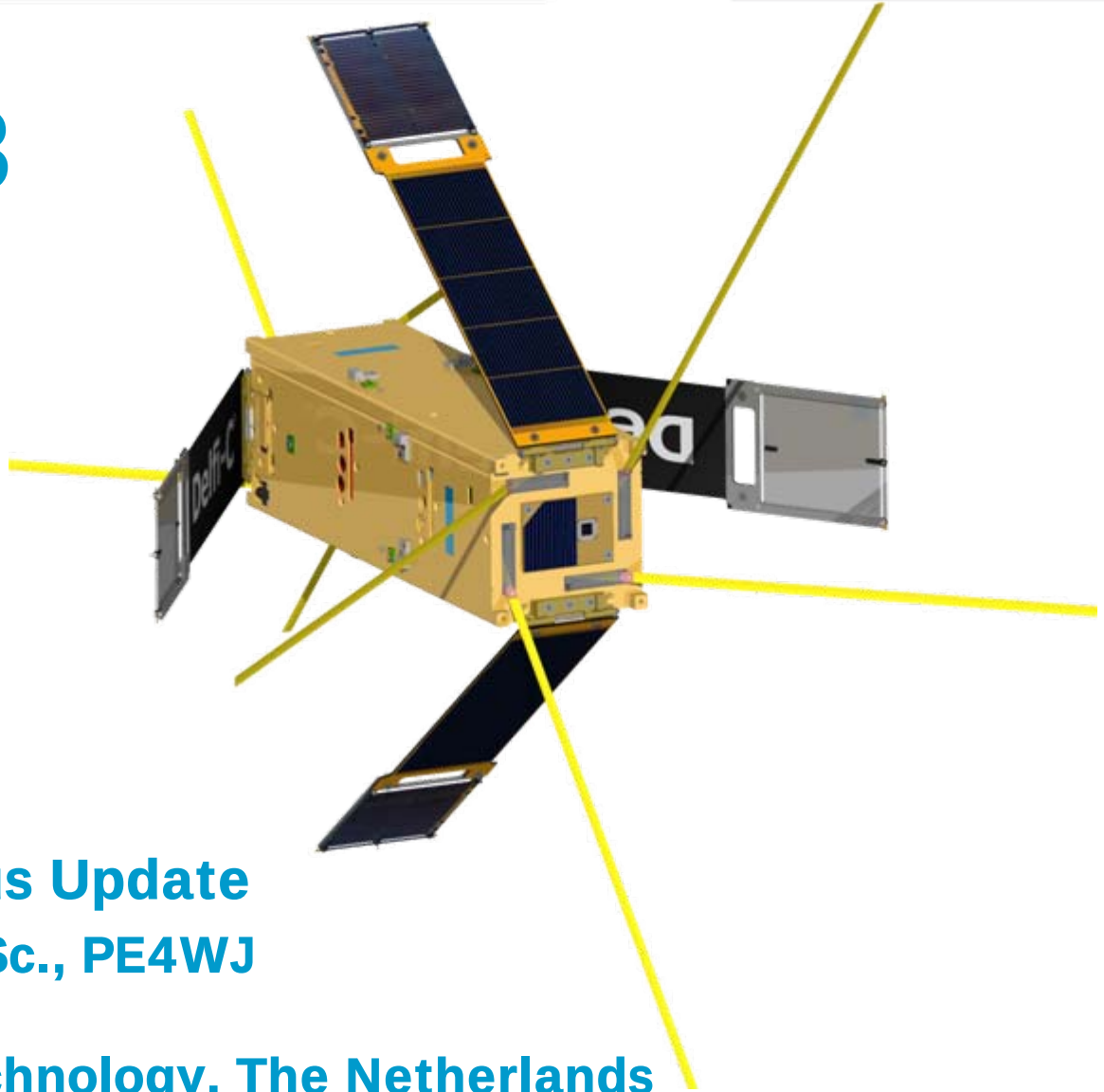
Delfi-C³



Integration, & Status Update

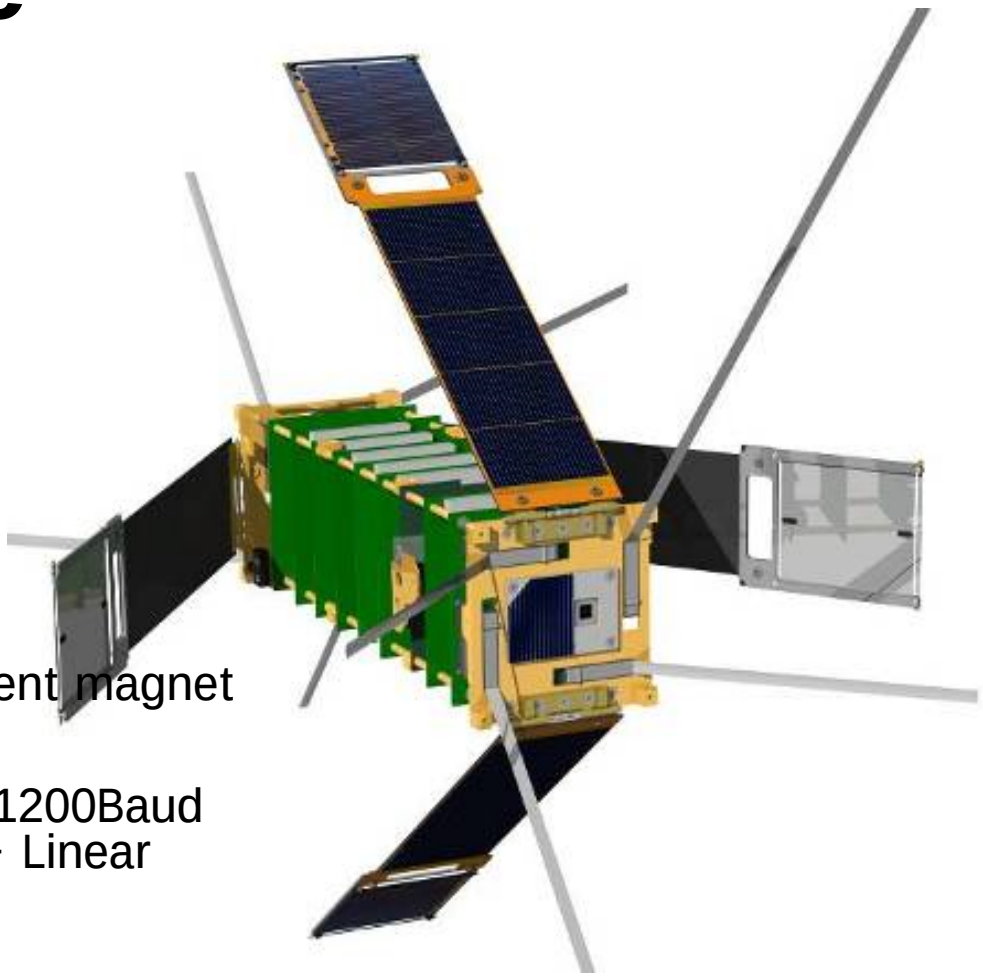
Wouter Jan Ubbels MSc., PE4WJ
Project Manager
Delft University of Technology, The Netherlands

The Delfi-C3 satellite

- 3 unit CubeSat structure, 3kg
- 2 Sun Sensor payload units
- 4 deployable panels at 35 degrees (max/min power):
  - –Carbon Fiber Reinforced Plastic
  - –Thin Film Solar Cell payload suspension frame
  - –5 TEC1 GaAs TJ solar cells
- 2.5 W min. power available
- 8 antennas:
  - –4 VHF 50 cm downlink
  - –4 UHF 18 cm uplink
- ***No battery***
- ***No active attitude control***

The Delfi-C3 satellite

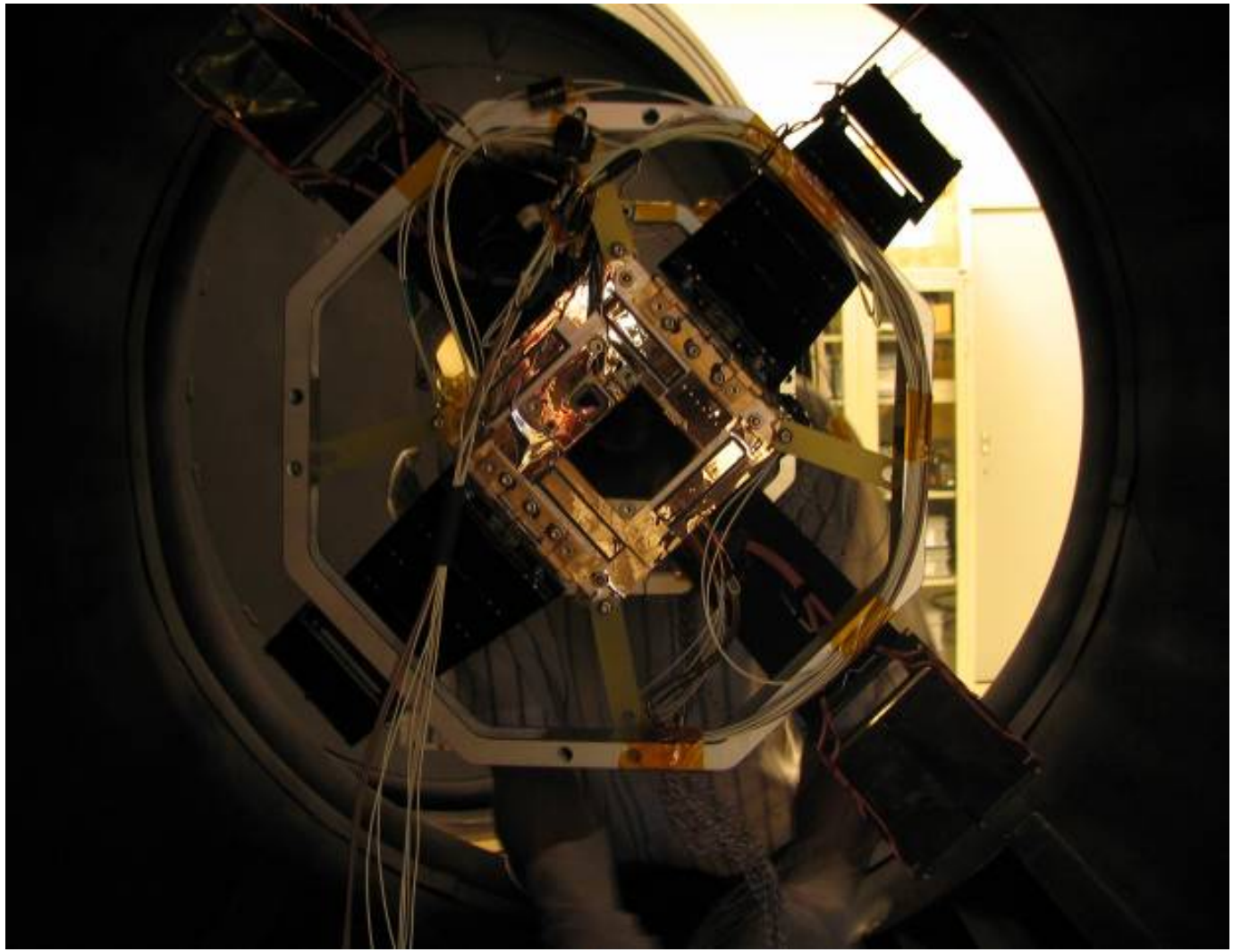
- EPS
  - 1 DC DC converter per solar panel
  - Current measurement
- CDHS
  - TI MSP430 OBC
  - Microchip PIC18LF4680 microcontrollers per subsystem
- Attitude Control
  - Magnetic hysteresis rods & permanent magnet
- COMMS
  - Two Redundant Transceivers, VHF 1200Baud BPSK AX.25 downlink, UHF uplink + Linear Transponder (after 3 months)
- Standard board interface
  - I^2C bus
  - 12 V DC power bus
- Passive thermal subsystem (thermal tapes)



Status

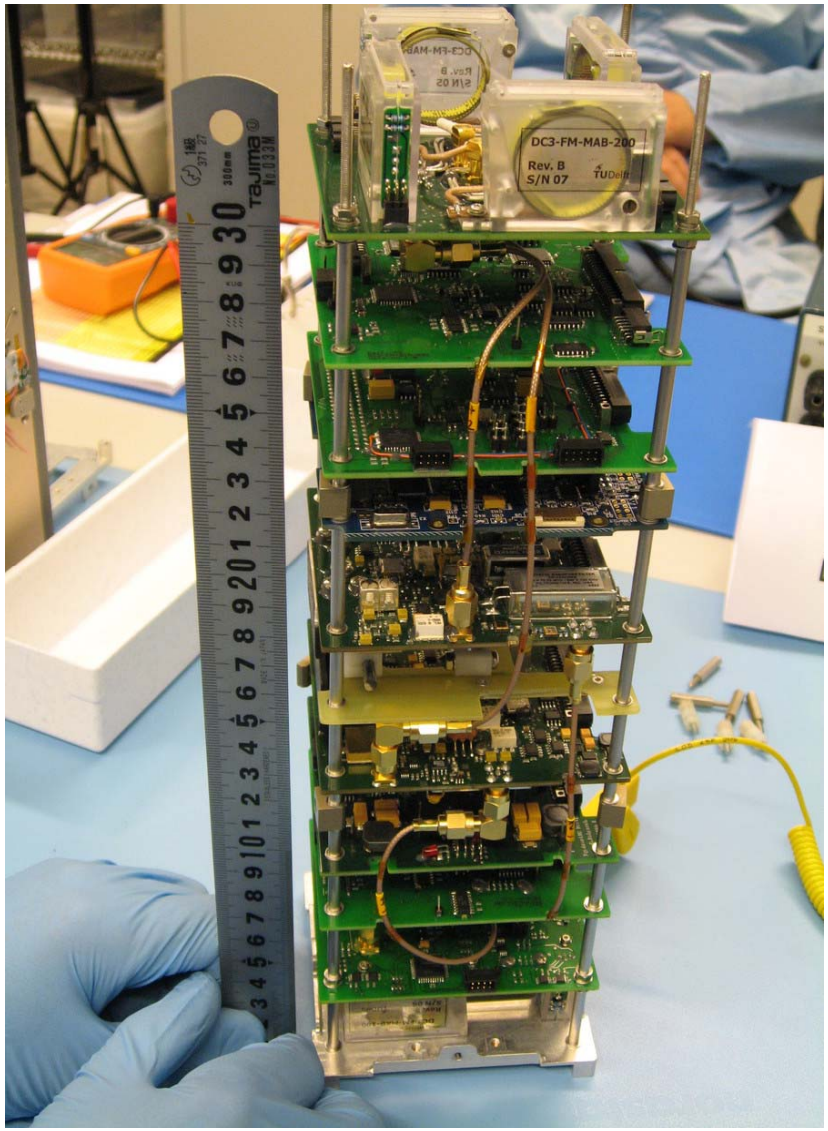
- Flight model successfully integrated
- Vibe test → ok
- TVac test → ok
- Currently in Toronto, awaiting shipment to India
- Launch on NLS-4 PSLV Sept-Nov 2007

TVAC Test

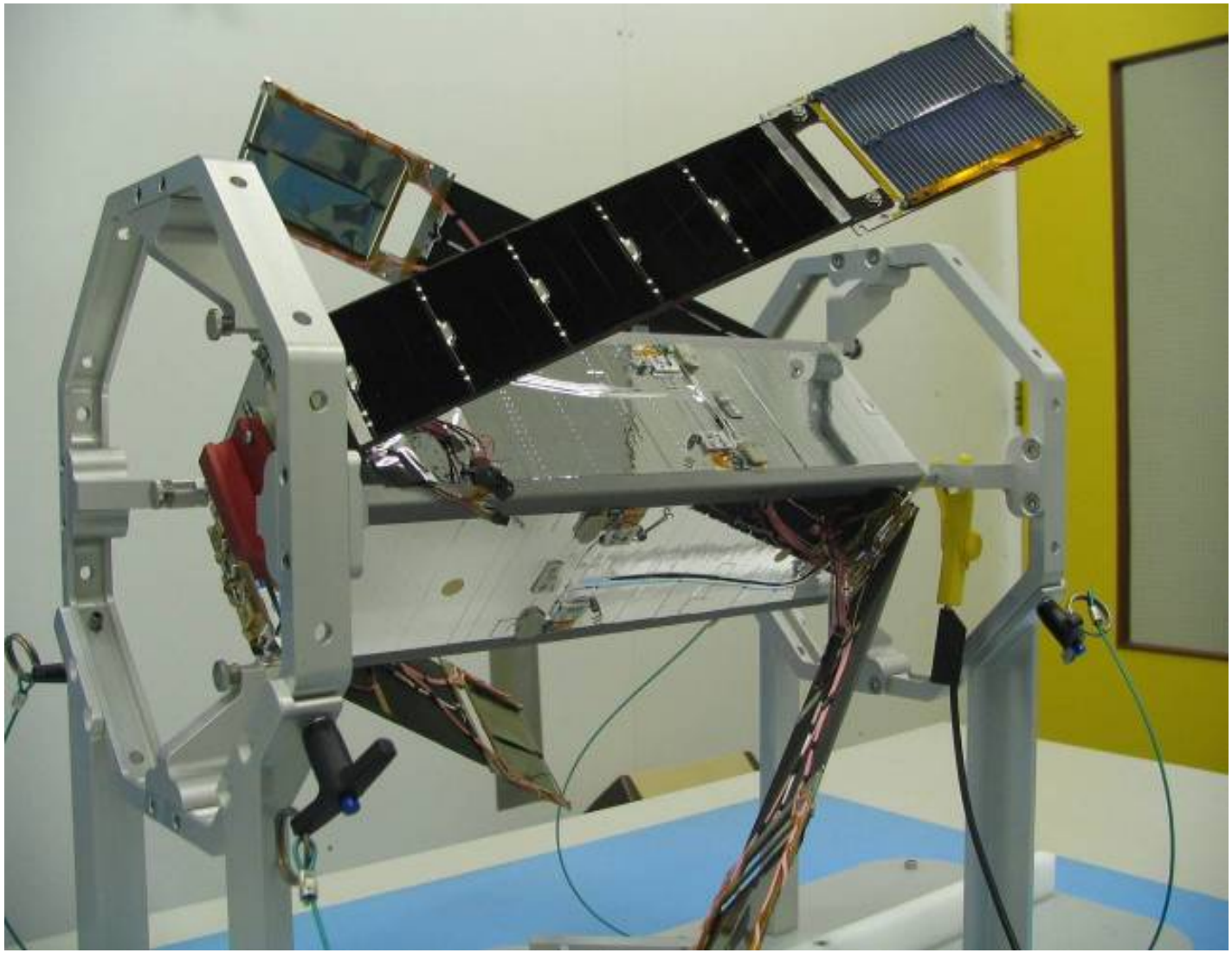


Vibe Test

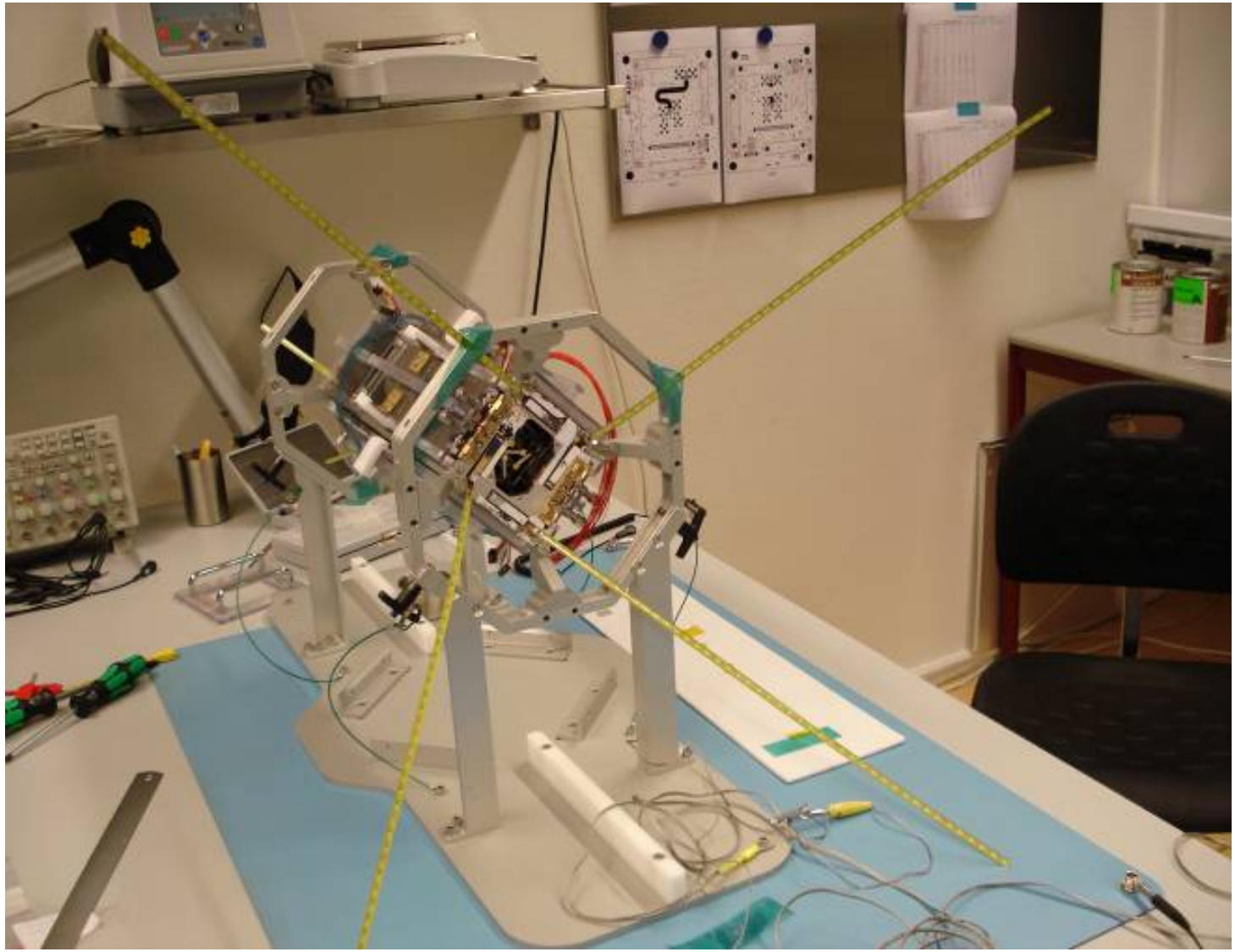
Delfi-C3 flight stack



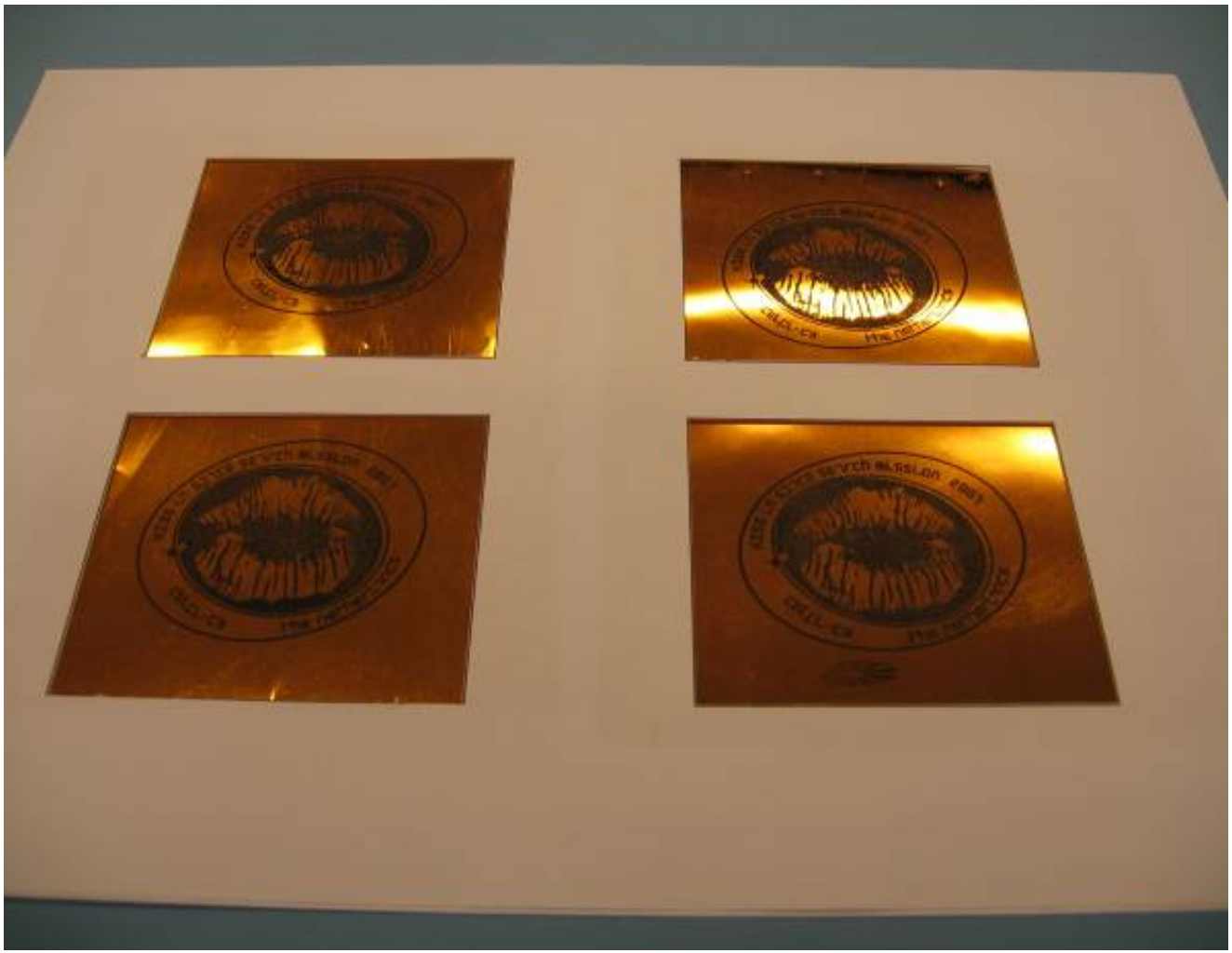
Flight configuration (antennas not deployed)



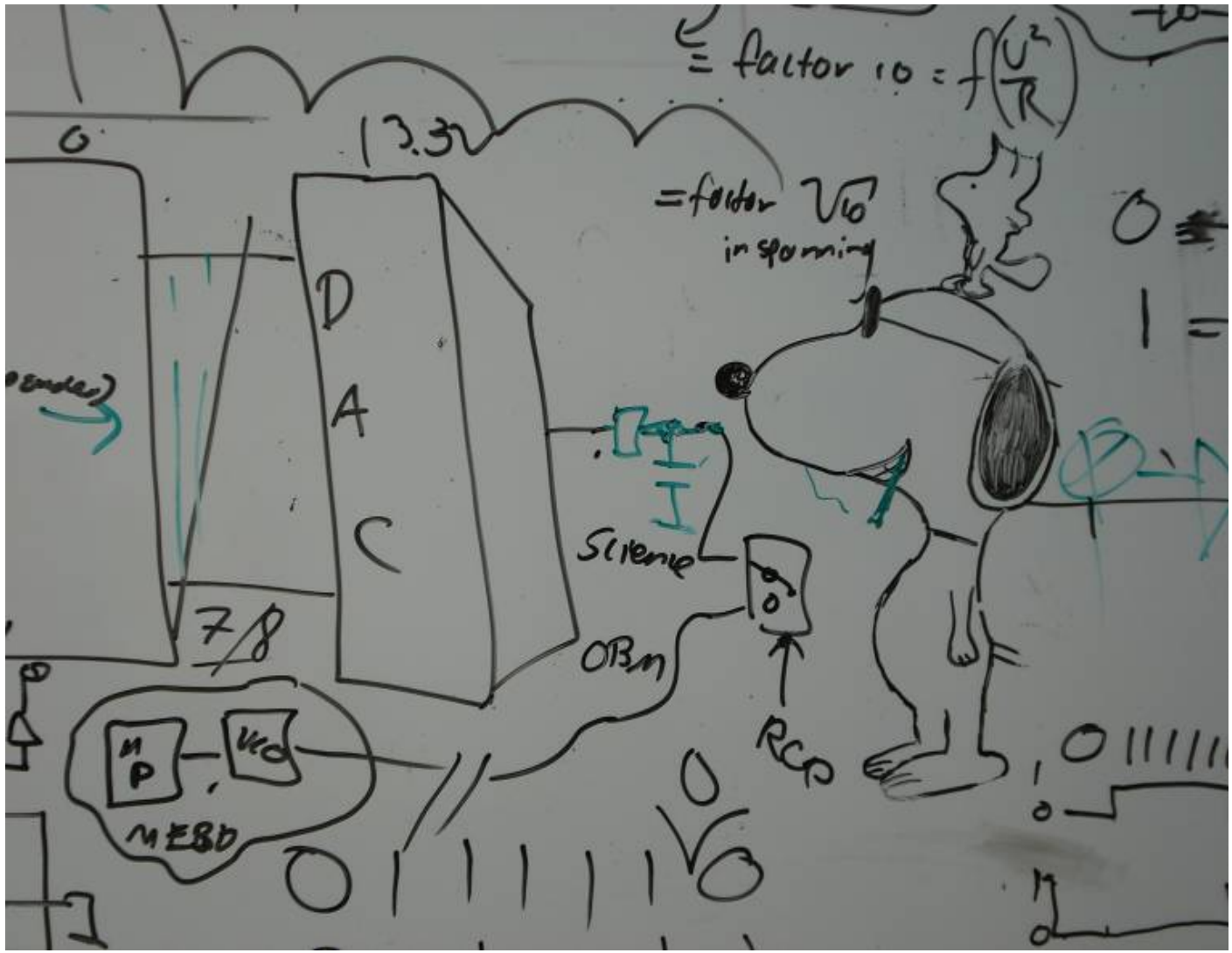
Deployed antennas



Space Art



How to design a satellite...



Lessons Learnt

- Start building prototypes early!
- In RF circuits, power matching is not always necessary
- Opamps make nice RF/IF amplifiers
- Do not choose 0000 as bus reset command
- Parasitic oscillations can popup just about anywhere
- I2C repeaters / pull down by PICs
- Use ground lines between I2C data lines (**Doh!**)
- Reserve spare pins on connectors, you will need them!
- Use 0-ohm resistors to connect subcircuits
- **And…**

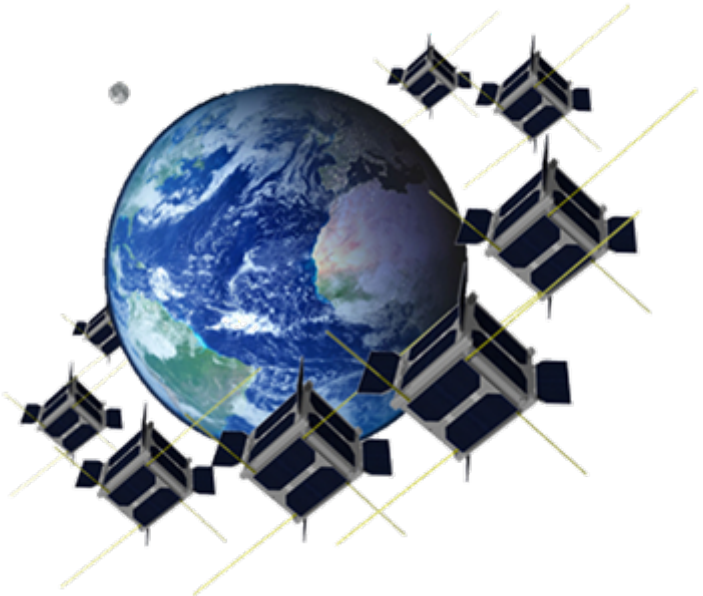
...Satellites are indeed, entirely constructed out of pizzas

Latest photos

- http://www.delfic3.nl/photoblog/

ISIS

Innovative Solutions In Space



Small Satellite Subsystems & Piggyback opportunities for (Cube)Sats

CubeSat Developers' Workshop 2007

ISIS – Innovative Solutions In Space B.V.
Satellites for fun, science and profit

- Founded in January 2006, indepently held company
- Board of 4 aerospace engineers
- Space systems engineering background
- Offices on campus of Delft University of Technology
- Spin-off from Delfi-C3 satellite project. This is not OUR project, but we all participate(d) in it and find it great fun.

ISIS – Innovative Solutions In Space B.V.

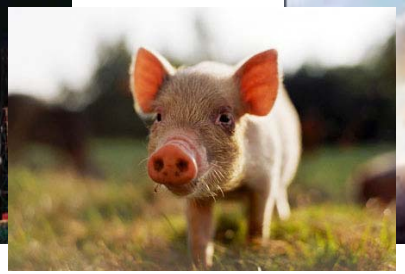
Marketing Director	Financial Director	Managing Director	Technology Director
A.R. Bonnema	E.D. van Breukelen	J.Rotteveel	W.J. Ubbels



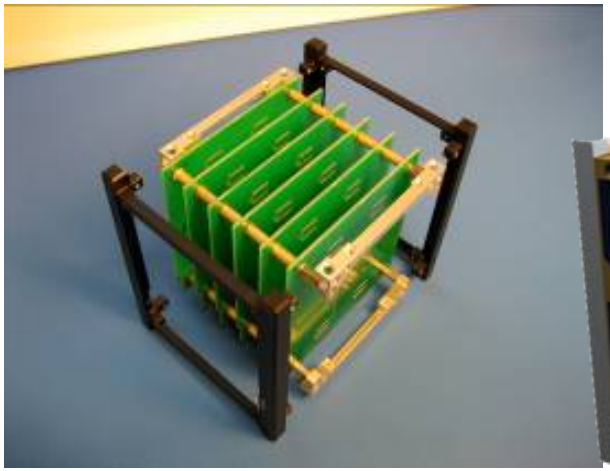

Vision

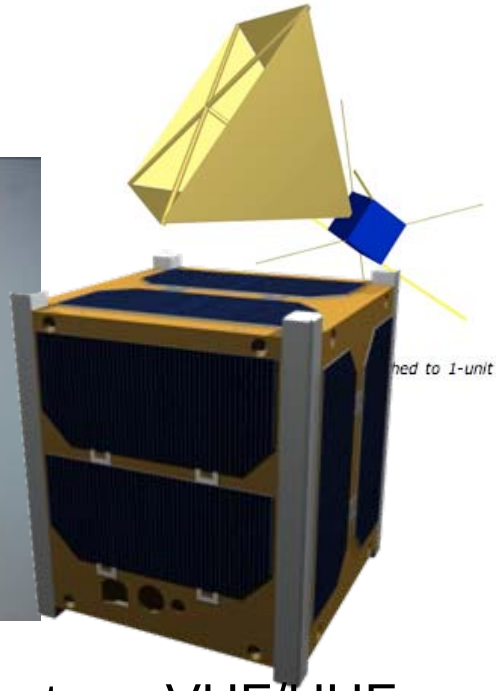
- Advances in electronics miniaturization
  - Commercial (micro-)systems technology applicable in space,
  - Smaller satellite systems as a result of improved functionality per unit mass
- Improved access to space
  - New launchers: Vega, Falcon, Stihl-II, Cyclone-4
  - Secondary payload rings: (ASAP, KAP, ESPA, etc)
- Temporal resolution will grow in importance
  - Growing need for small satellite constellations

What we do



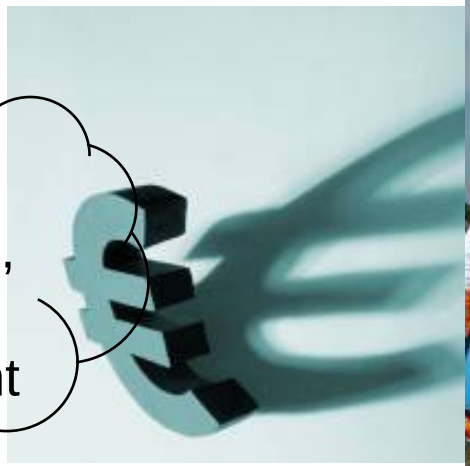
Piggyback launches 2008, 2009, ...





(Cube)Sat products: Structure, VHF/UHF Radio, Ground Station, microPropulsion, inflatables

Expertise, track record, Technology development



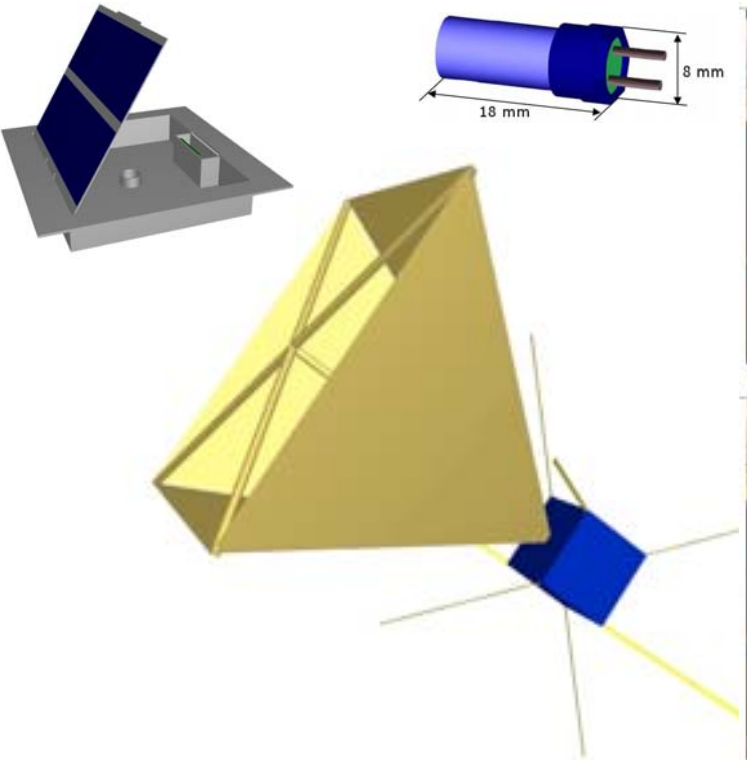
Small Satellite Engineering consultancy and subsidy projects for R&D

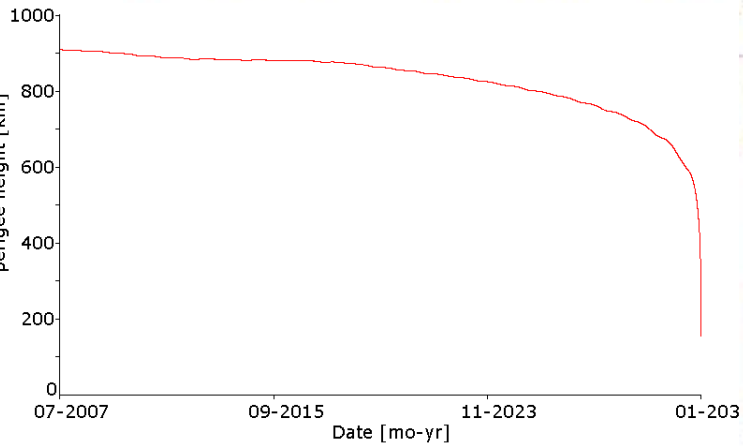
Educational space projects: CanSat, ..

Launch Services

- Access to space for payloads up to 10 kg
  - CubeSats
  - Nanosats
  - Fixed payloads
- LEO, piggy back
- Multiple configurations up to 20 kg
- Flight opportunities:
  - PSLV 2008Q2, one 1U CubeSat slot still available! (come and talk to me in the break if you're interested)
  - PSLV 2008Q4, …
  - Cyclone-4 maiden flight 2009Q4

What about space junk?
Long term R&D: inflatable De-orbit device





1: Opening of the lid

2: Introduction of gas

3: Central tube deploys

4: Initial spoke deployment

5: Spokes deployed halfway

6: Full deployment of the spokes

7: Deployment achieved

8: Internal pressure increases

9: Internal pressure maximal

Launching CubeSats

Launch Service Provider1

Launch Service Provider2

ASTRO
SPL
Launch Adapter

Test facilities

Suppliers

Lawyers...

ISIS
"Outsource your satellite launch"

- Launch
- Launch adapter
- Transport container
- Acceptance testing
- Shipment
- Acceptance testing
- Shipment
- Transport paperwork
- LV integration
- Launch adapter training
- Support
- Qualification testing

Excluded:
- Customer travel expenses
- Launch site activities
- Qualification testing

ISIS
- Related services
- Related products

Uni1
1-Unit CubeSat

Uni2
3-Unit CubeSat

Uni3
1-Unit CubeSat

Uni4
MicroSat?

Companies?
DemoSats
Institutes?
MicroSats
Amateurs?
BeaconSats

Questions?

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www.isispace.nl

www.cansat.nl