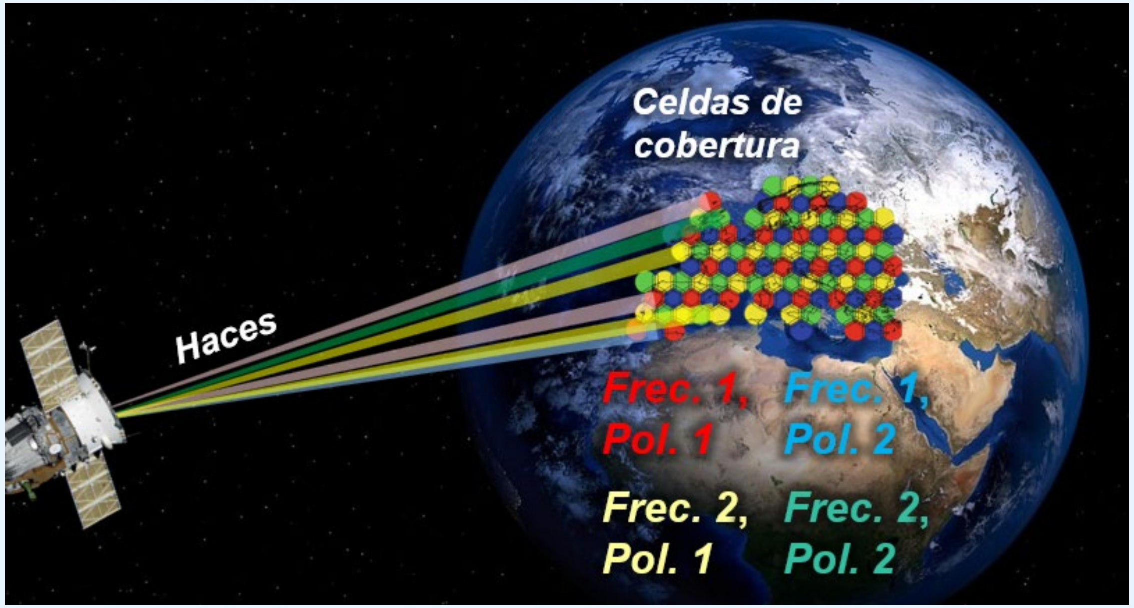
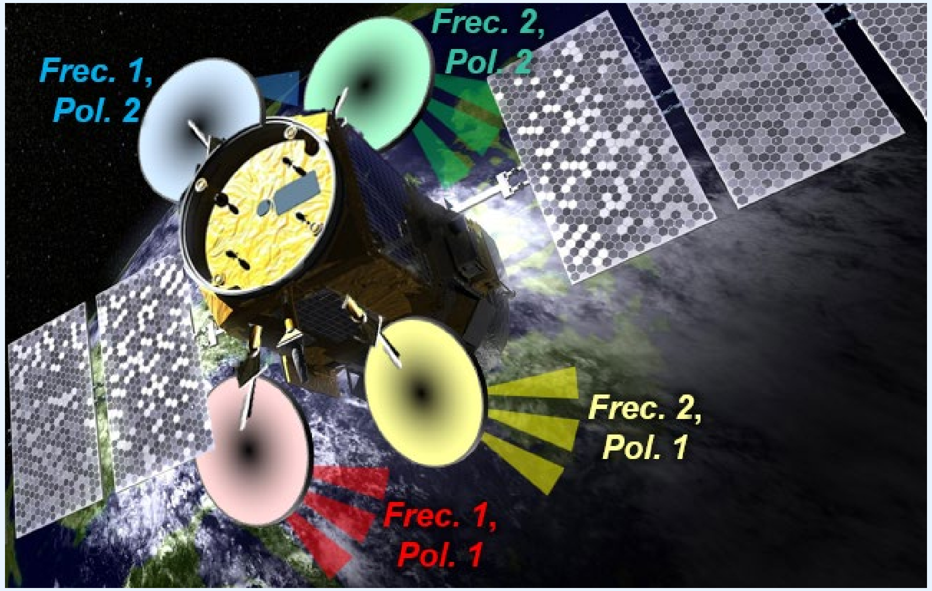
REALSAT: Multibeam antennas for GEO satellites

GEO satellites for high throughput communications operate by a cellular or **multibeam coverage**, dividing the earth's surface into small service cells. A region such as Europe would be divided into a hundred small cells.

The beams composing the coverage alternate between two frequency sub-bands (**Freq. 1 and 2**) and two polarizations (**Pol. 1 and 2**), generating a **four-color reuse scheme** to reduce interference between adjacent cells and increase the transmission rate.

Today, these satellites use **4 reflector antennas** of about two meters in diameter to generate a hundred of beams for a typical European coverage. **Each reflector** antenna generates the beams of a single color (one quarter of the coverage), which once properly imbricated complete the four-color coverage



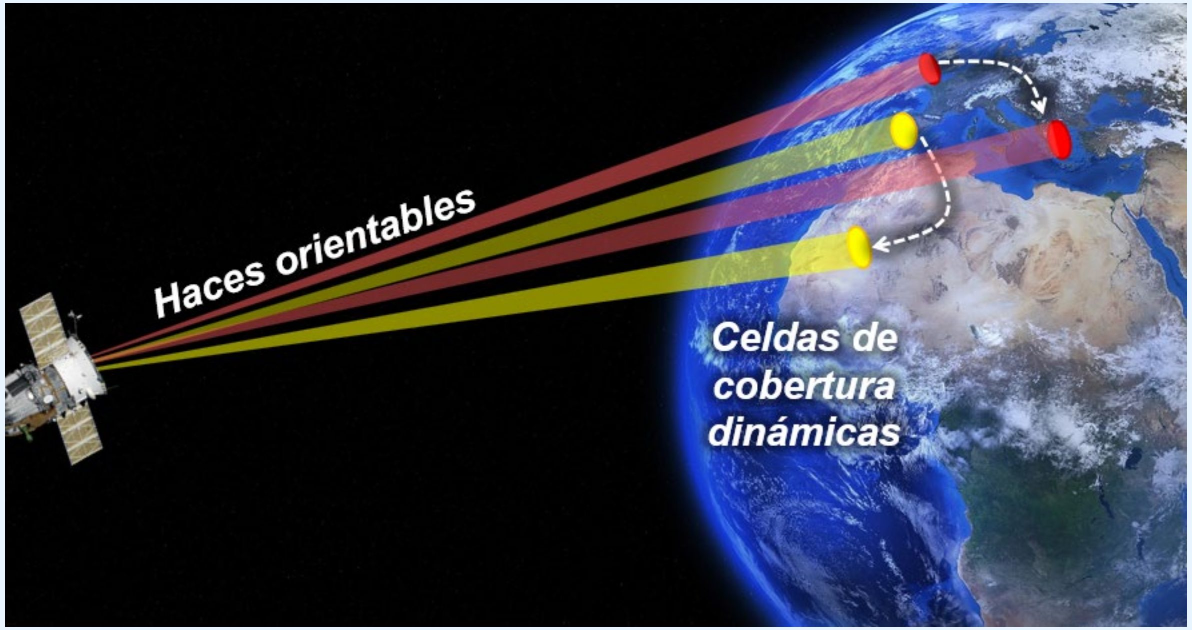


REALSAT: *SmallGEO* satellites

***SmallGEO* satellites** are new generation geostationary satellites. They aim for a **compact size** compared to traditional GEO satellites, making them more affordable and efficient, while providing a **more flexible operation** for a more efficient use of resources..

To achieve these objectives, the *SmallGEO* satellites require :

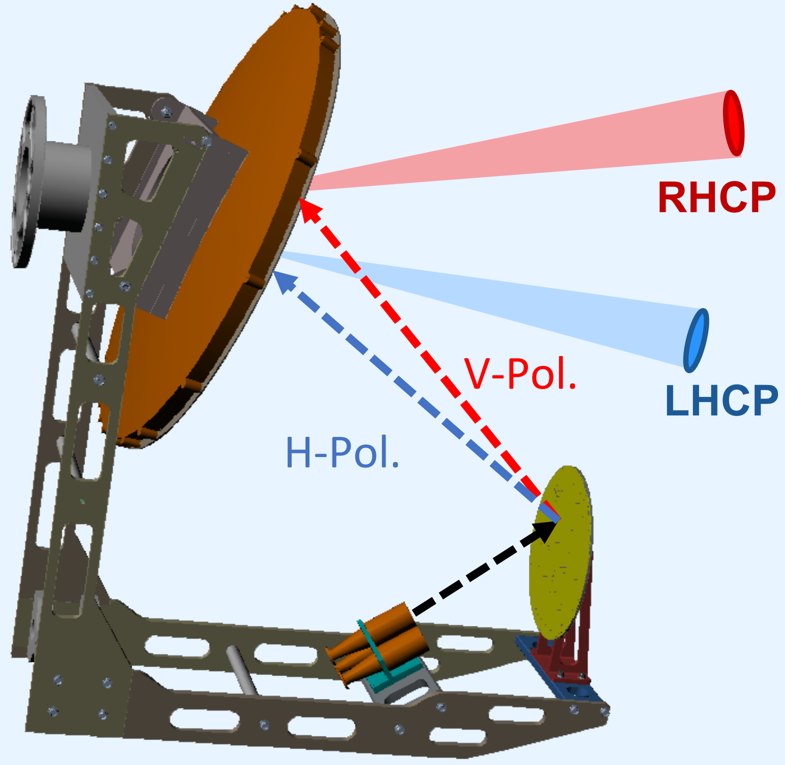
1) **More compact antenna systems**. The use of 4 large reflector antennas is a too bulky configuration (this system also requires as many feed chains on board the satellite as there are beams in the coverage).
2) **Antennas with reconfigurable beams**, which would allow to dynamically point the beams and generate flexible coverage, adaptable in time.



These antenna systems are **also of interest** for **new LEO satellite constellations** for high throughput communications.

REALSAT: Reflectarrays antennas for *SmallGEO* satellites

During the project, an antenna system has been **designed, manufactured and measured** to generate multiple beams in Ka-band (20&30GHz) with independent operation in left- and right-hand circular polarization (Pol. 1 and 2, or LHCP and RHCP), to provide broadband Internet access from *SmallGEO* satellites. The proposed configuration allows **halving the number of antennas** on the satellite by using **reflectarray antennas** on both flat and curved surfaces.



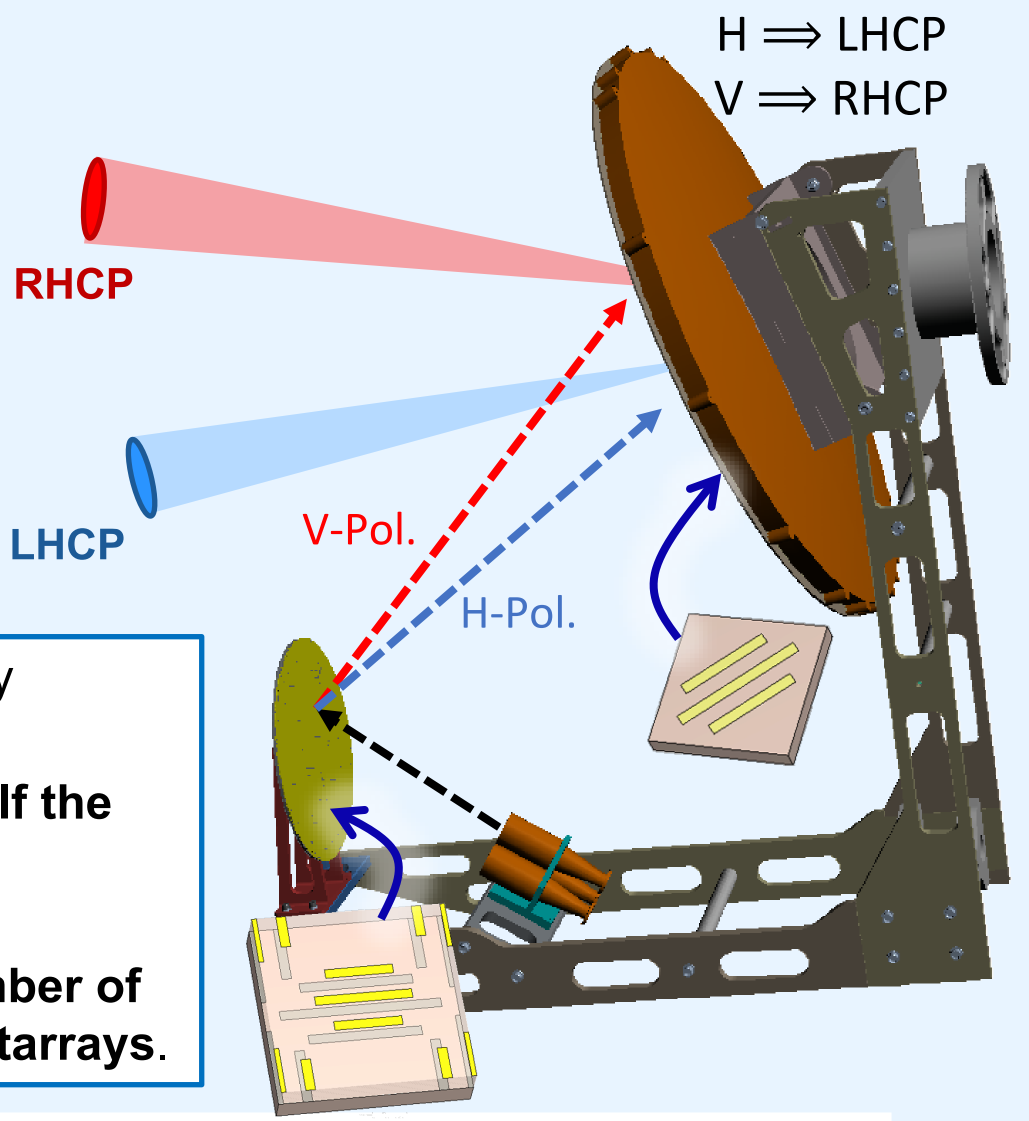
Antenna configuration	Dual configuration
Aperture type	Parabolic (main) + flat (sub)
Feeding configuration	Cluster of dual-LP horns
Antenna coverage	2 colors (Pol. 1, Pol. 2)
Frequency bands	2 (Tx & Rx)
Operation	Dual-CP, bandas de 1 GHz
Advanced functionality	50% reduction in the number of reflectors and feed-chains

Parabolic Reflectarray and Flat Sub-reflectarray (Tx & Rx)

The antenna configuration consists of a **parabolic polarizing reflectarray (RA)** and a **planar sub-RA** fed by a cluster of horns to generate 4-color cellular coverage using two frequencies and two polarizations (LHCP and RHCP) for high throughput GEO satellites (HTS).

The sub-RA **splits the beams** generated by the same feed in orthogonal linear polarizations. These beams are converted into **circularly polarized high-gain beams** (in LHCP and RHCP) in the main parabolic RA [1].

- The use of linearly polarized feeds **simplifies the feed-chains** by eliminating the polarizer device.
- The generation of 2 independent beams per horn **reduces by half the number of feeds** required on the satellite.
- The generation of beams in 2 different colors (LHCP and RHCP) simultaneously in the Tx and Rx bands **reduces by half the number of reflectors** required on the satellite, **from 4 reflectors to 2 reflectarrays**.



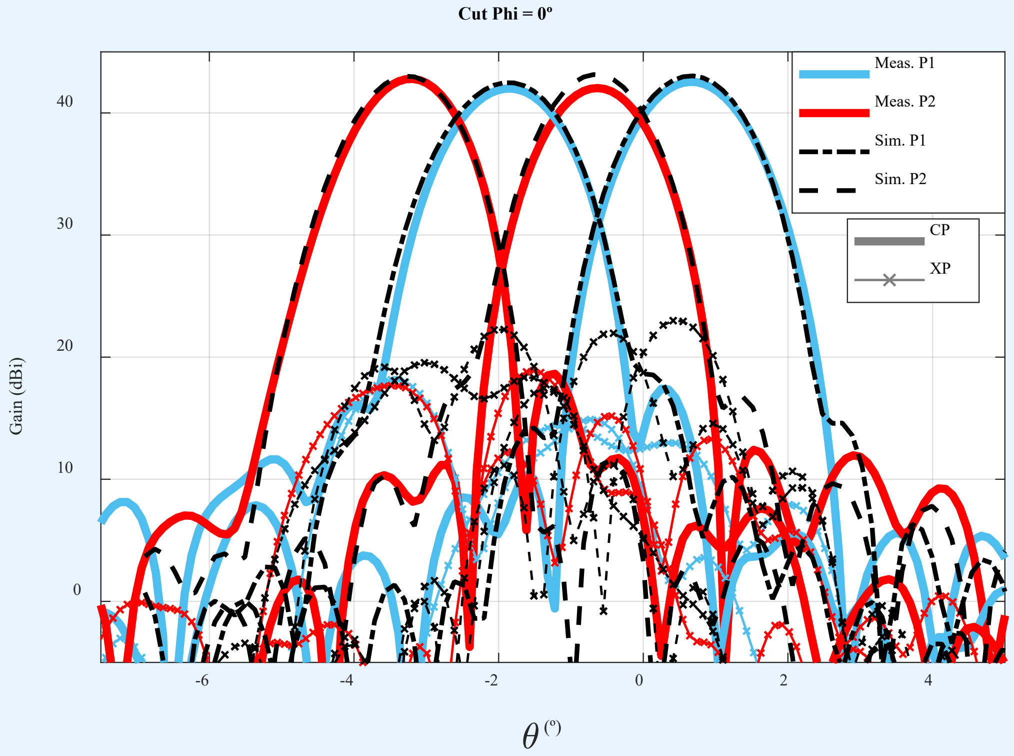
[1] E. Martinez-de-Rioja, J. A. Encinar, A. Pino and Y. Rodriguez-Vaqueiro, "Broadband Linear-to-Circular Polarizing Reflector for Space Applications in Ka-Band," in *IEEE Transactions on Antennas and Propagation*. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9016352&isnumber=4907023

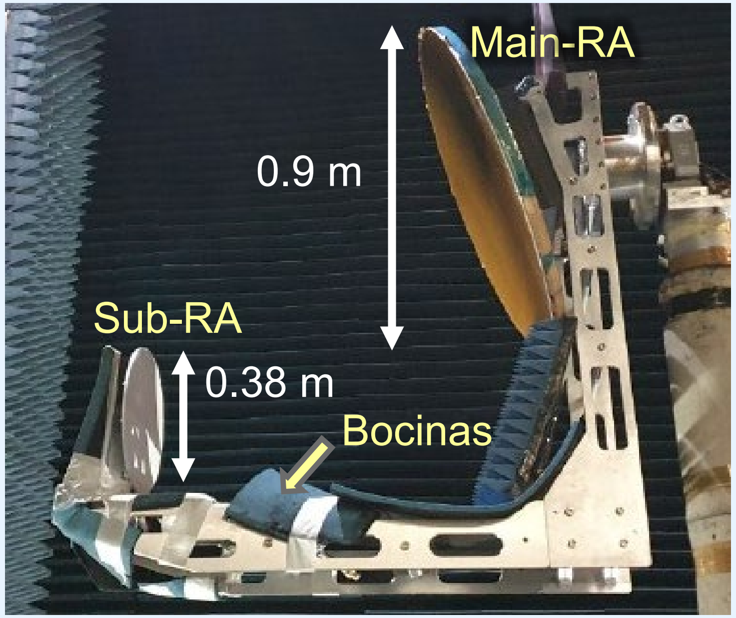
Experimental validation

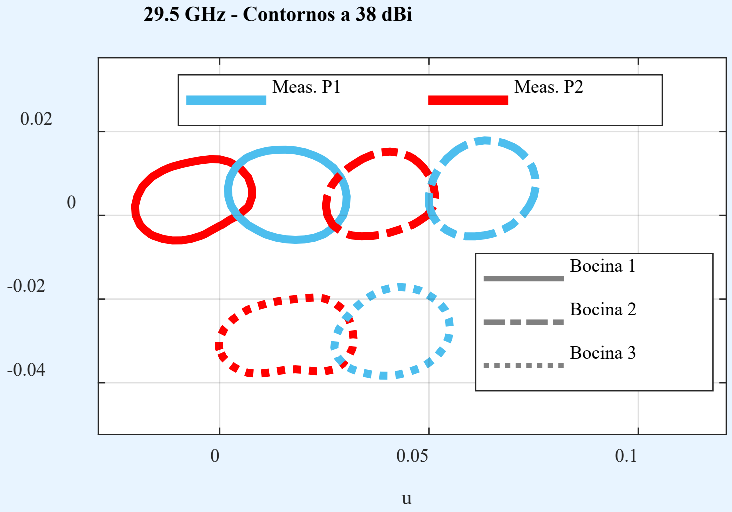
A ½ **scale demonstrator of a real antenna**, consisting of a 90 cm parabolic RA and a 38 cm flat sub-RA, fed by 3 horns, has been **designed, manufactured and measured**.

The **measured results** satisfactorily demonstrate the generation of 6 circularly polarized beams in the frequency bands for transmission, Tx, (19.2-20.2 GHz) and reception, Rx (29-30GHz).

- 1 GHz band in Tx and Rx.
- Axial ratio less than 2 dB in all beams.
- Co-polar/crosspolar level larger than 20 dB in all beams.
- The measurements validate the simulation software tools developed during the project.







REALSAT – Proof of Concept

The **technology validated** in this project allows a **reduction in the mass and volume of the payload for GEO satellites**, offering an interesting antenna solution for the new ***Small-GEO***, high-throughput geostationary satellites, but **with reduced dimensions and cost**.

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Plan de Recuperación, Transformación y Resiliencia
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