Volume 12, Issue 3

November 2024

R&D Newsletter

Indian Institute of Technology Kanpur

FEATURED RESEARCH

CoE in
Antimicrobial Resistance

Centre for
Bio-Sensing Technologies

Visualizing the real-time entry of
SARS-CoV-2

SWR1 chromatin remodeler in
Virulence Mechanism

Regulatory biomolecular circuits in
Synthetic Biology

Multimodal large language model
BharatGen

Dynamics & Motion control of
Telecommunication Spacecraft

Collaborations

MoU with Starkenn Technologies Pvt. Ltd.

IIT Kanpur signed MoU with **Starkenn Technologies Private Limited** to Develop Cutting-Edge mmWave Antennas for Advanced Driver Assistance Systems. The MoU was signed by Prof. Tarun Gupta, Dean of Research and Development (DORD), IIT Kanpur, and Mr. Paritosh Dagli, COO of Starkenn Technologies.

MoU with FusionX Asia Pacific Private Limited

FusionX Asia Pacific Private Limited (FXE) and IIT Kanpur entered into an MoU to collaborate on renewable energy generation and storage. The MoU was signed by Prof. Tarun Gupta, DORD, IITK and Mr. Vinay Vyas, Managing Director FXE.

MoU with Zynetic Electric Vehicles Charging Pvt. Ltd.

An MoU was signed with **Zynetic Electric Vehicles Charging Pvt Ltd.** to work in the areas of AC and DC EV Fast Chargers, Embedded Electronics, and AI/ML for Predictive Maintenance. The MoU was signed by Prof. Tarun Gupta, DORD, IITK and Mr. Harshvardhan Tiwari, CEO, Zynetic.

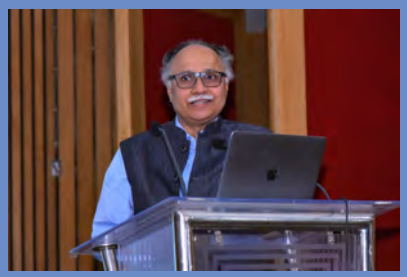
Visit of French Delegation

A distinguished delegation from the French Embassy visited IIT Kanpur on August 22, 2024. The delegation included Dr. Didier Raboisson, Attaché for Scientific Cooperation, Dr. Meenakshi Singh, Scientific Coordinator, and Mr. Aymmeric Voquang, Project Manager. The visit aimed to strengthen collaboration between India and France in the fields of research and innovation. The program also included a talk by the delegation on "*Research Opportunities in France*" which was highly informative for our students and researchers. This visit provided a significant opportunity to forge new connections and deepen existing collaborations between the two nations.

Institute Lecture Series (August 2024 - October 2024)

Prof. Saptarshi Basu
Indian Insitutte of Science Bangalore

Journey of Droplets: Baiju Bawra to Michael Jackson



Dr. Harit Chaturvedi
Chairperson, Max Institute of Cancer Care, Max Super Specialty Hospital, New Delhi

Dr. Aditi Chaturvedi
Senior Consultant, Max Institute of Cancer Care, Max Super Specialty Hospital, New Delhi

Myths and Facts about Cancer: What Every Person Must Know

Tech Corner

Technology Transfer to Prompt Equipments Pvt. Ltd.

IITK licensed a technology titled "**Lateral Flow Immunoassay Strip and Method for Detection of Mastitis in Bovines**" to "**Prompt Equipments Pvt. Ltd**.".

The invention developed by Prof. Siddhartha Panda & the team at NCFlexE, IIT Kanpur, helps to detect Staphylococcus aureus (a bacterium) which is a key contributor to mastitis & the associated enterotoxins, using a novel antibody & novel designs in the form of a strip test. Addressing preferences in the veterinary diagnostic market, the strip features a dual gold nanoparticle-based lateral flow immunoassay (LFIA) for enhanced sensitivity and specificity, offering rapid results and user-friendly testing. This invention exhibits long-term stability across varying weather conditions and relatively low manufacturing costs.

The MoU exchange ceremony was joined by Prof. Tarun Gupta, Dean of Research and Development (DORD), IIT Kanpur, Prof. Siddhartha Panda, ChE & NCFlexE (Inventor), Mr. Shridhar Mehta (Licensee & Chairman of Prompt Equipments) accompanied by Mr. Chirag Trivedi.

Technology Transfer to ScaNxt Technologies

IIT Kanpur transfers a technology for '**Soil Nutrient Sensing Device**' to **ScaNxt Scientific Technologies** to take the Made in Bharat Innovation to global markets. Developed by Prof. Jayant Kumar Singh and his team from the Department of Chemical Engineering, this advanced innovative device promises to revolutionize soil nutrient monitoring with its compact design and cutting-edge features.

This device represents a transformative innovation in agricultural technology, particularly beneficial for farmers in India. By addressing the significant challenges related to timely soil testing, it offers an efficient and user-friendly solution to improve soil health management.

The MoU was signed by Prof. Tarun Gupta, DORD, IIT Kanpur, and Mr. Rajat Vardhan, Founder & CEO, ScaNxt Scientific Technologies, in the presence of Prof. Raja Angamuthu, Associate Dean of Research & Development, IIT Kanpur, and Prof. Jayant Kumar Singh, the inventor behind the technology.

Technology Transfer to Scangenie Scientific Pvt. Ltd.

IITKanpur licensed a technology titled "**System for Detecting Oral Cancer and Method Thereof**" developed by Prof. Jayant K Singh & his team from Department of Chemical Engineering, IITK, to **Scangenie Scientific Pvt. Ltd**.

Munh-Parikshak is user friendly device having white and fluorescence light source that connects wirelessly to smartphones, tablets, iPads, etc. The device offers quick and painless screening with 90% accuracy in clinical settings. It is safe, radiation-free, and doesn't require any additional chemicals or processes.

The MoU ceremony was joined by Prof. Tarun Gupta DORD, IIT Kanpur, Prof. Ankush Sharma (former PIC, SIIC), Prof. Amitabha Bandyopadhyay (Head, BSBE), Dr. Prerana Singh (Head, Oral Pathology, MPDC and co-inventor), Prof. Jayant K Singh, ChE (Inventor) & Mr. Dhirendra Singh (Licensee & Director of Scangenie Scientific).

PROJECT HIGHLIGHTS

DBT SAHAJ Centre for Bio-Sensing Technologies






Project Coordinator

Prof. Tarun Gupta, Dean of Research & Development

Prof. Sri Siva Kumar, Dept. of Chemical Engineering

Co-PI

Prof. Sandeep Verma, Dept. of Chemistry

Prof. Ashutosh Sharma, Dept. of Chemical Engineering

Prof. Bushra Ateeq, Dept. of Biological Sciences & Bioengineering

Dr. Prabhat K. Dwivedi, Centre for Nanosciences

Sponsor: Department of Biotechnology (DBT)

Healthcare system in a country like India faces many challenges to provide rapid and low-cost medical facilities to the population living in remote areas and economically weaker sections. Hence, there is a need to develop an alternative point-of-care (POC) method for identification and prevention of diseases such as Neurodegenerative and Cancer, including pancreatic, ovarian, and oral cancer, at early stages. Recently, the Department of Biotechnology has funded a project at IIT Kanpur's Centre for Nanosciences under SAHAJ program to provide cutting edge research solutions to develop strategies for the POC biosensors.

Current diagnostic methods (point-of-care) have limitations in accuracy and resolution, often relying on traditional techniques. Despite significant research in biosensor technology, many innovations fail to reach commercialization due to the lack of facilities for bench-to-fabrication processes. This challenge underscores the necessity for cutting edge research to the development of biosensors prototype based POC devices.

This project aims to establish a comprehensive biosensor platform, to develop biosensors protype and their translation from research to market. In addition, this initiative also aims to establish state of the art resources across the country and to create a skilled manpower in this emerging field.

Methods of Artificial Intelligence and Magneto-electric Effects in the Dynamics and Motion Control Problems of Telecommunication Spacecraft

PI: Prof. Dipak Kumar Giri

Dept. of Aerospace Engineering

Sponsor: Department of Science & Technology

The proposed research aims to study efficient translation and attitude control using geomagnetic forces for satellite swarms, focusing on coordinated control. The project explores the orbital and attitude motion control of charged spacecraft interacting with Earth's magnetic field, employing mathematical models to capture spacecraft dynamics. Various control strategies will be tested through simulations to optimize satellite performance.

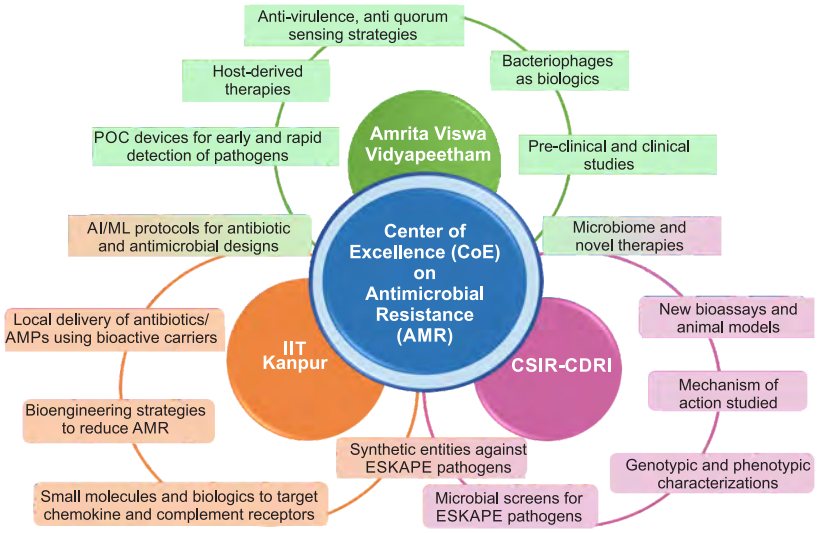
Next, the research focuses on developing control algorithms for seamless coordination between satellites in a swarm. Artificial intelligence (AI), including reinforcement learning and deep learning, will be integrated into the control system to improve decision-making, reduce communication requirements, and enhance adaptability in uncertain conditions. These AI techniques will allow satellite swarms to adjust to dynamic mission demands autonomously. The research is expected to contribute significantly to space missions, providing innovative methods for satellite operations, including on-orbit maintenance and space exploration.

PROJECT HIGHLIGHTS

DST Center of Excellence in Antimicrobial Resistance

PI: Prof. Sandeep Verma
Dept. of Chemistry
Professor In-Charge, Gangwal School of Medical Sciences and Technology (GSMST)
Sponsor: Department of Science & Technology

Antibiotic-resistant infections are responsible for a huge burden towards excess healthcare and societal costs (>$100 billion) and extended hospital stays. These numbers and the rapid emergence of antibiotic-resistant superbugs compels to study antimicrobial resistance (AMR) and develop new classes of effective antimicrobials. A paradigm shift in therapeutic strategies, along with out-of-box drug design thinking, is essential to overcome MDR/XDR-infections and tackle the AMR crisis.



The Center of Excellence in Antimicrobial Resistance will investigate multipronged approaches focused on "**Leads to Pre-Clinical Studies**", with machine learning aided development of new drug-like entities, antibiotic formulation and controlled antibiotic delivery, drug-resistant gram-negative and -positive pathogen microbiology, including a sharp focus on host-derived targets and therapies, and diagnostics and development of POC (microfluidic) devices for automated detection and pathogen quantification in clinical settings.

Partner Institutions: Amrita University and CSIR-CDRI

Bharat-GPT A Suite of Generative AI Tech for India

PI: Prof. Arnab Bhattacharya
Dept. of Computer Science & Engineering
Sponsor: Department of Science & Technology

BharatGen is a multimodal large language model initiative, developing advanced generative artificial intelligence (GenAI) models that are tailored to India's linguistic, cultural, and socio-economic diversity. At its core is Bharat Data Sagar, a vast repository of India-centric data that ensures that the AI models are deeply rooted in the country's unique context. By integrating text, speech, and images, BharatGen builds accessible AI technologies that foster innovation across key sectors like law, agriculture, education, and healthcare, ensuring inclusivity for India's diverse population.

The role of IIT Kanpur through its PI Arnab Bhattacharya is to lead the effort for generative AI in the field of legal text. Generative models for question-answering, summarization, case retrieval, statute retrieval, rhetorical role identification, etc. will be done for multiple Indian languages and English. In addition, genAI models that are IKS (Indian Knowledge System) aware will be also built.

The BharatGen website containing the details are available from: *https://bharatgen.tech/*

PROJECT HIGHLIGHTS

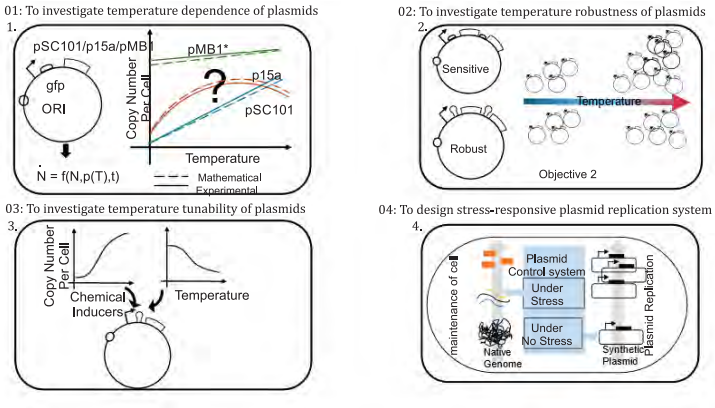
Development and Characterization of Regulatory Biomolecular Circuits for Plasmid Copy Numbers in Synthetic Biology



PI: Prof. Abhilash Patel
Dept. of Electrical Engineering
Co-PI: Prof. Soumya Ranjan Sahoo, Dept. of Electrical Engineering
Prof. Rakesh Kumar, Dept. of Biological Sciences & Bioengineering

Sponsor: Department of Biotechnology

The advancement of synthetic biology relies heavily on plasmids for recombinant gene expression, yet this approach presents significant challenges. Plasmid copy numbers within host cells can vary considerably. Low-copy plasmids may exhibit instability, risking loss or structural changes, especially under selective pressure, which complicates their use in long-term applications. On the other hand, the high replication demands of high-copy plasmids can impose a metabolic burden, impairing cell growth and productivity. Additionally, environmental factors, such as temperature fluctuations, can affect plasmid copy numbers, adding further complexity to the control and reproducibility of synthetic biological systems.



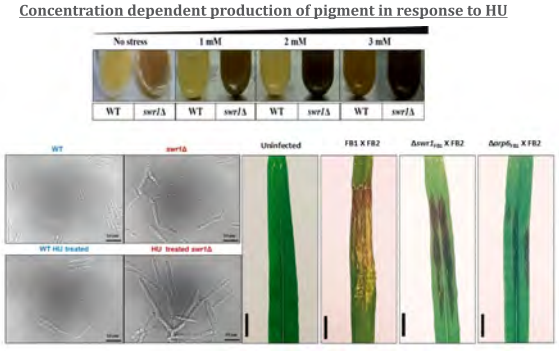
This proposal aims to overcome these obstacles by developing control systems specifically designed to regulate plasmid copy numbers within host cells. By addressing these multifaceted challenges, we endeavor to enhance the reliability, efficiency, and safety of plasmid-based applications in synthetic biology.

Deciphering the Role of Ustilago Maydis SWR1 Chromatin Remodeler in Melanin Biosynthesis, Morphogenesis, and Virulence Mechanism

PI: Prof. Saravanan Matheshwaran
Dept. of Biological Sciences & Bioengineering

Sponsor: Department of Biotechnology (Scheme: Frontiers in Biotechnology)

This project leverages deletion strains to identify metabolites, including melanin, regulated by the SWR1 chromatin remodeling complex (SWR1c). These metabolites have significant commercial potential in pharmaceuticals, agriculture, and biotechnology. By examining SWR1c's influence on fungal virulence and plant pathogenesis, the project aims to enhance disease management strategies that boost plant health and mitigate infections. Crucially, identifying effector proteins regulated by SWR1c will provide targets for reducing fungal virulence, and improving crop protection and sustainability.



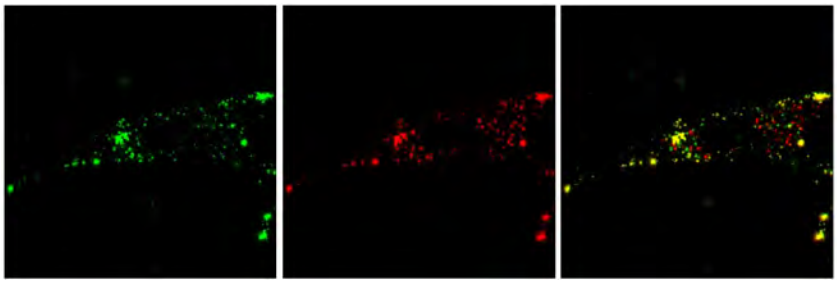
The project involves thorough analyses of deletion strains, assessments of SWR1c's impact on virulence, and the identification of key effector proteins. Through this focussed approach, the project aims to generate actionable insights for combating fungal infections in plants and harnessing metabolites for commercial applications.

PROJECT HIGHLIGHTS

Exploring the Structure and Dynamic Landscape: visualizing the real-time entry of SARS-CoV-2 by smFRET and Cryo-ET for potential therapeutic interventions

PI: Prof. Dibyendu Kumar Das
Dept. of Biological Sciences & Bioengineering
Collaborator: Prof. Debnath Ghosal, University of Melbourne
Sponsor: Department of Biotechnology

SARS-CoV-2 entry into host cell is mediated by the trimeric spike (S) glycoprotein. S is densely glycosylated and comprised of two functional subunits responsible for host receptor binding (S1 subunit) and fusion between the viral and host cellular membrane (S2 subunit).



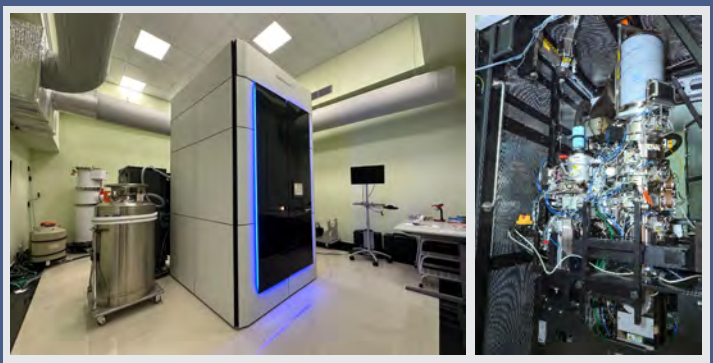
SARS-CoV-2 virus inside living cell | Lysosomes inside living cell | Virus and Lysosomes in living cell

However, little is understood about the inherent dynamics and flexibility of the Receptor Finding Domains (RBD) of S1 and how the conformational landscape changes upon S1 domain binding with ACE2, and how this conformational change propagates among neighboring S1 subunit in a single S trimer. In addition, nothing is known about how these host receptor ACE2-mediated S1 uncaging dynamics are coupled to the triggering of large-scale conformational changes of the S2 domain for mediating membrane fusion. Hence, a detailed knowledge of the conformational changes which drives fusion is lacking. To address this knowledge gap, we will use combination of single molecule fluorescence resonance energy transfer (smFRET) imaging and cryo-electron tomography (cryo-ET). The single molecule imaging at high spatial and temporal resolution and structural data at atomic resolution will provide unprecedented details of S protein dynamics, mechanism of membrane fusion and key functional intermediate states of S for SARS-CoV-2 entry into host cells.

The project aims to leverage the power of single molecule imaging, Cryo-ET based structure determination, nanobody development and engineering methodologies to understand how SARS-CoV-2 enter cells to facilitate the design of structure dynamics-based therapeutics against COVID-19.

National Cryo-EM Facility

In a significant step towards augmenting India's scientific research capabilities in Structural Biology Research, IIT Kanpur inaugurated National Cryo-EM Facility in August 2024.



The facility, established with the support from the Science and Engineering Research Board (SERB), now integrated with the Anusandhan National Research Foundation (ANRF), was inaugurated by Prof. Abhay Karandikar, Secretary, Department of Science and Technology, Government of India, in the presence of Prof. Manindra Agrawal, Director IIT Kanpur.

Cryo-EM is a revolutionary technology that allows scientists to visualize biological molecules, such as proteins and viruses, in their near-native states and at unprecedented resolutions. The state-of-the-art facility at IIT Kanpur is a significant milestone in India's pursuit of self-reliance in life science research in line with the Atmanirbhar Bharat vision.

Featured Technologies Available for Licensing

A System and a Method For Contactless Automated Crack Extension Measurement (ACEM)

Invented by: Dr. Pritam Chakraborty & Mr. Vipin Chandra

Dept. of Aerospace Engineering

Indian Patent Application no. 202411022761

- Simple and accurate tool that measures how cracks grow or become less sharp when materials are stressed or repeatedly loaded and unloaded.
- Requires no physical contact with the material. It helps engineers and researchers quickly and accurately measure crack growth, making it useful for studying how materials break down or weaken over time.

Hardware Acceleration System, Device & Method for Cryptographic Transactions", named 'Kryptoceler'

Invented by: Dr. Jubin Mitra, Prof. Sandeep K. Shukla, Prof. Manindra Agrawal

Dept. of Computer Science & Engineering

Indian Patent no. 481157

- It supports 4 x 10gbps LAN network and can be used to accelerate any cryptographic operations, with full source code open for formal verification,
- it assures that no backdoor or trojans are hidden and can safely be deployed in critical infrastructures with required customization.

Metal Cutting Device with Waste-Collection Mechanism

Invented by: Mr. Gopal Ashok Gupta (Design Dept.), Mr. Mahavir Singh (ME), Prof. J Ramkumar (ME & Design), Prof. Tarun Gupta (CE), Dr. Sandip Patil (E Spin Nanotech PVT LTD)

Indian Patent Application no. 202311055721

- The proposed design of the chop saw machine addresses the issue of high-speed hot metal particle splashing. It confines and collects these particles in a tray beneath the base plate, which features an array of conical-shaped holes for efficient collection.
- The novel design fully protects workers and surroundings from metal particles. It is user-friendly, economical, low-maintenance, and environmentally friendly.

Transdermal Patch for Drug Delivery and Method of Preparation Thereof

Invented by: Prof. Animangsu Ghatak, Mr. Kuldeep Kuhar

Dept. of Chemical Engineering

Indian Patent Application no. 202411034922

- This technology is a design of an adhesive patch for delivering medicine through the skin. It has a squeezable part that holds the medicine and a sticky layer to attach it to the skin.
- Unlike conventional patches, this design eliminates the need for complex steps involved in creating microneedles or layers. It also facilitates the simultaneous delivery of two or more different drugs, making it a versatile solution for drug administration.

Hyperloop Transporting System with Robot Vehicle for Transporting Goods

Invented by: Prof. Bishakh Bhattacharya , Mr. Kanhaiya Lal Chaurasiya, Yashaswi Sinha

Dept. of Mechanical Engineering

Patent Grant No. 541539

- This technology is an alternative means for transporting coal and ores from mines to user agencies. It utilizes a compressed air-based pipeline designed to propel a series of cargo modules harnessing energy from the fluid-flow.
- The novel technology can effectively reduce the air pollution, material loss and travel time significantly.

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