L’impegno Italiano nel settore dei CubeSat
Tecnologie e missioni future
2° edizione

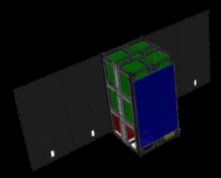
Franco Boldrini
Chief Business Development & Sales Officer

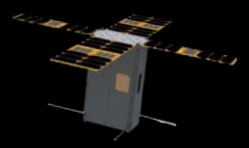
ASI Workshop – Roma, 2 ÷ 4 Luglio 2024

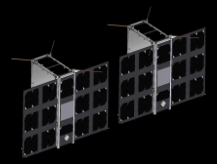
SPACE SYSTEMS

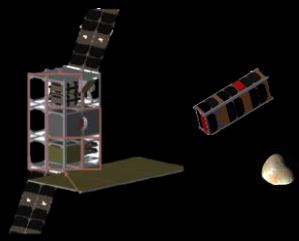
SATURN mission architecture paves the way for the future of SAR imaging

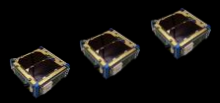
Agenzia Spaziale Italiana


SAILS (12U)

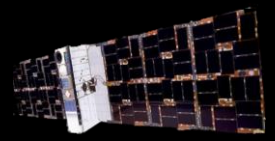

BOREALIS (6U)

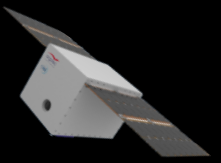

CUSP (2x6U)

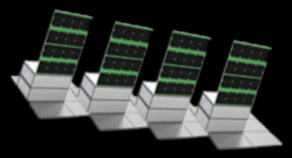

TASTE (9U+3U)

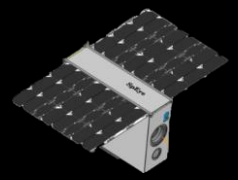

PICO-IOT (3x0.3U)

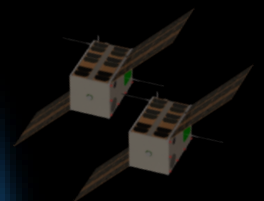

BISS (6U)

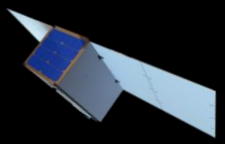

FUTURE (6U)

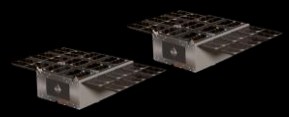

HENON (12U)

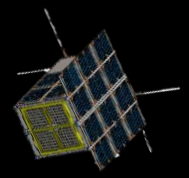

RODIO (4x16U)


SPEYE (6U)

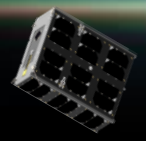

VULCAIN (2x12U)

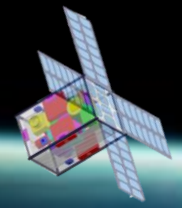

EARTHNEXT (16U)

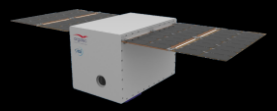

INNOVATOR (2x6U)

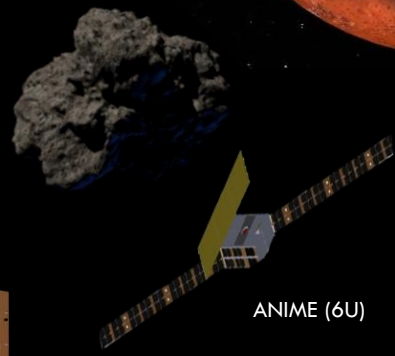

E.CUBE (12U)


SATURN (3x16U XL)


RAMSESS (6U)


EXCITE (12U)


SEE (12U)


ANIME (6U)


CHIPS (12U)

Alcor

- Earth Observation
- Telecommunications
- In Orbit Demonstration
- Astrophysics & Space Weather
- Planetary Exploration
- IOS & autonomous navigation
- Astrobiology

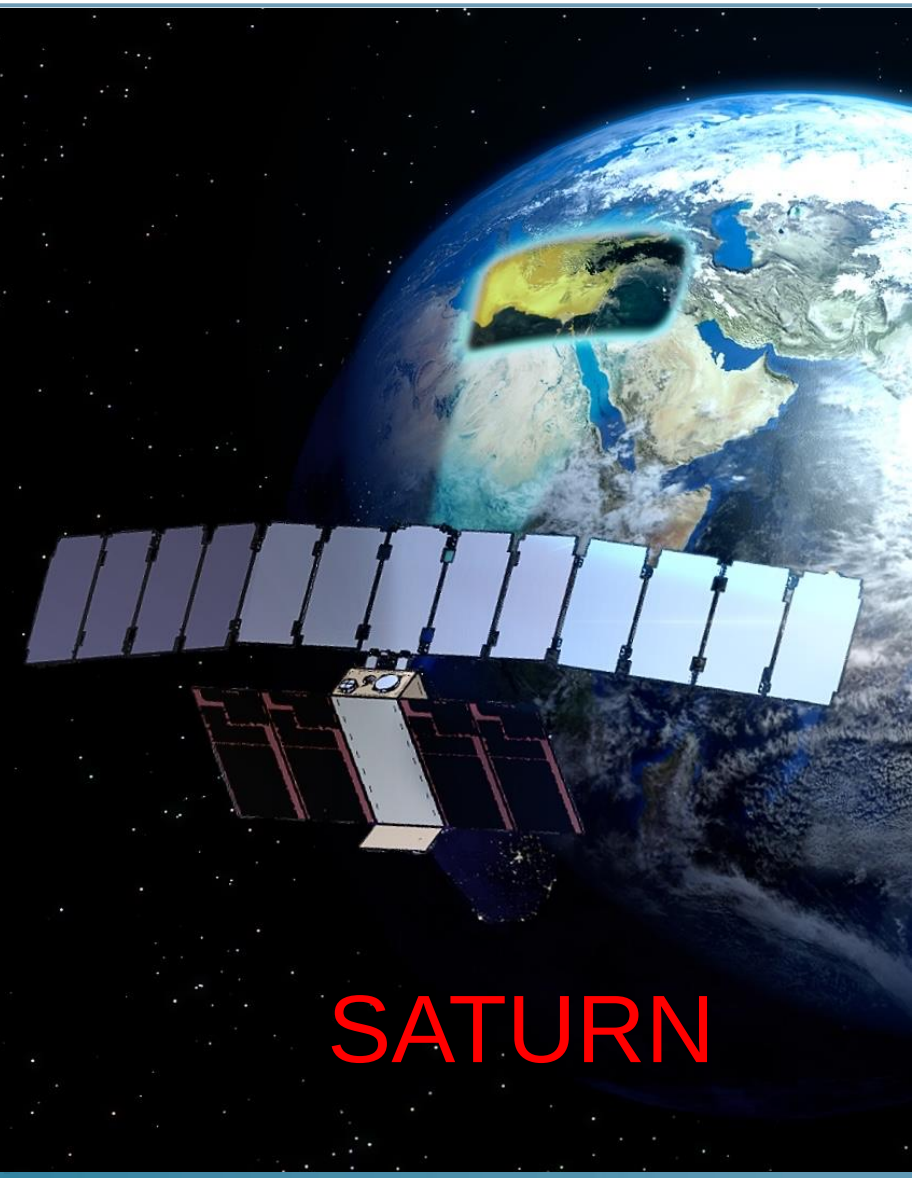
SATURN is part of the ASI ALCOR program aiming to promote the next generation of Italian CubeSats.

Mission Overview

- **SATURN** (***S****ynthetic* ***A****per****T****ure radar c****U****besat fo****R****mation flyi****N****g”)* is a demonstrative mission for *Multiple-Input-Multiple-Output* (**MIMO**) Technology applied to Swarms of 3 Micro-Satellites in close formation on a LEO SSO.

- **SATURN** enables low-cost and scalable SAR missions for affordable access to space, overcoming the single point of failure of large and complex SAR satellites.

- **SATURN** is based on the OHB-I **M³** (Multi-Mission-Modular) Platform, equipped with *Synthetic Aperture Radar* (**SAR**) Payload



OHB ITALIA – M³ MICROSAT PLATFORM

M³- Multi Modular Mission Micro-Satellite BUS

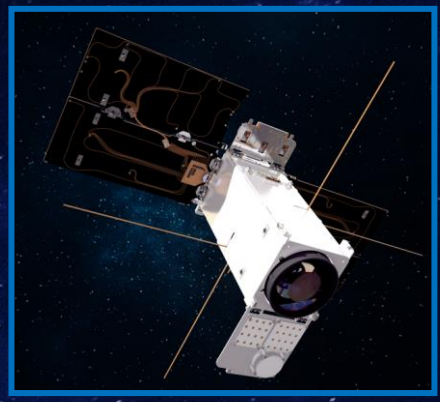
BEST COMPROMISE BETWEEN MICROSAT AND NEWSPACE

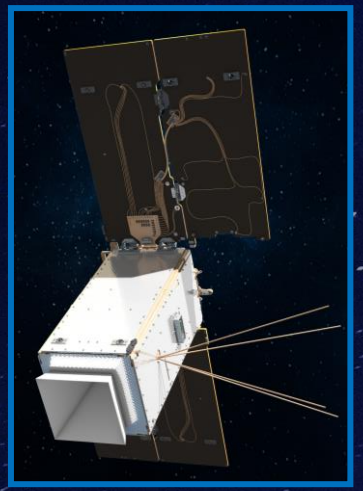
CUSTOM SOLUTIONS FOR:

- EO APPLICATIONS: OPTICAL (RGB & PAN) + AIS
- EO APPLICATIONS: RADAR SWARMs
- RF MONITORING: SIGINT SWARMs
- OTHER APPLICATIONS: IoT

SERVICES:

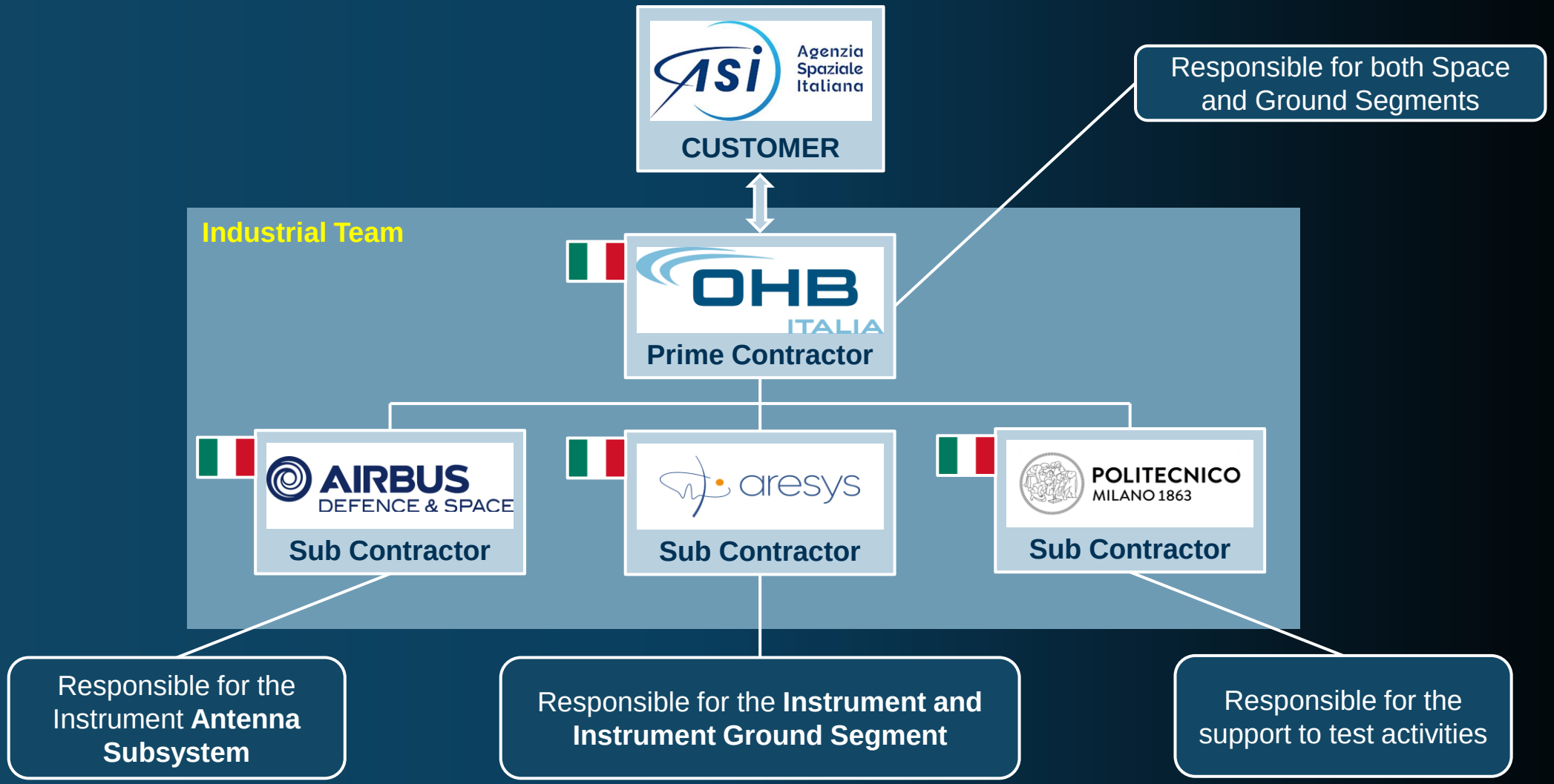
- Delivery and Training of the Platform
- Full AIT for the Satellite
- Launch, LEOP and Commissioning
- Operations
- Payload Data Center deployment





- MASS: 15 Kg
- BUS VOLUME 8U - PAYLOAD VOLUME +12U
- HIGH POWER/WEIGHT RATIO
- FINE POINTING ACCURACY
- HIGH DELTA-V FOR ORBITAL CONTROL
- HIGH SPEED DATA DOWNLINK (X-BAND)

SATURN Industrial Team Organization



Mission Scenarios

SATURN is conceived as an agile formation flying microsats mission supporting specific application needs.

Several operational scenarios may be covered by SATURN constellations in the worldwide market. The first two operational needs identified in the domestic market are:

- Routinary Mission operation:

  Monitoring of the sea for Maritime Surveillance. This scenario is active by default.

- Emergency Mission operation:

  Applicable on land, acquires specific Areas of Interest (AOI) that are identified on the basis of a priority index.

SATURN Schedule:

KO: 11 March 2022

End of Phase A: September 2022

End of Phase B: January 2024

End of phase CD: Q3 2026

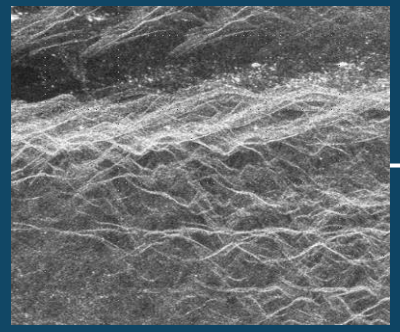
Launch: Q4 2026

Products & Services

- **SATURN** is **a** *Coherent SAR Formation* where the units simultaneously receive the backscattered signal of each sensor from the observed scene.

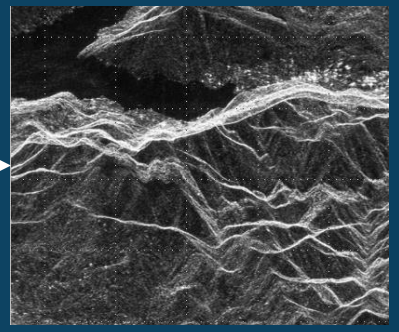
- The coherent combination, through MIMO, of the simultaneous signals by the different transmitting satellites are elaborated for improving the recombined image SNR.

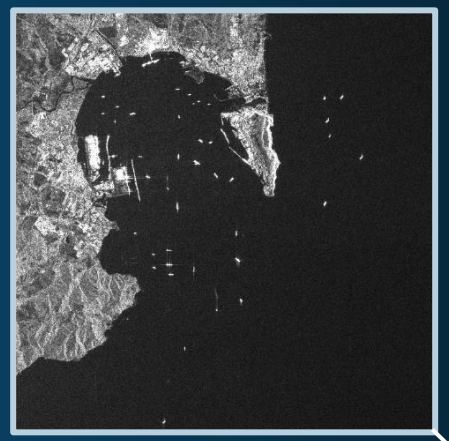
Single Sensor Image



MIMO

Multi-Sensor Image



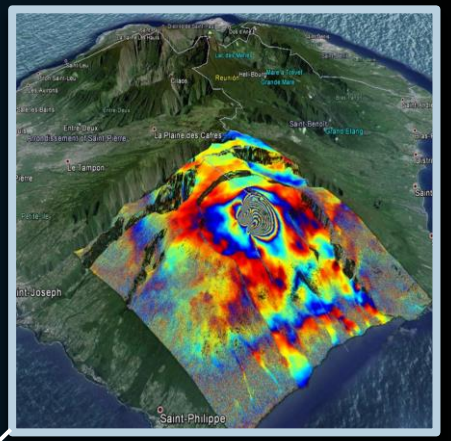


SHIP DETECTION

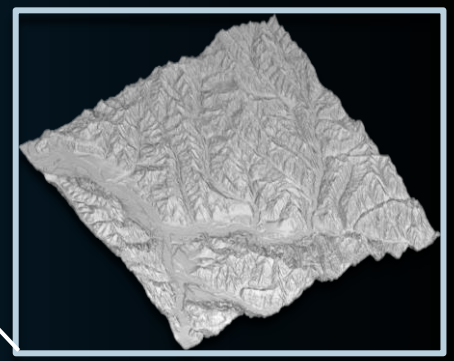
OIL SPILL DETECTION

SATURN PRODUCTS

In High Resolution



Landslide Detection



DEM

MARITIME SURVEILLANCE

LAND MONITORING

SATURN «typical» architecture

- **SPACE SEGMENT**

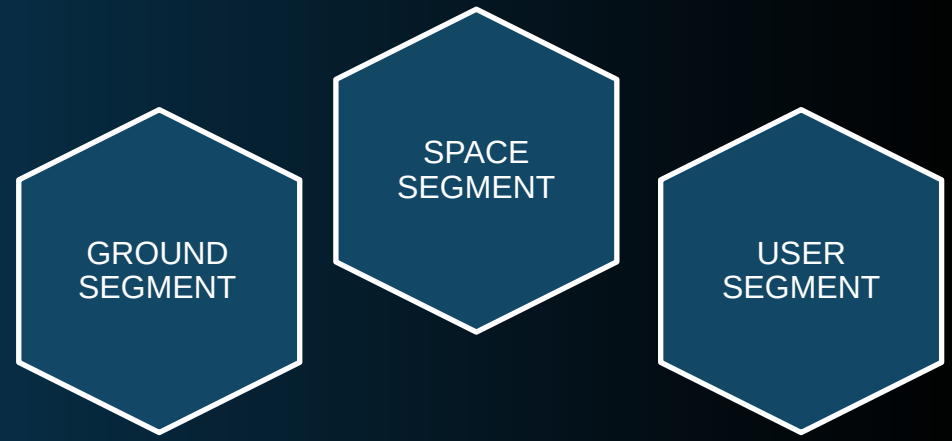
Composed by three **16U XL** MicroSats equipped with **SAR** Payload

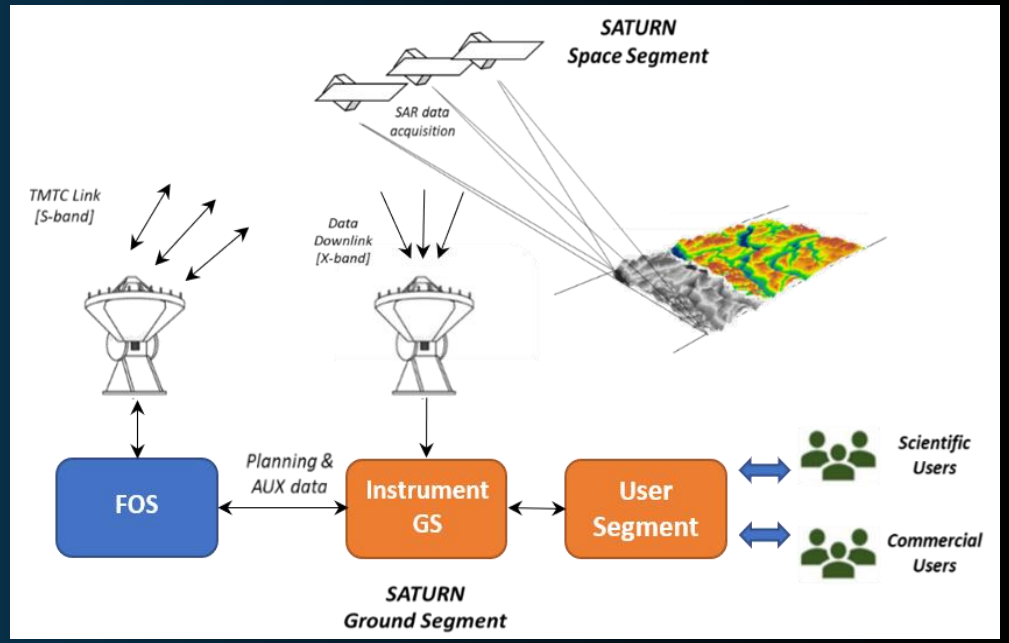
- **GROUND SEGMENT**

Composed by cloud-based Flight Operations Segment (FOS) and Payload Data Ground Segment (PDGS).

- **USER SEGMENT**

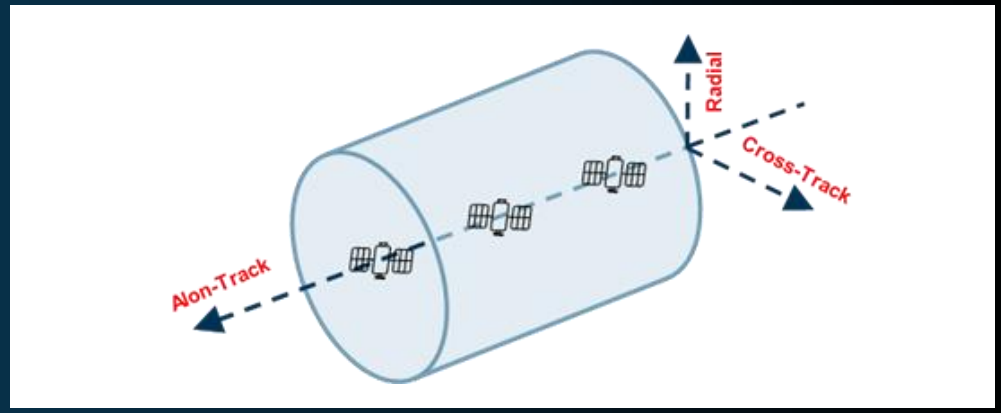
Data exploitation towards **Commercial** and **Scientific** users



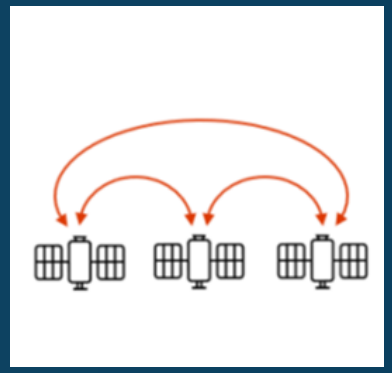


Single Swarm Management

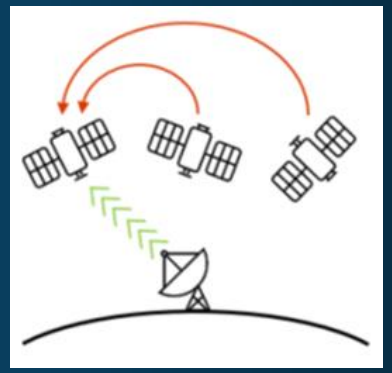
- The CubeSats fly in an "**along-track train**" formation.
- Nominal relative distance of 200m (+/-5m).



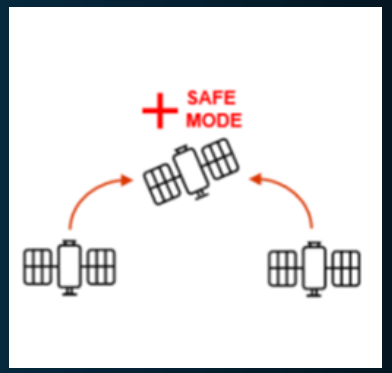
This allows a coherent recombination of the SAR echoes, allowing a single high-quality SAR.



Satellites exchange data and status



Satellites operates in coordination



Swarm-wide Safe Mode to avoid collisions

ASI SATURN Mission Roadmap

Demonstration Swarm

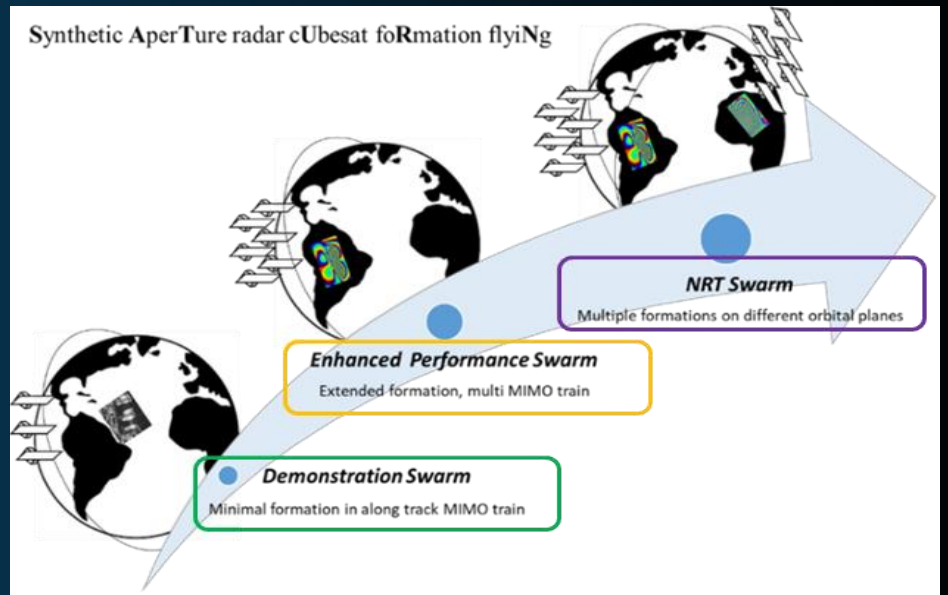
- A **three Micro-Sats** swarm for **demonstration** of the SAR MIMO technology capability.
- The imaging applications are mainly related to highly-reflective areas such as ships, urban and peri-urban areas.

Enhanced Performance Swarm

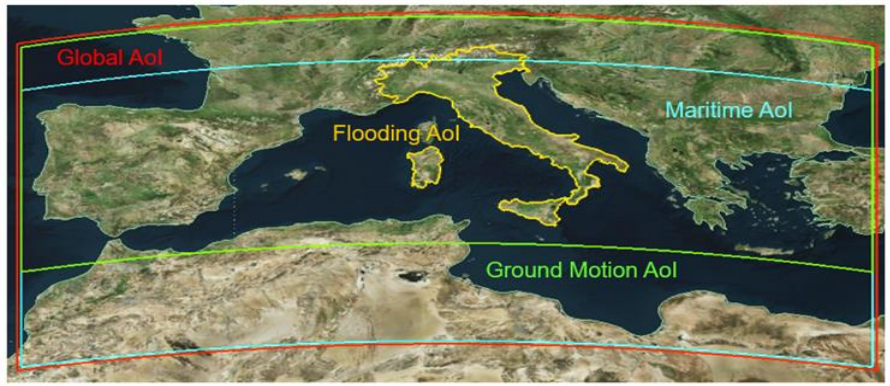
- Increasing the number of MicroSats/swarm, obtaining an **extended operational formation.**
- The target areas can be extended to regions of interest for land monitoring, including fast motion.

Full constellation (Near Real Time Swarm)

- MicroSat Swarms operating on **different orbital planes**, to enhance revisit time and coverage.
- **Near-Real-Time application** such as maritime surveillance and commodity tracking.



Mission Areas of Interest

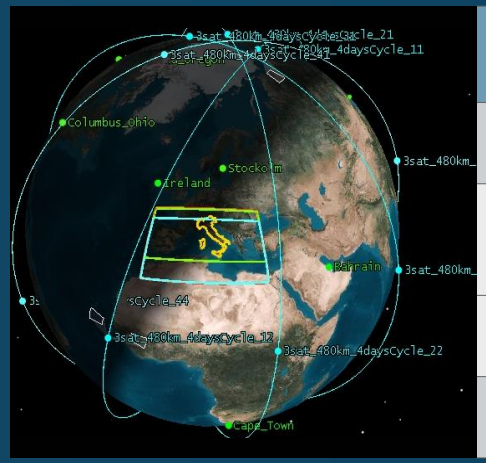


Full Constellation Design & Performances

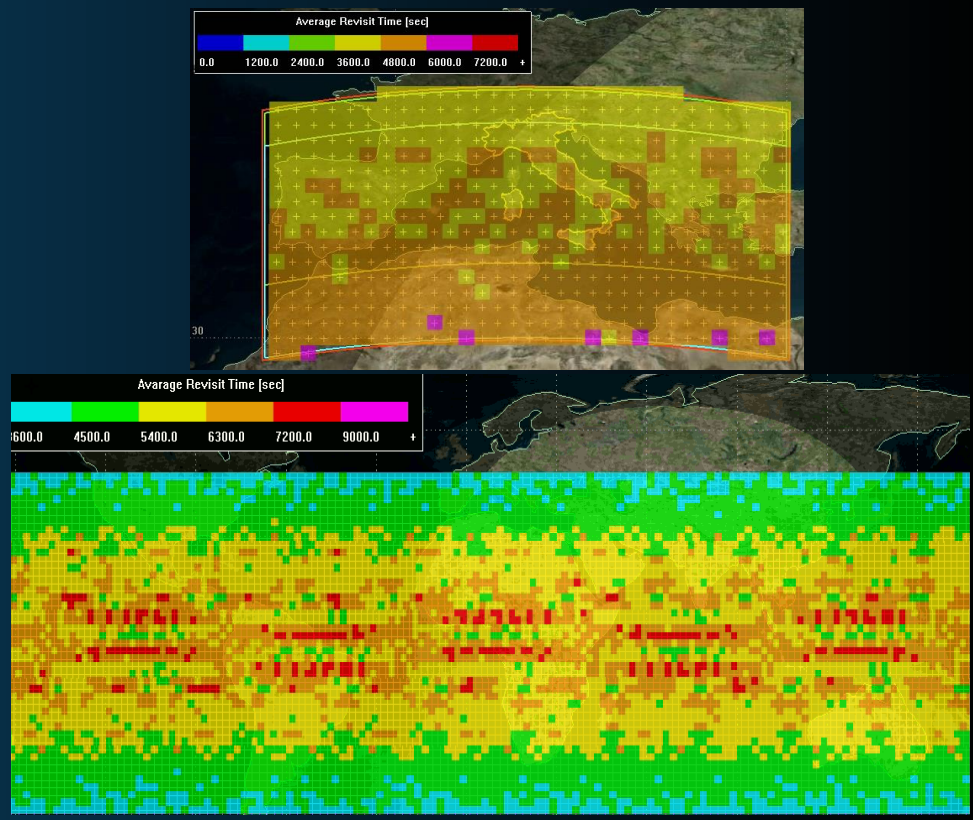
Case Study:

16 Mini-Swarms x 3 MicroSats, spread over 4 SSOs equally spaced by 3 hours of local time

- Image Size: Single pass **30x50 km**
- Resolution: **5x5 m**
- High Resolution **1.5x1.5 m**

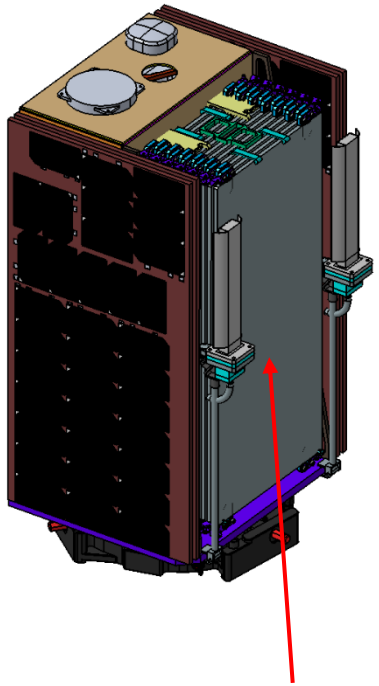


Full Constellation		
Orbit	**SSO** Frozen	
Altitude	**480 km (Nominal)**	460 – 500 km (Back-Ups)
Cycle	**4 days**	3 days
LTDN	06:00 – 09:00 – 12:00 – 15:00	



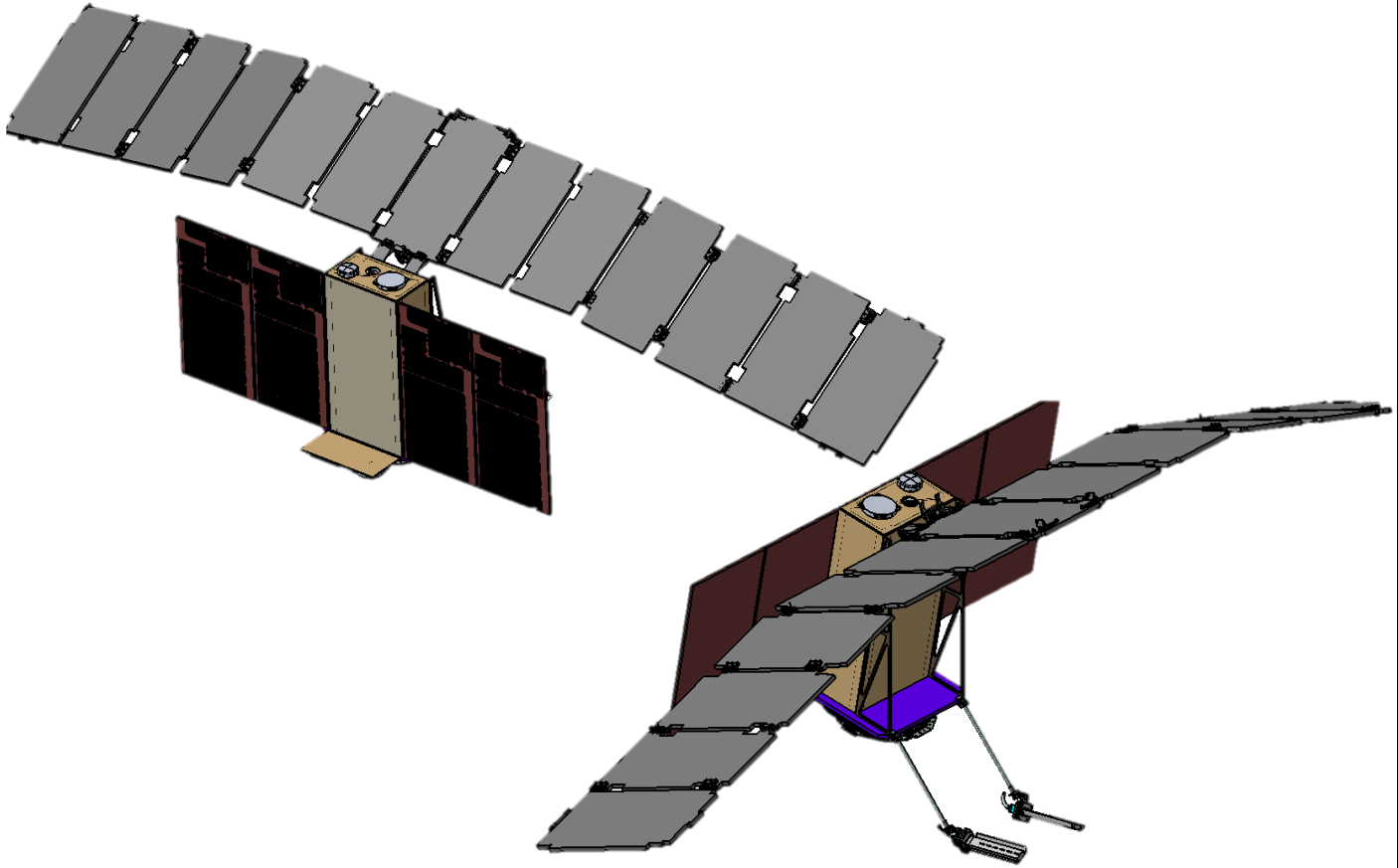
Average Full Constellation
Revisit Time: **1.5h**

SATURN Micro-Satellite Configuration



SAR Antenna and Feeds

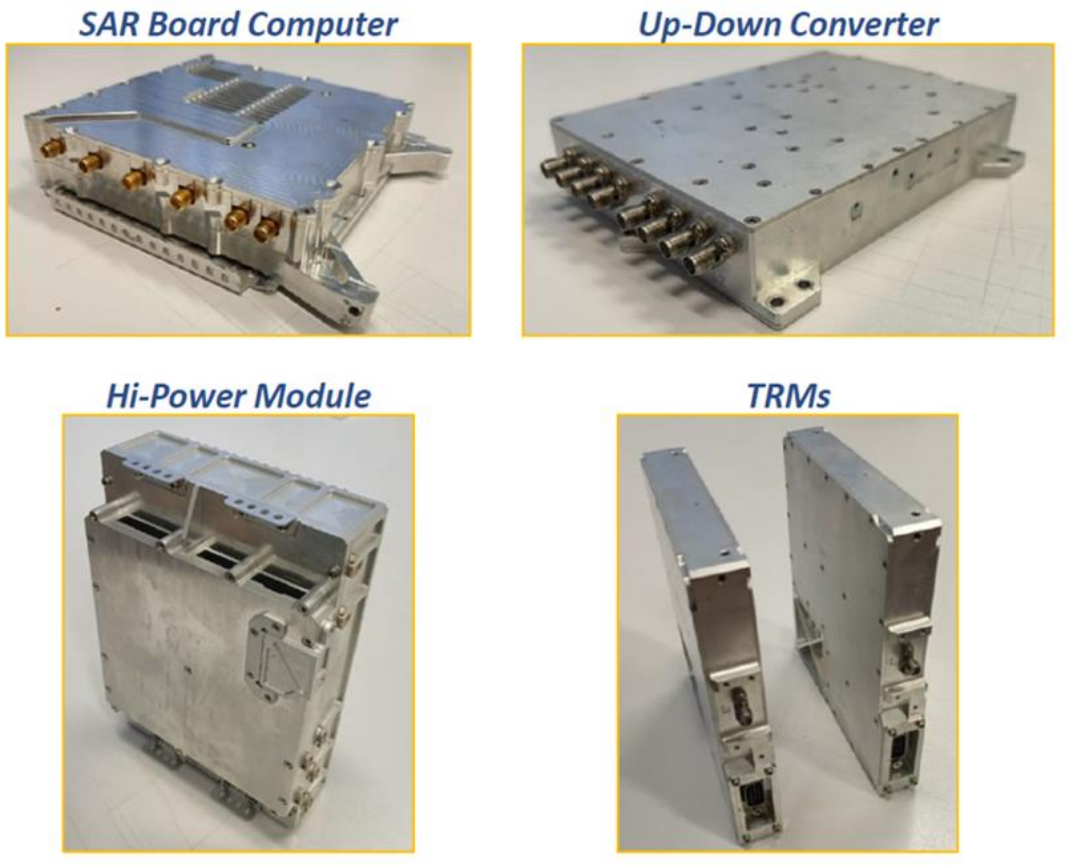
Stowed Configuration



Deployed Configuration

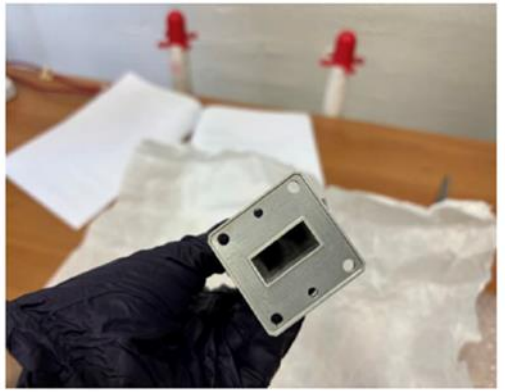
SATURN Phase A/B1 Results

- **Phase B1** completed. Prototypes have been realized and tested to verify preliminary design.



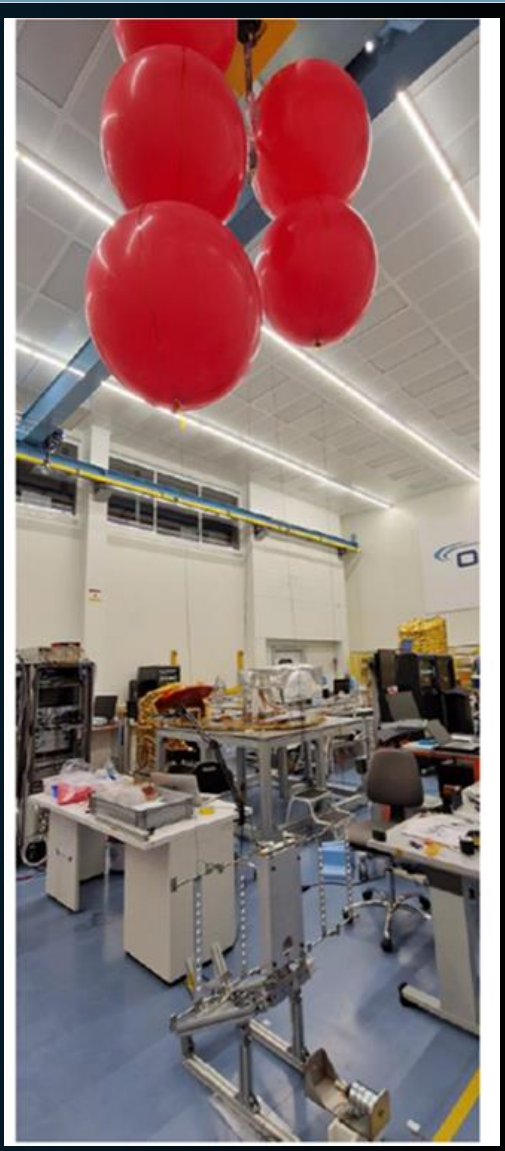
Panel – front view

Feed – top view



Feed – rear view

SAR antenna and Deployment Mechanism Prototyping

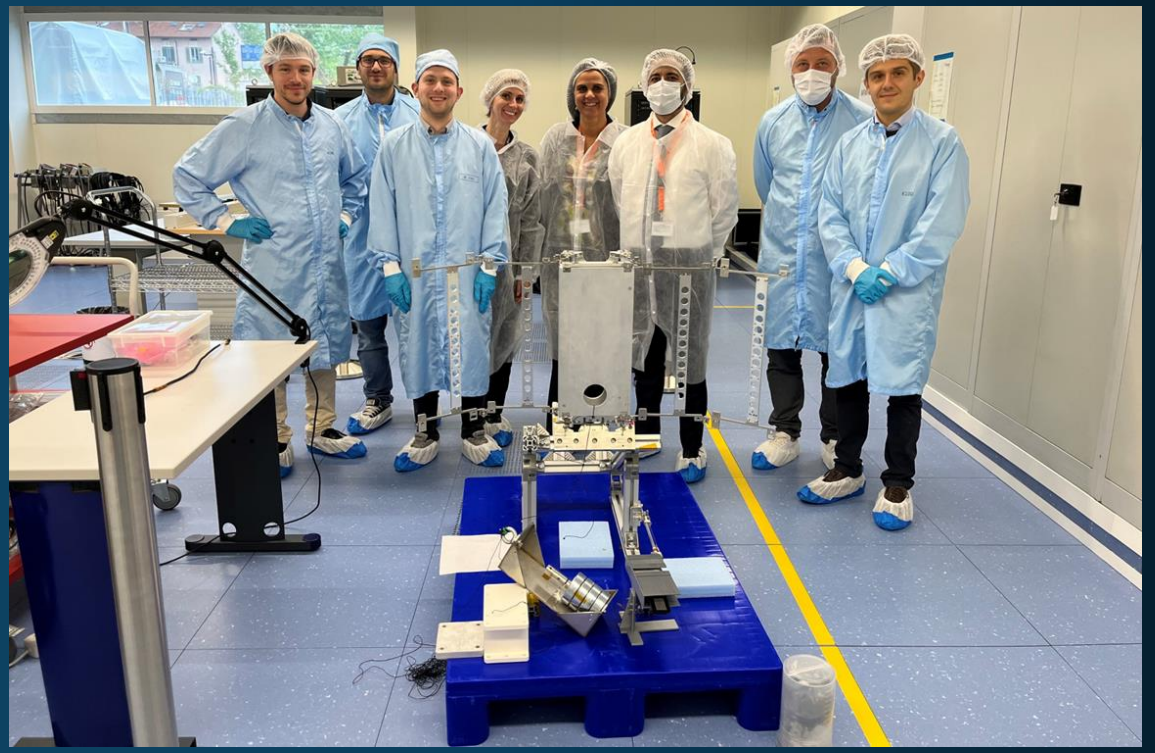


Next Step:

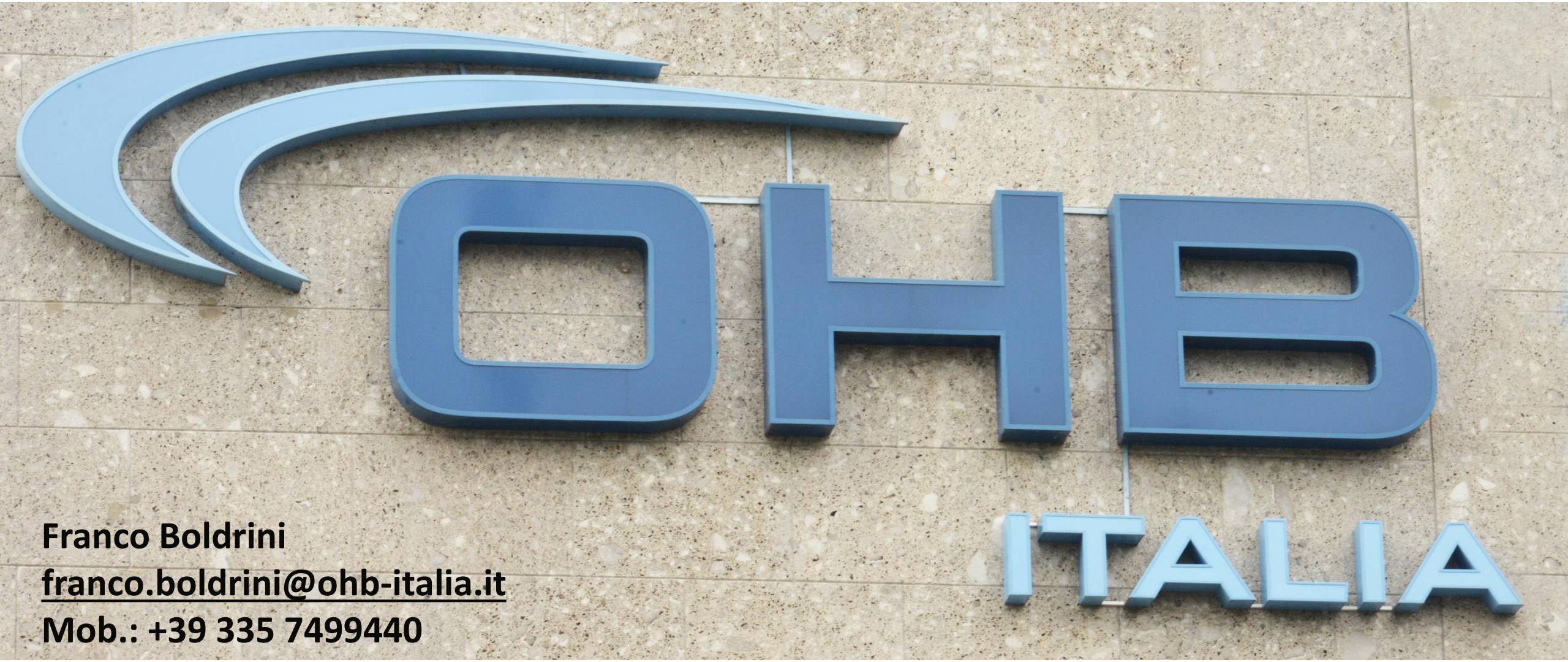
SATURN is, both for the Italian Space Agency and the Italian Industry, a unique opportunity in order to develop a scalable RADAR Earth Observation constellation based on MicroSats with state of the art performance.

The SATURN system is ready for further development and detailed design.

We look forward to **Phase C/D/E1** approval.



GRAZIE!



Franco Boldrini
franco.boldrini@ohb-italia.it
Mob.: +39 335 7499440