Adventures with the French Transportable Satellite Laser Ranger

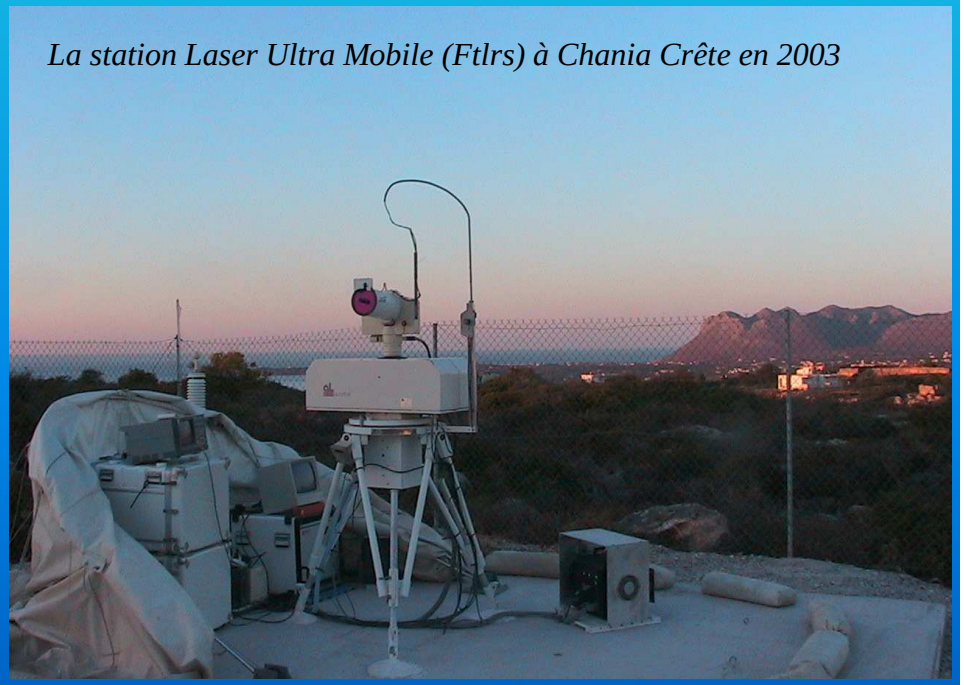
F. Pierron, *Observatoire de la Côte d'Azur (OCA), Grasse, FRANCE*

- Smaller Laser ranging system in the world (300 kg, Ø tél. =13cm) built in OCA with CNES/CNRS collaboration in 1995/2000

Operating at the best level (data quality and reliability) since 2002

- ***Unique by telescope size (13 cm) and compacity***
- ***Unique by setup time on site (72 hours)***
- ***Really a technological challenge***

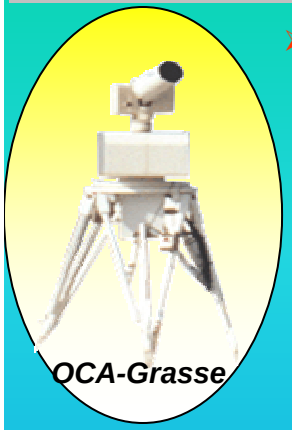
- For supporting scientific projects
  - Geodetic campaigns
  - Calibration of oceanographic satellites
  - International terrestrial reference frame
  - Ocean Loading effects on crustal monitoring
  - Multi-techniques colocations
  - Time transfer experiments



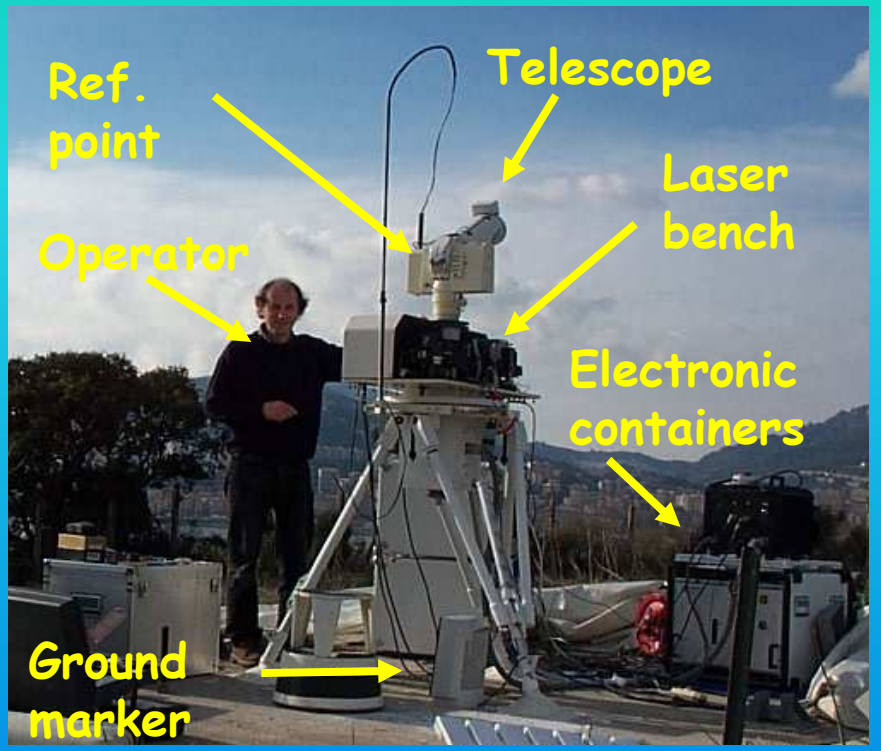
La station Laser Ultra Mobile (Ftlrs) à Chania Crête en 2003

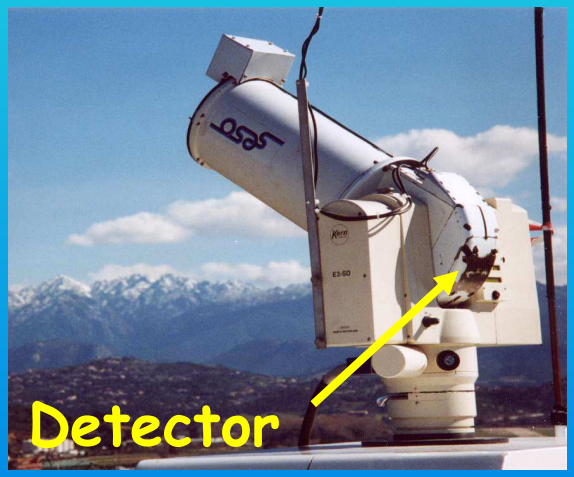
*** FTLRS : " French Transportable Laser Ranging Station"**

FTLRS : French Transportable Laser Ranging System



- Very small SLR system in operation for 5 years
  - 350 Kg
  - ∅ tel = 13 cm (emission/reception)
  - Time = GPS steered rubidium
  - LEO satellites to Lageos-1&-2



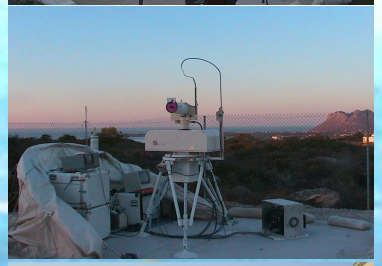


Applications

- Satellite Altimeter Calibration
- Reference Frame
- Charge Effects
- Co-localisation Mono or Multi-techniques

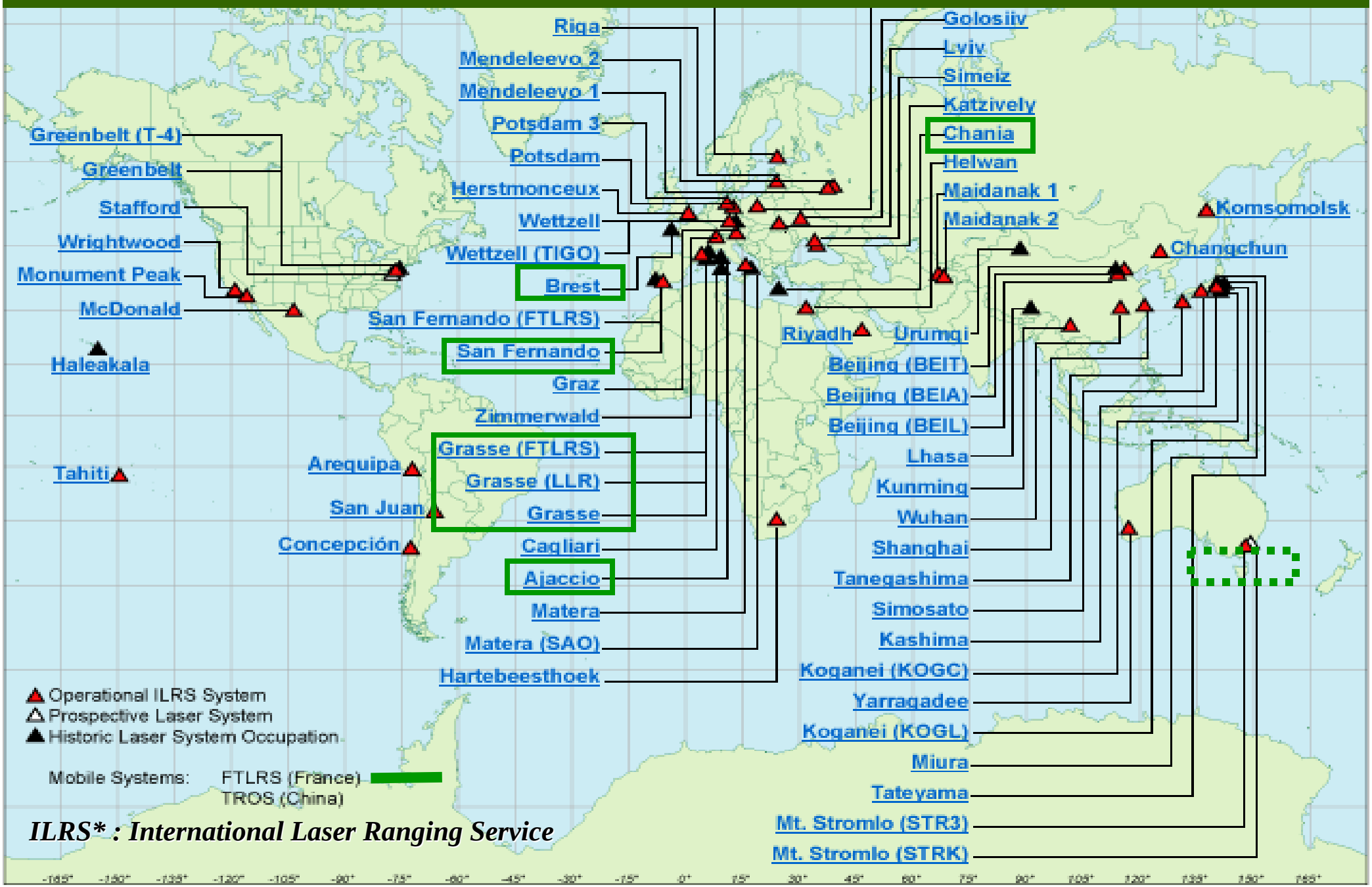
Ftlrs Campaigns along years

- calibration Topex/Jason – Corsica 2002- 6 months
- Crete 2003 : European collaborationbTopex/Jason
- « 14 th International Laser Workshop » (june 2004) and colocalisation to San-Fernando (Spain)
- Geophysics project for ocean loading effects West of France (Normandy) September/october 2004
- New calibration campaign Topex/Jason – Corsica 2005
- Campaign in Tasmania in collaboration with Australia and Hobart University (2007/2008)



* FTLRS : " French Transportable Laser Ranging Station"

ILRS* Network and GRGS participation (Fixed Grasse Stations & Mobile system)



ILRS* : International Laser Ranging Service

Ftlrs in the fields…

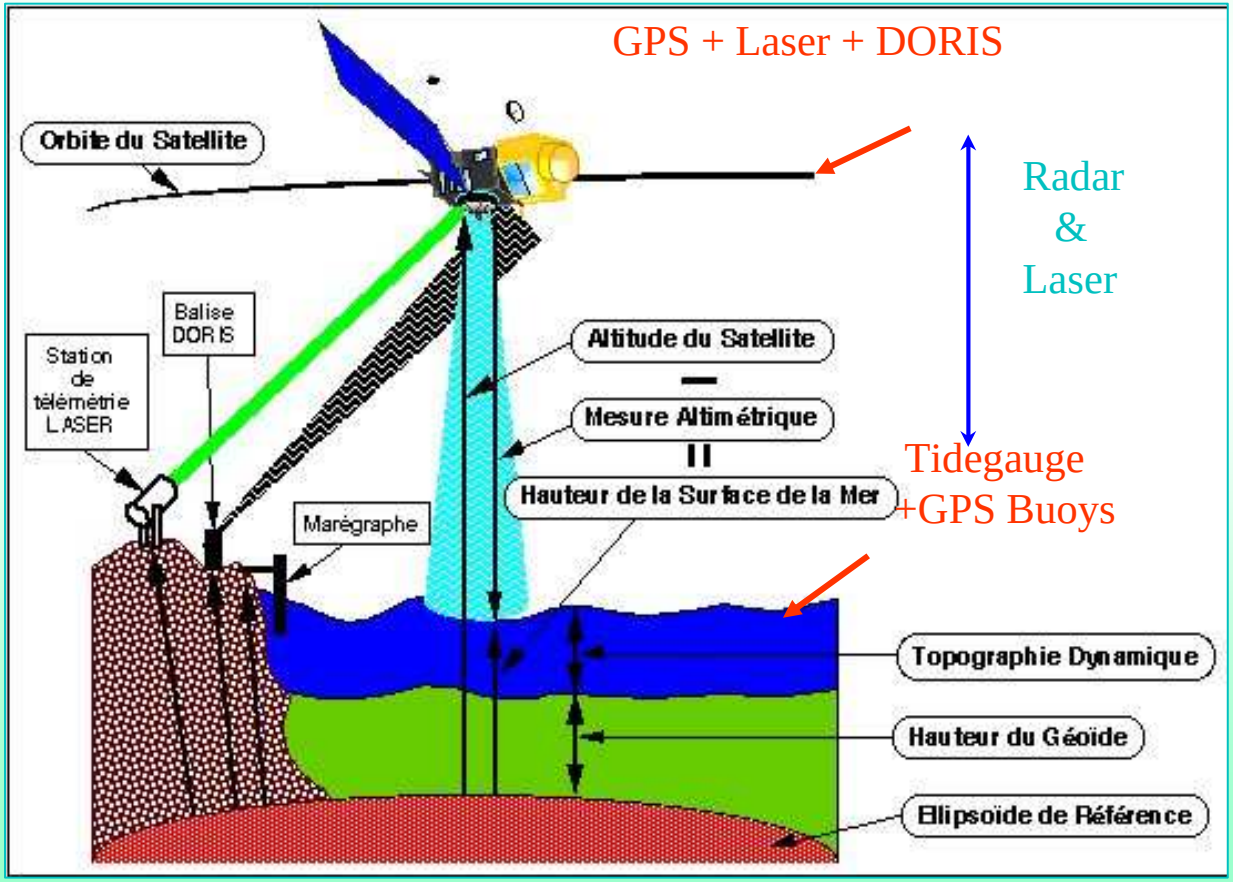
Observatoire de la Côte d'Azur

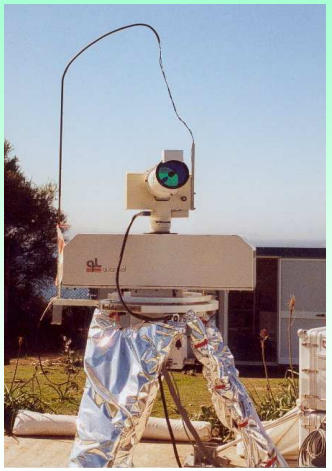
A tent to protect equipments in case of rain
Quickly opened (5 mn) by one observer..

Ftlrs in satellite laser ranging configuration

Slr Jason altimeter calibration scheme (2002-2005-Ajaccio)

- Need of stable and unique vertical reference (laser, VLBI, GPS, DORIS,..)
  Mean : The géoid ~ Mean sea level
- Need of radar calibrated altimeters on spacecrafts
- Vertical refrence ➲ Satellite laser ranging
- Calibration ➲ satellite track, sea proximity
- Response : **Mobile Laser Ranging System - FTLRS**

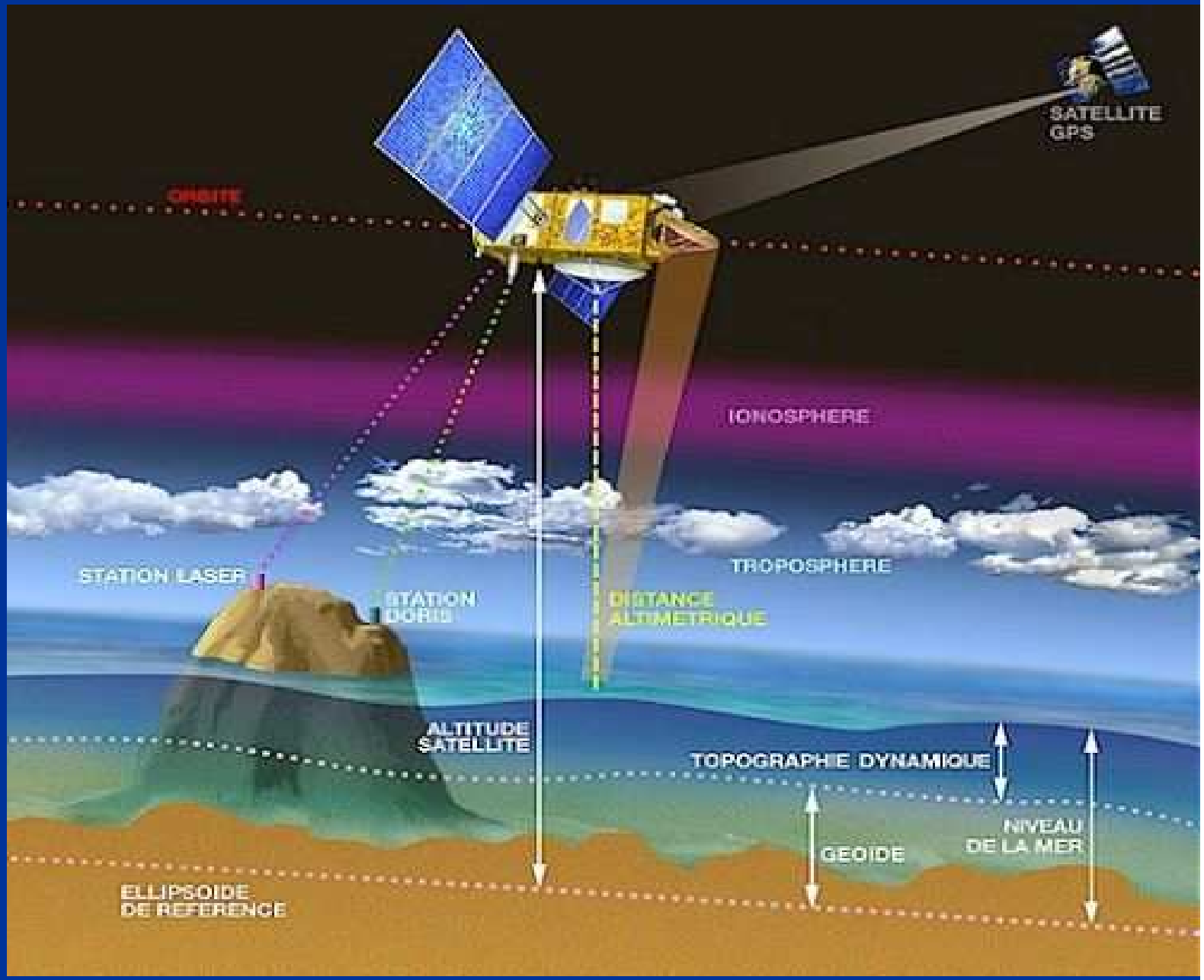




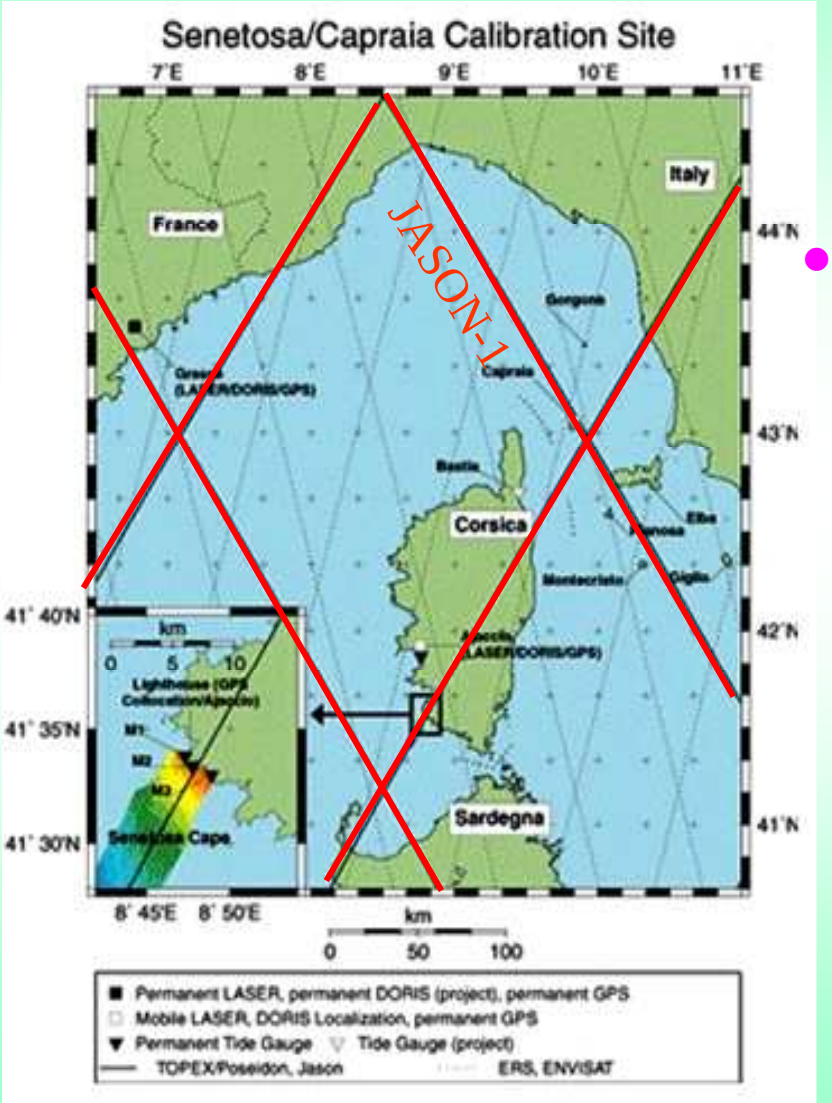
Station Laser Ultra Mobile Ajaccio, 2002

PRINCIPLE

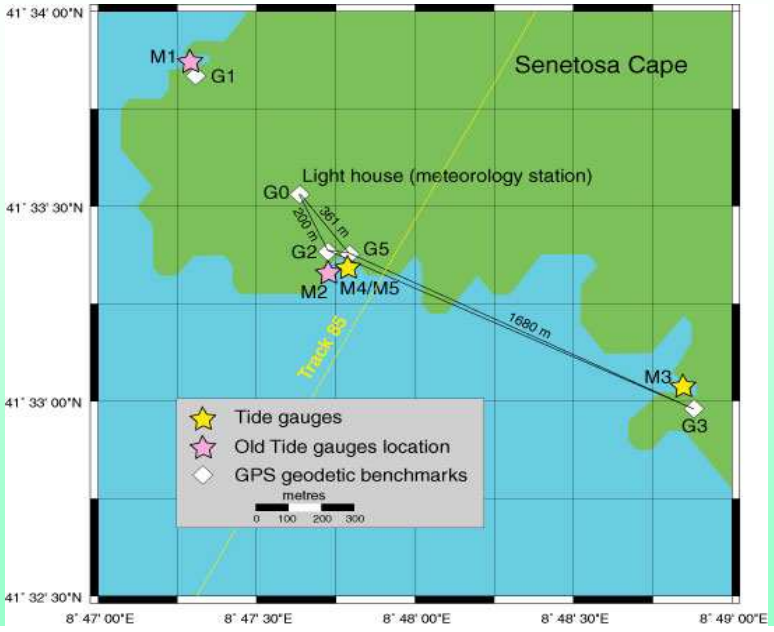
Need a Reference Frame : Accurate and stable



Corsica configuration



- Distance between the FTLRS and the satellite ground tracks
  - » T/P and JASON-1 : 25 km
  - » ERS and ENVISAT : 5 km west



LASER campaigns in Corsica

Geographical situation :

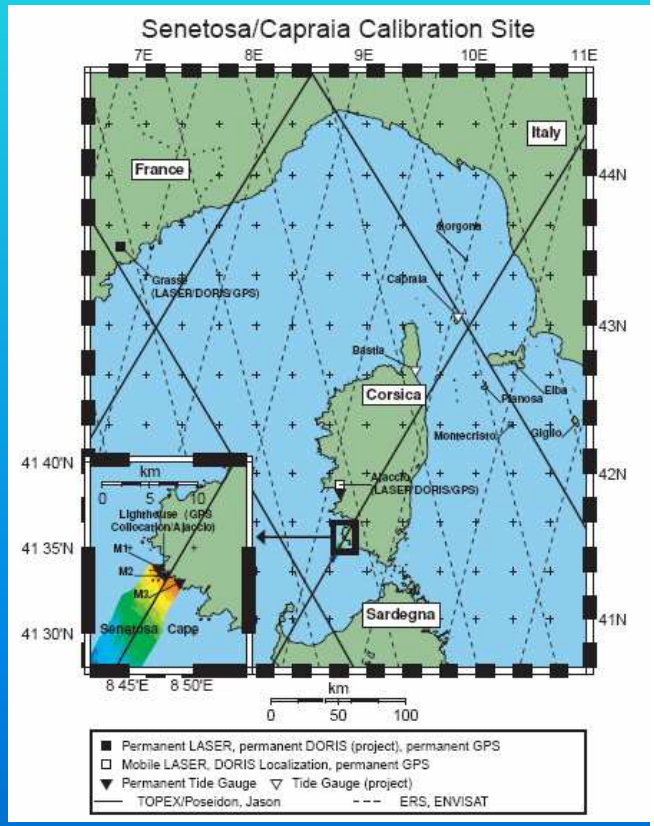
- Naval base at Aspretto (Ajaccio)
- *In situ* instruments at Senetosa Cape : Tide gauges,
- GPS buoys, meteo station,..

Laser campaigns :

- January – September 2002 (10 months)
- May – October 2005 (5 months)
- 4 satellites used : combination multi-satellite

Instrument :

French Transportable Laser Ranging System (FTLRS)



Calibration

The Ajaccio Site (Corsica) is the main calibration site of the satellite altimeters in the Mediterranean area.

Objectives :

- **Absolute sea level monitoring, altimeter calibration and orbit validation (CAL/VAL) of the Topex/Poseidon, Jason-1 and Envisat satellites from the Ajaccio site (Corsica - FRANCE).**

- **Estimation of the satellite altimeters biases and drifts**

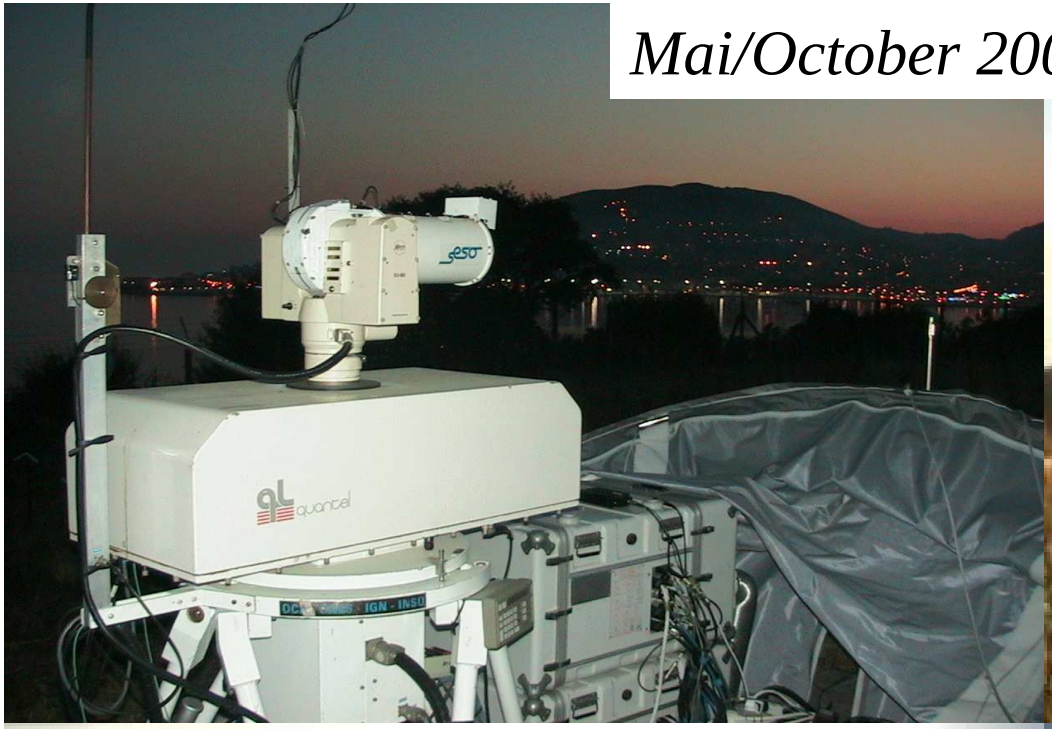
→ Need for carrying out an accurate SLR positioning from the geodetic satellites observations

Notice:

Altimeter calibration = precisely comparaison between

- **altimeter data**
- **satellite altitude above the sea level**

Mai/October 2005 : Ajaccio/ Calibration Jason1

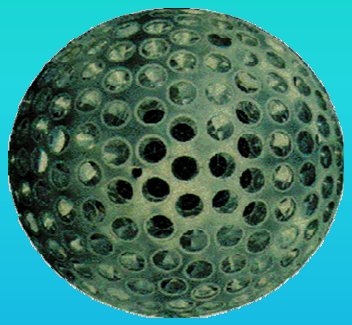


Scientific Investigation for Positionning

➔ **Positioning with 4 geodetic satellites :**

LAGEOS-1

LAGEOS-2



STARLETTE

STELLA

➔ **Goals :**

- Maintain the geodetic accuracy of the FTLRS position in Ajaccio site (Corsica) between the two campaigns

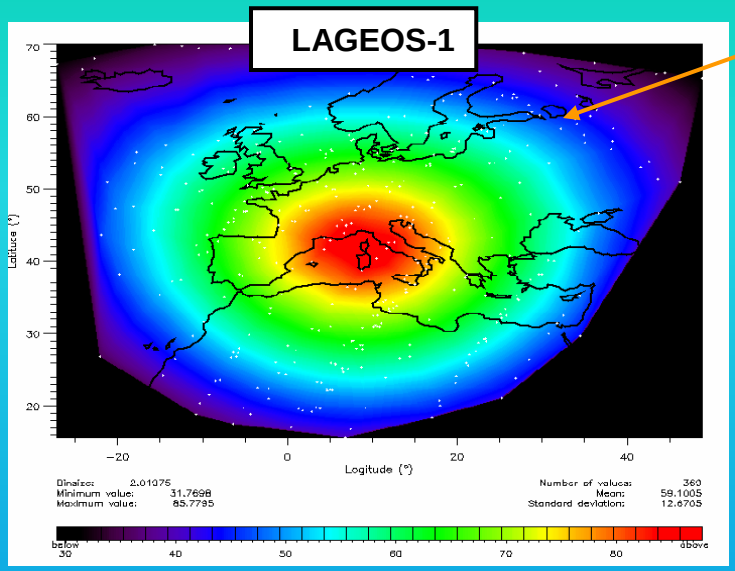
- Provide high accuracy local orbits for the Jason-1 altimeter calibration

➔ **Main steps of the work methodology :**

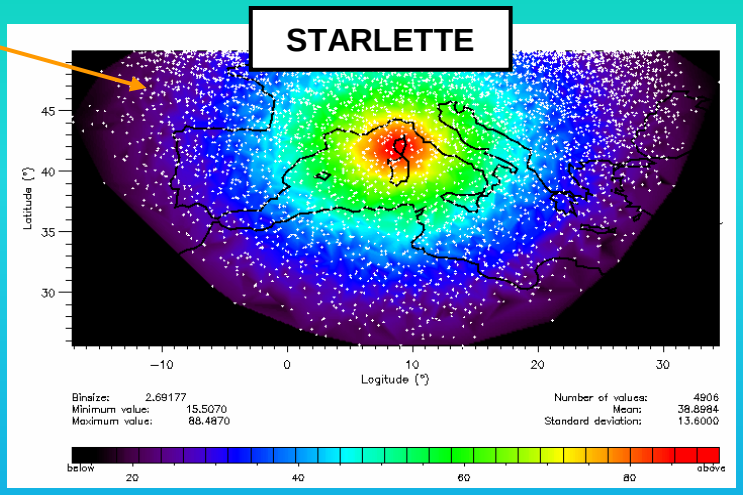
a – Orbit computation

b – Positioning of the FTLRS Station

Maps of the range data distribution during the 2005 campaign (05 months) above Ajaccio site



Normal Point:
White dot



LAGEOS :

- Few measurements on LAGEOS satellites, particularly at low elevation **(40°),** and irregular distribution of these data over the Ajaccio site
- Are difficult to reach by the FTLRS laser (high altitude)
- Low number of normal points collected : not enough to perform 3D geocentric positioning **(σ <±1cm)**

Starlette / Stella :

- Ten times more range data on Starlette/Stella relative to LAGEOS, and homogeneous distribution of the range data over the Ajaccio site.

Problematic

Problematic ?

➔ **Quality of the FTLRS positioning depends on the accuracy of the orbits.**

➔ **Starlette / Stella : More sensitive to remaining uncertainties in the dynamical models (gravit. & non gravit. Effects).**

Solution :

- ✓ **Since few years: Improvement of the field gravity model (GRACE mission)**
- ✓ **Adoption of an accurate field gravity model for the LEO computation**
- ✓ **Multi-satellite Combination**

Results & Analysis

Geographical coordinates differences from (Exertier et al., 2004) solution:

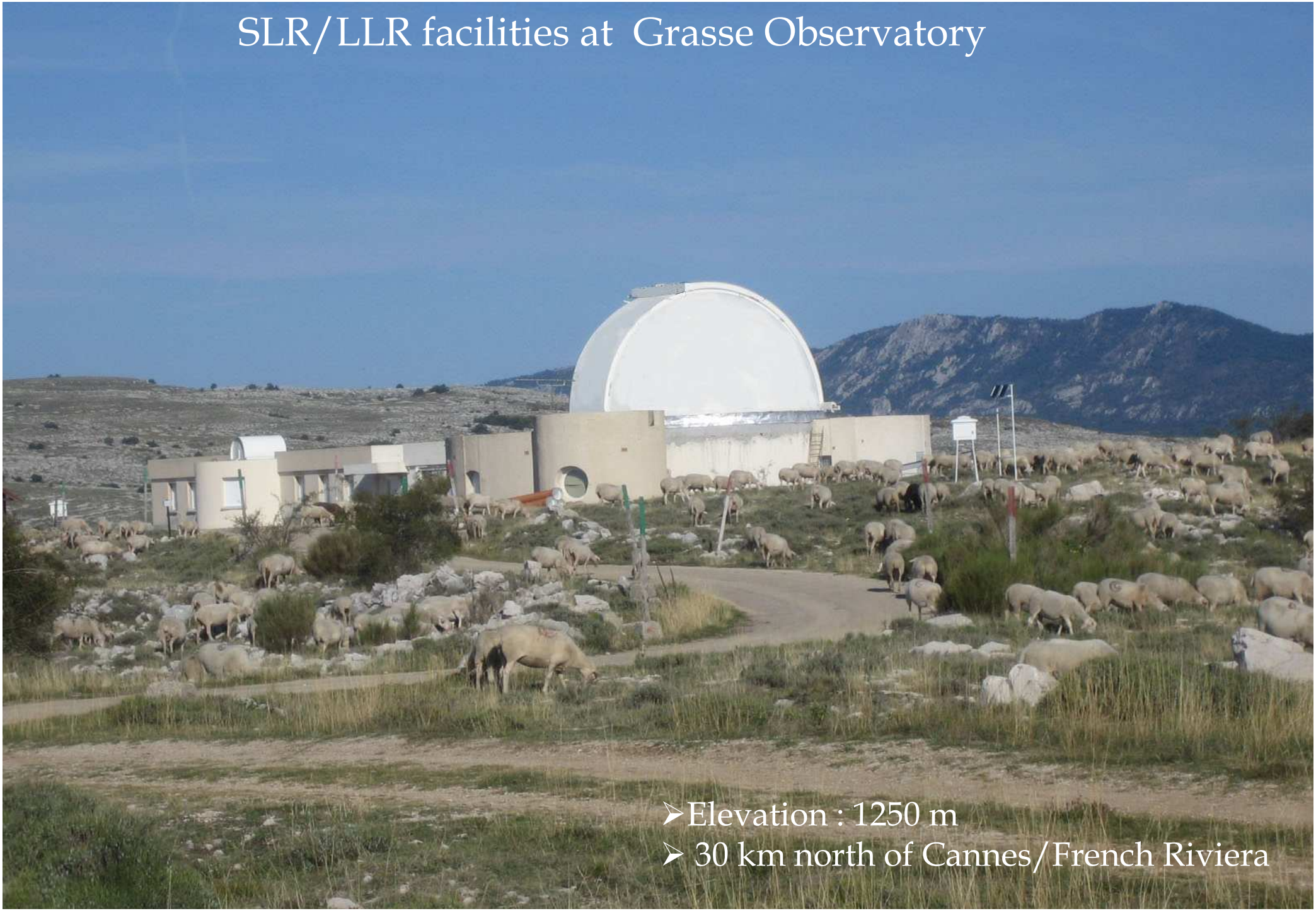
Coordinates differences	$\Delta\varphi$ (mm)	$\Delta\lambda$ (mm)	Δh (mm)
2002	+0.5 ± 0.7	+2.7 ± 0.7	-1.2 ± 0.8
2005	+4.1 ± 0.4	-2.9 ± 0.4	+4.0 ± 0.4

Stability :

Campaign	Number of solution	$\sigma\varphi$ (mm)	$\sigma\lambda$ (mm)	σh (mm)	σ (mm)
2002	28	14.6	13.1	10.5	12.9
2005	20	7.5	12.3	10.5	10.3

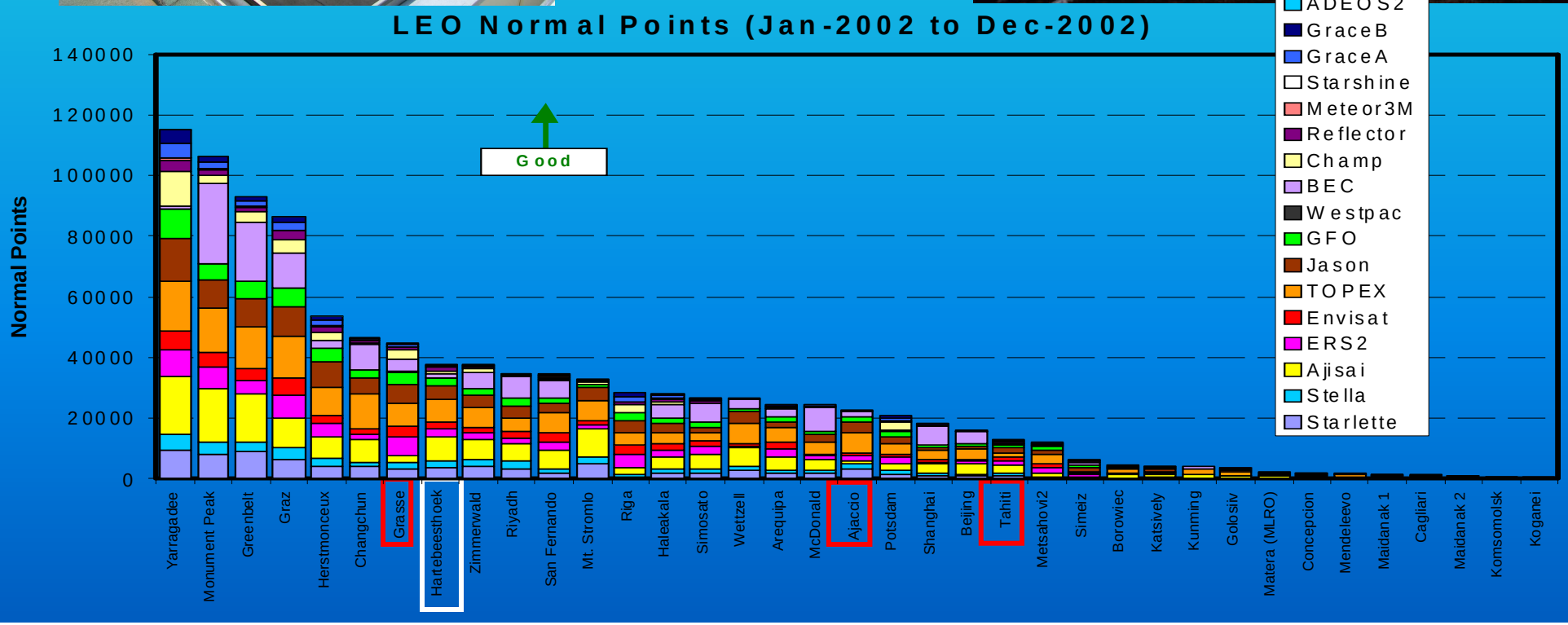
- Global mean of bias (-5mm): very close to the published one (-7mm) (Exertier et al., 2004)
- Coordinate updates values for 2002 and 2005 are at 3mm level in average relatively to (Exertier et al., 2004) solution.
- Coordinates differences are very small at level of residuals errors in the ITRF2000 velocities
- No significant differences between 2002 and 2005 coordinates (at level of the tectonic movement): FTLRS point is locally stable.

SLR/LLR facilities at Grasse Observatory



- Elevation : 1250 m
- 30 km north of Cannes/French Riviera

Historical Slr station stopped in September 2005 & Telescope moved in the trailer waiting South Africa departure

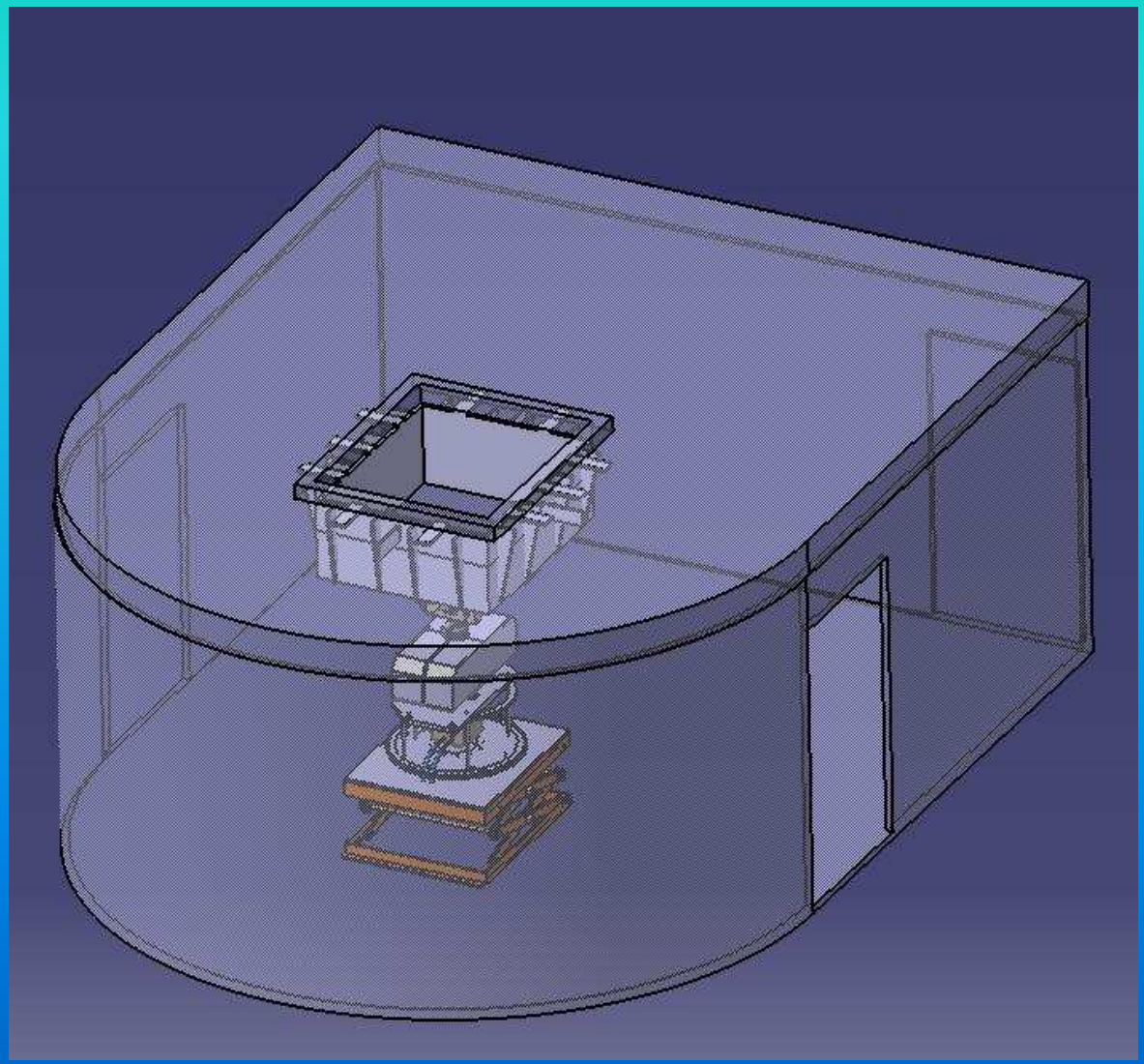



CNES
GRGS


GRGS

New laboratories For FTLRS built in 2005/2006

FTLRS* Laboratory design



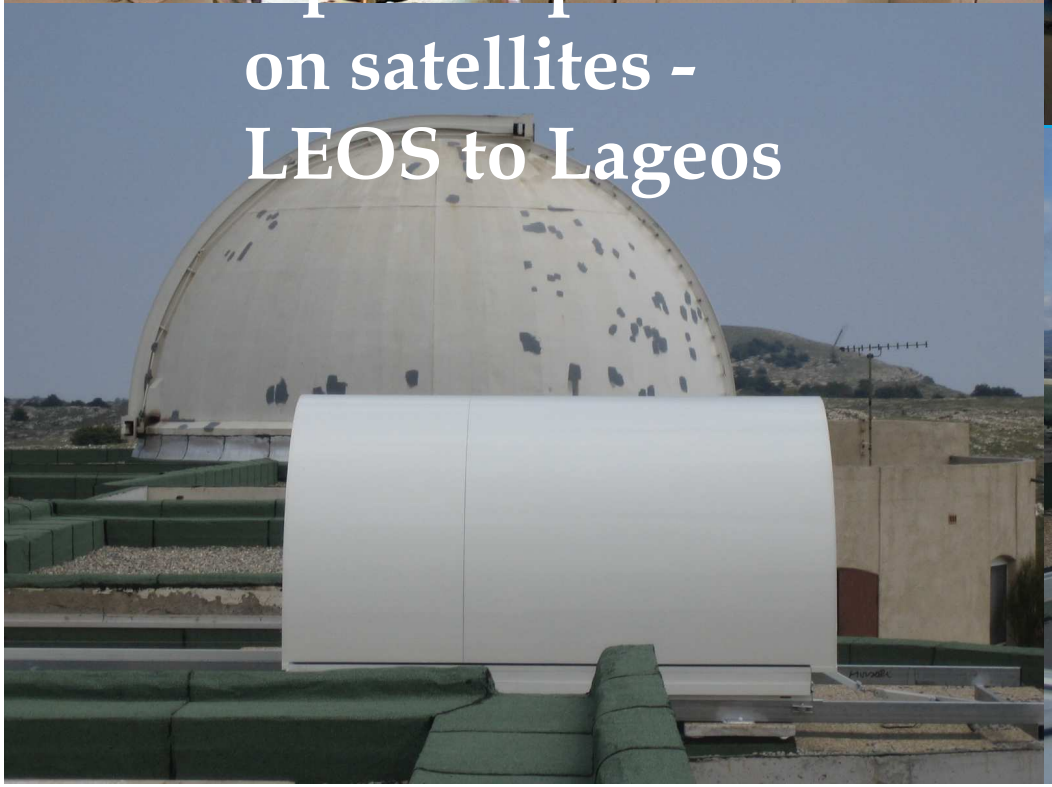
* FTLRS : “ French Transportable Laser Ranging Station”

Two positions of the system with opening roof

- Down for Technologic developments

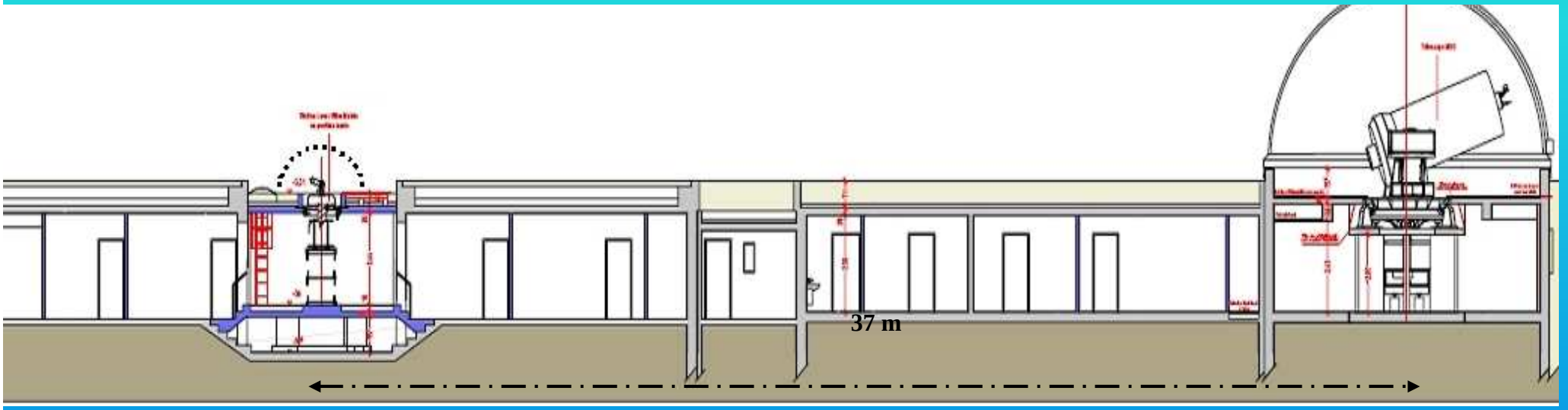
- Up for operations on satellites

- Up for Operation on satellites - LEOS to Lageos



In 2008 : Two Laser ranging instruments to Grasse Observatory

- Operationnal capacity on targets from 800 km to Moon and Solar system
- Campaign on site with mobile in new laboratory
- R&D for space projects



Today and future...

- **Mobile system operations in Grasse new laboratory**

- **Calibration/validation project on Jason in Tasmania**

5/6 months in 2007/2008 in collaboration wits Australian

- **Oca contribution :**
  - **-Technological Staff**
  - **- station preparation**

- **Australian contribution :**
  - **-Site preparation**
  - **- Travel & mission fees for french staff**

- Support for space mission **« Time transfert by Laser Link » Integrated on Jason2 (2008)**

- **Calibration of the Microwave Radar Altimeter from Jason2 in Corsica (2008)**

And soon telescope shipped to South Africa


The End
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