

SFL NANOSATELLITE MISSIONS & NANOSATELLITE LAUNCH SERVICE

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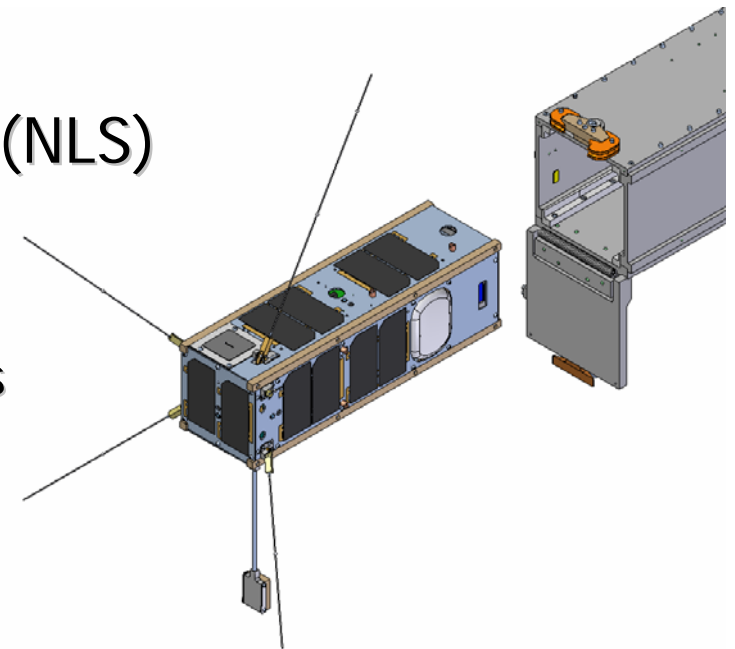
Space Flight Laboratory

University of Toronto Institute for Aerospace Studies



OVERVIEW

- The Space Flight Laboratory (SFL) at the University of Toronto Institute for Aerospace Studies (UTIAS)
- Current and Future Mission Horizon
 - CanX-2, CanX-4/-5, BRITE Constellation, AISSat-1
- Nanosatellite Launch Service (NLS)
 - XPOD Separation System
 - NLS-4 Launch in Oct-Nov 2007
 - Upcoming Launch Opportunities



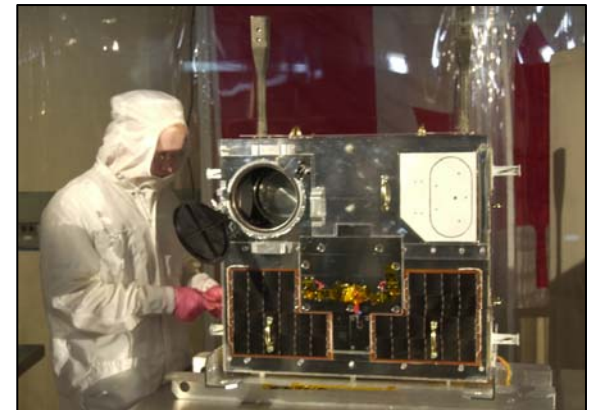
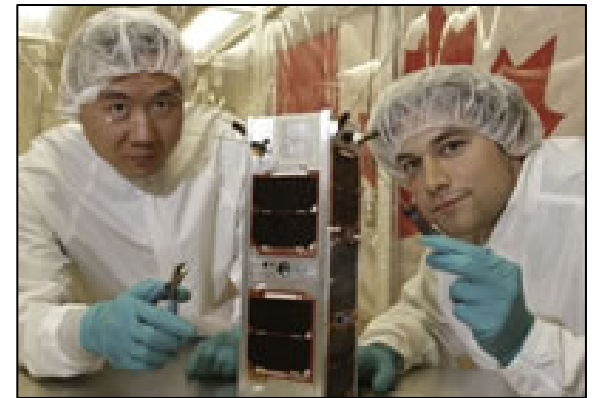
UTIAS SPACE FLIGHT LAB

- Part of University of Toronto Institute for Aerospace Studies
 - M.A.Sc. curriculum: spacecraft system/subsystem design from concept to operational
 - Ph.D. curriculum: research on spacecraft system/subsystem
 - Full-time experienced staff to support students
 - 15 students and 9 staff



UTIAS/SFL RESEARCH PROJECTS

- Canadian Advanced Nanospace eXperiment (CanX) Program: State-of-the-art research with nanosatellites (<10kg)
- Nanosatellite Launch Service (NLS): Regular launches for CanX spacecraft (and others)
- Radiation Test Program
- Microsatellite Projects (<100kg) to use proven technologies

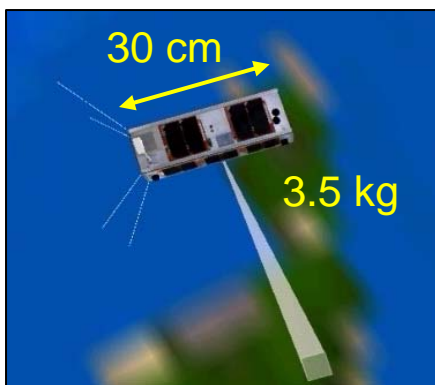


CANX MISSIONS

Canadian Advanced Nanospace eXperiment (CanX) program was established in 2001 for two purposes:



- *Train students* in building real spacecraft:
- *Cost-effective, rapid, regular access to space* for miniature payloads, technologies, experiments:
 - Aggressive experimentation, manage moderate risks, the "X" in CanX – mixture of microspace and X-plane philosophies.
 - Service to all Canadians and international partners.



Five funded missions currently underway:

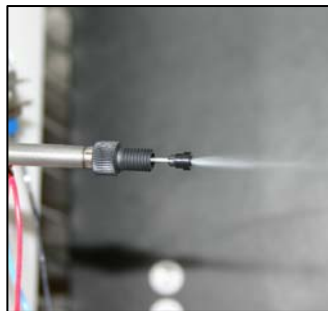
- Formation Flight: CanX-2, CanX-4/-5
- Asteroseismology: BRITE Constellation (CanX-3a, 3b)
- Ship Tracking from Space: AISSat-1

Other Nanosatellite Missions Under Study: Lunette

CANX-2 MISSION



- 3.6 kg, 10x10x34 cm
- Mission Objectives
 - Evaluate new systems needed for Formation Flight
 - Perform scientific investigations
 - Atmospheric Spectrometry
 - GPS Occultation Studies
 - Atomic Oxygen Coating Characterization
- Launch: NLS-4 / PLSV Oct/Nov 2007



Propulsion System



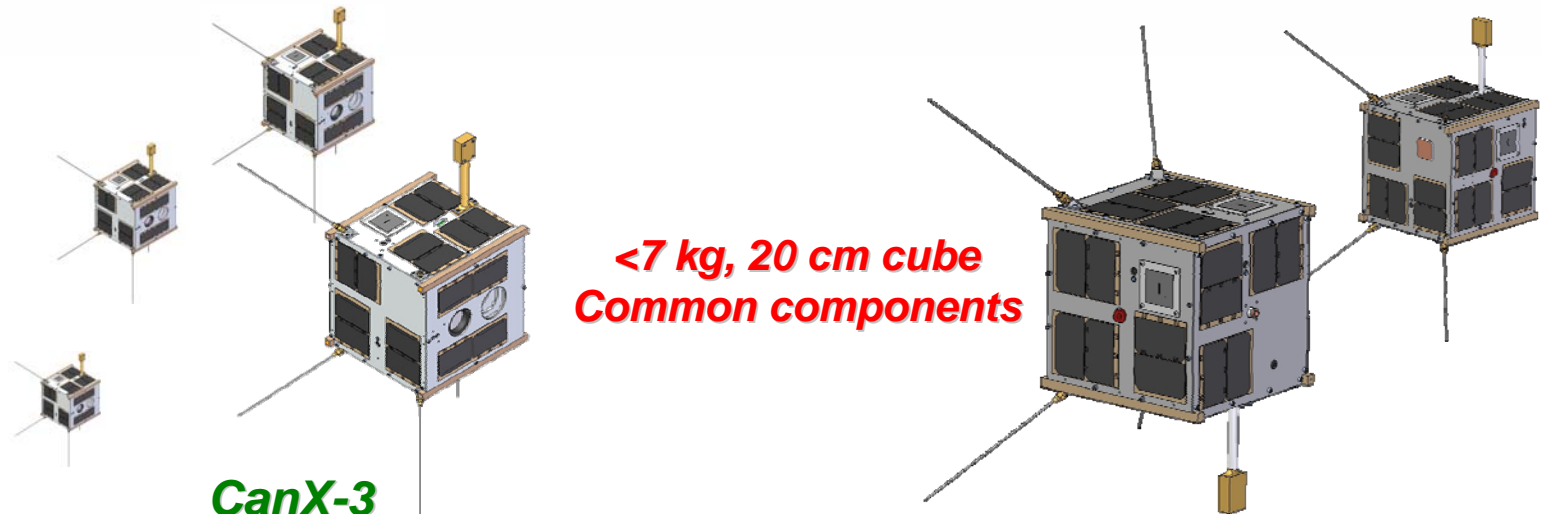
S-Band Transmitter



Sinclair-SFL Reaction Wheel



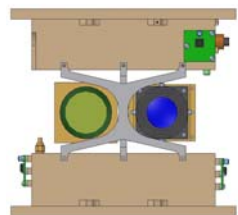
MULTI-MISSION DESIGN



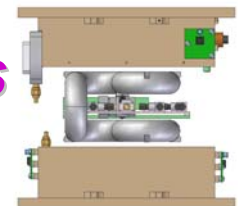
*<7 kg, 20 cm cube
Common components*

CanX-3
BRITE Constellation
(no formation control)

CanX-4 and CanX-5
Formation Flying
(formation control)



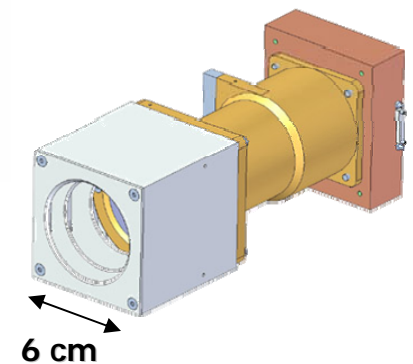
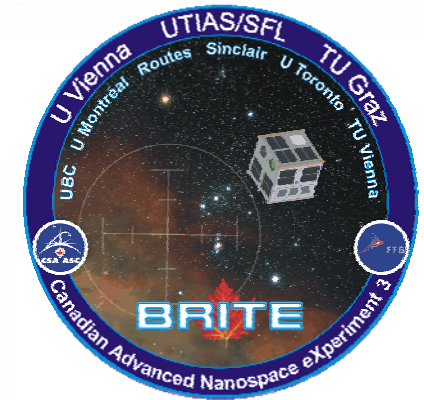
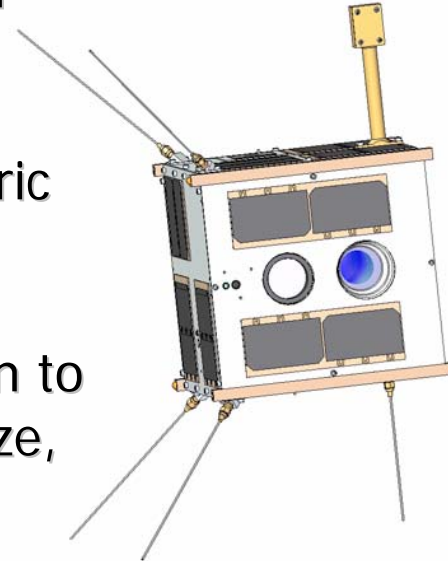
Multi-Mission or "Generic" Nanosatellite Bus
- To minimize costs, design a common bus ...



CANX-3

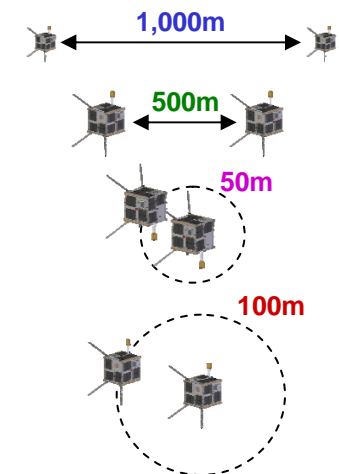
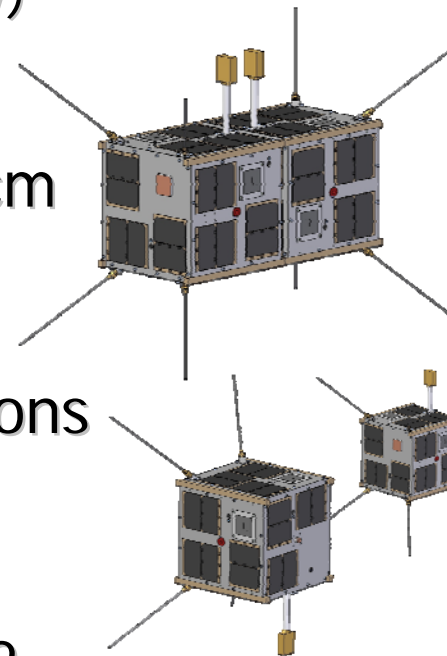
BRIGHT TARGET EXPLORER (BRITE)

- Asteroseismology:
 - Internal pressure waves and gravity waves cause a star's brightness to oscillate.
 - Use long duration photometric time series to extract frequencies of oscillation.
 - Use frequencies of oscillation to deduce core composition, size, age, internal structure.
- CDR 19 April 2007
- Target Launch in 2008-Q3/4



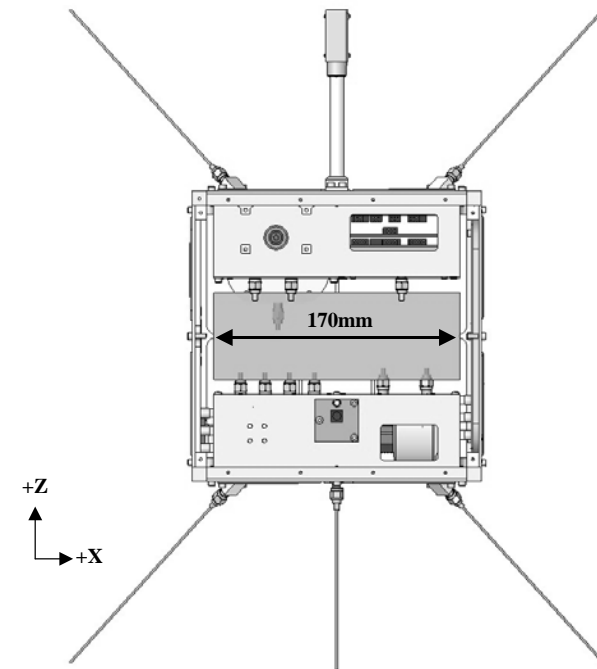
CANX-4 AND CANX-5 FORMATION FLYING MISSION

- Demonstrate precise formation flying in space
 - cm-level relative position determination with GPS (Cannon, U Calgary)
 - Sub-meter accurate position control (Damaren, UTIAS)
- Each <7 kg, 20 x 20 x 20 cm
- Nanosat Propulsion
 - 22 m/s, SF6, 40s Isp, 5 mN
- Inter-satellite communications
- Three-axis attitude control
- CDR 12 April 2007
- Target launch in 2009-Q1/2



AISSAT-1 MISSION

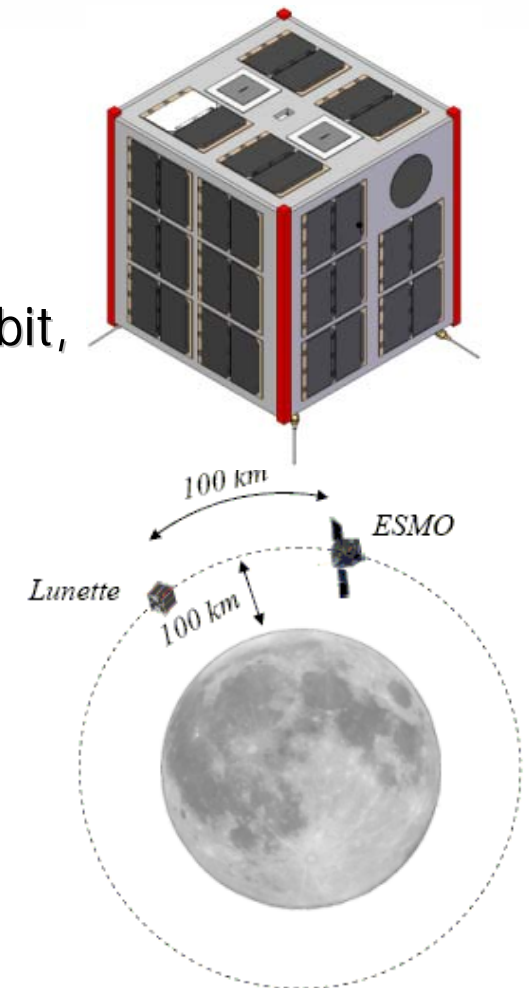
- AIS: Automatic Identification System
 - Required by the International Maritime Organization on all vessels over 300 tonnes, and all passenger vessels
 - Currently estimated to be >40,000 vessels worldwide equipped with AIS
- AIS messages broadcasted on 2 maritime VHF channels (~162 MHz)
- Goal is to demonstrate the reception of AIS signals from space, primarily in the regions of interest to Norway
- AISSat-1 is a project funded by the Norwegian government (FFI)



LUNETTE

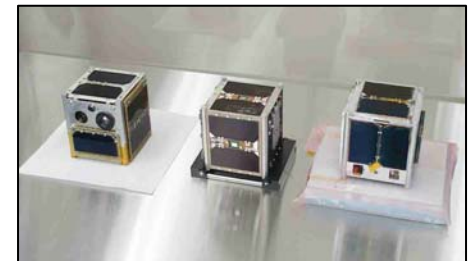
A LUNARY FAR-SIDE GRAVITY MAPPING NANOSATELLITE

- Nanosatellite to improve knowledge of lunar far-side gravity
 - Radio-tracking from a parent spacecraft to measure differential accelerations
 - Fly in formation at 100 km at initial lunar orbit, then lowers perilune for high-res mapping
- 10-20 mGal resolution
- GNB-based design with enhancements
 - Warm gas propulsion system
- Primary Science Mission aboard SSETI ESMO – 2011 launch
- Phase A underway



NANOSATELLITE LAUNCH SERVICE

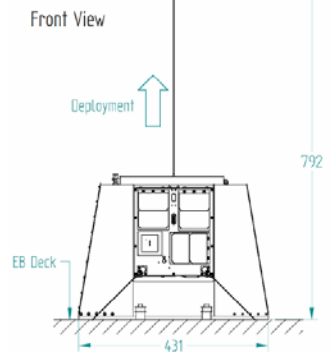
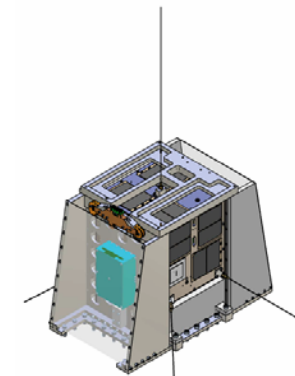
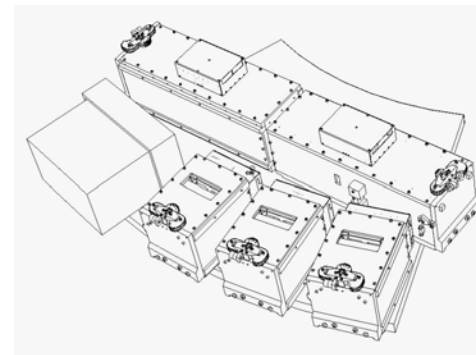
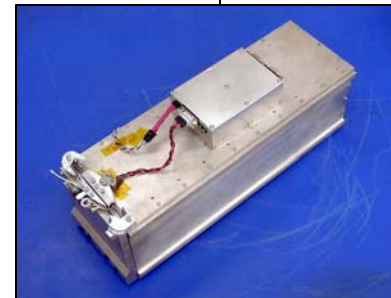
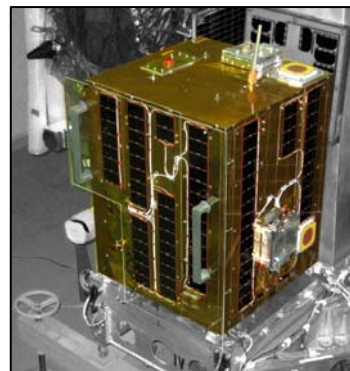
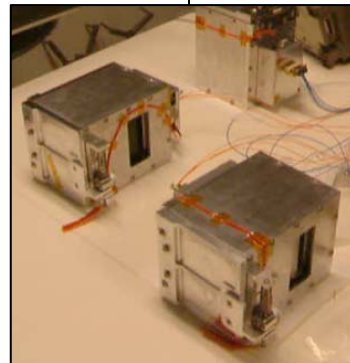
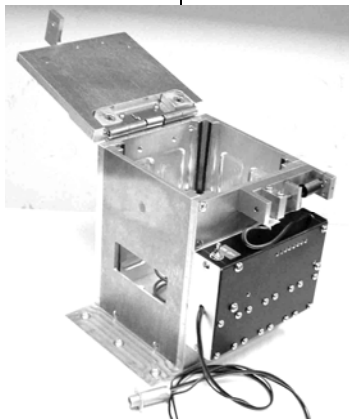
- Primary Objective:
 - Access to regularly scheduled launch in support of the CanX program and UTIAS/SFL education curriculum
- Secondary Objectives:
 - Cost sharing with launch partners through launching a small group (4-5) of spacecraft
 - Small number of participants simplifies LV integration, launch campaign logistics, post launch operations, schedule risks, therefore reducing the overall risk to all participants
- Nanosatellite Separation Systems
 - Flight-proven XPOD separation systems



XPOD DEVELOPMENT

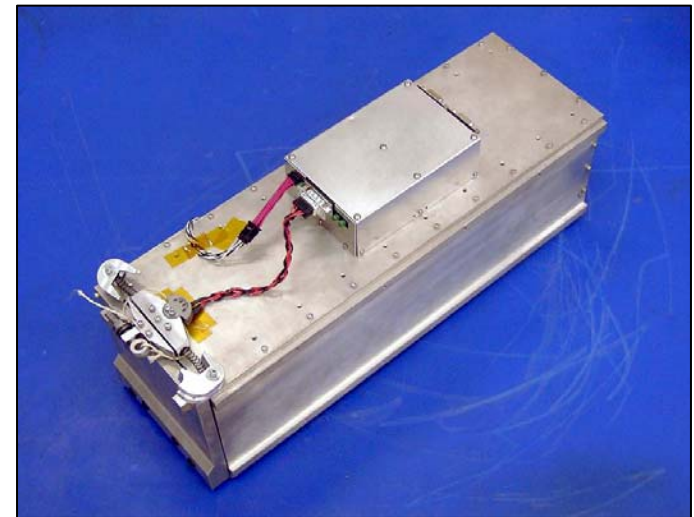
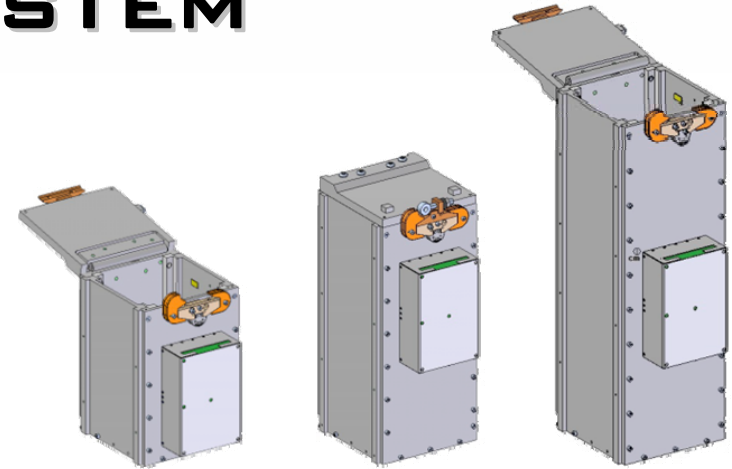


2003	2004	2005	2006	2007	2008	2009
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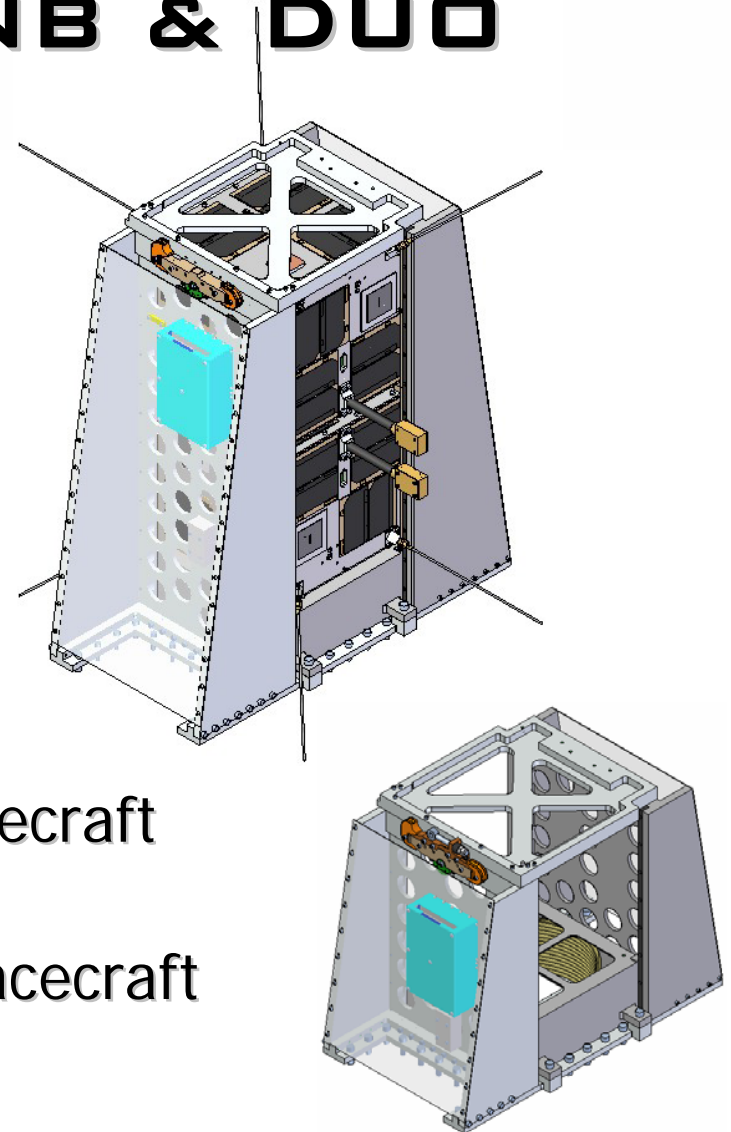
XPOD DEPLOYMENT SYSTEM

- Fully-enclosed design
- Clamp-type mechanism
- Spacecraft damper
- Deployment sensors
- Fail-safe, single failure tolerant
- Full s/c deployment test in 1-g
- Compatible with Cubesat Specification
- Scalable for spacecraft with arbitrary dimensions, up to 5 kg

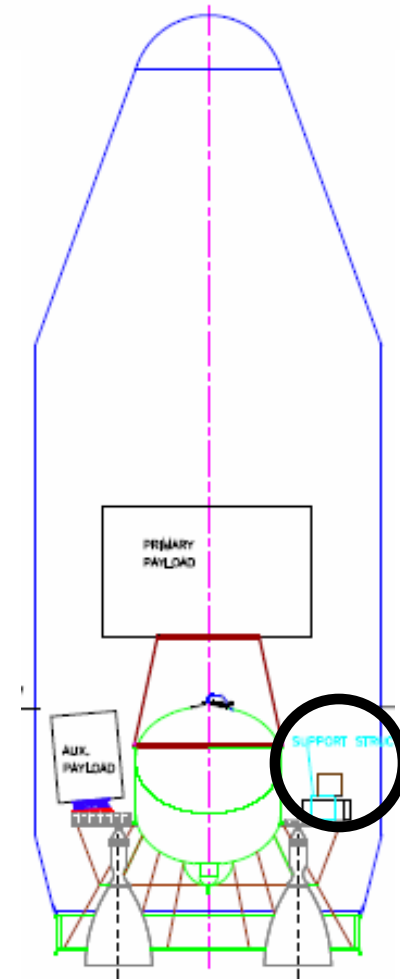
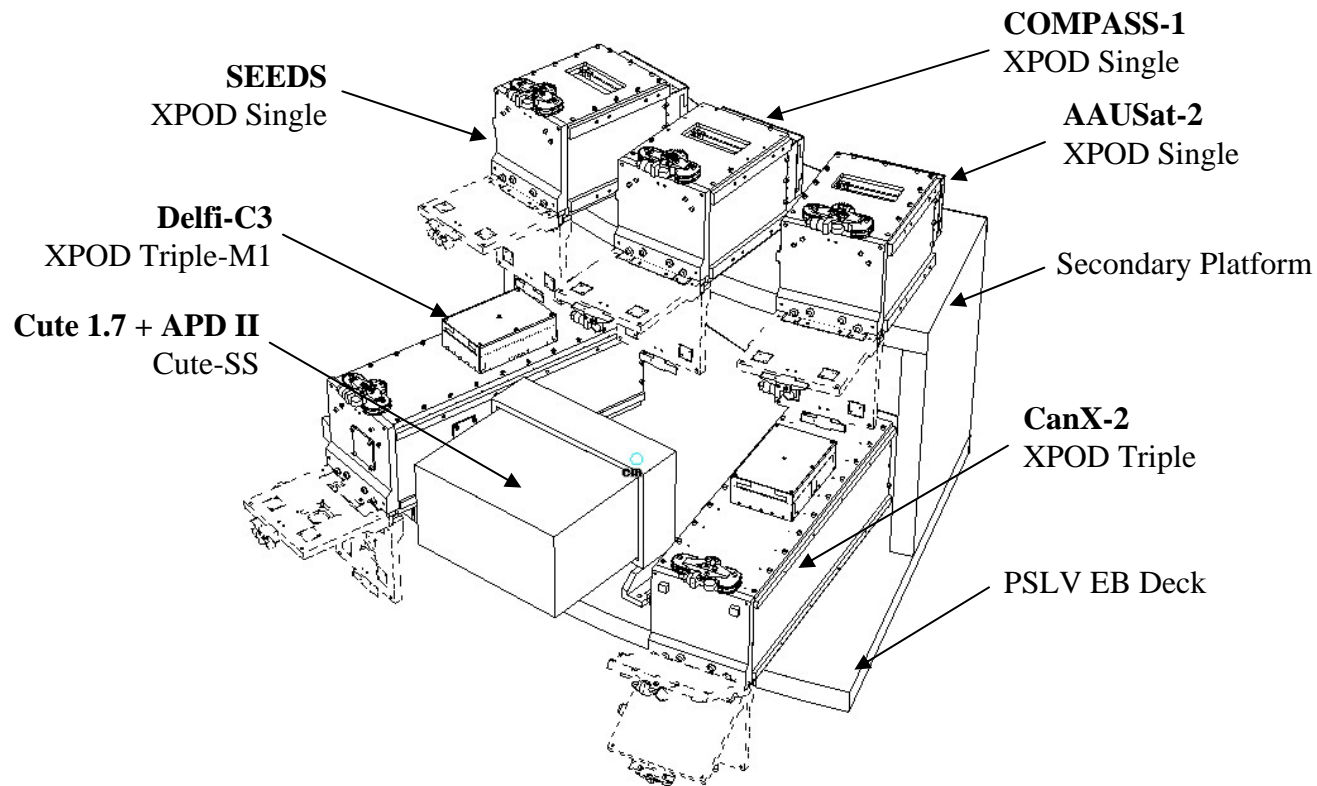


XPOD GNB & DUO

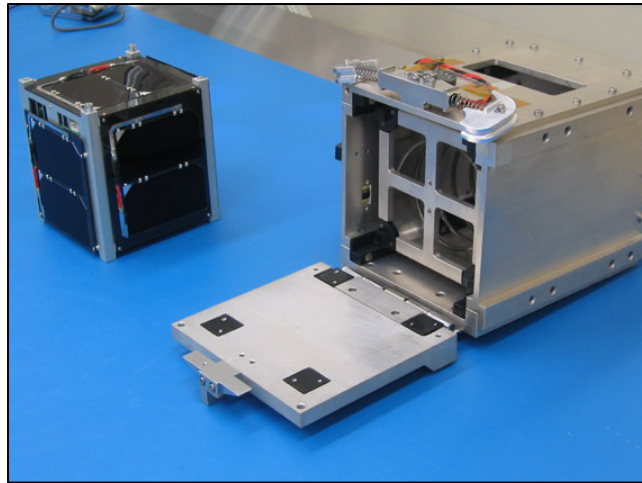
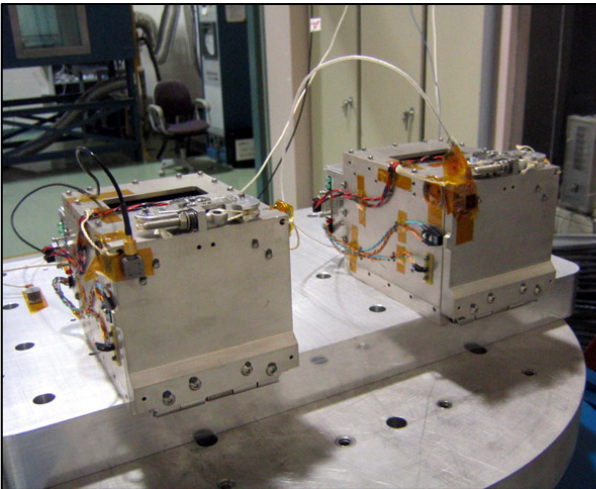
- Characteristics
 - Open-concept design, permitting fixed appendages
 - Clamp-type mechanism
 - Spacecraft damper and lock-system
 - Deployment sensors
 - Fail-safe, single failure tolerant
 - Full s/c deployment test in 1-g
- GNB: 20 x 20 x 20 cm, 7 kg spacecraft customizable
- DUO: 20 x 20 x 40 cm, 14 kg spacecraft customizable



NLS-4 ON PSLV-C9



NLS-4 INTEGRATION



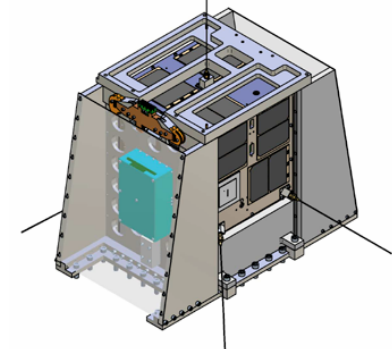
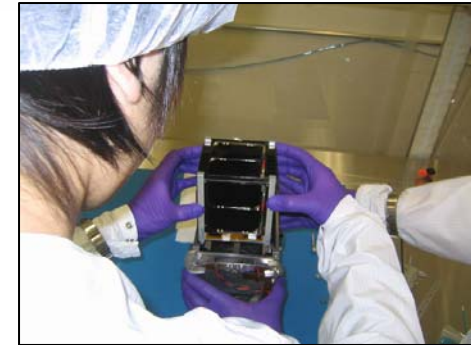
11 August 2007

SFL Nanosatellite Missions and Launches

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UPCOMING LAUNCH OPPORTUNITIES

- NLS-5: 2008 - Q3/4
 - UNIBRITE and partners
 - 600 km, Sun Synchronous Orbit, 0930 LTDN
- NLS-6: 2009 - Q1/2
 - CanX-4 and CanX-5, and partners
 - 800 km, Sun Synchronous Orbit, 0930 LTDN
- NLS-7: 2009 - Q3/4
 - AISSAT-1 and partners
 - Sun Synchronous Orbit, parameters TBC
- May be a launch opportunity in 2008-Q2 – TBA
- Additional launch partners are welcome
 - Choice of XPOD Single, Double, Triple, GNB, or DUO
 - Can accommodate customizations
 - Each spacecraft to have its own dedicated separation system



ACKNOWLEDGEMENTS

PARTNERS



SPONSORS

