

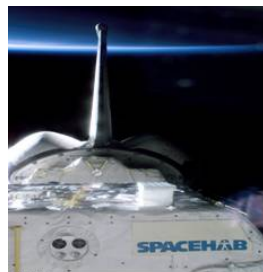
# ESA In Orbit Demonstration in Technical Directorate

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Since the early GSTP days (1987), ESA has included In Orbit Demonstration in the program (TDP, TFO, ...):

- More than 20 experiments/demonstrations have been performed on carrier of opportunity (GAS, EUTEF on ISS, ...),
- Missions based on small satellites have been performed and planned (Sloshat/Flevo, PROBA"x")

This presentation covers in particular Small Satellite IOD missions



## Why In Orbit Demonstration ?

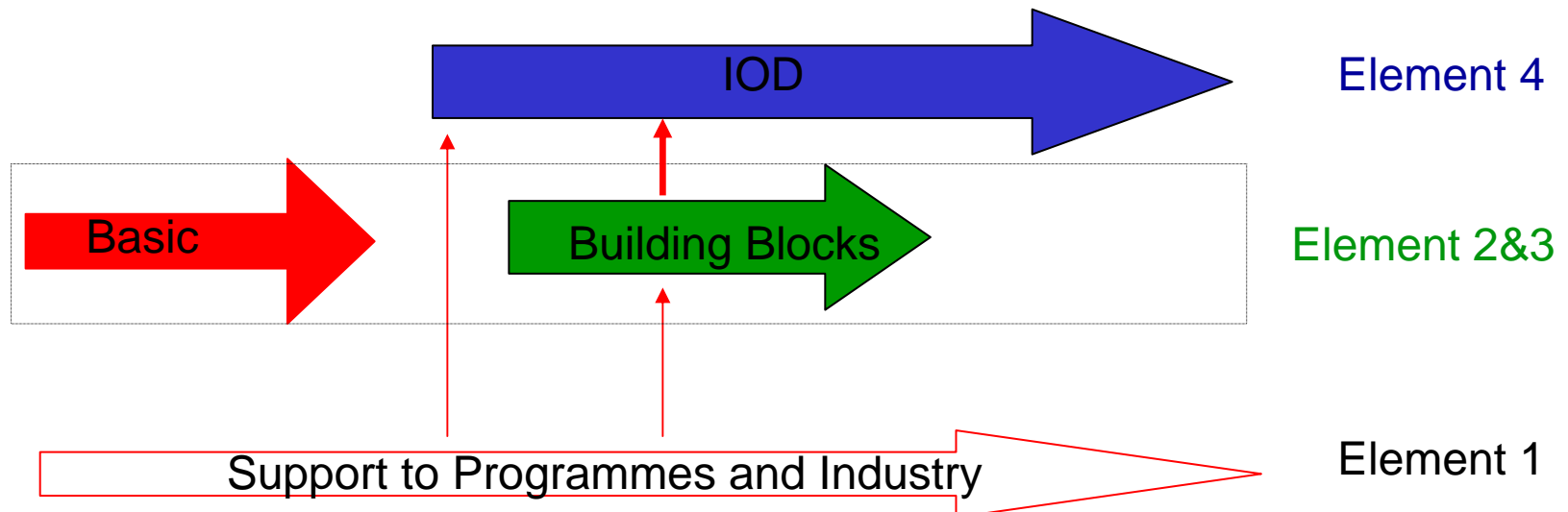
- A number of European technologies in particular generic technologies and techniques supporting industry competitiveness, require in orbit demonstration to achieve and demonstrate their maturity
- A number of mission concept require validation in space before being used in applications and main stream missions e.g. BRDF, PARIS
- Demonstration of technologies in orbit up to TRL 9,
- Introduction of advanced engineering process (integrated development, auto-code, startiger).

ESA has several technology programs including:

- TRP Technology Research Program
- GSTP General Support Technology Program

They include a specific component for in orbit demonstration of technology -> GSTP-5 Element 4.

It includes in orbit demonstration on small satellites.



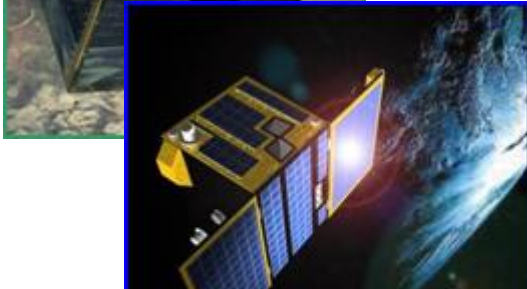
# Small Satellite Projects



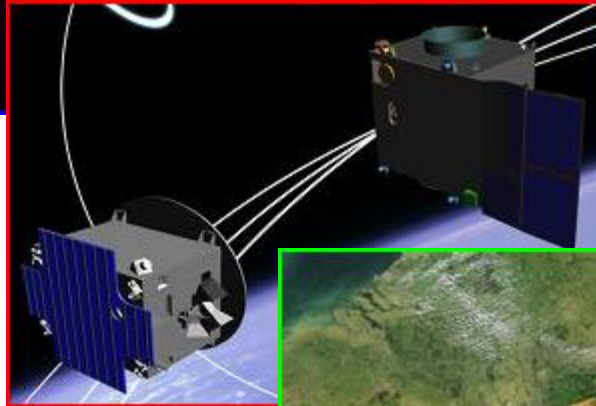
PROBA 1  
Development: 1998-2001  
Mission: 2001 – still fully operational



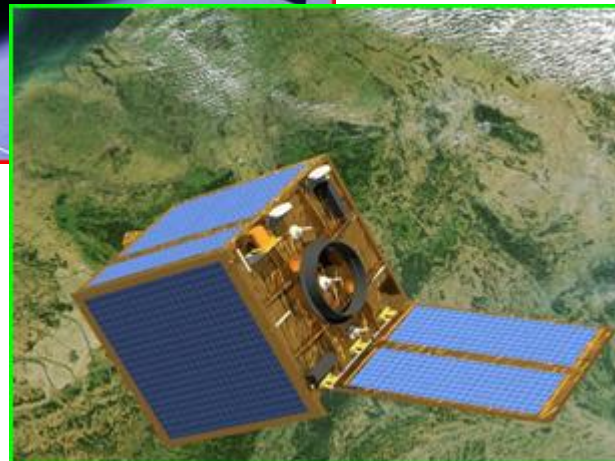
Slosat- Flevo  
Mission: Feb 2005



PROBA 2  
Development: 2004-2008  
Mission: Nov 2009 - ...

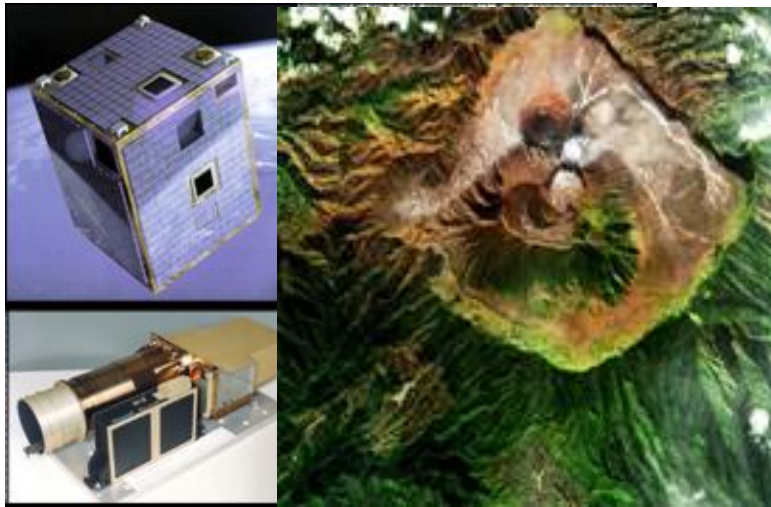


PROBA 3 – in preparation (B2)  
Development: foreseen 2009-2013  
Mission: foreseen 2014 - ...



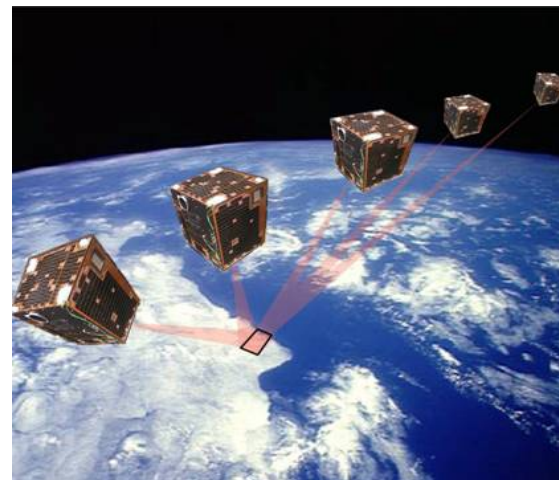
PROBA V (C/D)  
Development: 2009-2011  
Mission: 2012 - ...

# Techno demo



- PROBA – 1 carries a guest payload, the Compact High Resolution Spectrometer (CHRIS)
- CHRIS benefits from PROBA-1 technology features, autonomy, agility, precise AOCS
- Exploited by EOP, PROBA-1 (ESA/PB-EO(2008)14) provides data to
  - 160 Cat I projects based on CHRIS
  - 10 based on the HRC

- PROBA-1 launched in 2001
- Technology avionics, power, materials
- Development and verification techniques, requirements to coding
- Relation space – ground, validation - operations

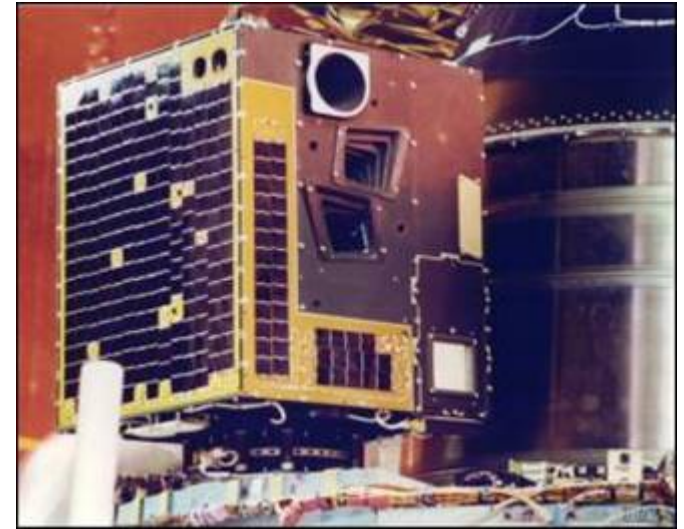


## PROBA 1

Small technology demonstrator satellite for autonomous operations and Earth observation (launched in 2001)

### Technology Demonstration / innovations:

- Autonomous on board flight dynamics (position, attitude and maneuver determination)
- Avionics technology (ERC32, DSP, 3D modules)
- Low cost autonomous star tracker for attitude and rate
- Gyro-less maneuvering satellite
- Software methodology (auto coding and SVF)
- Battery technology (Li-ion)
- New instruments and sensor test (HRC, MRM, PASS, SIPs)
- Common ground infrastructure (EGSE and mission control centre)
- Ground segment automation
- Compact High Resolution Imaging Spectrometer (CHRIS)



## PROBA 2

Small technology demonstrator satellite for autonomous operations and Sun monitoring (launched in 2009)

### Platform:

- lithium-ion battery,
- advanced data and power management system based on LEON
- combined carbon-fibre and aluminium structural panels,
- new miniature reaction wheels
- Miniaturised star tracker
- **COTS based GPS receivers**
- digital Sun-sensor
- dual-frequency GPS receiver
- fibre-sensor system for temperatures and pressures
- APS based star-tracker (BepiColombo)
- **New 3 axis magnetometers**
- very high precision flux-gate magnetometer
- Solar panel with a solar flux concentrator
- solid-state nitrogen gas generator
- exploration micro-camera (X-CAM)
- new GNC algorithms

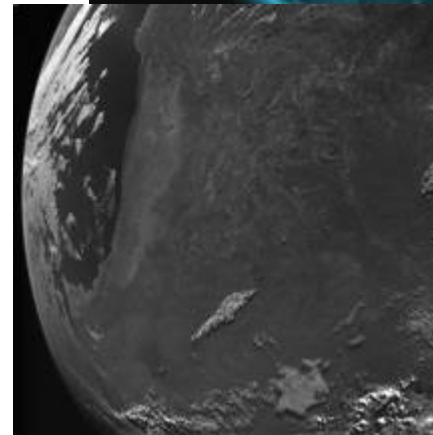
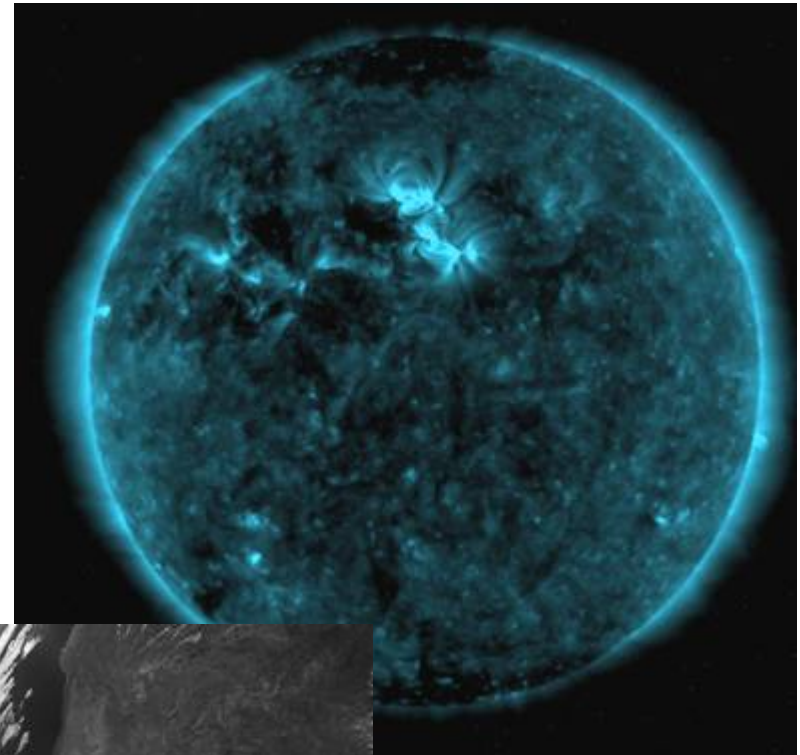


## PROBA 2

Small technology demonstrator satellite for autonomous operations and Sun monitoring

### Payload:

- SWAP - Sun Watcher using APS detector and image processing, based on new detector and providing high acquisition rate.
- LYRA - Lyman Alpha radiometer using a new type of detector.
- DSLP - Dual Segmented Langmuir Probe for plasma charging measurements
- TPMU - Thermal Plasma Measurement Unit
- SGVM - Science Grade Vectorized magnetometer (high accuracy)
- PALAMGI - Panoramic 360 degrees optic
- X-CAM - Miniaturised camera based on MEMS and panoramic optics

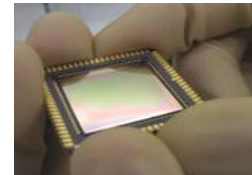


## PROBA 2 Sun Monitoring Mission

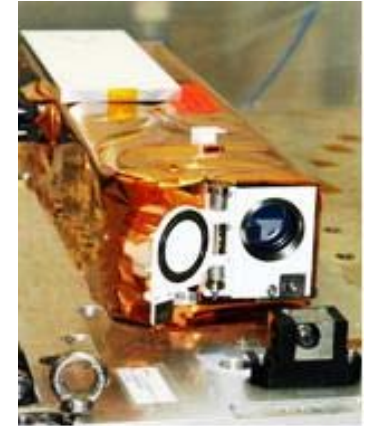
**PROBA 2 flies a new generation of miniaturised science instruments providing valuable and new scientific data (EUV at 17.5 nm).**

**SWAP** Sun Watcher using Active Pixel Sensor:

- low power (<10 Watt)
- Low Mass < 10kg
- Low volume (56x15x13 cm).
- New filter design/mounting concept,
- Use of APS sensor technology,
- Miniaturised electronics and near loss-less image compression, image selection, automated detection of space weather events (flares, EIT waves, prominence/filament eruptions), autonomous flare tracking.
- High cadence imaging (1 per minute, 120x per 2 hours)
  
- Compared to its predecessor, SOHO EIT instrument
  - Mass of about 18 kg
  - Volume of about 35 x 30 x 120 cm
  - Max. cadence 1 x image per 2 hours



Active Pixel Sensor



## PROBA V

### Gap Filler for Vegetation Mission

#### PROBA-2 Follow-on

#### Technology Demonstration:

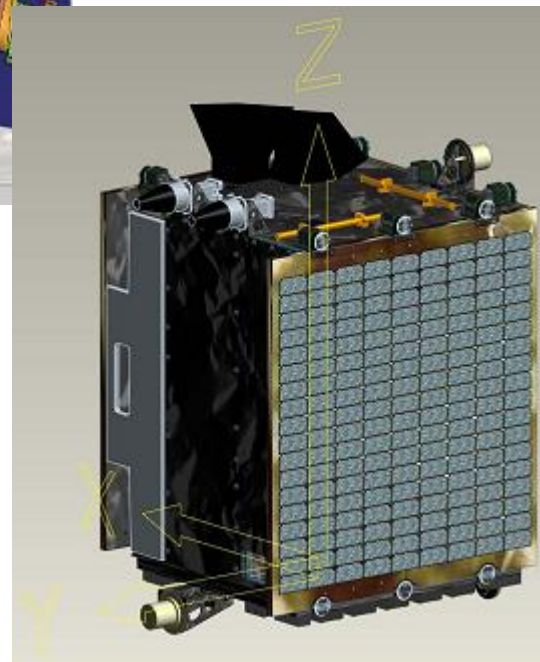
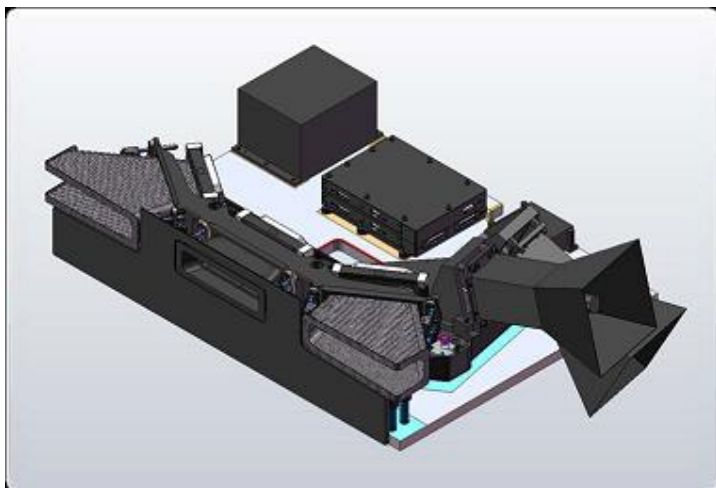
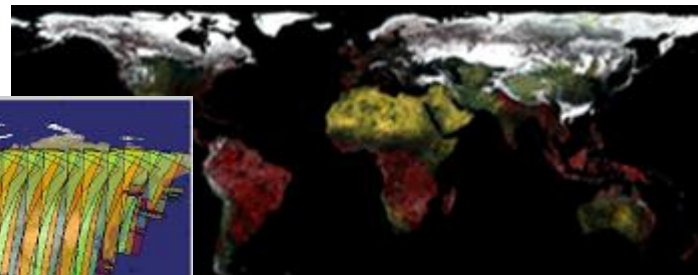
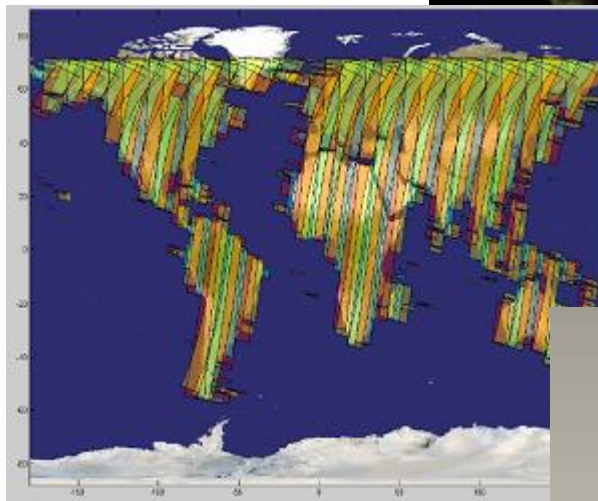
- SWIR detector
- GaN X band transmitter
- Wide angle TMA

#### Payload

- Mutli-spectral imager

#### Status

- Phase C/D (CDR)



# PROBA 3

## The mission requirements belong to two classes:

- Requirements associated to the formation flying, the development of the technology, the tools and facilities and utilisation of the techniques
- Requirements associated to the sun-coronagraph mission / payload.

## The intention is to progress also in the utilisation of advanced techniques for System Engineering and Software Development and AIV.

## This is to be achieved by:

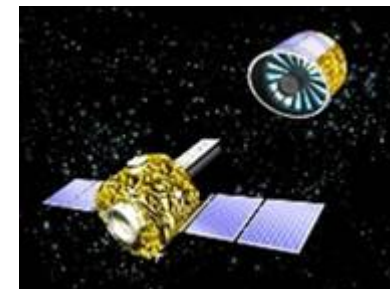
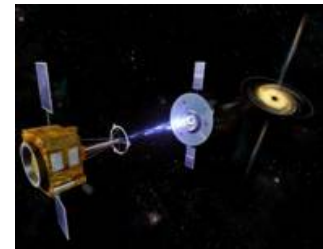
- Developing and deploying two high performance small satellites with the appropriate FF system and a sun coronagraph payload

## The challenge is also at system level:

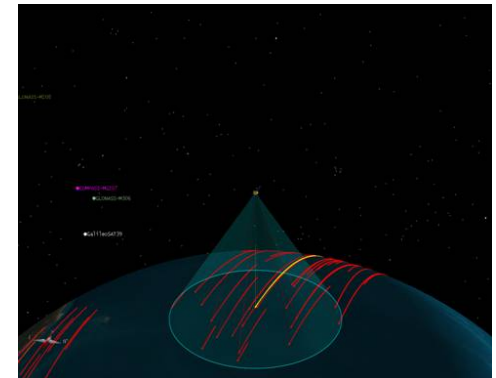
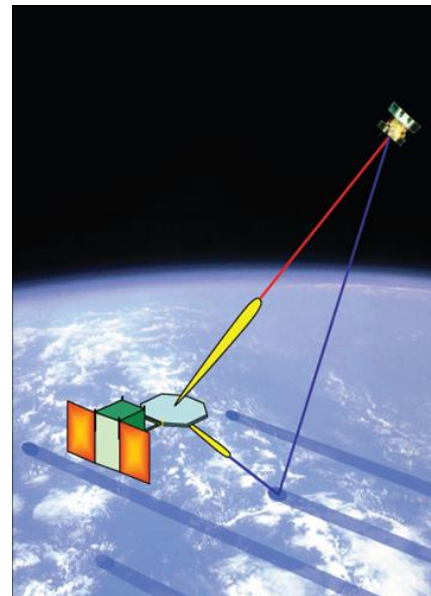
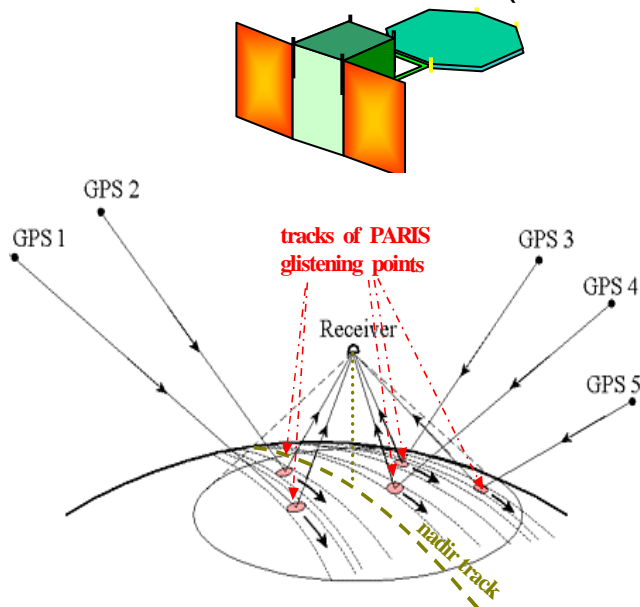
- First FF mission (i.e. mission where relative position and attitude of all spacecraft are measured and controlled in a feedback loop and where spacecraft together perform the function of an otherwise unrealistically large/stable/quiet single spacecraft).
- Upgrade of small spacecraft platform to include FF functionalities.

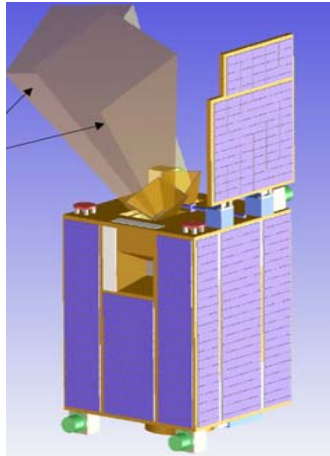
## Status

Phase B2

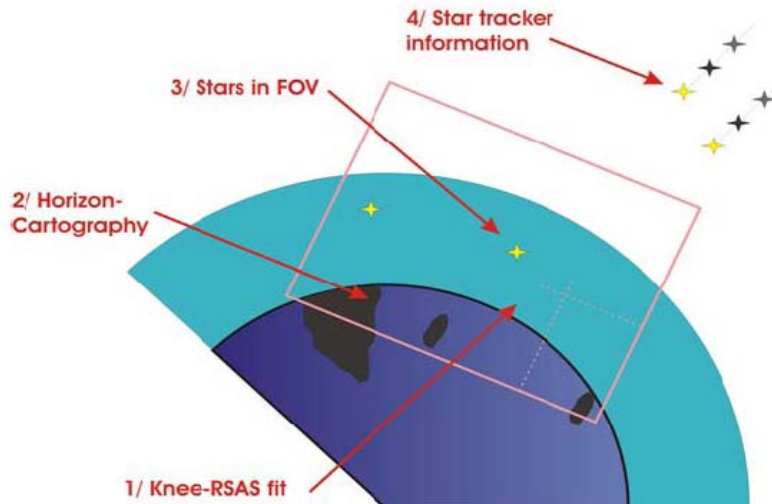


- **Demonstration mission** targetted to the demonstration of Galileo for research
- **Objective:** ocean mesoscale altimetry demonstration, ice topography, soil moisture, ionospheric monitoring
- **Challenge:**
  - Payload: antenna, receiver and processing technologies,
  - Platform: avionics, OB-SW, micro-propulsion, AOCS
- **Status**
  - Included in EGEP (Phase A) and TRP (techno developments)

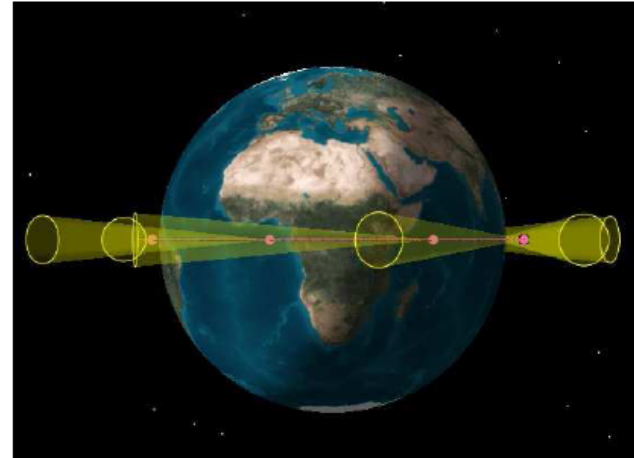
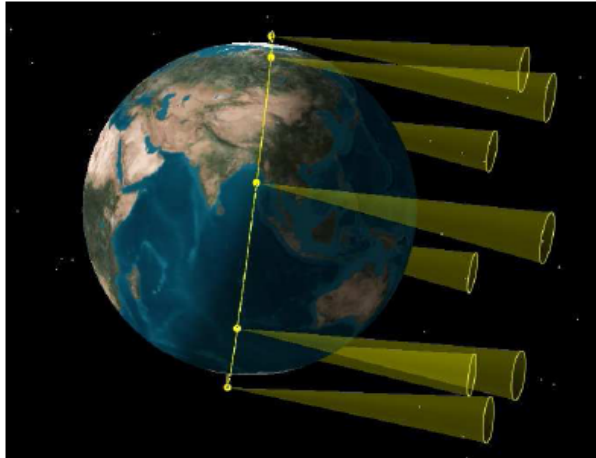




- **Demonstration mission:** Atmospheric Limb Tracker for Investigation of the Upcoming Stratosphere
- **Objective:** Demonstration of imaging spectrometer based on acousto-optical tunable filter (AOTF) devices in UV, VIS and NIR. Demonstration of small spacecraft agility and pointing stability
- **Challenge:** Monitoring of the upper atmosphere with good vertical resolution.
- **Status:** Phase A and UV AOTF pre-development on going.

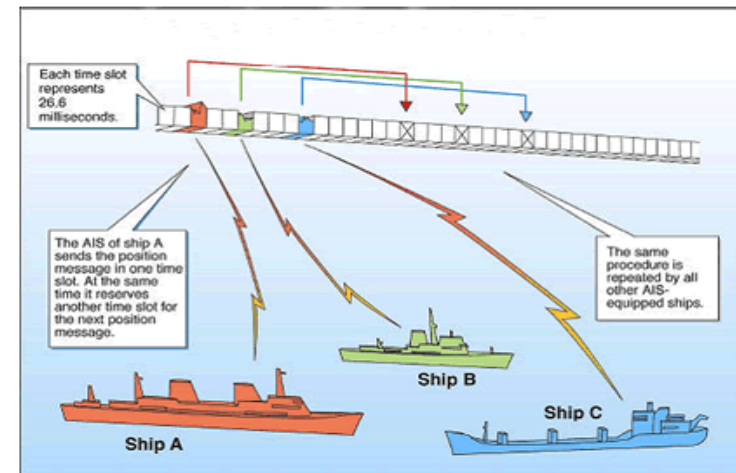
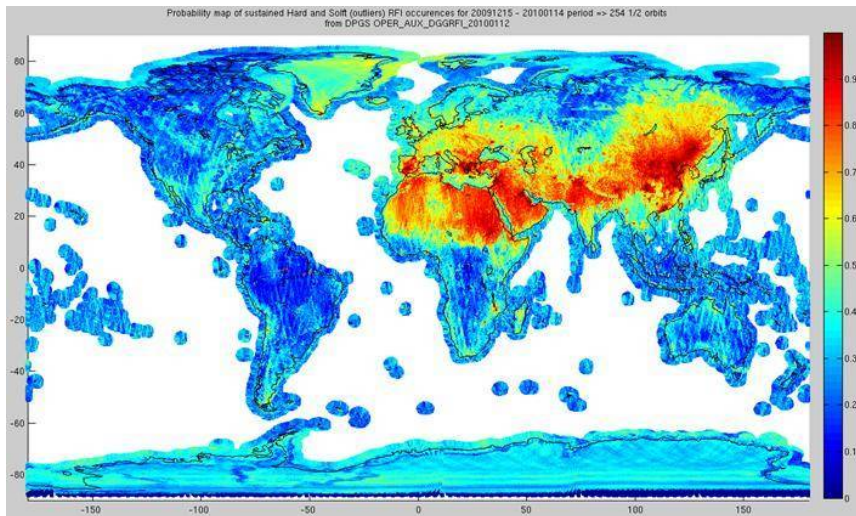


- **SSA program Phase 1** covers SSA components pre-developments, pilot projects, no space component but analysis of space component
- **Phase 2 (post CM11)** covers the implementation and includes a space component to improve survey of space objects and Space Weather in situ measurements.
- Sufficient elements are available to initiate Phase A in 2010, GSTP & SSA technology workplan cover already several required technologies (e.g. focal plane, ...)

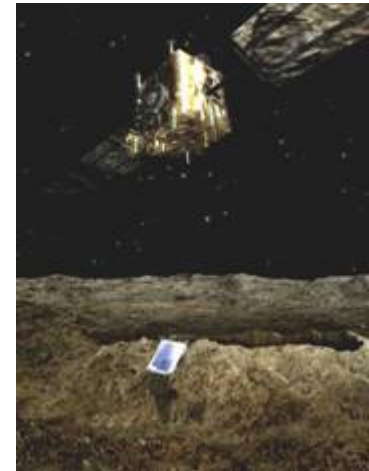
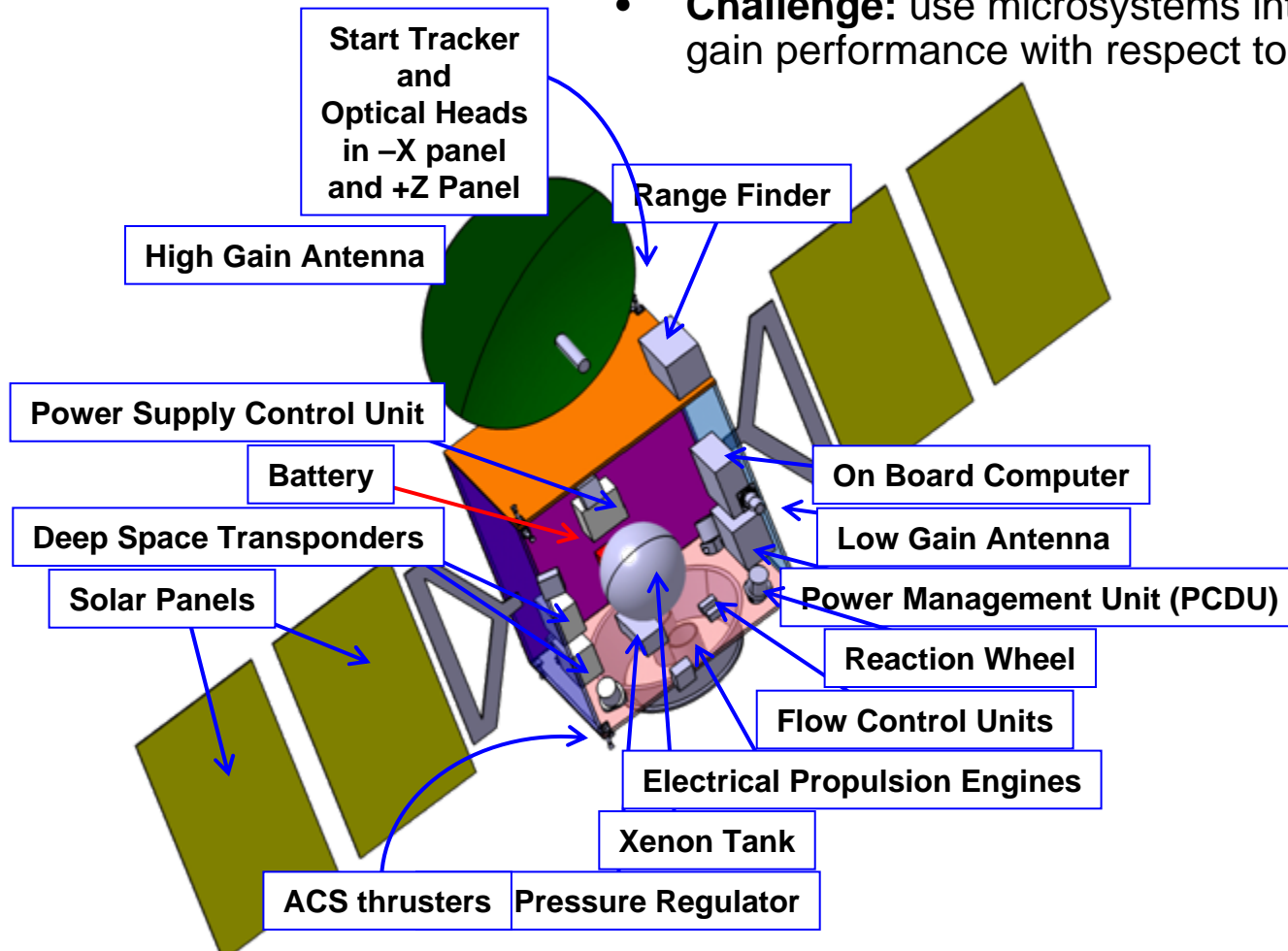


Demonstration of receiver technology for monitoring RF interferences from space and AIS signal detection from space

- ❑ In Orbit Demonstration needs:
  - ❑ Verify signal environment
  - ❑ Sensitive VHF receiver based on Software Defined Radio (SDR)
  - ❑ Receiver technology



- **Demonstration mission** targetted to Apophis (Phase A)
- **Objective:** To demonstrate autonomous navigation to a Near Earth Object and miniaturised spacecraft technology.
- **Challenge:** use microsystems integrated in a system to gain performance with respect to mass.

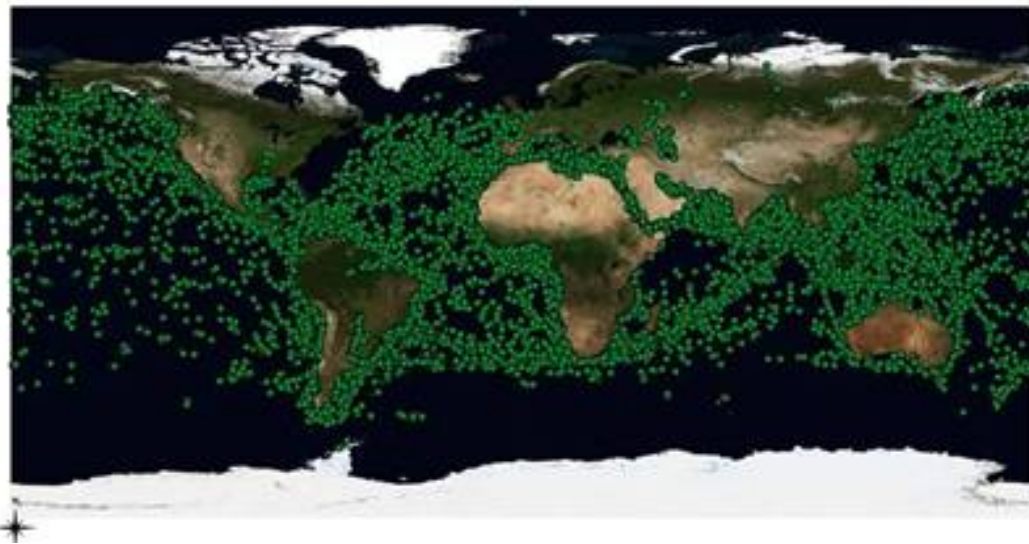
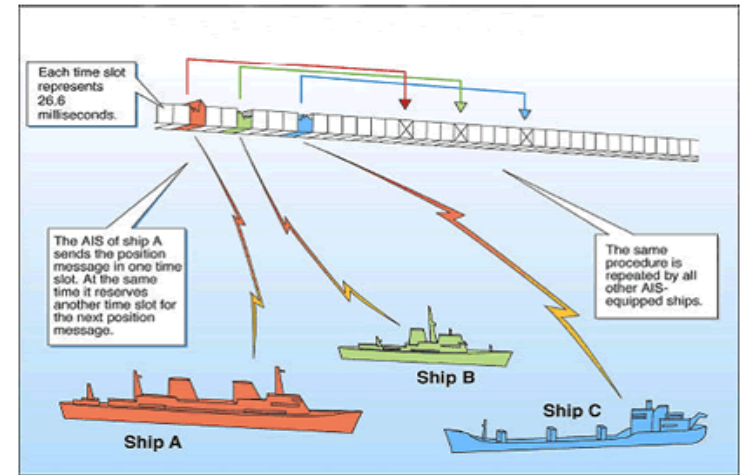


# Space Maritime Reconnaissance & Surveillance (SMRS)

Demonstration of AIS signal detection from space:

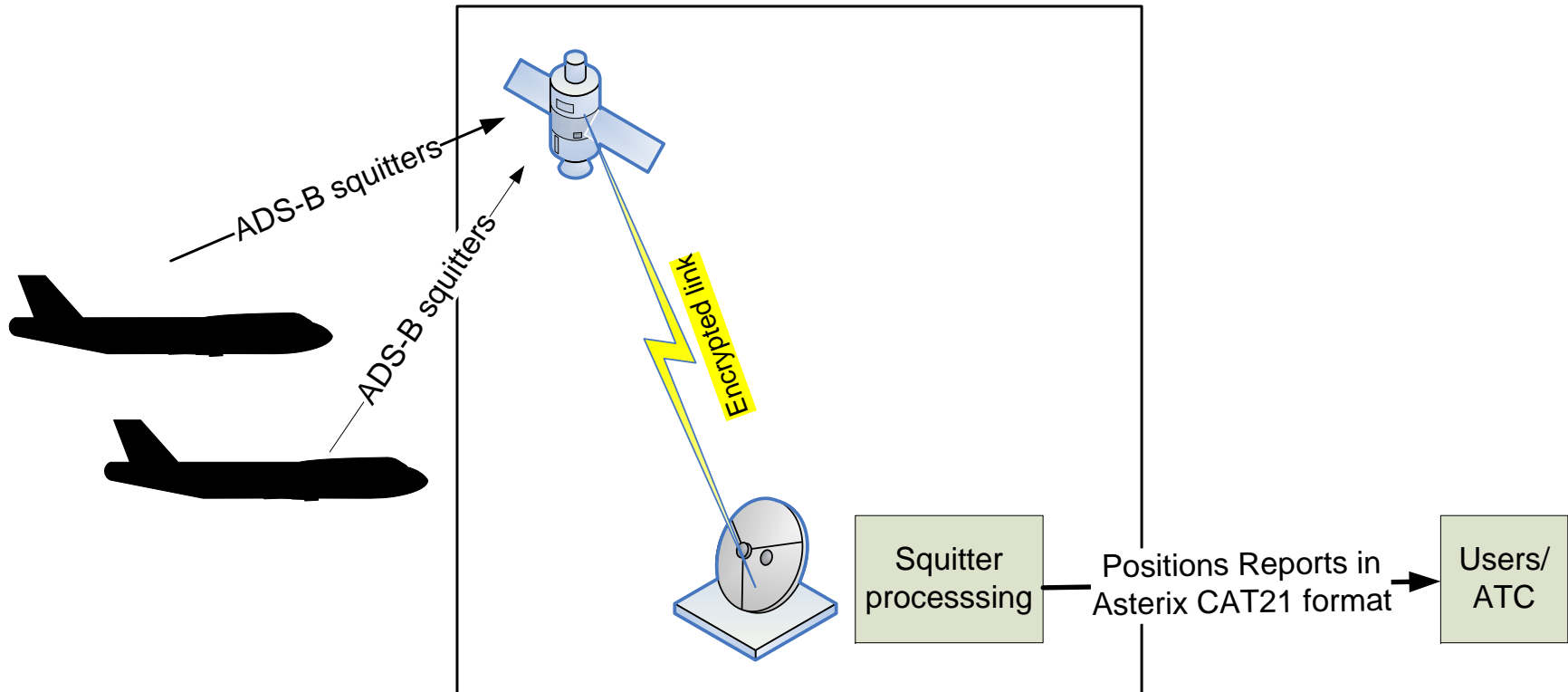
- ❑ Verify signal environment
- ❑ Receiver technology

As a first step, reception of AIS signals from space is being demonstrated on Columbus, together with SDR and algorithms,



Automatic Dependent Surveillance Broadcast: signals transmitted by aircraft (1090 MHz)

Objective: demonstrate space based reception of ADSB signals



# Conclusion

IOD with small satellites is a good vehicle for technology demonstration

It is supported by the Technology Programs of ESA, several mission concepts and technology pre-developments are on-going or ready for implementation

Small IOD mission shall combine generic space technology with payload technology and flight opportunity for small instruments to provide an attractive set-up and optimise return on investment by serving two communities (technology and users).

**Thank you for your attention and the invitation**