Absolute calibration of the MOBLAS laser station at Tahiti for the T2L2 experience

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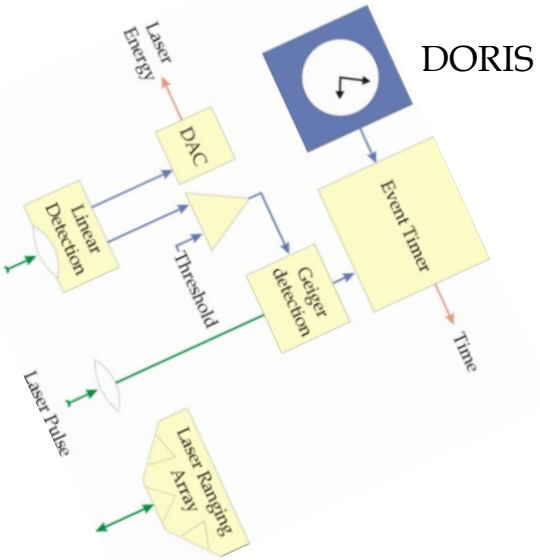
Summary

- Description of the T2L2 experience
  - » T2L2 principle
  - » T2L2 space instrument
  - » Tahiti campaign
- Absolute calibration of the MOBLAS and the FTLRS laser station
  - » Calibration principle
  - » Local configuration
  - » Implementation

Time Transfer by Laser Link (T2L2) Principle

- T2L2 is a 2 way technique based on the timing of optical pulses emitted (and received) by a laser station and received by a space segment
- Ground : T_{start} T_{return} Space : T_{board}
- From these 3 dates : Difference between the ground and space clock

T2L2 on Jason2

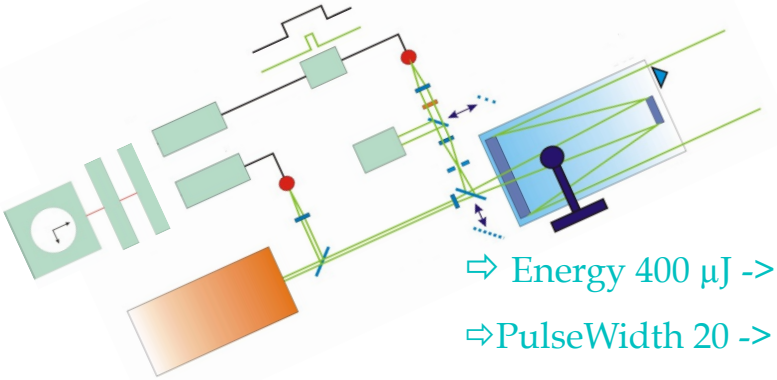


⇨ Masse: 10.4 kg

⇨ Power Consumption: 50 W

⇨ Volume : 20 l

Laser Station



⇨ Energy 400 µJ -> 200 mJ

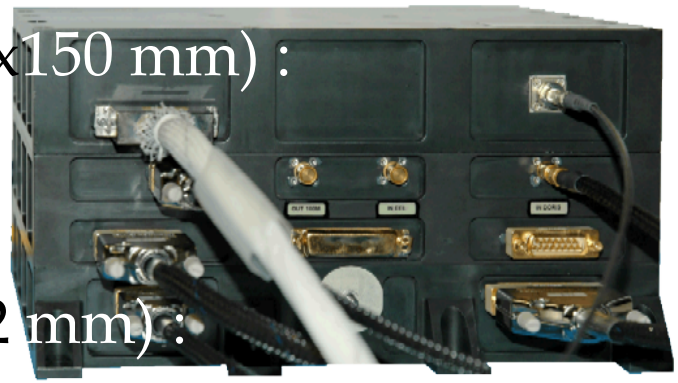
⇨PulseWidth 20 -> 200 ps

$$X = \frac{T_{start} + T_{return}}{2} - T_{board} + T_{correc}$$

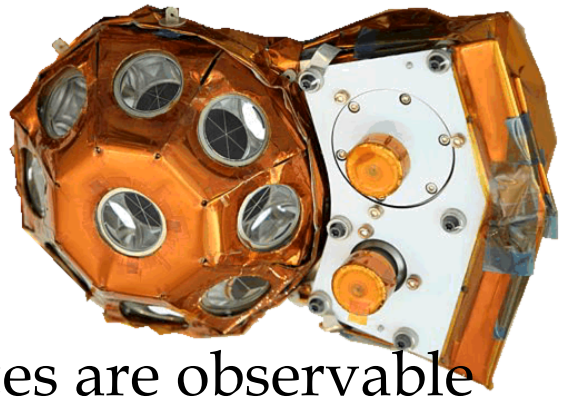
T2L2 Space instrument

- T2L2 was launched in June 2008 on Jason2 (1330 km)

- Electronic module (8.2 kg / 50 W / 280x270x150 mm) :
  - » Event timer: Repeatability error < 2 ps rms
  - » Some parts of the detection
    ⇒ Inside the satellite

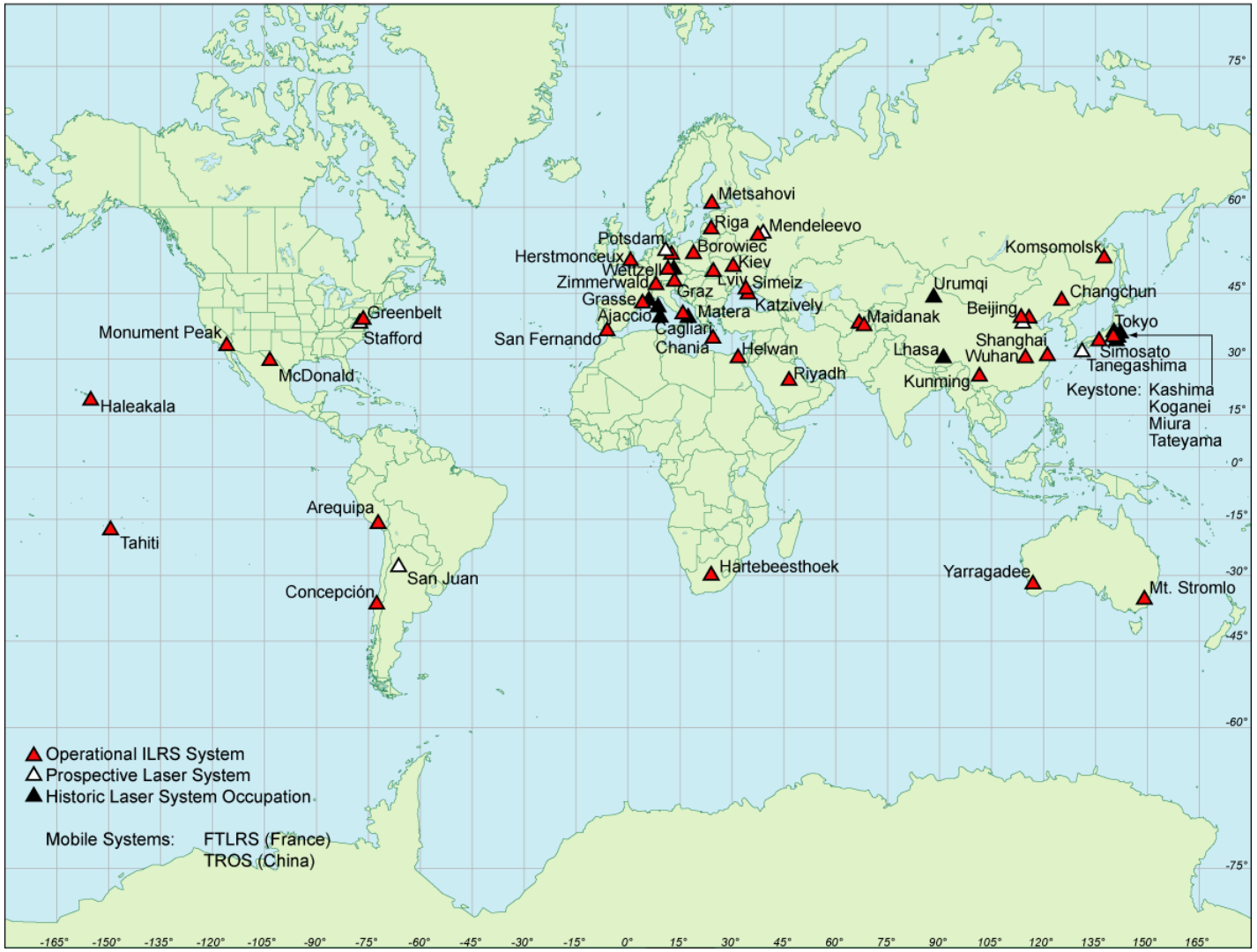


- Optical module (2.2 kg / 2 W / 182x143x102 mm) :
  - » Detection modules: Field of View 110°, λ = 532 nm
  - » Corner cube (Jason2)
  - » Link to the electronic module by optical fiber
    ⇒ Outside the satellite



- No evolution nor degradation of performances are observable since the launch

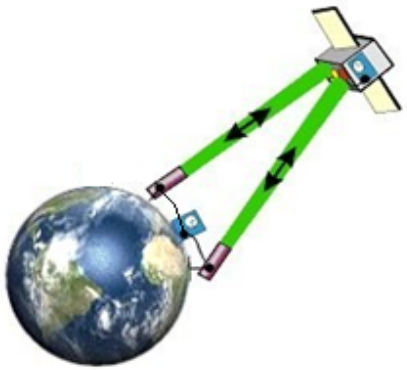
Tahiti campaign

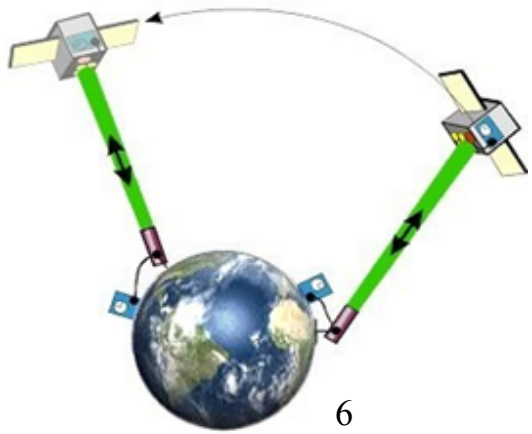


Tahiti campaign

- Objectives
  - » T2L2 FTLRS -Moblas time transfer collocation
  - » T2L2 - DORIS Inter comparison
    - Monitor the DORIS oscillator
    - Improve DORIS navigation
  - » Remote control of the onboard DORIS oscillator over a region currently not observed

- Duration of the mission
  - » 4 – 6 months since may 2011



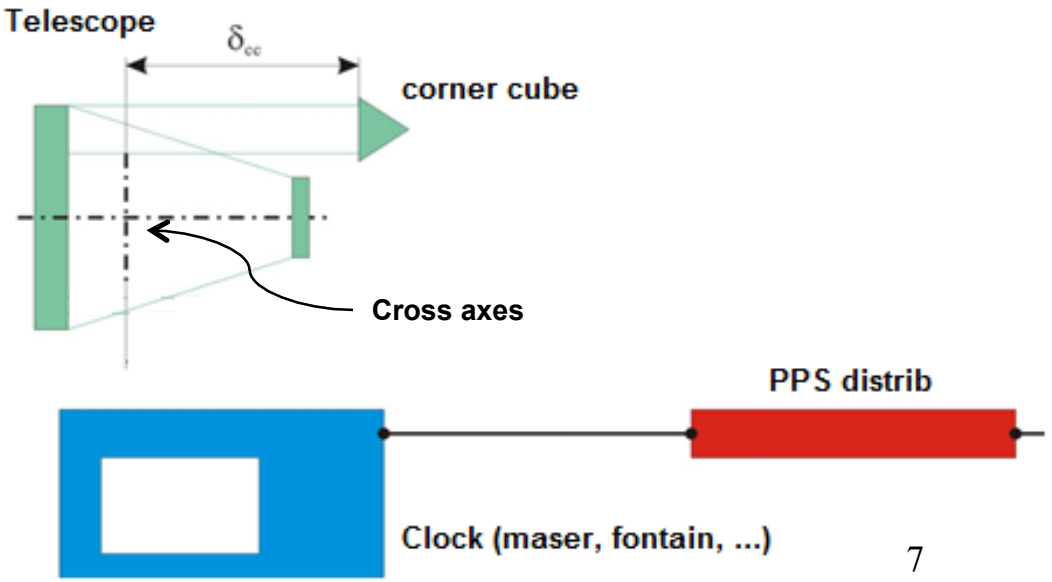


Absolute calibration of laser station

- Time and Space references
  - » Laser station
    - The reference point is the cross axes of the telescope which is also the space reference for laser ranging
    - Laser ranging is based on that point thanks to an internal calibration on an external target (corner cub)
  - » Time and frequency lab
    - PPS distribution unit

- Objective :

To measure *the delay* between the optical pulse at the cross axe of the telescope and the electrical reference coming from the Time and frequency lab



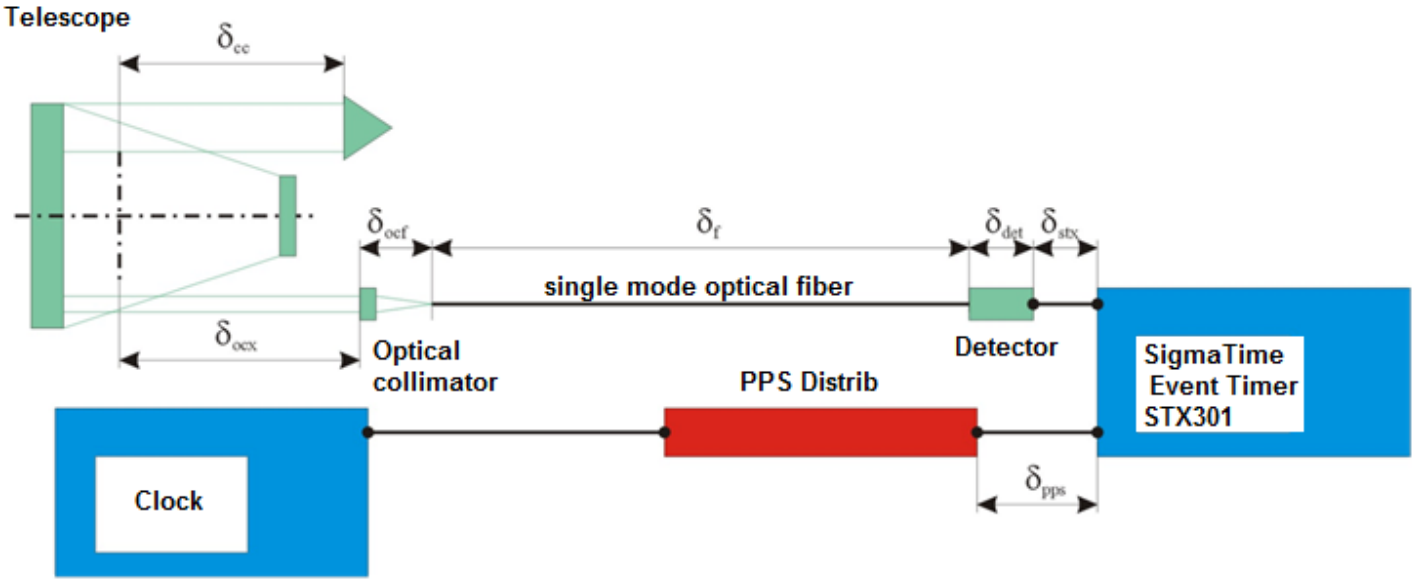
Absolute calibration of laser station

- Time equation that allows to date accurately laser pulses is given by:

$\delta_T = \delta_{cal} + \delta_{prg}$

δ_{cal} : difference between absolute measurement (calibration) and station measurement

δ_{prg}: global propagation between cross axes and the PPS unit. $= \delta_{PPS} - (\delta_{ocx} + \delta_{ocf} + \delta_f + \delta_{det})$



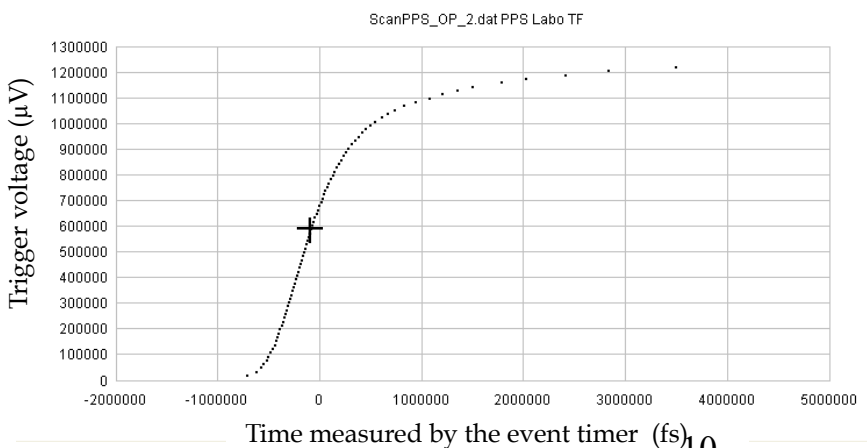
Determination of the term δprg

- $\delta_{prg} = \delta_{PPS} - (\delta_{ocx} + \delta_{ocf} + \delta_{f} + \delta_{det})$

- δ_{PPS} ; δ_{f} : propagation in cables/fiber
  - » Measured by the calibration station
- δ_{ocx} ; δ_{ocf} : propagation in free space
  - » Determined form the geometrical distance
- δ_{det} : Propagation in the detector (optical-electrical)
  - » Deduced form a propagation model (currently studied)

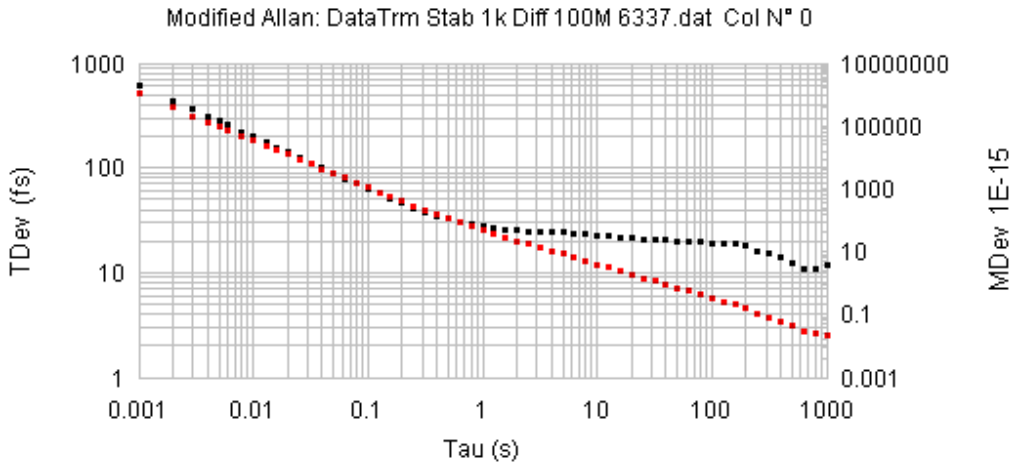
Determination of the term δcal

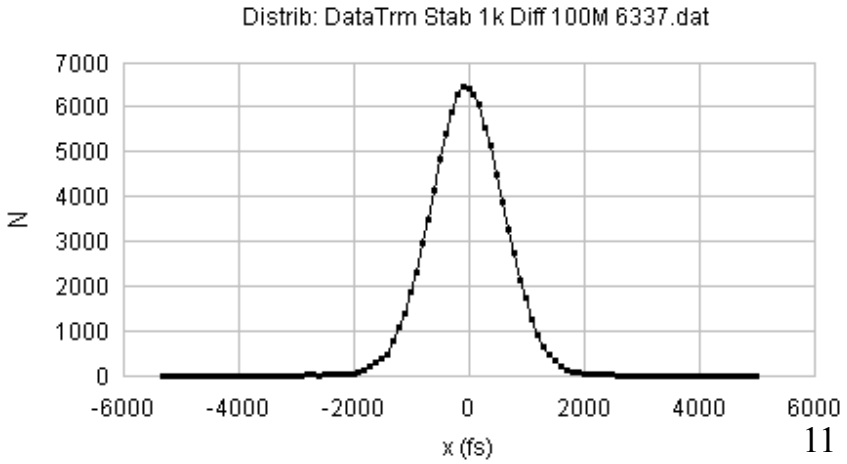
- PPS Synchronization of the SigmaTime STX301 event timer
  - » Scan of the PPS signal by the event timer
  - » Reference threshold from the inflexion point
  - » Synchronization of the timer with this Reference threshold
- Simultaneous acquisition of laser pulses from
  - » Laser station
  - » Calibration station



SigmaTime Event Timer STX301 Performances

- Time Stability @ 1000s: < 20 fs
- Linearity: 0.3 ps rms.
- Thermal Sensit. < 200 fs/°C
- Repeatability error
  - » Synchronous : 600 fs rms
  - » Random : 700 fs rms
- Rate
  - » Dead time: 130 ns
  - » High speed Acquisition : 500 kHz
  - » Continuous rate 35 kHz





- contact@sigmatime.fr

Absolute calibration of the MOBLAS and the FTLRS laser station

- Local configuration

French Transportable Laser Ranging Station (FTLRS)

MOBile LASer Ranging System (MOBLAS)

The Geodesic Observatory of Tahiti ; Time and Frequency lab

Absolute calibration of the MOBLAS and the FTLRS laser station

- Local configuration

French Transportable Laser Ranging Station (FTLRS)

- The smallest station in the world
- Laser: Nd-YAG dubbed in frequency, λ =532 nm, 50 mJ per impulsion, repetition rate 10 Hz, pulse width 35 ps
- Telescope diameter: 13 cm
- Pointing error: < 10" rms
- Detector : avalanche photodiode in Geiger mode
- Climatic conditions of use: 5 to 40°C, jup to 95% of humidity

Absolute calibration of the MOBLAS and the FTLRS laser station

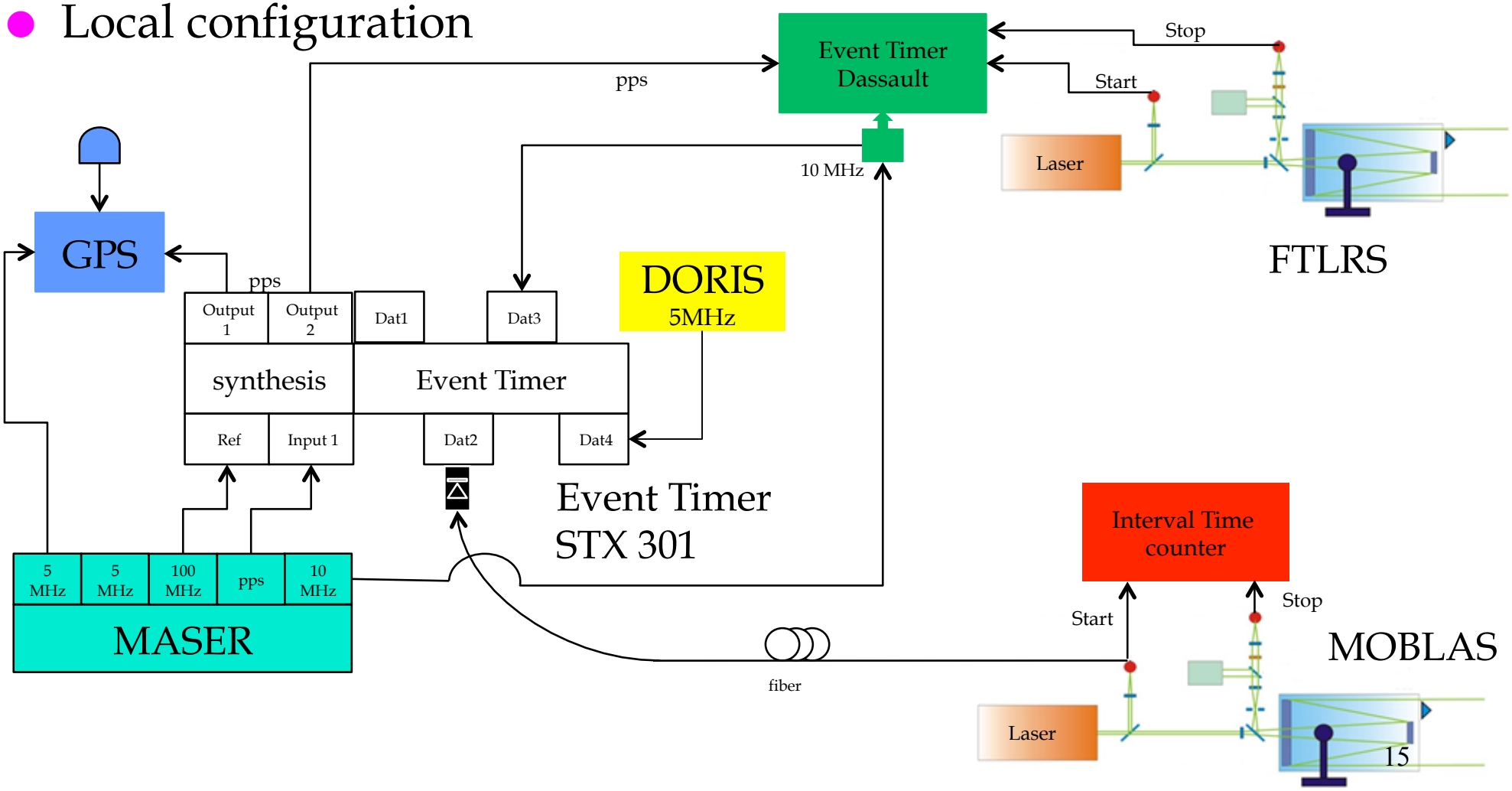
- Local configuration

NASA MOBile LASer Ranging System (MOBLAS 8)

- Laser : Nd-YAG dubbed in frequency, λ =532 nm, 100 mJ per impulsion, repetition rate of 5 to 10 Hz, pulse width 200 ps
- Reception telescope diameter: 76,2 cm
- Emission telescope diameter: 16,3 cm
- Detector : photomultiplier

Absolute calibration of the MOBLAS and the FTLRS laser station

- Local configuration



Status

- FTLRS is running since the 05/05/11
- The absolute calibration of the MOBLAS and the FTLRS laser station is done
- A technical problem on the MOBLAS station prevents ground to ground time transfer, up to now.


Thanks for
your attention

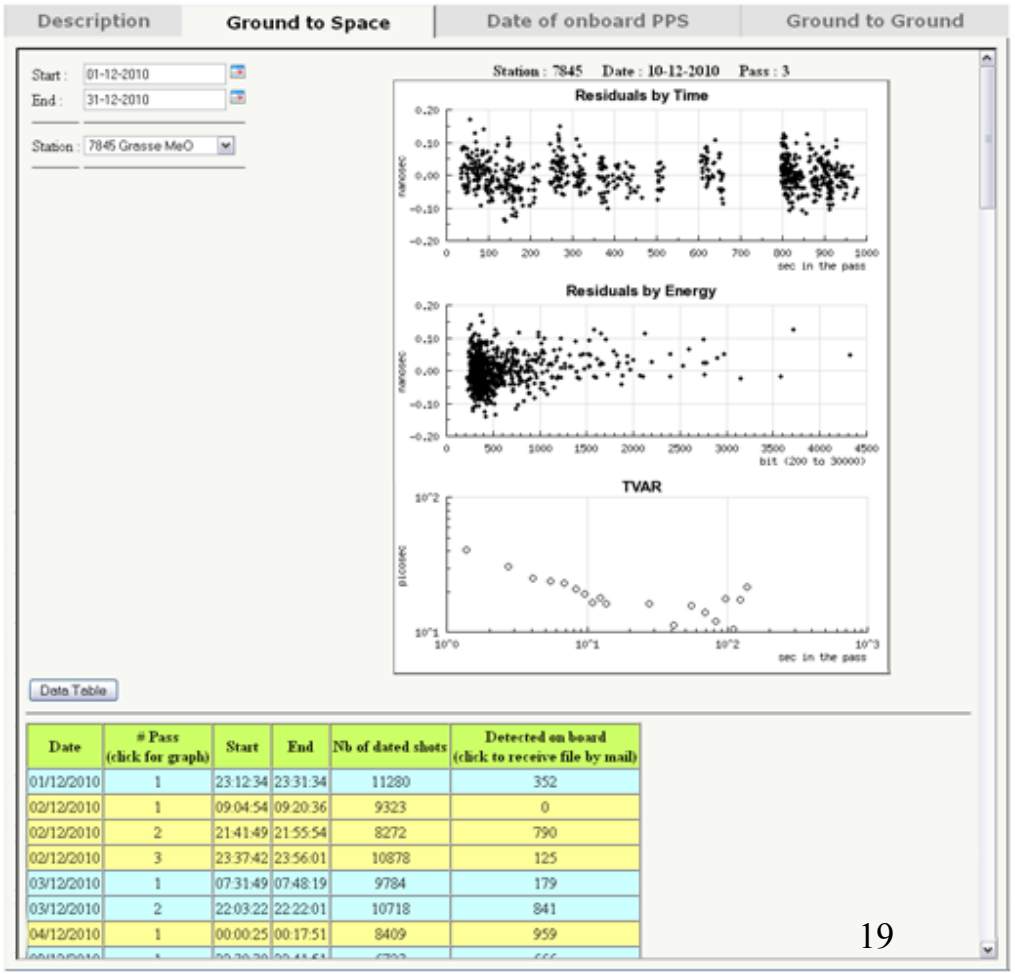
Calibration budget

- Budget exemple: MeO Station 01/07/2010

δ	Label/Ref	Valeur (ps)	Date
δ_{cc}	CC_{Lune}	12393	01/07/10
δ_{PPS}	$T2L2CalC_2$	9408	06/08/06
δ_{ocx}	Ref_{Axe}	12104	01/07/10
δ_{ocf}	$T2L2MC_2$	58	01/07/10
δ_f	$T2L2CalF_1$	248300	06/08/06
δ_{stx}	STX301-001-000-C_1	0	01/07/10
δ_{det}	NewFocus1454	660	01/07/10
δ_{cal}	GioveB 100522	628721	22/05/10
δ_T		**377007**	**01/07/10**

- French laser stations have been calibrated
- Several laser station of the global network will be calibrate in the next future

T2L2 Web
http://www.oca.eu/heberges/t2l2/home.htm



Date	# Pass (click for graph)	Start	End	Nb of dated shots	Detected on board (click to receive file by mail)
01/12/2010	1	23:12:34	23:31:34	11280	352
02/12/2010	1	09:04:54	09:20:36	9323	0
02/12/2010	2	21:41:49	21:55:54	8272	790
02/12/2010	3	23:37:42	23:56:01	10878	125
03/12/2010	1	07:31:49	07:48:19	9784	179
03/12/2010	2	22:03:22	22:22:01	10718	841
04/12/2010	1	00:00:25	00:17:51	8409	959