QB50 Science Units

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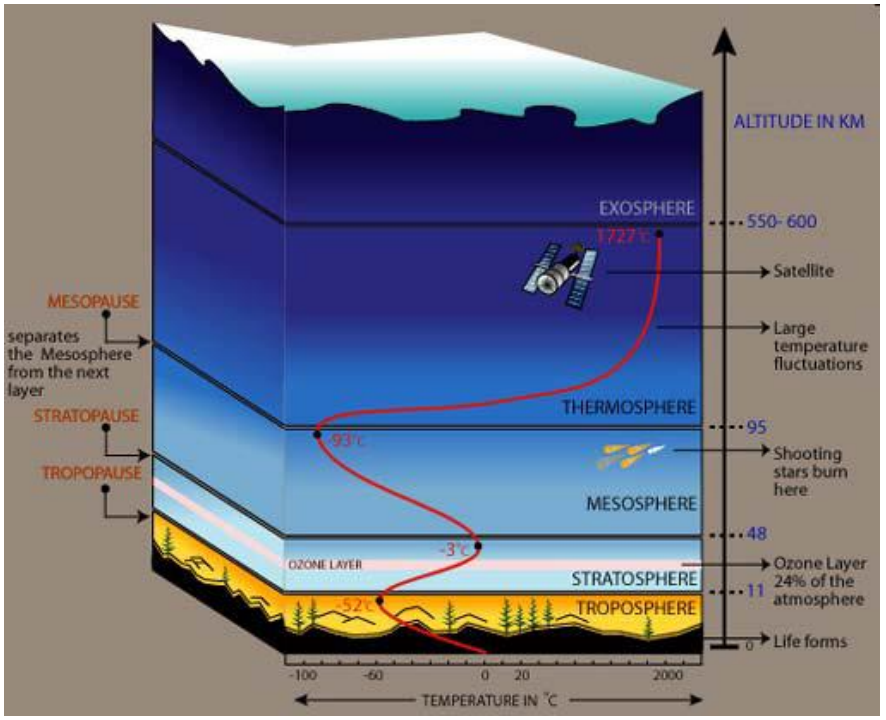
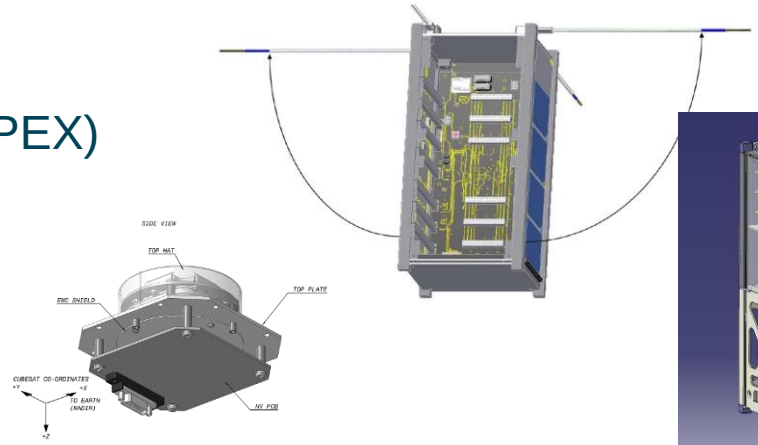
Plan

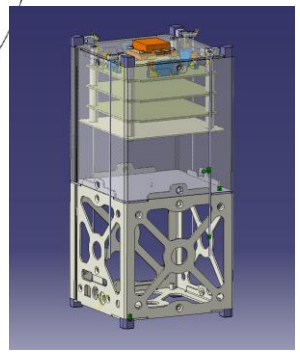
- Science Unit
- Logistics and interfaces
- Integration plan

QB50 Mission

- Mission Overview
  - Lower Thermosphere Science
  - 40 2U +IOD CubeSats
  - Built by different universities
  - 300-320 km Circular Orbit
  - String of pearls configuration
  - April 2015 launch
- Selected “standard” sensors
  - **Ion/Neutral Mass Spectrometer**
  - Flux-(Phi)-Probe-Experiments (FIPEX)
  - Langmuir Probe
  - Thermistors
  - Corner Cube Reflectors



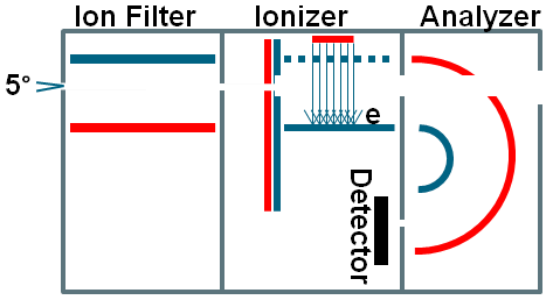


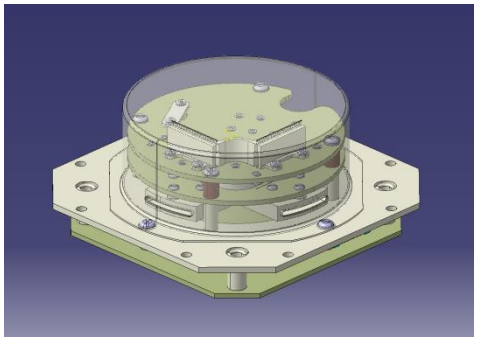


QB50 INMS – Overview

Dhiren Kataria, Alan Smith, Craig Leff, Rahil Chaudery, Matt Willock, Peter Coker, Hubert Hu, Mark Hailey, Andy Malpuss, MSSL

- Ion and Neutral Mass Spectrometer
- Measure dominant species
  - O, O_2, N_2, NO
- Ion sensor on TechDemoSat
  - Launch Q3 2013
- Density and possibly velocity
- Novel Ioniser design
- Twin headed CEM
- ~400 gms, 0.5U





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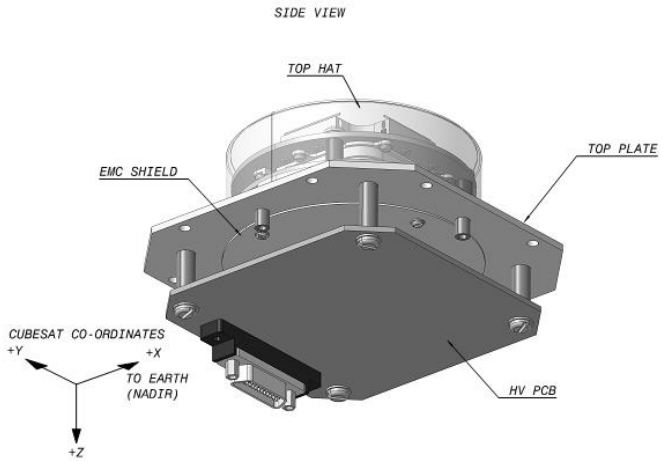
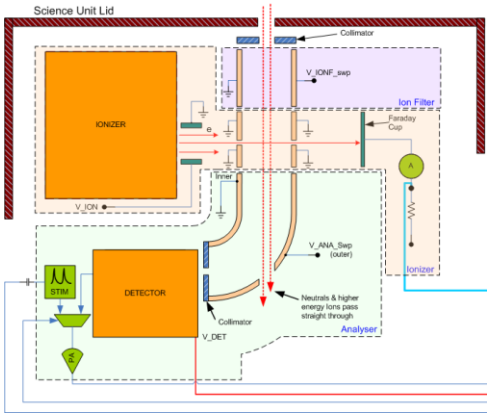
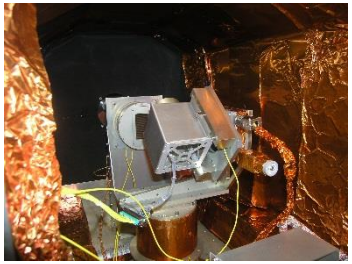
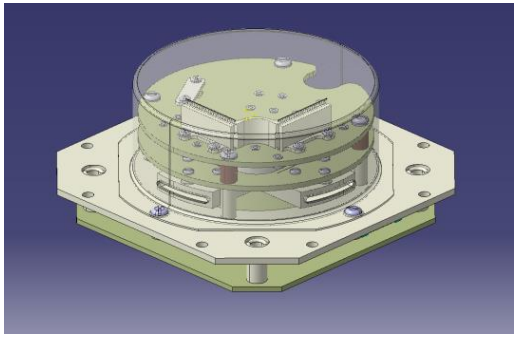
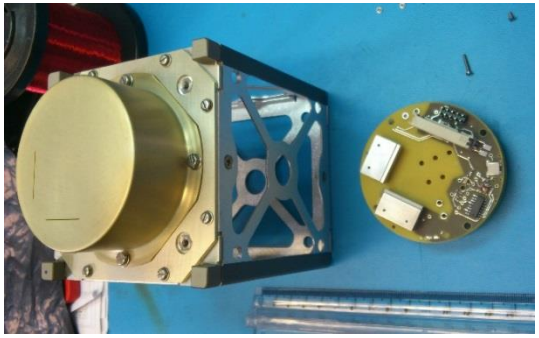








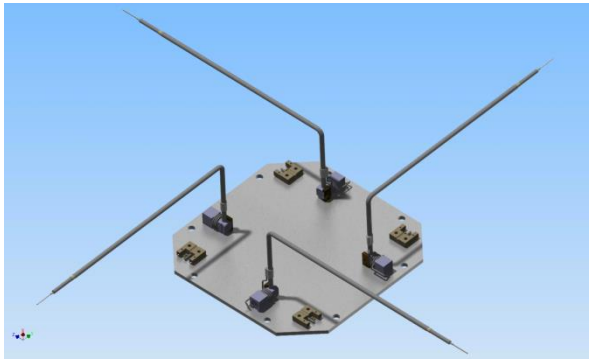


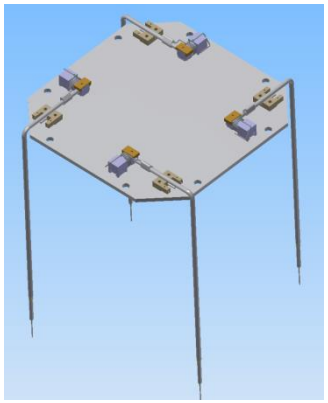
Several challenges being addressed

Multi-Needle Langmuir probe

T. A. Bekkeng, T. Espen and J. I. Moen, University of Oslo

Langmuir probe system which gives high time resolution measurements (up to 10 kHz sampling rate) of absolute electron density and spacecraft floating potential





Current measurement range	3 decades (i.e. 1 nA to 1 μA), but adjustable by in-flight automatic gain control
Electron density range	$10^{8}m^{-3}$ to $10^{12}m^{-3}$ (adjustable to match mission requirements)
Accuracy	24 bit raw data, but downsampled to 10 / 12 / 16 bit data product
Sampling rates	Up to 10 kHz, but fully adjustable

- Scaleable boom system for use on 1U, 2U and 3U CubeSats
- No voltage sweeping – Fixed bias voltage on all probes
- Separate electron emitter for control of the spacecraft floating potential

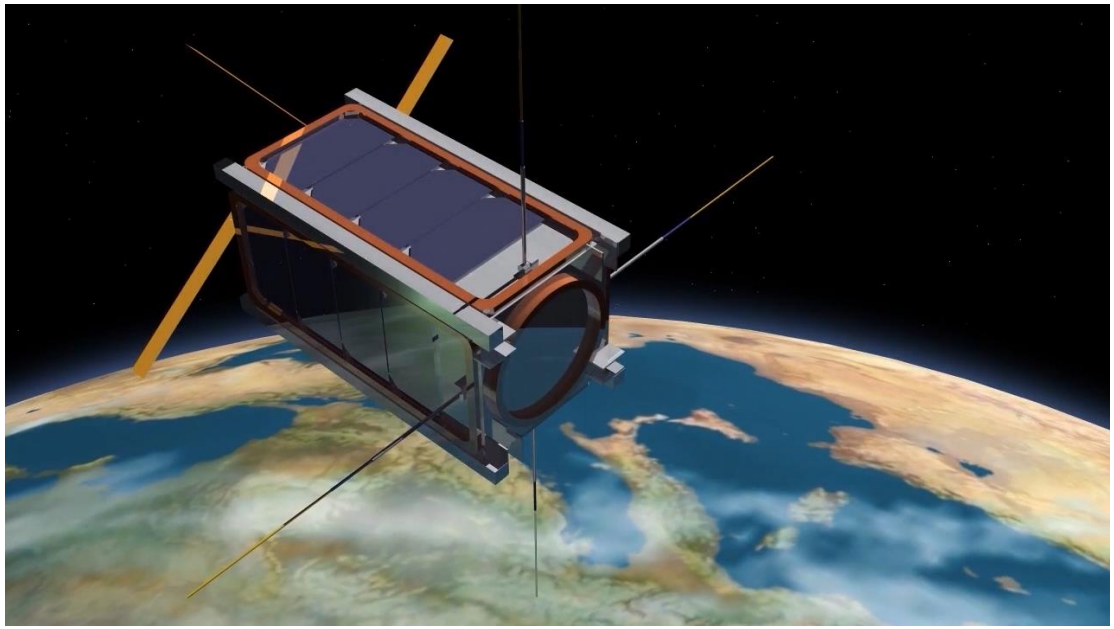
Multi-Needle Langmuir probe

T. A. Bekkeng, T. Espen and J. I. Moen, University of Oslo

- Payload already demonstrated on rocket flight

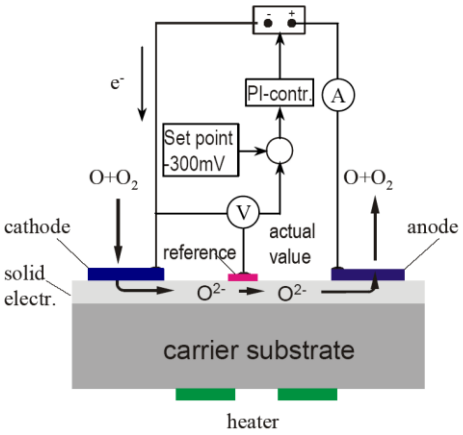
CUBESTAR

- Launch scheduled for late 2013
- 2U CubeSat
- All subsystems are built by Master's and PhD students
- Payload: m-NLP



Flux-Φ-Probe Experiment – FIPEX

T. Schmiel*, S. Fasoulas+, A. Weber*, *TU Dresden Germany, +Uni Stuttgart Germany



Au-cathode

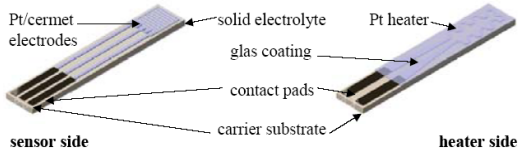
- non-dissociative adsorption
- detection of (AO)
- cathode reaction (simplified)

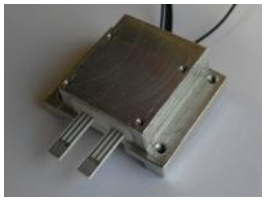
$(O_2) + O + 2e^- \rightarrow O^{2-} + (O_2)$

Pt-cathode

- dissociative adsorption
- detection of AO and O_2
- cathode reaction (simplified)

$O_2 + O + 6e^- \rightarrow 3\,O^{2-}$





Sensor Unit FIPEX

Sensor unit	
Dimension	36 x 30 x 12 mm³
No. of sensors	2
Type of sensors	AO (atomic oxygen), Time dependent
Mass	15g (excluding harness)
Field of View	~180 deg (free flow)
Heating Power	< 1,6 W
Electronic / PCB	
Sensor	1 + 1 spare, no parallel operation
Dimension	80 x 100 x 10 mm³ (form factor variable)
Power (includes sensor heating power)	5 V: switch on: 2500 mW; active measurement: 2000 mW 3,3 V: 100 mW
Mass	70g (excluding harness)

Elektronic FIPEX

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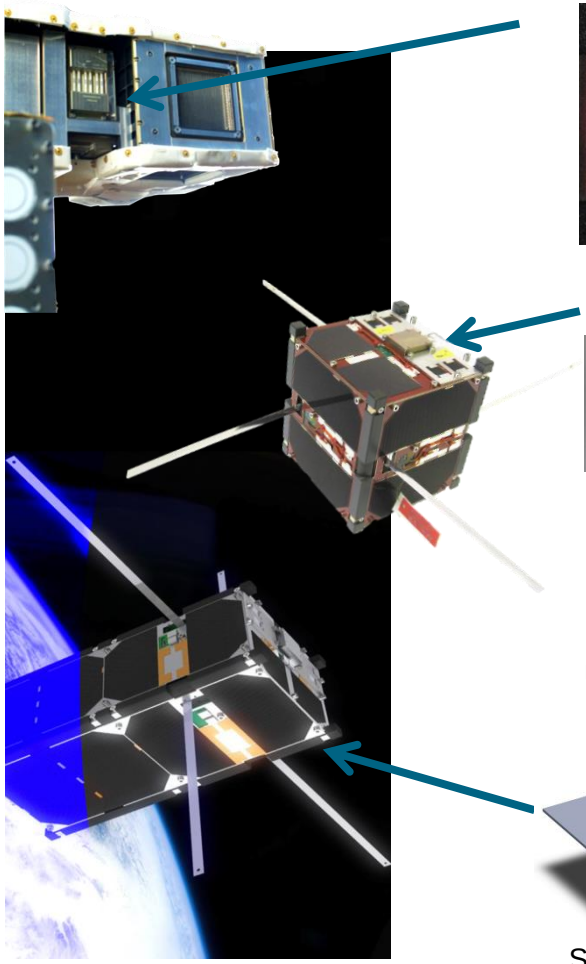
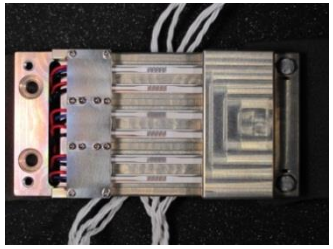
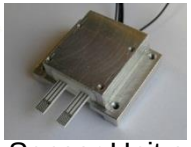




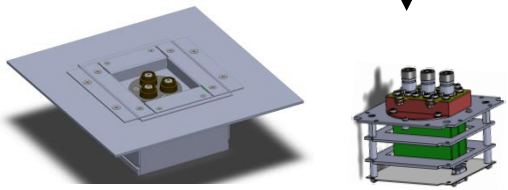
Sensor Unit on ISS



Sensor Unit on CubeSat SOMP-II

Sensors for QB50

Sensor Miniaturisation for QB50



Sensor Unit for QB50 containing max. 3 sensors

1) **Mission on ISS:**
   Status: 572 days succsessfully operation in 2008

2) **Precursor Flight:** on CubeSat SOMP
   Status: Ready for launch April 2013

3) **Further development for QB50/SOMP-II:**
   Status: Ground testing

Technical Budgets

- Orbit average 0.5W with duty cycling
- Higher time cadence desired

Unit	Mass (gms)	Power (W)	CubeSat Volume (litres)	
INMS	< 400	0.74	0.4	
	10%	10%	10%	
FIPEX	< 400	1.6	0.3	
	20%	20%	10%	
LP	< 400	0.70	0.3	
	30%	20%	10%	

Telemetry

- Duty cycling sensor operations
- 2 memory slots ideal
- Higher time cadence desired

Mode: Complete scientific coverage On-board processed: 100% Duty cycle:	**~1.25 MB per orbit**
Mode: Partial scientific coverage On-board processed: 25% Duty cycle:	~312.5 kB per orbit
Mode: Irregularity survey mode 100% Duty cycle	8.6 kB per orbit

Logistics and ICD

- Preference and allocation of Science Unit
  - Science requirements, cost trade-off
  - May not be able to meet team's preference
  - Consortium decision by end of June
- ICD
  - Number of updates from draft versions released
  - Update to be released by the 30th June
  - UART interface

3 - Stage integration plan

- #1: Software simulator – Computer is SU
- #2: Flight interface board with mass dummy
  - LP is more complex and design definition ongoing
  - Returned to MSSL/Dresden/Oslo for integration with flight sensors
- #3: Integration of full assembly at ISIS
  - Ideally by CubeSat team
  - Consultation with CubeSat teams

- Scheme to be finalised by end of August

Schedule

- **Stage #1**: Simulator delivery end of August 2013
- **Stage #2**: Flight interface board and mass dummy phased deliveries, Q1-Q2 2014
  - Units to be delivered and returned in shipping container
- **Stage #3**: Flight models phased deliveries, Q3-Q4 2014
  - Ideally team delivers CubeSat in person to integrate SU to their CubeSat and perform/support acceptance test
  - Integration at ISIS (TBD)

- Questions