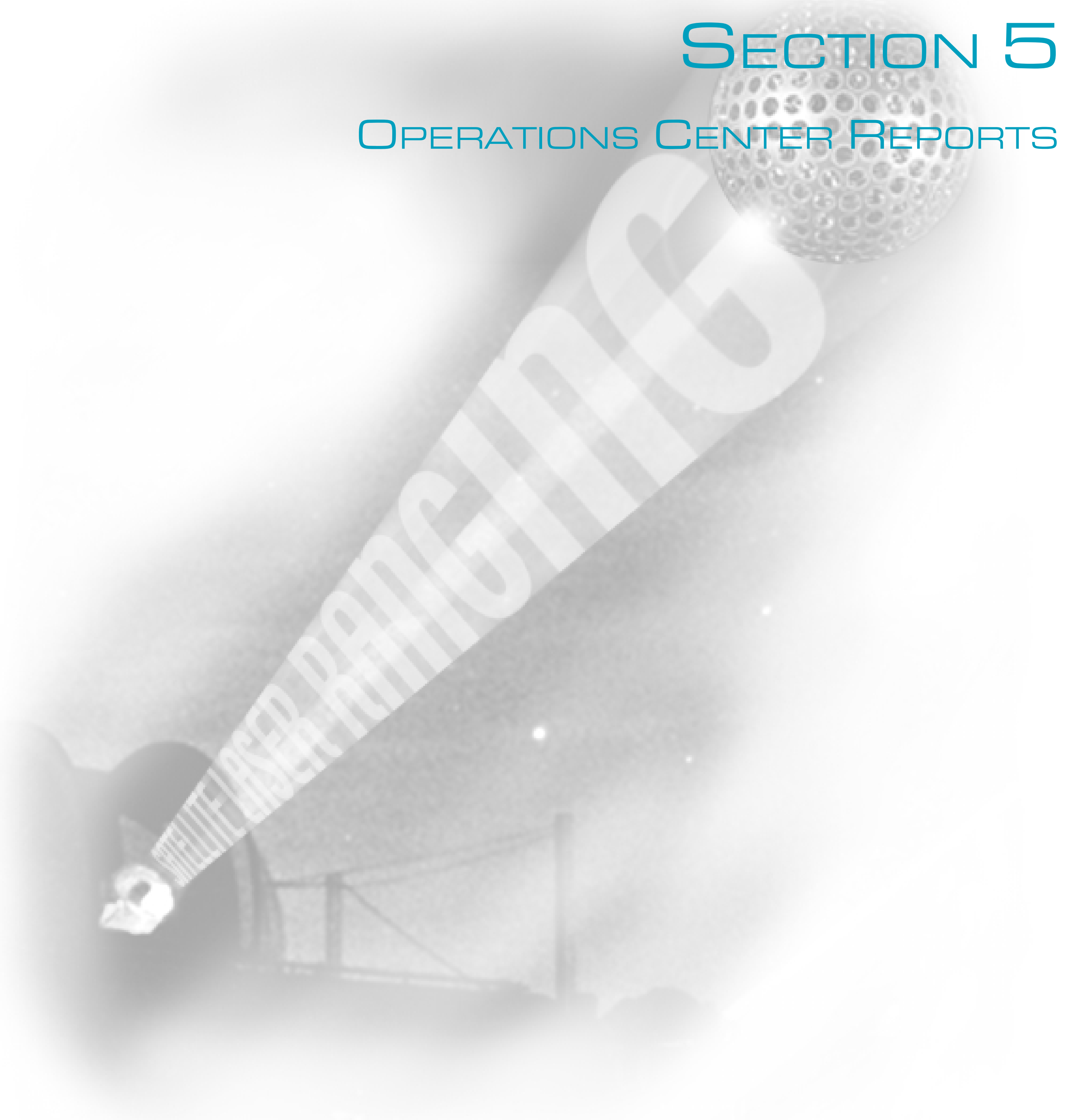
Section 5

Operations Center Reports



SECTION 5 – OPERATIONS CENTER REPORTS

5.1 Mission Control Center

Vladimer Glotov, *Russian Mission Control Center*

The Russian Mission Control Center's (MCC) activity, as the Operation Center of Russian SLR network, began in 1990. The MCC is responsible for coordinating the SLR activity. Stations transfer their data directly to the MCC. MCC supports the collection of raw data from the Russian stations and provides the SLR community with corresponding normal points. Starting in 1998 the MCC became the official processing center for the WPLTN. The MCC supported WESTPAC satellite mission with IRVS predictions through May 2000.

In 2000, MCC produced the following data:

Location	Station Number	LEO Pass Total	LAG Pass Total	High Pass Total	Pass Total
Golosiiv	1824	277	0	0	277
Komsomolsk	1868	167	15	26	208
Mendeleevo	1870	183	0	0	183
Simeiz	1873	100	26	4	130
Katsively	1893	140	46	20	206

Table 5.1-1. Data Yield from the Russian SLR Network.

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5.2 NASA Goddard Space Flight Center

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Scott Wetzel, *Honeywell Technology Solutions, Inc.*

The NASA SLR Operational Center provides oversight responsibilities for all components associated with NASA SLR including network control, mission operations, data operations, sustaining engineering, and logistics.

NASA SLR network control and sustaining engineering tasks include technical support, daily system performance monitoring, system scheduling, daily satellite prediction generation, operator training, station status reporting, system relocation, logistics and support of the ILRS Networks and Engineering Working Group. These fundamental activities provide the infrastructure necessary to meet or exceed all NASA SLR and ILRS mission goals and requirements.

ILRS mission operations tasks include mission planning, analysis, and coordination, development of mission support plans, and support of the ILRS Missions Working Group. These activities ensure that all new mission and campaign requirements are successfully and efficiently coordinated with all participating organizations.

Global ILRS Normal Points (NP) data, NASA SLR full-rate data, and satellite predictions are also managed as a function of data operations. In addition, data operations provide support to the ILRS Data Formats and Procedures Working Group.

NP data operations consist of receipt, format and data integrity verification, archiving and merging of the global NP data set. The daily transmission of the NP data to the CDDIS for scientific use remains the primary output of this process. All functions associated with NP operations are automated processes not subject to manual intervention. Maintenance and monitoring of all operational software systems, computer systems and networks are performed to confirm the reliability and accuracy of all data processing functions. Statistical analysis is also performed to compare station tracking activity with data center acquisition to assist in the identification of any potentially lost data.

A significant process upgrade to the NP data process occurred in 2000 with the implementation of sub-daily (i.e. hourly) data transmissions for more rapid global accessibility.

Future activities in NP data operations include the implementation of more comprehensive data integrity tests, and automatic station notification of format and data integrity issues.

The full-rate data product continued to be produced by NASA SLR systems and transferred to the CDDIS during 2000. Though this product was not an ILRS data requirement, full-rate data was automatically received, processed, and transmitted to the CDDIS on a daily basis to augment user needs and requirements by all NASA SLR systems with the exception of the Hawaii, and Texas systems." Daily satellite predictions continued to be generated and distributed to stations and ILRS data centers (i.e., CDDIS, EDC) for every ILRS and NASA supported satellite.

The NASA SLR Operations Center is located at:

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5.3 University of Texas LLR Operations Center

Peter Shelus, *University of Texas at Austin*

The small size of the LLR network and the small number of LLR Analysis Centers dictate the nature and operational procedures of the LLR Operations Center. Observing predictions are computed on-site at the stations and data are electronically transferred from the observing sites to the Data Centers on a near-real-time basis. Analysts secure their data directly from the Data Centers as needed. Feedback from the analysts, when necessary, goes directly to the observing stations. The responsibility of the LLR Operations Center has therefore evolved to be one that assures the smooth flow of data, in a form and format for obtaining scientific results.

Concerning work at the Operations Center on data formats, prior to the Laser Workshop and ILRS meetings in Matera in November 2000, a strawman prediction format was developed by R, L. Ricklefs to handle lunar and transponder laser ranging. At the Matera meeting in October 2000, this one-person effort was expanded to a full-fledged study group under the aegis of the ILRS Predictions and Formats Working Group. Further, the group was tasked with incorporating artificial satellites lower than the moon into the new format, the intention being to improve low earth satellite predictions and avoid the pitfalls of multiple formats. Since then the membership of the study group has grown to over a dozen people, each having a particular interest in some segment of the ranging target population. A charter and working document have been developed and circulated among the membership, and a short report is to be presented to the ILRS General Assembly in Nice next year. The charter and working document will then be finalized.

As to the LLR scheduling task, recall that early on in the experiment, the main task of the LLR program was to secure the maximum amount of data. However, as LLR data volume rose to reasonable levels, the analysts and observers, through the Operations Center, began to seek how best to improve the quality of the data, with, perhaps, a bit less emphasis on mere data volume. This entails improving system calibration stability, reducing photon detection jitter, and improving the timing systems. With limited budgets at the stations, each of these items can be daunting to accomplish. Looking for ways to improve data quality with less emphasis on dollars, we have now begun to also look into ways of obtaining more and better observations significantly nearer new moon and full moon. This is an important effort that will increase the scientific payback of the LLR experiment. The Operations Center coordinates this activity, serving as the intermediary between the observing stations and the analysis centers.

As discussed last year, we still have LLR data deficits near new and full moon. These deficits reduce the sensitivity of the Principal of Equivalence violation signal, i.e., c x cos (D), c is a constant and D is the mean elongation of the Moon from the Sun. If one visualizes the $0° < D < 180°$ interval between new and full moon, only the interval $40° < D < 160°$ is presently effectively being fit. In this interval, the function, cos (D), is virtually linear, with its strongest signal strength being unused. This calls for a concerted effort to obtain much more data nearer to both new moon and full moon, so long as the accuracy of the data is not affected too much.

Along the same lines, the LLR data density lacks symmetry around first and third quarter moon, in that more data is present on the full moon side of the monthly lunar cycle. This creates an overlap, or a projection, of the cos (D) signal onto two other of the partial derivative signals in the basic LLR model, i.e., -l and cos (2D), l being the mean anomaly of the Moon. If one solves for a hypothesized post-model signal, such as the Principle of Equivalence violation signal, any part of that signal that can be represented by partial derivatives already in the model, get assimilated by any adjustments of that model. This is happening to a significant effect. It results in further reducing the sensitivity of a cos (D) fit to the data, which is a natural consequence of the asymmetry of data quantity about the quarter moon phases. LLR stations should attempt to favor observations that are on the new moon side of the lunar quarter phases. This should tend to de-couple the scientifically interesting cos (D) signal from the 1 and the cos (2D) signals.

There are other negative effects of the data gaps at new moon and full moon, as well as the asymmetry about the quarter moon phases. These attributes couple the cos (D) signal to the cos (3D), cos (4D), etc. signals, and thereby bias the solutions for any cos (D) amplitude, in proportion to any of these higher Fourier signals from any synodically periodic systematic effect in LLR. Both theoretical and operational features of LLR are dominated by the synodic month cycle. So the present ability to separate an Principle of Equivalence violation signal from other synodic effects is degraded by the properties of the present data distribution.

It is also noted that there is a deficit of LLR data with sidereal periodicity, i.e., there being fewer observations when the moon is in the southern hemisphere of the celestial sphere. This is because the window for quality observations is smaller with both LLR-capable stations being located in the northern hemisphere. It is especially severe for the OCA station. This can potentially affect analytical fits for a cos (D) signal, if there are systematic effects in the residuals with annual period, where there presently seem to be. The full ramifications of this sidereal data density modulation are not yet fully understood, but it would suggest that, whenever possible, observations when the moon is in the southern hemisphere be favored, as long as observation quality is maintained.

Progress has been accomplished in the LLR experiment within the UT LLR Operations Center. We are looking forward to another year of successful activity.

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