

Erratum to: The Geodesist's Handbook 2012

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Unfortunately, the text describing the International Laser Ranging Service (ILRS) was duplicated from the previous article of the IGFS. The correct description of the ILRS is given in the following.

The online version of the original article can be found under
doi:[10.1007/s00190-012-0584-1](https://doi.org/10.1007/s00190-012-0584-1).

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The International Laser Ranging Service (ILRS)

<http://ilrs.gsfc.nasa.gov/>



Chairman of the Governing Board: G. Appleby (Great Britain)
 Director of the Central Bureau: M. Pearlman (USA)
 Secretary: C. Noll (USA)
 Analysis Coordinator: E. C. Pavlis (USA)

Development

Satellite Laser Ranging (SLR) was established in the mid-1960s, with early ground system developments by NASA and CNES. Early US and French satellites provided laser targets that were used mainly for inter-comparison with other tracking systems, refinement of orbit determination techniques, and as input to the development of ground station fiducial networks and global gravity field models. Early SLR brought the results of orbit determination and station positions to the meter level of accuracy. The SLR network was expanded in the 1970s and 1980s as other groups built and deployed systems and technological improvements began the evolution toward the decimeter and centimeter accuracy. Since 1976, the main geodetic target has been LAGEOS (subsequently joined by LAGEOS-2 in 1992), providing the backbone of the SLR technique's contribution to the realization of the International Terrestrial Reference Frame (ITRF).

Tracking campaigns were initially organized through COSPAR, the IAG Satellite and Lunar Laser Ranging (SLR/LLR) Sub-commission and the joint Commission on the Coordination of Space Techniques for Geodesy and Geodynamics (CSTG).

With strong encouragement from the President of the CSTG, the Sub-commission Steering Committee undertook the formation of the International Laser Ranging Service, ILRS in April 1998, following a similar initiative that had brought the GPS community together under the International GPS (now GNSS) Service, IGS, in 1993.

During the past few years, the Global Geodetic Observing System (GGOS) has been established as the Observing System of the International Association of Geodesy (IAG), working with all the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and for global change research. The ILRS is a major component of GGOS, providing observations that contribute to the determination of the three fundamental geodetic observables and their variations, that is, Earth's shape, Earth's gravity field and Earth's rotational motion. The ILRS continues as one of the fundamental inputs to the ITRF. Currently, 35 stations in the ILRS network track 30 – 40 satellites in LEO, MEO, GNSS, and synchronous orbits. Some stations in the ILRS network support lunar

ranging and ranging to the Lunar Orbiter, with plans to extend ranging to interplanetary missions with optical transponders.

Mission

The ILRS collects, merges, analyzes, archives and distributes Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) observation data sets of sufficient accuracy to satisfy the GGOS objectives of a wide range of scientific, engineering, and operational applications and experimentation. The basic observable is the precise time-of-flight of an ultra-short laser pulse to and from a retroreflector-equipped satellite. These data sets are used by the ILRS to generate a number of fundamental added value products, including but not limited to:

- Centimeter accuracy satellite ephemerides
- Earth orientation parameters (polar motion and length of day)
- Three-dimensional coordinates and velocities of the ILRS tracking stations
- Time-varying geocenter coordinates
- Static and time-varying coefficients of Earth's gravity field
- Fundamental physical constants
- Lunar ephemerides and librations
- Lunar orientation parameters

Structure

The ILRS accomplishes its mission through the following permanent components:

- Tracking Station Networks and Sub-networks
- Operations Centers
- Global and Regional Data Centers
- Analysis, Lunar Analysis, and Associate Analysis Centers
- Central Bureau
- Governing Board and Working Groups

Information on these permanent components can be found in the ILRS website (<http://ilrs.gsfc.nasa.gov/>).

Governing Board (2011)

- Michael Pearlman, Ex-Officio, Director, Central Bureau
- Carey Noll, Ex-Officio, Secretary, Central Bureau

- Tonie Van Dam, Ex-Officio, President IAG Commission 1
- Bob Schutz, Appointed, IERS representative to ILRS
- Francis Pierron, Appointed, EUROLAS Network Repres.
- Giuseppe Bianco, Appointed, EUROLAS Network Repres.
- Ramesh Govind, Appointed, WPLTN Network Repres.
- Hiroo Kunimori, Appointed, WPLTN Network Repres.
- David Carter, Appointed, NASA Network Representative
- Jan McGarry, Appointed, NASA Network Representative
- Vincenza Luceri, Elected, Analysis Center Representative
- Erricos C. Pavlis, Elected, Analysis Center Representative
- Horst Mueller, Elected, Data Center Representative
- Juergen Mueller, Elected, LLR Representative
- Georg Kirchner, Elected, At Large Representative
- Graham Appleby, Elected, At Large Representative, Chair of the Governing Board

Products

The most important aspects of the SLR and LLR observations are absolute accuracy and long, stable time histories at a number of sites. Accuracy approaches the level of a few mm for modern stations; time histories can be 25-30 years, or even longer in the case of some satellites. Since the inception of the service, the ILRS has put the generation of official analysis products high on its agenda. Official submissions to the IERS include weekly solutions for station coordinates and Earth Orientation Parameters (EOPs). Additionally, some of the ILRS Analysis Centers (ACs) submit estimates of GM and time-varying geocenter motion to the IERS Global Geophysical Fluids Center. Other user products include static and time-varying coefficients of Earth's gravity field, accurate satellite ephemerides for POD and validation of altimetry, relativity, and satellite dynamics, backup POD for other missions, and Lunar ephemeris for relativity studies and lunar libration for lunar interior studies.

The products of the Analysis, Lunar Analysis, and Associate Analysis Centers are made available to the scientific community through the two Global Data Centers:

- Crustal Dynamics Data Information System (CDDIS) at NASA's Goddard Space Flight Center, Greenbelt, MD, USA,
- European Data Center (EDC), at DGFI, Munich, Germany

The high accuracy of SLR/LLR data products support a variety of scientific, engineering, and operational applications including:

- Realization and maintenance of the International Terrestrial Reference Frame (ITRF)
- Access to Earth's center of mass relative to the global network and its time variations
- Monitoring three-dimensional deformations of the solid Earth
- Monitoring Earth rotation variations and polar motion

- Monitoring the long wavelength static and dynamic components of Earth's gravity field
- Supporting, via precise ranging to altimetric satellites, the monitoring of variations in the topography of the liquid and solid Earth (ocean circulation, mean sea level, ice sheet thickness, wave heights, vegetation canopies, etc.)
- Calibration and validation of microwave tracking techniques (e.g., GPS, GLONASS, Galileo, DORIS, and PRARE)
- Picosecond global time transfer experiments
- Determination of non-conservative forces acting on the satellite
- Astrodynamical observations including determination of the dynamic equinox, obliquity of the ecliptic, and the precession constant
- Gravitational and general relativistic tests, including Einstein's Equivalence Principle, the Robertson-Walker b parameter, and time rate of change of the gravitational constant, G
- Lunar physics including the dissipation of rotational energy, shape of the core-mantle boundary (Love Number k_2), and free librations and stimulating mechanisms
- Solar System ties to the International Celestial Reference Frame (ICRF)

Contacts

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Publications

The ILRS Central Bureau maintains a comprehensive website as the primary vehicle for the distribution of information within the ILRS community. This site can be accessed at <http://ilrs.gsfc.nasa.gov>. Many ILRS and related publications and reports can now be accessed online through the ILRS website including:

- ILRS Terms of Reference and Working Group Charters
- ILRS Network Description and Status
- ILRS Satellite Descriptions and Tracking Information
- ILRS Service Reports (first volume published covers year 1999)
- ILRS Meeting Reports (Governing Board, General Assembly, Working Group)
- ILRS Associates Directory
- ILRS Organizations and Technical Contacts
- Science and Engineering References and Reports