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°)
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 cm³):*

**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)
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

- 1st stage body impact zone
- Payload separation

3rd stage cruise engine impact zone
**QB50 – Launching & Deployment**

- **m_{SC}, kg**
- **Elliptic orbits**
- **Circular orbits**
- **H_r = 300 km**
- **H_r = 400 km**

**QB50**
- **2015**
- **Precursor flight**
- **2013**

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www.QB50.eu
QB50 – Launching & Deployment

**SHTIL 2.1:**

Better fairing

More volume (~1.8 m³)

Can handle 50 2U-CS deployers
(volume ~ 0.35 m³)

And Solar Sail
(volume ~ 0.1 m³)
CubeSat Accommodation

Precursor Flight

QB50 Flight

QB50 StackPack

QB50 QuadPack

QB50 QuadPack (TBC)
In-Orbit Demonstration

A modular deployment system for double and triple CubeSats

Gossamer-1 Solar Sail demonstration package

De-orbiting and debris mitigation by electrodynamic tether

Other In-Orbit Demos:
- End of life analysis, Debris
- Formation flight
- Micro-propulsion systems
- Micro-g experiment

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Electrodynamic Tether Deployer

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.
**Inflate-Sail**

for testing a solar sail with inflatable booms
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.
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

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**Total Letters of Intent**: 91
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