QB50

An international network of 50 CubeSats for multi-point, in-situ measurements in the lower thermosphere and for in-orbit demonstration

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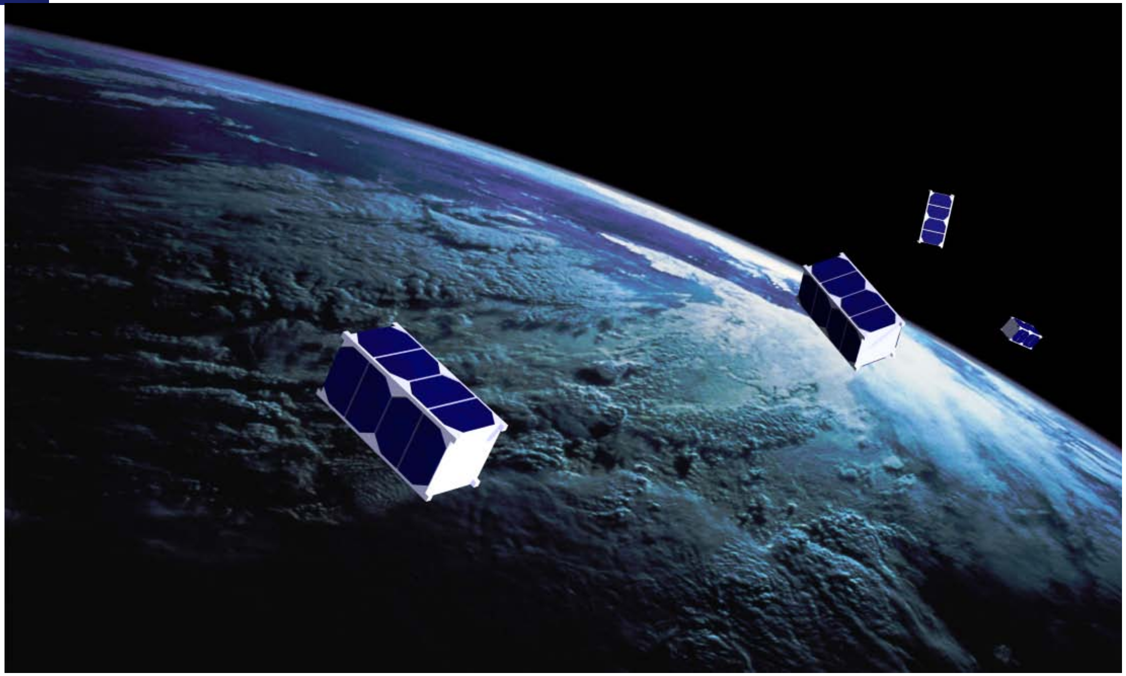
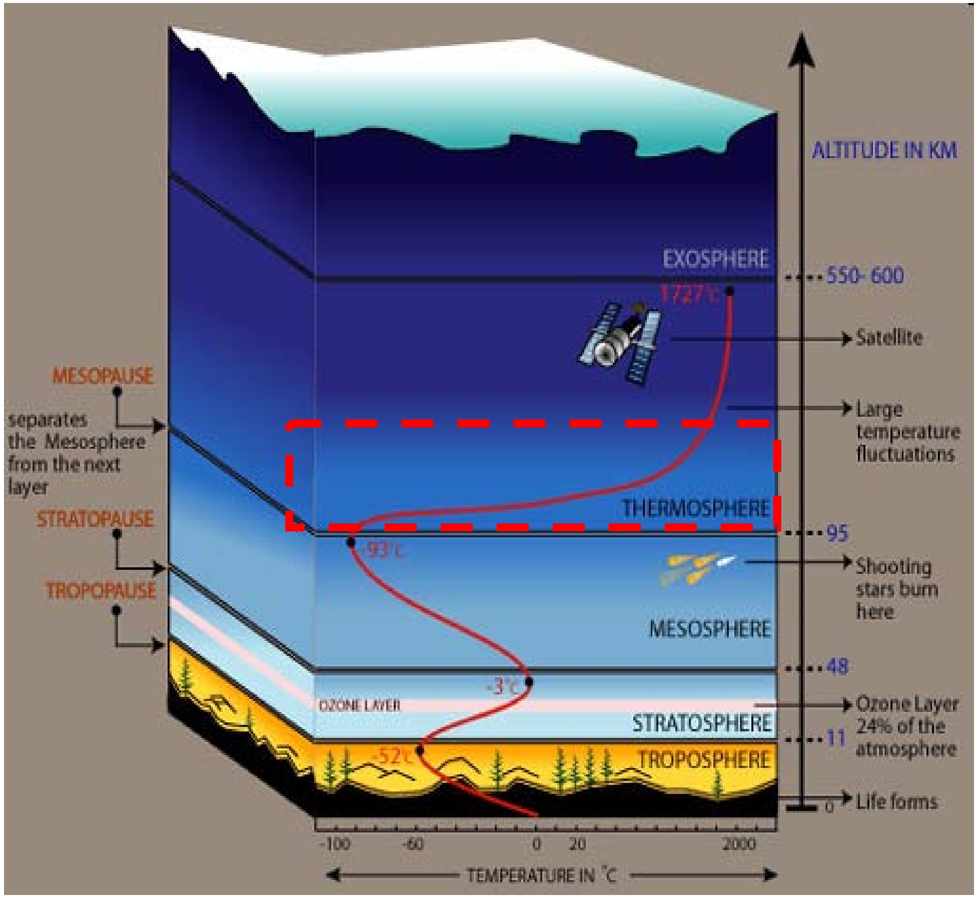
QB50 - THE IDEA



- 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: 320 km (circular orbit, i=79°)

Studying Lower Thermosphere

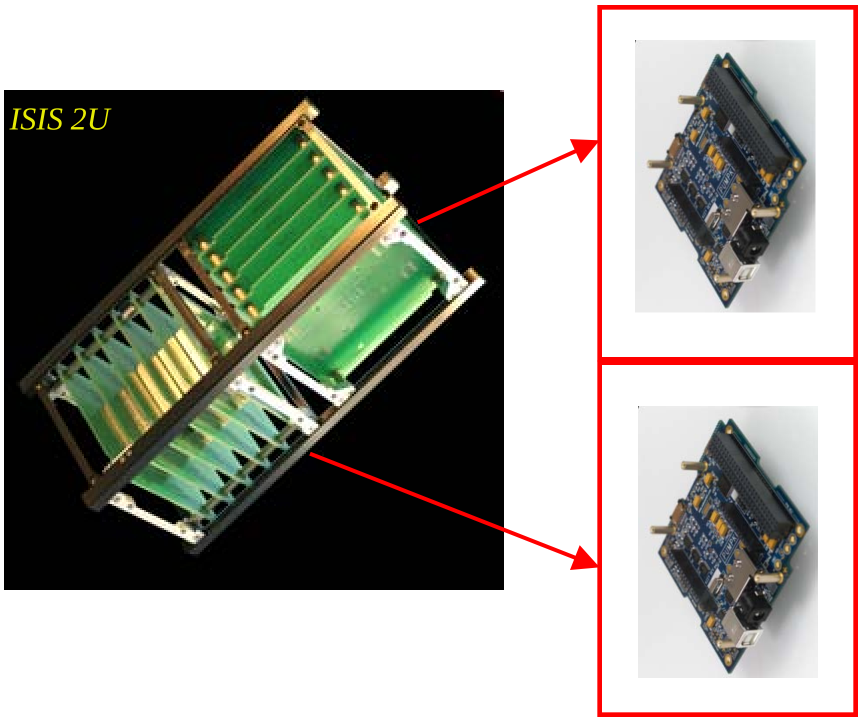
90 – 320 km: Why Lower Thermosphere?



- The ***least explored*** layer of the atmosphere
- Stratospheric balloons go to max 42 km
- Ground based lidars and radars can go up to max 105 km.
- Earth observation satellites in higher orbits (600 – 800 km) only observe constituents in the troposphere, stratosphere and mesosphere (lower thermosphere is too rarefied).
- In-situ measurements by sounding rockets in the mesosphere and lower thermosphere (MLT Region) provide only occasional (a few times per year), short, single-line measurements

QB50 - The CubeSat

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



Science Unit:

Lower Thermosphere Measurements

Sensors to be selected by a Working Group

Standard sensors for all CubeSats

Functional Unit:

Power, CPU, Telecommunication

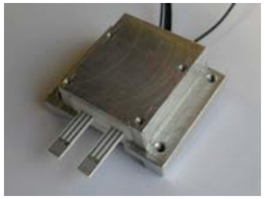
Optional Technology or Science Package

Universities are free to design the functional unit

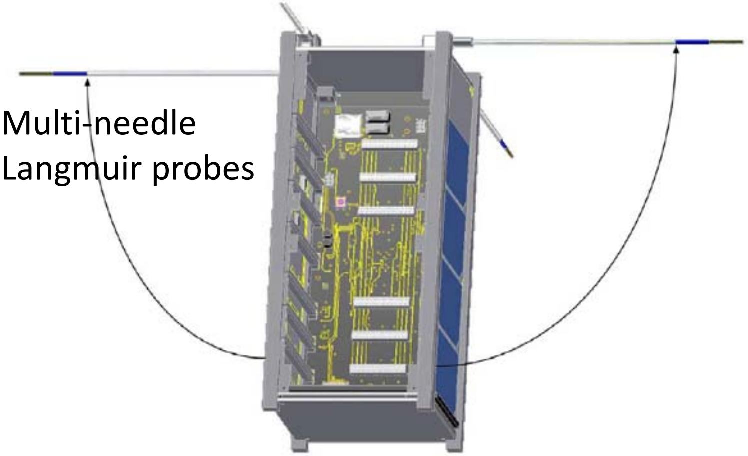
Sensor Selection

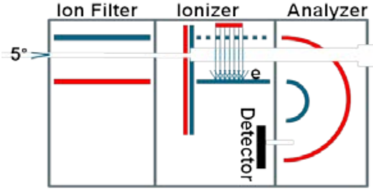
Sensors proposed by the Sensor Selection Working Group:

- FIPEX (oxygen sensor)
  (70 g, 2200-1600 mW)
- Multi-Needle Langmuir Probe
  (120 g, 400-1000 mW)
- Ion Mass Spectrometer
  (350 g, 500 mW)
- Neutral Mass Spectrometer
  (350 g, 500 mW)
- Laser Reflector
  (12 g, 0 mW)
- Thermal Sensors
  (180 g, 5 mW)

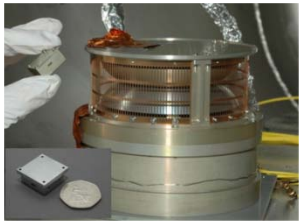


FIPEX sensor





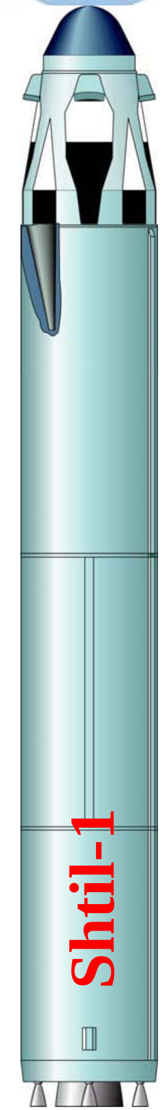
Schematic of the principle of working of the INMS



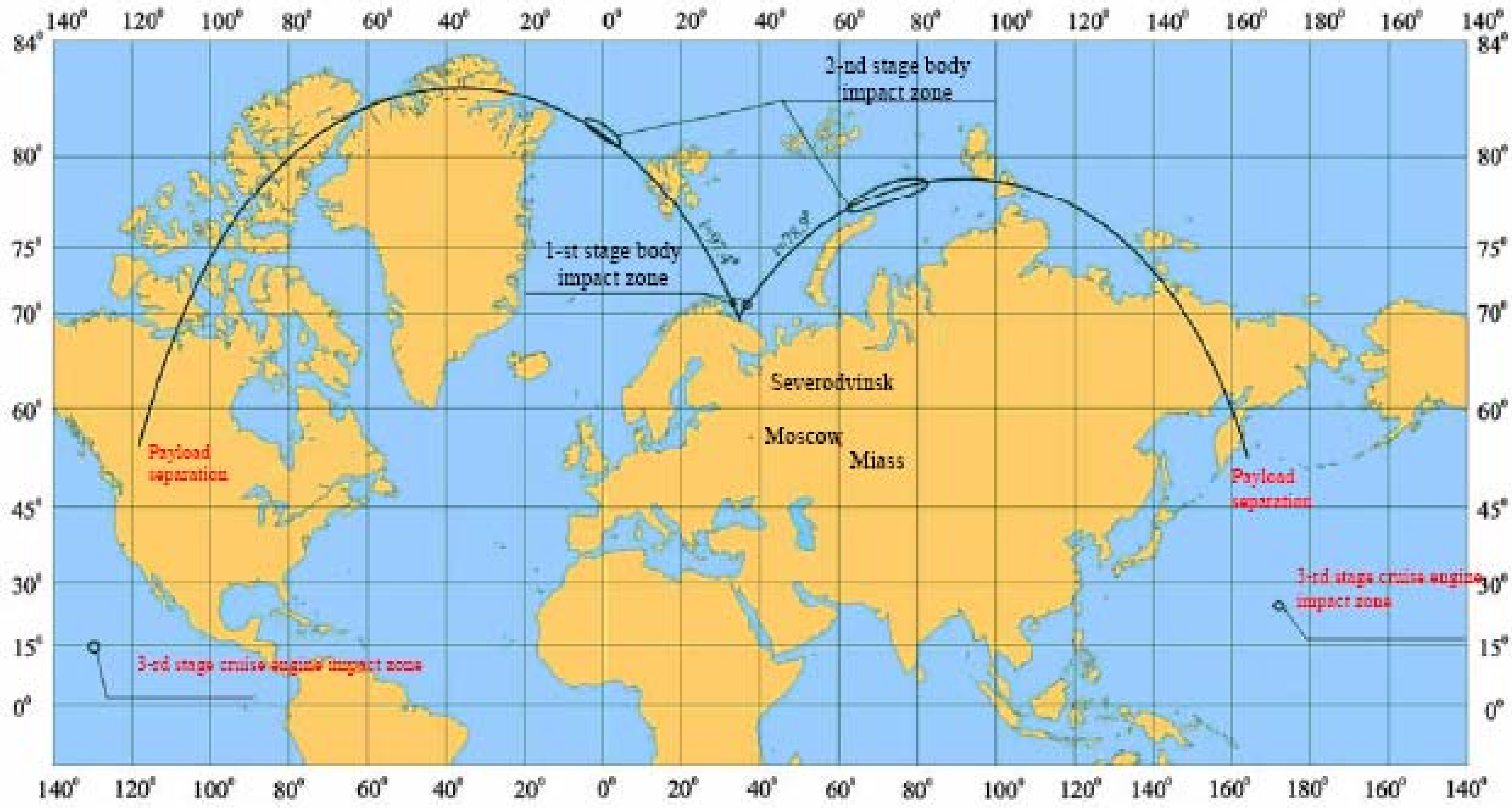
Miniaturised charged particle analyser along with the Improved Plasma Analyser

Launch Vehicle

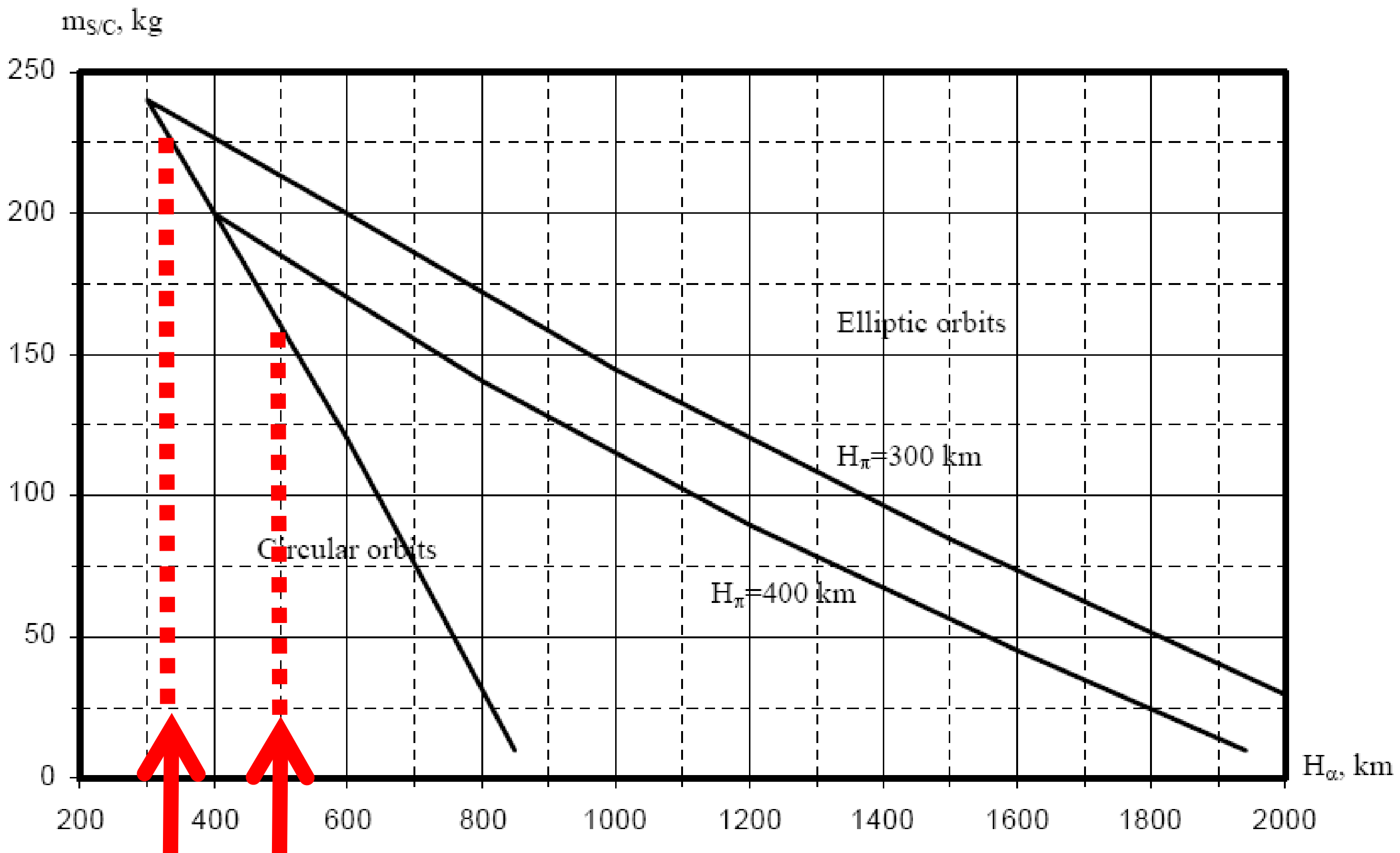
- The Shtil-1 is launched from a submarine
  - Featured in the recent block buster MI-4
- The Shtil -1 was used to launch :
  - TUBSAT-N (8kg) and TUBSAT-N1(3kg) nanosatellites into a 400x776 km orbit on 7 July 1998
  - Kompass-2 satellite (77kg) into a 402x525km orbit on 26 May 2006
- On the Shtil-1, the payload is placed inside a special container which is custom designed and mounted next to the third stage engine nozzle.
- The Shtil-2.1 is an improved version of the Shtil-1 where the payload is accommodated inside a fairing on top of the third stage
- The Shtil-2.1 is fully developed and hardware has been built and tested



QB50 – Launching & Deployment

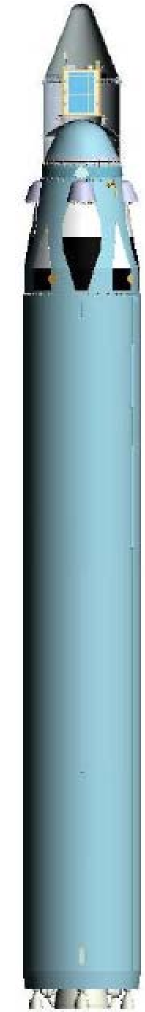


QB50 – Launching & Deployment



QB50
2015

Precursor flight
2013



Shtil - 2.1

QB50 – Launching & Deployment

SHTIL 2.1:

Better fairing

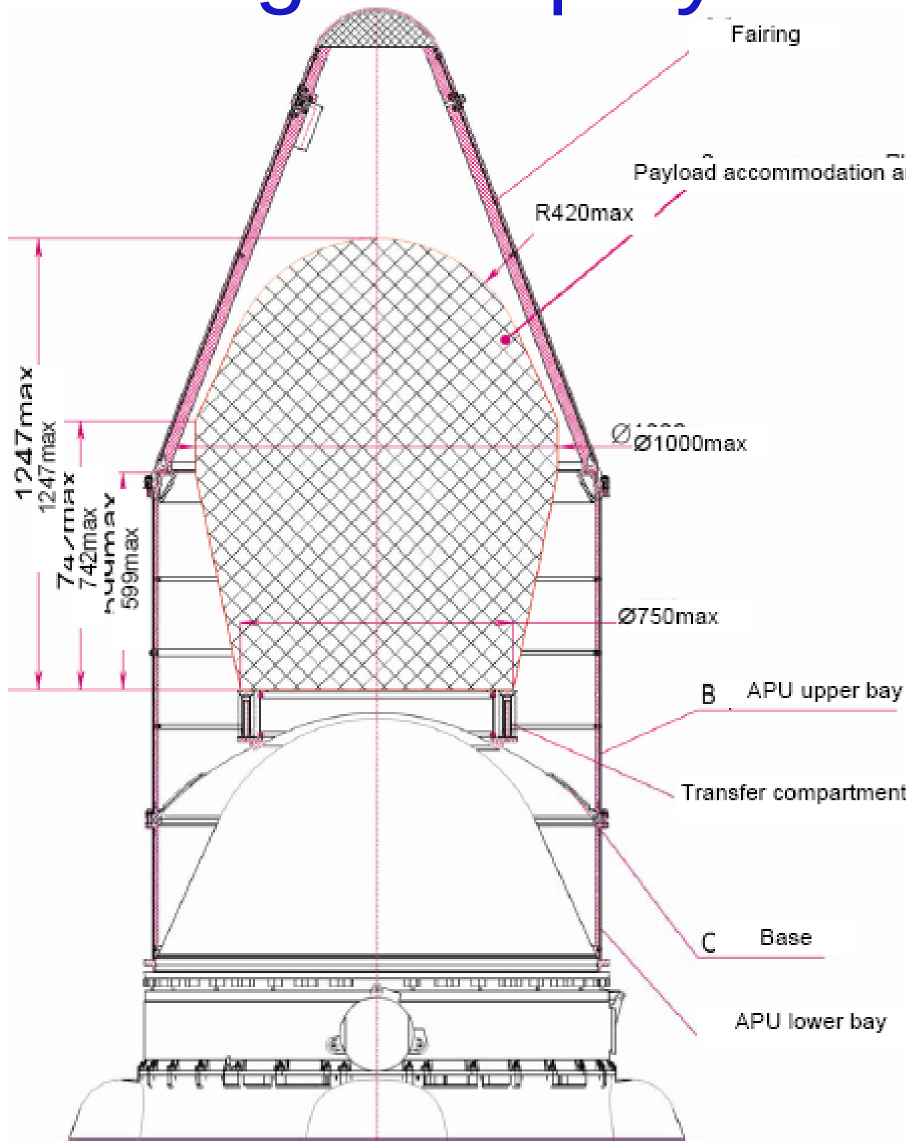
More volume (~ 1.8 m^3)

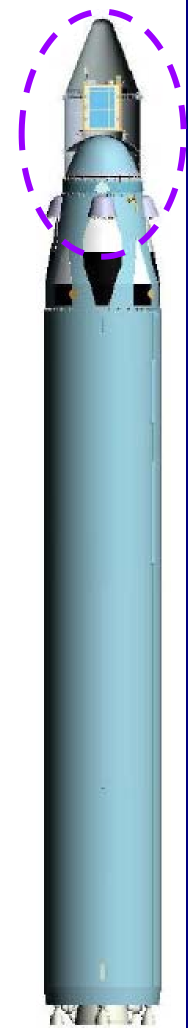
Can handle 50 2U-CS deployers

(volume ~ 0.35m^3)

And Solar Sail

(volume ~ 0.1m^3)





SHTIL 2.1

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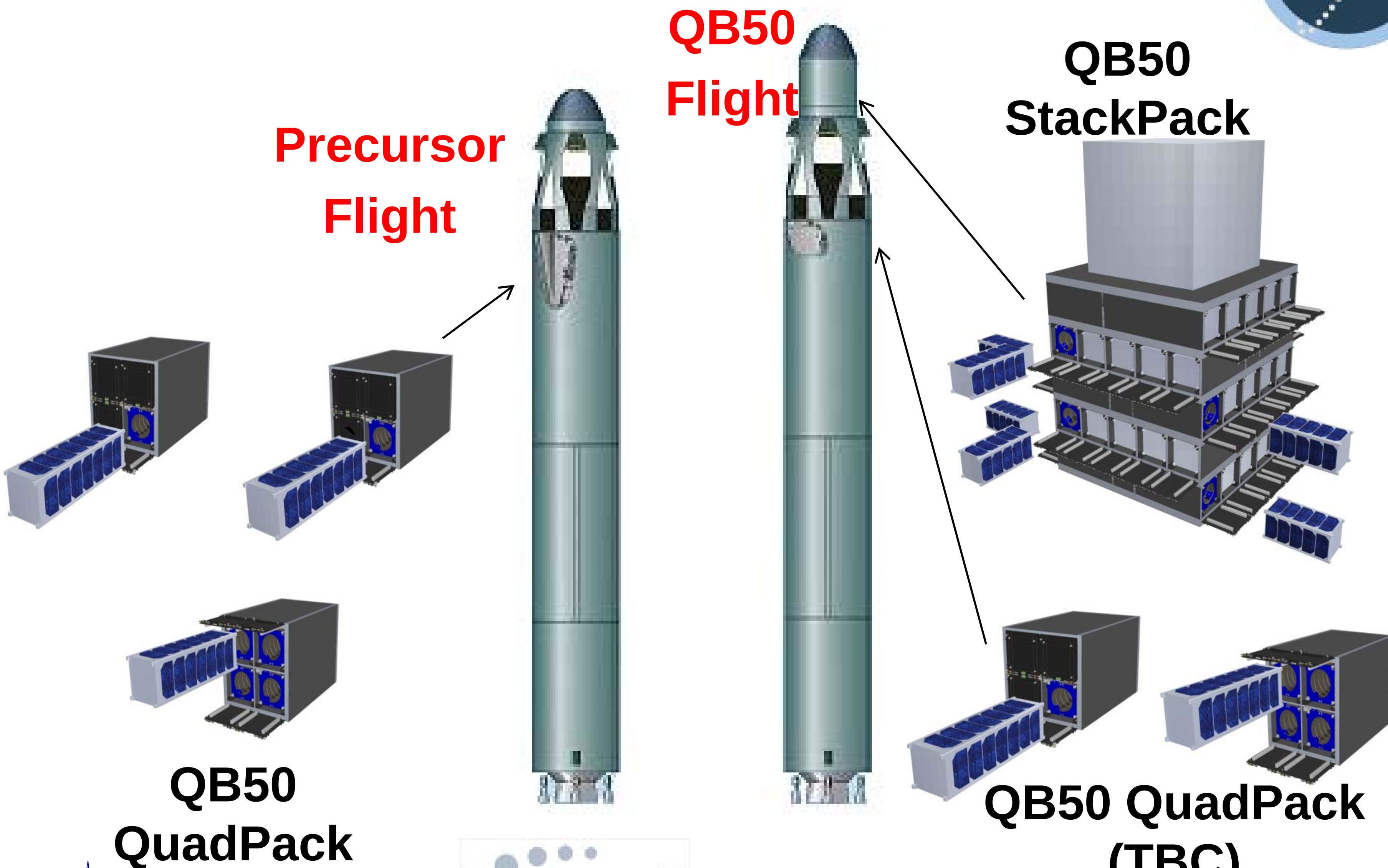
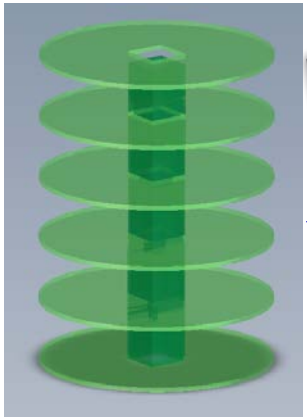
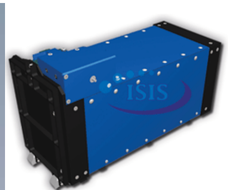
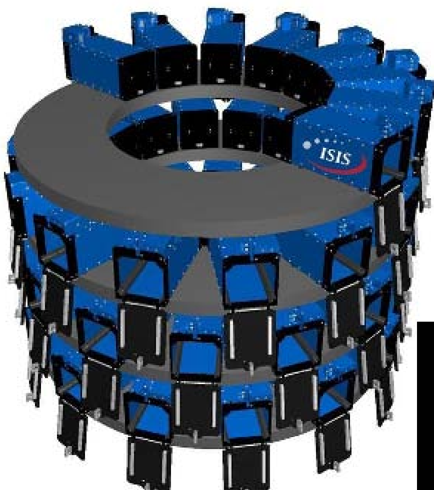
CubeSat Accommodation



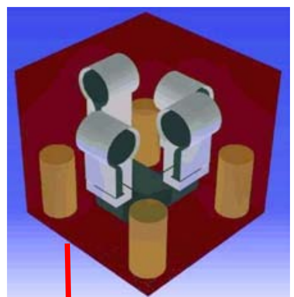
In-Orbit Demonstration

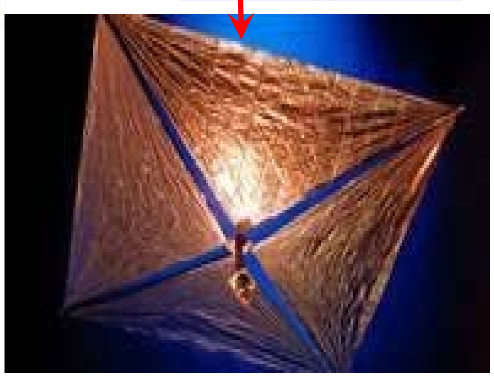



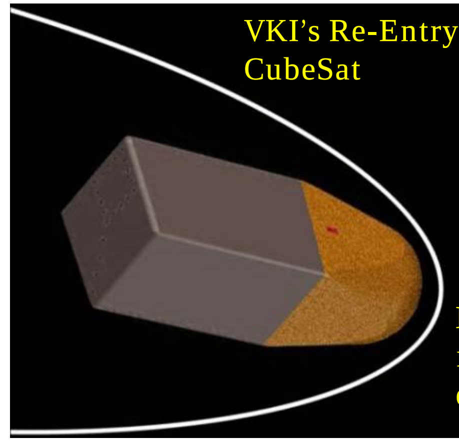
A modular deployment system for double and triple CubeSats



Gossamer-1 Solar Sail demonstration package

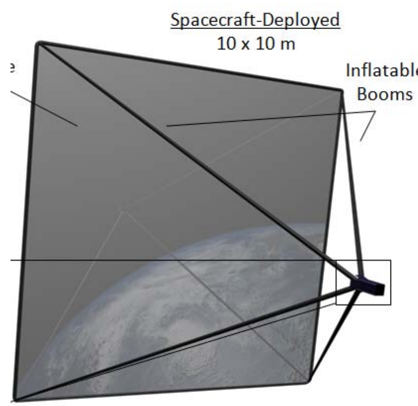






VKI's Re-Entry CubeSat

De-orbiting and debris mitigation by electrodynamic tether

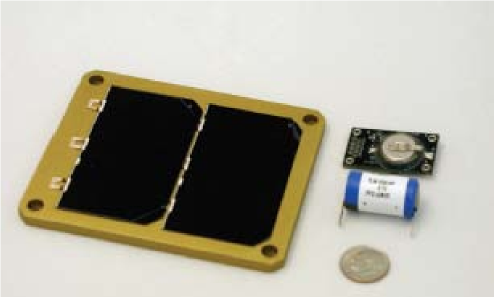


InflateSail demonstration mission

Other In-Orbit Demos:

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

Electrodynamic Tether Deployer

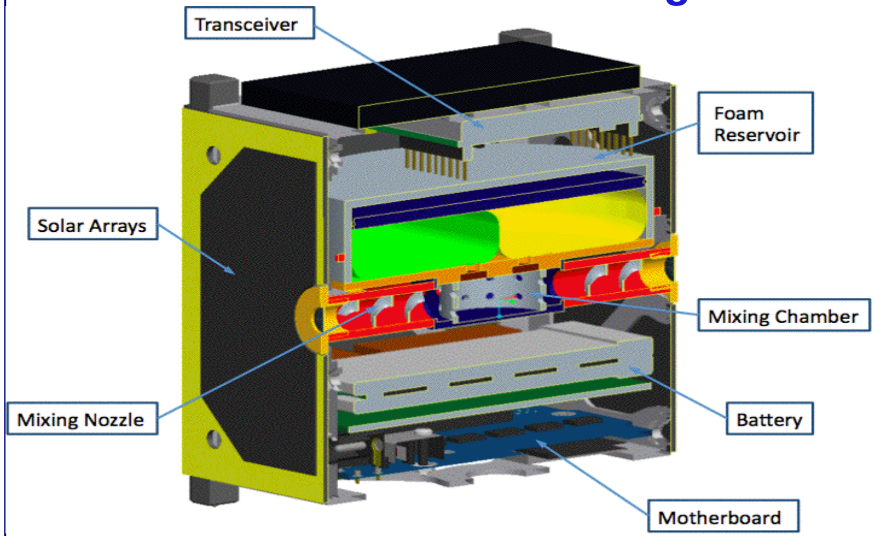


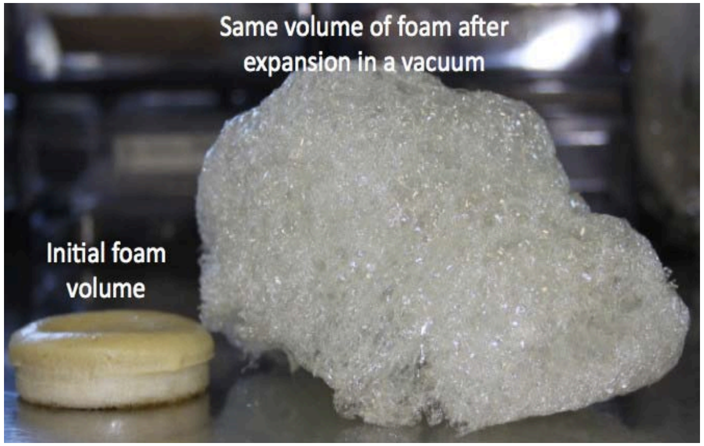
30 m terminator tape

In Orbit Demo on a double CubeSat of the Electrodynamic Tether
(One unit carries the standard sensors for atmospheric research)

Foam Assisted De-Orbiting

The core idea is to engulf the debris in a foam ball in order to increase its area-to-mass ratio such that the atmospheric drag can exert a significant deceleration.



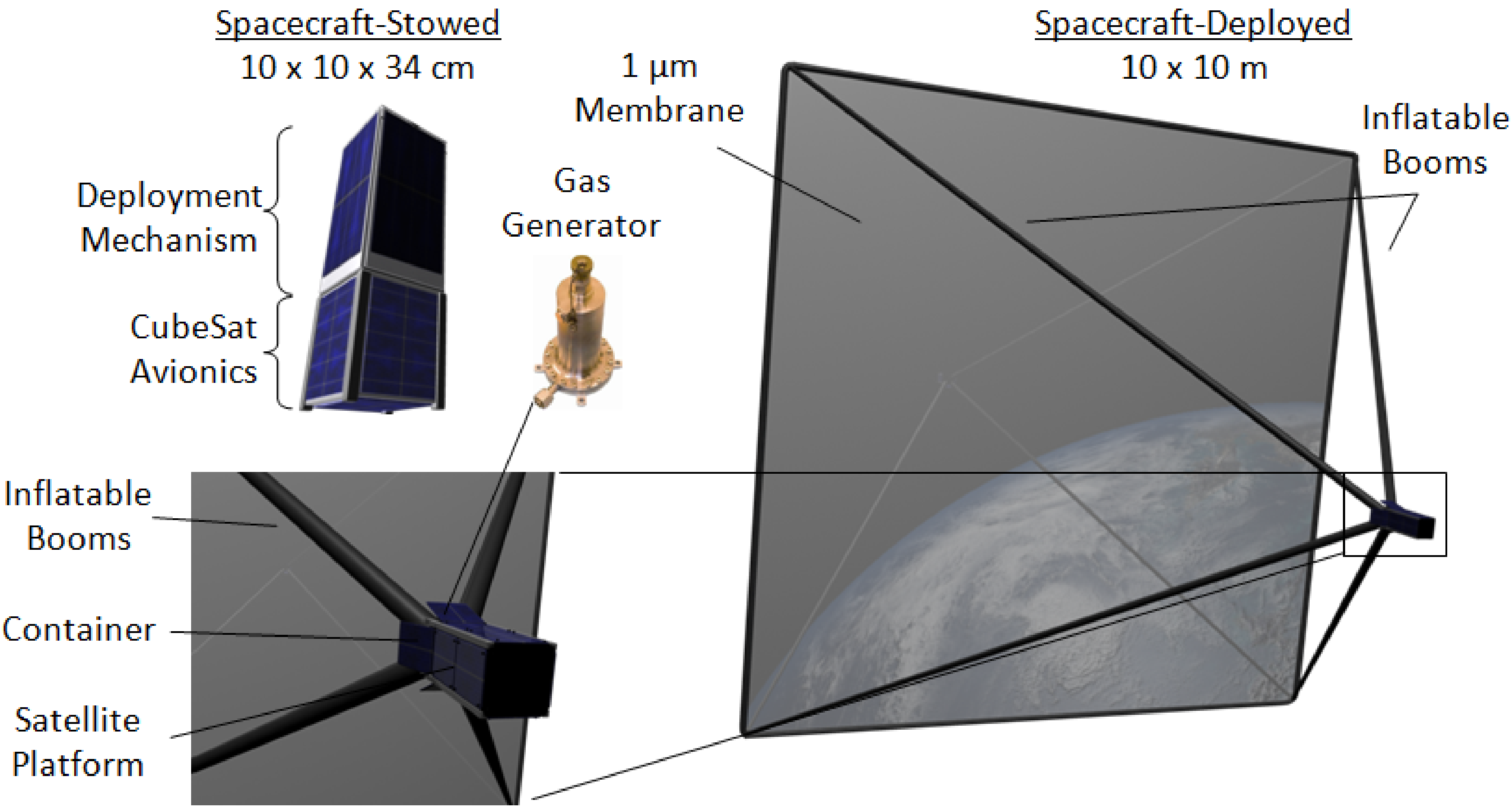


- This demonstration involves two identical double CubeSats, one with the foam ejection system, and the other without (for reference).
- The foam expanded to a cross section approximately 7 times larger. Recent models show the potential to reach a cross section expansion ratio of more than a factor 20 with a properly selected foam composition
- The second CubeSat will also be equipped with wide-angle miniature cameras to take pictures of the foam expansion.

ALTA

Inflate-Sail

for testing a solar sail with inflatable booms



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University of Surrey

www.QB50.eu

Formation Flying CubeSats

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

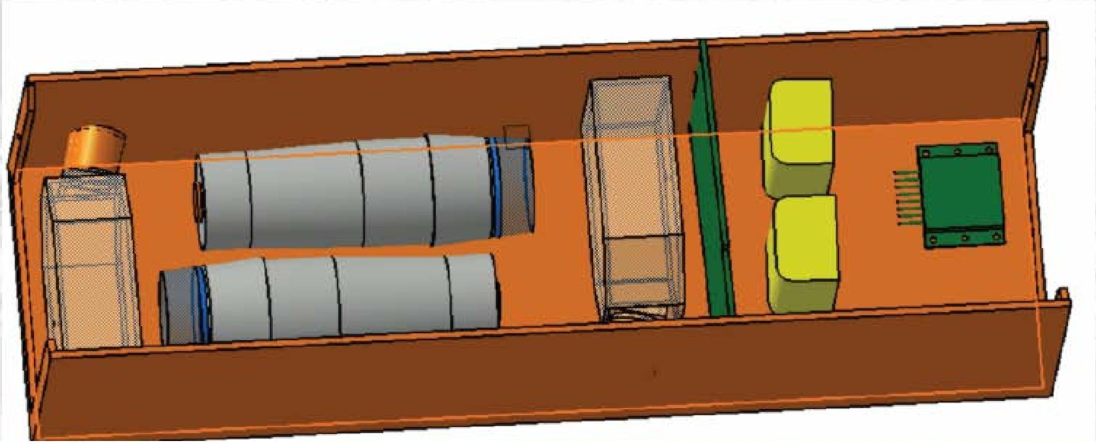
•Therefore, formation flight will be possible at any distance

Micro-gravity Experiments

Monitoring the space environment during the test
Monitoring the samples behaviour in orbit

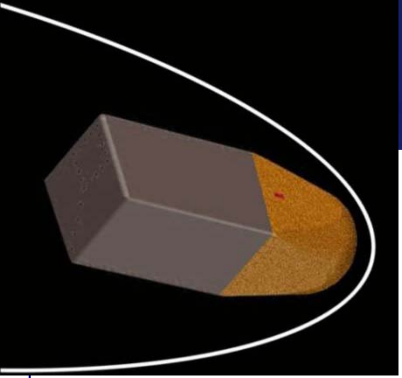
- <u>BUS</u> : 2U cubelabs in Nanoracks

- <u>Main System</u>: optical system (2 flasks/2 optical systems dedicated) microdosimeter and accelerometer

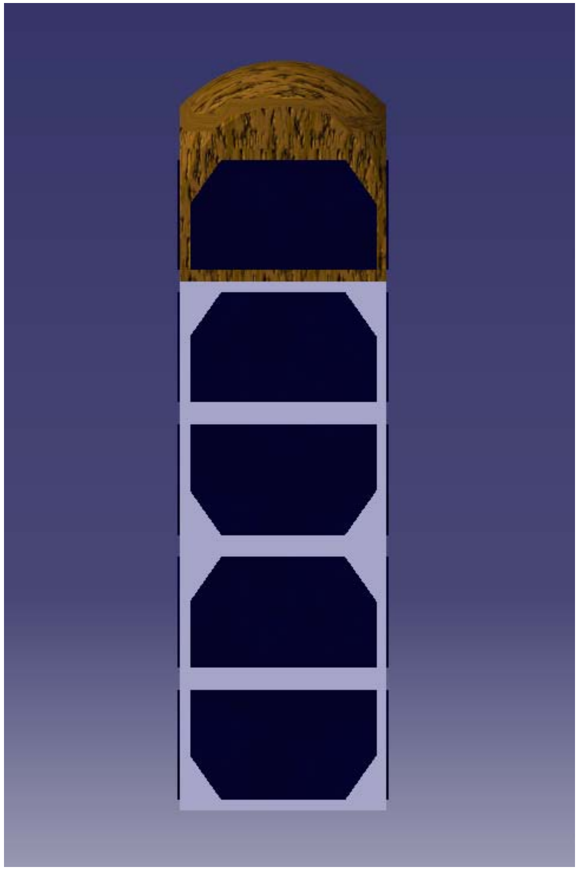


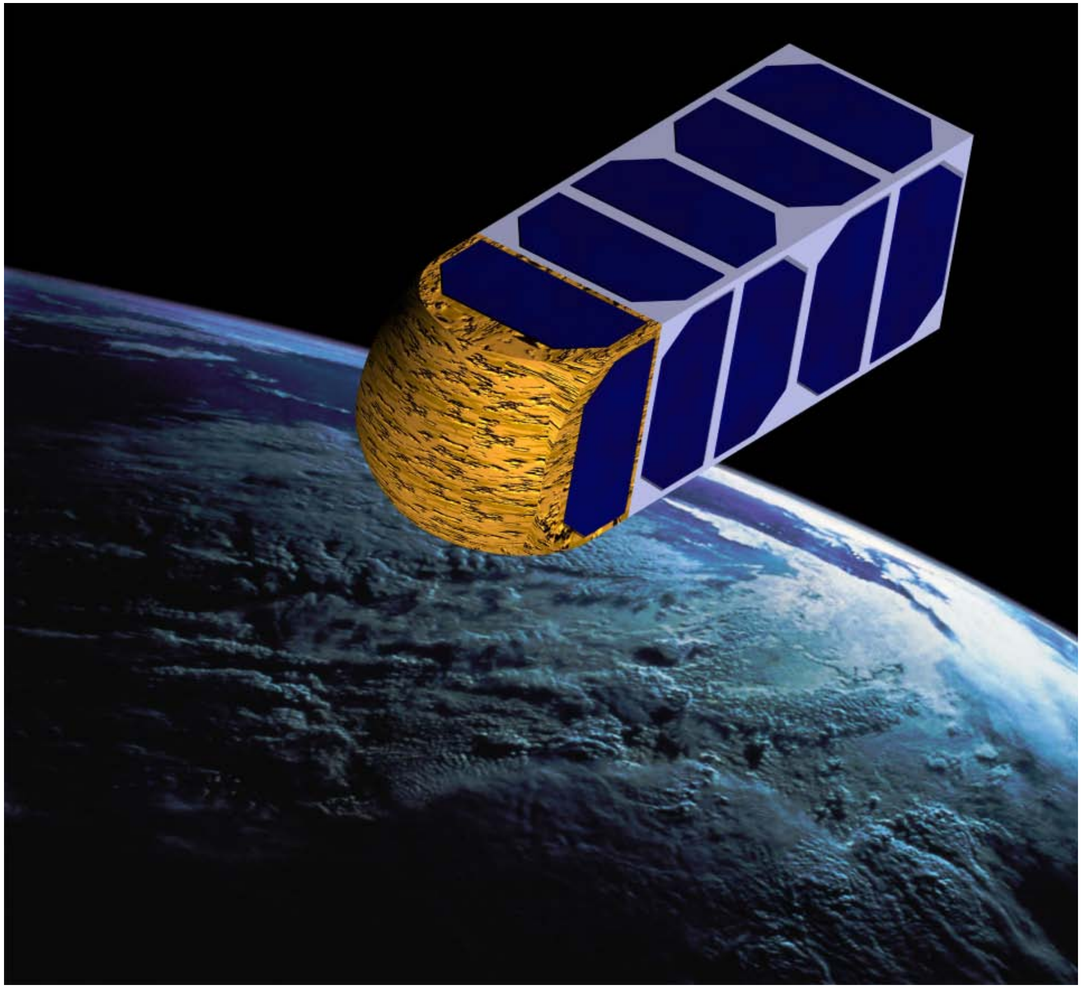
- This triple CubeSat aims at demonstrating that suitable microgravity experiments can be performed using a 2- or 3-unit CubeSat infrastructure in LEO.

- The University of Rome La Sapienza already performed microgravity experiments integrated in a nanorack and flown on the Space Shuttle. The purpose is to study the influence of ionizing radiation effects on cancer cell growth.



VKI Re-EntSat – Concept





Communication Demonstrations - GAMA-SAT

- The GAMA-Sat technology demonstration will focus on the usage of Software Defined Radio (SDR) to establish inter-satellite links
- These capabilities will be used to serve the scientific purpose of calculating the differential evolution of atmospheric drag between CubeSats.
- Combination of VHF, S-band and GNSS waveforms in a single HW platform;
- Inter-satellite ad-hoc networking capabilities, allowing each CubeSat to become a node in a mobile ad-hoc network and demonstrating the ad-hoc network concept in space;
- Range and attitude determination through the VHF Omni-directional radio Range (VOR) principle

GAMA-Sat's SDR transceiver will have to be installed aboard three different CubeSats

CubeSat Community

1 Argentina
2 Australia
3 Austria
4 Belgium
1 Brazil
1 Czech Republic
3 Canada
1 Chile
9 China
2 Denmark
1 Estonia
1 Ethiopia
1 Finland

4 France
7 Germany
2 Greece
1 Hungary
1 India
1 Iran
2 Ireland
2 Israel
2 Italy
1 Lithuania
1 Netherlands
1 Norway
10 Peru
1 Portugal

1 Russia
1 Singapore
1 Slovakia
2 South Korea
2 Spain
1 Sweden
1 Taiwan
2 Turkey
4 United Kingdom
9 USA
1 Vietnam

91 Letters of Intent

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Call for CubeSat Proposals

- The Call for Proposals will be issued on the QB50 web site on
  5 December 2011 (draft) – 15 Feb 2012 (official)

- Deadline for submission of proposals to VKI
  30 April 2012

- Proposal evaluation and selection
  3 June 2012 (TBC)

- Page limit: 15 pages

- Annexes for
  - Cost section (detailed and realistic cost breakdown
  - CubeSat management (organigramme, key personnel)

- Availability of a ground station is an advantage but not a necessary condition for selection