

Triple laser ranging collocation experiment at the Grasse observatory, France

September - November 2001

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Observatoire de la Côte d'Azur
CERGA
Grasse, France



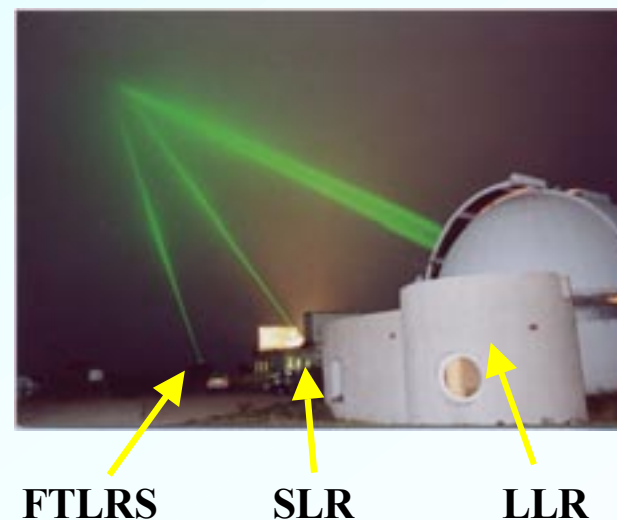
Introduction

- French Transportable Laser Ranging Station (FTLRS)
 - Improvements achievement
 - New capability of LAGEOS tracking
- Triple collocation experiment from Sept. to Nov. 2001
 - ⇒ FTLRS new performances validation
 - ⇒ Comparison with the other laser instruments of the Grasse observatory (France)



Grasse observatory

- 3 SLR stations totally independent, but very close (~ 20 m)
 - Satellite Laser Ranging (SLR)
 - Lunar Laser Ranging (LLR)
 - Mobile laser station FTLRS
- Common observations
 - SLR + FTLRS + LLR : LAGEOS -1 and -2
 - SLR + FTLRS : Stella, Starlette, TOPEX/POSEIDON



Method

Observations

- FTLRS, SLR, LLR
- LAGEOS -1 & -2
- **Common Normal Points**

O



C



Residual

O - C



Mean Residual

- By arc, by station, and by satellite



Mean station bias

- By station, over 3 months

Reference orbits

- ITRF2000, GRIM-5
- 10-day arcs with 10 stations
- 1- σ rms : ~ 1.5 cm
- **Without OCA laser stations**

Common normal point analysis advantages

- Minimization of the orbit and atmospheric correction errors
 - Because simultaneous observations
 - identical orbit errors
 - same tropospheric delay
 - Station coordinates
 - SLR → ITRF2000 (a few mm)
 - FTLRS → IGN local ties (2 mm)
 - LLR → IGN local ties (2 mm)
- ⇒ Bias differences mainly represent **instrumental errors**

Results on LAGEOS -1 & -2

- Combined solution LAGEOS -1 and -2 based on **common normal points**
- Weighted by normal point number (57 NP on LA1 - 93 NP on LA2)
- **Relative biases** between the different Grasse laser instruments
 - SLR - FTLRS : (5 ± 1) mm
 - LLR - FTLRS : (18 ± 1) mm
 - LLR - SLR : (13 ± 1) mm

- Comparison between FTLRS and other European laser stations on **common passes** (3 months)
 - FTLRS - Graz : (3 ± 1) mm
 - FTLRS - Herstmonceux : $-(3 \pm 1)$ mm

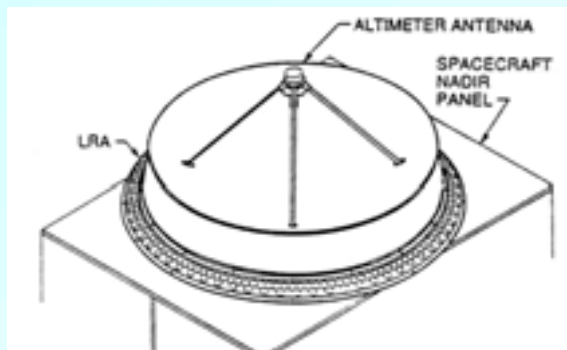
Interpretation of the differences between the 3 Grasse stations

- Center of mass correction depending on the detection level (single/multi photon mode)
 - ~ 5-10 mm between SLR and LLR
- Center-edge effect of the photodiode
 - LLR : ~ 9 mm
 - FTLRS : ~ 1 mm
 - SLR : ~ 5 mm
- Calibration target distance determination
 - ~ 2 mm
- Coordinate determination
 - ~ 2 mm

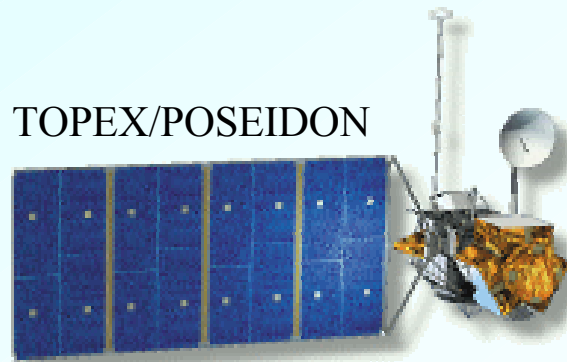
⇒ Possible interpretation at a few mm level

TOPEX/POSEIDON and LAGEOS comparison

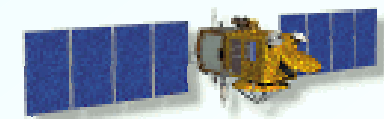
- **Mean residual** on TOPEX/POSEIDON (T/P) from 1-cm reference CNES orbits on the whole 3-month period
 - FTLRS : 2.3 cm (0.3 cm on LAGEOS -1 & -2)
 - SLR : 2.8 cm (0.8 cm on LAGEOS -1 & -2)
- ⇒ Agreement with LAGEOS results (Difference SLR - FTLRS : 5 mm)
- ⇒ **2 cm** systematical difference between T/P and LAGEOS mean residuals
 - not due to station performances
 - not observed on JASON-1 first results
- ⇒ Probable origin: T/P retroreflector array correction



TOPEX/POSEIDON

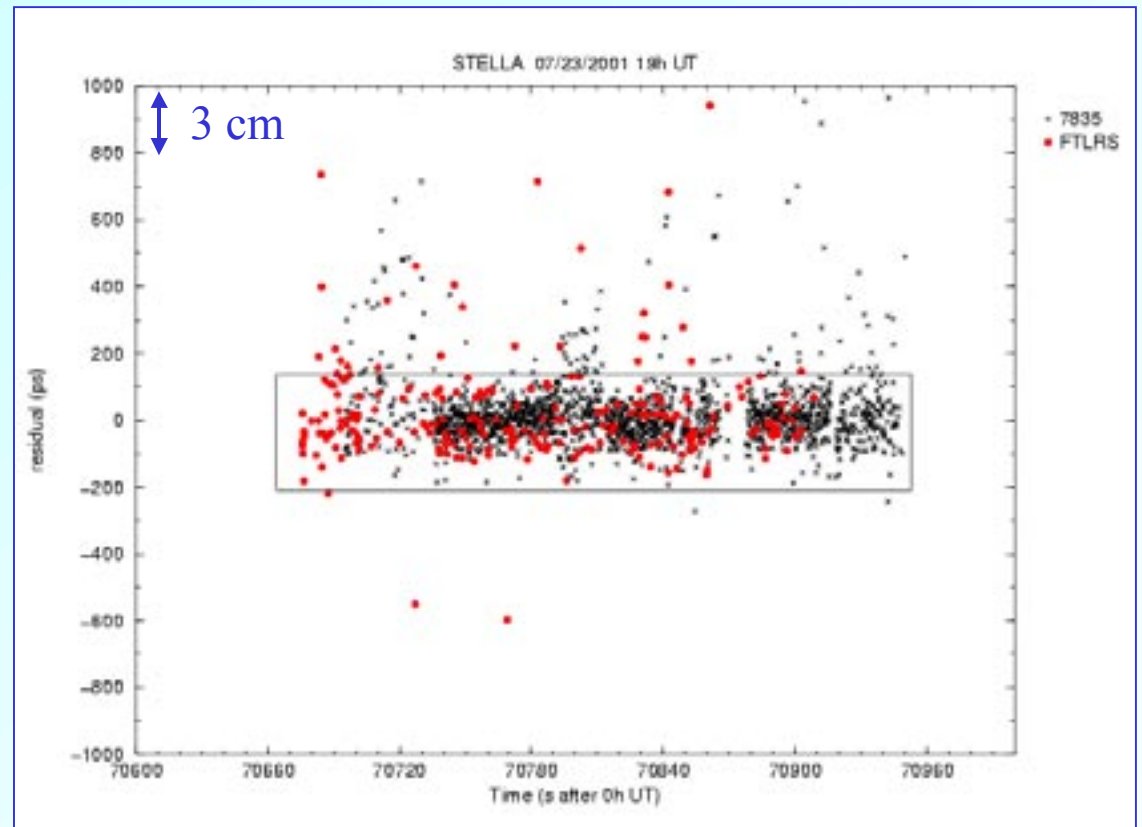


JASON-1



Results on STELLA

- FTLRS and SLR raw data
- FTLRS 1- σ rms for STELLA observation
 - single shot: 10.7 mm (8.5 mm for SLR)
 - normal points: 3 mm
- FTLRS results comparable to the Grasse SLR fixed station at a few mm level



STELLA satellite full-rate data (single shot) simultaneously observed by the FTLRS and the satellite laser ranging fixed station (7835) at the Grasse observatory, France. The box indicates the data used for the dispersion estimation.

Conclusion and prospects

- **Validation** of FTLRS new performances at the level of **few mm**
- Importance of the **center of mass correction** dependence on the detection level mode (computations in progress)
- Importance of the **center-edge effect** for few mm accuracy level
- Importance of the **geodetic local survey** and of **calibration** value determination
- Confirmation of the problem of **T/P retro-reflector array correction**

- Confirmation with the first results of the recent FTLRS Corsica campaign for JASON-1 and ENVISAT Calibration and Validation experiment (Jan. - Sept. 2002)
- Future FTLRS campaigns: Gavdos island (Crete, 2003), Mont St Michel experiment (Normandy, 2003)...

Ground target observations

- 3 external calibration targets (distances of 333 m, 1588 m, and 2533 m)
- Ranges measured with an accuracy of 1cm (F-IGN)
- 1- σ rms 35 ps (less than 4 mm)
- Stability at the level of few millimeters over few days
- Accuracy \sim 1 cm
- Calibration routinely performed on the 300 m ground target

