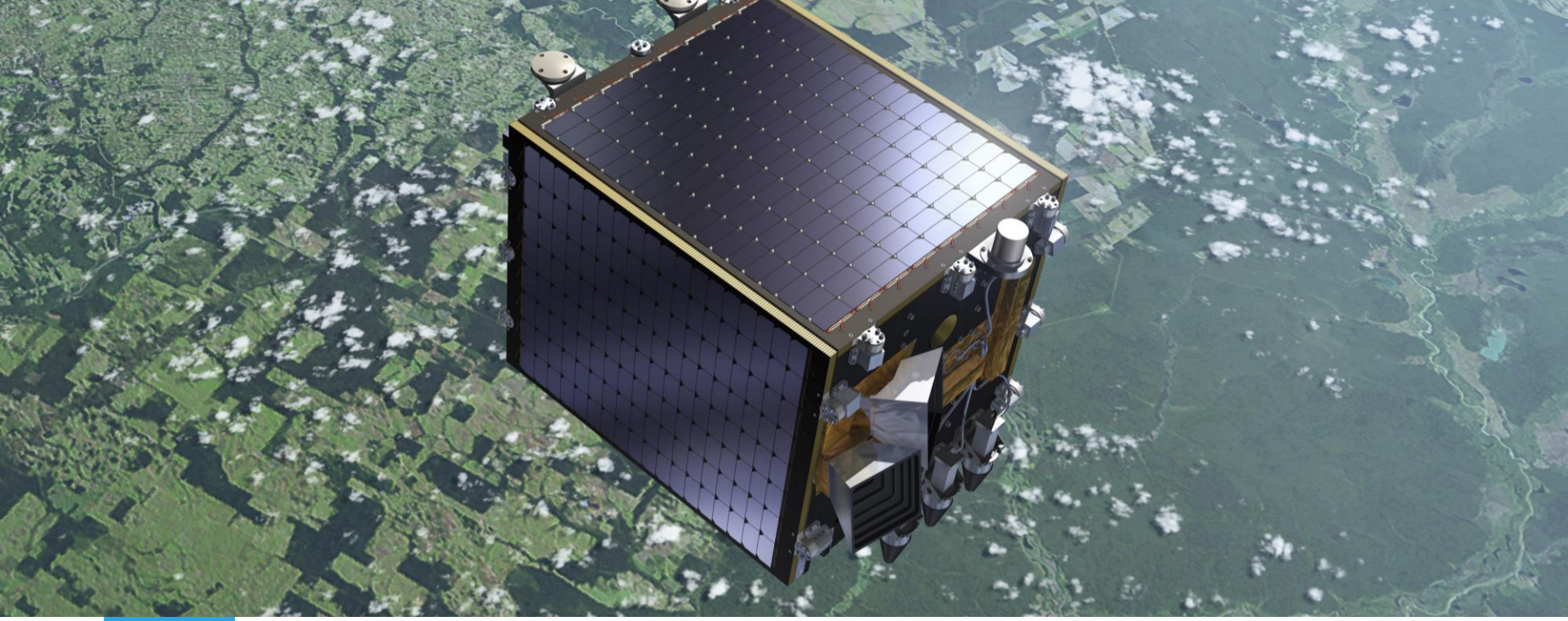


ECODESIGN APPLIED TO ESA'S PROBA-VEGETATION SATELLITE

An Vercalsteren (VITO)
Peter Holsters (QinetiQ Space)

Clean Space Industry days – 24-26 October 2017

QinetiQ Space

vito

OUTLOOK

- **Introduction**

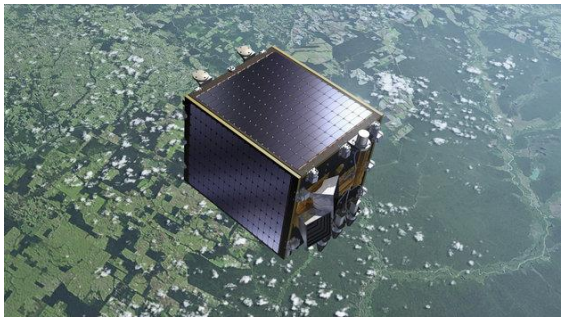
- **Life Cycle Assessment of PROBA-2 satellite**
  - Environmental hot spots
  - Lessons learned

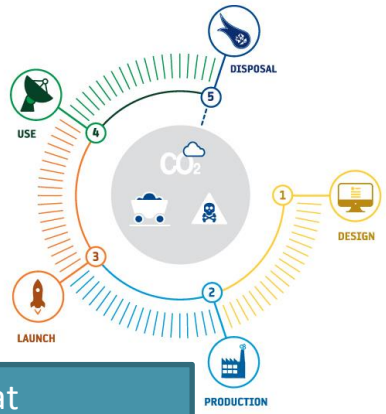
- **GreenSat project**
  - LCA of PROBA-V satellite
  - Approach towards Ecodesign options for PROBA-V
  - PROBA-V mission overview

INTRODUCTION

PROBA series

- PROBA (PRoject for On-Board Autonomy)
  - family of small satellites, developed by QinetiQ Space, for ESA
  - PROBA-1 (EO, launched in 2001)
  - PROBA-2 (Sun observation, 2009)
  - PROBA-V (EO, 2013), all three currently operating in orbit,
  - PROBA-3, consisting of 2 satellites flying in close formation, currently close to CDR





GreenSat
Based on PROBA-V

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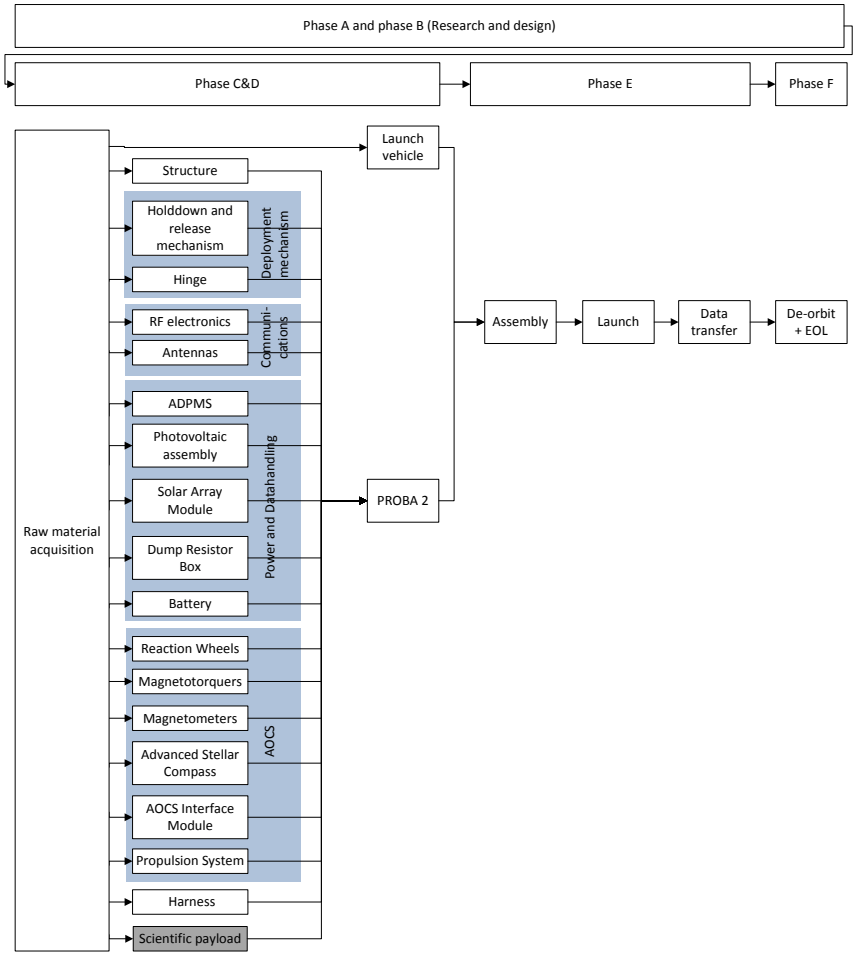
INTRODUCTION

Cooperation VITO – QinetiQ Space

- **Life Cycle Assessment of PROBA-2 mission:**
  - Objective:
    - Perform LCA of 2 selected ESA projects
    - Develop methodological framework
    - Input for database for space applications
  - 2012-2013

- **GreenSat: Ecodesign of PROBA-V mission**
  - Recently started – finalized by end of 2018
  - Objective:
    - Redesign a space mission based on ecodesign principles
    - Identify relevant design improvement options, leading to at least a 50% environmental impact reduction on at least three impacts
    - Use and test Space system LCA-guidelines and ESA LCI/LCA database
    - Identify potential benefits and difficulties of performing and implementing ecodesign in European space sector

LCA OF PROBA-2 MISSION



- **FU**: “one space project in accordance with the PROBA-2 mission's requirements”
- **System boundaries**
  - Phase A (design)
  - Phase B (design)
  - Phase C&D (production, verification and testing)
  - Phase E1 (launch event and commissioning phase)
  - Phase E2 (use phase)
  - Phase F (disposal)
  - Scientific payload not included
- **Data collection**
  - QinetiQ data on inputs for LCA and cost estimates
  - ESA data on testing and groundstations

Encountered issues

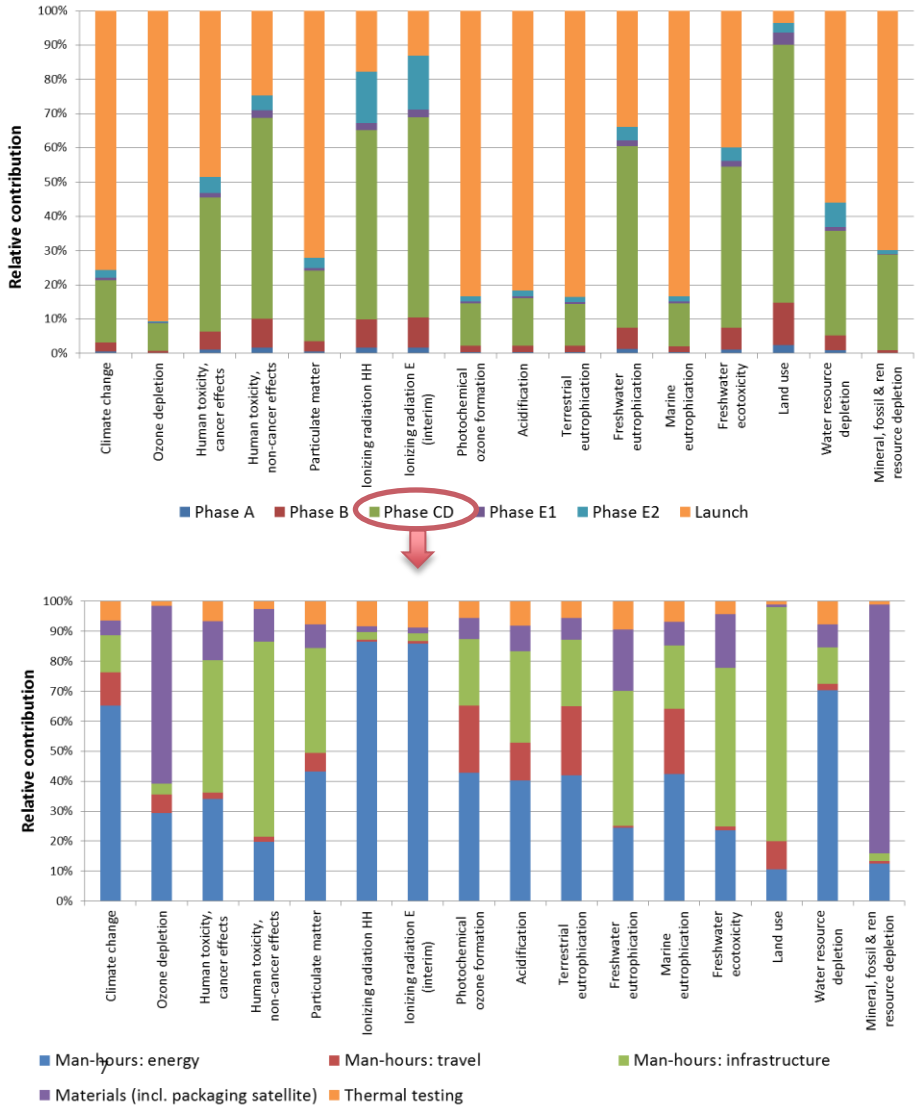
- Components for **space applications ≠ custom applications**
  - custom: price dependant on materials
  - space: price dependant on man-hours

  → ratio costs/weight is very high in space applications
  - **Solution:** include environmental impact of manhours

- Use of **specific materials**: no production data available in common LCA-databases
  - **Solution:** ESA space specific LCI-database

- How to model the **impact of manhours**?
  - Estimate manhours per phase, starting from cost data
  - Include direct energy consumption, infrastructure, business travel, use of consumables (water, paper, …)
  - 'Hybrid approach': combination of cost data and physical data

LCA OF PROBA-2 MISSION



- **Environmental hotspots:**
  - **Manhours**
    - **energy** production
    - **infrastructure** (both land use and the production of buildings)
  - Production of **electronic** components
    - Technology demonstrators
    - Harness
    - Antennas
  - Impact of **launch** is significant compared to rest of mission

- **Methodological:** Combination of
  - **process-based LCA** data on better known materials and processes
  - **IO (cost-based)** data on the not-included materials and processes

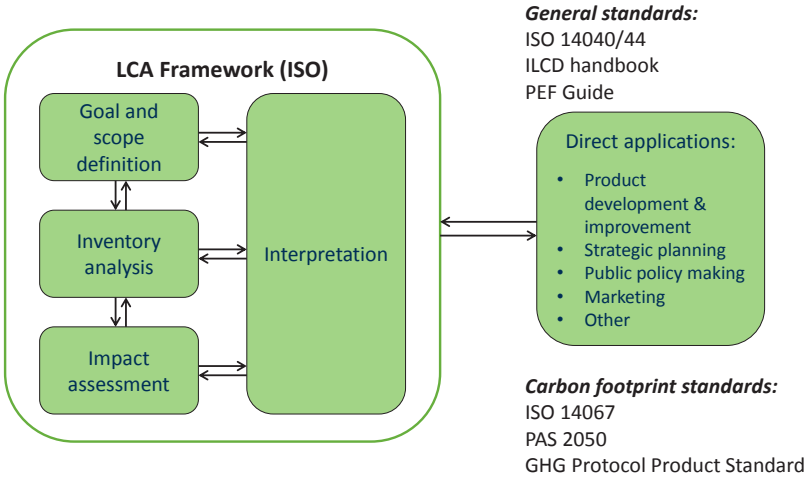
provides details and completeness

GREENSAT PROJECT

- **4 technical work packages:**
  - WP1: LCA of PROBA-V and identification of hot spots
  - WP2: Identification of ecodesign options – brainstorm and tradeoff
  - WP3: Ecodesign preliminary concept development and LCA
  - WP4: Quantitative comparison of ecodesign options

- **LCA of PROBA-V:**
  - Data inventory ongoing
  - System boundaries:
    - A&B: Design Phase, including office work and travelling.
    - C&D: Production, Verification and Testing Phase
    - E1: Launch Event and Commissioning Phase
    - E2: Use Phase
    - F: Disposal Phase
    - Including scientific payload
  - 2 iterations

- **Identification of environmental hot spots (≠ levels)**
  - literature review of ESA LCA studies
  - LCA results PROBA-2 and PROBA-V



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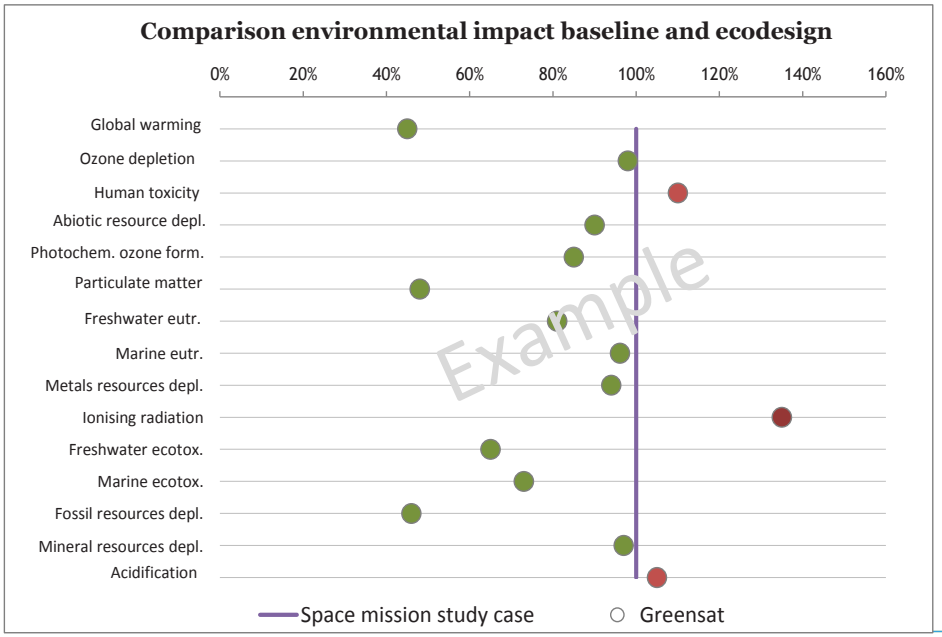
Workshop: Thursday 26/10 14:00-18:00

GREENSAT PROJECT

- **Brainstorm and workshop** to identify ecodesign options for selected space mission
  - On **different levels**:
    - Materials, equipment and components, manufacturing processes
    - System
    - Management and programmatic
    - Regulatory
- **Trade off and selection** of ecodesign options for further development
- Ecodesign **preliminary concept development** for 5 options, guided by LCA



- LCA to **compare** environmental impact of baseline and redesign PROBA-V mission
  - To identify environmental saving
  - To check feasibility of project objective (50% reduction for 3 environmental impacts)
- Assessment of **cost, performance, risk**, schedule and feasibility
- Develop **roadmap** for 3 selected options
- Revisit **missions specification**

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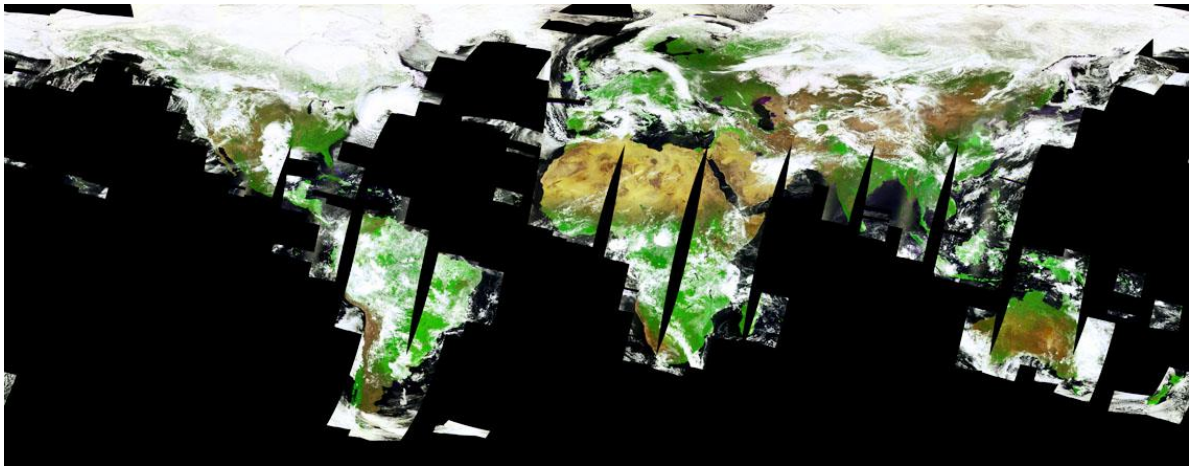
PROBA-V MISSION OVERVIEW

- **Mission objective -** Gap filler mission for SPOT-Vegetation and Sentinel-3
  - Spectral and radiometric performance identical to Vegetation
  - Ground sampling distance of 300 m
  - Daily global coverage for latitudes above 35°
  - Complete global coverage in 2 days

- **Project duration:** 3,5years
  - **Start of Phase B1:** January 2009
  - **Launch:** May 2013 on-board VV02 from Kourou

proba-v



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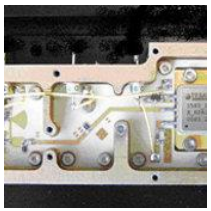
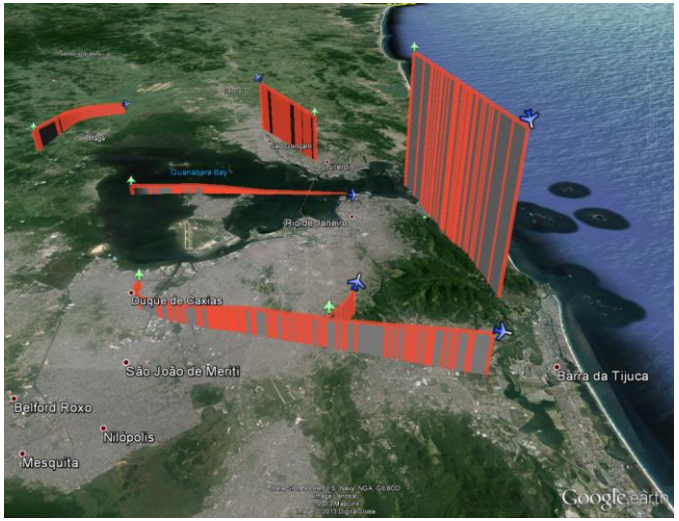
PROBA-V MISSION OVERVIEW – TECHNOLOGY DEMONSTRATIONS

- **In addition to main payload, 5 technology demonstrations**
  - GaN X-band transmitter
  - HERMOD – optical fibre
  - SATRAM – Radiation monitor
  - EPT – Radiation monitor
  - ADS-B – airplane tracking receiver



In-orbit demonstration
ADS-B receiver – tracking of airplanes



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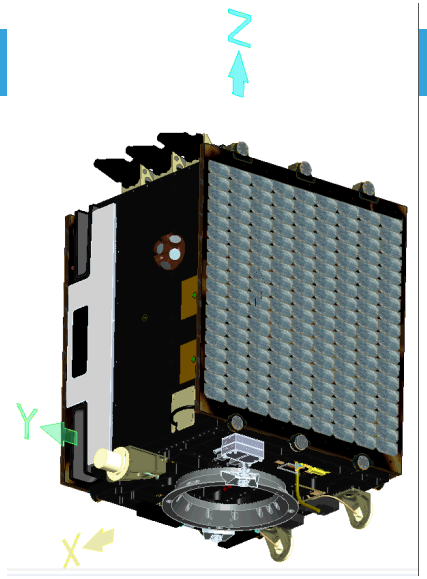
PROBA-V MISSION OVERVIEW

- **Satellite characteristics:**
  - 140kg - 300W - ~1m3
  - 5 years design
  - Cold redundant

- **Design highlight**
  - Design based on PROBA-2
  - Main differences:
    - Generally slightly larger and heavier
    - More efficient solar cells
    - Improved power performance
    - Improved downlink capability (X-band @100Mbps)
    - Improved mass memory (88Gbit NAND Flash)
    - Other battery type
    - More payloads



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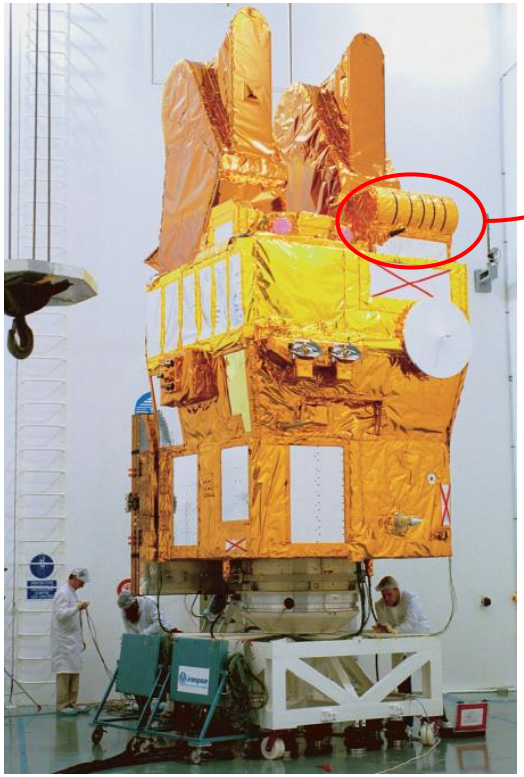
PROBA-V MISSION OVERVIEW

- **Technology evolution as natural partner of eco-design: major reductions in size and power**

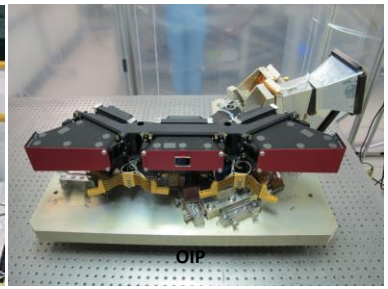


SPOT-5

Proba-V

Vegetation instrument

PROBA-V instrument



Spec	Vegetation on SPOT5	Vegetation on PROBA-V
Size	1000x1000x700mm^3	800x600x200mm^3
Mass	150kg	Max 34kg
Power	Max. 160W	Average +-21W; Max. 41W
FOV/Swath	101°/2250km	102.6°/>2250km
Spectral bands	B0(Blue)–B2(Red)–B3(NIR)-B4(SWIR)	B0(Blue) – B2(Red) – B3(NIR) B4(SWIR)
IQ (MTF)	?	>0.3
GSD	1000m	VNIR: 100m Nadir - 360m edge SWIR: 200m Nadir – 685m edge Much better GSD with much more compact system

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CONCLUSION

- **PROBA-series:**
  - Already ‘ecodesign’ alternative due to size in relation to functionality
  - PROBA-V: no propulsion -> propulsion required for next generation
  - Improvements from PROBA-2 to PROBA-V:
    - Use of recurrent solutions allows to improve development time
    - General technical advances allowing efficiency improvements (solar cells, battery, memory density,…)

- **GreenSAT:**
  - Only focussing on technological ecodesign options?
  - Checking theoretical potential of changes to system specifications?
    - Margins
    - Extension of lifetime

- **Methodological**:
  - Opportunity to check the feasibility of ESA-LCA Handbook and database

QUESTIONS

You are all invited to join the GreenSat workshop:

During the Industry days
Thursday 14:00-18:00 (26/10)
CDF

CONTACT

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