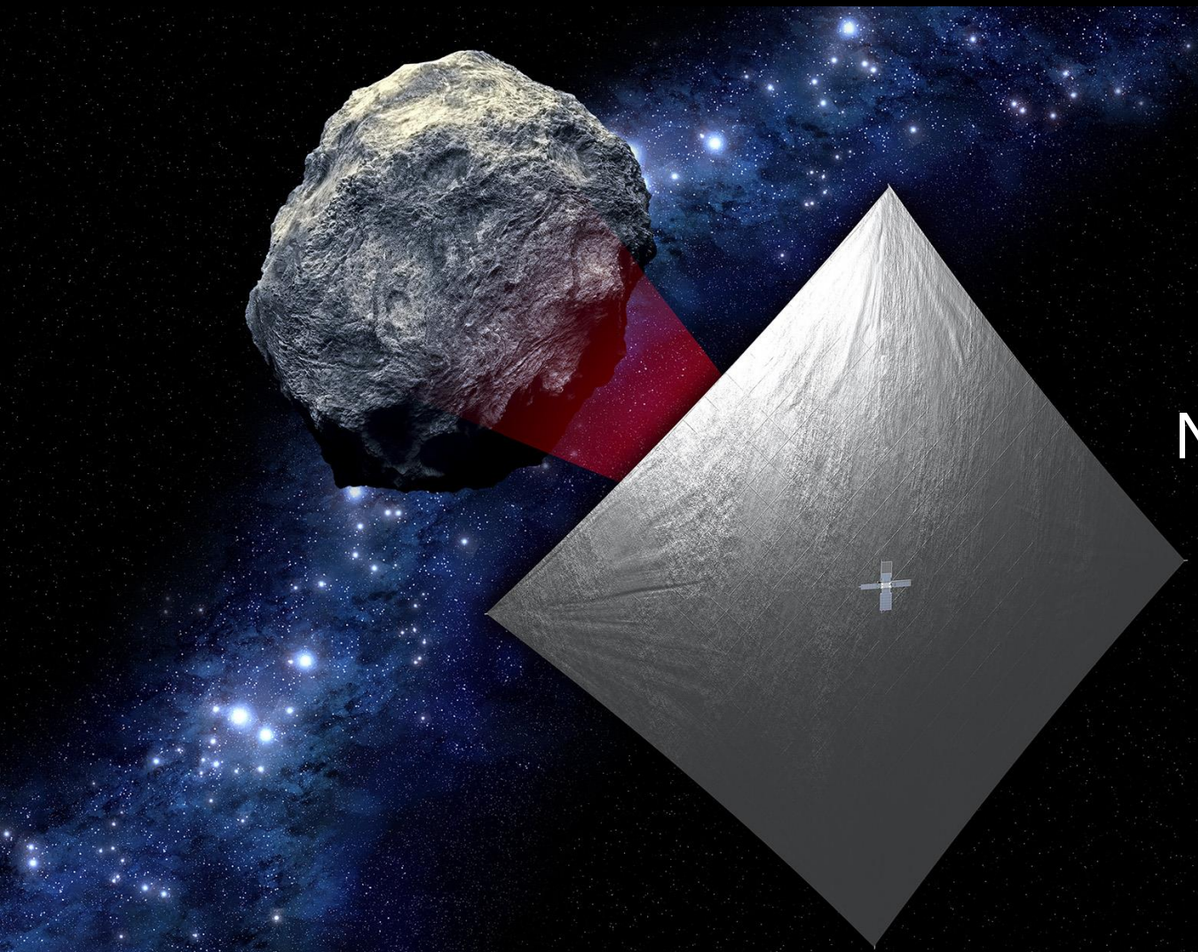
NASA's Near Earth Asteroid Scout Mission Status, History, and Lesson's Learned



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NASA George C. Marshall Space Flight Center

Science and Technology Office

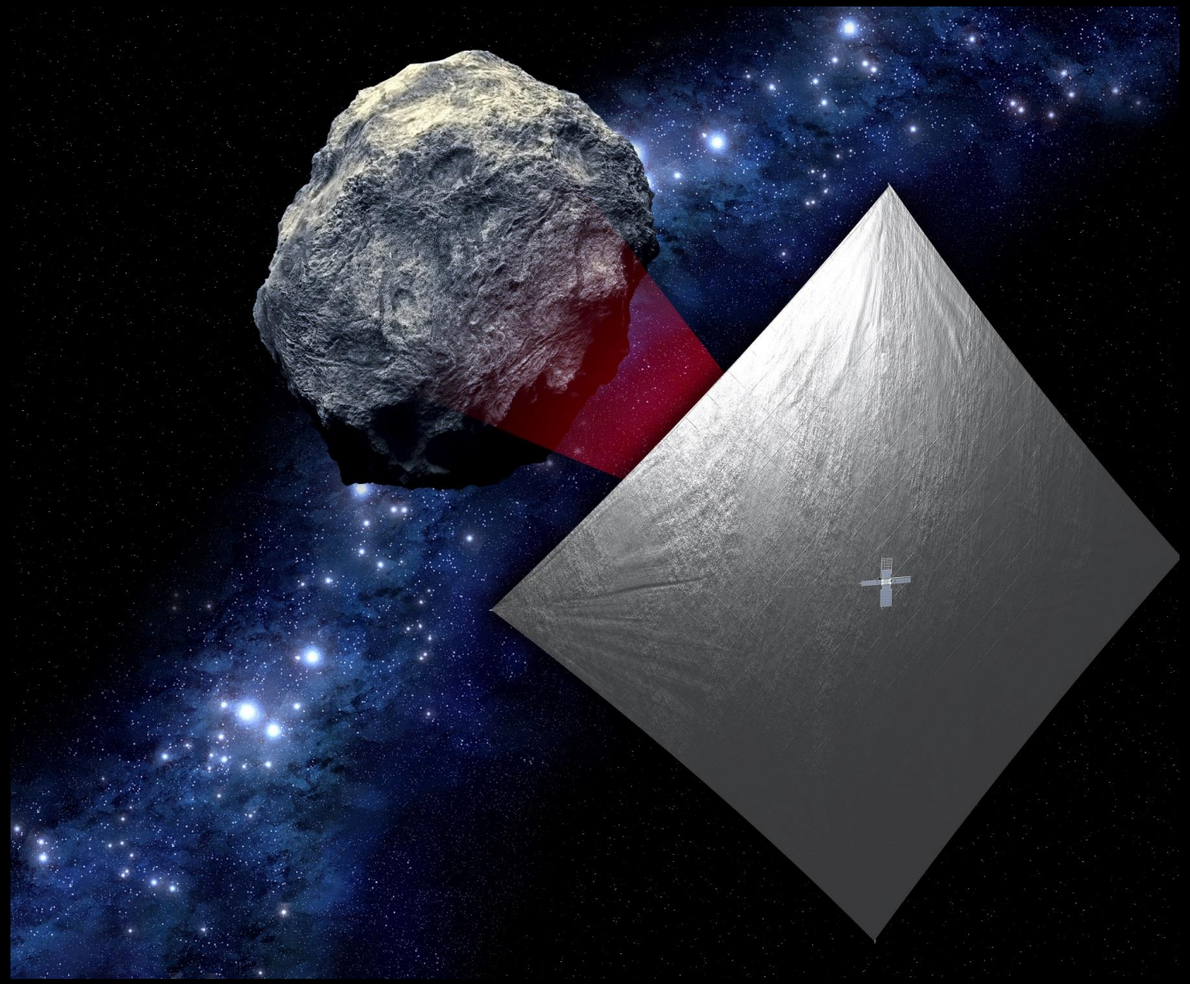
Near Earth Asteroid Scout

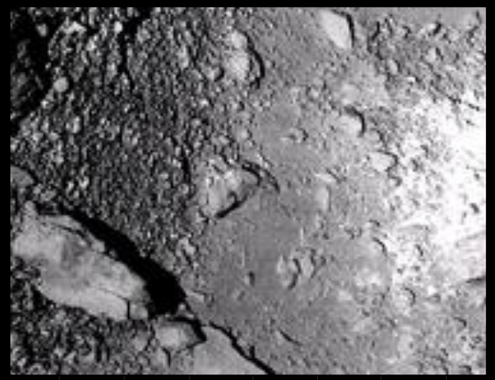
ISSS 2019

GOALS

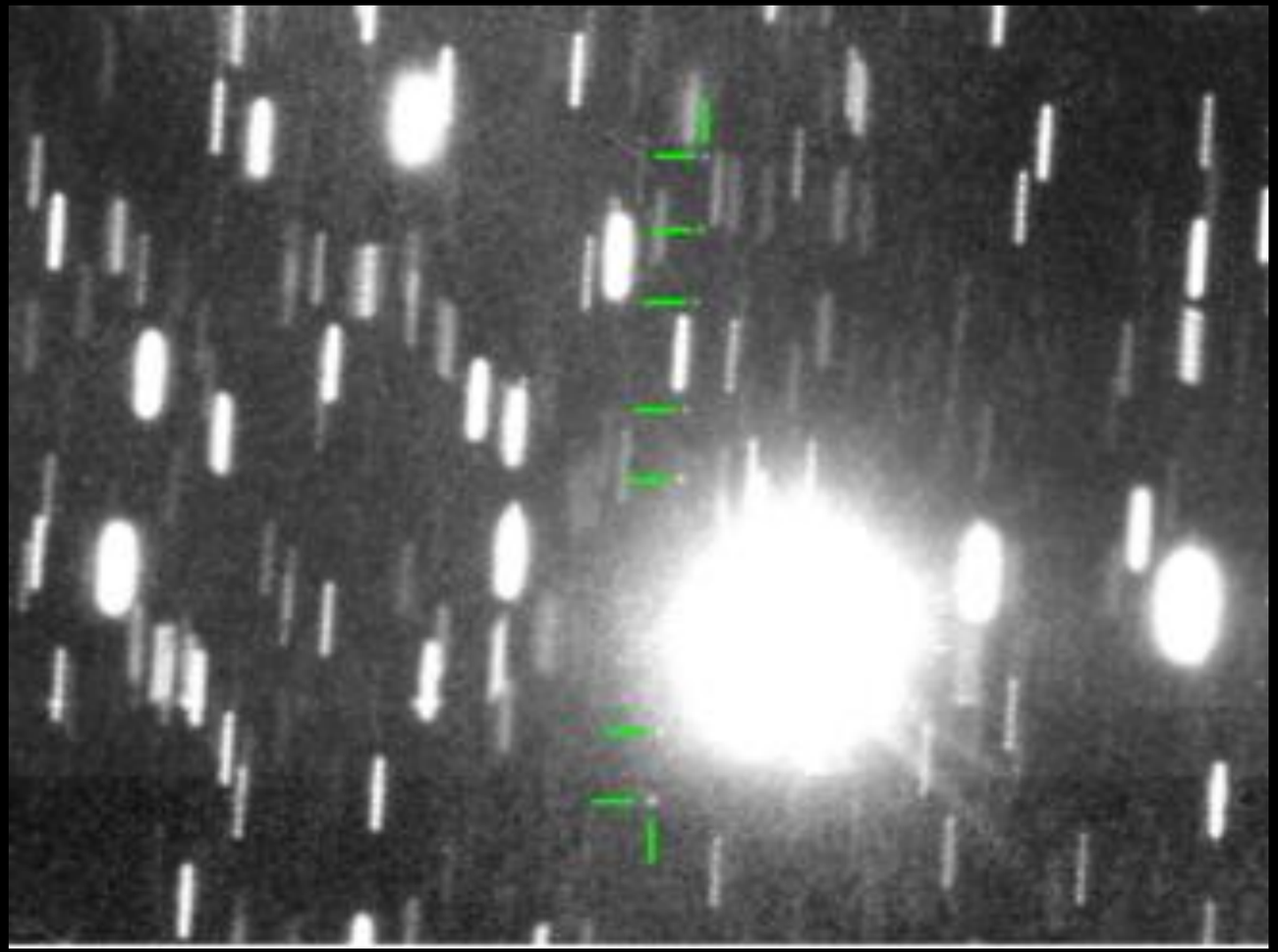
- Characterize one candidate NEA with an imager to address key Strategic Knowledge Gaps (SKGs) for Human Exploration
- Demonstrate low cost capability for NEA detection and reconnaissance
- *(And fly a solar sail in interplanetary space!)*

Measurements: *NEA volume, spectral type, spin and orbital properties, address key physical and regolith mechanical SKGs*





Target Asteroid: 1991 VG

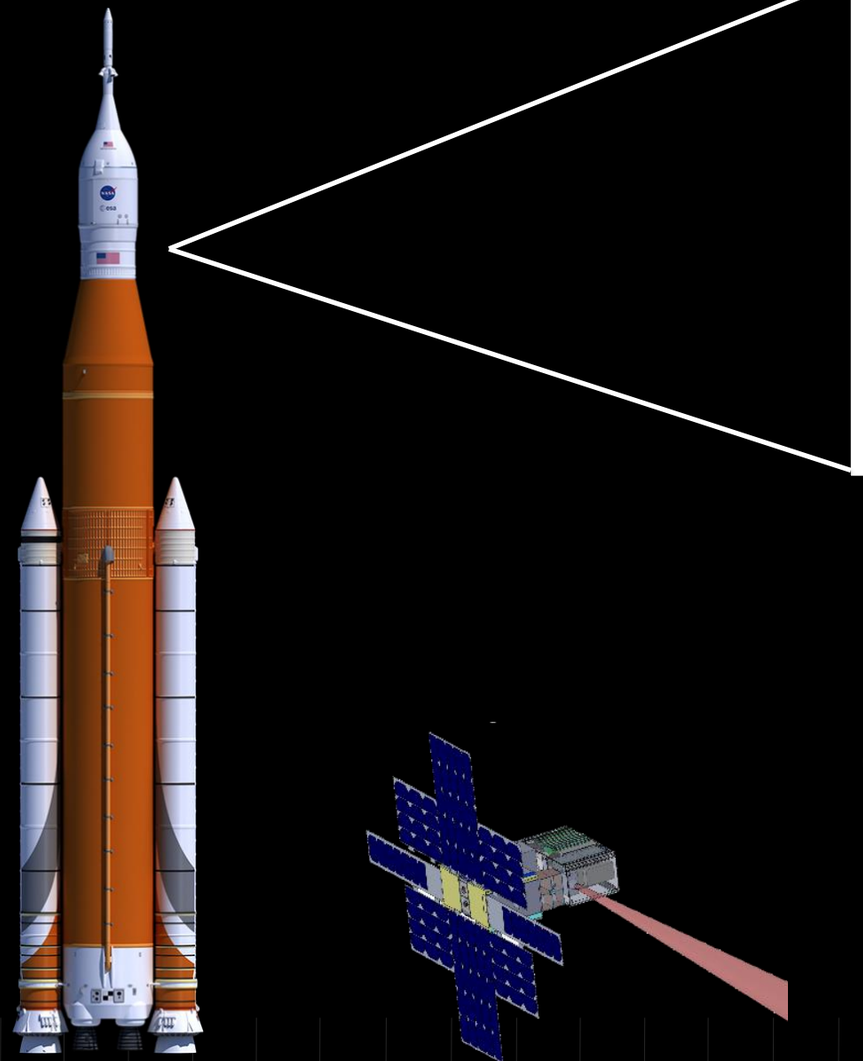


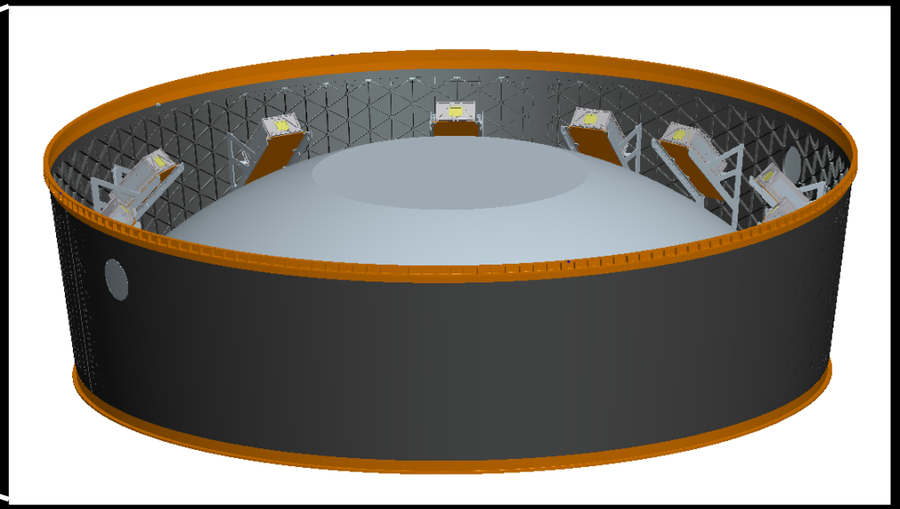
Near-Earth Asteroid 1991VG (marked with green lines) on 2017 May 30. This is a composite of 7 images obtained with the ESO VLT. These images have been combined, tracking the position of the asteroid. The stars appear trailed due to the motion of the asteroid during each series.
Credit Hainaut/Micheli/Koschny

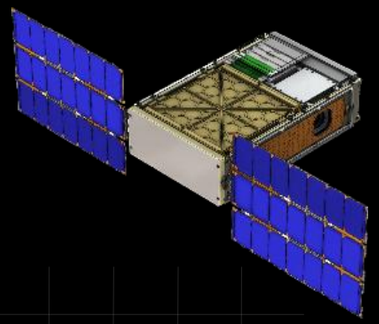
- Diameter ~ 5 -12 meters
- Rotation period between a few minutes and less than 1 hour
- Unlikely to have a companion
- Unlikely to retain an exosphere or dust cloud
  - Solar radiation pressure sweeps dust on timescales of hours or day

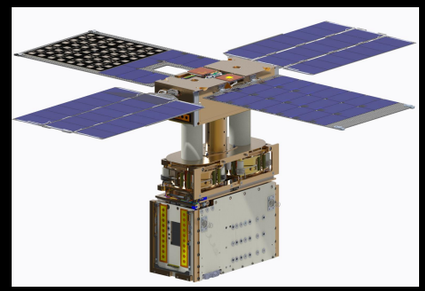
NEA Scout Launch

NEA Scout is one of 13 secondary payloads launching on SLS EM-1



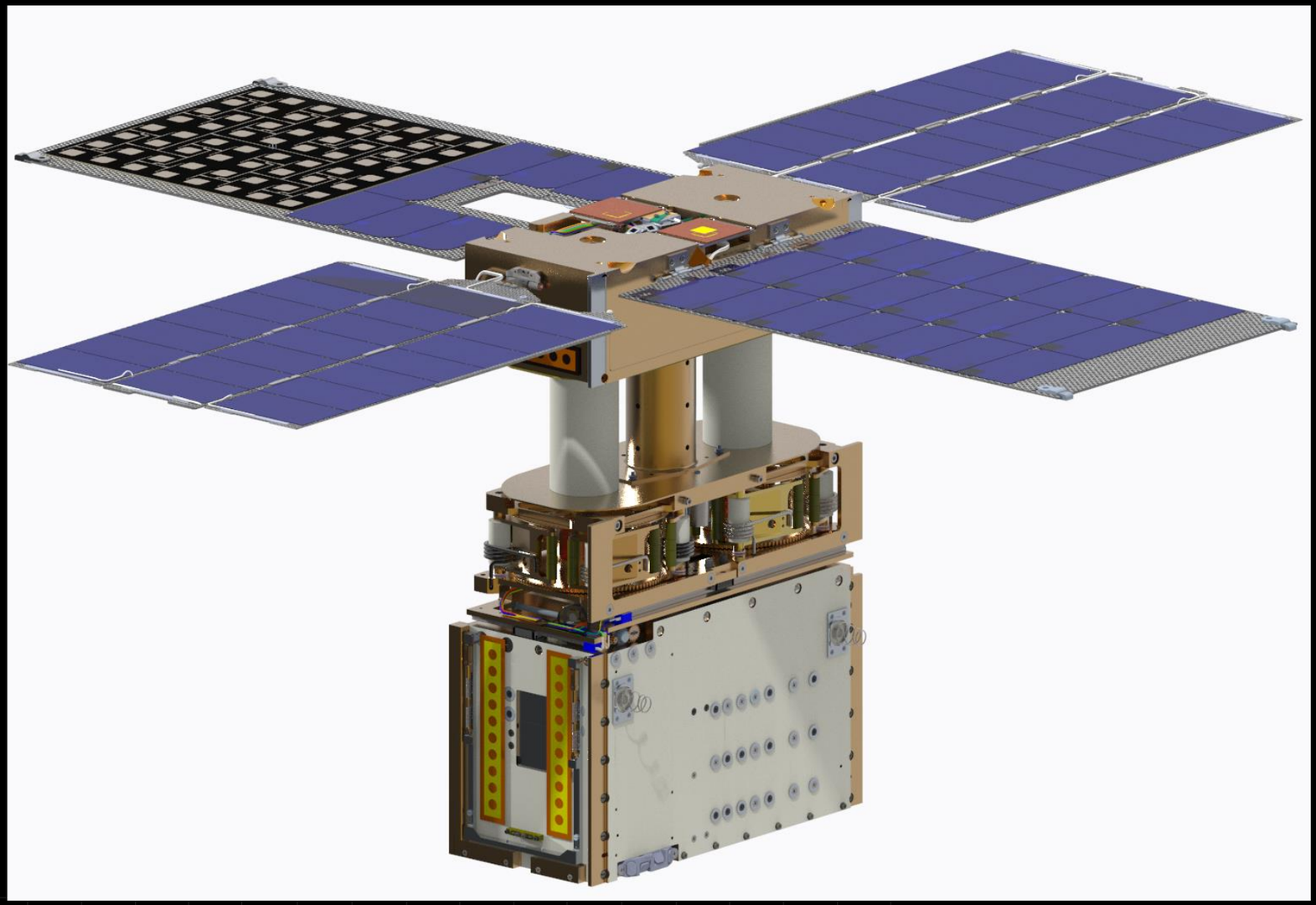






NEA Scout Spacecraft

NEA Scout is an interplanetary spacecraft stuffed into a 6U cubesat



6U Cubesat Form Factor: 30 x 20 x 10 cm

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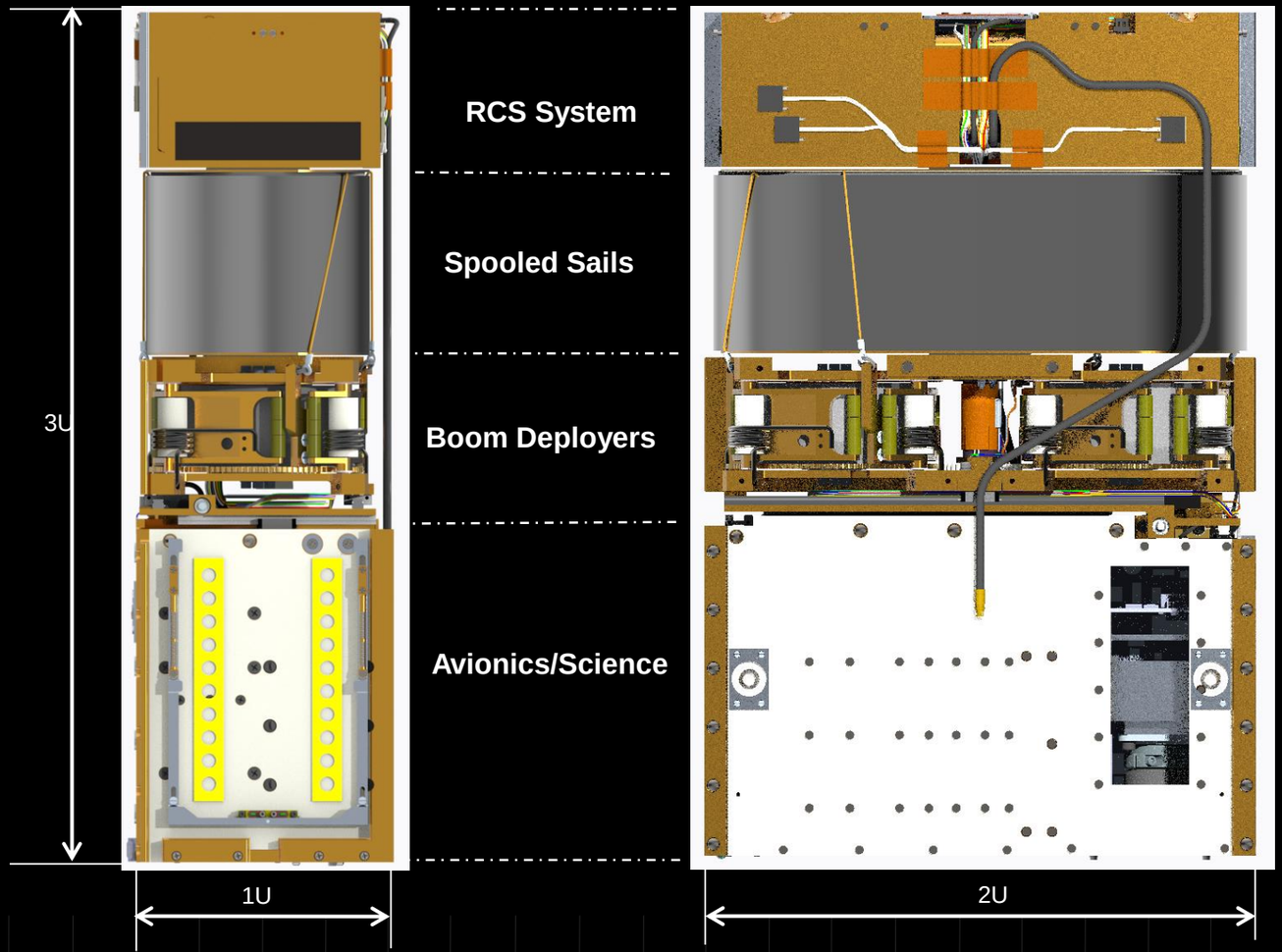
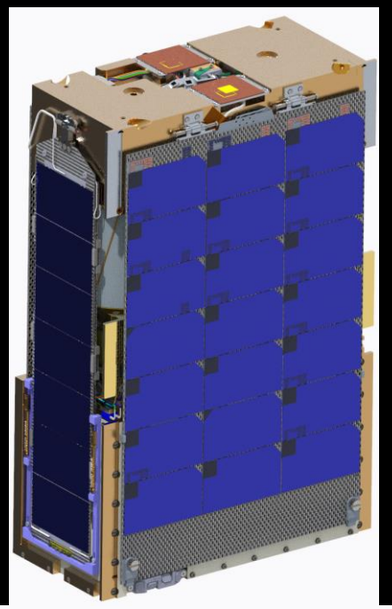
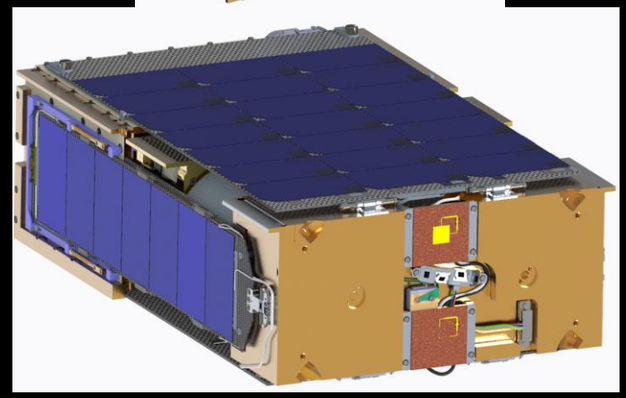
"Most difficult game of Tetris ever played"

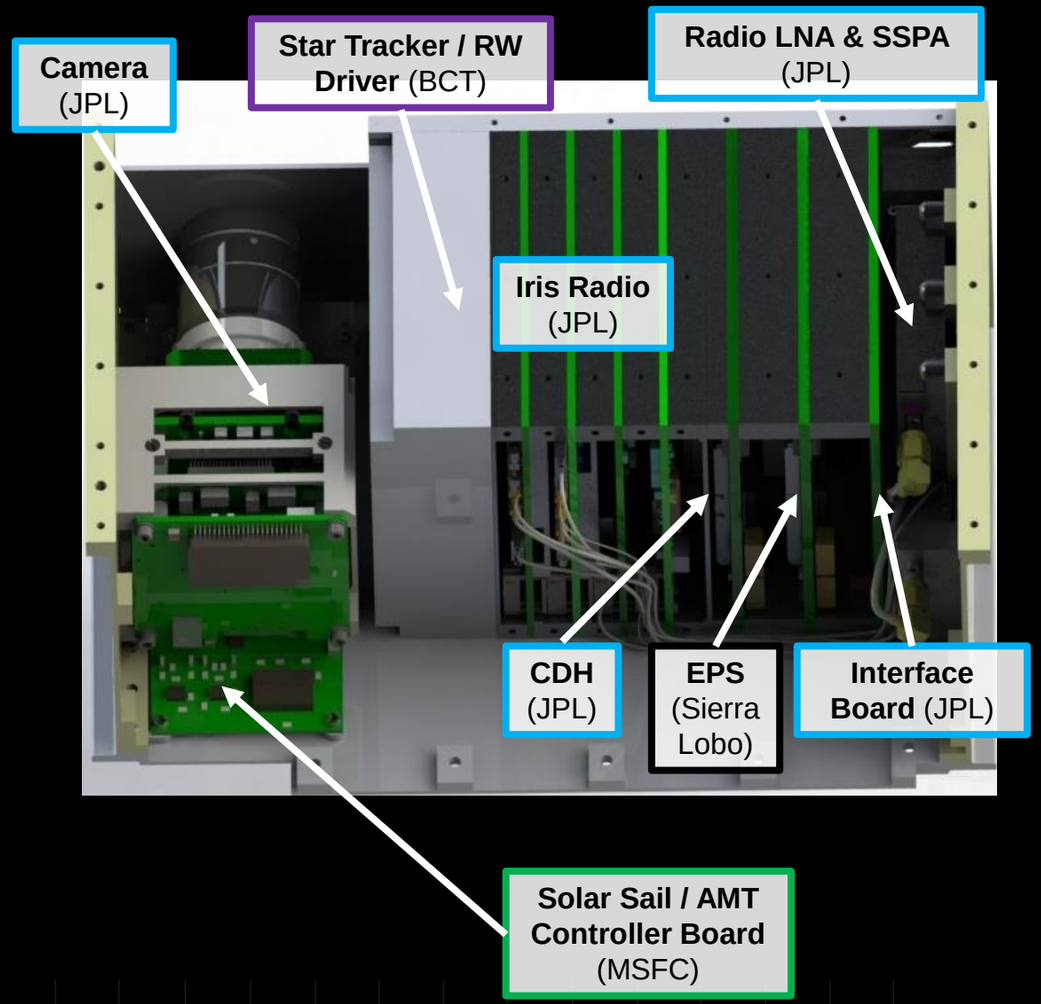






NEA Scout Flight System

A fully functional planetary spacecraft in a shoebox



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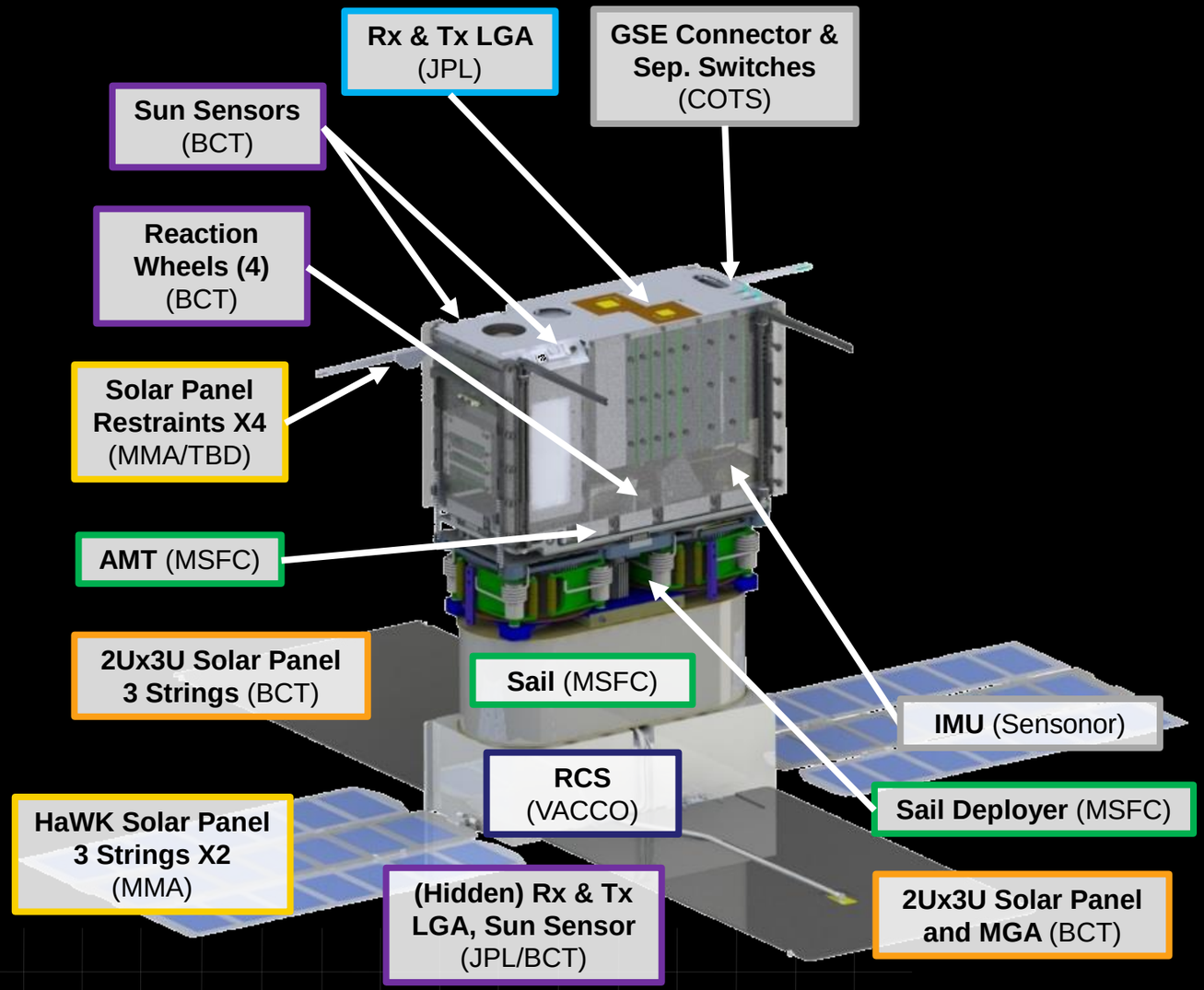

NEAS Configurations

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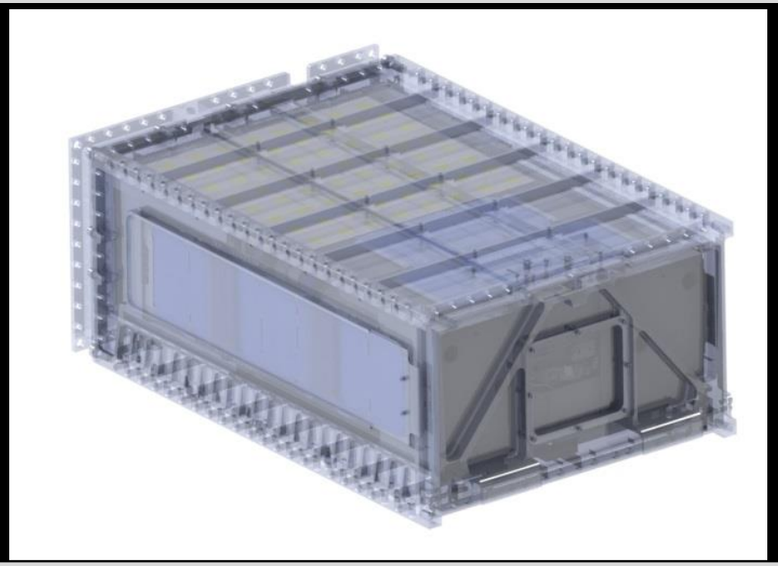
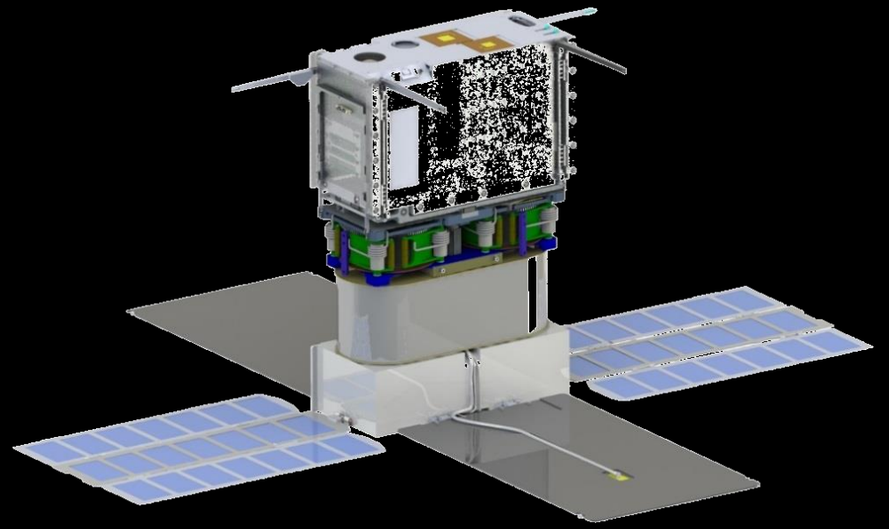
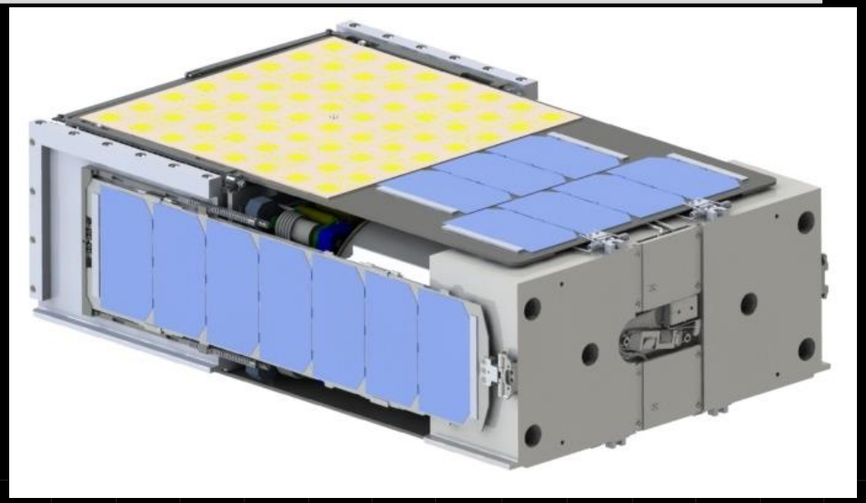
Stowed in Dispenser



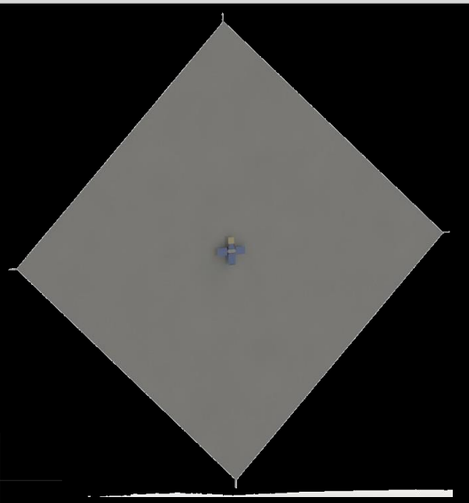
Configuration before sail deployment



Ejection, before panel deployments



Sail deployed



~9 x ~9m Solar Sail

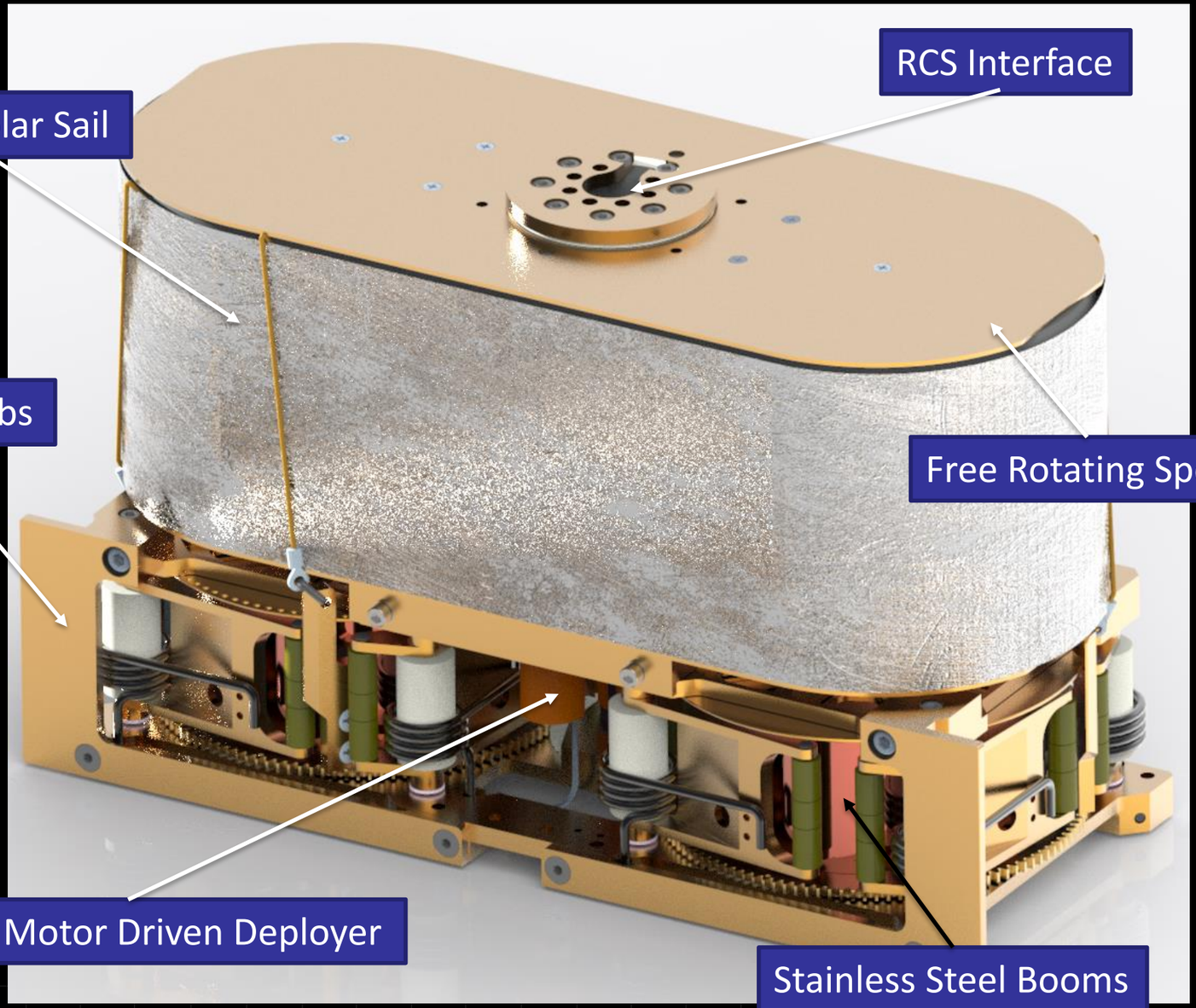
Deployed Solar Sail

School Bus

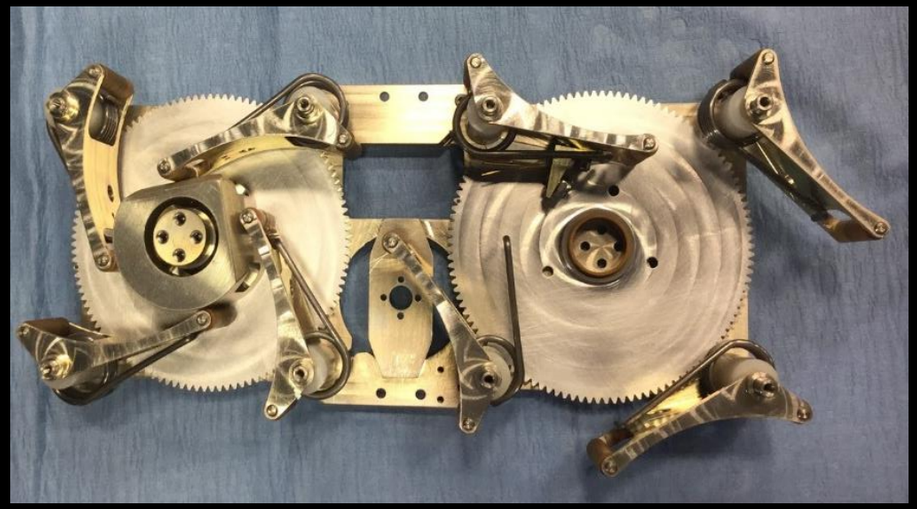
6U Stowed Flight System

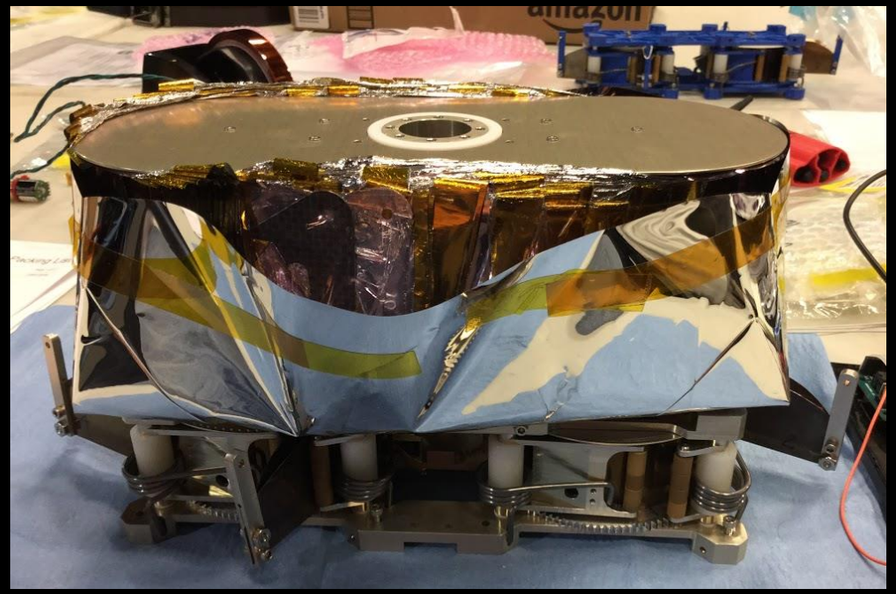
Folded, spooled and packaged in here

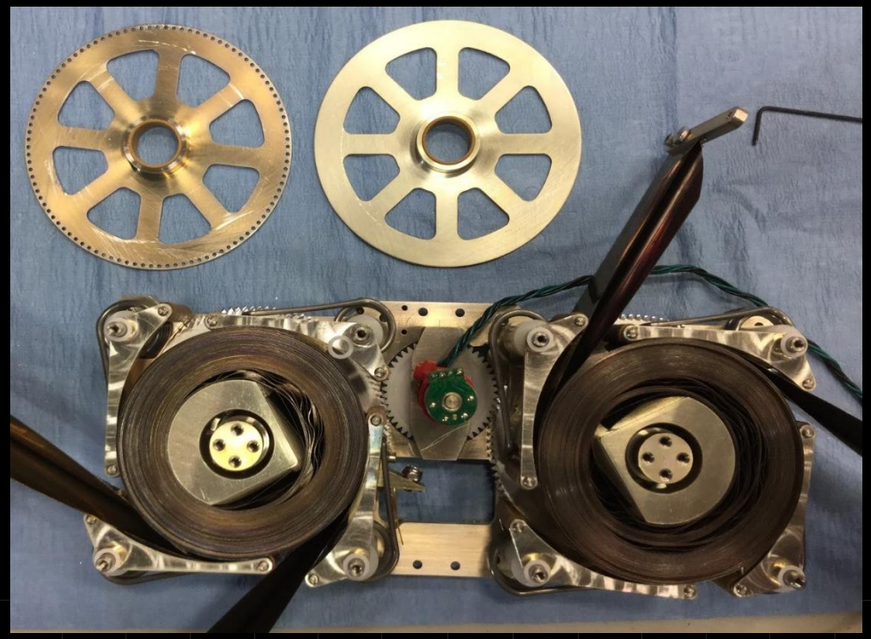
86m² Sail in <2U

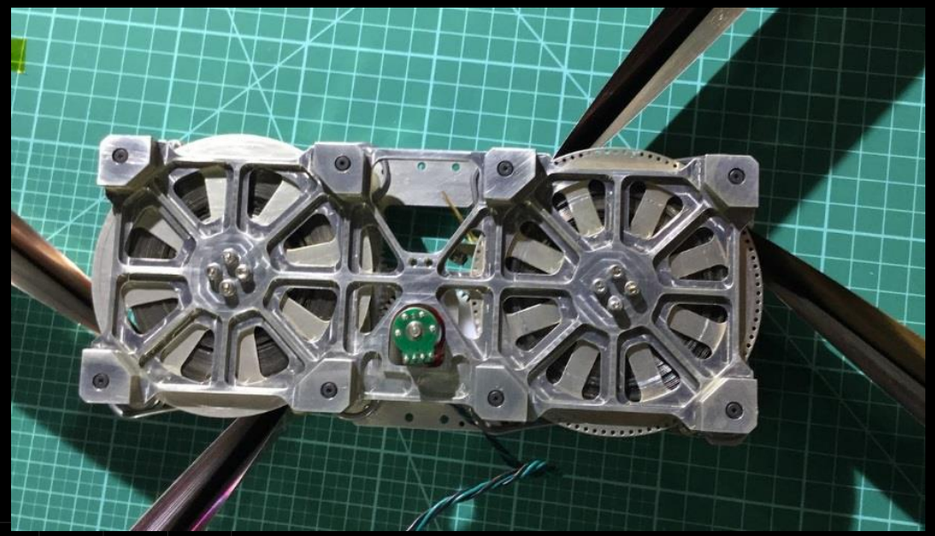


Full Scale Sail Assembly









Flight Sail Testing

NEA Scout Flight Operations

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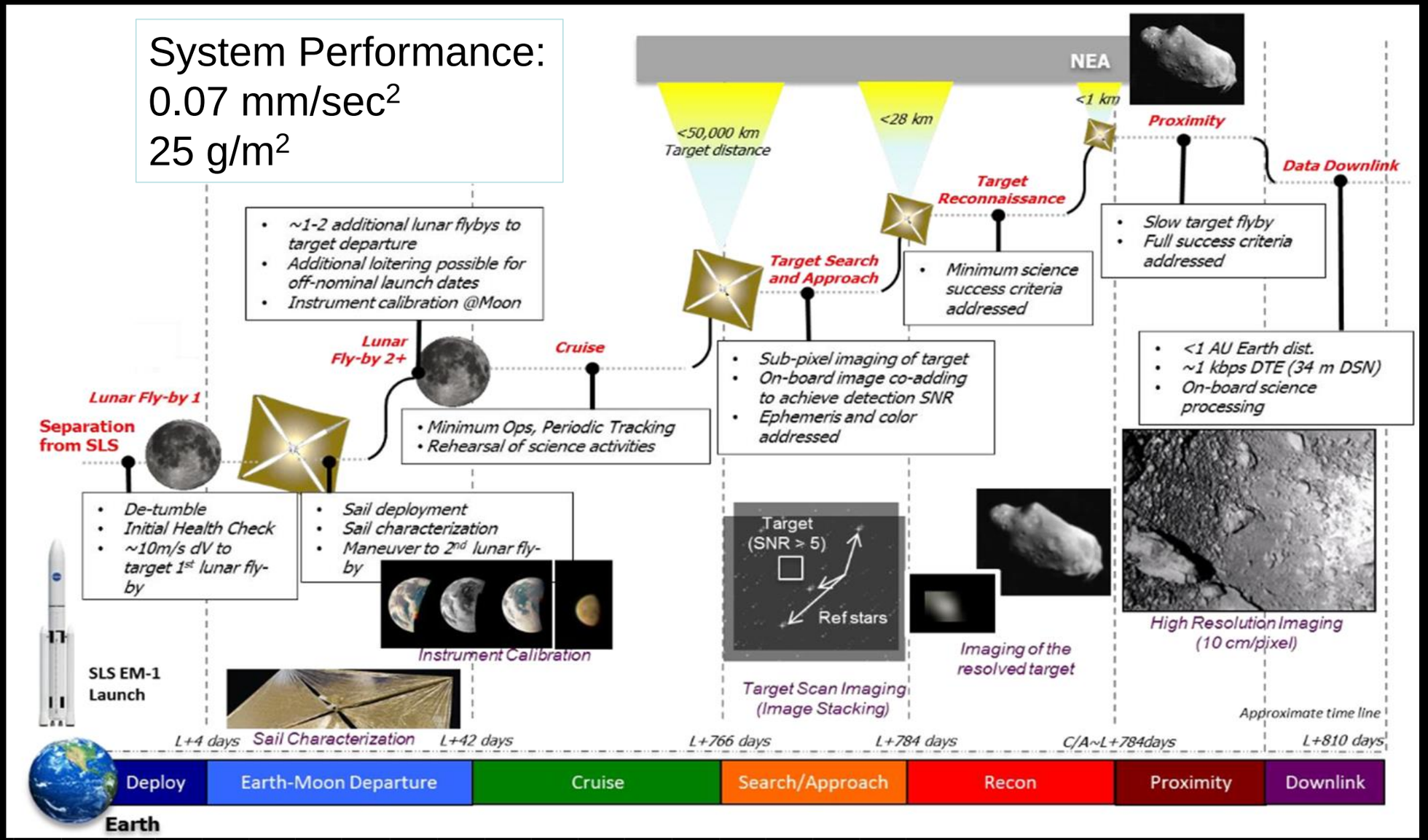
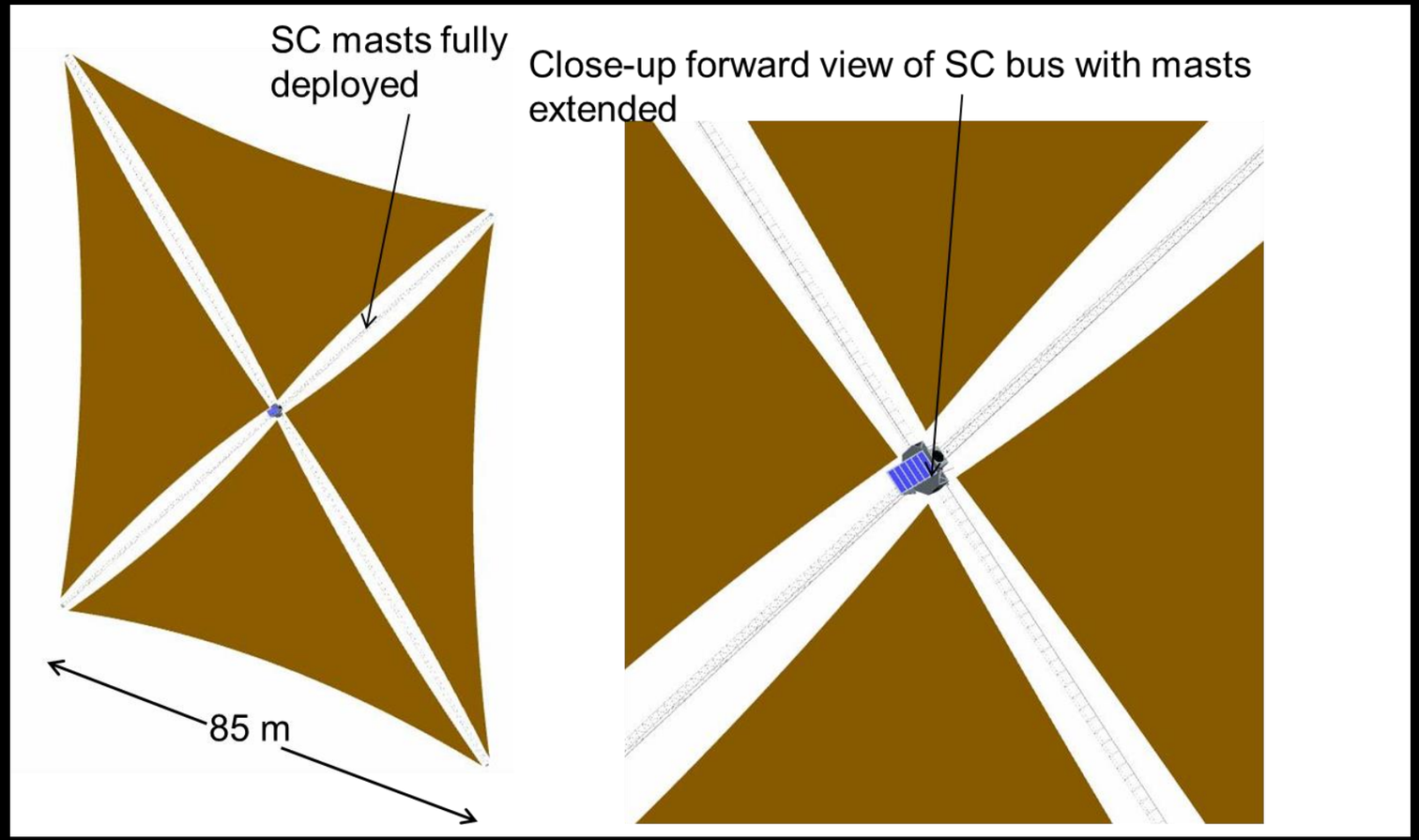
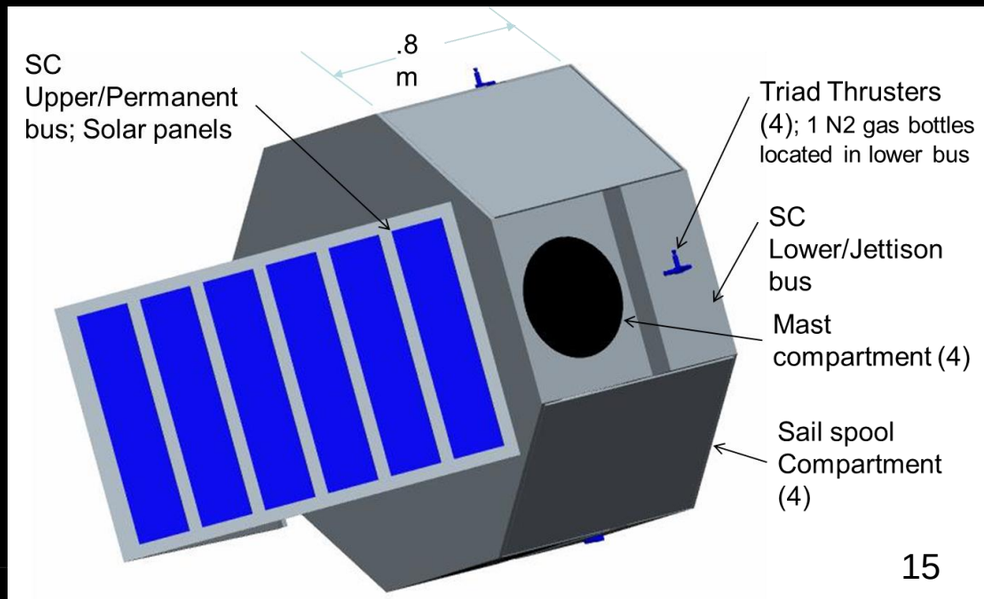
System Performance:
0.07 mm/sec^2
25 g/m^2



Before There Was NEA Scout



- 2010
  - Multiple Near Earth Object Rendezvous Using Solar Sails
    - 5000 square meter solar sail
    - Sail system mass = 71 kg
    - Total spacecraft mass = 340 kg
    - Estimated cost = $91M



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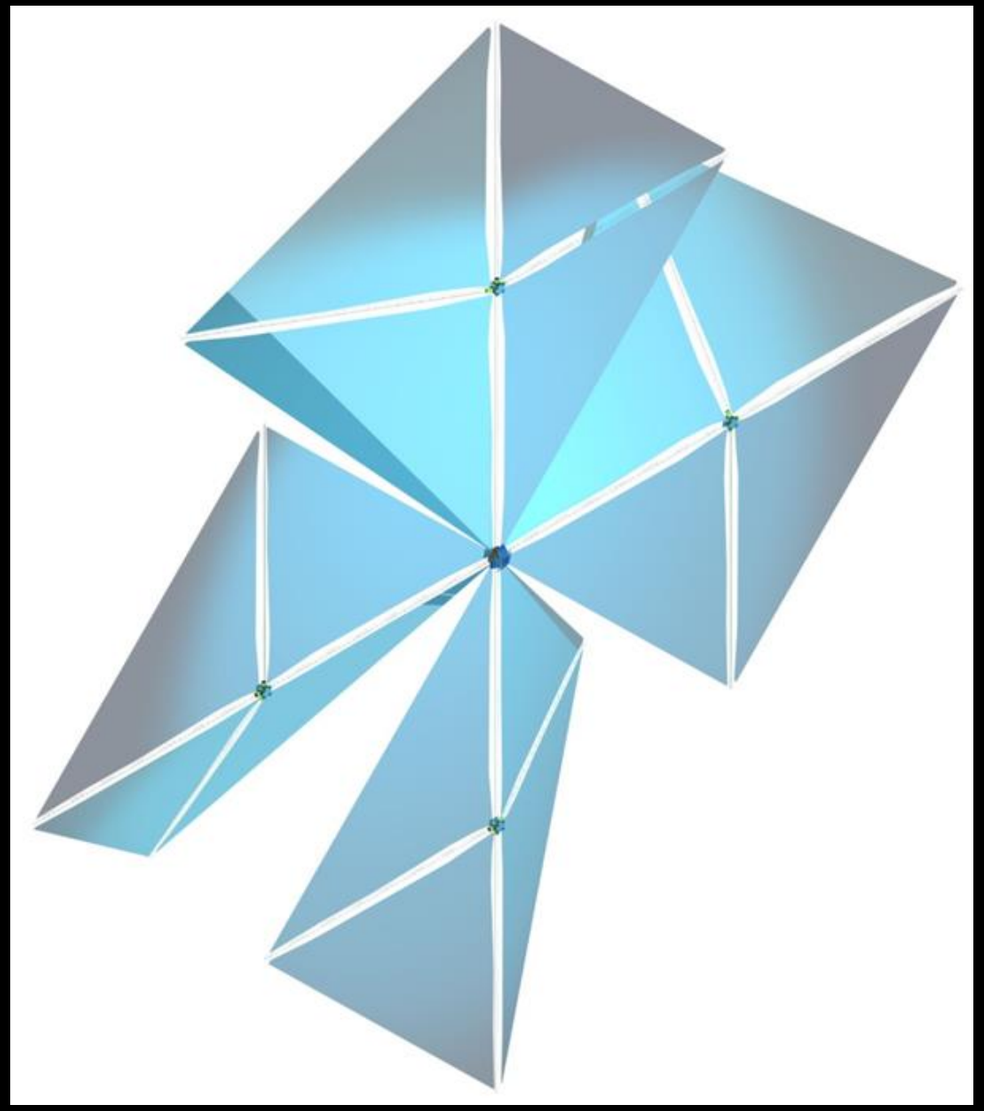
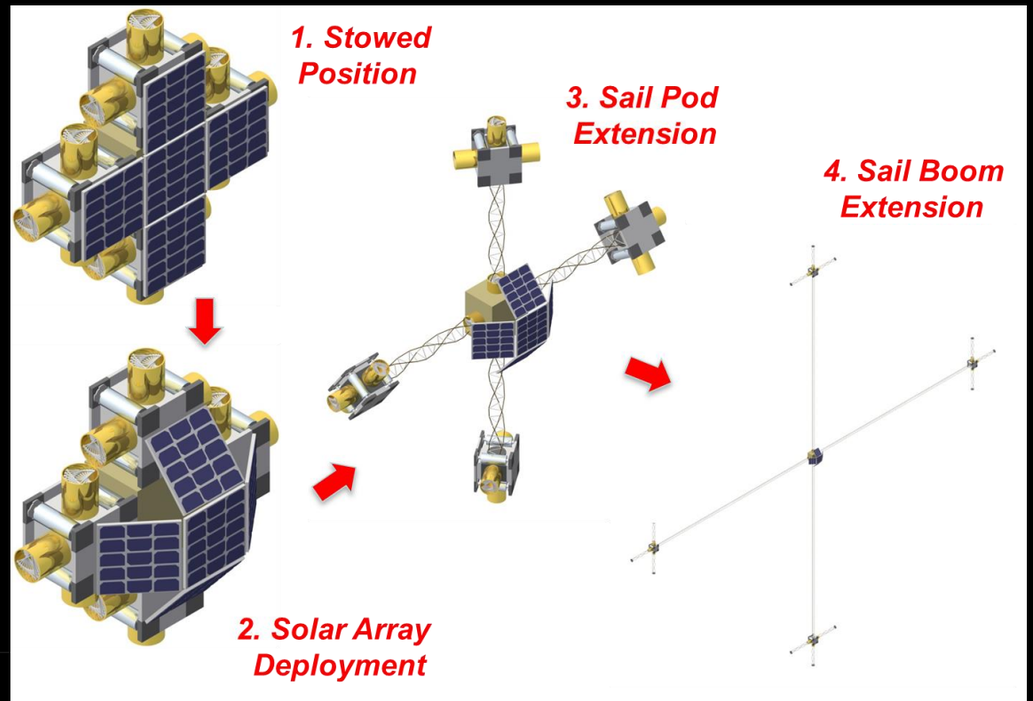


- 2012
  - Near Earth Object Precursor
    - 871 square meter solar sail
    - Sail system mass = 19 kg
    - Total spacecraft mass = 43 kg
    - Estimated cost = $91M



NEA Scout & Lunar Flashlight

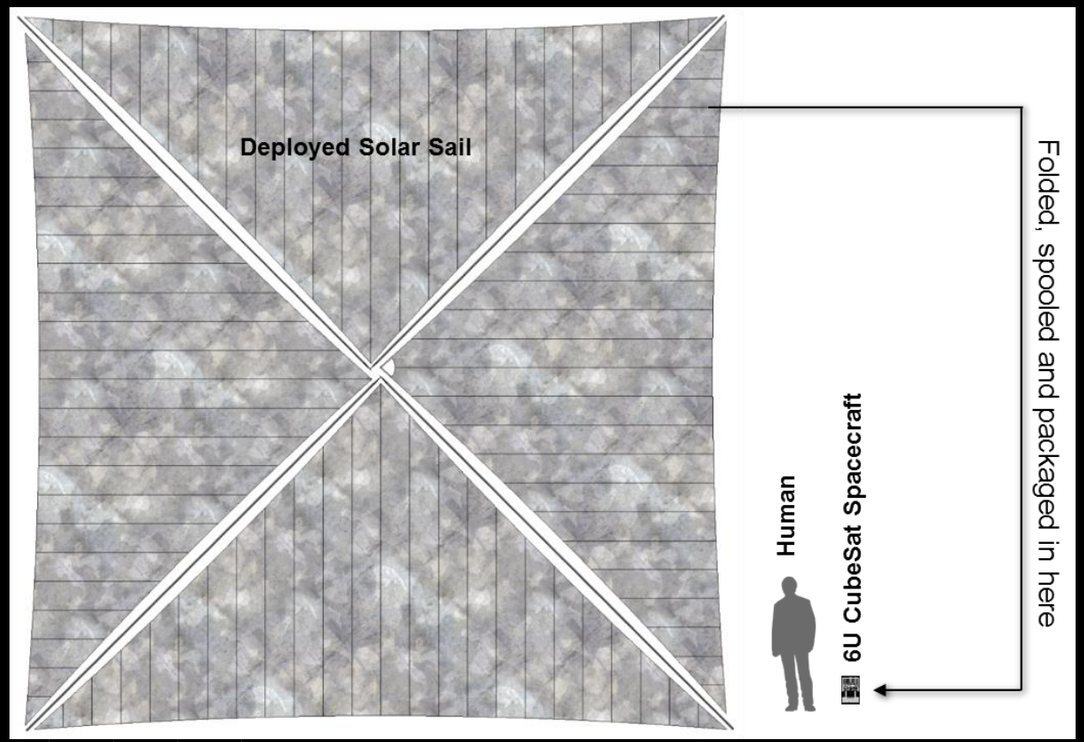
- 2013
  - Near Earth Asteroid Scout
    - >100 square meter solar sail
    - Sail system mass = ~4 kg
    - 12 U spacecraft bus
    - Total spacecraft mass = 30 kg
    - Estimated cost = $25M
  - Proposal submitted to HEOMD
  - JPL proposed the same mission independently
  - JPL also proposed Lunar Flashlight – an additional solar sail mission
  - MSFC and JPL told to merge into a single team

NEAS & LF Teams Merged

- 2013
  - Near Earth Asteroid Scout
    - 86 square meter solar sail
    - Sail system mass = <3 kg
    - 6 U spacecraft bus
    - Total spacecraft mass = ~24 kg
    - Estimated cost = $23M
  - Same solar sail for both missions
  - MSFC develop the solar sail
  - JPL develop the spacecraft
  - MSFC manage NEA Scout
  - JPL manage Lunar Flashlight

Solar Sail: Common System

- Commonality of sail design for NEA Scout and Lunar Flashlight will minimize development costs
  - Sail sized to meet propulsive requirements for both missions
  - Will additionally provide reflector for Lunar Flashlight science
  - Common elements include booms, materials, packaging, deployment and control systems
- Will seek commercial partner to license the sail technology for future NASA and commercial missions:
  - Exploration (additional NEA's)
  - Science (Planetary, Heliophysics)
  - Resource Identification (commercial)
- MSFC has Space Act Agreement with The Planetary Society for lessons learned on their LightSail Project



Solar Sail: Common System

ISSS 2019

- Commonality of sail design for NEA Scout and Lunar Flashlight will minimize development costs
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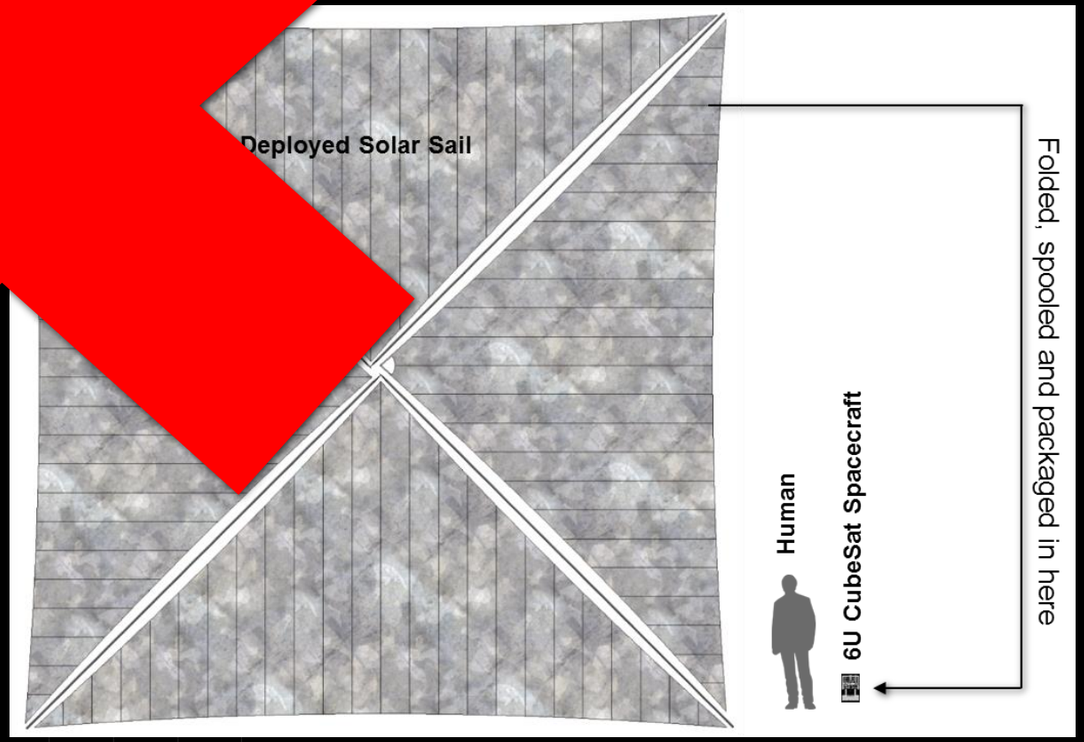
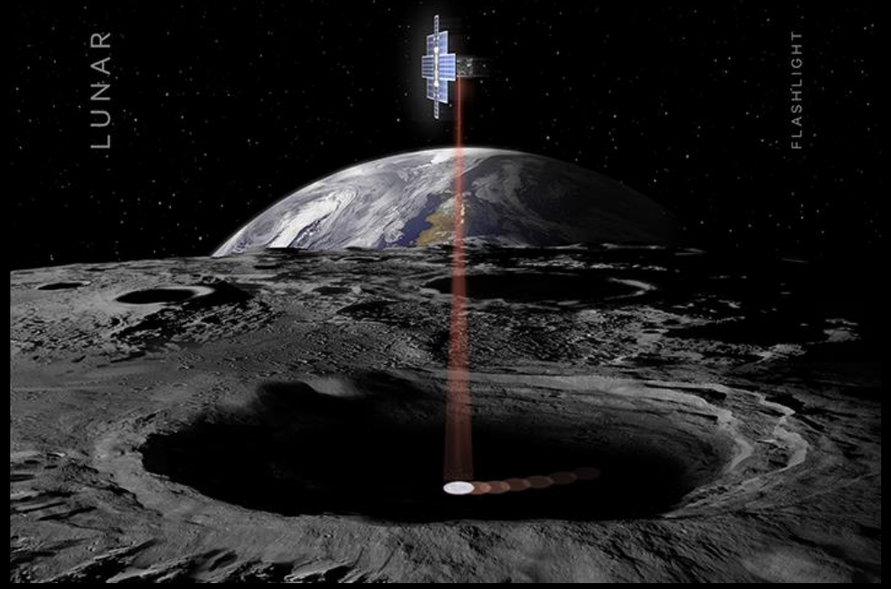
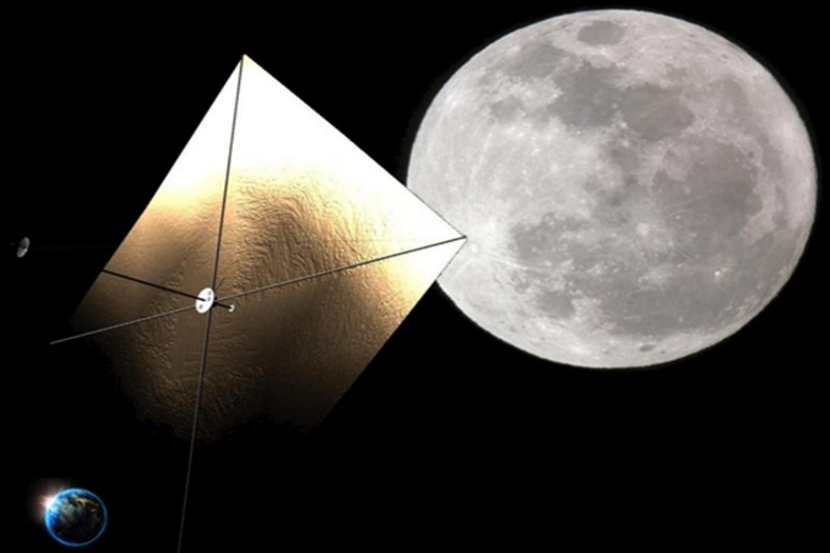


NEAS and LF Separated

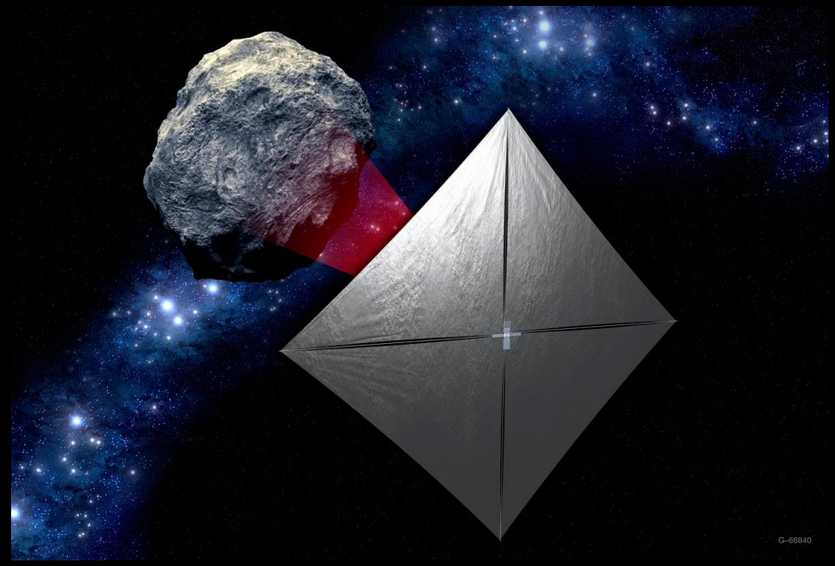




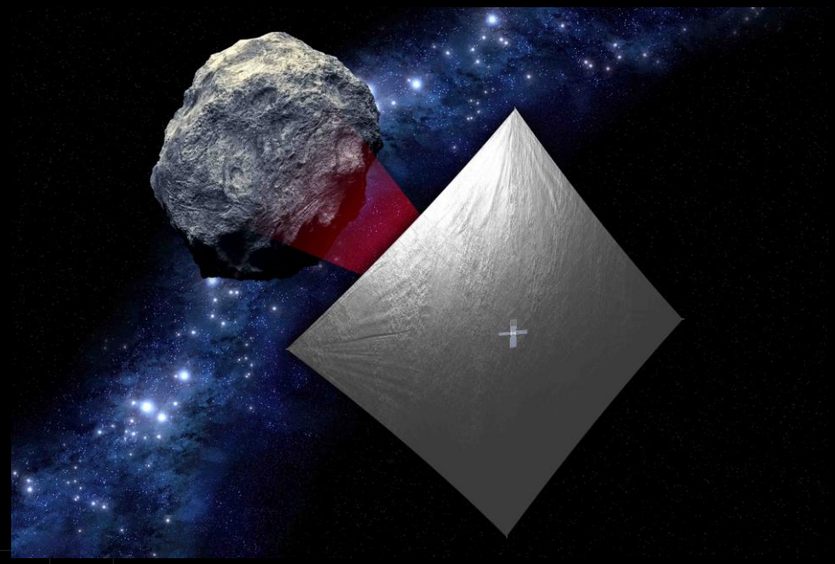
- 2015
  - Lunar Flashlight spacecraft became too heavy for a solar sail to provide sufficient propulsion
  - sail removed
  - Laser and chemical propulsion added

From 4 Quadrants to Single Sail

- NanoSail-D heritage 4-quadrant design with 4 metallic booms
- LaRC analysis showed that metallic booms would deform, destroying sail flatness

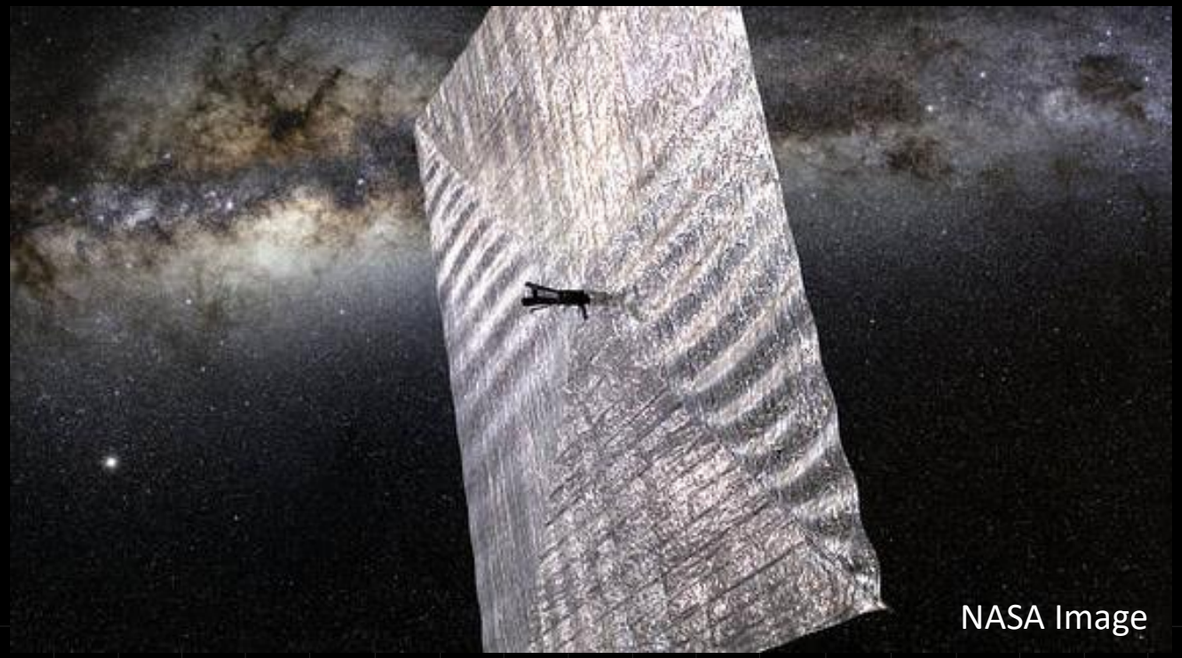


- Single sail developed to shade the booms and eliminate thermal deformation problems

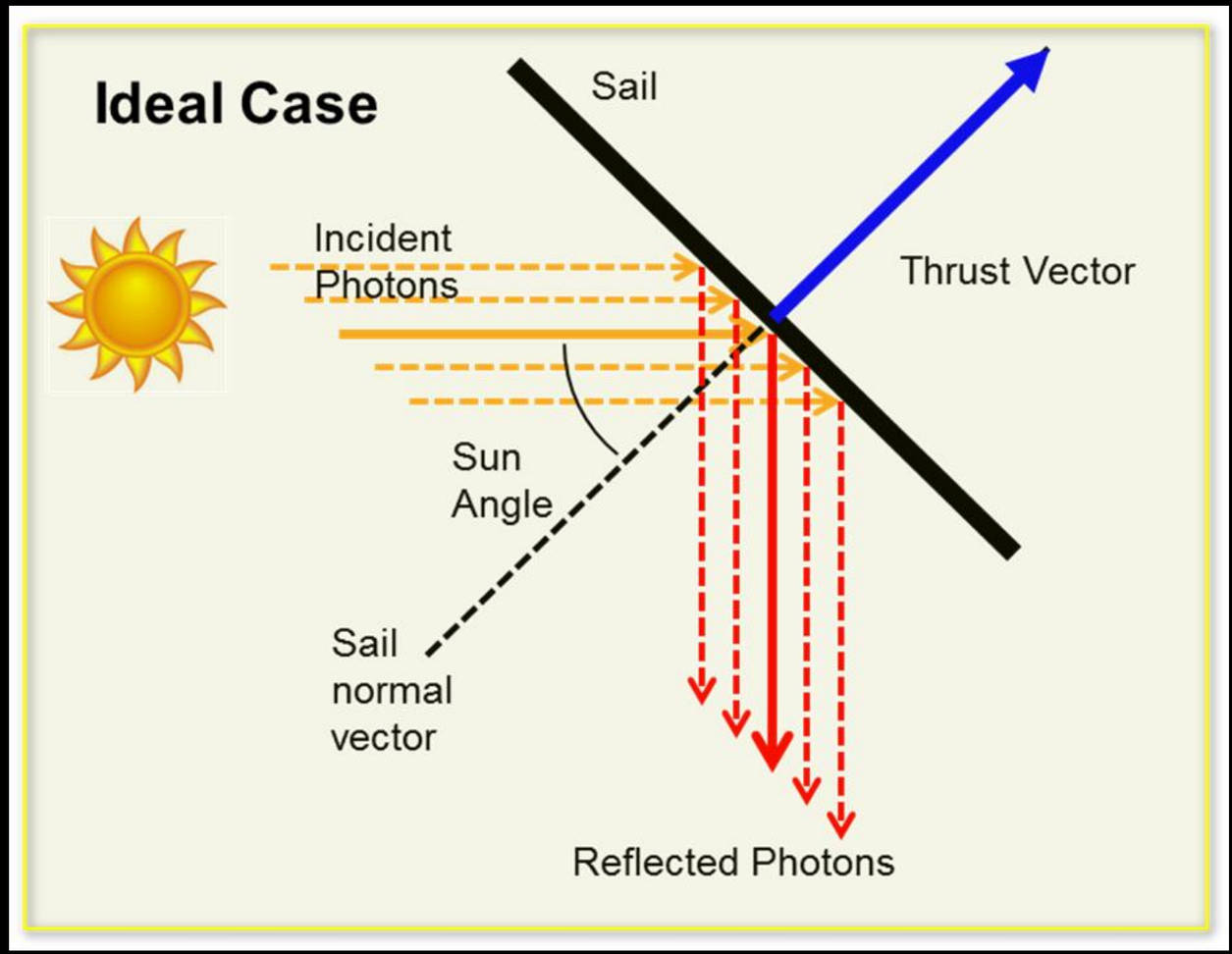


Ideal, Flat Solar Sails

Ideal sails are perfectly flat and have predictable and regular light reflection



NASA Image



Real Solar Sails Are Not “Ideal”

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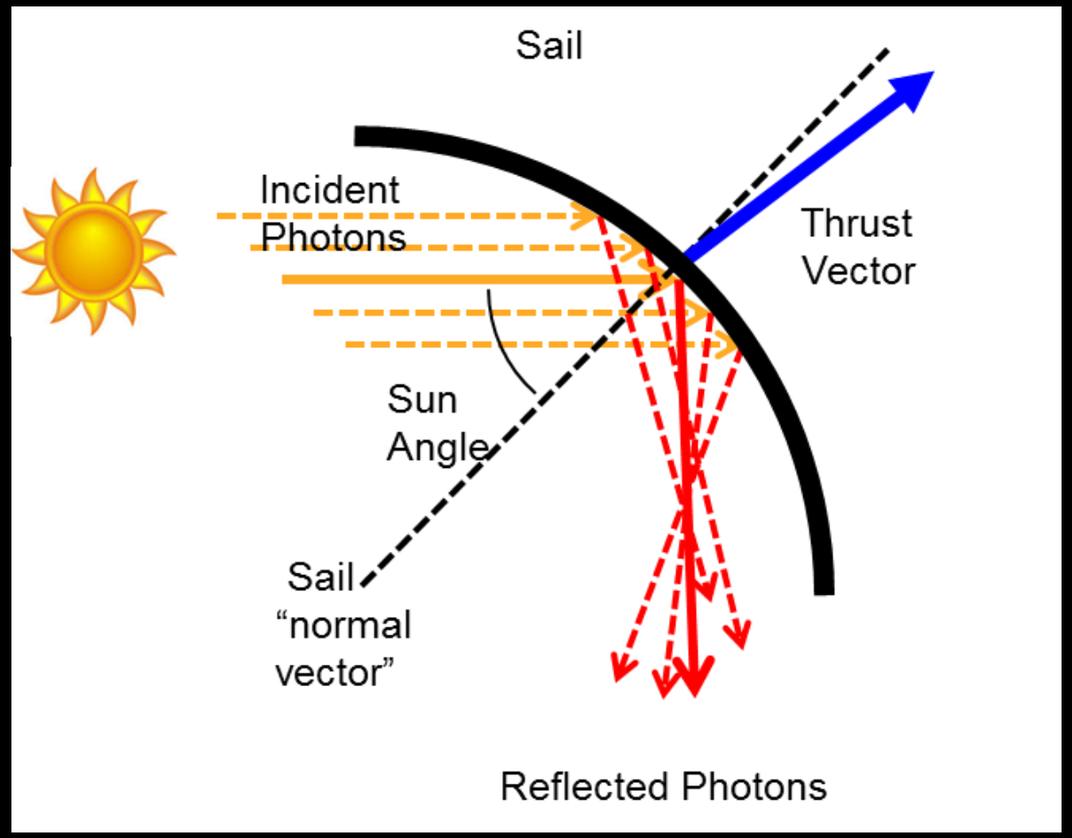
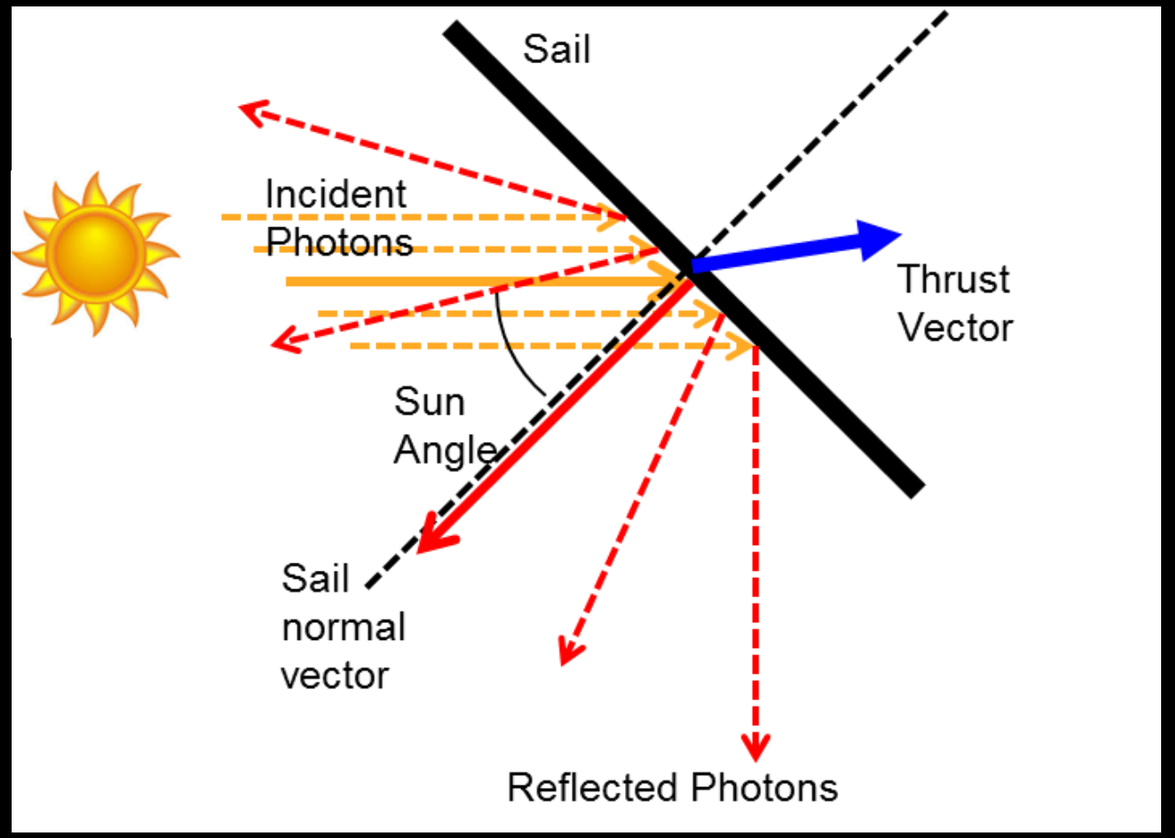
Billowed Quadrant



Diffuse Reflection



Real Sails Have Imperfections

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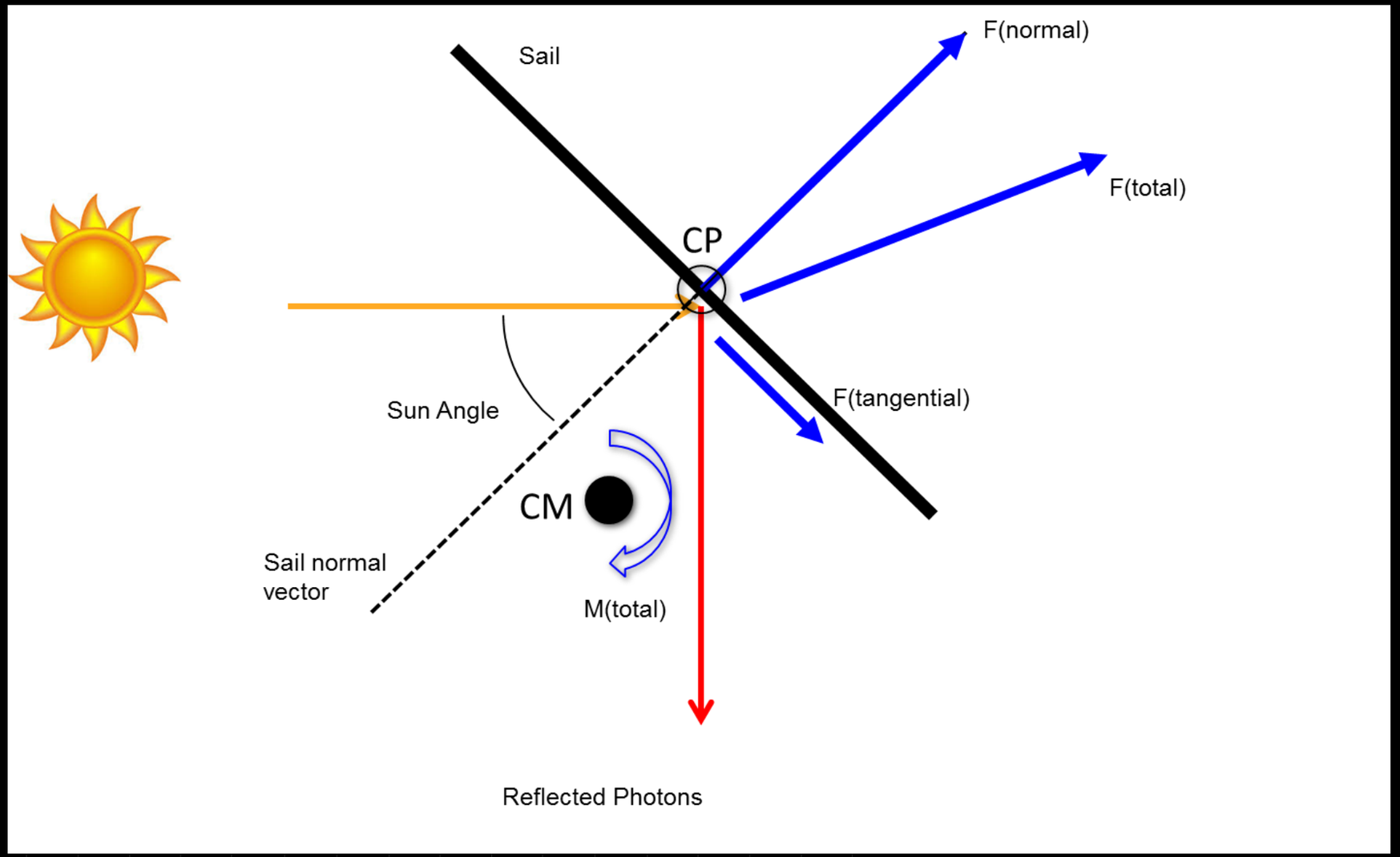
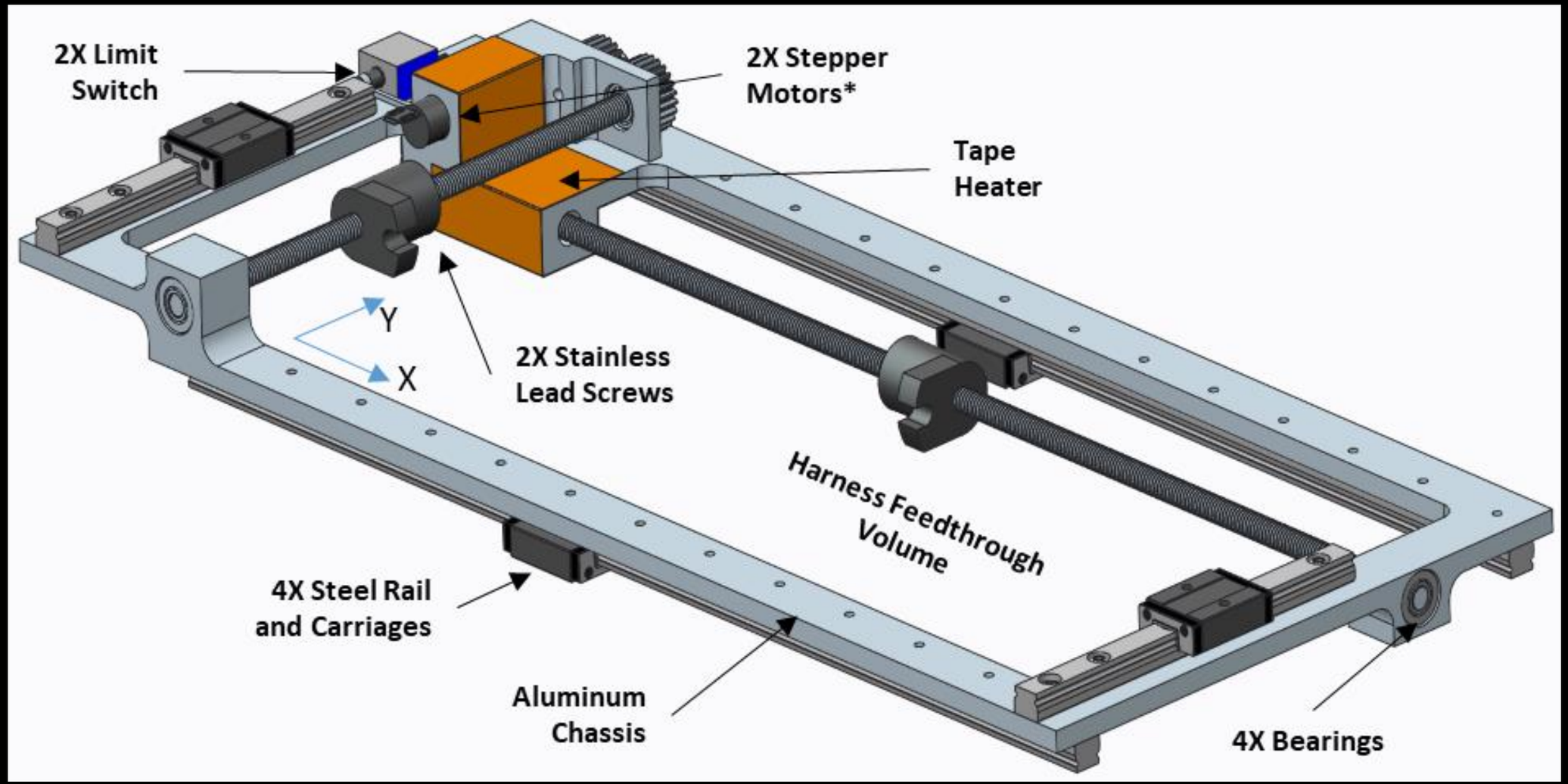
A deployed solar sail has misaligned CM / CP needing correction

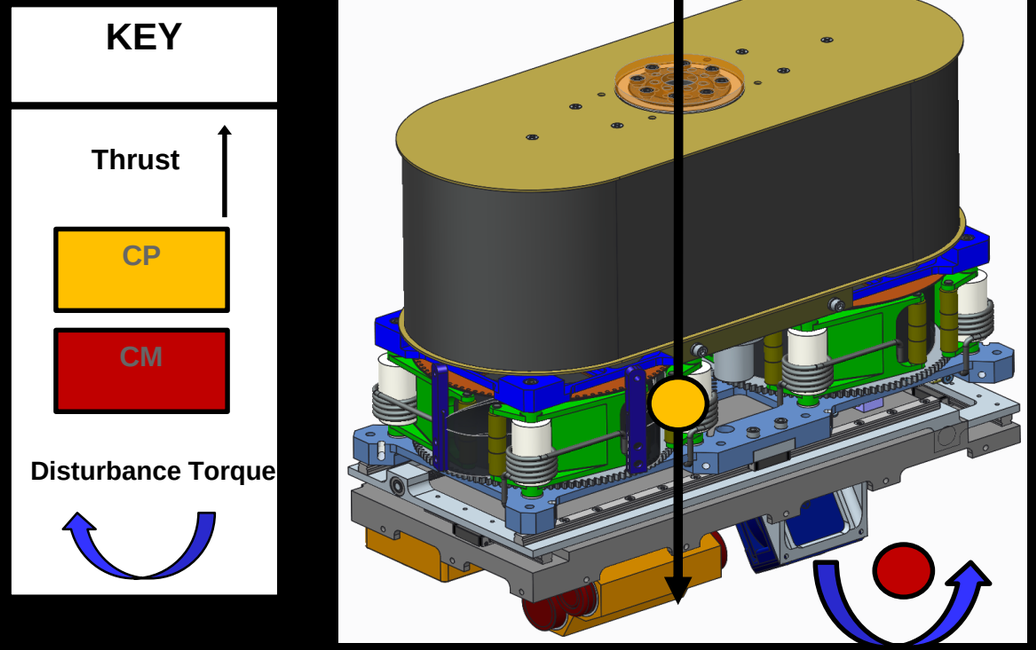


Active Mass Translator (AMT)

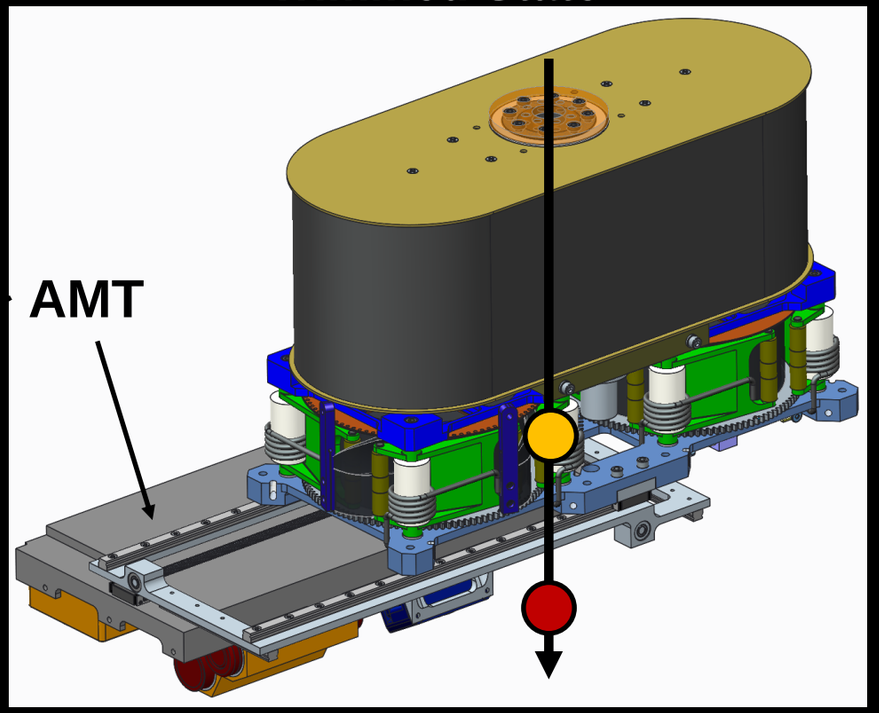


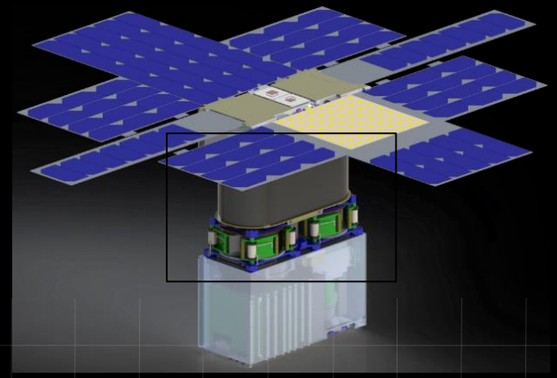
NEA Scout AMT

Nominal State

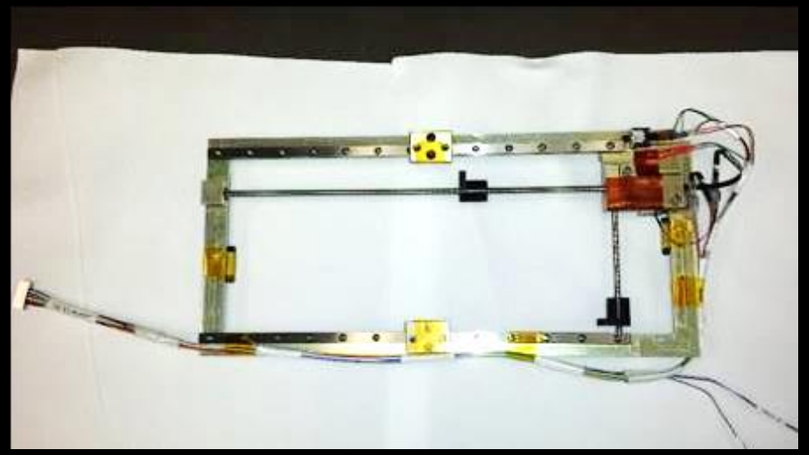


Trimmed State



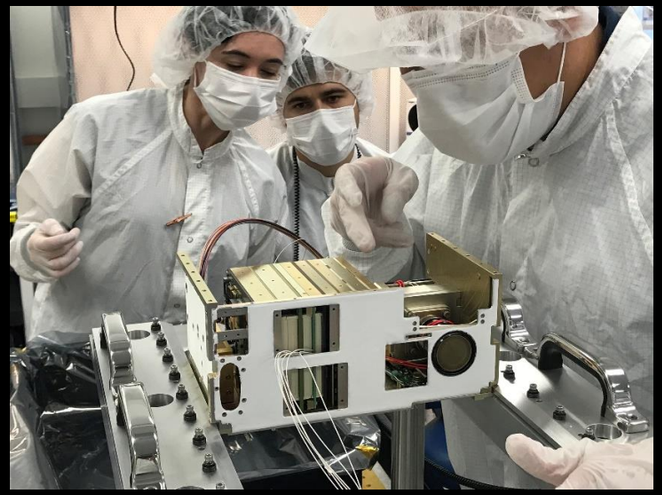


NEA Scout - Status

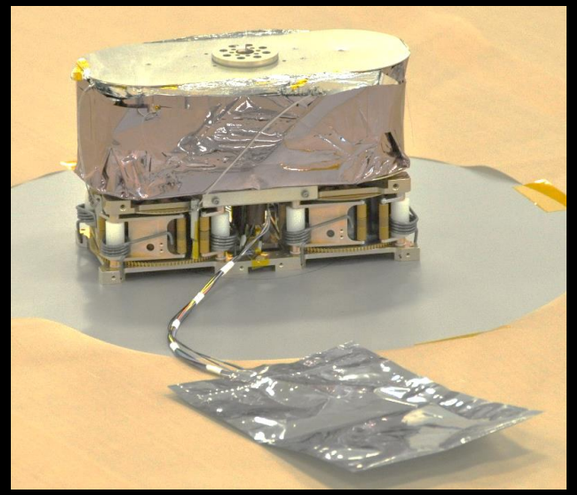


Flight AMT with thermocouples attached for testing

Reaction Control Unit (RCS) Flight Unit



Avionics Box Integration



Flight Solar Sail Spooled on Deployer

Questions?