

Historical development of the SLR data holding at EDC between 1976 and 2014

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Abstract.

On October 31, 2014, the International Laser Ranging Service (ILRS) has celebrated the 50th anniversary of the first successful Satellite Laser Ranging (SLR) measurement at NASA Goddard Space Flight Center (GSFC). Within the ILRS, two global data centers, the EUROLAS Data Center (EDC) and the Crustal Dynamics Data Information System (CDDIS) for the management of SLR measurements and products were established. In this paper, we show the development of the ILRS station network and the tracked satellites since 1976. Furthermore, statistics about the data amount of full-rate data and normal point data at EDC are shown.

ILRS station network

Over the last four decades, the station network has changed. The number of stations has increased continuously, starting with 10 stations in 1976 and reached the maximum of 50 stations in 1992. Since then, the number of stations has decreased slightly to about 40 in average until now. There are only two stations left, Greenbelt and Arequipa, which tracked satellites in 1976 and are still active. Figure 1 shows the development of the ILRS station network between 1976 and 2014. Until now, the most active stations in the SLR network are Yarragadee (7090), Herstmonceaux (7840), and Monument Peak (7110) which is shown in Table 1.

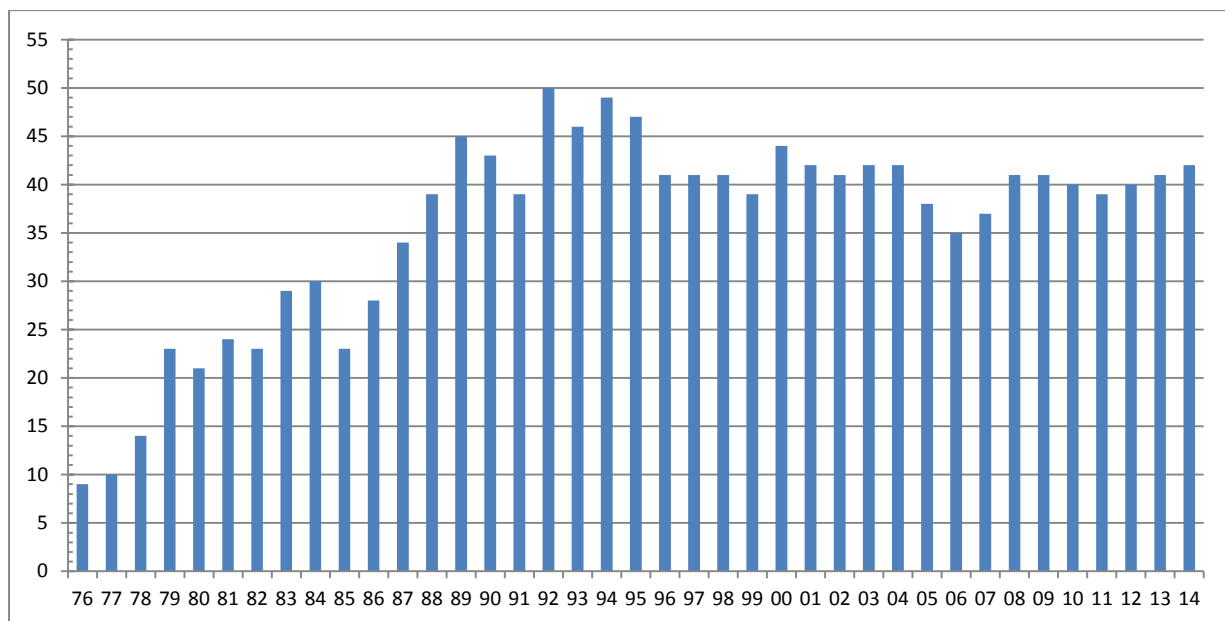


Figure 1: Yearly number of stations in the ILRS network which tracked satellites between 1976 and 2014

Satellites tracked since 1976

Since 1976, 166 targets (incl. moon) have been tracked by the stations of the ILRS network. In the 1970s and 1980s about three satellites were tracked in average. In the 1990s, the number of tracked satellites increased from 5 in the beginning to 40 in the end. In the 2000s, the number of satellites tracked decreased slightly to 35 in average. Due to the increased tracking of additional GNSS satellites in the 2010s, the amount reached the maximum with 77 satellites in 2013. Hereby, figure 2 shows the development of the tracked satellites between 1976 and 2014.

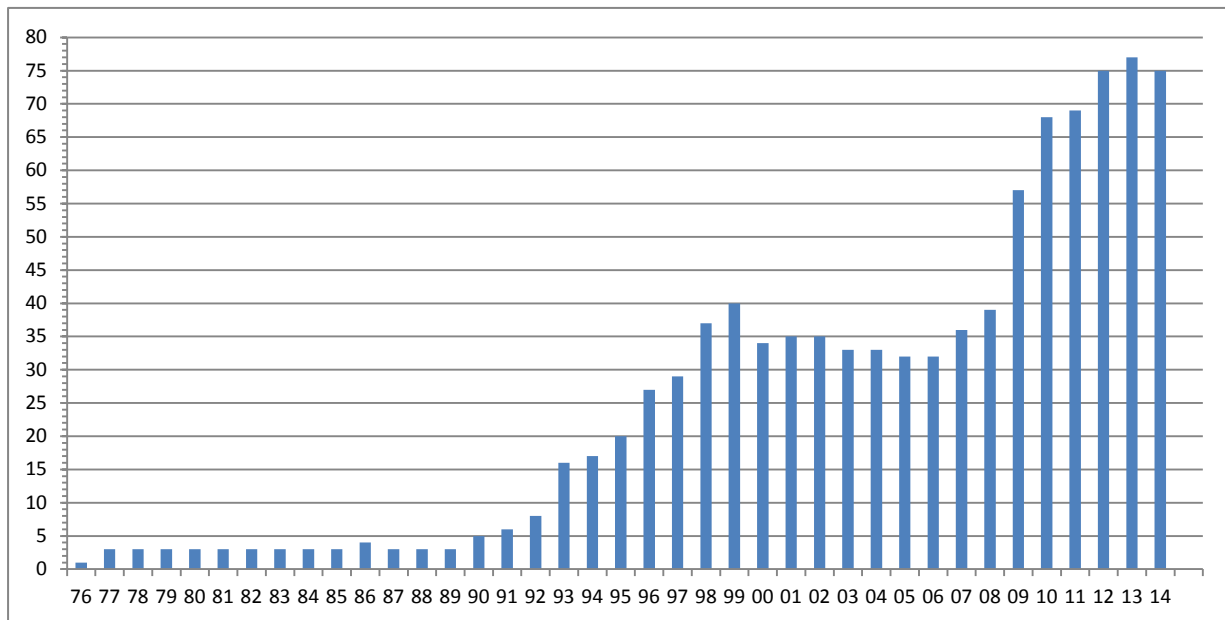


Figure 2: Yearly number of tracked targets (satellites, moon, etc.) between 1976 and 2014

Full-rate data between 1976 and 2014

Within the ILRS, full-rate data was the first SLR product in the 1970's. In the beginning, these data sets were published in the SEASAT/MERIT format and later in the extended MERIT format of version 3. In April 2008, the first data sets were published in the new Consolidated Laser Ranging Format (CRD). The new format consolidates full-rate and normal point data in one format. At the EDC, the first full-rate data were available in 1976. Figure 3 shows the strong increase of the number of full-rate data starting with 57k SLR observations in 1976 until now. The most full-rate data are available for 2010, in which 340m SLR observations were published. Due to the improvement of faster internet connections over the last few decades, the transfer of data to the data centers is not the limiting factor anymore. Furthermore, the development of SLR stations measuring in kHz mode lead to a strong increase of the amount of data at the ILRS data centers in the last few years.

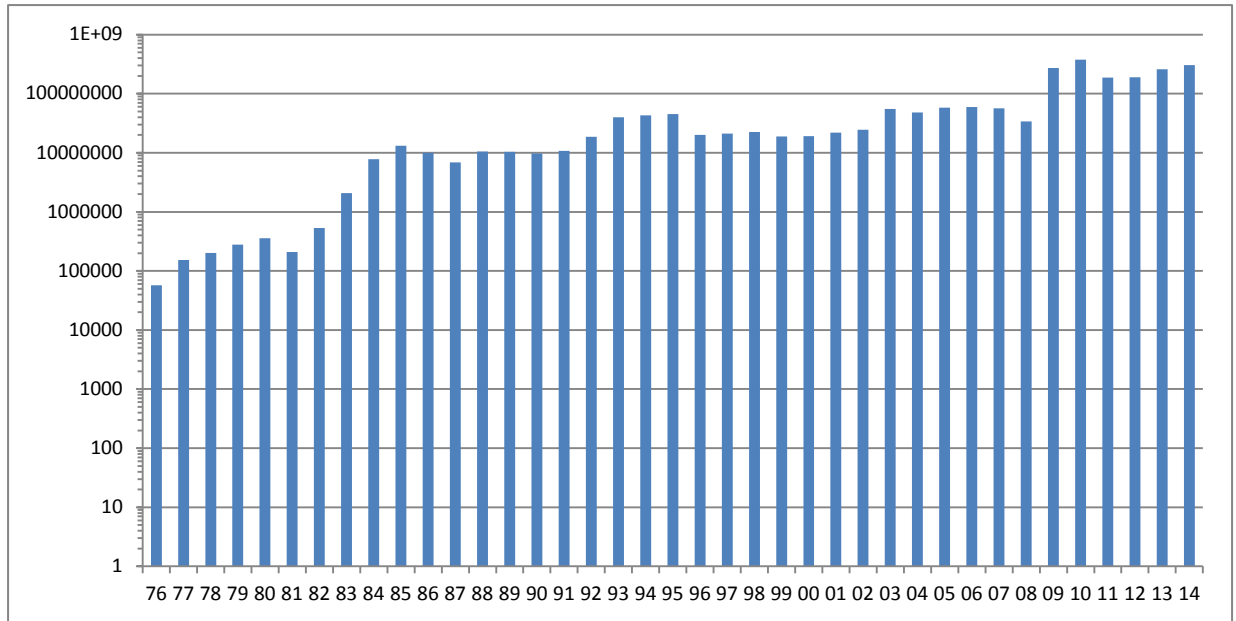


Figure 3: Yearly number of observations of full-rate data in Merit-II and CRD format between 1976 and 2014

Normal point data between 1983 and 2014

Due to the increasing amount of full-rate data, normal point data or quick-look data were introduced in 1983. This format should reduce the transferred data volume in the early years. For the computation of ILRS products, normal point data are sufficient. Especially nowadays, in which stations use kHz laser, the data amount of full-rate data is increasing exponentially. Therefore, the normal point data is the main data source for producing products such as the earth orientation parameters (EOP) and station positions (POS). Over the last 40 years, the format of normal point data changed several times. The first normal point data were produced in MERIT format in the 1980s and are available at EDC. At the beginning of the 1990's, the format was changed to the CSTG format. In 2012, the format was changed to the official Consolidated Data Format (CRD) which unifies full-rate data and normal point data in the same format. Figure 4 shows the development of the data holding at EDC starting in 1983. There was a continuous increase until the beginning 2000s. Since then the yearly amount of data has stayed at the same level until now.

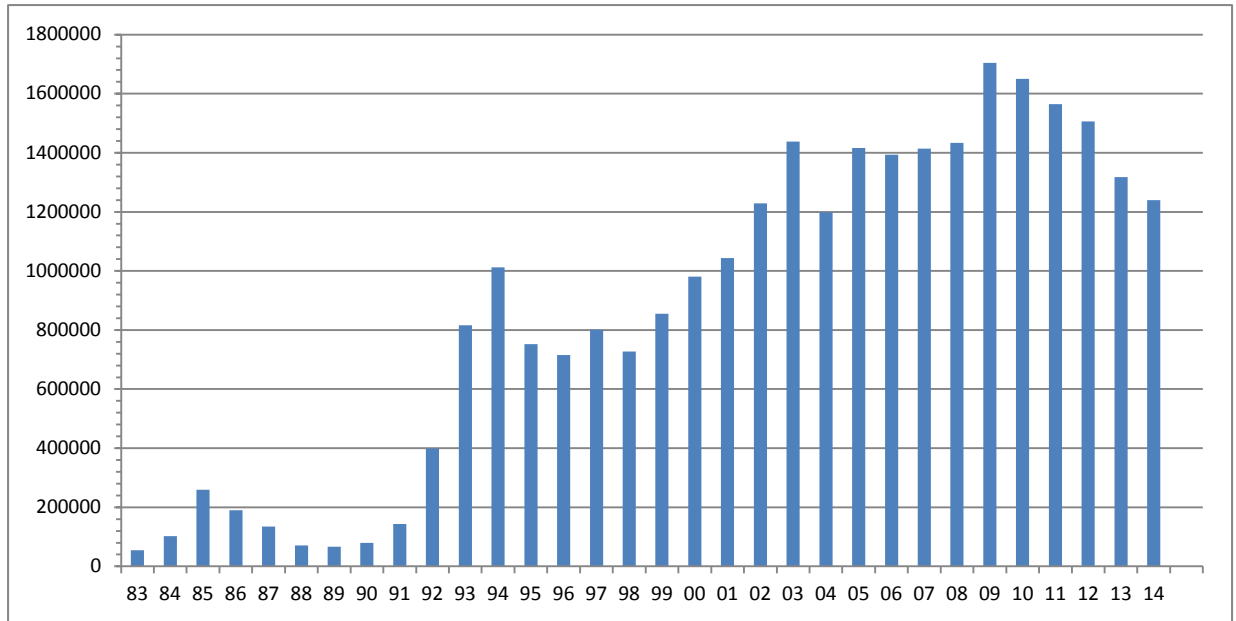


Figure 4: Yearly number of normal point data in Merit-II, CSTG, and CRD format between 1983 and 2014

Top 10 of the most active stations

The list of the most active stations shows the number of days when stations tracked satellites and the SLR data (normal points, full-rate data) are available at EDC.

Station	Duration
Yarragadee, Australia (7090)	9728d (26 y, 238 d)
Herstmonceaux, United Kingdom (7840)	8105d (22y, 75d)
Monument Peak, California (7110)	7110d (21y, 24d)
Greenbelt, Maryland (7105)	6794d (18y, 224d)
Graz, Austria (7839)	6313d (17y, 108d)
McDonald Observatory, Texas (7080)	5983d (16y, 143d)
Wetzell, Germany (8834)	5779d (15y, 304d)
Zimmerwald, Switzerland (7810)	5516d (15y, 41d)
San Fernando, Spain (7824)	5401d (14y, 291d)
Simosato, Japan (7838)	4992d (13y, 247d)

Table 1: Top 10 of the most active station in which the number of days were counted when SLR data exist at EDC

Top 10 of the most tracked satellites

The list of the most tracked satellites shows the number of days when satellites were tracked and the SLR data (normal points, full-rate data) are available at EDC.

Station	Duration	% of Lifetime
Lageos-1 (7603901)	13859d (37y, 354d)	98.69%
Starlette (7501001)	12152d (33y, 107d)	83.83%
Ajisai (8606101)	10157d (27y ,302d)	98.69%
Lageos-2 (9207002)	8012d (21y, 347d)	99.79%
Etalon-1 (8900103)	7865d (21y, 200d)	83.59%
Etalon-2 (8903903)	7799d (21y, 134d)	84.15%
Stella (9306102)	7659d (20d, 359d)	99.60%
Beacon-C (6503201)	7637d (20y, 337d)	42.42%
ERS-2 (9502101)	5955d (16y, 115d)	83.67%
GPS-36 (9401601)	5383d (14y, 273d)	71.54%

Table 2: Top 10 of the most tracked satellites counting the number of days on which SLR data exist at EDC

References

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Pearlman M.R., Degnan J.J., Bosworth J.M. „The International Laser Ranging Service“, Advances in Space Research, Vol. 30, No. 2, 135-143, 2002