



AlbertaSat-1

**Greenhouse Gas Monitoring for Industrial and
Environmental Improvement**

**Presenter:
Jordan Backs**

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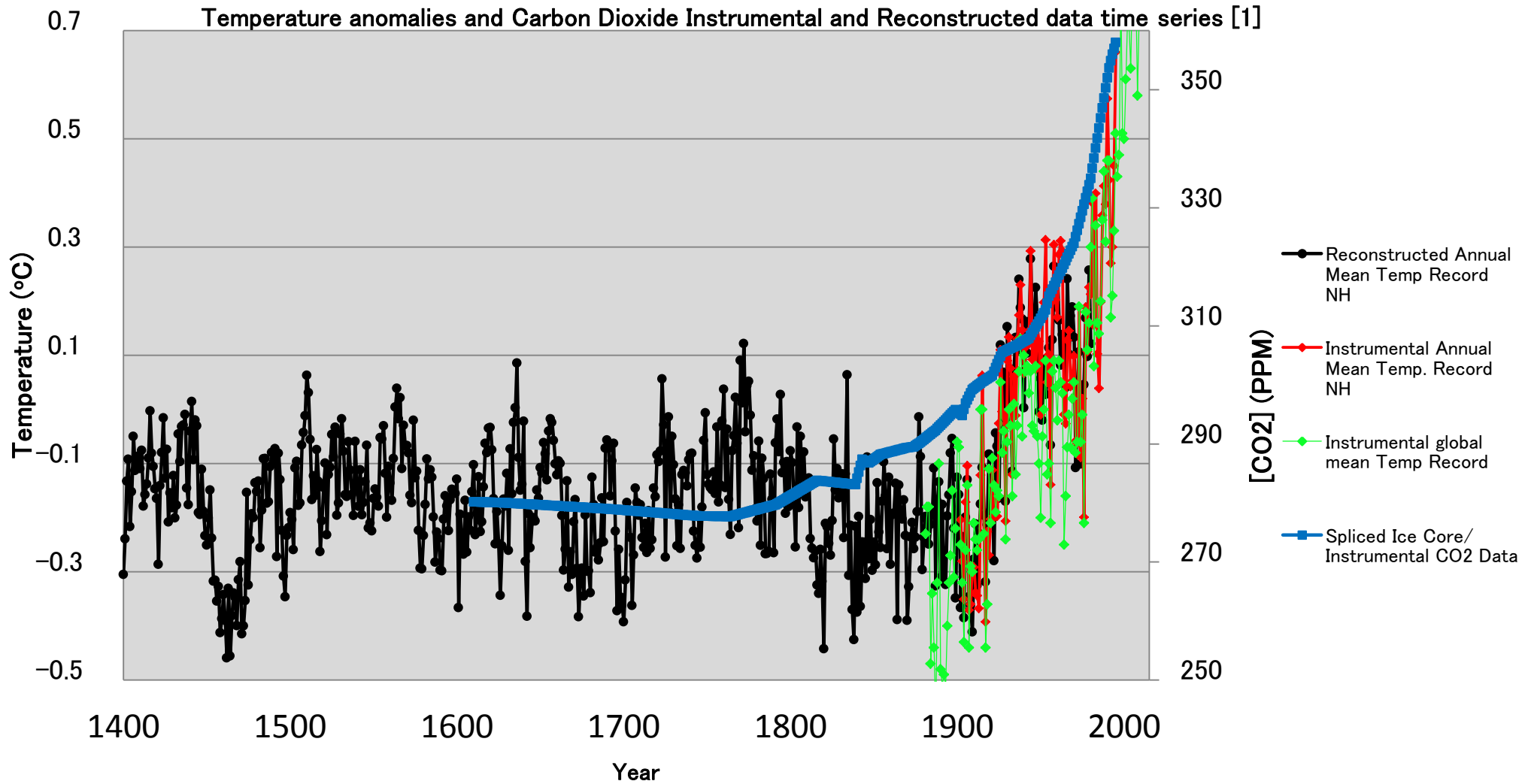


Presentation Outline

- Mission Overview
- Spacecraft Overview
 - Payload
 - Structure
 - Attitude Determination & Control
 - Power
 - Communications & Data
 - Orbit
- Concept of Operations
- Program Management
- Summary & Conclusions
- References



Mission Overview: Background





Mission Overview: Background

- Data shows positive correlation:
 - Increasing atmospheric CO₂ concentrations
 - Increasing global average temperature
 - Emission impact
- Global carbon balance has large uncertainties and sinks/sources are not fully understood
- Increased global coverage and enhanced temporal (diurnal, seasonal and interannual) and spatial (local to synoptic scale) observations of atmospheric [CO₂] will provide better estimates for sources and sinks [2]



Mission Overview: Background

- Monitoring CO₂ emissions is a high priority as stated by the governments of Canada and Alberta [4]



Image [3]: Alberta oil sands and large scale industrial GHG emissions

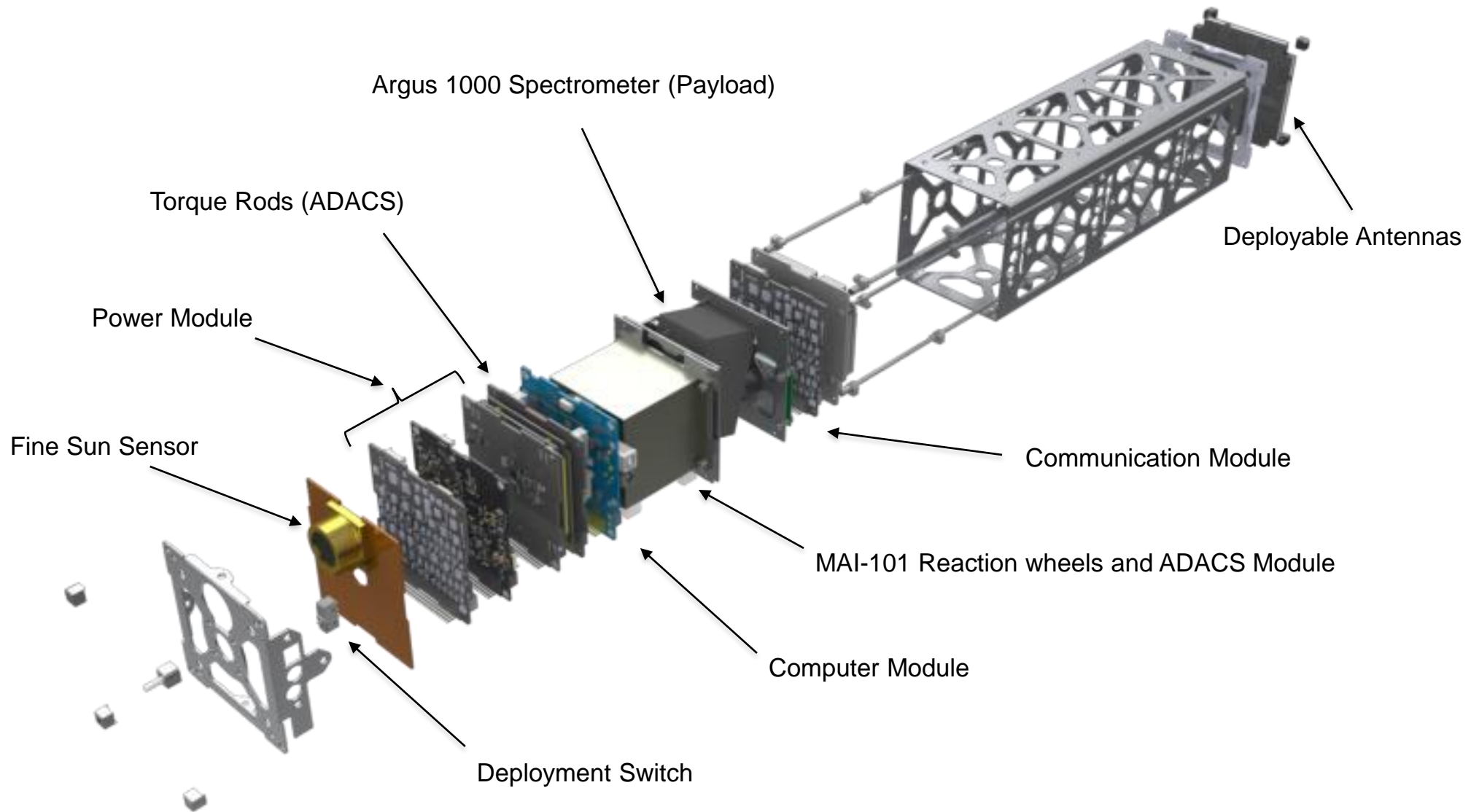


Mission Overview: Objectives

- Deploy a near-infrared (1000-1700nm) spectrometer payload to detect CO₂, H₂O and CH₄ concentrations for monitoring purposes.
- Develop local scale CO₂ transport and diffusion characterization around industrial regions (e.g. Alberta oilsands). Monitor and Map locally over time.
- High resolution and pointing accuracy to determine greenhouse gas (GHG) sources/sinks
- Engage students and public in space technology



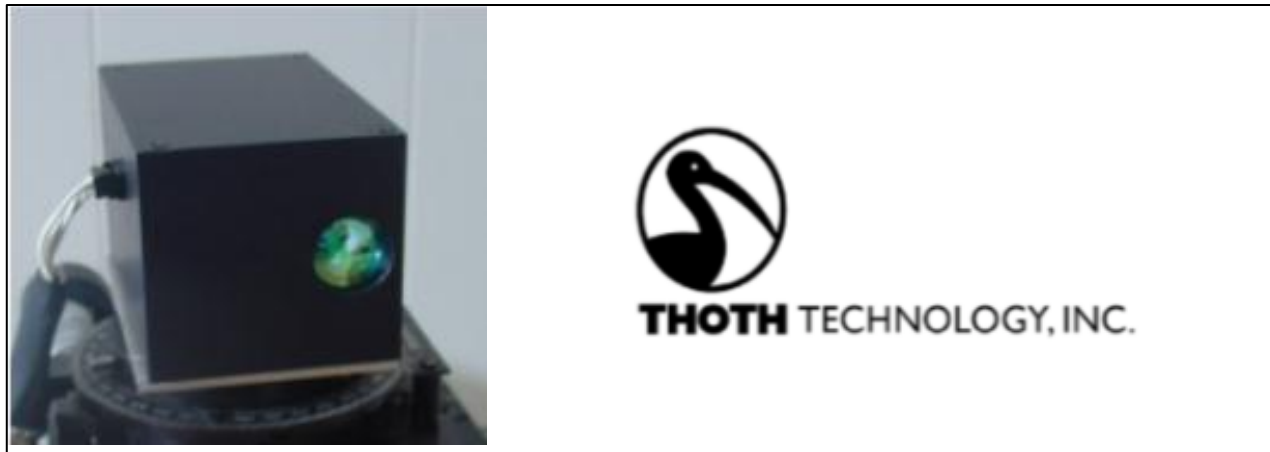
Spacecraft Overview: Exploded View





Spacecraft Overview: Payload

Argus 1000 IR Spectrometer



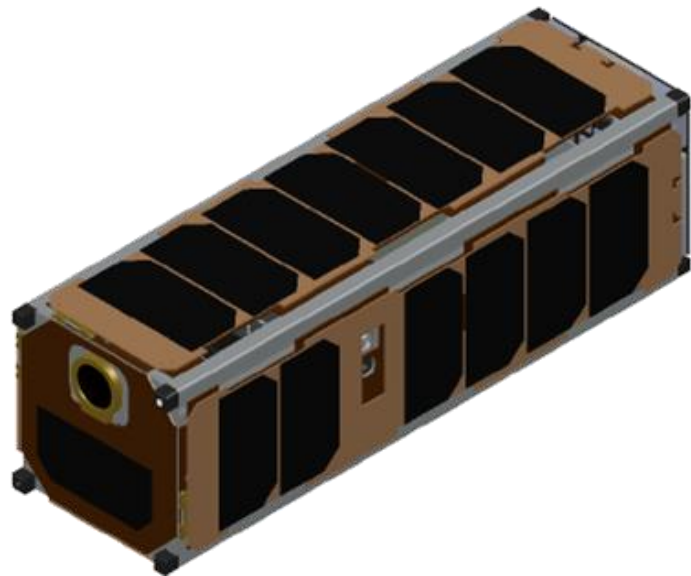
- NIR: 1000nm-1700nm
- ~1.5 km (across track) by ~10 km (along track) ground resolution
- Determine column densities of CO₂, H₂O and CH₄
- Space worthiness proven by CanX-2 (9:30am Descending node sun-sync orbit [5])



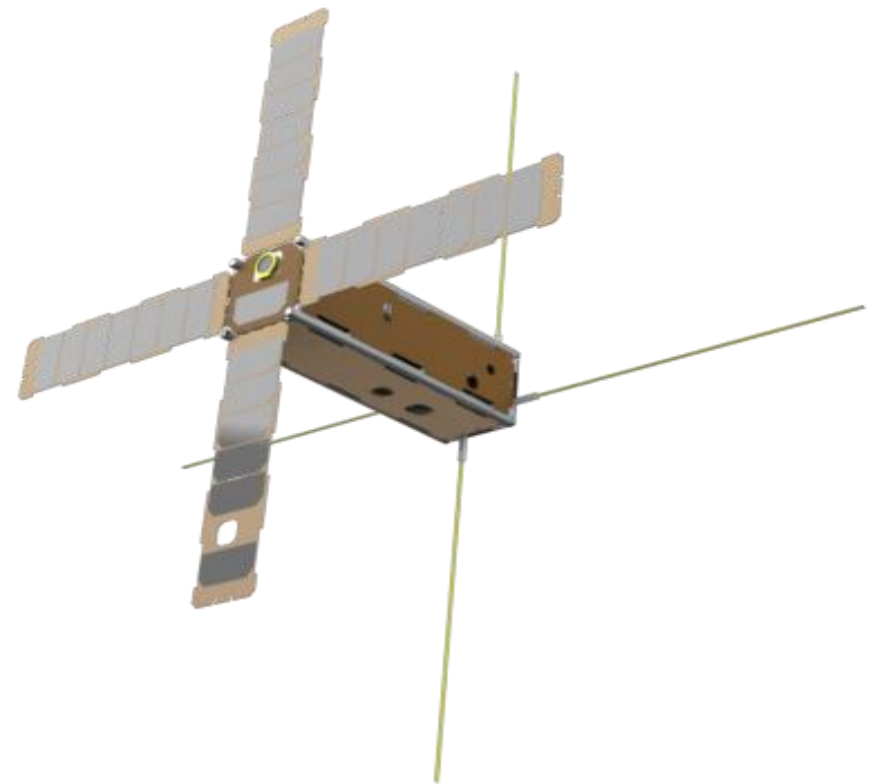
Spacecraft Overview – Structure

- Pumpkin 3U CubeSat COTS structure
- Total estimated mass (with margin): 3675.19 g

Stowed Configuration



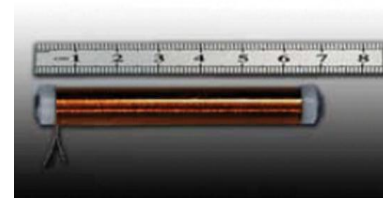
Deployed Configuration





Spacecraft Overview – ADACS

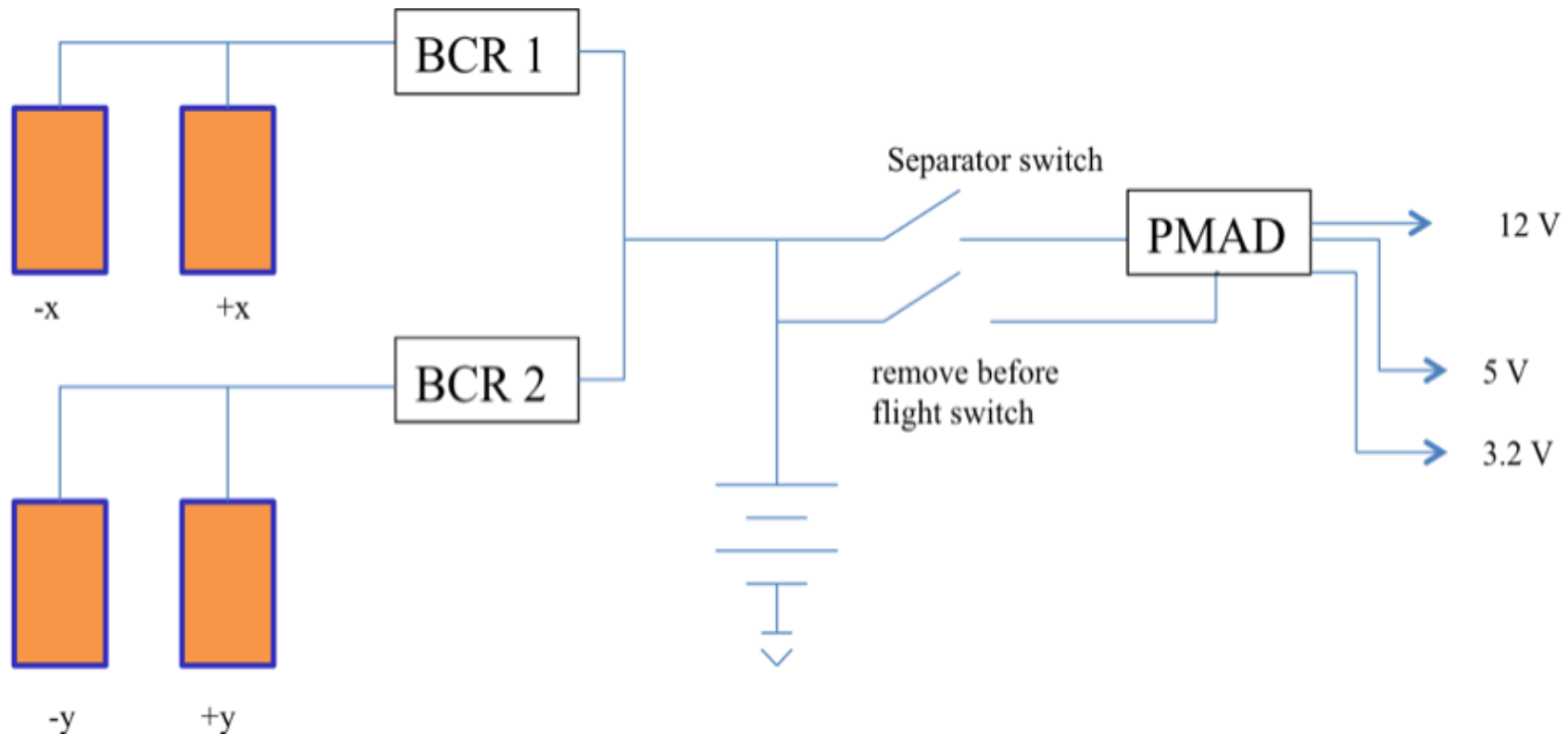
- Payload requires very high pointing accuracy
 - Observation accuracy: +/- 12km
 - Required control accuracy: ~1.0 degree
- Attitude sensors:
 - Two sun sensors (one fine and one coarse)
 - Two earth horizon sensors
 - Two 3-axis magnetometer
 - One 3-axis rate gyro
 - One GPS receiver
- Control actuators:
 - Reaction wheels
 - Torque rods





Spacecraft Overview – Power

- OAP consumed: 9.354 W
- OAP generated: 29.16 W
- Peak instantaneous power consumed: 25.786 W



Spacecraft Overview – Communications & Data

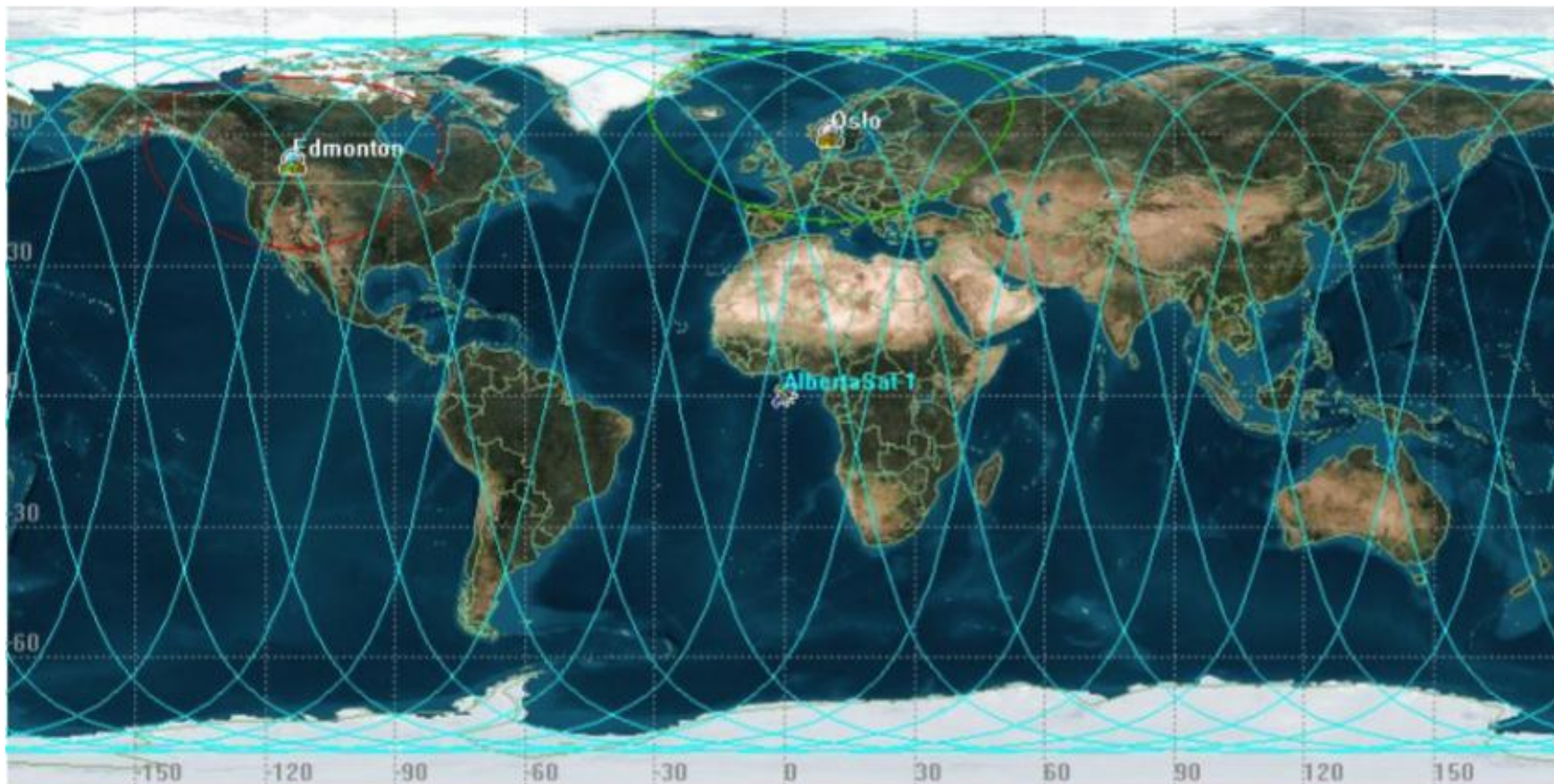


- Periodic UHF telemetry downlink (400-450 MHz)
 - 256 bytes of telemetry and status every 200 s
 - Amateur radio
- UHF data downlink (400-450 MHz)
 - Every sensor reading is at least 552 bytes (raw and uncompressed, includes contextual information such as timestamp/location)
 - Two ground stations
 - Edmonton, Alberta, Canada
 - Andøya, Norway
 - 1.2 MB science data down/day
- VHF Uplink (130-160 MHz)
- ARM Cortex M3 Board microcontroller



Spacecraft Overview - Orbit

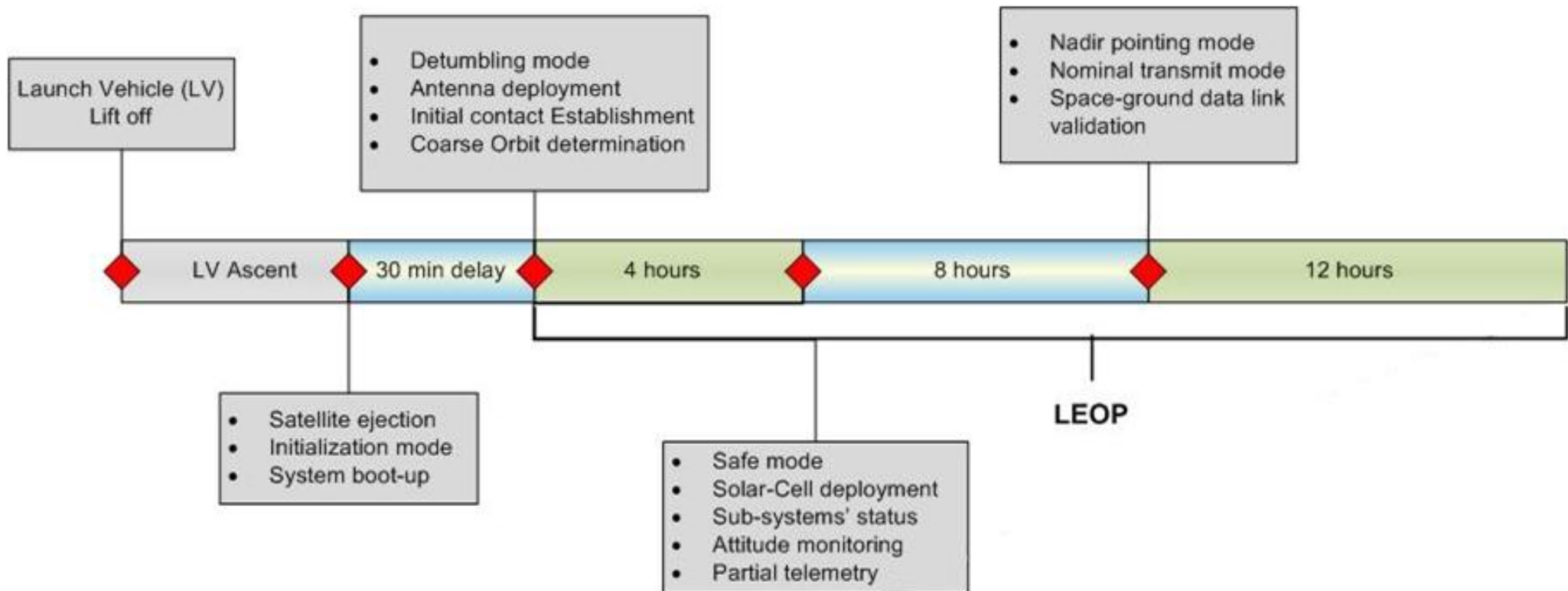
- Dusk-dawn (6:00 am ECT), near-polar, sun-synchronous
- Altitude: 700km
- Mission life of ~5 years





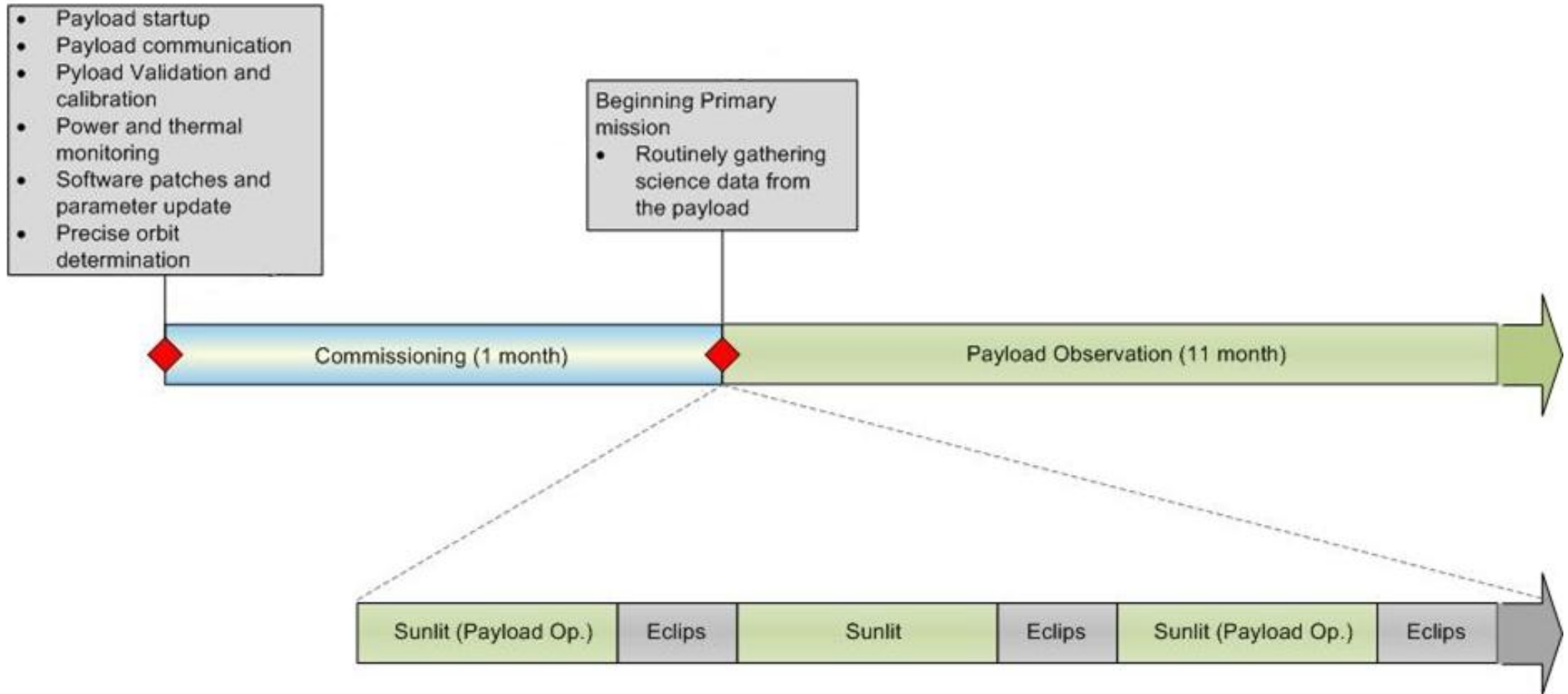
Concept of Operations

- Standard 3U CubeSat structure
- Compatible with Poly Picosatellite Orbital Deployer (PPOD) launch system





Concept of Operations





Program Management - Budget

Hardware costs	\$258,695.00
Operations costs	\$33,807.00
Total Development Costs	\$292,502.00
Launch Estimate	\$200,000.00
Post Launch operations Costs	\$4000.00/year



Program Management – Project Schedule

	2010				2011				2012				2013			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Organization Start	█	█														
Trade Studies		█	█													
Design and Development		█	█	█	█	█										
Simulation and Validation				█	█	█	█	█								
Preliminary Design Review							█									
Critical Design Review								█								
Funding and Training Second Session									█	█						
Major procurement										█	█	█				
AIT								█	█	█	█	█	█	█		
Environmental Testing													█			
Launch																█



Summary & Conclusions

- GHG monitoring critical for determining success of environmental projects
- AlbertaSat-1 to measure sources/sinks of CO₂, H₂O and CH₄
- Dedicated interdisciplinary university team





References

1. NH Temperature and CO2 data acquired from Mann et al., (1998) suppl. Material and global mean temperature data acquired from Goddard Institute for Space Science (GISS; Hansen et al., 2010)
2. Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
3. Pullman, Emma. (2011, May 30). *Canada Hides 20 Percent Tar Sands Annual Pollution Increase from UN*. Retrieved from <http://www.desmogblog.com/canada-hides-20-percent-tar-sands-annual-pollution-increase-un>
4. Carbon Management Canada. (n.d.). *Government and Agency Partners*. Retrieved from <http://www.cmc-nce.ca/partners/government-and-agency-partners/>
5. Kahr, E., Susan, S., & O'Keefe, K. (2010). *Orbit Determination for the Canx-2 Nanosatellite Using Intermittent GPS Data*. Retrieved from http://plan.geomatics.ucalgary.ca/papers/gnss2010_orbit_kahr_23sept2010.pdf