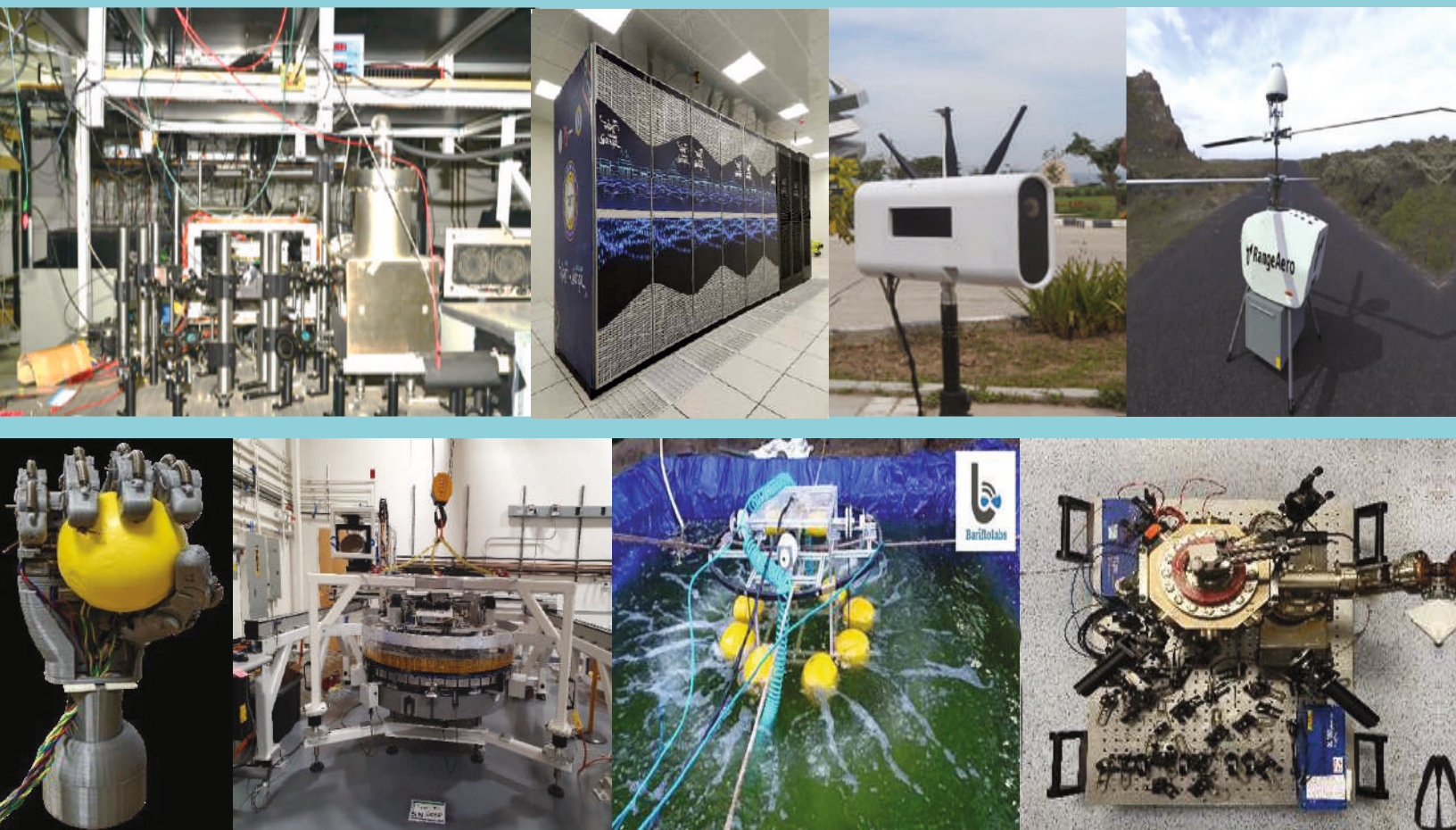
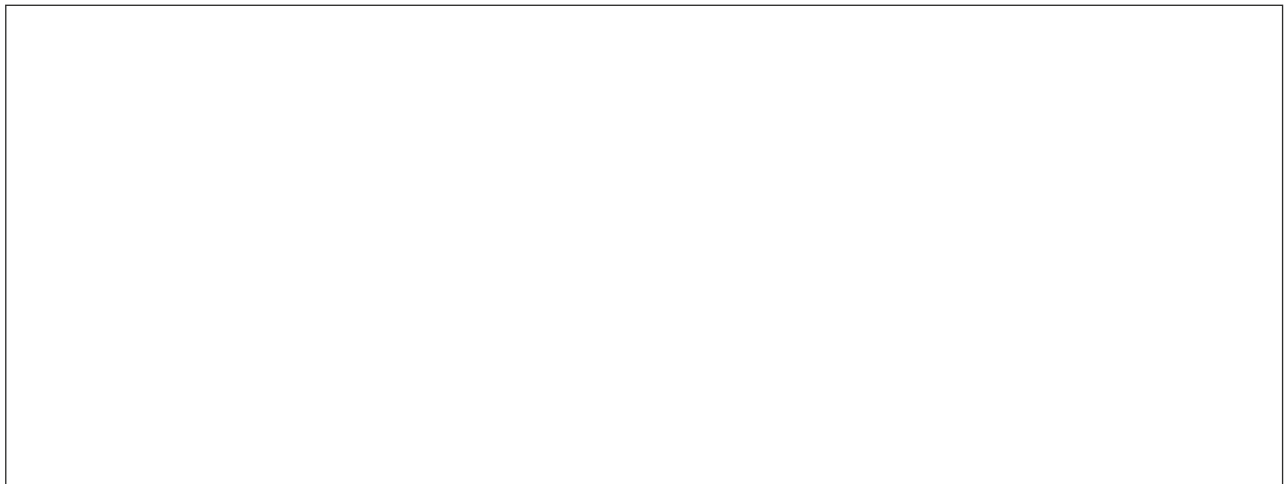


Annual Report 2022-23



Government of India
Department of Science & Technology
Ministry of Science & Technology
New Delhi



Department of Science and Technology and its various institutions made some sincere efforts towards research, technology development and innovation. The products depicted here represent some of the significant outcomes of Indigenous Technology Developments in the areas of advanced technology development, high performance computing, clean energy, Mega science, Start-up led technology innovations, Cyber physical systems, etc.

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OVERVIEW

The Department of Science & Technology (DST) is the nodal agency in the country for strengthening science, technology and innovation, identifying gap areas in S&T sectors, making planning and policy to meet the societal needs, promoting new areas of S&T in view of future demands. DST also serves in connecting the science and technology sectors with different Government horizontals and verticals, academia, R&D labs/institutions and industries. With the objective to strengthen the national S&T capacity and capability, DST provides the largest extramural research and development support in the country to scientists cutting across institutions and disciplines through a competitive mode reinforcing our country's education system, scientific and industrial R&D and the overall Science, Technology and Innovation landscape of the country.

The Department has been continuing its efforts towards strengthening the national STI ecosystem to emerge as a forerunner to play a critical role in science and technology for bringing positive transformations towards a safe, secure, better society, and the nation preparing for future disruptions. Some of the key success stories during the year 2022-23 are as follows:

- ❖ **India's ranking in global S&T indices continues to rise:** India achieved 40th position among innovative economies globally as per Global Innovation Index (GII), 2022. The country remains among the top 3 countries in terms of scientific publications in SCI journals as per NSF database, number of PhDs in science and engineering, size of Higher Education System and number of Startups.
- ❖ **India's Position in S&T engagement at international level:** India is convening the G20 Leaders' Summit for the first time. As part of the same, DST is coordinating the activities of Science-20 (S20) and Research Innovation Initiative Gathering (RIIG) Engagement Groups during India's G20 Presidency in 2023.
- ❖ **Improving the citizen's service through geospatial technology:** India was awarded to chair the new working group constituted for the Integrated Geospatial Information Framework (IGIF) during the Eleventh Plenary Meeting at Hyderabad organized by the Regional Committee of UN-GGIM for Asia and the Pacific (UN-GGIM-AP).
- ❖ **Policy Formulations:** DST has brought out one major policy, National Geospatial Policy and two guidelines, Scientific Research Infrastructure Sharing Maintenance & Networks (SRIMAN); and Scientific Social Responsibility (SSR) during the year.

While a detailed account of achievements out of Department's activities during the year is presented in relevant chapters, some of the major achievements and initiatives of 2022-23 are briefly presented in the following sections:

- ❖ **Fund for Improvement of S&T Infrastructure (FIST)** in University departments and Higher Educational Institutions is supported in competitive mode. The programme has been restructured to orient it towards the goal of Atmanirbhar Bharat by creating R&D infrastructure not only for R&D activities in academic organizations but also for use by the start-ups/ manufacturing industries/ MSMEs. All FIST supported facilities now need to connect with the I-STEM (Indian - Science Technology and Engineering Facilities Map) portal to display the utility and availability of slots of different facilities in their premises, for sample analysis by researchers outside the host organization. During the year, 525 fresh proposals have been received in seven subject areas out of which 90 projects have been recommended..
- ❖ **Promotion of University Research and Scientific Excellence (PURSE):** The main objective of the scheme is to pro-actively support for strengthening the R&D base of the performing Universities. In the current year, four new Universities identified for support. A "Special call for the unserved regions in the country to provide basic infrastructure and enabling the facilities for promoting R&D activities in new and emerging areas of Science & Technology has been announced through which twelve new universities are selected for support.
- ❖ **Sophisticated Analytical Instrument Facilities (SAIF)** have been established in different parts of the country to provide the facilities of sophisticated analytical instruments to the researchers in general and specially from the institutions which do not have access to such instruments to pursue R&D activities. There are at present 15 SAIF Centres in the country. Approximately 2400 research papers were published with the support provided by the SAIFs during the year and about 33,000 users from Pan India, belonging to all sectors have utilized and benefitted from the facilities at SAIF. An average of 79,000 samples were analyzed by all the SAIF centres.
- ❖ **Sophisticated Analytical & Technical Help Institutes (SATHI)**, a shared, professionally managed service and strong S&T infrastructure facilities for intensifying the base of S&T infrastructure and manpower, S&T led innovation and start-ups, technology development and futuristic areas of S&T. Three SATHI facilities have been hosted in first phase. A 300 keV Cryo Transmission Electron Microscope, one of the state-of-art infrastructure for the northern part of the country has been established at IIT Delhi through SATHI grant.
- ❖ **Synergistic Training program Utilizing the Scientific and Technological Infrastructure (STUTI)** is intended to boost human resource and its capacity building through open access to S&T Infrastructure across the country. A total of **192** training programs were organized under this Scheme during the year 2022 and around **6500** researchers have been trained under STUTI.

- ❖ **Support for Upgradation Preventive Repair and Maintenance of Equipment SUPREME**, a new initiative for the revival of major facilities established by DST Projects has been announced. The support would be provided for repair/ upgradation/ maintenance/ retrofitting or acquiring additional attachment to increase functional capabilities of existing analytical instrumentation facilities (AIFs) supported by DST in various Institutions/laboratories/academic institutions.
- ❖ **State S&T Programme** facilitates states to achieve the specific S&T objectives at their level. Currently, total 31 S&T Councils (28 states + 3 UTs) are being supported. The programme also supports studies and surveys on local S&T related issues. A year-long program “*Vigyan Utsav*” with twelve identified themes has been launched to showcase the emerging Science, Technology and Innovation (STI) ecosystem at States/UTs and its contribution towards *Atmanirbhar Bharat*. The Patent Facilitation Programme (PFP) of DST is being implemented through Patent Facilitation Centre (PFC) established at TIFAC, and the Patent Information Centers (PICs) established at State S&T Councils. PFC has filed 37 new patent applications, 2 Integrated Circuit (IC) Layout Design applications.
- ❖ **Policy Research Cell (PRC)** under Policy, Coordination and Programme Management (PCPM) division in Department of Science and Technology (DST) is mainly focused to promote STI policy research in the country and gather evidence-based input for future policy making in STI related areas. In the current year, two **Centres for Policy Research (CPRs)** have been supported and around 19 DST-STI fellows received the fellowship under the DST-STI fellowship programme. A 2-day “Centre-State Science Conclave” at Science City, Ahmedabad on 10-11 September 2022 was organized to sensitize and strengthen the Centre—State coordination on STI matters.
- ❖ **National Science & Technology Management Information System (NSTMIS)** conducts national surveys to generate and make available information on manpower as well as financial resources devoted to S&T activities. The data collection for National Survey 2021-22 on resources devoted to research and development activities is in progress. In addition, a National Manufacturing Innovation Survey (NMIS) 2021 is also under progress. The data collection has been completed and the draft report is under review.
- ❖ **WISE-KIRAN** (Knowledge Involvement in Research Advancement through Nurturing) embraces women-exclusive schemes of DST with the mandate to bring gender parity in S&T through various mechanisms. This year, 293 projects out of 990 proposals through 9 meetings of subject experts have been selected in 5 different streams under WOS-A. WOS-B promotes women to use their S&T knowledge and experience to address societal challenges. During this year, grant has been released for 9 ongoing projects. More than 30 publications have come out from the ongoing WOS-B projects. WOS-C provides opportunity to women with mid-career break and having qualifications in S&T to pursue

their career in the area of Intellectual Property Rights (IPR). The training for 98 women scientists selected under 12th batch has been provided. This year, 116 women from 11th and 12th batches cleared Patent Agent exam conducted by Patent Office of India. The Vigyan Jyoti aims to encourage girls to pursue higher education and career in STEM (Science, Technology, Engineering and Mathematics) especially in the areas where women participation is low in order to balance gender ratio across the streams. During 2022, the programme is extended to 200 districts (including 13 aspirational districts) of 34 states/ UTs of the country.

- ❖ **Cognitive Science Research Initiative (CSRI)** encourages research in highly interdisciplinary area of cognitive science that is trying to address various questions through combining ideas, principles and methods of psychology, computer science, linguistics, philosophy, neuroscience, etc.
- ❖ **Innovation in Science Pursuit for Inspired Research (INSPIRE)** is a flagship scheme of DST to attract talent to the study of science from an early age and build the required human resource pool for strengthening and expanding the R&D base. of the country. The INSPIRE- Scholarship for Higher Education (SHE) component supported the fellowship to 10,108 selected candidates. In addition, 424 INSPIRE scholarships have been offered to the selected candidates through institute mode. Under INSPIRE Fellowship component, evaluation of the 2,449 applications received is under progress and so far, 829 INSPIRE Fellowship applicants have been offered INSPIRE Fellowship. Out of the awarded/offered INSPIRE Fellows 67% are female and 33% are male. Of the total INSPIRE Fellowship beneficiaries, about 36% are SHE Scholars who have joined doctoral degree program in science and technology after availing 5 years INSPIRE Scholarship. During the year, 115 INSPIRE Faculty Fellowships were offered the fellowship. Out of the awarded/offered INSPIRE Faculty Fellows 43% are female and 57% are male.
- ❖ The INSPIRE-MANAK **Million Minds Augmenting National Aspirations and Knowledge** programme brought 7.05 lakh ideas during 2021-2022 from middle and high schools across the country, out of which 52,720 brilliant ones have been shortlisted for showcasing at district, state and then at the National Level Exhibition & Project Competition. The 9th NLEPC was organised during 14-16 September 2022, wherein the NLEPC award was given 60 creative students. A total of 7,96,189 nominations were received during 2022-2023 from all States and UTs across the country. Out of which, 43,381 students have been shortlisted to participate in the District Level Exhibition and Project Competition and subsequently the State and National level.
- ❖ **International Cooperation** programme is mandated of (i) negotiating, concluding and implementing Science & Technology Agreements between India and partnering countries; (ii) support scientific research and development activities through various regional and multilateral platforms, (iii) providing interventions on S&T aspects in international forums. Active bilateral S&T programs of cooperation has been continued with more

than 45 countries including dedicated regional and multilateral program. The multilateral cooperation was served with Asia Cooperation Dialogue (ACD), Africa, Association of Southeast Asian Nations (ASEAN), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), Brazil, Russia, India, China, and South Africa (BRICS), European Union (EU), *Indian Ocean Rim Association (IORA)*, *Indo-Pacific Oceans Initiative (IPOI)*, *Shanghai Cooperation Organisation (SCO)*

- ❖ **National Mission on Nano Science & Nano Technology** promotes basic research and focuses on Nano Technology adaptation and transfer to industry for use by masses. During the year 2022, nine patent filings are reported from the energy and Nano electronics research area, where efficient materials properties, sensors and devices are demonstrated, and one patent got awarded.
- ❖ Under the activities of **Mega Facility for Basic Research**, India is actively participating in establishment of international research facilities like Facility for Antiproton and Ion Research (FAIR) in Germany, Thirty Meter Telescope (TMT) in USA and Square Kilometer Array (SKA) in Australia and South Africa and aims to enable Indian researchers for using such state-of-the-art research facilities for their research work. Through this programme, Indian researchers are participating in two experiments at Large Hadron Collider (LHC), European Organization for Nuclear Research (CERN), Geneva and in experiments at Elettra Sincrotrone, Italy, Fermi National Accelerator Laboratory (Fermilab), USA.
- ❖ Under **Climate Change Programme**, two national missions on climate change under National Action Plan on Climate (NAPCC), viz., National Mission on Strategic Knowledge for Climate Change (NMSKCC) and National Mission for Sustaining the Himalayan Ecosystem (NMSHE) are being implemented. Four new State Climate Change Cells (SCCCs) were established in the States of Goa, Jharkhand, Uttar Pradesh (UP) and UT of Chandigarh making the presence in SCCC in 28 states/ UTs across the country during the year.
- ❖ **National Supercomputing Mission (NSM)** jointly implemented with MeitY targets to set up high performance systems ranging from a few 100 Tera FLOPS to Ten's of Peta FLOPS in the country. In the current year, five new installations of supercomputers have been successfully completed at IIT Roorkee, NIT Trichy, IIT Gandhinagar, IIT Guwahati, IIT Mandi. So far total 28 supercomputers have been installed. An indigenously developed *Rudra* server is getting ready for use.
- ❖ **Technology Fusion & Applications Research (TFAR)** Programme is meant to boost research in emerging technologies under single platform with the focus research for fusion, convergence and application of emerging technologies like Quantum Enabled Science & Technology, Network Project on Imaging Spectroscopy and Applications (NISA), Epidemiology Data Analytics and Indian Heritage in Digital Space.
- ❖ **Technology Development Programme** supports R&D for development of innovative technologies in identified areas. Total No. of 06 sub Schemes under TDP are aligned to

National priorities and ongoing National programmes. Around 170 project proposals were received during 2022 under Therapeutic Chemicals Programme (TCP) and Technology Enabling Centres (TEC) components of TDP. 7 new projects were sanctioned after systematic evaluation by Expert Advisory Committees.

- ❖ **Clean Energy Research Initiative (CERI):** The overarching objective of CERI is to nurture S&T led breakthroughs to make clean energy affordable and accessible through strengthening Research and Innovation Eco-System for Clean Energy. During the year, several new dimensions were added to the programme to accelerate the pace of clean innovations to meet national needs. The initiatives include Research & Development on Clean Coal Technologies, Materials for Energy Storage, Solar Energy, Mission Innovation, Mission Innovation Challenge, Cross-cutting Innovation Challenges, Energy Storage Solutions, Mission Innovation (MI) 2.0, smart grid and clear air.
- ❖ **Water Technology Initiative (WTI)** of the Department of Science & Technology (DST) is a pro-active India – centric ‘solution science’ endeavor that aims to strengthen the R&D capacity and capability to develop research-based solutions for existing and emerging water challenges faced in the country. The overarching goal of the scheme is to promote R&D activities that enable the winning of water from sustainable sources, augmentation of water quality for specific applications, and recycling and reuse of water. Several projects are being implemented to address water related issues.
- ❖ **National Geospatial Programme (NGP)** aims at promoting R&D in emerging areas of Geospatial technologies and applications. Several projects have been carried out under the programme. A National Network Programme has been developed involving three concerned Ministries and several partnering knowledge institutions with the objective of exploring the feasibility of monitoring total water storage variations using data from the Gravity Recovery and Climate Experiment (GRACE) satellite. In order to strengthen the area specific geospatial analytics capabilities of the country, 11 out of total 140 R&D proposals received were supported. India hosted the Second United Nations World Geospatial Information Congress (UNWGIC) at Hyderabad from 10-14 October 2022.
- ❖ **National Science & Technology Entrepreneurship Development Board (NSTEDB)** through its strong network of incubators is leveraging the technological strength of the higher learning institutes to nurture the technology start-ups. A new program, National Initiative for Developing and Harnessing Innovations (NIDHI)– Inclusive TBI (i-TBI) has been initiated to ensure inclusiveness of innovation and entrepreneurship across the country and to foster innovation and startup culture among the students, faculties, entrepreneurs, and nearby communities. Under i –TBI program, 30 institutions have been recommended for support to establish the i-TBIs. Support to four new i-TBIs has been sanctioned. During 2022, a new CoE at T-Hub, Hyderabad, Telangana has been established through the NIDHI Centre of Excellences (NIDHI - CoE) programme, making a total of 8 CoEs under active support.

- ❖ **National Council for Science and Technology Communication (NCSTC)** largely aims at communicating and popularizing science and technology (S&T) to masses and stimulate scientific temper amongst them. During the year several activities have been carried out for S&T awareness and popularization. On National Science Day (NSD), 28th Feb 2022, three PhD Scholars and one Post-Doc fellow were felicitated with AWSAR award. In addition, to the mentioned awards, the top 125 popular stories out of 1779 stories were selected for a cash prize. Through 'Mobile Science Exhibition' over 75300 students, 2770 teachers and 330 schools have benefited from this unique initiative over its three phases across Gujarat.
- ❖ **Science for Equity for Empowerment and Development (SEED)** scheme supports a variety of schemes that constantly work for the socio-economic empowerment and development of the disadvantage sections of the society viz. SC/ST, *Divyangjan*, elderly, Economically Weaker Section (EWS) and women besides encouraging young scientists & regular target groups to take up societally relevant Research and Development (R&D). Several initiatives such as Strengthening, Upscaling & Nurturing Innovations for Livelihood (SUNIL), Scheme for Young Scientists and Technologists (SYST), Technology Intervention for Disabled and Elderly (TIDE), S&T For Women have been taken.
- ❖ **Scheduled Caste Sub Plan (SCSP) & Tribal Sub Plan (TSP):** The department has been implementing two Schemes, viz Tribal Sub Plan (TSP) and Scheduled Castes Sub Plan(SCSP), since 1991-92 and 1992-93 respectively, to empower SC/ST population through the input of Science and Technology. Interventions through the **Tribal Sub-Plan** had directly benefited peoples. In addition to improved socio-economic status there had been a significant improvement in skills, building on local innovation & local knowledge. The projects implemented (completed) through the **Scheduled Caste Sub Plan** during the year directly benefited people and there has been a significant improvement in the socio-economic conditions of people.
- ❖ **Good Laboratory Practice (GLP):** As on date, there are 52 GLP certified test facilities in the country. India is 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 39 member-countries of the OECD and other countries, thus removing the technical barriers to trade.
- ❖ **Five Technical Research Centres (TRCs)** are being supported in 5 DST institutions since 2015-16. The TRCs have developed and transferred some significant technologies to industry during the period. One of the key achievement is Technology License Agreement between JNCASR and M/s. Hamsa Biopharma India Pvt. Ltd, New Delhi, which was entered into on 28th March 2022 for the development of TGR63, a molecule to effectively treat or prevent Alzheimer's disease. These TRCs provide techno-legal-commercial and financial support to scientists, entrepreneurs, and business fraternity to

achieve translation of research into products and processes for greater economic and societal benefits.

- ❖ **National Spatial Data Infrastructure (NSDI)** has been demonstrating the National Data Registry (NDR) Geo-portal and the individual organisational Data Nodes; provisioning a proof-of-concept Geospatial Cloud based Infrastructure (NSDI Geo-platform) services for hosting geospatial data/ applications; maintaining the NSDI Clearinghouse Node. During the current year, focus of the NSDI has been on implementation of the Interim Data Sharing Framework (IDSF), operationalisation of the Geo-Information Science & Engineering (GISE) Hub; strengthening of the National Data Registry (NDR) and individual organisational Data Nodes.
- ❖ **National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)** launched during 2018-19 has set up 25 Technology Innovation Hubs in top-ranking national institutions almost in all states covering the entire country. One of the key achievements during the year is that the TIH at IIT Kanpur has installed the first Security Operations Centre (SoC) based fully on open-source components and integration, C3iVazra, at National Highways Authority of India (NHAI) headquarters.
- ❖ 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. These institutions have a long and varied history and their variety of activities significantly contribute to the S&T eco-system of the country. **DST's autonomous institutions contribute to multifarious research ranging from Health, Medical devices, Energy to unraveling the mysteries of the Universe.** Following is a glimpse of some of the key achievements:
 - Aryabhata Research Institute of Observational Sciences (ARIES), Nainital accomplished a 4m International Liquid Mirror Telescope (ILMT) received first light in May, 2022. After first light, the 4.0m International Liquid Mirror Telescope (ILMT) is being prepared for science observations.
 - Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) designed a cost-effective metal-free catalyst to convert CO₂ to the value-added product methane by absorption of visible light.
 - Sree Chitra Tirunal Institute for Medical Sciences and Technology, (SCTIMST) Trivandrum has signed the license agreement with M/s Forsta meditech private limited for the technology transfer of Automatic Smart Trash Bin for Disinfection Using UV Enabled Microwave (Astra)..
 - North East Centre for Technology Application & Reach (NECTAR), Shillong has successfully implemented a project on setting up of a Honey Testing Laboratory at Dimapur, Nagaland through Nagaland Beekeeping and Honey Mission (NBHM). It has

also set up the GSM enabled, Bamboo based smart water harvesting tower at Ram Krishna Mission, Sohra, Meghalaya, an innovative technology on water harvesting from cloud and atmospheric moisture. It will be useful in lean season to store pure and clean water for local community.

- **Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru developed a cost-effective dual-functional polymeric electrochromic smart window with energy storage capability (transmittance modulation > 55%, switching speed < 5 s, cycling stability >500 cycles), and areal capacitance of ~ 8 mF cm²) was designed using hybrid transparent electrodes, which has the potential to replace the traditional ITO-based smart windows in modern infrastructures and automobile industries.**
- ❖ The **Science and Engineering Research Board** has come up with several innovative programmes and schemes to identify potential scientists and support them for undertaking R&D in frontier areas of Science and Engineering. One of these is a Special Call on Wearable Electronics for Biomedical Applications. Wearable medical devices offer great potential for reducing healthcare expenses with time cost effectiveness. A new programme **State University Research Excellence (SERB-SURE)** has been launched to augment the research capabilities in a structured way to create a robust R&D ecosystem in state universities and colleges by fostering collaboration for high-end research.
- ❖ **Technology Development Board (TDB)** provides financial assistance to the industrial concerns and other agencies attempting development and commercial applications of indigenous technology or adapting imported technology for wider domestic application. It accepts applications for financial assistance throughout the year from all sectors of economy such as Health & Medical, Engineering, IT, Chemical, Agriculture, Telecommunications, Road Transport, Energy & Waste Utilization, Electronics, Defence, Civil Aviation, Textile, etc. During the year 2022-23 (upto December, 2022), TDB has signed nine (9) agreements for providing financial support to various industrial concerns.
- ❖ Under **Strengthening Survey and Mapping** activity Survey of India and NATMO, have made some significant contributions with several geospatial solutions catering to various domains services. Survey of India has undertaken preparation of HRNTDB for entire country by using High Resolution Satellite Imageries (HRSI) to cater for accurate high-resolution data requirements/demands from various users and organisations. Sol is also developing the Geoid Model for the entire country with the accurate relationship between the geoid and WGS-84 Ellipsoid, so that heights given by satellite-based technologies and products viz., GNSS, satellite imageries can be directly converted to the orthometric heights with geodetic accuracy.

The Department has made sincere efforts to utilize the allocated budget fruitfully to implement its planned activities and programmes during the year. DST and its autonomous institutions have contributed to overall development of the nation with meaningful S&T interventions.

S&T INSTITUTIONAL & HUMAN CAPACITY BUILDING

The umbrella scheme S&T Institutional & Human Capacity Building mainly covers the programmes/schemes related to capacity building in terms of S&T infrastructure and critical human resources in the country at different levels.

1.1 R&D Support

Department of Science & Technology implements the following major scientific infrastructure related programs.

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

Fund for Improvement of S&T infrastructures in Universities and Higher Educational institutions (FIST) Program is an infrastructure augmentation program of Government which provides support for Scientific Infrastructure Building at the department level. FIST is an unparalleled infrastructure program across all the S&T funding agencies. The supports under the Program is basically for improving quality of research through modernization of laboratories by acquiring basic/state-of-the-art major research facilities, associated infrastructure facilities including modernization of labs, setting up of specialized research facilities for conducting internationally competitive and contemporary research as per global standards.

The Program is being implemented at four levels of supports i.e. Level A, Level B, Level C and Level D. While Level - A is for 'College as a whole', the Level B, Level C and Level D are for six broad subject areas i.e. Life Sciences, Physical Sciences, Chemical Sciences, Engineering Sciences, Earth & Atmospheric Sciences and Mathematical Sciences for Department in Universities and academic Institutions.

In the last twenty-one rounds, support has been provided to 3074 Departments and PG Colleges at a total budget of about Rs. 3130.82 crores (504 projects in Level A, 2276 projects in level B, 292 projects in Level C and 2 projects in Level D).

In the current year, the announcement for submission of fresh proposals under the Program was made during July 2022. 525 Proposals in four levels and seven different Subject areas have been received online from departments of universities and academic institutions. In the current cycle, 102 Proposals with a budget of Rs 135.10 Crores for five years duration were

recommended for support by FIST Advisory Board under the Program. The Award Letters to the recommended departments have been issued.

Monitoring and review are important aspects of the program. In the year One hundred and twenty three (123) Projects were assessed/reviewed through presentation by the concerned Department/College before the respective Subject Expert Committees. During this year Ninety (90) new projects were supported at various Departments of universities and academic institutions along with support to 11 ongoing projects.

Sixteen success stories were published as an article at Press Information Bureau and DST's website about the scientific outcomes using FIST program.

In the current year, twelve FIST interaction meetings have been organized by involving stakeholders from various academic institutions, associated with ongoing FIST projects sanctioned in different subject areas. The queries and implementation aspects of projects were discussed and stakeholders were apprised of the recent changes incorporated in the FIST Program.



Fig. Powder XRD & Mass Spectrometer facility at Department of Chemical Engineering, IIT Dhanbad

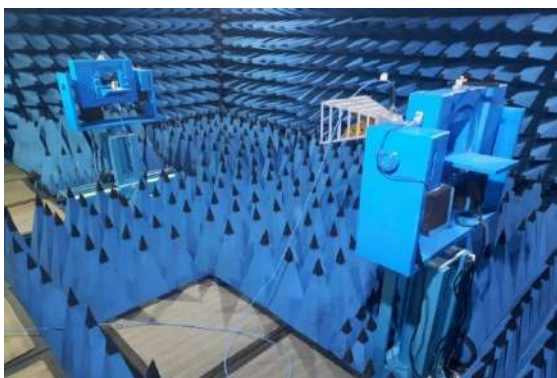


Fig. Fully Automatic antenna and RCS measurement facility up to 50 GHz facility at Department of Electronics Engineering, IIT Dhanbad,



Fig. Faraday Effect Apparatus acquired out of DST-FIST at PSGR Krishnammal College for Women, Tamil Nadu



Fig. Contact Angle System Measurement at ICT, Mumbai

1.1.2 Promotion of University Research and Scientific Excellence (PURSE)

“Promotion of University Research and Scientific Excellence (PURSE)” is an exclusive program for the Indian University sector to build the research capacity of performing Indian Universities. The main objective of the scheme is to provide the support for strengthening the R&D base of the performing Universities in the country with adequate financial support to nurture the research ecosystem in universities.

Recently, the PURSE program has been restructured and re-oriented. Universities have been encouraged to carry out Mission mode research activities to focus on thrust areas which align with National priorities of Excellence in Manufacturing, Waste processing, Clean Energy, Water and Start up India. Universities are encouraged to harness their areas of excellence into thematic effort of an accomplished team, with clearly articulated objectives. The broad objective is to support potentially high impact, interdisciplinary research (both basic and applied) aligned to national priorities and missions.

Under PURSE program large investments have been made to encourage, nourish and sustain research performance of the leading universities. The support under PURSE has been provided to **58 Universities** (40 State Universities, 14 Central Universities and 4 Private Universities) under PURSE to acquire research equipments, 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.

In the current year, four more Universities identified for support against PURSE 2021 call were supported in the area of “Design and Development of Materials for Applications in Energy Harvesting, Sensing and Organic Synthesis”, Interdisciplinary Research for Improving Human Health by the Development of Molecular Therapeutics and Device”, “Establishment of Holistic Electric Mobility Infrastructure and Supporting Networks to Promote Research and Startups towards National Electric Mobility”.

DST also organized Well Wisher Committee meetings at *Annamalai University, Alagappa University, University of Mysore, Sri Venkateswara University, Osmania University, Guru Jambheshwar University, Jamia Millia Islamia, Jamia Hamdard, Punjab Agricultural University* involving eminent experts from Programme Management Board of PURSE to discuss the technical and financial progress in the implementation of PURSE.

DST has announced a “Special call under PURSE for the unserved regions in the country to provide basic infrastructure and enabling the facilities for promoting R&D activities in new and emerging areas of Science & Technology in the Universities of North Eastern Region, Jammu & Kashmir, Chhattisgarh, Madhya Pradesh, Jharkhand, Bihar, Haryana, Telangana, Himachal Pradesh and Rajasthan. Under the Special Call, twelve new universities are selected to be supported. During the Year 2022, five success stories of PURSE Program were released through Press information Bureau and DST’s website about the PURSE program.



Fig. Field Emission Scanning Electron Microscope with EDS facilities supported out of DST PURSE at Visva- Bharati University, West Bengal

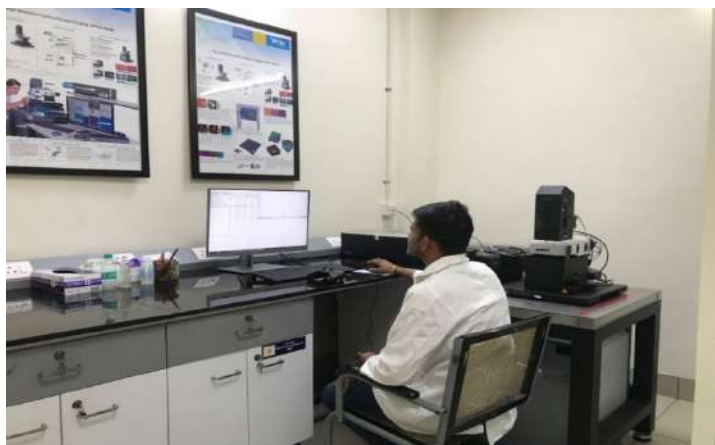


Fig. Raman Spectrometer supported out of DST PURSE grant at Guru Jambheshwar University of Science and Technology, Hisar, Haryana

1.1.3 Sophisticated Analytical Instrument Facilities (SAIF)

The SAIF program is being implemented regionally with the objective to provide facilities of sophisticated analytical instruments to the research workers in general and especially from the institutions which do not have such instruments to enable them to pursue R&D activities. This enables the institutions acquiring such facilities to keep pace with development taking place globally.

At present 15 SAIFs are being supported by DST at IIT Chennai; IIT Mumbai; CDRI, Lucknow; Punjab University, Chandigarh; NEHU, Shillong; IISc Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; C.V.M., Vallabh Vidyanagar; STIC, Kochi; Shivaji University Kolhapur; IIT Patna; IEST Shibpur; M.G. University, Kottayam and Karnataka University Dharwad.

The SAIFs are equipped with high end analytical facilities such as Cryo-Transmission Electron Microscope, Nuclear Magnetic Resonance etc to meet the need of researchers. SAIF facility is accessible to all the users from various academic institutes, R&D laboratories industries, MSME and start ups, irrespective of whether they belong to the host institute or not.

Major Highlights

(i) Analysis Provided/Usage of facility

The facilities at SAIF are meeting analytical needs of researchers, scientist and industries for material characterization including qualitative/quantitative analysis, structure determination, surface topographic studies etc.

- Approximately 2400 research papers were published with the support provided by the SAIFs during the year

- About 33,000 users from pan India, belonging to all sectors have utilized and benefited from the facilities at SAIF
- Approximately 70% of the users utilizing the SAIF facility were from outside the host institute
- An average of 79,000 samples were analyzed by 15 SAIF centres.



Fig. Powder X Ray Diffraction facility of SAIF at Gauhati University, Guwahati

(ii) Workshop & Training Programs

The SAIFs conduct trainings and workshops on regular basis to make researchers and users aware of the facilities these centres have to offer. This also aids in generating skilled work-force for handling, repair and maintenance of high-end equipment as well as interpretation of data. In total, approximately 104 webinars/workshops/training programs/seminars were hosted by SAIFs during the year on topics related to NMR, ICP-AES, TEM, SEM, Spectroscopy etc.

1.1.4 Sophisticated Analytical & Technical Help Institute (SATHI)

The objective of SATHI program is to establish shared, professionally managed services and strong science and technology infrastructure facilities at national level. SATHI is envisaged to be functional with efficiency, accessibility and transparency of highest order under one roof to cater services to the demands of researchers, scientists, students, start-ups, manufacturing units, industries and R&D Labs. In terms of “help” it will deal with knowledge generation and its dissemination by adopting best practices of such facility.

The usage of these facilities will be guided by the basic principle of maximum and effective utilization and accessibility to all; viz: 80% to external users by booking the slots on web-based platform. Largely SATHI scheme aims for : (a) procurement and maintenance of high-end equipment and infrastructure facility necessary for research/ testing/ manufacturing/ fabrication, (b) to cater service by understanding the demands of researchers, scientists,

students, start-ups, manufacturing units, industries and R&D Labs, (c) to provide access and sharing of scientific equipment and infrastructure, (d) For capacity building of engineers and technocrats for efficient operations and interpretations of results/ outcome, (e) Monitoring of usage pattern of expensive scientific research infrastructure for its maximum utilization by applying infrastructure management with efficient operations and to be a part of 'Atma nirbhar Bharat Abhiyan' (Self Reliant India Campaign).

Three SATHI facilities are hosted in first phase at IIT Delhi, IIT Kharagpur, and Banaras Hindu University Varanasi. Each SATHI facilities are supported for a period of 4 years duration, starting from FY 2019-20. In the current year total Six (06) no's of "SATHI Ki Baat" conducted by involving ongoing SATHI centres to get the updates about progressive steps followed at recently supported SATHI centres and for sharing the common thoughts of host institutes as well as different stakeholders of SATHI. The procurement & Installation of first & second phase of equipment are under progress at SATHI centres.

The incorporation & registration of Section-8 company, viz: SATHI FOUNDATION at IIT Kharagpur, IIT Delhi, BHU- Varanasi has completed and respective Chief operating officer (COO) for all three Section-8 company have joined through open advertisement, to lead the company for its self-reliance model achievement.

An important milestone is the installation of the 300 keV Cryo Transmission Electron Microscope, which is one of the state-of-art infrastructure for the northern part of the country which has been established at IIT Delhi through SATHI grant.

Some of the state-of-art infrastructure i.e. (i) High Resolution Accurate Mass Spectrometer System (For proteomics and metabolomics) (ii) Super Resolution Confocal Microscope with Live Cell Imaging (iii) Laser Ablation (Femto) Combustion Gas Chromatography- High Resolution- Isotope- Ratio Mass Spectrometry (LA-HR-CGC-IRMS) (iv) High Resolution – Nuclear Magnetic Resonance (HR-NMR- 600) with Solid State facility etc. has been established at BHU- Varanasi and all these research facilities are available at I-STEM portal for its wide usage.



Fig. Super Resolution Confocal Microscope with Live Cell Imaging facility of SATHI at BHU Varanasi



Fig. High Resolution – Nuclear Magnetic Resonance (HR-NMR- 600) with Solid State facility) facility of SATHI at BHU Varanasi.

Outreach and Industry Connect Activities Undertaken by SATHI IIT Kharagpur

SATHI Foundation IIT Kharagpur has initiated an industry outreach to connect with the startups, MSME's, large industries, professional societies, industry bodies, chambers of commerce and other institutions in the identified focus areas. In this regard, 21 meetings were held so far across six cities viz. Jamshedpur, Medinipur, Kolkata, Pune, Bengaluru and Mysuru.



Fig. 1st Industry Meet of SATHI foundation at IIT Kharagpur

Recently, DST has revamped the SATHI scheme and invited proposals on consortia mode. The department has received a total of 136 proposals under the call of SATHI 2022, which are under consideration. Establishment of SATHI facilities in the country with through (75:25) sharing mode and consortium mode of approach with academia, research institutes, non-government organizations, S&T councils and industries from current FY 2022-23 onward has been initiated. Through such initiative the selection of new SATHI facilities are under process to strengthen the R&D Infrastructure across the country.

1.1.5 Synergistic Training program Utilizing the Scientific and Technological Infrastructure (STUTI)

STUTI is a new initiative of the Department started in the year 2021 which would cater to build human resource and its knowledge capacity through open access S&T Infrastructure across the country. As a complement to the various schemes of DST funding (FIST, PURSE, SAIF, CURIE and SATHI) for expansion of R&D Infrastructure at academic institutions, STUTI scheme envisions a hands-on training program and sensitization of the state-of-the-art equipment.

The two major objectives of the program are as follows:

- Organization of training program on DST supported R&D equipment targeting Scientists/ Professors/ PhDs and PDFs actively involved in research across various institutions in the country.
- Organization of awareness program on R&D equipment/ facility for school students (Science stream) in catchment areas by means of short training and popular science events.

The Awareness programs were organized by the STUTI PMUs from 22nd-28th February 2022, the week designated to the Mo S&T by the Ministry of Culture under the 'Azadi ka Amrit Mahotsav' festivities. **7500** school students belonging to Science stream participated in various Science Popularization events organized by the PMUs all over the country. Special emphasis was given for participation of Girl students and students belonging to the disadvantaged sections of the society. Majority of the students were from Government schools of the country.

A total of **192** training programs were organized under this Scheme during the year 2022 and around **6500** researchers have been trained under STUTI.



Fig. Inauguration of STUTI Training Program at BITS, Goa by Mr. Pramod Sawant, Chief Minister of GOA



Fig. School students being familiarized with sophisticated instruments in STUTI Training Program



Fig. STUTI Training Program at Panjab University, Chandigarh



Fig. Training Program at Pt. Ravishankar Shukla University, Raipur, Chhattisgarh

1.1.6 SUPREME- Support for Upgradation Preventive Repair and Maintenance of Equipment

Department of Science & Technology recently announced a new initiative for the revival of major facilities established by DST Projects. Under “SUPREME” the support would be provided for repair/ upgradation/ maintenance/ retrofitting or acquiring additional attachment to increase functional capabilities of existing analytical instrumentation facilities (AIFs) supported by DST in various Institutions/laboratories/academic institutions.

1.2 State Science and Technology Programme (SSTP)

State Science and Technology Programme (SSTP) of DST supports State Science & Technology Councils for their S&T Human Resources to strengthen the Science Technology and Innovation (STI) ecosystem in the States. A yearlong program “Vigyan Utsav” initiated on 2nd September 2021 was concluded on 31st August 2022 along with the annual meet of State S&T Councils in Bhopal in the gracious presence of Hon’ble Minister of Science and Technology Madhya Pradesh, Shri Om Prakash Sakhlecha. During this program, 270 sessions on the 12 identified themes were virtually organized viz. *STI Institutions at the State level; Human Resource Development; R&D Infrastructure; Indigenous Technologies; Innovation & Start-ups; Science Communication & Popularisation; Women Scientists, Science & Society, Future Technologies, Basic Science for Atmanirbharata, Atmanirbharata & Industry and Intellectual Property Rights*. The sessions reached out to 6 lakh stakeholders through various social media platforms. A compendium on the STI ecosystem at the State level was prepared to capture the state-wise strengths and weaknesses of identified components for future policy initiatives.

- **Assam Science Technology & Environment Council (ASTEAC)**

ASTEAC hosted the National Conclave on “S&T Empowerment of Tribal Community” on 11th & 12th November 2022 at IIT Guwahati in collaboration with IASST, NECTAR and

Vigyan Prasar. The conclave was organised by DST, Govt. of India, in coordination with the Ministry of Tribal Affairs. The conclave was attended by stakeholders from Knowledge Organisations, R&D Labs, Civil Society, Social Entrepreneurs, Grassroots Innovators, Beneficiaries and change-makers from Tribal Communities. It brought out strategies and recommendations for strengthening the Institutional and Human Capacity for the comprehensive development of Tribal Communities through S&T.

- **State Council of Science Technology & Environment (SCSTE), Meghalaya**

The SCSTE, Meghalaya, for the value addition of raw ginger and pineapple, installed Solar Consistent Dryer in collaboration with PLUSS Advanced Technologies Pvt Ltd, Haryana, Clean Energy Access Network, New Delhi & EmSys Electronics Pvt Ltd, Bengaluru. SCSTE initiated E-Learning Classroom at Bolmoram Training Centre for the quality education of village children. SCSTE, Meghalaya has also installed 5 Biogas digester units at Mawlong Nongtluh Model Village, Kyiem Model Village East Khasi Hills, Upper Nongbak Apal Model Village East Garo Hills, IDP Upper Shillong East Khasi Hills and Ferrando Inclusive Education Centre Nongdiengngan.



Fig. Glimpse Two days Conclave on “Science & Technology Empowerment of Tribal Community”

- **Mizoram Science, Technology & Innovation Council (MISTIC)**

MISTIC has facilitated the establishment of 10MT solar cold storage developed by Inficold India Pvt. Ltd at the KVK Campus, Khawzawl, Mizoram, with the support of NECTAR. MISTIC also published a booklet, ‘Zoram Mil Technology’, containing the lists of relevant technologies developed by CSIR labs and institutions in the local language. A Centre for Mushroom Production at Young Mizo Association (YMA) Sub-Headquarters building, Mizoram. The Centre also extended technical support to young entrepreneurs.



Fig. Solar Cold storage installed at KVK Campus



Fig. Centre for Mushroom Production

- **Kerala State Council for Science Technology and Environment (KSCSTE)**

KSCSTE has facilitated establishment of a GIS lab under the Scheduled Caste (SC)/ Scheduled Tribe (ST) Cell. KSCSTE is implementing the 'Aspiring Students in Progressive and Innovative Research and Education (ASPIRE)' program in association with Scheduled Tribe Development Department to provide exposure to ST students about the culture of innovation through visits to R&D Institutes of Kerala.

- **Karnataka State Council for Science and Technology (KSCST)**

Rainwater Harvesting (RWH) Cell at KSCST is intensively working towards technical guidance and preparation of DPR which resulted in adoption of RWH by 500 institutions in the state and more than 1,75,000 residential properties in Bengaluru. KSCST in collaboration with Bangalore Water Supply and Sewerage Board has established RWH Helpdesk at Sir M. Visweswaraya RWH Theme Park to create awareness and training programs. During 2022, 8 awareness and 3 training programs were conducted for general public, architects, contractors and engineers.

- **Patent Facilitating Programme**

The Patent Facilitation Programme (PFP) of DST is being implemented through Patent Facilitation Centre (PFC) established at TIFAC, and the Patent Information Centers (PICs) established at State S&T Councils. The program creates IPR awareness and technical understanding of patents, facilitates patent filing, obtaining and maintaining patents, and provides patent information as input to R&D and handling IPR policy matters. In its endeavour to facilitate the filing and prosecution of patent and other IPR applications on behalf of academic institutions and government R&D institutes, PFC has filed 37 new patent applications, 2 Integrated Circuit (IC) Layout Design applications after due assessment of patentability of about 61 new inventions and 2 IC Layout Design requests. The details of nine Indian patents, two European and one US Patent granted during 2022, are given in Table-I.

Table-I: Patents granted during 2022

Indian Patents				
S. No.	Patent No.	Date of grant	Applicant	Title
1	394194	04.04.2022	Central Manufacturing Technology Institute, Tumkur	Reinforced cement concrete machine tool structure
2	396866	13.05.2022	Dibrugarh University, Dibrugarh	A multipurpose utility vehicle for loading and offloading materials such as litter, building material and the like
3	400170	28.06.2022	All India Institute of Medical Sciences (AIIMS), New Delhi	Cancer detection system
4	401416	15.07.2022	Banaras Hindu University, Varanasi	Novel composition for controlling storage pests and mycotoxin production
5	402928	03.08.2022	Panjab University, Chandigarh	Composition and system for transdermal delivery
6	408183	30.09.2022	Indian Association for The Cultivation of Science, Kolkata	Diaguanosine derivatives as synthetic membrane channels for drug delivery applications
7	408696	10.10.2022	Panjab University, Chandigarh	Method for Bacterial Cell Lysis and Bacteriophage DNA Isolation
8	411397	14.11.2022	Indian Institute of Technology (Banaras Hindu University), Varanasi	A bioreactor for culturing of living cells or tissues
9	411698	17.11.2022	Bose Institute, Kolkata	De Novo designed novel antimicrobial and antiseptic peptides and its application against plant pathogens
European Patent				
10	3191844	20.04.2022	Indian Institute of Science IISc, Bengaluru	Electrochemical biosensor method of sensing Albumin and its complexes
11	3294125	08.09.2021	Indian Institute of Science IISc, Bengaluru	Device and method for detecting creatinine and albumin to creatinine ratio
US Patent				
12	11435344	06.09.2022	Indian Institute of Science IISc, Bengaluru	Electrochemical biosensor method of sensing Albumin and its complexes

PFC organised a one-week training programme on “Understanding, Scouting, Protecting and Utilizing Intellectual Property from North East” at North Eastern Technology Demo Centre of NECTAR Guwahati in collaboration with NECTAR. Significant achievements of some of the Patent Information Centres (PICs) during 2022:

- PIC Assam facilitated the filing of 2 patents, 1 Geographical Indications (GI) and granting of 1 patent and Geographical Indications (GI) tag to Gamosa.
- The Geographical Indications (GI) tags were granted to Myndoli Banana, Goan Khaje and Harmal chilli with the technical support of PIC-Goa.
- PIC-Kerala has assisted in filing two patents, granting 5 patents and establishing 2 IPR Cells (SCMS School of Technology and Management and Adi Shankara Institute of Engineering and Technology) for providing IPR support to the Institutions.
- PIC-Himachal Pradesh has filed the GI applications of Chamba Metal Craft, Sirmouri Loiya, Himachali Cap and Sepu Vadi.
- PIC-Manipur has facilitated filing 7 Trademark applications, one Design application, the registration of 4 Trademarks, and the establishment of 5 IPR cells.
- PIC-Mizoram has facilitated the granting of patents to “Sacramental Wine Dispenser” and “Slicing Machine for Ginger and Turmeric” and registration of 2 Trademarks.

1.3 Policy Research Cell

Policy Research Cell (PRC) under Policy, Coordination and Programme Management (PCPM) division in Department of Science and Technology (DST) is mainly focused to promote STI policy research in the country and gather evidence-based input for future policy making in STI related areas. Under the programme, Centres for Policy Research (CPRs) in national academic institutes have been established across the country with the objective of strengthening the Policy Research Mechanism for generating evidence-base for policy planning. Similarly, a policy fellowship programme (PFP) is being supported with the aim to generate a pool of critical mass of the policy researchers in the country.

During the current year, two CPRs are being supported under the programme: (i) Panjab University, Chandigarh; and (ii) Indian Institute of Science, Bangalore. Additionally, two cohorts, 4th and 5th are currently working under the DST STI Fellowship programme.

1.3.1 Centres for Policy Research (CPR)

DST-CPR at Punjab University, Chandigarh:

It was established in the FY 2013-2014 and has been contributing in the policy research in different S&T sectors. In the FY 2022-23, the CPR had worked broadly in three different directions:

- (a) Development of a new country specific model for promotion of Public Private Partnership (PPP) for R&D.
- (b) Identify areas of policy gaps for stimulation of private sector investment in R&D and suggest changes in policy environment.
- (c) Adopt evidence-based approaches for identifying and promoting areas for generation of intellectual properties.

Development of a new country specific model for promotion of Public Private Partnership (PPP) for R&D: Studies in the domain of Industry-Academia (I-A) collaborations and public-private partnerships (PPPs) were initiated by collating data pertaining to resources and initiatives in India which fostered collaboration amongst the public and private sectors. This study provided evidence based recommendations for developing a robust and vibrant I-A R&D ecosystem. *Establishing an Apex Level [National Industry-Academia Centre (NIAC)]; Creation of national level Industry-Academia Web-Portal; Establishment of Translational Research Ecosystem (TRE) in Universities; Establishment of Industry Research Assistance Council in funding agencies; Mandating the partnership of Universities with DSIR Accredited R&D Units and National Research Labs, etc.* were a few of the prime recommendations of the study.

Studies of PPP initiatives globally were undertaken and a Suggestive Roadmap for Strengthening R&D Ecosystem through PPP, especially for developing countries based on the best practices followed world over was developed. The study on international models of PPP generated key recommendations, such as *Remodelling NRLs for Enhancing PPP in R&D (on the lines of Fraunhofer and Catapult Institutes); 'Fast-Track R&D Fund' for Assistance to Micro-Industries; Cluster Programme' for Risky & High End Innovations; Establishing Industry-Academia Chairs; Introduction of Vouchers; Mobilising Researchers/Scientists from Academia to Industry and vice versa; Positioning Moderators between Industry and Academia, etc.* a few of which have materialized into entities such as Technology Enabling Centres, Biomedical Hubs, etc.

Identify areas of policy gaps for stimulation of private sector investment in R&D and suggest changes in policy environment: India's aspiration to enhance its Gross Expenditure on R&D from current 0.7% to at least 2% requires more than 50% of private sector contribution (current nearly 36% levels (NSTMIS, 2019)) to the national R&D ecosystem. The study of public private partnership and policy interactions in the agricultural innovation system of India aimed to find the policy gaps, and addresses the issues related to the knowledge and technology transfer in agriculture. Despite an enhancement of 33 times in private investment in agricultural R&D, India has been unable to achieve its target of 1% agriculture GDP. This indicates the requirement to study the detailed policy gaps in the current agriculture R&D system to stimulate private investment and utilization of resources in a methodical and transparent manner.

In addition to that, regulatory norms associated with provision related to R&D tax incentivization and patent box regime should be streamlined for attracting the private sector to the national R&D ecosystem.

Adopt evidence-based approaches for identifying and promoting areas for generation of intellectual properties:

The Centre has conducted various studies and activities to understand the IP ecosystem in India. As per the findings of the studies, there is lack of awareness on IP issues and because the process of seeking the protection of IPs is time consuming and costly affair, the inventors opt for publishing their research in public domain instead of securing legal rights over it. Further Indian patentees are reluctant to file working statements (Form-27) of the patents granted to them and those who are submitting the form are mentioning infirm reasons for non-working status of the patent. To resolve the issues of working of the patents granted it is recommended to create a dedicated body to look after the causes hampering the working of the patents and make patentees aware about the seriousness of commercialization of their research. In addition, region wise studies are being conducted to understand the impact of parameters like innovation, IP filings/grant and technology commercialization in each of these universities/institutes in the Northern region of India. The ultimate aim is to suggest a model for enhancing the translational research ecosystem through technologies generation, I-A collaborations and the triple helix model.

Significant Research Achievements:

On the invitation of North-Eastern Development Finance Cooperation Limited (NEDFi), Guwahati, Assam under the Ministry of Development of North Eastern Region (M-DoNER), a roadmap for development of the Bamboo sector in North East India was formulated. Depending on the success, the proposal will be implemented in other regions of India. NEDFi has been instrumental in assisting the Government of India in policy formulation and research which are of economic and industrial importance. A series of stakeholders meetings with experts and institutes within and outside the country was held and a report has been submitted. The end users of the report are the M-DoNER, NITI Aayog and Prime Minister's Office.

Other detailed outcomes of the CPRs can be accessed at <https://ppprnd.puchd.ac.in>.

DST-CPR at Indian Institute of Science, Bangalore:

It was established in the FY 2014-2015 and has been contributing in the policy research in different S&T sectors. In the FY 2022-23, the CPR was pursuing the research on the four different themes as given below;

The Centre at IISc has been pursuing research on the following themes:

- Sectoral Research & Innovation
- Open Science
- STI Diplomacy
- Higher Education

Sectoral Research and Innovation

Innovation & Entrepreneurship: Innovation and entrepreneurship are widely recognized as the engines of economic growth and development. It is important to analyze the major drivers, barriers, opportunities, and challenges to entrepreneurship in the country. Thus, under the mandate, the Centre is focused on analyzing policies and programs for promoting science and technology driven entrepreneurship, institutional practices conducive to the process of exploitation of entrepreneurial opportunities, knowledge spillovers, and R&D funding.

Rare Diseases Research Ecosystem: Science policy interventions play a central role in the advancement of research in rare diseases. The Centre's work on rare disease research ecosystem is focused on (a) studying the impact of public policy and public health interventions on the quality-of-life outcomes of persons with rare diseases, (b) stakeholder-mapping and analysis of public policies for promoting rare disease research in India, and (c) implications of open data practices for rare disease research and treatment.

Open Science

Open science is an umbrella term referring to verticals like open access, open research data, open research protocols, sharing of research infrastructure, and citizen science. In continuation of the Centre's research on studying the knowledge dissemination component, especially the ongoing transition in scholarly communication practices, this work focuses on critically examining strategies and policy choices for open access publishing and open science practices in India. Use of scientometric method is a key feature of the project. Another focus of this project is on preparing a policy framework for citizen science in the country.

STI Diplomacy

Science, Technology, and Innovation (STI) Diplomacy is being increasingly used by countries around the world as an important instrument in foreign policy and diplomacy activities. The Centre's research on STI diplomacy is focused on (a) studying the role of STI, particularly in emerging technologies, in India's foreign policy agenda, and (b) examining relationships between India's STI capabilities and foreign policy goals, and (c) developing policy options for India's efforts in STI diplomacy.

Higher Education

Higher education institutions play a central role in developing the human, social, and knowledge capital of the STI ecosystems. The Centre's work on higher education is focused on: (a) Scientometric studies of publications from Indian institutions with a view to elucidate their research productivity and strengths in different fields of science and technology, and (b) a study on doctoral education in India whose aim is to assess the level and quality of training received by doctoral students to prepare them for both academic and non-academic careers.

Significant achievements of the centre can be summarized as follows;

Open Science: The project on Open Science deals with four verticals, Open Access, Open Research Data, Responsible Research Assessment and Citizen Science. The main tasks undertaken under this project are; Identifying the barriers and opportunities in achieving an open science ecosystem, and possible policy instruments for facilitating the transition towards an open science paradigm; Current status of open access and open research data (ORD) policies at the national and international level, and recommended policy actions in the Indian context; Policy actions to transform the present research assessment criteria towards a robust, flexible, and more practical approach;

Rare disease project is focused on understanding the Rare disease ecosystem of the country, and identifying the existing facilitators and barriers. This is followed by finding policy and public health interventions to address these challenges. Firstly, in this process, to understand the ecosystem, Rare disease stakeholder mapping is being done which will help to identify different stakeholders in the ecosystem and help to map their position and influence with respect to each other. Additionally, a survey was done to understand the awareness level of Healthcare Providers and Researchers about Rare Diseases in India. Secondly to identify existing facilitators and barriers various national public health programs have been reviewed and their potential to integrate Rds has been assessed. In this National Health Mission and Rashtriya Bal Suraksha Karyakram were found to be the most promising programs that can be easily expanded for Rare diseases (see Section 11a iv). Also, studies were carried out to understand the availability and accessibility of Orphan drugs. Finally, dissemination is being used as a tool both to take stakeholders' input into the research and to take research output to the stakeholders. Thus, the research is helping in generating awareness among key stakeholders as well as documenting the voice of these stakeholders. Centre is building collaboration with various national and international bodies and experts in Rare disease area to integrate wider perspectives in generating evidence for policies that would impact Rare diseases.

STI Diplomacy work in this period focused on two aspects: 1) Conceptual understanding of motives and mechanisms of tech diplomacy (section 11b iii), and 2) Emerging technologies as foreign policy instruments (section 11b iv,x,xi). Together, these working papers explore the interface of technology and foreign policy and highlight different trends. Especially, the contrast between the Global North and Global South is analysed in this research.

Research and Innovation: The work on informal innovations in India revolves around two aspects: 1) The desk research is done to identify the published studies on the topic of grassroots innovations and informal sector innovations. 2) The empirical work is concerned with the innovations in informal settings by taking the case study of makerspaces in India. The objective of the desk research was to search the research articles using scientometric methods to identify the research communities working in the domain of informal and grassroots innovations. Similarly, the empirical study (undergoing) aims to analyse the

funding, networking, knowledge sharing, and knowledge appropriation mechanism of informal innovation communities in India.

Additionally, the centre has published the articles/reports, conducted week seminars, symposium series & workshop, developed few collaborations and trained the personals towards the capacity building. The detailed centre's activities may be see through the Web Portal, via www.dstcpriisc.org.

1.3.2 STI Policy Fellowship Programme

Apart from the CPR activities, a DST-STI policy fellowship programme has been supported since 2016. The fellowship is supported in three categories: Senior Policy Fellows (SPF), Post-doctoral Fellows (PDF); and Young Policy Professionals (YPP). These policy fellows are being assigned with a defined research topic in the area of STI policy domain. During the year, fellowships were supported to the fourth and fifth cohorts of the fellows.

1.3.3 Expanding the Network of DST-CPRs

Currently, two DST-CPRs are running, one at IISc Bangalore and other at Panjab University, Chandigarh in specified policy research domains. As per the recommendation of the advisory committee, DST has invited proposals to expand the network of CPRs to e established in other specific domains and also representing other geographic regions of the country. The final selection of the proposals for establishing the new CPRs and SPRs is under process. To strengthen the network of Policy Research in the country, DST under the PRC is attempting to also establish Satellite centres for Policy Research in the country in addition to the CPRs.

1.3.4 Status of Draft of 5th National STI Policy

For India to achieve “Atmanirbhar Bharat” and holistic developments, several challenges and gaps need to address in different S&T sectors. It demands the new/modified national STI policy to meet the future aspirations at global platform. In this regard, formulation of a new, 5th national STI policy was initiated during the early of 2020. Currently, the STI policy draft is under the process for final approval.

1.3.5 Centre-State Coordination on STI areas

One of the goals in the new draft policy is to strengthen Centre-State coordination and collaboration mechanism in building a strong STI ecosystem and promoting innovation and entrepreneurship. As a first step in this direction, DST through its team of Policy Research Fellows has undertaken an exercise of preparing a detailed STI mapping to capture the STI ecosystem of each State and Union Territory in terms of research, higher education, innovation, incubators, start-ups, community-based organizations, industry, business opportunities, socio-economic parameters, policy initiatives, etc. Also, an attempt has been

made to identify some major problems, challenges, gaps areas, faced by the States including key weaknesses in the ecosystem. This is being carried out through collecting and collating publicly available information and more so through one on one interaction with nodal officers of several States and UTs. This exercise is currently ongoing and is expected to provide a glimpse of broad landscape of the STI ecosystem prevailing across the Indian state & UTs.

1.3.6 State S&T conclave

In order to strengthen Centre-State coordination and collaboration mechanism for building a robust STI ecosystem and promoting innovation and entrepreneurship, the Department of Science & Technology, Government of India jointly with Government of Gujarat has organised a 2-day “Centre-State Science Conclave” at Science City, Ahmedabad on 10-11 September 2022.

The conclave was inaugurated by Hon’ble Prime Minister Shri Narendra Modi. The Conclave was participated by a number of S&T Ministers of States like Assam, Gujarat, Uttarakhand, Madhya Pradesh, Odisha, Chhattisgarh, Rajasthan and Uttar Pradesh; Science Secretaries to Government of India, Chief Secretaries and Principal Secretaries of States, senior officials from Government of India, Industry captains, over 150 start up, NGOs, young scientists and students.

The Conclave had a leadership session with S&T Ministers and 8 Plenary Sessions in different thematic areas like *STI Vision 2047; Future Growth Pathways and Vision for STI in States; Health - Digital Health Care for All; Doubling Private Sector investment in R&D by 2030 and supplementing national and state level economy; Agriculture - Technological interventions for improving farmers’ income including Aroma Mission and Purple Revolution; Water - Innovation for producing potable drinking water including the application of technologies like Desalination, Heli-borne methods; Energy- Clean Energy for All including S&T role in Hydrogen mission; Deep Ocean Mission and its relevance for Coastal States/UTs as well as country’s future economy*. On the sidelines of the event, we have organised a Science Expo, which provided a platform for showcasing of emerging technologies developed by industries, start-ups, and R&D institutions



Fig. Hon’ble PM addressing in the Inaugural session of the 2-day “Centre-State Science Conclave” at Science City, Ahmedabad on 10-11 September 2022.

1.4 National Science and Technology Management Information System (NSTMIS)

National Science & Technology Management Information System (NSTMIS) has been entrusted with the task of building the information base on resources devoted to scientific and technological activities for policy planning in the country. The programme continued its efforts of generating and making available information on human as well as financial resources devoted to scientific and technological (S&T) activities by conducting national surveys conducted both through in-house as well as sponsored studies. As a result, a large number of structured information resources are being published by the Division in the form of reports, directories, statistical data, and other forms of documents. These publications are acclaimed both nationally and internationally and are widely referred to by scientists, funding agencies, planners, policy makers, scholars and academicians.

1.4.1 S&T Resource Studies

The data collection for National Survey 2021-22 on resources devoted to research and development activities is in progress. So far the survey response rate is a little over 65% out of around 6500 R&D organizations comprising of public sector, private sector, MNCs, higher education, SIROs and NGOs spread across the country. Checking of consistency of survey data as received and e-reminders to enhance the response rate is in progress. Based on the outcome of the survey, the next issue of national publication “**Research and Development Statistics**” is likely to be published early next year which would serve as an evidence base for the policy formulation in the S&T sector.

A survey entitled ‘India Innovation and Systems Survey 2019’ in collaboration with UNIDO, Austria is in progress. As part of the project, 2 surveys for undertaking survey of the Indian manufacturing sector were conducted: first, the firm-level innovation survey and second, the system of innovation survey. Both of these have a different yet complementary focus. The firm level survey involves surveying and assessing the innovation capabilities in manufacturing firms across the 58 sectors of the National Industrial Classification (NIC), from all 36 States and UTs in India. The sectoral system of innovation (SSI) survey involve mapping and measuring India’s ‘systems of innovation’ in 5 select sectors to evaluate the impact of the ecosystem for innovations in manufacturing sectors such as automotive; Food and beverages; textile and apparel, ICT and pharmaceutical. The survey aims to develop innovation indicators so as to understand the role of innovation and knowledge creation activities with the growth and benchmark the performance of the national innovation system. The data collection for National Manufacturing Innovation Survey (NMIS) have completed through 13,885 successful interviews. The initial findings from the survey data are currently being analysed through stakeholder meetings. As a part of the survey, a combined study tour to Japan and South Korea was organized to learn and adopt the best practices for their inclusion in the NMIS report for providing an impetus to the Indian innovation ecosystem. The final report is expected to be brought out during the year.

1.4.2 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 2019-20 and 2020-21 are being compiled and will be published together.

1.4.3 S&T Policy/ Guidelines

The guidelines on Scientific Research Infrastructure Sharing Maintenance and Networks (SRIMAN) and Scientific Social Responsibility (SSR) were launched on Technology Day on 11th May 2022.

SRIMAN aims at providing better access and sharing of public funded scientific research infrastructure and simplified but smarter ways of procurement, maintenance and disposal of scientific research infrastructure.

SSR seeks to harness the latent potential of the scientific community on a voluntary basis, strengthening science and society linkages and thereby making the S&T ecosystem responsive to societal needs. This primarily involves bridging science-society, science-science and society-science gaps, thereby bringing trust, partnership and responsibility of science at an accelerated pace towards achieving social goals.

1.4.4 NSTMIS Sponsored Studies

As a part of its outreach research programme, NSTMIS has sponsored several research studies/projects to various stakeholders viz. research institutions, universities, colleges, NGOs and consultancy organizations spread across the country.

The Program Advisory Committee (PAC) of experts for implementation of the NSTMIS Scheme recommended 11 proposals for funding under the scheme. At present, there are more than 35 on-going projects in the scheme. Key outcomes of some of the projects supported under the NSTMIS scheme are as under:

- Share of ‘Green Chemistry’ in Indian Chemistry Journals: A Comprehensive Bibliometric Study- This Bibliometric Study, has been published as a Focus Book by CRC Press Taylor & Francis, USA, entitled- “Green Chemistry in Scientific Literature: A Bibliometric Study and Research Trends”.
- S&T Research Impact and the contributing factors: Analysis of cross national data- Based on this study, 3 articles have been submitted for publication in ALIS (Published by CSIR-NISCAIR).

- Design & Development of Comprehensive Database of Indian Research Output in Physics and Space Science & Technology since independence under NSTMIS- Under this project, a bibliographic database of Indian physics and astronomy research output appeared in Indian journals since independence, i.e. from 1947 to 2019 was developed. The results of the scientometric analysis are presented in three articles and three more are under review process.
- Data Mining and Analysis of Indian Origin Academicians in Foreign Universities for Exploring Opportunities of Academic Interaction - As a part of this study, a database of 25543 out of which 1161 from BRICS having Indian origin academicians, scientist and research scholars from four major countries i.e. Australia, Canada, UK and USA has been developed. A MIS (Management Information System) has also been designed to search the database. A US patent application have been filed for 'Focused Web Crawling and Method Thereof' and 9 paper/articles have been published based on the study.

The completed project reports/studies are available in public domain through a web-based digital repository (<http://www.nstmis-dst.org/NSTDRepository.aspx>).

1.4.5 International Collaboration

The Department actively participates and contribute 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.

1.5 Training of Scientists and Technologists Working in Government Sector

Department of Science & Technology, in consultation with DoPT, other Scientific Departments and various organizations initiated an ambitious project of Human Resource Development namely "National Programme for Training of ScientistS&Technologists working in Government Sector" during the X Plan to meet the challenges of national development and international competitiveness in S&T area and since then it has been continuing considering the efficacy of the Scheme. Training imparted to ScientistS&Technologists strives to achieve better understanding of professional requirements, enhancing professional knowledge and skills needed for better performance.

"Scientists/ Technologists holding scientific posts/ working in scientific ministries/ departments of Govt. of India and State Governments, Autonomous Institutions/ Public Sector Undertakings of Central/ State Governments, Research and Development Institutions/ Research Laboratories of Central/ State Governments, Central/ State Universities, State Science &

Technology Councils” are targeted. During 2022-23, thirty - one training programmes were approved under this scheme under General component and 1000 scientists are likely to benefit from these training programmes. In addition, nine online training programmes were approved exclusively for women scientists under Women component of the Programme, in which approximately 350 women scientists are likely to be benefitted.



Fig. Training program at the Art of Living International Center, Bengaluru

1.6 Women in Science and Engineering-KIRAN (WISE-KIRAN)

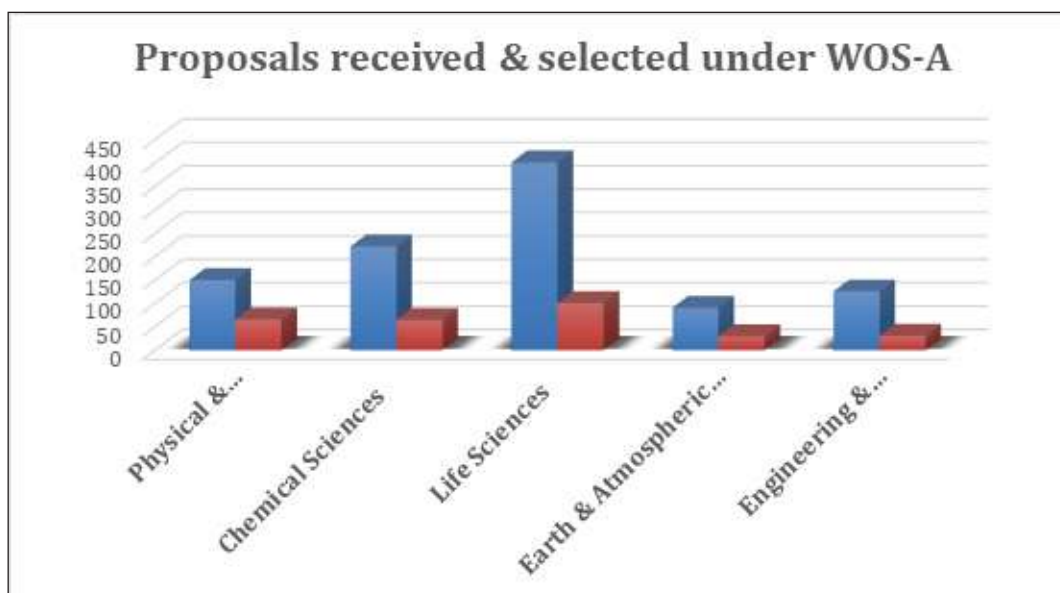
The Women in Science and Engineering - KIRAN (WISE-KIRAN) Scheme of the Department of Science and Technology aims to provide various opportunities to women in Science & Technology domain with ultimate goal to bring gender parity. WISE-KIRAN Scheme is coming up with new programmes which will create a smooth path for girls and women in STEM careers. The achievements of various programs under KIRAN during the year 2022 are as follows:

Human Resource Development

Women Scientists Scheme: Women Scientists Scheme is providing different kinds of opportunities to women who had break in their scientific career through its three components viz. WOS-A (in basic & applied sciences), WOS-B (S&T interventions for societal benefit) & WOS-C (in the area of Intellectual Property Rights).

Women Scientists Scheme-A (WOS-A): WOS-A provides opportunity to women scientists for research in 5 subject areas of basic and applied sciences. This year 19 Subject Expert Committees Meetings have been conducted wherein around 990 project proposals have been evaluated for final recommendations. Total 293 projects have been selected in 5

streams viz. 66 in Physical & Mathematical Sciences, 65 in Chemical Sciences, 101 in Life Sciences, 30 in Earth & Atmospheric Sciences and 31 in Engineering & Technology. Besides this, Subject Experts have also extended mentoring in few projects for strengthening the study and 51 such projects have also been recommended after minor revision. The grant has been released in around 110 new projects and 82 ongoing projects. Women Scientists have published more than 420 Research Papers in SCI Journals through their WOS-A projects.



Women Scientists Scheme-B (WOS-B): The programme is promoting women to use their S&T knowledge and experience to address societal challenges related to agriculture, health, food, nutrition, drudgery reduction, livelihood generation, waste management, energy, etc. During this year, grant has been released for 9 ongoing projects. More than 30 publications have come out from the ongoing WOS-B projects.

Women Scientists Scheme-C (WOS-C): The program provides opportunity to women with mid-career break and having qualifications in S&T to pursue their career in the area of Intellectual Property Rights (IPR). The training for 98 women scientists selected under 12th batch was started followed by on-the-job training at various agencies across the country under 4 Coordination Centres at Delhi, Bengaluru, Pune and Kharagpur. During on-the-job training women were exposed to various aspects of IPR which included patent searching, filing, prosecution, patent analysis, preparing technology scan reports, etc. During the year, 8 workshops were organized at all the centres on Patent Drafting and Copyright, Trademark, Industrial Designs and Geographical Indications for beneficiaries. Women scientists have also celebrated World IP Day at centres on April 26, 2022.

This year, 116 women from 11th and 12th batches cleared Patent Agent exam conducted by Patent Office of India. A specialized training was also provided to women scientists to clear this exam. After clearing this exam, the women can start their own enterprise.



Fig. Workshop at Delhi Centre on November 17-18, 2022

Vigyan Jyoti: Vigyan Jyoti Programme of the Department of Science & Technology became highly popular among girls due to various innovative activities. The programme aims to encourage girls to pursue higher education and career in STEM (Science, Technology, Engineering and Mathematics) especially in the areas where women participation is low in order to balance gender ratio across the streams. During 2022, the programme is extended to 200 districts (including 13 aspirational districts) of 34 states/ UTs of the country. Vigyan Jyoti is providing various interventions to around 20000 meritorious girls of Class IX-XII from JNVs, KVs, Army and other Government Schools in Phase-III at Vigyan Jyoti Knowledge Centres, i.e. JNVs in collaboration with Knowledge Partners such as IITs, NITs, IISERs, National R&D labs, Central/ State Universities, etc.



Fig. Visit to various Knowledge Partners, organized during 2022

During the year 2022, around 801 online special classes/ lectures were conducted covering basic and complex concepts of Physics, Chemistry, Mathematics and Biology which are important to qualify entrance examinations. More than 180 lectures, from eminent scientists/ role models were also organized. Further, 11 science camps, more than 65 visits to KPs/

Industries/Labs, 36 ATL workshops and around 200 student-parent counselling sessions were organized.

Special Events/ Interventions during 2022:

- **National Girl Child Day** was celebrated under “Azadi ka Amrit Mahotsav” and Dr. Amita Dev, Vice Chancellor IGDTUW, New Delhi delivered an Inspirational Talk on the Topic “Girls with Dreams Become Women with Vision”
- **International Day of Women and Girls in Science:** The occasion was celebrated through various activities. Secretary, DST inaugurated the event and released Vigyan Jyoti logo, e-Brochure and the Vigyan Jyoti portal. Dr. Tessy Thomas, Director General, Aeronautical Systems, DRDO graced the occasion as Chief Guest and inaugurated 3-day Science Festival followed by a lecture on “The Sky Is Not the Limit”
- **Science Festival** was organized in collaboration with AIF and Science Utsav, Bangalore in virtual mode for all the girls of Class IX-X. The festival includes separate activities for each day viz., Science of Wizards (Day 1), Amazing Astronomy and Space (Day 2) and Medical Investigations (Day 3).
- **Career Counselling Sessions** have been organized in February 2022 for the students of Class 12. Prof. Jasdeep Kaur Dhanoa, Dean (Academic Affairs) and Training & Placement Officer, Indira Gandhi Delhi Technical University for Women, New Delhi shared various career options available for girl students after Class 12.

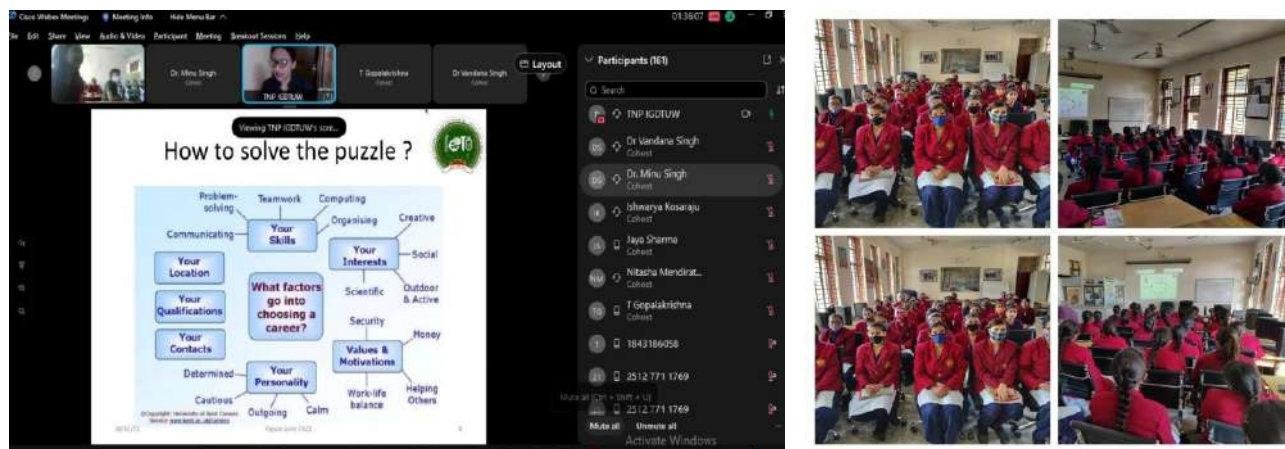


Fig. Career Counselling Session

- **All Girls Math Nurture Camp (AGMNC):** Seven sessions were conducted during January-February 2022. These sessions include topics such as Counting, Sorting, Pigeon Hole Principle, Proof by Story, Computer Science Perspective and experiments in probability.

- **Curriculum based STEM Workshops:** Fourteen Curriculum-based STEM workshops (C-STEM) have been conducted during 2022 for Class IX-X girls. A STEM kit also distributed to all girls enrolled under Vigyan Jyoti to conduct various activities for easy learning of Science Principles.



Fig. STEM Workshops & Kit Distribution

- **HT Codeathon:** One of India's largest Coding Olympiads was conducted by Hindustan Times in collaboration with IBM for students of class IX-X. At the end, 24 girls received certificate for Best Participation in the activity.
- **Python coding sessions:** Twenty sessions including practical were conducted for the Class IX-X Vigyan Jyoti scholars of Phase III by Tinker Coders in collaboration with Team IBM-AIF to make students learn fundamentals of coding via the Python programming language.
- **EY-STEM App:** The EY-STEM App has been introduced to Vigyan Jyoti students for exploring STEM phenomena during the summer holidays which has around 450 activities focusing on STEM, social and emotional learning.
- **National Talent Search Examination (NTSE) Aspiring Scholar Series:** Ten sessions had been conducted for 10,000 students of class IX-X in collaboration with American India Foundation for the preparation of NTSE and other competitive examinations.

- **Sparkle Series:** Sparkle Series was organized for girls of Class XI-XII in collaboration with Center for Creative learning (CCL), IIT Gandhinagar. This series is aiming for teaching of curriculum-based topics on Science, Math, and Computational Thinking through storytelling, experiential sessions, and discovery of fun facts. Total Seven sessions were conducted on various topics of Physics and Maths.
- **STEMPORIUM:** Two edition of Vigyan Jyoti e-newsletter has been issued with the objective to highlight the work of the Vigyan Jyoti Programme in promoting STEM education among the girl students across the country. It will also serve as a medium of 'edutainment' for the students to enhance their general knowledge in the field of STEM in a fun way.



S&T INFRASTRUCTURE DEVELOPMENT

CURIE (Consolidation of University Research for Innovation & Excellence) Programme:

During 2022, WISE-KIRAN Division announced a new component under CURIE (Consolidation of University Research for Innovation and Excellence) programme to support Women PG Colleges of the country. In this call, proposals have been received from 92 Women Colleges. Division has conducted Screening Meetings and Programme Advisory Committee (PAC) Meetings to evaluate these proposals. Finally, 25 Women PG Colleges of 16 States/ UTs of the country have been selected for CURIE support to develop research facilities and infrastructure.

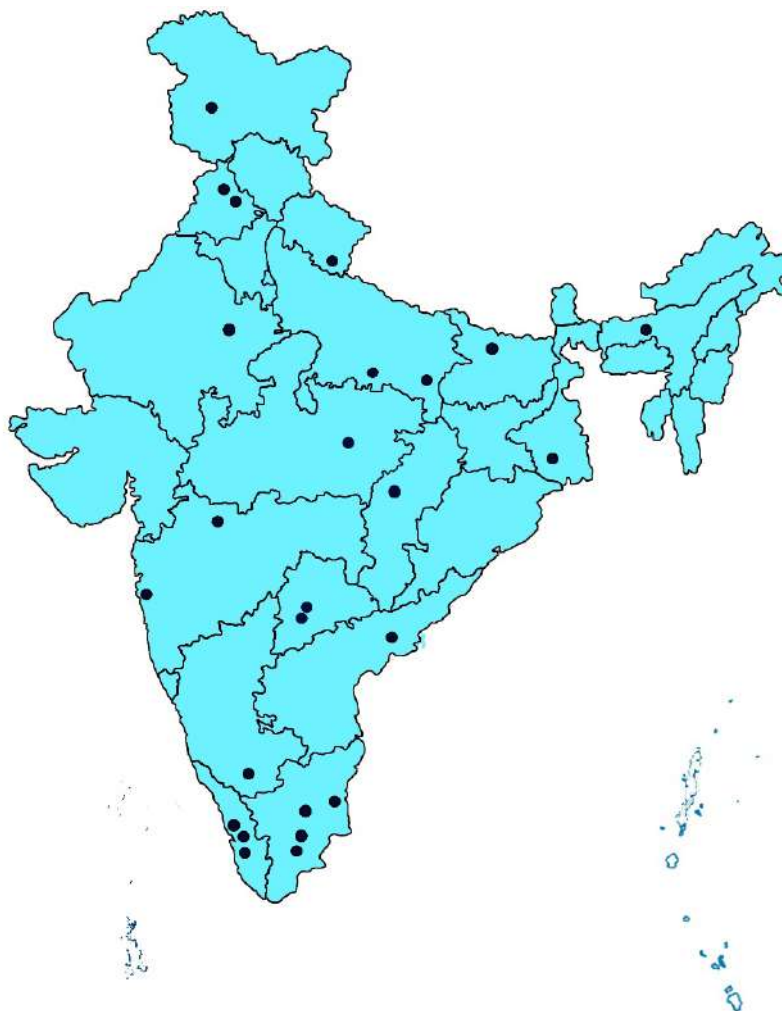


Fig. Map showing Women PG Colleges supported under CURIE

During December, another PAC meeting was organized to evaluate proposals received from three Women Universities for CURIE support. PAC members visited all the Universities to see the potential. PAC has also evaluated the progress of CURIE-AI project in Banasthali University, Banasthali (Rajasthan).

POLICY INTERVENTION FOR GENDER EQUITY

Gender Advancement for Transforming Institutions (GATI):

The new initiative “Gender Advancement for Transforming Institutions (GATI)” of DST is aiming to achieve gender equality in S&T through changes at policy level. Under GATI program an indigenous framework is being developed to assess and accredit institutions on the basis of gender sensitive approach. After completion of whole cycle of various activities,

the institutions will be recognized for their SMART action plans of gender equity. At present pilot of GATI programme is in implementation in 30 institutions of the country and during the year various activities have been conducted by WISE-KIRAN Division as well as institutions themselves. Few important activities are:

- **Study Visit:** GATI programme is inspired by Athena SWAN of United Kingdom (UK). This year DST Delegation has visited different institutions of UK for deeper understanding about implementation of Athena SWAN and also to share the unique concept of GATI program during the Diversity Interventions Conference organized by Advance HE, UK in Oxford. During this conference, DST Delegation interacted with participants from other countries and discussed some of the best practices in this area.
- **Launch of core webinar series:** Five Core Webinar introductory modules have been developed for pilot institutions under GATI. These modules are resource material for institutions on how to prepare themselves for self-assessment and make future plans in achieving Gender Equality in S&T.
- **Training Sessions for GATI Pilot Institutions:** 30 institutions have undergone training on how to do Self-assessment processes and also develop new action plans to empower women and girls of all levels in S&T area within the institutional ecosystem.
- **Workshops Organized:** More than 35 workshops/ interactions were organized for pilot institutions on various themes and topics, Self-Assessment Process, Data Collection Process and its Analysis, Action planning for success, Importance of mentoring in Gender Advancement, Experience of the Athena SWAN Application Process and Self-Assessment Team, Leadership in a gender balance culture, Building the evidence for Gender Empowerment, Lessons learnt and Good Practices, Maintaining momentum etc.
- **Progress Review:** Expert Advisory Committee (EAC) reviewed the progress made by GATI pilot institutions. Nodal Officers of 30 GATI Pilot Institutions and representatives of 6 UK mentor Institutions have participated in this EAC meeting at New Delhi. Indian Institutions have developed dedicated web pages under program which are expected to showcase the gender disaggregated data of institutions in Science and Technology. Institutions have completed more than 35 gender sensitization and awareness programs on women and girls in S&T.
- **Indo-UK Partner Summit:** DST and British Council jointly organized Indo-UK Partner Summit, in which Indian and UK partnering institutions were invited for detailed discussion on project updates, the topic of Self-Assessment and development of action plans under the process. They were also provided the knowledge of self-assessment application's evaluation processes by Advance HE, UK.

Outreach Activities:

International Women’s Day: The WISE-KIRAN Division has organized an event to celebrate International Women’s Day on March 8, 2022 at New Delhi. Hon’ble Minister of Science & Technology and Earth Sciences was the Chief Guest of the function. Dr Neeta Verma, DG, NIC, Dr Shekhar C Mande, DG, CSIR and Dr S Chandrashekar, Secretary, DST have graced the occasion. Hon’ble Minister announced age enhancement till 60 years in women centric fellowship programmes. As a part of Azadi ka Amrit Mahotsav, 75 Success Stories of Women Scientists Scheme-C (WOS-C) and a booklet on the programmes under WISE-KIRAN Division have also been released by the dignitaries.



Fig. Honorable MoS&T addressing the gathering on International Women’s Day 2022.



Fig. Release of WISE-KIRAN: At a Glance & 75 Success Stories from WOS-C booklets

Women Science Congress: The Department of Science and Technology supported 10th Women Science Congress (WSC) organised during 5-6 January 2023 as a part of 108th Indian Science Congress at Rashtrasant Tukadoji Maharaj Nagpur University. During this congress, contribution of women in all walks of life including STEM as well as conservation of biodiversity was highlighted. The experts discussed about role of S&T in Women

Empowerment; Opportunities in Food Science & Technology; Sustainable Development Goals; Science Communication, Role of Digitalization, etc. A panel discussion on 'Opportunities for Women in STEM' was also organised which was followed by experience sharing by stakeholders.



Fig. 10th Women Science Congress

1.7 Cognitive Science Research Initiative (CSRI)

Cognitive Science Research Initiative (CSRI) encourages research in highly interdisciplinary area of cognitive science that trying to address various questions through combining ideas, principles and methods of psychology, computer science, linguistics, philosophy, neuroscience etc.

1.7.1 Recommendations on New Projects:

Department has received 757 proposals from various areas of Cognitive Science. Division has conducted three rounds of screening to evaluate the proposals received under CSRI. 128 proposals have been shortlisted for final recommendation of CSRI-Task Force. Finally, 53 projects have been recommended for financial support of DST. These projects are covering diverse fields of Cognitive Science like neuroscience, Artificial Intelligence, Machine learning, Psychology, speech and hearing, linguistic, behavioural aspects, decision making, etc. The projects will also address some social issues like cyber bullying, OCD, cognitive disorders and rehabilitation of elderly, cognitive skills in youngsters, ADHD, alcohol dependence, etc. From

ongoing projects, 25 research publications come out during 2022.

1.7.2 Highlights of CSRI projects:

- **Computationally intelligent methods to provide visually impaired cognitive support for better learning**

Use of digital learning platforms and digital technologies can be a game changer in addressing the problem of visually impaired. The current project is implemented at Indian Institute of Technology Ropar aims to develop an automated classification method that automatically extracts the figures from provided document and classify them into pie chart, bar graphs, line plots, tables, etc. and also develop and implement a machine learning and NLP based algorithm to extract the content from them in a more meaningful manner (either via speech or printed on braille), that makes sense to the visually impaired person and helps one to clearly understand the conveyed information. It also would facilitate motivated visually impaired professionals in their job if that requires data analysis and interpreting graphs, plots etc. Findings of the study suggest that the non-textual components present a concise and summarized representation of the underlying information. Thus, understanding these components helps in a better and complete understanding of the document. The study proposes a novel Multi-Dilated Context Aggregation based Dense Network (MDCADNet) addressing the multi-resolution and larger receptive field modeling need for the non-textual component classification task. MDCADNet includes a densely connected convolution network for the feature map computation as front-end with a multi-dilated Backend Context Module (BCM).

Dataset Description

- The dataset is divided as follows:70% as training, 20% validation, and 10% testing

- A tool of seven categories have been chosen: Table, Chart, Equation, Image, Figure, Circuit Diagram, Logo.

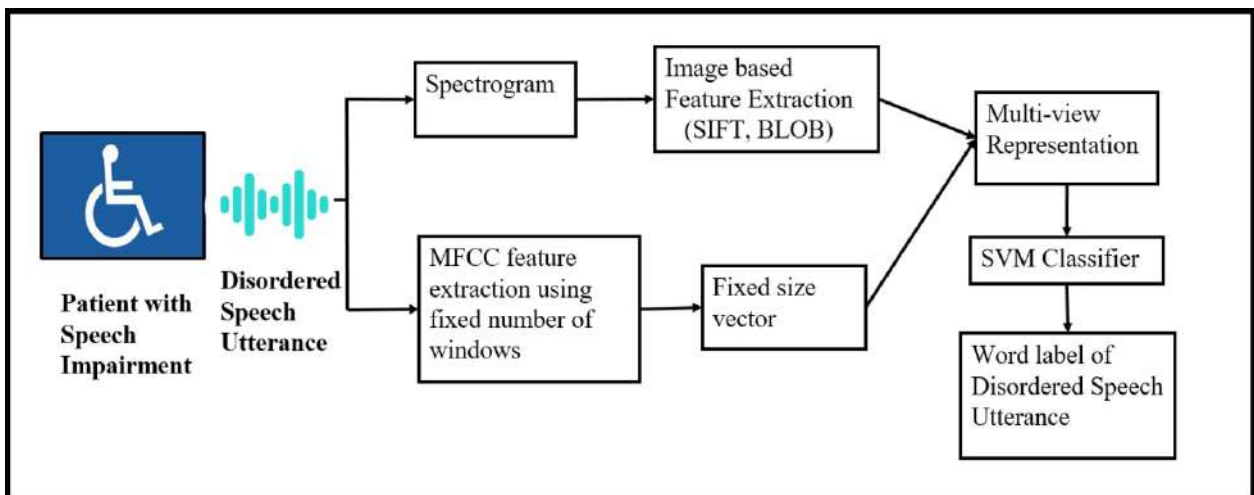
Page Objects	NCERTSK-IITRPR			
	Training	Validation	Test	Total
Table	1169 (72%)	287(17.7%)	167(10.3%)	1623
Chart	341 (66.9%)	101(19.8%)	68(13.3%)	510
Figure	1455 (70.7%)	439(21.3%)	163(7.9%)	2057
Image	1050 (67.9%)	337(21.8%)	165(10.6%)	1562
Equation	968 (73.7%)	252(19.2%)	93(7.1%)	1313
Circuit Diagram	159 (75%)	32(15.1%)	21(9.9%)	212
Logo	2377 (70.9%)	660(19.7%)	315(9.4%)	3352
Total	7529 (70.8)	2108(19.8)	992(9.4)	10629

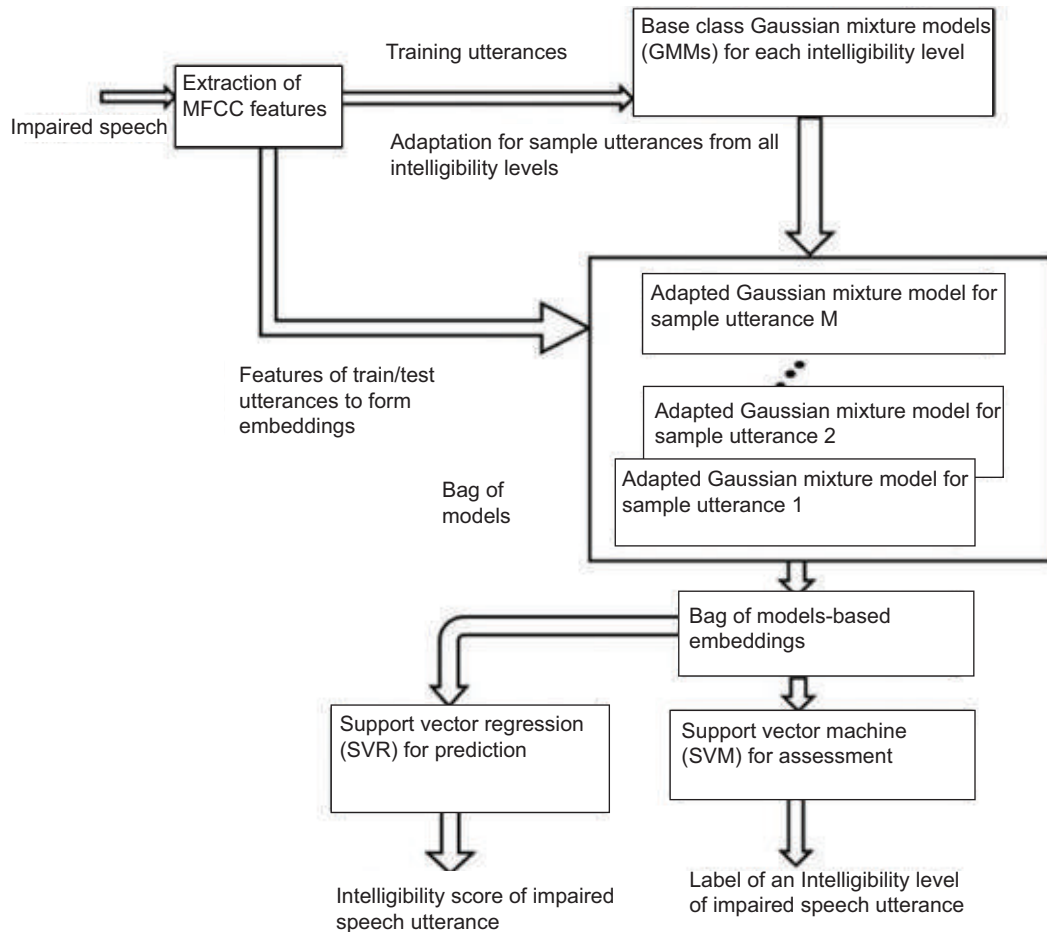
The proposed BCM generates multi-scale features and provides a systematic context aggregation of both low and high-level feature maps through its densely connected layers. Additionally, the controlled multi-dilation scheme offers a more extensive scale range for better prediction performance. Experimental results show MDCADNet performs consistently better than the state-of-the-art models across all datasets. This study also

introduces a novel dataset “NCERT5K-IITRPR” which is the first step towards developing a holistic and end-to-end model for data extraction and summarization of NCERT and similar books.

- **Representation Learning based Assistive speech tool for persons with Neurological disorder**

Speech impairment is caused by any kind of neuro cognitive disability that damages the speech articulation mechanism, and it influences speech intelligibility. Dysarthria is a kind of neurological disorder related with motor speech impairment which causes articulatory deficits. Focus of this project is on learning model driven representations for disordered speech utterances to improve the performance of disordered speech recognition which is the core part in the assistive speech technology. This study is conducted at SASTRA University, Thanjavur that develops multi-view representation based disordered speech recognition system for people with speech impairment. The proposed approach handles the inter-class overlaps with the help of features extracted from multiple views of impaired speech signals. This is evaluated using the UA-SPEECH corpus with two different datasets, namely 100 common words and 15-word classes of acoustically similar pairs of words. The training and testing samples are collected at varied intelligibility levels such as high, medium, low, and very low. Compared with conventional hidden Markov models (HMM), deep neural network-HMM, constant-Q-transform (CQT) and other single view auditory image-based approaches. The study proves that even the very low intelligibility words are recognized properly through this new method which leads to improvement in performance of disordered speech recognition.





Block diagram of the proposed bag of models-based approach for assesment of neurological disorder.

An assistive speech tool has been developed as a Mobile App under this study and was tested using impaired speech in English and it gives moderate performance. Currently study is focused on improving the recognition performance for Tamil. Proposed system can be tailored for a single person affected with neurological disorders such as Dysarthria. It can be improved and used as an assistive speech system for other neurological disorders such as Autism etc. Speech assistive tool as part of rehabilitation engineering for people affected with neurological disorders can enable their interactions with outside world thus improving their quality of life.

1.7.3 Outreach activity:

Division has supported 9th Annual Conference of Cognitive Science (ACCS9) at Indian Institute of Technology Delhi, New Delhi held during December 08-10, 2022 as one of the outreach activities under CSRI. The various themes of the conference covered many fields like Artificial Intelligent Agents, Cognitive Systems, Human-Computer Interaction, Judgment

& Decision Making, Language Processing & Production, Perception & Attention, Speech & Acoustics, etc.

1.8 INSPIRE

Innovation in Science Pursuit for Inspired Research (INSPIRE) is a flagship scheme of Department of Science and Technology (DST) which aims to attract meritorious youth to study basic and natural sciences at the college and university level and to pursue research careers in both basic and applied science areas including engineering, medicine, agriculture and veterinary sciences. The ultimate aim is to expand the R&D base of the country.

INSPIRE Scheme is aligned with the 'Minimum Government, Maximum Governance Model' as it makes use of technology in its operations right from submission of application to the delivery of grants. Scheme is implemented through the on-line dynamic INSPIRE web-portal and scholarship(s)/fellowship(s) are released to the INSPIRE beneficiaries on receipt of the requisite documents through online mode.

INSPIRE web-portal is also integrated with UMAANG and has its Mobile application for the INSPIRE aspirants/beneficiaries. During the year, INSPIRE online system recorded 4 crore hits out of which 1.8 crore hits were through mobile app and 2.2 crore were through Web Browser. Out of 4 crore hits, 5.46 Lakh hits were unique.

Scholarship for Higher Education (SHE) component under INSPIRE program aims to attract top 1% rank holder students to pursue their career in basic and natural science areas in higher academic qualifications by providing scholarships and mentorship grants. The scheme offers 12,000 Scholarships every year @ Rs 0.80 lakh per year (including Mentorship grant) for undertaking Bachelor and Master level qualification in natural and basic sciences for the talented youth in the age group of 17-22 years. Main feature of this component is to develop interest in scientific research among UG and PG level science students through research projects during their vacation period. Call for applications for 2021 for INSPIRE-SHE was completed and in response, 20,071 applications were received. 10,108 INSPIRE scholarships have been offered to the selected candidates. Also, 424 INSPIRE scholarships have been offered to the selected candidates through institutes (institute mode). Selection of students was based on their performance in class 12th examination conducted by State/ Central School Education Examination Boards and competitive examinations such as JEE (Main & Advance), NEET etc. All the selected students pursue the undergraduate / post graduate levels courses in basic and natural sciences. Out of the total students who were offered INSPIRE SHE scholarship, 54% are Female.

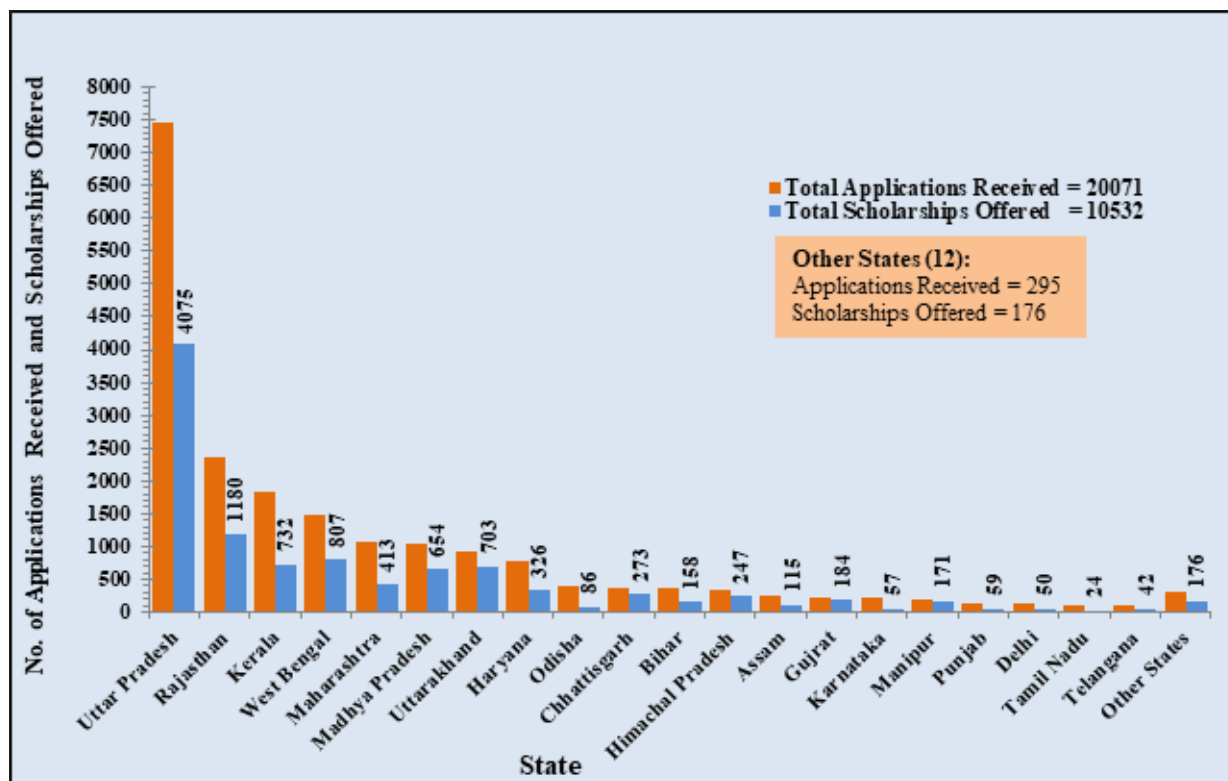


Fig. State-wise Distribution of Scholarships offered under INSPIRE-SHE during 2022-23

An Interaction meet of Dr Jitendra Singh, Hon'ble Minister of Science & Technology and Earth Sciences with INSPIRE Program beneficiaries was organised on 9th July, 2022 at Moradabad, Uttar Pradesh to get direct feedback from the scheme beneficiaries wherein more than 100 students / beneficiaries of INSPIRE Scholarship, INSPIRE Fellowship and MANAK programme participated.



Fig. Dr. Jitendra Singh, Hon'ble Minister of Science & Technology and Ministry of Earth Sciences interacting with the INSPIRE and MANAK students

The 14th Asian Science Camp 2022 held in IBS Science Culture Center in Daejeon, South Korea from July 24th–30th, 2022 was attended by about 250 delegates from 25 different Asian Countries including INSPIRE-SHE Scholars from India. Out of 19 scholars, 8 attended the 14th Asian Science Camp 2022 physically and rest attended online. INSPIRE SHE Scholar Mr. Sagar Gowala, Hindu College, University of Delhi, won the Third Prize in the Poster presentation Competition.

Olympiad programme implemented by Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai is partly funded by DST-INSPIRE. During the year, 30 Indian students who participated in Mathematics and Science Olympiads, 12 have won Gold, 13 Silver and 5 Bronze medals. In Science, this is the first occasion since participation started in 1998 that all students have won either gold or silver medals.

INSPIRE Fellowship component offers 1000 Fellowships every year for carrying out doctoral degree in both basic and applied sciences including engineering and medicine in the age group of 22-27 years. INSPIRE fellowship is offered to students having secured 1st 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. Students who have obtained scholarship at UG and PG level under INSPIRE-SHE are eligible for INSPIRE Fellowship if they have secured 70% marks in aggregate at the M.Sc. level and taken admission to the Ph.D. Program in any recognized university/ academic institutions in the country. The Fellowships are tenable for a maximum of five years (2 years as JRF and 3 years as SRF) period 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 by GoI norms & regulations.

The Level-1 scrutiny of applications of INSPIRE Fellowship Call 2021 was completed. Out of 2,449 received applications, 2026 applications were cleared for level-2 evaluation for award of INSPIRE fellowships. Level-2 evaluation of applications is a continuous process and so far, 829 INSPIRE Fellowship applicants were offered INSPIRE Fellowship. Out of the awarded/ offered INSPIRE Fellows 67% are female and 33% are male. Of the total INSPIRE Fellowship beneficiaries, about 36% are SHE Scholars who have joined doctoral degree program in science and technology after availing 5 years INSPIRE Scholarship. Three Hundred and Sixty-Seven INSPIRE Fellows were promoted from Junior Research Fellowship (JRF) to Senior Research Fellowship (SRF) after evaluation of the research work carried out by them. Nine INSPIRE Fellows have been selected for participation in 14th JSPS-HOPE meeting scheduled to be held in Japan during Feb-March 2023.

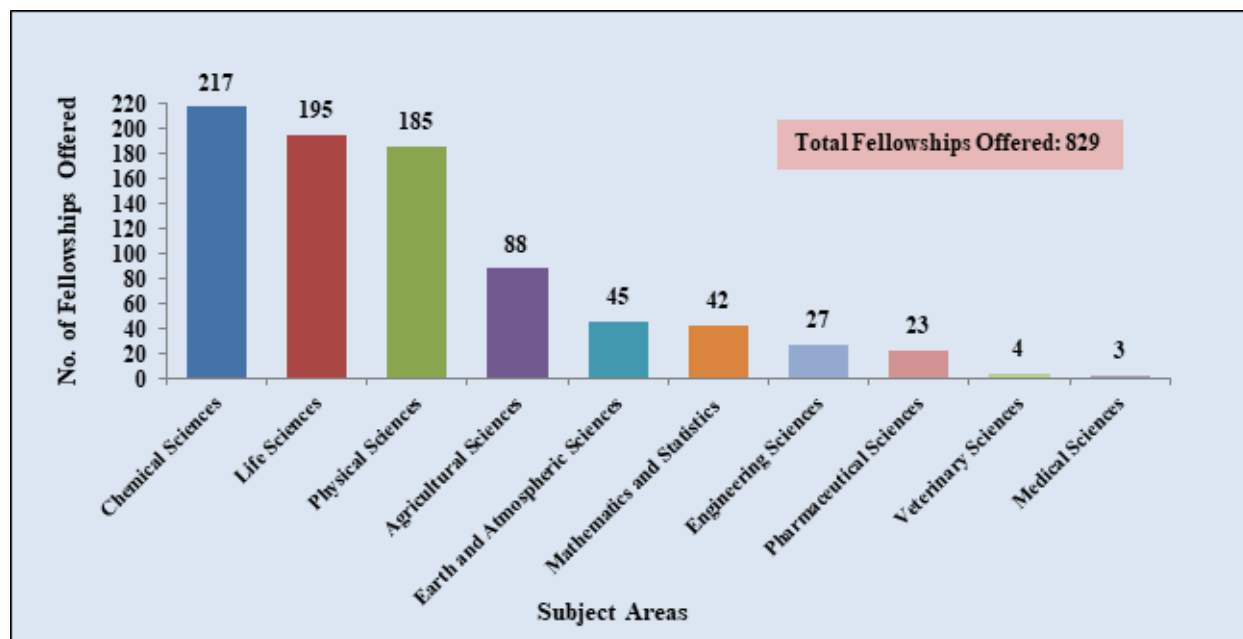


Fig. Subject area wise Distribution of Fellowships offered under INSPIRE-Fellowship during 2022-23

Research Exposure cum Training Programme for Students from North-Eastern States and UTs of Jammu and Kashmir and Ladakh under INSPIRE program, a Special Initiative for training of the talented youth from the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura (North-Eastern States), UTs of Jammu and Kashmir and Ladakh for pursuing research career in frontier areas of Science Technology and Innovation was initiated by the Department of Science and Technology. This initiative will be of great help to students from these areas and enable them to compete with their counterparts from other parts of the country.

INSPIRE Faculty Fellowship provides opportunities to the post-doctoral researchers in the age group of 27-32 years for 5 years INSPIRE Faculty Fellowship in both basic and applied sciences area including engineering, agriculture, veterinary and medicine. Each fellow receives fellowship of Rs 1,25,000/- per month with an annual increment of Rs. 2000/- and Rs. 35 lakh (at the rate of Rs 7.0 lakh per year) of Research Grant for 5 years. Its salient features are:

- 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.
- This component provides an independent research opportunity and not a guarantee for position beyond 5 years.

- While the vertical migration among students in different INSPIRE components is encouraged, the scheme also provides an opportunity to students for lateral entry into this component.

During the year 2022, 190 INSPIRE Faculty Fellows received their fellowship and are pursuing the post- doctoral research through contractual and tenure track position for 5 years in both basic and applied science areas including engineering, agriculture, veterinary and medicine. During the year, 115 INSPIRE Faculty Fellowships were offered the fellowship. Out of the awarded/offered INSPIRE Faculty Fellows 43% are female and 57% are male. More than 2318 applications have been received against the 2022 call of INSPIRE Faculty Fellowship for award of INSPIRE Faculty Fellowship. INSPIRE Faculty Fellowship selection process is in progress.

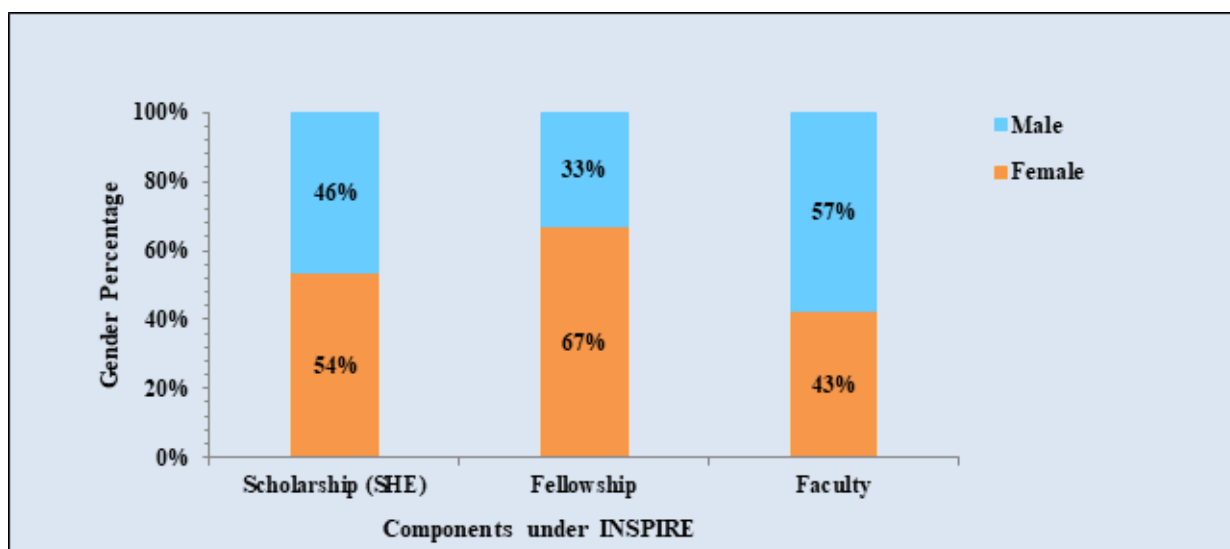


Fig. Gender-wise Distribution of INSPIRE Scholarships/Fellowships during 2022-23

1.9 INSPIRE– MANAK

INSPIRE–MANAK (Million Minds Augmenting National Aspiration and Knowledge) scheme implemented by Department of Science and Technology (DST), with objectives to attract young students to study science and pursue research career and promote creative thinking and foster a culture of innovation among them. Under the Scheme, 10 lakh ideas are targeted amongst the school students studying in class 6 to 10 from all eligible schools across the country every Year.

During the year, nominations were open from 01st July, 2022 till 15th October, 2022 and a total of 7,96,189 nominations were received from all States and UTs across the country and also from Kendriya Vidyalaya, Jawahar Navodaya Vidyalaya and Sainik Schools. This was preceded by a massive awareness campaign wherein teachers and school representatives in addition to Block, District and State Nodal Officers participated. In addition, State Nodal

officers meeting was organised at Delhi to mobilize maximum original nominations. Out of 7.96 lakh ideas 43,381 students have been shortlisted to participate in the District Level Exhibition and Project Competition (DLEPC) and subsequently the S/NLEPC (State and National) are being held. In order to arrive at this shortlist, a comprehensive review exercise has been undertaken with the involvement of around 400 experts from different parts of the country with deployment of Information Technology.

The 9th NLEPC (National Level Exhibition and Project Competition) of the INSPIRE – MANAK for FY 2020-21 was successfully organized from 14th September, 2022 to 16th September, 2022 at New Delhi. The exhibition was organized in Pragati Maidan at New Delhi during 14-15 September 2022 and award ceremony at Vigyan Bhawan, on 16th September 2022. In the valedictory function of 9th NLEPC, awards were conferred to sixty creative students by Dr. Jitendra Singh, Union Minister of State (Independent Charge) Science & Technology; Minister of State (Independent Charge) Earth Sciences.

Mr. Yash Dnyaneshwar Shinde, a student from Satara, Maharashtra, bagged the first prize for his innovation titled “Multipurpose Catering Equipment”, Mr. Bengia Ama from Kurung Kumey, Arunachal Pradesh, bagged the second prize for his innovation “Modified Arra for Multipurpose Use” and Ms. Elambirai M from Salem, Tamil Nadu, bagged the third prize for the innovation titled “Lift Accident Prevention”. For all the MANAK award winners, the incubation cycle is ongoing and important steps like protection of their Intellectual Property Rights (IPR) are being taken care of.



Fig. 9th NLEPC (National Level Exhibition and Project Competition) of the INSPIRE– MANAK

For the 52720 ideas/innovations which were shortlisted from the 7.05 lakh nominations received during FY 2021-22, district and state level exhibitions are under progress. 103 DLEPCs in 8 States/UTs (Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Telangana, Uttar Pradesh) and 4 State Level Exhibition and Project Competition (Goa, Ladakh, Meghalaya, Tripura) has been completed.

This year, new program “Building AI Readiness among Young Innovators” launched by the Hon’ble Minister during National Science Day 2022 at Vigyan Bhawan. It is a collaborative program of INSPIRE- MANAK, DST and Intel India implemented with an objective to demystify AI for the students and empower them with an appropriate AI mind-set, relevant skill sets and access to required toolsets.

In first cycle of program, AI readiness sessions were conducted for MANAK Awardees studying in class 6 to 10. For this, students registered themselves on the designated online portal. Two live sessions of 2 hours each and a series of self-paced learning videos in a completely online mode covering the basics of AI and its applications, Machine Learning, Deep Learning, Neural Networks, etc. were conducted. Based on the learning and exposure in these sessions, students submitted their AI-enabled social-impact solution in the idea submission form. Top 200 ideas were selected from the received entries post evaluation by a third-party agency. These 200 students were engaged in a 4 week boot camp having 2 weeks hands-on sessions and 2 weeks one on-one mentoring with AI coaches and sector experts. Top 50 ideas selected from the 200 ideas and these were showcased at National Level during 9th NLEPC (National Level Exhibition and Project Competition) of the INSPIRE – MANAK.



Fig. Building AI Readiness among Young Innovators: National Showcase and Felicitation

RESEARCH AND DEVELOPMENT

2.1 International Cooperation (IC)

2.1.1 International S&T Cooperation 2022-23

International Cooperation programme of the Department has been mandated responsibility of (i) negotiating, concluding and implementing Science & Technology Agreements between India and partnering countries; (ii) support scientific research and development activities through various regional and multilateral platforms, (iii) providing interventions on S&T aspects in international forums. This responsibility is carried out by the Division in close consultation with the Ministry of External Affairs; Indian Missions abroad; S&T Counsellors in Germany, Japan, Russia and USA; stakeholders in scientific, technological and academic institutions; sister scientific government departments; and with various industry associations in India.

New/extended Programme of Cooperation

Programs of Cooperation in Science, Technology and Innovation was concluded with Sri Lanka. This provided an opportunity to develop cooperation in identified themes in a given period.

New Indo German programme on IRTG

IRTGs (International Research Training Groups) are structured research and training programmes that strive to strengthen bilateral partnerships through joint research, a joint qualification programme, cross-border supervision of doctoral students from partner countries, and long-term coordinated and reciprocal exchange visits by doctoral students at respective partnering institutions. 5 proposals are being evaluated.

2.1.2 Bilateral Research Projects and Programs

Australia: Under AISRF - Round 14, DST recommended 03 joint proposals under the research areas of Quantum technologies, Earth observation remote sensing, Groundwater resources management and downstream processing, recycling and tailings reclamation of critical minerals.

Austria: Out of 61 proposals, the JSC recommended 15 proposals for financial support which were in the fields of life sciences, ICT, physics and material sciences & engineering under India-Austria Call-2021.

Belarus: A joint call inviting research proposals was launched with Belarus in the areas of (1) Information and Communication Technologies with the focus on Artificial Intelligence, Internet of Things, Machine Learning, Cloud Services (2) Biotechnology including Medicine and Pharmacy and (3) New Materials with particular focus on (i) Additive Manufacturing (AM) (ii) Powder production for AM and Powder Metallurgy Components (iii) Nanostructured Materials (iv) Ceramic Materials (v) Functional coatings and thin films for various applications. A total of 45 proposals received against the call are under evaluation.

Belgium: The call for joint proposals to support the long-term research cooperation between multiple Belgian and Indian Research institutions was launched along with Belgian Federal Science Policy Office (BELSPO). 4 joint projects have been recommended for support out of the 26 proposals received from both sides in space, including astronomy, solar physics and remote sensing; Marine sciences (except Bio concept); Geology; and Cybersecurity.

Canada: Secretary DST co- chaired the India-Canada Joint S&T Cooperation Committee (JSTCC) meeting, held on 19 May 2022 at Ottawa along with Deputy Science Minister of Canada to review the joint projects/programs supported so far. DST also signed a Memorandum of Understanding with the National Research Council for cooperation in Industrial R&D on 19 May 2022. The areas of research shall be mutually decided before announcing the new call.

DST, Department of Biotechnology (DBT) and Natural Science Engineering and Research Council (NSERC) Canada signed another MoU on 13th May 2022 in virtual mode to promote academic R&D to serve the civil society and for the welfare of humanity. Under this MoU, a new call was announced in the area of Water, Health, Carbon reduction in built environment and Agriculture. 113 project proposals have been received which are presently under review.



Fig. MoU signing ceremony during 7th India-Canada Joint S&T Cooperation committee meeting

Czech: Under the India-Czech bilateral Agreement on Scientific, Technical and Industrial Cooperation, a total of 20 joint proposals are being supported.

Denmark: As recommended by the last India-Denmark Joint Committee, held on 14th January 2022, a joint call for proposals was launched in the area of green hydrogen. Total 4 proposals

have been jointly selected for funding. Support was also extended to 5 ongoing research proposals in the area of Energy and Cyber Physical System.

Egypt: The support was extended to ongoing 25 joint projects in the research areas of information & communication technology, nano-technology for biomedical Sciences and Energy applications (especially fuel cells, CSP and self-cleaning PV and Biotechnology).

Finland: A Joint Declaration was signed with Finland on 18th April 2022 to establish Virtual Network Centre in Quantum Computing for jointly developing superconducting based Quantum Computer. India and Finland have strong bonding in Science, Technology and Innovation.



Fig. A Joint Declaration was signed with Finland.

Germany: The Indo-German Science & Technology cooperative program is implemented under an Inter-governmental Agreement on “Cooperation in Scientific Research and Technological Development” signed in May 1974. Under the ongoing DST DAAD Germany cooperation, a new call with Germany under DST-DAAD call 2022 was launched wherein 21 joint proposals were recommended.

Participation of the Hon’ble Union Minister of Union Minister of State (Independent Charge) Science & Technology in Inter Governmental Consultations (IGC)

Dr Jitendra Singh, Hon’ble Minister of State for Science & Technology and Earth Sciences (Independent Charge) visited Germany to participate in Inter-Governmental Consultations (IGC) between two governments. Two delegations were led by the Prime Minister of India and Chancellor of Germany. Hon’ble Minister was assisted by Adviser & Head, International Cooperation, Department of Science & Technology and OSD to Hon’ble Minister. Science Counsellor (S&T), Embassy of India in German also joined in.

Israel: An online 10th India Israel Joint Committee was organised on July 25, 2022. Support was extended to 16 ongoing/under closure joint research Projects in Advanced materials for next gen solar energy utilization and storage, Quantum devices for sensing imaging and communication, big data analytics in health care & security in cyber space.

The 9th Call for proposals was announced for India-Israel Industrial R&D projects. A total of 06 applications are received from both sides. The 10th Governing Board (GB) meeting of India Israel R&D Technological Innovation Fund (I4F) 2022 was held on 14th November 2022 under the Co-Chairmanship of Secretary DST & Dr. Amiram Appelbaum, Israel Innovation Authority (IIA) at Tel Aviv. During the meeting, the GB recommended 03 project proposals for developing a non-invasive integrated patient care monitor (NIM), Smart Agricultural Solution and a Dental 3D Versatile Printing Platform.

Italy: Under the India-Italy Executive Programme of Cooperation in S&T, support extended to 3 Network of Excellence in the areas of Technologies applied to cultural and natural heritage and Biomedical Sciences. A total of 08 significant research and 13 mobility-based joint projects were also supported. Support extended to 37 Indian scientists to perform 14 Indian research experiments awarded 252 shifts on the Elettra Synchrotron beamline at Trieste, Italy.

Japan: The Implementing Arrangement between the Ministry of Education, Culture, Sports, Science and Technology of Japan and the Department of Science and Technology, Ministry of Science and Technology of India and Implementation Guidelines for India-Japan Cooperation Scientific programme between DST, GOI and Japan Society for the promotion of Sciences (JSPS) were concluded in September 2022. Dr. S. Chandrasekhar, Secretary DST led a delegation to Japan during 26-28 September 2022. Secretary DST had meetings with his counterparts in Japan and various other agencies to discuss on strengthening the cooperation further in S&T matters.

Mexico: A high-official meeting between the Department of Science and Technology (DST), Ministry of Science & Technology of the Indian Republic and the National Council for Science and Technology (CONACYT) of the United Mexican States was held in the research areas of Energy and Innovation & Frontier Technologies for the future joint collaborations.

Norway: 6th Joint Working Group Meeting (JWG) on S&T between India and Norway was held in New Delhi on October 12, 2022. The Indian delegation was led by Mr. S. K. Varshney, Adviser & Head of International Cooperation of the Department of Science and Technology and the Norwegian delegation was led by Ms Anne Line Wold, Joint Secretary/Director General, Ministry of Education and Research of the Royal Norwegian Government. Support was extended to ongoing 20 joint R&D Projects.

Philippines: Three Joint R&D Projects are jointly selected against India Philippines joint R&D Call for proposals in the research areas of virology, applications of Artificial Intelligence on diverse areas such as agriculture, health, and smart cities; blockchain technologies on

Government services/processes, and; additive manufacturing of new materials (metal and ceramics). Total of 03 joint projects were recommended for support.

Portugal: A total of 10 joint projects were supported under the Indo-Portugal joint call in Biotechnology, Energy, Environment, Infrastructure Sustainability, Climate Change, Disaster Management, and Marine Science.

Russia: Presently, both countries have adopted multi-stakeholder bases and scientific cooperation is facilitated through multiple agencies from both sides. The India Russia Science and Technology programs are currently steered through India Russia Working Group on Science & Technology which reports to the India Russia Inter Governmental Commission (IRIGC-TEC).

- a) DST and Russian Science Foundation (RSF) under call 2021 have jointly decided to support 25 proposals in the areas of Smart transport and telecommunications; Smart healthcare and medicine; New Materials; Plant and Animal Bio-Technology; Clean Energy; Artificial Intelligence; and Safe Food.
- b) The Addendum of the DST-RSF Agreement to extend the validity for another six years was approved.
- c) Department of Science & Technology (DST), Government of India and Ministry of Science and Higher Education (MSHE) of the Russian Federation invite Indian and Russian scientists/ researchers to submit proposals for joint research projects in the Glyco Science & Technology, New Materials & Additive manufacturing, Precision Agriculture and Exploration of structures, Aerospace technologies, and functions of sugars for diverse application in medicine, energy generation and materials science. A total of 48 proposals received from the Indian side is under evaluation.

Sri Lanka: The 5th India-Sri Lanka S&T Joint Committee meeting was held online on 20 Jan 2022. The meeting was jointly chaired by the Head, of International Cooperation, Department of Science and Technology (DST), Ministry of Science and Technology, India and the Secretary, of State Ministry of Skills Development, Vocational Education, Research & Innovations, Sri Lanka. Research areas such as waste-water technologies, industry and biotech, sustainable agriculture, aerospace engineering, robotics, big data analytics, and artificial intelligence were identified to include in the Programme of Cooperation (POC) and new call subsequently. Both sides agreed to extend the current PoC for the next three years.

Slovenia: A total of 20 new joint projects were supported under the India-Slovenia joint call with the Ministry of Education, Science and Sport of the Republic of Slovenia and the Slovenian Research Agency of the Republic of Slovenia in the areas of Science & Technological Solutions against COVID-19/ Pandemic Challenges; Health, biomedicine and biotechnology; New materials, including polymers; Information and communication technologies; Renewable energy sources; Urban areas (smart cities); and Artificial intelligence.

South Africa: Support was extended to ongoing 10 projects in the research areas of biotechnology, advanced materials including manufacturing and renewable energy.

Sweden: Under India Sweden S&T cooperation, an Indo-Sweden Joint Call on Circular Economy 2022 with 03 Indian and 04 Swedish funding agencies were launched in February 2022. A total of 54 out of a total of 102 joint proposals were received in the DST are being evaluated. Hon'ble Minister of Science & Technology and Earth Science, Government of India Dr Jitendra Singh and H.E. Ebba Busch, Hon Minister for Energy, Business and Industry, and Deputy Prime Minister inaugurated the 9th edition of the India Sweden Innovation Day in Stockholm October 27, 2022.



Fig. India-Sweden Innovation Day 2022

A Sweden delegation along with young start-ups visited India for the enhancement of S&T Cooperation. Dr. S. Chandrasekhar, Secretary, DST and Ambassador Jan Thesleff, Embassy of Sweden in India addressed the delegation. Both parties shared the good response of researchers against the current 'Indo-Sweden call on the Circular Economy'. There are altogether seven funding agencies from both countries involved in this call.



Fig. A Sweden delegation along with young start-ups

Switzerland: The India-Switzerland Cooperation in the field of Science & Technology is pursued under the Inter-Governmental Agreement signed on November 10, 2003. DST from Indian side and Swiss Secretariat for Education and Research (SER) are the designated nodal departments for implementing the Agreement. 6th meeting of the India Swiss Joint Science & Technology Committee was held in New Delhi on 4th October 2022. The Indian and Swiss delegations were led by Mr. SK Varshney, Adviser & Head, International Division, DST and Ambassador Mr. Jacques Ducrest, Ambassador, Head of International Relations at the Swiss State Secretariat for Education, Research and Innovation. The Joint Committee discussed scientific priorities on both sides, reviewed ongoing bilateral cooperation and discussed on future engagements. Joint R&D proposals would be invited in broad area of Sustainability (including Biodiversity, Health, Glaciology, Climate Change, Environment Sciences, etc).

Thailand: Support was extended to 10 ongoing joint R&D projects in human health sciences, renewable energy covering solar cells and PV reliability, Photonics covering elastomeric optics and optical devices, geospatial technologies covering creation of GIS of towns in Thailand for urban development, Astronomy & Astrophysics.

United Kingdom: Several high-level exchanges and workshops were held towards developing new programmes in the area of environmental sensors, CCUS, advanced manufacturing, green hydrogen, net zero technologies, Women in science etc.

United States of America: The twenty-second meeting of Governing Body Indo-US Science Technology Forum was held on 15.12.2022. The meeting was co-chaired by Dr Chandrashekhar, Secretary Department of Science and Technology on the Indian side and Mr Jason Donovan, US State Department from the US side. The board members and observers from Governments, academia and industry also participated and contributed to the review of the strategy for enhancing the scale and scope of India-US collaboration in science, technology and innovation. Both sides showed keen interest to work together in the emerging areas such as Artificial intelligence, data science, Machine Learning, Quantum Technology & applications; Precision and climate resilient smart Agriculture; Biotechnology, bio-economy; Clean Coal Technologies, Carbon Capture Utilization and Storage, Hydrogen Fuel Cell Technologies etc.

2.1.3 Bilateral Industrial R&D Programme:

The bilateral Industrial R&D programmes are supported by DST. Presently the active bilateral programmes are with eight leading countries including Canada, Finland, Germany, Israel, Italy, Republic of Korea, Spain, Sweden, UK and USA. The industrial innovators from the two countries are encouraged to apply for the development of innovative products and technologies across a host of focus sectors selected as per the societal and technological needs of both the countries.

2.1.4 Multilateral and Regional STI programmes

India-ASEAN S&T Cooperation program:

- a) The 13th Meeting of the ASEAN-India Working Group on Science and Technology (AIWGST) was held in virtual mode on 15th June 2022. Dr. S. Chandrasekhar, Secretary, Department of Science and Technology (Govt. of India) co-chaired the meeting along with his ASEAN counterpart H.E. Mr Bui TheDuy, Deputy Minister of Science and Technology of Vietnam.
- b) The 1st Edition of the ASEAN-India Start-up Festival (AISF) was inaugurated by Secretary DST during 27–30 October 2022 in Bogor, Indonesia. The AISF hosted a delegation of prominent stakeholders from the startup ecosystem including 60 startup founders and 70 officials from the government and private sector across India and ASEAN Members States. The main objective of the AISF is the networking of Indian and ASEAN start-ups for sharing and transfer of technologies within the ASEAN region and India. More than 50 letters of intent between start-ups were signed for the transfer and commercialization of technologies among the participating start-ups.
- c) The 3rd ASEAN-India Grassroots Innovation Forum was organized at the Institute of Technology in Phnom Penh, Cambodia during 19–21 December 2022. A total of 120 ASEAN and Indian Students and Social Innovators participated in the 3 days events.
- d) 13 new collaborative R&D proposals in the broad areas of “Development of technology and Innovation for preventing and combating covid-19 disease” were sanctioned for 2 years duration under the ASEAN-India S&T Development Fund of Government of India.
- e) 14 Research and Training Fellowships were awarded to ASEAN professionals for carrying out their research work at various Indian Institutes under ASEAN-India S&T Development Fund.
- f) The call for proposals for inviting new ASEAN-India R&D proposals was launched with a deadline of 31st December 2022. 38 new fellowship applications from ASEAN researchers have been received..

Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)

A Memorandum of Association (MoA) for the establishment of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) Technology Transfer Facility (TTF) was signed by the BIMSTEC member countries at the 5th BIMSTEC Summit held at Colombo, Sri Lanka on 30th March 2022. The MoA was signed by Hon’ble External Affairs Minister Dr S. Jaishankar on behalf of the Government of India and Foreign Ministers/ Secretary /Ambassadors and/ or nominees of respective BIMSTEC Member States. The main objectives of the TTF is to coordinate, facilitate and strengthen cooperation in technology

transfer among the BIMSTEC Member States by promoting the transfer of technologies, sharing of experiences and capacity building. The TTF shall facilitate the transfer of technologies among the BIMSTEC Member States. The MoA has been ratified by Govt of India for its implementation.

BRICS STI- Cooperation

The theme for BRICS 2022 is “Foster High-Quality BRICS Partnership Usher in a New Era for Global Development”. Various thematic working group meetings under the STI track of BRICS were held during the year to harness S&T in a multidisciplinary manner keeping in mind the societal challenges, which can be achieved by adopting the smarter approach in a more efficient way.

The 10th BRICS Science and Technology ministerial meeting was held on 27th September 2022 through video conferencing, preceded by the BRICS Senior Officials Meeting on 26th September 2022. From the Indian side Hon’ble Minister of Science & Technology and Ministry of Earth Sciences, Dr Jitendra Singh led the Indian delegation. The key deliverable of the meeting includes the adoption of two documents (i) BRICS Science, Technology and Innovation Declaration (STI), 2022 (ii) BRICS Calendar of Science, Technology and Innovation activities 2022-2023.

The BRICS STI Declaration and associated Calendar of activities include several STI actions proposed to be carried out during 2022-2023 by all BRICS countries in a coordinated manner. India proposed to host five BRICS events in 2023: BRICS Start-Ups’ Forum Meeting, BRICS Innovation Launchpad as a Microsite (Knowledge Hub), Meeting of Working Group on New and Renewable Energy and Energy Efficiency (STI Meeting), BRICS Working Group Meeting on Biotechnology and Biomedicine, 6th Science, Technology Innovation Entrepreneurship Partnership Working Group Meeting.

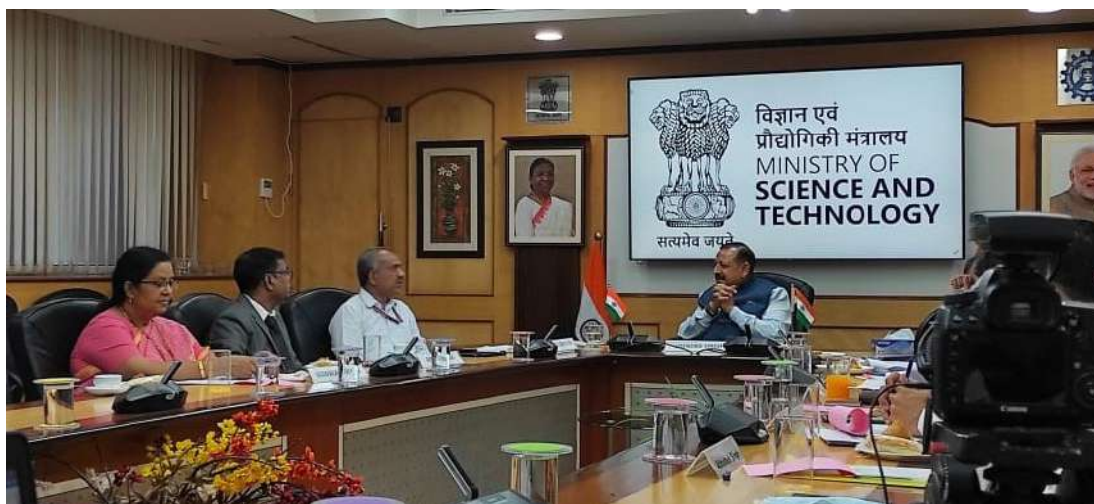


Fig. BRICS Ministerial Meeting held on 27th September, 2022

BRICS Young Scientist conclave

7th BRICS Young Scientist Forum and 5th BRICS Young Innovator Prize was held from 29th August, 2022 to 1st September, 2022. The Forum focussed on 4 thematic fields, namely biomedicine, artificial intelligence, new material, and low carbon technology.

BRICS Thematic Working Group meetings

- (i) **6th BRICS Working Group Meeting on ICT and HPC:** Under the Science, Technology and Innovation track, the Sixth BRICS Working Group meeting on High-Performance Computing (HPC) and Information Communication Technologies (ICT) was hosted and organized online by India on 22nd – 23rd June 2022.
- (ii) **4th BRICS Working Group Meeting on Photonics:** The WG on Photonics held on August 3-4, 2022 has agreed to finalize the strategic document «BRICS Road Map in Photonics»
- (iii) **Research Infrastructure and Mega Science Projects Working Group Meeting on 23rd – 24th August 2022:** Discussion and deliberation were held upon the Strategic Plan for sharing and access to each other Large Research Infrastructures (LRIs) among BRICS member countries.



Fig. Working Group Meeting on Research Infrastructure and Mega Science Projects under BRICS

(iv) BRICS Tech Transfer

The first meeting on BRICS Tech Transfer was held virtually in which the discussion was about the Technology Transfer Activities, and BRICS TechTransfer Implementation Plan developed by the National Institutes. Since startups are playing a key role in terms of technology innovation, India proposes that there should be Technology showcases to understand the technology innovations of other BRICS countries.

BRICS multilateral collaborative Projects

The 5th BRICS Call for Proposal was launched under ten thematic areas: (i) Transient astronomical events and Deep Survey Science, (ii) Antimicrobial Resistance (AMR): Technologies for diagnosis and treatment, (iii) Simulation and big data analytics for advanced precision medicine and public healthcare, (iv) HPC and Big Data for Sustainable Development: Solving Large Scale Ecological, Climate and Pollution Problems, (v) Innovation and entrepreneurship on Photonic, Nanophotonics and metamaterials for addressing bio-medicine, agriculture, food industry and energy harvesting issues, (vi) Materials Science and Nanotechnology for addressing environmental, climate change, agricultural, food and energy issues (vii) Renewable Energy including Smart Grid Integration, (viii) Ocean and Polar Science and Technology (ix) Water Treatment Technology (x) Research in Aeronautics and Aerospace. A total of 12 projects were recommended for support.

Indian Ocean Rim Association (IORA)

The Second meeting of the Indian Ocean Rim Association (IORA)-Working Group on Science, Technology and Innovation (WGSTI) was hosted by India in New Delhi on 30 September 2022. The meeting was Chaired by Shri Sanjeev Kumar Varshney, Head (IC) DST. The delegates from Kenya, Iran, Sri Lanka, South Africa, France, Mauritius and RCSST, Iran participated in the meeting. The meeting finalised and adopted the WGSTI Work Plan 2022-2027 for approval by the IORA Council of Ministers. The meeting also reviewed the status of the implementation of the WGSTI Work Plan.

G20 Research Innovation Initiative Gathering (RIIG) and Research Ministers Meeting:

Dr. S. Chandrasekhar, Secretary DST represented India at the G20 Research Ministers meeting hosted by Indonesia in Jakarta during 27-28 August 2022. The G20 Research Ministers meeting was attended by Indonesia (present G20 President), India (future President), Italy (Past President) along with other G20 nations and invited countries namely Netherlands, Singapore, Spain and UAE etc

The G20 Research Ministers adopted the Declaration on Research and Innovation Cooperation for the conservation of Biodiversity and its sustainable use to support the Green and Blue Economy. The Ministers agreed to intensify actions for the protection, conservation, restoration and sustainable use of biodiversity. The Ministers also committed to encouraging the promotion of open science in research and international cooperation in sharing research infrastructure and facilities and promoting the mobility of researchers.

DST took over the Chairmanship of the Research Innovation Initiative Gathering (RIIG) on 1st December 2022. DST would be hosting 5 meetings of RIIG during India's G-20 Presidency under the main theme "Research and Innovation for Equitable Society". The 4 sub-topics identified for organising side-events of RIIG are Material for Sustainable Energy; Circular Bio-economy; Eco-innovations for Energy Transition; Scientific Challenges and Opportunities

towards achieving a Sustainable Blue Economy. The G20 Research Ministers meeting is scheduled to be held in Mumbai in July 2023.

DST is also administering the Science-20 Engagement Group of G20. A total of 5 meetings are scheduled for hosting by India during 2023 under the main theme '**Disruptive Science for Innovative and Sustainable Development**'. The sub-themes identified under S-20 are Universal Holistic Health: Cure and Prevention of Disease; Clean energy for a greener future and Connecting Science to Society and Culture.

Shanghai Cooperation Organization (SCO) STI Cooperation

The sixth Session of Heads of Ministries and Agencies of Science and Technology of the Shanghai Cooperation Organization Member States was held in hybrid mode on 8th April 2022 in Tashkent. Hon'ble Minister for S&T and ES participated through virtual mode and led the Indian delegation. In the meeting, the Programme of Cooperation of the SCO Member States on the Artificial Intelligence Development, Action Plan for Scientific and Technical Cooperation in priority areas between the SCO Member States for 2022-2025, Mechanism for implementation of joint multilateral research and innovation projects within the SCO were endorsed by SCO S&T Ministers.

India has taken over the Presidency of SCO from September 2022. India would host the SCO STI Permanent Working Group Meeting, SCO S&T Minister meeting and 2nd edition of Young Scientist Conclave (YSC) to create connectivity and networking among the SCO youth to harness their knowledge for addressing common societal challenges through research & innovation and also strengthen the advancement of complementary skills and research competencies of youth.

STI Cooperation with European Union

The 2nd Joint Meeting between India and European Commission on Water Cooperation was held virtually on 15th May 2022 to review the progress of the water projects currently ongoing between India and the European Commission. The projects developed and tested 68 technologies - many technologies were established in Europe, and are implemented in India through the transfer of technology. They are being modified in each case in India to suit the local geographic and climatic conditions not only for adaptability but also for improved performance. Joint efforts for automation in monitoring, operation and maintenance using tools like artificial intelligence (AI) and machine learning (ML) are being made an integral part of the joint projects making them superior in the international market.

India-EU Co-funding Mechanism:

Department has agreed with European Commission to participate in the EU Horizon Europe programme through a Co-Funding Mechanism (CFM) to support Indian researcher's participation. The jointly agreed areas for collaboration include Efficient trustworthy

AI - making the best of data (AI, Data and Robotics Partnership); Explainable and Robust AI; Hybrid electric energy storage solutions for grid support and charging infrastructure; Circular economy approaches for zero-emission vehicles. This is in line with the joint commitments of India-EU Joint Steering Committee meetings.

India's participation in UNESCO and UN Bodies:

DST participated in various UNESCO, OECD (CSTP, NESTI), STEPAN and other multilateral forum agencies and bodies. Participation in OECD-CSTP and the associated working parties including NESTI is to gain direct access to global benchmarking and agenda setting related to S&T Policy matters, R&D Statistics and Innovation Statistics. India has been constantly participating in CSTP/NESTI meetings. This has enabled us to gain access to the latest R&D and Innovation standard-setting manuals i.e., recent revisions of Frascati and Oslo manuals. In addition, this engagement has provided us with the opportunity to engage with other OECD/associate member countries on good practices and cross-learning on matters related to STI statistics. This has benefitted India to launch its own STI statistics initiative with sufficient technical expertise.

2.1.5 Human capacity building/ overseas exposure visits

C.V. Raman Fellowship for African Researchers

Department of Science and Technology (DST) and Ministry of External Affairs (MEA), Government of India (GoI), through the Federation of Indian Chambers of Commerce & Industry (FICCI), launched the next Call for the C.V. Raman Fellowship for African Researchers programme to promote human capacity building through scientific and technological cooperation between Africa and India. About 430 applications are received from 33 countries which are under review.

India Science and Research Fellowship (ISRF) Programme

India Science and Research Fellowship is to provide opportunity to scientists and researchers from neighbouring countries namely Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka and Thailand to work in contemporary research areas across all major disciplines of science and technology including engineering and medical sciences at premier research laboratories and academic institutions in India. A total of 55 applications were considered under their 2022 under ISRF Call. Two new calls were announced this year on Feb 2022 and September 2022 for research scholars/faculty of eight neighbouring countries. Based on research proposal, experience, academic merit and publication record, 48 candidates were recommended for the award of India Science and Research Fellowship (ISRF) under Call 2021-22 while the applications received under ISRF Call 2022-23 are under review.

Nobel Laureate's meetings in Germany

Five young Indian researchers in the area of Chemistry participated in the 71st Nobel Laureates meeting at Lindau, Germany from June 25 – July 2, 2022. The meeting included lectures, round tables and interactive sessions among the young students and the scientists. These students interacted with Nobel Laureates and other scientists to shape their future research careers.

Raman–Charpak Fellowship Programme

The Raman–Charpak Fellowship Programme is implemented by CEFIPRA with joint funding from the Department of Science and Technology (DST), Government of India and French Embassy in India, Ministry of Europe & Foreign Affairs, Government of France. The Centre has received 388 applications under the 2022 call. Total 25 Indian and 3 French Students were awarded the fellowship after the rigorous evaluation process.

2.1.6 Bi-national Centres

Indo-French Centre for Promotion of Advanced Research

The 35th meeting of Governing Body (GB) of CEFIPRA was organized in hybrid mode on 14th April, 2022. Following documents were released by Co-Chairs of CEFIPRA: Annual Report FY 2020-21 & Annual Report FY 2021-22 b) Compilation of Publications-2021 (Vol 28 Nos 1 & 2) resulted from the Collaborative Scientific Research Programme (CSRP) c) Bibliometric Analysis – Report of papers emanated from projects supported under CSRP during 2020.

Under the Collaborative Scientific Research Programme (CSRP), CEFIPRA approved 45 new Indo-French projects in the areas like Life & Health Sciences, Science for Sustainability, AI & Big Data and Materials Science during the 67th, 68th and 69th meetings of the Scientific Council (SC).

Indo-French Industrial-Academia projects

CEFIPRA approved 7 new Indo-French Industrial-Academia projects in the advanced areas like Phytochemical production, Blockchain Geotechnical Engineering, Synthetic Aperture Sonar images, Acoustics Metamaterials, Materials Engineering, Neuroinflammation during the 37th meeting of its Industrial Research Committee (IRC). Further, the Industrial Research Committee (IRC) met on 24 March 2022, to carry out a detailed evaluation of all the completed projects a progress of ongoing projects.

Industry Academia Research Development Programme (IARDP) Programme

As per the directives of Governing Body, CEFIPRA re-launched the IARDP Programme on 25th November, 2022. The new Call for Proposals considered the areas, Renewable & Clean

Energy (Low Emission Fuels for mobility, Hydrogen), Water research (relevant to societal benefits), Artificial Intelligence and Big Data, Advanced Materials, Blue Economy, One Health & Affordable Health Care, Sustainable Nutrition, Agriculture, Environmental Ecosystems.

- Other Call for proposals/applications launched by CEFIPRA include programmes like under A) High Impact Scientific Research Network' programme in areas of 'One Health' & 'Data Science' B) Dedicated Programme on Water C) Indo-French Postdoctoral Research Programme for Women in Science (PROWIS-I) D) Indo-French Visitation Programme for Women in Science (PROWIS II)
- During the current year, approx. 100 publications are resulted out of the projects supported under CSRP & IARDP.

DST-Inria Targeted Programme

Department of Science and Technology (DST) and Institute National de Recherche en Informatique et en Automatique (Inria) launched a targeted programme to foster collaboration between scientific Communities of two countries in the area of Information and Communication Science & Technology. In India, on behalf of the Department of Science & Technology, Indo-French Centre for Promotion of Advanced Research (IFCPAR/CEFIPRA) invites proposals from the Indian scientists/researchers.

This Targeted programme was initiated in 2013 with focus on areas such as Big Data, Cyber-Physical Systems, High Performance Computing, Embedded Systems, Reliable and Scalable Computation, Computer Science for Biology and Life Sciences, Cyber Security and Machine Learning. A total of 13 projects are ongoing under the programme. 04 new proposals were jointly recommended for support in 2022.

Indo-German Science & Technology Centre (IGSTC)

Indo-German Science and Technology Centre (IGSTC) is a bilateral institution established by Department of Science and Technology (DST), Govt of India, and the Federal Ministry of Education and Research (BMBF), Government of Germany to catalyse Indo-German strategic R&D partnerships. IGSTC continues to enhance the Indo-German partnerships in Science & Technology through its programmes and plays a crucial link in enabling collaborative research through numerous Indian and German research institutions and industries.

To date, IGSTC's flagship programme namely the 2+2 scheme of funding has supported 44 projects partnering research institutions, academia and industries creating a network of more than 199 organisations in India and Germany. IGSTC's bilateral workshops program has networked approximately 2700 scientists and industry personnel from 54 institutions in India & Germany

During the year, IGSTC had launched key capacity building programs viz. Industrial Fellowships, Women in Science & Engineering Research (WISER), Paired Early Career

Fellowship in Applied Research (PECFAR) and Small Immediate Need Grants (SING) to act as a catalyst and bridge the Indo-German research partnerships at different levels like early, mid-career and women researchers. First of its kind program for lateral entry for women researchers in joint R&D projects between India and Germany -Women Involvement in Science and Engineering Research (WISER) was launched and the fellowship was awarded to 11 women scientists in 2022. IGSTC launched a new fellowship programme called “Paired Early Career Fellowship in Applied Research” (PECFAR) to provide opportunity to early-career scientists & engineers to explore Indian and German research landscape on various aspects, including entrepreneurship, collaborative research, and innovation and sharing of lab facilities and infrastructure. The first batch of 11 awardees was supported in 2022. Further, to support proposals/initiatives that require modest funding to kick start or have the potential to embark on good bilateral Indo-German collaboration, IGSTC launched the new initiative Small Immediate Need Grants (SING) and conferred 3 awards in 2022.

During the year 2022-23, IGSTC supported 25 joint projects in 2+2 mode in emerging areas of (i) sustainable energy (ii) advanced manufacturing (iii) biomedical devices and technology (iv) water & wastewater technologies (v) smart cities (vi) bioeconomy. Currently, ongoing IGSTC projects involve more than 100 project partners from academia and industry from India and Germany with total project investment (from BMBF and DST) of an estimated ` 147 Cr or € 18 million. IGSTC’s Open Call for workshops was resumed and seven workshops under this call were held in various parts of India and Germany. The areas of these workshops were in Photovoltaic technologies, chemical systems, biomedical implants, etc.

The 2+2 Call 2020 on Additive Manufacturing (AM) attracted a significant amount of interest, and six projects were recommended for funding during the year 2022-2023. These projects would work on transforming cutting-edge research into products and services for the benefit of society in the key areas of AM like materials technology, biomedical implants, etc. The IGSTC Industrial Fellowship programme is aimed towards young researchers in India. The Fellowship is offered at two levels, PhD Industrial Exposure Fellowship (PIEF) and Post-Doctoral Industrial Fellowship (PDIF). Currently 40 fellows (20 PhD and 20 Post-doc) have been selected for pursuing their research in various host organisations like BASF, BAM, Fraunhofer, Airbus. The Industrial Fellowship programme has generated a lot of interest among young Indian researchers and had motivated them to pursue industrial research in Germany from an early stage.

The Indo-US Science and Technology Forum (IUSSTF)

The Indo-U.S. Science & Technology Forum (IUSSTF) is an autonomous, binational organization established by the Governments of India and the United States in 2000. The broad mandate of IUSSTF is to promote, catalyze and seed bilateral collaboration in science, technology, engineering, and innovation through substantive interaction amongst federal agencies, academia, and industry. Over the past 22 years, IUSSTF has played a critical role in fostering collaborations between India and the United States in key areas of science and

technology and continues to pursue new opportunities to catalyze and seed partnerships in areas of strategic importance to the two countries.

USSTF Governing Board Meeting

The Twenty-Second Governing Board (GB) Meeting of the Indo-U.S. Science & Technology Forum (IUSSTF) was held virtually on 15th December 2022, under the Co-Chairmanship of Dr. S. Chandrasekhar, Secretary, Department of Science & Technology, Government of India, (India Co-Chair) and Mr. Jason Donovan, Director, Office of Science and Technology Cooperation, U.S. Department of State, (U.S. Co-Chair).

Dr. S. Chandrasekhar, India Co-Chair, noted that IUSSTF has played a critical role in ensuring that the Science and Technology relationships between India and the United States flourish. He commended IUSSTF for the range of activities undertaken across different sectors of Science and Technology, in particular the special emphasis placed on Net-Zero, Carbon Neutrality, and Global Warming issues. Mr. Jason Donovan, U.S. Co-Chair, highlighted the growing strategic partnership between the two countries, including the initiative on Critical and Emerging Technology (iCET) launched by President Biden and Prime Minister Modi earlier this year.

Strategic Initiatives in Artificial Intelligence

IUSSTF's U.S. India Artificial Intelligence (USIAI) initiative serves as a platform for key stakeholders from academia, government, industry, and foundations to identify opportunities for bilateral AI R&D collaboration, address the challenges of developing an AI workforce, and recommend innovative mechanisms for catalyzing and sustaining partnerships. Over the past year, IUSSTF has organized roundtables addressing critical areas including Trustworthy AI, Federated Learning, AI and Pandemic Preparedness, and AI and health.

IUSSTF, in partnership with Indian Institute of Science, organized an Indo-U.S. Visioning Workshop on *Developing a Diverse, Robust AI Workforce* in August 2022 which brought together key stakeholders from both countries, including leading academic institutions and industry to develop a roadmap for developing a diverse, globally-engaged, AI workforce. The event was marked by the release of a report on *The AI & Data Science Workforce: The State of Higher Education in India and an Overview of the U.S. Landscape* by IUSSTF and Iitihaasa.



Fig. Award ceremony of the Solar Decathlon India building challenge.

The report summarized the results of a first-of-its-kind survey on the Indian higher education landscape in AI and data science conducted in partnership with the National Programme on Technology Enhanced Learning (NPTEL) and the Association for Computing Machinery (ACM) India.

United States-India Science and Technology Endowment Fund (USISTEF)

The 23rd Meeting of the U.S.-India Science and Technology Endowment Board (USISTEB) was held on 30th November 2022 under the Co-Chairmanship of Head, International Cooperation, Department of Science & Technology, Government of India (Indian Co-Chair) and Mr Drew, Minister Counselor for Energy, Environment, Science, and Technology, U.S. Embassy, New Delhi (U.S. Co-Chair) to finalize the 'Technology-based Energy Solutions: Innovations for Net Zero' awards.

Solar Decathlon India

In 2020, IUSSTF and the U. S. Department of Energy signed a MOU to establish a framework of partnership and engagement toward the organization of a Solar Decathlon in India with the Indian Institute for Human Settlements and the Alliance for an Energy Efficient Economy serving as the implementation partners. Solar Decathlon India (<https://solardecathlonindia.in/>) is a competition for teams of post graduate and graduate students from Indian institutions to combat Climate Change in the buildings sector by developing solutions for net-zero-energy, net-zero-water, net-zero-waste and climate resilient buildings. In the second year of the program, SDI had over 1200 students representing 109 institutions from 42 different cities across India participating in 99 interdisciplinary teams. Dr. Jitendra Singh, Hon'ble

Minister of State (IC), Science and Technology & Earth Sciences graced the occasion as the Chief Guest during the award ceremony of the Solar Decathlon India building challenge.

Indo-US Joint Clean Energy Research & Development Centre (JCERDC): Phase II

The “UI-ASSIST: U.S.-India collABorative for smart diStribution System wIth Storage” project co-led by the Indian Institute of Technology, Kanpur and Washington State University, Pullman is funded by the Department of Science and Technology, Government of India, and the U. S. Department of Energy, is implemented and administered by IUSSTF under the Indo-U.S. Joint Clean Energy Research & Development Centre program (JCERDC) Phase II. The JCERDC Program.

UI-ASSIST seeks to address critical issues related to the adoption and deployment of smart grid concepts along with Distributed Energy Resources (DERs) including storage in the distribution network for its efficient and reliable operation. This is a unique project bringing together researchers from academia, national laboratories, industry, and private companies as well as policy experts and utility regulators.

2.1.7 Visitation Programs

The ‘**IUSSTF- Viterbi Program**’, a collaboration between IUSSTF and the Viterbi School of Engineering at the University of Southern California (USC), provides opportunities for Indian students in computer science and engineering to pursue a summer internship at USC.

The **Khorana Program for Scholars** is a prestigious internship program for Indian students currently enrolled in graduate and post graduate programs in biotechnology, life sciences and allied areas to undertake a summer research internship at U.S. Universities. Funded by the Department of Biotechnology, the program is implemented by IUSSTF in partnership with WINStep Forward.

2.2 National Mission on Nano Science & Nano Technology

Nano Mission focus on supporting the fundamental studies, technology driven areas, specific research theme-based support, inter-ministerial concepts and offers Beamline access to the Indian users through its International collaboration under the umbrella of Nano Science and Technology. Nano Mission successfully completed its Phase-1 and Phase-2, where it was started with infrastructure creation and attracting Indian researcher to take-up this domain as their professional career. Through its continuous effort in improving the quality and quantity of the researchers in Nano initiative, India has secured global ranking 3 in terms of total number of scientific publications since 2016.

The key achievements of Nano initiative in the year 2022 is as follows:

- a) Three start-ups are in the process of realization and one is already in operation.

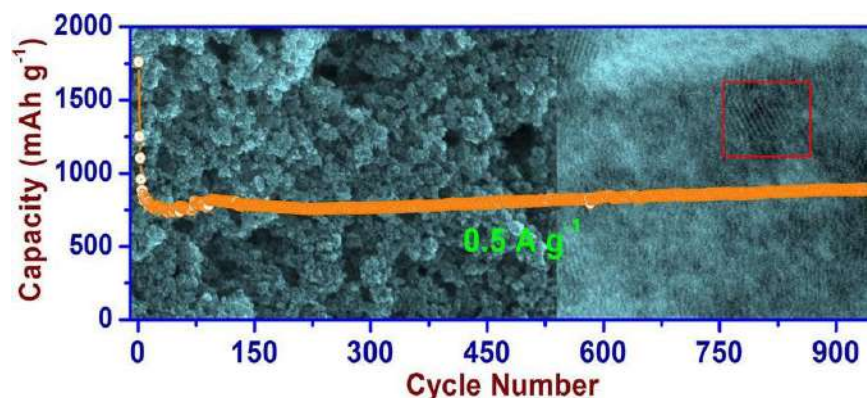
- b) Nine patent filings are reported from the energy and Nano electronics research area, where efficient materials properties, sensors and devices are demonstrated, and one patent is awarded from the similar field.
- c) In addition to support the basic science exploration, Nano mission focused on inspiring technology-based research support in the recent past. The outcome of that was seen in terms of PPE's during the Covid time. This year ten new projects under the Nano technology scheme received financial support along with other ongoing projects under various schemes of the mission.
- d) Around 247 peer reviewed publications are reported to the division in the year 2022 from Nano Science, Technology, Thematic and Nano electronics inter-ministerial programs.

Assorted scientific achievements reported from the Nano Program are as follows:

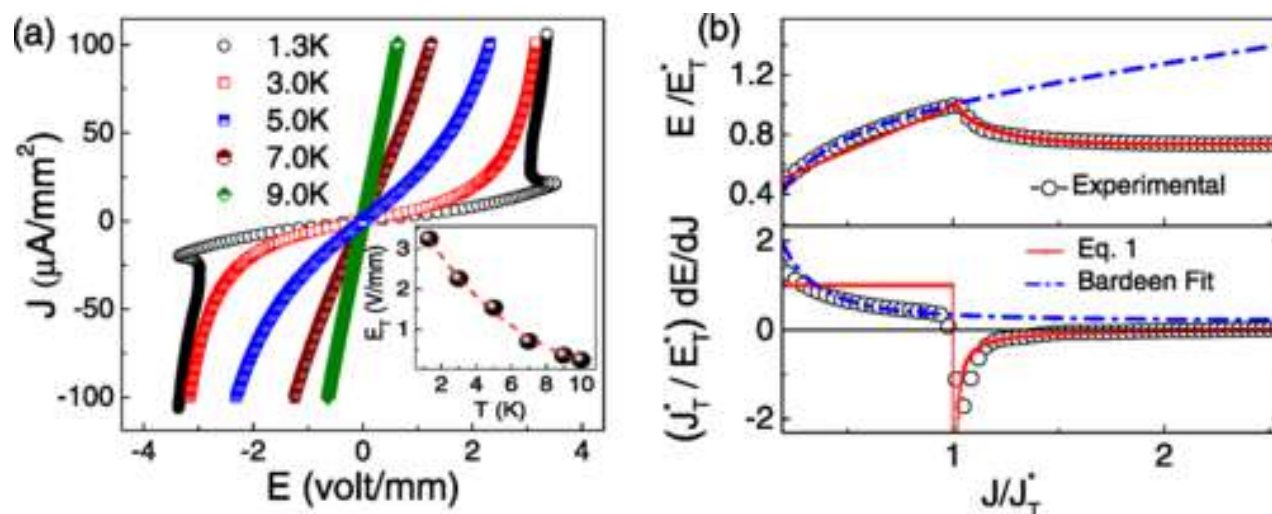
- a) Simultaneous monitoring of multiple cytokines via SERS signals using critically coupled optical perfect absorber sensor substrates.
 - Research & technological achievements:
 - Demonstrated sensitivity improvement of 10 times using OPAS based SERS substrates.
 - Built a custom modular optical setup for characterizing the OPAS substrates.
 - Optimized OPAS platform substrate fabrication using combination of reactive sputtering (for ITO layer) and nanoparticle assembly.
 - OPAS substrates capable of detection of multiple analytes demonstrated.
 - Integrated sensing platform using flow cell created and tested.
 - Developed the analysis codes required for extracting relevant information from the real-time measured SERS spectrum.
 - Presented the results and delivered 6 talks in various workshops and symposiums
 - 1-PhD, 2-MTech, 2-BTech are trained from this project
 - Instrument training and usage:

The instrument purchased from this project is fully functional and being used by multiple faculty, students & staff across the institutes (and optical setup) for their research works.
- b) Microstructure of single step solution process pure Cu_3SnS_4 Nano particles anode for high capacity Lithium ion battery. This anode delivered a high specific capacity of

1082 mAhg⁻¹ at 0.2 Ag- 1 and long-term stability of 950 cycles at 0.5 Ag-1 with specific capacity of 890 mAhg⁻¹.



- c) **Possible transition between charge density wave and Weyl semimetal phase in Y2Ir2O7:** Here, the possible evidence is provided for charge density wave (CDW) in bulk Y2Ir2O7, and the Weyl semimetal (WSM) phase. The characteristic properties of the CDW phase includes current induced nonlinear conductivity, low-frequency Debye-like dielectric relaxation at low temperature with a large dielectric constant~108, and an anomaly in the temperature-dependent thermal expansion coefficient. Moreover, dc and ac transport measurements show an inductive response at low frequencies in WSM phase [Abhishek Juyal et al. PRB 106, 155149 (2022)]



CDW phase in Y2Ir2O7 for $T < 10$ K. (a) dc IV characteristics for bulk Y2Ir2O7 showing CDW depinning induced nonlinear transport below 9 K, Characteristic plot (at $T = 1.3$ K) of E (top) and dE/dJ (bottom) normalized to E_T and J_T where current is regulated.

Nano Mission supports high energy international beamline access through its international beamline user program. Where the Indian researcher get access to the beamlines on merit basis for their fundamental and applied research.

The below pie chart shows the number of days Indian users carried out experiments in RAL-UK under the International collaboration up to year 2022:

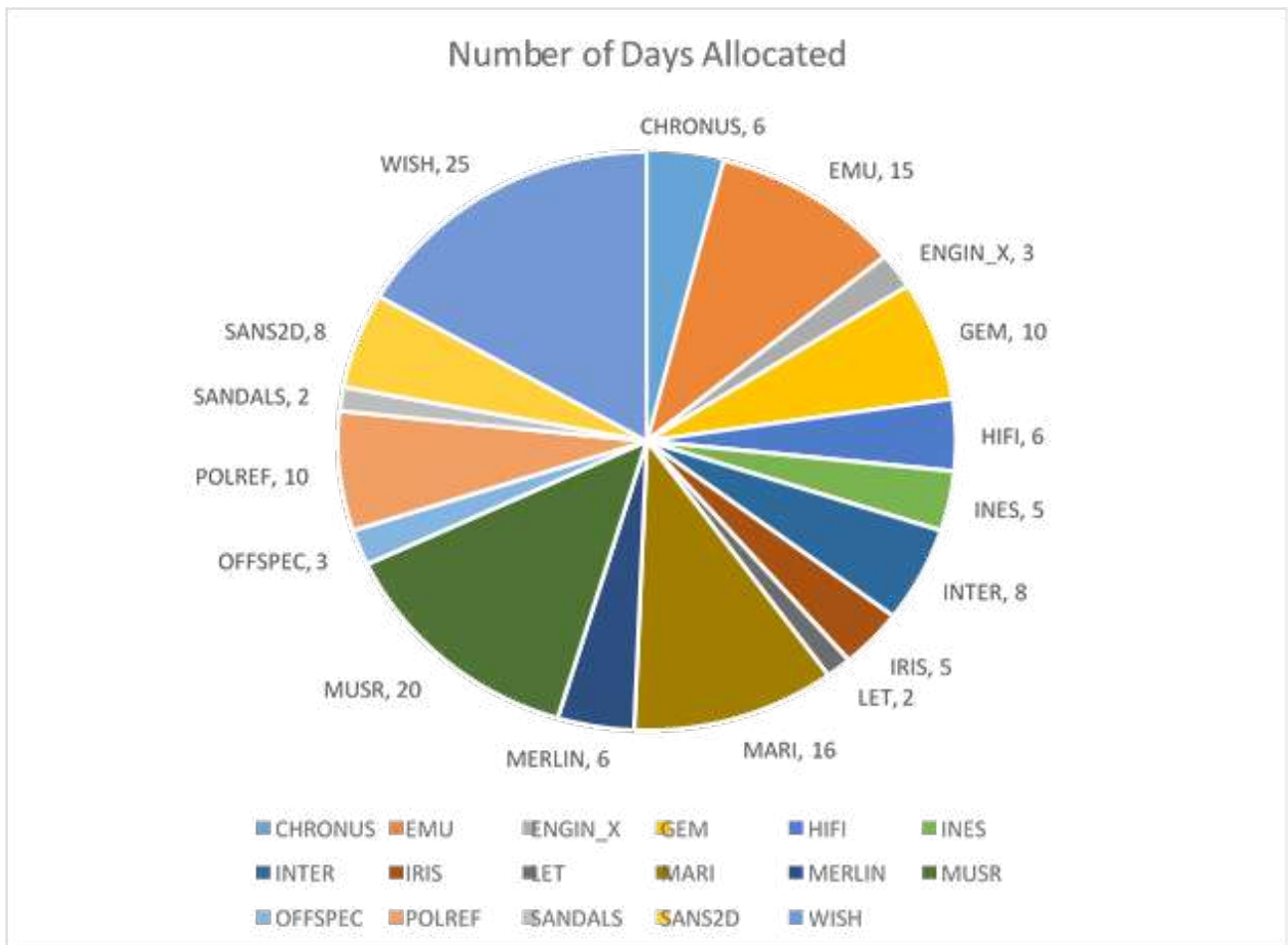


Fig. Number of days Indian users carried out experiments in RAL-UK under the International collaboration up to 2022

Details of Indian beamline users spanning across the country:

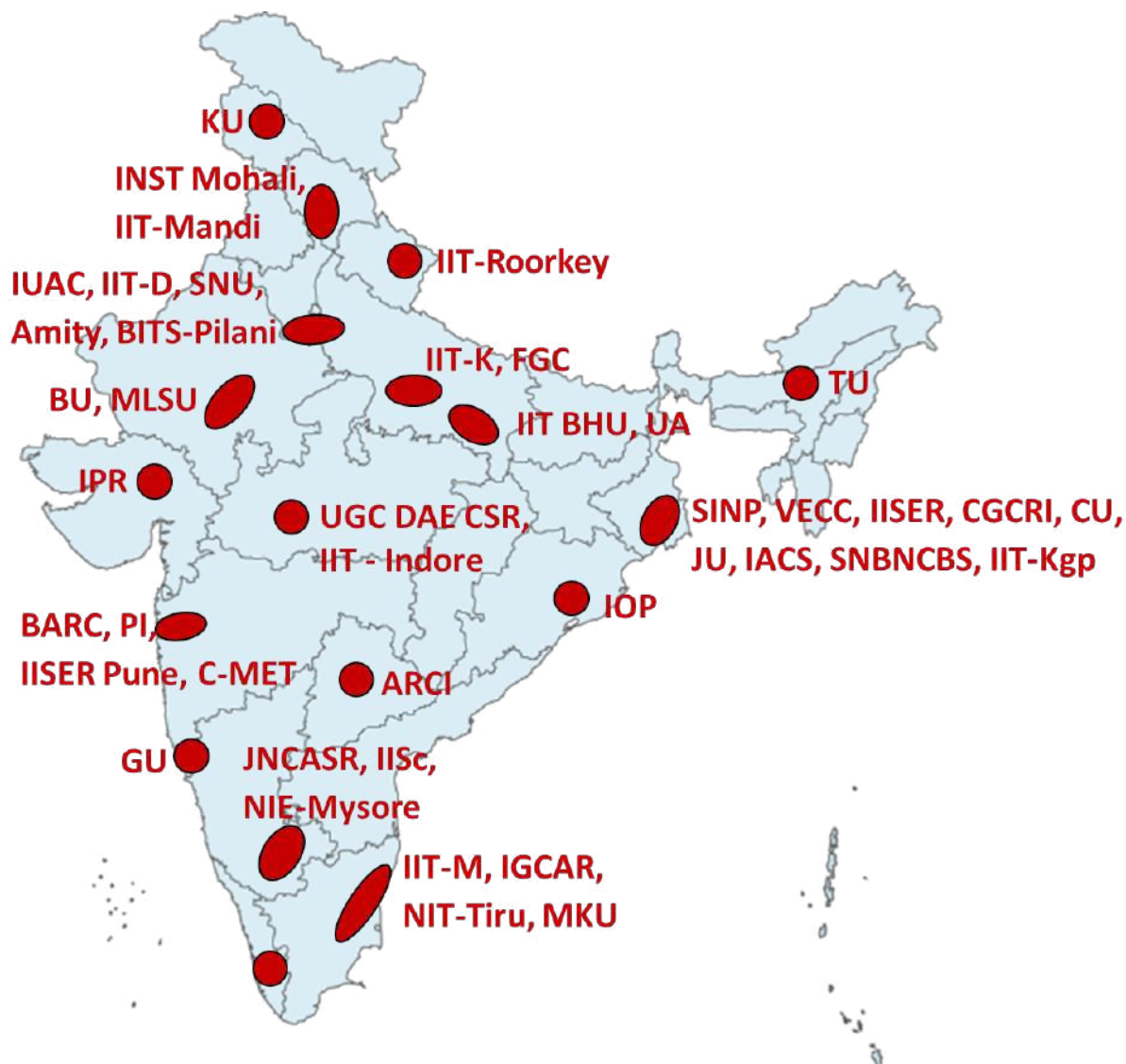


Fig. Demographic projection of Indian beamline users spanning across the country

2.3 Mega Facilities for Basic Research

Mega science projects are very long-term projects which involve state-of-the-art technologies and very complex issues. Such projects require very large resources both in terms of funds and expertise. Because of these reasons, such projects are manifestly multi-agency, multi-institutional and, most often, international in character.

Mega Facilities for Basic Research Scheme is aimed to enable participation of Indian researchers to such state-of-the-art research facilities abroad, especially from the academic

and scientific sectors, and to create mega science and technology facilities and launch mega science and technology projects in and out of the country. In many of these projects, Department of Science and Technology (DST) is partner with other governmental agencies, viz., Department of Atomic Energy.

Under this scheme, Indian researchers are participating in two experiments at Large Hadron Collider (LHC), European Organization for Nuclear Research (CERN), Geneva. Indian researchers are also participating in experiments at Elettra Sincrotrone, Italy, Fermi National Accelerator Laboratory (Fermilab), USA. Also, India is partner in establishment of international research facilities like Facility for Antiproton and Ion Research (FAIR) in Germany, Thirty Meter Telescope (TMT) in USA and Square Kilometer Array (SKA) in Australia and South Africa. During the year, lot of developments took place and the notable ones are described below project-wise.

2.3.1 Indian Participation in Research Initiatives at Large Hadron Collider (LHC), European Organization for Nuclear Research (CERN), Geneva

Indian researchers are participating in Compact Muon Solenoid (CMS) Experiment and A Large Ion Collider Experiment (ALICE) at LHC-CERN. In addition, they are also involved in utilization of Regional Worldwide Large Hadron Collider Computing Grid (WLCG) for CMS and ALICE experiments. India is also an Associate Member State of CERN. The important achievements from these initiatives are as under.

Indian Participation in CMS Experiment at LHC, CERN

Indian researchers are participating in this exciting physics experiment at CERN which involves 33 Indian scientists and 80 PhD students and Post-Docs from 14 research groups. India-CMS institutes continued R&D and related developmental activities during the year. The financial approval process for next phase of funding support completed during the year.

Indian Participation in ALICE Experiment at CERN

15 Indian research groups involving 30 Indian scientists and engineers along with 50 PhD students and Post-Docs continued their participation in ALICE experiment at CERN and Solenoid Tracker at RHIC (STAR) experiment at Brookhaven National Laboratory (BNL), USA.

During the year, the project established industry collaboration with Bharat Electronics Limited (BEL), Bengaluru for fabrication of 25 array of pad n-type silicon pad sensors on six-inch wafers for Forward Calorimeter (FOCAL) Detector of ALICE.



Fig. Interaction of India-ALICE Team at BEL, Bengaluru

The upgrade, installation, commissioning work on Muon Forward Tracker also continued.

During the year, Indian researchers were joint authors in 11 collaborative research publications from ALICE and STAR experiments along with 18 Conference papers. The output from the project also included 7 PhDs, 51 weeks of Data Taking Shifts, 9 Analysis Notes, 21 Public Lectures, Organization of 1 India-ALICE-STAR School, 1 Workshop on Applications of Artificial Intelligence and Machine Learning and 1 Symposium on Contemporary and Emerging Topics in High Energy and Nuclear Physics, 6 Webinars. 2 Collaboration meetings of the Indian research groups were organized. 3 Outreach activities were organized by NISER and Jammu research groups including International Day of Women and Girls in Science which also had a virtual visit to ALICE Control Room. One India-ALICE PhD student received the best thesis award in the ALICE collaboration.

Utilization of Regional WLCG

During the year, LHC resumed its Run3 operations and proton-on-proton collisions were recorded at the highest-ever center-of-mass energy of 13.6 TeV and data collected by CMS experiment amounted to integrated luminosity of about 40 fb⁻¹. Tata Institute of Fundamental Research (TIFR) CMS Tier-2 Centre participated in preparation of simulated data samples for physics analysis and it was also utilized for processing some of the collision data in addition to providing general computing support for the CMS experiment.

During the year, both Centres arranged many visits to their centres as part of 'Azadi Ka Amrit Mahotsav' Celebrations. Variable Energy Cyclotron Centre (VECC), Kolkata organized 'Open House' for general public visit. The Kolkata Facility was visited by hundreds from general public.

2.3.2 India's Associate Membership of CERN

India became Associate Member State of CERN in 2017. DST is equal partner with DAE in this initiative. The initiative also enabled participation of Indian Industries in CERN procurement processes. During the year, more than 10 Indian Companies submitted market

survey documents for different components being procured by CERN. The companies include, Fine Line Circuits, Starwire India, Saarloha Advanced, Mishra Dhatu Nigam Limited, Micro Precision, Micropack Limited, HiQ Electronics Private Limited, Inox India and Vacuum Techniques Private Limited.

Different Indian Companies continued participation in production of different components and also delivered some of them. Some important details are as under.

Printed Circuit Boards (PCBs) for ATLAS Experiment: Micropack received a three-year contract for supply of PCBs for ATLAS Phase-II upgrade having value of about Rs. 24 crores. The supply consists of about 6500 simple and 1350 complex PCBs, having many layers, high frequencies and of different materials. Five samples of 16-layer PCBs and 8 samples of 4-layer PCBs were sent to CERN during the year.

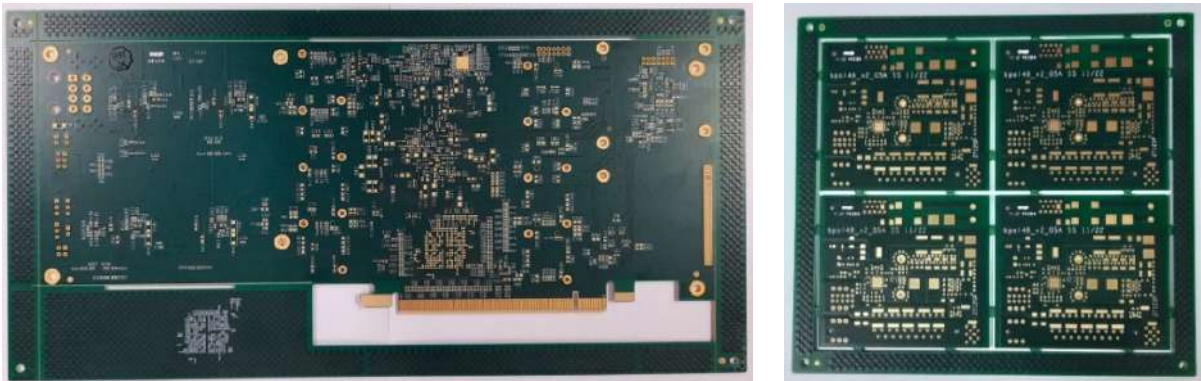


Fig. 16-layer PCBs (L), 4-layer PCBs (R) sent to CERN

Vacuum Vessels for Cryogenic Applications: Inox India completed fabrication and supply of 57 service module vacuum vessel, 22 jumper vacuum vessels and 24 dish cover to CERN. They also delivered 24 more vacuum vessels, test benches for magnet flanges and service module jumpers.



Fig. Service module, Jumper Vacuum Vessel (L), Jumper vessel machining (R)

The total value of the components delivered to CERN was about Rs. 6 crores.

Clean Rooms: Cadillac Filters, Kolkata supplied all materials and components for installation of two modular ISO7 compliant clean rooms which will be used for assembly and testing of CMS HGAL detector modules.



Fig. Clean Room under installation and commissioning at CERN

The work progressed further and is expected to be completed in next four months. This will be the first contract involving significant works performed by an Indian company at CERN site.

Sub-Assemblies for Vacuum Vessels of DFX-D1 Connection Module (DCM) Device of HL-LHC: Inox India secured a contract for supply of sub-assemblies for Vacuum Vessels of the DCM Device of the HL-LHC Project.

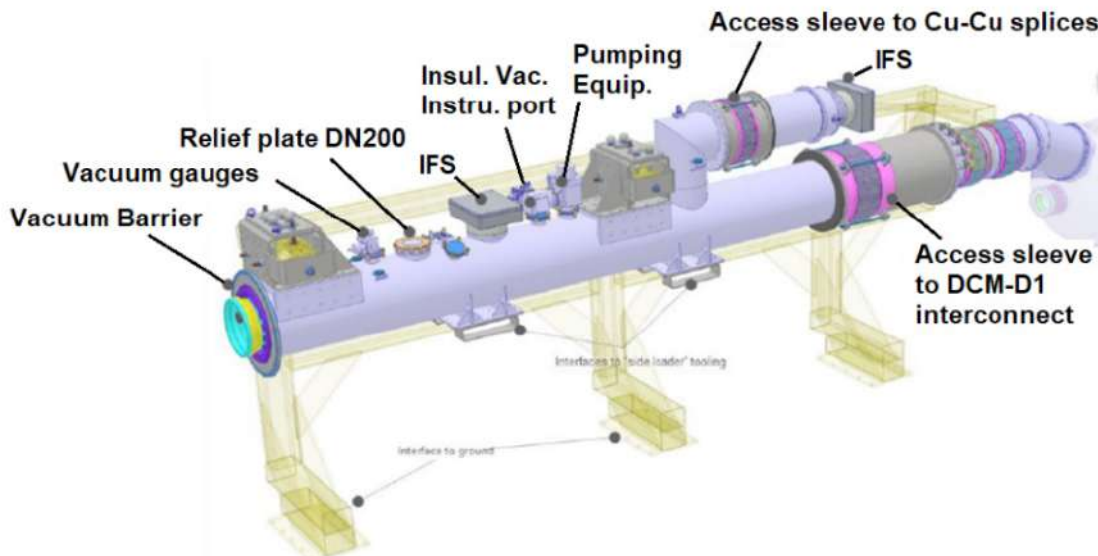


Fig. Schematic for sub-assemblies for DCM service line vacuum vessels

DCM is made of four units each one including a vacuum vessel. Each vacuum vessel is made of six sub-assemblies. Inox will supply four sets of six sub-assemblies for equipping the DCM vacuum vessels including all needed auxiliary mechanical components.

VXSS Vacuum Chamber for M2 Beamline: Vacuum Techniques, Bengaluru received order for fabrication and supply of one vacuum chamber for a beamline in the north experimental area at CERN.



Fig. Vacuum Chamber for M2 Beamline (under fabrication)

The supply will be installed in between the primary target and the beam absorber, in a sector that operates at primary vacuum pressures in the order of 10⁻³ mbar. Among the requirements are; leak tightness to helium gas, 100% weld penetration at some locations and good surface finish for the flanges.

CO₂ Distribution Racks: Inox received order for welding and assembly of two-phase CO₂ distribution racks for SR1 ATLAS Integration facility.

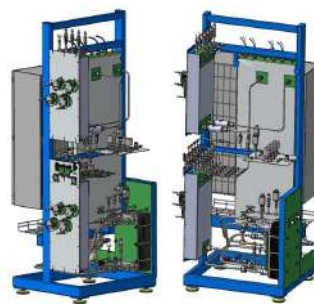


Fig. Schematic of CO₂ Distribution Racks

The work will involve orbital welding of the assemblies with Swagelok VCR fittings used as connectors, followed by leak test the welds joints and pressure test of whole assembly.

In addition to the above, Polycab, Vadodara delivered about 240 km of Flexible Low-Voltage Multicore Copper Cables, having value of about Rs. 9 crores as fulfilment of three-year

purchase contract with CERN. Also, Burckhardt Compression India Private Limited, Pune supplied high-pressure reciprocating compressor worth about Rs. 2 crores.

During the year, 5 Indian Companies, Digitra Solutions, New Delhi, GE T&D India Limited, Hosur, Hardcoats, Mumbai, Sailotech, Mumbai, Udemey India also received orders from CERN.

During the year, the CERN Task Force visited India to evaluate India's continued participation as Associate Member State of CERN.



Fig. Visit of CERN Task Force to DST

The CERN Task Force also visited two labs at University of Delhi and also interacted with faculty and students from University of Delhi, Panjab University, University of Jammu and Aligarh Muslim University.

2.3.3 Indian Institutions-Fermilab Collaboration in Neutrino Physics

Indian researchers are participating in ongoing neutrino experiments at Fermilab, USA which includes 15 faculty members, 20 PhD students and 2 Post-Docs from 9 research groups across the country. During the year, NOvA shifts were carried out remotely from the country using a Remote Operations Centre for NOvA Data Acquisition that was inaugurated this year.

During the year, output from the project included 8 collaborative research publications, 15 research publications, 25 Talks/Posters at Conferences, 1 PhD, training of 20 project human resources and 4 other students.

2.3.4 Utilization of Twin Beamlines for Macromolecular Crystallography (XRD2) and High-Pressure Physics (Xpress) at the Elettra Synchrotron Facility, Trieste, Italy.

India, jointly with Italy, had established XRD2 and Xpress beamlines at Elettra synchrotron facility. The utilization of these beamlines for carrying out research in macromolecular crystallography and high-pressure physics by the Indian scientific community has been continuing since then. The major developments and achievements from these two beamlines are as under.

XRD2: During the year, the beamline had undergone significant upgrades which improved time required for screening and data collection and enhanced the overall user experience. Computer and software with the diffractometer were upgraded which improved its response time. A new double gripper was installed for robotic sample changer leading to saving in time required to change crystals. A new zoom camera system was installed which offers better resolution and zoom required to centre the crystal in the beam. Data processing was implemented on a cluster which provides faster processed data to users. During the year, 8 Indian proposals were allocated beamtime. 818 crystals were sent to the beamline and 441 data sets were collected from them. The output included 8 research publications, benefits to about 20 PhD students and Post-docs and deposition of 21 protein structures in the Protein Data Bank.

Xpress: During the year, in-situ high-pressure high-temperature (HP-HT) diffraction set-up was introduced enabling the beamline to perform high-pressure diffraction measurements at elevated temperatures.



Fig. Experimental Station with HP-HT set-up installed on the sample stage (allowing diffraction measurements up to 30 GPa and 1000 K)

During the year, 23 Indian proposals were allocated beamtime which is about 30% of the total proposals. The output included 16 research publications. About 23 research students utilized the beamtime for their research activities in the country.

Outreach Activity for XRD2 and Xpress beamlines at Elettra Sincrotrone was organized at University of Jammu. Another such outreach activity for Xpress beamline was organized at Bharathidasan University, Tiruchirappalli.

2.3.5 Low-Energy Accelerator-based Research Facilities at Kurukshetra University and at Allahabad University

Support to Kurukshetra facility continued during the year. Sustained efforts were made by the investigators to bring the facility back to operational mode at par with pre-Covid times. During the year, Radio Frequency (RF) Sputtering set-up was used for growth of thin films of

Mo, ZnTe, Si₃N₄ over silicon, quartz and glass substrates by varying process parameters. Other auxiliary equipment was made operational and the same was utilized by external and internal users. The output from the project includes 4 research publications, 6 conference papers and 1 invited talk.



Fig. Visit of Expert Committee for review of progress

The progress made in the projects of both the facilities was reviewed during the year.

2.3.6 Indian Participation in the Construction of Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany

India is participating in construction of FAIR as a Founder-Member partner. The civil construction work at the project site in Germany nearly completed and installation of important accelerator components was scheduled.

During the year, 136 Power Converters and 56 Ultra High Vacuum (UHV) Chambers were supplied to FAIR as Indian in-kind contributions. For Beam Stoppers, Agreement between concerned stakeholder were signed. For Co-axial Power Cables, purchase order was released.

Besides developmental work, the output from the project includes 2 research publications, 6 conference papers, 25 internal notes, 2 PhDs and training of 10 project students.

2.3.7 India's Participation in the Thirty Meter Telescope (TMT) at Mauna Kea, Hawaii, USA.

India is participating in the construction of TMT project as a Founder-Member partner with continued support from DST and DAE. The access to the project site at Mauna Kea, Hawaii could not be made and efforts continued to resolve the issue. The project is facing time delay of about 10 years and cost escalation of about USD 2 B. The TMT project had submitted a proposal to National Science Foundation (NSF), USA to bridge this funding gap. The

proposal is under active consideration with NSF and lot of developments have taken place in this direction.

During the year, the progress made in the project at the Indian end was reviewed by Executive Council for the project.

India-TMT continued design, development and prototyping activities towards its in-kind commitments to the project.

HARDWARE

M1 Segment Polishing: During the year, India-TMT Optics Fabrication Facility (ITOFF) continued to be augmented. A number of machines like Coordinate Measuring Machine, Buy-Off Station, Etching Station, Thermal Chamber, Phase Measuring Microscope, 2-D Profilometer were installed and other equipment including Roundel Buy-off Station, Total Metrology Station and Blank Handling Fixture were successfully designed by India-TMT Team and these were fabricated by different Indian industries.

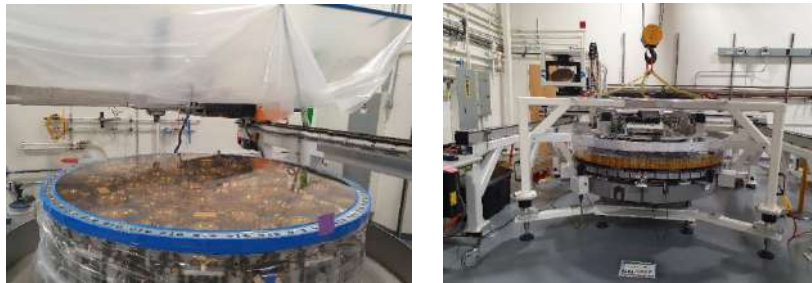


Fig. Segment Polishing Activity in progress

Hex-cutting Fixture for full-size roundel manufacturing completed at Optica, Bengaluru and Purchase Order released for thin slicing wheel.

Segment Support Assembly (SSA): During the year, three sets of SSAs were manufactured after successful completion of its R&D and prototyping.

Central Diaphragm: Development of prototype central diaphragm continued. 10 sets of central diaphragms are expected to be fabricated shortly.

Warping Harness Cables (WHC): 3 Indian companies qualified for production of WHC. The work for fabrication of 30 sets continued.

Actuators: Technical and commercial evaluation of vendors for P3 Actuator manufacturing phase completed during the year. Two vendors were selected for production of 20 actuators in this phase.

Edge Sensors: During the year, contract was signed with Optica, Bengaluru for machining 75 P3 Edge Sensor blocks. Purchase order for gold coating of 5 blocks was also issued.

SOFTWARE

Observatory Software (OSW): Prototyping of one module of OSW, Data Management System Science completed and delivered. Common Software Maintenance Work Package also completed. Work on OSW Operation and Maintenance Work Package continued during the year.

SCIENCE INSTRUMENTATION

Wide Field Optical Spectrograph (WFOS): India-TMT continued working on designing two major mechanical subsystems for TMT-WFOS.

High Resolution Optical Spectrograph (HROS) Opto-Mechanical Design: India-TMT team continued working towards design and development of TMT-HROS, a second-generation optical spectrograph instrument.

In addition to developmental activities, the project also resulted in 6 scientific and technical publications while 1 more has been submitted, 5 PhDs were ongoing and 2 Talks/Posters were presented by project human resource on different aspects of the project. India-TMT Team put up a stall at Bengaluru Tech Summit 2022 for dissemination and outreach purpose.

In this project, 14 Indian industries are very actively involved in this project. The project also involves 16 Project Engineers/Scientists, 1 Post-Doc, 4 Trainees, 1 M.Tech. Student and a number of other project staff.

2.3.8 Indian Participation in Square Kilometer Array (SKA) project in Australia and South Africa

India is a Member of the SKA project, which aims to build the next-generation global radio astronomy facility. Indian participation in this project continued with support from DAE. More than 20 Indian institutions are partners in the SKA-India Consortium which coordinates all scientific and technical activities related to the project.

During the year, the Indian Team (led by National Centre for Radio Astrophysics (NCRA), Pune in collaboration with industry partners) working on the Telescope Manager software system, transitioned from early prototyping activity phase to the actual construction phase of the Observatory Monitor & Control (OMC) for the project. The Indian team successfully completed four project increment cycles of work and provided leadership for the entire OMC release train. In addition, India also picked up on prototyping work on the SKA-Low station digital processing work package, with prototype of the hardware procured and installed at laboratories in Giant Metrewave Radio Telescope (GMRT) and Raman Research Institute. The Indian Team successfully demonstrated for the first time, the integration of the Monitor, Command & Control Software (MCCS) with the prototype SKA-Low digital hardware

system – this will significantly speed up the work on development of the SKA-Low system for the Array Release 0.5 target of the SKA Observatory (SKAO).

During the year, an interim Cooperation Agreement with the SKAO Council was agreed. The financial appraisal process for Indian participation in the construction phase of the project advanced further.

2.3.9 Establishment of Laser Interferometer Gravitational-wave Observatory-India (LIGO-India)

The 3rd Detector of LIGO is being established in Hingoli District in Maharashtra. Different project activities continued with DST's seed funding support. During the year, financial appraisal of the project advanced further.

2.4 Climate Change Programme (NMSHE & NMSKCC)

DST has been entrusted with the responsibility of coordinating two national missions on climate change as part of National Action on Climate Change (NAPCC). These are (i) National Mission for Sustaining the Himalayan Ecosystem [NMSHE] and (ii) National Mission on Strategic Knowledge for Climate Change [NMSKCC]. The Climate Change Programme (CCP) Division is implementing these two national missions.

2.4.1 Major Achievements and progress

New Initiatives

New initiatives taken up during the year were as under:

- **Four new State Climate Change Cells (SCCCs)** are established in the States of Goa, Jharkhand, Uttar Pradesh (UP) and UT of Chandigarh making the presence in SCCCs in 28 states/ UTs across the country. These are established to undertake vulnerability assessment, training programmes, public awareness and institutional capacity building and to carry out several activities that connect their State Action Plans on CC with NMSHE/NMSKCC priorities of action.
- **Centre of Excellence (CoE) on “Climate Change Research” (DST-CoE-CCR)** is established to work in the area of **Impact Assessment of Thermal Power Plants on Microclimate in the Vidarbha Region of Maharashtra State to be implemented at CSRI-NEERI Nagpur** which is aimed to conduct research on understanding the climate processes and their impact on human life and the environment. This Centre is devoted to work on understanding the change in micro-climate processes due to CO₂ emissions from thermal power plants spread in the Vidarbha region

- A project on **Risk Assessment & Mapping at District & State Level** is supported to Indian Institute of Technology (IIT) Mandi which aims to develop a comprehensive framework for assessing the overall risk related to climate change and carry out risk mapping..The project on climate risk assessment is co-developed which include hazards, exposure, and vulnerability components, to provide an important basis for the identification of adaptation requirements, prioritization and analyses of loss and damage. This assessment can aid both the national and state governments to identify the likelihood of current as well as future climate hazards and their potential impacts for prioritization of climate action and investment in adaptation.
- A project on '**Technology Needs Assessment**' is supported to Technology Information, Forecasting and Assessment Council (TIFAC), New Delhi to relook into the Technology Needs for different sectors. Technology needs assessment (TNA) is a set of activities that determine the priorities for mitigation and adaptation to CC in the country..
- **Four** Major Research and Development Programmes (MRDP) launched. Two of these projects have been supported in the area of (i) Reconstructing the Late Quaternary paleohydrology of the Lakes by University of Ladakh (ii) Development of climate resilient and sustainable agri-based systems by National Dairy Research Institute, Karnal, Haryana for support with budget ceiling of 3 crores for a period of three years. Both these projects are focused in the priority region of Ladakh. Another MRDP project on Working Frameworks for Climate Smart Village is supported to *Govind Ballabh Pant* 'National Institute of Himalayan Environment Sustainable Development '(GBPNIHESD), Almora. Under NMSKCC, MRDP is launched on Reversing Climate Change Via Solar Geoengineering and supported to IISc Bangalore to develop the modelling capability of injecting sulfate aerosols into the stratosphere which will be a first in India.
- Climate Change Programme, DST hosted and participated in technical sessions in United Nations Framework Convention on Climate Change (UNFCCC) **Conference of the Parties, COP-27** at Sharm El-Sheikh, Egypt, from November 6–10, 2022. DST coordinated a special technical side-event on "Technology Need Assessment" and "Climate Change Impacts on the Himalayan Cryosphere, North-Western Himalaya, India". During the event a compendium on "Climate Change Initiatives for the Indian Himalayan Region" was launched highlighting the outcome and achievement under NMSHE. In addition, TIFAC and DST organized a side event at India Pavilion at COP 27 on the theme "Decarbonization Technology for Indian Industries".



Fig. With Honourable Union Minister of Environment, Forestry, and Climate Change, Shri. Bhupender Yadav at India Pavillion at CoP-27 and the Launch of compendium on “Climate Change Initiatives for the Indian Himalayan Region”

- The expert committee of the programme was reconstituted and 4 meetings of reconstituted EC have been undertaken for reviewing the outcomes of ongoing projects and evaluation of new proposals which include evaluation of 8 new proposals, 10 phase II proposals and review of 45 ongoing projects.

Significant outcomes from the ongoing programmes

National Mission for Sustaining the Himalayan Ecosystem (NMSHE)

Under the mission, six (06) Thematic Task Forces (TF) have been set up to scientifically assess the socio-economic and ecological consequence of global environmental change by carrying out research in the 6 thematic areas viz.; Natural & geological wealth; water, ice, snow, including glaciers; micro flora & fauna, wildlife & animal population; forest resources & plant biodiversity; Himalayan agriculture and traditional knowledge.

I. Task Forces (TF)

Forest Resources and Plant Biodiversity (Phase II) coordinated by G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Uttarakhand is working on strengthen database on forest resources and plant biodiversity, Establishing an effective monitoring system, growth dynamics and carbon exchange potential, vulnerability of ecologically and economically important plants and forests. This year two new Global Observation Research Initiative in Alpine Environments (GLORIA) sites were established in the Trans-Himalayan region of Himachal Pradesh and Ladakh for understanding the climate change effects across the pan-Himalayan region. Assessment of seasonal variation of net ecosystem exchange (NEE) with gross primary productivity (GPP) and ecosystem respiration (RE) of a Banj-Oak dominated forest of Uttarakhand Himalaya revealed that

the daily average NEE was found to be $-2.21 \text{ gC.m}^{-2}.\text{day}^{-1}$. Species-level vulnerability assessments were carried out for *Betula utilis*, *Abies spectabilis*, *Pinus wallichiana*, *P. roxburghii*, *Quercus leucotrichophora*, and *Q.semecarpifolia* using an ensemble modeling approach.



Fig. Last village near LTEM plot (Kutti Village; Elevation: 3829 m amsl) and Re-assessment of vegetation sampling in Hat-Kalika LTEM plot (1650m asl; evergreen temperate coniferous forest) with *Cedrus deodara*, and *Quercus leucotrichophora* as dominant tree canopy species.

Task force IV Micro Flora and Fauna and Wildlife and Animal Population phase II is being coordinated by Wildlife Institute of India, Dehradun. The project was initiated to conduct an action-oriented research to strengthen the knowledge of climate implications on the wildlife of Himalaya. the project is engaged in generating spatially explicit information on observed and predicted impacts of climate change on wildlife populations (fauna and microflora) throughout the longitudinal and elevational gradient in the IHR and microclimatic pattern (data loggers for terrestrial and aquatic environments, permanent sampling plots and Open Top Chambers) for the assessing the climate impact on wildlife species.

Task Force on Himalayan Agriculture Phase-2, Indian Council of Agricultural Research (ICAR) is focussed to work on adaptation strategies under climate change scenarios for each state of IHR, develop ICT tools for adaptation technology dissemination, Analysis of climatic extremes from agriculture perspective, Mapping uncertainty in climate scenarios IHR, To pilot-test the adaptation technologies for improving livelihoods & To train the stakeholders and develop human resources for climate resilient agriculture. This year Pilot-based drip irrigation system in cabbage crops was successfully laid-out in four villages of trans-Singela area and vegetative and yield-attributing traits of cabbage crop under the drip irrigation system were recorded.

II. Centre of Excellences (CoEs):

Centre of Excellence on “Climate Change Impacts and Adaptation for Climate Resilient North East India” established in Department of Environmental Science,

Tezpur University. The CoE contributed towards building capacity on various fronts and organized various workshops and training programmes. In addition, exploration of plant diversity was completed in Soraipung range, DehingPatkai National Park, Assam and a total of 133 plant species (64 trees, 33 shrubs, and 36 herbs) belonging to 88 genera under 48 families were recorded.



Fig. Experimental field at Tezpur University campus, Assam, India (mustard genotypes: Potsangbam yela and TS 38)

Centre of Excellence on Glacial Studies in the Western Himalaya established at University of Kashmir in 2020 as an interdisciplinary research project involving researchers from the fields of cryosphere, hydrology, and climate change. The centre is devoted to work on glacio-hydrological dynamics, glacier mass balance, paleo climate and the impacts of climate change on cryosphere, stream flows, springs, and other related aspects.

DST's Centre of Excellence (CoE) on Water resources, Cryosphere and Climate change studies at Sikkim University has been contributing to strengthen the research infrastructure facilities and promote advance research at Sikkim University as well as in Eastern Himalayan region. Major technical outcomes of this year include:

- Water sampling from springs, rivers, and households of Sikkim for Pre-monsoon and Monsoon season 2022 was completed and results indicate that the water resources used for consumption are susceptible to coliform bacteria contamination.
- Established Cryospheric Data Acquisition Centre
- Bamboo stakes were installed on two glaciers in North Sikkim namely Jhaktang and Changme Khangpu glaciers to monitor the field-based glacier mass balance.



Fig. Stakes installation at ChangmeKhanpu (left) and Jhakthang glaciers (right).

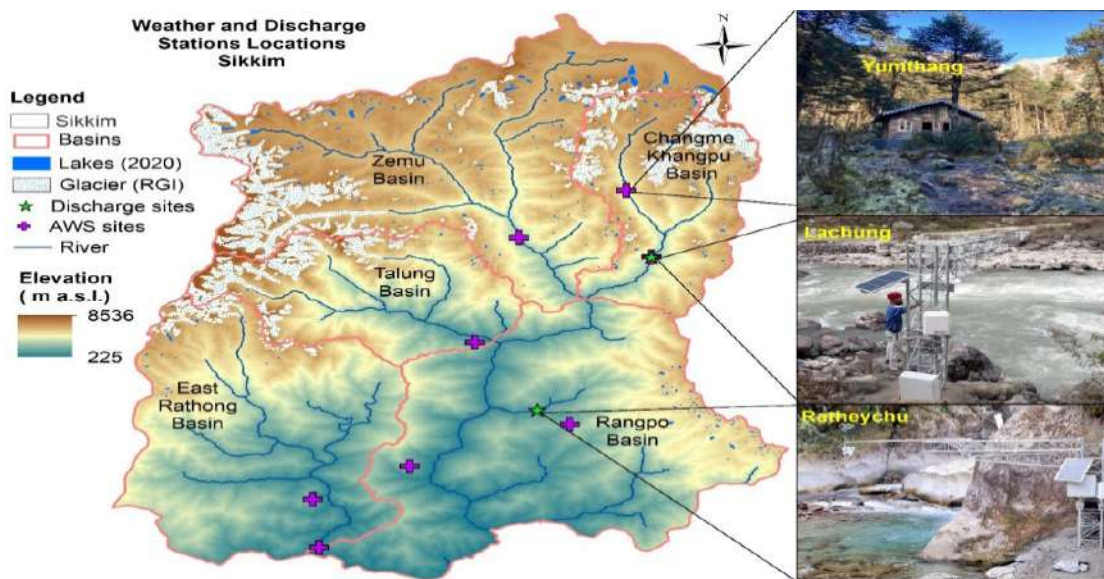


Fig. Cryospheric Data Acquisition Centre established at Yumthang in North Sikkim. Locations sites of automatic weather stations (AWS) and discharge stations installed at Sikkim

III. Capacity building: during the year training programmes on various aspects of Climate Change and Adaptation were organized under which around 1388 **Experts/ professionals/students/farmers** were trained under NMSHE.

2.4.2 National Mission for Strategic Knowledge on Climate Change Center of Excellence (CoE)

- **DST Centre of Excellence in Climate Modeling at IIT Delhi** is developing a reliable climate model for India. During the year center made significant improvements to the base model (NCAR Community Earth System Model) through regional customization of parametrization schemes, such as the deep convection parameterization, gravity

wave drag parameterization, and the surface flux parameterization schemes, with a motive to develop an India Centric Climate Model (ICCM). The improved version of ICCM alleviated some of the notable longstanding biases seen over the monsoon domain, such as precipitation pattern and magnitude over the Arabian Sea and western Equatorial Indian Ocean etc. In addition, simulated seasonal and intra-seasonal features are improved in the ICCM. At present CoE is working on improving the ICCM through additional customization, and are customising a regional model to improve the quality by better representing the physical processes via dynamical downscaling.

- Centre of Excellence in Climate Studies (DST-CoECS), IIT Bombay** undertakes interdisciplinary, problem driven research and teaching for end-to-end analysis of CC issues. The research group associated with the centre draws in around 32 faculty members from 12 disciplines. Through one-of-its kind interdisciplinary PhD programme in Climate Studies, **15 (13 PhD scholars and 2 RAs)** competent climate change professionals are being specially trained at IIT Bombay. During this year the CoE could brought out several high impact reserch papers in the area of climate change linked to ocean processes, irrigation, flood, transport, soil moisture aspect:

Organized opening ceremony for a year-long series of events towards the 10th anniversary celebration of the Interdisciplinary Program (IDP) in Climate Studies at IIT Mumbai

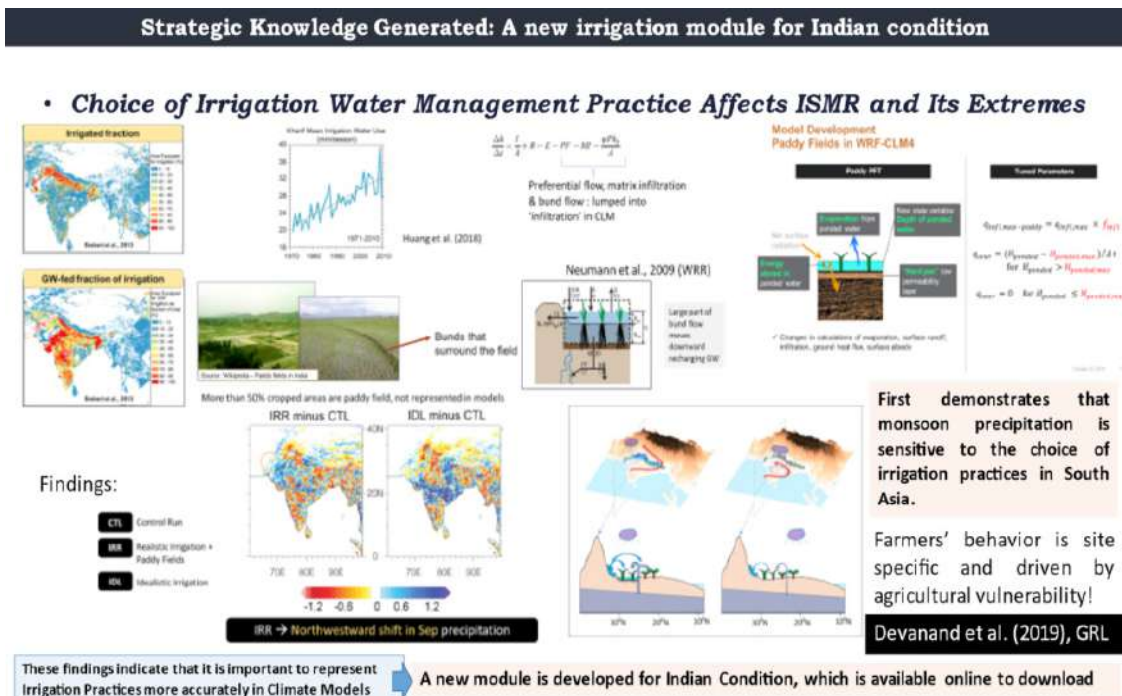


Fig. Irrigation module first-ever for India

- **DST-ICRISAT CoE on Climate Change Research for Plant Protection (CoE-CCRPP):** Pest and disease management for climate change adaptation. This CoE develops a framework and create facilities to develop adaptation strategies) to increase resilience and reduce the vulnerability of agriculture in India at the local, regional, and national levels. This year following technical outcomes have been achieved:



Future climate scenarios (2030 and 2050 under RCP4.5 and 8.5) generated for 98 districts of India predicts the increased incidence of pigeonpea *Phytophthora* blight distribution under cool-wet and hot-wet near 30; chickpea dry root rot distribution under hot-dry near 30.

Elevated temperature and CO₂ have significant impact on crops primary productivity parameters viz. leaf area, plant biomass and thus impacting the yield and nutrition in pearl millet, sorghum, pigeonpea, rice and cotton. As compared with ambient conditions, elevated CO₂ reduced the grain nutrient (Fe, Zn & Proteins) content by 20-40% in pearl millet and sorghum.



DST supported Climate Change Research facility at ICRISAT was inaugurated by hon'ble PM in the month of February. This advanced state-of-the art research facility is a dedicated platform to focus on developing modern crop production and protection tools that can make agriculture more sustainable and climate resilient. The facility hosts open-top chambers (OTC), controlled environment temperature gradient tunnels (CTGT) and free-air CO₂ enrichment (FACE) equipment's.

workshops/ awareness programmes for various stakeholders which were attended by more than 800 participants comprising of officials from line departments, farmers, students, media, NGOs etc.

Sikkim State Climate Change Cell: To generate micro climate profile of Sikkim Installation of a total of 70 Automatic Weather Stations were done across Sikkim. State had successfully done **bathymetric survey of Shakho Chu Lake** in North Sikkim in September 2022 using Apache 3 USV and data was collected from around **2800** discrete points. Scientific expedition to **East Rathong Glacier**, West Sikkim on June 2022 for studying glacial dynamics.

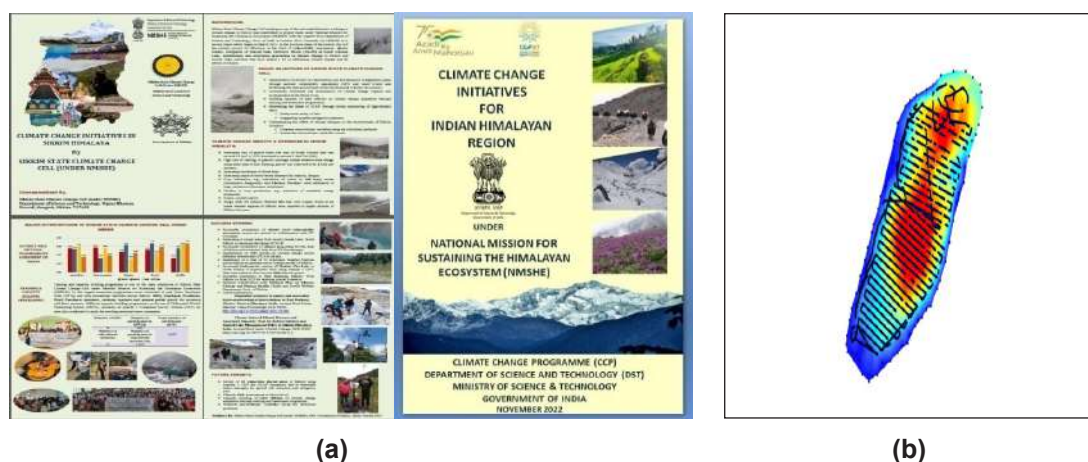


Fig. (a): I.E.C. materials published and (b) Data collected from 2800 discrete points at Lake Shakho Chu undertaken by Sikkim SCCC

HP Knowledge Network on Climate Change in its IInd phase is developing Micro-watershed level climate change vulnerability assessment of proposed river basins and panchayat/ village climate change adaptation plans of districts falling in river basins. This year vulnerability Assessment of Satluj River Basin (Kinnaur&Lahaul-Spiti district), Draft Roof Top Rain Water Harvesting Policy for HP State has been prepared for further finalization. In addition, Climate change Capacity Development Package (CDP) for Mahila Mandals & PRIs in both English & Hindi language have been prepared & published with the technical support extended by GIZ under Indo-German Technical Cooperation. Till date 10 training programme, field & exposure visits have been conducted & organized covering about 900 participants physical as well as virtually.

Punjab State Climate Change Knowledge Centre (PSCCKC) catalysed **year-long initiative ‘Mother’s Care for Environment’** by involving rural women in waste management. The participating mothers of the rural primary school students were recognized as ‘Sanitation Soldiers’ by Administration of District Faridkot and the school level coordinator of the initiative got selected for **‘Swatchhtha Sarthi’ Fellowship**. The center demonstrated **Climate Resilient Livestock Sheds** in households of small & marginal farmers in 3 districts viz. Bathinda, Ludhiana & Tarn Taran by mobilizing funding under NAFCC. These sheds have

been designed with optimum orientation, adequate ventilation, controlled cooling system, powdered coated reflective GI sheet as roof, Mixed flooring, flexible barricading to segregate sick animals, & calves, and apt access to water and proper management of wastes.

Assam State Climate Change Knowledge Centre (ASCCC) carried out a Pre-feasibility Study for the implementation of Green Brick Production in the state focused on three major cities of the state which are Guwahati, Dibrugarh, and Silchar. Highlights of the study are:

- Among the current practices observed on the ground of Assam, the kilns most in use are the Fixed Chimney Bull's Trench Kiln (FCBTK) type along with some instances of ZigZag kilns.
- The high humidity poses challenges for firing as bricks have high moisture content, demanding the consumption of large amounts of fuel and energy in the firing process.

Manipur State Climate Change Knowledge Centre (MSCCC) developed climate resilient interventions and revival of Critical Springs through recharge intervention like Crib structure, check dams, water harvesting structure, toe trenches, etc. in Lunghar village. In addition, the center has installed a total of 20 automated Rain-gauge stations at different sites ranging from 500 m to 2400 m msl.



Fig. Crib Structures at the spring site



Fig. Climate Resilient Agriculture at slope-land

2.5 National Super Computing Mission

- National Supercomputing Mission was started in collaboration with Ministry of Electronics and Information Technology under 60:40 financial commitment, envisioned to be executed in 3 phases through CDAC-Pune as the implementing agency in infrastructure and knowledge creation, and IISc-Bangalore as knowledge partner.
- The 1st two phase of infrastructure creation are completed successfully. It was planned initially as buy approach, however, during the execution of the program it is reoriented to align with the make-in-India policy. Therefore, the built approach has been adapted in all the machines commissioned across the nation other than few low range test machines.

- The following capacity are commissioned till now and being dedicated for researchers across the India

Range	Number of machines commissioned
Lower range (≥ 50 TF, < 200 TF)	13
Mid-range (above 500 TF, but < 1 Peta flops)	9
Large scale (> 1 Peta flops includes GPU)	6

- The key achievements of the NSM till now are,

Indigenous development of Rudra server board 1.0, Trinetra HPC interconnects, HPC system software stack 1.1 and various benchmarks (cloud, HPC) applications.

Also, through NSM 17500 people have been trained so far in High Performance Computing, more than 5354 expert users from 100+ institutes are using the facilities routinely, and 64,22,946 high performance computational queries have been executed till recently.

- In the current year, five new installations were successfully completed at IIT Roorkee, NIT Trichy, IIT Gandhinagar, IIT Guwahati, IIT Mandi. Among these, the IIT Guwahati machine was inaugurated by the Hon'ble President of India in Oct 2022.



Fig. Hon'ble President of India inaugurating PARAM Kampura (left), and PARAM Kamrupa at IIT-Guwahati facility (right)



Fig. PARAM Ananta at IIT Gandhinagar (left) and PARAM Porul at IIT Trichy (right)



Fig. PARAM Ganga at IIT Roorkee and PARAM Himalaya at IIT Mandi

- PARAM Vidya were installed at four HPC Nodal Center at IIT Goa, IIT Madras, IIT Palakkad and IIT Kharagpur under NSM. These Centers focus on manpower creation and up-skilling of students, faculty, scientists, researchers, scientific users in the areas of HPC and AI.
- MOUs were signed with IIT Madras, SN Bose Kolkata, IUAC New Delhi and IIT Patna for installation and commissioning of systems using indigenous Rudra-1 servers under phase 3.
- Rudra-I is designed, developed and manufactured with security trustworthiness. It has an exceptionally greater acceptance and has an edge in security conscious environments and businesses. To achieve 'true market potential' of Rudra-I server, the technology has been offered to the industry.



Fig. Test system using Rudra-I (left) and Trinetra B (right)

- For a robust business continuity of Rudra series servers, C-DAC is continuing working on Rudra-II server and HDR switch and HDR NIC.
- C-DAC has launched Trinetra-A, a fourth-generation network comprising of 600 Gbps (100Gbps*6) throughput for HPC systems. It has assembled a 3D-Torus based

12-node Trinetra test cluster and benchmarked the same for HPL and a range of scientific applications. HPL benchmark ran with 73% efficiency and results were submitted to topsc.in.

- C-DAC has developed Trinetra-B platform which was validated for (a) data transmission over 10 concurrent channels of 200Gbps each, full duplex, and (b) PCI-e Gen3, 16x interface using bidirectional DMA, with approximately 80% of peak throughput achieved.
- Along with Rudra-I server, Trinetra-A was featured at Digital India Week (DIW2022) held during July 4-8, 2022 at Gandhinagar, Gujarat.
- Towards development of Direct Contact Liquid Cooled (DCLC) System, a 30 kW Panel Water Cooler was designed and fabricated at Heat Pump Laboratory of IIT Bombay. It was installed and tested at IISER Pune.
- ANUGA, a flood simulation code from disaster management), was fine-tuned for optimal number of cores/ node and algorithmic parameters (including Minimum Allowed Height, Maximum Allowed Speed, CFL condition etc.). The performance was improved by 5.3 times.

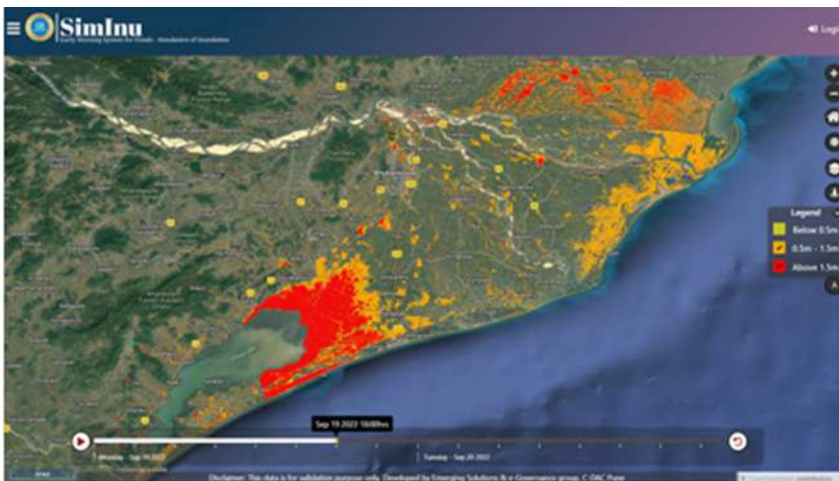


Fig. Inundation Forecast for 19 September 2022

Village	District	State	Inundation
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
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20
21
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29
30

Fig. Village wise flood spread report for 19th Sept. 222

- Early warning system for flood prediction in river basins of India: Since 2020, the simulation runs for predicting floods are being carried out by C-DAC. In the current year, daily flood prediction were started from June 1st, 2022 for the Mahanadi River Basin and the 2-days flood forecasts and percentage village inundation information were shared with CWC Delhi and Odisha State Water Resources Department at Bhubaneswar.
- Development of multi-sectorial simulation lab and science-based decision support framework to address urban environment issues: A forecasting system was set-up for Pune with 2x2 km resolution. It was fine-tuned with the ingestion of local emission inventory

and data assimilation from various sources. Particulate matter (PM_{2.5}) sampling to study chemical speciation was completed at Bangaluru city for winter season and for summer season. A WRF-Chem output-based decision support system for Delhi was developed at IITM, Pune and being used by concerned authorities for policy making decisions.

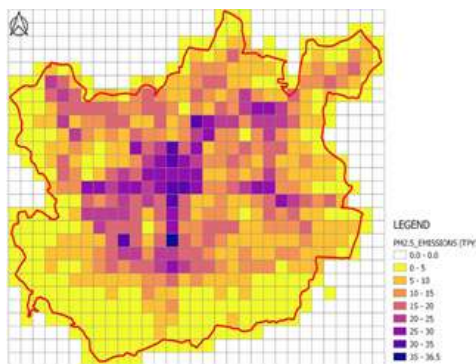


Fig. Spatial distribution of PM_{2.5} emissions (TPY) for Pune city

- C-DAC is developing a Reverse Time Migration (RTM) software for seismic imaging of complex structure on NSM systems for Indian Oil companies for their regular production usage. SeisRTM package comprising of 2D and 3D Isotropic Modeler and RTM, 2D Anisotropic Vertical Transverse Isotropy (VTI) Modeler and RTM with 8th order, and 2D Anisotropic Tilted Transverse Isotropy (TTI) Modeler and RTM with 4th order was deployed at GEOPIC-ONGC, Dehradun and IIT Roorkee.

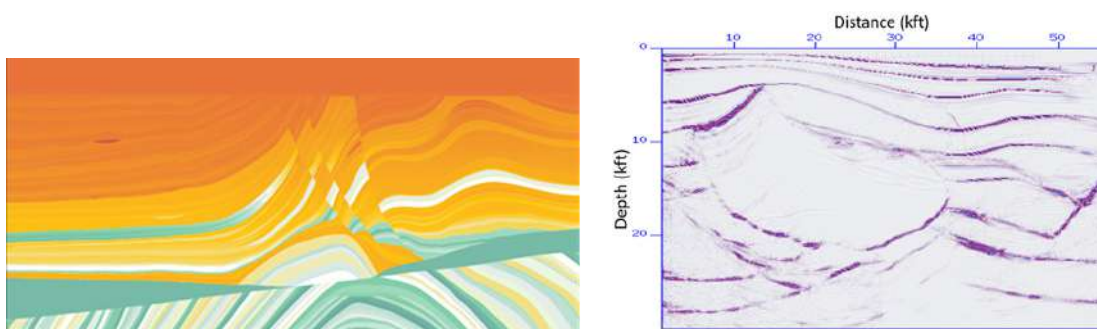


Fig. Geological subsurface 2D Marmousi Model (left) and RTM Outcome - SEG Hess VTI Model (right)

2.6 Technology Fusion & Applications Research (TFAR) Programme

The mandate of Technology Fusion & Applications Research (TFAR) Programme of Frontier & Futuristic (FFT) Division is to boost research in emerging technologies. The TFAR programme, an initiative with Pan India applicability is being implemented at a total outlay of Rs 250 Crore for a period of three years. The programme fosters research for fusion, convergence and application of emerging technologies.

Currently, the following multi-institutional and multi-disciplinary consortium based/cluster mode programmes are under TFAR Programme:

- Quantum Enabled Science & Technology (QuEST)
- Epidemiology Data Analytics Research Initiative (EDARI))
- Data Science Research Initiative (DSRI)
- Internet of Things Research Initiative (IoTRI)
- Cyber Security Research Initiative (CSRI)

All the technologies under TFAR programme are continually evolving beyond the boundaries of single disciplines, thereby generating innovations. Moreover, resulting patents can feed into a Start-up ecosystem and help employment generation. It can also create specially trained human resource & skilled workforce. These technologies are highly prominent today and compiling them on one platform could serve those engaged in R&D, translational research, policy and technology management, and accelerate the process of technical developments and societal problem solving. The TFAR programme would also establish outcome-based research collaborations within India and with International academic institutions for the advancement of interdisciplinary research in the country.

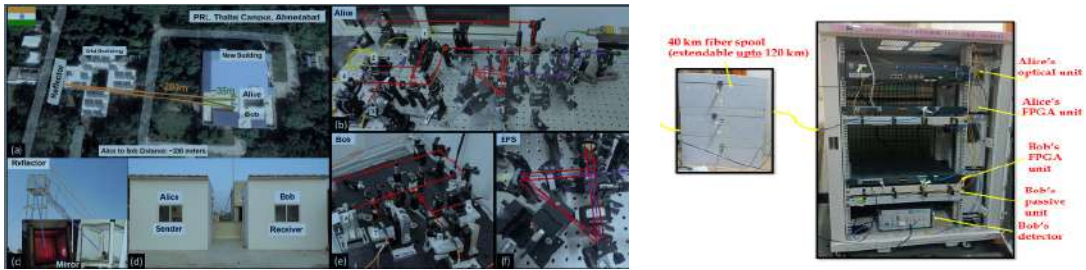
Quantum Enabled Science & Technology (QuEST): QuEST is a one-of-a-kind networked programme to ramp up the R&D activities in quantum science and technology in order to usher in the so-called second quantum revolution in India.

QuEST has 4 themes:

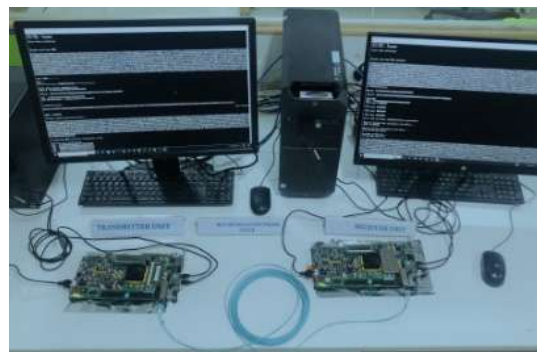
- Quantum Information Technologies (QIT) with Photonic Devices.
- QIT with Nitrogen Vacancy and Magnetic Resonance (NMR).
- QIT with Ion-Trap and Optical-Lattice Devices.
- QIT with Superconducting and Quantum Dot Devices.

Following are the key achievements under QuEST:

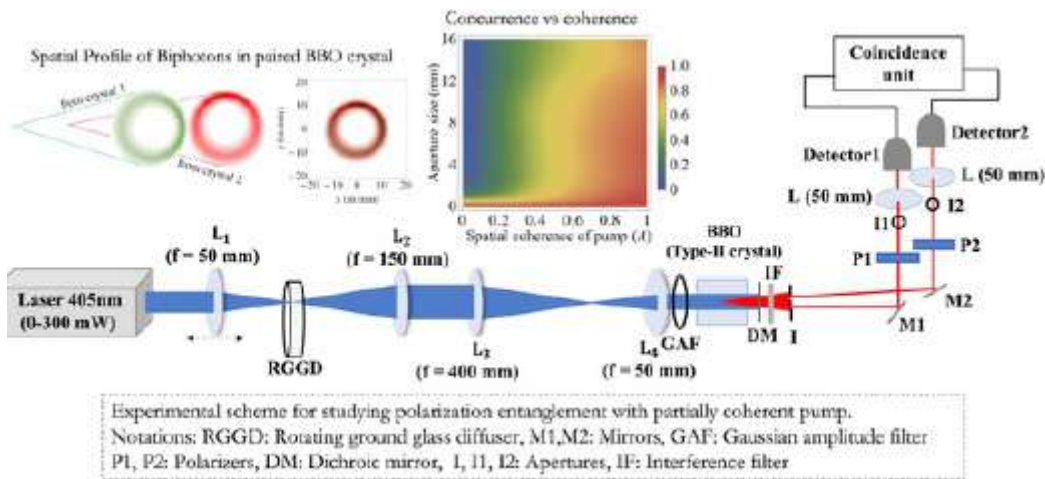
- Demonstrated free space QKD over 200 meters using weak coherent pulses and entangled photons, at Physical Research Laboratory (PRL), Ahmedabad.
- Demonstrated free space entanglement based quantum communication between two buildings as shown below, at Raman Research Institute (RRI), Bengaluru.



- Quantum key distillation algorithm hardware implementation completed, at Society for Electronic transaction and security (SETS), Chennai.

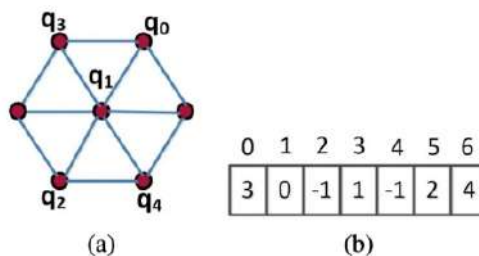
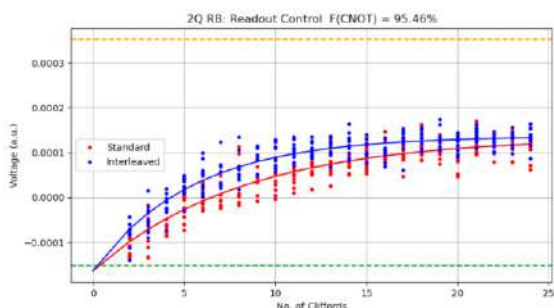


- Observation of the effect of partial coherence of pump in two-mode squeezing of biphotons (squeezed vacuum), at IIT Delhi.



- Demonstrated entanglement revival in the presence of turbulence, at IIT Kanpur.
- Developed a new Fock-space method to identify localized and ergodic phases, at Indian Institute of Science (IISc), Bengaluru
- Developed a method to improve key rate of PPT states, at Indian Institutes of Science Education and Research (IISER), Bengaluru

- Developed necessary conditions for LOCC between set of quantum states, at IISER, Bengaluru
- Designed an Yb⁺ ion trap for building an optical atomic clock, at Inter-University Centre for Astronomy and Astrophysics, Pune.
- Designed phase stabilisation scheme for light in optical fibers and developed electronics, at Inter-University Centre for Astronomy and Astrophysics, Pune.
- Designed experimental Setup for trapping single Rb atoms in arrays, at IIT Roorkee.
- Demonstrated Blue MOT for Yb at 399 nm transition, at IIT Guwahati.

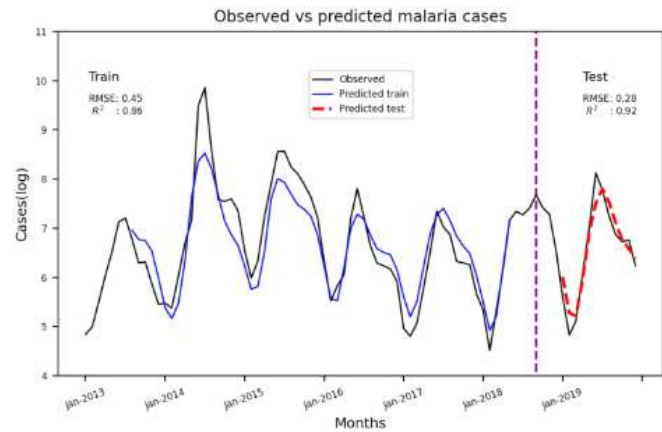
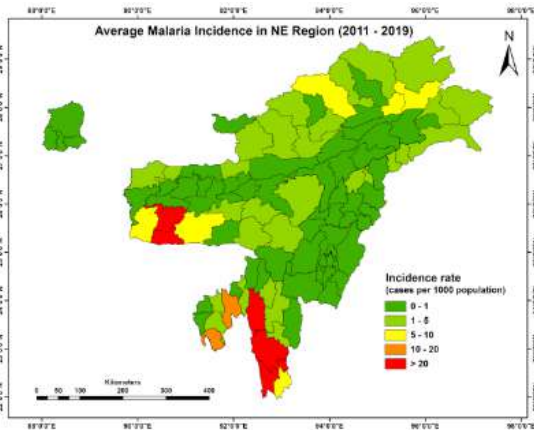


(a) Given qubit mapping, (b) Mapping to 1-D array.

- Novel Graphene based Parametric Amplifier for quantum measurements demonstrated, at Tata Institute of Fundamental Research (TIFR), Mumbai
- Efficient strategy for nearest-neighbour mapping of quantum gate operations has been developed, at IIT Kharagpur.

Epidemiology Data Analytics Research Initiative (EDARI): This cluster aims to create a scalable data-oriented open platform for public health epidemiology in India and to gain a systems view of the spectrum of population health challenges. EDA programme envisages to identify, collate, clean and analyse diverse data that reflect the health of a larger rural or urban population in varied locations across India. It also aims to create the digital platforms and tools that enable such work. Further creation of an open public health data platform with built-in tools for epidemiology data analytics, visualisation and analysis is targeted. Following are the key achievements under EDARI:

- Developed a tableau based data visualization platform, and user-focused tools for malaria data management, analysis, report generation, & decision-making, at CSIR-Indian Institute of Chemical Technology (CSIR-IICT), CSIR Fourth Paradigm Institute (CSIR-4PI) & National Institute of Pharmaceutical Education & Research (NIPER), Guwahati.



- Created a database of more than 2200 Head CT's with radiology reports and clinical data, at All India Institute of Medical Sciences (AIIMS), New Delhi. This is the largest repository of more than 2500 patients over the next six months.
- Developed Covid19 Tracker alongwith Covid19 Modelling and Long term predictions, at CSIR-National Chemical Laboratory (CSIR-NCL), Pune.

Data Science Research Initiative (DSRI): This cluster has facilitated innovations from different domains to be grouped in a large framework. The cluster focuses on five different sub-branches of data science i.e., core data science, deep learning, bio-informatics, social network analysis and real life applications. This has helped the associated researchers avoid overlapping areas and thus reduce redundancy and increase effectiveness. Following are the key achievements under DSRI:

- Developed an integrated inference and visualization, analysis and benchmarking tool at Sikkim University, Sikkim.
- A benchmark data set for the mobile LiDAR point cloud has been prepared at IIT Kanpur.
- Developed a new graph neural network based embedding method and node, edge anomaly detection methods for social networks, at NIT Puducherry..

Internet of Things Research Initiative (IoTRI): This cluster has three broad objectives: (a) Efficient and Reliable Architecture for IoT, (b) Efficient Communication Infrastructure for IoT and (c) IoT Application Development. Following are the key achievements under IoTRI:

- Developed a software architecture for streaming and predictive IoT applications to execute at scale across Edge, Fog, and Cloud computing resources, at IISc Bengaluru.
- Developed a base framework based on Language Server Protocol (LSP) for development of Domain-Specific Languages in an Integrated Development Environment (IDE)-agnostic fashion, at IIT Delhi

- Successfully implemented the Landslide Detection System and Flood Detection System, at NIT Agartala.
- Developed a set of DSLs for different stakeholders (Domain Experts, Architects, Deployment engineers, Network engineers) in an IoT development environment, at IIT Delhi.

Cyber Security Research Initiative (CSRI): The cyber security research initiative is an attempt to define a national R&D agenda that is required to enable the country to get ahead of adversaries and produce the technologies. This initiative is a platform to foster R&D to evolve transformative solutions and address critical cyber security challenges, through partnerships among academics, Industry and Govt. Following are the key achievements under CSRI:

- Designed a detection module by integrating hypergraph properties with intelligent learning models and optimization algorithms to detect unknown attack vectors, at Shanmugha Arts, Science, Technology & Research Academy, (SASTRA) University, Thirumalaisamudram.
- Developed a push button facilitated software for forensic investigation and detection of forged images, at IIT Kharagpur.
- Developed analysis tools for mobile financial apps on Android, at IISc, Bengaluru.

INNOVATION TECHNOLOGY DEVELOPMENT AND DEPLOYMENT

The umbrella scheme “Innovation, Technology Development and Deployment” focuses on strengthening the Innovation and technology development ecosystem for the development of the nation. This umbrella scheme with its sub-schemes contribute broadly on capacity building for research and innovation, creating an ecosystem for technology development and adaptation of need-based technologies to address the identified societal challenges; research and technology-based solutions for India-centric challenges related to Water and Clean Energy etc.; nurturing and scaling up of innovative technology-based start-ups through institutional support and incubation; scientific awareness, communication, popularisation and scientific temper for all; development of geo-spatial solutions for sustainable socio-economic growth; translation of research into products and processes for greater economic and societal benefits.

3.1 Technology Development Programmes (TDP)

Technology Development Programmes (TDP) are designed to convert proof-of- concept for technologies/ techniques/ processes/products into advance prototypes for validation and demonstration in actual field settings. Applicants are encouraged to involve industry from the inception of the project wherever possible. The main objectives of the program are:-

- 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/programs of TDP are:

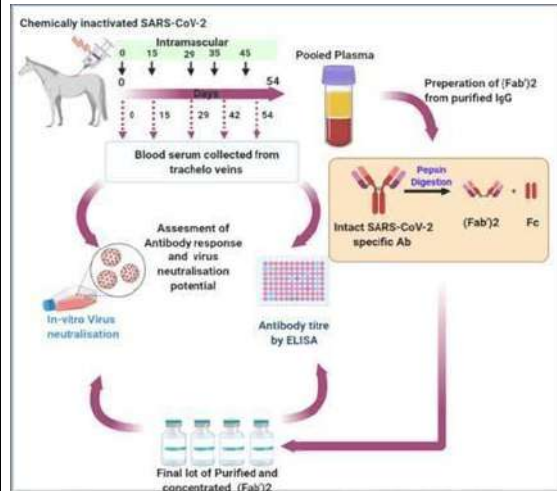
- **Technology Development Programme:** To facilitate and support development of products or techniques/technology aimed at specific end use. The specific objectives of the Programme are to develop and integrate technologies following a holistic approach in identified areas. As many as 55 proposals have been shortlisted for funding during 2022.
- **Waste Management Technologies (WMT) Programme:** To contribute towards Swachh Bharat, Waste Management Technologies (WMT) focuses on technological solutions for the problems faced by the country in solid waste management. Areas under this include hospital waste, plastic waste, industrial waste, agro-waste and e-waste, etc.

- **Advanced Manufacturing Technology (AMT) Programme:** Aligning with the Make in India agenda of the Government, the Department has initiated a programme to promote development of advance manufacturing technologies in the country. 58 proposals and 8 Centres of Excellence have been shortlisted for funding during 2022.
- **Biomedical Device and Technology Development (BDTD):** Focused on development of devices and related technologies for Medical and Healthcare applications. The targeted categories include screening, diagnostic, surgical and life support devices for clinical applications in healthcare sector. Two Hubs for Development of Biomedical Devices namely, National Hub for Healthcare instrumentation Development (NHHID), Anna University and Biomedical Instruments and Devices (BID) Hub at Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh are contributing in terms of Products/Prototypes/Services.
- **Therapeutic Chemicals Programme (TCP):** Concentrates on “Small Chemical Molecules, which essentially interact with biomolecules, and/or any of the bio- pharma/ bio-therapeutics processes.” The focus areas include Raw materials (Key starting materials and intermediates, Generics, New formulations and delivery systems, and New Drug Discovery including New chemical entities/ New therapeutic molecules. A new Call for proposals was launched for “Therapeutic strategies for prevalent Rare/Orphan Disorders” with an aim to deliver drug compound/new process/formulation for disease management, 13 proposals have been shortlisted for funding during the period.
- **Technology Enabling Centres (TEC):** Established in the Universities to bridge the gap between technology development and incubation activity and enable the investigators to pursue applied research involving stakeholders like industry, society and local government. 11 Universities have been shortlisted for establishing 9 TECs and 2 satellite centres. 9 TECs and 2 satellite centres are already pursuing various activities as per mandate. Some of the achievements of TEC’s are summarized as follows:

DST-Technology Enabling Centre at Punjab University got Lol from Oceaneering International Services Limited (OISL) expressing CSR support of Rs 1 Crore for establishment of Battery testing facility. A consultancy project worth Rs 33 Lacs involving researchers of Panjab University and IIT Ropar was formalized. TEC has formed 10 Interface clubs on themes like Medical, Agriculture, Textile, Automation etc. which are led by Interface Champions (Industry people). As outcome of these interface club meetings, 32 project statements have been extracted from Industry and 10 statements have been mapped with Scientists.



DST-Technology Enabling Centre at University of Hyderabad contributed for the technology transfer of VinCov-19, India's first antidote and a cure against SARS-CoV-2 virus. VINCOV-19 comprises highly purified F(ab')₂ antibody fragments from Equine (Horse) that have a high neutralizing capacity against the SARS-CoV-2 virus. The UoH and the Centre for Cellular and Molecular Biology (CCMB) in collaboration with VINS Bioproducts Limited, a leading immunological company (Hyderabad) successfully completed the Phase-2 Clinical Trials of VINCOV-19. VINCOV-19 is now ready for market authorization and for simultaneous Phase 3 Clinical Trials



DST-Technology Enabling Centre at Nitte University facilitated the development of technology for the production of almond and oatmilk for Antidote, New Delhi. M/s Dentronics Pvt Ltd, a startup was also enabled by Nitte TEC. This patented device measures temperature in the sub-gingival area and periodontal pockets and predicts inflammation. Scaling up of production of previously transferred technology - 'Betel leaf tea' to market ready stage was enabled.



DST-Technology Enabling Centre at Amity University, Noida has mined out 12 innovative ideas/technologies at school level, out of which five technologies have been supported under TEC (four were provided funds for prototype development, and two were connected to NGOs out of which one got funded as well for prototype development). A technology for Novel Bioagent has been transferred to Vedic Vigyan LLP, a Delhi based Start-up firm.



DST-Technology Enabling Centre at Amrita University introduced, Smart Ply: a device for monitoring the quality of plywood during manufacturing, in the market. This has helped the plywood MSME sector enhance their efficiency by 20%. Around 30 collaborative engagements with academia, industry and government were facilitated by TEC.



Around 170 project proposals were received during 2022 under Therapeutic Chemicals Programme (TCP) and Technology Enabling Centres (TEC) components of TDP. 7 new projects were sanctioned after systematic evaluation by Expert Advisory Committees. 38 projects were successfully completed. Some of the leading demonstrable technologies under the programme are as follows:

- (i) **Five Fingered Bionic Prosthetic Hand by Indian Institute of Technology, Guwahati, Assam.** Optimization of kinematic design of the under-actuated hand is achieved using synergies for grasp postures and Potential Grasp Robustness. Control and actuation of the muscular system is replicated through a two-layered architecture. Fabricated EMG controlled prosthetic hand is capable of executing six different grasp types based on user intention. The below figure shows the EMG grasp recognition architecture based on an original Kernel Partial Least Square Feature Selection Method; which is published in Pattern Recognition, and Prototype 2.0 of the anthropomorphic hand emulating a power grasp.

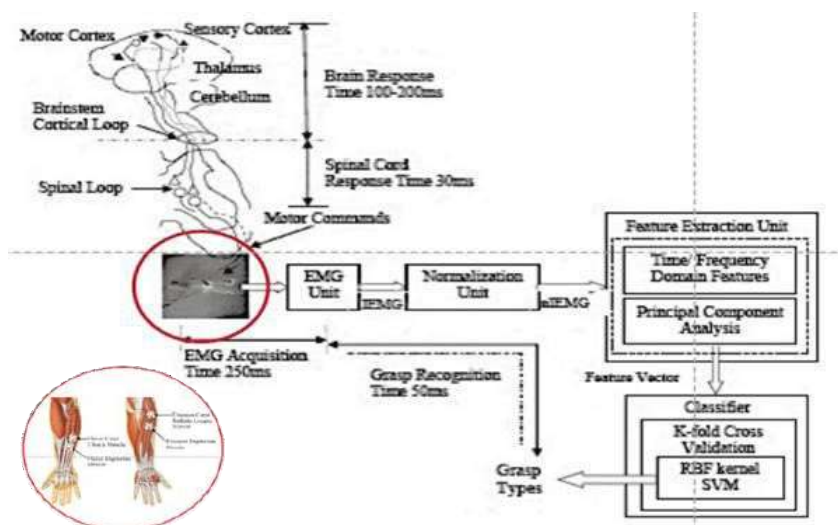


Fig. EMG based Grasp Recognition Architecture.



Fig. Prototype 2.0 of Prosthetic Hand.

- (ii) **Development of a sliding bearing for earthquake protection of structures by Indian Institute of Technology, Gandhinagar, Gujarat.** A single surface sliding bearing (S3B) device are known to reduce horizontal acceleration in the buildings during an earthquake-induced shaking, which can enable an enhanced safety and functionality for structures. The surface profile characterization and tribological tests on the sliding surface have been performed with device prototype.

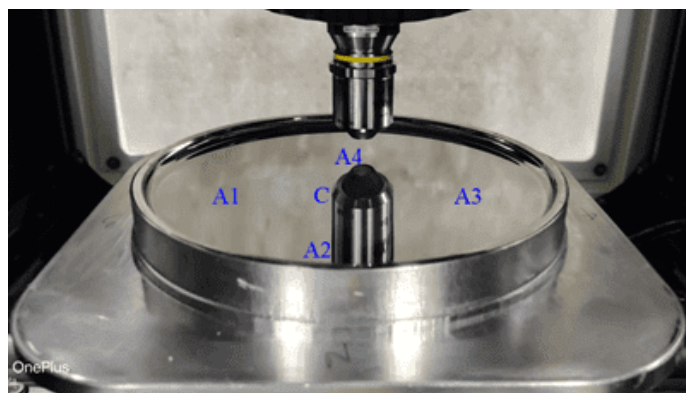


Fig. Sliding surface of the single surface sliding bearing

- (iii) **Process development for effective utilization of Lignocellulosic Natural Fibbers based Thermoplastics Hybrid Composites for High end Structural application by CIPET: Institute of Petrochemicals Technology (IPT), Bhubaneswar, Odisha.** Thermoplastic Polypropylene based composite resin compositions which includes natural fibers such as bamboo, coir, banana, sisal etc. have been prepared using melt blending technique. The surface of the fibres were mercerized subsequent to which it was modified with Maleic anhydride based compatibiliser to improve the interface between PP and fiber. Also, α -olefins were reactively blended to improve the impact strength. Furthermore, the Coir fibre powder is separated from coco-peat using sieve of 250 microns mesh size.



Fig. Steps involved in preparing Lignocellulosic Fiber Reinforced Thermoplastic Composites and High-end prototypes developed from natural fiber PP composites

- (iv) **Development of Optical Fiber Cable Coloring Machine by Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh.** A low cost optical fibre cable colouring machine has been developed with a focus on ease of operation and low machine cost. In the developed machine, setup modifications are made to cut the cost along with maintaining machine effectiveness. Developed machine can serve as an effective alternative in optical fiber cable coloring industry. The machine has been developed in collaboration with ITI, Raebareli. This technology will have great impact in the area of optical fiber cable manufacturing which is estimated to be a billion-dollar market in future.

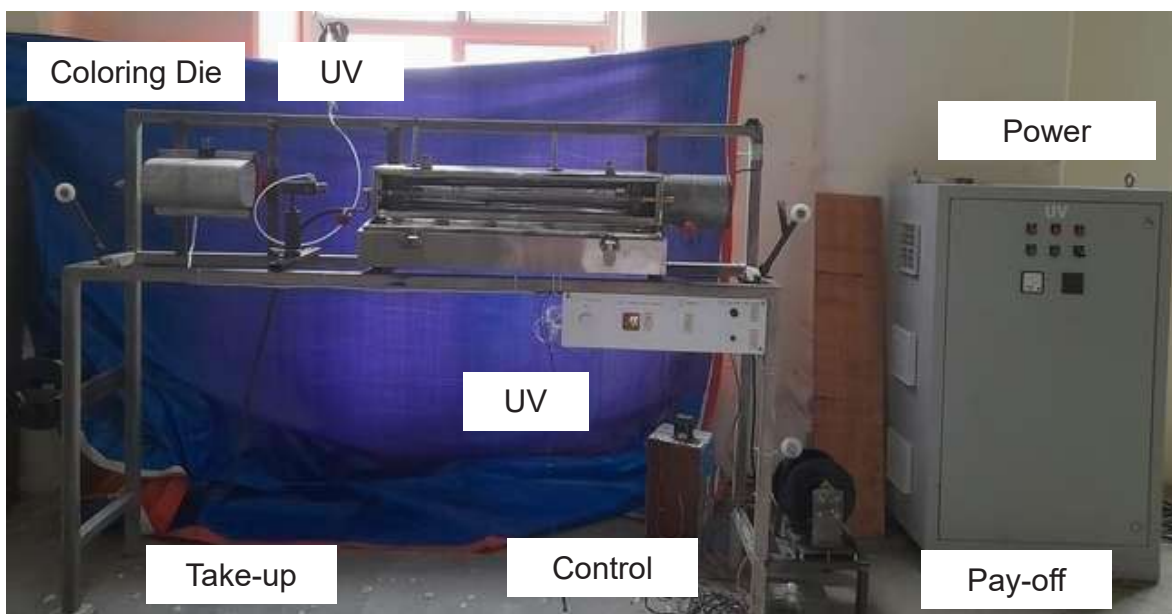


Fig. Optical Fiber Cable Coloring Machine Setup

- (v) **Development of Laser Decal Transfer based Micro-3D Printer for Printing Micro Devices by Indian Institute of Technology, Indore.** LASER decal transfer based micro 3D printer has been developed for printing of metals as well as polymers in micron level. The developed thin film-based 3D printer is unique of its kind for the fabrication functional devices in layer-by-layer fashion. The developed machine 3 degree of freedom for acceptor and 2 degrees of freedom for donor substrate with build volume of 35 x 50 x 30 mm³ at 10 μ m repeatability. The system will boost up the fabrication process of micron scale 3D structures to fulfil the increasing demand of sensors and actuators in the electronics industries and promote maskless manufacturing.

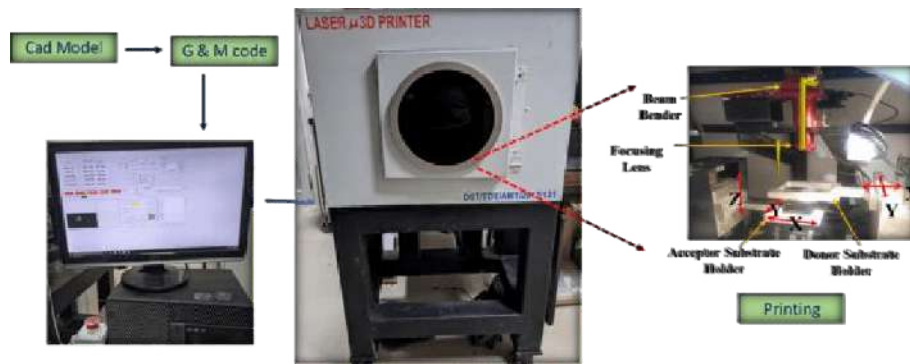
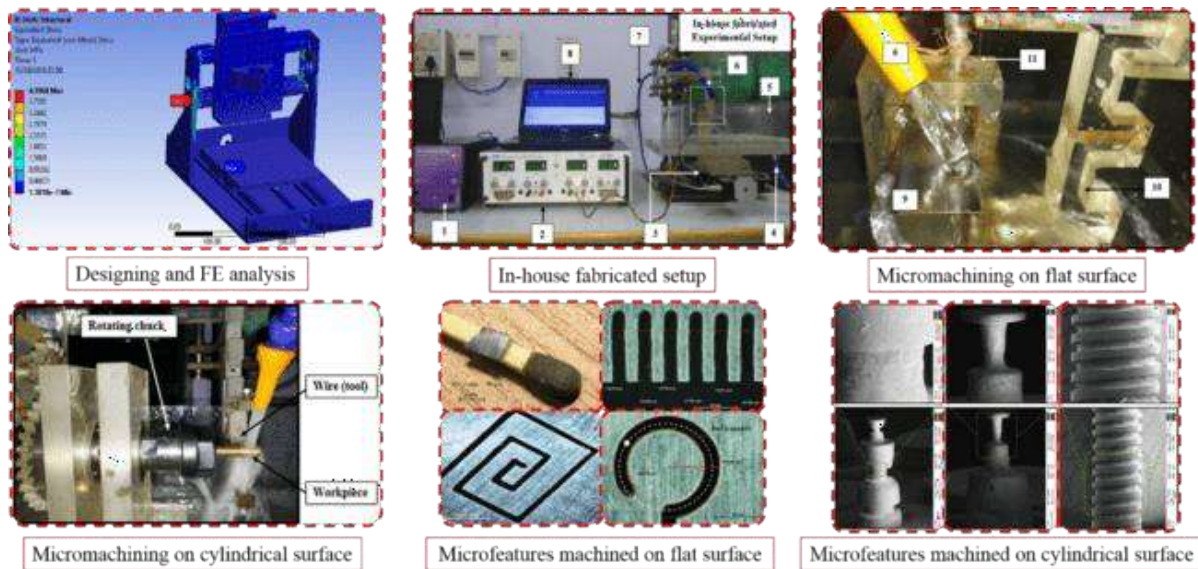


Fig. The in-house developed Micro 3D printing Setup

(vi) **Designing and Developing A Desktop Microwire ECM Machine by Indian Institute of Technology-Kanpur, Uttar Pradesh.** A desktop size machine for Wire electrochemical micromachining (Wire-ECMM) process specifically targeted towards machining of very hard and difficult to machine conducting engineering materials at micro and nanometre scale has been developed. This setup is fully automated, coupled with a closed loop feedback system and facilitates relative motion between the tool and the workpiece in 4 axes. With a detachable assembly for tool mounting, the applicability of this machine is not limited to only Wire-ECMM, other machining processes like electrochemical milling, drilling, slitting and different turning operations at micro scale are also possible under one work position.



(a) Circle

(b) Right angled triangle

(c) Square helix

Fig. Images of parts machined (Material: Stainless Steel 304) using the desktop microwire electrochemical machine

- (vii) **Wide Band Gap Devices based Electronic Balancing Circuits for Ultracapacitor Modules by Centre for Development of Advanced Computing, Thiruvananthapuram, Kerala.** A Wide Band Gap (WBG), Gallium Nitride (GaN) device based electronic balancing circuits for series / parallel connection of Ultracapacitor unit cells were developed with High frequency of operation with reduced size of components and High power density and high performance respectively. The application of the above technology is in the development of power banks for the active SONAR implementations in marine and air force requirements. With the above expertise, C-DAC is the technical partner with Naval Physics and Oceanographic Lab (NPOL) of DRDO in the development of 20KW marine and 32KW Air Power Amplifier Modules for the Active SONAR applications.

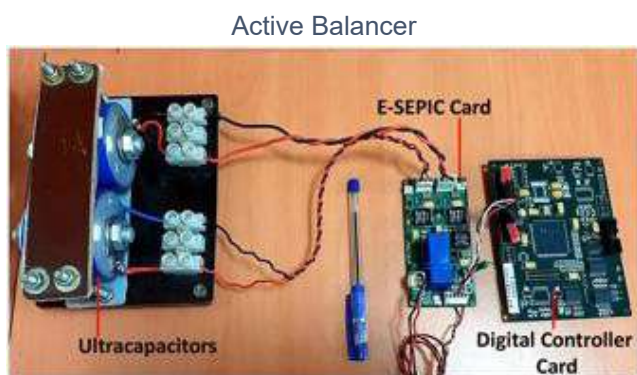


Fig. Ultracapacitor Balancing Module with E-SEPIC Active Balancer

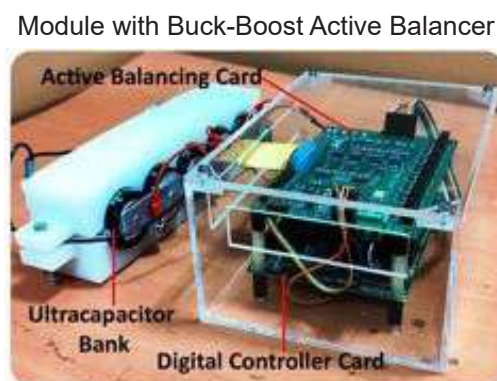


Fig. Ultracapacitor Balancing Module with Buck-Boost Active Balancer

- (viii) **Upscaling (to 10 tons per day) of Red mud Containing Geopolymer Paving Blocks Process by Council of Scientific and Industrial Research-National Metallurgical Laboratory (CSIR-NML), Jamshedpur, Jharkhand.** About 10 tons of samples prepared (under optimized conditions at atmospheric conditions with 20% red mud incorporation) were field tested. The process is not sensitive to the origin of red mud/fly ash. The figure given below presents a view of the pavers laid on a pathway. The durability studies (carried out for six months) did not show any appreciable deterioration of strength characteristics. Life cycle analysis (LCA) studies indicated that the red mud paving blocks have important environmental advantages in most impact categories which could help minimize natural resource depletion and environmental damages. It also helps to promote the sustainable management of waste. A DPR prepared for a 100 tpd plant indicates the return on investment is possible in four years.



Fig. Red mud containing geopolymer pavers laid on a pathway

- (ix) **Utilization of Paddy Straw for Making Composites Consortia Project by K. J. Somaiya College of Engineering (KJSCE), Mumbai and Godavari Bio Refineries Limited (GBL), Karnataka.** The consortia project focuses on process optimization for paddy straw pulping, segregation of silica and pulp and utilisation of large quantity of paddy straw to produce eco-friendly and 100% biodegradable tableware thereby also replacing single use plastic that is widely used for manufacturing tableware. The pulp prepared at bio refinery is used for making tableware using semi-automatic compression moulding machine. The products are currently developed at pilot scale and have the potential to replace the mainstream products made usually with bagasse or areca leaves.



Fig. Tableware made using paddy straw pulp



Fig. Compression moulding machine

- (x) **Anaerobic co-digestion of FOG (Fats, Oils and Grease) Containing Sludge from Dairy Industry using Novel pre-treatment and integration with membrane bioreactor for zero liquid discharge by CSIR-Central Food Technological Research Institute (CFTRI), Mysore, Karnataka.** A novel high-performance bioreactor system integrated with sustainable pre-treatment process has been developed for enabling anaerobic digestion of complex fat-rich sludge from dairy industry with enhanced biogas production. It has been further integrated with membrane bioreactor based-wastewater treatment to enable zero liquid discharge. The technology can

be used for solid and liquid waste management in food and allied industries. The technology has been demonstrated for 2 tones/day fat rich dairy sludge and 100 KLD wastewater in a model dairy industry with in-kind support of industrial partner M/s Sun Enviro Technologies Pvt Ltd, Nagpur.

- (xi) **Solar Pre-heated Thermochemical Conversion of Municipal Mixed Plastic Waste to high quality plasto-fuels for transportation and industrial heating applications by National Rail and Transportation Institute, Gujarat.** Thermo-Catalytic Depolymerization (TCD) plant of about 1.5 to 2 TPD all kinds of mixed plastic waste was installed at Vadodara Railway Station (BRC) Yard, Vadodara, Gujarat. Three products namely plasto-fuel (liquid product), plasto-gas (gaseous product), and plasto-char (solid product) are being produced from the plant. Successful trial runs were conducted with the Western Railway plastic waste (BRC) and Vadodara municipal corporation (VMC) plastic waste collected from Makarpura landfill site. The produced plasto-fuel was used in wide range of applications such as two-wheelers, agriculture engines/pump sets, electrical generator sets, Rail abrasive cutter, Agriculture pesticides sprayer machine, and other heating appliances (industrial burner), domestic air-pressure stove, domestic wick stove, etc.

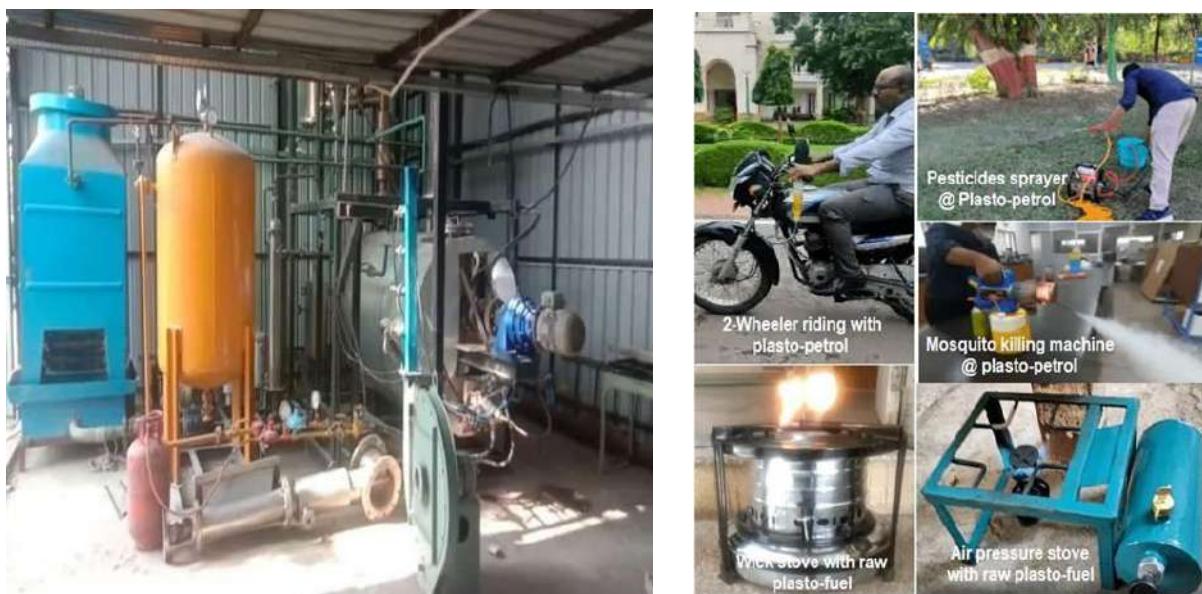


Fig. Thermo-Catalytic Depolymerization plant installed at Vadodara Railway Station and the produced products use in different applications

- (xii) **Diagnostic device for testing new generation monostable/bistable magnetic actuated medium voltage vacuum circuit breakers by Sona College of Technology, Salem, Tamilnadu.** A high performance diagnostic device was developed to control, monitor and analyze the operations of new generation magnetic actuated vacuum circuit breakers which will reduce the repair time and unplanned down time of operation.

This device includes test module for the trip/close current signals and provisions for understanding voltage variations of capacitive energy storage system suitable for the magnetic actuator mechanism, which will replace the conventional motor operated mechanism and spring operated energy storage system. This product will be useful for switchgear industries.



Fig. Testing device for magnetic actuated circuit breakers

(xiii) IoT based custom hiring monitoring meter for agricultural operations by Division of Agricultural Engineering, ICAR-Indian Agricultural Research Institute, New Delhi. The developed custom hiring monitoring calculate the custom hiring charges based on actual energy consumed during agricultural operation. The monitoring meter consist of fuel flow mechanical unit, oval gear fuel flow sensors, monitoring meter controller, programming code, Cloud configuration setting and mobile App. GPS module was attached for tracking of tractor in the real time. A mobile App was developed for display remotely data which is sketch based programming and developed on in MIT App inventor platform. Conceptual layout of custom hiring monitoring meter and developed meter are shown in given figure.

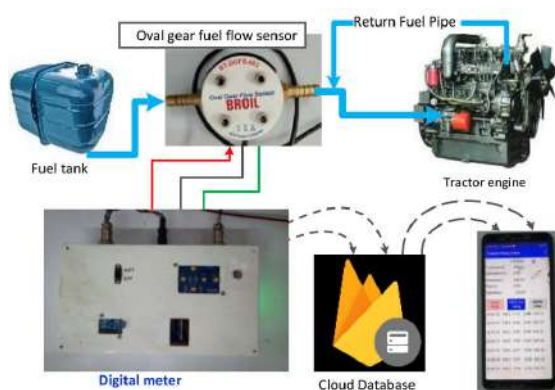


Fig. Conceptual layout of custom hiring monitoring meter diagram in the tractor

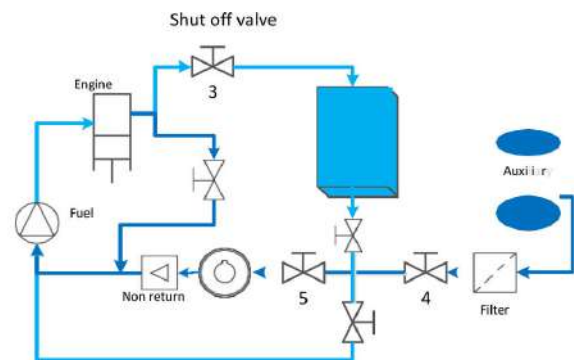


Fig. Fuel sensor mounting connection

- (xiv) **Non-invasive transdermal Collagen and Perfusion Sensor for Diagnostic Applications by Indian Institute of Technology, Madras, Tamilnadu.** The digital skin analyser can differentiate between healthy controls and subjects with disease related altered microcirculation. The instrument is designed, fabricated and clinically tested on a set of subjects delivering promising results. The device is able to classify the groups ~98% accuracy, in-near real time. The working of the digital skin analyser is based on light tissue interactions and analysis, and the concept is filed for a patent.



Fig. Perfusion sensor device

- (xv) **A Novel, Low Cost Automated Agrobot for Plant Disease Analysis and Control”, Karpagam Academy of Higher Education, Coimbatore, Tamil Nadu.** An Agrobot for plant disease and control, comprising of base frame, batteries, and wheels, cross span, robotic cross angle, UR5 control box, UR5 robotic arms, top frame, machine vision camera, and sprayer are structured in order to obtain robotic vehicle ability to spray pesticide on the farm land. Machine vision camera used for capturing the images of plant along with the image data, humidity, temperature and soil moisture sensor data sent to MATLAB software, in a WI-FI environment to obtain the condition of the plant. Once the condition of the plant is observed, the sprayer starts the spraying the fertilizer or pesticides based upon the requirement through MATLAB command received on UR5 control box. Demonstration in field and training given to farmers and the designed is patented (Granted Indian Patent Application No. – 345803-001).



Fig. Agrobot for Plant Disease Analysis and Control

(xvi) **Development of Deep Learning based Unmanned Animal Intrusion Monitoring and Deterrent system for Agricultural lands by PSG College of Technology, Coimbatore, Tamilnadu.** The Animal Intrusion Detection system (AIDS) was designed as a hardware setup for intrusion detection. The solar panel is used as one of the sources of power for the repelling device. Passive Infrared Sensors are deployed around the agricultural field to detect movement in that location. When a Passive Infrared Sensor detects motion, it provides a trigger pulse which moves the thermal camera through embedded controller toward that direction capturing animal in the image. The device will then generate an alarm to warn the public and the repellent system automatically emits ultrasonic waves and flashlights for wild animal.

3.2 Technology Missions (Energy, Water and Others)

3.2.1 Clean Energy Research Initiative (CERI)

The overarching objective of CERI is to nurture S&T led breakthroughs to make clean energy affordable and accessible through strengthening Research and Innovation Eco-System for Clean Energy. CERI aims to:

- Support upstream end of research to generate advanced knowledge of potential application to clean energy.
- Accelerate India centric innovations developed around user needs.
- Promote national, bilateral and multilateral collaboration between industry, academics, utilities and other stakeholders to gain value for such connections.
- Create national research competence in Clean Energy through human and institutional capacity development.

During the year 2022-23, several new dimensions were added to the programme to accelerate the pace of clean innovations to meet national needs, which are as under:

Research & Development on Clean Coal Technologies:

- **Advanced Ultra Super Critical (AUSC) Thermal Power Plant –R&D Phase:**

Two DST projects also made good progress. Highlights of the work are given below:



Fig. Test Loop Collected from FSCTR NTPC-Dadri site and Tube samples for studies

As part of the FSCTR (Fire side corrosion test rig) facility at NTPC Dadri-210MW site, new Heat Transfer Test Loop (made of Super 304H and Ni-based Super alloys) was introduced inside the Boiler to bring the steam parameters to 710°C / 720°C and 310 kg/cm². The Test rig is under successful operation since March-2019. After completion of 10,000 hours of operational exposure, the Test loop tube samples were collected for studies. Currently, the consortium members under the guidance of IGCAR are studying the collected FSCTR Test Loop samples in respective mechanical Labs.

- **Cleaner Fuel**

BHEL has indigenously developed Fluidized Bed Gasification (FBG) Technology that is suitable for high ash Indian coals. BHEL has demonstrated this technology by establishing 168 TPD (tons per day) coal through put gasification plant. BHEL has also set up 1.2 TPD FBG pilot plant to carry out further studies in the area of gasification. BHEL has integrated existing coal to syngas pilot plant at Hyderabad with suitable downstream process for converting syngas into methanol. This pilot scale project with methanol generation capacity of 0.25 TPD was been initiated by NITI Aayog and funded by DST.



Fig. Indigenously developed 0.25 TPD Coal to Methanol (CTM) Pilot Plant by BHEL, Hyderabad

- CSIR-Indian Institute of Chemical Technology, Hyderabad has successfully developed a 'Microwave Based Clean Coal Technologies' for Grinding, Dewatering and Desulphurization of indigenous coals at lab scale for establishing the proof-of concept. A 240 kg/hr continuous processing microwave pilot plant was fabricated to test the effects of the technology scale up to the industrial scale. The following achievements are gained through this technology: i) Moisture content of coals is reduced from 10-12% to 2-4%, ii) GCV (Gross Calorific Value) is increased by 45-355kcal/g of coal, which is about 1.25% increase in GCV iii) Grindability improved by 5-6%. iv) Sulphur levels are reduced by 3-4%.
- Automotive Research Association of India (ARAI) has carried out an assessment of M15 fuel and E 10 on Automotive Vehicles viz. 2-wheelers and 4 Wheelers with the support of Indian Oil Corporation Limited (IOCL). & Society of Indian Automobile Manufacturers (SIAM). They evaluated the effect of M15 fuel on E10 compatible vehicles 7-Nos of 2-wheelers (4-Nos of BS VI; 2-Nos of BS IV and 1-No of BS III) and 3-Nos of 4-wheeler (2-Nos of BS VI and 1-No of BS IV) vehicles. On-road durability for 30,000 km is completed on both 2W vehicles and 4W vehicles completed without any field issues.
- DST funded consortium of The Energy and Resources Institute (TERI), Punjab State Council for Science & Technology (PSCST), International Advanced Research Centre for Powder Metallurgy and New Material (ARCI) and an industrial partner M/s Hi-Tech Agro Energy Pvt. Ltd., have jointly demonstrated a small-scale (350 kg/hr.) decentralized 100% paddy straw-based briquetting plant at M/s PRESPL, Village Kulburchan, Distt. Patiala, Punjab, in Public Private Partnership (PPP) mode. R&D on the performance of the life cycle of wearing components has been studied to generate baseline data and explore options for improving the life of machinery components, i.e., hammer blades, shredder blades, wear-ring, ram & tikki for reducing downtime of machinery. After pilot studies, Titanium Chromium Nitride (TiCrN) coating has been identified as the wear-resistant coating for further field trials.



Fig. Paddy Straw briquetting plant at M/s PRESPL, Village Kulburchan, Distt. Patiala, Punjab, established in Public Private Partnership (PPP) mode.

Materials for Energy Storage

Rapidly charging E-cycle developed with Na-ion batteries and supercapacitors:

Indian Institute of Technology Kharagpur has been researching to develop energy storage technologies, which are based on Na-ion and their team has developed a large number of nanomaterials. The team has used their synthesized materials to obtain Na-ion based batteries and supercapacitors which are cheaper than Li-based materials, high performing and can be scaled up to industrial level production. Taking advantage of the fact that Na-ion batteries can be charged rapidly, the team has integrated it in e-cycles – an easy, affordable option for the general public. With further development, the price of these vehicles can be brought down to the range of Rs. 10-15 K, making them nearly 25% cheaper than Li-ion storage technologies based e-cycles. As disposal strategies of Na-ion based batteries would be simpler, it can also help in addressing the climate mitigation issue.



Fig. a) Rapidly charging E-cycle b) Solar photovoltaic array and VRFB system.

Solar Energy

The following are the major outcomes of the Research and Development work supported under Solar Energy domain:

- Sustainable Energy Storage Suitable for Microgrid (SENSUM).** Vanadium Redox Flow Battery is an excellent solution as energy storage technology to overcome the limitations of intermittency of renewable sources, extreme location and weather conditions, flexible energy demand and more. The present work describes the operational experience with an off-grid system equipped with solar photovoltaics and a vanadium redox flow battery located at an extreme location. The proposed location is considered one of the most challenging sites due to its inaccessibility, extreme weather conditions and thin air cover (~ 9% oxygen in the air). The present study investigates the operational performance of a 20 W/200 KWh vanadium redox flow battery integrated with 44.4 KWp at a high altitude off-grid location with a cold climate profile. The minimum ambient temperature faced by the system is observed to be as low as -25°C however, the vanadium redox flow battery successfully balances the energy mismatch in the system. The system also has the potential to reduce the carbon footprint around 71 tons per year by saving diesel consumption of 27480 litre per year, which is crucial for such

a site where fuel transportation is one of the major hurdles for supplying reliable power. The system has also reduced around 71 tons of CO₂ emission annually, which works towards the potential reduction of carbon footprint.

- Socializing the Micro-Solar Dome.** Micro solar domes (MSDs) are compact roof-based solar powered lighting systems that can be installed in kuchha roofs to provide both day light as well as PV generated, light. They are low cost, easy to install, and need minimum maintenance. The installation of around 42,000 units across various states of India has been executed. The large scale deployment of the micro solar dome (MSD) has enable the social empowerment of rural communities through integrated techno-social interventions in marginalized, SC and ST population as a scalable solution addressing energy poverty holistically. The project team (IITKGP & NBIRT) networked with more than 30 NGO/partners for implementation of the project, initiated with a National Workshop at Kolkata organized by NBIRT.



Fig. Outreach activities for Micro Solar Dome

- Development of Thermal Energy Storage System for Solar Thermal Power Plant.** The research team at Indian Institute of Technology Guwahati has developed scalable, low-cost, and energy-efficient thermal energy storage (TES) technologies. The research team has developed several novel heat exchanger designs, including conical tube heat exchanger, heat exchanger with novel fin, heat exchanger with non-uniform fin distribution, etc. These systems provided reduction in charging and discharging times up to 50%. The targeted applications are direct steam generation, waste heat recovery, and concentrated solar thermal power. All the developed prototypes were successfully tested up to 450°C and life cycle stability tests were also performed.

Mission Innovation: Mission Innovation (MI) is a global initiative of 25 countries to dramatically accelerate global clean energy innovation. Participating nations had 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.

Mission Innovation Challenge: Carbon Capture Utilization and Storage (CCUS)

This challenge aims to enable near-zero CO₂ emissions from power plants and carbon intensive industries.

- A systematic large-scale assessment for potential of CO₂ enhanced oil and natural gas recovery in key sedimentary basins in India.** DST supported MI (Mission Innovation) CCUS project at IIT Bombay, based on a review of global methodologies for storage capacity estimation, the team developed a systematic assessment for theoretical and effective CO₂ storage capacities for different geological formations in India. Four different storage pathways with adequate potential were identified: storage through CO₂-enhanced oil recovery (EOR), enhanced coalbed methane recovery (ECBMR), storage in deep saline aquifers, and basalt formations. Further, a detailed study was carried out to understand the potential for safe utilization of CO₂ for EOR in India's first planned pilot project in Gandhar field, located on the western flank of the Broach depression in the South Cambay Basin, which is in the development phase. The project team has combined the sonic and density information with the seismic traces to obtain lithological variation. Moreover, seismic attribute analyses have been done to understand the pay sand zones in the reservoir zone. Finally, to understand the storage capacity in the reservoir, the team carried out a porosity analysis. The study concluded that integrating impedance and porosity analysis is a reliable approach to best estimate the spatial distribution of reservoir characteristics in a heterogeneous reservoir. The results, through the proposed methodology, show good porosity distribution in sand reservoirs, GS-6, 7 & 9 for CO₂-EOR and storage.

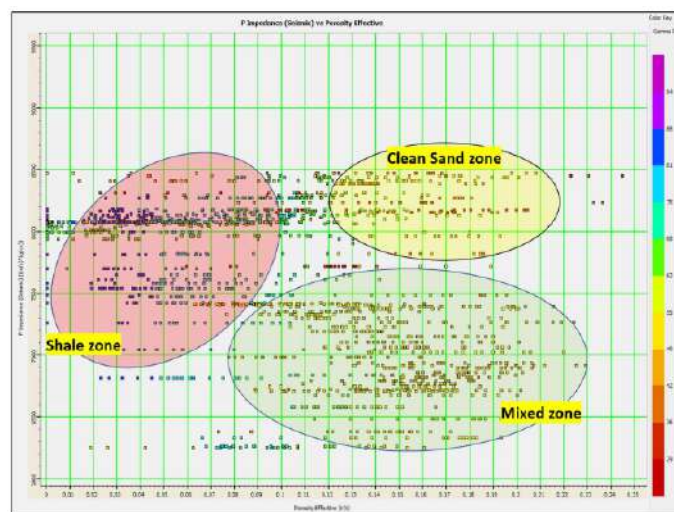


Figure 22: The cross-plot between the seismic impedance and the effective porosity from the well-log data. The gamma-ray values show the colour scale.

Fig. The cross-plot between the seismic impedance and the effective porosity from the well-log data helps in identifying the different lithological zones for implementing the CO₂-enhanced oil recovery in the study area

- Development of integrated technologies for CO₂ reduction to value added products.** Research team under DST supported MI₂ project at JNCASR, Bengaluru have demonstrated CO₂ capture from industrial flue stream (of any composition) and converting it to value added chemicals/fuels methanol, carbon monoxide, methane, dimethyl ether, C2-C5 & C5-C11 gasoline hydrocarbons. The team is keen upon translating innovative technologies from the lab to the industrial and commercial scale. The end-to-end technology comprises innovations in catalyst synthesis, reactor designs, hydrogen generation and product purification. The team has successfully translated the lab scale fundamental science to 300 kg CO₂/day to methanol pilot scale, which is expected to be one tonne CO₂/day capacity soon after completing this project.

Cross-cutting Innovation Challenges

Energy Storage Solutions: CSIR-CIMFR-Dhanbad and CSIR-AMPRI under DST supported Mission Innovation Joint Call 2019 (MICall19) project has developed prototypes for Advanced Composite Pressure Vessels for Hydrogen Storage. Different liner materials such as ABS, ABS-CF, Nylon, Nylon- CF, PEEK and Titanium have been investigated for their suitability, weight optimization, stability and mechanical performance. These aspects have been confirmed through structural and explicit analyses such as drop, and crash tests and the performance of these cylinder have been evaluated for the extent of deformation in them. The results of various material properties and their experimental and simulation studies are being extended further for detailed analysis and scale up.

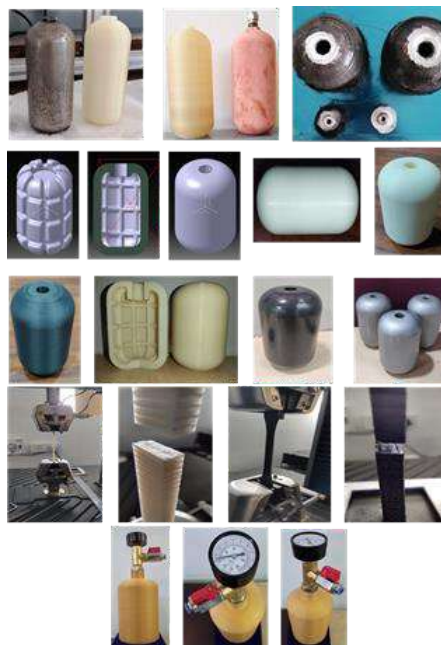


Fig. Sample prototypes and models of Composite High Pressure Hydrogen Storage Cylinders at different stages and test processes.

Mission Innovation (MI) 2.0 – Innovation Community on Affordable Heating and Cooling of Buildings (2021-2030)

As a part of Mission Innovation 2.0, India is co-leading the Innovation Community on low carbon affordable heating and cooling of buildings (IC 7) along with EC and the UK. Since its inception in May 2021, the IC 7 has received an overwhelming response. Canada, Australia, Finland, Morocco, Netherlands, Sweden, and Saudi Arabia have given commitment to work with the Innovation Community. In addition, IEA and RMI have agreed to participate as stakeholders.

Under Innovation Community on Affordable Heating and Cooling of Buildings DST has developed designed, developed and deployed a virtual resource platform miheatingcoolingwiki.com to capture transformative research and technology outcomes in the field of affordable low energy heating and cooling systems from India and MI member countries.

Smart Grids

- A first-of-its-kind Distributor System Operator (DSO) report has been prepared for implementation in India, addressing the technical requirements, institutional frameworks, regulatory requirements, and long-term economic implications. The introduction of DSOs can be a game-changer in transforming the operational and financial state of the Indian power sector and boost private sector's confidence attracting much-needed investment and innovation in the industry.
- Development of a solar-agriculture farm to enable multiple land use, viz., for agriculture as well as for solar energy farming. This will provide a stable and a second source of income for the farmer, even if he loses the crop due to vagaries of weather. The concept of solar-agriculture farm can be utilized to install the plants at the outskirts of the city without hampering agriculture, thereby saving lot of money and effort. The demonstration setup hosts a set of 19 sun-tracking towers, each accommodating 32 transparent solar modules of 345Wp, at a height of 18'.

Clean Air

Supported a project to carry out landfill fire related study and formulated guidelines on the prevention and control of landfill fires. Short term Action Plan for Prevention of Landfill Fires was prepared and submitted to Delhi Municipal Corporations. Delhi Municipal Corporations are actively participating and providing their inputs.

Other initiatives

During the year 2021-22 new projects were undertaken to develop laboratory led R&D equipment and systems to strengthen Atma Nirbhar Bharat mission that would help indigenization in Solar sector.

DST-IITM Solar Energy Harnessing Centre (DSEHC) organized online conference “Recent Advances and Innovations in Solar Energy (RAISE 2021)”. The conference was structured to foster discussion between participants around the core themes in the areas of Photovoltaics (Organic Photovoltaics, Silicon Cells, Heterojunction cells, Tandem cells, Mechanical processing of Si) Solar thermal (CSP, Solar Cooling, Solar desalination, Solar Thermal coating, Direct steam generation) Energy storage (Li /Na ion batteries, Flow batteries), and Solar Fuels (Photocatalysis, Electrocatalysis, Green Hydrogen). A dedicated industry session was held to get to know the latest technologies being commercialized in the solar industry.

DST jointly along with the Department of Energy (DoE) USA organised a series of six Indo-US Scoping workshops on Carbon Capture Utilization and Storage from January 2022 to February 2022. Secretary DST and Additional Secretary, DoE delivered opening messages and addressed the relevant stakeholders on both sides for the Indo US Scoping workshop on Carbon capture for evolving collaborative endeavours.

DST and UKRI/NERC/EPSCRC jointly commissioned a scoping exercise for mapping the Technology landscape in the areas of Carbon Capture, Utilization and Storage (CCUS) in India and UK. The CCUS report was officially released by Secretary DST and British High Commissioner in India on 14th Dec 2022.

3.2.2 Water Technology Initiative

The **Water Technology Initiative (WTI)** of the Department of Science & Technology (DST) is a pro-active India – centric ‘solution science’ endeavor that aims to strengthen the R&D capacity and capability to develop research-based solutions for existing and emerging water challenges faced in the country. WTC has been created in 2022 to add special thrust to the Water activities of the Department to nurture development research in laboratories and application research in the field. The overarching goal of the scheme is to promote R&D activities that enable the winning of water from sustainable sources, augmentation of water quality for specific applications, and recycling and reuse of water. Several achievements made during the FY 2022-23 are as under:

- **Development of novel sensors, Pulsed Power Plasma based reactor for removing toxic volatile compounds, and other emerging technologies for Emerging contaminants, micro-pollutant removal etc.** DST-WTC has supported a Water-IC (Innovation Centre) led by IIT Madras for Easy Water that has developed novel sensors for analyzing nitrite, nitrate, phosphate, trimethylamine, chromium, and mercury, and for simultaneous measurement of water level and conductivity, in water tanks, pipes etc. The activities have developed key technologies/processes such as advanced materials for fluoride removal from groundwater, pulsed power plasma technology-based reactors,) nano-porous organic frameworks for antibacterial and antiviral applications, and technology for the removal of dye from textile effluent etc. The center has already 23 patents already granted and more are in process. The developed technologies have

been already patented pilot-tested and implemented in the field. The processes and management practices suggested by the Center have been uptaken by the Chennai Metro Water Supply and Sewerage Board (CMWSSB) and CMDA for further deployments and upscaling.



Fig. Pilot Scale Plasma Reactor

- **Water Energy Food Nexus (WEFN) Through Solar-Green House-Based Hydroponic Solutions with Android Mobile Application of Vegetable Market for Rural farmers and Urban Users:** DST-WTC has supported the cross-sectoral project exploring the nexus of Water with Food/agriculture, which has recently completed its second year with project collaborators as (i) Uttarakhand State Council for Science and Technology (UCOST), Dehradun (lead organization), (ii) TERI-SAS (Former TERI-University), New Delhi, (iii) G. B. Pant University of Agriculture and Technology, Pantnagar and (iv) DAV(PG) College, Dehradun.



Fig.: Solar Green House developed

A Solar Green House established under the project is a state-of-the-Art facility, for optimizing the most suitable crops for sustainable hydroponic farming and testing and comparison of Solar based off-grid hydroponic techniques and conventional grid-based farming.

- **Microalgae-mediated Wastewater Reclamation with Bio-oil and Biogas Production: A Sustainable Approach:** Under this project, a novel integrated pilot scale process is being developed that involves sewage water treatment with the production of bio-oil,

biogas, and bio-manure from algal biomass. The whole process is being developed as a demonstration unit at the UPES, Dehradun campus with technical support from VIKALP (NGO Partner). Presently, the system has been developed and water treatment and oil testing have been done.

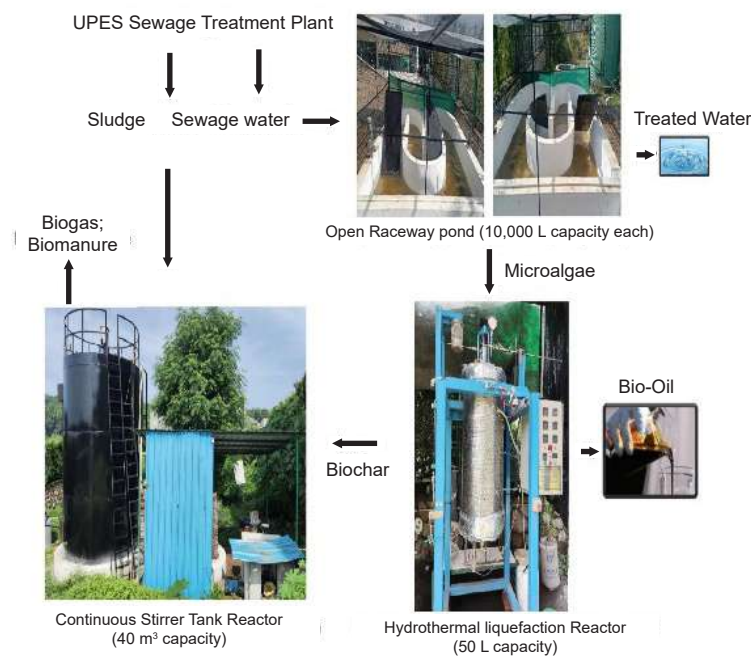


Fig. Integrated Pilot Scale Unit for Wastewater treatment with Bio-oil, Biogas & Bio-manure production

- Off the grid sensor-controlled irrigation using Bank Filtration Technology:** TERI, The Energy and Resources Institute, in collaboration with National Institute of Technology (NIT), Goa commissioned the above DST-WTC supported field intervention that aims to provide clean water to farmers for irrigation through River Bank Filtration (RBF) technology coupled with sensor-controlled irrigation system which is the first of its kind in the state of Goa. The project team has installed affordable RBF wells for the treatment of polluted water from Sal River near Navelim and Nauta lake at Cortalim, Goa, powered by renewable energy resource (solar powered pump) as shown in figures.



Fig. Solar-powered RBF wells at Cortalim, Chaudder lake Goa

The IoT-based irrigation system has been also installed for efficient water usage in the field and for ease of operation. This implementation helps the optimal use of water as well as allows farmers to use the system from anywhere where he/she has access to the internet.

- Pharmaceutical and Personal Care Products (PPCPs) in Sewage Water of District Bathinda, its Transport in the environmental compartment and Adsorptive Removal Using Metal-Organic framework (MOF):** Under this DST-WTC-supported project to MRSPTU, Punjab, the project team has developed a prototype नैल.मणि for tertiary wastewater treatment. The lab-scale pilot has been installed in the lab. Novel metal-organic frameworks (MOF's) with reticular structures differing in their pore sizes and surface charges have been designed and synthesized. These MOFs are being prepared from the recycling of plastic and are being studied under the project for adsorption of pharmaceutical and personal care products (PPCP) on a lab and pilot scale using an ultra-filtration-based process. Studies based on the pilot scale are being examined for PPCP (tetracycline, oxytetracycline, norflox, ofloxacin) removal from sewage water. of MOFs which demonstrate a significant removal of environmental contaminants like arsenic and PPCPs.



Fig. : Prototype of tertiary treatment plant for PPCPs from STPs

- Cavitation-Based Advanced Oxidation Process for Effective Degradation of Emerging Organic Micro-pollutants in Water:** In this DST-WTC-supported project, the CSIR-IICT team developed a cavitation-based advanced oxidation process for the effective degradation of emerging organic micro-pollutants using a skid-mounted rotating hydrodynamic cavitation (RHC) reactor. The uniqueness of the RHC lies in the shape or geometry of the cavitating rotor where the circular surfaces at the two-opposite end of the rotor are serrated and the wall of the circumference has numerous indentations.

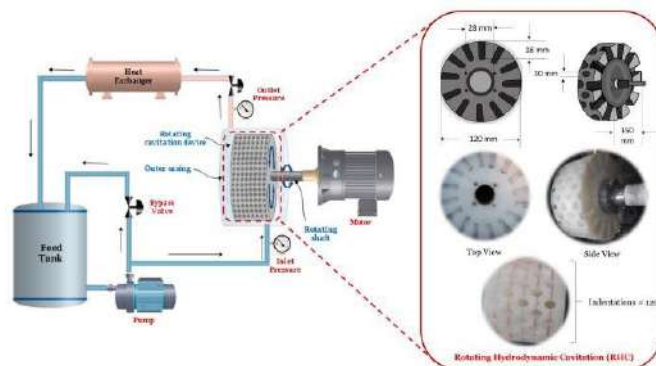


Fig. : Schematic diagram of fabricated cavitation unit

- Supply of Clean Drinking Water through IoT based solar powered station at a large village in Haryana through automated dispensing while improving the water table: Pilot – Faridpur:** Under the DST-WTC supported the project, the National Institute of Solar Energy (NISE) and Saurya Enerotech. Pvt. Ltd has jointly developed a solar-powered water purification systems ranging from 100LPH to 500LPH capacity and installed at the village community level in Haryana.

The Project envisages providing safe drinking water to the entire population of Faridpur village in the district of Gurgaon, Haryana. It employs an IoT-based remote monitoring system with 30 KWp of Solar Power to operate the water purification system along with a battery bank for the autonomy of two days.



Fig. IoT based solar powered station installed at Faridpur in Haryana

- Internet of Things (IoT) based Smart Water Supply and Distribution System for Coimbatore City:** DST- WTC has supported the above-mentioned project to PSG College of Technology, Coimbatore along with Industrial partner SMINT TIQ Pvt. Ltd, Chennai under a field intervention to implement smart water distribution systems for equal distribution, reducing the vast gap between supply and demand, minimize the wastage of water, online monitor and control the quantity, quality, distribution network and water modelling with real-time data input. The pilot area “Cheran Nagar-Koundampalayam” was allotted by CCMC for implementation and demonstration of the project.

The commissioning of the project has enabled the demonstration of innovative technology of water distribution systems at a pilot scale, based on consumer demand for water distribution, water security, and reducing wastage. The installed IoT-based technology along with the solar-based battery charging facility enables the online monitoring, control, and transmission of the process parameters.



Fig.: IoT-based Smart Water Supply and Distribution System at Coimbatore

- Interventions in the area of Industrial Wastewater: Ultra-low water pre-tanning and post-tanning technologies for leather making**

Ultra-low water pre-tanning process: The ultra-low water-based liming (pre-tanning) process employing 100% water, 1% sodium sulphide and 2% lime, which was verified at

pilot-scale experiments and validated at commercial scale, compared to 400% water, 4% sodium sulphide and 8% lime in the conventional process. The developed process enables 75% reduction in water requirement along with reductions in pollution loads such as COD, TS and sulphide by 50 to 84%. Hence, the developed process is techno-economically viable and ready for commercialization.

- **Ultra-low water post-tanning process:**

The ultra-low water-based post-tanning process employing 10% process water and dilution of fat liquor with 1:5 of water, which was verified at pilot-scale experiments and being validated at commercial scale, compared to 100% process water and dilution of fatliquor with 1:10 of water in the conventional process. Use of 15% syntan, 2% dye and 10% fatliquor in the post-tanning process was maintained similar to conventional process. The developed process enables up to 50% reduction in water requirement without increasing the pollution loads significantly. The developed process is both technically and economically viable.



Fig. (a) Cow hides flooded with 100% water in the drum (b) Cow limed pelts after 24 hr of treatment with 100% water, 2% lime and 2% sodium sulphide showing the complete hair removal at M/s Flamingo SSI, Ranipet

- **Bilateral Collaboration on Water:**

- Co-creating Sustainable Agri-Water Use in the Hindon sub-basin –A Multi Scale Participatory Approach : To rejuvenate the Hindon river and take care of the groundwater depletion in the basin, a multidisciplinary approach has been taken in this DST-NWO supported Indo Dutch project to IISER Kolkata, IIFSR Meerut, IIT Roorkee and PSI Dehradun along with Dutch partners. Preliminary data from the above study suggests not only the agricultural impact on water but industrial effluents seem to be significantly determining the quality of water in the basin too. To reduce the agricultural impact on both the quality and quantity of groundwater, under cluster mode, Atali Rajputana village has been identified for delineating the typology of farming systems which is in progress.
- DST India, and NWO, The Netherlands jointly organized the Indo-Dutch Kickstart meeting during September 2022 for the launch of the 3 joint Indo-Dutch Consortia projects



Fig. (a) Team at the confluence of Hindon with Yamuna river. (b) Participation of stake holders in alternate farming in the Hindon river

jointly supported by DST-NWO on Ganga cleaning and Agri Water Nexus and being led by IIT Kanpur, IISc Bengaluru, and IISER Kolkata from the Indian side with the active participation of scientists, researchers, students, societal partners, Industry and Government from both India and Netherlands.



- DST and UKRI/NERC/EPSRC jointly commissioned a scoping exercise for mapping the Technology landscape in the areas of Low-cost Environmental Sensors (**LEMS**). Based on that Indo-UK Scoping Report has been developed to bring out the Technology led R&D landscape in the area of **LEMS** in the two countries. The above-referred report has been officially released by Secretary DST Dr. S. Chandrashekar and British High Commissioner Mr. Alex Ellis on 14th Dec 2022 during the Indo-UK Scoping Workshop on Sensors organised by DST and UKRI on 14th-15th Dec 2022.



3.3 National Geospatial Programme (NGP)

The **National Geospatial Programme (NGP)** (erstwhile Natural Resources Data Management System (NRDMS) initiated in 1982), aims to catalyze the National Geospatial Ecosystem with the mandate of promoting geospatial science and technology, policy, solution, capacity building, entrepreneurship and international cooperation for sustainable socio-economic development at all levels of governance.

The progress made under various sub-programmes of NGP along with details of the various new initiatives are as under:

3.3.1 Geospatial Science Programme

National Programme on Geodesy: A National Centre for Geodesy (NCG) has been set up at IIT Kanpur (IITK with the primary objective to nucleate and strengthen the activities in geodesy education, capacity building, and academic research and development. In addition

to many training programmes, NCG has organized two major brainstorming sessions on (i) Indian national geodetic infrastructure: current status and a way forward and (ii) Understanding the synergies between geodesy and oceanography.

The major highlight of the various activities of NCG in the last year is as follows:

- NCG has been undertaking research initiatives in a wide domain of geodesy. A few of the projects include; Project Saptarshi for establishment of the First space geodetic technique observatory in the Country, Indian Geodetic Reference Frame (InGReF), Establishing the first DORIS station in India etc.
- NCG is closely working with the Moscow State University of Geodesy and Cartography to sign an MoU for various activities. Additionally, NCG has been collaborating with Survey of India (SoI) for: Analyzing the best strategy for Indian gravimetric geoid modelling; Geoid testing and validation; Exploring the geodetic applications using CORS, and Developing a strategy for a way forward to establish Indian geodetic datums.
- Further, NCG is acting as the National resource centre, i.e., making available its resources to Country's other institutions for education and training purposes. The permanent GNSS station at NCG, which was part of the Asia-Pacific Reference Frame, has now been included in the IGS (International GNSS Service) network. Following the latest issued geospatial guidelines, NCG is committed to sharing the geodetic data from the NCG facilities as and when requested for educational and research purposes.

3.3.2 Regional Centres for Geodesy

Six Regional Centres of Geodesy have been established across the Country working in tandem with NCG to spread Geodesy education, R&D and contribute towards the growth of Indian geodetic infrastructure. NCG is providing some initial handholding in terms of training students, researchers and faculty members in Geodesy. The six RCGs have been set up at IIT Bombay, IIST Trivandrum, IRS Anna University, IIT (ISM) Dhanbad, MNNIT Allahabad and MANIT.

National Network Programme on “Assessment of Regional Hydrological Systems using Space Borne Gravity Observations”.

This National Network Programme has been developed involving three concerned Ministries and several partnering knowledge institutions with the objective of exploring the feasibility of monitoring total water storage variations using data from the Gravity Recovery and Climate Experiment (GRACE) satellite which provides a new method for terrestrial hydrology research and enables researchers to monitor the fluxes of water mass changes and exchange of water masses between the ocean and land ice masses. The programme has provided the following significant findings so far:

- The decreasing trend of GRACE-TWS in northern India is probably caused by a combination of climatic and anthropogenic factors. A significant TWS (Total Water Storage) increase in the Narmada river basin appears to be primarily caused due to surge in surface water storage.
- Spatial distribution of TWS and extreme temperatures suggest the heat-stressed peninsular India is more influenced by TWS in the summer season indicating that water storage loss can inflate temperatures and indirectly exacerbate the drought impacts.
- Positive correlation between soil moisture and TWS is an indication of groundwater accumulation over the area.

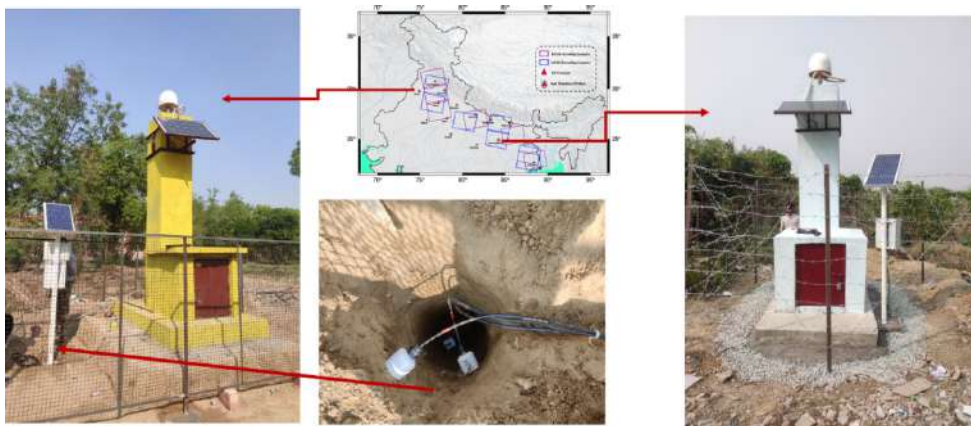


Fig. GNSS and SM (Soil Moisture) observations in Upper Ganga Basin

The multi-institutional, multidisciplinary studies using GRACE data sets supplemented by other data sets have provided the scope to understand the availability and the dynamics of water resources, with a focus on groundwater, in space and time on a regional scale while the new synergic approaches adopted in the present study proved to be promising to downscale the same to sub-basin level with a reasonable accuracy. In addition, as a part of capacity building, a central facility with a repository of soft computing techniques and data on TWS and other components of hydrological cycle along with an observational network have been established at NGRI, Hyderabad.

3.3.3 Geospatial Analytics

In order to strengthen the area specific geospatial analytics capabilities of the country, out of total 140 R&D proposals received online, eleven proposals were supported in the areas of Geospatial Analytics for Rural Livelihoods in Post-Pandemic Era; Inter-dependency modelling of Healthcare; Socio-economic Impact of Migration during Pandemic; Social Vulnerability Mapping Impact Assessment; and Modelling Geographically varying Relationships of COVID-19 outcomes. Few highlights of the work supported are as follows:

- Study of Socio-economic Impact of Migration during COVID-19 in the Sundarbans Region for providing Sustainable Solutions (Department of Industrial & Systems Engineering, IIT Kharagpur):** Land use and land cover (LULC) maps of the four blocks have been prepared to study the changes in agricultural land, settlements, vegetation, and water bodies using visual interpretation keys. Not only Resource maps of the surveyed villages, to aid in making policy decisions but also a multi-hazard cascade model to understand the impact and response to the pandemic along with the cyclones (2020 & 2021) were developed. An interactive web-based application is being development to store primary/ secondary data and visualize key socio-economic and demographic information of the villages in the region. Key stakeholders such as the villagers, local panchayet, South Twenty-Four Pargana Zilla Parishad (Govt. of WB), Department of Sundarban Affairs (Govt. of WB), NABARD, CSSRI and local NGOs have been consulted to seek sustainable livelihood solutions in the region.

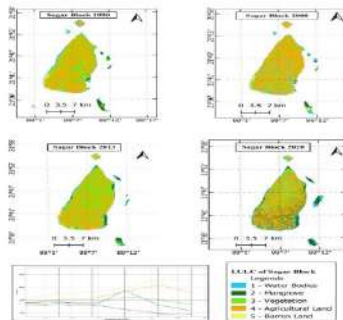


Fig. LULC Analysis of Sagar Block, South 24 Parganas, West Bengal



Fig. Discussion with a villager in Gosaba Block, South 24 Parganas, West Bengal

- Development of an e-Platform/website providing Pan India Geospatial Information System up to district level connecting immigrants/job seekers with different skill levels and those seeking immigrants/job providers (Delhi Technological University-DTU, New Delhi):** e-platform has been developed with the name ‘GESEME’-

Geo-enabled Socioeconomic Matchmaking Effort which is currently under testing. The e-platform is being organized in terms various GDP sectors. First two modules implemented are for immigrants/job seekers and job provides, and for Agriculture. It also has the facility for socioeconomic analysis and AI/ML analytics is being built into it. A Startup is also being registered at DTU to further run and manage the e-platform.

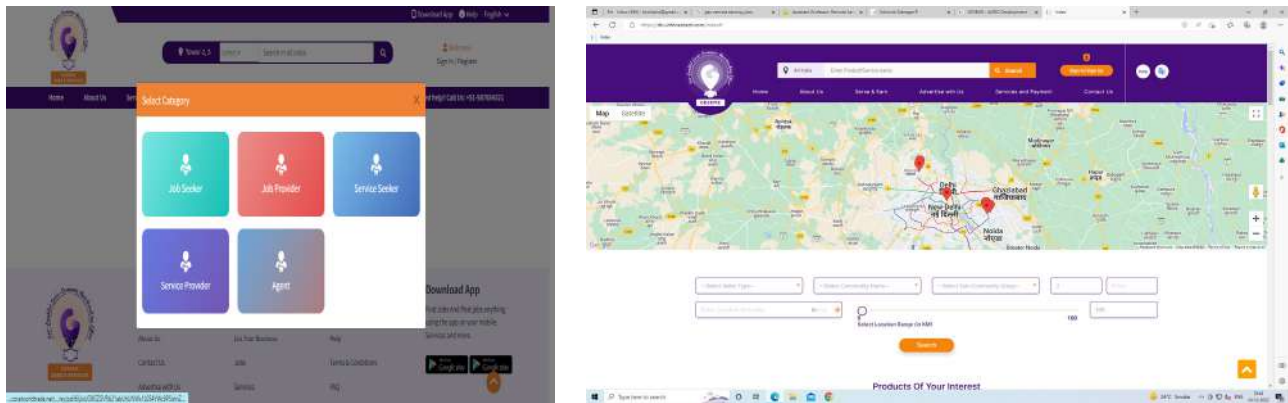


Fig. Screen shot of the e-platform on *GESEME – ‘Geo-enabled Socioeconomic Matchmaking Effort’* developed by DTU

3.3.4 Geospatial Technology Programme

The programme aims at catalyzing the development of indigenous geospatial/ location specific technologies in the country with the main objectives of; improving the economic value of the existing Geospatial Technologies in practice along with promotion of demand based futuristic Geospatial Technology development. Further, under this initiative, in order to Strengthen Nation’s Technology and Innovation Ecosystem, currently total 09 project proposals are being supported out of total 217 proposals received online. The projects proposals are supported in the areas of: Geospatially Enabled Learning approaches for Intelligent IoT based applications; Movable Monostatic Radar Mapping System for soil moisture retrieval; Hyperspectral Imaging System Development for Precision Remote Sensing Applications; Automatic Guided Weeding-tool based on Plant Geo-positions; Low-cost GNSS RTK Base for Precise Geo-location and Handheld Precise Geolocation Enabled Multi-Sensor Rover System; UAV-based near Real-time Surface Fire Detection and Delineation System; Geospatial Framework for Precision Agriculture – Leveraging the Synergy of Satellite and Drone imagery, Artificial Intelligence, Big data and Cloud Computing etc.

3.3.5 Geospatial Solutions Addressing National Priorities and Sustainable Development Goals

Geospatial Solutions for Urban Governance: Under this, projects are supported in the areas of city governance applications as well as in the core R&D areas focusing on emerging

technologies related to city development using Geo-ICT. Some of the highlights of the supported work are given below:

- IoT Enabled Smart Cities: Pollution, Health, and Governance (by IIIT Hyderabad):** An internet of things (IoT) network is being set up for monitoring air pollution and water flow in urban conditions in Indian cities along with correlation of the pollution measurements with quality of health parameters such as respiratory, cardiovascular, and psycho-physiological effects on people’s health in general and specifically on children and public service personnel.

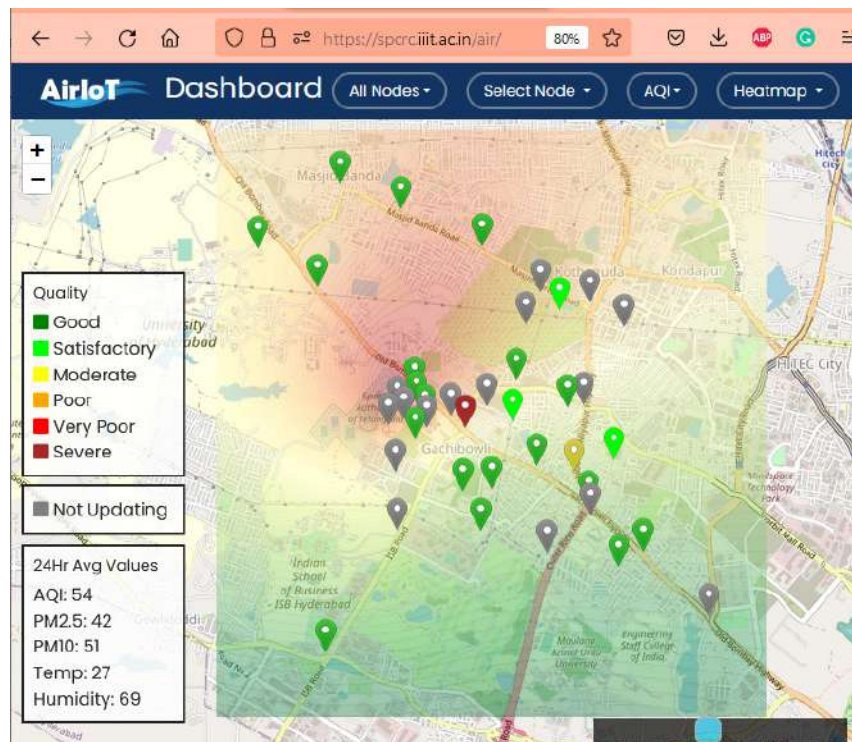


Fig. Dashboard developed for monitoring air pollution which is also accessible through mobile app

- CityGML based 3D models for Smart Cities in India using LiDAR Point cloud (IIST, Thiruvananthapuram):** A software tool has been developed to directly extract 3D building models from raw Aerial LiDAR data. To demonstrate the applicability of 3D models for spatial urban governance, flooding due to Karamana river basin in Thiruvananthapuram is simulated with a high-resolution DEM (Digital elevation model) from LiDAR point cloud. The 3D building maps were integrated with GIS based vector maps and flood risk maps to analyze the level of inundation due to various water flow discharges. A web-based GUI (Graphical User Interface) has been developed with the functionalities for visualization and querying.

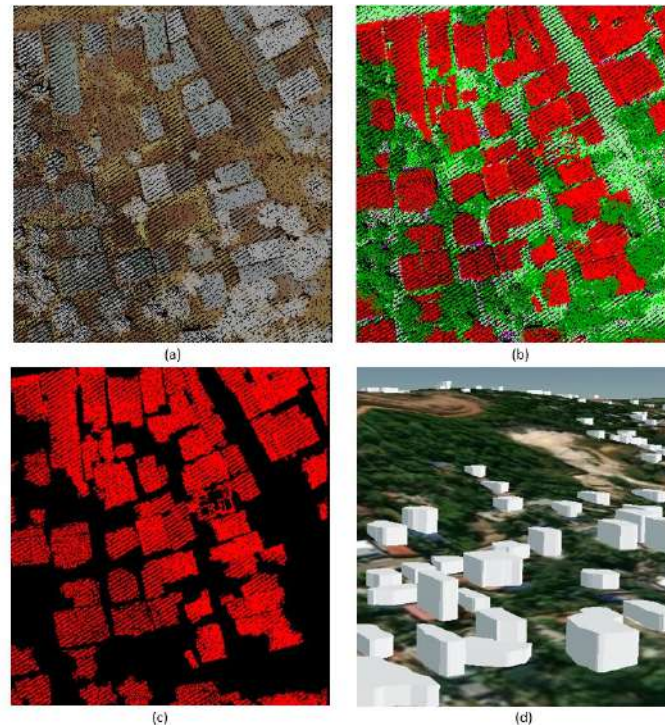


Fig. (a) Raw Aerial LiDAR point cloud (b) Classified Aerial LiDAR point cloud (c) individual building footprints (d) 3D building models

- Identification of Accident Black Spots & Safety Deficiencies, and Development of Countermeasures (Department of Civil Engineering, IIT Kharagpur):** This study aims to identify black spots/ hotspots in an urban road network so that effective site-specific measures can be developed which might save many human lives in future. Road accident database of West-Bengal was used for this purpose and six various crash-related parameters were considered such as accident frequency, total fatal frequency, total major and fatal frequency, total frequency and equivalent property damage only. Total 100 accident black spots were found as shown in figure below (figure 7).

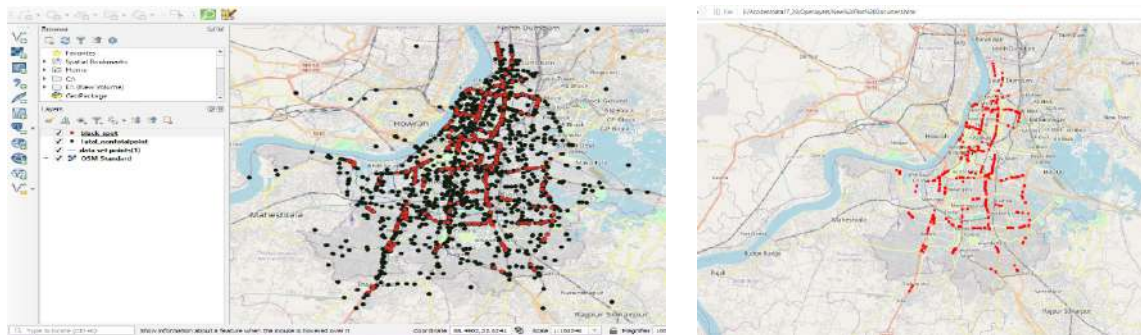


Fig. Accident locations and identified black spots (Red Colour- accident black spots; Black Colour- accident locations during 4 year time period (2017-2020))

3.3.6 National Programme on Spatial Disaster Risk Reduction (SDRR)

Landslide Hazard Mitigation (LHM): A set of 10 R&D projects has been supported for the development of an early warning system covering areas (States) like Sikkim, Nilgiris (Tamil Nadu), Manikaran, Kotropi, Mandi and Darmashala (Himachal Pradesh), and Uttarakhand. Highlights of the work supported are as follows:

- Geotechnical and Geology study of an active landslide in Himachal Pradesh (HP) for Vulnerability Mapping and Risk Assessment (Lovely Professional University, Punjab):** Based upon the causative factors for landslides, including slope, aspect, curvature, relative relief, geology, lithology, land use cover, distance to faults, distance to roads and distance to rivers, and using an Analytical Hierarchy Approach (AHP), landslide susceptibility map have been prepared in landslide-prone areas of Himachal Pradesh ranging from 1300 m to 4638 m elevation.

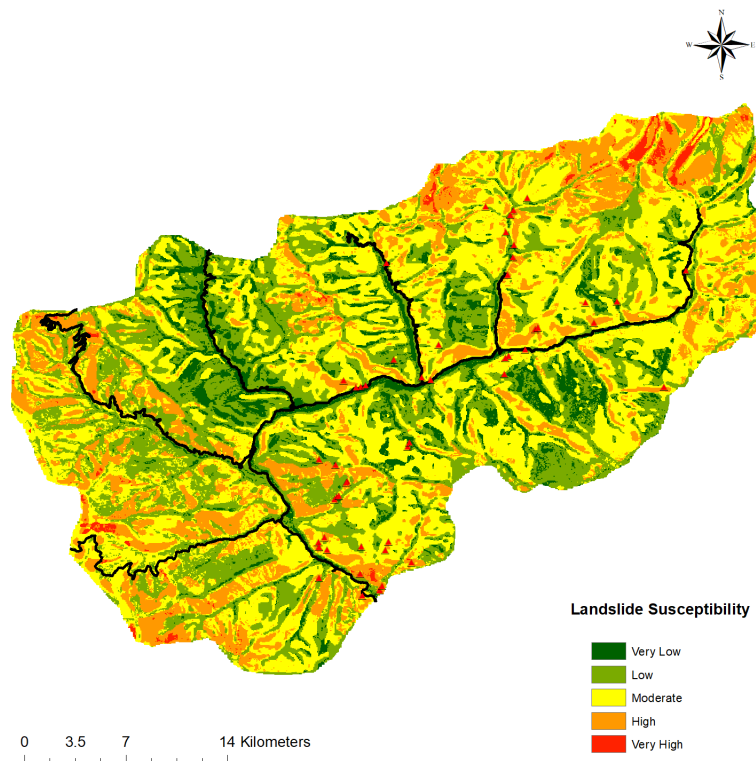


Fig. Landslide Susceptibility Map of a study area (between 77°77'98.73"E to 77°77'89.60"E and 31°20'86.37"N to 31°20'85.26"N) chosen considering the Pabbar catchment in Himachal Pradesh.

Coastal Hazard, Risk Assessment and Reduction (CHRAR): CHRAR has been initiated to cover the coastal areas of India with the aim to develop S&T enabled techniques for coastal disaster management encompassing disaster genetics, propagation, disaster vulnerability mapping, detection of causative factors, mitigation measures etc. Highlights of the work supported are as follows:

- Mapping Active Earth Movements along Odisha and Bengal Coast by CORS-GPS, Seismological and MT-InSAR Observations (IIT Kharagpur):** A comprehensive multi-disciplinary approach was adopted to study the active earth deformation and consequent vulnerability in the east coastal region of India. Seismological ambient noise and earthquake data was recorded during fieldworks. It is well known that during earthquakes, seismic waves may be amplified if trapped in loose sediments, and can severely damage critical and expensive infrastructures such as hospitals, bridges. Therefore, study of shallow subsurface structure, especially up to a few tens of meters, provides information about the compactness of the top layer of earth, which is important for avoiding damages during seismic activity. Most of the deformation is observed in the densely populated areas, where the rate of subsidence was found to be of the order of 25 ± 5 mm/yr.

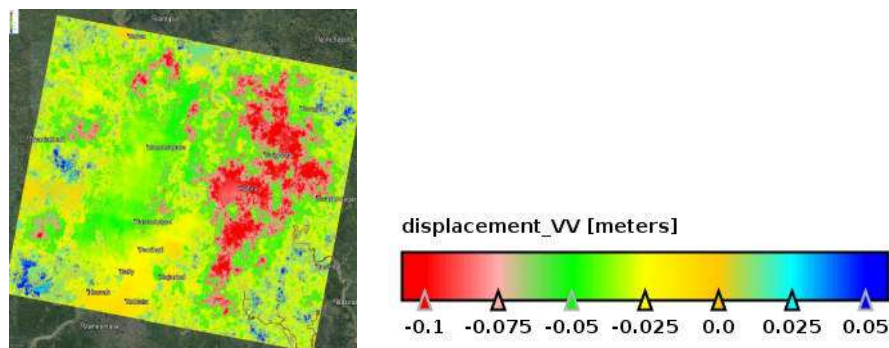


Fig. Upliftment and subsidence observed in Kolkata region

- Prediction of Coastal Zone Vulnerability due to SLR under Changing Climate (IIT Bombay):** The impact of regional sea level rise (SLR) on the coastal tidal variation, high tide lines, low tide lines, intertidal zones and tidal flooding along all nine coastal states of India using hydrodynamic modeling were estimated. Approximately 9.5 sq.km of Mumbai coast may be submerged due to SLR by the year 2100. Similar maps have been generated all along the Indian coast. These maps will help in planning for future projects, policy making, coastal protection and management plans.



Fig. Submergence area due to landward shift in High Tide Line along Mumbai (by the year 2100)

3.3.7 Geospatial Capacity Building Programme

Summer/ Winter Schools in Geospatial Science and Technology: This sub-programme has been strengthening Country's Geospatial capacity in geospatial science and technology through diverse programs in collaboration with various partner organizations across the country. Till date more than 6000 professionals have been trained and progress tracked through this initiative. The level 1 (L1) program covers the basics of geospatial science and technology with a standardized syllabus maintaining uniformity all across the country. The level 2 (L2) is a theme specific advanced training program. As a new initiative, in the current cycle (2021-23) also included a geoinnovation challenge to recognize, encourage and nurture innovation for national socio-economic developmental processes among the youth of our country. This Geo Innovation Challenge will serve as a repository of ideas leading to the development of full proposals that could be supported by the DST at a future stage. In the current cycle, 15 Level 1 program, 07 Level 2 program, and 08 Geoinnovation challenges conducted till date at Pan India involving 1142 participants. The program is assessed regularly through a structured feedback mechanism for the relevance of program content for trainees, program content (efficacy of knowledge and skill transfer), quality of trainers, overall organization of the training as well as use of training by the participants once they are back in their work places.

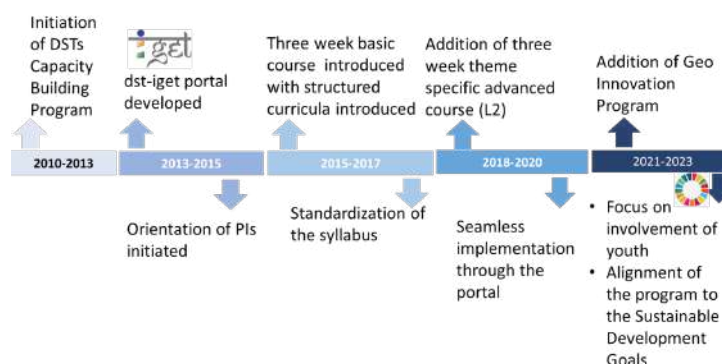


Fig. Timeline of NGP's Capacity Building Program over the years

3.3.8 International Collaboration

Activities under this Initiative aim at developing the national capacity for Geospatial Technology development, acquisition and transfer through international partnerships/ collaborations involving bodies/ agencies like the United Nations Global Geospatial Information Management (UNGGIM), Open Geospatial Consortium (OGC), Brazil Russia India China South Africa (BRICS) Cooperation, Indo-Africa collaborations etc. The following activities through UNGGIM collaborations have been carried out during the year:

- India was entrusted the responsibility of hosting the **Second United Nations World Geospatial Information Congress (UNWGIC)** at Hyderabad from 10-14 October 2022. Various pre-events to Second UNWGIC were held at Pan India level involving

stakeholders from Government, Civil Society, Industry, R&D institutions & Academia, with a aim to collect and collate various ideas and resource materials including applications and innovations in the field of Geospatial information generation to highlight the vibrant Indian Geospatial Ecosystem during the Congress.

- A delegation consisting of members from NGP Division, Survey of India and National Security Council Secretariat represented India at the twelfth session of the UN committee of experts on Global Geospatial Information Management (UN-GGIM) held from 1st to 5th August 2022 at UN headquarters, New York. A side event on Second UNWGIC was held on 3rd August, 2022 at New York. During this event, members of the International Geospatial Community were invited to participate in the Second UNWGIC hosted by India in October at Hyderabad.

3.3.9 New Initiatives and Major Achievements

- **The Second United Nations World Geospatial Information Congress (UNWGIC 2022) on the theme “Geo-Enabling the Global Village: No one should be left behind” was held successfully in Hyderabad from 10-14 October 2022.** The event was hosted by the Government of India and organized by the United Nations Department of Economic and Social Affairs. The theme was in line with the vision of the Hon’ble PM *Sabka Saath Sabka Vikas*. Over 1300 participants from 77 countries attended the five-day event, which featured plenary, and special sessions, thematic parallel sessions, and side events. The congress emphasized the importance of the “Community”, “Collaboration”, and “Commitment” to the United Nations Integrated Geospatial Information Framework (UN-IGIF) in achieving the Sustainable Development Goals and addressing climate-related challenges. The goal of the congress was to leave no one behind in the pursuit of a sustainable and inclusive global society. This event gave an opportunity for India to showcase its Geo-Spatial Initiatives and achievements in recent years. The main highlights of the five days international Congress are as follows:



Fig. Inaugural Video Address by Hon’ble Prime Minister of India, Shri Narendra Modi during Second UNWGIC

- **UNWGIC 2022: Connectivity and operationalization Emphasized for bringing sustainable Change:** The official Opening Ceremony of the Second UNWGIC was held on 11th October 2022 where addresses were given by Dr. S. Chandrasekhar, Secretary-DST; Mr. Stefan Schweinfest, Director, United Nations Statistics Department (UNSD); Dr. S. Somanath, Secretary, Department of Space; video address by Secretary-General for ECOSOC- UN; Ms. Ingrid Vanden Berghe, Co-chair of UN-GGIM; keynote address by Hon'ble Minister of Science and Technology and inaugural address through video message by Hon'ble Prime Minister. Mr. Schweinfest, underlined the importance of connectivity, belonging, outreach, and an outcome-oriented approach in bringing about change. He described geospatial technology as a “community of solidarity and solutions”. Ms. Ingrid Vanden Berghe, emphasized the importance of key elements such as operationalization and implementation for integration along with the need to continue to “geo-enable the global village, bridge the digital divide, build back better, and leave no one behind” at UNWGIC 2022.
- **Highlights of Prime Minister’s Inaugural Address:** In his inaugural Video address at the Second UNWGIC 2022, Hon'ble Prime Minister Shri Narendra Modi emphasized the boundless potential of geospatial technology for addressing challenges such as climate change and ensuring equitable resource allocation. He highlighted Indian National development schemes such as SVAMITVA and PM Gati Shakti, which extensively use geospatial technology. The Prime Minister emphasized the endless possibilities of geospatial technology and its potential to benefit the planet.
- **Youth Engagement in Sustainability Efforts Emphasized at the Congress:** The importance of engaging and inspiring young people to become more involved in sustainability efforts was emphasized. Using geospatial technology and its interactive visual appeal is an effective way to ignite the minds of young people and enable them to develop new solutions. Students from over 18 schools across India who attended the event demonstrated the potential of geospatial technology to address local challenges.



Fig. Special Event on “Geo-enabling the Global Village with Generations Z and Alpha”.

- **Using Geospatial Technology to Achieve SDGs through Localization:** Synchronizing the global and the local, through the use of geospatial technology, can help to develop a workable action plan for achieving the Sustainable Development Goals (SDGs). Students schools across the Country demonstrated this by linking their local use cases with SDGs such as zero hunger, gender equality, and climate action. Localization of SDGs using geospatial technology and involving students in the process was a key take away from the Second United Nations World Geospatial Information Congress (UNWGIC 2022). These schools can serve as microcosms of the potential interest in geospatial applications, with the right guidance, support, and feedback mechanisms in place.
- **“India Unveils Geospatial Initiatives at UNWGIC 2022”:** At the first day of the Congress, several items from India were unveiled by Hon’ble Minister for Science and Technology and Earth Sciences, Dr. Jitendra Singh, including the Geospatial Incubator, Solar Calculator, Bhunidhi Portal, National Toponymy Database, and a report on the “Indian experience in aligning with IGIF (Integrated Geospatial Information Framework)”. These initiatives showcase India’s commitment to using geospatial technology for sustainable development and inclusive growth.



Fig. Release of Report entitled “Indian Experience in alignment with UN IGIF (Integrated Geospatial Information Framework)” by Union Minister of State for Science and Technology along with other dignitaries at UNWGIC – 2022

- **Role of Geospatial Technology in Last-Mile Delivery and Empowerment:** At the closing Ceremony of the Second UNWGIC 2022, Dr. Tamilisai Soundararajan, Governor of the State of Telangana, highlighted the importance of geospatial technology in ensuring last-mile delivery of essential goods, medicines, and vaccines during the pandemic. As a medical physician, she emphasized the crucial role of geospatial in strengthening medical facilities and empowering marginalized people. Further,

Mr. Tulu Basha Bedada, Co-Chair of UNGGIM, emphasized to keep up the momentum and work with the committee of experts to make the world a better place.

- **The Eleventh Plenary Meeting of the Regional Committee of UN-GGIM for Asia and the Pacific (UN-GGIM-AP)** was also held during the last day of the Congress at Hyderabad. During the meeting a new working group for the Integrated Geospatial Information Framework (IGIF) was constituted and India was awarded the Chair of the working group.

3.4 National Science and Technology Entrepreneurship Development Board (NSTEDB)

NSTEDB, through its strong network of incubators is leveraging the technological strength of the higher learning institutes for nurturing the national innovation and entrepreneurship ecosystem. NSTEDB has adopted a multipronged approach in its mission to foster innovation & technology-based entrepreneurs. The key activities & outcomes of NSTEDB under its NIDHI umbrella programmes for the F.Y. 2022-23 are given below:

3.4.1 National Initiative for Developing and Harnessing Innovations (NIDHI)

Following are the key components of NIDHI umbrella programme:

NIDHI - CoE (Center of Excellence)

NIDHI-CoE strengthens existing incubation capacities of Technology Business Incubators (TBIs) to make them world class, state-of-art startup incubation centres. NIDHI CoE supports potential start-ups for translating technological innovations into marketable products and high-growth ventures. DST has supported eight NIDHI-CoEs at different premier institutions. These NIDHI-CoEs (Centre of Excellence) are at CIIE-IIM Ahmedabad; SINE IIT Bombay; PSG-Science & Technology Entrepreneurial Park (PSG-STEP) Coimbatore; TBI- Veltech University, Chennai; KIIT -TBI, Bhubaneswar; EDC NCL-Pune; FITT IIT Delhi and T-Hub, Hyderabad.

Some of the promising products from startups incubated at NIDHI CoE are :

Greyeast Technologies Pvt Ltd.; Incubated at: CoE at SINE, IIT Bombay

EffluePure is a multi-bioculture proprietary process innovation in fermenting bio-cultures and; bio-enzymes which helps degrading hazardous chemicals into simpler and non-toxic forms thereby significantly reducing COD, Color and; Foul Odour impacting social wellbeing of surroundings. This enzymatically enhanced liquid drop in solution treats effluent and; sewage waste discharged.



Fig. EffluePure effluent treatment plant

Bariflo Labs Pvt Ltd.; Incubated at: CoE at Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar

The invention discloses an intelligent maneuvering hypolimnetic aerator with an internet of things monitoring system that can autonomously navigate to different coordinates and aerate the hypolimnetic region of a water body to improve dissolved oxygen demand (DO) and thus maintain water quality standards. The data so transmitted can be used to rebuild a 3D image of the bathymetry, temperature distribution, DO distribution, and ORP distribution of the waterbody. Furthermore, the aeration system oscillates vertically in a sinusoidal way, resulting in the generation of standing waves horizontally, resulting in wave propagation to transmit DO farther from the device position and It also improves mixing at the sediment-water interface, allowing DO to penetrate into the sediment



Fig. Hypolimnetic aerator with an internet of things

Cyran Ai Solutions Pvt Ltd.; Incubated at: CoE at FIIT, IIT Delhi

BUDDHI Kit is the first-of-its-kind highly interactive and easy to use DIY educational kit that can be used to quickly learn the basics of AI and build AI-based solutions for real-world problems without any prior domain knowledge or training. The Kit can be used by young students, tinkerers, makers, innovators, hobbyists, teachers, educationists, artists, parents and professionals from any background. The DIY nature of the kit helps users develop core skills such as problem-solving, creative thinking and ability to work in teams. With BUDDHI Kit, the creative possibilities are endless as it can be used to easily introduce AI in any existing STEAM (Science Technology, Engineering, Art and Math) project.



Fig. BUDDHI educational kit

Rechargion Energy Pvt. Ltd., Pune Incubated at: CoE at Venture Center, Pune

The company has done major innovation on anode side by using modified hard carbon that can accommodate excess sodium ions, thereby increasing the storage capacity. As a proof of concept, they have fabricated sodium ion coin cell battery that exhibited energy density above 200 Wh/Kg over 5000 charging-discharging cycles. Their minimum demo able product is pouch cell wherein they have achieved energy density 120 Wh/kg. The company will design, fabricate pouch cells with customizable sizes and capacities.

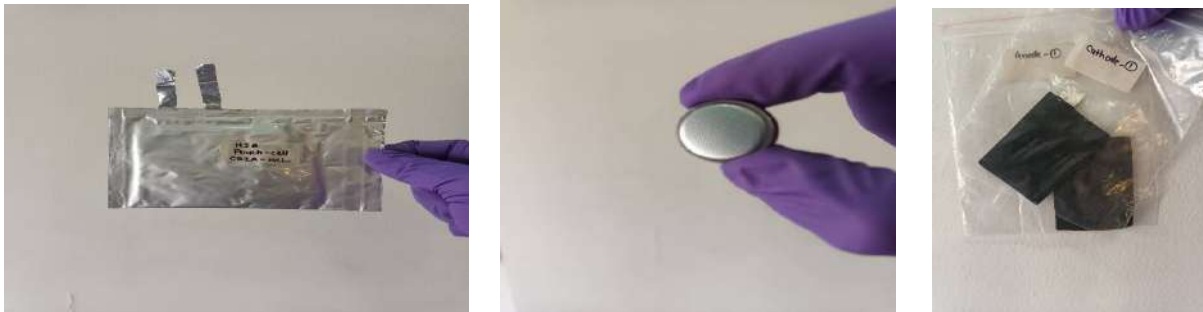


Fig. Sodium ion battery Electrodes; coin cell; pouch cell (left to right)

Bionic Yantra; Incubated at: Social Alpha, Tata Trust, Bengaluru

Bionic Yantra a wearable robotic exoskeleton that helps a paralyzed person to walk and thereby elevate locomotion- disabled person to greater levels of independence and productivity. It is intended to cater to the needs of the disabled and the elderly around the world. Exoskeletons can be used to stand, walk and assist in performing activities of daily living and would be useful not only for civilians but also veterans injured in the line of duty. The Exoskeleton is a battery powered “wearable suit” intelligently controlled by combination of motors, drives and mechanisms which are programmed to provide calibrated, on-demand assistance and resistance for limb movement as required for rehabilitation and locomotion. The system also generates an automated measurement of patient progress and documentation thus enabling high objectivity and transparency in rehabilitation of patients in hospitals/medical centres



Fig. Bionic Yantra

Galanto Innovations Incubated at: IIT Gandhinagar Research Park, Gandhinagar

Galanto Innovations: A sensory glove that help patients with restricted finger and wrist movement to recover faster using virtual gamified exercises. Gaming is designed to exercise the up and down movement of the wrist and imitating the squeezing movement to improve grip. Most patients are familiar with these games, which include well-known jump-and-run arcade games and the act of squeezing lemons into a glass. The indigenous systems is for the rehabilitation of patients with hand disabilities using virtual reality (VR) and robotic technologies.



Fig. Sensory Glove: Virtual reality-based assessment system to monitor the performance of hand movements actively using sensorised hand gloves.

Mring Technologies LLC Incubated at: Centre for Incubation and Business Acceleration, Goa

Spintly is transforming the physical security industry with its fully wireless, cloud based access control system. It removes the complexity out of the process of deploying an access control solution in a building. With absolutely no wiring the installers can save more than 60% of their time and cost and be more productive. Spintly offers a variety of software solutions, such as a Time and Attendance system, Wireless Access Control for large and small businesses, and Contactless Visitor Management. Spintly readers support various types of credentials like NFC Card, Fingerprint and Smartphones. It was awarded best IoT Company – 2020 by BETA

Smart Access Control Devices for Smart Offices



Fig. Smartphone-based Access Control System or “Smart Access”

NIDHI TBI (Technology Business Incubator)

Technology based new enterprises are high risk and high growth ventures, and require an enabling environment like NIDHI-TBI to enhance the prospects of their success. Under this programme, TBIs primarily in and around academic, technical and management institutions to tap innovations and technologies for venture creation by utilizing expertise and infrastructure available with the host institution are supported.

Some of the promising products from startups incubated at NIDHI TBI:

- D3S Healthcare Technologies LLP incubated at ASHINE TBI, Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat: D3S Healthcare Technologies LLP BR-Scan 1.0 device is a one of the new health and wellbeing product for women. It is a one of the unique invention for the detection of breast cancer and certain breast abnormalities at home on DIY basis. This device is also integrated with App so that user

could store scanned data in digital form (PDF) and share with doctor. The start-up has raised funding from 5th Parivartan SmartUp Grants, HDFC bank – Rs. 21,25,000



Fig. Robotic Vehicle for hospitals

Pavan Empower Solutions incubated at SPMVV Society for Innovation and Incubation Entrepreneurship (SSIIE) Tirupati: Remotely operated robotic vehicle that can be used in hospitals to deliver medicines and food material for Corona quarantined /affected patients without getting near to them. The device has both voice and video transmission system to communicate with the patient.

- Xfinito Bio designs Private Limited incubated at IIM Udaipur Incubation Centre: Xfinito Bio designs Private Limited is developing a series of smart footwear based on their platform Xeuron, which aims to provide monitoring progression, diagnosis and treatment for degenerative nerve disorders. The specially designed smart footwear considers the medical difficulties faced by patients suffering from various foot conditions which lead to pain & discomfort. It not only solves the problem in the leg movement but also comes with an advanced facility to track the progress of the patient with the help of batteries, vibrators and sensors attached at the precise foot pressure points.

NIDHI – iTBI (Inclusive-Technology Business Incubator)

The aim of Inclusive TBI is to instill a spirit of innovation and entrepreneurship (I&E) in students, inventors, and entrepreneurs, as well as to stimulate and support creative ideas and start-up creation through incubation. The i-TBI facilitates in conversion of ideas into startups. The Host Institution (HI) and surrounding geographies benefit from an i-TBI (Inclusive TBI) culture of innovation and entrepreneurship. I-TBI provides grants-in-aid to innovators to help them turn their ideas into prototypes and prototypes into enterprises. In 2022-23, DST supported setting up of iTBI at Andhra University, Vishakhapatnam;

Shri Govindram Seksaria Institute of Technology and Science – Indore; NIT Srinagar; Vignan’s Foundation for Science, Technology and Research – Vadlamudi; Siddaganga Institute of Technology (SIT), Tumakuru , MNNIT, Allahabad, Institute of Chemical Technology, Mumbai ,R.V.R J.C College of Engineering – Guntur,Chhattisgarh, Swami Vivekanand Technical University Bhilai, Guru Nanak Dev Engineering College, Bidar, R K University, Rajkot, Delhi Technological University, Delhi and Aligarh Muslim University, Aligarh.

NIDHI- Promoting and Accelerating Young and Aspiring technology entrepreneurs (PRAYAS)

PRAYAS program aims to support young innovators turn their ideas into Proof of Concept (PoC)/Prototype. The PRAYAS funding helps innovators/startups to reach a stage where they have a ready product and progress towards commercialization.

PRAYAS Program has generated a considerable impact. Under this programme 400+ innovators are supported across the country; 150+ prototypes developed; and 100+ patents filed by the innovators during the period.

Further, such support is more critical to encourage entrepreneurship and also foster indigenously developed innovations and product in alignment with the nation’s “Atma Nirbhar Bharat Mission”.

PRAYASEEs Product Details:

Product- Astrome Technologies has developed the world’s first multi-beam E-band radio (a viable alternative to fibre) makes it cheaper to distribute multi-Gbps capacity wirelessly. Multiple-Point-to-Point (Multi-P2P) communication means that a single Giga Mesh device can simultaneously communicate to multiple surrounding Giga Mesh radios while maintaining full data throughput to each surrounding radio.

PRAYAS Centre name – Society for Innovation and Development, IISC Bangalore

Product - EyeRov TUNA is India’s First Commercial Underwater Drone/Remotely Operated Vehicle (ROV). Eye Rov TUNA ROV has completed over 1000+ hours of operation doing an under water inspection of Dams, Bridges, Ports, Off shore structures, Ship Hulls, Pipeline and others



Fig. Multi-beam E-band radio



Fig. Underwater Drone/ Remotely Operated Vehicle (ROV)

PRAYAS Centre name – Maker Village, IIITMK, Kochi

Product - Sens Nemo Q - Sens Nemo Q is non-invasive device that analyses 6 key vitals like blood glucose, ECG, BP, HR, SPO2, and temperature in just 60 seconds. It also comes with an interactive mobile app to provide regular insights to users.



Fig. Sens Nemo Q

PRAYAS Centre name – CIE –IIT Hyderabad Foundation

Product- MiCoB focusses on bringing man-machine integration in the construction segment, using its state of the art, 3D concrete printing technology. The company has successfully developed its in-house 3D concrete printers, their printing ink and required software package allows faster, economic and quality compliant construction.



Fig. 3D Concrete printer

PRAYAS Centre name –IIT Gandhinagar Innovation and Entrepreneurship Center, Gandhinagar

NIDHI-EiR (Entrepreneurs-in-Residence) Program

NIDHI EiR Programme encourages to pursue entrepreneurship, enables creation of new start-ups by entrepreneurs and helps to progress towards raising funding. Through the programme 410+ EiRs have been supported which have in turn created 265+ IPs, 106 Patents, 86 trademark and 25 copyrights.

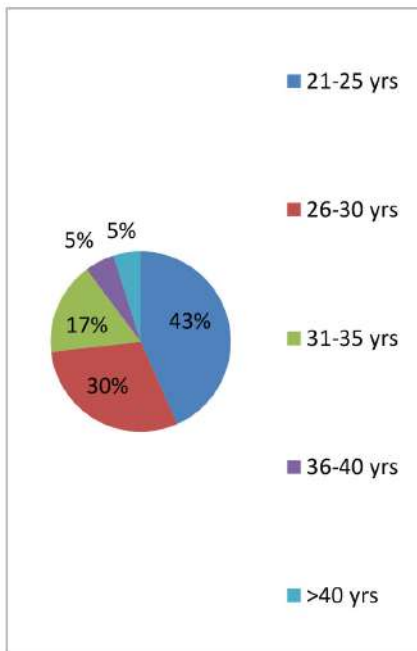


Fig. Age-wise pie chart of EiR supported

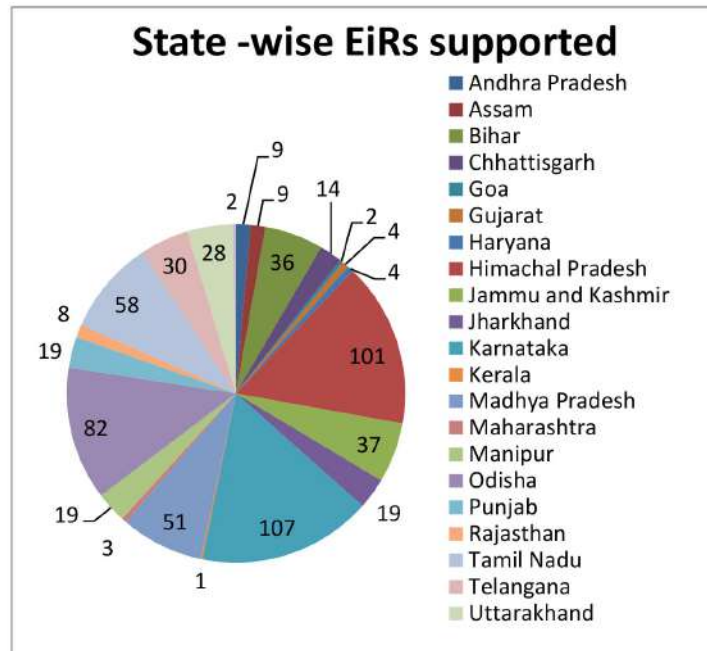


Fig. State-wise EiRs supported

NIDHI EiR Success stories:

Success story 1: Ensuring safety of passengers

Startup: Praesus Technologies Pvt. Ltd.

About the product: Smart Helmet with lightweight, modular technology that fits inside regular motorcycle helmets.

Problem solved: This innovation significantly increases the ease of locating an administering medical aid to an accident victim right after a crash, and also gamifies safe driving to make the rider drive better.

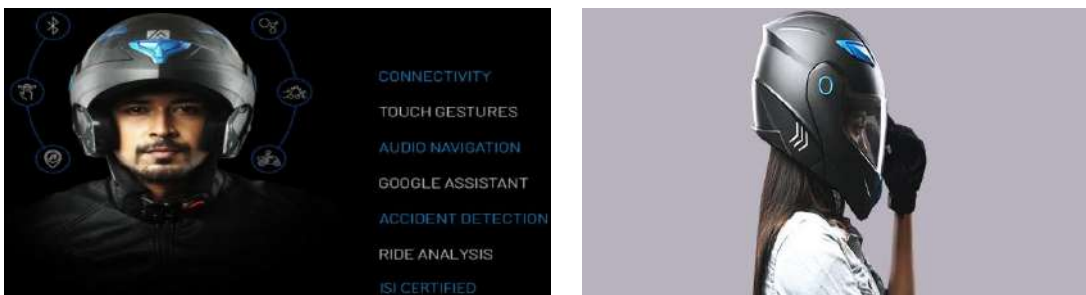


Fig. Smart Helmet with lightweight, modular technology

Success story 2: Plastic embedded bricks

Startup: Zerund Manufacturing Pvt. Ltd.

About the product: Zerund bricks are plastic embedded light-weight, cost-efficient, earthquake and fire resistant strong, durable, eco-friendly bricks.

Key problem solved: Overcomes disadvantages of Clay Bricks like high Cost, durability issues, fragility of material, the cost of clay brick pavers in any setting is relatively high compared to other materials.



Fig. Plastic Embedded bricks

Success story 3: Battery Swapping for EVs

Startup: Divish Mobility Pvt. Ltd.

About the product: BatteryPool, that facilitates battery swapping for immediate recharge of batteries of two and three wheeler vehicles

Key problem solved: Vehicles can be operated without zero downtime for charging by owners and fleet operators.



Fig. Battery Swapping for EVs

NIDHI – Accelerator

Under the Accelerator Program, 18 new Accelerator programs were supported to have customer centric validation models by way of quality mentoring, helping them to enhance the startups' investment readiness. These 18 Accelerator program were supported in the areas of Agri tech, Fin-tech, Social ventures, Digital Healthcare, women led tech based startup solutions, strategic sector for AatmaNirbhar Bharat, manufacturing, life science, healthcare, tech based startups with large socio economic impact, AI application in media-tech, medical device classification, scale up program, financial inclusion, agricultures , allied sectors, clean tech, waste and water environment, benefitting total of 270 startups with batch size of 15 each.

NIDHI- SEED SUPPORT PROGRAM (SSP)

NIDHI- SEED SUPPORT PROGRAM (SSP) is one of the key programs to support deserving startups within an incubator thereby enabling their venture to the next level and facilitate their success in the marketplace. A total of about 75 startups have been supported so far and six Incubators have been approved by DST for extended Seed Support under NIDHI during the F.Y. 2022-23. Few notable success stories of the Seed Support Program for this year are as under:

SAVEMOM by Startup: JioVio Healthcare; Incubated at DERBI, Bangalore

Product/Innovation: Savemom is a wearable maternal healthcare device that (together with a suite of apps) saves the lives of pregnant women and newborn infants.

Savemom, an IOT-based maternal healthcare solution, monitors a mother's health using smart wearables that collect various physiological signals (blood pressure, heart rate, temperature, respiratory rate, ECG, oxygen saturation, and glucose) continuously from the mother. These signals are processed with advanced techniques, and a risk assessment is done continuously to ensure her health. The vitals are continuously monitored and uploaded to the cloud for doctors to view remotely. Caregivers and doctors are alerted if any mother's risk assessment is negative, so preventive measures may be taken correctly. JioVio has filed provisional patent applications protecting its innovation.

Achievements: JioVio Healthcare signed a contract with Tamilnadu women development corporation to deploy solution to 50 lakhs women to access various financial support from Government. They have completed the Pilot study in Vizag District Andra Pradesh state government to provide digital health screening for 3000+ patients, they have completed the Pilot deployment in Thane District and Mumbai Suburbs, Maharashtra State Government to provide maternal care for 4050+ Pregnant mothers. Company has integrated this solution with esanjeevani platform to provide vital real-time tracking during the teleconsultation and deployed Save mom Solution to 3 Districts in Tamil Nadu to monitor 334 women as part

of the HDFC/DERBI Grant Award. The company has won following awards like DERBI | HDFC CSR GRANT Award 2022, Gifted Citizen 2019 Award from Nobel Prize team and UNESCO, Anjani Mashelkar inclusive innovation award 2022, Jancare Challenge organized by NASSCOM BIRAC, Health Innovation Challenge#2 organized by NASSCOM, winner of Code For The Next Billion by Facebook to name a few.

“Innovation: Product + Process + Technology + Business”



Fig. SAVEMOM By JIOVIO Healthcare: Complete Process flow

Mouseware by Startup: Dextroware Devices, Incubated at: Foundation for Innovation and Social Entrepreneurship (FISE) (Social Alpha), Bangalore

Product/Innovation: Dextroware Devices, incorporated in August 2020, has developed “**Mouseware**”, a device which helps Persons with Disability (PWDs) with upper limb locomotive disability operate laptops and computers (and any smart device) by replacing a traditional mouse. Mouseware is a wearable and



Fig. Mouseware by Dextroware Devices

affordable head gear with IMU (Inertial Measurement Unit) sensors that converts head movements into mouse coordinates on the screen and enables clicking using additional hardware switches. Its Unique selling point includes Customizable – can be set according to user's preferred mode, i.e Universal Strapable switch, Finger switch, Foot Tap switch, Dwell click and Speech to Text. It has Hassle-Free Set Up and Convenient and Calibrated.

Achievements: Dextroware Devices has won many awards and has many achievements like winner of Prosus Social Impact Challenge, UN Smart Solutions and Inclusive Cities award winner, TN Government TANSEED grant winner, DSIR PRISM Grant winner and has also featured by YourStory in the Top 30 startups of TechSparks.

Startup: Immuno adaptive Cell Therapy Private Limited (ImmunoACT) – Incubated at SINE, IIT-Bombay, Mumbai

Product/Innovation: Immuno adaptive Cell Therapy Private Limited (Immuno ACT) is a pioneer in the field of cell and gene therapy and aims at revolutionizing the cancer treatment in India by developing newer technologies for cell therapy and immunotherapy applications. Recently, they have developed an indigenous, novel and efficacious living drug called the Chimeric Antigen Receptor T cell (CAR T) therapy against B cell leukemia expressing CD19 antigen.

Achievement: The Company commence the first phase of the human clinical trials using its patented technology (HCAR - CD-19) for cure of DLBCL (Diffuse Large B Cell Lymphoma) in association with India's leading cancer research and treatment centre – Tata Memorial Hospital (TMH) and other leading Onco-specialist hospital. 3 out of 10 patients were announced cancer free during these trials. The company raised funds of Rs.55.75 crores from Laurus labs and their senior management.



Fig. Immuno Adaptive Cell Therapy Pvt Ltd

Next Gen 3D modelling by Startup: My3DSelfie Private Limited – Incubated at IIM Calcutta Innovation Park, Kolkata.

Product/Innovation: My3DSelfie Private Limited has contributed in building the world's most powerful technology platform for next gen 3D modelling of avatars, characters and accessories. It has developed a proprietary technology for manufacturing customized 3D figurines from photos. An asset light and distributed model which reduces the time to fulfill customer orders.

Achievements: The key achievements of My3DSelfie, so far, are as below-

- Has raised Rs 16.66 Cr follow on funding from NEDFI, Dholakia Ventures , US family Offices and other angels

- World's largest database of 3D models of humans and pets which are validated by customer across 40 countries
- D2C Customer Segment - 2000+ customers in 40 countries including India, US, North America, Europe, Middle East.

Range Aero by Startup: Rangeaero Private Limited – Incubated at CIIE, IIM-Ahmedabad

Product/Innovation: RangeAero works towards developing its flagship product Range100- a microlight pilotless coaxial helicopter. Along with this, company is also developing an end-to-end ecosystem of the functioning of unmanned aviation like ground control stations, command and control centers, unmanned helipads, etc. The vision is to operate a fleet of white-labelled aerial logistics vehicles for customers by charging our users a fixed fee for every pickup/delivery made using the platform and a variable fee for the type of payload and distance travelled. Currently, RangeAero has a product called Range5- a 20 kg AUW coaxial helicopter capable of carrying a 5kg payload for the end users.



Fig. Range Aero - Microlight Pilotless Helicopter

Achievements: Their products have passed a level of flight tests and are currently conducting more rigorous and use-cases-oriented tests on the same platform. The Range5 vehicle is autonomous and can land on a moving platform. It is designed in a way to perform operations in heavy wind conditions.

3.4.2 Other Innovation & Entrepreneurship Initiatives

New Generation Innovation and Entrepreneurship Development Centre (New Gen IEDCs)

Under NAB, 26 new Gen IEDC centers have been established in various academic institutions located in 13 States namely; Andhra Pradesh, Assam, Gujarat, Haryana, Karnataka, Maharashtra, Meghalaya, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Jammu and Kashmir. Some of the important host institutions are Indian Institute of Technology (IIT)-Guwahati, Indian Institute of Information Technology-Allahabad, Jawaharlal Nehru National College of Engineering, Shimoga, Datta Meghe Institute of Medical Sciences, Wardha, Sumathi Reddy Institute of Technology for Women, Warangal, College of Technology and Engineering, Udaipur, Dr. MGR Educational and Research Institute, Chennai etc.

Following are the highlights of projects supported by the NewGen IEDCs:

- Total number of Student Projects supported: 1571
- No. of Patents filed by students: 471

- No. of Patents Granted: 40
- No. of Companies/Startups Set up by Students: 138
- No. of Enterprise/Business Commercialized: 67

Innovation and Entrepreneurship Training Programmes

NSTEDB supported modules of I&E training programme i.e. Faculty Development Programme (FDP), Women's Entrepreneurship Development Programme (WEDP) and Technology Based Entrepreneurship Development Programme (TEDP) during 2022-23. Against a call for proposal, 281 proposals were received, out of which 115 proposals were recommended for the support for FDP (100), WEDP (143) and TEDP (145).

3.4.3 Conference/ workshop/Expo supported:

“DST STARTUP UTSAV” was organized on 12th August 2022 at New Delhi during **Azadi ka Amrit Mahotsav** to commemorate 75 years of India's Independence. The event showcased DST's pioneering efforts in building and supporting incubator networks and nurturing startups across the country. Apart from interactive sessions among startups, incubators, investors, government officials and other stakeholders, seventy-five most impactful DST supported startups from all over the country were showcased during the event.

During the event, 5 publications were also released by Hon'ble Minister of State (IC) for Science and Technology, Dr. Jitendra Singh featuring promising Start-ups under various components of DST NIDHI schemes. The five publications included impactful startups supported under NIDHI-TBI, NIDHI-SSP, NIDHI-PRAYAS, NIDHI-EIR and CAWACH initiative.



“**KASHMIR EXPO – Startup for Livelihood**” as first kind of its event was organised by DST in Srinagar, J&K showcasing 50 DST supported startups and livelihood projects from nearby regions. The three-day event was held during 9th – 11th November 2022 witnessed visit by huge number of students from nearby institutes and universities of the valley, encouraging them to take up entrepreneurship as their career option. The event was also witnessed by high level dignitaries from the nearby regions.



Fig. Hon'ble Minister of S&T, Dr. Jitendra Singh, Chief Guest for the inaugural session during the event



Fig. Hon'ble LG, J&K , Chief Guest for the Valedictory session during the event **National Award for Technology Business Incubators**

In order to recognize and reward Incubators, Department of Science and Technology, has instituted two National Awards: Technology Business Incubator Award with a cash prize of Rs. 5 lakh and Emerging Technology Business Incubator Award with a cash prize of Rs. 3 lakh. Both awards also carry a trophy and certificate. The awards for the year 2019 and 2020 was presented during Technology Day celebrations on 11th May 2022 at New Delhi.



Fig. Awardees of National Award for Technology Business Incubator for the year 2019 and 2020

3.5 National Council for Science & Technology Communication (NCSTC)

The NCSTC Division programmes of DST are geared largely to communicate and popularize science and technology, coach science communicators and foster engagement of diverse sections of the society with scientific thinking through extramural research funding. A notable progress has been made by NCSTC Division during the year of report. Some of the significant achievements in respect of NCSTC Division is given below:

3.5.1 Content Development

Science Channel, 'India Science':

Under the Science Chanel project, DST started two innovative platforms for science communication purposes, i.e. (i) DD Science – a one-hour slot on DD-National and (ii) India Science –a 24x7 OTT channel under the project Science Channel in the year 2019. Presently the operation of the India Science OTT channel is being carried out successfully. More than 4000 videos on various S&T themes have been produced in different formats like documentaries, weekly science news shows, studio-based discussion/interviews, talk shows, live shows, science magazines, R&D features, innovation features, short films, bulletins etc. The platform has a huge repository of Science and Technology related videos. The reach of the India Science OTT platform has crossed the figure of 230 million with the base of around three to four to five lakhs subscribers across platforms. Several collaborations were made with different organizations IIT Guwahati, IIT Delhi, Central University, Punjab, CBSE Schools, MyGov, Niti Aayog, CSIR, IBM, JIO etc. India Science OTT channel is accessible

on notable platforms -India Science App: Android / iOS App (download from Google play store /Apple store), YouTube: www.youtube.com/c/indiascience, Website www.indiascience.in, Facebook: <https://www.facebook.com/indiasciencetv>, Twitter: @indiascience, Instagram: indiasciencetv, LinkedIn: India Science, Pinterest, Jio TV, Jio STB, JioTV+, JioChat.

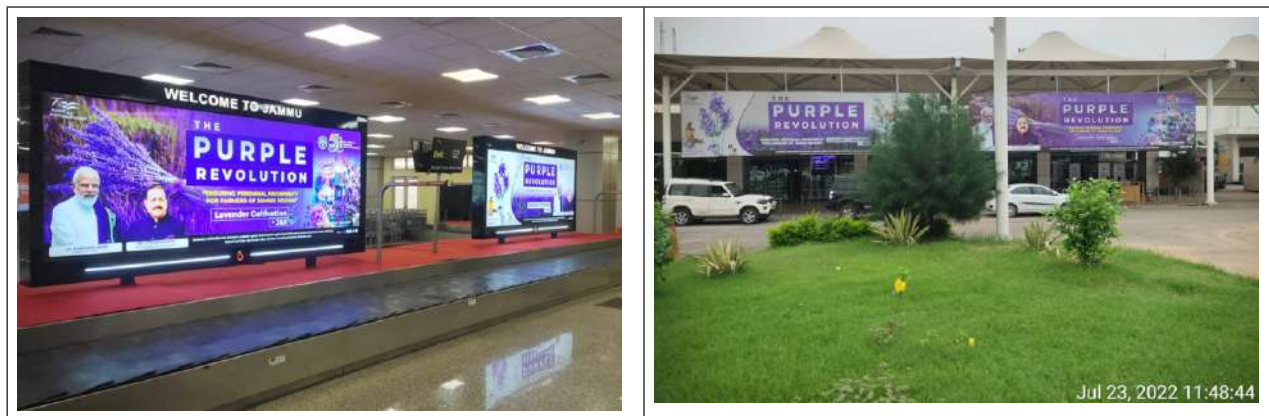
Science Channel is being implemented by Vigyan Prasar as an extra-mural project of the NCSTC Division of DST. The content and the service quality have received positive feedback from the audience as well as the industry. This is made evident by mobile app download analytics, India Science web analytics, user emails, and other offline acknowledgments. Moreover, there has been a huge groundswell of demand for premium S&T video-communication, which has been underlined in several focus group meetings involving various stakeholders – scientists, science communicators, senior faculty members, school administrators, school boards, universities, etc. The popular series which were conceived this year are (i) Life in Science with Pallav Bagla (ii) Vigyan Veer based on Inspire Manak Awardees (iii) Aagaaz-Journey of Indian Science Start-Ups supported by DST (iv) Science for a Self-Reliant India, and (v) Role of Indian Scientists in Freedom Struggle.



Showcase the Indian S&T Prowess at Airports and Outdoor City Locations of Srinagar and Jammu

In order to showcase the Indian S&T Prowess at airports across the country, a project for scientific outreach through digital and static media was carried out by Vigyan Prasar at the Srinagar Airport followed by Jammu Airport. The project showcased the prowess of Indian Scientific & Technological developments and advancements made by Scientific Institutions under Ministry of Science & Technology through various display panels at Airport. Showcasing of strength of Indian Scientific prowess at airport will have a chance to reach a high concentration of people (both National & International). According to Airports Authority of India, approx. 20 lakh and 15 lakhs passengers transited at the Srinagar and Jammu airport for both domestic and international flights respectively in March - April 2022. Different aspects of S&T interventions, specific to newly formed UTs of Jammu and Kashmir were showcased especially about Purple revolution, Biotechnology parks,

Heliborne technology, and Schemes and announcements of MoST, etc. This Outreach Program has spelled its effects on the locals as well as air travel tourists reaching the state about research on biodiversity, medicinal and aromatic plants of Jammu and Kashmir and Ladakh, and promoted green category businesses in the State. Lavender cultivation popularly known as Purple Revolution has been able to catalyse Rural Empowerment as it has engaged so many families of farmers. Also, women have benefited from this cultivation.



3.5.2 Professional Development

Augmenting Writing Skills for Articulating Research (AWSAR):

AWSAR, an all-India competition, was introduced in September 2018 by NCSTC Division. The program aims to motivate young research scholars (PhD and Post-Doctoral) to communicate their own research work to the common people in a popular format devoid of technical jargon to strengthen the ecosystem of science communication in the country. The program has inbuilt component of capacity building workshops, organized across the country to guide scholars about popular format, principle, methodology, tips and tricks for the national-level competition.

On National Science Day (NSD), 28th Feb 2022, three PhD Scholars and one Post-Doc fellow were felicitated with AWSAR Award. In addition, to the mentioned Awards, the top 125 popular stories out of 1779 stories were selected for a cash prize. During Call for Submission of Popular Stories for the year 2022, 4461 Scholars were guided on “Popular Science Writing” through seven webinars and five workshops in physical mode. A total of 2301 stories were received under AWSAR 2022.



Fig. Training & Research in Science Communication and Science Media

The following notable initiatives have been strengthened to promote research and capacity building in science communication & science media:

- *Science News & Features Service* & augmentation of the existing science news bi-monthly “Vaigyanik Drishtikon”
- Designing and developing theme based content for Mobile Science Exhibition Buses/Laboratories running in different states to take science to the doorsteps
- Virtual mode initiatives based on science media/virtual exhibitions have been encouraged notably the AR/VR Museum of Science for Students, Virtual Bioscope for School Students, and several community science media initiatives for students, homemakers, farmers, tribals, etc.
- Science Media Services (Internet Radio) for tribal girl students of Sirohi District Rajasthan
- Science Fiction & Science Media Talent Promotion Framework and a national contest to inspire and support Future Prototyping

National Awards for S&T Communication and Popularization:

NCSTC instituted National awards in 1987 to stimulate, encourage and recognize outstanding efforts in the area of science popularization and communication. Presently, there are six awards to be given on National Science Day, Feb 28, 2023 as follows:

- National Award for Outstanding Efforts in Science & Technology Communication in General

- National Award for Outstanding Efforts in Science & Technology Communication through Print Media including Books and Magazines
- National Award for Outstanding Efforts in Science & Technology Popularization among Children
- National Award for Outstanding Efforts in Translation of Popular Science & Technology Literature in Languages Mentioned in the Eighth Schedule of Constitution of India and in English
- National Award for Outstanding Efforts in Science & Technology Communication through Innovative and Traditional Methods
- National Award for Outstanding Efforts in Science & Technology Communication in the Electronic Media



3.5.3 Hands on Science Programme

National Children Science Congress 2022:

Started in 1993 by NCSTC, to encourage child scientists of the age group of 10-17 years for identifying some societal problems and motivate to arrive at a possible solution through their research-based solutions. It covers almost all the districts of the country with a participation of over 200,000 students. Emphasis is 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. The current edition of National Children's Science Congress is being convened with a theme of "Science for Sustainable Living".

Initiative in Research & Innovation in STEM (IRIS):

The 'Initiative for Research & Innovation in STEM (IRIS)' is a research-based science initiative for students, with an objective to inspire promising young scientists in India. It is a public-private partnership of DST and Broadcom for empowering the next generation of innovators. Winners of the Initiative for Research and Innovation in STEM – IRIS National Fair, who represented 'Team India 2022', have competed with about 2000 budding scientists from 80 countries, regions and territories across the globe and won 13 Grand Awards and 9 Special Awards at Regeneron International Science and Engineering Fair (ISEF), the largest pre-collegiate science & engineering fair in world.



Low Cost Teaching Aids for Innovative Hands-on Science Learning:

Training of teachers in innovative methods of science teaching by low cost teaching aids aims to develop the problem solving capacity, reasoning power and creativity of the students. Training workshops were supported for teachers training in different states with low cost teaching aids to help the teachers in making teaching interesting and also with an aim to motivate science teachers to perform hands on activities with students that would enable them to grasp the basic principles of science easily. The participating teachers encouraged students and promoted the concept of learning science by fun. The programmes have created and enlarged the groups of trained resource teachers and further evolved an experiment based methodology in the teaching of science. 80 training workshops were conducted for teachers training in different states i.e. Jammu and Kashmir, Madhya Pradesh, Odisha, Tamil Nadu, Uttar Pradesh, Andaman and Nicobar Islands, Daman, Diu and Dadar & Nagar Haveli, Haryana, Rajasthan, Karnataka, Telangana, Andhra Pradesh, Nagaland, Uttarakhand etc. with an aim to motivate science teachers to perform hands on activities that would enable them to easily grasp the communication of basic principles of science.



3.5.4 Promotion of Scientific Literacy

Celebration of the National Science Day (NSD) and National Mathematics Day (NMD):

The National Science Day programme was supported all over the country through State S&T Councils. Celebration of National Science Day began or culminated on 28 February. Similarly, the National Mathematics Day programme was supported all over the country through State S&T Councils involving colleges and school students. Celebrations or culminated on 22 December to commemorate the birthday of Srinivasa Ramanujan, the great mathematician with a focus on popularizing Mathematics.



STEMM India

Science, Technology, Engineering, Mathematics and Medicine (STEMM) India' activities comprise of Science fairs, melas, expositions, mobile science exhibitions, lecture-demonstrations, interactive media, visits to S&T establishments like labs and industry, hands-on-STEMM activities, and so on. These events, whether stationary or mobile, including mobile science exhibitions, serve to utilize the expertise of resource persons trained/being trained by NCSTC in various aspects of the concerned activities. More than **200** static and mobile exhibitions were organized in different parts of the country.

Expert scientists and teachers from different prominent universities and schools of India motivated young minds with talks, exhibitions, demonstrations and in-person discussions at various places in the country.



Science Exhibitions on Wheels:

Through 'Mobile Science Exhibition' students, especially having no or very little access to lab facilities, get an opportunity right at their school premises for hands-on engagement in science

activities which will help them in understanding difficult curriculum-based concepts with fun and ease. The target group for these activities includes general public, school & college students, youths, women, teachers, gram panchayat members, voluntary organizations and policy makers, etc. Several such Mobile Science Exhibitions run in different states. The Mobile Science Lab (MSL) is a unique lab-on-wheels, which aims to take the laboratory experience to underprivileged children right at their school premises. NCSTC has been catalyzing and supporting several such Mobile Science Labs, which are run by its partners in different states.



In Gujarat, the Mobile Lab programme is being implemented by Vikram A Sarabhai Community Science Centre since 2018. It is being taken to schools having no or very little access to laboratory facilities.

This includes schools from aspirational districts of Narmada and Dahod. Through the Mobile Lab, students are engaged in hands-on, experiential learning of science through activities and experiments. This has been helpful for them to understand difficult curriculum-based concepts with fun and ease. The Lab carries the necessary equipment, kits, consumables and other material required to perform curriculum-based science and mathematics sessions. A team of trained Science Communicators accompany the MSL and facilitate the activities with students. The methodology used includes hands-on sessions like model-making, activities, experiments, interactive exhibits, as well as panel exhibition, and demonstrations. All students are involved in the hands-on sessions and get to take away the models prepared by them. Demonstration sessions are conducted for curriculum-based topics and various current science topics, such as COVID-19. Each participating school is given a set of Science and Mathematics resource material for continuing the activities further. Over 75300 students, 2770 teachers and 330 schools have benefited from this unique initiative over its three phases across Gujarat.



Science on wheel – STEMM BUS –in Delhi region is Science Awareness programme with a mission to popularize science among students and General public of Delhi with an aim “ To Reach, Each and Teach”. The STEMM bus completed its journey for the period November 1st 2021 to October 2022. This STEMM bus has taken the science to the masses during its journey, nurtured the scientific talent, inculcated scientific temper among school students and general public. The emphasis of this programme is to develop an informed and knowledgeable society and free the masses from superstitions and misinformation. It aims at reaching out to people from all walks of life through fun and accessible scientific content, and removing the barriers to engagement through activities related to themes like Fun with Science – Magical Science, Solar appliances– Live Demo, Science Movie Show – lets visit the world of science, Hands on Experiment.



Mobile Science Laboratory – Circus of Science (*Vigyan ka Jantar Mantar*)

Mobile Science Laboratory was launched from Karnal District, Haryana in April 2016. The laboratory is equipped with all types of basic scientific equipments of physics, chemistry,

biology, electrical, electronics and mathematics in general and relates daily life activities through scientific experiments justifying – “*Parmanu se Brahmand, Ek Hi Vigyan - From Atom to the Universe, Science is One*”. The Mobile Science Laboratory has visited over 634 Government Senior Secondary, Government High and Government Middle Schools of districts Karnal, Kurukshetra, Yamunanagar and Nuh (aspirational district). More than 1,09,800 students and many teachers have performed hands-on experiments through mobile science laboratory.

The unique feature of this laboratory is that every child is engaged in performing at least one hands-on experiment fulfilling one of our ideologies - “*Har Bachcha Ek Vaigyanik Hota Hai – Every Child is a Born Scientist*”. Students are provided with variety of kits to work on optics, magnetism, electricity, electronics, human physiology, microscopes, telescopes, sundials, pinhole cameras, lens cameras, different types of chemicals & glassware and many other apparatus to inculcate the scientific interest in students. The science laboratory used to visit one school every day and the science communicators demonstrate a variety of fun-learning science experiments while engaging students in performing such activities. Further, biographies of the eminent Indian scientists are screened through projector which develops in students the spirit of “*Hum Bhi Kar Sakte Hain – Even we can do this*”. Another popular activity under the Mobile Science Laboratory is “*Sitaron Se Mulaqat – Meet with the Stars & Planets*” which involves the use of telescopes for watching planets, stars and constellations in night-sky.

3.5.5 Risk Communication Programme

National Programme on Risk & Health Science Communication

Country wide programme of Health & Risk Communication ‘Year of Awareness on Science and Health’ (YASH) was monitored for progress of initiatives. The project proposals received, evaluated and recommended against a special call were implemented based on a countrywide YASH programme architecture drawn towards

- improved risk understanding, an analytical mind, and informed decision making capacity amongst target groups including working with local sensitivities, belief systems, traditions, and indigenous knowledge translation, target group specific interpretations and usage of authentic scientific and health information to communicate the risks and facilitate risk management.
- attitudinal changes about appreciating risks, associated challenges and solutions and assessment of public perceptions improved ability to clarify mis-perceptions, mis-beliefs, malpractices based on authentic knowledge duly verified by scientific processes .

- trust in scientific competence of solutions and service providers and better working relations with community leaders, influencers including faith leaders, doctors, etc.
- benchmarking of communication aspects vis-à-vis national initiatives on COVID 19.

3.5.6 Cooperation in Science Communication

UNESCO Kalinga Award for Science Popularization (Biennial):

The UNESCO Kalinga Prize for Popularization of Science is a prestigious award given by UNESCO for exceptional skills in presenting the scientific ideas to lay people. It was created in 1951, following a donation from Shri Biju Patnaik, then Chief Minister of Odisha 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 Odisha. The recipient receives US\$40,000 and a UNESCO Albert Einstein Silver Medal. The recipient is also awarded the Kalinga Chair, introduced by the Government of India in 2001 to mark the 50th anniversary of the Kalinga Prize. As holder of the Kalinga Chair, the winner visits 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.

3.6 Science for Equity Empowerment & Development (SEED)

The SEED division of DST through its variety of schemes constantly works for the socio-economic empowerment and development of the disadvantages sections of the society viz. SC/ST, *Divyangjan*, elderly, Economically Weaker Section (EWS) and women besides encouraging young scientists & regular target groups to take up societally relevant Research and Development (R&D). In order to impart S&T based development effectively at State level, State Science and Technology Program (SSTP) has also been integrated in SEED division.

Specific initiative under SEED division during the year 2022-23 are as under:

3.6.1 Strengthening, Upscaling & Nurturing Innovations for Livelihood (SUNIL) program

The SUNIL program aims to support technology delivery and models of social enterprise creation for EWS (small land holder farmers, traditional artisans, blacksmiths, weavers, carpenters, landless labourer and workers of unorganized sector including transgender & prisoners) of society. It also supports need-based, action research projects to identify local & systemic solutions to implement S&T based projects at community level. SUNIL program also encourages improving S&T knowledge, skill enhancement, capacity building and socio-economic conditions of community. Some of the significant achievements during 2022 were as below:

- **Empowering Marginalised Communities through Innovations and Technologies in Flood Prone Areas of Eastern Uttar Pradesh and Bihar**

Gorakhpur Environmental Action Group (GEAG), Gorakhpur incubated and developed 24 tools & technologies on climate resilient farming, of which 5 technologies (Solar based fencing devices, Groundnut de-husking tool, compost filtering and packaging machine, customized raised low tunnel poly house for water logged areas and maize de-husking unit) were developed and transferred to the community for drudgery reduction and improving production efficiency. A total of 3141 men and 1346 women have benefitted in Eastern Uttar Pradesh and West *Champan* of Bihar and 4 model farmers were awarded by Indian Council of Agriculture Research (ICAR), Earth Day Network, Govt. of UP. The activities to improve the ecosystem services helped to reduce soil losses and wastewater for irrigation. Nine community-led institutions Agro Service Centers (ASC) are fulfilling the needs of 1170 small and marginal farmers and also gained Rs.82,563/- from rental services of equipment and tools to the farmers.



Fig. Technology of polythene mulching on tomato cultivation in sandy soil by GEAG, Gorakhpur

- **Development of nutraceutical/ functional foods and value-added products from Rhododendron flowers**

Society for Technology & Development (STD), Mandi developed value added products of Rhododendron and apple pomace and these products that are now being sold in market. Scientific validation through physico-chemical & nutritional analysis of these products were done at Central Food Technological Research Institute (CFTRI), Mysore and the Amaranthus-apple pomace biscuits were found to be rich iron, potassium and Vitamin C. Three variants of laundry soaps prepared and standardized using soap nut extract and natural essential oil of lemon grass. Analysis done at IRTC, PPC Palakad, Kerala laboratory and Shriram Institute for Industrial Research, Delhi (NABL lab) to comply with all BIS standards. Ten women SHGs and two Kisan clubs in Kullu and Mandi districts of H.P. are producing and selling herbal soaps at local levels.



Fig. Filling and sealing in glass bottles by STD



Fig. Retorting at 15 psi for 15 min by STD



Fig. Blending of soap mixture by STD Mandi

- Solar PV-micro hydel hybrid system for street light electricity in rural villages**

Foundation for Environment and Economic Development Services (FEEDS), Manipur constructed a runoff river 40-KW solar PV-micro hydel hybrid system (*12-KW micro-hydro turbine*) at Hengbung village, near Kangpokpi, Manipur. Two reservoirs viz., an upper reservoir (volume 3436 m³) and a lower reservoir (volume 1961 m³) are available for water storage. The plant has a provision to pump back water from the lower reservoir to the upper reservoir with the help of four 7.5 KW (10 hp) pumps operated by the 40 KW Solar PV arrays. During operation, the power plant could generate 8-10 KW of electricity which is utilized in lighting loads (street lights) and two community SHG centres in the nearby village (Hengbung).



Fig. Integrated solar micro hydel pumped storage power plant by FEEDS, Manipur

- Scaling up charring technology by biomass**

Appropriate Rural Technology Institute (ARTI), Pune developed new charring kiln for loose biomass a cylindrical structure (7.5 feet diameter X 1-meter height) made out of iron sheet and outer side insulated with one-inch-thick, rock wool sheet. Empty oil barrels are used for fabrication of kiln. On the top conical shape lid with cylindrical chimney is fitted. Air passages are kept from bottom side. A Farmer Producer Company (FPC)

promoted by BAIF, Ralegaon, Yawatmal, Maharashtra has produced 20 tons of charcoal from cotton stalks and used it as biochar. This new kiln is used to convert lantana, pine needles into charcoal and field trials are being performed in the applications of wastewater treatment, eco-friendly incense sticks production, filler material for polymer plastic, bio-char as a soil conditioner, briquettes as a clean fuel for domestic cooking devices and industrial boiler etc.



Fig. Charcoal Kiln for loose biomass, capacity 200 kg by ARTI Pune

- **Nutrition health and clean energy in Himachal Pradesh**

Himalayan Research Group (HRG) Shimla designed three biogas units of 1 m³ of plastic tank and metal sheet hood improved with DRDO biogas culture for gas production at low temperature (procured from Vigyan Ashram, Pune) in the selected households for real time testing. The unit expects to meet domestic cooking energy needs for about 9 months except 3 acute winter months to save cash used for LPG procurement. HRG also developed value added products, created quality control facility for *Swertia cordata* (*Chirayita*) at village Dhangiarra in District Mandi. A farmers' producer company "June Mountain Farmers Producer Company Limited (JMFPCL)" was launched with product brand of traditional crops of Red Rice, Kidney Beans, Amaranth, Buckwheat and Barley produced by the cluster of farmers under 2 Panchyats Kandhi Kamrunag and Jahal. Products were developed as per FSSAI standards after nutritional analysis.

- **Solar energy in improving education system and capacity building of community**

Barefoot College, Tilonia designed portable solar powered digital education delivery system to transfer knowledge and local know-how to rural communities in 12 states & 1800 children. Other solar based initiatives such as replacing one-time use lighting products by solar lanterns not only helped in the reduction of e-waste, it also saved the environment ensuring much needed light in some of the unreachable places. IoT controllers helped operate and manage 30 Rural electronic workshops and monitored

the health of the solar systems with 15+kW capacity. Products were tested on field and collected product usage data through offline as well as IoT platforms. Solar energy-based products were standardized keeping in mind adoption, repair, and maintenance at grassroots levels.



Fig. IoT solar dryer controller prototype by Barefoot College, Tilonia, Rajasthan



Fig. Solar Class room by Barefoot College Tilonia, Rajasthan

3.6.2 Scheme for Young Scientists and Technologists (SYST)

The Scheme for Young Scientists and Technologists (SYST) orients young researchers towards providing S&T interventions to address societal challenges for the socioeconomic development of the country. Under the Call for Proposals of SYST, 1008 new proposals were received, and 219 proposals were shortlisted for presentation by the Principal Investigators. A total of 80 proposals were recommended for funding by DST during current F.Y. Some of the noteworthy achievements under the supported projects under the program are as follows:

- **Herbal supplement to improve nutritional loss of human body**

An oral herbal supplement, 'Nutri-Gut' has been developed to ameliorate the nutritional loss of the body in post diarrheal conditions that need instant intervention was developed by the CSIR-National Botanical Research Institute (NBRI). The supplement suppresses the growth of diarrheal-causing agents, i.e. *Escherichia coli*, *Salmonella* sp., *Shigella* sp., and *Vibrio cholera* etc. and replenishes the gastrointestinal microflora. It also improves nutrient absorption and maintains sodium levels, fibre, vitamin C, vitamin B6, folate, and potassium level in the body. It also complements Zinc deficiency during diarrheal conditions. As repeated diarrheal infection leads to malnutrition and impaired development among children due to loss of bodily fluids and nutrition, this supplement would address the critical issue of malnutrition in India and contribute towards 'Atmanirbhar Bharat'. The cost of this water-soluble supplement is Rs 1.70/10g sachet.

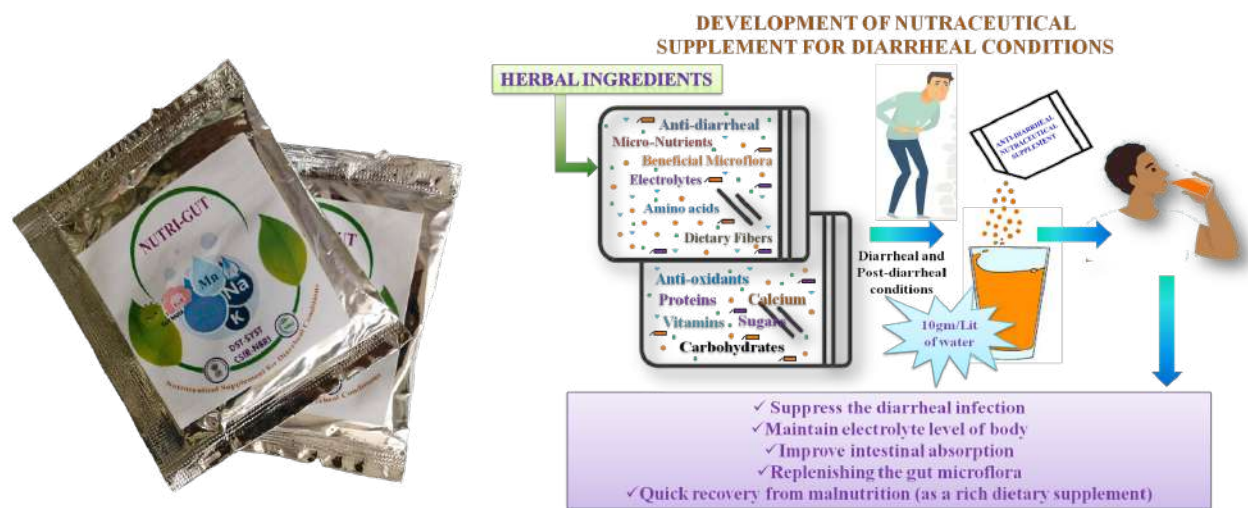
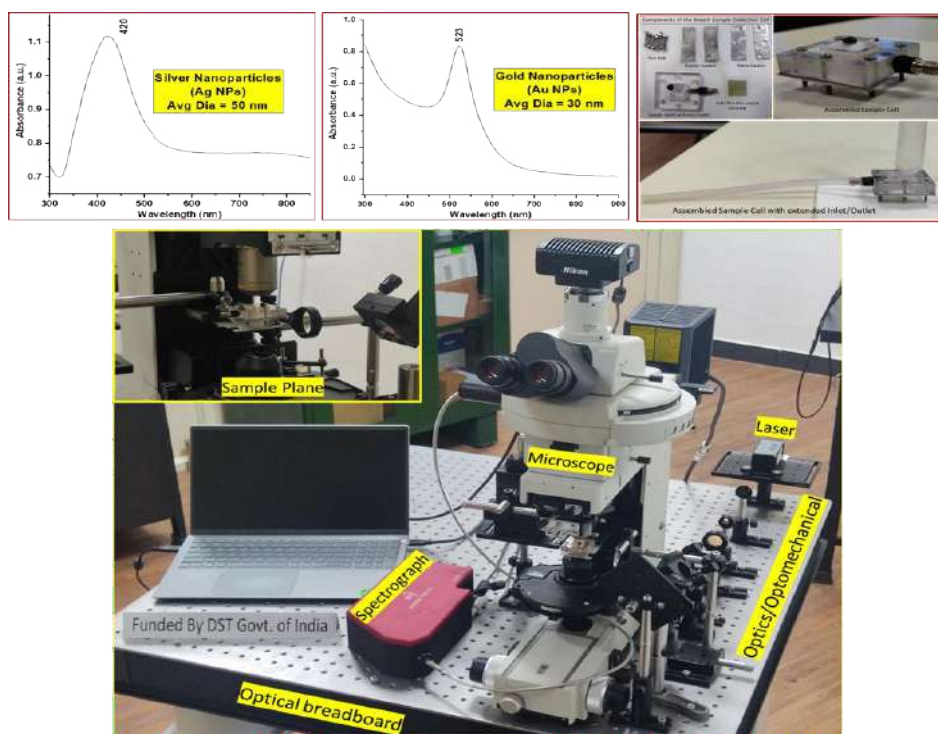


Fig. Development of nutraceutical supplement for diarrheal conditions

● **Portable SERS setup for screening of lung cancer**



Development of a portable Surface-Enhanced Raman Spectroscopy (SERS) setup for screening of lung cancer by breath analysis is under progress. Nanoparticle synthesis, fabrication of sample cells for breath sample collection, design and development of the portable setup for nanoparticle assembly, and subsequent SERS measurements have been achieved. The data for volatile organic compounds (VOCs) in simulated breath

and breath from human volunteers were compared for concentration estimation. The calibrated and standardised setup will be tested in a medical setting to screen high-risk lung cancer patients for identification, monitoring and validation of potential VOCs of lung cancer.

- **Improvement in saffron and rice cultivation practices**

A smart sensor network platform for irrigation scheduling of saffron and rice in Kashmir was developed to monitor the water requirement of these crops through real-time moisture measurement and irrigation scheduling with the help of sensors, data loggers and web-based applications. Irrigating saffron through real-time sensor data at 20% depletion of field capacity increased the saffron yield by 43% compared to conventional practice. Based on the data collected irrigation schedule for saffron was developed, which suggests that the saffron field should be irrigation during the last week of August at the rate of 15 mm of water per application, and the number of irrigations depends upon the moisture stress and the rainfall events. In rice, the sensor-based application resulted in water saving by 25-30%, without any yield compensation. The developed system aims to help the farmers in online monitoring thus reducing the drudgery and the input cost.



Fig. Response of saffron to different irrigation schedule

3.6.3 Technology Interventions for Disabled and Elderly (TIDE)

The Technology Interventions for Disabled and Elderly (TIDE) Programme aims at developing accessible and affordable tools, techniques and technologies for providing inclusiveness and improving the quality of life of *Divyangjan* and Elderly.

Ten new projects were supported during the year 2022-23 for development of various assistive tools and technologies focusing on various disabilities and 15 ongoing project were successfully completed with technologies developed at various stages of field trials, validation, scale up and commercialization etc. More than 30 research papers were published out of the completed and ongoing projects. Approximately 50 students were trained in research and

development activities pertaining to development of various assistive technologies. The projects yielded 5 patents which were published. The details of few significant products are given below.

- Power Assistive Hybrid e-Trike (PAH e-Trike) was designed and developed by CSIR-Central Electronics Engineering Research Institute, Pilani for persons with locomotor (lower limb) disabilities. The PAH e-Trike is more accessible and overcomes the limitations in the traditional tricycles and can be used in different built environments like inclined and sloppy terrains. PAH e-Trike is compact, light weight, low cost with power mobility controller for motor drive, hill assist and has better load-bearing capacity. The hand propelled version confirms to BIS specification IS 8088:2019 and battery operated motorized confirms to BIS specification IS 17154:2019. The bill of materials cost approximately Rs.23,5000/- and the e-Trike, runs 22 km in full charge condition with 24V 18AH battery, which further enhances on hybrid mode. The principal investigator for this research work won the National Award for Best Applied Research/Innovation/Product Development aimed at improving the life of persons with Disabilities given by Hon'ble President on 03rd December 2022 on the eve of International day for the disabled persons.
- 
- Artificial intelligence based non-invasive system for the identification and assessment of children with Autism Spectrum Disorders (ASD) has been developed under a project implemented by VIT University, Chennai and Sri Ramachandra Medical College & Research Institute, Chennai. An objective prominent biomarker for the identification of ASD in children was developed that overcomes the current limitations of assessment of ASD which are subjective, comprises of lengthy questions and checklists, shortage of trained rehabilitation professionals and are subject to observer variability. Current advancements in signal, image processing, machine learning and deep learning techniques were applied for detecting ASD. A wireless EEG cap was developed to acquire the EEG signals from the frontal, occipital, anterior temporal and posterior temporal regions. Developed software analyze the acquired EEG signal to identify the ASD children. Four nonlinear analysis, Two Machine learning models and one deep learning model were developed for the identification and classification of the ASD children using the acquired EEG signal. Also, deep learning model has been developed for the facial expression-based classification of ASD children. The software can be downloaded freely from <https://drive.google.com/drive/folders/1uxfkFaTJxslgg1NdBrIkJRMa2IRLY3xJ?usp=sharing>.

The developed technology has potential to identify the level of ASD, the level of impact of training given by the therapist, early diagnosis of the level of ASD to customize training processes for children with ASD

- Internet of Things (IoT) enabled Remote Vital Information and Surveillance System for Elderly and Disabled Persons were developed in a collaborative project implemented by CSIR-Central Electronics Engineering Research Institute, Pilani and Chitkara University, Punjab. The two different versions viz wearable device for vital parameters monitoring (VARDAAN-1.0) and handheld device for vital parameters monitoring (AROGYA-1.0) measures ECG, Heart rate, Blood Pressure, Blood Sugar, Blood oxygen (SPO₂) and Body Temperature.



Fig. AROGYA-1.0



Fig. VARDAAN-1.0

The data acquired can be stored and the entire systems support bi-directional communication between doctors and patients. The systems sent text message based notifications. The developed product can be used as Personal health analyzer, Primary Health Monitoring Device for Rural & Sub-urban clinics and Health Monitoring Device in Covid-19 Scenarios. The wearable device costs around Rs. 2000/- and the hand-held device costs around Rs. 3000/-. The technology has been transferred to M/s Kavitul Technologies, Vadodra, Gujarat.

- Gait Watch™ (<http://gaitwatch.in/index.html>) was developed under a project “Design and Development of a Wearable Intelligent Navigation Guidance (WING) kit (with a Fall Predictor) for Preventing wandering away and fall in Elderly with Dementia”. The technology of this TRL-9 market ready product for Gait Assessment and Fall Risk Prediction has been transferred to Ms. Agna Inc. for mass production and commercialization. The standalone user friendly wearable device is primarily meant for predicting the fall risk of geriatric population. The device assists a medical practitioner or physiotherapist by measuring the gait metrics like step length, stride length, velocity, cadence, swing phase and stance phase to comprehensively assess and quantify the gait wellness of an individual. The device also notifies the predicted risk categorization to



Fig. Gait Watch™

the caregivers and also support the individuals in rehabilitation stage after spine related injuries, stroke survivors etc. by monitoring their gait posture recovery. Gait Watch™ is a class A device, operating at maximum 3.7V and maximum current of 2A and cleared by Human Ethical Clearance Committee and confirms with wearable device testing standards (EMI/EMC Testing), Specific Absorption Rate (SAR) and biocompatibility. Apart from geriatric application, the device has much significance in Neuro Ortho, Sports Medicine and Rehab clinics. The device now provides medical practitioners objectively measure the spatio temporal kinematics related to walking and addresses several limitations like subjective assessments and costly procedures in Gait Labs

- Personal Assistant System for Alzheimer Patients has been developed by Sri Krishna College of Engineering and Technology, Coimbatore for real time tracking of the Dementia and Alzheimer patients. The personal assistance system integrates both hardware components and application module. The wearable gadget can be worn in the hip as a belt. The mobile and web application is used by the care takers to monitor the users of the wearable device. The smart wearable gadget contains TFT display, ESP32S microcontroller, push button, accelerometer, battery, heart rate sensor, temperature sensor and GSM modules. These sensors are integrated with microcontroller board for data transfer to the server for further processing. In the server, the real time sensing of location is processed to track the activities of the patient. The device also has a buzzer for sending message to the care taker. Web application is developed to support the care taker.



Fig. Wearable Gadget

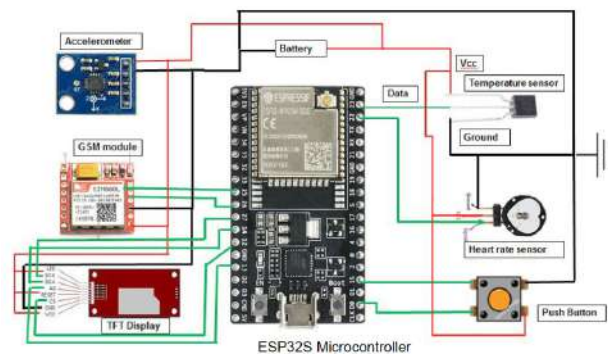


Fig. Electric Circuit

3.6.4 S&T For Women

- **Livelihood opportunities to under privileged specially, reverse migrant women:** A Women Technology Park (WTP) was supported to G.B Pant University of Agriculture & Technology, Uttarakhand for providing livelihood opportunities through establishment of enterprises viz., Spices, Backyard Poultry, Fisheries, European Vegetables, Sugarcane (Juice & Bagasse Brickettes) to underprivileged reverse migrant women of an aspirational



- Skill based training for preparation of superabsorbent of hydro-gel and its assessment in Jaipur, Rajasthan:** Central Institute of Petrochemical Engineering & Technology (CIPET), Jaipur developed skill-based training programs for preparation of superabsorbent of Hydrogel and its assessment in Jaipur, Rajasthan for crop production and economic empowerment of women. Biodegradable and Biocompatible Super Absorbent Polymer (SAP) material has been developed to improve the ability of soil to retain water for a longer period, thus reducing the water demand at arid and semi-arid regions. The material have the potential for 400 times water absorption and is prepared from waste wheat/rice straw cellulose derivative along with added novel topical gel of neem extract. It was tested in accordance with ISO 17088 for improving antibacterial activity and fungal growth inhibition as per the international standards. Three workshops were organized with the participation of 300 women and specific training was imparted in waste management for income generation, value addition of scrap, etc. Plastic Manufacturer Organisations (PMAR) officials are ready to give information on Plastic Waste Management Industry and required resources to women SHGs at various locations in Rajasthan.
- Women Technology Park (WTP) for Capacity Building and Entrepreneurship Development:** A Rural women technology park was supported to CSIR-National Metallurgical Laboratory, Jamshedpur, Jharkhand for capacity building and entrepreneurship development of women. Under this project several training programmes on 'Handmade Paper Making' 'Carpentry & Woodcraft with 3D Design Software', 'Basics of Computer & Graphic Design', and 'Computer, 3D Printing & Product Development' were organized for the women. In these training programs, women had developed thirty-three different types of products from waste paper, wood, and fly ash like paper plate, planter cover, paper bricks, bookmarks, key hanger, coloured paper, wooden earrings, flower pots, etc. More than 100 women have been trained till now.



Fig. Women Participants Making Products from Wood

To address challenges in Arid, Semi-Arid Regions and Cold Desert Regions (ASACODER), DST supported nine projects to provide enhanced livelihood opportunities, nutrition and drudgery reduction leading to better quality-of-life for the communities living in these regions. Some of the significant achievements under the one of the funded projects is as follows:

- Salt quality improvement and value addition in region of Gujarat:** A project was supported to enhance the income and improve the quality of life of salt producers (Agarias) of Halvad region in Little Ran of Kutch, Gujarat. The project implementation agency CSIR-CSMCRl characterised the brine quality and salt produced by locals, diagnosed the challenges related to producing inferior quality salt and assessed the potential of value addition. A running solar salt unit was converted into a model unit for in-house and field training purposes. Fifty *Agarias* were trained to produce high-purity solar salt that enhanced the overall purity of salt from 95 wt % NaCl to 98.5 wt % NaCl to meet the Bureau of Indian Standards (BIS) specifications of Industrial Grade Salt. Apart from salt quality improvement, other activities related to the value addition of bitters, halophyte plantation, and potable water recovery have also been initiated at the project implementation site.



Fig. In-house and field training to marginal salt producer and demonstration of production of industrial grade high purity solar salt through scientific intervention in Halvad, Little Ran of Kutch, Gujarat

- **Post-harvest processing and integrating water harvesting for sustainable production:** In another project supported under ASACODER program, 270 farm families from six blocks in the Jodhpur district were uplifted with the intervention of ten post-harvest processing units developed for women entrepreneurship based on pearl millets and local fruit (*Cucumis melo*) processing. Global Positioning System (GPS) was used to develop 10 customised farm plans integrating water harvesting, solar energy intervention, horticulture, crop cultivation and food processing. A technology integration model based on 21 proven dry land farming technologies was implemented for the sustainable production-processing initiative on fields of all selected farm families. Ten self-help groups (SHG) were created and linked with the National Rural Livelihood Mission (NRLM) and the Food Safety and Standards Authority of India (FSSAI).



TECH-नीव@75 program to commemorate Azadi Ka Amrit Mahotsav

As a part of *Azadi Ka Amrit Mahotsav*, Ministry of Science and Technology (DST, DBT and CSIR) in collaboration with Ministry of Earth Sciences (MoES) launched a programme “**TECH-नीव@75**” on 15th November 2021 and conducted for 75 hrs (3 hrs / day for 25 days) to highlight the impact of Science, Technology and Innovation (STI) in creating social equity and inclusion at societal foundation level (i.e. community). A National level conclave was conducted to conclude the programme on 21st Dec. 2022, wherein glimpses of experience sharing and feedback from community groups in adopting S&T for their livelihood, views of the social change-makers in building S&T capacity at societal level and importance of catalysing cross-bridge collaborations for nurturing the local level STI innovation ecosystem was highlighted to strengthen ‘Vocal for Local’ mission of the Government. Details and recordings of all sessions is available at <https://www.indiascienceandtechnology.gov.in/techneev@75>.

3.7 Scheduled Caste Sub Plan (SCSP) & Tribal Sub Plan (TSP)

The Department of Science and Technology has been implementing two Schemes, viz Tribal Sub Plan (TSP) and Scheduled Castes Sub Plan (SCSP), since 1991-92 and 1992-93 respectively, to empower SC/ST population through the input of Science and Technology. The programs are oriented towards the promotion of research, development & adaptation of S & T for improving the quality of life of SC/ST in rural/urban areas of India. Science for Equity Empowerment and Development (SEED) Division of DST has adopted a scientific approach oriented towards addressing the problems in the livelihood system consisting of Human, Natural, Social, Physical and Financial capital, through the infusion of available technological interventions.

In sync with the UN approach of taking poverty beyond monetary deprivations, a multipronged approach that addresses the issues related to SC/ST communities considering factors of multi-dimensional poverty (MDP) was adopted. Systemic interventions are taken up by creating SC/ST Cells, STI Hubs, individual projects and Community COVID Resilience Resource Centres (CCRRCs). To accomplish the goals, 65 new projects, addressing the issues in livelihood, health, education and standard of living were supported, during FY 2021-22, benefitting more than 50,000 SC/ST people. Some of the accomplishments during the period are given below

3.7.1 Individual Projects under SCSP and TSP

- The jute growing SC farmers in North 24 Parganas district of West Bengal, facing problems due to unavailability of seeds, critical inputs and marketing of perishable products including vegetables were provided with suitable technologies, packages and technical assistance for improved production, value addition and marketing by ICAR-Central Research Institute for Jute and Allied Fibres. Six villages, namely Indrapur, Beraberia Government Colony, Ratanpur of Amdanga block and Hansia, Beliaghata, Basudebpur of Barrackpore-1 block, involving 140 families are now using improved technologies that can be adopted in jute-based cropping sequences to enhance the system profitability. The average production of jute has increased by 9.8%.



Fig. Use of CRUAF inputs for jute retting



Fig. Trainings on Jute handicrafts

- The two fab labs established at, Khargone district in Madhya Pradesh and Palghar district in Maharashtra is training 300 students(including school and college students and artisans) per year from ST community on digital fabrication for decentralised production, sharing designs and local production to make valuable products from locally available material. Students have developed small DIY projects to meet local requirements such as a Water pump ON /OFF controller using mobile, security alarm systems, Height measuring device, Goat weight data logger, Temperature humidity controller for wafers, School bell etc. Fablab Naramdalaya's student sold 450 eco-friendly Diwali lanterns made using a laser cutter during the Diwali holidays. Fablab Plaghar is helping local women's self-help groups to prepare designed stencils required in stitching and embroidery. Fablab Narmadalaya student Shankar Kewat developed a new Solar chilli dryer prototype using Fablab tools, his idea was selected for MSME incubation support for next level of development. Both of these labs are in the process of registering with the Global Fablab Network.



Fig. Fablab at Palghar, Maharashtra



Fig. Students learning in Fablab

- S&T interventions are being carried out in Odisha to build S&T Capacities of 200 tribals to make them master trainers in *Patachitra* an indigenous folk and tribal art of Odisha. The art form is predominant in Puri, Konark and Bhubaneswar, especially in the village of Raghurajpur and the proposed interventions are building the capacities of tribal artisans present elsewhere in the state where the artform is still being practiced (other districts like Balanigir, Boudh, Ganjam, Gajapati, Sonapur etc). The project focuses on introducing new designs (design diversification) through CAD/ CAM technology, and all the existing tools are getting documented for further improvement. Quantitative assessment of physical load on the spine or lumbosacral region leading to musculoskeletal disorders due to prolonged sitting hours are analysed. Ergonomic parameters namely Heart Rate, Energy Expenditure Rate, Total Cardiac Cost of Work, Physiological Cost of Work, and VO2 Max are measured and analysed to propose a better work environment. The different problems existing in the value chain processes of *Patachitra* and Glass Painting viz production, design, skill upgradation, finance and marketing are addressed and a common facility centre has been established which is addressing the problem of raw materials like colors, material for brushes etc

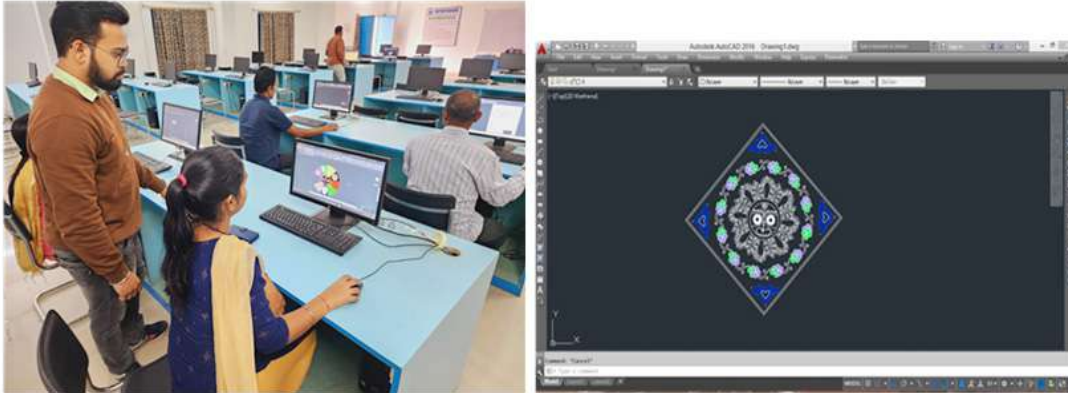


Fig. Training on glass painting using CAD

Fig. CHANDUA design using CAD

- Training was imparted to 220 individuals of Scheduled Caste families from 5 villages (Gangwa, Kaimari, Matersyam, Ludas and Balsamand) of Hisar for skill up gradation regarding feeding, breeding, housing management and disease prevention in pigs. Information from Single Nucleotide Polymorphisms (SNPs) linked to quantitative trait locus (QTL) is being utilised to increase litter size in pigs. The facilities developed under the project cater to the needs of pig farmers by facilitating them in selecting superior germplasm.



Fig. Training on improved rearing practices



Fig. UV Curing Equipment for 3-D Articles



Fig. Curated Walking sticks from Nainpura

The artisans of Nainpura village in Bijnor district Uttar Pradesh, engaged in making wooden walking sticks were facing problems due to (1) inhalation of harmful fumes from organic solvents used for curing the wooden articles and (2) quality issues in finished goods since the coating gets affected in the absence of the Sun during rainy days and winter time. The UV coatings facility introduced by Shriram Institute for Industrial Research is solving both these problems. The state-of-the-art technology on wood coatings by handicraft artisans not only prevent the health hazards caused by solvent-based coatings but also increases the productivity and acceptability of Indian handicrafts in the international market. Trainings are provided to all artisans on the basics of UV curing, making UV coatings, operation of all equipment installed in the UV curing centre and safety aspects of handling all equipment. The facility is helping more than 230 artisans engaged in the trade.

- A master facility / demonstration unit on marine ornamental fishes has been established in the Pitchavaram mangrove forest area located in between the Vellar and Coleroon estuaries (tributaries of river Cauvery) in Tamil Nadu. It is serving as a resource centre for marine ornamental fish seed production and germplasm resource centre for these species. Majority of beneficiaries are traditional fishers with no other additional income source. The fish rearing facilities formed by working group clusters is serving as a sustainable additional livelihood option for the mangrove dwellers/fisherfolk, with additional and regular income, creating employment opportunities, utilizing their own native resources and also helping to improve their socio-economic status through marine ornamental fish sale. Eight different indigenous clown fishes available in Indian water were collected from Gulf of Mannar, Tamil Nadu and Andaman islands and shifted to the hatchery for broodstock development.



Fig. Renovated Hatchery



Fig. Clown fish species in facility

- The Traditional Terracotta and Pottery articles produced by artists in Asharikandi village in Dhubri district of Assam are world famous but the art is labour-intensive and hazardous for health and severely underpaid. The artisans face high degree of drudgery in age-old clay processing and open firing methods. In consultation with local artisan community, NECTAR has introduced technological interventions in (i) Processing of Clay in de-airing Pug Mill (ii) Firing of terracotta wares in wood fired kiln and (iii) Introduction of Jiggar jolly and moulds for Kulhad making. This has not only lessened the drudgery with drastic decrease in processing time from days to few hours but has also increased the productivity with following results:

- Overall efficiency of the production system increased by almost 8 times
- Expenses on clay reduced from Rs. 5,500 per ton to Rs. 4,828 per ton and it can now be used for 7 days
- Improved furnace can be used for 12 months instead of initial 10 months
- Average profit margin is 4.5 times higher for each cluster

39 Beneficiaries are getting training on operation, process and quality control on improved machineries. 156 potter families are getting benefit from 3 Common Facility Centres built under the project.



Fig. Existing manual clay processing vs. use of de-airing pug mill

growbag and Pro-tray techniques are being propagated to improve crop income by yield enhancement. In Jasmine, crop regulation methods, Timely pruning, Pre and post-harvest handling including GAP (Good Agricultural Practices), GMP (Good Management Practices), with the use of crop growth regulators at the time of flowering are fetching more yield and income. The yield of turmeric is getting enhanced by 1-2 times, leading to improvement in Curcuma content up to 5-6 %/ wt, with oleoresin and other volatile oils as post-harvest products. Agricultural waste (floral and fruit tree biomass) are converted into vermicomposting and bio-degradable products to ensure environmental benefits with the extraction of secondary products like Curcumin, Oleoresin oils, Jasmine oils, Floral biomass products etc.

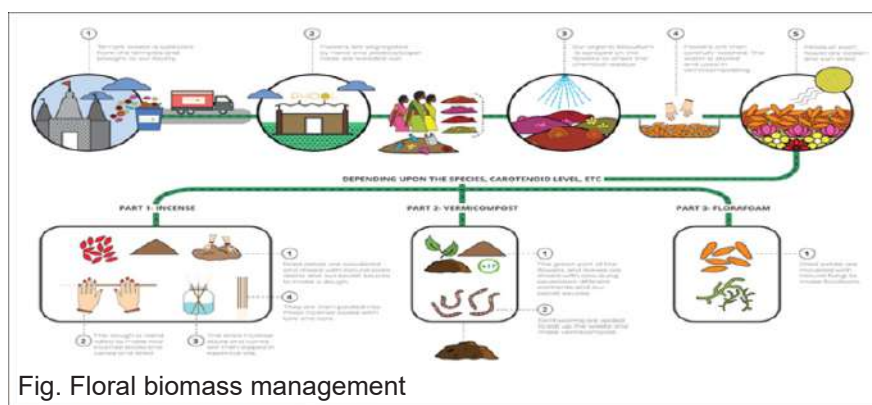


Fig. Floral biomass management

- Science Technology and Innovation Hub at Manthan Narmada Lok-Vigyan Kendra, Dediapada Block, Narmada District, Gujarat State is improving the livelihoods of ST population belonging to Vasava tribe, Kotwalia tribe, Bhagat community and other Farmer communities of Dediapada Block of Narmada District. The project intervenes in (1) Farming Technologies (Innovative tools for Drudgery Reduction, Innovative tools for Better Efficiency, Water & Irrigation Based Technologies, Yield Improvement Techniques, Technologies and Techniques Promoted by Krishi Vigyan Kendra), (2) Herbal Producers Technologies (Processing Technologies, Quality Control Technologies, Packaging Technologies Solar Dryer and Simple Food Processing), (3) Bamboo Craft Technologies (Mechanical Toolsets, Basic Workshop Infrastructure (Display), Drudgery Reduction Technologies, Design Based Technologies) and (4) Design and Innovation (Design Tools, Basic R&D Facilities (Support of Partnering Organizations), Basic Fabrication & Digital Prototyping facilities etc. Awareness and Knowledge Building activities have been carried out for more than 5000 members in the *Dediapada* block, in 57 villages.

The 37 STI Hubs established so far, will collectively benefit more than 50,000 SC/ST Households directly and will develop human resources (approximately 180 personnel) for finding solutions to specific livelihood problems faced by the SC/ST Communities. More than 450 Training and Capacity Building Workshops will be conducted to improve the STI capacities and capabilities of SC/ST communities for resilient and sustainable livelihoods.



Fig. Bamboo Product developed by Kotwalia community with improved tool kit

Scheduled Caste/Scheduled Tribe Cells in State Science and Technology Councils:

The program on the establishment of SC/ST cells in State S&T Councils is ensuring sustainable development of SC/ST Communities through collective cooperation between different stakeholders which includes government functionaries, industry, academia and the society at large. These cells are identifying the weakest linkages between the livelihood system and natural resources endowment of the target area for effective technology delivery mechanisms in areas of sustainable livelihood, better productivity and improved resource conservation. The role of SC/ST Cell is to act as a nodal coordination center and help in mapping of livelihood system for planning of development strategies, identification of technological gaps including mapping of technological needs, formulation of research/demonstration/ projects as well as specific programmes leading to socio-economic development of the community by utilizing local resources and skills of target communities. Four SC/ST Cells have been established during 2021-22 in the states of Karnataka, Telangana, West Bengal and Uttarakhand making it a total of 11 SC/ST cells established so far since 2020-21.

Community COVID Resilience Resource Centres (CCRRCs):

In the wake of the COVID19 pandemic, a new program called CCRRCs was conceived to strengthen community's preparedness, response and approach to future health challenges as well as other uncertainties (including uncertainties in livelihoods) for Resilience, Risk Reduction and Sustainable Development to develop an equitable, sustainable and resilient society through STI based ecosystem. These Centers would help in better recovery, building Science, Technology and Innovation (STI) capacities and capabilities of the communities for improved resilience against the pandemic and post-pandemic recovery for livelihood rejuvenation. During the formulation of the programme itself, it was envisaged that CCRRCs would evolve as Community Resilience Resource Centres (CRRCs) with time to strengthen STI-based resilience of the community in different aspects of livelihood system strengthening, the establishment of social enterprises etc besides the development of strategies for disaster risk reduction for developing sustainable, resilient communities. CRRCs will also address the issues related to multi-dimensional poverty. 26 CRRCs were established during 2021-22 in

Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Manipur, Odisha, Rajasthan, Uttarakhand, Uttar Pradesh and West Bengal. These existing organisational network resources created under SEED Division are being utilised for their establishment and catering for the need of 26,000 stakeholders belonging to various vulnerable community sections.

3.8 National Good Laboratory Practice (GLP)

DST is implementing the National Good Laboratory Practice (GLP) Compliance Monitoring Programme for certification of Indian Test Facilities conducting non-clinical health and environment safety studies on various chemicals, in accordance with the Organization for Economic Co-operation & Development (OECD) Principles of GLP and as per the OECD Test Guidelines. India is full adherent to OECD Council Acts related to Mutual Acceptance of Data (MAD) since March 3, 2011. This facilitates sharing and acceptance of results/data generated in GLP certified Test Facilities among 39 member-countries of the OECD and 7 non-member full adherent countries to MAD, for assessment purpose, thus avoiding the need for duplicative testing and thereby substantially reducing the resources required for testing of chemicals.

To implement the National GLP Program in India, 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 and currently there are **52 GLP certified Test Facilities** in the country including four government laboratories.

Some of the major achievements of the Indian GLP programme during the financial year 2022-23 are as given below:

- **Participating in 36th Meeting of OECD's Working Party on GLP:** Head-NGCMA participated in the 36th Meeting of OECD's Working Party on GLP as a Vice-Chair of the Working Party.
- **On Site Evaluation (OSE) of National Good Laboratory Practices (GLP) Program:** Indian GLP Program was evaluated by a team constituted by OECD Secretariat during 25-29th July, 2022, as part of their laid procedures under MAD. The team apart from physical verification of records and procedures of NGCMA also witnessed the on-site inspection carried out by Indian GLP inspectors at a Test Facility in India. The OECD team provided positive feedback about the implementation of National GLP Program of India and the report of the OSE will be discussed in the upcoming meeting of OECD's Working Party on GLP, to be held during March, 2023.
- **Participation in OECD's training Course for GLP Inspectors:** Head NGCMA participated as faculty and delivered a lecture on "Inspection **Techniques and Behavior**" in the 15th OECD Training course for GLP inspectors organized in Montreal, Canada during October 23-27, 2022.

- **GLP Certification:** During the financial year, 4 new Test Facilities were certified as GLP compliant after thorough inspection and review of their facilities and GLP studies conducted. Further, 16 existing Test Facilities were Re-certified as GLP compliant as per the laid down procedures of NGCMA. Also, a number of surveillance inspections for respective Test Facilities were conducted by the NGCMA, as per procedures of NGCMA.
- **Study Audits on request of Foreign Regulatory Authorities:** A study audit at an Indian Test Facility was conducted by the NGCMA on the request of Swiss Agency for Therapeutic Products (SWISSMEDIC).
- **Training Courses/ Capacity Building Programmes:** To augment capacity building in the area of GLP, NGCMA organized following training programs/workshops during the year:
 - Fifth Training Course for GLP Inspectors during May 23-27, 2022
 - Three Days Training Course for Quality Assurance Personnel of GLP Test Facilities
 - Sensitization Workshops on GLP for Students and Researchers of Amity University, Manesar (Haryana) and ISF College of Pharmacy, Moga (Punjab)



Fig. OSE team from OECD along with representatives of NGCMA, Indian regulatory authorities and Indian GLP inspectors.

3.9 Technical Research Centre (TRC)

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. Five Technical Research Centres (TRCs) were established with a mission to provide techno-legal-commercial and financial support to scientists, entrepreneurs, and business fraternity to achieve translation of research into products and processes for greater economic and societal benefits in 5 DST institution namely, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum; 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 for Science (IACS), Kolkata and S.N. Bose National Centre for Basic Sciences, Kolkata during FY 2015-16.

The TRC programme is translating scientific discoveries and technological inventions into products and services of societal and industrial relevance. TRCs have been instrumental in building R&D translation ecosystem by supporting advancements in technology readiness levels of background R&D capabilities and intellectual properties, streamlining multi-stakeholder involvement (including industry-academia partnership), technology out-licensing, setting-up platforms for start-ups, and strengthening state-of-the-art R&D infrastructure. After completion of first phase TRC are yielding results in second phase with nominal financial support.

The significant achievements made under these TRCs during the year of report are given below:

3.9.1 Technical Research Centre@ IACS-Kolkata

The TRC of IACS has a clear translational goal, based on molecules and materials, to take the research findings to industry for developing technology through PPP mode. The TRC in IACS covers a variety of areas such as preparations of nanomaterials, quantum materials, functional polymers, bio-materials, and manipulations of molecules and materials for medical, environmental and spintronic applications. To facilitate research which are mostly interdisciplinary by nature several advanced instrumental and computational facilities were created. In the immediate future, IACS plans to establish a technology business incubator to support and develop effective technopreneurship and facilitate networking with professional resources for the innovations that have potential for commercial ventures.

Significant Achievements:

- Chips are designed at IACS, based on the principle of electrochemical approach, for the trace level detection of the protein, human serum albumin, in clinical samples.

- Designing functional quantum devices using heterostructures at nano-scale

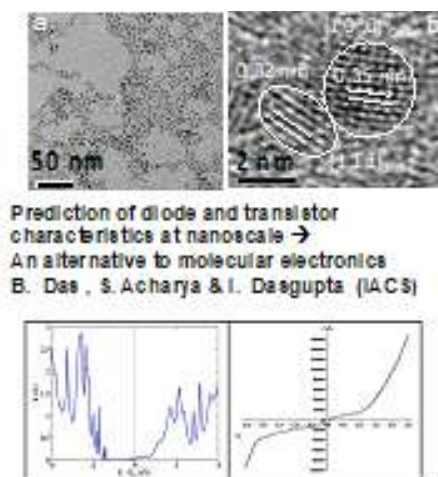


Fig. Coupled Quantum Dots: Interface as a device

- A pro-linamide catalyst has been developed for Cu(I) catalyzed transformations. The catalyst has been used for Ullman type cross coupling and asymmetric aldol reaction, and it has immense potential for commercialization.
- A series of water-soluble iron(II) complexes of polydentate nitrogen donor ligands have been developed, which can degrade poly-halogenated phenolic contaminants in water.

3.9.2 Technical Research Centre@ JNCASR – Bengaluru

The TRC at JNCASR has been instrumental in building R&D translation ecosystem by supporting advancements in technology readiness levels of background R&D capabilities and intellectual properties, streamlining multi-stakeholders involvement (including industry-academia partnerships), technology out-licensing, setting-up platforms for start-ups, and strengthening and sharing state-of-the-art R&D infrastructure.

Significant achievements:

- JNCASR transferred its IP rights on TGR63, a molecule with the potential to effectively treat or prevent Alzheimer's disease, to the Delhi-based pharma company, Hamsa Biopharma. Through its parent firm in the US, IGC Pharma, the company will conduct primate studies and then Phase-I trials involving humans.
- JNCASR has transferred the intellectual property rights of OxyJani to the start-up Rugn Abhilekha, the fifth start-up to be incubated by JNCASR. OxyJani is a robust, mobile group oxygen concentrator that uses sodium zeolites instead of conventional lithium zeolites, thereby avoiding the generation of toxic solid waste. Moreover, sodium zeolites can be manufactured in India, promoting the 'Make in India' initiative.

Commercialization of Technology:

- Technology License Agreement was entered into on 28th March 2022 between JNCASR and M/s. Hamsa Biopharma India Pvt. Ltd, New Delhi, for the development of TGR63, a molecule to effectively treat or prevent Alzheimer's disease.
- JNCASR has signed 2 MoUs; 3 Research Agreements and 2 Consultancy Agreements.

3.9.3 Technical Research Centre@ SCTIMST- Thiruvananthapuram

The Technical Research Centre for Biomedical Devices continued to focus on the development of cardiovascular, neuro-prosthetic, hard tissue (dental, craniofacial and orthopedic), in vitro diagnostic, biological and combinational devices.

Significant Achievements:

- Industrial partner was identified for following product and technology transfer agreement signed.

No	Product / Process	Name of Industry	Date of ToT agreement	Current Status (Transferred/ Commercialised)
1.	Liquid embolization device	M/s. Biorad Medisys, Pune	October 2022	Technology transfer in progress

- Scientist working in SCTIMST won 11th national Petrochemicals Award for their Invention; Metal-free radiopaque polymeric material for the embolization of arteriovenous malformation of the brain.

3.9.4 Technical Research Centre @ SBNCBS, Kolkata

The Technical Research Centre (TRC), funded by Department of Science & Technology, Ministry of Science & Technology, Government of India at S. N. Bose National Centre for Basic Sciences has been launched on 1st January 2016. The aim is to establish an innovation cum translational research centre within the S. N. Bose National Centre that would build harness able science and technology platforms by leveraging on its existing core strength in materials science and spectroscopic techniques.

- Development of Low-cost Non Invasive Medical Diagnostics for capacity building for maternal/child health care & Ulcer detection; Development of Low-cost Sensors for sustainable management of Water & Air for life on land and life below water; Development of Low-cost Sensors to provide food security to households; Development of low-cost instrumentation for the industries and to enhance employment opportunity and High-end computation for the development of technologically Important Indigenous Materials of national need.

- A patent on Digital camera based spectrometric system for point-of-care analysis of ultra-low volume whole blood sample was granted during the repeated period.

List of ongoing consultancy projects/Industrial Partners under TRC:

Sl. No	Particulars of Industrial Partner	Name of the Translational project/ technology	Specific role in Development / commercialization etc.
1	EzRex Health Tech Pvt. Ltd.	A low-cost non-contact AJO device	Taker of the technology for commercialization
2	Sarfez Cure India	Study the effect of additives on decomposition kinetics of hydrates	Industrial collaboration initiated
3	Dundee University, Scotland and EzRex Health Tech Pvt. Ltd (Joint consultancy project)	A screening device (Spec-U-Lesion) for the detection of bladder cancer using spectroscopic techniques	Joint Consultancy project

- The TRC also offers knowledge based services in a number of highly sophisticated instrumentation, ranging from several spectroscopic to microscopic instruments. <http://newweb.bose.res.in/departments/TRC>

3.9.5 Technical Research Centre @ ARCI - Hyderabad

The overall objective of TRC is to build-up technology strengths in the field of Alternative Energy Materials & Systems to reach a maturity level that is necessary for prototype development and demonstration and facilities subsequent technology assimilation by the automotive and energy related industries.

Significant Achievements:

- Lithium titanate (LTO), an electrode material (anode), synthesized by High Energy Attrition milling delivered a capacity of 161 mAh/g, at 0.2C and exhibited capacity retention of >95% after 260 cycles; Carbon coated Lithium Iron Phosphate (C-LFP) cathode material (for Lithium-ion battery applications) was produced in Kilograms by a process developed by ARCI. C-LFP thus produced exhibited a capacity of more than 130 mAh/g at 1C in half cell configuration. Fabricated 18650 Li-ion cells - cylindrical (27 Nos.) and pouch (4 Nos.) using indigenous carbon-coated LiFePO₄ cathode material developed by ARCI at the Li-ion pilot plant facility, IIT Bombay Mumbai. The charge capacity of these cells are comparable to the commercial cells.
- A tab-less 6080-sized Cylindrical Super Battery with the in-house developed LTO anode and LFP cathode materials was fabricated.

- Asymmetric super capacitor was fabricated using a Spent Li-ion battery material and the device was demonstrated in-house, and demonstrated by powering a Polyaniline-WO₃ based electrochromic device.
- E-vehicle (auto-rickshaw), that is powered by Lead acid battery was hybridized with Super-capacitor connected in parallel thus providing it with the additional power required during higher payloads, up-hill drives thereby resulting in enhancement of battery life and mileage per charge. Indigenously, developed a regenerative braking scheme in electric bicycle.
- Perovskite solar cells were fabricated with sputtered metal cathodes. Cells, with both organic and inorganic hole-transporting material (HTM), showed good performance with >10% cell efficiency, which is comparable with the thermally evaporated metal cathode.
- Indigenous perovskite solar-powered road reflector prototype was developed and demonstrated (in-house) for diffused light and outdoor conditions.
- CuMnNiO₄ spinel nanoparticles-based selective absorber coatings by spray technique for solar flat plate collector has been developed with 94% absorptance and 23% emittance.
- Eutectic nanocomposite phase change material (Nano-PCM) , developed by ARCI, showed 23 % enhancement of specific heat capacity as compared to their parent PCM for economic and efficient cold thermal energy storage applications.
- Additive manufacturing of magnetic materials, focused on Nd-Fe-B, is being carried out by using selective laser melting. Different shapes of magnets have been 3 D printed. A prototype drone motor using indigenous Fe-P alloy is being developed in collaboration with Academia.

3.10 National Spatial Data Infrastructure (NSDI)

National Spatial Data Infrastructure (NSDI)'s vision has been to ensure that “current, accurate and organized geospatial data sets are readily and continuously available and accessible on a national, state, district and village level basis to contribute to economic, environmental and social growth of the country”. Five strategic goals set for NSDI include establishing required governance structure, ensuring capture, preservation, and maintenance of both fundamental and non-fundamental data sets; ensuring that the governmental geospatial data sets are readily discovered, appraised, and accessed; ensuring that the geospatial data sets, services, and systems owned by different government agencies are interoperable, and can be combined and reused for multiple times; and providing a coordinating framework for the delivery of the desired product space for its multiple stakeholders.

Towards the above goals, during 2022-23, focus of the NSDI has been on implementation of the Interim Data Sharing Framework (IDSF), operationalisation of the Geo-Information

Science & Engineering (GISE) Hub; strengthening of the National Data Registry (NDR) and individual organisational Data Nodes; establishing the Disaster Recovery (DR)-site for the existing proof-of-concept Geospatial Cloud based Infrastructure (NSDI Geo-platform); maintaining the NSDI Clearinghouse Node as a single window gateway for access to digital geospatial data by the stakeholders; maintaining and establishing State SDIs/ Geoportals in States like Arunachal Pradesh, Andhra Pradesh, Goa, Sikkim, and Telangana; coordinating the development of National and State Level Geospatial Foundation Data and applications; framing and using geospatial data and process standards with the involvement of the Bureau of Indian Standards (BIS) and Open Geospatial Consortium (OGC); and contributing to the formulation and implementation of the National Geospatial Policy.

3.10.1 Interim Data Sharing Framework

On the recommendations of the Geospatial Data Promotion & Development Committee (GDPDC)'s Technological Sub-Committee in June 2022, it has been decided to implement the Interim Data Sharing Framework (IDSF). The Interim Framework is being implemented to expedite effective data sharing to support governance, Industry and Internal Trade pending finalization of the long term approach and operationalisation of adequately workable Data Sharing Portal. Aim of the framework has been to identify and resolve existing problems/ issues in sharing of data with immediate effect to maximise usage of data already captured and available with the Data Providers. By virtue of the IDSF, all data providers need to share their geospatial data and products with authorised recipients through requests by mail or by other similar means without resorting to only portal- or web-based communications. All Ministries, Departments at Central and State Governments, Agencies funded by them, NGOs, Academia, and the Private industry are expected to notify the prices/ charges for sharing the data, their terms & conditions; time line for sharing; and the details of the contact persons in their web site for quick and easy reference by the recipients. Complete metadata regarding the data also have to be made accessible in their portal. Through the IDSF mechanism, data sharing is required to be monitored, reviewed and reported on a monthly basis for possible resolution of any problems/ issues hindering the process of sharing. Some of the initial issues/ problems of data sharing identified and reported during the year include 'no show by end-user', 'non-receipt of payment'; 'request cancellation'; and 'provider in communication with end user for conflict resolution'.

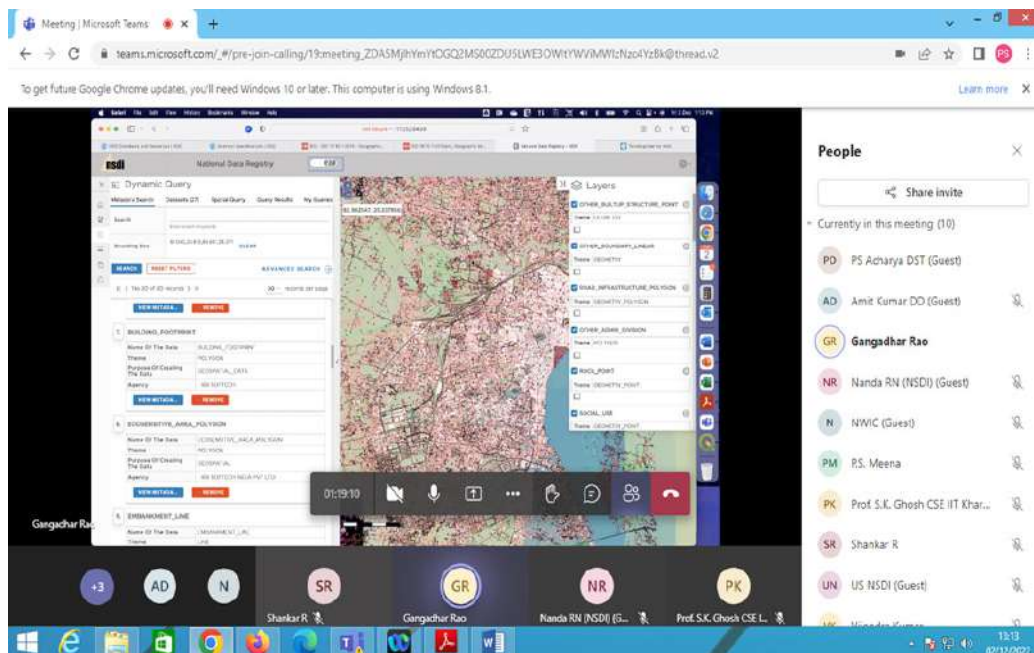
3.10.2 Geo-Information Science & Engineering (GISE) Hub

A Geo-Information Science & Engineering (GISE) Hub has been launched at the Department of Computer Science & Engineering (CSE), Indian Institute of Technology (IIT), Bombay to support the implementation of the NSDI and the State SDIs in a hub-spoke architecture. An Industry-Academia-Government Conclave has been organised on 13-14 June 2022 to explore establishment of the required spokes and identify priorities for application development. A set of 15 projects has been launched with the spokes established initially with the

concerned Departments/ Centres of the Institute in sectors like Agriculture, Water, Health, and Transportation. With the participation of the OGC, a Winter School has been organised at the International Institute of Information Technology Hyderabad (IIITH) on 15-31 December 2022, The Winter School aims at providing the participants a modular hands-on learning experience for OGC standards and technology stacks including APIs and data models.

3.10.3 National Data Registry (NDR)

During the year, the National Data Registry (NDR) - a set of on-line registers developed to facilitate search, discovery, access and utilisation of online interoperable geospatial data resources from various Central/ State level Partnering Agencies and Private Enterprises - has been further strengthened and



(Fig. Varanasi City 1:2000 scale NUIS data layers registered on the National Data Registry Geo-portal and accessed through its Dynamic Query Module)

used. A set of 281 geospatial data sets from multiple agencies have been registered so far along with standards-based geospatial metadata and access URLs. Working of the Registry has been demonstrated to the Government Agencies, Industry & Business, and Academic Institutions through Interaction Meets, Workshops and Conferences. Fresh data services from Central/ State/ UT Agencies and Industry have been registered in the NDR along with metadata. Up-to-date NUIS data layers (1:2000) for Varanasi City prepared under the Geospatial Cloud Platform project of NSDI have been registered unto the NDR.

3.10.4 Geospatial Cloud Platform

The proof-of-concept Geospatial Cloud-based Data Centre (NSDI Geo-platform) established in Survey of India (Hyderabad Campus) for demonstrating management of data life cycles has been further upgraded during the year. Voluminous drone-captured ortho-images and feature data sets of the City have been stored into a proprietary Relational Database Management System along with the Service Publishing Utility for sharing of the data sets as standards-based services for the development of application/ solutions for the stakeholders. QA/ QC of the published data sets has been carried out for further dissemination. A Disaster Recovery (DR) site for the Geo-platform is proposed to be made operational at the National Geospatial Data Centre (NGDC), SOI, Dehradun during the year to ensure high availability of the data services and provision of application/ solution services. Cloud VMs on the platform have been made accessible to the State SDI Teams and the Ministry of Defence for setting up their Geo-Portal Prototypes. The State Geo-portal for West Bengal is currently hosted from the Platform and the data services registered on the NDR.

3.10.5 Partnering Agency Data Nodes

NSDI and State SDI Partnering Agency Data Nodes provide interoperable access to map (display/ visualisation) services. Metadata and Data Services of the geospatial Data Nodes of the NSDI and State SDI Partnering Agency Data Nodes have been maintained in collaboration with the respective Ministries/ Departments and the State Governments for sustained access to their data sets. Data Nodes/ Geoportals for States/ Union Territories (UTs) like Karnataka, Kerala; West Bengal; Uttarakhand; Jharkhand; Haryana; Odisha; NCT of Delhi; Jammu & Kashmir; Madhya Pradesh; Himachal Pradesh; Nagaland; Punjab; Arunachal Pradesh; and Andhra Pradesh have been maintained/ developed for providing standards-based interoperable access to the geospatial data sets of the respective State/ UT Governments. During the year, steps have been taken to launch Geoportals for Goa; Sikkim; and Telangana. The Partnering Agency Data Nodes have been accessible from the single window gateway of the India Geoportal (<https://nsdiclearinghouse.gov.in>) that is evolving as a Data Clearinghouse to support orchestration of Data Services and development of on-line GIS applications.

3.10.6 Application Services

State-wide consistent and seamless high resolution foundation spatial data sets have been identified as the starting point for developing geospatial applications. Based on the recommendations of the State SDI workshops, State Geo-portals are being upgraded and re-oriented to capture and share high resolution foundation data sets over the web for the Line Departments to add their thematic details, attaching attributes; geo-registering their maps; and linking & orienting their results of applications to the local landscapes. It has thus

been recommended by the NSDI Executive Committee to prepare and share through the State Geo-portals foundation data sets in 1:2000 (panchayat level, 2D) and 1:500 (ward level, 2D/3D) scales. Towards coverage of one block and one city/ town each in Arunachal Pradesh and Odisha under the application development initiative, data gaps have been overcome by acquisition of fresh data sets and services registered on the NDR Geo-portal during the year as the first step. GIS applications have been identified in consultation with the local level Line Departments for the study areas dominated by scheduled tribe population for implementation using the registered services for preparation of panchayat and ward level geospatial application services.

3.10.7 Developing and Utilising ISO/ OGC/ BIS Geospatial Standards

A brainstorming on development and utilisation of geospatial data and process standards has been organised on 31.10.2022 with the participation of representatives from Central and State Government Agencies, Academia; and Industry to facilitate automated data sharing and integration of multi-source data. A common set of strategies relating to standards governance, sensitisation/ awareness, inventorying, need assessment, capacity development, more intensive engagement with agencies like ISO/ OGC/ BIS have been recommended.

NSDI has participated in OGC India Forum Meetings organised at DST New Delhi on 14.09.2022 and HICC Hyderabad on 16.11.2022. A group of 26 representatives of different stakeholder communities have participated in the 'OGC Stack' Winter School organised by GISE Hub IIT Bombay at IIIT Hyderabad on 15.12.2022 to 31.12.2022 for getting exposed to the existing and upcoming standards of OGC.

Efforts are afoot to harmonise topographic data models of leading data/ information providing agencies like Survey of India (SOI), National Remote Sensing Centre (NRSC)/ ISRO; Space Application Centre (SAC)/ ISRO; and National Informatics Centre (NIC)/ MeitY; and MoGSGS/ MoD in order to standardise the common topographic data content for adoption by all as a National Standard.

3.10.8 Training and Capacity Building

In order to sensitise end users and experts on the NSDI and State SDI Data Services including the NDR and the Cloud-based Geo-platform, products and services have been demonstrated in events like the Second United Nations World Geospatial Information Congress (UNWGIC) held at HICC Hyderabad on 10-14 October 2022, Indian National Cartographic Association (INCA) International Conference held at Dehradun on 9-11 November 2022; and Geo Smart India 2022 at Hyderabad on 15-17 November 2022. An End User Meet for the NGP-NSDI has been organised on the side-lines of the Geo-Smart India 2022 at Hyderabad on 16-17 November 2022 to deliberate and draw up a national level implementation plan for translating the Integrated Geospatial Information Framework (IGIF) of the Committee of Experts of the United Nations Geospatial Information Management into a reality.

3.10.9 National Geospatial Policy

The draft National Geospatial Policy has been further revised and approved by the Union Cabinet in December 2022. The Policy provides for the establishment of a National Geospatial Data Registry (NGDR) for the registration of data sets/ services to help develop a centrally-coordinated geospatial catalogue. The catalogue is expected to facilitate search, access, delivery and utilisation of standards-based geospatial data and avoid duplication in data acquisition. For easy access to geospatial data/ products/ services/ applications and solutions by efficient processing in a decentralised mode, the Policy provides for establishing a suitable Unified Geospatial Interface (UGI) with the help of a suitable managing technical partner. Interactions have been made with the Potential Industry Partners for working out strategies for increased investment by Industry in the management of data sets on Foundational and the Sectoral Data Themes and bolstering the existing geospatial infrastructures.

3.10.10 Future

Designed to be mounted on the National Geospatial Data Registry (NGDR) and the Unified Geospatial Interface (UGI) as envisioned in the National Geospatial Policy, NSDI is expected to evolve to its next version in the coming years. This evolution seems possible by leveraging the existing outputs covering the distributed network of geo-portals/ databases of the Partnering Central and State Government organisations; a well-knit team of scientists, experts and officials built over the past years; and an innovative group of Private Enterprises/ Start-Ups/ System Integrators powered by the mentorship of leading academic and R&D institutions. With the framing of the required institutional/ legal/ financial arrangements, launch of well-managed data supply chains/ innovations/ standards; and support of partnerships and capacity building initiatives, NSDI appears to have the potential to increasingly migrate in the short term into the UNGGIM's Integrated Geospatial Information Framework (IGIF) and establishment of the Geospatial Knowledge Infrastructure.

3.11 Exhibitions and Fairs

The Exhibition Cell is concerned with the work relating to organizing exhibitions and participation in science exhibitions at national and international level. In addition, it has also been assigned responsibility of coordinating the work of participation of Department of Science & Technology along with its organisations in science exhibitions. The aim of organising exhibitions is to bring awareness among students, scholars and general public about different Government policies, schemes, scientific innovations & milestones in the field of Science & Technology.

The activities of Exhibition Cell, DST during 2022-2023 were as under: -

- 8th edition of India International Science Festival (IISF) – 2022 in association with Ministry of Earth Sciences, Departments of Bio-Technology Scientific & Industrial Research,

Atomic Energy, space along with Vijnana Bharati (VIBHA – an NGO) during 21-24 January 2023 at Bhopal, Madhya Pradesh is being organized.

- Participated in the Pride of India Expo, part of 108th Indian Science Congress during 3-7 January, 2023 at Nagpur, Maharashtra.
- Participated in India International Trade Fair (New Delhi), 9th Indian National Exhibition Cum Fair (Kolkata), 25th National Science Exhibition (Kolkata), Rise in UP (Gaziabad), STREE 2020 Conference & Expo (JNU, New Delhi), Gramodaya Mela (Chitrakoot, MP).
- The Cell also coordinated with subordinate offices and autonomous institutions working under the Department for participation in a number of activities.



Fig. DST pavilion at India International Trade Fair 2022 at Pragati Maidan, New Delhi

NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)

Department of Science & Technology (DST) is implementing the National Mission on Interdisciplinary Cyber Physical Systems (NMICPS) since April 2019, at a total outlay of Rs 3660 Crores for a period of five years. Under the mission, 25 Technology Innovation Hubs (TIHs) have been established in reputed institutes across the country. Each hub is a Section-8 Company, an independent entity within the Host Institute and has been assigned a Technology Vertical in the areas of advanced technologies which includes: Artificial Intelligence and Machine Learning, Technologies for Internet of Things & Internet of Everything, Data Banks & Data Services, Data Analysis, Robotics & Autonomous Systems, etc.

The Mission aims at development of technology platforms to carry out R&D, Translational Research, Product Development, Incubating & Supporting Start-ups as well as Commercialization. The Mission is being implemented with all the TIHs undertaking activities under the four major categories i.e., 1. Technology Development 2. Entrepreneurship Development 3. Human Resource Development 4. International Collaborations.

Mission Office, NM-ICPS has organized a two-day Workshop on Technology Innovation in Cyber Physical System (TIPS) during 6th & 7th May, 2022 at IITM, Chennai in face-to-face (physical) mode, to monitor and review the physical achievements as well as financial performances of each Technology Innovation Hub (TIH). The Workshop was attended by all the TIHs, the members of Mission Governing Board (MGB) and Scientific Advisory Committee (SAC). As per the recommendations of Workshop on TIPS, a physical visit to all the TIHs has been conducted to review their physical and financial targets.

A few of the major achievements and technologies developed by these TIHs are as under:

- IHUB NTIHAC Foundation (C3iHub) at IIT Kanpur is working in the Technology Vertical “Cyber Security and Cyber Security for Physical Infrastructure”:
- a) The hub has installed the first Security Operations Centre (SoC) based fully on open-source components and integration, C3iVazra, at National Highways Authority of India (NHAI) headquarters. Major benefits of SoC are increased efficiency, reduced potential security threats, reduced



Fig. SoC C3iVazra installed at NHAI

impact of security breaches, improved reporting and notification, and log analysis & retention.

- b) Developed a self-sovereign identity (SSI) system based on blockchain technology. It allows users to have complete control over where and how their personal data may be used. The technology is useful for securely storing a wide range of personal information, such as degrees, certificates, and identity proofs.
- TIH Foundation for IoT and IoE at IIT Bombay is working in the Technology Vertical “Technologies for Internet of Things & Internet of Everything”: Major technologies developed by the hub include:
 - a) **EAgriS - A multichannel indigenous energy-autonomous integrated station with mobile App** which aims to establish a decision support system for the farmer which can predict possible weather changes, pest attacks, diseases and support the farmers with critical decisions related to required measures.



Fig. Picture of the EAgriS – App.

- b) **AYUR-CoVCARE : A *first-of-its-kind*** integrative and data-driven Ayurveda COVID care app for effective COVID treatment and monitoring and an AI-based recommendation engine for effective management.
- IIIT-H Data I-Hub Foundation at IIIT Hyderabad is working in Technology Vertical “Data Banks & Data Services, Data Analysis”: The hub has developed following major technologies.
 - a) **UAV-based Visual Remote Sensing for Automated Building Inspection:** Unmanned Aerial Vehicles (UAVs) mounted with cameras have the potential for executing contactless, rapid and automated inspection. These UAVs can also monitor civil structures apart from contributing to remote data acquisition.

- b) **AI-enabled Oral Cancer screening solution:** An AI based solution that could screen oral cavity images taken by smart phone cameras by trained health professionals, and flag them as malignant or benign and raise an alert immediately.
- I-HUB for Robotics and Autonomous Systems Innovation Foundation at IISc Bangalore is working in the Technology Vertical “Robotics & Autonomous Systems”:

The hub has hosted the Innovation Summit 2022: “Connecting the Unconnected” which was organised as a confluence of industry, academia and the government to facilitate more purpose-driven conversations to enable the bigger vision to become a reality in the coming years.

- AI4ICPS I-Hub Foundation at IIT Kharagpur is working in the Technology Vertical “Artificial Intelligence and Machine Learning”: The Hub has indigenously developed an AI based Autonomous Driving Agent, a resilient self-driving car which uses deep neural networks and vision based perception for controlling and navigation. The car detects and distinguishes traffic signs, based on which motion is determined. The AI model is tested in various environmental settings and is observed to be robust.
 - IHUB DRISHTI FOUNDATION at IIT Jodhpur is working in the Technology Vertical “Computer Vision, Augmented and Virtual Reality”. Major achievements of the hub are as follows.
- a) **Development of Campus Rakshak as a Service (CRaaS),** a safety assurance solution for Academic Institutes to manage their campuses during the pandemic and transition smoothly from the online/hybrid mode to fully physical mode.
- b) **Digitisation and Gamification of Indian Heritage Sites:**
- (i) Five Rajasthan Govt. museums at the cities of Alwar, Chittorgarh, Baran, Bundi, and Bharatpur in Rajasthan are digitised and uploaded to the Rajasthan Government server(<https://digitalmuseum.rajasthan.gov.in/>).
 - (ii) **Gamification of ASI Vадnagar Site :** A 2D side-scrolling single-player platformer game with three game levels for the Vадnagar excavation site of the ASI has been developed. The concept of the game is to tell stories about the rich heritage of the Vадnagar site.



Fig. (a) Digitized version of museum (b) A snapshot from the game developed for ASI Vадnagar site

- Divyasampark iHub Roorkee for Devices Material and Technology Foundation at IIT Roorkee is working in the Technology Vertical “ Device Technology and Materials”: A GIS & AI enabled software named SYENAH Software has been developed for detailed surveillance of Border & Critical areas.
- IIT PATNA VISHLESAN I-HUB FOUNDATION at IIT Patna is working in the Technology Vertical “Speech, Video & Text Analytics”: The hub has supported Portable Power Technology products and has manufactured first indigenous battery management System with zero components from foreign countries. The hub has also developed a technology to detect a large number of vulnerabilities including Default and Weak Passwords, Guest Access, Exposure to Man in the middle attacks, Stream Hijacking etc.
- IITM Pravartak Technologies Foundation at IIT Madras is working in the Technology Vertical “Sensors, Networking, Actuators & Controls”:

Under **Skill development** activities, IITM Pravartak has setup **PRAVARTAK KALVI SHAKTHI RURAL INTERACTION CENTRES** which focuses on bringing the best teachers to rural students through technology and **PRAVARTAK ASHA RURAL TECHNOLOGY CENTRES** which aims to spread the knowledge of technology and the benefits that come from it to rural areas of Tamil Nadu. The hub has also developed the following technologies:



Fig. Pictures showing outreach activities undertaken by IITM Pravartak Technologies Foundation.

- Portable and Disposable Ureteroscopy System:** Ureteroscope is the equipment used for the examination of the interior of the urethra, bladder, and ureters, and has a small camera at the end of a rigid or flexible probe. Ureteroscopy is widely used to address kidney stones.
- Advanced Human Performance Monitoring System:** This sensor-based hardware and software system is used to monitor energy expenditure, emotional stress & sleep quality and derive actionable insights from them to implement training and lifestyle modifications. These are fundamental for athletes’ performance improvement and individuals’ personal well-being.
- Distributed Acoustic Sensing based on Coherent Optical Time Domain Reflectometry:** Distributed Acoustic Sensing (DAS) is based on Coherent Optical Time

Domain Reflectometry (COTDR). DAS can be used to obtain full information on vibration; this includes the amplitude, the frequency and the phase. Each point along the fiber is considered a scatterer which reflects the incoming signal. This can be used for sensing.

- d) **Comprehensive Anterior Segment Screening Device for Large Scale Eye Screening:** This is a sensor device to investigate anomalies in the anterior segment of the eye. The designed device aims at having the three basic qualities – (1) small and lightweight, (2) easy to understand and operate and (3) cost-effective
- e) **Human Motion Capture Platform:** This Motion capturing bio mechanic system that uses sensors and actuators is used to capture spatiotemporal measures of stride length, stride rate, contact time, swing time and angular kinematic measures of angle in joints. Such measures are commonly used in disease/condition diagnosis, injury prevention, and sports performance analysis.
- f) **Cyber-physical system for a machine tool spindle with variable preload technology:** Preloading a spindle controls its stiffness, rotational accuracy, heat generation and life of the spindle, which in turn controls the stable process parameters of the machine tool. Variable preload mechanism allows the machine tool manufacturers to change the preload value of the spindle according to the requirements by the controller. The variable preload mechanism has been achieved by introducing different actuators in spindle design.
- NMICPS Technology Innovation Hub on Autonomous Navigation Foundation (TiHAN) at IIT Hyderabad is working in the Technology Vertical “Autonomous Navigation & Data Acquisition systems”. The achievements of the hub are as follows:
 - TiHAN Testbed on Autonomous Navigation (Aerial & Terrestrial) at IITH Campus:** It is a first-of-its-kind state-of-the-art testbed for Autonomous Navigation (Aerial/Terrestrial) developed after thorough validation before going for a real-field deployment. Facilities include – Proving Grounds, Test tracks, Mechanical integration facilities like Hangers, Ground control stations, State of the art Simulation tools (SIL, MIL, HIL, VIL), Test tracks/circuits, Road Infra – Smart Poles, signalized & unsignalized Intersections, Environment Emulators like Rainfall Simulators, V2X Communications, Drone Runways & Landing area, Control Test centers, etc.



Fig. Picture showing TiHAN Testbed on Autonomous Navigation

- b) **Autonomous Navigating Humanoid:** It is a SLAM and Map-based Autonomous Navigation Humanoid. A Hindi Text to speech synthesizer is developed using a deep learning-based tacotron 2 model. A speaker recognition system is developed using GMM technique.
- I-DAPT-HUB Foundation at IIT BHU is working in the Technology Vertical “Data Analytics & Predictive Technologies”: Major achievements of the Hub are as follows:
 - a) **Global Online Certification Course on Data-Driven Supply Chain Transformation 2022:** This course focused on Supply Chain Trends, Supply Chain Competency, Machine Learning Based Technology, and Digital Supply Chain Transformation. This course was open for academic and business people globally and received a huge response from academia and industries. In total, 1701 registered participants attended this course.
 - b) A demonstrable prototype of a real-time onboard vehicular exhaust gas monitoring system has been developed by the hub, which uses the signature pattern analysis of the volatile organic compounds (VOCs) through application of Artificial Intelligence (AI) based algorithms.
 - c) A 2.5 kW solar-integrated **IoT based smart grid** is being implemented at the library building of IIT BHU. The planned smart grid will have IoT-enabled technologies with which devices can be controlled remotely. A new type of converter topology has been developed that can take power from solar PV and give three simultaneous outputs i.e. 1) 230V, 50 Hz AC, 2) 90 V dc, and 3) 5V DC. With this smart grid Laptop, a mobile phone battery can be charged directly without local adapters.
- IIT Guwahati Technology Innovation and Development Foundation at IIT Guwahati is working in Technology Vertical “Technologies for Underwater Exploration”: Hub has developed mortar that can sustain underwater and harden like on-ground. This technology can be applied to the underwater repair of concrete structures and coral reefs. Also, several types of ROVs are being developed for different applications, and a few will require underwater vision. Underwater ROVs developed at the hub will also assist in several manufacturing-related activities, such as underwater welding by using Metal Inert Gas (MIG) welding system that can be retrofitted with an ROV and automatically perform the underwater repair work of metal joining.
- IIT Mandi IHub and HCI Foundation at IIT Mandi working in the Technology Vertical “Human Computer Interaction”: A startup supported by the hub has developed a Smart yoga mat integrated with hardware and software systems for preventive healthcare and fostering rehabilitation based on Human Computer Interaction (HCI) and using deep learning and advanced computer vision models. The hub has also developed a social robot in the area of conversational AI to address the pre-screening of mental health.

- I-Hub Foundation for Cobotics (IHFC) at IIT Delhi is working in Technology Vertical “Cobotics”: Some of the technologies developed by the hub are as follows:
 - a) **Drone Swarming:** The contributions of the startup, Botlab Dynamics, Delhi involves a combination of drones programmed to fly in 3D space to make identifiable 3D forms. An animation is created as part of a Drone Light Show for the client. This technology provides an eco-friendly substitute for fireworks.
 - b) **Inverted Pendulum:** Developed in Research and Entrepreneurship Development for You (READY) Project, comprises of an inverted pendulum as a robotic sub-system incorporating an advanced control algorithm. It is unique and indigenously developed for controlled experiments in research and laboratory teaching. Applications include self-balancing vehicles and stabilized landing.
 - c) **Cost-effective EMG-controlled prosthetic hand:** The developed prosthetic hand would be useful for upper limb amputees during daily living activities, specifically for multiple grasp patterns.
 - d) **Tele Observance Tele Operation (TOTO) Robot (by Start-up from READY Program):** A platform with autonomous navigation, obstacle avoidance and self-docking capabilities. The USP of TOTO is that it can be controlled over the internet from anywhere in the world. Applications of TOTO include working as an assistant robot and a tele observance robot.
- IIT Ropar Technology and Innovation Foundation at IIT Ropar is working in the Technology Vertical “Technologies for Agriculture & Water”: Some of the salient technologies & technology products developed by the hub in its domain are as follows:
 - a) **Digital Entomologist (Biodiversity Sensor):** The first 24-7 biodiversity monitoring technology to accelerate biodiversity restoration efforts across the planet. The technology detects and identifies most moving species with incredible accuracy. It will help meet an urgent need to generate in-the-field time series biodiversity measurement data globally.



Fig. Picture of Digital Entomologist (Biodiversity sensor)

- b) **MoohSense 1.0 (Livestock Tracker):** It monitors livestock/cow movements to accurately detect heat-related activity, rumination, resting, and feeding behaviour. This IoT-based cyber-physical system improves farm efficiency and profitability by reducing the labor requirement at the farm, improving livestock reproductive performance, thus minimizing losses due to missed heats, undiagnosed illnesses, and general animal health.
- Technology Innovation in Exploration & Mining Foundation at IIT (ISM) Dhanbad is working in the Technology Vertical “Technologies for Mining”: Some of the salient achievements of the hub are as follows:
 - a) **Sandvik Mine Automation Learning Center (SMAC):** Hub has launched a dedicated Center to keep the Mining sector with Future - Industry Ready.
 - b) **MoU with Curtin University, Australia:** The alliance is for carrying out CPS-based research & development activities on the mining domain at par with international standards, participating in international projects & advanced facilities to expand their relations and its incubatees on a global level fulfilling the vision of both institutions.
- IIT Palakkad Technology Ihub Foundation at IIT Palakkad is working in the Technology Vertical “Intelligent Collaborative Systems”: The achievement of the hub are as follows:
 - a) **Metaverse platform:** Developed for physical therapy rehabilitation which allows patients and doctors to interact in a virtual, 3D environment as avatars powered by the Unity game engine.
 - b) **Skill development:** To uplift the skillset of women in the society, contributing to women’s empowerment and their journey to being financially stable, implementing Rural I-trend centre (Ri-TREND) in Attapadi.
- IIITB Comet Foundation at IIIT Bangalore is working in the Technology Vertical “Advanced Communication System” : Hub is focused on developing indigenous 5G sub-systems and on influencing standards to address India specific use cases in 5G and beyond. Hub is working on the following technologies:
 - a) **5G O-RAN Base Station:** To develop world-class 5G massive MIMO base station, leveraging Open RAN, with capacity to simultaneously support a large number of users and services.
 - b) **Reconfigurable Intelligent Surfaces (RIS):** To create smart radio environments (SREs) by introducing controllable reflectors that are configured for intended wireless transmissions. These SREs can improve the performance of 5G and Beyond networks.
- BITS BioCYTiH Foundation at BITS Pilani is working in Technology Vertical of Bio-CPS: Some of the salient technologies developed by the hub are:

a) **Design and development of a portable Bio-Cyber Physical System based microfluidic cell culture platform:**

The technology developed is a standalone and integrated Lab-On-Chip (LoC) microfluidics-based system for cell and tissue culture studies.

b) **Technology for detection and analysis of Aflatoxin M1 in milk and milk products:**
It is a low cost and ultrasensitive biosensing device for detection of AFM1 in milk. (class 1 carcinogen).

- IDEAS-Institute of Data Engineering, Analytics and Science Foundation at ISI Kolkata is working in the technology vertical “Data Science, Big Data Analytics and Data curation etc.” ∴ The TIH is involved in analysing the Big Data (BD) through CPS, video, IoT, Sensor data, with the help of Data Science. The hub has developed a Vehicle speed detection and number plate recognition system and techniques for anomaly detection in streaming environment.
- IITI Drishti CPS Foundation at IIT Indore is working in Technology Vertical “System Simulation, Modelling & Visualization”: Hub works on research and development of several technologies aimed at assisting the digitization of micro, small, and medium-sized enterprises (MSMEs). Tools like the Cloud-based Process Simulation tool, the Cloud-based end to end traceability tool- TracExpert, and the Digital Twin for real-time shop floor decision support system have been created under the Hub.
- IHUB Anubhuti-IIITD Foundation at IIIT Delhi is working in the Technology Vertical “Cognitive Computing & Social Censing”: iHub-Anubhuti in collaboration with IIT-Delhi is in the process to set up a Medical Cobotics Center (MCC) with common goals of enhancing the research and development capabilities in medical technologies. It also aims to establish a training, research and development centre-MCC to act as a multi-purpose facility for enhancing the research and development capabilities in technologies associated with Cognitive Computing and Social Sensing (CCSS) and Robotics.
- I-Hub Quantum Technology Foundation at IISER Pune is working in the Technology Vertical “Quantum Technologies”. Some of the salient technologies developed by hub are as follows:

a) **Technology demonstration of Atom-Interferometry based absolute gravimeter:** It is a device to measure local acceleration due to gravity – the value of ‘g’. High precision measurements of gravity using a gravimeter has enormous applications in geology, hydrology, civil engineering, strategic applications etc. A technology demonstration of gravimetry using ultracold atoms of Rb in the BEC state has been done.

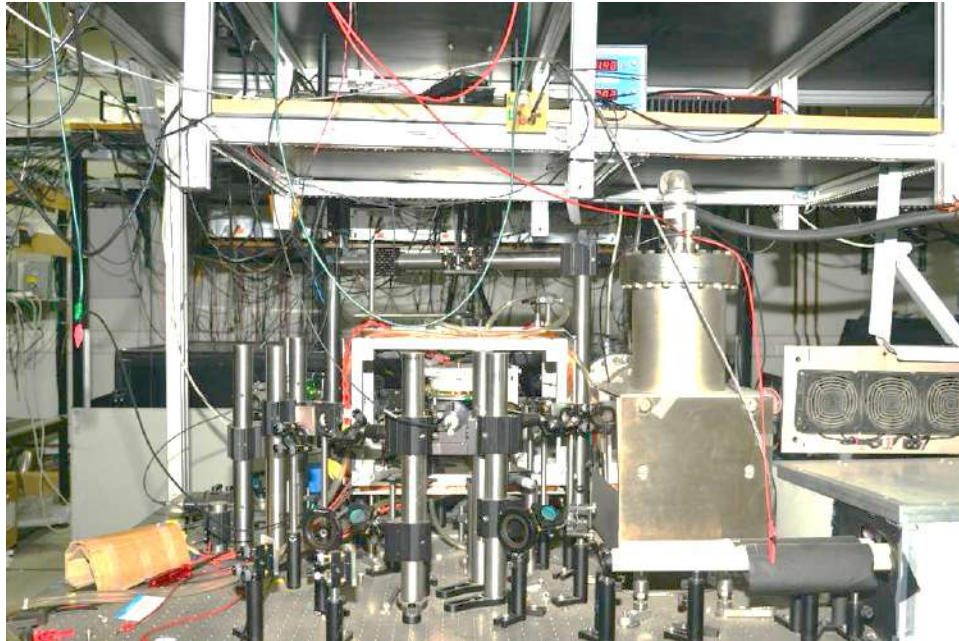


Fig. Experimental system that measures 'g' with high precision

- b) **Demonstration of a transportable cold atoms system for quantum simulators:** This system has been developed by the first start-up of I-HUB QTF – The GDQlabsPvt. Ltd. This will emerge into a cold atoms based Analog Quantum Computer (Quantum Simulator), where an array of about >200 atoms will be used as qubits.

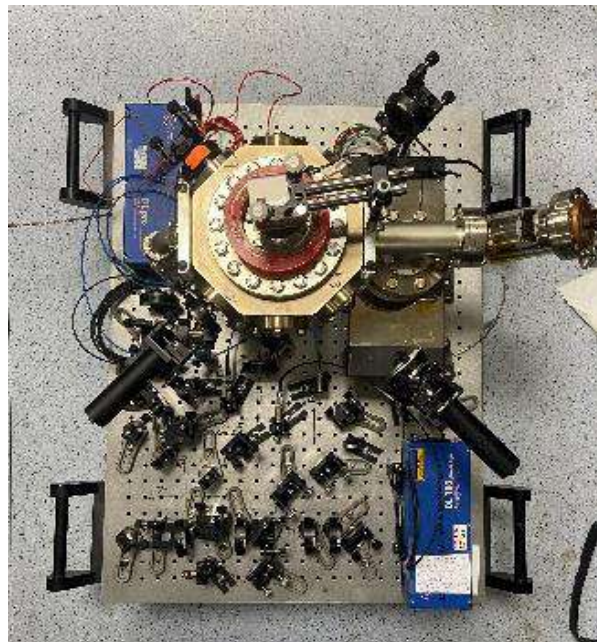


Fig. A picture showing transportable cold atoms system for quantum simulators

- IIT Tirupati Navavishkar I-Hub Foundation at IIT Tirupati working in the Technology Vertical “Positioning and Precision Technologies”: The hub has developed Web and Smart Phone-based Platform using AI and satellite data to Geo-enable Villages for Crop Health Monitoring. It has also developed a Sensor-based Soil Property Map and Targeted Nutrient Delivery System for Precision Agriculture which will facilitate on-the-go soil property sensing such as soil pH, soil moisture, soil N content.
- IIT Bhilai Innovation and Technology Foundation at IIT Bhilai is working in the Technology Vertical “Technologies for Financial Sector (Fintech)”: The Hub has developed a Blockchain and Machine Learning Powered Unified Video KYC Framework leveraging blockchain technology to establish mutual trust, an audio-visual conversational bot and machine learning driven methods for face spoofing detection, face biometrics, voice biometrics. All the security and privacy requirements are incorporated as per RBI guidelines.

AUTONOMOUS INSTITUTES

The Department of Science and Technology nurtures 25 Autonomous Bodies (ABs). These include 16 research institutions, 4 specialized knowledge and S&T service organizations and 5 professional bodies. These institutions, with long and cherished 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:

5.1 Maharashtra Association for the Cultivation of Science (MACS)-Agharkar Research Institute (ARI), Pune.

The institute's research is focused on Biodiversity & Palaeobiology; Bioenergy; Bioprospecting; Developmental Biology; Genetics & Plant Breeding; Nanobioscience.

Major Accomplishments:

- A new bread wheat variety **MACS 6768 (MACS SAKAS)** was notified for the timely sown irrigated condition of Central Zone of India. It is a bio-fortified wheat variety having better nutritional quality (Protein 12%, zinc content 45.1 ppm and iron content 41.2 ppm). It showed average yield of 56.6 q/ha with resistance to black and brown rust.
- A new durum wheat variety **MACS 4100 (MACS JEJURI)** was notified for the timely sown irrigated condition of Peninsular Zone of India. It showed average yield of 45.08 q/ha with resistance to black and brown rust. The variety showed excellent pasta-making potential, hence could be a good candidate for the pasta industry.
- A novel bacteriophage based biological process to control of SRB mediated H₂S production and reservoir souring was successfully demonstrated with the help of prototype. The process was developed in collaboration with, and transferred to ONGC energy Centre for the applications in ONGC owned field.



Fig. Wheat Variety



Important Highlights of Major Programmes:

- ARI scientist developed and maintained a unique collection of methanotrophs (bacteria oxidizing methane) isolated from rice fields and wetland habitats. These cultures are used for applications such as mitigation of greenhouse gas (methane); plant growth promotion, methane valorization, etc.
- ARI scientists documented diversity associated with niche habitats and reported novel species of anaerobic fungi, *Actinomyces ruminis* sp. nov.
- Species-environment correlation between the aquatic flora of rock pools from the Western Ghats was studied. A new rare type of Low-Level Basalt Mesa in the Western Ghats of India was discovered. Diatoms associated with tree moss were studied from the Blue Mountain, Mizoram.
- Natural product based Phenanthridinone-conjugates' ROS generation ability was confirmed with luminol and dihydroethidium assay.
- Three books on lichen species were published. A catalogue of grape germplasm collection was published.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	27
2.	Books/ Chapters in Books	4
3.	Number of Ph.Ds. produced	7
4.	Indian Patents granted	1
5.	Research Manpower trained (other than Ph.Ds)	2
6.	Technical Manpower trained	1

5.2 Aryabhata Research Institute of Observational Sciences (ARIES), Nainital

The Institute focuses research in the areas of Astronomy, Astrophysics and Atmospheric Sciences. The Institute operates a suite of optical telescopes and advanced instruments to study the Earth's atmosphere, Sun, Planets, Stars and Galaxies. Research at ARIES is being carried out on a variety of astrophysical sources in Galactic and Extragalactic astronomy covering both observational and theoretical aspects. The research in solar physics concentrates on the observations and modelling of transient phenomena, space weather phenomena and magneto-hydrodynamic waves in the solar atmosphere. In Atmospheric Sciences, research is focused on the lower atmospheric processes that are governing the air pollution and climate changes. Modelling and satellite data analyses are also carried out to understand the chemical, physical and dynamical processes in the atmosphere.

Major Accomplishments:

- 4m International Liquid Mirror Telescope (ILMT) received first light in May, 2022. After first light, 4.0m International Liquid Mirror Telescope (ILMT) is being prepared for science observations.
- Golden Jubilee of 104cm Sampurnanand Telescope (ST) was celebrated with a 3 day workshop.
- Extensive campaign mode and coordinated observations using ARIES Stratosphere Troposphere Radar (ASTRAD) and other similar radars in the country were performed.
- The primary mirror of 3.6m Devasthal Optical Telescope (DOT) was recoated to improve its reflectivity.



Fig. (Color composite first light image of a small portion of the sky observed with the ILMT through the g, r and i Sloan filters. NGC 4274 Galaxy can be seen in the top right corner.)

Important Highlights of Major Programmes:

- Observations of stellar occultation by Pluto from telescopes at ARIES showed that Pluto's atmospheric evolution is in plateau phase since 2015.
- A new episodically accreting young star belonging to an extremely rare class of sources was discovered.
- Radiative effects of water vapour at high-altitude Himalayan sites were investigated, highlighting the importance of such effects in the climate-sensitive Himalayan region.
- A new technique was developed to reveal the dynamic structures in the solar corona in coronagraph images as well as do much faster processing of the images.
- A novel theoretical model was developed to quantify the in homogeneities in the density structure generated by the magneto-hydrodynamic (MHD) turbulence in the solar corona.

- The evolution of a peculiar type Ibn supernova SN 2019wep was studied, revealing features of Hydrogen and Helium residual from the supernova simultaneously, suggesting that the progenitor star may be a Luminous Blue Variable (LBV) star transitioning to the Wolf-Rayet phase.
- A binary super massive black hole was discovered in a system which will be a strong candidate for future detection of gravitational waves (GWs).
- A possible acceleration mechanism for relativistic astrophysical jets was suggested using numerical simulation techniques.
- The mysterious circles of radio emission detected in space were suggested to be coming from supernova explosions or massive black holes.
- Surprising rapid oscillations of brightness, termed quasi-periodic oscillations (QPOs), were detected in a blazar jet rich in gamma rays. These oscillations have been attributed to twists in the magnetic field in the jet.
- Photometric observations taken with the 3.6m Devasthal Optical Telescope helped detect unexpected kilonova emission from a long-duration gamma-ray burst.

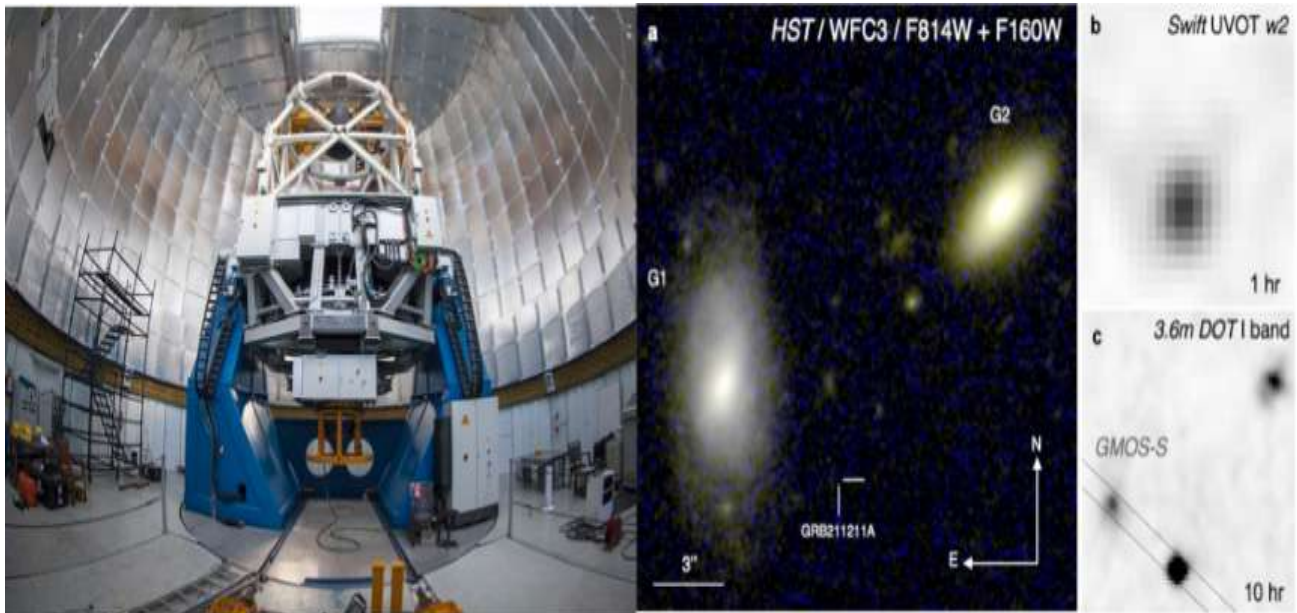


Fig. (3.6-meter Devasthal Optical Telescope detected unexpected kilonova emission from a long-duration gamma-ray burst)

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	116
2.	Number of Ph.Ds. produced	5
3.	Research Manpower trained (other than Ph.Ds)	45
4.	Technical Manpower trained	20
5.	M.Tech/M.Sc./M.Phil projects guided	25
6.	Scientific Lectures/Training Programmes organized	49
7.	National Conferences Organized	5
8.	Scientific Outreach Programmes organized	20
9.	Number of persons who attended various science outreach programmes/conferences etc.	11500

5.3 Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow

The institute carries out research on fundamental as well as applied aspects of Palaeosciences that includes Evolutionary history of biota, Paleoclimate, studies of past Civilization, Human history and contemporary climate change issues, following an integrated and multi-disciplinary approach. Key research activities are: Understanding origin and evolution of life through time and space; Understanding climate change in recent and deep geological times; Understanding past civilization and human history; Application of Palaeosciences in exploration of fossil fuel.

Major Accomplishments:

Some of the research output of BSIP are as follows:

- Southeast Asian Dipterocarp origin and diversification driven by Africa-India floristic interchange.
- Luminescence dating of late Pleistocene glacial and glacio-fluvial sediments in the Central Himalaya, India.
- Increasing incidence of droughts since later part of little ice age over North-Western Himalaya, India.
- Conifer-mixed tropical rainforest in the Indian Paleogene: New evidences from terpenoid signatures.
- Birnessite-clay mineral couple in the rock varnish: a nature's electrocatalyst.
- Abrupt changes in the southwest monsoon during Mid-Late Holocene in the western Bay of Bengal.

- Maturation study of vitrinite in carbonaceous shales and coals: Insights from hydrous pyrolysis.
- Oldest Asian Record of Snapping Shrimps (Alpheidae) from Kutch Basin, Western India and Associated Biota: Biostratigraphic, Palaeoenvironmental and Palaeoecological Significance.
- Legumes from the Paleocene sediments of India and their ecological significance.
- Rising winter temperatures might augment increasing wheat yield in Gangetic Plains.
- The mitochondrial genomes of two Pre-historic Hunter Gatherers in Sri Lanka.

Important Highlights of Major Programmes:

- Asian summer monsoon variability, global teleconnections, and dynamics during the last 1,000 years.
- New Material of Carbonaceous Compressions from the ~1.5 Ga Singhora Group, Chhattisgarh Supergroup, India, and their Interpretation as Benthic Algae.
- Ensemble modeling approach to predict the past and future climate suitability for two mangrove species along the coastal wetlands of peninsular India.
- Organized 1st Indian Quaternary Congress, AOQR
- Organized webinar on “Mangroves and Disaster risk reduction”
- Organized Palaeobotanical Society Lecture Series.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	113
2.	Chapters in Books	5
3.	Number of Ph.Ds. produced	10
4.	Research Manpower trained (other than Ph.Ds)	31

5.4 Bose Institute (BI), Kolkata

The Bose Institute pursues research for augmentation of fundamental knowledge-base and developing solutions in the areas to understand infectious diseases through classical biology, structural biology as well as bioinformatics assisted approaches; understand and target chronic disease like cancer and neurodegenerative diseases using chemical, structural as well as cell biology approaches; understanding response of plants under biotic and abiotic

stress; systems and synthetic biology; high energy and nuclear physics; sub-atomic particles; quantum information and communication; environmental microbiology and climate change; bioorganic chemistry for drug development & identification of drug target and validation of bioactive molecules for therapeutic intervention and dynamics of atmospheric pollutants especially in the Himalayan Region.

Major Accomplishments:

- Germplasm, R6 of Sesame, with high oil content and superior lignan profile has been developed. Plant Germplasm Registration Committee of the Indian Council of Agricultural Research has certified the germplasm (R6 of sesame) with the registration number INGR22090.
- Anti-CRC activity of an alkaloid-rich fraction of *E. coronaria* leaf extracts (AFE) and associated underlying mechanism has been reported. This study provides a logical basis for consideration of AFE in future therapy regimen to overcome the limitations associated with existing anti-CRC chemotherapy.

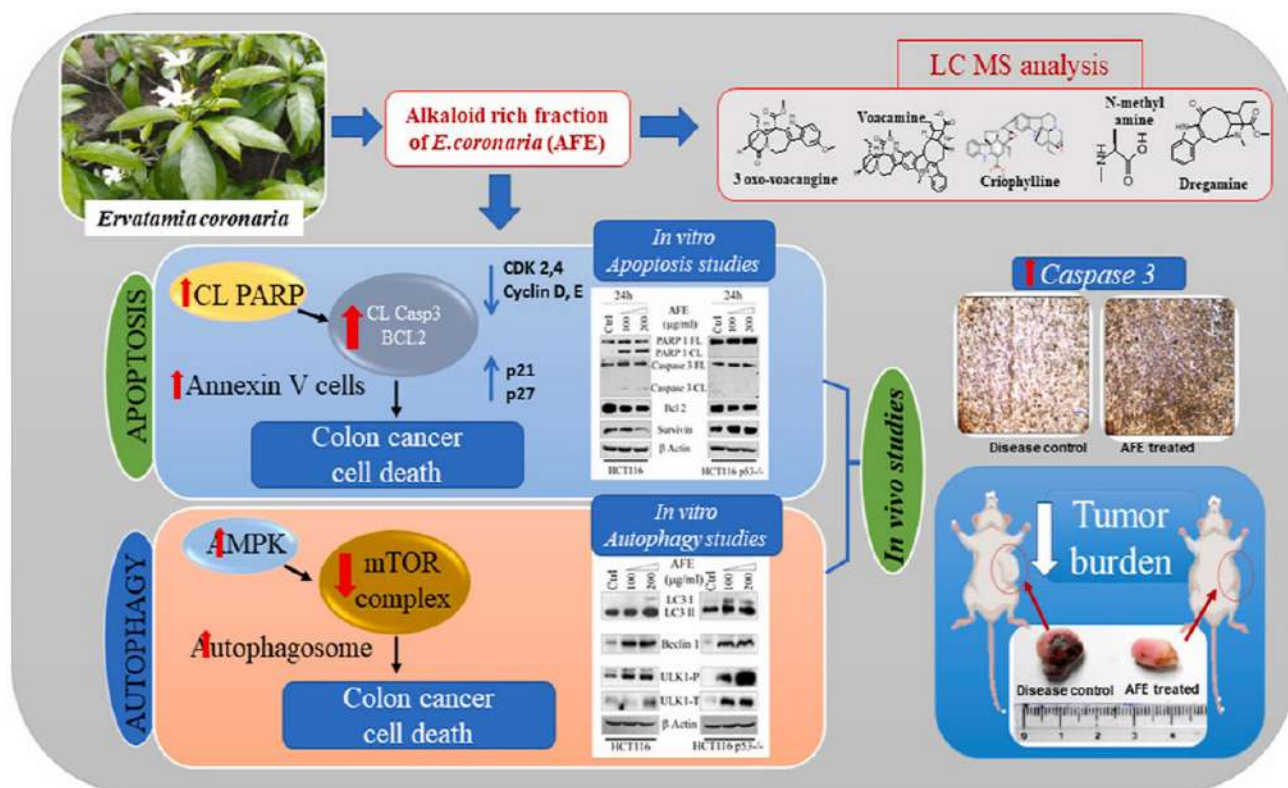


Fig. Graphical abstract of the study on *E. coronaria* leaf extract (<https://doi.org/10.1016/j.jep.2021.114666>)

- Water soluble Carbon dots (CD), have been synthesized which can be considered as a promising candidate for the biomedical applications due to its facile synthesis, low cytotoxicity, excellent fluorescent properties and potential as drug delivery systems.

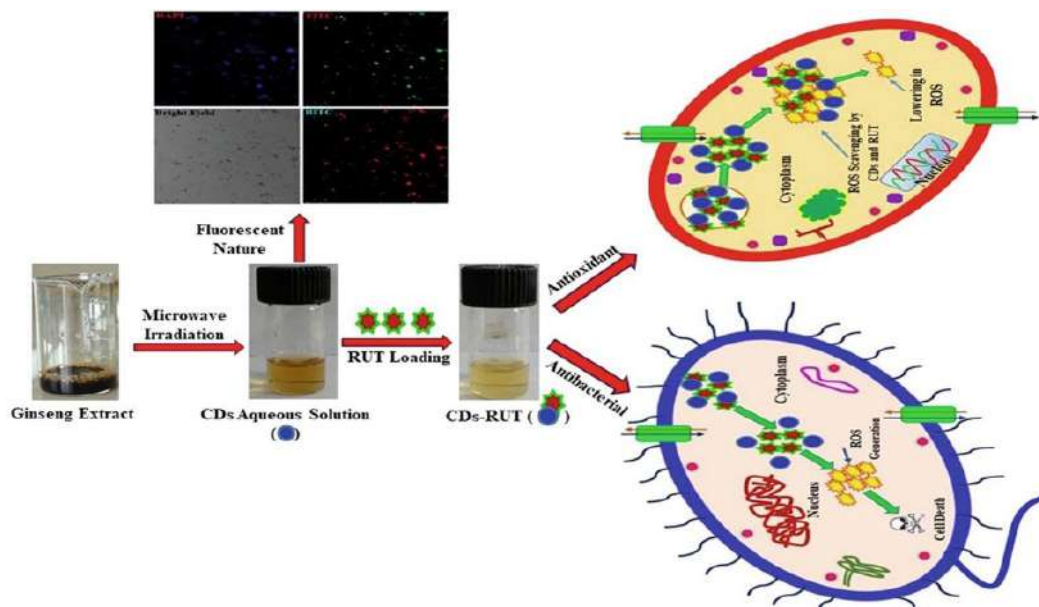


Fig. Carbon dots from red Korean Ginseng (<https://doi.org/10.1016/j.inoche.2022.109317>)

- A unique mannose binding plant lectin from *Narcissus tazetta* bulb, NTL125 is found to be a highly potential antiviral compound of natural origin against SARS-CoV-2 and may serve as an important therapeutic for management of COVID-19.
- A web based tool was developed that uses regression models to score CT scan reports from only 7 input features and predict risk of pneumonia. The automated determination of CT severity score can reduce the workload of radiologists significantly during the pandemic. It can be used by doctors for early detection of patients with high risk in order to offer better therapeutics.
- The anomaly in lithium abundance is a well-known unresolved problem in nuclear astrophysics. A recent revisit to the problem tried the avenue of resonance enhancement to account for the primordial 7Li abundance in standard big-bang nucleosynthesis.
- A new study unravels the potential of the Cygnus Cocoon to be a Galactic cosmic-ray source capable of accelerating at least up to PeV energies.
- A new method was developed, to transfer information of an unknown quantum state of any known dimensions, encompassing continuous variable states, from one party to another spatially separated party using a non-product bipartite quantum state of any dimensionality as a resource.

Important Highlights of Major Programmes:

- Multi-dimensional research to enable systems medicine: acceleration using a cluster approach at Kalyani, West Bengal.
- Next generation advanced therapies to fight b-hemoglobinopathies via rational intervention in g-globin regulatory network.
- Setting up a state-of-the-art CryoEM Regional/National facility in Eastern Region. Transforming the structure-guided drug discovery and therapeutics research landscape in India.
- Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribe community of West Bengal.
- Continuation of the existing Centre of Excellence in Bioinformatics and expanding it as a datacenter involving newer direction of research to address the healthcare and environmental issues of national need - BIC at Bose Institute.
- An new study provides a national scenario of aerosol pollution with the long-term (2005-2019) trend, source apportionment, and next year scenario for each of the Indian states. This study would complement and strengthen the ongoing national missions to combat air pollution in India.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	214
2.	Books	01
3.	Chapters in Books	11
4.	Papers in Conferences	02
5.	Number of Ph.Ds. produced / Thesis submitted	36
6.	Indian Patents granted	02
7.	Technical Manpower trained	28
8.	M.Tech/M.Sc./M.Phil projects guided	16
9.	No. of Conference/Webinar/Workshop etc. organized	21

5.5 Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru

The Centre focuses its R&D activities in the area of Nano science and nanotechnology; Resistive switching, High entropy alloys, Metal oxide based electro-catalysts for enhancing urea oxidation, Inorganic nanomaterials, 2D materials, Energy Storage Devices, Smart

window, Applications of perovskite nanocrystals, Synthesis and characterization of liquid crystals, Liquid crystal-Nano composites, Soft Optical Metamaterials, UV photodetector based on self-affine Langmuir-Blodgett film.

Major Accomplishments:

- A cost-effective dual-functional polymeric electrochromic smart window with energy storage capability (transmittance modulation > 55%, switching speed < 5 s, cycling stability >500 cycles), and areal capacitance of $\sim 8 \text{ mF cm}^2$) was designed using hybrid transparent electrodes, which has the potential to replace the traditional ITO-based smart windows in modern infrastructures and automobile industries.

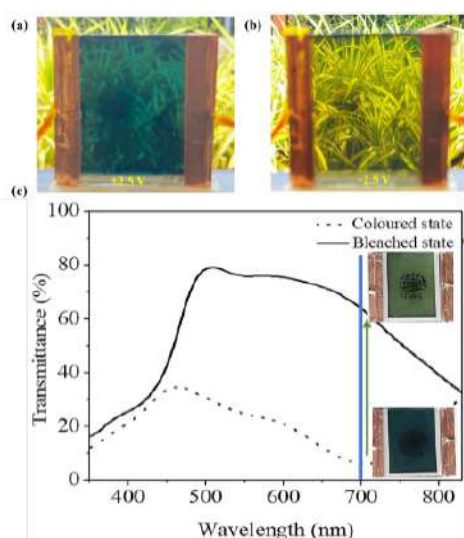


Fig. ((a) and (b) Photographs of the electrochromic energy storage device in colored (at +2.5 V) and bleached states (at -2.5 V), respectively; (c) transmittance spectra of the electrochromic device in colored and bleached states.)

- Sea urchin like MoO_3 loaded with a very small of silver (Ag/SUMoO_3) forming hierarchical micro-nano structures was demonstrated as SERS substrates for the detection of an environmental pollutant and a potent carcinogenic, N-nitrosodiphenylamine (NDPhA) up to 10^{-5} M concentration. Ag/SUMoO_3 substrate shows a high enhancement factor of 9.2×10^9 and a detection limit of 1 nM for the model molecule, 4-mercaptobenzoic acid.
- The demonstration of flexible photodetectors and photo-thermal actuators has been carried out by integrating 2D materials onto paper substrates. All-solution processed flexible photodetectors have been fabricated by spray coating dispersions of MoS_2 nanosheets onto screen printed carbon electrodes. By employing MoSe_2 as a photothermal conversion layer, actuators with paper-tape bilayers, devices like gripper, jack and crawler were fabricated. The current understanding would enable to fabricate soft robotics.

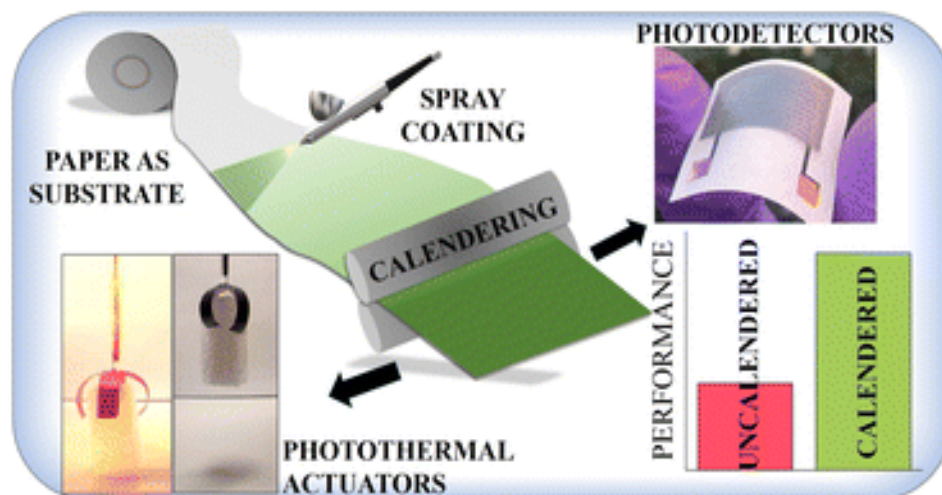


Fig. Flexible photodetectors & photo-thermal actuators

Important Highlights of Major Programmes:

- A solution-based process for directly depositing h-BN films on the desired substrate and employing the same to fabricate a Liquid Crystal Device (LCD) device has been demonstrated. The efficiency of this approach was amply showcased with the realization of unidirectional planar alignment over very large regions ($2 \times 2 \text{ cm}^2$), with the performance being comparable to an industry standard device.
- Scientists from CeNS established a mechanism of plasma treatment-induced stability enhancement and photoluminescence (PL) boost in perovskite nanocrystals. Plasma treatment induces the cross-linking of the passivating ligand oleylamine that creates a stronger network of ligands, providing better encapsulation and higher PL intensity.
- CeNS researchers have used a synchrotron-based variable energy photoelectron spectroscopy (VEPES) to probe the chemical composition variation in such heterostructured materials and interfaces. More specifically, the team shows how the internal heterostructures of lead halide perovskites (LHP) NCs are generated due to the surface chemistry and post-synthesis anion exchange.
- The existing anticounterfeiting based on perovskites have a reversible transition that does not allow to know whether the information is tampered or compromised. CeNS researchers have developed fluorescent anticounterfeiting security tags using micropatterned metal halide perovskite nanocrystals. The micro features were created by spray coating of stabilized methylammonium lead bromide nanocrystals (NCs) in polystyrene (PS) solution, which has a proper wettability to various rigid and flexible substrates. By combining stable and unstable NCs, the team created a double-layer fluorescent anticounterfeiting security tag.

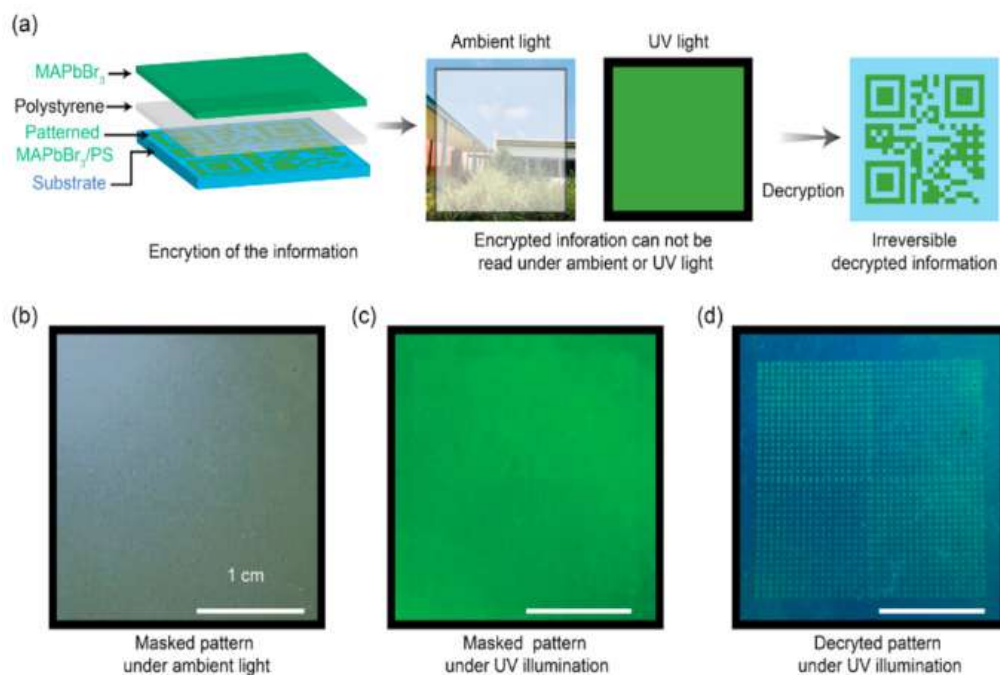


Fig. (a) Step by step schematic representation of the double-layer anti-counterfeiting; the information is hidden under both ambient and UV light and decryption is possible by using particular solvent. The masked hidden pattern under the (b) ambient light, and (c) UV light. (d) Decrypted hidden pattern can be revealed after the proper solvent washing.

Important Output Indicators:

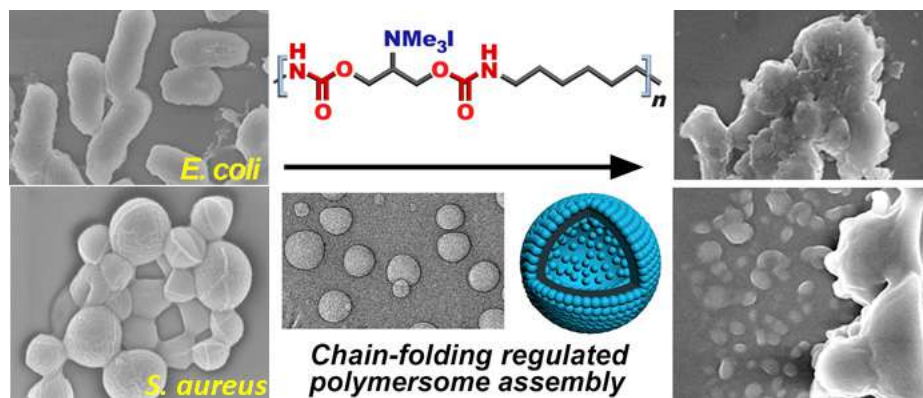
Sl.No	Parameters	Output
1.	Papers in refereed journals	36
2.	Indian Patents filed	07
3.	Indian Patents granted	02
4.	Research Manpower trained (other than Ph.Ds)	21
5.	Number of Ph.Ds. produced	05
6.	Technical Manpower trained	24
7.	Outreach programmes conducted	16
8.	M.Tech/M.Sc./M.Phil projects guided	04

5.6 Indian Association for the Cultivation of Science (IACS), Kolkata

The IACS pursues research on the areas of Biological Sciences, Chemical Sciences, Materials Sciences, Mathematical and Computational Sciences, Applied and Interdisciplinary Sciences and Physical Sciences.

Major Accomplishment:

- Development of a direct correlation between the secondary structure of synthetic macromolecules and functional (antibacterial, antiviral, ferroelectric) materials.



- The existence of extra dimensions has been shown to have observable effects on various features of gravitational waves and IACS used the presently available data on the quasi-normal modes of black holes to constrain the size of these extra dimensions as well.
- Chemisorption broadening of H_2/D_2 on $\text{Cu}(111)$ with increasing surface temperature has been shown for the first time employing Bose-Einstein statistics.
- A framework has been built by IACS for testing drug-target binding affinity using deep learning based techniques for screening of drugs in drug repurposing.
- An entirely new way to stabilize novel phases of non-equilibrium quantum matter is shown for implementing quantum technologies by suppressing many-body chaos.
- Non-standard soft supersymmetry breaking terms were probed by IACS for valuable phenomenological consequences through Heavy higgs physics and dark matter.

Important Highlights of Major Programmes:

- Development of chemical routes for the synthesis of structurally challenging and biologically active natural products.
- An unresolved issue concerning the Bio-active Chemical Structure of Curcumin, the primary medicinal constituent of turmeric, has been settled by means of Ion Mobility Mass Spectrometry.
- It was shown by IACS that equilibrium quantum phase transitions separating various equilibrium phases of quantum matters can be detected precisely using non-equilibrium dynamics, making those much easier to detect in experiments.

Important Output Indicators:

Sl. No.	Parameters	Output
01.	Papers in refereed journals	408
02.	Chapters in Books	07
03.	Number of Ph.Ds produced	61
04.	Indian Patents filed	03
05.	Indian Patents granted	04
06.	Research Manpower trained (other than Ph.D.)	48
07.	Technical Manpower trained	06

5.7 Indian Institute of Astrophysics (IIA), Bengaluru

IIA focusses its Research and development on Astronomy and Astrophysics, Atomic Physics, Laser Physics and Astronomical Instrumentation development of facilities. The institute continues to be in the forefront of research and development, operates observatories and field stations across India, has a large academic program and outreach project.

Major Accomplishments:

- The creation of a detailed method to predict polarization properties of planets surrounding other stars. An analytical formalism to predict transit light-curves for Exomoons was developed.
- MargNet, a deep learning-based classifier for identifying stars, quasars and compact galaxies, was developed.
- Discovery of excitation of vertical breathing motion in galaxies in fly-by interactions through simulations.
- Host stars of massive gas giant planets were shown to be younger than the stars hosting low-mass planets.
- Circular polarization detected in a type-II radio burst on the Sun, (b) understanding the role of magnetic fields in the stability and fragmentation of filamentary clouds for star formation.
- Sep A correlation is found between the ambient magnetic field and core orientations in selected molecular clouds. Large and small-scale field lines are found connected to each other.
- Using the highest known spatial and spectral resolution data of 'bright grains' on the Sun, further proof was provided that grains are due to upwards propagating acoustic shocks against a background of down flowing atmosphere.

Important Highlights of Major Programmes:

IIA is actively engaged in several national and international programmes like the Thirty Meter Telescope (TMT), Aditya-L1, Maunakea Spectroscopic Explorer, National Large Solar Telescope (NLST), and a next generation Ultraviolet space mission. Some achievements are highlighted below:

- Visible Emission Line Coronagraph (VELC) is a space payload that is being manufactured, assembled and tested at the MGK Menon lab at CREST campus of IIA, for the solar space mission Aditya-L1, to be launched by ISRO in a few months time. In 2022, the thermal systems were assembled, flight detectors integrated with payload, vacuum calibration completed, detectors integrated with payload and calibration of payload is ongoing.
- IIA is the nodal agency for India, in the international Thirty Meter Telescope (TMT) project, and is leading India's contribution in kind of precision equipment, with industry support. The first telescope-ready Segment Support Assembly assembled and is at ITOFF, CREST. Several modules of observatory software are completed.
- Others:
 - Design of the spectrograph and multifiber build and testing was completed for Indian Spectroscopic and Imaging Space Telescope.
 - In-house fabrication works of dome & outer structure of 11 inches celestron telescope is completed at shop floor testing level
 - Hanle Dark Sky Reserve has been notified by UT Ladakh. Telescopes and light pollution reduction equipment procured and distributed to villagers. Training workshop conducted for astro-tourism guides from the villages. A film was made on the reserve.
 - An all-sky fully automated camera based on Alcor System's ALPHEA 6CW is now operational at Indian Astronomical Observatory in Hanle, Ladakh.

Important Output Indicators:

S. No.	Parameters	Output
1	Papers in refereed journals	184
2	Number of Ph.Ds. produced	10
3	Research Manpower trained (other than Ph.Ds)	65
4	Technical Manpower trained	400
5	B.Tech/ UG projects guided	23
6	M.Tech/M.Sc./M.Phil projects guided	75
7	Scientific Webinars/Conferences/Workshops Organized	77

5.8 Indian Institute of Geomagnetism (IIG), New Mumbai

The Institute focuses its research on Earth Sciences - Environmental Magnetism and Paleoseismology, Probing the Lithosphere of Indian sub-continent and adjoining seas using gravity and magnetic signatures for structural mapping, Tectonics and Resource evaluation with emphasis on Deccan Volcanic Province, Hydrogeophysics & Water Chemistry, Archaeomagnetism, Polar Research, Forecasting of Geomagnetic Activity using real-time data assimilation, Lithosphere-Atmosphere-Ionosphere Coupling, Atmospheric Dynamics, Ionospheric Irregularities and Dynamics, Space weather, Theory and simulation of plasma processes in Earth's and other planetary environments

Major Accomplishments:

- Both audio magnetotelluric and magnetotelluric studies were carried out across the Aravali and Tural hot springs in south-western Maharashtra have revealed shallow conductivity anomalies related to the upward propagation of meteoric water through faults/fracture zones, major fracture/fault zones extending up to mid-crustal depths, and mid-crust conductivity anomalies related to trapped carbonate fluids linked to basaltic magmatic intrusions.
- VLF-EM and electrical resistivity tomography surveys were conducted in Ratnagiri and northern Maharashtra to map the lateral extent of subsurface geo-features and identify conduit and barrier type stretches of dykes, respectively. These studies provided insights into the fracture geometry and protective capacity rating of dykes, which have immense societal significance.
- Unraveled the crustal structure and a possible evolutionary model of the Maldiva Ridge segment of the Chagos-Laccadive Ridge system
- Generated a preliminary model of the Lithospheric magnetic anomalies over the Indian sub-continent from Swarm satellite constellation data
- Paleoseismological studies in Shillong plateau region and characterization of earthquake induced liquefaction features using palaeomagnetic tools attempted
- Atmospheric waves were found to be excited by vertical crustal movements associated with large earthquakes, with slower fault slips associated with tsunami earthquakes exciting longer period atmospheric waves more efficiently, as observations that examined coseismic ionospheric perturbations indicate.
- Proposed and validated novel fluid theories of solitary waves in Earth and Saturn's magnetosphere

Important Highlights of Major Programmes:

- The lithospheric anomaly map of the Indian sub-continent was generated using satellite data. The model reflects the long wavelength features of various tectonic provinces, such as low anomalies over the Deccan Volcanic Province and highs over the Saurashtra-Marwar block, Shillong Massif, and Eastern Dharwar and Bastar cratons.
- The inverted resistivity models of the Nandurbar region reveal the presence of massive and compact basalts, deep-seated dykes, shallow low resistivity zones, and very high resistivity features. The models suggest relics of NS oriented dykes and groundwater potential zones confined to upper layers of weathered/fractured zones.
- Studies carried out at IIG show that geomagnetic activity can influence the tropospheric polar vortex, with westerlies intensifying during storm days in both the stratosphere and troposphere. This supports the idea of coupling between magnetic activity and tropospheric processes.
- Signatures of ionospheric Alfvén resonators have been investigated over Indian latitudes for the first time and the results indicate a clear role of ionospheric cavity in trapping of Alfvén modes.
- Test particle simulations show that the lower boundary of the radiation belt has moved 430-500 km closer to Earth over the last 120 years due to the weakening of the geomagnetic field in the South Atlantic Anomaly (SAA) region, resulting in an increased radiation dose in the SAA region.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	64
2.	Chapters in Books	06
3.	Number of Ph.Ds. produced	05
4.	Research Manpower trained (other than Ph.Ds)	4
5.	M.Tech/M.Sc./M.Phil projects guided	08

5.9 Institute of Advanced Study in Science and Technology (IASST), Guwahati

The institute focuses on five research programs viz., (i) Basic and Applied Plasma Physics, (ii) Advanced Material Sciences, (iii) Mathematical and Computational Sciences, (iv) Biodiversity and Ecosystem Restoration Programme and (v) Traditional and Modern drug discovery and diagnosis.

Major Accomplishments:

- Sodium catalyzed growth of carbon nanotubes was achieved using atmospheric pressure plasma CVD.
- The traditional fermented mustard seeds, locally called Kharoli, were value added with enhanced poly unsaturated fatty acid content.
- A technique was developed for preparation of soy yoghurt with improved shelf-life (40 days), enriched with functional metabolites and preparation of cow milk curd with probiotics having anti-ageing property
- IASST developed carbon quantum-based imaging and detecting probes for nuclear hydrogen peroxide detection in living cells and demonstrated Anti-Inflammatory Activity and Internalization Pathway of Onion Peel-Derived Gold Nano Bioconjugates in RAW 264.7 Macrophages
- IASST developed Guar gum-sodium alginate nanocomposite film as a smart fluorescence-based humidity sensor that can be used as a smart packaging material.

Important Highlights of Major Programs:

- Snake venom nerve growth factor (NGF) is a prominent member of the neurotrophin family, having neurotropic and neuroprotective role, also found in snake venoms. Using of large neurotrophin polypeptide as drugs have several disadvantages. To overcome these impediments, custom peptides were designed from the TrkA receptor binding region of NGF which have significant potential as a drug prototype for the treatment of neurodegenerative diseases.
- Polyelectrolyte complex nanoparticles (PEC NPs) were synthesized using two oppositely charged polyelectrolytes, i.e., anionic poly(sodium 4-styrene sulfonate) and cationic poly(diallyle-dimethyl-ammonium-chloride). This specific PEC NPs can sense globular proteins (bovine serum albumin, human serum albumin, lysozyme and hemoglobin) within the detection limit of 5 nM and therefore can be used as an efficient and promising protein sensing material.

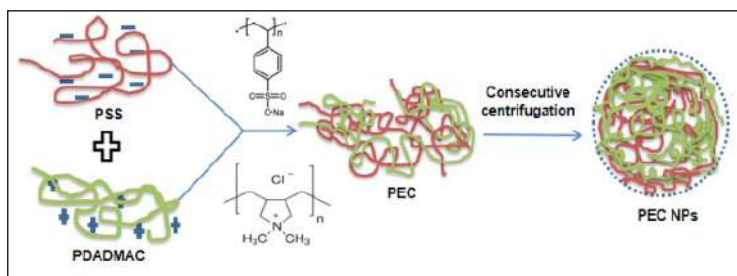


Fig. Polyelectrolyte complex nanoparticles (PEC NPs)

- A new longevity-promoting probiotic microbe *Lactobacillus plantarum* JD5 (LPJBC5) was discovered. The probiotic LPJBC5 increased the mean lifespan of the model *C. elegans* by 27.81% and accompanied with youngness, reduction in fat accumulation, enhancement of gut integrity and cognitive functions, that makes it a choice for broader acceptance and marketability as a next-generation probiotic.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	66
2.	Chapters in Books	16
3.	Number of Ph.Ds. produced	10
4.	Indian Patents filed	10
5.	Indian Patents granted	5
	Number of Technology leads awaiting transfer	5
6.	Research Manpower trained (other than Ph.Ds)	51
7.	Technical Manpower trained	10
8.	B.Tech/ UG projects guided	4
9.	M.Tech/M.Sc./M.Phil projects guided	12

5.10 Institute of Nano Science and Technology (INST), Mohali

Research activities at INST encompass physics, chemistry, biology, and interdisciplinary sciences addressing problems in the field of energy, environment, quantum materials, nano-devices, and chemical biology. Institute has set a unique mission to work at the forefront of fundamental science together with the development of technologies to address problems of national and global priorities.

Major Accomplishments:

- The researchers at INST has developed a Li-ion battery by using ultrafine mix-phase SnO-SnO₂ nanoparticles anchored on reduced graphene oxide, that boost the reversible Li-ion storage capacity beyond theoretical limit.
- A new type of polymeric biocide (100% drug units) was developed for antimicrobials coating of sutures.
- The researchers at INST have shown the Porous Carbonaceous matrix anchored with metal-phosphides (like: Ni₅P₄, Sn₄P₃, NiCoP etc.) that has demonstrated low over potentials for overall water splitting and to produce green-H₂ via cost-effective manner. Carbon fiber impregnated with electroactive materials demonstrates flexible template for renewable energy storage and transfer device.

- A new class of magnetic nanocrystals for magneto thermal application was reported by INST.
- A strategy is proposed to fabricate TENG by single active material by the INST's researchers.
- INST's researchers have computationally designed a low contact resistance metal-semiconductor interface with 2D monolayers for next-generation transistors, which can boost device performance.
- Researchers at the INST, have found a novel way to treat drug-resistant bacterial infections by inducing self-destruction in the bacteria.
- INST's scientists have synthesised a bi-functional catalyst made of nano-carbon material Fe, Co, N-C that can make rechargeable Zinc-air batteries used in electric vehicle propulsion more efficient and durable.
- The research at INST, Mohali has developed 9AA encapsulated caffeic acid conjugated nano-micelles for the management of experimental inflammatory arthritis.
- INST's researchers have designed Non-toxic in-vivo clearance of nanoparticles clusters for theranostics application. Elemental analysis of various organ indicated differential clearance of Gold and Iron via both renal and hepatobiliary routes.
- INST's researchers have reported drug nanocrystals stabilized with host specific serum protein with high loading. The human serum derives Curcumin Nanoparticles (Cu-Nanoparticles) showed superior in-vitro anticancer efficiency, compared to drug with substantial hemo-compatibility.
- INST researchers have reported that Lewis acid-dominated aqueous electrolyte acting as co-catalyst and overcoming N_2 **activation issues on catalyst surface**. Mechanistic investigation shows that Lewis acid (BF_3) has the capability to hold N_2 by forming a Lewis acid-base adduct, which further adsorbs on catalyst surface by a push-pull electronic effect. This report may open new vistas to studying and understanding the role of the NRR in aqueous medium.

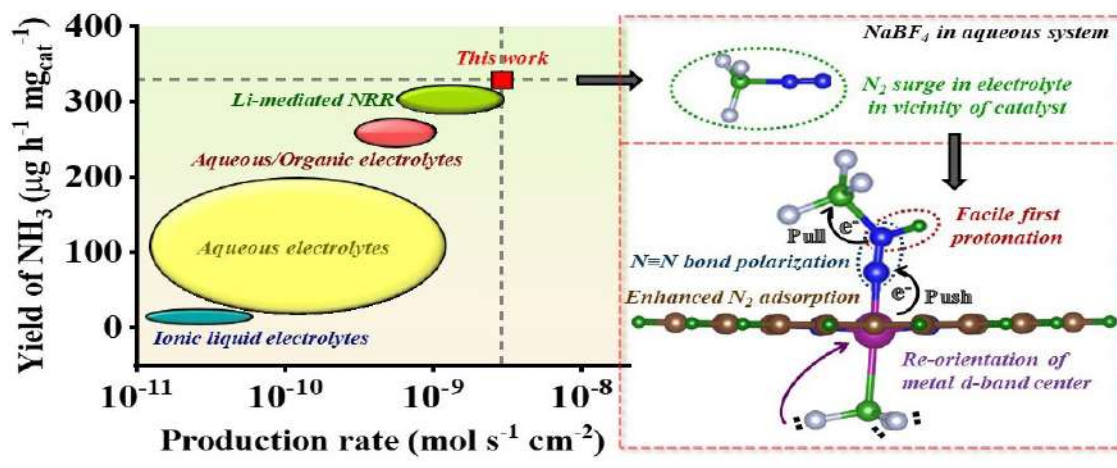


Fig. Comparison of yield and production rate of ammonia between NaBF_4 and other conventionally used electrolyte for electrochemical N_2 reduction reaction. Proposed mechanism of N_2 adsorption on catalyst surface in presence of NaBF_4 .

Important Highlights of Major Programmes:

- The number of students pursuing their Ph.D. at INST has reached 302. A total of 42 students number have been awarded Ph.D. degree during the period reported upon.
- INST has a vibrant Research Associate programme and 28 candidates were benefitted through this programme.
- INST provides an opportunity to exceptionally good undergraduate students to execute an innovative research and development project under the guidance of INST faculty. A total of 27 candidates are pursuing Internship at INST, Mohali.

Important Output Indicators

Sr.	Parameters	Output
1.	Papers in refereed journals	226
2.	Books / Chapters in Books	14
3.	Number of Ph.Ds. produced	42
4.	Indian Patents granted	02
5.	Number of Technology leads awaiting transfer	05
6.	Research Manpower trained (other than Ph.Ds)	35
7.	Technical Manpower trained	35
8.	B. Tech/ UG projects guided	04
9.	M. Tech/M.Sc./M. Phil projects guided	39

5.11 International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad

The Institute focuses its research on the areas of Automotive Energy Materials, Solar Energy Materials, Nanomaterials, Engineered Coatings, Ceramic Processing, Laser Processing of Materials, Fuel Cells, Carbon Materials.

Major Accomplishments:

- A comprehensive theoretical course and hands-on training for the Li-ion cell fabrication and testing, was conducted for the personnel of Nsure Reliable Power Solutions Pvt. Ltd. at ARCI Chennai.
- ARCI's Easy-to-clean coating technology was deployed successfully at a PV plant (600 KW capacity), BHEL, Tiruchirappalli.
- Nanoparticle-coated masks exhibiting self-disinfection, biodegradable, antiviral and antibacterial properties prepared and demonstrated at ARCI, tested by CCMB, Hyderabad for their efficacy against SARS CoV2. Large scale production of 7000 masks by the industry partner, Resil Chemicals Pvt. Ltd., Bengaluru.
- Handed over the Know-how for the 'Production of battery grade Lithium Iron Phosphate (LFP) as a cathode material for Li-ion battery' to Allox Minerals Pvt. Ltd., Hyderabad
- Handed over Know-how for 'Synthesis of electrocatalyst for use in Fuel Cells' to LAS Engineers & Pvt. Ltd, Mumbai.
- Handed over Know-how for 'Synthesis of sol and scratch and abrasion resistant coatings of sol on acrylic and PVC Laminates' to Reynobond India, New Delhi.
- Electrochemical Methanol Reformer developed by ARCI was integrated with the solar PV module at Rensol Pvt. Ltd., Chennai, completed 100 hours of operation resulting in the production of 4.25 Nm³/day of hydrogen on an average.
- ARCI's indigenously developed Lithium Ion Battery (LIB) pack (60 V, 25 Ah) was demonstrated by M/s LeeP eDrive, Hosur in its electric two-wheeler, at the Renewable Energy Expo held at Chennai.
- Developed Al₂O₃ coating on a relatively complex shaped Aluminium component by plasma electrolytic oxidation technique/ micro-arc oxidation for electrical insulation applications
- Developed TiCrN abrasive wear-resistant coatings on briquetting machine wearing components (50 Nos), and the coated components sent for real-time performance evaluation.

- Developed Mg-Zn-Zr Alloy by vacuum induction melting and characterized for phase, microstructure and mechanical and corrosion properties for its use as biodegradable implants.
- Process developed for producing graphene nanoplates on Kg-scale, exhibited specific capacity of 420 mAh/g at 100 mA/g for 100 cycles, for possible application in LIB anodes.
- Developed a high porosity carbon foam with tailored porosity higher than 75% by high pressure and high temperature (autoclave) process for thermal spreader application.

Important Highlights of Major Programmes:

- ARCI produced pure spherical Fe - Al - Zr alloy powders in 8 batches (nearly 50 kg) by inert gas atomization. Nano oxide dispersion strengthened iron aluminides are produced using these atomized powders by high energy ball milling for possible application as turbine blades in power plants.



Fig. Li-ion Cells Fabricated using indigenously developed carbon coated LFP

- Successfully completed High-temperature graphitization process runs (7) on C-C composites and delivered to VSCC-ISRO, Thiruvananthapuram.



Fig. ARCI's Easy-to-clean coating technology deployed at a PV plant with 600 KW capacity at BHEL, Trichy.

- Under the Integrated Clean Energy Material Acceleration Platform (IC-MAP) Thermal Energy Storage project, a 3 kWh paraffin phase change material-based latent heat thermal energy storage (LHTES) prototype system was developed and integrated with indigenous solar Flat-Plate Collector for solar water heating / space heating applications.
- Nanoparticle-coated masks exhibiting self-disinfection, biodegradable, antiviral and antibacterial properties prepared and demonstrated at ARCI, tested by CCMB, Hyderabad for their efficacy against SARS CoV2. Large scale production of 7000 masks by the industry partner, Resil Chemicals Pvt. Ltd., Bengaluru.



Fig. Biodegradable, self-disinfecting mask

- Developed a portable 1m X 2m automated spray coating equipment for photovoltaic and functional coating applications.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed Journals	118
2.	Books & Chapters in Books	6
3.	Number of Ph.Ds. produced (including employees and Fellows)	05
4.	Foreign Patents granted	2
5.	Indian Patents granted	7
6.	Number of Technologies Transferred/applications developed/ products supplied	26
7.	Number of Technology leads awaiting transfer	21
8.	Research Manpower trained (other than Ph.Ds)	11
9.	Technical Manpower trained	16

5.12 Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru

The Centre focuses its research on Chemistry and Physics of Materials, Engineering Mechanics, Evolutionary and Integrative Biology, Geodynamics, Molecular Biology and Genetics, Neurosciences, Theoretical Sciences, and New Chemistry.

Major Accomplishments:

- Designed a cost-effective metal-free catalyst to convert CO₂ to the value-added product methane by absorption of visible light.
- Developed a compound called “6BIO” that showed potential to treat autism spectrum disorder/intellectual disability in the Syngap1+/- pre-clinical mouse model. 6BIO can potentially restore neuronal function not only when administered during development (up to 6 years) but also after mid-childhood (7–11 years).
- A new platform for efficient fluorometric detection of pathogens such as viruses, including SARS-CoV-2, HIV, and Zika, and bacteria, was developed.
- Discovered that silver antimony selenide (AgSbSe₂), although crystalline in nature, exhibits thermal conductivity like amorphous materials.
- Showed that reduced sexual selection in *Drosophila melanogaster* populations can arise due to direct selection acting on mating-related behaviours and mate choices, and as a by-product of the evolution of a life history involving rapid development to adulthood and relatively early reproduction.
- JNCASR and its collaborators found that patterns can form in the presence of active elongated particles, helping the particles to keep moving and preventing the system from turning glassy.
- JNCASR and its collaborators discovered a novel material that can emit, detect, and modulate infrared light with high efficiency.
- Developed a new cyclic hydrophobic moiety in a triamine-containing compound, which, in combination with existing antibiotics, can weakly perturb the bacterial membrane. This novel strategy can not only counter antibiotic resistance in bacteria but also help revive the efficacy of obsolete antibiotics.
- Discovered that histone butyrylation underlies fat accumulation and subsequent obesity development.

Important Highlights of Major Programmes:

- Eighty students joined different degree programmes at the Centre. Students joined under different degree programmes are: 48 in Ph.D.; 9 in Int. Ph.D. Biological Sciences, 6 in Int. Ph.D. Chemical Sciences and 3 in Int. Ph.D. Materials Science; 1 in M.S. (Engg.); 8 in M.Sc. (Chemistry); and 5 in PGDMS. The current student strength of the Centre is 351. During this period, 73 students received degrees on completion of their respective degree programmes.
- Ninety Four students pursuing UG/PG programmes across India carried out research projects under various Fellowships & Extension Programmes such as Summer Research Fellowship Programme (53 students), Graduate Research Internship Programme (18 students), Project Oriented Biology Programme (4 students), Project Oriented Chemistry Programme (9 students) and Long-term Visiting Students Programme (10 students).
- Three hundred sixty four students/teachers from colleges across neighbouring states visited the Centre to get first-hand research exposure under Institution Visit Programme (IVP). Four faculty members from different colleges/universities in India and abroad carried out cutting-edge research work under different programmes such as DST-ISRA-ISRF(2), SERB-VAJRA (1), SERB-TARE(1).
- Twenty three science outreach programmes were organised by JNCASR, including teacher training workshops, workshops on learning science through experiments, workshops on learning physics through experiments, workshop on learning chemistry through experiments, an interactive lecture program in Biology, and programmes organised on National Science Day. 6003 students and 920 teachers, participated.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	275
2.	Number of Ph.Ds. produced	40
3.	Foreign Patents filed	5
4.	Foreign Patents granted	2
5.	Indian Patents filed	10
6.	Indian Patents granted	8
	Number of Technologies/Designs and other intellectual products commercialized	5
7.	Number of Technology leads awaiting transfer	1
	Research Manpower trained (other than Ph.Ds)	93
8.	Technical Manpower trained	12

5.13 Raman Research Institute (RRI), Bengaluru

The institute focuses research on Astronomy & Astrophysics, Light & Matter Physics, Soft Condensed Matter Physics and Theoretical Physics.

Major Accomplishments:

- A cluster of labs at RRI is in the forefront for developing quantum enabled technologies. The first loophole-free violation of the Leggett Garg inequalities (equivalent to the Bell inequalities) was demonstrated at the QuIC lab and was published in PRX Quantum.
- Another experiment involving entanglement measures directly determined using statistical correlation measures and one set of complementary measurements was successfully performed. The study has recommended a reliable alternative to the conventional schemes which fare bad when dimensions increase. Offering solutions to the industries like IBM and Rigetti platforms, researchers at the Quantum lab at RRI used the fundamental principles of quantum mechanics as deep quantum benchmarks for their commercially available quantum computers. Another study has thrown fresh light on how a charged particle in contact with an environment in the presence of a magnetic field behaves when it is subjected to ultra-cold temperatures.
- Data obtained using SARAS 3, the indigenously designed radio telescope at RRI, conclusively refuted the 21-cm signal detection from Cosmic Dawn claimed by the EDGES experiment, thus restoring the confidence in the prevailing model of the cosmos. SARAS became the first experiment to achieve the sensitivity to verify the claim. A follow-up analysis of SARAS 3 data led to one-of-its-first kind constraints on the properties of the early galaxies, when the Universe was just 200 million years old.
- In the ongoing project, PRATUSH, the RRI-proposed space-based radio telescope supported by ISRO, is in its pre-project studies phase. A first laboratory model prototype is ready. The manuscript mentioning the telescope design is under peer-review. Played key roles in other international collaborations, including Simons Observatory, HERA and CHIME.

Important Highlights of Major Programmes:

- POLIX is an X-ray Polarimeter Instrument which is under development at the Raman Research Institute. It will be used to perform astronomical observations in X-ray band. It is the only instrument in the medium energy X-ray band ranging 8 to 30 keV. It is the main payload on the soon-to-be launched dedicated satellite XPoSat by ISRO. This year, all 46 PCBs for the flight electronics were prepared and tested. All the four front-end and back-end electronics, each, for the flight model packages were assembled and tested. Flight harnesses are ready. Three of the required four reworks for the flight detectors are complete. Assembly and tests of the flight detectors is currently underway.

- A new instrumentation-facility was developed indigenously for electrofluidic detection of single cells. New experiments revealed the molecular information of CRISPR-Cas9 functioning at different temperatures and the nanoscale structural stability of nucleosomes.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	108
2.	Books	1
3.	Number of Ph.Ds. produced	20
4.	Indian Patents granted	01
5.	Research Manpower trained (other than Ph.Ds)	29
6.	Technical Manpower trained	30

5.14 Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), Trivandrum

The research areas of the Institutes focuses on Biomaterials Research and Development, Biomedical Device Development, Technology Transfer and Industrial Partnerships, Quality Management Systems, Testing and Technical Services, Research, Advanced Patient Care in Clinical Super-specialties in Cardiac and Neuro Sciences along with Human Resource Development in the above said areas and Public Health.

Major Accomplishments:

- Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivandrum secured 9th Rank under Medical category in National Institutional Ranking Framework.
- The license agreement with M/s Forsta meditech private limited for the technology transfer of Automatic Smart Trash Bin for Disinfection Using UV Enabled Microwave (Astra) was signed.
- The license agreement with M/s Onyx Medicals Pvt Ltd for the technology transfer of Drug Eluting Bioactive Calcium Sulfate Cement was signed.
- The license agreement with M/s Biorad Medisys Pvt Ltd for the technology transfer of liquid embolic agent for application as a permanent implant occluding the abnormal blood vessels of the brain was signed.
- An agreement with Tata Steel Limited was signed for collaboration on the development of "Biodegradable orthotic wrist support device from short coir fibre reinforced polylactic acid biocomposite".

- MoU for Implementation of Ayushman Bharat - Pradhan Mantri Jan Arogya Yojana (AB-PMJAY) - Karunya Arogya Suraksha Padhathi (KASP) between SCTIMST, Trivandrum and State Health Agency Kerala was signed.
- An MoU was signed with M/s Phraction Scientifics Private Limited for joint development of Biological Fluid Component Separator and Segregator.
- An MoU was signed with M/s Abhaya 3CD Private Limited for a project which imparts technical support on the regulatory aspects for the male incontinence device developed by the company.
- An MoU was signed with Central Manufacturing Technology Institute (CMTI), Bangalore for the development of scalable technology for fabrication of polymeric micro devices for biomedical applications.
- An MoU was signed with Government Engineering college, Barton Hill, Thiruvananthapuram to promote co-operation in research and development in areas of mutual interest.
- Non-Disclosure Agreement signed with Post Graduate Institute of Medical Education and Research (PGIMER) for testing of C1-2 artificial joint and research aspect.

Important Highlights of Major Programs:

- 'Combination Devices Block' was inaugurated by Dr. Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Science & Technology and Earth Sciences, on 15th November 2022 at BMT Wing, SCTIMST.



- The Inauguration of the Sree Chitra Technology Conclave 2022 was done by Shri. V. Muraleedharan, Hon'ble Minister of State for External Affairs and Parliamentary Affairs on 17th October 2022. The function was presided over by Dr. V.K. Saraswat, President, SCTIMST.



- Swachhata Pakwada, fortnight-long program launched by the Government of India, to ensure mass participation of citizens was conducted in Biomedical Technology Wing of the Institute.
- 5-Axis CNC Milling Machine (Mikron-Mill S 400U from GF Machining Solutions, Switzerland) was installed and commissioned at the Biomedical Technology Wing. This machine is utilized for machining intricate shapes/prototypes in ferrous, non-ferrous and polymeric materials.
- Workshop on “Indian medical device regulation” was conducted and around 60 participants from the medical device industry attend the workshop. The speakers were from the DCGI, industry and the institute.
- Sensitization program on science, technology and innovation conducted for school teachers.
- A customized training program was conducted by the Industry Institute Partnership Cell on “Sterilization of medical devices” to M/s DNV Business Assurance which is an international audit group involved in the testing, certification and technical services.

Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	273
2.	Books	1
3.	Book Chapters	7
4.	Papers in Conferences	245
5.	Number of Ph.Ds. produced	5
6.	Foreign Patents filed /granted	01/02
7.	Indian Patents filed/granted	12/20
8.	Number of Technology leads awaiting transfer	5
9.	Research Manpower trained (other than Ph.Ds)	654
10.	Technical Manpower trained	179
11.	M.Tech/M.Sc./M.Phil projects guided	26
12.	Design Registrations	08
13.	Technology Transfers	3

5.15 S. N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata

Areas of focus of the Centre are 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 in; Collective behavior 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.

Major Accomplishment:

- Astronomers tracking the constellation Ophiuchus have spotted a recurrent nova system (a transient astronomical event that causes the sudden appearance of a bright, apparently “new” star that slowly fades over weeks or months) approximately 5,000 light-years away. The Astrophysics team from the Centre acquired data from Astronomical Ring for Access to Spectroscopy Database (ARASD) to study the evolving spectra of the RS Ophiuchi Nova.

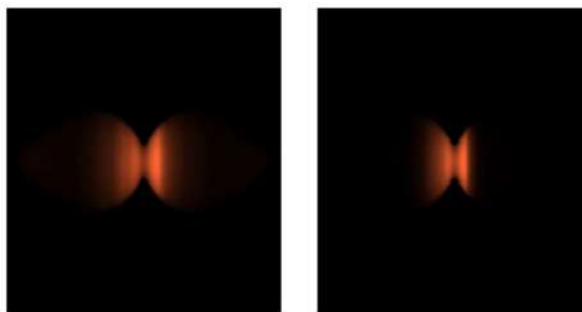


Fig. The model images of the ejecta of RS Oph 2021

- Harnessing quantum entanglement for futuristic energy storage technology. The idea if harnessed can open pathways for putting quantum batteries to use in a way that is much efficient than its classical counterpart.

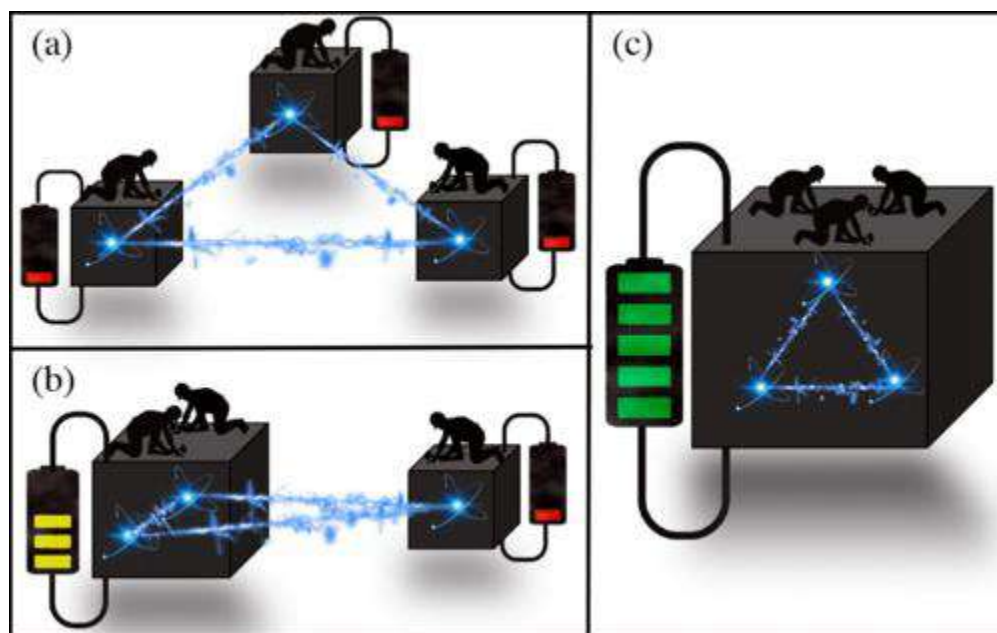


Fig. (a) Local ergotropic work: The local parts of a composite system are probed individually. (b) Biseparable ergotropic work: Different parts of a composite systems are combined and probed to extract work. (c) Global ergotropic work: This is the most efficient probing where the whole system is addressed for work extraction.

- Machine learning helps predict new materials for nano alloys, semiconductors & rare earths. Scientists from the SNBNCBS used Machine learning to develop a design map of alloys at the nanoscale which can help predict the match of pairs of metals that can form bimetallic nanoalloys.
- Researchers from the Centre found ways for broader design and engineering of

reconfigurable functional magnonic crystals, which can show the way for magnon based computing systems and bring about a paradigm shift in computing and communication devices.

- Hydration could act as a potential marker for an early detection of neuro-degenerative diseases.
- Water dynamics during protein phase transition. Modulation of such transition using excipients.
- A covariant formulation for the Newton-Hooke particle is presented by following an algorithm developed by SNBNCBS termed galilean gauge theory.

Important Highlights of Major Programmes:

- ALMA discovery of a dual dense probably rotating outflow from a massive young stellar object.
- Molecular dynamics simulations and dielectric relaxation (DR) measurements to explore the heterogeneous reorientation dynamics in deep eutectic solvents.
- Observation of Imbert–Fedorov (IF) shift in monolayer MoS₂ via quantum weak measurement (QWM).
- Application of 2-photon absorption spectroscopy as a novel tool to understand ligand-surfactant interaction.
- Design and Fabrication of washable all-cotton 3 or 4-layer mask with controlled super-hydrophilic/hydrophobic surface modifications.
- Ternary nanocomposites surpass the individual merits of their building blocks by augmenting the catalytic performances many-fold through their synergistic interfacial effects.
- A hybrid Exact Diagonalization (ED) and Density Matrix Renormalization Group (DMRG) approach which is based on combining exact diagonalization to study the high temperature and DMRG method for low temperature.
- Cubic PtBi₂ hosts a six-fold band touching point – a triple Dirac point near the Fermi level.
- Transport and fluctuations in mass aggregation processes has been studied and a novel type of phase transition characterized by mobility-driven clustering has been found.
- Hamiltonian formulation of higher rank symmetric gauge theories has been developed.

- A novel vortex solution in a rotating holographic superfluid have been obtained by considering a static disc at the AdS boundary and letting the superfluid rotate around it.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	190
2.	Number of Ph.Ds. Submitted	19
3.	Number of Technology leads awaiting transfer	6
4.	Research Manpower trained (other than Ph.Ds) Integrated PhD	20
5.	Technical Manpower trained (Summer Project)	39
6.	M.Tech/M.Sc./M.Phil projects guided	9

5.16 Wadia Institute of Himalayan Geology (WIHG), Dehradun

The Institute's focus is to study various geological and geophysical aspects of the Himalaya, including glaciers, earthquake precursors, landslides, biodiversity and climate-tectonic interaction and the geodynamic evolution of the Himalaya and artificial intelligence & machine learning applications to geosciences.

Major Accomplishment:

- A study of mafic and felsic rocks of Shyok suture zone, NW Ladakh Himalaya, indicates diverse magma sources in the subduction tectonic regime during the Neo-Tethyan plate subduction beneath the northern Eurasian plate.
- The first-ever study of the water-fluxed melting of the migmatite for the exhumation of the South Tibetan Crust reveals that Phase equilibria calculations are consistent with migmatization at 0.85–1.02 GPa and 640–670 °C in water-saturated conditions (i.e., 0.7 wt% H₂O), with subsequent decompression melting involving fluid-fluxed melting reactions.
- Zircon geochronology of migmatite from the upper Sutlej valley (Leo Pargil region) indicates partial melting related to the assembly of the Rodinia supercontinent at ~1000-1100 Ma.
- Receiver function imaging in the Eastern Himalayan Syntaxis (EHS) reveals that, unlike northwest Himalaya, the Main Himalayan Thrust does not play a major role in the earthquake generation process in the EHS.
- Seismological investigation reveals the presence of aseismic creeping patches in the Karakoram Fault producing low-stress drop (~0.06-64.36 bar) earthquakes at the expense of generating large/great earthquakes.

- About ~46% of the glacier area are lost in 47 years, between 1974 and 2021, in the Upper Kali Ganga region.
- Three phases of paleo floods occurred in Ladakh after the Last Glacial Maximum during 14–11, 10–8, and 7–4 ka with increased penetration of the Indian summer monsoon.
- Four climatic phases of alternating strengthened and weakened Indian summer monsoon (ISM) were identified for the last 20 kyr using multi-proxy data from 100 cm thick peat deposits in the Baspa Valley, NW Himalaya.
- The Vasudhara lake, Purvi Kamet (Raykana) Glacier, and Dhauliganga valley (Uttarakhand), indicate a huge expansion of the lake area from 1968 to 2021. The impact of climate change has been assessed.
- The Raykana glacier has retreated ~372.7 m with an average rate of 7 ma⁻¹ between 1968 and 2021.

Important Highlights of Major Programmes:

- AI/ML algorithms employed in the geosciences data for the investigation of in-situ glacier melt in the Himalaya (Pindari and Kafni glaciers) consisting of suspended sediment concentration.
- Landslide susceptibility maps of the Kali River valley, Kumaun Himalaya using machine learning algorithms indicate very high susceptible zones around Garbyang, Sobla, Tawaghat, Dharchula, Baluwakot, and Jauljibi villages
- Sub-surface fault geometry and architecture in the upper Assam basin, NE India was Delineated from high-resolution 3D seismic data, and provided geo-tectonic implications and hydrocarbon prospects
- A new genus and species belonging to tree shrews (*Sivatupaia ramnagarensis*) were identified within the Siwaliks from Udhampur District, Jammu & Kashmir.
- One of the rare snake fossils (Madtsoiidae) was reported from the late Oligocene sediments of Himalayan region of Ladakh suggesting their prevalence for a much longer time than previously thought.

Important Output Indicators:

S.No	Parameters	Output
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1.	Papers in refereed journals	134
2.	Books	1
3.	Chapters in Books	5
4.	Number of Ph.Ds. produced	12
5.	Research Manpower trained (other than Ph.Ds)	307
6.	M.Tech/M.Sc. projects guided	27
7.	Conference/workshops/webinar organized	4

5.17 National Innovation Foundation-India (NIF), Gandhinagar

The areas of the Institute include the Incubation and promotion of technological grassroots innovations including those which stems from children creativity and to add value to India's outstanding traditional knowledge base.

Major Accomplishments:

- “IS 17693: 2022 Non-electric cooling cabinet made of clay”, the first official standard for a grassroots innovation corresponding to “Mitticool” was formulated by Bureau of Indian Standards (BIS) with the intervention of NIF. This paves way for benefits like facilitation of trade and commerce, improvement of processes and making them more efficient, guidance in consistent functioning and quality, simplifying comparison of products and services, promoting further technological developments and so on for grassroots innovations in India.
- Improved prototype of 22 technologies were developed, a total of 10 technologies were refined through various stages so as to get them ready for Technology Transfer opportunities viz. Tennis ball for blind, Sola wood sheet making machine, Manual paddy transplanter, Walker for senior citizen, Pinkloo/standing toilet for women, Device for chilli bag filling, Drone for rescuing drowning people, Ceiling fan lifting rod, Lid opener of bottles in laboratories, Road gullies/manhole alert system.
- Continued focus on farmers, following was accomplished by NIF for plant varieties – Validation (9), On-farm trials / field demonstration (29), On-site evaluation /verification & scientific documentation (40), Multiplication trials (5) and Demand generation (3) varieties.
- NIF accomplished the scientific validation of 18 indigenous medicinal practices in treatment of anestrus, subclinical mastitis, ephemeral fever among large animals for poultry immunity.
- NIF along with DST organized a Start-up expo in Jammu and Kashmir (UT) which

provided exposure to several innovators turned entrepreneurs to pitch the merit in their technologies, and either emanating from the valley or emanating elsewhere but directly useful to the region.

- Grassroots Innovators supported by NIF are registering their significant presence by winning the awards instituted by the industry like “Amazon Smbhav ’22 – Start-up of the year” by the likes of Shri Subhash Ola while competing with entrepreneurs representing modern day sectors like Fintech, E-commerce, Blockchain, EdTech, Emerging Tech (AI, ML, etc.).

Important Highlights of Major Programmes:

- Multipurpose Chulha’, an innovation by Late Miss Ankita Singh, recognized through INSPIRE Awards - MANAK was transferred to an Odisha based enterprise M/s Hindustan Machinery.
- NIF facilitated the transplantation of over 50000 saplings of low-chilling apple variety HRMN99 in Meghalaya, Nagaland, Manipur and Mizoram in partnership with NERCORMP to enhance livelihood opportunities for farmers.
- The 9th National Level Exhibition and Project Competition (NLEPC) of the annual INSPIRE Awards MANAK was jointly organized by DST and NIF wherein top 60 student innovators were conferred with an award. This was pursuant to a total of 6.53 lakh ideas and innovations which were received during FY 2020-21 from all States/UT’s of the country. In addition, a start-up meet featuring beneficiaries was organized by NIF at Moradabad, UP.
- Magnifying exposure opportunities to boost commercialization and dissemination, innovators supported by NIF were invited to participate in various exhibitions like India International Trade Fair (IITF), Vigyan Sarvatra Puujate, National Conclave on S&T interventions for tribal communities, S&T Expo at Samba, J&K; Science Conclave, Gujarat amongst others.

Important Output Indicators:

S.No.	Parameters	Output
1	Number of Innovations Registered	6561

2	No. of Patents granted (facilitated)	90
3	No. of Patents applied (facilitated)	46
4	Plant Variety Applications granted under PPV&FR Act 2001	07
5	Papers / Books/Monographs/ Booklet/ Chapters	05
6	National Conferences Organized	03
7	Scientific Outreach Programmes organized	19
8	Number of persons who attended various science outreach programmes	>50,000
9	No. of students, innovators etc. trained	200
10	Scientific Lectures/Training Programmes organized	35

5.18 Technology Information Forecasting and Assessment Council (TIFAC), New Delhi

Areas of Focus of TIFAC are Technology foresight exercises, Vision 2035, nurturing Innovation, patent support, support to MSME clusters, capacity building and Technology Assessment, IT Tools for Agriculture, Sea Weed as model for Blue Economy, e Vehicles, etc.

Major Accomplishments:

- Modeling tools were developed for assessment of economic feasibility of Hyperloop and forecasting penetration of electric two-wheelers based on technological, economic and policy related parameters. Two reports were completed based on analyses using these models.
- The technology of modular Steel integrated floating jetty (SIFJ) replacing the existing HDPE based floating jetties with greater stability has been developed.
- The technology has been demonstrated at NAMO Ghat, Varanasi along with GAIL for installing floating CNG stations for filling gas to the small boats operating in Ganga basin.
- Technology based on GPS/GIS minefield recording and retrieval system (GBMRS) to record locations of battlefield mines manually laid by soldiers, recording their positions on a digital interactive real time Mine Map to provide centimetre (cm) level accuracy of mine locations using artificial intelligence (AI) has been developed as per protocol of

Indian Army.

- The technology for design and development of high precision low voltage miniature electronic connectors and terminals for applications in automobiles, defence, aerospace and consumer electronics sector has been the first indigenous manufacturing initiative to substitute import from China and Taiwan.

Important Highlights of Major Programmes:

- TIFAC has strengthened its international reach by collaborating with IIASA Climate Modelling, river resilience and Biodiversity issues in Hindukush region.
- The report titled “Forecasting Penetration of Electric Two-Wheelers in India: A Boot UP Analysis” was released. TIFAC has developed an agent-based model that simulates the electric two-wheeler purchase decision based on agent attributes as well as various policy options, technological and economic parameters. The model estimates penetration of electric two-wheelers under given scenario. It also projects required charging facility as well as demand for on-board energy storage device in various scenarios.
- To estimate the real-life fuel economy of Indian Vehicles by a Data Driven Approach, a model was developed for reconciliation between the top-down and bottom-up fuel consumption. It also includes estimation of vehicle stocks and age profile.
- TIFAC identified and assessed 07 technologies out of which 04 projects were technically recommended to SIDBI for financial appraisal; 03 new projects from start-ups based on innovative technologies were sanctioned for financial support towards scaling up; Towards wider dissemination and outreach of the impacts of Srijan supported technologies, an Audio-Visual film was made and showed in public domain through various platforms.
- A study has been carried out by TIFAC under the A2K+ programme of DSIR for scouting and assessment of technologies at TRL6 and above, developed by labs, academia and industries in India in the domains of chemicals, pharmaceuticals, medical sciences and healthcare and to identify the challenges/barriers/issues in transferring / licensing these technologies towards commercialization.
- TIFAC identified and assessed 80 technologies and 2 technologies from IIT-Kharagpur and 1 technology from IIT-Madras have been approved for extending handholding support.
- The portal Shramik Shakti Manch (SAKSHAM) to map skill profiles of the blue collared workers with the requirements of MSMEs and other industries using AI tools and data analytics has been developed and completed registration of more than 3.5 lakh workers and thousands of MSMEs. More than 4000 workers have been connected with their

potential employers. The attempts are being made now to devise a mechanism to implement it on a large scale on a self-sustainable basis.

Important Output Indicators:

S. No.	Parameters	Output
1.	Papers in refereed journals	3
2.	Books/Monographs/ Chapters in Books	2
3.	State-of-the-art-Reports Published	7
4.	Scientific Outreach Programmes organized	24
5.	Popular Science Books/Newsletters published	2
6.	Number of persons who attended various science outreach programmes/conferences etc.	2635
7.	Number of school/college/university teachers trained	100
8.	Number of Innovators	96
9.	Data Bases Compiled	3
10.	Foresight Reports and Analyses Prepared	5
11.	Patents filed (Facilitated)	28
12.	Patents granted (Facilitated)	12
13.	Technology Gap Analysis Reports	6

5.19 North East Centre for Technology Application & Reach (NECTAR), Shillong

NECTAR focuses on providing last mile guidance and support to north-eastern States in technology applications for socio-economic activities.

Major Accomplishments:

- NECTAR has successfully implemented a project on setting up of a Honey Testing Laboratory at Dimapur, Nagaland through Nagaland Beekeeping and Honey Mission (NBHM).
- NECTAR has set up the GSM enabled, Bamboo based smart water harvesting tower at Ram Krishna Mission, Sohra, Meghalaya, an innovative technology on water harvesting from cloud and atmospheric moisture. It will be useful in lean season to store pure and clean water for local community.



Fig. Bamboo based smart water harvesting tower

- Low-cost Cow-dung based flowerpots manufacturing facility at Dharitree Nursery, Sonapur near Guwahati was set up by NECTAR. The National Innovation Foundation (NIF) developed technology can produce 40 pots per hour and it can replace plastic bags that used for plant saplings.
- Pilot projects on banana fibre extraction and complete utilisation of banana pseudo stem were implemented in North East Region through NECTAR's support and various products like Handicrafts, Banana Chips, and Fertilizers etc. were developed.



Fig. Banana fibre extraction and utilization

- NECTAR implemented a project on design and development of a multi-modal, smart phone-based, field portable smart bag pack emergency oxygen concentrator for utilisation on medical emergency, high altitude, and home care for community outreach and remote locations. Design & Development of field-portable smart phone-based fluorescence, spectroscopy and videscopy device for imaging of breast cancer patients and tumour margin detection was implemented. The data collected will be validated with gold standard algorithm for image analysis using software.



Fig. Design & development of portable products

- NECTAR has accomplished projects on mapping of flood prone areas of Marigoan district of Assam Using Geospatial Technology for flood Risk Reduction and community Resilience Building. NECTAR has completed mapping of number of medicinal, aromatic and dye yielding plants across Assam, having good prospects of enhancing the sector through handholding with entrepreneurs.
- NECTAR has developed a competent in-house capacity through drone flying training to various personnel for DGCA authorised Remote Pilot Licence and taking up large scale Drone mapping projects from various stakeholders for revenue generation and capacity building in the sector.

Important Highlights of Major Programmes:

- NECTAR has taken up an extension of saffron cultivation project in entire North-East. Saffron corms were distributed to the farmers in Arunachal Pradesh, Meghalaya, Sikkim, and Mizoram. Flowering was shown in all the states in the current season.



Fig. Saffron cultivation

- NECTAR has distributed 3000 bee boxes with bee colonies for scientific beekeeping in NER. NECTAR is implementing the project through pay back mode with advance technology of quality and quantity honey production in North East Region.
- Forty-Seven projects have been shortlisted and supported through NECTAR Schemes viz., Technology Outreach Service Scheme (TOSS) and Bamboo Application and Support Scheme (BAANS) for diverse technological interventions in sectors of food processing, agriculture livelihood generation etc.

Important Output Indicator:

S.No.	Parameters	Output
1	National Conferences Organized, sponsored, and participated	17
2	National Level Online Webinars organized/Participated/talks delivered	27
3	Number of persons who attended various science outreach programs/conferences etc.	195
4	Number of students /Beneficiaries trained	1205
5	Foresight Reports and Analyses Prepared	02
6	Number of Technical papers published	02

5.20 Vigyan Prasar (VP), Noida

The Institute focuses on science communication popularisation & extension. Vigyan Prasar (VP) uses multiple approaches to deliver value-added scientific and technological information/

learning for a wide array of stakeholders. VP has established a network of science clubs and ventured into the areas of science communication, training, gender and technology communication, publishing popular science books/monthly science magazine, developing knowledge products including Audio & Video programmes for Radio and television.

Major Accomplishments:

The noteworthy accomplishment are:

- India Science- 24X7 OTT Channel
- ISTI (India Science Technology and Innovation Portal)
- Publication of Books and Magazines
- Science Communication in Indian languages
- India Science Wire -News Service
- Projects- AWASAR, Tech Nev, Science Communication for Tribal Communities
- Vigyan Prasar Network of Science Clubs, HAM Radio, Activity-Based Kits & Toys
- Gender Technology and Communication
- Science Film Festival
- Nationwide events and exhibitions- Vigyan Sarvatra Pujyate, Swachh Sagar Surakshit Sagar.

Important Highlights of major Programmes:

- India Science, India's only S&T OTT Channel, continued to produce more than 4000 films in the last three years and enhance its reach through its viewership of more than 2M viewers across the country and beyond the national boundaries.
- The OTT Channel produced more than ten serials on topics like success stories of start-ups through Science & Technology, student-led innovations, S&T efforts in India against COVID-19, and more. The Channel was supported by a national-level school engagement called Engage-with-Science, where more than 8000 schools were engaged.



Fig. India Science – India's only OTT Channel

- Vigyan Prasar's India Science Wire (ISW) continued to create ready-to-use news for various print & electronic media of the country in Hindi & English.
- Vigyan Prasar continued to enhance its Science & Technology Communication Popularization & its Extension (SCoPE) activities in Indian languages throughout the length & breadth of the country in various Indian languages.
- In commemorating 75 years of Indian Independence, VSP aligned the themes with 75 locations, 75 films, 75 popular science lectures, 75 posters, 75 books, book fairs, and organised several other scientific activities. 150 posters, 75 each on milestones in Indian S&T and scientists, were developed, designed, and translated into 15 Indian languages.

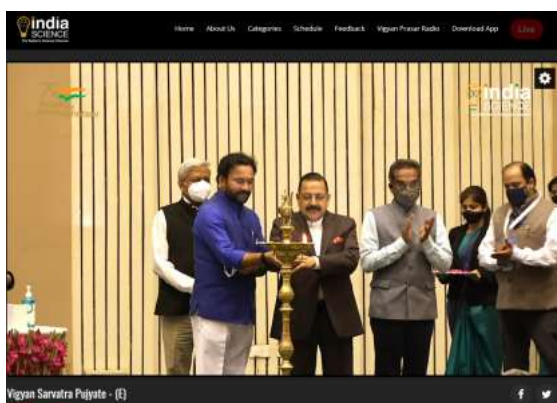


Fig. A glimpse of events being carried out at 75 locations across India

- A nationwide campaign on “Swachh Sagar Surakshit Sagar” culminated on 17th September on International Coastal Cleanup Day covering 75 beaches along India’s 7500-km long coastline to spread awareness about the campaign and for the common people to voluntarily register for various beach cleaning activities.



Fig. Beach Cleaning Drive

- Vigyan Prasar successfully developed a web repository of more than 100,000 science & technology information pages for students, researchers, industry, and the general public in ISTI Portal. The ISTI Portal is generating human capital in STI ecosystem by catering to the captive audience by providing information on research and funding.
- Vigyan Vidushi, a collection of biographies of 75 selected women scientists in the country who were the trailblazers in shaping Indian science, has been published to commemorate 75 years of India’s Independence.
- An extensive study on the Women Technology Parks (WTPs) across the country has been carried out to assess the sustainability and identify the systemic gaps in the technology delivery system.
- A programme “Techneev@75” has been initiated to highlight the impact of science, technology, and innovation in fostering social equity, inclusion, and aspiration. The programme highlighted the impact of STI intervention in empowering communities, whether tribal, rural, or urban. The programme aimed to display the STI capacity at the fundamental level of society and quantify the extent to which STI has permeated various communities and social structures over 75 years of India’s independence. A national conclave was organised to present the learning outcomes, proposed frameworks to strengthen the local livelihood system, and developed multiple models of taking science to the grassroots.



Fig. Techneev@75 – Testimony of Science & Technology of the Community

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	10
2.	Books/Monographs	26
3.	Chapters in Books	12
4.	Papers in Conferences	16
5.	National Conferences Organized	10
6.	State-of-the-art-Reports Published	8
7.	Scientific Outreach Programmes organized	40
8.	Original Science Communication Content Designed	2000
9.	Popular Science Books/Newsletters published	170
10.	A number of persons who attended various science outreach programmes/conferences etc.	80 Lakhs (Approx)

5.21 Indian Academy of Sciences (IASc), Bengaluru

The Academy strives to meet its objectives through promotion of original research and dissemination of scientific knowledge to the community via a variety of activities that include publishing scientific journals magazines, Recognition of scientific talent, to provide inputs for policies that pertain to science and translation, scientific meetings, discussions, seminars, symposia and science education courses and workshops.

Major Accomplishments:

- Over 1515 peer-reviewed articles in 19319 pages have been published in 11 thematic journals and the entire contents are available on a free access platform of the Academy.
- Worldwide visibility to Academy journals increased with more submission of articles. The Impact Factor of many journals increased over 2.
- Thirty-one distinguished Indian scientists were conferred with the Fellowship for their outstanding contribution to Science.
- Seven hundred Nine students and teachers were engaged under Summer Research Fellowship Programme.

Important Highlights of Major Programmes:

- Ten thousand five hundred forty-eight print copies of the monthly journal Resonance journal of science education were circulated to individuals/universities/institutions.
- Ten journals of the Academy are being co-published with Springer Nature and Springer Nature provides access to the journals' content worldwide on its journal platform – Springer Link.
- The academy annually elects distinguished scientists of the country to its Fellowship. It also elects as Honorary Fellows persons, working in institutions outside India, who are distinguished for their contributions to science or engineering. As on 10 December 2022, the number of Fellows on roll was 1101, and Honorary Fellows 48.
- The Associateship programme was introduced in 1983 to identify and encourage promising young scientists. During July 2022, 17 promising young scientists were selected. As on 10 December 2022, the number of Associates on roll was 84.
- The Academy supported educational institutions in the country to hold lecture workshops and refresher courses in all major disciplines of sciences.
- Repository of publications of fellows was strengthened by adding new records.

Important Output Indicators:

S.No.	Parameters	Output
1.	Papers in refereed journals	1515
2.	Books/Monographs	1
3.	Chapters in Books	10
4.	National Conferences Organized	2
5.	Journals Published	11
6.	Scientific Outreach Programmes organized	3
7.	Original Science Communication Content Designed	156
8.	Number of persons who attended various science outreach programmes/ conferences etc.	300
9.	Scientific Lectures/Training Programmes organized	85
10.	Number of students trained	702
11.	Number of school/college/university teachers trained	392
12.	Data Bases Compiled	15

5.22 Indian National Academy of Engineering (INAE), New Delhi

A brief overview of the major activities/achievements of Indian National Academy of Engineering (INAE) is as under:

Major accomplishment:

- To promote translational research, ten nominees were selected for Abdul Kalam Technology Innovation National Fellowship.
- INAE-SERB Youth Conclave on Technology Self- Reliance was organized with a focus on smart infrastructure, experiential interface; experiential learning; digital healthcare; quantum technology; materials for sustainability; food and drinking water.
- A Panel Discussion on “Opportunities and Challenges of Implementation of National Education Policy (NEP) 2020 for Engineering Disciplines and Profession” was organized.

- The SERB-INAE Gaming Conclave was organized as part of the SERB Digital Gaming Research Initiative launched in three directions viz. R&D in Learning & Leisure Gaming Platforms; Immersive Game Prototypes; and Collaborative Technical Design Process. Proposals were invited under this initiative from engineering institutions.
- A Workshop on Writing R&D Grant Proposal for Women Engineers was organized at IIT Tirupati. 35 Women faculty/researchers in Engineering disciplines from Engineering/ Technological Institutions/Universities from the states of Andhra Pradesh, Karnataka, Kerala, and Telangana participated during the event.
- Important Highlights of Major Programmes:
- The Ninth Engineers Conclave-2022 of INAE was organized jointly with Indian Space Research Organization at Liquid Propulsion Systems Centre, Thiruvananthapuram. The two themes were: “Space for National Development” and “Transforming India into a Global Manufacturing Hub”.
- The Compendium on “Women Engineers in India- Volume I” and on “Landmark Achievements in Engineering and Technology in Independent India” was published.
- Study Report on “Housing in India – Challenges and Way Forward” was published to address issues of concern in Housing and suggests actionable recommendations for the way forward.
- The Book on “Future Landscape of Structural Materials in India” was brought out to review the current status, outline the gaps and challenges and suggest solutions to meet futuristic demands of structural materials in India.
- The 16th National Frontiers of Engineering Symposium (NatFoE) Symposium was organized jointly with Jadavpur University and IIT at Jadavpur University, Kolkata. The themes were Field-Deployable Miniaturized Sensors; Waste Valorization and Circular Economy; Resource-Constrained Translational Technology and Nanostructured Surfaces for Functional Materials and Systems.
- The 5th INAE-NAEK Workshop on “Advanced Materials for Sustainable Development” was organized. The workshop focused totally on the “Materials for Quantum Computing” and “Machine Learning for development of Advanced Materials”.

Important Output Indicators:

S.No.	Parameters	Output
1	Books/Monographs	3
2	International Conferences Organized	1
3	National Conferences Organized	13
4	State-of-the-art-Reports Published	1
5	Journals Published	4
6	Popular Science Books/Newsletters published	3
7	Scientific Lectures/Training Programmes organized	60
8	Number of students trained	30
9	Number of school/college/university teachers trained	7

5.23 Indian National Science Academy (INSA), New Delhi

The areas of focus are the Promotion of science in India and harnessing scientific knowledge for the cause of humanity and national welfare.

Major Accomplishment:

Indian National Science Academy (INSA) is a national body of Indian Science devoted to the pursuit of identifying, nurturing excellence in sciences, assisting stakeholders with aspect of policies on science. INSA achieved all its objectives fully in respect of interfacing with international science bodies. The Academy recognizes Indian Scientists excelling in their work by electing them as Fellows covering all sciences, engineering, medicine, agriculture and interdisciplinary research.

Important Highlights of Major Programmes:

- The INSA elected 48 Indian Fellows and 5 Foreign Fellows to the Fellowship.
- INSA organised the “INSA-SERB science writing workshop” at INSA on hybrid mode.
- INSA nominated four scientists for the BRICS Forum on Big Data for Sustainable Development as speaker.
- International Council for Science (ISCU)/ International Science Council(ISC) National Committee meeting held at INSA in which all the Chair persons of National Committee made presentation of their activities of the respective committee. ISC Review Committee meeting held at INSA.
- Indian National Science Academy organized a mini symposium on *Contribution of Basic Sciences towards SDGs* at CSIR-Central Drug Research Institute, Lucknow to celebrate International Year of Basic Sciences for Sustainable Development (IYBSSD 2022).

- 11 Indian Scientists were supported to attend conferences abroad under ISC category.
- One special publication namely “JIDDI – The Zealous Ones” . The book is about unsung Women Scientists of the past.

Important Output Indicators

S.No.	Parameters	Output
1.	National Conferences Organized / Supported	42
2.	Journals Published	3
3.	Scientific Outreach Programmes organized (virtual and hybrid mode)	3
4.	Popular Science Books/Newsletters published	3
5.	Scientific Lectures/Training Programmes organized	24
6.	Number of school/college/university teachers trained (Support to Young faculties under Visiting Scientist Programme)	65

5.24 The Indian Science Congress Association (ISCA), Kolkata

The Indian Science Congress Association (ISCA) is working on the popularization and advancement of science by organizing seminars, symposia, discussions, popular lectures, quiz contest etc. throughout the year.

Major Accomplishments:

- Publications ISCA bi-monthly journal Everyman’s Science.
- Augmentation of ISCA Chapter Activities.
- Organized Seminars, Symposia, Discussions, Workshop etc.
- Science Awareness Programme for Popularization of Science were organized.
- A new chapter.

Important Highlights of Major Programmes:

ISCA chapter across the country have organized several webinars/conferences/seminars and workshop. The topic of few of the webinars/conferences were as follows:

- Trends in Life Science.
- Integrated Approach in Science & Technology for Sustainable Future.

- Science without Boundaries for Sustainable Development.
- Innovations in Science, Engg. And Technology
- Nanomaterials for Clean Energy & Space Astronomy (IWNCESA-2022).
- Impact of Global warming on Environment and Biodiversity.
- Nurturing Science and Technology in Tricity.
- Inter School & College Science Exhibition & Seminar' on national Science Day.
- Integrated Approach in Science and Technology for Sustainable Future.
- Science Orientation Program.
- Ecosystem Restoration and Sustainable Development
- National Scientific Conference on Multidisciplinary Research
- International Conclave on Use of Technology in Health care and Medical Sciences Sustainable Health Science for Future Generations
- Microbiome Literacy for better management of Human Health, Environment and Society
- The cold is getting Warmer
- Green Technology: Issues and Challenges
- Innovation and Entrepreneurship in Chemical Science for Inclusive Curriculum
- Science and Technology for Sustainable Development with Women Empowerment

Important Output Indicators:

S.No.	Parameters	Output
1.	Journals Published	2
2.	Scientific Outreach Programmes organized	40
3.	Number of persons who attended various science outreach programmes/ conferences etc.	1000
4.	Scientific Lectures/Training Programmes organized	14
5.	Number of students trained	300
6.	Number of school/college/university teachers trained	50

5.25 The National Academy of Sciences-India (NASI), Allahabad

Area of focus of the NASI are Promotion & Popularization of Science & Technology to aid & advise in Policy Making. The Academy continued to promote Science & Technology by regularly organizing several activities with the help and support of its Fellows and Members. During the year of the report, the following activities were undertaken.

Major Accomplishments:

- NASI published the Proceedings of NASI, Sec. A & B, each in IV parts and National Academy Science Letters in VI parts, in collaboration with the Springer Nature.
- National Academy Science Letters received Impact Factor (IF) as 0.649 in 2022 from Thomson Reuters; about 765 papers were received from eight countries/regions.
- PNASI, Sec. A received Impact Factor (IF) as 1.291 in 2022 from Thomson Reuters; and about 300 papers were received from twenty five countries/regions.
- The PNASI, Sec. B received Cite Score as 1.404 in 2022 from Scopus; and about 750 papers were received from forty-five countries/regions.
- NASI-ICMR Awareness Programme for “Covid-19 Pandemic Appropriate Behaviour”. was started in four states-Uttar Pradesh, Rajasthan, Orisa & Karnataka. The awareness programme was implemented considering the local issues, their needs, life style, custom etc. General Protection, proper vaccination acceptability, overall sanitation, preventive & protective measures of health were the focused points during the implementation of the programme.

Important Highlights of Major Programmes:

- NASI-HQ and it's 22 Chapters spread across India, organized several science education/communication activities (presently on WEB) in and around their respective regions. The main activities included Children Science Meets, Teacher's Training Workshops, Vigyan & Health Chaupals, Seminars, and celebration of the National Technology Day, the National Science Day, the National Constitution Day, the National Mathematics Day and the World Environment Day etc. The Academy also encouraged the teachers for out-of-the- class science activities by organizing special workshops/training to them.
- NASI, together with other two Science Academies, viz. Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore jointly sponsors Summer Research Fellowship under the joint Science Education Panel.

- About 22 Tribal centers were established which are working on different thrust areas, identified on the basis of first-hand information collected by the Chapters/resource persons. Several Awareness Camps have been organized in last 3-4 years with the intention of welfare of the tribal's by solving their problems.
- The 92nd Annual Session of the NASI, was organized, which was attended by more than 250 dignitaries and the participants; a symposium on “Science & Technology – A Vehicle for Social Transformation” celebrating 75 year of India’s Independence-Azadi ka Amrit Mahotsav, was also held during the session. Several scientific papers were presented.

Important Output Indicators:

Sl. No.	Parameters	Output
1.	National Conferences Organized	14
2.	Books/Monographs/Book-Chapters	15
3.	Journals Published	PNASI-A-Four Parts; PNASI-B-Four Parts; Sci. Letters – Six parts
4.	Scientific Outreach Programmes organized	102
5.	Refresher Course	03
6.	Original Science Communication Content Designed	05
7.	Popular Science Books/Newsletters published	05
8.	Number of persons who attended various science outreach programmes/conferences etc.	More than One lac
9.	Scientific Lectures/Training Programmes organized	73
10.	Number of students trained	1789
11.	Number of school/college/university teachers trained	503
12.	Number of Innovators trained (Summer Research Fellowship)	497
13.	Data Bases Compiled (Repository, Referees, Mentors, Fellows & Associates, Summer Research Fellows)	05
14.	Research Papers Published (by the NASI-Chairs/Senior Scientists/Hony. Scientists)	222
15.	Training/Outreach Programme for the SC/ST Population	21 Programmes involving more than 1000 tribals

SCIENCE AND ENGINEERING RESEARCH BOARD

The Science and Engineering Research Board (SERB), a Statutory body of Department of Science and Technology (DST) has taken several significant steps in advancing R&D in frontier areas of science and engineering in the country. The SERB (Board) interventions mainly aim to support the R & D projects in core areas of science, engineering and its interdisciplinary fields, targeting the young scientists/researchers to start/initiate their research through specific calls and fellowships programmes in view of equity and inclusion. In addition, SERB takes new initiatives through need-based calls to trigger the research in national interest and emerging technologies.

6.1 Ongoing Initiatives:

Promoting Opportunities for Women in Exploratory Research (SERB-POWER)

The SERB has been implementing POWER scheme, specially designed to provide structured effort towards enhanced diversity in research to ensure equal access and weighted opportunities for Indian women scientists in regular services to mitigate gender disparity. It has two delivery modes: Fellowship and Research Grant:

SERB-POWER Fellowship

A three year fellowship with personal emolument of Rs. 15,000/- per month in addition to regular income and a Research grant of Rs. 10 lakh per annum are provided to Women Scientists under this mode. A total of 9 nominations for SERB-POWER Fellowship were recommended in the first-round selection.

SERB-POWER Research Grant

The POWER research grant empowers women researchers under following two categories:

- Level I (Applicants from IITs, IISERs, IISc, NITs, Central Universities, and National Labs of Central Government Institutions): The scale of funding is up to 60 lakhs for three years.
- Level II (Applicants from State Universities/Colleges and Private Academic): The scale of funding is up to 30 lakhs for three years.

A total of 232 women scientists were sanctioned R&D projects under SERB-POWER grant.

Fund for Industrial Research Engagement) (SERB-FIRE)

The SERB-FIRE is an initiative under the Industry Relevant R&D (IRRD) Scheme of SERB aiming to support research and development to solve critical problems having to industries in a public private partnership mode through which industries become partner of academics bearing 50% of the cost. The program has been conceived in collaboration with Intel India, GE India and Applied Materials India Private Limited (AMAT). FIRE addresses wide set of research opportunities in the space of Artificial Intelligence (AI)/ Machine Learning (ML), platform systems, circuits & architecture, Internet of Things (IoT), materials & devices, security, next-generation gas turbines, additive manufacturing, engine services technology, electrical systems, digital technologies etc.

Empowerment and Equity Opportunities for Excellence in Science (SERB-EMEQ)

EMEQ scheme is aimed to provide research support to researchers belonging to the Scheduled Caste and Scheduled Tribe to undertake research in frontier areas of Science and Engineering. Support consists of a project grant upto Rs. 50 lakh excluding overheads for a three-year duration. In the reporting period a total of 1046 proposals were considered out of which 252 proposals were recommended.

Scientific and Useful Profound Research Advancement (SERB-SUPRA)

The scheme aims to explore new scientific breakthroughs, challenging the existing hypothesis and offer disruptive technologies at the cutting edge. The proposed research is expected to contain significant risk elements but promise of high reward if the difficulties could be circumvented. The funding is provided normally for a period of three years. During the year, a total of 353 proposals were received under the SERB-SUPRA scheme out of which 89 were selected for second phase evaluation.

Accelerate Vigyan

Accelerate Vigyan is an inter-ministerial initiative scheme conceptualized and steered by SERB. 'ABHYAAS', a program of Accelerate Vigyan scheme, is an attempt to boost Research & Development in the country by enabling and grooming potential PG / PhD level students by developing dedicated research skills in selected areas / disciplines / fields through its two components- High-End Workshops ('KARYASHALA') and Training and Skill Internships ('VRITIKA'). This is especially important for those researchers who have limited opportunities to access such learning capacities / facilities / infrastructure. Out of the 610 and 273 applications received under Karyashala and Vritika, total 131 and 85 applications were recommended for support respectively by the ABHYAAS Expert Committee (AEC).

SERB National Postdoctoral Fellowship (NPDF)

NPDF programme is designed to support and foster highly potential young researchers in leading research labs with accomplished mentors. The support consists of fellowship of Rs. 55,000 per month plus HRA, research grant of Rs. 2 lakh per annum and overhead for a period of two years. One call for proposal was solicited and received 3833 applications. In the reporting period 301 SERB NPDF fellowships were recommended.

Start-up Research Grant (SRG)

The SRG programme aims to assist newly appointed scientists/academicians to initiate their research career in a new institution. The support comprises of a flexibly structured research grant of Rs. 30 lakh plus overheads for a period of two years. A total of 510 projects out of 2283 were recommended under SRG in the year 2022-23.

SERB-International Research Exposure (SIRE)

This is a program to initiate imparting high-end research training in frontier areas of Science and Technology for young scientists. The candidates selected under this program will be supported for a period of 02-06 months to visit top institutions around the globe, preferably to the institutions where internationally acclaimed scientists are working. The first call for proposals was announced and received 789 proposals for consideration out of which 194 were recommended for funding.

Project Information System & Management (SERB-PRISM)

SERB has developed a real time information retrieval portal “SERB” that provides information related to research support extended by SERB over the years. It provides a platform to provide project details, research outcomes, facilities created and their achievement, making a strong scientist-scientist and science society connect.

6.2 New Initiatives:

State University Research Excellence (SURE)

The SERB-SURE is a new scheme launched to augment the research capabilities in a structured way and create a robust R&D ecosystem in state universities and colleges by fostering collaboration for high-end research. The growth of existing research capabilities at these institutions is imperative to ensure horizontal diffusion of research excellence reaching all research students hoping to contribute to the national R&D ecosystem and promoting the enhancement of quality through SERB support. The first call for proposals was announced and received 5599 proposals for consideration.

SERB-POWER Mobility (SPM)

To provide avenues to women scientists and technologists for capacity building, knowledge, and skill enhancement at the global level, SERB proposes to launch “SERB-POWER Mobility Grant” under the POWER Scheme. This Program aims to impart high-end research training and collaborative research to select women scientists in frontier areas of Science and Technology which will interest to India by providing opportunity to visit leading institutions/ universities across the globe for a period of 01-03 months.

SERB POWER Translation Grant

SERB -POWER Translational verticals is envisaged to encourage women researchers to translate their innovative ideas, discoveries and inventions. This will catalyse the spirit of entrepreneurship among women researchers from tier I and tier II institutions. This program will challenge women scientists executing SERB grants, such as CRG, to establish an effective, functional and synergistic working collaboration with an industry partner to elevate their breakthrough results and technologies to TRL level 5 and beyond.

Special Call on Wearable Electronics for Biomedical Applications

Mobile health technologies offer great potential for reducing healthcare expenses and improving patient treatment. Wearable technological solutions are providing a transformation in the mobile health era in terms of improvising healthcare and providing real-time analysis on improved health management and tracing. A special call was announced to catalyze R&D to develop portable, wearable & implantable electronic devices that are essential for medical purposes such as diagnosis, examination, treatment, care, assistance, and research. A total of 401 proposals were received in this call and 29 project proposals were recommended for financial support.

SERB-INAE Online and Digital Gaming Research Initiative

Advances in digital services, virtual technologies and the anvil of 5G and 6G services, will usher online gaming tools for education, entertainment and utility purposes. Focused studies with online and digital gaming tools could be applied to the board and video games, puzzles, ability enhancement games, and online content that will aid the development of digital games centred on ethos and values. It is quite useful for the horizontal diffusion of digital and online gaming tools in S&T disciplines along with contribution to social sciences such as sociology, psychology, values and ethos. Considering the above, in association with the Indian National Academy of Engineering (INAE) as a knowledge partner, the “SERB-INAE Digital Gaming Research Initiative” was launched and a call for proposals was made.

6.3 SERB on COVID-19

The Board was in forefront in initiating value-added programmes to address different facts of R&D management on COVID-19 pandemic. The Board continued its support in key R&D initiatives on COVID-19 by identifying projects through CRG COVID-19 Calls, IRHPA COVID-19 Calls and MATRICS COVID-19 Calls.

6.4 Research highlights

Research highlights of one EMEQ project is depicted below:

Combinatorial effect of Myc and Glycogen Synthase Kinase 3 (GSK3) modulation in pathogenesis of human neurodegenerative tauopathies in *Drosophila* disease models:

Tissue specific co-suppression of Myc and Glycogen Synthase Kinase 3 (GSK3) causes additive rescue against tau mediated neurodegeneration is reported for the first time. Intriguingly, the rescue flies exhibited almost a complete suppression of the neurodegenerative phenotype. In view of the fact that tau hyperphosphorylation is one of the major causes of the tau mediated neurotoxicity, hence the status of tau hyperphosphorylation in various genotypes was examined. The findings suggest that some of the Myc and Gsk3 β limiting molecules which are already being utilized in cancer therapy may be repurposed for restricting the pathogenesis of devastating human neuronal tauopathies. The study is in progress at University of Delhi, South Campus.

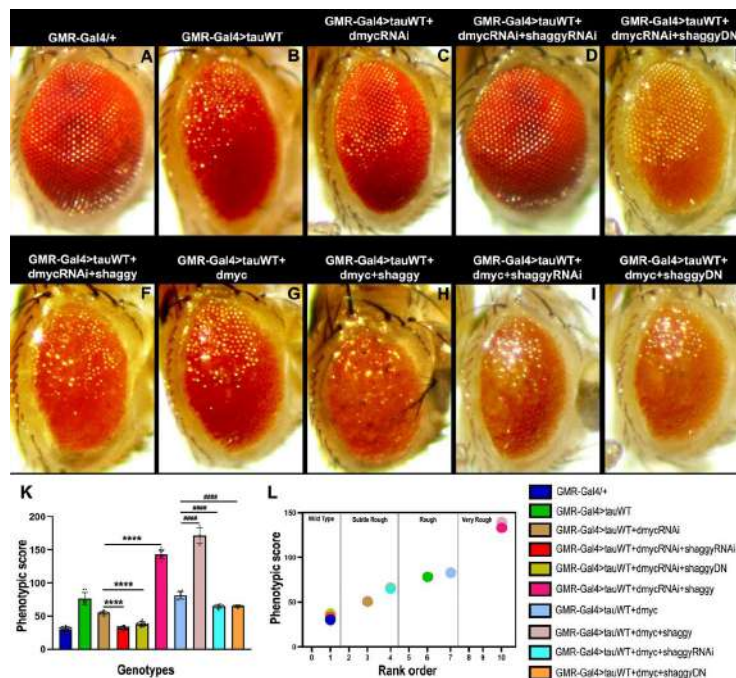


Fig. (A-J) Bright-field microscopy images of age-matched adult *Drosophila* eyes. (K) The graph shows a quantitative assessment of ommatidial fusions observed on the external eye surface of adult flies analyzed using Flynotyper J software. (L) Graph representing a positive correlation between mean phenotypic scores and phenotypic rank of control and other transgenic flies.

Research highlights of one SRG project is depicted below:

Production of a nanocomposite sealant from aquatic-derived waste materials:

The primary objective of the study was to develop an affordable and green sealant and demonstrate the sealant application in concrete for plugging micro-cracks. An affordable and environmental-friendly film-forming nanostructured bio-composite sealant of tuneable viscosity was developed. The composite is comprised of graphene-oxide and chitosan, derived from bio-waste chitin, through a soft chemical route at ambient conditions. The product named ‘Eco-Nanoseal’ is hydraulically stable and has desired qualities of a microcrack sealant, including tuneable viscosity and the ability to form an impermeable plug under an alkaline environment, quick-setting, and excellent ability to bind with concrete surface chemically. Besides, the product is low-cost and has less embodied energy. These properties make the sealant a potential alternative to conventional chemical grouts for healing microcracks in concrete. Due to its low viscosity and nanostructure, the composite can penetrate the pores and solidify to form a strong plug with concrete and enhance its compressive strength. This study is being done at IIT Tirupati.

6.5 Events organized

A women conclave entitled “**Women in Science & Technology: Fostering Innovation**” was held during 29-30th sept. 2022 at IIT Gandhinagar. The event was organised with the aim to encourage women researchers, scientists and engineers to translate their innovative ideas into technology. For that the women PIs working in SERB projects under POWER, IMPRINT-II and CRG (Engineering) with the potential of translational research were invited to participate. Around 150 participants were present during the Conclave. The conclave provided a platform to interact with Industry and academicians with the experience to work with industry. The event helped the participants to instil within them, the spirit of entrepreneurship as it facilitated the face to face discussions with Industry people about the translational research.



Fig. Women Conclave Organized by SERB at IIT Gandhinagar during 29th-30th September, 2022

- (ii) A two-days Professional Advancement Program for Indian Women Researchers in STEM, sponsored by SERB was organized at Doon University Dehradun (Uttarakhand) during 02nd-03rd June 2022. Enhancing the skills and competence of women scientists and academicians (engaged in research and development activities) was the main purpose of the program. Additional objectives were to sensitize, inspire and orient the women researchers in STEM for translational research and enable them to acquire competence for ensuring equal access and weighted opportunities in government funding schemes and their scientific growth. About 500 participants including, POWER (Promoting Opportunities For Women in Exploratory Research) grantee, women researchers and young faculty members from various states of the country attended the program. Some researchers from high hills of Uttarakhand also participated.

TECHNOLOGY DEVELOPMENT BOARD

Technology Development Board (TDB) is a statutory body under Department of Science & Technology with a mandate 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 Board was constituted through Technology Development Act, 1995 and has commenced its activities from 1st September, 1996. In pursuance to its mandate, TDB accepts applications for financial assistance throughout the year from all sectors of economy such as Health & Medical, Engineering, IT, Chemical, Agriculture, Telecommunications, Road Transport, Energy & Waste Utilization, Electronics, Defence, Civil Aviation, Textile etc.

7.1 Agreements signed during 2022-23

During the year 2022-23 (upto December, 2022), TDB has signed nine (9) agreements for providing financial support to various industrial concerns. The details of the same are as under:



Fig. Signing of Agreement with M/s Panacea Medical Technologies Pvt. Ltd., Bangalore

- TDB, an invisible thread in the development of the Indian Healthcare Ecosystem is providing an impetus to India's vision of becoming a global manufacturing hub for medical devices. TDB has signed an agreement with M/s Panacea Medical Technologies Pvt. Ltd., Bangalore to provide financial support for development and commercialisation of "S Band Tunable Magnetron for Particle Accelerators". The

Board has agreed to provide loan assistance of ₹4.87 crores, out of the total project cost of ₹9.73 crores to the company vide Loan Agreement dated 25.05.2022.



GigaMesh
Fig. World's First Multi-Beam E-Band Wireless Radio

- TDB has supported M/s Astrome Technologies Private Limited, Bengaluru for Productization and Commercialization of 'GigaMesh Solution for delivery of 4G/5G Telecom and Internet services for Defence and Rural Sectors'. To solve Internet Woes of Rural India, TDB has agreed to provide financial assistance of ₹2.97 crores, out of the total project cost of ₹19.79 crores to the company vide Loan Agreement dated 23.07.2022.
- TDB has agreed to provide financial support of Rs. 3.29 crores to M/s Kritsnam Technologies Private Limited, Ranchi, Jharkhand for commercialization of 'Dhaara Smart Flow Meter' vide Loan Agreement dated 16.08.2022. Kritsnam is a Startup Company, incubated at IIT Kanpur, working on the projects to develop smart water management technologies.



Fig. Signing of Agreement with M/s Kritsnam Technologies Pvt. Ltd.



Fig. Dhara Smart Flowmeter

- TDB has agreed to provide financial support of Rs. 3.29 crores to M/s Multi Nano Sense Technologies Private Limited, Maharashtra for commercialization of Novel Products from Indigenously Developed Patented Hydrogen Sensing & Analysis Technology. The Board has pledged to provide financial assistance of Rs.3.29 crores to the startup vide Loan Agreement dated 16.08.2022.



Fig. Multi Nano Sense

- TDB has extends financial support to M/s TGP Bioplastics Private Limited, Satara, Maharashtra for 'Commercialisation of Degradable Plastic Manufacturing.' The Board has pledged to provide ₹1.15 crores loan assistance to this startup to mitigate usage of Single Use Plastics vide Loan Agreement dated 16.08.2022.



Fig. Signing of Agreement with M/s TGP Bioplastics Pvt. Ltd., Maharashtra



Fig. Degradable Plastic Manufacturing

- TDB has supported M/s Fountainhead Agro Farms Private Limited, Navi Mumbai, Maharashtra for 'Advanced, Intensive, All Male Tilapia Aquaculture Project with Israeli Technology'. The board has penned an mutual agreement, to provide loan assistance of Rs. 8.42 crores out of the total project cost of Rs. 29.78 crores to the company vide Loan Agreement dated 17.08.2022. The company has adopted advanced Israeli Technology from Aquaculture Production Technology Limited (APTIL), Israel (under Technology Service Agreement signed in October, 2020) for land locked locations through closed loop farming for arid zone with seasonal water supply from rivers,

which may be replicated throughout India in multiple arid landlocked locations with reasonable water sources.

- TDB has supported M/s Ghaziabad Precision Products Private Limited, (GPP), Ghaziabad, Uttar Pradesh for 'Development by Critical machining & Inspection process of accessory components of SU-30MK1 Aircraft viz. Rotary Pipe Union & Cover respectively, valve train components of 1500 HP Battle Tank Engine and valve train components of Engine Components of Regular BEML Engines.' TDB has approved assistance of ₹5.5 crores out of ₹14.2 crores of the total project cost vide Loan Agreement dated 12.09.2022. Through this project, the company aims to set up a facility for the development and supply of critically machined accessory components of 'SUKHOI-30MKI' to Hindustan Aeronautic Ltd (HAL) and valve train components of 1500 HP 12V, 25 Litres capacity diesel engine of Armoured Fighting Vehicle (AFV) being developed by Combat Vehicles Research and Development establishment (CVRDE), Avadi and regular Bharat Earth Movers Limited (BEML) engine to BEML.
- TDB entered into a Loan Agreement with M/s Kriya Medical Technologies Private Limited, Chennai on 31st October 2022, to provide financial assistance of Rs. 4.00 crores out of the total project cost of Rs. 9.00 crores for project "Development and Commercialization of Saliva Direct Sample Collection Kit".



Fig. Saliva Direct Sample Collection Kit

The company, with this assistance, aims to manufacture and commercialize a saliva collection kit with a Molecular Transport media (MTM) that will advance molecular diagnosis of infectious diseases. At the start of the COVID-19 pandemic, the company came out with India's first domestic, ICMR-approved nasopharyngeal swab-based sample collection kit along with an innovative Safe Viral Molecular Transport Medium. The company successfully manufactured the kits and supported government hospitals and leading lab chains during times of international crisis.

- TDB entered into a Loan Agreement with M/s Planys Technologies Pvt. Ltd., Chennai on 20th December 2022, to provide financial assistance of Rs. 1.50 crores, out of the total project cost of Rs. 3.06 crores for project “Commercialization of ROVs”.



Fig. ROV for Port and Terminals

The company has approached TDB to help them commercialize the application of their ROVs with suitable enhancements. The project envisages building of 3 ROVs for inspection and monitoring of ports & terminals, process industry plants and civil structures.

- (a) The ROV for Ports and Terminals- This will make the overall inspection cost effective, safer and 3 times faster than traditional methods. This will also save the local environment and maintain ecological balance as marine growth can grow densely in some regions.
- (b) The ROV for Process Industry- This is very attractive to the industry as it will increase their operational efficiency (no shutdown required) and much safer than sending people inside. Several process industries can benefit from this in India and this will be for the first time a free-floating ROV will be able perform this.
- (c) The ROV for Civil Structures- This will allow the integrity testing of concrete structures that will help the asset managers understand the health better. These will allow them to detect defects inside the concrete structures that are perennially in water. Planys also intends to upgrade to LINE LASERS for defect quantification (especially depth of the cavities) which today is impossible to do. This robotic system developed will be one of its kind in the global industry.

Additionally, the company would also develop AI based reporting platform for infrastructure real-time monitoring using Internet of Underwater Things (IoUT).

7.2 Call for Proposals

This year TDB has taken out many call for proposal of specific sectors. The details are given in succeeding paragraphs.

7.2.1 “Technology interventions towards “Garbage Free Cities”

This year on May 03, 2022, TDB initiated a call for proposal in line with vision of Swachh Bharat Mission-Urban 2.0 to contribute in accomplishment of scientific waste processing for ‘Garbage Free Cities’. Through this Call for Proposal- **Technology intervention towards “Garbage Free Cities”**, applications were invited from Indian companies having innovative/ indigenous technologies at commercialization stage in this sector. The scope of the call was in line with the various waste management legal framework. Aim of this call was to explore and find affordable and adaptable technologies for waste management creating a positive socio-economic impact. The proposed innovative solutions were in waste to value, e-waste, plastic waste, AI based solutions, Bio Medical Waste (BMW) etc. domains.

7.2.2 “Innovative / Indigenous technologies for enabling commercialization in Space and Aviation Sector”

Dependence on Space assets has increased over past few years and therefore the space-based applications have seen rapid growth in various sectors such as agriculture, transport, smart cities, weather forecasting etc. In order to encourage the private sector participation in entire range of space activities the government has opened up the space sector to private players. In this endeavour, TDB on 12th July, 2022 launched a Call for Proposal in Space and Aviation Sector to invite proposals from Indian Companies with Innovative / Indigenous technologies for enabling commercialization in Space and Aviation Sector.

7.2.3 “Supporting commercialisation of Innovative Technologies towards Sustainable Agriculture”

TDB on 3rd August 2022 issued a Call for Proposal for “Supporting commercialisation of Innovative Technologies towards Sustainable Agriculture” inviting applications from private limited companies for commercialization of Innovative Indigenous Technologies in Agriculture and allied sectors. The aim of the call was to provide financial assistance to industrial concerns for improving efficiency of agricultural production through innovative technologies for raising farmer’s income.

7.2.4 “Green Technology interventions towards Sustainability”

This year on September 23, 2022, a call for proposal in the Area / Theme: “**Green Technology interventions towards Sustainability**” was announced. TDB initiated this Call to help in mitigating the climate change and reducing the greenhouse gas emissions. Climate and

clean technology companies will play vital role in deploying low-carbon innovations with global impact, helping India to achieve climate goals. Proposals were invited from the Indian companies having innovative and indigenous product/ technologies at commercialization stage. The innovative and environmental friendly technologies are to assist and facilitate stakeholders to adopt appropriate environmental friendly technologies. The proposed innovative solutions were in battery systems, hydrogen production, Air Purifier, Motors, Climate resilient agriculture, Bio-fuel, Food-tech, Waste management, Sustainability in minerals and materials, Energy Efficiency etc. domains.

7.2.5 “Enabling commercialization in Pharmaceuticals Innovations”

TDB issued a call for proposals on 1st November, 2022 inviting applications from Indian Companies ready for commercialization of innovative Indigenous Technologies in ‘Pharmaceuticals and Medical Devices’ under the following areas:

- **Novel Drugs, biosimilars, vaccines, APIs**
- ***Technological innovation in process and/or efficient manufacturing practices of pharmaceutical** with special emphasis on green technologies and technological platforms not available in India.
- **Import Substitution:** Domestic Manufacturing of critical Key Starting Materials (KSMs), Drug Intermediates, Active Pharmaceuticals Ingredients (APIs) etc that are heavily imported
- **Innovative Medical Devices**

7.2.6 “Accelerating towards ‘Self Reliance’ through Innovations in Advanced Materials”

Advanced Materials are at the heart of many technological developments that touch our lives. India has its own unique set of resource and technological challenges. A call for proposal on 5th December, 2022 was made to invite applications on “Accelerating towards ‘Self Reliance’ through Innovations in Advanced Materials” comprising of subdomains such as Structural Materials (steel, light alloys, Advanced Composite Materials, Particulate Materials, Ultrahigh Temperature Materials); Functional Materials (Electronic Materials, Energy Materials, Optoelectronic Materials and Devices, Smart Materials, Earth Abundant Element Based Functional Materials and technical textiles); Emerging Materials (Nanomaterials, Biomaterials and Devices, Polymeric and Soft Materials, Glassy and Amorphous Materials, Bio-Inspired and Patterned Functional Materials) and any other innovation in field of materials with funding as per TDB guidelines.

7.3 New Initiative

7.3.1 Nomination of TDB as Central Nodal Agency by DST for implementing Central Sector Schemes

DST has nominated TDB to act as Central Nodal Agency for two of the Central sector Schemes, namely, NM-ICPS (National Mission on Interdisciplinary Cyber physical Systems and Science & Technology Institutional & Human Capacity Building).

7.4 Participation in National Conference / Seminars / Other Events_

7.4.1 TDB celebrated 8th International Yoga Day, 2022



TDB celebrated 8th International Yoga Day, 2022 themed “Yoga for Humanity’. The event held at IIT Delhi campus was led by Acharya Dr. Ramesh Puri Ji & saw participation of Secretary, TDB along with other senior officials, staff members and their families.

7.4.2 TDB hosted young batch of IP&TAFS probationers to TDB’s office

Dr. Srivari Chandrashekhar, Secretary, Department of Science and Technology, Government of India & Chairperson, TDB touched upon his vision of positioning Science & Technology, at the centre-stage of the nation building. Whereas, Sh. Rajesh Kumar Pathak, IP&TAFS, Secretary, TDB and Sh. Akhilesh Jha (ICAS), Chief Controller of Accounts, DST gave an insight on Public Finance Management System (PFMS) & MANAK scheme of DST and project finance system of TDB, respectively.



STRENGTHENING SURVEY AND MAPPING ACTIVITY

8.1 Survey of India

Survey of India (Sol), the National Survey and Mapping Organization of the country, set up in 1767, is the oldest scientific organization in the country. It acts as adviser to the Government of India on all Geospatial matters, such as geodesy, photogrammetry, mapping, map reproduction, international boundaries. The following are the major activities carried out during 2022-23:

8.1.1 Departmental Activities:

- High Resolution National Topographical Data Base (HRNTDB):

The rapid economic development in the country requires proper planning and utilization of available resources which needs accurate mapping at optimum resolution. Survey of India has undertaken preparation of HRNTDB for entire country by using High Resolution Satellite Imageries (HRSI) to cater for accurate high-resolution data requirements/demands from various users and organisations. The following activities are being carried out for generation of HRNTDB:

- i. Data Acquisition using professional Survey Grade Drones/ Aerial Photography/ HRSI
- ii. Ground Control Provision (GCPs)/ High Precision Levelling
- iii. Geo-referencing of HRSI/Data Processing/Orthorectification
- iv. Feature Extraction
- v. Ground Validation
- vi. Establishment of Continuously Operating Reference Stations (CORS)
- vii. Geoid Model Development
- viii. Preparation & updation of Administrative Boundary Database
- ix. Toponymy (Place Names)

Achievements:

- **HRNTDB:**

- ✓ GCP Provisioning = 10,95,698 sq. km.
- ✓ Geo-referencing completed till date = 10,38,141 sq. km.
- ✓ Feature extraction: 7,98,022 sq. km.

- **Geoid Model Development:**

Sol is developing the Geoid Model for the entire country with the accurate relationship between the geoid and WGS-84 Ellipsoid, so that heights given by satellite-based technologies and products viz., GNSS, satellite imageries can be directly converted to the orthometric heights with geodetic accuracy. Geoid Model Development for the states of Uttar Pradesh, Part of Uttarakhand, West Bengal, Bihar, Goa, Punjab and Jharkhand has been completed. It is under progress for Andhra Pradesh and Telangana region in current financial year, which will be expanded to rest of the country.

- **Continuously Operated Reference Station (CORS) Network:**

Survey of India (Sol) is mandated to maintain the National Spatial Reference Frame (NSRF) of the country. It has undertaken modernization of NSRF by establishing Continuously Operating Reference Stations (CORS). A total of 1018 CORS stations have been planned to be established. As on date 85% of the stations have been installed. Country wide CORS completion is likely to be completed by March, 2023. To promote the use of CORS, Sol is offering CORS services free of cost to all the Indian entities upto March 2023.



Fig. CORS Station

- **International Boundary:**

The 5th Joint Boundary Conference (JBC) between India and Bangladesh was held from 21st to 23rd November, 2022 at Dhaka, Bangladesh. The Indian delegation was led by Sh. Sunil Kumar, JS (DST) & Surveyor General of India.

The Joint Technical Level Meeting between Survey organization of India and Bhutan on Bhutan–India boundaries tasks was held at Phuentsholing, Bhutan from 12-13 October, 2022. The delegation from Survey of India was led by Col Ranjan Negi, Director, Meghalaya & Arunachal Pradesh GDC, Shillong and Bhutanese delegation was led by Mr. Sangay Dorji, Director, Specialist, International Boundaries, Bhutan.



Fig. Joint Technical Level Meeting between India & Bhutan

- Onlinemaps Portal (<https://onlinemaps.surveyofindia.gov.in/>):

Sol has launched the “onlinemaps” portal on 17th of August 2021 for ease of access to Geospatial Data. The portal provides a range of digital products like Digital Geographical Map, Railway Map, Political Map, Digital Geographical Road Map, Digital Geographical Physical Map of India, Open Series Map Scale, and so on to citizens of India.

- 4544 Maps in PDF format are available on the portal.
- 43458 Individuals/private and 288 Govt. organization are registered with the portal.
- 405199 Free products (PDF) downloaded.

- Spelling of Geographical names:

New names / Change names request received for 29 Railway Stations, 16 places and 21 Islands names were processed for Standardised /Romanized spelling as per Indian System of Transliteration. These requests are duly verified in the field by State Geo- spatial data centres before submission to the DST/MHA.

8.1.2 Extra-Mural Projects:

- SVAMITVA:

Large scale mapping on 1:500 scale of the rural *abadi* areas using Professional Survey Grade UAV/ Drone for villages across the country is being undertaken by Ministry of Panchayati Raj (MoPR), Govt. of India under *Central Sector scheme “SVAMITVA”*. Survey of India has been

entrusted with the mapping work which includes establishment of Continuous Operating Reference System (CORS) network, Geoid model development, generation of GIS maps. The work components include data acquisition using professional survey grade drones; processing of data captured; feature extraction; attribute linkage to the extracted features; generation of land parcel maps.



Fig. Data acquisition using Professional survey grade drone

Achievements:

Activities	Data acquisition (villages)	Data processing (villages)	Feature extraction (villages)	Final GIS data submitted (villages)
	206003	195885	179581	84341

- National Hydrology Project (NHP):

Sol is carrying out high resolution mapping for major river basins. The objective is to provide the high-resolution GIS and Digital Elevation Model (DEM) to help improve the planning, development and management of water resources as-well-as flood forecasting and reservoir observations in real time. Sol has been tasked to generate, prepare and provide various types of Geo-spatial datasets i.e. for mapping/ preparing the Digital Elevation Model (DEM) of 0.5m & 3-5m for River Basin areas (plain), up to 5 km on either side of the river, GIS ready database on 1: 25 K scale, creation of Geoid model of 10 cm. accuracy.

Achievements:

- **Generation of 0.5 m Digital Elevation Model (DEM) for approx. 71,204 Sq.Km:**

Activities	Data Capturing (sq. km.)	Data Processing (sq. km.)	DEM Generation (sq. km.)
	54041	52837	51947

- **Generation of GIS data & 3-5 m Digital Elevation Model (DEM) for approx. 8.35 lakh**

sq. km.:

- ✓ Digital Data generation – 5,95,812 sq.km. completed

This project is an integrated conservation mission, aims towards effective abatement of pollution and conservation & rejuvenation of the national river Ganga. Survey of India has been tasked to generate High Resolution Digital Elevation Model (DEM) of 0.5 m resolution for part of River Ganga covering up to 10 km extent on either sides of the river using latest technology. **Total Project area is 44,526 sq. km.**

Achievements:**a) 0.5 m Digital Elevation Model (DEM) and GIS ready database**

LiDAR Data Acquisition completed.

Feature Extraction completed – 72%

b) Web Hosting & Application Development

Development of customised application development is under progress.

- Large Scale Mapping for States

Large scale mapping project, to generate up-to-date digital topographical map covering revenue villages in all districts using Professional Survey Grade Unmanned Aerial Vehicle/ Drone have been carried out for Haryana, Karnataka, Andhra Pradesh, Andaman & Nicobar.



Fig. Large scale mapping of revenue villages

- Geomagnetic Observations (Sabhawala Observatory):

Magnetic Observatory, Sabhawala- Automated recording for the variation of three geomagnetic elements i.e., Horizontal Force (HF), Vertical Force (VF) and Declination (D) throughout the year. Absolute measurement from Declination Inclination Magnetometer (DIM) and ENVI Mag has been done in order to control the baseline values of variographs. Data has been made available for scientific studies to other Govt departments also.

- Publication of Indian & Hugli River Tide Tables:

Indian Tide Table-2023 & Hugli River Tide Table -2023 have been published.

8.1.3 Other Activities:

The National Survey Day celebration on 10th April 2022 was organised at Brig Gambhir Singh Survey Auditorium, Hathibarkala Estate, Survey of India, Dehradun. The event was graced by **Hon'ble Governor of Uttarakhand, Lt. General Gurmeet Singh PVSM, UYSM, AVSM, VSM (Retd).**



Survey of India was awarded the 'Memento of Appreciation' on 5th July 2022 from Ministry of Jal Shakti for our contribution in National Hydrology Project.



During 2022, Sh. Sunil Kumar, Surveyor General of India has been elected as UN-GGIM Vice-President for the Asia-Pacific region. One chair position and three vice-chair positions

at UN-GGIM AP are being held by SOI officers.

8.2 National Atlas & Thematic Mapping Organisation (NATMO):

National Atlas and Thematic Mapping Organisation (NATMO) started its journey in 1956 for compilation of National Atlas of India as a leading mapping organisation under the administrative control of Department of Science & Technology, Govt. of India.

8.2.1 Major Activities and Achievements during the year 2022:

- District Planning Map Series (DPMS)

DPMS is one of the mega projects which supply detailed information on Land Use, Relief and slope, Rocks and Minerals, Hydrogeology, Climate, Cropping Patterns, Population and the main town map of the concerned district. This year NATMO completed eight (8) districts and they are all published for restricted sale.



Fig. DPMS Map of Narsinghpur

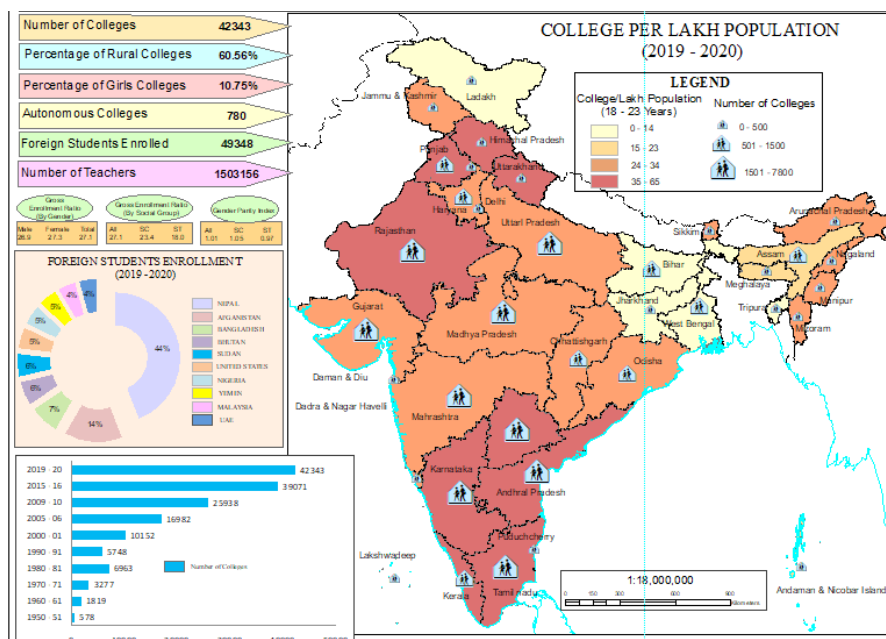
- Golden Map Service (GMS):

Basic objective of GMS is to map the physical connectivity between locations and all utilities spread across the cities and towns of the country. It also shows the locations with its name, the drainage networks and general land use. GMS mainly intends to provide web map services and cater the data requirements for Location Based Services (LBS). These maps are also useful for planners, tourists and the general citizens. Cities like Jaipur, Noida, Gurgaon,

are currently under process and Pratapgarh is under updation and expected to release very shortly.

- Thematic Maps:

As a thematic mapping organisation, mapping on several themes of socio-economic importance are always under the purview of NATMO. Thematic map on Banking Service has been published and for Specially-Abled (Divyangjan) & Scheduled Tribe is ready for publication. There are some other themes also under consideration which will be prepared during the course of period.



- Atlas Preparation:

Nine (9) different theme maps have already been prepared under Tribal Atlas and 11 themes out of 13 having contemporary importance are completed under Commemorative Atlas.

- Special Project:

Braille mapping is one of the most prestigious projects of NATMO which targets Visually impaired students. NATMO conduct workshops with these specially-abled students. The Braille Atlas of India in Hindi, English and Bengali has already been completed. State-wise Braille Atlas preparation, in English and Subsequently in the respective regional languages, is going on. State Atlas in English Braille script for West Bengal, Gujarat, Assam and Telangana is completed this year.

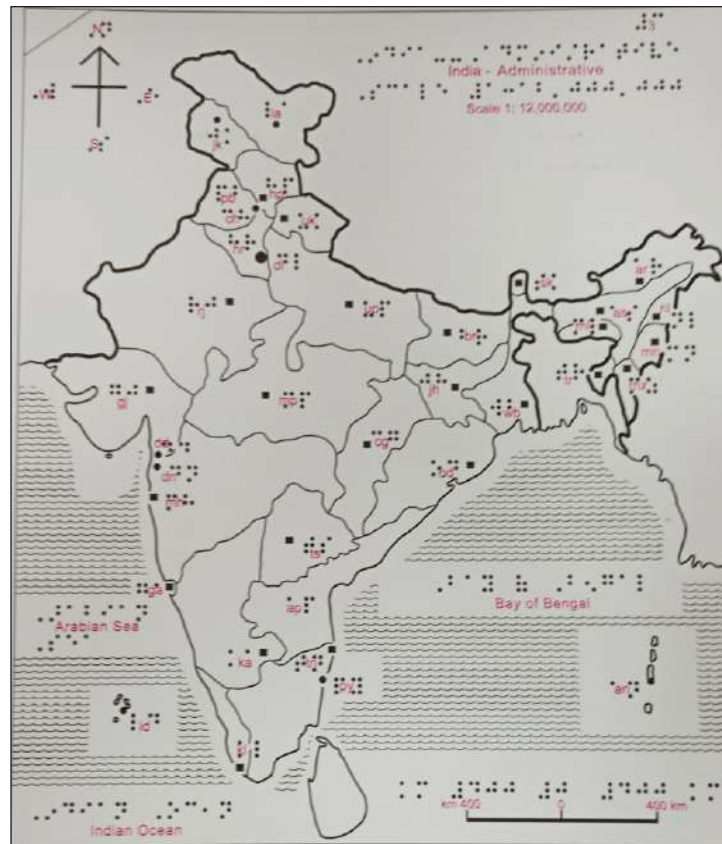


Fig. English Braille Map

- Research Work:

NATMO is engaged in research on different themes. Sub-group level classification of soil based on taxonomy has been attempted and the district level layer created in this regard has been incorporated in few DPMS. Landuse mapping through image processing and classification was also attempted. It also deals with the temporal changes in the land use and provides supplement information for DPMS.

- Enterprise Geo-Portal:

Following Prime Minister's digital India initiative, NATMO has already launched an Enterprise Geo-Portal named geoprtal.natmo.gov.in, popularly known as **Manchitran** which is a 24 hours service to access mapping information. Now regular upgradation is under process with uploading of new layers. Payment gateway integration is underway to enable online purchase of maps by users. Development of Mobile App for data collection from field has also been initiated by NATMO in association with ESRI. With the launch of this mobile app NATMO could gather real time location information from field and also can gather information through crowd sourcing.

- SVAMITA Project:

NATMO has been tasked with the responsibility of Feature Extraction (FE) from Ortho Rectified Images (ORI). 200 villages belonging to Uttar Pradesh state have been given to NATMO by Survey of India. Around 150 villages are already completed and submitted back and the rest of the villages will be completed by December 2022.

Conclusion:

NATMO, as a thematic mapping Organisation is always committed to provide best service to the society, especially those engaged in the realm of geographical and environmental research and teaching. GIS data development on various themes by this Organisation is an asset for the nation. NATMO, in spite of having many constraints, mainly shortage of man power, has raised its leadership in the field of map making in the country.

ADMINISTRATION

The administration and finance divisions of the Department continued to provide support and necessary administrative support for smooth functioning of the Department as well as its subordinate offices.

9.1 General Administration

9.1.1 Construction of new Office accommodation at Technology Bhawan and Shifting to New State of the Art Building, Office Block-I & Block-II in Technology Bhawan campus.

Shifting of remaining Officers/Scientists & staff members of Department of Science & Technology and Department of Scientific & Industrial Research to newly constructed, New Block-1 at Technology Bhawan has been completed during the year. Vacant possession of blocks identified for demolition have been handed over to the PMC for demolition. Construction of Block-V of the project for accommodating CISF personnel has been completed and has been offered for occupation in the first week of January, 2023.

Outsourced Canteen at Technology Bhawan for providing better food & refreshment services during meetings, conferences etc with foreign delegates and other dignitaries as well as to the officials and staff of the Department has commenced operation. The Canteen services has been outsourced through GeM Portal and has commenced the services from 01.10.2022.

Facility management Services (FMS) for comprehensive maintenance of new and existing buildings have commenced from 01.10.2022. Along with Housekeeping Services, Maintenance of Civil works and Electrical equipment, the FMS provider will maintain Building Management System, Telephone Exchange, Sewage Treatment Plant, grid interactive solar power generation of 500KW, access-controlled entry to buildings, automatic Fire Alarm System & Fire Fighting System, video Surveillance (CCTV) System etc.

9.1.2 Celebration of Swacchta Pakhwada and award distribution ceremony in Department of Science and Technology

During year Swachhta Pakhwada was organised from 2.05.2022 to 13.05.2022. Several activities were carried out during the period viz. Inauguration and pledge taking function, Special cleanliness drive of entire DST campus along with adjoining area of boundary wall etc. Thereafter, Swachhata Award Distribution was carried out.

9.1.3 Measures to contain impact of COVID-19 in Technology Bhawan

As the pandemic has been affecting several employees of the Department, several measures are being taken for mitigating the impact of COVID-19 outbreak. In this regard, two vaccination camps were organized by the Department for the welfare of Officials and their family members at Technology Bhawan Campus and Vigyan Sadan, DST Guest House.

9.1.4 Celebration of Constitution Day

To commemorate the adoption of the Constitution of India by the Constituent Assembly on 26th November, 1949, the Department of Science & Technology organized a pledge ceremony for celebration of the Constitution Day at Technology Bhawan. All the Scientists, officers and staff of DST, DSIR and PAO participated in the reading of preamble to the Constitution of India. The Constitution Day was also celebrated in subordinate offices and Autonomous Institutes/ Statutory Bodies under the administrative control of DST.

9.1.5 Special Green Drive

More than 300 flowering and fruit bearing tree saplings were planted in association with M/s Ircon and Brahma Kumaris at Technology Bhawan campus.



Additional Solar Power generation plant of 200 KW has been connected to the grid. Sewerage Treatment Plant was made functional.

9.2 Staff Position

Group A							
Category	Gen.	SC	ST	EWS	OBC	PH	Total
Scientific	73	5	2	0	8	4	92
Non-Scientific	38	9	0	0	6	0	53
Group B (Gazetted)							
Scientific	3	0	0	0	2	0	5
Non-Scientific	19	0	2	0	3	1	25
Group B (Non-Gazetted)							
Scientific	0	0	0	0	0	0	0
Non-Scientific	38	7	4	0	12	2	63
Group C							
Scientific	0	0	0	0	0	0	0
Non-Scientific	43	50	7	1	25	4	130

9.3 Parliamentary work

Parliament Unit in Department of Science and Technology (DST) serves as central coordinating point for all parliamentary work of the Department viz. forwarding parliament questions to concerned divisions to prepare the replies, submission of answers to Parliament Questions, fulfilling assurances, analyzing reports of Parliamentary Committees etc. It ensures that the parliamentary work pertaining to the Department 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 Department of Science & Technology.

The Unit coordinates work relating to consideration of Detailed Demand for Grants by the Parliamentary Standing Committee and also coordinates the visits of the Parliamentary Committees to various scientific institutions which are under the administrative control of this Department. The Unit is in the process of development of an IT enabled searchable repository of Parliament Questions that were answered in the past for aid of officers and officials of Programme Divisions for easy retrieval and reference.

9.4 Implementation of official Language Policy

The Department of Science and Technology 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 Division consisting of a Deputy Secretary, Assistant Director (O.L.) and other supporting staff which caters to the need of the Department of Science & Technology. Besides monitoring the implementation of the Official Language Policy and the Annual Programme, Hindi Division helps in arranging 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 as per need.

For promotion of use of Hindi in this Department and to create conducive environment for the officials to work in Hindi, various programmes are being undertaken in FY 2022-23. During the year, meetings of Departmental Official Language Implementation Committee and Hindi workshops were organized every quarter to encourage the officers / staff of the Department to execute most of their work in Hindi.

Hindi Advisory Committee meeting was organised on 6th June, 2022 under the chairmanship of Dr. Jitendra Singh, Minister of Science and Technology and Earth Sciences at Prithvi Bhawan.

Celebration of Hindi Pakhwara: Various Hindi competitions were organized during the Hindi Pakhwara of the Department, held from **14 to 28 September, 2022**. During the Pakhwara, successful participants were given cash awards and certificates. This year some new events were organised, including an Essay Writing Competition exclusively for the scientists, Extempore Translation Quiz and Antakshri. The closing ceremony of Hindi Pakhwada was organized in Raman Auditorium on 10th October, 2022.

9.5 Right to Information

Department of Science and Technology has been implementing the RTI Act in letter and spirit in view of the Right to Information Act, 2005 enacted by the Government of India to promote transparency and accountability in its functioning. To ensure transparency in its functioning, DST has been regularly making suo-moto disclosures on its web-site, as required under Section 4(1)(b) of the RTI Act, 2005.

During the period from 1st January, 2022 to 16th December, 2022, a total of 983 RTI applications and 69 First Appeals were received by the Department and out of which 954 RTI applications and 61 Appeals have been disposed of as per the provisions of RTI Act, 2005.

9.6 Public Grievances

Public Grievance redress mechanism is an instrument to gauge and measure efficiency and effectiveness of an organization as it provides important feedback on its working. An essential

pre-requisite to make the public service delivery system more accountable and responsive is to have a robust public grievance redress and monitoring mechanism.

Department of Science and Technology has made concerted efforts to redress the grievances and appeals received from its stakeholders and the public at large.

A total of 6946 public grievances were received by the Department during the period from 1st January, 2022 to 16th December, 2022. In addition to this, there was a backlog of 133 grievances. Out of these 7079 grievances (6946+133), a total of 6977 grievances have been disposed of by 16th December, 2022.

Further, a total of 174 appeals were received in respect of public grievances during the period from 1st January, 2022 to 16th December, 2022. Out of these, 158 appeals have been disposed of by 16th December, 2022.

9.7 List of 'Scientific Lab & Test Equipment' having sufficient Local Content and Local Suppliers

As part of Government's initiative to encourage 'Make in India' and promote manufacturing and production of goods and services in India with a view to enhancing income and employment, the Department of Science and Technology has been nominated as Nodal Department for 'Scientific Lab and Test Equipment'.

In consonance with Notification No.45021/2/2017-PP(B.E.II) dated 16.09.2020 of Department of Promotion of Industry & Internal Trade (DPIIT), the Department of Science and Technology has circulated a list of 'Scientific Lab & Test Equipment' having sufficient local capacity and competition, to be reserved for 'Class-I Local Suppliers' in public procurement,

9.8 SPECIAL CAMPAIGN 2.0

The Department of Science & Technology (DST), its subordinate offices and Autonomous Institutions vigorously participated in the swachhata campaign. The Achievements/ Outcomes of DST including its subordinate offices and Autonomous Institutions during the Special Campaign 2.0 are as under:-

- (i) DST, alongwith its subordinate and Autonomous Institutions carried out swachhata drives at 180 sites.
- (ii) A total of 1,16,896 files were reviewed and out of them 1,03,803 files have been identified for weeding out. All 1,03,803 files identified for weeding have been weeded out during the Implementation phase of Special Campaign 2.0.
- (iii) A total of 596 e-files have been closed after a review of 1719 e-files.
- (iv) Out of eight pending Parliamentary Assurances reported during preparatory phase of

Special Campaign 2.0, Implementation Report has been submitted in respect of seven Assurances.

- (v) All twelve pending VIP references identified during preparatory phase have been disposed of.
- (vi) All 115 Public Grievances which were identified during preparatory phase have been disposed of.
- (vii) All 20 Public Grievance Appeals identified during preparatory phase have been disposed of.
- (viii) A total of Rs. 23,10,826 has been generated as revenue by DST, its subordinate, and Autonomous Institutions by way of disposal of scrap, and 68,514 sq feet of space has been freed.

DST, its Subordinate Offices, and Autonomous Institutions have issued more than 50 tweets by using Special Campaign 2.0 hashtag. Moreover, four press releases about the best practices being followed in Department of Science and Technology have been also issued.

9.9 Vigilance

1. The Vigilance Unit of the Department of Science & Technology (DST) is headed by a Chief Vigilance Officer (CVO), who is a Joint Secretary of the Department. He is supported by a Deputy Secretary, a Section Officer and other Secretarial Staff.
2. Apart from handling vigilance related cases of the Department, its subordinate offices and aided institutions, it also deals with complaints received directly from complainants, the Central Vigilance Commission (CVC), Central Bureau of Investigation (CBI) and other sources. It plays an active role in ensuring the prompt disposal of these complaints. The vigilance unit also handles vigilance disciplinary proceedings and maintains a regular touch with the CVC and when necessary, with the CBI.
3. During 2022 (as on 20.12.2022), Vigilance Unit dealt with the following number of complaints:

Source	Opening Balance	Recd. During the year	Total	Disposed	Balance
CVC	1	22	23	18	5
Others	7	75	82	37	45

The balance complaints are at various stages of examination and are under process.

4. The 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 the Central Vigilance Commission and Department of Personnel and Training. The Department also maintains Agreed List in consultation with the CBI and List of Officers of Doubtful Integrity of Gazetted status.

5. Besides, CVO maintains close liaison with all attached/subordinate offices to ensure timely completion of various vigilance tasks. The CVO keeps a watch over all cases pending at different stages including the cases of its attached and subordinate offices to ensure a time bound disposal of such cases.
6. In accordance with the directives of the CVC to spread awareness about transparency, accountability and corruption free governance, Vigilance Awareness Week was observed in DST from 31st October to 6th November 2022 in association with the Department of Scientific and Industrial Research (DSIR). During this occasion an Integrity Pledge was administered to employees of DST & DSIR by CVO, DST. Events like Essay Writing Competition, Turncoat Debate, Slogan Writing Competition, Drawing Competition for children of employees, Poster Making competition, Story Weaving Competition were organized for DST/DSIR employees during this week.



VIGILANCE AWARENESS WEEK 2022
Fig. Integrity Pledge administered in DST



Fig. Debate Competition

AUDIT OBSERVATION

Annexure-I

Detailed position of Action Taken Notes (ATNs) to be included in the Annual Report for the year 2021-22 as per the table given below:

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
	Nil	Nil	Nil	Nil	Nil

Annexure-II

Position as on 19.12.2022

Summary of important Audit Observations pertaining to DST: NIL

BUDGET

FINANCIAL STATEMENT

DEPARTMENT OF SCIENCE AND TECHNOLOGY Summary of Financial Requirements					
SI No.	Head of Development Projects/ Programme/ Scheme	(` in crore)			
		Actual 2021-2022	BE 2022-2023	RE 2022-2023	BE 2023-2024
1	Secretariat	104.05	115.00	100.79	114.00
2	Survey of India	446.05	526.10	492.20	530.70
3	National Atlas and Thematic Mapping Organisation (NATMO)	33.87	50.20	31.52	36.05
4	Autonomous Institutions and Professional Bodies	1488.02	1500.00	1443.20	1560.00
5	Science and Engineering Research Board (SERB)	900.00	803.00	803.00	803.00
6	Science and Technology Institutional and Human Capacity Building	916.79	1128.00	836.80	1068.40
7	Research and Development	451.55	604.03	250.00	592.00
8	Innovation, Technology Development and Deployment	680.97	812.52	538.20	536.60
9	National Mission on Inter disciplinary Cyber Physical System	0.00	350.00	300.00	580.00
10	Technology Development Board (TDB)	125.00	100.00	100.00	100.00
11	Science Counsellors Abroad	0.00	13.35	11.45	11.50
12	National Research Foundation	0	0	0.01	2000.0
Total- DST		5146.30	6002.20	4907.17	7932.25

ABBREVIATION

AGMNC	All Girls Math Nurture Camp
AHP	Analytical Hierarchy Approach
AIDS	Animal Intrusion Detection system
ALICE	A Large Ion Collider Experiment
AM	Additive Manufacturing
AMR	Antimicrobial Resistance
AMT	Advanced Manufacturing Technologies
APIs	Active Pharmaceuticals Ingredients
ASD	Autism Spectrum Disorders
ASPIRE	Aspiring Students in Progressive and Innovative Research and Education
ASTEC	Assam Science Technology & Environment Council
ASTRAD	ARIES Stratosphere Troposphere Radar
ATNs	Action Taken Notes
AFV	Armoured Fighting Vehicle
AISF	ASEAN-India Start-up Festival
AIWGST	ASEAN-India Working Group on Science and Technology
AWS	Automatic Weather Stations
AWSAR	Augmenting Writing Skills for Articulating Research
BCM	Backend Context Module
BDTD	Biomedical Device and Technology Development Program
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BIS	Bureau of Indian Standards
BRICS	Brazil, Russia, India, China, and South Africa
BMW	Bio Medical Waste
CBI	Central Bureau of Investigation
CCRRCs	Community COVID Resilience Resource Centres
CCUS	Carbon Capture Utilisation & Storage
CD	Carbon Dots
CDW	Charge density wave

CERI	Clean Energy Research Initiative
CFM	Co-Funding Mechanism
CHRAR	Coastal Hazard, Risk Assessment and Reduction
CMS	Compact Muon Solenoid (CMS) experiment
CORS	Continuously Operating Reference Stations
COTDR	Coherent Optical Time Domain Reflectometry
CQT	Constant-Q-Transform
CPRs	Centres for Policy Research
CSRI	Cyber Security Research Initiatives
CSRI	Cognitive Science Research Initiative
CSRP	Collaborative Scientific Research Programme
CURIE	Consolidation of University Research for Innovation & Excellence
CVO	Chief Vigilance Officer
DAS	Distributed Acoustic Sensing
DCLC	Direct Contact Liquid System
DEM	Digital Elevation Model
DERs	Distributed Energy Resources
DIM	Declination Inclination Magnetometer
D/S/N -LEPC	District/ State/ National Level Exhibition and Project Competition
DO	Dissolved Oxygen Demand
DOT	Devasthal Optical Telescope
DPMS	District Planning Map Series
DSO	Distributor System Operator
DSRI	Data Science Research Initiatives
EDARI	Epidemiology Data Analytics Research Initiative
EMEQ	SERB-Empowerment and Equity Opportunities for Excellence in Science
FAIR	Facility for Antiproton and Ion Research
FSSAI	Food Safety and Standards Authority of India
FBG	Fluidized Bed Gasifier
FDP	Faculty Development Program

FIRE	SERB-Fund for Industrial Research Engagement
FIST	Fund for Improvement of S & T Infrastructure in Universities and Higher Educational Institutions
FSCTR	Fire Side Corrosion Test Rig
GAP	Good Agricultural Practices
GATI	Gender Advancement for Transforming Institutions
GCPs	Ground Control Points
GESEME	Geo-enabled Socioeconomic Matchmaking Effort
GISE	Geo-Information Science & Engineering (GISE) hub
GLORIA	Global Observation Research Initiative in Alpine Environments
GLP	Good Laboratory Practice
GMP	Good Management Practices
GMRT	Giant Metrewave Radio Telescope
GMS	Golden Map Service
GPP	Gross Primary Productivity
GPS	Global Positioning System
GRACE	The Gravity Recovery and Climate Experiment
GSK3	Glycogen Synthase Kinase 3
GWs	Gravitational Waves
HCI	Human Computer Interaction
HMM	Hidden Markov Models
HPC	High Performance Computing
HP-HT	High-Pressure High-Temperature
HRNTDB	High Resolution National Topographical Data Base
HROS	High Resolution Optical Spectrograph
HRSI	High Resolution Satellite Imageries
iCET	initiative on Critical and Emerging Technology
ICT	Information & Communication Technology
IDSF	Interim Data Sharing Framework
IGIF	Integrated Geospatial Information Framework

<i>IMU</i>	<i>Inertial Measurement Unit</i>
<i>InGReF</i>	<i>Indian Geodetic Reference Frame</i>
IRTGs	International Research Training Groups
ILMT	International Liquid Mirror Telescope
IISF	India International Science Festival
IORA	Indian Ocean Rim Association
INSPIRE	Innovation in Science Pursuit for Inspired Research
INSPIRE -MANAK	Million Minds Augmenting National Aspiration and Knowledge
IoT	Internet of Things
IoUT	Internet of Underwater Things
IoTRI	Internet of Things Research Initiatives
IPR	Intellectual Property Rights
IRIS	Initiative for Research & Innovation in STEM
ISEF	International Science and Engineering Fair
ISRF	India Science & Research Fellowship
ITOFF	India TMT Optics Fabrication Facility
JBC	Joint Boundary Conference
WISE-KIRAN	Knowledge Involvement in Research Advancement through Nurturing) Scheme as Women in Science and Engineering
KSCSTE	Kerala/ Karnataka - State Council for Science, Technology & Environment
LBS	Location Based Services
LBV	Luminous Blue Variable
LCA	Life Cycle Analysis
LEMS	Low-cost Environmental Sensors
LFP	Lithium Iron Phosphate
LHP	Lead Halide Perovskites
LHTES	Latent Heat Thermal Energy Storage
LIB	Lithium Ion Battery
LIGO	Laser Interferometer Gravitational-Wave Observatory
LRIs	Large Research Infrastructures

LULC	Land use and land cover
MAD	Mutual Acceptance of Data
MDCADNet	Multi-Dilated Context Aggregation based Dense Network
MHD	Magneto-Hydrodynamic
MI	Mission Innovation
MIG	Metal Inert Gas
MISTIC	Mizoram Science, Technology & Innovation Council
MOF	Metal-Organic framework
MSDs	Micro Solar Domes
MSL	Mobile Science Lab
MTM	Molecular Transport media
NATMO	National Atlas & Thematic Mapping Organisation
NDR	National Data Registry
NEE	Net Ecosystem Exchange
NCs	Nanocrystals
NCSTC	National Council of Science and Technology Communication
NCG	National Centre for Geodesy
NEDFi	North-Eastern Development Finance Cooperation Limited
NGF	Nerve Growth Factor
NGP	National Geospatial Programme
NHP	National Hydrology Project
NIC	National Industrial Classification
NIDHI	National Initiative for Developing and Harnessing Innovations
NLST	National Large Solar Telescope
NM-ICPS	National Mission on Interdisciplinary Cyber Physical System
NMIS	National Manufacturing Innovation Survey
NMR	Nuclear Magnetic Resonance
NMSHE	National Mission for Sustaining the Himalayan Ecosystem
NMSKCC	National Mission on Strategic Knowledge for Climate Change
NSD	National Science Day

NSRF	National Spatial Reference Frame
NSTEDB	National Science and Technology Entrepreneurship Development Board
NSTMIS	National Science & Technology Management Information System
OECD	Organization for Economic Cooperation and Development
OISL	Oceanering International Services Limited
OMC	Observatory Monitor & Control
ORD	Open Research Data
ORI	Ortho- Rectified Imagery
OSW	Observatory Software
OTT	Over The Top
PCR	Polymerase Chain Reaction
PDF	Post-Doctoral Fellows
PDIF	Post-Doctoral Industrial Fellowship
PECFAR	Paired Early Career in Applied Research
PFC	Patent Facilitation Centre
PFP	Patent Facilitation Programme
PFP	Policy Fellowship Programme
PICs	Patent Information Centers
PIEF	PhD Industrial Exposure Fellowship
PL	Photoluminescence
POC	Programme of Cooperation
POWER	SERB-Promoting Opportunities for Women in Exploratory Research
PPP	Public Private Partnership
PRAYAS	PRomotion and Acceleration of Young and Aspiring Technology Entrepreneurs
PRISM	SERB Project Information System & Management
PROWIS-I	Indo-French Postdoctoral Research Programme for Women in Science
PROWIS-II	Indo-French Visitation Programme for Women in Science
PURSE	Promotion of University Research and Scientific Excellence
QIT	Quantum Information Technologies
QPOs	Quasi-Periodic Oscillations

QTL	Quantitative Trait Locus
QuEST	Quantum Enabled Science & Technology
PwDs	Persons with Disability
RE	Ecosystem Respiration
READY	Research and Entrepreneurship Development for You
RIIG	Research Innovation Initiative Gathering (G20)
SAIF	Sophisticated Analytical Instrument Facilities
SAR	Specific Absorption Rate
SATHI	Sophisticated Analytical & Technical Help Institutes
SATYAM	Science and Technology of Yoga and Meditation
SCO	Shanghai Cooperation Organization
SCSP	Special Component Plan for Schedule Castes
SDGs	Sustainable Development Goals
SDRR	Spatial Disaster Risk Reduction
SEED	Science for Equity for Empowerment and Development
SENSUM	Sustainable Energy Storage Suitable for Microgrid
SERS	Surface-Enhanced Raman Spectroscopy
SHE	Scholarship for Higher Education
SIFJ	Steel Integrated Floating Jetty
SING	Small Immediate Need Grants
SIRE	SERB-International Research Exposure
SKA	Square Kilometer Array
SKAO	SKA Observatory
SLR	Sea Level Rise
SNPs	Single Nucleotide Polymorphisms
SoC	Security Operations Centre
Sol	Survey of India
SPF	Senior Policy Fellows
SRIMAN	Scientific Research Infrastructure Sharing Maintenance and Networks
SSI	Self-Sovereign Identity

SSIIE	Society for Innovation and Incubation Entrepreneurship
SSP	Seed Support Program
SSTP	State Science & Technology Programme
ST	Sampurnanand Telescope
STD	Society for Technology & Development
STEAM	Science Technology, Engineering, Art and Math
STEM	Science Technology Engineering and Mathematics
STI	Science, Technology and Innovation
STUTI	Synergistic Training program Utilizing the Scientific and Technological Infrastructure
SUNIL	Strengthening, Upscaling & Nurturing Innovations for Livelihood (SUNIL) program
SUPRA	SERB-Scientific and Useful Profound Research Advancement
SUPREME	Support for Upgradation Preventive Repair and Maintenance of Equipment
SURE	State University Research Excellence (SERB-SURE)
SVAMITVA	Survey of Villages Abadi and Mapping with Improvised Technology in Village Areas
SYST	Scheme for Young Scientist and Technologists
TCP	Therapeutic Chemicals Programme
TDP	Technology Development Programmes
TEC	Technology Enabling Centres for Universities
TEDP	Technology Entrepreneurship Development Program
TES	Thermal Energy Storage
TIDE	Technology Informatics Design Endeavour
TTF	Technology Transfer Facility
TIHs	Technology Innovation Hubs
TIPS	Technology Innovation in Cyber Physical System
TMT	Thirty Meter Telescope
TNA	Technology needs assessment
TOTO	Tele Observance Tele Operation (TOTO) Robot
TRCs	Technical Research Centres

TSP	Tribal area Sub-Plan
UAVs	Unmanned Aerial Vehicles
UHV	Ultra-High Vacuum
VELC	Visible Emission Line Coronagraph
VEPES	Variable Energy Photoelectron Spectroscopy
VOCs	Volatile organic compounds
WBG	Wide Band Gap
WDs	Western Disturbance
WEDP	Women Entrepreneurship Development Program
WFOS	Wide Field Optical Spectrograph
WGSTI	Working Group Science Technology and Innovation
WHC	Warping Harness Cables
Wire-ECMM	Wire Electrochemical Micromachining
WISER	Women involvement in Science and Engineering Research
WLCG	Worldwide Large Hadron Collider Computing Grid
WMT	Waste Management Technologies
WOS	Women Scientists
WSC	Women Science Congress
WSM	Weyl Semi-Metal
WTI	Water Technology Initiative
WTP	Women Technology Park
YASH	Year of Awareness on Science and Health
YPP	Young Policy Professionals
YSC	Young Scientist Conclave



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