Cooperation between China and EU in the QB50 Project

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Cubesat - Pico-satellite

A CubeSat is a miniaturised satellite which offers all the standard functions of a normal satellite. They can even have deployable solar panels, antennas, booms, limited orbit control using micropropulsion, S-band instead of VHF/UHF and wireless data transfer inside the CubeSat are now beginning to be used.

The hardware cost of a CubeSat is in the range 50-100 k€. Up to now, about 50 CubeSats have been successfully launched, an estimated 100-150 CubeSats are being readied for launch in the next few years.
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°)
- Downlink using the Global Educational Network for Satellite Operations (GENSO)
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 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
QB50 - 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)
**QB50 - Orbit Demonstration**

A modular deployment system for double and triple CubeSats

Gossamer-1 Solar Sail demonstration package

InflateSail demonstration mission

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

![Image of QB50 spacecraft and related demonstrations](image)
QB50 – Launching

QB50 2015
Precursor flight 2013
The project has been granted by EU, and 91 LOI has received worldwide.

NPU is the Asia coordinator and one of the three Mission Control Center: NPU, VKI, Stanford
CubeSat Community

1 Argentina
2 Australia
3 Austria
4 Belgium
1 Brazil
1 Czech Republic
3 Canada
1 Chile
10 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
2 Turkey
4 United Kingdom
9 USA
1 Vietnam

91 Letters of Intent
QB50 in China

- Northwestern Polytechnical University (Asia Coordinator)
  - Beijing University of Aeronautics and Astronautics
  - Harbin Institute of Technology,
  - Nanjing University of Aeronautics and Astronautics,
  - National University of Defense Technology,
  - Peking University,
  - Shanghai Jiao Tong University,
  - Zhejiang University,
  - University of Macau,
  - National Cheng Kung University.
Mission Control Center (NPU):

- Comparing predicted with actual trajectories, using different trajectory simulation software tools, atmospheric models and CubeSat drag coefficients,
- Monitoring the status and health of the 50 CubeSats and the deployment system,
- Displaying which ground station is in contact with which CubeSat and displaying the link quality,
- Predicting and continuously updating the approximate time and latitude/longitude of atmospheric re-entry for the 50 CubeSats.
Founded in 1938, featuring the development of education in aeronautics, astronautics and marine engineering.

NPU has 1900 full and associate professors and senior engineers, among whom there are 19 academicians of the Chinese Academy of Engineering and Chinese Academy of Science, 17 Yangtze River Scholars.

NPU has successfully undertaken more than 9000 research projects during the “Eleventh Five-year Plan”, Research fund was up to 1.9 billion RMB in 2011.
Future Cooperation Aspects

Featured Research in Space Technology

- Spacecraft dynamics and control
- Micro-satellite technology
- Micro/nano science and technology
- Space life science and technology
- Space material science
Prof J. Zhou

- Expert of Satellite
- Expert of National High Technology Research and Development Program of China
- Director of Shaan Xi Engineering Laboratory for Microsatellites, Northwestern Polytechnic University
Participation in National Programs

- **Manned space program**
  - Shenzhou spaceship

- **Meteorological satellites**
  - Fengyun series

- **Lunar probe program**
  - Chang-e series

- **Navigation Satellites**
  - Beidou II
Team Members for QB50 Project

Tutors of QB50
- NPU Professors
- Joint lab with Netherlands Experts of Industry (CAST)

Students
- 25 to 30 PhD candidates
- 35 to 40 Master candidates

Research Fields
- Electronics
- Mechanics
- Dynamics
- Control
- Communication

Team members

Flags: China, EU, QB50, Cooperation
Shaanxi Engineering Laboratory of Microsatellites (SELM) has professional test equipments which are specialized in satellites development and devices calibration. At present, we have 1000 square meters lab to do relevant research and test, as shown in left figures.
‘Aoxiang-1’ is the first satellite of Shaanxi province and is also the first CubeSat fabricated by students independently.

In the future, SELM will cooperate with the other universities, institutes and industries to give lectures of CubeSat and hold national competitions for the students with consortium members of QB50.

Because the cost of CubeSat development and launching is far below a large satellite, it is possible for students to implement the project by themselves.
Thank You