
Grasse laser stations in evolutions to future and technological developments

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Abstract

A very important project in term of buildings and technology for telescopes, mount and dome has been started at the Grasse Observatory since September 2005.

A new laboratory has been built in place of historical SLR fixed station (7835) to receive mobile SLR system (FTLRS) for upgrade, development and operations between field missions.

The current LLR station (7845), renamed MeO (for Metrology and Optics), is being completely rebuilt to track and range in the future from "Low Earth orbiting satellites" to the Moon and even further to support new missions in the solar system. The project status will be reported in this presentation with both technological issues and new potentialities for such installations at Grasse.



Introduction and short report 1980-2005 period

The Grasse LLR system with a large and accurate 1.5 meter telescope got first moon returns in 1982.

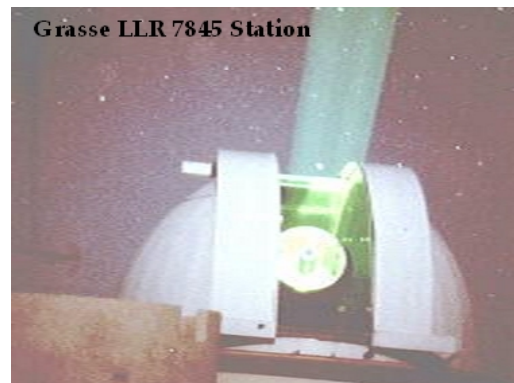
In this configuration (0.2 Hertz ruby laser with 3 nanoseconds pulses), 1166 normal points have been acquired in 5 years with an RMS of about 20 centimeters.

In 1987 a major upgrade was achieved on this system with a new Yag laser (10 hertz-300 ps pulses) and timing system (Dassault event timer).

During this very operational period, about 8500 npts (65% of the global network) were acquired with an rms of 3 cm and a stability at some millimeters level.

The station stopped in summer 2005 for new developments described below in this paper.

This very efficient SLR system installed at Grasse observatory in 1975 at 30 meter from the LLR system tracked in thirty years about 35000 satellites passes.



The quality and quantity of data over the years of this core station is very impressive and scientific community can thanks a lot observers, engineers and scientists involved in this process very consuming in term of manpower.

The station stopped definitively his activity in summer 2005 to involve laser staff in new evolution for SLR/LLR activity.

Historical SLR station definitively stopped, waiting South Africa collaboration

In September 2005, telescope and mount were dismantled and temporarily installed in the old trailer waiting new future abroad.

In fact for some years, South African colleagues are promoting an LLR/SLR development for this country in collaboration with global scientific community.



OCA/CNES/GRGS proposed to participate to this venture in putting this one meter telescope at South African geodesists disposal. Of course the mount and mechanical devices of this system will have to be refurbished (encoders, drive motors, coude mirrors etc.) and a budget is already planned by this partner for renewing this telescope/mount at HartRAO.

In the context of this interesting project in South Hemisphere a new site has been found in a very favorable place for SLR/LLR activity in term of meteorological conditions. We can see here on the next photo, this future site for Space Geodesy Observatory near Matjiesfontein at about 250 km north of Cape Town and 70 km south of GFZ Geodynamics Observatory and South African Astronomical Observatory.

After some administrative agreements in progress, OCA 1 meter telescope/mount should be shipped to South Africa before summer 2007.



Future site for Space Geodesy Observatory in South Africa



1 meter Telescope/mount in trailer at OCA in 2006

New laboratory for FTLRS developments and operations built in place of old telescope :



Just in the place of old one meter telescope, we built a new laboratory perfectly suited to host mobile system between fields campaigns.

The configuration of the setup has very original features.

The group laser /mount /telescope is installed on a platform elevator with two possible positions:



← **-One down** in the laboratory to achieve technological developments tuning and maintenance in good



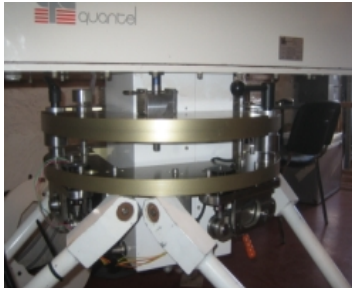
-The other one 1.40m higher (right picture)

conditions (left picture). with the roof open and the telescope able to view the sky and to achieve operations on satellites in normal conditions with operator control facilities inside the building. ↗



The reference point of the station in high position has been designed to be very stable and repetitive at better than one millimeter level. In this observation place, the station is no more supported by but lie on a metallic square embedded in the roof concrete, such a way the platform can be down in this phase.

For the campaigns setup the group laser/mount/ telescope is took off from the special support fixed on the elevator in the laboratory and installed in the tripod which can be easily packed for shipping and deployed on site to the concrete pad.



New devices (electric jacks software controlled) to easily adjust leveling in automatic mode have been

developed. This new facility is very important to assist local observers with remote control capability during outside campaign.



Ftlrs in campaign configuration – Ajaccio 2005

LLR Station renamed to MEO and completely rebuilt

In summer 2005 we stopped temporarily the old LLR station in order to modernize and to imply it in more goals (science programs and technology).

This important project in term of funding and manpower implied for design and buildings had been prepared for three years with detailed technical studies and looking in the future for emerging new projects on next 20 years.



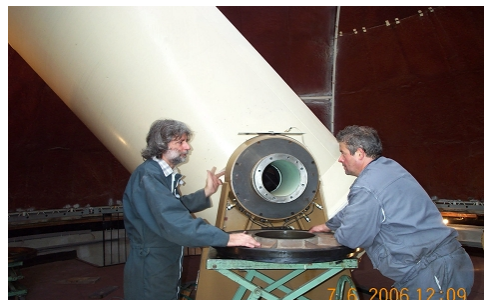
The main idea is to have flexibility in different configurations :

- **A new generation of Laser Ranging station**
 - From 400 km to the Moon
 - One Way Interplanetary mission
 - Highly Automatic
- **Research & Development facility**
 - New optical links
 - Time transfer experiments
 - One Way Interplanetary missions
 - Detection, Event Timer

A. *Telescope/mount*

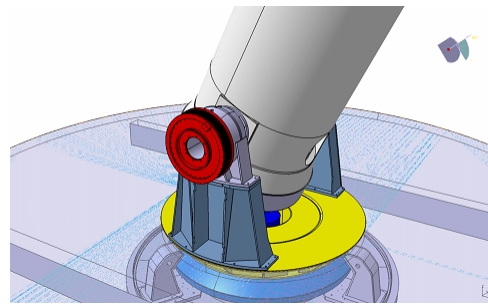
In the future, the mount will be able to have a speed compatible with SLR on lower satellites and this is a very strong constraint on such an heavy system.

We decided to install in this new design powerful and precise direct torque motors on the axes in such a way to have speed multiplied by an important factor .



Nevertheless, the pointing accuracy remains an important challenge especially to range moon and future spacecrafts in solar systems.

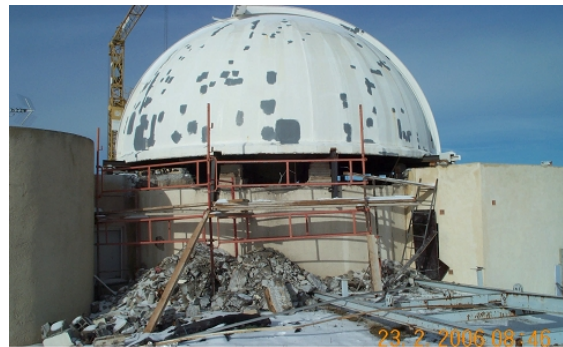
The quality of the encoders installed on the axes and the mechanical stability of the whole setup are been carefully designed and should lead to an absolute pointing accuracy below 1 arc second.



B. Dome

Similar constraints are applied on the dome and in order to remain compatible with mount speediness a lot of modifications are today achieved.

This dome is twenty five years old today and at this occasion the Observatory workshops undertook heavy maintenance works on metallic structures to hope reliable operations in future.

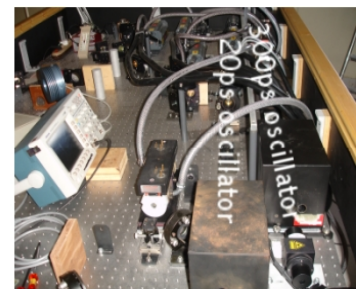


C. Laser and focal laboratories

To track both moon and HEO satellites, two lasers systems in different rooms were operated the past years (Quantel with 300ps and BMI with 20 ps).

A very important work and new design have been achieved to combine both lasers on a single bench with three capabilities

- 800 mJ in 10ns at 10 Hz
- 250 mJ in 300ps at 10 Hz
- 250 mJ in 14 x 20ps at 10 Hz



The last configuration with 14 pulses of 20 ps is a very original design to range the moon very accurately comparable with current SLR systems and achieving a return rate similar to previous configuration (single pulse of 300 ps).

In future, at least **3 focal laboratories** will be installed under the telescope to have different R&D experiments and routine operations accessible with a fast and easy mirror switch on the coude.

Conclusion

- **SLR fixed station (7835) stopped in june 2005**
 - 30 years of fruitful operations
 - Telescope and mount moved in the trailer waiting eventual collaboration abroad
- **New laboratory build in this place for FTLRS**
 - Two position capability with elevator system and opening roof
 - Technology developments
 - Operation on satellites to Lageos.

➤ **Old LLR Station renamed to MEO and completely refurbished.**

- Earth satellite capability 800 to 36000 km Moon reflectors.
- R&D studies and new experiments (Time transfer, transponder...).



➤ **New SLR facilities in 12/18 months**

- Two observing systems (0,13 and 1,50 m telescopes) occasionally collocated.
- Fields campaign for FTLRS (maximum 6 months/year).

