

## Integrated Instrumented CAL-VAL Facility

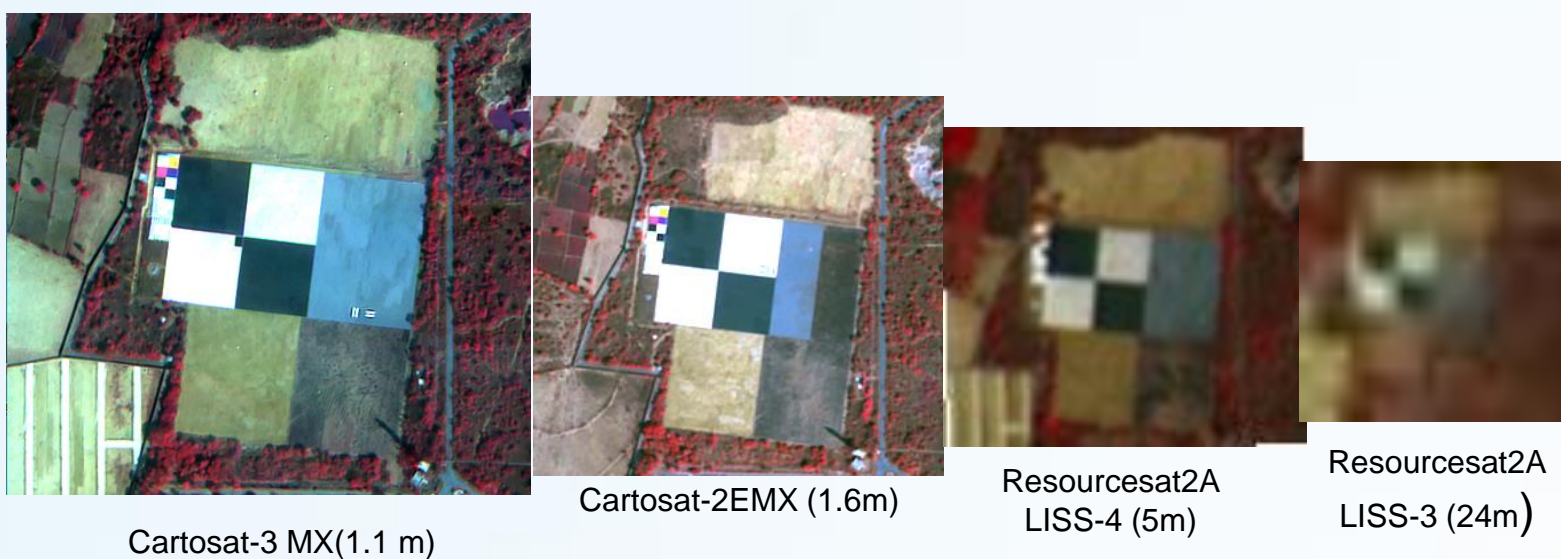
### Aerial view of optical targets



### Introduction

A state of art instrumented in-house CAL-VAL site which is an integrated facility for optical, thermal and microwave data calibration. It has been indigenously designed and developed in-house at ISRO's NRSC Shadnagar IMGEOs Campus. The five targets developed for optical sensor data calibration are natural stone and soil materials which are time invariant and cater the data calibration needs of upto 30m resolution. Currently, the facility caters absolute radiometric accuracy estimation for the mid dynamic range for 10m to 30m and full dynamic range for resolutions better than 10m. The facility is also envisaged for estimating the MTF upto 7m resolution data. Currently, Resourcesat-2, Resourcesat-2A, Cartosat-2S, Cartosat-3 on-orbit optical sensors are being monitored using this facility. The MTF target, Bar Target and Siemens targets which are paint targets, envisaged for spatial characterisation of high and very high resolution data. During the Cartosat-3 timeline, resolution based GCP has been developed and deployed to measure the finer geometric accuracy and resolvability. As part of this facility, for microwave data calibration customised CR's developed for 'X', 'C', 'S' and 'L' band data characterisation for the operational modes for all polarisations. This facility has been extensively used for RISAT-2B, RISAT-1 and RISAT-1A data characterisation. This facility has been also characterised for NOVASAR and ALOS data in view of readiness towards NISAR data calibration. This facility has been used for spaceborne and airborne SAR sensors. The facility has been augmented recently with ARC, testing phase is completed and entering into operational activities. By virtue of nature of optical targets, the same targets can be used for thermal data calibration with accurate ground measurements and good RT models. For high resolution thermal data customised gradients were simulated. In this decade, about 400 experiments were conducted for different spaceborne and airborne sensors. The computation methods and strategy for ground truth collection are pruned and achieved 99% efficiency and in good agreement with global standards.

### Site as viewed in different spatial resolutions

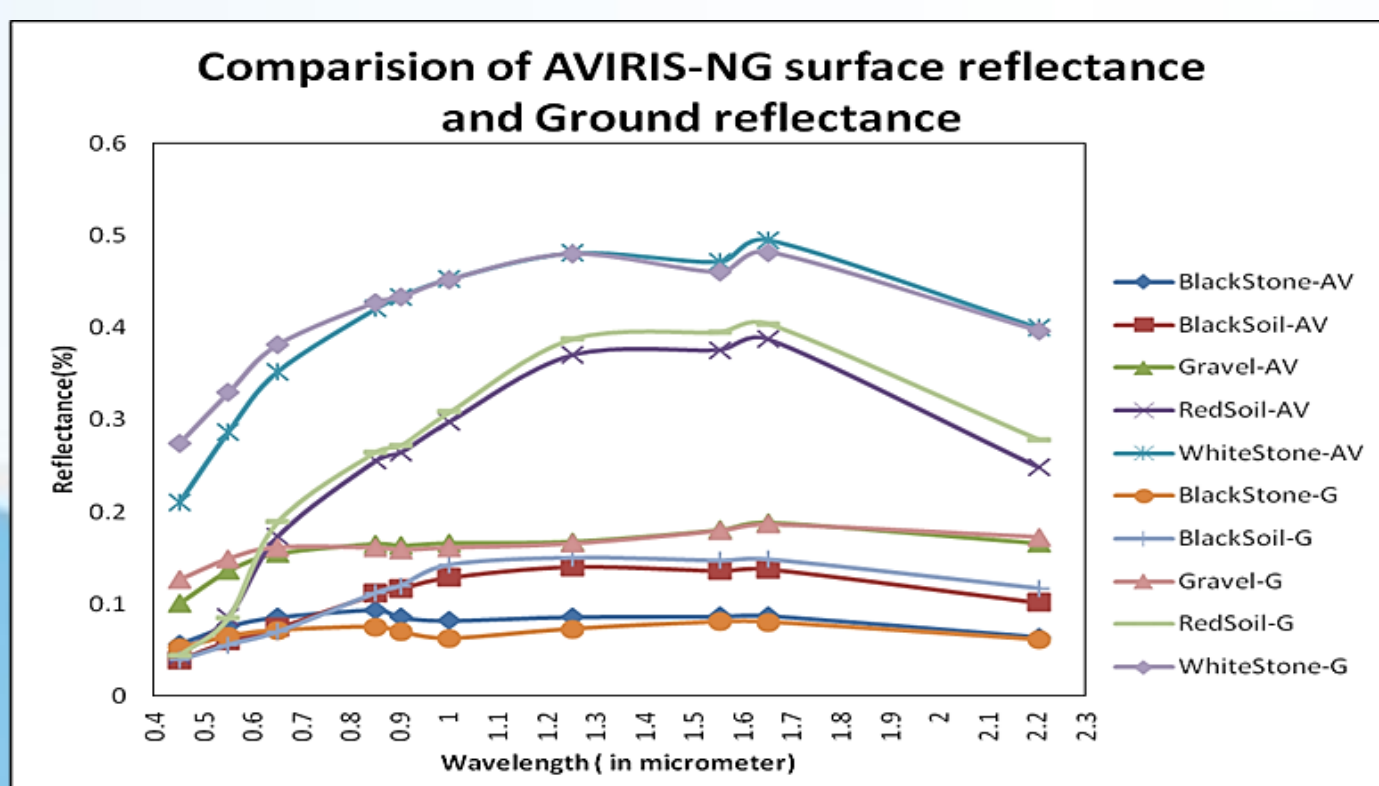


**This facility has been used extensively for ISRO's EO Optical and Microwave spaceborne sensors on-orbit response monitoring and calibration.**

**Apart from this primary objective, this facility also supports**

- **Testing of newly designed and developed Optical, Hyperspectral and Microwave sensors thru airborne/drone.**
- **High resolution targets supported LIDAR data characterisation.**
- **Opened for Academic and Industry partners thru IN-SPACE.**
- **Customised targets for Square wave response and MTF for optical and thermal spectral regions.**

### AVIRS-NG and ground spectroscopic measurements



The activities are extended to campaign mode sites over India to cater the needs of coarse resolution sensors. As a benchmarking exercise CEOS global sites are also monitored.

### Optical Targets





### Sun photometer

Sun photometer is a specialized narrow field of view optical instrument designed to measure solar irradiance in different narrow spectral bands.

**Wavelength of operation:** 340, 380, 440, 500, 675, 870, 1020 and 1640nm

**Make :** CIMEL, France

**Model:** CE-318N

**Outputs:** Aerosol Optical Depth (AOD), precipitable water vapour, Aerosol size and volume distributions, Scattering Albedo and phase function.



### Spectroradiometer

The SVC HR-1024i spectroradiometer is a field portable, easy to carry hyper spectral radiometer which measures the reflected radiance from terrestrial objects on the earth surface.

**Wavelength of operation:** 350-2500nm

**Make:** Spectra Vista Corporation, USA

**Model :** HR 1024i

**Outputs:** Hyper Spectral radiance and reflectance

**MICROTOPS Ozonometer / Sun photometer** is a 5-channel hand-held multi band radiometer to make quick and inexpensive measurements of the total ozone, direct solar irradiance, water vapour in the atmospheric column.

**Ozonometer:** 305nm, 312nm, 320nm, 936nm and 1020nm

**Sun photometer:** 500nm, 675nm, 870nm, 936nm and 1020nm

**Make:** Solar light, USA

**Model:** MicroTOPS 520 and 540

**Outputs:** Total columnar Ozone, water vapour, AOD @ 500, 675, 870 and 1020nm



### Thermometers

**Make :** Testo

**Model:** Data-logger 735 with three pt-100 probes (immersion, surface and air)

**Outputs:** Temperature in the range -50° to 300° C.



### Thermal Imager

This instrument is capable of imaging the objects emitting radiation in the long wave infrared region.

**Make :** Fluke (8-14 micrometer)

**Model:** Ti 3000

**Outputs:** Temperature in the range -20° to 650° C



### Goniometer

Goniometer is a mechanical structure to house spectroradiometer and measure the spectral reflectance of the target material in different zenith and azimuth angles.

**Make:** NRSC-ISRO

**Angle range:**

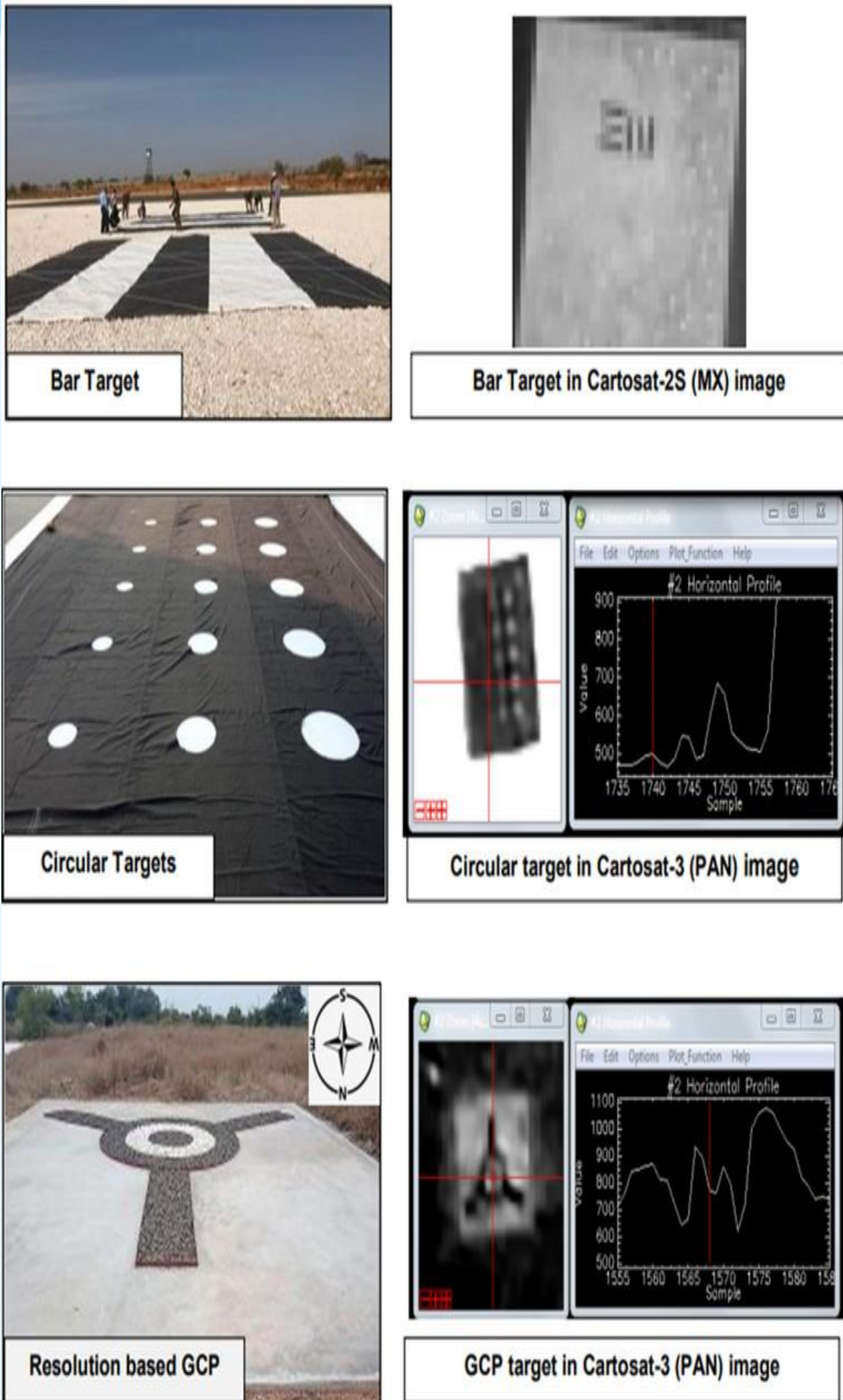
Zenith: ±60Deg and Azimuth: 360 Deg

**Outputs:** Study the Bidirectional properties of target materials

### Angle Measurement, Levelling, Location & North Finding



## High resolution customized optical data calibration targets



## Artificial targets

### Bar targets:

High contrast target to estimate the contrast ratio in the image. Dimensions: 1.6m width each , Length: 8m

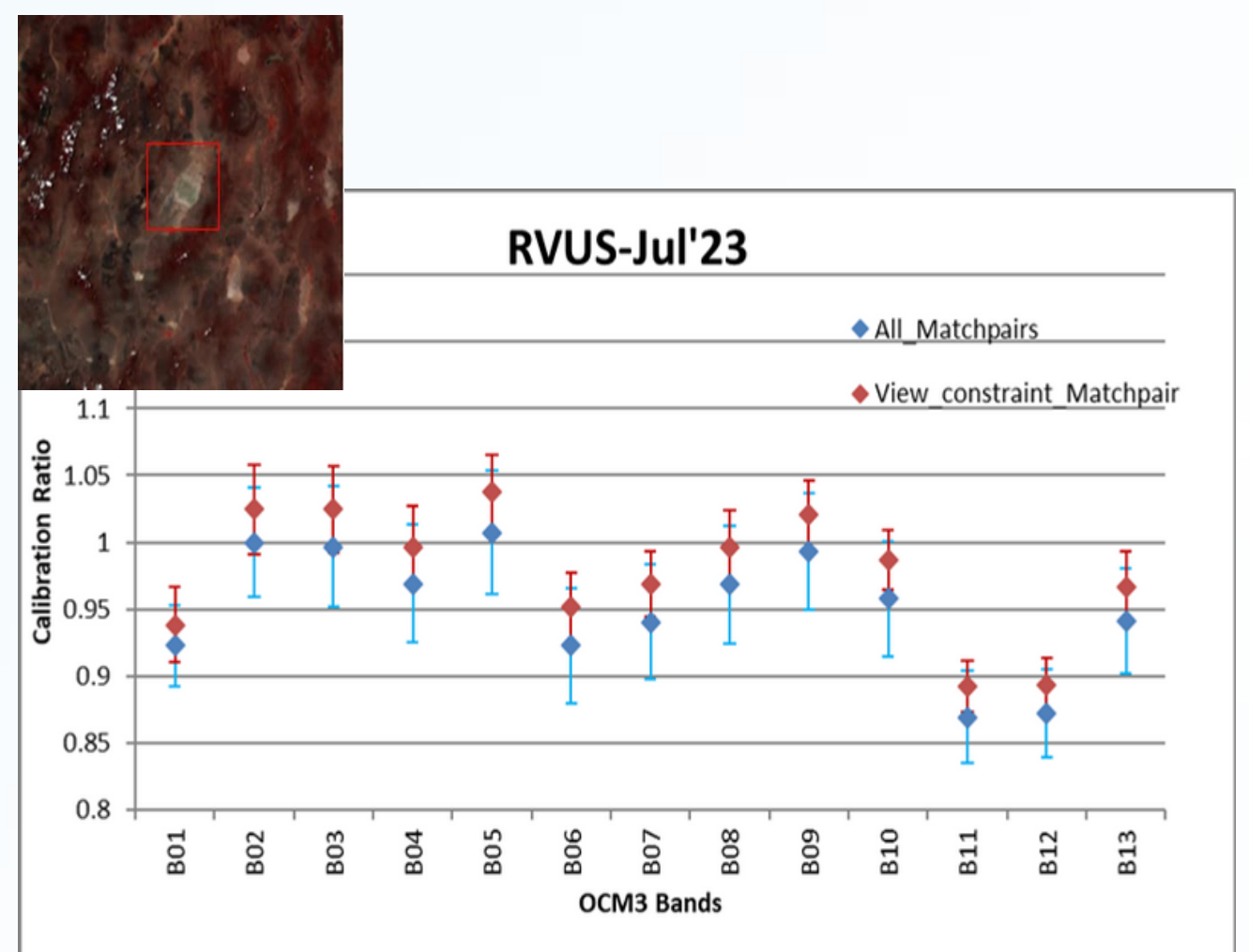
### Circular targets:

High contrast target to detect the smallest object in the image. Dimensions: 0.28m, 0.42m and 0.56m

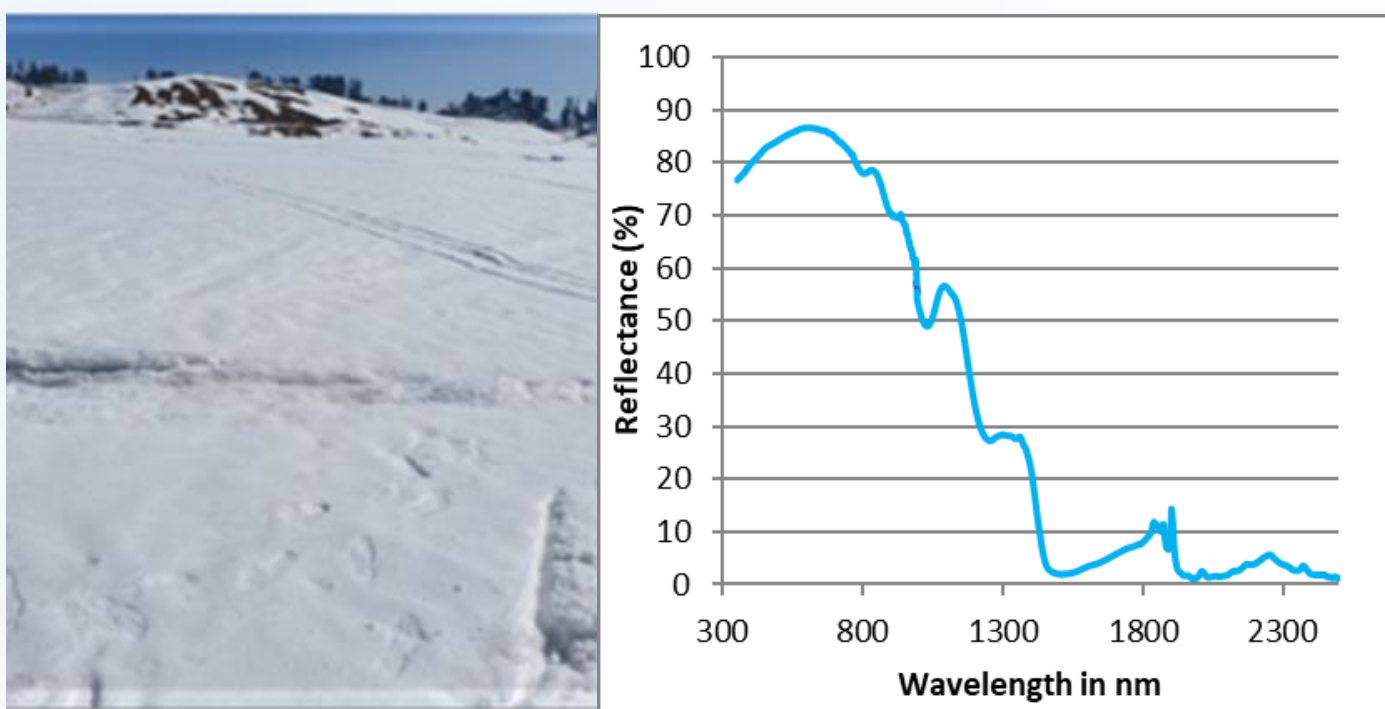
### GCP targets:

Resolution based high contrast target to navigate precisely and estimate the absolute geometric error.

## Absolute Calibration using RadCalNet

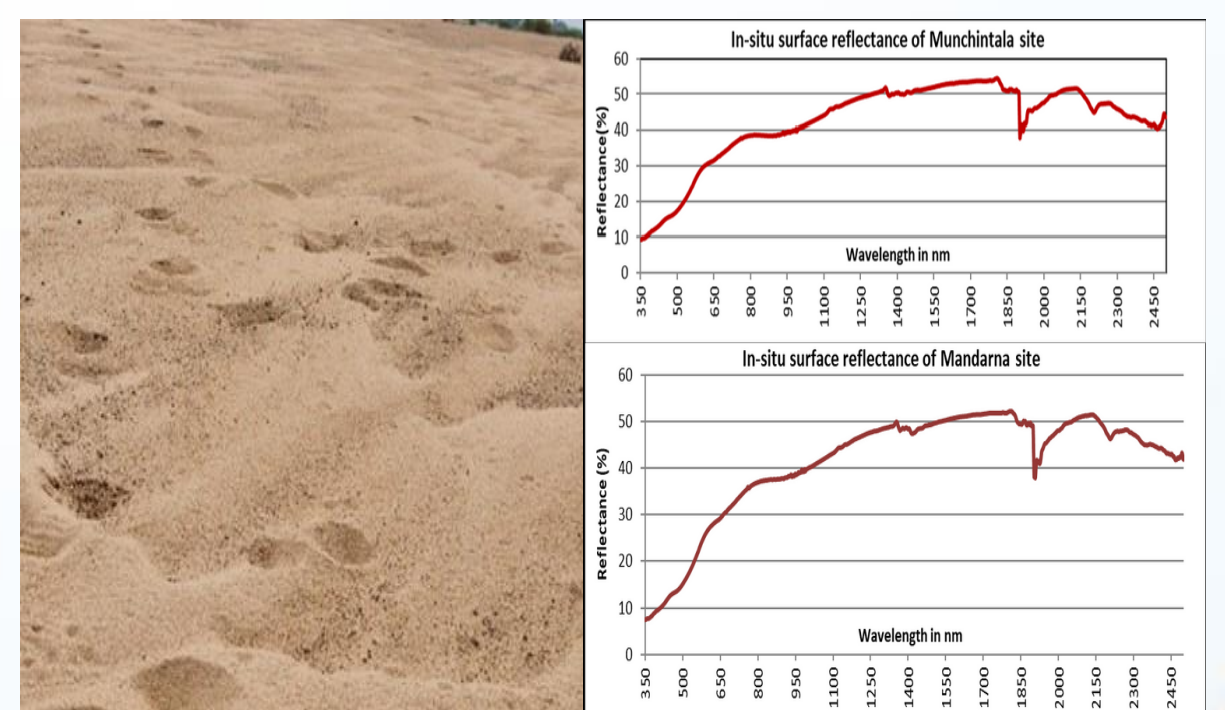


## High Reflectance (snow based) Optical Target



Gulmarg, Kashmir

## River Sand based sites for medium/coarse sensors



Munchintala & Mandarna

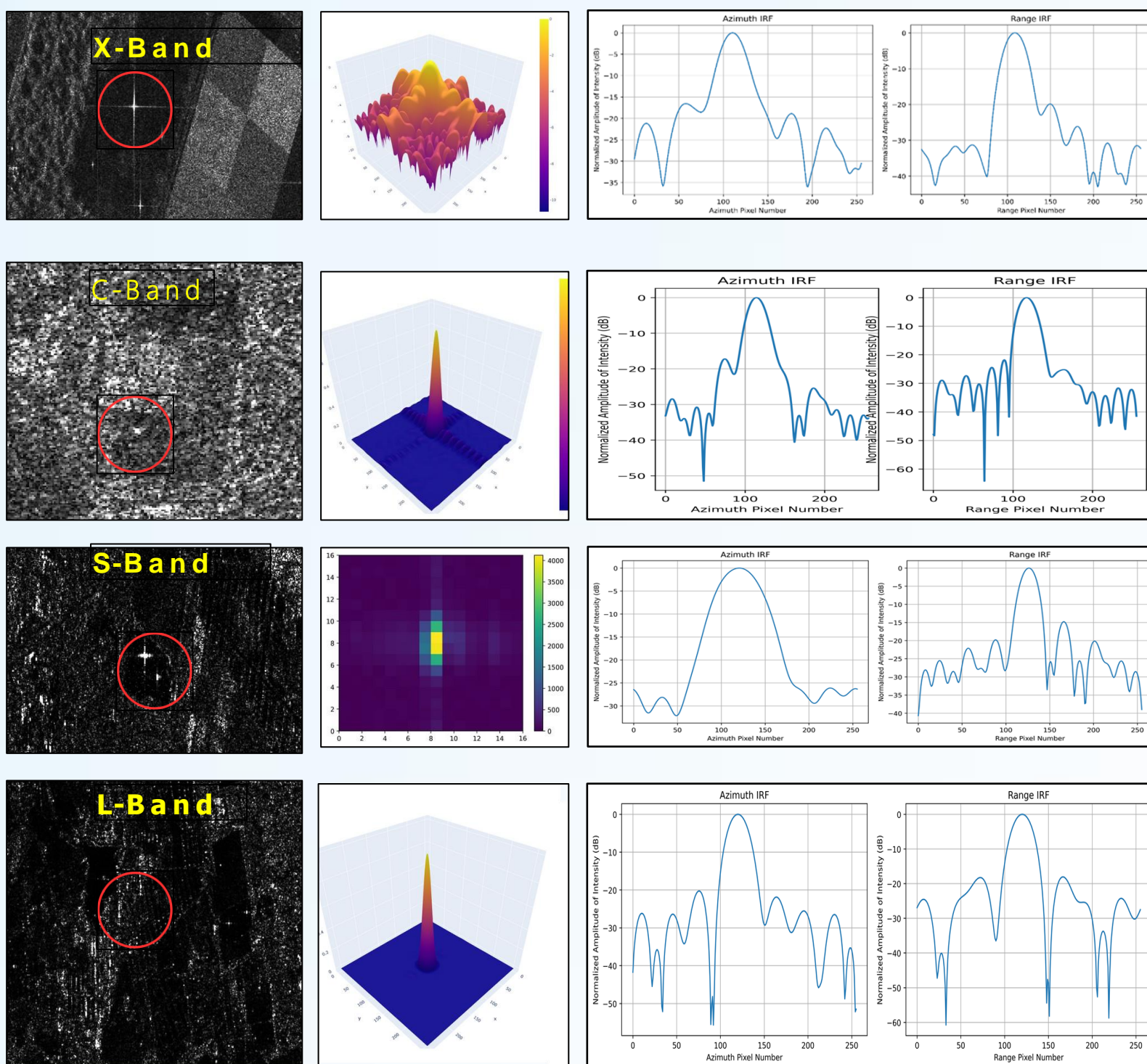
## 75cm Sq. Tri-CP Microwave data calibration facility



Size (cm)	Type	Qty
60	Dihedral	2
100	Dihedral	2
40	Trihedral	2
75	Trihedral	5
125	Trihedral	2

### Active Radar Calibrator (ARC)

ISRO's indigenously developed Multi-band Active Radar Calibrator (ARC) capable of performing radiometric, geometric and polarimetric calibration in single, dual, hybrid and full polarimetry (Co and Cross Polarization) for L, S, C and X band SAR missions.



**Multi-Mission Corner Reflector Orientation Tool** < AX-NRSCED

**MMCROT - SARDPD/MDPG/DPA**

For issues write to [samvram@nrsc.gov.in](mailto:samvram@nrsc.gov.in)

Satellite: EOS-4  
 Start Date: dd-mm-yyyy  
 Time of Day: 12:00  
 Latitude: 17.03509  
 Longitude: 78.18393  
 Height: 622

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**(a)** CR orientation angles for E04 (STRIP5878, FRS-1, FPFP) over SAC\_Ground Cal Site on 05-02-2023 at 12:48 (UTC), Azimuth: 77.24 deg Trihedral Elevation: 28.05 deg Dihedral Elevation: 18.55 deg From SARDPD/MDPG/DPA -NRSC

**(b)**

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EOS-4
1 51656U 22013A 23033.16877641 .00000399 00000-0 26464-4 0 9999
2 51656 97.5171 42.2899 0001579 86.5163 344.4075 15.12724848 53388
(1764634.10094969, 5601763.04633688, 2479248.28085756) m
Simulation Range : 2023-02-03 13:00:00 to 2023-02-03 14:00:00
The Time of Closest Ascent is
2023-02-03 13:10:34.588137
Azimuth : 259.43332098728354 ; Elevation : 56.20741275881772
Trihedral Elevation : 20.707412758817718 ; Dihedral Elevation : 11.207
Slant Range : 627.2791195155881 km
                    
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### Expertise gained over a decade

As the CAL-VAL activities operationally taken up in the NRSC Campus over a decade, the team could build expertise over a period on the required methods and targets for high and very high resolution optical data calibration targets using mirrors and cloth targets envisaged for Cartosat3 / Cartosat-2S. Extending to global scenario, the targets could also be used for Digital globe, AVIRIS-NG, PlanetScope, Pleiades, KompSat, TripleSat etc. To have a comparative observations for Resourcesat payload calibration requirements, Landsat8/Landsat 9- OLI and Sentinel are being monitored using the same targets. The team had a wide scope of handling, understanding the microwave data characterisation in the 'X', 'C', 'S' and 'L' band using CR's and also using ARC (Active Radar Calibrator) in the recent past. Based on the experimental satellite sensors and upcoming thermal sensors, team could also build and test high resolution thermal targets using the in-house facility. The in-house designed and developed Goniometer adds the strength to the facility for BRDF characterisation of the targets.

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