Improvements of the French Transportable Laser Ranging Station to high accuracy level

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Abstract

The very small (300 kg) French Transportable Laser Ranging Station (FTLRS) has been greatly improved the past two years and we'll summarize herein main improvements and different tests performed on the station.

The aim was to reach both high accuracy and stability necessary for JASON1 orbit validation and altimeter calibration experiment. These characteristics are also essential for station positioning adjustment, precise orbit determination, and terrestrial reference frame computation. To reach this performance, many major improvements have been carried out on the FTLRS, they mainly concern:

- *laser configuration (wavelength, pulse width, cooling, stability, reliability in hard environments)*
- *detection package with new optical configuration and C-SPAD detector*
- *start detection with permanent laser monitoring*
- *new GPS steered rubidium clock*
- *software*

The success of all these upgrades has been confirmed at the level of few millimeters by the analysis of a collocation experiment performed at the Grasse observatory between the three laser instruments (autumn 2001) and the evaluation of the eight months set of data from the Corsica campaign still in progress.

Colocation experiment with the three Grasse laser stations (FTLRS, SLR and LLR) on Lageos satellites (fall 20001)

Ftlrs status september 2002

- ***Lageos tracking capability***
- ***Fast switching on tandem satellites***
- ***Bias at some millimeters level***
- ***Stability at a good level (Ilrs analysis-quarter 2/2002)***
- ***Very good reliability for some months campaigns***
- ***Next campaign in Crete (March/september 2003)***

Technical improvements

- **Laser**
  Wavelength from infrared to green (532 nm)

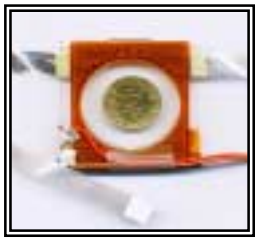
  Pulse length to 35 ps

  Mechanical design and thermal regulation for outdoor operations

- **Optical design**
  Synchronized electro optical shutter to protect SPAD from blinding at laser firing.

  Installation of a secondary focus point with an iris on the optical return way to limit the image of the field of view to the sensitive area of the Spad (100 micron)

  optical square for tuning, adjustment and calibrations.



Opto-electronic shutter

- **Detection systems**
  C-Spad module compensated with time walk variations for return detection

  Very fast and accurate (16 bits) start device with measurement, recording and screening shot by shot the laser pulse intensity.

  Replacement of the link through ring contacts by coaxial cable and development of software control for +/- 360 degrees mount rotation.

- **Timing devices**
  GPS steered rubidium clock Datum selected with engineering and qualifications tests

  Linearity control on Stanford SR620 chronometer.

- **Software control**
  New capabilities and hardware control. ...

  Fast switching (10 sec) between simultaneous satellites (Jason/Topex, GraceA/B).. ...

Engineering tests in laboratory

Chronometer qualification

linearity and stability

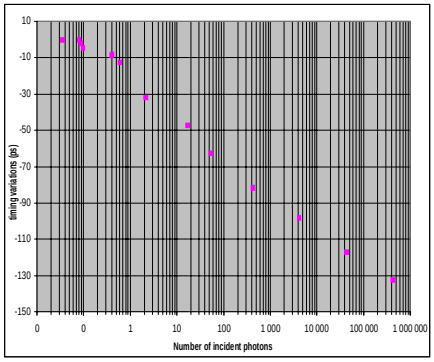
C-Spad detector

Time walk measurement :
Arrival time of events in the gating signal
minimum :100ns after gating

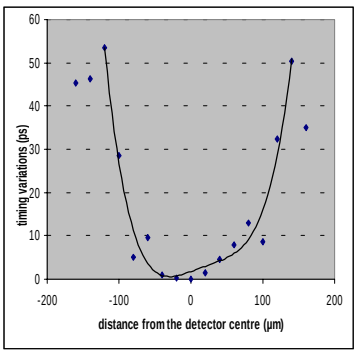
Dependance on :
-Photons number on the sensitive area : 20ps/decade

-Location of the photons (centre-edge effect)

-Outside temperature of the housing : 3ps/d°c
compensated by the calibrations



Effect of the incident photon number on the C-Spad delay



centre-edge effect on the chronometer measurements

Validation experiment (Grasse observatory - fall 2001)

Three stations (Slr, Llr, Ftlrs) colocation on Lageos satellites

Combined solution Lageos-1 and 2 based on common normal points:

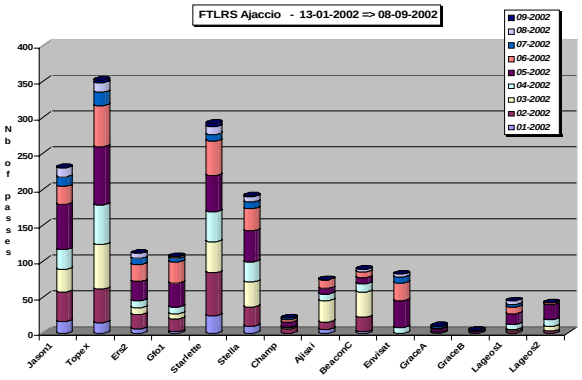
Relative biases Slr-Ftlrs : 5 mm +/- 1mm

Comparison between FTLRS and other European laser stations on 3 months passes :

FTLRS - Graz : 3 +/- 1mm

FTLRS - Hertsmonceux: 3 +/- 1mm

Results and performances with Corsica campaign (01-09 2002)



- Passes and Npts during the 6 months campaign

1563 low orbiting satellites

87 Lageos

467 passes common with Grasse Slr

- Lageos bias stability

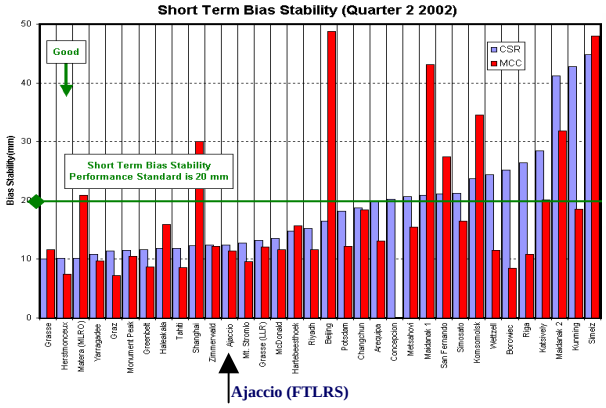


Fig : Lageos bias over 6 months

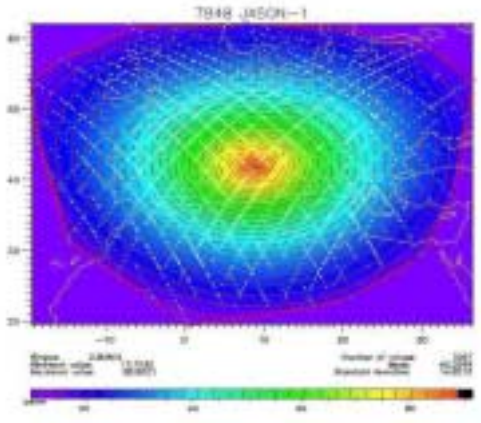
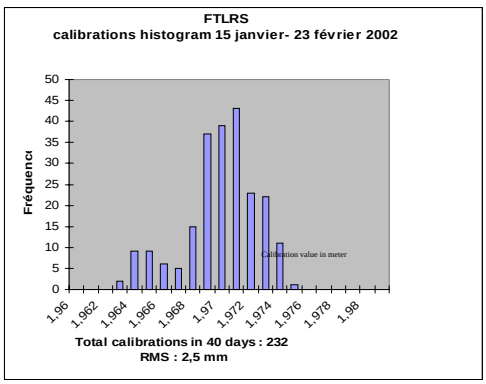


Fig : Jason1 Npts distribution on the sky during the campaign

- Calibration stability



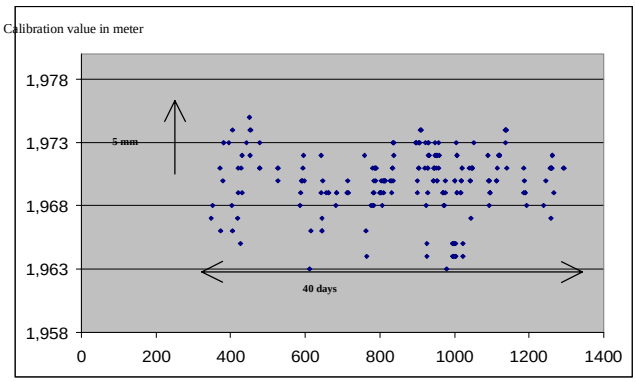


Fig : Calibration stability over a 40 day campaign period (jan 15 - febr 23/2002)