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R&D Newsletter

Indian Institute of Technology Kanpur

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Bridging Academia and Industry at IIT Kanpur

The PG Academics & Career Council (AnC), Students' Gymkhana, IIT Kanpur, in collaboration with the Office of Dean of Research & Development, IIT Kanpur, successfully organized a workshop on "**Industry 360°: Process Safety, ESG & Risk Management**" at the Outreach Auditorium, IIT Kanpur. The workshop aimed to bridge the gap between academic learning and real-world industry practices, while also creating awareness about the importance of process safety in both everyday life and industrial environments.

In the inaugural address, the Chief Guest, Prof. Tarun Gupta, Dean of Research & Development (DORD) emphasized the critical importance of understanding process safety, especially while working in laboratories and handling sophisticated instruments highlighting that a lack of proper knowledge can lead to equipment failure, unnecessary shutdowns, delays in research work, and in some cases, even fatal consequences.

The technical sessions of the workshop were conducted by industry experts Mr. Rakesh Verma and Ms. Rekha Sharma. The workshop was structured into four comprehensive sessions covering Process Safety Management, Project Management, ESG (Environmental, Social, and Governance), and Enterprise Risk Management. The workshop witnessed active participation from 100+ students, researchers, and professionals, making it an engaging and insightful learning experience for all attendees.

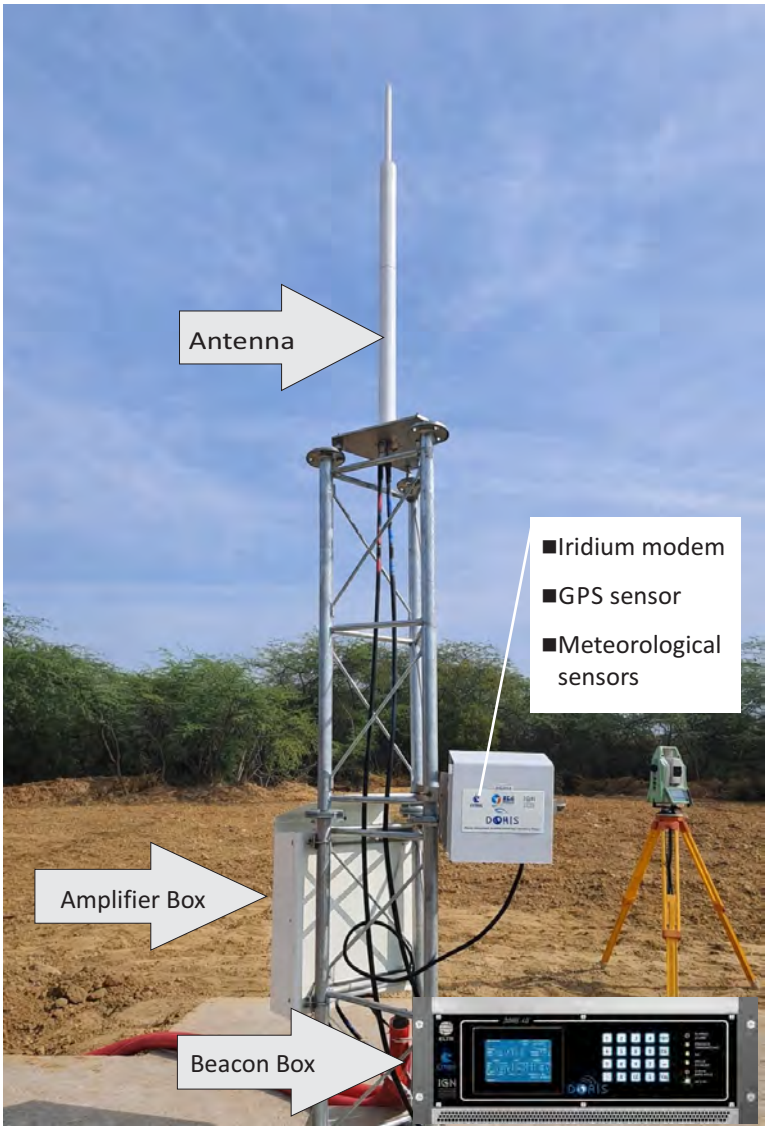
Industry Connect Series

As part of the **Industry Connect Series** initiative, office of Dean Research & Development hosted Dr. K. V. Subramaniam, President, **Reliance Life Sciences Pvt. Ltd.**, along with Mr. Praveen Sharma, Head, Peptide Business. They engaged in insightful discussions with the faculty members to explore potential avenues for research collaboration and enhanced student engagement. The meeting was moderated by Prof. Tarun Gupta, DORD, IIT Kanpur.

The Industry Connect Series is an initiative aimed at strengthening industry–academia collaboration, fostering indigenous technologies, and enabling innovative solutions through sustained engagement with leading industries. As part of this series, the first industry visit was conducted with **JK Cement**, whose team, led by Mr. Sameer Bharadwaj, Head of Manufacturing Excellence, and Mr. Prakhar Shrivastava, Head of Corporate Quality, shared key problem statements on cement quality, optimization, and plant automation.

India's first DORIS ground beackon at Geodesy Villiage, IIT Kanpur

The National Centre for Geodesy (NCG) has successfully installed and commissioned India's first **DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)** ground beacon at Geodesy Village, at IIT Kanpur. This milestone has been achieved through a tripartite collaboration between IIT Kanpur, CNES (France), and IGN France, marking a significant advancement in India's precision space geodetic capabilities. This integrated infrastructure reinforces India's geodetic and reference frame capabilities aligned with the **National Geospatial Policy** (2022) and the vision for **Aatmanirbhar Bharat** in geodetic and geospatial infrastructure.



IIT Kanpur DORIS station as part of the International DORIS Service (IDS)

DORIS System Overview

The DORIS system consists of several integrated components that together enable precise Doppler-based satellite tracking. At its core is the indoor beacon, which generates two coherent, modulated carrier signals at 400 MHz and 2 GHz using a high-stability reference oscillator and a frequency synthesizer. A management and control board supervises system operations, while a power supply with battery backup ensures uninterrupted functioning during power outages. These signals are transmitted through a Starec C omnidirectional antenna that provides near-uniform azimuthal radiation, allowing continuous visibility to Low Earth Orbit (LEO) satellites regardless of their pass direction, provided accurate vertical alignment is maintained to preserve phase-center stability and measurement accuracy. Supporting subsystems are housed in the external Monitoring and Management (MGM) box, which includes an Iridium modem operating through the Iridium Communications constellation, a GPS sensor for timing control and health monitoring, meteorological sensors, and an external amplifier box that boosts signal power.

With this installation, National Centre for Geodasy, IIT Kanpur now hosts **two of the four fundamental space geodetic techniques used globally, GNSS and DORIS**, contributing to the realization of the International Terrestrial Reference Frame (ITRF). The existing GNSS station "IITK" operates under the International GNSS Service (IGS), while the newly commissioned DORIS beacon "KANC' integrates NCG-IIT Kanpur into the International DORIS Service (IDS). The site has become the 52nd globally co-located GNSS-DORIS station, contributing to the definition and long-term stability of the ITRF and strengthening India's role in resilient global reference frame infrastructure.

DORIS supports precision satellite orbit determination, particularly for altimetry missions fundamental to global sea-level monitoring, while simultaneously contributing to Earth orientation parameter estimation, gravity field modeling, geocenter determination, tectonic plate motion analysis, crustal deformation studies, and ionospheric and tropospheric investigations, collectively strengthening applications in geodynamics, climate research, and Earth system science.

Guarding the Invisible: Why Hardware Security Research Shapes Our Digital Future

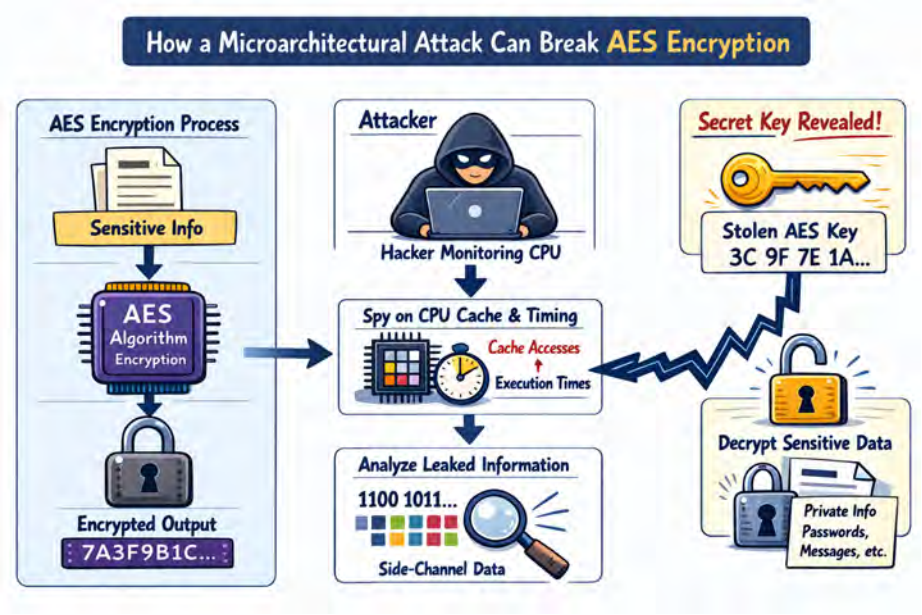
Prof. Urbi Chatterjee
SETTLOR, Dept. of Computer Science and Engineering

Imagine your smartphone as your best friend—always with you, holding photos, chats, and secrets. But what if a hacker plants a hidden "bug" in the phone's chip to spy? That's hardware security's battle, and research makes you the superhero building unbreakable shields for gadgets.

Hardware security protects physical parts like chips and processors from attacks. Even if software is perfectly written, a weakness inside the hardware can allow attackers to steal secrets like passwords, bank details, or confidential data.

Real dangers?

The famous attacks **Spectre** and **Meltdown** showed that modern processors could leak sensitive information because of the way they try to run programs faster using "speculative execution." These were not simple software bugs; they were deeply connected to hardware design decisions. Another example is **Plundervolt**, where attackers changed the voltage of Intel processors to corrupt secure computations and break cryptographic protections. Similarly, **PLATYPUS** demonstrated how attackers could read secret data by carefully observing power consumption patterns of a processor. A different class of threat is a **Hardware Trojan**, where a malicious circuit is secretly inserted into a chip during manufacturing, which can later leak data or cause failures. These examples show that hardware security is not science fiction. It directly affects real-world systems used by millions of people.



The representative picture shows how an attacker can secretly observe processor behavior (like cache and timing) during Advanced Encryption Standard (AES) execution to leak and reconstruct the hidden secret key, ultimately breaking the encryption.

SETTLOR: Building Trusted Hardware

The **Secure Embedded and Smart Things Laboratory (SETTLOR)** at IIT Kanpur works actively in this exciting field. Established in 2021 in the Dept. of Computer Science and Engineering, SETTLOR conducts research on both offensive and defensive hardware security such as power and electromagnetic side-channel attacks, acoustic attacks, timing and micro-architectural attacks, physically unclonable functions, UAV security, mobile security, network-on-chip security, approximate computing, hardware Trojan horse and post-quantum cryptography. The lab collaborates with national and international agencies and publishes in top journals and conferences. By identifying weaknesses and designing stronger protections, SETTLOR helps build safer and more trustworthy hardware systems for the future.

At SETTLOR, we believe that India's digital push needs this—secure 5G, EVs, defense. Research in hardware security is important because it protects the foundation of all digital technology. If we secure the hardware, we secure the world built on top of it. Curiosity drives it. Tinker now—your work could stop the next hack. Secure hardware; safeguard tomorrow!

Upgradation of the National Wind Tunnel Facility (NWTF), IIT Kanpur

PI: Prof. Alakesh Chandra Mandal
Dept. of Aerospace Engineering
Sponsor: Aeronautics R&D Board (ARDB)

The vision of establishing a large-scale subsonic wind tunnel facility in India was realized with the creation of the **National Wind Tunnel Facility (NWTF)** at IIT Kanpur by the late Prof. N. L. Arora. Commissioned in 1999, the facility was developed to meet the growing national demands of both aerospace and non-aerospace industries. Since its inception, NWTF has been widely used by government and non-government organizations, with the primary objective of supporting critical national research and development needs.

The facility actively collaborates with leading government agencies, including CSIR-NAL, DRDO (including ADE, ADRDE, DRDL and ADA), ISRO-VSSC, NSTL, as well as major public sector units such as BHEL, NTPC, and HAL. Over the years, NWTF has successfully executed numerous wind tunnel testing projects of national significance. Notable examples include intake studies for the Advanced Medium Combat Aircraft, force measurement studies of stealth-wing flying testbeds, propeller-effect studies of the Rustom UAV, and ground-effect analysis of reusable launch vehicles. Additional contributions include aerodynamic studies of space recovery capsules, launch vehicles, parachutes, aerostats, and civil infrastructure such as bridges, high rise buildings and chimneys, as well as automotive vehicles.

With the increasing demand for advanced research and precise testing, the need to upgrade existing facilities has become imperative. The project aims to enhance NWTF's capabilities to meet modern experimental requirements. Key upgrades include the integration of a state-of-the-art model support system, the installation of an advanced tunnel cooling system, an increase in wind speed, the incorporation of high-resolution high-speed cameras, and the high-speed double-pulsed laser system.

These enhancements will significantly expand the facility's ability to support a wide range of stakeholders, including DRDO (ADA, DRDL, ADE, NRB, NSTL), ISRO (VSSC), CSIR-NAL, automotive vehicle industries, public sector undertakings (HAL, NTPC, BHEL, MDL, GRSE), private industries, and academic researchers. The upgraded facility will enable more accurate data acquisition, reduce project turn around time, and deliver advanced experimental outcomes that are currently beyond reach.

Once upgraded, NWTF will emerge as a unique, world-class facility in India, capable of competing with leading wind tunnel laboratories worldwide.

Upgradation & Modification of Supersonic Wind Tunnel Facility



PI: Prof. Mohammed Ibrahim Sugarno
Co-PI: Prof. Arun Kumar Perumal
Dr. Soumya Ranjan Nanda, Ramanajum Faculty
Department of Aerospace Engineering
Sponsor: Aeronautics R&D Board (ARDB)

Ground test facilities are crucial for collecting and analysing data before proceeding for a flight test of high speed vehicles specially for the ones traveling at supersonic and hypersonic speeds rockets missiles spacecraft etc. The flow physics associated with such high speed flying vehicles are complicated and a comprehensive understanding of it is required before finalizing it's design. Keeping this in mind, a Mach 2 supersonic wind tunnel at IIT Kanpur was developed back in 1970, one of the oldest facility in the country to cater to the needs of DRDO AND ISRO. The facility in the past has been put to use for several fundamental and applied research as well as for academic teaching.

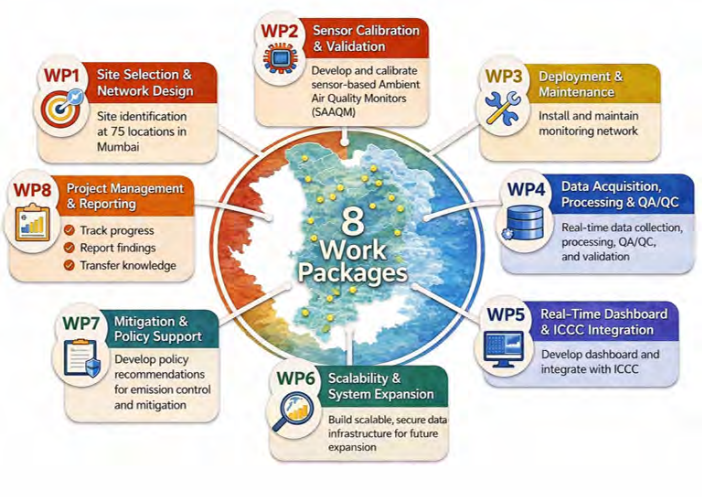
With the rising demand for the need for speed, the existing supersonic wind tunnel will be upgraded to push upto Mach 4 with the state of the art diagnostic systems. This will enable the study and detailed understanding of the higher flight regime and will also help train manpower in the field of high-speed testing for the years to come.

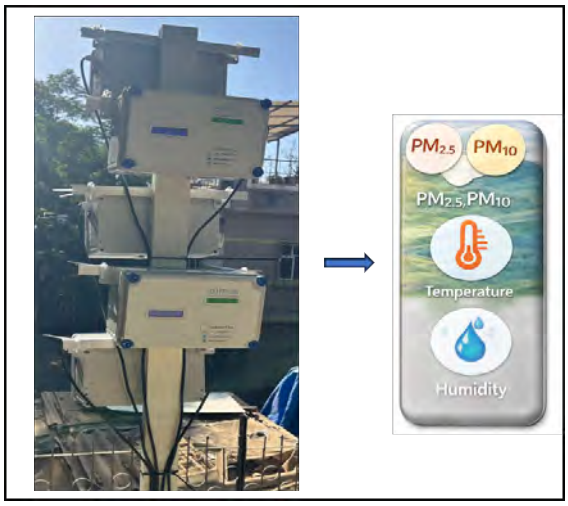
Mumbai Air Network for Advanced Sciences (MANAS)

PI: Prof. S.N. Tripathi
Dean of Kotak School of Sustainability (KSS)
Sponsor: Brihanmumbai Municipal Corporation (BMC)

Recent Air Quality Index of Mumbai exceeding 300 AQI levels indicate severe AIR pollution, with significant spatial variability and strong temporal fluctuations. These factors underscore the need for hyper-local monitoring to enable effective interventions.

MANAS proposes to set up a strong Decision Support System (DSS) to enable real-time data analysis, visualization, and informed decision-making. The system aims to create a comprehensive, real-time air quality monitoring network capable of hyper-local pollution mapping, enabling timely actions to improve urban environmental management and public health.





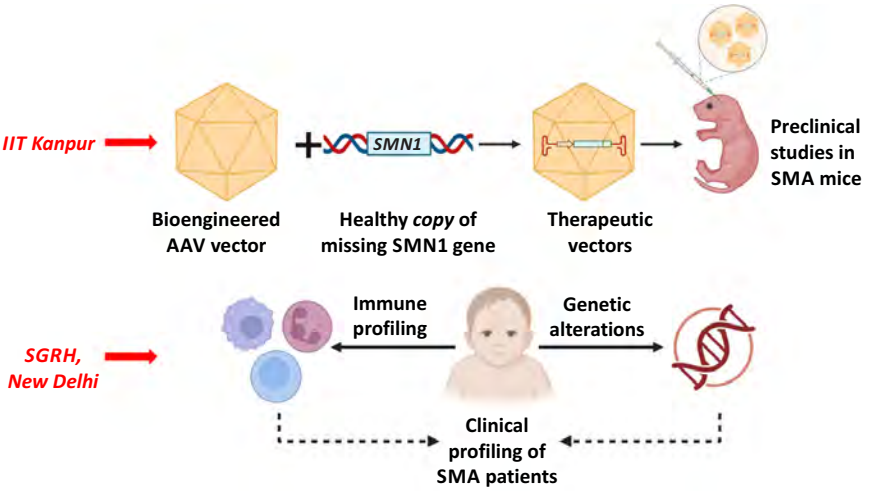
Co-location setup of MANAS sensors at Kandivali West CAAQMS site

Development of Indigenous Platform for Gene Therapy of Spinal Muscular Atrophy


PI: Prof. Jayandharan G Rao
Dept. of Biological Sciences & Bioengineering
Co- PI: Prof. Santosh K Misra, Dept. of Biological Sciences & Bioengineering
Dr. Ratna Puri Dua, Institute of Medical Genetics, Sir Gangaram Hospital, New Delhi

Sponsor: Anusandhan National Research Foundation (ANRF): Advanced Research Grant

Spinal muscular atrophy (SMA) is a fatal neuromuscular disorder characterized by muscle wasting. It affects about 1 in 10,000 births. Children affected by severe forms of SMA often live for only 2-3 years. Existing gene therapies are inadequate in completely reversing the disease phenotype and are expensive (~24crores per dose). This highlights the need to develop an efficacious and affordable treatment for SMA.



Schematic representation of the work plan for developing SMA gene therapy and genotype-phenotype correlation in SMA patients.

The goal of this project is to design a delivery system using novel AAV vectors carrying a healthy copy of the missing gene (SMN1). Its safety and efficacy in a mouse model of SMA will be evaluated. The engineered AAV vectors is expected to have improved gene transfer and immune-evasive potential which will facilitate achieving phenotypic improvement at lower dosages, thereby overcoming the current challenges to SMA gene therapy. Additionally, in collaboration with collaborators at Sir Gangaram Hospital, New Delhi, genetic alterations and the immune profile of a large cohort of SMA patients will be assessed providing valuable clinical insights into the role of recipient status in future gene therapy clinical trials.

Design of Metamaterial-Inspired Compact UWB Antenna at UHF and VHF Bands


PI: Prof. Raghvendra Kumar Chaudhary
Co-PI: Prof. Kumar Vaibhav Srivastava
Dept. of Electrical Engineering

Sponsor: DFTM, DRDO, Ministry of Defence, Govt. of India

VHF/UHF communication systems are integral to aircraft, ground vehicles, and modern military platforms, enabling reliable long-range connectivity. However, conventional antennas in these frequency bands are often bulky and mechanically less robust.

This project focuses on advancing antenna technology through the use of metamaterial-based designs, enabling miniaturized, low-profile, and lightweight solutions. Beyond defense applications, the technology also offers significant dual-use potential in civilian domains, including emergency communication, disaster management, and next-generation vehicular networks.

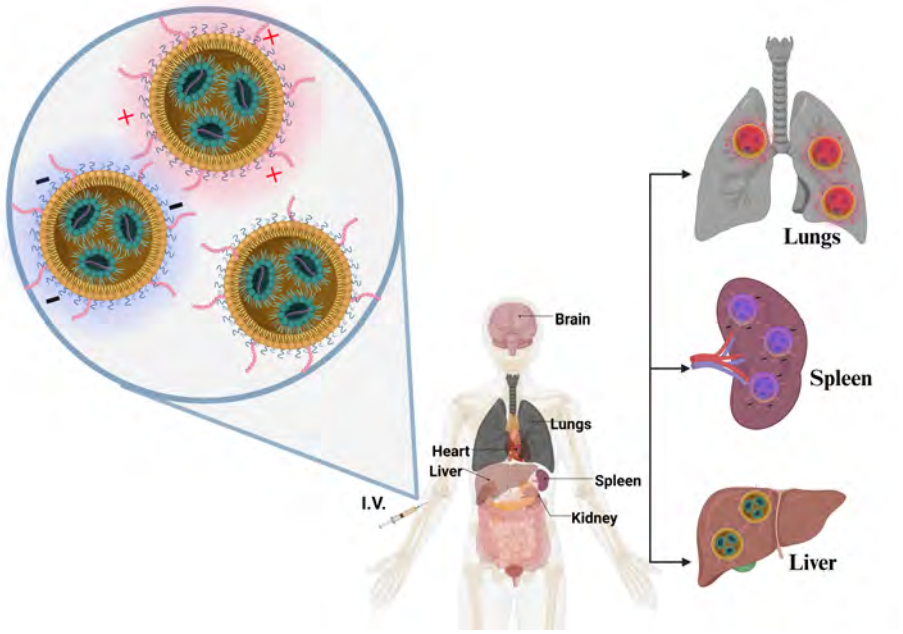
Spleen Sort RSV-LNPs as mRNA Vaccine Candidates against Respiratory Syncytial Virus


PI: Prof. Nagma Parveen
Dept. of Chemistry
Co-PI: Prof. Anusmita Sahoo, Dept. of Biological Sciences & Bioengineering
Dr. Mrigank Srivastava, CSIR-Central Drug Research Institute, Lucknow

Sponsor: Department of Biotechnology (DBT)

Lipid nanoparticles (LNPs) have emerged as a pivotal platform in gene therapy and vaccine development, exemplified by the clinical success of Comirnaty, SpikeVax, and RSV mRNA-1345 vaccines in 2021-2025. For effective activation of the adaptive immune system, LNPs must deliver antigen-encoding mRNA to the spleen.

We are developing RSV vaccine candidates implementing Selective Organ Targeting (SORT) LNPs that specifically target spleen-resident immunecells. This Spleen SORT RSV-LNPs technology will be established by mapping the functional relevance of 'core-shell' structure of and 'protein-corona' on the LNPs.



6G-RS: 6G Research & Standardization

PI: Prof. Rohit Budhiraja
Dept. of Electrical Engineering

Sponsor: Ministry of Electronics and Information Technology

The project is a joint effort by IIT Kanpur and partner institutes designed to drive India's objective of becoming a major player in the telecommunications space. Aligned with 3GPP (3rd Generation Partnership Project) Release 20 and IMT-2030 (International Mobile Telecommunications-2030) vision, the project focuses on advanced 6G technology research to generate essential intellectual property and simulation tools.

A primary objective is to secure Standard Essential Patents (SEPs) across global and national forums, including 3GPP, ITU (International Telecommunication Union), and TSDSI (Telecommunications Standards Development Society, India). Additionally, the initiative translates research into practical wireless solutions for India's telecom, railways and defence sectors. By enhancing the indigenous 5G testbed for algorithm validation and conducting extensive capacity-building programs, 6G-RS aims to foster self-reliance, build a robust expert workforce, and capture a 10% share of global 6G IPRs.

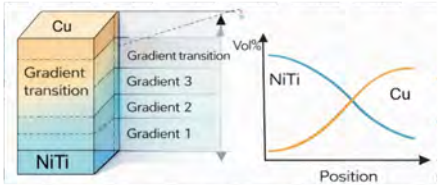
Design and Development of Functionally Graded NiTi-Cu Shape Memory Alloys for Next-Generation Biomedical Applications Using Additive Manufacturing

PI: Prof. Arvind Kumar
Dept. of Mechanical Engineering

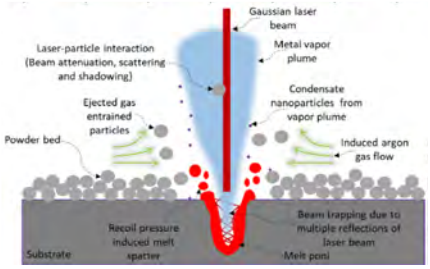
Sponsor: Anusandhan National Research Foundation (ANRF)

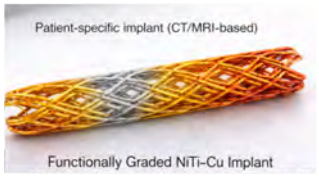
This project focuses on developing patient-specific biomedical implants using advanced shape memory alloys (NiTi–Cu) fabricated via Laser Powder Bed Fusion (LPBF) additive manufacturing. By creating functionally graded materials with precise control over composition and structure, the approach aims to overcome common challenges in traditional implants, such as stress shielding, fatigue failure, poor fit, and infection risks.

Laser Powder Bed Fusion (LPBF) additive manufacturing



Gradient material design





AM-enabled NiTi-Cu smart biomedical implants

By combining computational alloy design, mechanical performance optimization, and thermofluid physics-informed manufacturing control, the project ensures reliable material behavior and precise gradient formation. This will facilitate controlled phase evolution, tailored transformation behavior, and enhanced functional performance. Using patient CT and MRI data, each implant can be customized to match individual anatomy, offering improved comfort and functionality. From spinal implants to hernia meshes and orthopedic devices, this research will contribute to a new era of personalized, high-performance, and bioadaptive healthcare — where implants don't just fit better, but perform smarter.

Jeet Bindra Centre of Excellence in Speciality Chemicals

The Centre will address the rapidly growing demand for sustainable and high-performance surfactants, driven by population growth, rising incomes and expanding applications across sectors such as home and personal care, agrochemicals, enhanced oil recovery (EOR) and smart functional materials.

Three key verticals of the centre:

- Indigenous production of green and speciality surfactants
- Development of a digital platform to accelerate next-generation speciality chemical innovation
- Exploration of novel applications of speciality surfactants and polymeric films

The initiative is coordinated by **Prof. Jayant K. Singh**, Dept. of Chemical Engineering with funding support from the Ministry of Chemicals and Petro-Chemicals, Govt. of India, and generous contribution o f Mr. Jagjeet Singh Bindra (BT/CHE/1969).

Design of Ultra-Wideband Antenna Array and Artificial Magnetic Conductor for RF Applications


PI: Prof. Kumar Vaibhav Srivastava
Co-PI: Prof. Raghvendra Kumar Chaudhary
Dept. of Electrical Engineering

Sponsor: DFTM, DRDO, Ministry of Defence, Govt. of India

Ultra-wideband antenna arrays can be seamlessly integrated into communication systems for military personnel and vehicles, providing high-speed data transmission, reliable connectivity, and secure communication channels across diverse terrains and environments. These antennas play a crucial role in radar systems for surveillance, target detection, and tracking. Their wide bandwidth and unidirectional pattern significantly enhance radar performance.

The aim of this project is to advance antenna technology for defence applications by leveraging innovative approaches such as metamaterial-inspired designs and Artificial Magnetic Conductors (AMCs). This involves enhanced performance in terms of high gain, unidirectional radiation pattern, large bandwidth and good isolation, while maintaining a miniaturized, low-profile, and lightweight configuration.

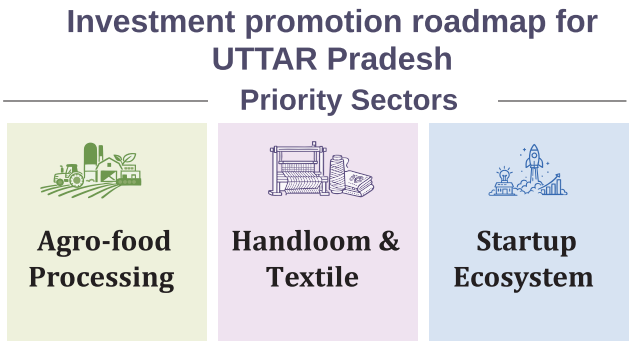
Sectoral Research on Textile Policy, Startup Policy, and Food Processing Policy for Uttar Pradesh




PI: Prof. Munmun Jha
Dept.of Humanities and Social Sciences
Co-PI: Prof. Amitabha Bandyopadhyay
Dept of Biological Sciences & Bioengineering
Prof. Sayan Chattopadhyay
Prof. Esha Chatterjee
Dept.of Humanities and Social Sciences

Sponsor: INVEST UP, Govt. of Uttar Pradesh

This project seeks to create a consolidated investment promotion roadmap for three priority sectors in Uttar Pradesh: agro-food processing, handloom and textile, and the startup ecosystem. The roadmap will set out strategies to enhance the state's investment attractiveness, strengthen key value chains, and position Uttar Pradesh as a leading destination for domestic and global investors, offering opportunities for innovation, building industry leadership, high-value job creation, and technology-driven solutions to developmental challenges.



The study will be evidence-based, combining data analysis, stakeholder consultations, and benchmarking with leading states to identify opportunities and challenges unique to each sector.

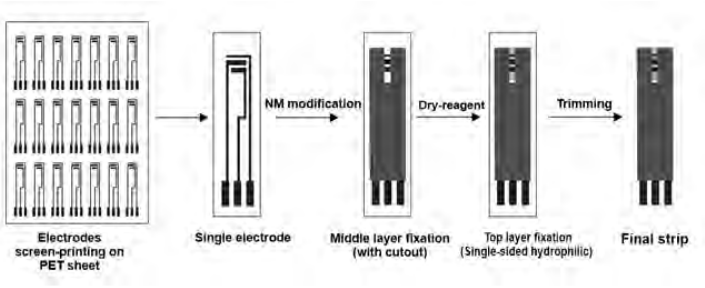
Non-Enzymatic Electrochemical Sensor Strip for Detecting Uric Acid and a Method for Fabrication Thereof

Invented by: Prof. Siddhartha Panda, Dept. of Chemical Engineering, SCDT, National Centre for Flexible Electronics &
Dr. Nishant Verma, SCDT, National Centre for Flexible Electronics

Licensed to: Sensa Core Medical Instrumentation Pvt. Ltd.

Patent No: 580805

The novel technology is a user-friendly, portable sensor for measuring uric acid concentration directly from blood or serum samples. The sensor requires only a drop of blood/serum, introduced into a sample-inlet zone, and provides a quantitative reading of uric acid levels within 60 seconds. This compact, strip-based electrochemical device enables rapid and reagent-free analysis, making it ideal for use in hospitals, diagnostic centers, home monitoring, and remote healthcare settings where quick and reliable results are critical.



With the growing prevalence of conditions linked to uric acid and the rising demand for rapid, portable diagnostics, this novel strip-based uric acid sensor technology is well-positioned to address the evolving needs effectively.

Apparatus for Micro-Resolution phasor Management

Invented by: Prof. Ankush Sharma and
Mr. Prateek Sharma,
Dept. of Electrical Engineering

Licensed to: Synergy Systems & Solutions

Indian Patent No. 410521

The technology includes both IRNSS and GPS clock to make measurement system more resilient against time synchronisation failure, with a low latency communication of 100 phasor measurements per second.

The invention offers significant potential to enhance both societal and economic development. Real-time monitoring capabilities promise fewer disruptions in power supply, empowering communities to manage energy resources effectively. Moreover, its affordability and efficiency can drive widespread adoption, lower electricity prices, and attract investment, ultimately spurring economic growth.

10 LPM Impaction-based Submicron (Pm1) Sampler

Invented by: Prof. Tarun Gupta
Dept. of Civil Engineering

Re-licensed to: Envirotech Instruments Pvt. Ltd.

This pioneering technology is a novel omnidirectional air inlet device that captures aerosol submicrons (particles smaller than 1 µm). The device features a 24-hours programmable timer that provides automatic start and shut off the sampler as per the requirement. Additionally, the device also maintains the constant sampling rate of 10 liter per minute, unaffected by voltage fluctuations, through a critical orifice system.

Based on the market research findings, the Global Particulate Matter Monitoring Market Size was estimated at 1.848 USD Billion in 2024 and is expected to reach 6.0 USD Billion by 2035, exhibiting a compound annual growth rate (CAGR) of 11.3% from 2025 to 2035. The developed technology aims to advance air quality monitoring and support efforts to mitigate pollution and safeguard public health.

Agreement was signed with **Ecosense Sustainable Solutions Pvt. Ltd.** to create a working prototype for waste heat recovery, which involves transferring heat from hot gases to cooler liquids. IIT Kanpur will provide research expertise, and Ecosense will focus on practical use and bringing the technology to market.

MoU signed with **Gati Shakti Vishwavidyalaya (GSV), Vadodara**, to collaborate on aerospace training and advanced laboratory exposure for GSV undergraduate students at IIT Kanpur and joint research initiatives across rail, road, aerospace, marine, cross-cutting digital technologies.

MoU with **Prevest DenPro Limited** to collaborate on the development and manufacturing of Class B & Class C biomaterials and biomedical devices for dental and orthopaedic care. Under this collaboration, IIT Kanpur will provide design and process specifications, while Prevest Denpro Limited will manufacture the relevant samples in its Class B/C facilities, enabling the translation of research into practical healthcare solutions. This partnership demonstrates both organizations' commitment to advancing biomaterials innovation and to building stronger ties between academia and industry to improve healthcare technologies.

Power Foundation of India have signed an MoU to establish the PFI Distinguished Chair Professorship on Power Sector Regulation and Policy. The initiative aims to promote excellence in teaching, research, and leadership while fostering deeper engagement between academia, policymakers, and industry stakeholders.

IIT Kanpur signed an MoU with the **642 Electronics and Mechanical Engineers Battalion, 42 Artillery Division of the Indian Army**. The collaboration will focus on the design, development, testing, and deployment of a next-generation unmanned aerial platform tailored for extreme and mountainous operational environments.

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Feedback/Suggestions

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