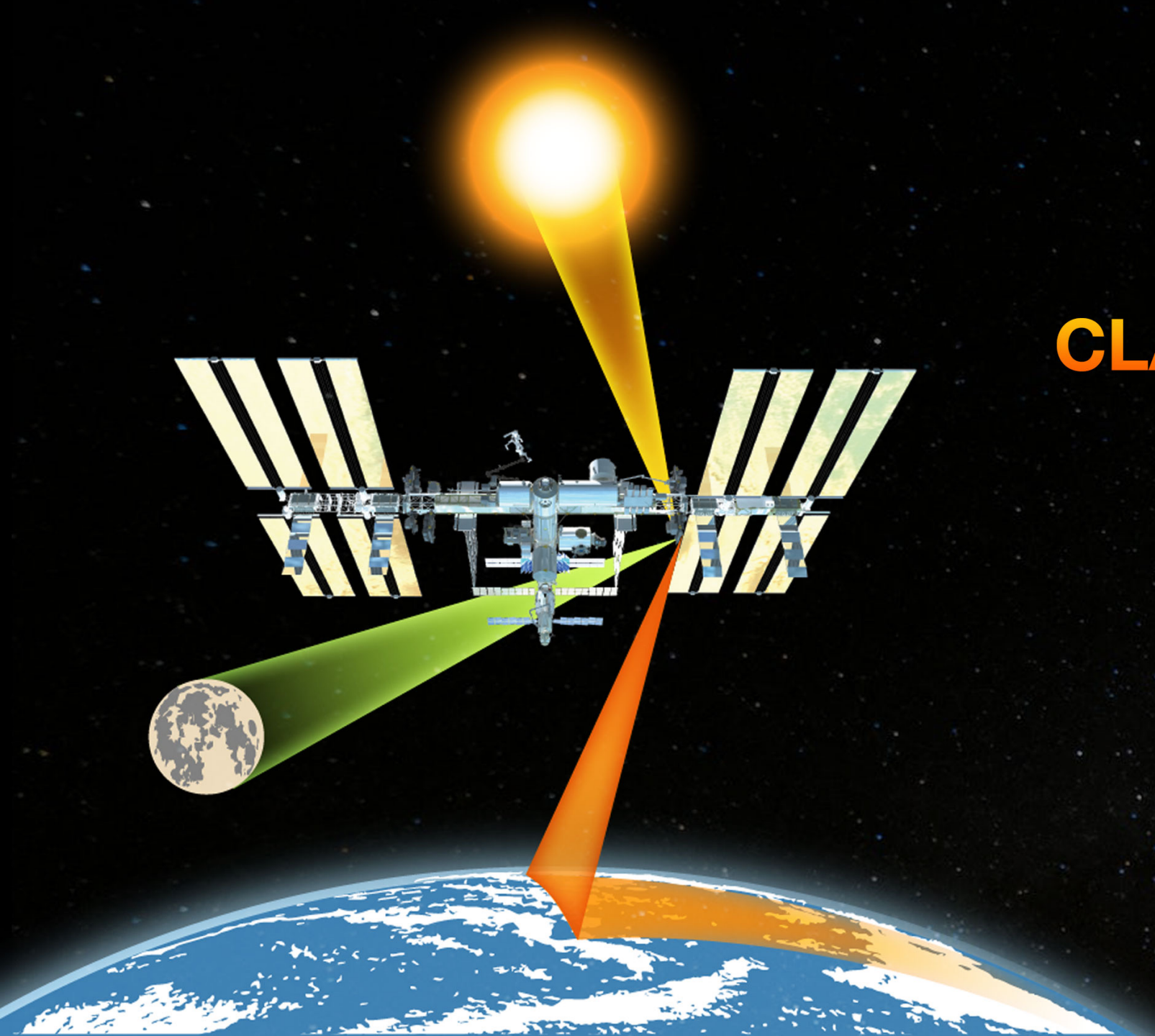
National Aeronautics and
Space Administration



CLARREO Pathfinder

Mission Update

Rajendra Bhatt
Yolanda Shea

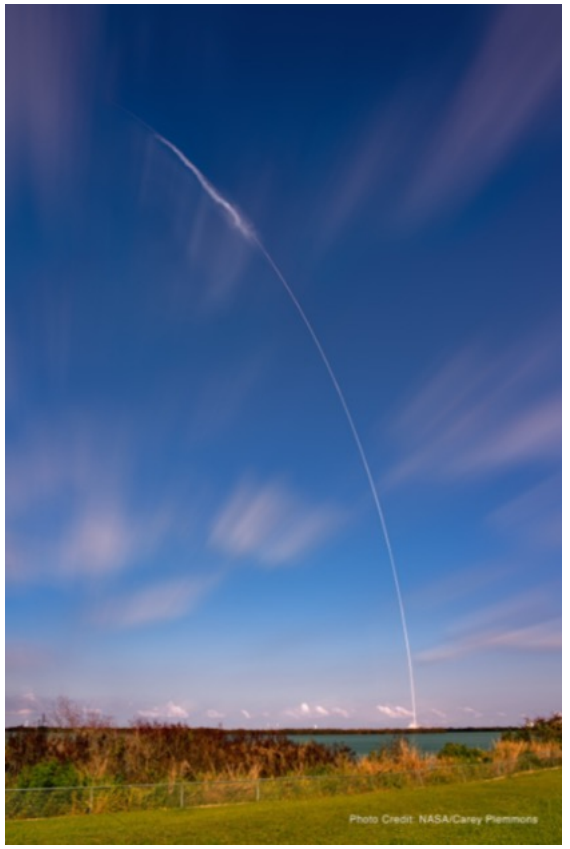
45th CERES Science Team Meeting
Hampton, VA
October 27-29, 2026

Mission Status Summary

- CLARREO Pathfinder Instrument Characterization and Calibration Report summarizes pre-launch testing, uncertainty analysis, and data pipeline assessments.
  - Pre-launch radiometric uncertainty: **0.42% average**; **0.57% integrated**.
  - These estimates will be validated through on-orbit calibration and further analysis.
- In early 2026, NASA HQ renamed CLARREO Pathfinder to the **Calibration Absolute Radiance and Refractivity Observatory Pathfinder (CLARREO Pathfinder)**
  - NASA HQ has updated our communication to be more focused on our role as a calibration observatory/mission.
- CLARREO Pathfinder launched aboard a SpaceX Dragon spacecraft to the International Space Station (ISS) as part of SpaceX's 34th Commercial Resupply Services mission for NASA on Friday, May 15, 2026.
- Commissioning was conducted in Two Phases
  - **Phase 1**: Initial Aliveness, Deployment, and Baseline Calibrations (and some initial science scans)
  - **Phase 2**: Advanced Science Scans and Precision Pointing
- In June 2026, NASA Headquarters directed the CLARREO Pathfinder project to support the **Sustainable Land Imaging (SLI)** commercialization initiative through mission operations.
- CLARREO Pathfinder **Post-Launch Assessment Review** (PLAR) was successfully conducted on October 21 – 22, 2026.
- The project officially entered Phase E, with nominal operations beginning on Friday, October 23, 2026.

CLARREO Pathfinder successfully launched to the ISS on Friday, May 15, 2026!





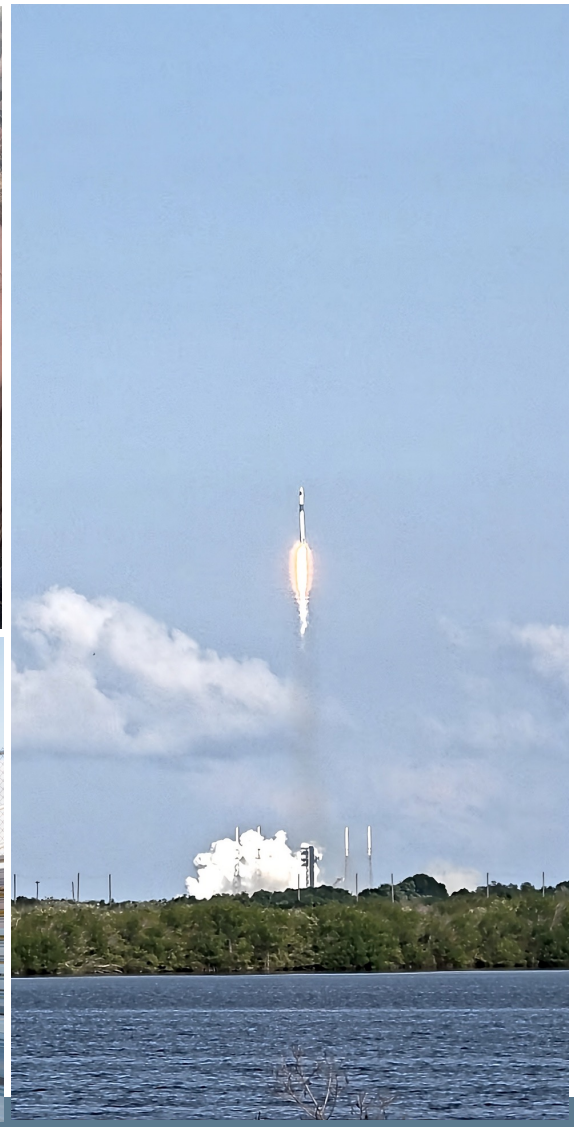


CLARREO Pathfinder Team at Launch















CLARREO Pathfinder on ISS!

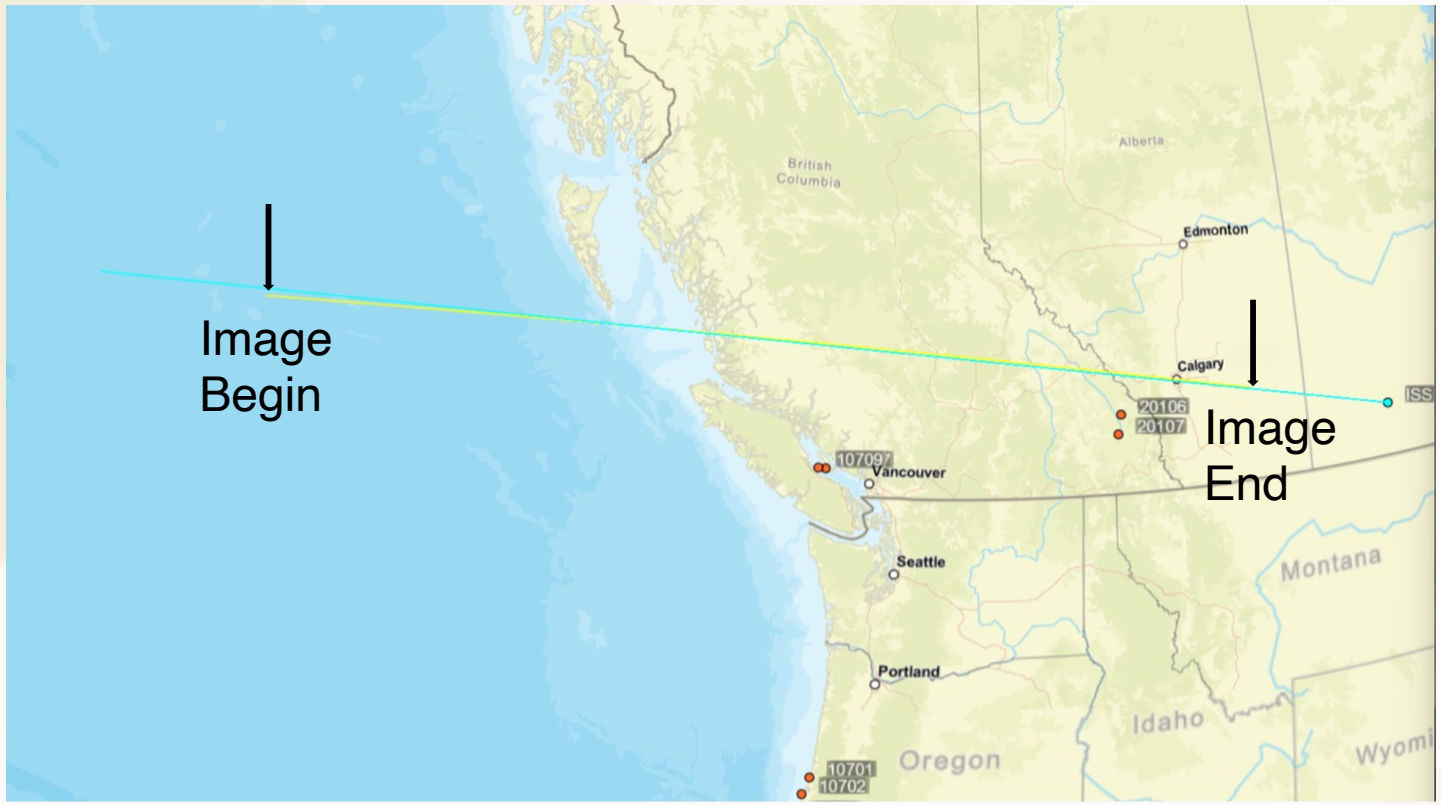


Payload inside the Dragon Trunk

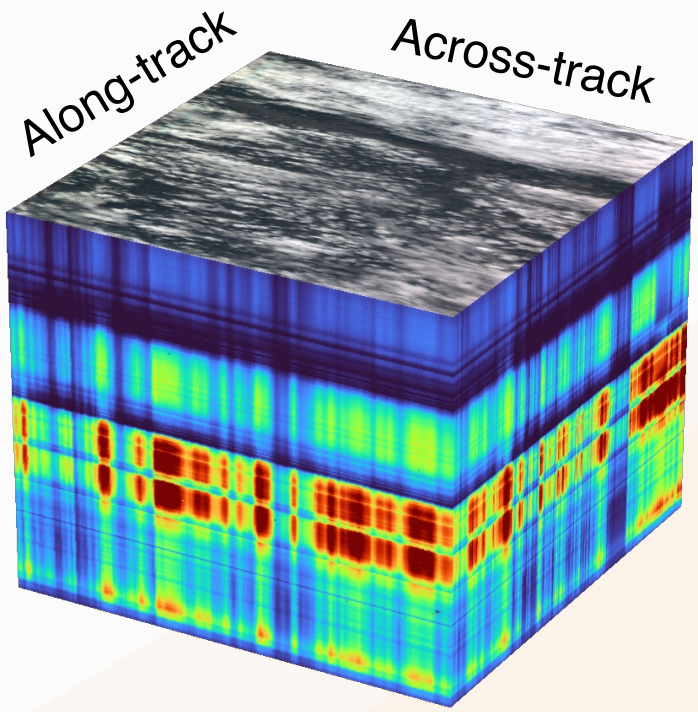


Install on ELC-1, Site 3 on Friday, May 22

First Light Nadir Scan – June 11, 2026



5-minute acquisition spanned 2,200 km from west of Canada to just east of Calgary, Alberta



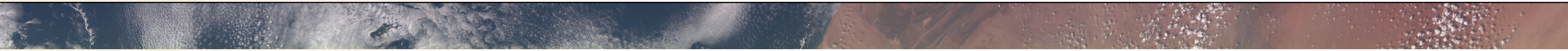
CLARREO Pathfinder measurements have 630 spectral channels between 350-2275 nm

CLARREO Pathfinder Data Cube

A 30-second snapshot of the full image

Nadir Commissioning RGB Images

Morocco, Sahara Desert



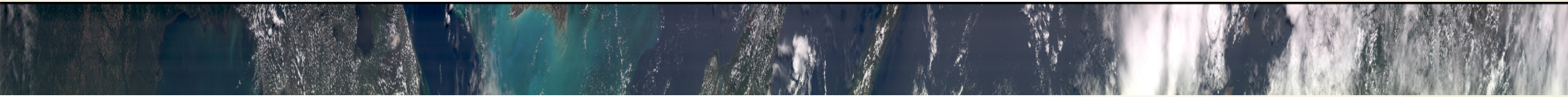
Great Lakes, Atlantic Ocean



New York, Pennsylvania, New Jersey



Florida, Cuba, Venezuela



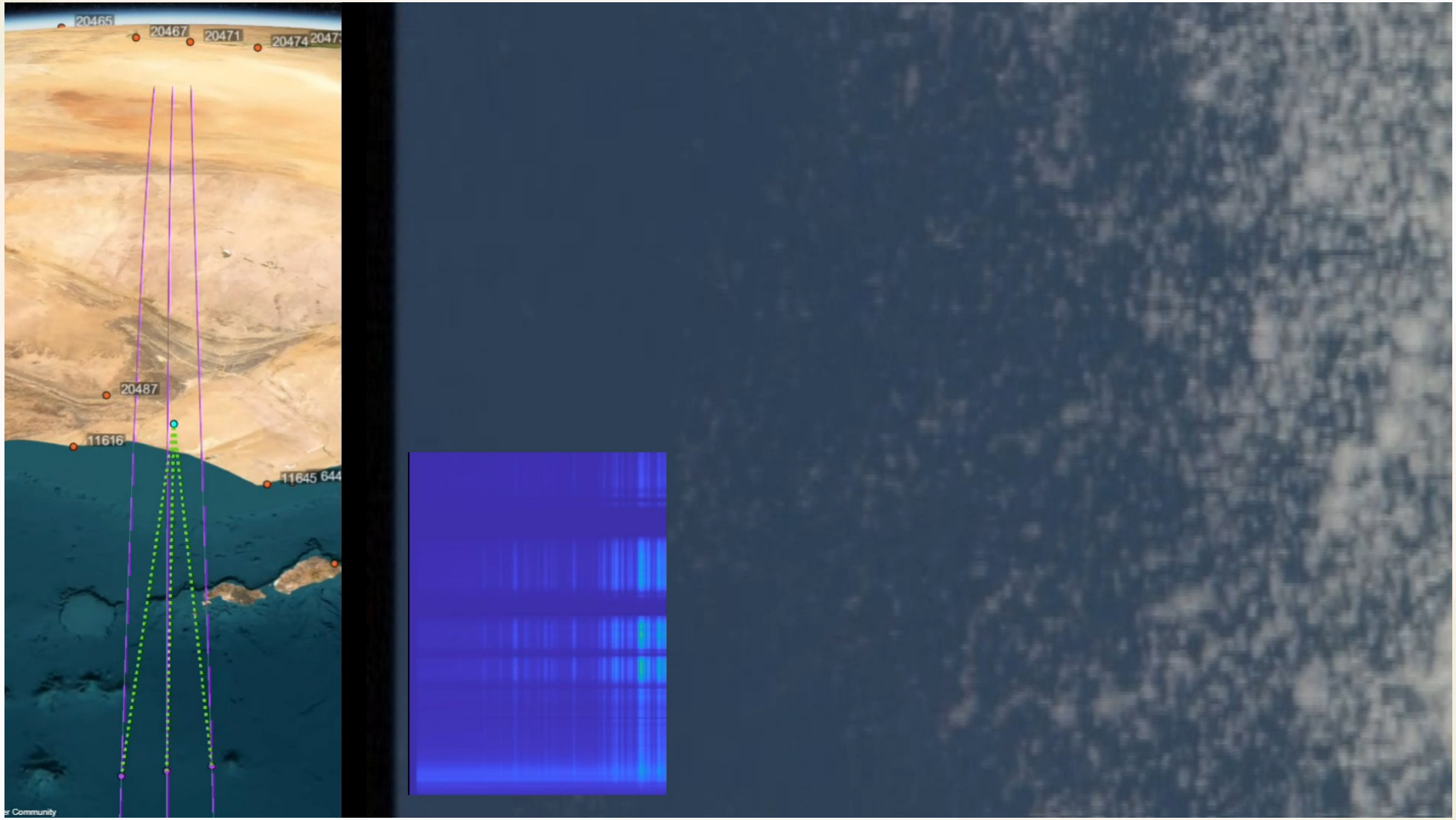
California, Nevada, Arizona



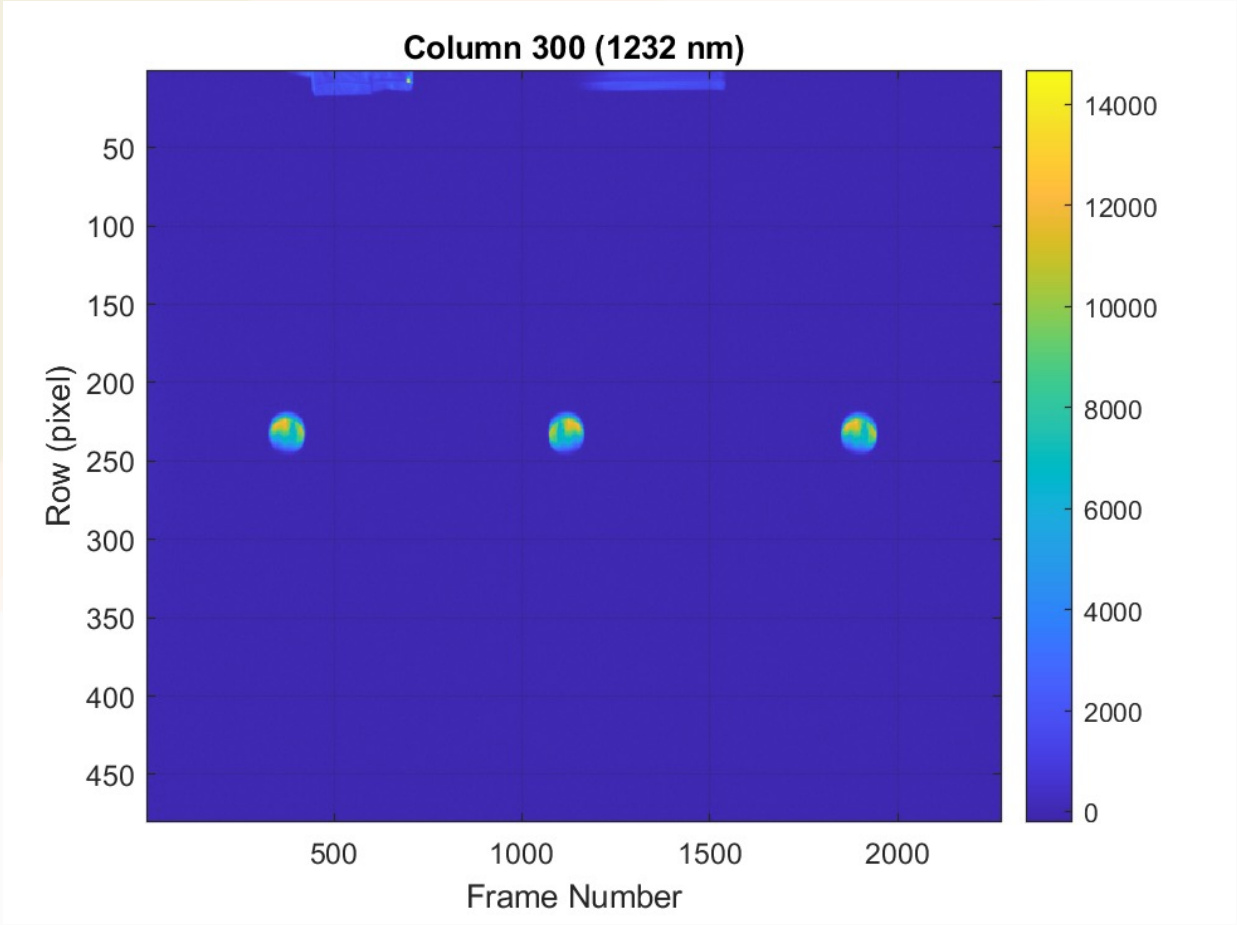
Chile, Bolivia



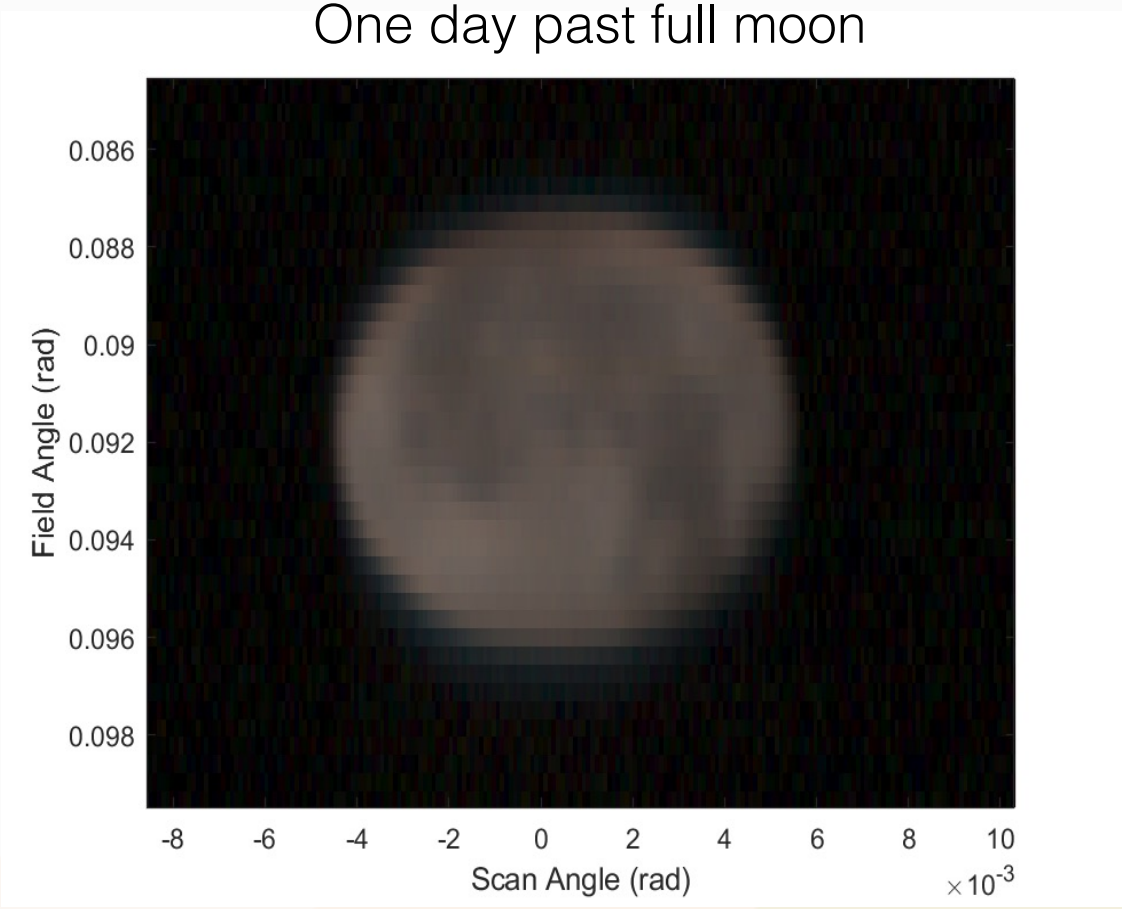
NADIR Image with Pointing Map



Our First Lunar Scan! – July 27, 2026

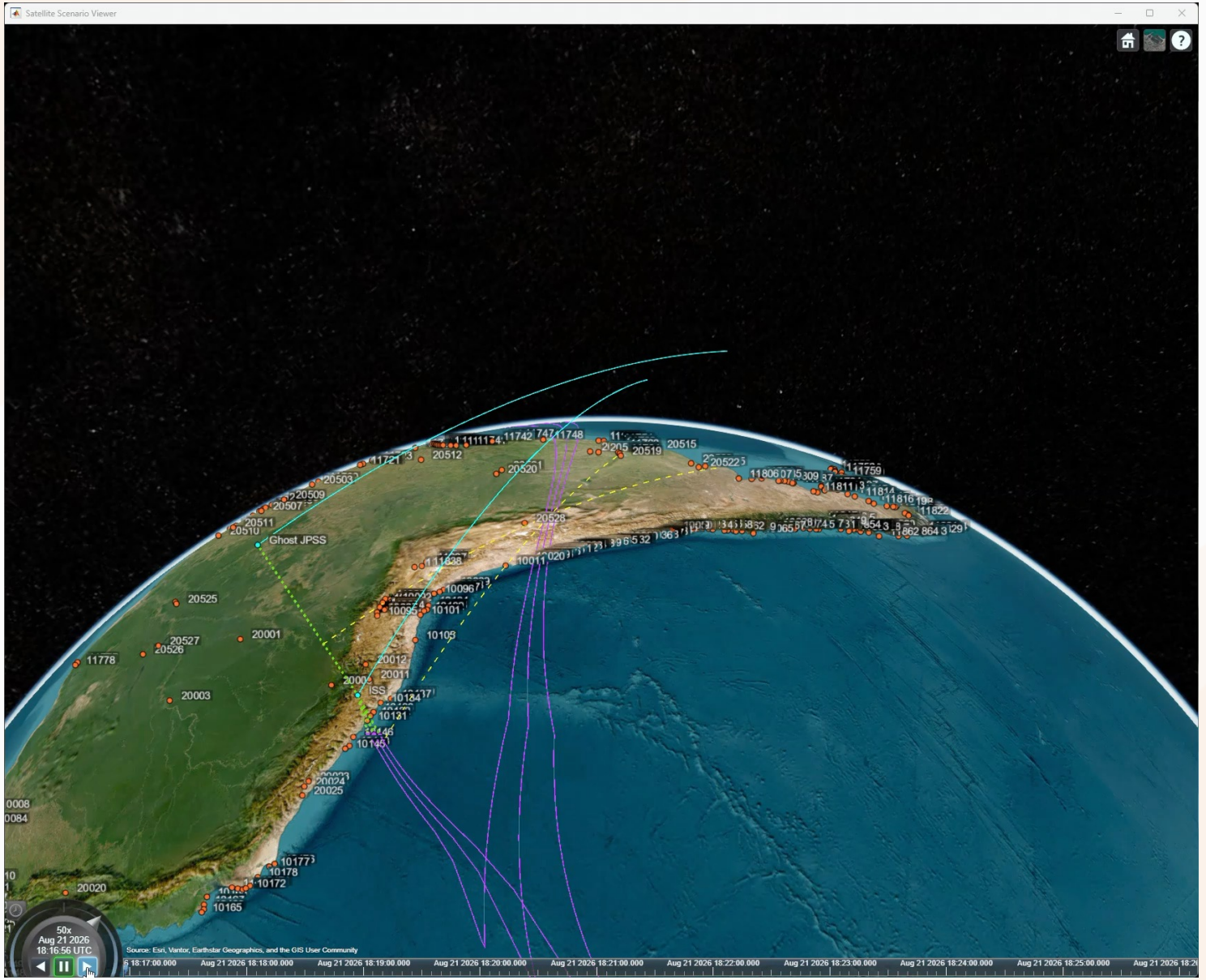


One day past full moon

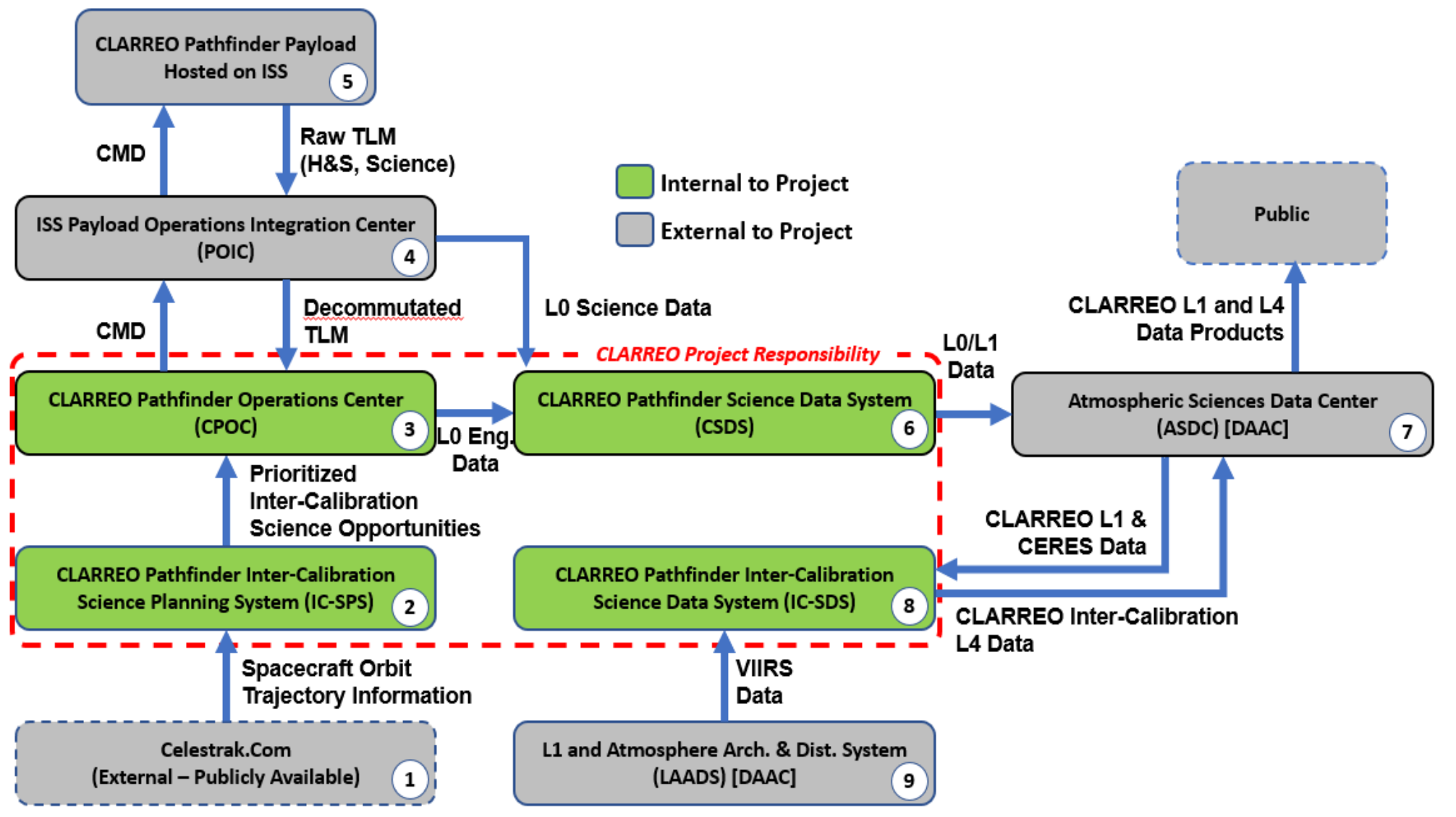


This lunar scan was collected by scanning across the Moon 3x. The x-axis (Frame Number) is representative of time.

LEO Intercalibration Scan (Aug 21, 2026)

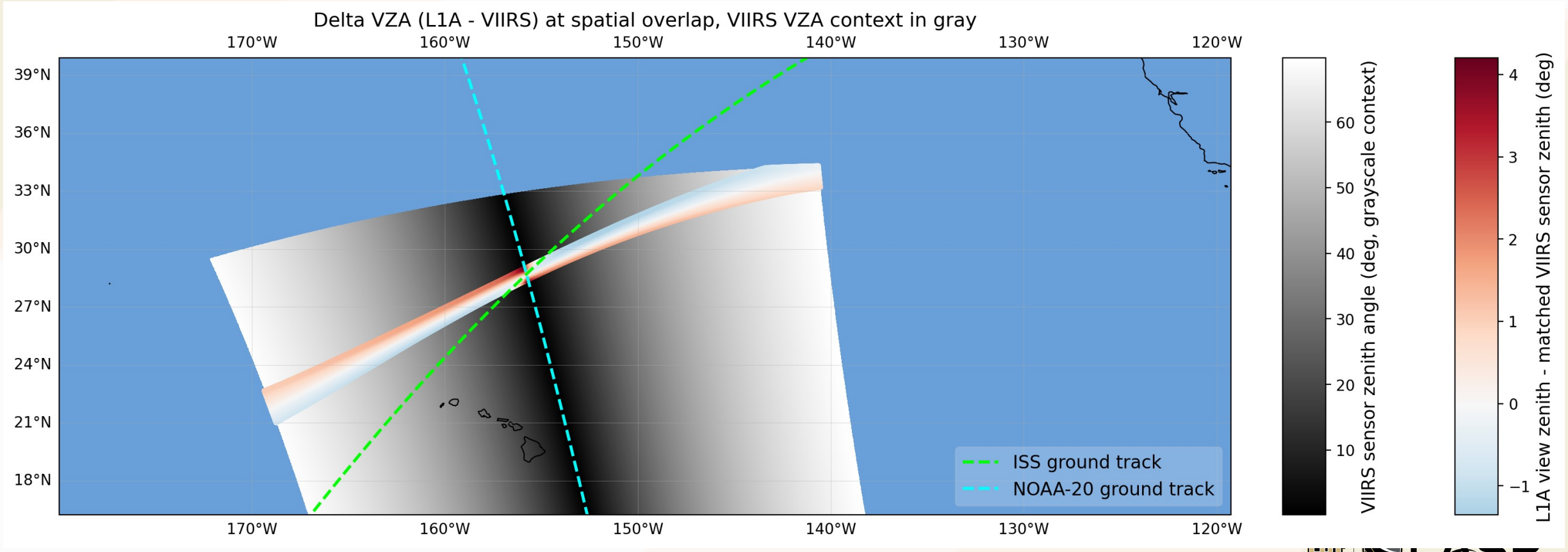


Data Flow


CLARREO Pathfinder Payload Hosted on ISS
5
CMD
Raw TLM (H&S, Science)
ISS Payload Operations Integration Center (POIC)
4
CMD
Decommutated TLM
L0 Science Data
Internal to Project
External to Project
Public
CLARREO L1 and L4 Data Products
CLARREO Project Responsibility
L0/L1 Data
CLARREO Pathfinder Operations Center (CPOC)
3
L0 Eng. Data
CLARREO Pathfinder Science Data System (CSDS)
6
Atmospheric Sciences Data Center (ASDC) [DAAC]
7
Prioritized Inter-Calibration Science Opportunities
CLARREO L1 & CERES Data
CLARREO Pathfinder Inter-Calibration Science Planning System (IC-SPS)
2
CLARREO Pathfinder Inter-Calibration Science Data System (IC-SDS)
8
CLARREO Inter-Calibration L4 Data
Spacecraft Orbit Trajectory Information
VIIRS Data
Celestrak.Com (External – Publicly Available)
1
L1 and Atmosphere Arch. & Dist. System (LAADS) [DAAC]
9

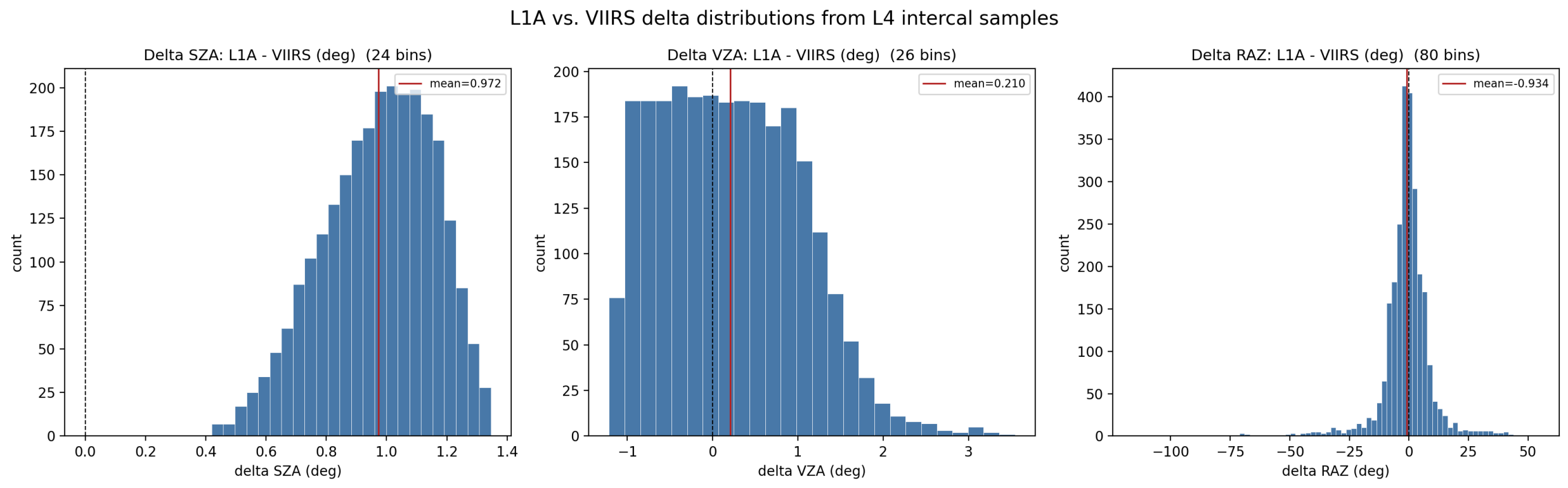
CLARREO Pathfinder-VIIRS intercalibration

- CPF-NOAA-20 Intercalibration Event, **2026/09/22** (ReferenceEventBeginTime = "2026-09-22T23:40:17Z")
- CPF L1A File: CPF_LEO_RAD_L1A.V00-000.20260922T234017.D06M36S.**20261008**T031752-v2.nc
- CPF_VIIRS_N20_INTERCAL_L4.V00-000.20260922T234017.D06M38S.**20261014**T135438.nc
- L4 file for CERES will be generated after the availability of CERES L2 product



Preliminary analysis

- Level-4 product validation tool confirmed that the product is generated consistently with the Data Product Definition
- Total Intercal Samples: 2575
- Initial results show that CLARREO Pathfinder–VIIRS intercalibration samples have closely matched viewing geometries, thanks to CPF's precise two-axis pointing mechanism



Overview of New Scope

- Demonstrate the value of CLARREO Pathfinder intercalibration capabilities to support potential transition of **Sustainable Land Imaging (SLI)** from gov't to commercial industry
  - **SLI Goal**: By 2035, all or most USGS Landsat products will be generated using commercially provided data that are harmonizable with the historical Landsat archive.
  - Biggest current gap between Landsat and commercial land imagers is calibration
  - CLARREO Pathfinder is to serve as intercalibration reference for commercial land imagers to support transition
- What is the *new* work?
  1. Demonstrate direct sensor-to-sensor intercalibration between CLARREO Pathfinder and Land Imagers via Landsat 8 and Landsat 9 Operational Land Imagers
     - Primarily through coincident nadir overpasses
  2. Develop approach to improve characterization of pseudo-invariant calibration sites (PICS)
     - Land imagers use these for Cal/Val
  3. Develop approach to improve characterization of instrumented cal/val sites
     - Provide independent verification of **RadCalNet** (Radiometric Calibration Network) data at TOA
     - Land imagers use these for Cal/Val
  4. Collect nadir measurements that closely coincide with **EMIT** (also on ISS), Planet's **Tanager**, and **Sentinel -2**
     - These will be predicted, collected, and distributed as nadir data products (not intercal data products)
     - Target instrument teams will lead intercal data analysis in partnership with CLARREO Pathfinder Intercal Team

New Scope Implementation: In Practice

1. CLARREO Pathfinder Instrument Radiometric Uncertainty validation
    1. Continue on-orbit calibration ops/analysis for in-orbit validation of uncertainty budget
2. CLARREO Pathfinder Geolocation uncertainty evaluation & initial corrections
    1. Continue acquiring GCP observations
3. Baseline intercal capability as designed via intercalibration of NOAA-20 VIIRS
    1. Focus on demonstrating our intercal capability works
    2. Plan to still conduct CPF-VIIRS intercal analysis (and possibly CPF-CERES, assuming feasible within resources)
4. Direct intercal demo with Landsat-8
    1. Develop approach for intercal w/ Landsat 8
    2. Conduct operations to support this demonstration, process L1 data, and conduct analysis
5. Improved Characterization of ground Cal/Val sites
    1. Collect and analyze cal/val ground site observations
6. Collect (no analysis) coincident nadir measurements with EMIT, Tanager, and Sentinel-2, and provide L1 data to target instrument teams

CLARREO Pathfinder successfully completed its PLAR on October 22, 2026, and has transitioned into the operational phase.



Thank you!


REFERENCE INTER CALIBRATION
ADVANCING OBSERVATION ACCURACY
CLARREO PATHFINDER