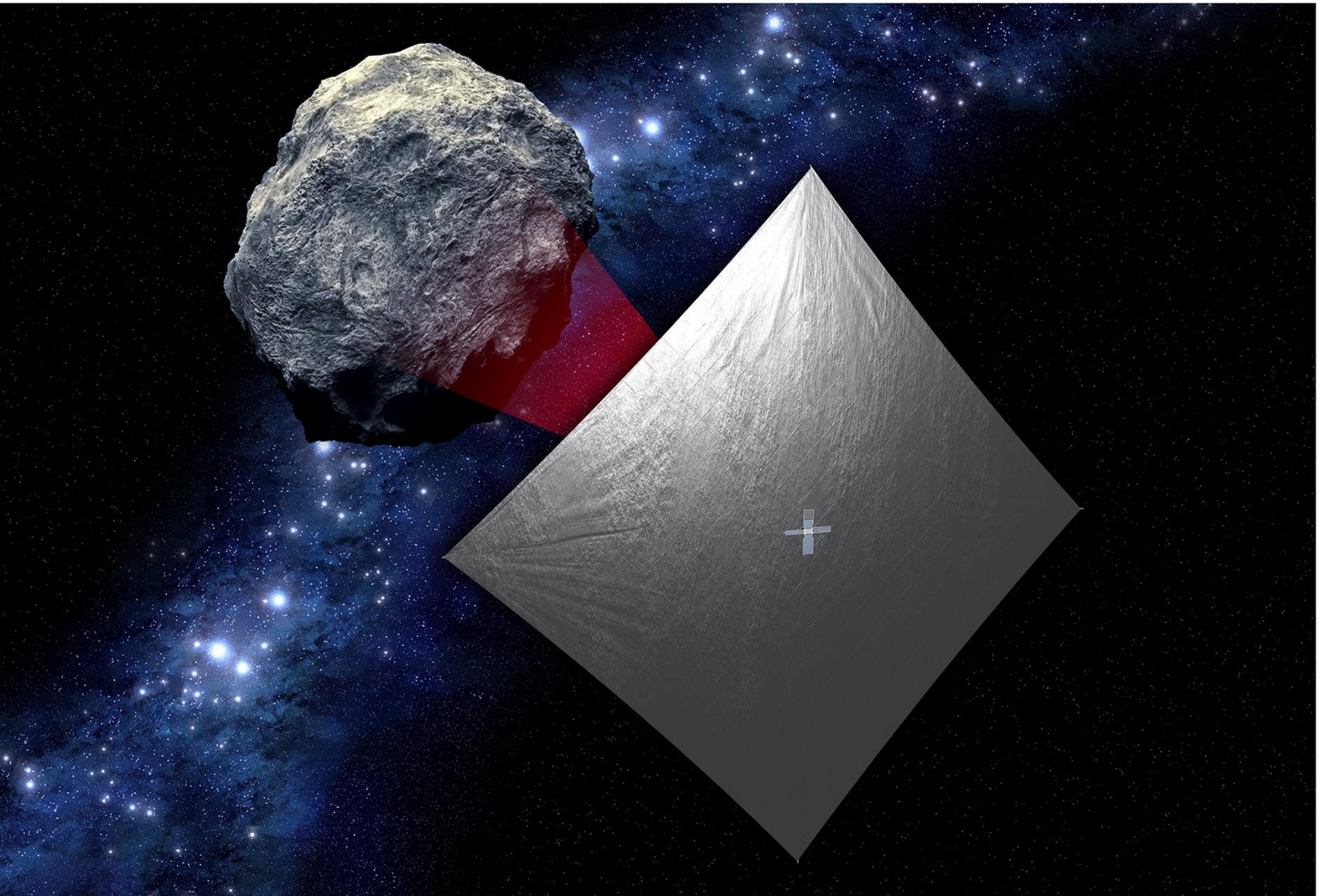
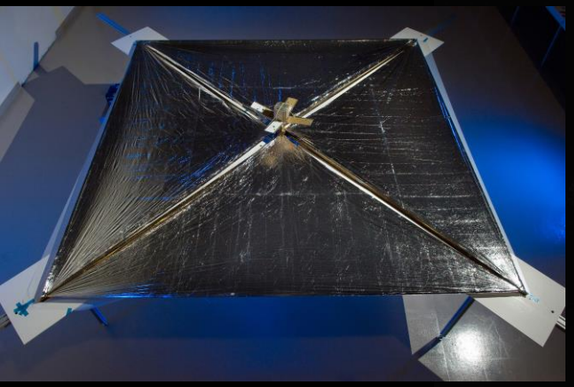
Near Earth Asteroid Scout: Exploring an Asteroid Using A Smallsat



Les Johnson & Tiffany Lockett,
NASA George C. Marshall Space Flight Center

Julie Castillo-Rogez
NASA Jet Propulsion Laboratory

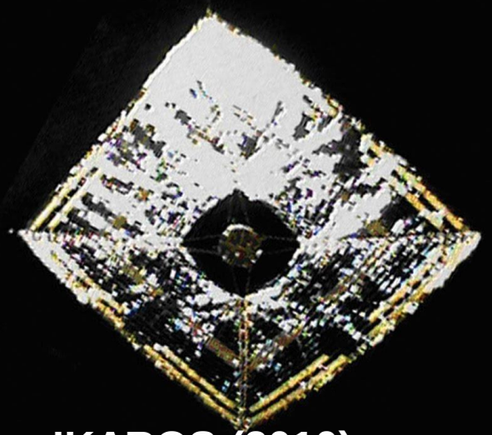
Solar Sail Missions Flown (as of October 2019)



NanoSail-D (2010)
NASA

Earth Orbit
Deployment Only

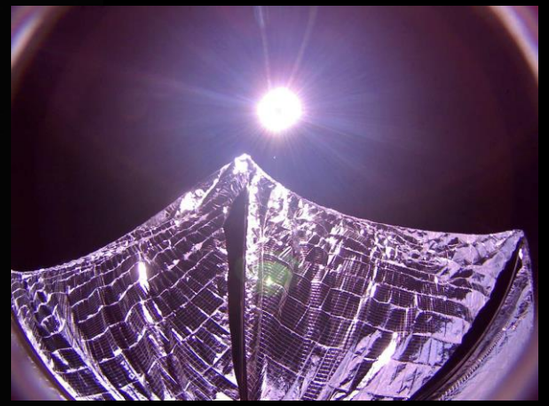
3U CubeSat
10 m^2



IKAROS (2010)
JAXA

Interplanetary
Full Flight

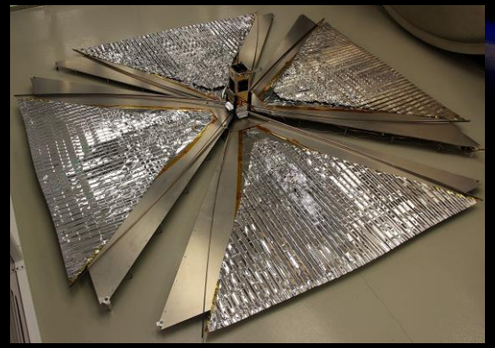
315 kg Smallsat
196 m^2



LightSail-1 (2015)
The Planetary Society

Earth Orbit
Deployment Only

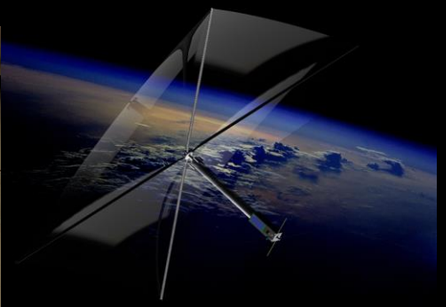
3U CubeSat
32 m^2



CanX-7 (2016)
Canada

Earth Orbit
Deployment Only

3U CubeSat
<10 m^2

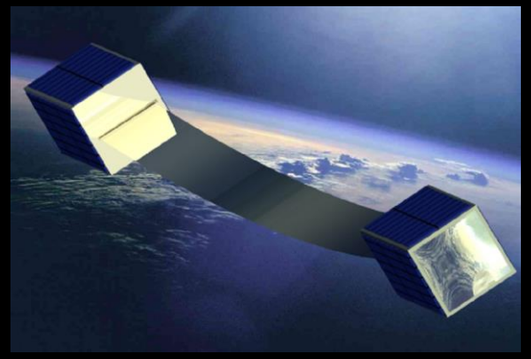


InflateSail (2017)
EU/Univ. of Surrey

Earth Orbit
Deployment Only

3U CubeSat
10 m^2

Current and Planned Solar Sail Missions



CU Aerospace (2018)
Univ. Illinois / NASA

Earth Orbit
Full Flight
In Orbit; Not yet deployed

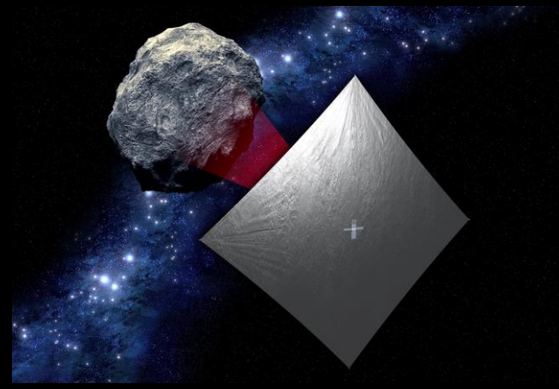
3U CubeSat
20 m^2



LightSail-2 (2019)
The Planetary Society

Earth Orbit
Full Flight
In Orbit; Successful

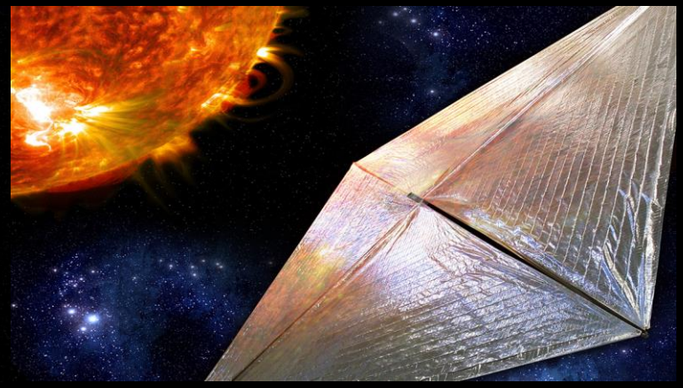
3U CubeSat
32 m^2



Near Earth Asteroid Scout (2020) NASA

Interplanetary
Full Flight

6U CubeSat
86 m^2



Solar Cruiser (2024)
NASA

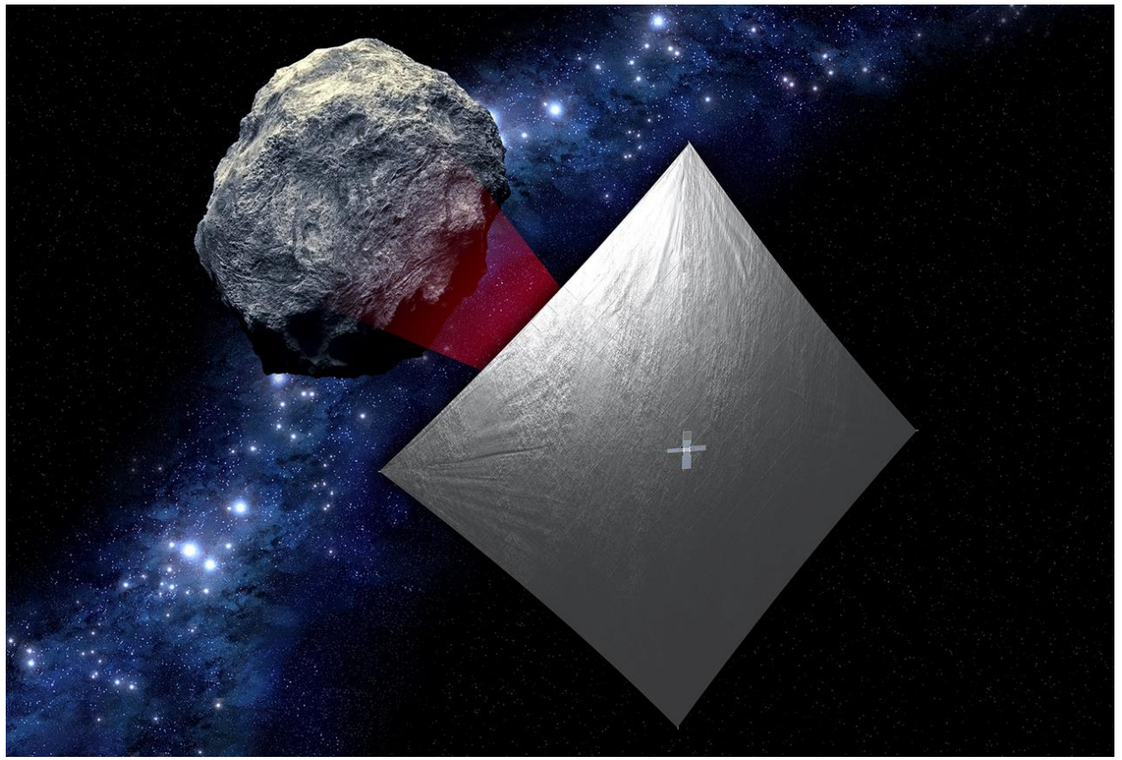
L-1
Full Flight

90 Kg Spacecraft
>1200 m^2

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



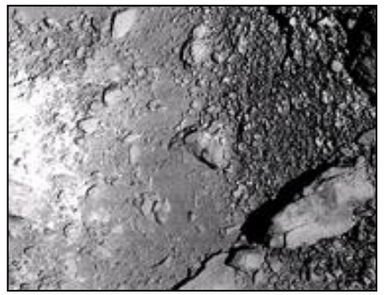
Key Spacecraft & Mission Parameters

- 6U cubesat (20cm X 10cm X 30 cm)
- ~86 m^2 solar sail propulsion system
- Manifested for launch on the Space Launch System (Artemis 1 / 2020)
- 1 AU maximum distance from Earth

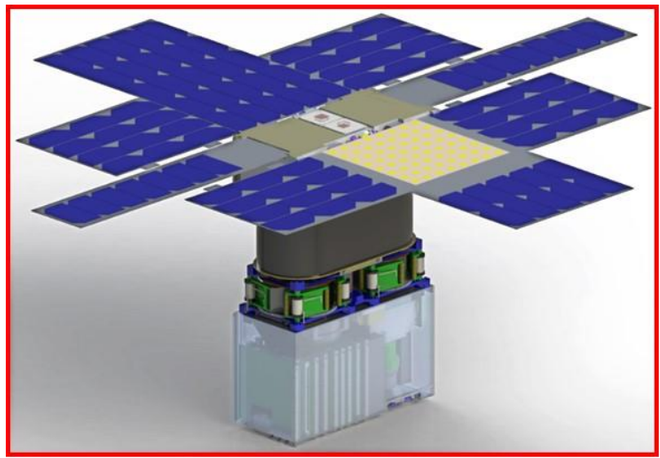
Leverages: combined experiences of MSFC and JPL with support from GSFC, JSC, & LaRC



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



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



Potential New Asteroid Target: 2013 WA44

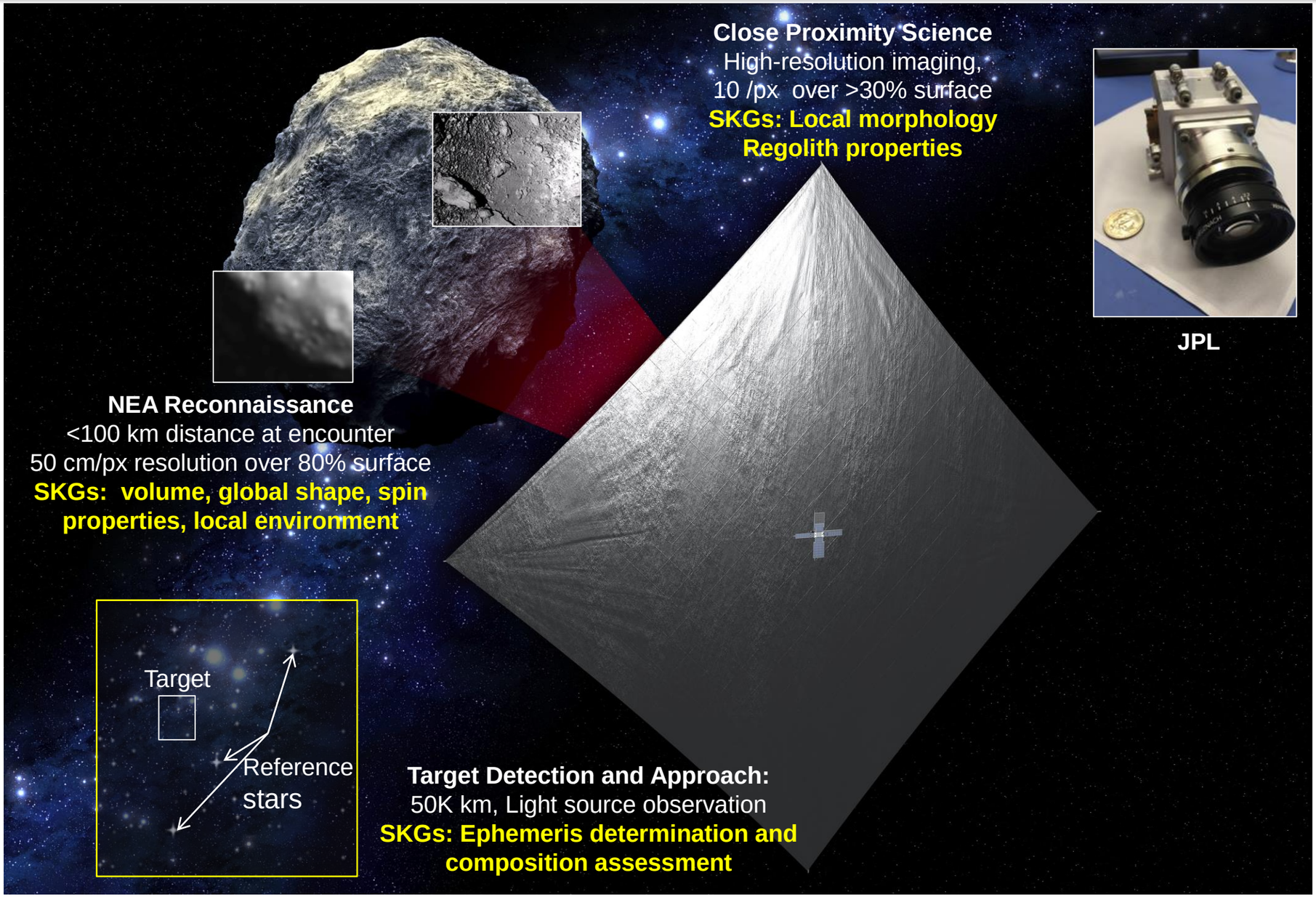


- Colors (AU)
  - blue < .25
  - green < .5
  - orange < .75
  - red < 1
- Shape (OCC)
  - △ under 2
  - □ under 4
  - ▽ under 7
- Size (appx dia.)
  - small < ~25 m
  - med. < ~50 m
  - large > ~50 m

- 14 kg, 86 m^2, ideal sail model with 93% efficiency, 90% duty cycle. Reduced efficiency and duty cycle account for:
  - pointing error, nav error, comm, control outages
  - McInnes model not implementable for cruise yet
- No limit on max sail angle (not implementable for cruise yet)
- Cruise flight time < 2.5 yr, Earth distance at encounter < 1 AU
- Lunar escape phase (3 months) and proximity operations (1 month) included
- Post-flyby downlink time not included (add ~6 months)
- Local minima for flight time. Flight time increases linearly with loiter time. Flight time increases non-linearly with delayed escapes

- OCC = 3 (Observations possible in December 2020 to refine and improve)
- Approximate Size: 32m – 142m
- Rotational Period: ~21 minutes
- Flight Time: ~1.5 years

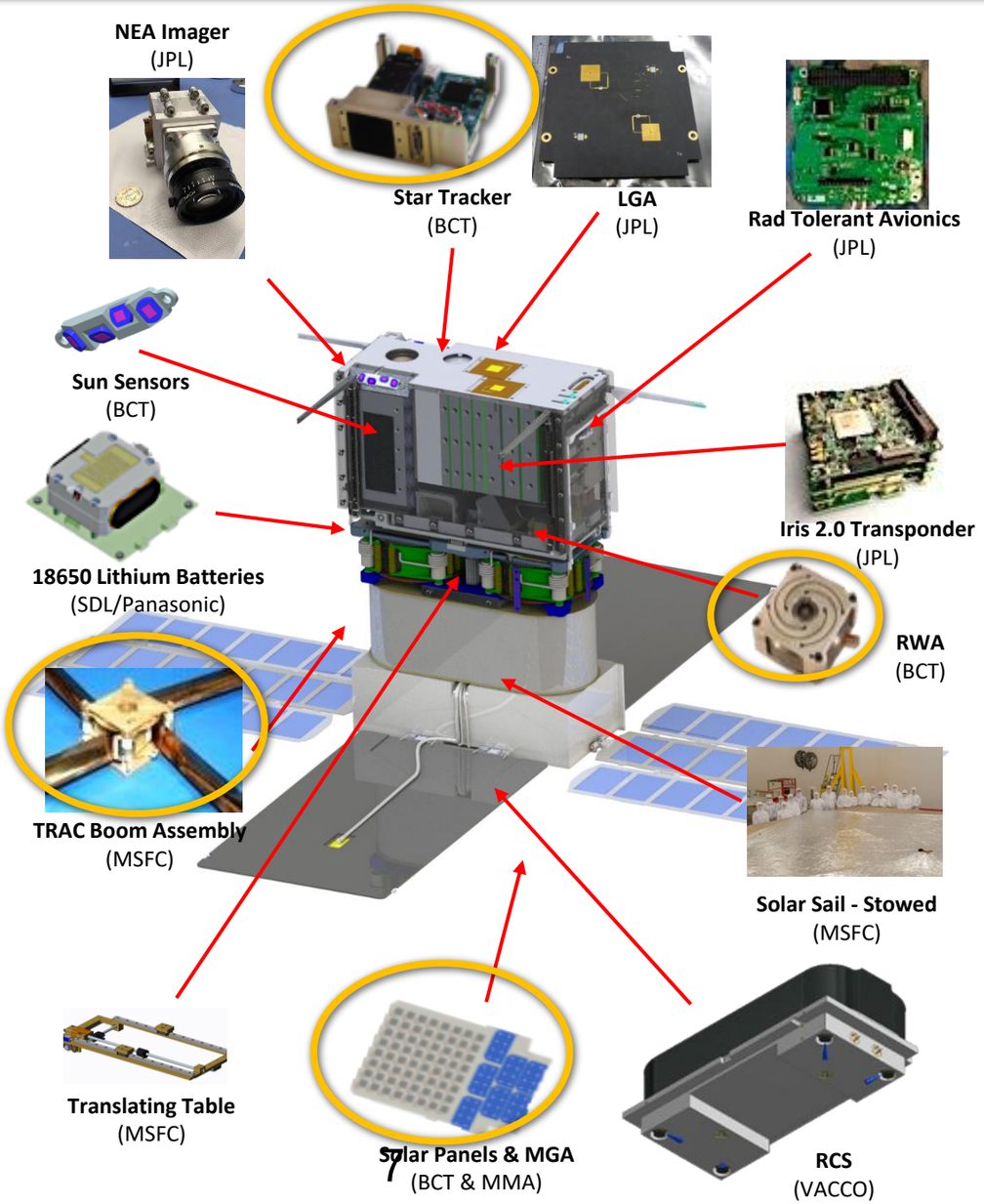
Near Earth Asteroid Scout Mission Overview



Flight System Overview

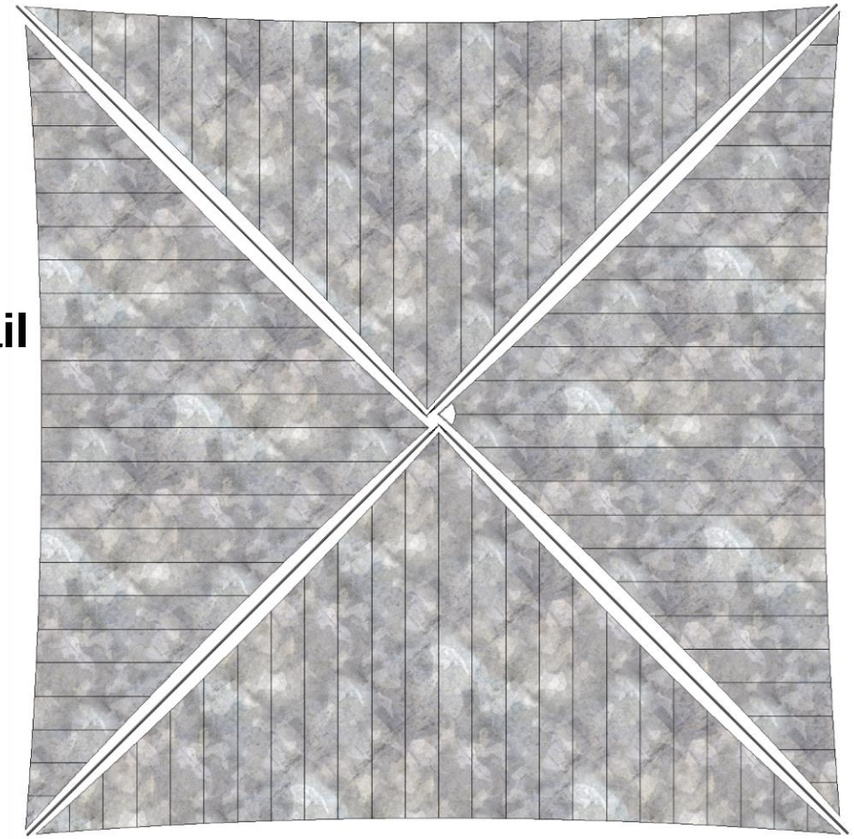
Payload	• Context Camera
Mechanical & Structure	• “6U” CubeSat form factor • <14 kg total launch mass • Modular flight system concept
Propulsion	• ~86 m^2 aluminized CP-1 solar sail (based on NanoSail-D2)
Avionics	• Radiation tolerant architecture
Electrical Power System	• Trifold deployable solar arrays 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 MGA (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



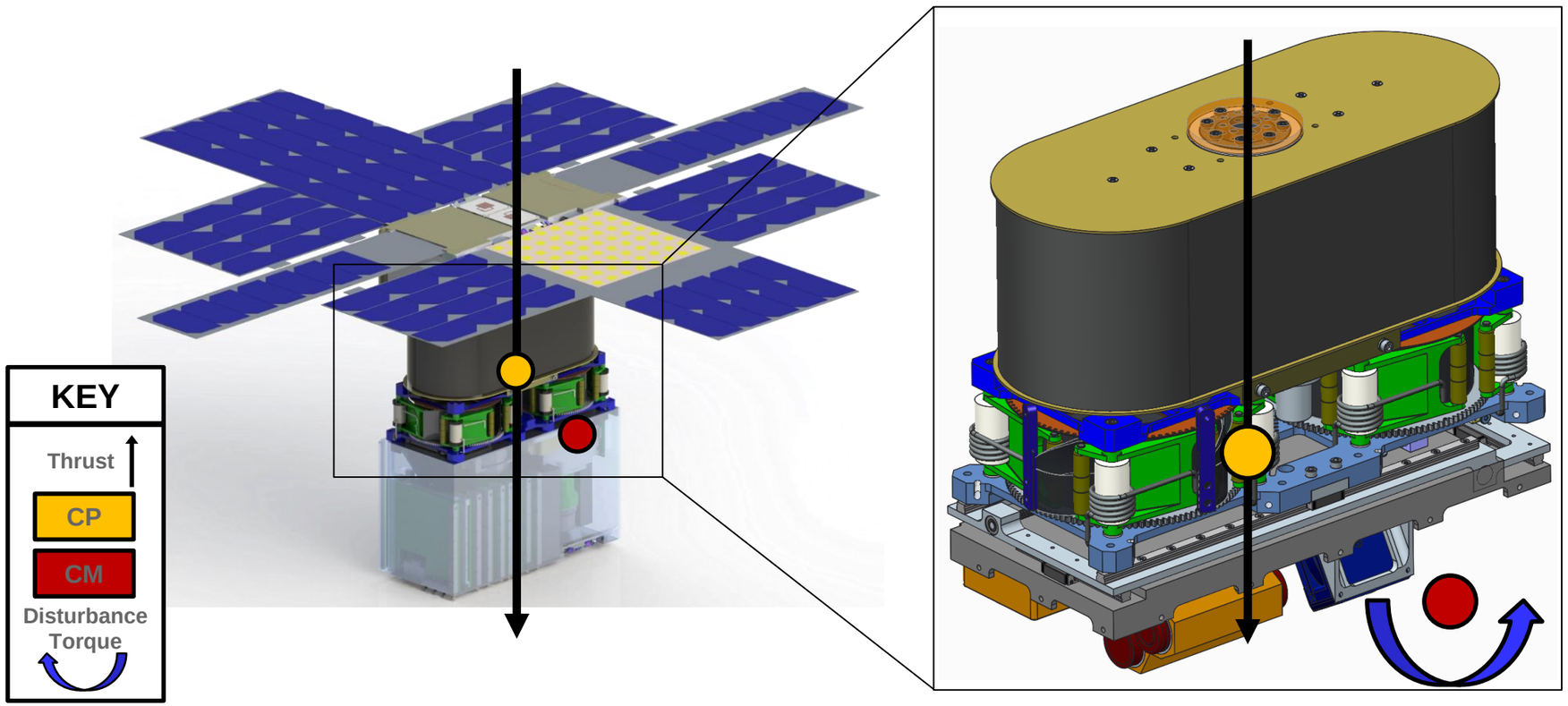
6U Stowed Flight System



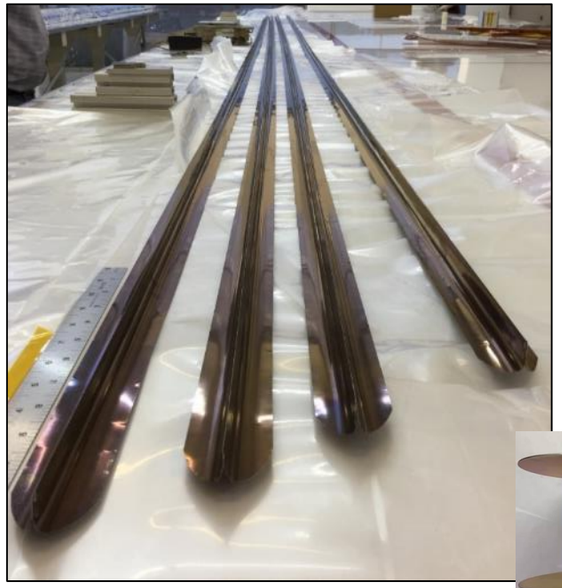
Folded, spooled and packaged in here

Active Mass Translation (AMT) Overview

NEA Scout's center of mass (CM) and center of pressure (CP) are not collinear with the estimated thrust vector. This creates a *disturbance torque*.

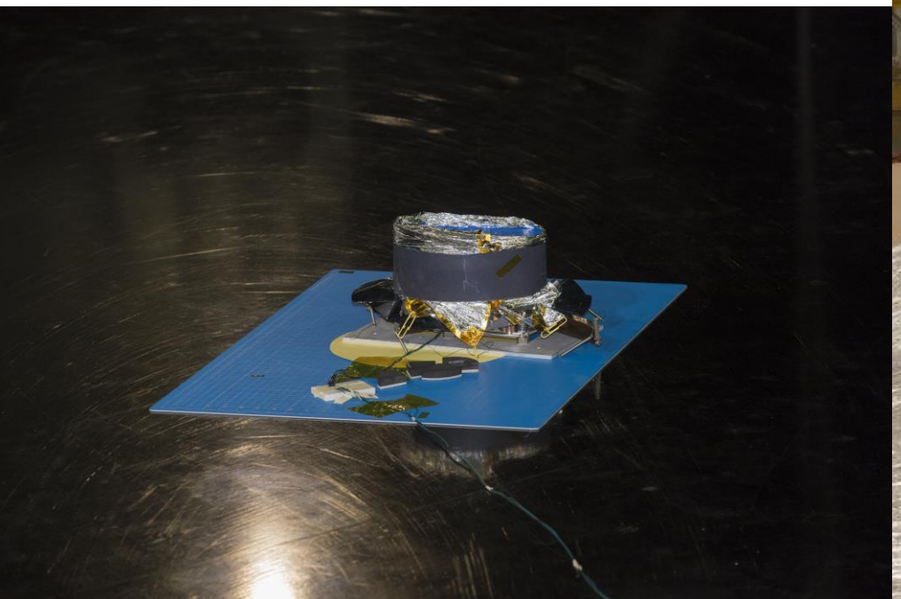


Hardware!

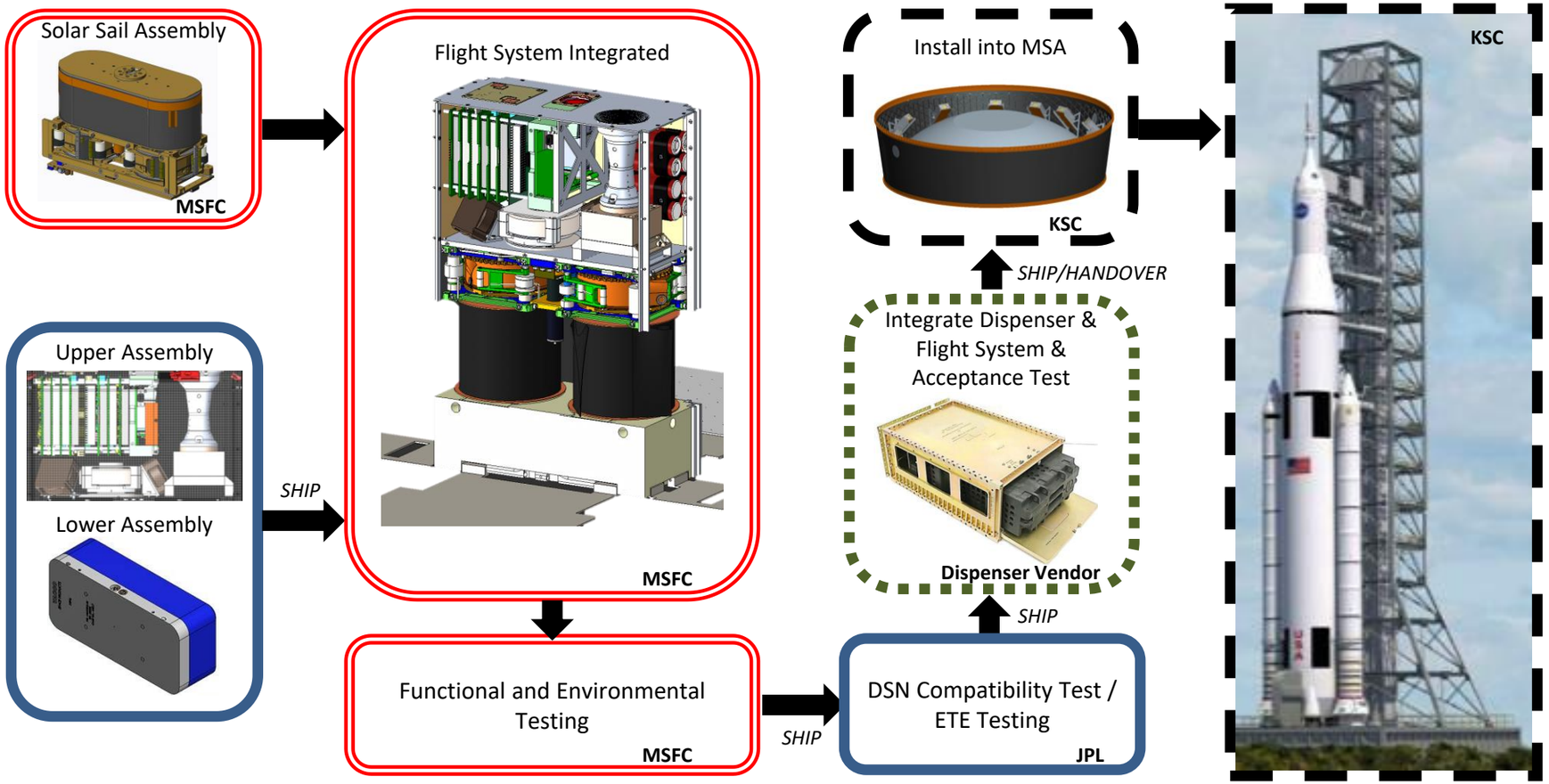




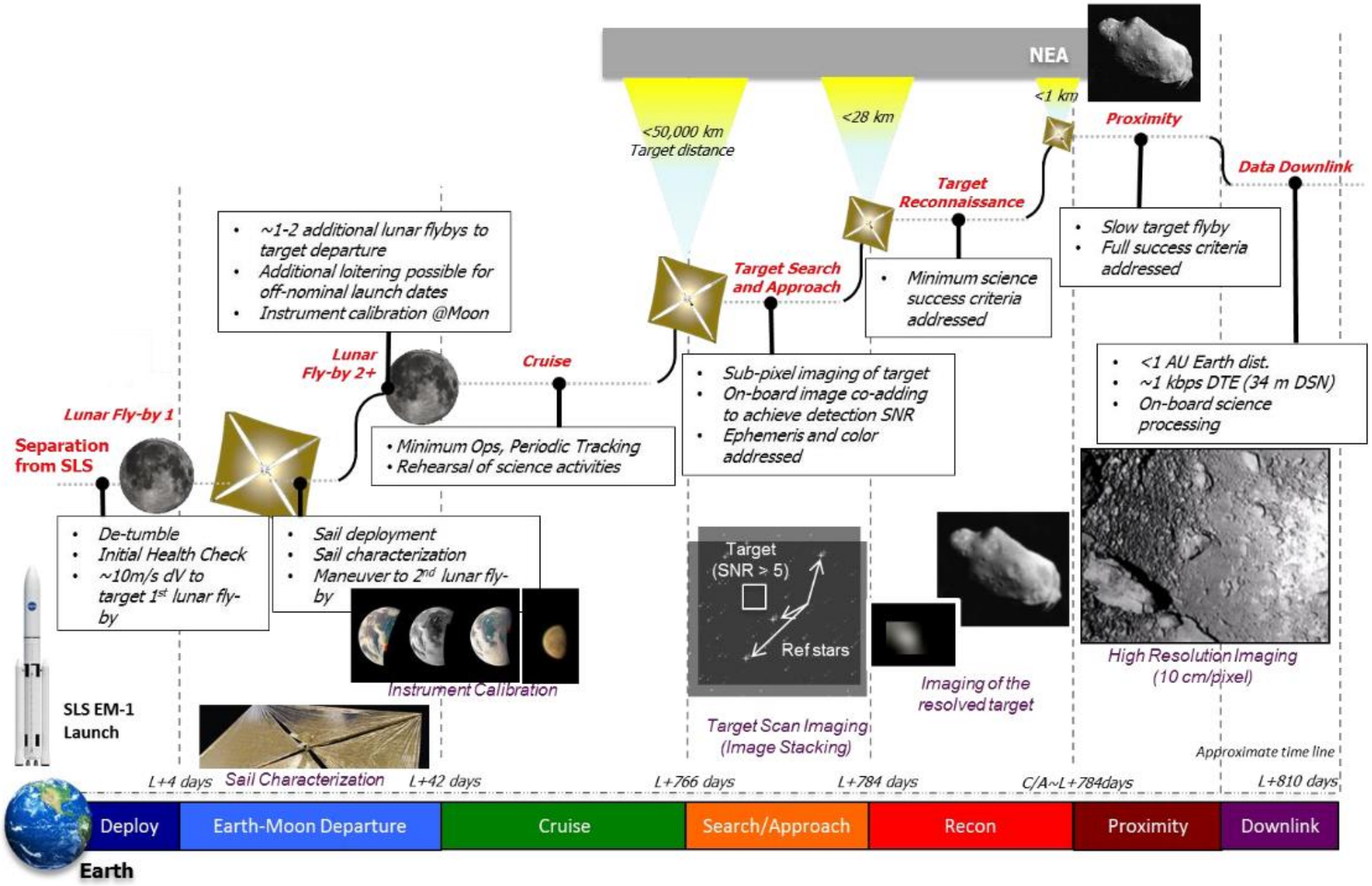




Assembly, Integration, and Test (AI&T) Overview



Concept of Operations Overview



Questions?

