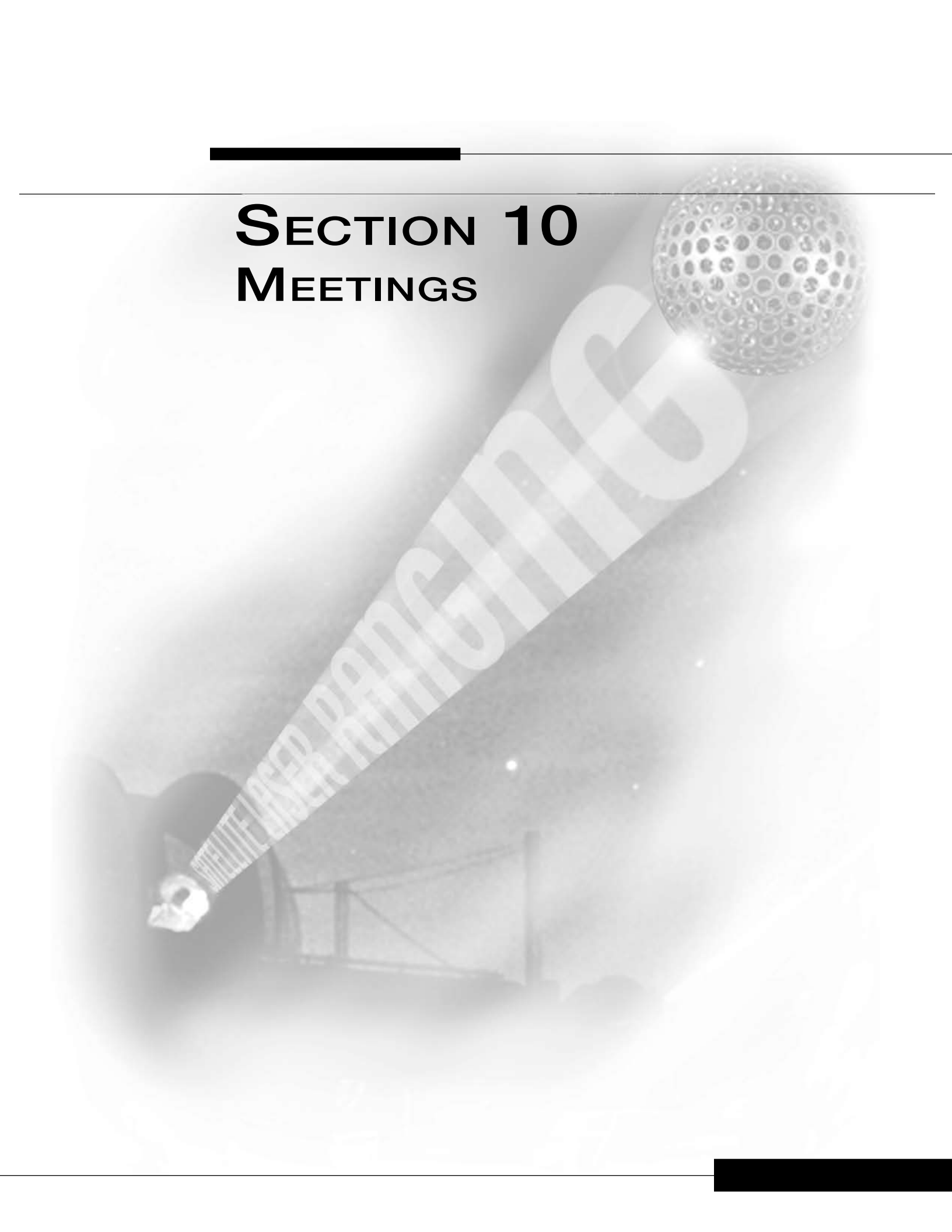
Section 10
Meetings



Section 10

Meetings

Carey Noll/GSFC

The ILRS organizes semi-annual meetings of the Governing Board and annual General Assemblies. General Assembly Meetings are open to all ILRS associates and correspondents. Reports for past Governing Board and Working Group Meetings can be found at: *http://ilrs.gsfc.nasa.gov/reports/ilrs_reports/index.html.*

ILRS Special Fall 2007 Workshop "Challenges for Laser Ranging in the 21st Century", Grasse France

Monique Pierron/CERGA

Figure 10-1. Attendees of the 2007 ILRS Workshop in Grasse, France.

The Observatoire de la Cote d'Azur (OCA) in France hosted the Fall 2007 ILRS Workshop "Challenges for Laser Ranging for the 21st Century" in September at the "Palais des Congrès", in the heart of Grasse, near downtown. The title was broad enough to merge all prospective ideas for constructive future work, and more than ninety participants registered for this meeting. The ILRS Analysis Working Group held a one-day meeting at the venue prior to the fall meeting. The workshop Web site contains presentations, session summaries and photos in full at *http://www-g.oca.eu/gemini/ecoles_colloq/colloques/ilrs2007/.*

The Workshop opened with a welcome reception in "Fragonard House" and included addresses from Jean Pierre Leleux, the Mayor of Grasse, from Dr. Francis Pierron, the principal organizer, from Dr. Mike Pearlman, the Director of the ILRS Central Bureau, and from Dr. Werner Gurtner, Chair of the ILRS Governing Board.

The sessions, focused on challenges for future, were organized around the following topics:

- Scientific and analysis challenges
- Automation for stations
- Stations operations and data analysis collaborations
- Counters performance and upcoming event timer
- kHz SLR
- Space projects, time transfer, transponder, laser reflector
- New and upgrading stations
- Data formats

After the welcome by Werner Gurtner and Francis Pierron, the session, "What are the Scientific Challenges for the Future" was introduced with review paper presented by Francois Barlier. Subsequent papers included topics such as the TRF and importance of SLR for the scale definition of the next ITRF solution, the latest numerical planetary ephemeris fitted with LLR observations (INPOP06), the next Generation Global Geodetic Networks, and fundamental Physics with Microscope mission were presented.

The session "Operations and Analysts Collaborations to be Developed in the Future", described the stability of SLR station range biases, SLRF2005 (the temporary ILRS reference frame) a way to find systematic measurements errors in the SLR data, the effect and evaluation of atmospheric gravity and the annual gravity field variation on LAGEOS orbits, and the potential use of Starlette and Ajisai for station positioning.

The second part of this session "Working Together: Station Operations and Data Analysis Groups" focused on the need for better inter- and intra-group communication, the work to remove ambiguities between the various data quality assessments, and the need to move toward developing a comprehensive consolidated analysis report. A key recommendation from the session was that the Network and Engineering, Analysis, and Data Formats and Procedures working groups form a task force to prepare, define, and install concrete procedures and processes for data review and station feedback.

The session "Technological Challenges for the Future" included a section reviewing the status of future transponder missions, including LRO, 3-D imaging lidar technology, T2L2 experiment and transponder ground simulation, and automation experiences at various SLR stations (Zimmerwald, Mt. Stromlo, NGSLR, and Herstmonceux).

The Chronometry session highlighted the need to analyze performance of the counters to calibrate and correct non-linearity of some instruments (especially Stanford counters), and described available and upcoming event timers with impressive performances at the level of a few ps up to sub-ps.

With an increasing number of stations upgrading to kHz ranging capability, the High Repetition Rate session provided recommendations for stations moving in that direction and illustrated the potential of kHz SLR for other applications (atmospheric seeing, satellite spin, etc.).

The "Projects, Missions and Stations" session began with time transfer experiment presentations: Chinese Laser Time Transfer (LTT) and the French Time Transfer by Laser Link (T2L2). Presentations on new or upgraded stations demonstrated that continued high level maintenance and development of instrumentation and network renewal (geometrically and instrumentally) continues within the ILRS and is driven by station and mission requirements as well as research priorities. An interesting conclusion found that inter-station collaboration plays a major role in successful ventures.

The session "Laser Reflector Array for Challenging Orbits" showed that there are more targets in '"challenging" orbits, e.g., at 20,000 km, geostationary, or highly elliptic orbits. These new missions illustrated that retroreflector array design must be considered, e.g., a large array for strong returns or a small array to reduce signature effects. Discussions on the types of retroreflectors and testing methodologies were reviewed. Results from successful ranging to Compass and ETS-8 were presented.

The session "Technological Challenges with Data Format presented the status for new ILRS formats, Consolidated Prediction Format (CPF) and Consolidated laser Ranging Data (CRD) format. The errors in the SLR predictions using CPF are minimal. LLR predictions in CPF are used at MLRS. CPF has also been successfully used in testing for transponder mission and LRO predictions. The CRD format design is virtually complete and test data analysis shows little accuracy difference from old format; parallel tests will start by end of year.

The workshop concluded with the ILRS General Assembly followed by a traditional banquet held in "Palais des Congrès". The final day included a visit to the Grasse observatory and a meeting of the ILRS Governing Board. In addition, the local organizers set up sightseeing tours of Grasse, conducted by a professional guide, for accompanying persons.

16th International Workshop on Laser Ranging, Poznan Poland

Michael Pearlman/CfA

The Committee on Space and Satellite Research of the Polish Academy of Sciences, the Space Research Centre of the Polish Acadame of Sciences, the Adam Mickiewicz University in Poznań and the ILRS hosted the 16th International Workshop on Laser Ranging in Poznań, Poland, October 13-17, 2008. The theme of the workshop was "SLR – The Next Generation". The Web site *http://www.astro.amu.edu.pl/ILRS_Workshop_2008/index.php* provides information about the workshop; proceedings and session summaries can also be found on the Web at *http://cddis.gsfc.nasa.gov/lw16/*.

Figure 10-2. Attendees of the 16th International Workshop on Laser Ranging Poznan, Poland, October 2008.

Over 140 people from 19 countries participated in the workshop, which included oral and poster presentations on scientific achievements, applications and future requirements, system hardware and software, operations, advanced systems, and analysis. ILRS working group and Governing Board meetings and the ILRS General Assembly were held in conjunction with the workshop. The local organizers also entertained the delegates with a reception and banquet and tours of the Borowiec laser station and Poznan city.

The workshop brought together an exceptional group of researchers who provided reports on the spectrum of science investigations being supported by Satellite and Lunar Laser Ranging (SLR and LLR) and Laser Altimetry. The three sessions comprising this portion of the meeting, containing over twenty oral presentations and three posters, covered a wide range of activities. These sessions where structured as follows.

The first science session focused on the reference frame, positioning SLR stations with high precision within this frame, and time variations in the gravity field, which both perturb the SLR satellite orbits and cause changes of the location of the geocenter with respect to the polyhedron realized by the geographic distribution of the SLR stations. The legacy of SLR over the 1970s and 1980s where it alone provided precise Earth orientation information and through the 1990s for monitoring changes in the longest wavelengths of the gravity field were described. Also presented were results showing the SLR contribution to the International Terrestrial Reference Frame (ITRF) both in terms of providing scale and in monitoring geocenter motion. New missions, like GRACE, which now provide far more detailed information on mass flux within the Earth's system, were also discussed with regard to improving SLR orbit accuracies.

Session two focused on orbit determination capabilities, analyses, and new applications for SLR including support for upcoming Lunar Reconnaissance Orbiter (LRO) mission. This session also discussed various highly interesting investigations made possible through the availability of detailed topographic mapping capabilities delivered by laser altimeters and the Lunar Laser Ranging acquired on the moon. SLR remains one of the surest ways to provide precision orbits in its own right, and for independent orbit verification for solutions produced by GPS and DORIS. A laser transponder being deployed on LRO will provide significantly improved orbits for this lunar orbiter enhancing mission science objectives. The second half of this session focused on the outstanding results for both Earth and Planetary applications, made possible with laser altimetry. Excellent papers were presented on ICESat, the MOLA altimeter flown on Mars Global Surveyor (MGS), and a survey of results from the NEAR, MESSENGER, and LRO spacecraft.

The third science session highlighted SLR and LLR contributions to planetary and lunar geophysics, fundamental physics (e.g. the Lens Thirring effect, the geophysical properties of the moon deduced from LLR) and the upcoming LARES experiment. SLR and LLR, given the long time history and stability of these systems, have made significant contributions to the study of fundamental physics in the field of General Relativity.

The science presentations at this workshop both individually and in total, were some of the most comprehensive ever presented within the ILRS Workshop framework. These papers clearly demonstrated the continuing role that SLR, LLR, and laser altimetry has in furthering our understanding of the dynamics ongoing in the Earth and its terrestrial-like planetary companions.

The session "The Role of Satellite Laser Ranging in the Global Geodetic Observing System" highlighted the central role that SLR plays within GGOS. The opening presentation summarized the main contributions of SLR to the three pillars of geodesy for GGOS with examples of the state-of-the-art in the definition of the origin and scale of the ITRF, the long history of SLR series of EOP, the longest of all space techniques, and mass load variations from long wavelength harmonics time series derived from SLR, with comparisons to other techniques (GRACE, GPS, hydrology, etc.). Efforts on a new ILRS product, daily delivery of fresh EOP estimates, show the product can be used to constrain the EOP forecasting process of the NEOS service of IERS. Other presentations highlighted the intercomparison and combination of SLR with other geodetic techniques. ESA's efforts to harmonize the reduction of GNSS and SLR data with a common analysis package would be an important contribution to GGOS for a combined and consistent estimation of geophysical parameters. Comparison between GPS- and SLR-derived time series of coordinates over a period of eleven years were shown, where the results indicated the general consistency of the results at the few millimeter level. This work demonstrated how well the two techniques compare at sites with data of exceptional quality, and how they can be used to identify problems in either technique when they are co-located and properly and accurately surveyed. Results of optimization studies in designing the future global geodetic networks that will support GGOS, focusing on the role of SLR and the possible products to be delivered, were shown. This presentation stressed the stringent requirements of GGOS and how the synergy of the geodetic techniques will meet this challenge. A poster illustrating the global map of the four networks of the space techniques as they exist today was shown. A second poster showed an example of how ILRS can make use of the Virtual Observatory on the web, following the example of astronomy.

The Network and Station Performance session covered three main topics: data quality control (at stations and at analysis centers), models, and the network in general. Presentations on data quality control reported on efforts to reach and maintain the highest data quality through the use of other on-site geodetic techniques (GNSS, absolute gravity), co-location, automation, and software monitoring development in cooperation with data analysts, engineers, and station operators. Data quality control at Analysis Centers included an overview of the routine quality control system for the ILRS global network provided by the Hitotsubashi University, which is available via web, ftp and email. Results from the re-processing of data from selected missions using the most accurate orbit models and the latest ITRF (SLRF2005) were shown; the analysis has been used in development of a new model, LPOD2005. A presentation was given summarizing an ILRS proposal to IERS for modification of the analysis standards related to the products contributing to the establishment of future ITRF solutions. Analysis of the correlation between the TRF datum and the ILRS network geometry was shown with the goal to explain the discontinuity in the SLR scale. Difficulties in tracking the future TanDEM-X mission were discussed with possible remedies for the various types of stations in the ILRS network.

There was significantly more activity in the Lunar Laser Ranging (LLR) and Interplanetary Laser Ranging session this year. A presentation on reference frames for lunar ranging analysis emphasized the need to avoid confusing gauge-dependent terms and physical effects. Two years of APOLLO operation has showed high photon rates and evidence for one-millimeter performance. There were also presentations on recent efforts to understand Earth orientation using 38 years of LLR data and the science that would be attainable with the next-generation (large) corner cubes on the lunar surface. There were several talks on one-way ranging to the lunar reconnaissance orbiter (LRO), focusing on technical parameters/capabilities, pointing strategies and verification, and scheduling and predictions. Preparations for the LRO experiment are taking place at the McDonald Observatory, where most of the software preparation is already completed. There was also a presentation on the science deliverables one may achieve through interplanetary laser ranging, including the successful ranging to the MESSENGER and MGS, as well as plans for LRO. Posters were displayed pertaining to using LLR for Celestial pole determination, and the minimum duration necessary for sea level rise determination.

In the High Repetition Systems Session, the five-year success of the Graz station with two kHz laser operation was reviewed. Other stations including Herstmonceux, Zimmerwald, TIGO, NGSLR, several Chinese stations, a Russian system, and the Potsdam station have or are switching to higher repetition rate laser. New control systems for higher repetition rate lasers have been developed and implemented; most kHz stations are now using the Riga event timer. With the benefit of kHz ranging, several new results and additional areas of study are underway including very accurate satellite spin determination, fast optical response retrieving, mm resolution accuracy from cm targets like LAGEOS and Ajisai, LIDAR applications, seeing measurements, and kHz ranging to a Mars transponder. The SLR future is talking “kHz”.

The Session on Lasers, Detectors and Timers included a review on commercially available kHz diode pumped lasers, and descriptions of a new high voltage Pockels cell driver for kHz SLR lasers, a new saturable absorber for laser transmitters, and a promising narrow-band holographic filters for ranging receivers. A new version of the Riga timer with improved resolution was introduced along with a presentation in the integration of Riga timers into Chinese SLR systems. The design for a commonly used TDC chips for high-speed event timers was presented as were the design and construction of compact event timing and laser fire control device for one-way laser ranging and a new, sub-picosecond timing device. A new photon counting detector for future space missions was also presented.

Several themes ran through the Software and Automation Session; major topics included software modularity and robustness, automation, and remote access to geodetic systems. Also discussed were automated processing of SLR data, CRD file creation, handling, and analysis, SLR predictions, and innovations in telescope pointing. Finally, a topic that has gained importance in the software industry, XML, has been applied to SLR station processing at Stromlo and Riga.

In New and Upgraded Stations, Extended Facilities, the Chinese network stations are being modernized with kHz lasers, event timers, CSPADS, and gravimeters. The Chinese TROS transportable system is operational in the Republic of Korea to support the ARGO project. In France, the new MEO station is operational on both satellites and the Moon, and the mobile FTLRS system has been upgraded with Dassaults event timers for T2L2 project. The Herstmonceux station is testing a new kHz ranging laser and now has an absolute gravimeter operating on site. The Borowiec station has undergone major upgrading, and upgrades on the Simeiz and Katzively stations are underway. In South America, the San Juan SLR station continues to perform exceptionally well and the TIGO system at Concepcion is operational again after delicate optical replacements.

In the session on Operational Issues and New Missions, several reports were given on new missions. Several current and upcoming European missions with retroreflectors including ERS-2, GOCE, and SWARM are focused on Earth sensing and technology applications. SOHLA-1, to be launched in early 2009 by JAXA for a demonstration of small, low cost technical payloads; since the spacecraft will be spinning, it will pose a tracking challenge since access to the retroreflector array will only last a few seconds in every few minute revolution period. Astro-G, a space borne VLBI antenna, is planned for launch in 2012; the highly elliptical orbit and bi-modal, switching operation of the antenna; will also limit normal points to very short intervals and require some special data handling procedures. The Precision Expandable Radar Calibration Satellite being planned by NRL for calibrating radars and studying drag and electromagnetic conditions in orbit will carry over 1000 retroreflectors distributed inside and outside of a spherical deployable frame. Consideration for an Optical Link for the ACES Mission was discussed along with concepts for resolving the range biases in one-way ranging experiments and a novel application of SPADs using no optics. An IR camera and aircraft radio detection beacon using a patched antenna array offers promise of new aircraft detection safety systems for laser ranging. The implementation of the Consolidated Laser Ranging Format is underway with full implementation later in 2009. MOBLAS-8 returned to operations. Posters included some historical SLR information, a status on the ILRS website update, and the upcoming ANDE mission scheduled for May 2009.

Papers presented during the Targets, Signatures, and Biases session covered retro-reflector array design and optical response functions. The continuing development of new missions that will require laser tracking support is evident, as is the ongoing and welcome dialogue between mission engineers and the laser community in developing the best array solutions to maximize the effectiveness of the tracking. Work on retro array design and chamber testing was shown, with particular emphasis on concepts for the next generation GPS satellites. A presentation described experimental results to determine pulse energy levels leaving the telescope as a function of its attitude and initial pulse polarization. Presentations were also given describing the laser arrays on the GEO and MEO elements of the emerging Chinese Compass GNSS and on the HEO two-satellite STSAT-2 technology mission. An optical response simulation was described for the proposed HEO VLBI mission ASTRO-G, which very interestingly will see the ILRS supporting an astrophysics mission.

In the session on Advanced Systems and Techniques: Transponders, Altimeters, and Time Transfer, Altimeters, papers were presented on the development of simulators for planetary exploration and present and future airborne photonic 3D-imaging. Transponder topics included transponder simulations using artificial satellites preliminary hardware designs to demonstrate the feasibility of Mars links. Papers were given on time transfer including first data from T2L2 and some preliminary results from the Chinese LTT experiment and a discussion on One-Way System Calibration Techniques. Other talks included an update on the Russian SLR program including the release of some of the data, a paper on ranging to uncooperative targets in China, and SLR engineering activities at Riga including new developments in their epoch timer work.

Future Workshops

The 17th International Workshop on Laser Ranging is being organized for the University of Concepción, in Concepción, Chile in the January 2011. A full slate of ILRS working group meetings, plus an ILRS Governing Board Meeting and an ILRS General Assembly will be held.

A specialized ILRS Technical Workshop on SLR Tracking of GNSS Constellations is being organized at the Metsovon Conference Center and at the Metsovion Interdisciplinary Research Center of the NTUA in Metsovo, Greece for September 14-18, 2009. The meeting will cover science and applications as well as system and operational issues of SLR tracking on GNSS satellites. Details are available at: *http://www.ntua.gr/MIRC/ILRS_W2009/.* Several ILRS Working Groups will also meet at this time.