Moon Tracking in Grasse, MeO Station

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Presentation

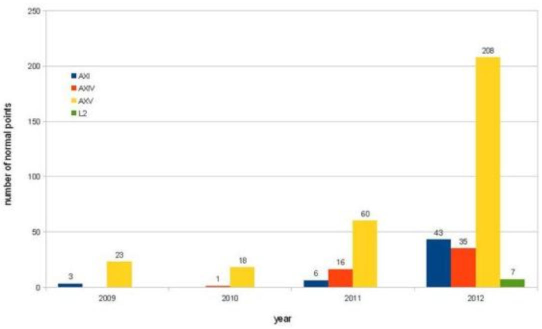
The LLR MeO Station (7845) is located in Caussols (near Grasse), France, at an altitude of 1270m. A 1.54m telescope is coupled to a Cr^{4+}:YAG (100ps, 200mJ in green) for LLR and SLR tracking.
Until 2006 the station was equipped with two lasers: one for the SLR (BMI, 20ps, 50mJ), and one for the LLR (QUANTEL, 150ps, 150mJ).
In 2009, these two lasers were combined into one. This configuration has been very unreliable due to the difficulty of aligning both oscillators in the common three amplifiers chain. We have also had many problems maintaining the quality of the dye cell and the stability of the oscillator. Additionally, the risk of rod breaking was higher due to the difficulty of adjusting the power of this laser.

2012 improvements

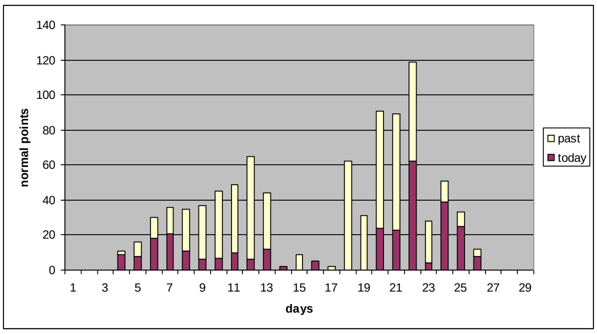
In 2008, during the 16^{th} International workshop on Laser Ranging in Poznan, our colleagues from Honeywell and NASA presented a new oscillator concept, replacing the dye cell with a Sesam crystal:
Dye Cell used in Active-Passive Laser Oscillator Replaced with a Cr^{4+}:YAG crystal Saturable Absorber for NASA SLR Stations
T. Oldham, H. Donovan, M. Blount, J. Horvath, O. Brogdon, D. McCollums, D.Carter, C. Emerson
With the help of Thomas Oldman, Grégoire Martinot-Lagarde developed a new oscillator for the MeO station.
This new oscillator, very stable, permits power increases without danger and eliminates the hazardous chemical products linked to the dye.

Results

The LLR station has returned to a normal level of data production. The arc observations have been increased until mid-day. We are also able to observe closer to the full Moon and hope to soon be able to observe closer the new Moon.



Normal points in 2012



Distribution of Normal points with the age of the Moon

Future

The next improvement of the station will be the installation of an adaptive optic on the telescope.
Depending on atmospheric conditions, the size of the laser beacon on the lunar surface is between 2 and 10 km. The diffraction limit of a 1.54m telescope permits a spot in the range of 200m.
An AO system used for the uplink could improve the efficiency by a factor of 100. This improvement presents some difficulties, such as the need for a high-energy deformable mirror, or the necessity to limit the diffusion of the laser pulses onto the wave front sensor.
The same AO system used for the downlink could permit a reduction in the detection field of view by a factor of 10; the signal to noise ratio would also be improved by a factor of 10. The analysis of the wave front must be performed on the details of the lunar surface while the sun lights it.
Although this improvement seems very interesting, it will be limited to the Apollo 15 reflector, and only when it is in the light. Therefore, unfortunately, it will be not possible to use it for the new and the full Moon and on the other reflectors.

Support

The MeO station needs support to continue to provide LLR data. In this day and age resources, money, and employment are directly connected to the number of publications produced by a team. In Grasse we are mainly a technical team and we don't use LLR data, we provide it.
Our team writes few publications. In the past we have simply asked for acknowledgements in publications using our data. Today this is no longer sufficient. We need to be co-authors in some of these publications, and therefore we need to know when a researcher is willing to add us as co-authors.
Before the end of this year we will send an email to all the known users of these data and we hope to see many positive replies to our request by the end of next year! Our future may depend upon it.

Conclusion

In reading this document, you have probably realised that, even though this new laser is good for LLR, the pulse width seems too large for SLR.
Currently, SLR and LLR are not fully compatible in a common station. SLR tracking needs short pulses at high cadence, while LLR tracking needs very powerful lasers and therefore large pulse widths. LLR could be done with kHz lasers when the reflectors are in the night; but the goal is not to have a lot of echoes when the reflectors are in the night or at the quarter, but to have echoes at the new and the full Moon. However there is a lot of noise during these periods, and opening the gate too often adds even more noise to the signal.
The increasing number of SLR targets limits the time for LLR observations and the time needed for optical adjustments necessary for Moon tracking.
LLR tracking needs a lot of adjustments, a lot of time, and should be coupled only to Lageos tracking for the stability and the positioning of the station. As in the past, difficult targets such as LRE, Radioastron, or coherent targets like LRO can be still be tracked, but tracking other satellites reduces time for Moon tracking.