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R&D Newsletter

Indian Institute of Technology Kanpur

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Terpene Blueprint**

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R&D News

IIT Kanpur Showcased Deep-Tech Innovations at Bharat Innovates 2026



IIT Kanpur proudly represented its deep-tech ecosystem at the inaugural edition of Bharat Innovates 2026, held at the Palais des Expositions de Nice, France, from June 14–16, 2026.

Led by the Director, Prof. Manindra Agrawal, IIT Kanpur delegation showcased a portfolio of cutting-edge technologies highlighting the Institute's research and innovation capabilities across diverse technology domains. The exhibits included **Bhu Parikshak**, an AI-driven Intelligent Decision System; an **IT-OT Security Operations Centre**; and a **Dual AAV-mediated Gene Therapy for Leber Congenital Amaurosis**. Hon'ble Union Minister of Commerce and Industry, Shri Piyush Goyal, interacted with the IIT Kanpur team, and explored the Institute's innovations and their potential to address critical challenges through advanced technologies.

An initiative of the Ministry of Education, Government of India, Bharat Innovates 2026 brought together 120 Indian deep-tech innovators on a global platform. IIT Kanpur's participation highlighted its commitment to advancing research and innovation for real-world impact.

Technologies Showcased

Bhu Parikshak
AI-driven Intelligent
Decision System

IT-OT Security
Operations Centre

Dual AAV-mediated
Gene Therapy for Leber
Congenital Amaurosis

Industry Connect Series



Under the "Industry Connect Series" we were happy to host **Dr. Kar Muthumani, President, R&D Bharat Biotech International Limited**. Dr. Muthumani shared the Bharat Biotech's vision in expanding academic collaboration in vaccine, Autoimmune and Cancer research. Faculty members engaged in this meaningful discussion.

The meeting was initiated by the Dean of Research & Development, Prof. Jayandharan Rao and moderated by Prof. Ashwani Kumar Thakur, Head Dept. of Biological Sciences and Engineering, IIT Kanpur followed by the visit of MFCM, Gangwal School of Medical Sciences and MEDTech Facility.



Through the Industry Connect Series, we aspire to bridge industry and academia collaborations and pave the way to cocreate indigenous technologies and innovative solutions.

Expanding Nature's Terpene Blueprint: Creating New-to-Nature Terpene

Prof. Basker Sundararaju

Dept. of Chemistry



Terpenes are one of the most versatile molecular families found in nature; the fragrant compounds behind essential oils, the backbone of countless drugs, and building blocks for flavors, fragrances, and even biofuels. In nature, these molecules are assembled biosynthetically, as enzymes stitch together simple five-carbon isoprene units into longer chains with remarkable precision.

But nature's toolkit has limits: biosynthesis can only extend terpenes in fixed five-carbon increments iteratively, and access a restricted set of structures, leaving many potentially useful terpene-like molecules beyond its reach.

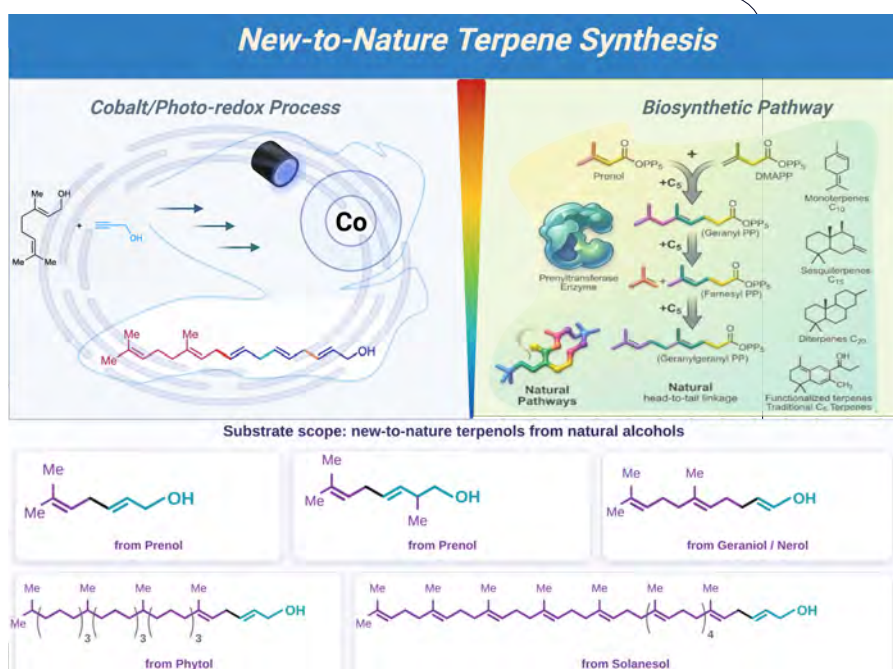
How can we go beyond what nature can do?

Here, we introduce a synthetic strategy that goes beyond what nature can do, using a one-step, light-driven reaction to build "new-to-nature" terpenes and extended to terpene derivatives with structures nature never makes.

Our methods utilize "allenyl carbonate" reagent, which acts as a stand-in for the petrochemical building block, i.e., 1,3-butadiene, along with an alkyne partner, using a dual catalytic system built around inexpensive cobalt and photocatalysts under light rather than toxic metals or reagents. This combination installs a four-carbon crotyl unit instead of nature's five-carbon isoprene unit, providing

with excellent control over both stereo and regioselectively. By repeating this step, we can iteratively homologate natural terpenols into longer, synthetic terpenoid chains, effectively reprogramming the terpene backbone beyond biological boundaries.

The approach works broadly across terminal alkynes, propargylic alcohols, and internal alkynes. Mechanistic and computational studies reveal a cobalt(II)–cobalt(I)–cobalt(III) catalytic cycle assisted by a simple amine proton source. This sustainable, photocatalytic platform offers a practical route to expand the terpene universe beyond nature's own design.



The article is based on the author's research published in:

S. Pradhan, D. Satav, S. Dutta, B. Maity, L. Cavallo, B. Sundararaju,* "Reductive coupling of allenyl/allyl carbonate with alkyne under dual cobalt-photoredox catalysis"

Nature Communication 2024, 15, 10421. DOI:<https://doi.org/10.1038/s41467>



Featured Technologies

5 Indian Patents | 1 US Patent

Patent No: 436990

Passive Vibration Screening Arrangement with Bamboo In-filled Wave Barriers for Mitigating Ground-borne Vibration



This technology uses bamboo-filled underground barriers to reduce and block vibrations. An affordable, lightweight and sustainable alternative to conventional vibration-control methods.

Inventors: Prof. Priyanka Ghosh & Mr. Sreyashrao Surapreddi
Dept. of Civil Engineering

Patent No: 508011

Device for Providing Assistance & Rehabilitation During Flexion & Extension Movement of Fingers



The novel technology mimics natural hand movement using two motor actuators and a pulley-based mechanism for adaptive grasping of objects of different shapes and sizes. Its compact, wearable design is suitable for hospitals and home use, supporting upper limb rehabilitation and helping individuals with hand impairment or paralysis perform daily activities more independently.

Inventors: Prof. Anupam Saxena & Mr. Vitthal Manohar Khatik
Dept. of Mechanical Engineering

Patent No: 589381

An Adaptor for Orthogonal Transmission of Torque



This special attachment for a socket-ratchet wrench allows users to tighten or loosen nuts & bolts in confined or obstructed spaces. The technology reduces effort during repair & maintenance tasks across

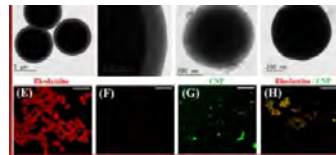
automotive, HVAC, furniture, bicycle, aerospace & other sectors.

Inventors: Prof. Amar Kumar Behera, Mr. Ankush Kumar Gagat, Mr. Prem Sai P, Mr. Rishab Gautam, Mr. Roshan Antony, Mr. Shyam Sundar Meher & Mr. Ashish Saini (MSE)
Dept. of Design

Patent No: 575844

Biodegradable Silica Based Therapeutic Carrier & Process of Synthesizing the Same

Improve drug delivery using tiny silica particles integrated with nano-sized carbon particles. This healthcare application is suitable for treating lung diseases through the nasal route.



Inventors: Prof. Santosh K. Misra, Mr. Niranjana Chatterjee & Ms. Akanksha Dohare
Dept. of Biological Sc. & Bioengineering

Patent No: 543745

System for Providing an Automatic Shifting of Gear in a Bicycle & Method Thereof

The device is powered by a rechargeable battery, charged using the bicycle's dynamo. It connects to



smartphones/ tablets/ laptops via Bluetooth/Wi-Fi, enabling ride-data access & fitness tracking through a dedicated app.

Inventors: Prof. Yatindra N. Singh & Mr. Pranesh Upadhyay
Dept. of Electrical Engineering

US Patent Granted

Patent No. 12,723,261 B2



A Process for Producing a Plurality of Neddylolation Site Modified AAV Vectors

This invention demonstrates, for the first time, the role of Neddylolation in AAV infection and its potential to generate novel AAV vectors with improved efficiency for ocular and hepatic gene therapy. It provides a process for producing Neddylolation site-modified AAV vectors, predicting high-confidence Neddylolation sites in the AAV VP1 capsid protein sequence (Protein ID: YP_680426.1) and generating modified AAV vectors based on the predicted sites.

Inventors: Prof. Jayandharan Giridhara Rao & Dr. Shubham Maurya
Dept. of Biological Sciences & Bioengineering, IIT Kanpur.

Research on Molecular Medicine and Cellular Engineering

Prof. Sivaprakash K. Ramalingam

Dept. of Biological Sciences & Bioengineering



Our research group at IIT Kanpur focuses on **molecular medicine and cellular engineering**. Using state-of-the-art genome engineering tools, including CRISPR/Cas9 and advanced omics technologies, we precisely manipulate genomic sequences to uncover the molecular mechanisms underlying genetic disorders and malignancies. Our interdisciplinary approach bridges fundamental research and clinical application, allowing us to identify the key biological pathways that drive disease.

Building on these insights, we develop **pathophysiologically relevant cellular models, including patient-derived induced pluripotent stem cells (iPSCs)**, to study disease biology and accelerate drug discovery. We investigate the regulatory landscape of fetal hemoglobin within the β -globin gene cluster at chromosome 11 in the human genome to develop therapeutic strategies for hemoglobinopathies, and we conduct high-throughput screens to identify small molecules that can treat genetic disorders.

In parallel, we decipher the mechanisms of antigen heterogeneity in B-cell malignancies and engineer immune cells to target a range of cancers.

Research Interests Include:

Disease modeling:

Developing pathophysiologically relevant cellular models, including patient-derived iPSCs, to study disease biology.

Fetal hemoglobin regulation:

Elucidating the regulatory landscape of fetal hemoglobin within the β -globin gene cluster to inform therapeutic intervention for hemoglobinopathies.

Small-molecule discovery:

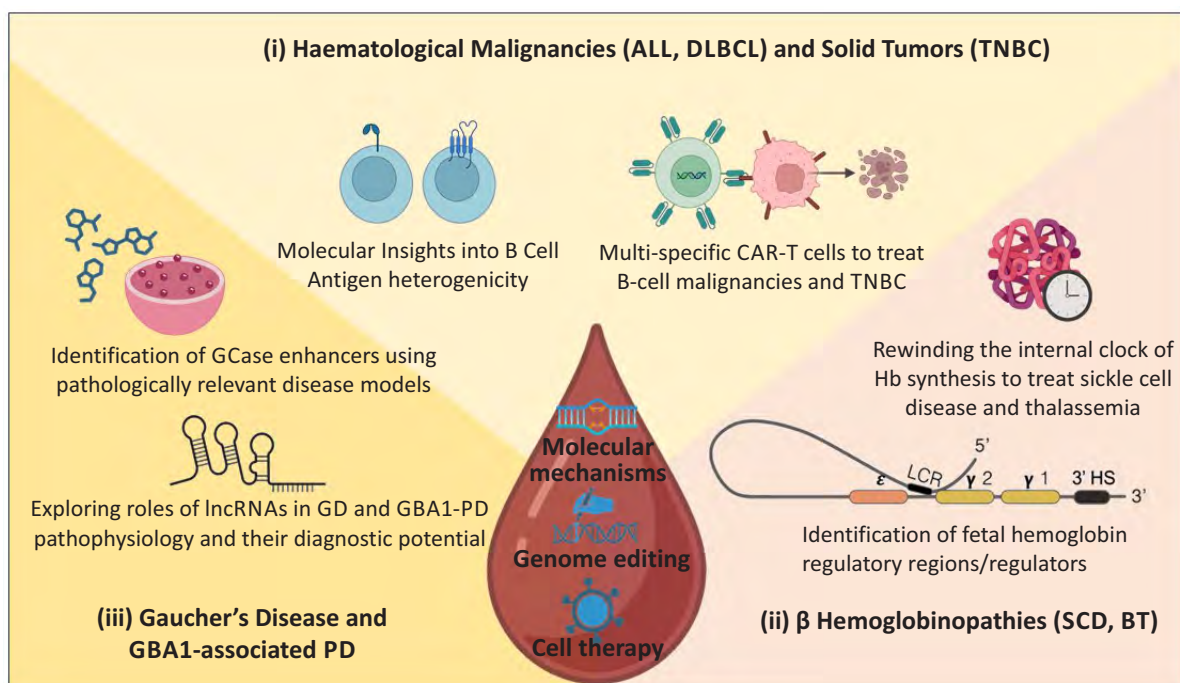
Conducting high-throughput screening to identify pharmacological small molecules for treating genetic disorders.

Antigen heterogeneity:

Deciphering the molecular mechanisms underlying antigen heterogeneity in B-cell malignancies.

Engineered immune cells:

Developing engineered immune cells for a range of malignancies.





MoU signed with **Central Industrial Security Force** to work in the areas of Drone Technology, Counter-Drone/Anti-Drone Systems, UAV Operations, Drone Forensics, and related

capacity-building activities. The collaboration also aims to support the establishment of a Centre of Excellence for Drone and Anti-Drone technologies at MPRTC, Behror, Rajasthan.

MoU signed with **Havells India Ltd**, to jointly pursue research and technological innovation in next-generation energy solutions. The collaboration marks the beginning

of a long-term partnership to develop practical, scalable technologies that support India's transition to cleaner, more resilient, and self-reliant energy systems.



IIT Kanpur signed MoU with **Advanced Weapons and Equipment India Limited** to establish a broad framework for collaboration in the field of defence technologies and other areas of mutual interest. The partnership aims to foster long-term collaboration through joint research and development, consultancy studies, and technology development to address strategic technological challenges.



IIT Kanpur partners with the **Government of Andhra Pradesh** to advance the vision of a Net Zero Andhra Pradesh. The Dept. of Design and Civil Engineering will lead this interdisciplinary statewide effort. The MoU was exchanged in Vijayawada by Prof. Jayandharan Rao, Dean of Research and Development, IIT Kanpur, and Mr. B. Sunil Reddy, Managing Director, Swachh Andhra Corporation, in the presence of the Hon'ble Chief Minister of Andhra Pradesh.



Danfoss Industries Private Limited and IIT Kanpur entered into an MoU to collaborate in areas including, but not limited to, Collaborative Research, Open Innovation, technol-

ogy development, problem statements, innovative ideas/concepts, product improvement, testing, evaluation, and other mutually agreed activities.

IIT Kanpur and **ADG Mil Svy (GSGS)** have entered into a strategic partnership for undertaking a research project titled Automated Generalization of Geographical Features

for Small Scale Representation. The project will be carried out by the National Centre for Geodesy, IIT Kanpur.



MoU with **Intellineuro Private Limited (Bharat1.ai)** to establish Wadhwani School of AI & Intelligent Systems (WSAIS), IIT Kanpur as a Foundational Partner for Bharat1.ai and to set out a structured collaboration framework to advance indigenous, trustworthy, and humanity-centric AI capabilities for India, including (as applicable) AI City technology stack modules, digital twin/simulation, safe AI deployment, and talent development.

Center of Excellence for Exploring Challenges, Identifying Antimicrobial Resistance (AMR) Drivers, and Developing Potential Antimicrobial Alternatives through a One Health Approach

PI: Prof. Saravanan Matheshwaran

Dept. of Biological Sciences & Bioengineering

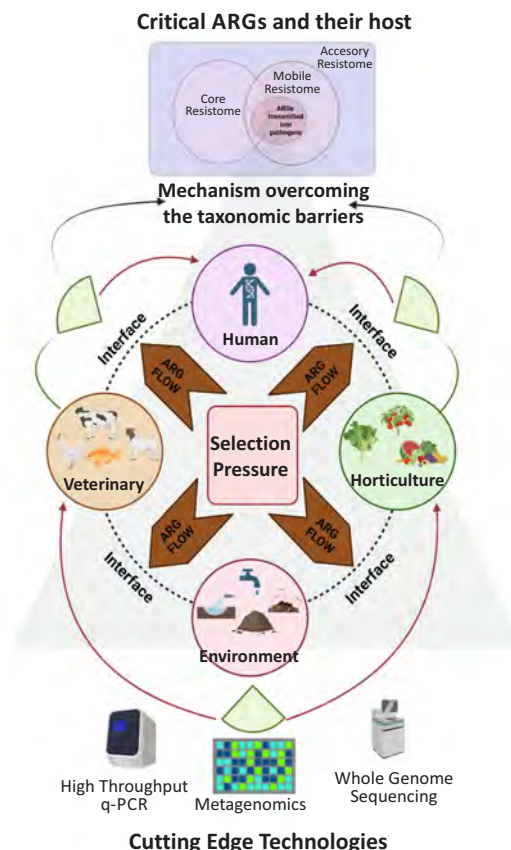
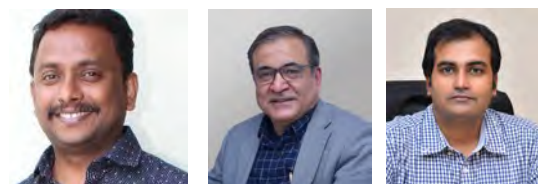
Co- PI: Prof. Prof. Ashok Kumar, Dept. of Biological Sciences & Bioengineering

Prof. Santosh K Misra, Dept. of Biological Sciences & Bioengineering

Sponsor: Department of Science & Technology (DST)

The **CoE-AMRDAPAA** is a multi-institutional Center of Excellence bringing together expertise from SKAUST, SKIMS, IMTECH, and IIT Kanpur to address the growing challenge of antimicrobial resistance (AMR) through an integrated One Health approach.

The Center will investigate the emergence, transmission, and drivers of AMR at the interconnected interfaces of human health, veterinary health, agriculture/horticulture, and the environment. The program will combine multidisciplinary approaches to identify determinants of AMR, understand selection pressures and the dissemination of resistance, and explore potential antimicrobial alternatives and innovative strategies to combat AMR.



Technology Transfer

Three Intellectual Property Assets comprise the patented technology titled, “**Refreshable Braille Display Device for “Visually Impaired Users”** (Indian Patent No. 538556), the trademark “**Tac Learn**” (Trademark No. 6157979), and the design “**Single-Cell Refreshable Braille Display to Connect with Smartphone**” (Design Application No. 463210-001) Licensed to **Torchit Electronics Pvt. Ltd.** for Enhanced Braille Learning

Invented by: Prof. Siddhartha Panda, Dept. of Chemical Engineering, SCDT, National Centre for Flexible Electronics
Mr. Vishwaraj Srivastava , SCDT, National Centre for Flexible Electronics



Centre of Excellence on Innovative and Integrated Ecosystem for Green Hydrogen

Project Lead: Prof. Prabodh Bajpai

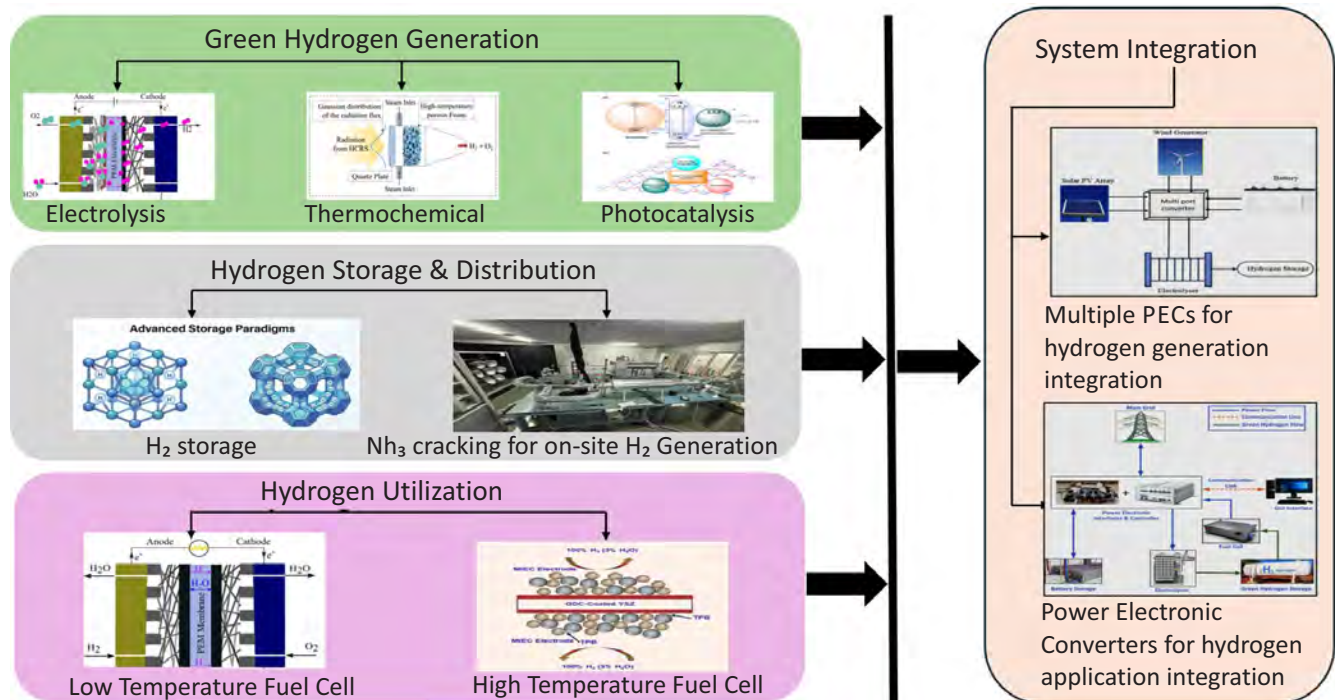
Dept. of Sustainable Engineering

Sponsor: Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA)



A Centre of Excellence on **Innovative and Integrated Ecosystem for Green Hydrogen (ECOGEN)** has been recently established at IIT Kanpur, focusing on research-driven innovations, for developing and adopting novel green hydrogen technologies at a low cost and high efficiency.

ECOGEN aims at the development of novel technologies namely through electrochemical, photochemical, and thermochemical routes for green hydrogen generation, solid and liquid forms for green hydrogen storage and safe transportation along with system integration technologies for green hydrogen generation and utilization. These activities aim at enhancing the efficiency of the green hydrogen generation system, technology adaptation, indigenisation, and cost reduction for the green hydrogen value chain. The undertaken research activities, supplemented with knowledge dissemination, will enable the development of skilled human resources.



Novel Technologies for Green H₂ Ecosystem under COE

MAJOR FOCUS

Advancing research and development in hydrogen energy generation, storage, utilisation, and system integration to reduce the production cost of green hydrogen and support sustainable energy solutions.

Accelerated Development of Next Generation High Strength High Performance Steel

PI: Prof. Amarendra Kumar Singh

Department of Materials Science and Engineering

Co-PI:

IIT Kanpur: Professors Somnath Bhowmick, Shivam Tripathi, Pritam Chakraborty, Rajdip Mukherjee, Nilesh P. Gurao, Rahul Sarkar, Niraj M. Chawake, Ushasi Roy, Sudhanshu S. Singh, Soumya Sridar, Heena Khanchandani, DLVK Prasad, Virkeswar Kumar, Soumya Dutta, Dipak Mazumdar (Ex-Professor, IIT Kanpur, Consultant)

IISc Bengaluru: Professor Abhik Choudhury
IIT Hyderabad: Professor Saswata Bhattacharya
IIT Bombay: Professors Anirban Patra
Shyamprasad Kargadde; Alankar Alankar
IIT Bhubaneswar: Professor Parthasarathi De
IIT Madras: Professor K. G. Pradeep

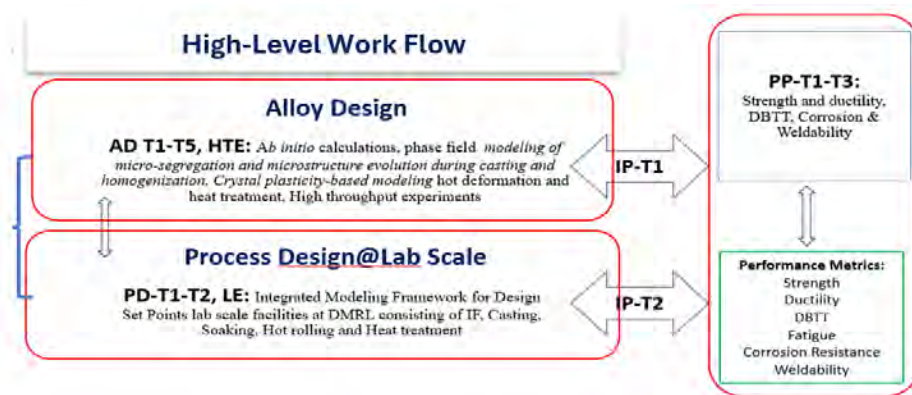


DMRL Leads: Drs. R. Sankarasubramaniam, Veera Babu R. and U. Chinta Babu

Collaborating Laboratory: DMRL

Industry Collaboration: Tata Consultancy Services

Sponsor: DRDO



Integrated Computational Materials Engineering (ICME) is an emerging and transformative discipline with huge potential to accelerate materials discovery, product design and process optimization. The focus of ICME is on **INTEGRATION**: integration of models of various processes, integration of models across multiple length scales, integration of design and manufacturing, integration of models with experiments, integration of software tools addressing multi-physics problems, and so on with the end objective of accelerating the design and industrial deployment of new materials in critical sectors.

The project aims to accelerate the development of next-generation high-strength, high-performance steels for defence applications through an Integrated Computational Materials Engineering (ICME) framework. Conventional development of advanced steels relies heavily on iterative experimentation and therefore demands substantial time and resources. The proposed programme integrates computational alloy design, process modelling, microstructure evolution, high-throughput experiments, property and performance prediction, and experimental validation within a common framework.

The targeted steel is aimed at achieving very high yield strength while retaining adequate ductility, low-temperature impact toughness, weldability, corrosion resistance, fracture toughness, stress-corrosion-cracking resistance and fatigue performance. The project will combine existing knowledge and proprietary data with state-of-the-art modelling and experiments to establish robust composition-processing-microstructure-property-performance linkages. The long-term objective is to demonstrate an integrated pathway for substantially reducing the time and cost required to realise new high-performance steel grades.

Engineering GHz-Driven Hybrid Junction Superconducting Devices for Low-Power AI Architecture Application

PI: Prof. Satyajit Banerjee

Dept. of Physics, IIT Kanpur

Collaborators: Prof. A. R. Harish, Dept. of Electrical Engineering, IIT Kanpur

Prof. Ravi Prakash Singh, Dept. of Physics, IISER Bhopal

Sponsor: Anusandhan National Research Foundation (ANRF)

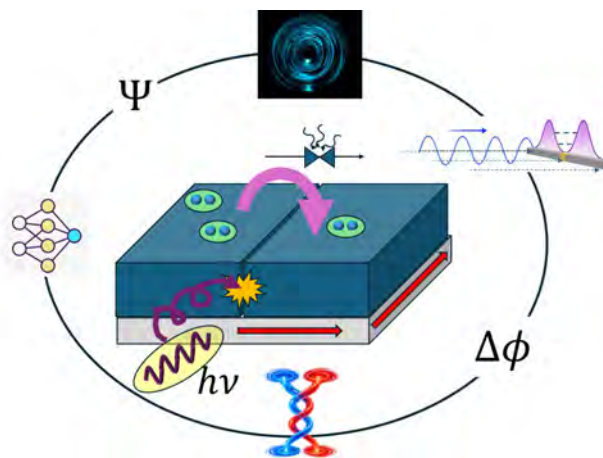


This project explores high frequency driven hybrid superconducting junctions as potential building blocks for energy-efficient cryogenic electronics. By attempting to develop dynamically tunable off-equilibrium superconducting circuit elements, the research aims to explore newer approaches to low-power information processing.

The project also explores broader approaches to reducing the growing energy footprint of AI data centres by leveraging the potential of superconducting electronics for energy-efficient computing.

LONG-TERM GOAL

To integrate neural-inspired circuit elements that operate at cryogenic temperatures, potentially supporting future AI systems alongside quantum processors and work towards developing interfaces working at the boundary of the two computation platforms.



Schematic illustration of hybrid superconducting junctions for dynamically tunable, low-power cryogenic computing, highlighting an imagined interplay between high-frequency driven superconducting dynamics, quantum states and neural-inspired information processing.

Image composition, proprietary: Prof. S. Banerjee, IIT Kanpur (acknowledgements: a few images in the composition sourced from Internet)

Powering the Future with Quantum-Enhanced Grid Optimization

PI: Prof. Ankush Sharma

Dept. of Electrical Engineering

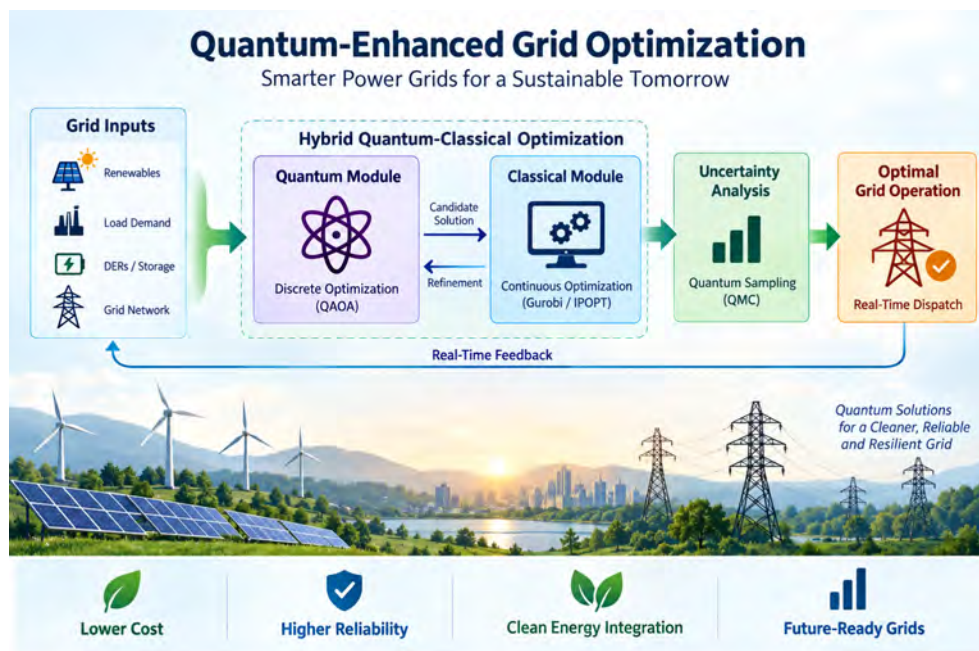
Co- PI: Prof. Prof. Abheejeet Mohapatra

Dept. of Electrical Engineering

Sponsor: Department of Science & Technology (DST)



Real-time Optimal Power Flow Analysis using Hybrid Quantum-Classical Algorithms is a three-year research initiative to create a **quantum-enhanced framework for Optimal Power Flow (OPF)** under uncertainty in today's power grid. The project tackles the increasing computational challenges posed by the variability of renewable energy, distributed energy resources (DERs), energy storage, demand flexibility, and discrete grid control decisions.



The proposed method is a fusion of the strengths of quantum and classical computing. The OPF problem will be formulated as a Mixed-Integer Quadratic Program (MIQP), where some variables are continuous (e.g., voltage, power generation, and line flows) and others are discrete (e.g., whether to turn on a DER or switch a generator on/off). The combinatorial/discrete optimization component will be tackled using the QAOA (Quantum Approximate Optimization Algorithm), with the optimization problem represented as a QUBO. Quantum Monte Carlo (QMC) techniques will also be explored to sample uncertainties in renewable generation and load efficiently. All these calculations in the power system will be performed by classical numerical solvers, thus establishing a practical hybrid workflow.

It will be developed and tested first with quantum simulators (e.g., Qiskit/Cirq) and classical solvers (e.g., Gurobi/IPOPT). The validation will be conducted from smaller IEEE systems to the IEEE 118-bus system with synthetic uncertainty in renewable and load outputs, and then scaled up to larger networks. The solution quality, robustness, computational time, and scalability will be evaluated.

The project will ultimately produce a hybrid quantum-classical OPF algorithm, an open-source software toolkit, benchmark results, research publications, and workshops with stakeholders, laying the groundwork for more efficient and robust real-time grid optimization enabled by quantum technologies.

Centre for Ayurveda Research for Clinical Validation, GSMST, IIT Kanpur

PI: Prof. Sandeep Verma

Dept. of Chemistry

Co-PI: Prof. S. Ganesh

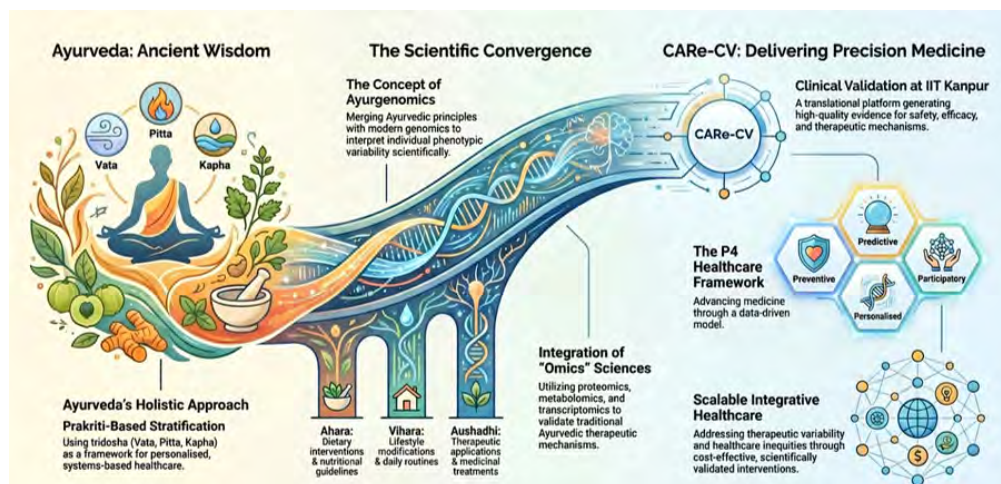
Dept. of Biological Sciences & Bioengineering

Sponsor: Government of Uttar Pradesh



The Government of Uttar Pradesh has sanctioned the **Centre for Ayurveda Research for Clinical Validation** (CARE-CV) as a translational research platform to systematically evaluate Ayurvedic formulations and therapeutic principles through contemporary biomedical science. This Centre, located at IIT Kanpur, will operationalize Ayurgenomics by integrating Prakriti-based patient stratification with genomics, transcriptomics, metabolomics, microbiome profiling and clinical phenotyping, and microfluidics. Its research framework will map classical constructs—including Dosha, Agni and disease phenotypes—to quantifiable molecular, physiological and digital biomarkers. Priority programmes will address high-burden chronic and lifestyle diseases in Uttar Pradesh, while establishing evidence-based standards for formulation identity, chemical fingerprinting, batch-to-batch consistency, pharmacokinetics, safety and efficacy.

A digital knowledge platform will integrate classical Ayurvedic knowledge with longitudinal clinical, molecular and real-world evidence, enabling reproducible translation and validation of Ayurvedic concepts into modern biomedical frameworks. CARE-CV will also interact with ayurveda drug industry to understand their research problems and offer solutions to make their products export-ready and validated.



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