

Indian Institute of Space Science and Technology

Department of AEROSPACE ENGINEERING



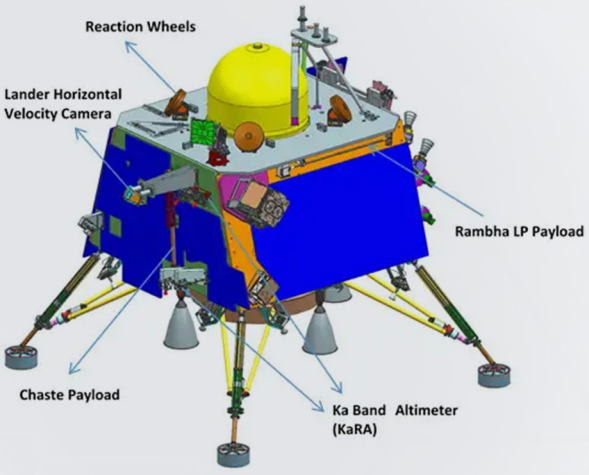
About IIST



Established in 2007 in Thiruvananthapuram, Kerala, the Indian Institute of Space Science and Technology (IIST) was founded with the aim of exploring new frontiers in science and technology while nurturing a skilled workforce to support these endeavors. Designated as a Deemed University under Section 3 of the UGC Act 1956 by the Department of Space, IIST proudly holds the distinction of Asia's first Space University. Over its 16 years of operation, the institute has dynamically grown into a hub for multidisciplinary learning and research, spanning fields such as Aerospace, Avionics, Chemistry, Earth and Space Sciences, Humanities, Mathematics, and Physics. Offering undergraduate courses across three branches and postgraduate programs across 15 branches in Science, Technology, and Engineering,

IIST places a synergistic emphasis on Space Science and Technology applications. Today, IIST stands as India's premier science and technology institute, fostering a rigorous, multidisciplinary approach to knowledge, encompassing concepts, models, and applications in science and technology. It has evolved into a center for learning and problem-solving, addressing both local and global needs, and bridging the realms of technology and society.The institute exists as a symbiotic counterpart of ISRO, injecting innovative ideas and cutting edge technology into ISRO's operational domains.

Students at IIST have numerous opportunities to contribute as interns and employees to various ISRO centers, establishing a valuable human resource pool. IIST's Doctoral and Post-Doctoral research programs encourage students to actively participate in groundbreaking and interdisciplinary research, addressing critical needs in the country. The advanced facilities across departments, coupled with a culture of robust interdisciplinary collaboration and support from ISRO centers, empower students and research scholars in their pursuits. Beyond advancing science and technology, scholars and students enthusiastically contribute to scholarship in social science, management, economics, and cultural studies.



From the Desk of HoD, Aerospace Department.

Department of Aerospace in IIST was established in 2007 and presently offering undergraduate (B.Tech.) program in Aerospace Engineering, Masters (M.Tech.) Programs in Aerodynamics and Flight Mechanics Thermal and Propulsion Structures and Design, and Manufacturing Technology. We also offer PhD programs in Aerospace Engineering related areas such as Aerodynamics, Gas Dynamics, heat transfer, Propulsion, Atmospheric & Spaceflight Mechanics, Applied Dynamics, Vibration, Theory of Elasticity, Aerospace Structures, Materials Science, Manufacturing Processes, industrial engineering etc. through Experimental/Theoretical/Numerical approaches. With a team of 23 highly qualified and experienced faculty members, the department boasts expertise across all key disciplines of aerospace engineering. It houses 28 state-of-the-art academic and research laboratories dedicated to various specializations. Faculty and students actively engage in collaborative research with ISRO centers and other academic and research institutions across the country.

Top-performing B.Tech students in Aerospace Engineering are granted the unique opportunity to pursue an MS degree at the Graduate Aerospace Laboratories (GALCIT) of the California Institute of Technology (Caltech) through the prestigious Satish Dhawan Fellowship. These students often achieve further distinction by winning the Abdul Kalam Prize, awarded to the toppers at GALCIT. This signifies the highest academic standards that our academic programs. Students also benefit from opportunities to undertake final-year projects and summer internships at leading international universities. The department's alumni have made significant contributions to key national space programs, and their involvement in satellite and payload development projects at IIST has facilitated placements in India's growing space-related startup ecosystem. Recently, the undergraduate curriculum has been revised based on the principles outlined in National Education Policy 2020 and being one of the top aerospace engineering schools of our nation, we have shown our commitment to achieve the broader goal of becoming a developed nation within the next decade.

Wish you all the best
Dr. Deepu M.
Professor &
Head of the Department.



VISION

To be a centre for learning and innovation in Aerospace Engineering, igniting in students the spark to explore the unknown and contributing at national and global level.

MISSION

- Provide excellent teaching and research environment for undergraduate, postgraduate and doctoral students conducive for critical thinking in the areas of aerospace engineering.
- Equip the students with the capacity to acquire integrated systems engineering approach, leading to innovative thinking for smart solutions in the areas of aerospace technology.
- Strive to create a longstanding synergy between the society, industry and other peer institutions to collectively address the nation's technological needs.
- Instill a deep sense of commitment to accept and overcome technological challenges, thereby nurturing future leaders of tomorrow.

1.Undergraduate Programmes:

- Aerospace Engineering
  (4-year B.Tech Programme)

2.Postgraduate Programmes:

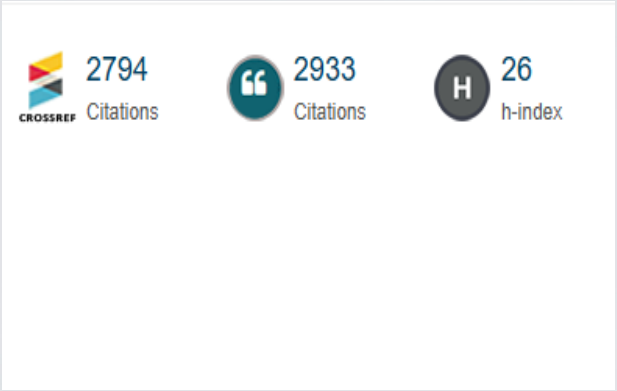
- M.Tech in Aerodynamics and Flight Mechanics
- M.Tech in Structure and Design
- M.Tech in Thermal and Propulsion
- M.Tech in Manufacturing Technology

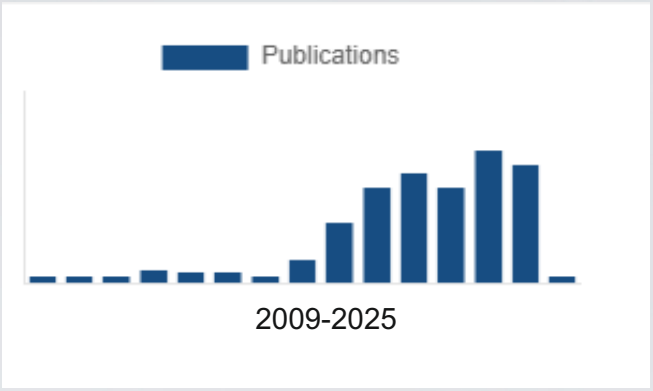
3.Doctor of Philosophy Core Research Areas

- Aerodynamics and Flight Mechanics
- Materials, Manufacturing and Industrial Engineering
- Structures and Design
- Thermal and Propulsion

PUBLICATION SUMMARY







Ph.D. AWARDED

18 Regular students, **12** Sponsored candidates had successfully defended their Ph.D. theses and awarded degrees in various titles from our department till 2024.



Our Team

HEAD OF THE DEPARTMENT



Deepu M. | Ph.D., (NIT, Calicut) Modeling of turbulent, compressible, reacting flows in propulsion systems, heat & mass transfer enhancement, heat transfer in micro channels, and heat transfer in phase changing materials.

Faculty & Core Research Areas

Aerodynamics and Flight Mechanics







Dhayalan.R. | Ph.D., (IIT, Kanpur) Aircraft and Unmanned Aerial Vehicle Design, System Identification and Parameter Estimation of Flight Vehicles, Dynamics and Control of Fixed wing and Multi-rotor UAVs, Reinforcement Learning-based control of UAVs

Devendra Prakash Ghate. | Ph.D., (University of Oxford, UK) Multidisciplinary optimization, Machine learning, Tragectory Optimisation.

Manoj T. Nair. | Ph.D., (IIT, Kanpur) Computational Fluid Mechanics, Hypersonic Aerothermodynamics, Aerodynamic Shape Optimization, Compressible & Incompressible Flow, Unsteady Flows.

Satheesh K. | Ph.D., (IISc, Bangalore) High Temperature gas dynamics, Laser diagnostics for high enthalpy flame.

Vinoth B R. | Ph.D., (IIT, Kanpur) Aerodynamics, Aeroacoustics, Unsteady flows, Flow instability, Experimental methods.

Materials, Manufacturing and Industrial Engineering





Chakravarthy P. | Ph.D., (IIT, Madras) Hot working process, Incremental forming process, Friction stir processing.

Girish B S. | Ph.D., (Anna University, Chennai) Sequencing and scheduling issues in manufacturing systems and Air traffic management, vehicle routing and scheduling issues in supply chains.

Sooraj V S. | Ph.D., (IIST, TVM) Additive & Subtractive Manufacturing, Aerospace & Bio-medical Manufacturing, Design for Manufacturing, Advanced Manufacturing Techniques.

Structures and Design









Anish Kumar. | Ph.D., (IIT, Kanpur), Nonlinear Dynamics and Vibrations, Structural Dynamics, Theory of Plates and Shells, Modelling and Simulation of MEMS & NEMS.

Anup S. | Ph.D., (IIT, Madras) Mechanics of biological and bio -inspired composites, Micromechanics, Buckling of Shells.

Bijudas C R. | Ph.D., (IIT, Bombay) Structural Health Monitoring.

Praveen Krishna I R. | Ph.D., (IIT, Madras) Nonlinear Dynamics, Fluid Structure Interaction, Acoustics

Raveendranath P. | Ph.D., (IIT, Kharagpur), Advanced Mechanics of Solids, Advanced Finite Element Methods

Sam Noble | Ph.D., (IIST, TVM), Design and synthesis of mechanisms, Robotics/assitive mechanisms, Optimal design.

U A Subramanian | (Rtd. Outstanding Scientist, ISRO) Reusable & Non-pyrotechnic space vehicle mechanisms, satellite dispensing systems and deployment mechanisms.

Thermal and Propulsion










A Salih. | Ph.D., (IIT, Kharagpur) Numerical solution of multiphase flows, Cryogenic sloshing.

Aravind.V. | Ph.D., (University of Florida, USA) Laser Diagnostics, Supersonic combustion, Rocket combustion, Spray characterization.

Mahesh S. | Ph.D., (IIT, Kanpur) Jet Flame Dynamics, Clean combustion, Microgravity combustion.

Manu K V. | Ph.D., (IISc, Bangalore) Computational Fluid Dynamics, Flow Instability & Transition to Turbulence, Boundary Layer Flows, CFD, Heat transfer Modeling.

Pradeep Kumar P. | Ph.D., (IIT, Bombay) Two-phase flow and heat transfer, Electronic cooling in micro and macro scale.

Prathap C. | Ph.D., (IIT, Delhi) Fundamental and applied research in Combustion.

Rajesh Sadanandan. | Ph.D., (University of Karlsruhe, Germany), Optical and Laser Diagnostics, Clean Combustion, Aerospace Propulsion.

Shine S R. | Ph.D., (IIST, TVM) Certified EA/EM, BPE. Heat transfer in Space Applications. Smart healthcare and medicine

Technical Staff

Dinesh D., (Technical Officer - C)

Muhammed Rijas A., (Technical Officer - C)

Nasaruddeen N. A., (Technical Officer - C)

Prakash R. S., (Technical Officer - C)

Satish Kumar V., (Technical Officer - C)

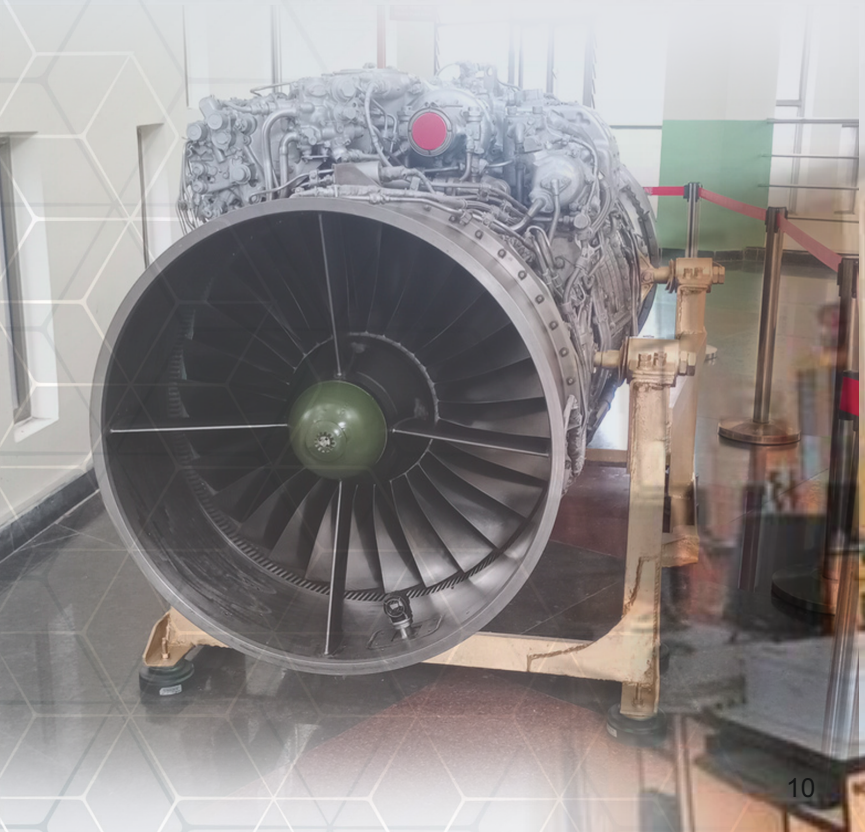
Vinil Kumar R. R., (Technical Officer - C)












Laboratory / Research Facilities

Details of Instructional and Research labs under the Department of Aerospace Engineering

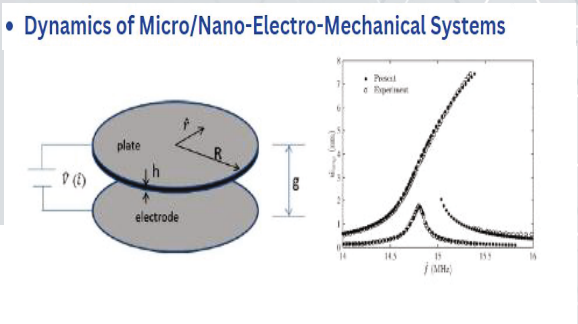
- Advanced Propulsion and Laser Diagnostics (APLD) facility
- Aerodynamics Lab
- Aerostructures Lab
- CADD Lab
- Computational Heat Transfer Lab
- Computational Lab
- Cryogenic Lab
- Engineering Drawing Hall
- Engineering Workshop(Basic Engineering lab)
- Experimental Composite Micro-mechanics lab and Raman Spectroscopy Facility
- Flame Diagnostics Lab
- Flight Mechanics Lab
- Fluid Mechanics Lab
- Heat Transfer Lab
- Heat Treatment and Metallography Lab
- High Speed Flow Lab
- Laser Absorption Spectroscopy Lab
- Manufacturing Processes Lab
- Mechanisms and Machine Elements Lab
- Metrology and Computer Aided Inspection Lab
- Micro-PIV Lab
- Robotics and Dynamics Lab
- Strength of Materials Lab
- Structural Dynamics and Vibration Lab
- Structural Health Monitoring (SHM) Lab
- Thermal Engineering and Propulsion Lab
- Thermal and Fluid Engineering
- Calibration Facility

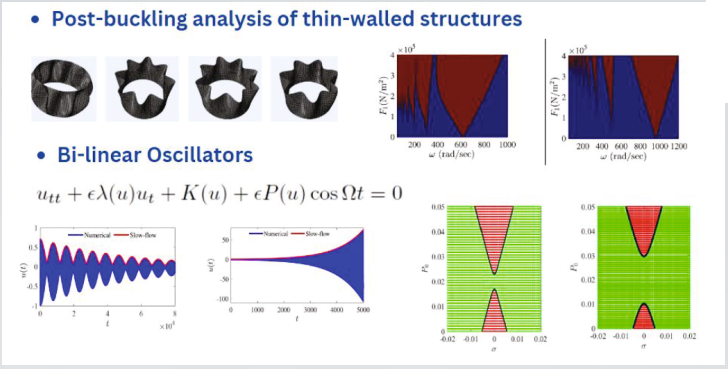


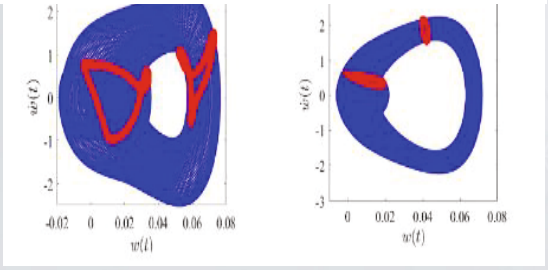
Research And Development

Dr. Anish Kumar

- Nonlinear Dynamics and Vibrations
- Theory of Plates and Shells
- Buckling and Postbuckling of Thin-Walled Structures
- Modelling and Simulation of MEMS & NEMS

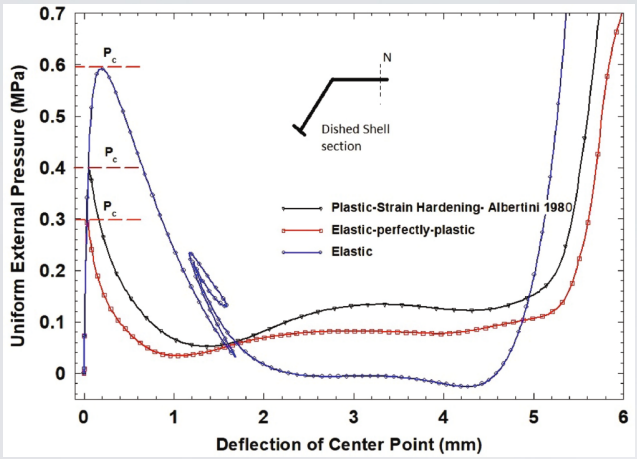






Dr. Anup S.

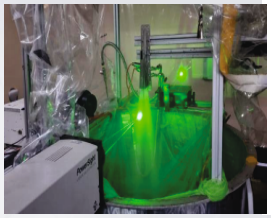
- The dual thickness dished shells are made of conical frustum with a closed stiff top at the smaller diameter end of the frustum. Investigations were conducted into the snap through buckling of such shells & the significance of material plasticity in the phenomenonis established.
- Biological composites such as bone & nacre has excellent mechanical properties that have inspired the development of synthetic composites. The influence of failure modes on the mechanical properties in staggered bio-inspired composites where stiff platelets are embedded in a pliant matrix is undertaken. The results of the analytical model indicate that the failure sequence indeed influences mechanical characteristics such as stiffness, strength, and toughness. Also, the results indicate that a major contribution of toughness comes from vertical interface failure, which is ignored in previous studies for estimating the toughness.

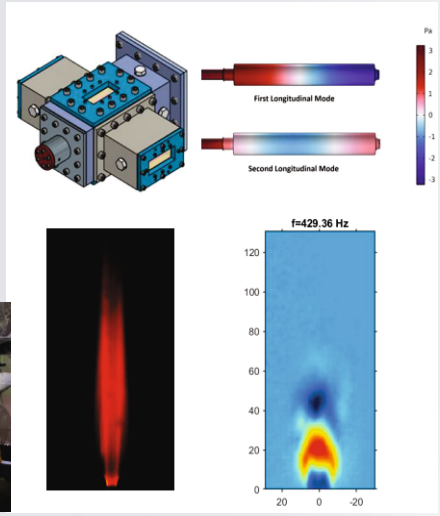


Dr. Aravind Vaidyanathan

Advanced Propulsion and Laser Diagnostic Facility

- Spray Characterization: High-speed and High-magnification LED/Laser Shadowgraphy, Mie-Scattering, PLIF, PIV, PDPA-LDV, Malvern Particle Size Analyzer.
- Supersonic mixing studies: High-speed Schlieren/Shadowgraphy, Mie-Scattering, PLIF, 2D and stereo-PIV, Unsteady Pressure Measurement.
- Combustion Instability: Triggering - O_2 flow rate Perturbation / secondary nozzle with toothed wheel, Flame characterization using PLIF.

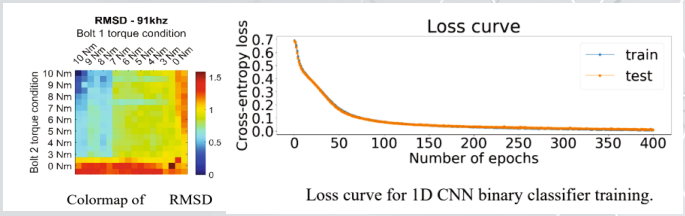




Dr. Bijudas C.R.

Structural Health Monitoring Lab

- Developed the digital twin of structural system with modal characteristics.
- Enhanced bolt loosening detection schemes are developed with the help of guided waves in plates fastened by bolts.



Dr. Chakravarthy P.

- Single stage and multi stage incremental forming
- Hot deformation of Monel alloys
- Forming of sheet metals using pneumatic loading

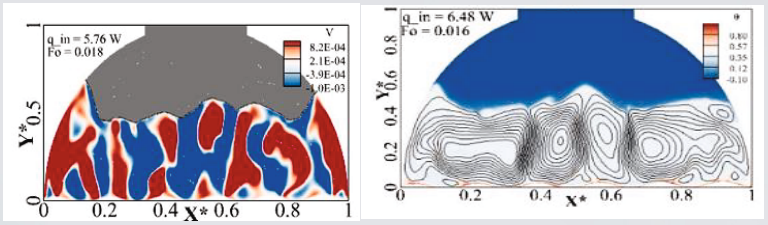


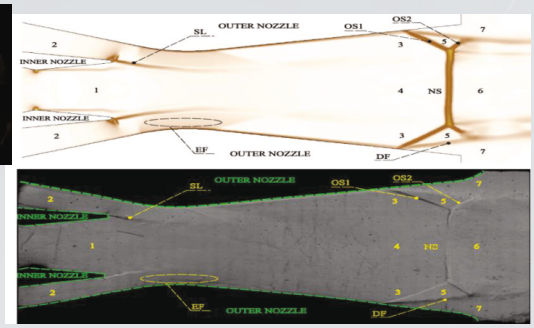
Dr. Deepu M.

Computational fluid Mechanics facility

- Latent heat storages
- Rayleigh–Bénard convection
- Non-conventional rocket nozzles
- Heat & mass transfer enhancement



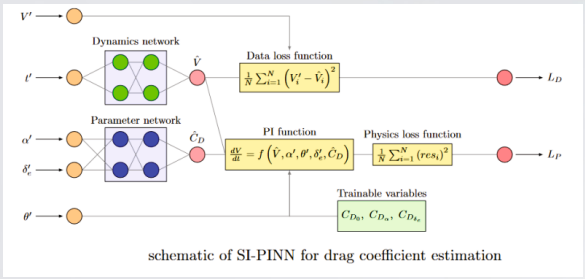




Schlieren visualizations obtained numerically(top) and experimentally(bottom)for a typical Dual Throat Nozzle operation (LPSC-IIST Project).

Dr. Devendra Prakash Ghate

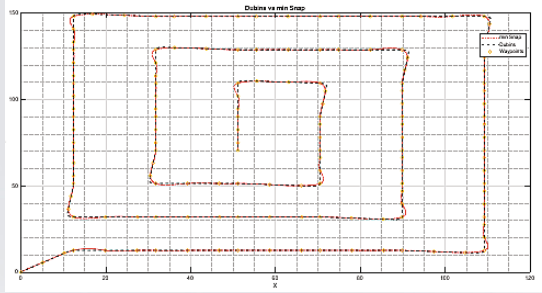
- Developed Hermite-Simpson direct collocation trajectory optimization software for retro-propulsive landing of a reusable launch vehicle.
- Developed Physics Informed Neural Networks based robust system identification library for HANSA aircraft.



Dr. Dhayalan R

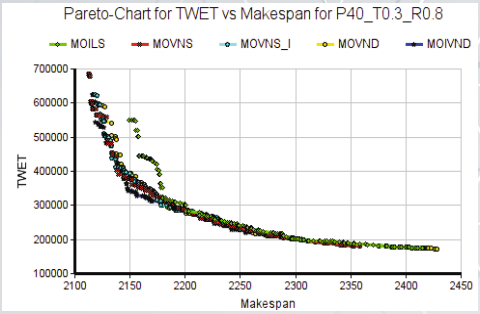
- Designed, Fabricated and flight tested a micro UAV of mass less than 250g, which can be used for shorter missions.
- A guidance algorithm combing Dubins path and Snap algorithm to find an optimum trajectory for aerial surveying multi-rotor UAV has been developed.
- A glider which can soar at large altitudes in Martian atmosphere has been designed using optimal soaring trajectory for Martian conditions.
- Development of coordinated control of swarm of Quadrotor drones connected with net to catch reentry launch vehicles has been carried out in simulation environments.





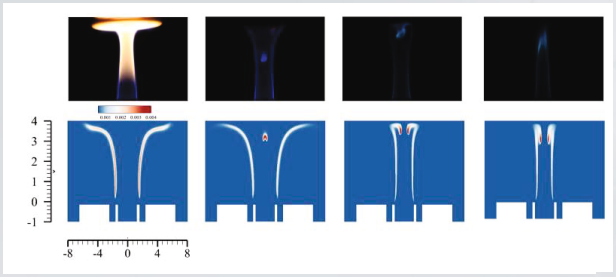
Dr. Girish B.S

- Developed a novel method to generate Pareto-optimal front from a set of piecewise linear trade-off curves typically encountered in bi-objective JIT scheduling problems.
- Proposed a dynamic programming algorithm for satellite scheduling in COSPAS SARSAT system for disaster management.



Dr. Mahesh S.

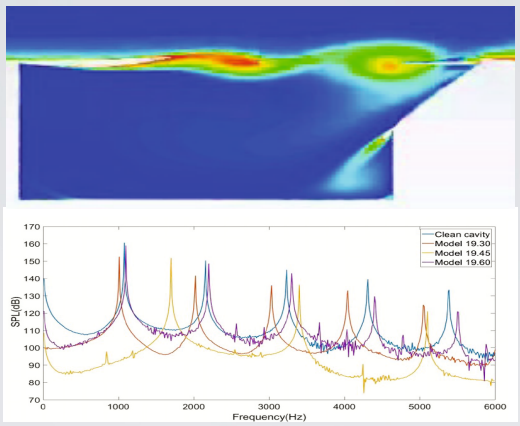
- Designed and developed a labscale experimental setup to investigate buoyant jet flame-wall interaction in the context of impingement flame heating.
- An open source CFD solver was utilized to model the buoyant jet flame-wall interaction which successfully captured the salient features observed from experiments.



Experimental (Top Row) and CFD Results (Bottom Row) Depicting the Evolution of Wall Impinging Buoyant Jet Flames with Variation in Air Jet Velocity for a Fixed Power Level.

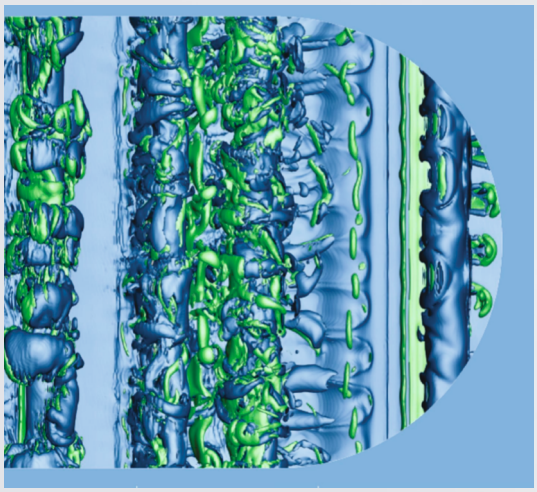
Dr. Manoj T. Nair.

- Numerical investigation of flow induced cavity oscillations at transonic speeds – effect of geometry.
- Study of supersonic flow past axisymmetric cavities.
- Study of the effect of vortex generators on slender bodies in supersonic flows Study of low Reynolds number compressible flows.
- Development of scale-adaptive TENO scheme based on a new smoothness indicator.



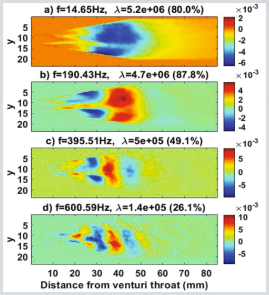
Dr. Manu K. Vasudevan.

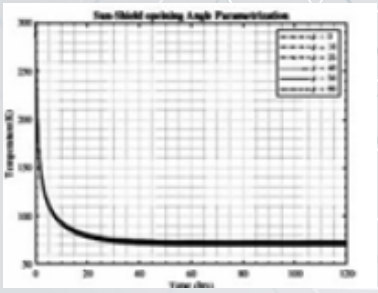
- **Phase Change Materials (PCM) Dynamics**: Focuses on the thermal behavior and melting dynamics of PCMs, particularly in complex enclosures.
- **Ablation modelling:** Investigate, analytical and numerical solutions to various ablation problems.
- **Fluid Dynamics:** Investigates the onset and development of turbulence in various flow configurations, such as diverging channels.
- **Thermal Convection:** Studies the interaction between thermal convection and PCM behavior in different geometric settings.
- **Analytical Solutions:** Applies analytical methods to solve complex problems in heat transfer and fluid dynamics.



Dr. Pradeep Kumar P.

- Experimental study of the cavitation zone dynamic behaviour in a cavitation Venturi.
- Numerical prediction of cavitation behavior in cavitation venturi using two fluid model.
- Characterisation of two-phase boiling instabilities.
- Thermal characterisation of insulation involving combined conduction and radiation.

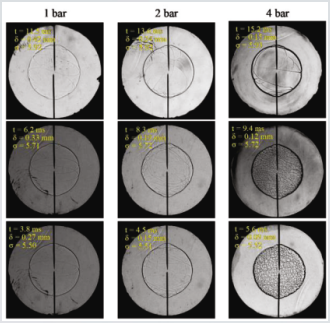


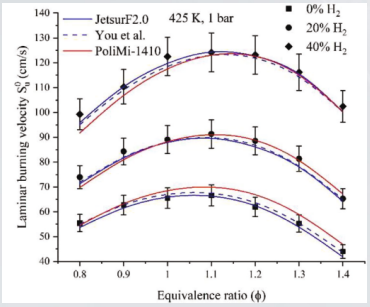


Dr. Prathap C.

Thermal & Flow Engineering labs

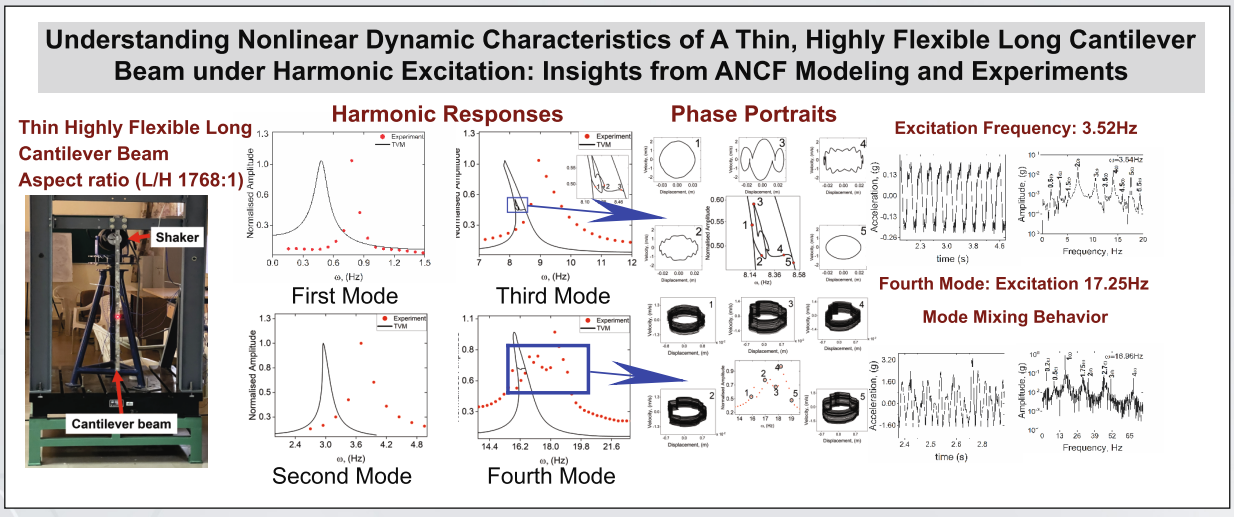
- N-dodecane was considered as a surrogate for kerosene. To enhance the combustion characteristics of n-dodecane, H_2 was added in different proportions, and its burning velocity was measured using freely expanding spherical flames.
- premixed n-dodecane-oxygen (diluted with N_2, H_2O, and CO_2) was also studied at different pressures and temperatures. High-temperature oxy-n-dodecane flames were less sensitive to initial pressure. Jetsurf2.0 mechanism predicted LBV accurately.
- Flame Speed
- SWIRL/ Self-aspirated Burners
- Direct contact condensation





Dr. Praveen Krishna I.R.

Structural Dynamics and Vibration Lab



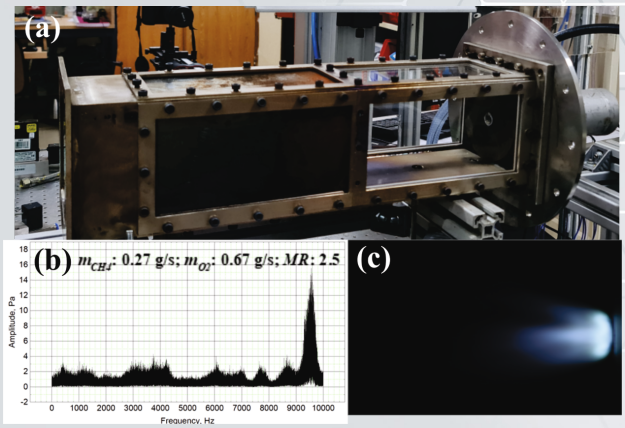
- Dynamic characteristics of a thin cantilever beam of aspect ratio (L/H) 1768:1.
- Modeling approach using ANCF and solution approach using TVM.
- The Fourth Mode shows a mode mixing behavior.
- The higher harmonics of fundamental frequencies are present in the responses.
- The harmonic response curve shows softening behavior for higher modes.

Dr. Rajesh Sadanandan.

Combustion Instability Studies in a Non-Premixed Swirl Coaxial Gaseous Methane Oxygen Injector

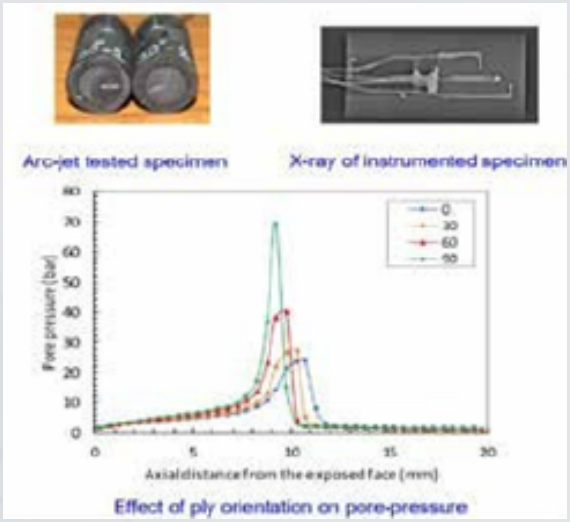
Combustion instability refers to self-sustained, large amplitude oscillations of pressure and velocity occurring in reacting flows. This phenomenon was present in applications like rocket propulsion, gas turbines utilized for aircraft engines, power generation, industrial boilers, etc. In liquid propellant rocket engines, where power density is higher than other power generating systems, combustion instabilities are found highly destructive as their pressure amplitudes are higher. Experimental investigations of combustion instability in a non-premixed swirl coaxial gaseous methane-oxygen injector

at atmospheric conditions are performed using non-intrusive diagnostic techniques. The objectives include GOX Reynolds number's influence on the injector's thermos-acoustic stability, understanding fundamental coupling mechanisms, exploring combustion instability dynamics, etc. The experiments are being conducted in a Combustion Acoustic Rig (CAR) at IIST with the swirl coaxial injector mounted on a windowed combustor with a square section. The oxidizer flows through the core of the injector and fuel through an annular path. The combustor is instrumented for its dynamic pressure and temperature measurements. Heat release data is obtained using a photomultiplier tube. The optical characteristics of the flame were obtained using high-speed imaging of flame luminosity and CH* chemiluminescence. The Reynolds number of oxygen (Reox) and mixture ratio (MR) were varied and the system's flame characteristics and thermos-acoustic response were analyzed.



(a) Photograph of the CAR setup at for combustion instability studies. (b) dominant acoustic instability frequency at a specific injector operating condition, and (c) corresponding flame luminosity.

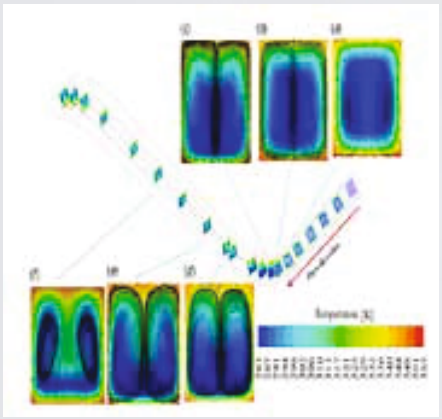
Dr. Raveendranath P



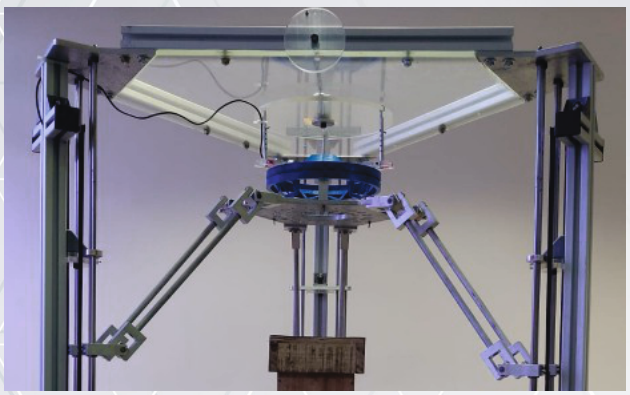
- Developed a two-dimensional axisymmetric, unstructured Finite volume model for thermochemical response of Carbon-Phenolic ablative composite.
- Decomposition kinetics model developed for Carbon-Phenolic material using thermogravimetry tests
- Arc jet tests conducted on Carbon-Phenolic material prepared at different ply orientations.

Dr. A. Salih

- Modeling and analysis of compressible liquids.
- Chilldown of cryogenic feed lines.
- Thermodynamic and fluid-dynamic of cryogenic propellant tank.



Dr. Sam Noble.

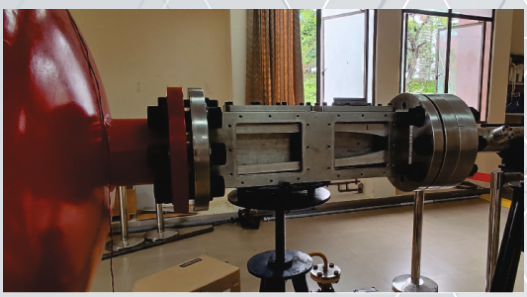


- Deployment mechanism for multifold mirror/ reflectors.
- Design and Realization of bipedal humanoid robot with human like walking ability in collaboration with VSSC under ASRG project.
- Development of a belt-driven actuator based stewart platform for docking.

Dr. Satheesh K

High pressure shock tube facility

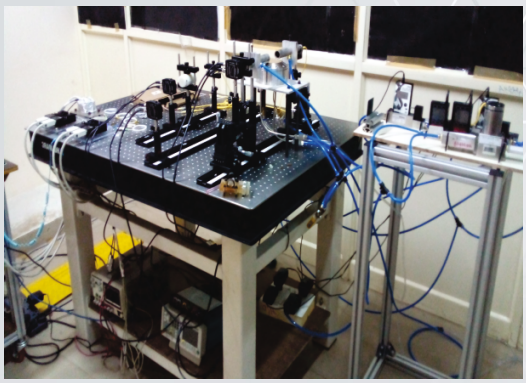
- Fundamental study on shock propagation
- Study of transient compressible flows
- Chemical kinetics
- Application of quantitative laser diagnostics



sonic nozzle with test sec

Laser absorption spectroscopy lab

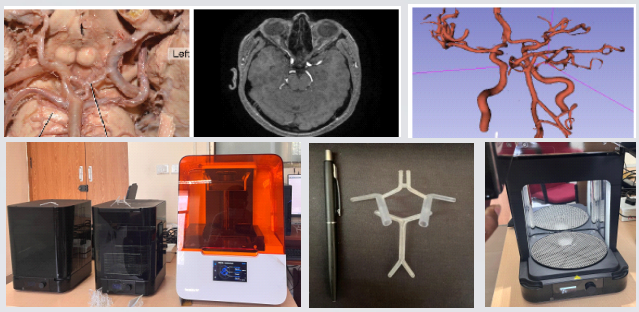
- Development of Laser absorption based sensors for Temperature and concentration measurement (Tunable DiodeLaser absorption Spectroscopy TDLAS)
- Application to combustion and high enthalpy flows
- Targeted species: H20, 02,CH4

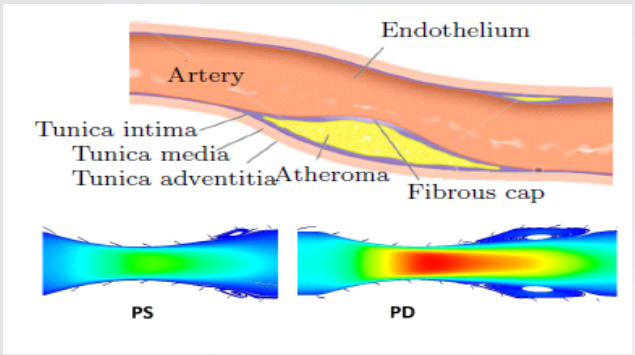


TDLAS test set-up

Dr. Shine S. R.

- Smart healthcare and medicine:-Major works include the development of computational models to study the effect of plaque geometry on coronary artery wall, development of human thermoregulation model, analysis of thermoregulatory mechanisms, models for investigating aneurysm initiation, hypoplastic arteries.

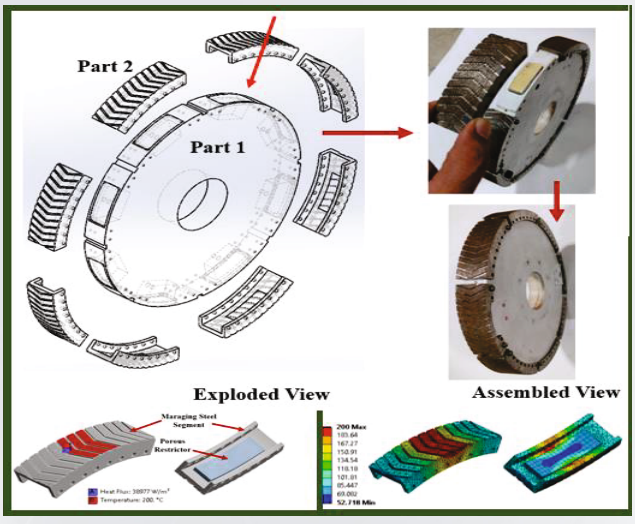




- Heat Transfer in Space applications: Major areas of research involves film/regenerative cooling of liquid rocket thrust chambers, liquid rocket engine cycle analysis, cryogenic two phase flow, plume radiation modeling of solid rocket motors, micro nozzles associated with attitude control, and gas turbine blade cooling, Direct Simulation Monte Carlo Method.

Dr. Sooraj V. S.

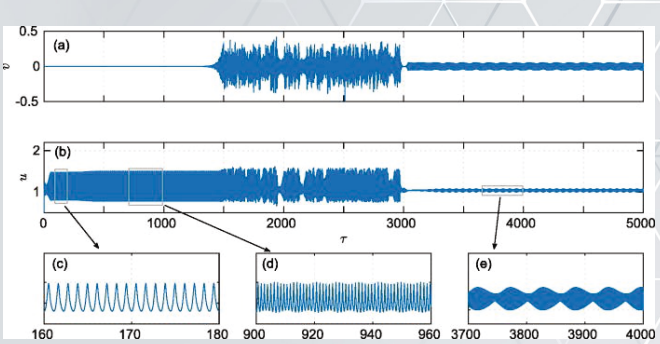
- Development of a Self- Sweating type Grinding Wheel.
- Development of Innovative Machining Strategy for FRPs.
- Design and process for Manufacturing – Space Payloads
- Metal Additive Manufacturing for Aerospace Manufacturing.
- 3D printing solutions for Bio-medical applications
- Generative design and Topology optimization for Additive Manufacturing, with special focus on space applications.



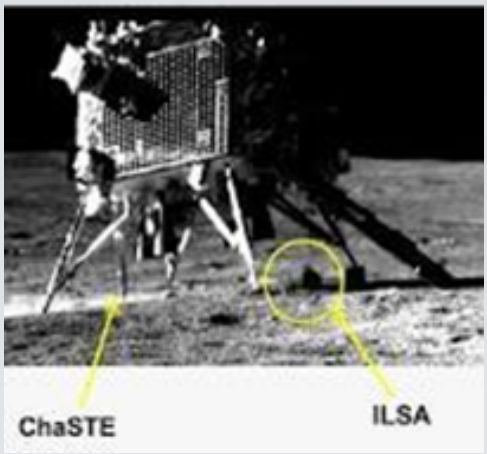
Additive Manufacturing as a Potential Solution for Sustainable Green Subtractive Manufacturing.

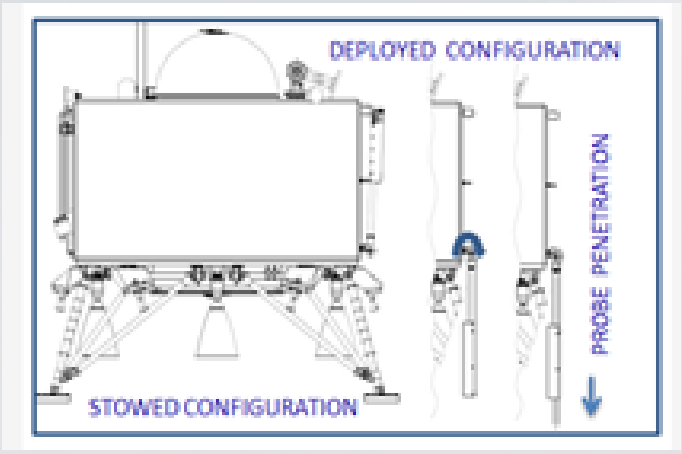
Dr. Vinoth B.R.

- Automatic derivation and development of stability code for non-ideal compressible flows.
- Global stability analysis of fluid flows
- Bifurcation and Non-linear analysis of fluid flows



Prof. U. A. Subramanian





- Design and Development of Deployment and Penetration Mechanism for ChaSTE payload in Chandrayaan - 2 & 3

The payload is held in stowed condition by a SMA based hold and release mechanism. A BLDC motor based mechanism deploys the payload and rotates to a configuration normal to the lander bottom deck and locks by a locking mechanism. The probe is inserted slowly into lunar regolith up to a depth of 140 mm by a BLDC operated ball screw mechanism. ChaSTE was released from its stowed configuration at 02.00 hrs on 24th August 2023 and successfully completed all operations and experiments.



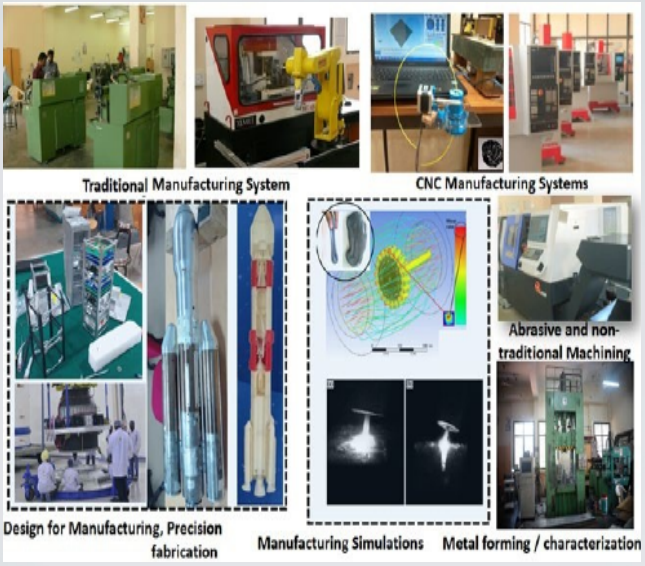


- Design and Development of low shock, non-pyrotechnic and fully resettable Payload Dispenser Mechanisms:

A cubesat dispensing system for 1Kg to 3 Kg class satellites. Satellites are housed inside a rectangular framed box and locked by a swinging door. A redundant wire fusing and lever mechanism releases and opens the door. A spring based ejection mechanism jettisons the satellites. An axial dispensing system for 10 Kg class satellites. Employs a wedge lock clamping mechanism actuated by a redundant solenoid pin puller release mechanism and jettisons by a spring based ejection mechanism. Successfully being used in ISRO's launch vehicles.

Central Workshop & Manufacturing Processes Lab

In line with national initiatives such as “Make in India” and “ Atmanirbhar Bharat”,manufacturing technology becomes one of the key subject domains that can drive great career prospective. “Manufacturing Lab” initiated by IIST under Department of Aerospace Engineering is oriented towards advanced manufacturing processes for aerospace applications, with specific core course on Additive Manufacturing and smart practices, Composite Manufacturing Technology, Advanceddeformation and joining process, Computer aided subtractive manufacturing,Manufacturing Planning and Control, etc. with hands-on experience on various equipmentrelated to manufacturing, materials testing and characterization.With a precise focus of developing creative and technologically competent humanresources along with innovative



research avenues/outcomes, the program is designed to cover both applied as well as advanced technologies of manufacturing to upgrade technical knowledge and skillset.

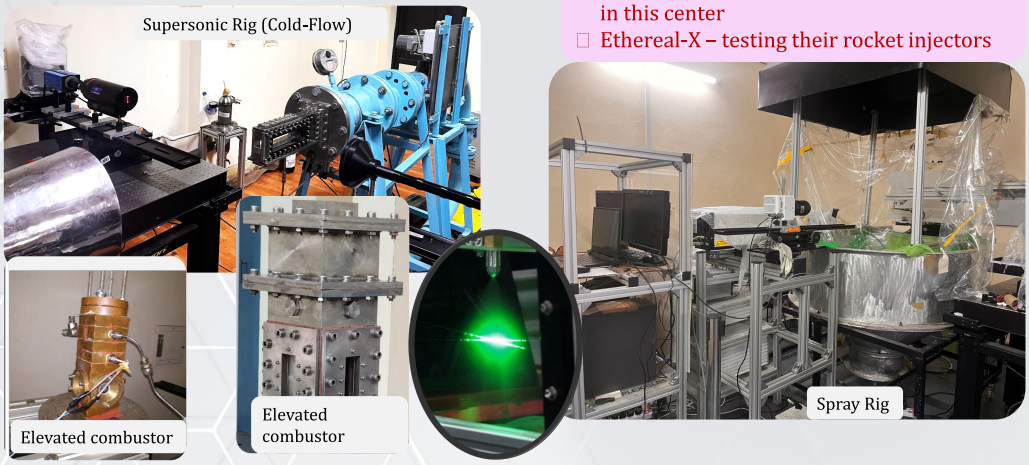
Salient features of MANUFACTURING TECHNOLOGY offered at IIST includethe possibilities to get connected with ISRO centers, innovative learning experiencesthrough space, specific case studies and practical demonstrations oriented towardsaerospace manufacturing, avenues to be the part of space research/discussions,opportunities for Internships and projects at ISRO centers, etc.

Advanced Propulsion and Laser Diagnostics (APLD) facility

The Advanced Propulsion and Laser Diagnostics (APLD) Facility has been established with a primary focus on conducting fundamental studies in the realm of propulsion research. It provides an invaluable platform for students and researchers at IIST to engage in cutting-edge research, primarily emphasizing fundamental studies encompassing supersonic mixing, supercritical injection, combustion, and other critical aspects of propulsion systems. Major instruments/ equipments: High-Speed Camera (Phantom VEO 410L), CCD Camera (PCO 2000, Pixelfly), ICCD (Nanostar), Low Speed and High-Speed IRO (Image Intensifiers), Stereo PIV Camera (Imager CX), PIV Nd-YAG laser, Dye Laser, High-speed Water Cooled Dynamic Pressure Transducers, Liquid Fuel Heater, Mass Flow Meters and Controllers, Free-Field Standard Microphone set .

Advanced Propulsion and Laser Diagnostics Lab

- 2 Space Start-up Companies are operating in this center
- Ethereal-X – testing their rocket injectors



Contact Us

Department of Aerospace Engineering
Room No. R 212 D4 Building
Indian Institute of Space Science and Technology Valiyamala
Thiruvananthapuram - 695 547
Kerala, India.
Tel: 91-471-2568416
Email: office-aero@iist.ac.in

https://www.iist.ac.in/departments/aerospace-profile

