Technical Report of Laboratory Visit -M.Tech Students 2021-2023
Department of Applied Physics

Laboratory name: LEOS,ISRO, Bengaluru.

Date of Visit: 30/05/2022

Total number of students visited: 10
Specialization of M.Tech: LEOC,OCP, ST

Our journey started with Laboratory for Electro-Optics Systems (LEOS) which is situated at Peenya Industrial Estate, Bengaluru. LEOS, one of the vital units of ISRO, deals with the design, development, and production of Attitude Sensors for all LEO, GEO, and interplanetary mission. It develops and delivers Optical Systems for remote sensing meteorological payloads. It is equipped with world-class fabrication, testing, and coating facilities. Next-generation technologies such as 3-axis Fiber Optics Gyro, Optical Communication, MEMS, Nanotechnology, Detectors, and Development of Science Payloads for future space missions are also being pursued.

We observed how satellite optics are fabricated from raw material and their optical optimization in MTF labs. The weight of optics is reduced by etching out access material from giant CNC machines with ultrasonic milling tips. We saw the working and calibration of Sun, Earth and Star sensors which are crucial for a satellite. They have had experiments running for live testing of satellite equipment since the beginning of ISRO.

Lab facilities visited in LEOS

1. **Sun sensor lab** – Here, they characterize the sensors that can identify the sun and orient the solar panels of the satellite towards the sun for energy harvesting. Every sensor that was designed must be characterized here before it goes to the satellite.

There are various types of sun sensors, which differ in their technology and performance characteristics. Sun presence sensors provide a binary output, indicating when the sun is within the sensor's field of view. Analog and digital sun sensors, in contrast, indicate the angle of the sun by continuous and discrete signal outputs, respectively. LEOS develops all kinds of sensors with auxiliary sensors.

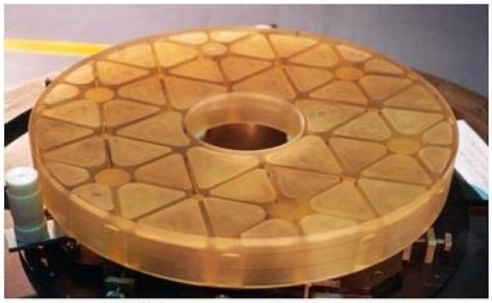
2. **Earth sensor lab:** Here, they characterize the sensors that can identify the earth and orient the transponder of the satellite towards the direction of the earth. The look for heat signatures at wavelengths 14-16 um. Considering earth as black body.

3. **Star Sensor Lab:** A star-sensor is an optical device that measures the positions of stars using photocells or a camera. As the positions of many stars have been measured by astronomers to a high degree of accuracy, a star tracker on a satellite or spacecraft may

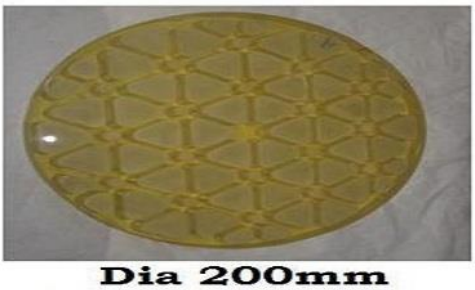
be used to determine the orientation (or attitude) of the spacecraft with respect to the stars. In this lab, they make such sensors by first emulating the space with stars on a 2D pixel array. They use LED screens starting with 480x460 pixel resolution to map out the stars on the XY plane. The size of the stars is mapped by brightness, and the number of pixels illuminated taking the light from stars is coming from infinity.

4. **<u>Light weighting of the optical Mirrors facilities:</u>** Light weighting of Optical Surfaces provides sufficient rigidity for ultra-high precision optical performance while reducing the weight of the mirror. The reduced weight, in turn, allows smaller, lighter support and control structures, reducing the overall cost and making room for other payloads on the satellite. The weight of optics is reduced by etching out material from giant CNC machines with ultrasonic milling tips.

Some of the light-weighted mirrors designed by LEOS look like this:



Dia 720mm Primary Mirror



Dia 200mm Secondary Mirror

5. **<u>Lens housing facility:</u>** Here mechanical testing and housing of the lenses are done at 0G i.e., zero-gravity conditions emulated by different stress mechanisms. They also have aspheric surface cutting machines.

6. **<u>Clean room for thin-film coating of air payload:</u>** Multi-spectral refractive optical systems with moderate and wide field-of-view lens assemblies such as Linear Imaging Self Scanning Sensor (LISS-III), LISS-IV, Advanced Wide Field Sensor (AWiFS), Hyper Spectral Imager (HySi), Field Corrector Optics (FCO) and Terrain Mapping Camera (TMC) have been developed in-house and flown. Refractive optical elements for different versions of Star tracker, Navigation sensors and LEOS payloads have been designed and realized. Medium/High-resolution large-area light-weight telescope mirrors ranging from 200mm to 705mm have been successfully developed which has yielded sub-meter resolution Earth Observation pictures. All the coating is done in the state-of-the-art clean rooms, any optical component developed here never leaves the

clean room or environment till the satellite launch. The protective coatings on the optical components is peeled off just right before the satellite launch.

7. **Life Time performance measurement facility of the Sensors**: A 1:1 replica of every mechanical component/sensor of a new design put on a satellite is subjected to lifetime experiment testing in a closed environment to estimate and predict the failure that might occur in a satellite. LEOS has their actuators and motors running since 1984. They also have indigenously developed Silicon photo-detector, Micro Coarse Analogue Sun Sensor (μ-CASS), Immersed Bolometer for Earth sensor, MEMS Inclinometer and MEMS seismometer. These have been flown on LEOS sensors/payloads successfully. Terra Hertz bolometer, UV detector, RF switch, and microvalve are in advanced stages of development.