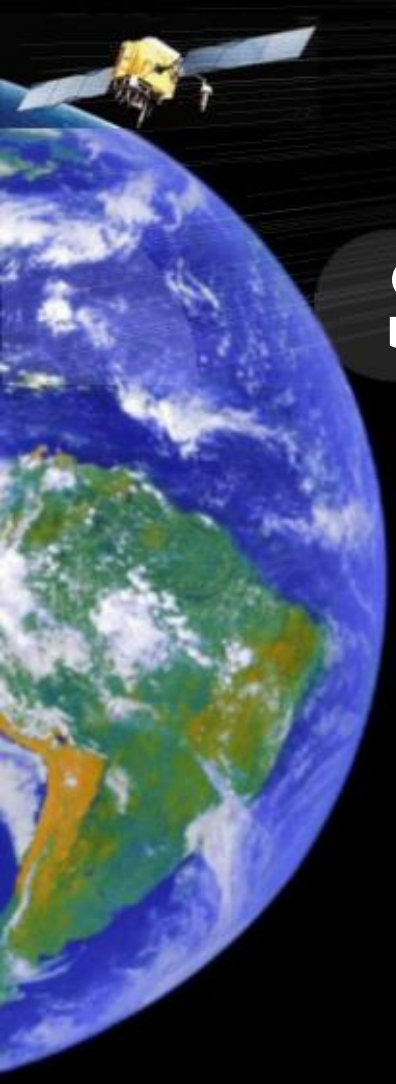


IITH
Student Satellite Project

Imaginations Beyond Boundaries

5th July, 2015

3rd UNISEC GLOBAL MEETING

Indian Institute of Technology Hyderabad

CONTENTS

OBJECTIVE

Vision

To achieve seamless communication across Indian subcontinent by a constellation of clusters of satellites flying in formation in Low Earth Orbits with each cluster containing 4-5 satellites which communicate with each other

SSP deliverables

- Flying a single cluster with 4 satellites (tentative) and a standalone satellite as a part of other cluster
- The payload of the satellites in cluster being communications and payload of standalone satellite being membrane optics
- The standalone satellite is for demonstrating the experimental membrane optics payload and for proving inter-cluster communication which is vital for realizing the vision

SPECIFICATIONS

Specification	Value (Conservative estimates)
Mass	22–24 Kg
Size	30 cm x 30 cm x 30 cm
Power	52–86 W
Altitude	600–800 km (tentative)
Type of Inter-Satellite Link	RF/Laser
Structural Material	Al 7075–T6/Al 6061–T6
Control Accuracy for ISL	1.2 mrad (if Laser)

SUBSYSTEMS

Attitude Determination and Control System (ADCS)

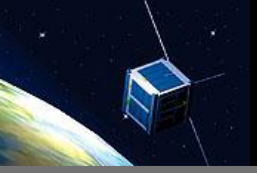
Payload(Membrane Optics)

Tracking, Telemetry and Command (TT&C)

On-Board Data Handling (OBDH)

Electrical Power Supply (EPS)

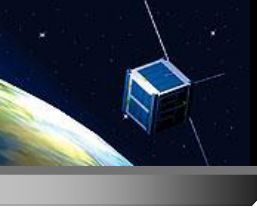
Structures, Thermal and Mechanisms (STM)



ADCS OBJECTIVES

The control system of each satellite has primarily three functions that it needs to perform

- It needs to maintain the absolute attitude of the satellite so that ground to satellite communication is possible via the antennas on board
- It needs to maintain the relative attitude of the satellites so that they maintain the desired formation and will be able to communicate with each other
- The relative position and distance between the satellites also needs to be maintained such that the combined footprint can span India without any uncovered regions and the satellites do not go out of each other's communicational range



FORMATION FLYING

- Pursuing Formation Flying architectures – Virtual structure and behavioural
- Maintain tight formation only while they are flying over India
- Virtual Structure Architecture – Formation is treated as single structure with rigid bodies embedded in it and the trajectory of the structure is used to generate the trajectories of the bodies
- Behavioural Architecture – Control of the satellites is guided by dictating behaviours like collision avoidance, formation maintenance

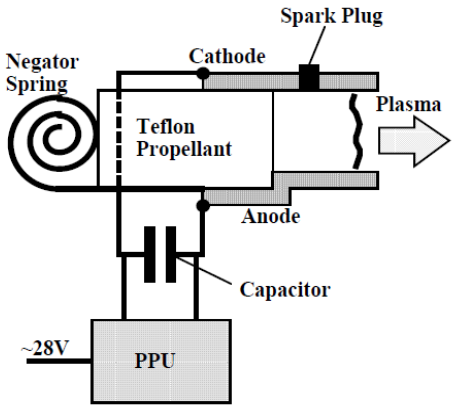
PROPULSION

Propulsion is needed for providing translational motion to the satellite which is needed for the formation maintenance

In view of the size and mass constraints of the satellite, a Micro Pulsed Plasma Thruster (μPPT) is found most suitable

From the literature, the parameters optimal for our constraints are

- 15mm separated, 75mm thick electrodes with area of 4cm^2
- Tungsten-Copper alloy for electrode material
- Nominal solid Teflon as propellant



MEMBRANE OPTICS

Objective

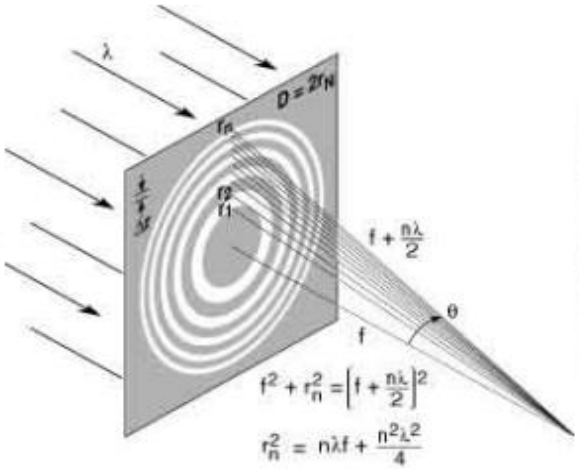
To demonstrate the utility of membrane optical systems in obtaining high resolution images of earth from space using nano-satellites

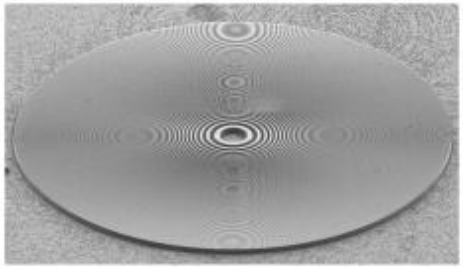
Motivation

- High resolution imagery using conventional optical systems (reflective/refractive) requires telescopes of very large apertures
- Such systems may not be suitable for nano-satellite imagery due to
  - Increase in the size and cost of the satellite.
  - Launch vehicle limits the mass of the optical system
- A novel image acquisition based on diffractive optics rather than conventional reflective/refractive optics

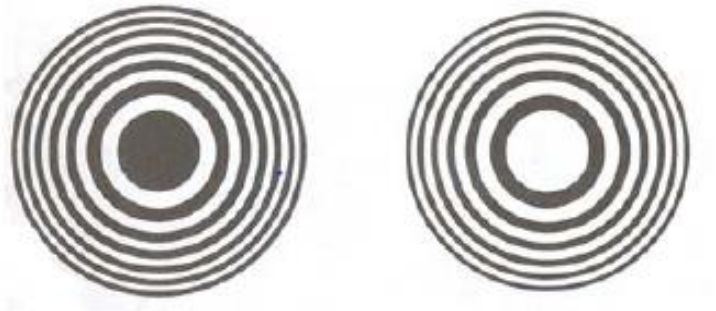
FRESNEL ZONE PLATE

- Fresnel Zone Plate is composed of a transparent substrate consist of an alternating transparent and opaque concentric circular rings.
- Light diffracts around the precisely spaced opaque zones, to interfere at the desired focus to create an image



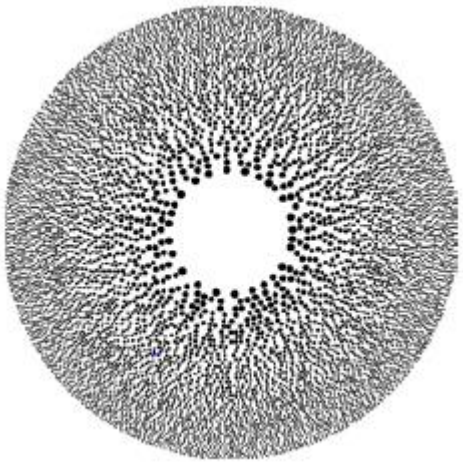


- Ring-shaped secondary maxima causes blurring of the images from the zone plates
- Resolution is controlled by the width of the outermost zone



Dark centre and bright centre Fresnel zone plates. The dark areas are opaque to the wavelength of the light

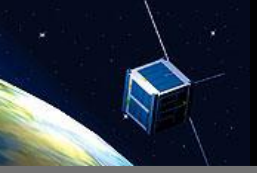
PHOTON SEIVE



- A photon-sieve is a modified FZP in which zones has been broken into isolated circular holes of comparable diameter
- Provides sharper focus than FZPs
- The major challenge in designing a photon sieve is to optimize the position and size of the holes

TTC OBJECTIVES

- Tracking, telemetry and command (TTC) or the communication subsystem is responsible for establishing a reliable and efficient communication link between the payload , base station and the satellites
- The TTC subsystem has primarily two functions that it needs to perform
  - It needs to maintain the communication link between the payload and satellite, base station and satellite and between the satellites
  - It needs to transfer the data regarding the position and health of each satellite to the base station and receive commands from the base station



Thank You

Questions and Suggestions ?