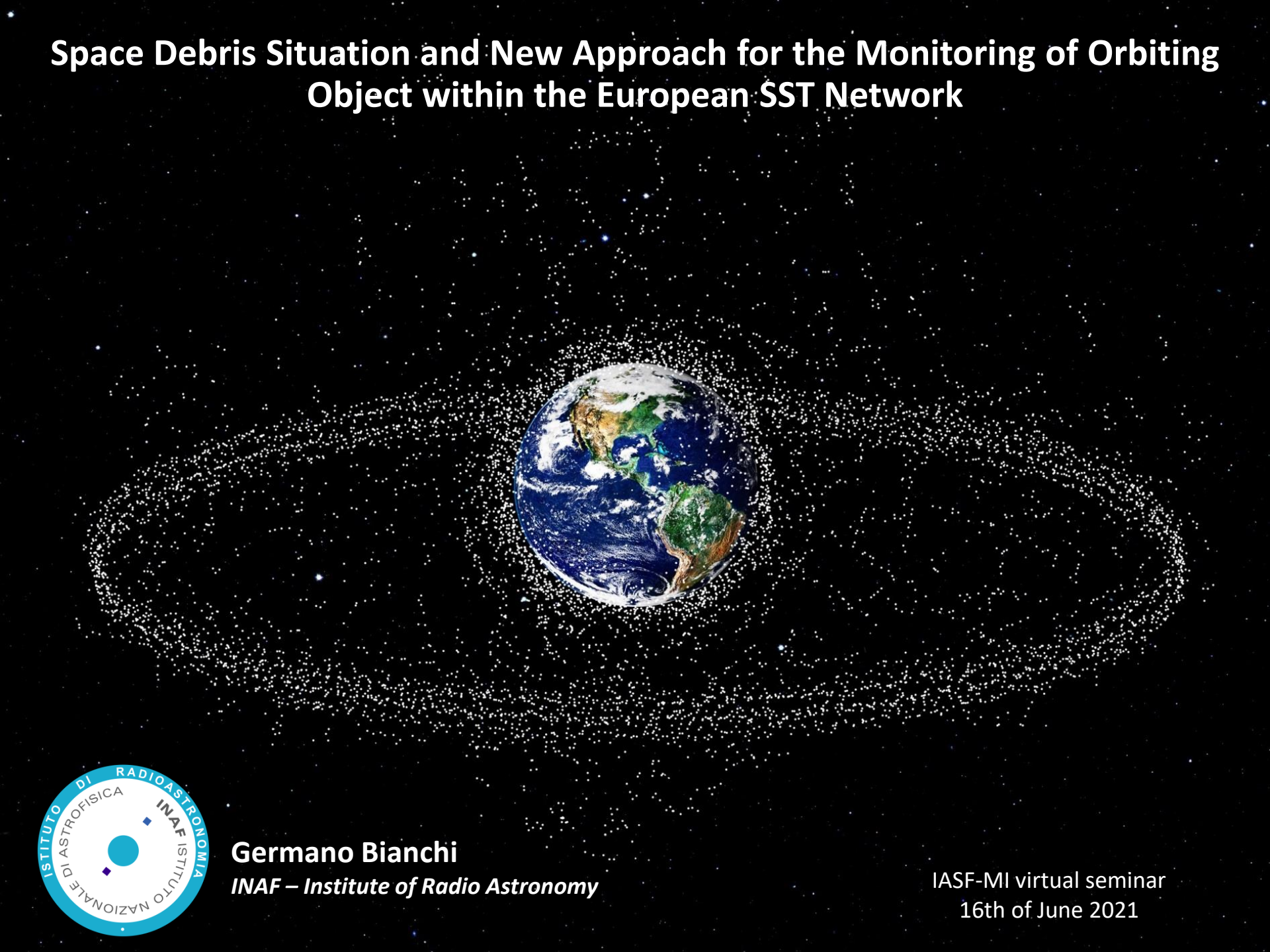
Space Debris Situation and New Approach for the Monitoring of Orbiting Object within the European SST Network



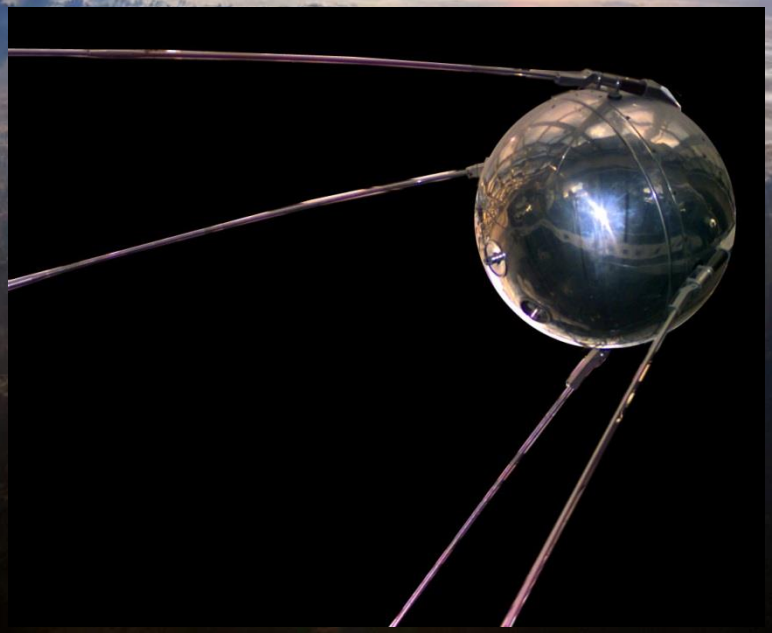
Germano Bianchi
INAF – Institute of Radio Astronomy

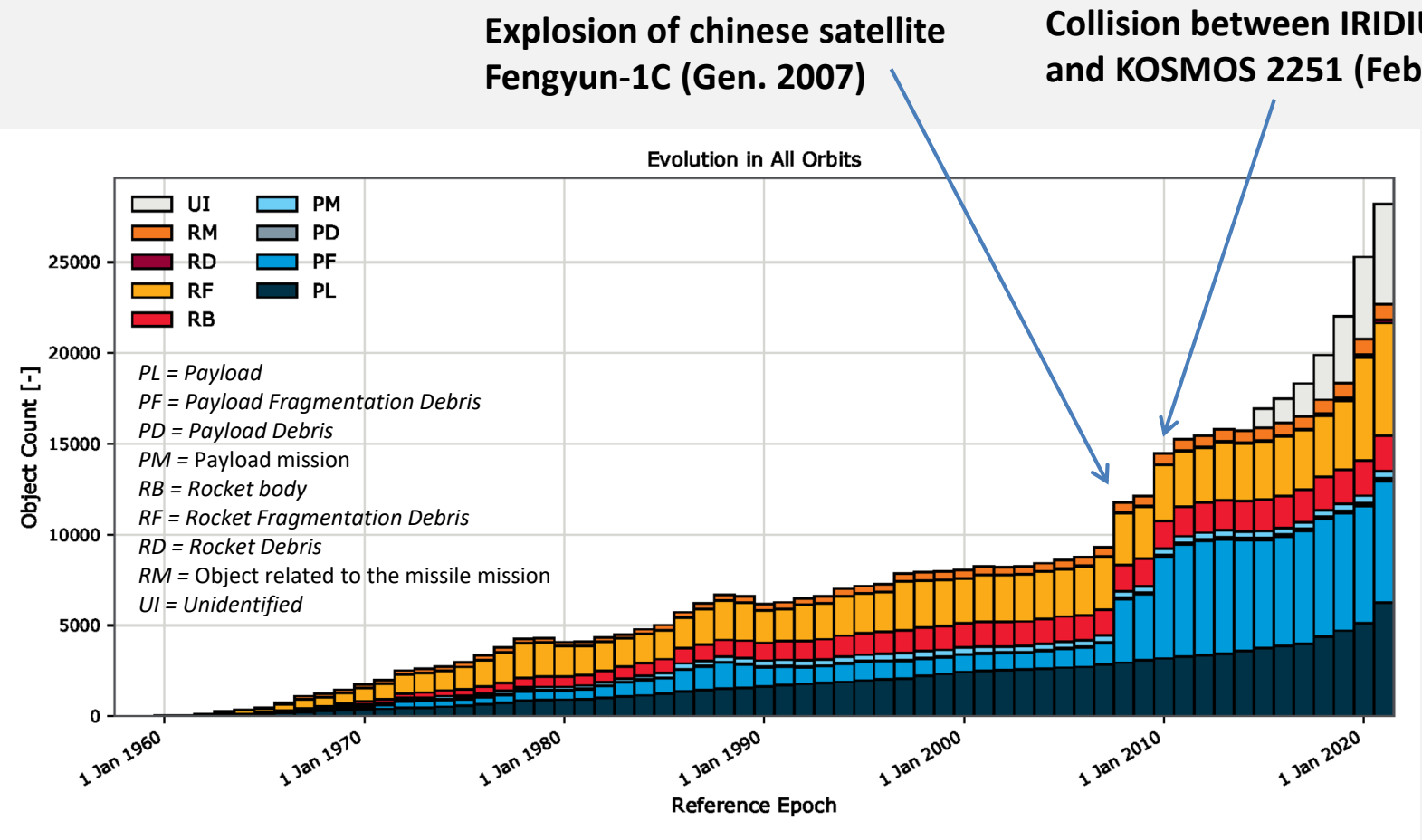
IASF-MI virtual seminar
16th of June 2021

Since the launch of Sputnik 1 (4th October 1957), a lot of satellites have been populated the space.

At present there are:

- **9.300 tons of space debris around the Earth on different orbits**
- **more than 28.000 cataloged objects and only the 13% are operational satellites**





56% of the space debris are fragments due to:

- **Explosions**

  About 200 explosions occurred, 30% intentional to avoid the re-entry of military satellites or to test anti-satellite procedure

- **Collisions**

IRIDIUM 33

KOSMOS 2251
(Debris)

ORBIT CLASSIFICATION

Low Earth Orbit (LEO): from 200 to 2000 km

Earth monitoring, Military, etc.

Geostationary Orbit (GEO): about 36.000 km (equatorial orbit)

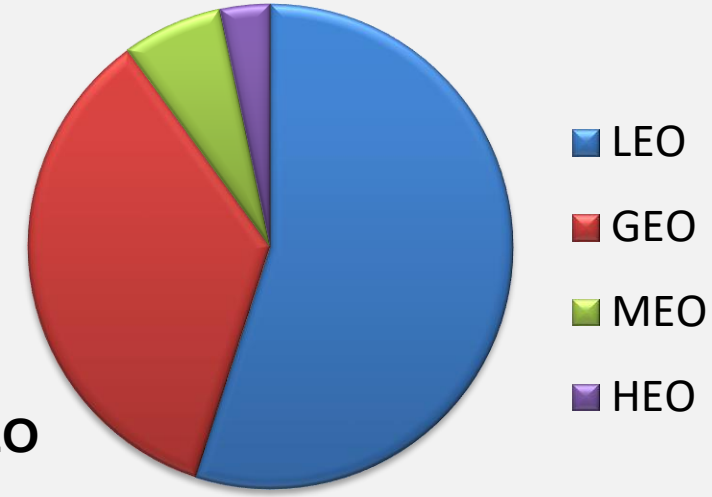
Weather and telecommunications satellites

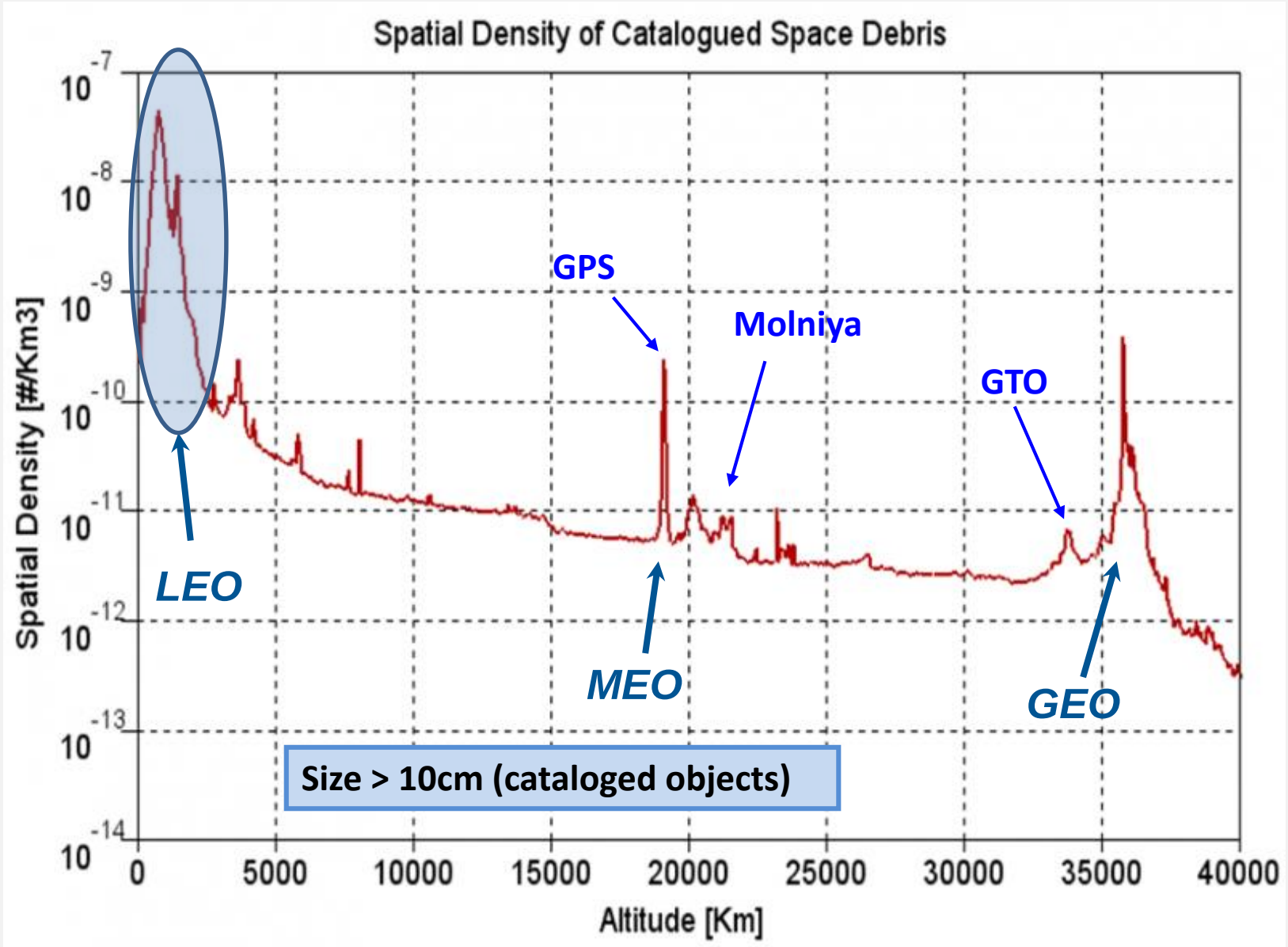
Medium Earth Orbit (MEO): between LEO & GEO

Navigation (Navstar, Glonass, GPS)

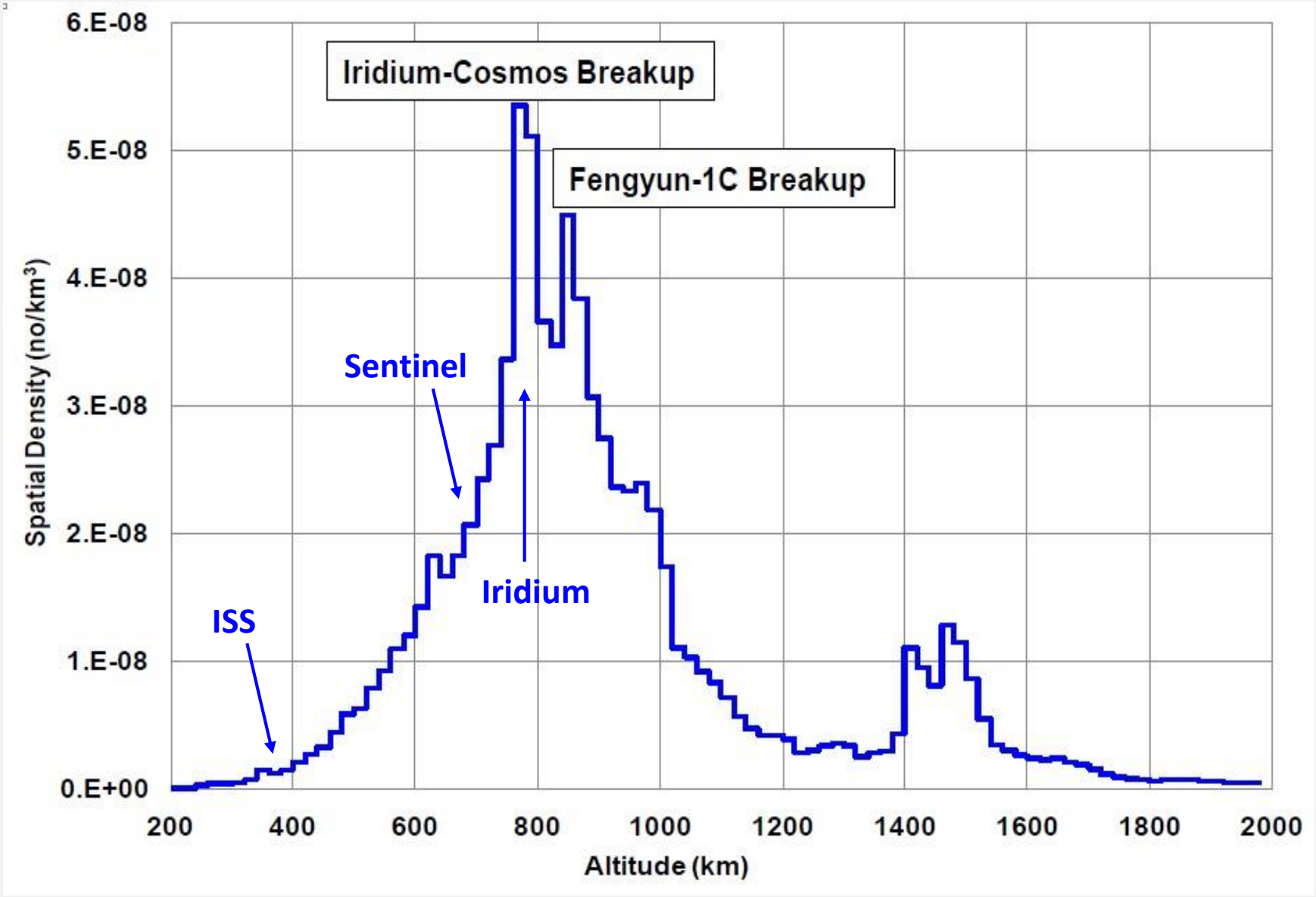
Highly Elliptical Orbit – Hight Earth Orbit (HEO):

Polar communications

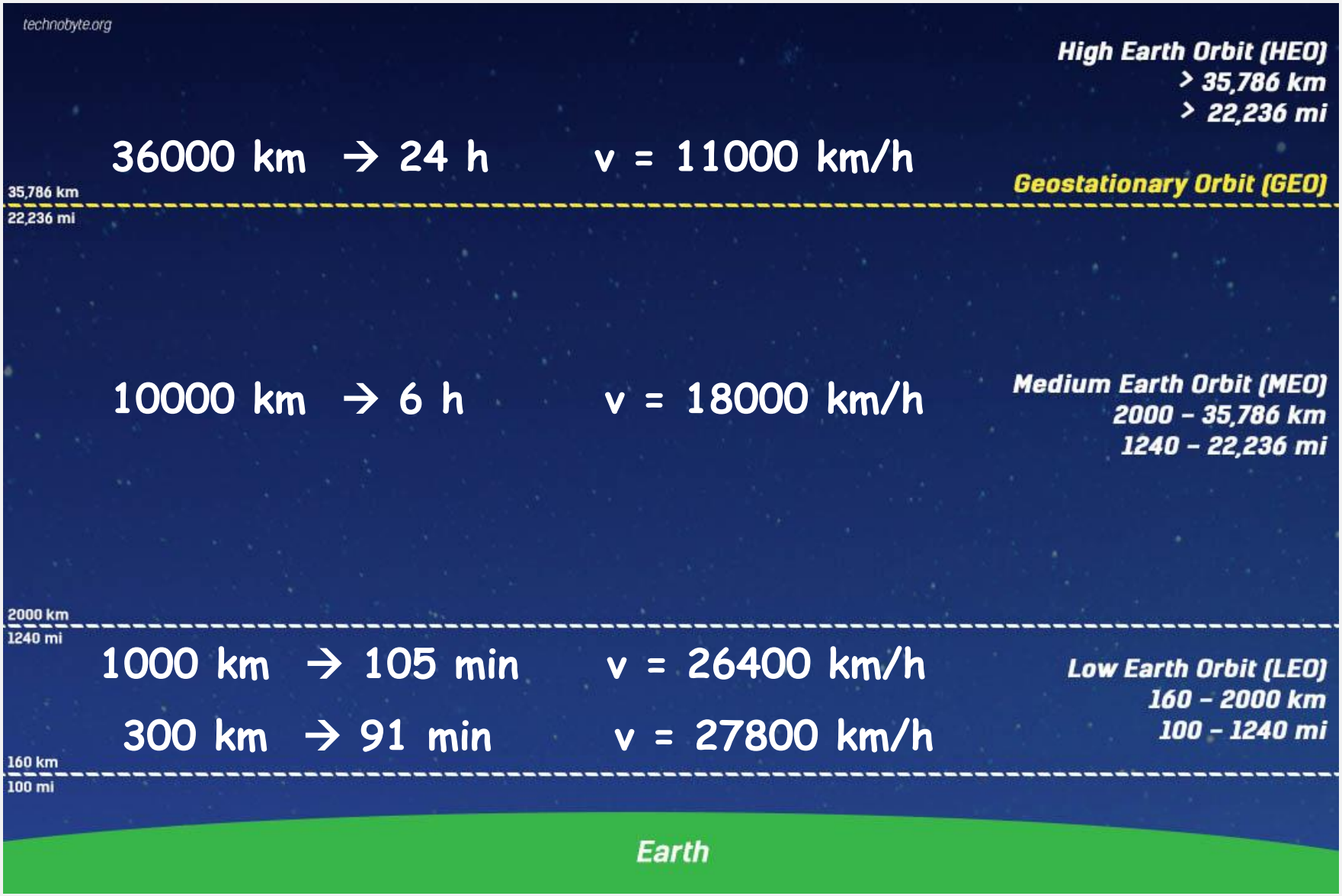



Spatial Density of Catalogued Space Debris
Spatial Density [#/Km3]
10^-7
10^-8
10^-9
10^-10
10^-11
10^-12
10^-13
10^-14
0
5000
10000
15000
20000
25000
30000
35000
40000
Altitude [Km]
LEO
GPS
Molniya
GTO
MEO
GEO
Size > 10cm (cataloged objects)

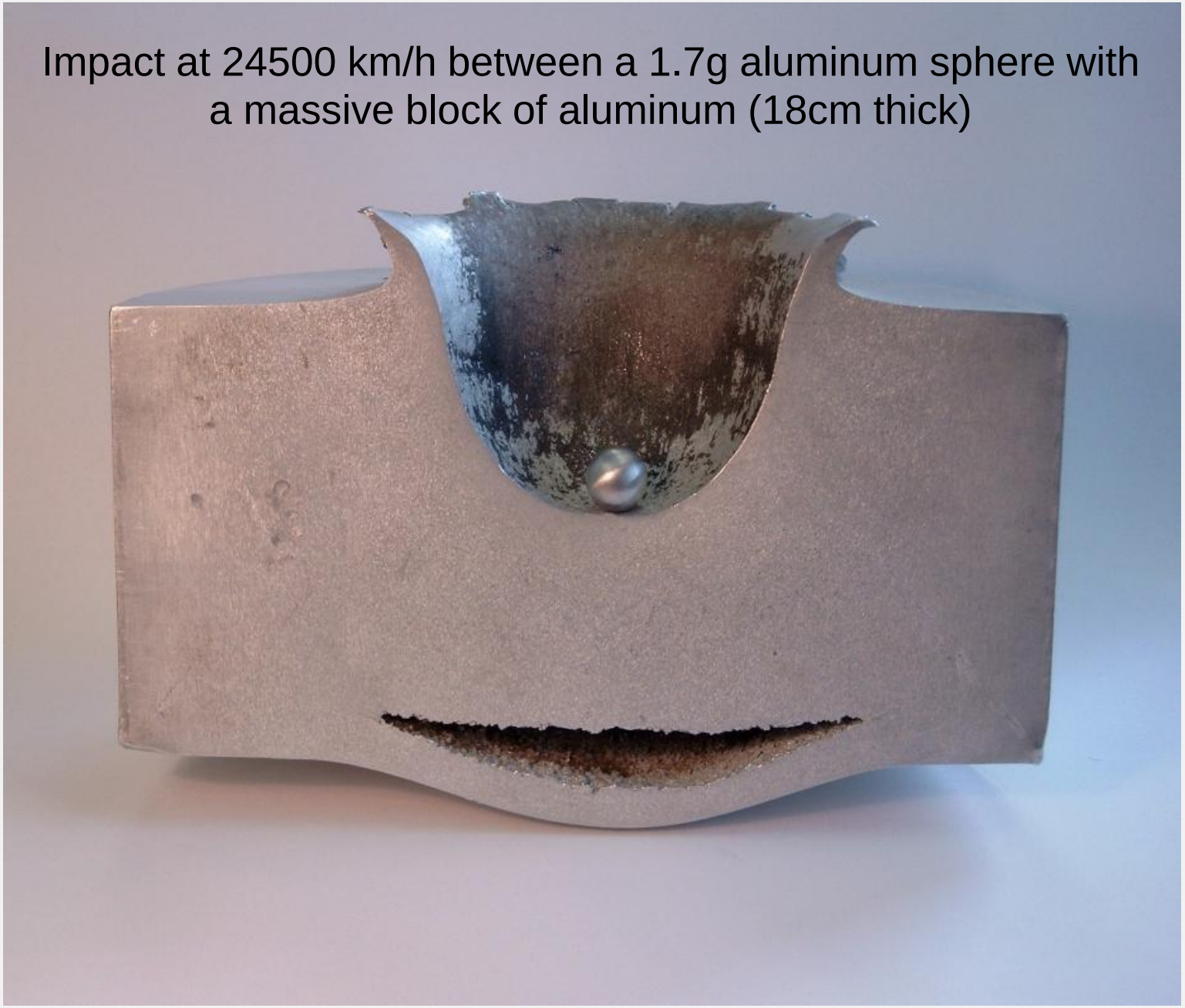
LEO distribution



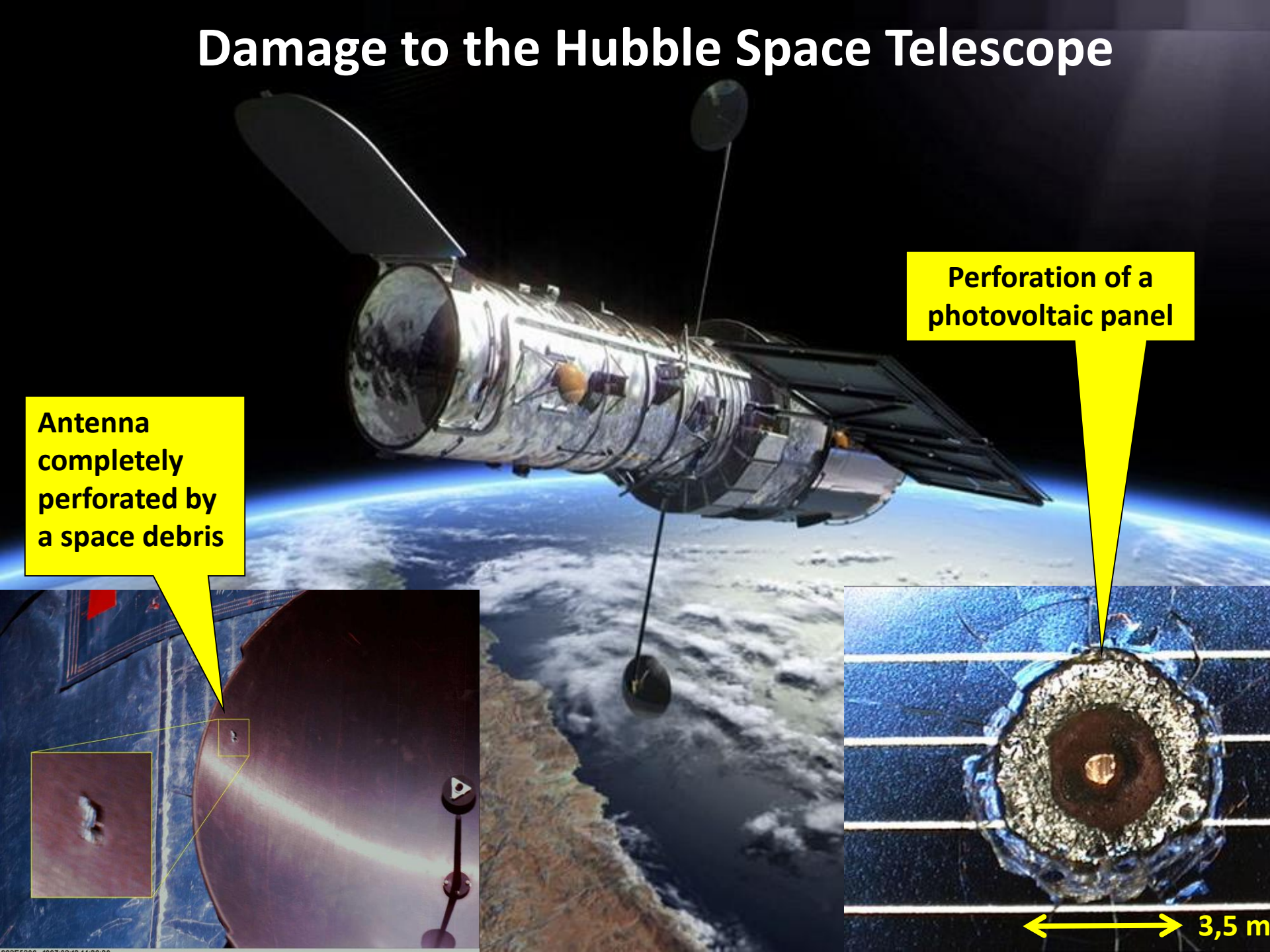
Risks: Impacts and collisions with operational satellites



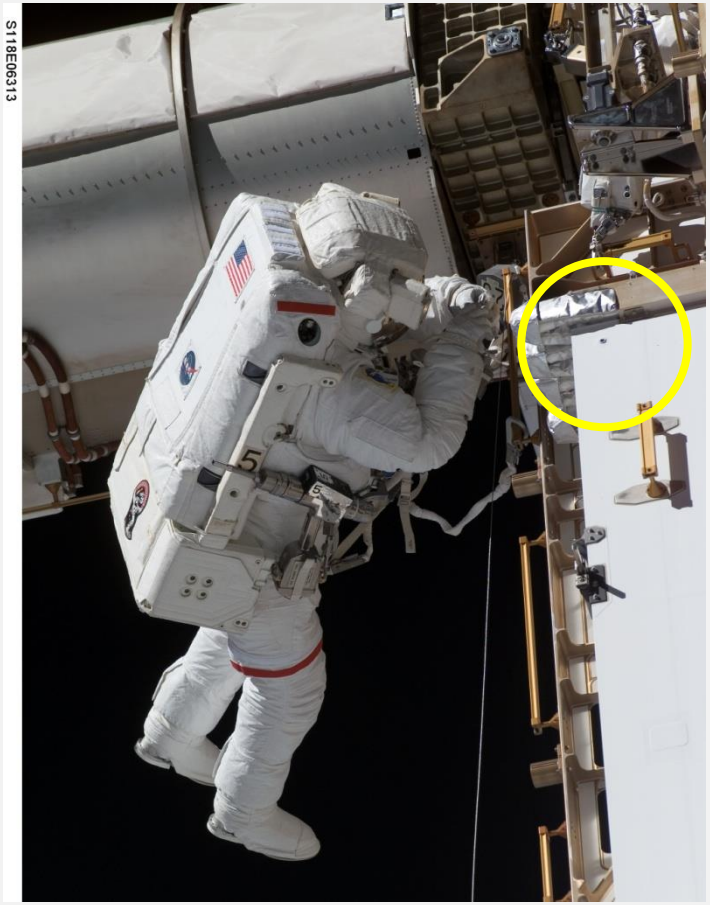
Impact at 24500 km/h between a 1.7g aluminum sphere with a massive block of aluminum (18cm thick)

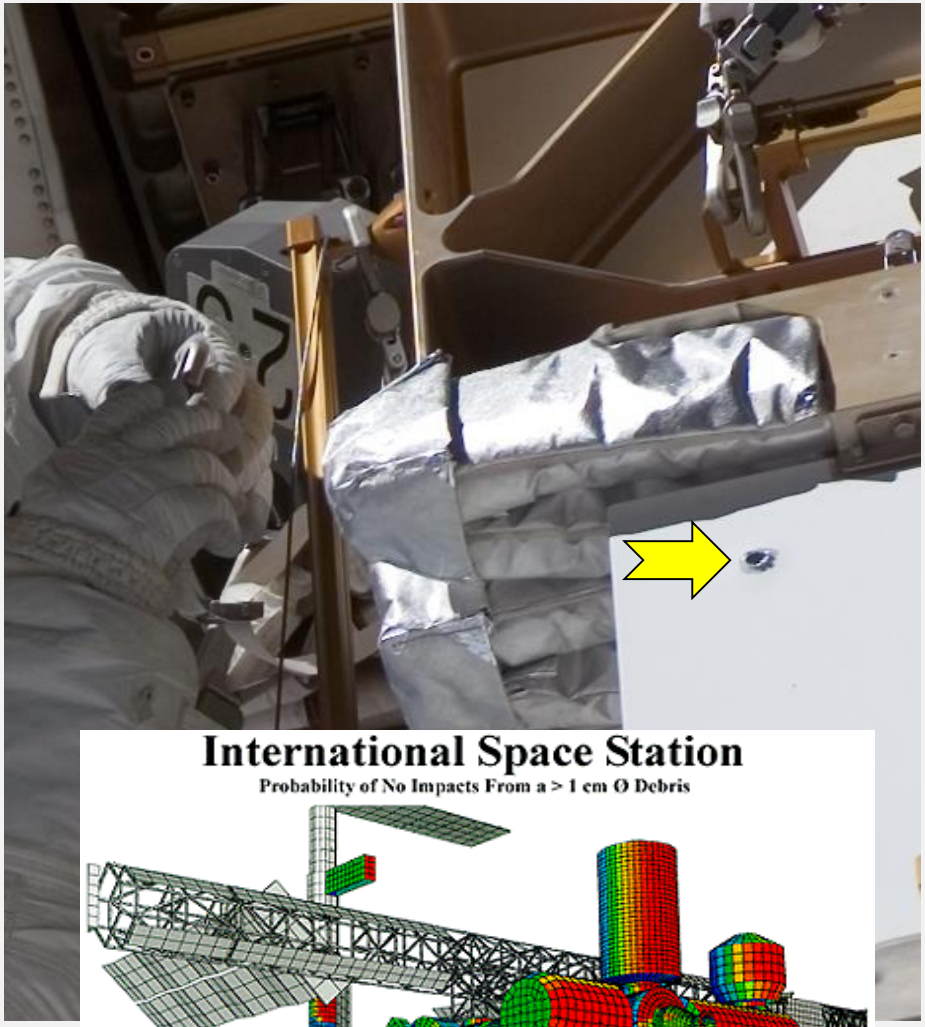


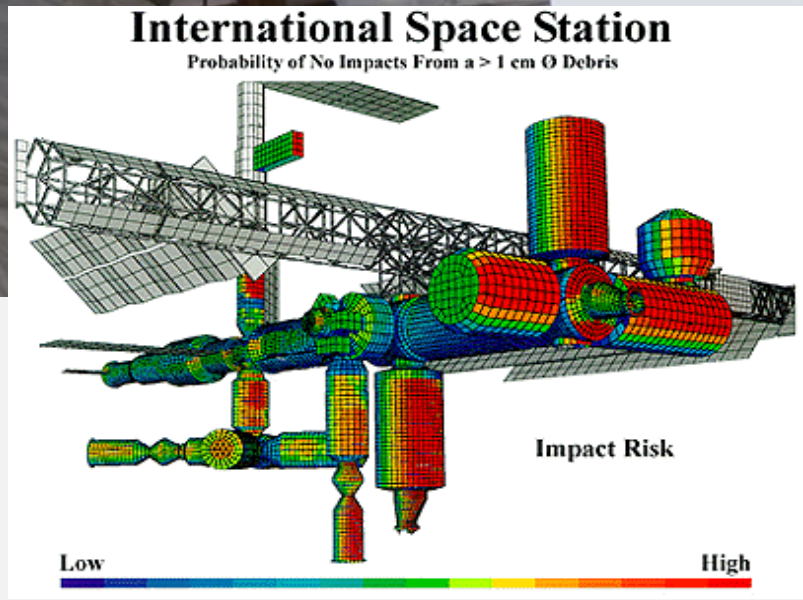
Damage to the Hubble Space Telescope



Risks: human space missions



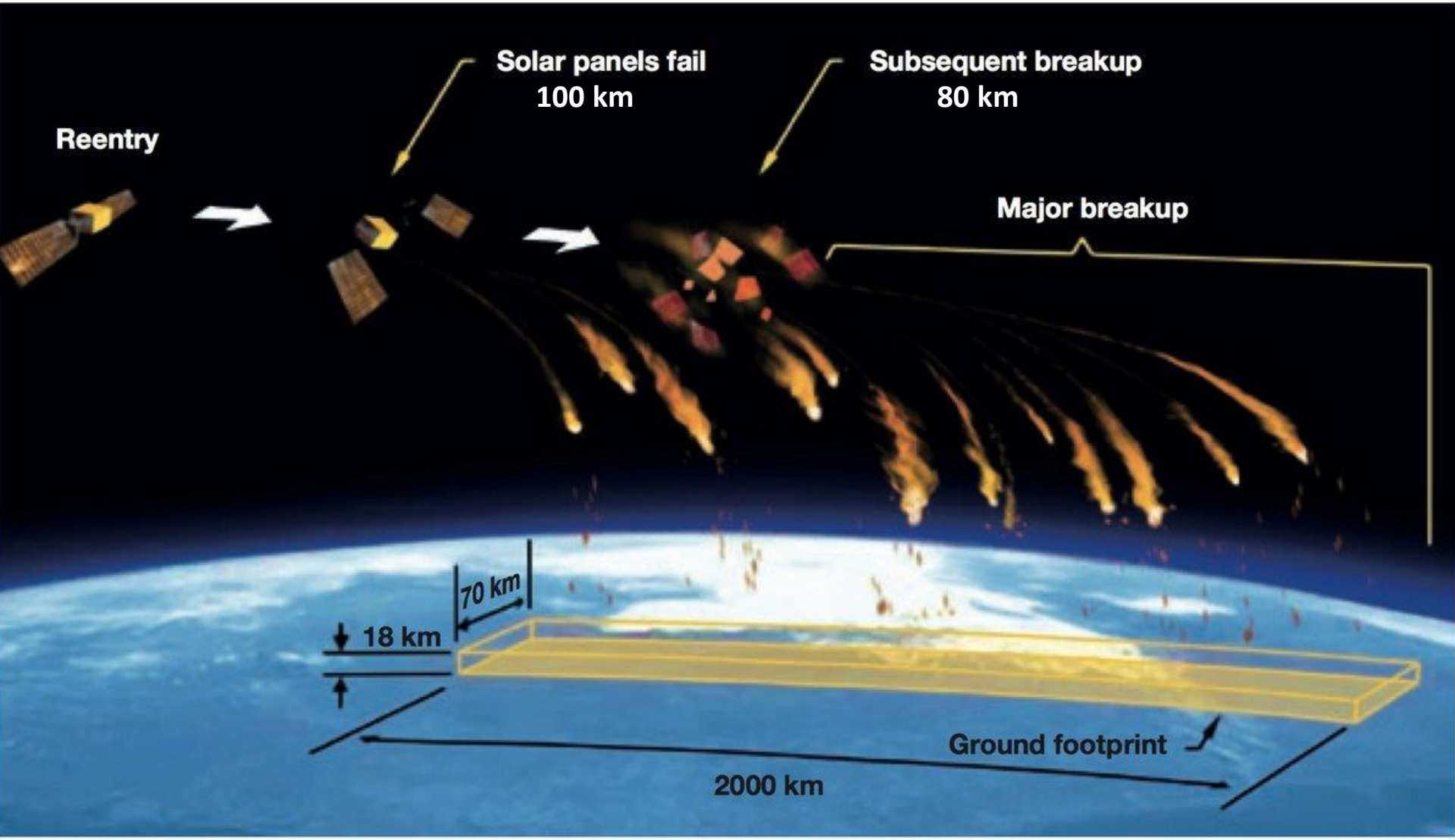


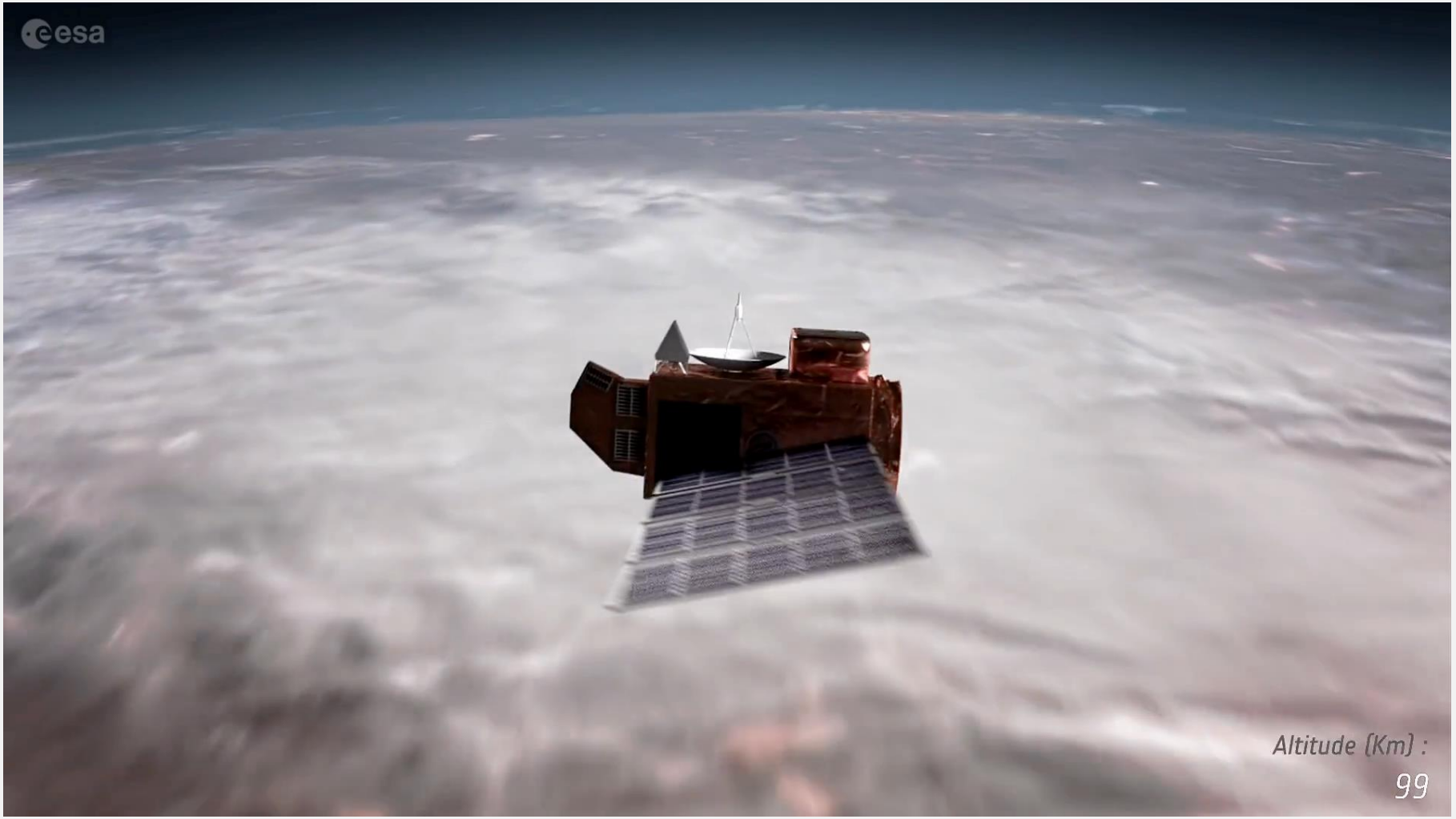


Mitigations:

- Shielding
- Evasive maneuvers

Risks: re-entry to the Earth




esa
Altitude (Km) :
99

Rocket tanks

Texas January 1997

Saudi Arabia Jannuary 2001

Ariane 5, Mexico 2013

Chang'e II, China 2012

EUSST programme

(European Space Surveillance and Tracking)

Decision of the European Parliament and of the Council of **16 April 2014** for the establishment of an European Space Surveillance and Monitoring Network

An European Consortium has been established on **15 June 2015**

1 January 2016 started the activities of the Consortium

The European Commission provides funds to the EUSST for:

- Upgrade of existing assets (H2020 framework)
- Operating cost (Copernicus-Galileo framework)

The EU SST Consortium

7 EU Member States +~~UK~~

- **from 2015**: France, Germany, Italy, Spain, ~~UK~~

- **and from 2019**: Poland, Portugal, Romania

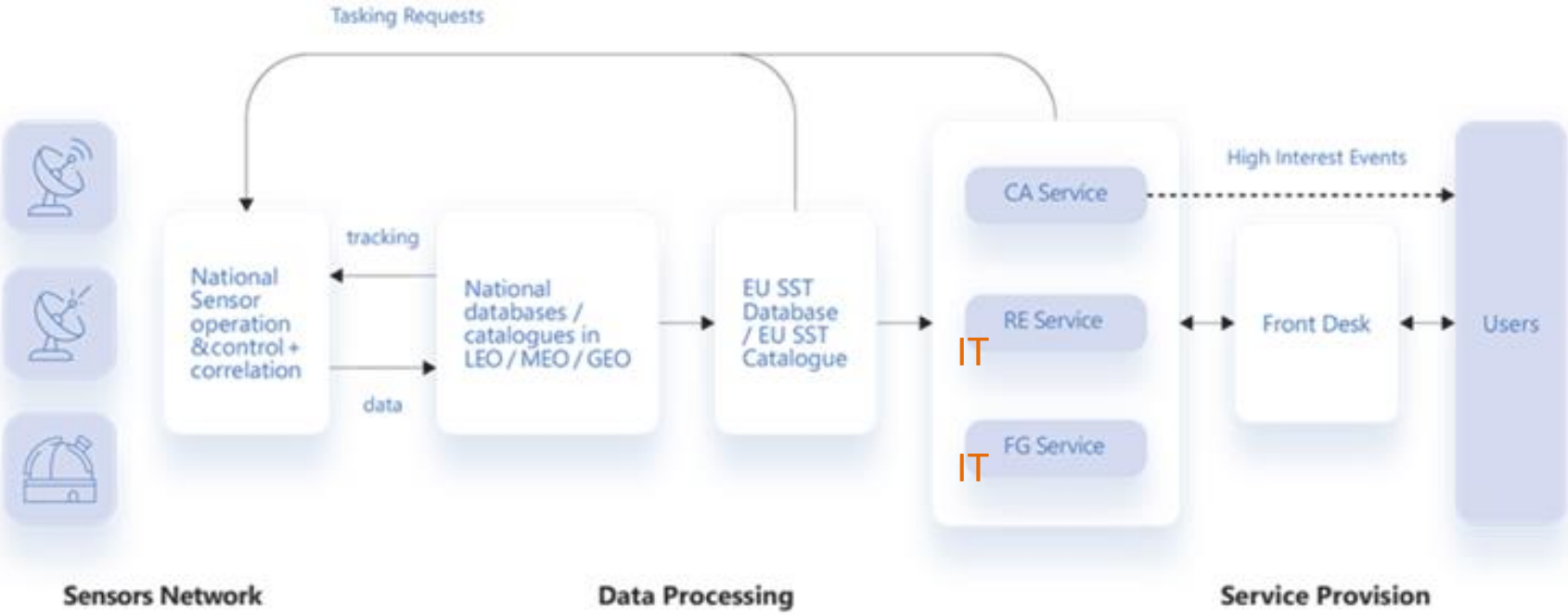
Collaboration with
Centro Satellitare Eu

Supervisor
European Commision

Italy is represented by the Italian Space Agency (National Entity), which participates in the Consortium together with INAF and the Ministry of Defense.

EUSST Sensor Network

EUSST operating block diagram

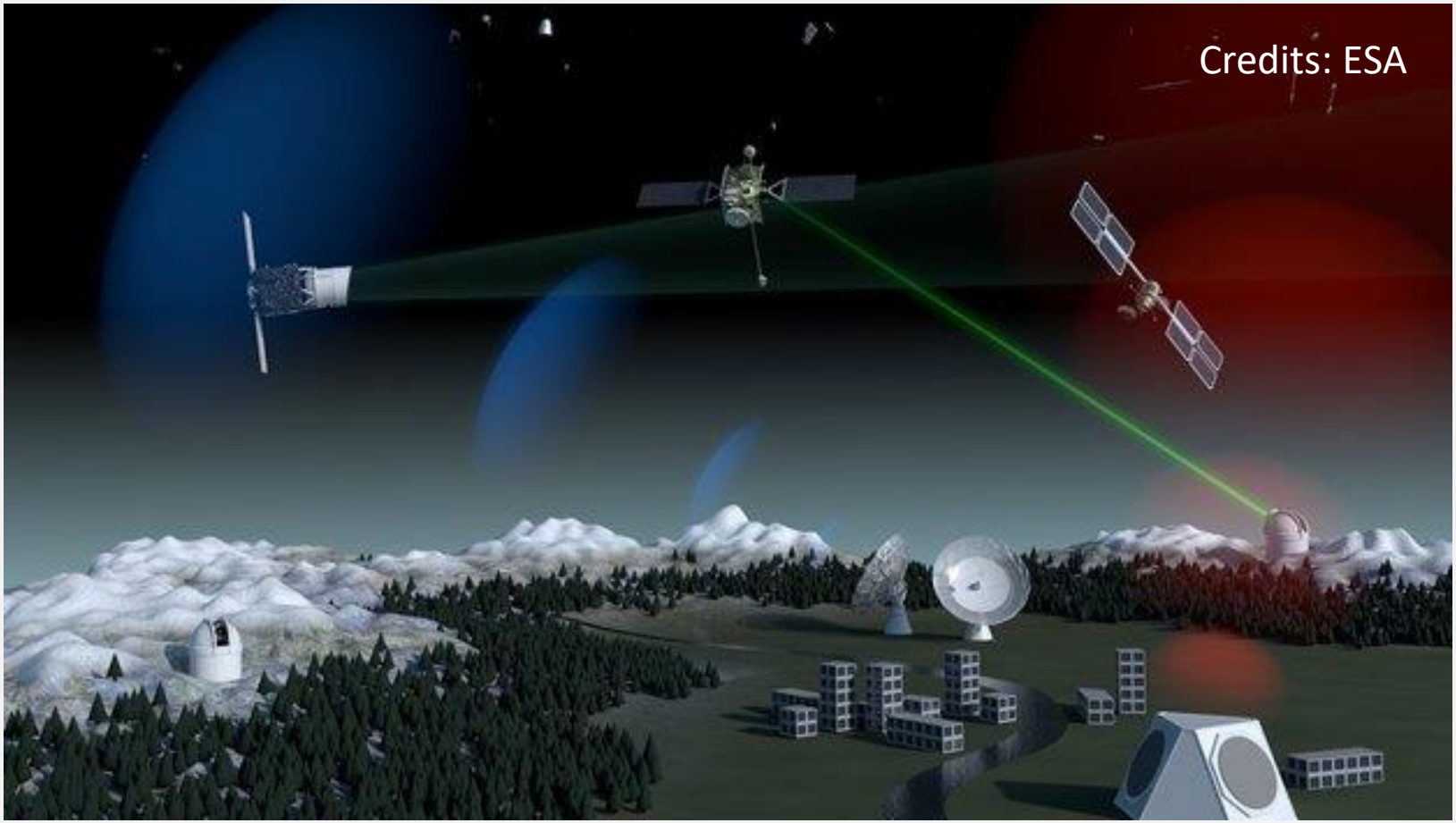


The RE and FG services are in charge of Italy, through the National Operations Center (ISOC) located at Pratica di Mare and managed by the Italian Air Force

Space debris monitoring

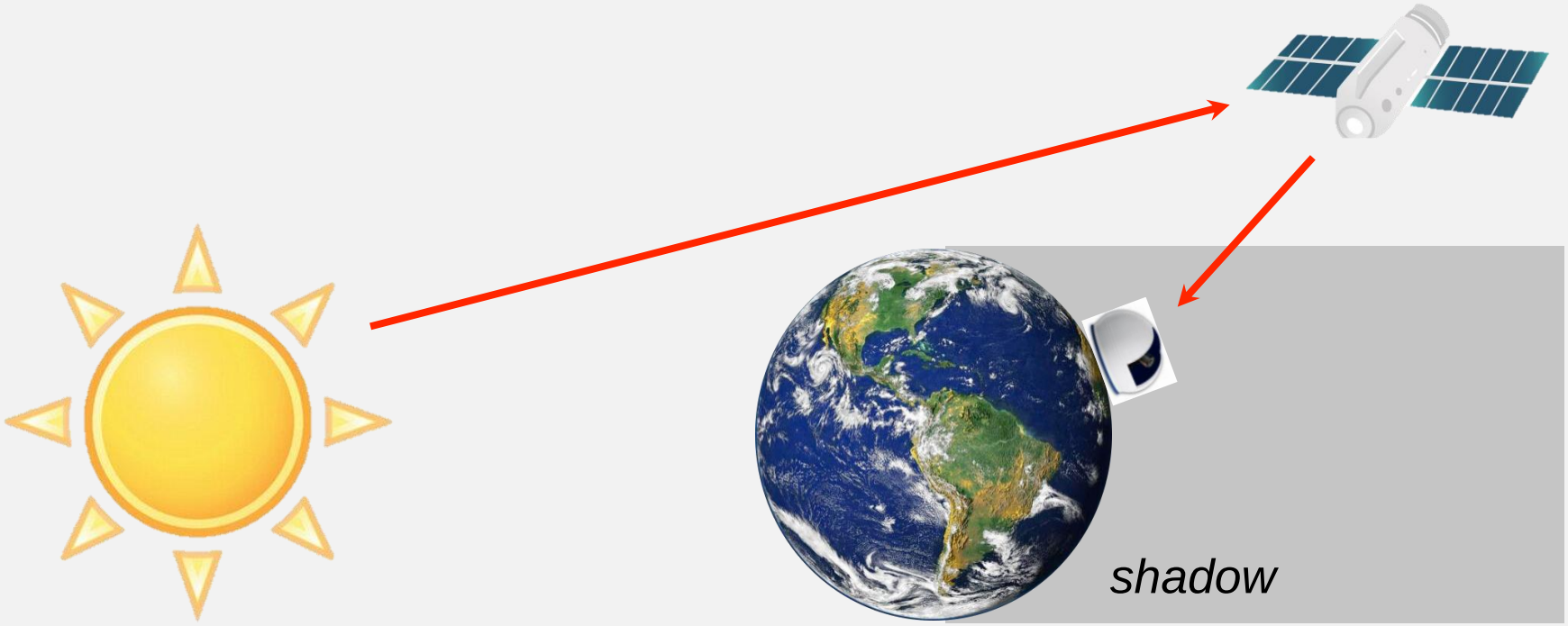
Sensors used for the space debris monitoring:

- Telescope
- Laser
- Radar

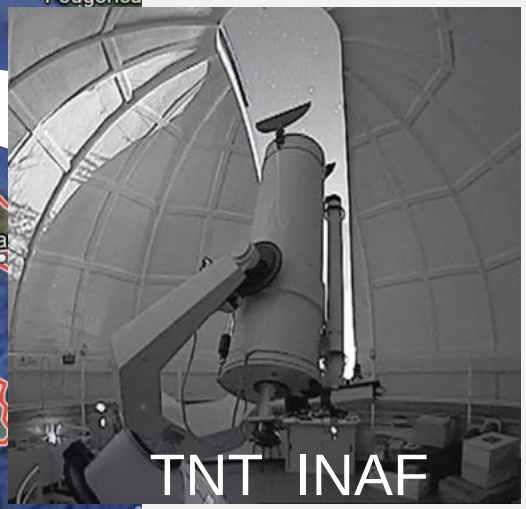


Telescope

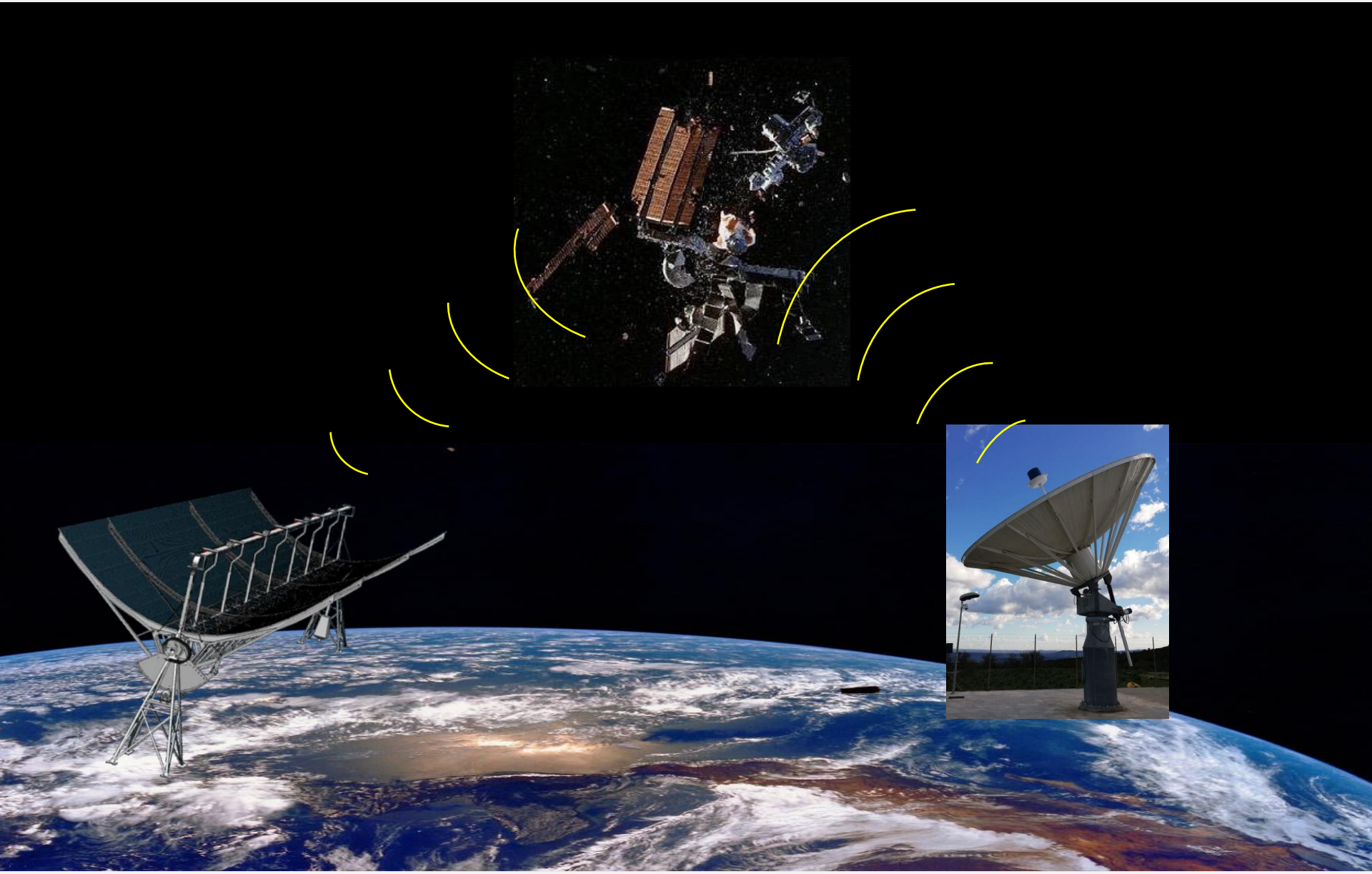
Some space debris reflect sunlight and they can be observed with optical telescopes. This technique can be used only for large debris and the observations can be carried out only in the night.



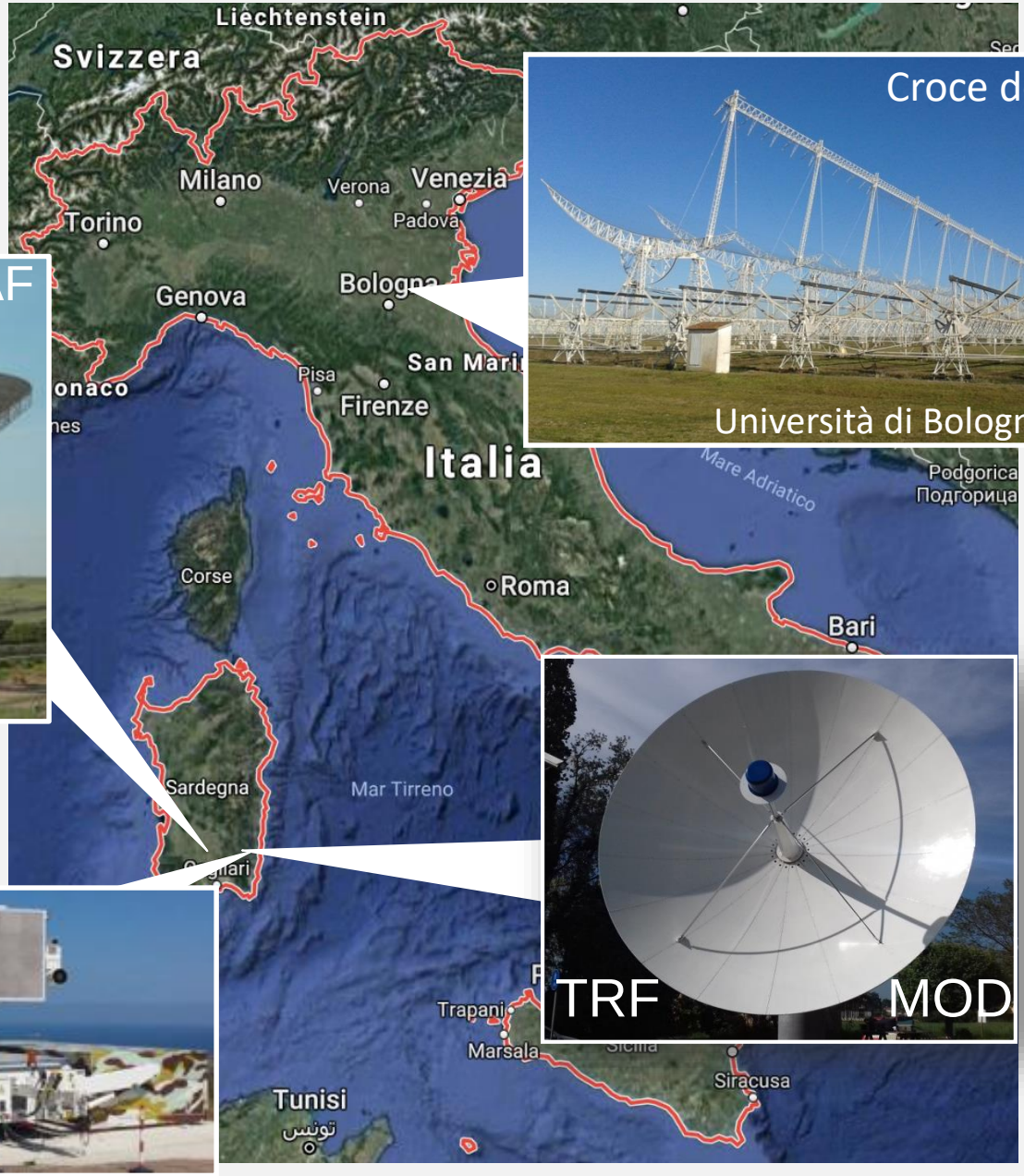
Italian telescopes

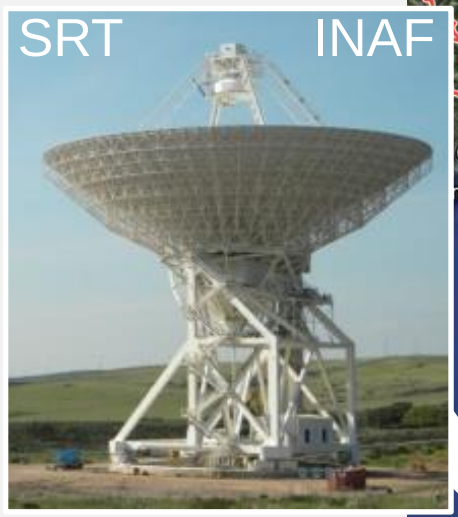


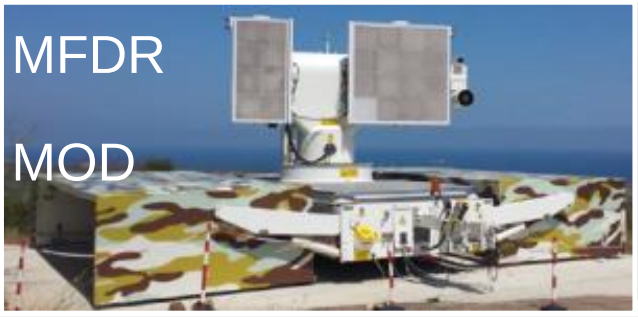
Radar



Italian radars

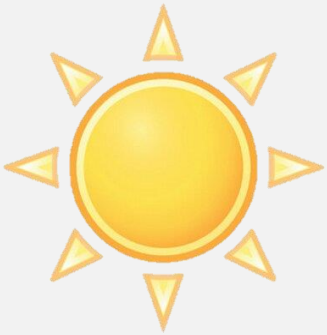


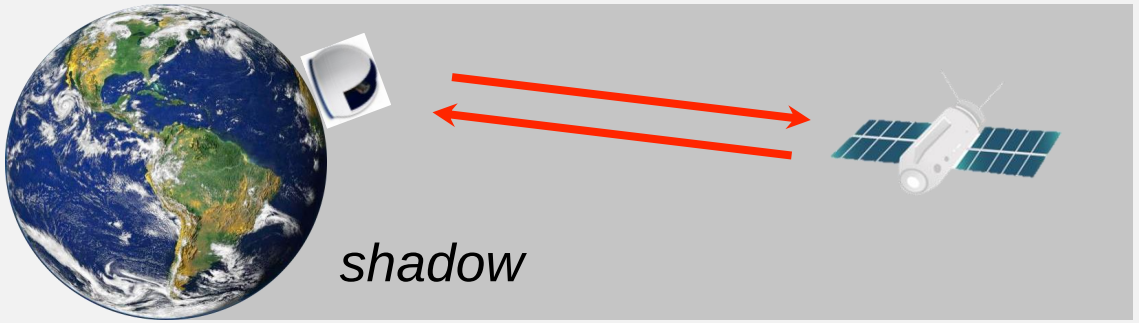


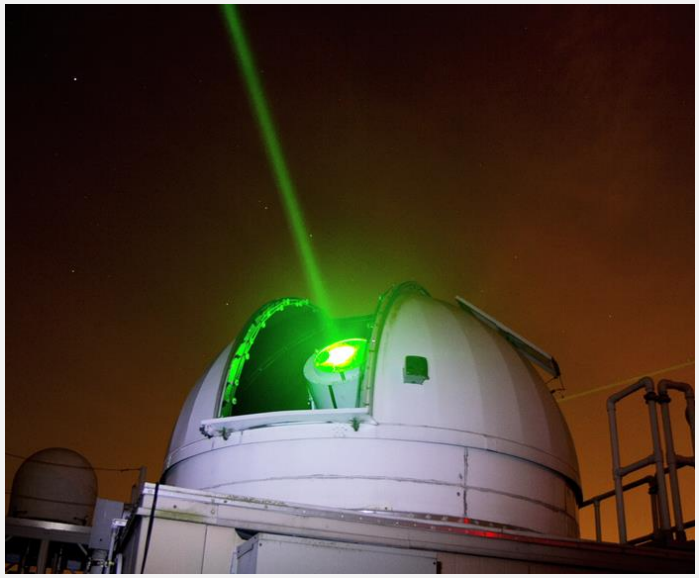


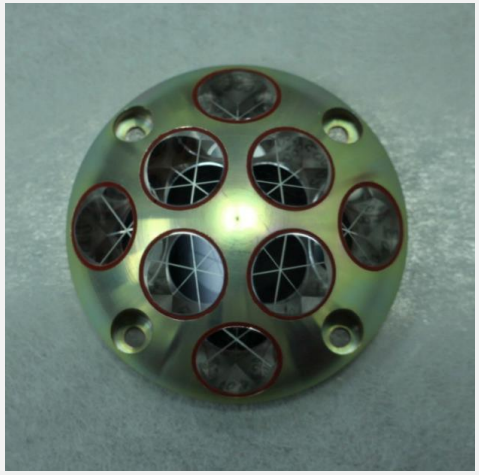
Laser

Laser "illuminates" the satellite and the telescope receives the reflected light. This technique is usually used for satellites with retroreflectors. Observations can be done at any time (weather conditions permitting).







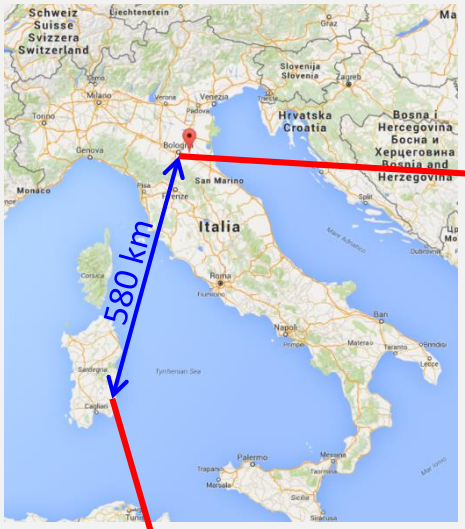


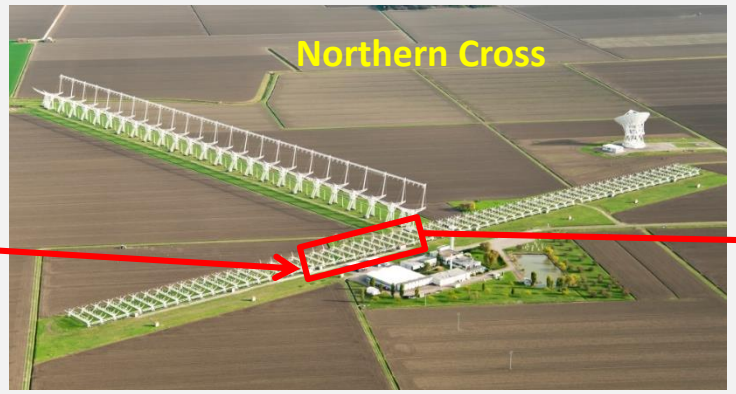
Retroreflector mounted on satellites

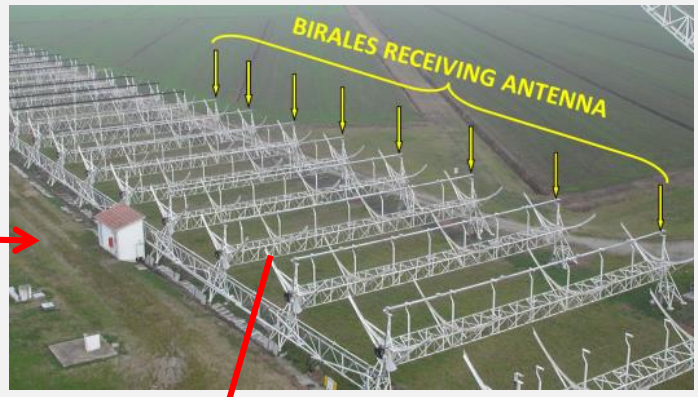
Italian laser

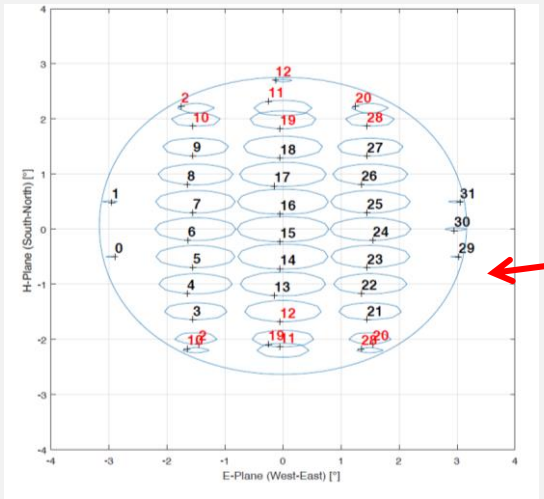
BIRALES: an Italian SST ground sensor

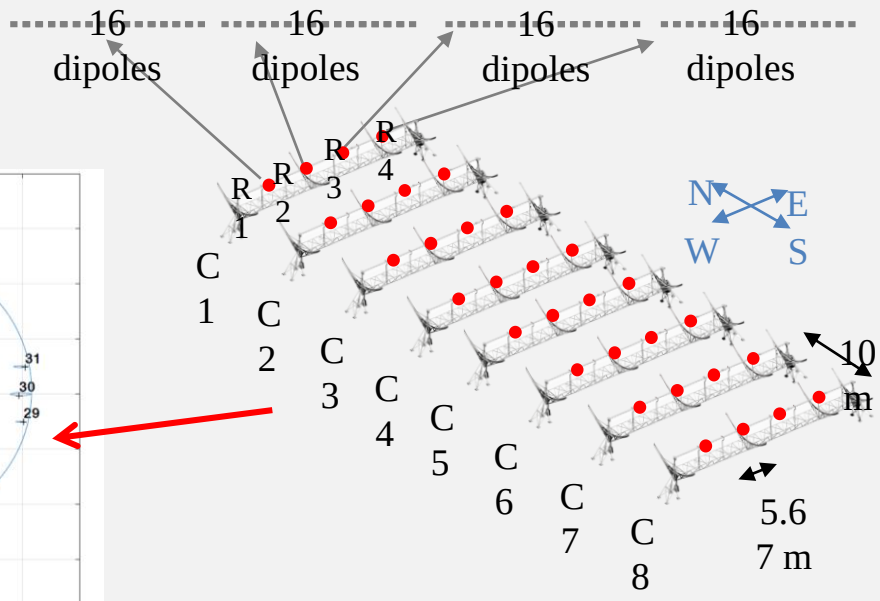
(BIstatic RAdar for LEO Survey)



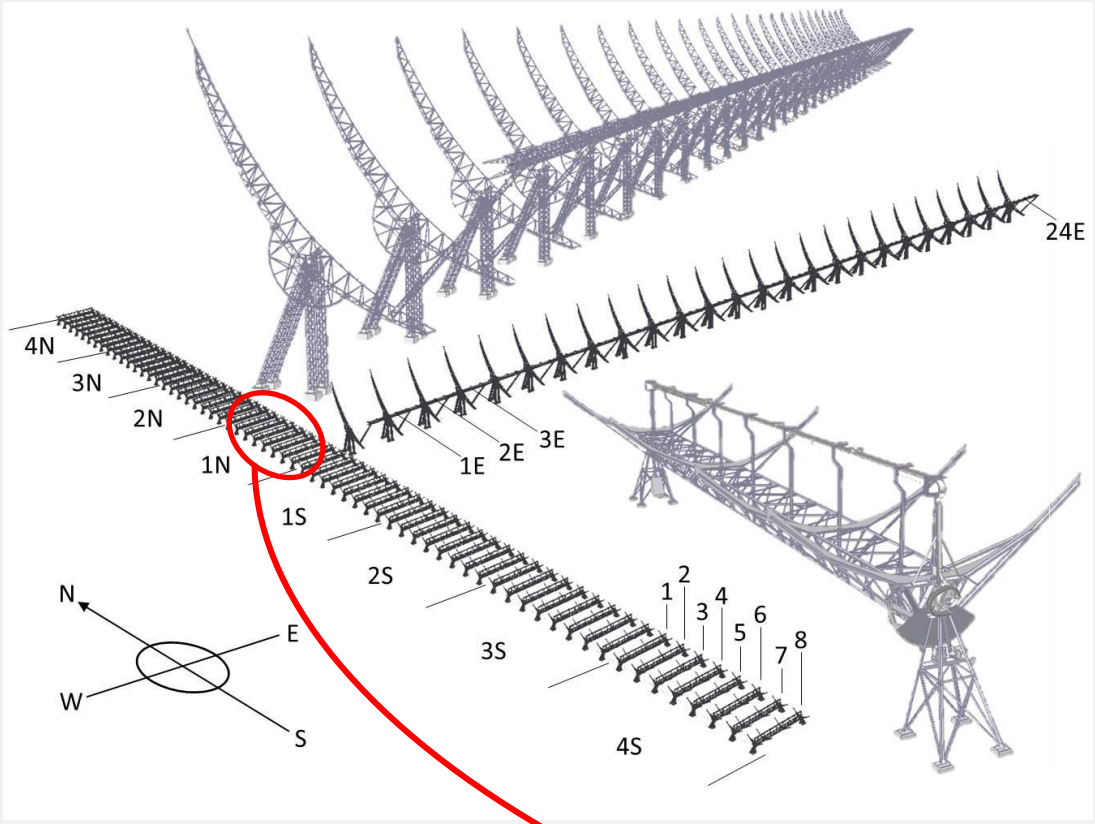


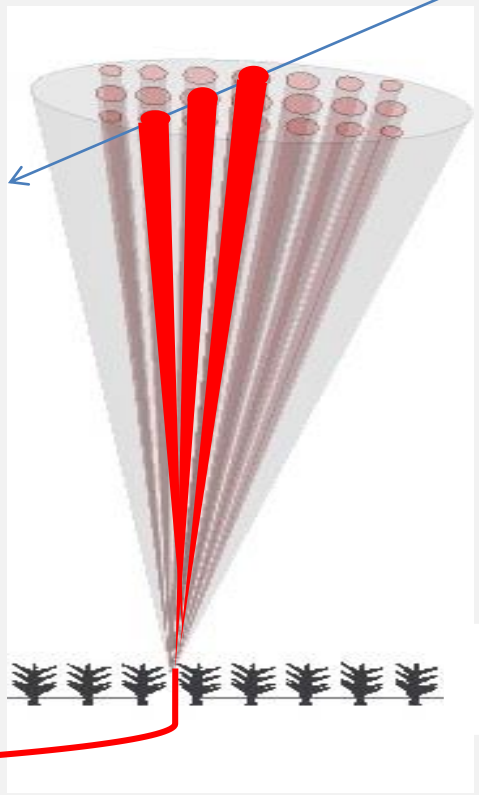


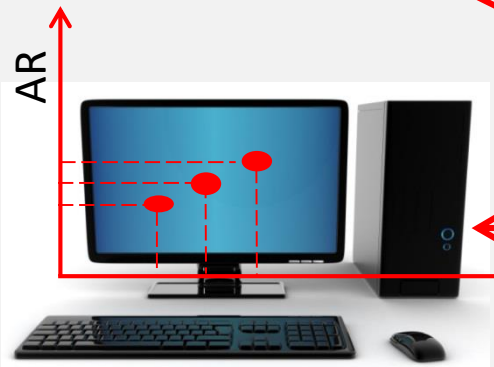




BIRALES: operation



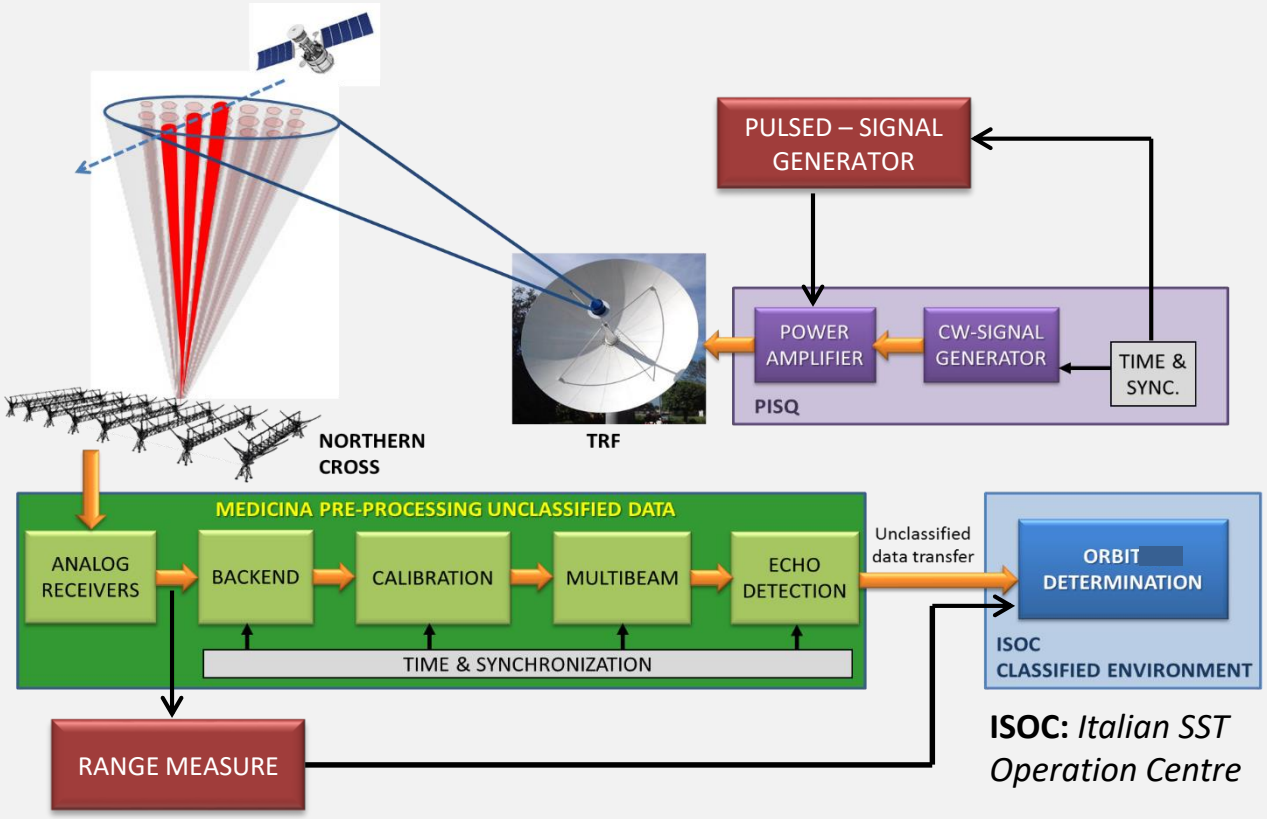




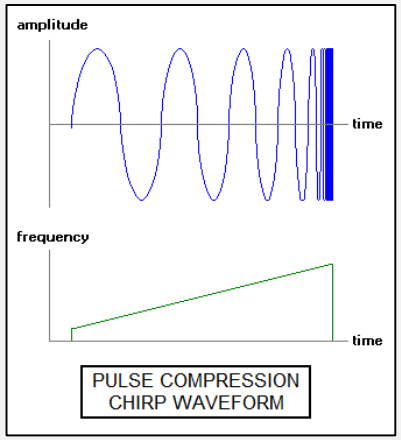
BIRALES architecture

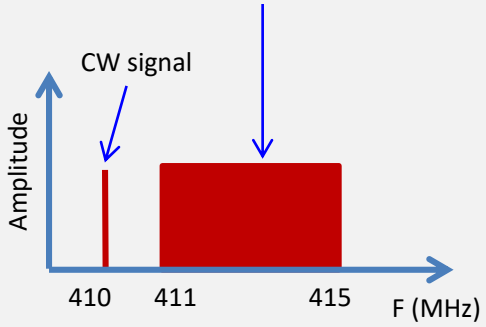
The sensor couples two radar systems:

- Multibeam CW system
- Single beam pulse compression radar



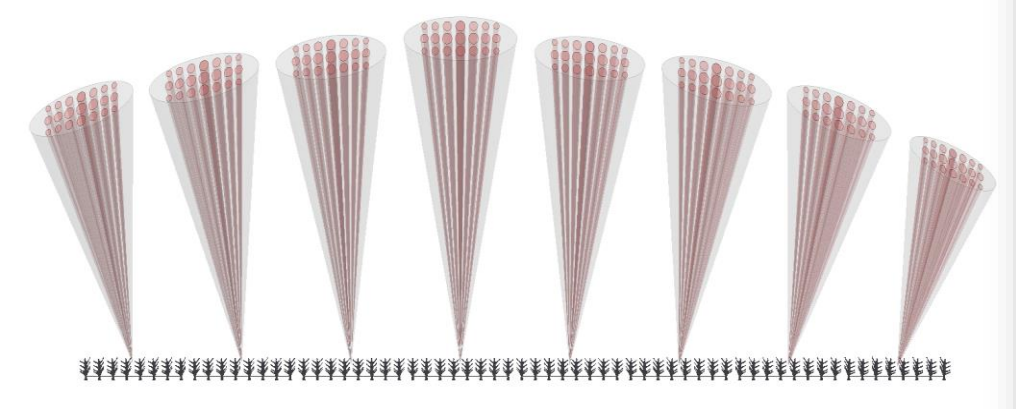
ISOC: *Italian SST Operation Centre*

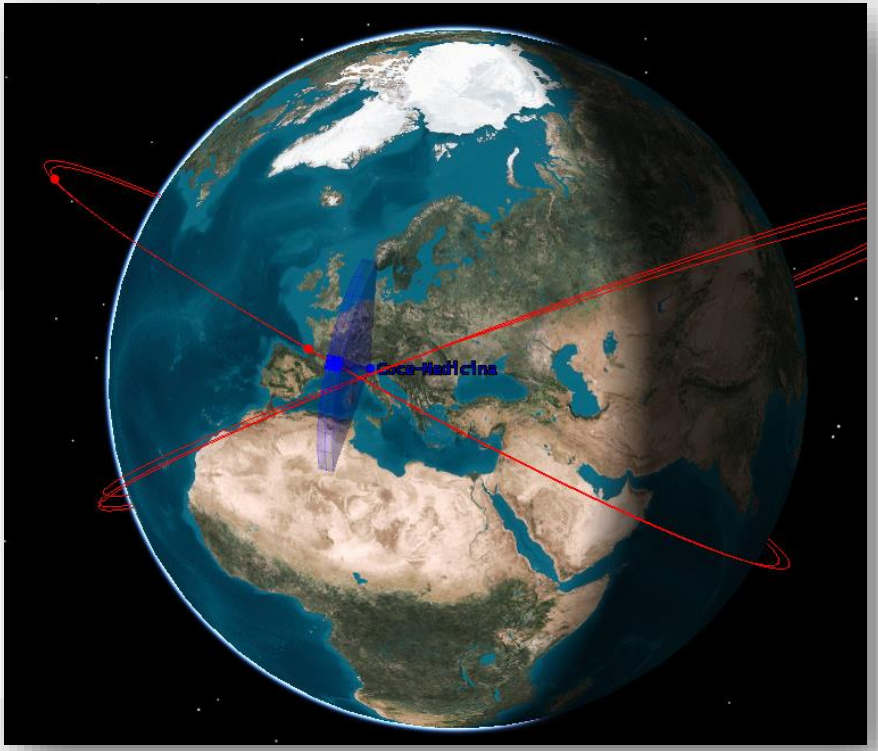




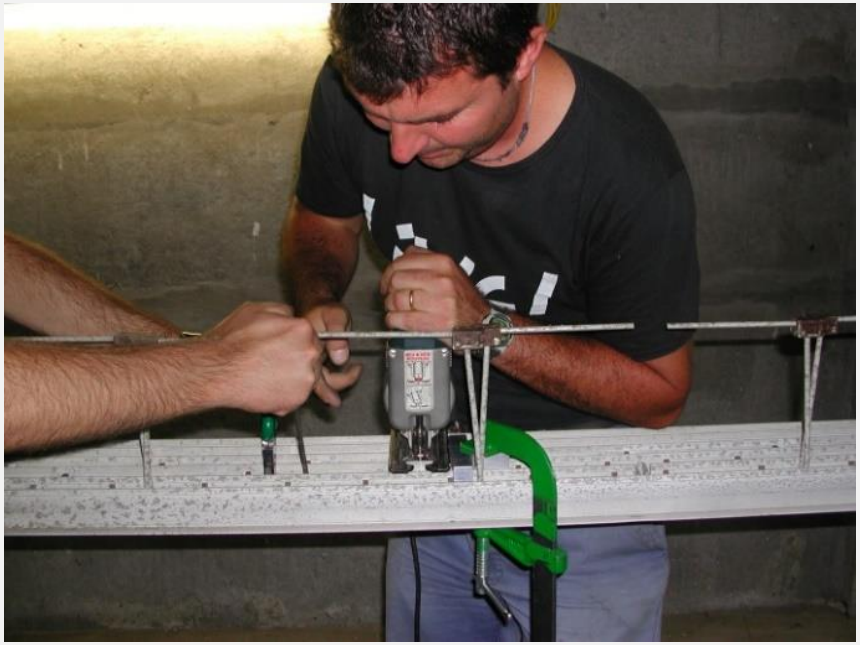
BIRALES field of view

90° x 7°

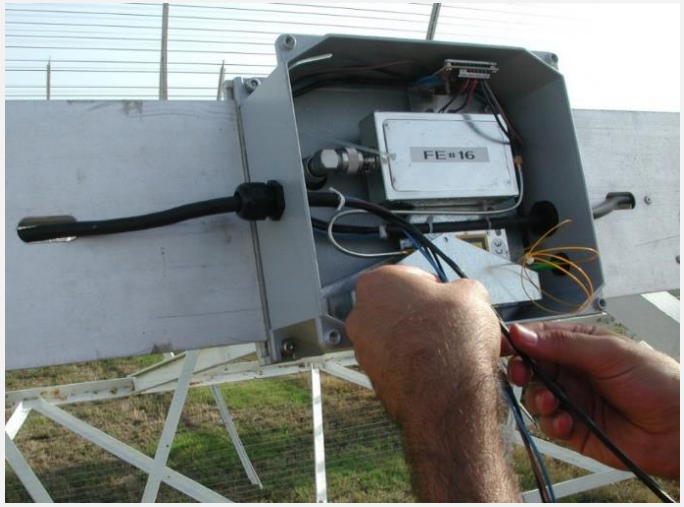


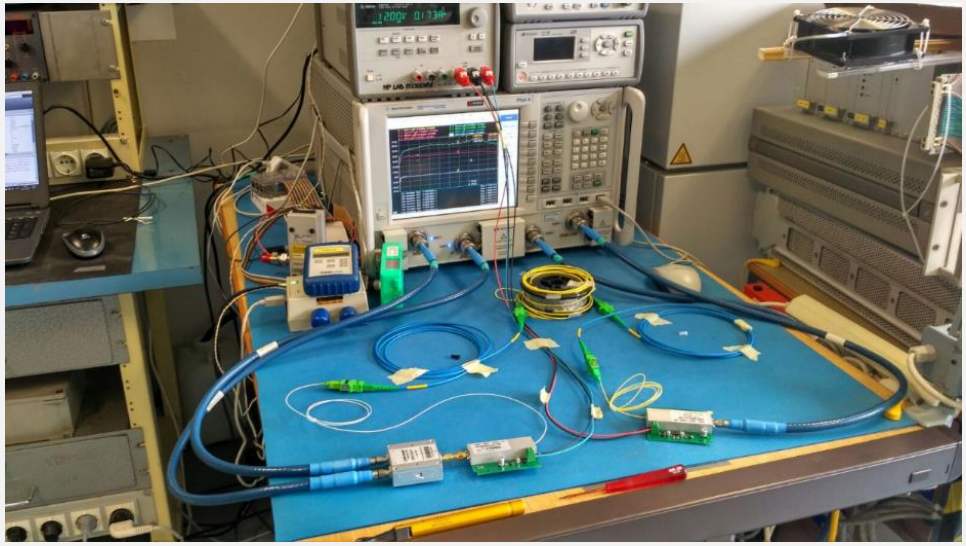


Modification of the focal lines



Receivers assembling, test and installation on the focal lines



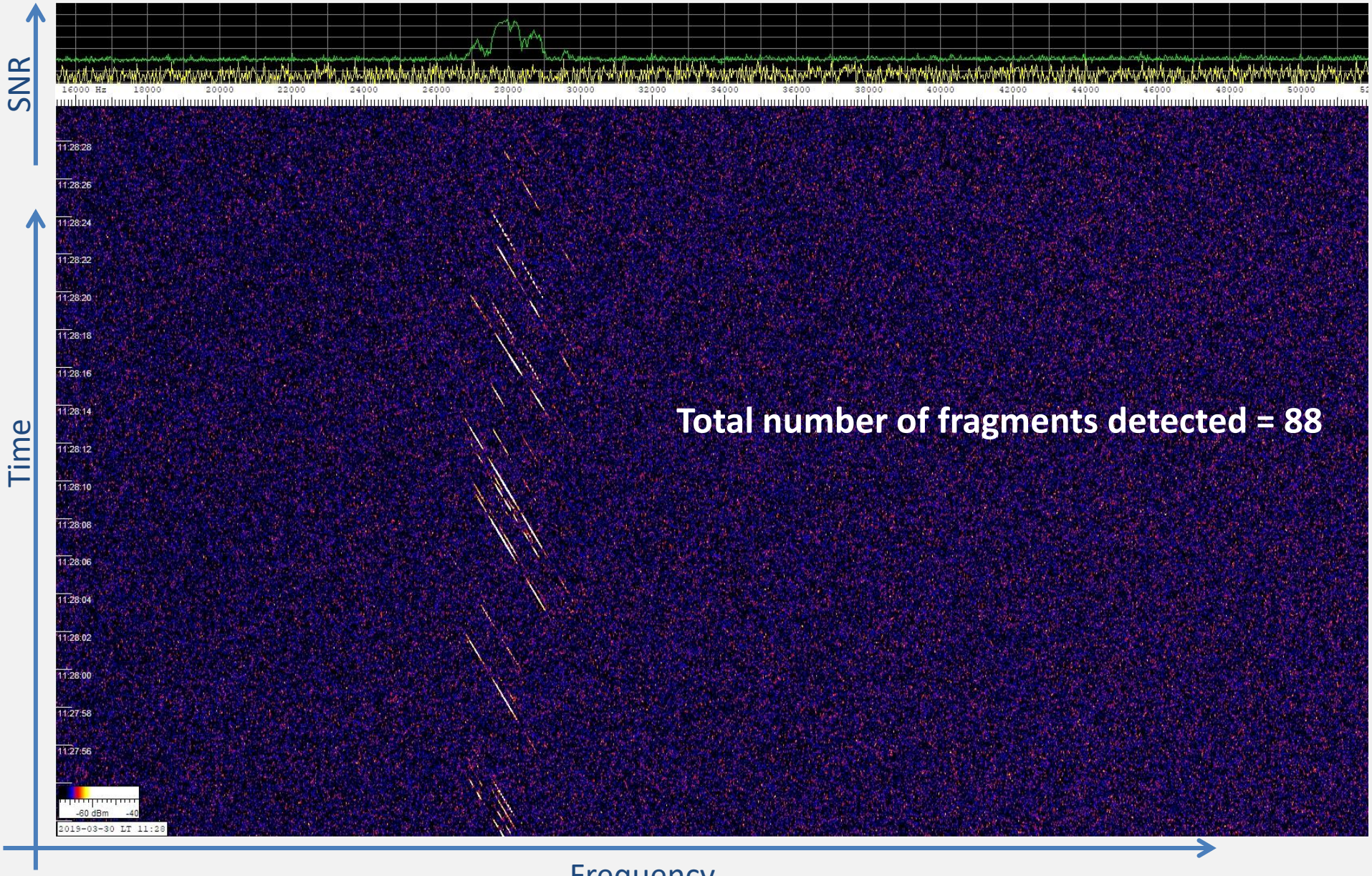


Installation of optical fibres

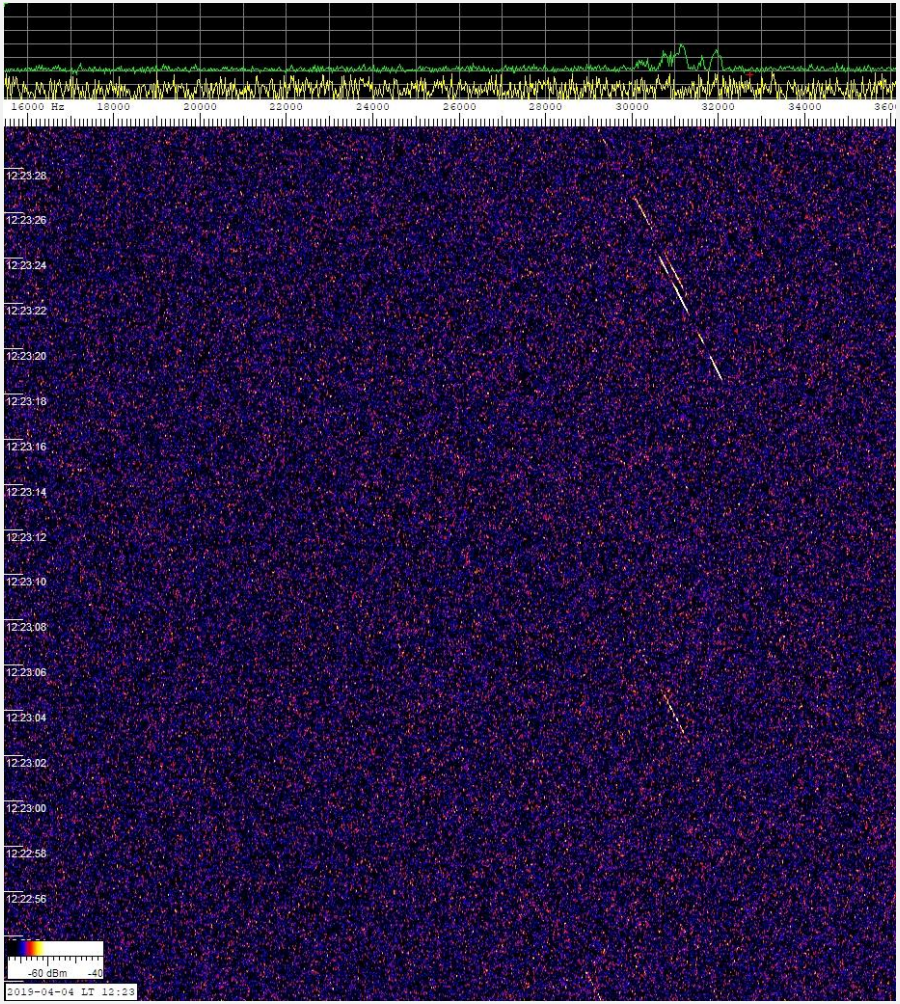
BIRALES fragmentation campaign on Indian MICROSAT-R satellite

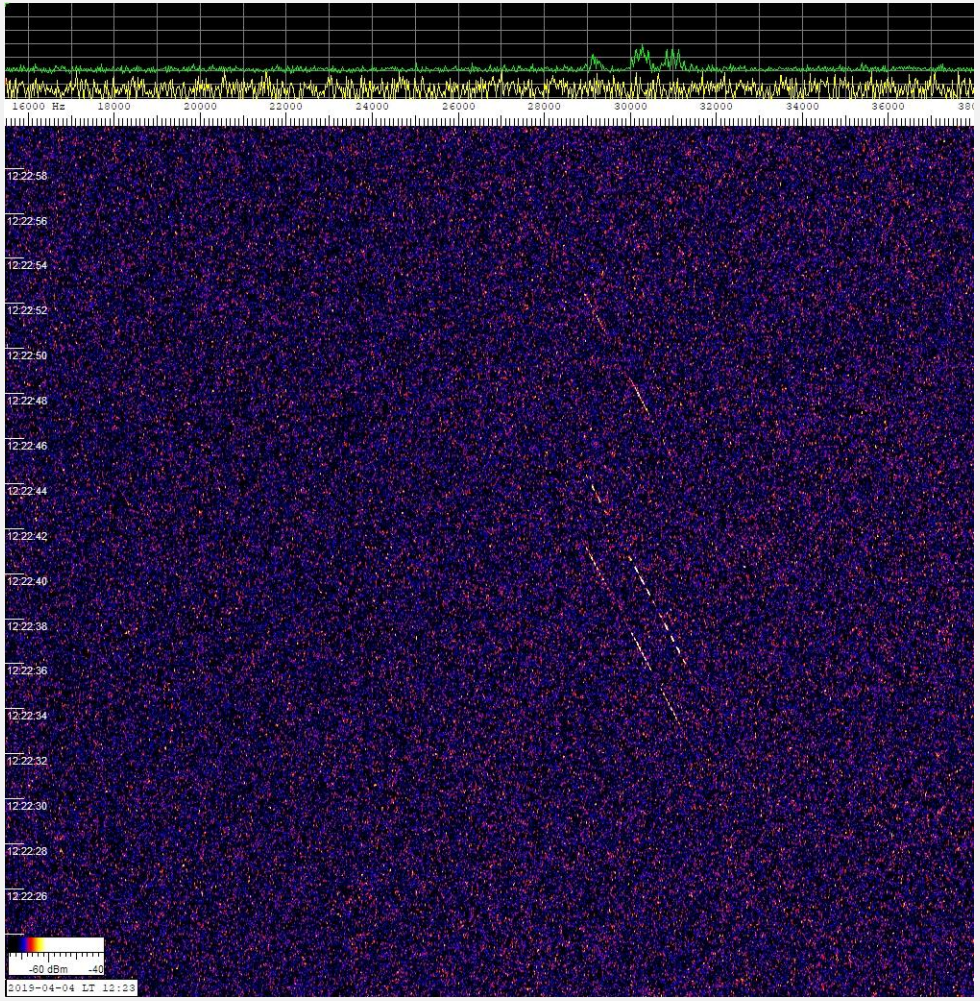
NAME = MICROSAT-R (2019-006A, #43947)
LAUNCHED = 24 January 2019
WEIGHT = 740 kg
EXPLOSION = 5:40 UTC - 27 March 2019

Cloud of fragments



Cloud of fragments after 1 week





Re-entry campaign of the chinese Long March CZ-5B R/B / 2021-035B

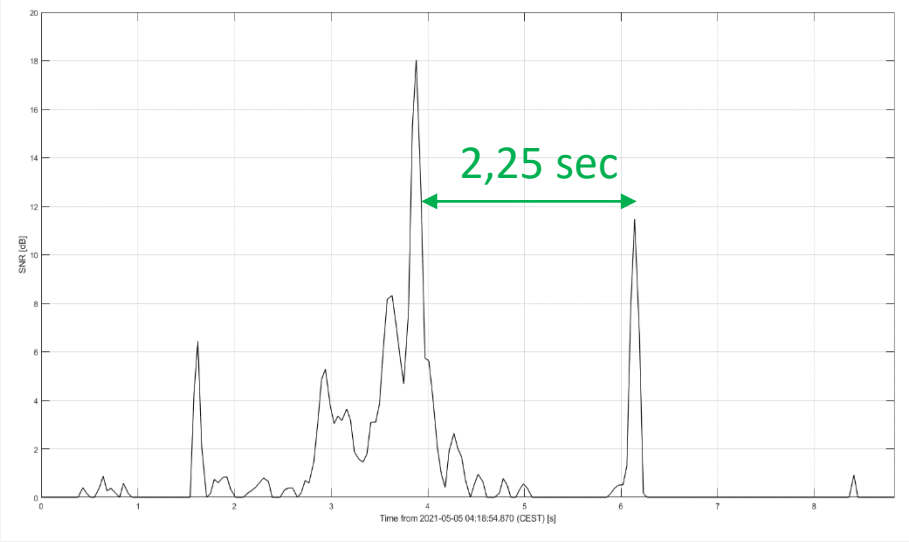
BIRALES was involved in the re-entry campaign of the Long March starting from the 3 May up to 9 May (day of the re-entry)

Measures were made at each passage of the rocket over Italy and fundamental and strategically important contributions were made for national and European security.

Re-entry campaign

Long March CZ-5B R/B/2021-035B

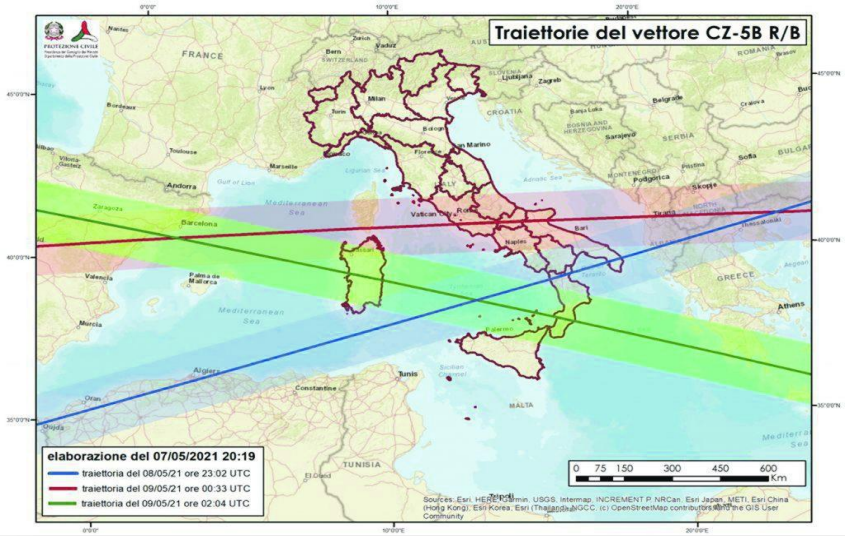
Variation of the received SNR vs time



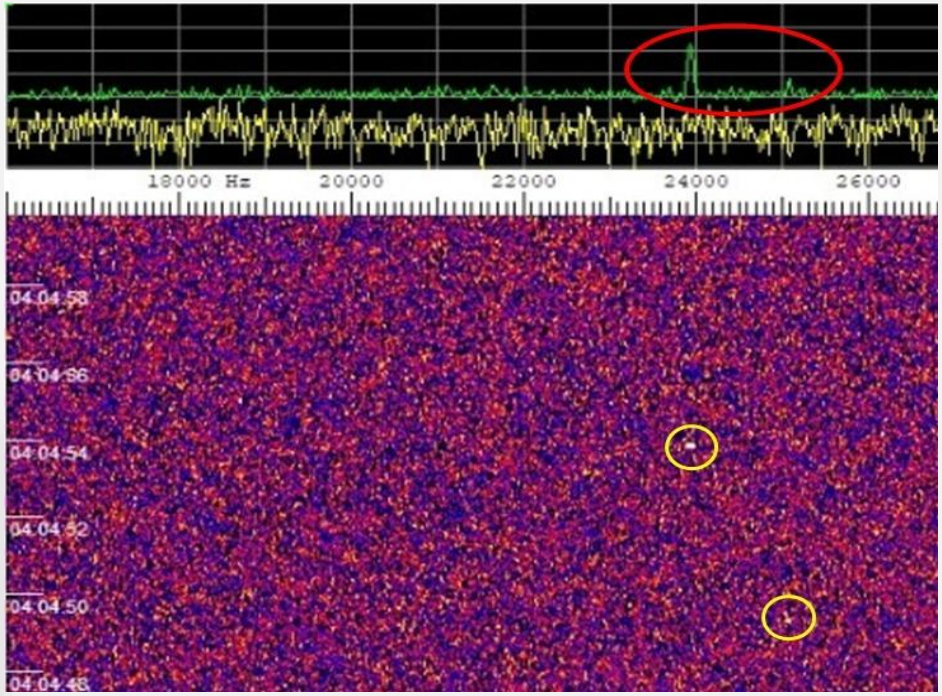
Rotation period about 4,5 sec

Last orbits before the re-entry
(9 May 2021)

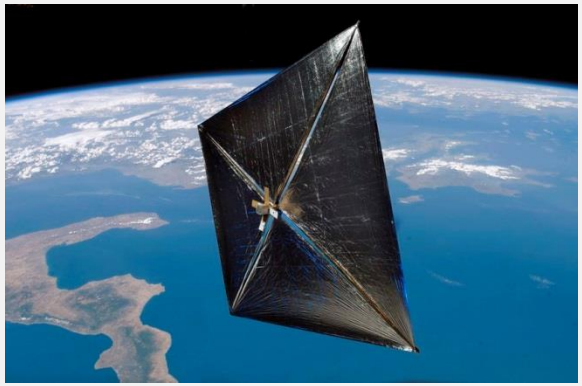
At 4:04:49 (local time) an echo appears on the Northern Cross monitor, so the object was still in orbit and therefore Italy would not have been involved by falling fragments.



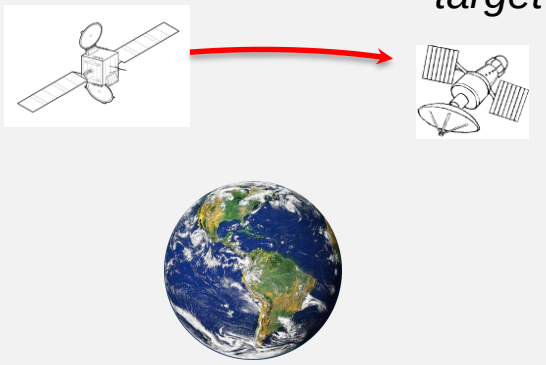
Eco detected by the Northern Cross



Mitigation plan and guidelines

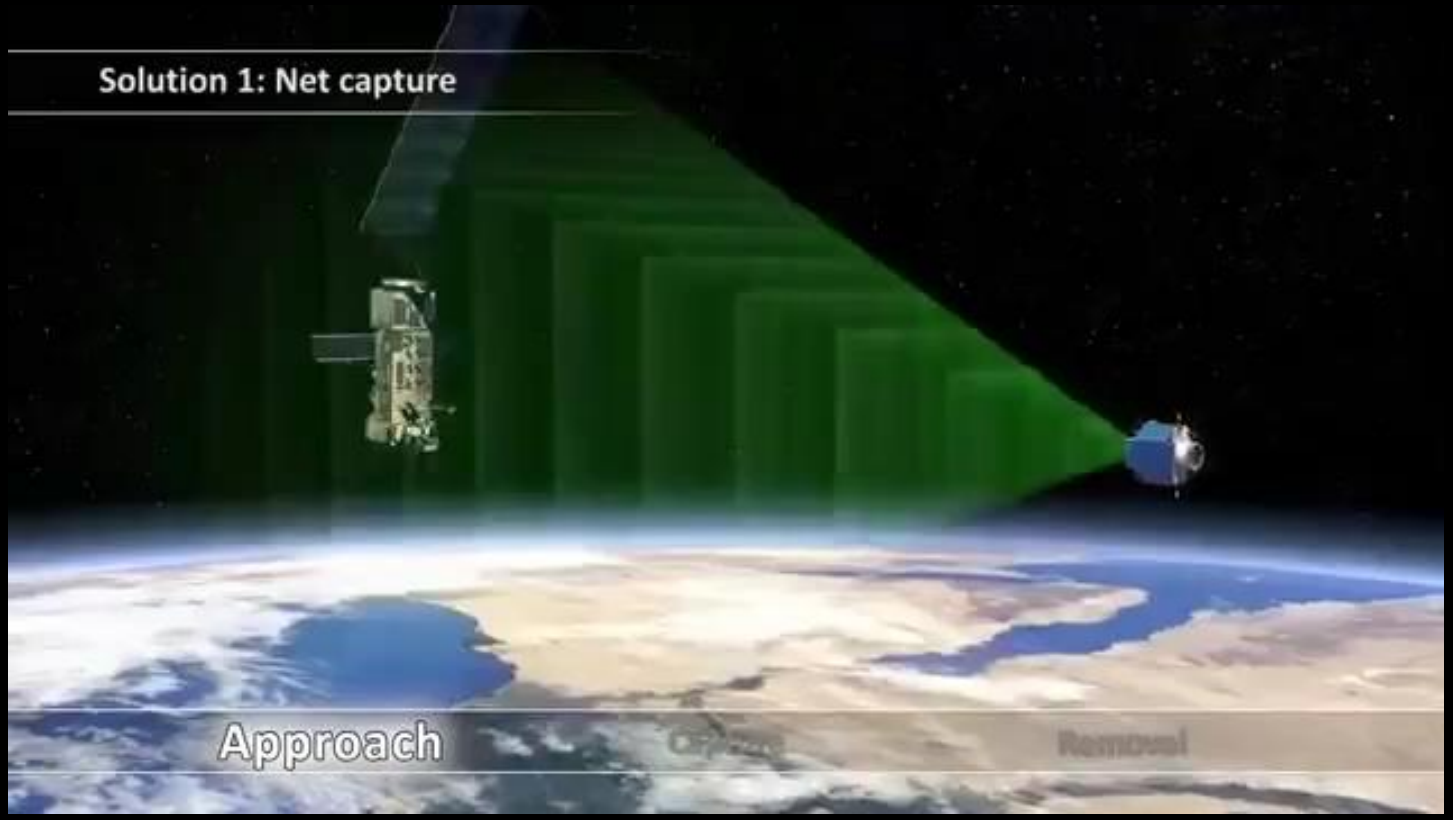


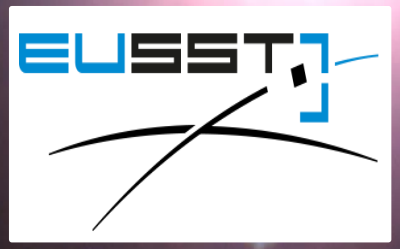
- Guidelines for future space missions:
  - Expel residual propellant
  - Low orbits: re-entering within 25 years
  - High orbits: cemetery orbits
- Procedure for Active Debris Removal (only for large debris)



Envisat

Active Debris Removal





Thank you

In collaboration with