# Providing a Unique STEM Education Opportunity with a Five Day ELEO Mission

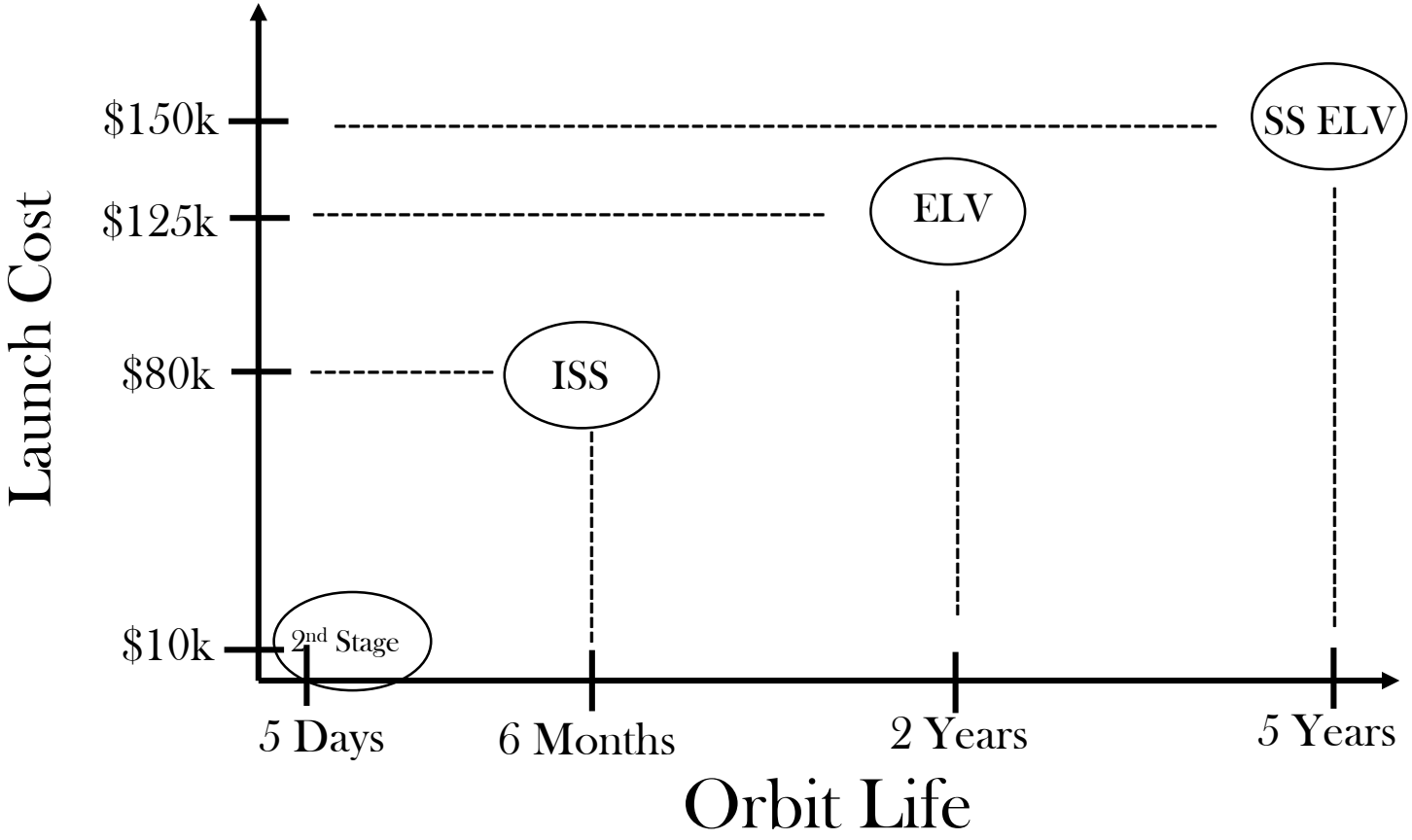
Robert Twiggs [1], Amin Djamshidpour [1], Matt Craft [1], Dale Nash [2], Hank Voss [3]

1 – Twiggs Space Lab (TSL)
2 – Virginia Commercial Space Authority
3 – Near Space Launch (NSL)

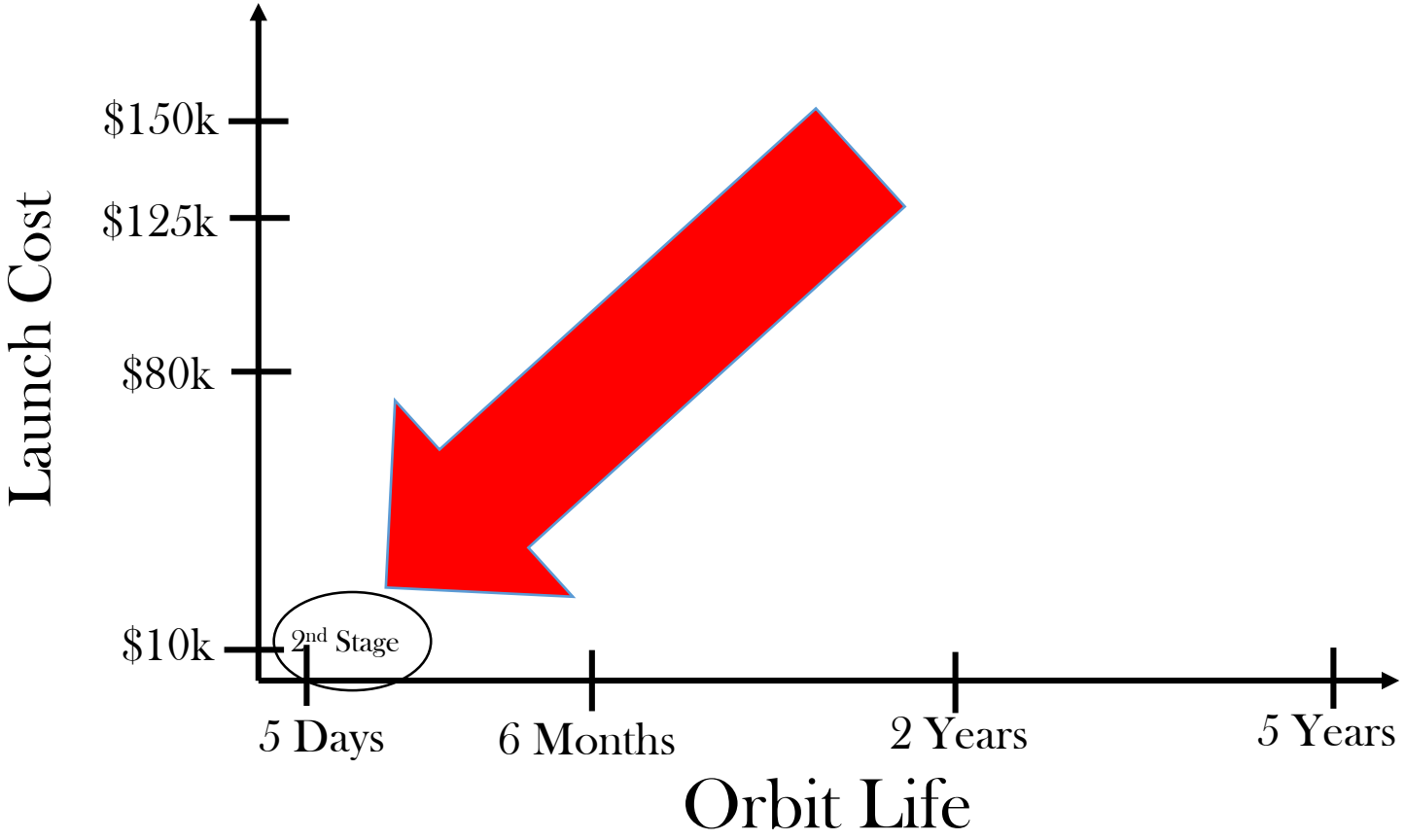
14th Cal Poly CubeSat Workshop
April 26-28, 2017

# New Spacecraft & Launch Program

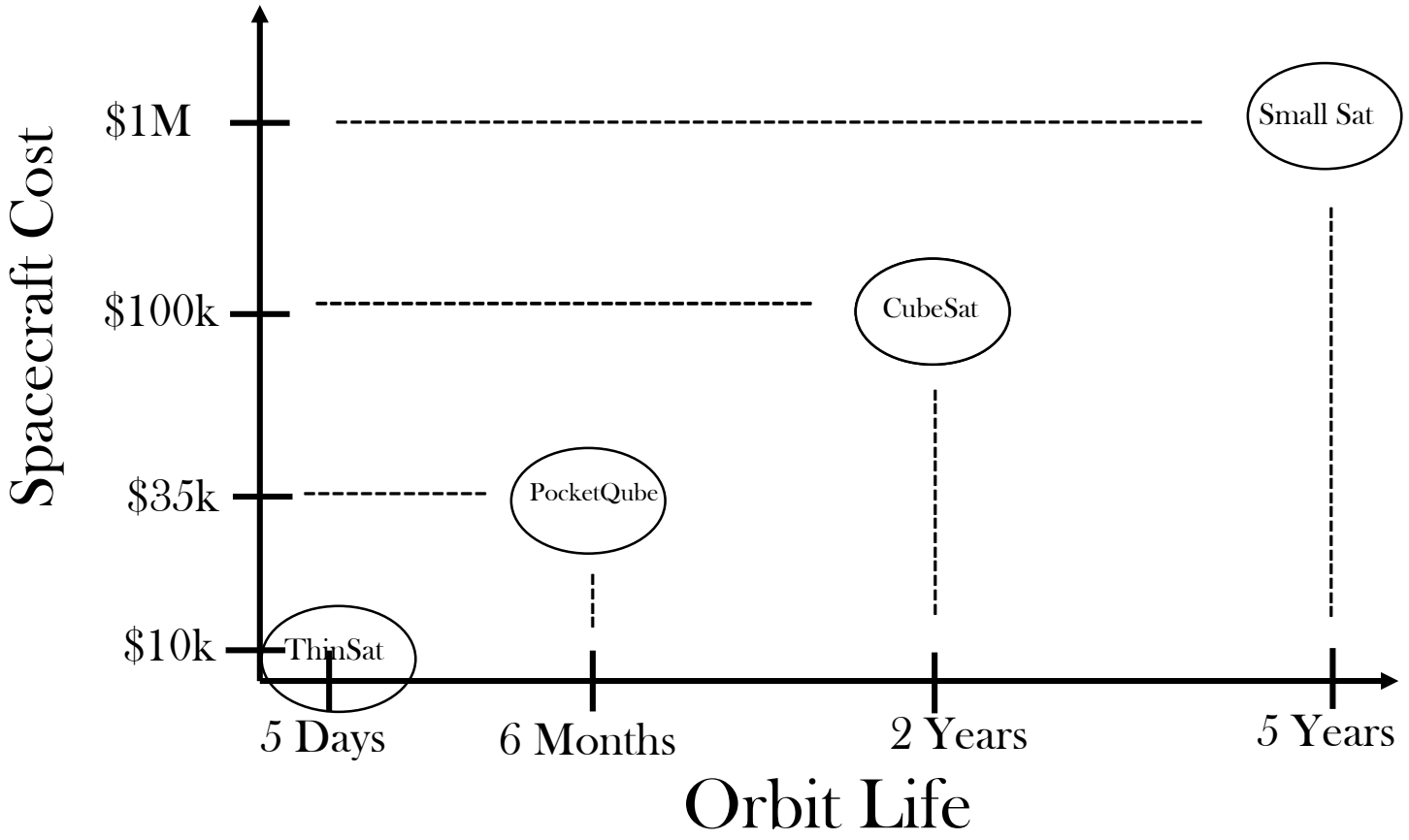
# Launch Costs vs Orbit Life



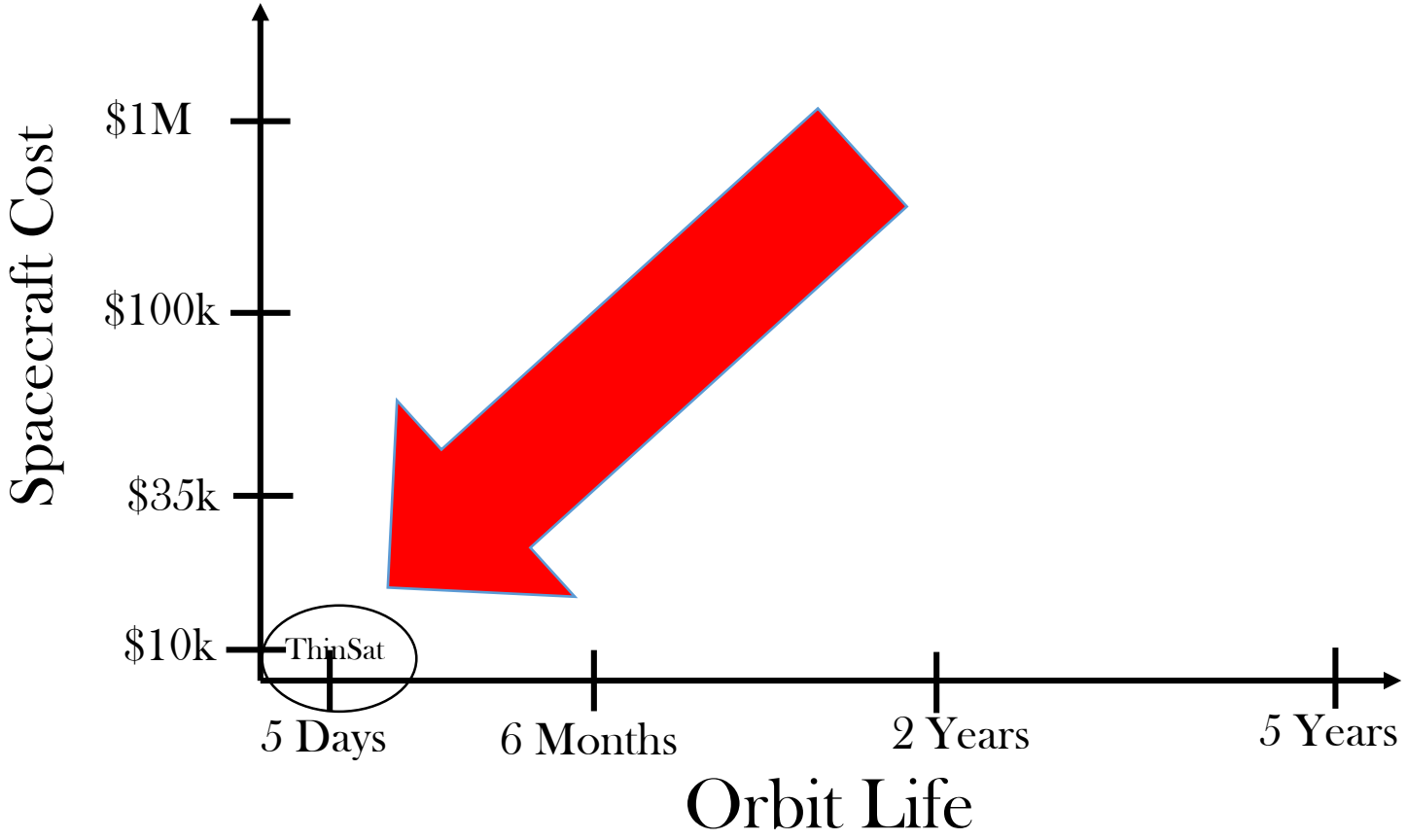
# Launch Costs vs Orbit Life



# Spacecraft Costs vs Orbit Life



# Spacecraft Costs vs Orbit Life



# Need

## Is there a need for a short orbit life?

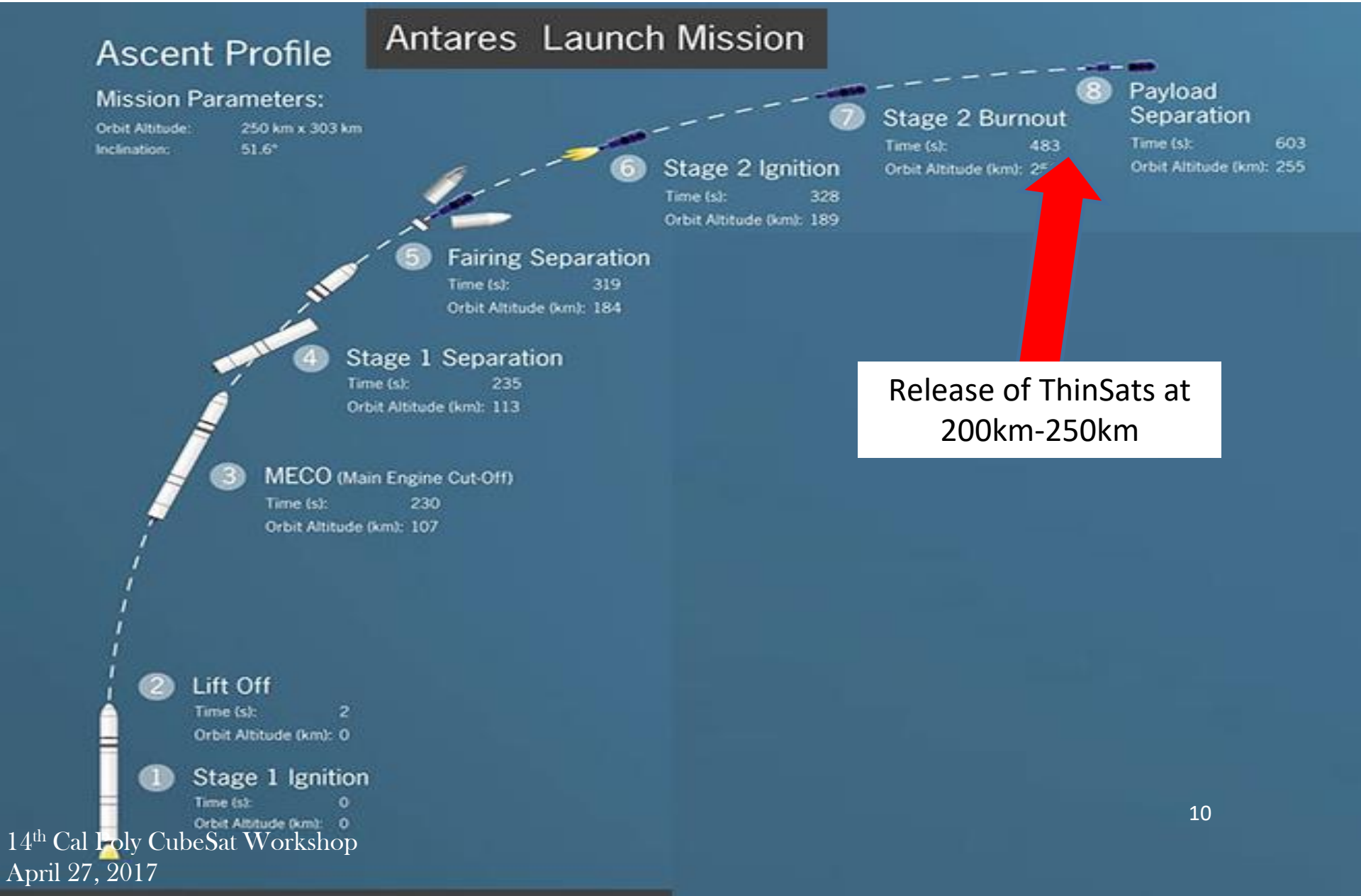
- STEM education attention span
- Low Cost
- Rapid repeat missions
- Getting through the mission cycle
- Scheduling

# New Spacecraft & Launch Program

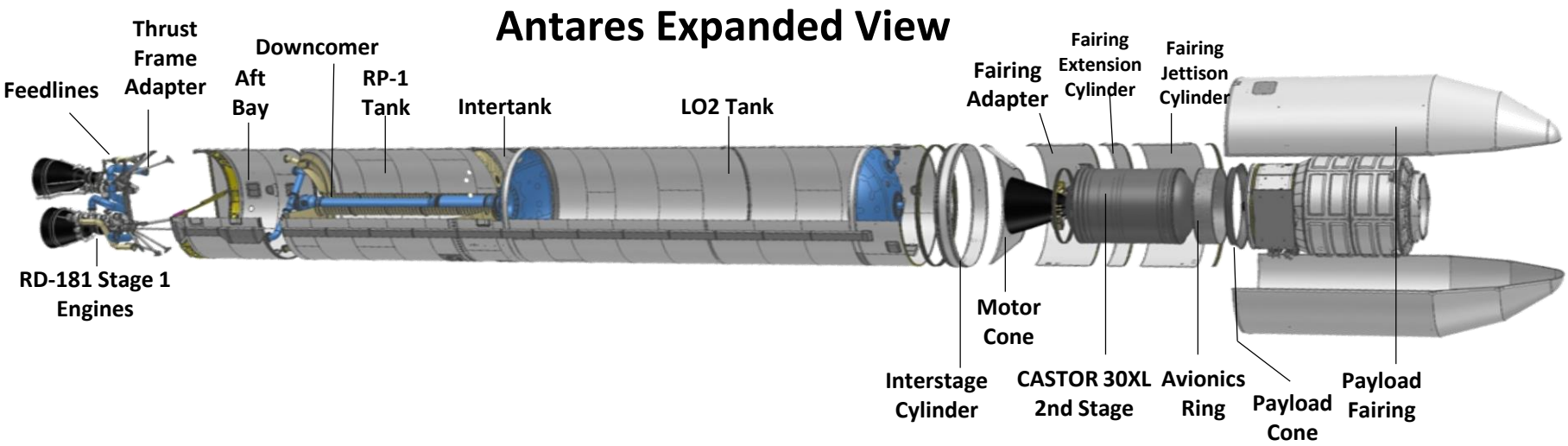
# Using the Antares Cygnus ISS Supply Mission

# Planned Program

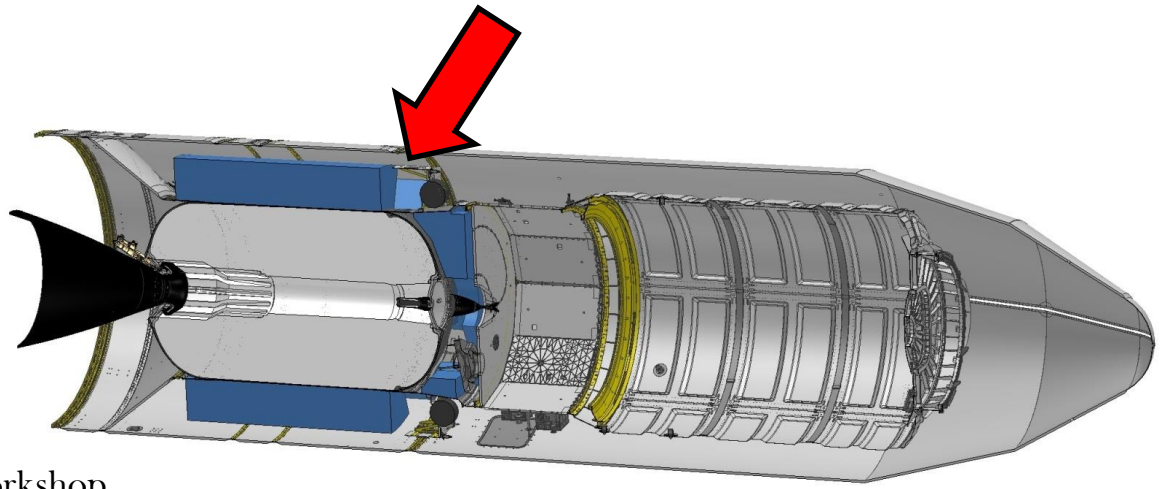
## Release from Second Stage



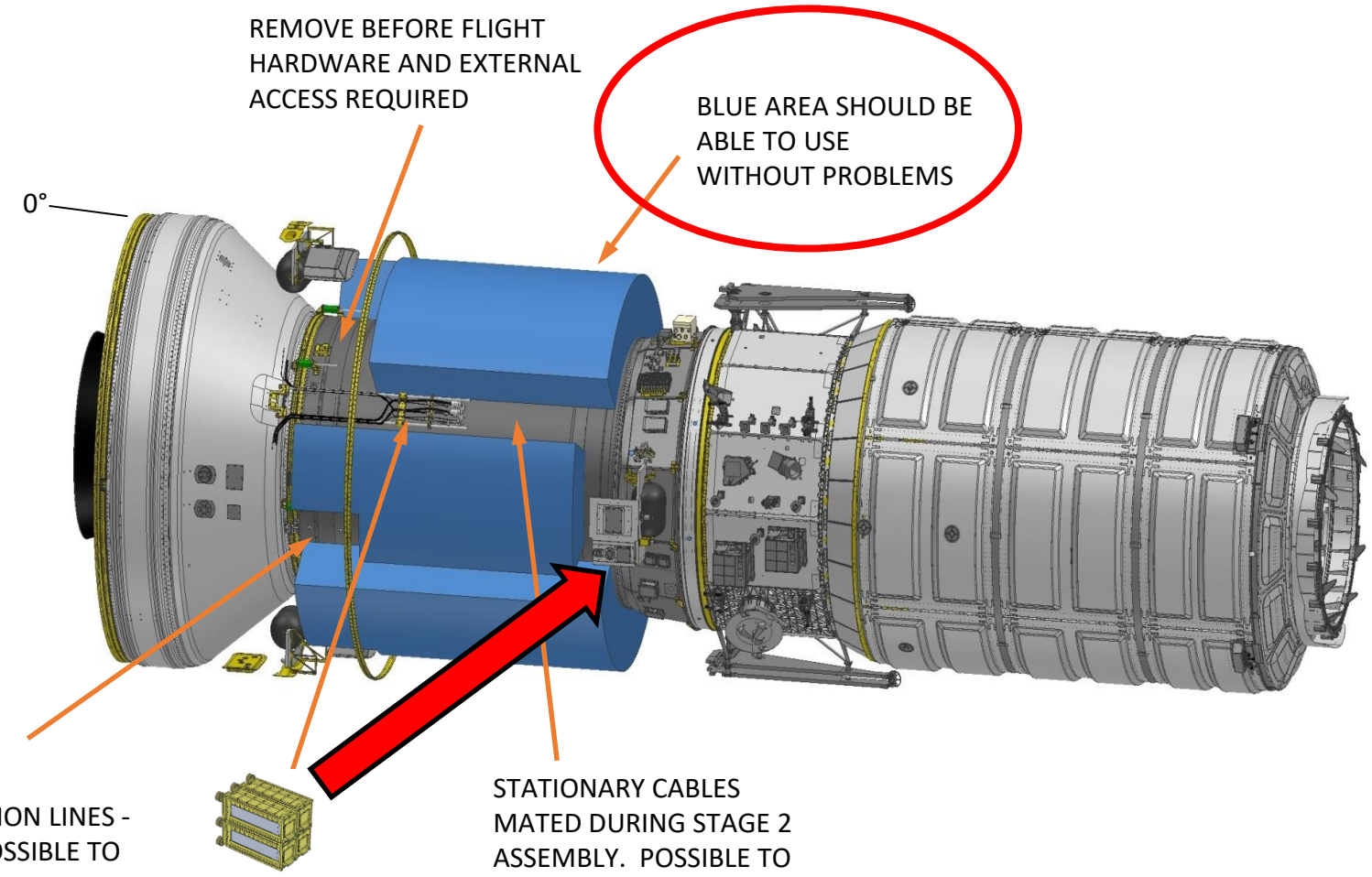
# Release from Second Stage




# Available Space for ThinSats

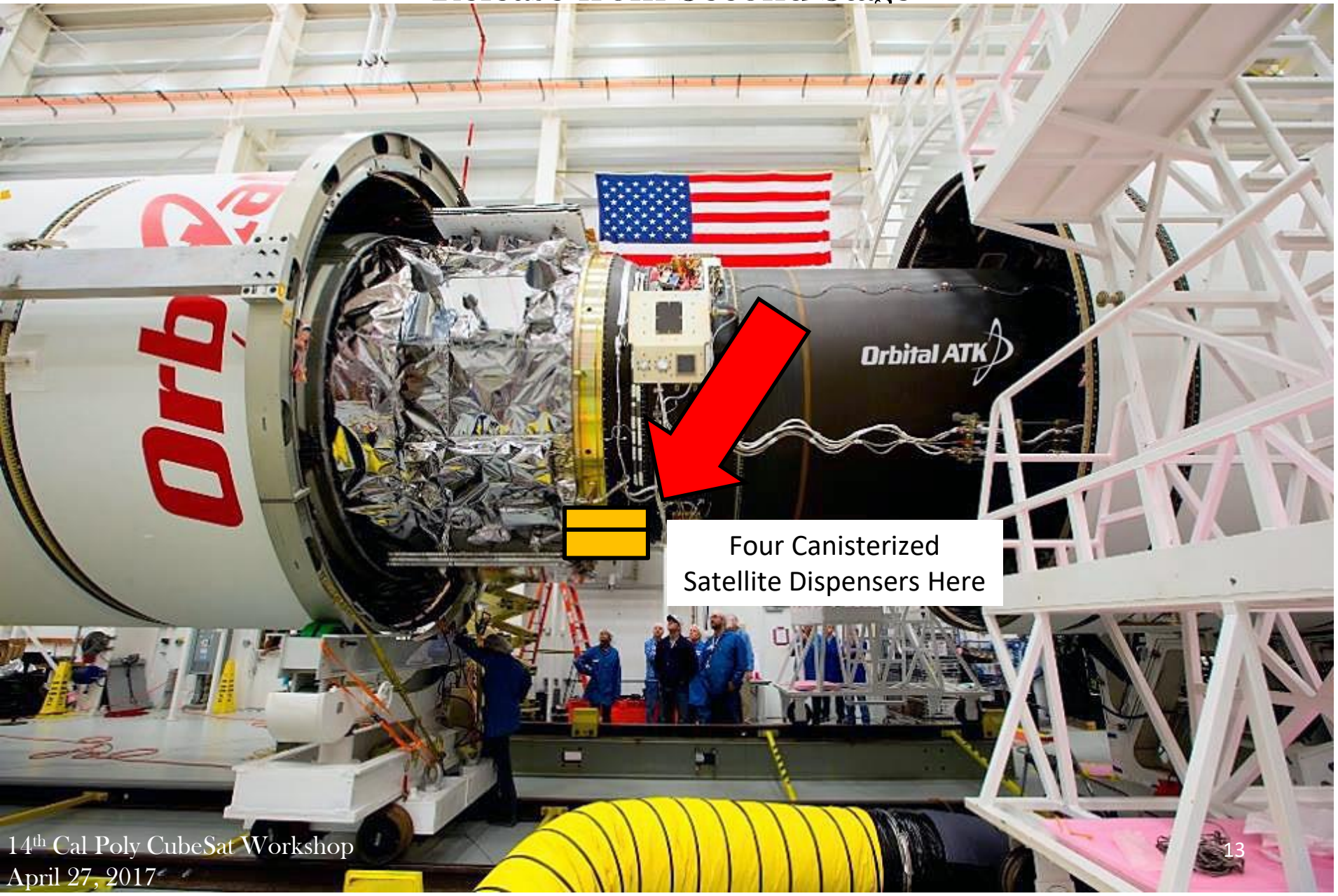


# Release from Second Stage



# Planned Program

## Release from Second Stage



# Planned Program

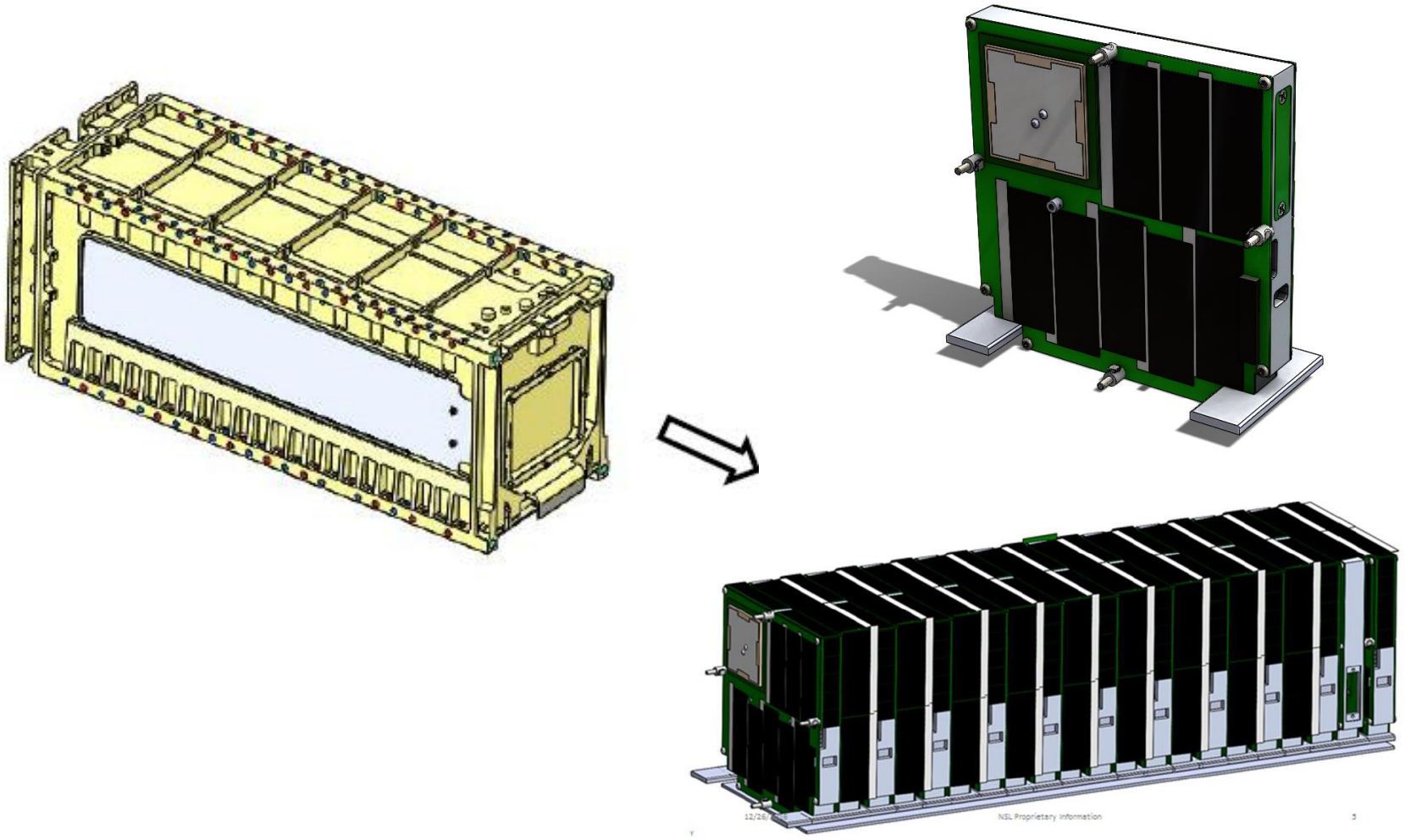
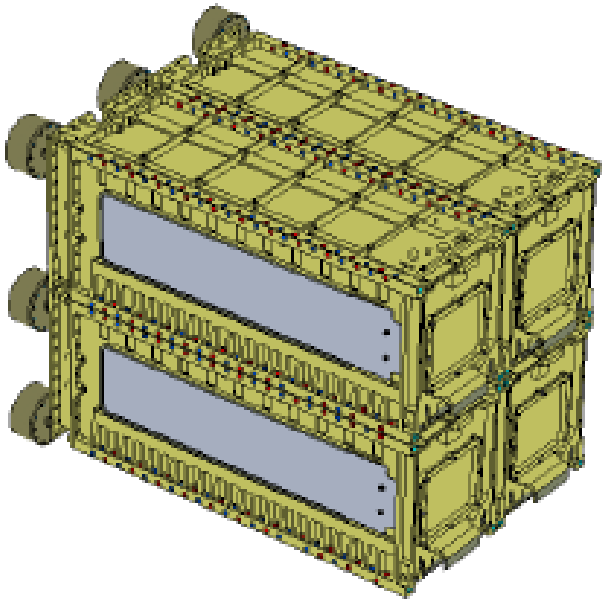


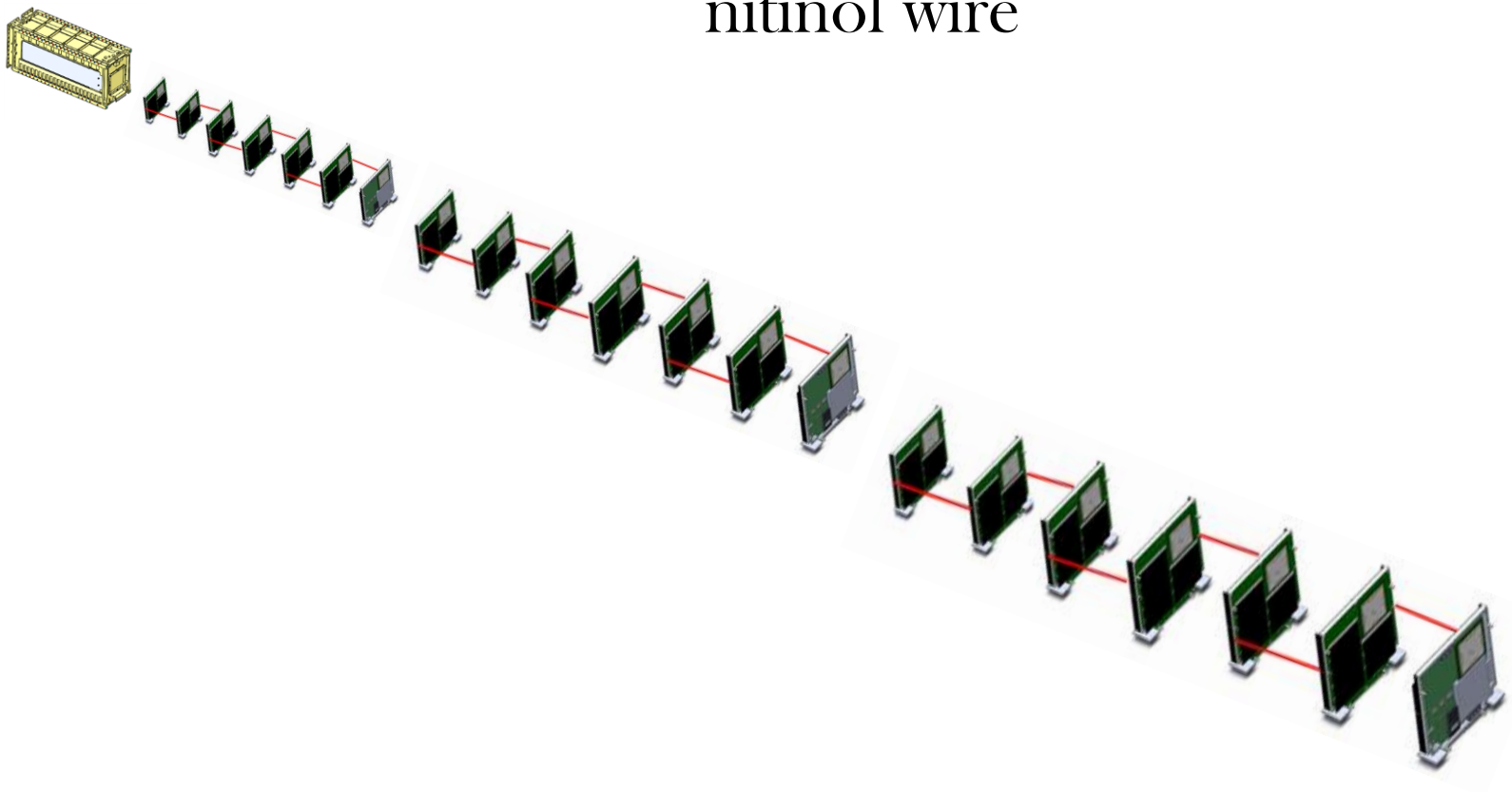

Figure: Twenty one Thin-Sats are flipped sequentially for space optimization with antennas and for centering the center of mass.

# 84 ThinSats



Four 3U CSD fastened together. Isolators fastened to the base

21 ThinSat/CSD released in groups of seven, connected together with stiff nitinol wire



# Advantages of Antares Launch

- Release PicoSat at an altitude of 200 km – 250 km
- Orbit life of approximately 5 days
- No lasting orbital debris

# Target Customers

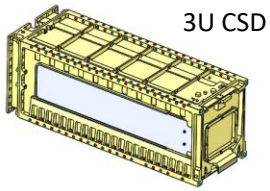
- **STEM K-12**
- **Jr Colleges**
- **University Lower Division**
- **ELEO Research**

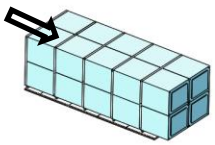
# Mission Objectives

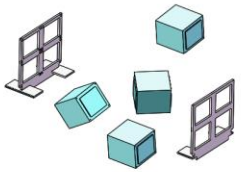
- Get **DATA**
- **You build your sensor board**
- **All Hardware Provided – ThinSat**
- **Communications with GlobalStar**

# Other Research Payloads

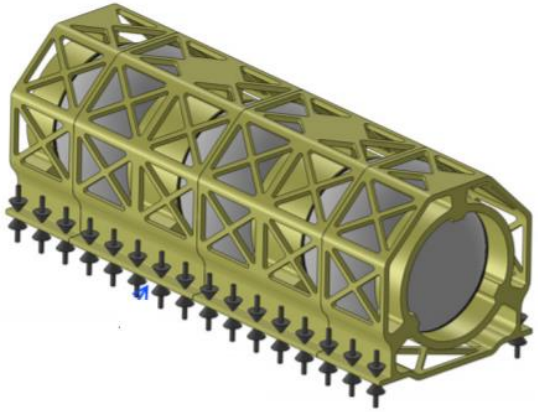
PocketQube



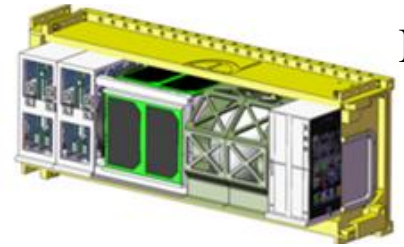





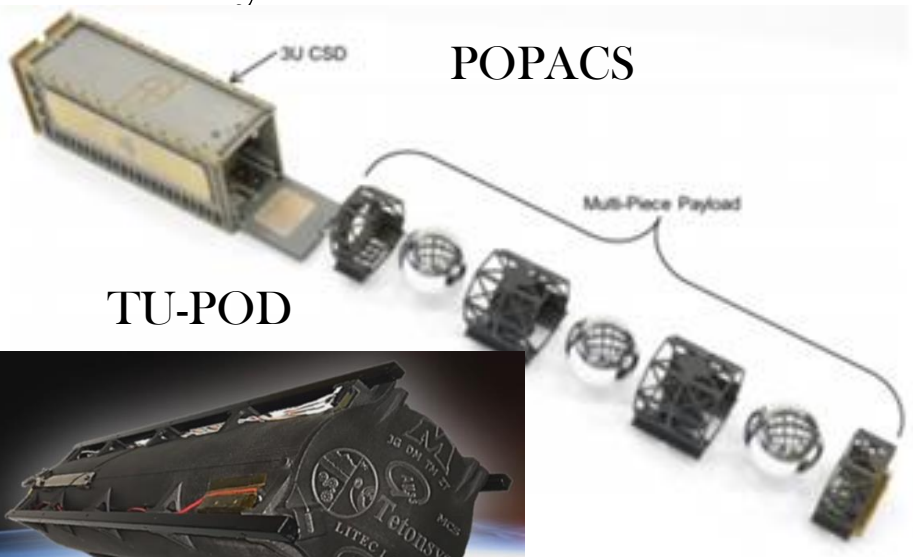
Spacer



Mixed Payload

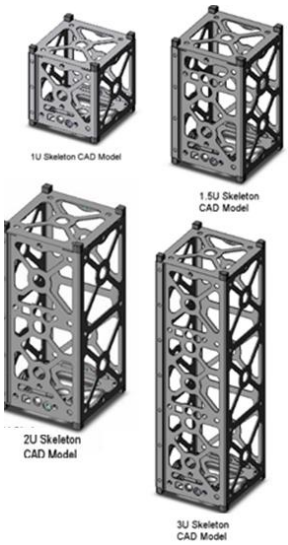


POPACS



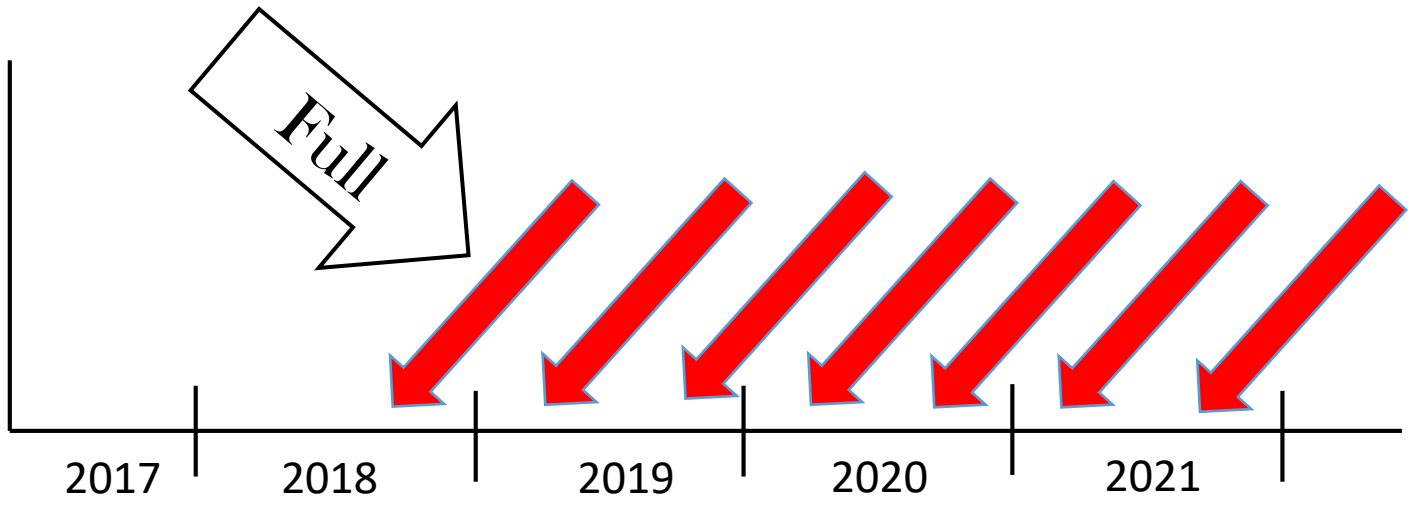

TU-POD



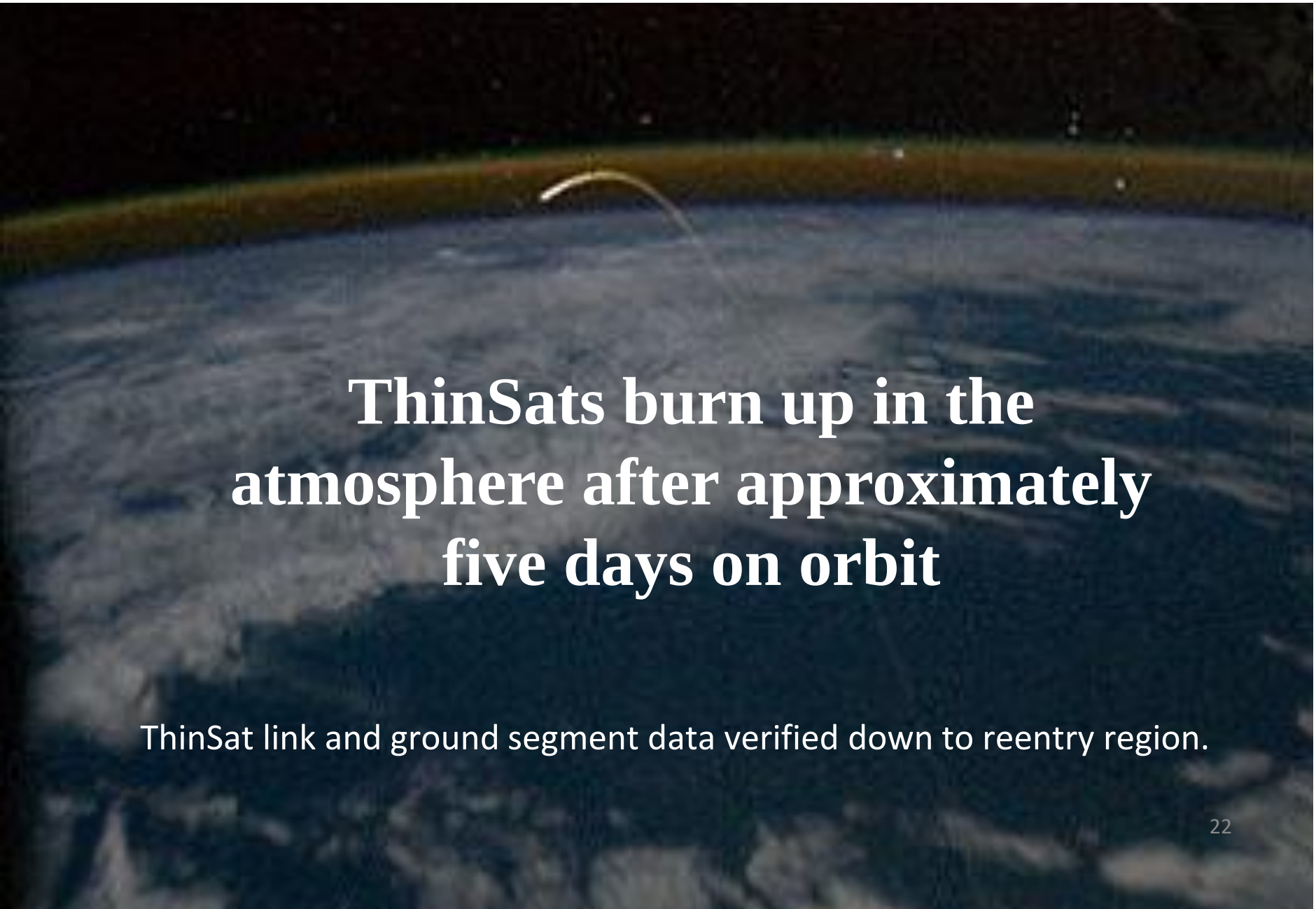




CubeSats

# Repeatable Launches




## Antares ISS Resupply Missions



# ThinSats burn up in the atmosphere after approximately five days on orbit

ThinSat link and ground segment data verified down to reentry region.

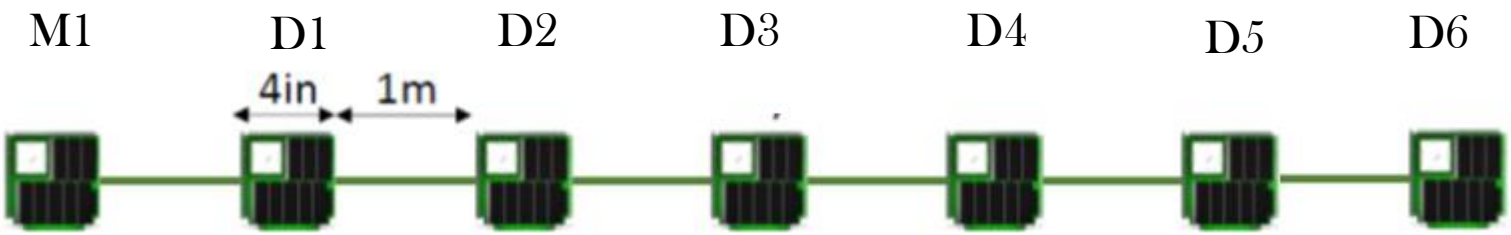
# Conclusion

- **Low Cost**
- **Repeatability**
- **Available Hardware and Launches**

# Question?

# Backup Slides

# Planned Program



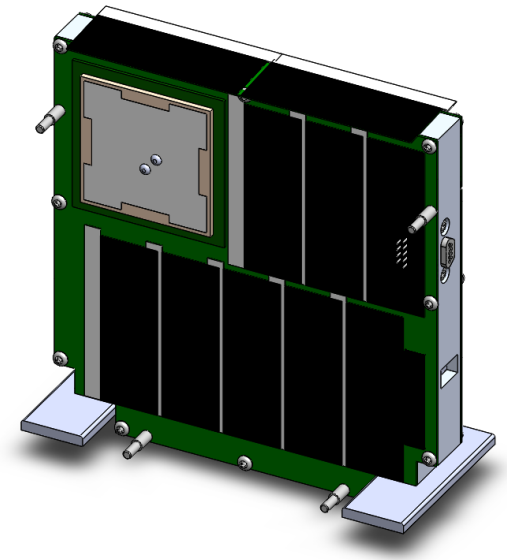

Mothership
GPS - Camera

Power Support
Daughtership

- Sensors
  - Temperature
  - Voltage
  - Currents
  - Accelerometer
  - Magnetometer
  - Gyro
  - Light Sensors
  - Radiation
- Payload
  - Energetic Particles & Dose
  - Specrum Filters
  - Plasma Density, Ionosphere
  - Reentry temperature and accelerations
  - Radio Coverage Mapping
  - Tether Motions
  - Thermospahere
  - GPS at 7 km/s
  - Aurora and South Atlantic Magnetic Anomaly
  - Ion (Magnet) versus Electron Radiation and Energy
  - Thermosphere Drag for Thin-Sat swarms
  - Attitude aerodynamic stabilization

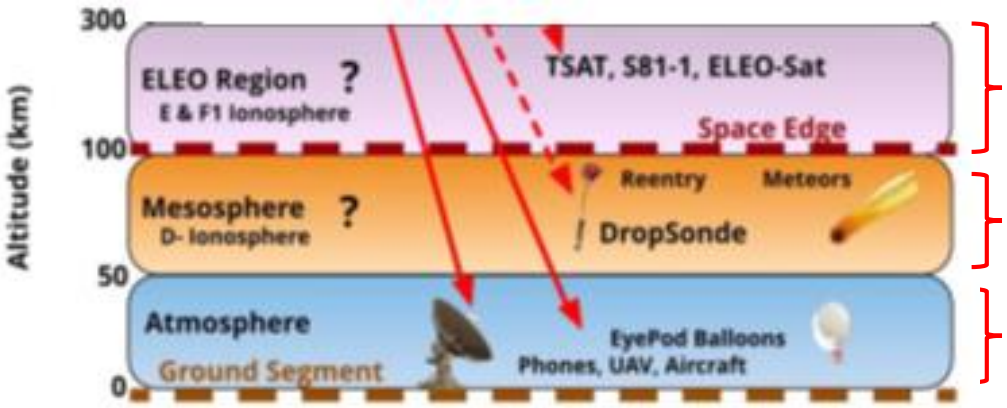
Standard Sensors

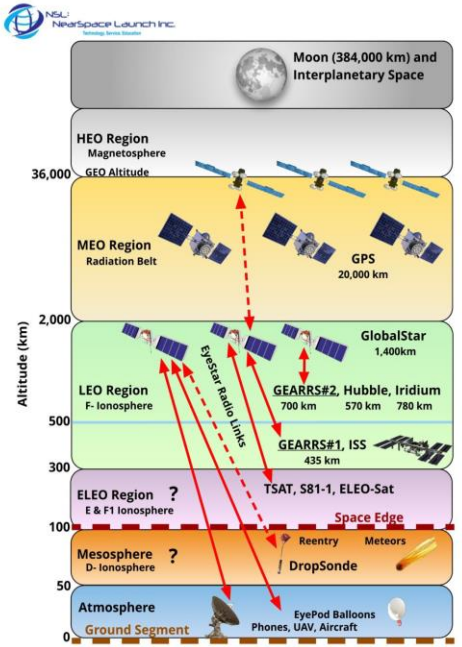
Options Sensors/experiments



# Planned Program

The three Phases of this mission provides a STEM program that allows the students over a 9-12 month period make meaningful measurements of the environment correlated with the National Science standards for K-12.




Phase 3 Extreme LEO Environment

Phase 2 Near Space Environment

Phase 1 Near Earth Environment

# Planned Program

## Phase 1

10 Satellite kits

2 large party balloon launch kits

1 ground station with Wi-Fi

Database and dashboard

Teacher training

Activity – build and run weather stations, launch 1 on a balloon as a test, launch a 2nd one on Earth Day with everyone else. Collect and analyze in

## Phase 2 Tentative Plans

- Near Space Launch
- Data comms link
- Database and dashboard
- Teacher feedback session on missions

Activity – build weather sats satellites based on learning in Phase 1. Launch to near space, collect data and analyze.

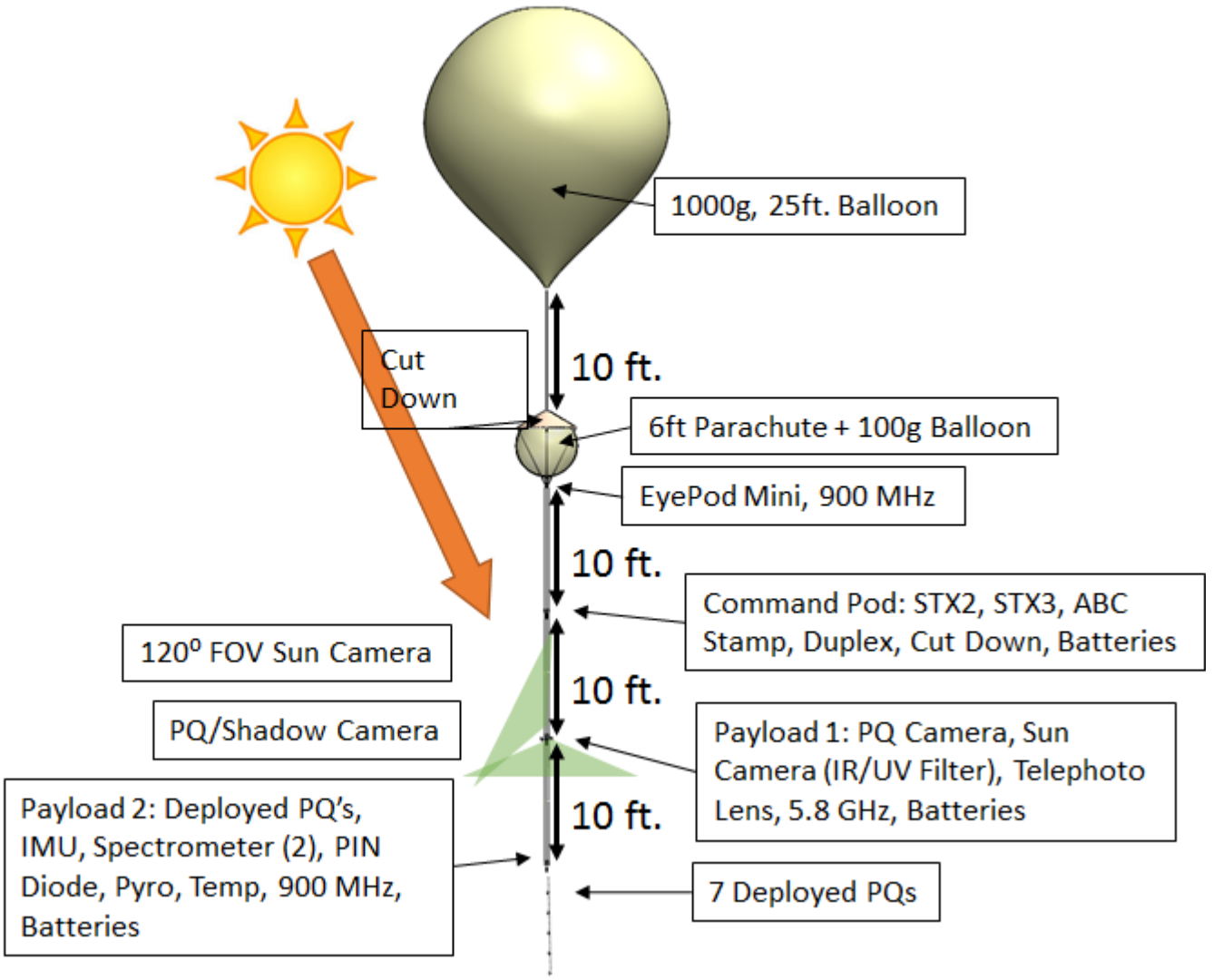
## Phase 3

- Prototype a ThinSat from what we have in our class kits
- Commission ThinSats build
- If permitted, elect one learner to attend launch event
- Launch ThinSats collect data over 5 days

Activity – design and launch our own satellite into space. Analyze the data collected.

# Planned Program

## Phase 2 Experiments: 4 Balloon Launches



# Planned Program

**Mission** | **Data Charts** | **Track** | **Analysis** | **Collaborate** | **Reports**

**Orbital ATK CRS-8**
- WiseCounty-1
- Addington-5
- Union-6
- Twiggs-1
- SetonStars
- Raider-1
- Langley-2
- NOAA-12

**Orbital ATK CRS-9**

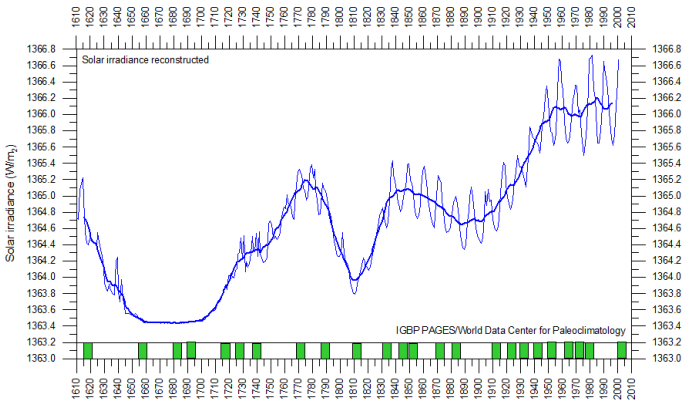
**Orbital ATK CRS-10**

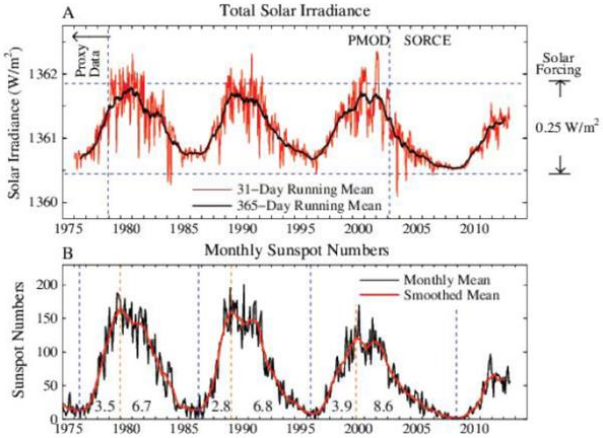
**Orbital ATK CRS-11**

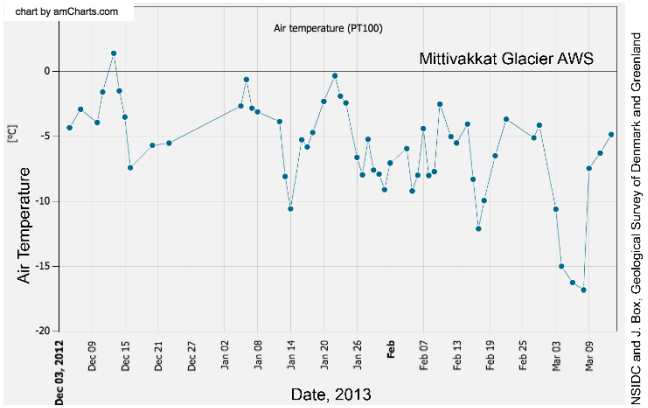
**Search**

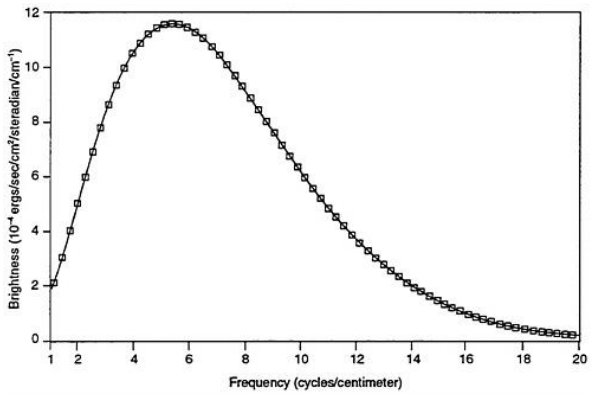
Sensor
Satellite

**XINABOX**



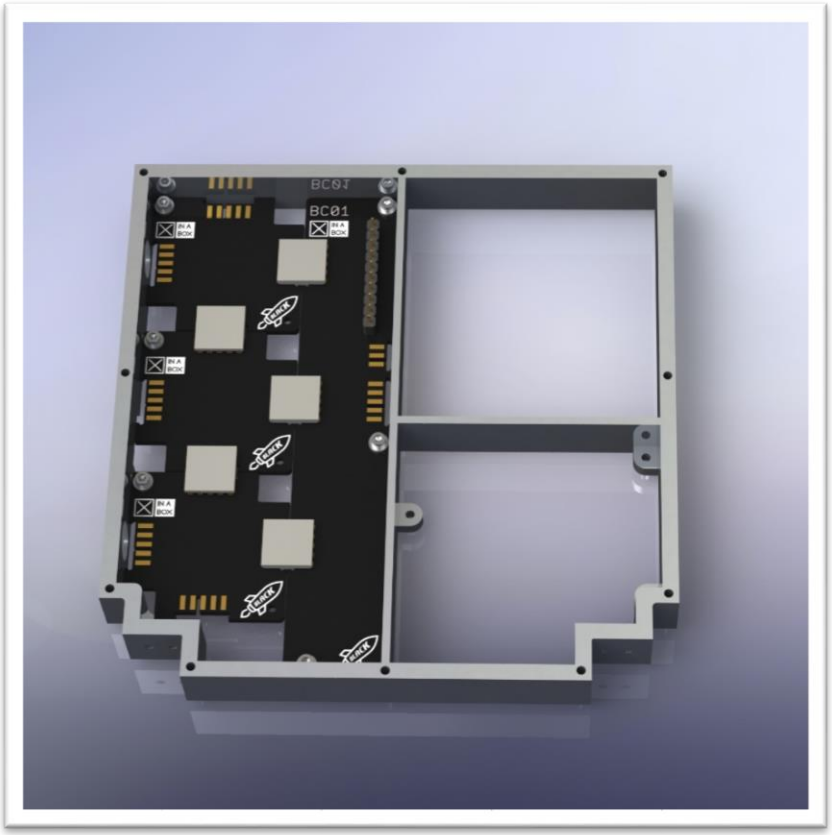



# Phases 2 and 3

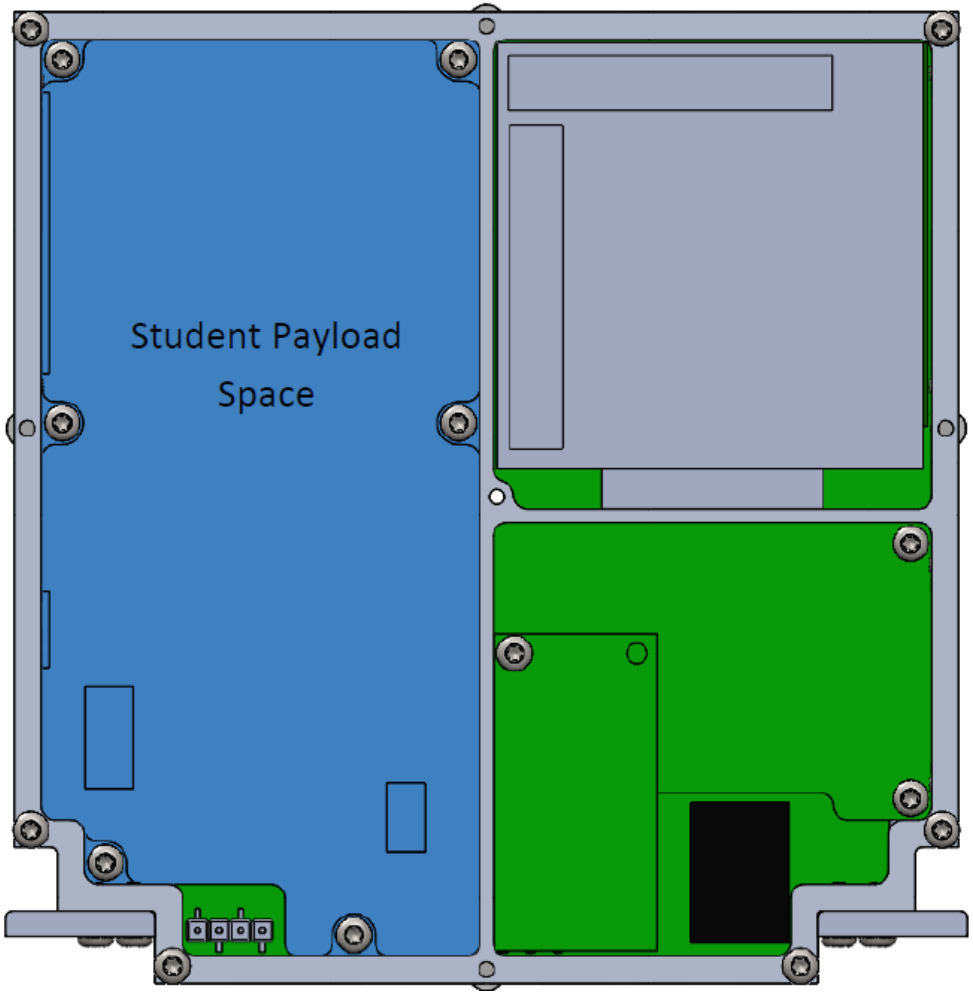
xCHIPS are incorporated into the ThinSat using a payload motherboard and connectors

Data transferred by Global Star radio to the same dashboard at the schools

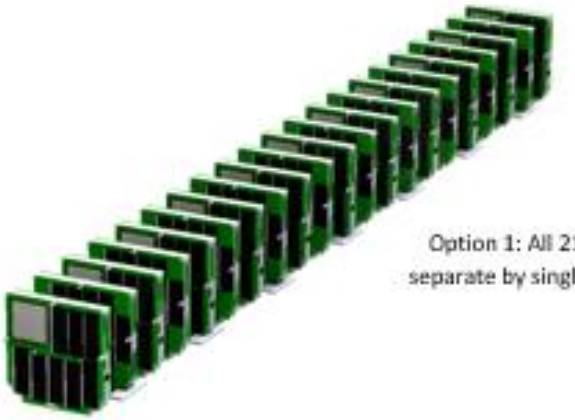


# Planned Program

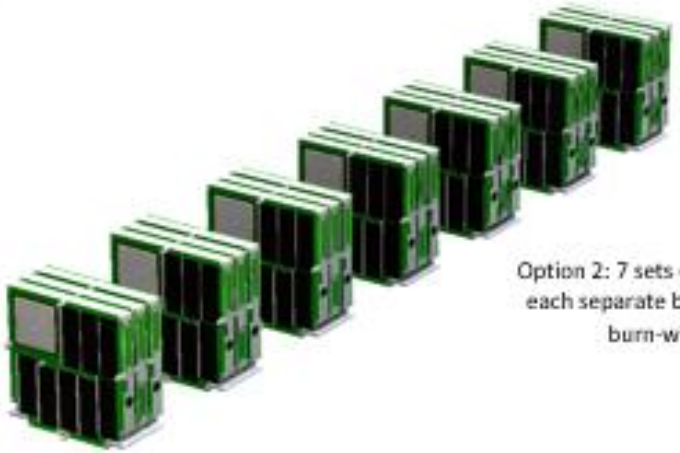
## Student Payload Space



# Option Configurations



Option 1: All 21 ThinSats separate by single burn-wire



Option 2: 7 sets of 3 ThinSats each separate by individual burn-wires

Option 3: 3 1U size sets of 7 ThinSats each separate by individual burn wires