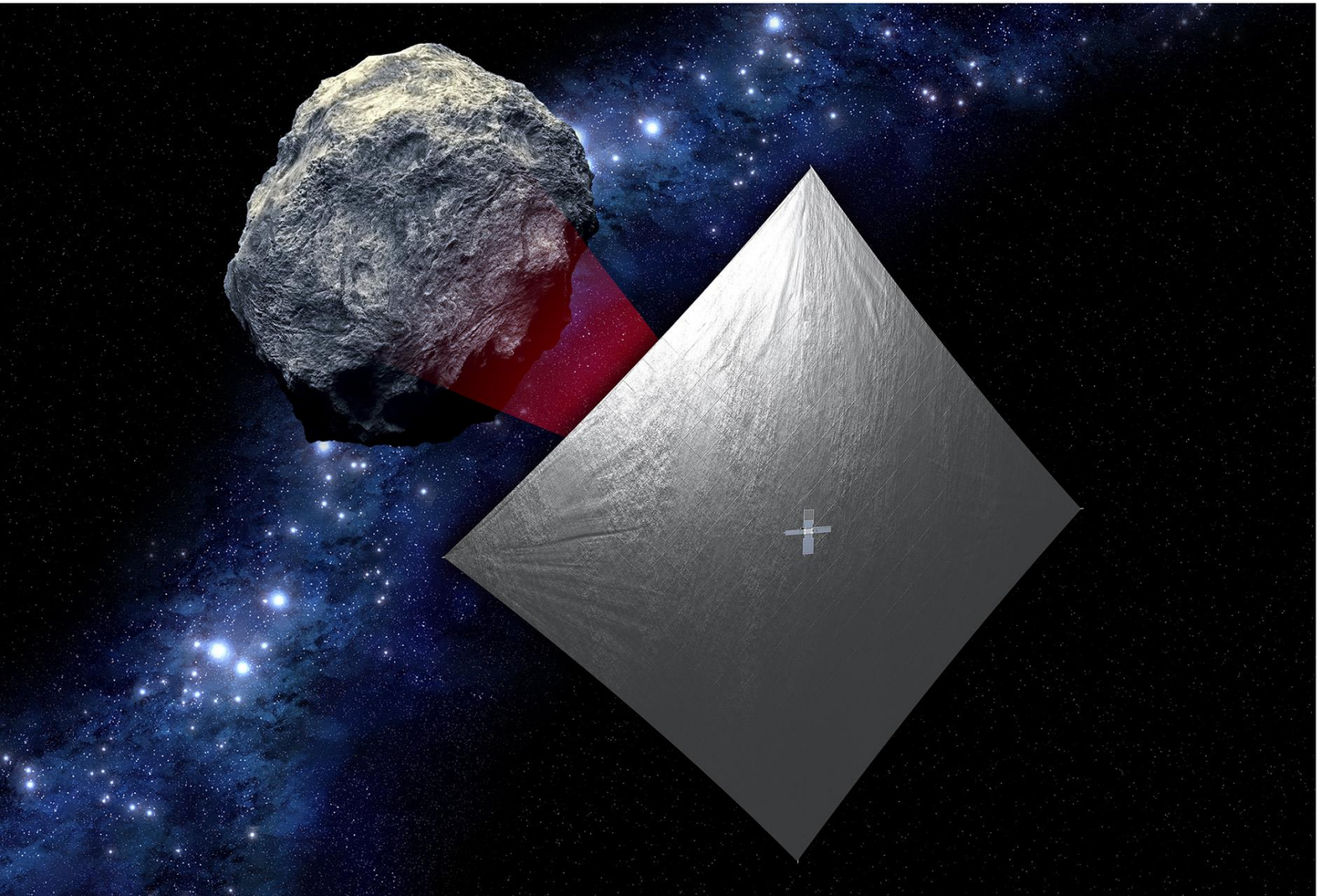
Near Earth Asteroid (NEA) Scout



Les Johnson, Jared Dervan and Leslie McNutt

NASA George C. Marshall Space Flight Center

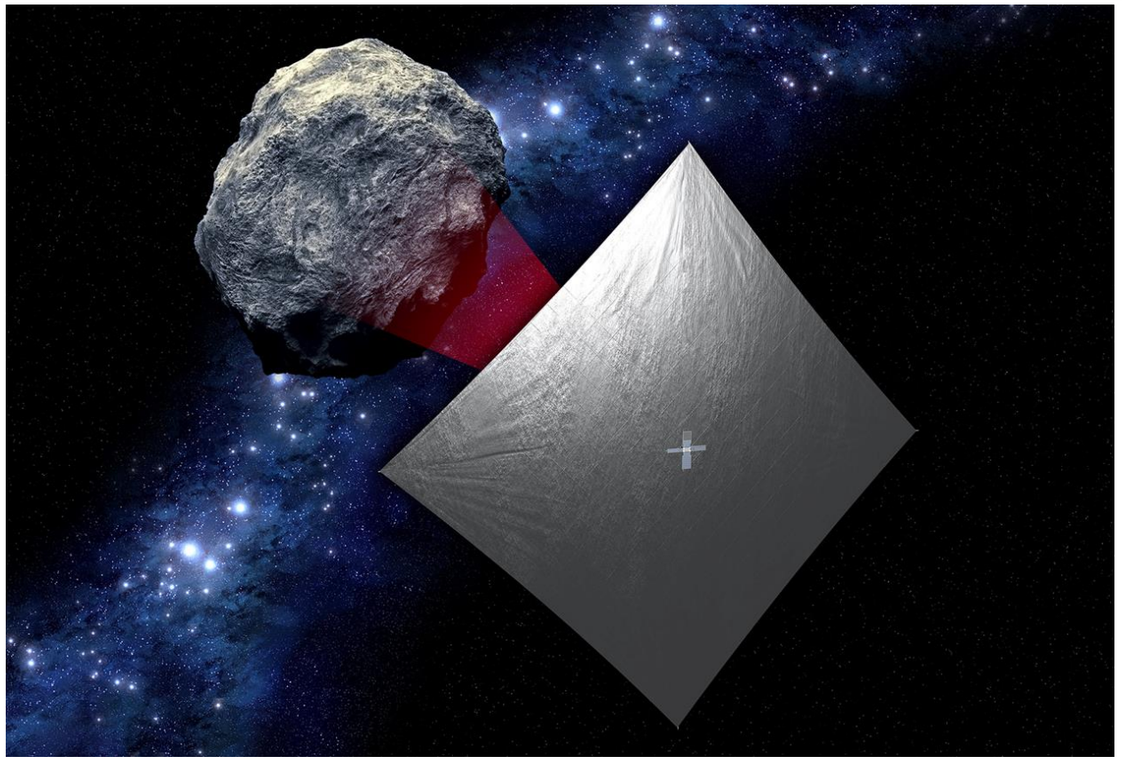
Julie Castillo-Rogez

NASA Jet Propulsion Laboratory

Near Earth Asteroid Scout

The Near Earth Asteroid Scout Will

- Image/characterize a NEA during a slow flyby
- Demonstrate a low cost asteroid reconnaissance capability

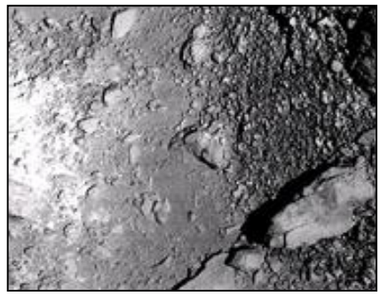


Key Spacecraft & Mission Parameters

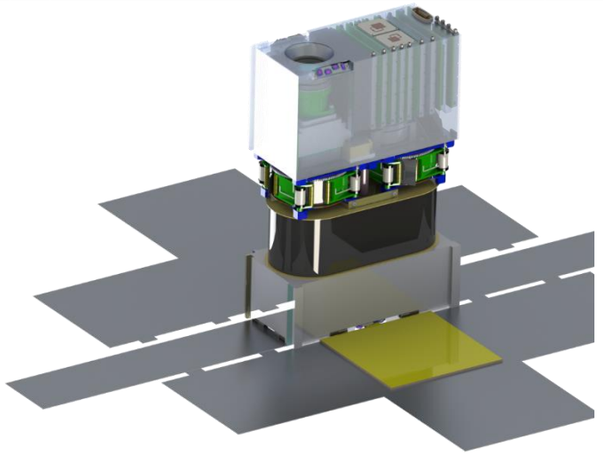
- 6U cubesat (20cm X 10cm X 30 cm)
- ~86 m^2 solar sail propulsion system
- Manifested for launch on the Space Launch System (EM-1/2018)
- 1 AU maximum distance from Earth

Leverages: combined experiences of MSFC and JPL with support from GSFC, JSC, & LaRC

Target Reconnaissance with medium field imaging
Shape, spin, and local environment

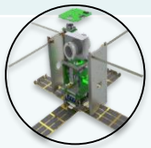
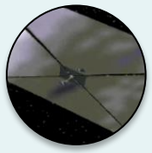


Close Proximity Imaging
Local scale morphology, terrain properties, landing site survey

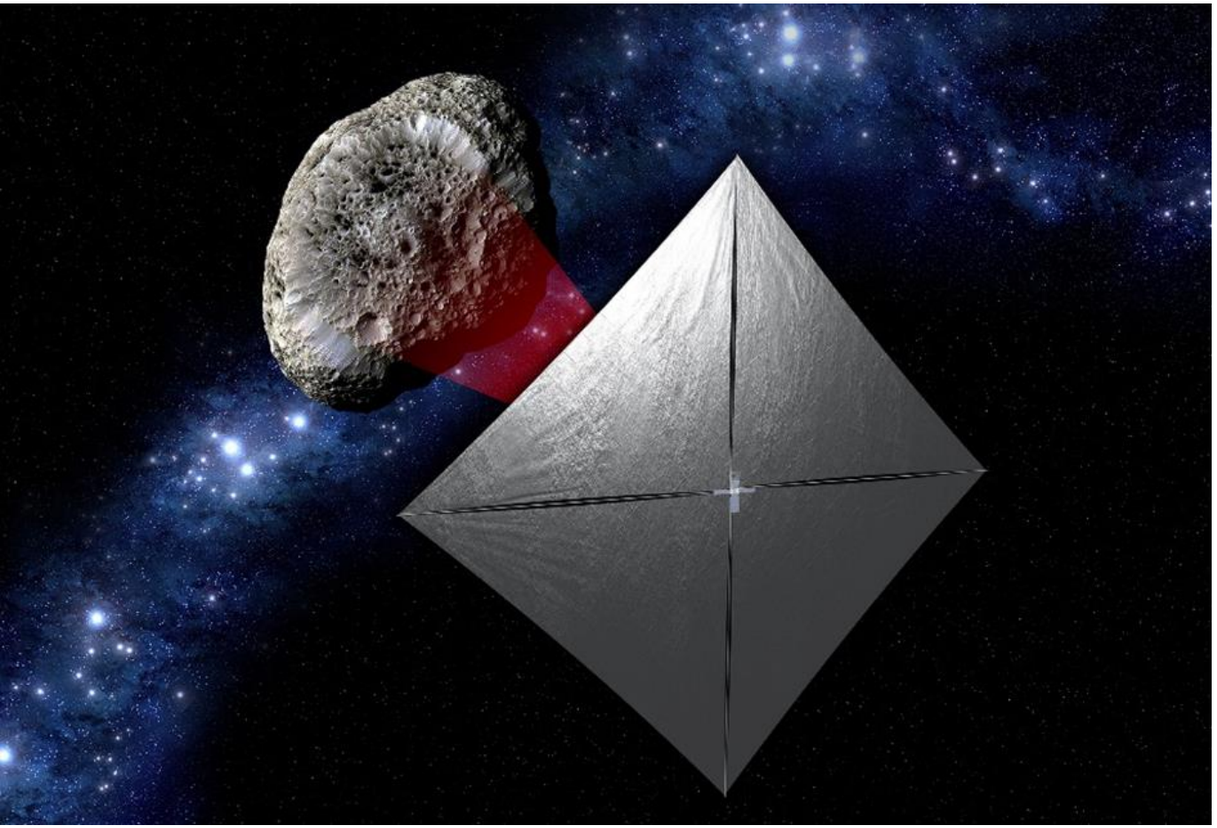


NEA Scout Sponsoring Organization within NASA

- **Human Exploration and Operations Mission Directorate (HEOMD) Advanced Exploration Systems (AES) selected 3 cubesats for flight on the first flight of the Space Launch System**
- **Primary selection criteria:**
  - Relevance to Space Exploration Strategic Knowledge Gaps (SKGs)
  - Life cycle cost
  - Synergistic use of previously demonstrated technologies

Payload *NASA Centers*	**Strategic Knowledge Gaps Addressed**	**Mission Concept**
BioSentinel ***ARC****/JSC* 	**Human health/performance in high-radiation space environments** • Fundamental effects on biological systems of ionizing radiation in space environments	Study radiation-induced DNA damage of live organisms in cis-lunar space; correlate with measurements on ISS and Earth
Lunar Flashlight ***JPL****/MSFC* 	**Lunar resource potential** • Quantity and distribution of water and other volatiles in lunar cold traps	Locate ice deposits in the Moon's permanently shadowed craters
Near Earth Asteroid (NEA) Scout ***MSFC****/JPL* 	**Human NEA mission target identification** • NEA size, rotation state (rate/pole position) **How to work on and interact with NEA surface** • NEA surface mechanical properties	Flyby and characterize one NEA that is candidate for a human mission

NEA Scout Roles and Responsibilities



Near Earth Asteroid Scout

- Project Manager: Leslie McNutt (MSFC)
- Science PI: Julie Castillo-Rogez (JPL)
- Solar Sail PI: Les Johnson (MSFC)
- Spacecraft System: JPL
- Solar Sail System: MSFC

NEA Scout Goals & Objectives

1) **Design, develop, integrate and operate a spacecraft for the purpose of demonstrating a low cost reconnaissance capability**
2) **Enable asteroids as potential destinations for human exploration**
3) **Characterize a candidate NEA with an imager to address key SKG's**

"Precursor robotics, robotic missions that investigate candidate destinations and provide vital information to prepare for human explorers, will lay the groundwork for humans to achieve new milestones in deep space."

HEOMD/AES Strategic Goals/Objectives

(Strategic Goal 1, Objective 1.1)

"Robotic exploration is the principal method we use to explore the solar system, and is an essential precursor to human exploration of space."

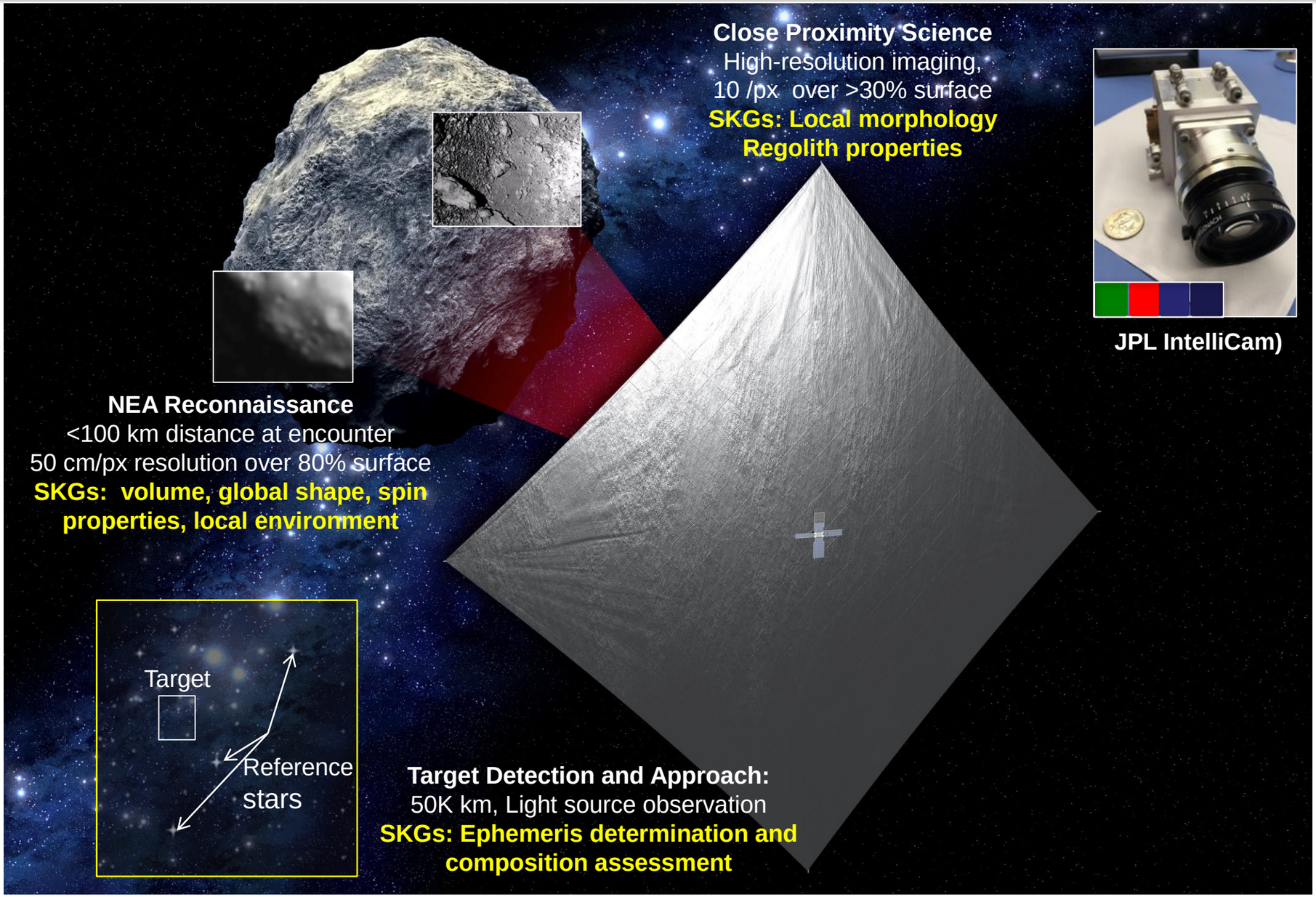
SMD Strategic Goals/Objectives

(Strategic Goal 1, Objective 1.5)

Baseline Target Asteroid: 1991 VG

- Diameter ~ 5-12 meters
- Albedo is unknown
- Position is known within 2700 km (1-σ) but optical observation opportunity in July ‘17 will decrease uncertainty to a few 100s km
- Rotation period between a few minutes and less than 1 hour
- Unlikely to have a companion
- Unlikely to retain an exosphere or dust cloud
  - Solar radiation pressure sweeps dust on timescales of hours or day

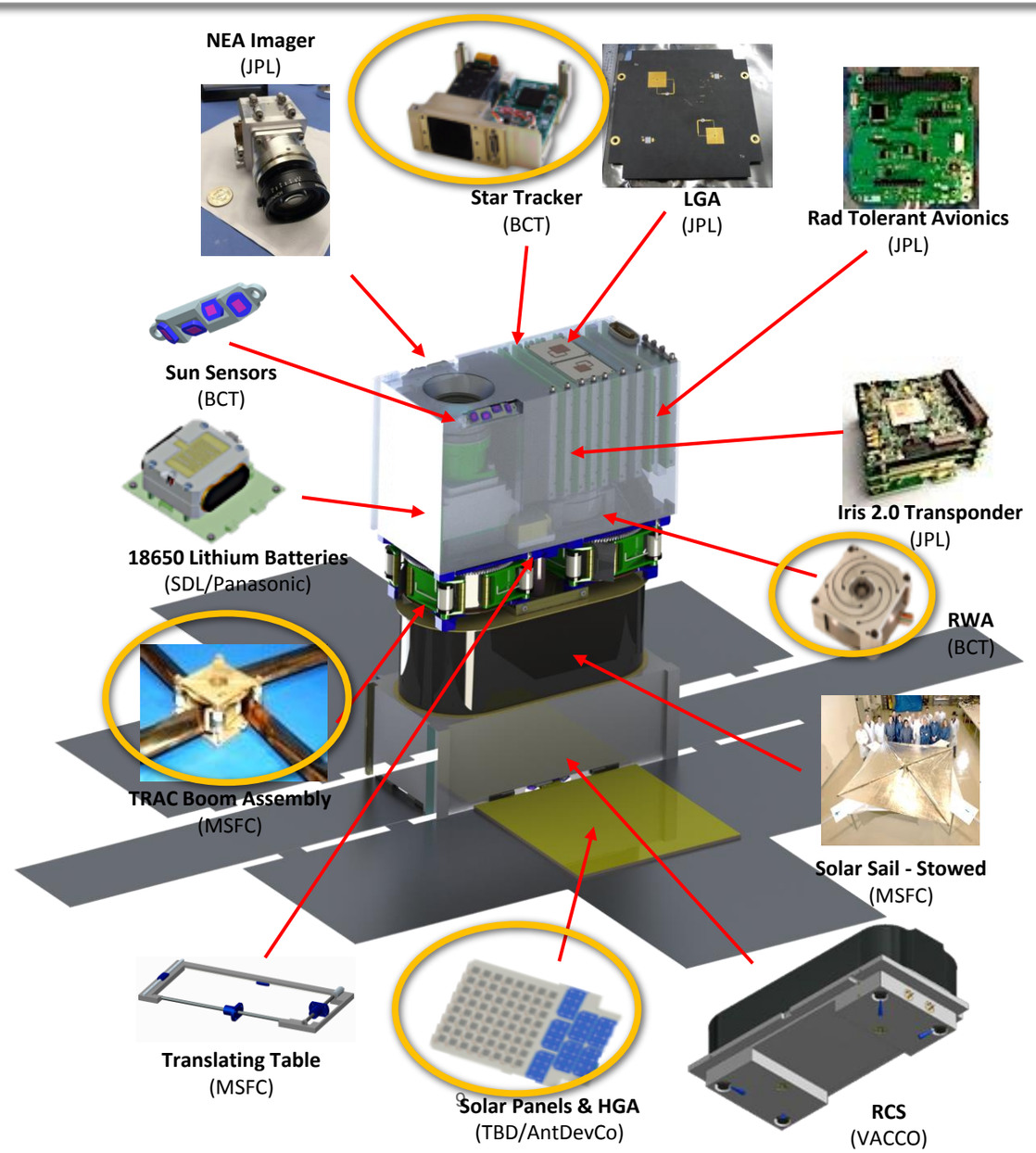
Near Earth Asteroid Scout Mission Overview



Flight System Overview

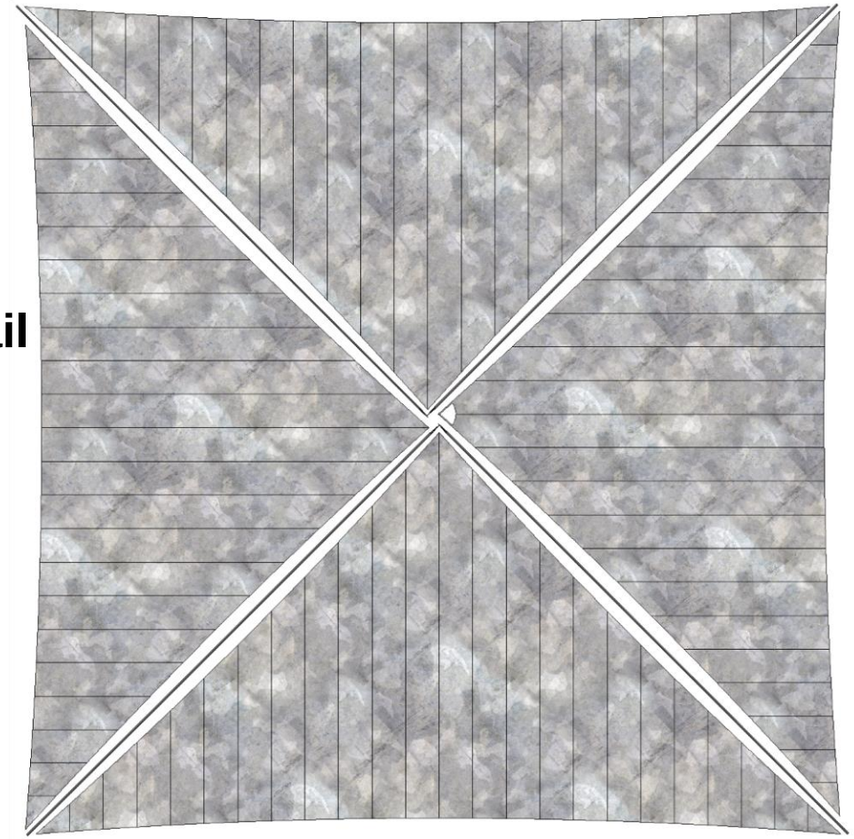
Payload	• Context Camera
Mechanical & Structure	• “6U” CubeSat form factor • <14 kg total launch mass • Modular flight system concept
Propulsion	• ~86 m^2 aluminized CP-1 solar sail (based on NanoSail-D2)
Avionics	• Radiation tolerant architecture
Electrical Power System	• Trifold deployable solar arrays with GaAs cells (~51.2 W EOL at 1 AU solar distance) • 6.2 Ah Battery • 10 -12.3 V unregulated, 5 V/3.5 V regulated
Telecom	• JPL Iris 2.0 X-Band Transponder; 4 W RF output power supports doppler, ranging, and D-DOR • 2 pairs of INSPIRE-heritage LGAs (RX/TX) • 8x8 element microstrip array HGA (TX); ~1 kbps to 34m DSN at 0.8 AU
Attitude Control System	• 15 mNm-s (x3) & 100 mNm-s RWAs • Active mass translation system • VACCO R-236fa (refrigerant gas) ‘warm gas’ RCS system • Nano StarTracker, Coarse Sun Sensors & MEMS IMU for attitude determination

A fully functional planetary spacecraft in a shoebox



NEA Scout Approximate Scale

Deployed Solar Sail



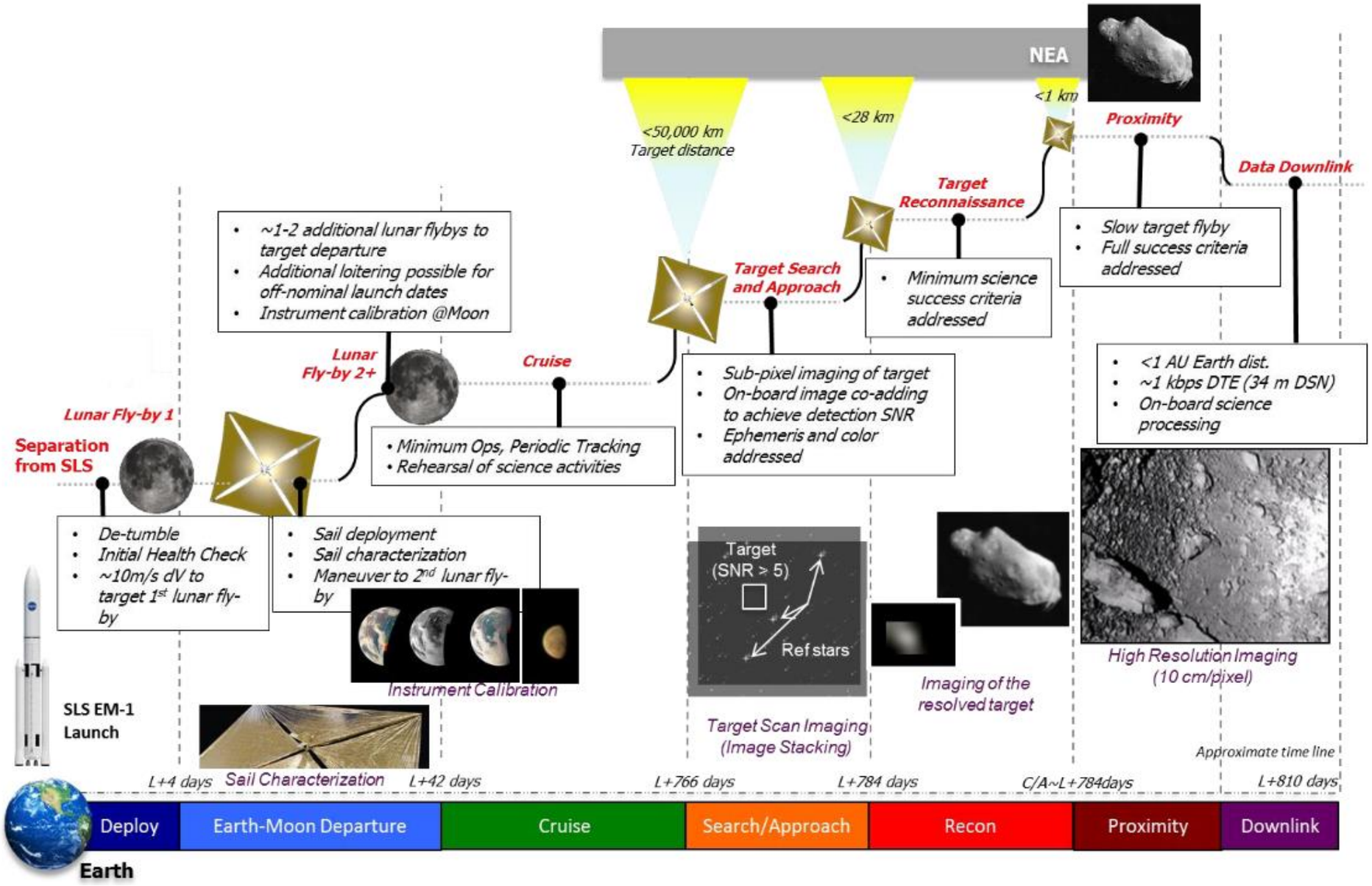
School Bus

Human

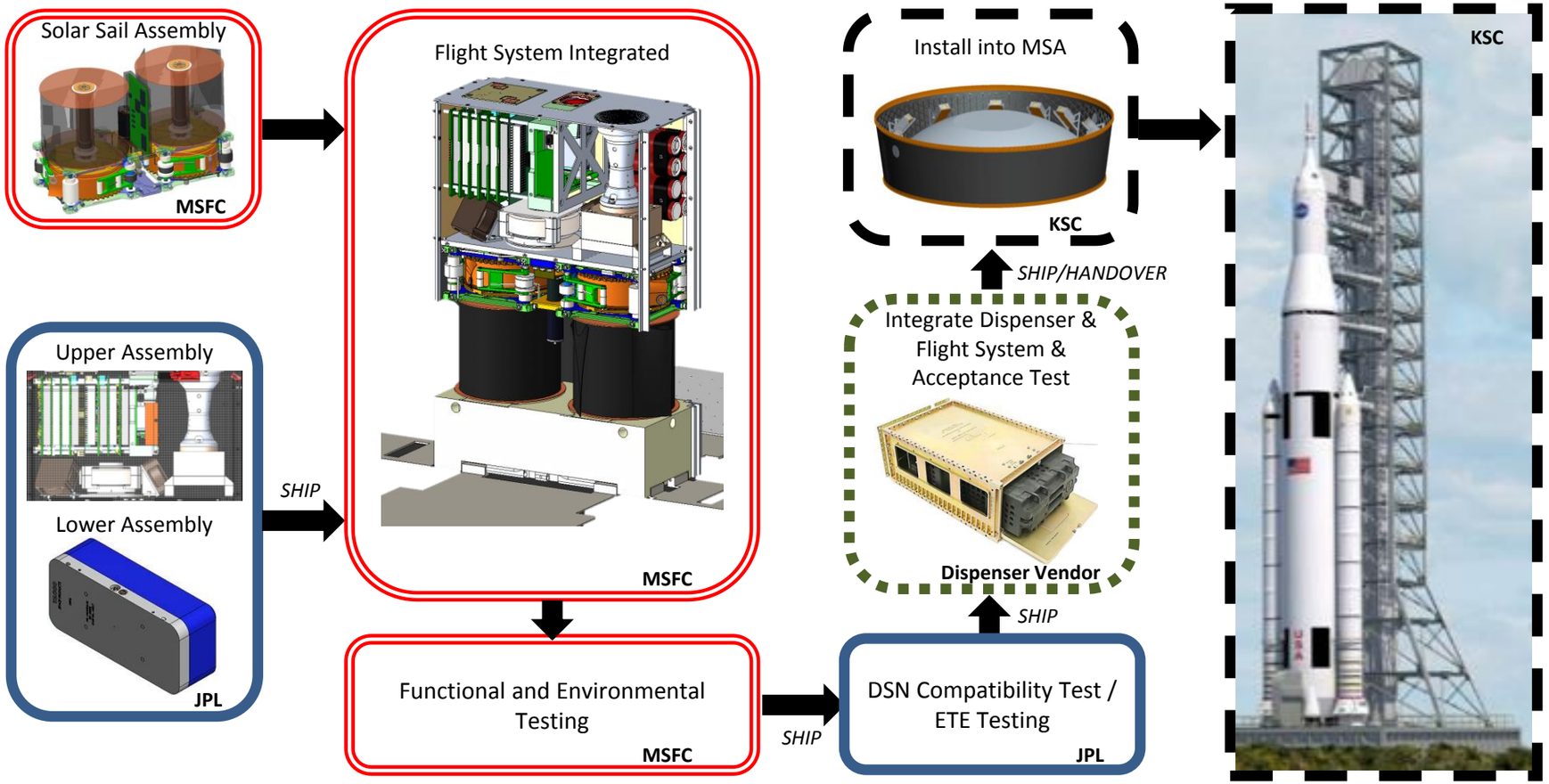
6U Stowed Flight System

Folded, spooled and packaged in here

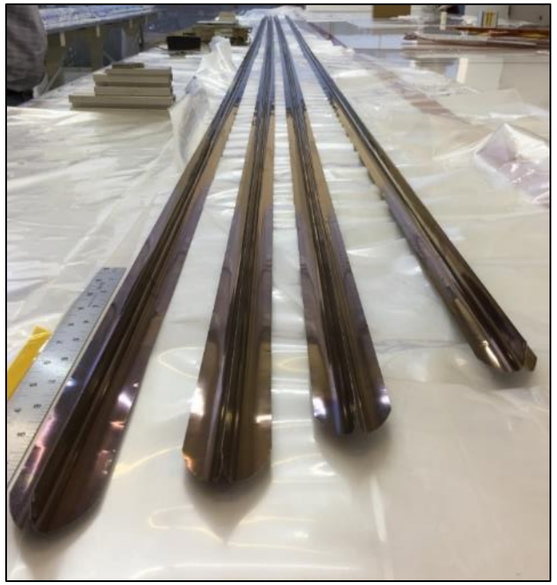
Concept of Operations Overview

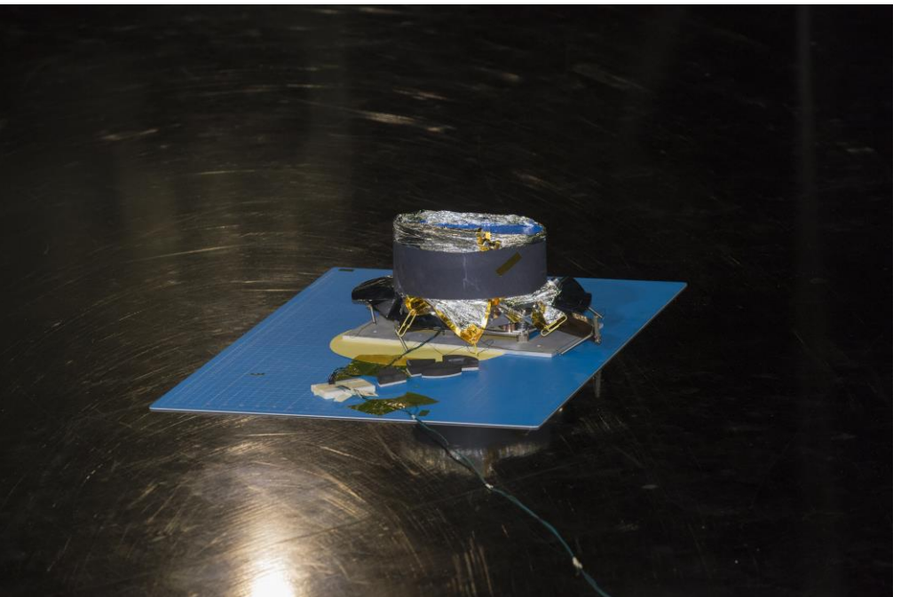


Assembly, Integration, and Test (AI&T) Overview

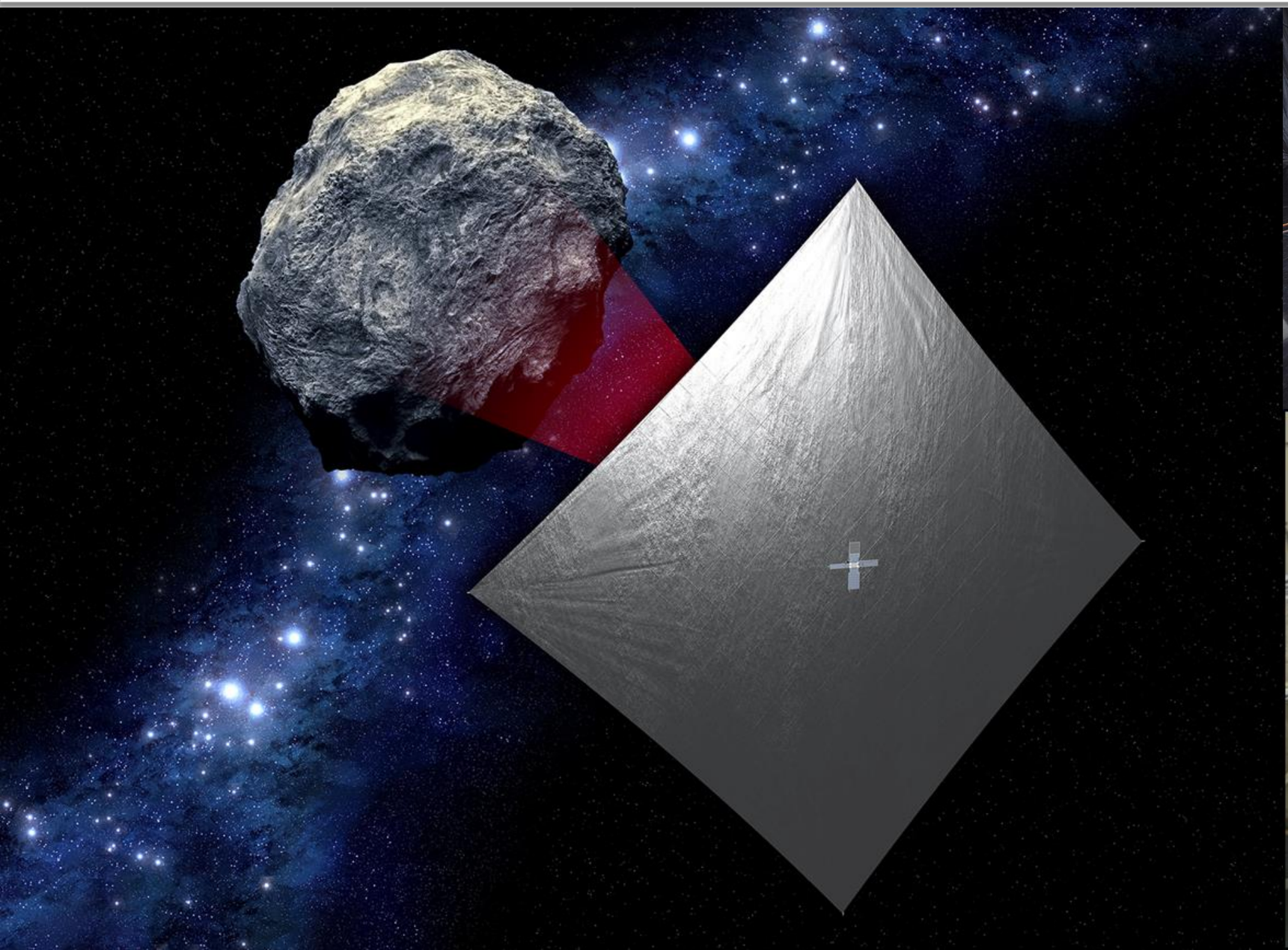


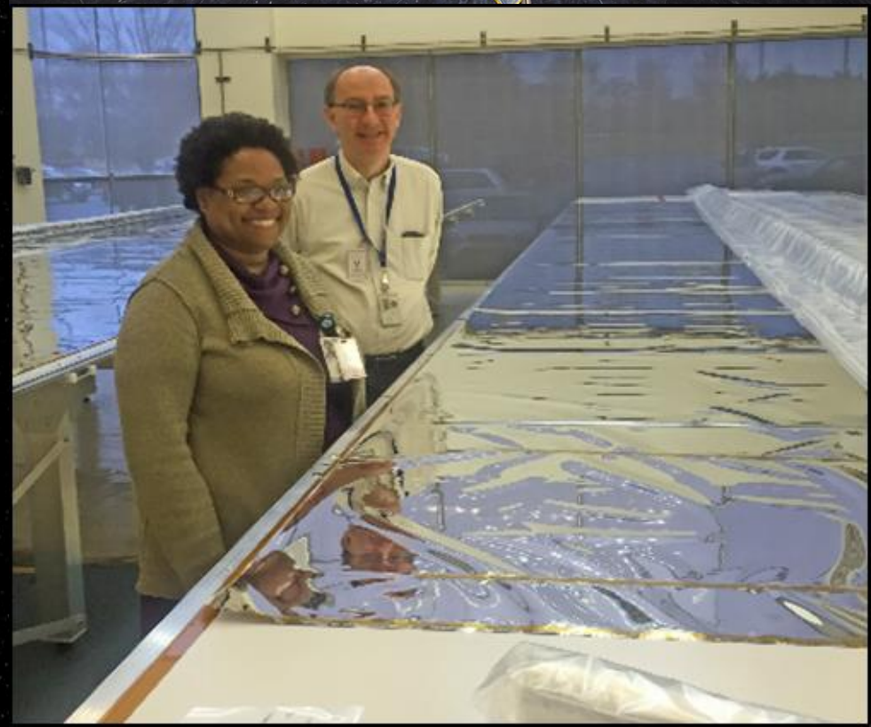
On Schedule to Deliver Spacecraft in 2017





Questions?



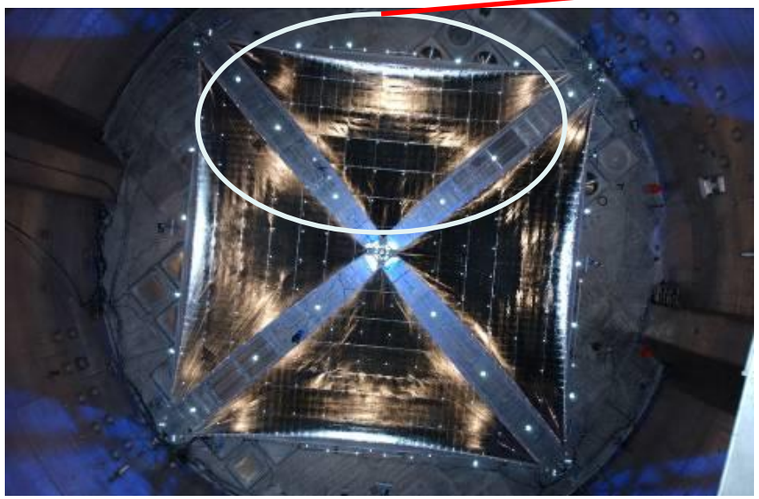


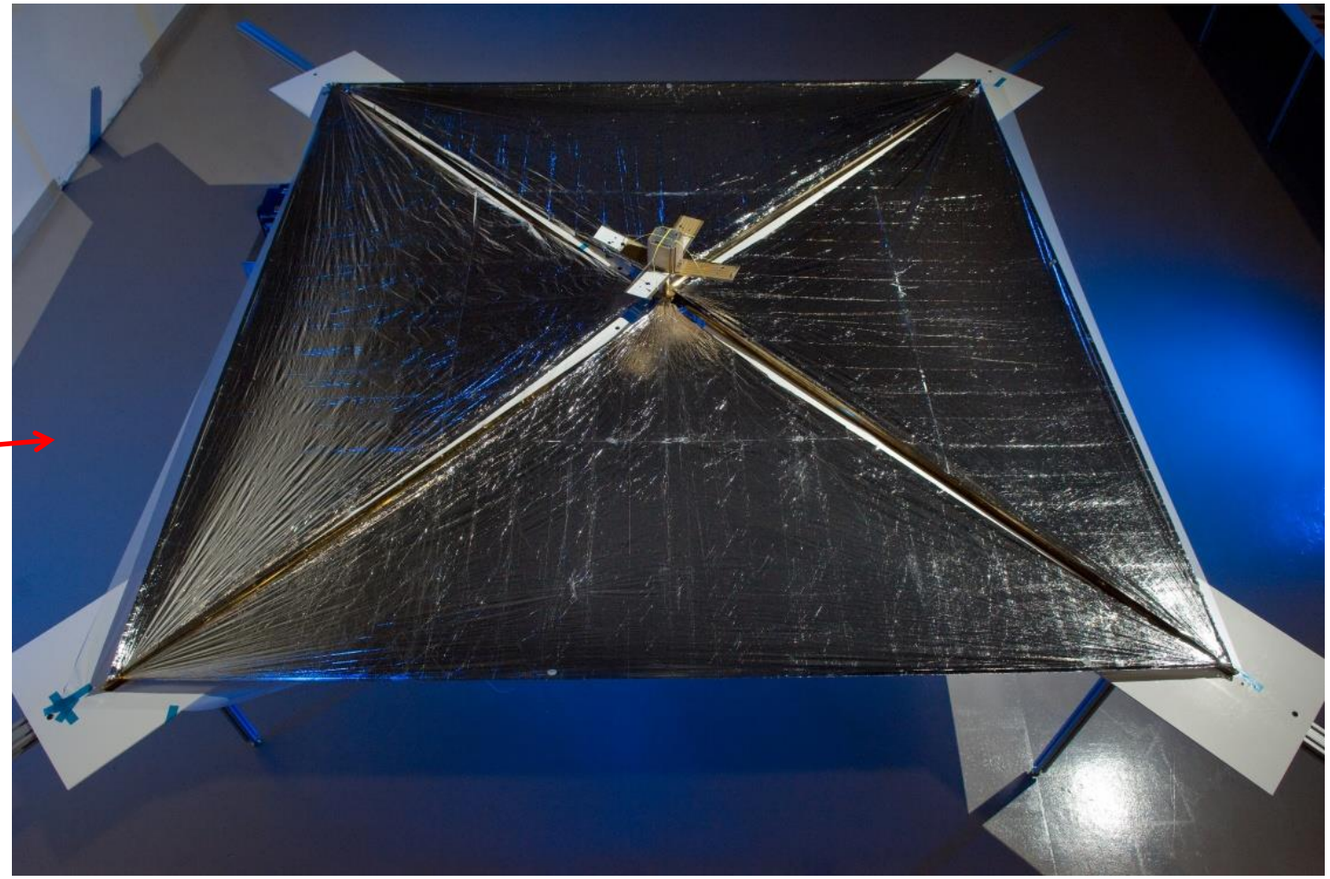
Backup Information

NanoSail-D Demonstration Solar Sail

Mission Description:

- 10 m^2 sail
- Made from tested ground demonstrator hardware

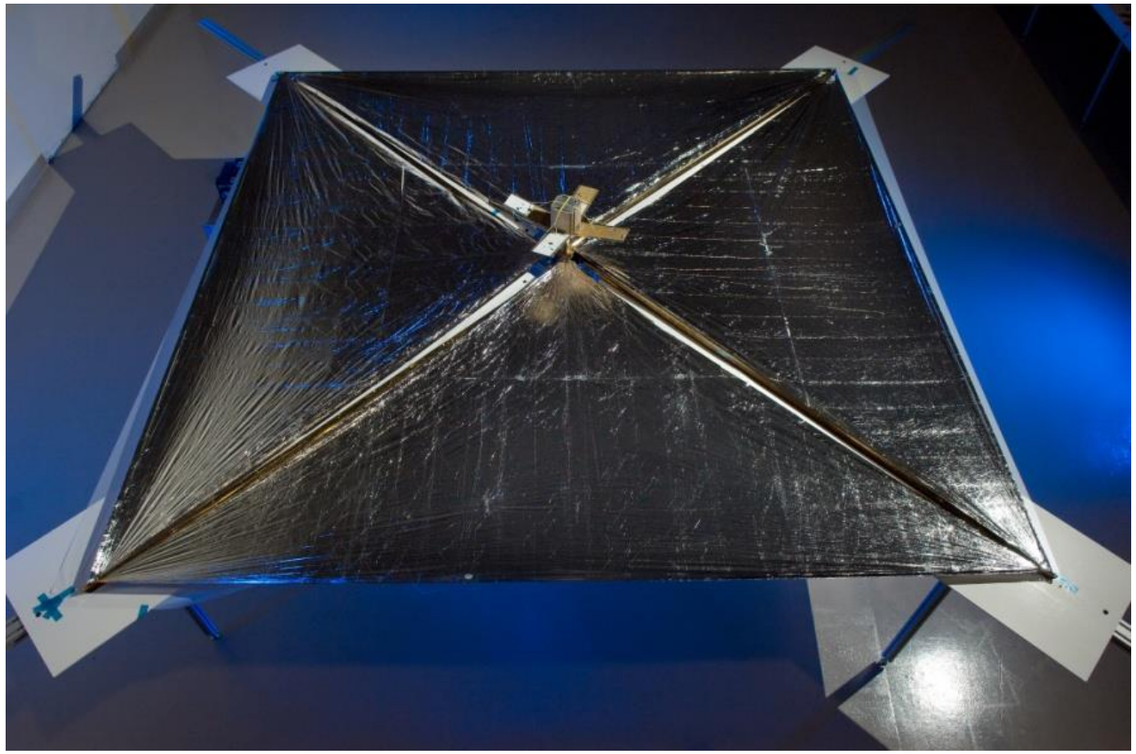




NanoSail-D1 Flight (2008)

Launch

- Falcon-1, flight 3
- Kwajalein, Missile Range
- Primary payload: AFRL PnPSat
- Secondary P-POD payloads (2)



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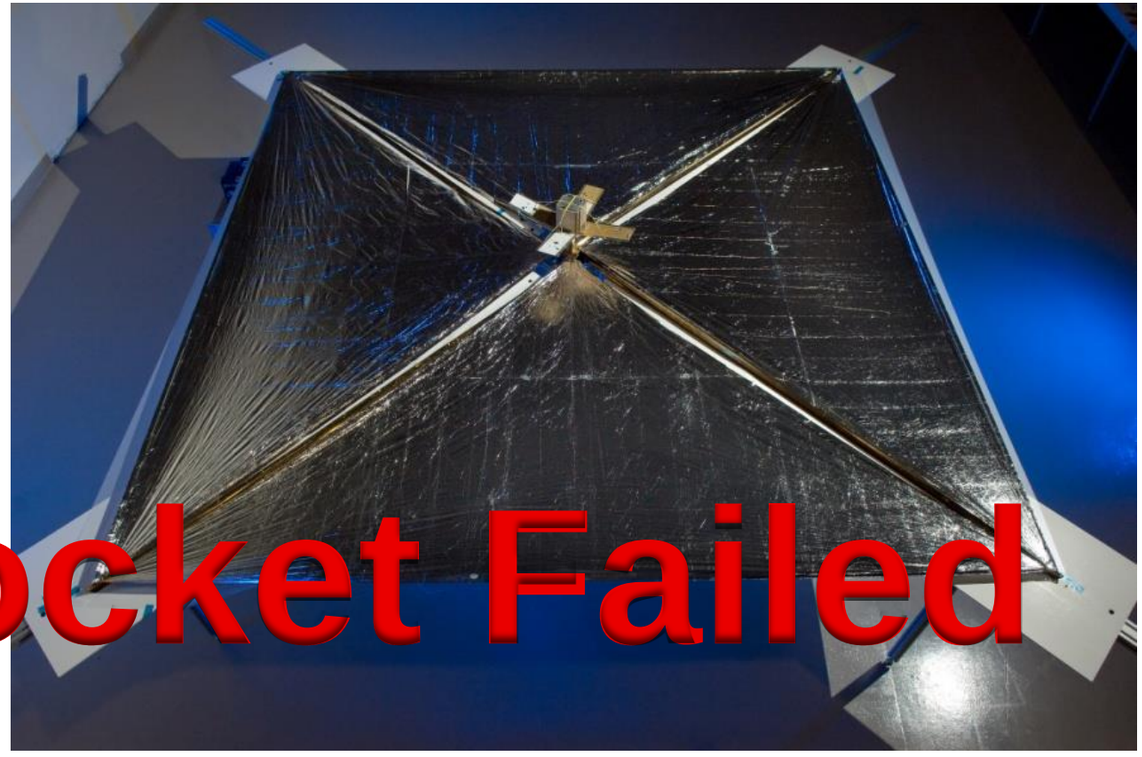
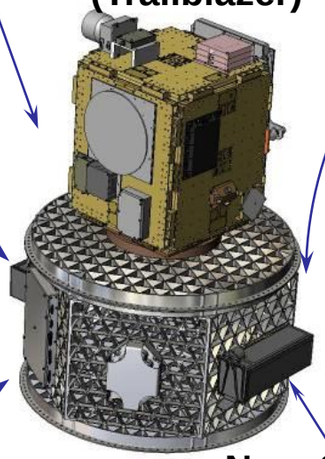


Rocket Failed

NanoSail-D2 Mission Configuration (2010)

AFRL Satellite (Trailblazer)

HSV-1

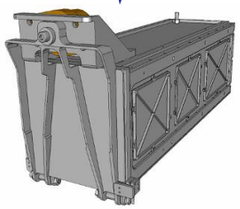


Adapter

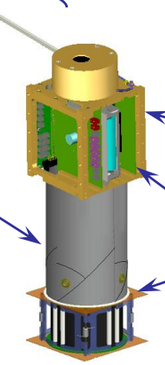
PreSat (ARC)

NanoSail-D (MSFC)

Ride Share Adapter (Space Access Technology)



PPOD Deployer (Cal-Poly)



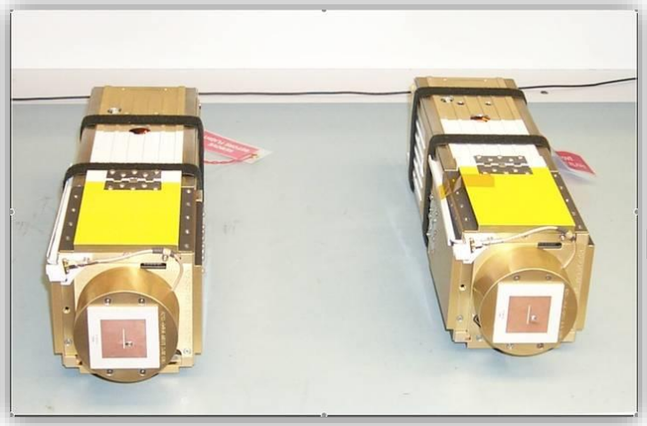
Boom & Sail Spool (ManTech SRS)

Spacecraft Bus (Ames Research Center)

Bus interfaces Actuation Electronics (MSFC/UAH)

NanoSail-D (Aluminum Closeout Panels Not Shown)

Stowed Configuration



NSD-002

NSD-001

- 3U Cubesat: 10 cm X 10 cm X 34 cm
- Deployed CP-1 sail: 10 m2 Sail Area (3.16 m side length)
- 2.2 m Elgiloy Trac Booms
- UHF and S-Band communications