CubeSat = Innovation

Craig Clark

Outline

1. What are the drivers for innovation in CubeSats?
2. CubeSat innovation at Clyde Space.
3. Living the dream?

I'm with you all the way on specific and measurable. Let's move on to achievable...

WHAT ARE THE DRIVERS FOR INNOVATION IN CUBESATS?

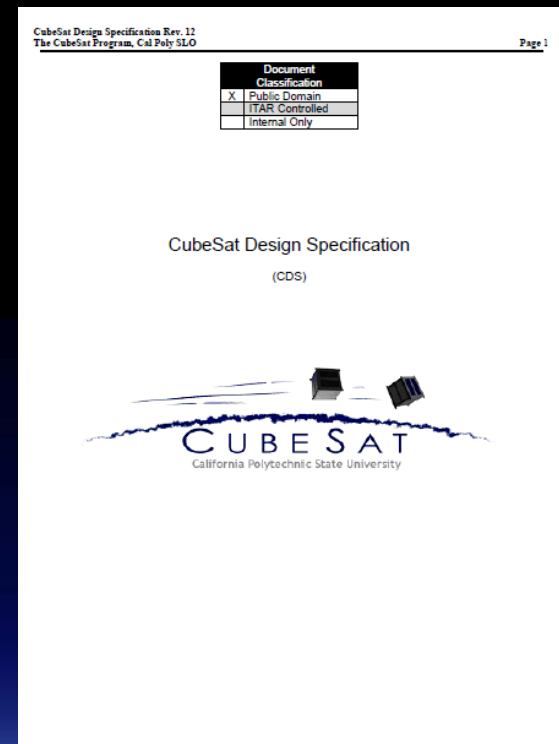# Small Satellites paved the way

- Small Satellite people have been innovating and pioneering since late 1970s.
- Innovating spacecraft engineering approach, Quality Assurance, technologies, applications.
- Very much individual efforts.
  - Different shapes, sizes and interfaces.
- Space industry took years to accept viability of approach.
- The door is now open…
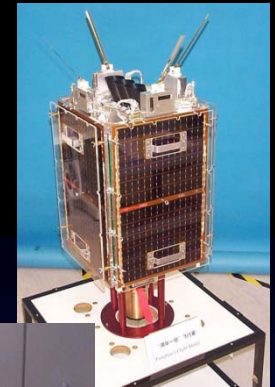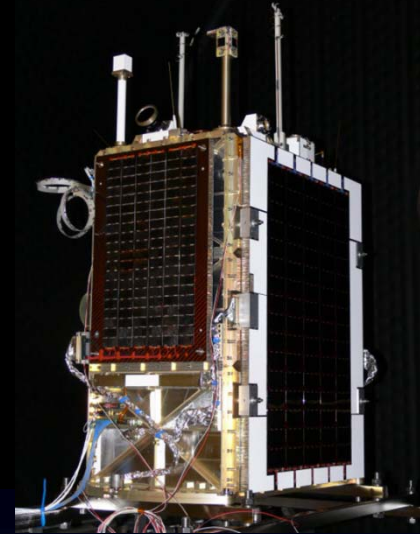
Think inside the box

- CubeSats, by their definition, challenge engineers to push limits of volume and mass constraints.
  - Thank you for setting us with the problem Prof. Twiggs.
- Miniaturisation is a universal goal
  - (even the big guys have a need for smaller parts)
- What kind of performance can I squeeze out of a 10cm cube?
  - There are still many sceptics about CubeSat utility value.
- We are here because we love the challenge that CubeSats provide.

CubeSat Design Specification Rev. 12
The CubeSat Program, Cal Poly SLO
Page 1

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CubeSat Design Specification

(CDS)

CUBESAT
California Polytechnic State University

A new space industry

- CubeSats have introduced an order of magnitude change in cost of space.

- Pumpkin pioneered the commercial CubeSat model.

- Calpoly have led the community

- Lower barriers to entry mean more SMEs and start-ups.
 - SMEs = innovation.

CUBESAT INNOVATION AT CLYDE SPACE.

EPS

- Interface to pull-pin and separation switch modified:
  - Zero current draw on launch vehicle
- 5V and 3.3V Regulators redesigned:
  - Efficiency up to 95-98%
  - Output current up to 2.5A nominal, 4A on request.
  - Additional 12V and 2.5V regulators available on request.
- XUEPS variant can handle 12 Solar panels of 12W
  - For deployed panel systems and also 6U, 8U and 12U CubeSats.

1U CubeSat EPS
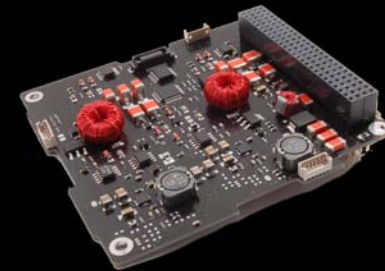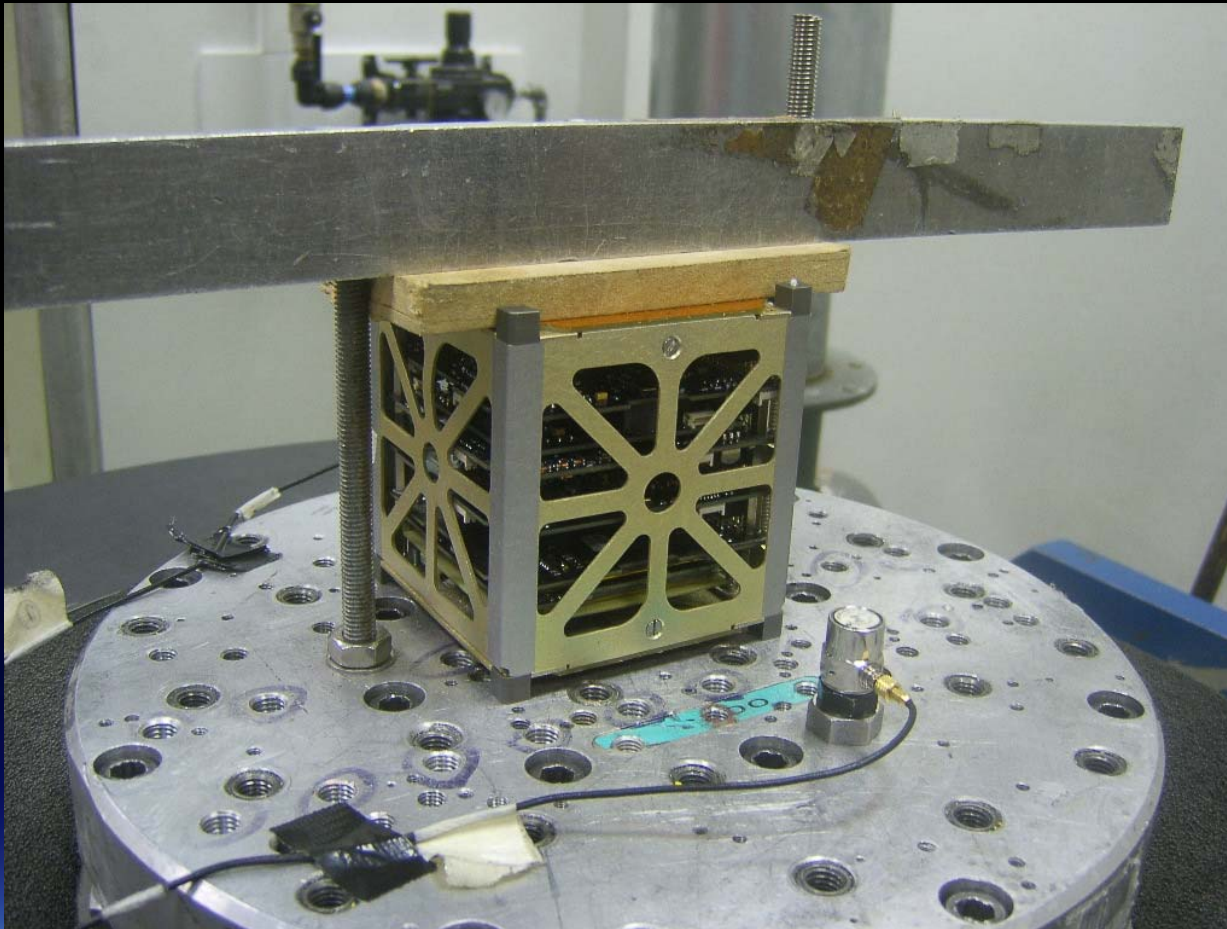
3U CubeSat EPS

XU CubeSat EPS

Batteries

- Updated the design of supporting electronics
  - Zero current draw from local circuitry
  - Improved protection circuit for over-current
- Improved battery assembly method
  - Includes battery 'clamping'
- New heater design
  - 200mW from 3.3V bus
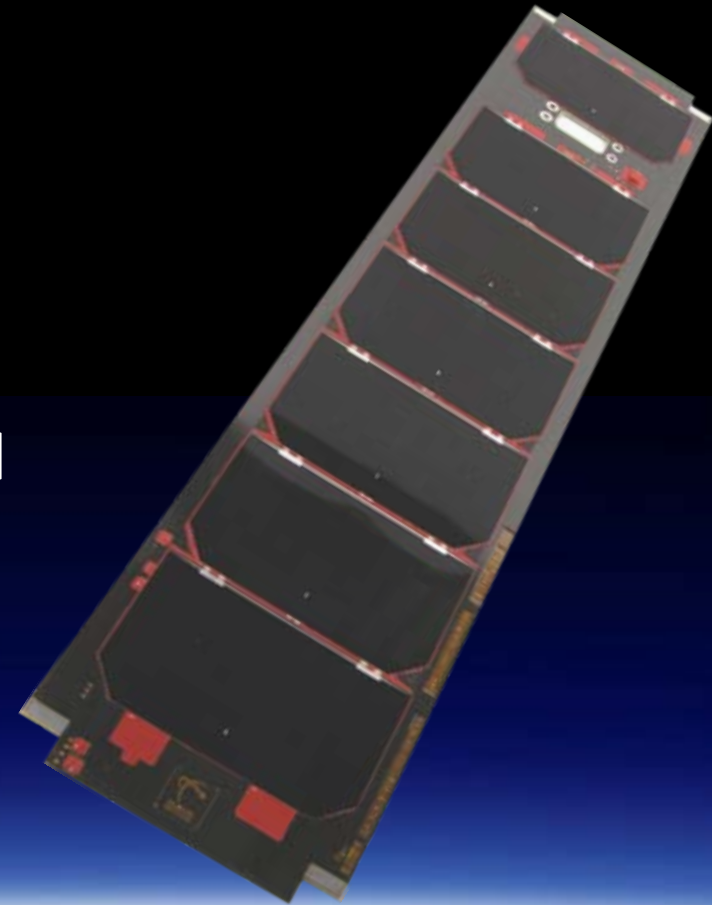 - Or 460mW from the 5V
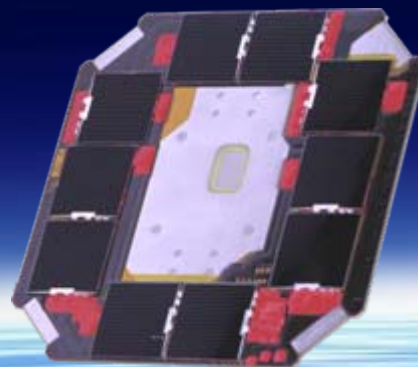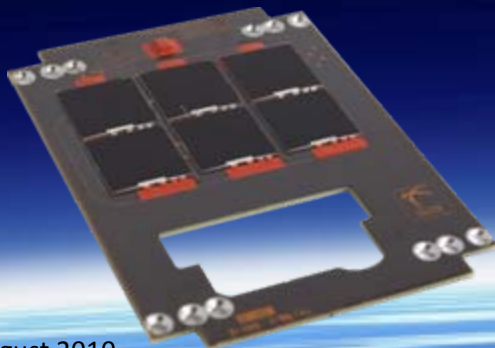- Tested for shuttle launch

..and qualified to NASA GEVS

Solar Panels...

- Refined our design and assembly process
- Two standard cell sizes
  - Large area and 2cmx2cm
- Hold stock of cells for shorter lead-times
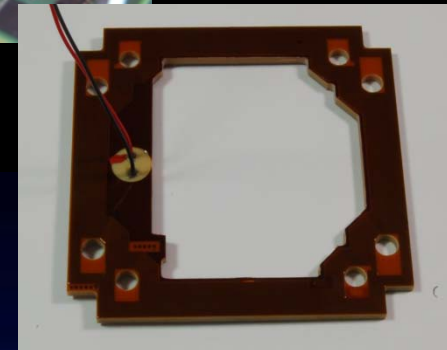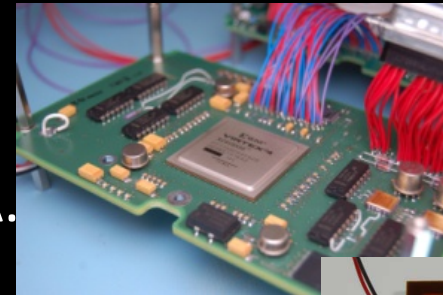- Embedded MTQ coil design refined
- Sensors mount direct to panel.

16 August 2010

ADCS Module

- **FPGA based system**
  - Extended-Kalman filter ADCS control algorithm running on FPGA.
  - +/- 1° pointing accuracy.
  - Magnetometers, MEMs rate sensors, sun-sensors and GPS
  - Magnetorquers and micro-reaction wheels.
  - Target volume of 90x90x28mm.
- **In development**
  - Available Q2 2011.

Interface Module

- 24 Switched lines.
  - SEVEN for 3.3V
  - SEVEN for 5V
  - SEVEN for Raw battery (VBAT)
  - THREE for 12V.
  - Each switch provides over-current protection switch and is commandable ON and OFF.
- 40 Analog channels for sensors.
- FIVE bidirectional serial to I2C interfaces.
- 10 Layer PCB
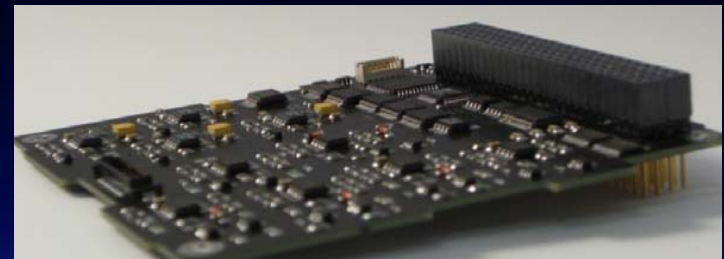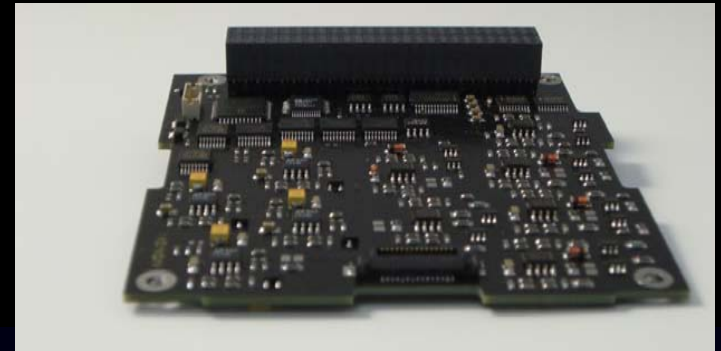
CubeSat Pulsed Plasma Thruster

- Design specifications (thrust is per pulse):
  - Power: 1W max. Quiescent power of 0.1W
  - Mass: Target of 120g. Absolute max is 150g
  - Volume: 90.17 x 95.89 x 27 mm
  - Thrust: 2.84uNs
  - ISP: 416.6s
- Joint development between Clyde Space and Mars Space

CubeSat Pulsed Plasma Thruster Control Electronics
July 2010

www.clyde-space.com

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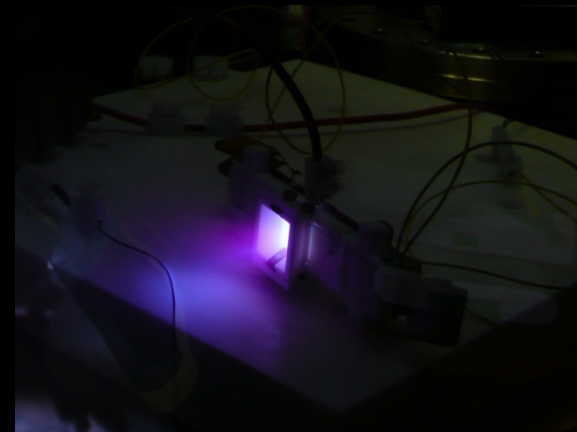
CubeSat Imager

Aims

Provide an extremely low cost optical imager
- With Landsat-class imaging
- Easily customisable for bespoke missions
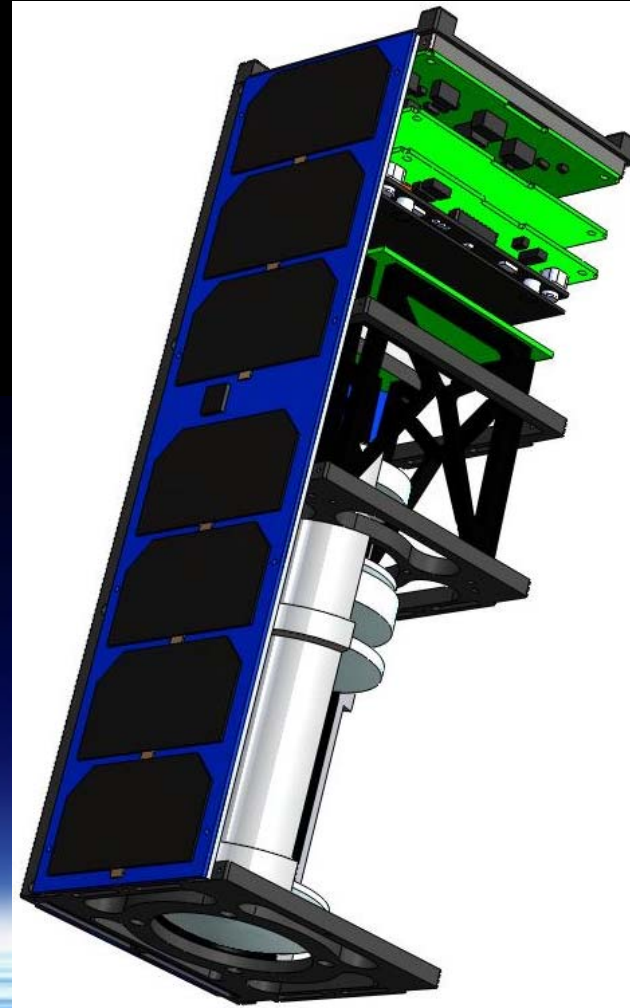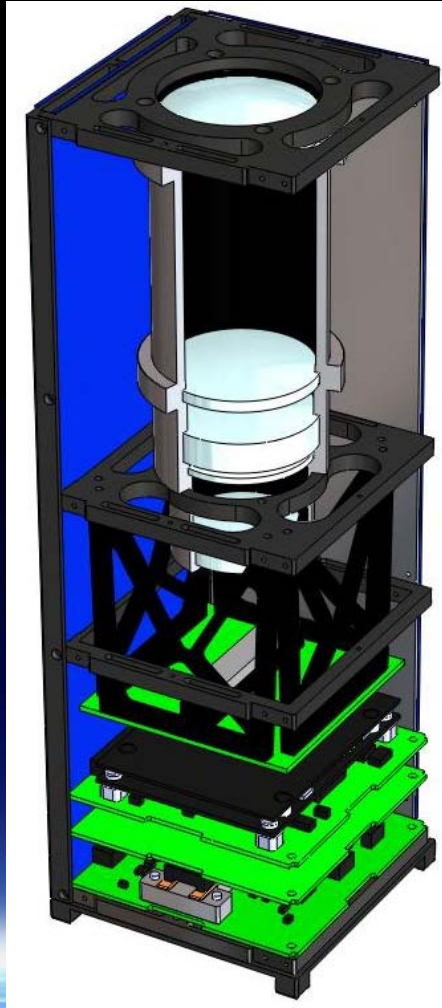- Low cost enables constellation missions

Baseline optical performance

Ground resolution:	30 m
Swathe:	122 km
Spectral properties:	Four channels 400-800 nm
Imaging mode:	Pushbroom

Science & Technology Facilities Council
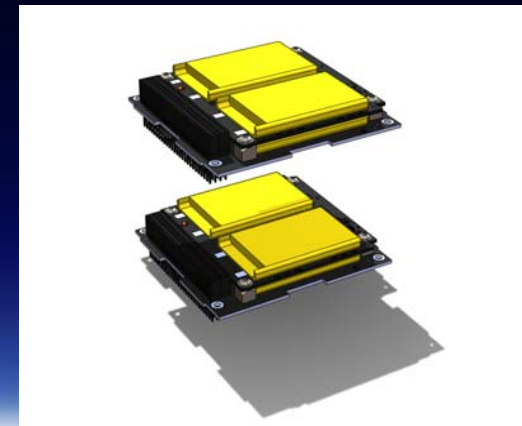**UK Astronomy Technology Centre**

First-cut design

Online updates

- User manuals are being migrated to online resource.
  - EPS and Battery User manuals now available for download.
- Mechanical 3D models
  - EPS and Battery 3D models now available online as .STEP files.
- We'll continue to populate for solar panels and other systems.

LIVING THE DREAM? CONCLUDING COMMENTS

Look before you leap!

Clyde Space is a small, space business in a world run by bankers. A few tips from our experience:

- Innovation needs funding.
- Universities can afford to do blue sky research; small businesses rarely can.
    - Keep your innovation current and market focussed.
- The CubeSat community is full of helpful people.
    - We're all in this together. Better CubeSat performance = more missions.
- ALWAYS have a plan!
- Make sure it is right for you
    - (if not, let someone else take the risk and you just work for them).
- Don't Panic!
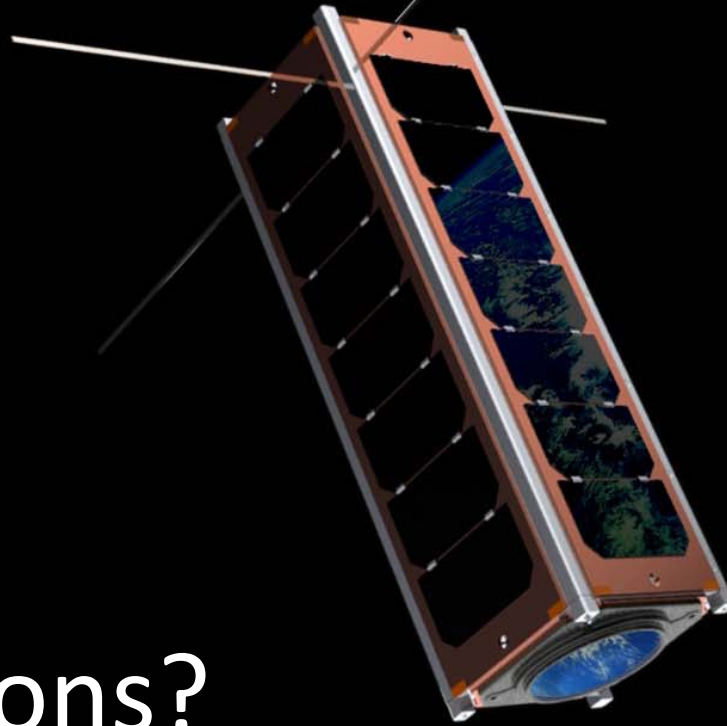
Questions?

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