New 2 kHz satellite laser ranging system at Metsähovi Geodetic Fundamental Station

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We present the current status and future prospects of the upcoming new Metsähovi Geodetic Fundamental Station (MGFS) kHz satellite laser ranging (SLR) system. MGFS, operated by the Department of Geodesy and Geodynamics of the Finnish Geospatial Research Institute (FGI, National Land Survey of Finland), is one of the Global Geodetic Observation System (GGOS) core sites that is equipped with all fundamental space geodetic techniques together with superconducting and absolute gravimeters. First SLR observations in Finland were made at MGFS already in 1978. In 2012 the Ministry of Agriculture and Forestry granted a special fund for upgrading the instrumentation and infrastructure of MGFS and the national GNSS network FinnRef. With this funding it became possible to acquire a new, modern, kHz-repetition-rate-capable SLR system. The new system will provide at least an order-of-magnitude improvement both in ranging accuracy (mm vs. cm) and data rate (2000 vs. $<$10 datapoints per second) over the previous MGFS SLR system.

SLR is a space-geodetic measurement technique where the round-trip flight time of short laser pulses to, e.g., Earth-orbiting satellites equipped with retroreflecting mirrors or prisms is used to range the objects with an accuracy that is a couple of mm for low-Earth-orbit targets. SLR can be used, e.g., in satellite orbit determination, to study the changes in the low harmonics of Earth's gravity fields, and to determine the position of the Earth's center of mass. Traditional SLR targets fall broadly into three categories: navigation system satellites, Earth observation satellites, and geodetic satellites. Lately, using SLR systems for space debris studies (orbit improvement, attitude parameters, etc.) has been emerging as a new key area of SLR research. There are currently approximately 40 operational SLR stations worldwide.

Building a new SLR system is a challenging task as there are few off-the-shelf solutions available: most of the existing stations have developed their own strategies for software and hardware during several decades. Key items in an SLR system are: A fast-moving telescope, either with one or two optical channels for separating the transmitted and received laser pulses; a laser with a stable repetition rate (Hz-kHz), energy level and pulse length (few picoseconds); a time interval counter / event timer for timing the flight time; a detector for observing the returning laser pulse, and a time reference.

Currently, most of the components for the MGFS kHz system have been procured and in addition a new observatory building for the system has been built. Contract for building the new telescope was awarded in late 2013, after an international call for tenders, to Cybioms Co., USA. The installation of the telescope is expected to take place in December 2015. The aim is to start testing the complete SLR system during winter 2015-2016. In addition, a MATINE funded pilot study has been made of the use of MGFS SLR system for space debris observations.