Italian Space Agency PLATiNO missions: observing the Earth with SAR, TIR, VNIR and Hyperspectral payloads.

Agenzia Spaziale Italiana

ASI Earth Observation Division

Living Planet Symposium, Bonn, 23-27 May 2022

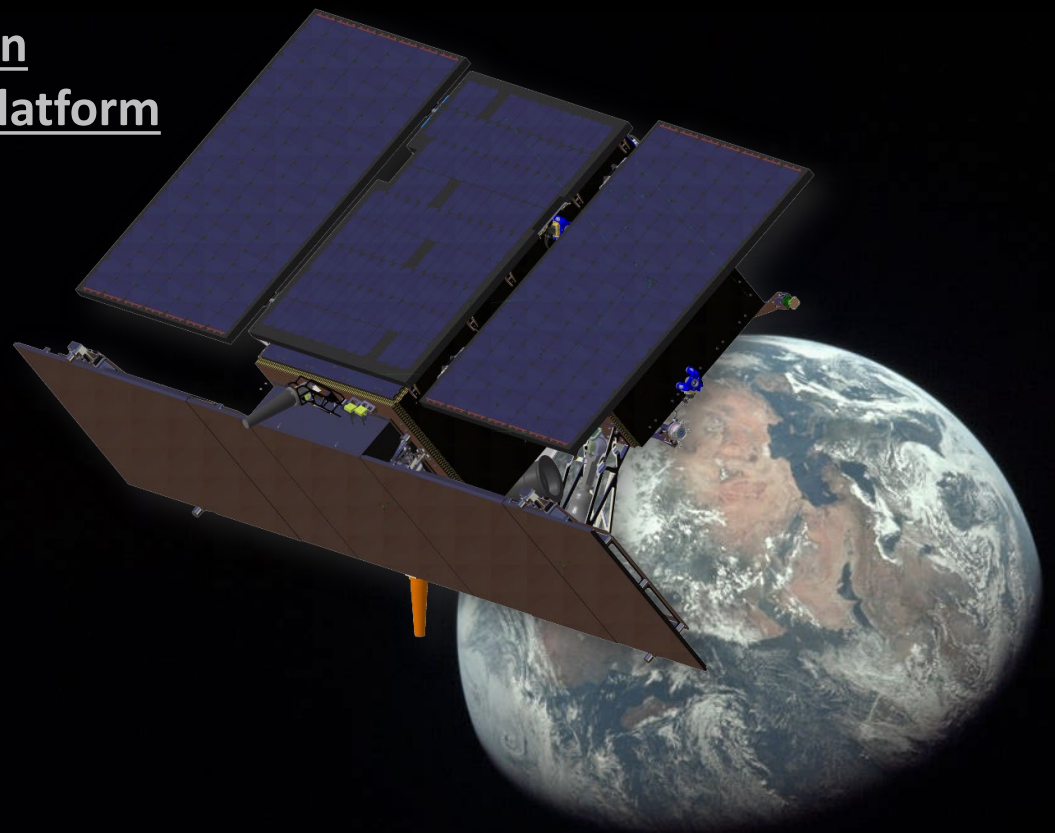
PLATiNO Platform Heritage

design approach

Developed by SITAEL, Thales Alenia Space Italia, Leonardo and Airbus under the homonymous ASI program, the PLATiNO Mini-Satellite Platform is characterized by state-of-art bus performances and is designed explicitly with multi-purpose/multi-payload features. PLATiNO is developed with a design-to-cost approach, granting the product the capability to compete on the global market, both institutional and private.

The objective of the PLATiNO project is to design and develop , in compliance with tailored ECSS standards, a mini-satellite class platform

- **Flexible and scalable**
- **Multi-application**
- **High performances**
- **High competitiveness**



PLATiNO FLEET

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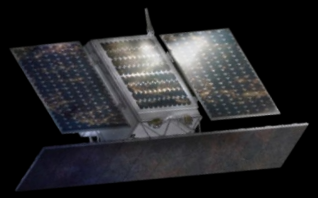
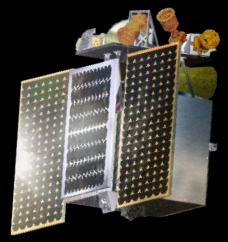
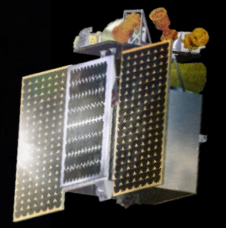


PLATiNO-1
X-band SAR
Launch planned 2023
Ilifetime: 3years

PLATiNO-3
Optical High Resolution
Launch planned 2026
Ilifetime: 3years



PLATiNO-2
TIR/MAIA
Launch planned 2024
Ilifetime: 3years



PLATiNO-4
Hyperspectral
Launch planned 2025
Ilifetime: 3years

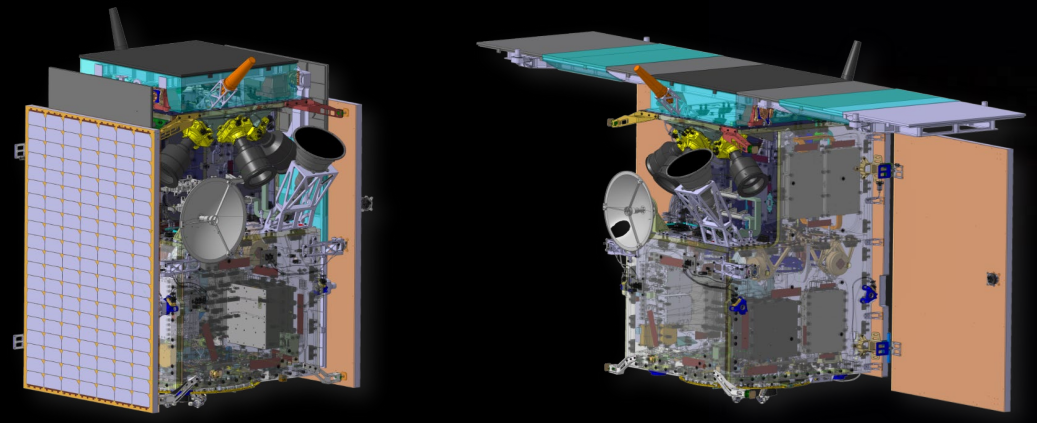
PLATiNO Platform

Platform configuration

PLATiNO Minisatellite Platform is characterized by state-of-art bus performances, high payload embarking capability, modular structure (P/L and P/F modules, easing MAIT activities), designed explicitly with multi-purpose features.

PLATiNO is an all-electric platform, equipped with SITAEL low power Hall effect electric propulsion subsystem (enhanced orbit control/manoeuvering capabilities), characterized by high power availability on-board (large deployable solar arrays and high battery capacity) and high performance AOCS (fine pointing with star tracker and high agility by torque/momentum actuators).

PLATiNO Platform, with its flexibility and multi-purpose features, is suitable for a wide series of space missions.

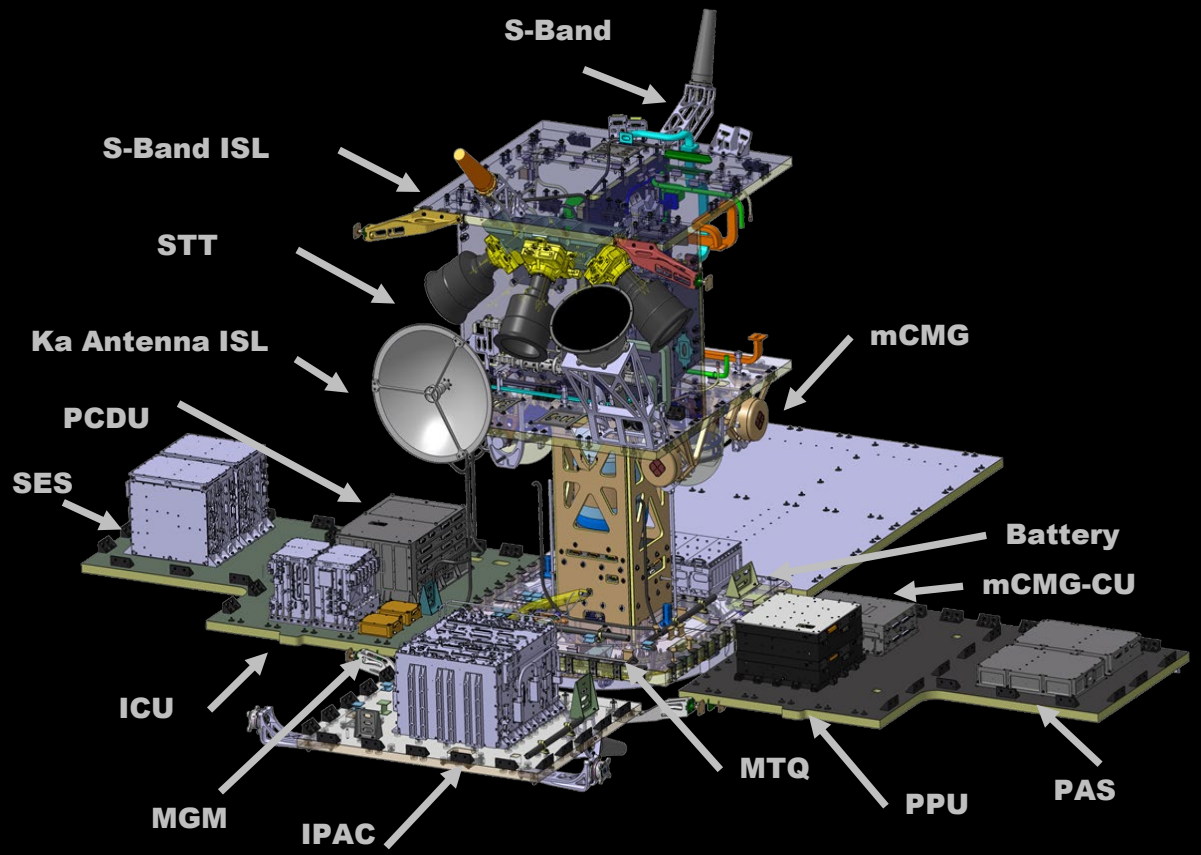


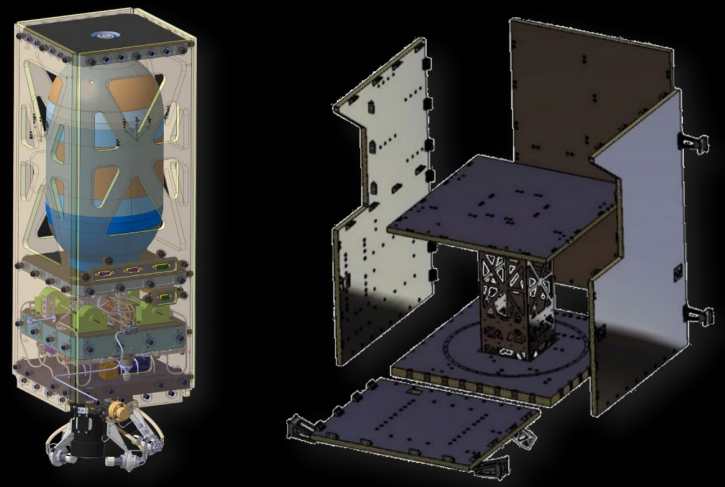
- P/L MASS : 90Kg
- P/L POWER CONS. : 200 W avg, 1kW Peak
- P/L ALLOWABLE VOLUME: 800x800x1000 mm^3
- TYPICAL LAUNCH MASS: 300 kg
- PLATFORM LIFETIME: Up to 5 years
- MISSIONS : PLATiNO-1 , PLATiNO-2

PLATiNO Platform

MODULARITY: the platform has been design to facilitate P/L accommodation and integration with the minimum degree of customization.

The EP module is accessible from the outside and configurable according to mission needs.





Platform S/S	Design features
Thermo-structure	» Metallic frame + sandwich panels » 0.8m x 0.8m x 1.2m envelope
Electrical Power S/S	» Power handling up to 1 kW (1.2 kW peak) » Two deployable solar array wings + one fixed solar array panel » Li-Ion Battery, 1200 Whr » 100W average to payload – 750w peak power to payload
OBDH	» Leon4 FT » CAN interface » 1 Tb memory
AOCS	» Mini-CMG on-board » High performance star tracker (3 OHs) » 3 MTQ » GPS » Sun Snesors » Magnetometer
Communications	» S-BAND TL + TM » X-Band P/L Data » Inter Satellite Link communication S/S
Electric Propulsion	» 2 HET Thruster » 15 kg Xenon Tank

PLATiNO-1 SAR Mission Overview

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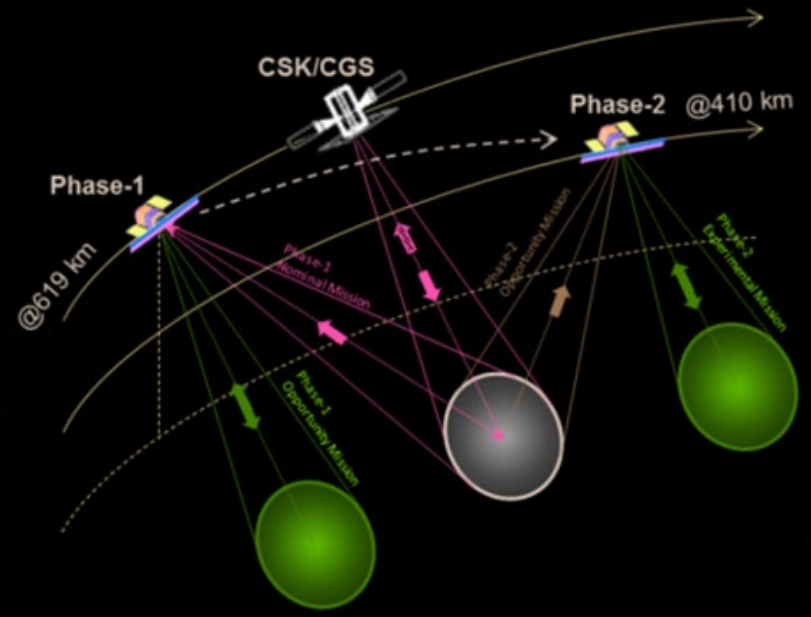
The mission phases are:

- **Phase-1**: PLT-1 flies in formation with one satellite among CSK/CSG **@619 km** for 1 year.
- **Re-orbiting Phase**: PLT-1 changes its orbit in 6 months;
- **Phase-2**: PLT-1 flies on a lower orbit (**@410 km**) for 1.5 years.

- During Phase-1 the following priority shall be considered:
  1. **Nominal**: **Bistatic Rx** acquisitions are **always acquired** when the master satellite is transmitting for Civilian Stripmap acquisitions;
  2. **Opportunity**: **Monostatic Stripmap and Spotlight** acquisitions requested **on demand** by End-Users, ranked;
  3. **Background**: **Monostatic Stripmap and Spotlight** acquisitions from **background mission**, ranked;

- During Phase-2 the following priority shall be considered:
  1. **Nominal**: **Monostatic Stripmap and Spotlight** acquisitions requested **on demand** by End-Users, ranked;
  2. **Opportunity**: **Bistatic Rx** acquisitions are **always acquired** when the master satellite is transmitting for Civilian Stripmap acquisitions;
  3. **Background**: **Monostatic Stripmap and Spotlight** acquisitions from **background mission**, ranked;



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

PLATiNO-1 SAR Mission Overview

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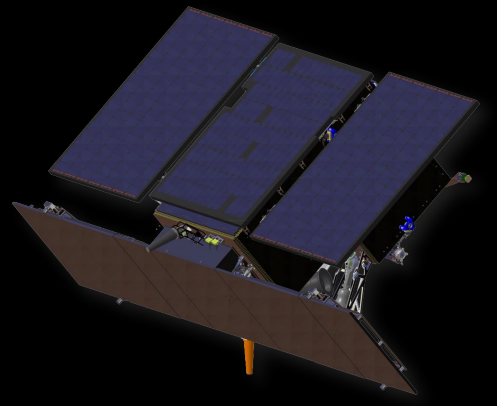
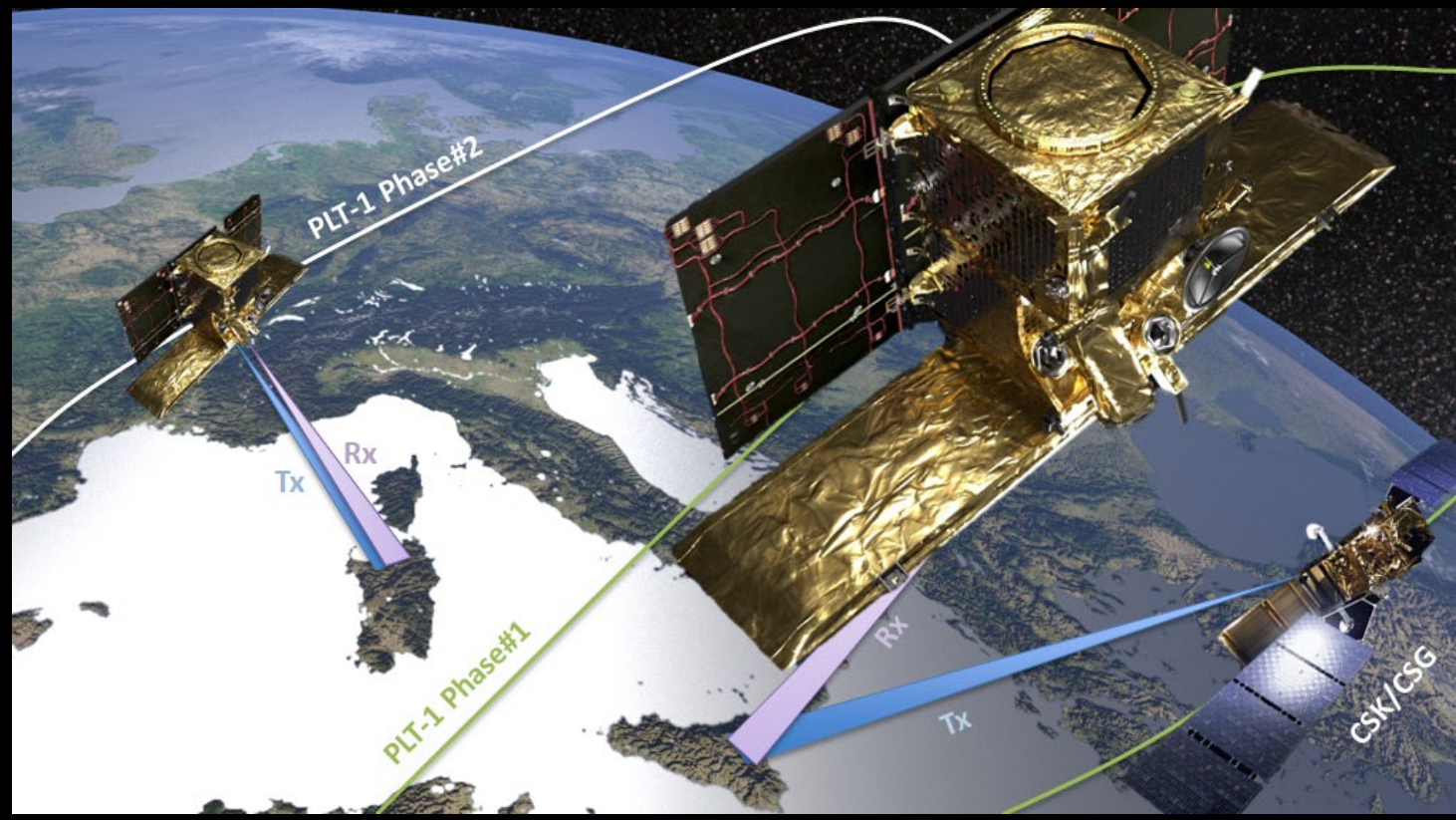


Bistatic performances (Phase-1)	
Altitude	619 km
Swath	40 km
Resolution	3 m
Target Experimental Resolution	1 m
Imaging mode	CSK/CSG Stripmap
Continuous stripmap	Up to 1000 km

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

Selectable Formation-Flying configurations:

- » **Leader-Follower (baseline)**
- » Pendulum
- » Cartwheel
- » Helixmonths



PLATiNO-2 TIR Mission Overview

Orbital parameters:

- SSO Frozen
- Local time of ascending node = 10:30
- Altitude = 393 km
- Inclination = 96 deg
- Repeat Cycle = 52 days

Attitude profiles:

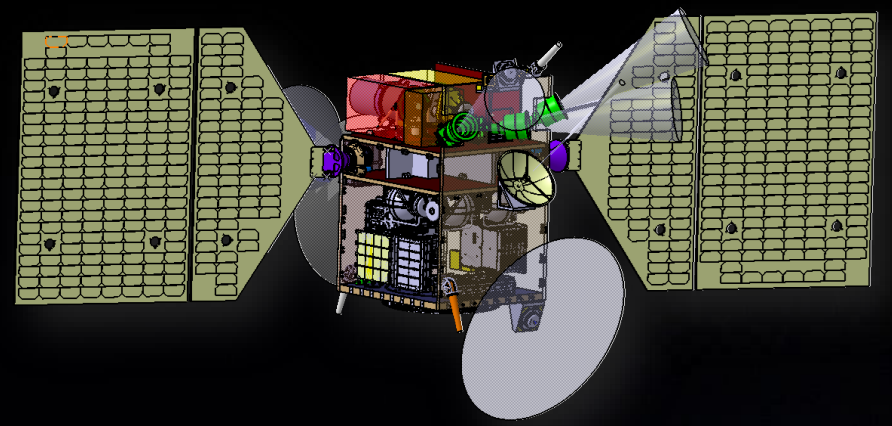
- **Nadir-pointing** -> data downlink and orbit maintennaince
- **Sun-Pointing** -> The solar arrays are sun pointed to balance the energy budget
- **Payload operation** -> “slow-down” maneouvre for acquisition (GSD = 40m)

PLATiNO-2 TIR Performances

- Spectral Range 8-12 micron
- Spectral Channels : 8.6, 9.1, 10.3, 11.5 micron
- Channel bandwidth: 1 micron

- Spatial resolution: 40m
- Accuracy <1.5 ° K
- Swath = 40 km
- Strip = up to170 km
- Daily coverage 170.000 km2

- Secondary P/L:
  - VNIR camera
  - Early Warning system



PLATiNO-2 candidate platform for MAIA Mission

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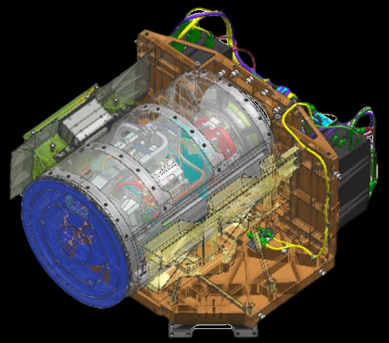
The MAIA instrument will ride on a host satellite, to be selected by NASA

NASA and ASI are discussing a possible Italian involvement in implementing the MAIA mission, which could lead to the definition of the mission as cooperation between the US and Italy.

PLATiNO-2 mission envisages the development of the second satellite based on **PLATiNO** platform and will embark MAIA Payload, validating **PLATiNO** multi-applicability feature and supporting the joint effort



PLATiNO-2 MAIA Mission Overview

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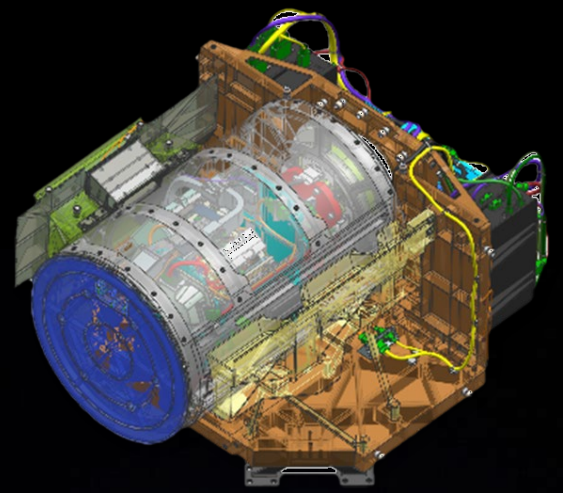
The Multi-Angle Imager for Aerosols (MAIA) investigation will seek to understand how different types of air pollution affect human health.

MAIA's main purpose is to study how different types of particulate matter air pollution affect our health. "Type" refers to the relative amounts of different components that make up the mixtures of airborne particles that we breathe.



» What types of airborne particles are dangerous over the short term (days to weeks) and what types of airborne particles are dangerous over the long term (multiple years)

» To collect measurements of Earth over areas that are interesting to scientists studying air quality and climate. These include observations of cities with high pollution levels and major events that impact air quality, including wildfires and erupting volcanoes.

The MAIA investigation is how we will provide a highly detailed view of key types of particulate matter air pollution (PM).
The MAIA satellite instrument will view a set of Primary Target Areas from space.
This data will be combined with other information, including measurements from air pollution monitors on the ground and outputs from computer models. The results will be used to create daily maps of PM amounts in the Primary Target Areas.
These maps and health records will be used by epidemiologists to conduct health studies. The findings from these studies will provide information about which types of PM are most harmful.

PLATiNO-2 MAIA Mission Overview

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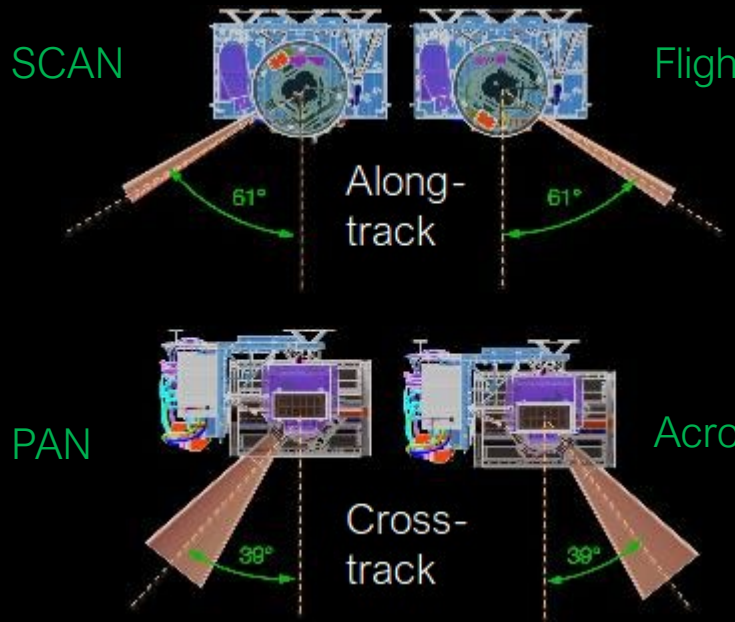
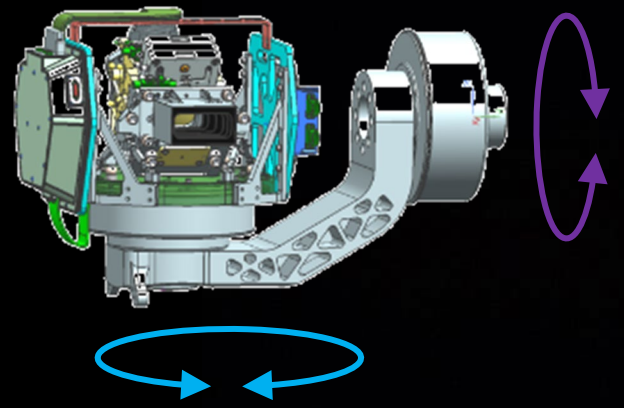
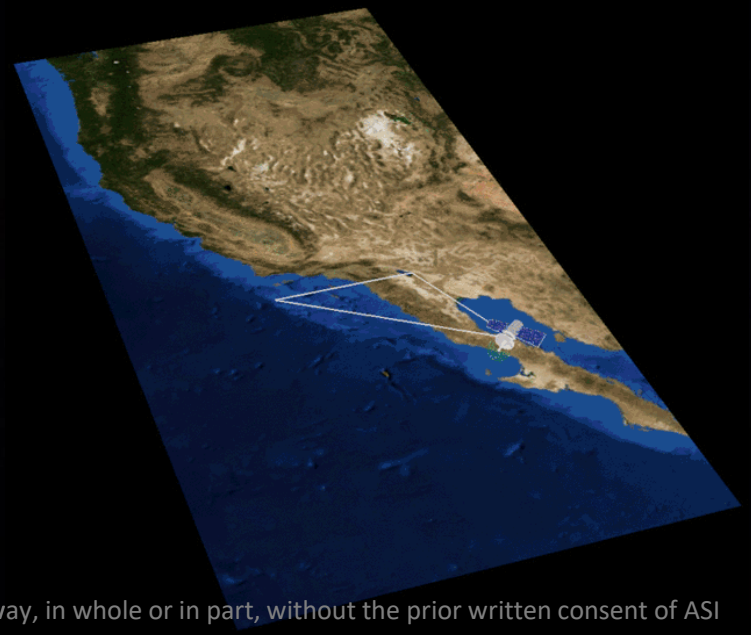
Data collected by the MAIA instrument, orbiting the Earth at 740 kilometers overhead, needs to be able to tell a group of tiny sulfate particles apart from a group of equally tiny dust particles. This is certainly a challenge, but MAIA will be able to distinguish types of particulate matter (PM) based on how the particles reflect or absorb sunlight.

MAIA contains a specialized digital camera that peers at how the Sun's light reflects off of the Earth and its atmosphere. This is no ordinary camera, however. It uses a combination of observing techniques to capture information about a layer of air pollution.
The MAIA camera is mounted on a motorized gimbal that can rotate 60 degrees forward and backward. As MAIA passes over a target on the Earth, the gimbal will rotate to point the camera at the target several times, capturing images from different angles. This technique is called "step and stare." The gimbal can also point to the left or right, which allows the camera to see cities that aren't directly underneath the satellite.







PLATiNO-3 & 4 Design approach

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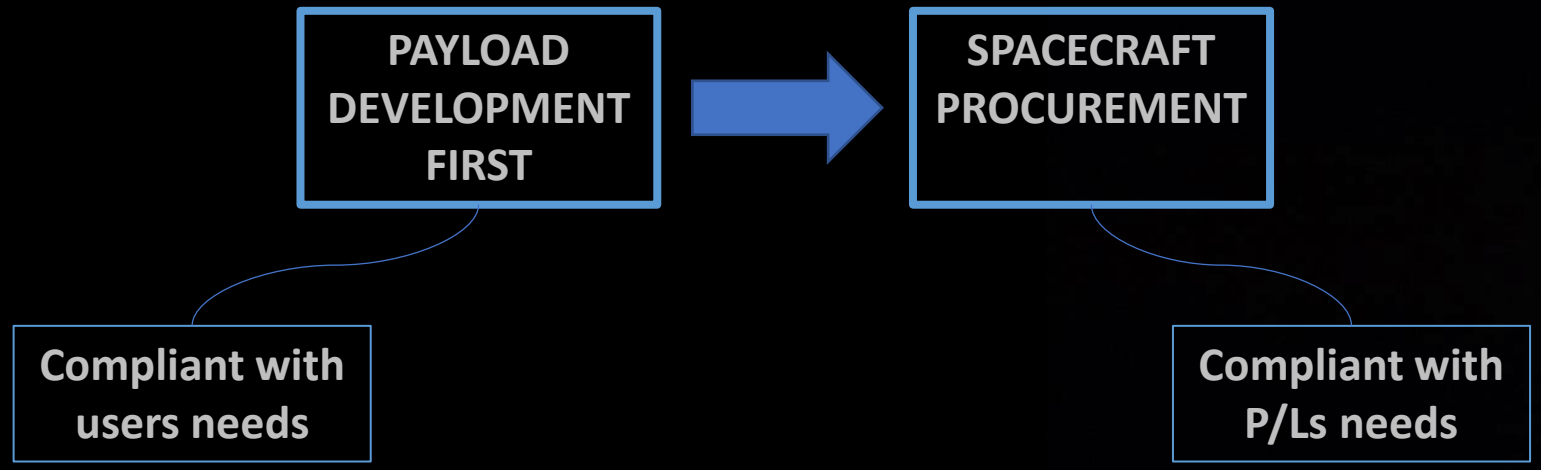
SATELLITE AS A SERVICE

PLATiNO modular architecture with a novel approach to assembly, integration, and test activities that spans ground through on-orbit operations.

PLATINO functionality will enable scalable multi-mission compatibility, long shelf-life, rapid call-up and field integration for launch, intelligent built-in test capability for rapid initialization on-orbit, and variable batch manufacturability.

Central to this architecture and design philosophy is the notion of “performance” modularity according to mission needs.



PLATiNO-3 VHR Mission Overview

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ASI VHR payload represents a mid-term engagement with the introduction of advanced technologies in Earth observation capabilities with the following overall objectives:

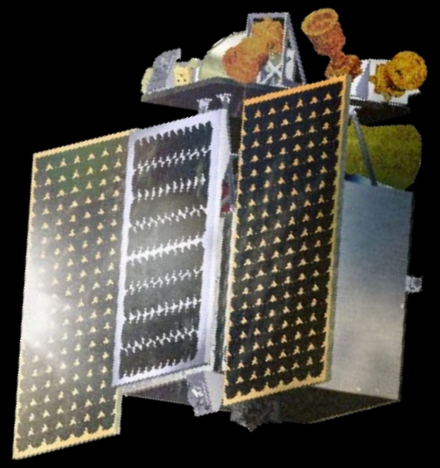
- Provision of an optical high-resolution panchromatic (0.5 m) and multispectral (2m) imagery with high quality product standards in terms of resolution, MTF (0.2 at system level), and a high image location accuracy
- Global coverage with service provision of level-2 products consisting of a panchromatic image with a merged multispectral image orthorectified on a DTM (Digital Terrain Matrix)
- The mission is required to support risk management support services in terms of observation coverage through an agile S/C design, a responsive operational concept, and a sufficient ground segment.

PRECISION AGRICULTURE FOREST MANAGEMENT GEOMARKETING
DISASTER MANAGEMENT URBAN PLANNIG SECURITY





PLATiNO-3 VHR Mission Overview



Very High Resolution (VHR)

	Readiness: 2024
band	VNIR
GSD [m]	2 x 2
GSD PAN [m]	0.5 x 0.5
Swath [km]	8
Spectral Range (nm)	455-902
# spectral bands	4 (RGB-NIR)
BAND 1	490 nm – SNR 154
BAND 2	560 nm – SNR 160
BAND 3	665 nm – SNR 162
BAND 4	842 nm – SNR 110
MTF	VNIR > 0.15 PAN > 015

PLATiNO-4 HYP Mission Overview

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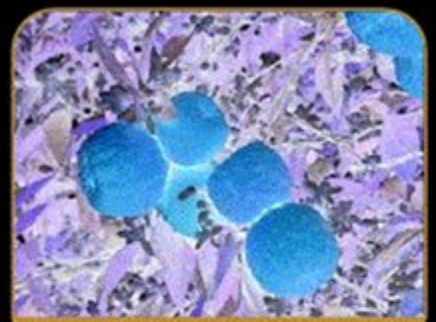
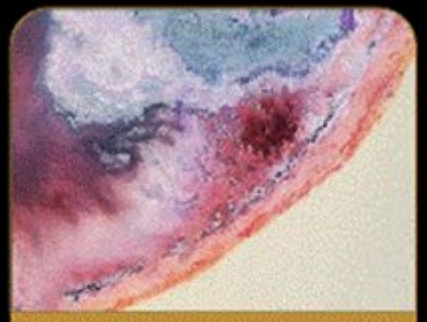
Earth observation payload with compact innovative electro-optical instrumentation which combines a hyperspectral sensor with a panchromatic camera. This combination couples geometrical characteristics recognition at high resolution chemical-physical composition scene.

This offers the scientific community and users many applications in the field of environmental monitoring, resource management, crop classification, pollution control, etc. Further applications are possible even in the field of National Security.



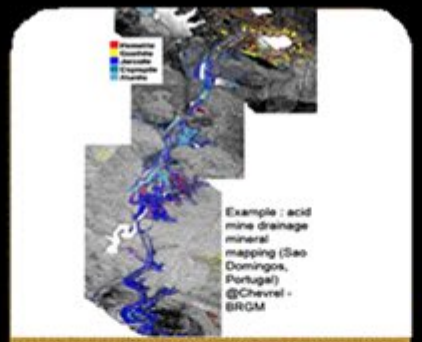
Vegetation

- Vegetation classification
- Pest detection and mapping
- Biophysical biochemical parameters estimation
- Top soil properties
- Biodiversity
- Vegetation monitoring



Coastal areas

- Bathymetry
- Alga monitoring
- Identification of bottom type (sea and lake)
- Water quality
- Maritime pollution

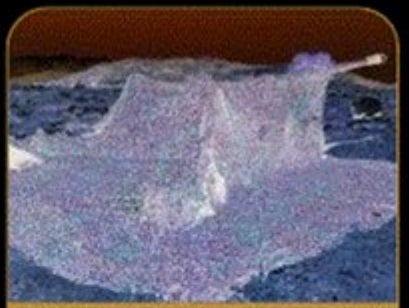


Geosciences

- Soil Composition
- Sand
- Clays (type of clay)
- Soil moisture content

Surveillance of industrial sites Natural & Anthropogenic hazards

- Industrial by-products
- Industrial residues
- Industrial plume
- Characterization of natural hazards
- Soil pollution



Tactical and strategic intelligence

- Decoy
- Decamouflage
- Anomaly and change detection
- Trafficability

Land use and urban characterization

- Land cover
- Urban land cover / man-made materials
- Desertification monitoring
- Flood prevention
- Urban mapping

PLATiNO-4 HYP Mission Overview

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Hyperspectral system based on key mission performance parameters : GSD, SNR, Spectral resolution and spectral sampling. It is intended to be a design to cost oriented program to prepare the potential operational program from a technology point of view and to assess and validate hyperspectral data processing capabilities.

Hyperspectral (HYP)

	Readiness: 2025
band	VNIR - SWIR
GSD [m]	30 x 30
GSD GMC [m]	15 x 15
GSD PAN [m]	5 x 5
Swath [km]	30 x 210
Spectral Range (nm)	VNIR: 400 – 1010 SWIR: 920 – 2500
# spectral bands	>230(VNIR-SWIR)
Spectral Resolution (nm)	< 10
VNIR SNR	>200:1
SWIR SNR	>100:1
VNIR GMC SNR	>100:1
SWIR GMC SNR	>50:1
MTF	VNIR/SWIR AT > 0.25 VNIR/SWIR CT > 0.25 PAN AT > 0.10 PAN CT > 0.10

Final remarks

PLATiNO is an all-electric versatile high tech multi-purpose small satellite platform deployable in constellation and suitable for a wide range of multi-mission applications (e.g. Optical, SAR, Telecom, etc.).

This platform ensures a reduction in development and operating costs in an extremely competitive market and supports a strategic placement of Italian industries in a sector where new space systems, such as mega-constellations, are multiplying.

PLATiNO sensors portfolio will consolidate and expand national EO capabilities.

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THANK YOU FOR YOUR ATTENTION

PLATiNO a Program to build a Multiporpose Platform

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PLATiNO PRIMARY OBJECTIVES:

OP-1 TECHNOLOGY: **Identify and develop as necessary national technologies** that can increase the Italian capacity to implement **space missions based on small satellites** and allow access to technologies currently precluded at national level;

OP-2 PRODUCT: To create a totally innovative product line, **a small multi-mission platform with different possible configurations**, capable of operating in **different mission scenarios and with different types of payloads**, and able to satisfy the **emerging demands of the commercial market and institutional**;

OP-3 COMPETITIVENESS: **To realize a supply chain and a production structure that allow to place on the market a recurring platform product**, characterized - in the various possible configurations - by competitive development times and costs at international level.

PLATiNO FLEET APPLICATION

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	PLATiNO 1	PLATiNO 2	PLATiNO 3	PLATiNO 4	JPL TIR	Constellation
Agriculture	✓	✓	✓	✓		✓
Air quality		✓		✓	✓	✓
Forestry	✓	✓	✓	✓	✓	✓
Maritime Surveillace	✓		✓			✓
Natural Disasters	✓	✓	✓	✓		✓
Ocean Monitoring	✓	✓		✓	✓	✓
Oil and Gas	✓					✓
Security	✓		✓			✓
Urban Monitoring	✓		✓	✓		✓

PLATiNO-2 TIR Acquisition concept

- The FPA array is divided in four 1024x32 pixel are each of them associated with a spectral band.
- Four spectral bands are projected on ground in different ALT position.
- Thanks to satellite motion the 170Km is composed by several detector acquisition ~120s.
- Thanks to **GMC** (4.35), the detector frame rate can be low enough ~21Hz and TDI technique can be implemented to increase NEdT performances.