Sensors and Science

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Sensor Providers and SPWG members

QB50 5th Workshop, VKI
29th January, 2013

Key Tasks

- Sensor and Science related working group activities
  - Scientific objectives, sensor performance, resources, accommodation, production, schedule, cost
- Development of sensor demonstration units
- Systems engineering of the Science Unit
- Procurement, development, manufacturing, testing and integration of the sensor set with CubeSats developed by the universities

On-going Activities

- Science Unit design options and resource trade-offs
  - Design options driven by SSWG recommendations
  - Accommodation, assessments for single/ combinations of sensors, resources evaluated (mass, power, volume, funding).
  - Common payload electronics design and associated trade-offs.
- Final recommended baseline: single sensors sets with integrated thermistors and free-issue of CCRs
  - Driven by resource limitations
  - Communicated by the PI to the CubeSat teams during the one-to-one meetings.

Selected Sensor Sets

Adopted for implementation

Set 1

Ion-Neutral Mass Spectrometer (INMS)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

Set 2

Flux-Φ-Probe Experiment (FIPEX)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

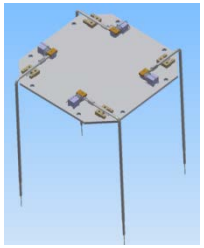
Set 3

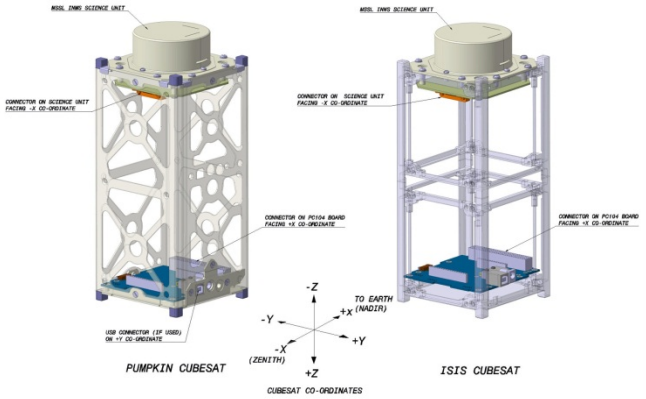
A set of 4 Langmuir probes (MNLP)
2 corner cube laser retroreflectors (CCR)*
Thermistors/thermocouples/RTD (TH)

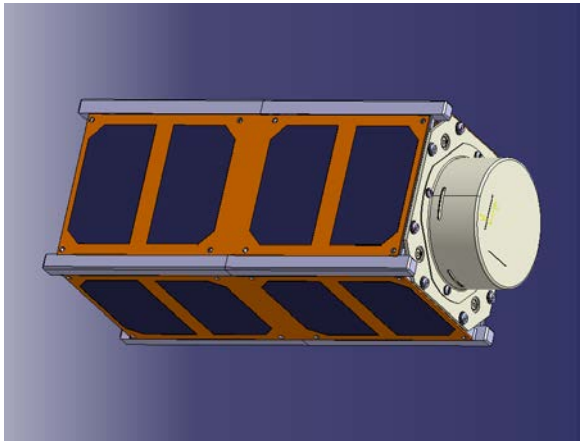
* Offered as an option

On-going activities - 1

- Working on preparation of the final version of the ICDs to be released
  - Draft versions of the ICDs are ready
  - Being reviewed by systems and CubeSat experts
  - VKI aim to release by Friday, 1st of Feb, 2013







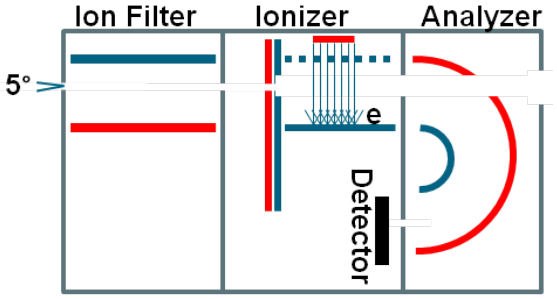
On-going activities - 2

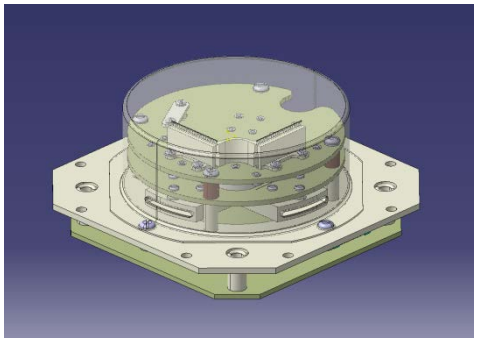
- Breadboard of the INMS unit - MSSL
  - Parts currently under fabrication, assembly by the middle of February
    - Flight-representative ioniser designed for the neutral mass component.
    - A special twin-headed CEM detector fabricated by the manufacturer for QB50
  - Ground Support Equipment (GSE)
- Development of electron source - University of Oslo
  - Tackle the spacecraft charging issue
  - Advanced stage of development, envisaged to be completed over the next few weeks
  - Requirements and interfaces will be included in the LP ICD

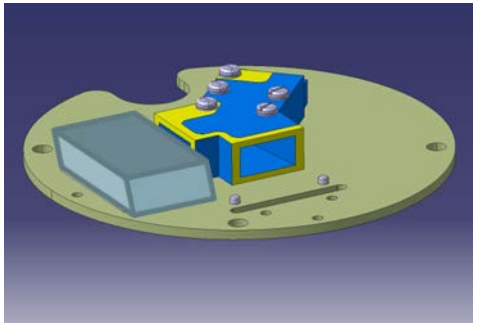
QB50 INMS – Overview

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

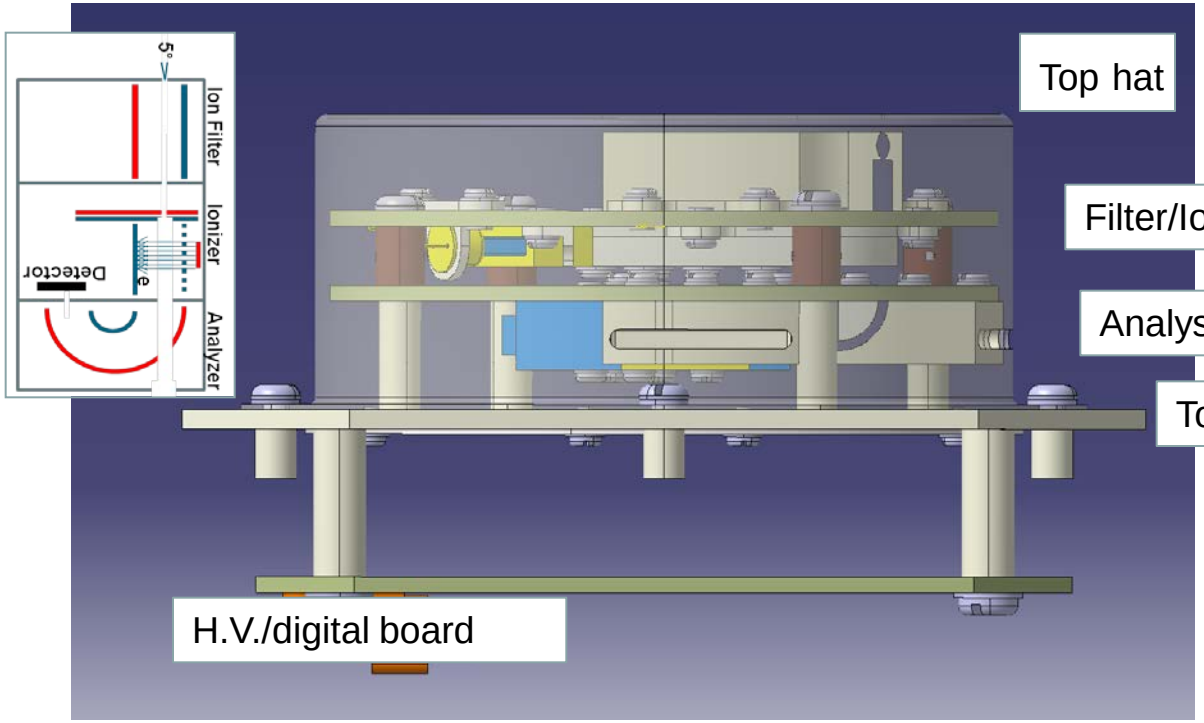
- Ion and Neutral Mass Spectrometer
- Measure dominant species
  - O, O_2, N_2, NO
- Ion sensor on TechDemoSat
  - Launch Q2-Q3 2013
- Density and temperature
- Novel Ioniser design
- Twin headed CEM
- ~400 gms, 0.5U



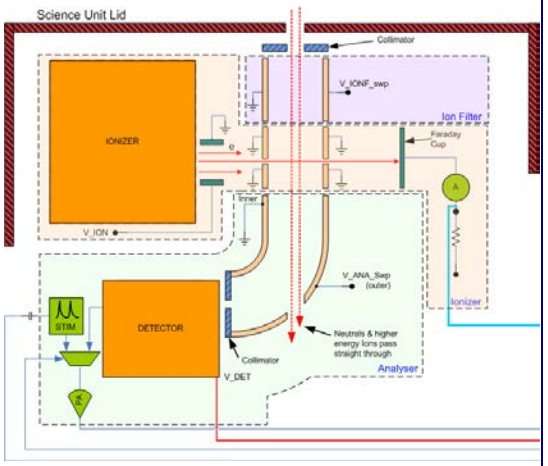




QB50 INMS – Overview



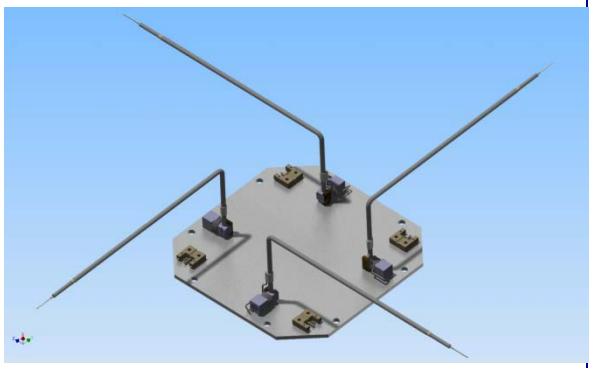
25 way micro D Interface connector

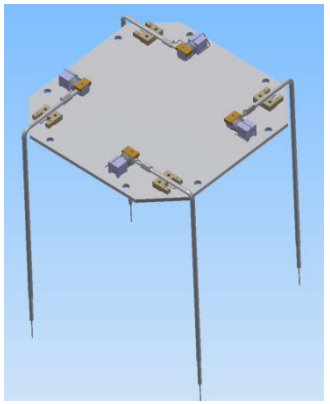


Multi-Needle Langmuir probe

T. A. Bekkeng 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

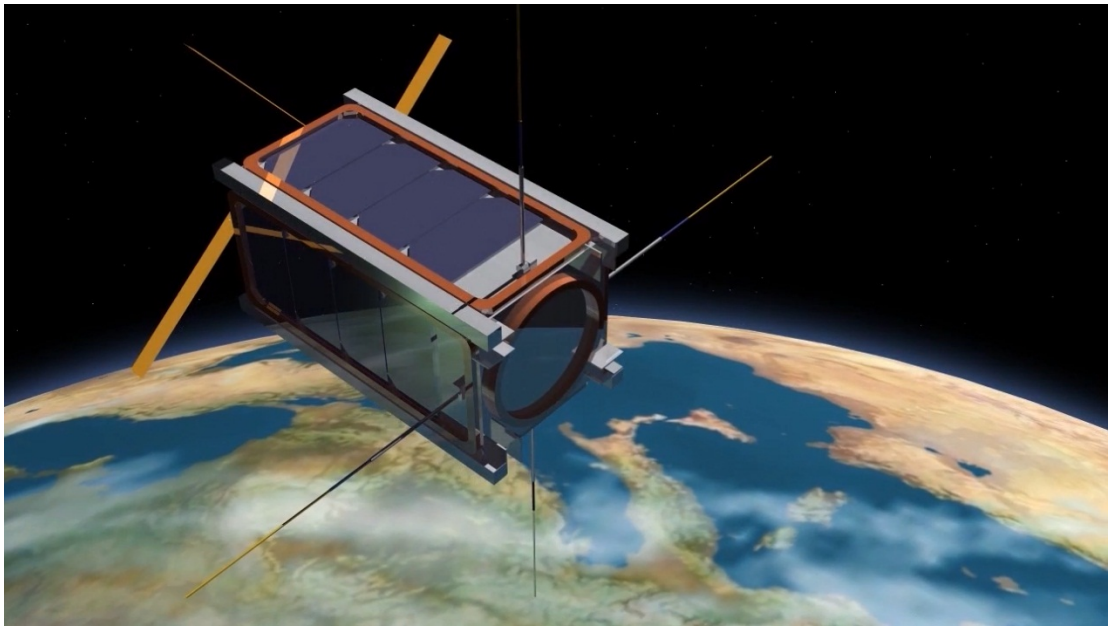
Multi-Needle Langmuir probe

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

- Payload already demonstrated on rocket flight

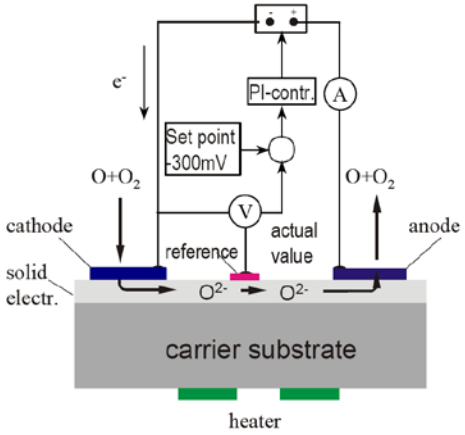
CUBESTAR

- Launch scheduled for late 2014
- 2U CubeSat
- All subsystems are built by master- 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

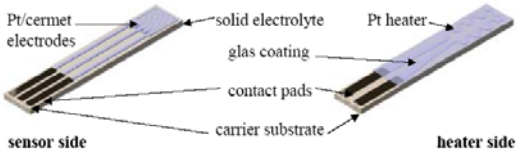
- non-dissociative adsorption
- detection of (AO)
- cathode reaction (simplified)

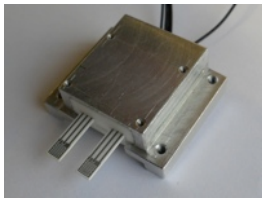
$(O_2) + O + 2e^- \rightarrow O^{2-} + (O_2)$

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

Flux-Φ-Probe Experiment – FIPEX

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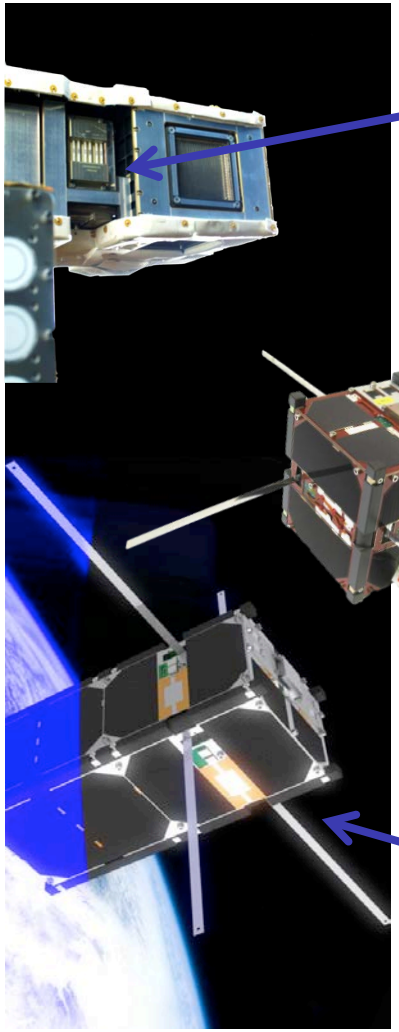
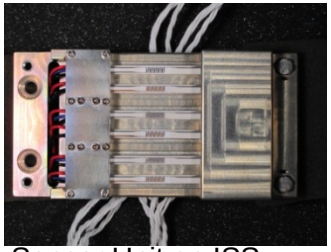
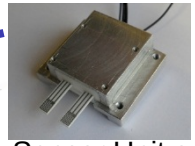




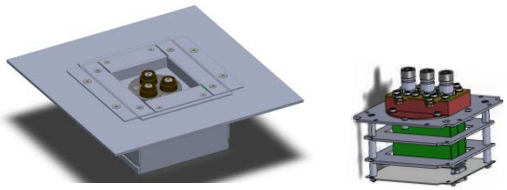
Sensor Unit on ISS



Sensor Unit on CubeSat SOMP-II

Sensors for QB50

Sensor Miniaturisation for QB50



Sensor Unit for QB50 containing max. 3 sensors

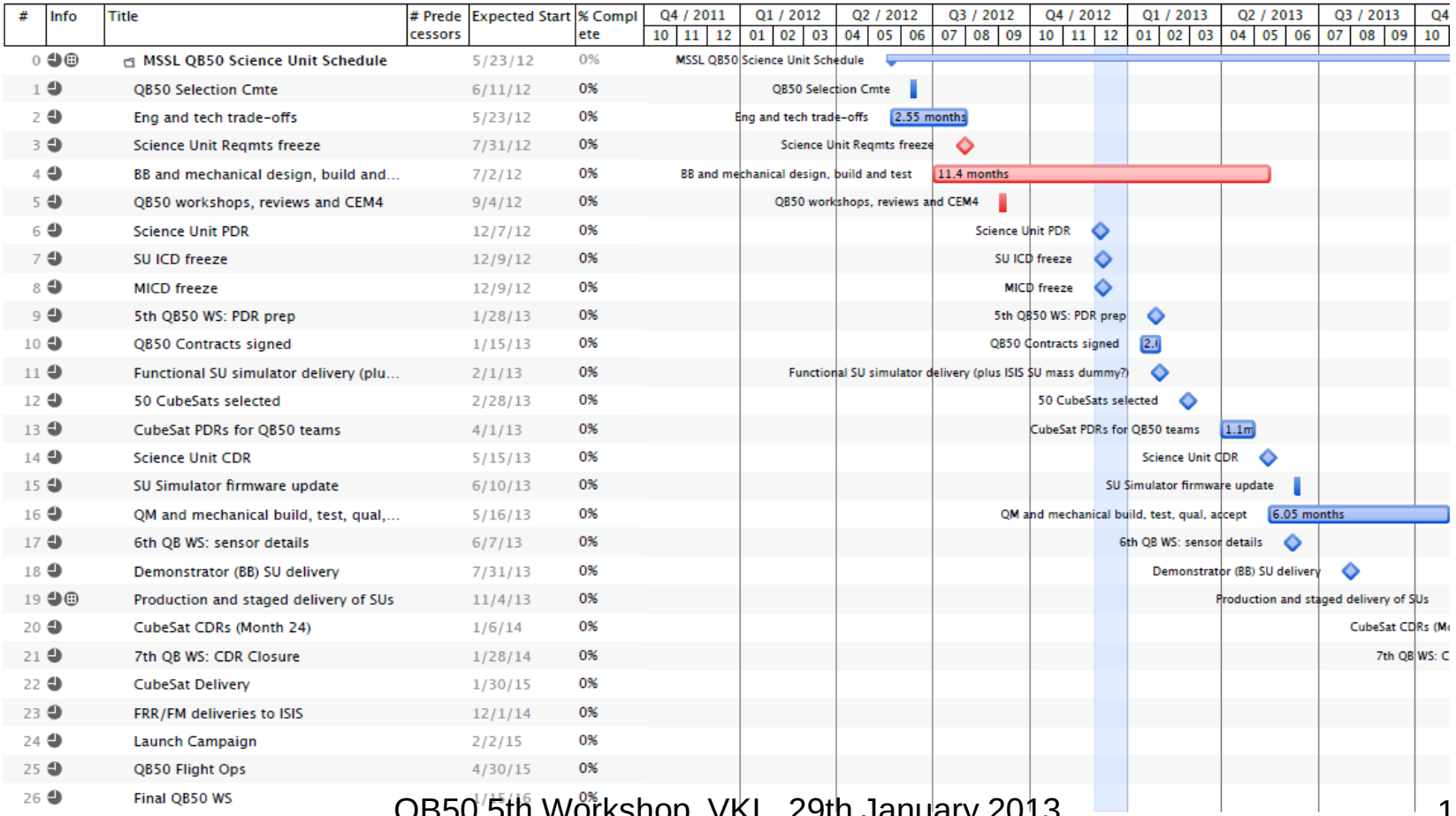
1) **Mission on ISS:**
Status: 572 days succsessfully operation in 2008

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

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

Development of demonstration units

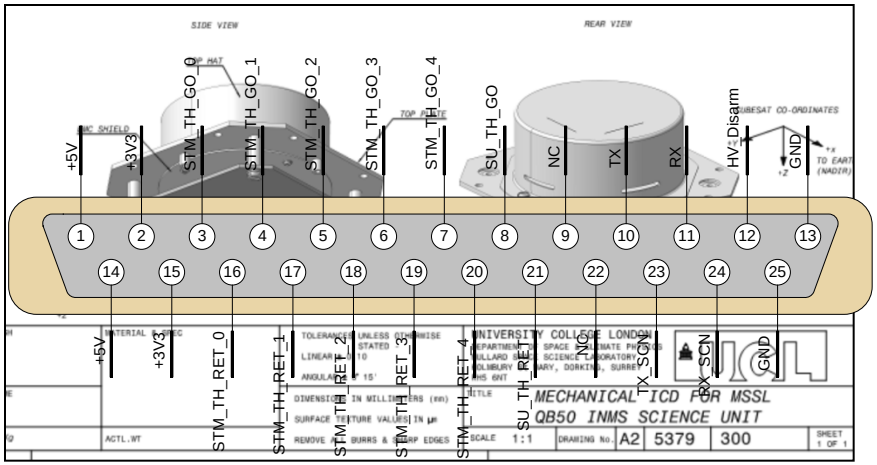
- Schedule for production of the sensors being updated and is being iterated with consortium



#	Info	Title	# Predecessors	Expected Start	% Complete
0		MSSL QB50 Science Unit Schedule		5/23/12	0%
1		QB50 Selection Cmte		6/11/12	0%
2		Eng and tech trade-offs		5/23/12	0%
3		Science Unit Reqmts freeze		7/31/12	0%
4		BB and mechanical design, build and...		7/2/12	0%
5		QB50 workshops, reviews and CEM4		9/4/12	0%
6		Science Unit PDR		12/7/12	0%
7		SU ICD freeze		12/9/12	0%
8		MICD freeze		12/9/12	0%
9		5th QB50 WS: PDR prep		1/28/13	0%
10		QB50 Contracts signed		1/15/13	0%
11		Functional SU simulator delivery (plu...		2/1/13	0%
12		50 CubeSats selected		2/28/13	0%
13		CubeSat PDRs for QB50 teams		4/1/13	0%
14		Science Unit CDR		5/15/13	0%
15		SU Simulator firmware update		6/10/13	0%
16		QM and mechanical build, test, qual,...		5/16/13	0%
17		6th QB WS: sensor details		6/7/13	0%
18		Demonstrator (BB) SU delivery		7/31/13	0%
19		Production and staged delivery of SUs		11/4/13	0%
20		CubeSat CDRs (Month 24)		1/6/14	0%
21		7th QB WS: CDR Closure		1/28/14	0%
22		CubeSat Delivery		1/30/15	0%
23		FRR/FM deliveries to ISIS		12/1/14	0%
24		Launch Campaign		2/2/15	0%
25		QB50 Flight Ops		4/30/15	0%
26		Final QB50 WS		1/15/16	0%

Interfaces

- Mechanical – top lid
  - Keep out zones
- Electrical
  - 25 pin MDM



- Serial UART link (was I^2C)
- Simulator: Arduino Development Board, software will be provided by SU team

- Attitude Control: pointing accuracy of +/-10° and pointing knowledge of +/-2°

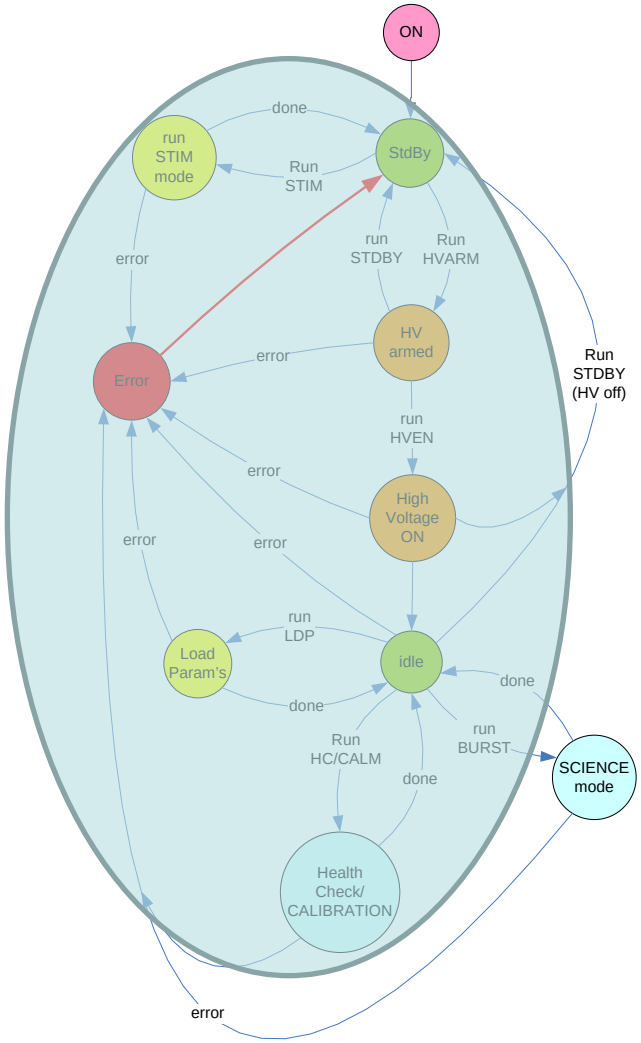
Requirements

- Mass: < 500 gms
- Power: 500 mW with duty cycle
- Science telemetry: 2 Mbits/day

- Operations
  - Two modes – full scan, peak sampling
  - Simple time-tagged on/off operations envisaged
  - Fixed data package size

Example operations

OBC_SU_ON @19:00:00
SU_STIM 0xF0 @19:02
SU_HVARM @19:03
SU_HVEN @19:04
SU_HK 60 @19:06
SU_CALM 5 64 28 ON ON ON @NOW
SU_LDP 0x09, 0x04,0x41,0x80,0x00, 0xFE,0x00,0x00,0x02,0xFF @NOW
SU_HC 100 64 24 ON ON ON @ 19:15
SU_SCI 01 28 90 5 10 32 @19:16
SU_SCI 02 28 90 5 10 500 @19:17
SU_SCI 02 28 90 5 10 500 @19:50
SU_SCI 02 28 90 5 10 500 @20:15
OBC_SU_OFF @20:02
OBC_SU_END



FIPEX Presentation