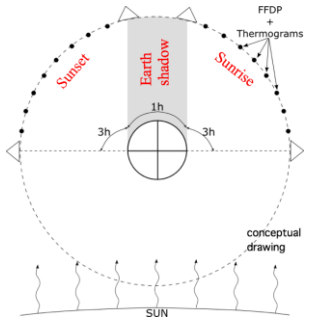
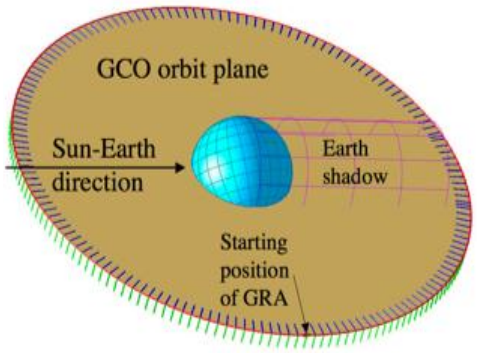
SCF_LAB: the Satellite/Lunar/GNSS laser ranging and altimetry Characterization Facilities' LABoratory

S. Dell'Agnello[1], G. O. Delle Monache[1], R. Vittori[2], C. Cantone[1], A. Boni[1], G. Patrizi[1], S. Berardi[1], M. Tibuzzi[1], C. Lops[1], M. Martini[1], E. Ciocci[1], N. Intaglietta[1], L. Salvatori, M. Maiello[1], D. G. Currie[3], G. Bianco[4], M. R. Pearlman[5], S. Contessa[1], L. Palandra[1]
[1] INFN-LNF, Italy
[2] INFN-LNF, ESA and Aeronautica Militare Italiana (AMI)
[3] University of Maryland, USA,
[4] ASI-CGS, Italy
[5] Center for Astrophysics USA

The "Satellite/Lunar/GNSS laser ranging and altimetry Characterization Facilities' LABoratory" (SCF_LAB) is located inside a dedicated infrastructure owned by INFN-LNF. The Laboratory includes two Optical Ground Support Equipment (OGSE) apparata: the SCF (Satellite/Lunar/GNSS laser ranging and altimetry Characterization Facility) [1] and the SCF-G [2], which is optimized for Galileo and GPS-3. Both are open to any GNSS (Global Navigation Satellite System). Both OGSEs are operated in a clean room of class 10000 (or better) owned by INFN-LNF. Both apparata are designed to perform the SCF-Test, which is a new thermal/vacuum/optical test procedure to characterize and model the detailed thermal behavior and optical performance of cube corner laser retroreflectors (CCRs) in accurately laboratory-simulated space conditions [1][2]. The SCF and SCF-Test have been developed by INFN-LNF with the INFN-CSN5 Project ETRUSCO (Extra Terrestrial Ranging to Unified Satellite COnstellations) and is in use by NASA, ASI and ESA. The SCF-G is built under ASI-INFN contract n. I/077/09/0 of the Project ETRUSCO-2 (Extra Terrestrial Ranging to Unified Satellite Constellations – Phase 2) to characterize and model the performance of GNSS Retroreflector Arrays (GRAs) of CCRs. Our key experimental innovation is the concurrent measurement and modelling of the optical Far Field Diffraction Pattern (FFDP) at 532 nm (or 633 nm) and the temperature distribution of retroreflector payloads under thermal conditions produced with a close-match AM0 solar simulator. The SCF-Test includes infrared camera for non-invasive thermometry, thermal control and real-time payload movement to simulate satellite orientation on orbit with respect to solar illumination and laser interrogation beams. Integrated thermal and optical modelling of retroreflectors on GNSS orbits, tuned to SCF-Test data, are also performed upon request. These capabilities provide: unique pre-launch performance validation of the space segment of LLR/SLR (Lunar/Satellite Laser Ranging); retroreflector design optimization to maximize ranging efficiency and signal-to-noise conditions in daylight; all this also applies to ground spare retroreflector models or copies of retroreflectors in orbit. In the framework of ETRUSCO-2: we are adding the capability of performing large aperture, selectable polarization, vibration insensitive, air-turbolence insensitive CCR Wavefront Fizeau Interferometry (WFI) at 633 nm laser wavelength; we are adding a second solar simulator; we built and tested an innovative prototype GRA of Hollow CCRs (GRA-H); we built and are starting the test of a standard GNSS Retroreflector Array (GRA) of uncoated solid CCRs optimized for Galileo and GPS-3. We are working on the SCF-Test of the first four Galileo In-Orbit Validation (IOV) satellites directly for ESA [2], with the endorsement of ASI; while for the GPS-3, a collaborative effort with the US GNSS community is in preparation. ETRUSCO-2 goals will be achieved using the SCF-Test, and its evolution and refinement outlined here, the "SCF-Test/Revision-ETRUSCO-2".





Futher upgrades of the SCF (which is very versatile due to its number of infrared thermometry and laser measurement ports and windows) are underway and will be outlined. In particular, the upgrade for SCF-Test characterization of infrared laser ranging and altimetry (at 1064 nm) to CCRs deployed on moon and planetary surfaces will be reported by a dedicated SCF_LAB talk at this workshop.

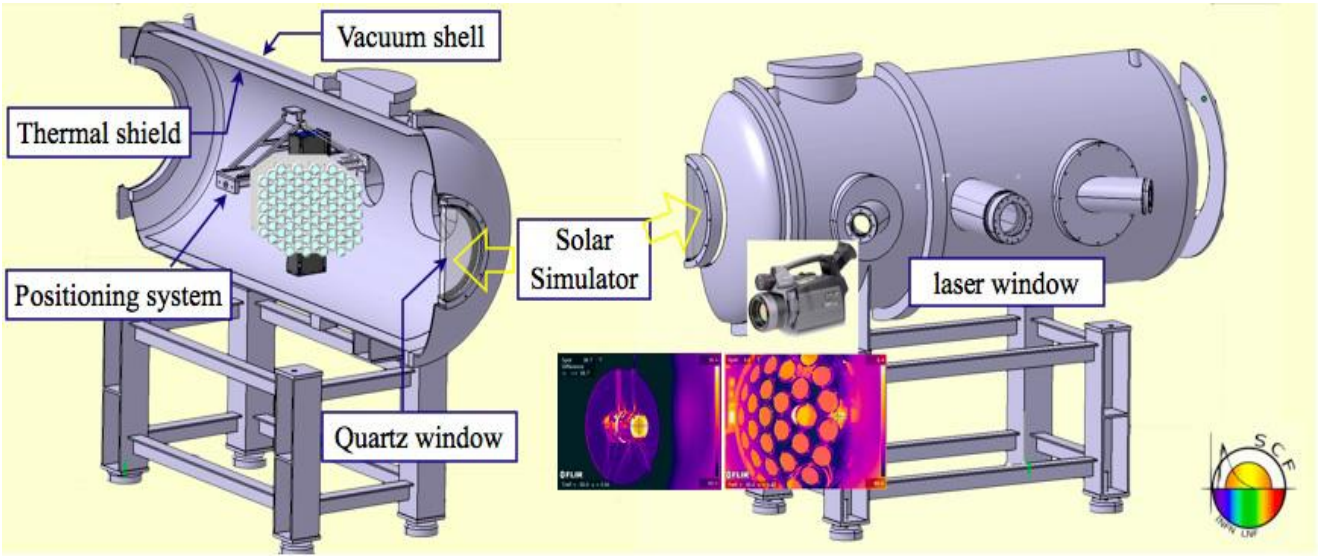


Figure: Schematic view of the SCF with a IR picture of the LAGEOS Sector, the IR camera of the lab and the logo of the facility.

Claudio.cantone@lnf.infn.it

[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.
Galileo Special Issue on "*Scientific Applications of Galileo and other Global Navigation Satellite Systems – II"*, March 1, 2011, published proceedings of the "2rd International Colloquium – Scientific and Fundamental Aspects of the Galileo Programme", Padua, September 2009.
See also http://ilrs.gsfc.nasa.gov/about/reports/other_publications.html.

[2] S. Dell'Agnello et al., *ETRUSCO-2, an ASI-INFN Project for the development and SCF-Test of GNSS laser retroreflector arrays*, ESA proceedings of the ESA "3rd International Colloquium – Scientific and Fundamental Aspects of the Galileo Programme", Copenhagen, Aug. 31 - Sep. 2, 2011. See also http://ilrs.gsfc.nasa.gov/missions/satellite_missions/current_missions/ga01_reflector.html