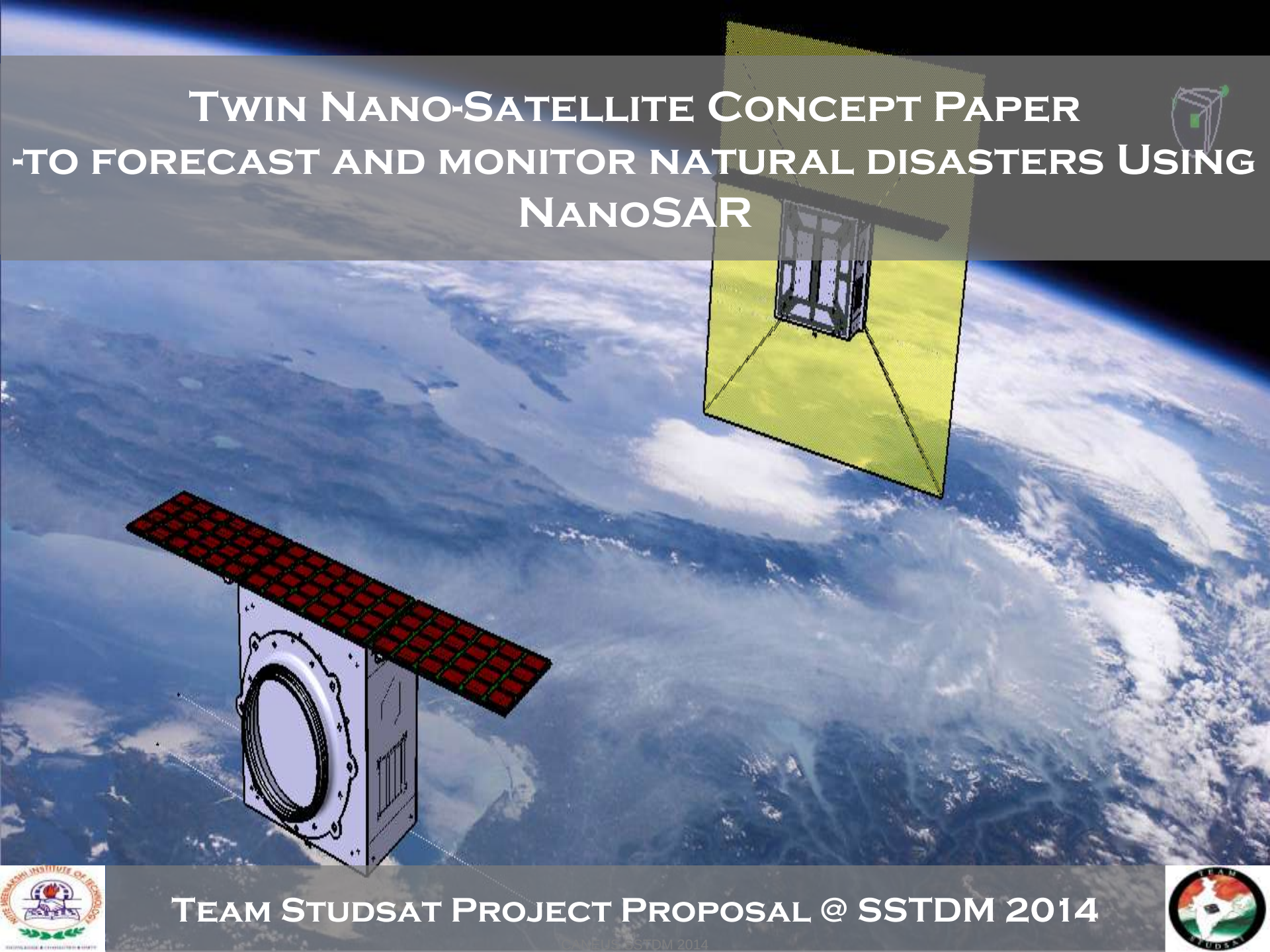
Twin Nano-Satellite Concept Paper -to forecast and monitor natural disasters Using NanoSAR



Team Studsat Project Proposal @ SSTDM 2014

Concept Overview

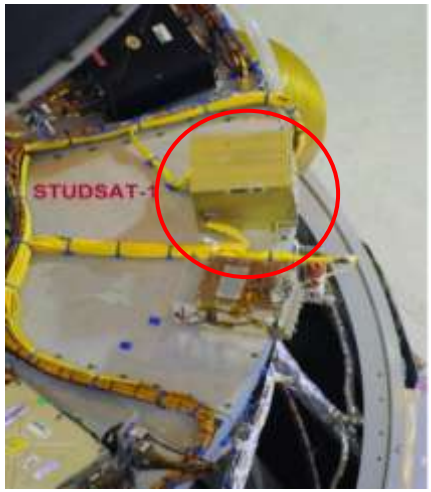
1. Twin Nano-Satellites with payload Nano Synthetic Aperture Radar (NanoSAR) for disaster management for :

- Earthquakes
- Floods
- Landslides

2. Continuous Open Source data sharing before and after disaster.
3. Interlinking Ground Station for data sharing
4. Design and development in collaboration with Nitte Meenakshi Institute of Technology (NMIT) and Universities from South Asian Association for Regional Cooperation (SAARC) member countries.

STUDSAT-1: India's First Pico Satellite

Handing over of STUDSAT – 1 to ISRO on 17th April 2010



STUDSAT in the Equipment bay of PSLV C 15

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First Beacon Received at NASTRAC on 12th July 2010

PSLV C 15 on Launch Pad

Current State-of-the-Art @ NMIT

Center for Small Satellite Research

(Recognized by ISRO for Small Satellite Development)

1. Clean Room Laboratory with ESD facility of class 10,000ppm
2. Software Development Laboratory

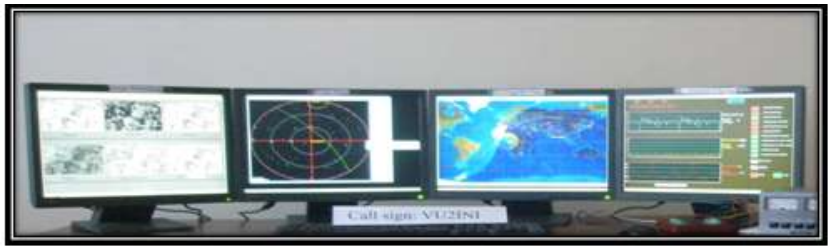
NMIT Clean Room

NMIT Software Development Laboratory

Current State-of-the-Art @ NMIT

1. Master Control Unit (MCU) with UHF and VHF Communication system
   - Ground Station- NASTRAC (Nitte Amateur Satellite Tracking Center)
   - HAM License obtained with Call Sign: VU2INI

VHF Antenna



NASTRAC Ground Station

UHF Antenna

Trends Impacting Improvement

1. **Nano-Satellite bus** can be implemented from current ongoing Project STUDSAT-2, being designed and developed at Centre for Small Satellite Research, Nitte Meenakshi Institute of Technology, Bangalore.
2. **Interlinking of Ground Stations** for continuous data sharing among the SAARC countries to forecast and monitor disasters.
3. **Open source web portal** to download satellite data, enabling fast response at district/ village level for disaster management.
4. Payload: **Nano Synthetic Aperture Radar** (NanoSAR), An all weather, Day and Night Sensing payload for Nano-Satellites which can operate in rain, snow, fog, dust, or Smoke.
5. **Separation system**: Twin Satellites to be separated in-orbit after the ejection from launch vehicle to provide same orbit path for both the satellites.
6. **STUDSAT-2 Drag Sail**: Implementation of Drag Sail to De-Orbit the satellites after mission life.
7. **In-house development of subsystems** to decrease project cost and to promote research and development in small satellites among Universities from SAARC Countries.

Leading Disaster Applications By NanoSAR

1. Earthquakes
2. Floods
3. Landslides
4. Dangerous Sea conditions

- **All Weather Imaging**: Due to cloud penetrating property of microwave, NanoSAR will be able to acquire ‘Cloud Free’ images in all weather. This is especially useful in Indian subcontinent regions which are frequently under cloud covers throughout the year. Being an active remote sensing device, its also capable of night time operation.
- Twin nano satellites with Inter-Satellite Link (ISL) along the path orbit can take images at different angles enabling the construction of a stereo imaging for the area.

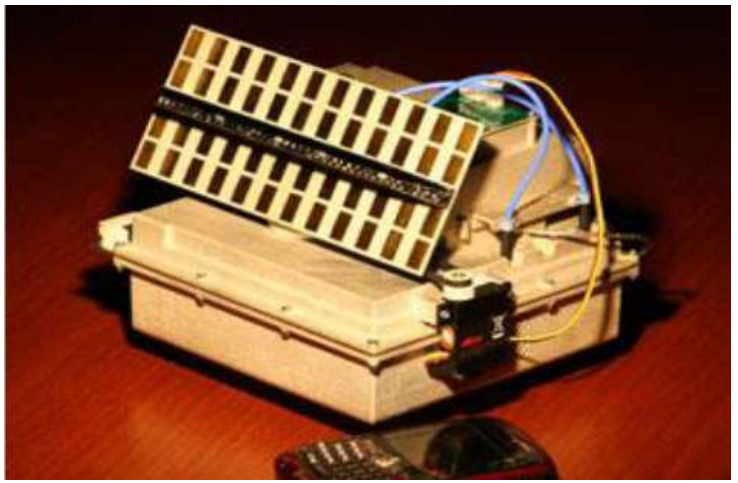
Drivers for Change

1. In-house development of Twin Nano-Satellites bus by Students to be achieved at low cost.
2. Development of low cost NanoSAR with specifications for Nano-Satellite standards.
3. In-Orbit Inter-Satellite Communication among twin satellites enables increased communication time with ground station for more data to be dumped from the satellites.
4. Twin Satellites increases the revisiting time of a particular area to monitor disasters such as propagation monitoring of floods.
5. Collaborative project among universities will help in decreasing the project cost and reducing the satellite development time.

Technical details- NanoSAR

Specifications:

1. Operating mode: Stripmap
2. Processing: Onboard, Real-Time
3. Communications: RS232, Serial TTL
4. Weight:0.9 kg
5. Size: 15x18x11 cms
6. Resolution: 1mtr
7. Supply Voltage: 12 V
8. Power: <15 watts
9. Frequency: X-Band
10. JPEG Compression
11. 32GB Solid State Drive



IMSAR's NanoSAR's B

Technical details- Twin Satellites

Project STUDSAT-2

India's First Twin Satellite Mission to Prove Inter-Satellite Communication

(Technology Demonstration Project)

A student satellite project being designed and developed in collaboration with seven engineering colleges from Karnataka.

Mission Objectives

Technical

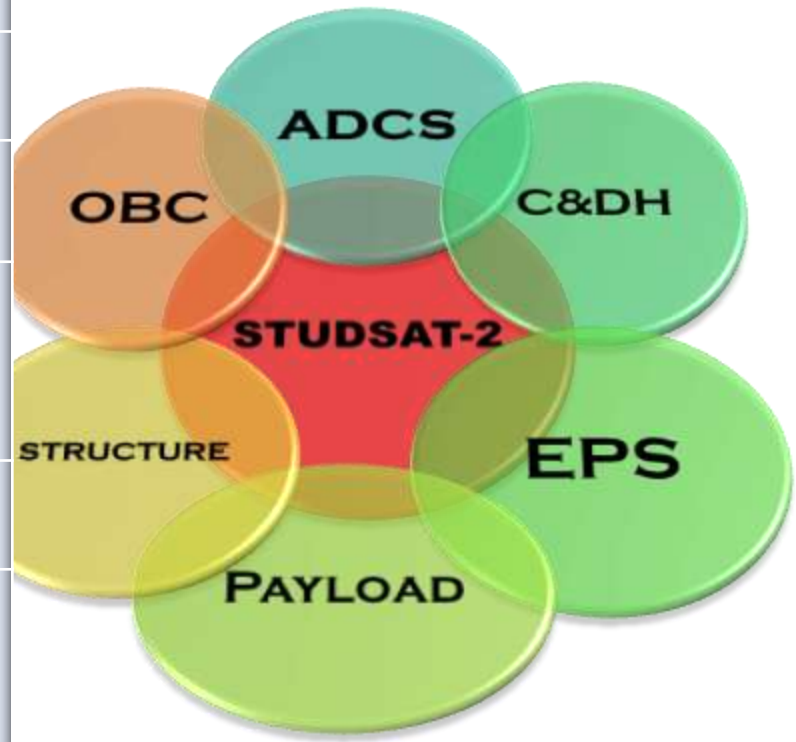
- To demonstrate the concept of Inter-Satellite Communication.
- To demonstrate an Inter-Satellite Separation Mechanism
- To demonstrate Solar panel and Antenna Deployment mechanism in a Nano satellite.

General

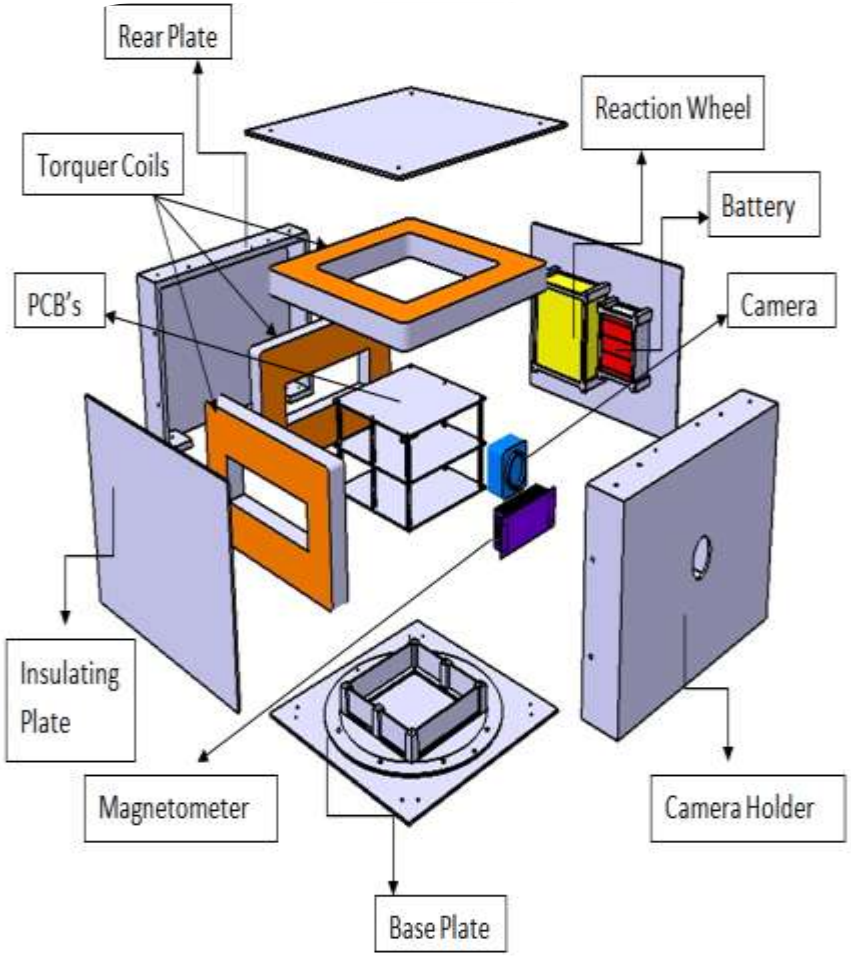
- To promote space technology in educational institutions and encourage research and development in miniaturized satellites.
- To create ecosystem between Research Organisations, academic institutes and Industries.

Studsat-2 Specifications

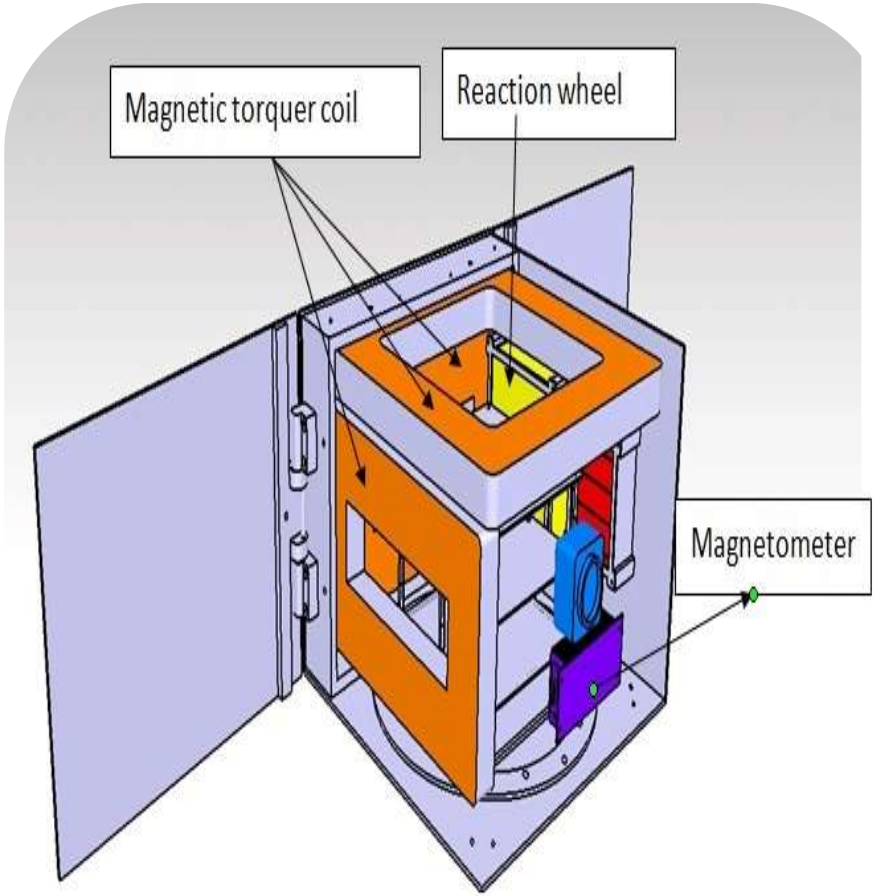
ORBIT	**Polar Sun-synchronous, at 98.3 deg inclination.**
MASS	**7kg (each)**
PHYSICAL DIMENSIONS	**30cm x 30cm x 15 cm (each)**
COMMUNICATION	**Downlink (UHF:433 MHz), Uplink (VHF:144 MHz)**
ON-BOARD CONTROLLER	**ARM Cortex M-4 (32 bit RISC ARM processor)**
ADCS	**3-axis stabilized, Orientation input from Magnetometer, Sun and Gyro sensor; reaction wheels and Magnetic torquers as actuators**
POINTING ACCURACY	**1 degree**
POWER	**Three solar panels (Two deployed, one body mounted) generating 23W of average power, Eight Li-ion batteries of 5.2 Ampere-Hour capacity (each).**
MISSION LIFE	**One year**



Studsat-2 Disassembled View



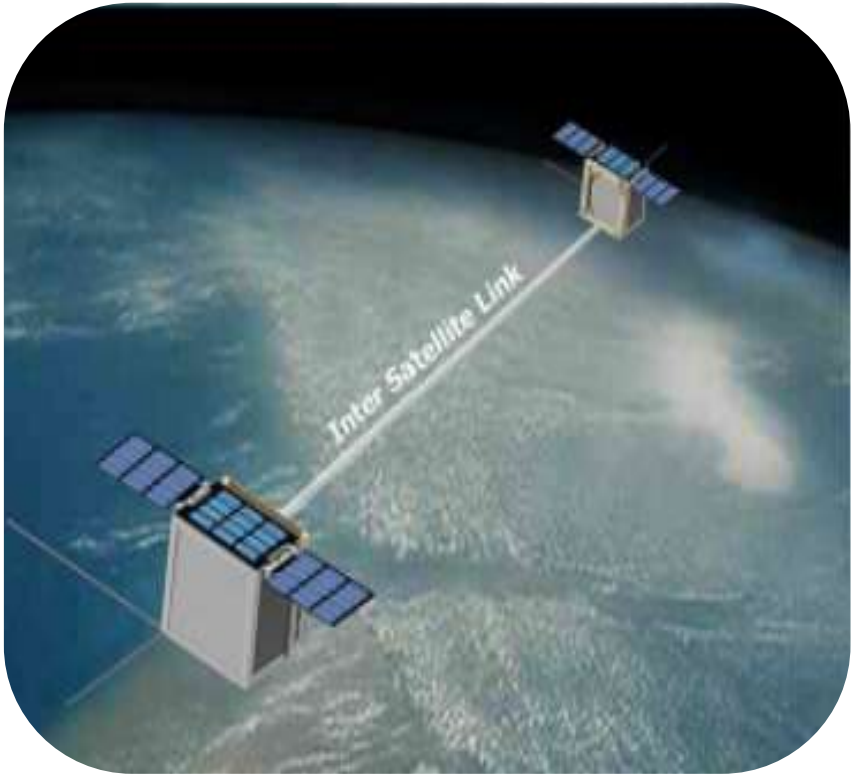
Exploded View



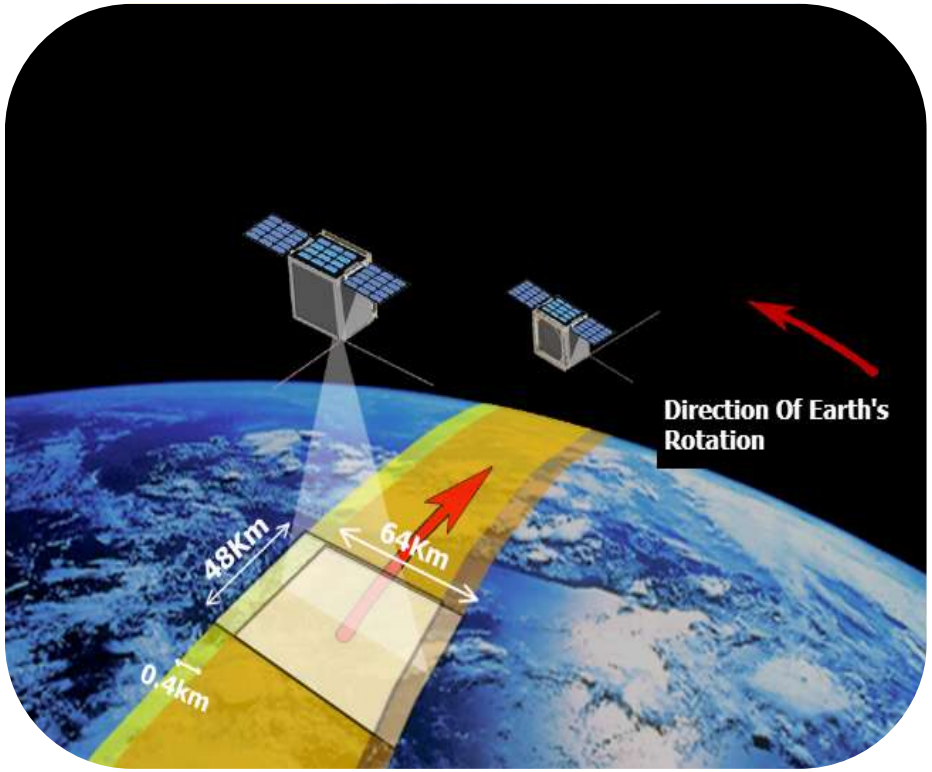
Deployed panels View

Payloads

STUDSAT-2A/2B carries three types of payloads - CMOS camera, Inter-Satellite Communication module to demonstrate Inter-Satellite Communication between two Satellites by transmitting telemetry and Image data from STUDSAT-2A to STUDSAT-2B and vice-versa and Drag Sail for technology demonstration to de-orbit satellite after the mission life.



Inter-Satellite link



Imaging

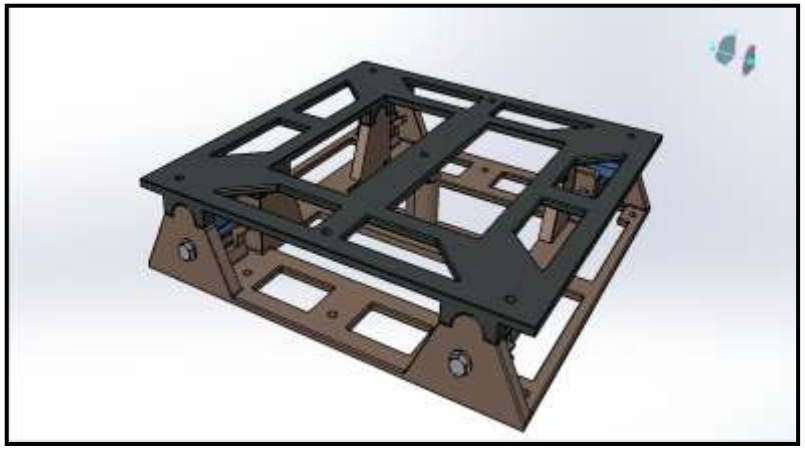
Separation Mechanism and Drag Sail

SAPARATION MECHANISM

• To demonstrate In-orbit Inter-Satellite separation mechanism.

•Mechanism separates the satellites after de-tumbling.

•Compression spring is used to achieve a separation of 100km in 100 days.



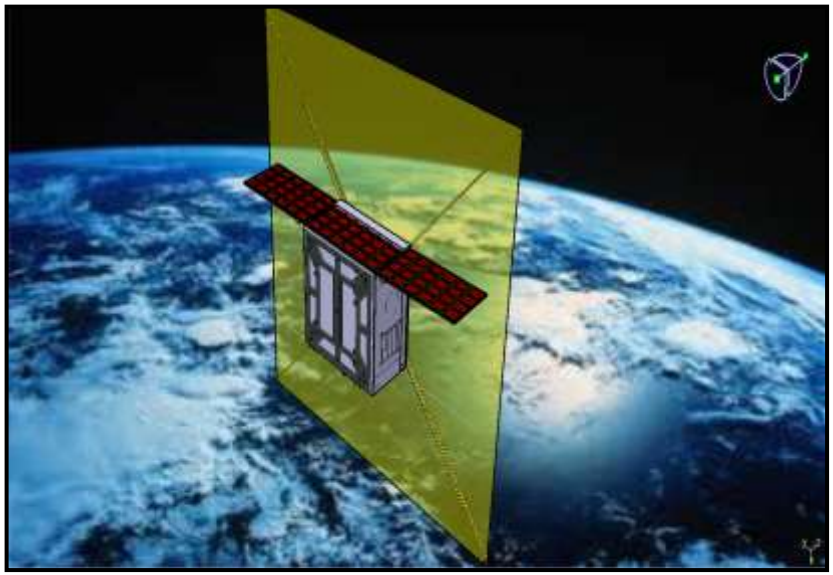
STUDSAT-2 SEPARATION MECHANISM

DRAG SAIL

•A concept to de-orbit the satellite after its operation has been proposed.

•The sail upon deployment increases the effective area for increasing the drag force experienced by the satellite.

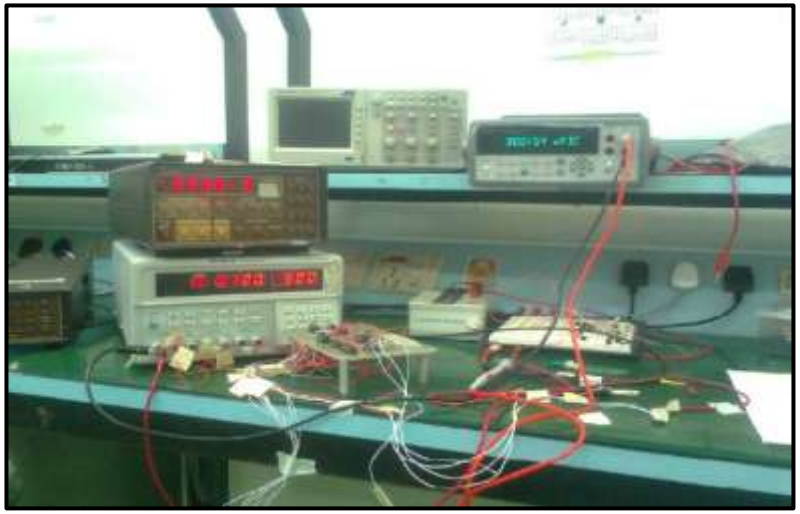
•This causes deceleration of the satellite and the centrifugal force of the satellite reduces and is pulled towards the Earth.



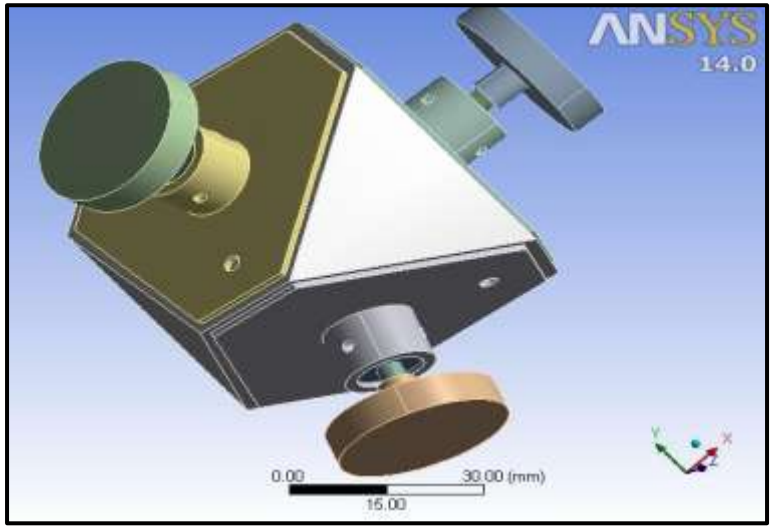
DRAG SAIL DEPLOYMENT ON STUDSAT-2B

Sensors and Actuators Testing

MAGNETOMETER TESTING AND CALIBRATION



DUAL AXIS MEMS SUN SENSOR TESTING



NANO REACTION WHEEL

GYRO SENSOR TESTING AND CALIBRATION

Project duration and Estimated Cost

1. Proposed Duration of the Research/project proposal: 36 months
2. Estimated Project Cost (In Rupees):

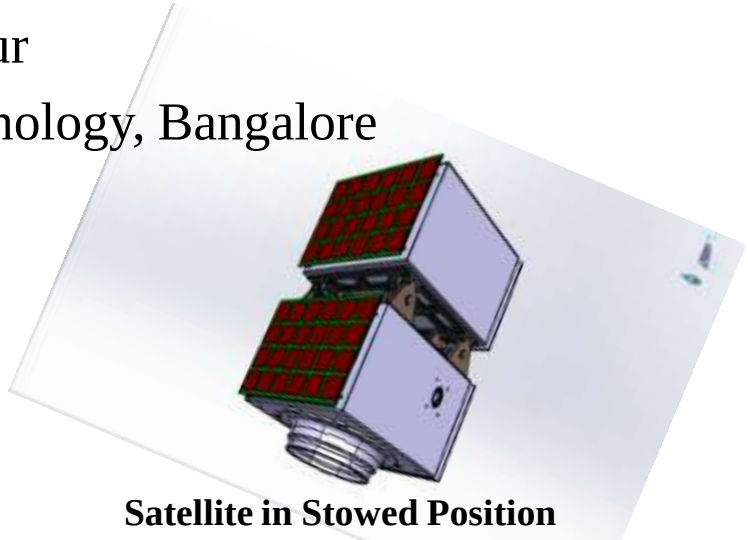
Sl. No.	Particular	Amount (In Rupees)
1.	In-house twin Satellite bus development	1.00 crore
2.	Payload development	1.00 crore
3.	Launch price*	1.24 crore
3.	Manpower	20.00 lakh
4.	Others	40.00 lakh
	Grand Total	**3.84 Crore (USD 639,936.72)**

* Launch cost is not charged by ISRO for nano satellites developed by Indian universities.

Organizational Details- Project STUDSAT-2

The consortium of Project STUDSAT-2 consists of following engineering institutions affiliated to Visveswaraya Technological University (VTU), Belgaum:

1. Nitte Meenakshi Institute of Technology (Lead College), Bangalore
2. M S Ramaiah Institute of Technology, Bangalore
3. R N S Institute of Technology, Bangalore
4. NMAM Institute of Technology, Nitte
5. Sri Sidhartha Institute of Technology, Tumkur
6. Nagarjuna College of Engineering and Technology, Bangalore
7. Siddaganga Institute of Technology, Tumkur



Satellite in Stowed Position

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2. A Cubesat Proposal for QB50 by The Space Laboratory of the Herzliya Science Center, Von Karman Institute for Fluid Dynamics (VKY), Belgium.
3. F-2 Nano-Satellite Proposal to QB50 Project, An example of Space Capacity Building Via International Collaboration.
4. QB50 Project in response toFP7 Space 2010 call “Facilitating access to space for small scale missions”. J. Muylaert, Von Karman Institute for Fluid Dynamics (VKY), Belgium, Sept,2011.
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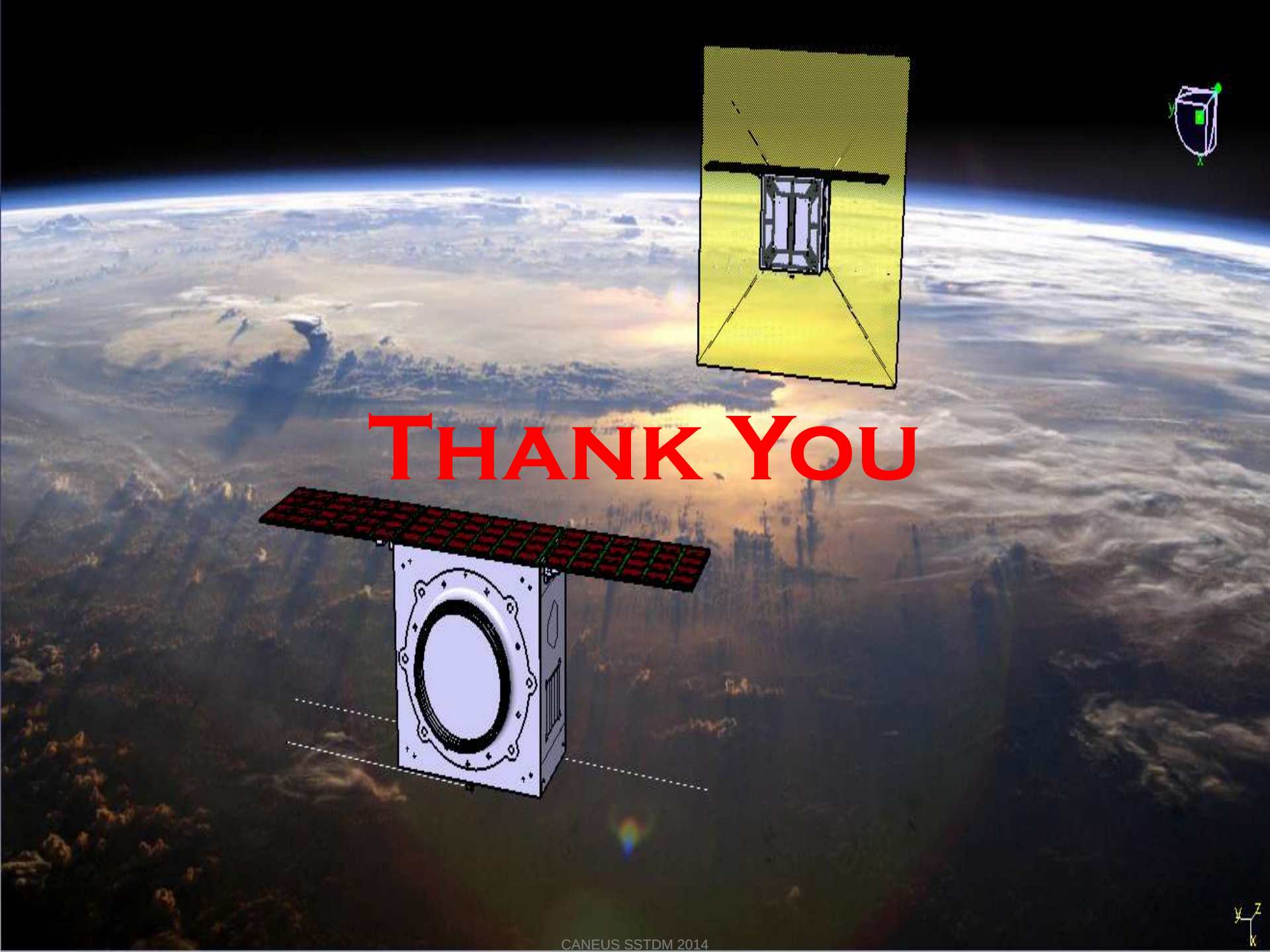
Thank You