

QB50



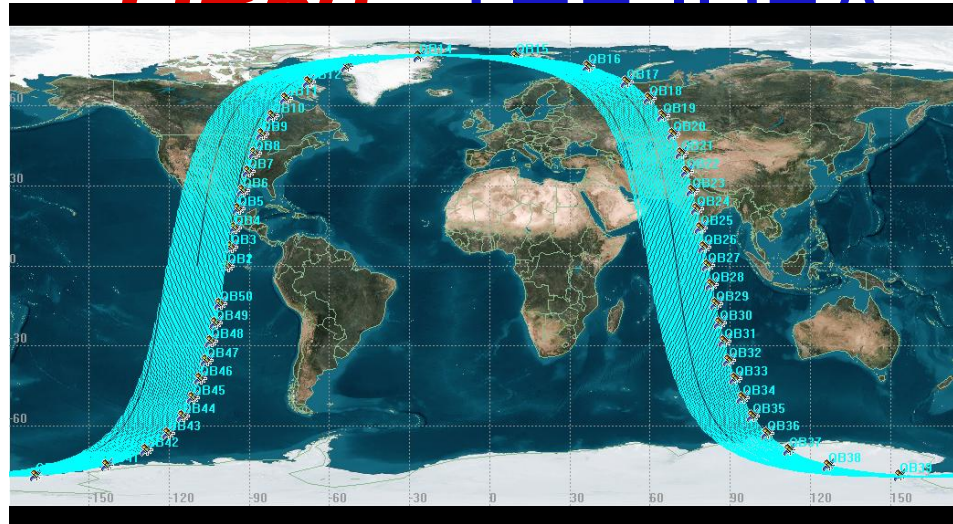
An International Network of
50 CubeSats
in Low-Earth Orbits for
Lower Thermosphere
and
Re-Entry Research

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QB50 THE IDEA



- A network of 50 CubeSats, launched at ~300km (Deployment sequence TBD)
- A network of 10000~20000 km
- Each performing in-situ measurements of atmospheric parameters
- Atmospheric data providing temporal and spatial variations
- Downlink using the Global Educational Network for Satellite Operations (GENSO)
- Mission duration: 3 months, down to ~90km without the need for propulsion

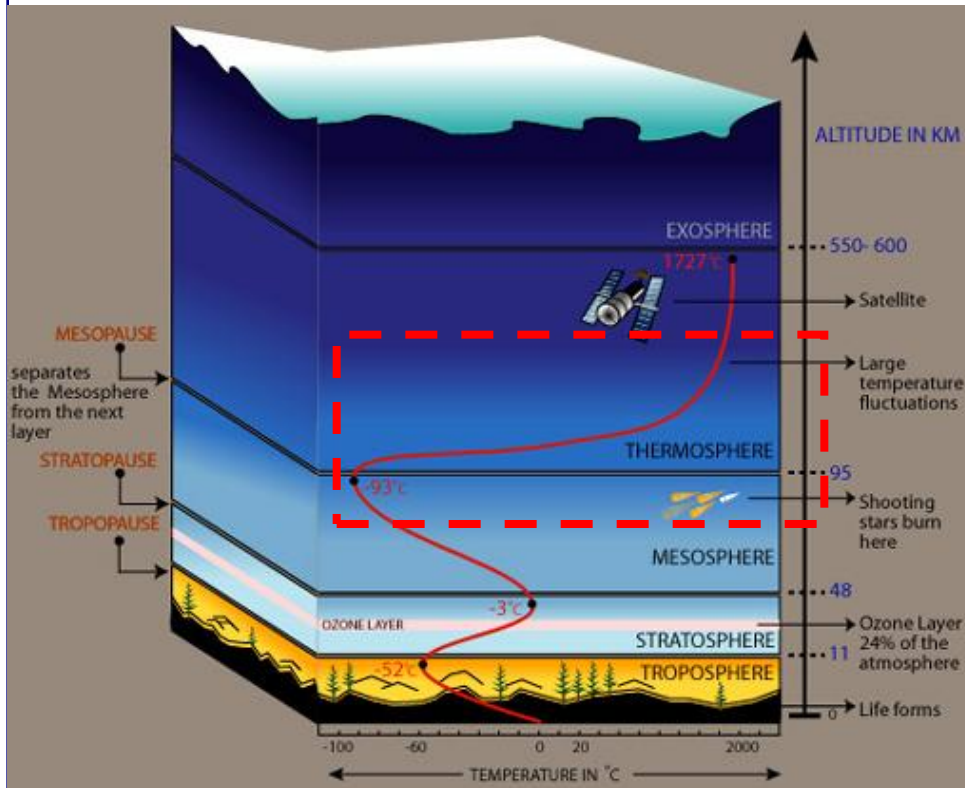




QB50 – Studying Lower Thermosphere

90-300km: Why Lower Thermosphere?

- The **least explored** layer of the atmosphere
- Stratospheric balloons go up to 42 km max.
- Remote-sensing by ground based lidars and radars up to 105 km.
- Remote-sensing by 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) single point measurements



QB50 – Studying Lower Thermosphere



Advantages of a CubeSat Network

A network of 50 CubeSats in the lower thermosphere compared to networks in higher orbits has the following advantages:

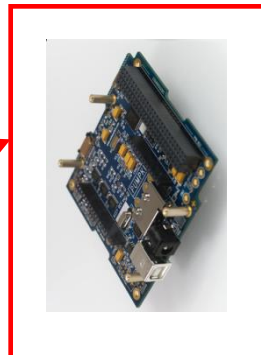
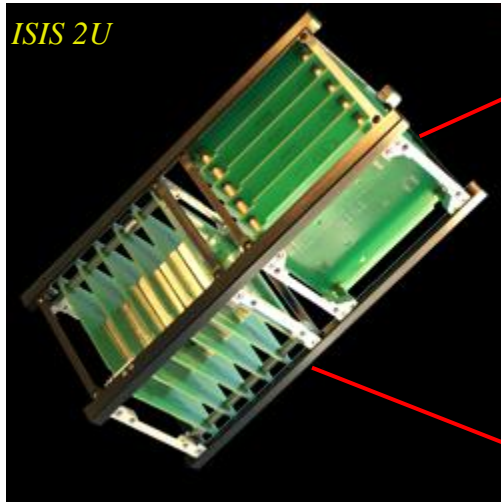
- The ***lifetime*** of a CubeSat in the envisaged low-Earth orbit will only be three months, i.e. much less than the 25 years stipulated by international requirements related to space debris
- A low Earth orbit allows ***high data rates*** because of the short communication distances involved
- In their low Earth orbits, the CubeSats will be below the Earth's radiation belts, which is very important because CubeSats use low-cost Commercial-Off-The-Shelf (***COTS***) components





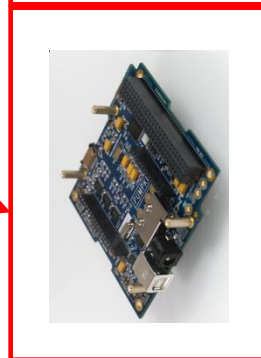
QB50 - THE IDEA

On a Double CubeSat:



Science Unit:

Lower Thermosphere Measurements
Sensors to be selected by a Working Group
Standard sensors for all CubeSats



Functional Unit:

*Power, CPU, Telecommunication, IMU,
GPS*

Optional Technology Package
available for the CubeSat
community !!





QB50 - THE IDEA

Advantages of the QB50:

The intention is to provide free of charge to the CubeSats participating in QB50 the

- launch vehicle
- custom-designed deployment system
- environmental testing at ESA – ESTEC (if requested)
- standardized sensors for the science unit
- launch services and interfaces to the launch vehicle authorities
- transport of the 50 CubeSats from ESA-ESTEC to the launch site
- CubeSat checkout testing during the launch campaign





QB50 – CubeSat Community

35 from Europe

2 Austrian, 2 Belgian, 1 Czech, 2 Danish,
1 Estonian, 1 Finnish, 3 French, 4 German
1 Hungarian, 2 Dutch, 3 Italian, 1 Norwegian
1 Polish, 1 Portuguese, 1 Romanian, 1 Swedish
3 Spanish, 2 Swiss, 3 British

10 from United States

2 from Canada

3 from Japan



QB50 – CubeSat Community



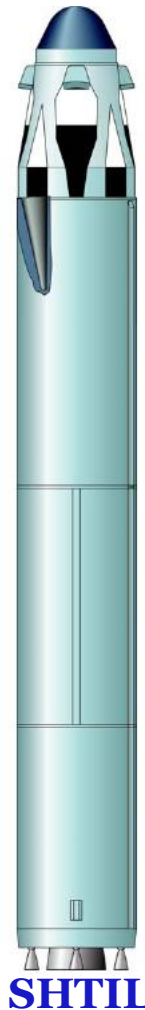
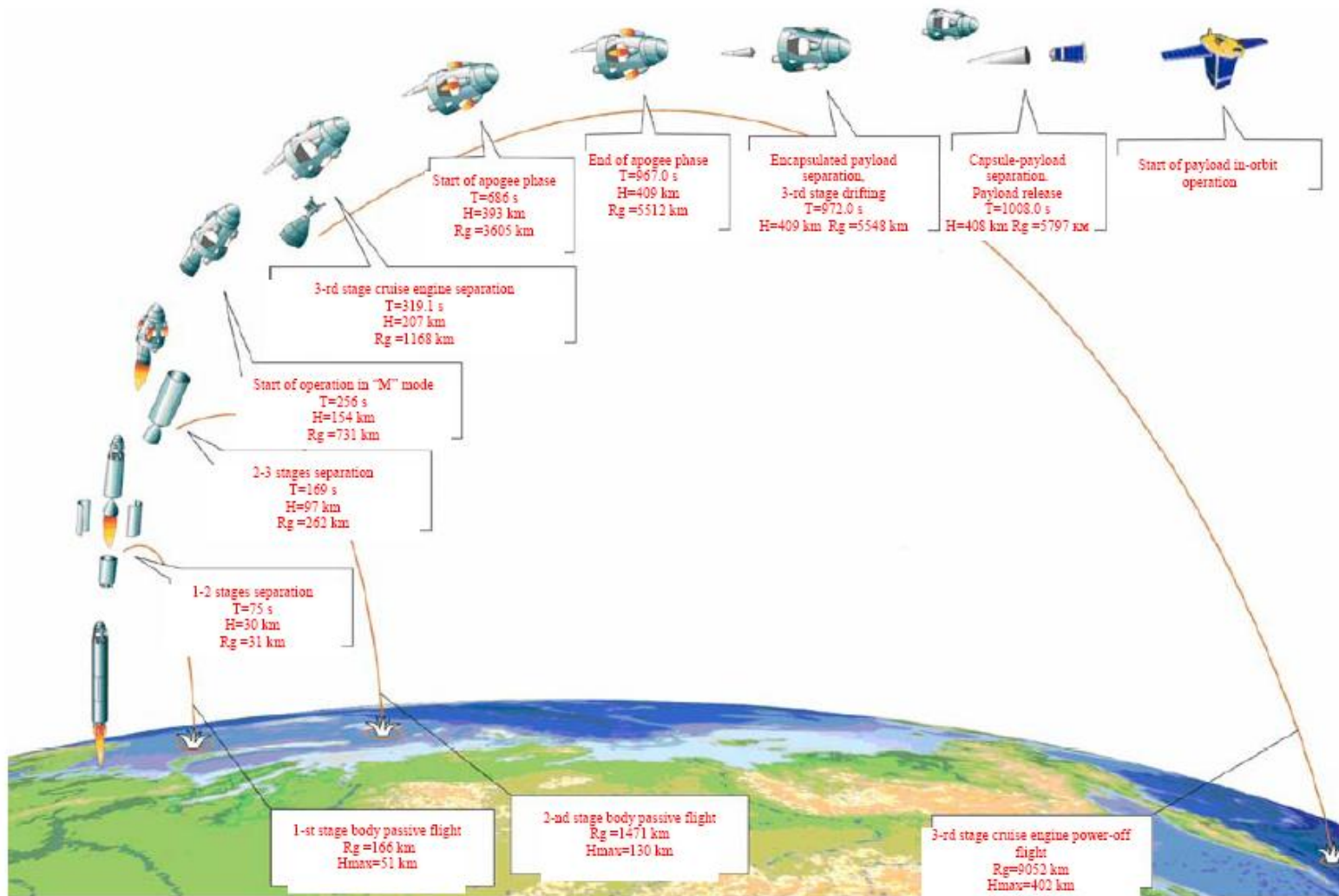
CubeSat Teams will:

- *Supply the required documentation in a timely manner*
- *Participate in major project reviews*
- *Support the test campaign (but not the launch campaign)*
- *Operate their CubeSats in orbit (expected lifetime is ~3 months)*
- *Provide calibrated science and selected housekeeping data to the QB50 Data Processing and Archiving Center at VKI*
- *Secure the funding for the development of their CubeSat*





QB50 – Launching & Deployment



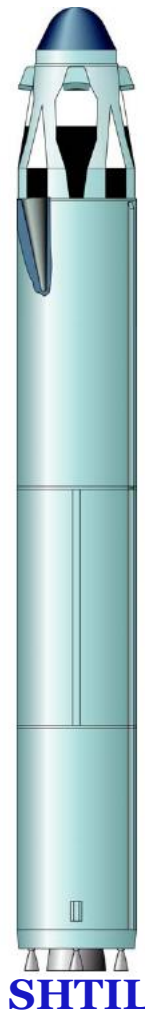
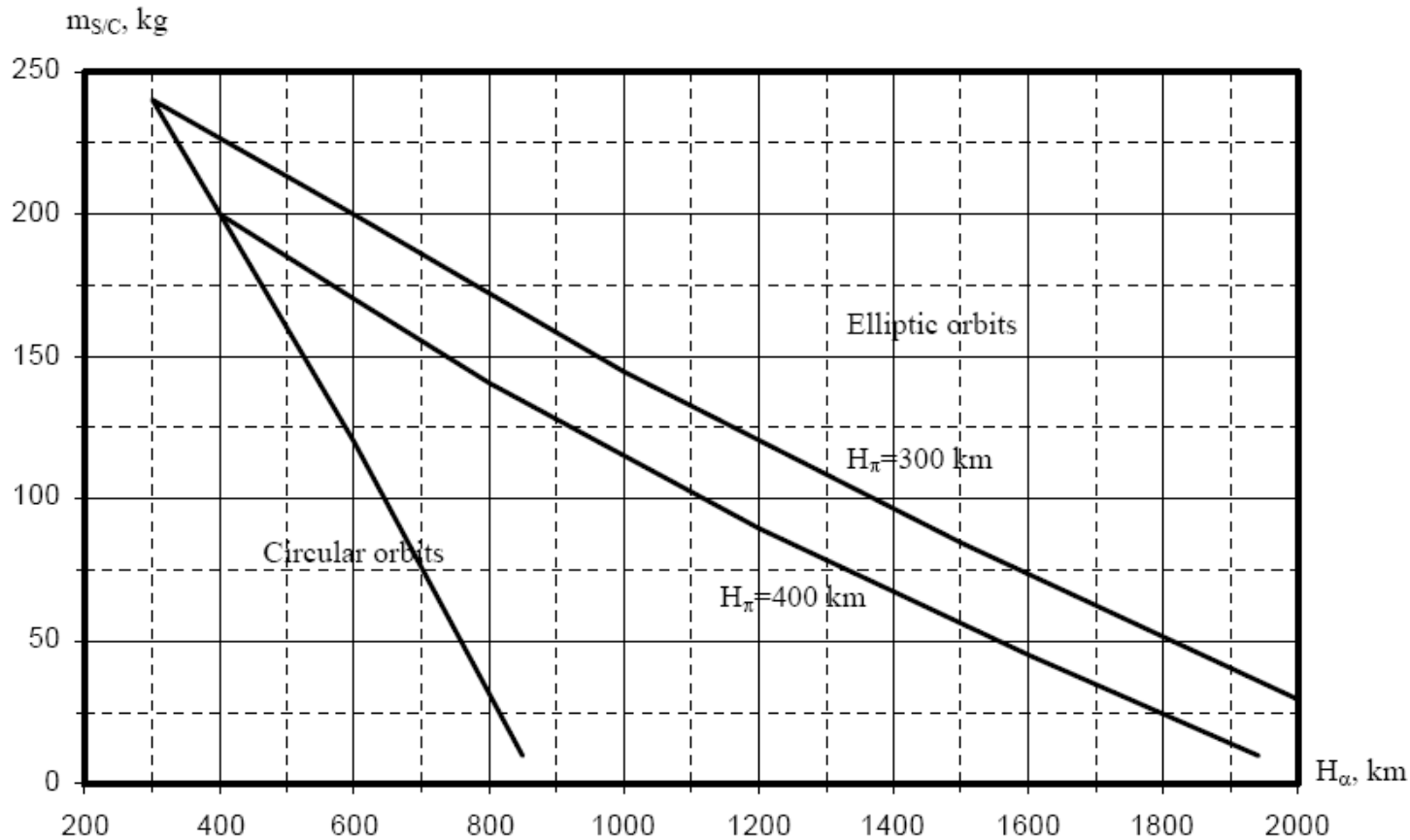
SHTIL





QB50 – Launching & Deployment

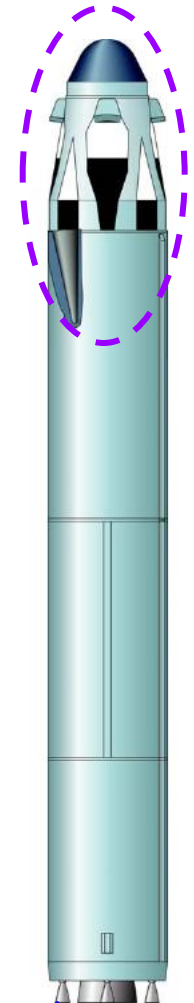
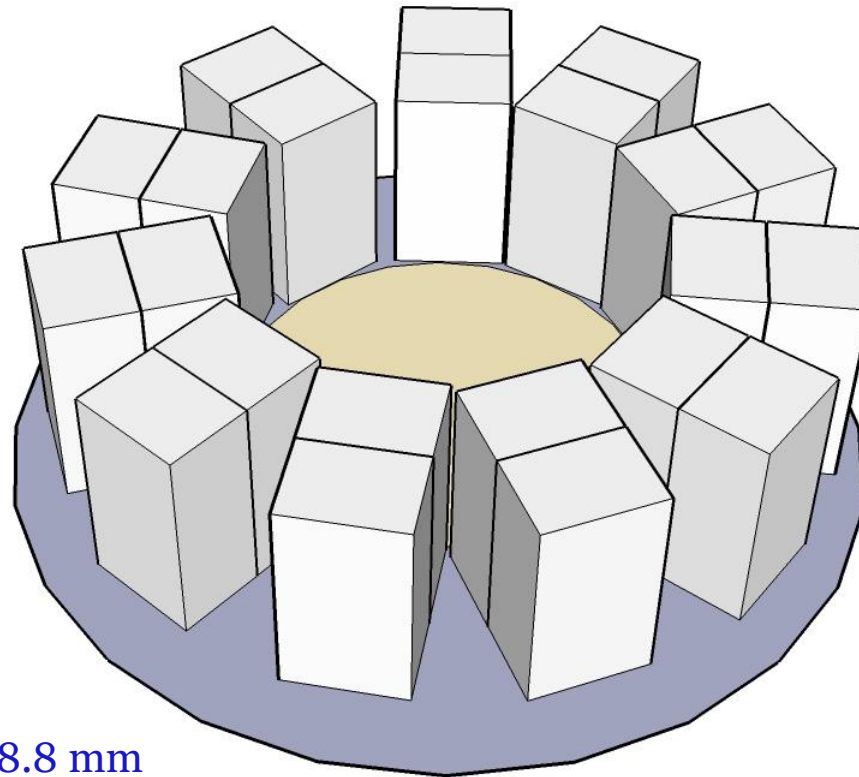
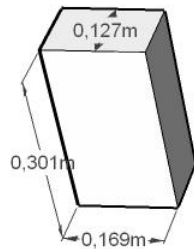
*The payload mass versus the altitude of an orbit inclined 78.9°
(above the mean Earth radius $R_{\text{mean}}=6371$ km)*



SHTIL



QB50 – Launching & Deployment Option 1



Deployer dimensions:

For a double CubeSat unit

Outside Envelope: 300.6 x 126.2 x 168.8 mm

Total Mass: 2kg + 1.7kg = 3.7kg

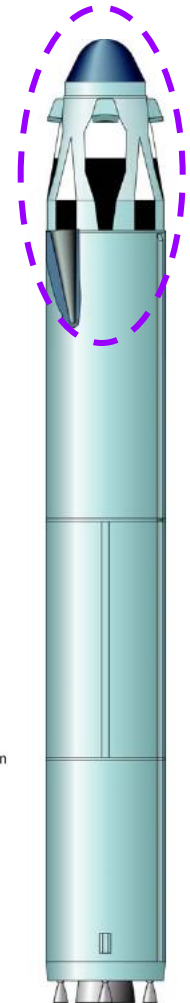
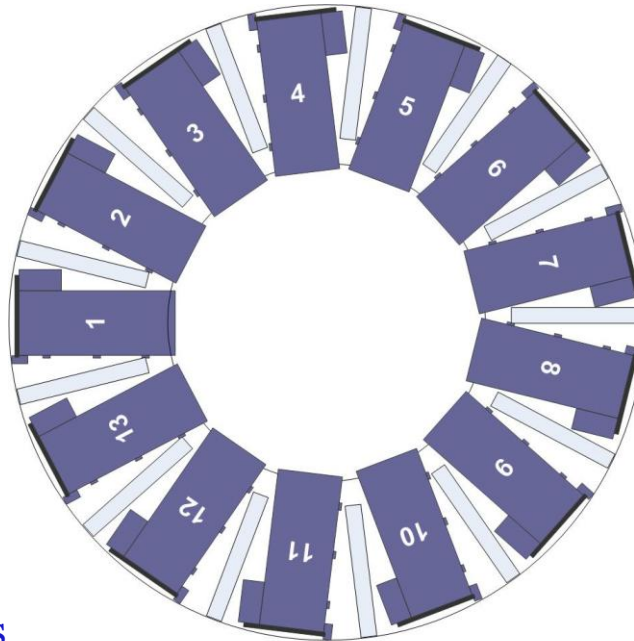
Platform 2 & 3:

22 CubeSats on one platform

The central 600mm diameter is for the engine



QB50 – Launching & Deployment Option 2

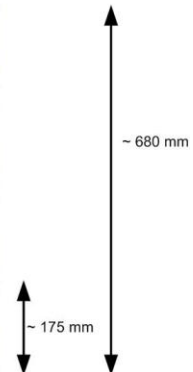
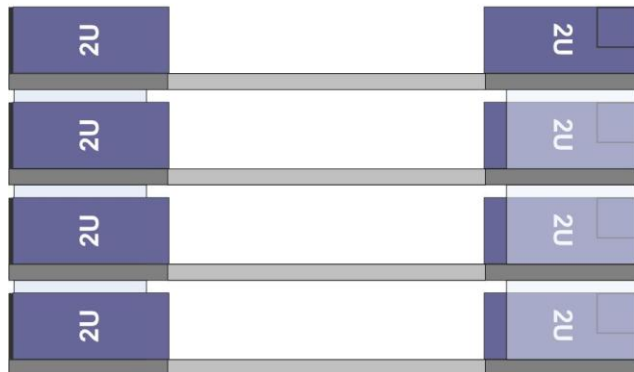


Alternative Radial Deployment:

13 deployers on each platform

50 deployers on four platforms

Possibility to deploy in different directions

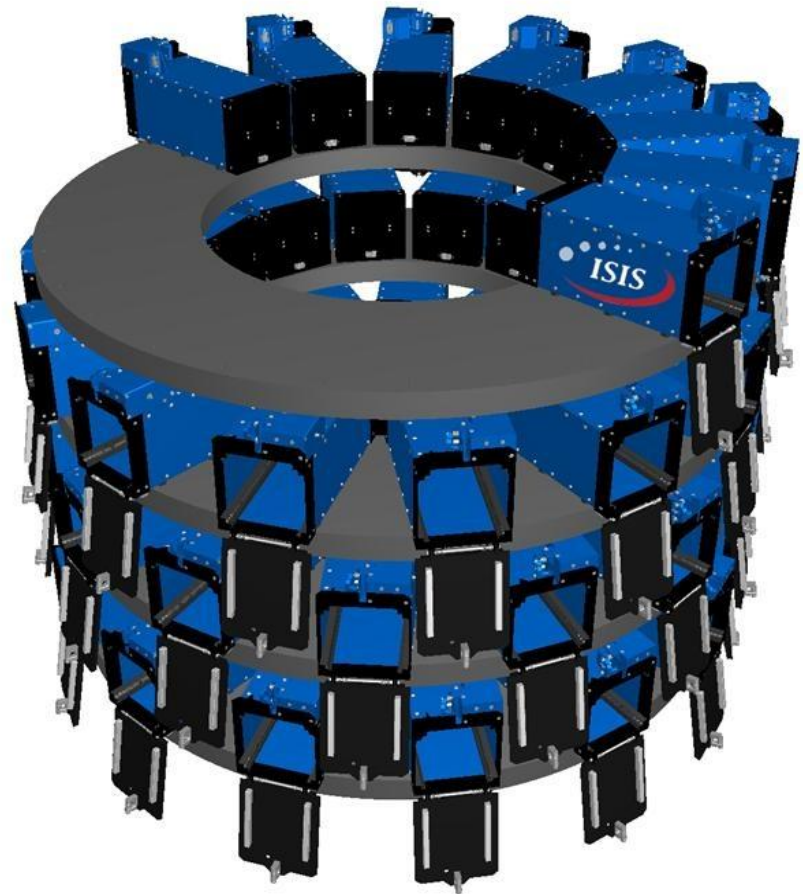


QB50 – Launching & Deployment Option 3



Radial Deployment:

14 2 Units ISIPODs for each platform
i.e. 3.5 platforms arranged so as to allow
adapter doors to be opened



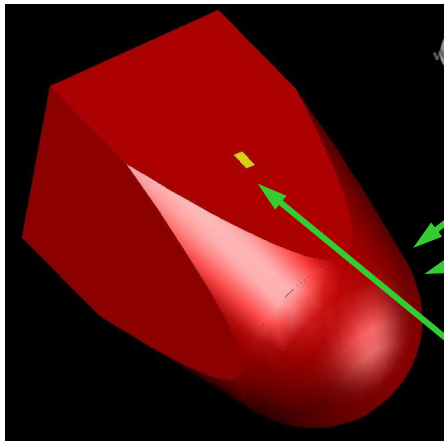


VKI ReEnt-Sat – Concept

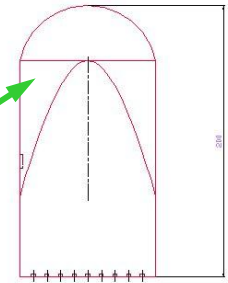
Atmospheric Re-Entry Flight Data

Flight data for Debris/Disintegration Tool (RAMSES) Validation

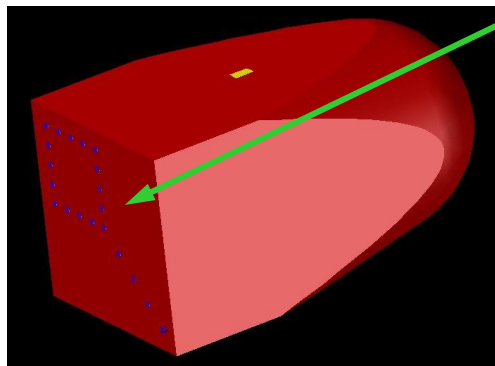
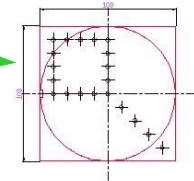
ReEnt-Sat to survive until ~70km (TBD) altitude



- Light ablative material as thermal shield
- Temperature & Pressure measurements on the thermal shield
- Skin friction measurements on the side



- Base flow measurements
- Materials experiment (tbc)
- Blackout experiment (tbc)



QB50 – von Karman Institute



The von Karman Institute for Fluid Dynamics (VKI) will provide:

- *Identification of the funding sources for the launch vehicle,*
- *Interface with launch vehicle authorities and launch campaign,*
- *Support to the selection of the standardized sensors for MLT and perform the CubeSAT re-entry research,*
- *Perform orbital dynamics sensitivity runs, and comparison of model predictions with actual CubeSat re-entry data,*
- *Provision of a CubeSat to the QB50 Network,*
- *Management of the QB50 Data Processing and Archiving Centre,*
- *Organization of a **QB50 Workshop on 17-18 November,***
- *Maintain QB50 website: **<http://www.vki.ac.be/QB50>***





QB50 – Schedule

Near-Term Schedule:

- *Letters of Intent (LoI) by interested CubeSat teams (5 received already)*

now to 1 Nov 2010

- *Call for CubeSat proposals, 15 Dec 2009*

- *Deadline for submission of proposals, 15 Jan 2010*

(~10 page proposal)

- *Selection of 50 CubeSats, 31 Jan 2010*

(plus 5 back-up CubeSats)

- *QB50 Project Kick-Off Meeting at VKI 4 May 2010*

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Goal:

- *Launch of 50 CubeSats End 2011-Mid 2012*



WORKSHOP

17-18 Nov 2009

www.vki.ac.be/QB50

**For Info please
contact
VKI
Jean Muylaert**



*von Karman Institute
for Fluid Dynamics*



QB50

An international network of 50 CubeSats in low-Earth orbits for lower thermosphere and re-entry research

17 – 18 November 2009
von Karman Institute for Fluid Dynamics
Sint-Genesius-Rode (Brussels), Belgium

QB50 is envisaged as a network of 50 double CubeSats provided by European, US, Canadian and Japanese universities carrying identical sensors for in-situ measurements in the largely unexplored lower thermosphere (90-300 km)

For information on the programme (Invited Papers only), accommodation, online registration, etc. see <http://www.vki.ac.be/QB50>
The participation is restricted to 120 persons, participation by invitation only

Topics

- Atmospheric composition and models
- CubeSat orbital dynamics
- Sensors for in-situ measurements by CubeSats
- Remote-sensing observations by satellites in higher orbits
- Sounding rocket in-situ measurements in the MLT region
- Ground-based lidar and radar remote-sensing observations of the MLT region
- Future CubeSat technologies
- CubeSat deployers
- GENSO ground station network
- QB50 implementation

Scientific Programme Committee

- J.-M. Buchlin (chair)
- M. Drinkwater (TBC)
- D. Fussen (TBC)
- E. Gill
- F.J. Lübken (TBC)
- J. Muylaert
- S. Nakasuka (TBC)
- M. Noca (TBC)
- R. Reinhard
- T. Sarris (TBC)
- K. Schilling (TBC)
- C. Stavrinos
- R. Twiggs (TBC)
- P. Worden (TBC)