Genesis Science Workshop

3rd -4th April 2025

Matera, Italy

Genesis Industrial Update

OHB-I and Antwerp Space

OHB Italia and AntwerpSpace, April the 03rd – 04th 2025, Matera

OHB ITALIA

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SPACE SYSTEMS

GENESIS SCIENCE WORKSHOP 2025

GEN-PRES-OHI-SYS-0010

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- Satellite Configuration
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- Payload Configuration
- Payload Instruments:
  - VLBI
  - GNSS
  - LRR
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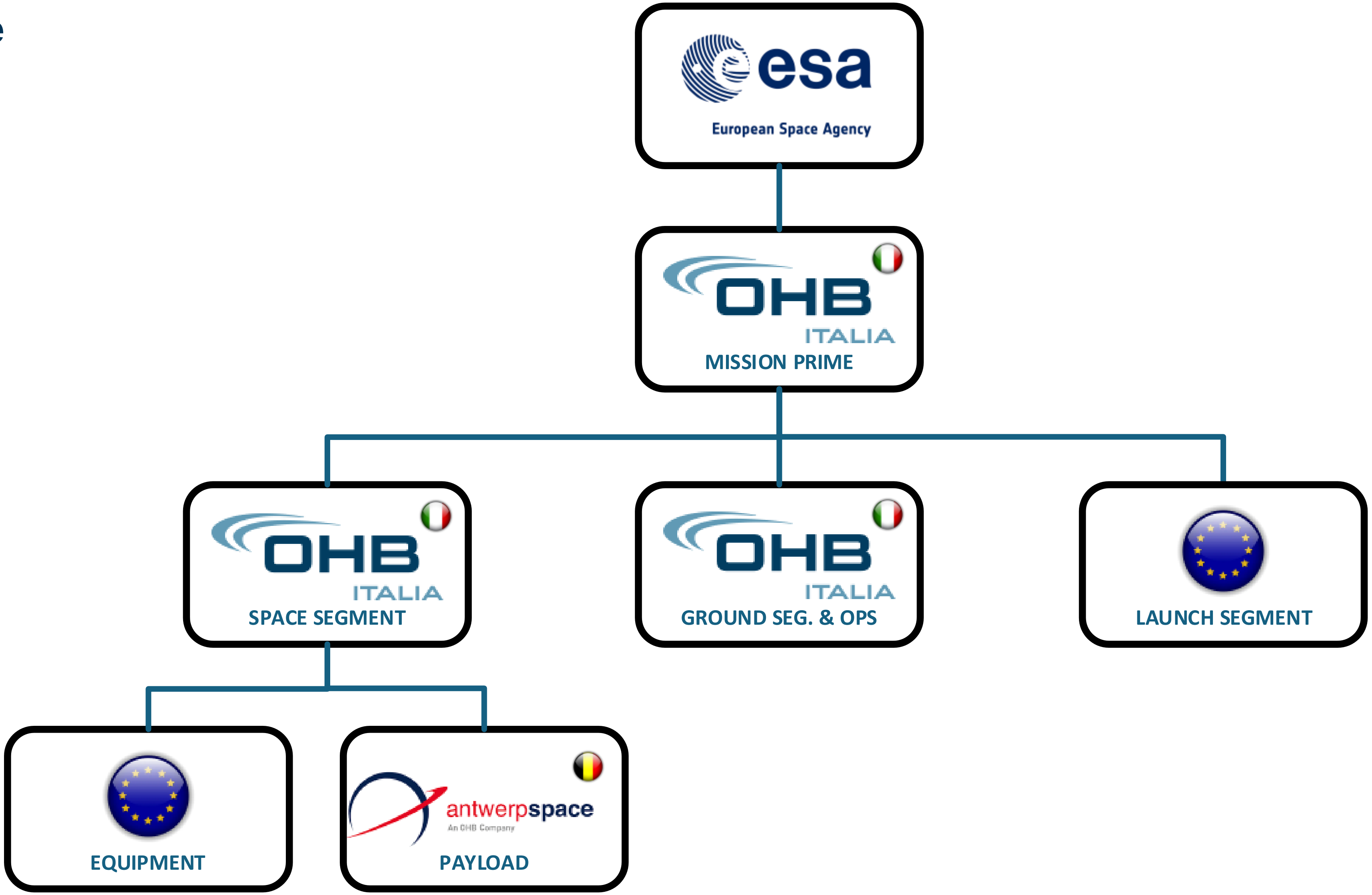
- Calibration Plan / Process

Industrial Structure



GENESIS System Architecture

❑ **Space Segment:**

One Satellite embarking 4 Geodetic Payloads:

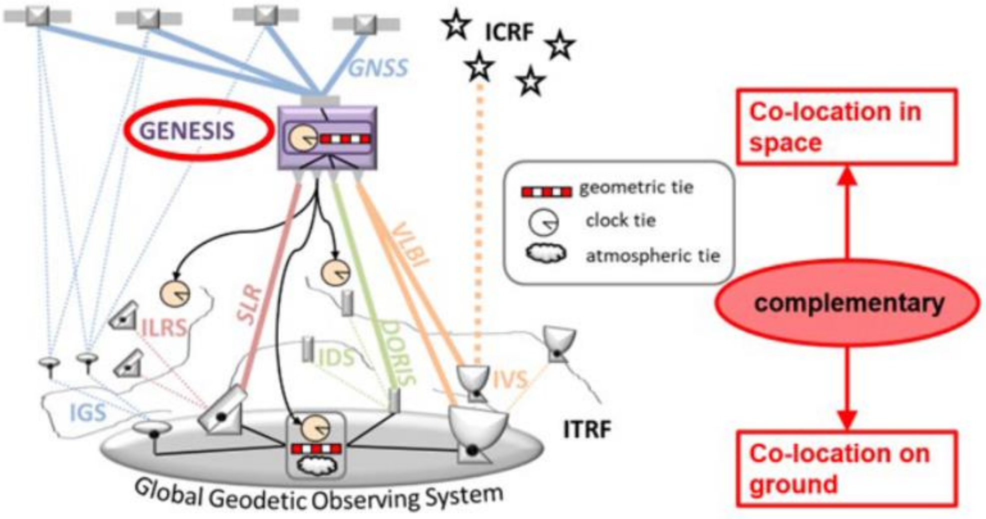
- Very-Long Baseline Interferometry (VLBI) - **TX**
- Global Navigation Satellite system (GNSS) - **RX**
- Satellite Laser Ranging (SLR) - **Passive**
- Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS) – **RX**

❑ **Ground Segment:**

- 1 Ground Station (G/S) for Nominal Ops (Polar):
  - Avg of 6 orbit per day; 1 pass/orbit
  - Pass duration: ~ 30-40 [min] (TBC)
  - Total HKTM+Science Data: ~ 570 MB/day (incl. margin)
- 1 Additional G/S for LEOP Phases
- 1 Mission Control Centre (OHB-I Rome premises) interfacing with PROAD
- Mission Control Team (OHB-I Staff)

❑ **Launcher:**

- EU Small Launcher Class



GENESIS Reference Orbit	
Semi-major axis	12378 km (h ~6000 km)
Inclination	95.5 deg (TBC)
Orbit period	228 min
Eccentricity	1E-3
Argument of perigee	30 deg
Reference epoch	01 January 2029 00:00.000

Satellite Configuration

Key drivers for the Satellite Configuration Design:

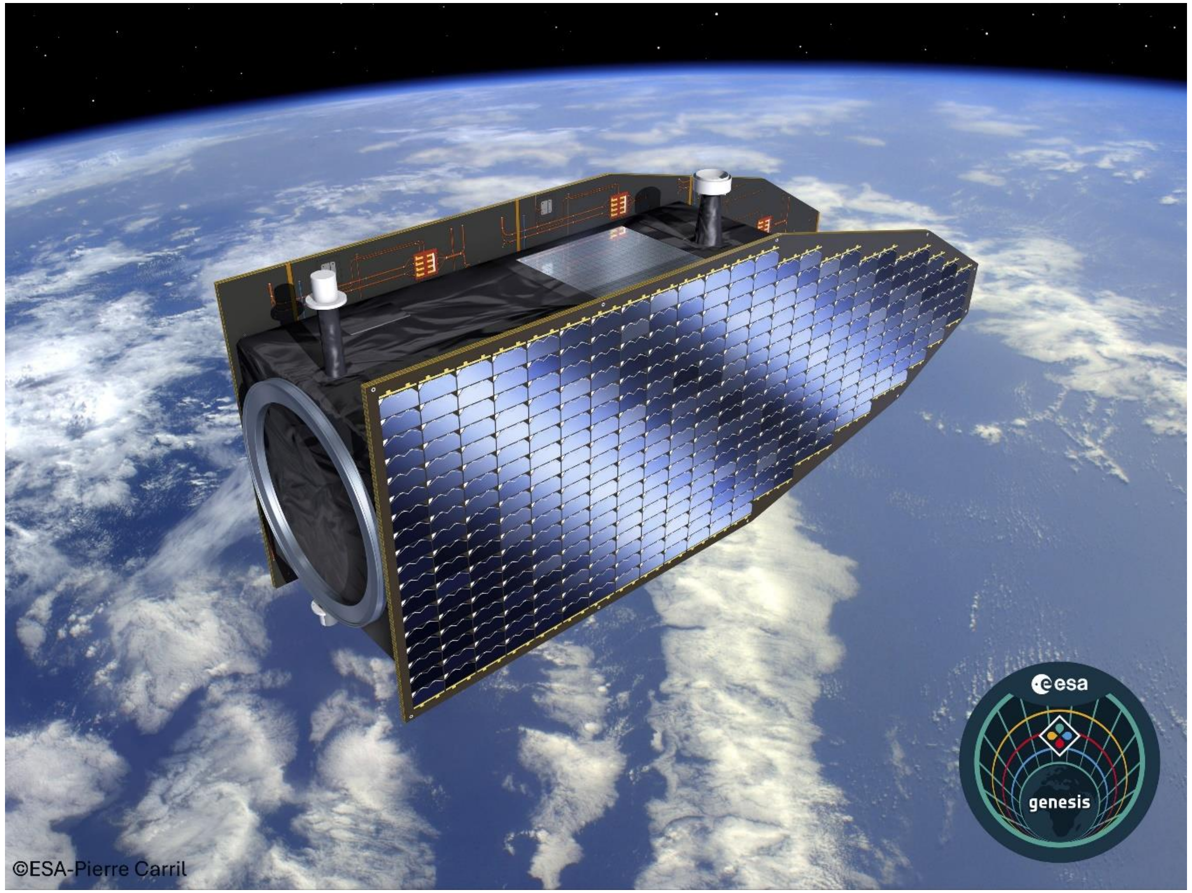
- Small EU Launcher **Fairing size** and **mass injectable in orbit**
- **Radiation Environment** @ 6000 [km] altitude:
    - Total Non-/Ionising Dose (TID, TNID) impacts electronic equipment
    - High structure mass

Current Configuration Design:

- Body mounted Solar array
- 1 or 2 SA panel (with dedicated guidance law)

Payload Accommodation:

- Electronics into satellite body
- 1 Item on Zenit panel: GNSS Ant. 1
- 4 Items on Nadir panel: GNSS Ant. 2, VLBI Ant., SLR, DORIS Ant.



SRR Design

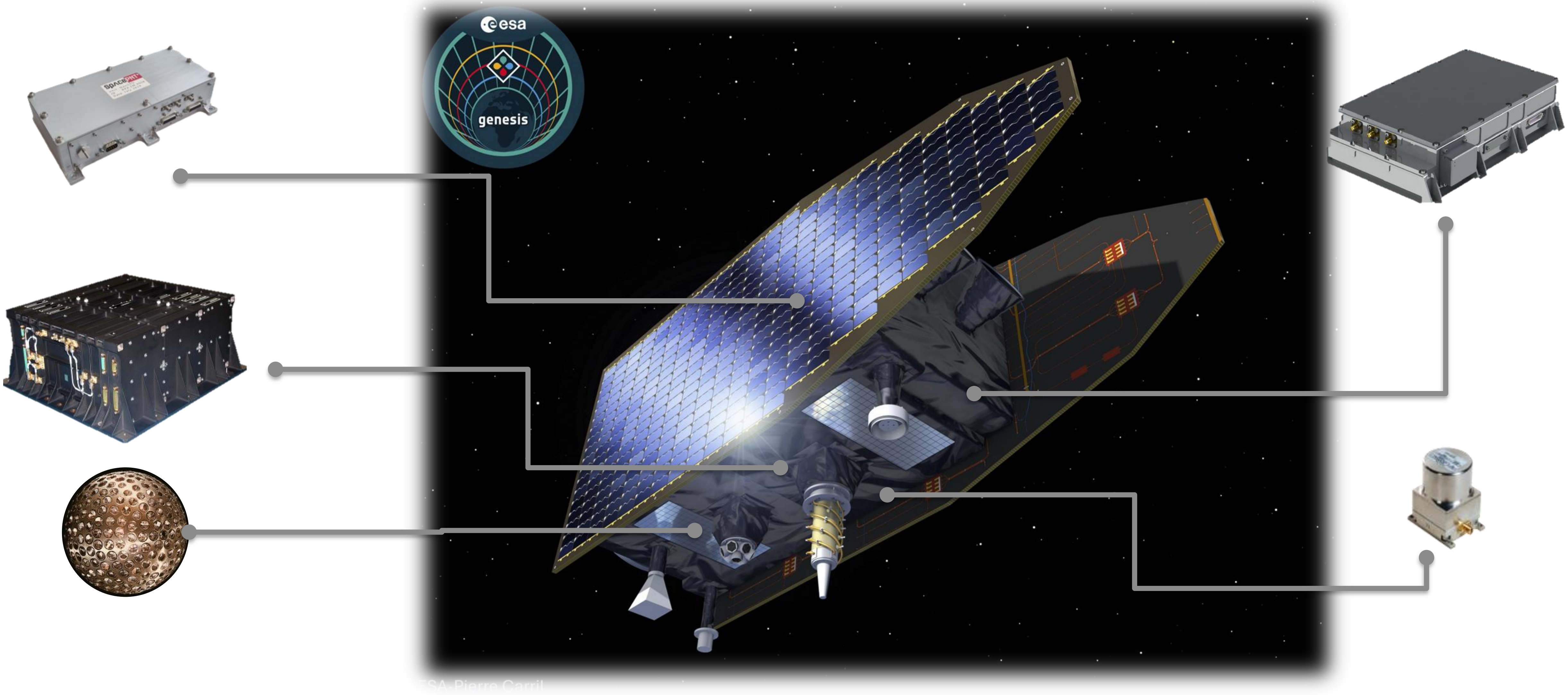
Satellite Main Data

Satellite Platform key facts:

- 3-axis stabilised satellite
- Nadir Pointing attitude
- No propulsion system (to improve CoM stability)
- Science Data Availability: ≥ 95% of the time (avg over year)

SATELLITE PLATFORM CHARACTERISTICS (1/2)	
Subsystem/Unit	**Baseline design**
System	Mass: ~400 Kg Envelope: 1700 x 700 x 2600 mm
EPS	Power consumption: 275 W
	Main bus: 28V unregulated
	Solar array: Fixed solar array. Overall surface 3.34m^2 (TBC)
	Battery: Li-Ion battery. Capacity 36Ah (TBC)
Communication	S-band Downlink datarate: 2 Mbps Uplink datarate: 64 Kbps

SATELLITE PLATFORM CHARACTERISTICS 2/2	
Subsystem/Unit	**Baseline design**
Data Handling	CPU: GR712RC with Dual-Core LEON3-FT SPARC V8 Processor (80 MHz) + RTG4 Companion FPGA
	Memory: 256MB SDRAM plus 128MB EDAC
	Mass memory dimension: ~ 200MB
ACS	**Actuators:** • Reaction wheels: 4 wheels of 1.0 Nms (TBC) and 0.03 Nm (TBC) • Magnetic torquers: 3 MGT of 50 Am2 (TBC) **Sensors:** • Star trackers: 2 cold-redundant units • Magnetometers: 2 redundant units • Sun-Sensors: 12 (TBC) Coarse Sun Sensors **Performance:** Nadir Pointing error accuracy: ≤1 deg (2σ)
Payloads	*Ref to dedicated slides*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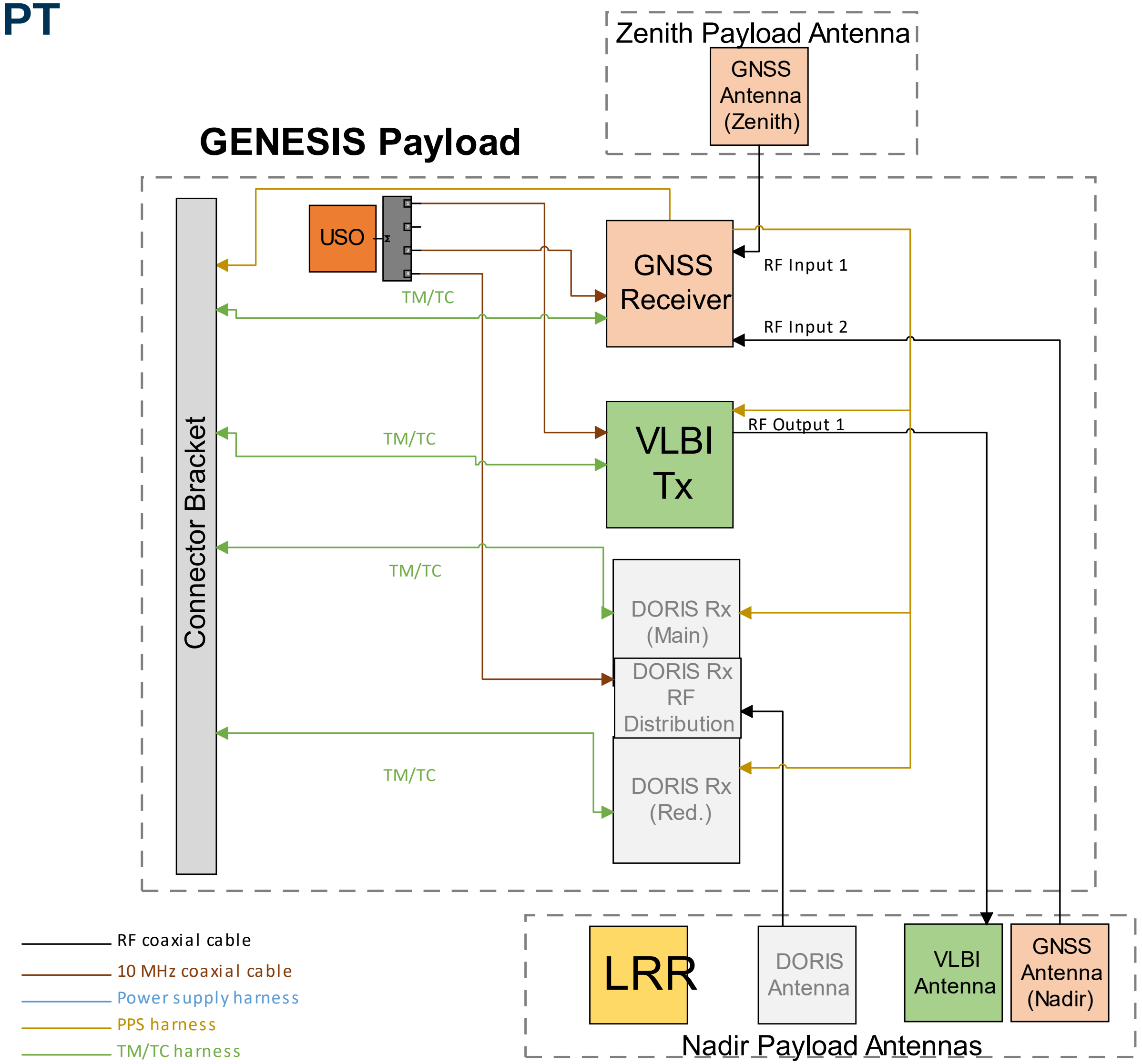
PAYLOAD DRAFT CONCEPT



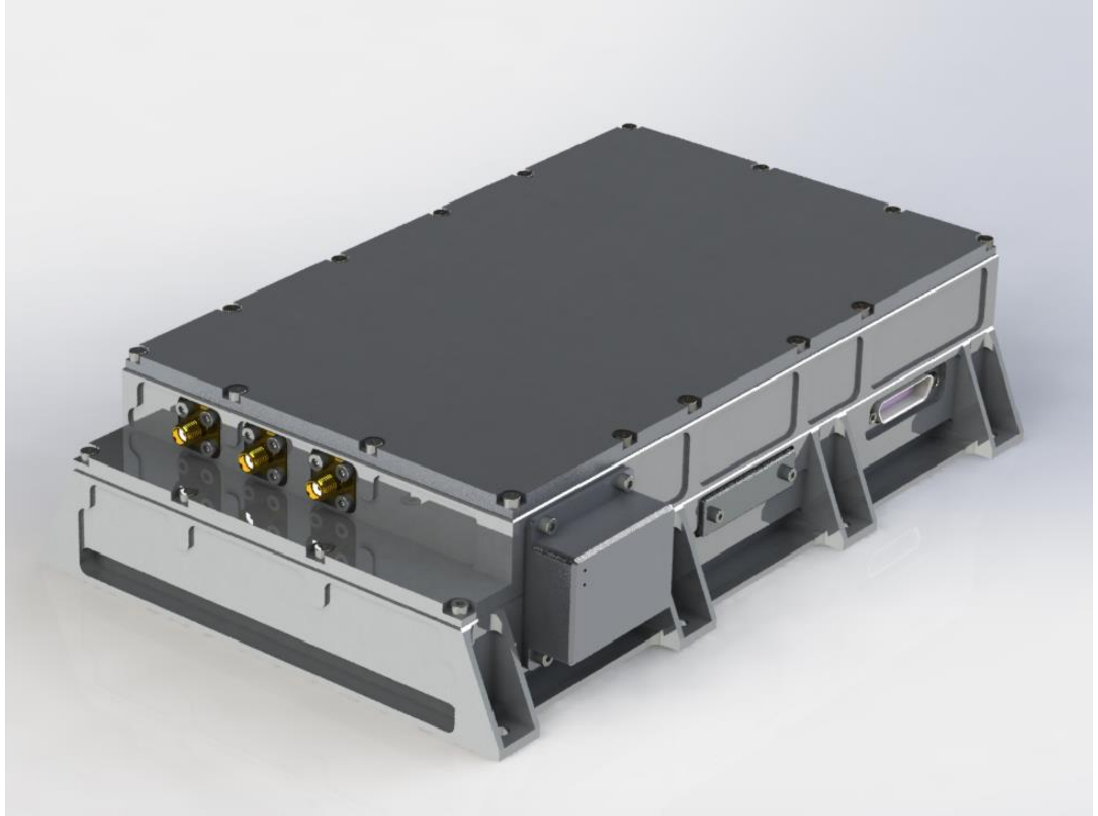
VLBI

- Under development in Antwerp Space and antenna under development at UCL (Université Catholique Louvain Belgium)

- Space geodetic VLBI technique:
  - Conventional “quasar-like” noise emissions in more than 1 GHz of combined bandwidth
  - Spread-spectrum-based time transfer feature

- Supports 4 frequency bands
  - S band at 3.2 GHz
  - C band at 5.41 GHz
  - Low X band at 8.3 GHz
  - High X band at 9.55 GHz

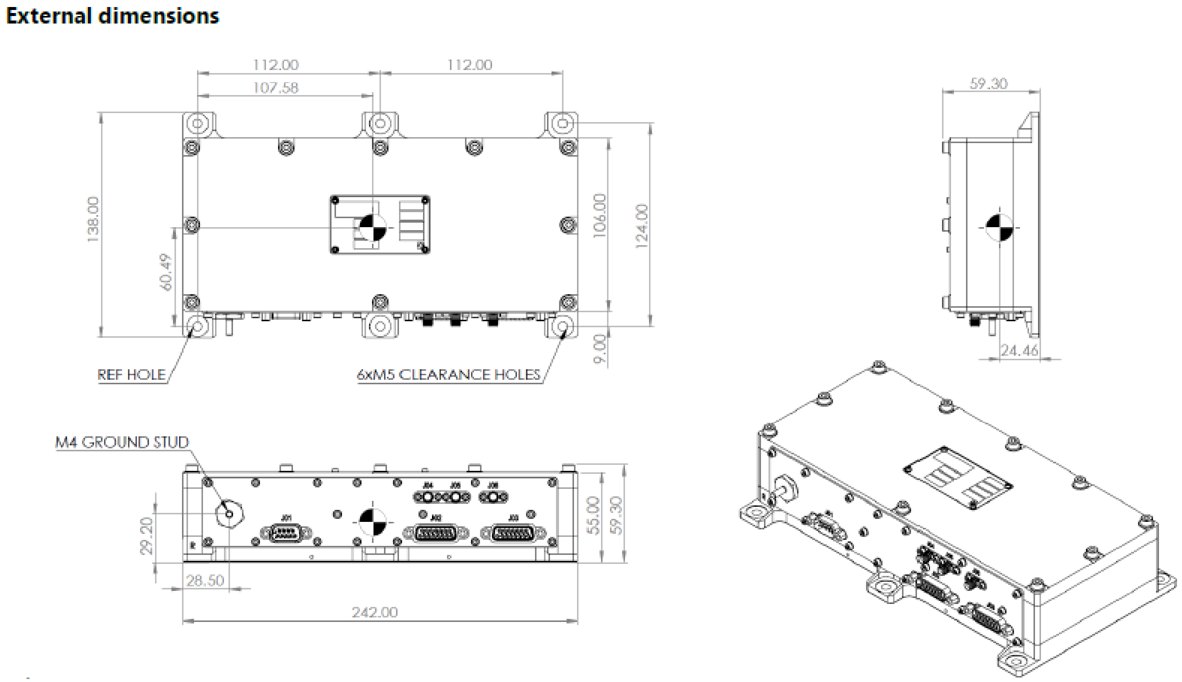
- Low-power emissions (< 10 Jy) with high dynamic range (20 dB)



GNSS Receiver

- **GENESIS mission challenges**
  - GNSS visibility from MEO orbit
  - Super high accuracy for POD post-processing
  - Operation in challenging MEO radiation environment

- **Proposed solution [NaviLEO^{TM}] - Tailored for GENESIS Mission**
  - Dual antennas
  - Triple frequencies
  - External clock input
  - Optimizations for MEO operations
  - Radiation Hardness Assurance to cope with extended mission lifetime



SpacePNT+

USO Technical Overall Structural Description

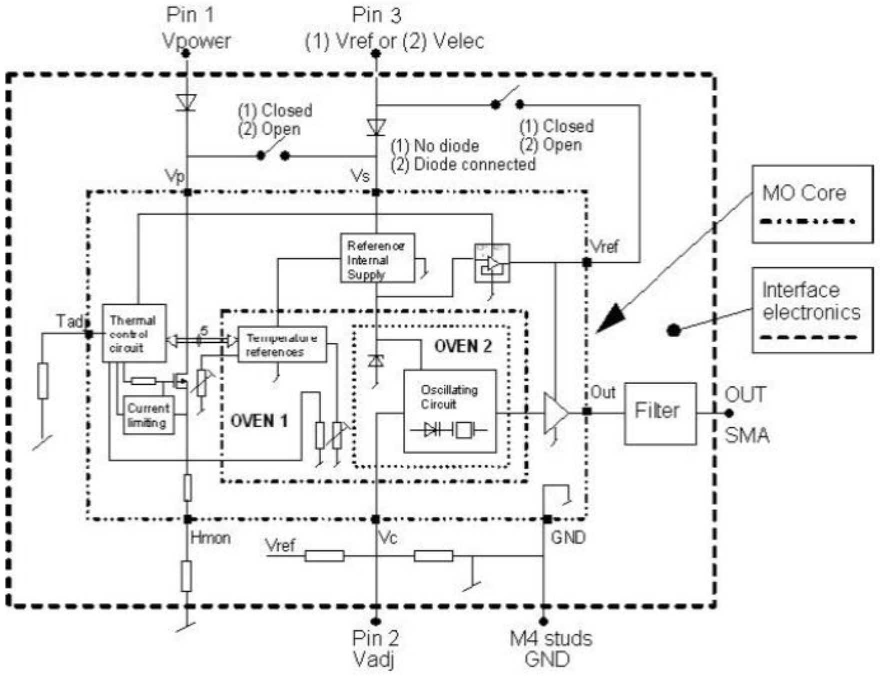
➢ Frequency reference of the payload for synchronization

- Master Oscillator

Space Ultra Stable OCXOs
> 380 Flight Models

- SAT COM
- Earth Observation
- Navigation
- Deep Space

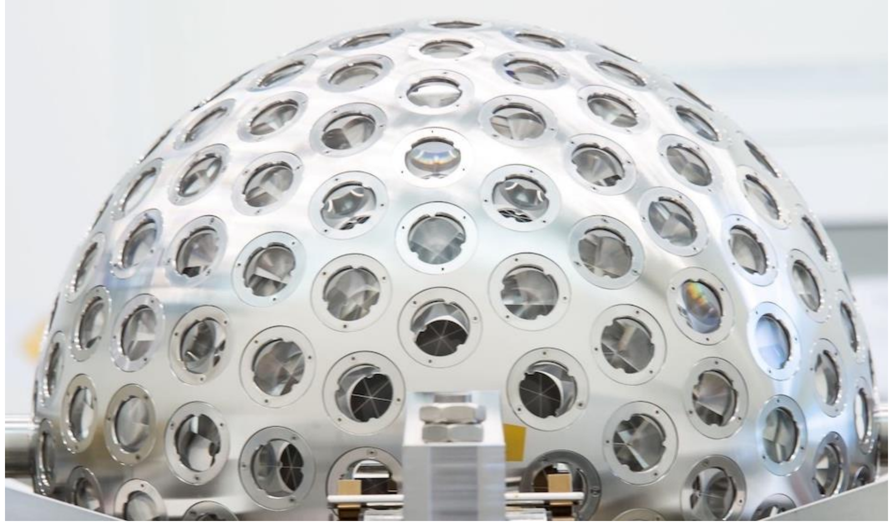
Adaptation for GENESIS Mission:
- Low phase noise (important for GNSS and DORIS
- Stringent ADEV requirements



FUNCTIONAL BLOCK DIAGRAM OF THE MO

TECH	STABILITY	KEY FEATURES	WEIGHT/ consumption	TRL ESA
OCXO 5 to 15MHz MO	<+/-1E-9 (-20° to 60°C) <+/-1E-10/day < 5 E-13 1s to 100s	• LEO/MEO/ GEO programs • Low phase noise (-110 dBC/Hz @1Hz) • High reliability	220 g/ 5W @-20°C	9

LRR Laser Retro-Reflector

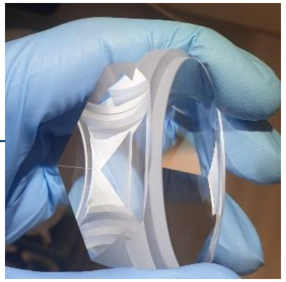


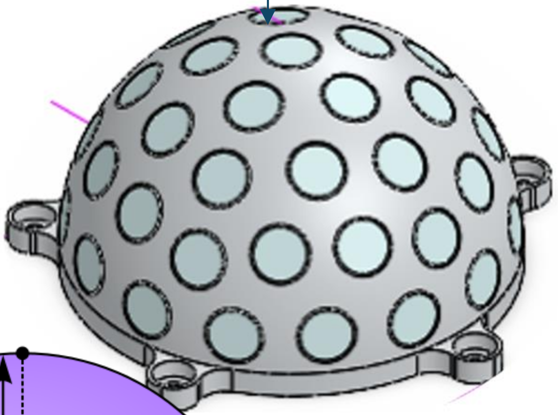
- LRR of many Cube Corner Retroreflectors (CCRs).
- OCS ≥ 6 Msqm
- Mass < 8 kg (with 15% maturity margin for a Category C LRR)
- Volume envelope < 300mm x 300mm x 150mm (h)

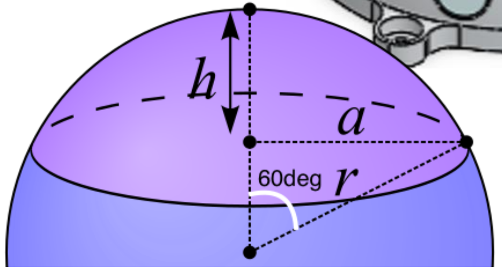
- Ideation design for GENESIS mission LRR

  Geometrical and mechanical scaling from heritage LRR

  (E-GRASP proposal to ESA 2017)
- D(cap) ≃ 335 mm
- N(CCRs) ≃ 385 (127 mm)
- D (LRR) ≃ 370 mm
- h (LRR) ≃ 130 mm (req: 150 mm)
- M (LRR) ≲ 6.7 kg (req: 8 kg).

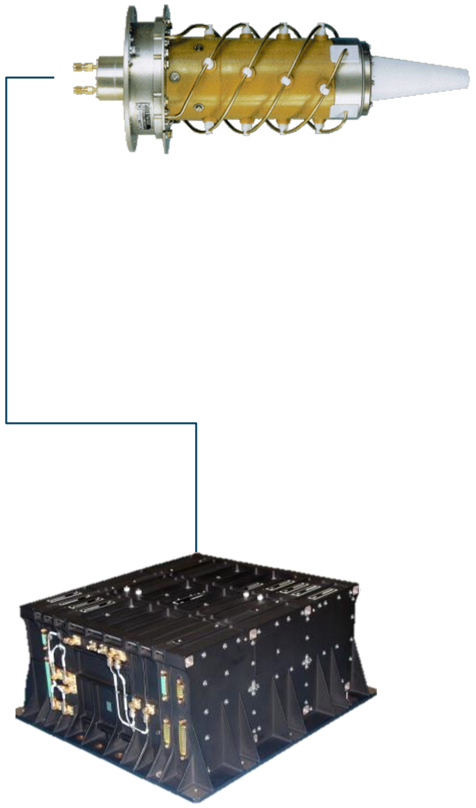






DORIS

The DORIS system (Doppler Orbitography and Radiopositioning Integrated by Satellite), developed by CNES in the 1980s, can pinpoint anywhere on Earth with centimetre accuracy and precisely determine satellite orbits.



DORIS omnidirectional antenna Credit: CNES

Technical Characteristics (when in LEO orbit)
- Orbit Type: Sun-synchronous
- Operation: continuously over full orbit
- Accuracy: Orbit error about 1 cm
- Position Accuracy:
  - Real Time 1 m
  - Resituated 0.05 m radial
- Velocity Accuracy:
  - Real Time < 2.5 mm/s
  - Resituated 0.4 mm/s
- Spatial Resolution: 5 cm in altitude
- Swath Width: FOV: 130 degrees
- Waveband:
  - Doppler Measurement 401.25 MHz
  - Ionospheric Correction 2036.25 MHz
- Data Rate: 16.7 kb/s
- Mass: 91 kg (including ICU)
- Power: 42 W

Mission	Orbit determination and ground positioning with centimetre accuracy, for altimetry, orbit determination and location missions
Domain	Earth observation
First launch	22 January 1990 (on SPOT 2)
Partners	GRGS, IGN
Carriers	SPOT, Envisat, Jason1-2-3, Pleiades, SARAL, CryoSat-2, Sentinel-3A & 3B, Sentinel-6A, HY2A-C-D, SWOT
Lifetime	Indefinite
Status	In operation

PAYLOAD CALIBRATION PLAN/PROCESS

- Calibration and characterizations will be carried out by a combination of tests and analysis on unit and spacecraft level.
  - Tests are done to the furthest extend possible on ground
  - In-orbit calibration plan will be determined at a later stage.
- Measurements Summary:
  - Antenna Gain Pattern
  - Antenna Phase Centre Offset and Phase Center Variation (in relation to the antenna reference point)
  - Antenna + Equipment Group Delay and Group delay Variation
  - Calibration of instruments over temperature
  - Calibration of cable delays over temperature
  - Antenna calibration measurements will be carried out in an anechoic chamber at PFM spacecraft level at ambient temperature.
- Analysis of instrument behaviour
  - Analysis of instrument internal biases over temperature and operational modes
  - LRR laser range correction will be calculated based on the placement and the properties of the corner cube reflectors

SPACE SYSTEMS

Thank you