Timer accuracy estimation for FTLRS, the French Transportable Laser Ranging Station, OCA-GEMINI Grasse (FRANCE)

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FTLRS tent (bad weather)

FTLRS in Chania (Crete)
Gavdos campaign – April to October 2004 -

Introduction

What are we looking for?
- Estimate the accuracy of FTLRS chronometry system

What conditions?
- External calibration (100 to 300 meters)
- For satellites tracking (400 to 10000 km)
- Time evolution (long-lasting effect)
- Very short time intervals (internal calibration less than 30 ns)

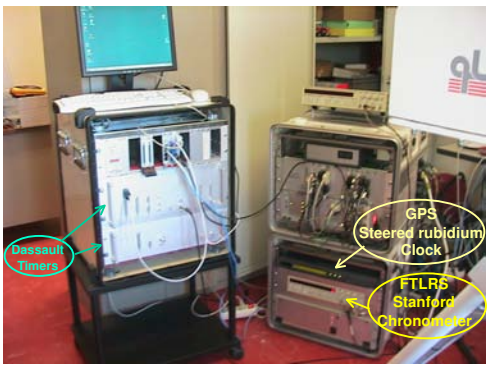
How?
With two timing systems:
- FTLRS Stanford chronometer
- 2 Dassault Timers, our reference for accuracy estimation.

Simultaneously : on same events (echo or noise)
In same Context :
- laser for start
- Photodiode for stop
- Without mutual perturbation

Crete laser maintenance

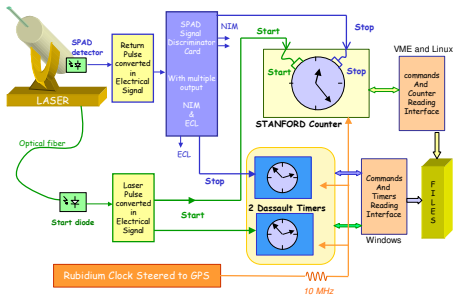
tracking

Hardware configuration



Under lab tests in April - Mai 2004

Synoptic scheme



Data acquisition achieved by normal or simulation tracking software (VME real time and Linux system)

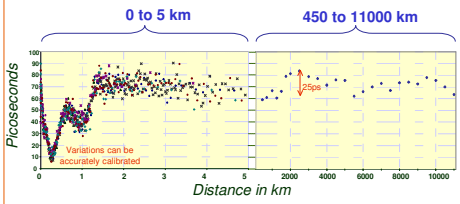
- For fltrs system with Stanford, the dating is absolute
- For Dassault timers, the dating is relative

Measurement results

Range dependence

For each measurement type, the relative difference between the 2 timing systems (Dassault timers – Stanford chronometer) is on Y_axis in picoseconds, and roundtrip time (or distance) on X_axis.

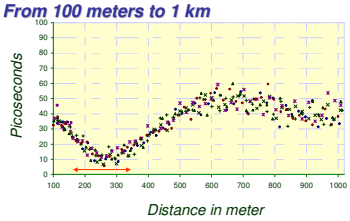
Global Plot (to 11000 km)



For calibration range, variations can be accurately calibrated

For satellites tracking range, difference less than 25 picos

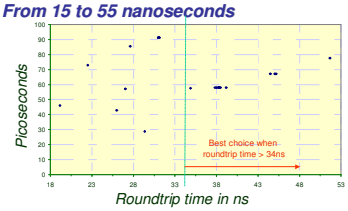
From 100 meters to 1 km



Few millimeter accuracy from 150 to 350 m

For external calibration, the best is to choose a target around between 100 m and 500 m

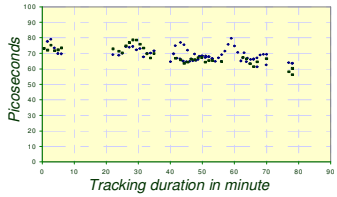
From 15 to 55 nanoseconds



For close internal calibration , Best choice with roundtrip time longer than 34 ns.

Complementary measurements to achieve

time stability



No problem with time stability; time stability behavior doesn't depend on range

Gavdos positioning result

Crete campaign in 2003 with 5 months of operations

Position estimated every 7 days while bias remains estimated with the whole data

dφ = -0,58 cm ± 0,35 cm
dλ = 0,16 cm ± 0,33 cm (Relative to GPS JCET solution)
dh = 1,25 cm ± 0,28 cm

Biases
LA1 = -0,96 cm ± 0,21 cm
LA2 = -0,97 cm ± 0,18 cm
STA = -1,57 cm ± 0,11 cm
STE = -2,02 cm ± 0,11 cm

Correlation position/bias = 0,57

Correlation position/bias decreases significantly
Bias is globally lower **B = 10 ± 2 mm**

Conclusion

It is very important to model chronometry behavior at different ranges, and to correct calibration value accordingly.
- Stanford Chronometer can achieve ***few millimeters accuracy during satellites tracking*** (from 400 to 10000 km)
- Range near external calibration is easy to model.
  Correction to achieve for external calibration can be tuned to 30/60 picos, depending on the target's range.
- Values near internal calibration range are more difficult to evaluate, except when the roundtrip time is longer than 34 nanoseconds.
  Difference between external and internal calibrations is about 50 picos (7,5 mm)