

SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)  
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ETRUSCO-2 @ SCF LAB: AN ASI-INFN PROJECT OF DEVELOPMENT AND  
THERMAL-OPTICAL-VACUUM TEST OF GNSS LASER RETROREFLECTOR ARRAYS

**Abstract**

The SCF and SCF-Test [1] are a new test facility and test procedure to characterize and model the detailed thermal behavior and optical performance of cube corner laser retroreflectors for the GNSS (Global Navigation Satellite System) in laboratory-simulated space conditions, developed by INFN-LNF

and in use by NASA, ESA, ASI and ISRO. Under ASI-INFN contract n. I/077/09/0 ETRUSCO-2 (Extra Terrestrial Ranging to Unified Satellite Constellations-2) we have built and we are operating a new experimental apparatus (our second), the “Satellite laser ranging (SLR) Characterization Facility optimized for Galileo and the GPS-3” (SCF-G) to characterize and model the detailed thermal behaviour and the optical performance of cube corner GNSS Retroreflector Arrays (GRAs). Our key experimental innovation is the concurrent measurement and modelling of the optical Far Field Diffraction Pattern (FFDP) and the temperature distribution of retroreflector payloads under thermal conditions produced with a close-match solar simulator. The apparatus includes infrared cameras 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, also performed. 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. Results of the SCF-Test of our CCR payload will be presented. We will describe the addition of a vibration-insensitive CCR optical Wavefront Fizeau Interferogram (WFI) to be used concurrently to CCR FFDP/temperature measurements in the framework of ETRUSCO-2. The SCF-G, is optimized for GNSS and we have built and tested a standard GNSS Retroreflector Array (GRA) of uncoated solid CCRs and an innovative prototype GRA of Hollow CCRs (GRA-H). We have worked on the SCF-Test of the first four Galileo In-Orbit Validation (IOV) satellites directly for ESA [2]; while for the GPS-3, a collaborative effort with the US GNSS community is in preparation. We will also SCF-Test the retroreflector array of the Indian Regional Navigation Satellite System. ETRUSCO-2 goals will be achieved using the innovative test procedure described in [1], the SCF-Test, and its evolution and refinement outlined here, the SCF-Test/Revision-ETRUSCO-2. The existing SCF facility and the new SCF-G are operated in an infrastructure owned by INFN-LNF, the SCF<sub>L</sub>AB, *which includes a dedicated cleanroom of class 10000 or better.*