

Major Achievements during 2022

I. INDIA'S RANKING IN GLOBAL S&T INDICES CONTINUES TO RISE

India is now placed at 40th position among the top innovative economies globally as per Global Innovation Index (GII) 2022. The country remains among the top 3 countries in scientific publication as per NSF database and also in terms of no of PhDs, in size of Higher Education System; as well as in terms of number of Startups.

II. CREATING A ROBUST START-UP AND INNOVATION ECOSYSTEM

DST has been pioneer in establishing a network of Technology Business Incubators (TBI) and Science & Technology Entrepreneur's Parks (STEP) across the country under the National Initiative for Developing and Harnessing Innovations (NIDHI) program. This had a major impact through all aspects of innovation ecosystem for scouting and mentoring of start-ups for commercialization including significant widening the base of innovation pyramid, enhanced support to frugal and grassroots innovations. NIDHI has the entire innovation value chain and built largely around Technology Business Incubators with several components like Institutional mechanisms with capital/equipment support through NIDHI-Technology Business Incubator (TBI), NIDHI-Centres of Excellence (NIDHI-CoE) NIDHI-Promotion and Acceleration of Young and Aspiring technology

With the aim to establish NIDHI – CoEs to act as a reservoir of knowledge in venture promotion and help in aligning the linkages with both national as well as international partners, a new Centre of Excellence at T-Hub, Hyderabad, Telangana has been established during 2022, making it a total of 8 CoEs under active support. Thirteen new PRAYAS centres have been supported during 2022 along with support to 30 ongoing PRAYAS centres across the country that are supporting young innovators to turn their ideas into prototype. Ten new Entrepreneurs-in- Residence (EIR) centres have been supported during the year along with support to 18 ongoing EIR centres that supports aspiring or budding entrepreneur of considerable potential for pursuing a promising technology business idea over a period up to 18 months.

III. INDIA ACHIEVING NEW HEIGHTS IN SUPERCOMPUTING CAPACITY

New installations of high performance computers at five institutes (IIT Kharagpur, NIT Trichy, IIT Gandhinagar, IIT Guwahati, IIT Mandi). The figures of human resource trained under the mission reached 17,500.

IV. BOOSTING TECHNOLOGY DEVELOPMENT IN CYBERPHYSICAL DOMAINS LIKE AI, ROBOTICS, IOT THROUGH RESEARCH AND INNOVATION HUBS

The Union Cabinet approved the National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS) in December, 2018 at a total outlay of Rs.3660 Crores for a period of five years, to be implemented by the Department of Science and Technology (DST). The Mission is being implemented through 25 Technology Innovation Hubs (TIHs) created at reputed academic institutes across the country. TIHs are working towards achieving the Mission objectives. The ARTPARK at IISc Bangalore developed an AI-driven platform called XraySetu that helped Chest X-ray interpretation of images sent over WhatsApp and brought early intervention through rapid screening of COVID 19, aiding doctors who have no access to X-ray machines. A team of scientists from IIT Bombay have developed a tapestry method for screening COVID-19 under Remedial Action, Knowledge Skimming, and Holistic Analysis of COVID-19 (RAKSHAK), an effort supported by the Technology Innovation Hub (TIH) at IIT Jodhpur. It has also led to the development of a New Chest X-ray based COVID diagnosis System, Open Data for Indian and International COVID Cases - COVBASE (Imaging, clinical parameters, longitudinal data, and annotations), Campus RAKSHAK - A decision framework for Campus Safety.

V. STRENGTHENING INDIA'S POSITION ON INTERNATIONAL S&T ENGAGEMENT

India assumes the G20 Presidency on the 1st of December 2022 and will convene the G20 Leaders' Summit for the first time in the country in 2023. As part of the same DST takes the responsibility of coordinating the activities of Science-20 (S20) and Research Innovation Initiative Gathering (RIIG) Engagement Groups during India's G20 Presidency in 2023.

India joins hand with Finland to establish Virtual Network Centre in Quantum Computing to jointly develop 20 qubits superconducting based Quantum Computer in 1st phase and further scale it up to 54 qubits in second phase.

VI. GEOSPATIAL DATA, INFRASTRUCTURE AND TECHNOLOGY LEADING TO IMPROVED CITIZEN SERVICES

- The Second United Nations World Geospatial Information Congress (UNWGIC) on the theme "Geo-Enabling the Global Village: No one should be left behind" was held successfully in Hyderabad from 10-14 October 2022. A Special Event on "Geo-enabling the Global Village with Generations Z and Alpha" was organized where school children from around the country participated and showcased the localizing of SDGs through spatial thinking.

- 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).
- Six Regional Centres for Geodesy have been established under the National Geospatial Programme at IIT Bombay, IIST Trivandrum, IRS Anna University, IIT (ISM) Dhanbad, MNNIT Allahabad and MANIT Bhopal with the aim to assist in spreading Geodesy Education and R&D in the country towards strengthening the Geodetic Infrastructure.
- Survey of India (SoI) the National Survey and Mapping Organization of the country has successfully carried out drone survey of rural abadi areas of 2,00,000+ villages as part of the SVAMITVA (Survey of villages and mapping with improvised technology in village areas) for distribution of Property Cards in Abadi Areas and providing 'Record of Rights' to village household owners. A Large Scale Mapping on 1:500 scale of States and UTs has been completed for several states and is being carried out for Haryana, Karnataka, Maharashtra, Andhra Pradesh, Andaman & Nicobar Islands.
- Continuously Operating Reference Stations (CORS) is one of its kind geodetic infrastructure (consisting of network of geodetic quality GNSS receivers and antennas that are permanently installed throughout the country. Total 815 Nos. of CORS stations have been established covering about 80% of the country. As on date a total of 1795 No. of users have registered on the stated portal till date.
- Onlinemaps portal launched on 17th August, 2021 provides various digital geospatial products (free as well as at fair & transparent price) to the users. From its inception till date, total 275 govt. users & 41182 private users have registered on this portal and 13957 paid products & 381345 free map products have been downloaded. Link - www.onlinemaps.surveyofindia.gov.in
- High resolution mapping for major river basins is also being carried out to provide the high resolution GIS and Digital Elevation Model (DEM) for improved flood hazard mapping and other planning purposes.
- Standardised Geographical Place Names (Toponymy): SOI has prepared National toponymic database in 23 languages.

VII. NEW FEATHERS TO TECHNOLOGY COMMERCIALIZATION

This year took well by witnessing the swarming of 1000 indigenized drones in the sky at the eve of beating the Retreat ceremony on January 29, 2022- a drone show by **women led** M/s Botlab Dynamics, proudly **positioning India at fourth place on the globe** and received appreciation from the Hon'ble Prime Minister. M/s Swajal Water Private Limited, Gurugram, a tech startup company proposed not only reduction in the use of plastic bottles but also showed potential to reduce **cost of purified water to as low as 25 paise per litre**. M/s Skyshade Daylights Private Limited, Hyderabad, proposes India's first integrated, centralized day lighting

system to **reduce the carbon footprint** and can also reduce AC load to which in turn protects our environment and climate. This daylight can reach to basements even. M/s Sapigen Biologix Pvt Ltd., Hyderabad has prepared a Covid-19 **intra nasal vaccine** that can generate mucosal immune response thereby protecting both the upper and lower respiratory system of a vaccinated individual and break the cycle of infection and transmission.

M/s Orange Koi Private Limited, Visakhapatnam aims at implementing the Metal Injection Molding (MIM) process for the manufacturing of medical surgical instruments and device components. The potential of MIM lies in its ability to combine the design flexibility of plastic injection molding and the versatility of unlimited choice of material offered by powder metallurgy. Women led startup M/s Astrome Technologies Private Limited, Bengaluru has proposed an Innovative Wireless Product to solve Internet connectivity issues of the Rural India. Their work is so eccentric that it gathered attention of **Hon'ble PM** and were named in **90th Mann ki Baat**.

In tune with Hon'ble Prime Minister's vision of National Hydrogen Mission (NHM), M/s Multi Nano Sense Technologies Private Limited, Maharashtra has come up with plan to manufacturing of Hydrogen sensors indigenously. For actual benefit of Prime Minister's Atal Bhujal Yojana (Atal Jal), a Jharkhand based startup, M/s Kritsnam Technologies Private Limited are developing 'Dhaara Smart Flowmeter' - an integrated system for online monitoring that is designed to track the water distribution in real-time.

M/s Panacea Medical Technologies Pvt. Ltd., Bangalore Panacea with TDB's financial assistance has developed a Linear Accelerator – "Siddharth II with advanced features of stereotactic imaging & advanced delivery techniques viz. IMRT, IGRT, VMAT and SBRT", a "Make in India" product which has played an important role in making India 'self-reliant'. With the development of India's first ring gantry based Linear Accelerator, Panacea aims to make cancer treatment affordable in India and in rest of the countries. The ring gantry based Siddharth II contain a beam stopper, minimizing shielding requirements and in turn reducing the cost of the bunker construction.

VIII. ACCESSIBLE SCIENTIFIC INFRASTRUCTURE FOR ALL STAKEHOLDERS

Four new Universities under '**Promotion of University Research and Scientific Excellence (PURSE)**' and 65 Departments in various academic organizations and universities under '**Fund for Improvement of S&T Infrastructure (FIST)**' were supported under FIST for strengthening the research infrastructure. A special call under PURSE for few unserved states in the Country was made to provide basic infrastructure and enabling the facilities for promoting R&D activities in new and emerging areas of Science & Technology in Universities of North Eastern Region, Jammu & Kashmir, Chhattisgarh, Madhya Pradesh,

Jharkhand, Bihar, Haryana, Telangana, Himachal Pradesh and Rajasthan and 11 new universities have been selected for support. Organised 191 training programs under **Synergistic Training program Utilizing the Scientific and Technological Infrastructure (STUTI) benefitting** 6395 researchers in the country.

IX. TECHNOLOGY-LED SOLUTIONS FOR ENERGY AND ENVIRONMENT CHALLENGES

The Department has been supporting mission mode technology development programmes in different areas of clean energy, water and environment areas. A first-of-its-kind Distributor System Operator (DSO) report has been prepared that can help 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. A real time pollution monitoring photonic system, Air Unique Quality Monitoring System (AUM) has been developed which is capable of real time remote monitoring of all air quality parameters, with high sensitivity and accuracy simultaneously, at a very high frequency of sampling. A coal to methanol pilot plant (0.25 TPD) to demonstrated the generation of methanol from high ash coal has been installed at BHEL-Hyderabad. Methanol with purity of more than 99% has been generated from syngas. An innovative interfacial engineering approach to enable fast charge-discharge rates in solid-state lithium metal batteries have been developed by researchers at IISc through a DST support under programme on **Material for Energy conservation and Storage Platform.**

X. CLIMATE CHANGE RESEARCH EXPANDING TO NEWER AREAS

The Department has been implementing two National missions on Climate Change. Four new State Climate Change Cells (SCCCs) have been established in the States of Goa, UT of Chandigarh and Jharkhand and Uttar Pradesh. One Centre of Excellence (CoE) has been supported in the Vidarbha Region of Maharashtra State to study the Impact Assessment of Thermal Power Plants on Microclimate.

XI. PROMOTING CAREER OPPORTUNITIES FOR WOMEN SCIENTISTS

DST is encouraging meritorious girls to pursue higher education and career in underrepresented STEM areas, through its major initiative 'Vigyan Jyoti'. During the year, 30000 girls of Class IX-XII from 200 districts were enrolled under Vigyan Jyoti to get benefits of various interventions like parent-student counselling, subject oriented classes, curriculum-based STEM activities, exposure visits, etc. **Research Support to Women Scientists was extended to** around 370 women **scientists** under Women Scientists Scheme-A (WOS-A) to pursue research after break in career in 5 subject areas of Basic and Applied Sciences. **Training in Intellectual Property Rights (IPRs) was provided to** 99 women scientists. **Research Infrastructure Support, CURIE** (Consolidation of University Research for

Innovation and Excellence) Programme extended to 25 Women PG Colleges. The 'SERB-POWER mobility grant' was introduced to provide opportunity to women scientists to visit leading institutions/universities across the globe for a period of 01-03 months

XII. ATTRACTING THE BEST TALENT POOLS TO PURSUE THEIR CAREER IN SCIENCE

The Scholarship for Higher Education (SHE) was supported to 10833 students, selected on competitive basis, for pursuing under-graduation and post-graduation in basic and natural sciences. Sixteen INSPIRE SHE Scholars identified on competitive mode were provided the opportunity to participate in Asian Science Camp held in South Korea during August 2022 and one of the Indian participant could win third prize in poster making competition. INSPIRE fellowship was offered to 845 Fellows for pursuing Doctoral Degree program in science & technology domain. The SERB-National Post-doctoral fellowship was extended to 300 fellows during the year.

XIII. CONSERVING THE HERITAGES THROUGH DIGITAL TECHNOLOGIES

Under the Science and Heritage Research Initiative (SHRI) programme of DST, the sound proofing qualities of Pattamadai mat, a mat made by weaving or interlacing korai grass with the cotton threads, has been explored for use in noise guarding classrooms as well as recording studios against external noise disturbances. This can increase the demand for this traditional art of Tirunelveli, Tamil Nadu. With SHRI support, SASTRA Deemed to be University traced, collected, redeemed, and restored around 20 heritage rice varieties of Tamil Nadu, through 10 community seed banks benefiting more than 500 farmers in the state.

XIV. AUGMENTING RESEARCH CAPABILITIES IN STATE UNIVERSITIES AND COLLEGES

The growth of existing research capabilities in state universities and colleges 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. A dedicated scheme, State University Research Excellence (SERB-SURE) has been launched by Science and Engineering Research Board (SERB) to create a robust R&D ecosystem in state universities and colleges including the private ones.

XV. KEY ACHIEVEMENTS FROM AUTONOMOUS INSTITUTIONS

a. Quantum Science and Technology

- Physicists from the Raman Research Institute (RRI) and TIFR with International Centre for Theoretical Sciences (ICTS), probed the role of noise in quantum technology and the evolving area called quantum Brownian motion threw 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. The study could help explore ways to control noise in the domain of quantum technology.
- Scientists from RRI and Institute for Quantum Computing, Canada, have found a simpler way to quantify the amount of entanglement in higher dimensional systems. They have formulated analytical relations between statistical correlation measures and known entanglement measures for any arbitrary dimension. The study could help potentially enable a better assessment of the efficacy of an entangled state for technological applications like quantum teleportation
- Scientists from S. N. Bose National Centre for Basic Sciences have formulated a new theoretical concept by Indian scientists exploring connections between the laws of thermodynamics and Quantum Information Theory (QIT).

b. Astronomy

- Using 3.6-m Devasthal optical telescope (DOT) (India's largest optical telescope) and 1.3-m Devasthal Fast Optical Telescope (DFOT) telescopes located at Devasthal, Nainital under ARIES, a team of scientists, including Indian and International collaborators, have derived the accurate value of Pluto's atmospheric pressure at its surface. It is more than 80,000 times less than the atmospheric pressure at mean sea level on Earth.
- Utilising the indigenously invented and built SARAS 3 radio telescope, researchers from Raman Research Institute, have conclusively refuted a recent claim of the discovery of a radio wave signal from cosmic dawn, the time in the infancy of our Universe when the first stars and galaxies came into existence.
- Astronomers from ARIES & IIA have developed a simple technique of separating the constant background of the Solar Corona and revealing the dynamic corona. The new method is capable of separating the background revealing the dynamic corona. This research has been accepted for publication in the Solar Physics journal.
- A team of astronomers from IIA along with their collaborators have found that interactions between two different Coronal Mass Ejections (CMEs) in the interplanetary medium as they travel towards the Earth play a key role in their evolution.
- Researchers from the Raman Research Institute (RRI) have determined properties of radio luminous galaxies formed just 200 million years post the Big Bang, a period known as the Cosmic Dawn thus providing an insight to the properties of the earliest radio loud galaxies that are usually powered by supermassive black holes.

c. Nano Science

- INST scientists for the 1st time, have proposed an efficient way to induce a property called piezoelectric delta phase in polymer (PVDF) nanoparticles making it useful for applications in touch sensors, acoustic sensor, and piezoelectric nanogenerators. They have made a device with PVDF

nanoparticles which exhibits much superior piezoelectric response in comparison to the film counterpart

- Scientists from the Institute of Advanced Study in Science and Technology (IASST) have developed biodegradable, biopolymer nanocomposite which can detect relative humidity can find application as smart packaging materials, especially for the food industry. The fabricated nanocomposite film was an excellent smart sensor based on the fluorescence 'on-off' mechanisms against humidity.
- Researchers at the S N Bose Centre for Basic Sciences have 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. They have calculated the Surface-to-core relative energy on a variety of possible binary combinations of alkali metals, alkaline earth, basic metals, transition metals and p-block metals to create a large data-set of 903 binary combinations.
- Scientists from INST have computationally predicted two fascinating 2D monolayers having great potential for applications in next-generation self-powered materials which develop spin currents in response to strain. They have proposed a new class of stable, hexagonal, buckled ZnX (X: S, Se, or Te) monolayers in the journal 'ACS Appl. Mater

d. Climate & Environment

- A study by Wadia Institute of Himalayan Geology (WIHG) has found that glaciers in Suru Basin, Ladakh, and western Himalaya, have fluctuated greatly throughout the Marine Isotope Stages (MIS) to the Little Ice Age (LIA). The glacial chronologies from such semi-arid regions can help understand the past climate changes and in assessing the impacts of future climate change in the region.
- Scientists of the Wadia Institute of Himalayan Geology, an autonomous institute of the Department of Science and Technology has reported first time the oldest glacial advance during 52 Kilo years from the Central Himalaya, as the evidence of glacial advance during the Last Glacial Maxima and subsequently younger time periods have already been reported from many parts of the Central Himalaya.
- Wadia Institute of Himalayan Geology (WIHG) has spotted fossils of a small mammal resembling squirrels called treeshrew belonging to a new genus and species from Ramnagar in Jammu and Kashmir.
- A study by the Indian Institute of Geomagnetism, Mumbai, an autonomous institute of the Department of Science & Technology, Govt. of India, has chalked the possible geological cross-sections along the Greater Maldive Ridge (GMR) for the first time with the help of satellite-derived high-resolution gravity data. The researchers postulated that the GMR may be underlain by an oceanic crust. The results from their study can provide additional constraints in understanding the plate-tectonic evolution of the Indian Ocean, better.
- Research by Birbal Sahni Institute of Paleobotany (BSIP) revealed that certain mangrove species in Chilika and Sundarbans along the east coast and Dwarka and Porbandar along the west coast of India is likely to reduce and shift landward by 2070 due to decline in suitable habitats in response to precipitation and sea level changes, said a study based on a prediction model.

The study can help identify highly suitable areas for conservation and management and develop conservation strategies for the future.

e. Health

- Scientists from Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR) studied the glassy dynamics of an artificial active-matter system and found that patterns can form in systems consisting of active elongated particles that help it elude turning glassy. Their research published in Physical Review Letters showed that the patterns were triggered by the defects in the orientation of the particles, and this helped keep the particles moving, preventing the system from behaving like a typical glass.
- Scientists at JNCASR have found a new ingredient that can weakly perturb bacterial membrane, thus countering bacterial resistance to multiple classes of antibiotics, can help revive the efficacy of obsolete antibiotics. They have come up with the approach of revitalising the efficacy of existing antibiotics by using them in combination with antibiotic adjuvants -- ingredients that can help counter resistance to existing antibiotics. This novel idea can help strengthen the activity of obsolete antibiotics and bring them back into use for treating complicated infections.
- A newly identified gene can hold the key to prevent fungal infection Candidiasis that often affects intensive-care unit (ICU) patients, cancer patients and patients receiving immunosuppressive therapy. The researchers have carried out a large-scale screen to identify regulators of chromosome stability in *C. albicans*, a clinically relevant fungal model system.

f. Energy

- JNCASR scientists have discovered a novel material called single-crystalline scandium nitride (ScN) that can emit, detect, and modulate infrared light with high efficiency making it useful for solar and thermal energy harvesting and for optical communication devices.
- ARCI has developed a new method to produce hydrogen with high purity (99.99%) from methanol-water mixture at ambient pressure and temperature that uses only one-third of the electrical energy required in water electrolysis. The method combines both the processes of electrolysis and reformation to produce hydrogen from methanol-water mixture by electrochemical methanol reformation (ECMR) at ambient pressure and temperature. The main advantage of this process is that the electrical energy needed to produce hydrogen is 1/3rd of water electrolysis.
- A platinum-based electrocatalyst has been developed by ARCI for use in fuel cells through an efficient procedure. This electrocatalyst showed comparable properties to the commercially available electrocatalyst and could enhance the lifetime of the fuel cell stack performance.

XVI. NURTURING SCIENCE AND TECHNOLOGY THROUGH THE S&T SUPPORTED IN STATES AND UTs

Many of the S&T councils supported by the Department of Science and Technology has taken up a proactive role in promoting science and technology in the states through new methods and new initiatives. The Gujarat Council of Science and Technology (GUJCOST) has come up with a unique project of establishing innovation clubs in 483 arts, commerce, and science colleges in the state. The Punjab State Council for Science & Technology has conceptualized and catalysed setting up of world class S&T infrastructure in the form of 'Knowledge City' housing state-of-the-art institutional cluster spread across 400 acres in Mohali.

XVII. GOOD LABORATORY PRACTICE:

Department of Science & Technology (DST) is implementing the National GLP Compliance Monitoring Programme for certification of Indian Test Facilities/laboratories, conducting non-clinical health and environment safety studies in accordance with the OECD Principles. Four new Test facilities/laboratories have been certified as GLP Compliant. Similarly, 16 existing Test facilities/laboratories have been Re-certified as GLP Compliant.

XVIII. POLICY FORMULATION IN SOME KEY AREAS

Brought out two guidelines during the year and two major policies are in the process of finalization.

- a. Scientific Research Infrastructure Sharing maintenance and Networks (SRIMAN) guidelines
- b. Scientific Social Responsibility (SSR) Guidelines
- c. Science, Technology and Innovation (STI) Policy
- d. National Geospatial Policy