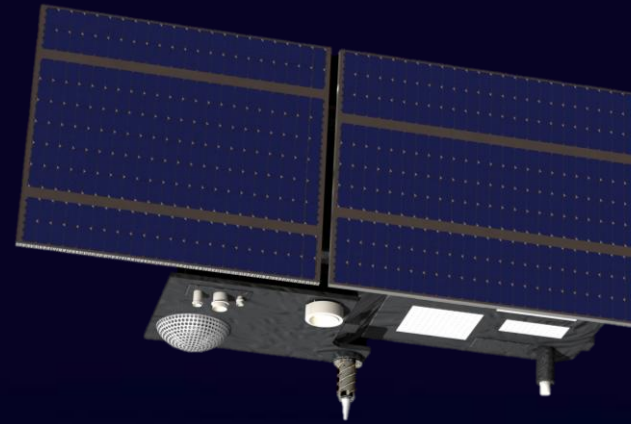




# Genesis: ESA's international geodetic satellite mission

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P.Waller, E.Honoré-Livermore: ESA Directorate of Technology, Engineering and Quality, ESTEC, The Netherlands

E.Schoenemann, J.C.Berton, F.Gini: ESA Directorate of Operations, ESOC, Germany

A.Mancas: ESA Directorate of Science, ESAC, Spain

**XI Hotine-Marussi Symposium. Genova, Italia, 10th September 2026**

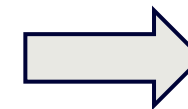
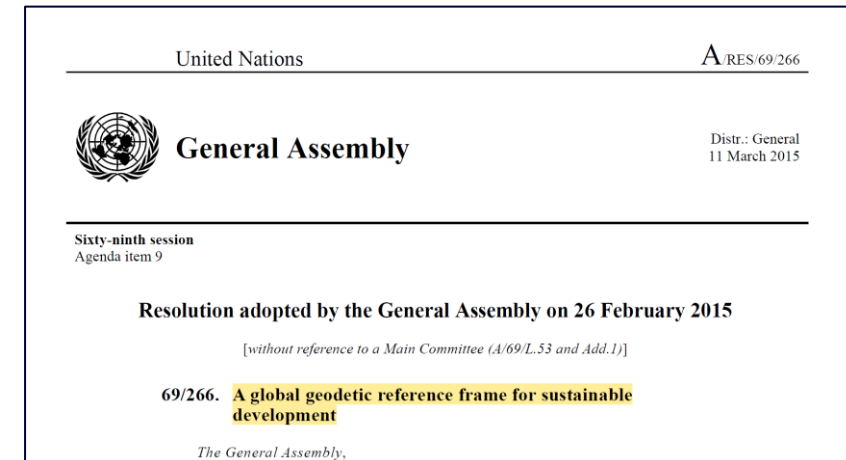
**EUROPEAN SPACE AGENCY**



# Genesis Primary Objectives

**Contribute to improve ITRF accuracy and stability** by providing in-orbit colocation and necessary combined processing for the four space-based geodetic techniques that contribute to its realization. The goal is to contribute to the achievement of the Geodetic Global Observing System (GGOS) objectives for the ITRF realisation, aiming for a parameter **accuracy of 1 mm and a stability of 0.1 mm/year**, in order to provide significant scientific benefits in Earth modelling, and to support a wide range of societal applications (as endorsed by the United Nation resolution A/RES/69/266).

**Contribute to improve the link between the ITRF and the ICRF**, thanks to the increased consistency of the Earth Orientation Parameters (EOP). In particular, this mission shall allow for the first time a link between the orbit reference frame, ITRF and ICRF.



## Targets:

**Accuracy:** 1 mm

**Stability:** 0.1 mm per year



# Overview of the Genesis Mission

## Overview

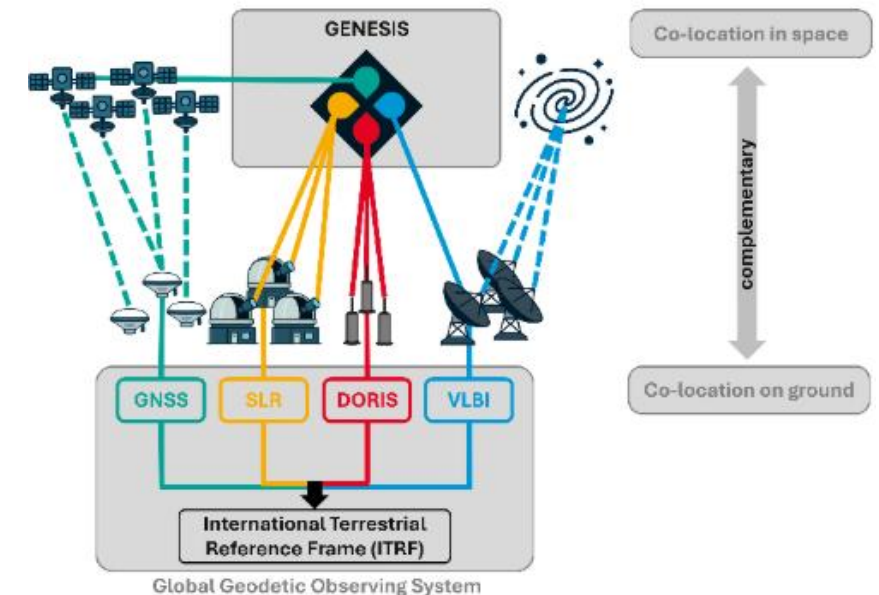
- **Genesis** is a **satellite mission** managed by the ESA Resilience, Navigation and Connectivity (RNC) Directorate and part of its **RNC Projects Department**

## Mission scope

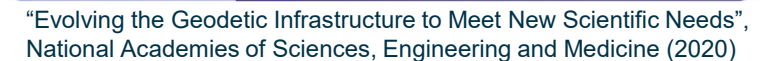
- Design, development, qualification and calibration of the **satellite (incl. payloads) and ground segment**
- **Launch and early operations** including commissioning and calibration
- **Operations** (2 years, option for extension)
- **Data exploitation** (Including processing, archiving and data distribution from ESA facilities → input to the Scientific Community)
- Key involvement of the **Scientific Community** and **International Geodetic Services** → maximize benefits



For the first time:  
**Co-location in space of the 4 space-based geodetic techniques**

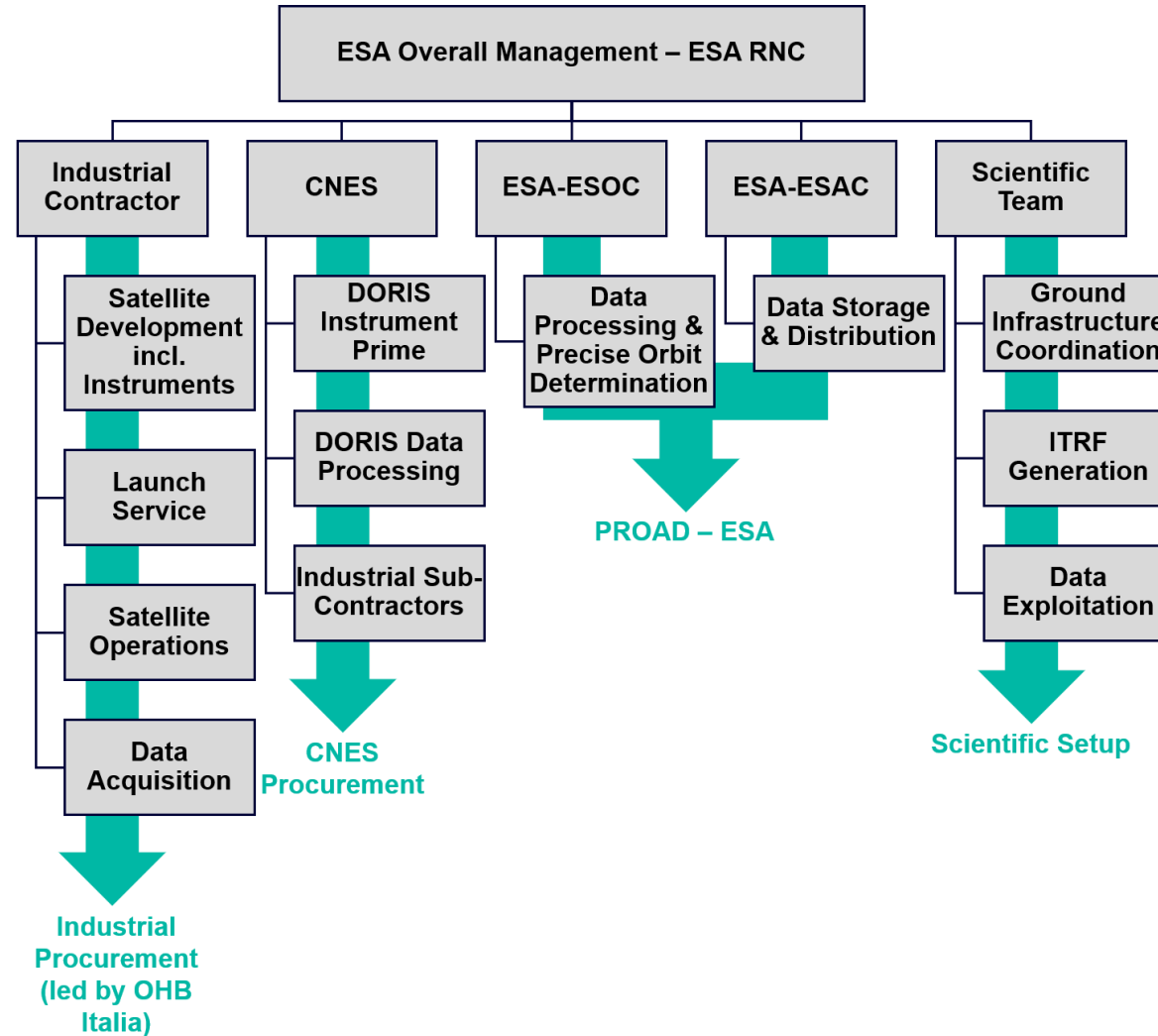


# Geodesy, Reference Frames

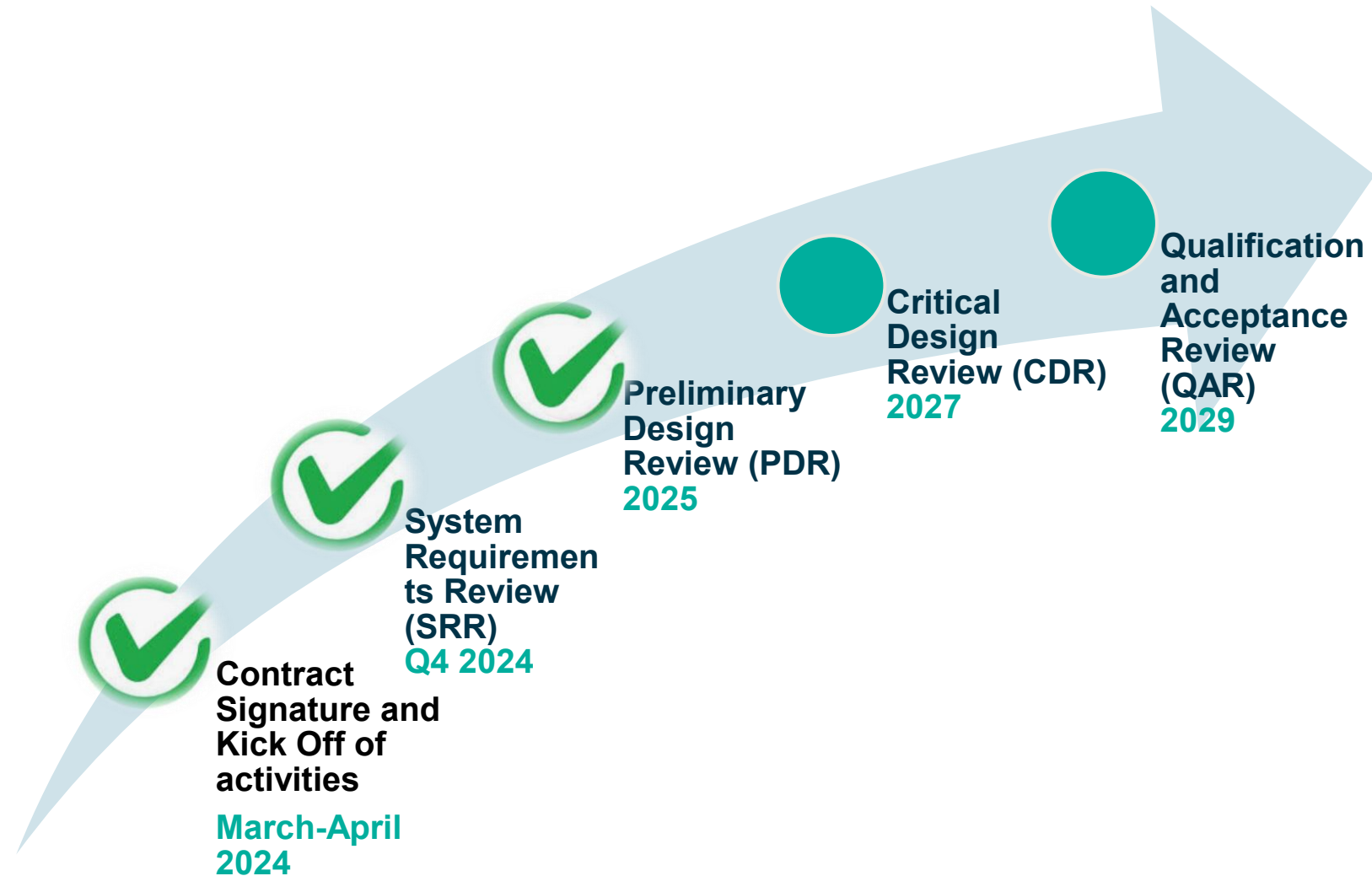




# Structure of the Genesis Mission



# Genesis Mission Timeline



## LAUNCH 2029

2 years of  
Operations with  
option for extension  
to 5 years

Scientific  
exploitation



# Genesis System: PDR Status

## Satellite

**Orbit:** 6000km altitude (low MEO), 95.5° inclination

**Mass:** 406kg

**Power:** 280W (nominal)

**Envelope:** 1.9m x 1.3m x 3.4m

**Attitude:** 3-axis stabilised, Nadir pointing, yaw-steering law

**Payload:** GNSS, LRR, DORIS, VLBI Instruments, external USO

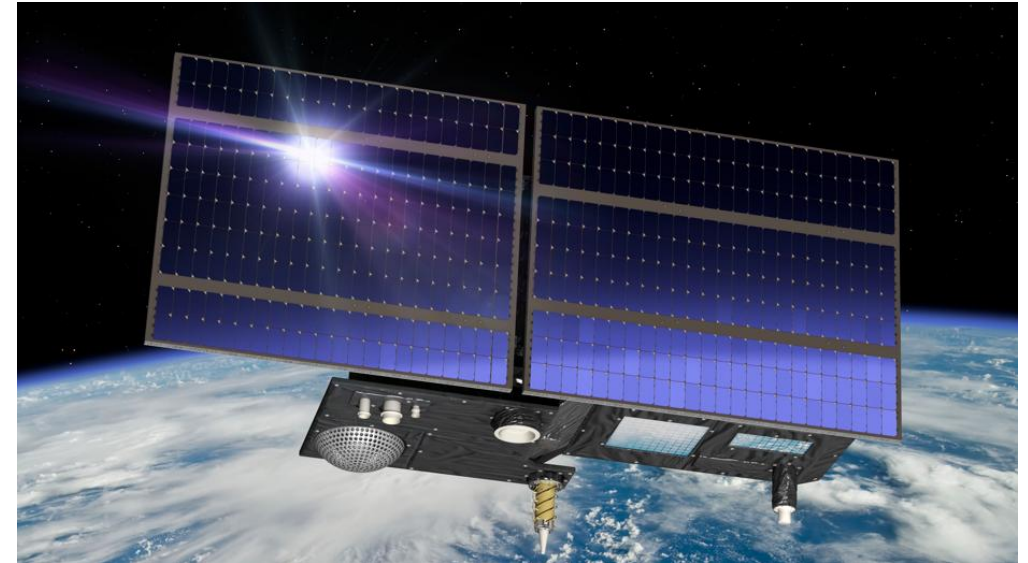
## Ground Segment

**Mission Control Centre, S-band TT&C stations still to be selected**

## Launch and Operation

**Launcher still to be selected**

**Commissioning Phase + 2 years of operations (option for extension)**



ESA Communications, Copyright ESA - D. Ducros



# Genesis Satellite: PDR Status

## Platform Module

Houses platform units and payload electronic boxes

Box-shape Aluminium sandwich panels for radiation shielding

S-band TT&C antennas (elevated on brackets)

Launcher Interface Ring

## Payload Module

Hosts instrument antennas, LRR and 2 star-trackers

Structure in CFRP sandwich panels for low Thermoelastic Distortion

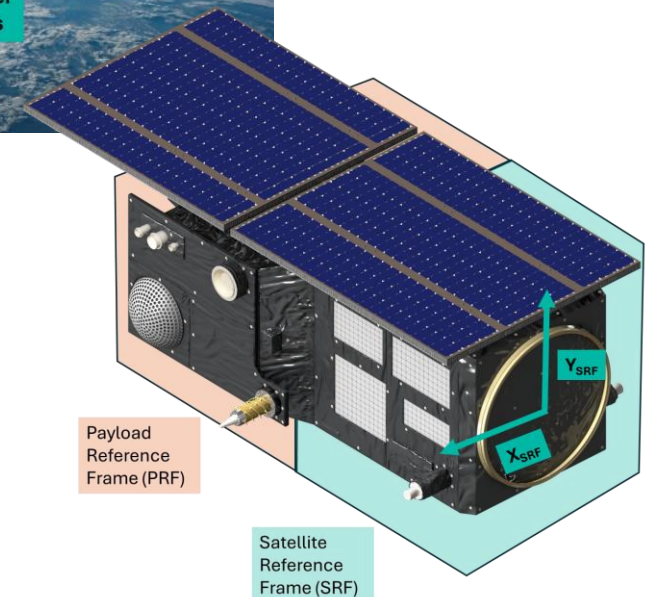
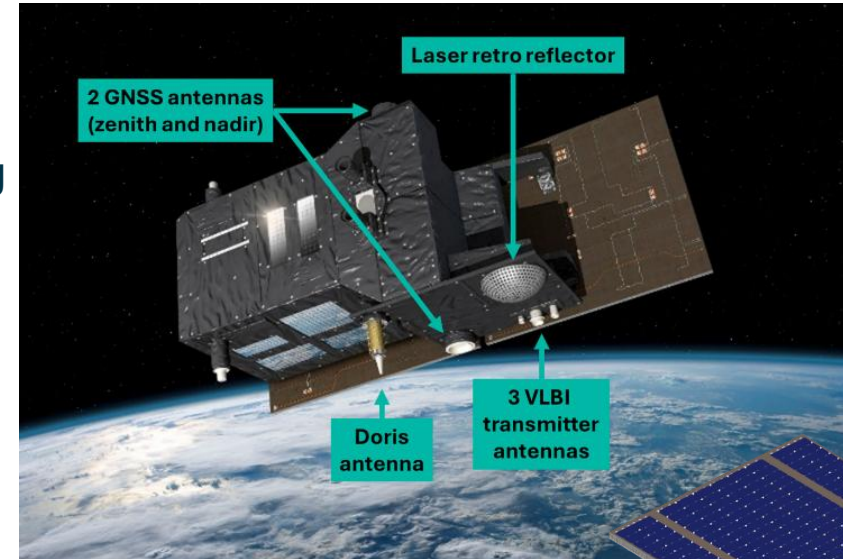
Connected to Platform Module through 4 titanium bipods

## Solar Panels

Two body-mounted, fixed solar panels

One integrated on the platform, the other on the payload modules

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# Genesis Payload



## Four Instruments, tightly tied:

### GNSS



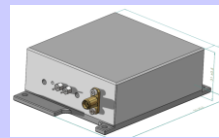
spacePNT+



beyond gravity



### Master USO



SAFRAN



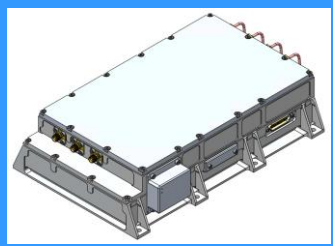
### Laser Retro-Reflector



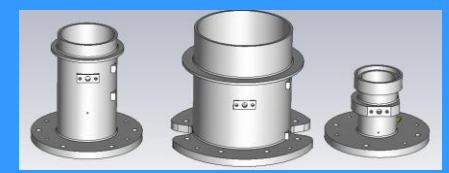
INFN  
Istituto Nazionale di Fisica Nucleare



### VLBI



antwerp space  
An OHB Company



UCLouvain



### DORIS



cnes

THALES





# Genesis Payload

## Four Instruments, tightly tied:

### GNSS

- Galileo E1/E5a, GPS L1/L2/L5
- Nadir + Zenith Antennae
- Tracking optimised for Genesis orbit
- High quality code and phase observables
- *SpacePNT (Rx) and Beyond Gravity (Ant)*

### Laser Retro-Reflector

- Compatible with ILRS stations (532nm)
- Nadir panel
- CCR & geometry optimised for Genesis orbit
- Increased optical cross-section (6Mm2)
- *INFN*

Master USO  
+ Distribution Amplifier  
*Safran Timing Technologies*

### VLBI

- Wideband signals in S, C and X-bands
- Compatible with VGOS stations
- 3 New multiband Tx antennas
- One-way ranging capability
- *AntwerpSpace (Tx) and UCLouvain (Ant)*

### DORIS

- Legacy DGXX-S instrument, UHF/S-band
- Legacy LEO Antenna
- On-board processing tuned for Genesis orbit
- Use of external USO signal
- *CNES/Thales*

# Genesis Preliminary Design Baseline Overview Paper





ESA'S GENESIS MISSION –

**PRELIMINARY DESIGN BASELINE OVERVIEW**

G. Fusco<sup>1</sup>, S. Gidlund<sup>1</sup>, P. Waller<sup>1</sup>, E. Honoré-Livemore<sup>1</sup>, A. Bieringer<sup>1</sup>, E. Schoenemann<sup>1</sup>, J.-C. Berton<sup>1</sup>, F. Gini<sup>1</sup>, A. Mancas<sup>1</sup>

<sup>1</sup> The European Space Agency (ESA)



**Abstract** – Improving the accuracy and long term stability of the International Terrestrial Reference Frame (ITRF) is essential for advancing techniques which rely on measuring Earth, like Navigation and Earth sciences. While there are co-location sites on Earth, which operate all four geodetic space techniques (GNSS, DORIS, SLR, VLBI), they lack global coverage and cannot sufficiently separate technique-specific inconsistencies and biases. The ESA Genesis mission is designed to address this limitation and contribute to the improvement of the ITRF by providing co-location in space with a well-known geometric space-tie between the four instruments. At the System Preliminary Design Review (S-PDR) milestone of the system development, the overall system architecture and payload configuration were assessed for technical completeness, feasibility, and consistency with the mission's scientific requirements.

The results of the S-PDR presented here provide a common and consolidated reference for ongoing scientific preparation and modelling activities. As the mission proceeds through subsequent phases, the consolidated information in this document will continue to evolve, ensuring alignment between system development and the mission's scientific exploitation strategy.

**1. Genesis Mission Overview**

**1.1. Genesis Objectives**

The main objective of the Genesis mission is to contribute to the improvement of the International Terrestrial Reference Frame [1]. The Genesis mission objectives are supporting the goal, as defined by the Global Geodetic Observing Systems (GGOS) of the International Association of Geodesy (IAG), to achieve an International Terrestrial Reference Frame (ITRF) parameter accuracy of 1 mm with a long-term stability of 0.1 mm/year. The importance of a highly accurate, stable and sustainable Global Geodetic Terrestrial Reference Frame has also been recognized by the recently signed Memorandum of Understanding (MMOU) [2] and the United Nations resolution on sustainable development, based on its

major societal benefits, for example in the context of climate change monitoring or GNSS high-accuracy applications [3].

Improvements of the ITRF will immediately impact and improve multiple geodetic and geophysical observables, as well as precise positioning and navigation, and strengthen the geodetic infrastructure, by unveiling and therewith allowing the reduction of systematic biases between the four different geodetic techniques [4].

The second objective of the Genesis mission is to improve the link between the ITRF and the International Celestial Reference Frame (ICRF), which will be achieved thanks to the VLBI payload.

improve ITRF accuracy and stability by monitoring the Earth's rotation and secondary coordinate processing of the four space-based geodetic techniques that contribute to the realization. The goal is to contribute to the achievement of the geodetic goal.

Observing system technical objectives for the mission are:

- provide a parameter accuracy of 1 mm and a stability of 0.1 mm/year, in order to provide a sustainable scientific reference frame for the future.
- support a wide range of geodetic applications (as required by the IAG and IAGG resolution ATC0000000).

improve the link between the ITRF and the ICRF by providing the required accuracy of the Earth Orientation Parameters (EOP) to achieve a link between the two reference frames, and a link between the two reference frames, and a link between the two reference frames.

Figure 1: Genesis Mission Objectives. Image created by the authors.

**1.2. Genesis Project Organisation**

Genesis is a satellite mission managed by the ESA Resilience, Navigation and Connectivity (RNC) Directorate and part of its RNC Projects Department.

The ESA Genesis Project Team manages and coordinates the work of all interfaces between i) the industrial consortium, ii) ESA's data processing, archiving and distribution centre (PROAD), iii) Genesis Scientific Exploitation Team (GSET) for the preparation of scientific exploitation and coherency between the project development and the scientific mission objective. In addition, the scientific community is playing a key role for the data collection within the operational phase of the Genesis project.

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Consolidated description of the Genesis system architecture at System Preliminary Design Review (S-PDR)

Reference for ongoing scientific preparation, modelling activities and community discussions

Available worldwide with a DOI that can be referenced in Genesis-related scientific publications

The paper is available in the [GSSC Archive](#), under the path /satellite/genesis/

DOI TBC

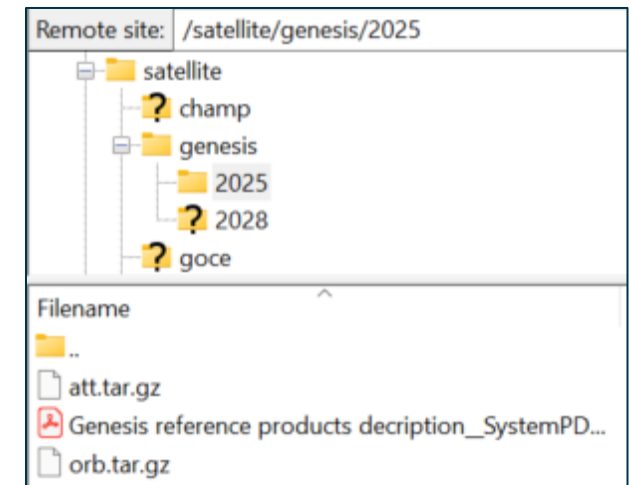
# Genesis Science Data



## Genesis Reference Orbit

- Genesis orbit files for each day of 2025 (365 files) in SP3 format
- Genesis attitude (quaternion) files for each for each day of 2025 (365 files)
- Document containing description of the dynamical models, orbital elements used to generate the orbit, attitude description and ICD

The files have been generated by the ESA Navigation Support Office and published by the GSSC to provide a common baseline for collaborative simulation, analysis and scientific activities related to Genesis.



These files are available in the [GSSC Archive](https://gssc.esa.int/archive/), under the path /satellite/genesis/

<https://doi.org/10.57780/esa-a0p3jgt>



# Genesis Science: GSET and IAG/IERS JWG 1.1.1

## Genesis Science Exploitation Team (GSET) Composition

- Scientists & Experts organised in 5 Working Groups
- All Relevant International Geodetical Services:
  - IAG, IERS, IGS, IVS, ILRS, IDS

## Genesis Science Exploitation Team (GSET) Management Board

- WG chairs, Lead & co-Lead Science Coordinators, ESA
- For coordination of GSET activities

## IAG/IERS JWG 1.1.1 (Chair: J. Boehm)

- Complementary working group under IAG
- Focused on science preparation and execution



**GSET Workshop – Brussels 2026**



**GSET Workshop – Matera 2025**



**GSET Workshop – ESA 2024**



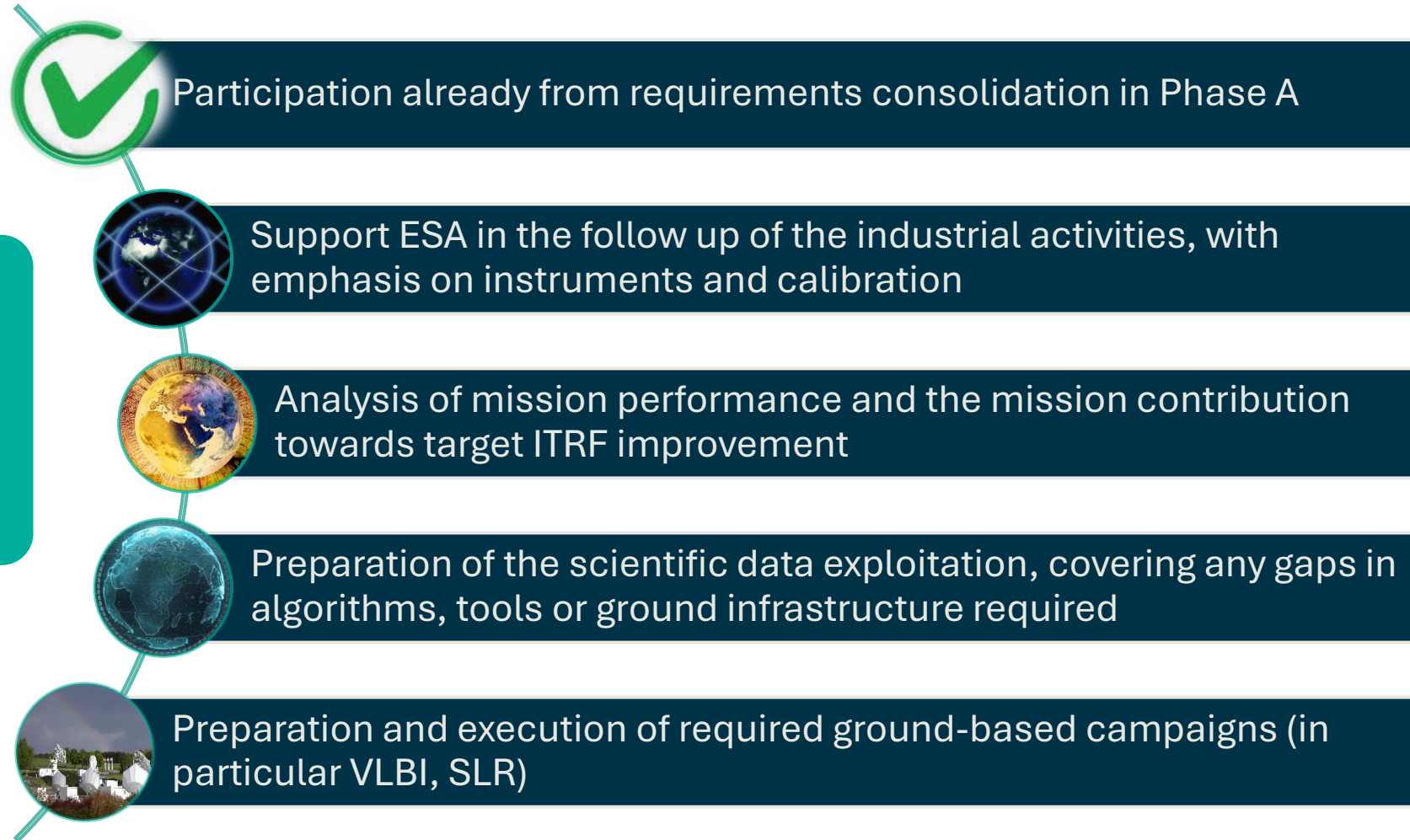
# Genesis Science Exploitation Team (GSET)

|                                                  |                                                                                                                                                                                                           |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Coordinator</b>                               | <b>Özgur Karatekin</b><br>Royal Observatory of Belgium – RoB                                                                                                                                              |
| <b>Co-Coordinator</b>                            | <b>Francesco Vespe</b><br>ASI Space Geodesy Centre at Matera                                                                                                                                              |
| <b>WG1: ITRF &amp; Combination of Techniques</b> | <b>Zuheir Altamimi</b><br>Institut national de l'information géographique et forestière – IGN<br><b>Florian Seitz</b><br>Deutsches Geodätisches Forschungsinstitut-Technischen Universität München – DGFI |
| <b>WG2: GNSS</b>                                 | <b>Rolf Dach</b><br>Universität Bern<br><b>Benjamin Männel</b><br>GFZ Helmholtz Centre for Geosciences                                                                                                    |
| <b>WG3: VLBI</b>                                 | <b>Rüdiger Haas</b><br>Chalmers Tekniska Högskola                                                                                                                                                         |
| <b>WG4: DORIS</b>                                | <b>Guilhem Moreaux</b><br>CLS-Collecte Localisation Satellites                                                                                                                                            |
| <b>WG5: Laser Ranging</b>                        | <b>Clément Courde</b><br>Centre national de la recherche scientifique-Géoazur                                                                                                                             |

# Genesis Science



## Scientific Involvement in the Genesis mission





# Genesis NextGen – Young Scientists Group

A forum to connect, train, and empower early-career geodesists within Genesis.

Informal • Cross Working Group • No age limit • Everyone who feels young

1

## Strengthen mission long-term legacy

Genesis science exploitation runs through 2031+

2

## Build next-generation space geodesists

Training, leadership, and coordination experience

3

## Increase diversity & fresh perspectives

Broaden participation across all 5 Working Groups

4

## Foster cross Working Group connections

Dedicated talks, discussions, and shared sessions

### Activities

- **Kick-Off on 13.07.2026**
- Status of Genesis Activities in the NextGen community
- Working Group member talks (30 min + discussion)
- Genesis-focused AI talks
- Online workshops & informal exchanges
- Meet-Ups at conferences
- Dedicated visits and tours (e.g. ESA-ESTEC tour)

**Join us!**  
No Working Group  
membership required



Coordinator: Antonia Bieringer

To join, send an email to: [Antonia.Bieringer@esa.int](mailto:Antonia.Bieringer@esa.int)



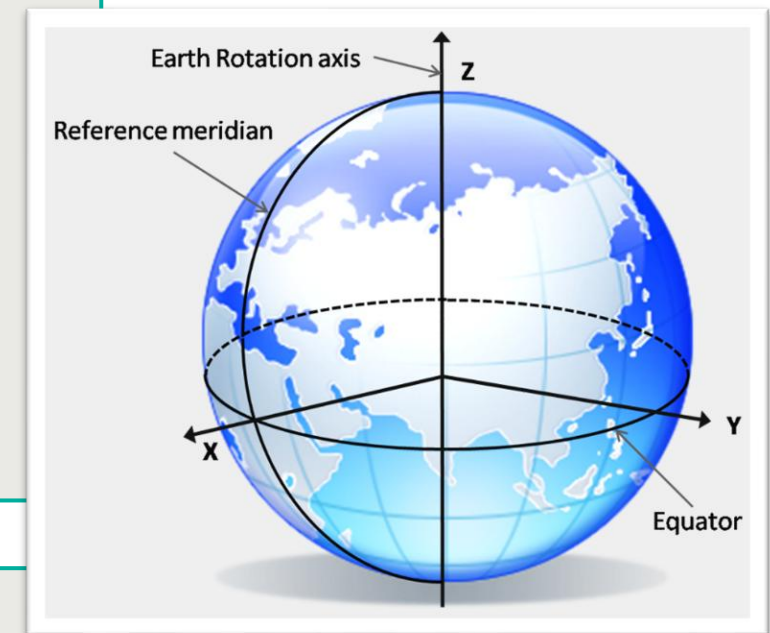
# Genesis – Contributing to Resilient Navigation

## Geodesy and Navigation

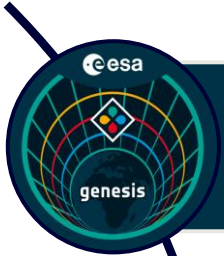
- GNSS have a **critical dependency on geodetic information** and ESA acknowledges the **importance of the Global Geodetic Supply chain**
- ESA acknowledges the **importance of a Global Geodetic Reference Frame** for Precise Navigation and Sustainable Development
- ESA significantly **contributes to the robustness of the Global Geodetic Supply chain and to the improvement of the Global Geodetic Reference Frame** - contributing to all Geodetic space techniques, and by dedicated Geodesy missions such as:
  - **Genesis - A Unique Space Geodetic Observatory**

## Navigating around Earth

- **The Earth is alive. It moves, it spins, and it wobbles.**  
Genesis will be there to ensure we take that all into account when safely and precisely navigating the future



# To summarize...



Thanks to combined efforts from Scientific Community, ESA Member States, Industry and ESA, the Genesis Mission has become a reality!



This challenging mission is currently in the design consolidation phase and will be a stepping stone towards improved GNSS with major positive impacts in Navigation and Earth Science



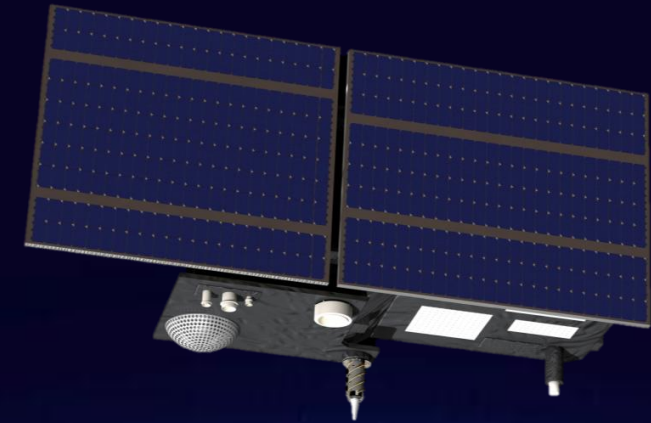
ESA, Industry and the Scientific community are fully committed to the success of the Mission



We are looking forward to updating the community on the progress of the Mission



# THANK YOU!



[gaia.fusco@esa.int](mailto:gaia.fusco@esa.int)