# SESSION 5: LABORATORY TESTING AND CHARACTERIZATION

## TUESDAY, NOV. 6, Session Co-Chairs: Simone Dell'Agnello and Jan McGarry

INTERNATIONAL TECHNICAL LASER WORKSHOP 2012 (ITLW-12)
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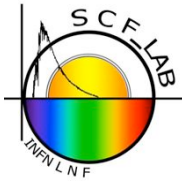
# Outline

- Laboratory characterization of the space segment of laser ranging and altimetry to retroreflectors
  - SLR
  - LLR
  - GNSS
  - New: IR (1064 nm) laser altimetry
- Setting standards: SCF_LAB

# Characterizing the space segment of laser ranging and altimetry to retroreflectors

# LRA characterization: Key Performance Indicators

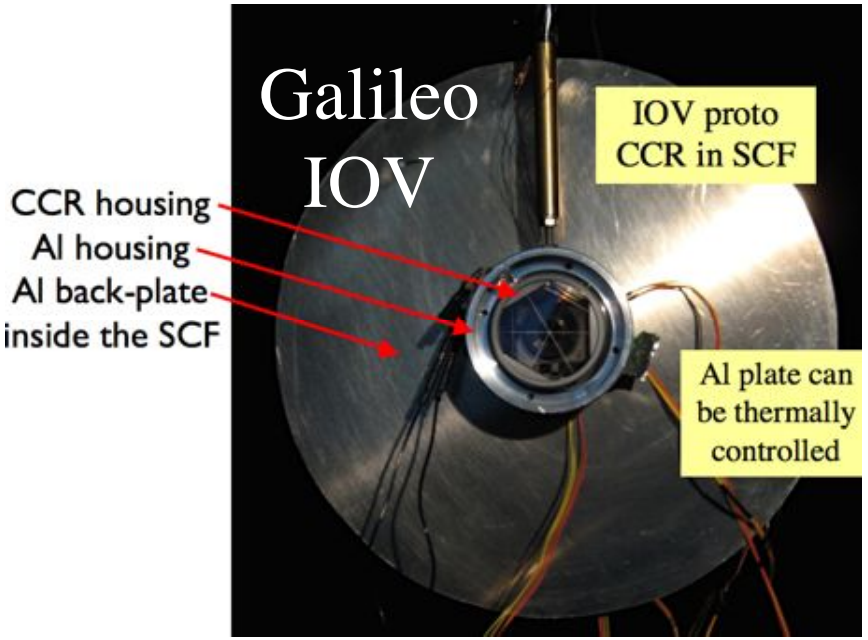



- Accurately laboratory-simulated space conditions
  - Orbit/planetary surface environment
  - Orientation/attitude wrt laser interrogation and thermal (solar) perturbation
  - Critical orbit configurations (worst-case thermal-optical behavior)
- Key Performance Indicators (KPIs) / Deliverables
  - **Thermal behavior**
  - **Optical response**
    - **Far Field Diffraction Pattern (FFDP)**
    - **(Near Field) Wavefront Fizeau Interferogram (WFI)**
    - Also invariant Optical Cross Section in air/isothermal conditions
- Integrated thermal-optical simulations (upon request)

Note: reduced, partial, incomplete tests (compared to the full space environment) are randomly misleading (either optimistic or pessimistic)

# Laser Retroreflector Arrays (LRAs)



# Global Navigation Satellite System (GNSS):

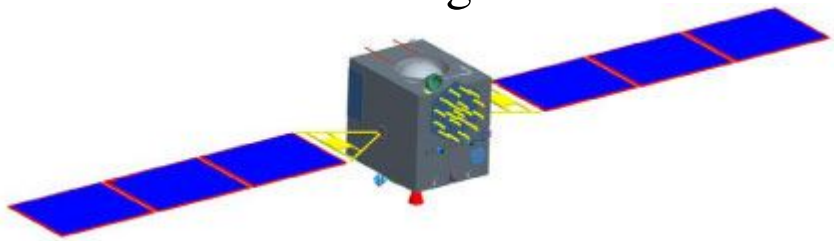
## ~100 satellites with laser retroreflectors (CCRs)


European Galileo:
30 satellites

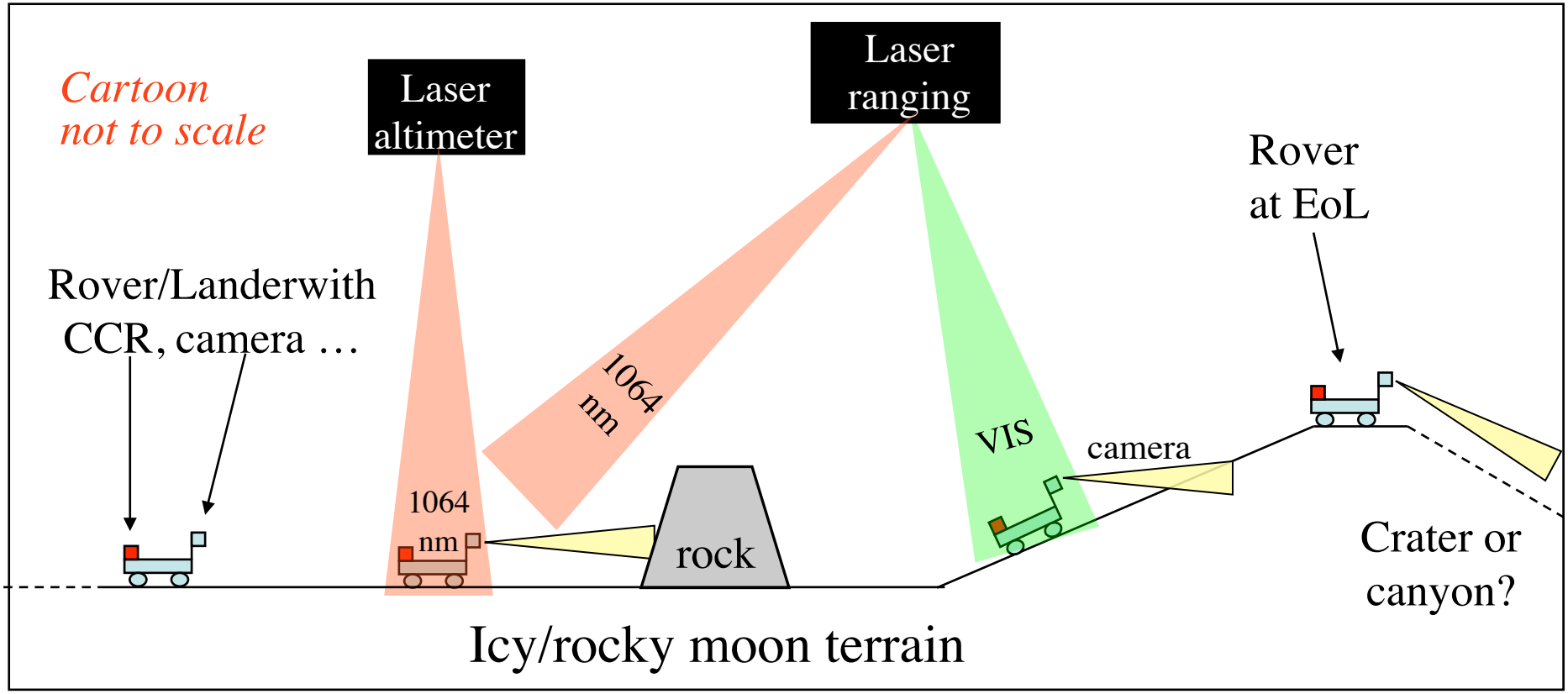


Russian GLONASS:
24 global satellites

Chinese COMPASS:
20 global and 5
regional satellites



# Future planetary laser ranging/altimetry to LRAs




- 532 nm, 633 nm, 1064 nm
- Future landing/roving mission in the Earth, Mars, Jupiter, Saturn systems
- One specific example: GETEMME proposal (Phobos, Deimos)

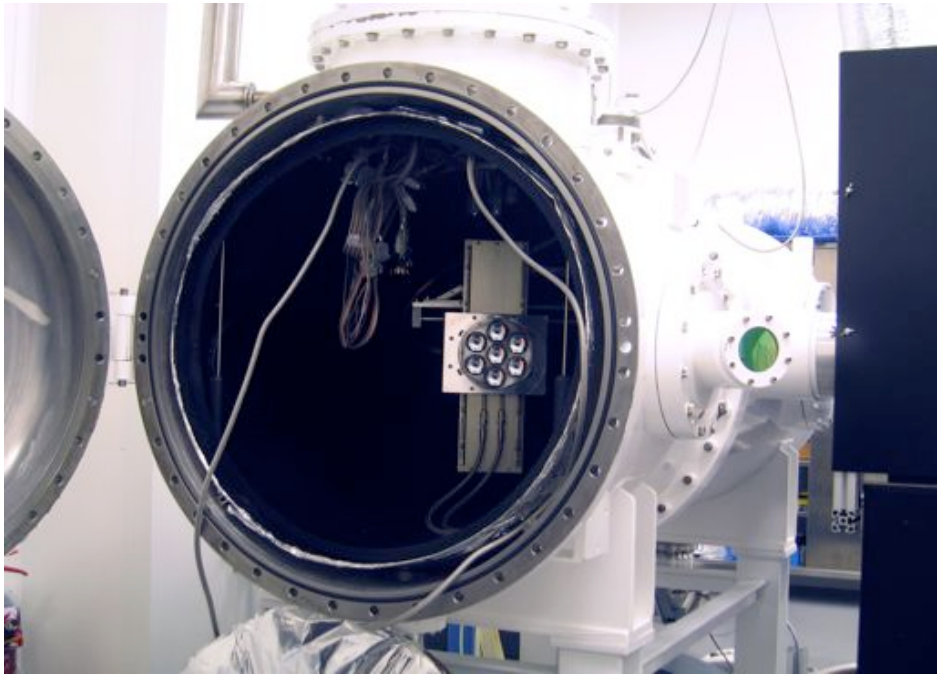
# Setting standards: SCF_LAB

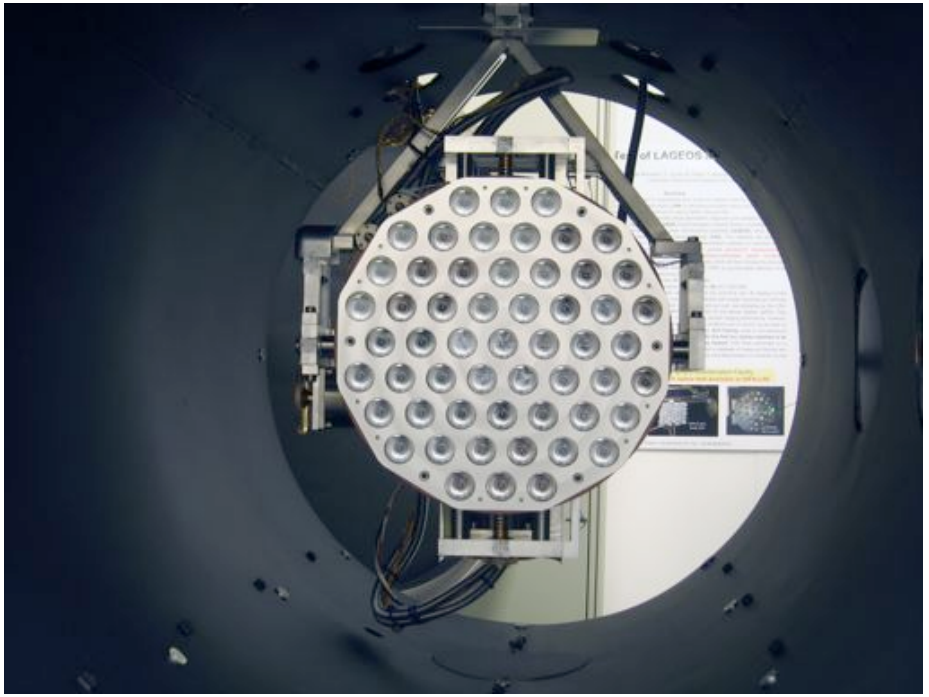
**SCF_LAB**

**S**atellite/Lunar/GNSS laser ranging and altimetry

**C**haracterization **F**acilities' **LAB**oratory

# Setting standards: SCF and SCF-G





# Talks

- **SCF_LAB: the Satellite/Lunar/GNSS laser ranging and altimetry Characterization Facilities' LABoratory** by

  Claudio.cantone@lnf.infn.it

- **SCF-Test of infrared laser ranging and altimetry to retroreflectors on moons and planets**

  Manuele.Martini@lnf.infn.it

- **Extended far field diffraction pattern characterization of LAGEOS and LARES retroreflectors in isothermal conditions (12:55-13:10)**

  Alessandro.Boni@lnf.infn.it

# Main Reference Documents


- [RD-1] Dell' Agnello, S., et al, **Creation of the new industry-standard space test of laser retroreflectors for the GNSS and LAGEOS**, J. Adv. Space Res. **47** (2011) 822–842.
- [RD-2] P. Willis, Preface, Scientific applications of Galileo and other Global Navigation Satellite Systems (II), J. Adv. Space Res., **47** (2011) 769.
- [RD-3] D. Currie, S. Dell' Agnello, G. Delle Monache, **A Lunar Laser Ranging Array for the 21st Century**, Acta Astron. **68** (2011) 667-680.
- [RD-4] Dell' Agnello, S., et al, Fundamental physics and absolute positioning metrology with the MAGIA lunar orbiter, Exp Astron, October 2011, Volume 32, Issue 1, pp 19-35 ASI Phase A study.
- [RD-5] Dell' Agnello, S. et al, **A Lunar Laser Ranging Retro-Reflector Array for NASA's Manned Landings, the International Lunar Network and the Proposed ASI Lunar Mission MAGIA**, Proceedings of the 16th International Workshop on Laser Ranging, Space Research Centre, Polish Academy of Sciences Warsaw, Poland, 2008.
- [RD-6] International Lunar Network (http://iln.arc.nasa.gov/), Core Instrument and Communications Working Group Final Reports.
- [RD-7] Yi Mao, Max Tegmark, Alan H. Guth, and Serkan Cabi, Constraining torsion with Gravity Probe B, Physical Review D **76,** 104029 (2007).
- [RD-8] March, R., Bellettini, G., Tauraso, R., Dell' Agnello, S., **Constraining spacetime torsion with the Moon and Mercury**, Physical Review D **83**, 104008 (2011).
- [RD-9] March, R., Bellettini, G., Tauraso, R., Dell' Agnello, S., **Constraining spacetime torsion with LAGEOS**, Gen Relativ Gravit (2011) 43:3099–3126.
- [RD-10] **ETRUSCO-2: An ASI-INFN project of technological development and "SCF-Test" of GNSS Laser Retroreflector Arrays**, S, Dell'Agnello, 3rd International Colloquium on on Scientific and Fundamental Aspects of the Galileo Programme, Copenhagen, Denmark, August 2011.