Metsähovi research station – four decades of SLR observations 1978-2005&2016->

Arttu Raja-Halli, Jyri Näränen and Markku Poutanen
Finnish Geodetic Institute

First generation 1978-1993

Development of the first Finnish SLR system started in 1972 with the co-operation of the Finnish Geodetic Institute (FGI) and the Helsinki University of Technology (HUT). First observations were recorded in 1978 at the Metsähovi research station by FGI with this system.

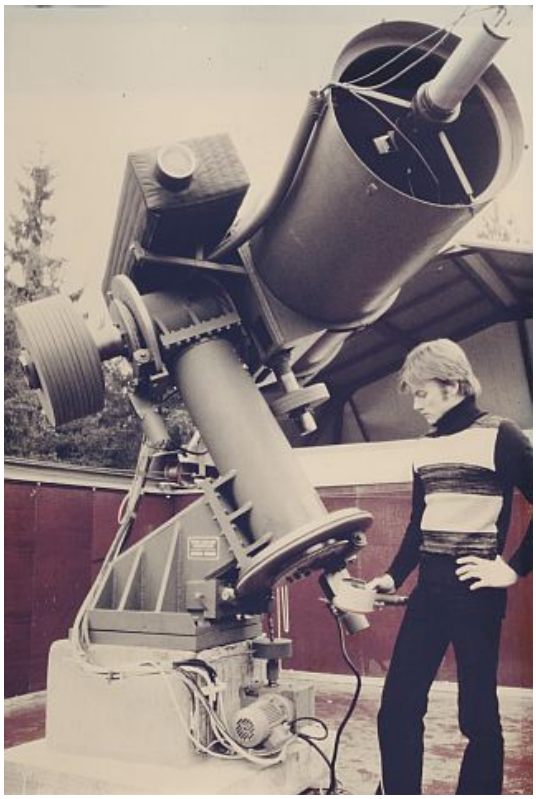

Figure 1. Testing of the first SLR system of FGI in 1981. Photo: FGI

Development of the first Finnish satellite laser ranging system started in 1972 when a grant from the Academy of Finland was awarded to Finnish Geodetic Institute (FGI) and Helsinki University of Technology (HUT). Designing of the new SLR system was started by **Seppo Halme** – former professor at HUT, and **Juhani Kakkuri** (emeritus Director General of FGI) with the help of Kari Kalliomäki, Matti Paunonen, Ossi Ojanen and Awnashilal Sharma. An SLR observatory designed by Kakkuri was built for FGI in Metsähovi, where the HUT radiotelescope as well as the University of Helsinki's astronomical telescopes were located. The telescope was modified from an astronomical telescope made in Tuorla observatory (Turku, Finland) equipped with a 63cm parabolic main mirror and driven with stepper motors (Figure 1.). A Rruby laser made in-house by FGI and HUT was mounted on top of the telescope. Laser energy was 1J, pulse length was 20ns, and repetition rate of 4 pulses per minute was achieved. The laser was so powerful that it went straight through a razor blade. The first observations with this system were acquired from GEOS-3 satellite in 1978 with accuracy of approximately 0.5m. Range accuracy to Lageos was 0.5-1.0m and daytime observations to GEOS-3 were also possible.

Second generation 1993-1997

In 1992 plans for a new FGI made 532nm Nd:YAG laser were made and the new laser replaced the old ruby laser in 1993. This system was operational until 1997.

By the year 1986 the ruby laser was improved to shoot 15 pulses per minute with 4ns pulse length, which reduced the RMS in range observations to approximately 0.2m. However, further improvement of the laser was essential for better accuracy. In 1992, development of Nd:YAG laser was started in FGI and in 1993 the ruby laser was replaced by a Nd:YAG laser made by Dr. Matti Paunonen (Figure 2.). Nd:YAG laser was capable for 1Hz repetition rate with 4ns pulses, with considerably lower energy of 50-100mJ. This configuration was used until 1997 and the accuracy of ~5cm was achieved.

Figure 1. Dr. Matti Paunonen doing SLR observations with the third generation SLR in the 90's. Photo: FGI

Third generation 1998-2005 (Station 7806)

In 1993 FGI was able to procure a new 1m Cassegrain telescope from University of Latvia. Together with an improved Nd:YAG laser this new SLR system operated from 1998 to 2005 with approximate RMS accuracy of 15mm to Lageos.

Simultaneously with operations with the 2nd generation system a development of a new SLR system was started in 1993 when FGI was able to purchase a 1m Cassegrain telescope from the University of Latvia (Figure 3.). A new observatory building was built for the new system. The laser was located in a separate room and the beam was transmitted through the main mirror, hence the system was a monostatic. The laser used in this system was an improved version of the in-house built Nd:YAG with pulse length of 50ps and energy of 10mJ. First successful observations were made in 1998 and the RMS accuracy to Lageos was 15mm.

Figure 3. The third generation SLR telescope of FGI with 1m main mirror. Photo: FGI

Fourth generation 2016->

In 2012 arrangements for a totally new and modern kHz-capable SLR system were started. A new bistatic telescope was ordered in 2014 from the Cybioms Corp. with installation at Metsähovi during 2015. New modern observatory building is built to replace the first SLR building and it will be ready by the end of 2014 (Figure 4.). Completely new master control software is built by SpaceTech GmBh during 2014. We expect to get the first observations with the new system in 2016.

Figure 4. New SLR observatory building being built at Metsähovi, October 2014. Photo: FGI

Sudden passing away of Matti Paunonen in 2003 seized the SLR operations at FGI. Hence, SLR observations from Metsähovi ended in 2005, once the Nd:YAG laser built by late Dr. Paunonen became degraded beyond repair. Work was planned to re-initiate with a new higher repetition rate laser which was loaned from Graz SLR station, Austria. Before the final installation of the laser, there opened a possibility to buy a completely new 2kHz laser from HighQ GmBh in 2007.

In 2007, work for the renovation of the telescope was started and also major upgrades were made in the hardware, including C-SPAD detector, new event timer etc. But during the renovation it came evident that the telescope needed major modifications to be able to do kHz-ranging.

Eventually, in 2012 Government granted FGI budget for upgrading the whole SLR station. A new 0.5m bistatic telescope was ordered after an international call for tenders. A new master control software was ordered from SpaceTech GmBh and it will be ready early 2015. New modern observatory building will replace the old SLR buildings in 2014. During 2015 we expect to integrate all the pieces and first echoes are expected in 2016.