

SAR activities and future plans at the Italian Space Agency.

ASI – Earth Observation Division

ASI SAR developments & evolution





SAR FLAGSHIP MISSION

COSMO-SkyMed

COSMO-SkyMed Second and Future Constellation

COSMO-SkyMed - The First and the Second Generation

COSMO-SkyMed Second Generation (CSG) will:

- Ensure operational continuity to the currently operating constellation
- Achieve a step ahead in terms of functionality, performances and system services for the Earth Observation users

The 4 CSG Satellites will have an operational lifetime of at least 7 years. Evolutive approach already in place with FM3 & FM4



COSMO-SkyMed is the Italian end-to-end System for Earth Observation, funded by:



CSG IMPROVEMENTS IN ACQUISITION MODES

CSG HIMAGE mode:

- A Quad-Pol mode introduced

CSG Spotlight standard mode:

- Improved resolution
- Separation between spotlight images is ~ 100 km

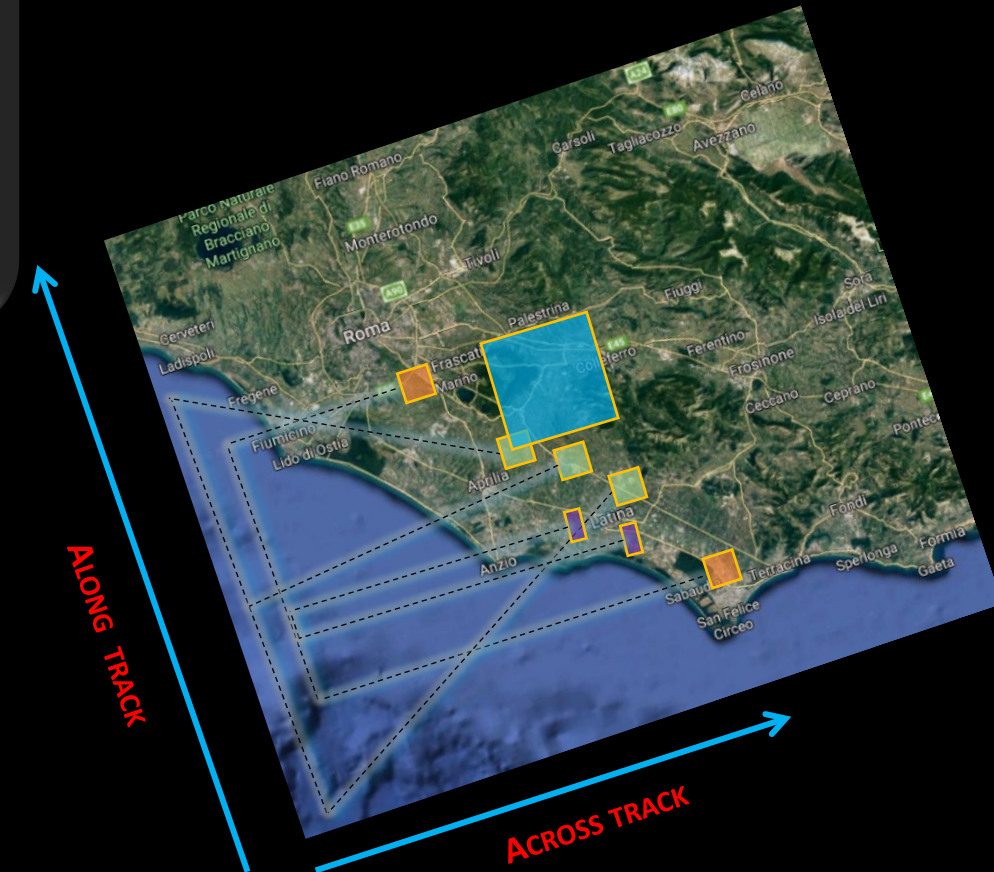
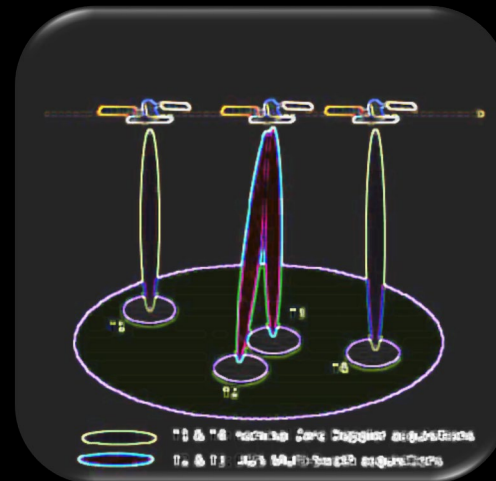
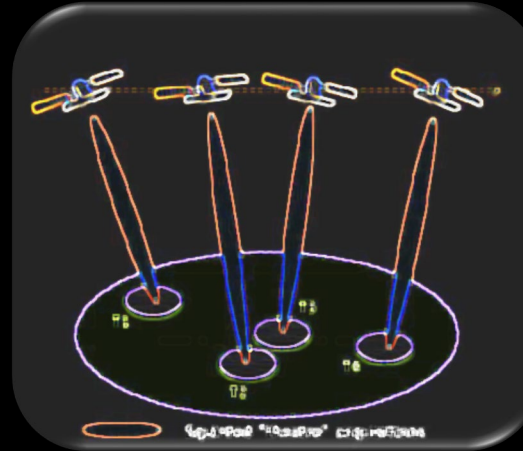
CSG Theatre mode:

- The platform agility allows to perform pitch maneuvers
- **More images in a theatre region** can be acquired

CSG DI2S:

- The SAR instrument capabilities allows to acquire **two targets almost simultaneously** (using double PRF)
- The swath is reduced in range

NOT STANDARD ACQ. MODES



Future COSMO-SkyMed: Beyond the Second Generation

CSK

CSG

The FUTURE

SPOTLIGHT

Very High Resolution
VHR (*sub-metric*)
Governmental Use

Ultra-High Resolution (UHR)
Governmental Use

Resolution: 1 m
Single Polarization
Size 10 km x 10 km
Civilian and Defence use

Spot-2
VHR and Dual Pol. (**)
Sp-2A res. $\leq 0.35 \times 0.55$ m
Swath $\geq 3.1 \times 7.3$ Km
Sp-2B res. $\leq 0.63 \times 0.63$ m
Swath $\geq 10 \times 10$ Km
Sp-2C res. $\leq 0.80 \times 0.80$ m
Swath $\geq 5 \times 10$ Km
Civilian and Defence Use

STRIPMAP

Resolution: 3 m
Single Polarization
Swath Size 40 km
Civilian and Defence use

Resolution : 3m x 3m
Swath Size Dual Pol 40 km
Swath Size QUADPOL 15 km
Civilian and Defence use

SCANSAR

Resolution: 30 m
Single Polarization
Swath Size: 100 km
or
Resolution : 100 m
Single Polarization
Swath Size: 200 Km
Civilian and Defence use

Resolution : 4 x 20 m
Double Polarization
Swath Size : 100 km
or
Resolution : 6 x 40 m
Double Polarization
Swath Size: 200 Km
Civilian and Defence use

- » New architectures: a system of systems
 - » GEO and LEO elements
 - » Multi-Sensor capabilities (X and L band SAR)
 - » Multi modes: mono and bi-static SAR
 - » VHR capabilities
- » Enhanced performances
- » Systematic approach and new on-demand services



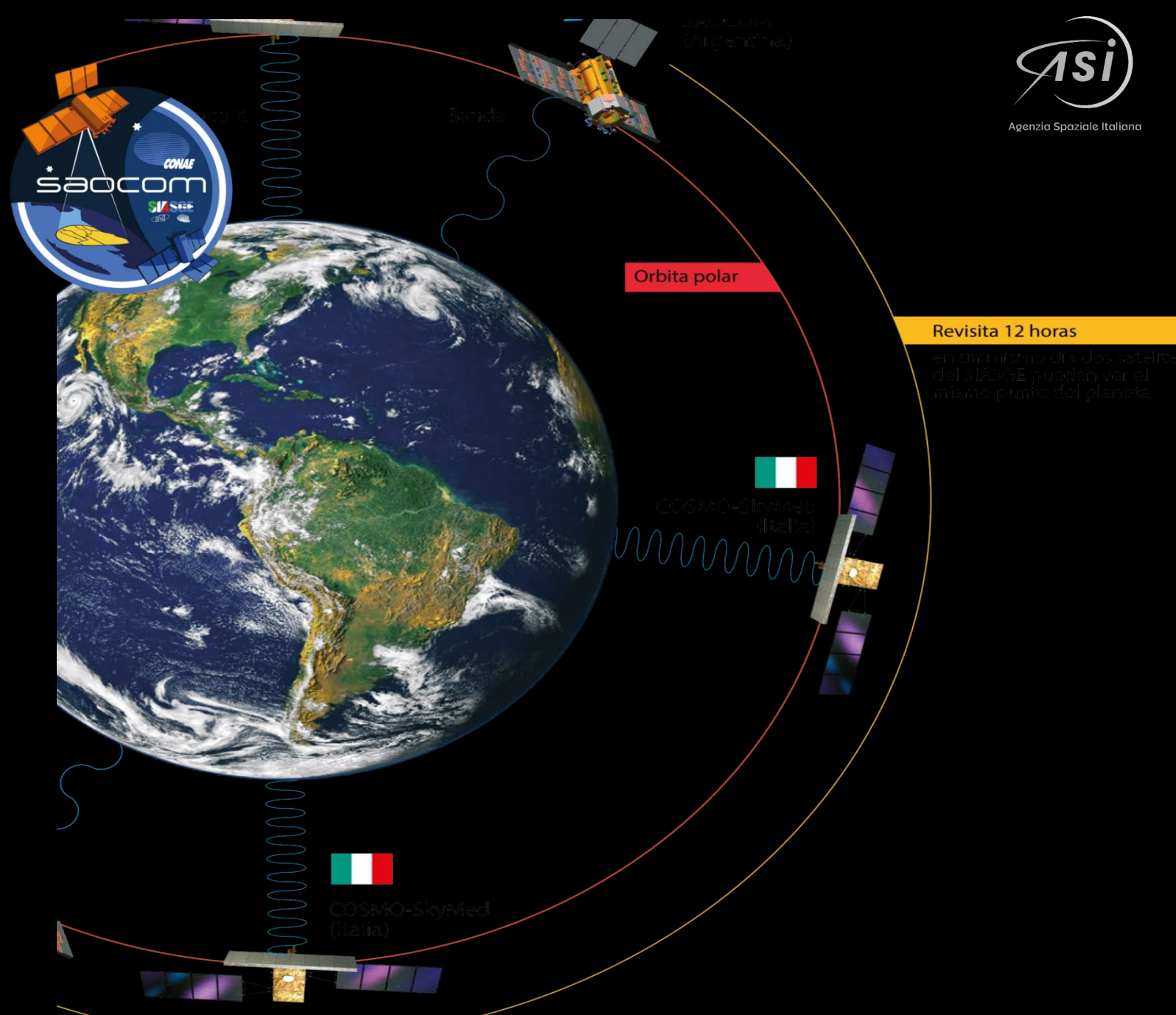
SIASGE

SIASGE is the Italian-Argentinian satellite system for Disaster Management and economic development. Such system is the result of the partnership between two countries, which have decided to develop together an operationally integrated system to manage and prevent major natural and environmental emergencies.

The SIASGE system is made up of:

- **COSMO-SkyMed** which acquire images through a SAR sensor in the X-band;
- **SAOCOM** which can shoot images with a SAR in the L-band.

The SIASGE system meets the needs of the civilian communities of both countries and of the international community as well, in the areas of monitoring and management of environmental risks, emergency management, scientific and commercial applications



SAOCOM - L-band polarimetric SAR



Agenzia Spaziale Italiana

SAOCOM-SAR is an L-band polarimetric SAR instrument, the prime payload of the mission providing all weather, day/night observations to satisfy most of the applications considered in the Argentinean National Space Program, involving studies on agriculture, fishery, forestry, weather, hydrology, oceanography, emergencies, natural resources of land and sea, urban areas, cartography, geology, mining, soil exploitation, archeology and health



Parameter	Value	Parameter	Value
Center frequency	1275 MHz (L-band)	Antenna looking angle	left or right side of path (left side is default)
		Incidence angles	20-50°
Maximum bandwidth	<45 MHz	Data quantization	8 bit
Transmit peak power	3.1 kW	Duty cycle	15% (about 15 min/orbit)
Operational modes	Stripmap TopSAR	Stripmap high resolution TopSAR wide mode	10 m x 10 m (pixel) 100 m x 100 m (pixel)
Stripmap swath width	> 65 km (each beam)	ScanSAR wide swath TopSAR narrow swath	> 320 km > 170 km (quadpol)
Signal transmission	HH or VV polarization	Signal reception Reception (double polarization)	HH or VV (single pol.) HH & HV or VV & VH
NESZ (Noise Equivalent Sigma Zero)	<-25 dB	Stripmap mid-resolution TopSAR narrow mode	25 m x 25 m (pixel) 50 m x 50 m (pixel)



SAOCOM – in the frame of SIASGE



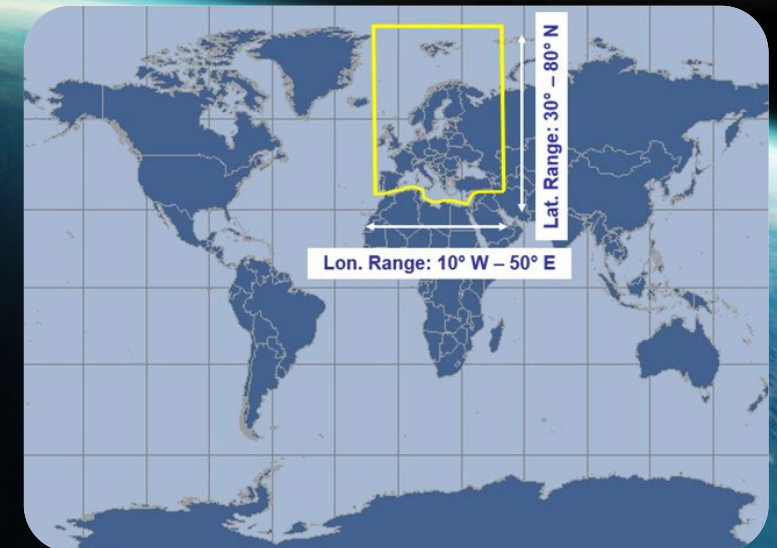
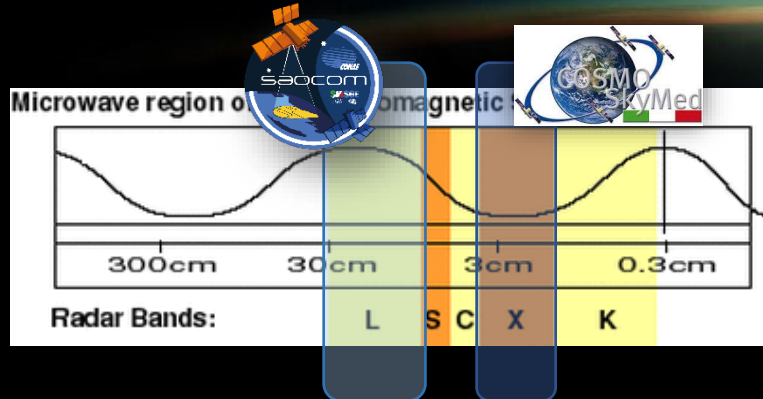
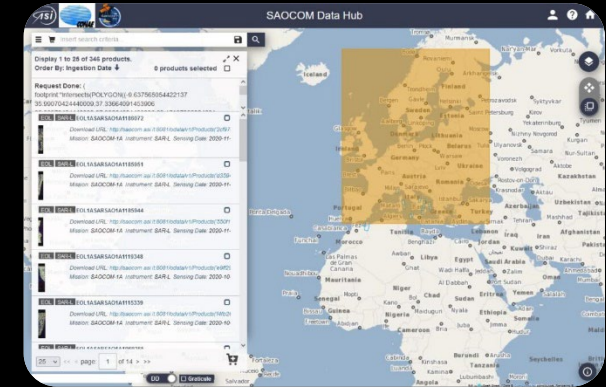
Agenzia Spaziale Italiana

2 Argentinian SAOCOM satellites (1A and 1B) with an L-Band SAR sensor onboard. Same orbit of COSMO-SkyMed satellites.

ASI has full utilization rights on its Area of Exclusivity AoE (approximately all the Europe territory).

Users:

- ✓ Scientific, institutional and commercial
- ✓ Italian and International
- ✓ only for non-commercial purposes



Access to data on ASI AoE:

1. Registration following the instruction at: <https://www.asi.it/en/earth-science/saocom/>
2. Access through the ASI SAOCOM Portal <http://saocom.asi.it:8081>



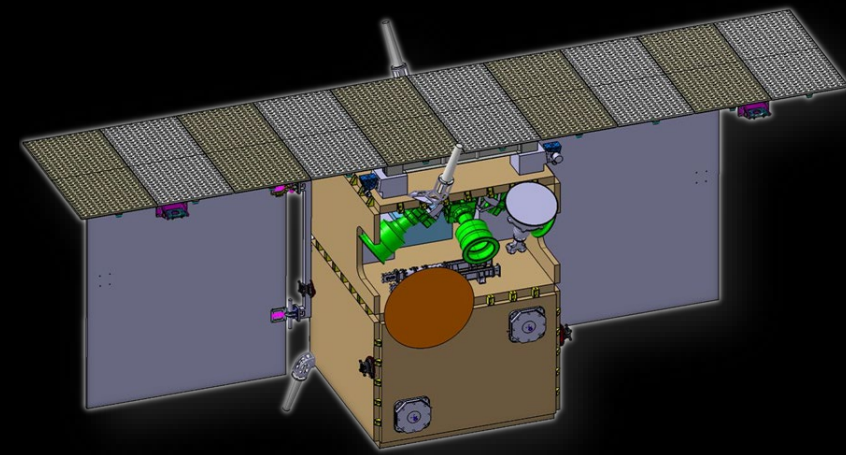
COMPACT SAR

PLATINO 1
SATURN
RODIO

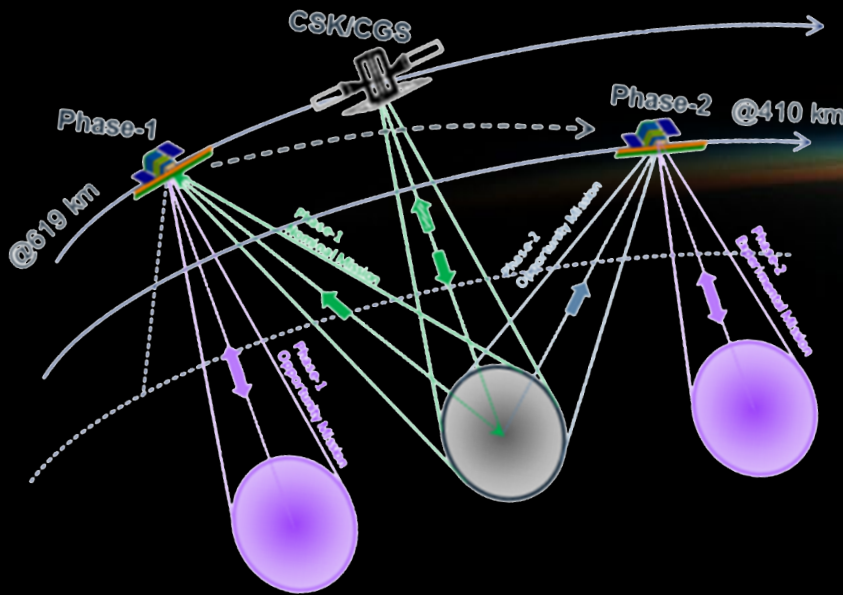
PLATiNO-1 – SAR Mission

Mission Phases are:

- Commissioning (LEOP and Commissioning) 3 months;
- Phase-1 (@619 km, formation flying with CSK/CSG) 1 year;
- Re-orbit phase (orbit transfer with HET) 6 months;
- Phase-2 (@410 km, monostatic acquisition) 1.5 years;
- De-orbiting phase 6 months.



During Phase-1 PLT-1 will mainly work as a receiver acquiring from Earth the signal generated by CSK/CSG

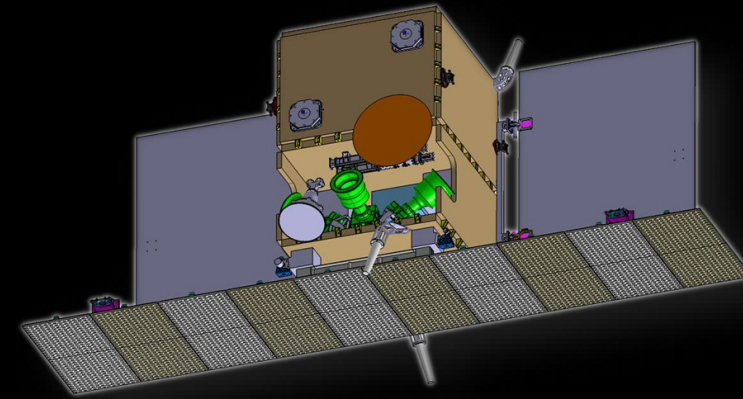


PLT-1 shall be sized to provide the capacity to acquire, downlink and archive images totaling **20000 km² daily**.

Bistatic performances (Phase-1)	
Altitude	619 km
Swath	40 km
Stripmap Resolution	3 m
Spotlight Resolution	1 m
Continuous stripmap	Up to 1000 km

Monostatic performances (Phase -2)	
Altitude	410 km
Swath	15 km
Stripmap Resolution	3 m
Spotlight Resolution	1 m
Continuous stripmap	Up to 800km

RODiO 4x12U mission



RODiO is a cluster of 4 CubeSats flying in formation with PLATiNO-1 (PLT-1) satellite. Each CubeSat embarks a receiving-only X-band SAR instrument able to collect bistatic echoes exploiting PLT-1 as an opportunity illuminator.

The passive radar, including a very compact receiving unit and the proper deployment mechanisms for the antenna, is conceived to comply with a 12 U CubeSat.

RODiO is thus a multi-platform Distributed SAR (DSAR) working in passive mode.

RODiO mission is aimed at both the in-orbit technological demonstration of DSAR concept (multi-platform image synthesis) and the delivery of SAR images for downstream. RODiO is in the mainstream of innovative bistatic and multi-static SAR mission concepts.

RODiO is a new mission concept which combines the advantages of a sensor distributed onboard different CubeSats with those of a bistatic radar working with an illuminator of opportunity.



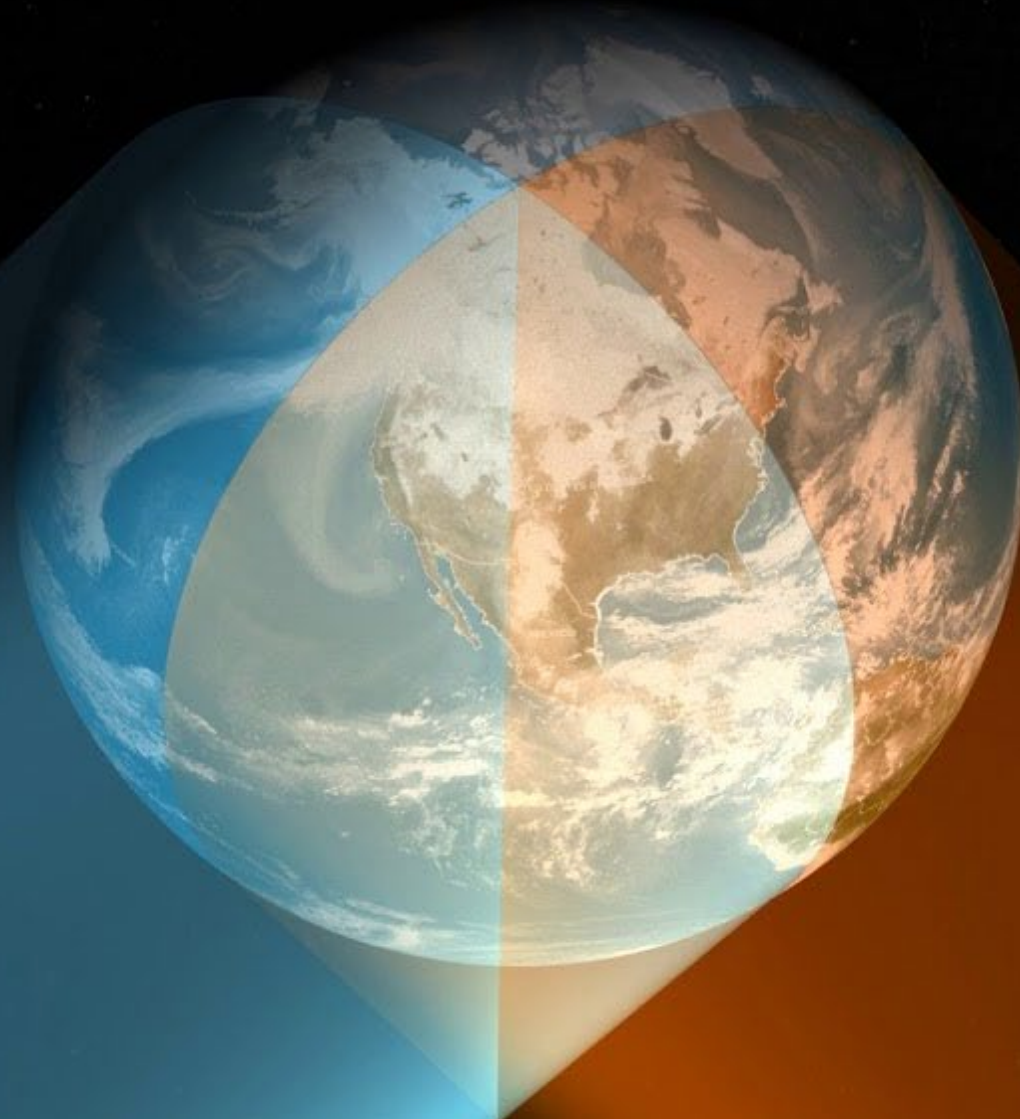
SATURN 3x16U mission

Synthetic Aperture Radar cubesats formation flying aims to demonstrate in orbit the “Cooperative Multiple-Input-Multiple-Output (MIMO)” key technology for innovative, low cost and versatile Earth Observation capabilities using a train of three, 16U-CubeSats equipped with X-band SAR instrument flying in SSO-dawn dusk at 500 km.

The distribution of the key resources, normally concentrated in a single, large and complex satellite, can be distributed among small-sized and simpler systems, thanks to the proper combination of the signals from each single node of the swarm. Such constellation of swarms deployed on different orbital planes allows high revisit time and high performance independently from the available daylight and cloud cover.



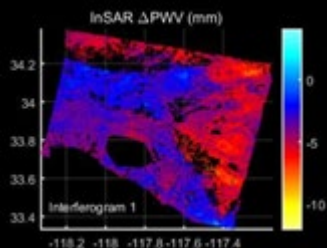
GEOSAR



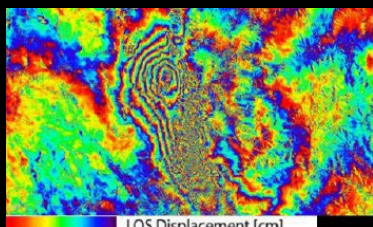
GEOSAR: The GEOSYNCRONOUS SAR Mission

- Geosynchronous satellites are suitable for the applications that require constant coverage of a specific spot on the Earth surface.
- Such platform can be equipped with a Synthetic Aperture Radar that requires relative motion with respect to the observation target.
- X-band SAR, GSD up to 8 m

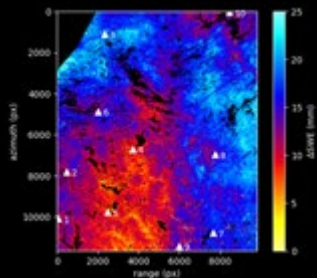
ATMOSPHERE



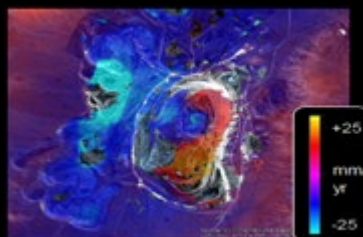
EMERGENCY



CLIMATE CHANGE



LAND



Orbit:

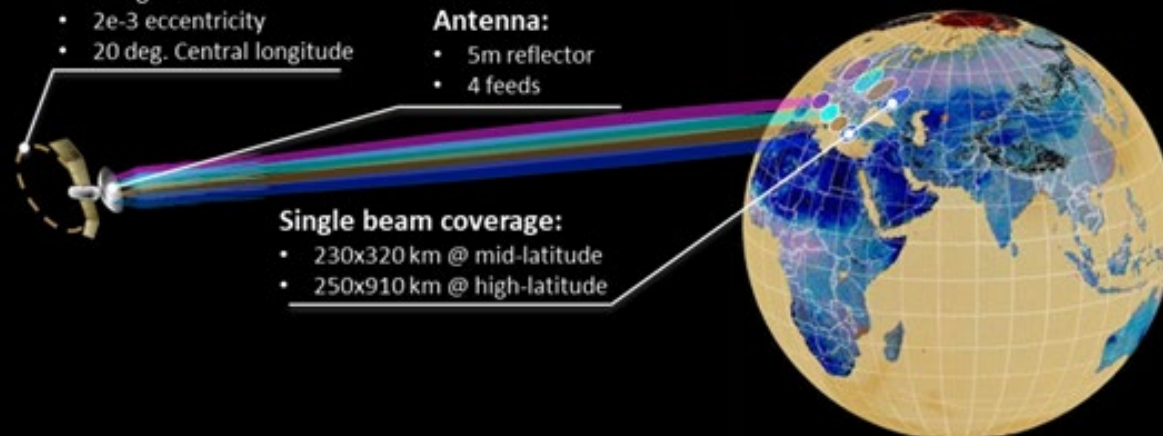
- 0 deg. inclination
- 2e-3 eccentricity
- 20 deg. Central longitude

Antenna:

- 5m reflector
- 4 feeds

Single beam coverage:

- 230x320 km @ mid-latitude
- 250x910 km @ high-latitude



P BAND



CONCLUSIONS

Towards the development and exploitation in a coordinated approach over the full range of SAR Opportunities:

- Bands: X, (C), L & P
- Classes of Satellites: Nano, Mini, Small, Large
- Orbits: LEO – GEO
- SAR architectures: Mono, Bi-Static, Constellation, Distributed (SIMO, MIMO)

X SAR
CONSOLIDATION
AND
IMPROVEMENT



L SAR
DEVELOPMENT
AND
DEPLOYMENT



P BAND
RESEARCH
AND
DEVELOPMENT





Agenzia Spaziale Italiana

THANK YOU FOR YOUR ATTENTION

