MeO - The future of the French Lunar Laser Ranging Station

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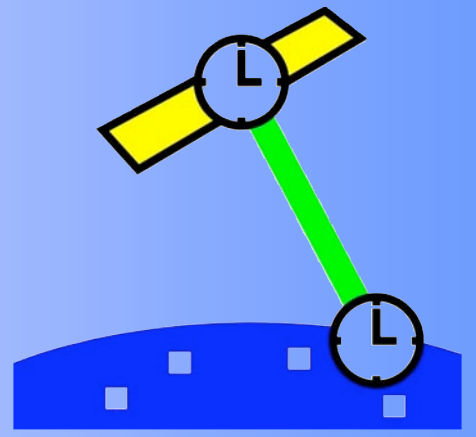


OCA past organization

Until 2003 the French laser ranging activity was represented by 3 tracking laser stations

CERGA

François Mignard

Lunar Laser Ranging (LLR)

for the Moon and high altitude satellites

Satellite Laser Ranging (SLR)

for low altitude satellites

Transportable Laser Ranging System (FTLRS)

for mobile campaigns

OCA New Organization

Since 2004 a new organisation has been set up to initiate, in addition to the actual program on the Moon and satellites, a Research and Development activity

GEMINI

Pierre Exertier

MeO Station

(Ex LLR)

Etienne Samain

for the Moon and both high and low altitude satellites

Research and Develepment

Transportable Laser Ranging System (FTLRS)

Francis Pierron

for mobile campaigns

MeO Station

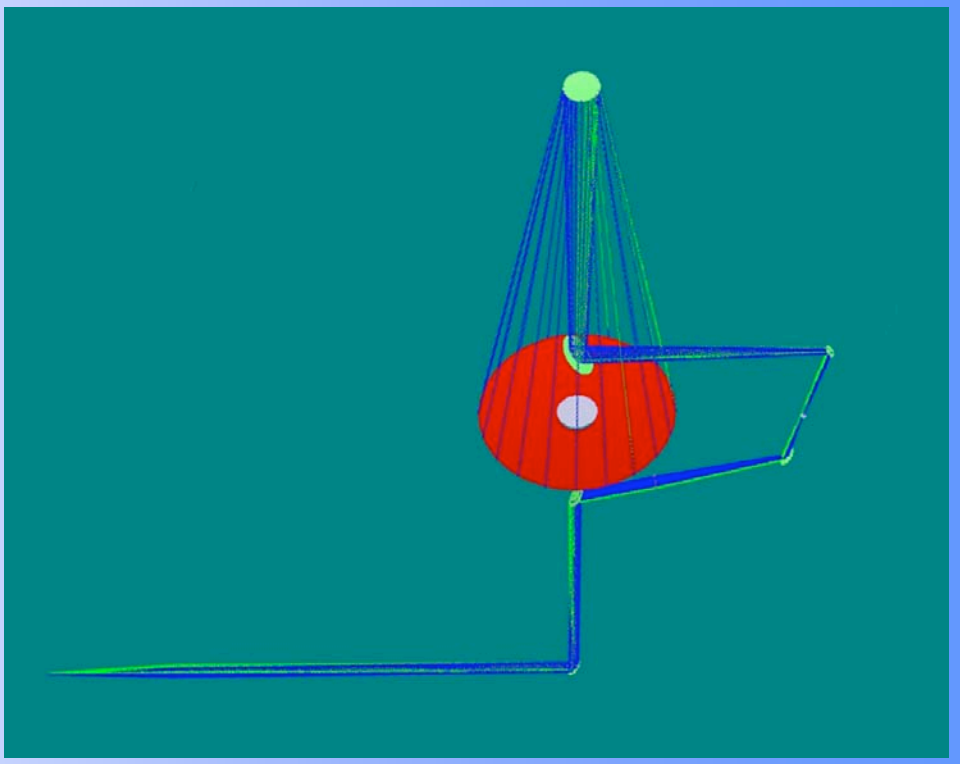
A new generation of Laser Ranging station

- From 400 km to the Moon
- One Way Interplanetary mission
- Highly Automatic

- Instrumental Developments
  - » Focus Laboratory
  - » Motorisation of the telescope
  - » Control Software
  - » Automatisation
- Research & Development
  - » New optical link
  - » Detection, Event timer
  - » 2 colors
  - » atmosphere

Actual status of the MeO Station Telescope

- Ritchey Chretien configuration
  - Primary Mirror: Parabolic 1540 mm
  - Secondary Mirror: Hyperbolic 290 mm
  - Tertiary mirror: Plane 330 mm
- Common Telescope
  - Laser emission
  - Detection
  - Video
- Diffraction limited
- Detection on the Nasmyth table
- Laser emission in a fixed laboratory under the telescope



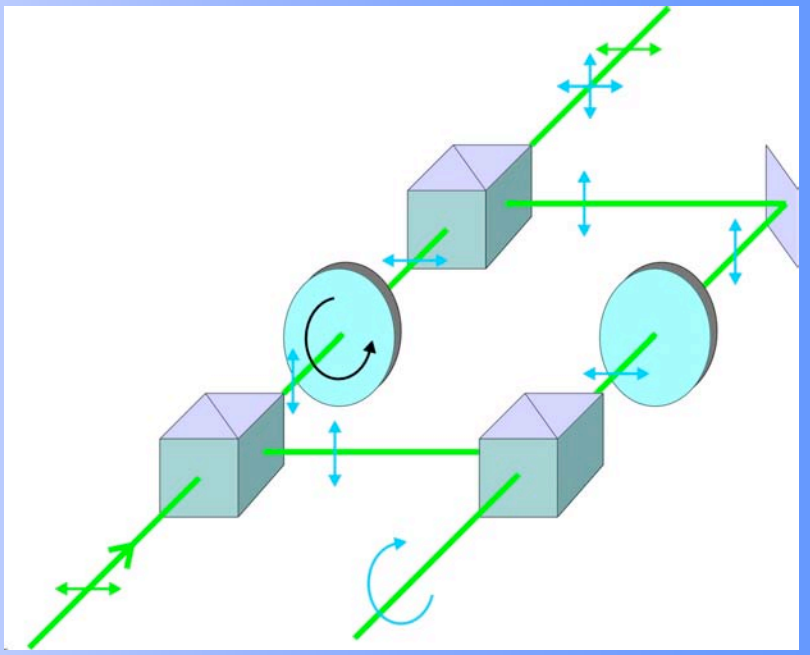
Optics

- Actually :
  - Distinct reception and emission paths
  - Mechanical commutation @ 10 Hz: Moon-Lageos
  - Dedicated configuration for operational telemetry only
  - Dedicated optics for Nd:Yag Laser

- Objectives
  - Common optical path for the emission and reception
  - Large global field of view: 300 arcsec
  - Distribution of the flux on 5 distinct optical benches for several experiments
  - Simultaneous distribution of the flux on 2 optical benches
  - Laser commutation well suited for both low and high altitude
  - From 400 to 1100 nm

High speed active commutation based on polarisation

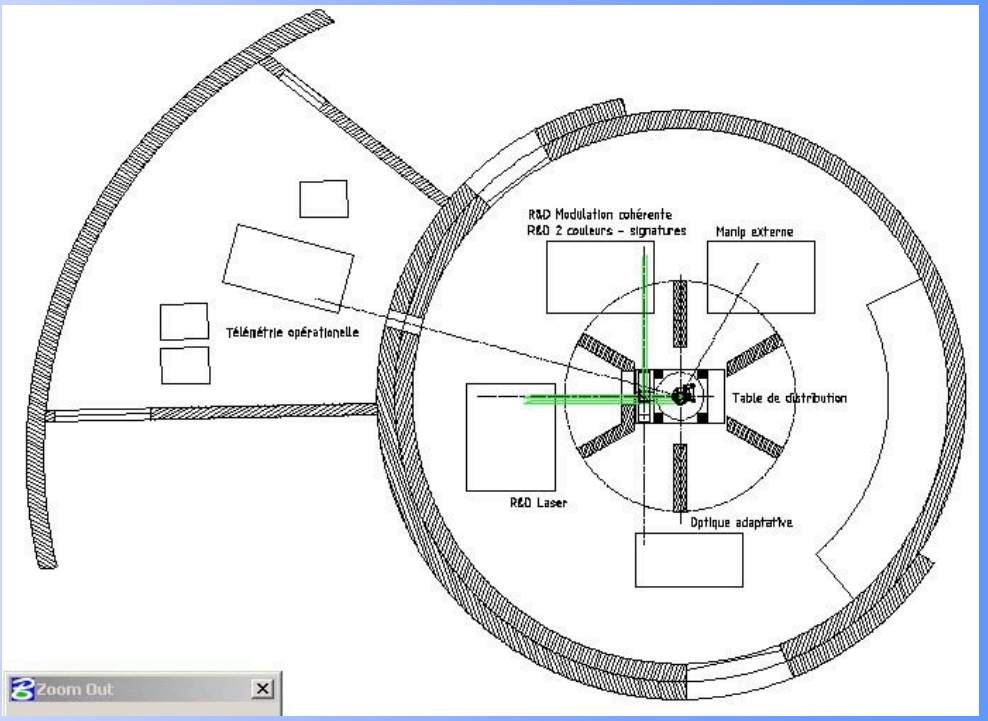
- Liquid crystal: FLC polarization rotator
  - large diameter, up to 100 mm
  - Low thershold damage: 30 mJ/cm_ @ 200 ps
  - Commutation time 1 ms
- Pockel cell
  - Small diameter ~ 25 mm
  - High threshold damage: 2 J/cm_
  - Commutation time ~ ns



Focus laboratories

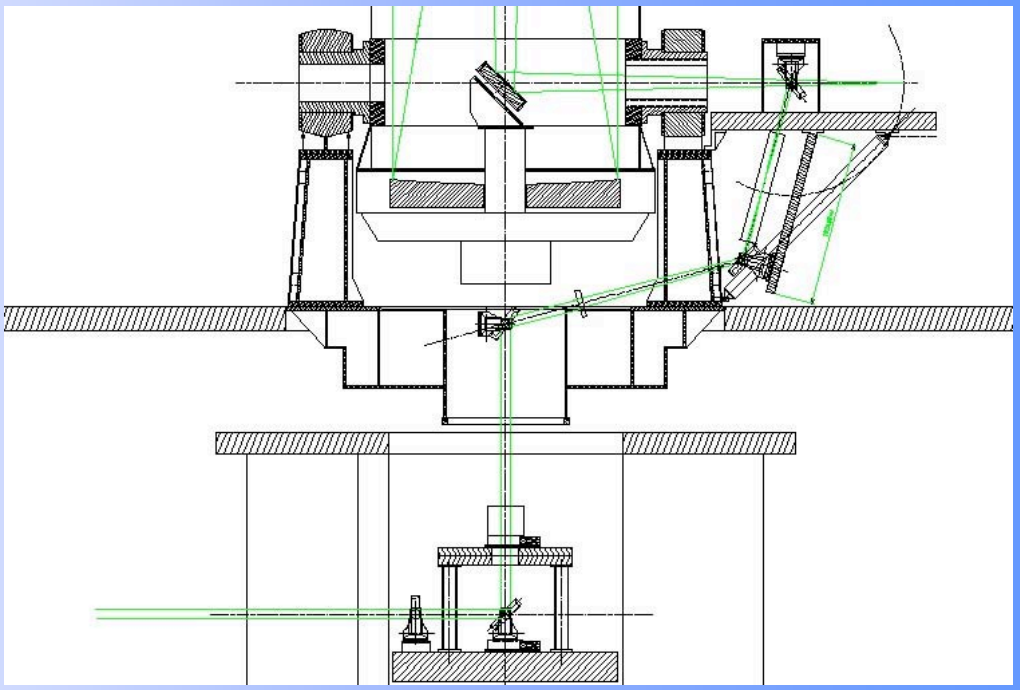
- Construction of a laboratory for research and development:
  - » Circular room : 60 m_,
  - » 4 optical benches
  - » 1 optical bench for the optical flux distribution

- Construction of a laboratory for operational telemetry
  - » 6 m away from the telescope : 45 m_
  - » 1 optical bench for the laser and the detection unit



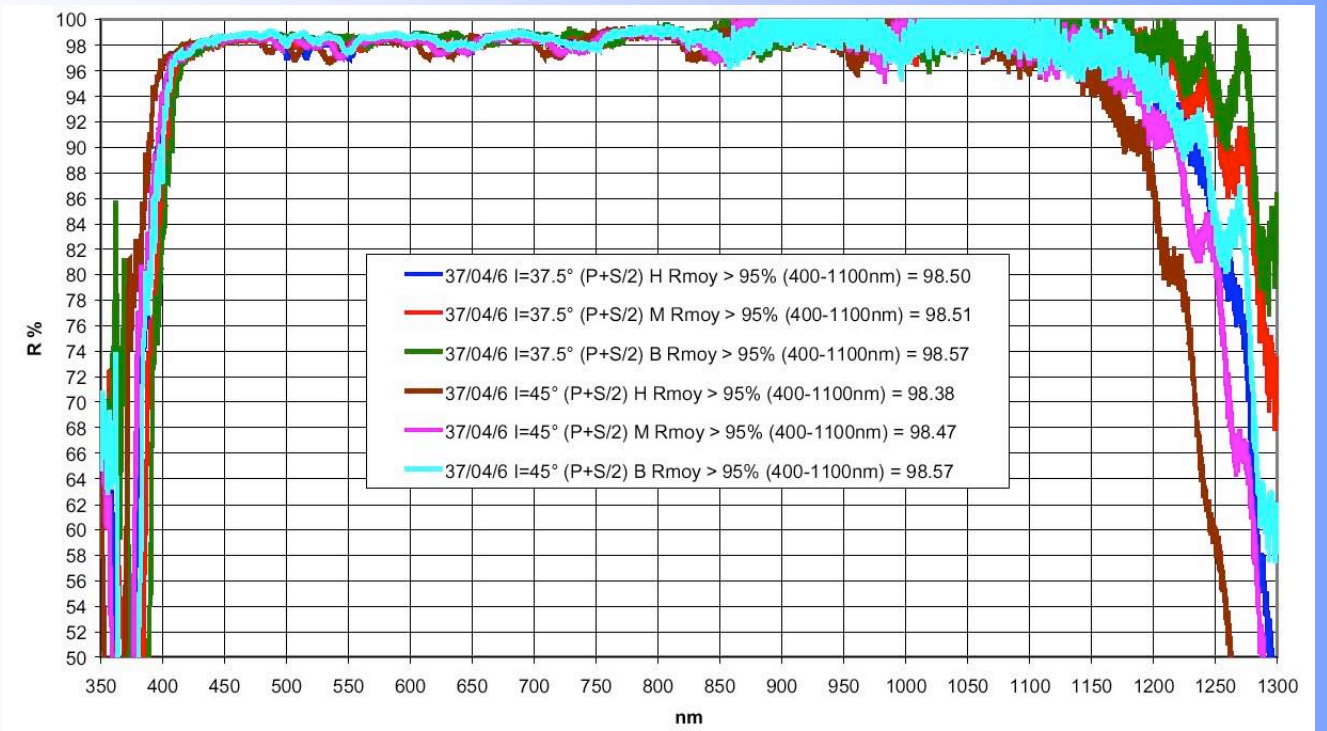
Nasmyth benches

- Construction of 2 nasmyth benches for direct observations
  - » Distribution of the optical flux
  - » High resolutionVideo
  - » Vacuum cuve to avoid Plasma



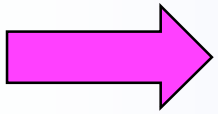
Fold mirrors

- Zerodur mirrors 200 mm
- Dielectric treatment (from the development for the Bern University): 10 J/cm_ @ 3 ns



Laser

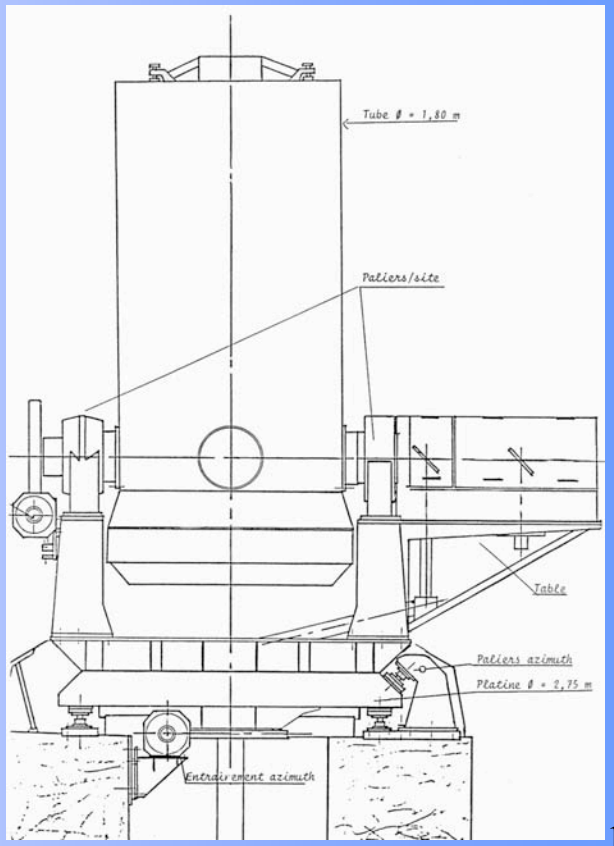
- An aluminium table contains two 532 nm lasers :
  - a « satellite » BMI laser : 20 ps pulses with 60 mJ / 3 pulses
  - a « lunar » BMI laser : 10 ns pulses with 650 mJ /pulse
- A marble table contains a third 532 nm laser :
  - an « adaptable » quantel laser : 300 ps of [150;250] mJ /pulse



Migration of all lasers on a single 20 cm thick optical table also comprising the operational telemetry instruments

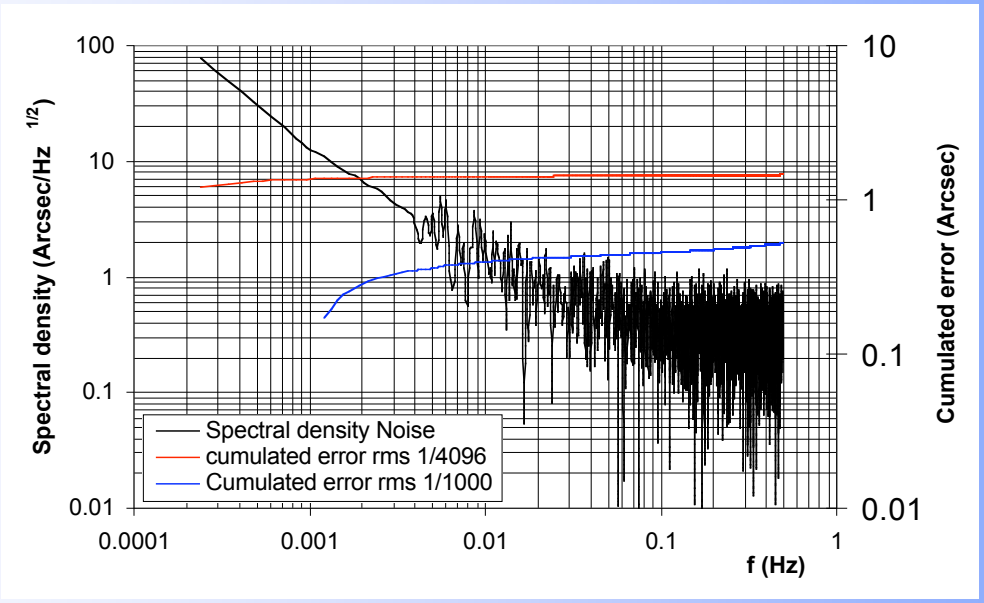
Telescope motorisation
Speed and acceleration

- Increase the speed of the telescope to be able to track low altitude satellite (400 km)
  - » Azimuth axis speed: 5°/s
    (actually 0.5°/S)
  - » Azimuth axis acceleration: 0.5°/s^{-2}
    (actually 0.05°/S^{-2})
  - » Dôme speed: v = 5°/s
  - » Security



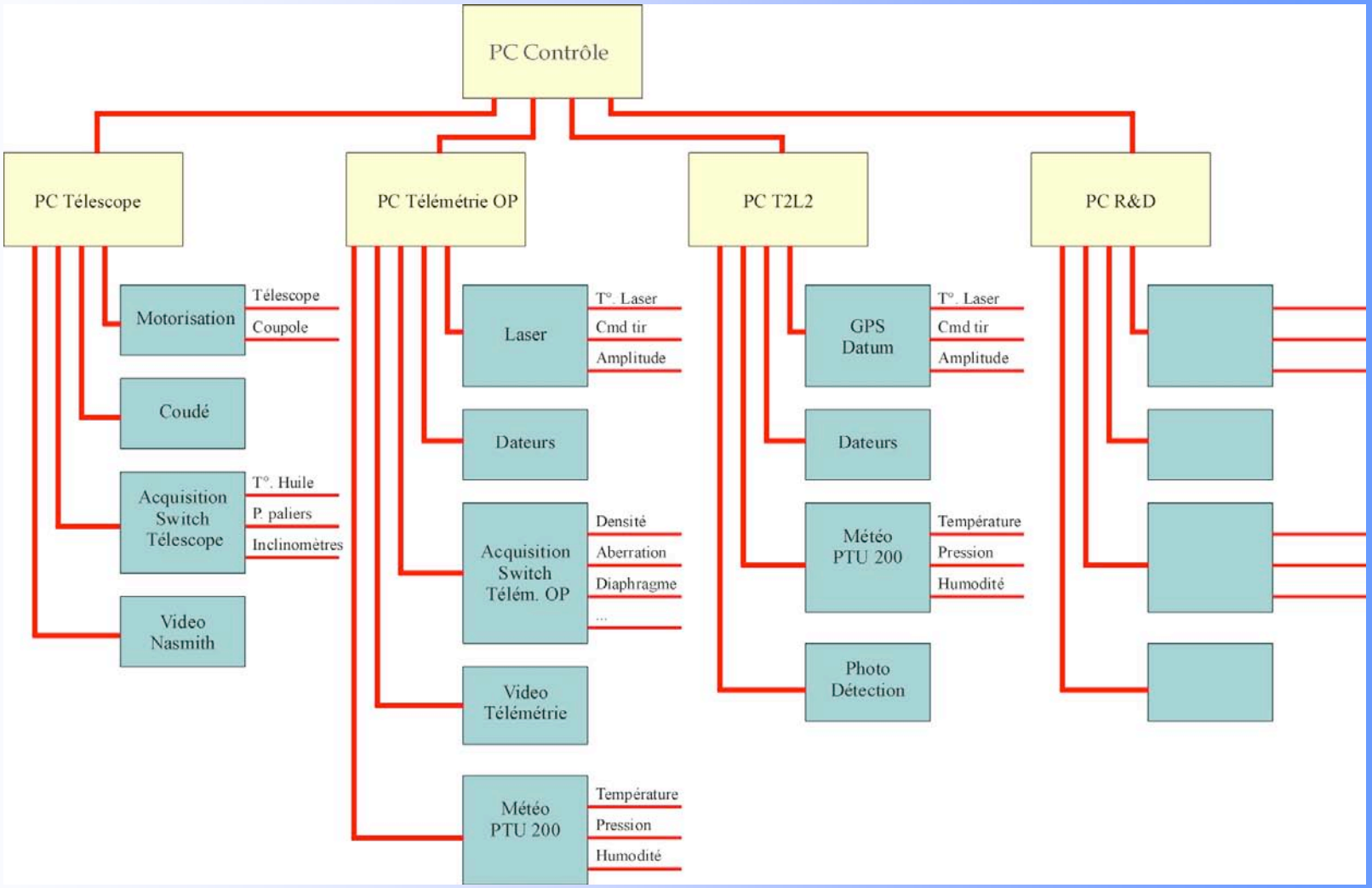
Telescope motorisation
Pointing accuracy

- Actual performance:



- Improve the stability and the accuracy of the telescope : One way laser ranging in the solar system
  - » Stabilité du télescope ~ 0.2 arcsec sur 1000 s

Software
Win32 Client Server



Future R & D

- New Optical link
  - » Coherent modulation over long period
- Multi photon detection
- Optical targets (in connection with T2L2)
- Adaptative optics
- Multicolor laser ranging
  - » Femto second lasers
  - » Streak camera

- One way laser ranging in the solar system
  - » TIPO & ASTROD
- Laser ranging in space
  - » ESA SSI Mission (Satellite to Satellite Interferometer)
  - » Metrology in space

Conclusions

- The capability of the station will be extended from low altitude satellites to (future) spacecrafts in the solar system
- The Moon will continue to be a major objective for the station
- The new architecture of the station will permit to perform both tracking and experimental research

The MeO station should be operational in its new configuration in 2006