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SCF-Test of LAGEOS and the GNSS for geodesy and navigation applications

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The SCF-Test is a new test procedure to characterize and model the detailed thermal behavior and optical performance of cube corner laser retroreflectors in laboratory-simulated space conditions for industrial and scientific applications, developed by INFN-LNF and in use by NASA, ESA and ASI. The SCF-Test is described in detail in 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. (2010), doi: 10.1016/j.asr.2010.10.022. The primary goal of this innovative tool is to provide critical optimization, diagnostic and validation capabilities for Satellites Laser Ranging (SLR) to Galileo and other GNSS (Global Navigation Satellite System) constellations. It was also used to characterize the in-orbit behavior of the LAser GEOdynamics Satellites (LAGEOS), which are now a reference payload standard for the International Laser Ranging Service (ILRS). This capability will allow us to optimize the design of any new SLR (or Lunar Laser Ranging) retroreflector payload, to maximize ranging efficiency, to improve signal-to-noise conditions in daylight and to provide pre-launch measurement of retroreflector key performance indicators (KPIs) under laboratory-simulated space conditions. Implementation of new retroreflector designs will help to improve GNSS orbits, which will then increase the accuracy, stability, and distribution of the International Terrestrial Reference Frame (ITRF), to provide better definition of the geocenter (origin) and the scale (length unit).
We SCF-Tested older generation, Al back-coated retroreflectors of the GIOVE-A and -B (Galileo In-Orbit Validation Elements) and the GPS-35 and -36 designs. Uncoated retroreflectors with proper mounting can minimize thermal degradation and significantly increase the optical performance, and as such, are emerging as the ILRS-recommended design for modern GNSS satellites (COMPASS, GLONASS-115 and above, Galileo, QZSS). They provide better efficiency than those on GPS and GIOVE, including better daylight ranging performance. However, these retroreflectors were not characterized in the laboratory under space conditions prior to launch, so we have no basis to evaluate how well they were optimized for future GNSS satellites. SCF-Testing, under a non-disclosure agreement between INFN-LNF and the European Space Agency (ESA), of prototype uncoated cubes for the first four Galileo satellites to be launched (named "IOV", In-Orbit Validation satellites) is a major step forward. SCF-Tests performed on a LAGEOS engineering model retroreflector array provided by NASA provided a database of measured thermal and optical KPIs (presented here), which can then be used to improve the precise orbit determination of LAGEOS, for the benefit of all its important geodesy applications.