Geodetic Reference Instrument Transponder for Small Satellites (GRITSS)

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23rd International Workshop on Laser Ranging, Kunming, China
October 20-26, 2024

The Geodetic Measurement System

VLBI
- Orientation of ITRF with respect to ICRF
- ITRF Scale

SLR
- Origin of ITRF (Earth's CM)
- ITRF Scale
- Position spacecraft in ITRF ("Orbits")

GNSS
- Precise monitoring of Polar Motion and Rotation Rate
- Position spacecraft in ITRF ("Orbits")
- Position instruments on Land and Sea (Tide Gauges and Buoys, Geodetic Instruments)

DORIS
- Position spacecraft in ITRF ("Orbits")
- Enhances global distribution of ITRF Station positions and velocities

Technique Connectivity (Station Co-Location)

Fully Define ITRF

Low-Density Global Distribution

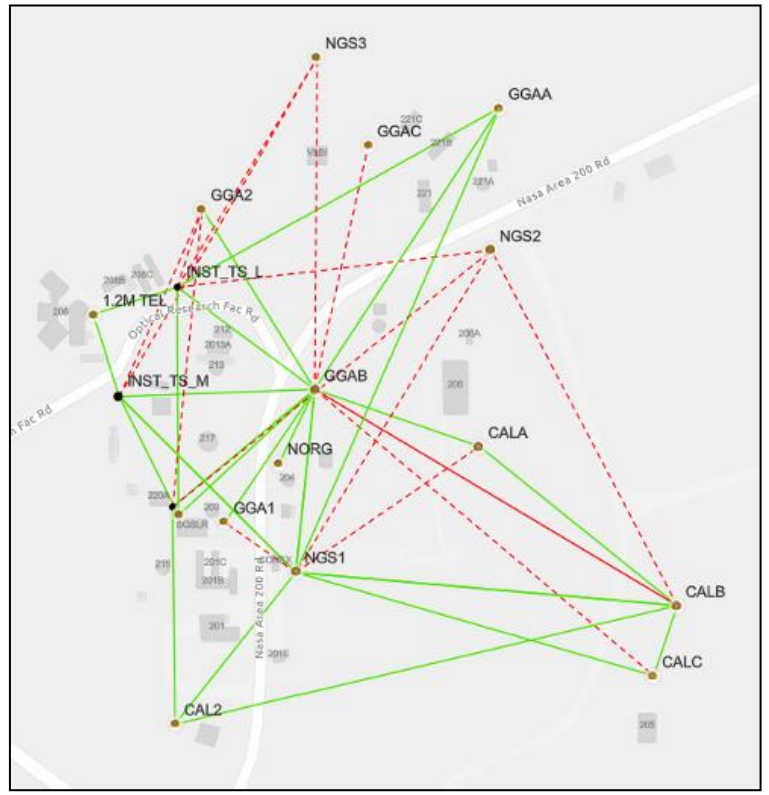
High-Density Global Distribution

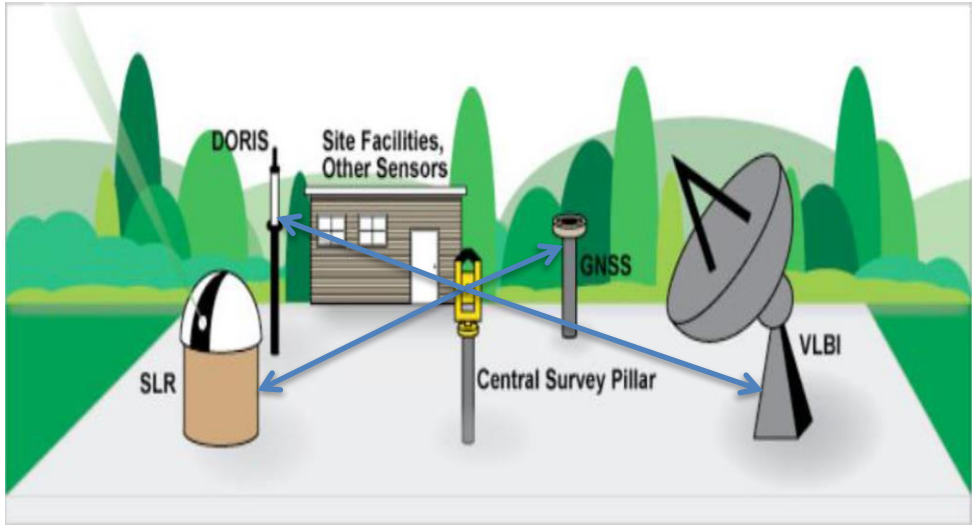
Origin, Scale, Orientation

VTS: ITRF Performance Improvement

Traditional Local Tie Surveys

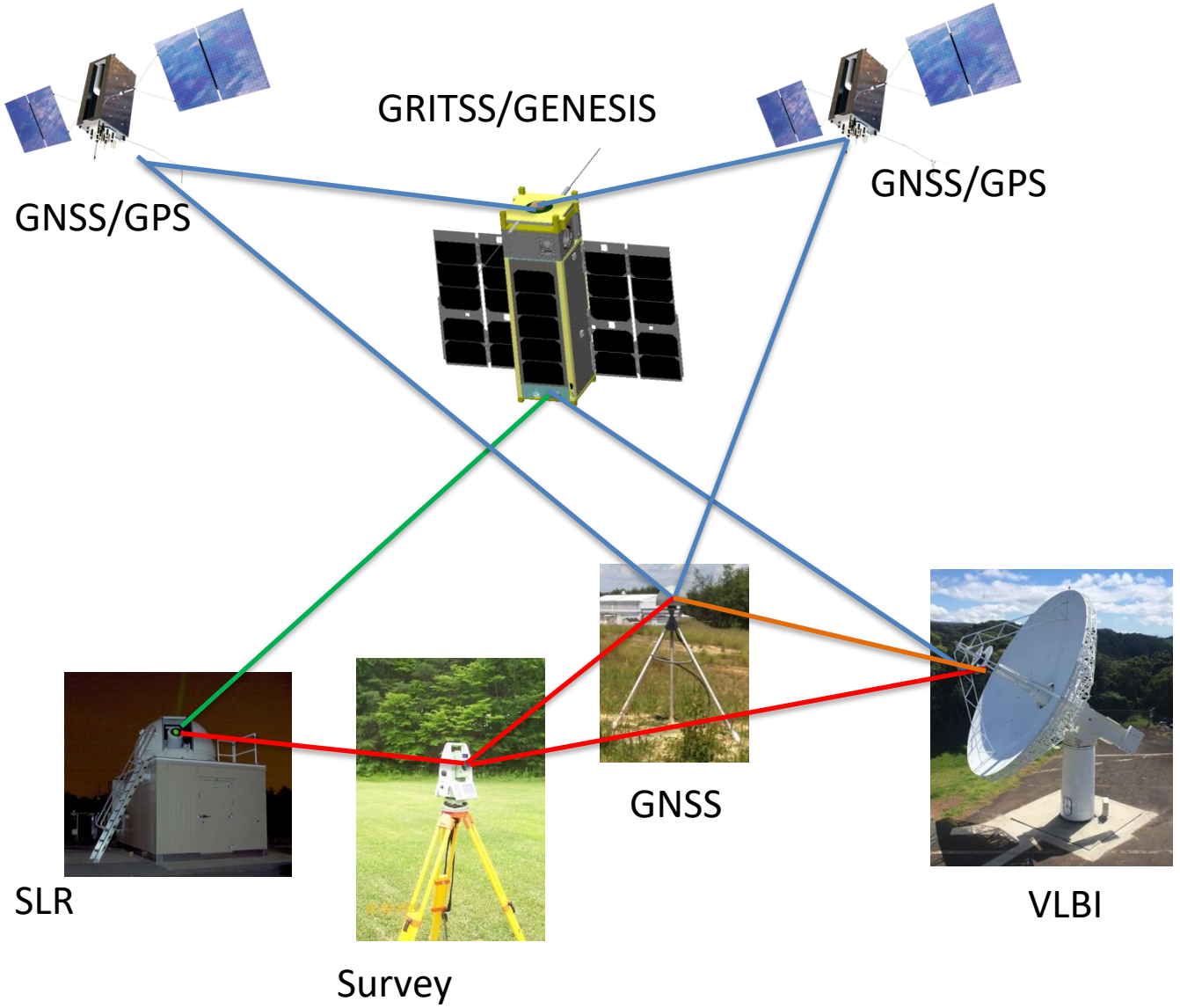
- Survey of site ground control network, site reference, optical access points, and supplemental targets to estimate the measurement points of space geodesy instruments.
- The actual instrument measurement point is often not accessible to survey techniques and must be estimated, introducing errors in the local tie.
- Surveys are only performed periodically further introducing the possibility of errors.





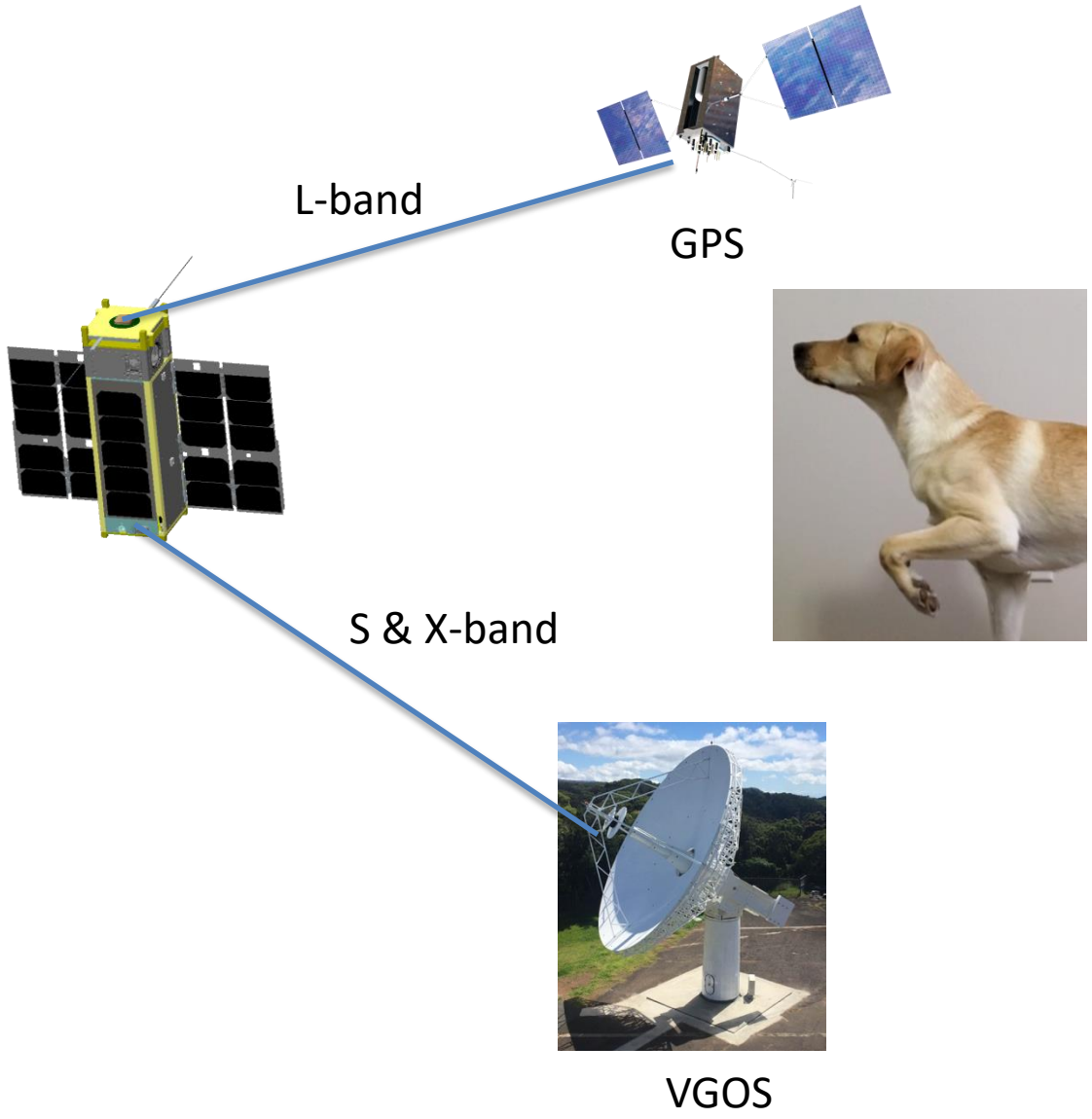
Geodetic Colocation In Space

Observations of a common space-based reference has the potential for reducing the uncertainty in the local-ties to the mm level thus improving the ITRF combination.



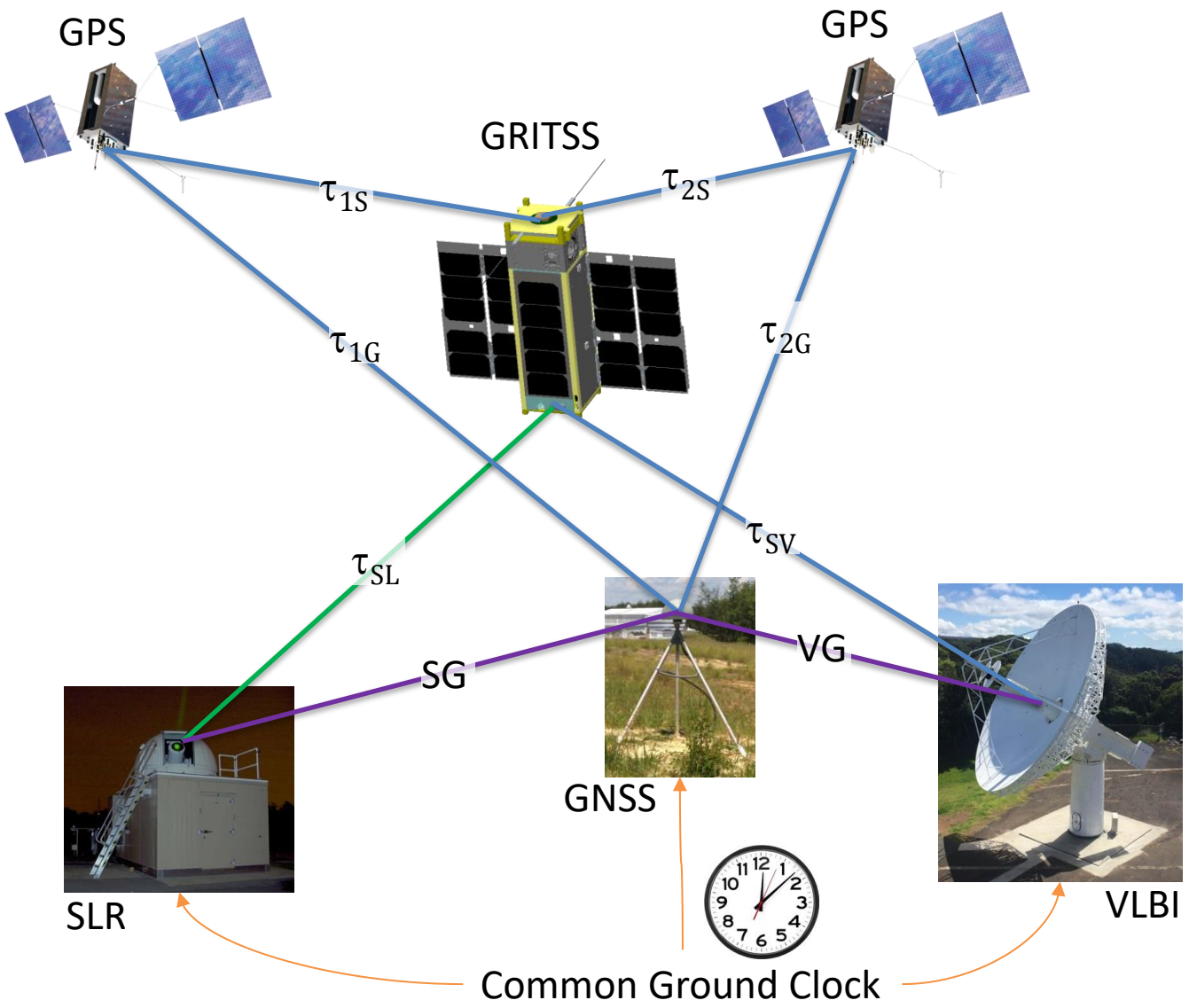
The GRITSS Dog-Leg

GRITSS upconverts and transponds GPS signals to individual VGOS ground stations.



The GRITSS Observables

- τ_{SV} observable is a clock bias term that is obtained through differencing of space/VLBI GPS clock biases
- Differencing allows direct suppression of common clock terms.
- Fitting τ_{SV} to model given CubeSat Precision Orbit Determination yields VLBI position



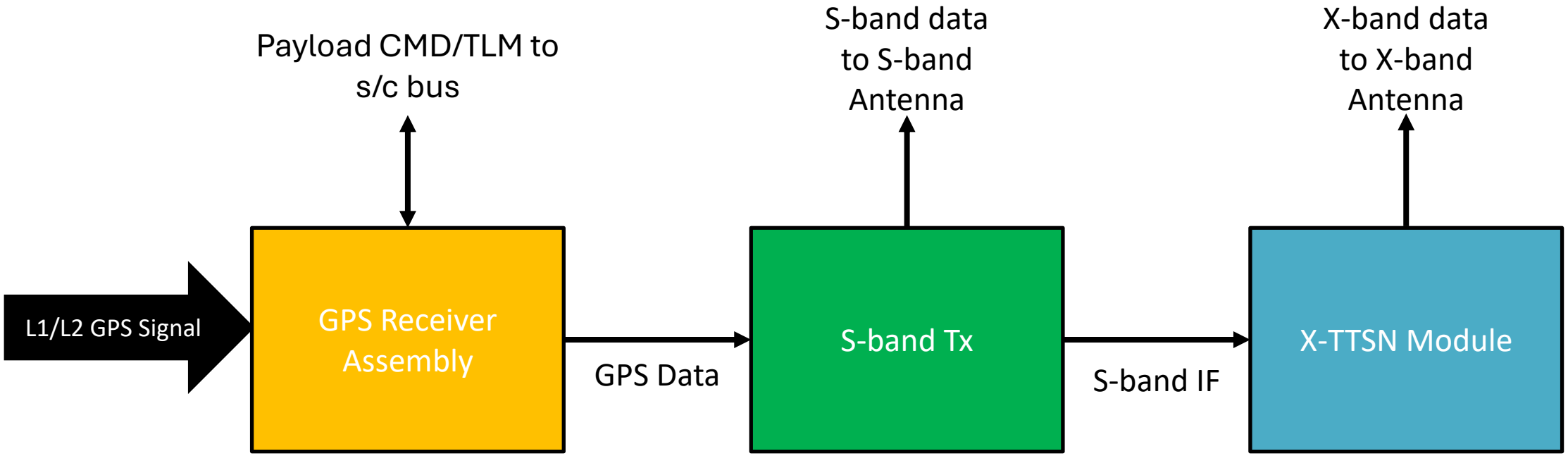
The GRITSS Demonstration Mission

- A NASA Earth Science and Technology Office sub-class D technology demonstration mission
- Jointly developed by the University of Massachusetts, Lowell and NASA GSFC
- 12UXL CubeSat, launch, and operations services provided by ISISpace in the Netherlands.
- Nominal operations: 1 year (extendable)
- Orbit: ~550km sun synchronous, Nadir pointing
- Only broadcasts GRITSS signals over VGOS stations as spacecraft power permits
- Spacecraft kept nadir pointing throughout orbit to enable global SLR tracking.

Initially targeting US NASA VOGS stations and will invite other VGOS stations to participate after successful first phase

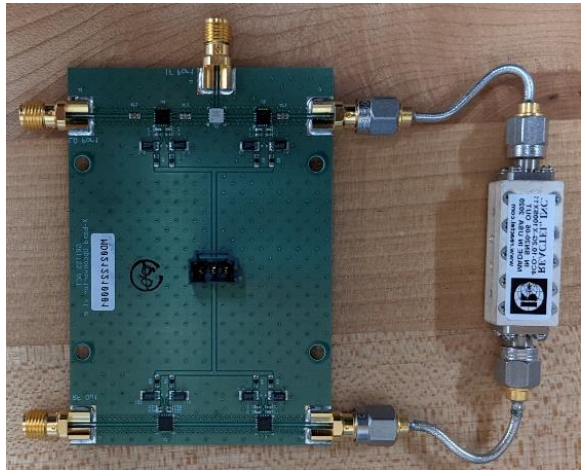
GRITSS Instrument Subsystems

- GPS Receiver Assembly
- Ultra-Stable Oscillator (USO)
- X-band Transmitter and Timing extenSionN (X-TTSN) Module - 10.2 GHz
- S-band Transmitter - 3.2 GHz
- Antennas (L1/L2 GPS, X-band, and S-band)
- Laser Retroreflector



Completed Technology Readiness Level 5 Development

S-band Transmitter



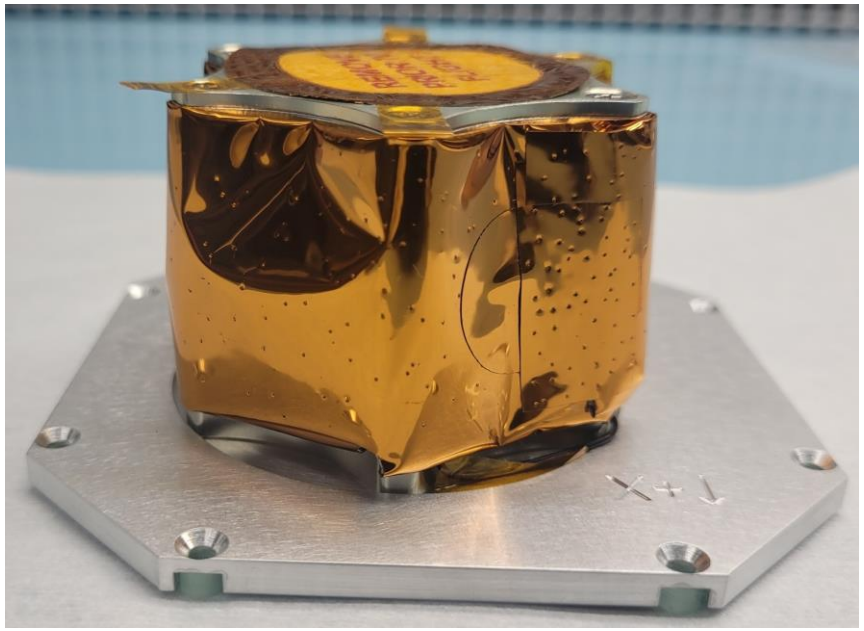
X-band Transmitter

Wenzel USO

GPS Receiver Assembly

Laser Retroreflector

- Single 1.6 inch diameter cube corner with measured dihedral angles offsets of 1.7, 1.4, and 1.5 arcsec designed and built by KBR.
- Mounted to the nadir deck that will be kept nadir pointing for the majority of time.
- ILRS tracking is a critical component to the success of the GRITSS demonstration.

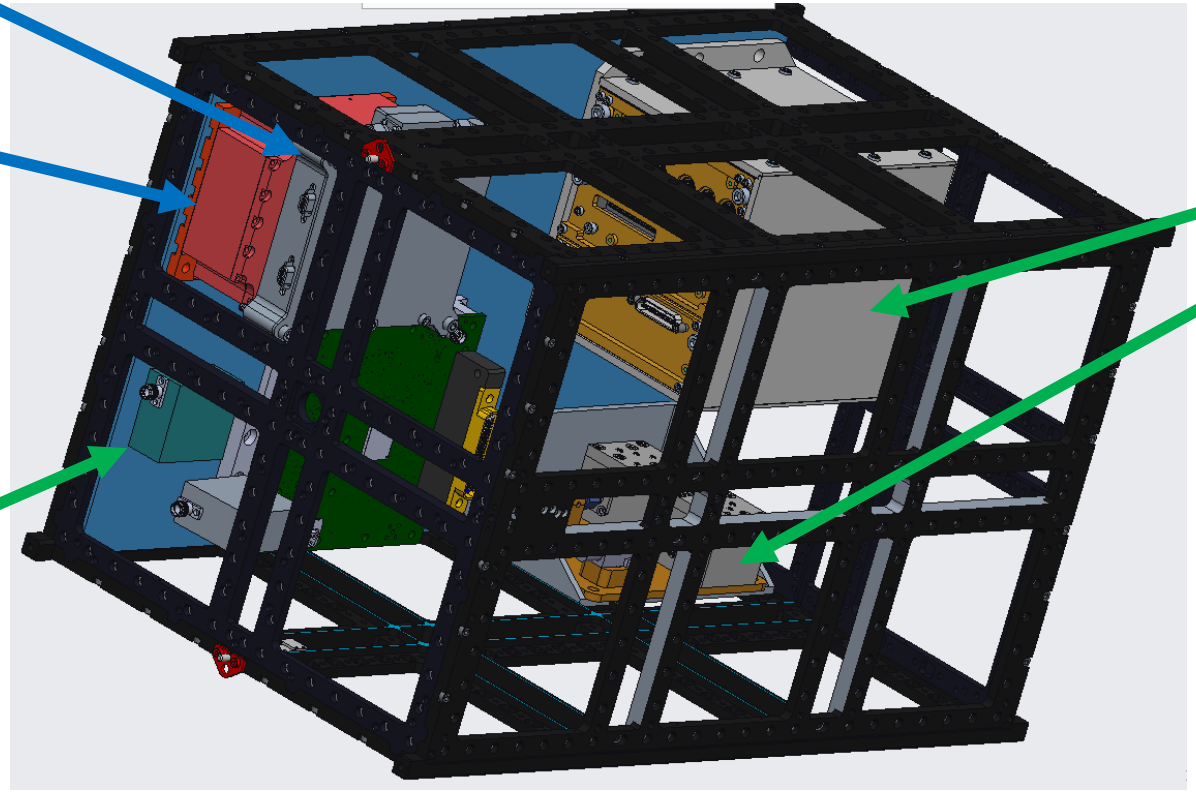


GRITSS Instrument Fits Within 6U Volume

X-TTSN Module

USO

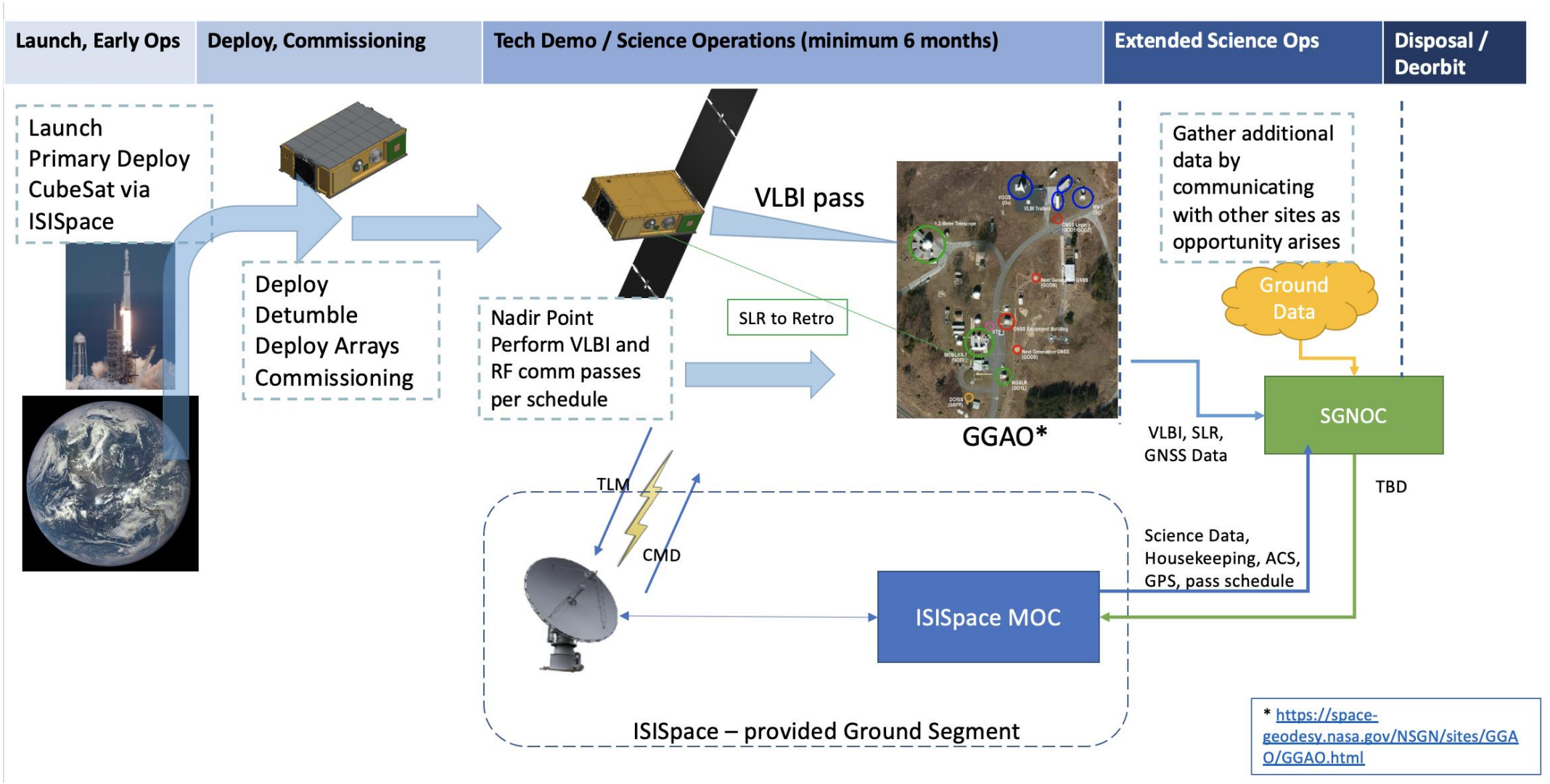
S-band Tx



GPS Receiver Assembly
- NavCube3-mini
- Low-Noise Amplifier (LNA)

Instrument Size:
20 cm × 11 cm × 34 cm

Concept of Operations



Project Status

- ✓ 2022 - Demonstrated Technology Readiness Level 5
- ✓ July 2023 - Payload Preliminary Design Review
- ✓ Feb 2024 - Spacecraft Design Review
- ✓ Apr 2024 - Payload Final Design Review
- ◆ Oct 2024 - Spacecraft Final Design Review
- ◆ May 2025 - Instrument-Spacecraft Integration and Test
- 🚀 Oct 2025 - Launch

Summary

- GRITSS will demonstrate a space-tie using the novel approach of transponding the GPS signals to a VGOS antenna.
- GRITSS is on a fast-track for launch and operations in 2025.
- We look forward to working with the ILRS!