

French Transportable Laser Ranging Station

Stanford SR620 chronometer accuracy

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Towards zero bias...

What conditions?

- ▶ Very short time intervals: (internal cal. < 30 ns)
- ▶ External calibration: (100 m to 300 m)
- ▶ For satellites tracking: (400 km to 10 000 km)
- ▶ Time evolution (long-lasting effect)

How?

With two timing systems:

- ▶ FTLRS Stanford chronometer (temperature controlled)
- ▶ Dassault Timers as a reference



FTLRS in San Fernando (Spain)
June 2004



FTLRS in Chania (Crete)
Gavdos campaign - 04 to 10 2003

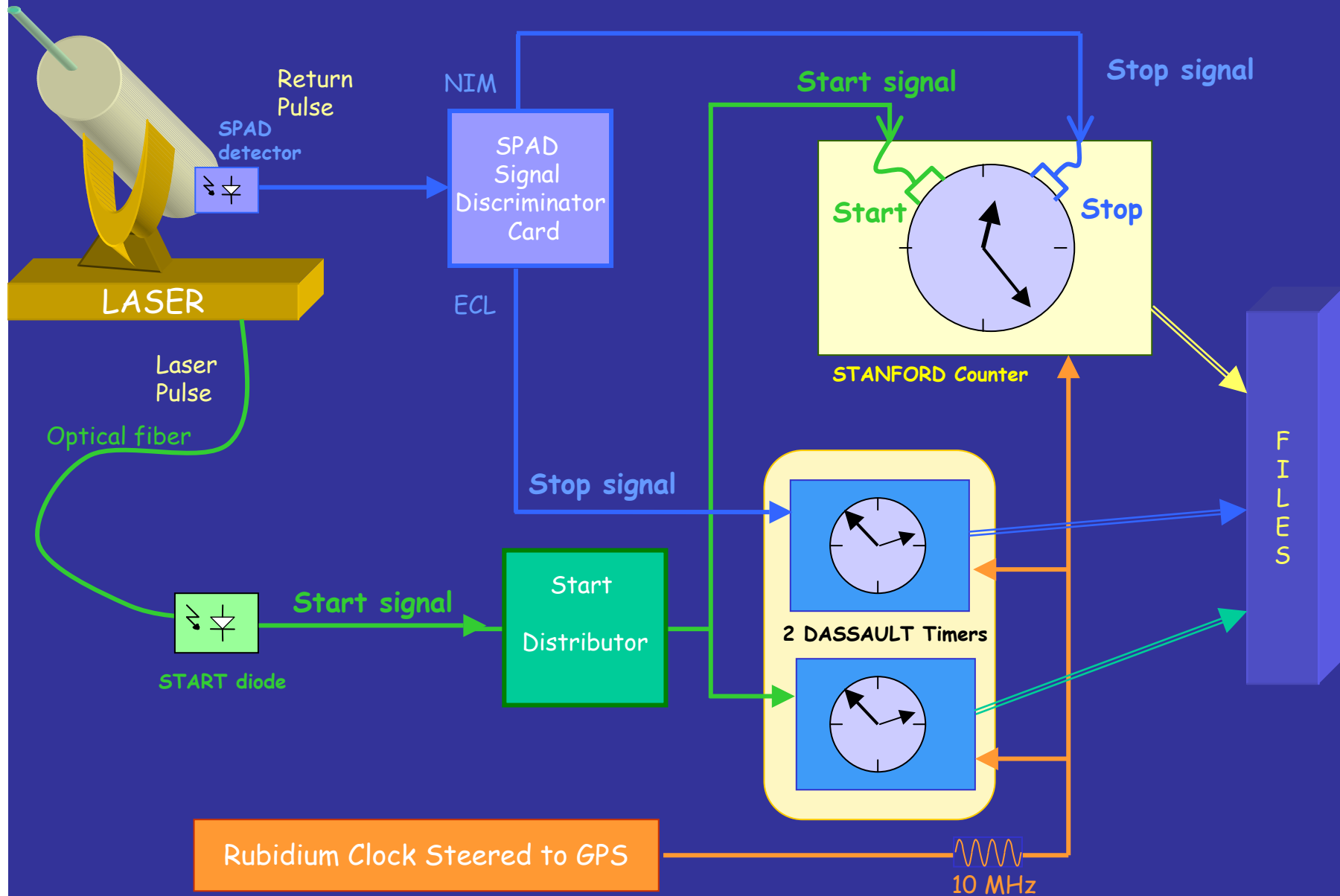


In same Context:

Laser for start
Photodiode for stop
Without mutual perturbation

On same events:

Echo or noise

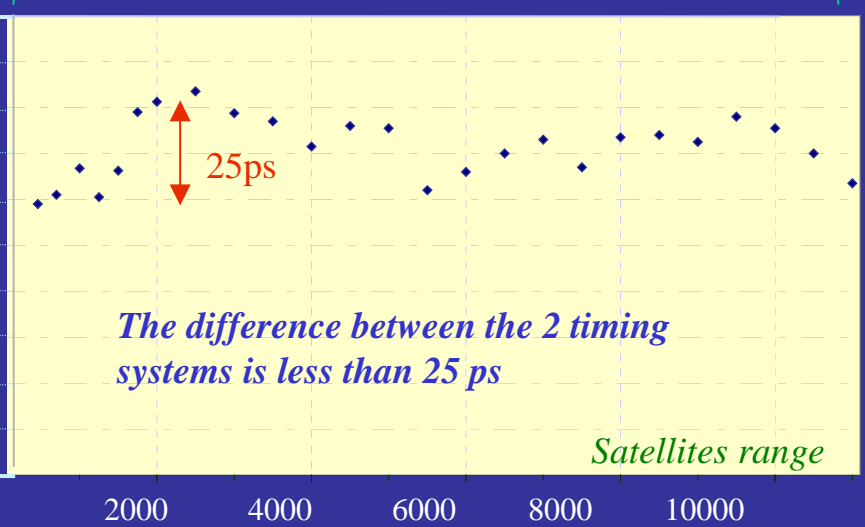
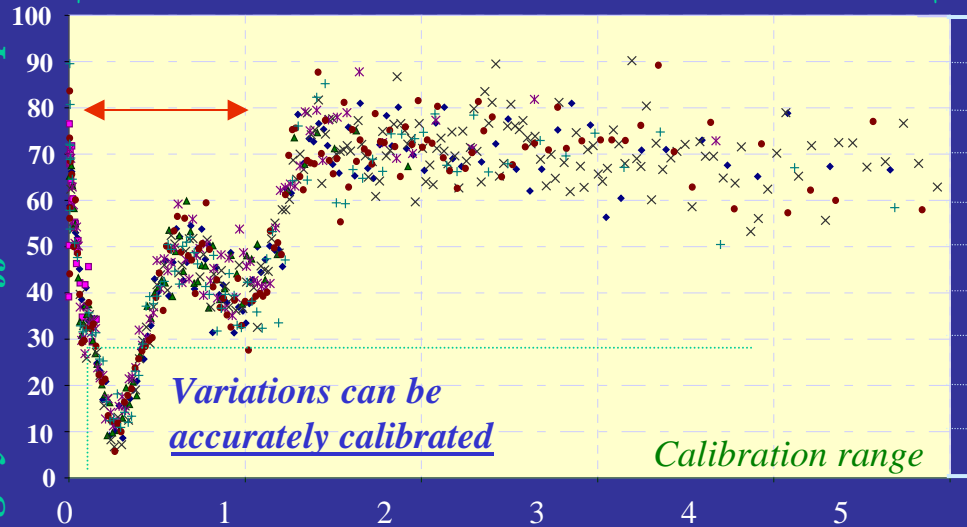


Measurement results

0 to 5 km

400 to 10 000 km

Timing systems difference in ps



Variations can be accurately calibrated

Calibration range

25ps

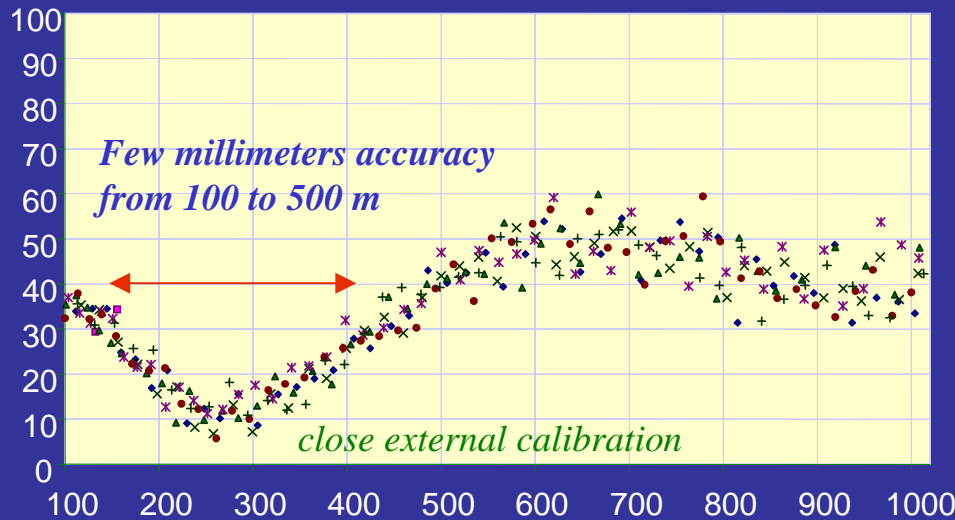
The difference between the 2 timing systems is less than 25 ps

Satellites range

All this measurements are NOT time dependant

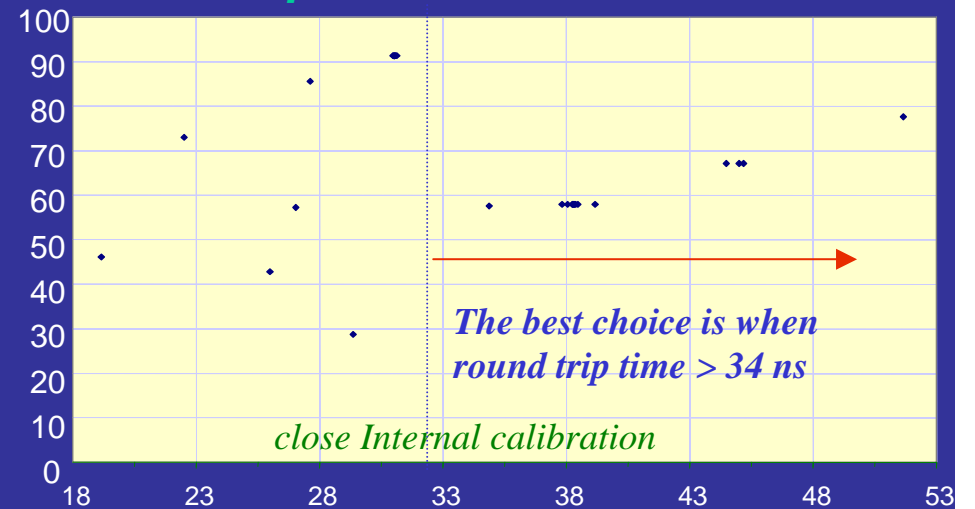
From 100 meters to 1 km

Roundtrip time from 15 to 55 ns



Few millimeters accuracy from 100 to 500 m

close external calibration

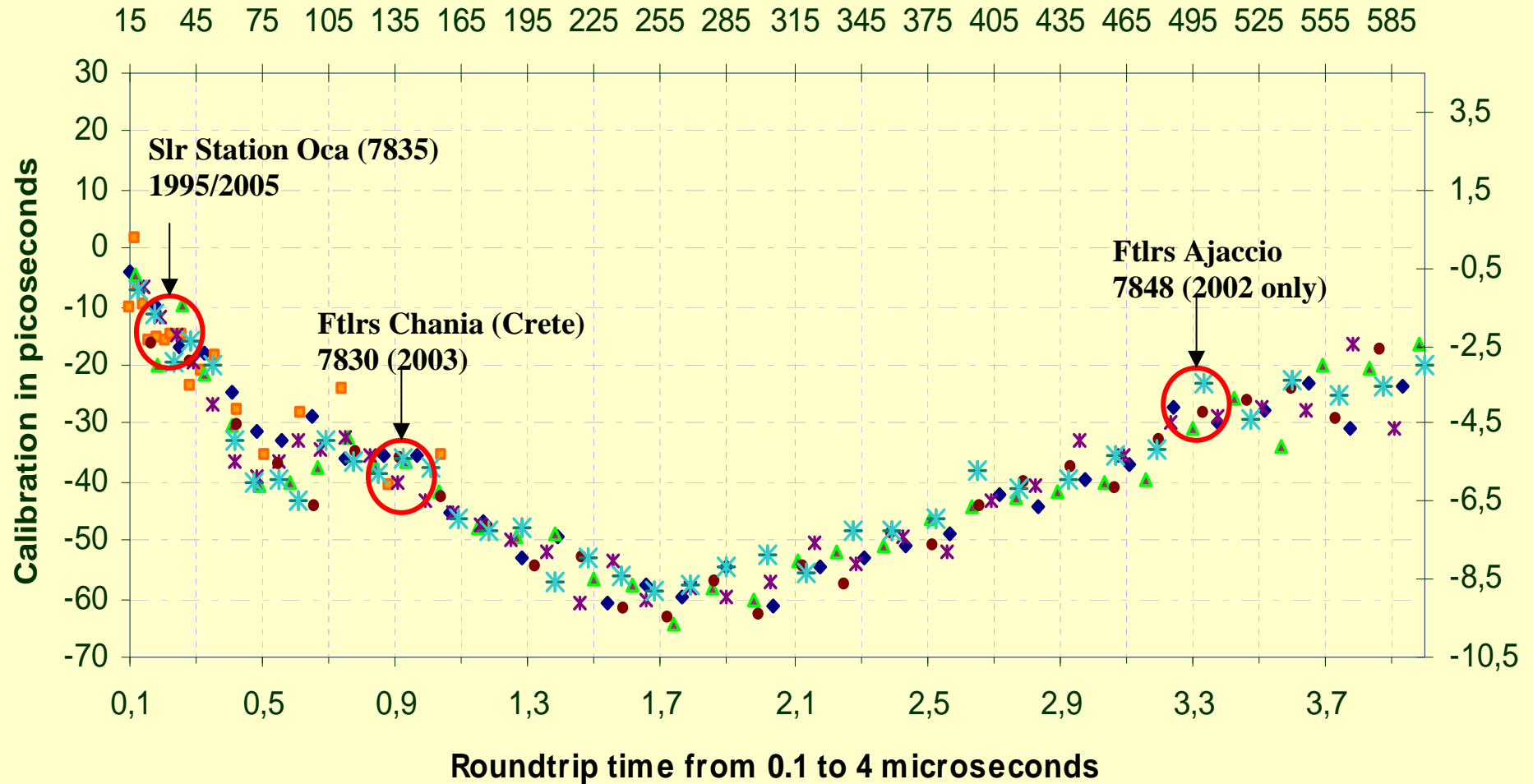


The best choice is when round trip time > 34 ns

close Internal calibration

Stanford Calibration

One way in meter



Method and Results

Very important to model the chronometry behavior at different ranges, and to process the calibration value accordingly.

➤ Stanford Chronometer can achieve *few millimetres accuracy after modelling* (from 5 m to 10 000 km).

➤ Range near external calibration is easy to model.

The correction to achieve for this external calibration can be tuned to some millimetres depending on the target's range.

➤ Values near internal calibration range are more difficult to evaluate, except with roundtrip time longer than 34 nanoseconds (5.1 m range)

Corrections proposed

Non applied today :

Fixed Grasse slr system (7835) stopped today :

GRSL	Grasse	7835	1995-09-01 to 2005-08-01	+3 mm (to add on the range to data)
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Non applied today :

Mobile Slr system : FTLRS

AJAF	Ajaccio	7848	2002-04-01 to 2002-10-01	+8 mm (to add on the range to data)
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CHAF	Chania	7830	2003-04-01 to 2003-10-01	+ 6 mm (to add on the range to data)
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For FTLRS, this value has been fixed to zero after calibrating Stanford non linearity and introducing this correction depending on ground target ranges since 2004.

Mobile Slr system : FTLRS after Stanford calibration

SFEF	San Fernando	7823	2004-06-01 to 2004-07-01	0 mm
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BREF	Brest	7604	2004-09-01 to 2004-11-02	0 mm
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AJAF	Ajaccio	7848	2005-05-01 to 2005-11-01	0 mm
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Thanks for your attention...