# THERMAL AND OPTICAL CHARACTERIZATION OF A GNSS RETROREFLECTOR ARRAY AT THE SCF_LAB.

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**Introduction:** ETRUSCO-2 (Extra Terrestrial Ranging to Unified Satellite COnstellations-2), was a 3-year ASI-INFN project of technological development whose main purpose was to design, characterize and model a GNSS Retroreflector Array (GRA), with application on Galileo and GPS3 constellations. Thanks to the ETRUSCO-2 project, we matured the experience to design a payload that could improve LRAs performance, for GNSS, in orbit. In this work we present the result of the complete thermal and optical characterization carried on for the project at the SCF_Lab (Satellite/lunar/GNSS laser ranging/altimetry and cube/microsat Characterization Facilities Laboratory), describing the main results achieved with this new design, from the thermal and optical point of view.

**GNSS Retroreflector Array (GRA):** The GRA is a planar array made of an aluminum base onto which are mounted 55 33mm front face aperture Laser Retroreflectors (LRR), made of Suprasil 1. This choice followed a simulation process optimized to meet ILRS specifications for GNSS LRAs tracking [3]. To control target signature effects we decided to design a quasi-circular shaped array. These LRR were then arranged on the array in four groups of orientation, in order to obtain an axial-symmetric FFDP, and evenly distribut. The resulting intensity of the array at the VA (Velocity Aberration) of a Galileo satellite, ~24 μrad, is $113 \bullet 10^6$ $m^2$, in Optical Cross Section (OCS) units.

**Characterization of the GRA at the SCF_Lab:** The SCF-Test is a standard procedure we applied during the ten years activity of the laboratory on many retroreflector payloads [1] and revised for the ETRUSCO-2 project in order to introduce the measurement of an LRA on a simulated orbit, called GCO (Galileo half-Critical Orbit), whose distinctive features are described in detail in [2].

*SCF-Test of the GRA.* The main outputs of this phase are: thermal relaxation times of LRR and optical intensity variation, in terms of OCS. During the test period we repeated the SCF-Test with the array base plate at three different temperatures, to check variation of performance, focusing on the concurrent thermal and optical measurement of two retroreflectors of the GRA. The SCF-Test showed thermal relaxation times of LRR consistent with previous LAGEOS LRR measured at the SCF_Lab [4], and consequently a contained variation of OCS at the VA of Galileo.

*Simulated Orbit test (GCO):* With this test, exploiting the potentials of our rotation/translation positioning system, onto which payloads are mounted, we recreate the changing Sun radiation conditions of a simple orbit. Its procedure is described in [2]. The measurement was repeated on 8 of the GRA LRR, one for each orientation and, for each orientation, one inside and one on the edge of the array. Five LRR of the GRA were realized with a different material, Suprasil 311, and two of the eight tested LRR were made of this material. We gathered the results of these eight tested LRR to obtain the OCS variation of a whole GRA druring the orbit. The GRA shows an impressively contained intensity variation. In particular during the first part of the orbit, where we expected a consistent reduction of OCS, the intensity slightly increases. At the end of the orbit the intensity decreases, but the overall variation of OCS, from the beginning to the end of the orbit, is contained to about 16%. This is a great improvement with respect to the Galileo IOV LRR previously measured ate the SCF_Lab [2]. We did not record any evident performance differences between the two materials chosen.

**References:**

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