Engineering Data File Proposal

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1. Introduction

This proposal is addressing the range bias phenomenon as one of the most persistent issues in satellite laser ranging. In particular the long-term stability of a ranging site needs to be maintained in a much better way than obtained so far. In the past this has been established entirely by satellite orbit analysis (the identification of monument instabilities which affect the coordinates of a station is not to be expected; because of it's rare occurrence they are not within the scope of this proposal.).

The orbit analysis has done and is doing a good job to detect such biases in the order of some cm; but it has not – yet – the capability to verify fast and reliably biases of few cm or sub-cm, especially with limited pass numbers; in addition, different analysis schemes and groups are producing different results at this levels. It also does not show WHERE a particular SLR station could easily improve performance, stability etc.

This proposal wishes to approach the station stability issue from the other side by generating and comparing time-series of station parameters, in order to establish and maintain criteria at the instrumental level. By inter-comparison between the various stations in the network together with the occasional station verification by the application of a portable calibration standard, we believe that the consistency of the range data measurement can be improved. If successful this would be a further step towards the goal of obtaining a proper scale from laser ranging.

The basic concept of this approach is the expectation that subtle changes that develop at the ranging facility correlate with the overall system stability. Sudden or more significant problems are usually identified by the station crew in the course of their own internal consistency checks, while small drifts over longer periods of time may remain unidentified. It may be long before such instrumentally caused changes show up in the orbit analysis. Furthermore it would be desirable to have data available which are not necessarily requiring satellite returns, so that the station stability can be continuously verified even through extended periods of bad weather.

2. Sources of system instabilities

In general all aspects which are related to the detection, triggering and transfer of electrical signals are sensitive to larger offsets and variations in time, which are essentially hard to determine. In particular temperature variations are affecting the transit time of electrical signal pulses through the electronic circuits substantially. When this effect is not properly reduced by calibrations a bias for the measured range will be the result.

Geometrical (monument position) and optical (beam path) misalignments are producing offsets which are both small and not varying with time (with the exception of substantial

3. Proposal: The Engineering Data File

We therefore propose to extend the current analysis of local station parameters. Until now only the calibration value taken during or around a satellite pass is generally available as part of the normal point file. It is not arguable that this parameter will be the most important information. However it may turn out that looking at this value alone is not enough. It may be very useful to collect all available local system parameters as a function of time into an engineering data file of standardized format and make them available to the community. Since these parameters can be taken also in periods where no ranging operation is possible, a more or less continuous system performance history can be built. The following advantages come to mind:

- Continuous system history over a wide variety of parameters
- Inter-comparison between parameters of different SLR stations
- Rapid identification of system drifts or degradation effects
- Correlation of system data with bias reports based on orbit analysis

Inter-comparison means that by looking at the engineering data file of similar stations the local technical staff could identify problems in their system more clearly. For example if one station obtains a calibration R.M.S. of 30 ps while a similar station typically obtains 45 ps they can hunt for differences in their system operations or setup in order to improve their own system. A comparison would also allow to distinguish unavoidable temperature related drifts over time from avoidable ones.

The format of the engineering data file is not yet established and subject to discussion. We have tried to identify parameters which are readily available at the varias systems. Neither of them has been looked at with respect to their suitability. These parameters are:

Calibration Details:
epoch, range, R.M.S., peak-mean value, skew, kurtosis, return-rate or signal strength

Meteorological data:
To allow for easy correlation of any drifts etc. with temperature, pressure, humidity …

Ranging System:
temperature (laboratory, laser, timer, etc.), laser power, various voltage settings (trigger levels)

Counters:
Setup file, with trigger settings etc.

Event timer:
Channel offsets, epoch synchronization, epoch reference source, frequency reference source,

4. Calibration Standard

The here proposed engineering data-file will generate a history of operational parameters of a SLR system and it's variation with time. In order to relate the systems to each other, we wish

to take up an earlier proposal by Ivan Prochazka of analyzing each ranging station by means of a portable calibration standard on a more or less regular basis.

5. Summary

SLR is not yet fulfilling the expectation of providing a scale for geodesy. Up to now the station performance has been established from bias values based on an orbit analysis. Apart from differences between the solutions of various analysis centers there remains also the difficulty of non-continuous operations because of bad weather. The goal is to establish another independent system monitoring and assessment approach, which is independent of the satellite orbit and continuous in time. The here proposed engineering data-file has the potential to reveal subtle drifts of the ranging system, while at the same time acts as a benchmark for optimum system performance.