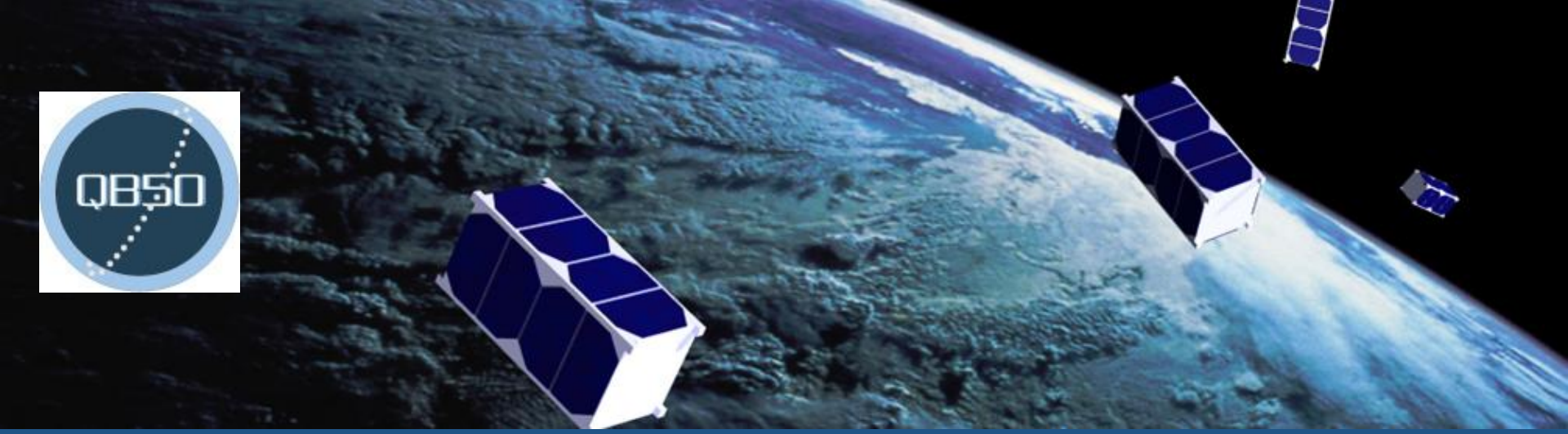


QB50 Project Status and Ground Segment

Thorsten Scholz
(von Karman Institute, Belgium)

ITU Symposium and Workshop on small satellite regulation and communication systems
Prague, Czech Republic
02-04/03/2015

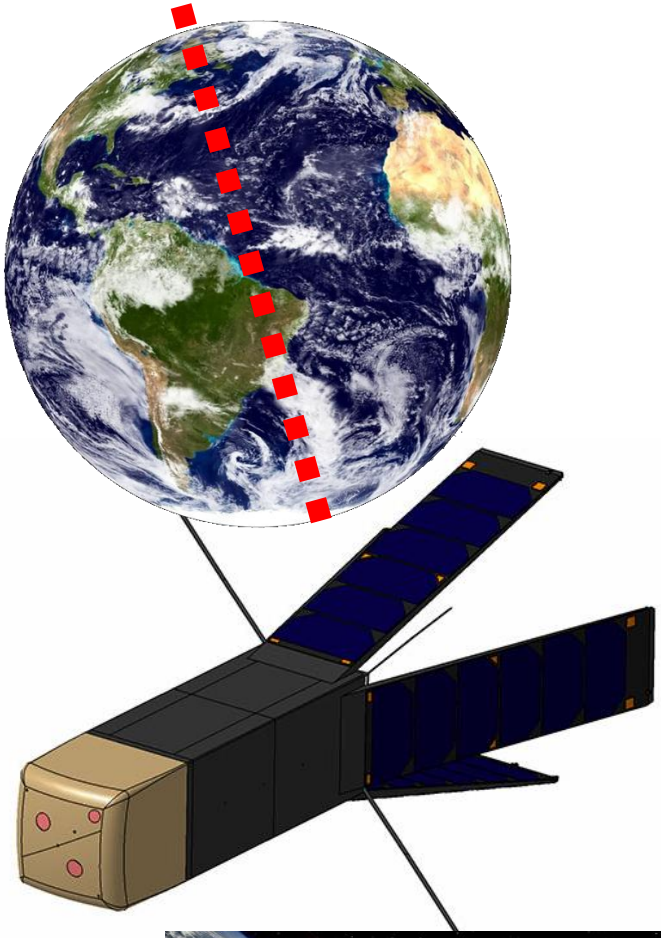
von Karman Institute

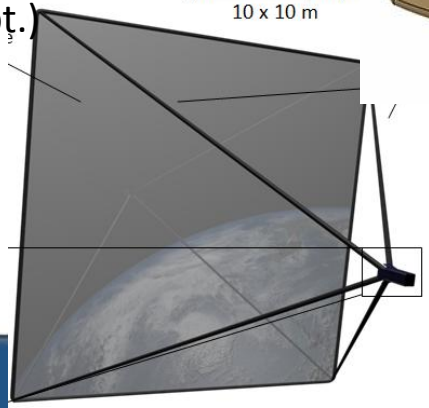
SEVENTH FRAMEWORK PROGRAMME

Overview

QB50

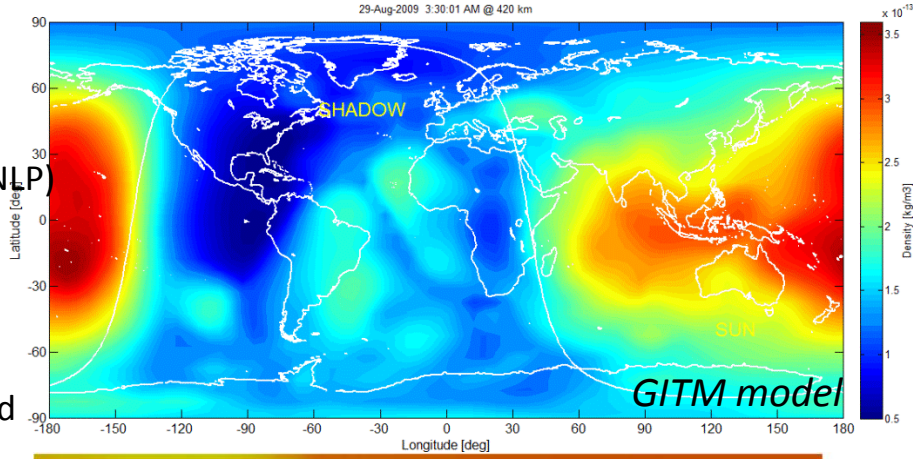
- will send 50 double CubeSats into LEO
  - 400 km, 98 deg
  - End of 02/2016
- carry out an unprecedented science campaign to probe the middle and lower thermosphere with
  - distributed sensors on 43 satellites
  - of 3 different types:
    - Ion and Neutral Mass Spectrometer (INMS)
    - AO and O2 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

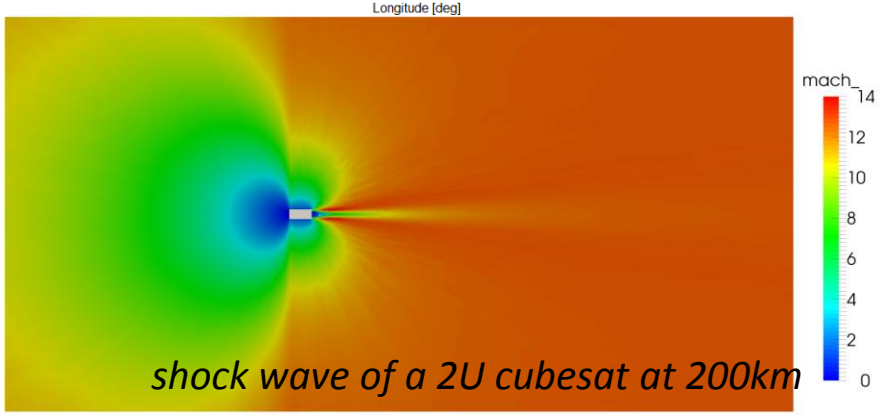


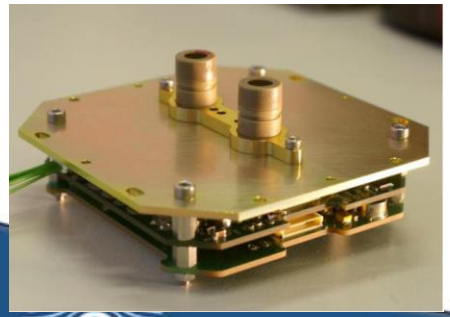


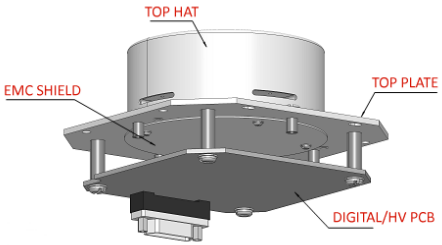
Science, Sensor Units

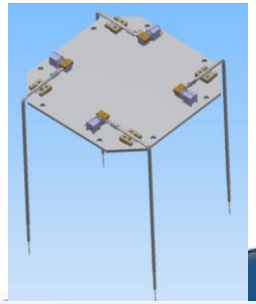
- objectives: improve thermosphere modeling
- sensor means: ~ 43 distributed sensors
  - 19 AO, O2: FIPEX
  - 11 electron density: multi Needle Langmuir probes (MNLP)
  - 13 ion and neutral mass spectrometers (INMS)
- science team:
  - Mullard Space Science Laboratory (MSSL, UK)
    - ->sensor Development/Procurement, 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

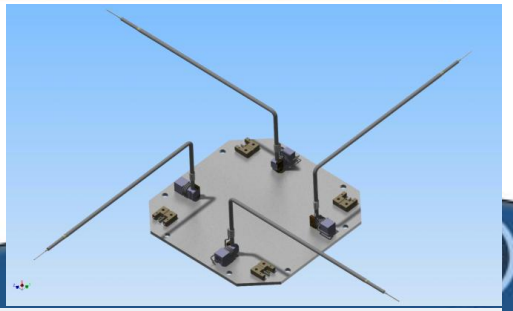








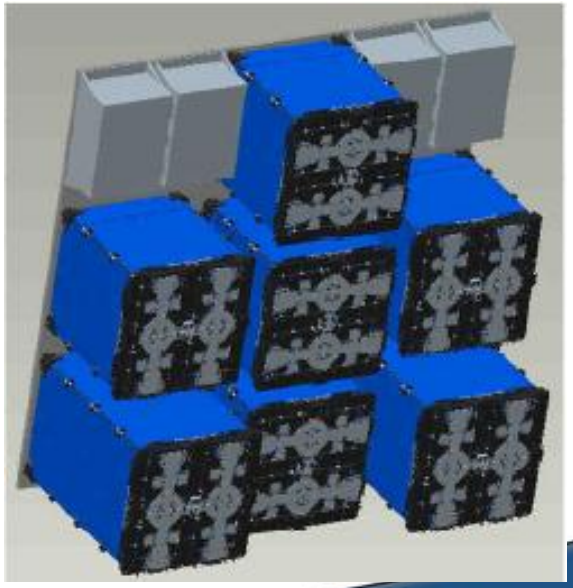


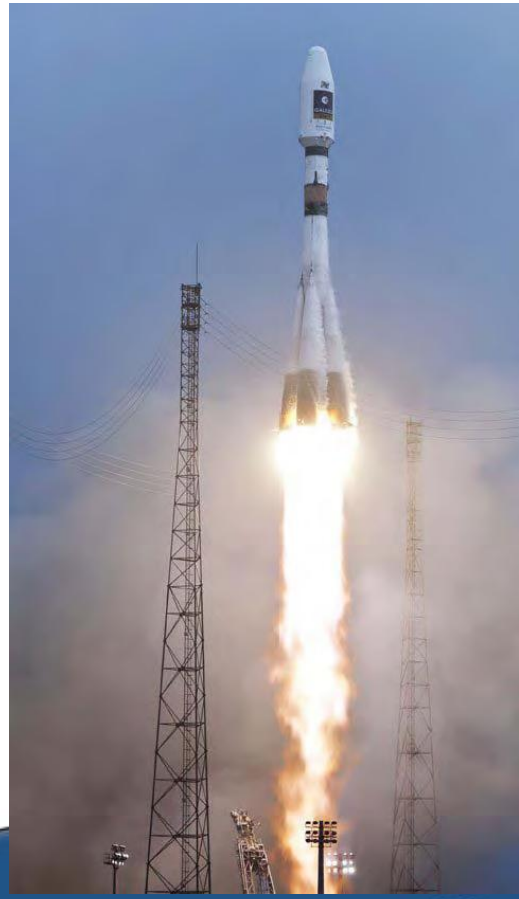


FIPEX (TU-Dresden, D), INMS (MSSL, UK), Langmuir Probe, stowed, deployed (UiO, Norway)

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



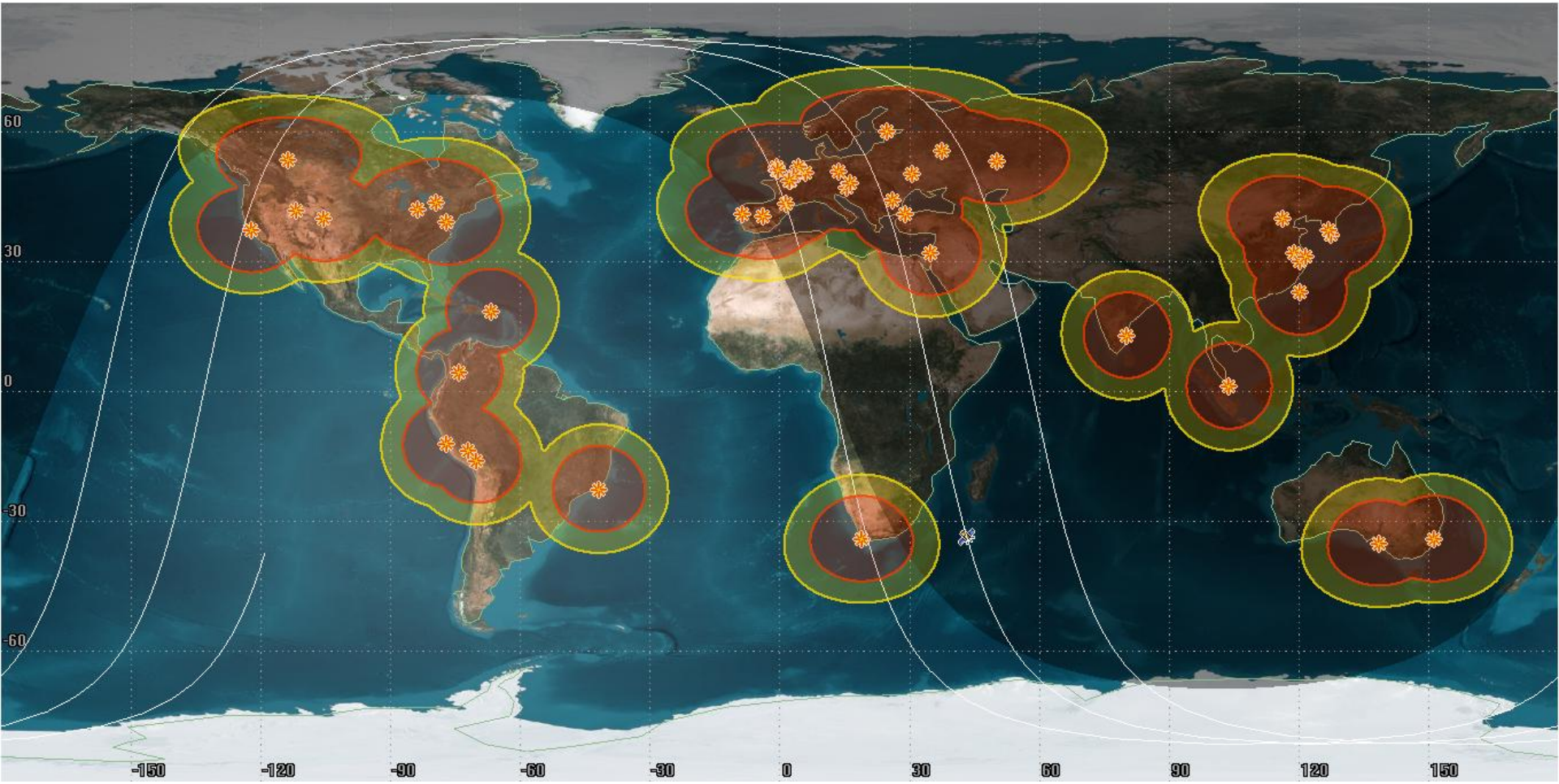


Ground Segment

QB50 Ground Segment

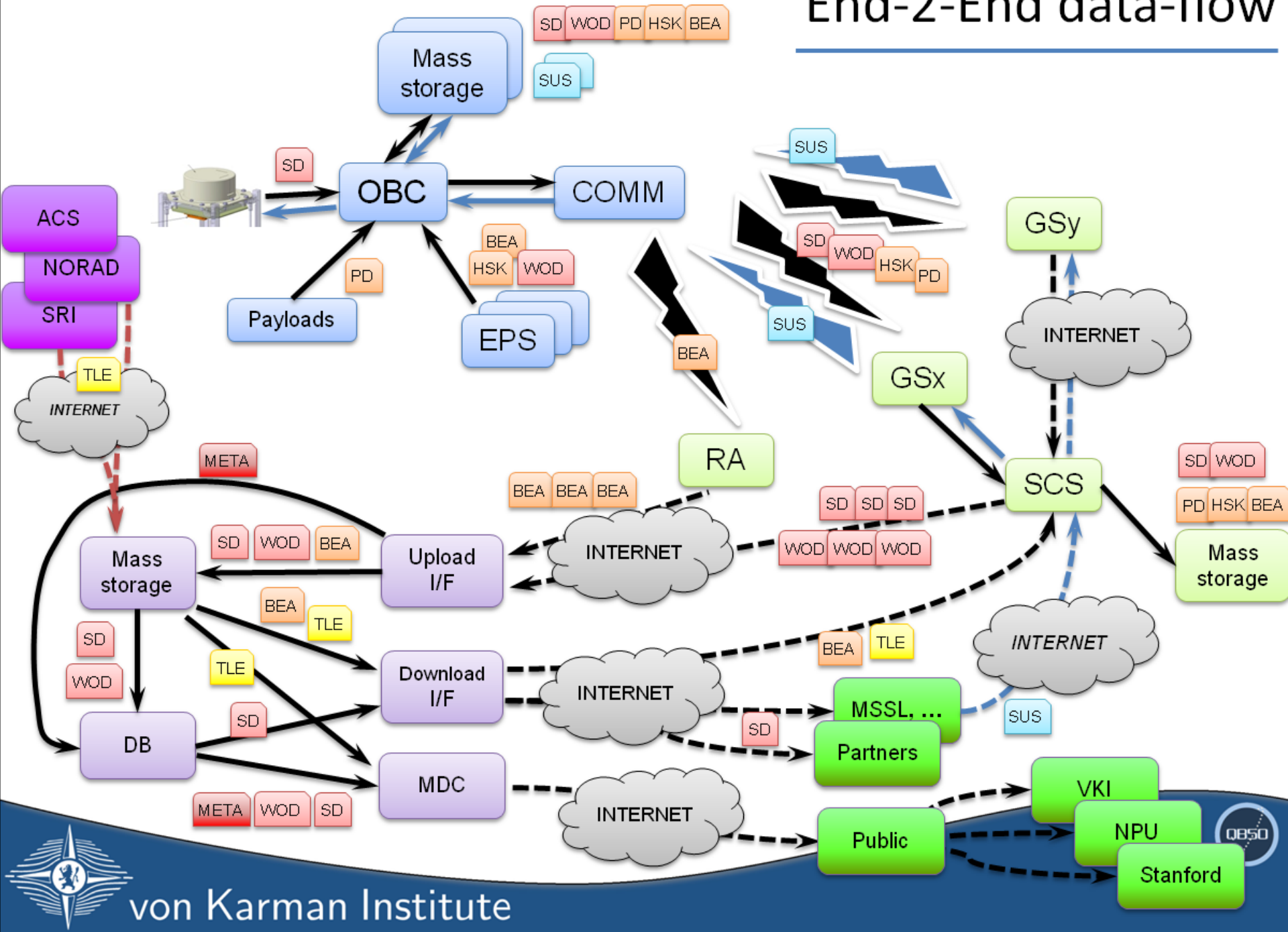
- consists of
  - 50 amateur ground stations located at the QB50 team premises
  - DPAC server: Central functions for TLE distribution, Science Data collection and WOD storage, Archiving
  - Radio Amateurs collaboration (frequency spectrum and ground stations)
- dissemination via Data Processing & Archiving 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

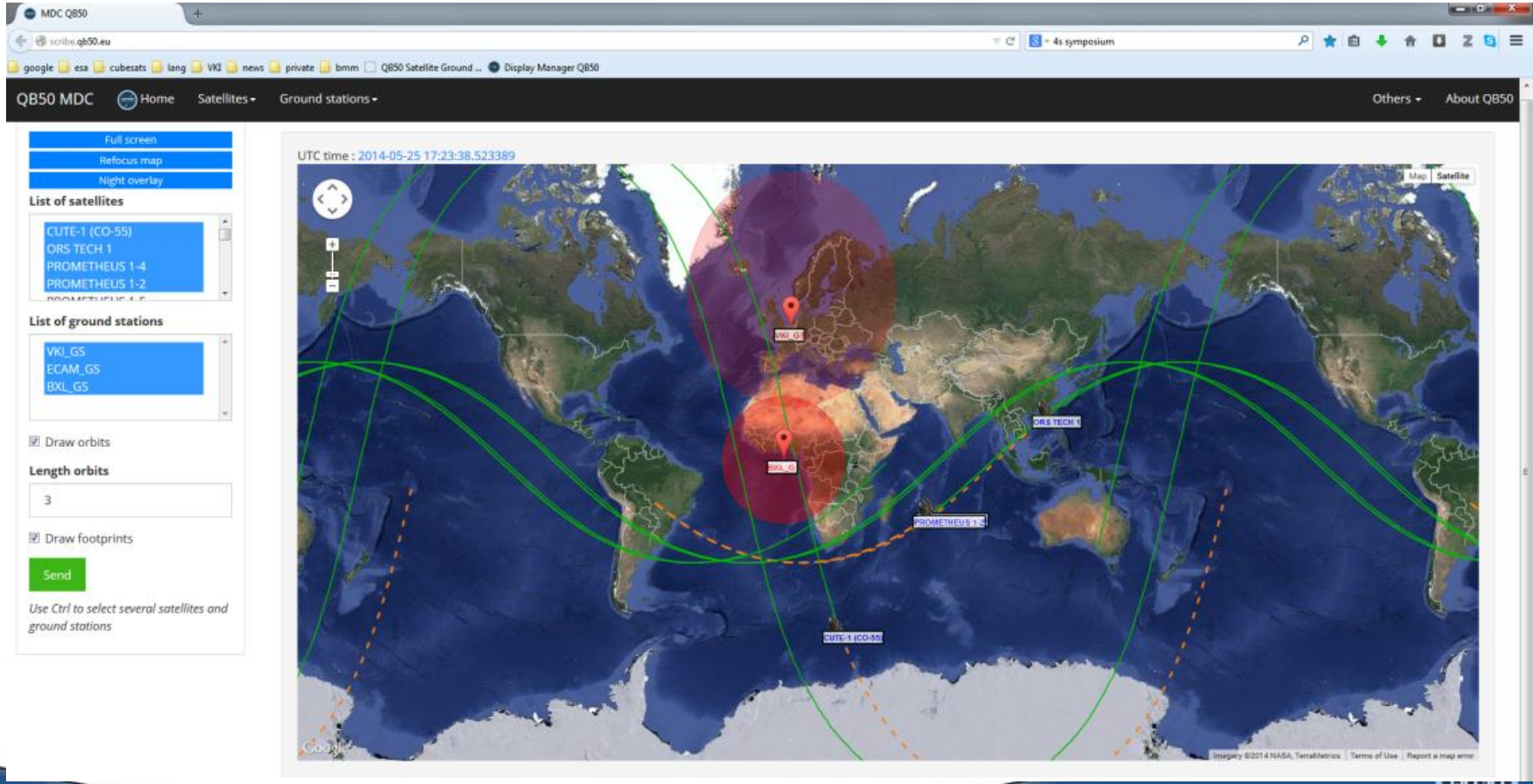
End-2-End data-flow



DPAC overview

Data Processing/Archiving Center

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



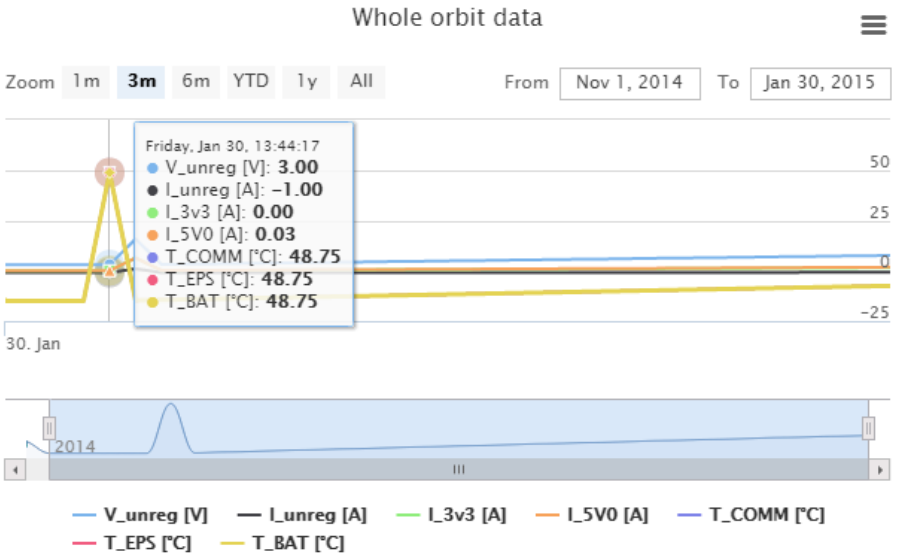
DPAC overview

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

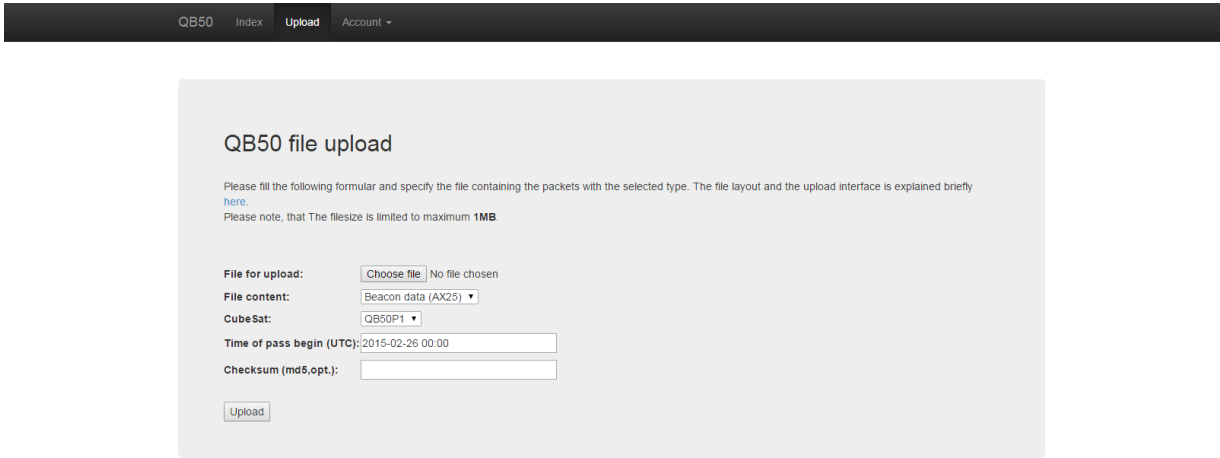
Uploaded [UTC]	Jan. 30, 2015, 1:45 p.m.	Jan. 30, 2015, 1:45 p.m.	Jan. 30, 2015, 1:45 p.m.
Timestamp [UTC]	Jan. 30, 2015, 1:44 p.m.	Jan. 30, 2015, 1:44 p.m.	Jan. 30, 2015, 1:44 p.m.
SU status	Non operational	Non operational	Non operational
V_unreg [V]	7.600	7.400	7.300
I_unreg [A]	-0.811	-0.811	-0.827
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



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

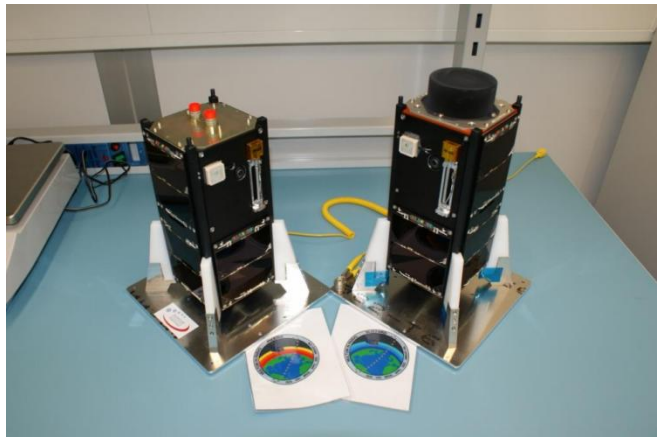
  Successful ITU filing (API) to be checked at FRR by QB50

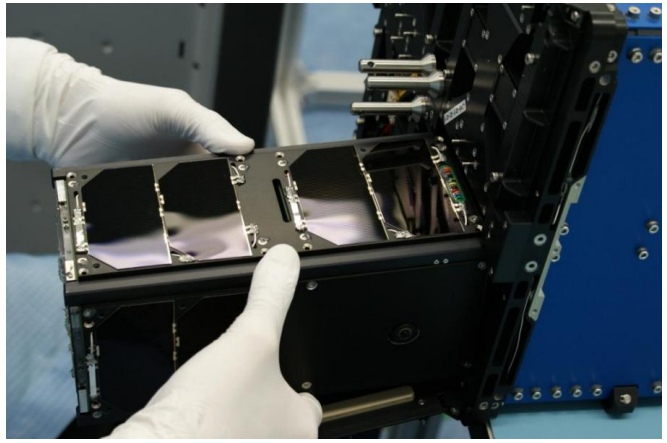
- Processes verified using QB50 precursor campaign

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)

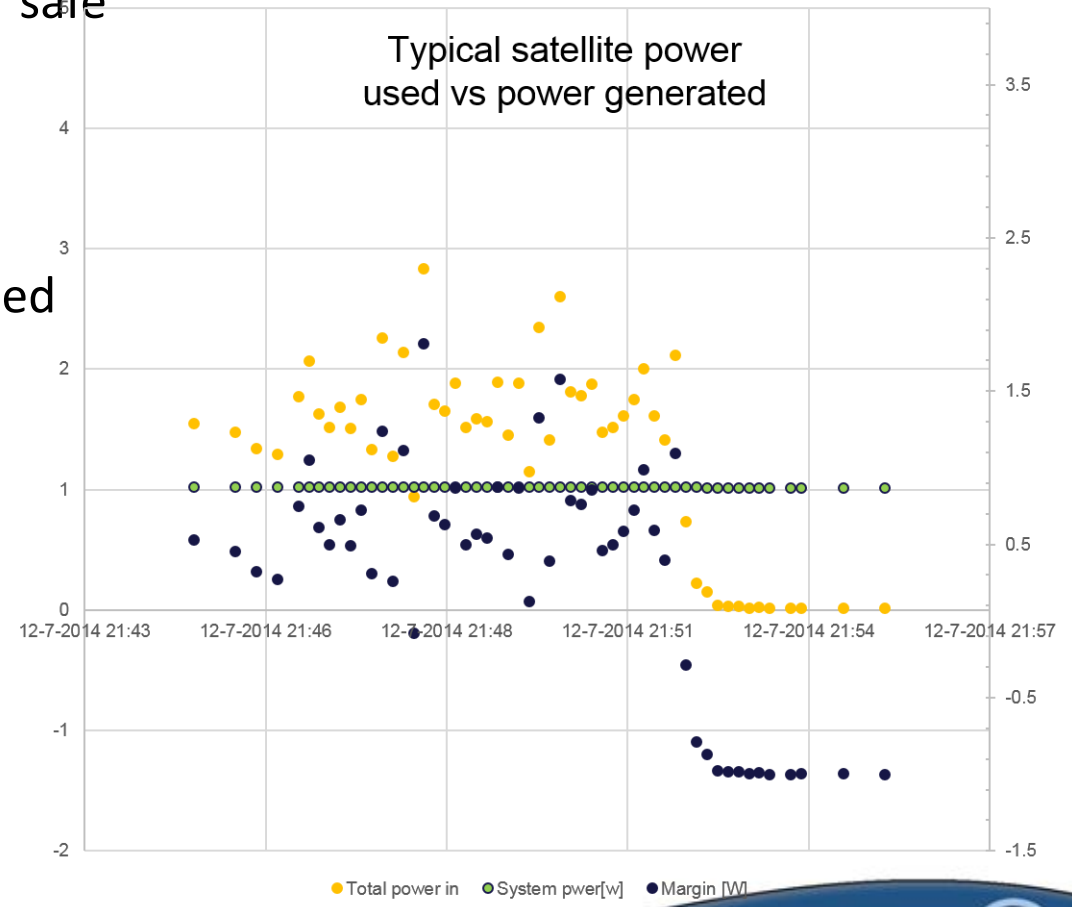




Precursor Derisking Campaign

Current status:

- Beacon of P1/P2 received ~10min after launch
- CubeSats are thermal and power safe
- Recovered from tumbling rates up to 30°/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

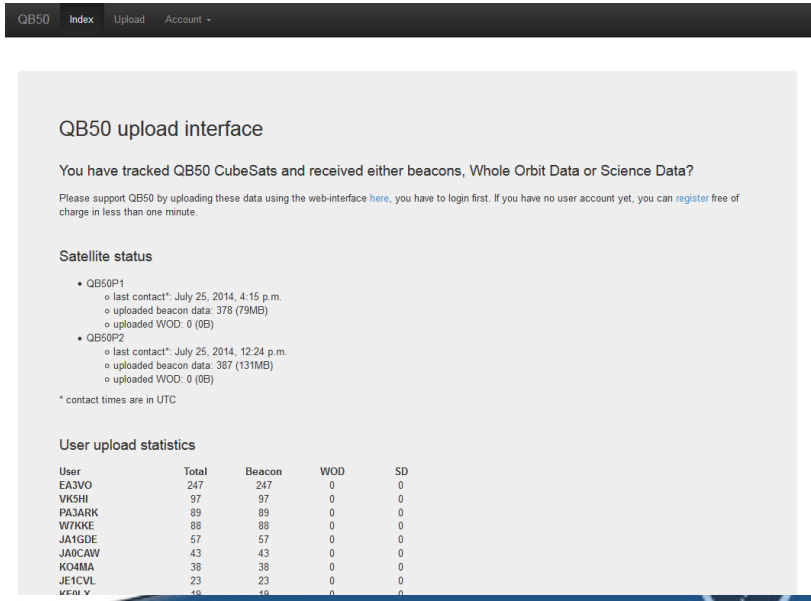
  https://qb50.eu/index.php/precursor-amateur-radio-operator

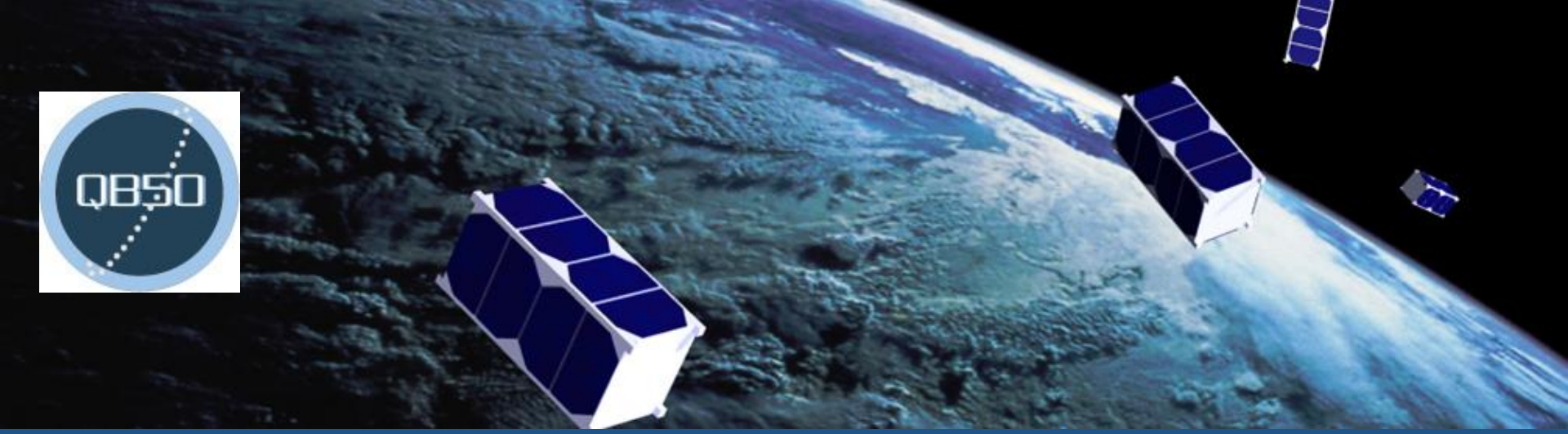
- Upload interface for radio amateur participation

  https://upload.qb50.eu/

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

Your help & support is appreciated!





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

VON KARMAN INSTITUTE FOR FLUID DYNAMICS

Université de Liège

QB50 Consortium

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