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SECOND ANNOUNCEMENT
International Technical Laser Workshop 2012 (ITLW-12)

"Satellite, Lunar and Planetary Laser Ranging: characterizing the space segment"

Frascati National Laboratories of the INFN-LNF,
Frascati (Rome), Italy (http://www.lnf.infn.it/user.html)
November 5-9, 2012,

in conjunction with a one-day Workshop on
"ASI-INFN ETRUSCO-2 Project of Technological Development and Test of SLR Payloads for GNSS Satellites"

November 7, 2012

Draft Scientific Program

Satellite and Lunar Laser Ranging (SLR and LLR) missions have a wide spectrum of scientific goals, including:

- Definition of the International Terrestrial Reference Frame (ITRF), especially the Geocenter and scale (GM)
- Precision orbit determination in support of gravity field determination, other orbiting observation sensors (e.g. altimeters), and the calibration of Global Navigation Satellite Systems (GNSS)
- Fundamental physics, especially tests of general relativity via precise ranging to the Moon or interplanetary spacecraft
- Interplanetary navigation, time transfer and support of planetary and planetary moon science (e.g. laser altimetry from Mercury to Jupiter/Saturn icy Moons)

Achieving the ranging accuracy goals puts increasingly stringent performance requirements on the design and construction of SLR/LLR/transponder payloads. This workshop will focus on the critical design issues and on the characterization of payload performance for present and future missions. Such characterization is based on:

- SLR/LLR tracking experience of stations of the International Laser Ranging Service (ILRS) distributed worldwide
- Ground testing of prior and newly developed payloads at dedicated facilities (e.g., the SCF and SCF-G in operation at INFN-LNF, Frascati)
- Specialized optical, thermal, structural and orbital software modeling.

This meeting will focus on the laser ranging space segment, characterization approaches and optimization for different classes of missions supporting programs of interest to the ILRS, its members, and the scientific community. We will also discuss any impact the space segment design preferences will have on the ground segment.

The meeting is intended to generate community discussion on the various subtopics of interest. A chair and co-chair will be chosen for each session. To preserve adequate time for group discussion, the Chair and Co-Chair, with the help of the Program Committee, will serve as the principal arbiters for the selection of a very limited number of contributed oral presentations, which are likely to suggest a solution or further elucidate the issues of that particular subtopic. Our plan is to invite well-qualified individuals to provide opening presentations in each session which (1) briefly summarize the current state of our knowledge on the subtopic; (2) highlight questions and issues to be addressed by the community during the session, and (3) lead the session discussion with the goal of drawing topic conclusions or outlining a course of action to bring us to conclusion. Contributed talks should be short (10 minutes) and must be relevant to the session topic.

All ILRS international colleagues, and interested vendors are invited and encouraged to attend and participate in the discussions. There will also be opportunity for poster papers on relevant topics.

A tentative schedule for the meeting:

SESSION TOPICS

MONDAY

1. Introduction
   - Greetings, salutations, and administrative details
   - Brief historical overview – where are we coming from?
     - Requirements - What performance (e.g., accuracy, spatial and temporal coverage, etc.) does the science community (GGOS, ILRS, IGS, etc.) currently expect and need?
     - What are the projected requirements in the future?
     - What range of ground technologies will we have to deal with?
   - Tutorial on Retroreflectors
     - Retroreflector array design issues, what's important?
     - Array Cross-sections required for adequate signal
     - Retroreflector spoiling versus satellite altitude and relative velocity and its impact on effective cross-section
     - Impact of array design on target impulse response
     - Depolarization effects (uncoated, metallic coatings, dielectric coatings) and their effects on ground SLR station design/performance.

2. Performance from Current Satellite Arrays (LEO, LAGEOS, HEO, synch.) *
   - What performance (signal strength and precision) do we get? How do ground SLR observations of signal strength and precision compare with engineering expectations and what factors (e.g., atmosphere, etc.) potentially induce differences? Do we see any evidence of degradation over time?

* GNSS to be dealt with during the dedicated 1-day workshop on Wed. Nov. 7.

TUESDAY

3. Satellite signatures (LEO, LAGEOS, HEO, synch.)
   Which satellite arrays have had their signatures measured during ground testing and what do they look like?
   Which satellite array impulse responses have been generated analytically and what do they look like?
   Which satellite signatures have been studied using photon-counting ground stations and how do they compare with ground tests or analytical results? How much variation does the target aspect angle induce?
   Can we use the signatures to improve the range measurement? What correction techniques are currently being used?

4. Satellite Center of Mass Correction (LEO, LAGEOS, HEO, synch.)
   Different modeling techniques – who is doing what?
   How are they calculated?
   Where are the models published?
   Comparison of modeling results?
   How large are the differences?
   What is the best ranging precision and accuracy we can expect from spherical satellites?
   Can we get 1 mm RMS?
   Does the de-spinning of geodetic satellites corrupt results or make orbital modeling more complicated? How do laser pulse width, detector choice, and/or signal strength (e.g. photon-counting versus conventional multiphoton SLR) impact station bias, RMS, and global orbital fits.

5. Laboratory Testing and Characterization (*SCF_LAB visit on Wed. Nov. 7*)
   What tests should be performed?
   What are the characterization procedures and standards?
   Summary of existing qualified test facilities and their availability to the global SLR community.
   Examples of what has been seen
   What is the current planning?

WEDNESDAY

Special Session GNSS Session – See below

THURSDAY

6. Ranging experience on the lunar reflectors
   What performance do we get? Level of success? Who has tried? Who has been successful? What precision do we get?
   What target range corrections do we make?
   Do we see any target signatures? How do we interpret them?
   Do we see any evidence of array deterioration? Speculation on the cause? lifetime, launch considerations, etc.

7. Array and corner cube manufacturers
   Which commercial vendors provide retroreflectors and/or build space-qualified arrays? What level of specification will they accept?
   Are there any known differences in physical characteristics and performance?
   Can we recommend standard array packages for various altitudes? What specification do they currently provide?
   What are the ground station requirements? Cross Section, off-normal characteristics; etc.
   Available footprint on Satellite; thermal considerations, weight limitations, cost

8. Novel array designs
   Galileo special design.
   BLITS, etc.
   Advantages and disadvantages of open versus solid cubes; status of various programs to create open corner cubes
   Single cube for lunar ranging

FRIDAY

9. Transponders and Receivers
   Successful experiments/operations to date (MLA, MOLA, LOLA, T2L2)
   What future missions have been proposed? What progress is being made with time-transfer and what are the future prospects?
   What new approaches/technologies are required to operate over interplanetary distances that minimize space segment prime power, volume, and mass?

10. Summary and Wrap-up Session

Each session chair (or co-chair) must present a session summary (2 charts max) at the final session on Friday. All presentations and session summaries will be made available on the Workshop website

Time will be allocated during the week for meetings of the ILRS working groups (if their members so desire) and the Governing Board.

Many of topics in this workshop have been discussed at previous workshops. The final report "SLR tracking of GNSS Constellations" from the workshop held in Greece in 2009 can be accessed at http://www.ntua.gr/MIRC/ILRS_W2009/.

Wednesday Nov. 7, 2012

ITLW-12 session on: "**SLR Tracking of GNSS Constellations**"

Jointly with the Workshop on
"**ASI-INFN ETRUSCO-2 Project of Technological Development and Test of SLR Payloads for GNSS Satellites"**

Chairs: Simone Dell'Agnello and Mike Pearlman

9:00 Welcome/logistics (INFN)

9:10 Position talk: ILRS view of SLR tracking of GNSS *(ILRS speaker)*

9:35 Status and prospects of SLR of GLONASS *(A. Sokolov)*

9:50 Status and prospects of SLR of GPS *(Stephen Merkowitz)*

10:05 Status and prospects of SLR of Compass *(Zhang Zhongping)*

10:20 Status and prospects of SLR of QZSS (*Toshi Otsubo*)

10:35 Coffee break

11:00 ILRS stations' experience: new constellations, daylight ranging, prospects for comprehensive GNSS tracking (station talks)

12:00 Orbit analysis experience: combined SLR-GNSS orbits, new constellations, prospects for SLR only orbits, etc.

12:50 Lunch

14:15 ETRUSCO-2 @ SCF_LAB (*Simone Dell'Agnello*)

14:30 Status and prospects of SLR of Galileo IOV and FOC *(Daniel Navarro-Reyes)*

14:45 SCF-Test of Galileo IOV retroreflectors *(INFN)*

15:00 Thermal-optical design and preliminary simulation for the ETRUSCO-2 GNSS Retroreflector Array *(INFN)*

15:15 Galileo in ASI's Long Term Plan 2010-20 *(ASI Rep)*

15:30 Status and prospects of SLR of IRNSS *(ISRO Rep)*

15:45 Distribution of ETRUSCO-2 brochure and workshop photo

16:10 Coffee break

16:30 Visit of SCF LAB (and, possibly, of other open LNF facilities)

20:30 Joint ITLW/ETRUSCO Social Dinner