NLS
FINNISH GEOSPATIAL
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Metsähovi Geodetic Research Station

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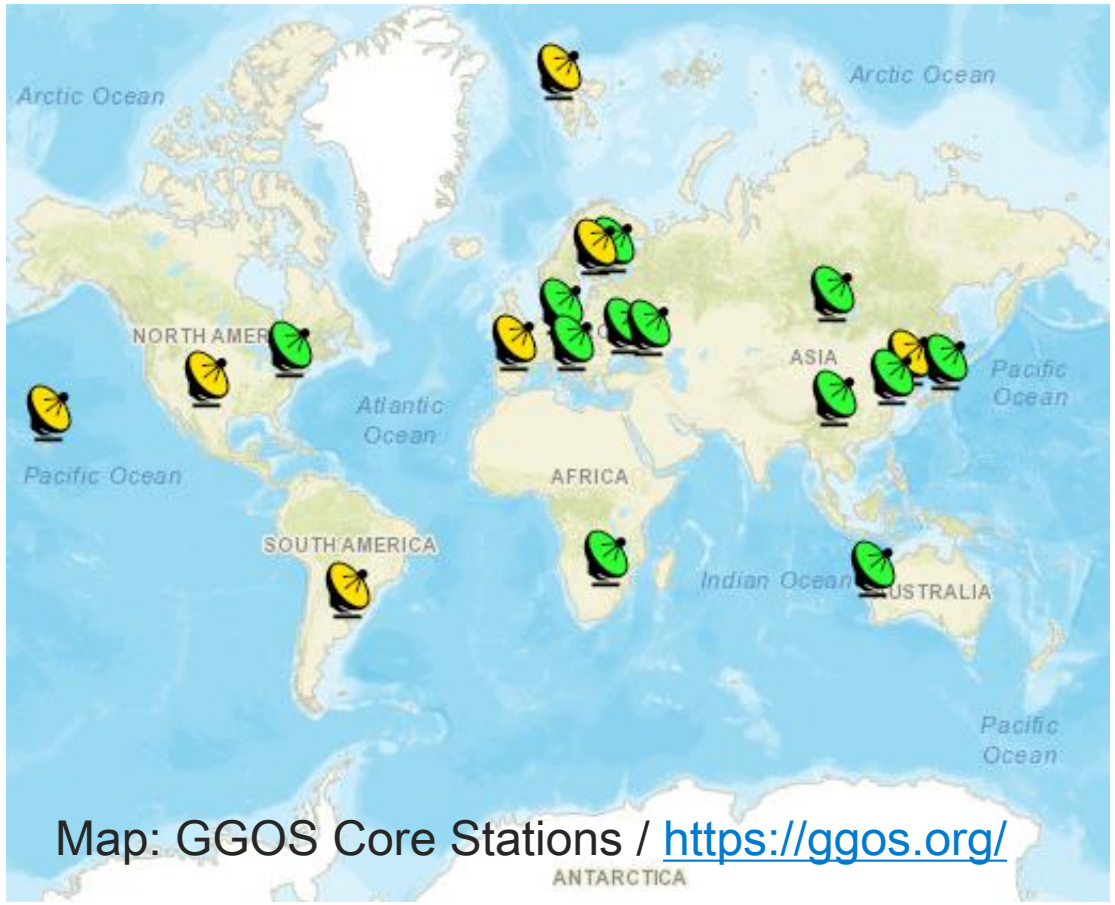
Global Geodetic Core Sites

Sites with multi-technique instrumentation have the central role. They are the backbone of global geodetic observing system (GGOS) and data analysis. Global reference frames (both ITRF and ICRF) depends on multi-technique sites and their long-term time series.



Map: GGOS Core Stations / https://ggos.org/

Typical instrumentation at core stations

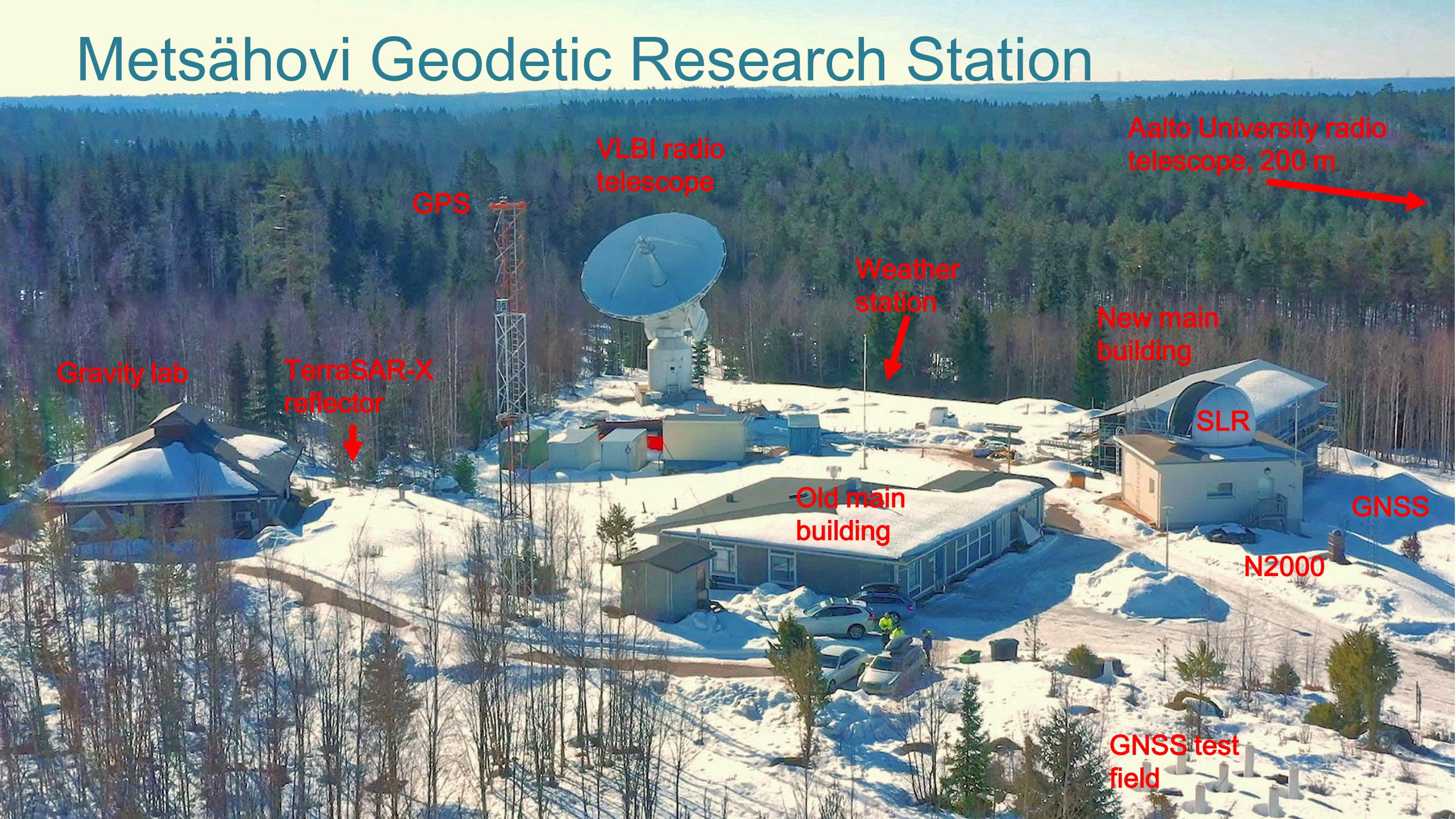
- GNSS (typically more than one)
- Satellite Laser Ranging (SLR) system
- VLBI Global Observing System (VGOS)
- DORIS
- Local tie network / facilities

- Absolute gravimeter
- Superconducting gravimeter
- Environment detecting instruments
- Tide gauge
- (In)SAR reflector(s)
- et al.

Metsähovi Geodetic Research Station

- First geodetic measurements (SLR) in 1978
- Operated continuously since with measurement techniques added along the way
- In 2012 a major upgrade of all equipment was started; major upgrades also in the station infrastructure

Metsähovi Geodetic Research Station



Infrastructure at Metsähovi

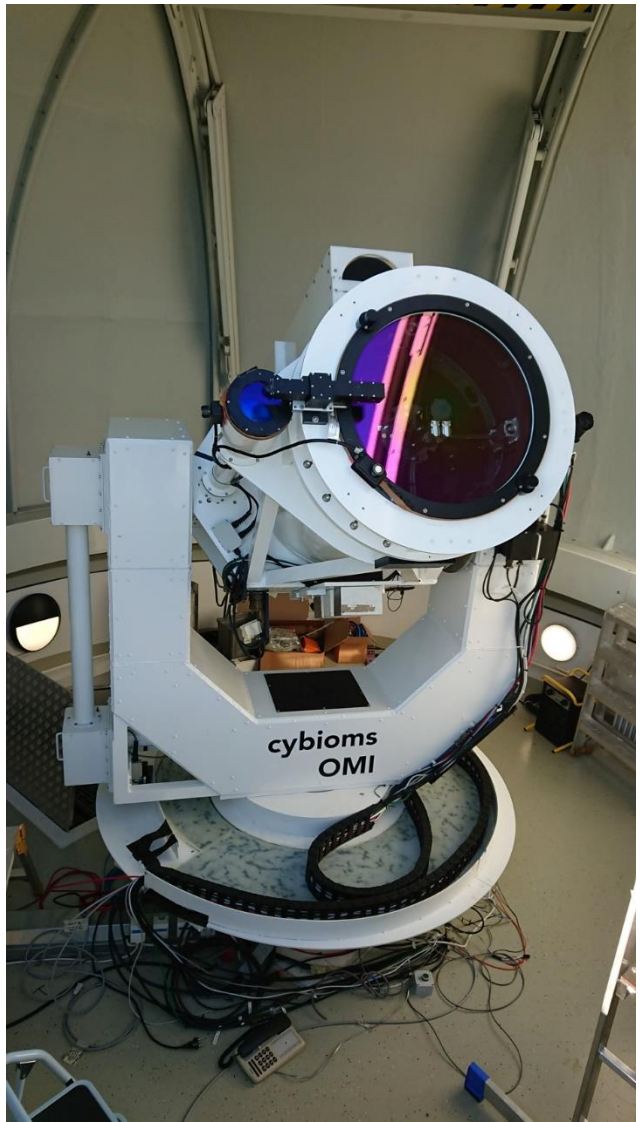
1) Satellite laser ranging (SLR), 1978, renewal 2015-23
2) Geodetic VLBI since 2004, renewal 2016-23
3) Geodetic GPS/GNSS receiver, since 1992, 2014
4) Superconducting gravimeter 1994, renewal 2014/16
5) Absolute gravimeter FG5X-221, 1988, renewal/upgrade 2004, 2013
6) Pillar network + facilities for local ties
7) GNSS receiver, real-time NASA tracking network (NASA)
8) REGINA GNSS receiver. CNES France 2013
9) DORIS beacon. CNES, France 1992, renewals 2013, 2021
10) Seismometer (Seismological Institute, Univ. of Helsinki)
11) A site for absolute gravimeter intercomparison
12) Fundamental gravity point of Finland
13) Fundamental point of the Finnish height system N2000, 2006
14) Pillar network for GNSS antenna calibration tests, 2014
15) A soil moisture tracking network
16) Vaisala weather station, 2015
17) TerraSAR-X retroreflector (DLR, TuM) 2013
18) (In)SAR reflectors (Sentinel) for geodetic purposes, 2023

Also major upgrades in the station infrastructure

New Main building

- Construction of the new main building started in October 2021
- The building was handed for us in August 2022
- New building designed with VLBI in mind
  - dedicated space for VLBI operation
  - special attention to reducing RFI, including building-wide RFI shielding mesh/netting

Satellite Laser Ranging (SLR)



- 3rd generation SLR system is being commissioned, major delays due to telescope subcomponent manufacturer
- 2kHz 532nm laser
- System fully capable of daytime operation
- Fast-moving telescope to minimize the target acquisition time
- New observatory building
- Aircraft avoidance via primarily via ADS-B receivers, no radar

Geodetic VLBI

- Geodetic VLBI sessions have been observed since 2005 in collaboration with close-by Metsähovi Radio Observatory of Aalto University using their legacy radio telescope (a few sessions annually)
- A dedicated VGOS-compatible (single) radio telescope system for NLS/FGI
- 13.2 m VGOS radio telescope (MTM) built in 2019
- A 2.1-14 GHz QRFH broadband receiver (Yebes). First light with VGOS telescope was obtained in 2020
- Backend is DBBC3 + FlexBuff
- Commissioning and warranty repairs 2021-2022

Gravimeters

- First absolute gravimeter in 1988, AG upgraded to FG5X in 2013
- First superconducting gravimeter in 1994. SGs iOSG-022 and iGrav-013 have been operational since 2016
- Scintrex CG6 relative gravimeter was procured in 2021 within the project FLEX-EPOS supported by the Academy of Finland to complement our RG pool
- We are the National Standards Laboratory for free-fall acceleration

GNSS

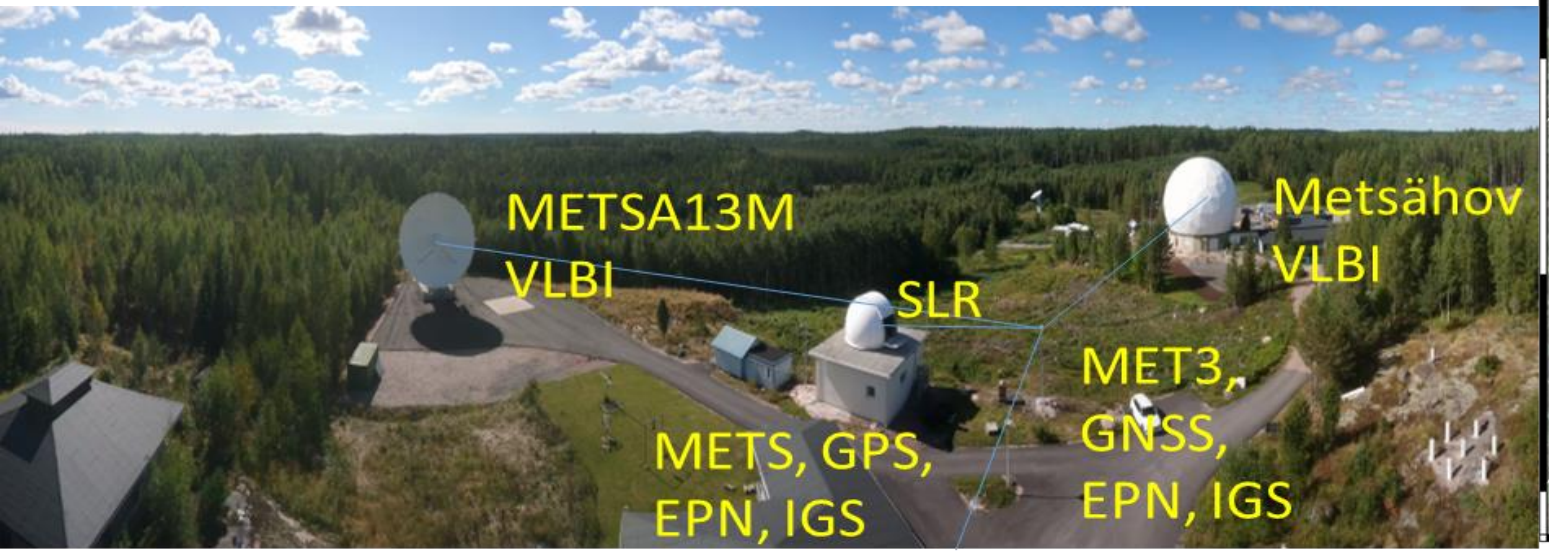
- Continuous GPS measurements since 1990
- 2 IGS receivers (+1 at DORIS site), NASA/UNAVCO receiver, REGINA receiver, and others for research, time, etc.
- Calibration/validation field for antennas

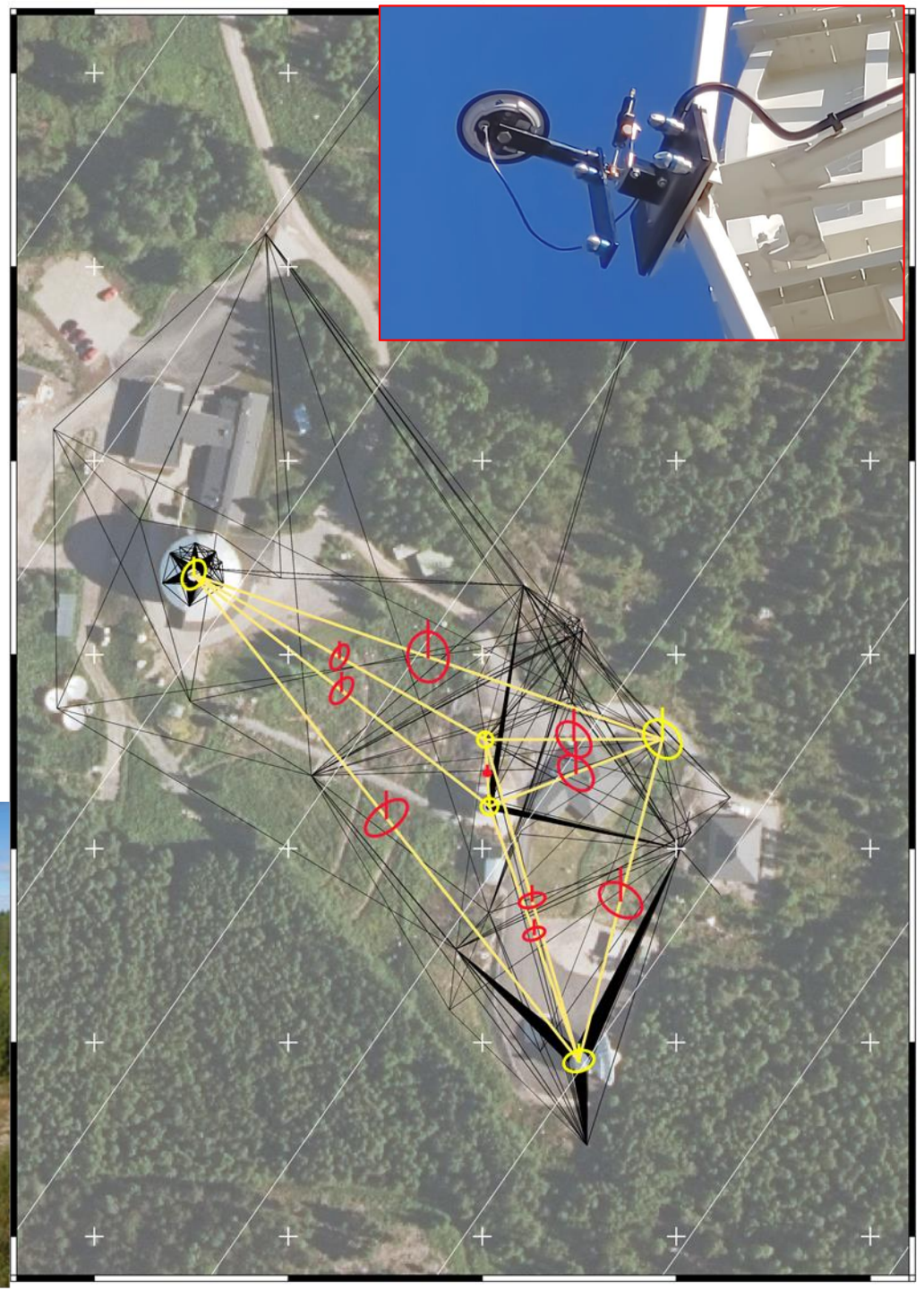
DORIS & REGINA

- Doris beacon since 1988
- 4th gen. beacon installed in 2021, and a new instrument cabin 2022
- Co-located with REGINA (CNES) GNSS receiver since 2013
- DORIS beacon is placed ~3 km from other Metsähovi instruments to avoid RFI

Local ties

- The local survey and monitoring network consists of concrete pillars equipped with adapters for instruments.
- All local ties between the reference points in Metsähovi have been completed. Measurements will be repeated regularly.
- Readiness to continuous monitoring of the VGOS antenna with two GNSS antennas attached to the edges of the dish





Connectivity/data transfer

- New fiber-optics link with 100Gb capacity was installed in 2021
- Current connection is 10Gb/s. It will be upgraded to 100Gb/s in 2022.
- A 60-km-long time and frequency transfer link via fiber optics has been established between Metsähovi and VTT MIKES (metrology institute of Finland), connecting our time base to the national realization of UTC. Technologies used are both commercial White Rabbit and in-house built (for high-precision frequency transfer).
- This work was done under projects funded by the Academy of Finland.

Official opening 30.8.2022

NLS Director General Arvo Kokkonen welcomed the guests, and the Minister of Agriculture and Forestry, Mr. Antti Kurvinen started the VGOS radio telescope.

Next steps

- Metsähovi Geodetic Research station (maintenance and operations) is added to the Government budget 2023 –
- NLS creates a new unit called ”Geodetic Infrastructures”
  - FinnRef stations
  - RIMS stations
  - Metsähovi
- First tasks of the unit is to get all equipment fully operational
- We remain responsible for science, development, data quality and international contacts

Conclusions

- Metsähovi Geodetic Research Station has provided various data products to IAG Services since 1978.
- Renewal started 2012, and all major instruments have been now renewed or on commissioning phase
  - GNSS and gravity equipment are operational and produce data for IAG Services
  - VGOS and SLR systems are on commissioning phase

- Infrastructure and facilities are also renewed
- From 2023 on the new Geodetic Infrastructure Unit will be responsible for the functionality of instruments and networks.
- We remain responsible for science, development, data quality and international contacts