NASA's Next Generation Space Geodesy Project at GGAO

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Space Geodesy Project

Goals of the Project

Establish and operate a prototype next generation space geodetic station with integrated next generation SLR, VLBI, GNSS (and DORIS) systems, along with a system that provides for accurate vector ties between them

Develop a Project Implementation Plan for the construction, deployment and operation of a NASA network of similar next generation stations that will become the core of a larger global network of modern space geodetic stations

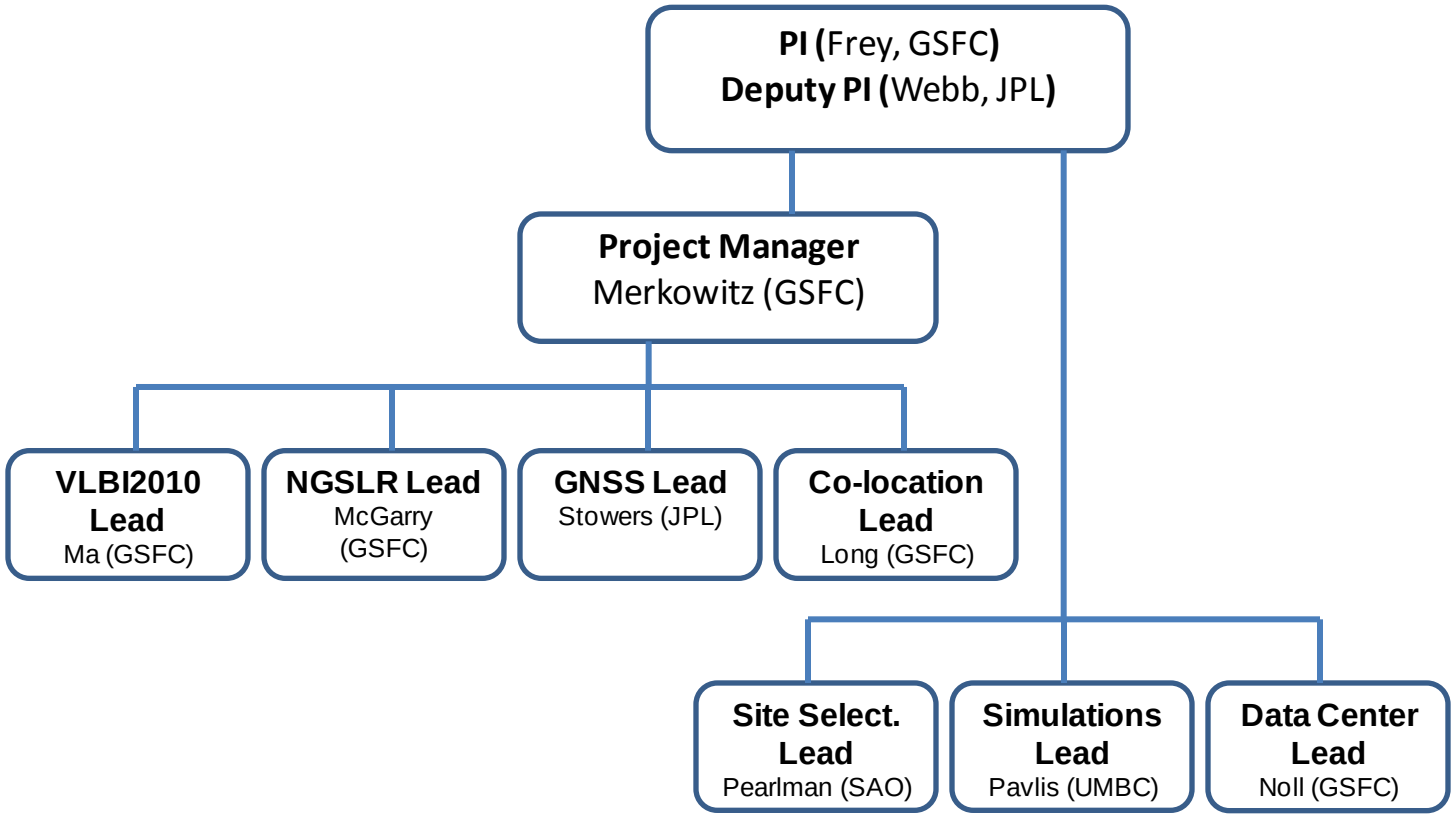
Timeline

Approved by NASA's Earth Science Division – May 2011

Funding provided – August 2011

Project duration – 2 years

Organization



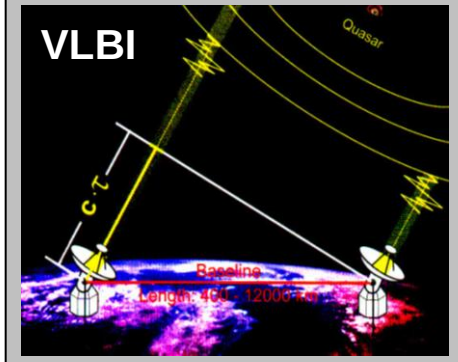
- GSFC: PI, Project Manager, SLR/VLBI/Co-location Leads, Data Center Lead
- JPL: Deputy PI, GNSS Lead
- SAO / UMBC: Site Selection and Simulations

Roles and Responsibilities

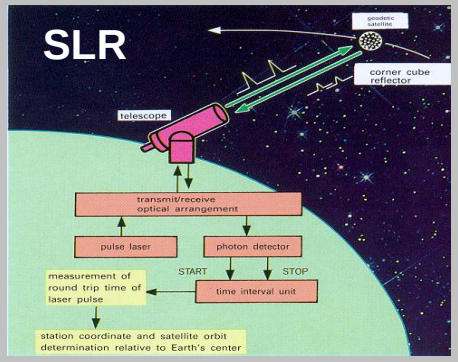
- Deliverables:
  - Prototype Station that demonstrates next generation multi-technique geodetic capabilities
  - Implementation Plan for creation of a global network of multi-technique stations
- Deliverables by organization:
  - GSFC:
    - Will provide management of work
    - Deliver Prototype Station
    - Create plan for global network implementation
  - JPL:
    - Deliver and install GNSS system at GGAO
  - UMBC:
    - Simulate and analyze global network
  - SAO:
    - Assist with site selection, international relations

Prototype Station Components

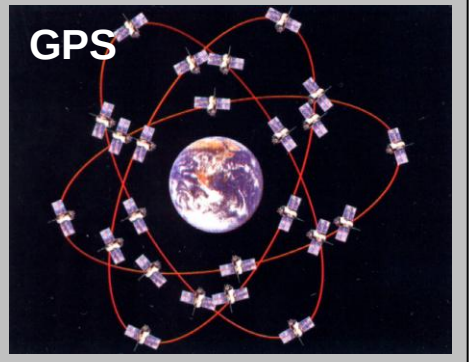
- NGSLR
- VLBI2010
- GNSS
- DORIS
- Co-location vector measurement system



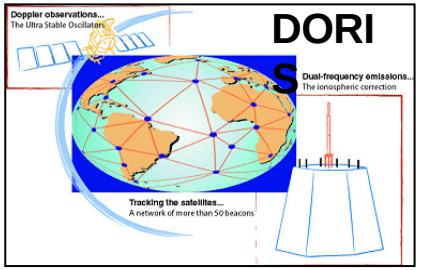
Very Long Baseline Interferometry



Satellite Laser Ranging



Global Positioning System

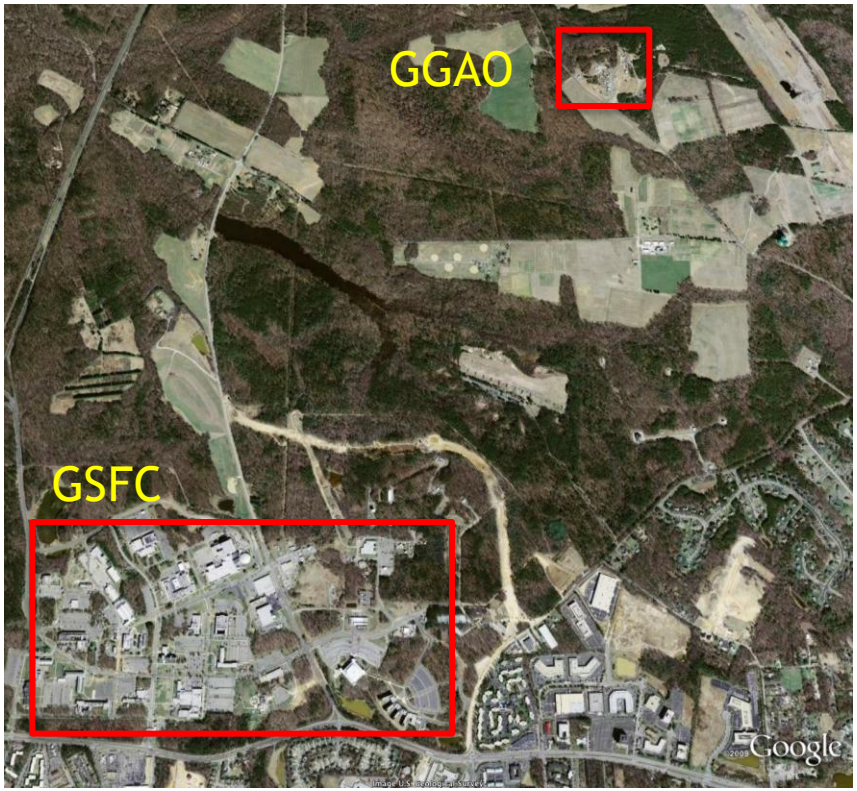


Doppler Orbitography and Radio Positioning Integrated by Satellite

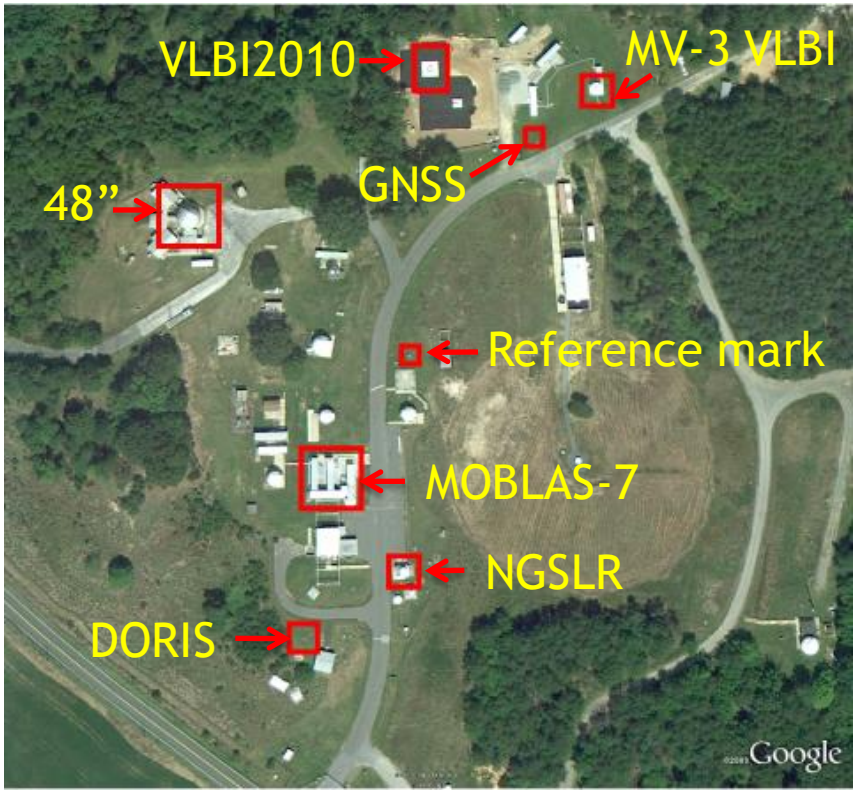
GGAO Overview

- Goddard Geophysical and Astronomical Observatory is located 5 km from Goddard Space Flight Center in the middle of the Beltsville Agricultural Research Center. GGAO is one of the few sites in the world to have all four geodetic techniques co-located at a single location.

Local Area Map

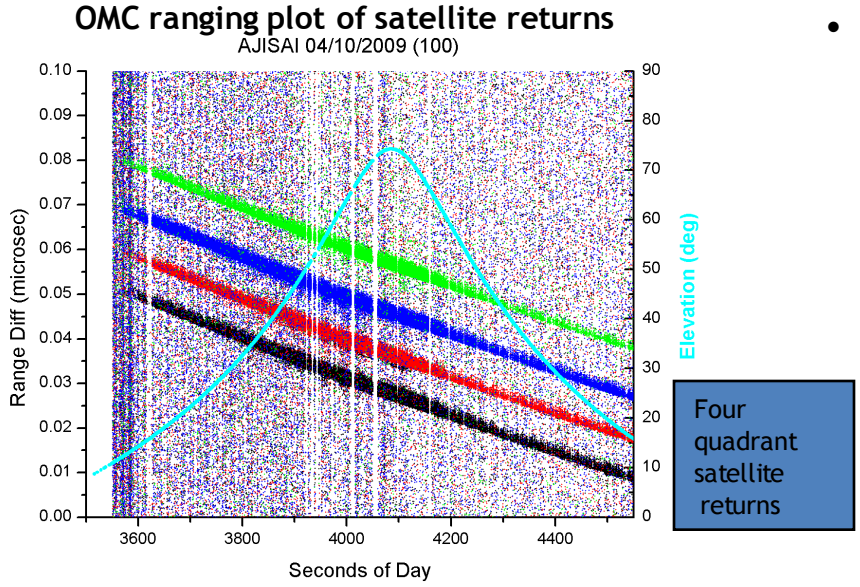


GGAO



NGSLR Development at GGAO

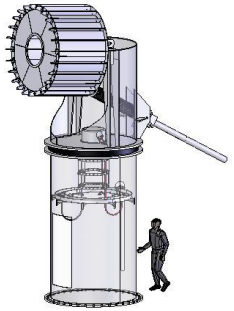
NASA's Next Generation Satellite Laser Ranging System (NGSLR) is a low energy/high repetition rate singe photon detection laser ranging system capable of tracking cube corner equipped satellites in Earth orbit. The concept of NGSLR was developed by J. Degnan. The system has demonstrated tracking of Earth orbit satellites with altitudes from ~ 1000 km to 20000 km. Completion of the NGSLR prototype will occur during the Space Geodesy Project.

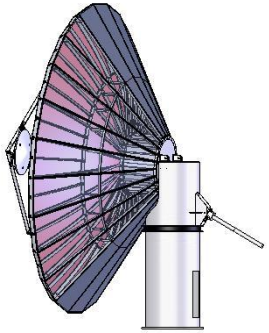


- System Features:
  - 1 to 2 arcsecond pointing/tracking accuracy
  - Track CCR equipped satellites to 20,000 km altitude, 24/7 operation
  - Reduced ocular, chemical, electrical hazards
  - Semi automated tracking features
  - Small, compact, low maintenance, increased reliability
  - Lower operating/replication costs

Patriot 12-Meter VLBI Antenna

- Erected at GGAO October 2010
- Quad Ridge Feed Horn (QRFH) designed by Caltech for Patriot optics being tested





QRFH feed with dewar removed

dewar: 28 cm wide

42 cm tall

Feed: 22 cm wide

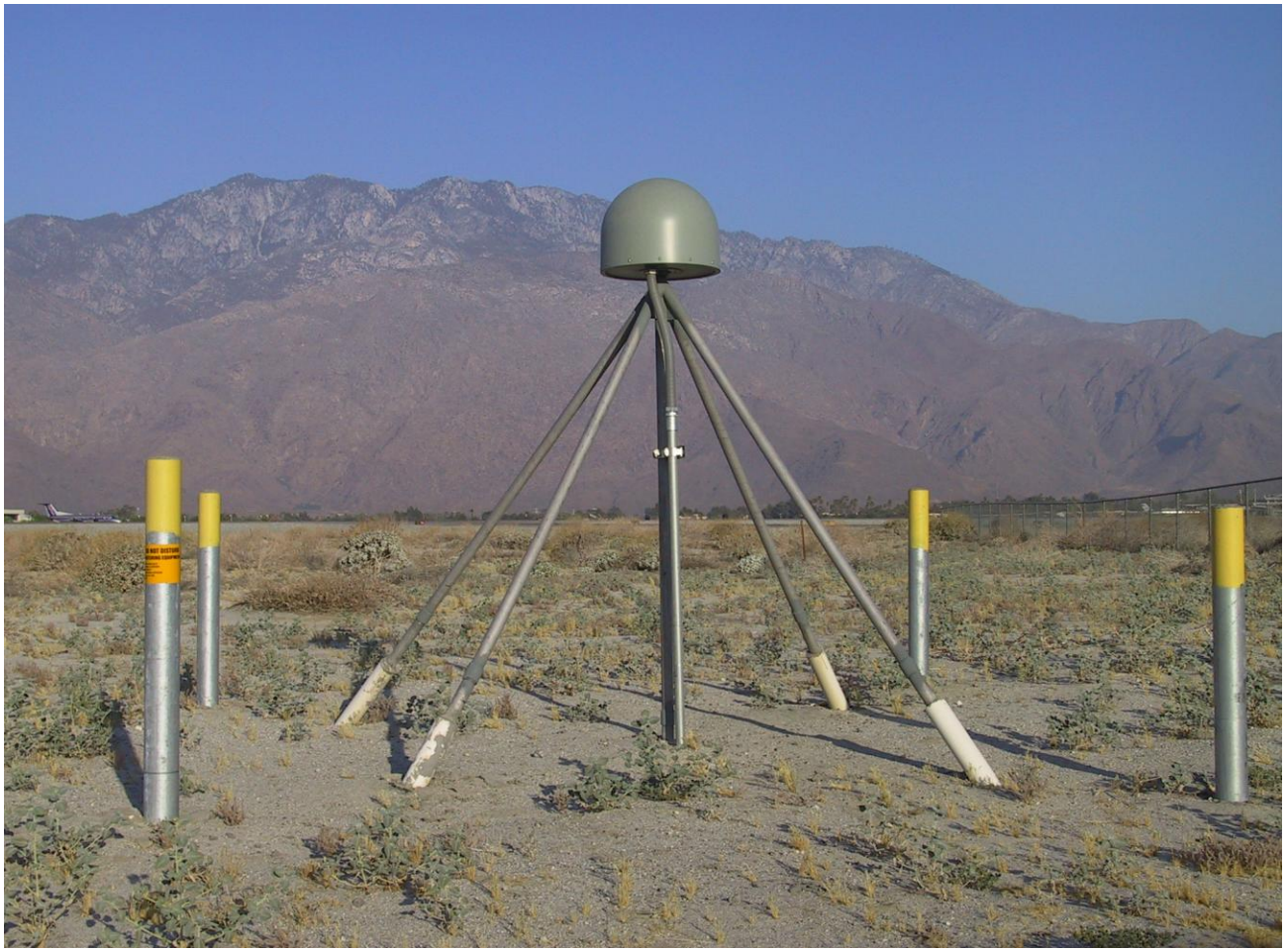
18 cm tall


2 DBEs
Mk5B+
Mk5B+
2 UDCs
ORCA
2 UDCs
Mk5B+
Mk5B+
2 DBEs

VLBI2010 Accomplishments to Date

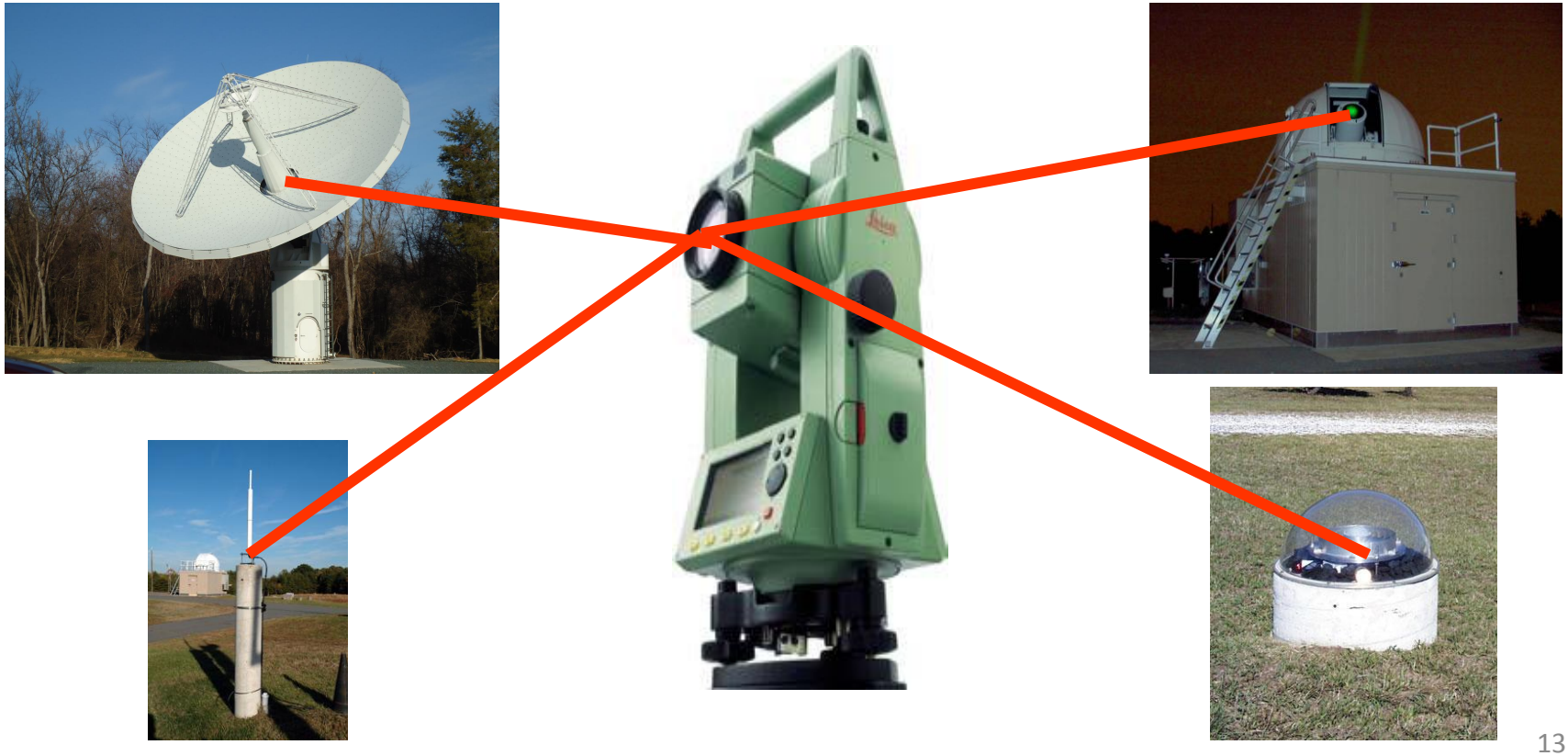
- Mounted cryogenic broadband feeds on antennas at Westford, MA and GGAO
  - Record 512 MHz from 4 bands between 2 GHz and 14 GHz
  - Dual linear polarizations
- Down converted each band using flexible Up-Down Converter (UDC)
- Separated each band into 32 MHz channels using Digital Backend (DBE)
- Recorded 2 Gbps on each of 4 Mk5B^{+} recorders
- Installed fast 12-m Patriot antenna to significantly increase observations
- Measured antenna aperture efficiency 60%, SEFD 2600 Janskys
- VLBI2010 data expected to be phase delay with much lower uncertainty than current group delay observable
- Entire VLBI2010 system is newly designed. Some currently deployed equipment dates from the 1970s

GNSS Monument



Co-location Vector Monitoring

- Automated measurement of inter-instrument vectors is an essential aspect of an integrated space geodesy station
- Measurements provide closure between terrestrial reference frames derived from different space geodesy techniques
- Tests of technologies and currently available systems underway at GGAO



Vector Monitoring System Development

- Robotic Total Station: Leica TS30
  - Evaluating prism target performance
- Evaluating Leica GeoMoS software for precise monitoring applications
- Incorporate new GNSS drilled brace monuments into ground monument network