

NUMERICAL NOISE IN SATELLITE LASER RANGING DATA PROCESSING

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Abstract

The SLR station Graz is producing millimeter precision ranging data at a return rate of 2 kHz. Ranging to terrestrial targets, the ranging precision below 1 mm is achieved, ranging to low pulse spreading satellite, the precision of 2-3 mm is achieved. These ranging data sets have been analyzed / smoothed using two different algorithms and working groups. The first solution has been based on the polynomial fitting, the second one on the orbital fitting approach. The computed o-c residuals have been compared for both solutions on a shot by shot basis. These differences are on single picosecond level, just indicating the order of magnitude of a numerical noise within the SLR data processing algorithms.

Goals:

- WHAT CAN WE GET FROM 2kHz / mm large volumes data averaging ?
- To optimise the procedure for 2kHz millimeter ranging data processing
- To estimate the performance of the SLR data processing software:
 - ◆ fitting algorithms (orbit, residuals) accuracy
 - ◆ numerical noise of the computation

Philosophy

- numerical experiments based on Graz SLR data Oct.2003 - Jan 2004
2 kHz / C-SPAD, rms < 3mm
- satellite signature eliminated by single CCR echoes / data selection
- inter-comparison of two completely independent data processing / fitting algorithms on a echo-by-echo basis:
Graz SLR X Portable Calib. Standard PET2k
- MERIT2 data format : 1 psec granularity

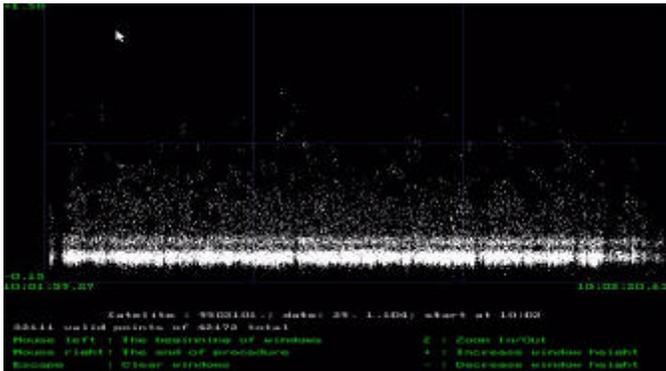
SLR data fitting procedures compared

- Graz SLR data fit
- orbit IRVINT integrator, 1 minutes x,y,z
- 8-pt Lagrange interp., topocentric conversion
- optional manual RB / TB tuning
- Polynomial fitting, standard scheme, deg. 5-10 (20)
- data screening / editing

- Portable Calibration Standard 2k
- orbit RGO integration, 1 minutes x,y,z
- 8-pt Lagrange interp., topocentric conversion
- automated RB / TB / DUT tuning
- Iterative polynomial fitting & automated data editing

SLR data sample used for tests

2 ns

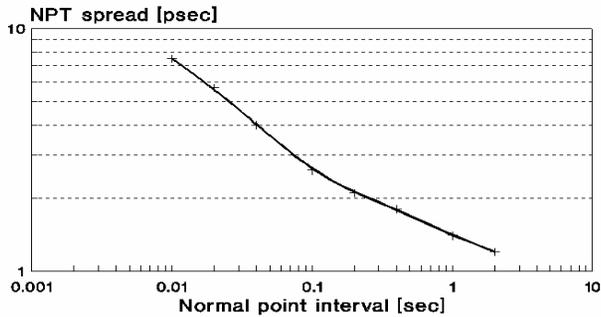


- ERS-2 Jan 29, 2004, 10 h UT, 86 deg. max. elevation,
- first 80 seconds of tracking selected, 32 000 echoes
- note two retro response, the first one used, only

Normal point construction

2kHz SLR normal points data spread

ERS2,Graz,11.10.'03,750 echoes/sec
single shot 17 ps r.m.s.



- deviation from ideal : > 100 echoes / NPT 2.5 psec
- saturation : > 2000 echos / NPT 1.0 psec

Conclusion

- The limits of averaging of the 2kHz / mm SLR data have been characterised
- the SLR data processing numerical noise is of the order of 1 psec (random numerical, interpolation)
- the normal point precision saturates at 1 psec level compressing > 2000 echoes
- these limit values are negligible in comparison to satellite signatures (!)