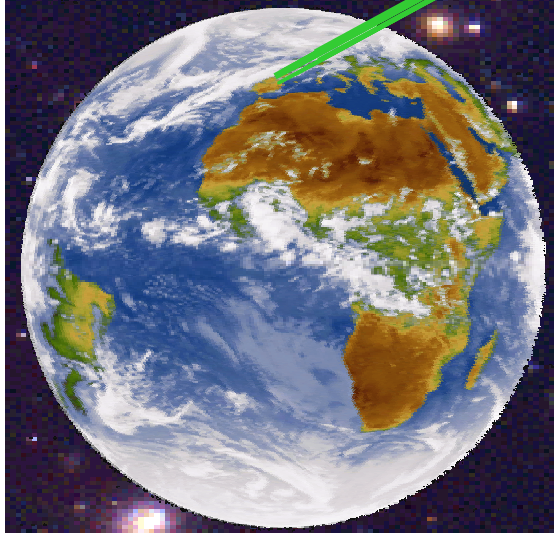
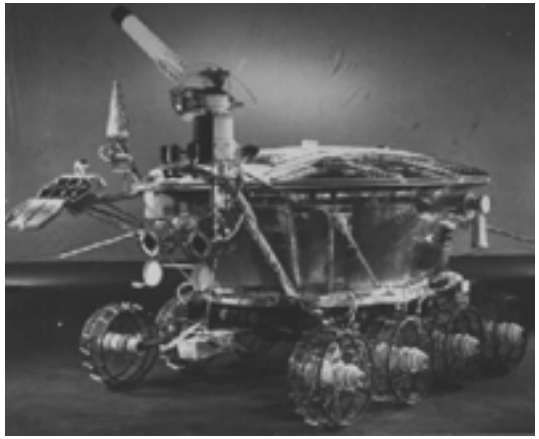
The French Lunar-Laser Ranging Station

An Update

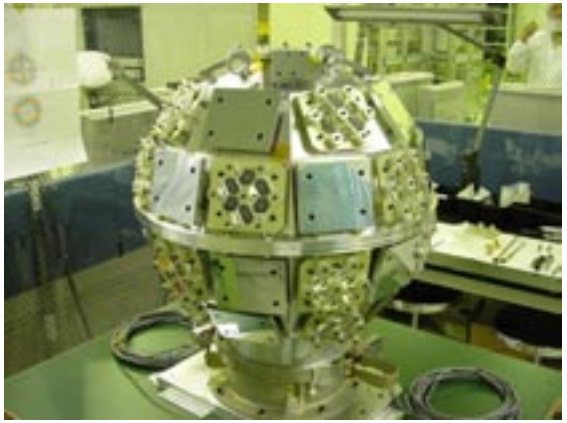
Presented by G.Vigouroux



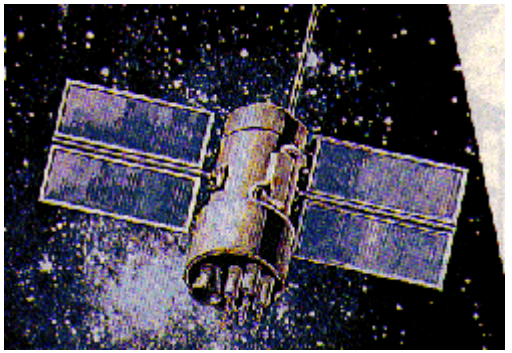
LUNA 17 et 21



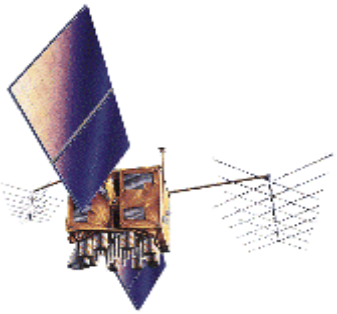
380 000 km



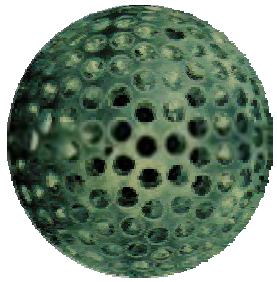
LRE 250 to 36198 km



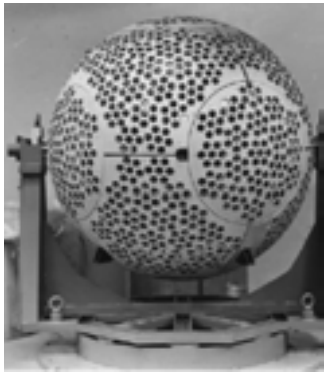
Glonass 19000km



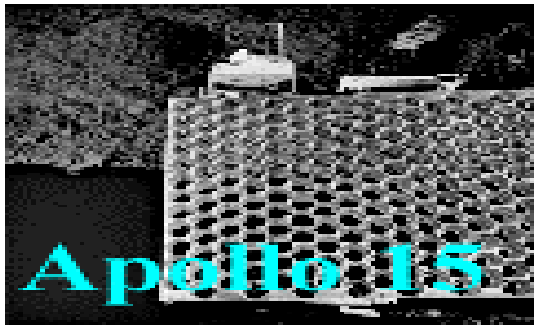
GPS 20000km



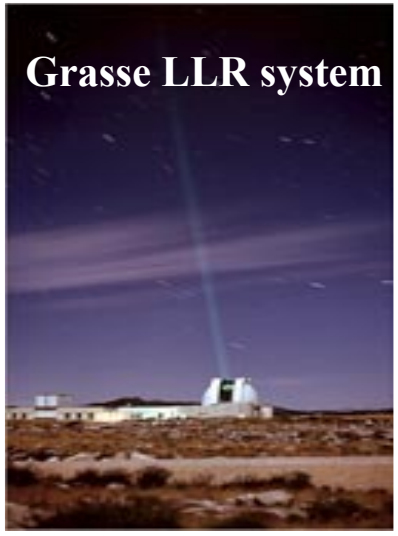
Lageos 6000km



Etalons à 19000km



Targets ranged with the Grasse LLR system



SCIENTIFIC OBJECTIVES

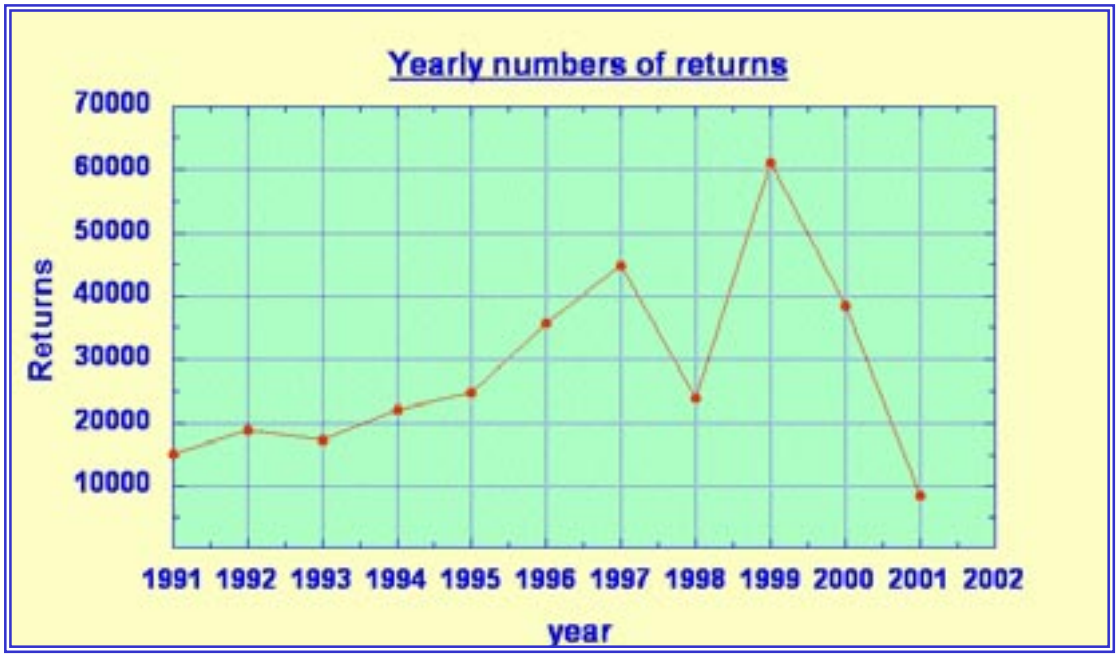
For the Moon

- Geophysics
- Selenophysics
- Celestial mechanics
- Rotation of the Earth and Moon
- Precession and nutation
- Terrestrial and celestial reference frames
- Test of gravitation theories

For the distant satellites

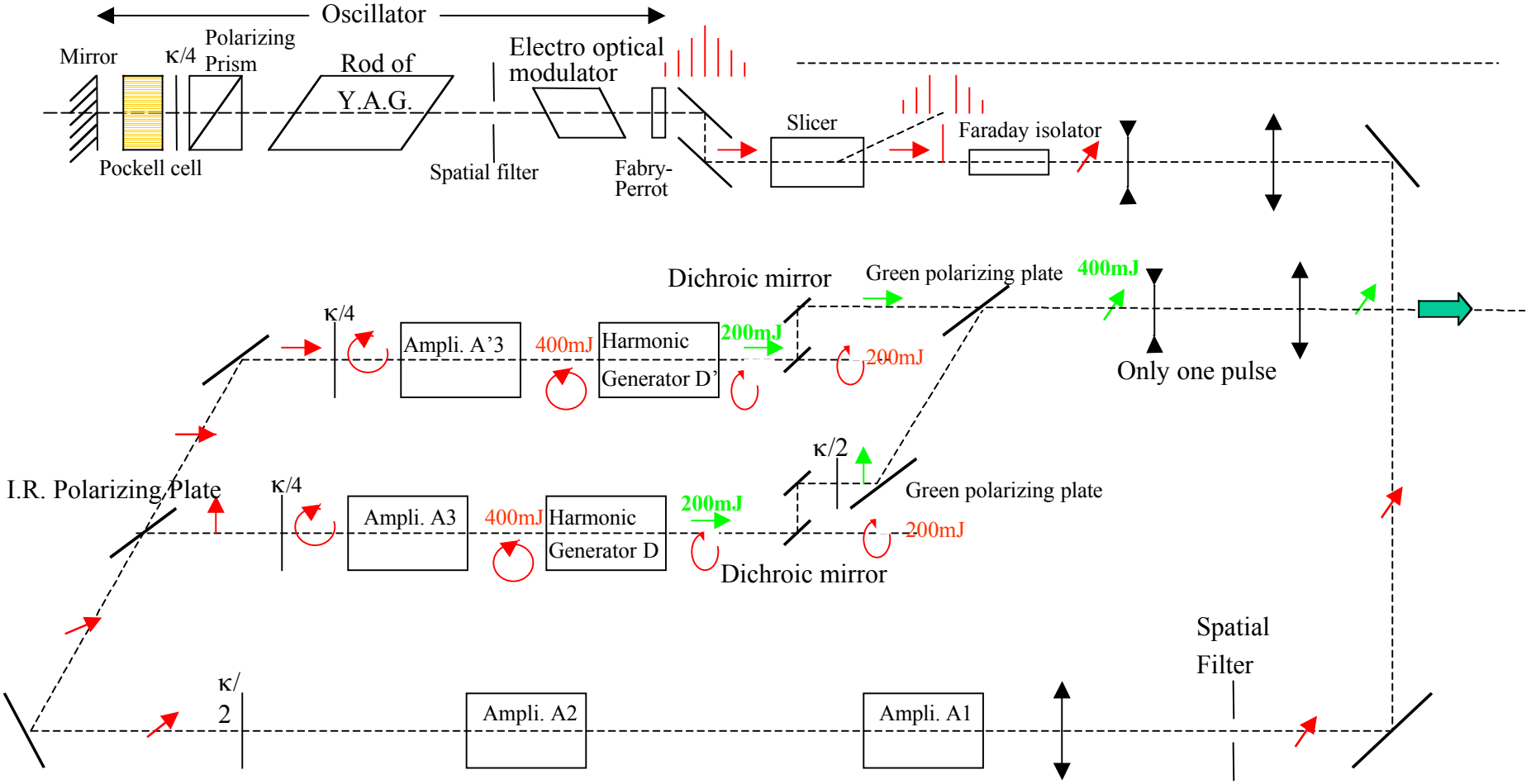
- Orbitography
- Geodynamics
- Positioning
- Comparison of tracking techniques
- Terrestrial reference frames

Raw data production on the Moon



It is possible to increase the energy of our laser

It is possible by using an additional amplifier and double-frequency. This would permit to improve the number of returns from the Moon without increasing the noise.



Technical improvements for high altitude satellites

- We use another laser with a semi-train and a 20 ps pulse width. It permits to increase the precision on high-altitude satellites.

- For the satellites, we have implemented, on the return path, a wedge plate to correct the angle, between the emission and reception axis, due to the velocity aberration. The first tests will begin soon. It should permit to decrease the noise and reduce the scattering of the transit time between the center and the edge of the detection diode.

- We have just started, for the high-altitude satellites, the automation of the observations.

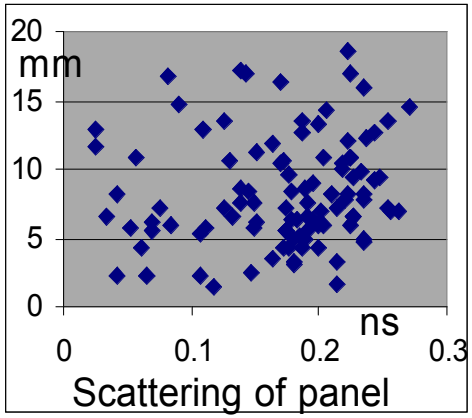
- A major maintenance on the steering of the dome has been carried out in 2002 to replace the worn-out main rail.

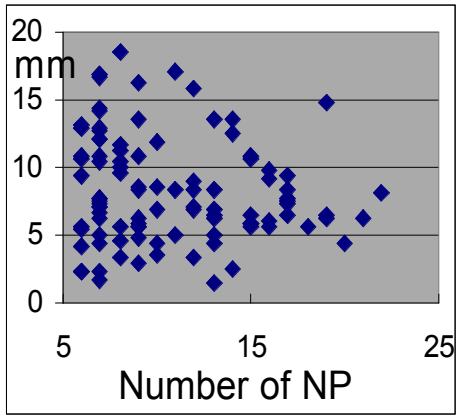
A quality assessment

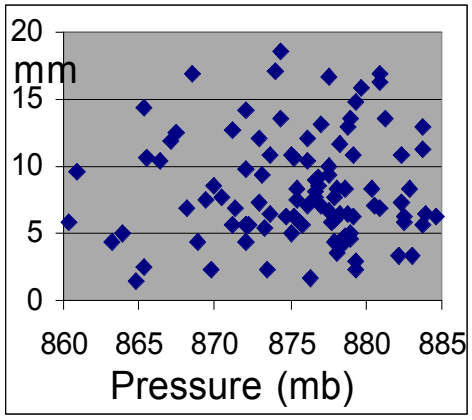
• **Objective:** Evaluate the performances of the Grasse LLR system and try to understand their variations. It seems possible from nights where the number of normal points is superior to 6 , on Apollo XV.

•**Method :** We use the same method showed in 12th WS Matera. We add a third degree polynomial fit on residues and compute the Normal Points rms. We analysed 101 nights between Oct.1998 and Dec.2000.

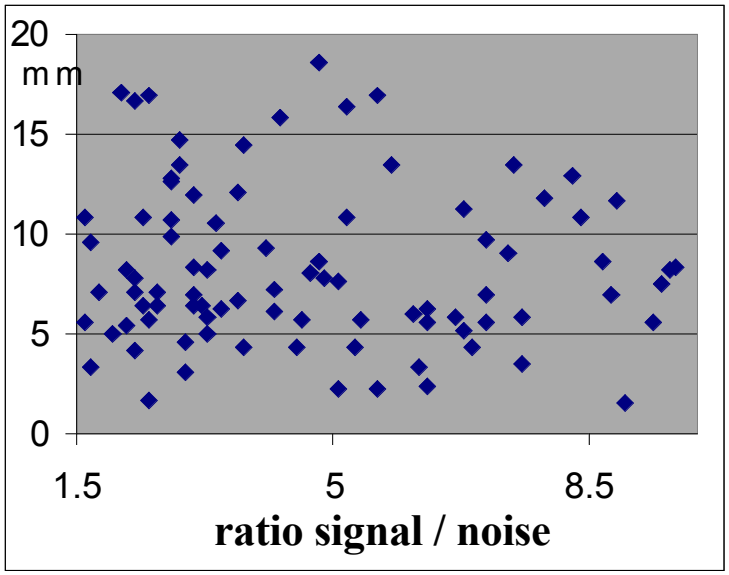
•**Results :** The internal consistency per night is excellent, varying between 1 to 15 mm, with no obvious correlation with the lunar libration, the number of normal points over each night, the pressure, the signal/noise ratio or the number of returns.

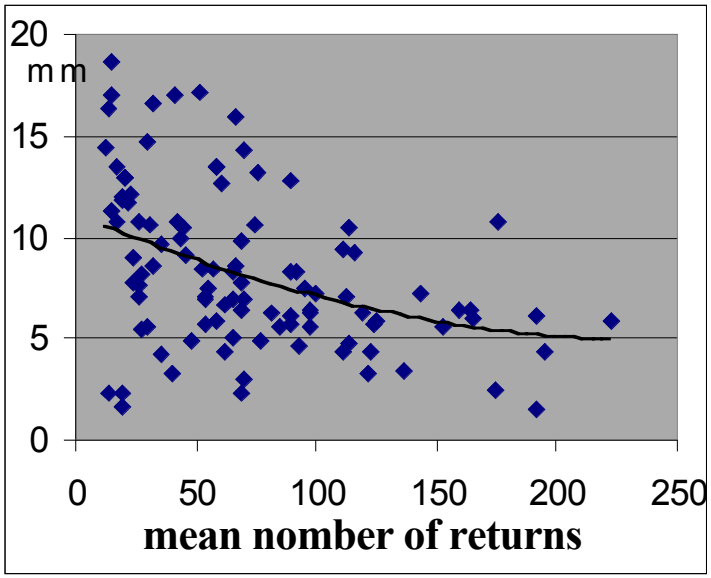






A quality assessment (ctd)

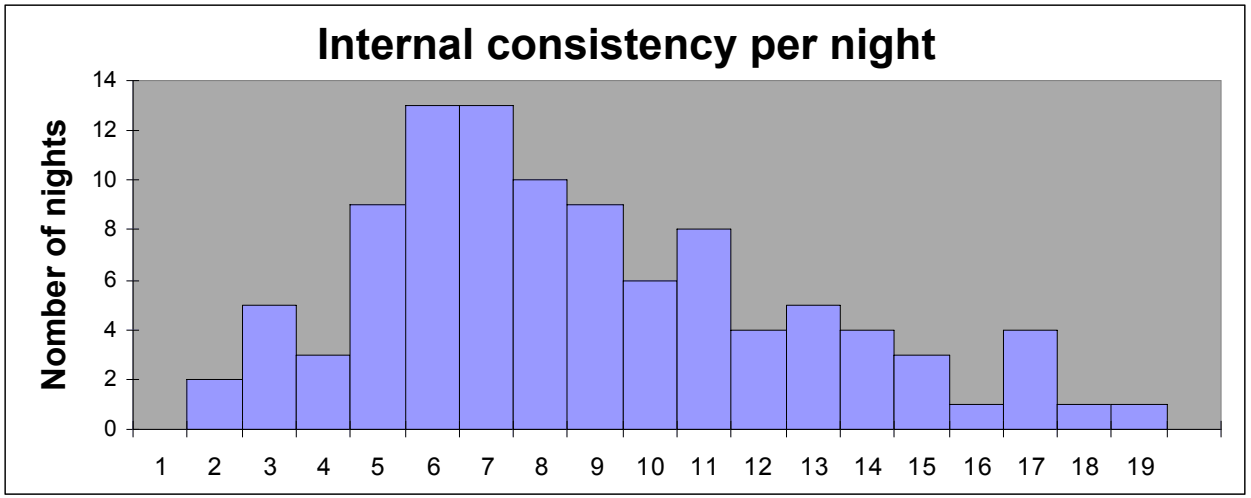




- If the signal/noise ratio is > 6, the RMS. of the Normal Points is less than 15 mm. If the mean number of returns by serials in the night is larger than 100, the RMS goes down below 10 mm.

- The sources of these variations are not properly indentified : noise, insufficient number of echoes, etc... and variation of the atmospheric properties ?

CONCLUSION



- For 20% of nights, the internal consistency is lower than 5 mm and for 50% falls between 5 and 10 mm.

- Interestingly the internal consistency on GPS 35 and 36 (with similar signature : panel of reflectors) varies between 0.4 mm and 4mm, but with a laser 20ps. It seems that it is a link with the windspeed.

- We hope in a near future, thanks to the doubling of the laser energy, to increase the number of returns and the signal / noise ratio, **therefore the precision**.