DESCRIPTION

- High-relevance Italy-USA bilateral project of the Research area "Marine and Earth Sciences (Including Space applications related to Earth Sciences)"
- Study of applications of innovative ground segment devices (mainly developed with other contracts with ASI and the Italian Ministry of Defense) for the co-location, intercalibration and absolute geo-referencing of GNSS (Global Navigation Satellite System), SLR (Satellite Laser Ranging), SAR, Optical EO survey and geodesy techniques from space satellites, for applications to, and benefit of Earth and Ice/Iceberg sciences
  - Absolute georeferencing, with respect to the scale and origin International Terrestrial Reference System/Frame (ITRS/F), is provided by mainly by SLR
- Study of ground segment device for EO, GMES (Global Monitoring for Environment and Security) and geodesy, for inter-technique calibration and absolute laser geo-referencing
- EO-LRA: Laser Retroreflector Arrays (LRAs) for EO satellites
- Carried out in the framework of the "International Laser Ranging Service (ILRS)", of which PI and Co-PI are members, with several other project participants.

The Teams

Italian Team:

Dr. Giuseppe Bianco: Head of ASI-MLRO (Matera Laser Ranging Observatory), Chairman of ILRS Governing Board
SCF_Lab Team of INFN-LNF: R. Vittori R, G. Delle Monache, Boni A, Cantone C, Ciocci E, Lops C, Martini M, Patrizi G, Tibuzzi M, Intaglietta N, Salvatori L, Contessa S, Porcelli L, Tuscano P, Mondaini C, Maiello M.

US Team:

Dr. Jan F. McGarry: NASA-GSFC, Responsible for operation of GSFC laser stations
Dr. Mike Pearlman: Harvard-Smithsonian Center for Astrophysics, Director of the ILRS Central Bureau
Mr. Thomas Cecere: USGS, Land Remote Sensing Program
Dr. Pablo Clemente-Colón: US NIC, Chief Scientist

ACTIVITY

- USGS/NIC inputs on geo-referencing requirements for EO for crust and glacier sites of their interest
- Define specs for ground inter-calibration devices based on USGS/NIC inputs and improve the EO techniques (INFN)
  - SAR, GNSS, SLR observations. Add optical on year 2
  - INFN will table list of EO satellites of Italy-USA interest: Sentinels; Cosmo-SkyMed; A-Train; LandSat; Jasons; CryoSat (and others with laser altimeter)
    - Operating entity, altitude, EO technique, pixel size, DEM (Digital Elevation Model) pixel size (if different), data availability
  - Ground inter-calibration devices studied will be the upgraded, augmented and expanded versions of device built by INFN-Ministry of Defense
    - Design study for model "A" for ice formations of the Alps in Italy and of Alaska in the USA
    - Design study of model "I" for Icebergs
- Study LRAs of existing EO satellites in US and Europe, their typical SLR observation accuracies and SLR data taking schedule (INFN, GSFC, ASI, ILRS)
- Study if optimization of EO-LRAs is needed (INFN)

COPERNICUS/GMES

EU flagship program: Copernicus/GMES Observing our planet for a safer world

COPERNICUS (formerly, GMES) will provide data to help deal with a range of disparate issues including climate change and border surveillance. Land, sea and atmosphere; each will be observed through GMES, helping to make our lives safer. The purpose of Copernicus/GMES is to deliver information on environment and security, which correspond to identified user needs.

Text and logo of this section courtesy of

AUGUSTUS-2014

Absolute crUst, Glacier and iceberG Georeferencing with Unified Sar, optical, gnss and laser observations by iTaly and USa – 2014

A.D. 2014, MM Anni ab Imperio Augusti

Project led by INFN-LNF *(Italian National Institute for Nuclear Physics – Frascati National Laboratories)*

Italian PI: Simone Dell'Agnello (INFN-LNF)
simone.dellagnello@lnf.infn.it
US PI: Stephen Merkowitz (NASA – Goddard Space Flight Center)
stephen.m.merkowitz@nasa.gov

National Partners:

ASI-Centro di Geodesia Spaziale

Ministry of Foreign Affairs and International Cooperation (MAECI)

International Partners:

International Laser Ranging Service

NASA-GSFC

SCF_Lab

Satellite/Lunar/GNSS

laser ranging/altimetry and Cube/microsat

Characterization Facilities Laboratory

SCF_Lab *(Satellite Lunar/GNSS laser ranging/altimetry and Cube/microsat Characterization Facility Laboratory)*

http://www.lnf.infn.it/esperimenti/etrusco/

AUGUSTUS-2014 is carried out and conceived by the SCF_Lab.

SCF_Lab is a new ISO 7 Clean Room of about 85 m^2 located inside the Frascati National Laboratories of the INFN. Unique worldwide, it is dedicated to design, characterization and modeling of the space segment of Satellite Laser Ranging (SLR), Lunar Laser Ranging (LLR) and Planetary Laser Ranging and Altimetry (PLRA) for industrial and scientific applications and endorsed by the International Laser Ranging Service (ILRS). The SCF_Lab defined the *SCF-Test*, an innovative industrial thermal-optical-vacuum test procedure to characterize and model the detailed thermal behavior and optical performance of Cube Corner laser Retroreflectors (CCRs) for the SLR to GNSS. The SCF-Test is background intellectual property of INFN [1]. The SCF_Lab is equipped with specialized instruments able to measure and model optical Far Field Diffraction Patterns (FFDP), Wavefront Fizeau Interferograms (WFI) and temperature distribution (IR thermometry) of Laser Retroreflector Arrays (LRAs) of CCRs under space conditions accurately simulated in the laboratory and also produced with two close-match solar simulators.

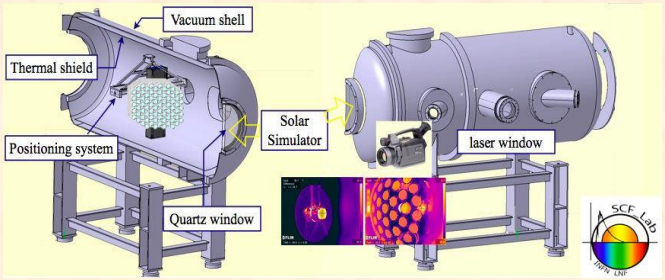
SCF_Lab ISO 7 Clean Room.

The SCF_Lab is located in Frascati, Italy, at a walking distance from ESRIN, which is ESA site dedicated to EO.

SCF: a Unique OGSE Facility (Optical Ground Support Equipment)

Our key to experimental innovation is the concurrent measurement and modeling of the optical Far Field Diffraction Pattern (FFDP) and the temperature distribution of SLR payloads under simulated space conditions.

The SCF is very versatile for its large number of measurement ports (side and back), very long horizontal translations and capabilities for lunar laser ranging (LLR) and laser altimetry CCR payloads.

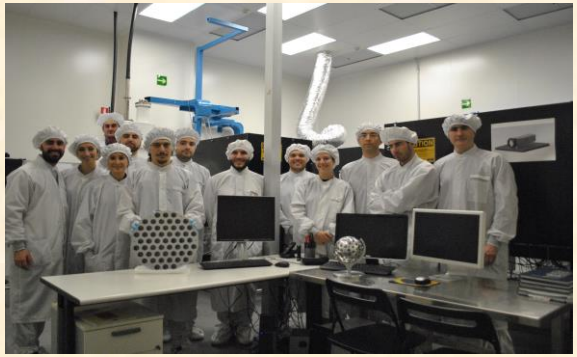


Schematic view of SCF cryostat with: IR picture of the LAGEOS Sector, IR camera and SCF_Lab logo.

SCF-G: 2nd OGSE Facility for GNSS

Based on the experience made with the SCF, with ASI co-funding we designed and built the "Satellite laser ranging Characterization Facility optimized for Galileo and GPS-3", SCF-G, which is operational in the same Clean Room infrastructure of INFN, the SCF_Lab, built in 2011. This is an ISO 7 Clean Room kept at an average isothermal temperature of about 21°C, which hosts both OGSEs.

Both the SCF and SCF-G provide critical diagnostic, optimization and validation tools for SLR to all GNSS programs. The capability will allow us to optimize GRA (GNSS laser Retroreflector Arrays) designs to maximize ranging efficiency, to improve signal-to-noise conditions in daylight, to provide pre-launch validation of retroreflector performance under space conditions accurately simulated in the laboratory, as well as to characterize 'as-built' payloads.



Some members of the SCF_Lab Team with GRA hold on the left.

First-ever SCF-Tests of

- ***GPS-2*** retroreflector array flight model property of UMD
- ***GLONASS*** and Galileo's GIOVE-A and -B CCR prototypes
- ***LAGEOS Sector*** engineering model property of NASA-GSFC
- ***Hollow*** retroreflector prototype provided by GSFC
- ***Galileo IOV*** retroreflector prototype property of ESA
- ***MoonLIGHT*** New generation LLR retroreflector developed for NASA (led by UMD) and for INFN (led by LNF: MoonLIGHT-ILN of INFN-CSN5 and MoonLIGHT-2 of INFN-CSN2). The latter includes development of a laser altimetry CCR (INRRI) and of a specialized SCF-Test at 1064 nm for laser ranging and altimetry to solar system moon and Mars (**SCF-Test/Revision-IR**)
- ***ETRUSCO-GMES*** (Global Monitoring for Environment and Security) EU flagship program dedicated to Earth Observation
- ***G-CALIMES*** Unification of Galileo and Italian constellations for radar mapping of Earth surface. Continuation, enhancement and major extension of ETRUSCO program with development of fundamental geometrodynamics networks.

Main References

[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. 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 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.