

# Annual Report 2017-18

DEPARTMENT OF SCIENCE & TECHNOLOGY



Government of India  
Ministry of Science & Technology  
New Delhi



Supercritical CO<sub>2</sub> Brayton Cycle Test Facility

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## OVERVIEW

The Department of Science and Technology (DST) functions as the nodal agency to connect science and technology sector to Government verticals. DST provides the largest extramural research and development support in the country to strengthen national S&T capacity and capability through a competitive mode to scientists cutting across institutions and disciplines. This strategically important function mutually reinforces outcomes of our country's educational, scientific and industrial R&D initiatives and helps transform the S&T landscape of the country.

During the current financial year, a major exercise to review all ongoing schemes/programmes was undertaken. Starting from current financial year, all the schemes of the Department have been grouped into 3 broad heads viz. (i) Science and Technology Institutional and Human Capacity Building; (ii) Research and Development; and (iii) Innovation, Technology Development and Deployment. Reorganisation of schemes into 3 budget heads would facilitate greater flexibility to apportion funds depending on the priority of the programme within a particular broad scheme. Statutory Bodies viz. Science and Engineering Research Board and Technology Development Board and Autonomous Institutes and subordinate offices viz. Survey of India and National Atlas and Thematic Mapping Organisation have been classified as non-schemes.

While detailed report on activities carried out during the year is presented in the relevant chapters, some important highlights of the year are as following:

**Innovation in Science Pursuit for Inspired Research (INSPIRE)** scheme for attracting talented students to pursue study of science and careers in S&T provided opportunity to 50000 class XI students to participate in science camps; offered 10000 fellowships to pursue UG/PG courses in science; 1000 scholarships for pursuing doctoral research; and 200 faculty awards as assured career opportunity for post doctoral researchers.

**INSPIRE Award MANAK (Million Minds Augmenting National Aspiration and Knowledge)** was made operational during the year. Approximately 2.50 lakh nominations received from various schools across the country, out of which about 30,000 have been shortlisted for INSPIRE Award.

**Science and Engineering Research Board (SERB) approved over 1500 extramural R&D projects and 1700 fellowships** of various kinds to enable scientists to carry out research activities in their chosen areas of science and engineering.

Forty three distinguished scientists from 13 foreign countries have been selected to join the Indian institutions as **visiting faculty under Visiting Advanced Joint Research (VAJRA) Faculty** scheme which was announced last year.

A new scheme called **SERB Distinguished Investigator Award (SERB-DIA)** has been approved for

early identification and empowerment of exceptional scientists. The scheme aims to recognize and reward the young scientists who have performed extraordinarily well in the SERB supported projects.

**TARE (Teacher Associates for Research Excellence) Mobility Scheme** has been formulated and approved which aims to activate the latent and unused R&D capacity in our colleges and state universities that lack S&T infrastructure and culture.

**Interdisciplinary Centre for Cyber Security and Cyber Defence of Critical Infrastructures has been funded at** IIT Kanpur with a total cost of around Rs.15 crores to create India's first such research centre.

**Quantum Information Science & Technology (QuST)** programme initiated for developing next generation and futuristic computation, communication and cryptography systems.

A new national programme on Initiative to **Promote Habitat Energy Efficiency (I-PHEE)** to improve energy performance of buildings and cities has been launched. 31 proposals recommended for funding.

A new programme on the **Materials on Energy Storage (MES)** to support R&D activities aimed at innovative materials for energy storage and to build energy storage device with enhanced output for multifunctional applications was launched during the year. 18 research projects approved for funding.

**Science and Heritage Research Initiative (SHRI)** programme was launched by Hon'ble Union Ministers for S&T on October 13, 2017 during 3rd India International Science Festival (IISF)-2017 held at Chennai. It envisages to engage experts from diverse fields for data capture and analysis to form new collaborations and provide viable technology to address cultural heritage related issues.

**Fund for Improvement of S&T Infrastructure (FIST)** programme identified 195 proposals to consider financial support of varying quantum at a total budget of about Rs.258.36 Crores for 5 years.

As part of National Mission for Strategic Knowledge for Climate Change deliverables, **4 new Centres of Excellence** were launched during the year. These were positioned at IIT Delhi; BHU, Varanasi; IIT Kharagpur; and National Institute of Malaria Research (NIMR), Delhi.

**Eight Global Technology Watch Groups (GTWGs)** have been set up in the areas of Renewable Energy; Clean Coal Technology; Agriculture; Water; Sustainable Habitat; Green India; Enhanced Energy Efficiency; and Manufacturing.

**About 250 Joint International R&D projects and over 30 Joint workshops/seminars** were supported and more than 700 exchange visits took place under various International S&T Cooperation programs.

Utilization of twin **Indian beamlines, XRD2 and XPRESS** at the Elettra Synchrotron Facility, Trieste, Italy for scientific experiments to carry out frontline research in diffraction techniques by the Indian scientific community started during the year.

**Science and Technology Ministers Conclave** for neighbouring countries was organized as a part

of the 2017 India International Science Festival (IISF) held in Chennai from 13-16 October, 2017. The call announcement of the India Science and Research Fellowship (ISRF) 2017-18 was launched during the event.

**Improved Natural Draft Fixed Chimney Bull's Trench Kiln**, a Novel Energy Efficient Design with Zig-Zag Firing Technology was demonstrated by Punjab State Council for Science & Technology through DST supported project.

**InnoNano Research Private Limited** was licensed 13 patents from Nano Mission. The company established production facilities to take drinking water technologies to people. Arsenic removal technology has reached over 6,00,000 people now through various installations in arsenic affected regions of India.

**Vayujal Technologies Private Limited** has put together its first prototype on atmospheric water capture at 100 L/day scale using highly efficient surfaces. It has received initial funding needed for its activities.

Some important projects supported under **Water Technology Initiative** for development of convergent technology solutions are: Arsenic Removal Technology based on nanomaterials; Community Based Participatory Aquifer Management System for Providing Equity and Sustainability in Water Resource Management; Deployment of cost effective biosand filter technology for promoting community health by addressing incidence of waterborne diseases in select villages of Bihar.

Some of the projects supported for **Augmenting Water Quality** are: Development and Assessment of online Water quality monitoring technology; Demonstration of deep Ultra Violet Light Emitting Diode (UV LED) based on Aluminium Gallium Nitride (AlGaN) for water sterilization; Development of a polymer based sensor for detecting nitrate in water; and Development of Colorimetric sensor for Cr (VI) detection.

A consortium of three Government Entities, namely Bharat Heavy Electricals Limited (BHEL), Indira Gandhi Centre of Atomic Research (IGCAR) and National Thermal Power Corporation (NTPC) have formulated R&D project for development of **Advanced Ultra Super Critical (AUSC) Thermal Power Plant**. Two proposals have been supported by DST to IGCAR, Kalpakkam-BHEL to develop advanced rotor testing facility and spin test rig for Dadri Plant using indigenous material.

Two **Indo-UK Joint Virtual Clean Energy Centres** were launched at Second International Mission Innovation Smart Grids Workshop on 18th November, 2017. The two Indian consortia led by IIT Kharagpur and IIT Bombay will bring together experts from national laboratories, universities and industry in both India and the UK to leverage their expertise and resources to unlock the huge potential of clean energy technologies.

A major development programme for **production of Methanol** from various sources including Indian coal and CO<sub>2</sub> from thermal plants, steel plants etc. was initiated and 8 projects have been supported during the year.

For promotion of **innovation, entrepreneurship and start-ups**, 12 new Technology Business Incubators; 10 Accelerators; 3 Centres of Excellence and 10 PRAYAS Centres are being established. 11 new TBIs have been recommended for providing seed support to start-ups. The new and ongoing mechanisms supported by the Department offer incubation facility to approximately 2500 start-ups.

**Some of the innovative products developed by Start-ups** at various Technology Business Incubators (TBIs) supported by the department are: **AirOK Smart Purifier** by an incubatee at IIT Madras Incubation Cell that can be used in indoor environments. The company has raised Series A Investment (~Rs.12 crore) in November 2017; **Planys Technologies Pvt Ltd** founded by IIT Madras Alumnus and incubated at IIT Madras provides underwater robotic inspection and survey solutions using indigenously manufactured underwater robots; and **Incredible Devices** incubated at Foundation for Innovation and Social Entrepreneurship (FISE), Tata Trust, Bengaluru is a med-tech start-up that produces automated catheter reprocessing systems (CRS) for angioplasty procedures.

**Technology Development Board** signed 6 new agreements with private companies costing Rs.106.13 cr with TDBs contribution of Rs. 47.23 cr for commercialization of technologies. TDB's total commitment towards technology commercialization including ongoing projects during 2017-18 is around Rs.250 cr.

**Design and development of continuous Ragi mudde (finger millet ball) machine** has been worked out to develop a commercially viable prototype machine. The commercially viable machine was inaugurated by the Former Prime Minister Sri H. D. Deve Gowda.

Additional **Soil Micronutrients Testing facility** for analyzing Boron (B) and Molybdenum (Mo) in soil on colour chart basis by chemical reactions has been developed and incorporated in existing FERTICHECK™ soil testing kit.

In order to address challenge of water and room space heating in high altitude mountain region, **cost effective space and water heating device using solar energy and local resources has been developed.**

Technologies for utilization of waste materials like marble sludge, pond ash, foundry slag and construction and demolition waste were developed. 12 enterprises in Samalkha, Ludhiana and Jalandhar have adopted this technology successfully.

**Sustainable livelihood model for communities in Arid Region** of Western India (Little Rann of Kutch, Gujarat and Barmer, Rajasthan) through suitable technology interventions has been developed. Agro forestry farming system has been introduced to 657 families with cultivation of arid fruit crops

A mini cold storage with a capacity of 5MT was designed for small farmers using sub-cooling technique incorporating Phase Change Material (PCM) latent storage system and heat pipes for a Vapor Compression Refrigeration System (VCRS). The cold storage has an energy saving potential of 1200kW/year with a payback period of 6 years. Awareness program conducted under the project benefited 135 farmers of Thriuvallur and Kancheepuram Districts. The facility is also being utilized



under National Skill Development Corporation Curriculum for training Cold Storage Technician.

**CMC Stim**, a multi-channel, portable, hand-held, Stimulator for Functional Electrical Stimulation for patients with spinal cord injuries, cerebrovascular stroke and for cerebral palsy children, has been developed. The prototype is under extensive clinical trials.

**Twenty five autonomous institutions** nurtured by the Department occupy a very important place in S&T eco-system of the country. One of them, viz. Bose Institute in Kolkata, celebrated its centenary year during 2017. These institutions generated extremely valuable scientific and technological input during the year.

Some important events which took place during the year are:

- Launch of “nakshe” portal by the Minister of S&T on 250th Anniversary of Survey of India on 10th April 2017.
- Celebration of Technology Day on 11th May 2017 to commemorate India’s success in taking Science and Technology to the service of the country.
- The President of India, Shri Pranab Mukherjee inaugurated the Bose Institute’s Unified Campus at Salt Lake, Kolkata on 29th June 2017.
- A commemorative stamp was released to mark the occasion of 250 years of Survey of India by the Minister of State for Communication (I/C) and Railways, Shri Manoj Sinha on 22nd June 2017.
- The Minister of Science & Technology launched “Pt Deen Dayal Upadhyay Vigyan Gram Sankul Pariyojana” on 22nd Sept. 2017.
- India and UK Science & Technology Ministers reviewed the progress made in the India-UK partnership in science, technology and innovation on 1st Nov. 2017.
- India and Canada Technology Summit inaugurated on 14th November 2017.
- Mission Innovation Smart Grids Workshop was organised during 16-19th November, 2017 in New Delhi.
- The President of India, Shri Ram Nath Kovind, graced and addressed the closing ceremony of centenary celebrations of the Bose Institute in Kolkata on 29th November, 2017.

The Department has made every effort to utilize the allocated budget fruitfully to implement its planned activities and programmes during the year. This year was also an important year from the point of view of review of its ongoing programmes for continuation till 2019-20. Almost all the programmes and schemes of the Department have been reviewed during the year.



# SCIENCE & TECHNOLOGY INSTITUTIONAL AND HUMAN CAPACITY BUILDING

Enhancing scientific manpower is critical for the country in order to meet the ever increasing requirement of S&T manpower for teaching, research and private sector. Several initiatives and fellowship schemes are under implementation to attract and retain scientific manpower in S&T system. Special attention is also given to encourage engagement of women in scientific research. Training programmes for scientists and technologists working in the government sector to meet the challenges of national development and international competitiveness are some of the programmes towards human capacity building in S&T in the country. Strengthening science and technology infrastructure in academic and R&D institutions is an important activity of the Department to facilitate carrying out R&D by researchers in these institutions in their respective domains. Major outcomes of these activities are described in the following sections.

## 1. Innovation in Science Pursuit for Inspired Research (INSPIRE)

INSPIRE is one of the innovative programs of the Department for attraction of talent to science. The basic objective of INSPIRE is to communicate to the youth population of the country the excitements of creative pursuit of science and attract talent to the study of science at an early stage and build the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base.

**INSPIRE Award MANAK (Million Minds Augmenting National Aspiration and Knowledge)** scheme aims to communicate to the youth of the country the excitement of creative pursuit of science, attract talent to study science at an early age and help build the required critical human resource pool for strengthening and expanding the Science and Technology system and R&D base. This scheme is promoting research and innovation among students thereby fostering culture of creative thinking among them.

Under the INSPIRE Award MANAK scheme, in a Financial Year, ten lakh ideas are to be targeted from age group of 10-15 years or studying in standard 6 to 10 in more than five lakh middle and high schools across the country, out of which one lakh ideas are to be shortlisted for an initial award of Rs.10000/- for preparation of project/model/showcasing of idea and participation in the District Level Exhibition & Project Competition (DLEPC). From these, best ten thousand projects are to be selected for participation in the State Level Exhibitions & Project Competitions (SLEPC) and among SLEPC participants top one thousand projects are to be selected for National Level Exhibition

& Project Competition (NLEPC). The participants selected for National Level Exhibition will again envision an investment of Rs.50,000/- per participant, out of which Rs.25000/- will be towards providing useful educational material and another Rs.25000/- will be utilized for mentoring support for prototype development to these participants. The mentoring support will be provided by National Innovation Foundation (NIF) in coordination with reputed academic and technology institutions of the country. Top 60 projects will be selected for National Awards and will also be showcased at the Annual Festival of Innovations at Rashtrapati Bhawan, New Delhi.

In 2017-18, approximately 2.50 lakh nominations have been received from various schools across the country, out of which about 30,000 have been short listed for INSPIRE Award by National Innovation Foundation, based on the idea submitted during the nomination process.

**INSPIRE Internship** is the second component of the **Scheme for Early Attraction of Talent for Science (SEATS)**. It aims at providing exposure to young science students by organizing Science Camps either in summer or winter holidays. Around 50,000 students of Class XI pursuing science in any school are invited every year to participate at the 5 days' science camps and provided opportunity to interact with the Science icons from India and abroad including Nobel Laureates to experience the joy of innovations on an annual basis through INSPIRE Internship. Such Science Camps cover entire country in length and breadth i.e. from Leh to Kanyakumari and Goa to Arunachal Pradesh. However, these Science Camps have been organized with the cooperation of Academicians, Scientists, Academic Institutions, Research Institutions, Indian Army, Indian Navy as well as NHPC to motivate the national youth to take up science as a career. During the year 2017-18,

This year, Shri Mata Vaishno Devi University (SMVDU), Katra (J&K) organized the INSPIRE Internship Camp with an excellent logistical support of Army in this hostile terrain for the students of Ladakh Region. The residential camp was hosted by Ladakh Scouts Regimental Centre (LSRC) of 14 Corps.

**Scholarship for Higher Education (SHE)** aims for enhancement in rate of attachment of talented youth to undertake higher education in science intensive program by providing scholarships and mentoring through summer attachment to performing researchers. The scheme offers 10,000 Scholarship every year @ Rs. 0.80 lakh per year for undertaking Bachelor and Masters level education in natural and basic sciences for the talented youth in the age group 17-22 years. The main feature of the scheme is in mentorship support to carry out research during vacation period for every scholar through **INSPIRE Scholarship**. So far more than 80000 INSPIRE Scholars has been offered INSPIRE scholarship to pursue a career in sciences. During 2017-18, 22320 SHE scholarship applications for the academic year 2016 were processed, out of these, 10,000 INSPIRE scholarships have been offered to students including students from institutes like IISERs and IITs etc. based on their performance (top 1%) in + 2 examination of State/Central School Education Examination Boards and through competitive examination basis, for pursuing BSc, Integrated MSc and BS-MS courses in basic and natural sciences (Figure -1). The gender-wise distribution of the INSPIRE scholars is given at Figure -2. The

applications from students passed their Class XII examination in the year 2017 are being processed during the current year.

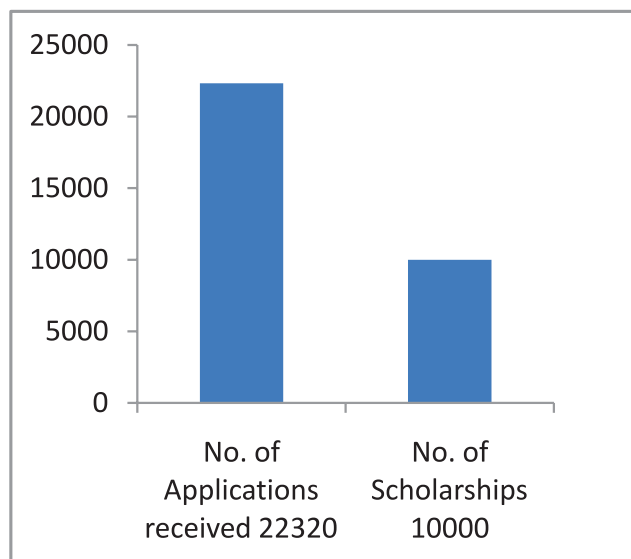


Figure –1: Scholarships Offered in 2017-18

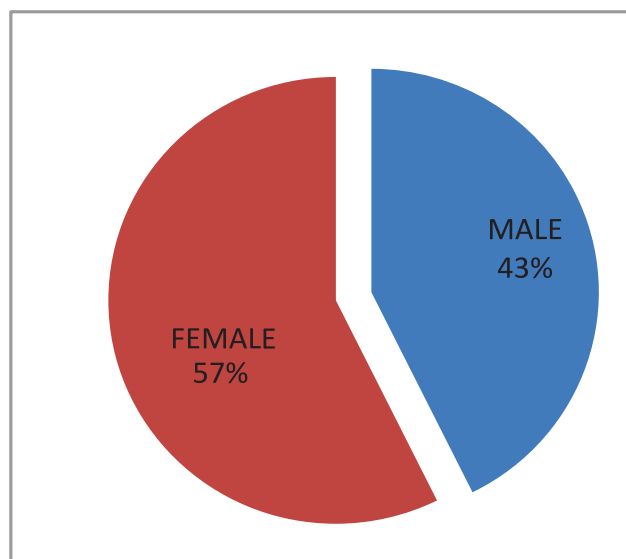


Figure – 2: Gender-wise Distribution

**Opportunity for Research Careers (ORC)** aims to attract, attach, retain and nourish talented young scientific Human Resource for strengthening the R&D foundation and base. It has two components. In the first component i.e. **INSPIRE Fellowship** in the age group of 22-27 years, it offers 1000 Fellowships every year for carrying out doctoral degree in both basic and applied sciences including engineering and medicine. In the second component i.e. **INSPIRE Faculty Scheme** assured opportunity for 200 post- doctoral researchers in the age group of 27-32 years through contractual and tenure track positions for 5 years in both basic and applied sciences area.

**INSPIRE Fellowship**, the first component of ORC is offered to students having secured 1<sup>st</sup> Rank in Basic & Applied Sciences including engineering, medicine, agriculture, veterinary at the University/ academic institute of national importance i.e. IITs, NITs, IISERs level examination as well as Inspire Scholars having secured 65% marks in aggregate at the MSc level which are eligible for admission to the PhD Program in any recognized University/Academic Institution in the country. The Fellowship shall be tenable maximum for 5 years (2 years as JRF and 3 years as SRF) or completion of PhD, whichever is earlier to pursue full-time PhD program. The Fellowship amount including the contingencies is equivalent to CSIR-UGC NET Fellowship and is governed as per GOI norms & regulations. So far, more than 6588 students are awarded the INSPIRE fellowship and are pursuing their Ph.D. in Basic & Applied Sciences including engineering, medicine, agriculture, veterinary at the University/ academic institute of national importance. Out of the awarded INSPIRE Fellows 61% are women (Figure - 3) and subject wise distribution of the INSPIRE Fellows is given at Figure -4. Nearly, 30-35% INSPIRE

Scholars have come back to pursue their doctoral degree in science after availing 5 years INSPIRE Scholarship to study science subjects. Out of 6588 INSPIRE fellowships, 1000 Fellowships have been offered during the year 2017-18 till December, 2017. Besides this, 9 INSPIRE Fellows working as Senior Research Fellows have participated at the 4<sup>th</sup> HOPE meeting in Japan. 25 INSPIRE Fellows working as Senior Research Fellows and 4 UK fellows are also selected for participating short-term research internship at the various Laboratories/Universities in UK and India respectively under Newton-Bhabha Joint Program of DST and UK.

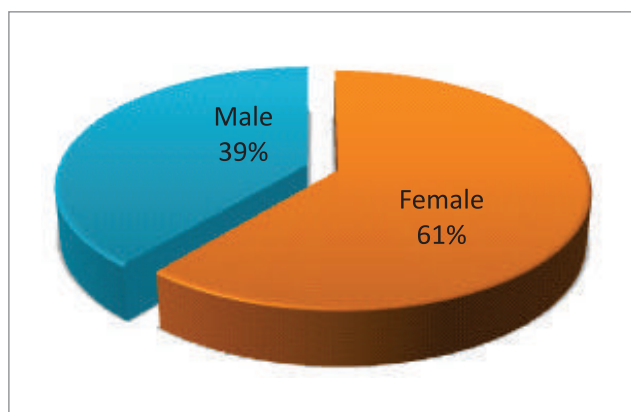


Figure-3: Gender-wise Distribution

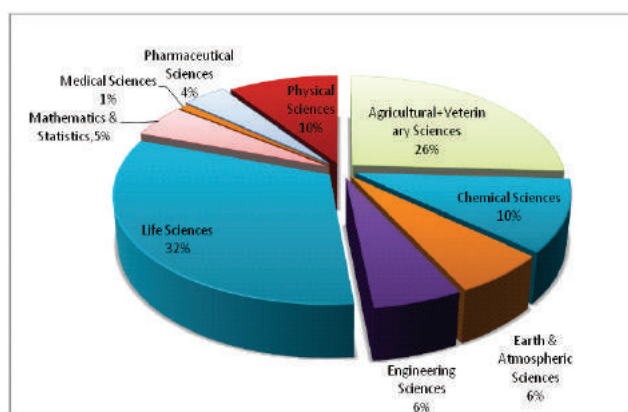


Figure-4: Subject-area wise distribution

**INSPIRE FACULTY AWARD**, the second component of **Opportunity for Research Careers (ORC)** assures opportunities for post- doctoral researchers in the age group of 27-32 years through contractual and tenure track positions for 5 years in both basic and applied sciences area including engineering, agriculture, veterinary and medicine. It aims at following:

- To provide attractive opportunities to young achievers for developing independent scientific profiles and launch them in fulfilling long term careers.
- Expected to augment high quality scientific manpower for scientific and educational institutions, specially the Central and State universities.
- While the vertical migration among students in different INSPIRE components would be encouraged, the Scheme would also provide opportunity to students for lateral entry into this component.
- This component would provide an independent research opportunity and not a guarantee for tenure positions after 5 years.

So far, more than 1234 fellows have been provided an opportunity to pursue post-doctoral research through contractual and tenure track position for 5 years in both basic and applied sciences area including engineering, agriculture, veterinary and medicine. Out of these, more than 996 awardees are



already positioned at various host institutes in India and remaining are in process of selecting their host (**Figure - 5**). The subject wise distribution of the INSPIRE Faculties is given at Figure – 6. During the current year 116 awards have been offered till December, 2017.

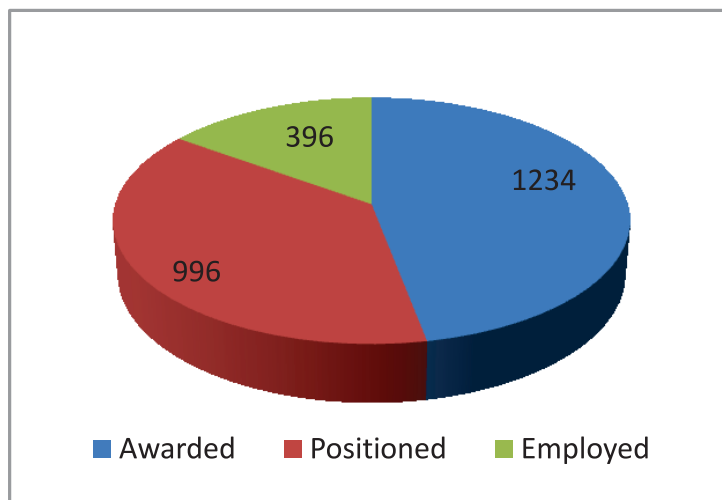


Figure- 5: Status of INSPIRE Faculty

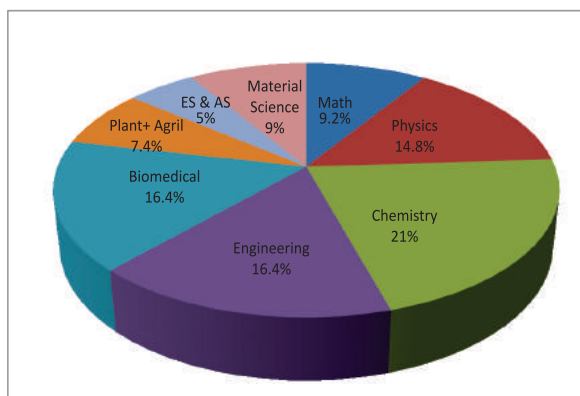


Figure-6: Subject-area wise distribution

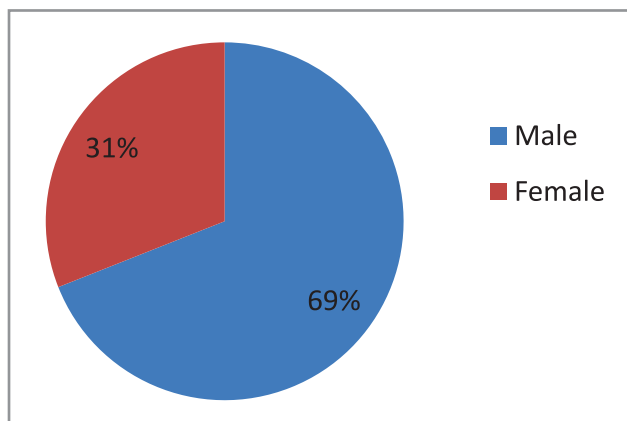


Figure-7: Gender-wise Distribution

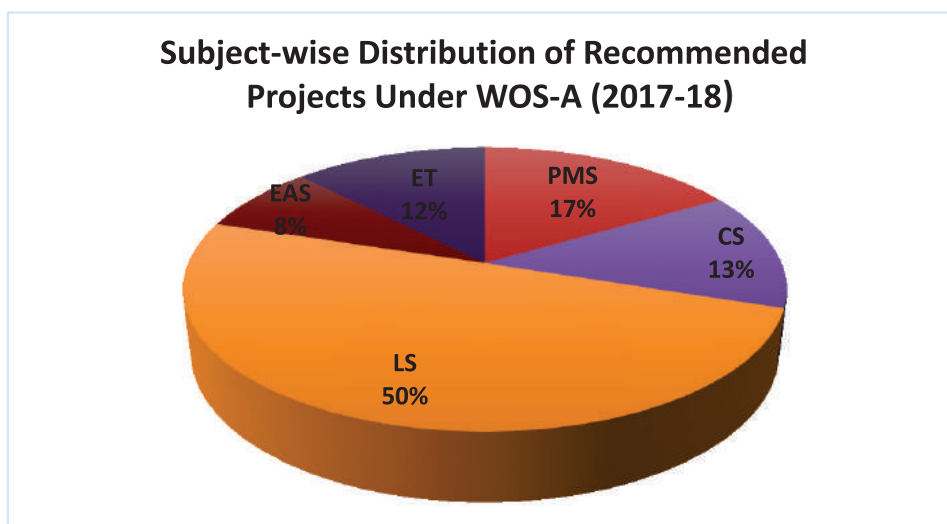
Nearly 30% candidates, who were pursuing research abroad, have come into the fold of this scheme. By now out of 996 Faculty Awardees positioned, since 1<sup>st</sup> round of selection, 396 (39.7%) have got their permanent positions at various academic/ research institutions in the country. Out of the positioned INSPIRE Faculty awardees 31% (312) are women beneficiaries **Figure -7**.

## 2. KIRAN (Knowledge Involvement in Research Advancement through Nurturing) Programme for Women Scientists

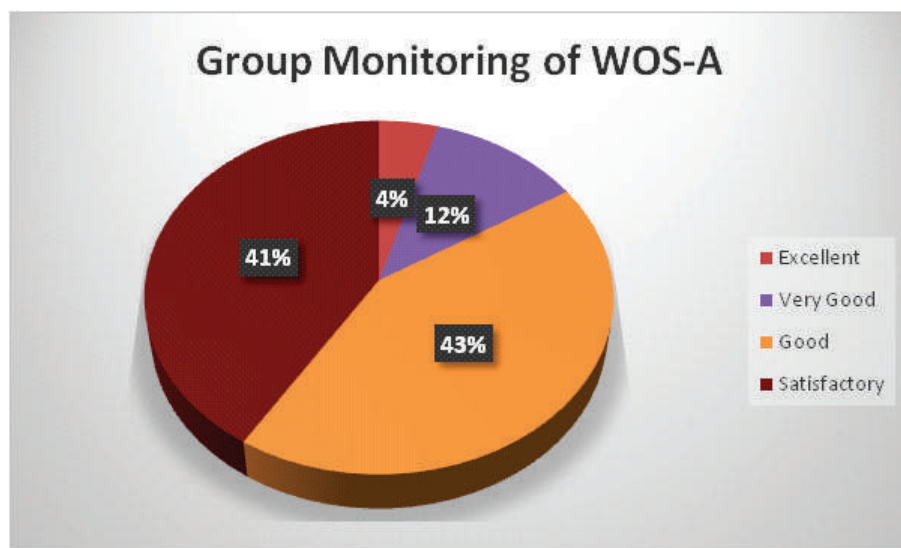
KIRAN embraces women-exclusive schemes of DST with the mandate to bring gender parity in S&T through gender mainstreaming. Different programs and components of KIRAN deal with various crucial issues (break in career primarily due to family responsibilities, self-employment, part time career, relocation, etc.) faced by women scientists in their career path. The achievements of various programs under KIRAN during the year 2017-18 are as follows:

### Gender Mainstreaming:

**Women Scientist Scheme-A (WOS-A):** WOS-A is aimed to provide opportunities to women scientists and technologists, who had a break in career, **for pursuing research in basic or applied sciences in frontier areas of science and engineering**. This year, DST received 876 new proposals and after extensive as well as intensive scrutiny, 283 projects (Life Sciences–140 out of 514, Chemical Sciences–40 out of 117, Physical and Mathematical Sciences–47 out of 90, Earth and Atmospheric Sciences–21 out of 34, Engineering Sciences–35 out of 121) were recommended. Subject-wise distribution of recommended projects is given in the Chart:



Approximately 40% selected women scientists received Ph.D. degree with the help of WOS-A during the tenancy of their project which proves the relevance and popularity of the scheme. During the year, 179 ongoing projects, funded under this component, were also monitored.



**Women Scientists Scheme-B (WOS-B):** Women Scientists Scheme-B (WOS-B) is an interesting component of KIRAN programs and focuses on S&T solutions of challenges/issues faced by society. On one hand, it provides opportunity to women scientists and technologists who had break in their S&T career and on the other it engages highly skilled brains to usher in change at grassroots level through their research and S&T interventions. WOS-B program is revamped and restructured to make it more meaningful for society and also to provide different kind of opportunity to women in S&T domain to think differently and address societal challenges through lab to land transfer of research, location specific research, etc. Three subject areas viz. Agriculture & Allied Sciences (AAS), Health Food & Nutrition (HFN) and Engineering & Technology Development (ETD) have been selected for support projects under WOS-B. Out of 885 project proposals received, 206 proposals were screened for presentation before 3 Subject Expert Committees (SECs), which eventually recommended 61 Projects for budgetary support (32 projects out of 86 in AAS, 14 Projects out of 45 in HFN and 15 Projects out of 75 in ETD) distributed in 24 States and Union Territories. 37 ongoing projects were also extended budgetary support.

### **Opportunity for Self-employment for Women Scientists & Technologists:**

**Women Scientists Scheme-C (WOS-C):** The scheme provides opportunity for women with mid-career break and having qualifications in S&T to pursue their career in Intellectual Property Rights (IPR). It prepares them towards self-employment by providing on-the-job training in the area of IPR. A total of 108 women joined the 9th batch of training. One month orientation for them was held at

New Delhi in May 2017 followed by 11 months long on-the-job training at various agencies located throughout the country. All the lectures during orientation program and recent developments in IPRs are posted on the module for updating beneficiaries. Almost 50% of beneficiaries have been gainfully employed in the area of IPR with IPR attorney law firms, government agencies, MNCs, KPOs, etc. out of the total women trained in 8th Batch in 2017. A few have started on their own like freelancing of IPR work, IPR Consultancy and IPR firm. For the first time, a formal placement process was started for 8th Batch trainees during May-July, 2017 which facilitated women in finding jobs in this area. While 8 women got employment with the efforts of placement process, 33 became registered Patent Agents with Indian Patent Office.



### **R&D Facilities in Women Only Universities:**

**CURIE (Consolidation of University Research for Innovation & Excellence in Women Universities):** “CURIE” was launched in 2009 to strengthen R&D infrastructure & facilities of women-only Universities. In the 1<sup>st</sup> Phase, 6 Women Universities have been supported for a period of 3 years on the basis of overall performance which are Banasthali University, Banasthali (Rajasthan); Avinashilingam Women University, Coimbatore; Sri Padmavati Mahila Vishvavidyalayam, Tirupati; SNDT Women University, Mumbai; Karnataka State Women University, Bijapur; and Mother Teresa Women University, Kodaikanal. This year, 2nd Phase CURIE support has been extended to Avinashilingam Women University, Coimbatore and Sri Padmavati Mahila Vishvavidyalayam, Tirupati. Proposal of Indira Gandhi Delhi Technical University, Delhi, the 7th such institution is also in process for CURIE support.

### **Societal Based Programs for Women:**

The mandate of Science and Technology for Women (S&T for Women) program is to empower women at grassroots level with inputs of S&T through development, adaptation, adoption, transfer, demonstration and replication of appropriate and successful technologies. The scheme focuses on

empowerment of women through sustainable livelihoods, besides addressing women health and nutrition. A number of programs are catalysed and supported under this scheme.

**All India Coordinated Research Projects:** The “All India Coordinated research project on Bio-Mass based Dryers” is in Phase II. TIDE, Malleswaram, is coordinating this project and Vivekananda Institute of Biotechnology, Sagar Island, West Bengal; SR Engineering College, Warangal and SAMBANDH, Odisha are main partner NGOs which received training at TIDE. These partners give training to local population. The main focus of this project is to establish biomass dryers at different locations in association with partner NGOs. The entrepreneurs from local community have been trained in dryer fabrication and on-site dryer construction and with this training and consultancy support they are starting their small enterprise.

**Natural Dying Technology:** There are large numbers of textile mills producing raw yarn in and around Dindigul District that gave idea to provide training of natural dye extraction from various plants to local community. The scientific protocol for extraction of these natural dyes is also not very complicated and local women are being trained in extraction technology of natural dyes from marigold flower, fountain flower, teak leaves, areca nuts, etc. Skilled women procure and dye raw yarn and then sell to nearby industries thus enhancing their income.

**Income Generation Program for Rural Women through High Value Medicinal Plants:** The project on ‘Income generation through medicinal plants in high altitude villages’ is being implemented in 4 clusters namely Chirbitiya, Ghuttu, Budhakedar, Pokhal clusters of Uttarakhand. Crops like Kuth, Kutki, Atees and Jatamansi were planted and more than 13 lakhs seedlings were distributed to more than 200 women farmers. The selection of beneficiaries is being done on the basis of land availability, irrigation facility and other standard parameters of the target population. For additional income generation, some of the cash crops like rosemary, oregano, kalajeera were also incorporated on experimental basis.

**Intensive cultivation, traditional dietary formulations and popularization of Moringa leaves among rural people in different agro climatic zones of Tamil Nadu:** In this project, women farmers from Dindigul, Madurai and Karur district of Tamil Nadu were trained in cultivation of different varieties of Moringa. They were also trained in leaf processing, food processing and formulation of value added products from Moringa leaves. More than 1000 kgs of Moringa leaves were harvested and converted into leaf powder. The value added products from Moringa leaves such as Idli mix, soups, chocolate and porridge, etc. were formulated and sold @ Rs.100 to 200 per kg.

**Enhancement and Securing Child Health through Capacity Building:** Visva Bharati, Sriniketan, Birbhoom is implementing this project and conducted number of nutritional awareness camps wherein more than 600 mothers were sensitized on child health and nutrition. Separate workshops on health and nutrition have also been organized for ICDS workers, ASHA workers and SHGs.

**Sensitization Meetings:** Two sensitization meetings have also been organized during 2017-18 to increase outreach of various activities under S&T for Women. The focus is on hilly regions (North and



North-East regions) of the country. Therefore, one meeting was conducted at Shimla in collaboration with H.P. State Council for Science, Technology & Environment, Shimla and other one at Agartala in association with Tripura State Council for S&T.

### **Training and Capacity Building:**

During 2017-18, Six training programmes have been organized under National Training Program specifically for women scientists & technologists working in Government covering multifarious themes. More than 150 women benefitted through these programs. Besides this, two hands-on workshops on 'Proteomics Approaches' have been organized at Banaras Hindu University, Varanasi wherein more than 50 young women scientists have been trained in this important methodology of Life Sciences.



### **Overseas Opportunity for Women in STEMM (New Component):**

***Indo-US Fellowship for Women in STEMM:*** This is a new initiative of DST which has been recently launched. This fellowship program will be useful for women Scientists & Technologists to work in state-of-the-art laboratories in USA, to understand their R&D functioning, learning from best practices, networking and to explore more collaboration at international level. Women Scientists working in permanent position or at temporary/contractual/ad-hoc position or doing individual projects are eligible for Indo-US fellowship. The fellowship tenure will be from 3-6 months maximum. The fellowship will include monthly stipend, return airfare, contingency, medical insurance allowance, conference allowance.

### **3. Swarna Jayanti Fellowship for outstanding scientists**

The **Swarna Jayanti Fellowships Scheme** was initiated by the Government in 1997-1998 to commemorate 50<sup>th</sup> year of India's independence. The objective of this Fellowship Award Scheme was to

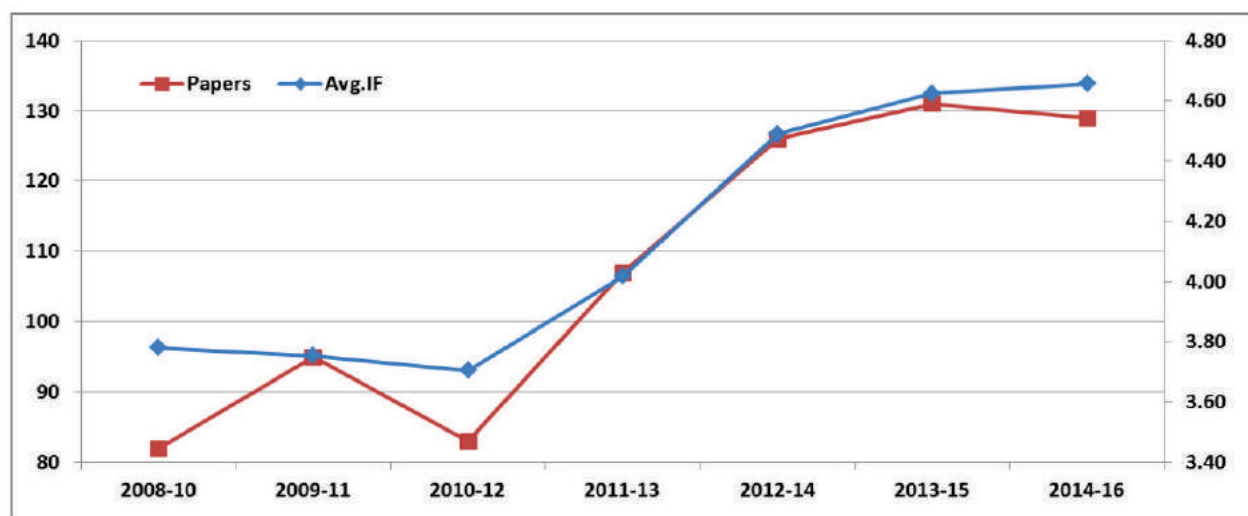


award talented young scientists, upto 40 years of age, in their innovative and inter-disciplinary projects that may result in providing leadership to the country in advanced areas of science and technology.

The Scheme was reviewed recently by a High Level Committee, constituted by DST. The Committee was highly appreciative of the achievements of the scheme and wanted the benchmarks to be maintained in future.

Since inception of the Swarna Jayanti Fellowships Scheme in 1997-98, 157 fellows (including fellows selected his year) have been finally selected for the award of the Swarna Jayanti Fellowship.

Preliminary analysis on number of publications and impact factor from the Fellows shows substantial growth during 2008 to 2016 as depicted below:



During the current year, 12 Fellows have been selected through a three-tier rigorous screening process, from 381 applications received. The list of fellows selected for Swarna Jayanti Fellowship for the year 2016-17 is as follows:

S. No.	Name and Address of Fellow	Discipline
1.	Dr. Shamik Sen, IIT-Bombay, Mumbai	Life Science
2.	Dr. Ashwani Kumar, CSIR-IMTECH, Chandigarh	Life Science
3.	Dr Dipyaman Ganguly, CSIR-IICB, Kolkata	Life Science
4.	Dr. Anish Ghosh, TIFR, Mumbai	Mathematical Science

S. No.	Name and Address of Fellow	Discipline
5.	Dr. Rahul Banerjee, IISER-Kolkata, Mohanpur	Chemical Science
6.	Dr. Subi Jacob George, JNCASR, Bengaluru	Chemical Science
7.	Dr. Aweek Bid, IISc, Bengaluru	Physical Science
8.	Dr. Suvrat Raju, ICTS-TIFR, Bengaluru	Physical Science
9.	Dr. Prateek Sharma, IISc, Bengaluru	Physical Science
10.	Dr. KanteshBalani, IIT-Kanpur, Kanpur	Engineering Science
11.	Dr. Saurabh V Lodha, IIT-Bombay, Mumbai	Engineering Science
12.	Dr. Suryendu Dutta, IIT-Bombay, Mumbai	Earth&Atmospheric Science

#### 4. Cognitive Science Research Initiative

Cognitive Science Research Initiative (CSRI) is a novel effort of DST to promote research in this challenging domain as study of cognition, brain and related fields is one of the focus areas of 21<sup>st</sup> century. This Initiative supports variety of programs like multi-centric mega projects, individual projects, Post-Doctoral Fellowship (PDF) and also facilitates infrastructure development, sharing of experiences and networking activities.

During the year, 37 individual projects and 7 CSRI-PDF projects have been given financial sanction. Budgetary support has also been extended for 30 ongoing projects. Next Call for proposals was also made in second half of 2017 against which DST received 469 project proposals and 80 applications for PDF and the process of scrutiny, shortlisting and recommendation by Expert Committee has been completed. Extension of budgetary support to the recommended case is on the anvil. The highlights of some of the completed projects are:

***Social Communication System for Children with Autism Spectrum Disorder (ASD):*** The project is aimed to develop intelligent, adaptive and individualized social communication platform. This smart system predicts anxiety level of ASD child based on viewing pattern and eye physiology and subsequently based on one's anxiety level and performance in social task, the system responds adaptively. It is found that Anxiety-sensitive (AS) system developed in this project is better than Performance-sensitive (PS) System as AS system brings greater improvement in performance score of ASD individual. It also improves looking pattern of ASD affected individual during social communication and brings greater reduction in blink rate. This system is potent to contribute to scaffolded learning of social communication while maintaining the comfort level of individuals with ASD.



**Virtual Reality Based Gaze-sensitive Social Communication System**

***Effect of Auditory-Cognitive Training in Individuals with Sensory-neural Hearing Loss:*** The main focus of this project was to investigate the role of working memory in auditory information processing and to evaluate the efficacy of auditory alone and auditory-cognitive training program on range of auditory and cognitive skills. Thirty-Seven participants of age range of 40-65 years with mild to moderate sensory-neural hearing loss were recruited and received structured training in auditory-cognitive and auditory mode alone. It was observed that both trainings improved auditory skills including speech perception in noise. However, only auditory-cognitive training resulted in improvement in working memory skills. In auditory-cognitive training, activations were seen in posterior superior temporal gyrus, posterior middle temporal gyrus and middle superior gyrus. Larger activation of this brain region indicates that auditory-cognitive group had recruited more brain regions to access phonology compared to the auditory group. Stronger activation of this region indicates better sensory-motor integration. Training on auditory-cognitive skills activated more top-down process to compensate the distorted input from the periphery and resulted in better performance and better functional plasticity of the brain compared to auditory training.

### **Science and Technology of Yoga and Meditation (SATYAM)**

Science and Technology of Yoga and Meditation (SATYAM), is a new initiative of DST, which was conceived and initiated in 2015-16. It is aimed to foster scientific research on the effects of yoga and meditation on physical & mental health besides on cognitive functioning in not only in patients with disorders with a focus on validation but also healthy people. Against the second Call

for Proposals, made in 2016, DST received 257 research proposals from across the country. After intensive scrutiny, 77 projects were ‘screened’ in and Principal Investigators of these proposals were called for presentation before a Task Force constituted for this purpose. Finally, 19 Projects have been recommended for financial support. The Call for Proposal for 2017-18 was also made in second half of 2017 and DST received 214 proposals. These proposals have been scrutinized and the screened in proposals examined by the Task Force which has made its recommendations. The budgetary support to the recommended cases will be extended during 2018-19.

DST has provided financial assistance to following Conferences and Workshops: Summer School on ‘Statistical and Machine Learning Approaches in Neuroimaging and Cognitive Neuroscience’; International Conference on ‘Chemistry of Yoga’; Fourth Annual Conference of the Association for Cognitive Science (ACS); International conference on Yoga Tradition and Application; National workshop on “Experimental methods in cognitive neurosciences; and Conference on “Brain Modes 2017”.

## 5. Capacity Building of R&D Institutions

### 5.1 Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions (FIST)

FIST program is the major infrastructure augmentation program which was launched by the Government in FY 2000-01. The Program facilitates support towards augmenting higher education and research largely at the university and academic sectors by augmenting basic infrastructural facilities for teaching as well as for conducting research in basic or applied science areas.

The Program is currently operated in competitive mode of support at three levels i.e. Level 0, Level I and Level II covering six subject areas (Life Sciences, Physical Sciences, Chemical Sciences, Engineering Sciences, Earth & Atmospheric Sciences, Mathematical Sciences) and PG Colleges. While support under Level 0 is provided to all PG Science as “Colleges as a whole” mode, supports under Level I and Level II are meant for all Sciences and Applied Sciences departments including Medicine, Pharma, Agriculture, Veterinary etc. of Universities and Academic institutions. The financial support circumscribes four basic purposes i.e. Equipment, Networking & Computational Facilities, Infrastructural Facilities and Maintenance. The quantum of support is limited to Rs 1.50 Crore, Rs 3.0 Crore and Rs 10.0 Crore for Level 0, Level I and Level II respectively, depending upon the type of department or college and quality of research/teaching imparted.

#### Highlights of activities during 2017-18

The 17<sup>th</sup> round of operation was initiated and fresh proposals were invited in May 2017 through advertisements from eligible S&T related departments from universities and

academic institutions as well as PG Colleges for considering support under this program. During this year, 581 new proposals in all levels (L0- 227, Level I-235 and Level II –119) were received and finally 195 proposals (L0-56, Level I-167 and Level II-25) were identified through the available mechanism of the FIST Program to consider financial support of varying quantum's at a total budget of about Rs.258.36 Crores for 5 years. Apart from, the process of evaluation and identification of new proposals to consider of support, progresses of 184 ongoing projects at departments and PG Colleges were also reviewed. DST also adopted some pro-active measures towards encouraging research at the College level by making provision of additional support to the performing colleges.

Besides the new proposals, grants to the ongoing projects were also released during this year. So far, nearly 2475 S&T departments spread over 650 Academic Institutions and PG colleges (Level 0-353, Level I-1892 and Level II-230) have been supported with a total investment of Rs. 2380 Crores.

### **Outcome**

Ever since its beginning, the FIST Program has provided sustainable funding over last fifteen years that has made deep impacts in many departments across the country to carry out advanced research in contemporary areas of science and technology and also set-up modern teaching facilities. The researchers are benefited so that their potential is tapped for scientific advance and innovation. FIST Program has been instrumental in establishing state-of-the-art facilities for performing high end research and have thus benefited academicians and researchers across the country. Some of the major facilities installed/recommended for support under the Program are: Automated DNA Sequencers, Ultracentrifuges, FACS, Scanning Probe Microscope, Molecular Imaging System, Liquid Nitrogen Plant, Liquid Helium Plant, High Resolution Powder X-ray Diffractometer, Single Crystal X-ray Diffractometer, 400 MHz & 500 MHz FT-NMRs, Mass Spectrometer, Universal Testing Machines (UTMs), EPMA, Confocal Microscope, Field Emission Scanning Electron Microscope, High Resolution Transmission Electron Microscope, Protein Sequencing Platform, Atomic Force Microscope, Scanning Tunneling Microscope, HRMS etc.

FIST for PG Colleges has been initiated by Department of Science & Technology to support Post Graduate Science Colleges to improve the Research as well as Post Graduate teaching. FIST PG College scheme aims to improve and nourish the Research potential in the faculties and also to improve practical training to students by providing access to specialized infrastructure. So far, 353 colleges have been supported under this programme across breadth and width of the country. The scheme provided considerable support to various colleges which is including Science and Engineering Colleges. The support has strengthened infrastructure in laboratories, library, teaching aids, and networking. Some of the prestigious PG Colleges supported under FIST are National College, Tiruchirapalli,

Tamilnadu; St. Aloysius College, Mangalore, Karnataka; Providence Women’s College, Kozhikode, Kerala; Loyola College, Chennai; Ramakrishna Mission College, West Bengal; Institute of Home Economics, New Delhi; DAV College, Jalandhar; PSG College of Pharmacy, Coimbatore; Christian Medical College, Vellore; Bihar Veterinary College, Bihar; and College of Engineering, Pune.

## 5.2 Promotion of University Research and Scientific Excellence (PURSE)

**PURSE** is a proactive measure to build the research capacity of performing Indian Universities. The main objective of the scheme is to pro-actively support for strengthening the R&D base of the performing Universities in the country with adequate financial support and associated flexibility. It is formulated on the basis of 10 years aggregate publications and h-index towards creating and nurturing the research ecosystem among performing universities in the country

Using transparent criteria, forty-four (44) performing universities whose h-index ranging from 56 to 26 have been supported ranging from Rs. 30.0 Crores to Rs. 6.0 Crores for 4 years’ period based on the study report by NISTADS “Status of India in Science and Technology” as reflected in its publication output in Scopus International Database, for the three study periods 1996-2006, 1998-2008 and 2000-2010. However, the criteria has been revised recently as given below:

**Table- 1: Criteria for Support in PURSE Program**

Initial h-Index (2008-2015)	Revised h-index (2016-onward)	Research Grant for 3 years
More than 50	More than 70	<b>Category A</b> (Rs 30.0 cr.)
40-49	60-69	<b>Category B</b> (Rs 15.0 cr.)
30-39	50-59	<b>Category C</b> (Rs 9.0 Cr.)
26-29	45-49	<b>Category D</b> (Rs 6.0 cr.)

### Highlights of activities during 2017-18

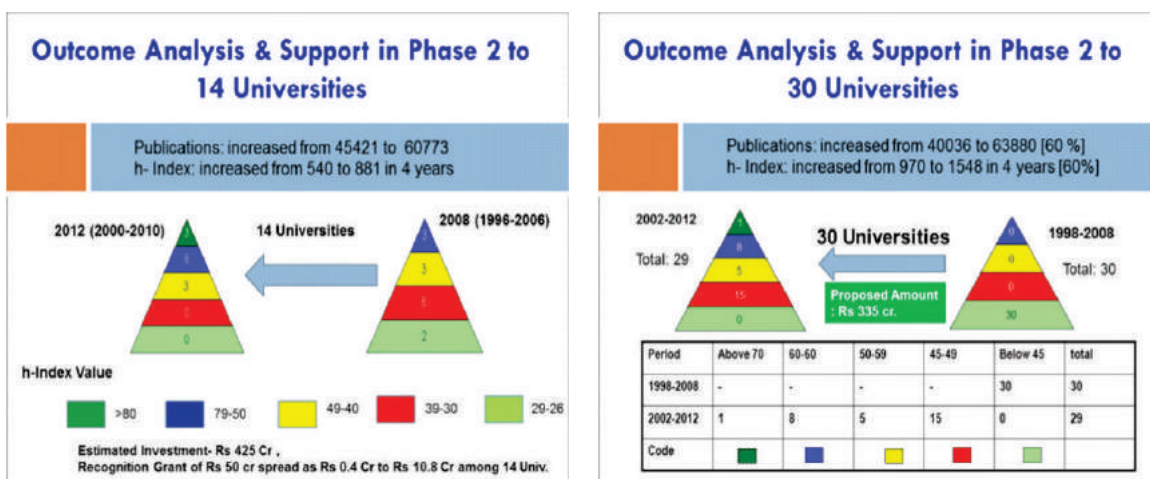
DST had commissioned a study with Elsevier using SCOPUS database for studying performance of universities and academic institutes for the period 2002-2012. Based on the recommendations of the Program Management Board (PMB) on PURSE, 30 Universities including 6 New Universities have been identified and considered of varying quantum of support depending upon the revised h-index value. 6 Universities supported in previous round based on their performance have also been dropped now. The funds to strengthen the research infrastructure have been released in the current financial year. The support has been provided to acquire research equipment, research man-power cost, augmentation



of computational facilities, establishing research infrastructure, acquiring research consumables, fund for travel, organizing workshops and conferences, contingencies and maintenance of the facilities.

### Outcome

PURSE Scheme has provided a triggering mechanism for promoting publication oriented research in the University sector deploying evidence based approaches. There has been significant increase in R&D outputs in PURSE supported Universities. Performance for the period of 1996-2006 and 2000-2010 for Set of 14 Universities has also been compared. Publications of this group of 14 Universities have increased by nearly 34% i.e. from 45421 to 60773 and h-Index increased from 540 to 881 in 4 years. Similarly, the increase in publications is about 60% i.e. from 40036 to 63880 for the period of 1998-2008 and 2002-2012 for another set of 30 Universities and h-Index also increased from 970 to 1548 in that corresponding period of 4 years.



An investment of Rs. 1220 crore was planned for 44 performing Universities identified and supported 14 Universities for 2 rounds and 30 Universities for 1 round since FY 2009-10 to till date and an amount of about Rs 700 Crores has already been made available so far to these Universities.

DST has re-constituted Program Management Board (PMB) this year to guide the DST on PURSE and to review the progress in PURSE Project at performing universities. Regular reviews of the PURSE Projects at various Universities have been performed. The monitoring has been further strengthened by introducing recently another review process at the University site under the chairmanship of the concerned Vice-Chancellor of the University. The meetings have been conducted at University of Mumbai, Mumbai; Jadavpur University, Kolkata; Savitribai Phule Pune University; University of Rajasthan;



Punjab University, Chandigarh; and Banaras Hindu University, Varanasi to review the implementation of PURSE.



**IMAGE 800 facility at the Department of Pathology, BHU, Varanasi.**



**AAS Facility at Department of Botany, Punjab University, Chandigarh**

### **5.3 Sophisticated Analytical Instrument Facilities (SAIF)**

Many academic institutions including Universities in the country still lack the existence of specialized facilities to carry out both basic and advanced research in contemporary areas of science and technology. The Department has thus set up Sophisticated Analytical Instrument Facilities (SAIFs) in different parts of the country to provide services of the facilities of sophisticated analytical instruments to the researchers in general and specially from the institutions which do not have such instruments and enable them to pursue R&D activities requiring such facilities and keep pace with developments taking place globally.

At present, there are 17 Nos. Sophisticated Analytical Instrument Facility (SAIF) Centres viz. at IIT, Chennai; IIT, Mumbai; CDRI, Lucknow; Panjab University, Chandigarh; NEHU, Shillong; IISc, Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; CVM, VallabhVidyanagar; Sophisticated Test & Instrumentation Centre (STIC), Kochi; IIT Patna; IEST, Shibpur, Guru Ghasidas University, Bilaspur; Shivaji University, Kolhapur; University of Rajasthan, Jaipur; MG University, Kottayam; and Karnataka University, Dharwad, and these are being supported by the Department of Science and Technology.

The SAIFs are equipped with instruments such as Nuclear Magnetic Resonance Spectrometer, Scanning Electron Microscopes, Transmission Electron Microscopes, Secondary Ion Mass Spectrometer, ICP, EPR Spectrometers, Mass Spectrometers, X-ray Diffractometers and Thermal Analysis Systems etc. to meet the needs of research workers in various areas of Science & Technology. The instrument facilities at the SAIFs are accessible to all the users irrespective of whether they belong to the host institutes or are from outside the host institutes and are being used extensively by the researchers from all parts of the country.

### a) Instrument Facilities Strengthened in Various SAIFs

Instrument facilities were strengthened during the year in the areas of Electron Paramagnetic Resonance Spectroscopy, High Resolution Mass Spectrometry, Elemental Analysis and Thermal Analysis to meet the current and emerging needs of research community.

Some of the Major instrument facilities installed at the SAIFs during the year are Orbitrap High Resolution Mass Spectrometer at IIT, Mumbai, 600 MHz FT-NMR Spectrometer at IIT, Mumbai; 500 MHz FT-NMR at Panjab University, Chandigarh and at IISc., Bangalore with Cryo Probes and 400 MHz FT-NMR Spectrometer at Karnataka University, Dharwad; GC- MS/MS, ICP-OES with Microwave digester, Particle Size analyser with Zeta Potential at to make them more useful to the user



HR-ORBITRAP LC-MS at SAIF, IIT Mumbai



600 MHz NMR at SAIF, IIT Mumbai.

Some of the facilities like SAXS facility at IIT, Bombay, Mumbai; XRD Powder at Gauhati University, Guwahati and at Karnataka University Dharwad; 400 MHz FT-NMR Spectrometer and High Resolution Mass Spectrometer at IEST, Shibpur; 500 MHz FT-NMR Spectrometer at IIT, Patna; Field Emissive Scanning Electron Microscope and LC-MS/MS at M.G. University, Kottayam; SEM with EDS/WDS at Karnataka University, Dharwad are being added to further strengthen them.

### b) Analysis Provided/ Usage of the facilities

The instrument facilities at the SAIFs are meeting the analytical needs of scientists for materials characterization including qualitative/quantitative elemental, molecular/compound analysis/ characterization, structure determination, microstructure analysis and surface topographic studies etc., and enabling them to pursue research in various frontline areas of S&T.

About 2,000 research papers (partial number) were published by the users of the SAIFs

with the support from the facilities provided by the SAIFs during the year. About 17,000 researchers from all over the country utilized and benefited from the facilities provided by the SAIFs during the year. These included research workers from almost all the universities in the country. About 90% of the users are from academic sector. These SAIF Centres have analysed about 1,25,000 samples during the year and earned a revenue of about Rs 9.5 crores in this year.

**c) Workshops/Training programs/Short term courses organized**

Eight Workshops and trainings were organized by the SAIFs during the year towards the use and application of various instruments and analytical techniques to create awareness among the research community about them and on maintenance/repair/operation of the instruments for technicians. About 300 participants (50-60 each) attended these workshops/trainings. Some of the workshops/training programs/ short term courses organized are as follows:

1. Short term course on Single Crystal XRD was organized for Research Scholars of IIT Madras and for IIT Patna.
2. A summer training course in Electron Microscopy and Electron Microscopy for AIIMS M. Bio Tech 1<sup>ST</sup> Year students was organized at AIIMS, New Delhi.
3. A Workshop cum Hand on Experience on i) Spectroscopic and Chromatographic Techniques and ii) a workshop on FT-NMR Spectrometer was organized by SAIF at SICART Vallabh Vidhyanagar, Gujarat.
4. At SAIF Panjab University, Chandigarh, a Workshop on i) Confocal Microscopy, ii) X-Ray Absorption Spectroscopy materials inside analysis tools and iii) an International Workshop on Neuropharmacology of addiction and on Small Angle X-ray Scattering was organized.
5. The meeting of all SAIF Coordinators was held at SICART, Vallabh Vidyanagar in the month April 2017 and discussed various issues on SAIF Program.



SAIF Coordinators Meet at SICART, Vallabh Vidyanagar held on 22.04.2017.



## 6. State Science & Technology Programme

This Department has been playing a proactive role by encouraging various S&T related interventions at the State level to achieve specific S&T objectives. State S&T Programme (SSTP) provides core support to the S&T councils besides providing funding support for location specific research and technology development and demonstration. The programme also supports studies on local S&T related issues, surveys etc.

During the year, 28 State Councils for S&T were supported and Rs. 23.04 Crore was released as core grant and 25 new projects/ programme were supported to address the State specific S&T challenges, S&T surveys and studies through S&T intervention.

Some illustrative examples of the activities supported under the programme are as following:-

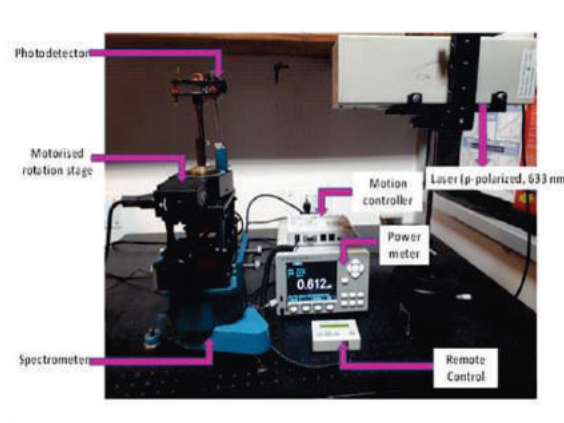
### 1. Demonstration and Adaptive Research of Biogas Purification & Bottling Technology for Vehicular Application

A Biogas Purification & Bottling Technology for Vehicular Application developed at Indian Institute of Technology, Delhi which is having the capacity of generation of 100 m<sup>3</sup>/day biogas is in process of demonstration and commissioning at Bhopal.



### 2. Validation and improvement of indigenously developed table top Surface Plasmon Resonance (SPR)

Under the project, eight sophisticated low-cost SPR systems were fabricated at Delhi University in collaboration with M/s Optiregion. The systems were delivered and demonstrated at eight research Institutes/Universities for validation of the technology. Training was also provided to the designated members from these institutes and based on the feedback received from these Institutes/Universities, required modifications have also been made in the technology.

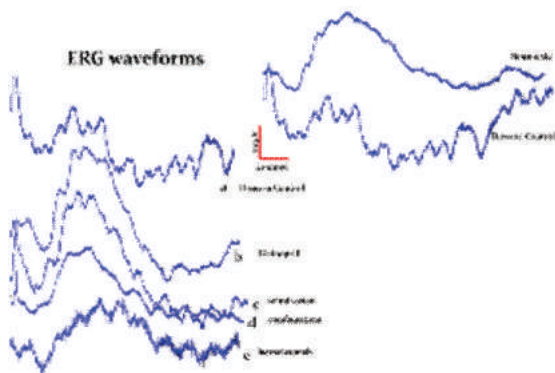


Developed SPR measurement system utilizing a precision rotation stage

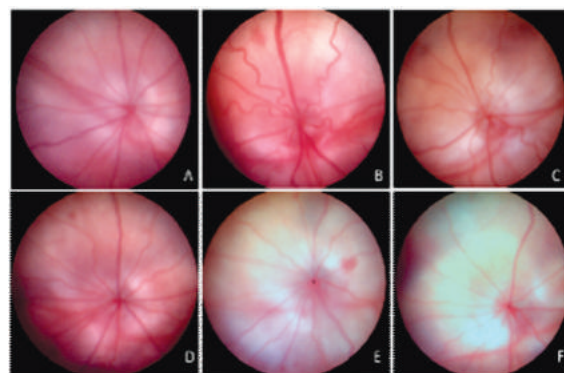
### 3. Evaluation of Pharmacological interventions targeting Retinal Renin Angiotensin System in Retinopathy of Prematurity

During this study supported to AIIMS, New Delhi, for the first time, the involvement of Retinal Renin Angiotensin System (RRAS) has been studied in babies suffering from retinopathy of prematurity (ROP) with the help of Oxygen Induced Retinopathy (OIR) model in rat-pups, the role of RRAS system has been reproduced and this model was subjected for pharmacological interventions.

Animal studies revealed angiotensin converting enzyme inhibitor and angiotensin receptor blocker were able to regulate RAS system to prevent the pathological vascular and functional changes in the retina of the experimental model. Pharmacological levels of injected drugs (lisinopril and telmisartan) were detected in the retina of the OIR pups.



ERG wave study



Fundus images

### 4. Development and Evaluation of Nanocarrier for Enhanced Antimicrobial Activity of Anacardic acid Against Human and Plant Pathogens

During the study, Anacardic Acids were extracted and isolated from the cashew nut shells and the isolated Anacardic Acids (AA) were characterized using FT-IR, NMR, HPTLC, and HPLC etc. The Drug-Excipient compatibility studies were performed to check the compatibility of Anacardic Acids with excipients used to prepare nano-formulations. Such a nano-formulation was made with solid lipid nanoparticles and Anacardic Acids by encapsulation method and the antimicrobial study against *Xanthomonas oryzae* (Bacterial Leaf Blight) was performed. The study showed significant antimicrobial activities by the encapsulation of Anacardic Acids by solid lipid nanoparticles.

**5. Demonstration of Improved Natural Draft Fixed Chimney Bull's Trench Kiln, a Novel Energy Efficient Design with Zig-Zag Firing technology at Punjab State Council for Science & Technology, Chandigarh, Punjab.**

The study successfully developed a new Hybrid Kiln having features of both natural draft and induced draft kiln with more efficiency at less fuel consumption. The patent has already been filed for this "New Hybrid Kiln with zig-zag technology". The kiln can work on natural draft as well as on induced draft with a unique switch over mechanism. Hybrid kiln reduces the energy consumption as well as maintains the required production level throughout the operating season of brick kilns.



**New Hybrid Kiln with zig- zag technology**

**6. Establishment of tribal resource centre for Chakrotatribe by at Himalayan Environmental Studies & Conservation Ambiwala, Dehradun Uttarakhand-248001**

A **Tribal Resource Centre (TRC)** has been established for transfer of resource based rural technologies and knowledge at Rikhad Village, Chakrata, District Dehradun. This Centre will also help the villagers immediate surroundings of six villages for technological intervention on their daily needs. The whole village has been served with toilets, bathrooms, dustbins, soak pits and improved drainage brining complete sanitation in the village. Processing and production facility centre has been developed with community participation for utilizing local Agri-horti produce.





### Important meetings:

State S&T Councils annual meet was organized at Gujarat Science City, Ahmadabad, Gujarat during 27<sup>th</sup>-28<sup>th</sup> April, 2017. The meet was attended by the member Secretaries/ Directors/ Director Generals of the Councils. The recommendations of the meet were helpful in preparing document for the Standing Finance Committee for its continuation.

## 7. Policies for S&T

The Department of Science and Technology is mandated to develop and deliver public policy support for the promotion of research and development in the country. Policy Research initiative of the Department is engaging itself with stakeholders, national and international experts and others to develop policy related papers.

DST has recognized the importance of evidence-driven research and analysis in underpinning the effective achievement of the objectives of this policy and has established DST-Centres for Policy Research (CPRs) in various academic institutions across the country. These centers are engaged in targeted research in number of key areas relevant to the country, train young scholars in STI policy research, and contribute towards better STI policy making by providing inputs to Government's agencies/departments. Apart from this, STI Fellowships at post-doctoral level were announced to generate a critical mass of policy researchers. It will provide an opportunity to develop the skills of young-scientists and engineers who are interested in engagement with the STI policy domain and/or as STI policy researchers.

A discussion cum review meeting of the above Centres was organised at Panjab University, Chandigarh (August 17, 2017). During the meeting, discussions were made on the progress in the various research activities that have been entrusted with the five DST-Centres for Policy Research. A brainstorming discussion on need of STI policy studies related to issue of women in science was also held. Apart from Centre' Coordinators and Experts, representatives from women only universities were present

and participated in the discussion. Representatives from Women Only Universities were sensitized about STI Policy 2013 and issue of Gender parity in Science. A detailed discussion was made on the role of women in science and thereof active contribution towards national priorities through STI.



**A Roundtable Meet on Developing Country Specific Models for the Promotion of R&D via PPP Mode at Panjab University, Chandigarh (August 19th, 2017).**

Following two research studies completed by Policy Research Centre at EDII, Ahmedabad were launched by Dr. Harsh Vardhan, Hon'ble Minister for S&T on May 11, on occasion of National Technology Day held at Vigyan Bhawan, New Delhi.

- i) Effectiveness and Efficacy of Incubators in India and Benchmarking Indian Incubators with best Global Practices in Incubation Space”, and
- ii) Inclusion of Technically Qualified Women with Mid-Career Break into Technopreneurial Activities – Understanding the Potential and the Constraints.



**Release of Research Studies by Hon'ble Minister of S&T**

During the year, the Centre for Policy Research at IIT Delhi continued its ongoing work on research related to systematic mapping of the state and patterns of innovation in the country (in relation to specific national STI policy objectives, and in relation to other countries). It also continued to analyze the organization and functioning of the current systems of innovation in the country (at the macro scale as well as within specific sectors and regions) and the factors that promote or inhibit successful innovation outcomes. A study report on the '*Role of incubators and public policy*' was also published. The study recommends actionable steps for policy makers, incubator managers, and other actors to address four key aspects that can strengthen publicly-funded incubators and S&T-based entrepreneurship: (a) Broadening and deepening the Pipeline of S&T talent; (b) purposely aligning strategy, design and operations of the incubator with the context of the incubator; (c) addressing the specific market failures; and (d) system-level coordination and assessment to exploit synergies between individual incubators that are not undertaken by any single entity. The study on the Indian scientists who came back to the country from post-doctoral programs overseas was also completed by the Centre. The study featured in Nature India (<https://www.natureasia.com/en/nindia/article/10.1038/nindia.2017.82>) on 14<sup>th</sup> July, 2017. Apart from 10 research article publication, many seminars, workshops were jointly organized with the MIT-Tata Centre for Technology and Design and the Tata Trust, Stanford University; Indian Statistical Institute, Kolkata; Indian Council of Medical Research; and Science and Engineering Research Board (SERB).

Centre at Panjab University, Chandigarh organised several Round Table Meets on Industry-Academia issues. Centre at BBAU, Lucknow conducted field survey for STI interventions in the States of Uttar Pradesh, Gujarat, Telangana and Maharashtra in the areas of water, health and agriculture with respect to inclusion criteria.

Centre at IISc Bangalore has developed a methodology for data collection for studying the research performance of Indian institutions in various scientific disciplines. Working papers for Chemistry Research in India, Scientometric analysis of research in engineering, Strengthening India's industrial R&D capabilities, have been drafted. A Study of the National Institutional Ranking Framework (NIRF) Data is in progress. The Centre will launch a study of this data with a view to comparing this Framework with similar initiatives elsewhere (Research Effectiveness Framework in the UK, and the National Research Council Framework in USA).

Policy Research Cell through Centre at IIT Delhi has prepared a zero level draft Policy on *Technology led Innovation*. To take it forward, a national level Expert Panel was constituted and two discussion meetings were organised at Bengaluru and Delhi. A think tank meet for STI Policy was organised at NIAS Bengaluru. For the continuation of the Policy Research Scheme beyond 12<sup>th</sup> Plan period, a high level review meet was conducted.





**Expert Panel discussion meeting for draft Policy on Technology led Innovation**

To generate a critical mass of policy researchers, Policy Research Cell has granted Five STI Fellowships at post-doctoral level. Apart from this, an International Conference on Science and the Small Nations- Bridging the Gap: A science diplomacy Initiative in a collaboration with UNESCO was supported. A comprehensive Workshop on STI Policy Research organised by DST-CPR at IISc Bangalore in collaboration with National Institute of Advanced Studies (NIAS), Bengaluru was supported.

The Department participated in Asian STI Think Tanks Network (ASTN) Roundtable and 3<sup>rd</sup> Asian Innovation Forum meetings during August 28-29 2017 at Korea Institute of S&T Evaluation and Planning (KISTEP), Seoul, Republic of Korea.

## **8. Strengthening STI Information System**

The details of activities and significant achievements related to S&T Innovation and Information System during 2017-18 are as following:

### **National Science & Technology Management Information System (NSTMIS)**

The National Science & Technology Management Information System (NSTMIS) continued its efforts of generating and making available information on resources both manpower as well as financial devoted to scientific and technological (S&T) activities by conducting national surveys both through in-house as well as sponsored studies.

#### **(i) S&T Resources Studies**

Based on the National Survey on Resources Devoted to S&T Activities 2014-15, the publication titled '**R&D Statistics at a Glance – 2017-18**' December, 2017, giving salient findings of the survey was brought out. **S&T Indicators Tables** based on the survey have also been generated and uploaded on the NSTMIS website for quick and wider dissemination. Launching of the next National Survey on R&D for the year 2018-19 is under progress. The salient features of this survey are:

The National investment on R&D activities attained a level of Rs. 85,326.10 crores in 2014-15. It is estimated to be Rs. 94,516.45 crores in 2015-16 and Rs. 1,04,864.03 crores in 2017-18.

The major share of R&D expenditure was met from Central Government sources (45.1%); State Governments contributed 7.4%, Higher Education 3.9%, Public Sector Industries 5.5% and the remaining 38.1% from the Private Sector Industries.

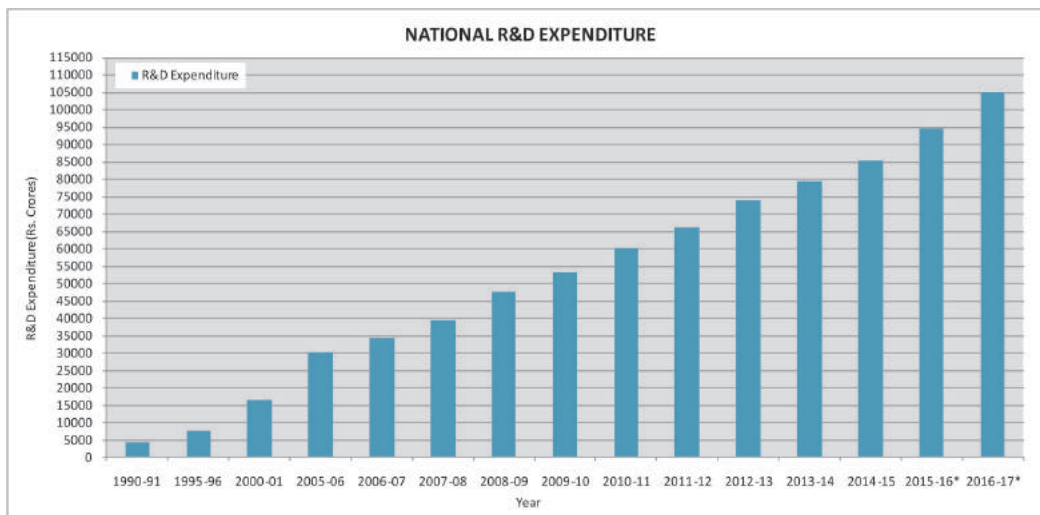


Fig 1.1: Trends in National R&D Expenditure

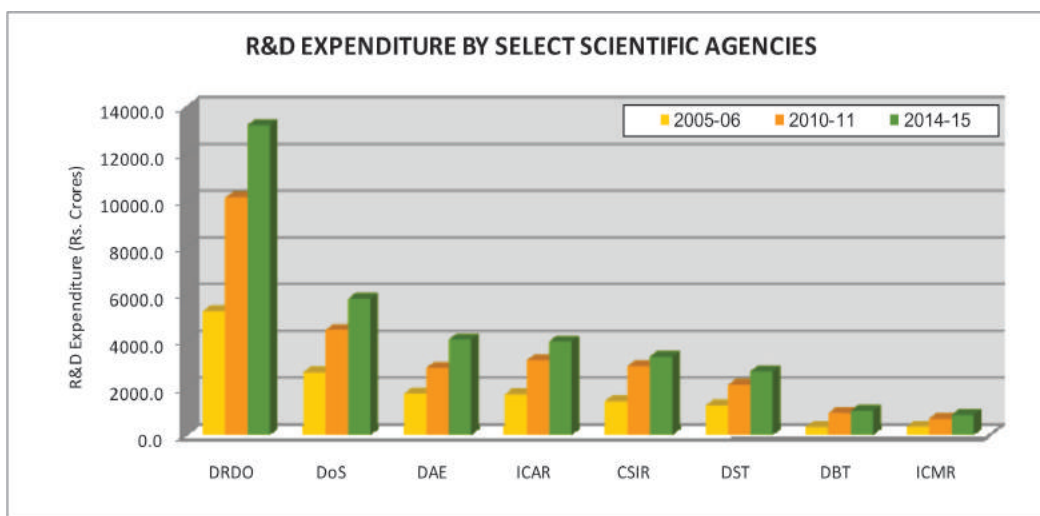


Fig 1.2: R&D Expenditure by Select Scientific Agencies

Nearly 5.28 lakh personnel were employed in the R&D establishments including in-house R&D units of public and private sector industries. There were 77,706 women employed in R&D establishments which work out to be 14.7% of the total manpower employed in the country in R&D establishments.

Out of this, 2.83 lakh were performing R&D activities, which is 53.6% of total personnel performing R&D activities. The document also provides detailed information collected from secondary sources on patents, enrolment, out-turn, Full Time Equivalent Researchers per million population and R&D expenditure per capita etc.

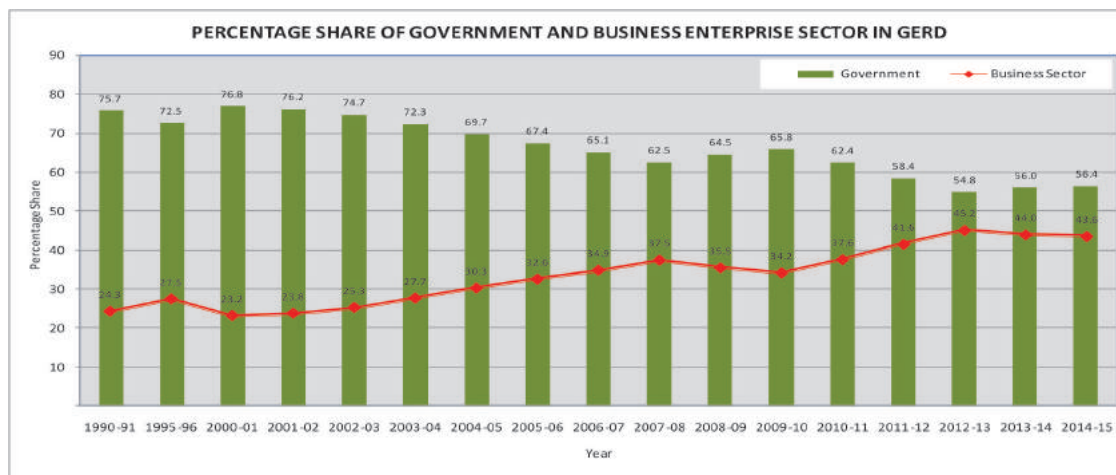


Fig 1.3: Percentage Share of Government and Business Enterprise Sector in GERD

**Bibliometric Studies** were commissioned on India's research output, collaboration and comparative performance based on the global databases SCI and SCOPUS to bring out a new set of Bibliometric Indicators for the time window 2011-2016. These studies/reports would serve as an evidence base leading to evaluation and monitoring of scientific research for policy planning.

A report on the proceedings of the Brainstorming Session (BSS) on sponsored research studies on Innovation was brought out. The main purpose of the BSS was to deliberate, consolidate and understand the connecting story underlying the outcome of the eight research studies on Innovation during 2014-16. The report underlined the need for initiation of a next phase of National Innovation Survey (NIS), strengthening of the innovation support system at local level, consolidating the studies on innovation to develop a comprehensive body of knowledge and dissemination of the lessons thereof to the stakeholders, etc. as a part of Way Forward in advancing this subject of national and global importance.

## (ii) Information System/Database Activities

With a view to disseminate information on sponsored research and development (R&D) projects for the benefit of different stakeholders, NSTMIS since 1990-91, has been continuously engaged in compiling information on extramural R&D projects funded by various central S&T agencies and publishing an annual *Directory of Extramural R&D Projects*. The latest directories "**Directory of Extramural R&D Projects**" for the years **2015-16** and **2016-17** are being compiled and would be published together.



It may be seen that Women participation in extramural R&D projects has increased significantly to 29% in 2014-15 from 13% in 2000-01 due to various initiatives undertaken by the Government in S&T sector. In absolute terms, 1,301 women Principal Investigators (PIs) during 2014-15 availed extramural R&D support as against 232 in 2000-01.

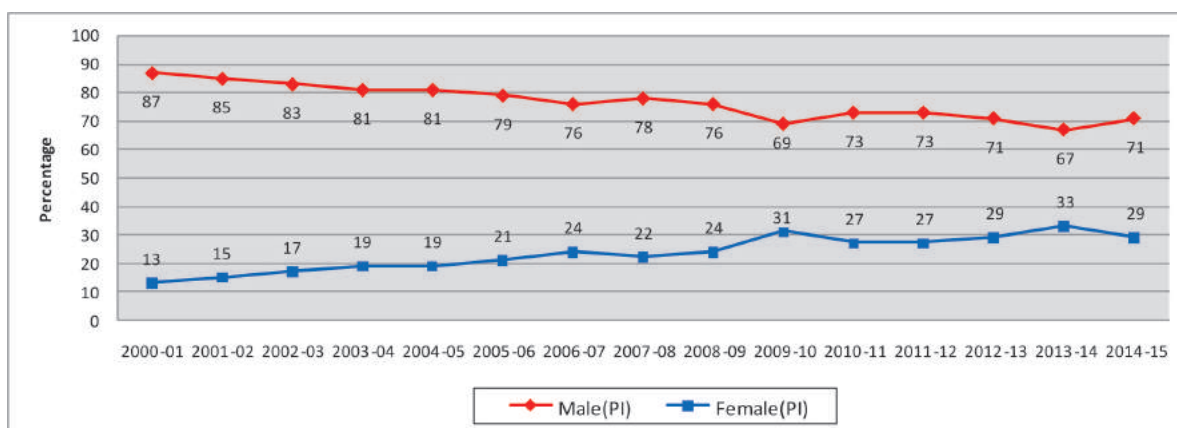


Fig 1.4: Gender Participation in Extramural R&D Support by Central S&T Agencies

### (iii) NSTMIS Sponsored Studies

As a part of its outreach research programme, NSTMIS has sponsored several research studies/projects during the last three decades to various stakeholders viz. research institutions, universities, colleges, NGOs and consultancy organizations spread across the country. The sponsored research studies have imparted backward and forward linkages with the in-house research activities of NSTMIS by providing the much needed evidence base for policy actions in the S&T sector. The completed project reports/studies are available in public domain through a **web-based digital repository** (<http://www.nstmis-dst.org/NSTDRepository.aspx>).

### (iv) International Collaboration

The Department has actively participated and contributed in the UNESCO Institutes of Statistics (UIS) and Organization for Economic Cooperation and Development (OECD) meetings for the development and revision of standards/concepts/definitions used for collection of Science Statistics and development of Science, Technology and Innovation Indicators. The department also provided information for the country on Science & Technology Indicators to UNESCO Institute for Statistics for the Global database on S&T Indicators and other related publications such as UNESCO Science Report etc.

### Academy for Science, Policy Implementation and Research (ASPIRE)

ASPIRE being incubated in project mode at the Administrative Staff College of India (ASCI),

Hyderabad aims to provide a common platform for interconnecting and enhancing competencies in policy development and implementation emphasizing Science Technology and Innovation across various stakeholders and arms of the Government leading to evidence based decision making.

A series of reports were prepared under the “STI for Make in India: Promoting Manufacturing at District Level” programme for the states of Sikkim, Guwahati and Kolkata. These reports impart an in-depth understanding on the issues related to strengthening of Science, Technology and Innovation (STI) inputs for enhanced industrial activities at district/ regional level.

A pilot study on Scientific Research Infrastructure in the country dealing with the analysis of the issues on procurement, maintenance, sharing and disposal of scientific equipment was carried out. Thereafter, upon in-depth deliberations, a national policy on ‘**Scientific Research Infrastructure for Maintenance and Networks (SRIMAN)**’ is being contemplated so as to bring greater efficiency and utilization of public research infrastructure for the non- strategic sector. The draft of the policy would be shortly uploaded on the website for wider consultation and suggestions by the stakeholders in the country.

Further efforts are on to upscale the level of engagement of socio-economic ministries and public sector industries apart from international organizations in ASPIRE for R&D management, Innovation and Policy including capacity building.

## 9. Training of Scientists and Technologists working in Government Sector

Department implements National Programme for Training of Scientists & Technologists working in Government Sector to meet the challenges of national development and international competitiveness in S&T area.

Training imparted to Scientists & Technologists strives to achieve better understanding of professional requirements, enhancing professional knowledge and skills needed for better performance of individuals and organisations in the profession of science and technology, creating awareness of latest technological, economic and social developments and infusion of scientific temper in the society, generating responsiveness to the challenging needs of the democratic system and expectations of the citizens from the scientific and technological developments, providing structured forum for peer to peer interaction, experience sharing and exchange of views among the scientific community for better networking and synergy.

During the year 2017-18, 25 training programmes are being held and about 600 scientists will be benefitted from these training programmes.

Under Women Component Plan of the Training Programme, 6 programmes are to be conducted exclusively for women scientists during 2017-18 in which about 150 women scientists would be benefitted.



Participants at National Institute of Advanced Studies, Bengaluru during 11-22 December, 2017

## RESEARCH AND DEVELOPMENT

One of the core mandates of the Department is to promote R&D in emerging areas which are critical and have potential to transform the landscape of science and technology in the near future. Some of the activities dedicated in this direction include National Mission on Nano Science and Nano Technology; Mega Science projects in the frontier areas of science; Missions on Climate Change programme; National Supercomputing Mission; and leveraging international S&T cooperation for enhancing S&T competitiveness of the country. Outcomes of these activities are described briefly below:

### 1. National Mission on Nano Science and Nano Technology

The Nano Mission is an umbrella programme to promote R&D in the emerging and active area of research namely Nano Science & Technology with focus on support to Basic Research Promotion; Infrastructure Development for Nano Science & Technology Research; Nano Applications & Technology Development Programmes including Joint Industry-Institute Partnership Programme; International Collaborative Programmes in Nano S&T and Human Resource Development in this area through Fellowships.

Nano Mission has been successful in creating the ecosystem for Nano S&T research in the country by supporting human resource development projects related to Nano Science and Technology and building infrastructure of Nano S&T Laboratories at several Institutes spread across the country. The efforts of Nano Mission are evident since India's global ranking, based on publications in SCI Journals, which was 9/10<sup>th</sup> in 2001 became 6<sup>th</sup> in 2004-05 and is 3<sup>rd</sup> since 2013-14. We continue to hold this position since last 5 years. The capability and capacity growth is evident from India's 16<sup>th</sup> rank in USPTO in 2016 patents. There is an unprecedented growth by 36.36% in the area of Nano S&T in number of patents granted in 2016 as compared to 2015 figures.

The Nano Mission has been granted an extension till March, 2020. The Nano Mission while continuing support to basic R&D in the area, will focus more on creating an enabling environment for supporting more technology relevant projects. This will be achieved through an active dialogue with the Industry either by co-funding the industry sponsored relevant projects in Nano S&T or by supporting incubators and start-ups in the area in close consultation with other Innovation Programmes in DST and other Departments/Ministries. It is also planned to fund prototype development with Industry involvement so as to make technology ready for transfer to start-ups or collaborating industry.

### BASIC RESEARCH PROMOTION

During the year, 39 new individual scientist-centric R&D projects have been supported through release

of grants. These are related to Superconducting 2D materials and their nanoscale devices; Synthesis and application of nano materials towards energy storage and EMI shielding; targeted drug delivery; and theranostics application of biocompatible micro particles derived from human platelet for nano therapeutics etc.

Support to ongoing R&D projects continues with proper monitoring of the projects firstly between 15 to 18 months to rate the progress.

Some important achievements from the ongoing projects are summarized below:

- Under the project ‘New Generation Molecular Magnets’ new observations reported include: i) a novel synthetic approach to rationally switch the single ion magnetic anisotropy of Co(II) tetrahedral complexes; ii) The importance of higher order symmetry to achieve high performance high temperature Dy (III) based single ion magnet (SIM) was observed in a monometallic dysprosium phosphamidon complex; iii) A new synthetic strategy for enhancing effective barrier by simply exploiting a diamagnetic metal ion such as zinc (II) ion.; iv) by exploiting the diffused 4d-orbital metal complexes, the largest super exchange interaction reported for any transition metal complexes and v) suppressing quantum tunneling of magnetization in lanthanide by increasing the exchange interactions between the 3d-Ln complexes, suppression of quantum tunneling of magnetization (QTM).
- The project entitled “Nanoformulation of siRNA: A strategy for effective treatment of drug resistant breast cancer” the following observations were made: i) from the literature search that 27 nucleotide sequence is much stable and less prone for the immunological reactions. It is 10-100 fold active than 21 nucleotide sequences. Thus we designed a 27 nucleotide siRNA sequences for better and effective activity; ii) Development of resistance on sequential treatment of DOX and now we reached to a concentration of 70 nM; ii) in vitro transfection was found to be efficient in forward process and in reverse process cells; iii) stability of siRNA in serum was less than 12h. Thus there is a great need in protecting the siRNA from serum nuclease activity by nano-formulating it and Knock down potential of ABC genes was found to be >75% on drug resistant MCF-7 at 55nM DOX.
- In a study on metal-oxide and sulfide based nanostructures for charge storage applications,  $\text{CuCo}_2\text{O}_4$  (CCO) ternary metal oxide has been synthesized via very simple and cost-effective process to fabricate different charge storage devices like lithium ion batteries and micro super capacitors.
- Development of PbS QD based solar cell using 3 mercapto propionic acid, thioglycolic acid, thilatic acid and 3-chloro-1-propanethiol as surface ligands.
- In a completed project, the project team was able to establish that the Leidenfrost point can be identified *via* analyzing the acoustic emissions from the droplet on the heated surface. The



amplitude of the sound shows noticeable intermittent fluctuations as the droplet approaches the Leidenfrost point. *They have analyzed the data further and are in process of applying for a patent.*

- In another project, *the group has synthesized infrared Nanoparticles very rapidly (2 hrs at 215°C) with these nanoparticles displaying ferromagnetic properties.* Also the synthesized nanoparticles were bio-compatible in nature and new morphologies can be developed by changing the substrate during thin-film synthesis. Thin-film as thin as 120 nm to 200 nm can be easily formed in one pot synthesis in hydrothermal synthesis.
- Some of the crucial observations in a project were Correlation between spatial and temporal heterogeneities examined through ID-IR and 2D-IR spectroscopic studies of water across the Widom line and in confined geometries: Cross over behavior in distance dependence of hydrophobic force law; Breakdown of universal Lindemann criteria in melting of 2D & 3D polydisperse systems; Multistage phase separation kinetics in quenched liquid binary mixtures; Appearance of transient spinodal decomposition; Phase separation kinetics in quenched liquid binary mixtures; Evolution of nanoscale patterns through multiple stages and heterogeneous dynamics.
- They were successful in development of an easily synthesizable, inexpensive, recyclable and stereo-chemically efficient imidazolidinone catalysts, that have catalytic applications in the dipolar cycloaddition and Fridel-craft alkylation of indoles with  $\alpha,\beta$ -unsaturated aldehydes to provide desired product with high yield and high enantiomeric excess. The magnetic nanocatalysts can be used for several other enantioselective reactions such as aldol reactions and Diels-Alder reactions, etc.
- Mesoporous silica nanoparticles tagged with aptamers were also developed. These nanoparticles are being studied for the influence of avidity on nanoparticle internalization as proposed in one of the objectives of project. *These nanoparticulate systems are further being explored for targeted drug delivery to tumors.*
- Some of the projects under Nano-Bio were focused on Green Synthesis of bio-active nanoparticles; Hybrid magnetic nano-composites for selective tumor theranostics; Engineered nanoparticles on reproductive and development toxicity; Super molecular assembly of Glyco-nanoparticles to target endothelial brain inflammation; Development of nanobiochip for oral cancer detection; Nano bio approach for tissue engineering; Nano base smart delivery of agri-inputs to promote pulses productivity; Mitochondrial Central Dogma by Chimeric nano-particle in cancer; and Development of Electrochemical nano biosensors for the early detection of liver cancer.

## HUMAN RESOURCE DEVELOPMENT

During the year, following activities with major focus on Human Resources were supported:

- Support for ongoing Post Graduate programmes [M.Sc./M. Tech in Nano Science & Technology] continued at few institutions.
- Support to 2 Nano Mission Schools – one each on NS & NT-Physical Sciences at the Centre for Nano and Soft Matter Sciences, Bengaluru and NS & NT-Biological Sciences at the Indian Institute of Nano Science and Technology (INST)-Mohali.
- 3 National/ International Conferences were supported.
- 14 Institutions with established research infrastructure and having established profile in Nano S&T in the country, have been approached, to implement a new programme titled **Nano Science & Nanotechnology Visiting Associateship (NS&T-VA)**. Each of these institutions would be provided funds for managing the Fellowships programme, with provisions of travel support, fellowship, boarding and lodging expenses and research expenses for Visiting Associates.
- Support was also continued for Post-Doctoral Fellowships to attract talented young researchers towards advanced research in Nano Science & Technology through the Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru. 8 students completed their research work under the PDF programme.
- Similarly, support also continued for the Nano S&T Overseas Fellowship during this year. Currently, 3 fellows are continuing their Fellowship.

## DEVELOPMENT OF R&D INFRASTRUCTURE

One Thematic Project in frontiers of Nano S&T entitled “Water purification using Nanotechnology” was supported. Support to ongoing Units, Thematic Units of Excellence and Thematic Project in frontiers of Nano S&T were continued. Some important achievements from them are summarized below:

### **Rapid growth of vertically aligned h-moo3 nanorods on rigid substrates:**

A novel synthesis strategy, to obtain vertically aligned h-MoO<sub>3</sub> nanorods (NRs) on rigid substrates by microwave irradiation using ammonium heptamolybdate (AHM) and concentrated nitric acid as precursors, is demonstrated. FTO substrates seeded with MoO<sub>3</sub> nanoparticles were subjected to microwave irradiation in the precursor solutions and the optimum conditions for obtaining defect free, vertically aligned h-MoO<sub>3</sub> NRs with dimensions of 5.8 μm length and 420 nm diameter. The dimensions and density of the NRs can be tuned by appropriately varying the synthesis time, choice of substrate and precursor concentration. Further, h-MoO<sub>3</sub> NRs have been completely transformed into layered α-MoO<sub>3</sub> NRs by annealing in air preserving the vertical alignment. This study paves the way for the controlled generation of MoO<sub>3</sub> NRs on different substrates in a short period of time with the potential to fabricate various electrochromic, photo-electrochemical and photovoltaic devices based on such well aligned vertical NRs.

### Unusual forms of gold

Inducing lattice strain in crystals may cause structural transformation and the same has been achieved in the case of gold, by stabilizing nanocorrugated morphologies. This ‘microrice gold’ (Figure 1) is nobler than the conventional gold; it withstands aquaregia and mercury treatments and exhibits interesting catalytic properties!

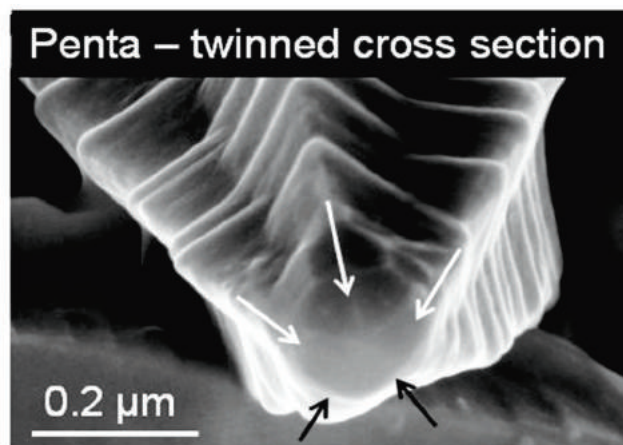


Fig. 1

### Supramolecular nanofiber-based passive memory device for remembering past humidity

Memorizing the magnitude of a physical parameter such as relative humidity in a consignment, may be useful while maintaining recommended condition over a period of time. The fabricated humidity-responsive device can memorize the humidity condition it had experienced while being unpowered. The device makes use of supramolecular nanofibers (Fig. 2) obtained from the self-assembly of donor-acceptor (D-A) molecules, coronenetetracarboxylate salt (CS) and dodecyl methyl viologen (DMV) respectively, from aqueous medium. The fibres tend to develop electrically induced disorder under constant voltage, leading to increased resistance with time. The conducting state can be regained via self-assembly by exposing the device to humidity in the absence of applied voltage, the extent of recovery depending on the magnitude of the humidity applied under no bias. This nature of the fibres has been exploited in reading the humidity memory state which interestingly, is independent of the lapsed time since the humidity exposure as well as the duration of exposure. The device finds use in applications requiring stringent condition monitoring.

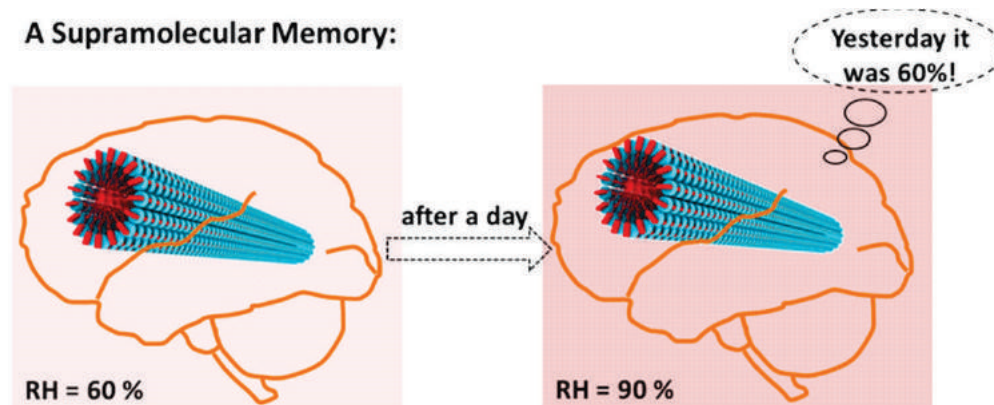


Fig. 2

**Synthesis of PEGylated polymer capsules** encapsulating LaVO<sub>4</sub>:Tb<sup>3+</sup>, GdVO<sub>4</sub>:Tb<sup>3+</sup>, Gd<sub>2</sub>O<sub>3</sub>:Tb<sup>3+</sup>, GdF<sub>3</sub>:Tb<sup>3+</sup>, YVO<sub>4</sub>:Tb<sup>3+</sup> and iron oxide nanoparticles are promising new fluorescence, magnetic and magneto-fluorescence imaging agents (Fig 3):

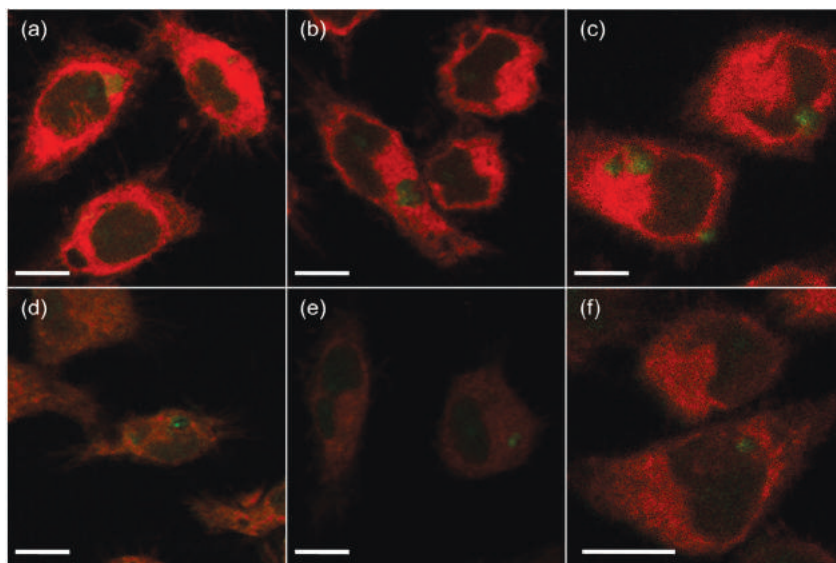


Fig. 3

**Development of mesoporous hierarchical NiMoO<sub>4</sub> hollow nanofibers for asymmetric supercapacitors.** The device displayed a capacity retention of 97% after 5000 cycles. This excellent stability could be attributed to the hollow core of the nanofibers that could facilitate the nanostructure in accommodating more strain during the volume expansions of the cycling process. Our work not only presents a high performance energy storage device, but also outlines a facile, scalable and tunable process for manufacturing various nanostructures of transition metal oxides for supercapacitors.

Studies on **cavity shape transformation** on micropatterned surfaces during offer better understanding of the cavity-growth phenomenon based on the pattern dimensions and viscoelastic effect, which could help in improving the design of pressure-sensitive adhesives.

A number of new phenomena have been observed and a number of new insights has been obtained through computational studies carried out. Some of the important findings are listed below.

- Understanding of cooperativity and hysteresis in metalorganic spin crossover compounds, which should lead to designing of spin-crossover polymers with large hysteresis loops operating at room temperature having application as memory devices.
- Detection and manipulation of magnetism in 2D materials like graphene and Mxene.
- Understanding mechanical degradation and improvement of formability of metals through solute effect.

- The role of the size of the organic molecule at the A-site in determining the band gaps of organic halide perovskites has been clarified for the first time.
- The possibility of magnetic states and their effects on the tunneling properties arising from B diffusion into MgO in CoFeB based tunnel junctions has been explored.
- Computer simulation and understanding of instabilities in ultra-thin solid and hollow nano-wires in the pre-melting regime.
- Hydrogen-bond relaxation in molten acetamide, deep eutectic mixtures and ionic liquids through jump dynamics.
- Discovering the role of the coordinating and the non-coordinating residues to stabilize the coordination geometry in proteins.
- Understanding problems of geological interest using first-principles tools.

#### **Molecular dynamics simulations on interaction between bacterial proteins: Implication on pathogenic activities**

Molecular dynamics simulation studies on interaction between bacterial proteins: an outer-membrane protein STY3179 and a yfdX protein STY3178 of *Salmonella Typhi* (Fig. 4). These two proteins co-occur and are from neighboring gene in *S. Typhi*. To understand the molecular basis of interaction between STY3178 and STY3179 we compute the conformational thermodynamics which indicate that these two proteins interact via polar and acidic residues belonging to their interfacial region. Conformational thermodynamics results further reveal instability of certain residues in extra-cellular loops of STY3179 upon complexation with STY3178 which is an indication for binding with host cell protein laminin.

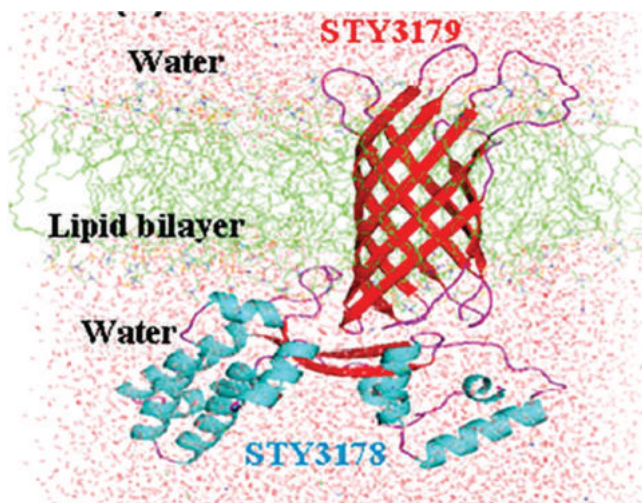


Fig. 4



## TECHNOLOGY DEVELOPMENT

Support to ongoing projects in this category continued. 9 technology development projects were supported. These include the following:

- Development of nanoscale multiferroic hetero structures integrated on silicon for room temperature ME-RAM and magnetic sensors applications;
- Prototype Large-scale reactor for simultaneous production of H<sub>2</sub> and fine chemicals under natural sunlight;
- Transparent conducting glasses made of metal nanomesh coated with metal oxide overlayer and scaling their production to m<sup>2</sup> area;
- Metal oxides anchored nanosheets for fabrication of energy storage devices;
- Development of nanoporous capacitive thin film ceramic sensor for low ppm moisture detection in gas/liquid system;
- Novel nanostructured high performance anode materials for high energy Na-ion batteries;
- Development of electrically tunable nanoscale microwave oscillator prototypes using spin hall effect;
- Design and applications of magnetically responsive self-assembled polymer nanocomposites;
- Self-assembled nanostructured silica-graphene oxide core-shell particle reinforced natural rubber composites for green tyres;
- A novel Immuno Nano Fluorescence Assay (INFA) system for noninvasive detection of prostate cancer using urine based protein biomarkers, PSA and MSMB;
- Synthesis of triazolo-capped silver nanoparticles (A-AgNPs);
- Miniaturized flexible planar antennas for body worn applications as health monitoring systems in L and S band using nano magneto-dielectric composite as substrate.

Support to ongoing Joint Industry Institute Projects (JIIP) and technology development projects was continued. Some important achievements from them are summarized below:

- Some of the research outcomes have been transferred to 5 incubated companies, three were formed this year.
- Some technologies have been successfully transferred to the community.
- Arsenic and iron removal units have been set-up in the state of Punjab with 70 litres per capita

daily (LPCD) capacity in the affected areas. A video of one of these installations is available at <https://youtu.be/QBJtLICO7Qo>. The technologies have been approved nationally.

#### **Incubation – Research bench to Companies:**

**InnoNano Research Private Limited** was initiated to take drinking water technologies to people. The company licensed 13 of our patents. It has established production facilities. Arsenic technology has reached over 600,000 people now through various installations in arsenic affected regions of India. It has been expanded to Punjab. A photograph of one such unit is shown below. The technologies have been approved nationally.



**Safewater Nano Private Limited** is a company incorporated in Singapore, to take our water technologies to international markets, at a funding of \$18 million.

**InnoDI Water Technologies Private Limited**, started producing capacitive deionization units. Factory for production was inaugurated on December 10, 2017.

**Vayujal Technologies Private Limited**, has put together its first prototype on atmospheric water capture at 100 L/day scale using our highly efficient surfaces. It has received initial funding needed for its activities.

**AquEasy Innovations Private Limited** has been established to create efficient water transport solutions. Prototypes have been tested.

#### **Technology Development**

Several technologies have been developed which are part of the following patent applications.

#### **INTERNATIONAL COLLABORATIONS**

Support to the India-Japan Beamline Phase-II, access to all the beam lines of ISIS neutron scattering facility at Rutherford Appleton Laboratory (RAL), UK for carrying out research in Nano Science and Technology and PETRA-III Synchrotron Radiation Facility at DESY, Hamburg, Germany.

**OUTPUT INDICATORS**

Research papers from Thematic Units, Thematic Projects in frontiers of Nano S&T, R&D projects and other major projects.	350
Patents application filed	11
Patents granted	4
Ph Ds produced	3
Manpower trained (MSc dissertation produced)	5
Research Manpower supported under projects supported (This includes Research Scientist–B, Research Associates, Senior Research Fellows, Junior Research Fellows, Technical Assistants, Project Assistants)	25103

**2. Mega Facilities for Basic Research**

This programme is aimed to create Mega Science facilities and launch Mega Science projects in and out of the country to improve access to such state-of-the-art facilities for the Indian scientific community, especially from the academic sector. Because of technical complexities and requirement of huge funds and other resources, such projects are manifestly multi-agency, multi-institutional and, most often, international in character. The Department of Science & Technology and the Department of Atomic Energy (DAE) have been jointly promoting most of such projects. Both DST and DAE have a long-standing Memorandum of Understanding (MoU) on joint funding, implementation and monitoring of such projects and the inter-agency cooperation has been exemplary. Under this programme, several important developments took place during the year.

**Facility for Antiproton and Ion Research (FAIR), Darmstadt, Germany**

Support towards construction of this accelerator facility continued during the year. The implementation of FAIR project gained further momentum during the year both at project site in Germany and in India. During the year, civil construction resumed in full swing at project site in Germany; the tunnel work reached a depth of 8 metre from target depth of 17 metre. In India, work on building in-kind accelerator and detector items, viz., power converters, vacuum chambers, beam stoppers, superconducting magnets and advanced detector systems gained further momentum during the year. Significant progress was made with regard to each item mentioned below:

**Power Converters:** The function of power converter is to energize the magnets installed in various accelerator rings of FAIR. Electronics Corporation of India Limited (ECIL), Hyderabad has to build about 500 power converter units of different specifications. One specific challenge of the device is its ultra-high stability in terms of voltage and current. So far, two prototypes have been shipped to FAIR by

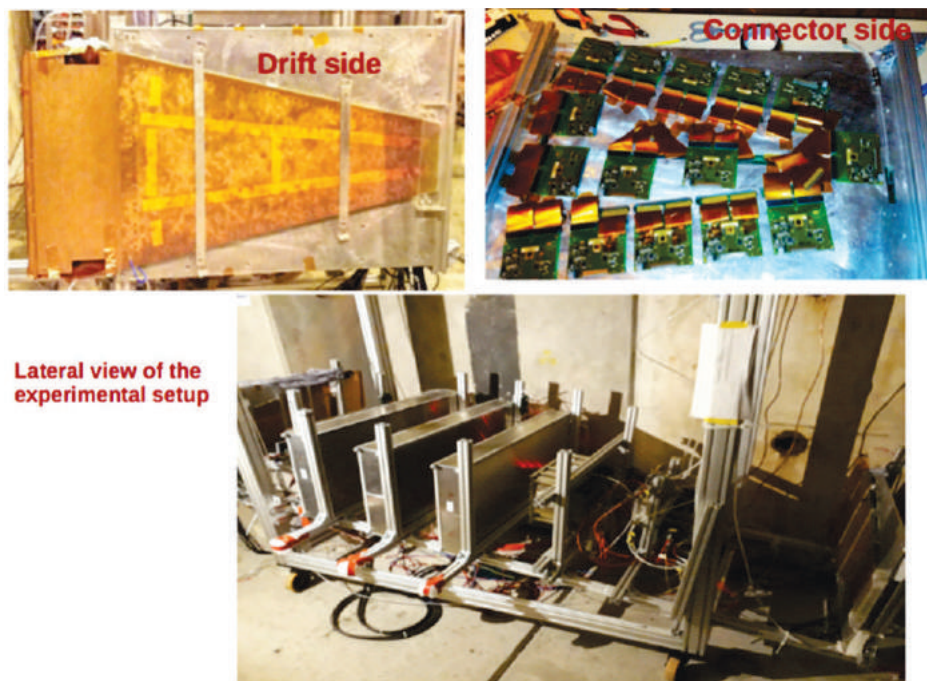
ECIL, Hyderabad after extensive Factory Acceptance Test (FAT). During the year, ECIL, Hyderabad completed documentation and manufacturing drawings of six more power converters which are being assembled for inspection by the FAIR team in early part of 2018.

**Beam Stoppers:** The function of beam stopper is to absorb high-energy and high-intensity primary and secondary beam particles. In FAIR, beam stoppers will be used to stop highly energetic uranium beam dumping huge amount of power in a dynamic mode. There will be three such absorbers and Indian contribution is to design, build and test the entire system. The design is a specialized work as the system is in high radiation environment and needs to deal with static and dynamic beam profiles. During the year, the Central Mechanical Engineering Research Institute (CMERI), Durgapur completed the Conceptual Design Report of beam stopper and got it cleared by the FAIR team. The process of finding a manufacturer to build the beam stopper was initiated. This design work has been mentioned as a specially challenging contribution from India as this involves design of a system capable of dissipating huge power (~23 kW average) in a very short time interval (100 nano second).

**Vacuum Chambers:** India has to also supply 71 vacuum chambers to FAIR as one of India's in-kind contributions. These vacuum chambers would be capable of withstanding ultra-high vacuum of the order of 10 pico bar and will be made of extremely thin plates. Achieving precise mechanical tolerances and withstanding the ultra-high vacuum is itself a big challenge. During the year, a prototype vacuum chamber built by an Indian industry passed the vacuum test in a Factory Acceptance Test (FAT) conducted by the FAIR team. However, it required further tuning of the mechanical accuracy of the chamber. During the year, the industry carried out extensive investigations and has now attained the desired accuracy parameters and is ready to have another FAT shortly. The production of 52 vacuum chambers will commence soon after its acceptance by FAIR.

**Superconducting Magnets:** The Low Energy Branch (LEB) of the superconducting Fragment Separator (Super-FRS) of FAIR will consist of several dipole and multipole magnets in order to achieve very high quality bunching and spectrometer capabilities. A team from VECC, Kolkata completed the physics design of a Low Energy Buncher set-up consisting of superconducting magnets. The Conceptual Design Report prepared by the team was accepted by FAIR. Now, efforts are being made to find a suitable vendor for production of superconducting magnets in the country.

**Advanced Detectors for FAIR Experiments:** All groups in India involved in FAIR experiments continued their work to participate in the initial experiments to be performed using SIS18 beams. The CBM collaboration has been working to install 3 large Gas Electron Multiplier (GEM) chambers in May 2018 to take data in the mini-CBM setup.



**GEM chambers under testing at CERN, Geneva**

During the year, a modified proposal for FAIR including provisions for additional Cash Contribution etc. was formulated and evaluated. The Executive Council on FAIR project reviewed the progress made in the project during the year.

Besides the above mentioned hardware development work, the project also resulted in two Ph.Ds during the year, one each from Gauhati University and Kashmir University on the CBM Experiment of FAIR. 4 research publications in reputed international journals also emerged from the project during the year. Indian researchers also made scientific contributions in 15 reports published by the CBM collaboration during the year.

### **Experiments at the Large Hadron Collider (LHC) at CERN, Geneva**

#### ***Compact Muon Solenoid (CMS) Upgrade, Operation & Utilization***

The India-CMS collaboration is a consortium consisting of 46 Faculty Members and Scientists, 6 Postdoc Fellows, 77 Ph.D. students, 12 Engineers, 4 Scientific Officers and 19 Technical Staff from 13 Indian Institutions across the country participating in the CMS experiment at the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN), Geneva. The India-CMS collaboration is the 8<sup>th</sup> largest collaboration in the CMS experiment after USA, Italy, Russia, Germany, France, CERN and UK. There is a strong Indian presence of 43 Ph.D. Physicists among the 1407 Ph.D. Physicists in the CMS collaboration during the current year. The project is jointly funded and



implemented by the Department of Atomic Energy (DAE) and Department of Science & Technology (DST). Support to the collaborative project continued during the year.

India-CMS has fulfilled major responsibilities within the collaboration in hardware, software, physics analysis, operation of the experiment, leadership roles within the collaboration and future upgrade of the detector. In Physics, India-CMS members participate in and lead many analyses in various Physics groups within the CMS collaboration such as Higgs, Top, Electroweak, Exotica, Super Symmetry (SUSY), Quantum Chromo Dynamics (QCD), Flavor Physics, Forward-Physics and Quark Gluon Plasma (QGP). India is taking a lead in the Phase-II upgrade of the CMS detector.

During the year, Indian researchers continued participation in project activities. Presently, India-CMS is involved in 5 projects, viz., GEM Detector, Outer Tracker, High Granularity Calorimeter (HGAL), Hadron Calorimeter (HCAL) and Trigger for which work is in progress by different groups in the country to fulfill Indian commitments. During the year, Indian researchers contributed towards 21 research publications out of about 100 research publications by the CMS collaboration. The project also resulted in 9 Ph.Ds from 5 institutions across the country, training of 94 undergraduate and other students from different institutions on different aspects of the CMS detector and experiments during the year. 17 India-CMS faculty members, few post-docs and some Ph.D. students played Lead Roles in different capacities in CMS-related activities. About 20 Indian faculty members and several post-docs and Ph.D. students also delivered talks at important events across the globe.

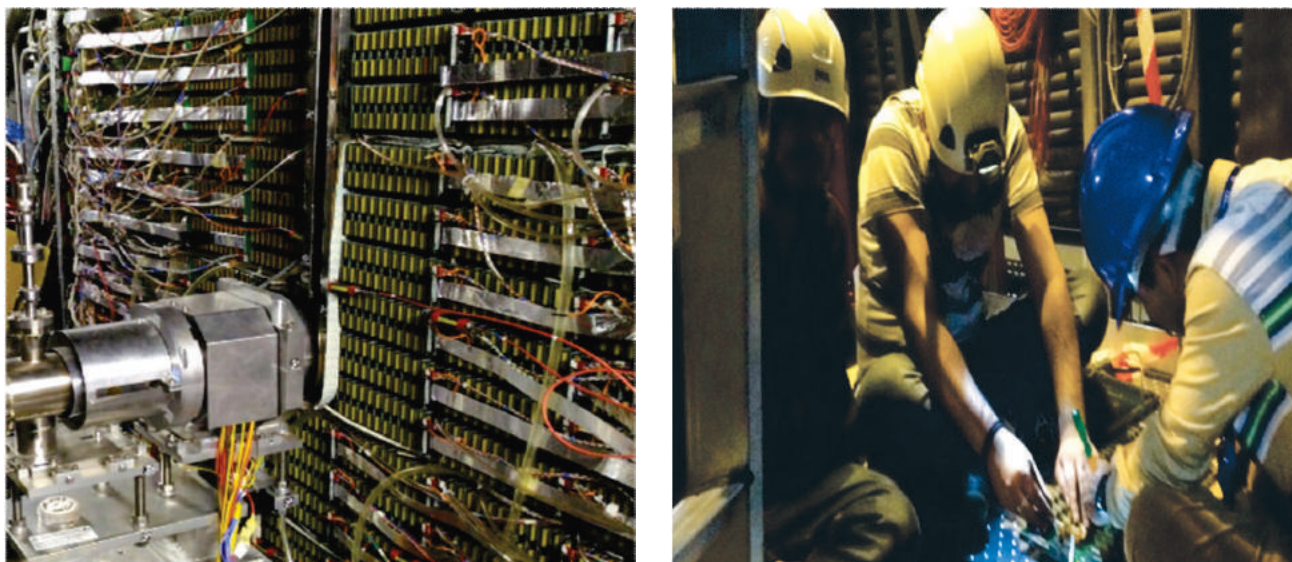
### **ALICE Upgrade, Operation & Utilization**

A Large Ion Collider Experiment (ALICE) is one of the four major experiments at LHC-CERN dedicated to the study of heavy ion collisions that creates a high temperature state of strongly interacting matter called QGP. 12 Indian institutions have participated in this experiment and built two major detectors viz., the Photon Multiplicity Detector (PMD) and the 2<sup>nd</sup> station of the ALICE muon detection system. About 120 members from India have been participating in this collaboration, out of which about half are Ph.D. students. Among the authors of the collaborative research publications from ALICE, about 10% are Indian.

Apart from design, development, fabrication, installation and operation of the two major detectors mentioned above, the Indian collaborators are involved in maintenance and upgradation of the ALICE detectors. Indians are heavily involved in analyzing the ALICE data towards extraction of novel physics information and publication. The areas in which Indians have contributed significantly are (a) global observables (b) fluctuation and correlations at low and intermediate transverse momenta (c) production of heavy flavor (d) production and quenching of jets and (e) resonance production, among others.

During the year, about 22 internal notes describing analysis details were submitted by Indian authors which were accepted by the ALICE collaboration. 5 Ph.Ds from different institutions across the country were produced on different topics of the ALICE experiment.

During this year, upgradation of the PMD system was carried out that included, improvement of coverage up to 95% and repair of readout electronics. After this, PMD has collected more than 250 Million events with pp collisions this year.



PMD after repairs in 2017 (Left) and Repair work in progress (Right).

### **Grid, Updating and Operation of Regional WLCG Grid system**

Support to this project continued during the year and the WLCG Grid enabled the scientists to process the voluminous data obtained from the CMS and ALICE experiments.

### **India-based Neutrino Observatory (INO), Madurai**

Support to 13 university groups for INO-related R&D work continued during the year. The groups continued detector R&D and prototyping during the year.

### **The Thirty Metre Telescope (TMT) Project**

TMT is an ambitious project at the international level which aims at hosting a 30-metre diameter telescope at Mauna Kea site in Hawaii (USA) at an estimated cost of 1.47 billion USD (Base year 2012 USD) involving an international consortium of National Scientific Organizations and Institutions in Canada, China, India, Japan and USA. In this project, India is a Founder-Member partner country at about 10% level. India's contribution to the project includes 30% in 'Cash' and 70% 'In-Kind'. The Indian Institute of Astrophysics (IIA), Bengaluru is the nodal institution from the country for implementation of the project. India's in-kind contributions include Hardware (Segment Support Assemblies, Actuators, Edge Sensors, Segment Polishing and Segment Coating), Instrumentation (First Light Instruments) and Software (Observatory Software and Telescope Control Systems).

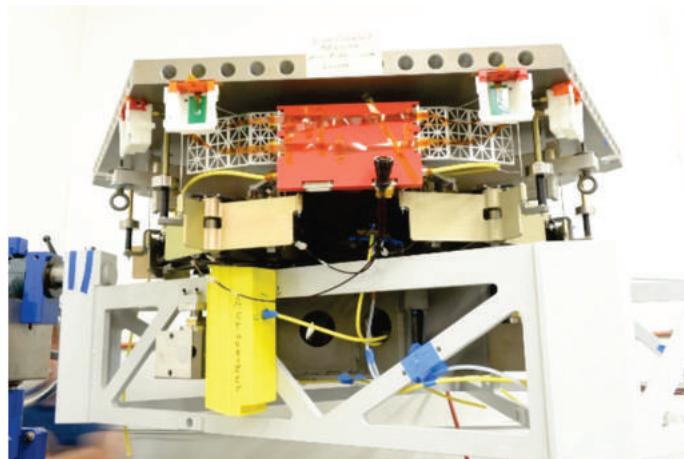
Support to this project continued during the year. As civil work at Mauna Kea site was stalled due to revocation of Permits by orders of the Supreme Court of Hawaii, La Palma in Canary Islands of Spain was identified as an alternate site for hosting TMT. In parallel, the TMT Board sought permits afresh for Mauna Kea site as it is the best site. In September 2017, the State of Hawaii Board of Land and Natural Resources approved a Conservation District Use Permit that would allow construction of TMT at Mauna Kea site. This permit was challenged in the Court. The final decision as to whether to stay at Mauna Kea or move to the La Palma site will be taken by April, 2018.

During the year, about 70 researchers and engineers from participating institutes, 60 engineers at 22 different Indian industries continued work on different aspects of the work packages assigned to India. Significant progress was made in all segments as mentioned below.

### Hardware

As part of its in-kind contributions, India is responsible for Segment Support Assemblies (SSAs), Actuators, Edge Sensors, Segment Polishing and Segment Coating. Considerable progress was made towards developing these in-kind items during the year as per the details given below.

**Segment Support Assemblies (SSAs):** These are critical high-precision mechanical systems on which final mirror segments will be mounted. India is responsible for producing all of the 574 (492 + 82 spares) SSAs. Three prototypes each were developed by two industries and these were shipped to the Project Office (PO), Pasadena (USA). Further, selection of suitable companies for production qualification is underway. Negotiations with technically qualified vendors are underway.



**Prototype of Segment Support Assembly**

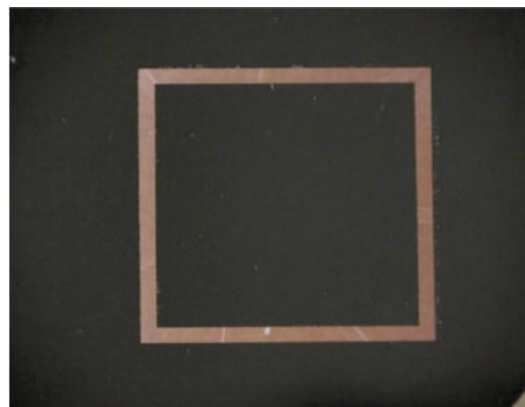
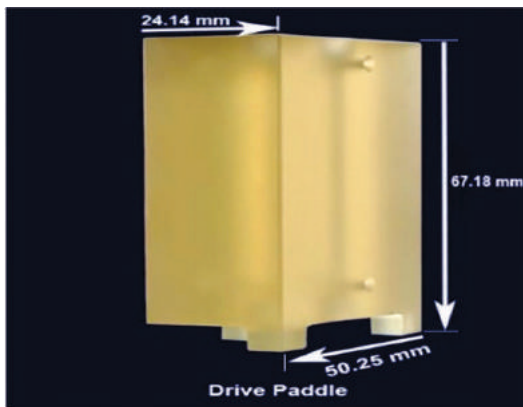
**Actuators:** India is also responsible for manufacturing primary mirror segment controls. In order to keep all the 492 segments behaving like a single mirror of 30-m diameter with surface accuracy within few nanometres at any given time, to achieve best possible image of the celestial objects, any deviations in mirror positions with respect to each other have to be corrected in real time. To achieve

this, each segment will be attached to three actuators. It is India's responsibility to manufacture about 1600 actuators. 10 prototypes have been shipped and tested for performance. At present, work is given to 4 vendors for production qualification out of which at least two industries will be chosen for production contract by late 2018.



Actuators manufactured at Indian industry

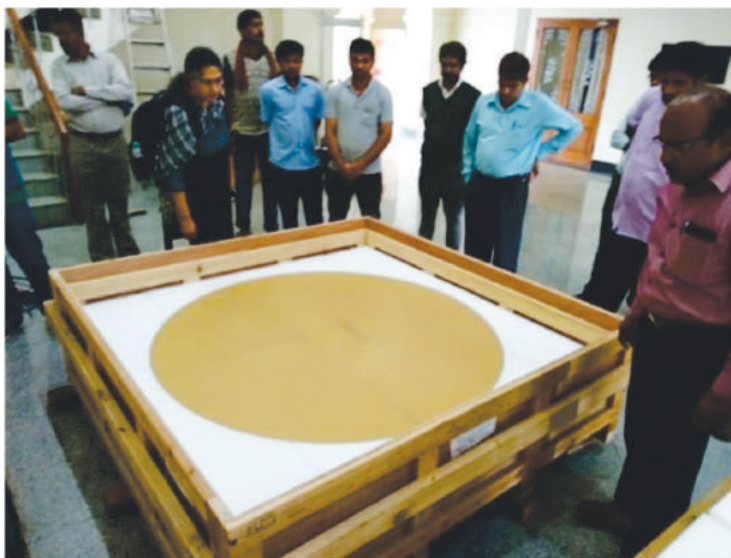
**Edge Sensors:** The sensor developed for TMT is based on capacitive sensor technology, which allows high precision contactless measurement, over a large operational range. Each mirror segment will have 6 edge sensors and in total 3234 sensors are required for TMT. As a part of India's in-kind contribution, all TMT edge sensors are to be manufactured in India and supplied to TMT project. Edge sensor design is under finalization phase. A cost-effective laser etching process is being explored at Raja Ramanna Centre for Advanced Technology (RRCAT), Indore for prototyping and the same appears to be encouraging as compared to expensive and time consuming photolithography technique used earlier. Industrial participation for the same is being explored.



Drive Sensor Block machined by an industry (Left) and Pattern coated by RRCAT, Indore on gold coated coupons (Right)



**M1 Segment Polishing:** As part of its in-kind contribution, India has to carry out polishing of 90 TMT segments each of 1.44 metre diameter. As no industry has the capability to fabricate large size optics with high precision in the country, IIA has taken up the challenge to meet this obligation. An Optics Fabrication Facility is being set up at IIA's CREST Campus, Bengaluru. Construction work at CREST campus is progressing as per schedule and is expected to be completed by July 2018. In parallel, different activities related to segment polishing like hex cutting, pocketing process development, and Whiffletree system design are in progress. The practice blank from Japan reached India-TMT Coordination Centre (ITCC) facility at Hoskote, Bengaluru on 1<sup>st</sup> December 2017.



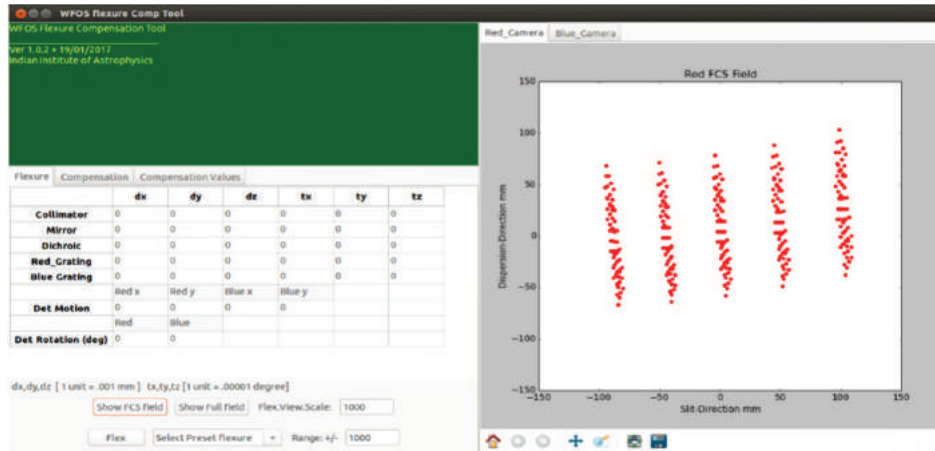
Practice blank received at Hoskote, Bengaluru from Japan

### Instrumentation

Team at India-TMT is involved in testing and design improvement of one of the first light instrument called Wide Field Optical Spectrograph (WFOS). The TMT-WFOS Instrument is currently in conceptual design phase. A number of tasks were undertaken by the instrument team of IIA for this phase which includes — Analysis of the ZEMAX optical design of the instrument to determine the spectral format and different tolerances; Development of a Flexure Compensation Simulation Tool for analysis of the different approaches of implementing compensation system for flexure induced distortions in the system; Development of a Target Allocation Simulation Tool for the fiber concept of the WFOS instrument; and Development of the Micro-lens array optical design for the fiber concept of WFOS.

A Review meeting involving contributors from all the participating organisations of WFOS was held at IIA during November 4-5, 2017. The two-day meeting discussed the status of the efforts undertaken during the current phase.





Graphical User Interface of the Flexure Compensation Simulation Tool

## Software

As part of its in-kind contributions, India is also responsible for delivering the Observatory Control Software and Telescope Control System.

**Observatory Control Software (OSW):** TMT Observatory Software consists of a set of software components that control the operations of the telescope, the mirrors, the telescope dome or enclosure, and the various instruments. Three modules of Observatory Software are, Common Software, Data Management System and Executive Software. India's work share includes 49% of the Observatory Software. During the year, ITCC, Project Office (PO) and an Indian industry worked together on the first module of OSW- Common Software (CSW).

ITCC participated in Software Integration and Testing Lab Workshop conducted by PO during April 2017 to demonstrate the Software Test and Integration Lab (STIL) setup.

Prototype phase OSW – Executive Software – Observatory Control System will begin in early 2018. Meeting to take up new tasks will be held in Jan 2018 at Pune.

**Telescope Control System (TCS):** TCS is responsible for coordination and control of various telescope subsystems. India is responsible for taking TCS through various project phases – preliminary design, final design, code and test, integration and test phase and finally assembly, integration and verification at TMT site. IUCAA, on behalf of India-TMT, is responsible for delivering TCS to the TMT. An industry partner has also been identified for the same.

**Outreach Activities:** TMT hosted its 5<sup>th</sup> Annual TMT Science Forum Meeting in the country during November 7-9, 2017 at Mysore. This year, the theme was 'Beyond First Light'. About 200 participants including scientists, engineers, students, educators and public relations experts from around the world participated in the event to discuss and shape the future of TMT next generation instruments. As part

of the outreach activities under the project, a High Resolution Spectroscopy Workshop was organized with participation of about 60 participants from all over the country, which also included 20 participants from the universities.

**Research Publications and Human Resource Development:** Besides scientific results and development work mentioned above, 7 scientific and technical publications emerged from the project during the year. 5 Project Engineers, 1 Post-Doctoral fellow, 4 Ph.D students, 3 M.Tech. students and 2 Project Interns received training regarding different aspects of the TMT project during the year.

The Executive Council for the project reviewed the progress made in the project during the year.

### **Laser Interferometer Gravitational-Wave Observatory (LIGO) Project**

Support to project continued during the year. First piece of land measuring 5.94 hectares was acquired by LIGO-India while acquisition of the remaining land in progress. Other preparatory activities like geotechnical, seismic and topographic studies at project site in Hingoli district in Maharashtra were initiated during the year. Scientific deliberations among the LIGO-India scientific community continued during the year. The computational facility at Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune serving as a Tier-2 Data Centre, was augmented during the year with installation of additional hardware, leading to doubling of its capacity.

### **Square Kilometre Array (SKA) Project at South Africa and Australia**

SKA will be the most powerful radio telescope and it is an international venture. At present, SKA is going through detailed design for Phase-I and construction of SKA is expected to commence in 2019 and early science is expected from 2023.

India joined the project as Associate Member in 2012 and became a Full Member on 5<sup>th</sup> October, 2015. SKA India Consortium was formed in 2014 involving 16 institutions from the country. India is leading an international consortium of 7 Members for the design of one major work package, Telescope Manager, with active partnership of the Indian industry.

The India-led Telescope Manager consortium has crossed the initial design reviews and is well on course towards completion of the Critical Design Review by mid-2018. In parallel, the National Centre for Radio Astrophysics (NCRA) is leading the development of a next-generation Monitor and Control system for the upgraded Giant Metrewave Radio Telescope (GMRT) facility that is aligned with the design concepts and technology platform proposed for the SKA Telescope Manager system, and will act as a valuable technology demonstrator and pathfinder for the SKA. The GMRT-system is expected to be ready by mid-2018, and could be expanded into an evolutionary prototype for the early phase of the SKA.

**Utilization of Twin Indian Beamlines for Macromolecular Crystallography (XRD2) and High Pressure Physics (XPRESS) at the Elettra Synchrotron Facility, Trieste, Italy.**

Utilization of twin Indian beamlines, XRD2 and XPRESS for scientific experiments to carry out frontline research in diffraction techniques by the Indian scientific community started during the year.



Scientists working on XRD2 Beamline

Efforts were made by both Indian and Italian partners to educate and popularize the Indian scientific community of the facilities established and to cultivate a vibrant and active Indian user group through discussions in different symposia/conferences organized in the country and abroad. One such specific event ‘First Awareness Programme for DST-Elettra Beamlines’ was organized at Bengaluru during August, 2017. Research publications started coming from initial scientific experiments; 8 research publications emerged during 2017 and their number is expected to pick up sharply in the coming years.

### Accelerator-based Research Facilities

#### Low Energy Ion Beam Facility at Kurukshetra University

Support to the ion beam facility at Kurukshetra University continued during the year. The facility was established through extramural R&D support from DST and building-related infrastructure support from the university. The developmental phase of the project was completed during the year and the facility was opened to the users for scientific experiments.

During the year, 9 user research groups carried out a variety of experiments using  $\text{Ar}^+$ ,  $\text{N}^+$ ,  $\text{N}_2^+$ ,  $\text{B}^+$ ,  $\text{Au}^+$  and  $\text{He}^+$  beams on different targets in the energy range of 50 keV to 200 keV having ion fluence ranging from  $1 \times 10^{13}$  ions  $\text{cm}^{-2}$  to  $5 \times 10^{17}$  ions  $\text{cm}^{-2}$ .

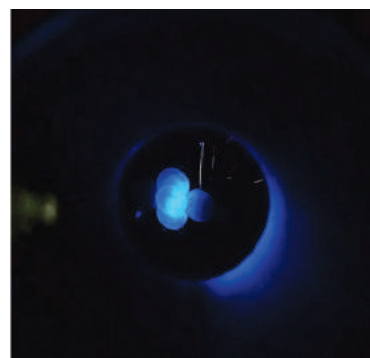
The facility resulted in 3 research publications, 3 conference publications and 1 Ph.D. during the year and these numbers are expected to pick up considerably in the coming time. A large number of undergraduate and postgraduate students from different institutions in the neighboring region were provided demonstration of the facility for encouraging them to pursue further studies in the exciting field of accelerator science and technology.

A new project for continued utilization of this facility was sanctioned during the year.

### High-Fluence Ion Beam Facility at Allahabad University

Support to high-fluence ion beam facility at Allahabad University continued during the year. Installation and commissioning of the facility were completed followed by inspection of the facility by the Atomic Energy Regulatory Board (AERB). AERB accorded clearance for running the facility during the year. At present, the facility is undergoing exploratory experiments using He, C, O, Ar, Xe, Ta and Bi ion sources, using Electron Cyclotron Resonance (ECR) ion source. Following table indicates typical intensities (mA) for selected charge states which were produced from the facility during the trial run.

Ion	Charge State	Current (mA)
He	2+	600
C	4+	160
O	6+	160
Ar	8+	140
Xe	20+	12
Ta	20+	10
Bi	20+	3



Ar Ion Beam on Quartz during trial run.

The progress made in the project was also reviewed during the year.



High-Fluence Ion Beam Facility at Allahabad University during Review meeting

The facility has resulted in two conference publications during the year and two more conference publications have been accepted.

### National Large Solar Telescope (NLST) project.

During the year, land for the project at Merak site in Ladakh region was approved by the J&K Government. The Detailed Project Report and other documents for seeking financial approval of the project were finalized.

### Others

As most of these projects are very long-term projects, DST and DAE provided funds to the scientific community to participate in deliberations of the Asian and International Committee for Future Accelerators (ACFA and ICFA).

Indian scientists participated in the deliberations of the ICFA/ACFA meetings during the year. A Workshop on Superconducting Radio Frequency Science & Technology was organized at the Inter-University Accelerator Centre (IUAC), New Delhi during September 20-22, 2017.

## 3. Climate Change Programme

Activities related to climate change in this Department include two national missions on climate change viz. (i) National Mission for Sustaining the Himalayan Ecosystem [NMSHE] and (ii) National Mission on Strategic Knowledge for Climate Change [NMSKCC] and implement National programme on CO<sub>2</sub> Sequestration Research (NPCSR). Major outcomes of these programmes are as following:

### New Programmes initiated/launched during the year:

As part of implementation of two national missions on climate change i.e., NMSKCC and NMSHE, following new programmes were initiated/launched during the year 2017-18:

#### (i) 4 New Centres of Excellence

As part of NMSKCC deliverables, DST supported 4 Centres of Excellence during past 3-4 years. These include CoEs at Divecha Centre of Climate Change, IISc, Bangalore; IIT Bombay; IIT Madras and ICRISAT, Hyderabad. 4 new Centres of Excellence were launched during the year. These were positioned at IIT Delhi; BHU, Varanasi; IIT Kharagpur and National Institute of Malaria Research (NIMR), Delhi. A gist of their broad objectives is given below:

S. No	CoE	Broad objectives
1.	IIT, Delhi	To develop an India centric climate model for creating scenarios for different regions of the country.
2.	BHU, Varanasi	To carry out state-of-art research in climate change and its impacts and build capacity building by organizing advanced training.
3.	IIT, Kharagpur	To investigate the vulnerability and risk assessment due to various environmental drivers in a Climate Change scenario over eastern India.



S. No	CoE	Broad objectives
4.	NIMR, Delhi	To undertake studies on climate inflicted vector borne diseases that include Dengue, Chikungunya, Japanese Encephalitis, Scrub typhus Kyasanur Forest Disease in addition to malaria.

### (ii) 7 Major R&D Programmes (MRDPs)

7 new Major R&D Programmes were launched during the year. These MRDPs cover a range of issues in climate change areas and have been positioned in some key universities and national institutions in the country. A summary of their broad objectives and focus of studies is given below:

S. No	MRDP institution	Broad objectives
1.	Indian Institute of Science Education and Research, Pune	To reconstruct the natural variability of the Indian monsoon and identify its drivers in decadal to centennial timescales
2.	Cochin University of Science and Technology (CUSAT), Cochin	To improve the understanding of the regional climate, especially studying the underlying physical and meteorological processes impacting monsoon in the southern peninsular India (SPI) region using a regional coupled model (RCM).
3.	Indian Institute of Science, Bengaluru	To undertake geoengineering research in India
4.	Andhra University, Visakhapatnam	To provide a comprehensive regional climate assessment for the Indian sub continent and to identify societal impacts related to two important issues of climate change on agriculture and air quality-health
5.	Indian Institute of Technology, Guwahati	To undertake assessment of impact of climate change on crop water requirements and productivity of major crops in Himalayan Region of northeast India.
6.	IIT Bhubaneswar	Understanding the vulnerability of this region in terms of precipitation patterns, evaporation losses and over-utilization of irrigation water due to impacts of climate change and to investigate the impacts of climate change on hydro-meteorological processes and extreme events, and their implications on sustainable development over the Eastern India region.
7.	IISER Mohali	State-of-the-art field measurements of Biogenic Volatile Organic Compounds (BVOCs) and ground truthing of land-use-land cover data for building an accurate BVOC emission inventory over Indian region.

### (iii) 3 New National Knowledge Network Programmes

During 2017-18, three new national network programmes have been launched in following three thematic areas:

- ❖ Climate Modelling
- ❖ Climate Change and Human Health
- ❖ Climate Change and Coastal Vulnerability

**(iv) Human Capacity Building Programmes:**

During the year, a Human Capacity Building Programme (HCBP) in climate Change adaptation was initiated wherein following lead institutions were sanctioned projects to conduct trainings for different stakeholders

S. No.	Name of Institute	Brief information about the Training
1	Administrative Staff College of India (ASCI), Hyderabad	3 trainings of one week duration for Senior level scientists / administrators & 6 trainings of 2 weeks duration for middle level scientists / academicians in the area of Climate Change Adaptation for Natural Resource Management
2	Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore	Two Summer Schools - 15-days each, One training - 5 days, two workshops - 5 days each, Two pre-consultation workshops - 2 days each in the areas of Climate change adaptation, with special reference to Himalayan ecosystems; and Climate change mitigation with special reference to sustainable habitats in critical ecosystems such as wetlands and grasslands
3	Indian Institute of Forest Management, Bhopal	Six training programmes of one week duration on the theme “Approach for Effective Planning and Implementation of Climate Adaptation Strategies in Himalayan States”
4	Indian Institute of Forest Management, Bhopal	Three training programmes of one week duration on the theme “Behavioural Adaptation with Climate Change in Himalayas”
5	Indian Institute of Public Administration, New Delhi	2 weeks Summer School for teachers, professionals, scientists, 2 weeks Capacity building programme for middle level officers, policy makers, one week Capacity building programme for senior level administrators, legislators on the theme “Climate Change Mitigation and Adaptation”
6	Tata Institute of Social Sciences, Mumbai	2 summer trainings of 3 weeks, 2 winter trainings of 2 weeks, 3 Conferences on Climate Change of 2 days duration on the theme “Trans-disciplinary perspectives in climate change adaptation, mitigation and governance”
7	Visvesvaraya National Institute of Technology, Nagpur	5 trainings of one week each on different topics & 2 short term programmes of 3 days each on the theme “Climate Change Mitigation and Adaptation”

**(v) State CC Cells/Centres**

- (a) Two new State Climate Change Centers for the states of Arunachal Pradesh and West

Bengal. The State Climate Change cells have been established at the State Government's nodal departments designated to implement State Action Plan on Climate Change. These centers have been assigned following tasks :

- Vulnerability and risk assessment at district/sub-district levels
- Institutional Capacity building and R&D for data base/ Information generation
- Training programmes for stakeholders, and.
- Public awareness as per the requirements of state and national action plan on climate change.

- (b) Three new proposals for establishing State CC Cells/Centres in the states of Odisha, Maharashtra and Haryana were formulated and recommended for support during this year.

#### **(vi) Indo-US Fulbright-Kalam Doctoral and Post-Doctoral Fellowships in Climate Change;**

In a September 2014 Joint Statement, the President of the United States of America and the Prime Minister of India launched a new U.S.-India Climate Fellowship Program to build long-term capacity to address climate change related issues in both countries. In pursuance of this statement, the Fulbright-Kalam Climate Doctoral and Post-doctoral Fellowship programme was launched. The selection process for first batch of 6 candidates was completed during 2016-17 and selected candidates have proceeded to US institutions for undergoing their respective courses. The selection process for the second batch of 6 candidates for above fellowship for the year 2017-18 is underway.

#### **(vii) Indo-German Research Collaboration**

A Joint Declaration of Intent (JDI) between Department of Science and Technology (DST), Government of the Republic of India and the Federal Ministry of Education and Research (BMBF) of the Government of the Federal Republic of Germany on Indo German-Centre for Sustainability (IGCS) was concluded on 30<sup>th</sup> May, 2017 in Germany during the fourth Inter-Governmental Consultations [IGC]. Under this JDI, DST is expected to support the IGCS at IIT, Madras for a period of 5 years beginning from next year.

#### **Monitoring of Ongoing Programmes**

Following ongoing programmes were monitored and their performance assessed during the year

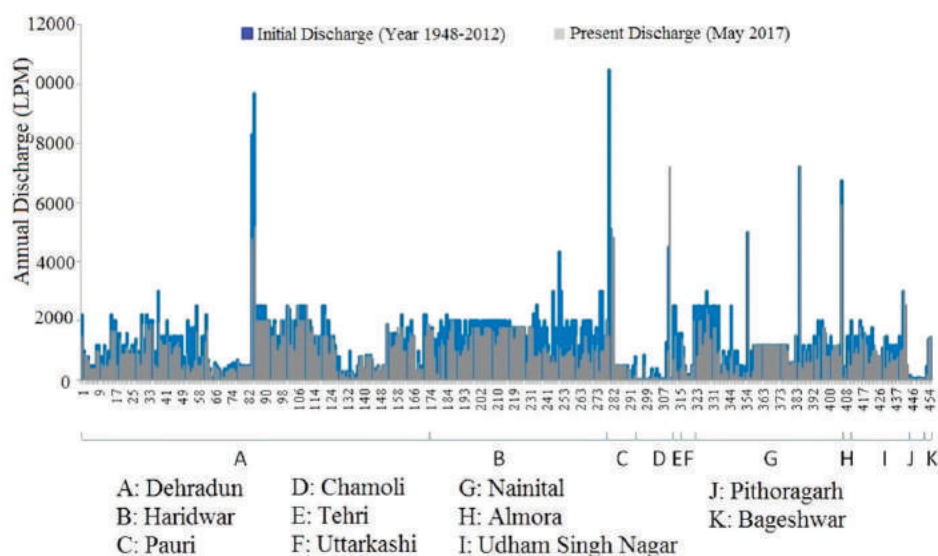
##### **(i) Thematic Task Forces in Himalayan ecosystem areas under NMSHE**

Six thematic task forces anchored around 6 lead institutions have been working in the areas of Himalayan ecosystem. These include; Wadia Institute of Himalayan Geology (WIHG), Dehradun; National Institute of Hydrology (NIH), Roorkee; Wildlife Institute of India (WII), Dehradun; GB Pant National Institute of Himalayan Environment and Sustainable Development (GBNIHESD) Dehradun; institutions of Indian Council of Agriculture Research (ICAR) in the Himalayan

region and research team from Jawaharlal Nehru University (JNU). These Task Forces have engaged more than 100 research teams from more than 60 research and academic institutions spread across the IHR. Some of major results/achievements under the TFs are as follows:

**(a) Task Force on Natural & geological wealth implemented by Wadia Institute of Himalayan Geology, Dehradun.**

The project aims to prepare database and information system about geological resources and exogenic geological processes. The progress reported includes the preparation of a database of, ground water, landslides, glaciers/snow cover in the NW Himalayas, establishment of a site for monitoring of glaciers in Zaskar range of Ladakh region in 2017, assessment of Groundwater Resources in Uttarakhand; inventory of active landslides and related mass movement activities for the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand. One of the studies indicates immense pressure on the groundwater reservoirs and water scarcity in all the districts of Uttarakhand state



**Fig.1 Tube well discharge in different districts of Uttarakhand state (Data adapted from Uttarakhand Jal Sansthan, Dehradun)**

**(b) Task Force on Forest Resources and Plant Biodiversity implemented by GB Pant National Institute of Himalayan Environment and Sustainable Development**

The project aims to develop coherent database for forest resources and plant biodiversity of Indian Himalayan Region; establish effective monitoring system for forests resources and plant biodiversity in relation to climate change; validate of Climate Model Projections with reference to forest resources and plant diversity in Indian Himalayan Region.

Some of the major outcomes of the project include; Six representative Long-Term Ecological

Monitoring (LTEM) sites for intensive long term monitoring following the criteria of Representativeness, Richness and Uniqueness along with Sensitivity considerations; use of CORDEX-CSIRO dynamically down scaled model simulations for futuristic change assessment; Pilot studies for revalidation and vulnerability assessment; Capacity Building & Forecasting have been identified. Characterization of tree species, shrubs and herbs of Trans, North Western and Western Himalaya covering J&K and Himachal Pradesh has been conducted. Seven research papers were published under the project. A GIS and RS based pilot study for assessment of overall vulnerability in Himachal Pradesh indicate that manmade activities are highly responsible for the forest loss in the study area

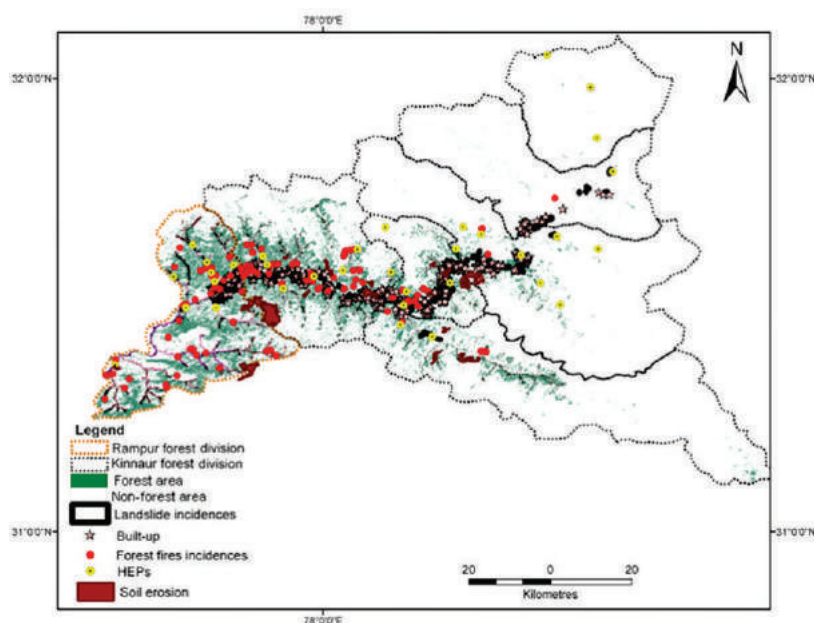


Fig.2 Overlay analysis of identified vulnerable indicators using GIS

A Center of Forest biodiversity has also been established at the institute as one of the Task Force activities

(c) **Task Force on Micro flora & fauna, wildlife & animal population implemented by Wildlife Institute of India, Dehradun**

The project aims to identify the drivers of landscape change (climatic and anthropogenic) in the IHR and their effects on the ecological and social systems; conduct focussed research on wildlife aspects and human dimensions for framing evidence-based policy measures; develop monitoring and Decision Support Systems (DSS) for indicator species; undertake climate change scenario analyses and visualization for predicting potential effects on fauna and ecosystems as a strategy to communicate with stakeholders and to influence policy and decision making.



Some of the major outcomes from the project include; selection of Bhagirathi basin (~7000km<sup>2</sup>) in Uttarakhand as the primary study area. Other sites in Eastern and North-Western Himalaya are Beas Basin (~ 3,000 km<sup>2</sup>, Himachal Pradesh), and Teesta Basin (~ 5,000 km<sup>2</sup>, Sikkim). For six Himalayan States, a 17 model ensemble was used to project changes in mean annual temperature and annual precipitation for future periods (2050s and 2080s) with respect to the baseline (1960-1990) and for two scenarios RCP45 and RCP85. An increasing warming trend and rising precipitation levels are observed. Human footprint was found to be one of the primary drivers behind the decline in landscape productivity at all the scales. In order to simulate the warming effects on microflora (lichens and soil bacteria) and microfauna (soil nematodes), six Open Top Chambers (Fig.3) were deployed inside Gangotri National Park.



Fig.3 Open Top Chambers deployed inside Gangotri National Park.

**(d) Task Force on Himalayan Agriculture implemented by Indian Council of Agriculture Research**

The project aims to prepare databases on soil water, genetic resources (arable crops, horticulture, agroforestry, livestock particularly double humped camel and yak, and cold-water fisheries) and farmers' practices; validation of the extant technologies and refinement of agronomic practices and cropping systems to overcome the negative influence of climate change.

Major outcomes reported during the year include; vulnerability assessment using indicator method; evaluation of different genotypes of fruits and vegetable crops to assess the

performance and suitability for the area under changing climate; collection and analysis of long term yield data of different crops and climate data; Planted fruit crops *viz.*, Apple, Seabuckthorn Peach, Plum, Apricot, Kiwi and Walnut across the project sites during 2015-16 and 2016-17 to assess their growth, yield and quality in different conditions; demonstration of various climate resilient technologies at farmers' fields; revival of existing climate change policies programme and schemes related to agriculture in Uttarakhand.



**Fig 4. Documentation of occurrence, types and use of Frost at Leh and Nubra Valleys**

The Project team has published 27 research papers in reputed journals. More than 30 workshops/ conferences/ seminars/ capacity building programmes benefitting more than 7000 farmers in the Indian Himalayan region were organized.

**(e) Task Force on Traditional Knowledge Systems implemented by Jawaharlal Nehru University**

The project aims to document, validate/find scientific evidence & analyze Traditional Knowledge Systems (TKS) in IHR; create Digital library based on documented Traditional knowledge; understand linkage between Traditional Knowledge and Formal/Scientific Knowledge in order to identify promising TKS for improvement and adoption; capacity building of institutions for TKS for Sustainable Development in IHR; strategic framework for TK management in ecologically fragile Himalayan region in the face of Climate Change adaptation & mitigation.

Some of the major outcomes include; identification of over 45 indigenous / traditional groups all across the IHR comprising settled farmers, shifting agricultural or Jhum farmers, transhumant and nomadic pastoralists, local artisans and traditional healers have been conducted for knowledge documentation; extensive literature survey of over 100 relevant national and international journals/magazines consisting nearly 3000 volumes and 9000 issues and carrying about 900 research papers/articles between 2000 and 2015. The survey revealed that states *viz.*, Nagaland, Mizoram, West Bengal Hills, Tripura are the least investigated states from traditional knowledge documentation standpoint in the areas of



climate change adaptation, disaster management, weather forecasting, human-wildlife conflict management, livelihoods and gender perspective themes.



Fig: 5 Traditional Agro-forestry System in Leh Valley

### State CC Centres in the Himalayan and Non-Himalayan States/UTs

19 ongoing State Climate change cells established by CCP in the States/UTs of Punjab, Madhya Pradesh, J&K, Himachal Pradesh, Uttarakhand, Nagaland Sikkim, Mizoram, Manipur, Tripura, West Bengal, Meghalaya, Tamil Nadu, Telangana, Chhattisgarh, Karnataka, Kerala, Puducherry and Arunachal Pradesh were monitored against their targeted deliverables viz., vulnerability & risk assessment; organising training programmes; public awareness programmes and building institutional capacity at state level.

### Global Technology Watch Groups (GTWGs)

The primary aim of this programme is to create various technology watch groups to keep track of the state-of-the-art technologies in India and abroad and also to keep abreast of current and emerging technologies and their developments worldwide in the key the areas like; Solar & other renewable energy; Energy efficiency; Sustainable habitat; Water resources; Sustainable agriculture; Green forestry; Himalayan ecosystem; Clean coal technology; Manufacturing etc. The GTWGs in each sector is expected to provide an assessment of technology needs in the adaptation and mitigations strategies dealt by other National Missions on climate change under NAPCC. This will be done largely by:

- Mapping of technologies available globally
- Selection and prioritization of technologies which are sustainable, energy efficient and relevant to India for mitigation and adaptation process.
- Preparing technology forecast reports that India will require for next 20 year in Climate Change perspective.

The GTWG Project is a national level exercise conducted on a pan India basis that involves a combination of both top-down and bottom-up approaches for accomplishing its objectives.

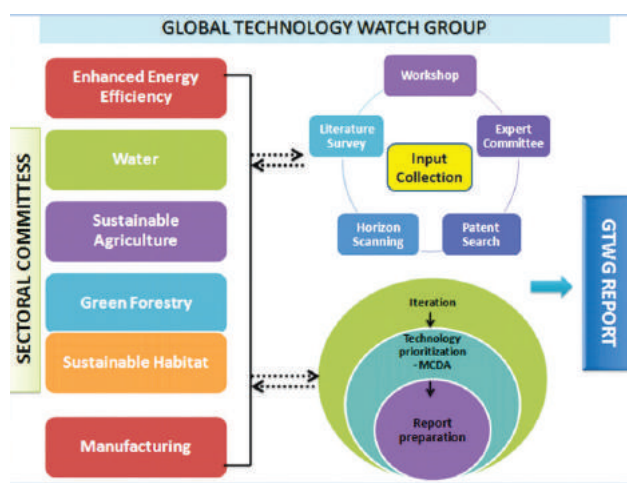


Fig: 6 Framework of the GTWG process

8 GTWGs have been set up in the areas of Renewable energy, Clean Coal technology; Agriculture, Water; Sustainable habitat, Green India; Enhanced energy Efficiency and Manufacturing. GTWGs on first two technology areas are coordinated by National Institute of Advanced Studies (NIAS), Bangalore and IIT Madras whereas GTWGS on remaining 6 areas are implemented by TIFAC, New Delhi.

## National programme on CO<sub>2</sub> Sequestration Research

The National Programme on CO<sub>2</sub> Sequestration Research (NPCSR) is being carried out by DST with the main focus to promote research on development of technologies for efficient sequestration of CO<sub>2</sub> in three sectors, such as Terrestrial, Bi-algal and Post Combustion CO<sub>2</sub> Capture emitted from different sources. More than 110 projects have been supported under the programme. Some of the major outcomes under the programme are as follows:

- Under the project titled **Synthesis and characterization of high capacity adsorbents for CO<sub>2</sub> capture**, nanostructured carbon adsorbents were prepared from melamine-formaldehyde and urea-formaldehyde using nano-clustering technique. Carbon adsorbent having a high nitrogen content and oxygen content exhibited dynamic CO<sub>2</sub> adsorption capacity of 0.64 mmol g<sup>-1</sup> at 30 °C (MFZ-700), 0.65 mmol g<sup>-1</sup> (EZ-700) and 0.84 mmol g<sup>-1</sup> (UFZ-700) at 12.5% CO<sub>2</sub> feed concentration with complete regeneration. This has potential application in areas such as heterogeneous catalysis, adsorption, gas sensing, energy storage, drug delivery biomedical applications, electrochemistry, etc. Total nine research papers were published under the project.
- Under the project titled **An integrated green process for biological carbon sequestration coupled with domestic sewage remediation by algae in closed photobioreactor and subsequent utilisation of biomass as biofertiliser**, developed & integrated a process for algal cultivation in a closed photobioreactor system, optimized the integrated green process for maximising biomass productivity, photosynthetic efficiency. A mathematical model was also developed for the integrated process. The Growth of *Scenedesmus* sp. was found to be most feasible in domestic wastewater based culture medium. The studies on combined application of microalgae based bio-fertilizer with inorganic fertilizer was observed to have enhanced crop productivity. Total 8 research papers were published under the project.



Fig.: 9 Evaluation of lipid-extracted biomass of *Scenedesmus* sp. as controlled-release biofertilizer



- c) Under the project titled **Development of green process for CO<sub>2</sub> sequestration using high rate algal ponds**, a bubble column photobioreactor was fabricated to carry sequestration studies. One *Scenedesmus* and *Chlorella* strain were selected for large scale studies and both strains could not sustain at ambient temperature of 40° C. Microalgae were found to be capable of significant growth in presence of mineral industry wastes for CO<sub>2</sub> fixation. The study has published 2 research papers.
- d) Under the project titled **Scope of enhancing carbon sequestration by oak forests in Central Himalaya**, the influence of Himalayan alder in oak forest carbon dynamics was studied. Highly significant variation ( $P < 0.001$ ) in total biomass ensued from one side to another. Total carbon stock in Oak stands ranged from 371.81 to 476.366 MgCha<sup>-1</sup> while it ranged from 505.41 to 600.13 MgCha<sup>-1</sup> in Alder Oak stands.
- e) Under the project titled **Sequestration of carbon dioxide by biochar and chemolithotrophic bacteria *Serratia* sp. in sequential bioreactor for production of biodiesel**, Carbon dioxide concentrating chemolithotrophic bacteria was isolated and identified in chemostat and CO<sub>2</sub> dioxide sequestration was established by proteomics and genomic approaches. The Chemolithotrophic bacteria applied for production of biodiesel in 20 litre fermenter. Also developed methods for preparation of biocomposite material, calcium-silicon-phosphate, from calcite formed by *Serratia* sp. and its biomedical application. Published 9 research papers in journals.

#### 4. National Super Computing Mission(NSM)-Building Capacity & Capability

The NSM was approved by the Government on 25<sup>th</sup> March, 2015 at a total cost of Rs. 4500 crore over a 7-year period of implementation. The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY) along with the Implementing Agencies viz. Indian Institute of Science (IISc), Bengaluru and Centre for Development of Advanced Computing (C-DAC), Pune.

The mission aims to enhance the research capacities and capabilities in the country by connecting them to the Supercomputer grid, with National Knowledge Network (NKN) as the back bone. This will be the first step in the direction to have a supercomputer machine in the top 20 list. The NSM intends to set up a grid of supercomputing facilities, using both “buy” and “build” approach at academic and research institutions across the country. A couple of these facilities would have petascale computers which will be in the range above 8 petaflops (PF), with next level of mid-range supercomputers with 650 Teraflop to 2.5 PF capacity. In addition, the entry-level supercomputer will be between 100 to 300 teraflop capacity. Peta-scale computing refers to the capability to add at least a quadrillion (1,000 trillion) real numbers in a second.

During the year, NSM-Technical Advisory Committee (NSM-TAC) recommended setting of 6 systems as per the following details, which has the approval of NSM-Executive Board (NSM-EB):

- C-DAC to “build” two 650 TF systems and one 1.3 PF system in Phase-I to be installed at IIT Varanasi, IISER Pune and IIT Kharagpur respectively;
- IISc to “buy” two 650 TF systems and one 1.3 PF system in Phase I for installation at IIT Hyderabad, JNCASR-Bengaluru and IIT-Kanpur;

**Activities accomplished during the year**

**a) Infrastructure Creation:**

- Mission will focus on developing indigenous super computers and enable local manufacturing thereof.
- C-DAC has been entrusted with building systems indigenously in phased manner (Phase-I: Assembly in India, Phase-II: Manufacturing in India, Phase-III: Design and Manufacturing in India)
- C-DAC to build four pilot systems of 100TF in single rack with different technologies (Intel, IBM, ARM & AMD), to enable NSM to decide appropriate technology for Phase-III design.
- C-DAC has set up HPC Lab at C-DAC Pune for HPC system design, development and integration. Setting up of System Software Lab at C-DAC Bangalore for developing HPC System Software stack is in progress.

**b) Applications Development:**

The following areas have been identified for applications development.

- Computational Biology and Drug Discovery
- Climate modelling, Weather and Disaster prediction
- Geophysical Applications (Oil, Gas and Mineral Exploration)
- AI and BIG Data Analytics
- Cryptography and Crypt Analysis
- Computational Fluid Dynamics (CFD) for Engineering Applications
- Materials & Computational Chemistry
- Astronomy & Computational Physics

**c) Exa-scale R&D:**

The focus of R&D is building capability to develop Exa-scale systems. Some of the challenges are Energy efficiency, System resilience, Exa-scale algorithms, Scalable System Software, Increasing

efficiency of data movement etc. R&D in Silicon Photonics as an alternative technology to build processor interconnects would be explored and promoted.

The following areas have been identified for Exa-scale Research and projects evolved by the EG on R&D.

- **System Architecture** (Heterogeneous system design, Energy efficient design, Interconnect network, network on chip, special-purpose machines)
- **System Software** (Communication library, programming models, compiler, runtime systems for heterogeneous systems, middleware for reliable system (checkpoint and recovery), performance tuning tools)
- **Infrastructure Management** (Data Centre design, cooling technologies)
- **Scalable Algorithms/Libraries** (Architecture- optimized libraries, auto-tuning libraries for specific application domains)

**d) Human Resource Development:**

Based on NSM-TAC recommendations, The HR Group has designed Short term (1-2 weeks), Medium term (6 months) and Long term (UG & PG courses) in HPC.

As of this year, Short term (1-2 weeks) and Medium term (6 months) training courses have been designed for faculty and industry professionals. Few batches have already been trained by C-DAC and IITs. For further proliferation of these courses, HPC nodal centres are being identified across the country, in consultation with Department of Higher Education. Introduction of HPC at higher education level has also been planned at UG and PG levels and curriculum for the same has been designed.

The mission supports the government's vision of "Digital India" and "Make in India" and would also generate highly skilled manpower for multi-disciplinary application development and also for meeting requirements of the scientific community.

## 5. International S&T Co-operation

### A. Bilateral Cooperation

DST has the mandated responsibility of (i) negotiating, concluding and implementing S&T Agreements between India and partnering countries; (ii) providing interventions on S&T aspects in international forums. This responsibility is carried out in close consultation with the Ministry of External Affairs; Indian Missions abroad; S&T Counselors in Germany, Japan, Russia and USA; stakeholders in scientific, technological and academic institutions; sister scientific government departments; and with various industry associations in India.

During the year, DST undertook a spectrum of bilateral cooperative activities such as: (i) bilateral

S&T Joint Committee Meetings and ministerial missions; (ii) bilateral workshops and symposiums; (iii) joint research projects; (iv) multi-institutional networked R&D projects; (v) establishing virtual joint laboratories; (vi) training programs; (vii) access to advanced research facilities abroad & participation in international mega-science projects; (viii) continue support to bi-national S&T bodies; (ix) fellowships and visitation programs for both Indian and foreign researchers; (x) participation of young student researchers in international meets; (xi) promoting academia-industry partnerships for industrial R&D on bilateral level; and (xii) Technology summits, technology fairs, S&T exhibitions.

### SALIENT ACTIVITIES DURING THE YEAR

**Joint S&T Committee/Council meetings** were held with Canada, Columbia, Egypt, Ethiopia, Germany, Japan, Netherland, Portugal, Serbia, Spain, South Africa, Sweden, Tunisia, Taiwan and Thailand. Governing Body meetings of the bi-national Indo-U.S. S&T Forum (IUSSTF), Indo-French Centre for Promotion of Advanced Research (IFCPAR), and Indo-German S&T Centre (IGSTC) were also held during the year. These meetings led to the renewal of the Program of Cooperation (PoC) and Action Plan with various partnering countries.

**Ministerial level** meetings were held with Afghanistan, Bangladesh, Canada, Ethiopia, Germany, Portugal, South Africa and United Kingdom for the review and up-scaling of the bilateral programs of cooperation.

**About 250 Joint R&D projects and over 30 Joint workshops/seminars** were supported. More than 700 exchange visits took place under various bilateral programs.

**S&T Ministers Conclave:** Addressing our foreign policy initiatives on ‘Neighbours First’, DST organized a Science and Technology Ministers Conclave for neighbouring countries as a part of the 2017 India International Science Festival (IISF) held in Chennai from 13-16 October. Higher Education Minister from Afghanistan and S&T Minister from Bangladesh participated in the event. Nearly 46 participants from 24 developing countries attended the event. The call announcement of the India Science and Research Fellowship (ISRF) 2017-18 was launched in the event.



**The call announcement of the India Science and Research Fellowship (ISRF) 2017-18 launched in the India International Science Festival (2017), Chennai.**

**New programs of cooperation** were initiated with:

**Canada:** An innovative model of R&D cooperation between India and Canada will be implemented under a MoU concluded between DST and the Natural Sciences and Engineering Research Council (NSERC) of Canada. India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability (IC-IMPACTS) programme will be supported to promote multidisciplinary research partnerships aimed at accelerating social transformation by providing solutions through application of science and technology. To begin with, the identified areas of mutual cooperation includes safe and sustainable civil infrastructure and integrated water management.



**Exchange of MoU between DST and NSERC, Canada on IC-IMPACTS program**

**Colombia:** Bilateral cooperation with Colombia was activated through the 1st meeting of Scientific and Technological Joint Committee. The two sides focused on developing pathways for new partnerships to initiate cooperation in areas of (i) biotechnology, (ii) Informatics and ICT, (iii) earth sciences including oceanic sciences and climate change, (iv) engineering the science of materials and nanotechnology (v) biomedical & health sciences, and (vi) renewable energy, including energy efficient and low carbon emission technologies.

**Ethiopia:** DST will strengthen four Centres of Excellence being set up at the Addis Ababa Science and Technology University and Adama Science and Technology University in Ethiopia through a twinning model with leading Indian academic institutions. The Indian side will provide capacity building and training for Ethiopian researchers towards building the Ethiopian Centres of Excellence in the areas of food bio-processing, sustainable energy, water resources engineering and geospatial information systems.

**Germany:** Considering the relevance of ‘Digital economy and society’, DST and Max Plank have



agreed to support the new Phase of the Indo-German Centre on Computer Sciences. The Centre will undertake research on cyber security which will strengthen the cyber-physical systems. The next phase of the Indo German Centre for Sustainability supported by DST and BMBF will undertake research on impacts of climate change on the coastal infrastructure and the adaptation strategies on coastal vulnerability.

**Italy:** A new chapter of cooperation on Industrial R&D was launched focused on industry led research which would enable development of new IP, process, prototype or products in sectoral areas covering Advanced Materials, Smart Manufacturing, Technologies for Cultural Heritage and Water technologies.

**Israel:** The India-Israel agreed to significantly step up the scientific and technological collaboration through the establishment of “India-Israel Industrial R&D and Technological Innovation Fund, (I<sup>4</sup>F) with a contribution of \$ 20 million US Dollars from each side for the period of 5 years. The Fund is aimed to promote, facilitate and support joint industrial R&D projects between India and Israel which would lead to co-development and commercialization of innovative technologies benefiting both the countries in sectors covering Agriculture, Energy, ICT and Water challenges.

**Portugal:** The R&D collaboration between India and Portugal will be substantially strengthened with the announcement of a fund of 4 million Euros joint fund to support collaborative activities over a period of 5 years.

**Russia:** DST and the Foundation for Assistance to Small Innovative Enterprise (FASIE) of the Russian Federation concluded a new MoU to further their objectives of supporting enterprises in both countries via technology transfer, industrial research, technological development and innovation for the purpose of generating economic benefits for both India and Russia.

**South Africa:** A novel program on Grass-root Innovations was launched aimed towards sharing of open source technologies and IPR protection of traditional knowledge systems. This program is designed for co-development of products through value addition, validation through product deployment and market ready technology transfer with a focus on affordability to meet the unmet needs of common people. A multi-institutional project on HIV Vaccine Research Collaboration has been also initiated. It is aimed to develop preventive HIV vaccine and will also lead to the identification of biomarkers and development of novel techniques for diagnosis and management of tuberculosis.

**South Korea:** Under the India-Korea Programme of cooperation a new stand of cooperation for supporting Virtual Network Centre was launched. Two joint R&D Networked Centres focused on ‘Robotics’ and ‘Computational Materials’ have been established. These Centres will be aimed to leverage complimentary R&D strengths of both countries through convergence of competencies in design, simulation and development of advanced manufacturing techniques.

**UK:** Several major initiatives have been launched as a part of the multifaceted collaboration in STI between India and the UK under the Newton-Bhabha Program. These include projects on Energy

Efficient Building Materials as a part of green initiative with co-investment of £ 8.4 million. Indo-UK Clean Energy Virtual Centre has been established with leading academic centres in India and UK to work on advanced R&D in Solar Energy, Storage and Grid Networks.

**USA:** To enhance the cooperation with USA under the Partnership to Advance Clean Energy Research (PACE-R) a new priority R&D area on Smart Grids and Energy Storage was supported through joint consortia based projects.

## Bilateral Research Projects & Programs

International interactions through joint collaborative projects with countries mentioned below have been instrumental in accelerating outcome and adding value to national science, technology and innovation enterprises at large. Spectrum of impact can be gauged from illustrations such as (i) creation of new knowledge and research tools captured in co-authored papers with foreign scientists published in world class scientific journals; (ii) joint patents filed with foreign scientists; (iii) project based mobility provides opportunity to Indian scientists for joining international R&D projects; (iv) absorbing experience of existing global research facilities in fine-tuning and/or coupling with upcoming or existing Indian research facilities; (v) building extended and stable institutional tie-ups with foreign partners to incubate feasibility of and/or scaling up of research, pilot scale production and high tech competence in India; etc.

**Africa Initiative:** Under the India-Africa Forum Summit (IAFS), DST in partnership with MEA is implementing the CV Raman Fellowships which enables researchers from across African nations to undertake research in Indian R&D and academic institutions under a fully paid fellowship. Against the last call, a total of 110 fellows were awarded the CV Raman Fellowship in 2016. Towards the efforts in strengthening African institutions through a twinning program, the Institute of Mathematics and Physical Sciences (IMSP), Benin has been linked with a cohort of Indian institutions for human capacity building and strengthening of the R&D and academic set-up. Two senior scientists from IMSP Benin visited University of Hyderabad for one month as a part of this initiative. The call announcement of the 2018 CV Raman Fellowship with 200 slots across African countries has been launched. Under the Africa initiative it has been also decided to launch Technology Transfer programs with Rwanda and Ethiopia.

**Australia:** Support continued for sixteen on-going competitive grant projects and seven major Grand Challenge projects under the Australia-India Strategic Research Fund (AISRF). Two new projects were supported under the competitive grant category in the areas “Clean Energy Technologies” under AISRF Phase-II. Three new projects were supported under AISRF Round 10 covering the areas of advanced manufacturing, smart cities and survey and exploration of natural resources. The cooperation was strengthened with the announcement of reciprocal fellowship awards for early and mid-career researchers to undertake fellowship immersions in each other’s country.



**Release of the 10 years accomplishments booklet of the India-Australia Strategic Research Fund by the Hon. Prime Minister of Australia and the Hon. S&T Minister, India**

**Austria:** Under the DST-Austrian Ministry of Science and Research (BMFWF) program of cooperation nine projects are being currently implemented. The projects are in the areas of high energy physics, medical technology, health sciences, clean energy and electronic devices.

**Argentina:** Eleven bilateral R&D projects in areas of agri-biotechnology, automation engineering and renewable energy were continued to be supported.

**Belarus:** Days of ‘Belarus Science in India’ was celebrated in New Delhi in the annual Trade Fair held in November 2016, where Belarus was a partner country. In a meeting between Secretary DST and Vice Chairman, State Committee on Science & Technology, Belarus it was agreed to support ten new joint R&D projects on solar harvesting materials, polymer coatings, biofuels and bioenergy, in addition to twelve ongoing R&D projects. An India Belarus Round Table meeting with participants of academic and research institutes was also organized. A joint workshop on cyber-security was organized at CDAC, Noida in November 2016.

**Belgium:** Six new joint R&D projects in Earth Sciences, Astrophysics, Biology, and Material Sciences were approved for implementation. India will continue to provide access to Belgian scientists at the 3.6m Optical Telescope of AREIS at Devasthal.

**Canada:** The new model of R&D cooperation under the IC-IMPACTS (India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability) has helped to promote multidisciplinary research partnerships aimed at accelerating social transformation by providing solutions through application of science and technology. In addition to the five ongoing projects, another set of five new projects were agreed for support. The projects cover areas of sustainable infrastructure, energy conservation, and integrated water management. Three new

Industrial R&D projects in the areas of Affordable health care and Clean Technology, implemented through the Global Innovation Technology Alliance (GITA) platform were also announced for joint implementation.



**Hon'ble Minister of S&T Dr. Harsh Vardhan meeting his Canadian counterpart Shri Navdeep Singh Bains in New Delhi**

The 23<sup>rd</sup> **DST-CII Technology Summit with Canada as partner country** was held in New Delhi during 14-15 November, 2017. The flagship event was inaugurated by Union Minister of Science & Technology and Earth Sciences Dr. Harsh Vardhan and Canada's Minister of Innovation, Science and Economic Development, Mr. Navdeep Singh Bains. The strong Canadian delegation of 165 members also included the Trade and Transport Ministers of the Canadian government. The Tech Summit highlighted range of research and innovations areas where India and Canada are world leaders covering Advanced Manufacturing, Transportation, Artificial Intelligence, Life Sciences, Agricultural Technology and Energy. Nearly 60 world class innovative technologies on Healthcare, Manufacturing, Smart cities with potential for bilateral B to B tie-ups to improve lives and drives growth were displayed. A particular focus of the summit was highlighting the role of women in science and business as well as promoting the start-up and incubator communities in India and Canada.



**Inauguration of the India-Canada Technology Summit held in New Delhi on 14-15 November 2017**

**Colombia:** Bilateral cooperation with Colombia was activated through the 1st meeting of Scientific and Technological Joint Committee which provided a road map of future cooperation between India and Colombia. The Joint Committee focused on developing pathways for new partnerships to initiate bilateral cooperation in areas of (i) biotechnology, (ii) Informatics and ICT, (iii) earth sciences including oceanic sciences and climate change, (iv) engineering, the science of materials and nanotechnology, (v) biomedical & health sciences, and (vi) renewable energy including energy efficient, and low carbon emission technologies. A new program of cooperation in science and technology for the coming three years was concluded.

**Egypt:** Following the S&T Joint Committee meeting held in April 2017 in New Delhi, twenty new joint R&D projects were initiated in the area of Agriculture Biotechnology, Nanotechnology and Information and Communication Technology. In addition, it was agreed to convene two bilateral workshops before announcing the next call for joint project proposals in 2018.

**Finland:** Support was continued to six joint projects in the areas of nano-materials and three projects in the area of Energy Research.

**France:** Targeted programs in focused areas enabling research funding agencies of both the nations were supported. These include (i) Indo-French Centre for Applied Mathematics (IFCAM), between DST and Centre National de la Recherche Scientifique (CNRS); (ii) DST-Inria program in Information and Communication Science & Technology; (iii) DST-ANR joint projects in the areas of Neuroscience and Engineering Sciences. Four joint projects against the fourth DST-Inria joint call were agreed for support during this period. The Indo-French Centre for Applied Mathematics (IFCAM) is proactively facilitating cross-disciplinary interactions between mathematicians, engineers and other scientists of the two countries. An active short-term visitors program and exchange of post-doctoral fellows/research students are form important components of this Centre's activities. Considering outcome of the IFCAM during last 4 years, both sides have renewed the IFCAM for another 4 years.

**Germany:** The 4<sup>th</sup> Indo-German Joint S&T Committee Meeting took place on 8 May 2017 in Berlin. Subsequently, the Indo-German Inter-Governmental Consultative (IGC) meeting was held under the Co-chairmanship of Hon. Prime Minister of India and German Chancellor on 30 May 2017 in Berlin. Hon. Minister for S&T and ES participated in the IGC. Following these meetings it was agreed to enhance the scope and content of bilateral cooperation in science, technology and innovation. The bilateral Indo-German Science & Technology Center will support 2+2 projects aligned with the national missions of the Government of India and the German High Tech strategy with potential to generate technologies in sectors like advanced manufacturing, automobiles, renewable energy, clean water, health care and smart cities. Considering the relevance of Digital economy, DST and Max Plank have agreed to support the new Phase of the Indo-German Centre on Computer Sciences which will undertake research on cyber-physical systems. The next phase of the Indo German Centre for Sustainability supported by DST and BMBF will undertake research on impacts of climate change on the coastal infrastructure and the adaptation strategies on coastal vulnerability.



Under the DST-DAAD project based personnel exchange program, support to twenty on-going joint research projects was continued and 29 new projects were jointly awarded in 2017 in various areas of basic research which includes physical, and chemical sciences; biotechnology, earth and atmospheric sciences. Under DST-DFG program support was extended to the on-going seven projects in the areas of chemical sciences, physics and astronomy. Under the DST-MPG Partner group program seventeen ongoing partner groups were supported in the areas of atmospheric chemistry, plant-insect interaction, tumor specific drug delivery system, cosmology and gravity, mass black holes in gravitational wave window, human genetic diversity, health sciences and evolutionary biology and structure-function relationship in protein machinery.

DST has been supporting the participation of meritorious Indian students at masters, doctoral and post-doctoral levels to participate in the Lindau Nobel Laureates meeting in Germany to help them shape their future research careers. Twenty three Indian students from across universities and research institutes participated in the 67<sup>th</sup> Nobel Laureates meeting in Lindau held during 25-30 June 2017. The meeting was attended by 30 Nobel Laureates in Chemistry and Medicine. The Lindau program was also reviewed through an alumni meeting organized by DFG and DST in New Delhi on 1-2 Dec 2017. DST in partnership with the Humboldt Foundation also organized the 9<sup>th</sup> Indo-German Frontiers of Engineering (FOE) Symposium attended by nearly 65 young Indian and German engineers and technologists across disciplines of engineering sciences. The 9<sup>th</sup> FOE was held in Jaipur covering four themes on circular economy, functional surfaces, nano-electronics and energy systems.



Secretary DST addressing the Lindau Alumni Meet in New Delhi

**Hungary:** Six projects in the areas of Mathematics, Earth Science, Biology & Medical Sciences, Chemical Sciences, and Physics & Astrophysics are currently under implementation.

**Israel:** During the visit of Hon'ble Prime Minister to Israel, a Memorandum of Understanding was concluded on 5th July, 2017 between the Department of Science and Technology and the National Technological Innovation Authority of the State of Israel for establishing "India-Israel Industrial R&D

and Technological Innovation Fund (I<sup>4</sup>F) with a contribution of 20 million US Dollars from each side for the period of 5 years. The Fund is aimed to promote, facilitate and support joint industrial R&D projects between enterprises and institutions from India and Israel which would lead to co-development and commercialization of innovative technologies benefiting both the countries. Under cooperation between DST and MOST, Israel nine joint R&D projects in the areas of Big Data Analytics in Health Care and Security in Cyber Space have been also supported. As a part of these projects, student exchanges will be encouraged in order to connect the next generation and sustain the pipeline of future collaboration.



**Italy:** Program of Cooperation between India and Italy in S&T for 3 years was concluded by Secretary Department of S&T and Ambassador of Italy in New Delhi. Thirteen mobility based projects and ten joint research projects for the Significant Research in the areas such as Information & Communication Technology; Energy, Environment & Sustainable Agriculture; Health, Biotechnology & Medicine; Physical & Chemical Sciences and Technology applied to the cultural and natural heritage have been funded. The two countries launched joint Industrial R&D Program which will open a new chapter in India-Italy S&T relationship by promoting technological innovation aimed at joint development of innovative products or processes in areas covering Advanced Materials, Smart Manufacturing, Clean Water Technologies and Cultural Heritage Preservation.

**Japan:** Twenty three new joint projects and five workshops were supported in the areas of fundamental and basic sciences, materials and system engineering, natural systems, astronomy, space, earth system and sciences; and mathematics and computational science under the DST-JSPS program. Under the DST-JST cooperation framework, three new India-Japan Joint Laboratories were approved and

initiated in the area of artificial intelligence, data analytics, and cyber security. About sixty INSPIRE school students from across India visited Japan under the DST-SAKURA program. India participated in the Asia Heads of Research Council meeting organized by JSPS in Indonesia. Under DST-AMED framework three projects on biomedical devices were continued to be supported. DST and JSPS also agreed to launch a new reciprocal fellowship program to help networking and building human capacity through promotion of individual excellence. The Raman-Mizushima lecture was delivered by Indian Scientist from TIFR, Mumbai in Japan during September 2017.

**Mexico:** Under the program of cooperation between DST and CONACYT, Mexico, fourteen joint R&D projects in the areas covering health, seismology, renewable energy and waste water treatment are being currently supported.

**Neighbouring Countries:** India Science and Research Fellowship (ISRF) scheme was expanded for seven neighbouring country scientists for undertaking R&D work in India. These include fellowships for Afghanistan, Bhutan, Bangladesh, Maldives, Myanmar, Nepal and Sri Lanka. In 2017, fifteen fellowships were awarded covering all the countries except Maldives and 18 fellows from last call has availed the fellowship this year. A Science and Technology Ministers Conclave for neighbouring countries was organised as a part of the 2017- India International Science Festival (IISF) held in Chennai from 13-16 Oct. Higher Education Minister from Afghanistan and S&T Minister from Bangladesh participated in the event. On the occasion, Hon'ble Minister announced the India Science and Research Fellowship 2017-18 Call and offered 200 travel slots for researchers and scientists to avail various training opportunities in India.

**Norway:** The joint project call on ICT and Bio-economy was announced in 2017. The evaluation process for these projects is underway. A joint seminar on Renewable Energy was also held in Delhi following which a new call on renewable energy has been also launched for enabling public-private R&D projects in this sector.

**Poland:** Against the last call for project proposals in basic sciences, 78 joint proposals were received. Eighteen joint R&D projects were approved and are under implementation covering basic sciences and fundamental research.

**Portugal:** The 5th meeting of the India-Portugal Scientific and Technological Joint Committee was held in Lisbon during March 13-14, 2017. Major decisions arrived in the meeting included support to 15 joint R&D projects in areas of materials, energy, biotechnology, and health sciences; three workshops to be held in next two years in the fields of Marine/Ocean science, Nano-technology and Tissue-engineering/bio-medicine; India was invited as a guest country at Ciencia 2017 (Annual Portuguese Science Meeting), on the sidelines of which the bilateral workshop on marine sciences took place in Lisbon from 3-5 July 2017. India and Portugal have also announced a four million euros joint fund to bolster research in science and technology.



S&T Minister Dr. Harsh Vardhan with the Hon. PM of Portugal in Lisbon

**Russia:** Tenth anniversary of the DST-RFBR partnership and 70th anniversary of establishment of India-Russian diplomatic relations was marked by an exposition and a seminar at Moscow, Russia on 21st June 2017, which was jointly inaugurated by Secretary DST and Chairman RFBR. Under the DST-RFBR program, seventy-eight joint R&D projects are currently under implementation. A new call for proposals was launched in November 2017. Six new projects were also approved for implementation in Applied Sciences in partnership with Russian Ministry of Education & Science (RMES) on subjects covering Energy & Environment, Manufacturing & Materials, Oceanography. These are in addition to ongoing 6 proposals which were approved earlier. Further, nineteen joint R&D projects are under implementation in partnership with Russian Science Foundation (RSF) in areas covering all aspects of Basic Sciences.

**Serbia:** India-Serbia bilateral cooperation in S&T was reactivated through the 2nd meeting of the India-Serbia Joint Committee on S&T held in Belgrade on 2-3rd October 2017. A new Program of Cooperation (POC) was signed in priority areas namely: (i) New materials and Nanotechnology, (ii) Energy and Energy efficiency, (iii) Information and Communication Technologies, (iv) Human Health, (v) Biotechnology including food technology and food security. The joint committee decided to hold two workshops in biotechnology & human health and ICT in India and Serbia respectively. It was agreed to announce joint calls for projects in the second half of 2018 in accordance with priority fields identified.

**Singapore:** Support continued to five joint R&D projects in the areas of Materials and Energy and four in the areas of Advances in Chemistry; Biology and Technology for Medicine. Under the project entitled “Soft active dielectric elastomers for human-motion-based energy harvesting” at Indian Institute of Technology Patna and National University of Singapore, an Indian patent for jointly invented device on Knee Motion Harvester has been filed.

**Slovenia:** During the year, fifteen joint projects in areas of digital image processing, advanced



manufacturing processes, sensors for various applications, smart textile, solar cells, water technology and health were continued for support. The new areas identified for the next call will cover health and biotechnology, new materials, renewable energy, smart cities and ICT.

**South Korea:** Support continued to the six on-going joint research projects in the areas of (i) Nutrition & Food Safety; (ii) Chemical & Biochemical Technologies; (iii) Water Resources & Environment (iv) Green Mobility (Transportation) and (v) Information & Communication Technologies. In addition twelve new joint projects were funded in the areas of (i) Engineering Sciences (ii) Health & Medical Sciences and (iii) ICT Convergence. In addition, under the GITA platform an Industrial R& Project on Design and Development of Advanced Power Electronics and Related Technologies for Integration of Solar Power Plants with Power Utility Grids was also funded. Support continued to other four ongoing Industrial R&D projects under GITA platform. A new stand of cooperation for supporting Virtual Network Centre was also launched. Two joint R&D Networked Centres focused on ‘Robotics’ and ‘Computational Materials’ have been established. These Centres will be aimed to leverage complimentary R&D strengths of both countries through convergence of competencies in design, simulation and development of advanced manufacturing techniques.

**South Africa:** Dr. Harsh Vardhan, Union Minister for Science & Technology and Earth Sciences visited South Africa in Oct. 2017 to attend the 20 years celebration of the India-South Africa collaboration in Science and Technology in Durban. The South African Minister for S&T, Ms. Naledi Pandor along with the Hon. Minister released a booklet highlighting the two decades of fruitful and mutually beneficial cooperation in science and technology spanning across the knowledge chain which has resulted into a robust networking of the best researchers and academic institutions. Inter-governmental agreement on cooperation in the field of Science & Technology was concluded in 1995. Since 1997 the S&T cooperation has progressively evolved as an important pillar in the two decades of India-South Africa strategic partnership.

Under India-South Africa Cooperation program three major R&D project in consortia mode for the prognosis of HIV-TB disease biology were approved in collaboration with DBT, India. Twenty-two ongoing projects in the area of Astronomy, Agriculture Biotechnology and IKS were supported. A new Program on ‘grass root innovation’ aimed towards sharing of open source technologies and IPR protection of traditional knowledge systems has been launched. This program is designed for co-development of products through value addition, validation through product deployment and market ready technology transfer with a focus on affordability.





**Hon. Minister of S&T visiting the Square Kilometer Array (SKA)  
Radio telescope at Karoo Desert, South Africa**

**Spain:** The meeting of India-Spain Science, Technology and Innovation Steering Committee was held at Ministry of Economy, Industry and Competitiveness in Madrid on 1st September, 2017. The Steering Committee explored new opportunities to expand the S&T cooperation agenda, keeping in cognizance the summit statement issued following the meeting between the Hon. Prime Minister of India and President of Spain in May 2017. Based on complementary strengths and mutual interests the areas identified for collaboration will cover Astrophysics; Renewal Energy; Nano Science and Technology; Cancer Research Alliance; Neuro-degenerative Disease and Biotechnology R&D Corridor. The meeting of India-Spain Industrial R&D Committee was also held which reviewed the three ongoing Industrial R&D projects being implemented in the areas of Information and Communication Technology, Nano Materials and Affordable health care. The Joint Committee also recommended the implementation of three new projects in the areas of Manufacturing Technology, Smart Cities and Food & Agro Technology. It was also agreed that the next call for industrial R&D project proposals will be announced in 2018 in the areas of Green Energy, Food & Agro Technology, Manufacturing Technology and Smart Cities – all aligned with the national missions of Government of India.

**Sri Lanka:** A commemorative event to mark science partnership between the two countries was held at Colombo, which was inaugurated by Sri Lankan Minister for Research & Technology and High Commissioner of India to Sri Lanka. In the event, 19 new joint R&D projects and 2 bilateral workshops were announced for joint implementation.

**Sweden:** The 5<sup>th</sup> meeting of the Indo-Swede S&T Joint Committee was held in New Delhi in 2017. It was agreed to conclude a new Protocol of Cooperation between DST-VINNOVA covering industrially relevant research future areas of cooperation like ICT, Clean energy and Smart cities. Currently, joint projects on embedded systems are being implemented. Under the last DST-VR (Sweden Research Council) call twelve projects are currently under implementation in areas of health sciences, genomics, bioinformatics and synthetic biology.

**Switzerland:** The 4<sup>th</sup> meeting of the Indo-Swiss S&T Joint Committee was held in New Delhi in Nov 2017. Under the DST-SDC (Swiss Developmental Cooperation) program in the field of glaciology it was agreed to continue and strengthen the cooperation on human and institutional capacity building in the Indian Himalayan States on climate change adaptation planning and promoting science-policy interface including cooperation in promoting technologies for climate change mitigation and adaptation. The Academia-Industry Training (AIT) Program launched between DST and Swissnex will continue to support promising Swiss and Indian researchers in transforming their research results into market applications. Under the AIT program, 11 Indian participants and 13 Swiss participants have become entrepreneurs, making AIT one of the most successful joint programs.

**Thailand:** The Program of Cooperation (PoC) in Science & Technology for the period of 2018-20 was concluded on 21st December 2017. This will pave the way for supporting joint research projects and workshop in the areas of (i) human health (ii) renewable energy (iii) photonics and (iv) geospatial technologies between the two countries. Under the framework of cooperation the Survey of India is imparting training to Thai officials in mapping technologies.

**Tunisia:** Following the 4<sup>th</sup> India-Tunisia S&T Joint Committee Meeting held in March 2016, in New Delhi, nineteen new projects were approved and initiated against the last call. In addition, support continued to twelve ongoing projects. Both sides also agreed to hold bilateral workshops in the areas of Health Sciences and Water Technology and launch the next call for joint R&D projects in 2018.

**United Kingdom:** UK Minister of State for Universities & Science called on Dr. Harsh Vardhan, Hon'ble Minister at New Delhi. Two leaders discussed on further enhancement of bilateral scientific cooperation. Present bilateral cooperation covers clean Energy, Efficient built environment, data science, weather modelling, marine sciences, agricultural biotechnology and human & child health being pursued under Newton Bhabha Program. Further, access for Indian researchers to the neutron facility at the Rutherford Appleton Laboratory in Oxford is being also implemented. This will enable Indian scientists to work on frontiers of new materials. Under the translation strand, six industrial R&D projects were announced in the areas of Affordable Healthcare, Clean Technology and Manufacturing Technology.

33 joint R&D projects were implemented under phase III of DST-UKIERI programme in the areas of affordable healthcare, climate science, marine science, material science and communication technologies. A new call for proposals was also announced.

**USA:** In the space of Innovation and Entrepreneurship, DST through Indo-US Science & Technology Forum (IUSSTF) supported the activities under the United States-India Science & Technology Endowment Fund which provides hand holding to promising joint Indo-American Technology Start-ups. The innovators from India and USA are jointly supported to develop and commercialize products under two broad categories i.e. 'Health Citizens' and 'Empowering Citizens'. This year against the 8<sup>th</sup> Call for proposals, response of 452 applications were received which are under evaluation. Presently 19 projects under this program are under support. The impact of this program has been realized through

commercial launch of more than 16 co-developed products like Affordable Mechanical Ventilator, Solar Electric Tractor, Affordable Digital Braille Accessibility, Low-cost, Portable Auto refractor, Transformational Modular Roofing Solution, to quote a few.

### **Bilateral Workshops**

Nearly 30 joint S&T workshops/ symposia and training programs were supported in India and abroad in partnership with Belarus, Egypt, Finland, Germany, Italy, Iran, Japan, Mexico, Norway, Portugal, Russia, Singapore, South Korea, South Africa, Switzerland, Taiwan, and UK. These activities were aimed towards information dissemination, networking and human capacity building and also helped to define the common areas of mutual interest for initiating cooperation with these countries.

### **Industrial R&D Programs**

For ensuring that R&D output is translated beyond the realms of the laboratories with tangible outcome through creation of new IP, processes, prototype and products bilateral industrial R&D program on Applied R&D have been pursued with chosen partner countries like Israel, Canada, Finland, France, Germany, Italy, South Korea, Spain, UK and USA. These programs are based on a PPP model of funding and are being implemented through the Global Innovation Technology Alliance (GITA) platform, except those with France, Germany and USA, the latter being implemented through the respective bilateral bodies. These projects directly feed to some of the national initiatives on Clean & Green India, Digital India, Make in India, Start-up India and Smart Cities. Twenty new projects were approved for launch with various partnering countries in the year under reporting.

### **Joint R&D Centers**

Twenty virtual R&D centers with networking between Indian and institutions abroad were continued to be supported. These Centers have been built on leveraging complementarity around existing capabilities, strengths and infrastructure towards optimal utilization of resources and also build human capital through seamless networking and mobility. These centers are meant for facilitating focused and integrated interaction and collaboration through networking of capabilities and infra-structure between Indian and institutions in partner countries like Australia, Canada, France, Germany, Japan, S. Africa, UK, and USA. Two new joint R&D Network Centres focused on 'Robotics' and 'Computational Materials' with South Korea have also been established during the year.

### **Fellowships/Internships**

#### **Outgoing Fellowships for Indians:**

Nine PhD students in the area of Life Sciences, Chemical Sciences and Physical Sciences were sent to Japan for interaction meetings with Japanese Nobel Laureates under the HOPE meeting. Twenty-three PhD and Post Doctorate researchers in the areas of Physics participated in the 67<sup>th</sup> Meeting of Nobel Laureates and students at Lindau, Germany in June 2017. Twenty Indian students attended the

11<sup>th</sup> Asian Science Camp held in Malaysia during August 20-26, 2017 under support of DST. The Camp was attended by 220 outstanding science students from across 23 countries in Asia, including India. Eight Indian Ph. D students were selected to visit South Korea under the India-Korea Research Internship Program. Twenty-five Indian PhD students have been selected to visit France under the Raman-Charpak Scholarship. Thirty INSPIRE PhD students visited UK institutions as a part of DST-Royal Society exchange program under Newton-Bhabha scheme. A young and mid-career research fellowship program with Australia was launched and implemented through INSA. Twenty young faculty/researchers have been selected for the Australian fellowship award. Fifteen researchers were selected to avail the DST-JSPS award for Young Researcher Fellowship to carryout R&D work at Japan.

### **Incoming Fellowships for Foreign Scientists to India:**

Under India Science and Research Fellowship (ISRF), fifteen researchers from five neighbouring countries including Afghanistan, Bhutan, Bangladesh, Nepal, Sri Lanka were awarded fellowships to work in Indian R&D institutions. 4th Call for the 2018 fellowship for five countries including Bangladesh, Bhutan, Nepal, Myanmar, Sri Lanka was announced in December 2017.

CV Raman Fellowships which enables researchers from across African nations to undertake research in Indian R&D and academic institutions under a fully paid fellowship. A total of 111 applicants were awarded the Fellowship in 2017. A new call for the 2018 CV Raman fellowship has been also announced. Six French PhD students have been awarded the Raman-Charpak Fellowship to work in Indian laboratories and R&D Institutes.

### **Bi-national Centres**

Bi-national R&D Centres are independent bilateral entities established under inter-governmental agreements between India and the partner country. The activities undertaken and implemented by these Centres which are supported through DST are as follows:

#### **Indo-French Centre for Promotion of Advanced Research (CEFIPRA)**

The bilateral Centre was established in 1987 and completed its 30 years of existence. To mark the historic occasion, an event was formally launched on 15th May, 2017 at Reims, France on the sidelines of Scientific Committee meeting held in May, 2017 at Reims, France. This will be followed by a series of celebratory activities over the year.

During the year 2017-18, 17 new joint R&D projects were recommended for support in the 59th & 60th Scientific Council (SC) meetings of CEFIPRA held on 15-17th May, 2017 at Reims, France and 9-11th November, 2017, at New Delhi, India respectively. During the year, 14 fresh projects were initiated in various areas of S&T and 63 projects are ongoing. Mobility of approx. 100 scientists and students between two countries were supported under the program. In addition, around 45 PhD/Post Docs from India were trained in France. Four new projects on industrial R&D were also recommended

for support during the year. In order to harvest the strength of existing R&D network in India and France, CEFIPRA launched its High Impact Scientific Research Network Program in areas of interest in Science & Technology. Under this program, two new projects one each in areas of High Energy Physics and Health Sciences are ongoing.



**Meeting of the French Co-Chair and Indian Co-Chair, CEFIPRA in New Delhi**

The bilateral knowledge space had been further catalyzed through supporting 10 seminars/workshops/training schools in various areas of S&T. Through these seminars, the Centre has brought more than 350 scientists/students/researchers from India and France together to share the knowledge in the advanced areas for planning of future collaboration.

The Centre continued to offer a platform for implementing targeted Indo-French programs of national funding agencies to support collaborative scientific research in focused areas of mutual interest. The targeted programs operational during the year were (i) DST-ANR (ii) DST-INRIA-CNRS and (iii) Indo-French Water Networking (IFWN) program, covering Waste water treatment and Natural water treatment systems.

In order to strengthen individual excellence across the knowledge innovation chain under the existing Raman-Charpak Fellowship a total of 25 Indian and 7 French doctoral students were awarded in 2017. For the first time a dedicated call for French Masters' student was launched by CEFIPRA and 5 French students were recommended for support. For European School on Nanosciences and Nanotechnologies (ESONN) Fellowship Program, the Centre supported the participation of 8 Indian doctoral students at Grenoble, France. Under the CEFIPRA-SOLEIL Synchrotron Program, the CEFIPRA supported visit of 3 Indian researchers to SOLEIL facility.

As a part of the Public-Private Partnership Programs, under the CEFIPRA-Saint Gobain Research India Program four projects are ongoing in the areas of sustainable habitat for hot and humid climate. Under the BIRAC, CEFIPRA and French Embassy Program in the area of red biotechnology two projects are ongoing in cardiovascular diseases. One new project has been initiated under the 2nd call in the area of Alzheimer's disease. CEFIPRA has also expanded its activity by bringing Bpifrance (a public



investment bank) as a new stakeholder and launched the Indo-French health technology initiative with Bpifrance and BIRAC in the area of red biotechnology for support up to pre-commercialization stage. One project has been initiated in the area of Digital Health (Tele-Medicine).

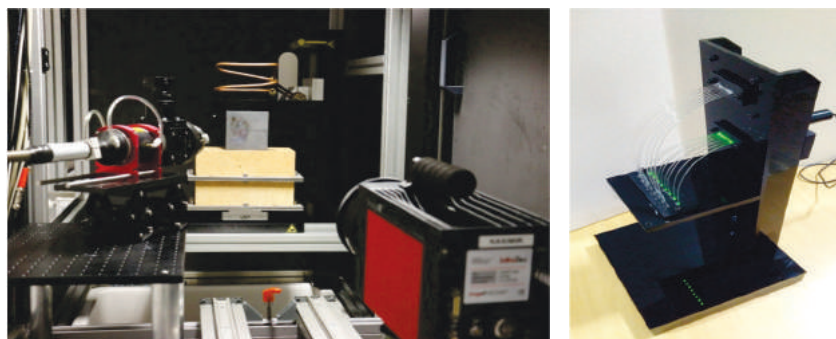
### **Indo-German Science and Technology Centre (IGSTC)**

Indo-German Science & Technology Centre (IGSTC), the binational Centre between India (DST) and Germany (BMBF) to promote industrially relevant R&D partnership on PPP mode entered into its seventh year of existence. The 2+2 model, connecting academia and industry for translation of research results into products/processes and services received widespread acceptance as a unique model of research partnership for socio-economic contribution through technological interventions.

During the year 2017-18, IGSTC supported 21 joint projects in 2+2 mode in emerging areas of (i) sustainable energy (ii) advanced manufacturing (iii) biomedical devices & biotechnology (iv) water & wastewater technologies (v) nanotechnology and (vi) embedded system & ICT (vii) energy materials, energy storage and (viii) water biosensors & wastewater technologies. This also includes six new projects from Call 2016 in the thematic area Smart Cities. Currently, ongoing IGSTC projects involve 84 project partners from academia and industry from India and Approximately 250 scientists, researchers, engineers from both countries are networked through this program.

In conjunction with the 9th GB meeting of IGSTC held on 24-25th October 2017 in Jodhpur, IGSTC organised its Partners Meet. The Partners Meet was aimed to demonstrate the progress and outcome of the completed projects so far. The GB also approved the launch of two new programs on (i) Indo-German Industrial and Academia R&D Network Call aimed at promoting application oriented joint R&D activity through virtual R&D Networked Centres and (ii) Industrial Research Fellowship for PhD and Post-doctoral students in an industrial research set up in Germany for capacity building among researchers at an early stage of their career.

IGSTC continued the implementation of the DST-Max Planck Program on behalf of DST. This program has provided an excellent opportunity to the Indian young scientists to partner with the global leaders at the Max Planck Institutes in Germany through a networked model of cooperation. Currently IGSTC is implementing seven Partner Groups and 14 Visiting Fellowships.



**Experimental Setup for high temperature laser Fiber Array Sensor with Laser and CCD detector thermographic**

### Indo-U.S. Science and Technology Forum (IUSSTF)

The Indo-U.S. Science and Technology Forum (IUSSTF) is a bilateral body that acts as a catalyst to promote and support scientific collaborations between India and the U.S through partnerships amongst scientists, scientific institutions and the entrepreneurial community of both countries. The activities of IUSSTF are broadly grouped into four categories: (i) Scientific Networking; (ii) Innovation and Entrepreneurship; (iii) Research and Development & (iv) Visitations and Fellowships.

Scientific Networking: Emphasizing the importance of collaborative research in significant areas of science and technology, eighteen Indo-U.S. Bilateral Workshops focusing research on Atmospheric and Earth Sciences, Engineering Sciences, Life Sciences, Medical Sciences and Physical Sciences were supported this year. Likewise to facilitate linkage and seamless connectivity among two research groups working on specific collaborations in both the countries, grant support was awarded to thirteen Virtual R&D Networked Centers. The support is for an extended period of two years.

In the space of Innovation and Entrepreneurship IUSSTF through the United States–India Science & Technology Endowment Fund provides hand holding to promising joint Indo-American Technology Start-ups. The Innovators are supported to develop and commercialize products under two broad categories i.e. ‘Health Citizens’ and ‘Empowering Citizens’. This year against its 8th Call for Proposals, IUSSTF received an unprecedented response of 452 applications. Presently 19 projects are ongoing. The impact has been realized through launch of more than 16 co-developed products like Affordable Mechanical Ventilator, Solar Electric Tractor, Affordable Digital Braille Accessibility, Low-cost, Portable Auto refractor, Transformational Modular Roofing Solution, to quote a few.



Affordable Mechanical Ventilator



Affordable Digital Braille Accessibility



Solar Electric Tractor

Other landmark programs include the DST-Lockheed Martin India Innovation Growth Program (IIGP) and Women Entrepreneur Quest (WEQ). IIGP aims to create an ecosystem enabling entrepreneurs to develop technology-based solutions for betterment of society. Similarly, Women Entrepreneur Quest (WEQ) identifies and rewards 10 women entrepreneurs who are founders of technology start-ups by taking them for an experiential learning program in Silicon Valley.

The Joint Clean Energy R&D Centre (JCERDC) an initiative of the Ministry of Science and Technology and the U.S. Department of Energy Partnership for Advancement of Clean Energy Research (PACE-R). The aim is to facilitate joint research and development of clean energy technologies. Support was continued to the final phase of three ongoing consortia established on Solar Energy, Second Generation Biofuels and Energy Efficiency of Buildings. During 2017-18, a new consortium titled “UI-ASSIST: U.S.-India collaborative for smart distribution System with Storage” under the Smart Grids and Energy Storage track, was selected for award under JCERDC: Phase II. The Indian team of Indo-US Grand Challenge: Affordable Blood Pressure Technologies for Low Resource Settings in India and U.S has generated 3 patents and 20 publications.

Recognizing the importance of developing online River Water and Air Quality Monitoring (WAQM) systems, DST and Intel Corp. collaborated to initiate research in this area. Under the Air Quality Monitoring category, two projects were awarded on Streaming Analytics over Temporal Variables from Air quality Monitoring (Lead Institution: IIT Kanpur) and High Resolution Air Quality Monitoring and Air Pollutant Data Analytics (Lead Institution: IISc Bangalore). Correspondingly, under the Water Quality Monitoring category, two projects supported were on Design and Development of Aquatic Autonomous Observatory for In situ Monitoring, Real Time Data Transmission and Web based Visualization (Lead Institution: IIT Kanpur) and Integrated low cost water sensors for real- time river water monitoring and decision- making (Lead Institution: IIT Delhi).

With a spirit to promote Research and Capacity building in frontline areas of Science & Technology, IUSSTF implements several Visitation Programs. The aim is to provide Indian & American researchers scientific exposure, access to world class facilities, interact with peers and build long-term R&D linkages & collaborations. During this year IUSSTF in along with several Federal agencies, Industry, Professional Bodies and Not for-profit Organizations administered 14 Visitation Programs. These programs provided opportunity to almost 225 Indian and US student & researcher to exchanges visits through programs namely, SN Bose Fellowships, Viterbi-India program, Research Internship in Science and Engineering, Bhaskara Advance Solar Energy Research Fellowships, Graduate Research Opportunities World Wide (GROW)-India, Initiative for Research and Innovation in Science (IRIS), SERB Indo-U.S. Postdoctoral Fellowships for Indian Researchers and Others.

## **B. Regional and Multilateral Cooperation**

The Department continued to play its mandated role in fostering India’s regional and multilateral science and technology cooperation frameworks at inter-governmental level with a view to make a positive contributions, gainful consequences and spin offs in : (i) Enlarging India’s pursuit of influence in global arena/platforms and mainstreaming Science, Technology and Innovation (STI) into international diplomacy and foreign relations; (ii) Moving up the ranks for India’s scientific excellence in the global research landscape; (iii) Leveraging foreign alliances and partnerships to accelerate key priorities and programs devoted to strengthening India’s national science and technology (S&T)/ Research and Development (R&D) competencies-capabilities-access to technologies.

India's regional and multilateral S&T cooperation related functions performed during the year included the following:

- Coordination of negotiation, conclusion, implementation and monitoring of India's international regional and multilateral S&T cooperation agreements/frameworks and related S&T Program of Cooperation (**India's S&T Cooperation with EU, ASEAN, BRICS, IBSA, SAARC, BIMSTEC, ASEM, EAS, e-Asia**);
- India's engagements vis-à-vis S&T aspects of UN and other international organizations (**India's S&T engagements with NAM S&T Centre, UNESCO-TWAS-ICTP, UNCSTD, OECD, IOR-ARC**);and
- Indian perspectives at S & T Ministerial Multilateral Platforms and its spin offs ( **G20, Carnegie Group Meetings and its spin offs like GSO-GRI, Science and Technology for Society Forum**).

These functions ,in sync with India's overall foreign policy, were carried out in close consultation with Ministry of External Affairs, NITI Aayog, Ministry of Commerce and Industry, Ministry of Human Resources Development (MHRD), Scientific Ministries/Agencies, National Scientific Expert Committee on the Indian side and with DSTcounterparts abroad for regional- multilateral entities-UN and international organizations dealing in S&T.

Brief account on some of the significant India's multilateral and regional STI cooperation program's framework, key achievements is given in the following paragraphs:

### **India-European Union Science and Technology Cooperation**

The 11<sup>th</sup> India-EU Steering Committee on Science and Technology took place in Brussels on 6 June 2017, co-chaired by the Director-General for Research and Innovation Mr Robert-Jan Smits and the Secretary of the Department of Science and Technology (DST), Prof. Ashutosh Sharma, with the participation of government representatives and thematic experts from both sides.



11th India-EU Steering Committee on Science and Technology in Brussels, 6 June, 2017



Pursuant to decisions of this meeting, following actions were initiated.

- (i) Joint India-EU Water Call was launched on November 7, 2017 with focus on wastewater treatment technology including bioremediation, drinking water purification, real time water quality monitoring. Both sides together will co-invest €30 million to address these water challenges faced by India. From Indian side Department of Science and Technology and Department of Biotechnology are the funding agencies for this initiative while the EU side Directorate of Research and Innovation, European Commission is the funding partner.
- (ii) As a follow up action, to promote and disseminate the Call, information and networking events have been organized, first on 3<sup>rd</sup> November, 2017 in Delhi while the 2<sup>nd</sup> on 30 November 2017 in Bengaluru. The first event was participated by more than 195 professionals and the second by more than 120 delegates representing academia, industry professional and Government organizations from India and EU. A number of innovative ideas on the selected themes have been deliberated for demonstration and implementation.
- (iii) During 14<sup>th</sup> India-EU Summit held in New Delhi on 6 October 2017, the leaders agreed to scale-up cooperation under the renewed India-EU Science and Technology Cooperation Agreement in frontier areas of science and technology and in addressing current global challenges in particular in the areas of health, water and clean energy. They welcomed the agreement to launch a major joint flagship initiative of €30 million on water-related challenges reflecting the pressing need to cooperate on technological and scientific knowledge and management capacities to cope with increasing stress on water resources. Both sides agreed to work towards reciprocal opening of the EU Framework Programme for Research and Innovation 'Horizon 2020' and Indian programmes, and called for an intensified two-way mobility of researchers. To this extent, the two sides welcomed the conclusion of the Implementing Arrangement between the Science & Engineering Research Board (SERB) and the European Research Council (ERC).
- (iv) Furthermore, both sides had shown strong mutual interest in collaboration in the areas of Smart Grids, Health, Advanced Materials and Nanotechnology, Bio-economy, ICT and Polar research. In case of Smart Grids, development of demonstration projects to convert existing research results into concrete applications on the ground and to showcase the excellent cooperation between the EU and India would be the aim for collaboration.
- (v) The two sides agreed to develop innovation cooperation between India and Europe. The focus of cooperation would be on creation of networks of science parks, technology business incubators and SMEs; encouraging and supporting start-ups, linking up start-up coaching networks and platforms; creation of cross-cultural talent pools for converting ideas into solution in domains such as ICT, materials, water, health, energy, natural disaster risk reduction and resilience.
- (vi) The meeting reiterated that EU-India Co-Funding Mechanism(CFM) Calls across all domains of HORIZON 2020 will be pursued which are of India's interest, according to its internal rules &



procedures .They also agreed to co-brand and jointly promote the cooperation actions and new opportunities more actively to increase participation and ownership from both sides

- (vii) Four India-EU member States Joint R&D projects in the areas of bio-economy were funded by DST and counterpart funding agencies from Europe. These projects aims at bio based energy and; research and innovation action in bio-economy.

### **Outcomes & Impact of India-EU Water Projects**

The DST, with the main objective to adopt and foster proven European technologies to demonstrate potable water and waste water treatment systems has promoted the deployment of a number of established and innovative technologies to provide affordable, accessible and sustainable solutions to address the challenges to provide safe potable and recycled water in varied geographic, climatic and societal conditions under India-EU S&T agreement for multilateral scientific cooperation. Technologies like Constructed Wetlands- Vertical flow and Horizontal flow with enhanced natural aeration, French Type, SBR and MBR, Soil Scape Filter System, Horizontal Roughing Filtration (HRF), Slow Sand Filtration, Activated Carbon Filtration (ACF), mixed oxidants, Modified UASB-R, Solar Driven Anodic Oxidation (AO) and Ultra-Violet (UV) disinfection System, UASB- High Rate Algal Pond combination, Ballasted Flocculation, Anaerobic Treatment, Mobile Anaerobic Sludge Digesting, Closed vessel composting system and bioremediation, suitably modified and deployed in varied combinations in more than 18 locations distributed all over the country proved to be successful in serving populations varying from 5000 to 20000 in providing safe drinking water and treated black and grey water from 500m<sup>3</sup> to 5MLD for multiple reuse to meet urban user demands, gardening, horticulture, irrigation, aquaculture etc.. These establishments with a provision for seamless replication and up-scaling have demonstrated their efficacy to maintain the levels of BOD, COD, TSS, TN, TP, DO, Pathogen removal in treated water as per BIS standards apart from being eco-friendly and low energy demanding. They also proved to significantly reduce stress on fresh water demands while contributing to resource recovery and safe and smart disposal and management of treated residual reject with low O&M and Capital investment costs, and skilled manpower requirements. These technologies, built as community based decentralized systems proved to be self contained and self-sustained utilizing indigenous technology, media and macrophytes to a reasonable level. Providing safe arsenic free safe drinking water using an integrated catchment treatment approach, simple and effective treatment and distribution systems, solar energy and stakeholder participation proved to be highly rewarding in remote and inaccessible areas. Use of solar energy for generation of chlorine from raw sewage using anodic oxidation, UV disinfection, pumping ground water and uninterrupted power supply for SCADA enabled modules is a novel innovation in these endeavours.

### Waste water treatment technology deployed at different locations



Site	Kharagpur, West Bengal
Type of Technology	Anaerobic and natural treatment plant for black-water treatment
Type of Wastewater	Blackwater
Design Flow Rate	300 m <sup>3</sup> /day
Desired Effluent Quality	BOD<30 mg/L, TSS<50 mg/L
Intended Reuse	Agriculture
No. of Beneficiaries	1500 persons

Anaerobic and natural treatment plant for black-water treatment, Kharagpur, West Bengal (IIT Kharagpur and CENTA, Spain)



Type of Wastewater	Combined
Flow Rate	30-100 m <sup>3</sup> /day
Effluent Quality	BOD < 10 mg/L, TSS < 10 mg/L,
Intended Reuse	Non-Potable urban Resue
No. of Beneficiaries	300-1000

HY-SAF Package wastewater Treatment Plant, Rishikesh, Uttarakhand (On the bank of River Ganga)- IIT Roorkee and HYDROK –UK

### Outcomes and impact of India-EU/Member States Energy project

Under the framework of India-EU Member States New Indigo Program, seven multi-countries projects were supported in the areas of New Energy Materials and Smart Grids. The projects are coordinated by leading Indian research organisations such as IITs- Delhi, Kanpur, Madras; IICT Hyderabad, CGCRI Kolkata, Amrita University, VIT Vellore from Indian side and leading research institutes from Europe such as Max Planck Institute for Polymer Research, Germany University of Freiburg, Germany, University of Antwerp, Belgium, Institute for Energy Research IFE, Kjeller, Norway; Istanbul Technical Univ, Turkey, Fortiss, Germany VTT, Finland; Evoleo Technologies, Portugal, Institute of Photonic Technology (IPHT) Jena, Germany; Nanoscience Center (NSC), University of Jyväskylä (JYU), Finland, University Trondheim (NTNU), Norway, University of Applied Sciences, Bremerhaven, Germany, Gaziosmanpaşa University, Turkey etc.

The collaboration has significant tangible outcomes cover 55 research publications (10 Joint publications), exchange of researchers (453 outbound/475 inbound), capacity building (29 Master/PhD PDF and 22 other), 14 joint scientific workshops. Apart from this, these projects have provided value addition by co-generation of knowledge and technology. The scientific output include development of Multi-functional Nanocomposite Materials for Low Temperature Ceramic Fuel Cells (**NanoMFC**), constructed Low-cost and efficient electrode assemblies and demonstrated power output of 1 W/m<sup>2</sup> using wastewater as the feedstock in an MFC using continuous mode operation (**Bio-eMat**); A state-of-the-art computational model was developed for phase change and heat storage characteristics in salt hydrate PCM (**INOTES**); designed and developed new material systems, and its DFT calculations, synthesis of pure phase binary, ternary and quaternary systems for PEC applications (**INSOL**); CZTS thin films have been prepared using a single alloy target and characterized. CdS thin films have been prepared and by Chemical bath (dip coating) technique. CZTS thin films are being prepared with individual targets. CZTS/ CdS solar cells (of area 1.65 cm<sup>2</sup>) have been prepared and an AM 1.5 efficiency of 1.5% has been achieved (**PVMARS**); Power distribution system reconfiguration methodologies are developed by IIT Kanpur (**STABELIZE-E**). The methodology can be applied for intentional as well as emergency reconfiguration. A lookup table based methodology and a Hopfield network based methodology is proposed for real-time reconfiguration of the distribution network.

### **BRICS Science and Technology Cooperation**

The 5<sup>th</sup> BRICS Science, Technology and Innovation (STI) Ministerial Meeting was held on 18 July, 2017 at Hangzhou, China. This was preceded by 7<sup>th</sup> BRICS STI Senior Officials Meeting on 17<sup>th</sup> July, 2018. The high level delegation from India participated in these meetings. BRICS Ministerial Meeting commended that the BRICS scientific identity under the BRICS STI Cooperation MoU is growing. The BRICS Young Scientist Forum/Conclave is becoming an effective platform to network young creative talent. BRICS research and development projects on cost sharing basis are being rolled out and are offering experienced researchers to collaborate in the fields of materials sciences, photonics, biomedical sciences, energy, ICT amongst others.

The meeting endorsed setting up of the BRICS Innovation Cooperation Action Plan 2017-2020 and its implementation through dedicated Working Group to foster science and technology led innovation and entrepreneurship partnership, with provision of attracting investments across BRICS. The Terms of Reference for this Working Group prepared by India was duly endorsed by Ministerial meeting.

The meeting also endorsed updated BRICS STI Work Plan 2015-18 which include organizing fifteen thematic Workshops/Working Groups Meetings, 3<sup>rd</sup> BRICS Young Scientist Conclave and launching of 2<sup>nd</sup> BRICS Call for Proposals for BRICS multi-countries projects.

### **Signing BRICS Action Plan for Innovation Cooperation 2017-2020**

An Action Plan for BRICS Innovation Cooperation (2017-2020) was signed between the BRICS Governments on 5<sup>th</sup> September 2017 at IXth BRICS Summit in Xiamen, China. The objectives of the

BRICS Innovation Action Plan are to promote and undertake innovation cooperation and facilitate innovation-driven development among BRICS countries for sustainable development of the world economy as well as to build long-term BRICS Science, Technology, Innovation and Entrepreneurship Partnership. The BRICS Innovation cooperation under the BRICS Innovation Action Plan is to be realized through: promoting exchanges and good practices among the BRICS countries on innovation strategies and policies; encouraging cooperation among science parks including supporting the transnational establishment of BRICS hi-tech enterprises in S&T parks, and tech companies; Promoting BRICS Partnerships on Youth Innovation and Entrepreneurship, and to create a favourable ecosystem for innovation and entrepreneurship amongst the younger generation; A dedicated BRICS Science Technology Innovation and Entrepreneurship Partnership (STIEP) Working Group will be constituted who will be responsible for the development of mechanisms and opportunities to implement the Action Plan with initial focus on two deliverables namely: (i) Creation of networks of science parks, technology business incubators and SMEs, and (ii) Creation of cross-cultural talent pools for converting ideas into solution in domains of ICT, materials, water, health, energy, natural disaster risk reduction and resilience etc. The Department of Science and Technology, Government of India from India and the counterpart Ministries/Departments from other BRICS countries shall be the implementing agencies the said Action Plan.

### **BRICS Science, Technology, Innovation, Entrepreneurship Partnership**

India is steering the BRICS Science, Technology, Innovation, Entrepreneurship Partnership (BRICS STIEP). Accordingly, the first BRICS Science, Technology, Innovation, Entrepreneurship Partnership Meeting (BRICS STIEP) hosted by India at the National Institute of Advanced Studies, Bengaluru on April 9, 2017 was attended by BRICS Science, Technology and Innovation focal points in Brazil, Russia, India, China and experts from India in the area. The Meeting recognized the potential among BRICS, of co-creation of affordable, functional, scaleable and innovative products and solutions. It agreed to establish a dedicated BRICS Working Group on Science, Technology, Innovation, Entrepreneurship Partnership (BRICS STIEP), which would be instrumental in promoting dialogue on policies, strategies, best practices and addressing challenges related to innovation and entrepreneurship-led development.

The Terms of Reference (ToRs) of this Working Group have since been finalized to draw the BRICS STIEP roadmap, funding mechanisms and kick off actions during 2017-2018. To begin with, the actions will focus on two deliverables namely: (i) Creation of networks of science parks, technology business incubators and SMEs, and (ii) Creation of cross-cultural talent pools for converting ideas into solution in domains of ICT, materials, water, health, energy, natural disaster risk reduction and resilience etc.

### **BRICS Young Scientists Conclave**

25 Indian participants (20 young scientists and 5 key-note speakers/experts/officials) participated in the 2<sup>nd</sup> edition of the BRICS Young Scientist Conclave which was held at Hangzhou, China during 11-15 July 2017. The BYS Conclave covered the three thematic topics namely energy, material and



biotechnology & biomedicine. The 5 day event was hosted by the Ministry of Science & Technology of China under BRICS framework. The BYS Conclave aimed at engaging, connecting and networking bright and talented youth in the age group of 22-35 years of age drawn from science, engineering and allied disciplines.

### **BRICS multilateral R&D projects**

2016 BRICS Call for R&D Proposals led to 198 eligible applications. 26 BRICS R&D projects have been chosen for grant related procedures. India partners in 22 of these. Material Science, Biomedicine Science, Astronomy, Photonics are the key research fields in which success in response & selection has been noteworthy. The 5th Science Technology and Innovation Ministerial Meeting held in Hangzhou, China on 18 July 2017 noted this development. These projects were supported in the areas of Material Science and Nano technology, Biotechnology and Biomedicine, Photonics, Astronomy, New and Renewable Energy, Prevention and Monitoring of Natural Disaster, ICT & High Performance Computing, Ocean and Polar Sciences, Geospatial technology applications.

Keeping huge response in the first Call, 2017 BRICS Call for proposal was launched for multi-countries project in six thematic areas namely Advanced Material & nanotechnology, Biotechnology & Biomedicine, New and renewable energy & energy efficiency, Natural Disaster Mitigation, Water resources and pollution treatments, ICT and will be supported by 8 funding agencies from BRICS Countries including India.

### **BRICS cooperation in Area of Astronomy**

Astronomy has been identified as one of the areas of Cooperation among BRICS with South Africa in the lead. India hosted the Workshop and the 3rd meeting of the BRICS Working Group on Astronomy at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune on 21-22 September 2017. A framework of BRICS cooperation in Astronomy was finalized that provides details of strengths of each BRICS country in Astronomy and BRICS modalities of engagement in astronomy and the implementation plan. The framework also provides indicative areas of cooperation in astronomy among BRICS countries and includes : cosmology, galaxy formation and evolution, stellar and compact object astrophysics, astronomy related instrumentation, technology, and infrastructure, big data Science. In the future, India aims at leveraging BRICS complementarities for national gains and also contribute to world astronomy.



**3rd meeting of the Working Group on BRICS Astronomy at the IUCAA, Pune 21-22 September 2017**



## India-ASEAN S&T Cooperation program

Subsequent to the enhancement of ASEAN-India Science & Technology Development Fund (AISTDF) to 5 Million USD, jointly shared by Department of Science & Technology (DST) and Ministry of External Affairs (MEA), the Secretariat of AISTDF has been setup at Science & Engineering Research Board (SERB). The web portal and electronic project management system (ePPMS) of AISTDF has been developed for online submission, receipt and monitoring of the project proposals under AISTDF.

The announcements for inviting collaborative R&D proposals and Research & Training Fellowships for ASEAN Researchers for attachment at Indian Institutes were launched. 10 collaborative R&D proposals in the abroad areas of advanced materials, Electronics and ICT, Bio-energy and Biotechnology has been shortlisted for support for a period of 3 years.

The concept note for ASEAN-India Innovation Platform (Idea to solution) is under finalization with ASEAN Secretariat. The AIIP shall have following components-

- Inclusive Innovation (social challenges)
- Research Innovation (technology commercialization)
- Product & Service Innovation (private sector)

50 (5 from each ASEAN Member State) ASEAN School Children and Teachers were supported for participation in National Children Science Congress of India held in Science City, Ahmadabad (Gujarat) during 26-31 December 2017.

A 5 member Indian team comprising scientists/ experts/ professionals and officials etc. from IMRC Division DST, Institute of Genomics, New Delhi; National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) Sonipat, National Institute of Nutrition (NIN), Hyderabad and FICCI, New Delhi attended and participated in the ASEAN-Food Conference held at Ho Chi Minh City, Vietnam during 14-17 November 2017 which was attended by about 500 students, Food experts/ researchers/ educationist / technologists/ entrepreneurs etc. from ASEAN Member States. The Indian delegates delivered key note lectures in their respective sessions. India and ASEAN agreed to strengthen cooperation in Food S&T through following mechanisms –

- Networking of ASEAN and Indian R&D institutions
- Networking and connecting ASEAN-India private food companies
- Organizing ASEAN-India Food Conference in India.

## South-South and extended neighbourhood Cooperation

### Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre)

The Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM

S&T Centre) is an inter-governmental organisation with 48 member countries. India is a founder member and also the host country of the Centre. DST as the designated Focal Point for the Centre in India has been paying the annual membership contribution on behalf of India and has also been nominating Indian researchers and experts to participate in various scientific activities of the Centre.

The meeting of the 14<sup>th</sup> Governing Council (GC) of the NAM S&T Centre was held in Putrajaya, Malaysia during 6-7 September 2017. India was represented by Head (IMRC) DST and a representative from Indian High Commission in Kuala Lumpur, Malaysia. The Governing Council reviewed the ongoing activities of the NAM S&T Centre and approved the calendar of scientific events/activities to be organized by NAM S&T Centre during next one year. India proposed that an international integrated review of NAM S&T Centre for re-imagining NAM S&T Centre for next decade is highly desirable to be in tune with current realities, context and needs.

#### **Research Training Fellowship for Developing Countries Scientists (RTF-DCS)**

50 (Fifty) Fellowships were awarded among 30 developing countries in various fields of Science & Technology. These 50 researchers from developing countries will be attached to Indian research Institutes/Universities/Laboratories for carrying out their research work for a period of 6 months. The Government of India (through DST) is supporting entire expenses including fellowship amount, international airfare and research contingencies etc. for hosting in India these 50 fellows from Developing countries.

#### **Bay of Bengal Initiative for Multi Sectoral Technical & Economic Cooperation (BIMSTEC)**

The 4<sup>th</sup> Meeting of the BIMSTEC Expert Group on establishment of BIMSTEC Technology Transfer Facility (TTF), was held during 21-22 November 2017 at Colombo, Srilanka. The Meeting was hosted by Ministry of Science & Technology (MoST) and was coordinated by BIMSTEC Secretariat, Dhaka Bangladesh. The Meeting was inaugurated by Hon'ble Minister of Science & Technology of Sri Lanka. The main purpose of the Meeting was to finalize the draft text of the Memorandum of Association (MoA) among BIMSTEC countries for establishment of BIMSTEC Technology Transfer Facility at Colombo, Srilanka.

The Meeting finalized the text of the MoA to be concluded between BIMSTEC member countries (i.e. Bangladesh, Bhutan, India, Myanmar, Nepal, Srilanka and Thailand) during next BIMSTEC Summit which is likely to take place in Nepal in first quarter of 2018.

#### **DST STI engagements with the Group of 20 Countries (G20) / Science 20 (S20)**

For the first time, the science and research community is included in the G20 process in 2017 as "Science20"(S20) Forum. DST Actively contributed to the G20/ S20 Science agenda process emphasizing on Science, Technology, Innovation and Entrepreneurship cooperation to achieve SDGs, Accordingly, the first S20 Forum on "Improving Global Health: Strategies and Tools to Combat Communicable and Non-Communicable Diseases", was held on March 22, 2017, at Leopoldina,

Halle, Germany. The S20 recommendations called for: (1) Reliable and Resilient health system; (2) Addressing broader social, environmental and economic determinants of health and (3) Developing strategic instruments for ensuring access to health resources globally (vaccine, diagnostic medical devices, therapeutic drugs at affordable prices). India aims at leverage G20/ S20 STI cooperation in the future, for national gains.

### **India participation in the 14th S&T Ministerial Roundtable during the Science and Technology in Society Forum (STS Forum), Japan**

Secretary DSIR and DG CSIR led DST delegation participated in the inaugural session of the 14<sup>th</sup> STS forum on October 1, 2017 that drew nearly 1400 global leaders in science and Technology, policy-making, business and media from nearly 80 countries, regions and international organizations. The delegation also participated in the 14<sup>th</sup> S&T Ministerial Roundtable on the theme: “The Role of Science, Technology and Innovation for Future Society- Human-Centred Society to be Realized through Society 5.0”. India called for compassion driven S&T as part of common wealth for all societies and nations. The Ministerial, among others emphasized the key role of governments in the S&T Policies; higher education; and inclusiveness and protection of private data in view of concerns around digitization. The meeting called for S&T cooperation to meet the diversified challenges of societies across the globe and in the area of food, water, security and aging.

### **India (DST) contributions to development of Global Research Infrastructure (GSO-GRI)**

DST has been contributing to the global initiative on co- development and management of, existing and future-single sited and distributed, big research infrastructure. The Group has since finalized a framework that has been tested on some select research infrastructures DST participated in the 10<sup>th</sup> Meeting of the Group of Senior Officials on development of Global Research Infrastructure consisting of the G8 countries, EU and emerging economies including India (GSO-GRI) held on 9-10 October 2017 in Dubna, Russia. India reiterated its interest in the International Mouse Phenotyping Consortium (IMPC) project and also extended its offer of exploring international participation in the LIGO project, co-hosted by India. It floated the concept of innovations in development of GRIs that has since been used for building the approach paper of GSO-GRI on “Global Open Innovations” for future agenda.

### **India contribution to recognising talent in Mathematics in the developing countries through award of ‘ Ramanujan Prize’**

The ICTP ‘Ramanujan Prize of US\$ 15000, to acknowledge outstanding contributions by Young Mathematician Scientists from the developing countries, is being funded by Govt. of India (DST) for a period of five years, from 2014 onwards. The 2017 Ramanujan Prize has been awarded to Eduardo Teixeira of the Federal University of Ceará, Brazil. The prize is in recognition of Teixeira’s outstanding work in Analysis and Partial Differential Equations (PDE), his original approach to the regularity of degenerate elliptic equations, which consists in viewing the set of critical points of a solution as a free

boundary, leading to the solution of several outstanding open problems. He was awarded the prize in a ceremony held at ICTP, Trieste, Italy.

### **Review of International Science and Technology Cooperation schemes**

Review of DST coordinated International Science and Technology Cooperation schemes was done by an external review committee. After considering the scientific achievements and geopolitical advantages that has been evidently accrued over the last 3 to 4 years through the multifaceted programs implemented, the Committee unanimously concluded the continuation of the scheme with some observations and recommendations.

# INNOVATION, TECHNOLOGY DEVELOPMENT AND DEPLOYMENT

Innovation, technology development and deployment forms an important component of multidimensional activities of the Department aiming at development of relevant technologies e.g. clean energy, water, waste management, advanced manufacturing, etc.; initiate programmes on emerging and futuristic technologies e.g. Cyber-Physical-Systems; deployment and demonstration of successful technology solutions; support specific programmes addressing the challenges faced by the underprivileged sections of society and less endowed regions of the country; promote start-up, innovation and incubation ecosystem; and developing scientific temper in the society. A brief description of major activities carried out under this component is given below:

## 1. Technology Development Programme

Technology Development Programme (TDP) aims to convert proof-of-concepts for technologies/ techniques/ processes/products into advance prototypes for validation and demonstration in field settings. The main objectives of the program include:

- Support R&D for development of innovative technologies in identified areas.
- Promote application of advanced technology for improving the performance and value addition to existing technology.
- Capacity building in the area of technology development in terms of human resource and infra-structure.

The sub schemes of TDP are:

**Advanced Manufacturing Technologies (AMT)** focuses on areas like Digital Manufacturing - Design tools, process innovations, modelling & simulation platforms, near net shape processing, Flexible scale & Additive manufacturing (AM), Production scale materials processing, Smart Manufacturing - Automation and Information & Communication Technologies (ICT); Robotics (AR) & Industrial Internet of Things (IIOT), Manufacturing low power electronics.

**Biomedical Device and Technology Development (BDTD)** focuses on development of devices and related technologies for Medical and Healthcare applications. The targeted categories include screening, diagnostic, surgical and life support equipment for clinical applications in healthcare sector.



**Device Development Programme (DDP)** promotes and supports Research, Design and Development (RD&D) of devices.

**Technology Development Programme** facilitates and supports development of products /techniques/ technology aimed at specific end use.

**Technology Platform for Electric Mobility (TPEM)** primarily focuses on supporting R&D for Lithium ion Battery, Charging Devices, Motors & Drives and Driving Cycle/ Traffic Pattern & Light weighting.

**Waste Management Technologies (WMT)** program aims to promote the development of suitable technologies with potential to ameliorate the environmental load from the huge amount of residuals generated by industrial development and consumption lifestyle. The specific objectives of the Programme include: Take stock of technological development, assess, analyse and look for material recycling systems with low environment loading and improve upon them or find better alternatives; Develop waste management technologies that can be adopted in small & medium scale enterprises in order to improve their productivity and global competitiveness; and Establish techno-economic feasibility of proposed methodologies/ technologies.

**New initiatives:**

- **Technology Compendium:** The detailed information of 39 technologies developed and demonstrated in field through technology development programmes has been compiled.
- **Science and Heritage Research Initiative (SHRI)** envisages to engage experts from diverse fields for data capture and analysis to form new collaborations and provide viable technology to address cultural heritage related issues. The programme was launched by Hon'ble Union Ministers for S&T on October 13, 2017 during 3<sup>rd</sup> India International Science Festival (IISF)-2017 held at Chennai.



- **Agro-technologies:** Stakeholders Consultation on Science, Technology & Innovation in Agriculture was organised on Sept. 01, 2017 at MNIT, Jaipur, Rajasthan. Shri Sudarshan Bhagat, Hon'ble Minister of State for Agriculture & Farmers Welfare, GoI graced the event and delivered inaugural address.

- **Brainstorming meet** was organized at National Institute of Technology, Delhi on Nov. 27, 2017 to identify the potential technology leads in Opto-electronic, laser based and biosensor based device development catering to needs of different industrial sectors.



- **Landfill Reclamation:** DST has constituted a scientific advisory committee on the request of Govt. of Delhi for the reclamation of sanitary landfill site. The committee recommended short term, medium term and long term measures and action plan to the concerned municipal bodies.

Total 800 project proposals were received during 2017-18 under various sub schemes of Technology Development Program and 100 new technology development projects have been recommended for funding by the respective Expert Advisory Committees by following a stringent systematic evaluation mechanism. 25 projects were successfully completed and some leading technologies demonstrated in field are as follows:

### 1. **Continuous Ragi Mudde Making Machine by CSIR-Central Food Technological Research Institute, Mysuru**

The production of ragi mudde in large scale was felt very difficult to many catering institutions, student hostels, industries and restaurant due to existing manual method of batch type operations. It is a quite cumbersome manual process which undergoes three stages to get the final product namely preparation of ragi porridge and addition of ragi powder followed by vigorous mixing and final cooking and then



made in to round balls. Design and development of continuous Ragi mudde (finger millet ball) machine has been worked out to develop a commercially viable prototype machine, which can produce ragi mudde continuously in a hygienic manner, economically and reducing the drudgery of a cooking chef. The commercially viable machine was inaugurated by Hon'ble Former Prime Minister Sri H. D. Deve Gowda.

**2. Incorporation of Additional Soil Micronutrients Testing with Fertilizer by Raja Balwant Singh College, Agra**

Additional Soil Micronutrients Testing facility for analyzing Boron (B) and Molybdenum (Mo) in soil on colour chart basis by chemical reactions has been developed and incorporated in existing FERTICHECK™ soil testing kit. Around 110 soil samples were collected from different places in India and tests were performed to study the variation in results according to the developed tests and validated with standard methods of soil testing. Conclusively the existing FERTICHECK™ soil testing kit, now has facility for testing 14 parameters (pH, EC, OC, N, P, K, Cu, Zn, Fe, S, Mn, Cl, B and Mo) which has been validated for its performance by Indira Gandhi Agricultural University, Raipur and ICAR-CPRI, Modipuram. The cost of these two additional micronutrients has been set at Rs.55/- while the testing facility for additional 2 micronutrients (Magnesium and Calcium) are currently under process.



FERTICHECK™ Soil testing kit

**3. Designing, Development and Calibration of PM2.5, PM10 High-Volume Sampler by CSIR-National Physical Laboratory, New Delhi.**

High-Volume PM2.5 Impactor Sampler is developed by CSIR-National Physical Laboratory (NPL), New Delhi under a project supported by Technology Development and Transfer Division. This technology involves a novel design of PM<sub>2.5</sub> impactor sampler, which segregates particulate matter (PM) > 2.5 µm size (aerodynamic diameter) and facilitate to collect ≤ 2.5 µm size particles



suspended in ambient air on filter size 8 inch × 10 inch with a high-flow rate (1.13 m<sup>3</sup>/min, i.e. 40 cfm). The technology was transferred to M/s Environmental Solutions, C-24, Sector-85, Noida (UP) on September 25, 2017.

4. **Design and Development of Tele-Medicine based health care unit for diabetic disorder (InDiatel – A Telemedicine based Diabetic Healthcare Unit) by VIT, Vellore**



InDiatel is a device that is designed to acquire various physiological data from patients suffering from Diabetes. The captured physiological data from the patients can be sent to Doctors, Nursing Stations, Clinics using wireless communication. This system uses Wi Fi technology for communication. Medical specialists can monitor the health of the patients from distant locations. The system can be wirelessly connected to a desktop, laptop, netbook or similar computer system with standard Microsoft Windows. InDiatel has been developed as a product in association with M/s TMI Systems Bangalore and launched on 8<sup>th</sup> Dec, 2017 by VIT, Vellore.



**InDiatel – A Telemedicine based Diabetic Healthcare Unit**

5. **Resource recovery from Waste Electrical and Electronic Equipment's (WEEE): Eco-friendly technology for recycling plastics and metallic components by CIPET, Bhubaneswar**

WEEE referred to as the waste generated from waste electrical & electronic equipment is among the fastest growing waste stream. WEEE constitutes of various valuable metals like gold, copper, palladium as well as very high grade engineering plastics. High Impact grade, improved Flow Grade, FR grade and improved Impact with Better flow grade engineering plastics have been validated for many high end applications with reduction in cost & improved process parameters

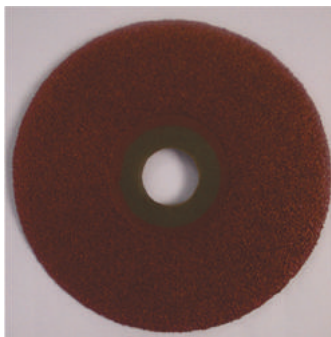
as well. Currently, the laboratory is seeking interested Entrepreneurs for technology transfer and the process is under progress.



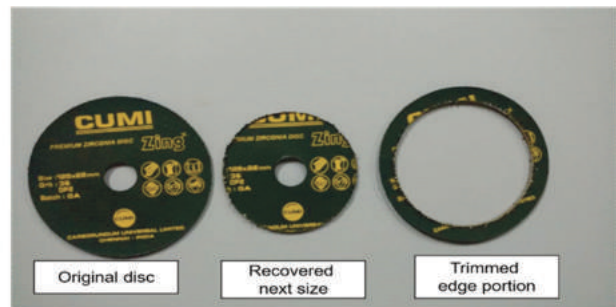
Various products from WEEE

**6. Reclamation of Abrasives from Bonded, Coated and Sanitary ware rejects by SSN College of Engineering, Chennai**

During the production of vitrified products, approximately 3-5% will be as rejects which contains valuable tough and hard roasted grains. Centre for Product Development (CPD) of SSN College of Engineering, Chennai has successfully developed coated abrasive discs from the recovered abrasive grains. Technology proves the utility of vitrified reclaimed grains in Coated abrasive disc products, to the tune of 50% replacement of virgin grains by reclaimed grains, without loss in performance. In addition, the lab is equipped with coated size reduction machine which will convert the used disc to next usable size without fraying the edges. At present, the laboratory is interacting with industry for commercializing the coated disc product to the market.



Developed products from the recovered grain



Backing portion is shown. The other side has abrasive grains.

Size reduced discs



### 7. Direct Recycling of Polystyrene Waste using Orange Peel Extract by Indian Institute of Technology, Hyderabad

A new technology was developed to recycle waste polystyrene using another agriculture waste (citrus peel extract) into a non-woven fabric. Polystyrene (e.g. thermocol) is a non-biodegradable materials leading to serious impact on health and environment as a waste. This fabric can selectively absorb oil and are hydrophobic, and therefore can be used for a wide variety of applications including households (kitchen napkins), to flexible packaging to global requirement of oil spillage remediation. For technology transfer and commercialization, a start-up company, M/s. Restyro Technologies Private Limited ([www.restyro.com](http://www.restyro.com)) was incubated at IIT Hyderabad. This project Won (i) Gold Medal in Indian International Innovation Fair, Sept. 9-11, 2016 at Vishakapatnam, A.P. (ii) Gold Medal in International Trade Fair for Ideas, Innovations and New Products (iENA) in Germany on Nov. 2-5, 2017 (iii) Gold Medal in 2nd World Invention and Innovation Fair (WIIF), China (Nov. 23-25, 2017).

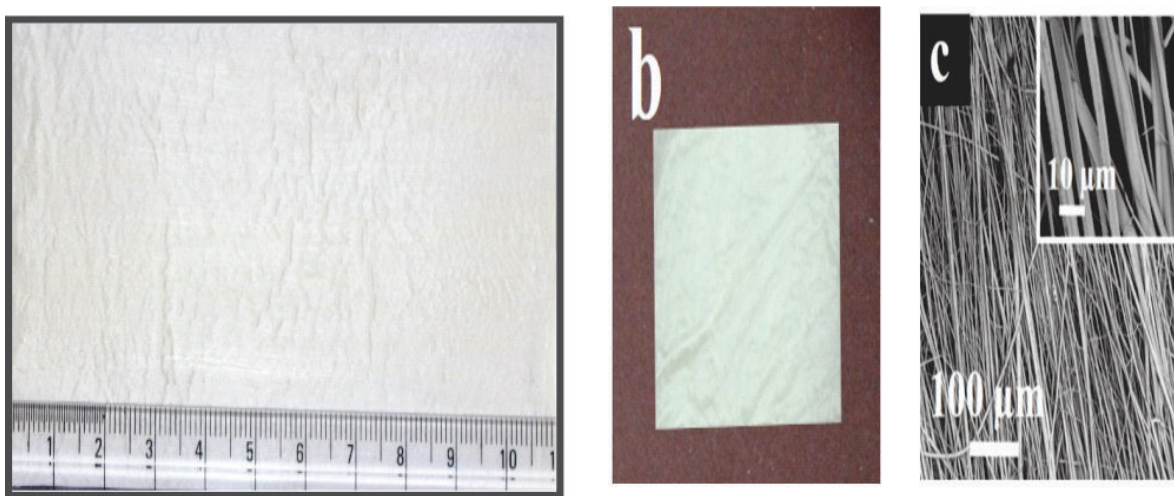
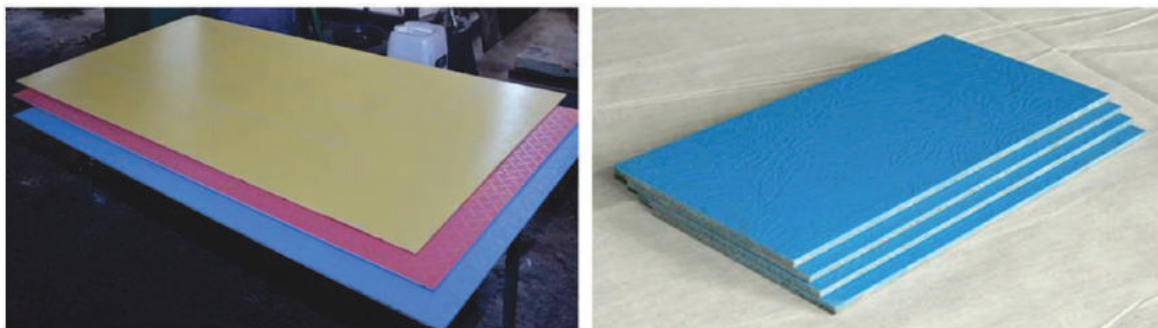


Figure: (a) and (b) digital image of recycled PS fabric; (c) high magnification SEM images showing the fibers

### 9. Manufacturing Hybrid Light Weight, High Strength and Glossy Finish, Polymeric Composites from Marble & Granite Waste Stream by CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal

Technology developed for making green composites by utilisation of marble and granite wastes. It is evident from this study that the developed hybrid green composites can be used as viable alternative materials for timber, synthetic wood and plastics for use in civil infrastructure. To generate awareness and confidence an Industry Institution Enclave (IIE) 2017 was organized in Coimbatore where hybrid green composites made from marble wastes were showcased.

Networking with few promising entrepreneurs and start-ups have also been established for commercial exploitation.



Hybrid green composite panels developed at CSIR-AMPRI using marble wastes collected from Rajasthan

#### 10. Advanced Non-toxic of Radiation Shielding Materials of Strategic Importance utilizing Industrial Wastes by CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal

The group has developed Advanced Non-toxic Radiation Shielding Materials of strategic importance using industrial waste. The Aluminium industry waste i.e. Red Mud is used for development of synthetic radiation shielding aggregates by minerologically designing and ceramic processing. The developed Red Mud based synthetic shielding aggregates will replace conventionally used iron ore hematite aggregates for making heavy density radiation shielding concrete. Under the project, a “Centre for Advanced Radiation Shielding Materials” which is the first of its kind in India is under establishment at CSIR-AMPRI, Bhopal.



Red Mud

Synthetic Shielding Aggregate

Radiation Shielding Concrete

#### Good Laboratory Practice (GLP) Compliance

Good Laboratory Practice (GLP) is a quality system under which non-clinical health and environmental safety studies are conducted on various chemicals viz. Industrial Chemicals, Pharmaceuticals, Pesticides, Veterinary Drugs, Cosmetics, Food additives, Feed Additives etc. The National Good Laboratory Practice Compliance Monitoring Authority (NGCMA) was set up under the administrative control of Department of Science and Technology (DST) in August, 2002 to provide GLP certification

to the test facilities, which are involved in conducting safety studies on such chemicals in accordance with Organization for Economic Co-operation and Development (OECD) Principles of GLP. India is a full adherent to OECD Council Acts related to Mutual Acceptance of Data (MAD) since March 3, 2011, which ensures that the data generated by the GLP certified Test facilities in India is acceptable in the 35 member-countries of the OECD and other countries, thus removing the technical barriers to trade.

Some of the major achievements of the Indian GLP programme during the financial year 2017-18 are given below:

- **Six new test facilities were granted the GLP-compliance status.** These include:
  - a) Ross Life science Private Limited, Pune
  - b) Dabur Research Foundation, Ghaziabad
  - c) Anthem Biosciences Private Limited, Bengaluru
  - d) Meghmani Organics Ltd., Ahmedabad
  - e) Sipra Labs Limited, Hyderabad
  - f) CSIR – Central Drug Research Institute, Lucknow
- **Seven test facilities werere-certified.** These include:
  - a) sA-FORD, Raigad
  - b) Toxicity Testing: GLP Test Facility, CSIR- Indian Institute of Toxicology Research, Lucknow
  - c) Vivo Bio Tech Ltd, Pregnapur, Medak District
  - d) R&D Center, PI Industries Limited, Udaipur
  - e) Bionees India Private Limited, Bengaluru
  - f) Centre for Toxicology and Developmental Research, Chennai
  - g) Drug Safety Assessment, Novel Drug Discovery and Development, Lupin Limited (Research Park), Pune
- **Surveillance inspection of the following test facilities was conducted and their GLP-compliance status was continued till the validity of current GLP certificate :**
  - a) Himalaya Drug Company, Bangalore
  - b) Syngenta Biosciences, Goa
  - c) Zydus Research Centre, Ahmedabad
  - d) Vimta Labs Limited, Hyderabad
  - e) Vanta Biosciences, Chennai
  - f) National Toxicology Centre, National Institute of Pharmaceutical Education and Research, Mohali

- g) Upasi Tea Research Foundation, Valparai
- **Surveillance cum extension in scope inspection of the following test facilities was conducted, their compliance status was continued and GLP-compliance status was granted in additional areas of expertise:**
  - a) Palampur Biosciences Pvt. Ltd., Mahabubnagar
  - b) Natural Remedies, Bengaluru
  - c) Krish Biotech Research Private Limited, Kalyani (WB)
- **Joint-inspection and Study Audits with United States Food and Drug Administration were conducted for the test facility Bionees India Private Limited, Bangaloreas per Mutual Acceptance of Data Agreement of OECD Working Group on GLP.**
- **The following training courses were organized by NGCMA:**
  - o Sensitization Workshop on GLP – May 8&9, 2017
  - o Training Course For QA Personnel of GLP Test Facilities – July 19-21, 2017
  - o Training Course for Test Item Control Officers of GLP Test Facilities – August 31, 2017
  - o Refresher Training Course for GLP Inspectors - October 26&27, 2017
  - o Sensitization Workshop on GLP – November 20&21, 2017

On the OECD front, a representative of NGCMA, India attended the 31<sup>st</sup> meeting of OECD's Working Group on GLP. Further, India has been elected as a member for conducting the On-site evaluation of the GLP Monitoring Authority of Japan (Workplace Chemicals).

## Patent Facilitation Programme

Patent Facilitation Centre (PFC) is functioning at the Technology Information Forecasting and Assessment Council (TIFAC). It has been mandated to create awareness on Intellectual Property Rights (IPRs), facilitate filing, obtaining and maintaining patents free of cost. It also provides patent information as an input to R&D and handles IPR policy matters. In addition to the awareness and training, it is actively engaged in the implementation of the National IPR Policy.

During the year following activities were implemented:

### 1. Patent/IP Facilitation

**Patent/IP Filing:** PFC has assessed the patentability of about 50 new cases on behalf of academic and government organisations; out of which 6 new patent applications were filed in India and 2 PCT applications were filed in other countries.

**Patent Grant:** During this period 12 Indian patents, one Australian patent and one European patent have been granted.

## 2. National IPR Policy

PFC is assisting for implementation of the National IPR Policy. Two task force have been constituted for:

- i. Enhancing IPR output of universities and government institutions, to address issues like division of royalty etc.
- ii. Industry academia collaboration and IPR sharing, preparation of standard templates for technology transfer and other related issues.
- iii. A separate Committee has also been constituted to prepare IPR toolkit.

## 3. IPR Awareness Workshops and Training

Conducted three one day IPR Awareness Workshops at Itanagar, Arunachal Pradesh in association with Patent Information Centre, Arunachal Pradesh State Council of Science & Technology on May 25-26, 2017; NIT Kurukshetra on September 22, 2017 and Desh Bhagat University, Mandi Gobindgarh in Punjab in association with PIC Punjab on November 28, 2017 respectively. **500 participants** were benefited by these workshops.

## 4. Specialised IPR Workshop with UNIDO

Two workshops were organised on Patents and IPRs in association with UNIDO International Centre for Inclusive & Sustainable Industrial Development (IC-ISID at Ludhiana for bicycle sector on June 8-9<sup>th</sup> 2017 and Saharanpur for pulp and paper sector on June 2-3<sup>rd</sup> 2017 respectively.

5. **Training of Trainer:** The training of trainer programme was organised in Delhi for creating awareness about National IPR Policy for a duration of one week. It was supported by Department of Industrial Policy and Promotion (DIPP) and 30 candidates attended the programme out of which 16 have been certified as TIFAC-CIPAM trainers (The Cell for IPR Promotions & Management (CIPAM) is a professional body under aegis of DIPP). The participants included 23 alumni of KIRAN IPR and 7 from National Productivity Council (NPC).

## 2. Technical Research Centres

This programme was launched as a follow-up of the budget announcement made by the Hon'ble Finance Minister of India in his Budget Speech in FY 2014-15. Accordingly, Technical Research Centres (TRCs) were established in 5 DST institutions namely, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandru;, International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad; Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru; Indian Association for the Cultivation of Science (IACS), Kolkata; and S.N. Bose National Centre for Basic Sciences, Kolkata during FY 2015-16.

Support to these five TRCs continued during the year. These institutions continued work as per their



specific targets to carry out applied and translational research in their respective domains. Significant progress was made in all the TRCs as detailed below:

**SCTIMST, Trivandrum:** During the year, four new technology development projects were initiated, taking the total number to 28. Four new projects were also initiated during the year under Medical Device Regulatory Compliance and Certification Facility (MDRCF) programme enhancing the number to 11. The Industry-Institute Partnership Cell (IIPC) conducted four Workshops during the year in the area of medical device development and characterization.

Significant progress was reported in all the activities undertaken under the TRC project. During the year, 14 patents were filed enhancing the number to 18. The 2<sup>nd</sup> Technology Conclave & Industrial Meet was organized during May 15-16, 2017 at SCTIMST, Trivandrum which aimed at promoting R&D projects with potential industrial partners for taking them to the commercialization stage. The Hon'ble Union Minister for Health and Family Welfare, Shri J.P. Nadda inaugurated the event. The 1<sup>st</sup> Technology from this project, "A wound healing matrix from porcine cholecystic – extracellular matrix" was transferred to an Industry, Optimus Life Sciences, Ltd, Trivandrum during the event. The product is a scaffold derived from animal tissue meant for wound healing, cornea repair and hernia repair.



**Hon'ble Union Minister for Health and Family Welfare handing over the License for Commercialization to Optimus Life Sciences, Ltd.**

**ARCI, Hyderabad:** TRC at ARCI had initiated applied R&D in five broad areas — solar energy (concentrated solar-thermal power, photovoltaic), energy storage (batteries and super capacitors), energy efficiency (motors, waste heat recovery, magnetic refrigerator, turbines and coatings), energy conversion (fuel cells) and electric/hybrid vehicle systems (involving Li-ion batteries with battery management systems, electric motors etc.). During the year, applied R&D work gained further momentum in these areas in the 16 projects mentioned below.

1. Li-ion batteries electric vehicles (EVs) and battery management system.
2. Motors for EVs and various other automotive applications.
3. Waste heat recovery using thermoelectric modules.
4. Proton-exchange membrane (PEM) fuel cell for materials handling devices (Forklifts).

5. PEM fuel cell based power supply systems.
6. High temperature stable nanocomposite solar absorber coatings for concentrated solar-thermal power (CSP) applications.
7. Highly transparent dust repellent coatings for photovoltaic (PV) panels and aluminium reflectors.
8. Oxide dispersion strengthened (ODS) steels for gas turbine blades.
9. Electric bus based on charging by supercapacitors.
10. Metal-air battery for back-up energy storage systems.
11. Transparent perovskite solar cell modules for functional windows in energy-efficient buildings.
12. Broadband anti-reflective coatings for CSP and PV applications.
13. Community solar parking lot based on perovskite solar roof.
14. Nanoink and pulsed electro-deposition (PED) based  $\text{Cu}_2\text{ZnSnS}_4$  (CZTS) solar cells for building integrated photovoltaic (BIPV) applications.
15. Ozone-friendly magnetic refrigerators – an alternative to conventional cooling technology for energy savings.
16. 50 kW Copper Indium Gallium Selenide (CIGS) thin film modules for DC power applications.

The work on developing the above mentioned 16 technologies/products for automotive and other sectors progressed further and these technologies continued to move up to the higher technology readiness levels during the year. 14 Indian industries expressed interest in these technologies. The project resulted in 1 Patent and one more was filed; 7 journal publications; 2 conference publications; and 2 Book Chapters.

**JNCASR, Bengaluru:** TRC at JNCASR had initiated eight applied R&D projects viz. Application of SERS for non-PCR based RNA/DNA detection of HIV, Development of diagnostic probe/agents for Alzheimer's disease (in-cellulo studies), Materials and devices for 'Waste heat to electrical energy' conversion, Diagnostics for Candida species detection in clinical samples, Solution processed solar cell – development, performance monitoring and prototypes, Renewable energy, Organic phosphorescent materials, and Organic porous materials for  $\text{H}_2$  storage and catalytic  $\text{H}_2$  generation and adsorptive based separations (separation of C8 isomers, and  $\text{C}_2\text{H}_2$  from  $\text{C}_2\text{H}_4$ ). During the year, work on these projects progressed further to attain higher technology readiness levels.

Work on three new projects was initiated during the year, viz., Industry scale carbon dioxide reduction from coal power plant flue stream to produce methanol and other high value fuels. Injectable sealant: new technology to prevent surgical site infection, and Controlled delivery of pheromone of key lepidopteran pest of rice, corn, brinjal and citrus.

During the year, 2 Patents were filed and 2 Start-ups were created. The project also resulted in 4

research publications in reputed international journals.

**IACS, Kolkata:** TRC at IACS has initiated applied R&D in four areas — Quantum materials for application, Materials for energy and environment, Polymers, disordered, soft and nano-bio materials for devices, diagnostics and therapeutics and Molecules: Understanding, making and exploring commercial viability.

During the year, applied R&D work gained further momentum for development of 4 Technologies/ Products which are progressing towards higher technology readiness levels.

**S.N. Bose National Centre for Basic Sciences, Kolkata:** TRC at SN Bose Centre has initiated applied R&D in four areas — Healthcare: non-invasive diagnostics, Environment, Mitigation of Food adulteration and food security, and Metal and alloy industry.

During the year, applied R&D work gained further momentum for development of 10 Technologies/ Products which are moving towards higher technology readiness level. Work on 3 new technologies initiated during the year.

### 3. Clean Energy Research Initiative

Clean Energy Research Initiative (CERI) aims to develop national capacities and capabilities in developing research led competitive and cost effective clean energy and energy efficiency options for power and non-power applications. The areas of research are identified through stakeholder consultation based on national needs. The research spectrum covers entire gamut of clean energy viz. smart grid, off grid, energy storage, building energy efficiency, cleaner fuels, clean coal and energy materials. It supports both upstream end of research where knowledge, more advanced than the current practice in the industry finds a space. It also envisages to successively enhance Technology Readiness Level (TRL) of promising options in partnership with industries and other stakeholders. The programme has close linkage with concerned line ministries and stakeholders for identification of research needs. During the year 2017-18, several new dimensions were added to the programme to accelerate the pace of clean innovations to meet national needs as well as international commitments.

1. **Mission Innovation:** Mission Innovation (MI) is a global initiative of 22 countries and European Union to dramatically accelerate global clean energy innovation. Participating nations have committed to double their governments' clean energy research and development (R&D) investments over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies. Participated in Strategic Dialogues on Effective Public-Private Cooperation on Clean Energy Innovation at Mexico City held from 11-14 September 2017. More than 130 attendees participated from top universities and research institutions. The keynote speakers and panellists included Nobel Laureate Dr. Mario Molina and 11 country representatives from Mission Innovation countries (Canada, Denmark, EU, India, Italy, Mexico, Saudi Arabia, UK, and the US) and observers from the private and public sectors.

### **1.1 Mission Innovation Challenge #1: Smart Grids**

The Challenge targets innovation and deployment of reliable, efficient and affordable smart grids technologies at regional, distribution and micro-grids levels in various geographical areas to achieve the ability to accommodate 100% renewable based energy sources in power grids. In addition, IC#1 takes into account the aspects related to cross innovation, which focus on smart grids related fields such as power electronics, electric materials, simulations and ICT.

The IC#1 on smart grids is co-led by China, India and Italy. Participant countries include Australia, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Indonesia, Italy, Mexico, Norway, Saudi Arabia, South Korea, Sweden, The Netherlands, United Kingdom, United States of America and the European Commission.

DST organized MI India Workshop on Smart Grid on 22<sup>nd</sup> May 2017 at IIT-Delhi to identify R&D themes relevant to challenge objectives. A Funding Opportunity Announcement (FOA) was announced in June 2017 earmarking US \$ 5 million for collaborative projects with MI countries at MI Ministerial-2 in Beijing, China. 115 proposals were received out of which 28 were screened for next level. India conducted the second International Mission Innovation Smart Grids Workshop on 16-18 November, 2017 at IIT Delhi. Delegates from India as well as 12 Mission Innovation Countries participated in the event along with the Industry. An Exhibition was also conducted on 18<sup>th</sup> November, 2017 to showcase the work taken under by Government bodies as well as Industries.

### **1.2 Mission Innovation Challenge #2: Off Grid Access to Electricity**

Innovation challenges on “Off grid access to electricity” has larger objectives to support significant reduction in price and increase performance of renewable power systems by 2020 for individual homes in off grid region and for remote communities. The objective is to demonstrate in diverse geographic and climate conditions, the robust, reliable, autonomous operation of renewable power systems less than at a significant lower cost than today.

India organised the first MI-India Workshop on “Off Grid Access to Electricity Innovation Challenge” on 23<sup>rd</sup> May, 2017 at IIT Delhi. Based on the R&D needs identified at the workshop, a Funding Opportunity Announcement (FOA) was announced in June 2017 earmarking US \$ 5 million for collaborative projects with MI countries at MI Ministerial-2 in Beijing, China. More than 80 proposals have been received and are in advance stage of evaluation. DST also participated in the International Workshop on theme to identify areas for collaboration. A synthesis document was also prepared detailing spectrum of activities, institutions and research priorities of participating countries.

### **1.3 Mission Innovation Challenge #6: Clean Energy Materials: First MI-India Workshop**



on “Clean Energy Materials Innovation Challenge” was organized on 17th August 2017 at TERI University, New Delhi in order to identify country’s research priorities in conformity to the goals of Innovation Challenge for Clean Energy and develop the country status report in this area. The event was attended by scientists, industry, utilities and other stakeholders together to discuss & deliberate on the work done in area of Clean Energy Materials and exploring collaboration opportunities under Mission Innovation.



Participants of Clean Energy Workshop at TERI, New Delhi

The Department of Science and Technology (DST) participated in Mission Innovation’s (MI’s) Clean Energy Materials Innovation Challenge, an International Experts’ workshop at Mexico City in the month of September, 2017. The aim of the workshop was to support the Innovation Challenge’s goal of accelerating the exploration, discovery and use of new, high-performance, low-cost clean energy materials by at least ten times.

**1.4 Mission Innovation Challenge #7: Affordable Heating and Cooling of Buildings:** DST with CEPT University and Alliance for Energy Efficiency Economy (AEEE) organised a workshop on Affordable Heating and Cooling of Buildings on Aug 1, 2017 in New Delhi.

The objective of the workshop was to create awareness about Innovation Challenge # 7 and discusses India’s priorities in the area of “Affordable Heating and Cooling of Buildings” and Explore possibilities for India’s R&D initiatives. The discussion culminated in identification of a set of R&D priorities and development of R&D status report on the same. DST delegation participated in International Workshop at Abu Dhabi and made important contribution in all 6 thematic subareas including storage and physiological studies in which India is taking a lead.

**2. Expo 2017 “Future Energy”:** DST showcased five working models on “Future Energy” in the India Pavilion at largest International event on clean energy during June 10th - September 10th,

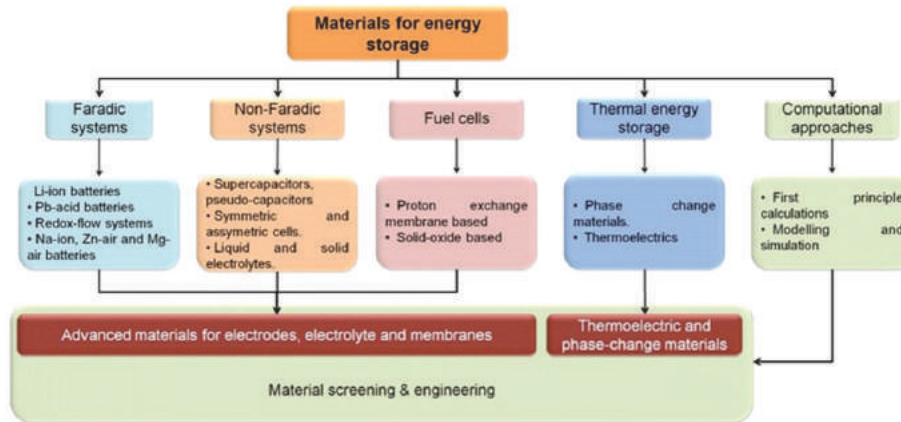


2017 at Astana, Kazakhstan. It focused on development of renewable energy in India with focus on solar energy. DST demonstrated five working models and posters developed under the aegis of DST namely “Solar sea water desalination and thermal storage units, Shallow emitter silicon solar cell and modules process technology, Surya Jyoti – Micro Solar Dome, Hybrid Solar-Biomass Power Plant and Solar Inverter” exhibited in the India pavilion.



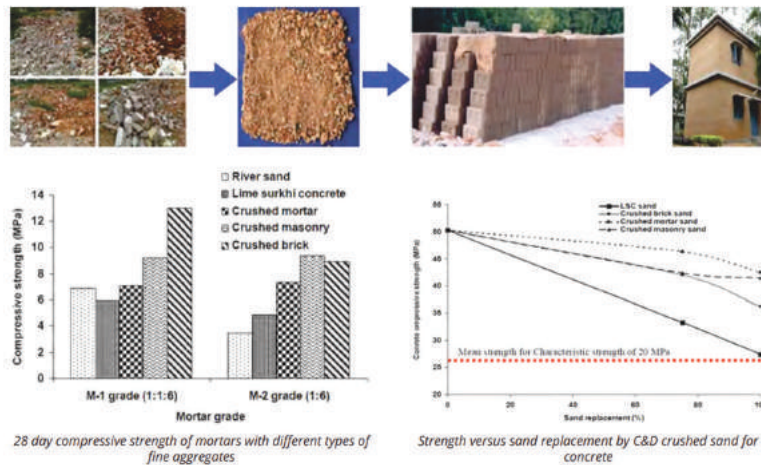
Showing working models on Future Energy

3. **Energy demand reduction in the Built Environment:** A joint India & UK research programme to help reduce energy demand in UK & India’s built stock, both new major urban developments’ currently being planned and existing built stock has been initiated with a commitment of £3.8M with matching support from DST to support R&D projects in the area of Energy demand reduction in the Built Environment. A call was announced in January, 2017 on the initiative. Total 22 proposals have been received against Call and 4 proposals have been initiated.
3. **Materials for Energy Storage (MES):** The initiative supports R&D activities aimed at innovative materials for energy storage and to build energy storage device with enhanced output for multifunctional applications. The initiative aims at the efficient use and further increase of renewable energy and demonstrating its value in terms of flexibility in the energy systems and is expected to lead to the outputs which would substantially enhance technology readiness of the applied research for targeted application/ use. A MES 2017 Call was launched in February, 2017 and added Research stream in addition to technology stream during the year. 125 proposals were received out of which 33 have been approved.



Programme Spectrum of Materials for Energy Storage

5. **Initiative to Promote Habitat Energy Efficiency (I-PHEE):** The initiative is geared to support enhancement of knowledge and practice to save energy in design, construction and operation of human habitats. The initiative also envisages support to India specific outcome based research in the areas of energy efficient building envelop technologies, low energy cooling systems, daylighting and electric lighting, building automation and controls for energy savings and research which can provide scientific weights to policy formulation and help devise procedures, codes and standards. During the year, 30 projects have been initiated.



6. **Solar Energy Research Institute for India and the United States (SERIUS):** The Solar Energy Research Institute for India and the United States (SERIUS) is co-led by the Indian Institute of Science (IISc)-Bangalore and the National Renewable Energy Laboratory (NREL). SERIUS carries out fundamental and applied research, analysis and assessment, outreach and workforce development through specific bi-national projects in three Research Thrusts of Sustainable Photovoltaics (PV), Multiscale Concentrated Solar Power (CSP) and Solar Energy Integration (SEI). The scientific highlights of current year is as follows:

- **Photovoltaic activities** continue to focus on developing ink-based components for roll-to-roll processing. There was focus on charge-selective contacts and transparent conductors. The team continues to look both at reliability and to develop new, more-aging-resistant materials based on the detailed examination of reliability data.
- **Concentrated solar power** made considerable progress toward developing an integrated Brayton-cycle system. Further progress has been made on the oil separator for the test loop and the control circuitry. A second test system has been made by HPCL for testing high-temperature molten salts synergistic with the test loop at IISc., Bangalore. In the organic Rankine cycle, a new expander design has been fabricated and is being tested at the University of Florida.
- **Solar Energy Integration analysis** has begun to evaluate the manufacturing costs for both a silicon manufacturing plant and a module assembly line in India given current costs and technology.

### Impact of work

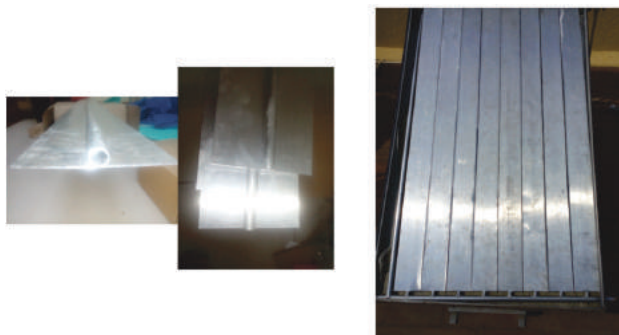
- New partners—Kodak and Sigma Aldrich—are now active in the roll-to-roll and organic photovoltaics (OPV) areas, respectively. Fluorine doped Organic active layers: Improved stability materials, Sigma-Aldrich is interested in making this a catalogue item.
- New Molten Salt Characterization System developed at HPCL, India.
- Supercritical CO<sub>2</sub> Brayton Cycle Test Facility at IISc Bangalore
- Online Analysis Tools: Atoms to Bankability, Basic Materials Properties, Solar and Reliability Data, SAM for India.
- Additionally, the Elsevier International Journal *Applied Thermal Engineering* published a special issue (Vol. 109, 2016) on “*Advances in Concentrating Solar Power Research – A SERIUS Initiative*”
- 250 publications have emanated out from scientific work carried out
- 9 Invention disclosures under SERIUS consortium.



Supercritical CO<sub>2</sub> Brayton Cycle Test Facility at IISc Bengaluru



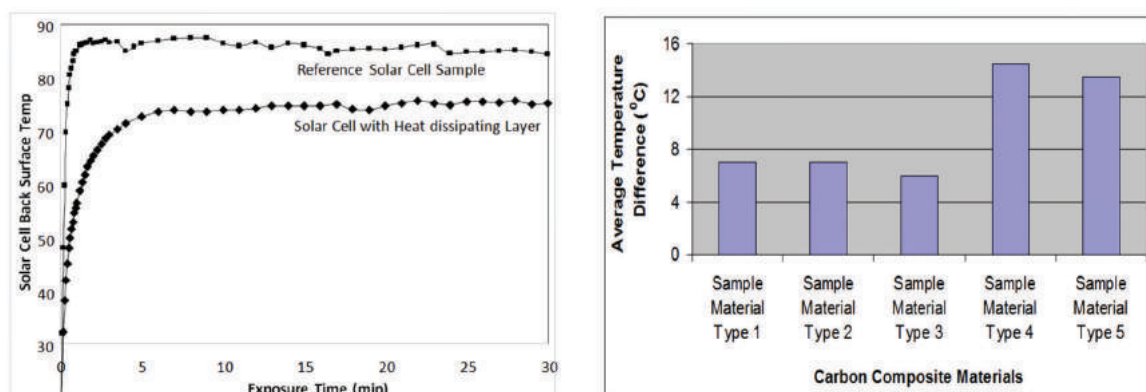
7. **Research & Development on Clean Coal Technologies:** Two Round Table meetings on Clean Coal Technologies in India: Current Status, Demands and Aspirations – Pathways to Achievements were held last year. During the Round Table meeting, thrust areas of relevance to India were identified. Call for inviting proposals on “R&D on Clean Coal technologies” was announced in February, 2017. 33 proposals were received against the call. 7 proposals have been recommended for funding.
8. **Technology Mission for Indian Railways (TMIR):** The programme is collaboration between the Department of Science and Technology (DST), Ministry of Railways (MoR), Ministry of Human Resource Development and Ministry of Industry on an investment sharing model for taking up identified research projects for applied research and use on Indian Railways. The objective is to develop state-of-the-art technologies defined by needs related to Indian conditions. DST has agreed to contribute Rs.75 crore in the TMIR.
9. **Research & Development on Production and Utilization of Methanol & Di-Methyl Ether (DME) as Sustainable Fuel:** DST initiated a major development programme for production of Methanol from various sources including Indian coal and CO<sub>2</sub> from thermal plants, steel plants etc. The programme would also include direct utilization as drop-in fuel in automobiles and fuel for fuel cell based vehicles. 8 projects have been supported during the year.
10. **Advanced Ultra Super Critical (AUSC) Thermal Power Plant –R&D Phase:** A consortium of three Government Entities, namely Bharat Heavy Electricals Limited (BHEL); Indira Gandhi Centre of Atomic Research (IGCAR) and National Thermal Power Corporation (NTPC) have formulated R&D project for development of AUSC Technology for Thermal Power Plants of future, envisaging reduced coal consumption as well as Carbon Di-oxide (CO<sub>2</sub>) emission. The project has a time cycle of two and a half years, with an estimated cost of Rs.1554 crore, with a contribution of Rs.270 crore from BHEL, Rs.50 crore from NTPC, Rs.234crore from IGCAR and Rs.100 crore from Department of Science and Technology (DST). Balance amount of Rs.900 crore will be contributed by Department of Heavy Industry (DHI) as grant. Accordingly, two proposals have been supported by DST to IGCAR, Kalpakkam- BHEL to develop advanced rotor testing facility and spin test rig for Dadri Plant using indigenous material.
11. **Integral Fin Extruded Aluminium Flat Plate Solar Water Heater (IISc, Bangalore):** A prototype solar water heating collector is being developed with extruded aluminum section having integral fins, for the purpose of demonstrating proof-of-concept of the new design. The new product not only has the potential to make indigenously made flat plate collectors compete favorably with



Different stages of fabrication of Extruded section produced at Hindalco's Renukoot plant

evacuated tube solar heaters (which have primarily imported parts), but also it can open up a new market for Aluminium which is abundant.

- 12. Efficiency Enhancement of Solar Cells & Panels using Thermal Cooling Layer (Amity University, UP):** The Group has developed a highly porous carbon based thermal cooling layer (TCL) composed of carbon powder and binder, which is simple, low cost and easy to fabricate. The carbon based porous TCL was inserted beneath the solar cell, which acts as heat dissipating agent in between the solar cell and ambient, which decreases the working temperature of the cell thereby increasing the efficiency of the device. One patent has been filed.



Experimental results of Thermal Cooling Layer

- 13. Joint Virtual Centre for Clean Energy:** India and UK together have set up virtual Joint Clean Energy Centre on Clean Energy focusing on integration of intermittent clean energy with storage for stable power supply at grid as well grid isolated communities at a total investment of £ 10 million.

The two Indian consortia led by IIT Kharagpur and IIT Bombay will bring together experts from national laboratories, universities and industry in both India and the UK to leverage their expertise and resources to unlock the huge potential of clean energy technologies. 2 research proposals were supported. The two Indo-UK Joint Virtual Clean Energy Centres were launched at Second International Mission Innovation Smart Grids Workshop on 18<sup>th</sup> November, 2017



Launching of two Indo-UK Joint Virtual Clean Energy Centres



#### 14. Smart Energy Grids and Energy Storage (SEGES)

DST with Engineering and Physical Sciences Research Council (EPSRC) has identified Smart Energy Grids and Energy Storage as areas of significance in providing solutions of meeting future energy needs. 5 research proposals were supported focusing. 9 national institutions were supported in these projects. These projects were show cased in the Second International Mission Innovation Smart Grids Workshop on 18 November, 2017 at IIT Delhi. Few achievements of these Projects are given below:

- A methodology has been developed based on Recurrence Quantification Analysis (RQA) for the clustering of generator dynamic behaviour.
- A new configuration of Dual Stator Winding Induction Generator (DSWIG), aimed at improving power density, has been developed for wind power integration to dc microgrid.
- An innovative hybrid energy storage sizing methodology is developed based on pinch analysis and design space approach to cater to the supply demand variability in renewable microgrid.
- Designed and developed prototype of a 5-kW back-to-back inverter for soft meshing applications. This is capable of modular expansion, with additional modules in parallel for transacting higher powers between asynchronous AC grids. Presently the prototype is capable of interfacing to LT voltage levels (415V, 3-phase) without any requirement of 50 Hz transformer.



SEGES PIs showcasing their Research at Smart Grids Workshop

#### New Projects initiated:

81 new projects have been supported during the year for R&D in the area of Solar Energy (30), Habitat Energy Efficiency (30), Built Environment (4), Cleaner Fuel Methanol (8), and Clean Coal (9).

#### 4. Water Technology Initiative

DST is implementing an initiative on Water Technology research and innovations to find out

appropriate technological solutions through field level interventions to demonstrate technical, social, environmental and eventually economic sustainable solution for water challenges. DST is supporting research and technology development in various water related areas. The research outcomes are expected to feed in and dovetailed with major national missions. DST moved into a thematic call based approach for soliciting proposals in identified water challenges of relevance to country. Based on above, WTI Call 2017 on Demand Driven convergent Water solution in mission mode was launched to address the challenges. The consortium essentially included at least a user having interest in the intervention, a solution designer and a solution provider. The call got an overwhelming response and 76 full proposals were submitted against the call which were evaluated out of which 12 proposals have been recommended for support. These proposals relate to water-energy nexus, desalination, waste water treatment, flood management, water supply and distribution systems, water conservation and water budgeting.

The Water Technology Research and Innovation Centres (WATER-IC) theme based Call-WTI 2017 was also launched for soliciting proposals to establish Virtual Networked Centres that can develop knowledge base to cater to the various water relevant issues through supporting R&D for water quality, quantity and recycle & reuse. These centres are expected to nurture knowledge, innovation, expertise through institutional and human capacity building of water researchers, professionals, community etc. and to address the gap areas in Water Technology research, development, demonstration, adaptation, adoption and commercialization of water. Creation of virtual networked centres will encourage synergistic joint programme on water technology, research & innovation through networking of competence, experience and expertise, it will also promote translational research and enabling mechanisms for last mile connectivity of the research findings into the field. 48 proposals have been received against the WIC Call and are under evaluation.

During the year, 39 new projects have been supported under research, technology and solution stream in 2017.

## **1. Development and Proving of Convergent Technology Solutions:-**

### ***1.1 Arsenic removing Technology based on nanomaterials***

A technological solution has been supported to IIT Madras (IITM) for deployment and validation of nanomaterials based arsenic removing technology in South 24 Parganas district of West Bengal. The project envisages to install 200 online units and 200 storage units and about 1000 domestic units covering a population of 100000 people. A field survey conducted through primary data collection has finalized the phase I project blocks as Baruipur and Sonarpur. An extensive grass root level work was conducted to identify the arsenic affected hand pumps in Baruipur block. Out of 2700 hand pumps in the block, 30 hand pumps have been shortlisted in 4 gram panchayats of Baruipur which are arsenic affected (ranges from 0.1 to 0.68 mg/L, above the WHO & BIS standards). In addition, 4 locations from Bishnupur I block

have also been identified to implement the Arsenic and Metal Removal by Indian Technology (AMRIT) technology. All the selected hand pumps have been validated based on various aspects including, water sample analysis, personal data collection from the villagers, cross verification with the existing water testing report from Public Health Engineering Department (PHED) lab, utilisation pattern, etc. In addition to the program implementation, setting up of Quality Monitoring Lab is also under progress.



### 1.2 Community Based Participatory Aquifer Management System for Providing Equity and Sustainability in Water Resource Management

A convergent solution that aims to develop a community based ground water conservation and augmentation model for 35 villages of Chirawa block, Jhunjhunu District. Improved first flush devices are incorporated in water conveyance system of 218 roof top rain water harvesting benefitting 3200 families. 875 Field demonstrations of improved agricultural practices for Rabi and Kharif crops have been undertaken in the farmers' field.



Prototype developed at CEERI Pilani

Geologic, geophysical, hydrologic and chemical data has been collected and analyzed to characterize the quantity, quality and sustainability of ground water in aquifers. To delineate the subsurface geology, depth and thickness of geoelectric layers and quality of ground water, Geophysical Electrical Resistivity Survey has been conducted at 110 Village Elementary School (VES) locations, in the study area of many villages of block Chirawa, district- Jhunjhunu. The field data have been collected and interpreted and the inferences are drawn on the basis of resistivity values of different layers and the nature of curves obtained from field data and its interpretation. Latitude, longitude and elevation of each location were recorded using GPS (Global Positioning system). In collaboration with Central Electronics Engineering Research Institute (CEERI) Pilani initial prototype of Portable Smart Phone based Water Quality Measurement System is under trial. The Internet of Things (IoT) enabled developed system are cost effective, low power, small size and also eliminates the errors due to human intervention and also efficiently stores the data on the cloud for further analysis.

### **1.3 *Deployment of cost effective biosand filter technology for promoting community health by addressing incidence of waterborne diseases in select villages of Bihar***

A field extensive project has been implemented to sensitize the rural communities about these issues and demonstrate the appropriate sustainable solutions. Presently innovative Bio-sand (JalKalp) water filter technology is being promoted to address arsenic, iron and pathogens in water as an innovative and cost effective alternative. 204 villages have been approached for sensitization and awareness building. Sensitization and awareness building is being carried out through small meetings with village communities. So far 337 meetings involving 5438 males and 4879 females carried out. Sensitization and awareness building is also being carried out in village schools for children. So far 37 sessions in different schools were carried out involving students of class 5<sup>th</sup> and above. 688 households adopted the JalKalp water filters and are satisfied with the performance of filter and the quality of filtered water. Quality of raw and filtered water is also tested in presence of community members for Arsenic, Iron and Biological contamination through field test kits. A safe water storage container has also been designed, produced and distributed to filter users.





## 2.0 Augmenting Water Quality:

### 2.1 *Development and Assessment of online Water quality monitoring technology*

A project has been supported to validate test kit for rapid water quality testing under both laboratory and field conditions through comparative assessments in state of Bihar. It involves developing valid scheme for acceptability; addressing regulatory, economic and social aspects.

Most of the study has been done in rural areas of south Bihar, field trips through out Bihar have been done and 8 districts are under study. 129 water samples have been collected and community responses have been recorded through questionnaire. A comparative analytical study on the 129 water samples collected from real field has been done using the German technology (Aquacheck 2) and the other commercially available kits. Special features like Real time data transfer as well as apps for data transfer are being integrated into the updated version of Aquacheck 2 i.e. Aquacheck 3 for the real time monitoring of water contaminants in field.



### 2.2 *Demonstration of deep Ultra Violet Light Emitting Diode (UV LED) based on Aluminium Gallium Nitride (AlGaN) for water sterilization*

A technology using deep UV LED based on Aluminium Gallium Nitride (AlGaN) is being developed in which it would be grown, fabricated and characterized in-house at (CeNSE) IISc, and secondly, use of such LEDs to sterilize water is being studied. Achieving UV emission from AlGaN has proved to be extremely challenging, worldwide, with a plethora of material & device issues and challenges in extracting deep UV light. And the methodology outlined in the project proposal is to first achieve epitaxial growth of high quality AlGaN thin films using MOCVD. On-wafer electroluminescence of indigenous LEDs will also be demonstrated with access to on-wafer testing facility.



### 2.3 *Development of a polymer based sensor for detecting nitrate in water*

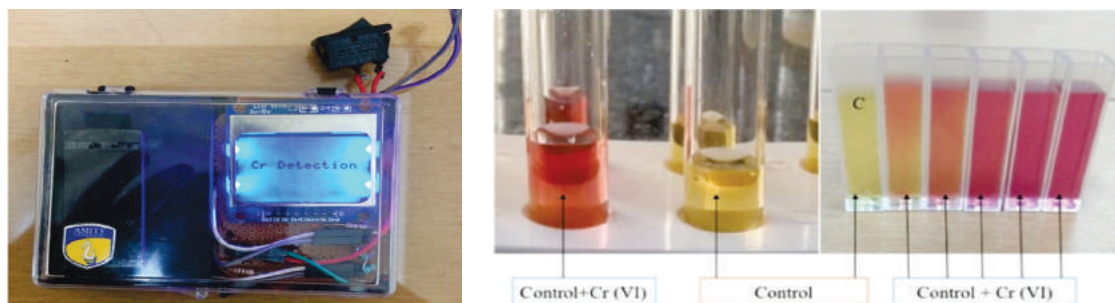
A handheld sensor measurement system has been designed and developed by Indian Institute of Science (IISc) Bangalore as a prototype for measuring nitrate ions in water. Prototype sensor testing apparatus has been fabricated; in addition android-based application was also developed for measuring change in resistance of the sensor in presence of nitrate ions.



Prototype connected to phone

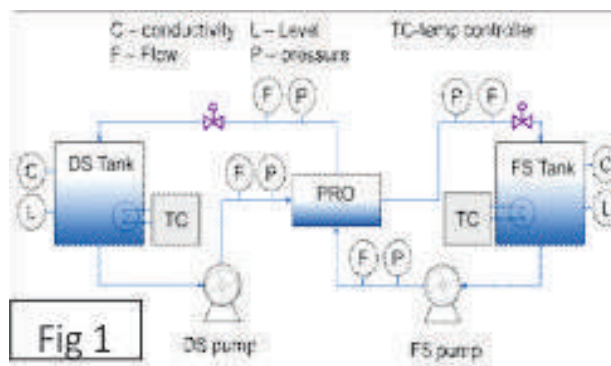
### 2.4 *Development of Colorimetric sensor for Cr (VI) detection:*

A prototype has been developed at Amity University based on the colorimetric determination of Cr VI in water with the use of nanomaterial. The device detects and quantifies the color complex for chromium detection. The device consists of a source, sample holder, detector and a microcontroller-processing unit with a display unit. The method does not interfere with any ions present in the water. In addition, the color complex formation takes 1-2 minutes compared to the conventional method of using diphenyl-carbazide that takes 10-15 minutes. Therefore, the present device can be used for chromium detection upto ppb level for on-field monitoring.



### 3.0 *Energy efficient Waste Water Treatment*

A lab scale system for Waste Water treatment with Membrane based efficient energy storage and clean energy generation has been supported at IIT Guwahati. Design and manufacturing of low cost membrane distillation unit is completed and lab scale testing is in progress. The development of lab scale experimental setup for integrated PRO and MD has also been done.



### 4.0 *Development of Real Time Wireless Embedded Multi-sensor System for Monitoring of RO Plants with Water Quality*

A smart monitoring station for RO plant was designed, developed and installed at five villages of Rajasthan nearby Pilani namely Tumkore, Budha ka bas, Deepalsar, Shivpura, Raboodi and in CEERI. The system has the facility to monitor flow rate of water, water quality parameters (pH and TDS), alarm signals of power failure etc. in a real time. The embedded monitoring units have internet connectivity to transfer real-time data on the server. A dedicated web page has been designed to monitor real-time data of different RO plant, water quality parameters and features like flow, power failure etc. The monitoring unit has HDMI based touch screen for human interface with ARM11 based processing and control unit for multi-sensor connectivity. The overall system consist of an ARM based embedded monitoring unit with actuation unit for relay installed for water quality sensing chamber. Power failure, over voltage and under voltage conditions have been monitored

based on phase failure relay unit feedback to embedded monitoring unit. Other than developed interface board has readout for all sensors and also actuation unit for sampling chamber.



RO plant with controller system

## 5.0 Capacity Building:

### 5.1 *Water Advanced Research & Innovation (WARI) fellowship program*

Recognizing the accomplishments of Daugherty Water for Food Institute, University of Nebraska (UNL), USA in the field of water resources, DST has partnered with UNL to implement a capacity building programme on water resources to support 15 fellowships and 15 interns for a period of 3 years. In the second year of the program 5 fellows and 6 interns have been exposed to relevant labs and groups at UNL for residencies for durations ranging from 3 months to one year.



## 6.0 International Cooperation:

### 6.1 *Indo-UK Collaboration on Water Quality Research in India and UK*

DST is implementing an initiative on Water Quality Research Programme in collaboration with NERC and EPSRC inviting proposals for a new 3-year research programme to improve water quality by providing a better understanding of the sources



and fate of different pollutants and by supporting the development of management strategies and technologies to reduce pollution levels. India and UK agreed on mounting a joint research initiative with a committed investment of £ 4.2 million from each side. The aim of this programme is to tackle India and UK’s water quality issues and secure the provision of clean water, rejuvenate rivers, and restore ecosystems. This joint programme envisages to support research for improved understanding of the sources, transport, transformation, interactions and fate of pollutants, and determining the risks they pose to both people and the environment. The call for this Research Initiative for request for proposals was launched in May 2017 with an over whelming response of 77 full proposals against the call. The Indo UK Joint Panel has recommended eight projects in the area of Water Quality Research.



**6.2 DST-Intel Collaborative Research on River and Air Quality Monitoring in PPP mode**



The Department of Science and Technology (DST), Govt. of India and Intel’s Corporate Research Council have collaborated to invite research proposals as part of a program titled “Research Initiative for Real-time River Water and Air Quality Monitoring” with an aim to develop key technologies for sensing, communication and analysis of large-scale data collected from autonomous networks of perpetual/long-lived sensor nodes, followed by integration and deployment for water and air quality monitoring in real-time. This real time data will significantly further strengthen and

complement the Missions of National priority like Namami Gange Programme and others by serving as critical data feeders for pre and post treatment analysis”. The program is being administered by the binational Indo U.S. Science and Technology Forum (IUSSTF). The call for this Research Initiative for request for proposals got an over whelming response of 50 proposals against the call. The evaluation process resulted in recommendation of total four projects, two in Air Quality Monitoring and two in Water Quality Monitoring.

## 5. Interdisciplinary Cyber-Physical-Systems

DST has identified the Interdisciplinary area of Cyber Physical Systems (ICPS) as one of the emerging fields, progress in which is expected to have significant impact on health care, urban transportation, water distribution, energy, urban air quality, manufacturing and governance. The *complex socio-technical systems*, involving interactions between ‘cyber’ and ‘physical’ are addressed by CPS technologies. The R&D activities envisioned under this program will provide a great fillip to Indian manufacturing via invention of new products and services, and the creation of skilled human resource at all levels (from technicians to, researchers, and entrepreneurs) and will become a key contributor in realizing the vision of a “Digital India” and for economic growth.

Major activities carried out under ICPS programme are briefly highlighted below:

### 5.1 Indian Heritage in Digital Space (IHDS):

Indian Digital Heritage (IDH) Project is a unique initiative of the DST supporting collaborative projects between researchers in the areas of Technology and Humanities for the digital documentation and interpretation of tangible and intangible heritage. The project highlights the art, architecture and cultural legacy of the world heritage site of Hampi in Karnataka, the medieval capital of the Vijaynagara dynasty.

The project has generated methodologies and technology for digital preservation and presentation of tangible and intangible heritage. These techniques can bring to life old Indian traditions for the present generation. It provides mechanisms to tourists for more informed tour of the site. The project has created a set of technologies and tools that can be used for any heritage sites and has established a close collaboration at national and international agencies. As an outcome of the IDH Scheme, a total of 37 generic technologies, 7 prototypes and scaled models have been developed and demonstrated. These technologies are generic in nature and thus can be applied on any monuments. Developed technologies broadly relates to Murals, Knowledge bank, Interfaces, Intangible, Memorialization, Design, Crafts, the 3D Printing, Features, Resurrection, Ontologies, Representation, 3D Surface, Preservation, Immersion, Reconstruction, Haptic, Walkthrough, Scaling etc. Three Start-up Companies spinned off from IDH research and technologies.





Hampi monuments, 3d laser scanned images, cad diagrams generated from terrestrial laser scanned point cloud data

## 5.2 Epidemiology Data & Analytics (EDA):

The objective of the programme is to carry out analytics over the data, examine and evaluate data about epidemiology, diseases burden, clinical trials being generated all over the country. For the purpose DST will partner with Digital India, DeITY, DBT and ICMR and facilitate seamless access of the data. The EDA scheme has been initiated. An advanced data analytics technology platform is being created to meet the stakeholders requirements.

## 5.3 Imaging Spectroscopy & Applications Programme

Imaging Spectroscopy & Applications (NISA) is a cluster based multidisciplinary Networked scheme to promote research on various aspects of Imaging Spectroscopy and Applications (ISA). This scheme is expected to evolve reference standards, protocols, database and research methodologies - for adaptation in various fields relevant to society. This networked scheme has 37 projects in seven theme areas (such as geology, agriculture, forestry, water, snow and glacier ice, urban & built-in materials and algorithms).

Seven major themes are networked with mutual inter and intra-theme linkages. The group evolved common protocols for data processing and analysis tools. One of the major advantages of this networked project is the involvement of a number of national government organizations and academic institutions. The investigators from the academic universities will benefit from the state-of-the-art laboratory facilities of the government organisations. Whereas, the government agencies will benefit from the advantage of getting trained human resources for solving their problems. Outcome of this project will add new dimension to India's natural resource exploration strategies and resource inventory. The scientific understanding in each thematic area emerging from this networked project will also fill the gaps in present understanding on this subject globally. ISA being the current and futuristic technique, the proposed networked project will certainly pave way for technology development, generating human resource in the country.

Major deliverables of the project are as following:

- Technologies for soil health parameters extraction, water quality and pollution.
- Quantitative characterization and discrimination of different earth surface features like rocks, minerals, soil, vegetation, water, snow & ice and urban and man-made features
- A well characterized exhaustive spectral database.
- Standard protocols and algorithms for Imaging Spectroscopy (S).
- Methodology for application IS in various scientific endeavours for societal benefits such soil and crop health monitoring, water pollution, mineral exploration etc.
- A web portal containing the entire database, software tools and documents.
- As part of NISA scheme, 70 JRFs are working towards their Ph.Ds in this advanced field of Imaging Spectroscopy & Application.

#### **5.4 New directed research programme on “Quantum Information Science and Technology (QuST)”:**

The present century has witnessed a revolution in harnessing the principles of quantum systems for information processing. The frontier area of Quantum Information Science is truly an interdisciplinary one that is developed by scientists from Physics, Computer Science, Mathematics, and Information Theory as well as Engineers. Some of the important developments were the discovery of quantum computers, fast quantum algorithms, quantum teleportation, super dense coding, remote state preparation, quantum cryptography, and several quantum communication protocols. Quantum Information Science and Technology (QuST) promises to revolutionize the future computation and communication systems which will ultimately have huge impact on the Nation and our society as a whole. In order

to evolve and finalize the research topics & thrust areas of QuST, two Brain Storming Meetings were organised, one at Centre for High Energy Physics, IISc, Bangalore and another at HRI, Allahabad. ICPS Division has initiated a new directed research programme on **“Quantum Information Science and Technology (QuST)”** with the following broad objectives:

- Development and demonstration of quantum computers.
- Development and demonstration of quantum communication & cryptography.
- Development of quantum-enhanced and inspired technology.
- Development of advanced mathematical quantum techniques, algorithms and theory of quantum information systems.

At present, the Department is working on development of a cluster based networked programme under directed research to meet the QuST objectives.

## 6. Building Geospatial Capacity

### **Natural Resources Data Management System (NRDMS) and National Spatial Data Infrastructure (NSDI)**

NRDMS Programme is the geospatial technology based which aims at promoting R&D for solving area specific problems. In order to help good governance and digital India programmes, NRDMS is supporting various sub programmes like Health Geographic Information Science (HGIS), Village Information System (VIS) and Revival of Village Ponds. To develop capacity in such areas, specific training course on geospatial technologies and applications are organised for various target groups. The progress made over last one year on geospatial policies and technical sub programmes, are as under-

1. **National Spatial Data Infrastructure (NSDI)**. NSDI was re-oriented to upgrade the software and hardware of Indian Geo-portal to ensure easy and fast access of geospatial data by the users. NSDI mechanism basically helps the users for single window accessibility of geospatial data through the web portal without any charge. This can help easy access of geospatial data for planning processes.
2. **National Data Sharing and Accessibility Policy (NDSAP)** – notified in March, 2012 is a national open data sharing portal i.e. data.gov.in which was developed to proactively share the government shareable data to the general public. At present more than 1,41984 data sets contributed by more than 108 Central Govt. departments/ Ministries have been uploaded on the portal for sharing to the general public. Efforts are also being made to enroll all the State Governments to adopt the NDSAP.
3. **National Geospatial Policy (NGP)**: It focuses on geospatial data, products, services and solutions. NGP draft policy document has been prepared. It will empower people through

geospatial data and easy accessibility of the products, solutions and services offered by Govt., private organisations NGOs and individuals. Policy is under circulation among the concerned Government Departments for consultation. It will create good balance between geospatial data requirement for development and national security.

#### **4. Sub – programmes**

##### **4.1 State Data Infrastructure (State SDIs)**

State Geoportal of Karnataka has been maintained and used in updation of panchayat boundaries with the assistance of the District NRDMS Centres operational in the State. Geoportals of Uttarakhand and Haryana have been made operational for providing access to data sets of the respective State Governments. Geoportal prototypes of Odisha and Jharkhand have been tested and validated for operationalization. Geoportals of West Bengal and J&K have been under development. It has been decided to provide geospatial data services to support implementation of GIS applications in the domain of 'Úrban Governance' in Karnataka and Uttarakhand and maintenance of the geospatial data assets.

##### **4.2 Health GIS**

Health GIS was supported to map the diseases using spatial pattern and also help in developing the health emergency management system. For the last two years, more than one dozen projects have been supported on various aspects of health diseases and are being monitored in the networking mode. The major outcome is the decision support system for better management of geospatial health data of different diseases and their diagnostic schedule, interactive health maps to allow citizens to understand health performance. To achieve this various mobile applications have been developed for detecting the patient status and recommending medical aid.

##### **4.3 Village Information System**

As per the Government initiatives to identify villages for drawing development plan using geospatial technologies, 120 villages in different geo-environmental settings in different States have been selected to develop a spatial data model for data collection required for local level planning and other developmental activities. it will also help in development of an integrated information system using geospatial technologies. Finally, a decision support information module to empower planners and citizens would be developed.

##### **4.4 Revival of Village Ponds**

In order to revive the village ponds with more S&T inputs to ensure availability of

water in the ponds which basically help in recharging the ground water and bringing the ground water table water up, a coordinated programme has been formulated with the involvement of academic institutions and village farmers. The programme is being implemented in different agro-ecological regions in the country to ensure proper representation of the test sites.

#### **4.5 Landslide forewarning System**

As part of the integrated landslide programme, efforts were made to develop forewarning system to monitor the critical landslides in different geo-environmental areas. At present instrument monitoring is being carried out in 5 locations i.e. Himachal near Naptha Jhakri Project, Linga landslide in Ooty and Munnar slide in Kerala, Kunjethi in Uttarakhand and NGF in Dehradun. Efforts are being made to develop a correlation between threshold of the rainfall intensity and landslide occurrence. This will help in forecasting the information to the user agencies well in advance before the actual landslide take place.

#### **4.6 Large Scale Geological and Geotechnical Mapping from Rishikesh to Kedarnath in Uttarakhand.**

Detailed studies of geological and geotechnical aspects were undertaken along the Rishikesh to Kedarnath stretch to develop a co-relation between the landslide occurrence vis-a-vis. geological structures and geotechnical properties of the slope material. This is being done on large scale 1:4K which will help the decision makers to decide the reconstruction of infrastructure facilities along with the study zones to minimise the impact of landslides and reduce the losses.

#### **4.7 National Geotechnical Facility**

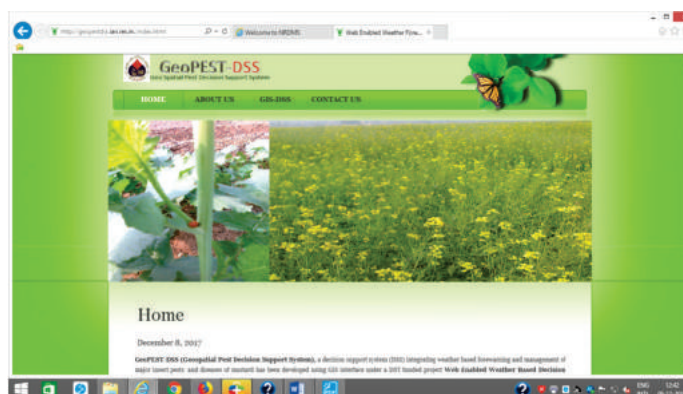
The National Geotechnical Facility has been set up in Poonch House, Dehradun. Survey of India, Dehradun is coordinating the activities. As part of this, state of the art facility on rock and soil mechanics testing facilities have been set up. This facility is providing enough scope to meet the requirement from academic as well as stakeholders to analyse the soil and rock samples for their strength parameters. This is important to draw a comprehensive action plan for implementation of major developmental projects.

#### **5.0 R&D Applications and Demonstration of the use of Geospatial Technologies.**

**5.1 A Geospatial Pest Decision Support System (GeoPest-DSS) for forewarning and management of two major insect pests (aphid & painted bug) and two major diseases (white rust & Alternaria) of mustard (Research Agency: IARI, New Delhi)**



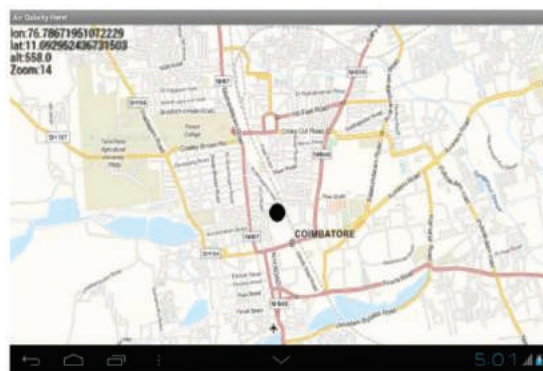
GeoPest-DSS (Geospatial Pest Decision Support System) - a dynamic decision support system (DSS) integrating weather based forewarning and management of two major insect pests (aphid & painted bug) and two major diseases (white rust & Alternaria) of mustard - has been developed using GIS platform. GeoPest-DSS is accessing real time hourly weather data from 3 automatic weather stations (AWS) installed in 3 locations (IARI farm, KVK (IARI); Shikohpur and NBPGR farm, Issapur) within the National Capital Region (NCR). Weather data sets are getting collected in the Data Server at IARI automatically. Forewarning of pests and disease levels and appropriate IPM practice recommendations emerge as output for the farmers and other stakeholders.



Home page of the Geo-PEST DSS Tool

## 5.2. A low cost real time particulate matter monitor and a mobile application for location specific particulate pollution information (Research Agency: Bharthidasan University, Tiruchirappalli, Tamil Nadu)

A low cost real time particulate matter monitor was developed and tested in four locations of the Coimbatore urban area by combining Dylopro, a commodity indoor air quality monitor, single board computer and real time data communication system. A mobile application for location specific particulate pollution information comprising of a server side program and client side android application has been developed. (Figure 2).



Off-line view of the Client side android application showing the required location

### **5.3 A Spatial Decision Support System (SDSS) for Western Ghats (Research Agency: IISc., Bengaluru)**

A Western Ghats Spatial Decision Support System (SDSS) has been developed by incorporating multi-tier architecture of structured query based inputs of various datasets. External existing support services have been incorporated for effective decision making. For effective natural resource management of Uttara Kannada district in the State, in particular, as a basis for decision making in operations with the aim of biodiversity conservation, socio-economic development, reliable information on land cover and its change are required to be assessed along with the threats and the opportunities. The attributes of geo-climatic features, the biological features and the social relevance of the study area have been comprehensively analyzed. Resource managers and decision makers can use this information for effective management and conservation in relation to the environmental status of the district. The Geo-server GUI module supports storage and visualization of maps and spatial data, and provides functions for spatial analysis. The integrated information system – WGSDS – has been designed to provide the users with a flexible environment based on formal multiple criteria methodologies for structuring information, and providing decision aid by enabling a detailed comparative analysis of eco-sensitive regions.

## **6. Capacity Building and Training**

In order to create awareness and build up capacity among different types of stakeholders in academia and government, the division has supported 15 training programmes of 21 days and 16 training programmes of 3 days. As a result, around 550 stakeholders were exposed to the advances in the Geospatial Science and Technology, its application and hands on training.

Six Geospatial Chair Professors have been selected as part of the NRDMS programme. These Professors will be posted in various institutions to guide geospatial research and various applications.

Three workshops on “State SDIs and Their Applications” have been organized on 8-9 June 2017, 22-24 August 2017 and 15-17 November, 2017 for the participants of various State SDI implementing agencies.

## **7. New Initiatives**

### **7.1 Indo-US Space Borne Gravity Observation Collaboration.**

In order to strengthen the collaboration between India and US in the field of space borne gravity observations, especially under the GRACE and GRACE FO missions, A

**Networking sub programme on GRACE** satellite data and its applications has been initiated for assessment of ground water and other applications.

## 7.2 Geodesy

Considering the importance of Geodesy in developing geoid model of the country, it is felt essential to develop a national programme. Efforts are being made to prepare the detailed scientific action plan with the institutions likely to participate and their work components. Programme will be launched very soon.

## 7. Drugs & Pharmaceuticals Research

The Drugs and Pharmaceuticals Research Programme (DPRP) was initiated in 1994-95 for promoting Industry–Institutional collaboration in drug and pharmaceuticals sector. This programme aims at enhancing capabilities of institutions and Indian Drugs & Pharmaceuticals Industry towards development of New Drugs in all systems of medicine. The specific objectives of this scheme are:

- To synergize the strengths of publicly funded R&D institutions and Indian Pharmaceutical Industry in developing drugs in areas of national relevance;
- To create an enabling infrastructure, mechanisms and linkages to facilitate new drug development;
- To extend soft loan for Pharma Industrial R&D projects; and
- To stimulate skill development of human resources in R&D for drugs and pharmaceuticals.

### Achievements:

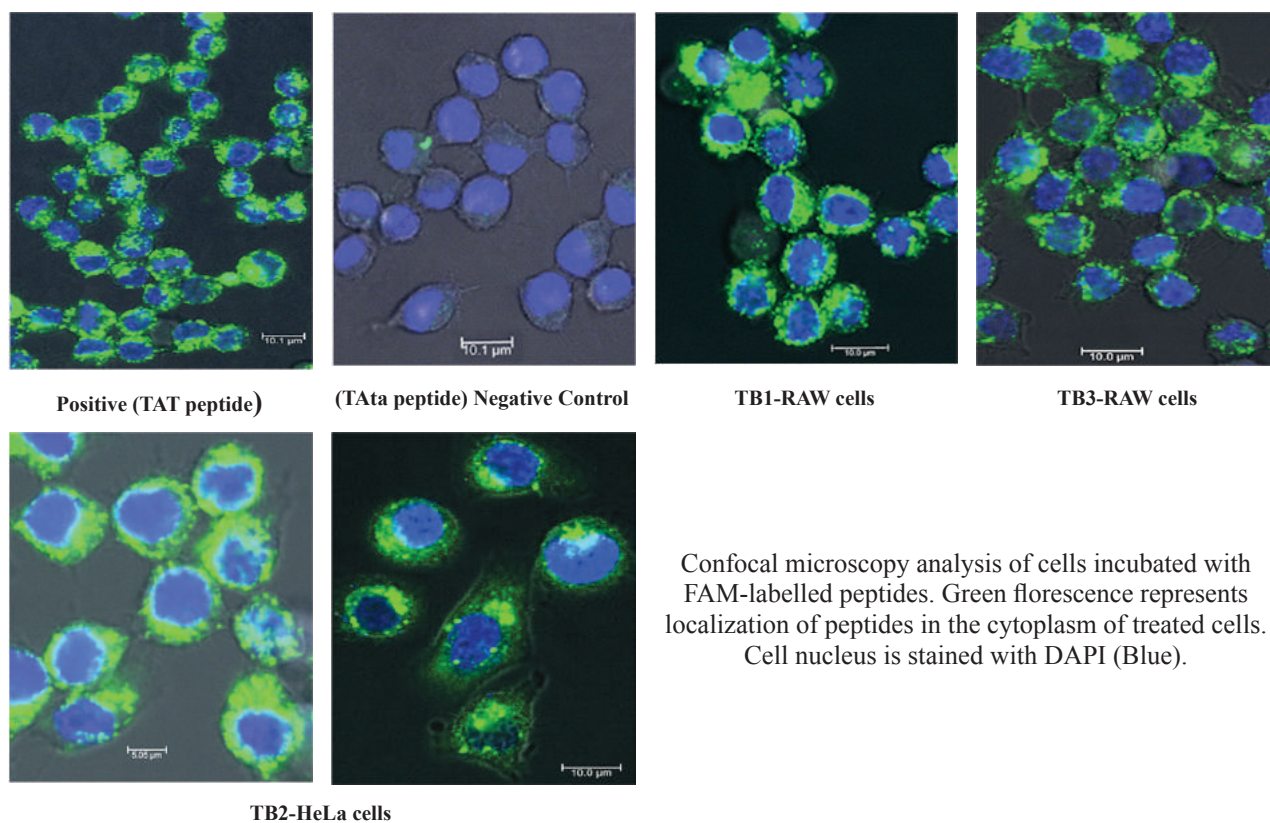
#### R&D initiatives as public private partnership

**12R-Lipoxygenase as a Target for Development of Drugs against Psoriasis**-this project is being implemented at University of Hyderabad in collaboration with Dr. Reddy's Institute of Life Sciences, Hyderabad.

Psoriasis is an inflammatory skin disease mediated by the cells of innate and adaptive systems characterized by the sharply demarcated, erythematous, squamous lesions on elbows, knees, scalp, and lumbar sacral areas. Recent studies established that during psoriasis IL-17A, a pro-inflammatory cytokine levels increases at the site of inflammation. Interestingly we noticed enhanced percent of IL-17A producing cell in 12RLOX over expressing mice compared to control.

**Development of peptide-based anti-inflammatory drug for septicemia**-this project is being implemented at National Institute of Animal Biotechnology, Hyderabad in collaboration with Chemveda Life Sciences India Pvt. Ltd, Hyderabad.



Sepsis is the leading cause of hospital admissions, morbidity and mortality. No treatment targeting the underlying mechanism of sepsis is actually available. Inappropriate activation of Toll-like receptors (TLRs) leads to exaggerated inflammatory responses resulting in the pathogenesis of sepsis. TcpB is a TIR-domain containing protein from a Gram-negative bacterial pathogen (*Brucellamelitensis*), that displays highly efficient anti-inflammatory properties. TcpB selectively inhibits NF- $\kappa$ B activation and secretion of pro-inflammatory cytokines mediated by TLR4 and TLR2 receptors. This project aims to develop TcpB peptide-based anti-inflammatory drugs for sepsis. TcpB harbors two functional domains, a TIR domain at the C-terminal and a lipid-binding domain at the N-terminus. An analysis of the sequences in the lipid-binding region of TcpB indicated a basic amino acid motif (46KKRxxxxKK54). Mutation of these basic amino acid residues to Alanine abolished the lipid binding property of TcpB (Figure 1). These studies indicate that basic amino acid residues at 45 to 53 are essential for lipid binding and putative cell permeability of TcpB.




The identified cell permeable peptides could be used for intracellular delivery of various therapeutic molecules. TB2 peptide will be used for delivery of BB-loop peptide, which will be derived from the TIR domain of TcpB to develop the cell permeable anti-inflammatory drug for sepsis.

**Highlights of some of the State-of-the-art Facilities recently supported for R&D activities towards drug development**



Sl. No.	National Facility	Year of Establishment	Highlights of the Facility	List of services
1.	'cGMP Pilot Plant for Extraction Formulation and Packaging of Traditional (ISM) Herbal Medicinal Formulation at IIIM, Jammu	2016	<p>CSIR-Indian Institute of Integrative Medicine has set up a state-of-the-art, national facility for start-ups, small and medium scale manufacturers to get their phytopharmaceutical products manufactured under GMP/GLP conditions, besides its use for the production of pre-clinical / clinical batches of botanical drugs for R&amp;D Institutes.</p> 	<p>Production and development of botanical extracts and CMC Stability studies of extracts and formulations. QC/QA and CMC of botanical / herbal products. Regulatory support for start-ups.</p>
2.	National Facility for Marine Natural Products and Drug Discovery, Annamalai University, Chidambaram	2017	<p>First National Facility for Marine Natural Products and Drug Discovery established targeting specific screening of various marine metabolites from marine flora and fauna. Development of a 'chemical finger printing database' for promising lead molecules with bioactivity testing facility.</p> 	<p>High Performance Liquid Chromatography (HPLC): C8, C18 and amino columns - Analytical and Preparative.</p> <p>High Performance Thin Layer Chromatography (HPTLC): semi-automated with scanner facility.</p> <p>Enzyme-linked Immunosorbent Assay (ELISA) Reader: Screening facility available for life threatened diseases like 'Dengue Fever'.</p>



Sl. No.	National Facility	Year of Establishment	Highlights of the Facility	List of services
3.	National Facility for drug discovery and developmental therapeutics (NFDDDT) at Rajiv Gandhi Centre of Biotechnology, Thiruvananthapuram	2016	<p>Establishing cell based assays for identifying anticancer activity</p> <p>High throughput adaptation of diverse Target specific assays against cancer such as Caspase, tumour stem cells, 3D real time drug screening tools, Cell cycle, proteasome, DNA damage, EGFR, Her2</p> <p>Live cell assay for discriminating apoptosis from necrosis</p> <p>Large scale screening capability using the above mentioned assays</p> <p>Extension of these assays for drug discovery companies and academics for augmenting drug discovery process in our country</p> 	<p>Nicolas Life Sciences Pvt Ltd</p> <p>Nagarjuna Pharma</p> <p>Vinvish technology</p> <p>IIT, Assam, IISER TVM</p> <p>Researchers from Diverse universities and research Institutes</p> <p>Hindustan Latex Limited</p>

## 8. S&T Programme for Socio-Economic Development

### Technological Advancement for Rural Areas (TARA)

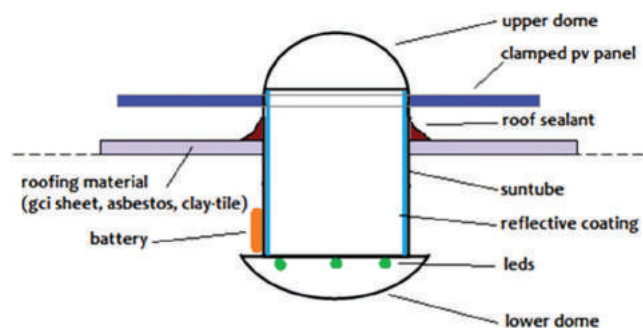
TARA scheme aims to develop & deliver innovative S&T packages through adaptive research, primarily for rural and remote areas applications. In this endeavour, Core Support Groups (CSGs) are identifying location-specific problems, converting them to S&T based research challenges and developing & demonstrating S&T packages which are subsequently transferred to people. During the year, 22 ongoing CSGs or S&T led field action groups, based in 14 States, were supported. To expand the outreach of the scheme, 4 new groups were identified to work in



**Innovative, cost-effective, environment friendly space & water heating system using Solar energy in Zaskar Valley, J&K**

Rajasthan, Gujarat and Uttar Pradesh. Some of the significant achievements are given below:

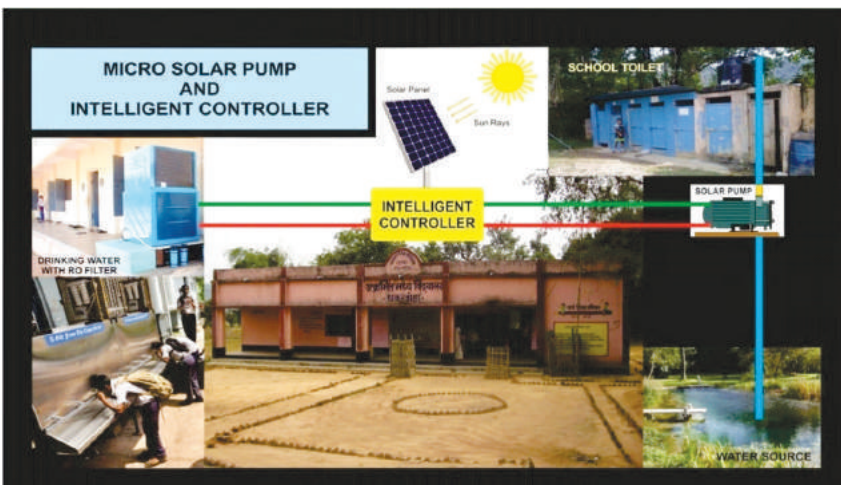
- In order to address challenge of water and room space heating in high altitude Mountain region, cost effective space and water heating devices using solar energy and local resources has been developed by Himalayan Research Group (HRG), Shimla, which increases average room temperature by 15°C and heats water to over 80°C from 10°C in 30-35 minutes of sun illumination. A single panel saves average 2000 kg fuel wood/annum/household. The process reduces drudgery of women as it halves number of trips for fuelwood collection/annum and saves around 40% fuelwood and thus mitigating 2.5 ton of CO<sub>2</sub> emission/annum/panel. The technology was successfully demonstrated in Kinnaur District of Himachal Pradesh and extended to difficult cold desert area in Zaskar Valley, Ladakh region of J&K.
- In the area of waste management, technologies for utilization of waste materials like marble sludge, pond ash, foundry slag and construction and demolition waste were developed by Society for Development Alternatives (DA), New Delhi. These not only reduce the use of sand and other virgin raw materials but also promote effective utilization of waste materials. The technology for making bricks by using such waste materials are benefiting the building material industry in and around thermal power plants in Rajasthan and neighboring States. Lab scale trials were conducted and pilot scale production tested. Compressive strength of the bricks produced is quite promising (5-6 MPa) as compared to the poor quality of red bricks available in and around Rajasthan. Production cost of the brick is equivalent to that of existing fly ash brick. Further, value added products such as pavement blocks of M30 and M40 grade using foundry slag waste generated from cupola and induction furnace were designed and produced replacing natural stone aggregate. 12 enterprises in Samalkha, Ludhiana and Jalandhar in Haryana and Punjab have adopted this technology successfully.
- NB Institute of Rural Technology (NBIRT), another CSG working in remote tribal villages of West Tripura made innovative S&T interventions for lighting and drinking water solution and improved sanitation system. PV integrated Micro Solar Dome (MSD-Surya Jyoti) has been introduced in the village to provide 24x7 lighting where conventional power is either not available or is unreliable. The integrated PV module charges a battery during daytime, which, in turn provides light during night-time from the MSD for about 4 hours through LED fitted in the lower dome and is leak proof.



**PV INTEGRATED MICRO SOLAR DOME**

Besides, NBIRT has also provided an integrated technological solution to provide water for

drinking and sanitation through Solar power operated Micro Pump and water purification system. The electricity obtained from panels is diverted to charge the battery once water collection from water purifier is over through intelligent converter. These interventions ensure safe drinking water and clean &hygienic toilets with



lighting thus transforming lives of people in remote area. State Government of Tripura intends to launch such programmes in at least one village of each of the 54 blocks of the State.

- Society for Energy, Environment & Development, Hyderabad, working primarily in renewable energy sector has developed improved Solar Cabinet Dryer Technology with specific features like - i) Up-scale capacity; ii) Redesigned walls with additional insulation (iii) Hybrid technology with integration of Solar PV. It has also designed and developed Nutritious supplements to combat fatigue and environmental stress in defence & police force personnel in High Altitudes using locally grown and easily available ingredients and processing these in Solar Cabinet Dryer with its new processes.
- BAIF Development Research Foundation, Pune has developed sustainable livelihood model for communities in Arid Region of Western India (Little Rann of Kutch, Gujarat and Barmer, Rajasthan) through suitable technology interventions. Agro forestry farming system have been introduced to 657 families with cultivation of arid fruit crops such as Ber, Pomegranate, Lasoda (In Barmer) and Date palm, Ber, (In Kutch) with hedge plantation of multi-purpose arid forestry species like Khejri, Subabul, Ardu, Neem, Sesbania, etc. and intercropping with legumes like moth bean, mung bean, cluster bean and vegetables like Brinjal, Chilly, Tomato, Cauliflower, Water Melon, Kachari. Standardization of cactus nursery and fodder production and performance of the cactus feeding in small ruminants were evaluated. Feeding of cactus in goats enhanced the performance in total weight and average daily gain in body weight. BAIF has also introduced suitable technologies for tapping of rainwater, innovative storage and efficient use of water, etc. thereby creating reserves of water. To reduce the salinity of ground water and to effectively tap available rainwater, a process of open-well and bore-well recharge has been introduced among 165 farmers. Gravity based drip irrigation system and mulching were also introduced. This has helped ensuring access of water near households, year round water for drinking and agriculture purpose in 337 families, so far. Importantly, it has helped in reducing the hardship of desert

women for water collection. In Kutch region, focused efforts are being made to conserve and revive the locally useful and worthy breeds of Cow, mainly, Kankrej and Gir and Banni breed in case of Buffalo.

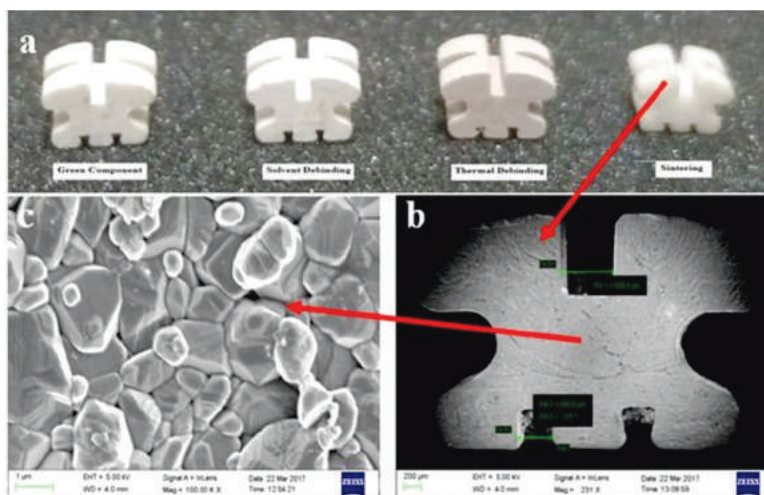
### **Scheme for Young Scientist and Technologists (SYST)**

Scheme for Young Scientists and Technologists (SYST), was evolved in 1992 with a vision to encourage young scientists to identify social challenges and provide S&T based solutions using lab-to-land approach. The scheme was revamped, rejuvenated and reenergized in 2014 to inspire young S&T professionals to present ideas of social relevance and received overwhelming response and since then, over 50 projects were funded across the country. In 2017-18, about 45 more projects have been recommended for support.

Major achievements: for the projects funded under SYST are as given below:

1. In northern India, the insect species *Closteracupreata* (Lepidoptera: *Notodontidae*) an important defoliator of Poplar (a commercial crop), appears several times in outbreaks thus resulting in reduction of productivity and quality of timber. In order to control the damage in eco-friendly manner a bio-pesticide was developed from *Calotropisprocera* (weed) by Forest Research Institute (FRI) which demonstrated efficacy of 70% against Poplar defoliator under laboratory and semi-field conditions. Repeated field trials were carried out and 67% efficacy against Poplar defoliator was reported which was found to be at par with synthetic pesticides being used by farmers. 2 training cum awareness programs conducted by FRI were attended by 150 farmers from villages of Uttarakhand, Uttar Pradesh and Haryana. Extension material viz. brochures, pamphlets in Hindi were distributed to farmers. The product developed is now ready for commercialization.
2. Well-aligned teeth and jaws are highly important for oral health as they help in better chewing, digestion, and prevent associated illnesses. Various type of orthodontic brackets (metallic, gold-plated, silver coated, plastic, translucent plastic and ceramic) are available for correction of irregular and deformable teeth. Under SYST project, CSIR-CMERI, Durgapur has developed low cost indigenous ceramic brackets using Micro Ceramic Injection Moulding ( $\mu$ -CIM) process technology that will cost 70% less as compared to other similar products. These ceramic brackets would cost even less than the market price of metallic brackets, widely used by the patients for treatment due to its cost effectiveness. Dr. Prosenjit Das, PI of the project won CSIR Young Scientist Award 2017 in Engineering Sciences category.





(a) Bracket development stages, FESEM image of the (b) sintered bracket and (c) micrograph .

3. A mini cold storage with a capacity of 5MT was designed for small farmers using sub-cooling technique incorporating Phase Change Material (PCM) latent storage system and heat pipes for a Vapor Compression Refrigeration System (VCRS). Cold storage using sub-cooling technique showed improvement of 14-18% when compared with cold storage without sub cooling technique. The cold storage has an energy saving potential of 1200kW/year with a payback period of 6 years. The test facility created in the premises of Sree Sastha Institute of Engineering and Technology, Chennai has a capacity to handle approximately 600 tons of vegetables and fruits. 35 farmers and 10 retailers of Thiruvallur district and Chennai suburb used this facility through a rent-free model. Awareness program conducted under the project benefited 135 farmers of Thiruvallur and Kancheepuram Districts. The created facility is also being utilized under National Skill Development Corporation Curriculum for training Cold Storage Technician.

### Technological Interventions for Addressing Societal Needs (TIASN)

TIASN primarily involves technology development and adaptive R&D for the benefit of society. Projects are primarily supported in the area of Agriculture, Health, Nutrition and activities related to Non-Farm sector. In current financial year, DST has supported 2 projects and recommended 8 for financial support. Some of the noteworthy achievements are:

1. DST has supported Uttarakhand State Council of Science and Technology (UCOST) for a novel “*Pt Deen Dayal Upadhyay Vigyan Gram Sankul Pariyojana*” which emerged during the deliberations to explore possibilities of ‘S&T Interventions for Sustainable Development’ during a workshop held in November 2016 at Dehradun. Focus under this initiative would be to make use of appropriate S&T interventions targeting natural resources, skills, traditional crafts and thus generating sustainable & enhanced livelihood opportunities for people in 4 identified clusters- *Gaundikhata, Bazeera, Bhigun* (in Garhwal) and *Kausani* (in Kumaon) comprising of 60 villages. The project was launched by Dr. Harsh Vardhan, Hon’ble Minister of S&T and ES and EFCC.





**Press Conference during the launch of Pt. Deen Dayal Upadhyay Vigyan Gram Sankul Pariyojana**

2. North-Western India particularly in Punjab, Haryana and Western Uttar Pradesh, widely practices rice-wheat, cropping system and farmers of these region burn rice residue prior to wheat sowing as they are unable to manage heavy loads of rice residue that hampers tillage and seeding operations of subsequent wheat crop. Burning of crop residue leads to losses of soil organic matter & nutrients (especially N, P, K, S and C) and leads to environmental pollution. In order to address this burning issue challenge, DST, funded a pilot project to Punjab Agricultural University (PAU), Ludhiana for impact assessment and popularization of Happy Seeder technology among the farmers of Punjab. Happy Seeder is a tractor-powered machine that cuts and lifts the rice straw, sows wheat seeds into the bare soil, and deposits the straw over the sown area as a mulch. It combines stubble mulching, seed and fertilizer drilling into a single pass. This technology may help in reducing rice straw burning and improving the soil fertility by incorporation of organic matter in the soil. The project was initiated in October 2017 and the technique has been demonstrated in 23 acre of farmer's field in 4 villages of District Ludhiana.



**Demonstration of Happy Seeder in Farmer's field in Punjab**

### Technology Interventions for Disabled and Elderly (TIDE)

Under TIASN scheme, DST has been spearheading a unique initiative- “Technology Interventions for Disabled and Elderly (TIDE)”. In addition to improving the quality-of-life of target population, TIDE also aims at enabling and empowering them with autonomy and independence. Concerted efforts of DST in alliance with S&T institutions to offer solutions to identified challenges faced by them aligns well with dream of Accessible India-Empowered India of our Hon’ble Prime Minister. Prototypes of several assistive devices are presently at different phases of Technology Readiness Level and few have also been commercialized in current year. Some of the significant achievements are mentioned below:

**CMC Stim**, a multi-channel, portable, hand-held, Stimulator for Functional Electrical Stimulation for patients with Spinal cord injuries, cerebrovascular stroke and for cerebral palsy children, has been developed by CMC, Vellore. This 4-channel device can be used for therapy to exercise the muscles and for other functional purposes. It also has user adjustable parameters along with a user interface for therapists. The user interface can be used either on a computer with a cable connection or a mobile phone with wireless interface. The device is a transcutaneous stimulator, and therefore capable of generating sufficient current and voltage to achieve strong muscle contraction and can replace many desktop stimulation devices used in clinics. Since it is handheld and rechargeable, it is suitable for home use. A special novelty is in its ability to stimulate denervated muscle. The prototype is under extensive clinical trials.



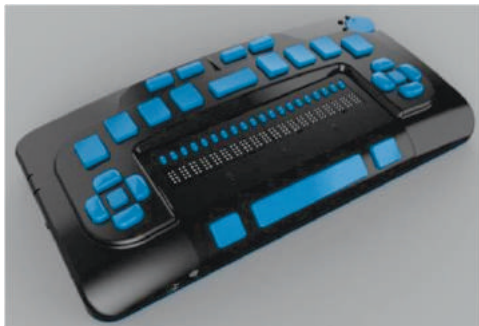
CMC Stim and Accessories



CMC Stim and Mobile

**Refreshable Braille Display (RBD)** developed by IIT, Delhi enables people with visual impairment to access digital text through a tactile interface and textual content in multiple formats. Commercially available RBDs based on piezoelectric (PZT) actuation have not been able to penetrate the market due to their high cost. Typical 20-cell device costs USD 2500+, making it expensive, even in the developed countries and unaffordable for users in developing countries. The device developed by IIT-D (1669/DEL/2012 and 1575/DEL/2014 applied for patent) with budgetary support of DST uses

patented technology of Shape Memory Alloy (SMA) based actuation, which is a low-cost alternative compared to the existing RBDs. This technology could bring down the cost of the device to 1/5<sup>th</sup> of the existing devices. RBD is a standalone device used to read, write, listen, browse, edit, and accumulate chat information from multiple sources when connected to computers, laptops, kindle, web, mobile through cable, WiFi, data card, Bluetooth, etc. Once ready as a product, it would be available in two versions-20 character display with Braille keyboard and 40 character display with Qwerty keyboard as shown below:



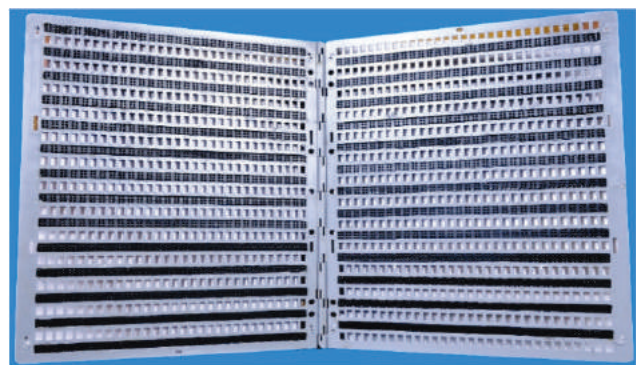
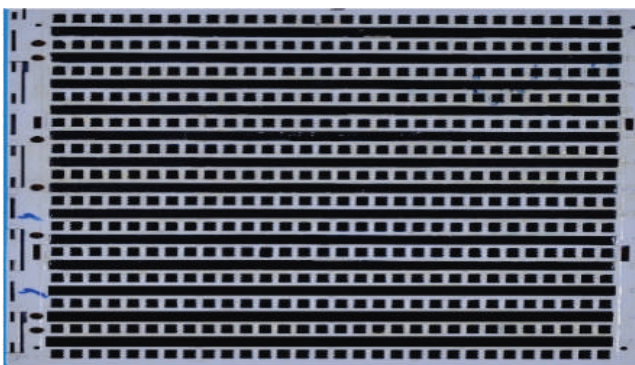
20 Character RBD



40 Character RBD

Production ready prototypes have been developed and pilot production of the devices has already started. The product is ready for launch in summer of 2018.

**Interline Braille Slates** currently available in the market are robust and difficult to carry by visually challenged school going children. The spaces between the lines in the existing slates is less, poses difficulty in reading with fingers, punching, and have issue of metallic deformation. The new Interline Braille Slate is designed and developed in such a way that the lines have enough space to read. The board has two flaps of A4 size paper. The flaps are hinged so that it can be opened like a notebook. Using this Slate, one can write 30 characters in a row and 14 lines on one side of the paper. There is no need of removing the paper from the slate to write on the other side as the page can be turned.



External and Internal Views of Interline Braille Slate



**Digital Pulse Oximeter:** A low cost digital pulse oximeter for the non-invasive measurement of arterial blood oxygen saturation (SpO<sub>2</sub>) and pulse rate (HR) has been developed with support under TIDE. Oximeters are widely used in hospitals, medical clinics, operating rooms, and homes. Both oxygen saturation level and pulse rate are vital signs of a patient. Oximeters can report an accurate reading within seconds. The prototype was calibrated and its sensitivity checked against many of the commercially available bulky and expensive devices. The prototype developed can calculate and monitor SpO<sub>2</sub> and pulse rate simultaneously in both digital and wave forms in real time.



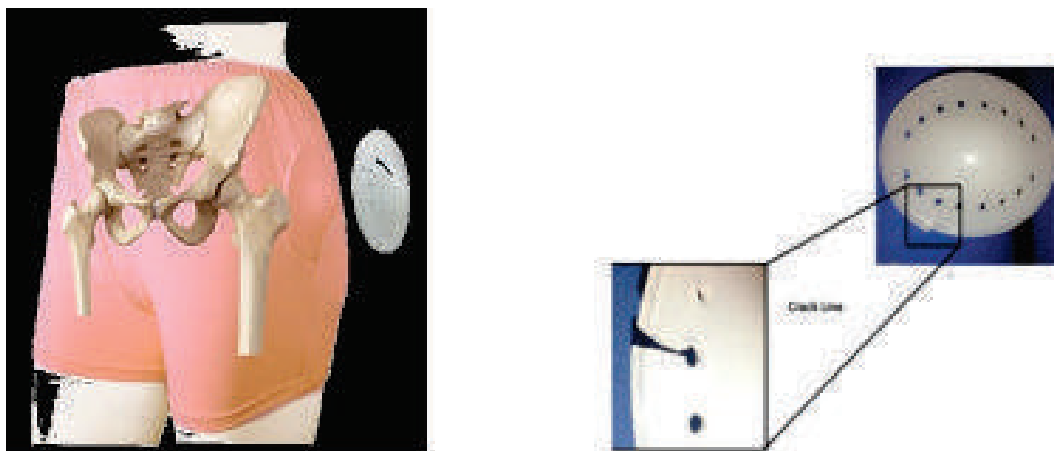
External and internal views of Digital Oximeter

**Compliant Easy Chair for Elderly:** For the elderly and arthritics, sitting in a chair and rising from it are painful. Surveys in India and abroad indicate that a large percentage of these two user groups need assistance of caregivers in such a simple task. Also the needs of individuals are highly variable depending on their weight, height, and physical ability. A conventional “easy chair” is not the solution as it requires considerable exertion to sit and rise. Powered chairs are expensive and often inaccessible to public at large. The “compliant easy chair” developed through TIDE funding in IISc, Bengaluru, provides support while an individual sits on it as well as stands up from the sitting position. It does not use any external power or actuation. It uses specially designed springs retrofitted onto any existing chair as shown in figures below. The design of the compliant chair is such that it can be adjusted to the height, weight, and physical abilities of a person using modular construction. It feels like a normal chair in the seated position because of a special feature called bistability as it provides suitable resistance and support so that a person can sit in gradually. The chair gently pushes the occupant from the sitting position to standing position once the occupant presses a handle. Its design reduces the stress exerted on the knees, which is problem for most elderly as well as arthritics.



Compliant Easy Chair with features of Bistability and Static Balancing

**Tro Guard** – a novel hip protective device developed by IIT-Delhi to protect and shield the greater trochanter of the Femur bone getting impacted during a sudden fall on a hard surface thus prevents possible fracture of hip joint in an elderly (70+). The product is made of a microcellular thermoplastic, which is injection molded in a unique profile geometry to absorb and attenuate the impact force and associated energy by dispersing the same to the surrounding muscle mass. The device reduces the cost of hospitalization and mortality due to hip fracture because of a fall or slip, which heals with difficulty during old age. The device has been tested by (i) Department of Orthopaedics, AIIMS, Delhi (approx. 300 patients for hip replacement were offered the devices for future protection) and (ii) Department of Geriatrics, AIIMS, Delhi (where 52 patients of unbalanced walking, Alzheimer, Parkinson with other co-morbid situations were offered the hip protection devices). The technology has been transferred to M/s Ozla Healthcare Pvt Ltd., Noida in 2016. No such microcellular polymer based device exists anywhere.



**Hip Protective**

### Location Specific Program

**TIME-LEARN:** Technology Intervention for Mountain Eco-Systems (TIME)-Livelihood Enhancement through Action Research & Networking(**LEARN**) program is designed for North-Western Himalaya covering Uttarakhand, Himachal Pradesh and Jammu and Kashmir. The network programme aims to evolve technology-driven intervention model(s)/packages through action research, which may be taken up further for adoption by other developmental agencies for the benefit of mountain community. 19 projects have been initiated at various locations involving premier S&T institutions, field agencies with people-centric and collaborative approach. Major sectors in which the projects are being implemented relate to-horticulture, livestock management, post-harvest technology, utilization of local bio-resources to develop bio-pesticides, addressing human-wildlife conflict, food and nutrition, conventional ropeway, and construction technologies for multi-hazard resistant housing in mountain areas.





Technology Application to address Human-Wildlife Conflict in PirPanjal, J&K by WWF-India : Use of Bio-acoustic, Solar-powered LED and Ultrasonic devices



Shri N.N. Vohra, Hon'ble Governor, J&K & Chancellor, SKUAST-Jammu inaugurated Group Monitoring Workshop of TIME-LEARN Programme for development of prototypes/products such as improved river ropeway, solar space/water heating system and post-harvest technologies to benefit mountain community.

### Network Program: Conservation and Sustainable Livelihoods in Partnership with Local Communities around Protected Areas (PAs)

“People and Protected Areas (PPA): Conservation and Sustainable Livelihoods in Partnership with Local Communities” is a multi-locational network program implemented as joint initiative of SEED, DST and WWF-India. The Program aims to coordinate and support the efforts of local and grassroots NGOs promoting innovative mechanisms to enhance livelihoods for communities living in and around PAs located in diverse ecosystems.

Under the 2<sup>nd</sup> Phase (2014-2017) of the network program, fifteen civil society organizations in addition to WWF India as project implementing organizations were involved to work around sixteen Protected Areas (PAs) for addressing conservation and livelihood issues through need-based S&T interventions. Program has covered over 4000 households of 20 tribal groups including PTGs in 75 villages with technical back-stopping from nearby S&T institutions and Core Support Groups (CSGs) of SEED, DST to enhance local livelihoods options for resource dependent communities living in and around PAs. Some of these communities are based in remote areas and inside the PAs having little or no access to fair weather roads.

### Coverage under PPA Network Program:

Name of Project Implementing Organisation	Protected Area Name and Location	Tribe/Community
<b>SOUTH</b>		
Sahayadri Wildlife and Conservation Trust (SWIFT)	Dandeli- Anshi Tiger Reserve, Uttara Kannada, Karnataka	<i>Kunbis</i>
Shola Trust	Mudumalai Tiger Reserve, Nilgiris, Tamil Nadu	<i>Kattunayakan and Bettakurumba</i>
River Research Centre (RRC)	Parambikulam Tiger Reserve, Thrissur, Kerala	<i>Kadar, Malayan, Malamalasar, Malasar, Muthuvan and Mannan</i>
Laya	Papikonda Wildlife Sanctuary, East Godavari, Andhra Pradesh	<i>Konda Reddy, Koya Dora, Konda Kammara</i>
Centre for People's Forestry (CPF)	Kawal Tiger Reserve, Adilabad, Telangana	<i>Gonds, Kolam</i>
<b>WEST</b>		
WWF India	Ranthambore National Park, Sawai Madhopur, Rajasthan	<i>Meenas, Mogias</i>
Jagran Jan Vikas Samiti (JJVS)	Jaisamand Wild Life Sanctuary, Udaipur, Rajasthan	<i>Meena, Gameti, Bhil</i>
<b>EAST</b>		
Jan Sewa Parishad (JSP)	Hazaribagh National Park, Hazaribagh, Jharkhand	<i>Santhal</i>
Gorakhpur Environmental Action Group (GEAG)	Valmiki Tiger Reserve, West Champaran, Bihar	<i>Mushar, Dhakar, Tharu, Cahamar</i>
<b>NORTH</b>		
Society for Rural Development and Action (SRDA)	Nargu Wildlife Sanctuary, Mandi, Himachal Pradesh	Rajput, Lohari
Himal Prakriti	Askot Wildlife Sanctuary, Pithoragarh, Uttarakhand	<i>Bhotia (Shaukha)</i>
Jagriti	Khokan Wildlife Sanctuary, Kullu, Himachal Pradesh	Nath, Koli

Name of Project Implementing Organisation	Protected Area Name and Location	Tribe/Community
<b>NORTH-EAST</b>		
Manas Ever Welfare Society (MEWS)	Manas National Park, Baksa, Assam	<i>Bodo</i>
Khangchendzonga Conservation Committee (KCC)	Barsey Rhododendron Wildlife Sanctuary, West Sikkim, Sikkim	<i>Bhutia, Lepcha, Limboo, Tamang and Sherpa</i>
Thembang Bapu Community Conserved Areas Management Committee (TBCCA)	Thembang Bapu Community Conserved Area, West Kameng, Arunachal Pradesh	<i>Monpa</i>
<b>ISLANDS</b>		
Madras Crocodile Bank Trust (MCBT)	Great Nicobar Biosphere Reserve, Nicobar Islands, Andaman and Nicobar	<i>Great Nicobarese</i>

**Number of Households involved in Major Activities under PPA Program:**

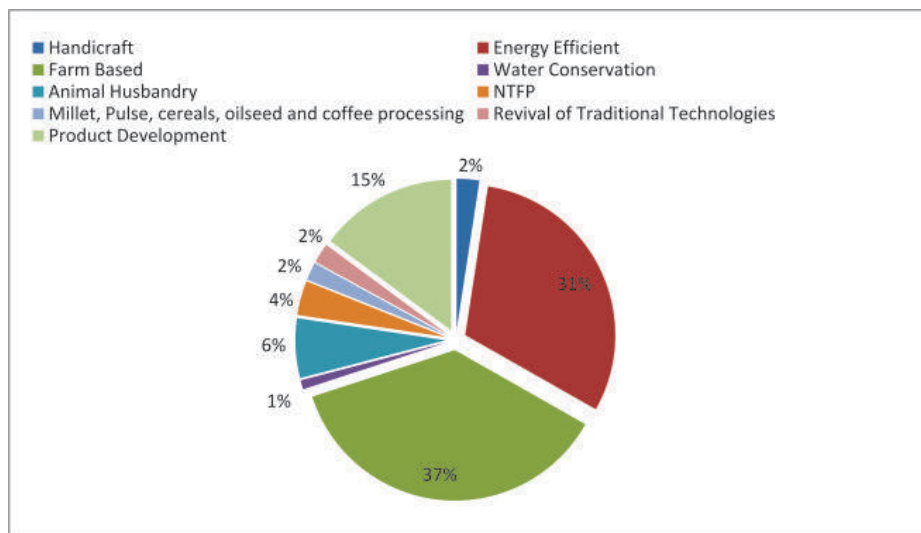
Energy Efficient Devices (Fuel Efficient Devices, Biogas, Solar LEDs, Biomass Briquettes, Solar Water heaters, etc.) = **1584**;

Farm Based (Agriculture, Horticulture, Agro-forestry, Composting, Vegetable and Mushroom Cultivation and Forest Home Garden) = **1893**; Water Conservation = **50**; Animal Husbandry & Fodder = **329**;

Forest Based (NTFP Value Addition, Herbal Products, Nursery Raising etc.) = **190**;

Millet, Pulse, Cereals, Oilseed and Coffee Processing = **99**; Community Based Tourism = **15**; Handicrafts = **125**; Revival of Traditional Technologies = **110**; Product Development = **767**

Reduce Human Wildlife Conflict = **30** (Lemon plantation & solar application)



## Key Highlights: Building Capacities at Local level

### Ecological Impacts:

- Reduction in fuelwood extraction from PA in most project sites with use and adoption of energy efficient cooking devices as reported about reduction in fuelwood consumption by 7 kg/HH/day in a village covering 60 Household (HH) around Kawal Tiger Reserve, Adilabad, Telangana.
- Sustainable resource use and value addition of NTFP's leading to better conservation practices.

### Social and Economic Impacts

- Livelihood Diversification to make value-added products with scientific processing like rhododendron-basil tea, rosehip-mint tea, apricot oil, peach oil, virgin coconut oil; agro-products from Ragi, amaranth, soybean, rajma, maize, millets, cereal; kokum juice, kokum butter, jackfruit papad, tuber chips, honey, Lantana furniture, bee-wax products like moisturizing cream, and bamboo products like straws, mats, etc. For instance in Parambikulam project area, about 45% increase in income level was reported though organized production and sale of value added products (Jack fruits, Honey, Manjakoova, NTFPs) by women group.
- New skills learning like Low External Input Sustainable Agriculture (LEISA) cultivation, vegetable square meter gardening, tuber cultivation, protected cultivation, community-based tourism, etc.
- Building and strengthening of local institutions in most project sites- Formation of 101 new technology user groups and strengthening of 121 existing groups.
- Convergence with other developmental agencies to involve and benefit more number of beneficiaries in technologies adoption thus impacting quality-of-life with social, ecological and livelihood benefits.
- Food security augmentation and reduction in input cost of agriculture across various project sites.



Handicrafts making near Thembang Bapu Community Conserved Area, Arunachal Pradesh by TBCCA



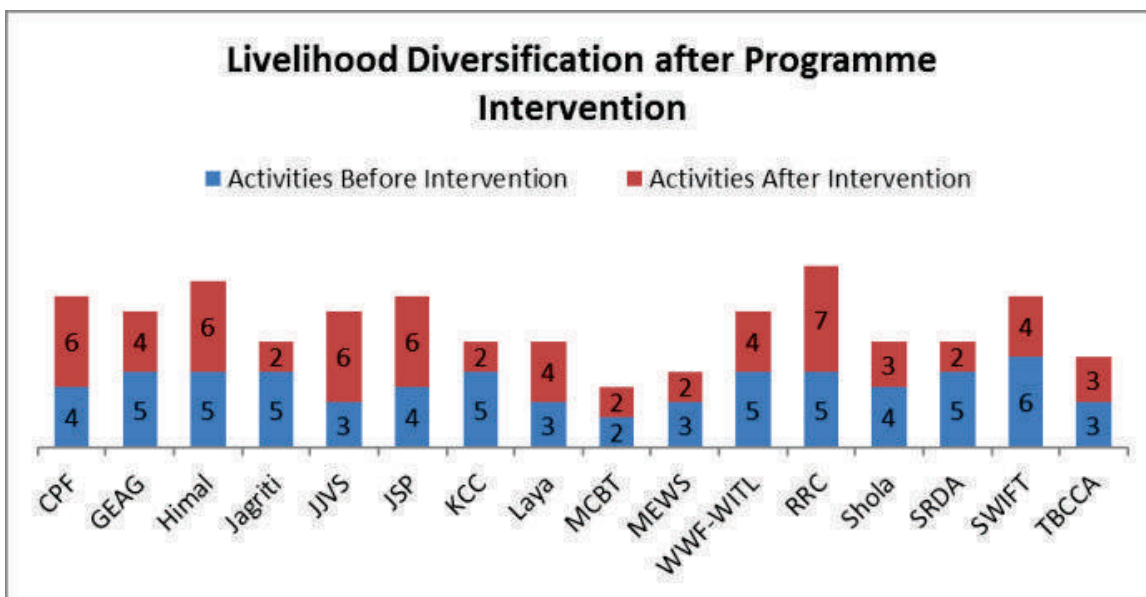
Herbal tea production near Khokhan Wildlife Sanctuary, Himachal Pradesh by Jagriti



Value addition using bee-wax around Parambikulam Tiger Reserve, Kerala by RRC



		
<p>Addressing Human Elephant Conflict through Lemon plantation: Bio-fencing in villages around Manas National Park, Assam by MEWS</p>	<p>Affordable solution for irrigated agriculture: Double piston hand pump introduced near Dandeli-Anshi Tiger Reserve, Karnataka by SWIFT</p>	<p>Low External Input Sustainable Agriculture (LEISA) introduced in villages near Valmiki Tiger Reserve, Bihar by GEAG, Gorakhpur</p>



PPA Network Program: to address conservation & livelihoods issues around PAs by building local capacities and skills through need based S&T Interventions

## 9. S&T led Entrepreneurship and Innovation Promotion

### Technology Business Incubator

Business incubation has been globally recognized as an important tool for job creation and economic development. The Department is supporting Technology Business Incubators primarily in and around academic, technical and management institutions to tap innovations and technologies for venture creation by utilizing expertise and infrastructure already available with

the host institution. Technology based new enterprises are high risk and high growth ventures, and require an enabling environment like NIDHI-TBI (TBIs being established under National Initiative for Developing and Harnessing Innovations initiative) to enhance the prospects of their success. Under this flagship program, department has established more than 120 Technology Business Incubators (TBI) and Science and Technology Entrepreneurs Parks (STEP) and several among them have matured and developed competence to become state-of-the-art Incubators.

During the year 2017-18, TBIs are being established at Aditya Global Business Incubator, Kakinada; Mizoram University Incubation Centre, Aizawl; College of Engineering, Pune; ICICI Knowledge Park-EDEN, Bangalore; Don-Bosco College of Engineering, Goa; IIM Lucknow; Sri Padmavati Mahila Visvavidyalayam (Women's University), Tirupati (1st Women specific Technology Business Incubator); Indian Institute of Millets Research (IIMR), Hyderabad; Siddharth Institute of Engineering & Technology (SIETK), Puttur; SASTRA University, Thanjavur; Indian Institute of Science Education & Research (IISER), Bhopal; Indian Institute of Integrative Medicine, Jammu; and Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat.

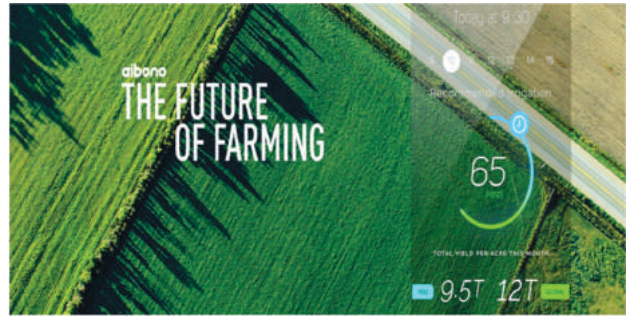
#### **Some of the innovative Products developed by Start-ups at various TBIs :**

**1. Air OK Smart Purifier** by AirOK Technologies, an incubatee at IIT Madras Incubation Cell is **Air Quality Management** Company. AirOK can be used in Indoor environments like Hospitals, Industries, Institutions, Pharmaceuticals, hospitality and waste management facilities. AirOK's **Smart Air purifier** with novel patented filter technology can remove more than 20 different environmental pollutants like Particulates (PM1, PM 2.5, PM10), Allergens (Pollen, dander, dust mites, mold spores), Tobacco smoke, Air borne bacteria, Chemical fumes, Volatile Organic Compounds (VOCs), Formaldehyde, odours, gaseous pollutants (Carbon monoxide, Carbon dioxide, Sulfur dioxide, Nitrogen dioxide), Lead, Asbestos and Radon etc., from indoor environments. Recently the company has raised Series A Investment (~Rs 12 crore) in November 2017



**Smart Air purifier**

**2. Aibono**, Founded by Vivek Rajkumar (IITM alumnus) is an IIT Madras Incubation cell incubated startup. It is India's first Smart Farming Collective™. It aggregates and turns small farms into smart farms with the help of internet and AI. The company is primarily focused on providing precision farming input and end-to-end production management advise for fruits & vegetable farmers using Sensors, Cloud Application, Data Analytics, Soil & Ambient Sensors, as well as multispectral crop stress using drone imaging.



Winner of Economic Times Start-up Award 2017 for Social Enterprise

**3. Planys Technologies Pvt Ltd** also founded by IIT Madras Alumnus, and incubated at IIT Madras, Planys provides underwater robotic inspection and survey solutions using indigenously manufactured underwater robots. Planys caters to sectors like Oil and Gas, Shipping, Ports, Dams, Bridges and Power plants. It was finalist in the Economic Times Start-up Awards 2016 and 2017 under Best in Campus category. Winner of INAE Young Entrepreneur Award. Have raised Series A investment (~Rs 16 crore) in December 2017 from leading VCs and HNIs in India and ONGC. Also supported by BPCL's Start-up Fund.



Underwater Robotic inspection System by Planys Tech.

#### 4. Log9 Material Private Limited

Log 9 Material Private Limited is incubated at TBI at IIT Roorkee. Log 9 Material uses Graphene Nanotechnology, with an aim to innovate and develop end user commercial

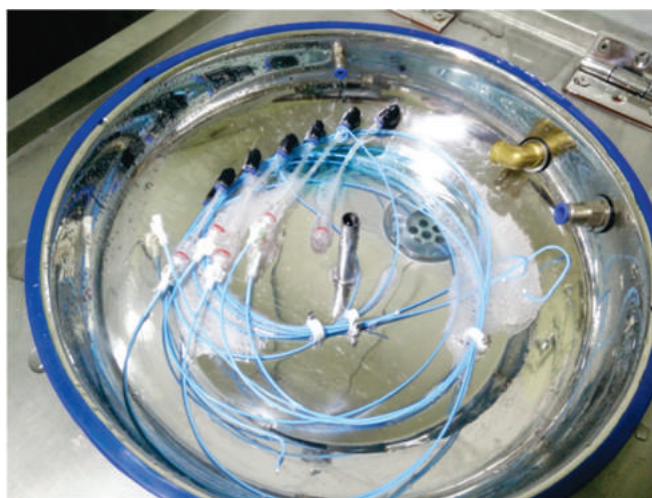




applications of ‘Graphene’. It has setup a state-of-the-art R&D centre in Bengaluru and Deoband (UP). It has filed for 4 patents and 6 more technologies are under development. First product PPUF has already been licensed out to a Pharma Company in India. It has received Pre-Series A funding from GEMS Plus, Delhi based Micro VC firm. Log9 material is also a start-up affiliate member of Centre of Nanoscience and Engineering, IISc Bengaluru.

**5. Discover Dollar**, an AI start-up from Amrita TBI, Kollam helps retailers to detect and resolve overpayments, missed discounts and un-recovered vendor incomes. Its powerful algorithms can scan through all available data sources including unstructured data like emails and contracts and notify relevant people in an organization about potential overpayment and resolve it by just a click of a button. *Discover Dollar became part of case study for Wharton Business School, Pennsylvania and IIM Bengaluru.* SAP in Orlando listed them among Innovative Solution. They also won various awards from IIM Bengaluru, IMT Nagpur and also is a winner of ‘Amrita TBI Pitchfest 2015’.

**6. Start-up “Incredible Devices”** incubated at Foundation for Innovation and Social Entrepreneurship (FISE), Tata Trust, Bengaluru- is a med-tech start-up that produces automated catheter reprocessing systems (CRS) for angioplasty procedures. CRS is an automatic angiography and angioplasty catheter cleaning machine which is developed to use at Hospitals. CRS is cost effective & quality assured way of reprocessing catheter to make treatment cost effective. It automates the entire manual cleaning process to avoid infection and also eliminates human error. This is estimated to bring down costs of procedures by 10-55%.



**Catheter Reprocessing System**

**7. Help Us Green** Start-up collects flower waste from temples and mosques for processing into natural products such as incense, bio-fertiliser and biodegradable styrofoam, thereby reducing pollution and pesticide discharge. The company has pioneered a unique concept called *flowercycling* to process waste flowers and about 5 patents are in progress.





**8. Nellikuru Innovations Private Limited** is an innovation led start-up incubated by TBI-CIBA, Goa under Advanced Manufacturing category for Hot Metal Pre-Treatment in Integrated Steel Plants. The process is under provisional patent, and helps reduce the cost of manufacturing steel. It is 3rd place winners of China (Shenzhen) Innovation & Entrepreneurship International Competition

**9. Start-up- Dimension NXG** at TBI-Zone Start-ups, BSE, Mumbai has developed Ajnalens - With an edge-to-edge field of view of over 90 degrees, every hologram leaps from reality in rich, vibrant detail & their mapping technology includes one of the world's most advanced 3D capture systems.



**10. Altius Start-up** at TBI-iCreate, Ahmedabad -3D designed and printed prosthetic arm which will be actuated by linear actuated motors or servo motors and the motors gets input from an MCU having a myoelectric and a flex sensor.



Prosthetic arm

### National Award for Technology Business Incubators for the year 2016

In order to recognize and reward the remarkable work done in the area of incubation and technology entrepreneurship through value added business support by specialized facilities such as Technology Business Incubators and Technology Parks, Department has established a National Award for Technology Business Incubators. The National Award for Technology Business Incubators for the year 2016 was presented to the ‘Amrita Technology Business Incubator’, Kollam on the Technology Day, 11th May 2017. For the year 2016, the National Award for Emerging Technology Business Incubator was presented to ‘IIT Madras Incubation Cell’.



**National Award for Technology Business Incubators for the year 2016 being presented to the ‘Amrita Technology Business Incubator’, Kollam**

### Seed Support to Incubators

The Seed fund provided by the Department equips the STEP/TBI with the much needed early stage financial assistance to be provided timely to deserving start-ups under incubation in a relatively hassle free manner. In F.Y. 2017-18, 11 TBIs/STEPS have been recommended for Seed support under “National Initiative for Developing and Harnessing Innovations- Seed Support System (NIDHI-SSS)” programme. In FY 2017-18, cases for release of grant for 15 TBIs/STEPS namely, CIIE Initiatives, Centre for Innovation Incubation and Entrepreneurship (CIIE), Gujarat; Entrepreneurship Development Center (Venture Center), Maharashtra; Amrita Technology Business Incubator, Kerala; Ahmedabad University Support Foundation (AUSF), Gujarat; Shri Mata Vaishno Devi University Technology

Business Incubator Center Society (SMVDU TBIC), Jammu & Kashmir; GLS University Incubator, Gujarat; FITT, IIT Delhi, Tata Trusts, Bengaluru, Karnataka; SCTIMST-TIMED, Technology Business Incubator for Medical Devices & biomaterials, SreeChitraTirunal Institute for Medical Sciences & Technology, Trivandrum, Kerala; Foundation for Sandbox Startups Initiatives (FSSI), Despande Foundation, Hubali, Karnataka; TIDES Incubation Centre, IIT Roorkee, Uttarakhand; Technology Business Incubator National Institute of Technology, Calicut, Kerala; Zone Start-up India, Bombay Stock Exchange Institute, Mumbai, Maharashtra; Tiruchirappalli Regional Engineering College - Science and Technology Entrepreneurs Park (TREC-STEP), Tamil Nadu; NSRCEL; and VIT-TBI were processed and are likely to be sanctioned in current year.

### **Accelerator Programme:**

Accelerator is typically a 3-6 months' fast track structured program implemented by TBIs helping ideas get accelerated to the next level through rigorous mentoring and investment preparedness. In F.Y. 2017-18, following TBIs/STEPS are being supported under "National Initiative for Developing and Harnessing Innovations- Accelerator (NIDHI-Accelerator)" programme. CIIE Initiatives, Centre for Innovation Incubation and Entrepreneurship (CIIE), Gujarat; KIIT -Technology Business Incubator (KIIT-TBI), Odish; IIM Calcutta Innovation Park, Kolkatta; Amrita Technology Business Incubator, Kerala; Ahmedabad University Support Foundation (AUSF), Gujarat; NAARM-TBI a-iDEA, Telangana; LEAF – GLS University Incubator, LEAF- Leadership, Entrepreneurship & Acceleration Foundation, Ahmedabad, Gujarat, iCreate International Centre for Entrepreneurship and Technology, Gujarat Foundation for Entrepreneurial Excellence, Ahmedabad, Gujarat; and Tiruchirappalli Regional Engineering College - Science and Technology Entrepreneurs Park (TREC-STEP), Tamil Nadu; and Zone Start-ups India, Maharashtra.

### **Centres of Excellence (NIDHI-COE)**

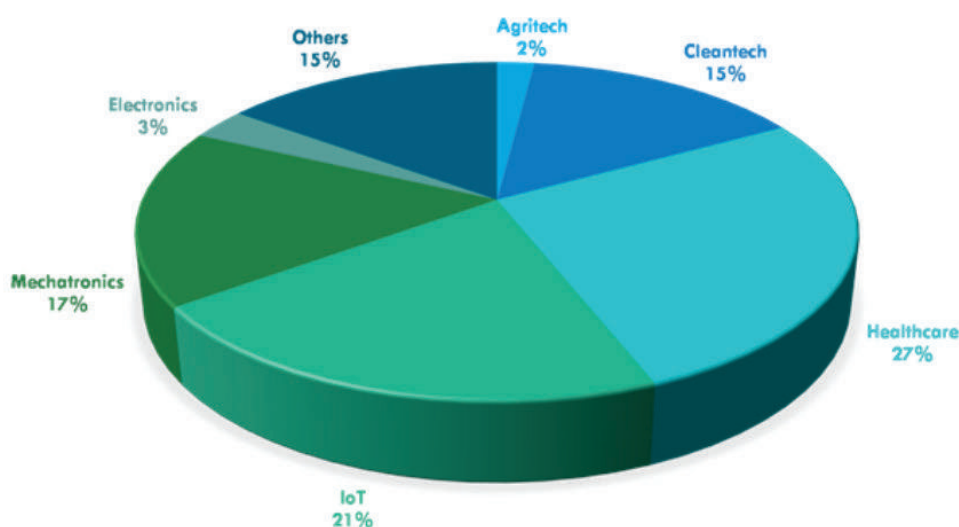
NIDHI-Centre of Excellence (NIDHI-CoE) provides an enabling environment to Technology based new enterprises which are high risk and high growth ventures. The existing STEPs and TBIs would act as a reservoir of knowledge in venture promotion including the resources and networks and help NIDHI-CoE in aligning the linkages with both national as well as international partners. NIDHI-CoE strengthens existing capacities of STEP/TBIs and supports potential start-ups with different pursuits and practices in transferring technological innovations into marketable products/high-growth companies. The new NIDHI-COEs (Centre of Excellence) being established during the F.Y. 2017-18 are at -Vel Tech Dr. RR & Dr. SR Technical University, Chennai; SINE, IIT Bombay; and CIIE-IIM Ahmedabad.

### **NIDHI PRAYAS (Promotion and Acceleration of Young and Aspiring innovators and start-ups)**

NIDHI PRAYAS program has been focusing to address the funding gap from idea to prototype and is positioned as pre-incubation initiative. During current year, 10 PRAYAS Centres were opened at 10 TBIs i.e. Ahmedabad University Support Foundation; Kongu Engineering College, Perudurai;



PSG-STEP, Coimbatore; IKP Knowledge Park, Hyderabad; SIDBI Innovation and Incubation Center, IIT Kanpur; International Centre for Entrepreneurship and Tech (icreate), Ahmedabad; Science and Technology Park (STEP-Pune), KIIT Technology Business Incubator (KIIT-TBI), SINE-IIT, Bombay; and Venture Center, NCL-Pune to provide support to the innovator with a prototype grant upto Rs.10 Lakh for converting their idea into a prototype. 10 DST PRAYAS Shala (fab lab) were opened at 10 Technology Business Incubators to facilitate mechanical and digital fabrication besides providing physical infrastructure, technical guidance and business mentorship to the PRAYASEEs (innovators). Currently 100 Innovators are being supported under the PRAYAS grant covering domains as given below:



Domain-wise distribution of Prayas projects

### Entrepreneurs-in-Residence (EIR) Programme:

Entrepreneurs-in-Residence (EIR) Programme has been focusing to inspire the best talents to be entrepreneurs, to minimize the risk involved in pursuing start-ups, through providing support as a fellowship up to Rs. 30,000/- for a period of one year. During current year, 100 fellowships were provided by 10 TBIs i.e. Entrepreneurship Development Center (Venture Center), CSIR- NCL, Pune; PSG Science & Technology Entrepreneurial park (PSG-STEP), PSG College; Society for Innovation and Entrepreneurship, IIT-Bombay, Mumbai; CIIE Initiatives, IIM-A, Ahmedabad; Ahmedabad University support Foundation, Ahmedabad; Manipal University Technology Business incubator, Manipal University, Manipal; KIIT - Technology Business Incubator (KIIT- TBI), KIIT, Bhubaneswar; SIDBI Innovation & Incubation Centre, IIT Kanpur; Krishna path Incubation society-TBI, KEIT, Ghaziabad; and PSG-STEP, Coimbatore to the young innovators to expand their networks and get critical feedback on their ventures in order to promote their entrepreneurial career goals and aspirations.



### **New Generation Innovation and Entrepreneurship Development Centre (New-Gen IEDC)**

The NewGen IEDC program is aiming to inculcate the spirit of innovation and entrepreneurship amongst the young S&T students, encourage and support start-up creation through guidance, mentorship and support. During 2017-18, 14 New-Gen IEDCs were opened in various academic Institutions. Currently 50 New-Gen IEDC/IEDC operational in the Country support 200 innovative students projects for development of new product or process having potential for commercialization.

### **DST-Lockheed Martin-Tata Trusts India Innovation Growth Programme 2.0**



**Launch of IIGP 2.0 at Rashtrapati Bhawan**

The India Innovation Growth Programme 2.0 was launched on March 10<sup>th</sup>, 2017 at the Festival of Innovations at the Rashtrapati Bhavan. India Innovation Growth Program (IIGP) is a unique public private partnership initiated in 2007 between Department of Science and Technology and Lockheed Martin Corporation. Tata Trusts joined the newly revamped India Innovation Growth Programme 2.0 (IIGP 2.0).

A total of 1590 applications were received under IIGP2.0. For the top 50 Open Innovation Challenge teams, a one week bootcamp was organized at the Indian Institute of Management, Ahmedabad during 25<sup>th</sup>– 30<sup>th</sup> June, 2017. The University Challenge Competition was organized at IIT-Bombay on 24<sup>th</sup> June, 2017 for both the industrial and social tracks. The Open Innovation Competition was held during 25-26 July 2017 where 47 start-ups pitched to an eminent jury panel at Hotel Taj Mansingh. Subsequently, nine University Teams and Ten Open Innovation Teams were awarded. Each university team was awarded a cash award of Rs.10 Lakhs and each open innovation team was awarded Rs.25

Lakhs. The top 10 awardees of the Open Innovation Challenge were taken to the USA from September 6-15, 2017 to participate in a global exposure visit. In Boston, delegates attended the demo day of the most recent batch of Delta V start-ups, funded and mentored by Martin Trust Center.



Sh. Y.S.Chowdary, Minister of State (S&T) Presenting IIGP 2.0 Awards

### **DST-Texas Instruments “India Innovation Challenge 2017”**

DST has partnered with the Texas Instruments to scout, motivate, validate and incubate Engineering students driven innovative design ideas with commercial potential under Make in India, anchored by MyGov platform and implemented through Indian Institute of Management, Bangalore. Project submission round of DST-Texas instruments India Innovation Challenge 2017 (IICDC2017) closed on 25<sup>th</sup> Sept 2017. The theme of IICDC2017 in keeping with the start-up buoyancy is “Innovation, Entrepreneurship and Nation Building”. A total of 5049 proposals from 965 Indian Engineering Colleges were received in IICDC2017 and are being shortlisted for further stage of screening.

### **Power of Ideas-2017**

The Economic Times Power of Ideas is a largest entrepreneurship development initiative which started in 2009 jointly organized by The Economic Times in association with the Department of Science and Technology and Centre for Innovation Incubation and Entrepreneurship (CIIE), the business incubator at Indian Institute of Management, Ahmedabad, to seek, reward, nurture and groom business ideas by connecting them with relevant evaluators, mentors and investors. Facebook is the new partner in POI-2017. POI 2017 was launched on 24th October, 2017. Call for applications closed on November 13, 2017. A total of more than 9000 applications were registered and 3000 were finally submitted. After evaluation, shortlisted 500 were announced on December 22, 2017.

## DST-ABI-IUSSTF supports Women Entrepreneurship Quest (WEQ) 2017

WEQ is a unique program designed to promote and showcase early-stage technology ventures which are founded or led by women entrepreneurs in all technologies. The program is one of its kind to be organized in the country for tapping talented technical women. The WEQ 2017 finale was held on 17<sup>th</sup> November this year during AnitaB.org's flagship conference in Bengaluru, the Grace Hopper Celebration India 2017 (GHCI 17), one of the largest conferences for women technologists in the country. The Top 10 winners were selected from 257 applications received from across India. The applicants were evaluated on strength of team, unique business proposition and market traction.

The Top 10 winners of WEQ 2017 are *BhavjotKaur*, Co-Founder of Clinikk Healthcare (Bengaluru); *Kausambi Manjita*, co-founder at Kubric (Bengaluru); *Madhulika Mukherjee*, co-founder at Survaider (Bengaluru); *Monika Shukla*, co-founder & CEO at Letsendorse (Bengaluru); *Meghna Saraogi*, founder & CEO at Styledotme (Delhi); *Pallavi Bishnoi*, co-founder & COO at Real Time Renewables (Lucknow); *Radhika Choudary*, co-founder at Freyr Energy Services (Hyderabad); *Saigole*, co-founder & COO at Leanagri (Pune); *Supriy Rathi*, founder & CEO at Robovr (Mumbai); *Vishakha Singh*, co-founder at Vicit info Tech (Mumbai). They will be taken to an all paid experiential visit to silicon valley in March-17 April 2018.



Award Ceremony of WEQ 2017 held on 17.11.17 at Bengaluru.

## DST supports Women Accelerator programme “-empower ” by Zone Start-ups, Bombay Stock Exchange Institute, Mumbai

Second Empower programme which is dedicated exclusively for women entrepreneur concluded



through a Demo day. It was organized by Zone Start-up in Bombay Stock Exchange on December 13, 2017. This 6 weeks program for accelerating 15 women entrepreneurs was successfully conducted.

### **DST supports an exclusive Mentorship Program: Women Entrepreneurship and Empowerment (WEE) to IIT Delhi**

WEE (Women Entrepreneurship and Empowerment) Mentorship program is 4-month program initiated by IIT Delhi through FITT, IIT Delhi and WEE Foundation to empower and encourage women entrepreneurs by training them in entrepreneurship skills, mentoring and enabling them to convert their idea(s) into a successful business models. The II<sup>nd</sup> cohort was concluded in November, 2017. Top 5 out of the cohort of 30 were awarded Rs.5 lakh each.

### **i-STED (Innovation, Science and Technology led Entrepreneurship Development)**

**Programme:** i-STED programme is aimed at inculcating strong entrepreneurial orientation in people to translate already developed innovative/S&T solutions in the market. A total of 6 new i-STED projects are being considered for support in F.Y. 2017-18 i.e. CSIR-National Metallurgical Laboratory, Jamshedpur, Jharkhand; R V College of Engineering, Bengaluru, Karnataka; SAHYOG, Ahmedabad, Gujarat; Columbia College of Pharmacy, Raipur, Chhattisgarh; Adhiyamaan College of Engineering, Hosur, Tamil Nadu; and Centre for Social Development Kanyakumari District, Tamil Nadu. Support to ongoing 15 i-STED projects was continued.

### **NIDHI Student Start-up Award**

NIDHI Student Start-up Award aiming to provide ignition funding to the students to commercialize their product or process developed by them. During 2017-18, 12 students were awarded NIDHI-Student-Award to accelerate the journey of idea to prototype by providing initial funding assistance upto Rs.10 Lakh.

### **NSTEDB Training Programmes**

The training programmes (EAC, EDP, WEDP, TEDP, FDP) of NSTEDB are able to generate an ecosystem and technology-based entrepreneurial culture in S&T institutions in the country by sensitizing 1.30 lakh students towards entrepreneurship through EACs, training 3840 number of teachers/ trainers/ resource persons for promoting S&T entrepreneurship covering 360 institutions across the country. The training programmes were able to promote establishment of 4718 enterprises during 2017-18.

## **10. Developing Scientific Temper in society**

**National Council for Science and Technology Communication (NCSTC)** builds programs with focus on outreach activities to popularize science; training in science communication; development, production & dissemination of S&T software; organizing field based projects; promotion of research; international co-operation; ecological sciences communication and so on, which percolate to every



nook and corner of the country. The programme division has also instituted awards and incentives to recognize the best efforts in this challenging domain. Some key achievements and activities are highlighted below:

**a. Science Express– Phase IX (SECAS- II)**

One of the most popular, mega outreach and flagship programs of NCSTC in the last 10 years has been the ‘Science Express (SE)’. It is an innovative mobile science exhibition mounted on a specially designed 16 coach AC train, which has been traveling across India since October 2007. It has completed 9 tours of the country, covering 1,61,000 km and exhibiting at 529 locations on Broad Gauge, spread across the length & breadth of country. Science Express received overwhelming response and reached out directly to over 18.1 million visitors and thus become the largest, the longest running and the most visited mobile science exhibition. It has 12 entries in the Limca Book of Records including 6 new ones in the 2017 edition.

Whereas, Science Express from Phase I to IV showcased cutting-edge research in S&T being carried out worldwide in collaboration with Max Planck Society and Federal Republic of Germany, later in its *avatar* as ‘Science Express Biodiversity Special (SEBS)’ (Phase V-VII) it showcased the rich biodiversity of India and its conservation measures with the then Ministry of Environment and Forest as partner. Phase VIII and IX of SE were titled ‘Climate Action Special (SECAS)’ which highlighted the global challenges of climate change.

The 9<sup>th</sup> phase of Science Express as SECAS II was flagged off on 17 Feb 2017 from Delhi Safdarjung by Dr. Harsh Vardhan, Hon’ble Minister of Science & Technology and Earth Sciences (S&T and ES); and Late Shri Anil Madhav Dave, the then Hon’ble Minister of State (I/C) for Environment, Forest and Climate Change (MoEFCC). Shri Suresh Prabhu, the then Hon’ble Minister of Railways, addressed the gathering through video conferencing.



Hon’ble Minister of S&T and ES in SECAS II



Visitors learning aspects of Climate Change

SECAS II, scheduled from 17 Feb 2017 to 8 Sept 2017, was exhibited at 74 locations across India as a unique collaborative initiative of DST, MoEFCC, DBT, and Ministry of Railways. It received an overwhelming response with over 24.72 lakh people visiting the exhibition train, which is the highest amongst all the 9 phases. The state-of-the-art exhibition on board the SECAS II aimed to create awareness among various sections of society as to how climate change can be combated through mitigation and adaptation. It also intended to contribute towards increasing the understanding of the science of climate change, its observed and anticipated impacts, and different possible responses.

Of the 16 coaches of SECAS, exhibition in 8 coaches was exclusively devoted to information, case studies and material related to various aspect of Climate Change, in an easy to understand and interesting format, for not just school students but also the masses. At each halt, activities were planned to engage visitors across different age groups to reinforce its message. An exciting and much sought-after Outreach Programme was also conducted in local schools along with activities on the railway platforms. In addition, informative take-away material was made available for distribution amongst schools and colleges.

DST entrusted Vikram A Sarabhai Community Science Centre (VASCSC), Ahmedabad, with the task of managing SE program since inception. Its team of qualified, trained and motivated Science Communicators travelled with the train, facilitating the visitors, explaining and interpreting the exhibits, answering queries, and conducting its complementary activities. Science Express has achieved a grand success in course of its nine years of journey. Through, this mega outreach programme, DST has been able to directly reach out to over 18.1 million visitors and many more through its presence and coverage in Media. It has created a paradigm shift in the field of science communication by bringing science to the people and spreading awareness about recent advances in S&T, Biodiversity Conservation, and Climate Action through Mitigation and Adaptation strategies to be followed.



Students wait for their turn to see exhibition



While waiting they engage in platform activities

### **b. Children Science Congress 2017**

Children Science Congress (CSC) is a flagship programme of the DST to initiate the young students in

the age group of 10-17 years in the process of scientific thinking and satisfying their quest for scientific knowledge through hands-on, minds-on approach by doing projects. Children have a burning desire to understand how and why of processes occurring in nature and CSC provides a viable platform to fulfil this quest.

The focal theme of 25<sup>th</sup> edition of CSC 2017 is ‘Science Technology and Innovation for Sustainable Development with special emphasis on accessibility for Persons with Disabilities’. CSC covers almost all the districts of the country with a participation of over 500,000 students each year and the year under report was no exception. Emphasis was on hands-on science and presentation of the results and its analysis. Some teams also presented working prototype and models. Through a process of evaluation, best of promising ideas and projects were shortlisted for presentation at State level and further scrutiny lead to about 650 projects getting shortlisted for a presentation at national level. The whole process of CSC was guided by an Activity Guide Book (AGB) which was prepared in consultation with experts. The grand finale of CSC, popularly known as National Children Science Congress (NCSC) was held during 27-31 December 2017 at Science City, Ahmedabad.

Eminent scientists from several premier S&T agencies of India participated in NSCS and interacted with the children and addressed their queries.

### **c. Hands-on STEM & Innovation Demonstration**

Science, Technology, Engineering and Mathematics (STEM) demonstration activities form another major component of NCSTC which comprise of science fairs, *melas*, expositions, mobile exhibitions, lecture-demonstrations, interactive media, visits to S&T establishments like labs and industry, hands-on activities, and so on. These events, whether stationary or otherwise, including mobile science exhibitions, serve to utilize the expertise of resource persons trained/being trained by NCSTC in various aspects of activities listed above. Different kinds of demonstrations on a variety of STEM themes and also on environment, health, medicine, etc. are held across the nation each year. Support is extended for scientific awareness and exposure on these realms including hands-on activities. Various formats like toys & games, quizzes, puzzles, mathematical games & activities, short design/redesign, spot-the-odd-one, draw a future, painting, presentations, skits and street plays, etc. are utilized to arouse curiosity and sustain the interest of young and old alike.



Students participate in on-the-spot competition on S&T themes



Science exhibition is one of the most important activities to create and enhance scientific knowledge of children; teachers, parents, peoples representative and common man, and it also brings about change in their attitude. It is participatory in nature where audiences learn by doing. DST initiated Science Exhibitions, S&T Fairs, Basic Science, Technology and Innovation workshops, besides lectures and hands-on activities and demonstration of workmanship on different processes, technological developments and innovative methods. More than 40 static and mobile exhibitions were organized in Andhra Pradesh, Kerala, Arunachal Pradesh, Andaman & Nicobar Islands, Assam, Tripura, Nagaland, Manipur, West Bengal, Orissa, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Delhi, Punjab, Haryana, Uttarakhand, Jammu & Kashmir, Uttar Pradesh, Rajasthan and Maharashtra.

### India International Science Festival 2017 (IISF 2017)

IISF-2017, a Mega Science, Technology and Industry Expo, was conducted successfully at Anna University Grounds, Chennai during 13-16, October 2017. IISF 2017 was organised by Ministry of Science and Technology and Ministry of Earth Sciences in association with *Vijnana Bharati*, NCSTC and Vigyan Prasar were the major participants. 25 State Councils of Science and Technology also took part besides 300 Labs and Institutions from across the country and displayed their capabilities and achievements in the S&T domain. About 25 Central Ministries were also present in the Expo.

### Perfect Health Mela:

MTNL Perfect Health Mela is one of the most visited community health events held annually in Delhi since 1993. Celebrating the 24<sup>th</sup> Year of Perfect Health Mela, Heart Care Foundation of India organized Perfect Health Mela 2017 during 4-8 October 2017. The theme was “Digital Health” and all activities were based around this. More than 200 organizations including schools and colleges, Government Departments, PSUs, Corporates and NGOs participated and conducted their activities, which included exhibition of their schemes, free counselling and OPDs, on-the-spot demonstrations of detection of food adulteration and science corners. Large number of people visited DST stalls where scientific activity corners were put up on various science popularization-related activity like Vermi composting, Hydroponics, Nature Study, Soil & Water Testing, Explaining Science behind Miracles, Detection of Food Adulteration, Low-Cost Teaching Aids, Origami, etc.



Model created by young scientists on display



### Science Exhibition on Wheels:

Mobile Science Exhibitions aim to reach the unreached with the message of effective Science Communication and for developing scientific temper among the masses, especially students. The idea of mobile science exhibition bus was conceived to reach the unreached. The activities include science model exhibition, regular sky gazing camps through telescope, scientific explanation to miracles, etc. The target group for these activities includes school & college students, youths, women, teachers, *gram panchayat* members, voluntary organization, policy makers, etc.

In Assam 'Science Exhibition on Wheel' conducted 252 programs in 12 district including outreach activities like popular talks, science awareness campaign, demonstration, competition, quizzes, etc. In the evening scientific film were shown in schools. The exhibition received tremendous response from Students and Teachers and general public. Mobile Science Exhibition of Pushpa Gujral Science City aimed at reaching out to people from all walks of life through fun and accessible scientific content, and removing the barriers to engagement. The exhibition comprised 34 interactive exhibits and information panels giving the students/visitors an opportunity to learn through the process of interaction and discovery. It was also equipped with Mobile planetarium and high powered telescopes to hold night sky-watching sessions. Demonstrations and special programs were also taken up to educate the visiting public about renewable energy sources and water testing. The exhibition was organized in rural schools where it remained for 2-3 days each. This Exhibition bus has extended its outreach in all 22 districts (more than 100 blocks and 1500 villages) of Punjab. Pre and post visit Questionnaire based analysis of students revealed marked improvement in their scientific knowledge. The introduction of Mobile Science Exploratory in Kerala was appreciated by Justice P. Sathasivam, Governor of Kerala. It was conceived to explain the uses of appropriate/ intermediate technologies to educate the masses on healthcare, first-aid, need of clean drinking water, *swatchh* literacy, hazards of pollution, etc. Through the scientific equipment fitted in the Mobile Science Exploratory, student were motivated to do scientific experiments. Similar

initiatives were taken up in Andhra Pradesh, Uttar Pradesh and Haryana.



Inside View of Mobile Science Exhibition

#### d. INTEL ISEF and IRIS

Team India, comprising of 29 school students (IX-XII grade), who were winners at Innovation for Research and Initiative in Science (IRIS) National Fair 2016, represented India at INTEL International Science and Engineering Fair (ISEF) held in Los Angeles, California, USA during 14-19 May 2017. Indo US Science and Technology Forum (IUSSTF) in partnership with DST facilitated the participants of Team India. In addition to ISEF, they also visited Maker Fair in San Francisco. Team India in ISEF 2017 has done the Nation pride by winning a total of 21 awards, 10 Grand Awards and 11 Special Awards, at ISEF 2017, the maximum by any of the 78 participating countries. In addition, 6 minor planets were named after these outstanding Indian students. This has been the largest award Team India has won so far and its members also met Maya Ajmera, CEO, Society for Science and the Public and shared their learning and experiences. ISEF 2017 also provided a platform for Indian students to interact with the students of the World community at large and also the representatives of American Universities. In addition to the scientific exchange, Indian students participated in cultural programmes and visited various educational institutions like University of Southern California and Walt Disney Animation Studio to see the application of modern technology in various walks of life. IUSSTF also announced the IUSSTF-Visit to India Award in which 3 best of the INTEL-ISEF category winning students from USA travelled to India to present their projects at National Science Fair in 2017.

**Initiative for Research & Innovation in Science (IRIS)** is a public-private partnership between DST, Intel and IUSSTF for empowering the next generation of innovators. IRIS aims to promote and nurture science and research amongst young Indian innovators. It is research-based science fair for students, which aims to inspire budding scientists in India. Since its inception, IRIS promotes and nurtures science and scientific research amongst young Indian innovators. With the purpose to recognize and reward outstanding projects, IRIS provides a platform for these young and talented ones to represent India at global science competitions like Intel International Science and Engineering Fair (Intel-ISEF). Each year, IRIS, with the help of Senior Scientists, and through its online presence, reaches out to students, teachers and schools across the country and encourages them to come up with research based science projects and so far it has touched over 3 million students. IRIS National Fair is conducted annually in India for school students, who compete in 17 subject categories. By August, the students send in their entries which are thoroughly scrutinized by the IRIS Scientific Review Committee (SRC). Only the best shortlisted projects are chosen for the IRIS National Fair which has been running for past 9 years. National IRIS Fair was held in New Delhi during 16-18 November 2017. Over 100 child scientists/ innovators participated in the Fair and presented their innovative research based projects. 20 Outstanding projects were selected for National IRIS awards. They will form Team India and would compete in Intel-International Science & Engineering Fair to be held in USA in May 2018.

#### e. India Innovation Initiative (I3)

India Innovation Initiative (I3) is a joint program of DST, Confederation of Indian Industries (CII) and All India Council for Technical Education (AICTE). I3 aims to promote scientific thinking and

problem solving amongst the youth of the country. It encourages them to apply theories and methods of science to carve out high impact and disruptive solution to industry and social challenges. In I3 final event held in AICTE Headquarters in New Delhi on 8 December 2017, 40 of the top innovators, identified through intensive scrutiny at 4 regional workshops, participated and 23 won various Awards that were at stake. Also, an enabling mechanism was created for commercialising the best and home grown initiatives through support mentorship, investors and industry connect.

**f. Sci-com Folk Media, Low Cost Teaching Aids, Science behind Miracles**



**Scientists performing so-called miracles**

Science Communication initiatives of NCSTC also strives to reach the unreachable, through training, demonstrations, low cost teaching aids, folk media, puppetry, street plays or *nukkadnatak*, folk songs, dances, etc., and to address societal misconceptions like blind beliefs, myths, so-called miracles, and other controversies which can be addressed using S&T and thus instil scientific temper amongst the gullible.

Resource person training workshop on scientific explanation of miracles was conducted in four district of Haryana by Indian Resource and Development Association, Kurukshetra. Around 300 participants attended the workshops. In the activities sessions it was demonstrated how Miracles are performed by so called God-men who want to mislead the gullible. A resource group was formed at district level. The participants now have started conducting same activities in their area for students and general public. Similar programs were conducted at several other locations across the country through trained S&T communicators.

### g. S&T Communication through CR

Realizing the reach of Community Radio (CR) to communities which do not have formal or easy access to verifiable information & knowledge about issues affecting them (like health & nutrition), initiatives have been launched by NCSTC in conceiving, designing, preparing and delivering radio programmes that can be heard by communities located even in far-flung or otherwise unreachable areas. During the recent interventions, the focus has been on achieving gender equity and align with national priority *Beti Bachao, Beti Padhao*, which has been well leveraged by Community Radios across the entire nation. NCSTC has so far supported 68 CRs under its Science for Women's Health & Nutrition (SWHN) initiative besides Radio Mathematics which is aimed at inculcating basic Maths skills among even the illiterate. The program, which envisages 365 episodes, mostly in local language in one year tenancy, is being re-oriented to raise level of hand-holding by DST so that infrastructure, facilities and manpower engaged in this endeavour could be utilized to its fullest. NCSTC recommended supporting 10 CRs after doing need assessment and capacity building of 12 CRs in its Expert Committee meeting held during 7-8 July 2017 at Madurai. The CRs recommended for support are Radio JIMS-New Delhi; Kamalvani- Jhunjhunu, Rajasthan; Jnan Taranga- KK Handique State Open University, Guwahati, Assam; Samudayik Vanya Radio-Khalwa, Madhya Pradesh; Alwarki Awaz-Alwar, Rajasthan; VasundharaVahini-Baramati, Maharashtra; Pasumai CR-Dindigul, Tamil Nadu; Janadhvani CR-Saraguru, H.D Kote Taluk, Karnataka; Radio Active CR-Bengaluru, Karnataka; and Periyar CR-Thanjavur Periyar Maniammai University, Thanjavur, Tamil Nadu. Members visited Shyamalavani Community Radio at Rural Madurai, Pasumai Community Radio at Sirumalai, Dindigul and Vaylagam Community Radio at Kottampatti, near Dindigul and also reviewed 8 projects funded under SWHN program during the year 2016-17.

### h. Mission Eco Next

The programmes aims to inspire and nurture the Eco Intelligent Youth Young Change Makers. 'Mission Eco NEXT' initiatives focus upon promoting real-time responsiveness for building regenerative ecological futures which are leveraged by eco-media, eco-design, eco-innovation for promoting integrated efforts for conservation of natural resources, specifically aimed at developing models in public guidance systems based on science communication. These may include location-specific innovative initiatives for actionable learning and building field capacity for adopting best practices in knowledge critical domains. S&T Communication Trainings and support are provided in project mode for knowledge-led motivation and capacity building of youth for leadership and improvement of quality-of-life of specific target groups, based on scientific approaches of 'being-on-their-own' and 'collective response' to challenges and location-specific issues.

2<sup>nd</sup> Meeting of Technical Advisory Committee for the Mission and Regional Youth Consultation for West Bengal, Bihar, Jharkhand and Odisha was organized at ICAR Research Complex for Eastern Region, Ranchi during 17-19 June 2017 and 3<sup>rd</sup> Meeting of Technical Advisory Committee and Regional Consultation Eco Next "CONSULT" for Kerala, Karnataka, Tamil Nadu, and Pondicherry



was organized by PN Panicker Vigyan Vikas Kendra, Thiruvananthapuram during 29-30 October 2017, which was addressed by Dr. PJ Kurien, Hon'ble Deputy Chairman, Rajya Sabha who appreciated this initiative of DST.

Eco Eureka Workshops, Eco Studios for Eco Creatives with post-trainings engagements, Water Clinics, Eco Smart School Modules, are a series of continuing initiatives whereby scores of young leaders have been trained. Emphasis has been laid on model interventions for remote, inaccessible, marginalized and challenging areas & populations. Eco Eureka training was organized in Nemmara, Distt Palakkad, Kerala. The participants were exposed to Silent Valley Eco Systems and Nelliampathy Valley with interactive learning and action plans. Eco Eureka Trainings was also concluded at Someswar, Uttarakhand; Mudumalai Tiger Reserve, Tamil Nadu and Auroville Botanical Garden, Puducherry. Eco Studio trainings have been organized in Rajasthan, Uttarakhand, Maharashtra, and Manipur.



Some noteworthy field interventions are:

- *“Eco Wash- Innovations & Excellence in Water Credits & Water Budgeting Skills of Girl Students & Teachers– Neer Naari Vigyan”*: A country wide programme, involving School Children and Teachers focusing on the role of Women in Water Conservation, was implemented with Eco Roots Foundation, Delhi. Workshops in 180 schools in 10 selected cities were undertaken. The teachers mentored students to prepare a theatrical skit, musical play on the role of women in water conservation and earning water credits.
- *Hands on training on effective leadership and management for Water, Sanitation & Hygiene:* The Eco Creative’s Training in Wada Taluka, Mumbai, Maharashtra focussed upon theoretical understanding about watershed, Basic technical knowhow, Methods of analysis and synthesis of available multidisciplinary data, arriving at application and its effective communication to the concerned, S&T based societal problem-solving approach. Four research Projects were undertaken by the fellows.
- *School in Eco-Media & WaSH Science Communication:* The initiative has produced participatory videos and disseminated scientific information on eco-system and water issues around 100 kms of Madurai. This participatory process empowers local community to take part in the decision making for protecting the sustainability of eco-water sources. Young fellows have been trained for 20 different places. They have taken forward their learned participatory methods of safeguarding eco-systems and eco values and build scientific temper among public, those who are affected by

water related issues. The local public had an opportunity to learn, scientific facts behind their eco system and concepts in a natural way.

- *Eco Eyes: Creating Youth Leadership Group for conserving the Water Ecologies & promoting WaSH in Haryana:* This unique initiative with INCLEN Trust, Faridabad, focusses on developing youth as a change agent to conserve water ecologies and promote WaSH in rural areas through utilizing scientific evidence based Geomedia communication tools. The developed Eco-WaSH maps will enable local functionaries to understand the contextual ecological issues and their cross-sectoral linkages to develop more strategic district wide planning for improving WaSH.
- *Intervention for creation of water valuing society in 10 villages of Jaunsar tribal mountainous area of Uttarakhand:* Scientific & culturally acceptable messages in Sanitation & Hygiene were developed for easy understanding by children and community. Trained student motivators were employed to develop 12 WASH progressive/smart schools.

#### **i. Science Media Research**

In order to strengthen Science Media, NCSTC aims to innovate, augment, synergize and harness research in keeping with emerging trends like transdisciplinary imaging science media. Support is considered for innovative Sci-Media research, including research on future of science literature, media magazines, research modules for existing/new popular science magazines/publication/ translations and pilot publication runs of the research-enriched versions so as to assess the impact, especially on youth, and defining the innovative models for replication/or scale up. The aim is to involve lead institutions so that path-breaking innovative concepts research is nurtured and shared especially for young practitioners in science media. The successful models may be then considered for upgradation as Science Media Centres. Recommended thrust areas for such initiatives include Environmental Health Sciences, Public Health, Medicine Sciences, Food, Biosciences, Agricultural Sciences, Energy, S&T Information Sciences, Science Fiction, Computational Media, Animation, Gamification for Scientific Literacy & Temper among others. “Vaigyanik Drishtikon- *Shodh ki Parampara aur Vaigyanik Drishtikon*”, the Science Communication Monthly, was relaunched from Jaipur in its present, recast version focussing upon scientific research having 16 pages and coloured visuals on four pages. The inaugural issue was unveiled by Hon’ble Minister of S&T and ES.

#### **j. Celebrating NSD and NMD**

Every year, 28 February is celebrated as the National Science Day (NSD). The program was initiated to trigger science popularization activities throughout the country. NCSTC acts as a nodal agency to support and coordinate celebration of NSD by giving grants to State S&T Councils/ Departments for organization of lectures, quizzes, open houses, science week, etc. For the past few years, National Mathematics Day (NMD) has also been celebrated on 22 December. The theme of NSD-2017 was “Science & Technology for Specially-abled persons”. NCSTC supported various programmes countrywide by giving grants to State S&T Councils & Departments which conducted numerous

activities like science essay completion, on-the-sport painting competitions, popular lectures by eminent scientists and officials, exhibition of models, assistive technologies useful for specially-abled, gadgets developed by students, among others.

**k. National Awards for S&T Communication and Popularization**

DST instituted National awards in 1987 to stimulate, encourage and recognize outstanding efforts in the area of science popularization and communication. Following six awards are given each year: National Award for Outstanding Efforts in S&T Communication in general; National Award for Outstanding Efforts in S&T Communication through Print Media including Books and Magazines; National Award for Outstanding Efforts in S&T Popularization among Children; National Award for Outstanding Efforts in Translation of Popular S&T Literature in Languages Mentioned in 8<sup>th</sup> Schedule of Constitution of India and in English; National Award for Outstanding Efforts in S&T Communication through Innovative and Traditional Methods; and National Award for Outstanding Efforts in Science & Technology Communication in the Electronic Media.

**i. UNESCO Kalinga Award for Science Popularization (*Biennial*)**

The UNESCO Kalinga Prize for Popularization of Science is a prestigious award given by UNESCO for exceptional skill in presenting scientific ideas to lay people. It was created in 1951, following a donation from Shri Biju Patnaik, then Chief Minister of Orissa and Founder President of the Kalinga Foundation Trust. Now the Prize is co-funded by DST, Government of India, Kalinga Foundation Trust and DST, Government of Orissa. Each member State is entitled to nominate one candidate, through its National Commission for UNESCO, on recommendation of national associations for the advancement of science or other science associations, or national associations of science writers/journalists. The laureate is selected by Director-General of UNESCO upon the recommendation of a five-member jury designated by her/him. The recipient receives US\$40,000 and UNESCO Albert Einstein Silver Medal. The recipient is also awarded the Kalinga Chair, introduced by Government of India in 2001. As holder of the Kalinga Chair, the winner travels to India for a period of 2-4 weeks as the guest of Government of India. The Chair also comprises a token honorarium of US\$5,000. Prof. Diego Andres Golombek, Department of Science & Technology, National University of Quilmes, Buenos Aires, Argentina, was the winner for 2015. He was invited by Secretary, DST to visit India to deliver popular lectures in various cities and was also presented Kalinga Chair by Secretary, DST on 19 April 2017 at Technology Bhawan, New Delhi.

## **11. Exhibition and Fairs**

The Exhibition Cell is concerned with the work relating to organizing exhibitions, participation in science exhibitions at national and international level. In addition, it has also been assigned responsibility of coordinating the work related to participation of Department of Science & Technology along with its organisations in the exhibitions.

The aim of Exhibition Cell is organising exhibitions to bring awareness among students, scholars and general public about different Government policies, schemes, scientific innovations, milestones in the field of Science & Technology.

The Exhibition Cell has participated in India International Science Festival (IISF) – 2017 held at Chennai from 13-16 October, 2017; India International Trade Fair (IITF) – 2017 held at Delhi from 14-27 November, 2017 alongwith its Subordinate Offices/Aided Institutions. The Cell also coordinated with subordinate offices and autonomous institutions working under the Department for participation in a number of exhibitions in various states.





## AUTONOMOUS INSTITUTES

The Department of Science and Technology nurtures 25 Autonomous Bodies (ABs). These include 16 research institutions, 4 specialized knowledge institutions and S&T service organizations and 5 professional bodies.

The 16 research institutions in the DST family form a very special group from several points of view. Some of these are among the oldest research institutions in the country (including the oldest), some were started by eminent scientists and individuals like Mahendra Lal Sircar, CV Raman, JC Bose, Birbal Sahni and DN Wadia, some are repositories of very old and valuable scientific data, some lead the nation in niche areas like astronomy and astrophysics, geomagnetism, advanced materials and nano science and technology – and so on. Most research institutions in the DST family are basic research institutions. The only exceptions are SCTIMST-Trivandrum and ARCI-Hyderabad. SCTIMST-Trivandrum is the national torchbearer in the field of indigenous biomedical device development which has helped lower the cost of healthcare for large number of our citizens. ARCI-Hyderabad has carved a very special place for itself as a premier technology development and transfer organization in the area of advanced materials. These Research Institutions have an impressive portfolio of research publications and awards and honours earned by their scientists and they produce.

The 4 specialized knowledge institutions and S&T service organizations – TIFAC, NECTAR, VP and NIF – are unique in their own ways. TIFAC approaches technology forecasting in different sectors in a very structured fashion involving all stakeholders and has also promoted new instruments of technology development and diffusion across the country. NECTAR is unique in sourcing technologies for finding solutions to problems specific to the North Eastern States and Vigyan Prasar innovates on instruments of science communication and popularization. NIF is a unique body which scouts for grassroots innovations and helps develop them further into viable, technology-backed products or processes.

All the 5 premier science and engineering professional bodies of the country, viz. INSA-Delhi, IAS-Bangalore, NASI-Allahabad, INAE-Delhi and ISCA-Kolkata belong to the DST family. Most of these are again very old organizations established by eminent scientists and individuals, including the Indian Science Congress Association which is more than a century old. These professional bodies, through their multifarious activities, deliberate on policy issues of national importance related to S&T and help in dissemination of scientific knowledge through journals, meetings, conferences, national and international scientist-exchange programmes. In recent times, they have become important vehicles for special manpower development programmes focused on young students and science teachers in the country.

These institutions, with long and varied history and their variety of activities, occupy a very important place in the S&T eco-system of the country. Activities and achievements of autonomous institutes during the year under report are briefly described below:

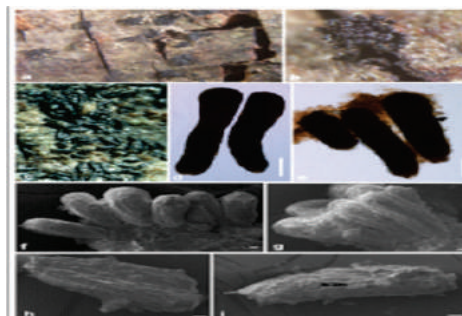
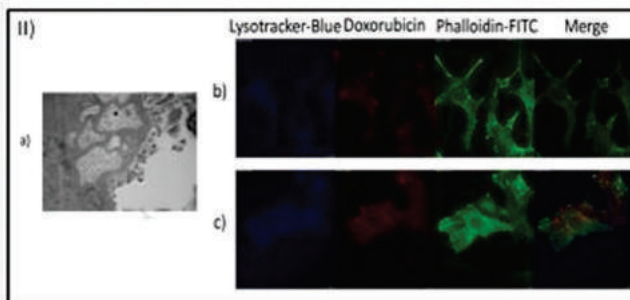
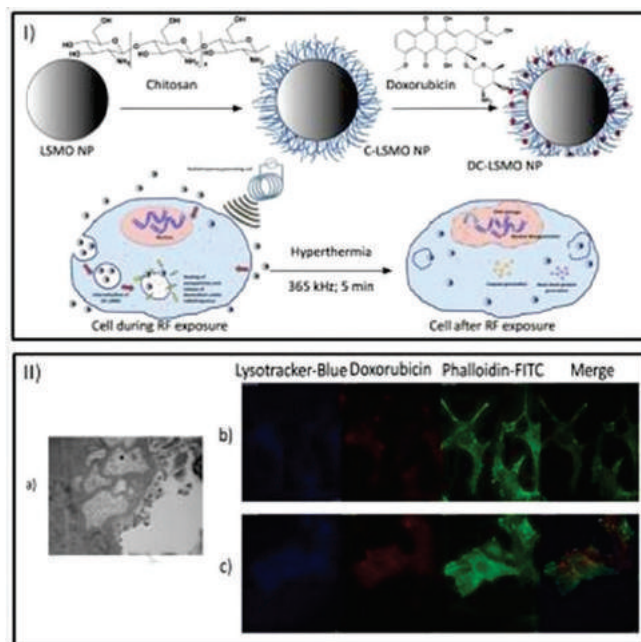
## MACS-AGHARKAR RESEARCH INSTITUTE (ARI), PUNE

### Areas of Focus

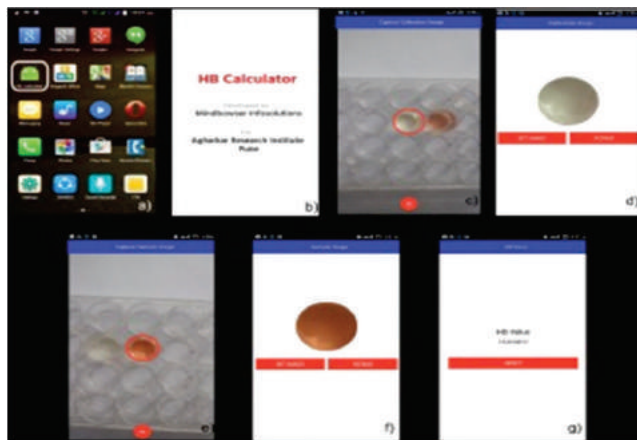
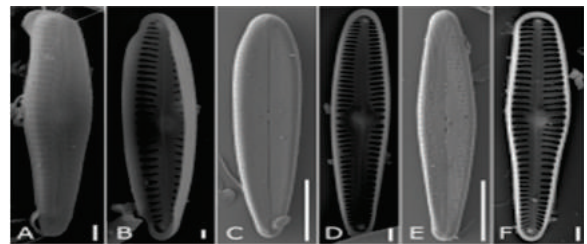
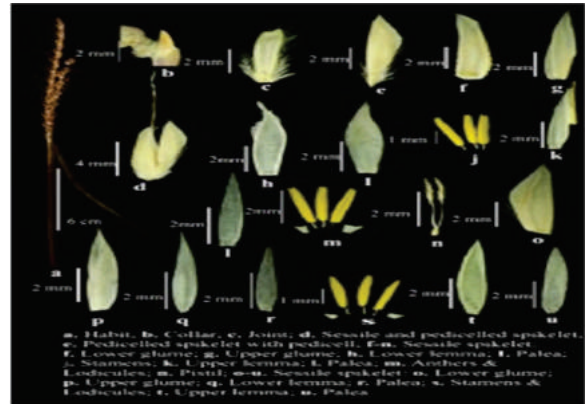
Biodiversity and Palaeobiology, Bioenergy, Bioprospecting, Developmental Biology, Genetics and Plant Breeding and Nanobioscience.

### Some Major Accomplishments

- Doxorubicin-loaded dextran coated lanthanum strontium manganite (DC-LSMO) nanoparticles hold promise as bimodal therapeutic agents for cancer treatment by hyperthermia and anti-cancer drug.
- Triptorelin tethered multifunctional polyamidoamine- histidine-polyethylene glycol (PAMAM-Histidine- PEG) nanoconstructs that enable efficient targeting and gene silencing in breast cancer cells have been developed.
- Investigation of microbial diversity of subseafloor sediments associated with methane hydrate deposits has led to the isolation of a novel methanogen *Methanosarcinasp* MSH10X37.
- Culturing of previously uncultured anaerobic microbes include the anaerobic bacteria from the rumen of buffalo, goat and sheep and methanogens from Indian star tortoise and green iguana.
- A new fungus *Berkleasmiiumariense* Rajesh kumar & Marathe, sp. nov. has been named after ARI.

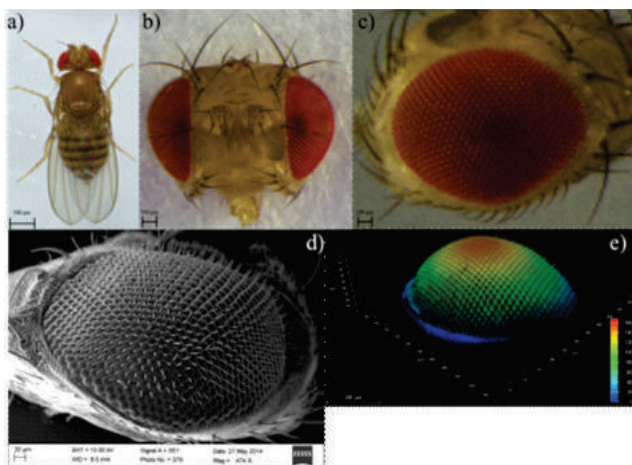


- Exploration of biodiversity rich areas of Northern Region of Western Ghats has yielded an interesting novel species, which has been named after renowned botanist late Prof. SP Agharkar, Founder-Director of Agharkar Research Institute, as *Ischaemumagharkarii*.
- Studies of the diatoms from the Western Ghats have revealed the morphological diversity of *Luticola* species, and commonly occurring water quality indicator species. Three new diatom species of *Gomphonema* have been discovered from Arunachal Pradesh.
- Integrated morphological and molecular taxonomy of benthic foraminifera is a new initiative in the field of paleobiology.



- An android system based smartphone app called Hemoglobin (Hb) Calculator for accurate and sensitive measurement of Hb has been developed. Its higher sensitivity, specificity, accuracy and reliability make it an attractive alternative for Hb estimation in resource-limiting conditions.

- Our work on zebrafish uncovers that connective tissue growth factor (*ctgfa*) is necessary to stimulate spinal cord regeneration via glial bridging.
- Wheat variety MACS 3949 (durum) was released by the Central Varietal Release Committee for irrigated-timely sown condition in Peninsular Zone. It is high yielding (average 46 q/ ha, with highest yield potential of 64.3 q/ ha), disease resistant (stem and leaf rust), has bold lustrous grain (1000 grain weight 47 gm), better nutritional quality (zinc 40.6 ppm, iron 38.6 ppm, protein 12.9 %), good milling (test weight 81.4 kg/ hl) and pasta making quality (7.25 out of 9).
- A new durum wheat variety MACS 4028 has been identified for timely sown rain-fed conditions in peninsular zone. It has a average yield 19.3 q/ha, good milling quality, better nutritional quality, is resistant to black and brown rusts, and has 1000-grain weight of 47g.
- A new soybean variety MACS 1460 has been identified for release in Southern (5 states), Eastern (5 states) and North Eastern Hill Zones of India. It shows wider adaptability, disease resistance, is suitable for mechanical harvesting, highly resistant to pod shattering and early maturing (88 days).
- A 12-amino acid long peptide for detection of white spot syndrome virus in shrimp has been identified. The lateral flow assay test developed using the peptide requires only 20 minutes.
- Drosophila eye templated microchips for cell culture have been developed. The chip can be used in single-cell analyses and generation of tumor-like structures.





- First-ever phylogenetic study on Indian *Eriocaulon* using molecular tools has been done to study the diversity of these unique plants. *Eriocaulonparvicephalum* has been reported as a new species from the Western Ghats.
- A microbial consortium has been developed for biomethanation of lignite, which under un-optimized conditions is able to produce methane from lignite at an efficiency of 80-95 ml of biogas per gram of lignite with methane concentration of 26-52 %.

### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	42
2.	Chapters in Books	10
3.	Papers in Conferences	9
4.	Number of Ph.Ds. produced	4
5.	Indian Patents filed	0
	Indian Patents granted	1
6.	Number of Technologies/Designs and other intellectual products commercialized	1
7.	Number of Technology leads awaiting transfer	1
8.	Research Manpower trained (other than Ph.Ds)	1
9.	Technical Manpower trained	1
10.	M.Tech/M.Sc./M.Phil projects guided	5
11.	Other Products/ Indicators	2

## ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES), NAINITAL

### Areas of Focus

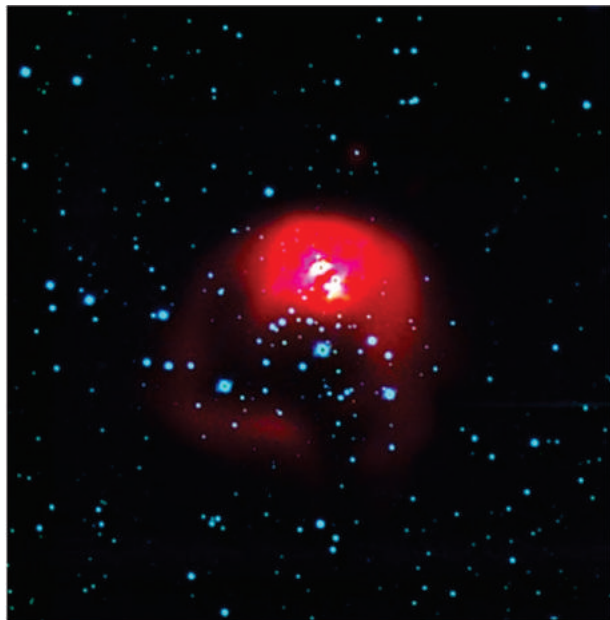
*Astronomy & Astrophysics:* Galactic and Extragalactic Astronomy which include the fields of exoplanetary systems, star formation, star clusters, roAp stars, micro-lensing, active galactic nuclei (AGNs), quasars, supernovae, X-ray sources, Wolf-Rayet galaxies, giant radio galaxies and gamma ray bursts (GRBs). In Solar Physics, research concentrates on observations and modelling of the transients (e.g., flares and associated plasma processes, jets, spicules, etc.), space weather phenomena and magneto-hydrodynamic waves in the solar atmosphere.

*Atmospheric Sciences:* Lower atmospheric processes that contribute to air pollution and climate change. Extensive observations of trace gases (including greenhouse gases), aerosols, and meteorological and modelling activities to understand the chemical, physical and dynamical processes.

### Some Major Accomplishments

- Regular observations using 3.6m Devasthal Optical Telescope (DOT) as a National facility

started from April 2017. The Devasthal Time Allotment Committee (DTAC) announced the call for observing proposals with 3.6m DOT for early science for the period October 2017- January 2018. Forty-six proposals were received and reviewed. Thirty proposals were accepted and the observing nights have been allotted to the accepted proposals.



Color composite image of NGC 2316 (H II region) using the 4K x 4K CCD imager mounted at the axial port of the 3.6m DOT



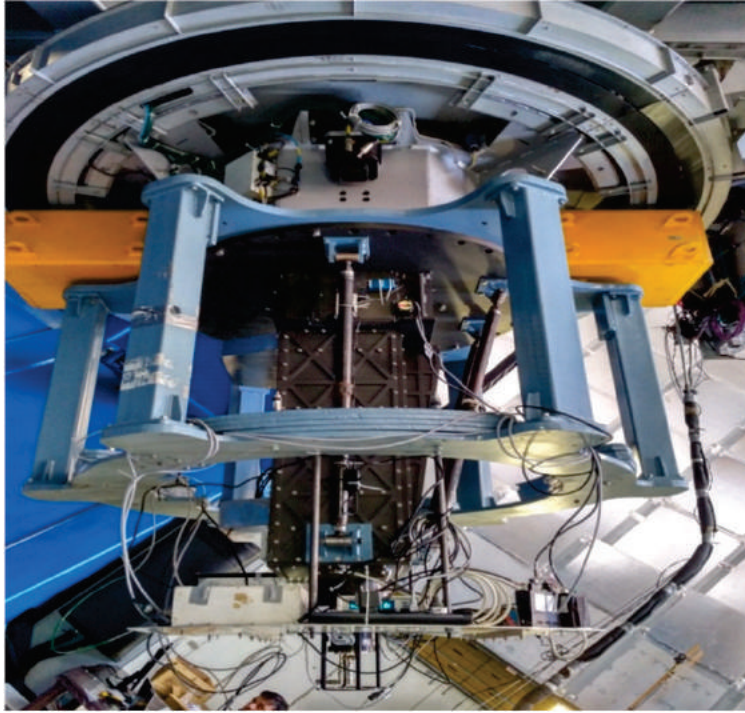
Color composite image of NGC 613 (Galaxy) using the 4K x 4K CCD imager mounted at the axial port of the 3.6m DOT.



International Liquid Mirror Telescope (ILMT), 3.6m Devasthal Optical Telescope (DOT) and 1.3m Devasthal Fast Optical Telescope (DFOT) at Devasthal, ARIES, Nainital.



3.6m Devasthal Optical Telescope (DOT) Building.



**Faint Object Spectrograph and CCD Camera, both built in ARIES mounted on 3.6m DOT.**

- ARIES ST Radar is being operated with 10 clusters and the wind data recorded are in reasonable agreement with balloon-borne wind observations. Extensive balloon-borne observations over Nainital show very high wind speed near the subtropical jet and highlight the discrepancy in temperature profile from space-borne sensors.
- Installation of 4m International Liquid Mirror Telescope has been completed.
- Theoretical studies of astrophysical jets and accretion disk have been done.
- Using the optical observations from ARIES and X-ray observations from ROSAT, SUZAKU and XMM-Newton, four new magnetic cataclysmic variables have been identified. Two largest X-ray super-flares (energy three orders more than the solar flare) in a solar-type active star have also been detected.
- Using multi-wavelength data from ground and space based telescopes, studies related to star formation, variability of pre-main sequence stars, binaries in open clusters, main sequence variable stars, and evolved sources have been done.
- Optical intra-night variability of radio quiet BL Lac candidates have been studied. Multi-wavelength flux and spectral variability studies of blazars on diverse time-scales using various ground and space based telescopes have been done.

- ARIES team attended the TMT science forum meeting held at Mysore, India during 07-09 November 2017. ARIES scientists delivered talks (a) On the high-resolution spectroscopic requirements for the studies of the cosmological variation of fundamental constants; (b) High-z science cases for TMT-related to QSOs and QSOs absorption lines; and (c) High energy transients in the TMT era.
- Study on aerosol hygroscopicity has been carried out for the first time over the Central Himalayas. The study shows slightly larger light scattering enhancement factor  $f(RH)$  values for the fine particles which increase in aerosol hygroscopicity under more turbid atmospheres.
- Study of unusual enhancement in tropospheric and surface ozone due to orography induced gravity waves has been carried out.
- A gas chromatograph facility (GC) has been setup for the observations of volatile organic compounds (VOCs).

### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	27
2.	Book	01
3.	Papers in Conferences	03
4.	Number of Ph.Ds. produced	03
5.	Research Manpower trained (other than Ph.Ds)	06
6.	Technical Manpower trained	26
7.	B.Tech/ UG projects guided	36
8.	M.Tech/M.Sc./M.Phil projects guided	19

## BOSE INSTITUTE (BI), KOLKATA

### Areas of Focus

Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources; Protein Structure, Function and Engineering; Bioinformatics and Computational Biology; Molecular Medicine; Microbial Genomics and Infection Biology; Development of Systems Biology; Basic and Applied Problems in Physical and Environmental Sciences.

### Some Major Accomplishments

- 2017 was the Centenary Year of the Bose Institute. The Closing Ceremony of the Centenary Celebrations of the Bose Institute was graced by the Hon'ble President of India, Shri Ram Nath Kovind, on 29 November 2017. Speaking on the occasion, the Hon'ble President said that the Bose Institute occupied a unique and exalted position in the landscape of Indian Science.



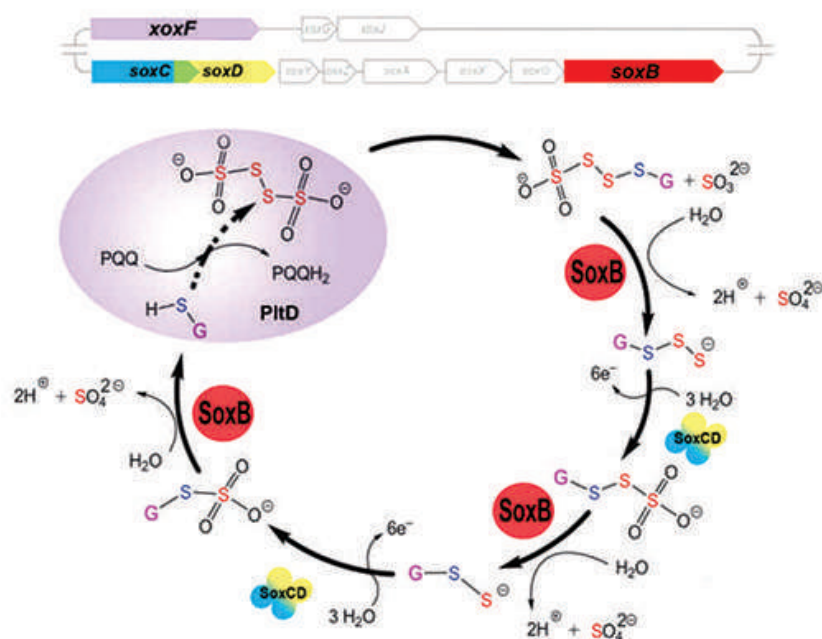


Hon'ble President addressing the gathering on the occasion of Closing Ceremony of Centenary Celebrations of Bose Institute, Kolkata on 29 November 2017,

- In order to bring all the laboratories under one roof, a new Unified Campus of Bose Institute has been built at Sector V, Bidhannagar, Kolkata.
- On the scientific side, the following important scientific investigations and results were reported:
  - ❖ *Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources*: The effective exploitation of novel genes and regulatory elements are being continued to improve the plant performance in the field; and to combat biotic and abiotic stresses of crop plants.
  - ❖ *Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources*: The effective exploitation of novel genes and regulatory elements are being continued to improve the plant performance in the field; and to combat biotic and abiotic stresses of crop plants.
  - ❖ *Protein Structure, Function and Engineering*: Resolution of Protein structure is the key criterion to determine functional organization of a protein. Study on the structure-function relation coupled with expression analyses have been undertaken to design therapeutically and other economically important protein molecules.
  - ❖ *Bioinformatics and Computational Biology*: Network analysis of microRNA and

neurodegenerative diseases, ii) Therapeutic molecular design including genomics and proteomics approaches, iii) Comparative genome analysis and protein evolution, iv) Protein structure, dynamics and protein-protein interactions, v) Development of bioinformatics tools and web-based servers.

- ❖ *Molecular Medicine:* The primary focus of the division is to study molecules related to health and diseases and manipulating those molecules to improve diagnosis, prevention and treatment of diseases like Cancer, Diabetes, Cardiovascular problems, Leishmaniasis, Tuberculosis etc.

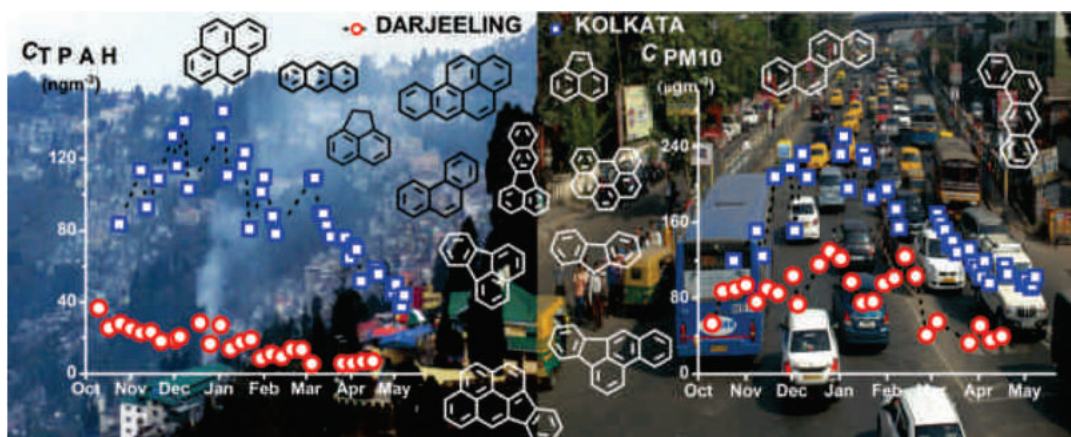


Putative mechanism of tetrathionate oxidation in *A. kashmirensis*

- ❖ *Microbial Genomics and Infection Biology:* Genomic approaches have been taken to study the basic biology of microbes leading to useful insights into the mechanisms of their growth, proliferation and cell-cycle regulation. Identification of microorganisms with a potential for bioremediation is also under study.
- ❖ *Systems Biology:* In this programme scientists are working on various aspects of understanding disease processes and infections using Systems Biology approaches. Specifically, high throughput approaches have been taken to understand pathogen-tuned signalling networks in host cells. MicroRNA let-7 has been shown to regulate inflammatory signalling during mycobacterial infection. Mathematical modelling has been employed to understand stress responses in mammalian cells and in bacterial pathogens.
- ❖ *Basic and Applied Problems in Physical and Environmental Sciences:* This programme

contributes both to fundamental knowledge as well as applications relevant to industry. The Institute's current research activities in this program are in the areas of Radiation Physics, Statistical Mechanics, Quantum Mechanics, Astroparticle physics, Physics of Strongly Interacting Matter, Nuclear Physics, Radiation Physics and detector development, Material Science, Soft Condensed Matter Physics, Nano-science, Millimeter-Microwaves and Atmospheric Sciences.

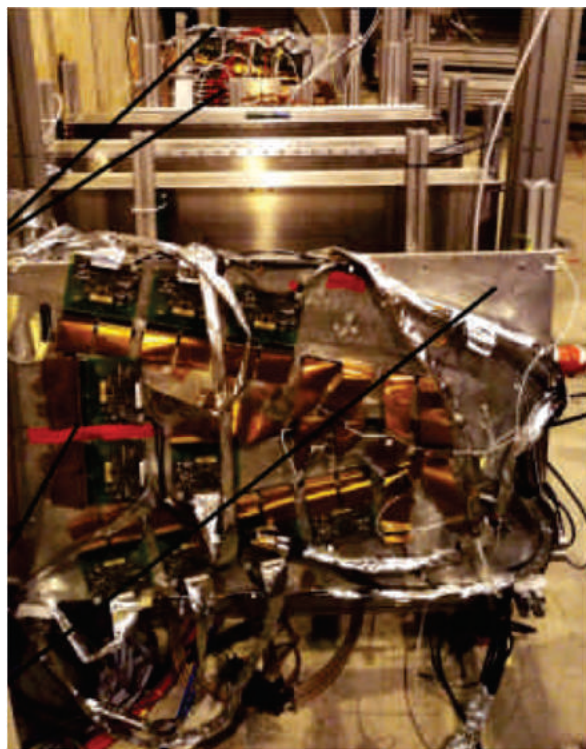
- ❖ Mathematical modelling and experiments demonstrated that mycobacteriophages can kill bacteria through non-lytic mechanisms. The information derived could lead to the development of new drugs for the treatment of TB.
- ❖ Key molecular regulators of early blight disease response in tomato have been revealed.
- ❖ Mechanism of ganglioside (GM2) mediated migration of tumor cells - a pivotal role of the integrin receptor has been identified.
- ❖ Newly designed mASAL, a lectin like Protein conferring sheath blight resistance in transgenic rice has been developed.
- ❖ Critical roles of Hsp90 in CRAF kinase stabilization and actin dependent translocation to the plasma membrane during MAPK signaling have been demonstrated.
- ❖ An antimetastatic chemotherapeutic agent has been developed which targets a novel long non-coding RNA, LINC00273, inducing metastasis in malignant cancer.
- ❖ Bose Institute is playing a major role in a national network program for investigation of atmospheric carbon particles, one of the key factors for Global Warming. This long term project would enable us to find out the exact sources of Atmospheric carbon pollution almost at every corner of the country and to adopt mitigation, adaptation and control strategies.



Hazardous carbonaceous aerosol pollutants over Kolkata and Darjeeling



- Bose Institute is a part of the following important scientific collaborative Programmes:
  - ✓ *ALICE Collaboration*: A Large Ion Collider Experiment (ALICE) is an ongoing experiment at CERN, Geneva which started taking data in 2010. This experiment is using two colliding beams from the world's largest collider facility called the Large Hadron Collider (LHC) to study both hadronic as well as heavy ion collisions at ultra relativistic energy.
  - ✓ *CBM Collaboration*: The Institute is a collaborator at the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany in 2016. This is a multi-dimensional facility for research in the areas of high energy nuclear physics, low energy nuclear reaction and astrophysics, particle physics and plasma physics. The group from Bose Institute is involved in the Compressed Baryonic Matter (CBM) experiment which will study nuclear matter at very high density and moderate temperature. Bose Institute is also a nodal Institute for FAIR.



Setup of GEM Muon Chamber Experiment at CBM

- ✓ *Indo-Korean Collaborative Programme* aimed at understanding the role of microRNAs in regulating the immune response of macrophages.
- ✓ *Indo-Swedish Collaborative Programme* on latency of Mycobacterium tuberculosis: evaluating drugs and drug targets using innovative models.



**Some Important Output Indicators**

S. No.	Parameters	Output
1.	Papers in refereed journals	239
2.	Books	3
3.	Number of Ph.Ds. produced	26
4.	Research Manpower trained (other than Ph.Ds)	237
5.	Technical Manpower trained	7
6.	M.Tech/M.Sc./M.Phil projects guided	30

**BIRBAL SAHNI INSTITUTE OF PALAEOSCIENCES (BSIP), LUCKNOW****Areas of Focus**

- Early life and environment: Evidence from Indian Precambrian basins.
- Phanerozoic terrestrial and coastal ecosystems: Biostratigraphical, palaeoenvironmental, palaeoecological and palaeogeographical aspects.
- Integrative marine micropalaeontology: Focus on high resolution biostratigraphy, sea level changes, palaeo-oceanographic and palaeoclimatic events.
- Organic petrology: Characterization of solid fossil fuel for depositional and utilizational aspects.
- Quaternary palaeoclimate reconstructions, vegetation dynamics and relative sea level changes.
- Domestication of plants, early farming and ecosystem dynamics during Holocene/ Anthropocene.
- Geochronological and geochemical parameters for high resolution dating, correlation, palaeoclimatic, tectonic and provenance studies.
- Preparation of books, catalogues, atlases, databases, digitization of library, museum and outreach activities.

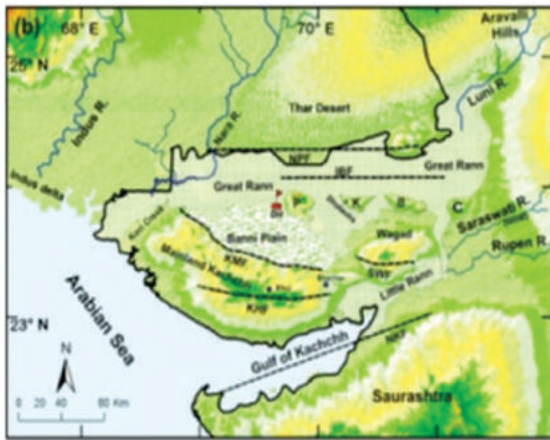
**Some Major Accomplishments**

- Evidence found for altered cropping pattern in Mature Harappans in response to arid climatic conditions.
- Evidence found for the advent of strong South Asian monsoon around 20 million years ago.
- Evidence found for traces of distinct river source (Vedic Saraswati River) in the Great Rann of Kutch.
- Assessment of mass balance of Himalayan glaciers of the recent past based on tree ring studies.

- Ancient DNA reveals Late Pleistocene existence of Ostriches in Indian Sub-Continent.
- Reconstruction of genetic history of the Parsi populations.
- Determination of Indus River water isotopic composition in the Ladakh region showing contribution of moisture from Mediterranean westerlies (~26%) and the Indian Summer Monsoon (~74%).
- Fossil leaf forms from Eocene-earliest Miocene of southern Asia reveals a strong monsoonal climate typical of those experienced today as a result of annual migrations of the ITCZ.
- CLAMP analysis of fossil leaves from Paleocene-Miocene from India and Southern Tibet reveals an increase in precipitation seasonality vis-à-vis Himalayan Orogeny.
- Determination of depositional history and hydrocarbon generation potential of Surkha lignite mine.
- Identification of a deep time globally warm hyperthermal event (i.e. Eocene Thermal Maximum or ETM2) in Panandhro lignite mine, Kutch.
- Organization of a brainstorming workshop on “Quaternary Environments and Climates with focus on Holocene and Anthropocene” during 21-23 February, 2017).
- Commissioning and utilization of advanced Geochemistry and Palaeomagnetism labs.
- Recruitment of scientists in several new fields (Ancient DNA, Palaeomagnetism, Paleoclimate modeling, Sedimentology, Vertebrate Palaeontology etc.) in order to develop multi- and interdisciplinary approaches in palaeosciences.
- Four young scientists selected for prestigious post-doctoral fellowships abroad.
- Several outreach activities and programmes organized to familiarize students with the discipline of Palaeosciences in schools and colleges.

### Some Important Output Indicators

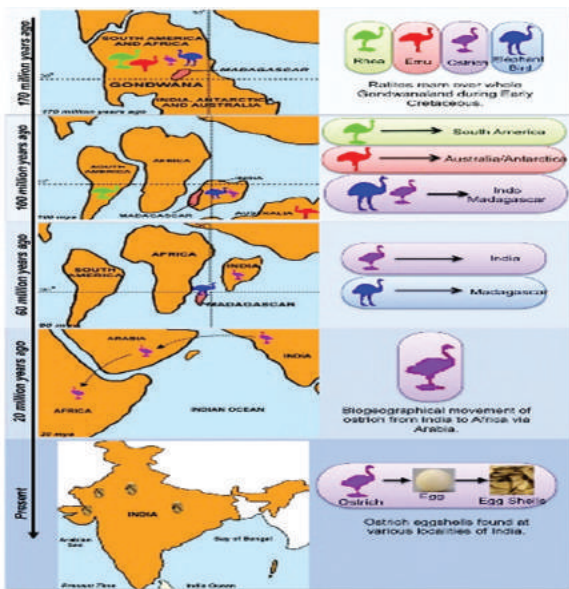
S.No.	Parameters	Output
1.	Papers in refereed journals	104
2.	Books	1
3.	Chapters in Books	4
4.	Papers in Conferences	35
5.	Number of Ph.Ds. produced	6
6.	Research Manpower trained (other than Ph.D.s)	31
7.	Technical Manpower trained	10
8.	M.Tech/M.Sc./M.Phil projects guided	14



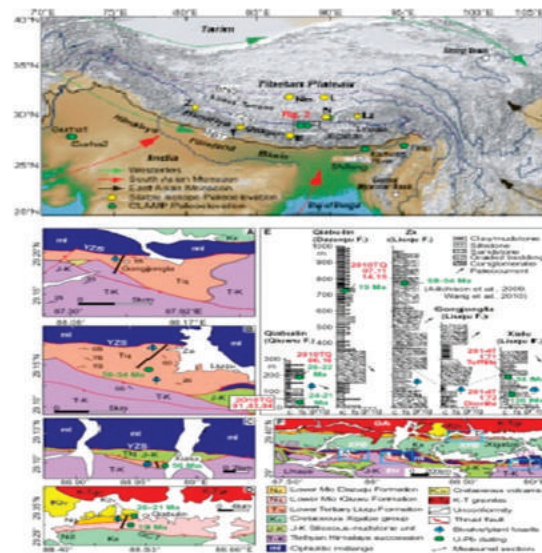
Evidence found for traces of distinct river source (Vedic Saraswati River) in the Great Rann of Kachchh



Altered cropping pattern in Mature Harappans in response to arid climatic conditions



Ancient DNA reveals Late Pleistocene existence of Ostriches in Indian Sub-Continent



Quantifying the rise of the Himalaya and its implications for the South Asian monsoon

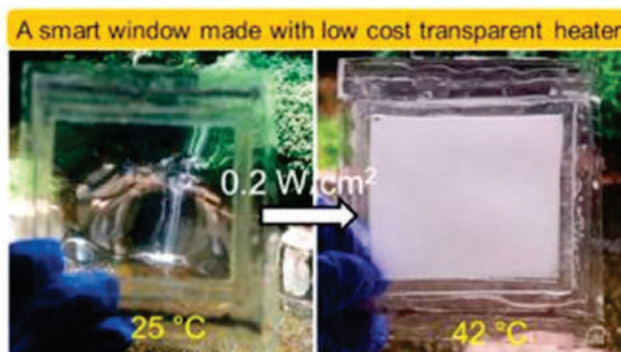
## CENTRE FOR NANO AND SOFT MATTER SCIENCES (CeNS), BENGALURU

### Areas of Focus

Nanoscience and Nanotechnology; Nano-Soft composites; Soft Matter such as liquid crystals, polymers, gels, membranes etc.

### Some Major Accomplishments

- Giant Enhancement of Photoluminescence and Tertiary Emission in a Chiral Nematic: Chiral nematic liquid crystal compositions incorporated with fluorophores, wherein the photonic band gap of the liquid crystal is matched with the excitation wavelength of the fluorophore, results in significant enhancement in the overall photoluminescence of the system and eliciting secondary and tertiary emission such that a single low wavelength illumination can give emissions at multiple and highly desirable Red, Green and Blue wavelengths.
- Switchable colour-reflecting mirror: The electric field tunability of photonic band gap in a blue phase liquid crystal gel resulted in selective reflection colours switching between red and green and further increase in the field led to a complete non-reflecting transparent state. This phenomenon is envisaged in the fabrication of a tunable mirror device.
- Supramolecular nanofiber-based humidity memory device: A nanofiber-based device that can memorize the humidity condition it had experienced while being unpowered has been fabricated. It makes use of supramolecular nanofibers obtained from self-assembly of donor–acceptor (D-A) molecules in aqueous medium. The device finds use in applications requiring stringent humidity monitoring.
- Energy efficient hydrogel based smart windows: A thermochromic device using inexpensive tin mesh electrodes produced by crackle lithography and hydroxypropyl methyl cellulose (HPMC) as active material has been demonstrated. When laminated and coated on the inner surface of a PET window the mesh serves as a transparent heater which causes the gelation in HPMC at  $\sim 40^\circ\text{C}$ . Switching between water-clear transparency to paper-white opaqueness with 1 mm thick active layer consumes power as low as  $0.2\text{ W/cm}^2$ .
- Rapid growth of vertically aligned h-MoO<sub>3</sub> nanorods on rigid substrates: A novel synthesis strategy, to obtain vertically aligned h-MoO<sub>3</sub> nanorods (NRs) on rigid substrates by microwave irradiation using ammonium heptamolybdate (AHM) and concentrated nitric acid as precursors, has been demonstrated. This study paves the way for controlled generation of MoO<sub>3</sub> NRs on different substrates in a short period of time with the potential to fabricate various electrochromic, photo-electrochemical and photovoltaic devices based on such well-aligned vertical NRs.
- Highly concentrated and stable semiconducting inks in low boiling point solvents for printed electronics: To realize printed electronics onto flexible substrates, formulation of functional inks is vital. The use of high boiling point solvents for exfoliation curbs their usage in printing. Conventional solvent selection rules suggest the inability of low boiling point solvents for





exfoliation, unless a surfactant is used. A semiconducting dispersion ink of concentration as high as 2.8 mg/ml in a low boiling point solvent without any use of surfactant has been obtained. This method is expected to pave a new path for obtaining functional inks in low boiling point solvents for various other exotic layered materials.

- Semiconductor junction for photogenerated electrons.
- A process for producing graphene-based transparent conductive electrode.
- Technology transfer to Lab Engineers (India) to manufacture and commercialize Projection Lithography system.
- Glass slides with built-in transparent heater.
- R&D project to manufacture oxide coated metal mesh based transparent conducting plates with HHV Co. Pvt. Ltd.
- A fast switching orthogonal polar smectic phase has been observed in a V-shaped compound. Technologically important ferroelectric state has been observed in a bent-core compound. Very rarely found B5 mesophase, has been observed in a V-shaped compound for the first time.
- A CNT reinforced polymer stabilized liquid crystal device with enhanced electro-optic properties.
- Influence of chirality on the thermal and electric properties of the ferroelectric columnar mesophase.
- Fabrication of perovskite based solar cells.
- Gas sensors lab capable to sense gases, such as, O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO, NO, etc.
- Chiral plasmonic metal (gold) nanoparticles, NIR-Emissive discotics and Cholesterol-based dimers.
- Simple chemical route via liquid/liquid interface to synthesize thin films of MoO<sub>3</sub>, MoS<sub>2</sub> and MoSe<sub>2</sub>.
- Metallophthalocyanine nanostructures for supercapacitor applications.
- Fast and inexpensive way to detect heavy metal ions in water based on quantum dot luminescence.
- Surface chemistry of cesium lead halide perovskite nanocrystals.
- Improving the quality of graphene/Cu by Joule heating and enabling polymer-free direct transfer onto arbitrary substrates.
- Highly conformal Ni micromesh as a Current Collecting Front Electrode for Reduced Cost Si Solar Cell.
- Cu textured films.
- Magnetoimpedance (MI) of NiO nanoparticles compacts.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	37
2.	Patents	7
3.	Books/Chapters in Books	3
4.	Papers in Conferences	3
5.	Number of Ph.Ds. produced	5
6.	Number of Technology leads awaiting transfer	2
7.	Research Manpower trained (other than Ph.Ds)	23
8.	Other Products/ Indicators (Lectures given at schools/colleges under popularization of science / V4 Programme)	Under V4 Programme and ROIS Programme of CeNS, 1130 students of different school/colleges of the country have been benefitted during the period of the report.

## INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE (IACS), KOLKATA

### Areas of Focus

Theoretical Sciences, Molecular Sciences, Materials Sciences and Biological Sciences.

### Some Major Accomplishments

#### *Theoretical Sciences*

- Aspects of Radon transform in Quantum Field Theories.
- Spherically symmetric brane in a bulk of  $f(R)$  and Gauss-Bonnet Gravity.
- Solving higher curvature gravity theories.
- Lightest Kaluza-Klein graviton mode in a back-reacted Randall Sundrum scenario.
- Penrose process in a charged axion-dilaton coupled black hole.
- Diphoton signal at the LHC via Chern-Simons interaction in a warped geometry scenario.
- Kinematics of radion field: a possible source of dark matter.
- Study of the Littlest Higgs model with T-parity in the one lepton plus jets plus missing transverse energy channel at the LHC.
- Light higgsino or wino dark matter in a compressed scenario of MSSM.
- Exploring viable vacua of the Z3-symmetric NMSSM.

- Generation of radiative neutrino mass in the linear seesaw framework, charged lepton flavor violation, and dark matter.
- R-parity violating super symmetry at IceCube.
- Lattice QCD simulations at both zero and finite temperatures, both with and without dynamical fermions.
- Entanglement properties of many-body systems.
- Several aspects of physics of strong correlations and dynamics in ultracold atom and condensed matter systems.
- Aspects of quantum many body theories, e.g., non-equilibrium dynamics of quantum many-body systems under external drive, signature of quantum phase transition in highly excited state, open quantum systems and more.
- Frustrated magnets and spin liquids.
- Unconventional phase transitions.
- First principle calculations on electronic structure of low dimensional quantum spin systems.
- Role of spin-orbit coupling in strongly correlated systems;
- Electronic structure of coupled quantum dots and doped nanowires.
- Modelling two-dimensional materials like Silicene and Phosphorene.
- Study of cell biology and statistical mechanics including agent-based modelling, Monte Carlo methods and molecular dynamics to quantify various biological processes.
- Theoretical studies also involve problems, such as probing state-to-state reaction dynamics and molecular surface scattering, ultracold atomic photoassociative processes, photo-redox processes, atom-atom interaction in external fields and magnetic properties of molecules within relativistic and nonrelativistic framework.
- Developing methodologies for studying van der Waals complexes and reaction mechanism for detoxification of model nerve agents on surface.
- Computation of terahertz spectra of molecular solids.

#### *Materials Sciences*

- The main thrust has been to discover, design new materials (synthesizing) and study their physical, chemical, electrical, optical, magnetic and catalytic properties of materials as well as to explore their possible applications.
- Organic electronics, Solar cells based on hybrid perovskites, inorganic semiconductors, optical and optoelectronic properties of II-VI semiconducting thin films and nanostructures are some of the

prime works in the field of semiconductor and opto-electronic devices. Charge carrier dynamics in ion conducting glasses, polymers and oxides is studied and correlated with characteristic lengths and population density of structural units.

- A new super-dense nonmagnetic cobalt film is synthesized for the first time on Si substrate.
- Electrical, optical and magnetic properties of graphene-based functionalized nanostructures are investigated. A wealth of nano-structured materials including nano-ribbons, nano-rods, nano-composites are designed and synthesized for various applications, including its use as efficient adsorbent, as a general decontaminant.
- Study of bulk transition metal oxides where some fascinating magnetic, dielectric and multiferroic properties are observed. Important works are done on Iridium and Rhodium based oxides where large spin-orbit coupling can give rise to intriguing magnetic ground state.

#### *Molecular Sciences*

- Research work was primarily focused on the preparation and characterization of organic, inorganic and macromolecular compounds with potential applications in drug development, catalysis and materials development. Towards that direction, novel synthetic methodologies have been developed for asymmetric and stereo-controlled synthesis of complex organic molecules with potential biological applications.
- Transition metal complexes supported by different organic ligands have been prepared to investigate their ability as catalysts for oxidative transformation reactions.
- Supramolecular helical assembly and dynamic interlocked molecular systems have been developed. Mechanistic studies of multi-proton and multi-electron processes have been carried out.
- New gelator molecules have been prepared and used for sustained pheromone release toward live insect control in open fruit orchard.
- Methods have been developed to remove toxic ions and organic pollutants from ground water.

#### *Biological Sciences*

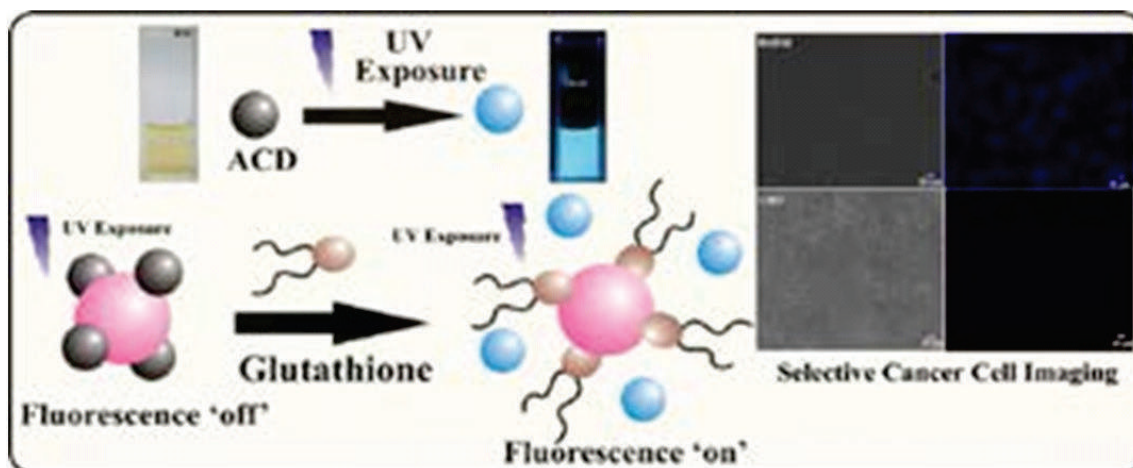
- An interdisciplinary approach towards development of molecules, active principles and methods to address several issues in biological sciences has been undertaken. Thus, this area spans from biological chemistry to chemical biology involving supramolecular chemistry and nanoscience/nanotechnology.
- In chemical biology, research works on stabilization of non-Watson-Crick nucleic acid structures and targeting of cancer cells and cancer stem cells have been carried out.
- The application of nanomaterial included supramolecular systems in biomedicine, and fluorescent carbon dots in biosensing and imaging have been explored.



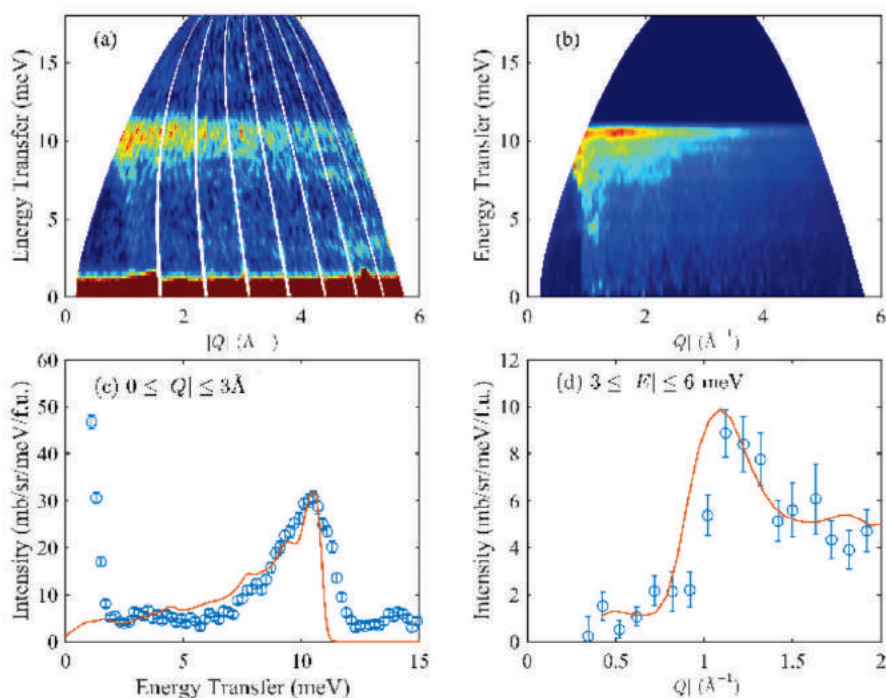
- Hydrogels, polymersome and metal-complex-based drug delivery vehicles for treating inflammation and cancer have been evaluated.
- The reactivity of heme amyloid beta peptides associated with Alzheimer’s diseases has been investigated.
- Spectroscopic and theoretical studies to unravel the mechanism of protein folding, drug-DNA interactions, DNA damage and repair in cancer have been carried out.
- During 2017-18, one faculty member has been awarded Gandhian Young Technological Innovation (GYTI) Award; one faculty member became a Fellow of the Indian Academy of Sciences, Bangalore (FASc.); one faculty member became a J C Bose National Fellow and one faculty member has been awarded the Swarnajayanti Fellowship.
- Technical Research Centre (TRC) has been set up and is working with the goal to develop liaison with industries. Under this Centre, several sophisticated research facilities have been installed and also been created in the first year of the project. Facilities such as environmental SEM, ESI-MS secondary ion mass spectrometer, Mössbauer spectrometer, Ultrafast transient spectroscopy are being created and installed to support research work in molecular, applied, biological and materials science. A new animal house has been developed to give a boost to biological research.
- To strengthen collaborative work with industries, a laboratory for incubation and prototyping is being set up. An ultra-high resolution AFM has been installed very recently while a high power, high resolution X-ray diffractometer as well as a 25 litre/day Helium liquefier are going to arrive very soon. Many facilities for Biological research have been added such as “Bacteria Culture System”. The computational facility has also been enhanced significantly.

**Some Important Output Indicators**

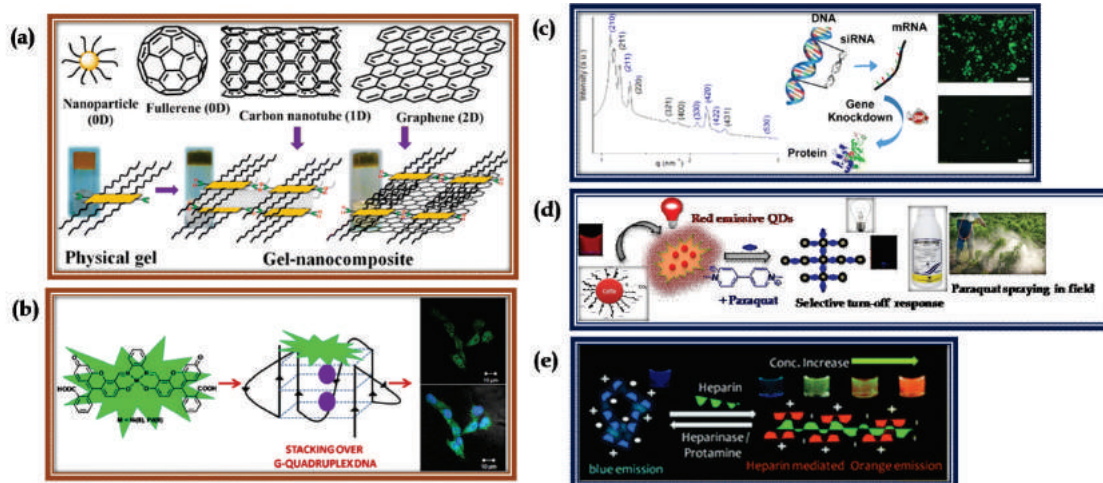
Sl. No.	Parameters	Output
1.	Papers in refereed journals	434
2.	Chapters in Books	09
3.	Papers in Conferences	57
4.	Number of Ph.Ds. produced	58
5.	Foreign Patents filed	03
6.	Indian Patents Filed	15
	Indian Patents granted	01
7.	Number of Technologies/Designs and other intellectual products commercialized	01
8.	Research Manpower trained (other than Ph.Ds)	20
9.	Technical Manpower trained	01
10.	B. Tech/UG projects guided	14
11.	M. Tech/M.Sc./M.Phil project guided	26



Self-assembled soft matter and carbon nanomaterials in biosensing.



Figures (a) and (b) show the 2D colour plots of the neutron-scattering intensity of  $\alpha$ -Cu<sub>2</sub>V<sub>2</sub>O<sub>7</sub> as obtained from phonon-corrected measured experimental data (at 5 K) and simulated by the SPINW package, respectively. Figures (c) and (d) show the experimental and simulated scattering intensity as a function of energy transfer for the  $|Q|$  range  $0-3 \text{\AA}^{-1}$  and as a function of momentum transfer summed over  $3-6 \text{ meV}$ , respectively



(a) Various gel-nanocomposites assembled from different metal-based nanoparticles or nanocarbons (fullerene, carbon nanotubes (CNTs) and graphenes); (b) Metal based salen complexes as an important scaffold toward targeting of DNA structures; (c) Liposomal gene carriers derived from a gemini cationic lipid as highly efficient cytofectins for pDNA; (d) QDs with a negatively charged nanosurface showing excellent selectivity for paraquat (PQ) and (e) oligo (p-phenylenevinylene) based bis-pyridinium derivatives showing 'ratiometric' detection of heparin in water.

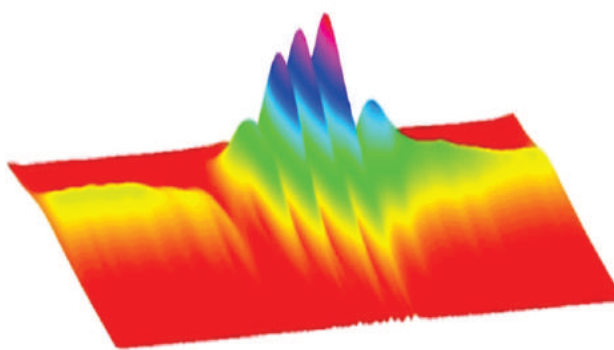
## INSTITUTE OF ADVANCED STUDY IN SCIENCE & TECHNOLOGY (IASST), GUWAHATI

### Areas of Focus

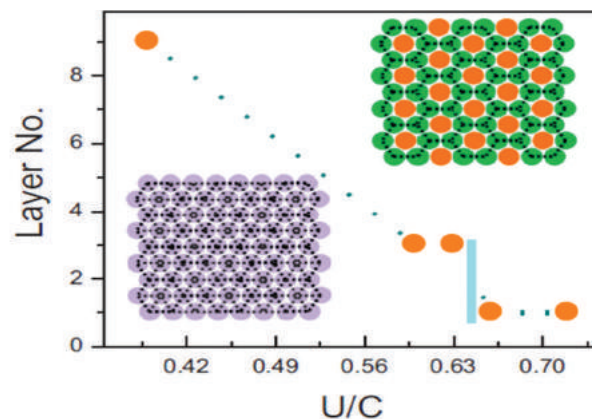
Basic and Applied Plasma Physics, Advanced Materials Sciences, Mathematical and Computational Sciences, Biodiversity and Ecosystem Restoration Programme and Traditional Knowledge-based Drug Discovery.

### Some Major Accomplishments

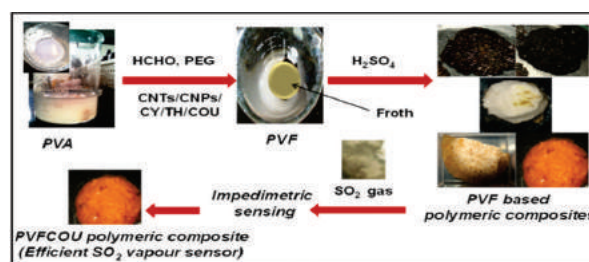
- Fused hollow cathode cold atmospheric pressure plasma has been utilized for synthesis of vertically aligned and hierarchically branched carbon nanostructures on metallic substrates without use of any additional catalyst layer, which shows very significant field emission with turn on field of 0.83 Volt/micro-meter and field enhancement factor of more than 7300.



- Absorption of light in metal nanoparticles and subsequent generation of hot carrier and transfer to semiconductor has been studied in a material system where there is no excitonic contribution. This study reveals significant variation in the energy and concentration of hot carriers that are generated and transported in gold and silver based devices which depend on the position of the Fermi level of metal and valence band and conduction band of the semiconductor.
- A self-excited dust acoustic wave with characteristic frequency  $\sim 100$  Hz was observed in a nanodusty plasma produced by external injection of carbon nanopowder into a rf discharge Argon plasma.
- Evolution of multi-Peregrine soliton in multicomponent plasma with negative ions has been observed and studied for the first time.
- Model membranes formed by fatty acid molecules at air-water interface show two-dimensional (2D) structures. In the presence of  $Mg^{2+}$  and  $Ca^{2+}$  ions monolayer structure remained unaffected, but in the presence of  $Zn^{2+}$  and  $Cd^{2+}$  ions monolayer to trilayer transformation occurred, whereas, in the presence of  $Ba^{2+}$  ions multilayer structure formed. Collapse of model membranes followed two-dimensional lattice percolation model.



- An Efficient Sulphur dioxide Vapour Detection Sensor has been developed using PVF Composite: The composite PVFCOU was found to exhibit a response time of 3 s for 400 ppt  $SO_2$  and a LOD of 1.15 ppb  $SO_2$  at ambient condition.
- The thrown away residue that is the seed cover of the *E. ferox* seed has been effectively utilized for the removal of Basic fuchsin dye from aqueous solutions. This is a novel, efficient, biofriendly and economically low-cost alternative adsorbent.
- A bacterial consortium for remediation of hydrocarbon contaminated soil ecosystem and a novel antimycotic drug from biosurfactant – a bacterial metabolite have been developed.
- The utility of liquid biopsy by monitoring the cell free mitochondrial DNA (cfmtDNA) content in the management of Head and Neck Squamous Cell Carcinoma (HNSCC) as an early diagnostic marker has been reported for the first time from India.
- Influence of ethnicity on gut microbiome and metabolite profile has been established based on





a study on five ethnic groups (Tai-Aiton, Bodo, Karbi, Tea-tribe and Tai-Phake) from Assam. Metabolites of microbial origins were found to be linked with specific microbiomes.

- Development of an “Enzyme-Free” fluorescent based detection of cholesterol through carbon nanodots.
- Application of rhamnolipid biosurfactant for controlling dermatophytic disease caused due to infection of a fungus named *Trichophyton rubrum*.
- Translational health practitioner knowledge based 10 herbal formulations of NE India are being studied for integrating through system biology approach and bioactivity guided fraction of the herbs with controlled approach to integrate prevention and cure of diabetes.
- Investigation on the mechanism of development of the golden color of Muga silk.

### Some Important Output Indicators

Sl. No.	Parameters	Output
1.	Papers in refereed journals	61
2.	Chapters in Books	02
3.	Papers in Conferences	70
4.	Number of Ph.Ds. produced	14
5.	Indian Patents filed	03
6.	Number of Technologies/Designs and other intellectual products commercialized	01
7.	Number of Technology leads awaiting transfer	01
8.	Research Manpower trained (other than Ph.Ds)	33
9.	Technical Manpower trained	01
10.	B.Tech/ UG projects guided	12
11.	M.Tech/M.Sc./M.Phil projects guided	17

## INDIAN INSTITUTE OF ASTROPHYSICS (IIA), BENGALURU

### Areas of Focus

Research in Astronomy and Astrophysics on topics covering the Sun and Solar System, Stellar and Galactic Astrophysics, Cosmology and Extragalactic Astronomy, Theoretical Physics and Astrophysics.

Operation of Observational Facilities and Development of Instruments and Facilities for undertaking research in Astronomy and Astrophysics.

### Some Major Accomplishments

- *Gauribidanur Radio Observatory and Kodaikanal Solar Observatory*: Shock waves propagate through the solar atmosphere in the aftermath of intense and eruptive activity on the Sun. An

understanding of the driver of these shocks is important since they accelerate energetic particles. Some of the shocks propagate all the way to the near-Earth space. Such shocks can cause damage to the electronics onboard the satellites that are in their path of propagation, transient changes in the Earth's magnetic field leading to transformer failures on the ground, etc. A strong eruption from the Sun occurred on 4 November 2015, and it was observed simultaneously with the radio telescopes in the Gauribidanur Observatory, the H-alpha telescope in the Kodaikanal Observatory, and the Scanning Sky Monitor (X-ray observations) onboard ASTROSAT (India's first space mission for multi-wavelength astronomy). After a detailed analysis of the data, scientists at the Indian Institute of Astrophysics recently established unambiguously that the mass ejections from the solar corona (called the coronal mass ejections or CMEs) are the driver of the aforementioned shocks, irrespective of whether they originate near or far from the Sun.

- *National Large Solar Telescope (NLST) project:* The Standing Committee of National Board for Wildlife has recommended the proposal for utilization of 7.6 ha forest land from Changthang Cold Desert Wildlife Sanctuary for establishment of the National Large Solar Telescope at Merak on August 10, 2017. A Weather Station, an All Sky Camera, a Solar Differential Image Motion Monitor (SDIMM) and a Shadow Band Ranging (SHABAR) instrument have also been deployed for measuring the observing conditions at Merak.



The site survey and weather station instruments (e.g. all sky camera, Solar Differential Image Motion Monitor, Shadow Band Ranging) deployed at the Merak site.



A closer view of site survey instruments deployed at Merak.

- *Ultra-Violet Imaging Telescope (UVIT) Project:* The UVIT payload on-board ASTROSAT has been routinely carrying out quality observations since its launch on September 28, 2015. There is no noticeable degradation in the imaging capabilities of the instrument. The UVIT payload operations center at IIA, entrusted with the responsibilities of health monitoring and data processing of UVIT has been functioning very well. Important findings from UVIT are being regularly published in leading journals.
- *The Thirty Meter Telescope (TMT) Project:* India-TMT, led by IIA, made significant progress on its assigned work packages. The segment polishing building work at CREST, Hosakote is also progressing well and will be completed by mid-June, 2018. Related machineries are



### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	78
2.	Chapters in Books	01
3.	Papers in Conferences	03
4.	Number of Ph.Ds. produced	04
5.	Research Manpower trained (other than Ph.Ds)	06
6.	Technical Manpower trained	27
7.	M.Tech/M.Sc./M.Phil projects guided	10

## INDIAN INSTITUTE OF GEOMAGNETISM (IIG), NAVI MUMBAI

### Areas of Focus

Geomagnetism and Allied Fields.

### Some Major Accomplishments

- An alternative generation mechanism for the electrostatic waves observed in the lunar wake during the first flyby of the Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS) mission in terms of slow and fast ion-acoustic and electron acoustic solitons has been proposed. The lunar wake plasma has been modelled by fluid multi-component magnetized plasma comprising hot protons, doubly charged helium ions, electron beam, and suprathermal electrons following kappa distribution. Our results show that the electric fields associated with the slow and fast ion-acoustic and electron-acoustic solitons are in excellent agreement with observed electrostatic wave electric fields in the lunar wake. The broadband spectrum generated through these waves matches well with the observed frequencies of the electrostatic waves in the lunar wake.
- A new Artificial Neural Network-based global 2-dimensional Ionospheric Model (ANNIM) has been developed to predict the ionospheric NmF2 and hmF2 variations. The ANNIM has captured the spatial and temporal variations of NmF2 and hmF2 well. Current ANNIM predictions are better than the existing IRI-2016 model. Also, the ANNIM can be further improved to develop a complete 3-dimensional model.
- Analysis and interpretation of aeromagnetic and Bouguer gravity data over the seismically active Koyna region delineated the interface between the traps and the underlying crust. Further, an interface within the granitic-gneissic crust has been observed that may possibly represent the top of intermediate metamorphic amphibolitic crust or a reworked granitic-gneissic crust as the Indian plate moved over the reunion plume.
- Electrical resistivity studies over hard-rock, semi-arid regions over south eastern Deccan Volcanic



Province were carried out to assess aquifer protection and vulnerability. The study area revealed poor aquifer protective capacity rating, and hence more prone to infiltrating contaminants. The soil corrosivity revealed the degree of competence of the sub-soil to withstand the corrosion levels of buried metallic pipes. This study, first of its kind in the drought-prone region of Deccan Volcanic Province, Maharashtra, is expected to be a pre-requisite for delineation of aquifers obscured within and below the Deccan traps besides assessment of groundwater potential, its protection ability and corrosivity level of soil.

- The anomalously large cosmic noise absorption (CNA) observed at Maitri, Antarctica ( $L = 5$ ; CGM-62°S, 55°E) during the recovery phase of 17 March 2015 St. Patrick's Day storm was an enigma, which was settled invoking the wave-particle interaction. The CNA enhancement during recovery was as large as that during the main phase of the storm, which was surprising. Absence of electromagnetic ion cyclotron (EMIC) waves suggested the possible role of VLF waves in precipitation. The investigation showed that the precipitation due to hiss-driven sub-relativistic electrons was the main cause for such an intense CNA. The CNA enhancement event was located well inside the dusk plasmaspheric bulge region during the dusk time, which is dominated by the interaction of sub-relativistic electrons with hiss waves. Enhanced eastward electrojet at Maitri during that time (14–17 MLT) could be an additional factor for such a large CNA. The CNA pattern also exhibited oscillation in the Pc5 (2–7 mHz) range and was in simultaneity with geomagnetic pulsations in the same frequency range. Further examination of these pulsations using transfer entropy method confirmed that the CNA oscillations were modulated by geomagnetic pulsations in Pc5 band.
- The first observations of Gigantic Jets in Indian subcontinent over the Indo-Gangetic plains during the monsoon season were reported. Gigantic Jets are electric discharges from thunderstorm cloud tops to the bottom of ionosphere at ~90 km altitude and electrically connect the troposphere and lower ionosphere. Two storms each produced two jets with characteristics not documented so far. Jets propagated ~37 km up remarkably in ~5 ms with velocity of  $\sim 7.4 \times 10^6 \text{ms}^{-1}$  and disappeared within ~40-80 ms, which is faster compared to jets reported earlier. The electromagnetic signatures show that they are of negative polarity, transporting net negative charge of ~17-23 C to the lower ionosphere. One jet had an unusual form observed for the first time, which emerged from the leading edge of a slowly drifting complex convective cloud close to the highest regions at ~17 km altitude. A horizontal displacement of ~10 km developed at ~50 km altitude before connecting to the lower ionosphere.
- A new mechanism for electron acceleration and ion deceleration in terms of the interaction of head-on collision of solitary waves has been proposed. The particle-in-cell simulation of head-on collision of multiple counter-propagating coherent wave structures associated with ion acoustic solitary waves (IASWs) in plasmas shows that the electrons trapped within these IASW potentials accelerated, while the ions decelerated during the course of their collisions. This is the first experimental evidence of particle acceleration/deceleration due to head-on collision of the

coherent waves that may be applicable in interpreting local particle acceleration/deceleration in space and laboratory plasmas.

- Paleoseismic investigations were carried out at Shillong, NE India region to explore the possibility of identifying and dating past seismic events through documentation of liquefaction features and Radiocarbon and Thermoluminescence ( $^{14}\text{C}$  and TL) dating. The trenches excavated at 27 locations revealed liquefaction features (sand dikes, flame structures etc.). In order to explore whether palaeomagnetic studies can aid in obtaining a time constraint on palaeoliquefaction, samples were collected for remnant magnetic studies on sand dykes and the host strata (undeformed). The characteristic remnant magnetizations (ChRM) data of liquefaction feature possess a strong clustering around the mean value; a value that fits well with the geomagnetic field values for this place at this time in the past (i.e. the values recorded in the host strata). Thermomagnetic and Isothermal Remnant Magnetization (IRM) studies show that the dominant magnetic carrier in liquefaction and host strata is magnetite. The degree of orientation and ordering of the Anisotropy of Magnetic Susceptibility (AMS) generating particles in the liquefaction exhibit different and distinctive AMS fabrics whereas host strata show depositional fabric.
- Palaeomagnetic studies on the dykes of the northern part of Singhbhum craton in and around Tatanagar revealed three different virtual geomagnetic poles (VGP), suggesting three distinct episodes of dyke intrusion. Rock magnetic measurements consisting of high temperature magnetic susceptibility study indicate the presence of magnetite as the major magnetic mineral in the northern Singhbhum craton dykes.
- Space Weather is generally referred to disturbed weather in Earth's upper atmosphere and outer space due to energetic phenomena on Sun like Coronal Mass Ejections (CME), Solar Flares, etc., which can have potential effects on satellite orbital position, payload electronics, radiation safety of astronauts, satellite communication/navigational systems, electrical power grids and long distance pipe-lines on Earth. Due to the increasing dependence of society on technological systems, severe space weather can cause extensive social and economic disruptions in the modern high-technology society. It is, therefore, important to develop space weather forecasting models that can alert users about the severity of space weather with a lead time of few hours to few days in order to be able to mitigate its effects. Recent studies at IIG suggest that  $\Delta V * \text{IMF } B_z$  below a threshold  $< -15 \times 10^3 \text{ km s}^{-1} \text{ nT at L1}$  ( $\sim 220 R_E$ ) is crucial. This provides a lead time of  $\sim 35$  min enabling mitigation from consequent hazards.
- VLF receiver being installed at Bharati, Antarctica during the present Antarctic Expedition.
- A well-equipped state-of-the-art environmental magnetism laboratory is maintained and run at IIG for research and it has played a major role in training students and professionals in the country for R&D.
- Tri axial Helmholtz coil test facility has been designed and developed for calibrating magnetometer sensors. A data logging system, nTLOGGER, which is a Dual-Core Intel® Atom™ processor, has been developed.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	52
2.	Chapters in Books	2
3.	Papers in Conferences	38
4.	M.Tech/M.Sc./M.Phil projects guided	34
5.	Scientific Outreach Programmes organized	A number of talks, articles, awareness workshops, science day, open house, etc. organized.
6.	Popular Science Articles published	10
7.	Number of persons who attended various science outreach programmes/conferences etc.	1200
8.	Scientific Lectures/Training Programmes organized	10
9.	Number of students trained	60
10.	Number of school/college/university teachers trained	12

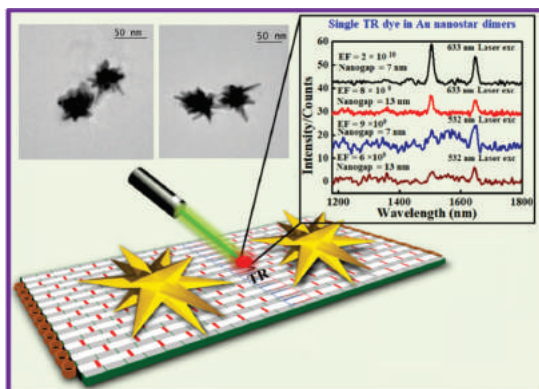
## INSTITUTE OF NANO SCIENCE AND TECHNOLOGY (INST), MOHALI

### Area of Focus

Research on all areas of nano science and technology with special emphasis on materials and devices for energy harvesting, water purification, micro-fluidics based devices, bio-sensors, nano medicine, tissue engineering, nanotechnology in agriculture and understanding phenomena at the nanoscale.

### Some Major Accomplishments

- Reported electrochemical detection of cardiac biomarker using specific aptamers.
- Development of low-cost cartridges for purification of industrial and domestic waste water. Plans are afoot to test this modified adsorbent on real waste water contaminated with arsenic collected from rural area and cities.
- Developed hierarchically porous inhalable microspheres for efficient pulmonary drug delivery.
- Developed Cubic Mesoporous Ag-doped Carbon Nitride materials for humidity sensing applications.
- Collaborative work with other institutions like CSIO, Chandigarh resulted in the development of low cost Microprobe system, which is used for microelectronics.
- Developing Air purification device for harmful pollutants (Ammonia) and Volatile organic compounds (VoCs) : economical and reusable.



### DNA Origami Directed Au Nanostar Dimers for Single-Molecule Surface-Enhanced Raman Scattering

- Under the Outreach Programme - Initiated Chhatra Protsahan Vyakhyan Shrankhla (CPVS), North East Educational Development (NEED), Outreach programme for Women, School adoption programme. Nearly 270 schools (~18,500 students) from rural and remote areas covered in last three years in 18 states including Assam, Andhra Pradesh, Chhattisgarh, J&K, Kerala, Himachal Pradesh, Meghalaya, Rajasthan, Odisha, Punjab, Haryana, Uttar Pradesh, Uttarakhand etc.
- During the period of report, INST succeeded in getting 19 sponsored-research projects, focused on application-oriented research of societal relevance, at a total sanctioned cost of INR ~10.042 crores.
- During the reporting year, under INST-Industry collaborative programme: A) a project with NTPC Energy Technology Research Alliance has also been initiated on conversion of gaseous effluents released from power plants to nanostructured materials which has high demand in industry and society B) Another project titled “*Method Development for measurement of thermal conductivity for Heat Transfer Fluids (HFTs)*” with Indian Oil Corporation Limited, Research and Development Centre, Faridabad. C) An MoU with Titan Industries, Tamilnadu has also been initiated for Scratch less and Luster Enhancing Gold for Next Generation Jewellery D) Talks have been also initiated with Tata Steel for synthesis of fine chemicals from Industrial effluents.
- Under its Ph D programme, INST has started 10 Ph.D. courses in association with IISER Mohali and Panjab University (as degree awarding universities) for enrollment of PhD students. Currently, INST has 84 PhD students and 04 Post-doctoral students.
- Established Nanoscale Physics and Device Laboratory; Nano-science and Nanotechnology a lab in Panjab University, Chandigarh; Added sophisticated instruments to the Faraday Laboratory at INST and a Bio and Nano functional materials laboratory at IISER, Mohali
- An MoU with Post-Graduate Institute of Medical Education and Research (PGIMER), Chandigarh was signed in the area of nano-diagnostics and therapeutics.
  - MoU with IIT-Delhi for a project titled “Development of Cartridges for removal of Lanthanides from Water”.



- An MoU signed between INST and the Centre for Nanoscience and Technology, Panjab University, Chandigarh to do research work on applications of Nano Science and Technology.
- Collaboration with PSCST initiated for dissemination of Science and Technology to economically poorer and weaker sections of the society.

### Some Important Output Indicators

Sr. No.	Parameters	Output
1.	Papers in refereed journals	61
2.	Chapters in Books	01
3.	Indian Patents filed	03
4.	Number of Technology leads awaiting transfer	02
5.	Research Manpower trained (other than Ph.Ds.)	26
6.	B. Tech/ UG projects guided	08
7.	M. Tech/ M.Sc./ M. Phil projects guided	06

## INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS (ARCI), HYDERABAD

### Areas of Focus

Nanomaterials, Engineered Coatings, Ceramic Processing, Laser Processing of Materials, Sol-Gel Technology, Carbon Materials, Fuel Cells, Solar Energy Materials, Automotive Energy Materials.

### Some Major Accomplishments

- Technology to manufacture Nano Titania Suspension for Self Cleaning Textiles has been commercialized. Several renowned brands manufacturing readymade garments are beginning to use it.
- 5 kW PEM fuel cell systems have been successfully demonstrated at Gas Authority of India Limited (GAIL)'s R&D Centre, Noida using bottled hydrogen.
- 'Pulsed electrodeposition of Nickel Tungsten alloy coatings' know-how demonstration and transfer agreement has been concluded with an Indian company.
- Using in-house developed Lithium ion 3.2 V-28Ah cells, battery modules of 48V-720 Wh and 48V-850Wh have been assembled and demonstrated on road for riding e-cycle and e-scooter, respectively.
- Indigenously developed soft magnetic material used in making prototype claw pole alternators has demonstrated performance on par with commercial ones.

- Environment Friendly hexavalent chrome-free sol-gel coatings on Aluminium alloys (2024, 6061, 7075 and Alclad) has been developed for aerospace applications.
- Designed complex shaped Ceramic Heater Holders for environmental friendly Sanitary Pad incinerators.
- Synthesized on large-scale - carbon coated Lithium Iron Phosphate Powder for Li-ion battery cathode application.
- Large scale development of receiver tubes and proto-type receiver assembly (4m length) for Concentrated Solar Power application.
- High temperature (HT) stable spinel based absorber coatings developed for high temperature solar thermal applications.
- Lead free copper alloys for bimetal bearings.
- Large quantities (140 kg) of Oxide dispersion strengthened 9Cr RAFM steels for application in fusion reactor were supplied to Institute of Plasma Research for conversion into plates.
- Developed laser surface treatment process for taper roller bearings to enhance bearing capacity.
- Tungsten coating technology for first wall applications and thick copper coatings on steels for ITER applications.
- Environmentally preferred coatings using cold spray and MAO technology for structural repair of Al alloys.
- Environmentally stable transparent super hydrophobic coating sol for self-cleaning PV panels and high performance broad band antireflective coatings using hollow  $MgF_2$  nanoparticles for PV and Solar Thermal applications have been developed;
- Perovskite solar cell with 16.2 % power conversion efficiency were fabricated at lab-scale; Band gap engineered perovskite developed for semitransparent solar cell exhibited 8 % efficiency.
- High coercive anisotropic dopant for strontium ferrite hard magnetic materials has been developed; A 300W thermoelectric generator has been built for testing in an in-house developed IC engine simulator
- 5kW packaged system has been made for forklift/stationary application; developed metal air battery of 20Wh capacity; developed 1.5  $NM^3$  water electrolyser with chemical depolarizer using alternative catalysts and membranes.
- Developing Ni-based nanostructures on carbon cloth by electrodeposition technique for electrode materials in high performance super-capacitor application.
- IN718 Ni-based alloy powders were produced by inert gas atomisation for additive manufacturing trials; development of mesoporous carbon from jute sticks for use as electrode materials for super capacitor; development of ODS-austenitic steels for high temperature application.

- Development of SiC based thrusters of different sizes; Silicon reflective coating sintered silicon carbide space mirror substrate for various applications is in progress.
- Refurbishment process for 7-pinion housing using laser cladding, Laser Surface Texturing for automotive applications, fabrication of control and shield grids for pulsed microwave applications using ultrafast laser and Spiral grooving on journal and thrust bearings of X-ray tube components by Lasers are in progress.
- Wear resistant coatings comprising hard and low friction coefficient material developed on MINT dies which enhanced its life by nearly 2.5 folds with improved followability; composite coatings for electromagnetic railgun application and Ni based cermet coating for tribological applications have been developed.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed (SCI) journals	82
2.	Books & Chapters in Books	8
3.	Papers in Conferences (with or without proceedings)	99
4.	Number of Ph.Ds. produced (including employees and Fellows)	03
5.	Foreign Patents filed	-
	Foreign Patents granted	1
6.	Indian Patents filed	5
	Indian Patents granted	9
7.	Number of Technologies Transferred/applications developed/products supplied#	17
8.	Number of Technology leads awaiting transfer#	21
9.	Research Manpower trained (other than Ph.Ds)	27
10.	Technical Manpower trained	84
11.	B.Tech/ M.Sc projects guided	80
12.	M.Tech/ projects guided	41
13.	Number of Fellows Pursuing Ph.D	50

## JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH (JNCASR), BENGALURU

### Areas of Focus

Chemistry and Physics of Materials, Engineering Mechanics, Evolutionary and Integrative Biology, Geodynamics, Molecular Biology and Genetics, Neurosciences, Theoretical Sciences and New Chemistry.

### Some Major Accomplishments

There have been regular breakthroughs, discoveries, and inventions in each of the areas as mentioned above. A few representative accomplishments are the following:

- Researchers from the Centre have developed a unique DNA-based technology, which can be used to detect extremely low concentrations of mercury in any form in human body that causes fatal diseases.
- Researchers at the Centre have discovered new classes of compounds that can help fight 'superbugs' that are organisms resistant to powerful antibiotics.
- Experiments carried out at the Centre helped dispel the notion that continuous darkness may regress the body's biological clock and showed that absence of light may have caused the evolution of a more robust clock.
- Two new molecules capable of destroying bio-film forming bacteria have been found by researchers at JNCASR. The molecules performed better than conventional antibiotics in killing the bacteria during the dormant phase.
- Researchers at the Centre have identified a small molecule called 6-Bio which cleans up toxic protein clumps in brain cells. They found that the small molecule of 6-Bio can clear accumulated cellular junk and avert further neuronal loss.
- In NIRF ranking 2017, JNCASR ranked 4<sup>th</sup> among universities and 11<sup>th</sup> in overall category.
- *Student Buddy Programme*: A total of 76 students participated from Jawahar Navodaya Vidyalaya, Belgaum, Udupi and Mundugod, Karnataka in the programme.
- *Visiting Fellowship Programme*: The Centre received 13 applications for the Visiting Fellowships Programme under different categories out of which 09 faculty from research institutions/universities across the country were selected.
- *Summer Research Fellowship Programme*: 77 students availed the scholarship for SRFP 2017 and 12 SRFP students of 2016 had their SRFP tenure renewed for another year. These students received research training in various areas of Physics, Chemistry, Biology or Engineering at research institutes in Bangalore, and elsewhere in the country.
- *Project Oriented Chemistry Education (POCE)*: 10 students from 10 states were selected for POCE program. Ten students of POCE-2015-17 batch were awarded Diploma in Chemistry and two of them have been selected by IITs, two by NITs, two (one of 2014-16 batch) by JNCASR (and IISc) and others have joined state universities for their higher studies.
- *Project Oriented Biology Education (POBE)*: Ten students were selected from different parts of the country. Nine students of POBE 2015 received their Diplomas in Biology on successful completion of their three-year POBE tenure.



- *Science Outreach Programme and Education Technology Unit (ETU):*
  - ✓ CNR Rao Education Foundation with the support of Faculty and Students of the Centre regularly conduct various science outreach programme which benefits school children immensely, especially children from rural areas. Approximately 800 students and 100 teachers benefitted from these programmes.
  - ✓ Further between July - September 2017, 03 programs viz., ‘Program in Physics’, ‘Program in Chemistry’ and ‘Program in Biology’ were organized for students. These programs were attended by over 400 students.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	268
2.	Books	02
3.	Chapters in Books	02
4.	Papers in Conferences	03
5.	Number of Ph.Ds. produced	43
6.	Foreign Patents filed	7
	Foreign Patents granted	5
7.	Indian Patents filed	5
	Indian Patents granted	2
8.	Number of Technologies/Designs and other intellectual products commercialized	2
9.	Number of Technology leads awaiting transfer	15
10.	Research Manpower trained (other than Ph.Ds)	80
11.	Technical Manpower trained	07
12.	B.Tech/ UG projects guided	88
13.	M.Tech/M.Sc./M.Phil projects guided	

## RAMAN RESEARCH INSTITUTE (RRI), BENGALURU

### Areas of Focus

Astronomy & Astrophysics, Light & Matter Physics, Soft Condensed Matter and Theoretical Physics.

### Some Major Accomplishments

- A quantum atom optics experiment at RRI has overthrown a long-held view that heavier atoms cannot cool lighter trapped ions. It was demonstrated, for the first time, that cooling of trapped lighter ions is possible by collisions with co-trapped, higher mass neutral atoms.
- The X-ray astronomy group carried out investigations of phenomena in the area of binary X-ray

stars using several international space X-ray observatories. One remarkable discovery has been that of a massive planet around an X-ray binary system, the first of its kind and also the first one discovered with a new technique of periodic variation in X-ray eclipse timing. Another important discovery made was that a peculiar class of X-ray binaries called Super-giant Fast X-ray Transients (SFXT) were found to have systematically low absorption column density and strength of iron emission line, indicating their environment to be significantly different from that of their parent population, the Super-giant High Mass X-ray Binaries (SgHMXB). This is an important clue to understand the SFXTs that has intrigued X-ray astronomers for more than a decade.

- The biophysics laboratory probed rheological properties of axons using in-house developed microscope mountable force apparatus and revealed unexpected mechanical properties of axons arising from the unfolding of folded repeat units in spectrin protein scaffold. Another in-house developed microscope mountable device, which apply rotational fluid shear stress to cells has been successfully demonstrated as a simple way to quantitatively investigate cell adhesion properties.
- RRI researchers have conducted the first measurement of a non-zero Sorkin parameter. The naive application of the superposition principle in experimental and theoretical studies involving multiple slits interference experiment was questioned. It was brought out both experimentally and theoretically that boundary conditions have a very non-trivial effect on the so-called Sorkin parameter. The experiment, which was done with microwaves, showed that indeed even without violating fundamental principles of quantum mechanics the Sorkin parameter could be non-zero due to incorrect application of boundary conditions.
- RRI research advanced basic science of liquid crystals in photovoltaic applications. Two designs in which bulk heterojunction solar cells were incorporated with liquid crystalline triphenylene derivative as well as carbazole copolymer and fullerene derivative with an inserted layer of discotic material showed higher efficiency attributed to the presence of liquid crystal layer.
- RRI research staff has recently provided a review of the physics theory of strongly interacting photons in experimental realizations of qubits, including superconducting transmission lines with localized qubits or cold gas of Rydberg atoms in atomic traps, which are basic building blocks in quantum computing. This involves photon-photon interactions realized by light-matter coupling between photons propagating along 1-D systems without optical confinement.
- In X-ray astronomy, there has been significant progress in fabrication of a qualification model of the POLIX instrument to be flown as main instrument on XPoSat, a satellite mission of ISRO dedicated for investigation of polarization properties of cosmic X-ray sources. An MOU was signed for ISRO for joint development of the mission and funding RRI for delivery of the POLIX instrument. A detailed design document of POLIX has been prepared and submitted to ISRO for Preliminary Design Review. A collimator calibration facility has been fabricated and installation of the same is ongoing.
- The Nano-BioPhysics laboratory has applied the in-house developed Quartz nanopore platform

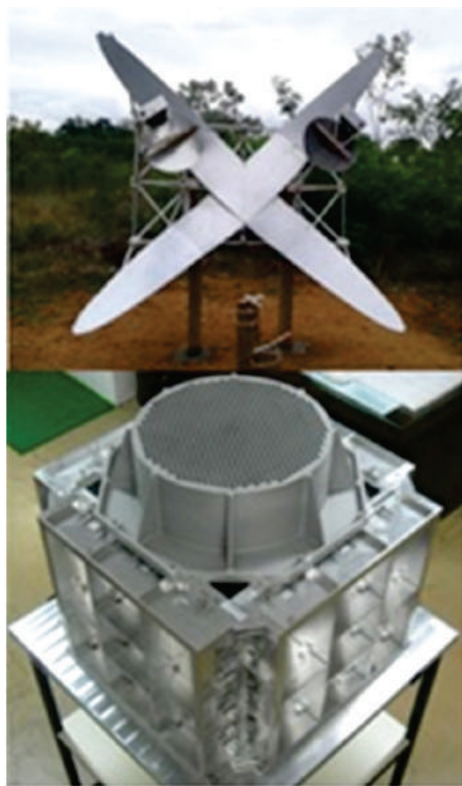
to understand temperature dependence of DNA unfolding. This elucidates mechanisms behind nanometre-scale changes in DNA structure caused by the environmental factors, such as salinity and temperature.

- In the field of Radio Astronomy, a precision radiometer called SARAS 2, built at the Institute, has been deployed in a radio quiet site in Timbactu Collective in Andhra Pradesh. Measurements made by the radio telescope have been examined using Bayesian Likelihood ratio tests and also frequentist approach for presence of theoretically predicted redshifted 21-cm signals from Cosmic Dawn, when the First Stars of the universe formed. The analysis has so far already ruled out 10 percent of predicted models, which imply that X-rays from the First Stars did heat the surrounding gas and that subsequent reionization of the neutral intergalactic gas by the UV luminosity was gradual, not rapid. This is the first time that precision radiometer measurements have thrown light on the physics of Cosmic Dawn, thus providing a path-breaking effort into what is a key science goal for the international SKA. The Sky Watch Array built by RRI is now commissioned and watching the skies from the Gauribidanur Field Station for fast radio bursts and other transients, thus giving Indian Radio astronomers an entry into this emerging field. A scale model for a novel cross telescope, called Efficient Linear-array Imager, is now complete and work on construction of the radio telescope is in progress.



**A precision radiometer called SARAS 2, built at the Raman Research Institute deployed in a radio quiet site in Timbactu Collective in Andhra Pradesh**

- In 2017-18 two new MoUs were signed between RRI and ISRO for (a) the deployment of POLIX, world's first X-ray polarimeter, to be flown onboard ISRO's XPoSat mission and (b) to develop quantum communication technologies using satellites.



(top) A scale model for a novel cross telescope, the Efficient Linear-array Imager, is now complete and work on construction of the radio telescope is in progress.

(bottom) Mechanical Assembly of X-ray polarimeter (POLIX) detectors with collimator.

### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	118
2.	Books	1
3.	Chapters in Books	1
4.	Papers in Conferences	5
5.	Number of Ph.Ds. produced	6
6.	Foreign Patents granted	1
7.	Indian Patents granted	1



S.No.	Parameters	Output
8.	Number of Technologies/Designs and other intellectual products commercialized	1
9.	Number of Technology leads awaiting transfer	2
10.	Research Manpower trained (other than Ph.Ds)	77
11.	Technical Manpower trained	26

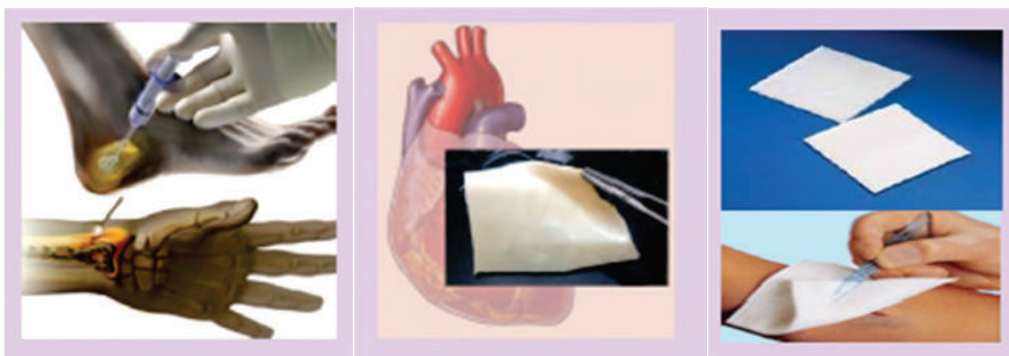
## SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY (SCTIMST), THIRUVANANTHAPURAM

### Areas of Focus

Biomaterials Research and Development, Biomedical Product Development, Technology Transfer and Industrial Linkages, Quality Management Systems, Testing and Technical Services, Research in Cardiac and Neurosciences, Patient Care and Public Health.

### Some Major Accomplishments

- New super-speciality block: The Ministry of Health and Family Welfare, in partnership with the Department of Science and Technology, sanctioned funding for a new super-speciality block for the Hospital Wing under the Pradhan Mantri Swasthya Suraksha Yojana.
- The Congenital Heart Surgery Intermediate Care Unit, a recent venture of Cardiology and Cardiothoracic Surgery Unit, is fully equipped and functional.
- The nine-bed dedicated Heart Failure ICU started functioning with facilities like extracorporeal membrane oxygenation system and positive pressure ventilation to treat post-transplant patients.
- The Heart Team, comprising cardiologists and cardiac surgeons, initiated the trans-catheter aortic valve implantation programme and performed two surgeries successfully.
- The technology / products viz. Calcium Sulfate cement, process for Glutaraldehyde cross-linking of pericardium with anti-mineralization treatment, Poly Vinyl Alcohol (PVA) sponge were transferred to M/s G. Surgiwear Ltd, Shahjahanpur, UP.



- The Process for preparation of extracellular matrix scaffolds from mammalian cholecyst/jejunum/ urinary-bladder was transferred to M/s Optimus Life Sciences, Kerala.
- Rapid Urinary Tract Infection (UTI) diagnostic kit with antibiotic sensitivity test was transferred to M/s Agappe Diagnostics Limited, Kerala.
- Fibrin sealant to M/S ZumHeilen Healthcare Private Limited, Bangalore in 2017.
- Blood/IV fluid warming system to M/S HLL Lifecare Ltd, Kerala.



- Infant warmer – Bassinet and wrapper to M/S HLL Lifecare Ltd, Kerala.



- In October the Vein viewer device was transferred to M/s Agappe Diagnostics Limited, Kerala.



- In November, Technology for the manufacture of bone graft materials Beta Tricalcium Phosphate, 60% synthetic Hydroxyapatite and 40% Beta Tricalcium Phosphate were transferred to M/s Onyx Medicals Pvt Ltd, Meerut, UP.
- The tilting disc heart valve and gel-coated vascular graft - second generation cardiovascular products entered into the clinical trial phase. Technology documents for the same were transferred to M/s TTK Healthcare Ltd., Trivandrum.
- Co-development of snake antivenom (pure polyclonal IgY) developed against neurotoxins has been initiated between the Institute and M/s New Medicon Pharm Lab Pvt Ltd
- The Ministry of Electronics and Information Technology, Government of India, sanctioned Rs 8.94 Crores for an e-Delivery System for Health Care Management and Research at the Institute.
- Ms. Indriyam Biologics Pvt. Ltd., a start up incubating at TIMed has been shortlisted after two-level screening as Top 10 Healthcare Startups for the ‘National Bio Entrepreneurship Competition 2017’ conducted by BIRAC and CCAPM and also invited for the grand finale in December, 2017.
- The “Snake Venom Detections Biosensor” development project of Indriyam has been funded under the Industry Innovation Programme in Medical Electronics (IIPME) of BIRAC.
- The Institute hosted the “6th Asian Biomaterials Congress” (ABMC6), organized jointly by the Society for Biomaterials and Artificial Organs (India), Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram (SCTIMST), Society for Tissue Engineering and Regenerative Medicine (India) and Asia Pacific Society for Artificial Organs, Japan, at Thiruvananthapuram from 25th to 27th October, 2017. Asian Biomaterials Congress series is a biennial meeting to facilitate scientific co-operation and development of collaborative programmes between the scientists in Asian countries in the areas related to Biomaterials and Medical Devices. It was conducted in India for the first time.
- The Institute hosted the 10th Cytometry Society-India Annual Meeting and Workshop (TCS-2017) on “Applications of Flow Cytometry in Health & Disease” from 28th to 31st October, 2017. This event was organized in collaboration with Regional Cancer Centre Trivandrum and Rajiv Gandhi Centre for Biotechnology, Trivandrum.
- Industry Institute Partnership Cell of the Institute conducted two series of the workshop “An Insight into Analytical Instruments in Research” at the Biomedical Technology Wing during 17th and 18th November, 2017 and 15th and 16th December 2017. The main objective of the Workshop was to provide an insight into the prominent techniques of characterization and giving an exposure of sophisticated analytical instruments to the participants.
- Dr M Unnikrishnan, Professor, Cardiovascular and Thoracic Surgery, was awarded the Dr B C Roy Award under the category of “Eminent Medical Teacher-2016” on 28 March 2017 by the Hon’ble President of India.

- Dr Lizymol of the Department of Biomaterials Science and Technology won the 7th National Award for Technology Innovation from the Ministry of Chemicals & Fertilizers, Government of India.
- The Society of Toxicology, India conferred “Life Time Achievement Award” to Dr. P.V. Mohanan, Scientist-G, Division of Toxicology in recognition of his outstanding contribution to the field of Toxicology, at the 37th Annual Conference of the Society of Toxicology held at Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh from 17 to 19 November, 2017.

### Some Important Output Indicators

S. N.	Parameters	Output
1.	Papers in refereed journals	223
2.	Books	1
3.	Chapters in Books	14
4.	Scientific Papers in Conferences	21
5.	Number of PhDs produced	23
6.	Indian Patents filed	22
	Design Registrations filed	7
	Indian Patents granted	2
7.	Number of Technologies / Designs and other intellectual products transferred/commercialized	12
8.	Number of Technology leads awaiting transfer	4
9.	Research Manpower trained (other than PhDs) including DM/PDCC/PDF/MPH/Nursing and under TRC Projects	395
10.	Technical Manpower trained in the Institute	21
11.	M.Tech/M.Sc./M.Phil projects guided	29

## S N BOSE NATIONAL CENTRE FOR BASIC SCIENCES (SNBNCBS), KOLKATA

### Areas of Focus

- Physics of nanomaterials including application-specific materials and nanodevices.
- Advanced computational materials science including soft condensed matter, ionic liquids and biomolecules.
- Interface of biology and condensed matter physics : DNA-protein and nanomaterials interactions, biomolecular recognition and application of ultrafast spectroscopy.
- Collective behaviour in quantum and classical condensed state including driven systems, ultra cold quantum gases and spin transport through quantum wires.



- Theoretical work on black holes and its cosmological consequences and astro-chemistry. Selected problems in Quantum Field Theory, Statistical Physics and Non-Linear Dynamics.
- Networked research programmes through the visitor and associateship programmes.

### Some Major Accomplishments

- The 125<sup>th</sup> Birth Anniversary of Prof. Satyendra Nath Bose fell on 1 January 2018. The Hon'ble Prime Minister, Shri Narendra Modi, inaugurated the curtain raiser ceremony of year-long celebrations to commemorate the 125<sup>th</sup> Birth Anniversary of Prof. SN Bose and addressed the gathering at Kolkata through video conferencing. The occasion was also graced by Dr. Harsh Vardhan, the Hon'ble Minister for Science and Technology, Earth Sciences and Environment, Forest & Climate Change and Shri YS Chowdary, the Minister of State for Science and Technology and Earth Sciences.



The Hon'ble Prime Minister addressing the gathering on the occasion of the curtain raiser ceremony of 125<sup>th</sup> Birth Anniversary of Prof. SN Bose



The Hon'ble Minister for Science and Technology, Earth Sciences and Environment, Forest & Climate Change, Dr. Harsh Vardhan releasing a special cover on Prof. SN Bose, on the occasion of the curtain raiser ceremony of Prof. Bose's 125<sup>th</sup> birth anniversary at the Centre on 1 January 2018. The Minister of State for Science and Technology and Earth Sciences, Shri YS Chowdary, the Secretary, Department of Science and Technology, Prof. Ashutosh Sharma, the Chairman, Governing Body, Dr. Srikumar Banerjee and the Director, Prof. Samit K. Ray are also seen.

- On the scientific side, the following investigations and results were reported from various Departments of the Centre.

*Department of Astrophysics & Cosmology*

- Observational constraints on back-reaction models in the context of analogous scalar field cosmology.
- Optimal violation of Leggett-Garg inequality for arbitrary spin.
- Preservation of teleportation fidelity for noisy channels.
- Optical Photometric Variable Stars towards Galactic HII region NGC 2282.
- Phase dependent spectroscopy of a new Mira variable and fundamental parameters of M-giants from optical/IR spectra.
- Effects of gravitational bending on the images of a black hole with accretion flows.
- Estimation of mass of several stellar mass black holes.
- Estimating the size of accretion disks around black holes.
- Solar-soft X-ray spectra from VLF radio signal data from a ground based receiver.

*Department of Chemical, Biological & Macro-Molecular Sciences*

- Inactivation pathway of sodium ion channel studied.
- Isochronicity for different chemical oscillators studied.
- Responses in driven systems studied.
- Spatio-temporal correlations among functional protein residues explored.
- High resolution laser spectroscopic system and protocol for tracer gas detection.
- Human breath analyses for non-invasive disease detection established.
- Hydrophobic hydration by THz spectroscopy investigated.
- New material characterization done via THz spectroscopy.
- Ultrafast dynamics of materials and nano-bio interactions explored.
- Structure and dynamics of deep eutectics studied.
- Biomedical instruments for non-invasive medical diagnosis developed.
- New nanomaterials, intermetallics, etc. synthesized, and their interactions studied.

*Department of Condensed Matter Physics and Materials Science*

- Simulation of elastic behavior of crystalline-amorphous Si-nanocomposites.
- Interfacial Dzyaloshinskii-Moriya Interaction using Brillouin Light Scattering on W/CoFeB interface in W/CoFeB/SiO<sub>2</sub> heterostructures.

- Optical response in a single strand of a branched Y-junction CNT.
- Stable and enhanced visible-light water electrolysis for clean and sustainable energy by using surface functionalized/surface doped ZnO Nanorods.
- Development of Efficient Density Matrix Renormalization Group technique for one- dimensional periodic boundary condition system, through Matrix Product State algorithm.
- A metallic antiferromagnetic system with simultaneously enhanced disordered induced weak localization, indicating magnetic transitions concomitantly with resistivity minima.
- A smart fluid showing bullet stopping ability, for use in the body armours of defense.
- Nonstoichiometric ferromagnetic shape memory alloys of type Ni-Mn-Sn exhibiting transition from high symmetric cubic phase investigated from first principle calculations.
- Detailed theoretical investigation of generalized spin stiffness constant for doped quantum antiferromagnet with strong electronic correlations on low dimensional lattices.
- ZnO nanorod array hybrid photodetectors on Au nanoparticle-embedded silk protein as a biopolymer substrate for flexible photonic devices.
- Grown and modelled topological phases in thin films of correlated oxide and heterostructures, a quantum anomalous Hall insulator in ultrathin films of double perovskites based on mixed 3d–5d or 3d–4d transition-metal ions.

*Department of Theoretical Sciences*

- Study of two Higgs doublet models with softly broken U(1) symmetry, Gauge theories in the presence of Black holes, Categorical fiber bundles and connection on path spaces.
- Schrodinger equation in non-commutative space time, spectral distance in doubled Moyal plane.
- Gauging non relativistic diffeomorphism and its application, Fluid dynamics in non-commutative space, new results in the context of Newton Cartan geometry.
- Canonical transformations and Duality in SU(N) lattice gauge theories leading to new disorder operators.
- Regularization of kappa deformed Kepler problem, Poisson structures of dynamical systems with three degrees of freedom having chaotic properties.
- Entanglement of quantum optical states and squeezing.
- Study of fiber bundle model with non-linear fibers, study of lattice percolation model and a model of ‘Colored percolation’ has been introduced.
- Phase ordering in coupled systems, Actin filaments, Bacterial chemotaxis, Periodically driven systems.
- Study of light scattering methods for biomedical tissue characterization.

*Technical Research Centre*

Innovation/Deliverable	Sector
1. A simple diagnostic methodology for <i>non-invasive</i> detection of infection in real-time using human breath analysis.	Healthcare
2. Pico-calorimeter for biochemical and small volume analyzer for DSC/microscope attachment	Value added product to an existing sector of economy
3. Prototyping thin film devices using functional oxide patterned films.	Value added product for an existing sector of economy
4. Development of light operated micro-actuator using photomechanical actuation of ferromagnetic shape memory alloys	Healthcare: Engineering Applications
5.(a) Hybrid Nanocomposites and (b) porous metal-organic framework compounds for CO <sub>2</sub> and toxic gases removal	Environment
6. Enzyme Catalyzed Biodegradation of Xenobiotic Compounds: Treatment of Industrial Effluents.	Environment
7. NIR Optical instrumentation for application.	Value added product

**Some Important Output Indicators**

S.No.	Parameters	Output
1.	Papers in refereed journals	172
2.	Papers in Conferences	6
3.	Number of Ph.Ds. produced	21
4.	Indian Patents filed	10
	Indian Patents granted	1
5.	Research Manpower trained (other than Ph.Ds) PDRA	18
6.	B.Tech/ UG projects guided	3
7.	M.Tech/M.Sc./M.Phil projects guided	7
8.	Summer Project at PG level	25
9.	Completed M.Sc. under Integrated Ph.D.	7

**WADIA INSTITUTE OF HIMALAYAN GEOLOGY (WIHG), DEHRADUN****Areas of Focus**

Study of Himalayan river systems, glaciers, earthquake precursors, landslides, biodiversity and climate-tectonic interaction with major emphasis on the geodynamics of the Himalaya.

**Some Major Accomplishments**

- The evidence has been collected for a co-seismic slip of  $5.5 \pm 0.7$  meters for the surface breaking



fault of 15th August, 1950 Tibet-Assam earthquake ( $M_w \sim 8.6$ ) along eastern Himalayan front.

- The luminescence chronology of the fill sequences in the Ramganga river basin suggests that the valley filling occurred mainly in response to the enhanced monsoon after the Last Glacial Maxima, during Medieval Warm Period and Little Ice Age. This phase is common in both glaciated and the non-glaciated catchments of the Himalaya.
- The discharge after the breaching of the Chorabari lake during 2013 flood in Kedarnath has been estimated to be  $\sim 1429 \text{ m}^3/\text{s}$ , a disastrous flood of such high magnitude has not been witnessed during the last 100 years.
- The fluvial landscape along the Indus River in Ladakh evolved in response to the far field effect of NW syntaxes and neotectonic activity along the suture zone of the Himalaya.
- The Institute demonstrated the seismograph and organized mock drill on November 07, 2017 as part of preparedness for earthquake for the students and teachers of Eklavya Adarsh Residential School located in Kalasi, Chakrata.
- The Institute also organized half day workshop on October 26, 2017 for the delegates of joint Indian Academy of Highway Engineers (IAHE), Noida and Japan International Cooperation Agency (JICA), Japan.
- Glacier lake inventory of Himachal Pradesh has been generated using high-resolution Resourcesat 2 LISS IV satellite images. In total, 958 glacier lakes of size  $> 500 \text{ m}^2$  covering an area of  $9.6 \pm 0.3 \text{ km}^2$  have been mapped. Out of this, 345 have been classified as moraine-dammed lakes having a total area of  $5.1 \pm 0.2 \text{ km}^2$  (53.1 % of the total glacier lake area).
- High resolution climate reconstruction of the past 8000 years recorded from the 5 m thick peat sequence from Kedarnath indicates the alignment of tropical and global climate since the Mid-Holocene.
- The shortening in the frontal fold thrust belt along the Jawalamukhi Thrust and Jhor Fault, lying between the Himalayan Frontal Thrust (HFT) and the Main Boundary Thrust (MBT) were estimated to be  $\sim 6.06 \text{ km}$  and  $0.25 \text{ km}$ , respectively.

### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	90
2.	Books	1
3.	Chapters in Books	2
4.	Papers in Conferences	2
5.	Number of Ph.Ds. produced	8
6.	Indian Patents filed	1
	Indian Patents granted	1

S.No.	Parameters	Output
7.	Research Manpower trained (other than Ph.Ds)	75
8.	B.Tech/ UG projects guided	20
9.	M.Tech/M.Sc./M.Phil projects guided	20
10.	Other Products/ Indicators (to be specified by adding rows to this Table) <ul style="list-style-type: none"> <li>• 2<sup>nd</sup> National Geo-Research Scholars Meet organized during May 17-20, 2017.</li> <li>• 3<sup>rd</sup> International Yoga Day observed on June 21, 2017.</li> <li>• Foundation Day of WIHG celebrated on June 29, 2017, which also marks the beginning of the year-long Golden Jubilee celebrations.</li> <li>• Release of a book written by Eminent Geoscientist Padma Bhushan Prof. K.S. Valdiya on the life of Padma Vibhusan Sh. Sundar Lal Bahuguna, noted environmentalist and leader of Chipko movement in on September 07, 2017.</li> <li>• Hindi Pakhwara organized during September 14-28, 2017.</li> <li>• International Fossil Day celebrated on October 16, 2017 to create awareness about the fossils and life of the past.</li> <li>• ‘Swachhta Hi Seva’ fortnight Campaign was observed from Sept 15, 2017 to October 02, 2017 as part of the Government of India campaign.</li> </ul>	7

## THE NORTH EAST CENTRE FOR TECHNOLOGY APPLICATION AND REACH (NECTAR)

### Areas of Focus

- Work with domain experts and with Central and State Government funded laboratories to identify techno-economic gaps and technologies to induct them in the North East.
- Provide last mile guidance and support to States to ensure that such technologies reach ultimate beneficiaries in the North Eastern States.
- To give a fillip to the economic activities in the North East and generate employment potential through induction and implementation of such technologies.

### Some Major Accomplishments

- Productivity and Acreage estimation of Rabi 2016-17 crops in 55 districts of India.
- To promote the unique traditional art of concrete hive beekeeping, which is vanishing with time a project was supported to revive the scientific method of beekeeping. More than 500 underground concrete hives were constructed along with water reservoirs.
- Under the beekeeping project, 170 beekeepers were supported and 1700 bee boxes were distributed among the farmers in the villages of Tuensang district of Nagaland viz. Chendang, Konya, Longtang, Chingmei, Kiding and Yangli. This intervention was aimed at empowering the local village people to the subsidiary occupation of beekeeping to generate supplementary income. Further, this intervention would increase the output of honey production in the state.

- NECTAR has extended capital support to North East Network (NEN) - Chizami Weaves – The project has engaged 300 back-strap loom weavers from 11 locations under Phek district to produce home furnishings (cushion cover, table runner), garments (shawls and mekhas) and accessories (bags) that cater to both rural and urban consumers. NECTAR also linked the weavers with designers, thereby facilitating the weavers to enhance their skill and understand the knowhow of market trends.
- After successful completion of wireless CCTV project in Shillong, the expansion project has been taken up at Tura. On the basis of survey and LoS (Line of Sight) analysis, 12 locations have been finalised for round the clock monitoring. This video surveillance system will enable the following:
  - o Providing alerts to the Police Department about abnormal movements/suspicious objects.
  - o Better Management of Security breaches based on alerts received from System.
  - o Improved turnaround time in responding to any investigation case, faster access to evidence, law violation in the prescribed areas.

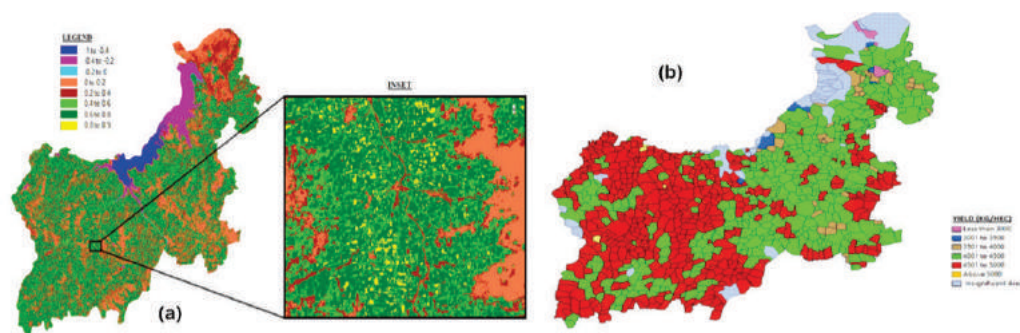


Fig:1 (a) Monitoring of Crop Health using Vegetation Indices, ( b) Identification of High and Low yield crop productivity in Mandasaur Dist,MP

- Providing Technology Support for “Pradhan Mantri Fasal Beema Yojna (PMBFY)” - NECTAR has provided services on feasible technology based agriculture crop analysis using satellite imagery and UAV acquired data for 50 Million hectares in different states during the Rabi season.
- NECTAR has covered more than 1400 km of linear stretch of highways through UAV imaging and processed the data into various high precision 3D mapping products for National Highways Authorities of India (NHAI) to help in planning, construction, quality monitoring, traffic congestion and toll management.
- NECTAR has accomplished a major water resources planning project in Odisha for Ministry of Water Resources, Government of India. The scope of the project involved high precision 3D Mapping of approximately 450 sq km area to study the submergence area, number of villages to be inundated and to quantify the approximate volume of water capacity by the reservoir (RL91m) forming due to the proposed construction of Dam over Mahanadi River near Barmul Village in Odisha.

## NATIONAL INNOVATION FOUNDATION-INDIA (NIF), GANDHINAGAR

### Areas of Focus

Incubation and promotion of contemporary technological grassroots innovations and add value to India's outstanding traditional knowledge base

### Some Major Accomplishments

- NIF facilitated hosting of the Third Festival of Innovation (FOIN) at the RashtrapatiBhavan, New Delhi under which NIF's 9th National Biennial Award Function, Global Roundtable for Inclusive Innovations, Financing of Innovations, Exhibitions of Innovations related to Medical Science and Biotechnology, etc. were organized.
- NIF coordinated DST's INSPIRE Award - MANAK (Million Minds Augmenting National Aspirations and Knowledge) Scheme, nationally inviting students (class 6-10) to submit their innovative ideas. The scheme envisions an investment of Rs. 10,000 each for best one lakh ideas with the top 60 ideas being incubated by NIF, which will also facilitate their participation in the annual Festival of Innovation (FOIN) at RashtrapatiBhavan, New Delhi.
- NIF's efforts led to the acknowledgement of the importance of grassroots innovation in the Global Innovation Index 2017 report.
- The role of NIF in knowledge creation was also acknowledged in the "Task Force on Innovation - Report on Global Innovation Index: An Indian Perspective".
- NIF organized the Grassroots Innovator Summit 2017 at the India International Science Festival-2017 where it organized an 'Innovation Exhibition', which aimed at providing a common platform for various stakeholders – from innovators, students, researchers to policy makers.
- NIF organized a Capacity Building Workshop on Intellectual Property Rights for South African delegation and also hosted the India - South Africa Joint Committee Meeting (JCM). This is as per Government of India and Government of South Africa's ongoing partnership.
- NIF has been sharing its experiences of working on grassroots innovations with many countries in Asia and Africa and elsewhere. An international delegation comprising researchers from 12 African PARI (Program of Accompanying Research for Agricultural Innovation) countries viz. Benin, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mali, Nigeria, Togo, Tunisia, Zambia; along with representatives from ICRIER (Indian Council for Research on International Economic Relations) and Center for Development Research (ZEF), University of Bonn, Germany visited NIF to understand its work on grassroots innovations. NIF also participated in ASEAN Science, Technology and Innovation Exhibition for Sustainable, Inclusive and Equitable Growth at Myanmar.
- A book of NIF activities during Festival of Innovation, "The Innovation President" was presented



on 24th July, 2017 to Shri Pranab Mukherjee at RashtrapatiBhavan in the presence of the then President-Elect and now Hon'ble President of India Shri Ram Nath Kovind and Prime Minister of India Shri Narendra Modi.

- NIF supported establishment of five new community workshops in Assam, Jammu and Kashmir and Odisha. It also supported twenty-five innovators for developing value-added prototypes and developed twenty-two prototypes based on award winning student ideas of IGNITE 2017 competition.
- NIF initiated trials of 27 farmers' varieties at more than 800 farmers' field in 23 states. Station trials of 16 varieties were initiated at 6 difference research institutes and biochemical analysis for 23 plant varieties were carried out at two different research institutes. For multi-location trials, 11 plant varieties were submitted at 8 AICRP centres in 5 states.
- To reduce drudgery, provide livelihood options, provide low-cost solutions and solve local problems, NIF facilitated introduction/diffusion of thirteen innovations and three herbal products in thirteen states including Jammu and Kashmir, North Eastern States and tribal areas of Odisha, Chhattisgarh and Jharkhand.
- Seven Grassroots Innovation-based Private Limited Companies have been incorporated during the period with all of them being registered as a Start-up under DIPP. Five other Private Limited Companies incorporated earlier were granted the status of a Start-up by DIPP this year, thereby taking the total count of grassroots innovation-based start-ups to twelve.
- NIF and National Institute of Technology, Silchar entered into an understanding for collaboration in incubation, dissemination, value addition of grassroots innovations.
- NIF entered into a joint venture-cum-technology transfer agreement with Luckys Bakery Private Limited and Warriors Marketing and Distribution Limited for commercialization of nutraceutical products.
- NIF, Haldiram Snacks Private Limited and Warriors Marketing and Distribution Limited signed a letter of intent to form an association for developing various innovative and healthy range of food products.

### Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	7
2.	Books/Monographs/booklets	7
3.	Chapters in Books	1
4.	Papers/presentations in Conferences	6
5.	International Conferences Organized	1
6.	Indian Patents filed	37

S.No.	Parameters	Output
7.	Indian patents granted	6
8.	Applications filed under PPV&FR Act 2001	13
9.	Designs registered	3
10.	Trademarks registered	3
11.	Number of Technologies/Designs and other intellectual products commercialized/ technologies transferred	8
12.	Number of Technology leads awaiting transfer	52
13.	Number of GRIs based companies incorporated	7
14.	Number of companies registered as Start Ups	12
15.	Number of innovators supported under Micro Venture Innovation Fund (MVIF)	4
16.	National Conferences/Workshops Organized	3
17.	Scientific Outreach Programmes organized	12
18.	Original Science Communication Content Designed	1
19.	Number of persons who attended various science outreach programmes/conferences etc.	Around 1,000
20.	Scientific Lectures/Training Programmes organized	4
21.	Number of students trained (during Summer Internship)	49
22.	Number of school/college/university teachers trained	21
23.	Number of Innovators trained	5
24.	Number of Innovations Registered	50,510
25.	Data Bases Compiled	2
26.	National Missions Led and Coordinated	3

## TECHNOLOGY INFORMATION, FORECASTING AND ASSESSMENT COUNCIL (TIFAC), NEW DELHI

### Areas of Focus

Technology foresight exercises, Vision 2035, nurturing innovation, supporting MSME clusters, capacity building, electric mobility, collaborative linkages etc.

### Some Major Accomplishments

- Technology Vision 2035 (TV 2035) Technology Roadmaps on education sector was released during the reporting period. Further, three more TV 2035 technology roadmaps are being lined-up for release by the end of FY 2017-18.
- Five (05) indigenously developed technology innovations have been successfully commercialized and ten (10) innovative products have been identified, evaluated and technically recommended for implementation under Srijan Programme.

- DPR for the Technology Platform under National Mission on Electric Mobility has been prepared by TIFAC covering simulation model for optimization of charging infrastructure for electric public transport buses, Interface Standards for “India Integrated Electric Wheelchair” using an Android App etc.
- Nine (9) Technology Gap Analysis (TGA) Studies are ongoing for various MSME clusters across Country. Out of these, one TGA study has been completed for the Refractory Cluster at Bangabhoomi, Asansol (West Bengal)
- Efforts of TIFAC and IIASA in preparing energy scenarios for 2050 has led NITI Aayog to take up energy modeling, energy system planning, and energy policy and enhance the capacity to conduct energy systems modeling and policy analysis to relate energy policy to other sustainable development objectives. GAINS model developed for Delhi for estimating and suggesting technologies to combat air pollution has been very encouraging. Both air quality and impact on health have been studied and analyzed.
- Twelve (12) Indian patents, 1 Australian patent and 1 European patent have been granted since April 1, 2017 which was facilitated by the Patent Facilitating Cell (PFC). 6 Industrial Designs have also been registered. 101 patent analysis reports for 140 raw materials being exported from India have been generated. The one-year training on IPR for 103 KIRAN-IPR trainees of 8<sup>th</sup> batch has been completed. 16 number of TIFAC-CIPAM certified trainers have been created for awareness program under the National IPR Policy 2016.
- Under the MSME Internship Scheme, nine (9) technology development projects under Stage – II of the scheme on development of low-cost and easily implementable solutions for MSME industries have been successfully completed.
- Under Bio Process and Bio Products programme, pilot plant trials for two selected Indian biomass (sugarcane tops and cotton stalks) have been completed. Technology Assessment Study on ‘Updated information of biomass availability and technologies for conversion to biofuels in Indian context’ with IARI has been completed for Phase-I and other study on ‘spatial information system on biomass potential from crop residues over India using geospatial techniques’ by NRSC, Hyderabad is underway.
- Technology Roadmap on education sector released during the reporting period covers education from perspectives such as Literacy, Creativity and Skills; Ensuring Access; Achieving Quality Culture, Recreation and the Good Life; Research, Innovation and Product Development; Technological Future of Education; Emerging Knowledge-scapes and Institutional Architectures. Additionally, the roadmap has identified five Grand Challenges namely, enabling universal personalised access to knowledge and skills, enabling language neutral content through real time translation and interpretation, building universal interactive and adaptive simulators, integrating diverse knowledge systems and replacing individual certification and institutional ranking with social reputation metrics.

- Under TIFAC-SIDBI Technology Innovation Programme (Srijan), one start-up entity has been identified as collaborative R&D partner by Bharat Electronics Ltd. for scaling up the technology on “Inertial Navigation Sensors”. Technology on “Trash Boom for collecting surface trash from water bodies” developed by a start-up has been identified as a potential technology under the National Mission for Clean Ganga (NMCG).
- Technology Foresight study on electric mobility including optimization of charging infrastructure for electric vehicles, impacts on electricity distribution grid, and energy storage options for electric vehicles have been carried out. Simulation models for transportation sector have been developed to compare various options of transportation technologies in terms of meeting national commitments and targets.
- PFC evaluated 50 new cases for filing of patents and facilitated filing of 6 patent applications in India and 2 PCT applications. Organized three workshops on IPR, two for UNIDO (pulp and paper and bicycle sector at Saharanpur and Ludhiana respectively) and one for Patent Information Centre (PIC) at Itanagar. Inducted 107 women scientist trainees for the 9<sup>th</sup> batch of KIRAN-IPR. One training of trainers has been conducted with CIPAM and DIPP.
- A centre for biofuels for producing lignocellulosic ethanol with a processing capacity of 80kgs/ per day of biomass had been created at CSIR-NIIST Trivandrum, as a national facility.
- Dialogue has been initiated with Madhya Pradesh towards initiating the Vision Document/ Perspective Plan for MP in collaboration with MP Council on Science & Technology (MPCOST) based on the Technology Vision 2035 document. In this regard, a workshop was conducted and hands-on training was imparted on foresight and visioning methodologies.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	2
2.	Papers in Conferences	2
3.	National Conferences/Workshops/Brainstorming Meets Organized	6
4.	State-of-the-art-Reports Published	3
5.	Scientific Outreach Programmes organized	1
6.	Original Science Communication Content Designed	1
7.	Popular Science Books/Newsletters published	1
8.	Number of persons who attended various science outreach programmes/conferences etc.	14
9.	Scientific Lectures/Training Programmes organized	4
10.	Number of students trained	133
11.	Number of school/college/university teachers trained	200
12.	Number of Innovators trained	50
13.	Data Bases Compiled	1



S. No.	Parameters	Output
14.	National Missions Led and Coordinated	1
15.	Foresight Reports and Analyses Prepared	130
16.	Other products/projects/technologies developed under the programme	18

## VIGYAN PRASAR (VP), NEW DELHI

### Areas of Focus

Science and Technology (S&T) Communication and Popularization through development & delivery of communication software, capacity building through training of writers, journalists and outreach initiatives, through various media and the exposition route.

### Some Major Accomplishments

- India Science Wire (ISW), a premier knowledge product, was recently launched to highlight science & technology (S&T) stories and their coverage in Media in India. Every month, about 35 news stories are released. This product has in the current year achieved more than 800,000 tweet impression and has 10,000 Facebook followers and a reach exceeding 60,000.
- Over 150 new S&T based video episodes were produced and telecast through Doordarshan National, Lok Sabha TV, Rajya Sabha TV, DD India, DD Urdu and Doordarshan regional Kendra's. Important series were on Ancient Architecture (Building blocks of Bharat), *Ubharti Prodhoyoki Aur Savarta Kal* (Cutting edge technologies), Weekly science news program (Science Monitor and *GyanVigyan*), Conversation with Indian Scientists (Eureka) and Information Technology (India@IT revolution).
- Through social media like YouTube, NROER and different TV channels, programs are made available to the public. Total viewers on YouTube have exceeded 400,000 and this number is increasing.
- A new Mobile App 'Celebrating Yoga' was developed and launched on the occasion of International Yoga Day (21 June 2017) by Dr. Harsh Vardhan, Hon'ble Minister of S&T and ES. This App is populated with short films on various Yoga postures & techniques with a brief on their application & utility in people's well being.
- Coordinated the first ever online examination - *Vidyarthi Vigyan Manthan*, a talent search exam in collaboration with *VijnanaBharati*; it was held on 26 November 2017 in about 2300 centers across the country. Nearly 91,000 students from all parts of the country had taken part in this examination. A Mobile App for the same was also released.
- India International Science Film Festival was held as a part of IISF-2017 at Chennai, which attracted several noted film makers and experts in the field. A National Workshop on Science Film Making was also organized in collaboration with NIRD&PR, Hyderabad.

- VP managed and participated in an exhibition on S&T achievements organized at the residence of Hon'ble Minister of S&T and ES. Other noteworthy expos were *Vigyan Kala Parv* 2017, DST pavilion at 21<sup>st</sup> National Science Exhibition, Kolkata and DST pavilion at India International Trade Fair 2017 which was a huge attraction.
- A new program Sci-Connect- Nurturing Young Talents of North-East on Science was launched. This is an integration of science film screening, hands-on training on Science and Studio based quiz competition. VP films were screened in a large number of schools of North East. Based on written examination, 15 students of 8<sup>th</sup> and 9<sup>th</sup> Class from each State were selected for training and quiz competition. Out of the total 6000 students participated, 9 were selected for the Award. The Quiz show was telecast through DD regional Kendra's situated in North East.
- Special focus initiatives for ST communities included Capacity Building Workshop on adolescent health and training program for tribal girls in five States; Workshop on health, hygiene and sanitation awareness for tribal women in Assam and demonstration and awareness program on women-friendly agricultural tools and equipment in tribal areas. A film for Drudgery Reduction through women-friendly tools, technologies in association with CIAE, Bhopal was made. Gender responsive application of S&T for Home Garden was also developed.
- National Science Teacher's Workshop (focusing North Eastern States) during India International Science Festival (IISF-2017) was organized at Anna University, Chennai on 14 & 15 October 2017 and about 350 teachers from all across the country participated in it.
- Organized three 5-days long Astronomical Telescope making workshops in collaboration with *Kendriya Vidyalaya Sangathan* for 60 KV schools during August-November 2017. Two such workshops were also held with the support of NCSTC for 46 VIPNET (VP's Network of Science Clubs) members at Coimbatore and Bhopal during April to June 2017.
- Several hands-on activities on S&T were organized for school children to enable them to learn and understand science by doing things themselves, with an aim to sensitize children about the activity based science learning, induce an interdisciplinary & integrated approach to science learning through experimentation and to inculcate scientific temper.
- 9 Books and 12 issues of monthly newsletter 'Dream 2047' published; 20 books Reprinted; VP books were reviewed in renowned journals, magazine and newspapers and VP also participated in several national and regional science exhibitions/ book fairs.
- VP continued to play HAM Radio leadership role. Hands-on workshop at NIT Hamirpur was conducted during 7-8 April 2017 to prepare students to appear for the amateurradio licensing examination. "Ham Radio Society" was formed by the Web Ref:<https://hamnith.wordpress.com/>. Besides, a Session on Ham Radio for Emergency Communication was conducted at HIPA, Gurugram on 9 May 2017 for 50 Civil Defence Officials. An Activity Book on "Radio Communication" for hands-on kit building workshop is also brought out by VP.
- During EduSAT Summer Science Festival, a radio transmitter kit building workshop was

conducted at VP during 14-21 June 2017 where students were trained to assemble a toy radio transmitter. In July 2017, Army officials of the 21 Signal Group visited VP's HAM radio to get acquainted with amateur radio communication system and the possibility of incorporating HAM radio as a second line of communication.

- Developing and updating the popular *Vigyan Prasara* website.
- S&T Communication through Social and Digital Media for Ministry of S&T.
- Biotechnology Communication through Digital Media on behalf of DBT.
- Organized two 3-day VIPNET orientation workshops in Madhya Pradesh.

## INDIAN ACADEMY OF SCIENCES, BENGALURU

### Areas of Focus

The Academy has been engaged in the promotion of original research and dissemination of scientific knowledge to the community via a variety of activities, such as - Publication of scientific journals, Organise Annual mid-year and scientific meetings, Curation of Fellows' repository of publications, Chair Professorships, Science education programmes and Election of distinguished scientists as Fellows of the Academy and selection of Associates.

### Some Major Accomplishments

#### *Publication of scientific journals:*

- The Academy covers all major disciplines in science & technology and currently 13 journals are published.
- Over 1366 peer-reviewed articles have been published in 11 thematic journals and the entire contents are available in free access platform (<http://www.ias.ac.in/Journals/Overview/>).
- Over 13951/1970 print versions of these journals were circulated to institutions/individuals on subscription basis respectively. Academy journals have attracted readership and submissions of articles have increased from around the World.
- Journals' citations have enhanced over years.
- Initiated the publication of an online only journal - Dialogue: Science, Scientists, and Society that was launched in January 2018, along with online publication of IASc Conference Proceedings Series.
- Besides regular journals, special publications of topical interest and Patrika – the newsletter of the Academy – are frequently brought out.
- 10 journals of the Academy are being co-published with Springer Nature (<http://www.springer.com>). Springer Nature provides access to the journals' content worldwide on its journal platform

SpringerLink (<https://link.springer.com>). Springer Nature also distributes print editions of the journals outside India.

- Full and free access to the Academy journals is available worldwide on the website of the Academy (<http://www.ias.ac.in>). The Current Science Association works with the Academy in bringing out the fortnightly multidisciplinary journal Current Science, published since 1932.

The journal wise account for 2017 is indicated below:

Name of the Journal	No. of articles received	No. of articles published	No. of issues published	No. of pages published	Circulation figures
Pramana	692	185	12	1620	1803
Journal of Astrophysics & Astron.	216	67	4	730	1032
Proceedings Mathematical Sci.	394	60	5	934	1517
Journal of Chemical Sciences	1418	195	12	1940	1600
Bulletin of Materials Science	1322	177	7	1534	1482
Sadhana-Proceedings in Engg. Sci.	1797	175	12	2190	1341
Journal of Biosciences	820	70	4	708	1622
Journal of Genetics	725	137	6	1245	1361
Journal of Earth System Science	581	177	8	1932	1058
Resonance- J. of Science Education	206	98	12	1220	3105
Indian Academy of Sciences Conference Series	25	25	1	246	Online journal

*Science Academies' Education Panel Programmes:*

- The Academy has collaborated with the National Academy of Science, Allahabad and Indian National Science Academy, New Delhi for implementing the Science Education Programmes.
- Through this initiative attempts to improve the state of higher education and teaching of science in the country are being made. Components of the programme are - (a) Invitation of college and university teachers to participate in the Academy annual meetings, (b) Summer Research Fellowships to students and teachers, (c) Refresher courses for teachers, (d) Lecture workshops for students and teachers.
- Under Summer Fellowship Programme, a total of 1493 students and teachers availed the Fellowship and underwent 2 months' Fellowship and worked with Fellows and other mentors spread across many research institutions of the country.
- With a view to enhance the spread of Science & Technology in the specific regions of the country, the Inter Academy Panel initiated the Focus Area Science & Technology Summer Fellowship (FAST-SF) in 2017. The focus was on North Eastern States of the country. 92 students/teachers



availed the fellowship. The focus keeps shifting from geographical regions to topics every year.

- Till December 2017, 38 refresher courses in Physics, Life sciences, Engineering and Earth & Planetary Science have been conducted for university science teachers in different parts of the country.
- 156 Lecture Workshops were held in Physics, Life Sciences, Engineering, Earth & Planetary Science, Mathematics and Chemistry in different parts of the country.

*Election of Fellows and Associates:*

- The Academy annually elects distinguished scientists of the country to its Fellowship; it also elects persons distinguished for contributions to science or engineering, whose place of work is outside India, as Honorary Fellows. 456 nominations for the Fellowship were considered for 2017. 28 outstanding scientists and foreign scientists were inducted in to the Academy Fellowship and one Honorary scientist respectively. As on 31 December 2017, the number of Fellows on roll is 1051, and Honorary Fellows 56.
- Selection of Associates: This programme was introduced in 1983 to identify and encourage promising young scientists under 35 years of age. The Associate ship is tenable for a minimum period of three years or maximum period of five years until the age of 35. 26 Associates were selected during the reporting period.

*Organizing Scientific Meetings:*

- The Academy annually holds scientific meetings, symposia and public lectures and encourages other similar activities to provide means of exchange of scientific knowledge among scientists and to bring new knowledge to the attention of the whole scientific community. The mid-year meeting was organized during June 30- July 01, 2017 at Indian Institute of Science, Bengaluru. The annual meeting was organized at NEHU, Shillong 3-5 November, 2017; Symposia, public lectures and scientific talks by Fellows/Associates were held in these meetings.
- Besides, 2 discussion meetings were held on scientific themes. The Academy also organized a national discussion meeting on School Education in August 2017, recommendations were submitted to the committee constituted by the Government, to frame National Education Policy.

*Jubilee Chair Professorship:*

Instituted during the Platinum Jubilee Year of the Academy in 2009. Eminent scientists Prof. Andrej Sali (University of California) and Prof. Veena Sahajwalla (UNSW Australia) visited India under this scheme during August 2017.

*Repository of Publications of Fellows:*

This initiative is intended to make available to the knowledge seeker all the research and review papers published by Fellows in peer-reviewed journals. At the end of December 2017, the repository had 1,00,705 records.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Books	6
2.	National Conferences Organized	3
3.	State-of-the-art-Reports Published	1
4.	Journals Published	13
5.	Scientific Outreach Programmes organized	4
6.	Original Science Communication Content Designed	1366
7.	Popular Science Books/Newsletters published	2
8.	Number of persons who attended various science outreach programmes/conferences etc.	around 800
9.	Scientific Lectures/Training Programmes organized	38
10.	Number of students trained	17,600
11.	Number of school/college/university teachers trained	958
12.	Number of Innovators trained	1398
13.	Data Bases Compiled	757

## INDIAN NATIONAL ACADEMY OF ENGINEERING (INAE), GURUGRAM

### Areas of Focus

INAE, a professional body, provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. It is the only engineering Academy in India. It consists of India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines.

### Some Major Accomplishments

- *Encouraging Innovation and Translational Research through the launch of the Abdul Kalam Technology Innovation National Fellowship:* INAE and Science and Engineering Research Board (SERB) have taken an initiative to institute "Abdul Kalam Technology Innovation National Fellowship" to recognize, encourage and support translational research by individuals to achieve excellence in engineering, innovation and technology development. All areas of engineering, innovation and technology are covered by this fellowship. A Maximum of 10 Fellowships will be awarded per year.



**Dr BN Suresh, President, INAE lighting the lamp**

- *Building up the Young Engineers through institution of the INAE Youth Forum and Conduct of INAE Youth Conclave:* An INAE Youth Forum for engineering students has been established in the year 2017, with the objective of facilitating the engagement of Indian youth in engineering activities at national level, thereby enhancing engineering excellence, promoting youth leadership and assisting in nation building. As a first activity of the Youth Forum, INAE conducted an Online National Essay Competition in the year 2017, for the 4th year engineering students from B.Tech/ BE /BSc (Tech)/ Integrated MTech/ M.E. streams of all MHRD/AICTE approved institutions and universities.



**Dr K Kasturirangan, FNAE Inaugurating the Youth Conclave**

- INAE has also taken the initiative of organizing an annual “Youth Conclave” for engineering students starting from the year 2017; with a view to encourage the involvement of youth for

contributing to the engineering activities of the nation. The prize winners of the essay competition were also felicitated during the INAE Youth Conclave.

- *Engineers Conclave 2017*: INAE had taken an initiative of organizing an annual mega event of engineers as “Engineers Conclave” in the year 2013. The Fifth Engineers Conclave-2017 (EC-2017) was held jointly with CSIR on September 14-16, 2017 at NAL, Bangalore. The two themes for Engineers Conclave-2017 (EC-2017) were: “Regional Air Connectivity” coordinated by NAL, Bangalore and “Digital Economy” coordinated by INAE. Eminent experts and senior functionaries from National and State Centres/ Departments/ Units, Academia, Industry and INAE participated in the conclave to deliberate on the important themes. Actionable recommendations will be forwarded to the concerned Government Departments/Agencies for consideration.
- *11<sup>th</sup> National Frontiers of Engineering Symposium (NatFoE-11)*: The Eleventh National Frontiers of Engineering Symposium (NatFoE-11) was held from June 30-July 1, 2017 at IIT Bombay. The aim of the Symposium was to promote cross-disciplinary exchange of ideas and transfer of new techniques to build and sustain the innovation paradigm. The discussions were held in four thematic areas: Alternate and Advanced Fuels; Manufacturing and Heat Transfer for Aerospace Applications; Technology for Improving Childcare and Mothercare and Technology for tackling Fog and Pollutants.
- *INAE-NIRDPR Workshop on “Frugal Innovations”*: INAE, jointly with National Institute of Rural Development and Panchayati Raj (NIRDPR) and VijnanaBharathi, organized a Workshop on “Frugal Innovations” on July 7-8, 2017 at NIRDPR, Hyderabad. The Workshop focused on ways and means to encourage frugal innovation and to create much needed eco- system in the country for the same. The Chief Guest, Shri M Venkaiah Naidu, Hon’ble Union Minister for Urban Development, Housing and Poverty Alleviation and Information and Broadcasting, Govt. of India delivered the Inaugural Address on July 7<sup>th</sup>, 2017.





- *NIAS –MNRE-TERI–INAE Workshop on “Enabling 100 GW Solar Power Capacity by 2022”*: This was held on November 9, 2017 at New Delhi. The objective of the workshop was to deliberate on all pertinent issues relating to enabling 100 GW Solar Power Capacity in India by 2022 with a view to arrive at actionable recommendations to be forwarded to the concerned stakeholders and policy makers for consideration.

### **Some Important Output Indicators**

<b>S.No.</b>	<b>Parameters</b>	<b>Output</b>
1.	National Conferences Organized	4
2.	Number of students trained	47
3.	Number of school/college/university teachers trained	15

## **INDIAN NATIONAL SCIENCE ACADEMY (INSA), NEW DELHI**

### **Areas of Focus**

Science Promotion and Recognition of Scientists.

### **Some Major Accomplishments**

- The Academy elected 31 Fellows and 4 Foreign Fellows to the Fellowship during the Calendar year 2017.
- 30 young researchers were selected by the Academy for the INSA Medal for Young Scientists and 1 young historians for INSA Young Historian of Science Award for the year 2017.
- 12 outstanding teachers were honoured with INSA Teachers Award for the year 2017.
- Two international, six general and 10 subject-wise medals/lectures awards were announced by the Academy.
- The Academy supported 70 Indian scientists to work in overseas laboratories and R & D institutions and facilitated 5 overseas scientists to work in India under various International Exchange Programmes.
- Under the Science Promotion Programme, the Academy supported 75 Senior Scientists, 26 Honorary Scientists and 53 Young Scientists Awardees for advanced research in their specialized disciplines.
- 137 Conferences/Seminars/Symposia/Workshops which were held in different parts of the country were financially supported.
- Under the History of Science Programme, the Academy supported 19 research projects during the year.

- The first 24 new members of INYAS (2017-21) were selected from the pool of INSA Young Scientist Awardees.
- 15 award lectures under the aegis of different Local Chapters of the Academy were delivered under Science and Society Programme.
- 93 popular lectures were delivered to young students and teachers of schools and colleges by the Fellows in remote/rural areas.
- All the 42 volumes of *Biographical Memoirs of Deceased Fellows of the Academy* were digitized and uploaded on the Academy's website.
- AASSA-INSA-NISCAIR Regional Workshop on “Sustainable Development Goals: Communication Strategies” was held at New Delhi, during 16-18 November 2017.
- Indo-Turkmenistan Round Table meeting on Science and Technology was organized at INSA, New Delhi, during 4-5 December 2017.
- As a part of INSA-Leopoldina Cooperation, a joint symposium on “The challenge to learn: new approaches to study the problem of stability vs plasticity in the brain”, was held at Hyderabad during November 28 & 29, 2017.
- Since inception, the Academy has fostered scientific relationships with prominent scientific academies and organizations of the world to develop and promote the internationalization of science. The Academy has established linkages with Science Academies / Organizations in 50 countries in Europe, Asia, North America, South America and Latin America.

### Some Important Output Indicators

S. No.	Parameters	Output
1.	Books (Indian National Science Academy's Inspirational journey in 75 years)	01
2.	Journals Published	13
3.	Refresher Course	24
4.	Lecture workshop	120
5.	Research Projects in History of Science	19
6.	International Conferences Organized	07
7.	National Conferences Organized	04
8.	Number of persons who attended various science outreach programmes/conferences etc.	709
9.	No. of New MoU signed	01
10.	Scientific Lectures/Training Programmes organized	107
11.	Number of students trained	1409
12.	Number of school/college/Univ teachers trained	109

## THE INDIAN SCIENCE CONGRESS ASSOCIATION (ISCA), KOLKATA

### Areas of Focus

The Indian Science Congress Association was established in 1914 with the following objectives:

- To advance and promote the cause of Science in India;
- To hold an Annual Congress at a suitable place in India;
- To publish such proceedings, journals, transactions and other publications as may be considered desirable;
- To secure and manage funds and endowments for the promotion of Science including the rights of disposing of, or selling all or any portion of the properties of the Association;
- To do and perform any or all other acts, matters and things as are conducive to, or incidental to, or necessary for, the above objects.

### Some Major Accomplishments

- Holding of the 105<sup>th</sup> Annual Session of the Indian Science Congress.
- Publications including ISCA bi-monthly journal Everyman's Science.
- Augmentation of ISCA Chapter Activities.
- Organising Seminars, Symposia, Discussions, Workshop etc.
- Young Scientists' Award Programme
- Best Poster Presentation Award Programme
- Science Awareness Programme for Popularisation of Science
- Advancement and Promotion of Science and Technology through National/International Symposia, Follow-up of Recommendation(s) involving Young Scientists
- International Collaboration: Exchange Programmes
- Infrastructure Development

## THE NATIONAL ACADEMY OF SCIENCES, INDIA (NASI), ALLAHABAD

### Areas of Focus

Promotion and Popularization of Science & Technology; to aid and advise in policy making.

### Some Major Accomplishments

#### Publications

- NASI published the Proceedings of NASI, Sec. A & B, each in four parts and Science Letters in

six parts in collaboration with Springer India.

- A 'Festschrift', dedicated to the eminent scientist Professor M.G.K. Menon, published by NASI and released by the Hon'ble Minister for Science & Technology, Government of India on August 27, 2016 at New Delhi, was distributed to several governmental and non-governmental agencies. A copy of the same was later presented to the Hon'ble Prime Minister of India.
- The 9 volumes on the History of Science in India were also distributed to the concerned government and non-government agencies for dissemination of knowledge.
- A 'Vision Document' on Women in Science was also released.

#### Science Communication Activities

- The highlights of these activities were Children Science Meet, Summer and Winter Schools, Vocational Training Programmes, Teachers' Workshops, Scientific Writing Contest, Vigyan, Jal and Health Chaupals, Seminars and celebration of the National Technology Day, National Science Day, National Mathematics Day, World Environment Day etc. The Academy also encouraged teachers for out-of-the-class science activities by recognizing their talent and giving away NASI-Science Teacher's Awards to them.
- NASI's 18 Chapters spread across India, organized hundreds of science communication activities in and around their respective regions throughout the year. More than 10,000 students and teachers benefitted from these activities.
- In the series of workshops on Scientific Paper Writing organized by the Academy (since 2012), 3 were organized during the year 2017-18.
- Two Science Awareness Programmes (relating to health issues) were organized for the Army personnel.

#### S&T Entrepreneurship development

- Training programs for entrepreneurs – To inculcate the spirit of entrepreneurship in youth, and in line with the National Mission Programmes of Skill Development and Start Up India, NASI organised several programmes at Mohali, Lucknow, Chennai, Madurai, Mumbai, Jamshedpur and Guwahati.
- Awareness and Training – on Nutrition, Safe Drinking Water, Health and Hygiene, Pollution Abatement etc. A mixed participation of rural and urban population was ensured. This was included as part of "Swasth Bharat Mission" and "Swachh Bharat Mission".

#### Science Education Programmes in joint collaboration with National Science Academies

The extremely popular Science Education Panel, that provides opportunities to bright under- and post-graduate students and teachers to usefully spend their summer/winter vacations, was also organized this year jointly with the other two Science Academies - Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore.



Annual Session/Symposia/Seminars and Scientific Discussions

The Academy organized its 87<sup>th</sup> Annual Session and Symposium on ‘Basic Research - its role in national development’ at SPPU, Pune on December 8-10, 2017. More than 500 researchers and scientists participated in these events. Other seminars/symposia were also organised/attended by NASI.

Fellowship / Membership

To recognize outstanding scientific contributions by scientists, the Academy awards every year its prestigious Fellowship/Membership to some of them. More than 100 scientists working in different areas of Science & Technology were awarded NASI Fellowship during 2017. It also awarded Fellowships to a few foreign scientists who are collaborating with scientists from India.

Recognition and Awards- The following awards were given in the year 2017-18:

NASI-Reliance Industries Platinum Jubilee Awards for Application Oriented Innovations covering both Physical and Biological Sciences to four distinguished scientists; NASI-Young Scientist Platinum Jubilee Awards to about a dozen young scientists/researchers in the fields of Biological/Physical/Chemical Sciences; 11<sup>th</sup> NASI Scopus Awards to 10 young scientists/researchers; NASI-Senior Scientist Platinum Jubilee Fellowships; Professor M.G.K. Menon Memorial Lecture Award; NASI – *SwarnaJayantiPuruskars* for Best Paper Presentation to young scientists/researchers; NASI – Springer Awards for Best Paper Presentation to young scientists/researchers; Memorial Lecture Awards to about 13 eminent scientists; NASI – Science and Maths Teacher Awards by NASI HQ and NASI Chapters to a number of teachers.

Establishment of River Galleries

Following the establishment of Ganga Gallery at NASI Headquarters, Allahabad, and the Brahmaputra Gallery in Guwahati, the work on Cauvery Gallery was also completed at Mysuru with major support from the Government of Karnataka.

Sensitization Programmes for Women Researchers/Scientists

The Academy organized 3 workshops on Technological Empowerment of Women in different parts of the country during the year.

Rejuvenation of Baolies (Step wells) in Bundelkhand area

IV Brainstorming on ‘Safe Water and Sanitation’ was organised at NASI (HQ) on September 15-17, 2017.

Evaluation of the Projects/Ideas of Amateur Scientists and Others forwarded by DST

The Academy has been regularly helping DST for the past several years in getting the ideas/projects of amateur scientists evaluated by Fellows/Members of the Academy.

## Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	About 225 (by NASI-Senior Scientists & researchers)
2.	Books/Monographs	05 books published by NASI
3.	Chapters in Books	About 08 (by NASI-Senior Scientists & researchers)
4.	National Conferences Organized	05
5.	State-of-the-art-Reports Published	03
6.	Journals Published	Total 14 issues of PNASI-A & B; and Science Letters
7.	Scientific Outreach Programmes organized	About 150
8.	Popular Science Books/Newsletters published	2
9.	Number of persons who attended various science outreach programmes/conferences etc.	More than 1 lakh
10.	Scientific Lectures/Training Programmes organized	About 50
11.	Number of students trained	About 700
12.	Number of school/college/university teachers trained	About 500
13.	Number of Innovators trained	About 25
14.	Number of Innovations Registered	About 10
15.	Data Bases Compiled	Research data of about 35 NASI-Senior Scientists Compiled
16.	Compendia of Historical Data compiled	Compendia of about 55 Innovators/ Entrepreneurs Published
17.	Foresight Reports and Analyses Prepared	A Report on School Education



Festschrift being presented to Hon'ble P.M.



Brainstorming on 'Safe Water &amp; Sanitation'



Goddess Cauvery (Statue in the gallery at Mysuru)



Exhibits installed in the gallery

## SCIENCE AND ENGINEERING RESEARCH BOARD

The Science and Engineering Research Board (SERB) has its origins from erstwhile Science and Engineering Research Council (SERC) of the Department of Science & Technology (DST), which promoted and served the cause of extramural funding in science and engineering for over 4 decades. SERB was created as a statutory body by the Parliament under the SERB act of 2008 to provide an impetus to research through expeditious decisions, enhanced responsiveness and flexible funding as per practice followed by global research funding agencies.

The SERB Board, Chaired by Secretary, DST, is comprised of 17 members including 7 Secretaries to the Government of India.

### The SERB

- Serves as premier agency for planning, promoting and funding internationally competitive research in emerging areas;
- Identifies major inter-disciplinary research areas, and individuals, groups or institutions and funds them for research;
- Assists in setting up infrastructure and environment for scientific pursuit;
- Enables synergy between academic institutions, research and development laboratories and industry for research in science and engineering; and
- Evolves a management system to speedily provide research funds, including monitoring and evaluation by adopting management practices.

SERB is trying to raise the quality and footprint of Indian science and engineering to the highest global levels in an accelerated mode, through calibrated, competitive support of R&D under various schemes.

### I. NEW INITIATIVES

The Board in the reporting period has taken significant decisions and implemented many new initiatives for the cause of furthering extramural R&D in S&T, some of these are:

- a) **Vision, Mission & Goals:** To better focus its energies and resources on realization of its mandate, SERB defined and adopted its vision, mission and goals statements during the year under review.
- b) **Uchhatar Avishkar Yojana (UAY)**

The UAY has been launched by the MHRD with a view to promote innovation of a higher order

that directly impacts the need of the industries, thereby improving the competitive edge of Indian manufacturing capabilities. While MHRD funds 50% of the project cost, industry and other participating Ministries share the balance project cost (25% each). The projects funded under this scheme will be named as “UAY SERB” projects. Over 50 proposals are under reviewing process after clearance from MHRD.

c) **Visiting Advance Joint Research (VAJRA)**

Another new program named Visiting Advanced Joint Research (VAJRA) Faculty announced by the Honourable Prime Minister was launched to bring a strong international connect to the Research and Development (R&D) ecosystem of India. The scheme offers adjunct / visiting faculty positions to overseas scientist / faculty / R&D professionals including Non-resident Indians (NRI) & Overseas Citizen of India (OCI) to undertake quality collaborative research in public-funded academic and research institutions of India. A total of 229 eligible applications from 39 countries were received. SERB, through its Peer Review mechanism involving two levels of Committees, a Selection Committee and an Apex Committee, has selected 43 foreign faculties including NRIs from various institutions spread across 13 countries. Some of the foreign faculties are going to join the Indian Institutions in the current year itself.

d) **MATRICS (Mathematical Research Impact-Centric Support)**

This scheme is aimed to provide fixed grant support to active researchers with good credentials in Mathematical Sciences. The main attribute of this scheme would be the submission of a simple one-page mathematical proposal along with curriculum vitae. The funding provided would cater to the specific needs of Mathematical Sciences research. About 1056 projects were received under this scheme of which 188 projects were recommended for support.

e) **Abdul Kalam Technology Innovation National Fellowship**

The Board has approved the scheme Abdul Kalam Technology Innovation National Fellowship & as well as will be initiated. The aim of the scheme is to incorporate performance based evaluation w.r.t the effectiveness of the scheme, at the inception stage itself. The fellowship amount is Rs. 25,000/- per month, research grant of Rs. 15 lakhs per annum, overhead of Rs.01 lakh for 5 years for 10 fellowships per year at a total cost of Rs.9.5 crore. The scheme was formally launched and 3 scientists were awarded the fellowship during the year.

f) **J C Bose, SERB Distinguished & Year of Science Chair Professorship:**

J C Bose Fellowship is instituted to recognize active scientists for their outstanding performance. Whereas the SERB Distinguished Fellowship is to cater to the eminent superannuated scientists who do not hold any administrative roles and functions but are active and performing, the YoS Chair Professorships are to acknowledge the outstanding contribution of scientists and academicians to the cause of Indian science, in the areas of STEM. These Professors are regarded as benchmark for stature, value and eminence in the international area. The board decided to work out

a mechanism to regulate the number of JC Bose Fellows at a given point in time and develop a dynamic criterion to measure the performance of the fellows so that parameters so developed can be taken as performance index for taking decision while seeking extension by the fellows. The other two fellowships were revised upward, considering the need of the times.

g) **Promoting International Linkages in existing schemes:**

Having received several requests from the scientific community to open up the scheme for various categories of researchers such as Non-Resident Indians (NRI), Person of Indian Origin (PIO), Overseas Citizen of India (OCI), the board has opened up SERB schemes/programs such as EMR, ECRA, HRHR, IRRD, IRHPA etc. to scientists regardless of nationality to apply and compete for grants. However, this will not be applicable to fellowship such as JC Bose, Ramanujan, N PDF etc.

h) **Utilization of Social Media:**

The organization has recently opened a Twitter (@serbonline), LinkedIn and Facebook accounts for wider dissemination of new schemes as well as to expand the scope of utilization of outcome of the R&D projects by public at large.

## II. FUTURE INITIATIVES

Some of the other schemes that have already been approved by the board and are being implemented and launched soon are as follows:

a) **Accelerate Vigyan**

The objective of this scheme is to have a systems approach, that can push high-end scientific research and prepare scientific manpower capable enough to venture into research careers.

This programme has been conceived by SERB on the recommendation of Group of Secretaries (SGO-8) to give a boost to science. The programme aims to (1) Consolidate the existing training related programs and activities in the country to provide single platform for access for the ease of students as well as other stakeholders and (2) organise and support of the High-End Workshops and Research Internships by SERB during next five years for dedicated capacity building in selected areas / disciplines.

b) **TARE (Teachers Associateship for Research Excellence)**

This is a scheme for bringing out latent talent of researchers working in State Universities, Colleges and Academic Institutions in Private Sector. The aim is to facilitate mobility of faculty members working in a regular capacity in State Universities/ Colleges/ Academic Institutions in private sectors to work in established public funded institutions such as IITs, IISc, IISERS, National Labs etc. located nearer to the institution where the faculty member is working. Provision of fellowship amount of Rs. 5000 pm, contingency grants of Rs. 5 lakhs per annum, and overhead



for a period of 3 years has been catered. A total of 500 such awards per annum would be taken into consideration.

c) **SERB Research Associates**

SERB approved the fellowships will be called “SERB RESEARCH ASSOCIATES” as Post-Doctoral Fellowship for INSPIRE Faculty Awardees and Ramanujan Fellows with the fellowship amount of Rs. 60,000/- pm. The main intent behind the inclusion of INSPIRE Faculty / Ramanujan Fellows schemes is to attract talented researchers to pursue independent science careers, and the host institutes are actively encouraged to absorb the awardees in a regular position, but for various factors some of them could not be able to absorb in regular position. Therefore, there is a need for providing breathing period for the fellows to get regular position.

d) **DIA (Distinguished Investigator Award)**

To award performance based research grant with honorarium to PIs who have excelled in existing SERB or DST projects but have not received any other recognition like Bhatnagar Fellowships, JC Bose Fellowships, etc, the board has approved a onetime career award known as Distinguished Investigator Award (DIA), that grants an additional project sanction to the perspective Project Investigator as well as monthly honorarium.

e) **Development of Management Information System and Science and Engineering Indicators**

A Management Information Systems and Science and Engineering Indicators system is being developed with the aim to quantitatively measure the performance of various Schemes/ Programmes for providing clear performance parameters, outputs, detailed programme of work, qualitative improvement in output along with commensurate input requirement; output target forming the basis of budgetary support.

f) **OVDF (Overseas Visiting Doctoral Fellowship)**

The Board has approved the launch of a Scheme titled ‘Overseas Visiting Doctoral Fellowship (OVDF)’. The Scheme offers opportunities for PhD students admitted in the Indian institutions for gaining exposure and training in overseas universities / institutions of repute and areas of importance to country for period up to 12 months (extendable up-to a maximum of six months on case-to-case basis, based on performance evaluation) during their doctoral research. The selected fellows will be paid a monthly fellowship amount equivalent to US \$ 2000, one-time Contingency / Preparatory allowances of Rs. 60,000/- to cover visa fee, airport transfer charges, medical insurance etc. The selected fellows will also be provided shortest route economy class air fare from their place of work in India to the place of the host institute and back. One additional to and fro travel cost would also be provided to the fellow, if the period of stay is one year or more. One visit, each by the Indian supervisor to the Overseas Institution where the student is working and overseas faculty to the host Indian Institution of the student will be supported during the tenure of the fellowship.

### III. NEW MEGA PROJECTS

The board approved the following two mega proposals as recommended by the Empowered Committee, for implementation: -

- a) ‘Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructures’ by Prof. Manindra Agarwal, IIT Kanpur. The objective of the project is to become an internationally renowned and nationally the most important centre for research, education, public research and national service for securing and defending our national critical infrastructure from cybre attacks and electronic warfare, and the centre to create next generation work force in cyber security / defence.
- b) ‘Investigation of orientation effects and shell-selectivity in molecular fragmentation under slow highly charged ion impact’ by Prof. Bapat, IISER Pune. One of the major objective of the project is to develop a facility for studying collisions between slow, highly charged ions and molecules in a kinematic-ally complete manner.

### IV. INTERNATIONAL LINKAGES & NATIONAL COLLABORATIONS

Over the past more than six decades, certain events have influenced international scientific and engineering R&D cooperation, throwing up new challenges and concerns in their wake. These include, but are not restricted to, capacity building, sustainability, data management, mega science cooperation, ethics, conduct of science, human rights and multilateral institutional reforms. Recognising this, SERB has been making constant efforts to build peer networks through its pillar “Building Research Networks (BRN)”. Some of the international linkages are:

#### 1. Overseas Doctoral Fellowship:

The Board continued the Fellowship Scheme along the lines of the Memorandum of Understanding (MoU) which the Board had entered with select Overseas Universities to undertake doctoral research by Indian students in those institutions. Five students in Cambridge University and one in Rice University have been selected for doctoral research.

#### 2. Overseas Postdoctoral Fellowship

Overseas Postdoctoral Fellowship Programme that the Board had initiated in the past to build national capacity in frontier areas of Science which are of interest to India was continued in the current year also. Indo-US Science and Technology Forum (IUSSTF) has made a separate call for US specific institutions. 50 researchers have been offered fellowship to pursue their postdoctoral research in various countries under renowned guides. Another 50 researchers have been selected to US Institutions by IUSSTF.

#### 3. SERB Newton - Bhabha International Fellowships

A MoU had been signed between The Royal Society, United Kingdom and SERB to institute

15 Newton - Bhabha International Fellowships per year to the Indian research community to undertake postdoctoral level research covering fields of Science, Technology, Engineering and Mathematics (STEM) in U.K for a period of two years. 15 students have been selected for the fellowship in the reporting period.

#### 4. European Commission (EU) SERB Research Partnership

The Board approved an Implementing Arrangement (IA) between the European Commission (EU) and SERB to provide opportunities for Indian early career researchers and engineers [Early Career Research Awardees (ECRA) / National Postdoctoral Fellows (N-PDF)] to pursue research collaboration with European scientists who are supported through the EU-funded European Research Council (ERC) grants. IA was signed by Dr. Rajiv Sharma, Secretary, SERB and Ambassador Tomasz Kozlowski of the European Commission on 6 October, 2017, and exchanged it in the presence of Hon'ble Prime Minister Shri Narendra Modi, Mr Jean-Claude Juncker, the President of the European Commission, and Mr Donald Tusk, the President of the European Council, during the 14<sup>th</sup> EU-India Summit in New Delhi.



Signing of MoU between SERB and EU

Some of the national collaborations of SERB are as follows:

#### 5. Cell Tower and mobile radiation programme

A joint initiative has been launched with Department of Telecommunication in 2013 to study possible impact of EMF radiation exposure from mobile towers and handsets in the non-ionizing band (300MHZ to 3 GHZ) on life. i.e. Humans, Living Organisms, Flora & Fauna and Environment and 19 projects were funded in the area of sleep disorders, neuro cognitive functions, prenatal and postnatal effects, psychosocial implications, biological correlations, DNA damage and repair, ENT functions, nano composite absorbers, yoga intervention and brain hemodynamics, effects of semen parameters and reproductive systems etc.

## 6. Food Processing Scheme

Ministry of Food Processing Industries (MFPI) extends financial assistance as grant-in-aid to various institutions/universities, Public funded organizations and recognized R&D laboratories both in public and private sector, to promote and undertake demand driven R&D work in the field of Food Processing Sector for product and process development, design and development of equipment, improved storage, shelf-life, packaging etc. 21 supported projects are in on-going stage. A good number of research publications have been resulted through projects supported under this scheme. The research outcome of one of the supported project is in Development of Technology that enables distribution and marketing of processed pork products by storing the products at room temperature. This obviates the requirement of cold storage. Providing refrigeration facility in remote hilly areas of the NER is a challenge due to cost involved and non-availability of uninterrupted power supply.



Retort processed shelf stable ready-to-eat *mix veg pork curry* pouches and Retort processed shelf stable ready-to-eat *mix veg pork curry* pouches with secondary packaging

## V. Review of Intensification of Research in High Priority Areas (IRHPA):

Recognizing the need to facilitate increased Public Private Partnerships, the SERB has a scheme that provides an opportunity for collaborative research between academic institutions and industry. This scheme aims to bridge the gap between public funded research and industrial R&D by setting up of core groups, centers of excellence and national facilities in emerging areas. The need for focusing the scheme to encourage the inter-disciplinary research was observed and the board identified few areas like Cyber Physical Systems, Low energy, low carbon emission manufacturing of cement and bricks, Value addition processing of raw material such as sea weed, Anti-microbial coating, Antibiotic resistance and Glass Industry specific research, in which new projects will be developed and supported.

## VI. Few Research Highlights

The Board funded a large number of projects during last few years, the outcome of few of them representing various major programmes and schemes like EMR, ECRA, IRHPA, etc. in the five basic disciplines Chemical Sciences, Earth and Atmospheric Sciences, Engineering Sciences, Life Sciences and Physical & Mathematical Sciences are as given below: -



## 1. Earth and Atmospheric Sciences:

***Stratosphere Troposphere (ST) Wind Profiler Radars at Cochin, Nainital and Kolkata:*** The ST Radars have been planned and supported at three locations. These radars have a variety of applications in the study of:

- Monsoon characteristics and variability
- Heavy rainfall events, severe droughts, landslides and floods
- Thunderstorm, Lightning, Scorching Winds and Heat Burst etc.
- Sea-level Rise, Coastal Erosion, Monsoon surges etc.
- Monsoonal climate change
- Agriculture, Plantation, Crop yields, Hydro-Electrical Power Generation

The Cochin University of Science and Technology (CUSAT) has installed the most sophisticated and indigenously developed Stratosphere-Troposphere (ST) radar being operated at 205 MHz frequency. Perhaps being the first radar in the World operating at this frequency, it is also the first wind profiler radar in the near equatorial site set up primarily to study the characteristics of Indian summer monsoon right at its Gateway at Cochin. The Radar has been positioned in the campus of Advanced Centre for Atmospheric Radar Research (ACARR) under CUSAT. The ST radar bears 619 three element Yagi-Uda antennae capable of probing atmosphere from 315 m to 20 km. The technical aspects and initial results of the prototype Radar were published in peer reviewed scientific journals and a user workshop was organised for the scientific community to inculcate interest in the new arena of R&D. Scientific validation under different environmental condition is in progress.



The 619-element antenna arrangement of ST radar at CUSAT



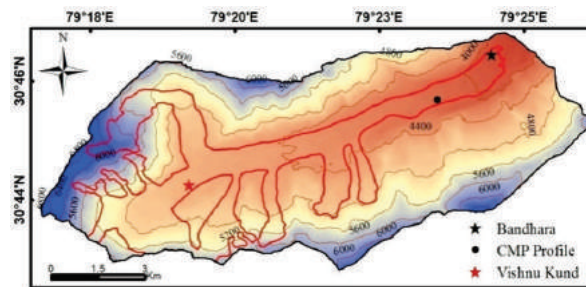
ASTRAD antenna array on the roof-top of the ASTRAD building with recently installed clutter fence along the periphery of the antenna array.



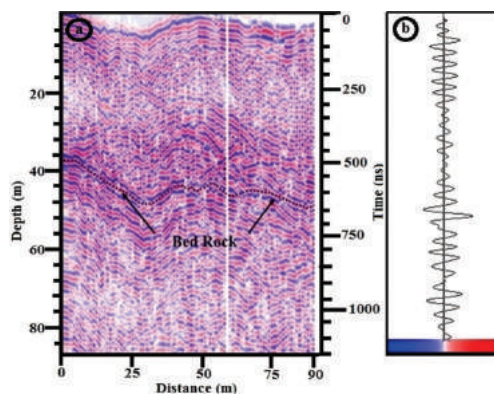
ARIES ST Radar (ASTRAD) Project at Nainital is also in the final stages of modification and system is likely to be functional. Another facility for geophysical sensitive Tropical to Sub-Tropical Transition Region Studies with ST Radar Facilities is being established at Calcutta University.

**Estimation of ice thickness and surface velocity using Ground Penetrating Radar (GPR) and Differential Global Positioning System (DGPS) on Satopanth Glacier**

The project is funded by SERB to Estimate ice thickness using Ground Penetrating Radar at selected sections of the Satopanth glacier, to measure surface velocity of Satopanth glacier in a dense stake network in ablation zone using Differential Global Positioning System and based on the glacier depth and surface velocities, a model is developed to compute the bed rock profile and subsurface ice flow in order to understand the coupled debris-ice dynamics of Satopanth glacier. Ice thickness of Satopanth glacier was estimated at two different locations (i.e. Bandhara & Vishnu Kund) using GPR. Thickness at Bandhara and Vishnu Kund are estimated to be ~39 to 50 m and 98 to 112 m respectively. Surface velocity was measured for ablation season from May to October, 2014-16. The average surface velocity in 20 m/y was measured in 2014. Using the ice thickness from GPR measurements at two locations and their corresponding surface velocity data, flow parameters (deformation and slip) were derived. From these flow parameters and surface velocities of other 60 stakes, ice thickness was estimated by mathematical modelling using Shallow Ice Approximation. The average ice thickness and volume of the studied area were estimated to be 108 m and 0.85 cubic km respectively.



**Bandhara Profile**



Ice thickness-  $38.5 \pm 3.5$  m to  $49.5 \pm 3.5$  m

**Vishnu Kund Profile**

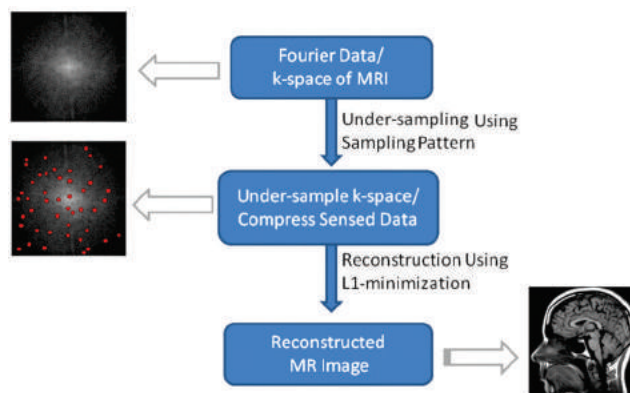
## 2. Engineering Sciences:

The field of Engineering Sciences continue to achieve a decent balance between productivity and excellence in exciting frontline areas, involving quality fundamental research. Some of the highlights of this discipline are in the succeeding paragraphs.

**Addressing the Twin Challenges of Alternate Energy and Environmental Protection at NCCRD (IIT Madras):** To predicate on effective utilization of combustion as a means of thermo-chemical energy conversion in India, one of the modern and emerging economy, and address the twin challenges, SERB established the National Centre for Combustion Research & Development (NCCRD) at the Indian Institute of Technology Madras and Indian Institute of Science, Bengaluru. This is the largest grouping of academic combustion researchers globally with the research interests in three major application sectors - automotive, thermal power, and aerospace propulsion, besides fire research and microgravity combustion to minor extents. The NCCRD pursues key innovative R&D in various fields including gasoline direct injection (GDI), flame stabilization, lowering emissions and mitigating combustion instability in gas turbines and improved fuel-air mixing in supersonic combustors. One of the major achievement at this combustion center is high-ash coal gasification for electricity generation, and methanol or urea production. Highest levels of cold gas and carbon conversion efficiencies are reported for the first time in the world with high levels of ash content in the coal through optimized air and steam gasification in a bubbling fluidized bed.

**Compressed Sensing MRI in Engineering Sciences:** Few of the highlights are:

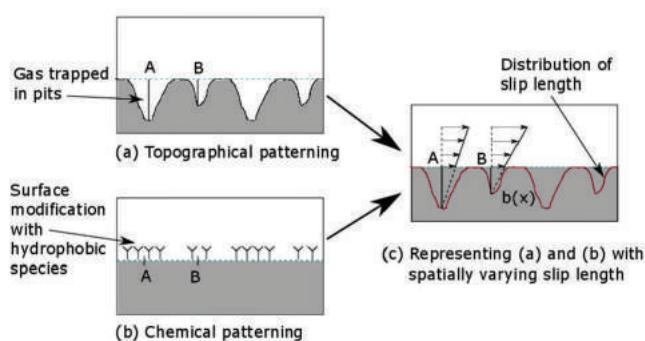
- ❖ An efficient variable density sampling pattern for Compressed Sensing MRI is introduced.
- ❖ An interpolation scheme for compressed sensing based 2D multi-slice MR image reconstruction is developed.
- ❖ A state-of-the-art compressed sensing magnetic resonance imaging (CS-MRI) reconstruction model to include a structural sparsity based wavelet tree regularization sparsity inducing term for further improvement of the CS based image reconstruction quality.



**Block diagram representation of proposed compressed sensing magnetic resonance imaging (CSMRI) reconstruction**

- ❖ A weighted TV-L1-L2 model based MR image reconstruction technique using compressed sensing.

- ❖ A 1-D/2-D FFT hardware implementation using the pipeline CORDIC algorithm on the embedded FPGA development board for obtaining complex k-space data from MR images. An architecture for pipeline implementation of the orthogonal matching pursuit (OMP) algorithm.
- ❖ The promising technology of nano-fluidic diodes through nano-channel electrostatic models that take the first time, the interplay of formation of fixed surface on a solid surface and redistribution of mobile charges in the interfacing confined electrolyte.
- ❖ A comprehensive body of theoretical, semi-analytical and numerical results from different limiting viewpoints as well as intermediate value of parameters for effects and interplay of spatial in-homogeneities in surface charge and surface slip.



#### Origin of patterns in slip length ( $b(x)$ ) due to topographical or chemical surface modification

#### Development of Stirling type, three stage, high frequency Pulse Tube Cryocooler:

Thermally Coupled Three Stage Pulse Tube Cryo-cooler (PTC) is designed and developed at IIT Bombay, which can attain lowest temperature of 19.61 K at the third stage. Except compressor all the other parts of the system are manufactured in India. The application Potential of the developed cryo-cooler are as follows:

- Storage of Cryogenic fuels and cryogens for space applications.
- To increase signal to noise ratio in the detectors using Very Long Wave Length Infrared Sensors (15-1000  $\mu\text{m}$ ) for military sensing systems by cooling it to 20 K.
- Superconducting Electronics and Communication Transmission Apparatus.
- Areas like space, medical, superconducting devices, Super conducting Quantum Interference Device (SQUID) and fundamental physics research.

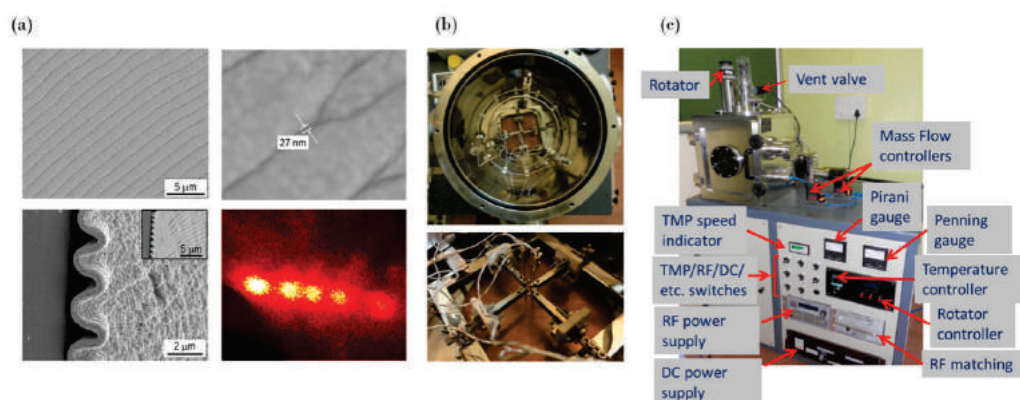
**Research and Development in Precision and Conservation Farming:** Systematic Research & Development efforts have been made to enhance agricultural productivity through development of farm machinery in selected areas to bridge the existing mechanization gaps with respect to international scenario and to facilitate precision & conservation farming. Some of the key technologies developed are:

- Pneumatic Precision Planter for Vegetables for direct seeding of small, irregular shaped vegetable seeds leading to timeliness in sowing, input cost saving, and reduction in total production cost.
- Development of electrostatic nozzle system along with High voltage generation module for charging of liquid sprays in air-assisted spraying system.
- Inter-row rotary Cultivator for removing the weeds and shallow tilling in the inter-row space in the wide-row crops like sugarcane, cotton, soybean, maize and pulses.
- Cotton picker head development for mechanical picking of cotton and it will help Indian Farm Machinery Manufacturers to develop a tractor-driven or self-propelled machine for cotton picking.

### Effect of structure & chemistry of hetero-interfaces on thermo-electro-mechanical induced response of micro and nano-structures:

Interrelationship between the interfacial layer and the interfacial sliding and failures in metal-semiconductor system due to a thermo-electro-mechanical stimulus have been studied at IISc Bangalore. Following are the highlights of the outcomes of the investigations undertaken:

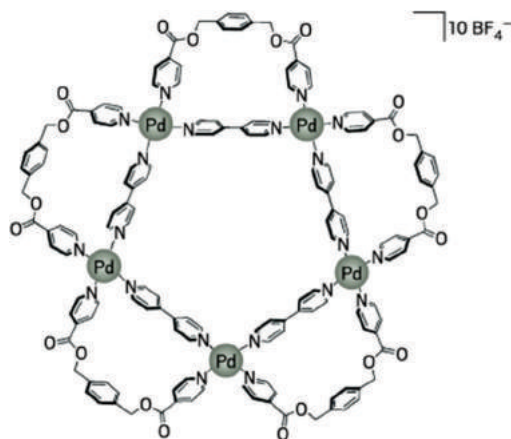
- Discovery of interfacial layer mediated thermo-migration-electro-migration coupling in metal-semiconductor systems.
- Proposal of usage of high conductivity interfacial layer for reduction in electro-migration and electro-migration-thermo-migration coupling induced damages.
- Discovery of role of interfacial layer in formation of unique periodic surface patterns in the electric current induced flow in liquid metals.
- Design and development of a state-of-art experimental setup for studying electro-migration.



(a) (clockwise) (i) SEM micrograph of a ripple pattern of Ga formed on Au fabricated with electric field. (ii) Narrow channels in between the heel regions. Minimum channel width of 27 nm is achieved. (iii) Digital photograph of the diffraction patterns formed by ripple structures. (iv) SEM image of the edge of a ripple pattern; inset picture is showing the zoomed out view of the region. (b) state-of-art setup for performing electro-migration experiment in controlled environment. (c) Indigenously designed and built RF-cum-DC sputtering unit.

### 3. Chemical Sciences

Chemistry is making up a very significant contribution to the R&D sponsored through SERB or otherwise in the country. SERB has supported projects in pioneer research areas of Organic as well as Inorganic & Physical chemistry. In one of the project funded under Inorganic Chemistry segment, an important discovery has been made as shown below.



A new molecular star is born

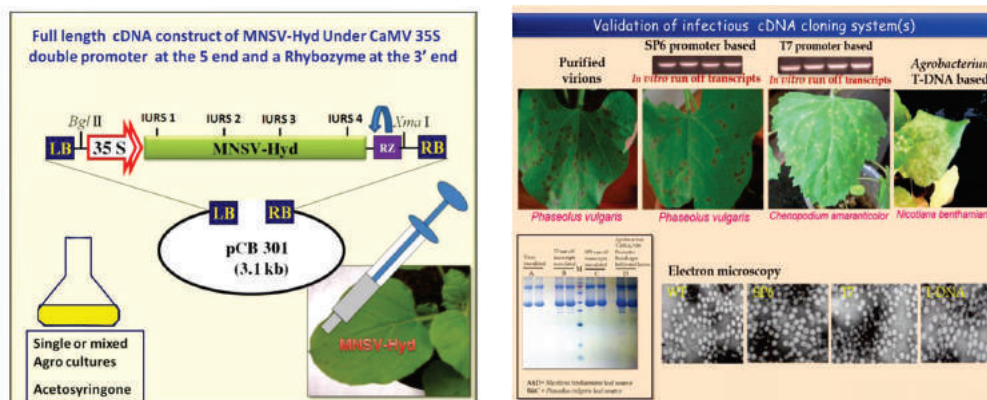
### 4. Life Sciences

Studies in various sub areas of animal sciences, from ecosystem level to molecular level were promoted using multi-pronged actions. SERB school in Insect Biology was organized to foster the sub area. Several new projects were launched in various sub areas of animal sciences such as wildlife studies, bird biology, insect biology, reproduction biology, neurobiology, livestock studies, parasitology, molecular biology, cell biology, immunology, virology, bacteriology.

Some highlights of the results in plant sciences are given below:

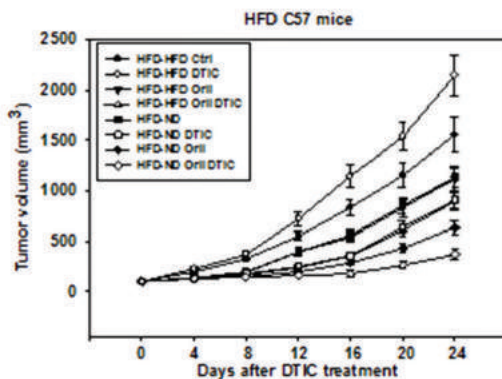
- ❖ Response of Indian wheat cultivars under tropospheric ozone was studied in BHU and suggested foliar injury in the form of chlorotic spots, interveinal chlorosis and necrotic areas in the elevated  $O_3$ . Simultaneously the other important effect of elevated  $O_3$  were reduction of leaf span as the accelerated senescence (% leaf injury) shortens the period of grain filling and reduction in photosynthetic rate. This elevated  $O_3$  exposure has significantly affect the yield of all the studied wheat cultivars.
- ❖ Melon Necrotic Spot Virus-Hyd encoded genes and its replications was studied in plant, using this virus as a model viral system which is spherical, positive strand RNA virus and identified as a Carmo-virus member and designated as Melon Necrotic Spot Virus-Hyd (MNSV-Hyd). It is apparently the first report from the Indian subcontinent. Engineering the full length infectious cDNA clone of this virus and can be used as 'viral tools' to functionally analyze each gene individually and delineates the viral mechanisms in planta directly.





Melon Necrotic Spot Virus-Hyd (MNSV-Hyd) in plant

- ❖ In the study of exploring Heat-stable RuBisCo activase from Wheat or Maize for augmenting the activity of RuBisCo under the heat stress showed that Wheat and Maize varieties comprises thermo-stable Rca (Rubisco activase (RCA) catalyzes the activation of Rubisco in vivo and plays a crucial role in regulating plant growth). Some novel RuBisCo activase genes were cloned from wheat and maize. And developed a thermo-stable RuBisCo activase from wheat through site-directed mutagenesis.

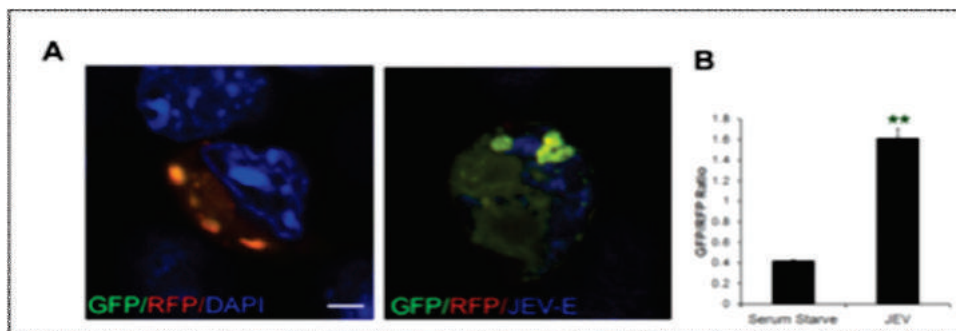


Tumour volume vs Days after DTIC treatment

To promote basic scientific opportunities in the field of the public health, Board continued its R&D activities under Health science program. The prime importance of the program is to understand the cause and subsequent development of an abnormal condition or of a disease(s) that affects our population interms of modern sciences such as molecular biology, genomics, immunology, proteomics, etc. Under communicable disease segment, proposals towards understanding and targeting the drug resistance mechanism of mycobacterium tuberculosis, leishmanial donvanii infection, malarial transmitted disease and HIV/AIDS have supported.

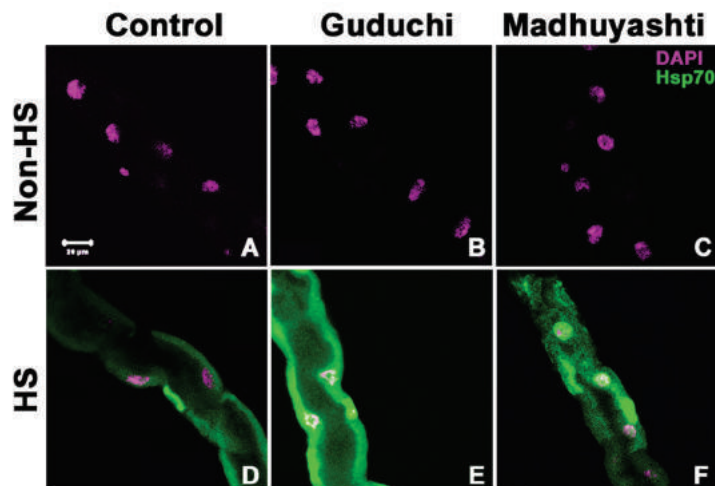
- ❖ Japanese Encephalitis Virus (JEV) is a leading cause of viral encephalitis in Southeast Asia and

India. JEV is highly neuroinvasive with symptoms ranging from mild fever to severe encephalitis and death. This research attempts to characterize how the host autophagy cellular mechanism responds to infection by JEV and its role in pathogenesis.



**Autophagosomes in JEV infected cells show a defect in acidification.** (A) Neuro2a cells transfected with GFP-RFP-LC3 were either serum starved (left) or JEV infected (right). Cells were fixed, stained with anti-JEV E antibody (blue in right panel). (B) Histogram showing quantification of GFP/RFP ratio in LC3 puncta in serum starvation versus JEV infection.

To nurture the research in the field of Ayurveda, India's traditional system of medicine, a special program called Ayurvedic Biology program promotes the application of basic sciences in the investigation of Ayurvedic concepts, procedures and products of Ayurveda in terms of modern sciences such as Molecular Biology, Immunology and Chemistry.

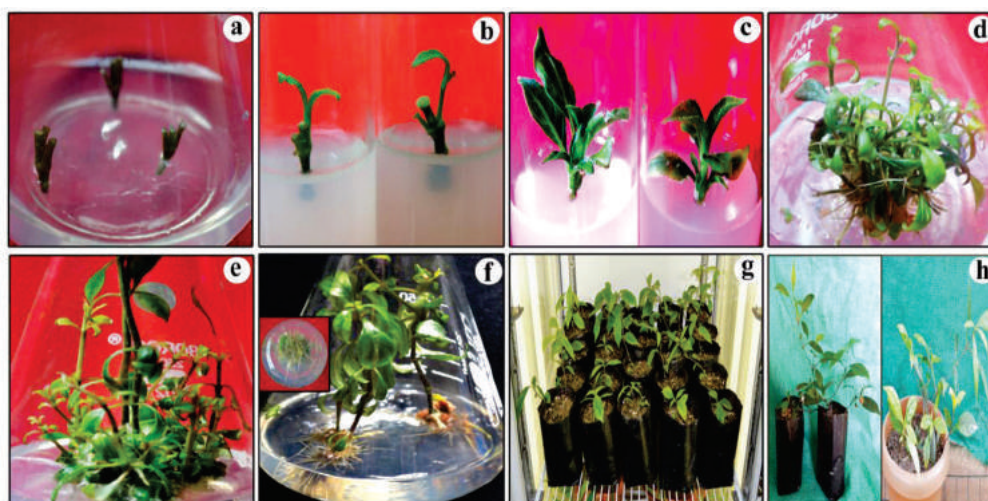


Confocal projection images show Hsp70 (green) and DAPI (pink) fluorescence in Malpighian tubules from third instar larvae reared on Control or Guduchi or Madhuyashti supplemented food as noted on top of each column, and subjected to heat shock 37°C for 1 hour. The scale bar in A(10μm)applies to A-F.

### Micro propagation and Reintroduction of endangered medicinal plant *Nilgiranthus ciliatus* (Nees) Bremek

*Nilgiranthus ciliatus* (Nees.) Bremek (Syn. *Strobilanthes ciliatus* Nees) belongs to Acanthaceae family

is a globally endangered species of evergreen Nilgiri Biosphere reserve ([envis.frlht.org/junclist.php](http://envis.frlht.org/junclist.php)). It is an important medicinal plant used against neurological disorders, sciatica, glandular swellings and oedema. A rapid protocol was developed for *in vitro* propagation of *Nilgirianthus ciliatus* used as a potential alternative to conventional propagation as a possible conservatory measure to protect this ever declining globally endangered medicinal plant. In future, this protocol could serve as the first step in the production of hairy roots, secondary metabolites, synthetic seeds and transgenic plants. Shade house and nursery maintained plants harbour bacterial and fungal endophytes. A total of 1000 *in vitro* micro-propagated plants were developed (Figure 16) and handed over to the foresters of the Tamil Nadu Forest Department Nursery, Muthorai, Ooty for maintenance in the nursery followed by reintroduction in the wild.



Various stages of multiple shoot induction & rooting of *Nilgirianthus ciliatus* from nodal explants.

## 5. Physical and Mathematical Sciences

**The Mathematical Sciences Programme** encourages research in the areas of Mathematics, Statistics, Operations Research and Theoretical Computer Science. The research projects were supported in the areas including Algebra, Functional Analysis, Graph theory, Wavelet Analysis, Fractional Calculus, Differential Equations, Cryptography, Mathematical Modeling, Stochastic Process Modelling, Statistics, Operations Research, etc. During this reporting year CIMPA School costing Rs.13lakh was also supported. About Rs.1.46Cr was spent under EMR-Mathematical Sciences this reporting.

**Physical Science:** The research projects and programmes supported under Physical Sciences covered a wide range of emerging topics. One interaction meeting will be organized in January 2018 at PSN College of Engineering and Technology, Tirunelveli, Tamilnadu on the topic of recent advances in thermal plasma processing which will be beneficial for the scientific community working in this field.

## **VII. Capacity Building**

Capacity building is the bedrock on which success in any human endeavor rests. SERB has been constantly striving hard to design and implement HRD modules that help bring S&T professionals update themselves speed with latest developments in frontier areas of science and technology. Realising this, a several SERB schools organized in various disciplines / sub disciplines A few Brainstorming sessions were also organized by various Program Advisory Committees and Expert Committees of SERB for this purpose.

## **VIII. Awareness and Outreach**

SERB has recently initiated few drives like writing Articles, Advertorials, etc. and organising exhibitions for propagating and bringing awareness about the activities of the organization. SERB actively participated in the exhibitions organized during various scientific events such as India International Science Festival in October 2017 at Chennai.

## TECHNOLOGY DEVELOPMENT BOARD

The Government of India constituted the Technology Development Board (TDB) in September 1996, under the provisions of the Technology Development Board Act, 1995. The mandate of the TDB is to provide financial assistance to the industrial concerns and other agencies attempting development and commercial application of indigenous technology or adapting imported technology for wider domestic application.

The financial assistance from TDB is available in the form of loan or equity; in exceptional cases, it may be grant. The loan assistance is provided up to 50 percent of the approved project cost and carries 5 percent simple rate of interest per annum. In the alternative, TDB may also subscribe by way of equity capital in a company, subject to maximum up to 25 percent of the approved project cost. The financial assistance is provided during the commencement, start-up or growth stages of an industrial concern. The website of TDB is [www.tdb.gov.in](http://www.tdb.gov.in).

During the year 2017-18 (till December, 2017), TDB has signed 6 agreements with a total project cost of Rs.106.13 crore with TDB's contribution of Rs.47.23 crore. The commitment for the FY 2017-18 is about Rs. 250.00 crore. TDB's support covers various sectors such as Defence, Medical Devices, Healthcare, Engineering, Agriculture, Energy & Waste Utilization, Telecommunications and Information Technology etc.

Till December, 2017, TDB has disbursed an amount of Rs.78.22 crore towards on-going & new projects and other schemes. This included Rs. 67.78 crore as loan; Rs.5.15 crore as Grant and Rs. 5.29 crore to VCF for investment.

### **Some highlights are given below:**

TDB till December, 2017 has signed 6 agreements with various industrial concerns for providing financial assistance for commercialization of their indigenously developed product. However, 16 agreements are likely to be signed during the current FY 2017-18. A nationally relevant project is with M/s Grasim Industries, Mumbai for "Setting up a first commercial line for production of Solvent Spun 3<sup>rd</sup> Generation Cellulosic Fibre Lyocell, under the Brand name Birla Excel" at Birla Cellulosic campus at Kharach, District Bharuch, Gujarat. TDB has sanctioned financial assistance of Rs. 250.00 crore biggest ever by the Ministry.

### **Agreements concluded by TDB till December, 2017:**

- 1) TDB executed Agreements (both Grant and Loan) with M/s Mobilexion Technologies Pvt.



Ltd. Trivandrum for providing financial assistance to their project titled ‘Development and Commercialization of Ubimedique Acute Care System (UMACS)’.

- 2) TDB executed an agreement with M/s S3V Vascular Technologies Pvt. Limited, Bangalore for providing financial assistance to their project titled “PTCA Balloon Dilatation Catheter System (Brand name: 3V PAULO)”.
- 3) TDB executed an agreement with M/s Akshaya AgriBiomed Pvt. Ltd., Hyderabad for providing financial assistance to their project titled “Defibrinated Sheep Blood”.
- 4) TDB executed an agreement with M/s Panacea Biotec Ltd., New Delhi for providing financial assistance to their project titled “Development and commercialization of Dengue Tetravalent Vaccine (Live Attenuated, Recombinant, Lyophilized)”.
- 5) TDB executed an agreement with M/s IMCO Alloys Private Limited, Mumbai for providing financial assistance to their project titled “Development and Commercialization of Sintered Carbide Alloys Technology”.
- 6) TDB executed an agreement with M/s Incredible Devices Private Limited, Chandigarh for providing financial assistance to their project titled “Catheter Reprocessing System (CRS)”.

#### Technology Day Function- 2017

The Technology Day 2017 was celebrated on 11<sup>th</sup> May at Vigyan Bhawan, New Delhi. The then President of India, Shri Pranab Mukherjee graced the occasion as the Chief Guest in presence of Hon’ble Union Minister of Science & Technology and Earth Sciences Dr. Harsh Vardhan who presided over the Function. Shri Y. S. Chowdary, Hon’ble Minister of State for Science & Technology and Earth Sciences was the Guest of Honor for the event.



Awards were presented by the Hon’ble President of India under following three categories:

- **National Award – 2017 to an industrial concern who successfully developed & commercialized an indigenous technology** was given to M/s Numaligarh Refinery Limited (NRL) for “Indigenous

Development and commercialization of Wax De-oiling Technology”; jointly in collaboration with CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun; Engineers India Limited (EIL), New Delhi and M/s Numaligarh Refinery Limited.

➤ **Awards for MSME 2017 was given to:**

- (i) M/s Vikarsh Nanotechnology & Alloys Pvt. Ltd. Pune for “Commercializing Commercialization of i) Nano Crystalline Ribbons ii) Amorphous Ribbons.
- (ii) M/s Pluss Advanced Technologies Pvt. Ltd. Gurugram for “Development and commercialization of MiraCradle™, a neonatal cooler for treating birth asphyxia.

**The year 2017-18 witnessed initiation of the National Technology Start-up Award for promising new technology with potential for commercialization.** These Start-up Awards were accorded, one each to:

- (i) M/s Bellatrix Aerospace Pvt. Ltd, Mysore for “Development of Microwave Electrotherma Thruster; an efficient electric propulsion system for satellites”.
- (ii) M/s Padmaseetha Technologies Pvt. Ltd, Chennai for “Development of MCAPD Device”; a ‘Wearable Alternate Kidney’, for CAPD dialysis anytime/anywhere.
- (iii) M/s Nanoclean Global Private Limited, Gurugram for “Development of Nano-respiratory Nasal Filter”; the first ever non-inserted, hypo-allergenic and self-adhering nanofiber based respiratory disposable nasal filters to guard against finest pollutants in the air.

**Product Launch during National Technology Day - 2017:**

Shri Y. S. Chowdary, Hon’ble Minister of State (S&T and ES) commercially launched the product “Electric Vehicle charger” developed by M/s Ampere Vehicles Private Limited, Coimbatore under TDB’s financial assistance, on the Technology Day.

TDB organized an exhibition of TDB projects supported during the year 2016-17 under the title “TDB’s Future Symphony” on the Technology Day. The exhibition was inaugurated by Hon’ble Union Minister for S&T and ES, Dr. Harsh Vardhan and Hon’ble Minister of State for S&T and ES Shri Y. S. Chowdary.



# STRENGTHENING SURVEY AND MAPPING CAPABILITY

## SURVEY OF INDIA

Survey of India, the National Survey and Mapping Organisation of the country, under the Department has the unique responsibility of providing timely, updated, cost effective and accurate Topographical Data Base for expeditious and integrated development and ensure that all resources contribute their full measure to the progress, prosperity and security of our country now and for generations to come. In this prominent role, the Department ensures that the country's domain is explored and mapped suitably to meet the emerging needs of the user community.

Survey of India is also responsible for Geodetic Control (Horizontal and Vertical), Geodetic & Geophysical surveys, Production of Aeronautical Charts; undertaking specialised surveys for Developmental Projects, demarcation of the external boundaries of India, ensuring their accurate depiction on the maps published in the country and also advice on the demarcation of inter-state boundaries.

### Highlights of activities during 2017-18:

**Updation of National Topographical Database on various Scales:** Survey of India has completed the Updation of Topographical Data on the 1:50,000 scale and 1:25,000 scale as detailed below:

#### 1:50,000 scale

Pre Field Updation using latest satellite imagery (sheets)	Revision Survey (sheets)
15	7

#### 1:25,000 scale

Digitization of 1:25,000 scale maps, QC/ Examination of digital data and OSM preparation completed during the year.

Digitization (sheets)	QC (sheets)	Preparation of OSM (sheets)
144	269	334

<b>Pre Field Updation using latest satellite imagery (sheets)</b>	<b>Revision Survey (sheets)</b>
<b>91</b>	<b>3</b>

**1:250,000 scale**

<b>Updation by using 1:50K components (sheets)</b>	<b>DTDB (sheets)</b>	<b>DCDB (sheets)</b>
13	13	13

**Generation of OSM Hindi version and OSM Regional Language (s) version:** Survey of India has completed Open Series Maps (OSMs) on 1:50,000 Scale English version and are available for use by the users. To fulfill the requirements for Hindi version and regional language (s) version preparation of OSM (Hindi) and OSM (Regional Languages) on 1:50,000 scale is under progress.

<b>OSM English Printed off (sheets)</b>	<b>OSM Hindi Printed off (sheets)</b>
<b>36</b>	<b>23</b>

**State /Guide Maps:**

<b>State Map</b>	<b>Guide Map</b>	<b>Other Maps</b>
Andhra Pradesh 2 <sup>nd</sup> Edn.	Tirumala Tirupati	Political map of India 7 <sup>th</sup> Edn. English and 5 <sup>th</sup> Edn. Hindi Railway map of India 26 <sup>th</sup> Edn. Eng. and 25 <sup>th</sup> Edn.Hindi

**Providing OSM DTDB Data for Web Services like WMS/WFS:** Survey of India has been providing Web Map Service (WMS) based on 1:50K OSMs through SoI portal "surveykshan.gov.in" for the open viewing as mandated by the NDSAP-2012. Following achievements have been made in 2017-18:

<b>No. of sheets uploaded on Web Portal (WMS)</b>	<b>No. of sheets uploaded on Web Portal (WFS)</b>	<b>F clean of OSM DTDB data for WFS (sheets)</b>
4483	4159	994

**Specialized Survey:** Survey of India is responsible for defining the horizontal and vertical frame work for entire country, maintains a series of Tidal Observatories located all along Indian Coast and Islands and also has the responsibility to Provide and Maintain the Gravimetric and Geomagnetic control network of country.

Geodetic & Research Branch of Survey of India carried out the following activities during the year.

- Publication of Geomagnetic Bulletin, 2015 and Magnetic Declination Chart Epoch 2015.0 have been completed.
- Work of Geomagnetic Bulletin, 2016 is under progress.

- c) Indian Tide Table 2018 and Hugli River Tide Table 2018 have been printed off.
- d) Geo-magnetic observations are continued at Digital Geomagnetic Observatory, Sabhawala Dehradun for determination of Horizontal Force (HF), Vertical Force and Declination (D). These observations are helpful to monitor and record different components of Geomagnetic variations and are necessary to control the baseline values of the Magnetogram.
- e) Processing for tidal prediction for 76 Primary ports (30 Indian & 14 foreign ports). Tidal Predictions one year in advance in the form of India Tide Table and Hugli River Tide Table for safe navigation.
- f) 32 days Tidal observation in Andaman & Nicobar Islands 5 ports and 30 lin. km. HP/Secondary levelling.
- g) Provision of Monthly and Annual Mean Sea Level to Permanent Services for Mean Sea Level (PSMSL), UK as an international commitment.
- h) Non-harmonic tide levels for Harbour / Port developmental activities.
- i) Provision of tidal data to Early Tsunami Warning Centre, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad.
- j) Provision of tidal data to Bhaba Atomic Research Centre (BARC), Mumbai.

**International Boundary Demarcation/Pillar Re-location or Relay Survey Works:** Survey of India has been given the responsibility by the Ministry of External Affairs for all surveying works i.e. boundary demarcation, relocation of boundary pillars of International boundary with Nepal, Bhutan, Bangladesh, Myanmar, Pakistan and China. SoI also advises State Govts. and Govt. of India on matters of International boundary and States/ UTs boundaries and carries out surveys as and when required to resolve the disputes as Extra-Departmental jobs.

All Surveying tasks associated with the International Boundary like Joint Inspection/Maintenance / Relocation of missing / damaged boundary pillars etc. along International Border as given below are going to be carried out from Dec, 2017 onwards:

- Joint Inspection/Maintenance of boundary pillars along Indo – Bhutan boundary.
- Joint Inspection/Maintenance of boundary pillars along Indo – Myanmar boundary.
- Joint survey construction / relocation of missing pillars along Indo - Pak Boundary (Punjab and Rajasthan Sector).
- Joint survey construction / relocation of missing pillars and coordinating by GPS along Indo – Nepal boundary.

**Mapping and Delineation of Hazard Line:** The Ministry of Environment and Forest (MoEF) had



initiated a project titled “**Integrated Coastal Zone Management (ICZM) Project**”. Survey of India has to generate a 0.5 meter elevation contour map on 1:10,000 scale as base map to delineate the Hazard Line for the entire mainland coast of India upto the maximum width of 7 Km from shore line on the landward side.

Work up to Feature Extraction has been completed for Zones i.e.(1,2,3&4) work of the remaining Zones 5,6&7 are at different stages. Work has been carried out by the Eight coastal GDCs of Survey of India i.e. Gujarat, Maharashtra, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Orissa and West Bengal are engaged in various ICZM activities viz. Field control, Quality control works, Data handling etc.

**Coal Mine Project:** This project aims to generate updated Topographical Maps of Major Indian Coal fields (27 coal fields / 5246 sheets) on 1:5000 scale with contour interval 2 meters in plain and 3-5 meters in case of hilly terrain in GIS Digital format based on Digital Photogrammetric Techniques using high resolution aerial photographs and adequate ground verification. The following stages of works has been carried out as part of this project by SOI.

All activities covering various work stages are being carried out continuously by the 07 GDCs of Survey of India i.e. Chhattisgarh, Orissa, Madhya Pradesh, Jharkhand, Maharashtra & Goa, West Bengal and Meghalaya & Arunachal Pradesh GDCs and some part of work i.e. 2D & 3D Feature Extraction are distributed to other GDC so that project work can be completed quickly.

Present status of the work is as under:

**Primary Control:**

<b>12 hours GPS observation (points)</b>	<b>DT levelling (Lin.Km)</b>
<b>Completed</b>	<b>Completed</b>

**Block Control point:**

<b>2 Hours GPS observation (points)</b>	<b>ST levelling (Lin.Km)</b>
<b>Completed</b>	<b>Completed</b>

**Detail Survey:**

<b>2D Feature Extraction (Sheets)</b>	<b>3D Feature Extraction (Sheets)</b>	<b>Ground Verification (Sheets)</b>	<b>Post Field Updation (Sheets)</b>
3832	3356	1840	1013

**Map the Neighbourhood in Uttarakhand (MANU) Project:** It aims to prepare DEM (Digital Elevation Model) and map on 1:10K scale for disaster affected area of Uttarakhand for macro and micro level planning and post disaster scientific application by other agencies involved in MANU project.

Data Acquisition work in part of the area by using Modern Techniques of Air- Borne LiDAR and digital Aerial Photography of Disaster affected Areas of “**Char Dham and Pindar Valley**” has been already completed and the following work for carried out the Quality Control & further processing to generate deliverables has been completed.

- Work completed and Raw data has been accepted.
- Final acceptance test for DEM is under progress.
- Final acceptance test for Map feature is under progress.

**National Hydrology Project (NHP):** Survey of India (SoI) has been identified as one of the Central Implementation Agency in the scheme of National Hydrology Project to generate, prepare and provide various types of Geo-spatial datasets i.e. for mapping/ preparing the Digital Elevation Model (DEM) of 0.5m, 5m & 10 m for River Basin areas (plain), up to 5 km on both the sides of river and GIS ready data of SOI Topo sheets on 1: 25 K scale under the **Component B:** Water Resources Information System and **Component D:** Institutions Capacity Enhancement.

**Control Survey for Hydro Electric project:** This activity provides Control Points for different Hydro Electric Power Projects (HE) as per indentors requirement.

Control points (Horizontal& Vertical) has been provided by GPS observation and Levelling.

- (i) Kholongchhu HE Project (Bhutan)
- (ii) Sela Urthing Project
- (iii) Rinand Dam Project
- (iv) Lakhwar HE Project
- (v) Luhri HE Project stage I&II
- (vi) Sunni Dam Project



Inspection of Detachments working for Kholongchhu HE Project

**Antarctica Expedition:** Survey of India started participation in Indian Antarctica Research Programme from 10<sup>th</sup> Expedition, since then a network of Ground Control Points and Large scale mapping has been carried out during all Expedition.



**GPS observation in Antarctica by Survey of India Team**

Survey of India Team completed detail survey of 3.06 Sq. Km. on scale 1:5,000 with contour Interval of 2m with GPS observation on 31 stations at Larseman Hills and 2.4 Sq. Km. on scale 1:10,000 with contour Interval 5m with GPS observation on 27 stations at SchimacherOsis during 36<sup>th</sup> Indian Scientific Expedition.

A Team from Survey of India departed for 37<sup>th</sup> Indian Scientific Expedition to Antarctica. The team will carry out Large Scale mapping at Sciirmachar Oasis & Larsemann Hill and study of Inter plate movement between Indian Plate and Antarctica Plate during the Expedition.

**R&D Project on Mapping and Impact Assessment on Land subsidence in North India:** Levelling observations for 1<sup>st</sup> epoch has been completed at Delhi and Chandigarh. 2<sup>nd</sup> epoch work is to be taken up soon.

**R&D manpower trained/generated:** Indian Institute of Surveying & Mapping (IISM), imparts training to the Officers and Staff of Survey of India and other Government Organisations, Private Individuals and Scholars from various Afro-Asian countries. IISM, Hyderabad conducts M.Tech. (Geomatics) and M.sc (Geospatial Science) post graduate programme of two years duration in collaboration with Jawaharlal Nehru Technological University (JNTU), Hyderabad. 217 Departmental, 36 Extra-Departmental, 2 Foreign and 51 Private students have completed training up to November, 2017. Further 76 Departmental, 32 Extra Departmental from Centre/State Government organizations and 1 Private student, are under training at IISM, Hyderabad.

**Launch of Nakshe web portal:** A new web portal “Nakshe” was launched by the Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan in New Delhi on 10<sup>th</sup> April, 2017 on the occasion of 250 anniversary of Survey of India.

Topographical maps or Open Series Maps (OSM) containing natural and man made geographical features including terrain or topography are prepared by the SoI since its inception in 1767 and is in conformity with the National Map Policy -2005. These OSM maps have been made available for free download from “Nakshe” web portal in pdf format on 1:50,000 scale through Aadhar enabled user authentication process, in line with Digital India programme of the Government of India.

**Special Survey for Indian Air Force:**

Survey of India also prepared IAF-OGM, IAF-PGM, IAF-JGM, Landing Approach Chart (LAC), IAF-LNC etc. and Carried out obstruction Survey Work for Indian Air Force.

Survey of India has completed the following maps and Data for IAF during the Year :

IAF-OGM (sheets)	IAF-PGM (sheets)	IAF-JGM (sheets)	IAF-LNC (parts)	Landing Approach Charts (Charts)
16	32	1	8	2

Verification of Landing charts on 1:50k Scale for 50 Airfields including Obstruction Survey for 30 NM from ARP for Indian Air Force.

**Special Survey for ISRO:**

Planimetric and Height control at Mt. Abu (Rajasthan) have been completed while work is to be taken up at Ponmudi (Kerala).

**NATIONAL ATLAS & THEMATIC MAPPING ORGANISATION**

National Atlas and Thematic Mapping Organisation (NATMO) functions under the administrative control of the Union Ministry of Science & Technology (Department of Science & Technology), Government of India.

Thematic maps and atlases compiled by NATMO are the vital inputs for planning at various levels. The maps and atlases prepared by NATMO serve as visible tools to understand the changes and developments taking place in the domains of geo-environmental, political, socio-economic conditions in the country. NATMO’s most popular themes such as physiography, hydrology, climate, administrative, political, socio-economic, agriculture, industry, history, culture, tourism, archaeology etc. serve as the basic tools for a wide range of users including planners, decision makers, researchers and students and the common public.

**Major activities and achievements during the year 2017-18**

**Golden Map Service (GMS):** On the occasion of Golden Jubilee Celebration of NATMO, this project was taken up with the aim to prepare large-scale map of the cities and towns of the country consisting minute level information relevant to the available utilities, communication, and land use. This map is

very much useful for the planners, architects and tourists as well. In the current year following GMS have been completed.

- |               |              |
|---------------|--------------|
| 1. KuluManali | 5. Agartala  |
| 2. Kharagpur  | 6. Jaisalmer |
| 3. Ajmer      | 7. Medinipur |
| 4. Kohima     | 8. Ooty      |

**District Planning Map Series (DPMS):** NATMO has completed maps of 260 districts and published for the users. Digital version of the maps are also going on in the final stage and will be published for the users very soon. However, revision and updation work on account of formation of new districts, are in progress along with the rest project.

DPMS maps completed during this year are-

- |   |                        |
|---|------------------------|
| 1. Godda                                      | 9. Ujjain              |
| 2. Purulia                                    | 10. Nadia              |
| 3. Chamoli                                    | 11. Bolangir           |
| 4. Kollam                                     | 12. Mainpuri           |
| 5. Kollam in Regional language<br>(Malayalam) | 13. Thiruvananthapuram |
| 6. Alappuzha                                  | 14. Bhavnagar          |
| 7. Indore                                     | 15. Betul              |
| 8. Vidisha                                    | 16. Upper Siang        |
|   | 17. Tumkur (Reprinted) |

**National Atlas of India:** National Atlas of India, both in English and in Hindi version, has been appreciated by the users of every corner. It is for the vertical demand of the users, NATMO is still publishing the editions of the Atlas till today and regular updation and revision of the same is going on. Following Atlases were completed during this year:

1. Socio-Economic Atlas (Urdu),
2. Cultural Heritage Atlas, second edition;
3. National School Atlas (Bengali),
4. Secondary School Atlas of Tripura

**Atlas for Visually Impaired (braille map):** 'Atlas for Visually Impaired' has been published depicting



physical and political features of every continent along with special focus on physical, political features of India has been published both in English and Hindi Braille Script. Atlas of West Bengal in Bengali Braille Script, Atlas of Tamil Nadu in Telugu Braille Script has been published. Braille Atlas for other states of the country in concerned regional Braille Script, has been taken up as well.

In addition to this NATMO has for the first time arranged a National level Map Quiz for the Blind Students in collaboration with Indian National Cartographic Association. The quiz competition was conducted at five regions viz., Kolkata, Chandigarh, New Delhi, Vishakapatnam and Hyderabad. The winners were rewarded during the occasion of 37<sup>th</sup> INCA Annual Conference held at Dehra Dun from 1<sup>st</sup> Nov to 3<sup>rd</sup> Nov. 2017 . This programme received wide publicity and many other schools are requesting NATMO to get their students enrolled in such programmes.



National Map Quiz at Vishakhapatnam and New Delhi

**Resource Planning Atlas:** Resource Planning Atlas has been initiated as a new project with the aim to create a sound spatial data on the disposition of various resources that could cater the information inputs for regional/spatial planning at district level. Projects undertaken in this area are: Keonjhar District of Odisha and Churachandpur District of Manipur

**Medical Tourism Maps:** This year NATMO has introduced a new theme map on Medical Tourism. As a pilot study, NATMO has completed the Medical Tourism map of Kolkata. The map is a ready reference for the people visiting the city from different parts of the country or abroad for treatment purposes. These maps provide information on the various facilities available in the Health Care domain for any medical tourist visiting the city.

The project shall be extended to other major cities where there is a large flow of Medical Tourists.

**Maps completed during this year are:** India Tribes; India Administrative Map (Hindi); Jyotirlinga and Shaktipeeth, India; Medical Tourism Map of Kolkata; Water Resources, Southern India Plate.

**Online Maps/Mobile Apps:** NATMO is committed to provide accurate information not only in the form of paper maps but also in web platforms. There is increasing demand for the NATMO maps to

publish in internet for the benefit of the stakeholders. Keeping these things in view, a new attempt has been made to publish the map of Salt Lake with special emphasis on the services of Medical Shops to be made available online as web service and mobile apps service. Benefits of this project are manifold. People with internet facility can locate the medical shops nearby to them, they can get information regarding the availability of the medicines and also about the services like home delivery.

**Training and Development:** NATMO also provides training on Thematic Cartography, Digital Cartography, Photogrammetry, Remote Sensing and GIS, Aerial Photography and Colour Cartography to the officers and staff of various govt. and private departments, university and college teachers, scholars and students of the country. Training courses of NATMO are held in high esteem by scientific departments and organizations all over the country as well as abroad. During this year, NATMO conducted two training courses.

**Infrastructure Development:** During the year, NATMO has almost completed the construction of **Rashtriya Atlas Bhavan** to get a wholly dedicated place for its research activities which will house a complete Digital Laboratory and Printing & Camera Unit.



**Dr. Harsh Vardhan, Hon'ble Union Minister of Science & Technology Inaugurating the Rashtriya Atlas Bhavan (Phase-IV) on 4<sup>th</sup> May, 2017**

### **International Collaboration:**

NATMO is always committed to successful completion of collaborative projects. At international level, for the first time, NATMO has prepared 'India-ASEAN Archaeological Atlas from Satellite Data – Connectivity of Regional Culture' in collaboration with Geo-Informatics & Space Technology Development Agency (GISTDA), the Government of the Kingdom of Thailand. The atlas has been released in Thailand on 3<sup>rd</sup> August 2017.



**Release of India ASEAN Archaeological Atlas by Dr. Anond Snidvongs and Shri Harsh Vardhan Shringla, Indian Ambassador to Thailand**

**Extra Departmental projects :** NATMO has taken up an extra departmental project with Bidhan Chandra KrishiVidyalaya (BCKV), to prepare Soil Nutrient Atlas of 14 districts of West Bengal. The project was aimed to complete in a short span of three months time. NATMO has completed the task very efficiently to the complete satisfaction of BCKV authorities. These atlases were released on the occasion of “National Seminar on Nutrients and Pollutants in soil-plant-animal-human continuum for sustaining soil, food and nutrient security-way forward” held at BCKV, Kalyani. Other extra-departmental services NATMO has given during the current year are -Map of Bushire Province and Iran Province on request of Embassy of Iran; and Mapping for Installation of Community Radio Station of the area around 15km radius of Ramakrishna Mission, Narendrapur, West Bengal.

## CHAPTER 8

## ADMINISTRATION AND FINANCE

The administration and finance divisions of the Department continued to provide support and necessary administrative decisions for smooth functioning of the Department as well as its subordinate offices.

## STAFF POSITION

Department has a total number of 193 Group 'A' and Group 'B' (Gazetted) officers as per the break-up given below:-

Group 'A'	General	SC	ST	OBC	PH	Total
Scientific	89	08	02	03	04	106
Non-Scientific	25	03	02	-	-	30
Group 'B'						
Scientific	07	01	01	01	-	10
Non-Scientific	34	10	01	02	-	47
<b>Grand Total</b>	<b>155</b>	<b>22</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>193</b>

Department has a total number of 257 non-gazetted staff on its rolls as per the break-up given below:-

Group	General	SC	ST	OBC	PH	Total
Group 'B' (Non-Gazetted)	63	09	04	10	03	89
Group 'C'	73	65	09	16	05	168
<b>Grand Total</b>	<b>136</b>	<b>74</b>	<b>13</b>	<b>26</b>	<b>08</b>	<b>257</b>

## PARLIAMENTARY WORK

The Parliament Unit is assigned with the responsibility of handling entire parliamentary works of the Department. It ensures that the parliamentary work pertaining to the Ministry of Science & Technology is accomplished as per the prescribed schedule and procedures. The unit maintains liaison with the Ministry of Parliamentary Affairs, Secretariats of Lok Sabha/ Rajya Sabha, other Ministries/ Departments (including Scientific Departments) with a view to fully discharge the parliamentary obligations of the Ministry of Science & Technology. The Unit also coordinates the visits of the Parliamentary Committees to various scientific institutions which are under the administrative control of this Department.

## IMPLEMENTATION OF OFFICIAL LANGUAGE POLICY

The Department continued to make concerted efforts to promote the use of Hindi in official work and to ensure compliance with the provisions of the Official Language Act, 1963 as amended in 1967 and Rules 1976 framed thereunder as also the various orders/instructions issued by the Department

of Official Language from time to time with a view to ensure proper implementation of the Official Language Policy of the Government.

DST has a full-fledged Hindi Section consisting of a Joint Director (O.L.) assisted by an Assistant Director (O.L.) and other supporting staff which caters to the need of the Department of Science & Technology and also its Subordinate offices/Autonomous Institutions. Besides monitoring the implementation of the Official Language Policy and the Annual Programme, Hindi Section arranges for in-service training of the staff in Hindi Language, Hindi Typewriting and Hindi Stenography. It also undertakes translation of the material received from various Sections/Desks of the Department from English to Hindi and vice-versa.

For promotion of use of Hindi in this Department and to create conducive environment for the officials to work more in Hindi, various programmes are being undertaken:

- All documents coming under Section 3(3) of the official language Act, 1963 like general orders, notification, cabinet note, annual report and any paper which is to be laid in the parliament were issued bilingually in both Hindi and English. Letters received in Hindi were invariably replied to in Hindi.
- The officers of Hindi Section conducted inspections of Subordinate offices / Autonomous Institutions and 8 sections of the department regarding progressive use of Hindi.
- During the year, quarterly meetings of Departmental Official Language Implementation Committee were organized regularly. Likewise, Hindi workshops were organized to encourage the officers / staff of the department to do their maximum work in Hindi.

**Cash Awards and Incentive Schemes:** An incentive scheme to encourage officers and employees to do their maximum official work in Hindi is in vogue in the Ministry. Under the scheme, cash awards are given for doing noting and drafting in Hindi.

**Celebration of Hindi Pakhwara:** Hindi Pakhwara was organized from 11 to 22 September, 2017 in the Ministry of Science and Technology. Various Hindi competitions were organized and the successful participants were given cash awards and certificates.

### **RIGHT TO INFORMATION (RTI)**

A total of 1120 applications and 65 Appeals were received by the Department during the period from 1st April, 2017 to 27th November, 2017. All applications and Appeals are disposed of as per the provisions of RTI Act, 2005.

### **PUBLIC GRIEVANCES**

A total of 1586 public grievances were received by the Department during the period from 1st April, 2017 to 27th November, 2017. Out of these, 1405 have been disposed of.

### **CITIZEN'S CHARTER**

Department has prepared a Citizen's Charter in consultation with the Performance Management



Division of the Cabinet Secretariat and uploaded on the department's website in December, 2013.

## VIGILANCE

Vigilance unit handles complaints related to the Department, its subordinate offices and aided institutions; it also deals with complaints received from the Central Vigilance Commission (CVC) / Central Bureau of Investigation (CBI) and other sources. It plays a proactive role in ensuring prompt disposal of these complaints.

Vigilance Unit also consolidates reports/returns received from the subordinate offices and aided institutions on vigilance matters and furnishes these reports (monthly, quarterly and annual basis) to various agencies like Central Vigilance Commission, Central Bureau of Investigation and Department of Personnel & Training. Other tasks involve maintaining of Agreed List and List of Officers of Doubtful Integrity of Gazetted status etc. Summary of complaints dealt during 2017 is as following:

Source	Opening Balance	Received during the period	Total	Disposed	Balance
CVC	10	35	45	37	08
OTHERS	20	125	145	130	15

In accordance with the directives of the CVC to encourage all stakeholders to collectively participate in the prevention of and the fight against corruption, Vigilance Awareness Week was observed in the Department during 30th October to 4th November 2017. The closing ceremony of the Vigilance Awareness Week was held on 6th Nov. 2017 which was graced by Prof. Madabhushanam Sridhar Acharyulu, Information Commissioner, Central Information Commission. Prof. Acharyulu delivered a thought-provoking and inspiring speech on this year's theme "Corruption Free India" in relation to RTI enthraling the officers and staff of this Department.



Information Commissioner Prof. M.S. Acharyulu delivering speech on Corruption Free India

During 2017, DST also organized an in-house 3 day - Administrative Vigilance Course for all Vigilance Officers working under the umbrella of DST from 18th Sept. to 20th Sept. 2017. The training programme was very well received by the participants.

## AUDIT OBSERVATIONS

Detailed position of Action Taken Notes (ATNs) for the year 2017-18 is as following:

Sl. No.	Year	No. of Paras / PA Reports on which ATNs have been submitted to PAC after vetting by Audit	Details of the Paras/PA reports on which ATNs are pending.		
			No. of ATNs not sent by the Ministry even for the first time.	No. of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	No. of ATNs which have been finally vetted by audit but have not been submitted by the Ministry to PAC
1	5 of 2004 UG(SD)			1 (3.1 to 3.11)	
2	5 of 2005(SD)	1(5.1)			
3	PA 13 of 2007	1(5.3.1 to 5.3.8)			
4	CA 3 of 2008(SD)DST				1(5.2)
5	CA 16 of 2008-2009(SD)DST			1(5.1) (*)	
6	CA 16 of 2008-2009(SDs)	1(5.3)			
7	22 of 2013(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments	1(5.2)			
8	27 of 2014(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments			1(3.1) (*)	
9	30 of 2015 (Compliance Audit), Union Government Scientific and Environmental Ministries/Departments				1 (3.1)
10	30 of 2015 (Compliance Audit), Union Government Scientific and Environmental Ministries/Departments	1 (3.2)			

11	26 of 2016 Department of Science and Technology (Compliance Audit), Union Government –Department of Science and Technology			1 (1.1 to 4.7)	
12	17 of 2017 (Compliance Audit), Union Government, Scientific and Environmental Ministries/Departments			1(4.1) (*)	

(\*)ATNs have been sent to O/o PDA (SDs), New Delhi/uploaded on APMS portal on 18.01.2018 (Sl. No. 5), on 11.01.2018 (Sl. No.8) and on 30.01.2018 (Sl. No. 12) respectively for vetting.

Name of Report	No. and Year of the Report	Date of presentation to Parliament/State Legislative	Performance/Compliance/ Financial Report
Report of the Comptroller and Auditor General of India for year ended March 2016	17 of 2017	21.07.2017	Compliance Audit

### Department of Science and Technology

#### Inadequate implementation of National Map Policy 2005

Even after 11 years of approval of the National Map Policy 2005, Survey of India, the National Surveying and Mapping Organisation of the country, failed to develop and maintain the National Topographical Data Base of the country. Of the seven series of maps envisaged under the policy, only one series in the scale 1: 50,000 was prepared. Printing of the maps was achieved for only 52 per cent of the country. As a result, topographic data was not disseminated to the end users.

*(Paragraph 4.1)*

# FINANCIAL SUMMARY

Demand No.84- Department of Science and Technology						
SUMMARY OF FINANCIAL REQUIREMENTS						
SI No.	Description	Actual 2016-17		BE 2017-18	RE 2017-18	BE 2018-19
		Plan	Non- Plan			
<b>I</b>	<b>ESTABLISHMENT EXPENDITURE</b>					
<b>1</b>	<b>SECRETARIAT</b>					
	Revenue	0.00	71.17	83.15	76.95	84.10
	Capital	0.00	0.00	0.00	2.00	50.00
	<b>Total- Secreariat</b>	<b>0.00</b>	<b>71.17</b>	<b>83.15</b>	<b>78.95</b>	<b>134.10</b>
<b>2</b>	<b>SURVEY OF INDIA</b>					
	Revenue	14.30	347.67	390.89	393.10	397.87
	Capital	6.63	0.00	9.58	12.58	14.00
	<b>Total- Survey of India</b>	<b>20.92</b>	<b>347.67</b>	<b>400.47</b>	<b>405.68</b>	<b>411.87</b>
<b>3</b>	<b>NATMO</b>					
	Revenue	1.71	10.89	17.30	16.17	17.98
	Capital	1.88	0.00	2.01	2.01	3.50
	<b>Total- NATMO</b>	<b>3.59</b>	<b>10.89</b>	<b>19.31</b>	<b>18.18</b>	<b>21.48</b>
<b>4</b>	<b>Total- Science Counselors Abroad</b>	<b>0.00</b>	<b>9.25</b>	<b>13.54</b>	<b>11.00</b>	<b>11.50</b>
	<b>Total- Establishment</b>	<b>24.52</b>	<b>438.98</b>	<b>516.47</b>	<b>513.81</b>	<b>578.95</b>
<b>II</b>	<b>CENTRE SECTOR SCHEMES</b>					
<b>5</b>	<b>S &amp; T Institutional and Human Capacity Building</b>					
	S & T Institutional and Human Capacity Building	921.44	15.00	1069.50	1004.86	1104.58
	S & T Institutional and Human Capacity Building( SC Component)	7.54	0.00	12.00	12.00	13.00
	S & T Institutional and Human Capacity Building (ST Component)	3.39	0.00	6.00	6.00	6.85
	<b>Total- S &amp; T Institutional and Human Capacity Building</b>	<b>932.37</b>	<b>15.00</b>	<b>1087.50</b>	<b>1022.86</b>	<b>1124.43</b>
<b>6</b>	<b>Research and Development</b>					
	<b>Total- Research and Development</b>	<b>467.62</b>	<b>0.00</b>	<b>595.50</b>	<b>505.14</b>	<b>609.00</b>
<b>7</b>	<b>Innovation, Technology Development and Deployment</b>					

Demand No.84- Department of Science and Technology						
SUMMARY OF FINANCIAL REQUIREMENTS						
SI No.	Description	Actual 2016-17		BE 2017-18	RE 2017-18	BE 2018-19
		Plan	Non- Plan			
Revenue	Innovation, Technology Development and Deployment	513.68	3.75	570.90	589.00	643.00
	Innovation, Technology Development and Deployment (SC Component)	6.16	0.00	19.00	19.00	19.00
	Innovation, Technology Development and Deployment (ST Component)	22.71	0.00	58.00	58.00	58.00
Capital	Innovation, Technology Development and Deployment (Capital Section)	4.00	0.00	4.00	4.00	0.00
<b>Total- Innovation, Technology Development and Deployment</b>		<b>546.55</b>	<b>3.75</b>	<b>651.90</b>	<b>670.00</b>	<b>720.00</b>
<b>Total- Centre Sector Scheme</b>		<b>1946.54</b>	<b>18.75</b>	<b>2334.90</b>	<b>2198.00</b>	<b>2453.43</b>
<b>III Other Central Expenditure</b>						
8	Science and Engineering Research Board	712.50	0.00	750.00	750.00	847.15
	Science and Engineering Research Board (SC Component)	54.50	0.00	50.00	50.00	52.85
<b>Total- Science and Engineering Research Board</b>		<b>767.00</b>	<b>0.00</b>	<b>800.00</b>	<b>800.00</b>	<b>900.00</b>
9	<b>Technology Development Board</b>	<b>0.00</b>	<b>30.30</b>	<b>20.00</b>	<b>170.00</b>	<b>100.00</b>
10	Autonomous Institutes and Professional Bodies	1044.35	2.24	1109.00	1008.00	1042.50
	Autonomous Institutes and Professional Bodies (SC Component)	19.94	0.00	20.00	20.00	20.00
	Autonomous Institutes and Professional Bodies (ST Component)	33.00	0.00	37.00	37.00	40.00
<b>Total- Autonomous Institutes and Professional Bodies</b>		<b>1097.28</b>	<b>2.24</b>	<b>1166.00</b>	<b>1065.00</b>	<b>1102.50</b>
<b>Total- Other Central Expenditure</b>		<b>1864.28</b>	<b>32.54</b>	<b>1986.00</b>	<b>2035.00</b>	<b>2102.50</b>
<b>Grant Total- DST</b>		<b>3835.34</b>	<b>490.26</b>	<b>4837.37</b>	<b>4746.81</b>	<b>5134.88</b>
<b>REVENUE</b>		<b>3822.83</b>	<b>490.26</b>	<b>4821.78</b>	<b>4726.22</b>	<b>5067.38</b>
<b>CAPITAL</b>		<b>12.51</b>	<b>0.00</b>	<b>15.59</b>	<b>20.59</b>	<b>67.50</b>
<b>SC Component</b>		<b>88.13</b>	<b>0.00</b>	<b>101.00</b>	<b>101.00</b>	<b>104.85</b>
<b>ST Component</b>		<b>59.10</b>	<b>0.00</b>	<b>101.00</b>	<b>101.00</b>	<b>104.85</b>



## ABBREVIATIONS

<b>AAS</b>	Agriculture and Allied Sciences
<b>ACS</b>	Association for Cognitive Science
<b>AEEE</b>	Alliance for Energy Efficiency Economy
<b>AERB</b>	Atomic Energy Regulatory Board
<b>AICTE</b>	All India Council for Technical Education
<b>AISRF</b>	Australia-India Strategic Research Fund
<b>ALICE</b>	A Large Ion Collider Experiment
<b>AMPRI</b>	Advanced Materials and Processes Research Institute
<b>AMT</b>	Advanced Manufacturing Technologies
<b>ASCI</b>	Administrative Staff College of India
<b>ASD</b>	Autism Spectrum Disorder
<b>ARCI</b>	International Advanced Research Centre for Powder Metallurgy and New Materials
<b>ARI</b>	Agharkar Research Institute
<b>ARIES</b>	Aryabhata Research Institute of Observational Sciences
<b>ASHA</b>	Accredited Social Health Activist
<b>ASPIRE</b>	Academy for Science, Policy Implementation and Research
<b>ASTN</b>	Asian STI Think Tanks Network
<b>ATREE</b>	Ashoka Trust for Research in Ecology and the Environment
<b>AUSC</b>	Advanced Ultra Super Critical
<b>AWS</b>	Automatic Weather Stations
<b>BARC</b>	Bhaba Atomic Research Centre
<b>BDTD</b>	Biomedical Devices and Technology Development
<b>BHEL</b>	Bharat Heavy Electricals Limited
<b>BHU</b>	Banaras Hindu University
<b>BIMSTEC</b>	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
<b>BIRAC</b>	Biotechnology Industry Research Assistance Council
<b>BRICS</b>	Brazil, Russia, India, China and South Africa
<b>BRN</b>	Building Research Networks
<b>BSIP</b>	Birbal Sahni Institute of Palaeosciences
<b>C-DAC</b>	Centre for Development of Advanced Computing
<b>CEFIPRA</b>	Indo-French Centre for Promotion of Advanced Research
<b>CERI</b>	Clean Energy Research Initiative
<b>CIIE</b>	Centre for Innovation Incubation and Entrepreneurship
<b>CIPAM</b>	Cell for IPR Promotions and Management
<b>CIPET</b>	Central Institute of Plastics Engineering and Technology
<b>CMERI</b>	Central Mechanical Engineering Research Institute
<b>CeNS</b>	Centre for Nano and Soft Matter Sciences
<b>CNRS</b>	Centre National de la Recherche Scientifique

<b>CPD</b>	Centre for Product Development
<b>CPF</b>	Centre for People's Forestry
<b>CPR</b>	Center for Policy Research
<b>CSC</b>	Children Science Congress
<b>CSG</b>	Core Support Group
<b>CSP</b>	Concentrated Solar Power
<b>CSRI</b>	Cognitive Science Research Initiative
<b>CURIE</b>	Consolidation of University Research for Innovation and Excellence in Women Universities
<b>CUSAT</b>	Cochin University of Science and Technology
<b>CVC</b>	Central Vigilance Commission
<b>DA</b>	Development Alternatives
<b>DAE</b>	Department of Atomic Energy
<b>DBT</b>	Department of Biotechnology
<b>DDP</b>	Device Development Programme
<b>DGPS</b>	Differential Global Positioning System
<b>DHI</b>	Department of Heavy Industry
<b>DIA</b>	Distinguished Investigator Award
<b>DIPP</b>	Department of Industrial Policy and Promotion
<b>MeitY</b>	Ministry of Electronics and Information Technology
<b>DLEPC</b>	District Level Exhibition and Project Competition
<b>DOT</b>	Devasthal Optical Telescope
<b>DPMS</b>	District Planning Map Series
<b>DPRP</b>	Drugs and Pharmaceuticals Research Programme
<b>DSS</b>	Decision Support Systems
<b>DST</b>	Department of Science and Technology
<b>DSWIG</b>	Dual Stator Winding Induction Generator
<b>DTAC</b>	Devasthal Time Allotment Committee
<b>EAS</b>	East Asia Summit
<b>ECIL</b>	Electronics Corporation of India Limited
<b>ECRA</b>	Early Career Research Award
<b>EDA</b>	Epidemiology Data and Analytics
<b>EIR</b>	Entrepreneurs-in-Residence
<b>EPSRC</b>	Engineering and Physical Sciences Research Council
<b>ERC</b>	European Research Council
<b>ESONN</b>	European School on Nanosciences and Nanotechnologies
<b>ETD</b>	Engineering and Technology Development
<b>EU</b>	European Union
<b>FAIR</b>	Facility for Antiproton and Ion Research
<b>FASIE</b>	Foundation for Assistance to Small Innovative Enterprises
<b>FAT</b>	Factory Acceptance Test
<b>FIST</b>	Fund for Improvement of S&T Infrastructure

<b>FOA</b>	Funding Opportunity Announcement
<b>FSSI</b>	Foundation for Sandbox Start-ups Initiatives
<b>GBNIHESD</b>	GB Pant National Institute of Himalayan Environment and Sustainable Development
<b>GeoPest-DSS</b>	Geospatial Pest Decision Support System
<b>GERD</b>	Gross Expenditure on R&D
<b>GITA</b>	Global Innovation and Technology Alliance
<b>GMRT</b>	Giant Metrewave Radio Telescope
<b>GMS</b>	Golden Map Service
<b>GPR</b>	Ground Penetrating Radar
<b>GROW</b>	Graduate Research Opportunities World Wide
<b>GTWG</b>	Global Technology Watch Group
<b>HGIS</b>	Health Geographic Information Science
<b>HRG</b>	Himalayan Research Group
<b>IACS</b>	Indian Association for the Cultivation of Science
<b>IASST</b>	Institute of Advanced Study in Science and Technology
<b>ICAR</b>	Indian Council of Agricultural Research
<b>ICDS</b>	Integrated Child Development Services
<b>IC-IMPACTS</b>	India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability
<b>IC-ISID</b>	International Centre for Inclusive and Sustainable Industrial Development
<b>ICMR</b>	Indian Council of Medical Research
<b>ICPS</b>	Interdisciplinary Cyber Physical Systems
<b>ICZM</b>	Integrated Coastal Zone Management
<b>IFCAM</b>	Indo-French Centre for Applied Mathematics
<b>IFCPAR</b>	Indo-French Centre for Promotion of Advanced Research
<b>IGC</b>	Inter-Governmental Consultations
<b>IGCAR</b>	Indira Gandhi Centre of Atomic Research
<b>IGCS</b>	Indo German-Centre for Sustainability
<b>IGSTC</b>	Indo-German S&T Centre
<b>IHDS</b>	Indian Heritage in Digital Space
<b>IIA</b>	Indian Institute of Astrophysics
<b>IIE</b>	Industry Institution Enclave
<b>IIG</b>	Indian Institute of Geomagnetism
<b>IIPC</b>	Industry-Institute Partnership Cell
<b>IISc</b>	Indian Institute of Science
<b>IISF</b>	India International Science Festival
<b>IISER</b>	Indian Institute of Science Education and Research
<b>IISM</b>	Indian Institute of Surveying and Mapping
<b>IMSP</b>	Institute of Mathematics and Physical Sciences
<b>INO</b>	India-based Neutrino Observatory
<b>INSA</b>	Indian National Science Academy

<b>INSPIRE</b>	Innovation in Science Pursuit for Inspired Research
<b>INST</b>	Institute of Nano Science and Technology
<b>I-PHEE</b>	Initiative to Promote Habitat Energy Efficiency
<b>IPHT</b>	Institute of Photonic Technology
<b>IPR</b>	Intellectual Property Rights
<b>IRHPA</b>	Intensification of Research in High Priority Areas
<b>IRIS</b>	Initiative for Research and Innovation in Science
<b>ISA</b>	Imaging Spectroscopy and Applications
<b>ISRF</b>	India Science and Research Fellowship
<b>ISRO</b>	Indian Space Research Organisation
<b>i-STED</b>	Innovation, Science and Technology led Entrepreneurship Development
<b>IoT</b>	Internet of Things
<b>ITCC</b>	India-TMT Coordination Centre
<b>IUAC</b>	Inter-University Accelerator Centre
<b>IUCAA</b>	Inter-University Centre for Astronomy and Astrophysics
<b>IUSSTF</b>	Indo-U.S. S&T Forum
<b>JCERDC</b>	Joint Clean Energy R&D Centre
<b>JDI</b>	Joint Declaration of Intent
<b>JNCASR</b>	Jawaharlal Nehru Centre for Advanced Scientific Research
<b>JNU</b>	Jawaharlal Nehru University
<b>JYU</b>	University of Jyväskylä
<b>KCC</b>	Khangchendzonga Conservation Committee
<b>KIRAN</b>	Knowledge Involvement in Research Advancement through Nurturing
<b>KISTEP</b>	Korea Institute of S&T Evaluation and Planning
<b>LEARN</b>	Livelihood Enhancement through Action Research and Networking
<b>LEB</b>	Low Energy Branch
<b>LEISA</b>	Low External Input Sustainable Agriculture
<b>LIGO</b>	Laser Interferometer Gravitational-Wave Observatory
<b>LSRC</b>	Ladakh Scouts Regimental Centre
<b>LTEM</b>	Long-Term Ecological Monitoring
<b>MAD</b>	Mutual Acceptance of Data
<b>MANAK</b>	Million Minds Augmenting National Aspiration and Knowledge
<b>MANU</b>	Map the Neighbourhood in Uttarakhand
<b>MATRICES</b>	Mathematical Research Impact-Centric Support
<b>MCBT</b>	Madras Crocodile Bank Trust
<b>MDRCF</b>	Medical Device Regulatory Compliance and Certification Facility
<b>MES</b>	Materials for Energy Storage
<b>MFPI</b>	Ministry of Food Processing Industries
<b>MI</b>	Mission Innovation
<b>MoEFCC</b>	Ministry of Environment, Forest and Climate Change
<b>MoR</b>	Ministry of Railways

<b>MoU</b>	Memorandum of Understanding
<b>MRDPs</b>	Major R&D Programmes
<b>NAPCC</b>	National Action Plan on Climate Change
<b>NASI</b>	National Academy of Sciences
<b>NATMO</b>	National Atlas and Thematic Mapping Organisation
<b>NBIRT</b>	NB Institute of Rural Technology
<b>NCCRD</b>	National Centre for Combustion Research and Development
<b>NCRA</b>	National Centre for Radio Astrophysics
<b>NCSTC</b>	National Council for Science and Technology Communication
<b>NDSAP</b>	National Data Sharing and Accessibility Policy
<b>NFDDDT</b>	National Facility for Drug Discovery and Developmental Therapeutics
<b>NGCMA</b>	National Good Laboratory Practice Compliance Monitoring Authority
<b>NGP</b>	National Geospatial Policy
<b>NHP</b>	National Hydrology Project
<b>NIAS</b>	National Institute of Advanced Studies
<b>NIDHI</b>	National Initiative for Developing and Harnessing Innovations
<b>NIF</b>	National Innovation Foundation
<b>NIH</b>	National Institute of Hydrology
<b>NIMR</b>	National Institute of Malaria Research
<b>NIRF</b>	National Institutional Ranking Framework
<b>NIS</b>	National Innovation Survey
<b>NISTADS</b>	National Institute of Science, Technology and Development Studies
<b>NLEPC</b>	National Level Exhibition and Project Competition
<b>NLST</b>	National Large Solar Telescope
<b>NKN</b>	National Knowledge Network
<b>NMSHE</b>	National Mission for Sustaining the Himalayan Ecosystem
<b>NMSKCC</b>	National Mission on Strategic Knowledge for Climate Change
<b>NPC</b>	National Productivity Council
<b>NPCSR</b>	National programme on CO <sub>2</sub> Sequestration Research
<b>N-PDF</b>	National Postdoctoral Fellowship
<b>NRDMS</b>	Natural Resources Data Management System
<b>NREL</b>	National Renewable Energy Laboratory
<b>NSC</b>	Nanoscience Centre
<b>NSDI</b>	National Spatial Data Infrastructure
<b>NSERC</b>	Natural Sciences and Engineering Research Council
<b>NSM</b>	National Super Computing Mission
<b>NSTMIS</b>	National Science and Technology Management Information System
<b>NTPC</b>	National Thermal Power Corporation
<b>OECD</b>	Organization for Economic Cooperation and Development
<b>OIR</b>	Oxygen Induced Retinopathy
<b>ORC</b>	Opportunity for Research Careers



<b>OVSDF</b>	Overseas Visiting Doctoral Fellowship
<b>PACE-R</b>	Partnership to Advance Clean Energy Research
<b>PAU</b>	Punjab Agricultural University
<b>PCM</b>	Phase Change Material
<b>PDF</b>	Post-Doctoral Fellowship
<b>PFC</b>	Patent Facilitation Centre
<b>PHED</b>	Public Health Engineering Department
<b>PMB</b>	Program Management Board
<b>PMD</b>	Photon Multiplicity Detector
<b>POC</b>	Program of Cooperation
<b>PPA</b>	People and Protected Areas
<b>PRAYAS</b>	Promotion and Acceleration of Young and Aspiring innovators and Start-ups
<b>PURSE</b>	Promotion of University Research and Scientific Excellence
<b>QGP</b>	Quark Gluon Plasma
<b>QuIST</b>	Quantum Information Science and Technology
<b>QTM</b>	Quantum Tunnelling of Magnetization
<b>R&amp;D</b>	Research and Development
<b>RAL</b>	Rutherford Appleton Laboratory
<b>RBD</b>	Refreshable Braille Display
<b>RCM</b>	Regional Coupled Model
<b>ROP</b>	Retinopathy of Prematurity
<b>RMES</b>	Russian Ministry of Education and Science
<b>RQA</b>	Recurrence Quantification Analysis
<b>RRAS</b>	Retinal Renin Angiotensin System
<b>RRC</b>	River Research Centre
<b>RRCAT</b>	Raja Ramanna Centre for Advanced Technology
<b>RRI</b>	Raman Research Institute
<b>RSF</b>	Russian Science Foundation
<b>RTF-DCS</b>	Research Training Fellowship for Developing Countries Scientists
<b>SAARC</b>	South Asian Association for Regional Cooperation
<b>SAIF</b>	Sophisticated Analytical Instrument Facilities
<b>SATYAM</b>	Science and Technology of Yoga and Meditation
<b>SCI</b>	Science Citation Index
<b>SCTIMST</b>	Sree Chitra Tirunal Institute for Medical Sciences and Technology
<b>SDSS</b>	Spatial Decision Support System
<b>SEATS</b>	Scheme for Early Attraction of Talent for Science
<b>SEBS</b>	Science Express Biodiversity Special
<b>SECs</b>	Subject Expert Committees
<b>SEED</b>	Science for Equity Empowerment and Development
<b>SEI</b>	Solar Energy Integration
<b>SEGES</b>	Smart Energy Grids and Energy Storage

<b>SERB</b>	Science and Engineering Research Board
<b>SERC</b>	Science and Engineering Research Council
<b>SERIIUS</b>	Solar Energy Research Institute for India and the United States
<b>SHE</b>	Scholarship for Higher Education
<b>SHG</b>	Self-Help Group
<b>SHRI</b>	Science and Heritage Research Initiative
<b>SKA</b>	Square Kilometre Array
<b>SLEPC</b>	State Level Exhibitions and Project Competitions
<b>SMA</b>	Shape Memory Alloy
<b>SNBNCBS</b>	S N Bose National Centre for Basic Sciences
<b>SPI</b>	Southern Peninsular India
<b>SPR</b>	Surface Plasmon Resonance
<b>SRIMAN</b>	Scientific Research Infrastructure for Maintenance and Networks
<b>SSA</b>	Segment Support Assemblies
<b>SSTP</b>	State S&T Programme
<b>STEM</b>	Science, Technology, Engineering and Mathematics
<b>STEP</b>	Science and Technology Entrepreneurs Park
<b>STIC</b>	Sophisticated Test and Instrumentation Centre
<b>STIL</b>	Software Test and Integration Lab
<b>SYST</b>	Scheme for Young Scientists and Technologists
<b>TARA</b>	Technological Advancement for Rural Areas
<b>TBI</b>	Technology Business Incubator
<b>TCS</b>	Telescope Control System
<b>TDB</b>	Technology Development Board
<b>TDP</b>	Technology Development Programme
<b>TIASN</b>	Technological Interventions for Addressing Societal Needs
<b>TIDE</b>	Technology Interventions for Disabled and Elderly
<b>TIFAC</b>	Technology Information Forecasting and Assessment Council
<b>TIME</b>	Technology Intervention for Mountain Eco-Systems
<b>TKS</b>	Traditional Knowledge Systems
<b>TMIR</b>	Technology Mission for Indian Railways
<b>TPEM</b>	Technology Platform for Electric Mobility
<b>TRC</b>	Tribal Resource Centre
<b>TREC-STEP</b>	Tiruchirappalli Regional Engineering College - Science and Technology Entrepreneurs Park
<b>UAY</b>	Uchhatar Avishkar Yojana
<b>UCOST</b>	Uttarakhand State Council of Science and Technology
<b>UIS</b>	UNESCO Institutes of Statistics
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UNIDO</b>	United Nations Industrial Development Organization
<b>USPTO</b>	United States Patent and Trademark Office
<b>UV LED</b>	Ultra Violet Light Emitting Diode

<b>VAJRA</b>	Visiting Advance Joint Research
<b>VCRS</b>	Vapor Compression Refrigeration System
<b>VIS</b>	Village Information System
<b>VP</b>	Vigyan Prasar
<b>WAQM</b>	Water and Air Quality Monitoring
<b>WATER-IC</b>	Water Technology Research and Innovation Centre
<b>WEE</b>	Women Entrepreneurship and Empowerment
<b>WEEE</b>	Waste Electrical and Electronic Equipment
<b>WEQ</b>	Women Entrepreneurship Quest
<b>WFOS</b>	Wide Field Optical Spectrograph
<b>WII</b>	Wildlife Institute of India
<b>WIHG</b>	Wadia Institute of Himalayan Geology
<b>WMT</b>	Waste Management Technologies
<b>WOS</b>	Women Scientist Scheme
<b>WWF</b>	World Wildlife Fund





Department of Science and Technology  
Ministry of Science and Technology  
Technology Bhawan, New Mehrauli Road  
New Delhi-110016, INDIA