ESA's GENESIS Mission – At the foundation of Navigation

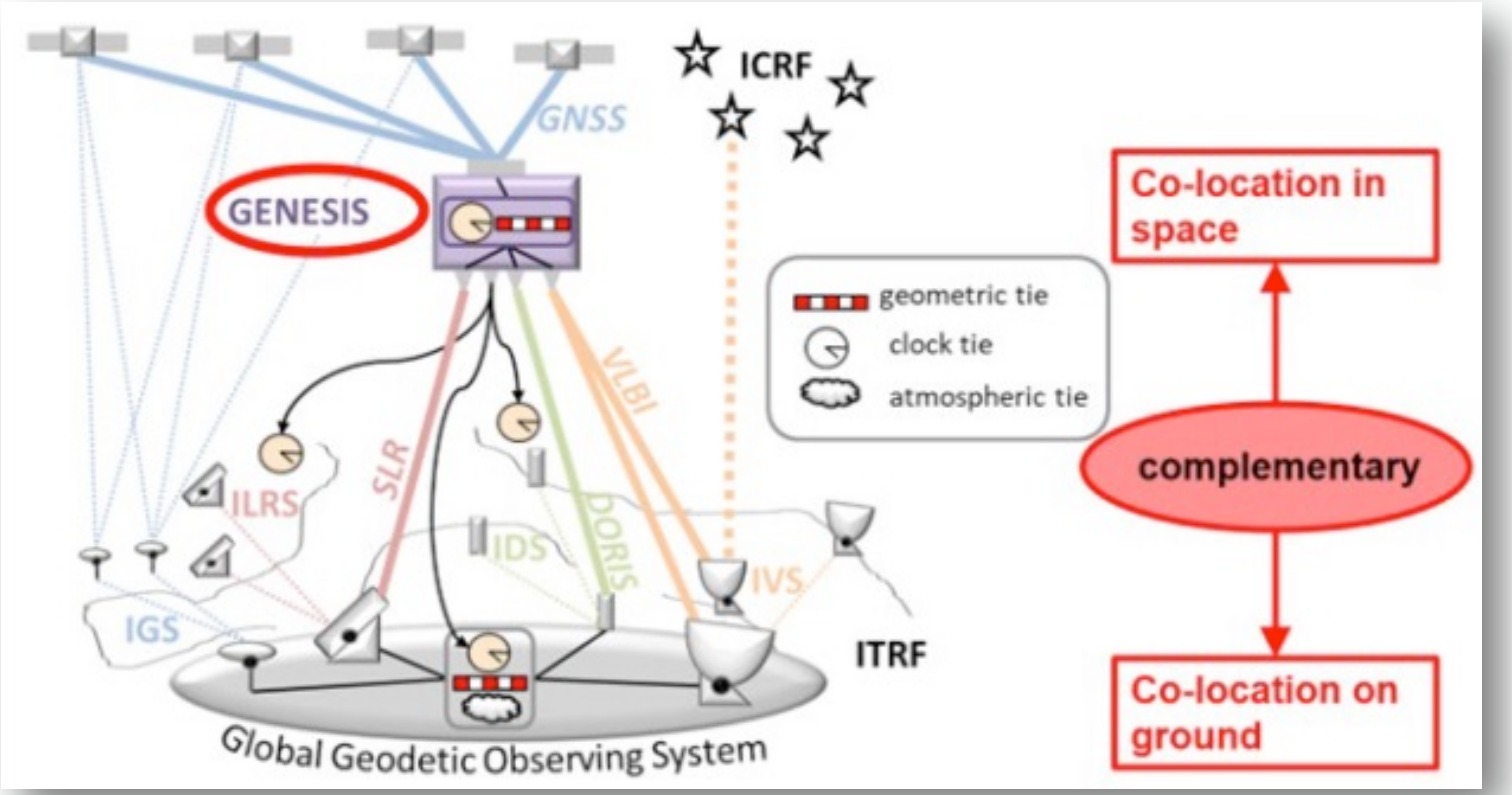
Werner Enderle, Erik Schoenemann, Tim Springer, Javier Ventura and Sara Gidlund

ESA/ESOC and ESTEC

ICG-17, Madrid, Spain – 16/10/2023

ESA's GENESIS Mission – Overview

All four space-based geodetic techniques on-board



The GENESIS Mission – Objectives

Objective 1

Improve ITRF accuracy and stability by providing in-orbit colocation and necessary combined processing of 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).

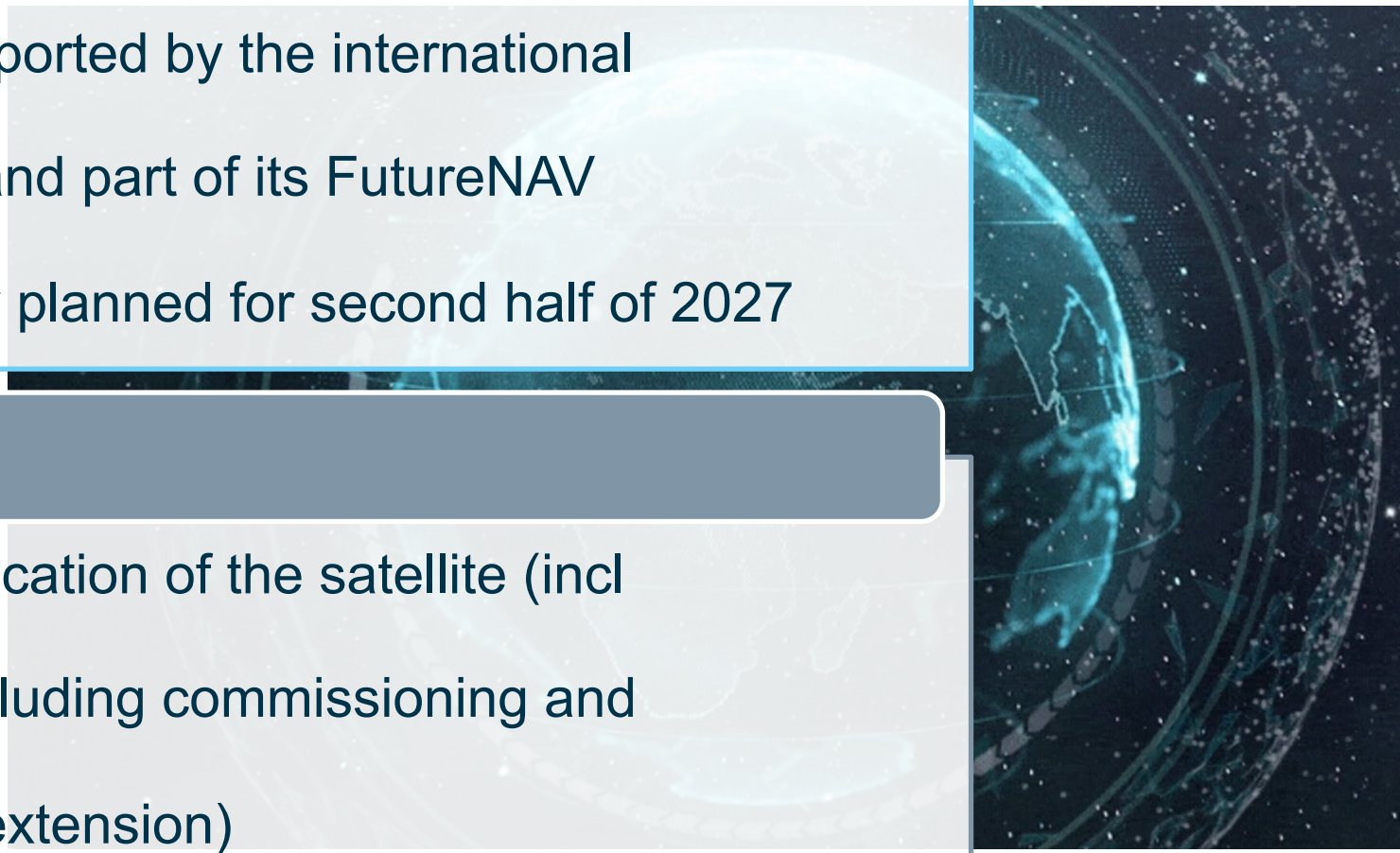
Objective 2

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.

The GENESIS Mission – Background and Scope

Background

- GENESIS mission is widely supported by the international scientific community
- GENESIS is managed by ESA and part of its FutureNAV Programme
- Launch of GENESIS is currently planned for second half of 2027



Mission scope

- Design, development and qualification of the satellite (incl payloads) and ground segment
- Launch and early operations including commissioning and calibration
- Operations (2 years, option for extension)
- Data exploitation

The GENESIS Mission – Potential for International Collaboration

Ground Infrastructure

- Especially for the VLBI and Laser ranging campaigns – access to ground infrastructure

Data Exploitation

- Opportunity to get involved in the work of the GENESIS Scientific Exploitation Team

The GENESIS Mission – POD Aspects – Requirements for GNSS Measurements

A sufficient number of satellite measurements (15 to 25 satellites) have to:

- come from satellite antenna main lobe;
- have a CN0 above 25 dBHz;
- Multi-constellation and dual frequency measurement simultaneously available
- Optical and thermal material properties (absorption, reflection, etc.) of the satellite outer surfaces has to be known in order to make an accurate radiation pressure model of the satellite.
- GNSS observations (combined Galileo and GPS) must be of high quality and unbiased (after calibration is applied) to allow high success rate Integer ambiguity resolution

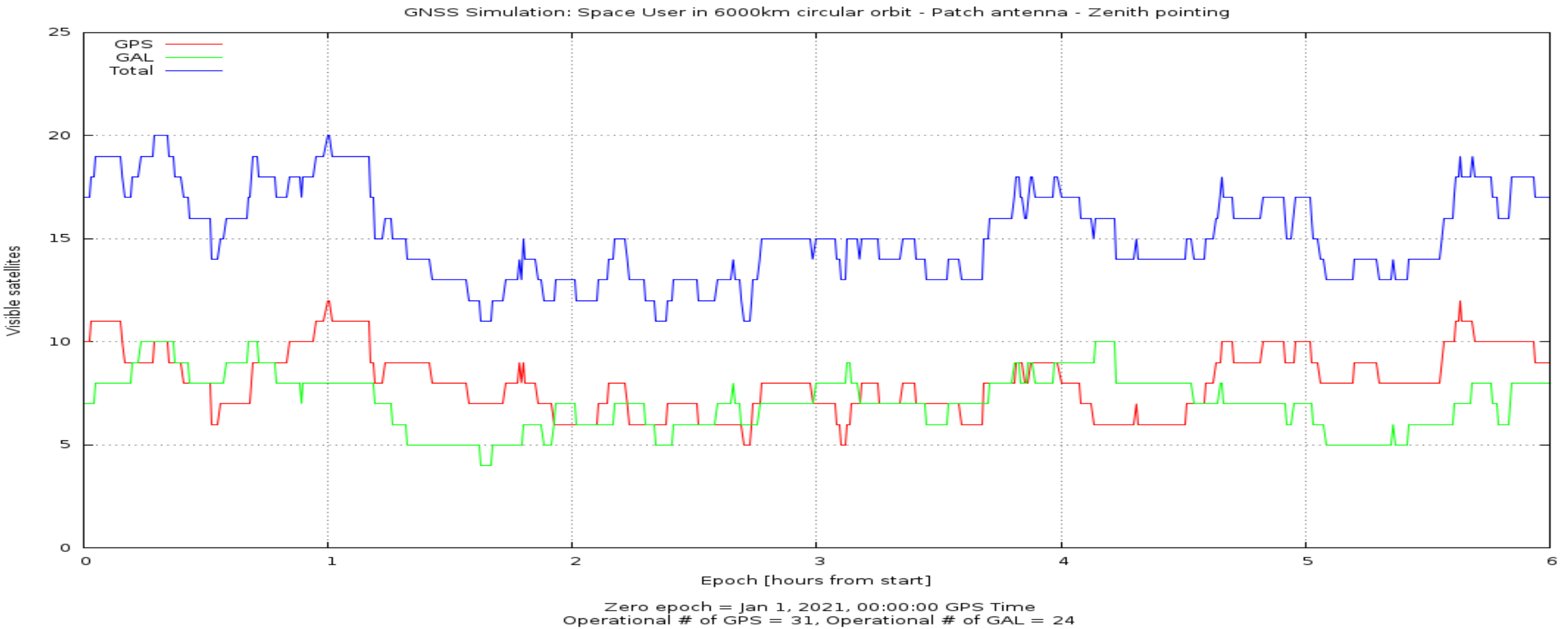
The GENESIS Mission – POD Aspects

GENESIS POD and GNSS observation simulation within the Concurrent Design Facility (CDF) Activities:

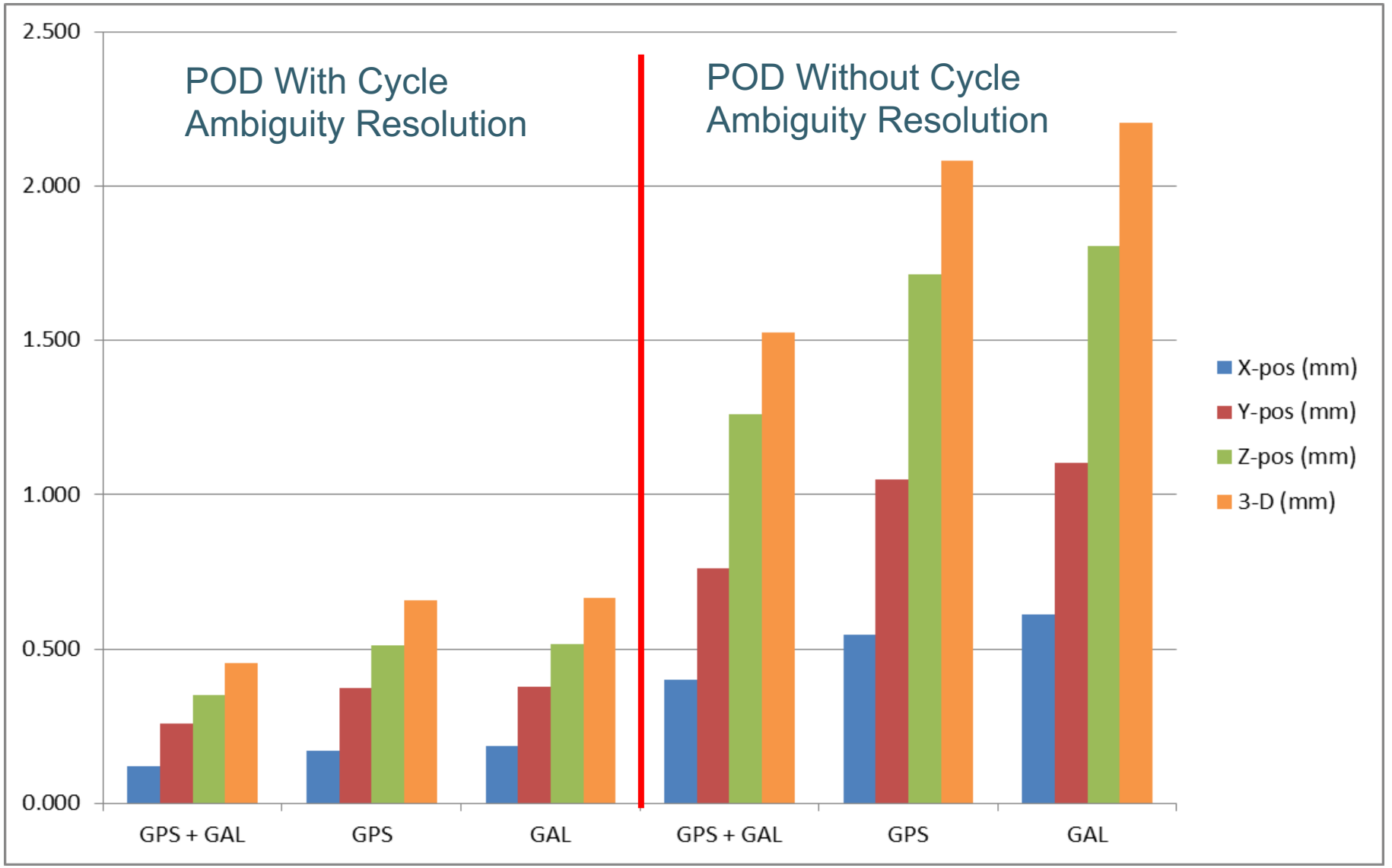
- Three different scenarios for POD calculation
  - GPS-only observations
  - GALILEO-only observations
  - GPS + GALILEO combined observations
- Two different processing approaches
  - Carrier-phase Ambiguities Integer resolved
  - Carrier-phase Ambiguities estimated (floating solution)

The GENESIS Mission – POD Aspects - Visibility

Patch Antenna – Zenith Pointing, SNR = 25dBHz



The GENESIS Mission – POD Aspects Satellite Position Formal Errors (m



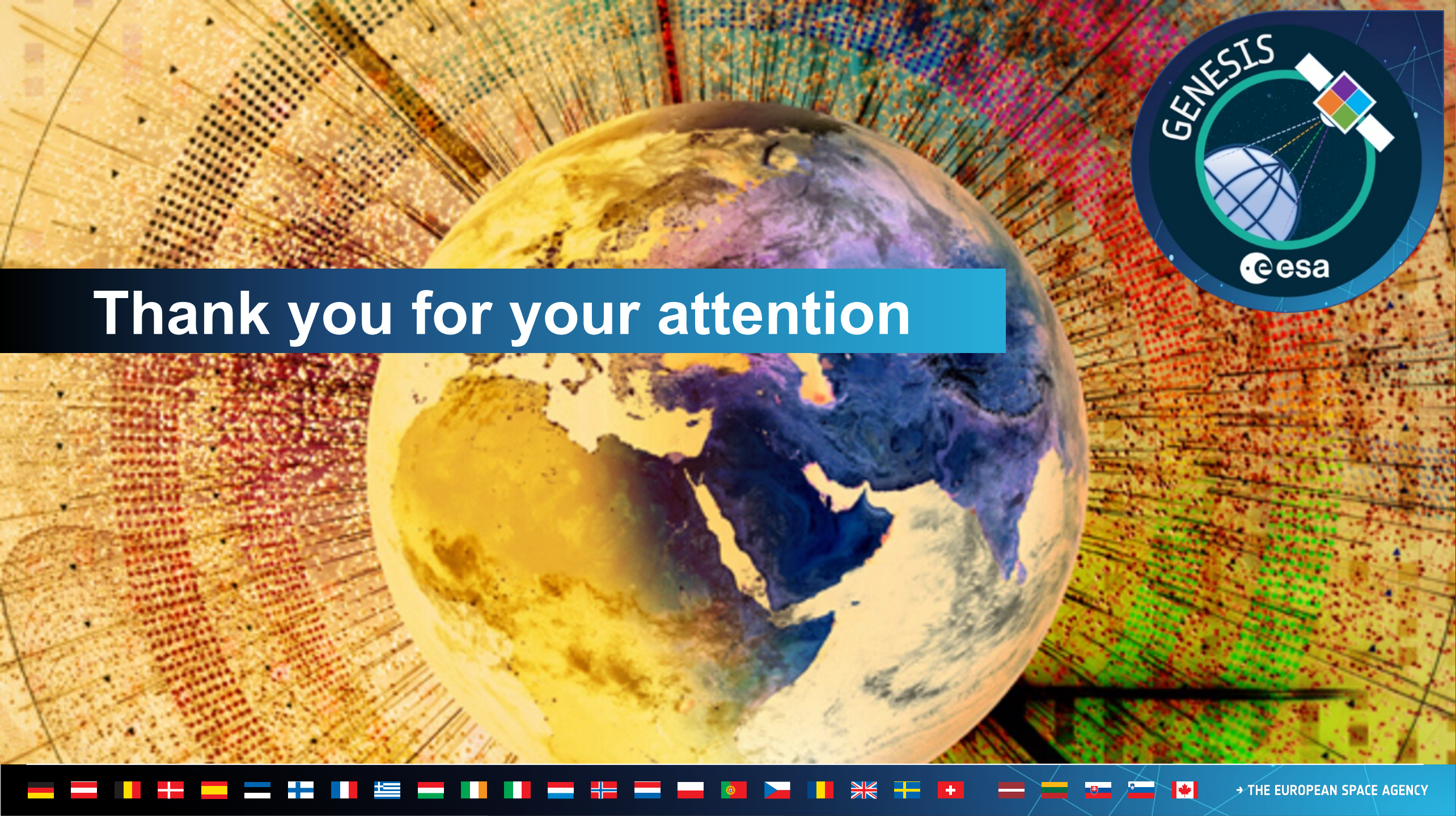
The GENESIS Mission - Conclusions

POD Analysis

- Successful Integer ambiguity resolution is key for achievable POD accuracy!
- Individual (not combined) POD solutions for GALILEO and GPS shows very similar accuracy performance
- Combined GPS and GALILEO observation processing shows best POD accuracy performance
- GNSS Interoperability is important for POD achievable accuracy
  - NOTE: Formal errors do depend on the location of the state vector. Selected initial inertial state vector was (x, y, z) = (12378, 0, 0) km. For the chosen state vector X and Z are highly correlated (radial and along-track)

GENESIS Mission Implementation

- **Challenging and Exciting path ahead!**
- The teams are working hard to realise the mission and ensure the best conditions for data exploitation
- A mission with high potential for international collaboration



Thank you for your attention