Team Name: Agneyam

Name of the Startup: Agneyam Aerospace Labs, Chennai.
Udyam Reg No: Udyam-TN-08-011-0118821.
Founder & CEO: R. Prithivirajan**.**
Co-Founder & Co-CEO: S. Naveenkumar**.**
Incubation cell: Incubated at Sathyabama Startup Cell.
Official ISRO (InSpace) user name: Agneyam@2006
Fund Raised so far: 1. equipment support for R&D from Sathyabama Innovation council and startup cell.

Research paper Published

Advanced Nano-satellite design with propulsion system and IR spectrometer payload.

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Abstract—In this manuscript, Indigenous design and fabrication of CubeSat with Propulsion system and IR spectrometer payload has been discussed which may find various applications in remote sensing activities and interplanetary mission capabilities. The presented Broadband IR spectrometer Payload (900nm to 5000nm) is an imager with an array of 64 detectors. We have introduced an optical bandpass filter namely a BK7 substrate coated with semiconductor material with larger band gap in the input optics of the payload to pass only the IR radiation and reflect other radiation in the space environment. The CubeSat propulsion system is a pulsing engine for achieving slingshot manoeuvres, it uses fuels with hypergolic behavior namely Unsymmetrical Dimethylhydrazine and Dinitrogen tetroxide. The CubeSat structure and engine part is made up of carbon-carbon composites in layered coating with silicon carbide and zirconium oxide to reduce oxidation and crack of the structure and engine parts in deep space environment. Other subsystems include altitude determination using magnetorquer, ground station design using Yagi antenna in Ham radio frequencies for telemetry, command and beacon, and rotor interface. Fabrication of the IR detector, solar cells and optical filter is carried out in PVD method (Physical Vapour Deposition) and the engine parts with 3D printing technology (CC Composites based filaments). The cubesat employs gaseous purge system using nitrogen injected upstream on to the motherboards to safeguard the onboard equipment from potential contamination in low earth orbit. The simulated results are in good agreement with the results from the fabricated prototypes.

Keywords: CubeSat, carbon-carbon composites, layered coating, magnetorquer, upstream.

Auto-ignition studies on gelled purified low sulphur kerosene with GONPs aerogel as gellant and AgPtNPs catalyst and H2O2

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Abstract: In this work, the numerical investigation on auto-ignition of rocket-grade kerosene is discussed. The numerical simulations were carried out using 100 mL of purified low-sulphur kerosene with 1.2 g of graphene oxide nanoparticle (GONPs) aerogel as an absorbing agent and 0.25 g of silver-platinum bimetallic nanoparticles (AgPtNPs) as catalyst for decomposition of nontoxic oxidant hydrogen peroxide. The low-sulphur kerosene was prepared by physisorption process using activated carbon [2] to remove residual sulphur compound and GONPs aerogel was further added to absorb and store the purified kerosene. AgPtNPs were added to reduce the activation energy of the combustion there by induce the auto-ignition in kerosene. For any proposed gel propellant, rheological properties are the primary key to study their impact on fluid flow and their subsequent injection in to the combustion chamber. Here Teng model is used as quantitative tool to describe about the characterization and the thixotropic behavior of the proposed mixture [1], the Steady-state and transient rheological behaviours were examined using the simulated plot of viscosity–shear rate, shear stress–shear rate, thixotropic hysteresis loop, and viscosity recovery. The results show that the proposed gel propellant flows very easily at a oscillatory applied shear rate of 50 s-1 . This implies that the viscosity decreases linearly as a function of applied shear. This property of the gel-fuel mixture makes it easier toto handle it. At rest, the gel has a moderate yield stress, which helps it remain stable and solid-like during its storage in the fuel tank. Under the application of external shear during flow the gel network breaks. Once the shear is removed, the gel structure rebuilds quickly but in a controlled manner, showing good thixotropic behaviour. The hysteresis loop further confirms that the gel can break down under flow and recover its structure afterward, which is important for reliable propulsion performance. The TENG model parameters indicate that the internal structure breaks rapidly at high shear rates and recovers effectively due to the graphene oxide aerogel network strengthened by nanoparticle interactions. Overall, these rheological properties show that the entrapment of kerosene in a aerogel is highly suitable for rocket propulsion systems, offering stable storage, smooth injection, and predictable flow behaviour. The same will be verified in rheometer experiments and shock tube test to study the ignition delay of the mixture in a premixing tank. It will involve the secondary atomization of the fuel mixture using an atomization nozzle under different pressure ranging from 0.5 atm - atm and at various temperature ranging from up to 1000 K with different H2O2 initial concentrations, specifically at 30%, 40%, 50%, 60%, 70%, 80%, and 90%.

Keywords: Auto-ignition, Bimetallic catalyst, Teng model, Shock tube experiments.

PROBLEM STATEMENT.

Problem statement: Nano satellite lack Indigenous design and fabrication in INDIA, cannot be used for interplanetary mission and traditional nano IR spectrometer payload are limited to detect only a specific band in Spectrum not a wide band. So, the task is to develop a CubeSat with micro-propulsion and broadband spectrometer payload for various application like remote sensing, agriculture monitoring, military application, climate studies.

Abstract Acceptance notification (#18) (Abstract Acceptance Notification (#18)) Inbox

Conferences <noreply@ursc.gov.in> Fri, Oct 24, 4:53 PM (6 days ago)
to me, kammata

Translated: Kannada → English
Translate can make mistakes, so verify translations
Show original

Dear R Prithvirajan,

We're pleased to announce that your abstract "Indigenous Design and Manufacture of 16U CubeSat with Micro Propulsion System and Broadband IR Spectrometer Payload" with ID #18 has been accepted.

See below a summary of your submitted abstract:
Conference: National Level Kannada Technical Seminar – 2025
Submitted by: R Prithvirajan
Title: Indigenous design and manufacturing of a 16U CubeSat with Micro Propulsion System and Broadband IR Spectrometer Payload
Authors: R Prithvirajan

Kannada Kammata - 2025 Inbox

kammata@ursc.gov.in Wed, Nov 19, 12:40 PM (7 days ago)
to Ninaada, Ananda, Nagendra, Swetha, SUSHANTH, Manjunatha, me, ABHISHEK, Mohana, Akash, PRASAD, Girish, SATISH, Pushpanjali, Harsha, Sujay, Deepak, divya, pradeepaerosky, vasude

It looks like this message is in Hindi
Translate to English

Dear Authors,

Your full length Technical paper is accepted for Kannada Kammata -2025. You are invited to present your paper, during Kannada Kammata -2025, to be held on 26th November,2025 at U.R. Rao Satellite Centre, Bengaluru.

Request authors to report to URSC on 26th November at 8.30AM. Authors, who are yet to confirm their participation, kindly do so by replying to this mail and please mention the name of presenter/s from your side.

Request authors to share the presentations (in pdf and ppt formats) to this mail ID, by 24-11-2025, 10:00AM IST.

Proof that **ISRO satellite center** accepted Our Problem statement and proposal at the Private space sector competition

IDEA & APPROACH

Idea: Indigenous Design and Fabrication of 6U CubeSat with micro propulsion system and a Broadband spectrometer Payload for Interplanetary Missions

Proposed solution:

- Patented Self Powered Broadband IR spectrometer (Near-IR – Far-IR) (900nm to 5000nm).
- Palm Sized Pulsing Micro propulsion system using Hypergolic fuel (Using low sulphur kerosene and H2O2) for orbit slingshot.
- Patented helix-structured algorithm for Compress encryption with 145.98 MHz downlink for secure data transmission.
- Use of Inert gases (N_2) for mission life expansion.

How it addresses the problem:

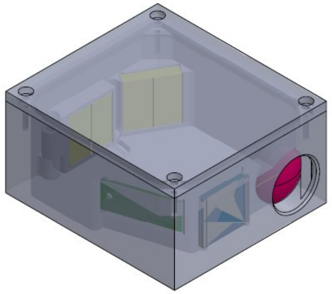
- Conventional spectrometers limited to specific bands (visible, NIR, or MIR) preventing comprehensive analysis.
- Traditional Propulsion system has lower specific impulse.
- Problem in larger Data transmission within the Signal Window.
- Minimum life span due to degradation of Onboard subsystems.

Root Cause of the problem:

- Lack of fine encrypt & decrypt algorithm.
- Propulsion system with less specific impulse.
- Absence of broad band IR detector.
- Traditional Engine material undergoes oxidation and crack under harsh environmental condition.

Innovation & Uniqueness:

- Use of Promoter in gelled purified low sulphur kerosene with GONPs aerogel as gellant and AgPtNPs catalyst and H2O2
- Mercury Cadmium Telluride (MCT), IR detector
- Use of Optical bandpass filter in spectrometer payload to eliminate unwanted radiation in space environment.
- Carbon-Carbon composite in layered coating with silicon carbide and zirconium diboride (alloy) to avoid oxidation and Crack of Engine parts.
- Graphene based High density battery.
- Using Inert gases (N) injected Upstream onto subsystem to avoid Contamination from dust particles.



Palm sized Broadband IR spectrometer

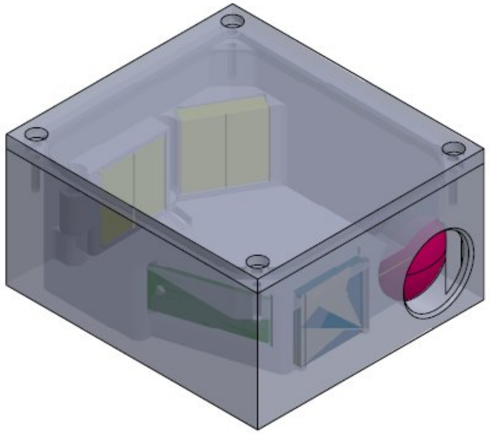
Working CubeSat Prototype

Complete System overview

- **6-Unit (6) CubeSat Bus:**
  - 1U of internal payload volume
  - 1U Payload
  - 3 U propulsion system
  - 1 U cooling and gaseous purge system
- **Payload average power:**
  - Up to 6 W peak power
- **Solar array:** Body-mounted panels
  - Solar panels on ±X, ±Y, and -Z faces.
  - 9 W peak power.
- **Battery:** Graphene oxide based batteries from startup (MOU)

- **Pointing accuracy:**
  - Nadir pointing nominal
  - 3-axis stabilization
  - 1-axis (pitch) control
  - Roll and Yaw angles: < 5° error
  - Pitch angle control: < 1° error
- **Payload Data Bus:** I2C
- **Propulsion:** present
- **Fuel**: Kerosene gel with GO aerogel and AgPtNps catalyst and conc 30% H2O2
- **Expected mission life:** 2.5 years in LEO
- **Antenna:** 437 MHz UHF dipole antenna

- **Payload**: Broadband IR spectrometer payload (900nm to 5000nm).
- **Material used**: Carbon fibre coated with silicon carbide and zirconium dioxide
- **Housekeeping Telemetry Collection:**
  - Temperature
  - Voltage, current, and power consumption
  - Logs and flags
- **On Board Computer:** Arduino, STM32



Tech Stack

Technology Stack:

IDE:

STM32 CubeIDE

ARDUINO

Orbital monitoring:

Orbitron

Nova for Windows

Simulation software:

MATLAB

AUTODESK EAGLE

SOLIDWORKS

optence networking in photonics

CATIA

Thin Film Labs

SATLAB GEOSOLUTIONS

Operating system:

freeRTOS

Mechanical simulation:

Ansys

FLOW-3D HYDRO

AUTODESK CFD

Hardware Used:


DIP coating

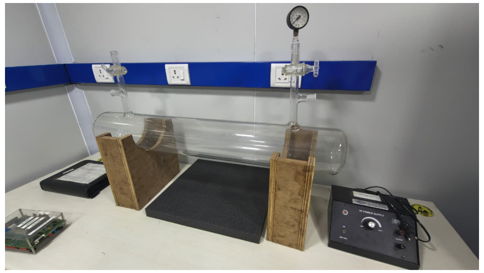

Tensile strength tester


Optical density machine


PVD machine

Semiconductor used :

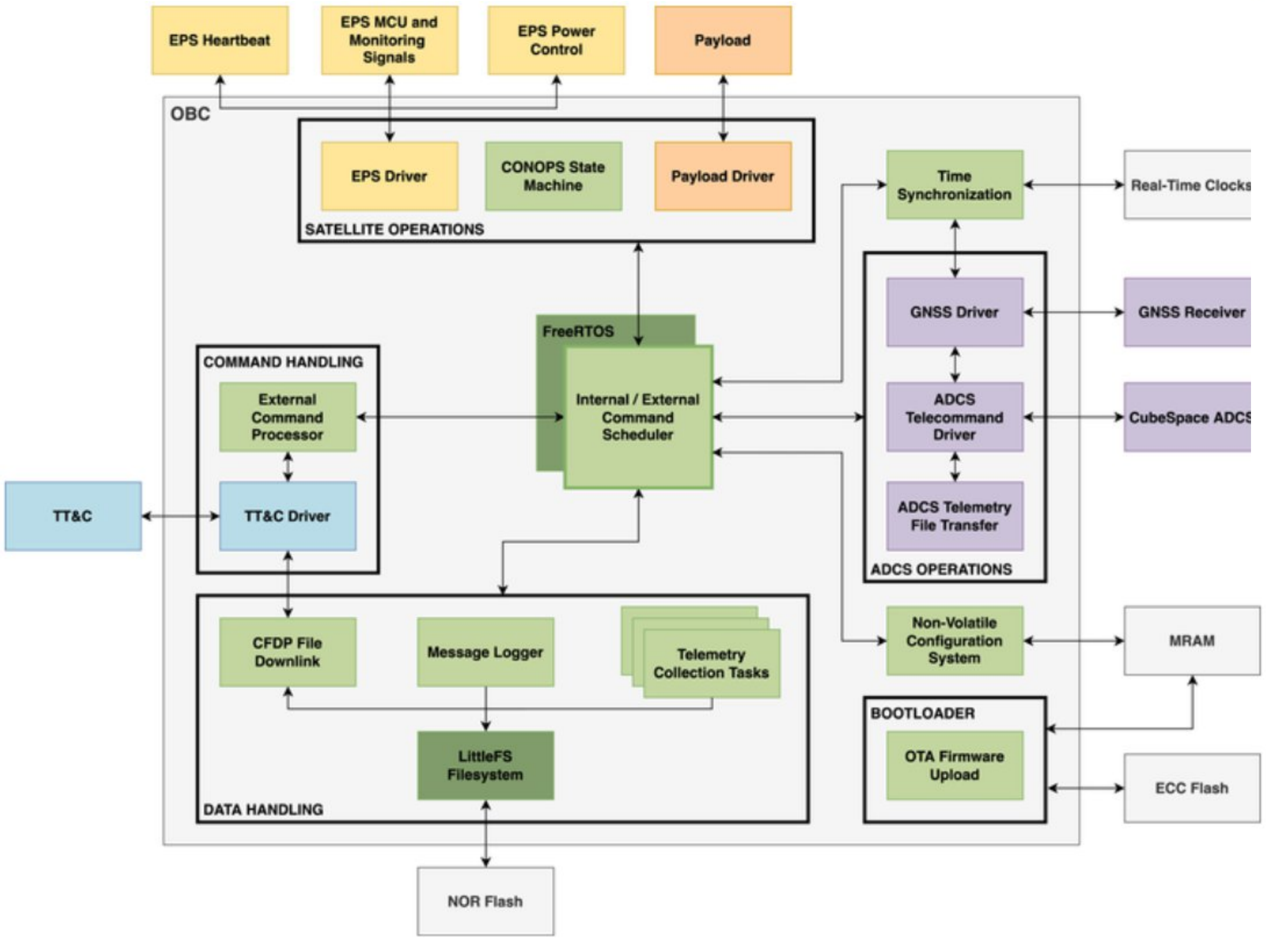

laser interferometer


Vacuum calibration tube

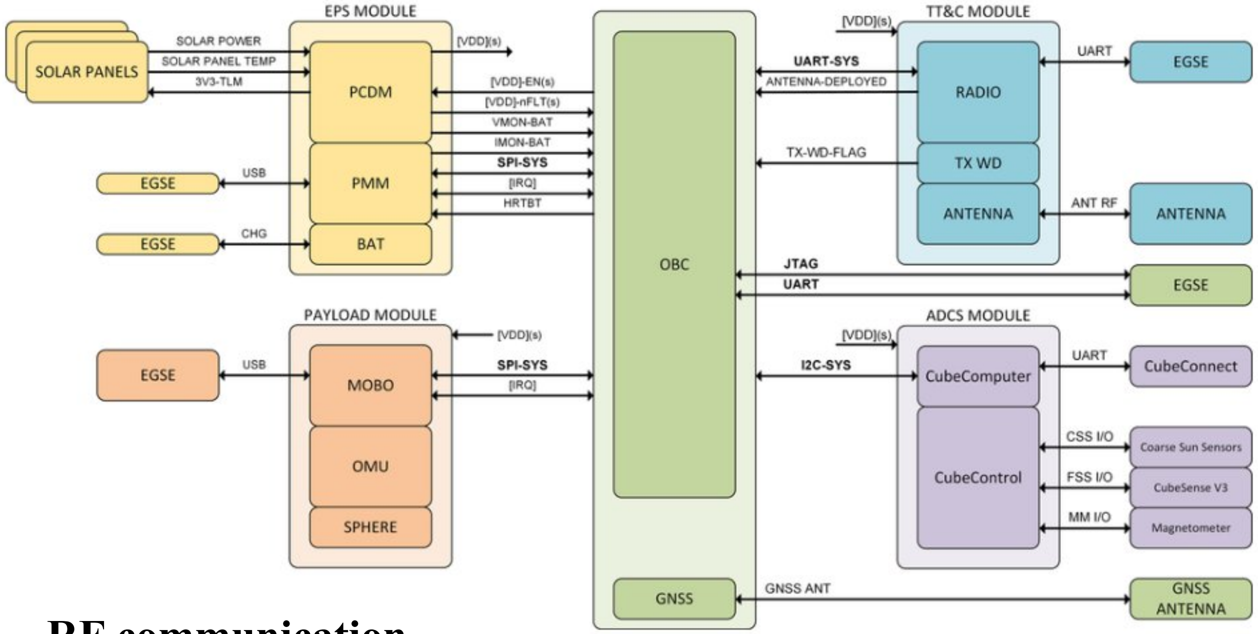

Ultra sound Cleanser

Work Flow Diagram

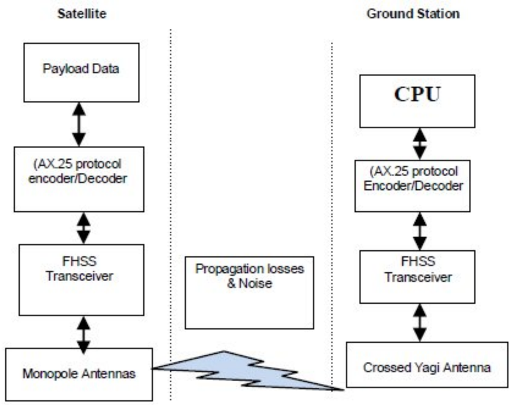
Software work flow:



Hardware work flow:



RF communication protocol:

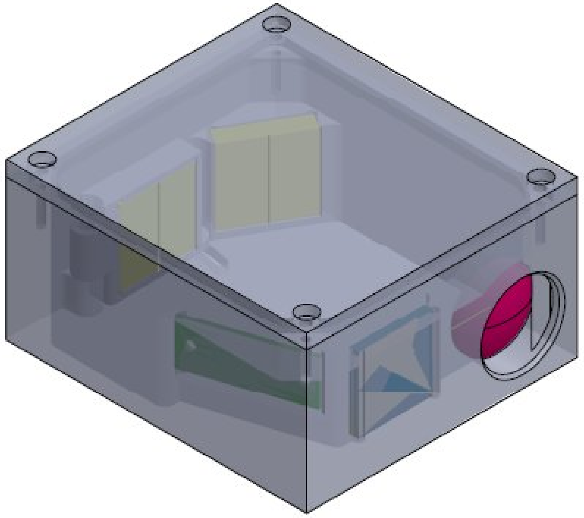


Payload overview

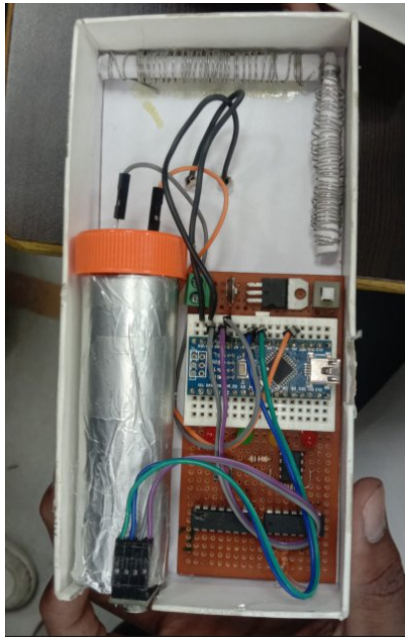
Payload: Broadband IR spectrometer.
Spectral Range: 900nm to 5000nm.
Detector: Mercury Cadmium Telluride photodetector
Imager: 32 array of MCT detector, Linearly arranged pixel.
Detector pixel size: 0.5 mm x 1mm.
Problem in traditional payload: Conventional spectrometers limited to specific bands (visible, NIR, or MIR) preventing comprehensive analysis.
Innovation:

1. Use of optical bandpass filter to eliminate unwanted radiation in space environment.
2. Watchdog timer circuit using IC 555 timer to monitor the continuous pulse of the payload, if fails will pass reset of the complete system.

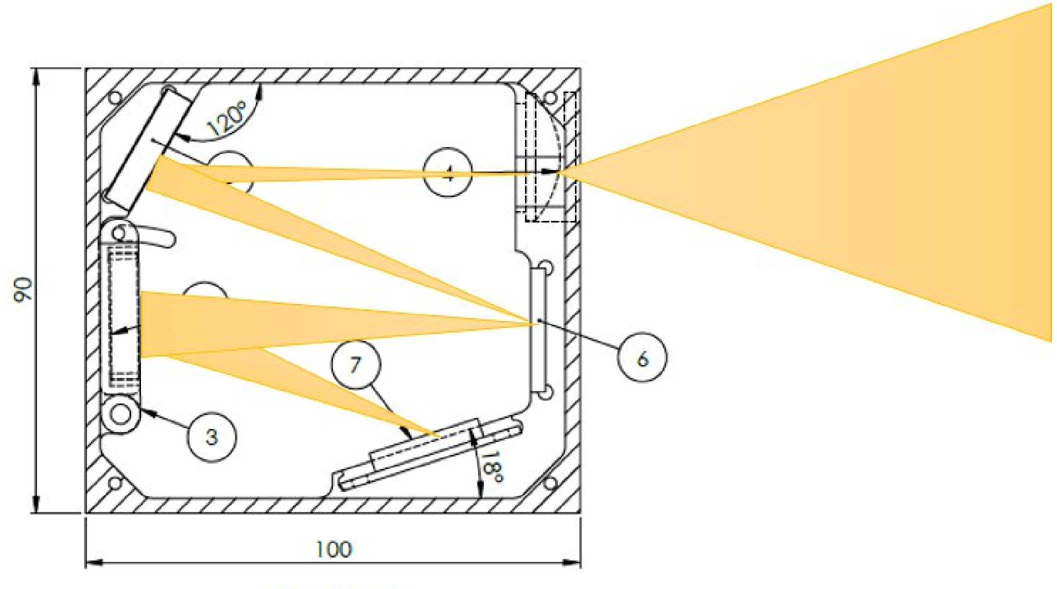
Mirrors used: Gold coated mirror for 99% reflection, Grating lens (300groves/mm).
Algorithms used: Advanced bald eagle search algorithm for optical filter coating.
Simulation software used: MATLAB, ARDUINO IDE.
Machinery used: Physical vapour deposition (PVD), Photolithography, optical density



CAD Model



1st MVP



Radiation in put flow

Payload overview

Output: Fluctuating voltage pulse

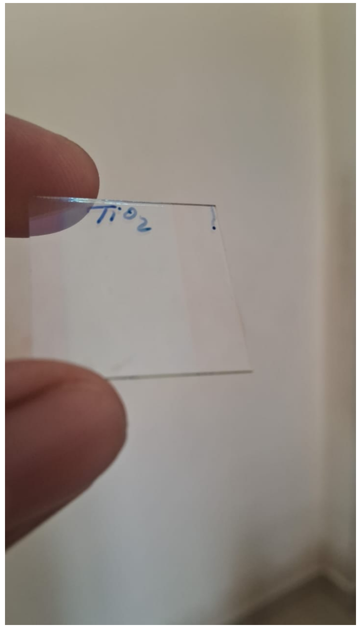
1. The intensity values will be plotted

Machine learning model:

1. Thermal Image, Time vs Intensity graph and causes prediction.

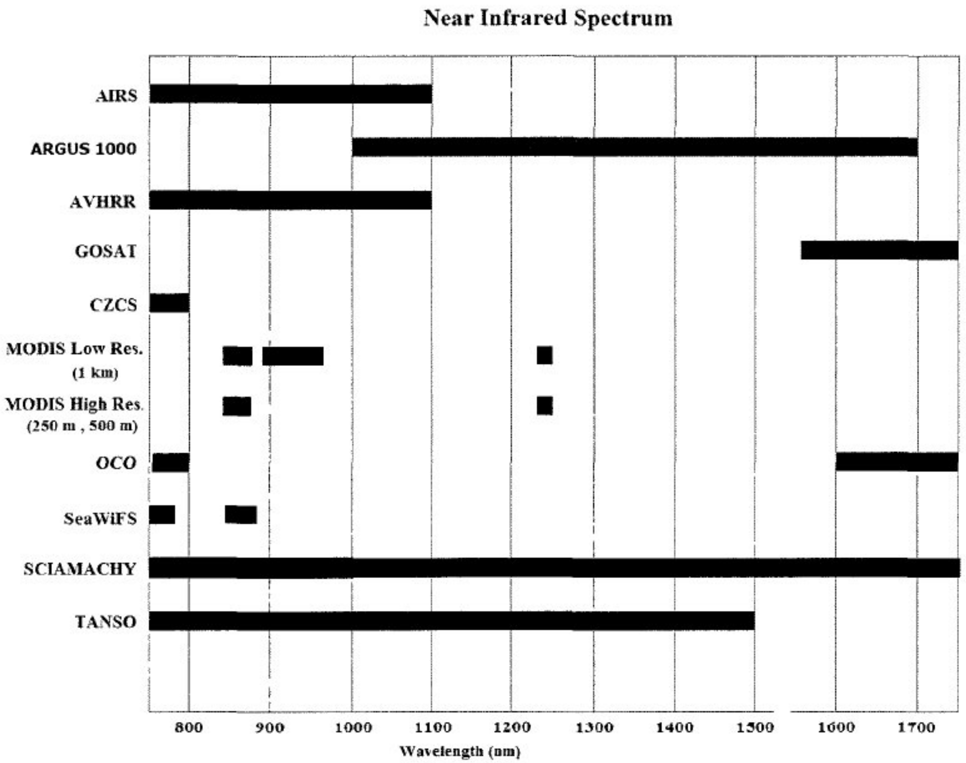
Application of the developed payload:

1. Border Intelligence, weather monitoring, electron density graph, gas molecules detection, atmospheric composition detection, nuclear plant monitoring.

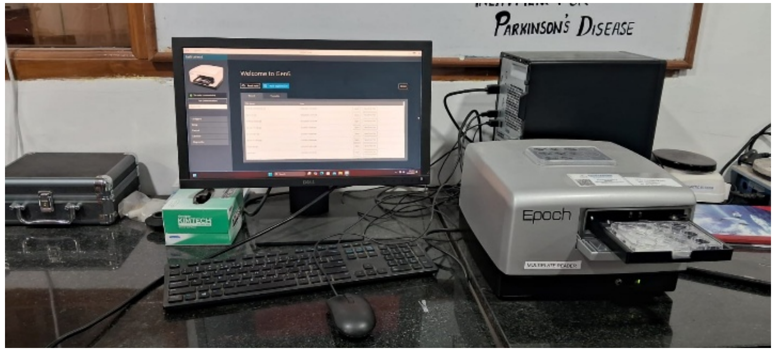


Designed optical filter in PVD machine

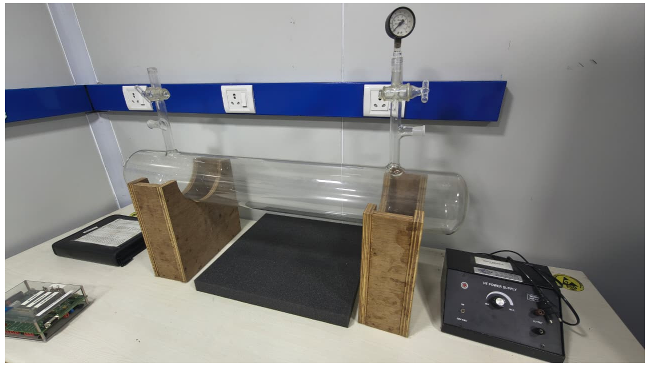
PVD machine



Comparison of traditional payload



Optical density machine

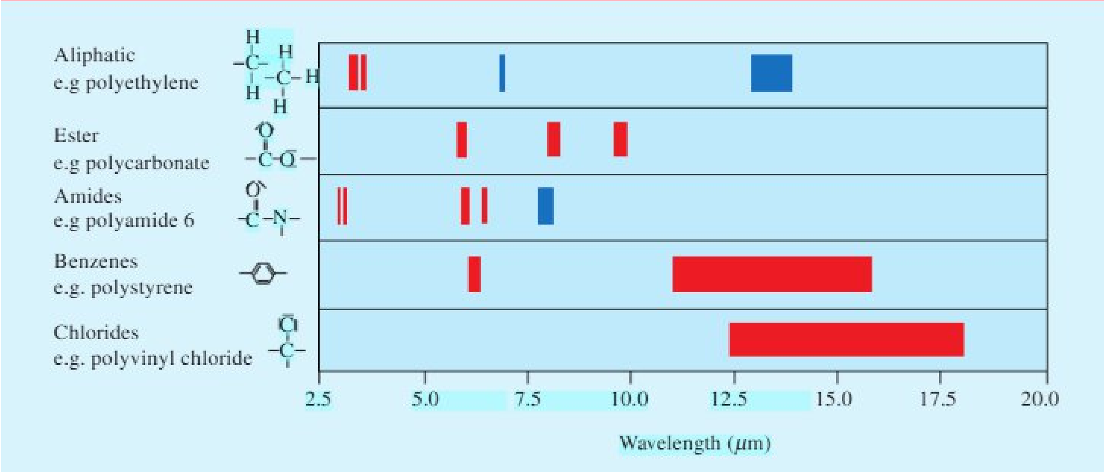


Vacuum calibration tube

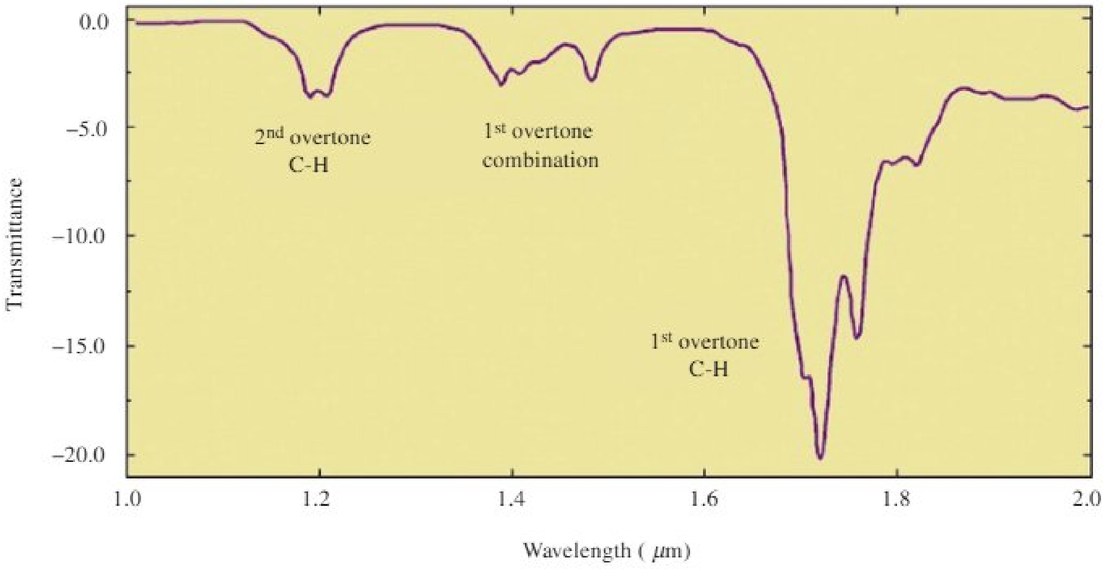
laser interferometer

Application of the Developed Payload.

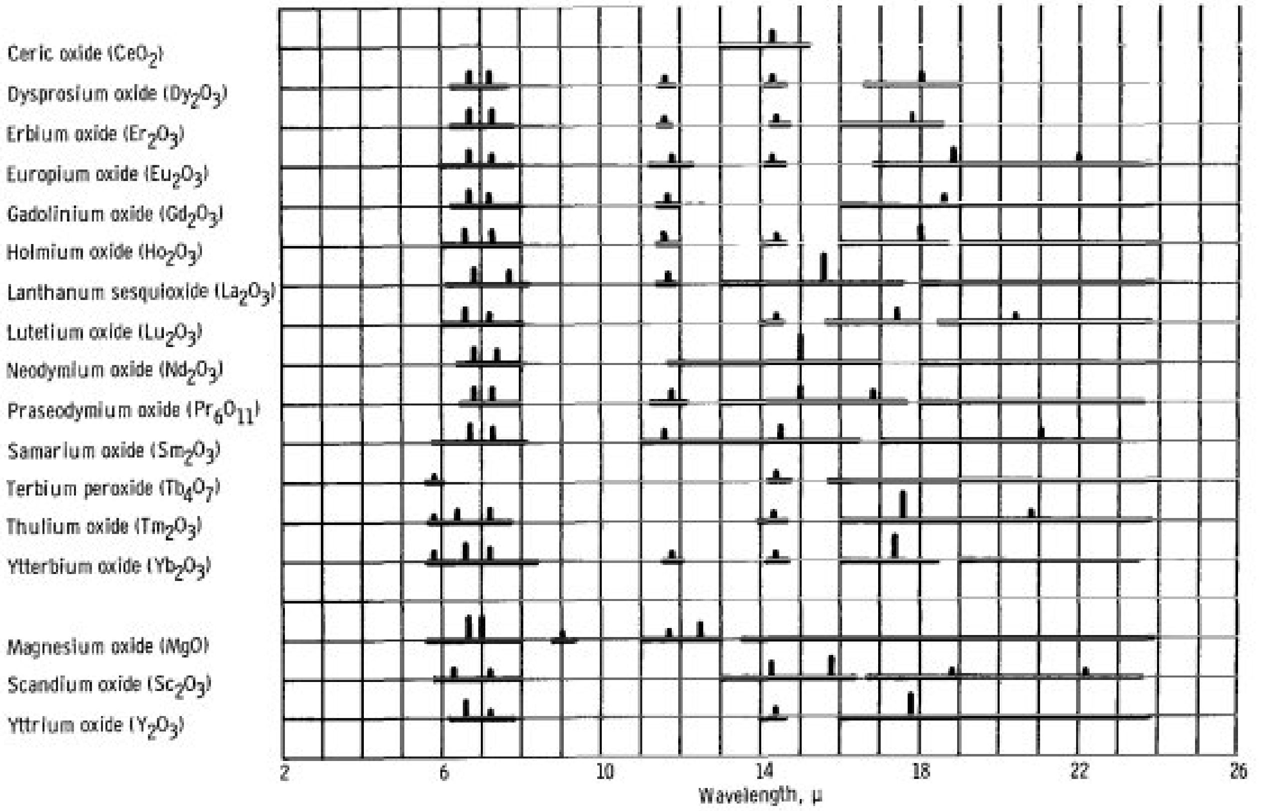
Space debris management



IR spectral Signature of the plastic groups



Noted IR spectral signature of the plastic groups



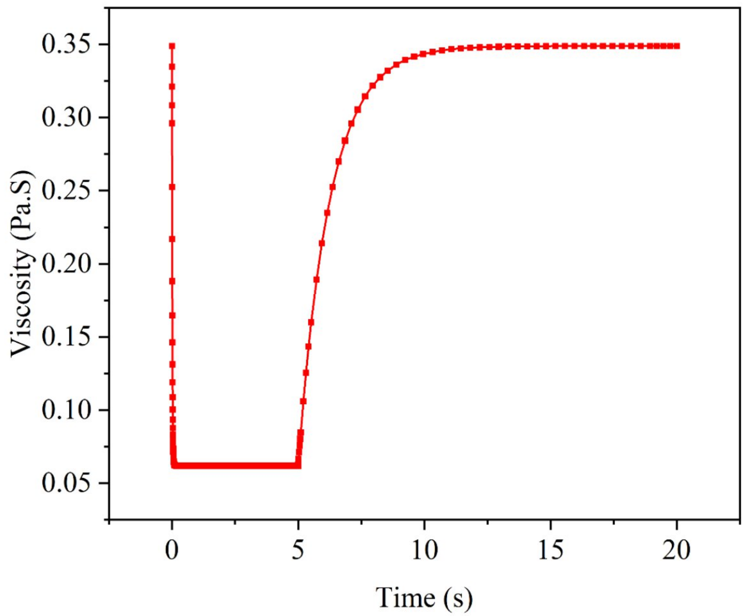
Noted IR spectral signature of the metal groups used in space

Size of the plastic and metals it can detect present in space.
Minimum size: 1mm
Maximum size: variable.
Total area can be covered at a single shot: 2Km*2Km tile

Fuel Overview

Fuel: gelled purified low Sulphur kerosene with GONPs aerogel as gellant and AgPtNPs catalyst.
Oxidizer: 90% conc.H2O2
The results are taken for 100ml of kerosene with 1.2 g graphene-oxide aerogel and 0.25 g Ag–Pt nanoparticles.

Gel Strength Needed: Normal propellant-grade gel
Behaviour: Clear shear-thinning, stable, non-flowing
GO Aerogel Required for 100 mL: 1.0 g
Working mechanism: Graphene oxide aerogel forms a 3D porous network that traps kerosene through van der Waals interactions
Simulation software used: MATLAB, ORIGIN for plotting.
Algorithm used: Teng model for rheological properties.



Viscosity vs Time recovery

Chemicals used

Fuel KIT

Fuel Overview

Green Production of the Required materials

1. Production of low Sulphur kerosene:

Process name: Physisorption.

- Finding Sulphur content in the kerosene we are using.
- Preparing Activated carbon for coconut waste, charcoal etc
- Add 2mg of kerosene
- Stir for 30 mins at R.T
- Leave it over night
- Filter using filter paper.
- Check final sulphur content in GCMS

Final product: low sulphur kerosene (60% - 70% reduced).

2. Production of Graphene oxide NPs Aerogel:

GO source: Sangeetha Akka from lab

- Mix 1 gram of GO in 40 ml of deionized water.
- Ultrasound bath for 2 hours (40-46 khz).
- Place the GO solution in autoclave and heat for 24 hours at 180 deg.

Solvent exchange: direct drying can disturb porous structure.

- Place the gel in container in ethanol
- Soak for 6 hours.
- Replace it (Repeat for 5 to 6 times)

Drying to aerogel:

- Ambient temp drying.

3. Production of AgPtNPs:

Reducing and stabilizing agent: turmeric (curcuma-longa).

Silver source: silver nitrate

Platinum source: Potassium tetra chloroplatinate(II) (K_2PtCl_4) or chloroplatinic acid (H_2PtCl_6).

- Mix 10g of turmeric in 100ml of distilled water.
- Heat the mixture at 100deg for 15 mins with stirring.
- Filter the extract (it contains curcumin and polyphends).

Preparation of metal solution:

- 32mg each of both metal source in 20 ml of Dis.water
- Heat at 100deg stirring at 400rpm for 36 hr
- Centrifuge at 4000rpm for 15 min
- Dry at 45deg for 24 hr.

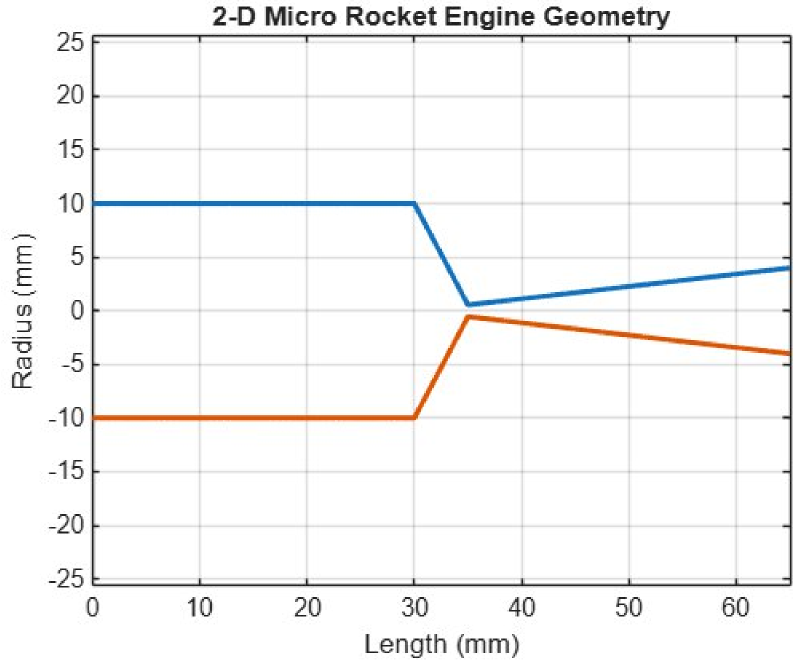
Engine design

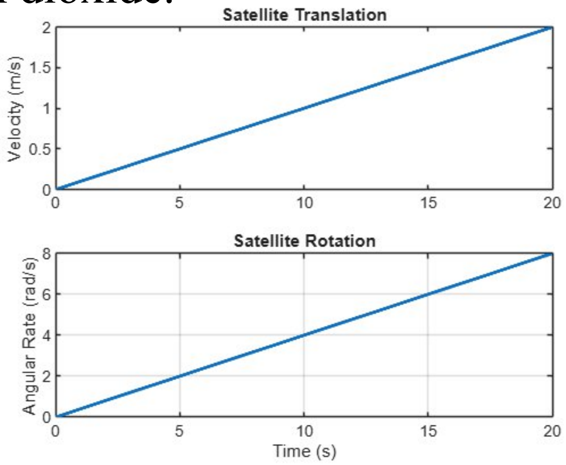
The engine material is designed in MATLAB and fabricated in 3D printing technology.
Material: Carbon-Carbon composites (PEEK Filament).
Coating layer: Silicon carbide and Zirconium dioxide.
Approach: Layered coating.

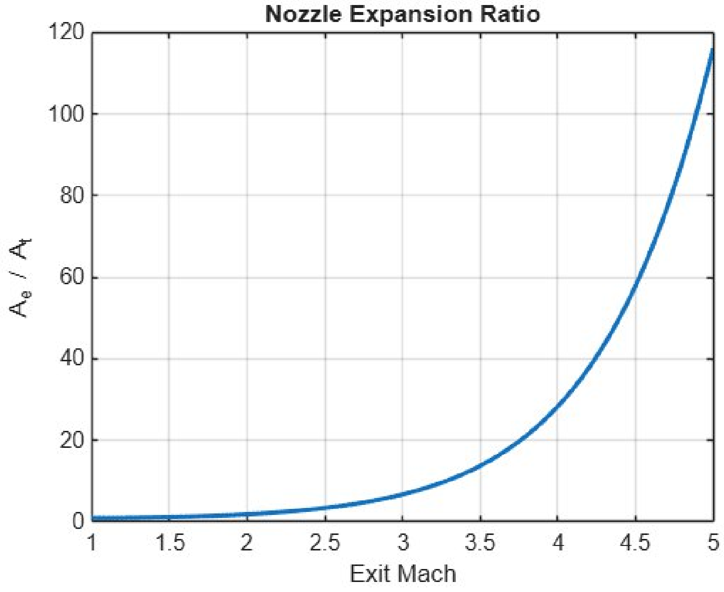
Mass flow rate : 0.4633 g/s

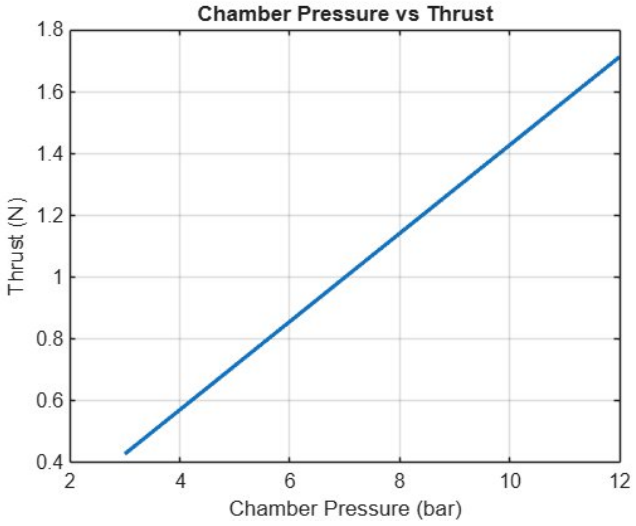
Throat diameter : 1.09 mm

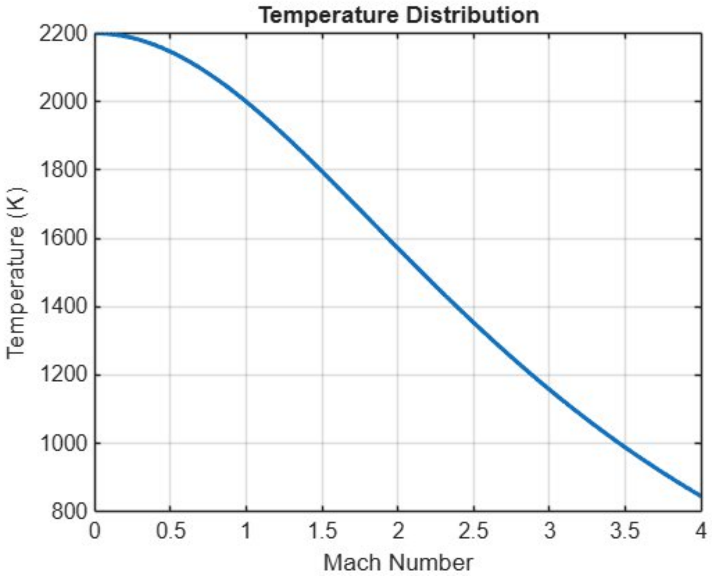
Chamber volume : 0.649 cc











Detumbling model

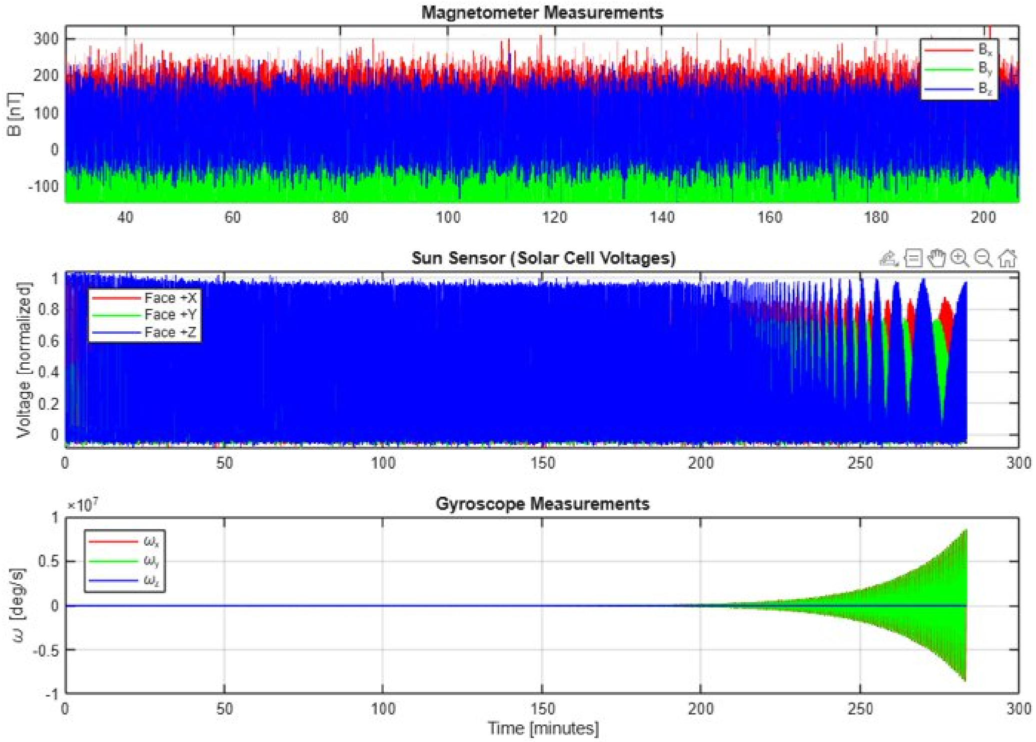
Actuators:
•2x Rod magnetorquers (± 0.24 Am²)
•1x Air core magnetorquer (± 0.13 Am²)

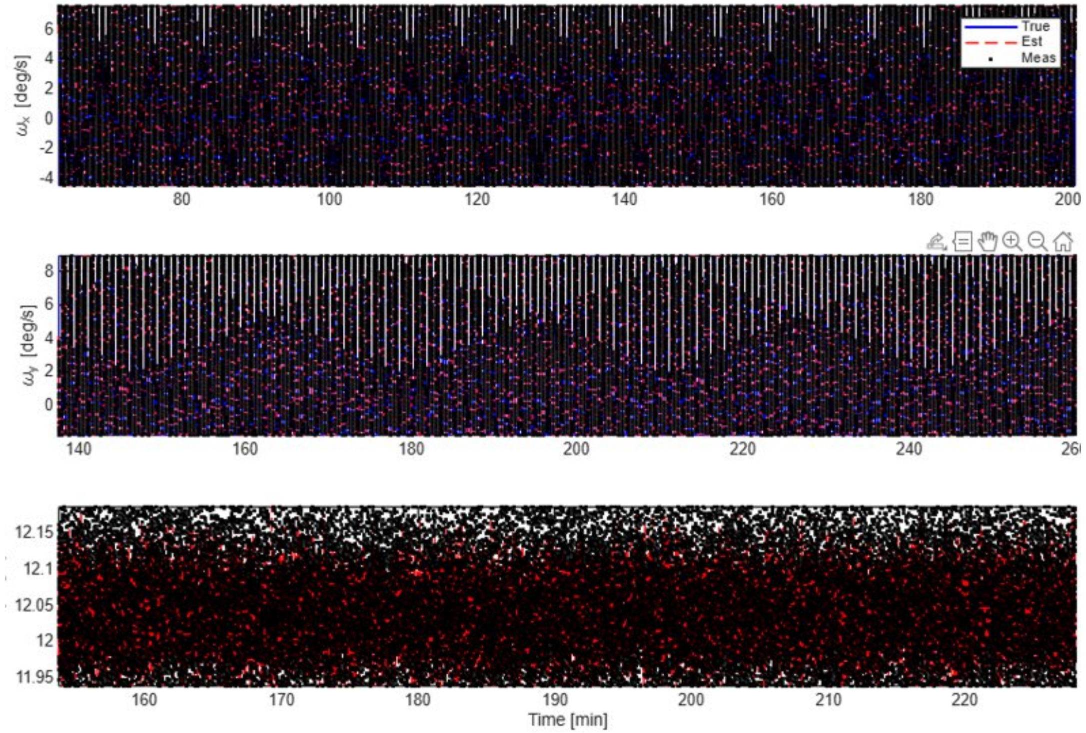
Control Modes:
•Detumbling
•Y-Thomson
•Nadir Pointing

Pointing Accuracy (Nadir Pointing Mode):
•<10° in eclipse
•<5° in sunlight

Sensors:
•Magnetometer, Gyroscope, accelerometer
•sun sensor using solar cell.

Estimation Modes:
•Kalman Filter
•B DOT algorithms
•Maximum power point tracking (MPPT).





Mechanical simulation and fabrication results

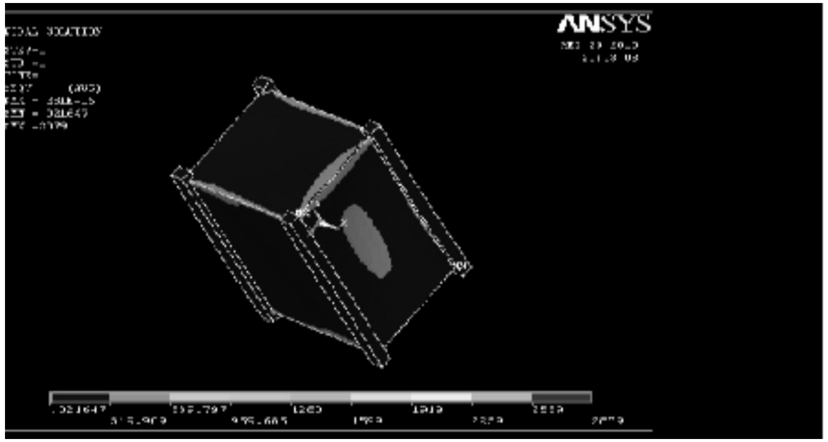
Mechanical Simulation Results:

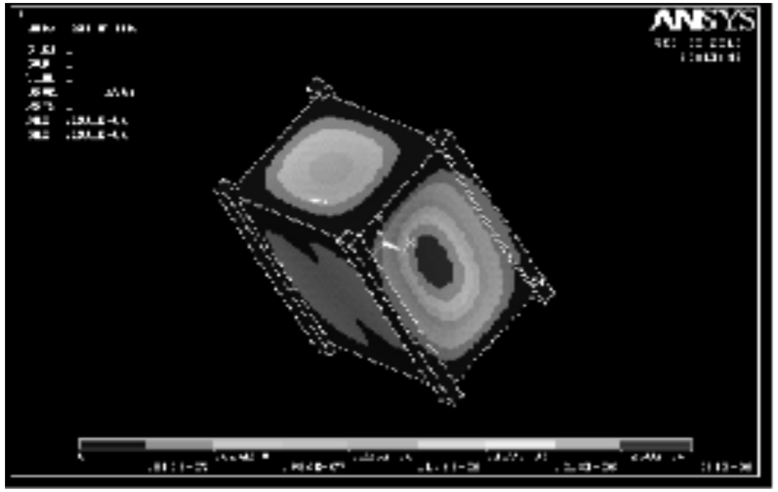
✓ The simulate results and the fabricate Structure are in good agreement.

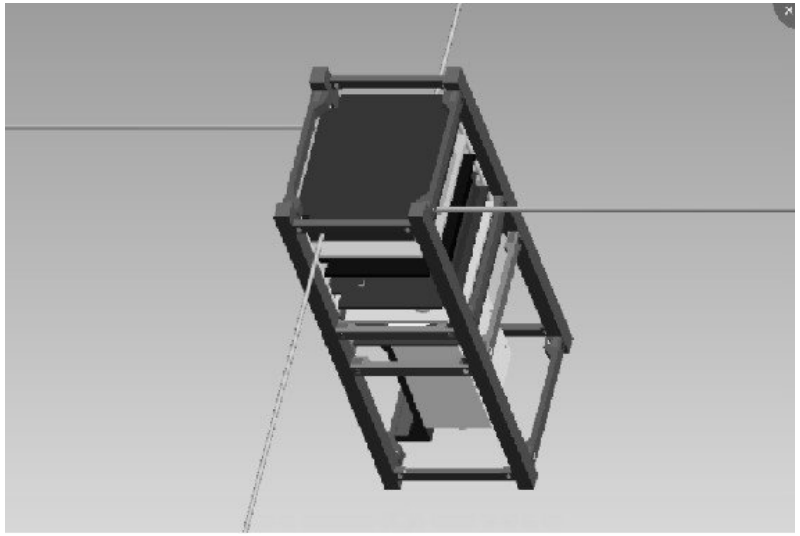
Software used: Ansys, MATLAB.

Material used: Aluminium 6050, carbon-carbon composites coated with silicon carbide and zirconium dioxide.

Displacement Minimum (cm)	Displacement Maximum (cm)	Stress Minimum (N/cm^2)	Stress Maximum (N/cm^2)	Tensile strength (N/cm^2)
0.312x10^-7	2.81x10^-7	0.021647	2879	34000



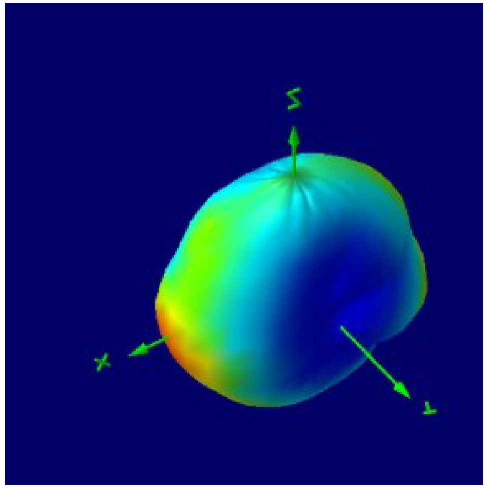


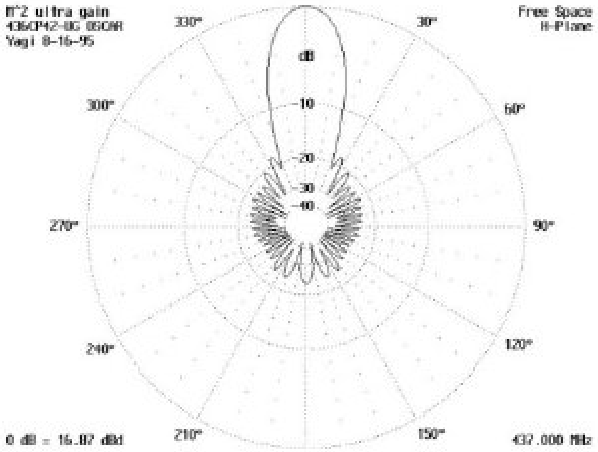


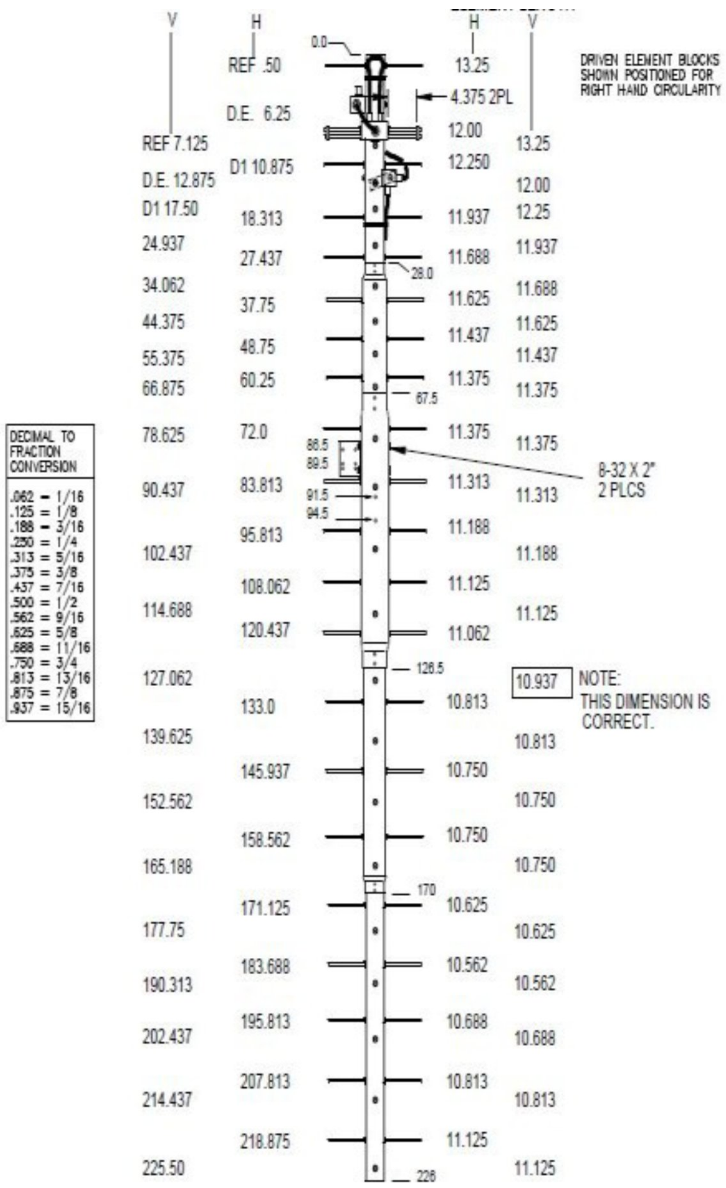
Mechanical simulation

Ground station overview

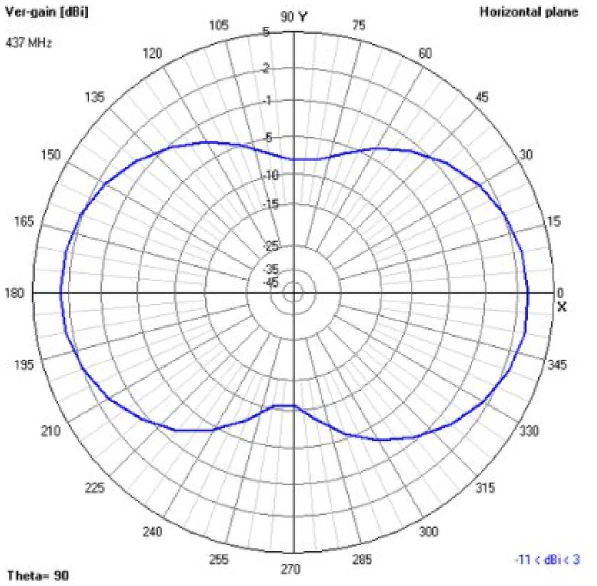
Antenna in CubeSat: deployable tape antenna.
Ground station antenna: Yagi antenna
Software used: CFT microwave studios

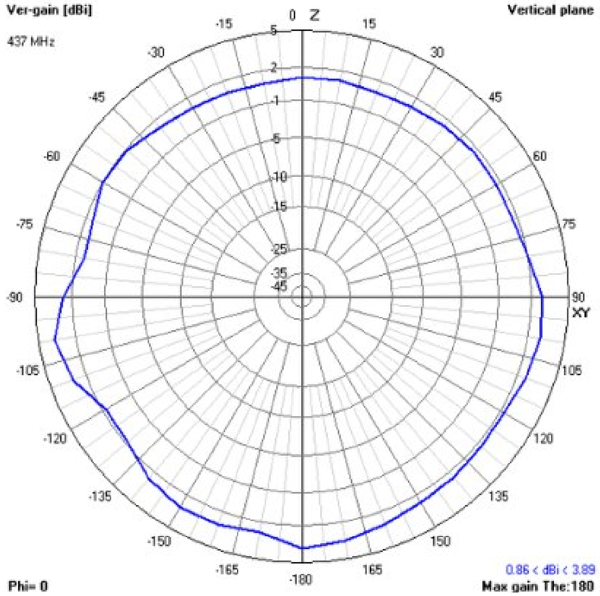






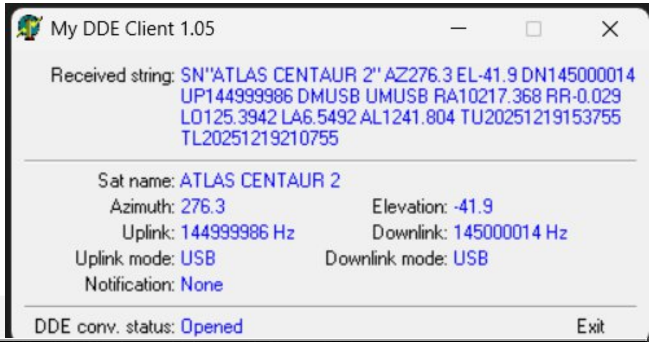
Designed antenna parameter

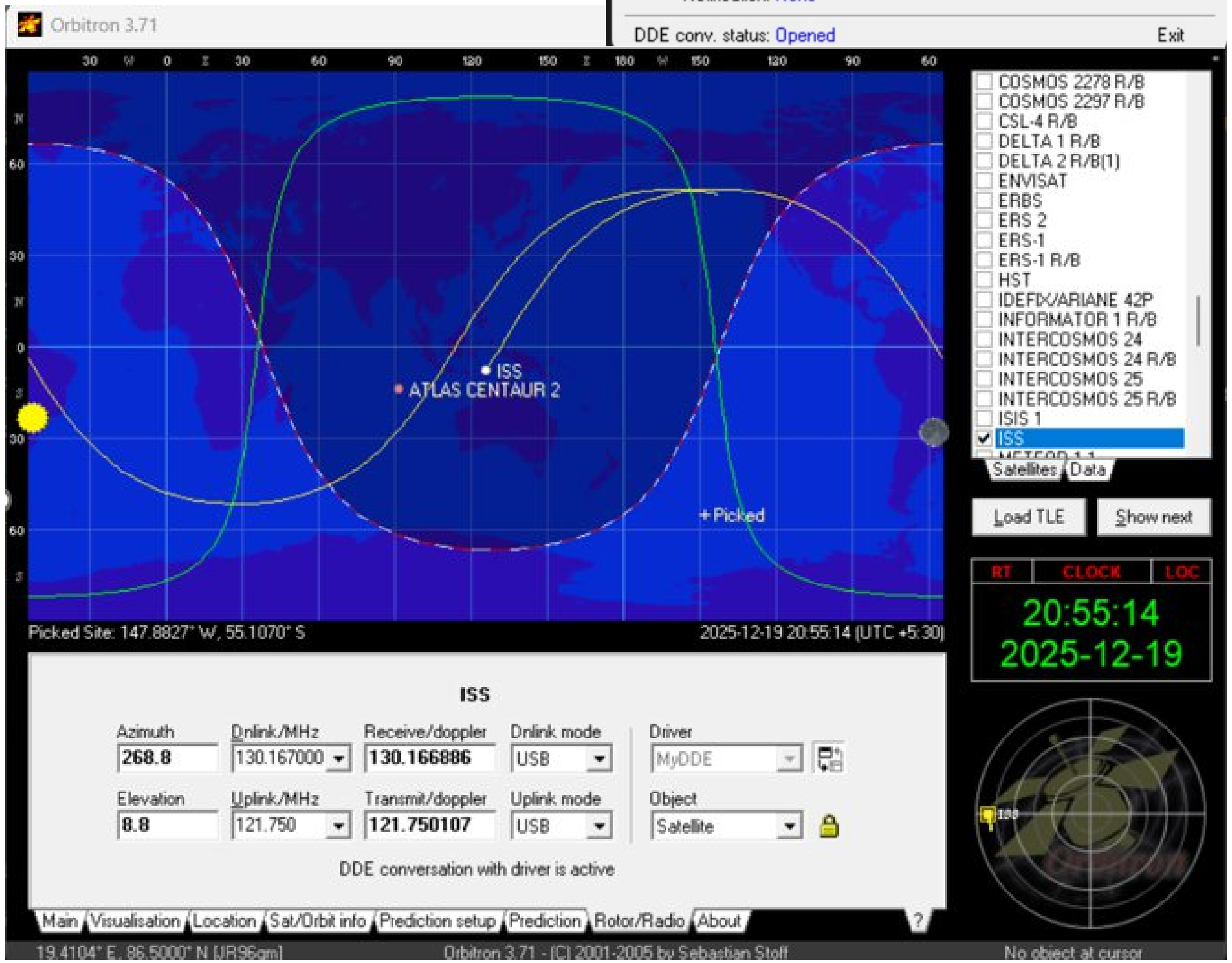




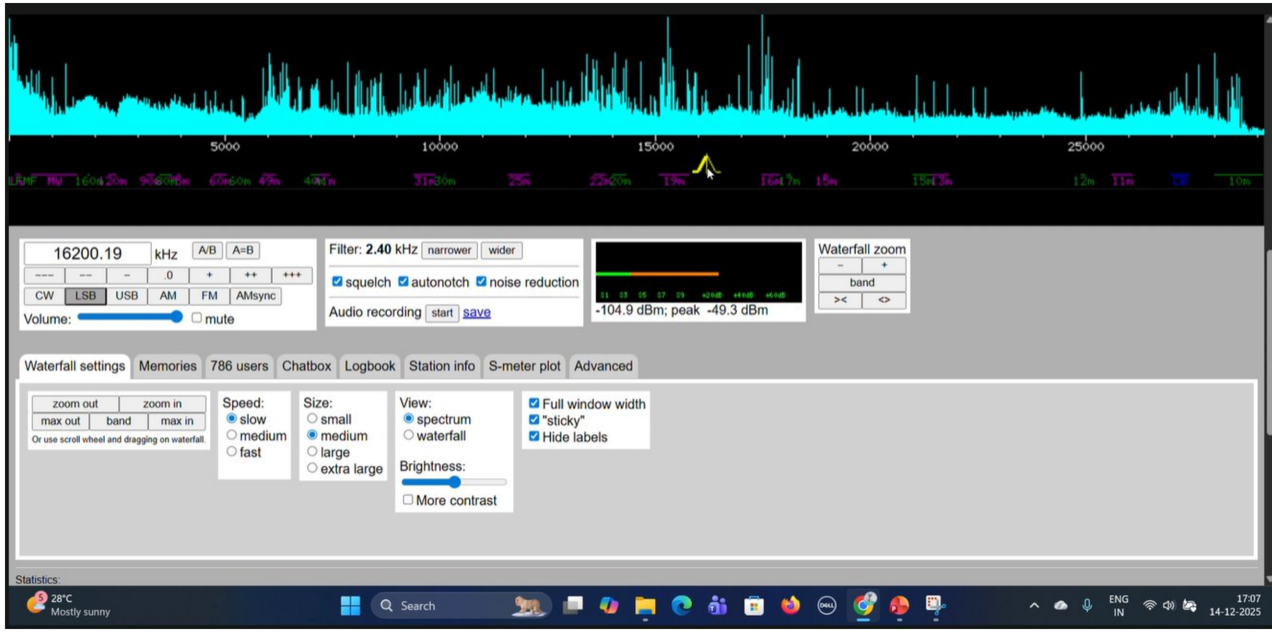
Ground station overview

Software used:
Orbitron, My DDE client, Web SDR





Parameters	Command	Telemetry	Beacon
Frequency	437.5MHz	437.8MHz	145.7MHz
Tx Power	20W	1W	50mW
Data Rate	1200bps	9600bps	12bps
Modulation	FSK	FSK	OOK
Satellite Antenna	monopole	monopole	monopole
Minimum Gain	-4dB	4dB	4dB
Antenna Gain (GS)	Crossed Yagi 14dBi	Crossed Yagi 14dBi	Crossed Yagi 12dBi



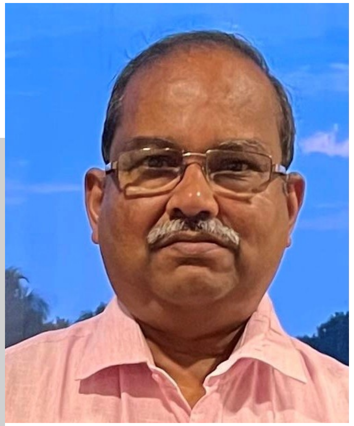
Mentors of Agneyam from ISRO (Inspace)

Laxmiprasad A S
Optoelectronics and Sensors, Design of Electro Optical systems, IR detector, Photon detector

Dilipkumar Patel
Thermovac systems, thermal cycling chambers, vibrator test facility

T Sundararajan
Structural dynamic analysis of Launch vehicle and Satellites including vibration Load Testing

V Masilamani
Actuation System, Control actuators of Launch Vehicle



Dr. Philip N K
Control and Operations, Spacecraft operations, Control system of Spacecraft

Ajay Kumar Lal
System reliability, QAQC, qualification of components, material, Payloads, systems, qualification of MMIC

Dr. Raj Kumar
Oceanography and Meteorology, Applications, Oceanography

Ravindran S
Mechanism - Deployment, Mechanism of Spacecraft Antenna- alignment

Roy M Cherian
Launch Vehicle Development

RESEARCH AND REFERENCES

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- https://ntrs.nasa.gov/api/citations/20050239004/downloads/20050239004.pdf
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- https://www.researchgate.net/publication/224218950_Attitude_determination_and_control_system_of_Sathyabamasat
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Market Research:

- https://www.grandviewresearch.com/industry-analysis/cubesat-market-report.

Innovation Validation:

- Validated by **Dr. T. Sasipraba, Director (Innovation)**, Sathyabama Institute of Science and Technology.
- Validated by **Dr. Sheela Rani, Director (Research)**, Sathyabama Institute of Science and Technology.