# Station Operational Issues –an analysis perspective

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**Abstract**
The work discussed in this short paper records and is intended to act as a stimulus to further dialogue between the ILRS tracking network and the analysts who use the data. Such a dialogue may provide a valuable input to discussions on tracking priorities and on the best use of the diverse capabilities of the network stations. Members of the ILRS Analysis Working Group took part in a brainstorming session during which a series of questions were discussed relating to the use of SLR data.

**Introduction**
By engaging the views of those analysts who process laser data we can hope to gain insight that will inform discussion on how best to maximise the use of the diverse capabilities of the elements of the ILRS network. Analysts, particularly those involved with the Analysis Working Group, provided comments and responses to the broad issues raised in the following sections. An attempt has been made to represent the views of those analysts who contributed to the discussions, but the author remains responsible for the content of this paper.

**Data time-distribution**.
Discussed was the concept of optimal numbers and time-distribution of normal points within a pass, for example whether there is a minimum number of useful normal points per pass. It was agreed that ideally stations should observe enough observations to form two, good, normal points at acquisition of signal (AOS), at point of closest approach (PCA), and before loss of signal (LOS). However, it was strongly pointed out that of course *any good* data is valuable.

**Dedication of stations to specific satellites.**
Given the diverse configurations of stations in the Network and particularly in regions where stations are in relatively close geographic proximity, of interest was whether individual systems should be encouraged to concentrate on those targets that best match the system's capabilities. In this way it may be possible, say, to obtain a greater data yield from the more difficult, high or small-array targets, such as ETALON, GPS, Moon, whilst having minimum impact on the total useful quantity of data from the 'easier' LEO and MEO targets. For instance, in dense clusters like Europe, does it really make sense to have all stations abandon LAGEOS or HEO objects in order to track say AJISAI or STARLETTE, or for the larger systems not to concentrate on the difficult HEO targets. This is a complex issue since, as discussed in the previous section, all that is really required scientifically from each pass is a few normal points from AOS, PCA and LOS. For an efficient system with a well-constructed scheduling system, this may not be an issue. However, it is clear that some degree of specialization may be advantageous to the network yield as a whole. What perhaps is required as an incentive is a way of 'giving credit' in the ILRS performance cards for perhaps a small yield of data from the difficult, but scientifically equally valuable targets?

**Optimisation of tracking**
This leads on to consideration of a more proactive scheme whereby there is an effort to schedule dynamically the component stations of the network. For instance, it may be possible to obtain a better overall performance if stations were to track satellites that they could see were not being tracked by other stations in the same geographic region. The technology is in place to make such choices; the EUROLAS real-time status exchange is already used to good effect to pass on information about the best value of time-bias to use for a given set of predictions (Wood & Gurtner, 2003). To apply the scheme to optimization of tracking as suggested here, all the ILRS stations should be encouraged to both submit their status in real-time and use the information to look for opportunities to track satellites that are being 'missed'. The information in the status exchange could be expanded to include a history of global tracking for each satellite, such that a rising priority may be attached to a satellite that has not been tracked for say *n* time units. Of course, for particular campaigns such as altimeter calibration, where simultaneous laser tracking over Europe or intense global tracking for example may be advantageous, the scheme could easily be used to *maximize* the numbers of stations providing tracking support to the mission.

**Data availability**
Discussed was the question of whether the data submission rates or procedures should be changed with a view to improving the quality of the predictions that are generated from the data. That is to whom and how fast should the data be made available for quick improvement of predictions/time bias functions. It was considered that provided passes are not being missed due to poor predictions, current processes are probably adequate and should remain. The overall requirement must be to maximize the data yield. Insufficient evidence is currently available on whether there are serious shortcomings with the current levels of prediction accuracy.

**Data Quality**
The question considered was whether it is more important to achieve a small single-shot RMS or obtain a large number of less precise single shots in each normal point, for instance from a high repetition-rate, single-photon system. Both schemes may result in the same level of formal precision in the normal points, but the hardware philosophies may be very different. For instance, it is well understood that if a ranging system operates in single-photon mode, then, due to the effect of satellite signature in the error budget, the single-shot precision will be worse than that achieved by a comparable system working in multi-photon mode. In fact, in the case of the single-photon system, it is likely also to obtain less raw data points for compression into each normal point, further reducing the precision relative to other systems. However, it was stressed that as always the minimization of systematic error is of prime concern. Provided that the systems do not introduce range bias, both will provide valuable data. Further it was recommended that stations keep within their chosen regime, whether that be at multi- or single-photon return-level.

**Dual Wavelength data**
Several systems such as Zimmerwald, Graz and Matera are now producing dual wavelength data on more or less regular bases. The questions raised were whether the extra information is considered useful and what is being done with the data, bearing in mind the extra effort required at the stations. It was agreed that the data is almost certainly of value and recognized that it has

not yet been fully exploited. Nonetheless, stations should be encouraged to attempt dual-wavelength work and to submit the data to the centers on a routine basis.

**General Comments and Conclusions**

Of particular interest was whether current analysis capabilities were being limited significantly by particular operational procedures. It was agreed that there could probably never be too much good quality data and never a perfect global distribution of high-yield laser stations. However, the geographic distribution of stations is now getting much better, with several good sites in the Southern hemisphere and more expected in the future.

It is hoped that the discussions summarized in this paper and ideally provoked in the future may help the network to maximize its usefulness to the space geodesy analysis community. In particular analysts are encouraged to approach ILRS with proposals for tracking strategies that might better suit their science needs.

**Reference**

Wood R and Gurtner W, 2003. The Herstmonceux/Berne Time bias Service, *Proc 13th Int. Laser Ranging Workshop*, Washington DC.