

CANX-2 AND NTS

CANADA'S SMALLEST OPERATIONAL SATELLITES



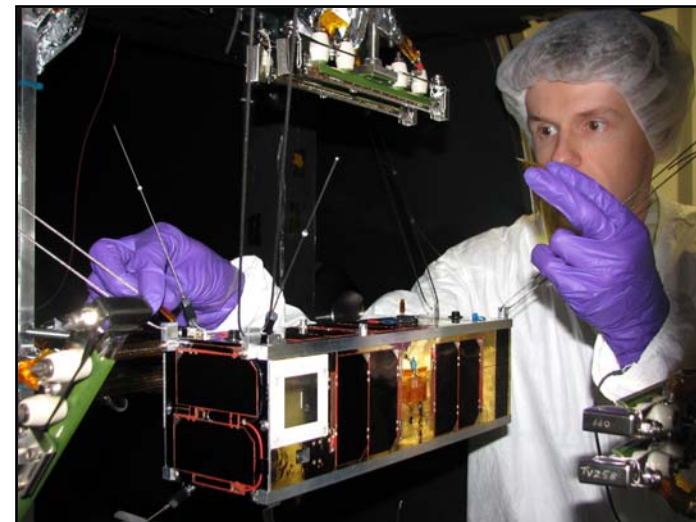
Daniel D. Kekez
Space Flight Laboratory

University of Toronto
Institute for Aerospace Studies
9 August 2008



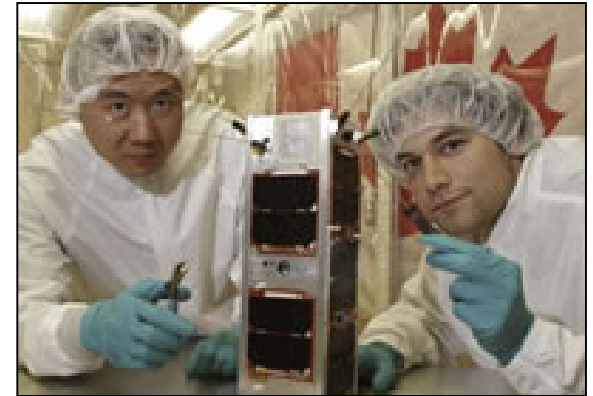
OVERVIEW

- Introduction to UTIAS/SFL
- Mission Overviews
 - CanX-2 and NTS (CanX-6)
- NLS-4 and NLS-5
- Launch Opportunities



SPACE FLIGHT LABORATORY

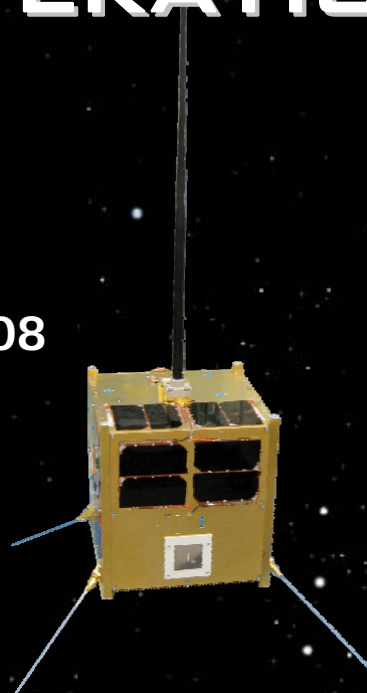
- Building low-cost spacecraft
- Part of University of Toronto
Institute for Aerospace
Studies
 - M.A.Sc. curriculum: spacecraft
system/subsystem design from
concept to operations
- Full-time experienced staff
to support students



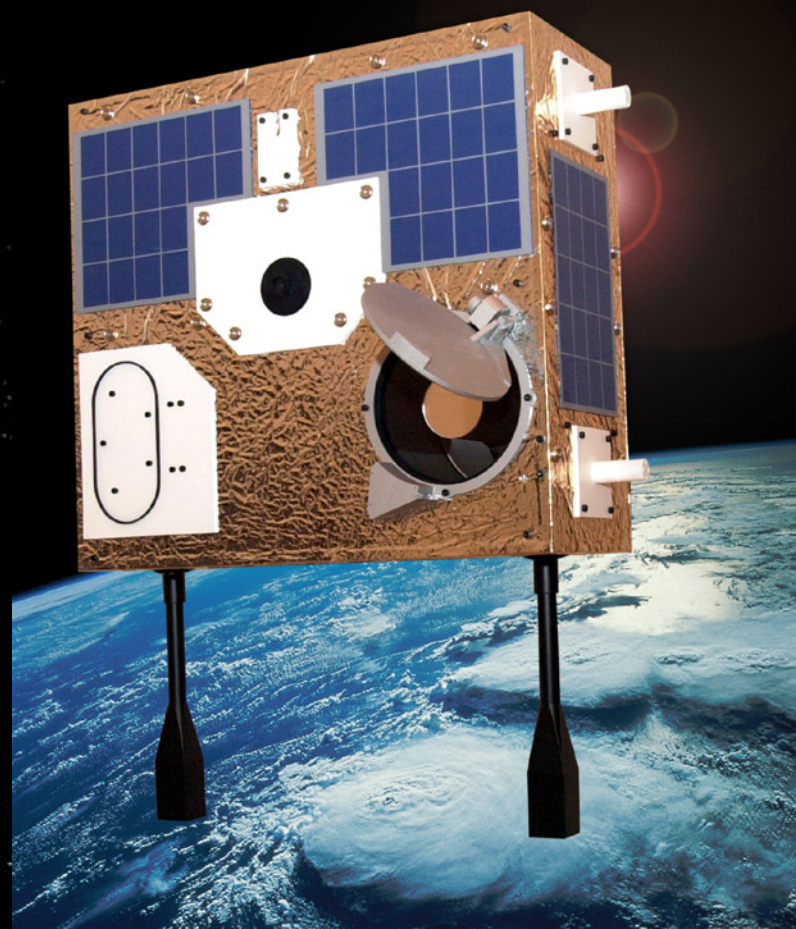
OPERATIONAL ON ORBIT

MOST
June 30, 2003

NTS
April 28, 2008

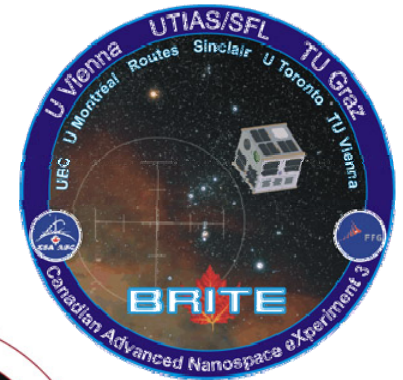


CanX-2
April 28, 2008



MISSIONS UNDER DEVELOPMENT

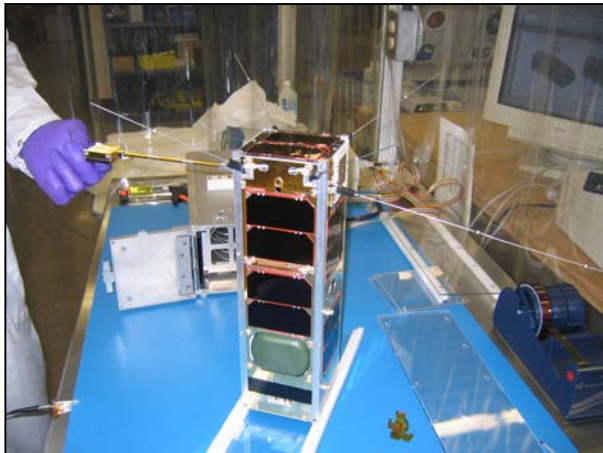
- BRITE Constellation
(CanX-3A, 3B, 3C, 3D)
 - Differential Stellar Photometry
- CanX-4 & CanX-5
 - Autonomous Formation Flight
- AISSat-1
 - Space-borne Receiver for Maritime Automatic Identification System

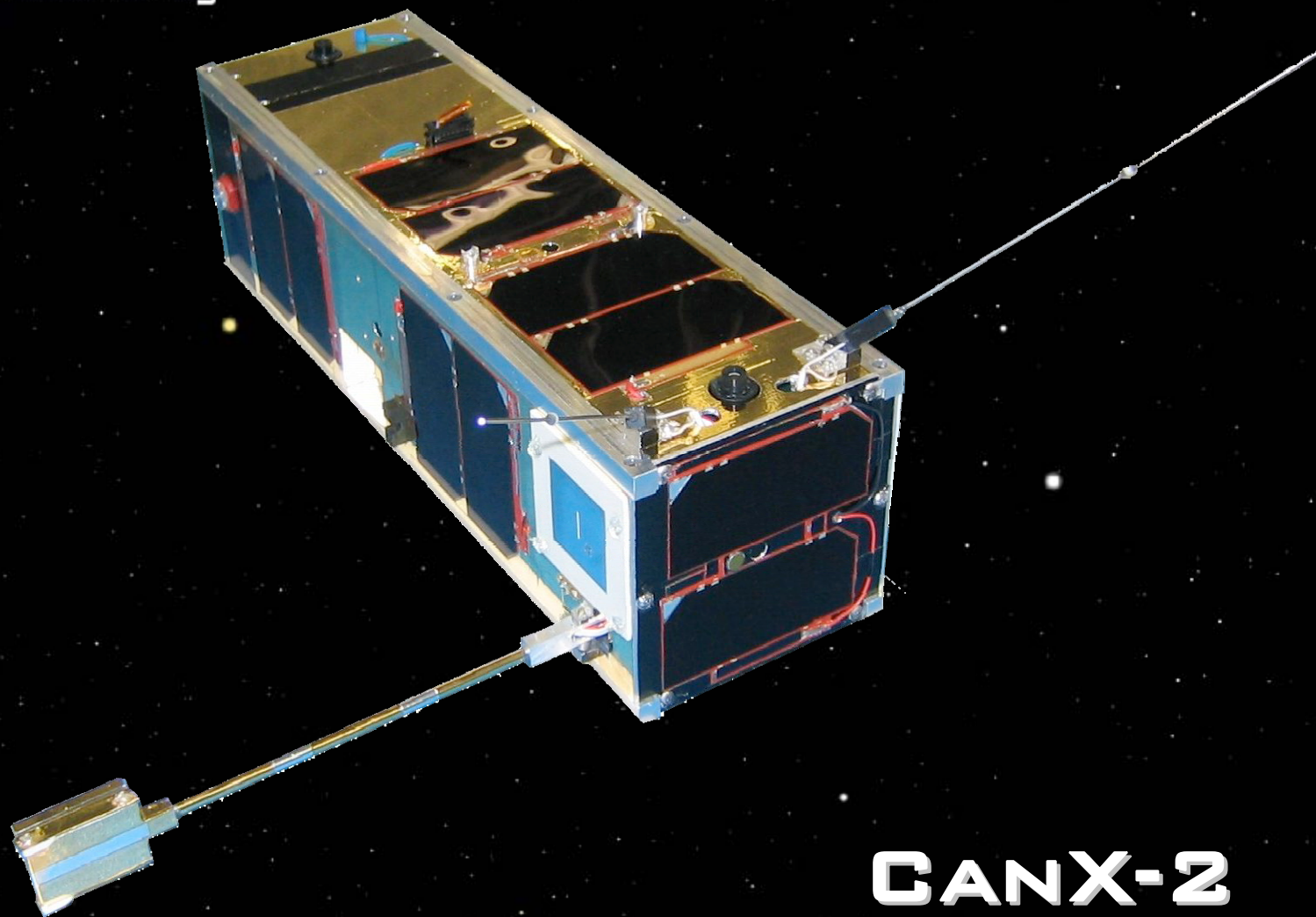


CANX-2 – MISSION

Mission Goals

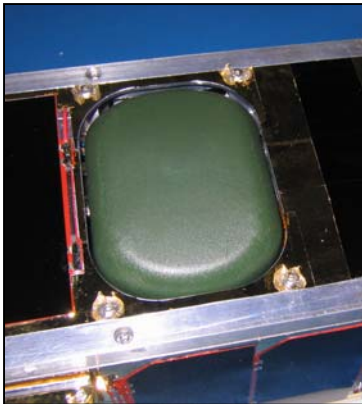
- Technology demonstrator for future SFL spacecraft
 - Evaluate technologies critical for formation-flight (CanX-4 & 5)
- Scientific test-bed for Canadian researchers
 - Cost-effective access to space



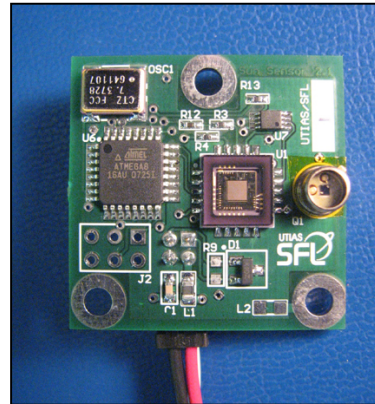


CANX-2

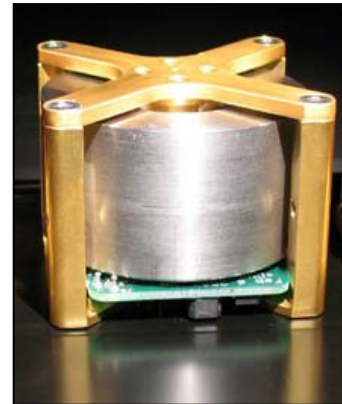
TECHNOLOGY VALIDATION



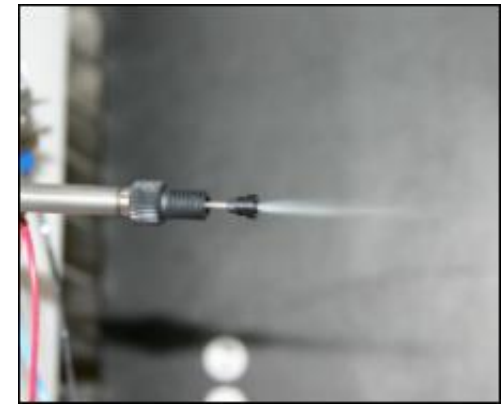
GPS Hardware



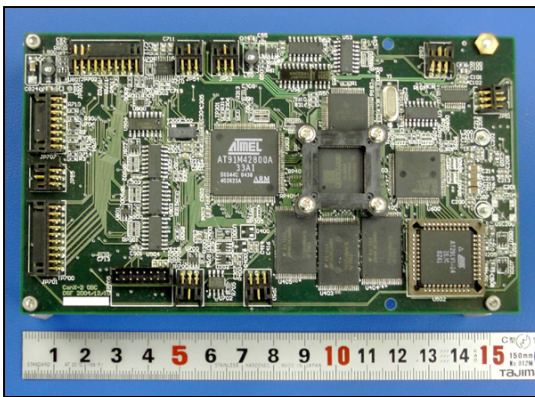
Sun Sensors



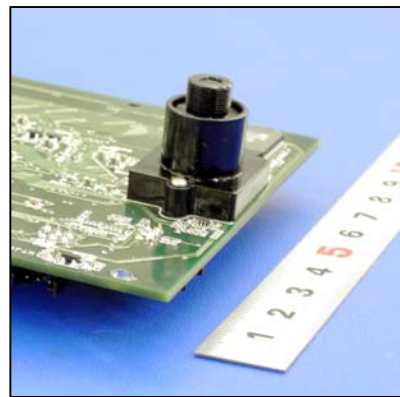
Sinclair/SFL
Reaction Wheel



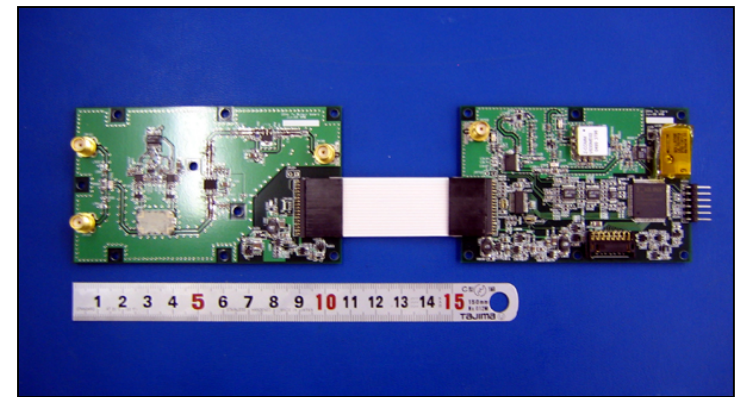
NANO Propulsion System



On-Board Computers



CMOS Imagers



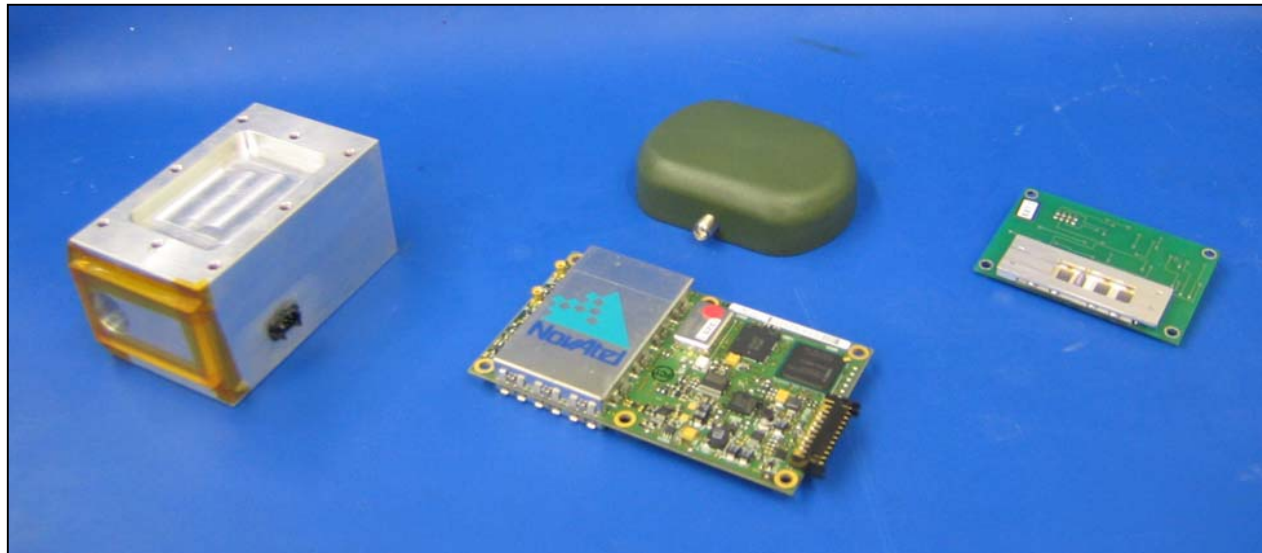
S-Band Transmitter

SCIENCE PAYLOADS

- Atmospheric Spectrometer: Green-house gasses
- GPS Occultation: Water vapour (Troposphere) and Electron density (Ionosphere)
- Materials Science: Atomic oxygen resistance



UNIVERSITY OF
CALGARY



Carleton
UNIVERSITY

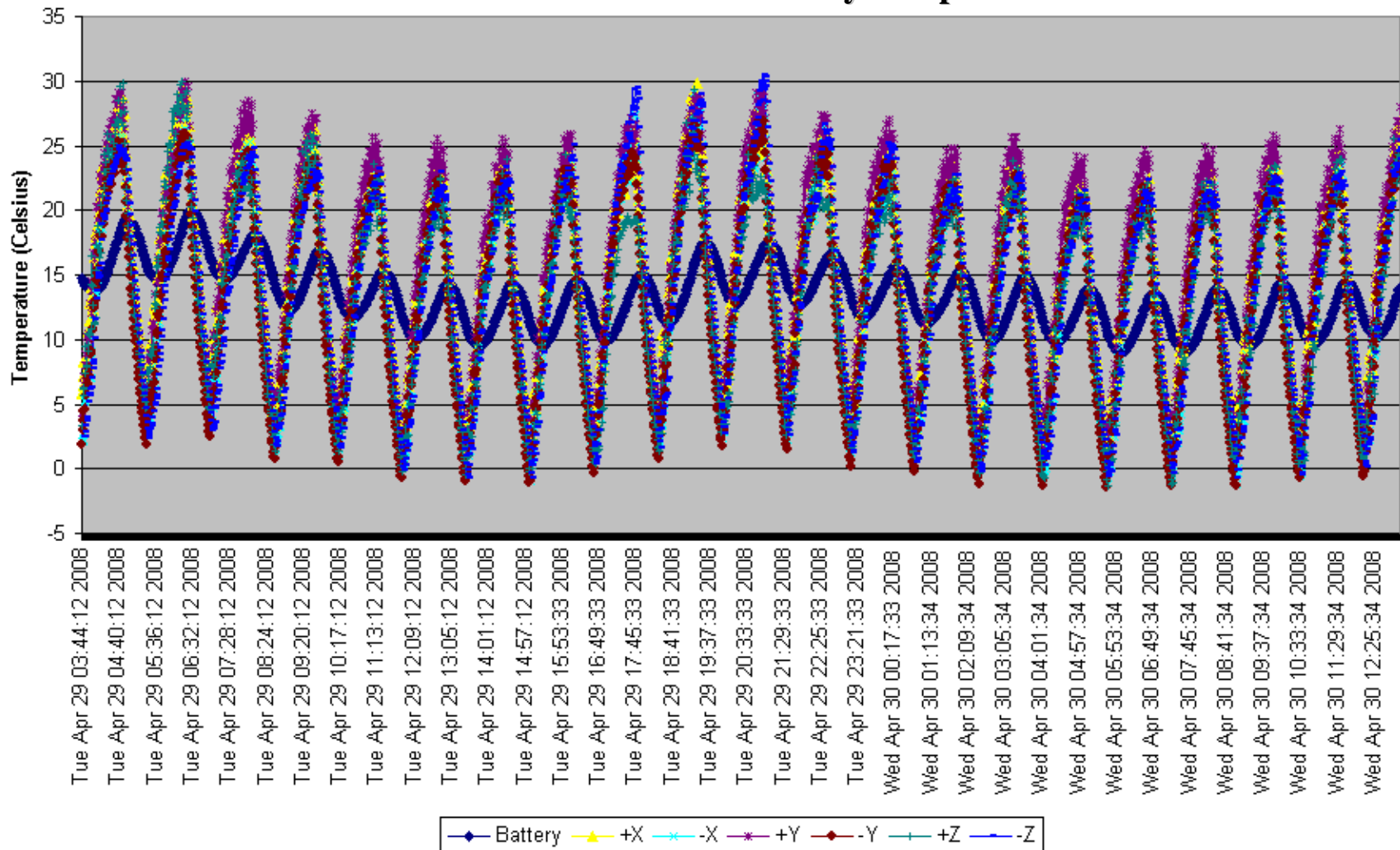
CANX-2 STATUS

- Commissioning during the first month
 - ✓ Power and Thermal Models Validated
 - ✓ Attitude determination sensors and Extended Kalman Filter
 - ✓ Attitude Actuators: Magnetorquers and Reaction Wheel
 - ✓ NANO Propulsion System (NANOPS)
 - ✓ UHF & S-band Radios
 - ✓ Material Coating Experiment activated
- At Present
 - NANOPS Thrust Tests underway
 - ACS algorithm commissioning and refinement underway
 - Spectrometer and GPS Science to start in September

NO MAJOR DIFFICULTIES YET... !!

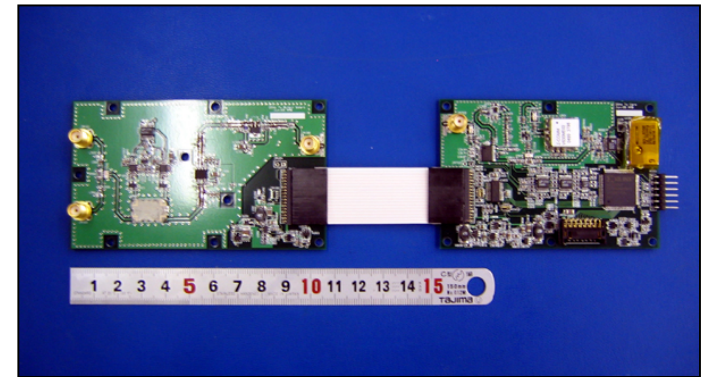
TELEMETRY: TEMPERATURE

CanX-2 Structural Panel and Battery Temperature



COMMUNICATION LINKS

- S-band Transmitter
 - BPSK & QPSK modulation schemes demonstrated in orbit
 - Data rates up to 256kbps demonstrated in orbit
- Data Downlink
 - CanX-2 > 131 MB downloaded
 - NTS > 230 MB downloaded

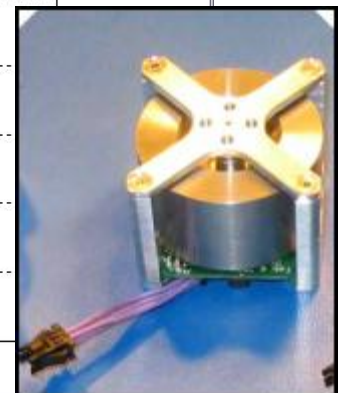
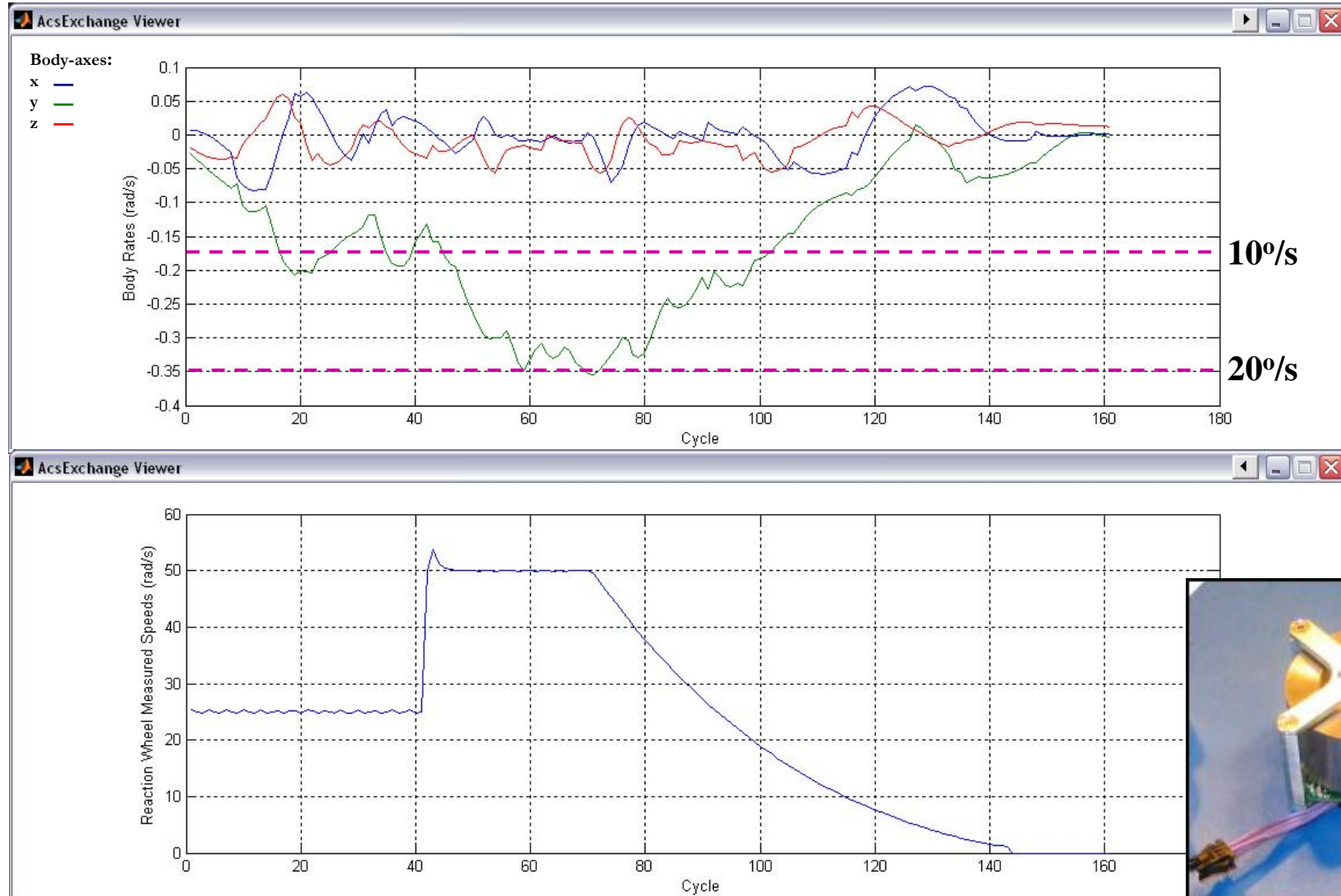


S-Band Transmitter

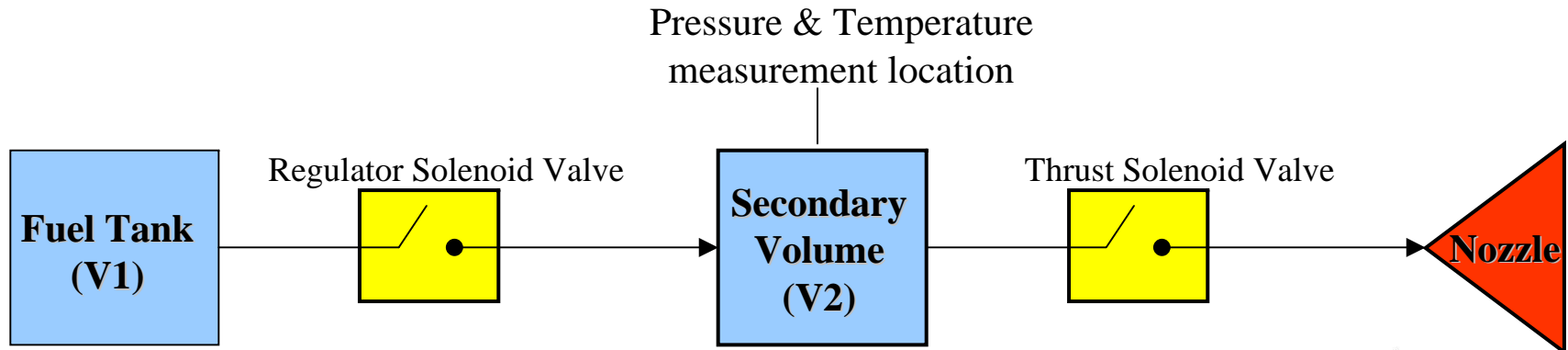


UHF Transceiver

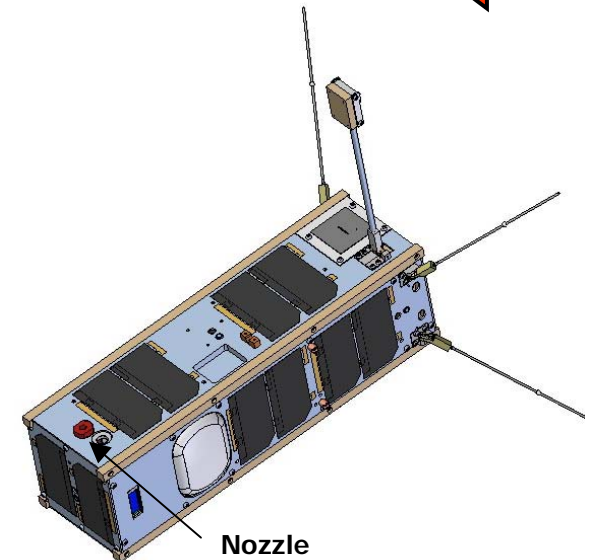
WHEEL SPIN-UP

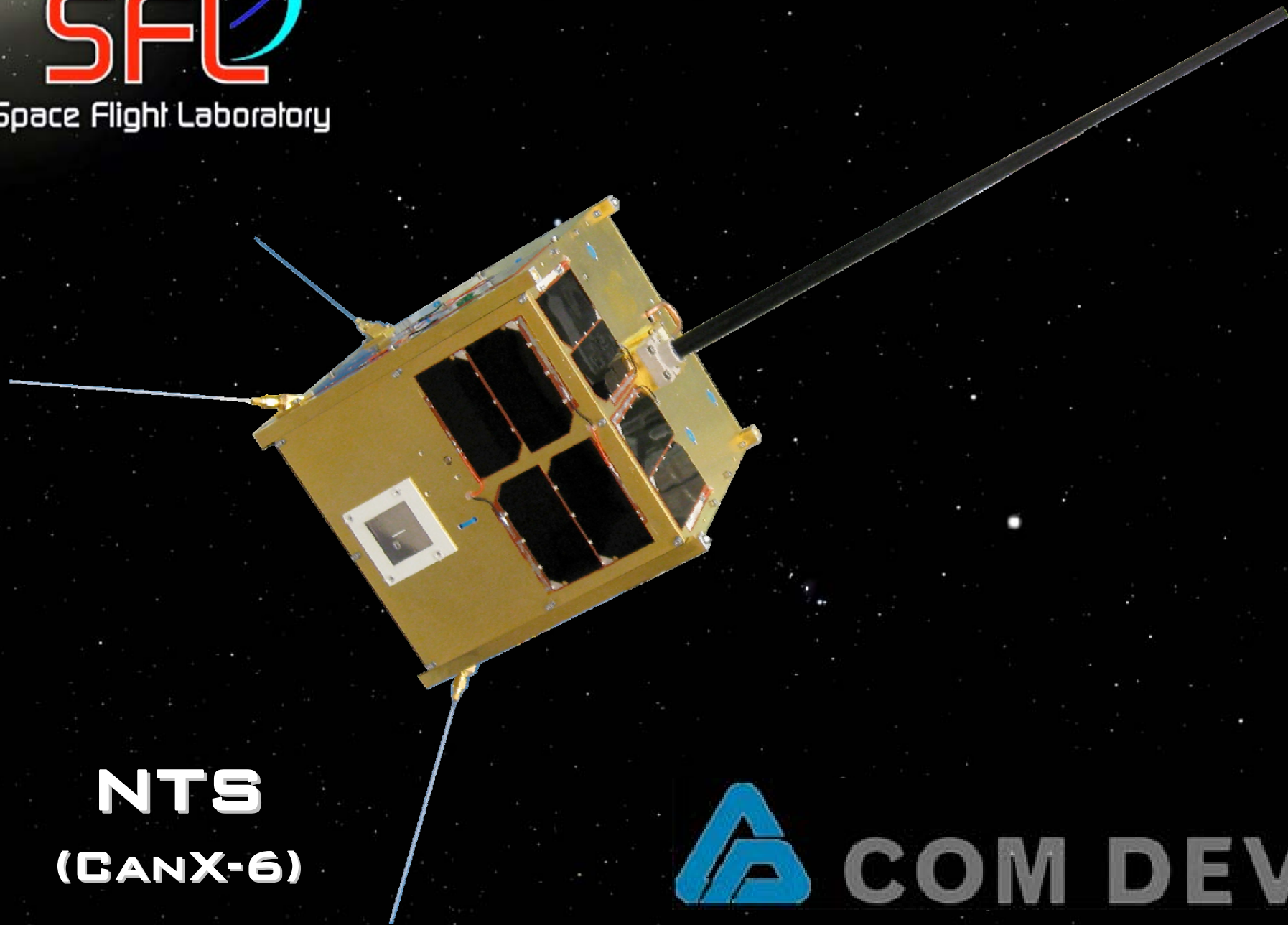


NANO PROPULSION SYSTEM



- SF₆ Fuel Leakage: Negligible
- ISP: ~46s
- Minimum Impulse Bit: ~0.13 mNs
- Valve on-time (testing to date): 1ms - 500ms
- Upcoming Tests
 - Constant Thrust Test: Impulse and thrust-level determination at various pressures





NTS
(CANX-6)

 **COM DEV**

CANX-6 – NTS

Mission Objective

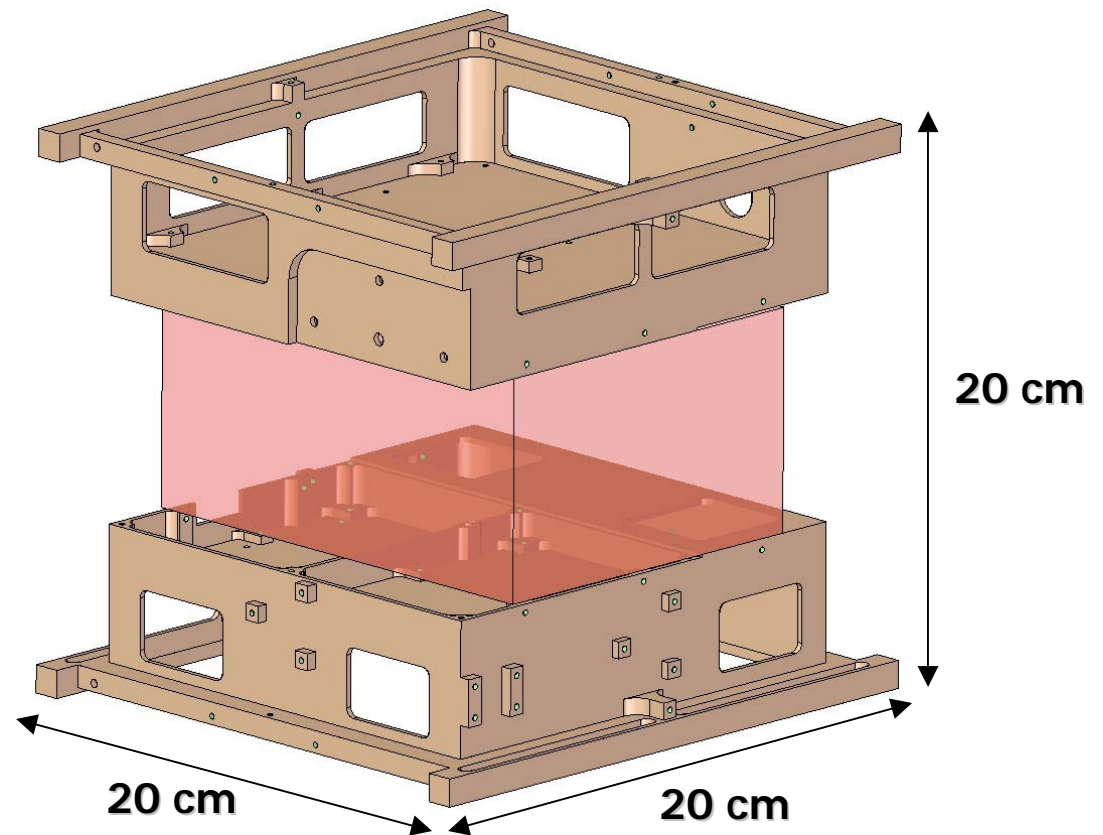
Validate on orbit the space-based AIS receiver payload developed by COM DEV Ltd.

- Result: NTS
The Nanosatellite Tracking Ships
- Responsive Space
7 months from concept to launch
 - Project Start: October 2007
 - Launch: April 28, 2008



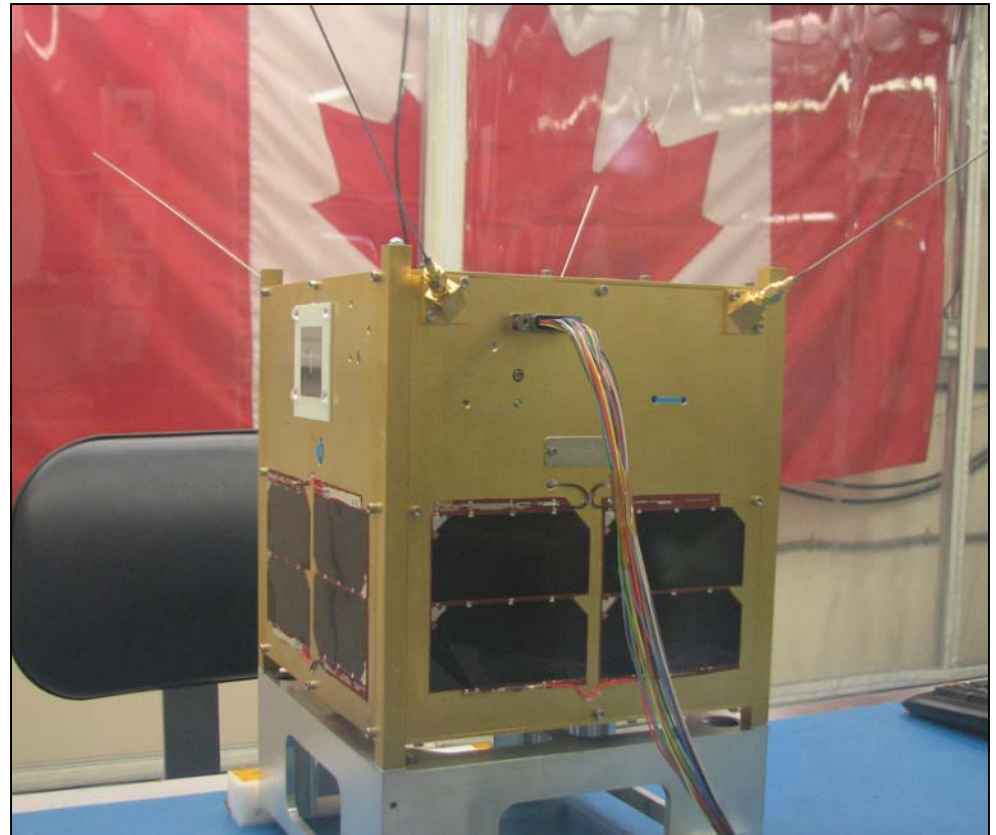
NTS – SPACECRAFT BUS

- Structure based on SFL Generic Nanosatellite Bus
 - 20 x 20 x 20 cm
 - 6.5 kg mass including payload



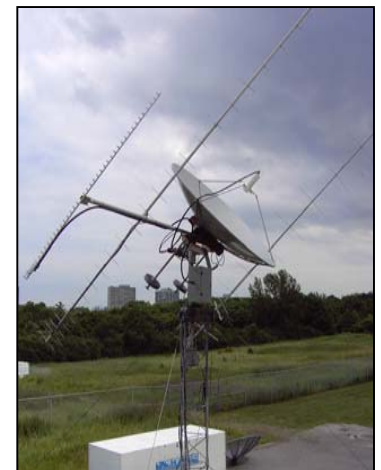
NTS – SPACECRAFT BUS

- Structure based on SFL Generic Nanosatellite Bus
 - 20 x 20 x 20 cm
 - 6.5 kg mass including payload
- CanX-2 Electronics
 - OBC, Power, TT&C
- Passive attitude control



NTS STATUS

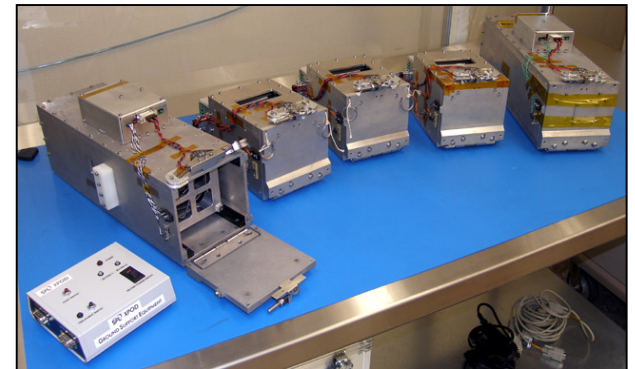
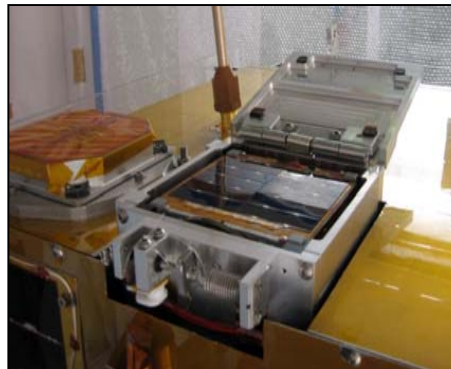
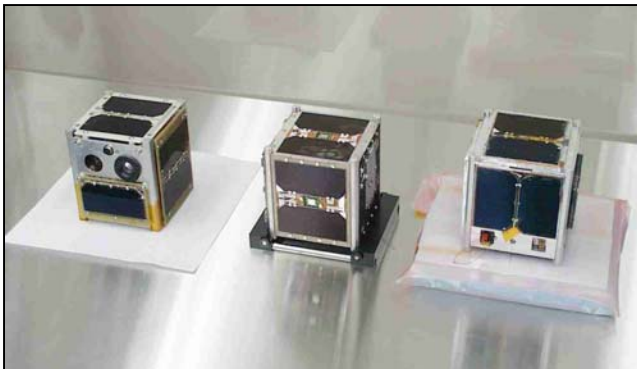
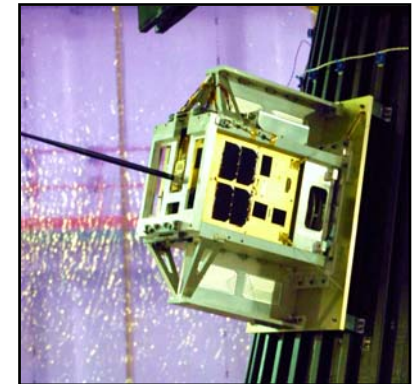
- Footprint overlap between CanX-2 and NTS during the first month
 - Contacts were split between satellites: 1-2 for NTS
- Early Operations for NTS
 - April 28, 03:53:51 UTC: Launch
 - April 28, 04:13:02: Deployment and Wake-up
 - April 28, 15:13:18: AOS at UTIAS/SFL
 - May 2: Start of Payload Commissioning
 - May 6: Collection of First Data
- Data collection continues



NANOSATELLITE LAUNCH SERVICE

Primary Objective

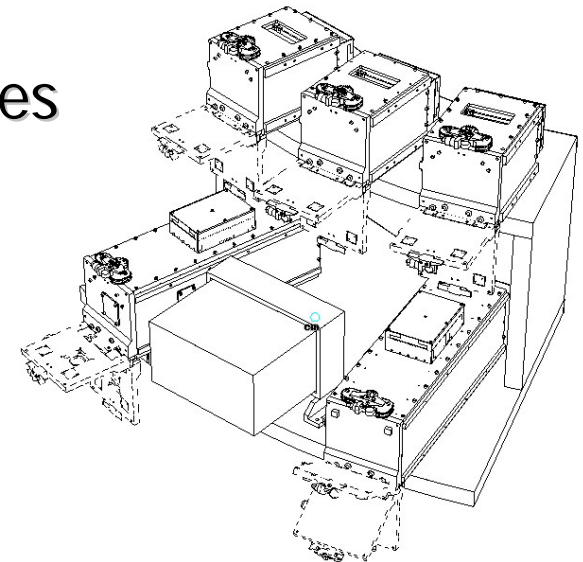
- Access to regularly scheduled launch in support of the CanX program and UTIAS/SFL education curriculum



NANOSATELLITE LAUNCH SERVICE

Secondary Objectives

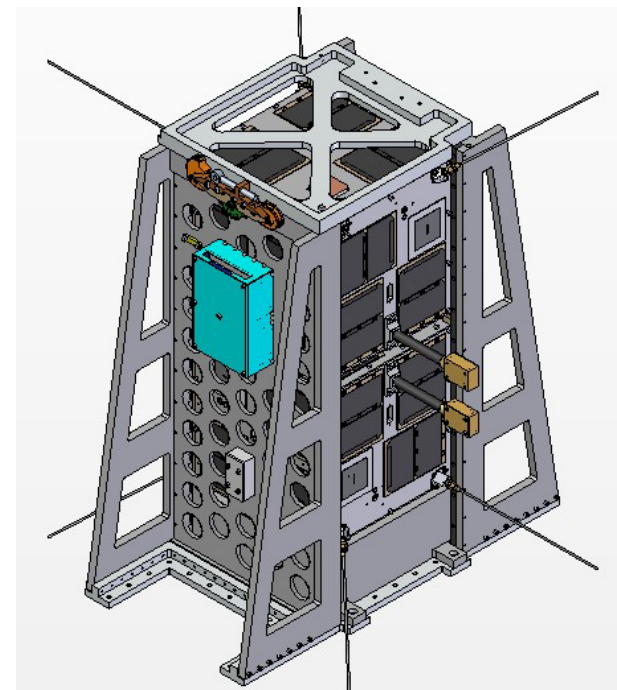
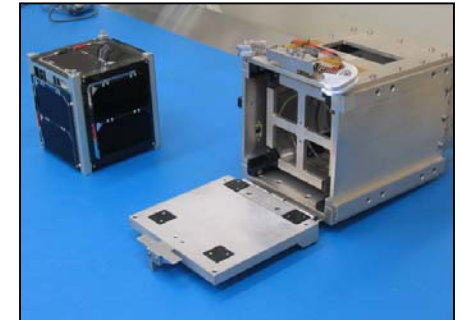
- Cost sharing with launch partners through launching a small group (4-5) of spacecraft
- Small number of participants simplifies LV integration, launch campaign logistics, post launch operations, schedule risks, therefore reducing the overall risk to all participants



XPOD SEPARATION SYSTEM

Flight-proven XPOD separation systems

- XPOD Single, Double, Triple
 - Compatible with the Stanford/CalPoly CubeSat standard
- XPOD GNB: 20x20x20 cm satellite
 - Target Missions: NTS, BRITE Constellation, AISSat-1
- XPOD DUO: 20x20x40 cm
 - Target Mission: CanX-4 & CanX-5



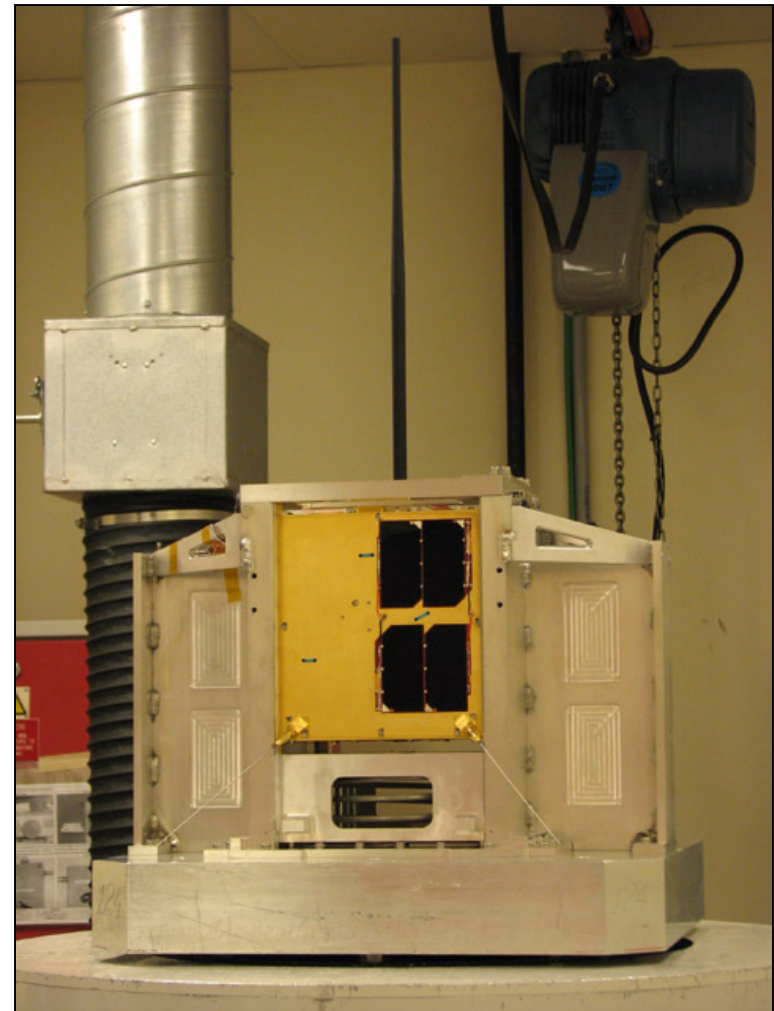
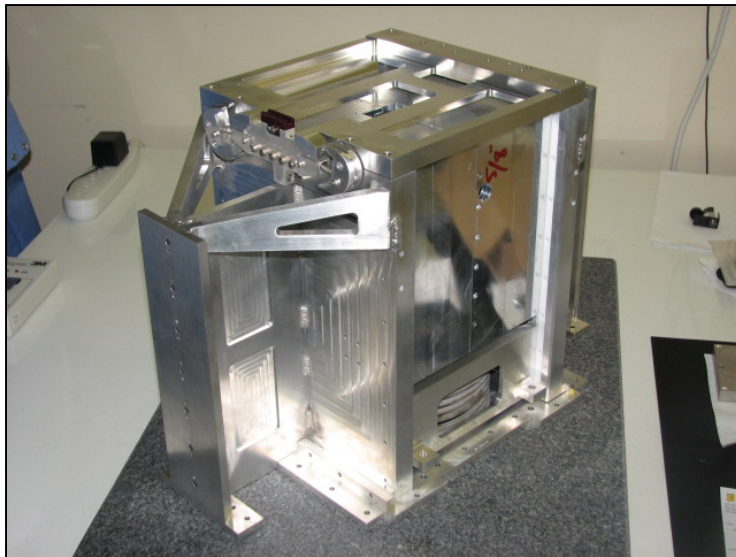
NLS-4

- **CanX-2**
UTIAS Space Flight Lab, Canada
- **AAUSat-II**
University of Aalborg, Denmark
- **2nd SEEDS**
Nihon University, Japan
- **Delfi-C3**
University of Delft, Netherlands
- **COMPASS-1**
Aachen University of Applied Sciences, Germany
- **CUTE-1.7 + APD II**
Tokyo Institute of Technology, Japan



NLS-5

- NTS (CanX-6)
 - Originally scheduled for PSLV-C12
 - Moved up to C9

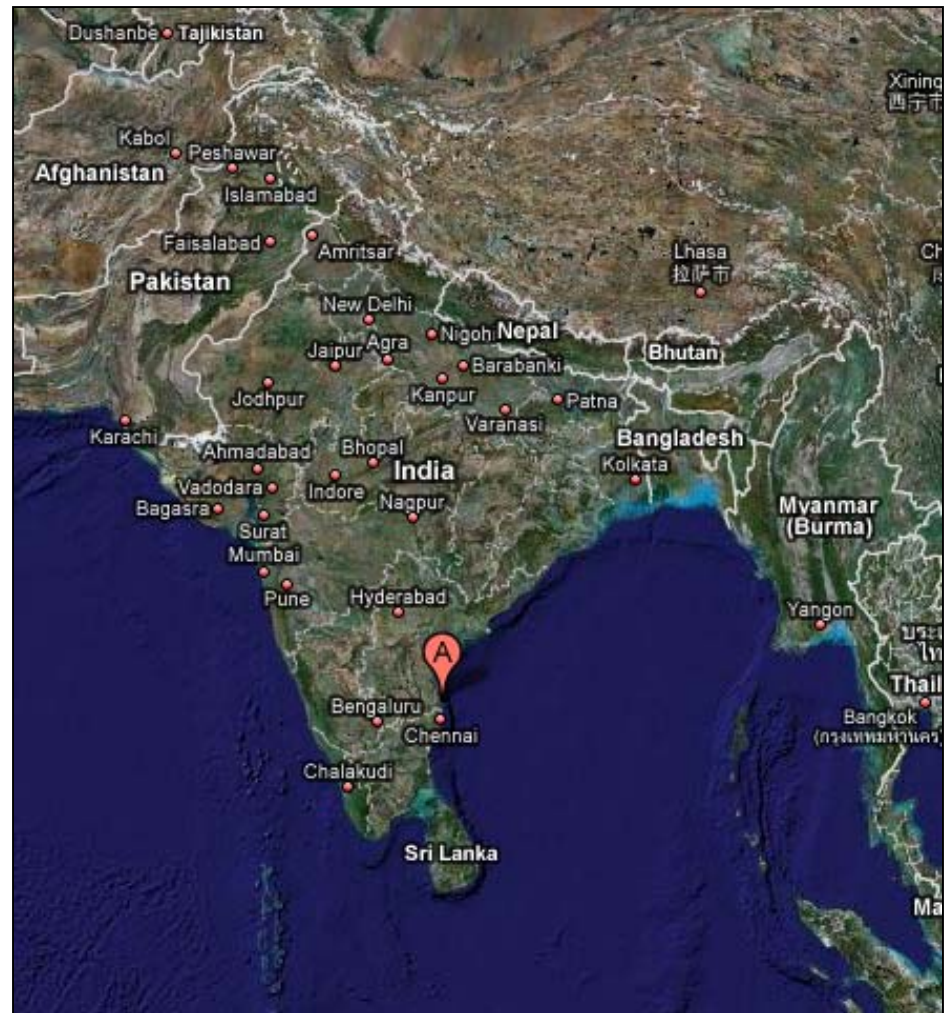


ISRO POLAR SATELLITE LAUNCH VEHICLE

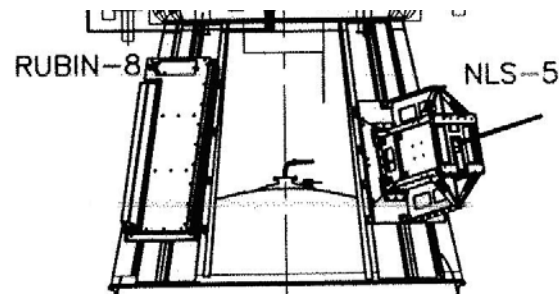
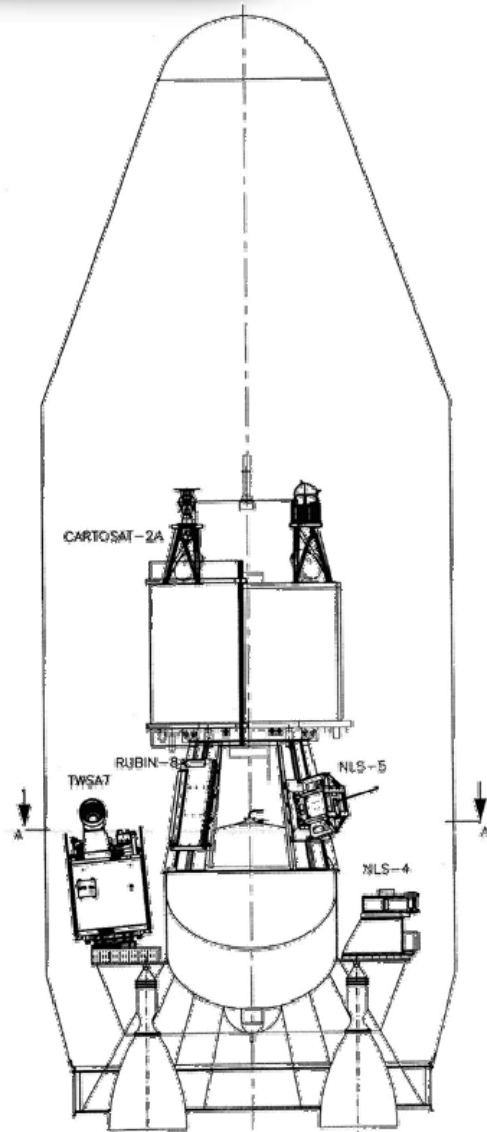
4-Stage Vehicle

- 4 - 6 Solid Strap-ons
- 1: Solid
- 2: N₂O₄/UDMH
- 3: Solid
- 4: N₂O₄/UDMH

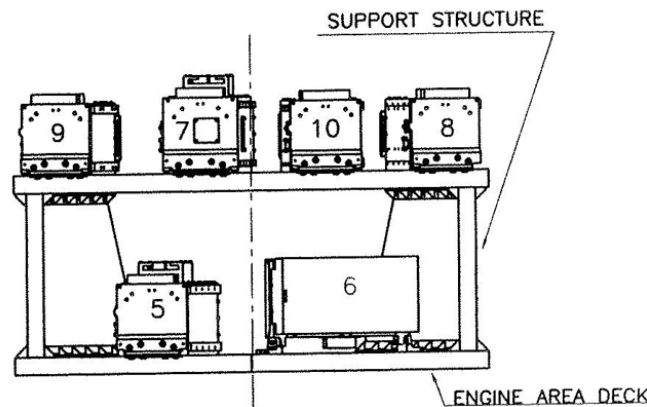
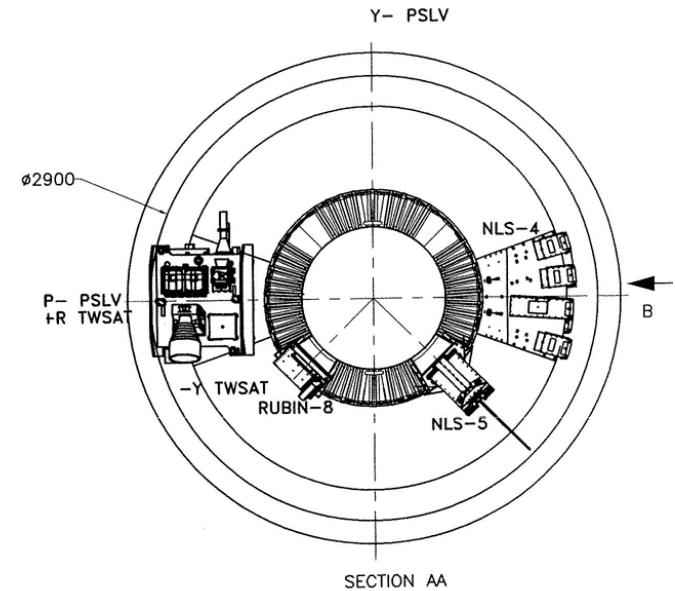
- C9: 823 kg to SSO at 635 km
- Lift-off mass: 230 tonnes



LV ACCOMMODATION



Payload Launch Adapter



VIEW B

- 5 – CanX-2
- 6 – CUTE 1.7 + APD II
- 7 – Delfi-C3
- 8 – AAUSat-II
- 9 – COMPASS-1
- 10 – SEEDS



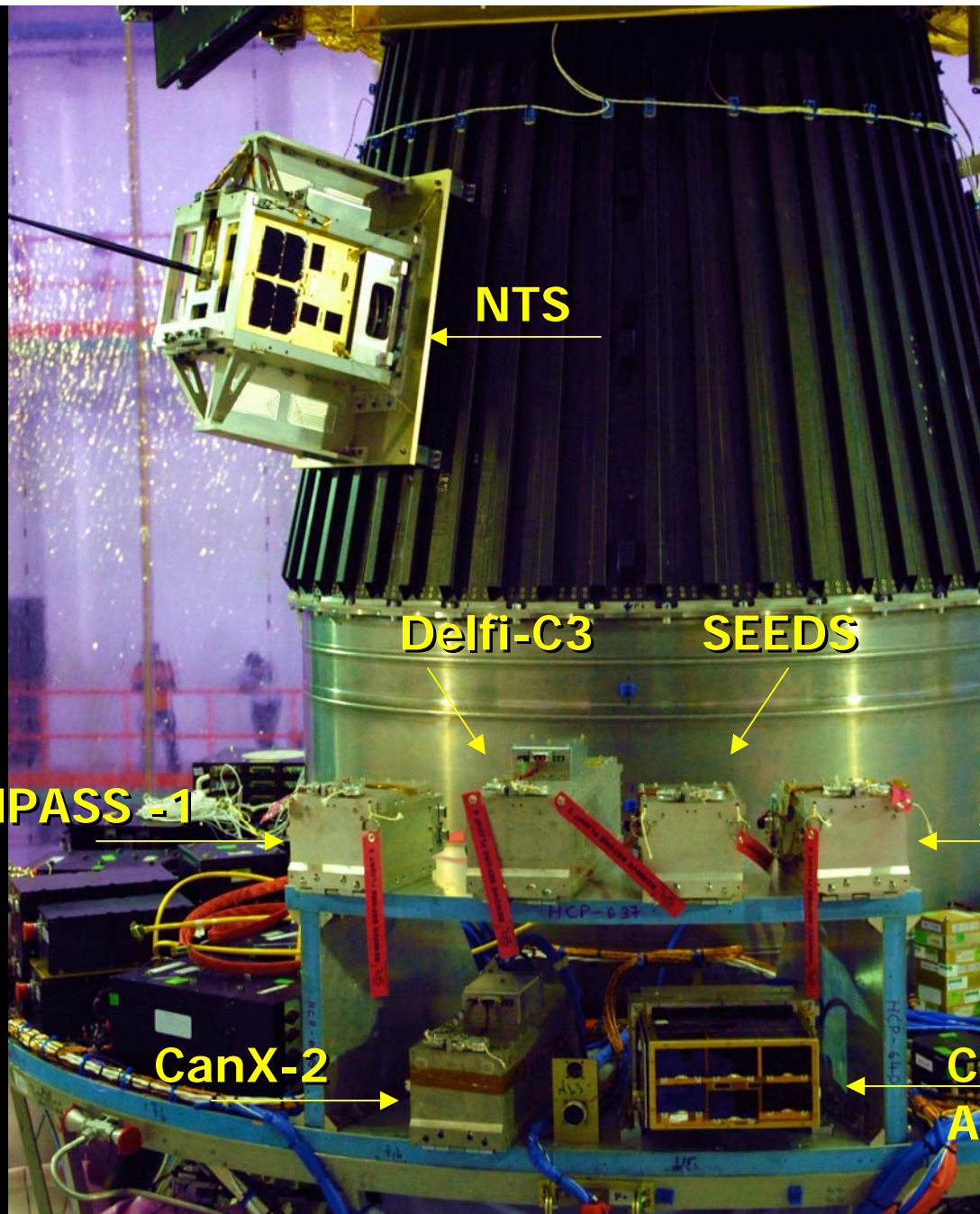
April 17: L-11 – NLS-5 is mounted on the PLA



April 18: L-10 – NLS-4 is mounted on the LV



PSLV-C9 Upper Stage



COMPASS -1

NTS

Delfi-C3

SEEDS

AAUSat-2

CanX-2

**CUTE-1.7 +
APD 2**

PSLV-C9 Upper Stage



UPCOMING LAUNCHES

- Nanosatellite Launch Service 6 (NLS-6)
 - Time frame: Jun-Jul 2009
 - Orbit: Sun Synchronous, 800 km, 10:30 LTDN
- Nanosatellite Launch Service 7 (NLS-7)
 - Time frame: Jul-Sep 2009
 - Orbit: Sun Synchronous, 650-670 km, 10:15 LTDN
- Nanosatellite Launch Service 8 (NLS-8)
 - Time frame: Mid-2010
 - Orbit: Sun Synchronous, 800 km, 06:00 LTDN



SUMMARY

- Both spacecraft are operating well on orbit.
- **CanX-2** is a clear example of what a Triple-CubeSat is capable of accomplishing.
- **NTS** shows the opportunities from **responsive space**.

