Moon tracking in Grasse
MeO station (7845)

MeO LLR station

- Telescope diameter: 1.54 m
- Altitude: 1270 m
- Laser: Nd-YAG frequency-doubled 532nm
  - 100ps pulse width
  - 200mJ in green
  - 10Hz pulse rate
- Detection: APD in Single photon mode
Laser configuration

• Until 2006:
  – One laser for satellites: 20ps, 50mJ
  – One laser for the Moon: 150ps, 150mJ

• From 2009 to 2012:
  – One laser, two oscillators

• Since January 2012:
  – One laser: 100ps 200mJ
Why a new laser

• Difficulties to align the two oscillators in the common three amplifiers
• Difficulty of cell dye maintenance
• Difficulty (and danger) to adjust the power
New laser

- Cr$^{4+}$:YAG laser: 100ps, 200mJ in green
Message

• From : Grégoire Martinot-Lagarde
• To : Thomas Oldham

– Thank you very much for your patience and your kindness
– Thank you for helping me to develop this very stable oscillator
An other message

- From: Jean-Marie Torre
- To: T. Oldham, H. Donovan, M. Blount, J. Horvath, O. Brogdon, D. McCollums, D. Carter, C. Emerson

  - Thank you! Your presentation contributes to prolong my life:
    - No dye = No hazardous product like dichloroethane…
2012: Results

Number of echoes

Number of echoes per normal point

Number of echoes

Number of normal points

Distribution of Normal Points with the age of the Moon

Only 3 observations at the full Moon in 1990, 1996 and 2000 during an eclipse
Lunar Laser Ranging
Adaptive Optic (AO)

- The diffraction limit of a 1.54 m telescope could permit to have a spot in the range of 200 m.
- An AO system used for the up link could improve the link budget by a factor 100
- The same AO system used for the down link could permit to reduce the detection field of view by a factor 10: the noise to signal ratio would be improved by 10
- Depending on the atmospheric conditions, the size of the laser beacon on the lunar surface is between 2 to 10 km.
Adaptive optic

• Downlink
  – The analysis of the wave front has to be done on the details of the lunar surface (when the surface is lighted by the Sun)

• Uplink
  – Injection of the laser through the classical optical path
  – High energy deformable mirror
  – Diffusion of the laser pulses onto the wave front sensor

• The speed aberration introduces an angular shift between the uplink and the downlink
  – As soon this angle is greater than the isoplanetism area, the correction between the 2 paths has to be different
  – The lunar surface used to analyze the wave front is shifted of few km from the actual position of the target
What do the scientists need?  
What we can improve?

• More accuracy
• To increase the number of observations
• To increase the arc per night
• More echoes at the:
  
  Full Moon
  New Moon
Which Data Format?

- MNC
  5120091210035843116817924883858265921301910028002928040 087865+05426 5320a1638

- CSTG
  99999
  00001030934478457801532000007147900003000442764102891001
  143231168178488385826592000028908786278502600280224000

- CRD (new ILRS data format)
We need a strong support

• We have no scientist in our observatory using the LLR data! => No publication!

• The value of our job is evaluated on the number of publications!

• Publications = Money
We need a strong support

• If you are user of LLR data from Grasse

• If you want to continue to receive LLR data from Grasse, please add our name in your publications

• Our survival depends on the annual number of publications
If you use Grasse LLR data

• In the past:
  – For publications using LLR data from Grasse the MéO team asked for acknowledgement of input

• Now:
  – We need to be co-authors
  – We need to be informed
Grazie !!!