QB50 ADCS + GPS

2.2.12

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- Surrey ADCS Cubesat heritage
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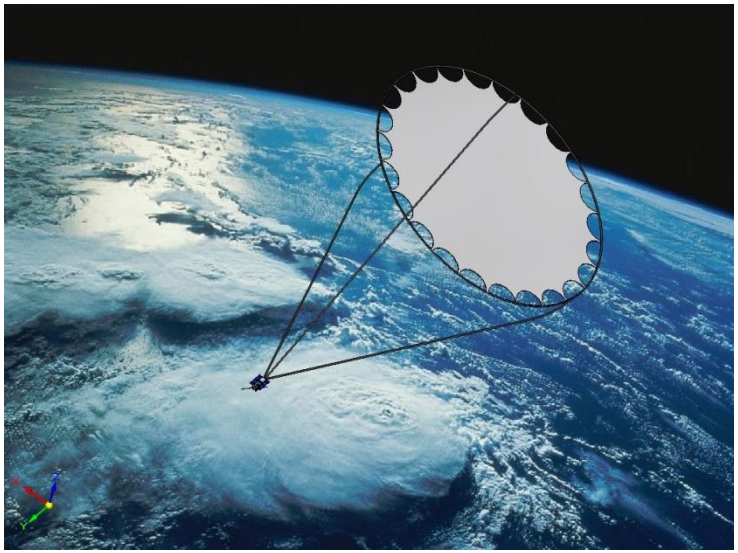
Surrey Role in QB50

- Provide ADCS tailored Solution
- Provide ADCS Support (software/hardware)
- Provide systems engineering support
- Provide the Inflatesail Deorbiting nanosat (IOD)

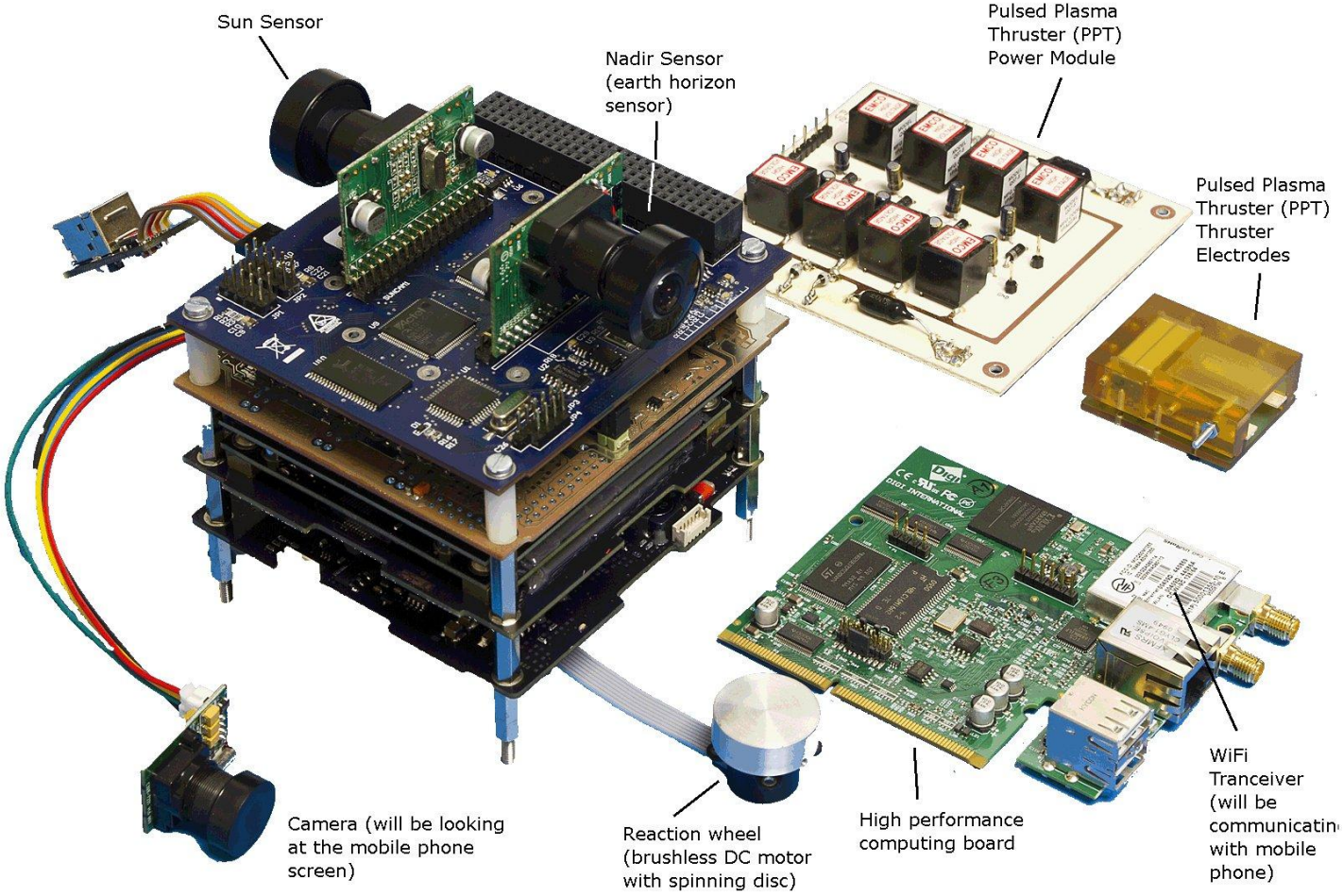


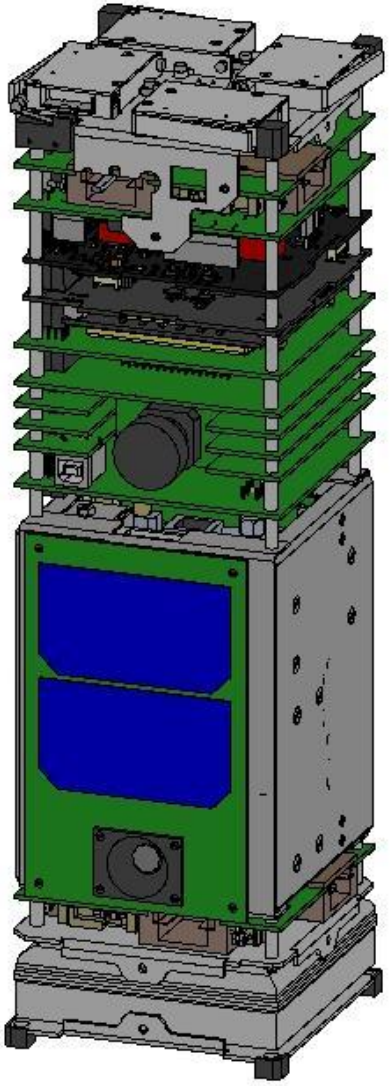
SSC CubeSat Projects: STRaND-1

- Demonstration mission: demonstrate key technologies for nano-satellites:
  - 3-axis agile attitude control
  - Low-cost computing platform
  - Wireless communications
  - Mobile smartphone use in space application
- Sensors
  - CubeSense – combined Sun and Nadir optical sensor.
  - Uses 2 CMOS camera's with wide FOV (190 degrees) lenses. Sun sensor has neutral density filter to reduce intensity.
  - Magnetometer
- Actuators
  - Magnetorquers
  - 3x Reaction wheels
- Other Cubesat missions in development:
  - Cubesail, DEORBITSAIL, Inflatesail, AgileSAT, InspectorSAT, CleanSAT

SSC CubeSat Projects: STRaND-1

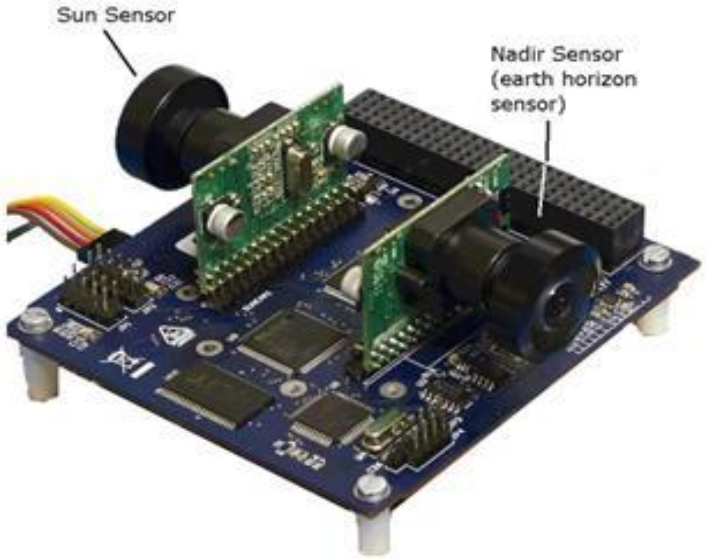
Launch: July 2012

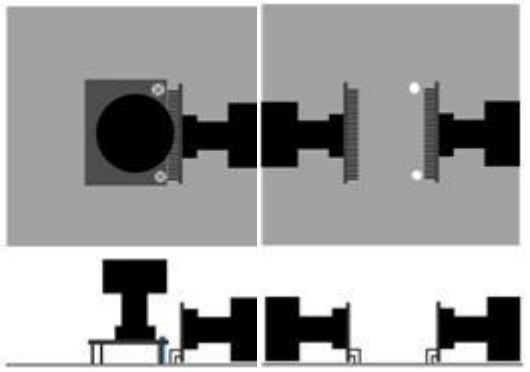




SSC ADCS Components: CubeSense

- Combined Sun and Nadir optical sensor
- 2 CMOS camera's with wide FOV (190 degrees) lenses
- Sun sensor has neutral density filter to reduce intensity
- 2 configurations for camera mounting. (can also be connected via harness)





QB50 ADCS Mission Requirements
QB50 Cubesat RFP

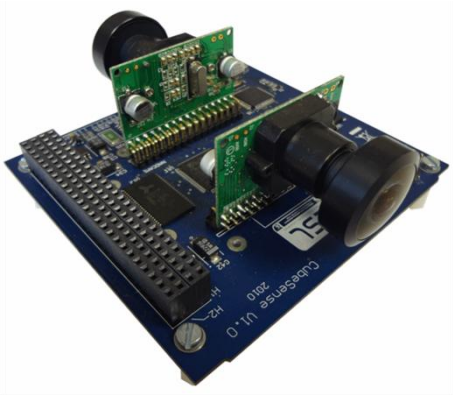
- **ADCS-1: Velocity-vector Stabilization:** The long axis of the CubeSat shall be aligned with the velocity vector in such a way as to point the experiment package in the direction of motion.
- **ADCS-2:** Velocity-vector Pointing Accuracy: The CubeSat attitude shall be controlled such that there is less than 5 degrees between the long axis of the CubeSat and the velocity vector (3-sigma, 95% confidence), down to 250km altitude. This should be achieved below 200km. There is no mission level requirement for roll angle.
- **ADCS-3: Tip-off Rates:** The CubeSat shall be able to recover from tip-off rates of up to 100 degrees/second
- **ADCS-4:** Velocity-vector Attitude Knowledge: The CubeSat shall measure its velocity-vector attitude to within ±1º at the time of receiving data from the payload and link that attitude report to the data.
- **ADCS-5: De-tumble:** CubeSats should be able to de-tumble and stabilise (commissioning) within 2 days [TBC].

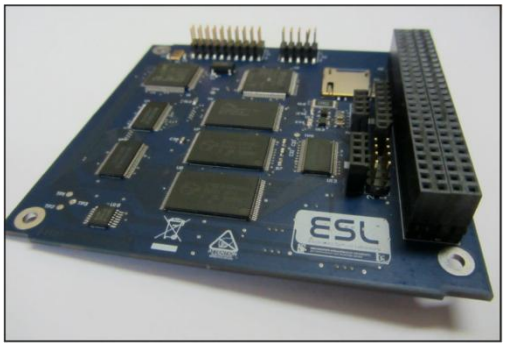
QB50 ADCS Issues

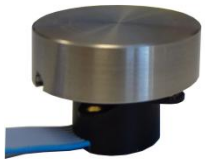
- QB50 ADCS system should be:
  - Robust, simple, achieve the QB50 requirements
  - Compact and low mass
  - Low power
  - Detumble cubesat quickly
  - Some ADCS software should be available..
  - Have system ready soon!
  - Very cheap...

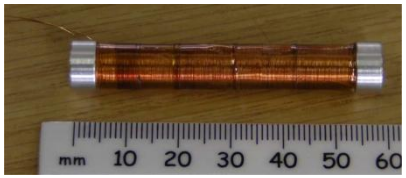
QB50 ADCS Tailored Solution

- 3-axis stabilized attitude control
- Accurate position, velocity & time from GPS
- < 1° roll, pitch, yaw stability (sunlit part of orbit)
- Low power: 2W (3-axis mode)
- Compact size: 0.4U (Full configuration with GPS)
- Low Cost
- Developed with Stellenbosch University (SA)

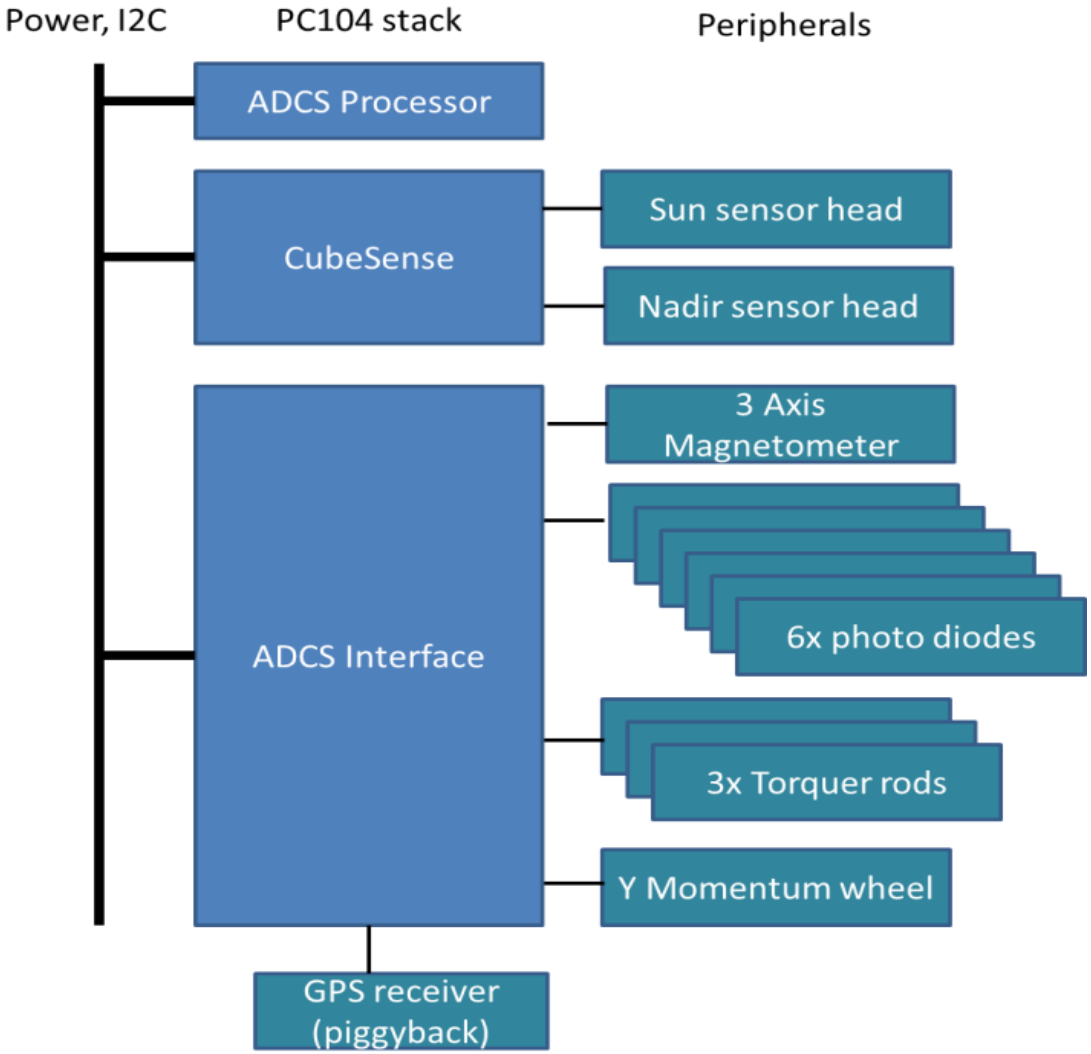








QB50 ADCS Architecture



QB50 ADCS Sensors: CubeSense

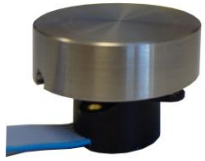
Coarse sun sensor	
Visibility	360°
Accuracy	< 10°
Sun & nadir sensor	
Mass	110 g
Power use	360 mW
Update rate	2 Hz
Sun sensor range	± 90°
Nadir sensor range	± 50°
Sun sensor accuracy	
within 40° of boresight	0.3°
full range	< 2°
Nadir sensor accuracy	0.18°

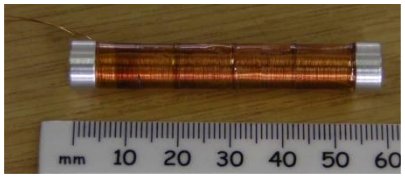
ADCS Sensors for QB50: Magnetometer

	Honewell HMC5843
accuracy	10 milli-gauss
Dimensions	4 x 4 x 2mm
Mass	IC
Power	< 1mW

QB50 Actuators

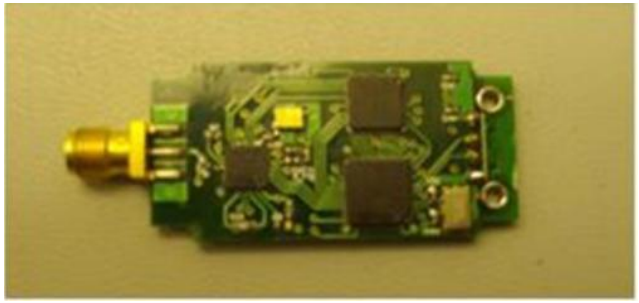
Magnetic torquer rods	
Mass	22 g
Dimensions	60 x 8 x 8 mm
Maximum magnetic dipole moment	0.2 Am^2
Y momentum wheel	
Mass	25 g
Maximum momentum	0.03 Nms





QB50 GPS Options

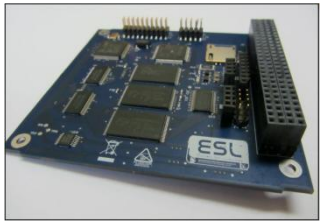
- Exploring 3 options:
  - Novatek GPS
  - SSTL GPS
  - SSBV Reconfigurable GPS



QB50 ADCS Processing

Processing

Processor	32-bit ARM Cortex-M3
Clock frequency	4-48 MHz
EEPROM	256 KB
Code Memory (flash)	4 MB
Data Memory (EDAC protected SRAM)	2x 1 MB
MicroSD support	Up to 2 GB
Communication	2x I^2C
	2x UART
Power use	< 200 mW



QB50 ADCS Options

Option	1	2	3	4	5	6
	With GPS			Without GPS		
	Full ADCS suite (ADCS OBC, CubeSense, ADCS i/f, sensors, actuators, GPS)	Full suite excl OBC	Attitude sensing only: Excludes OBC, torquer rods & wheel	Full ADCS suite (ADCS OBC, CubeSense, ADCS i/f, sensors, actuators)	Full suite excl OBC	Attitude sensing only: Excludes OBC, torquer rods & wheel
Mass	410 g	330 g	240 g	380 g	300 g	210 g
Dimensions (PCB stack height)	40 mm	30 mm	30 mm	30 mm	18 mm	18 mm
Power	2 W (3-axis mode, GPS enabled)	1.5 W (detumbling mode, GPS enabled)	1.1 W (GPS enabled)	1 W (3-axis mode)	0.5 W (detumbling mode)	0.5 W

QB50 ADCS-Conclusions

- A tailored ADCS system for QB50 is being developed
  - Low mass, volume, cost
  - Development of the University of Surrey and Stellenbosch University (SA)
  - System includes OBC (for payload/subsystems)
  - Detumbling and basic ADCS software to be provided with Surrey ADCS system
  - Can use GPS for real time measurements
  - Full option (with OBC/GPS): 0.4U, 410 g, 2W
  - Available to order from 20.2.12

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Thank you!