Current status of the new Metsähovi kHz SLR system

Jyri Näränen & Arttu Raja-Halli
Finnish Geospatial Research Institute, FGI, jyri.naranen@nls.fi

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Introduction:

Metsähovi Geodetic Research Station of the Finnish Geospatial Research Institute (FGI) of National Land Survey of Finland (former Finnish Geodetic Institute) is one of the Global Geodetic Observation System (GGOS) core sites that is equipped with all fundamental space geodetic techniques (SLR, VLBI, GNSS and DORIS) together with superconducting and absolute gravimeters. Since 2012, FGI has been renewing the instrumentation at Metsähovi. As part of the station renewal, FGI is now in the last phases of establishing a new, modern, kHz SLR system in Metsähovi.

The Telescope

- Bistatic 50cm & 10cm telescope manufactured by Cybioms Corp. (USA)
- Installation in Metsähovi early 2016, installation finalization ongoing
- High speed gimbal to allow fast tracking and interleaving between targets
- Capable of tracking objects with orbits between 200 - 25000km, during night and day, with a few arcsecond accuracy.
- Optics suitable for 532 and 1064nm enabling the possibility for, e.g., future space debris observations in NIR
- 152mm auxiliary (third) telescope equipped with high QE CCD for optical tracking of targets
- Special attention has been placed in enabling local tie measurement with 1mm accuracy to other geodetic measurement systems at Metsähovi such as GNSS and VLBI

The new Metsähovi SLR telescope. The telescope is bistatic, with a closed-tube design for reducing the need for cleaning mirror surfaces and keeping the optical surfaces water condensation free. The slit-type dome provides additional functionality as a sun shield during day-time operations. The dome is operated in such a way that the Sun is never allowed to shine directly inside the dome. The detector is located in a specially built detector box at the Cassegrain focus of the telescope. The auxiliary telescope is missing in this image.

New observatory building

- New observatory building was built in 2014 with a 5.3 meter Baader GmbH dome (Germany)
- Very stable pillars anchored directly to bedrock for the telescope and optical tables
- High speed dome allowing fast tracking and keeping the telescope in shadow at all times
- When dome is closed, the humidity is actively controlled to minimize condensation buildup
- Instrument room temperature stabilized within one degree
- Operator controls everything from a separate office room
- Entrance to the observing level through the building for easy and safe access especially during winter

The new Metsähovi SLR observatory building. Radome of Aalto University radio telescope, currently used also for geodetic VLBI, in the background

Control software and electronics

- Master control software SCOPE and new range gate generator by DiGOS GmbH (Germany) installed and tested in August 2015. SCOPE controls all station hardware components in real-time, running on a single Linux based workstation (with real-time kernel)
- Range gate generator allows kHz range-gating to ranges above GNSS and could be modified to be used in space debris observations, e.g., multi-static observations
- Post-processing software originally produced in Riga SLR station installed and tested in August 2015. The SW is routinely used in Riga and Potsdam stations.
- HighQ 2kHz 0.4mJ laser, maintenance and alignment by HighQ in Spring 2015, new NLO-crystal in August 2015
- 2 C-SPADs by Peso Consulting
- A033-ET Riga event timer, with linux drivers, controlled by SCOPE.

Auxiliary instruments

- Aircraft safety:
  - Airnav Radarbox ADS-B receiver
  - Kinetic SBS-3 ADS-B receiver
  - Alcor OMEA allsky camera
  - Video camera on telescope, microphone
  - Preliminary comparison of the two ADS-B receivers done in October 2015
  - Due to nearby astronomical radio telescope, no possibility for an active radar
- State-of-art Vaisala meteo station with T, RH, P as well as global radiation, precipitation and wind

Conclusions

- All the major parts of the new SLR system are expected to be ready by the end of 2016, the last remaining major item is the finalization of telescope installation.
- Integration and testing of the system is expected to start during winter 2016-2017. The aim is to start routine SLR operations by the end of 2017.
- In 2015, FGI investigated system's feasibility for space debris observations in a MATINE-funded research project.
- The system is designed to be easily upgradeable in the future to be able to participate in e.g., space-debris tracking and time transfer studies.

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FINNISH GEOSPATIAL RESEARCH INSTITUTE
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