

**First One-day Introductory and Refresher Course on  
Satellite and Lunar Laser Ranging**

Sunday, October 20, 2019

German Aerospace Center (DLR)  
Stuttgart, Germany

The ILRS has scheduled a one-day introductory course to give non-practitioners in SLR an opportunity to broaden their knowledge about laser ranging to Earth-orbiting satellites and the Moon. The course will also provide those with some experience in the field an opportunity to refresh strengthen their knowledge and increase their appreciation of this powerful measurement technique that supports geoscience and applications. The course is scheduled for Sunday, October 20, 2019, in Stuttgart, Germany, just prior to the 2019 ILRS Technical Workshop (<http://dlr.de/ilrs2019>). The program for this one-day “SLR School” is provided below.

Talks will be given in a tutorial format, with time for questions and discussion. Interested parties can attend the school with or without participating in the Workshop. Attendees will be charged an entrance fee of 30 Euros to cover lunch and breaks.

Tutorials will differ in length depending on the topic, but each session should leave ample time for questions and discussion. Seminars will be given at the level of a non-expert, recognizing that we expect people to attend who are not currently working in the field, but are curious, as well as people who are newly involved in laser ranging, but need to broadening their current level of understanding.

The one-day SLR School will be a great way for attendees to get an overview of an important component of the space geodesy measurement constellation.

Participants in the 2019 ILRS Technical Workshop can indicate their plans to attend the SLR School during registration (see <http://dlr.de/ilrs2019>). Those wishing to attend only the SLR School should contact the workshop’s local organizing committee ([ilrs.workshop@dlr.de](mailto:ilrs.workshop@dlr.de)); arrangements are being made for payment of the one-day fee.

This one-day event is an opportunity for participants to get an overall view of satellite laser ranging and is the first time that such a school has been offered. The school will be held at the:

**Pullman Stuttgart Fontana Hotel**

Vollmoellerstraße 5, 70563 Stuttgart, Germany

More Information on hotels, transportation, etc., is available on the workshop website at:

<http://dlr.de/ilrs2019>

Please contact Carey Noll with any questions. Don’t miss this opportunity!

We hope to see you in Stuttgart.

# Introductory and Refresher Course on Satellite and Lunar Laser Ranging

October 20, 2019

## Program

### **09:00—10:30 Session 1: Introduction to the Satellite Laser Ranging Technique**

- Introduction: Mike Pearlman
- Satellite laser ranging (John Degnan/60 min)
  - Ground segment: laser, detector, event timers, tracking telescopes, meteorological stations, safety radars, ground calibration target
  - Space segment: retroreflector tutorial, array design considerations (total cross-section and link budgets, observation symmetry, minimizing pulse spread)
  - Overview of ground system and network evolution to achieve maximum range accuracy (1964 to present)
  - Overview of SLR contributions to Earth science and engineering applications
  - Ranging to the Moon and planets (intro to LLR and transponders)
- Lunar laser ranging (Jean-Marie Torre and Doug Currie/20 min)
  - Ground segment: how is LLR different from SLR?
  - Space segment: lunar retroreflector, current and planned
  - History of LLR and its impact on SLR
  - LLR contribution to science
  - Challenges of LLR

### **10:30—11:00 Break**

### **11:00—12:30 Session 2: Data Analysis**

- Role and function of the Data Centers (Carey Noll/20 min)
- Analyzing of SLR observations - what do we do with the data? (Mathis Blossfeld/25 min)
- Data analysis demonstration - data download and normal point computation (Alex Kehn/ 25 min)
- Reference frames and geodetic products (Daniela Thaller/20 min))

### **12:30—13:00 Lunch**

### **13:00—15:00 Session 3: Corrections and Error Sources**

- What corrections do we add to our basic range data? Where do they come from? (Jose Rodriguez/15 min)
- How do we calibrate and to get the most accurate data products; what are the issues? (Ivan Procházka/15 min)
- What are the error sources to our ranging data? (Ivan Procházka/15 min)
- Accurate timing; how do we get it? How good is it? What improvements are coming? (Ivan Procházka/15 min)
- The importance of ground surveys and how do we do them (Johann Eckl/15 min)

- Spacecraft center of mass modeling: modeling considerations and operational issues (Jose Rodriguez/15 min)

**15:00—15:30 Break**

**15:30—17:00 Session 4: Station Operations and Other Applications of Satellite Laser Ranging**

- Space debris, technique and applications (Michael Steindorfer/20 min)
- SLR Operations
  - SLR Tracking: To successfully conduct SLR there are critical things to consider, including: beam alignment, beam expansion, spectral filtering, telescope pointing, time bias, detector gating, return energy control etc. (Rob Sherwood/20 min)
  - In-sky Safety: It is important to operate in a safe manor and a SLR station must include aircraft-safety systems such as: active radar, ADS-B, camera detection. (Matt Wilkinson/20 min)
  - Building a SLR Station in 2019: An overview of the activities and modern approaches taken by the new and upcoming SLR systems for the future ILRS network (André Kloth and Sven Bauer/20 min).

**17:00—17:30 Wrap up**