

QB50 Project Status and Ground Segment

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ITU Symposium and Workshop on small satellite
regulation and communication systems

Prague, Czech Republic

02-04/03/2015



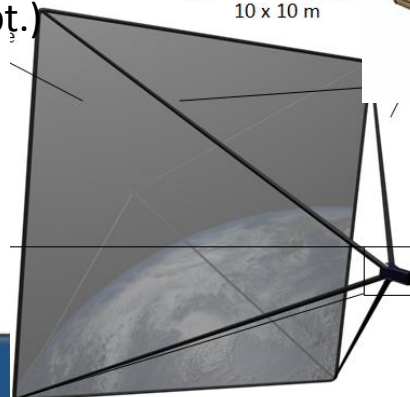
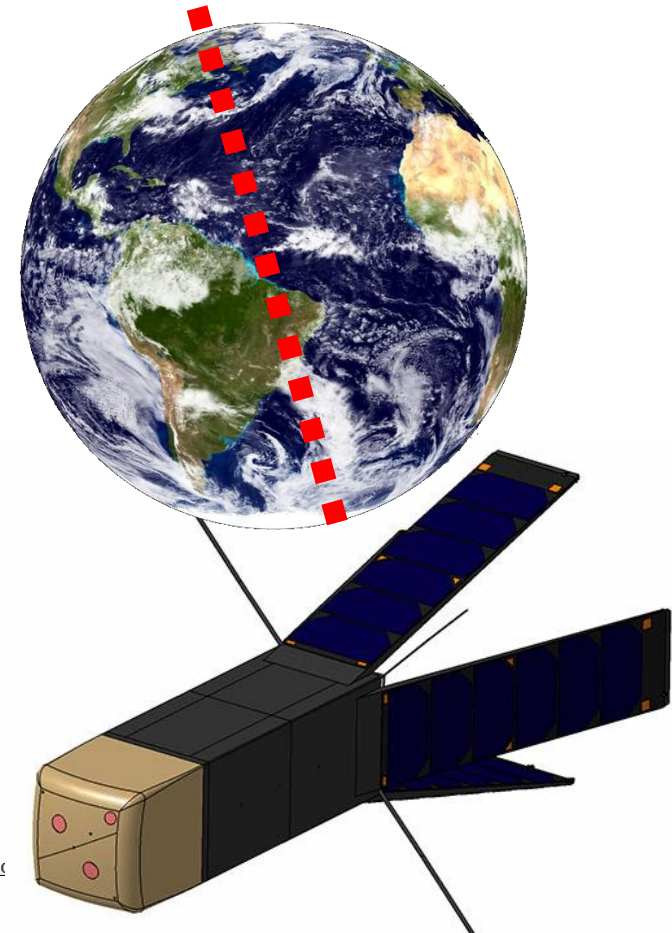
von Karman Institute



Overview

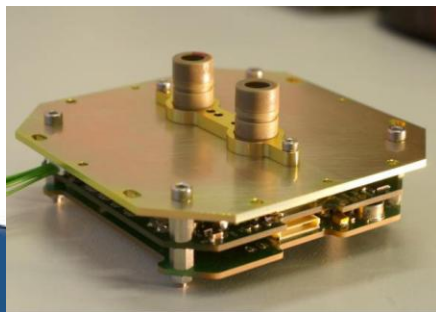
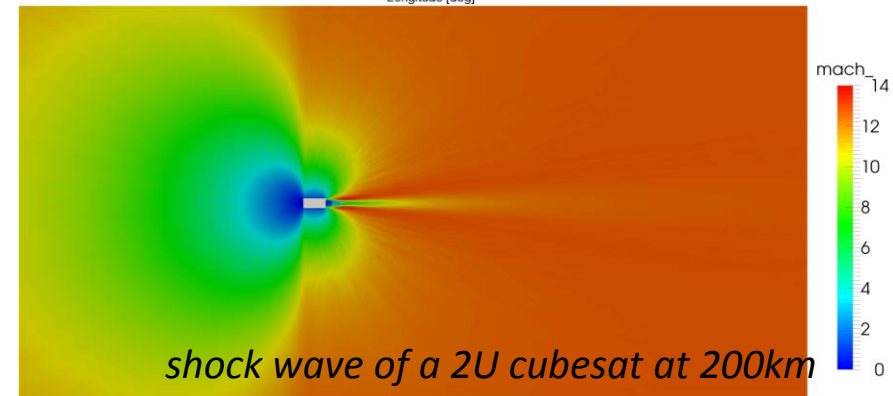
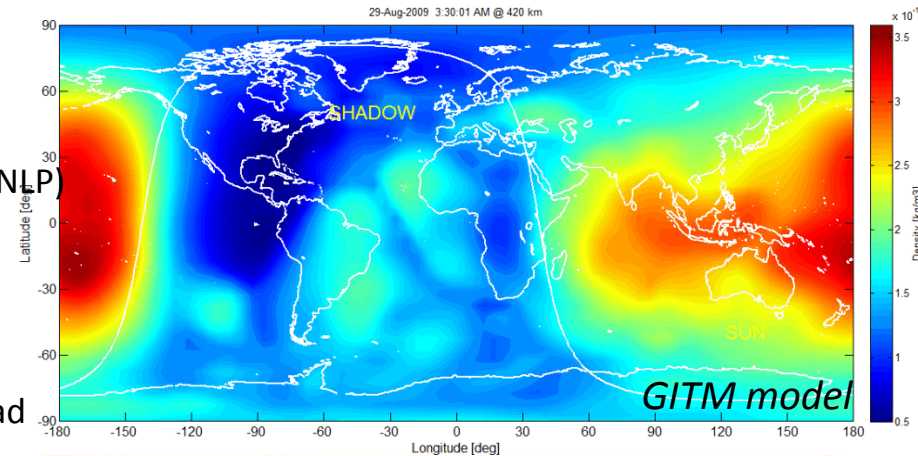
QB50

- will send 50 double CubeSats into LEO
 - 400 km, 98 deg
 - End of 02/2016
- carry out an unprecedented science campaign to probe the middle and lower thermosphere with
 - distributed sensors on 43 satellites
 - of 3 different types:
 - Ion and Neutral Mass Spectrometer (INMS)
 - AO and O2 sensor (FIPEX)
 - Langmuir Probe (MNLP)
- supports teams with
 - provision of Sensor Units and ADCS
 - provision of satellite control software (opt.)
 - guidance on satellite design
- Carries out a test flight in June 2014

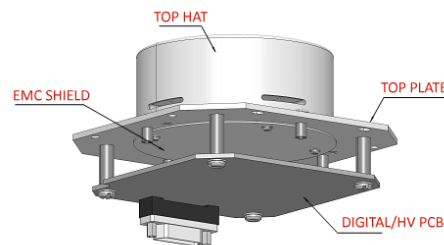


Science, Sensor Units

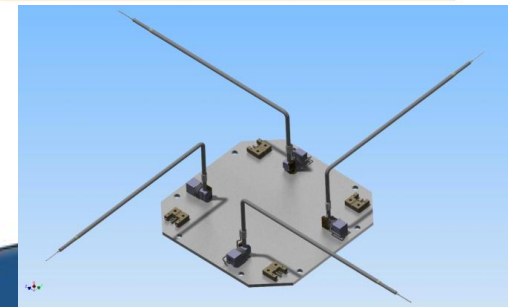
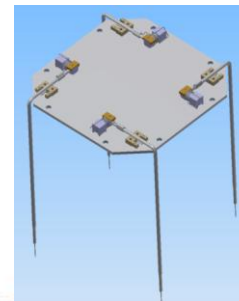
- objectives: improve thermosphere modeling
- sensor means: ~ 43 distributed sensors
 - 19 AO, O2: FIPEX
 - 11 electron density: multi Needle Langmuir probes (MNL P)
 - 13 ion and neutral mass spectrometers (INMS)
- science team:
 - Mullard Space Science Laboratory (MSSL, UK)
 - ->sensor Development/Procurement, Science Lead
 - von Karman Institute (VKI, B)
 - ->sensor output predictions
 - Institute for Atmospheric Physics (IAP)
 - ->ground based sensors
- key requirement on science CubeSats:
 - acquire and downlink 2Mbit/day for 60 days
 - baseline operations: poles and equator



FIPEX (TU-Dresden, D),



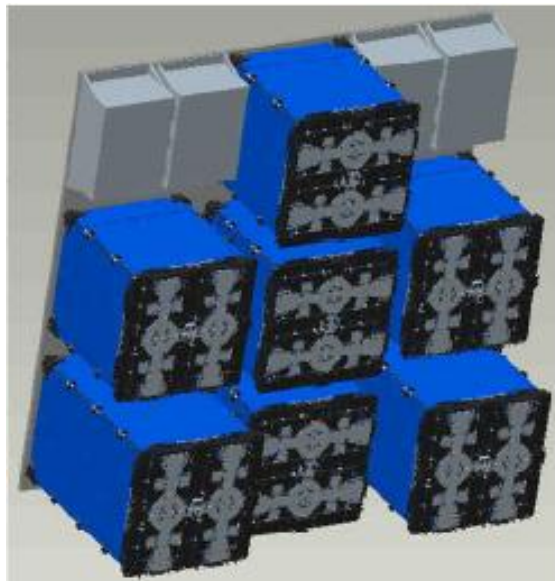
INMS (MSSL, UK),



Langmuir Probe, stowed, deployed (UiO, Norway)

Launch Segment

- deployment system made of versatile QuadPack modules, designed and manufactured by ISIS B.V., NL
- launch will take place February 2016
- unprecedented launch campaign
- orbit:
 - 400 km altitude
 - 98 deg inclination
 - LTAN: 6 am



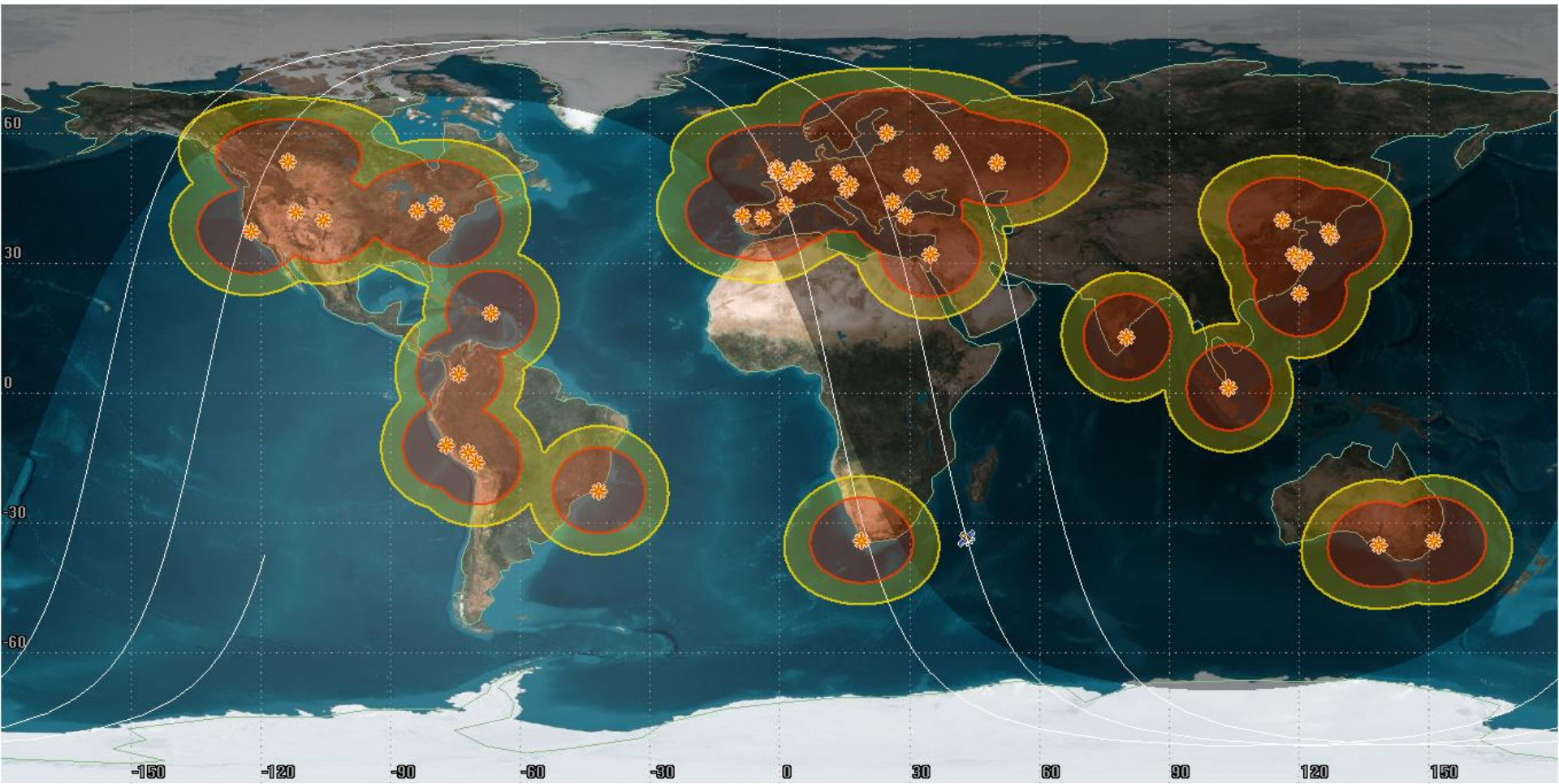
Ground Segment

QB50 Ground Segment

- consists of
 - 50 amateur ground stations located at the QB50 team premises
 - DPAC server: Central functions for TLE distribution, Science Data collection and WOD storage, Archiving
 - Radio Amateurs collaboration (frequency spectrum and ground stations)
- dissemination via Data Processing & Archiving Centre (DPAC)
- passed CDR review carried out by
 - DLR/GSOC
 - Morehead State University
- assisting in early discrimination of the 50 CubeSats



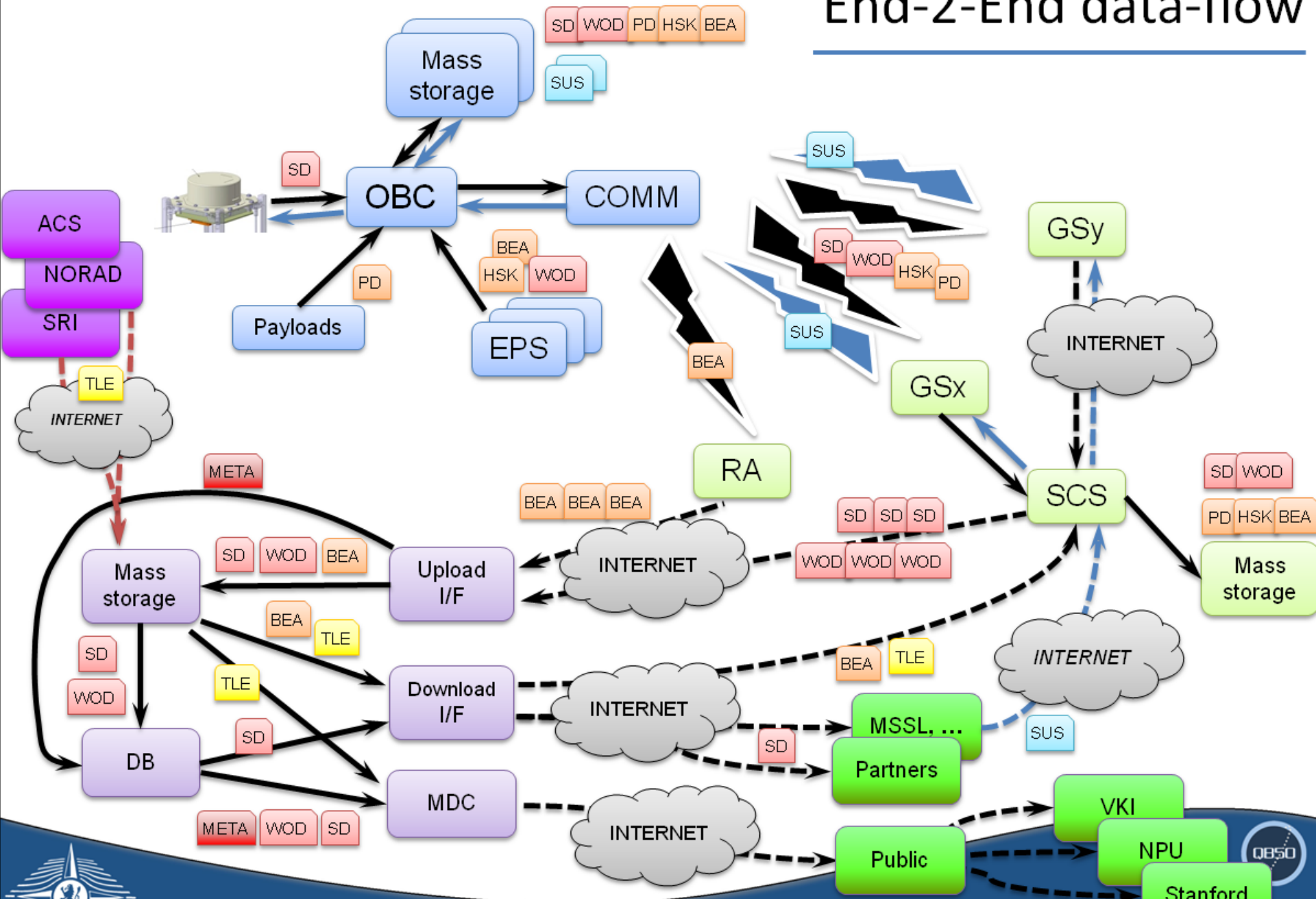
Distribution and Coverage



Distribution of ground station and coverage for 380 and 200 km altitude



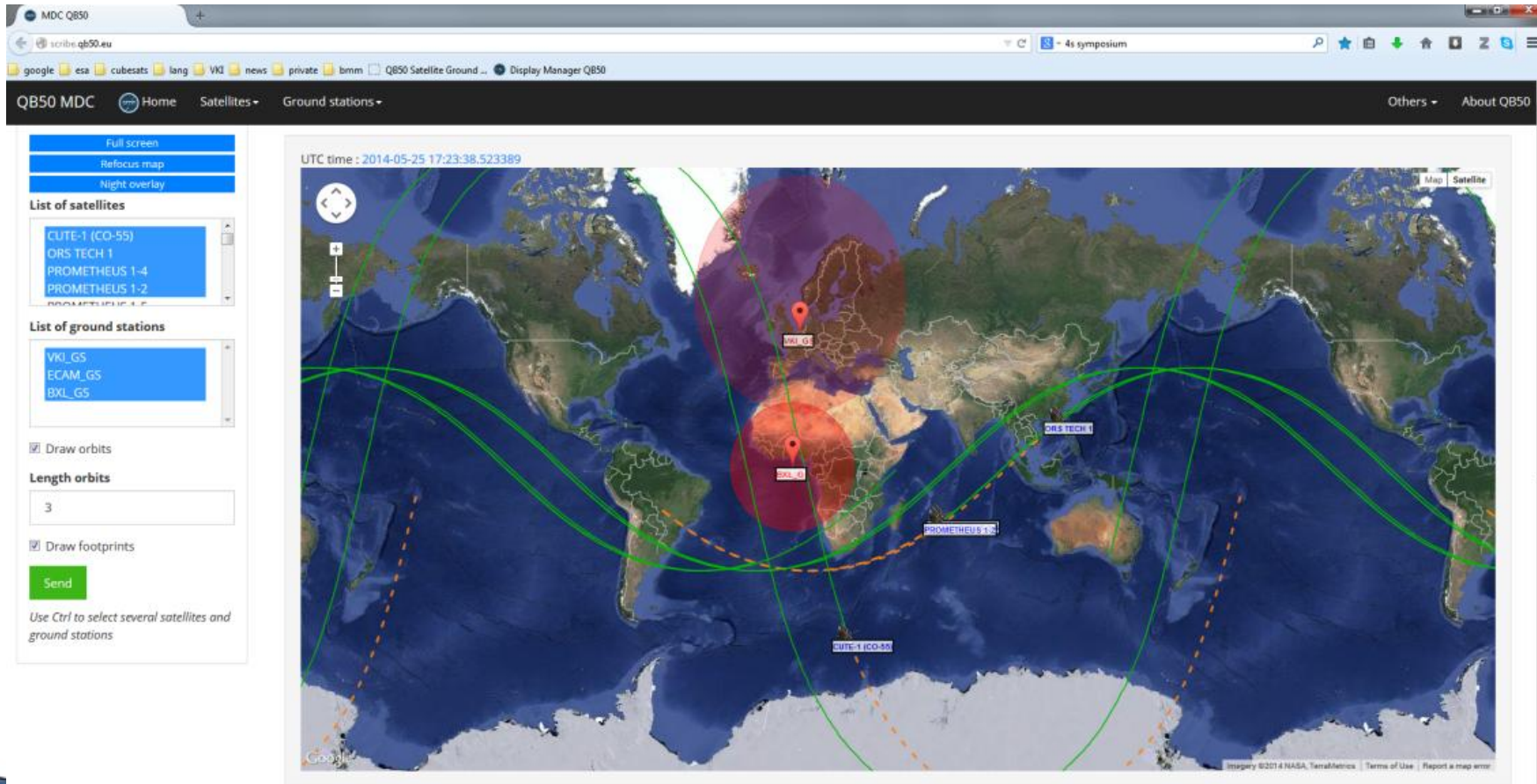
End-2-End data-flow



DPAC overview

Data Processing/Archiving Center

- Web-based application for universal/simple access
- Display satellite positions and potential ground stations



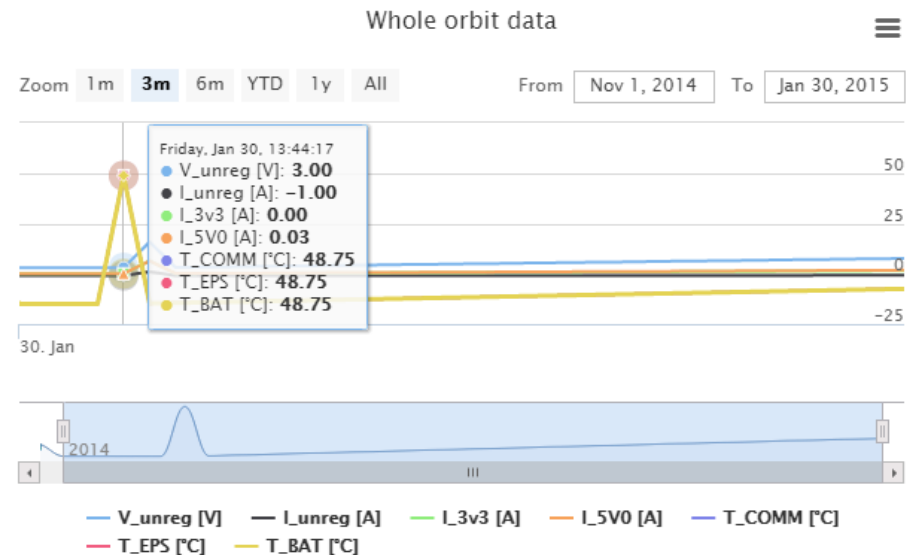
DPAC overview

Data Processing/Archiving Center

- Web-based application for universal/simple access
- Display satellite positions and potential ground stations
- Display of CubeSat status and detailed information
 - University and operator details
 - RF Frequencies and beacon format description
 - Dissemination of received WOD

Whole Orbit Data last 3 wod

Uploaded [UTC]	Jan. 30, 2015, 1:45 p.m.	Jan. 30, 2015, 1:45 p.m.	Jan. 30, 2015, 1:45 p.m.
Timestamp [UTC]	Jan. 30, 2015, 1:44 p.m.	Jan. 30, 2015, 1:44 p.m.	Jan. 30, 2015, 1:44 p.m.
SU status	Non operational	Non operational	Non operational
V_unreg [V]	7.600	7.400	7.300
I_unreg [A]	-0.811	-0.811	-0.827
I_3V3 [A]	1.450	1.400	1.350
I_5V0 [A]	1.775	1.700	1.675
T_COMM [°C]	-7.500	-7.750	-8.000
T_EPS [°C]	-7.500	-7.750	-8.000
T_BAT [°C]	-7.500	-7.750	-8.000



DPAC overview

Data Processing/Archiving Center

- Web-based application for universal/simple access
- Display satellite positions and potential ground stations
- Display of CubeSat status and detailed information
 - University and operator details
 - RF Frequencies and beacon format description
 - Dissemination of received WOD
- Display of registered ground stations and pass propagation
- Upload/Download interface for QB50 teams/RA



QB50 file upload

Please fill the following formular and specify the file containing the packets with the selected type. The file layout and the upload interface is explained briefly [here](#).
Please note, that The filesize is limited to maximum **1MB**

File for upload: No file chosen

File content: ▾

CubeSat: ▾

Time of pass begin (UTC):

Checksum (md5,opt.):

Registration and freq. filing

VKI follow-up with the legal obligations

- CubeSats are registered as Belgium satellites
- IARU (RA spectrum usage):
 - Collaboration with RA on QB50 precursor satellites (AMSAT-FR/NL)
 - Coordination of frequencies together with IARU supported by AMSAT-UK
- ITU (combined filing performed by VKI via Belgium BIPT)
 - Notification of local administrations about proposed filing of the satellites
 - Preparation of the API's for all CubeSats (currently on-going)
 - CR/notification after integration/shipping to launch site
 - Exceptions:
 - CubeSats with non-RA bands
 - teams where local administrations rejected

Successful ITU filing (API) to be checked at FRR by QB50

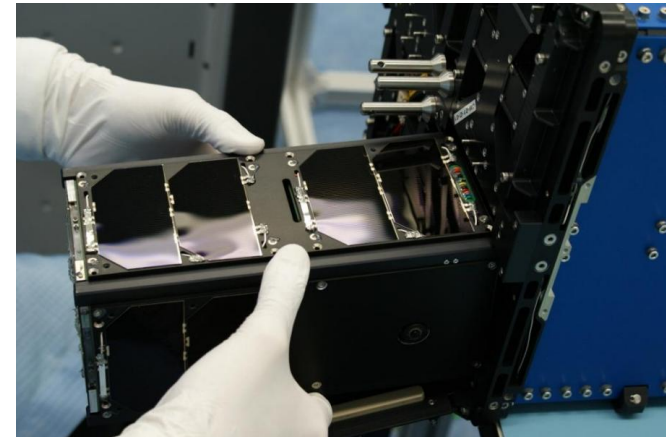
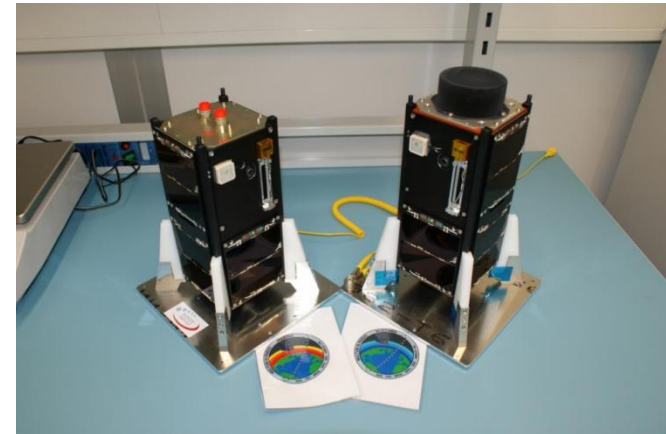
- Processes verified using QB50 precursor campaign



Precursor Derisking Campaign

in less than 12 months:

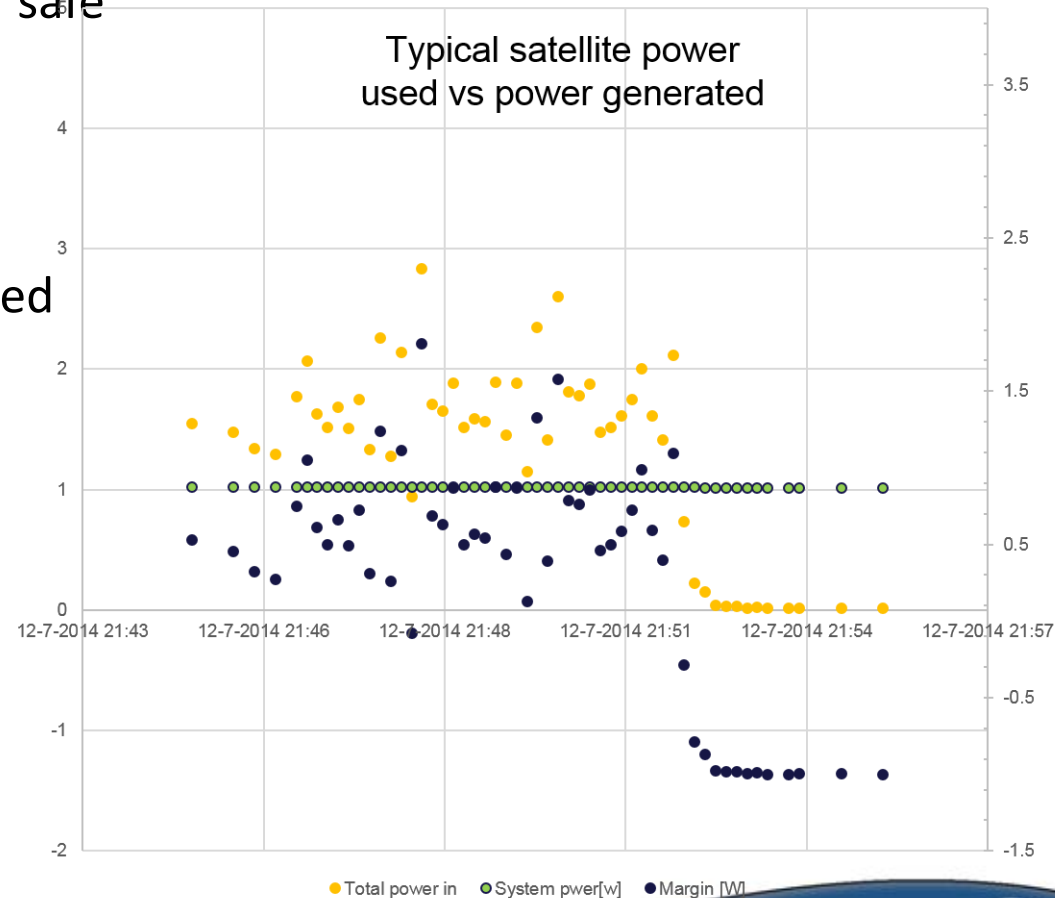
- consortium and collaborators management
- subsystems definition, design, manufacturing:
 - INMS, FIPEX (MSSL, TU-Dresden)
 - ADCS (SSC)
 - thermal payload and thermal analysis (VKI)
 - communication payloads (AMSAT)
- satellite design, assembly and management (ISIS)
- frequency allocation and space object registration (VKI)



Precursor Derisking Campaign

Current status:

- Beacon of P1/P2 received ~10min after launch
- CubeSats are thermal and power safe
- Recovered from tumbling rates up to $30^\circ/\text{s}$
- OBC software in-flight updated
- Commissioning of ADCS performed (MTQ and reaction wheel)
- Currently on-going: SU
 - current draws/in-rush
 - HSK/STM packets received
 - Science data from instrument
- Afterwards hand-over to AMSAT with enabling of transponders



Precursor Derisking Campaign

- Beacon format and transponder information

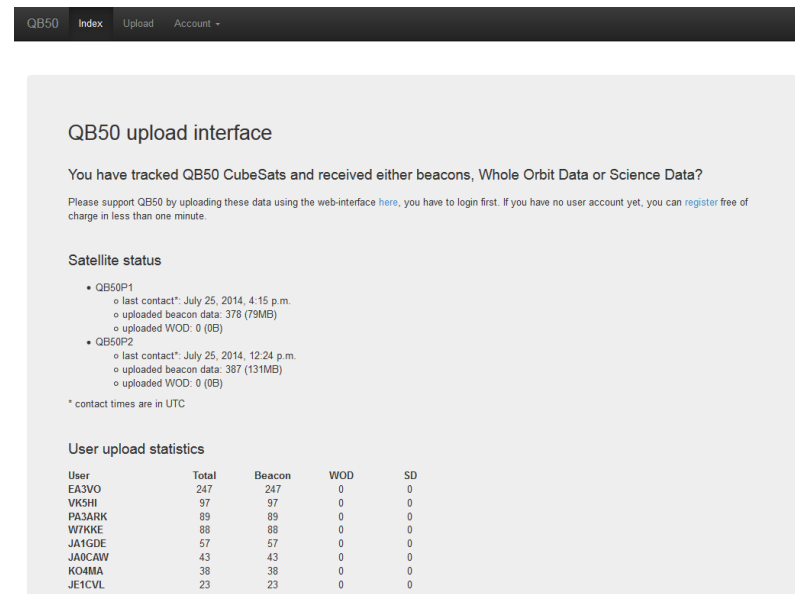
<https://qb50.eu/index.php/precursor-amateur-radio-operator>

- Upload interface for radio amateur participation

<https://upload.qb50.eu/>

- Received over >350 MB beacon data
- Bugs & questions: scholz@vki.ac.be

Your help & support is appreciated!



QB50 Index Upload Account

QB50 upload interface

You have tracked QB50 CubeSats and received either beacons, Whole Orbit Data or Science Data?

Please support QB50 by uploading these data using the web-interface [here](#), you have to login first. If you have no user account yet, you can [register](#) free of charge in less than one minute.

Satellite status

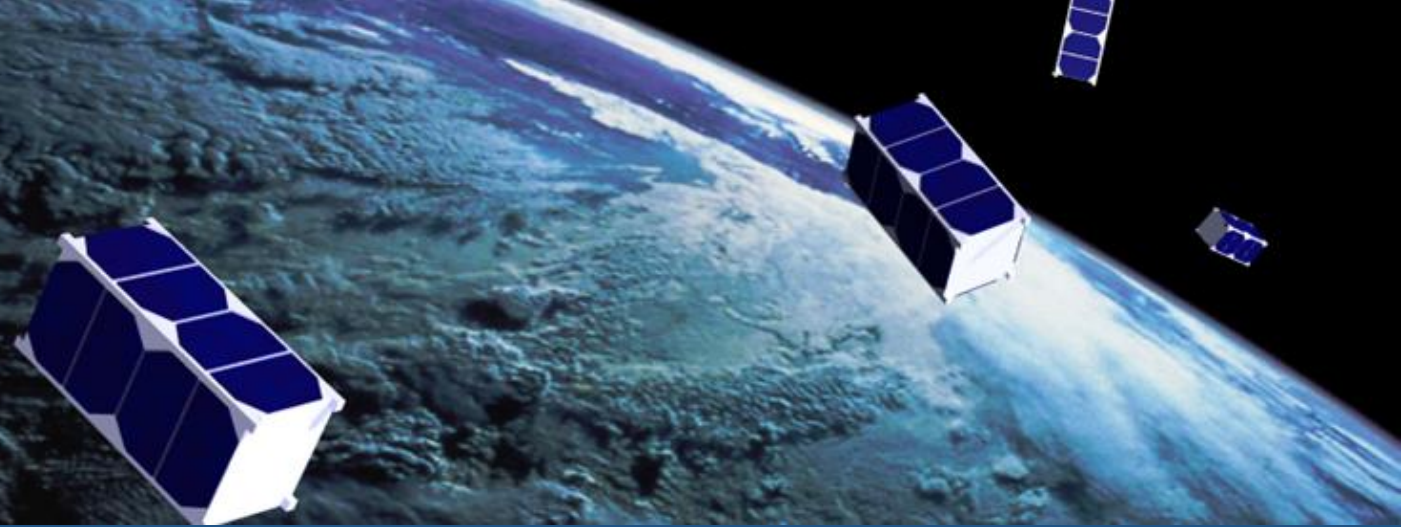
- QB50P1
 - last contact*: July 25, 2014, 4:15 p.m.
 - uploaded beacon data: 378 (79MB)
 - uploaded WOD: 0 (0B)
- QB50P2
 - last contact*: July 25, 2014, 12:24 p.m.
 - uploaded beacon data: 387 (131MB)
 - uploaded WOD: 0 (0B)

* contact times are in UTC

User upload statistics

User	Total	Beacon	WOD	SD
EASVO	247	247	0	0
VKSH	97	97	0	0
PA3ARK	89	89	0	0
W7KKE	88	88	0	0
JA1GDE	57	57	0	0
JA0CAW	43	43	0	0
K0MMA	38	38	0	0
JE1CVL	23	23	0	0
W2CVL	19	19	0	0





Thank you for your interest.
Do you have any questions?

7th EUROPEAN CUBESAT SYMPOSIUM

Liège, Belgium

9-11 September 2015

<http://www.cubesatsymposium.eu>

9th QB50 WORKSHOP

Liège, Belgium

8 September 2015

(by invitation only)



VON KARMAN INSTITUTE
FOR FLUID DYNAMICS



Université
de Liège

QB50 Consortium



QB50 is an European FP7 Project for Facilitating Access to Space



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