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THALES SESO's HOLLOW AND MASSIVE CORNER CUBE SOLUTIONS

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1. POSTER TITLE

THALES SESO's HOLLOW AND MASSIVE CORNER CUBE SOLUTIONS

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3. OUTLINE OF THE POSTER:

For Space Activities, more and more Corner Cubes, used as solution for retro reflection of light (telemetry and positioning), are emerging worldwide in different projects. Depending on the application, they can be massive or hollow Corner Cubes. For corners as well as for any kind of space optics, it usual that use of light/lightened components is always a baseline for purpose of mass reduction payloads. But other parameters, such as the system stability under severe environment, are also major issues, especially for the corner cube systems which require generally very tight angular accuracies.

For the particular case of the hollow corner cube, an alternative solution to the usual cementing of the 3 reflective surfaces, has been developed with success in collaboration with CNES to guarantee a better stability and fulfill the weight requirements..

Another important parameter is the dihedral angles that have a great influence on the wavefront error. Two technologies can be considered, either a Corner Cubes array assembled in a very stable housing, or the irreversible adherence technology used for assembling the three parts of a cube. This latter technology enables in particular not having to use cement.

The poster will point out the conceptual design, the manufacturing and control key-aspects of such corner cube assemblies as well as the technologies used for their assembling.

MASSIVE CORNER CUBES

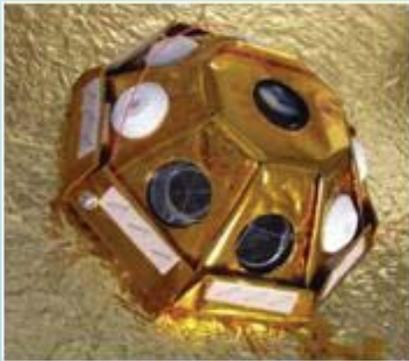
Customer: CNES

Achievement: Phase B/C/D – Design, manufacturing and test of a retro reflector boarded on the Altika payload (SARAL satellite)

Challenges: The Dihedral angle and deviation accuracy

Delivery date: 2009

For this project, THALES SESO, was in charge of the design and realisation of a retro reflector used in the Altika payload, boarded onto the SARAL satellite (Indian/French satellite, launch operated by ISRO). This LRA (Laser Retro reflector Array) is a passive instrument composed of 9 corner cubes, reflecting the laser beams coming from ground stations located onto the earth globe. The corner cubes are placed into a mechanical housing offering a conical shape. This arrangement is used to reflect the laser beams within an azimuth angle of 360° and 150° on the perpendicular axis. Because of the launch and flight conditions, the assembly method had to be robust, stable and precise, as well as compatible with space vacuum and radiations. One of the key-issue for the optical production and testing of these cubes was because the light has to be reflected not exactly at 180° but with a perfectly mastered angular deviation shift. This made the production totally not standard.



Integrated LRA with 9 corner cubes

Performances of each Corner Cube:

- Deviation: 7.2 arcsec 2.4arcsec
- Dihedral angle: 1.6 arcsec 0.5arcsec
- CA (of each cube): $\varnothing 32$ mm
- Coating: Enhanced silver
- Specific MLI (Multi Layer Insulation)
- Grounded
- Thermistor equipped

Customer: CNES / OCA (Observatoire de la Côte d'Azur)

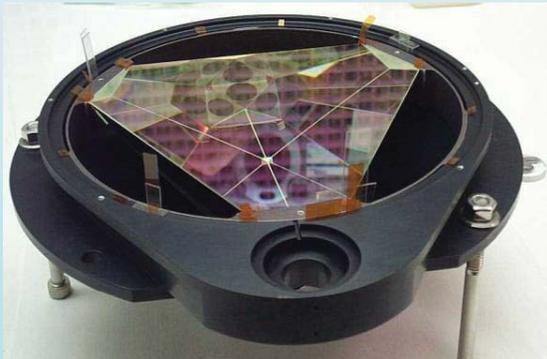
Achievement: Breadboard for the T2L2 mission

Challenges: The weight constraints and thermal loads (wide range of temperature)

Delivery date: 2003

For this project, THALES SESO was in charge of the design and realisation of a demonstrator for a large and massive corner cube expected to be used afterwards for the T2L2 mission operated onto the JASON2 satellite. This corner cube was foreseen to reflect the light coming from different laser stations located on ground. The operating mode was necessarily requesting a very wide angular field of view (more than $\pm 60^\circ$) and a unique component. This was possible to achieve only using a massive corner cube (i.e. not a hollow one) and cut from a very high index material (S-LAH65 in the present case). One of the main challenges for the mechanical mount was to design simultaneously:

- a sufficiently light global assembly, as the mass of the optical cube only, with such glass and such optical material, was already important;
- having sufficient stiffness to withstand environmental loads
- but also providing sufficient thermal dilatation possibilities (to avoid cube constraints) taking into account the very wide operating temperature range (-40°C to $+40^\circ\text{C}$)



Large and massive corner cube
for T2L2 – JASON2
(Breadboard Model)

Performances of the Corner Cube:

- High index massive corner cube in order to procure a very wide angular retro reflection possibilities (i.e. at least $\pm 60^\circ$) with a unique component
- Deviation accuracy: < 2 arcsec
- Dihedral angle: $< 0,5$ arcsec
- Size: $\varnothing 180$ mm (corner to corner)
- Mounting: Aluminum Housing + flexible annular ring (attachment of cube with space qualified glue)

HOLLOW CORNER CUBES

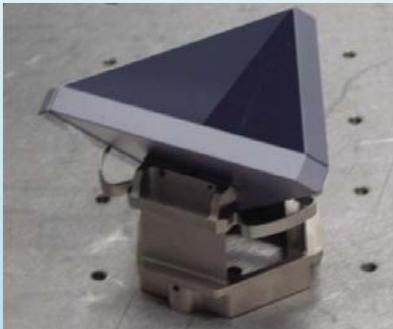
Customer: CNES

Achievement: Breadboard of a boarded reflector

Challenges: The assembly method and the weight

Delivery date: 2012

In the frame of an R&T CNES program, THALES SESO developed this corner cube by assembling three triangular plates of silicon which are bonded onto their edges. This attachment was made without any cement (to avoid risk of deformation due to stresses in the glue and thermal loads) by using our process of irreversible optical contacting (or irreversible molecular adherence). Once assembled it is cemented onto a common invar MFD.



Performances of the Corner Cube:

- Global SFE over the useful area: 32 nm RMS
- Weight: 481.7gr
- Offset angle $2.5'' \pm 0.5''$
- First Eigen frequency mode $> 100\text{Hz}$

Three triangular silicon mirrors assembled by irreversible molecular adherence onto a MFD

Customer: THALES ALENIA SPACE

Achievement: Phase B/C/D – Manufacturing and tests of the MTG Corner Cubes FM (in progress)

Challenges: The Flatness of the mirrors, the roughness, the weight and the angle tolerances

Delivery date: expected 2016

For this project, THALES SESO is in charge of the realisation of corner cubes boarded on the MTG-IRS (Meteosat Third Generation Infrared Sonder Instrument). The corner cubes are made with lightened Silicon mirrors. They are globally bonded onto a MFD and fixed onto the optical bench of the IRS instrument to be part of a Michelson interferometer. It is an ongoing project for which the mirrors have already been light weighted and the MFD design optimized.

