LEHA-UPM: experts in Antenna Measurements

M. Sierra Castañer, B. Galocha Iragüen

**Laboratorio de Ensayos y Homologación de Antenas, Grupo Radiación. Information Processing and Telecommunications Center.*

ETSI Telecomunicación. UPM – Madrid.

February 2024

UPM experience and facilities

Radiation Group: presentation

2 Full Professors:
Prof. Manuel Sierra Castañer
Prof. Ramón Martínez

6 Associate Professors:
Prof. Belén Galocha Iragüen
Prof. J.M. Fernández González
Prof. J.L. Masa Campos
Dr. Miguel Salas Natera
Dr. Pablo Sánchez Olivares
Dr. Adrián Tamayo

3 Emeritus Professors:
Prof. Miguel Calvo Ramón
Prof. José Luis Besada Sanmartín
Prof. Manuel Sierra Pérez

5 PhD Students
Master thesis students

3 Laboratory engineers
1 Administrative

Radiation Group: research areas

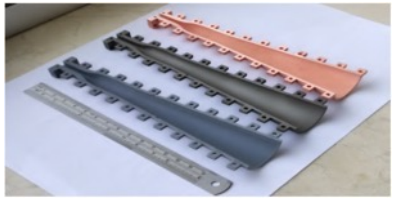
- **Antenna design and prototyping:**

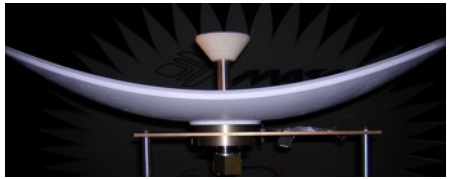
  → Planar active and passive array antennas, horn antennas and reflectors.

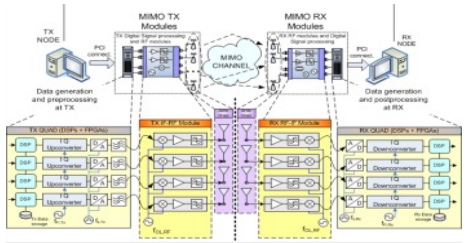
- **Satellite Communication systems**
- **Antenna 3D printing.**
- **Antenna Measurement Activities:**

  →R&D in new measurement systems and techniques.

  →External Measurements through LEHA-UPM.







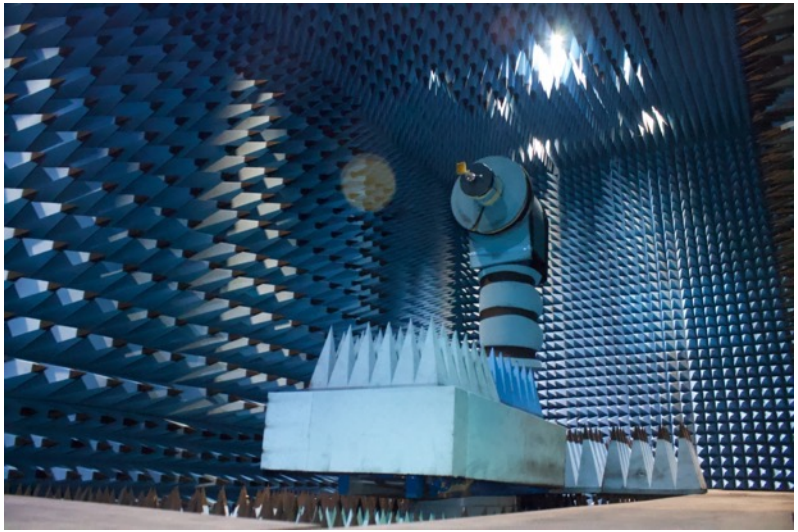
LEHA-UPM facilities

GR-UPM has been working on Antenna Measurement Systems since 1980

- **3 anechoic systems at ETSIT-UPM:**

Near Field Spherical System:

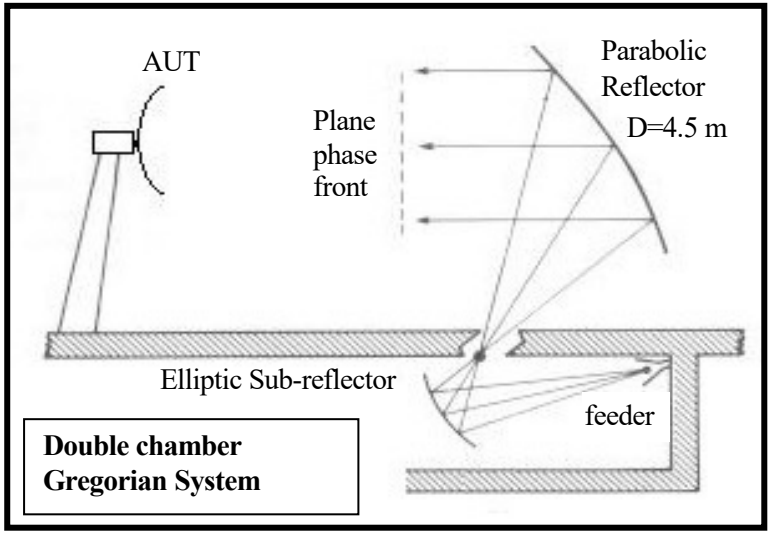
Dimensions: 7.3 x 4.3 x 4.3 m
Frequency band: 660 MHz – 110 GHz
ORBIT Controller and positioners
Agilent HP8530A VNA and PNA-X
Approved for Space Measurements (ESA) at 5.3 GHz using ERS panel



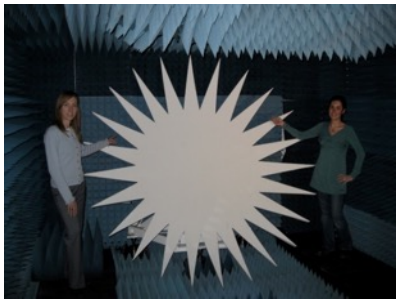
AUT Positioner. Roll over Azimuth on longitudinal table

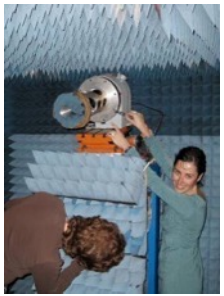
Polarization Positioner

LEHA-UPM facilities



Main Chamber : 15L x 8W x 7.5H m
Frequency Band : 6 -110 GHz
Quiet Zone : 3 m diameter
Amplitude Ripple : 0.5 dB peak to peak
Phase Ripple : ± 5º
Crosspolar Level : < -38 dB

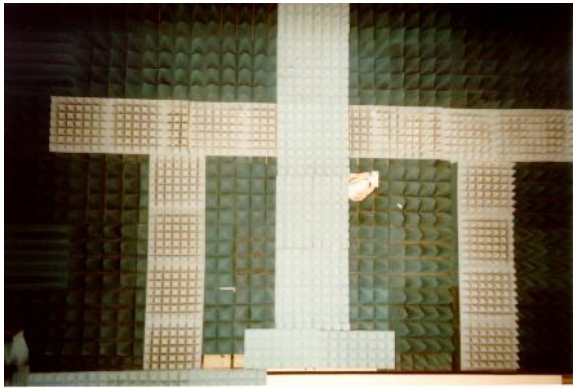


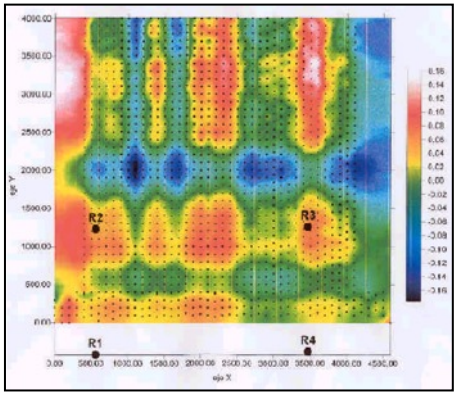


LEHA-UPM facilities

Near Field Planar-Cylindrical-Spherical System:

- 3 high precision linear elements assure the scanner high precision.
- Scan area: 4.75 x 4.75 meters.
- Frequency band: 660 MHz – 110 GHz.
- Velocity: 10cm/sec (Horizontal Axis), 33cm/sec (Vertical Axis).
- Rectitude for basement and vertical tower: 150 μm (peak to peak value).
- Planarity for the planar scanner: Zrms error <0.1 mm.

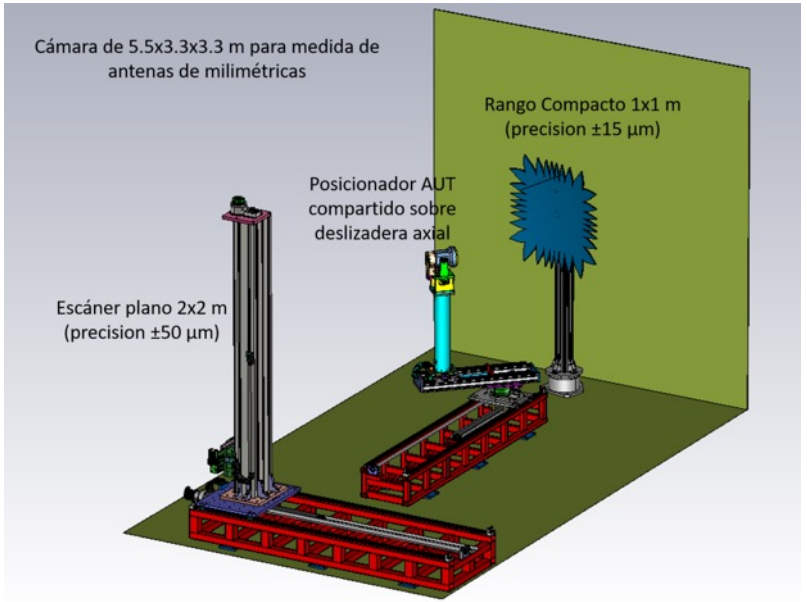




LEHA-UPM facilities

New millimeter antenna measurement system (available soon)

- Measurements of Antennas from 30 GHz to 300 GHz
- Dimensions: 5.5 x 3.3 x 3.3 m
- Planar scanner
- Compact antenna test range
- Spherical and cylindrical systems



LEHA-UPM facilities

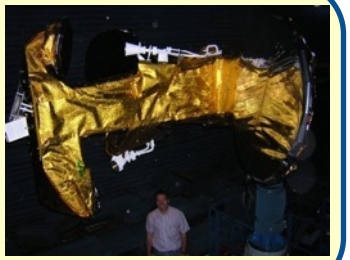
New Multiprobe Antenna Measurement System for 5G antennas (available soon)

- **Measurements of Passive Antennas from 650 MHz to 18 GHz.**
- **OTA Measurements of 5G antennas**
- **Maximum size of AUT: 45 cm**
- **Passive and active antennas measurement parameters.**

Antenna Measurement Services

Satellite antenna measurement for EADS-CASA, RYMSA, TTI:

- ✓ Hispasat A, Hispasat Amazonas, 1E
- ✓ASAR panels for Envisat, ASTRA 3B
- ✓Antennas for Venus and Mars Express, Solar Orbiter, Bepi Colombo, Juice …



Cellular Telephony Systems:

- ✓Homologation of Telefónica Móviles antennas and radome structures.
- ✓Measurement of Vodafone Global BTS antennas.

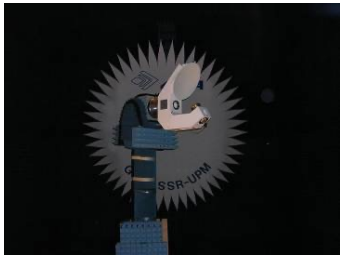
- ✓ Measurement of Earth stations for satellite communications.
- ✓ Measurement of RADAR systems
- ✓ RCS measurements
- ✓ Radome measurements

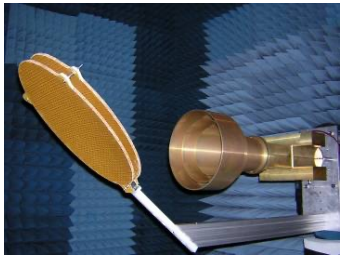
ENAC ENSAYO ISO 17025 Nº844 / LE1576

POLITÉCNICA

rla red de laboratorios Sistema madrid Nº Registro: 33

- Working on Antenna Measurement Systems since 1980's.
- ISO 17025 Accreditation



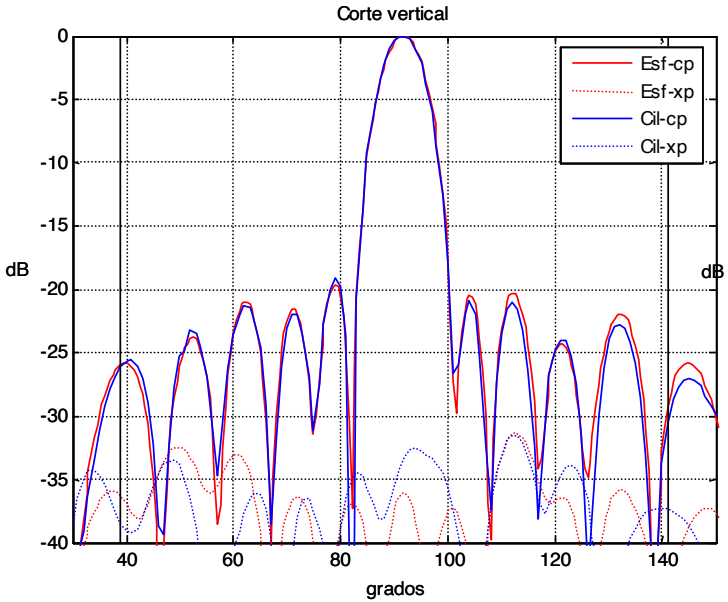


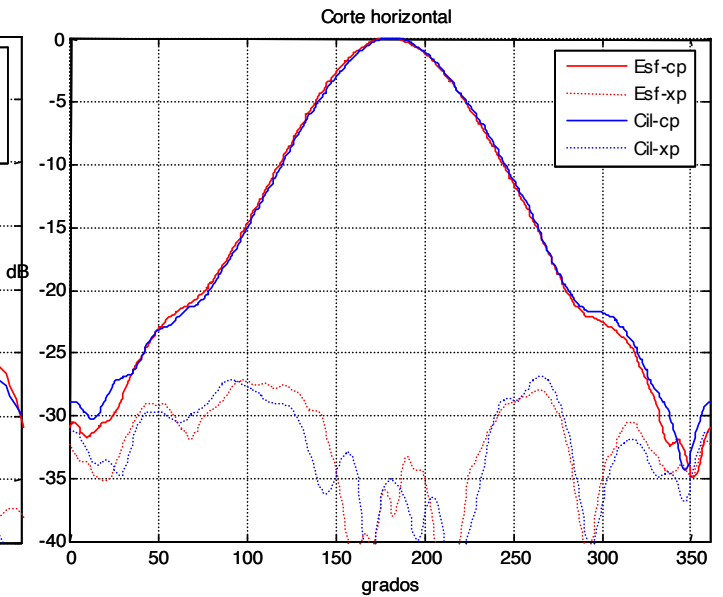
Laboratorio de Ensayo y Homologación de Antenas

Intercomparison: CNF - SNF

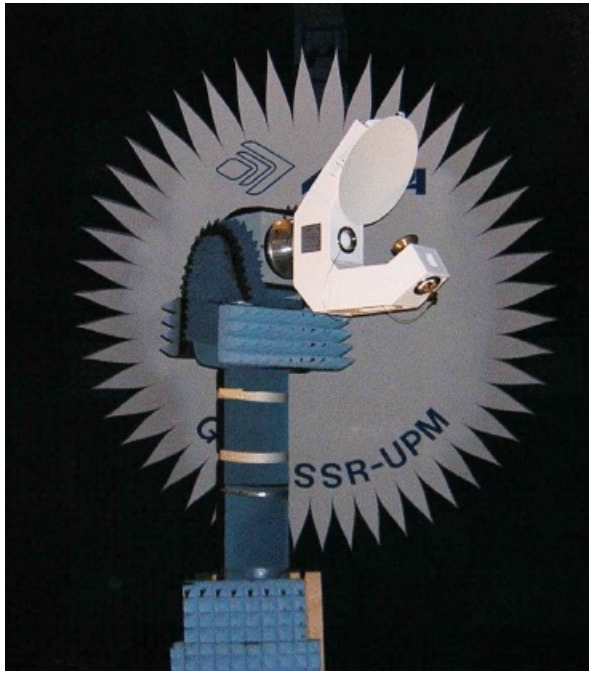
Intercomparison of measurements performed in spherical system (using SNIFTD) and cylindrical system at LEHA-UPM**:**

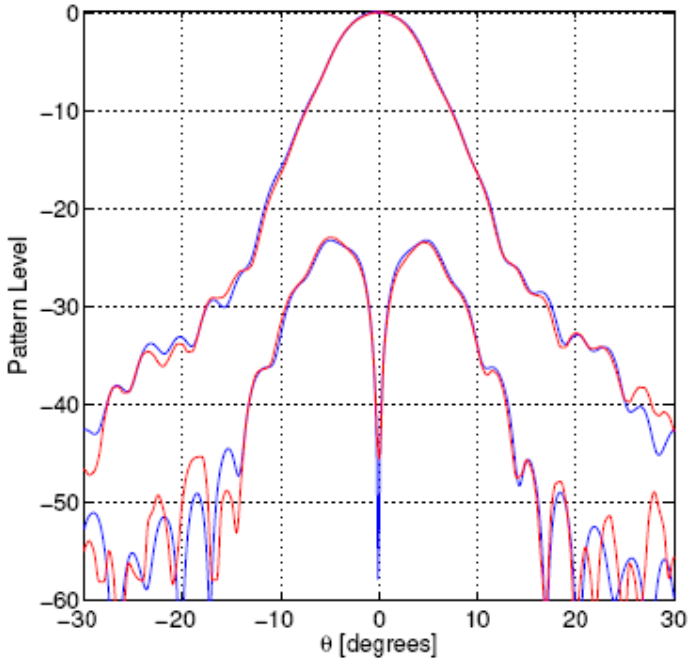
UMTS antenna
(1920 MHz)





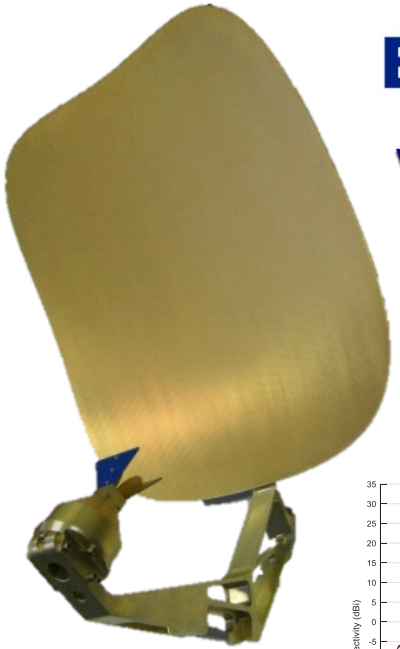
Intercomparison SNF-CATR





Superposition of radiation antenna patterns for VAST12 antenna: red in CATR-UPM and blue in SNF-UPM

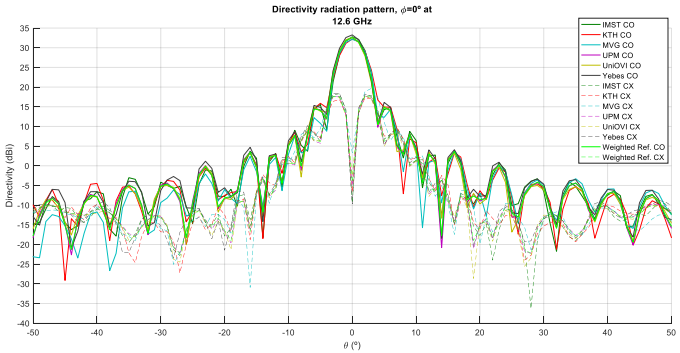
EurAAP Intercomparisons

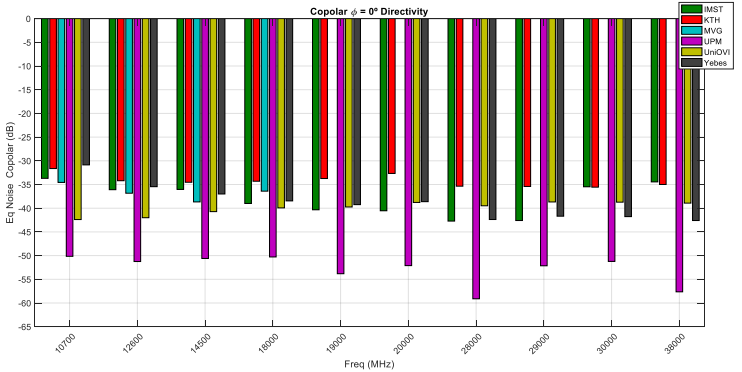


EurAAP

WG Technical Working Groups

- Spherical NF:
  - KTH
  - MVG SG64
  - Oviedo Un.
  - Yebes Observatory
  - UPM
- Far Field :
  - RWTH Aachen
- Cylindrical NF:
  - IMST



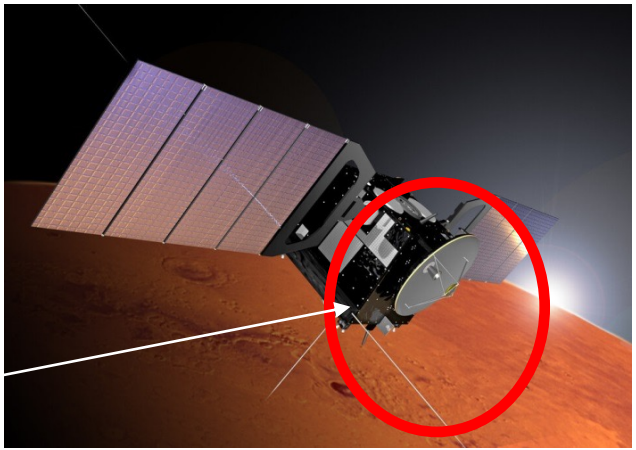


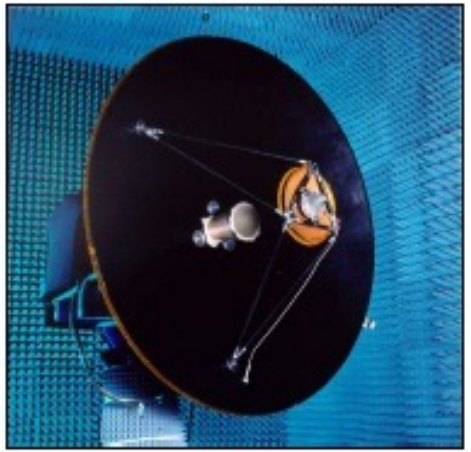
mvg Microwave Vision Group

Space missions: Mars Express

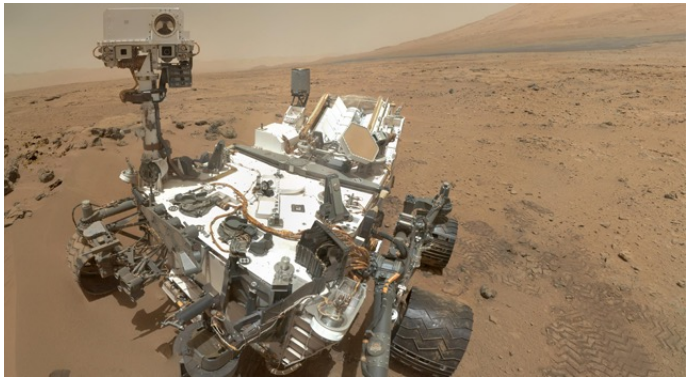
- ESA project for Mars exploration
- Why is there no water on Mars?
- Launched June 2, 2003
- Arrived on Mars on December 25, 2003 after traveling 400 million km

High gain antenna: diameter 1.6 m

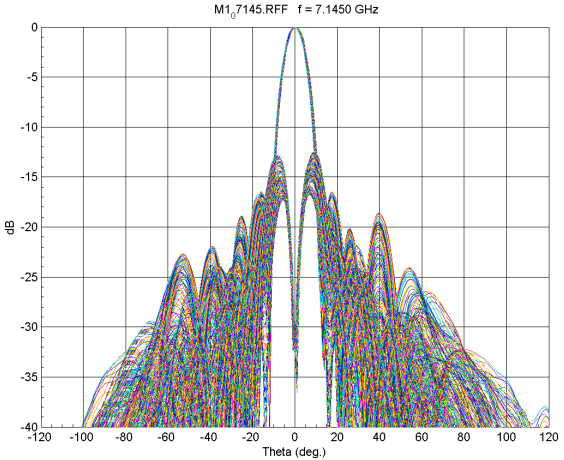


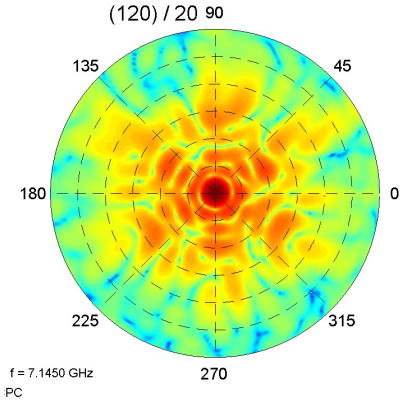


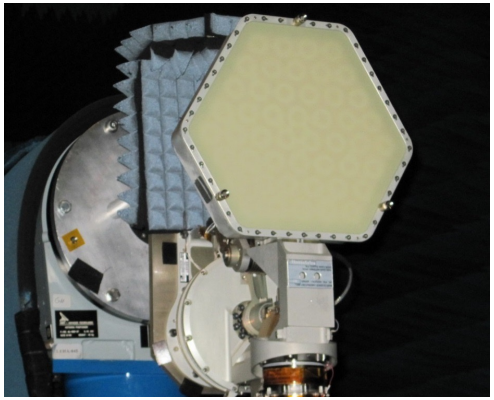
Mars Science Laboratory. Rover



Rover Curiosity High gain antenna

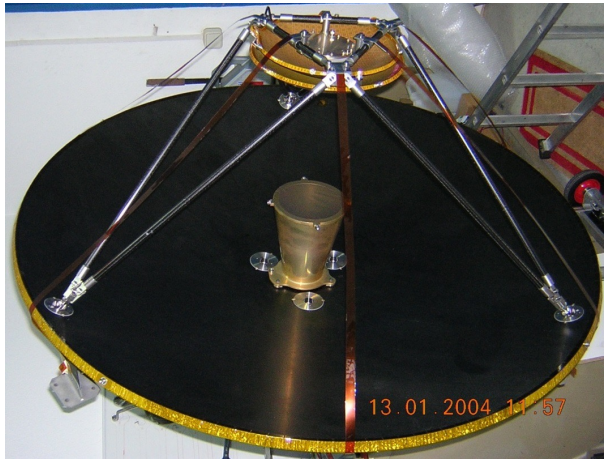


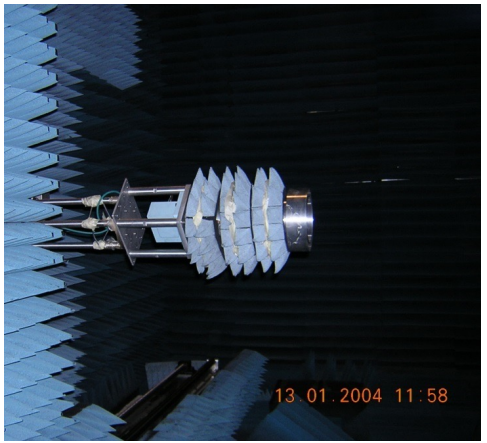




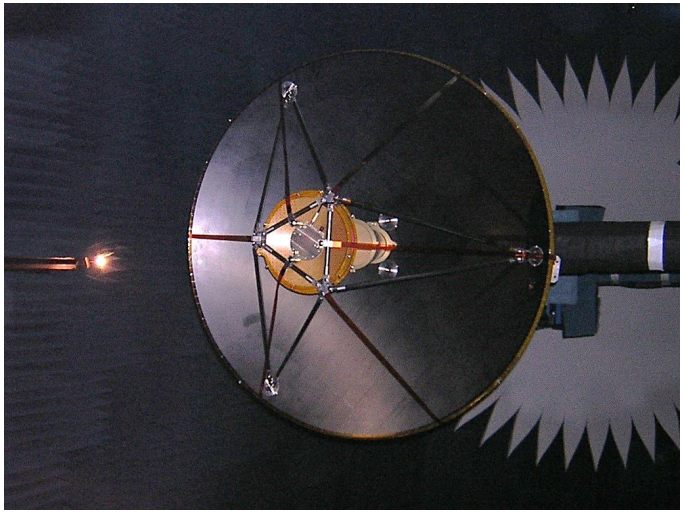
Venus Express

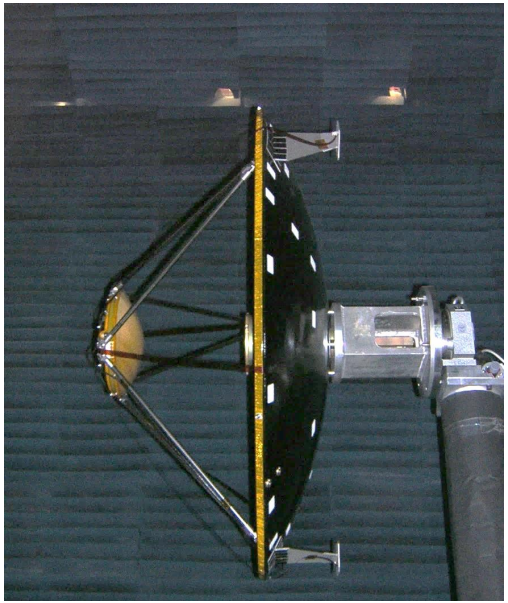
- ESA project to explore Venus
- Study the atmosphere, the plasma medium, the surface of Venus, and surface-atmosphere interactions
- Launched in November 2005
- Arrived at Venus in May 2006



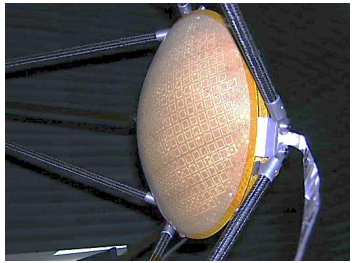


Venus Express. High gain antenna.





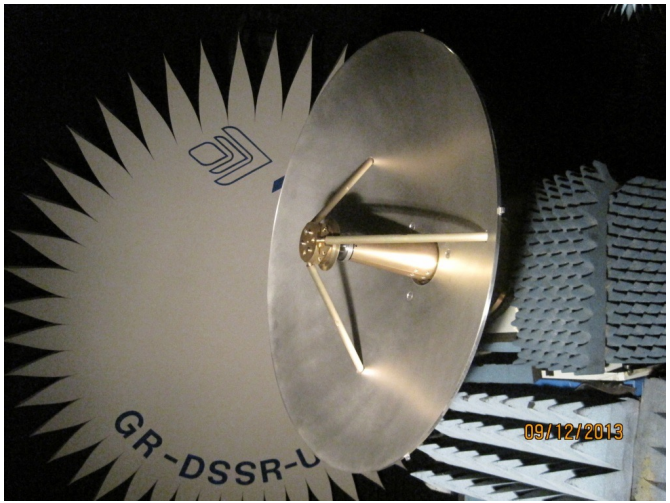
EADS astrium

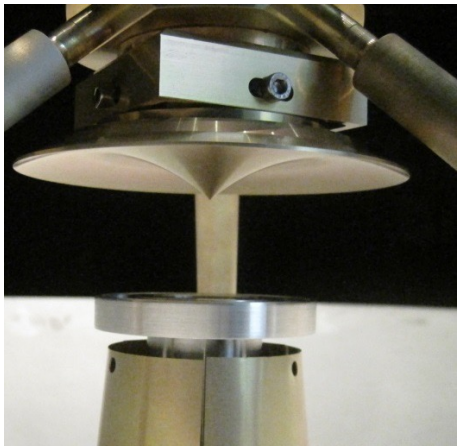


Measurement in the UPM planar system of the high gain antenna

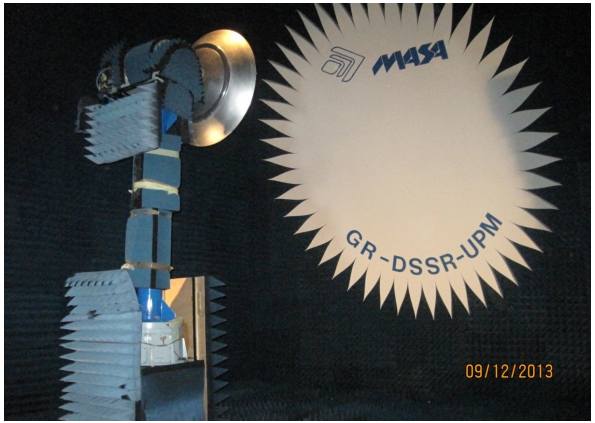
Solar Orbiter

- ESA project for exploration of the sun Its objective is to find out what causes the behavior of the Sun (solar flares, solar wind, plasma, magnetic field,…)
- Launched on February 10, 2020
- Planned until September 2030





Solar Orbiter. Engineering Model

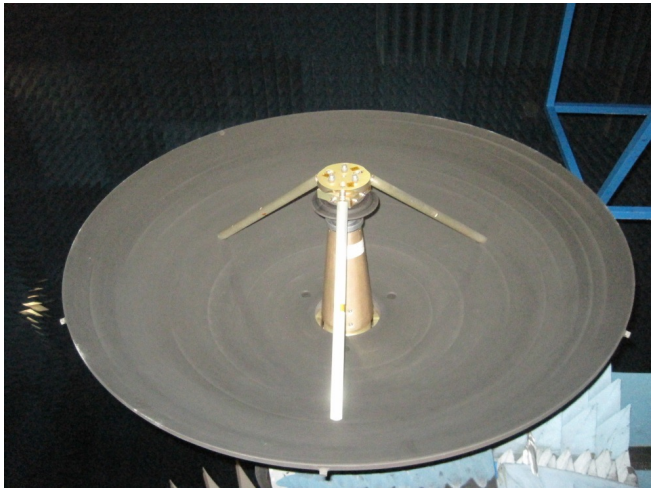


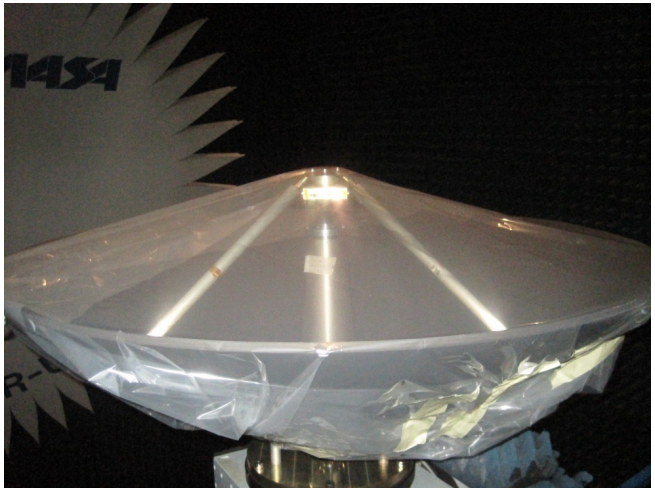
Measurement in the Compact Range

Measurement in the planar system

Measurement in the spherical system

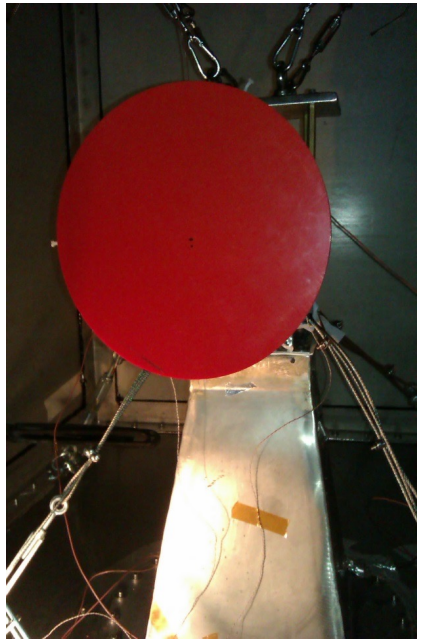
Solar Orbiter. Flight model





Measurement in the Compact Range

ESA to Mercure: BepiColombo



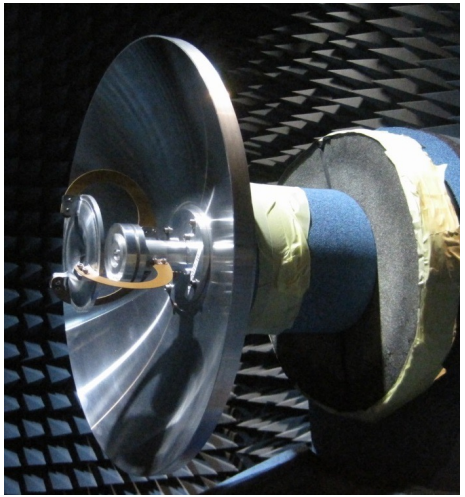
Medium gain antenna

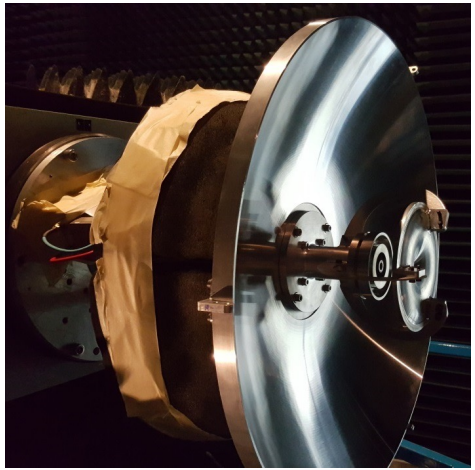
Boom

Sarcophagus

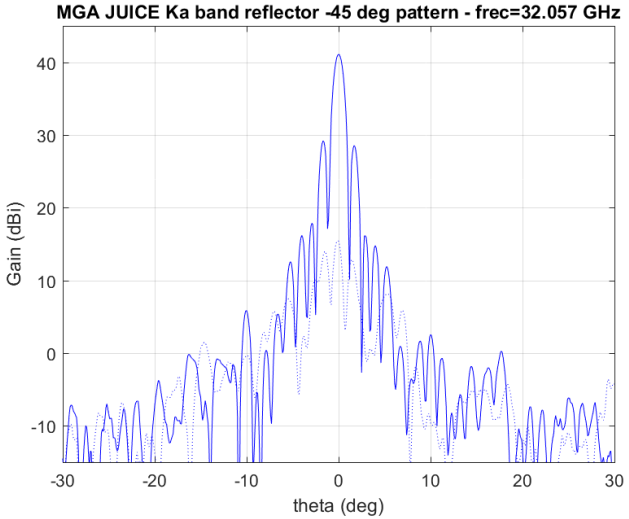
JUICE. Engineering model

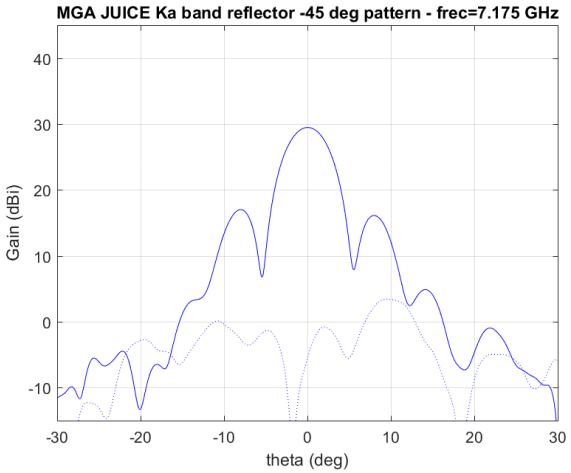
- ESA mission to study Jupiter and its moons (Ganymede, Europa and Callisto) (excluding Io because it is too volcanically active.
- Launched recently in 2023.

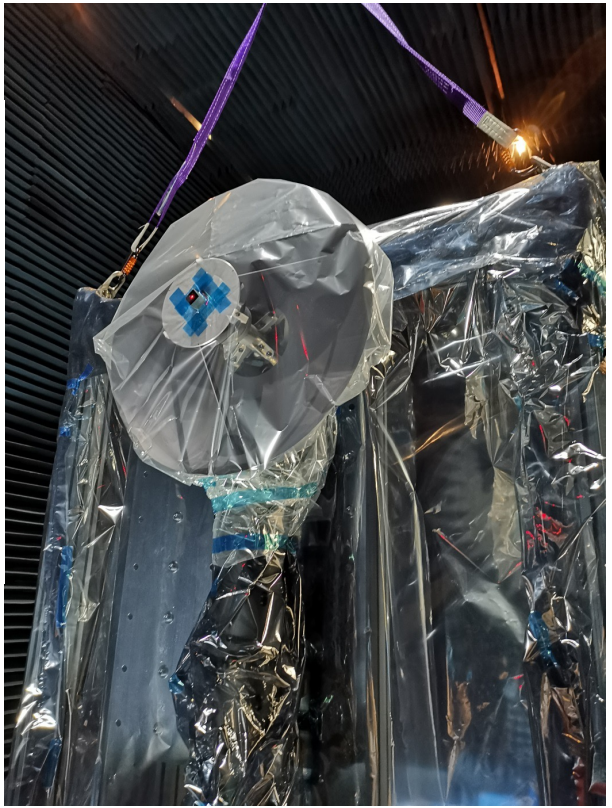




JUICE. Flight Model







L-band RADAR Antenna

Cylindrical near field system for primary and secondary radar antennas.

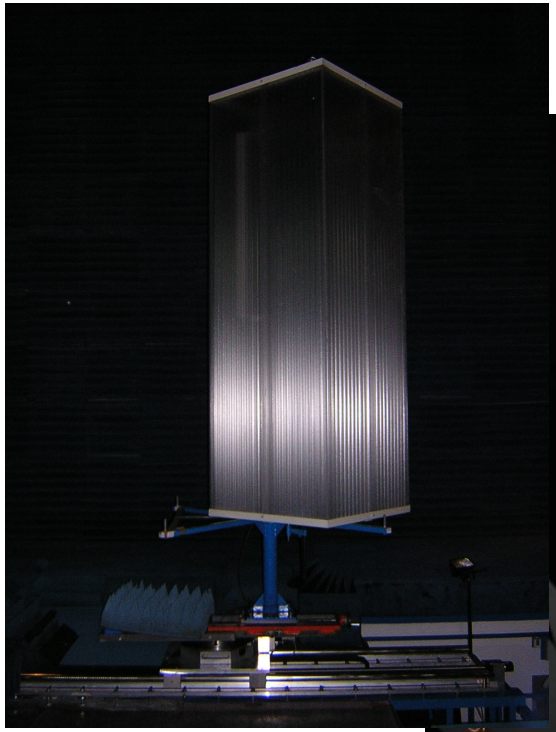
17.5 m of vertical tower

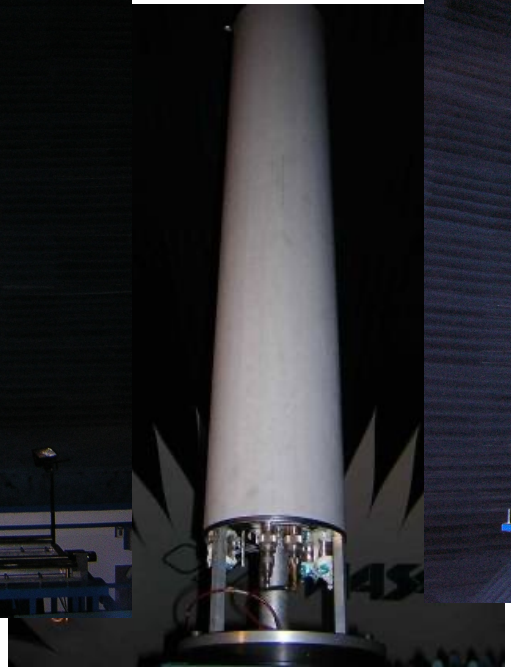
System developed for
Spanish Defence Ministry under INDRA contract

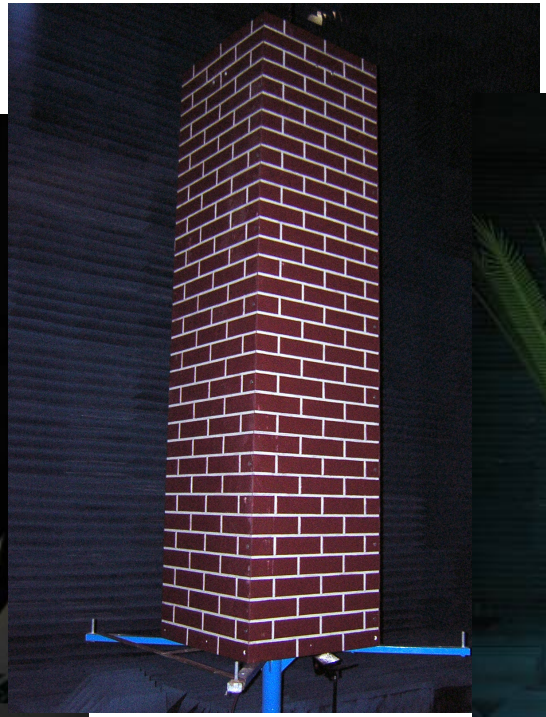
RADAR Antenna Measurements

RADAR array antennas in L and X Band for F110

Measurement of Radomes







Challenges in Antenna Measurements

Antenna Technology is changing very quickly, demanding new challenges for measurement engineers.

Very large antennas

Outdoor systems: reduction of spurious signals

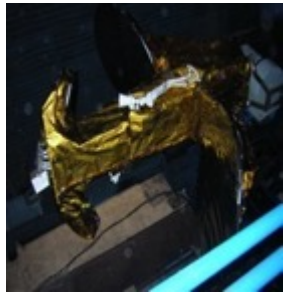
Active antennas / commodity antennas

Reduction of measurement time

Towards Submillimeter wave antennas

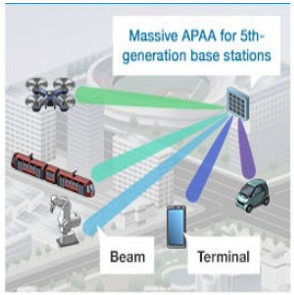
Low power and poor dynamic range

Space and Defense applications



Always requiring extremely high precision

SMART antennas and Massive MIMO

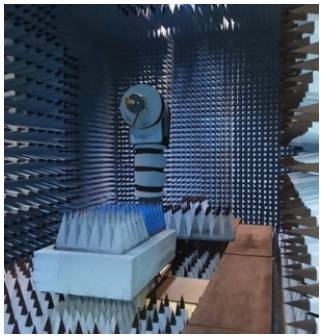


Over-the-air measurements

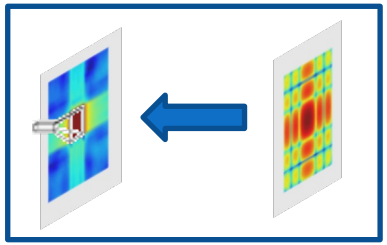
Techniques investigated at UPM

We would like to measure the radiation pattern instantly, with perfect resolution, and with non-invasive methods. We cannot do today, but until we get it, we are working in:

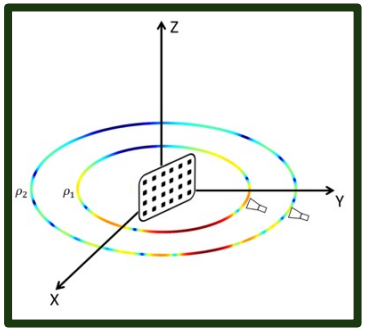
Time Reduction using improved Near to Far Field Transformations



Improve accuracy through Post Processing Techniques



Avoiding phase measurements (phaseless / reference less)



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