Moon tracking in Grasse MeO station (7845)

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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

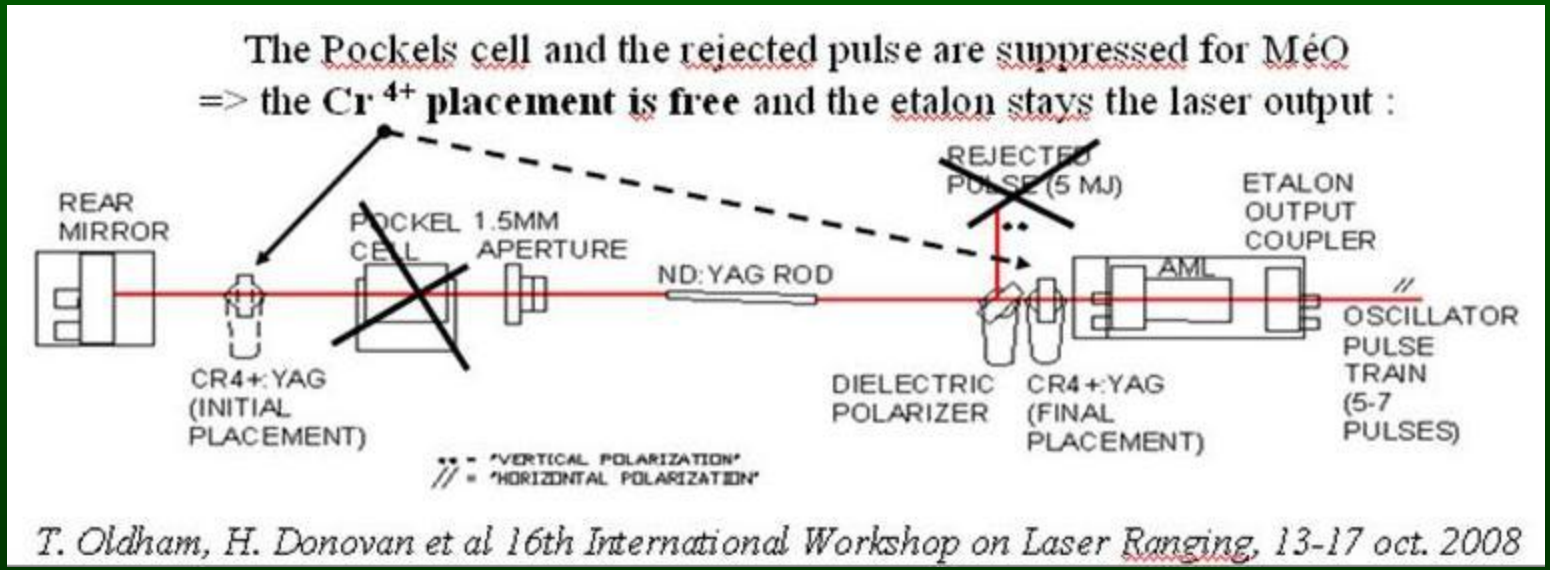
- Until 2006 :
  - One laser for satellites : 20ps, 50mJ
  - One laser for the Moon : 150ps, 150mJ
- From 2009 to 2012 :
  - One laser, two oscillators
- Since January 2012 :
  - One laser : 100ps 200mJ

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

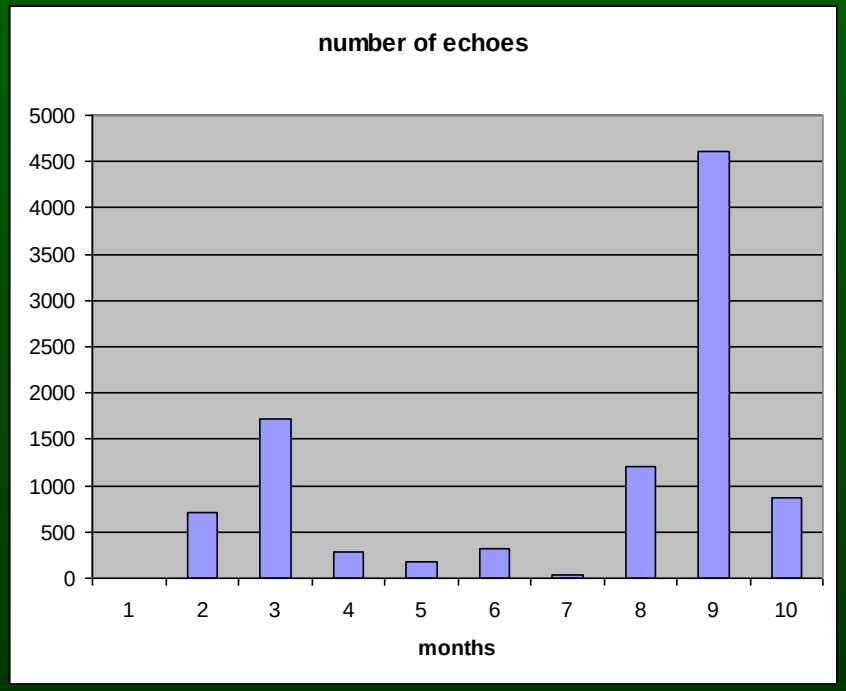
  – Thank you very much for your patience and your kindness
  – Thank you for helping me to develop this very stable oscillator

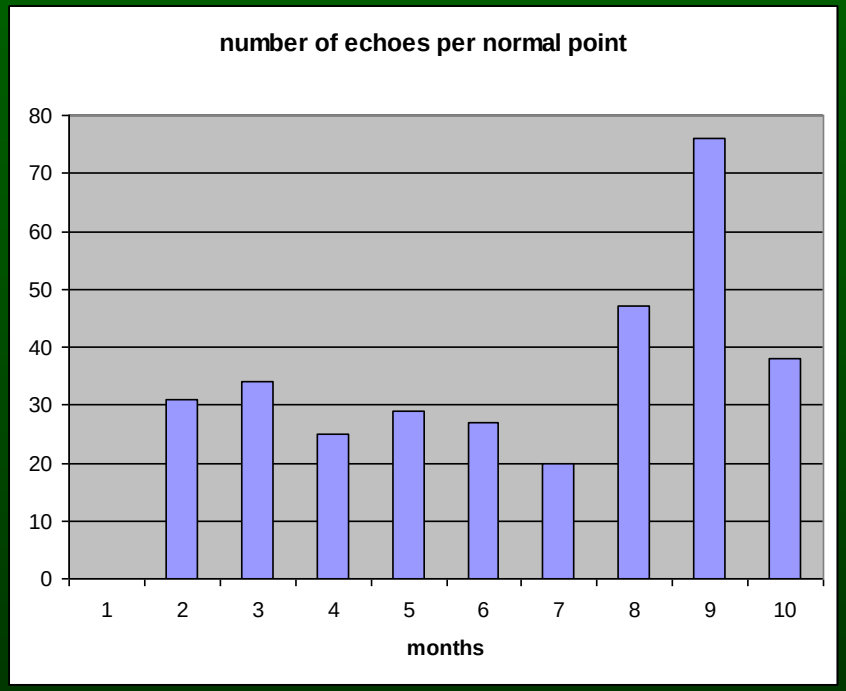
An other message

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

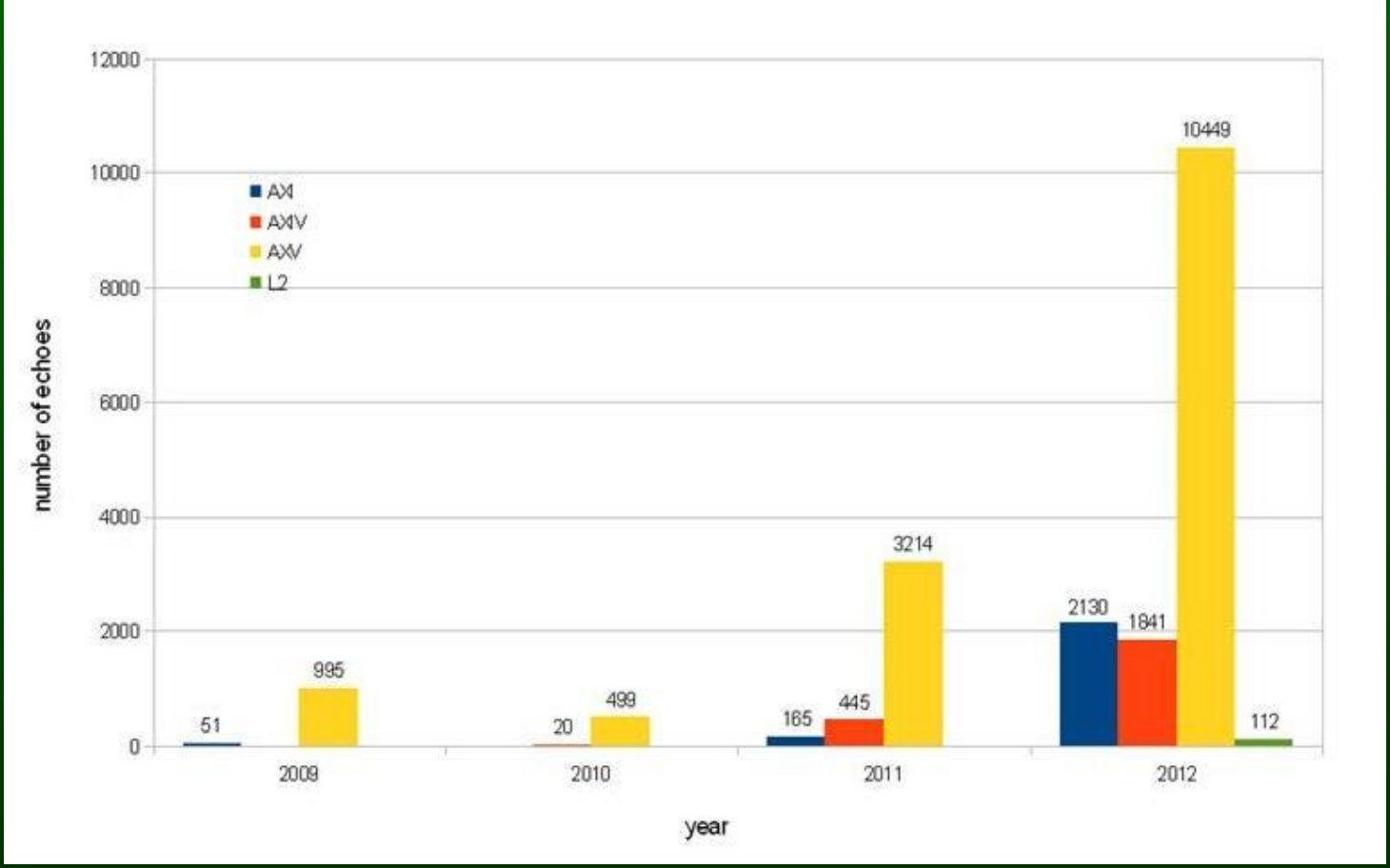
  – Thank you ! Your presentation contributes to prolong my life :
    - No dye = No hazardous product like dichloroethane…

2012 : Results

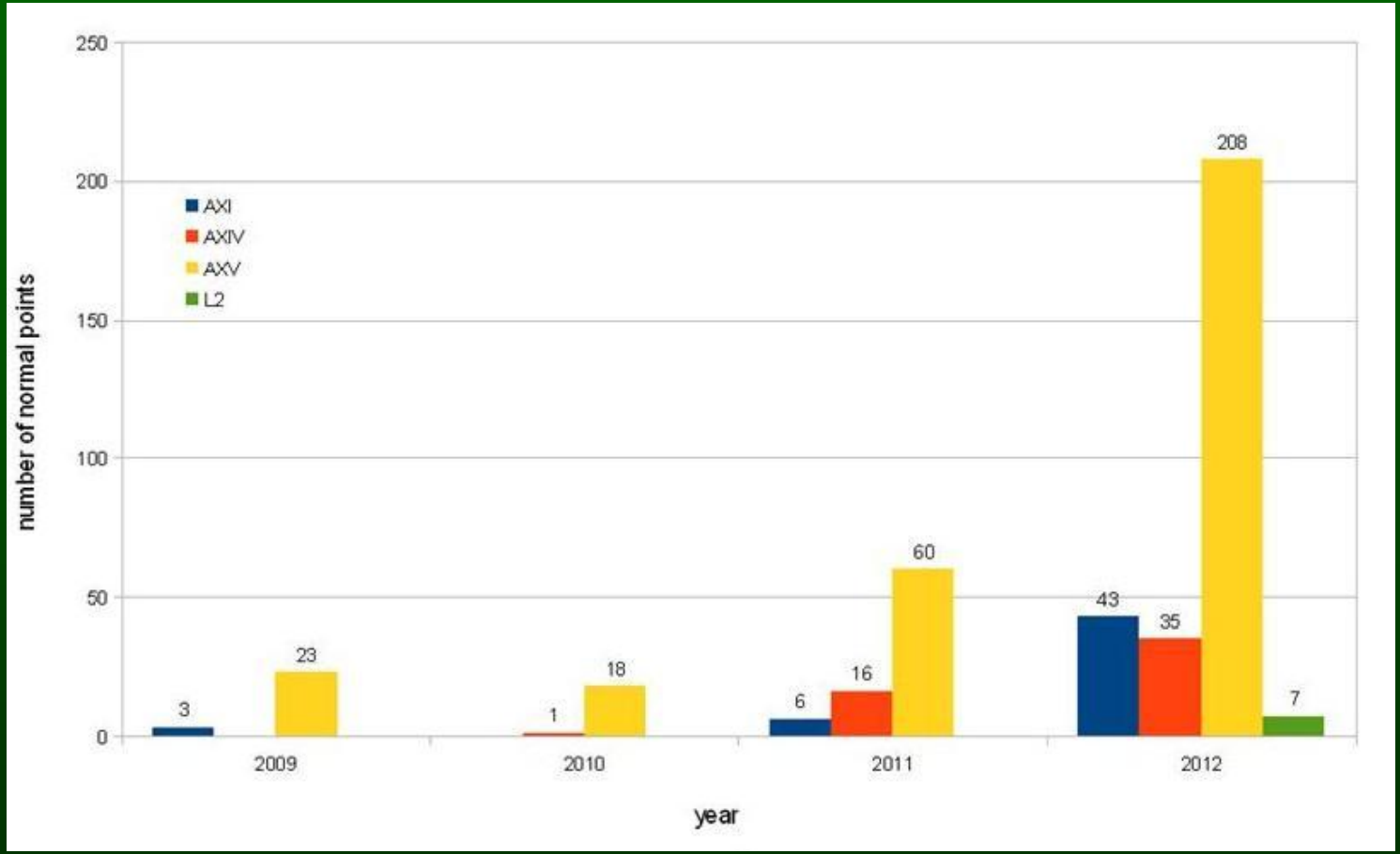




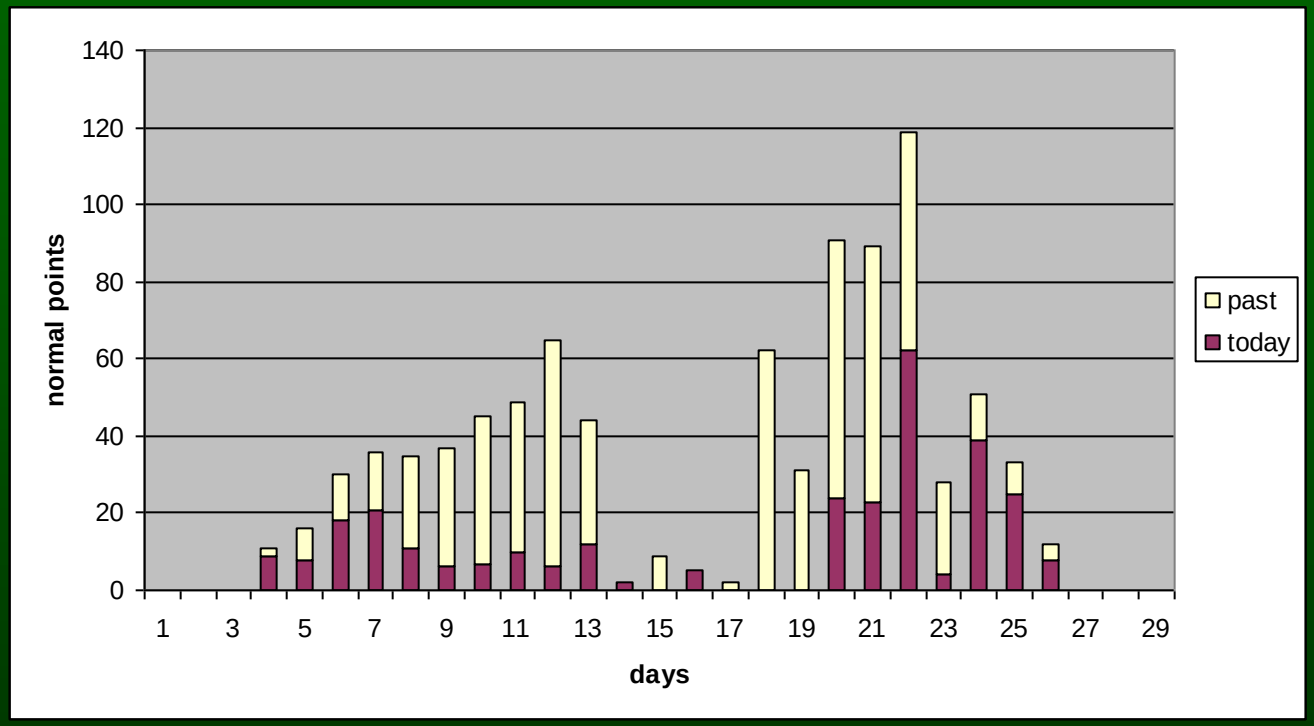
Number of echoes



Number of 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
00001030934478457801532000071479000030004427641028910011432311681784883858265920000289087862785026002802240000
```

- 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 !!!