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Author: Dr. Claudio Cantone
Istituto Nazionale di Fisica Nucleare (INFN), Italy, claudio.cantone@lnf.infn.it

STRUCTURAL ANALYSIS AND PRELIMINARY SPACE CHARACTERIZATION OF A PROTOTYPE HOLLOW LASER RETROREFLECTOR.

Abstract

A new kind of Cube Corner Retroreflector (CCR) for Satellite Laser Ranging (SLR) has been modeled from the structural point of view. Traditional CCRs are solid pieces of fused silica while this new kind of CCR is hollow. This means that there are only the three reflecting surfaces without the bulk volume material whose index of refraction and, therefore, optical performance is affected by thermal gradients which may develop in space conditions. In addition, hollow cubes allow a significant lightening of all laser ranged payloads. However, it is difficult to manufacture hollow CCRs which maintain structural integrity and optical performance in the harsh space environment. We are mainly interested in the application of hollow CCRs to future Global Navigation Satellite System (GNSS) constellations. since, coupling traditional microwave ranging of GNSS constellation with laser ranging, will improve the accuracy on the positioning, and then the performance of the system, but will also provide important data for gravitational Physics. The optical behavior of a retroreflector is given by its Far Field Diffraction Pattern (FFDP). Inside the Frascati National Laboratories (LNF) of the Italian National Institute for Research in Nuclear Physics (INFN), near Rome, there is an experimental apparatus, the SCF, designed to measure the FFDP of CCRs kept in a representative space environment. INFN, together with the Italian Space Agency (ASI) is starting a project to develop, build and test an optimized GNSS retroreflector array, including also the characterization of hollow retroreflectors in collaboration with NASA-GSFC. In fact, hollow cubes are structurally weaker than solid ones and they need refined analyses to understand the relationship between thermal deformation and optical performance. Several simulations have been developed using the finite element commercial software ANSYS®. The interaction between the faces through the connecting glue has been the core of the finite element study. A versatile post-processing technique has been used to compute, from the results of the simulation, the peak to valley distance over each deformed face and the mutual position among them i.e. the alteration of dihedral angles; both these parameters give information on the optical performance of the retroreflector before measuring its FFDP. The comparison between simulation and experimental data is also shown in this paper.