15ª Conferencia Interparlamentaria Europea del Espacio (CIEE)
Reunión preparatoria
Bruselas, 24 y 25 de marzo de 2013.

Los días 24 y 25 de marzo de 2013, con motivo de la reunión preparatoria de la 15ª Conferencia Interparlamentaria Europea del Espacio, se desplazaron a Bruselas el Presidente de la Comisión de Economía y Competitividad, D. Santiago Lanzuela Marina y la Letrada de la misma, Dña. Mónica Moreno Fernández- Santa Cruz. La Delegación estuvo acompañada por D. Jorge Lomba, Jefe del Departamento de Industria de la Ciencia y del Espacio del CDTI.

El 24 de marzo se ofreció una cena a los asistentes en el Senado de Bélgica.

El 25 de marzo dio comienzo la reunión de trabajo en Transinne, en el Eurospace Center, a las 10.00 horas, con el discurso de apertura a cargo de la Senadora Dominique Tillmans, Presidenta del Grupo de Trabajo del Espacio belga y Presidenta de la XV CIEE que, tras dar la bienvenida a los asistentes, hizo un breve repaso sobre lo que representa el espacio para Europa. Concluyó su intervención haciendo hincapié en el protagonismo que ha otorgado la actual presidencia del CIEE en involucrar a los jóvenes en carreras que tengan que ver con el espacio y resaltando el lanzamiento, en noviembre de 2012, de un nuevo programa llamado Small Mission Initiative sobre micro-satélites o Cube Sats. A continuación tomaron la palabra D. Philippe Courard, Viceministro de Ciencia de Bélgica y D. Bernard Caprasse, Gobernador de la Provincia de Luxemburgo.

Tras estas intervenciones comenzó la presentación de diversas ponencias referidas al diseño, desarrollo y operación de satélites pequeños, micro y nano y CubeSats. Comenzó la exposición D. Paolo Tortora, profesor de la Universidad de Bolonia y coordinador de ESEO (European Student Earth Orbiter) que se refirió a la adjudicación, en diciembre de 2012, de un contrato de la ESA con ALMASpace que, en colaboración con ESEO, permite que sean los estudiantes universitarios europeos quienes desarrollen, construyan, prueben y operen los sistemas de satélites. Hizo especial mención de los satélites de ALMA: ALMASat-1, lanzado en 2012 y ALMASat-EO y ESEO de próximo lanzamiento en 2014 y 2016.

Tras terminar esta ponencia, tomó la palabra D. Jean Muylaert, Director del Instituto Van Karman de Dinámica de Fluidos, que explicó en que consiste la red QB50, una red internacional de 50 CubeSats para medidas multipunto, in-situ y de larga duración y demostración orbital en la baja termosfera con una altitud inicial de 350 kilómetros. Con la ayuda de la Universidad de Tecnologia de Delf estudian poner en órbita tres unidades triples de CubeSats, en vuelo coordinado, que pueden ajustarse durante la misión según las necesidades tecnológicas, guiados mediante GPS. A continuación D. Frank Preu'homme, Director Comercial de Qinetiq Space y D. Thierry Chantrine, del Centro Espacial de Lieja para misiones pequeñas, explicaron el funcionamiento y aplicaciones de los satélites pequeños.

A continuación tuvo lugar un debate general, moderado por la Senadora Dominique Tilmans y las conclusiones finales, que se adjuntan, corrieron a cargo del Dr. Kai-Uwe Schrogl, Director del Departamento de Estrategia y políticas de desarrollo de la ESA.

Posteriormente las delegaciones se desplazaron a REDU, donde tuvieron la oportunidad de visitar el Centro de la Agencia Espacial Europea.

Se adjunta programa y documentación de la reunión.

Palacio del Congreso de los Diputados, a 23 de abril de 2013.

La Letrada de la Comisión de Economía y Competitividad

1 Discurso de bienvenida de la Senadora Tilmans.

MONDAY 25th MARCH 2013 – REDU

Congratulations ! You made a really good choice to join us in Redu and Transinne for the 15th European Interparliamentary Space Conference.

We will do everything so that you have a great time here!

Dear Colleagues and friends, members of the national Parliaments and the industrial, academic and institutional representatives of Poland, Germany, UK, Spain, Romania, Luxemburg, Russia, Italy, Austria, France, Armenia and Belgium; I would like to welcome you all and take the opportunity to welcome in particular :

- Ladies first : Ms. Anne Laffut who is the mayor of Libin, the city of Space.
- Mr. Philippe Courard, Minister of Science Policy
- Mr. Bernard Caprasse, Governor of the Province of Luxembourg,
- Mr. Vittorio Prodi, Chair of the Sky and Space Intergroup at the European Parliament
- Mr. Philippe Mettens, Chair of the Directors Comittee at the Department of Science Policy
- Ambassador Eric Beka, High Representative for Space Policy of Belgium
- Mr. Georges Cottin, Secretary general of IDELUX (Economic development agency of the Province)

And of course the many representatives of ESA : Mr. Schrogl, Head of ESA Policies Department, Mr. Galardini, head of ESA Redu, Mr. Marée, Mr. Barbolani, Mr. Galeone and I conclude with two women in space : Mrs Giannopapa from ESA and Mrs. Simonetta Di Pippo, founder of the initiative “Women in Aerospace Europe”.

Before we begin our activities, I would like to make a short overview on what Space represents in Europe :

Space is :

1. A European annual budget "Horizon 2020" of 1.750 billion of euro, + ESA annual budget of 3 billion euros contributed by each single Member State (the European subsidies not included)

2. 32.000 to 35.000 jobs in Europe (2011)

3. A multiplier effect in the economy : every €1 invested in space returns an average of €10.

4. 10 euros per European citizen on an annual basis for institutional investments and 1 euro per European citizen annualy for human spaceflights

5. Innovation and competitiveness, which boost economic growth. Too many ignore that space can also contribute to re-industrializing our economy.

6. The average age in space jobs is 47 year old. Hence the necessity of boosting young people's interest in space: not only engineers, but also the holders of non-university degrees in the technical and industrial fiel

7 .Our safety, convenience and healthcare like telemedicine (that we know less): it's operations performed at distance, diabetes controlled by smart phones, patients monitored at home, ambulances connected to hospitals by satellite. But Space is also what we know better: weather forecast, GPS, cellular phones, television, financial transactions, aerial and maritime navigation.

Yes, dear colleagues, Space is not only about technological challenges, but also about major challenges for our society: climate change, resource shortages, health, ageing, education,...

Getting back to our Workshop. As you know, we have decided to dedicate this EISC Presidency to a better involvement of younger generations in space careers.

Our workshop is focused on small satellites missions and the plenary session of October will definitely address how we can put space students at the center of an industrial project.

Small missions and Cube Sats

If we consider the USA's lead on Europe for the past 25 years, we can be happy that the ESA Ministerial Conference of November 2012 has launched a new program called Small Mission Initiative, which was requested by Switzerland, Luxembourg, Romania, Poland and Belgium. However, ESA has already anticipated small missions projects since the ESEO project is already the second micro-satellite mission within ESA's Education Satellite Programme (we will see it with the Prof.Tortora).

We call them Cube Sats, Nano sats, mini satellites, micro sats, pico satellites, satellite on a chip, ultra small missions,...

Their size can vary from that of a laundry machine to a postage stamp! Those technological and innovative wonders, this high tech, unlike big satellites, became fortunately in Europe accessible to dynamic, imaginative and high skilled young professionals !

Those Small Missions cost 1 million to 50 million euros. Inexpensive when compared to the price of 330 million euros for their bigger equivalents.

- They do not create space debris because they disintegrate in the atmosphere
- They are stable and agile, polyvalent and smart
- The time to market is short
- They develop current technologies
- They develop and stimulate competences/skills and they contribute to the generation of incubators
- Their miniaturization opens a potential unseen before
- They allow to test the reliability of instruments before integrating them on bigger satellites
- Of course, they don't replace big satellites, they are complementary !

My questions during our workshop will address the plusses and minuses and the limits of Small Missions and CubeSats. Are they a real opportunity for students but also for Europe and Space?

I give the floor to my colleague, Senator Cécile Thibaut, she will introduce the 4 keynote speakers.

I wish you all a fruitful Workshop!

Workshop of the European Interparliamentary Space Conference (EISC)
March 25, 2013 - Brussels

ESEO

European Student Earth Orbiter: ESA's Educational Microsatellite Program

Prof. Paolo Tortora
University of Bologna, Forlì, Italy

SUMMARY

- ESEO Project Goals and Organization
- ALMASpace/UniBO Microsatellite Missions Heritage
- University Network Roles
- ESEO Lecture and Training Courses
- ESEO S/C Design
- Why Low-Cost Educational Spacecraft?
- Conclusions

ESEO PROJECT OBJECTIVES

The European Space Agency issued an Open Invitation to Tender (ITT) in February 2012.

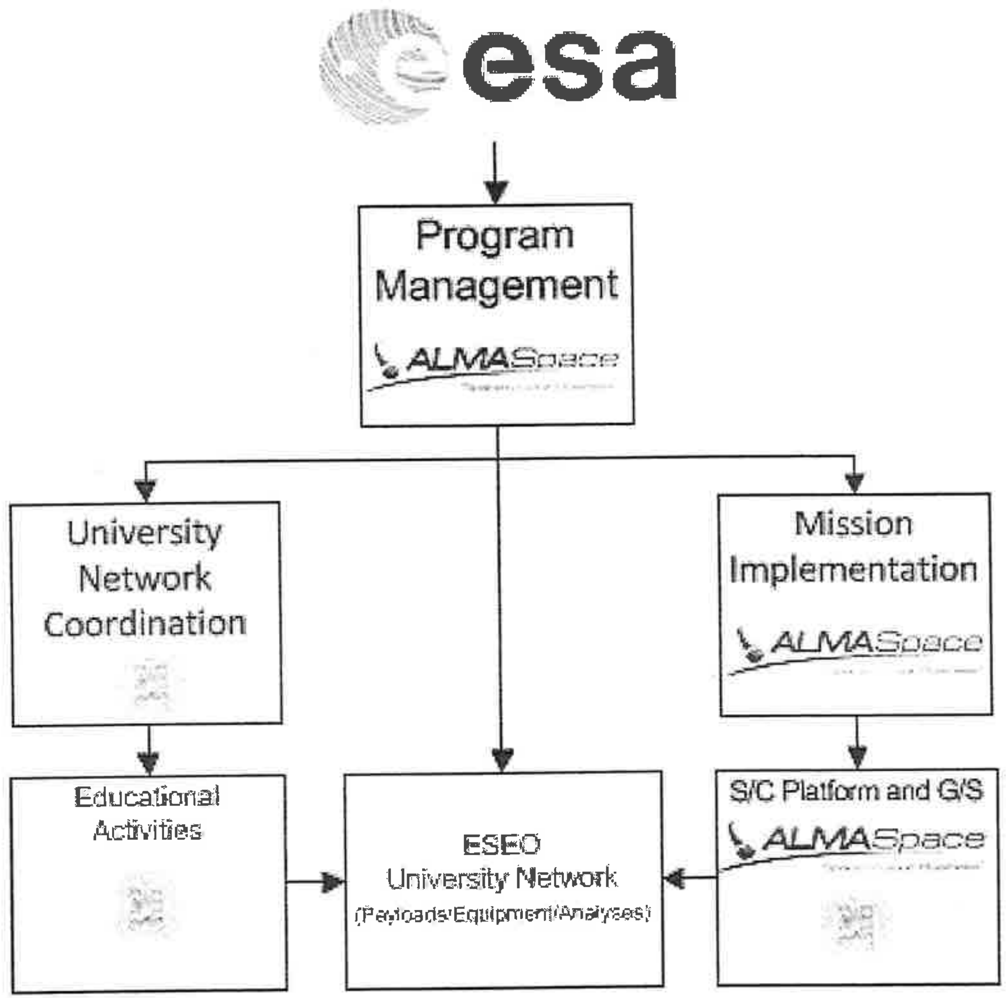
*"...**The scope of the activity includes the hands-on training of university students on the development, assembly integration, test, verification and delivery of a complete satellite system**, including the satellite subsystems, the payload elements, and the ground segment systems required to operate the spacecraft and its payload; **in addition, the scope of the activity includes also the preparation and the conduct of the Launch Campaign and the Launch and Early Orbit Phase**."*

*"The primary objective of the ESEO project is to provide students with valuable and challenging hands-on space project experience across all disciplines and throughout the full project lifecycle **in order to fully prepare a well-qualified space workforce for the future**."*

*"Commensurate with the education objectives of the project, and with the constraints deriving from re-utilising a pre-existing spacecraft, **the ESEO system elements shall therefore be designed, developed, built, tested and operated, to the maximum possible extent, by European university students**."*

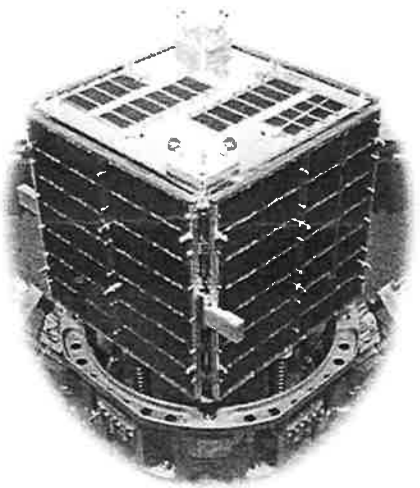
ESEO PROJECT DEVELOPMENT

After ESA's evaluation, in Dec. 2012 a contract was awarded to the ALMASpace/UniBO team:



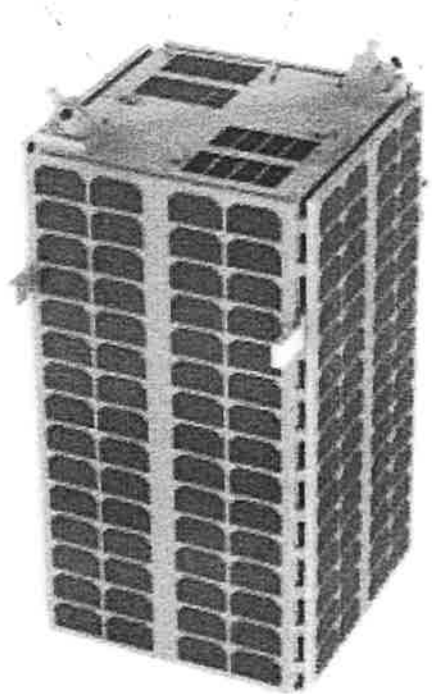
ALMASPACE/UNIBO MICROSATELLITES HERITAGE

ALMASat-1



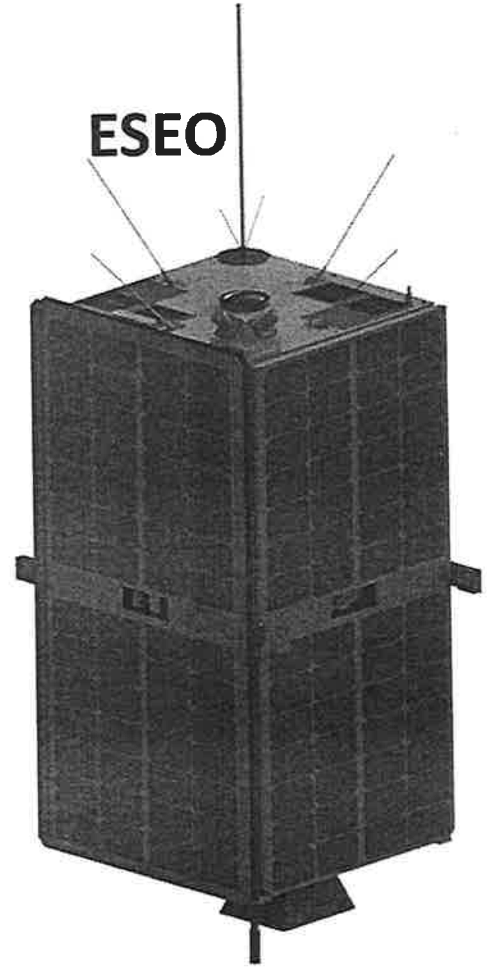
Launched in 2012

ALMASat-EO



Launch 2014 (TBC)

ESEO



Launch 2016 (TBC)

ESEO UNIVERSITY NETWORK

University of Bologna
GPS Receiver and OD

Denmark Univ. of Technology
Microcamera

Hungarian Academy of Sciences
Tritel Dosimeter

Wroclaw Univ. of Technology
S-Band System

Budapest Univ. of Technology
Langumuir Probe

Technical Univ. of Delft
AODCS S/W Experiment

Technical Univ. of Munich
S-band Ground Station

University of Zaragoza
Mission Analysis

University of Vigo
GENSO for ESEO

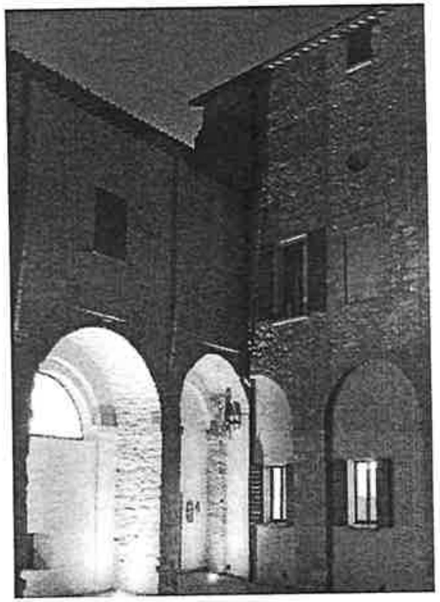
Cranfield University
Deorbiting Device

AMSAT-UK
Educational HR Payload

ESEO LECTURE COURSES

To be held at the University
Residential Centre of Bertinoro (FC)

1st week:
Space Environment
Orbital Mechanics
Attitude Dynamics and Control
Mission Analysis
AGI/STK Fundamentals



2nd week:
S/C subsystems
Remote Sensing
S/C AIV
Ground Segment
Course Test

20 students in each course, to be repeated three times in 18 months **(Grants 9 ECTS)**

ESEO TRAINING COURSES

To be held at ALMASpace's premises (1 week), **granting 3 ECTS**:

Mechanical Design
Mechanical and Thermal Analysis
Electronics Design
Power Electronics Design
PA/QA/SA Management

Spacecraft Subsystems AIV Workshop (Mechanical)
Spacecraft Subsystems AIV Workshop (Thermal)
Solar Panels Assembly Workshop
Hardware-In-the-Loop Simulations Workshop

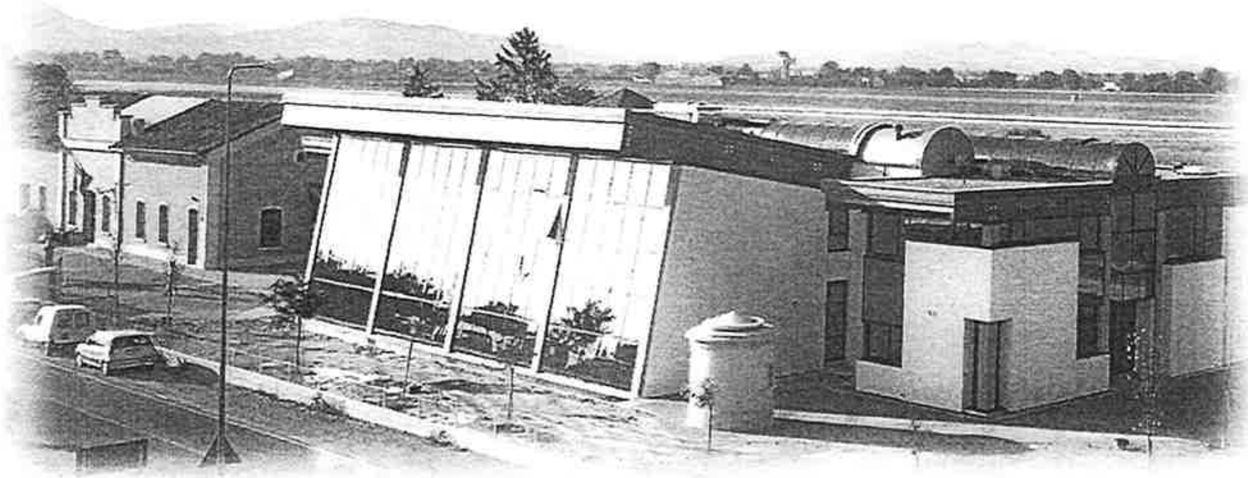
ESEO INTERNSHIPS

To be held at UniBO's premises (4 weeks), **granting 6 ECTS**:

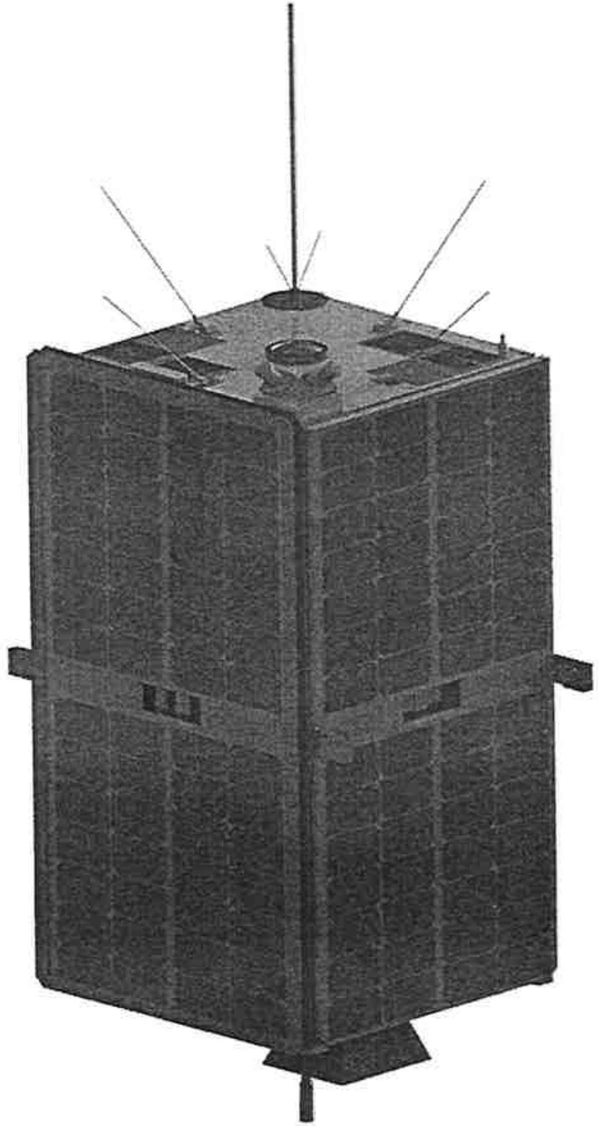
Students from the Universities Network are hosted (in small groups of 5 individuals) at UniBO premises for a period of 4 weeks working in close connection with personnel involved in the ESEO mission:

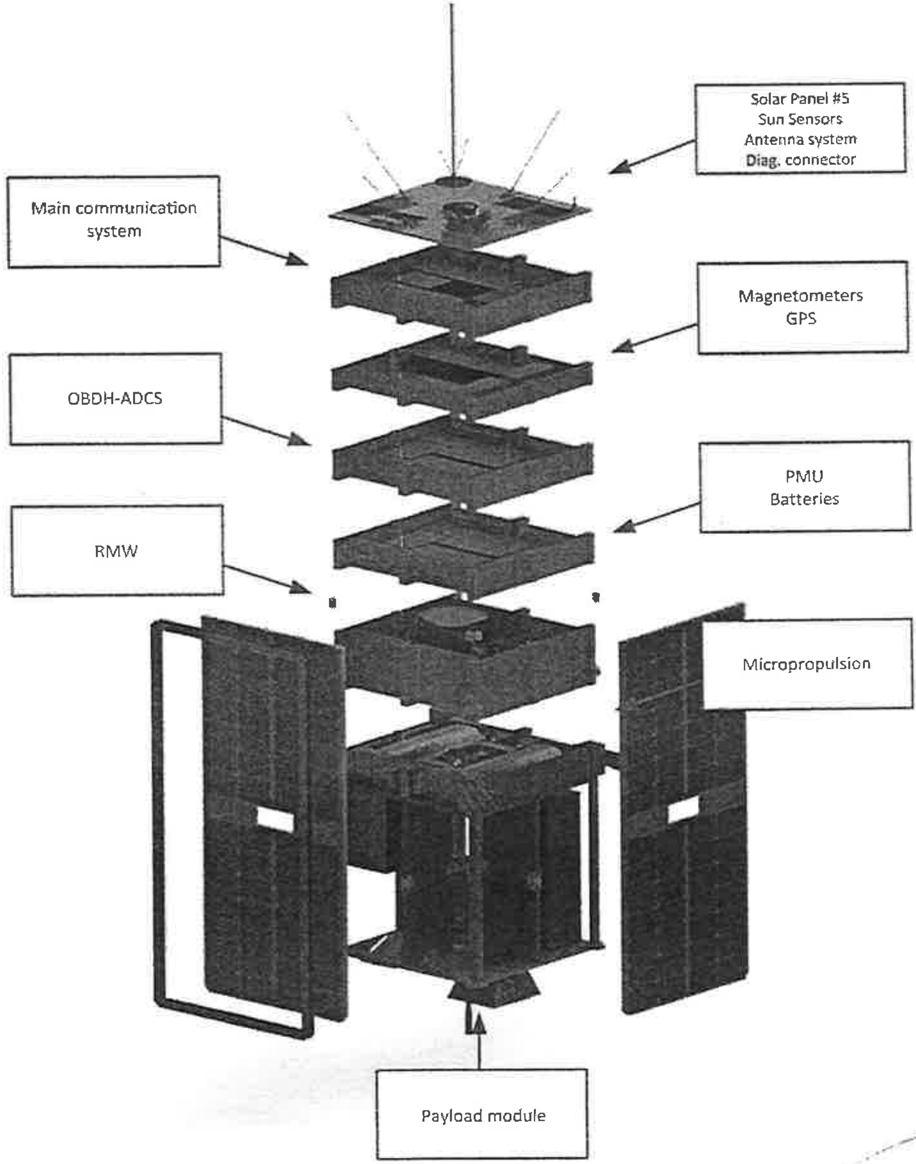
1) to let students gain experience in space-system design, prototyping, assembly and integration by applying knowledge and skills previously achieved during Lectures and Training Courses

2) to perform payload engineering activities under the assistance of a team of experts

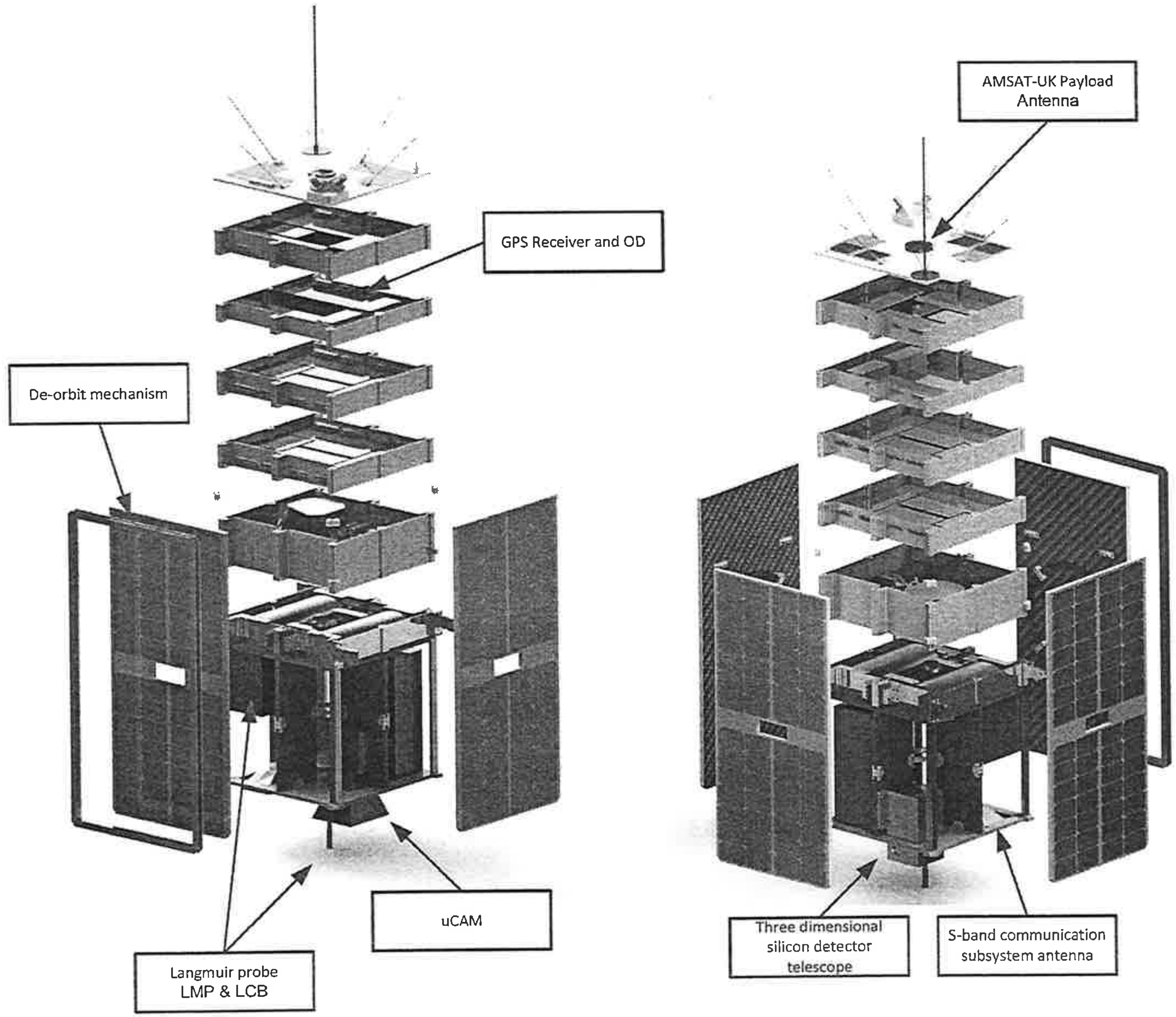


PROPOSED ESEO S/C (1/2)





PROPOSED ESEO S/C (2/2)



WHY A LOW-COST EDUCATIONAL SPACECRAFT?

- Large scientific and technological programs have very long development times and are incompatible with hands-on education
- Let's compare NASA/ESA/ASI Cassini-Huygens with ESA's ESEO:

	Cassini-Huygens	ESEO
Mission Concept	1982	2007
Start of Mission Implementation	1989	2013 (current)
Launch	1997	2016 (TBC)
Development time	8 years	30 months
Number of people involved	+5000	250 (TBC)
Budget	$3.27 Billions	~ 2.5 M€
Cruise Time	7 years	~ 25 min
From Implementation to Target Orbit	15 years	3 years (TBC)
Years of Operations	20	0.5

ESEO FACT SHEET

- ALMASpace/UniBO selected as System Prime Contractor
- Involvement of 10 EU Universities + AMSAT-UK
- 60+ students involved on site plus ~120 at their home institutions
- ESEO launch currently foreseen at end 2015/beg 2016
- ESEO's "mantra":

***"I hear and I forget; I see and I remember; I do and I understand"* ***

Students make up in enthusiasm what they lack in experience!

*** Confucius - China's most famous teacher, philosopher, and political theorist, 551-479 BC***

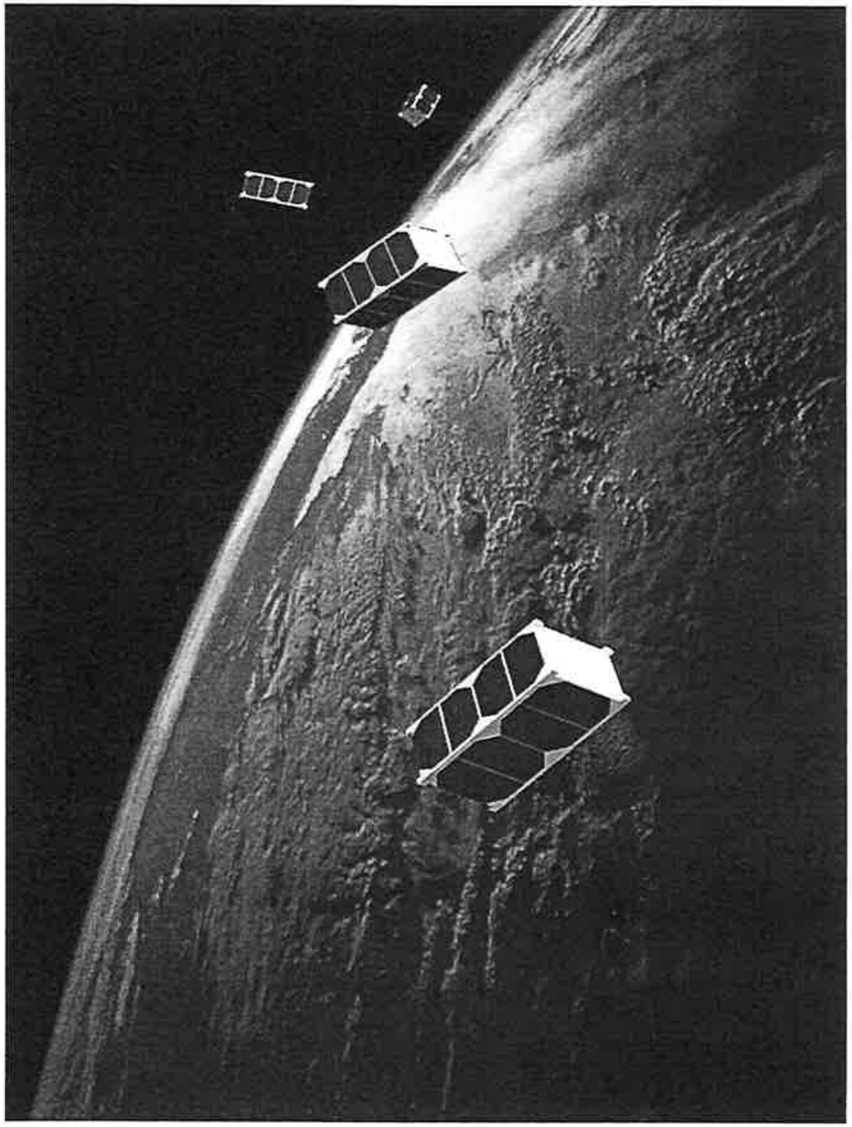
ALMASat-1
Ground Station
Forlì, Italy

SEVENTH FRAMEWORK PROGRAMME

3

QB50

An international network of CubeSats for scientific research and technology demonstration

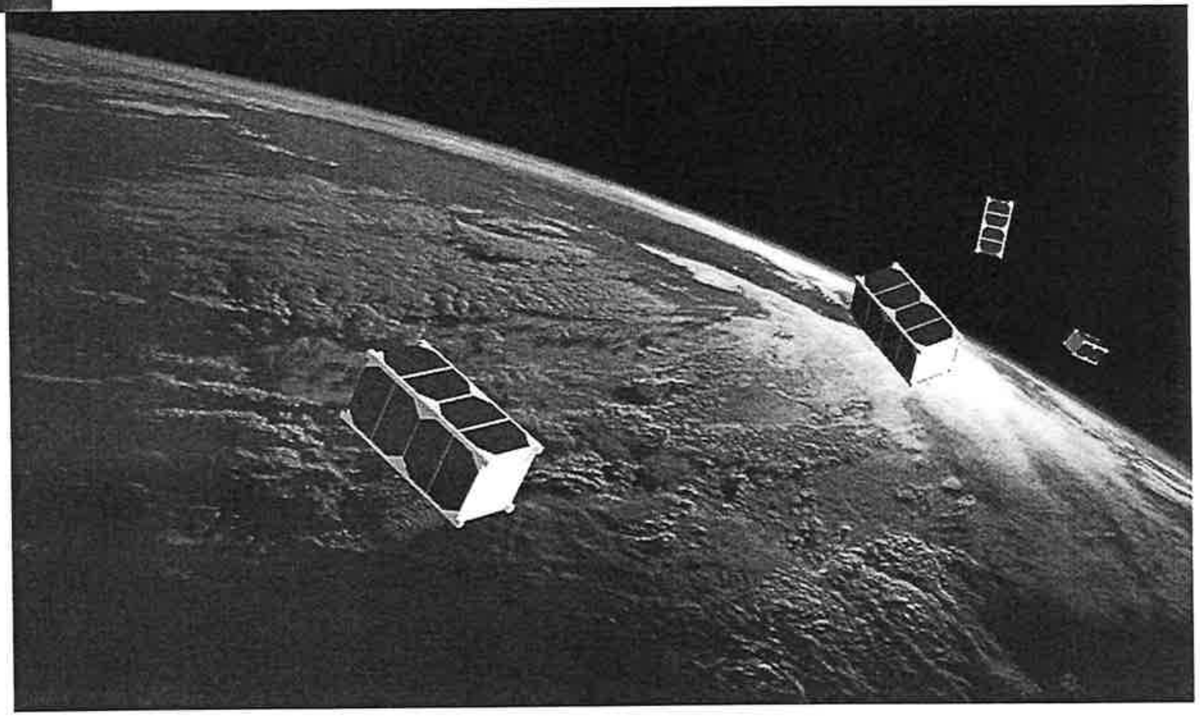


J. Muylaert, C. Asma
von Karman Institute for Fluid Dynamics
Rhode-Saint-Genèse (Brussels)

Belgian Senate
25 March 2013
Brussels, Belgium

SEVENTH FRAMEWORK PROGRAMME

QB50 - THE IDEA



- An international network of 50 CubeSats for multi-point, in-situ, long-duration measurements and in-orbit demonstration in the lower thermosphere
- A network of *50 CubeSats* sequentially deployed
- Initial altitude: 350 km (circular orbit, high inclination)
- Downlink using the QB50 Network of Ground Stations

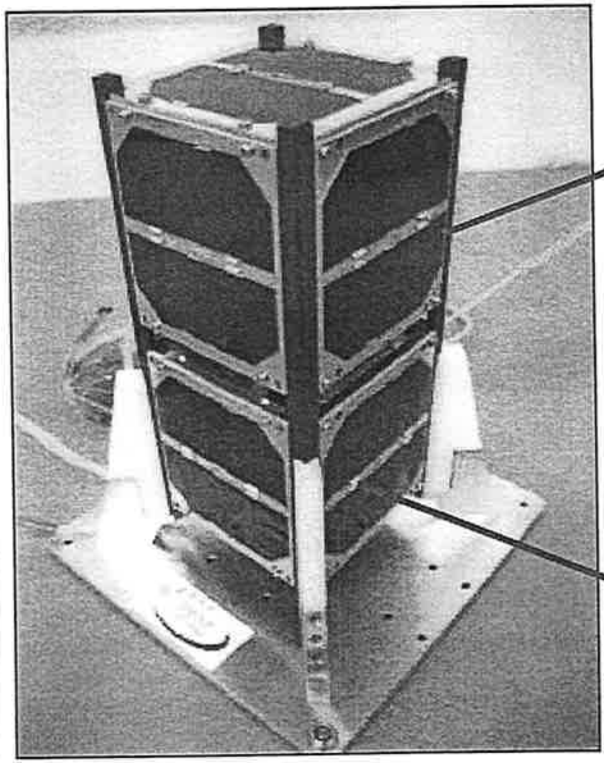
von Karman Institute
for Fluid Dynamics

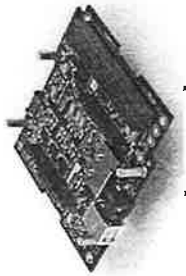
www.QB50.eu

SEVENTH FRAMEWORK PROGRAMME

QB50 - The CubeSat

On a Double CubeSat (10 x 10 x 20 cm^3):



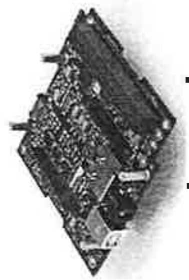


Science Unit:

Lower Thermosphere Measurements

Sensors designed by MSSL

Standard sensors for all CubeSats



Functional Unit:

Power, CPU, Telecommunication

Optional Technology or Science Package

Universities are free to design the functional unit

Sensor Selection

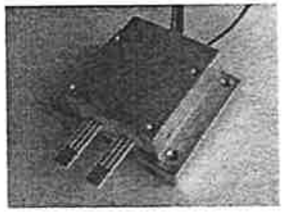
Set 1
Ion-Neutral Mass Spectrometer (INMS)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

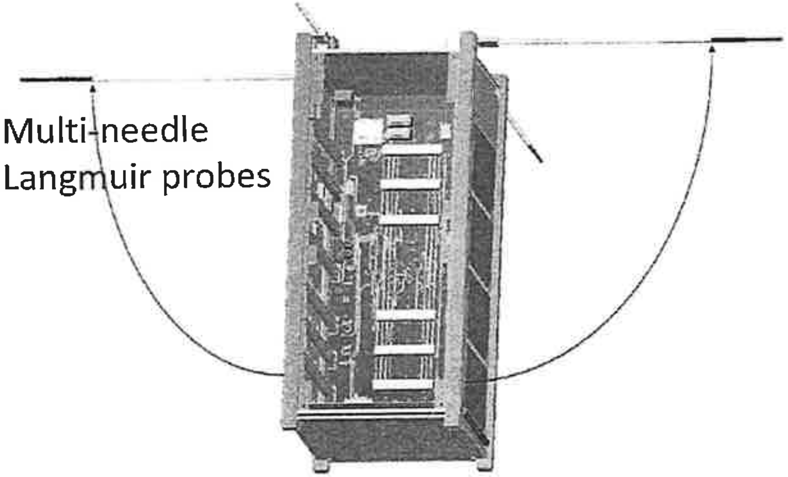
Set 2
Flux-Φ-Probe Experiment (FIPEX)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

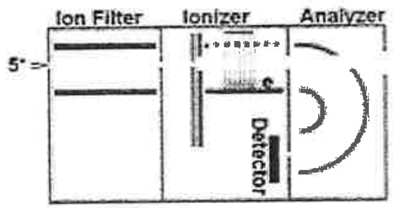
Set 3
A set of 4 Langmuir probes (MNLP)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

* Offered as an option

FIPEX sensor



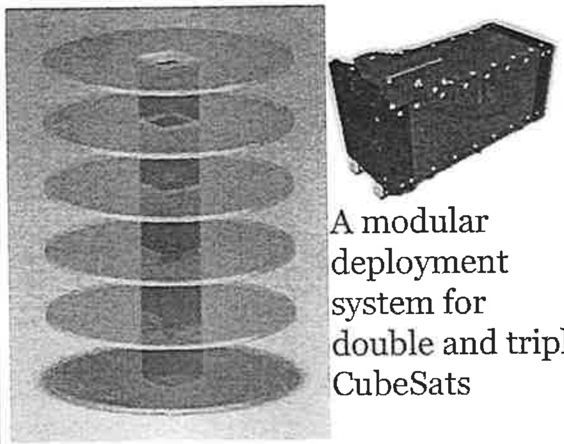




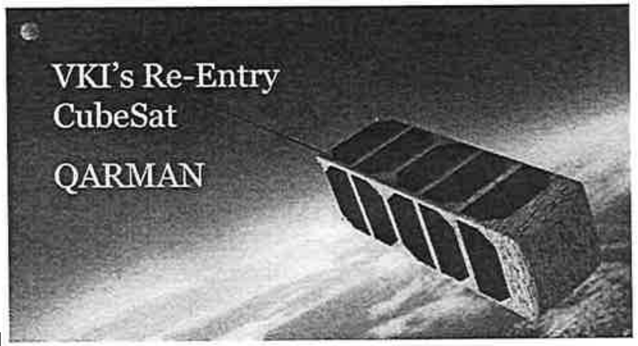
Schematic of the principle of working of the INMS

Miniaturised charged particle analyser along with the Improved Plasma Analyser

In-Orbit Demonstration

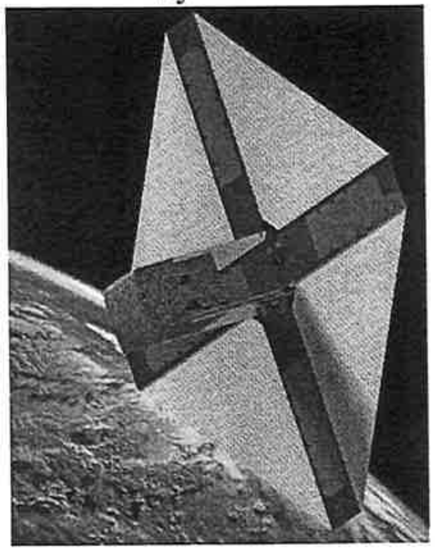


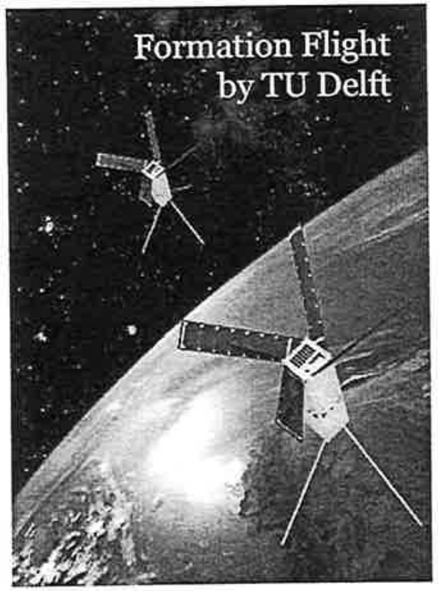
A modular deployment system for double and triple CubeSats



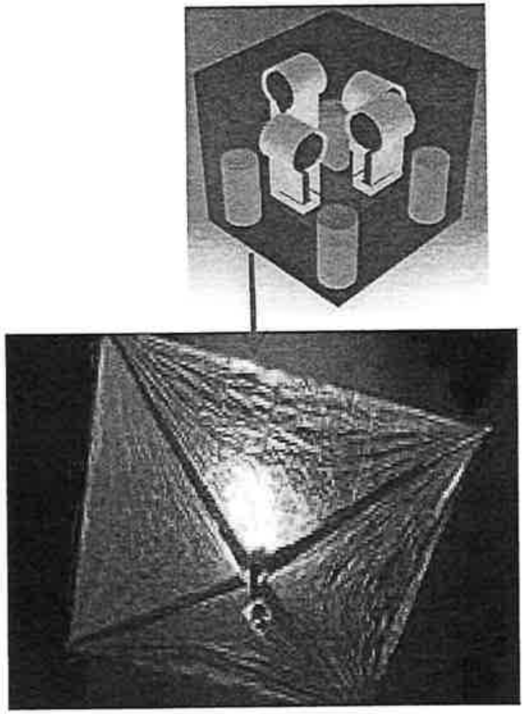
De-orbiting and aerodynamic stability

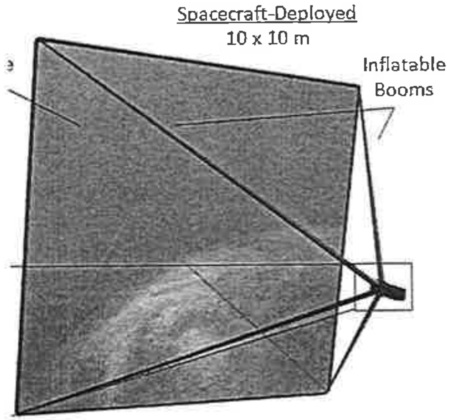
AeroSDS by VKI





Gossamer-1 Solar Sail demonstration packagem DLR





InflateSail demonstration mission, SSC

Other In-Orbit Demos:

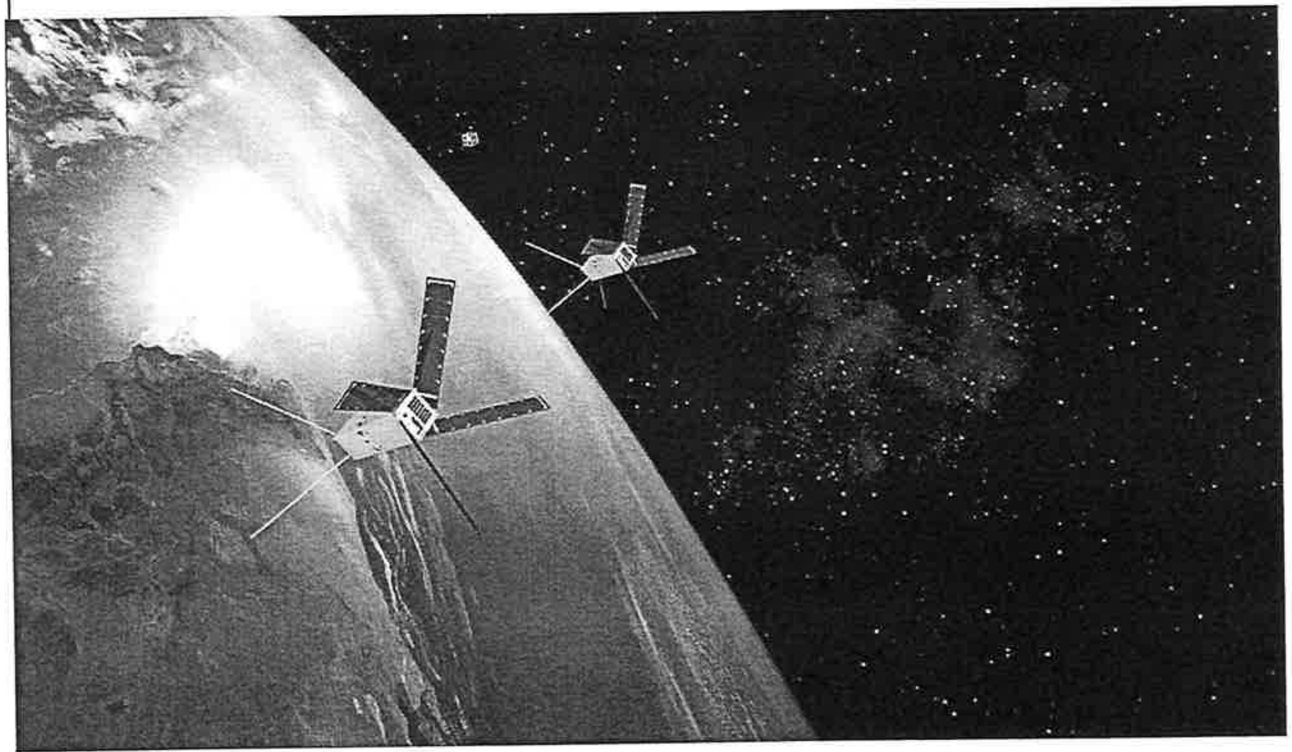
- End of life analysis, Debris
- Micro-propulsion systems
- Micro-g experiment

von Karman Institute for Fluid Dynamics

www.QB50.eu

Formation Flying

DelFFI Project: with triple CubeSats "Delta" and "Phi"

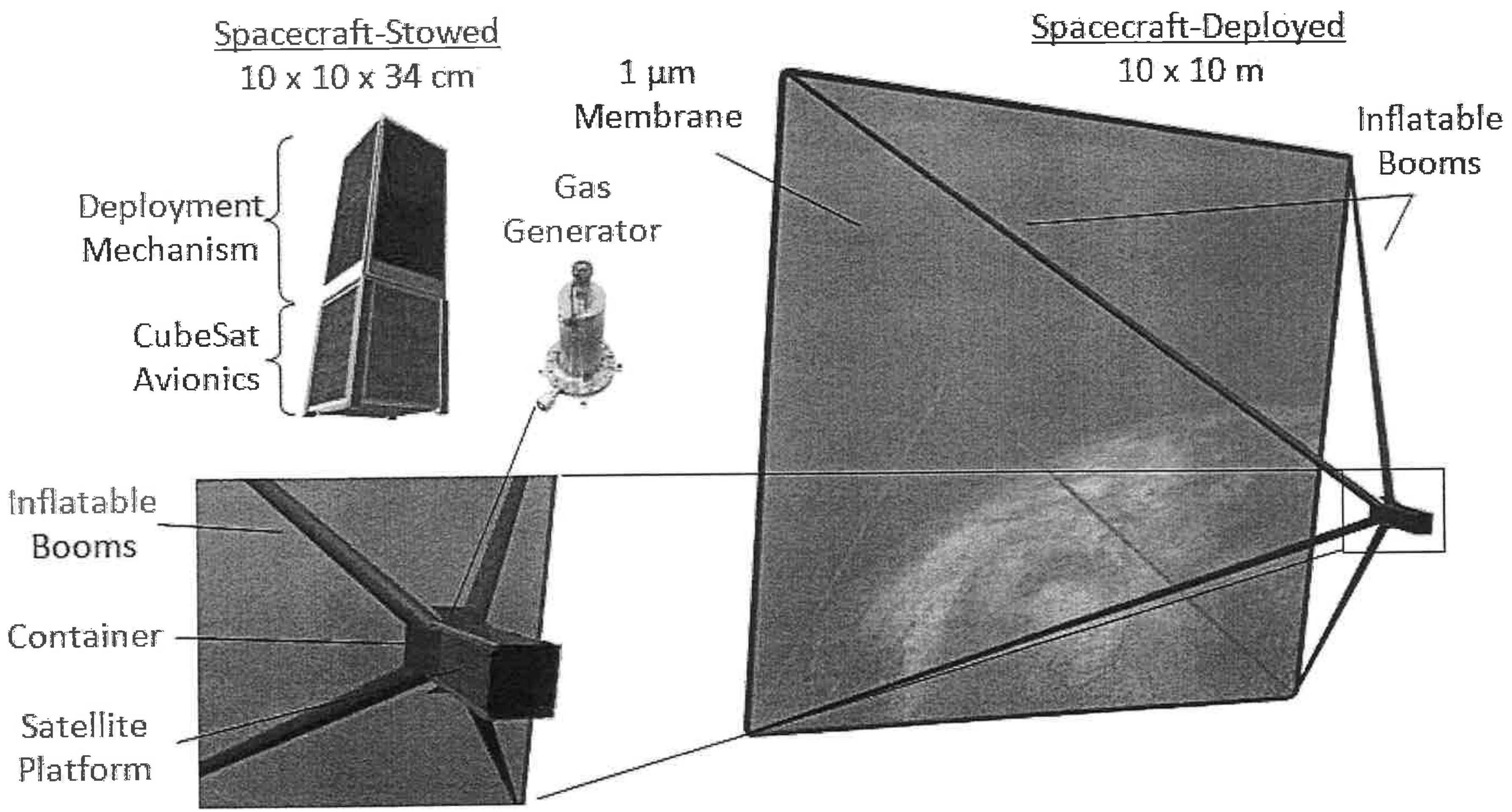


- Delft University of Technology intends to provide two triple-unit Cubesats, both being equipped with a highly miniaturized propulsion system in addition to the standard science payload.
- This allows for a coordinated formation flying of these two satellites using baselines, which can be realized, maintained and adjusted during the mission based on scientific and technological needs.

- The position of the satellite will be determined by GPS. The inter-satellite communication will be realized by ground stations
- Therefore, formation flight will be possible at any distance

Inflate-Sail

for testing a solar sail with inflatable booms



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UNIVERSITY OF SURREY

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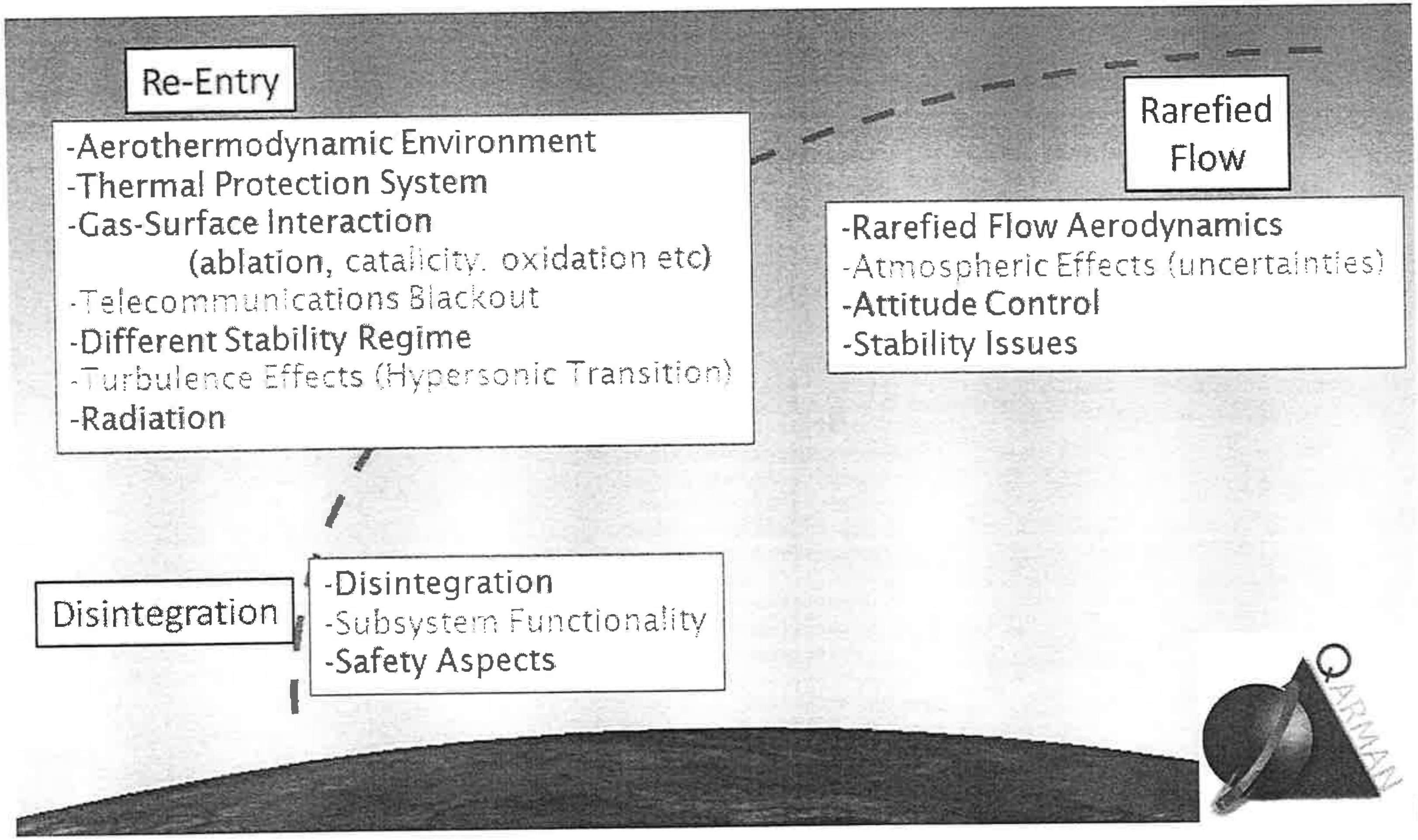
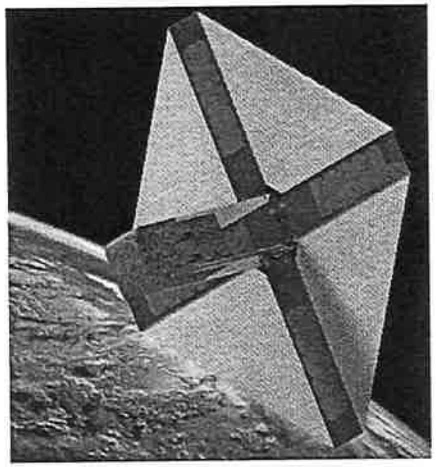
QARMAN: Re-entry Demonstrator

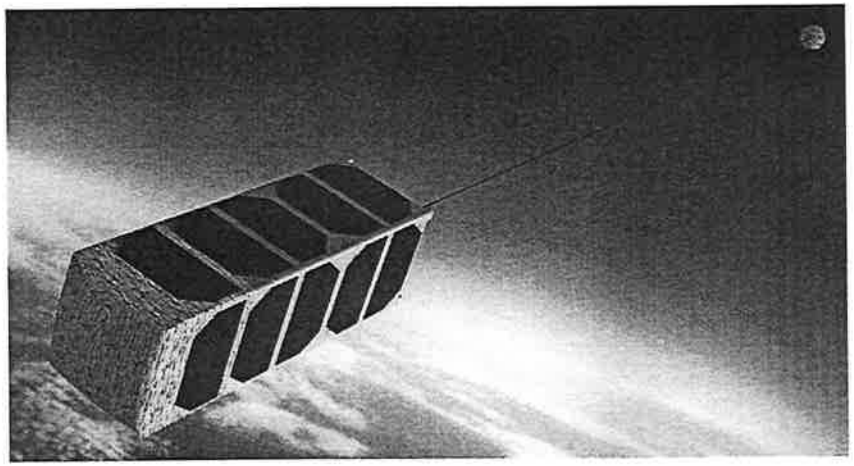
- Low Cost Flight Test: Low altitudes and re-entry conditions



QARMAN: AeroSDS

- low-cost, passive and permanent stability
  - -powered only during deployment
  - -standard COTS systems
- two modes for rarefied & entry phase

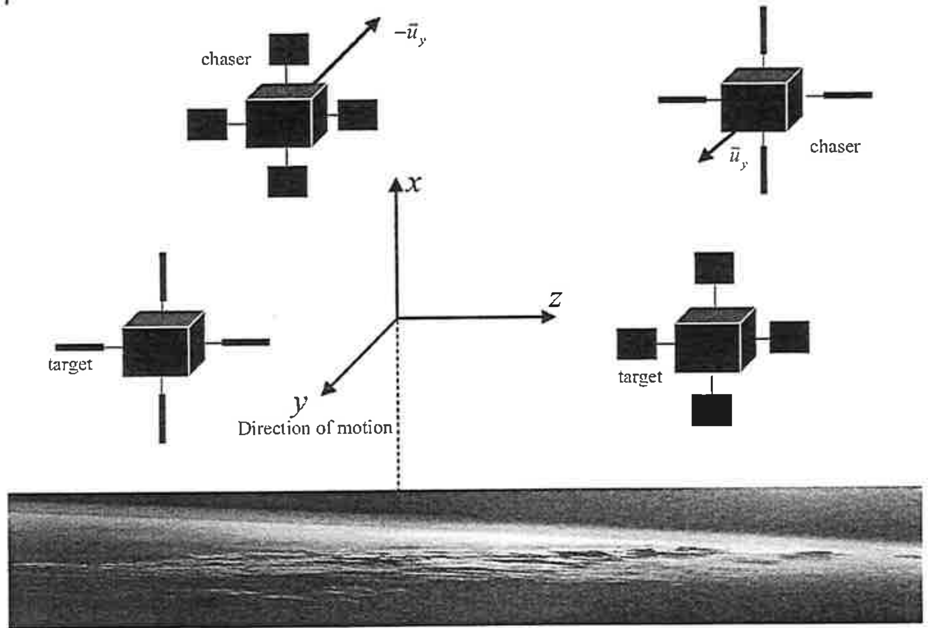




- flexible sizing according to desired entry conditions and lifetime

QARMAN: Differential Drag

By *controlling* (increasing and decreasing) the surface exposed to the residual atmosphere it is possible to change the magnitude of the atmospheric drag and therefore create a (differential) acceleration, in the plane of the orbit), between one spacecraft and either another spacecraft or a desired target point.



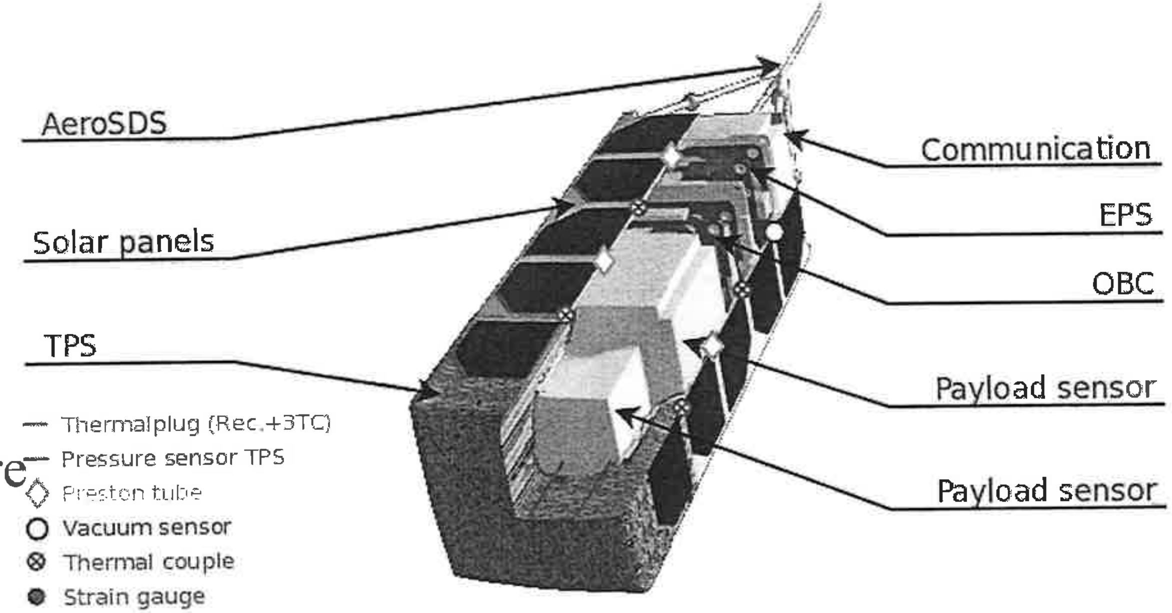
The *control of the exposed surface* can be achieved in essentially two ways:

1) by opening/closing “drag vanes” [see figure on the left]

2) by changing the orientation of the spacecraft (offering a larger or smaller front area to the relative wind) [method preferred for this proposed effort]

QARMAN Subsystems

- Measurements for Satellite Re-Entry Trajectory Rebuilding:
  - Ablation
  - Radiation
  - TPS Efficiency
  - Shear Force & Transition
  - Off-Stagnation Temperature
  - Rarefied Flow
  - Stability
- Feasible Off-the-Shelf Subsystems: IRIDIUM Downlink
- Models for extrapolation of data: **Ground ⇔ Flight**

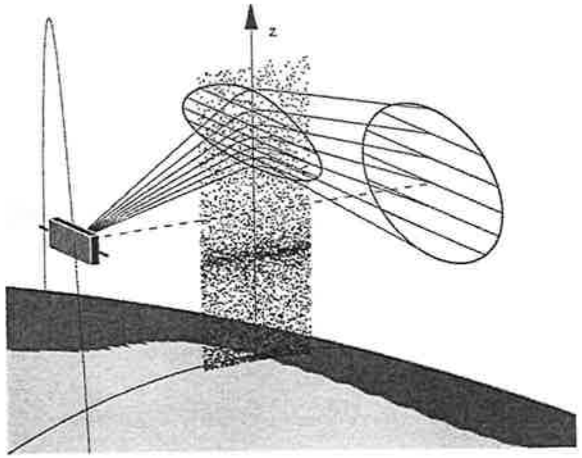


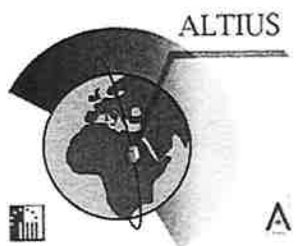
PICASSO CubeSat

(BIRA/ROB)

Module 1 (BISA): A spectro-imager in the visible range

- Atmospheric remote sounding by solar occultation
- Observation of airglow and auroral emissions

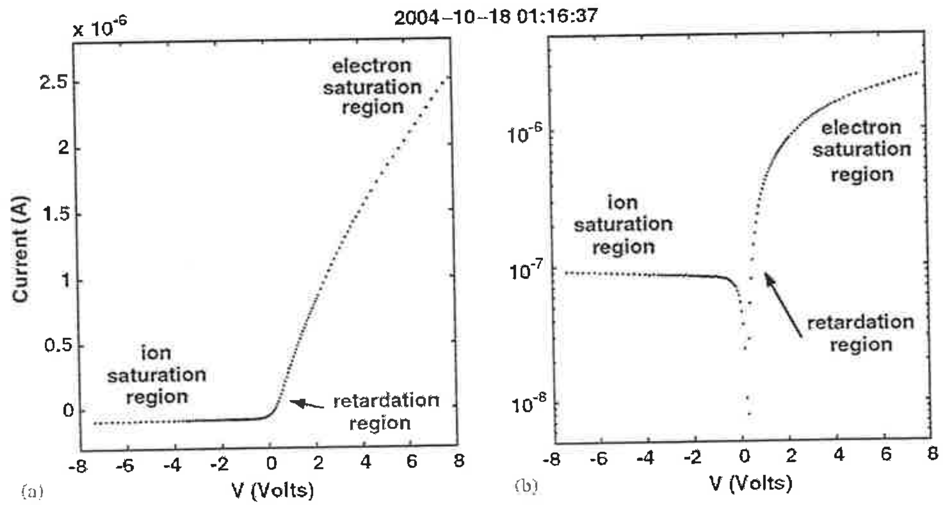




SEVENTH FRAMEWORK PROGRAMME

PICASSO CubeSat

Module 2 (BISA): Langmuir Probe



Goal: to measure electron density and temperature (or s/c potential)

A typical I-V characteristic of a Langmuir probe (Bekkeng 2009)

Two types of LP:

- swept bias: N_e, T_e, N_i but $\Delta t \cong 1$ sec $\Rightarrow$ poor spatial resolution

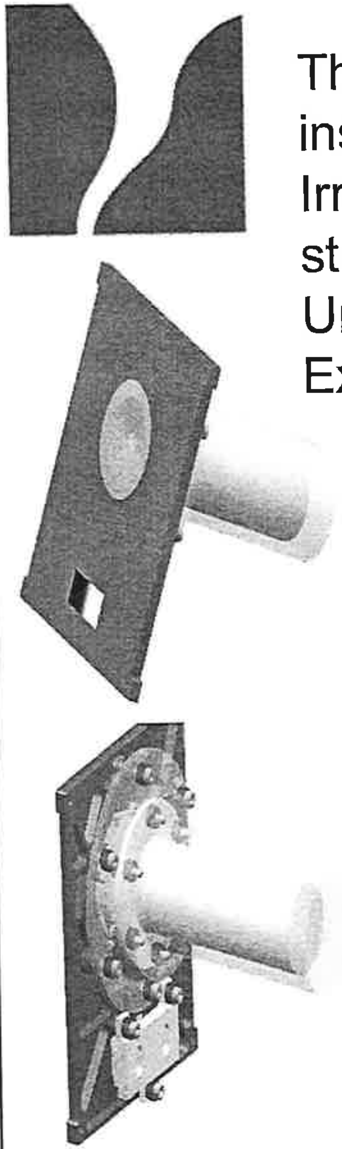
- fixed bias: used when high sample rates are needed. Cannot make absolute measurements of N_e with only one probe

to resolve ionospheric plasma structures of ~ 10m

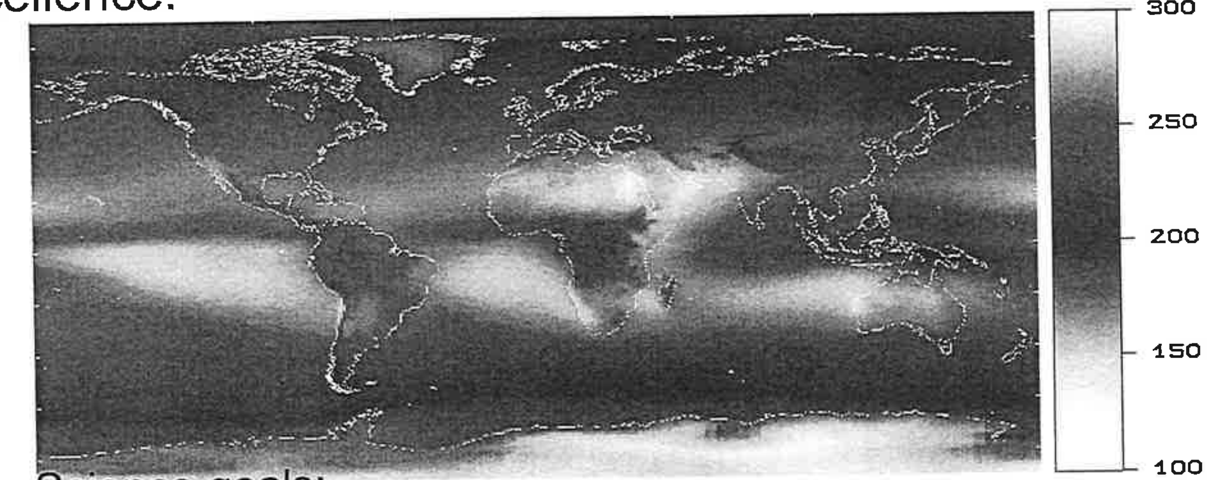
2 cylindrical LPs with different fixed bias

Bekkeng (2009)

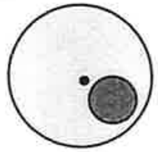
SIMBA CubeSat
(BIRA/ROB)



The Sun-earth Imbalance (SIMBA) radiometer is an innovative instrument concept for the simultaneous measurement of the Total Solar Irradiance (TSI) and the Earth Radiation Budget (ERB) that has been studied by the Royal Meteorological Institute of Belgium and the University of Liege in the framework of the Solar Terrestrial Center of Excellence.



Annual mean thermal radiation flux (W/m^2) emitted by the earth measured by the CERES Terra instrument.



Science goals:

- Continue and improve the measurement of the absolute value of the TSI
- Continue and improve the ERB measurements
- Understand and explain the Sun – Earth Radiation Imbalance problem

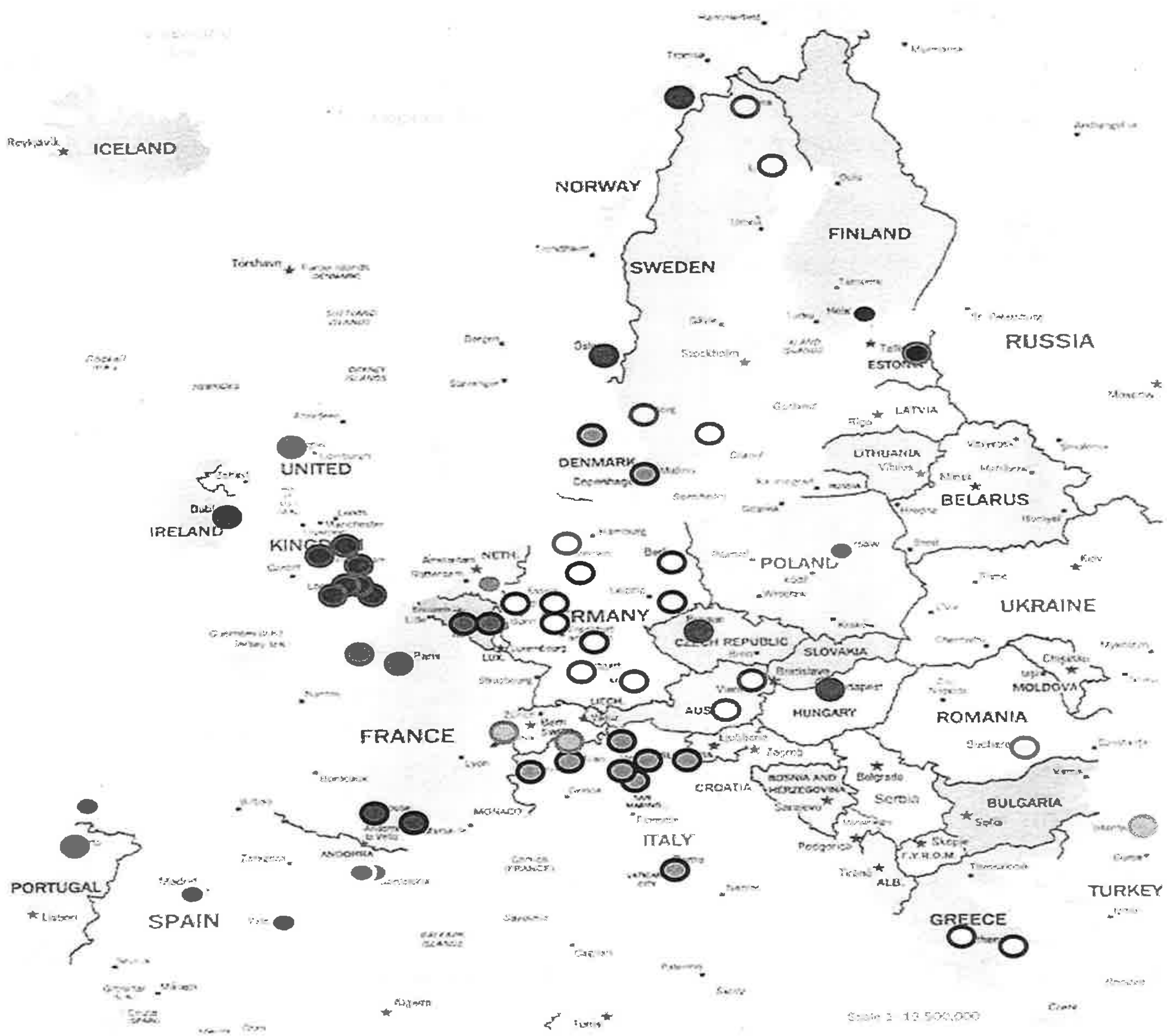
Selection of CubeSat Teams

- More than 70 proposals received
- Selection of the 50 CubeSats
  - about 40 double CubeSats for atmospheric research to be selected from 50 proposals,
  - about 10 double and triple In-Orbit-Demonstration CubeSats to be selected from 20 proposals, 4 of them already pre-selected (Delta, Phi, QARMAN, Inflatesail)
  - The two other Belgian CubeSats PICASSO and SIMBA are also approved.
- Contractual Agreement between the QB50 Consortium and the proposing universities

- Availability of funding and readiness at the PDR are critical issues in the selection process,
- There will be backup CubeSat teams as well

SEVENTH FRAMEWORK PROGRAMME

European CubeSat Teams

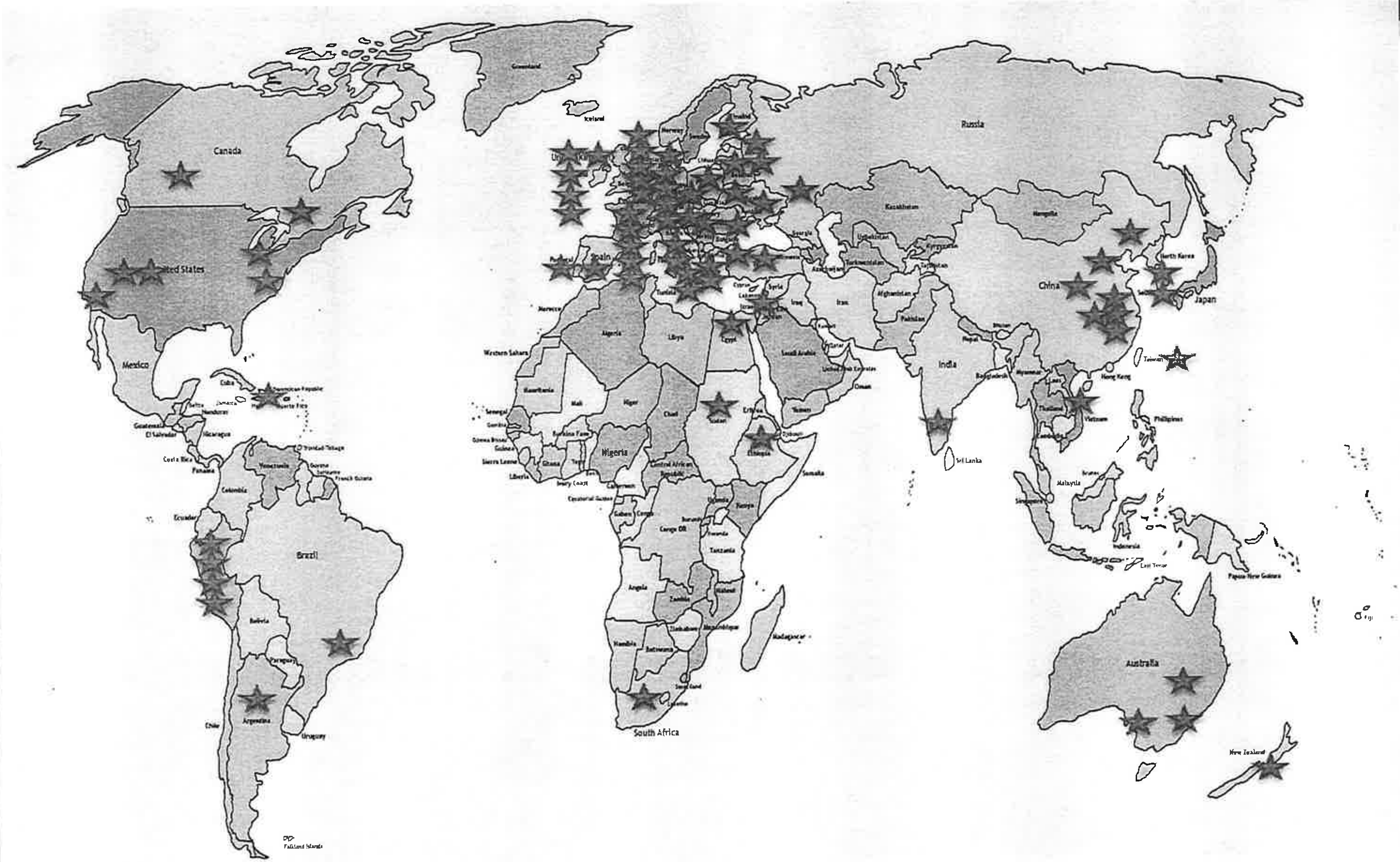


von Karman Institute for Fluid Dynamics

www.QB50.eu

SEVENTH FRAMEWORK PROGRAMME

QB50 – CubeSat Teams



von Karman Institute for Fluid Dynamics

SEVENTH FRAMEWORK PROGRAMME

QB50 – Educational Impact

- European Union funds 15 industrial/research partners to prepare the infrastructure of QB50 and similar future missions. The total cost is estimated to be ~11 M€ with a reimbursement of 8 M€ from the EU.
- The Call for proposals has attracted more than 70 CubeSat teams worldwide, almost all of them being universities. Assuming an average CubeSat hardware and lab cost of 500 k€, this corresponds to 35 M€.
- Besides, a total of 1000 students and faculty members are expected to work for QB50 worldwide.
- This is a HUGE worldwide educational impact. Only at VKI and only in 2 years, more than 15 Belgian students have assumed active roles.
- In 2012, the Best Wallonia Space Project award was given to a UCL student who worked on QB50; this was a first for UCL in its history.
- QB50 is an international innovative and pioneering project, driven by Europe. In Europe, the major partner is Belgium.

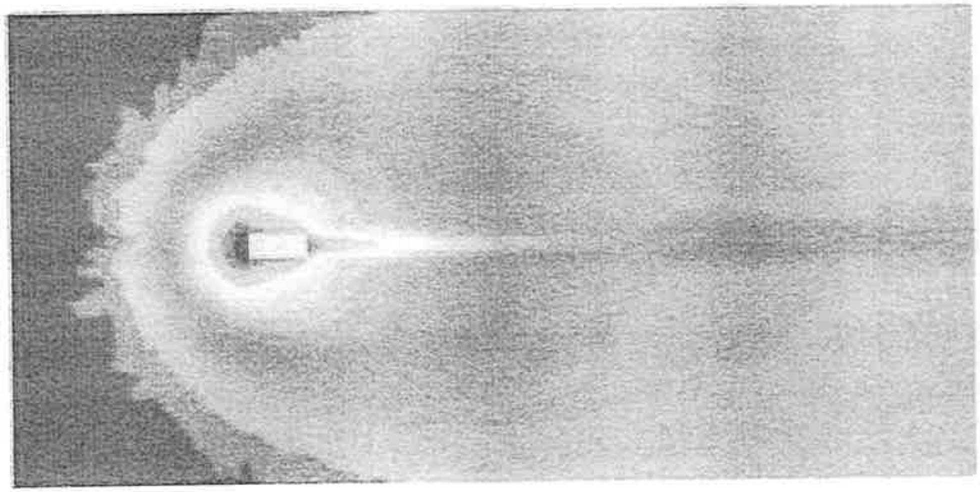
Status of QB50 Project

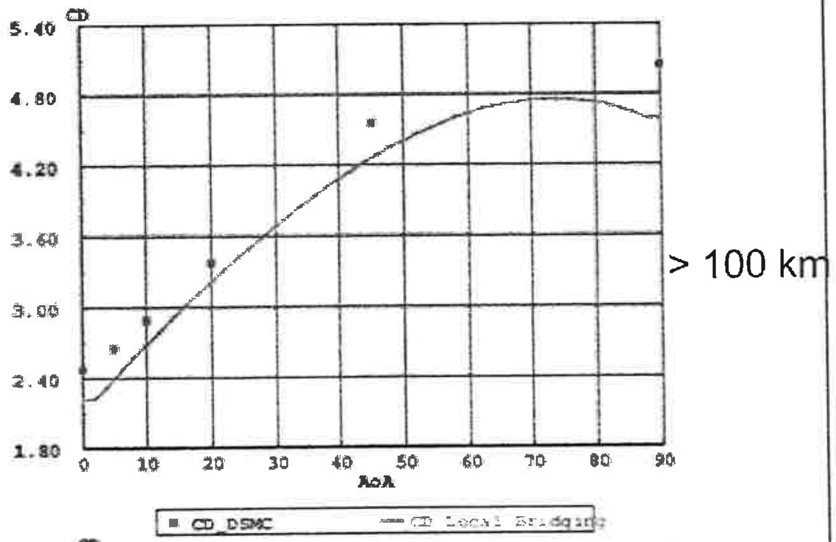
- Started working on the Project as of Nov 2011
- Kick-off was held at 22 Nov 2011

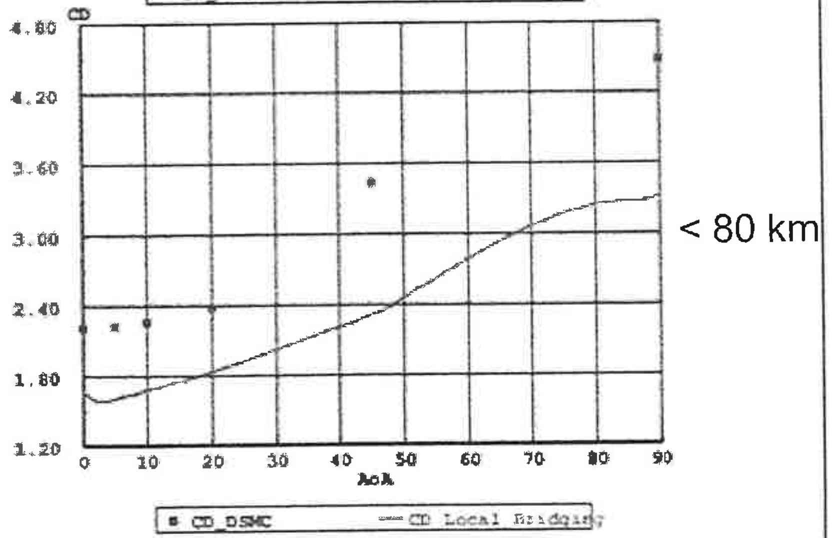
- The Call for Proposals issued on the QB50 web site
- More than 70 proposals were received
- Major technical work accomplished on
  - Orbital dynamics
  - Sensitivity analysis on interaction with the atmosphere
  - Deployment strategy
  - Deployment system
  - Science payload design

DSMC simulations for CubeSat – Atmosphere interaction

Preliminary computations for selected amount of points of re-entry trajectory were performed and aerothermodynamic characteristics of CubeSat were obtained in free-molecular, transitional, and near-continuum flow regimes and accuracy of the engineering methods was assessed by comparison with the results obtained by the DSMC SMILE code (ITAM & VKI)



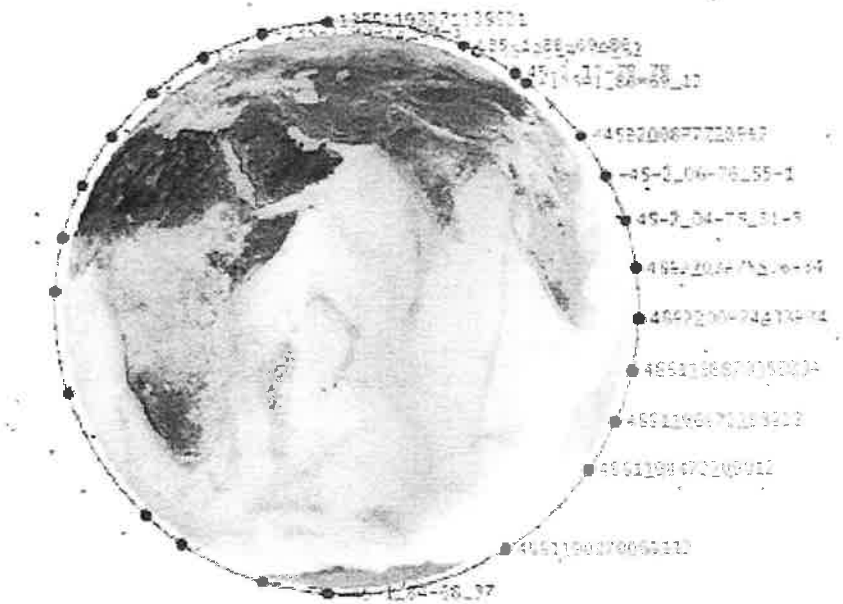




Deployment Strategy

- How to deploy the 50 CubeSats with minimal collision risk and optimised distribution ?
- Detailed analysis covering ballistic coefficient, deployment direction, deployment frequency
- Best scenario to minimize risk in the first 8 hours, and to optimise a uniform network distribution – the developed strategy can be used directly with the ballistic coefficient database of the selected CubeSats.

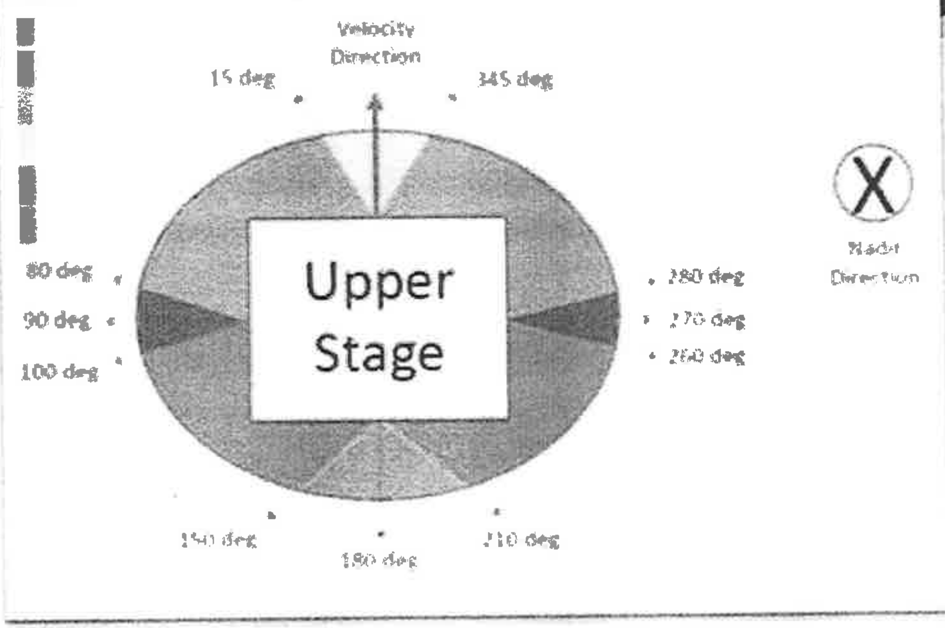
After 20 days



After 30 days

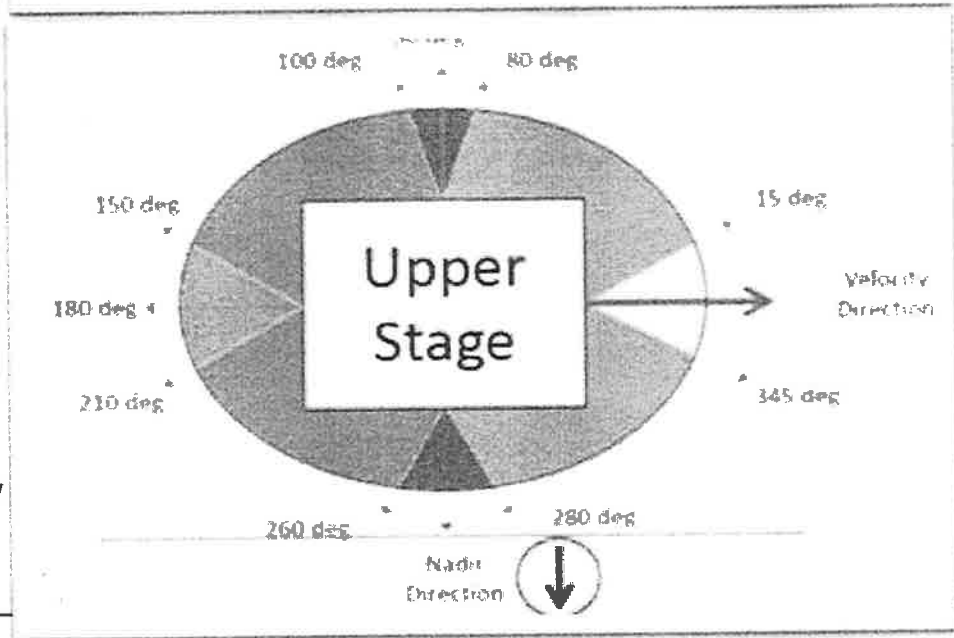
Deployment Strategy

TopView



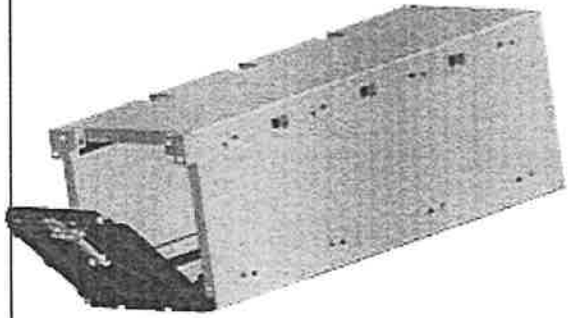
Risk Colors
High
High-Medium
Medium
Medium-Low
Low

Side View

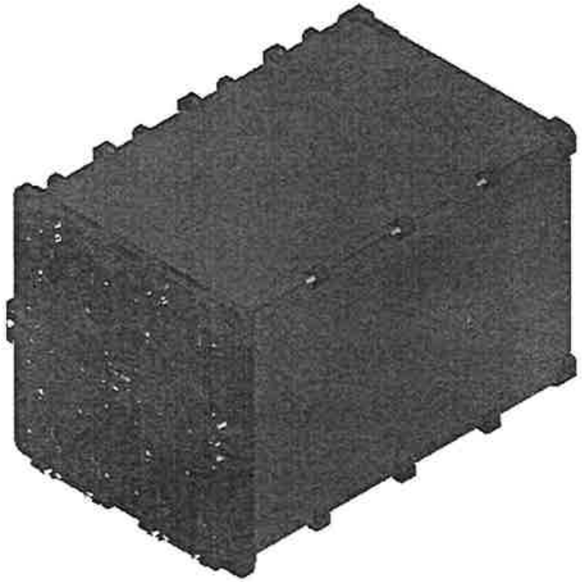


SEVENTH FRAMEWORK PROGRAMME

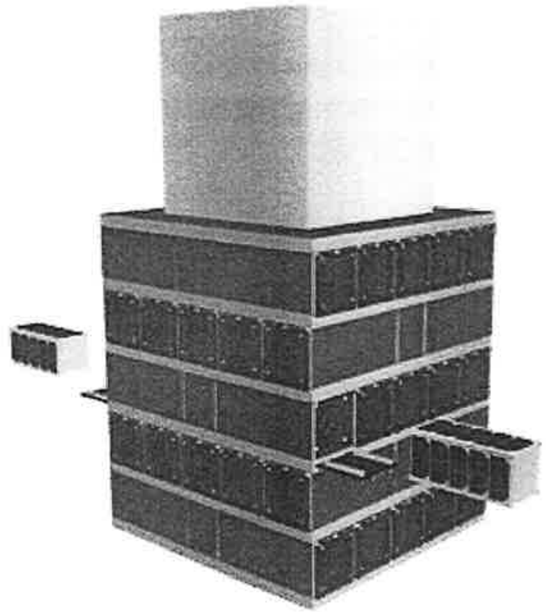
Deployment System



Concept De-risk Prototype
Prototype



Precursor Flight
QuadPack



QB50
StackPack

von Karman Institute for Fluid Dynamics

SEVENTH FRAMEWORK PROGRAMME

Hands on Experience for young Aerospace Engineers

– **Unique expertize for students, PhD's, young engineers to :**

- **Learn on Cu development, design , qualification, flight and post flight within short cycle (3 years)**
- **Understand missins analysis, system engineering, launcher interface loads and commucation issues**
- **Work in international frame learning and exchanging from each other through the bi annuakl workshops at the VKI**
- **Perform great atmospheric science with CU Networks**
- **Execute In Orbit Demonstrations advancing TRL (Technological Research Level) for new Space Technologies**

Hands on Experience for young Aerospace Engineers

– **Great future for Cu developments and applications :**

- **Earth atmosphric science measurements measurements , net work of 3 CU with S band , IMS's , LP, Fipex, (Lessons learned from QB50)**
- **In Orbit Demonstrations for technologies such as nano propulsion, debris mitigation, sensors, sloshing, camera's,**
- **Im Orbit demo of systems such as R&V and docking, formation flying, inspections, network communications, cloud computaions**
- **Planetary entry , Exploration flights**
- **Space station retrieval system , Micro G and reentry**
- **Dual use , science piece and security (NATO SPS)**
- **United Nations environmental monitoring**

Next Steps

- www.CubeSatSymposium.eu
  - Abstract submission: 15 Mar 2013
  - 6 June 2013: 6th QB50 Workshop at VKI, Brussels

ACKNOWLEDGEMENT

The QB50 Project, and all related activities are supported by the European Community Framework Programme 7, Grant Agreement no. 284427

4

Small satellites : Operational solutions are readily available

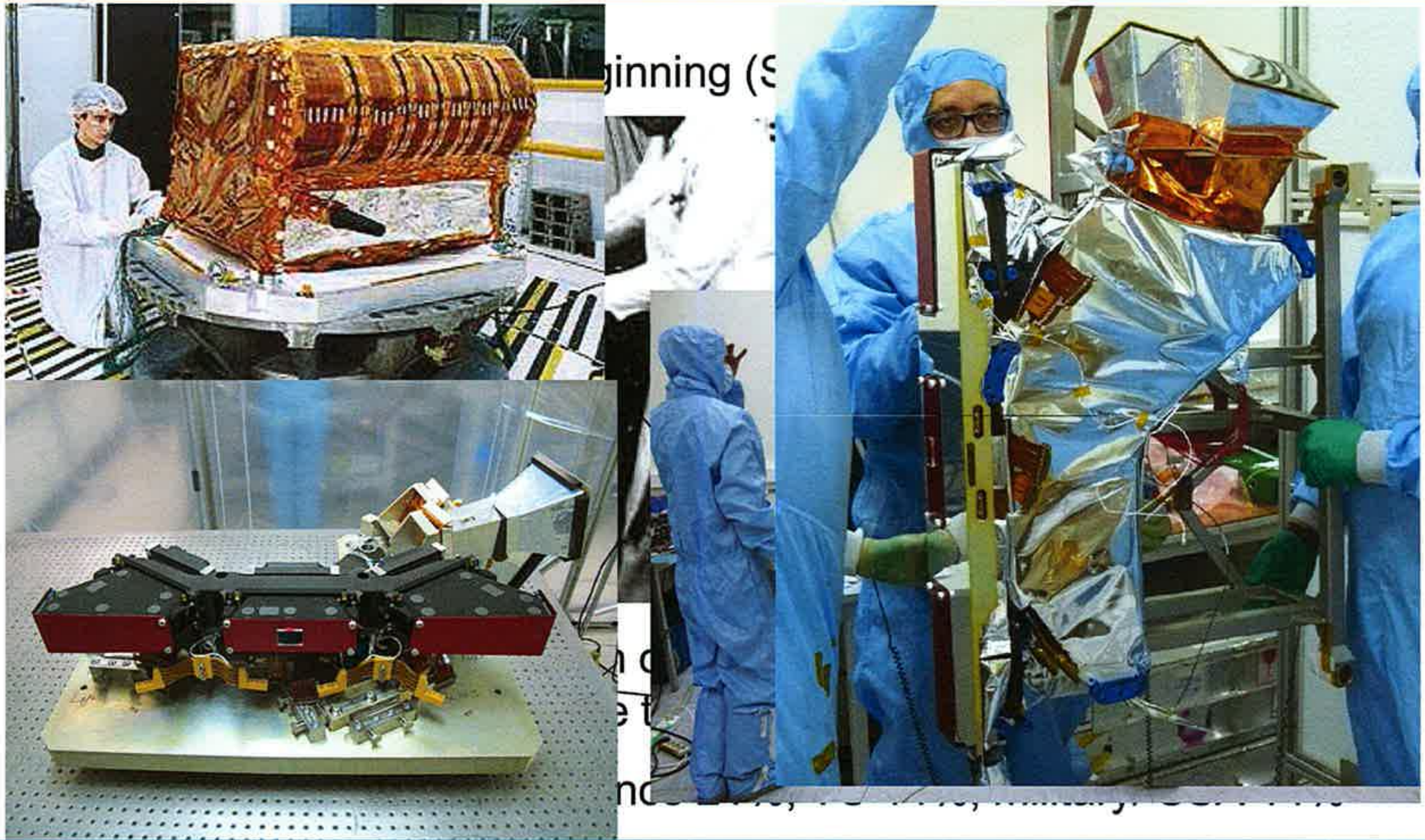
Frank Preud'homme
A presentation to: EISC

25 March 2013

QinetiQ

1. APPLICATIONS
2. PROBA V : AN EXAMPLE
3. INSPIRATION TO THE YOUTH

1. Small satellite applications

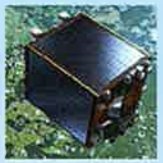


1. Small satellite applications

REMOTE SENSING

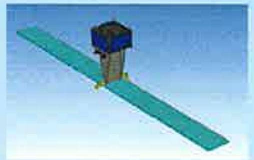
IMAGING


HR+HS


MR

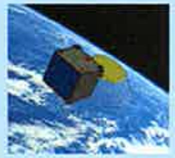

HS


VHR Surveillance


SAR

DATA COLLECTION

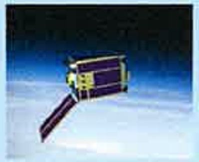

AIS


PARIS-GNSS

SCIENCE


SOLAR

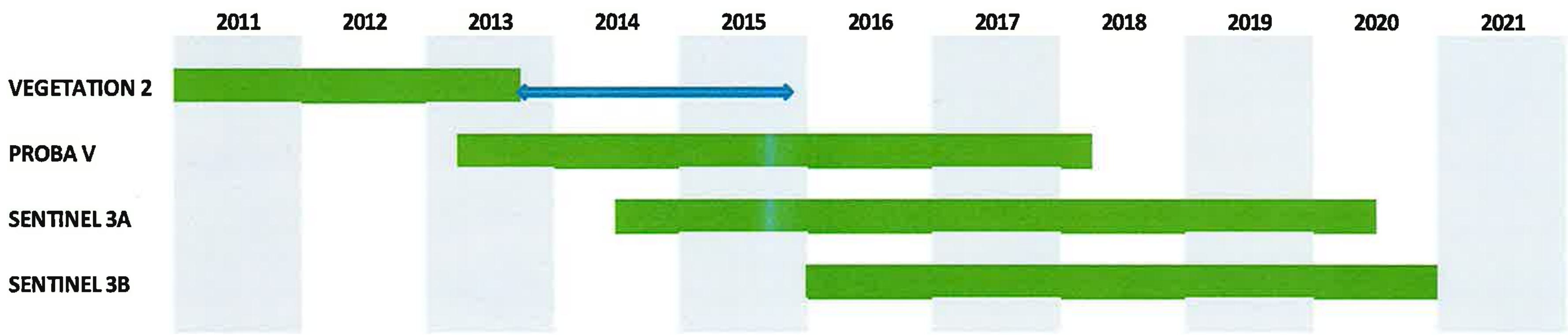

PLANETS


ATMOSPHERE

2.1 PROBA-V Mission Objectives

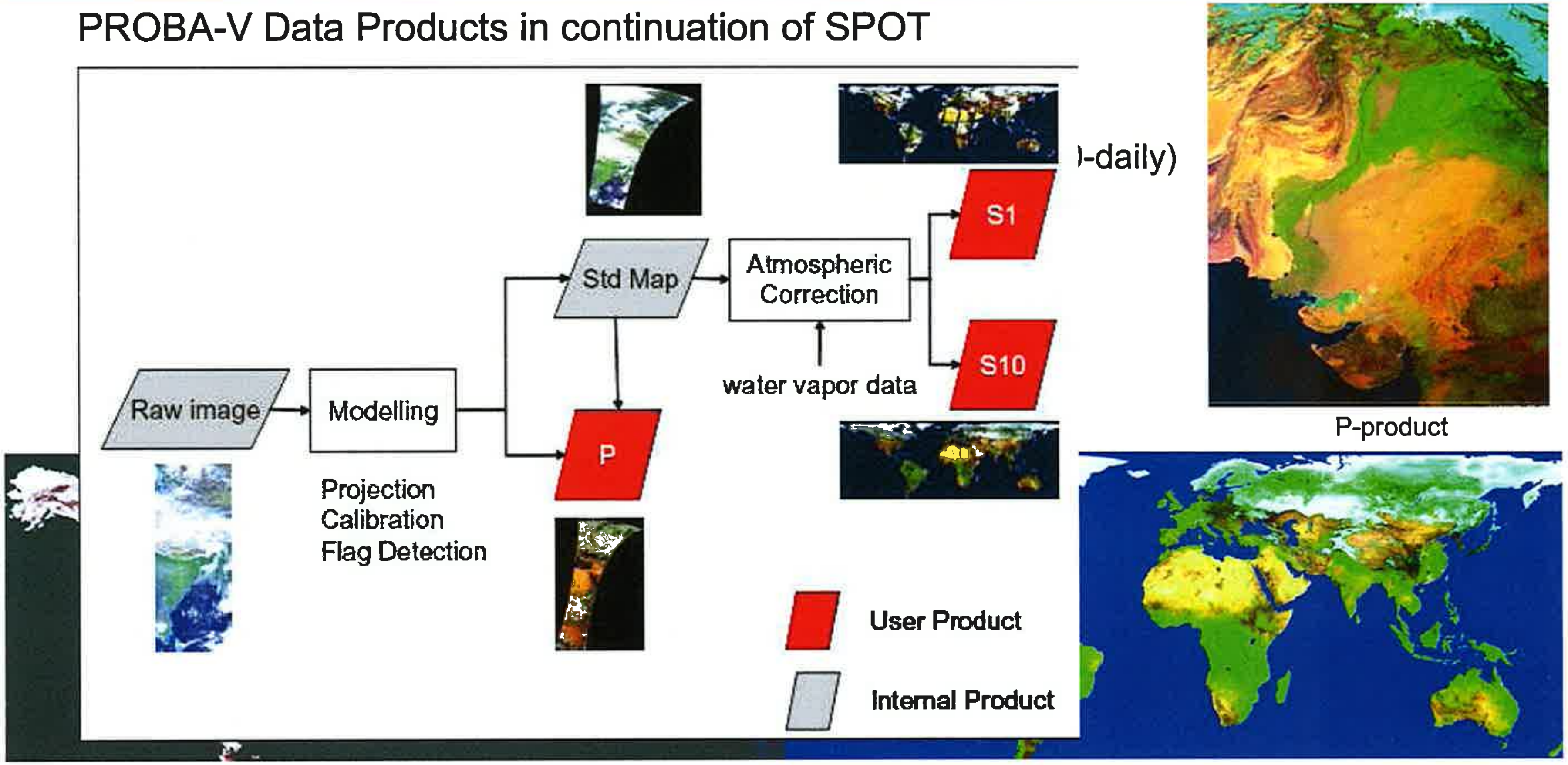
Primary Mission Objectives

- Continuation of Vegetation Products Generation (SPOT 4 and 5 since 1998)
- Operations shall start in 2013 to obtain an overlap with SPOT/VGT
- Mission Lifetime of 5 years

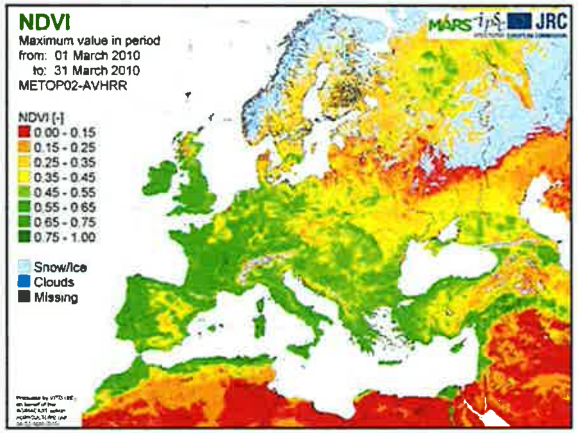


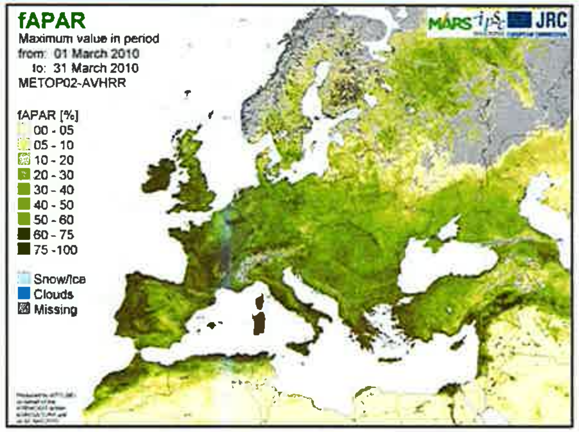
2.1 PROBA V Mission Objectives

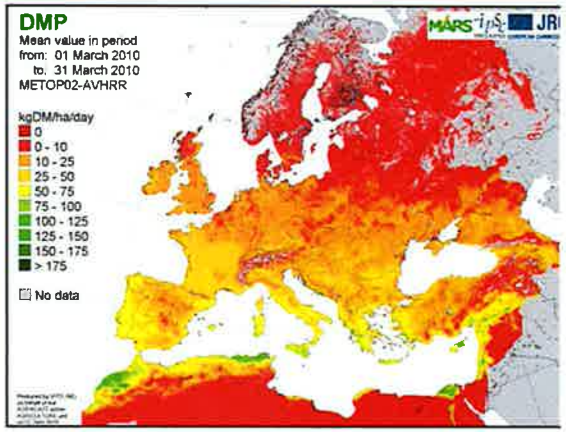
PROBA-V Data Products in continuation of SPOT

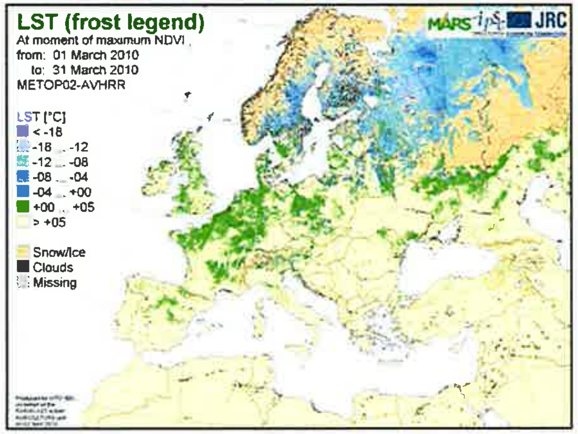


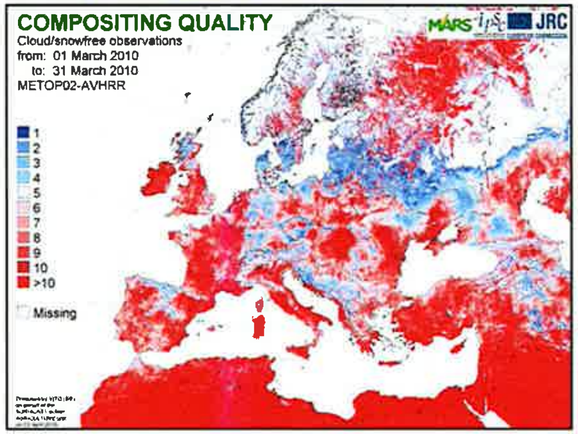
Produce Earth Observation based Indicators

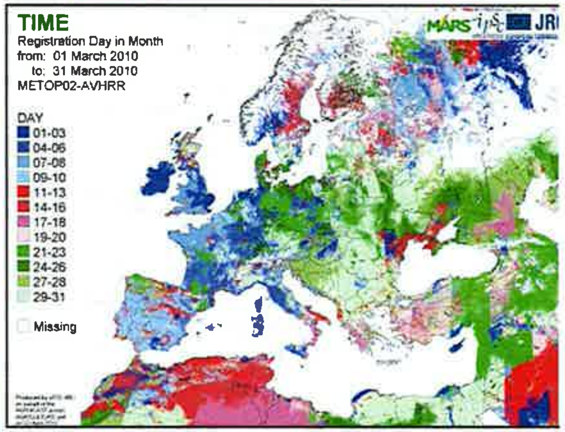












QinetiQ

QinetiQ Space nv

USE

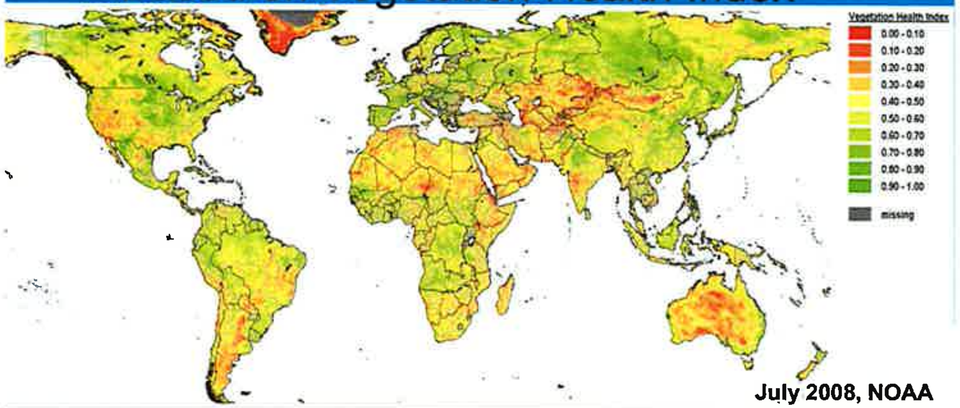
Uptake by user communities

Development of a global Agricultural Drought Stress Index System (ASIS) based on remote sensing data

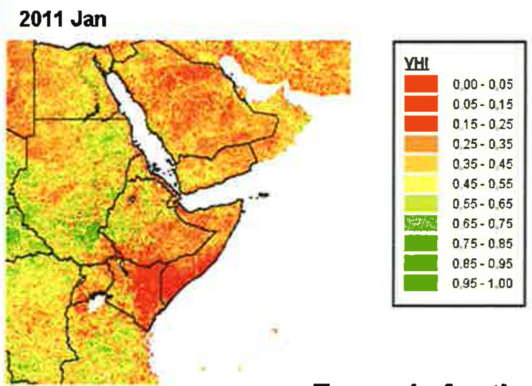
- ASIS is about monitoring vegetation drought stress
  ……only in crop growing season…
  …over crop areas…
  …on a sub-national level…
  …on a global scale…

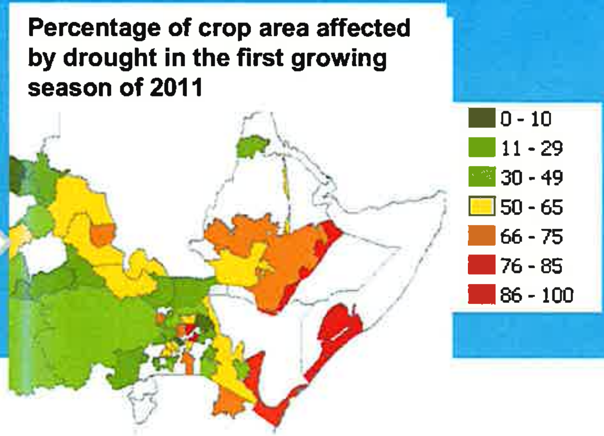
"ASIS serves the Global Information and Early Warning System (GIEWS) of FAO every 10 days with global maps to detect hotspots of drought in a Near Real Time mode."

Based on Vegetation Health Index



July 2008, NOAA



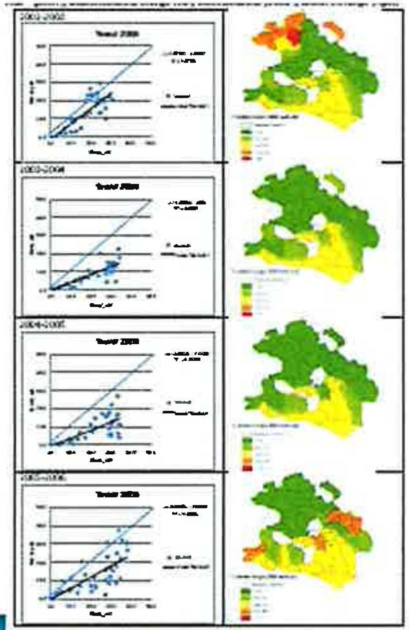


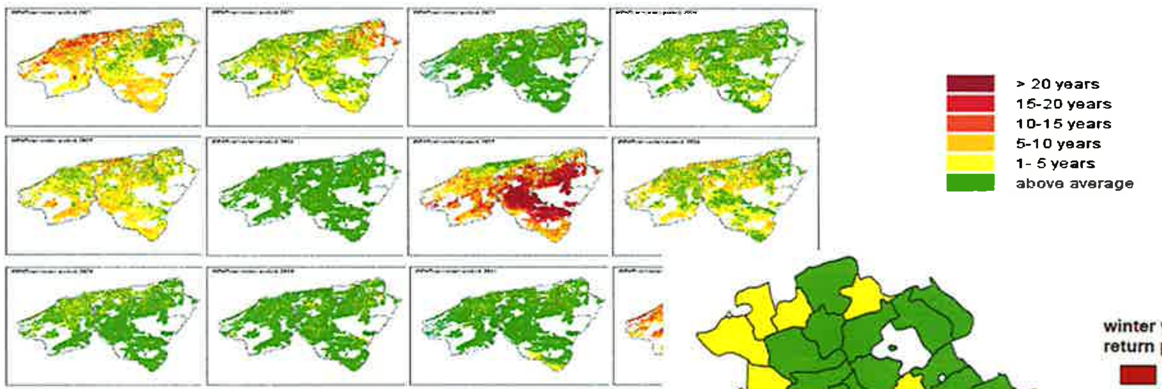
Example for the 2011 drought in the Horn Of Africa

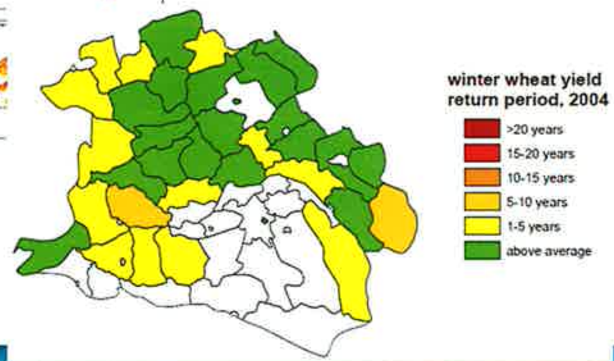
QinetiQ

USE

- Drought risk estimation and its impact on cereals by developing indices from Earth Observation: application to agricultural insurance on a pilot site in Morocco
- Winter crop / kill mapping & risk assessment in Krasnodar (Russia)
- Ethiopia, Belgium, Spain



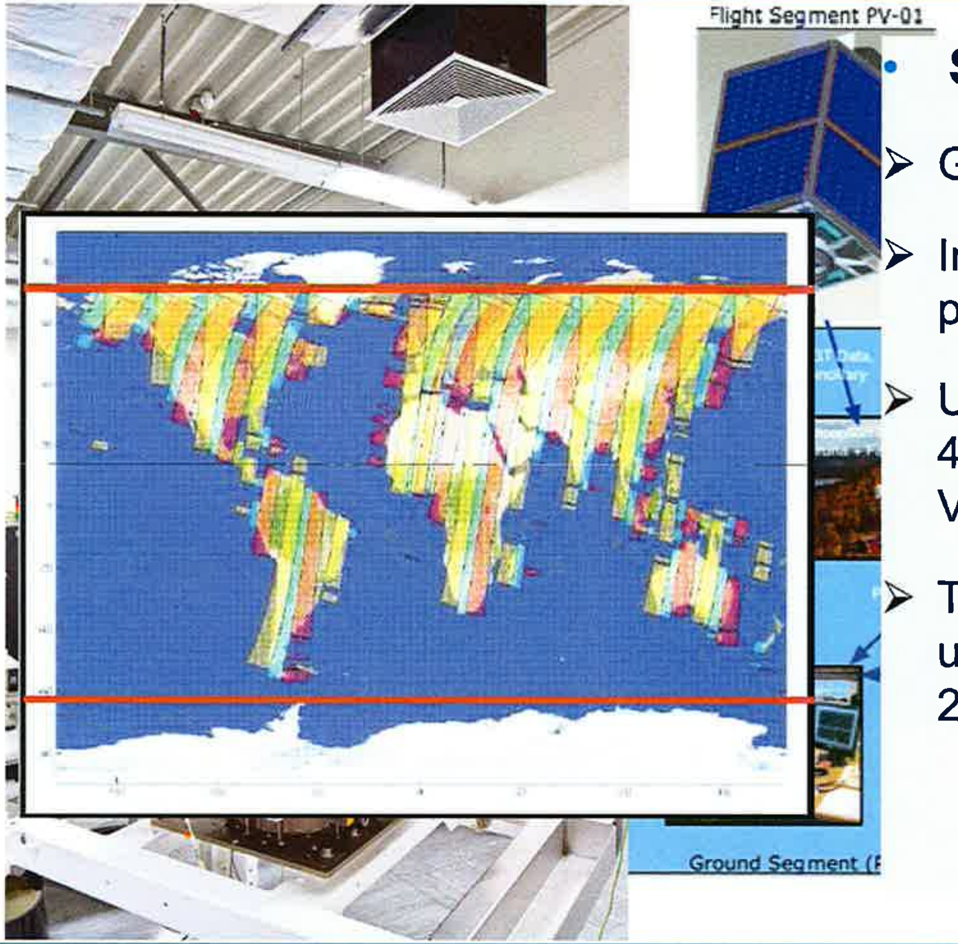




QinetiQ

QinetiQ Space nv

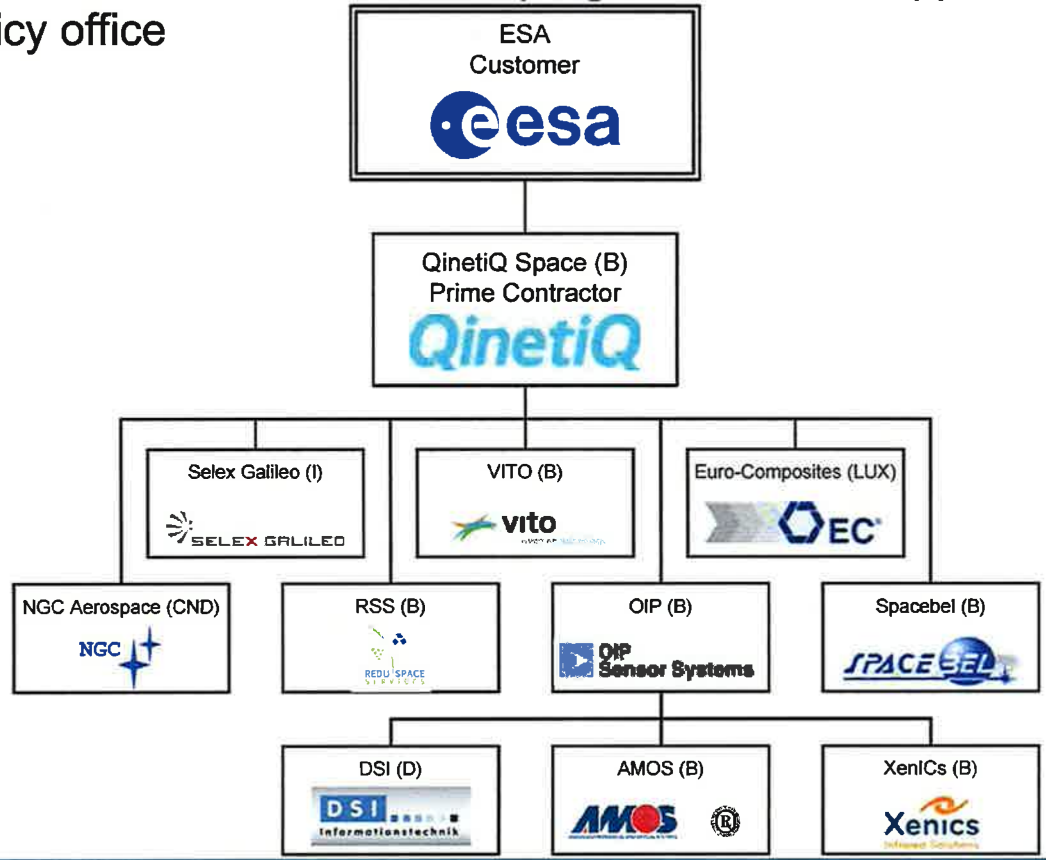
2.2 Project Set-up



- **Spacecraft improvements :**
  - Geometric accuracy improvement.
  - Increased power (191W versus 120W peak power EOL).
  - Upgrade of the **mass memory** from 4Gbit (PROBA-2) to 128 Gbit (PROBA-V) + data reduction methods
  - The **RF communication system** is upgraded for higher data capacity 2Mbips to PROBA V (35 Mbps)

2.2 Project Set-up

Project performed under ESA GSTP programme, with support from the Belgian Space Policy office



2.3 Technology Demonstration Payloads

Implemented Technology Demonstration Payloads

- Experimental X-band transmitter
  - Based on GaN technology
  - Providing additional redundancy in science data downlink chain
- Energetic Particle Telescope (EPT)
  - Innovative science class radiation spectrometer
  - Demonstration of sensor technology and on-board treatment of data
- Automatic Dependent Surveillance Broadcast (ADS-B)
  - Air traffic surveillance system
  - Validation of space-based monitoring system
- SATRAM
  - TIMEPIX based radiation monitor, complementing EPT

3 Space inspiring young people

Schools

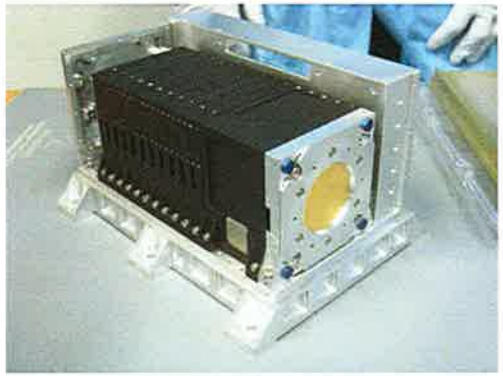
- Girl's Day inspiring young girls
- Thesis works
- Technical schools => Queen Paola Foundation

Young engineering teams

- 5 out of 17 team members < 30 years
- 7 out of 17 team members < 35 years

Cooperation with universities/ research centra

- Master thesis, stages, project works
- Guest lectures
- Development and delivery of scientific instruments
- Industrial and space projects development



Co-operation with high schools

Computers

- Used computers are offered to high schools

Stage + thesis work

- Study on human centrifuges + structural calculations (GTI Beveren)

EDUPROBA contest

- Proposals for use of Proba Satellite
  (Earth Observation & “on-board autonomy”)
- Lectures on use of on-board instruments
- Support and follow-up by E-learning
- Selection and execution of the experiments

QinetiQ Space nv

www.QinetiQ.be

Marie-Laure Hellin
Yvan Stockman
Thierry Chantraine
www.csl.ulg.ac.be

Centre Spatial de Liège

Workshop EISC – 25/03/13

PROBA V Instruments Calibration and Tests

LIEGE Science Park
Av. Pré Aily
4031 Angleur - Liège

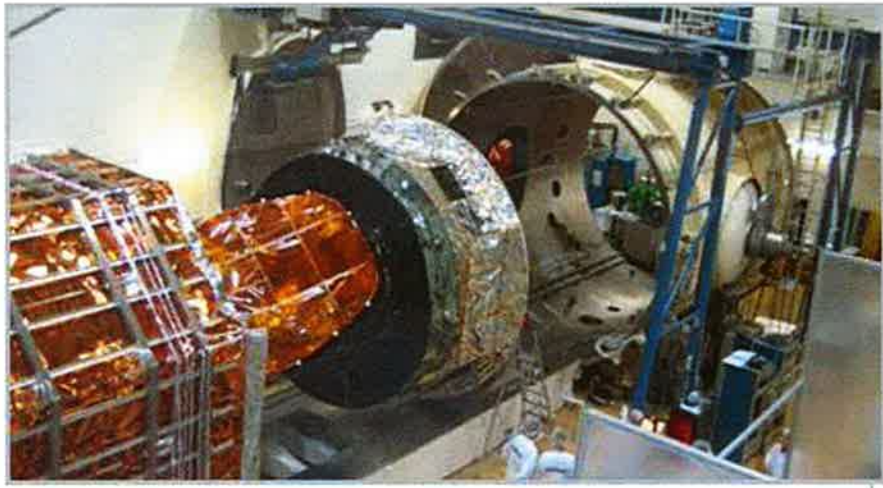
Université de Liège

CSL Test Center

- CSL is an applied Research Center of the University of Liège created in 1959 and located in the Liège Science Park.

- Active in space instruments (observation) and space systems engineering since the 60's, CSL is recognized worldwide as an Optics Center of Excellence.

- CSL operates a comprehensive Space Environmental Test Center equipped to test instruments and structures up to 6 meters diameter in ultra clean conditions.



- CSL employs 90 highly skilled employees including 60% of Engineers, Master of Science and PhD's

- Earth Observation instruments on board of small satellites are more and more ambitious.

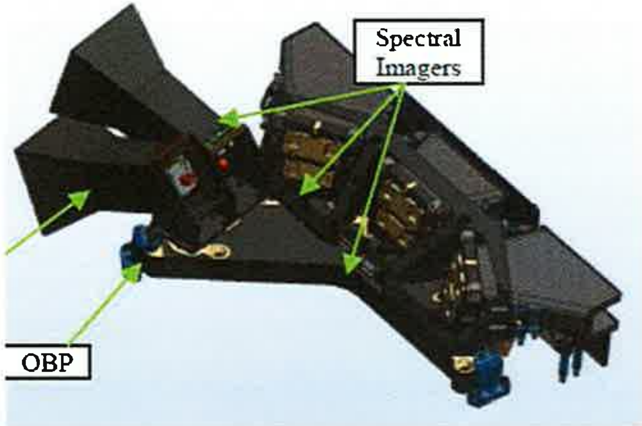
  Typically, PROBA V payload has to ensure the continuity of Vegetation Instruments (on board of SPOT 4 & 5), with the same data precision but with an overall mass of about 30 kg, instead of the 130 kg of the actual ones.

  Upsizing the performances while downsizing the payload lead to a real challenge :

  The calibration campaign requires a high level of accuracy, with a reduced level of cash.

PROBA V instruments

- The instruments (manufactured by OIP) is composed of three TMA telescopes, each of them containing 4 spectral bands (VNIR & SWIR). Those multispectral imagers are assembled in order to ensure à comprehensive 102 field of view.



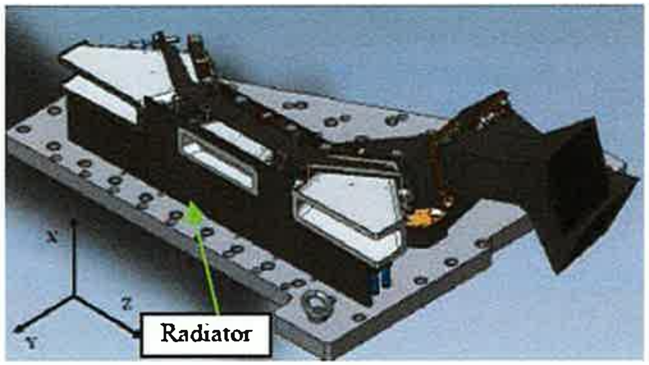


Figure 2. Concept of the PROBA V instrument

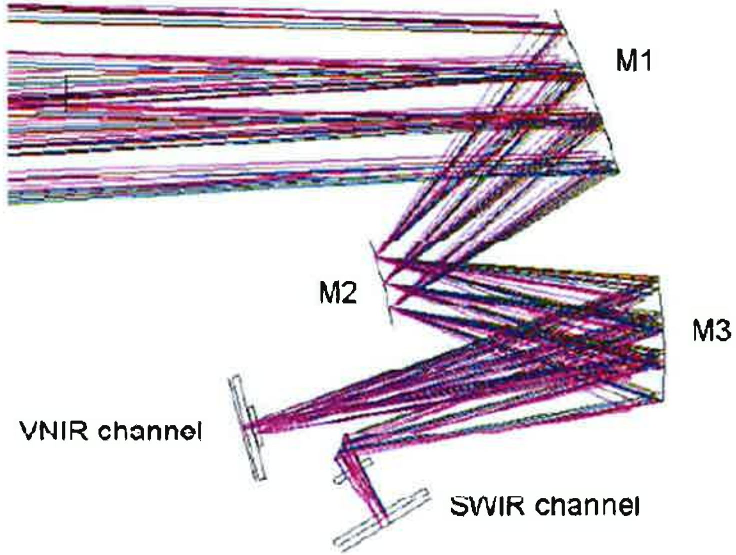
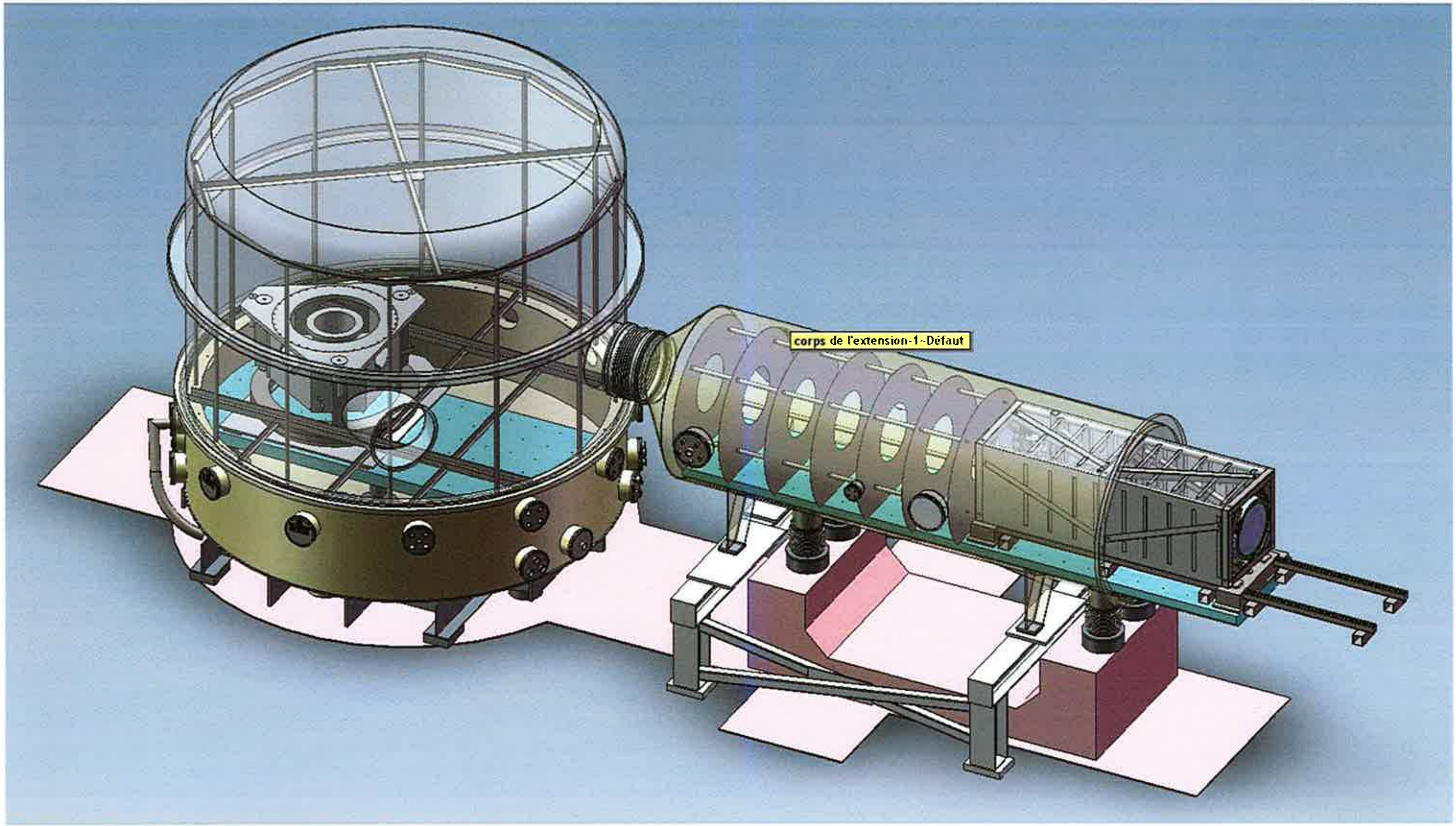


Figure 1. Optical design of the PROBA V TMA

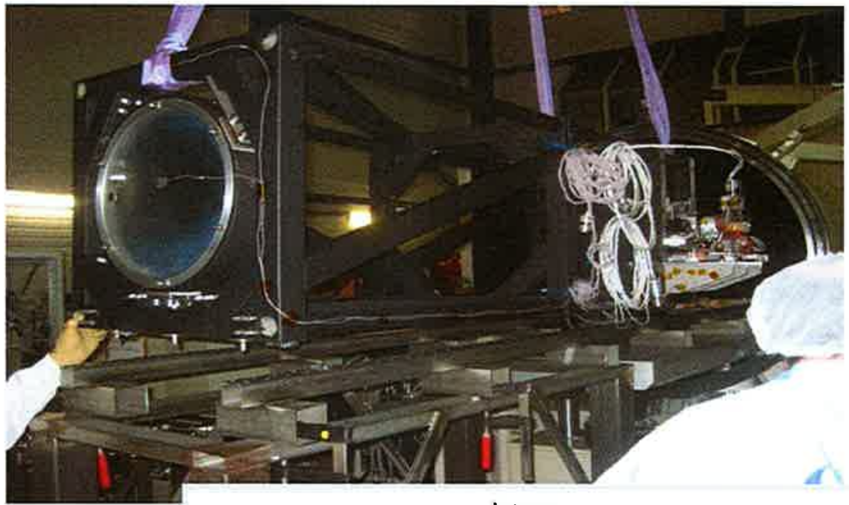
The optical design of the PROBA-V telescopes involves only reflective elements assembled in a TMA telescope which allows a significant reduction of mass and complexity for a multispectral imager with a wide field of view. However the mirrors are off-axis and aspherical bringing manufacturing and alignment difficulties.

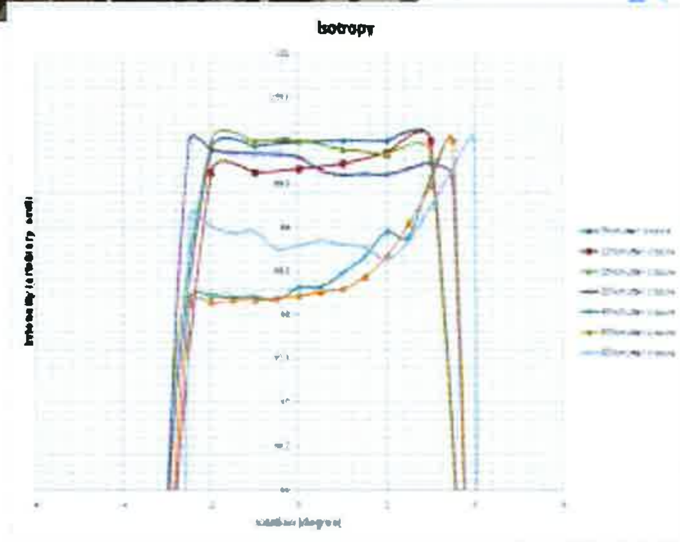
The Test Facility



Calibration test Requirements

- The facility needs to address the geometrical and radiometric calibration of the payload in ultra-clean environment (ISO 4).





To achieve this, a 400 mm clear aperture off axis collimator with a dedicated focal plane was developed for the geometrical calibration and a 300 mm integrating sphere calibrated was used for the radiometric calibration. To access all the Field Of View, the payload was placed on a rotating tip tilt table allowing rotation of +/- 180 for across track Field Of View scanning and +/- 10 for along track scanning. The payload was surrounded by thermal shroud to provide the required thermal environment (-40° to 60°C).

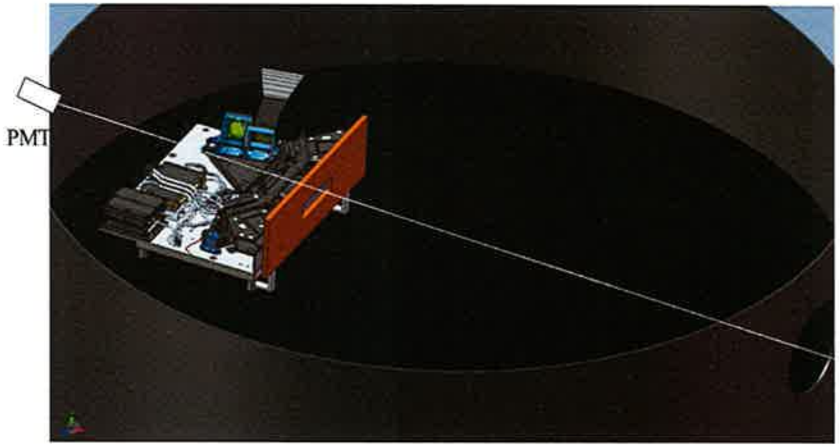
The calibration process requested almost two weeks under vacuum.

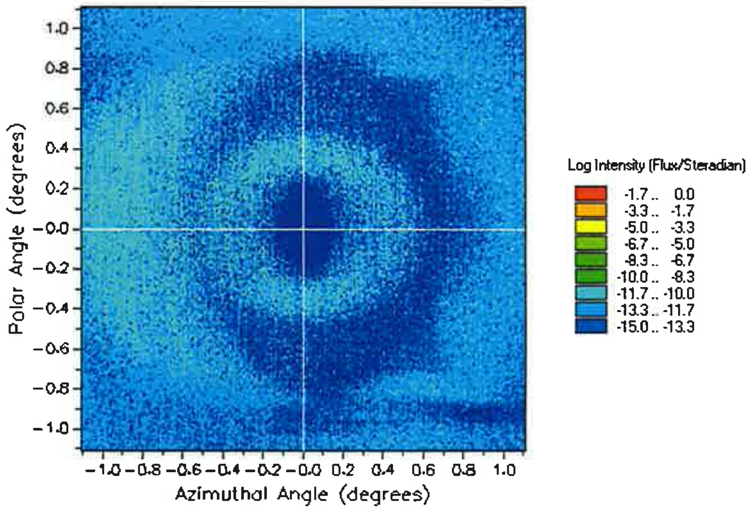
Straylight Analysis

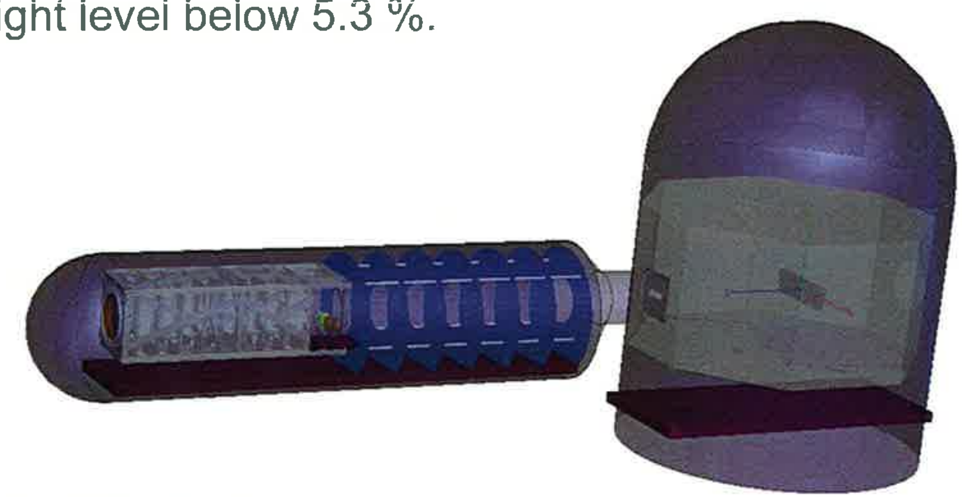
- In addition of the calibration campaign, CSL performed the Stray Light analysis of the Proba V instrument.

The purpose of this analysis is to avoid out-of-field stray light on the detectors coming directly or through reflections on the mirrors. The possible stray light by reflection, transmission or scattering on the SWIR folding mirror has also been studied.

Through this analysis, CSL was able to recommend specific adjustments allowing a reduction of the stray light level below 5.3 %.







Conclusions

- The increasing performances of compact satellites and instruments leads to new challenges.
- One of the most critical is the ability to perform a highly precise calibration with a reduce amount of time and money.
- Proba V experience highlighted the capability of Belgian industry to achieve this goal. It stands on a large range of competences and skills available in Belgium in the domain of small sats.
- CSL is part of this team and strongly support the Belgian strategy in this matter.

THANKS FOR YOUR ATTENTION

Université de Liège

6

EISC WORKSHOP DRAFT CONCLUSIONS
Designing, developing and operating small, micro, nano satellites and CubeSats: hands on experience for aerospace engineering students

15th European Interparliamentary Space Conference (EISC)
Belgium
Brussels 2013

- Space is extremely useful to raise the interest of young people in science, technology, engineering and mathematics (STEM) in general, and to prepare the future European highly skilled workforce
- Small, micro, nano satellites and CubeSats (Smaller Satellites) (also hosted payloads) are a multipurpose instrument for education, science, technology demonstration, services and entrepreneurship
- CubeSats are "high-end" tools for tertiary space-related education (besides other tools such as drop/spin/fly) as proven by the success of the ESA Education Programme offering a unique hands-on opportunity to also have access to state-of-the-art facilities and expertise from ESA
- CubeSat projects as QB50 and small satellites as ESEO as well as small missions as Proba V do, through Europe-wide cooperation (and even further international scope), not only provide exciting scientific and engineering opportunities but also support the strengthening of the European spirit and identity
- The commercial potential of Smaller Satellites is increasingly receiving greater attention by a number of actors: academia, science, space agencies, industry, entrepreneurs etc.

25 March 2013, Redu, Belgium

EISC WORKSHOP DRAFT CONCLUSIONS
Designing, developing and operating small, micro, nano satellites and CubeSats: hands on experience for aerospace engineering students

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Parliamentarians have an important role in convincing people about the role of space in everyday live and for the future of humankind. What they can do in concrete terms for Smaller Satellites is:

- Inform their constituencies, media, fellow parliamentarians about the benefits of science, technology, engineering and mathematics (STEM) education with the tool of space in general and Smaller Satellites in particular; and take more efforts to increase the number of women (from Girlsday to Hollywood)
- Support that space is reflected in curricula of primary and secondary education, vis-a-vis the responsible levels; space is not a topic per se of the curriculum but it should be used as a learning context
- Encourage universities to set up Smaller Satellite programmes to be funded by regional, national or European organisations and to improve the triangle of industry-universities-agencies
- Call upon the space sector, especially industry, to integrate young people into the heart of space projects and in particular Smaller Satellites in order to provide them with access to high-tech
- Provide frameworks for encouraging entrepreneurship
- Support the provision of access to space (timely and affordable)
- Provide, through legislative action, on the national and European level the adequate regulatory framework for the operations of Smaller Satellites (licensing, registration, frequency use, space debris mitigation) and ask executive bodies to carefully enforce this for the benefit of orderly and sustainable conduct of space activities

Grupo de Trabajo del Espacio

Conferencia Europea Interparlamentaria
del Espacio (CIEE) - Bruselas 2013

PROGRAMA

Taller de la Conferencia Interparlamentaria Europea del Espacio (CIEE)
Lunes, 25 de marzo de 2013 (lugar: Euro Space Center Auditorium Transinne)

10.00: Discurso de apertura a cargo del Senador Dominique TILMANS, Presidente del Grupo de Trabajo del Espacio belga, y presidente de la XV CIEE

10.10: Discurso a cargo de Philippe COURARD, Viceministro de Ciencia de Bélgica

10.20: Discurso a cargo del Sr. Bernard CAPRASSE, Gobernador de la Provincia de Luxemburgo

10.30: **El diseño, desarrollo y operación de satélites pequeños, micro y nano y CubeSats: experiencia práctica para estudiantes de ingeniería aeroespacial**

Presentaciones de ponentes:

10.30-10.45: Cat. Paolo TORTORA, Universidad de Bolonia (Italia), coordinador de ESEO

ESEO, o European Student Earth Orbiters, es una misión de microsatélites que operará desde una órbita de baja altitud. Está siendo desarrollado, integrado y probado por estudiantes universitarios como parte de un proyecto de la Oficina de Educación y Gestión del Conocimiento de la ESA.

10.45-11.00: Sr. Jean MUYLAERT, Director del Instituto Van Karman de Dinámica de fluidos, sobre QB 50

QB50 es una red académica europea e internacional que impulsa el proyecto de desarrollo de una constelación de 50 cubesats para estudiar la capa inferior de la termosfera e investigar el fenómeno de la reentrada.

11.00-11.20: Sr. Frank PREUD'HOMME, Director Comercial de Qinetiq Space & el Sr. Thierry CHANTRINE, Centro Espacial de Lieja para misiones pequeñas

Las misiones pequeñas de bajo coste permiten el acceso al espacio de las empresas pequeñas y medianas y les facilitan una experiencia esencial para que las industrias europeas sean competitivas e innovadoras

11.20-12.50: Debate general moderado por el Senador Dominique TILMANS

12.50-01.00: Conclusiones a cargo del Cat. Dr. Kai-Uwe SCHROGL, Director del Departamento de Estrategia y políticas de desarrollo de la ESA.