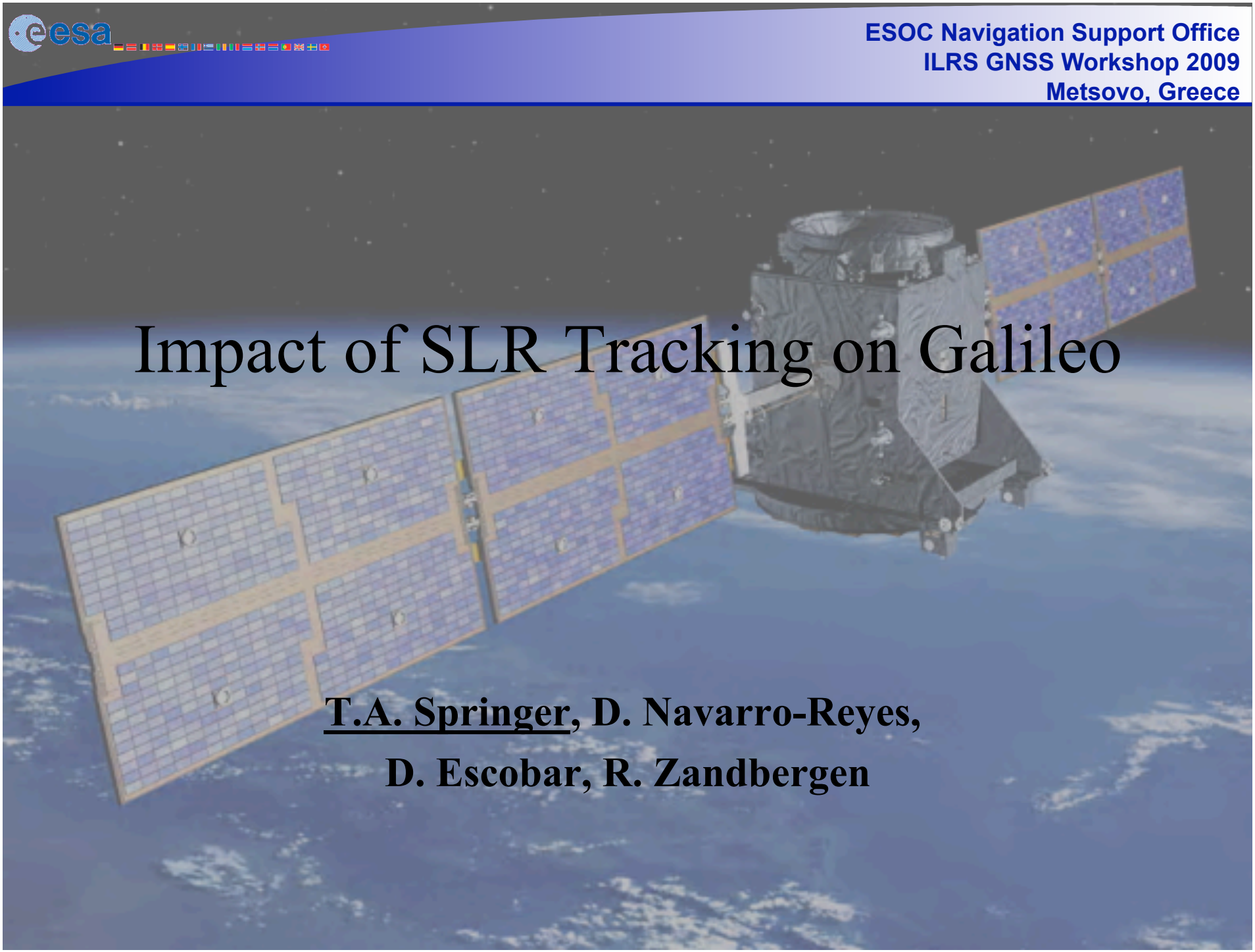


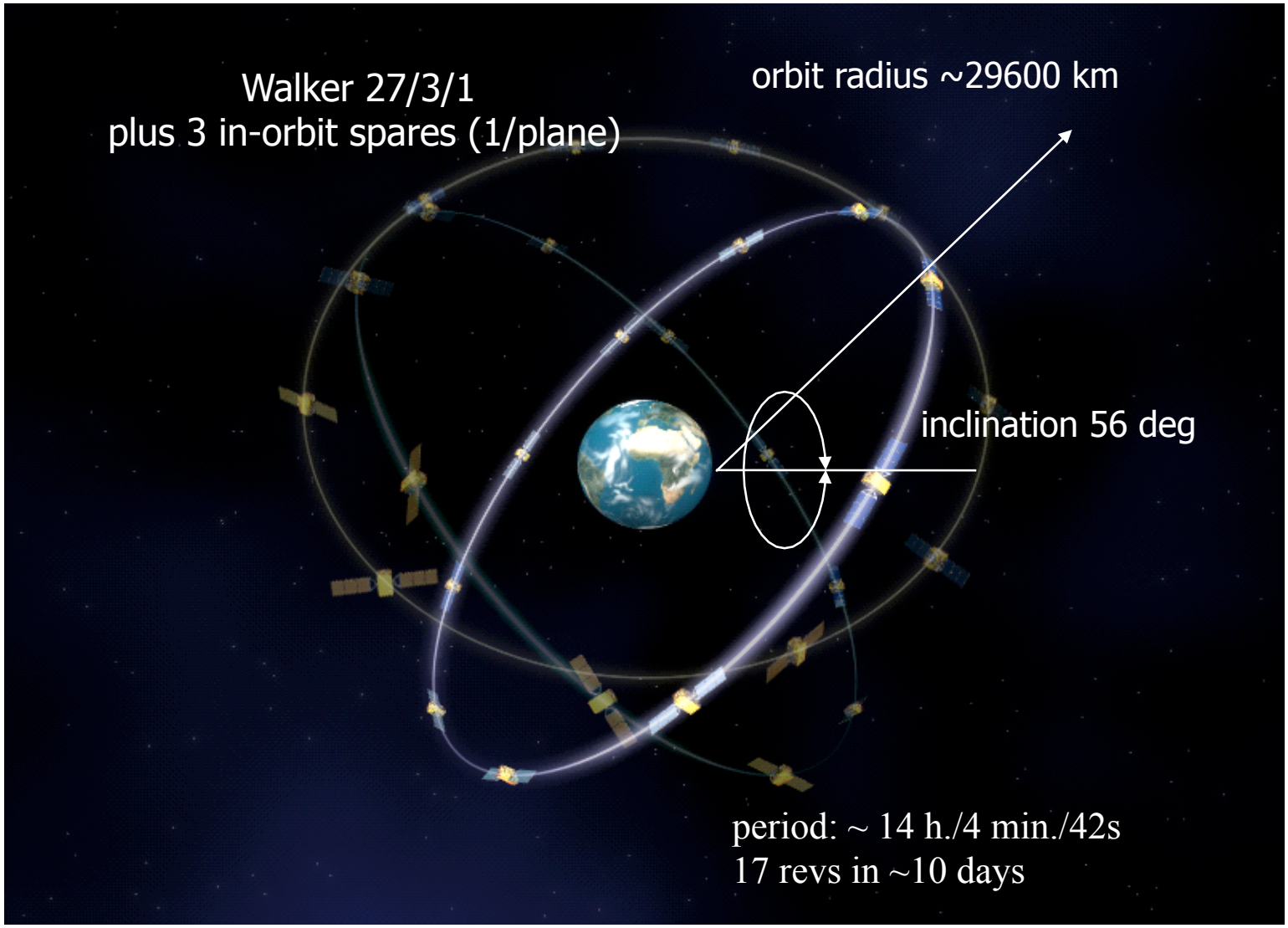
Impact of SLR Tracking on Galileo

T.A. Springer, D. Navarro-Reyes,
D. Escobar, R. Zandbergen

Galileo Orbit Constellation

- **Prime design criteria**
  - Avoid “station keeping” orbital maneuvers during the spacecraft lifetime
    - ✓ Avoid the “deep 1:2 resonance“ from the GPS satellites
- **Constellation Features**
  - So called “Walker 27/3/1” constellation
  - Almost circular orbit
    - ✓ Orbit Radius ~29'600 km (above GLONASS and GPS)
  - Orbit repeat period 10 days
    - ✓ 17 revolutions in 10 days, ~14 hour per revolution
  - Inclination 56 degrees
  - Three equally spaced orbital planes
  - Nine operational satellites, equally spaced in each plane
    - ✓ Plus one spare satellite in each plane

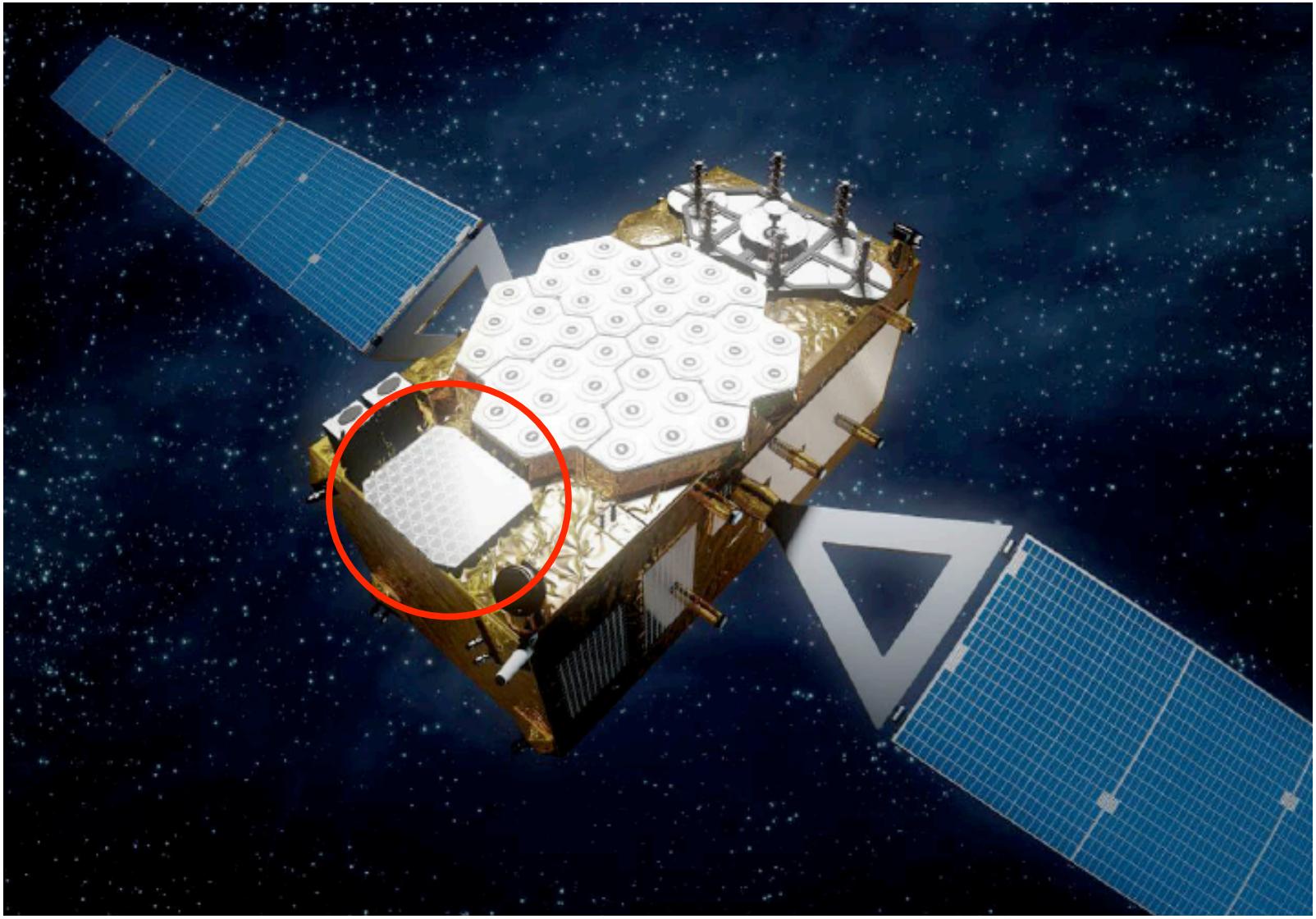
Galileo Orbit Constellation



The Galileo Satellites

- **Dimensions**
  - 2.5 x 1.2 x 1.1 m
- **Length (Y-axis) 19 m with deployed solar arrays**
- **Spacecraft weight: ~700kg**
- **Power: ~ 1.5 kW**
- **Navigation payload: ~130kg**
- **Power consumption: 900 W**
- **Launcher options**
  - Ariane-5
  - Proton
  - Soyuz (from Kourou)
  - Zenit.

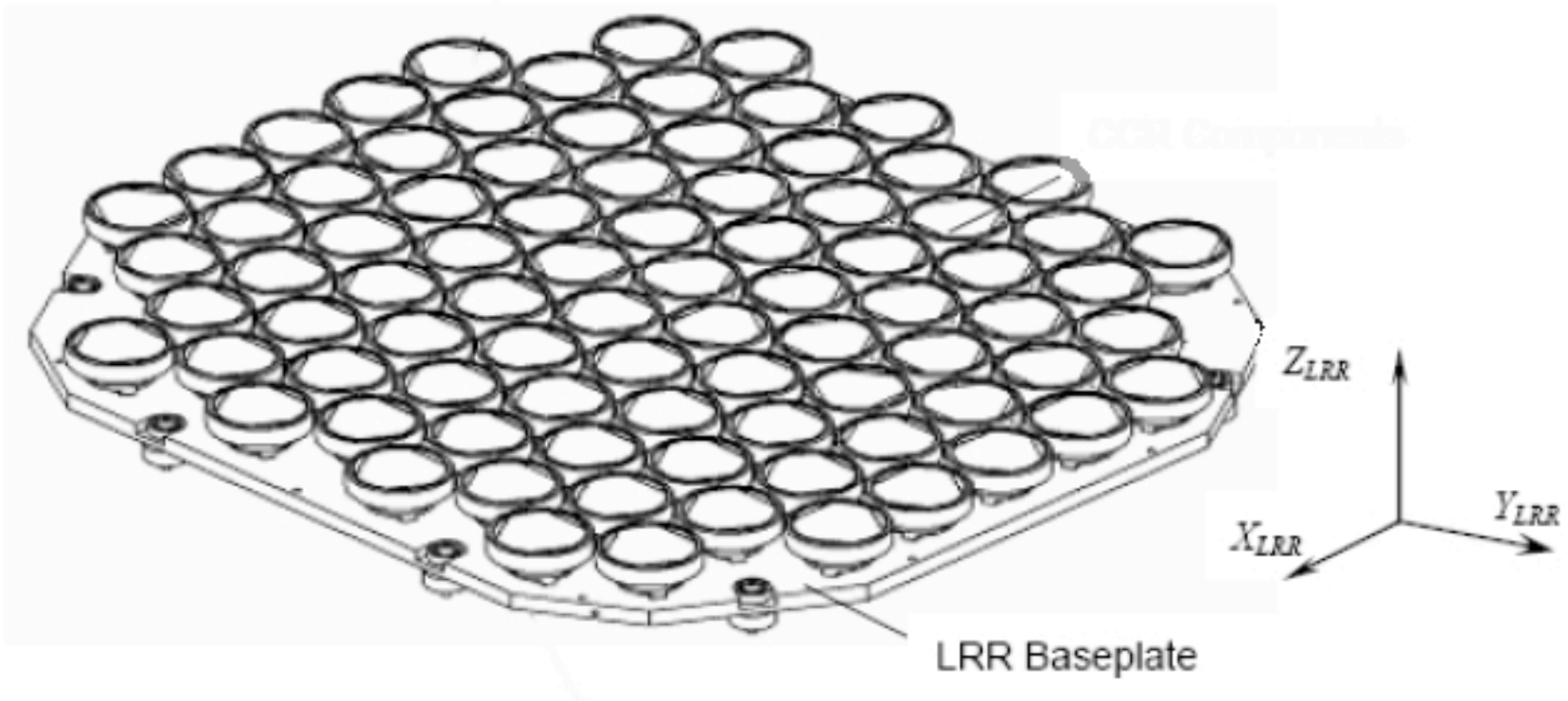
Galileo IOV LRA



Galileo SLR Scenario

- **Support to Galileo for early phases**
  - With low number of GSS and few IGS Galileo stations GNSS based orbits of Galileo will be of medium accuracy
  - Addition of SLR observation will offer a significant accuracy improvement
- **Calibration of Spacecraft Dynamics**
  - The Y-bias as present on most GNSS satellites has a long term effect on the satellite position.
  - The accurate determination of the Y-bias for each Galileo satellite will be of prime importance to fulfill the “once in a lifetime“ station keeping manoeuvre requirement
- **Alignment of GTRF to ITRF**

IOV LRA

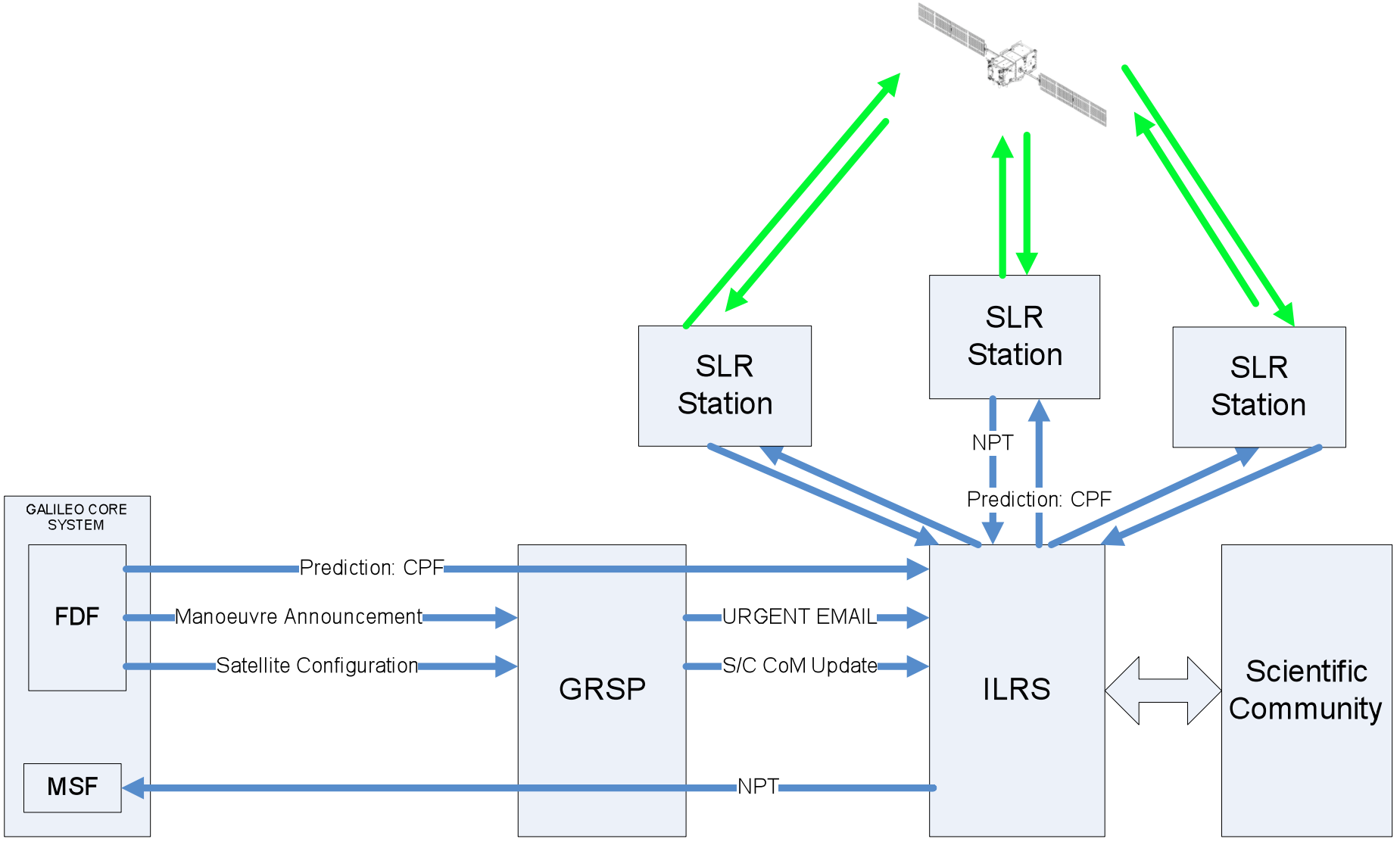


Size of Array ~0.35 x 0.35 m = 0.12 m²

Conner Cube Reflectors

- **84 Corner Cube Reflectors (CCR)**
  - doped fused silica glass tetrahedron
  - no metallic coating
  - aperture face is included in a circle of 43 mm diameter
  - height of the tetrahedron is 23.3 mm
  - Iso-static mounting to plate
  - N = 1.46, critical angle16.9 deg
    - ✓ which covers the entire LRR operating range (Earth radius of 12.44°)
    - ✓ no coating, total reflection is obtained without any loss
  - Velocity aberration compensation 24 µrad
  - CCR are randomly oriented
  - LRA Centre of Phase TBD after Qualification Tests
- **This information will be published in an update to "Specification of Galileo and GIVOVE Space Segment Properties Relevant for Satellite Laser Ranging" (ESA-EUING-TN-10206) and in the "Mission Support Request Form"**

SLR-relevant Data Flow



Summary of SLR Tracking Benefits

- **Support to Galileo for early phases**
  - Support for satellite “fine positioning“
  - Support for Galileo operational POD
- **Completely independent validation**
- **Calibration and validation of spacecraft dynamics**
- **Alignment of GTRF to ITRF**
- **Maintain and improve the ITRF**
- **Ensure the position of Galileo**
- **Position Galileo as „best“ GNSS system**
  - No SLR LRA's on GPS
  - „split“ LRA's on GLONASS
- **Ensure GNSS interoperability through a common independent measurement technique**