Progress Report on the New SLR System of GGOS's Core Site Metsähovi, Finland.

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Abstract

Metsähovi Geodetic Research Station of the Finnish Geospatial Research Institute (FGI) of National Land Survey of Finland (NLS) (before 1.1.2015 Finnish Geodetic Institute) is one of the GGOS's core sites and equipped with all the fundamental space geodetic techniques together with superconducting and absolute gravimeters. First SLR observations in Finland were made at the Metsähovi research station already in 1978. In 2012 the Ministry of Agriculture and Forestry granted a special fund for upgrading the instrumentation of Metsähovi and the national GNSS network FinnRef. With this funding it became possible to acquire a completely new modern kHz-capable SLR system. Here we present the current status of the upcoming new SLR system.

New Observatory

The first SLR building in Metsähovi, erected in 1975 was torn down in August 2014 and a new modern observatory building was constructed to its place. The observatory building with a 5.3m dome by Baader Planetarium GMBH (Germany) was finalized in December 2014. In the middle of the building stands a ~3.5m high hollow rectangular concrete pillar which is anchored to bedrock and separated from the floor structures to minimize all vibrations and movements. The new telescope will stand on the pillar at the second floor and will be sheltered by the weather proof dome. On the ground floor the observatory has two rooms. All the SLR electronics as well as the HighQ 2kHz 532nm laser will be located in a room with an almost clean-room environment and temperature stability within one degree. Operator will control everything from the second room and entering the instrument room or the dome are necessary only during maintenance or when adjusting or installing something. In the instrument room the pillar has two large optical windows 90degrees apart to two separate optical tables from which two independent lasers can be guided up through to the telescope's Coudé path. This will allow in the future the possibility for using e.g., a more powerful laser for space debris observations.

New Telescope

FGI published an international invitation to tender on March 2013 for procuring a new state-of-the-art SLR telescope system to Metsähovi. In September 2013 the contract was awarded to Cybioms Corp. (USA) who will supply FGI with a bistatic telescope system with a 0.5m receive telescope and a 0.1m transmit telescope. The CSPAD detector will be installed into the Cassegrain focus of the telescope into an environmentally sealed detector box. The detector box will have space also for additional detectors or cameras. The telescope will be installed to

Metsähovi during fall 2015. The telescope will be capable of tracking objects with orbits between 200-25000km with few arcsecond accuracy during night and day.

Figure 1. The new SLR building of the Metsähovi Geodetic Research Station.

SCOPE – SLR Control and Operation Software

SCOPE is a software stack for SLR stations which covers all aspects of the SLR operation. It was initially designed and developed by SpaceTech GmbH (STI) for the SLR station in Potsdam and is now being adapted for the new kHz SLR system in Metsähovi. The SCOPE software stack consists of a daemon which commands and controls all station hardware components in real-time, an operator interface which allows the operator to monitor and perform all SLR operations and the SCOPE station simulation for software verification, troubleshooting and training. All these software components are running on a single Linux based workstation (with real-time kernel) (Fig. 2.).

Key aspects:

- Build on top of a state-of-the-art operating system with continuous long-term support
- Modern modular software design which allows extending the software for new SLR applications

- Flexibly exchangeable drivers for all hardware components like telescope, dome, range gate, laser, optical devices, rain & meteorological sensors, ... allowing an adaptation of the software to different SLR stations
- Configurable safety limits for hardware and operations like speed limits for dome and telescope, minimal sun distance, minimum tracking elevation, etc.
- Easy to use central operator interface to command and control all aspects of the station and the SLR operation.

In addition the SCOPE Station Simulator supports:

- Validation and verification of hardware drivers or software changes
- Troubleshooting of faults which result from interaction between different subsystems
- Training of new operators even without already existing hardware

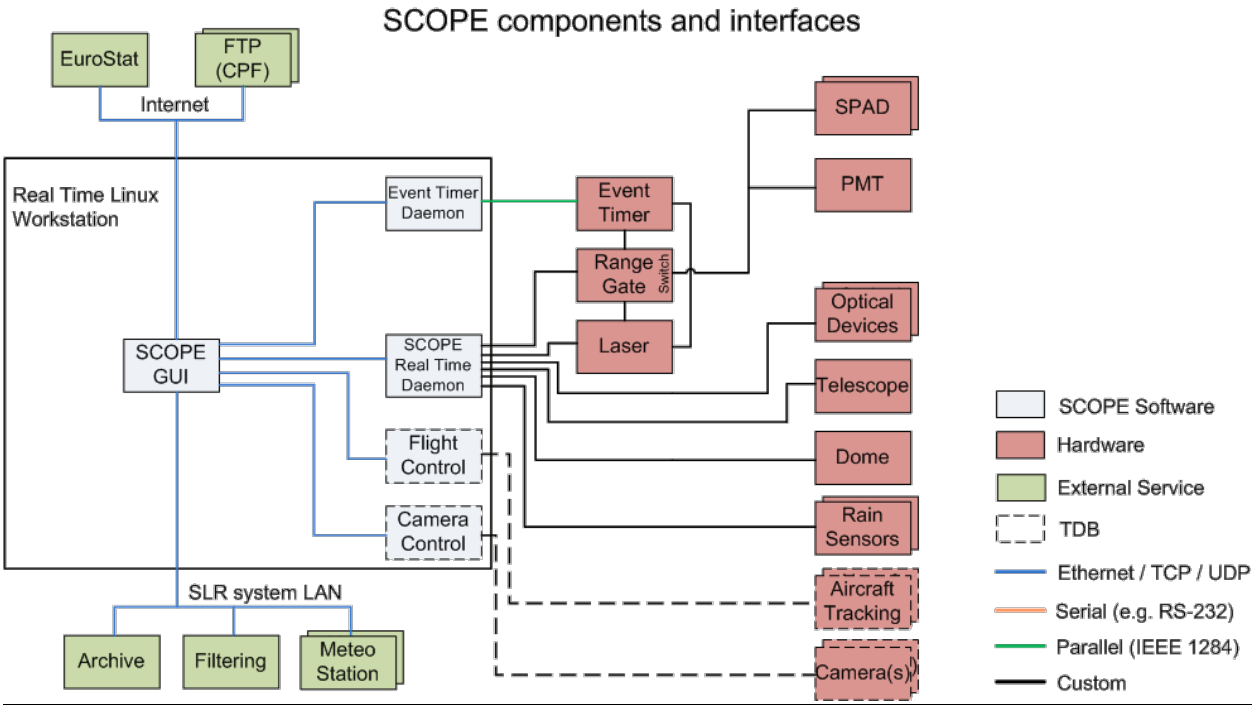

Figure 2. A block diagram of the SCOPE.

The new range gate

SpaceTech GmbH and GFZ are currently developing an enhanced version of the existing Potsdam range gate for the Potsdam and Metsähovi SLR systems. Beside a major hardware upgrade, the new version will also include a newly developed firmware. The hardware upgrade is based on commercial off-the-shelf hardware components for easy reproduction and includes a

faster processor and a better time resolution. The new firmware will support all the standard SLR applications but is already designed to be extended for advanced SLR applications like synchronised space debris tracking together with other stations.

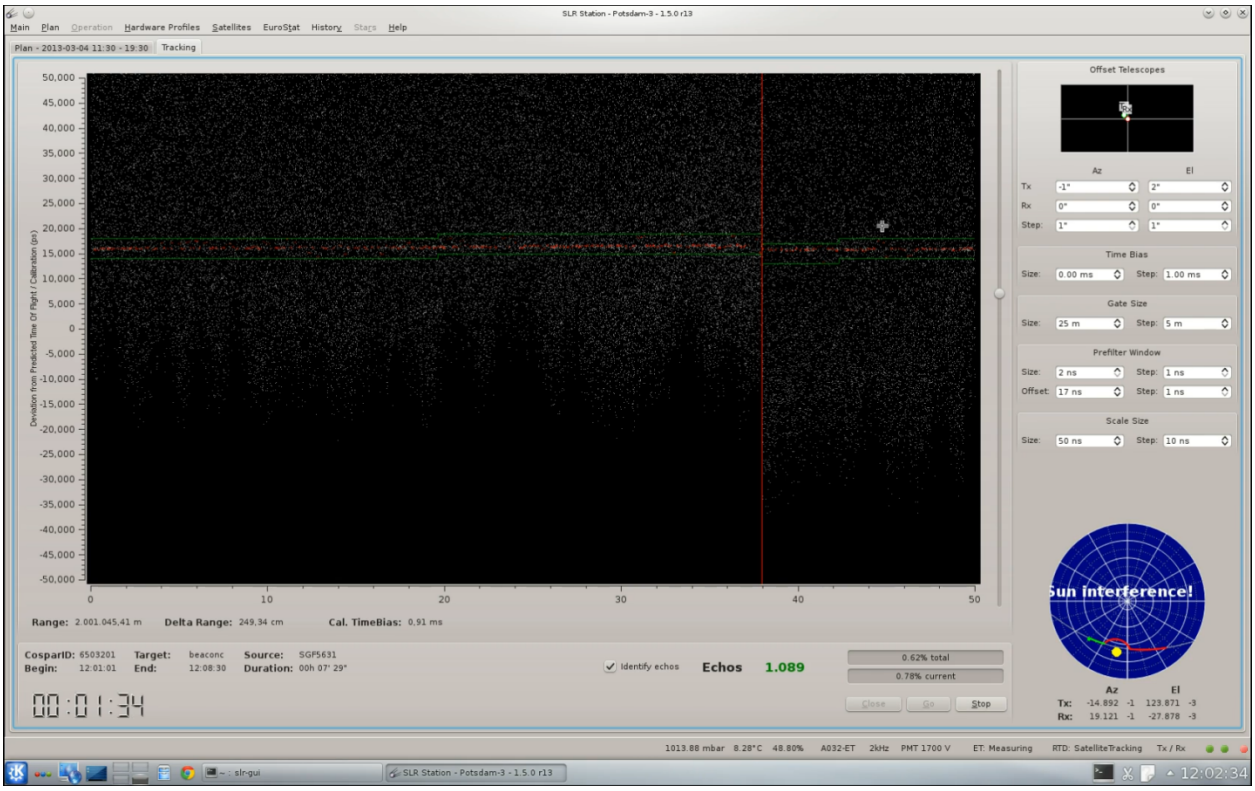

Figure 3. A screenshot showing the user interface of SCOPE while tracking Beacon-C with automatically performed sun avoidance.

Conclusions and Future Work

Much effort has been put to establishing the third SLR system of Metsähovi: new observatory, new telescope and the new control software, but a lot of engineering work is still needed before we can start tracking. All the major pieces of the system are expected to be ready by the end of 2015: the new telescope, the SCOPE and maintenance of the the HighQ 2kHz laser. The aim is to start testing the system during winter 2015-2016.