

The PocketQube Concept

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California State Polytechnic University
CubeSat Workshop
April 23, 2014



T-LogoQube Team

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Lead Engineering Mentor
Science Mentor
Science Mentor
Software Mentor
Software Mentor
Engineering Mentor
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Prof. Robert Twiggs (MSU)
Prof. Lynn Cominsky (SSU)
Prof. Benjamin Malphrus (MSU)
Brian Silverman (PICO)
Barry Silverman (DiSUS)
Dr. John Doty (NA)
Jeffrey Kruth (MSU)
Steve Anderson (SSU)

Overall Student Team Leader
MSU Student Team Leaders

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Sean McNeil and Will Roach (MSU)

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Mills, Hunter
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Fitzpatrick, John
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Grindrod, Jennafer
Healea, Jordan
Lawson, Eric
Mabry, Hannah
Mays, David

Institutions

SSU (Sonoma State University)
MSU (Morehead State University)
LHR (Little H-Bar Ranch)
NA (Noqsi Aerospace)
PICO (Playful Invention Company)
DiSUS



Acknowledgements:

Chantal Cappelletti and the UniSat-5 team; Prof. Kevin Brown, Tyler Rose, Lance Simms, Luke Lim, Bob Kroll, Eric Thomas, Mike Combs and the entire CXBN team; 50 Dollar Team: Stuart Robinson, Michael Kirkhart, Howie DeFelice, Charlie Cantrill, Bo Lowery; also Eric Tapio, Greg Sprehn, David McCall, Kamal Prasad, John Collins, Laura Chase, Aureore Simonne and Haider Khaleel.



Overview

- Development objectives
- Launch of PocketQubes
- Summary of operational performance
- Future of PocketQubes
- Conclusion

Why PocketQube?

- We have the CubeSat and the CubeSat standard
- Internationally accepted space concept
- Many launch opportunities, even on the ISS
- Wide spectrum of vendors with proven components
- Rapid technology demonstrations
- Commercial applications
 - Planet Labs
 - Small satellite validation by Google's purchase of Skybox

- We have everything with Cubes
- Why introduce a new concept in small satellites?
- CubeSats were developed for education and university use

Now everyone else has accepted the concept, we got

SCREWED



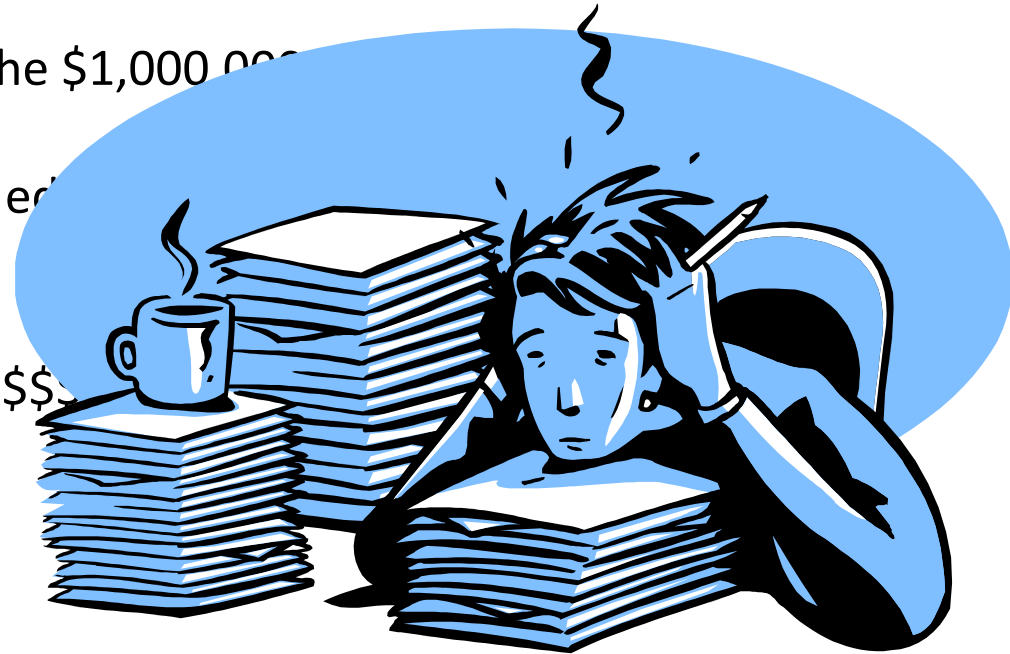
Launch costs have risen to accommodate to meet demand

\$40k to \$120k for a 1U

Insignificant expense in the \$1,000,000

Opportunity for independent ed

We have ElaNa, but we trade \$\$\$



Enough to stop students from considering a career in space

Why PocketQube?

Launch cost

Launch cost

Launch cost

\$\$\$\$\$\$\$

Divide cost of a 1U launch with each small spacecraft

How small, how many = 1U CubeSat?

Make a spacecraft 1/2 size of CubeSat?

Already done – high cost

Make a spacecraft ¼ size of CubeSat?

Still cost \$40k

Want to significantly lower cost

How to significantly lower cost?

For cost less than or equal to \$20,000

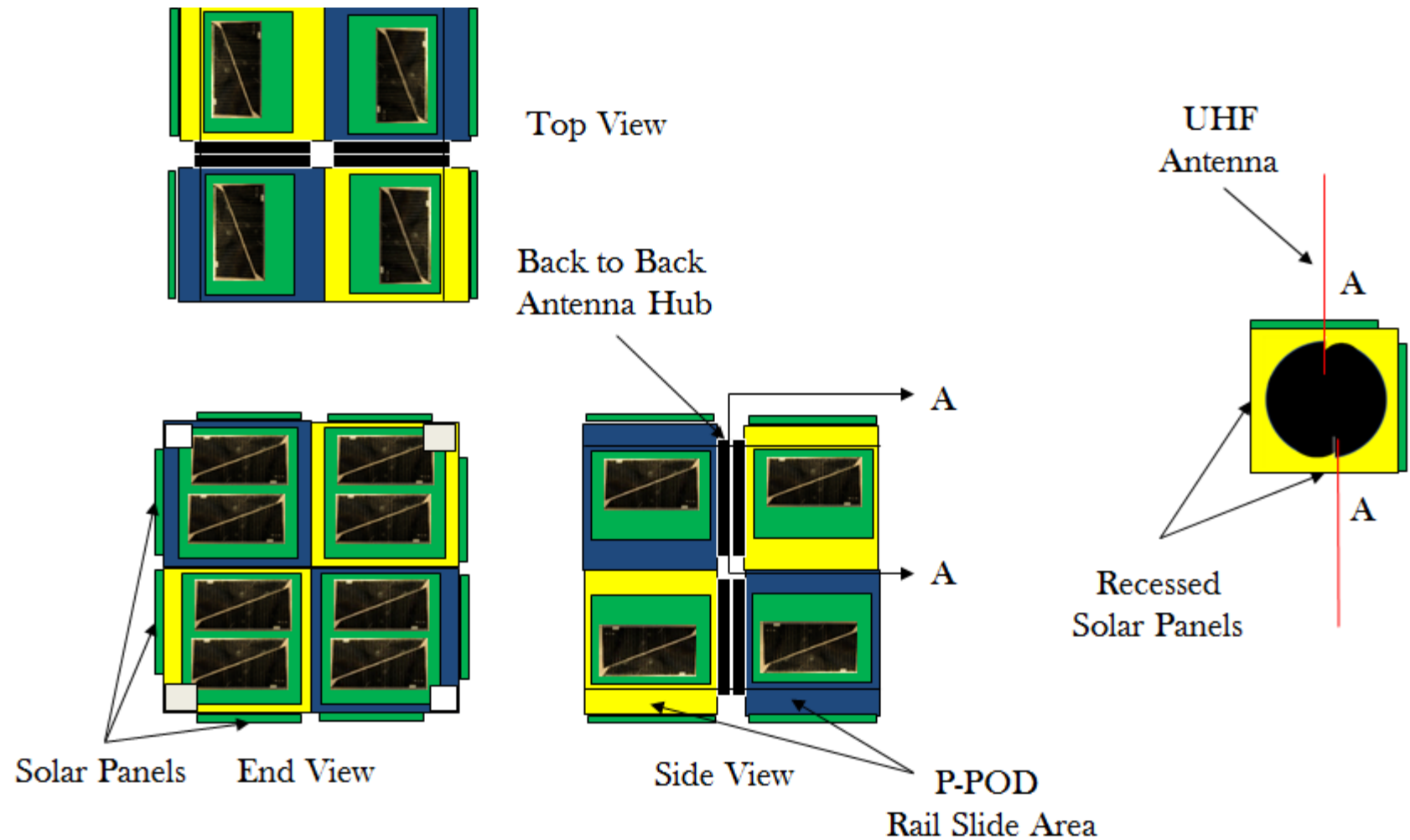
Need to divide \$120k/6 or \$120k/8

Try eight Femto sats in place of 1U CubeSat

= 5 cm cube

Get eight for 1U format

The PocketQube Concept

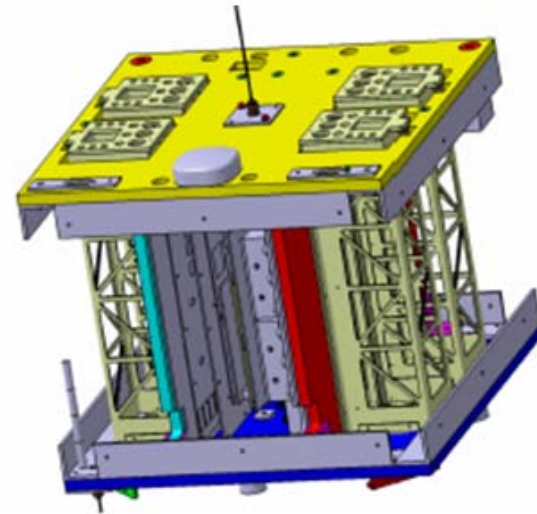


What happened in reality?

First design driven by launch opportunity

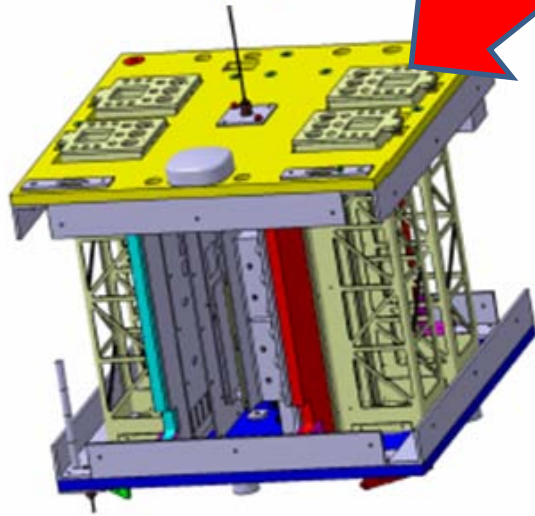
University of Rome
EduSat launch on Dnepr

PocketQub deployment test (MRFOD)



Funded by Italian Space Agency (ASI)

PocketQub deployment test (MR-FOD)



Launched 2011

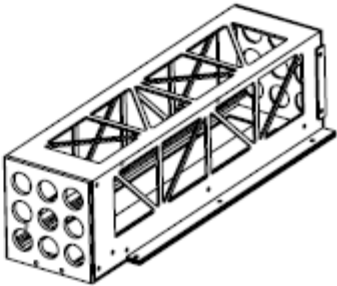
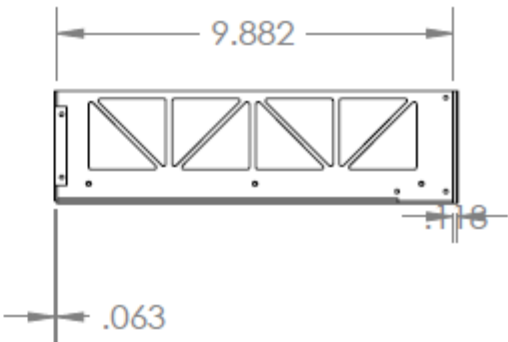
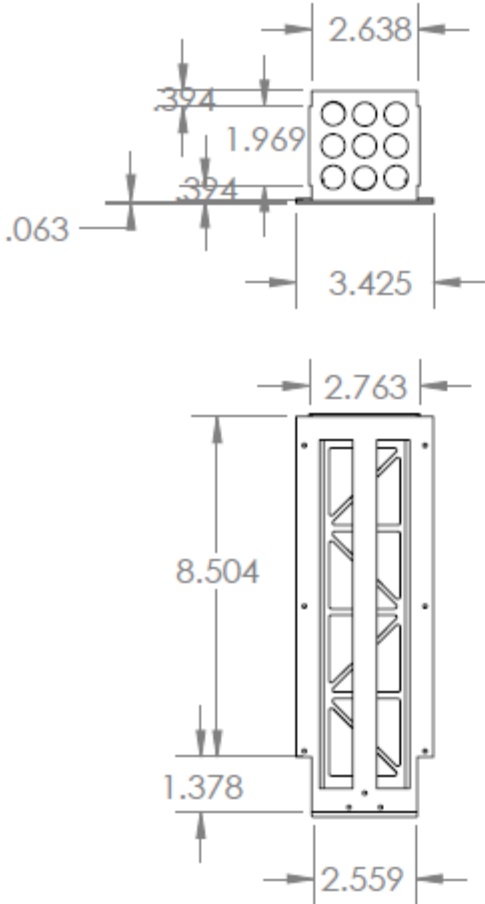
Flew MR-FOD

Not 1U CubeSat format

No PocketQubes

Funded by Italian Space Agency (ASI)

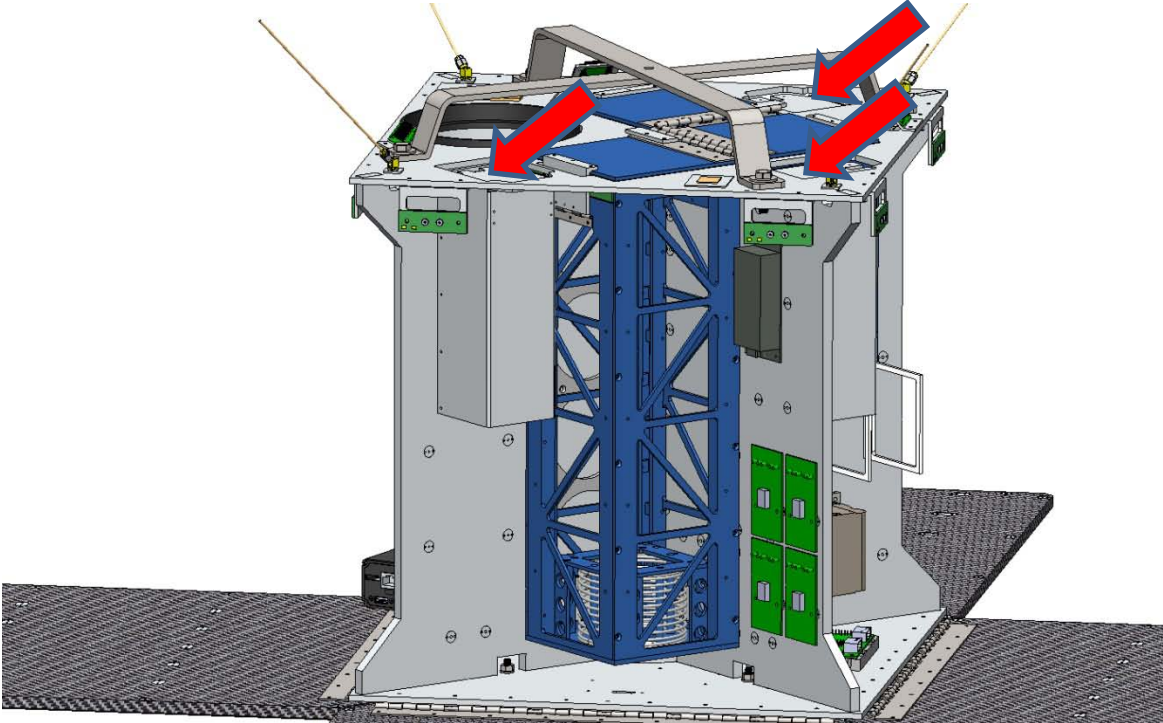
MR-FOD PocketQube Launcher



Second Chance 2011

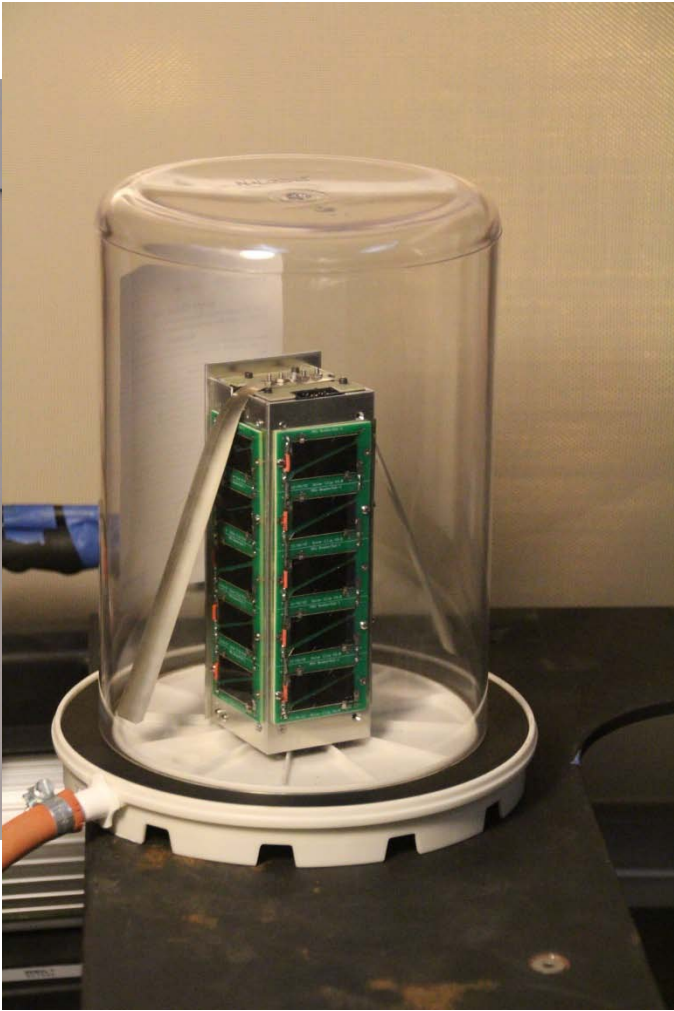
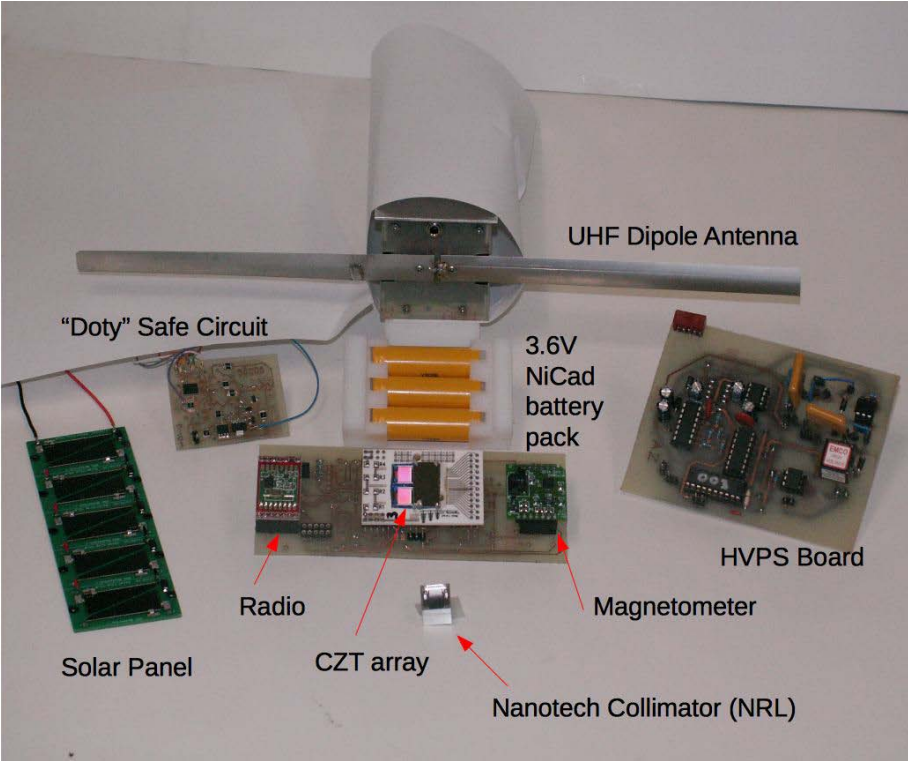
UniSat-5 – another Dnepr launch -2013

3- MR-FOD deployers



UniSat-5 – another Dnepr launch

2.5P T-LogoQube/Eagle-1



1.5P \$50Sat/Eagle-2



Wren *STADOKO*

Launch
2013

The German PocketQub “Just4You”

By : Paul Kocyla, Sacha Tholl, Bastian Döen, Matthias Stahnke

Attitude and Orbital Control



Reaction wheels



Pulsed Plasma Thrusters

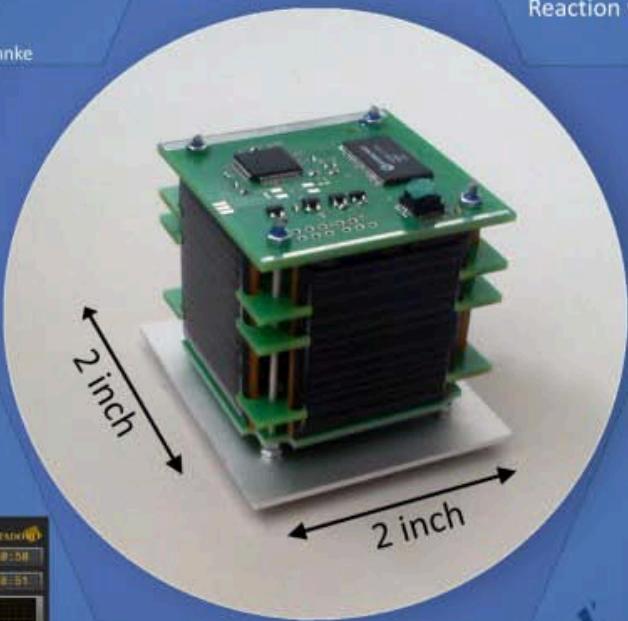
Ground Control



Mobile Ground Station

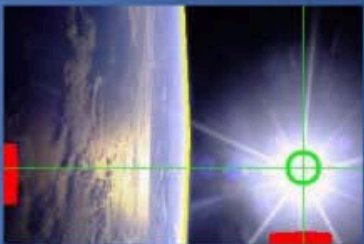


Intuitive Mission Control Software



PocketQub
privately funded
design matches proposal
from Prof. Bob Twiggs

Navigation



Camera based determination
of sun and earth horizon vector



3 axes rotation rate



3 axes magnetometer

UniSat-5 -Dnepr launch Nov. 29, 2013



UniSat-5 – another Dnepr launch

Operational Results

T-LogoQube/ Eagle-1 ----- 2 months operation – now no contact

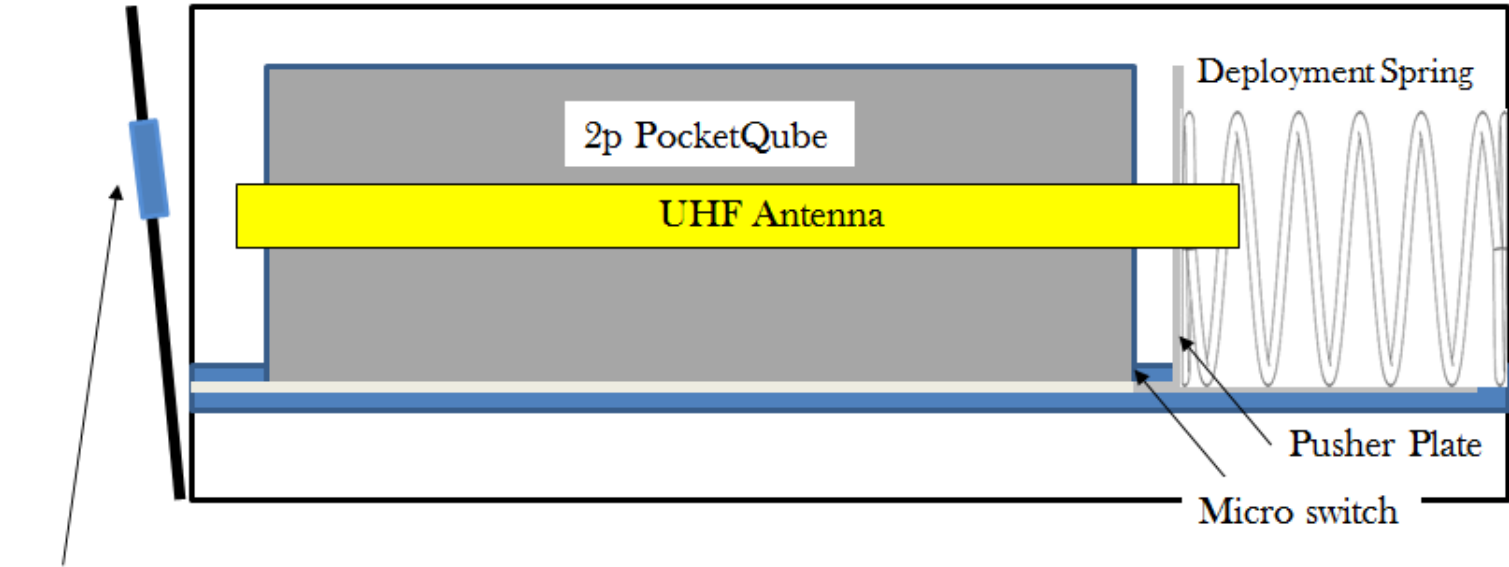
\$50Sat/ Eagle-2 ----- still operating – all systems GO

CubScout ----- no contact

Wren ---- some recent contact

MR-FOD
PocketQube Deployer

Deployer Door



1/2 dia hole in door
for remove-before-
light pin

Antennas can be folded
and rub on the inside of
the deployer

The image contains two sets of technical drawings for PocketQube modules. The left set is for a 1 p 50 mm module, and the right set is for a 2 p 50 mm module. Each set includes top, side, and end views with various dimensions and labels for mounting options.

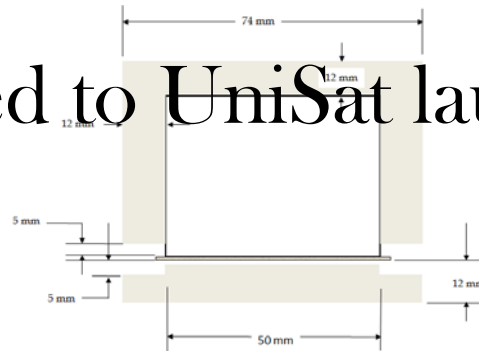
1 p 50 mm PocketQube:

- Top Views:**
 - Option 1:** Dimensions 64 mm (total width) and 50 mm (inner width).
 - Option 2:** Dimensions 64 mm (total width) and 57 mm (inner width).
- Side View:** Dimensions 64 mm (width) and 50 mm (height). Label: "7 mm on ends for mounting antennas or other stuff."
- End View:** Dimensions 56 mm (+/- 0.25 mm) (width) and 50 mm (height). Label: "Base Plate 0.0625 Al or PCB".
- Optional cut off switch mounting:** Shows a side view with a dashed box for a switch and an end view with two vertical pins.

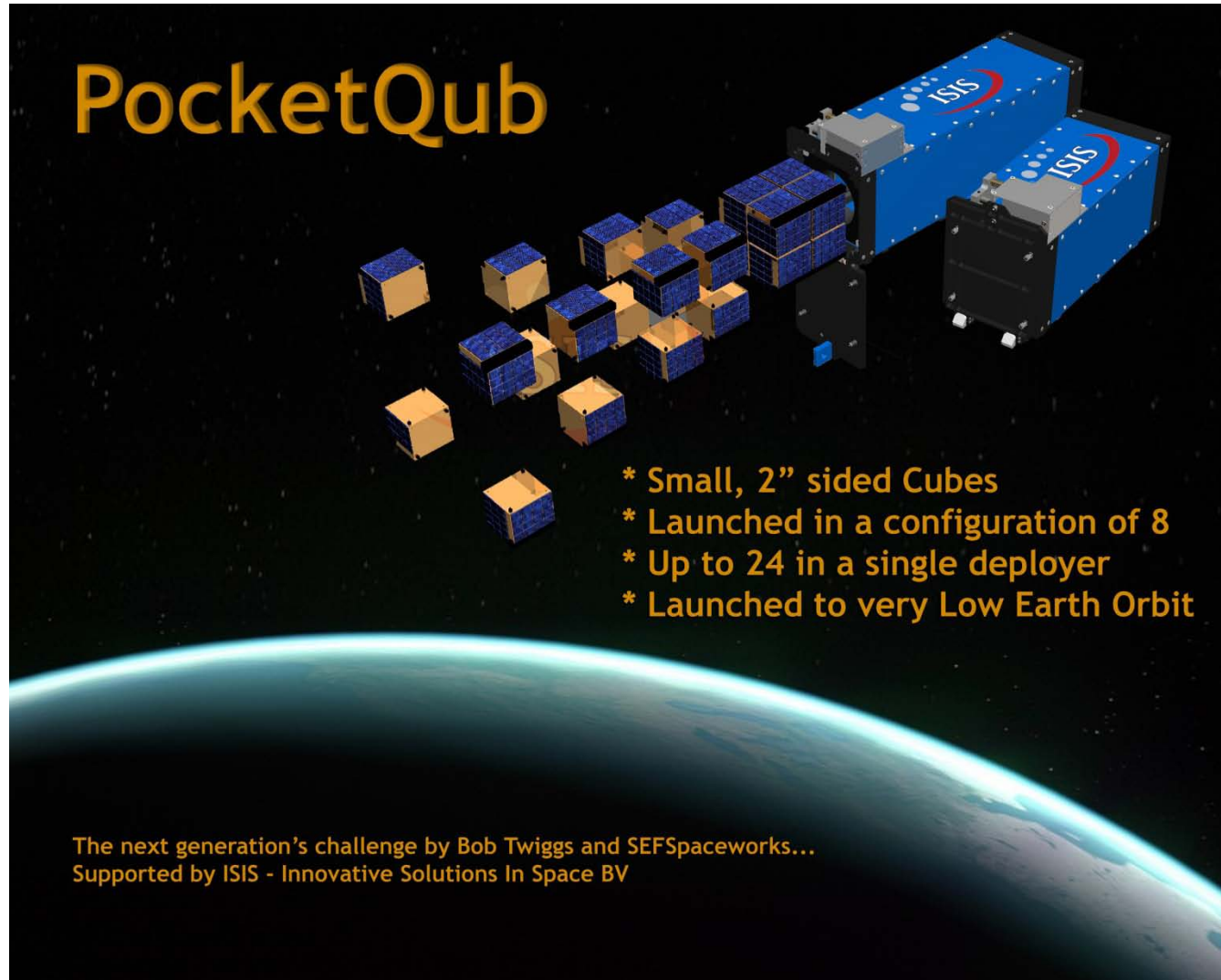
2 p 50 mm PocketQube:

- Top Views:**
 - Option 1:** Dimensions 128 mm (total width) and 114 mm (inner width).
 - Option 2:** Dimensions 128 mm (total width) and 121 mm (inner width).
- Side View:** Dimensions 128 mm (width) and 50 mm (height). Label: "7 mm on ends for mounting antennas or other stuff."
- End View:** Dimensions 56 mm (+/- 0.25 mm) (width) and 50 mm (height). Label: "Base Plate 0.0625 Al or PCB".
- Optional cut off switch mounting:** Shows a side view with a dashed box for a switch and an end view with two vertical pins.

Presently Limited to UniSat launch on Dnepr



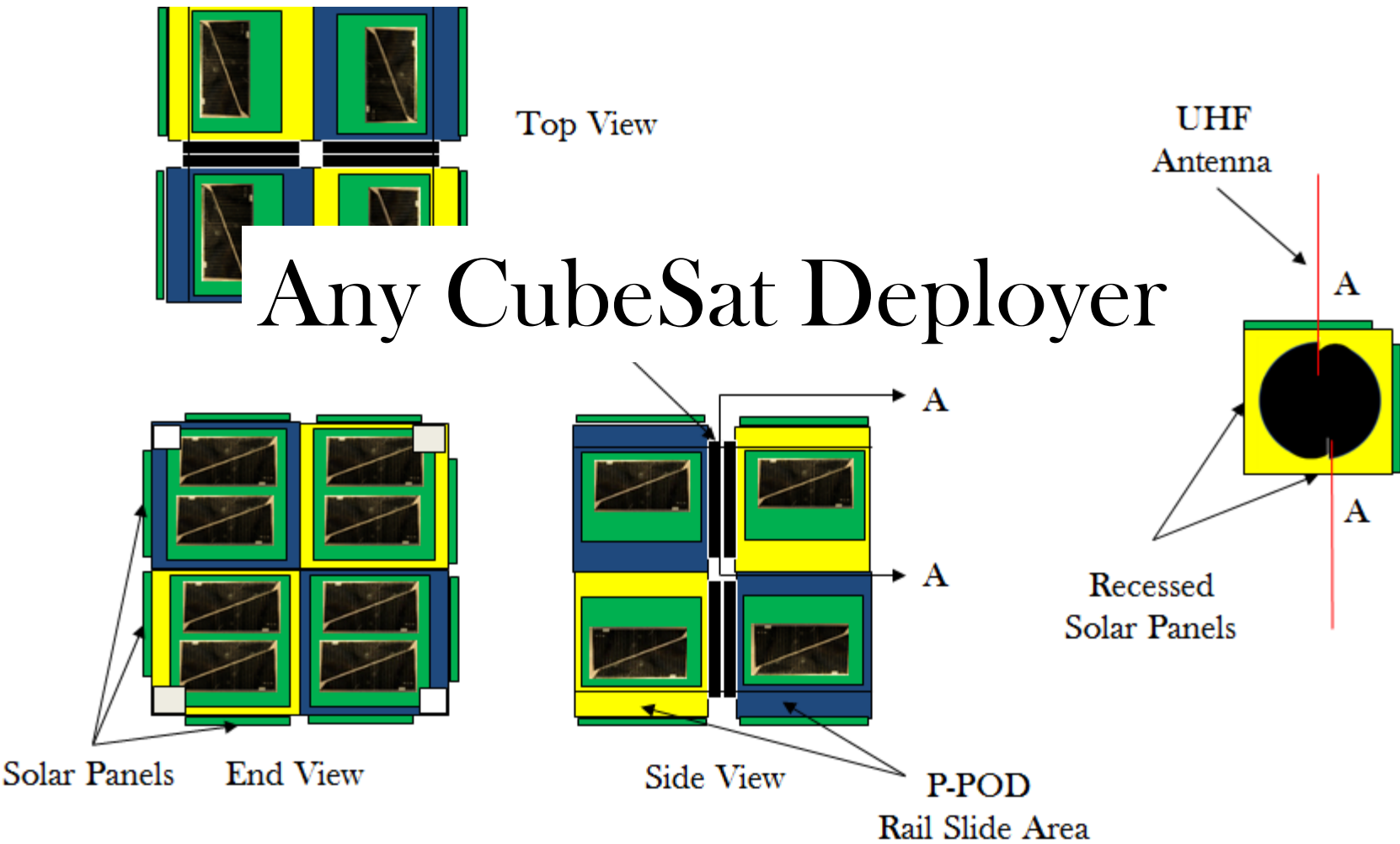
Allowable expansion around the PocketQube for Deployer



PocketQub

- * Small, 2" sided Cubes
- * Launched in a configuration of 8
- * Up to 24 in a single deployer
- * Launched to very Low Earth Orbit

The next generation's challenge by Bob Twiggs and SEFSpaceworks...
Supported by ISIS - Innovative Solutions In Space BV



Conclusion

First PocketQubes launched

Proven do work with really cheap parts

Expect launch costs to be $\sim 25\%$ or less from CubeSat

Two launch methods

UniSat – Dnepr

Any CubeSat launch

More to come on PocketQubes in following two presentations