

SLR Global Performance Evaluation

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Abstract: In 1997, the first quarterly global performance report card was issued via SLRMail. The areas of system performance include data quantity, data quality, and operational compliance. The baseline goals in the report were based on the high performance guidelines presented by Dr. Michael Pearlman at the November 1996 Shanghai SLR Workshop [1]. The metrics are intended as a measure of minimum performance. As more and more systems improve their performance, the performance „bar(s)“ may be raised to the next level.

System performance is measured in both the short term (i.e. the last three months) and the long term (i.e. the past 12 months) [2]. Data quantity is evaluated over a 12 month period, while data quality is measured in both the last quarter and the long term. Operational compliance is restricted to the last three months of the reporting period.

Now, a total of four report cards, spanning 7 quarters of performance, have been generated and are on-line on the International Laser Ranging Service (ILRS) Web Site at **Fehler! Textmarke nicht definiert..**. This history of reports enables the long term monitoring of system performance (i.e. are systems really improving or digressing). The rest of this paper will address the change in global geometric coverage between 1996 and 1998, but will primarily dwell on the improvements systems have made the past 7 quarters.

1. Geometric Coverage (1996 vs 1998)

One of the largest weaknesses in the Satellite Laser Ranging (SLR) technique is the poor global SLR network geometric distribution. The biggest single distribution problem is lack of tracking coverage in the southern hemisphere. Ongoing coordinated efforts by NASA SLR and EUROLAS to re-locate existing systems to South Africa and more recently, India, have not been successful, but still continue. The most recent re-location of a system, within the last 2 years, which did improve the global coverage situation, has been the move of MOB LAS 8 from Northern California to French Polynesia.

Below are two tables (Table 1 and Table 2) depicting the global coverage in 1996 (actually September 1995 through August 1996) and 1998 (actually September 1997 through August 1998) including the number of systems contributing and total satellite passes tracked. The globe distribution is broken into eight sectors based on longitude, four in each of the northern and the southern hemispheres.

**Table 1. Global Tracking Coverage
(September 1995 to August 1996)**

Hemisphere	Latitude (degrees)	SLR Systems	Total SLR Passes
North	315 to 45	18	17613
South	315 to 45	0	0
North	45 to 135	7	3568
South	45 to 135	2	4398

North	135 to 225	3	4134
South	135 to 225	1	2968
North	225 to 315	4	11,854
South	225 to 315	2	2902

**Table 2. Global Tracking Coverage
(September 1997 to August 1998)**

Hemisphere	Latitude (degrees)	SLR Systems	Total SLR Passes
North	315 to 45	18	20296
South	315 to 45	0	0
North	45 to 135	7	5385
South	45 to 135	1	5910
North	135 to 225	3	3544
South	135 to 225	2	4789
North	225 to 315	4	14,043
South	225 to 315	1	2205

It is interesting to note that the biggest reduction in SLR systems in any sector the past two years has been in the North American Sector. This was caused by MOBLAS 8 relocating from California to Tahiti; the discontinuation of operations at Star Fire by the Naval Research Laboratory; and the placement of MOBLAS 6 into caretaker status due to NASA budget reductions.

However; despite this system reduction in the northern sector (225 to 315 degrees latitude) from 7 systems to 4 systems the past two years, the actual data yield has increased. This is due primarily to the performance improvements of MOBLAS 4 and MOBLAS 7 systems located in Southern California and Maryland, respectively. The performance improvements were the results of implementing the NASA/ATSC Single Operator Automation Project in both these systems [3].

2. Systems Performance Improvements

Many SLR systems have shown noticeable improvement in either data quality or data quantity or both the past 2 years. Hopefully, the performance report cards have provided motivation for systems to improve, but one thing is certain. The quality controls checks within the EUROLAS Cluster implemented by RGO have been instrumental in the improvement of EUROLAS system performance [4]. In the past two years ago, these quality controls checks have been automated and placed on the Web for easy access [5]. Emails are automatically sent on individual passes to the appropriate system that exhibit noticeable range or time biases.

Below is a list of systems, sorted by marker number, that have shown noticeable performance improvements.

- **1870 Mendeleevo** - 30% increase in data quantity the past 2 years.
- **1873 Simeiz** - 50% increase in data quantity the past 2 years.
- **1893 Katsively** - new counter installation and calibration procedure on 24 June 1998. This has resulted in the elimination of a long standing (-200) cm fixed range bias. The computed range bias since 13 July 1998 has been near zero based on Center for Space Research LAGEOS Weekly Analysis.
- **7105 Greenbelt** - 70% increase in data quantity the past 2 years due to single automation operator project implementation on 1 August 1996 [4].
- **7110 Monument Peak** - 190% increase in data quantity the past 2 years due to single automation operator project implementation on 1 October 1996 [4].
- **7236 Wuhan** - 100% increase in data quantity the past 2 years.
- **7237 Changchun** - 300% increase in data quality and 70% improvement in precision the past 2 years. Note: new detector installed 18 August 1997 [6]. Also, system performance improvement as a result of the collocation with a portable calibration standard [7].
- **7249 Beijing** - 70% increase in data quantity the past 2 years. Also, their data exhibited less frequent epoch time bias problems.
- **7811 Borowiec** - 20% increase in data quantity the past 2 years. Also, several centimeter improvement in data accuracy due to the elimination of a 3 to 4 millibar barometric error on 1 July 1998, when a new barometer was installed.
- **7824 San Fernando** - 110% increase in data quantity the past 2 years plus added LAGEOS ranging capability.
- **7831 Helwan** - 50% increase in data quantity the past 2 years.
- **7835 Grasse** - 40% improvement in precision the past 2 years. In addition, system bias stability has improved from 23 to 7mm since 4 September 1997 due to the installation of new APD detector replacing their Photo-Multiplier Tube (PMT). *Note: Their TOPEX RRA correction look-up table needed to be changed on the same date the detector was replaced.*
- **7843 Orroral** - 40% increase in data quantity the past 2 years.
- **8834 Wettzell** - data precision improvement (APD 35 to 25mm; MCP 17 to 11 mm) in the September and October 1996 timeframe.

In addition, below is a list of 2 newly developed fixed systems that became operational in the last two years: Both of these system replaced their older generation systems.

- **7806 Metsahovi** - improved LAGEOS ranging capability and data precision. This system will eventually replace the 7805 Metsahovi Station.

- **7810 Zimmerwald** - improved ranging capability and data precision. This system replaced the old 7810 Zimmerwald Station.

3. Conclusions

Many systems have significantly enhanced their performance the past two years. If system continue to progress, hopefully, before the next workshop, there will be new performance goals to try and achieve to continue the push toward absolute millimeter ranging accuracy and repeatability. The geometric distribution of the ILRS network continue to be a problem, but hopefully, with better international cooperation the political and economic barriers to system re-locations can be overcome.

4. Acknowledgements

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5. References

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