

NASA's Advanced Concepts Office at the George C. Marshall Space Flight Center



Les Johnson
NASA MSFC / ED04

NASA Around the Country



Supporting NASA's mission with unique engineering expertise.

Marshall Profile



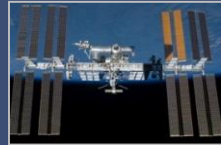
\$2B expenditures nationally
(\$1.2B in Alabama)



6,000 employees
(FY13: 2,446 civil service)



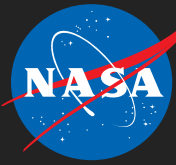
3rd largest employer
in the Huntsville –
Madison County area



4 core product lines
supported by more than
125 unique and
specialized facilities

Part of an Aerospace/Defense/Commercial Technical Community

- Redstone Arsenal – home to 18 primary Federal organizations
- Cummings Research Park – 2nd largest in U.S. and 4th largest in the world
- Huntsville's concentration of high-tech workers is 2nd in the nation



What is the NASA MSFC Advanced Concepts Office?

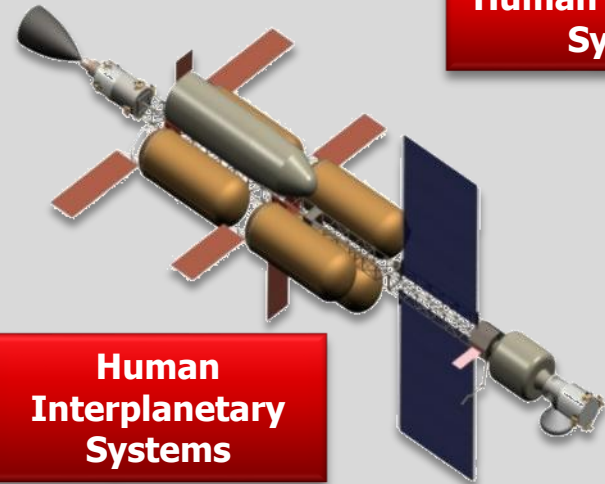
***We answer the questions:
Will it work?
What will it look like?
What is the preliminary design?***



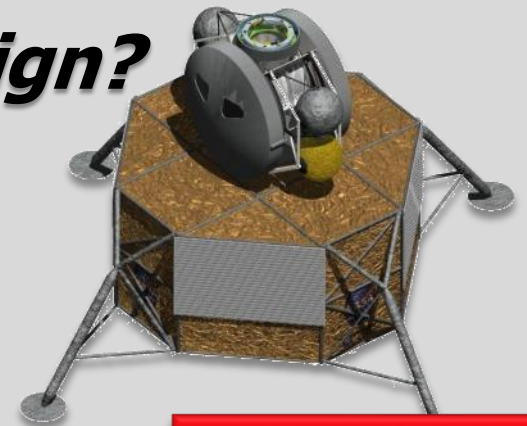
Launch Vehicle Systems



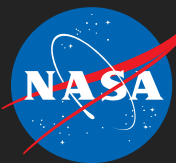
Robotic & Science Systems



Human Interplanetary Systems

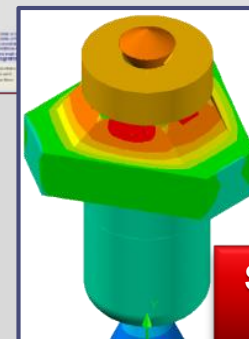
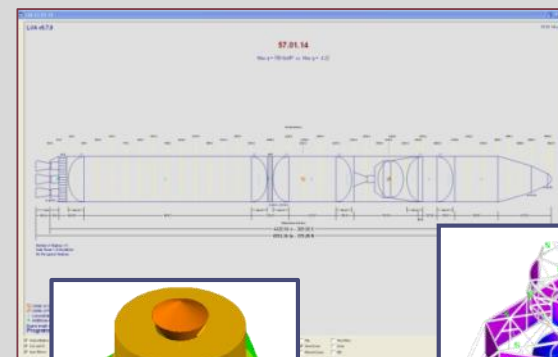
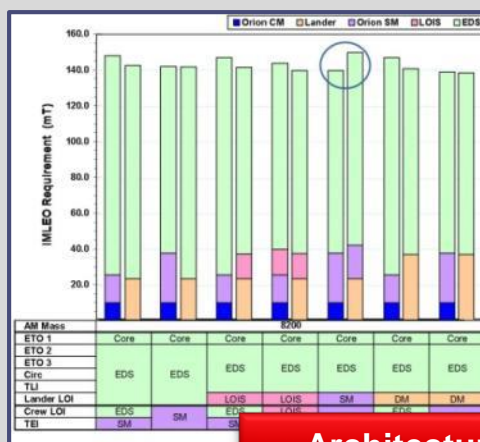
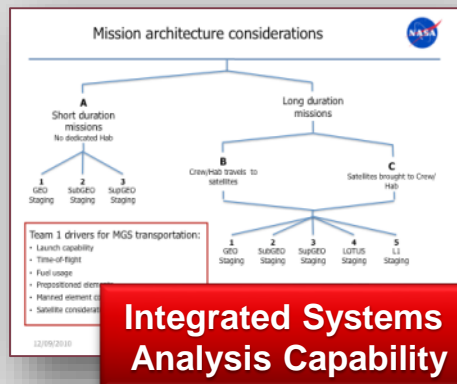


Human Exploration Systems

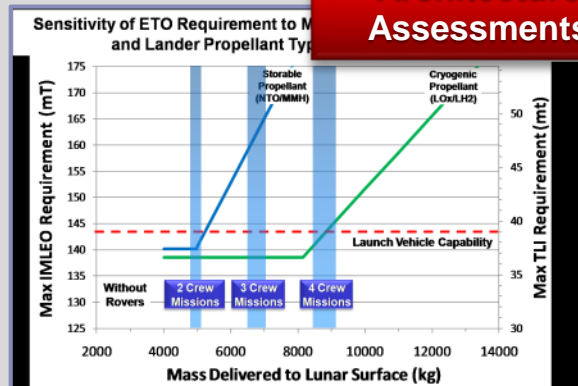


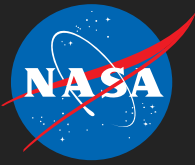
How Does Advanced Concepts Work?

We Utilize Multi-Disciplined Teams Within the Office to Provide Fully Integrated Assessments of Missions and Their Elements



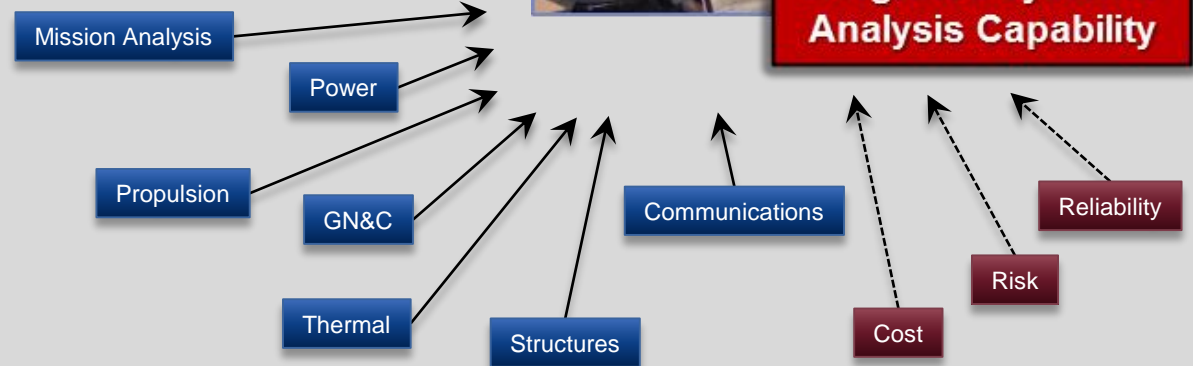
Subsystem Design & Analysis

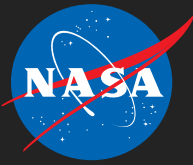




Collaborative Design Teams

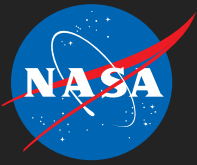
- ◆ The ACO Design Teams are established, co-located teams of systems and design engineers
- ◆ Other disciplines or specific expertise are matrixed into the team as necessary
- ◆ Scientific Areas of Interest
- ◆ Programmatic Support
- ◆ Additional Discipline Support



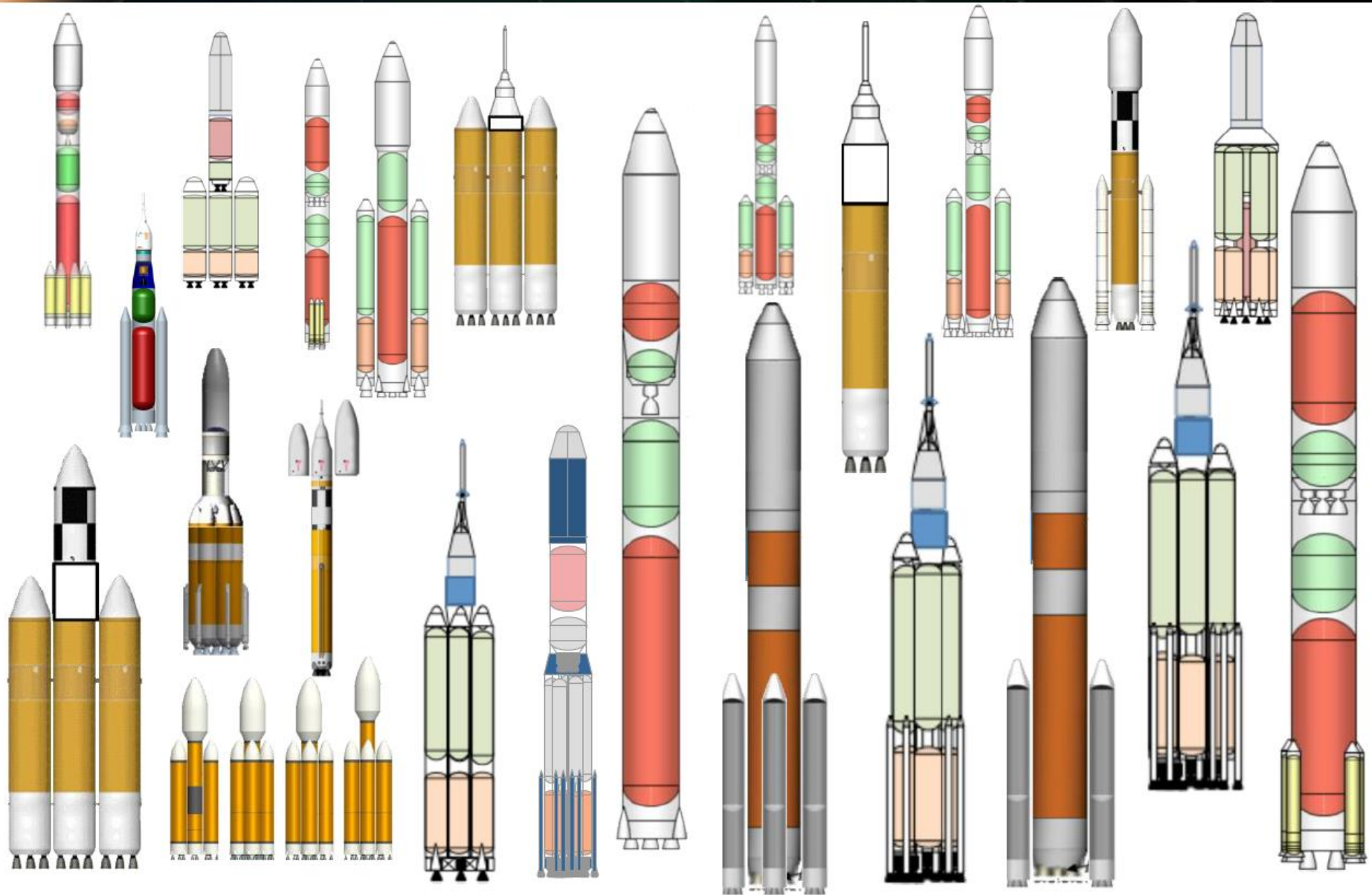


Space Launch: Advancing the Legacy of Human Exploration



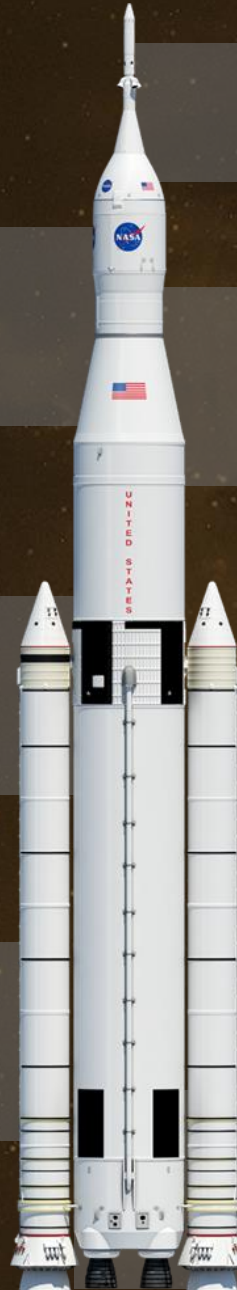


ACO Traded >8000 Options



*"This enterprise is not for the faint of heart."
—Wayne Hale*

THE WORLD'S MOST POWERFUL ROCKET



Orion:

Carries astronauts into deep space

Stage Adapters:

The Orion stage adapter will be the first new SLS hardware to fly.

Interim Cryogenic Propulsion Stage:

Based on the Delta IV Heavy upper stage; the power to leave Earth

Core Stage:

Newly developed for SLS, the Core Stage towers more than 200 feet tall

Solid Rocket Boosters:

Built on Space Shuttle hardware; more powerful for a new era of exploration

RS-25 Engines:

Space Shuttle engines for the first four flights are already in inventory

THE ROCKETS, THE MISSIONS



235 ft.

Capability to Low-Earth Orbit (LEO):
26 metric tons

Payload:
*Critical crew module systems and
Basic LAS/SM structure*

DELTA IV HEAVY



322.4 ft.

Capability to Low-Earth Orbit (LEO):
70 metric tons

Payload:
Full Orion (Unmanned)

SPACE LAUNCH SYSTEM (SLS)

ORION'S FLIGHT TEST

OBJECTIVE:
Acquire data at beyond-Earth orbit reentry velocities

DISTANCE FROM EARTH:
3,600 miles

DURATION:
5 Hours

EXPLORATION MISSION ONE (EM-1)

OBJECTIVE:
*System readiness for astronauts to travel farther than
humans have ever gone before*

DISTANCE FROM EARTH:
*Will break the distance record reached by the most remote Apollo
spacecraft, and then **30,000 miles farther out (275,000 total miles)***

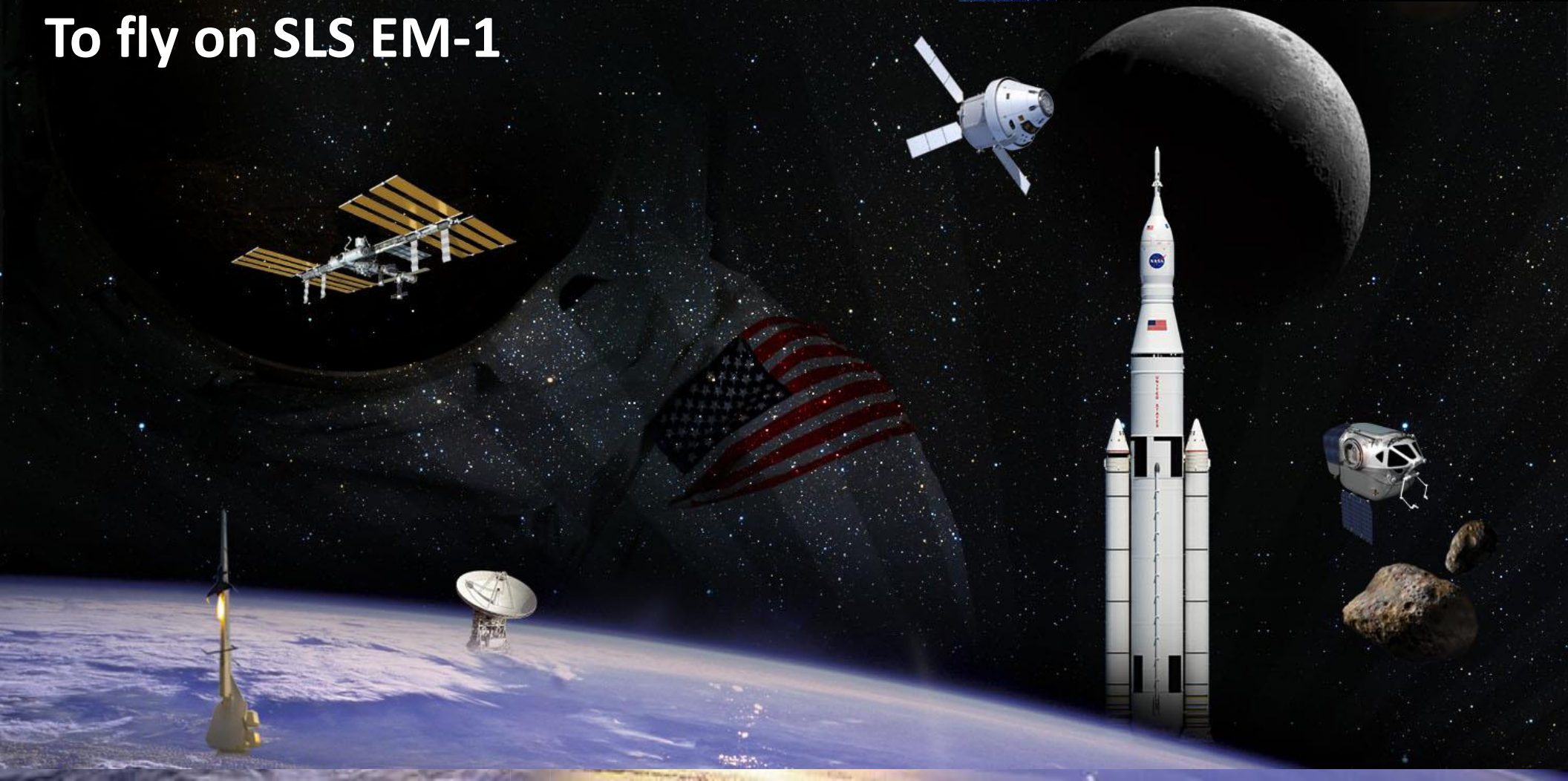
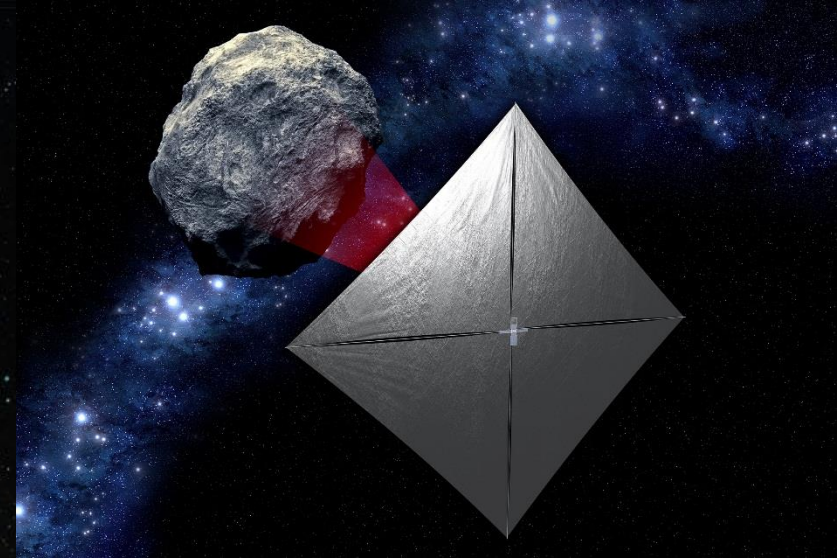
DURATION:
22 days



National Aeronautics and Space Administration

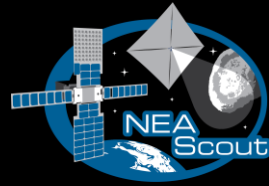
Near Earth Asteroid Scout

To fly on SLS EM-1

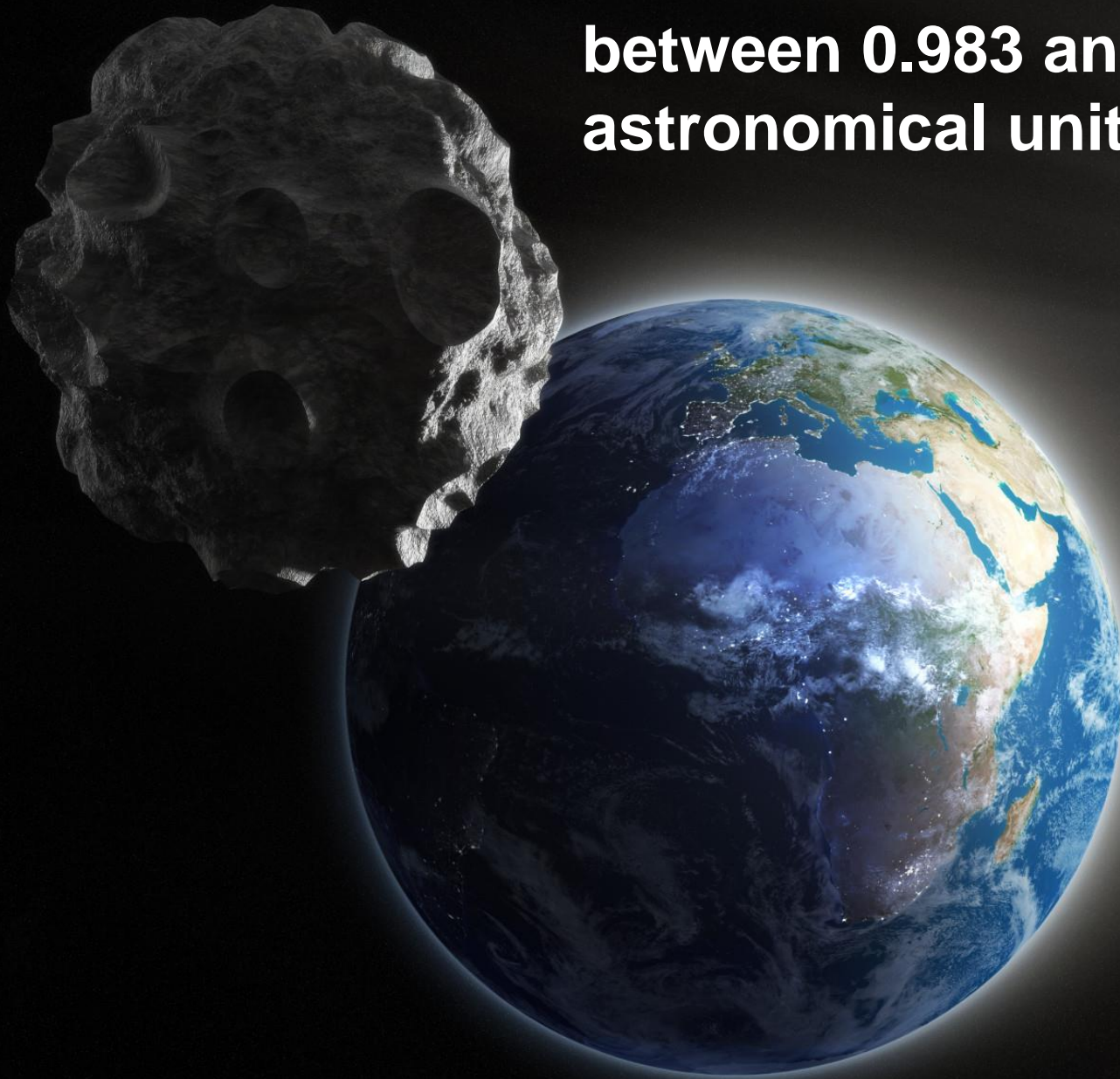




Near Earth Asteroids – Why Visit One?

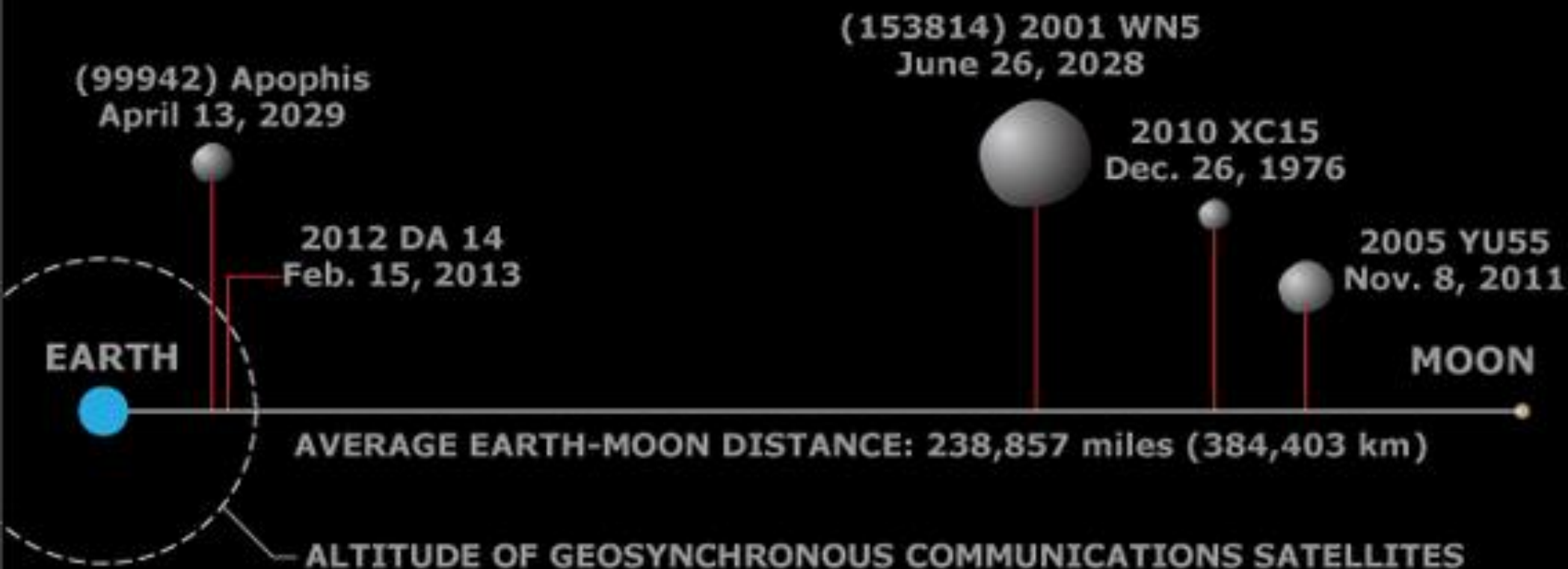


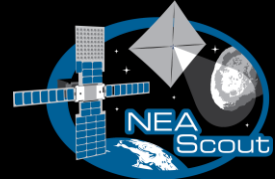
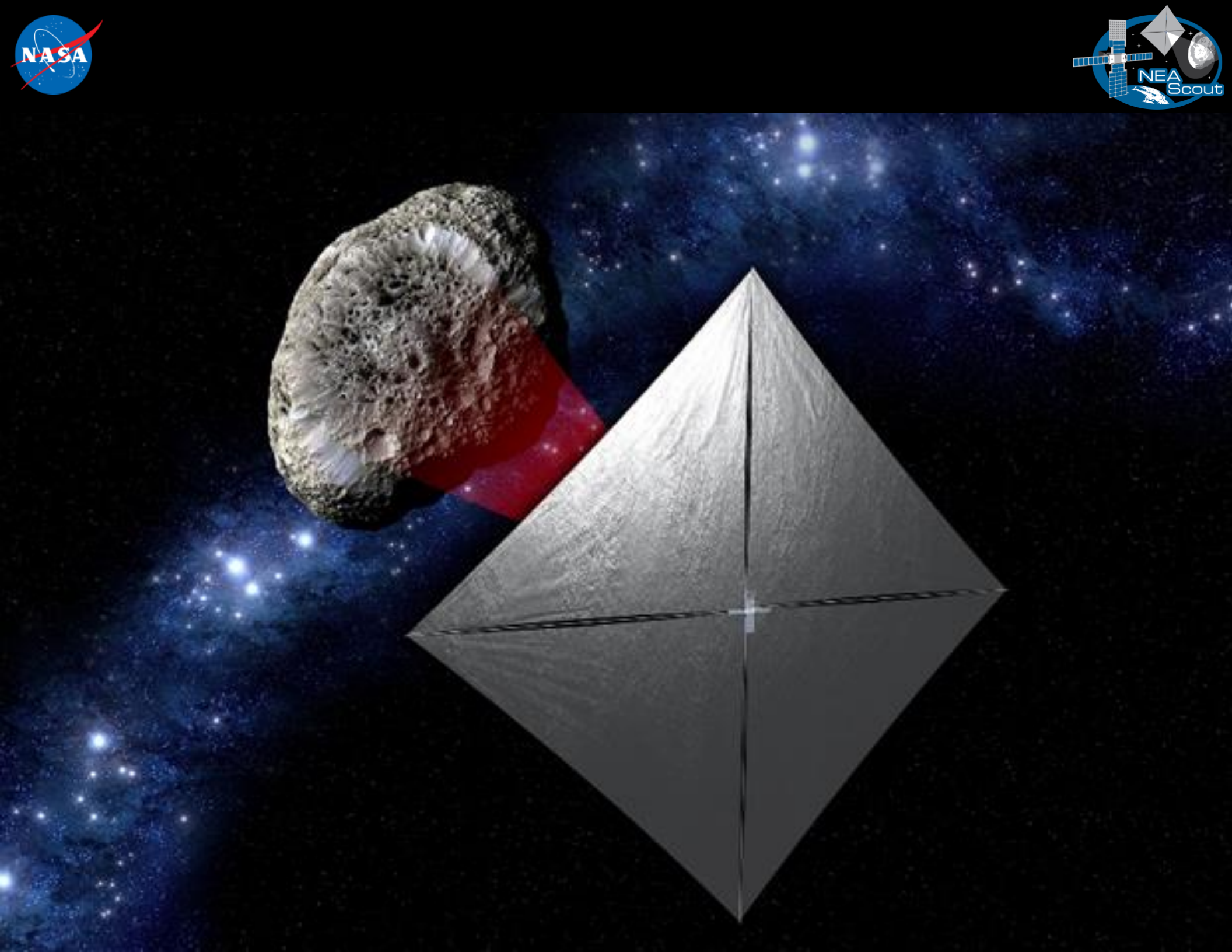
NEA's have orbits that lie partly between 0.983 and 1.3 astronomical units from the Sun.



Famous Flybys of Near-Earth Objects

Note: asteroids are shown to scale with each other but are greatly magnified compared to the Earth and Moon.







Near Earth Asteroid Scout Overview



The Near Earth Asteroid Scout Will

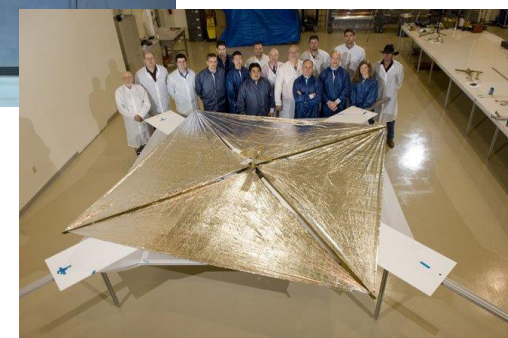
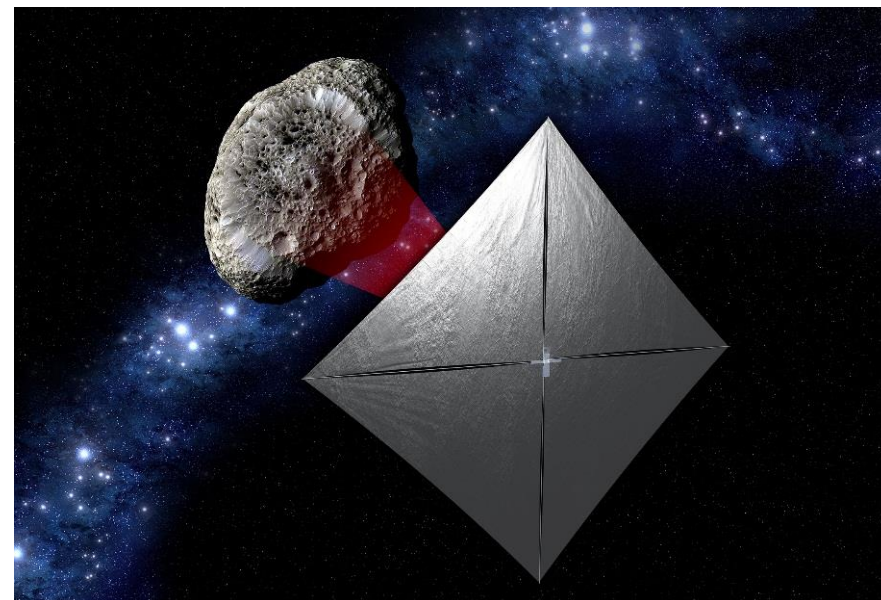
- Image/characterize an asteroid
- Demonstrate a low cost asteroid reconnaissance capability

Key Spacecraft & Mission Parameters

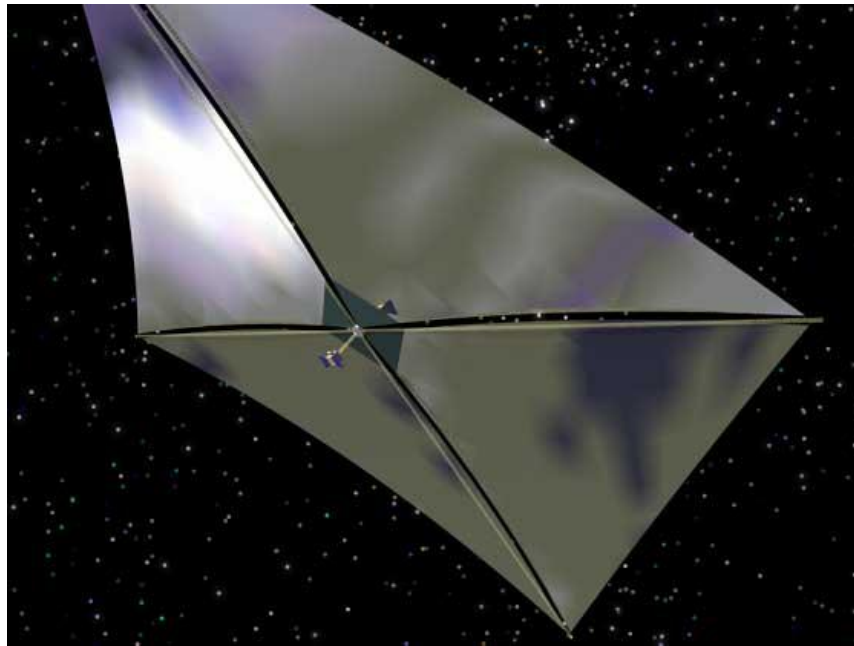
- 6U cubesat (20 cm X 10 cm X 30 cm)
- ~85 m² solar sail propulsion system
- Manifested for launch on the Space Launch System (EM-1/2017)
- Up to 2.5 year mission duration
- 1 AU (93,000,000 mile) maximum distance from Earth

Solar Sail Propulsion System Characteristics

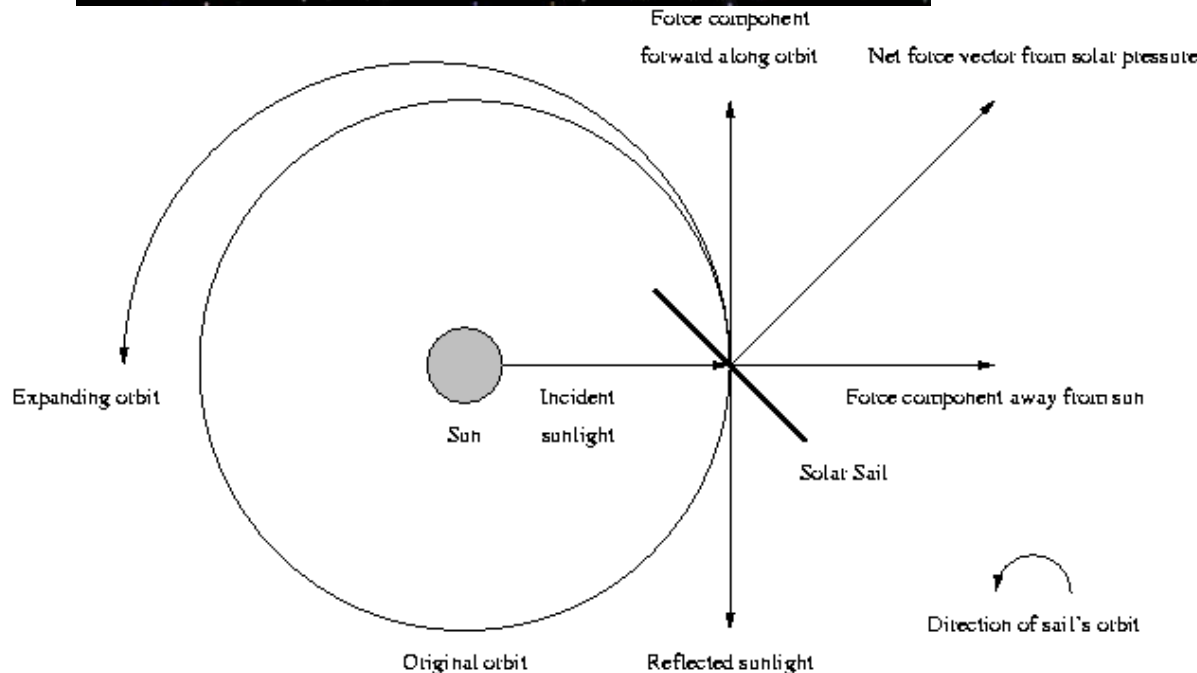
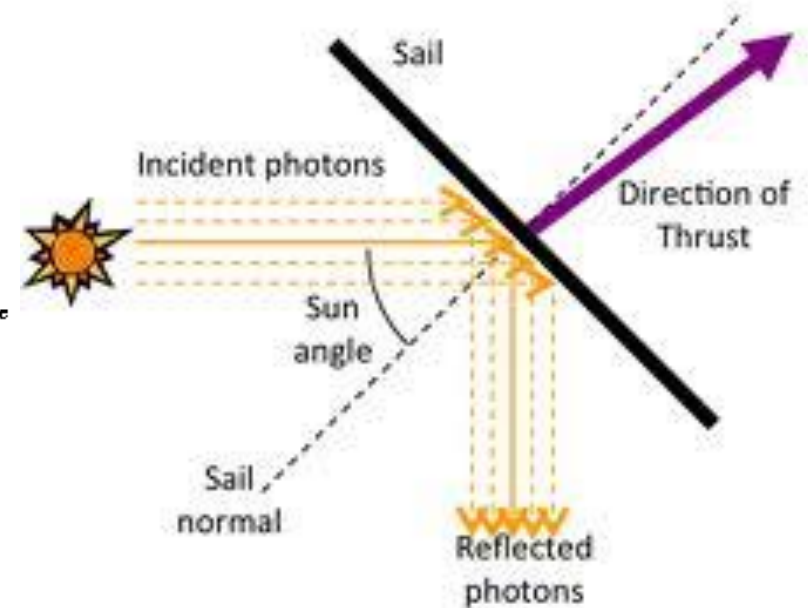
- ~ 7.3 m Trac booms
- 2.5 μ aluminized CP-1 substrate
- > 90% reflectivity



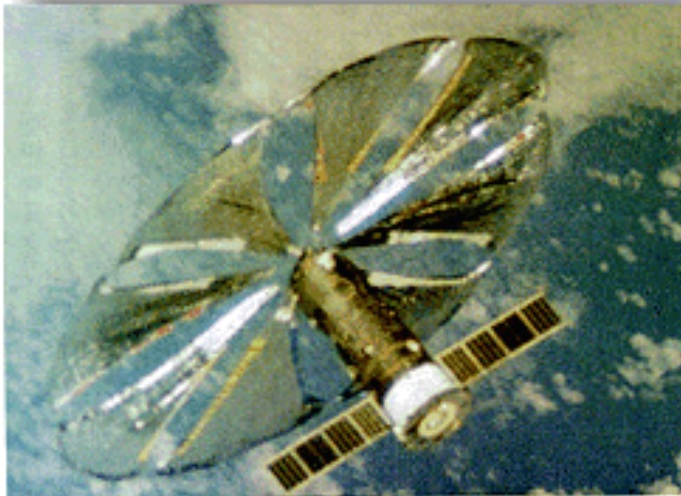
How does a solar sail work?



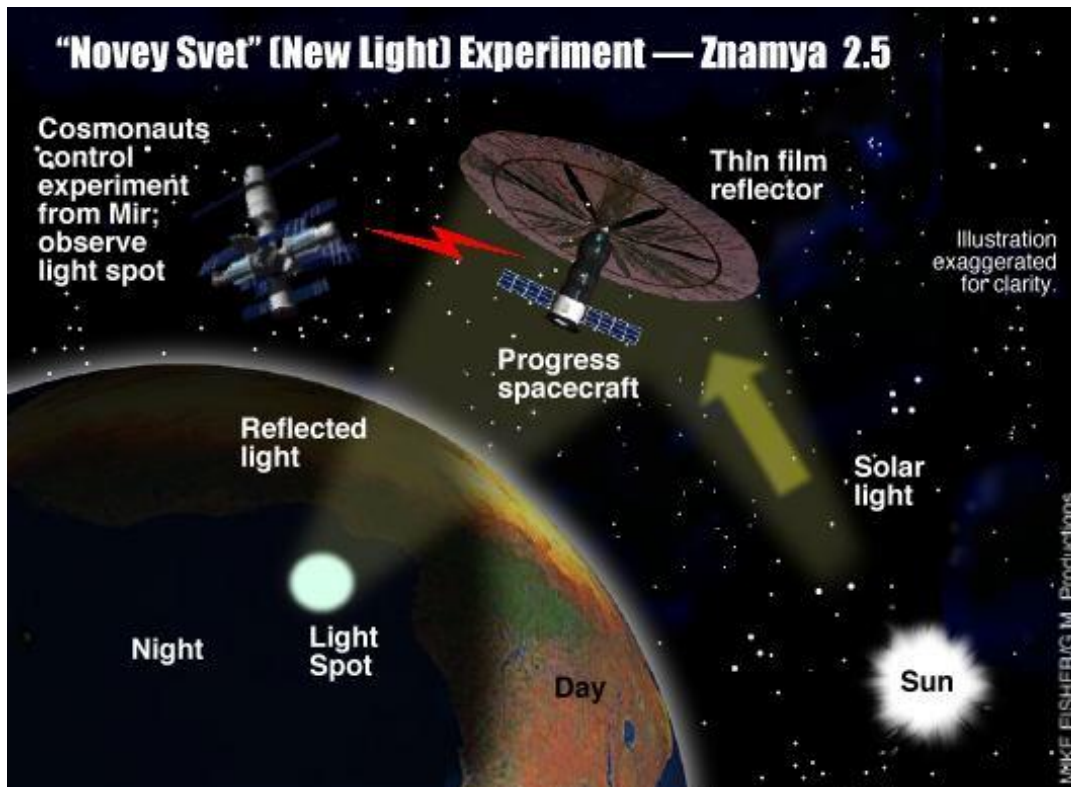
Solar sails use photon “pressure” or force on thin, lightweight reflective sheet to produce thrust.



Znamya (Space Mirror)

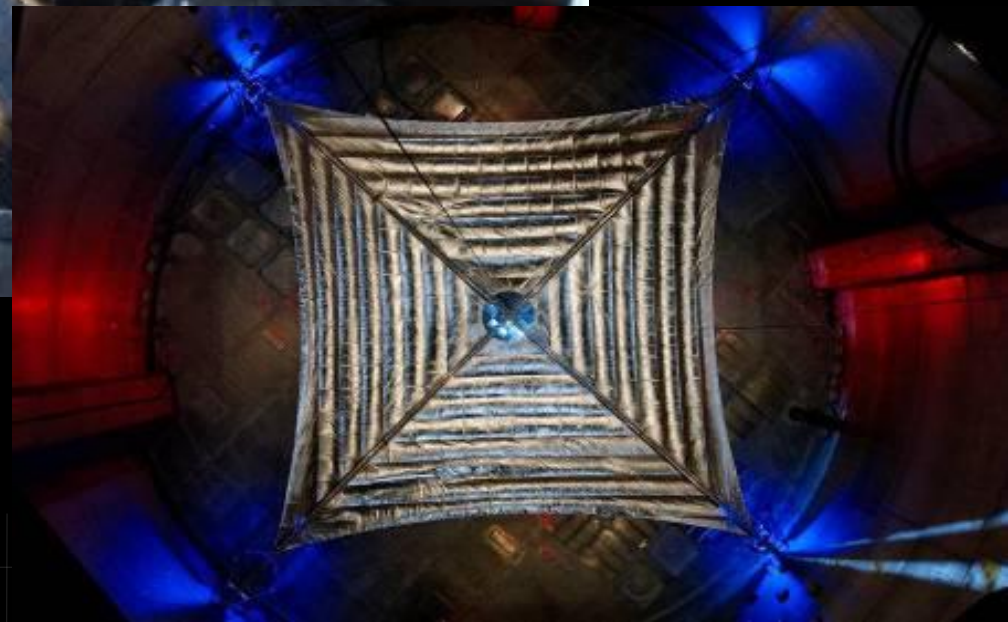
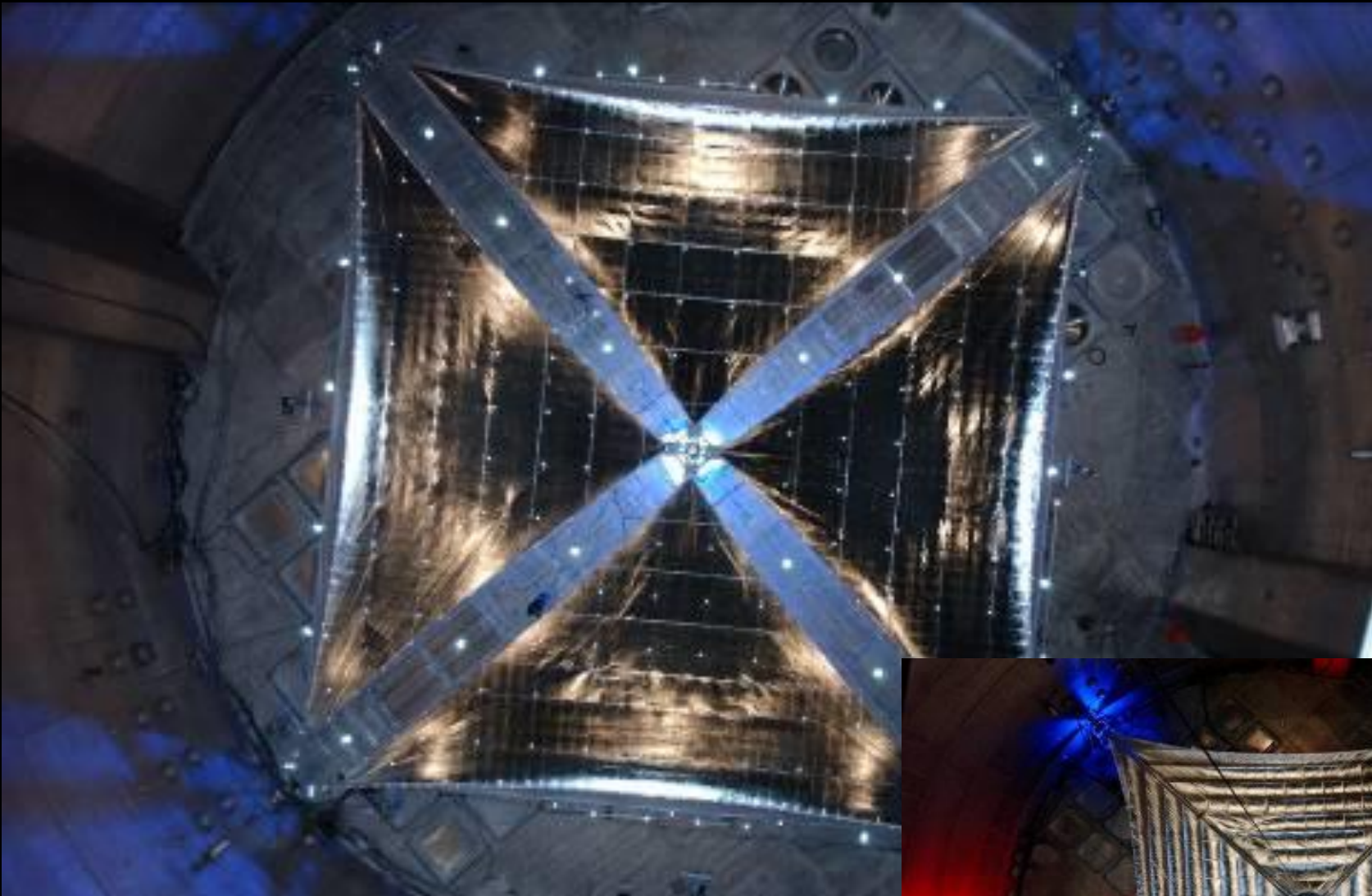


- ◆ Russian experiment that flew on Progress after undocking from Mir Space Station in 1993.
- ◆ Purpose was to reflect sunlight onto the ground from space.
- ◆ 20-m diameter sail successfully deployed
- ◆ 5-km spot illuminated Europe from France to Russia moving at 8 km/sec.
- ◆ Follow-on mission flew, but was damaged during deployment.





NASA Ground Tested Solar Sails



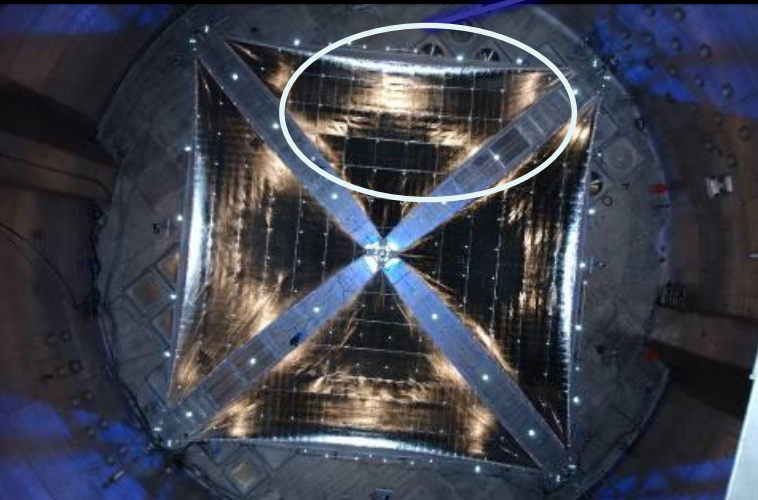


NanoSail-D Demonstration Solar Sail

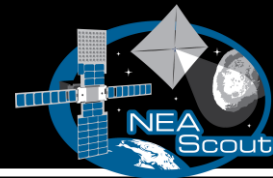


10 m² sail

Made from tested ground demonstrator hardware

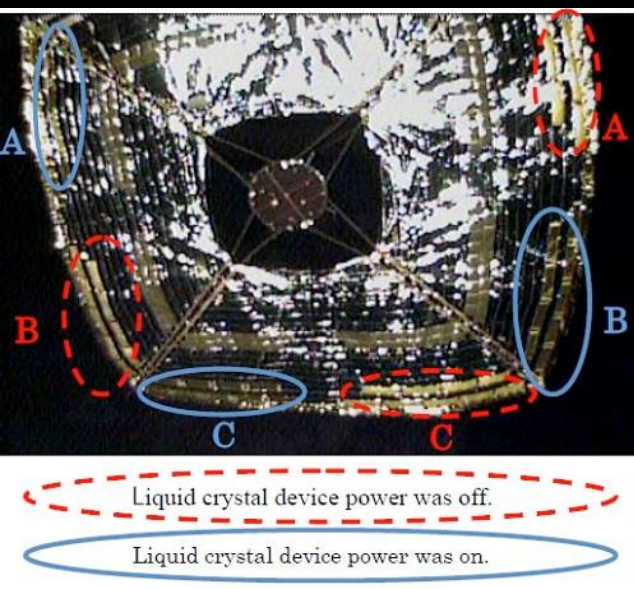
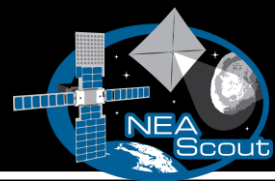


NanoSail-D in Flight



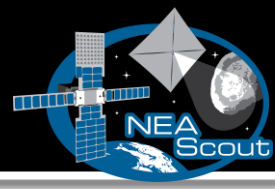


Interplanetary Kite-craft Accelerated by Radiation of the Sun (IKAROS)

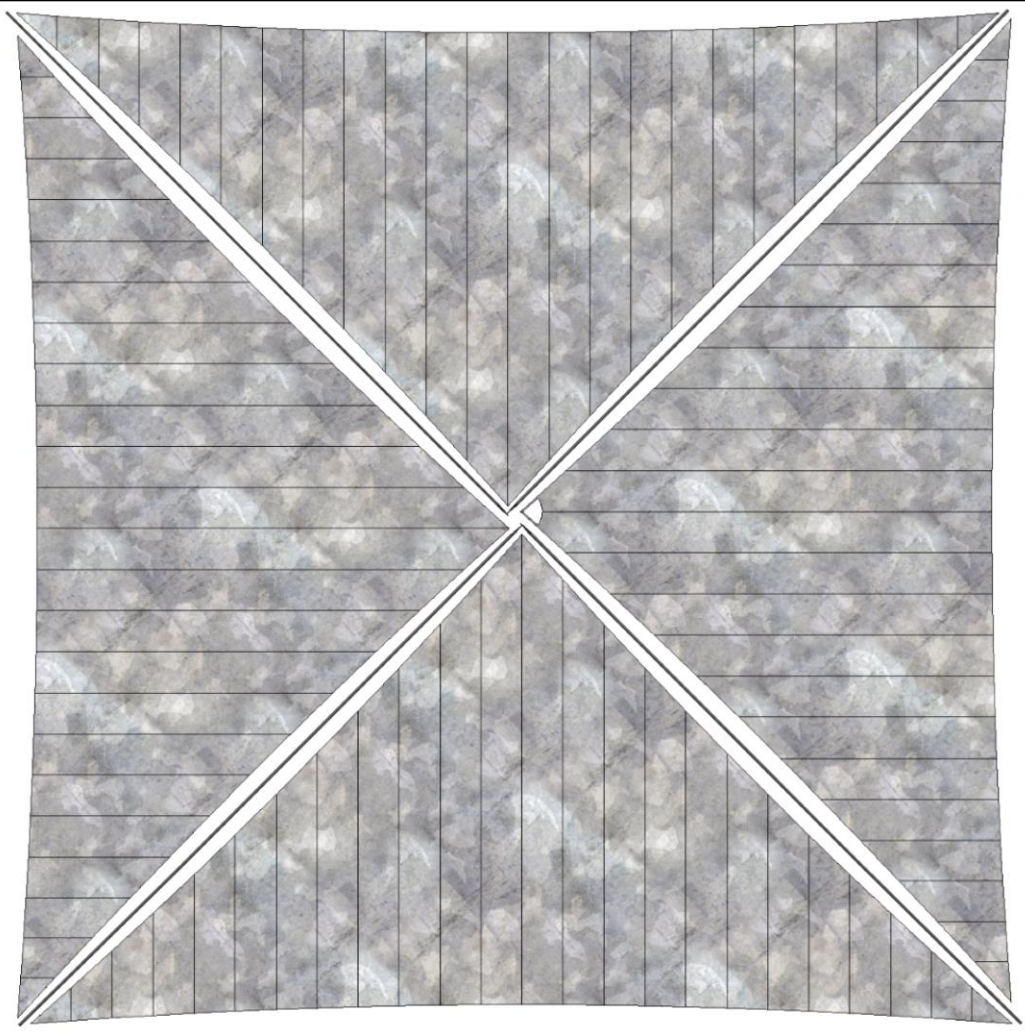




NEA Scout Approximate Scale



Deployed Solar Sail



School Bus



Human

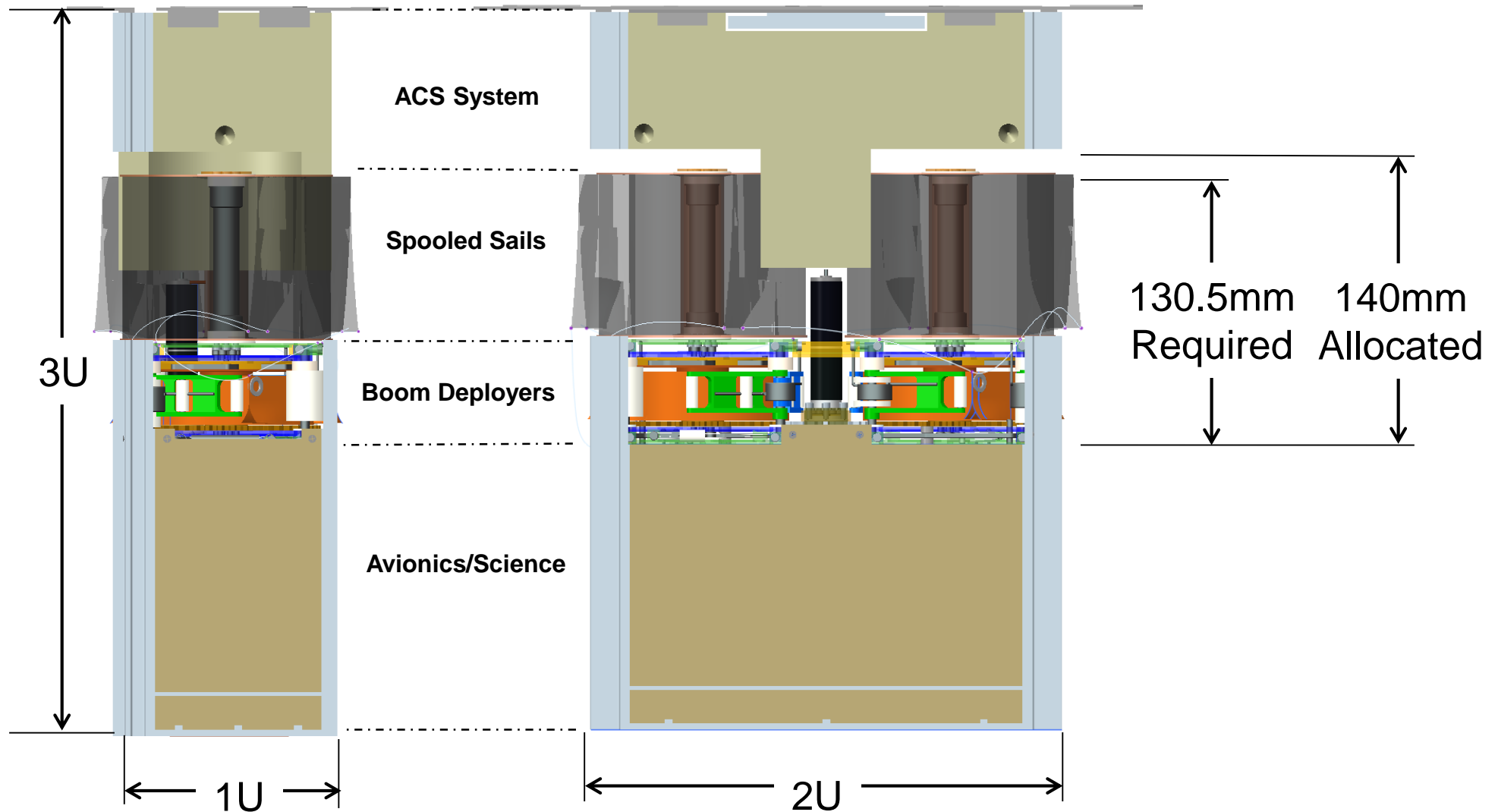
6U Stowed Flight System



Folded, spooled and packaged in here

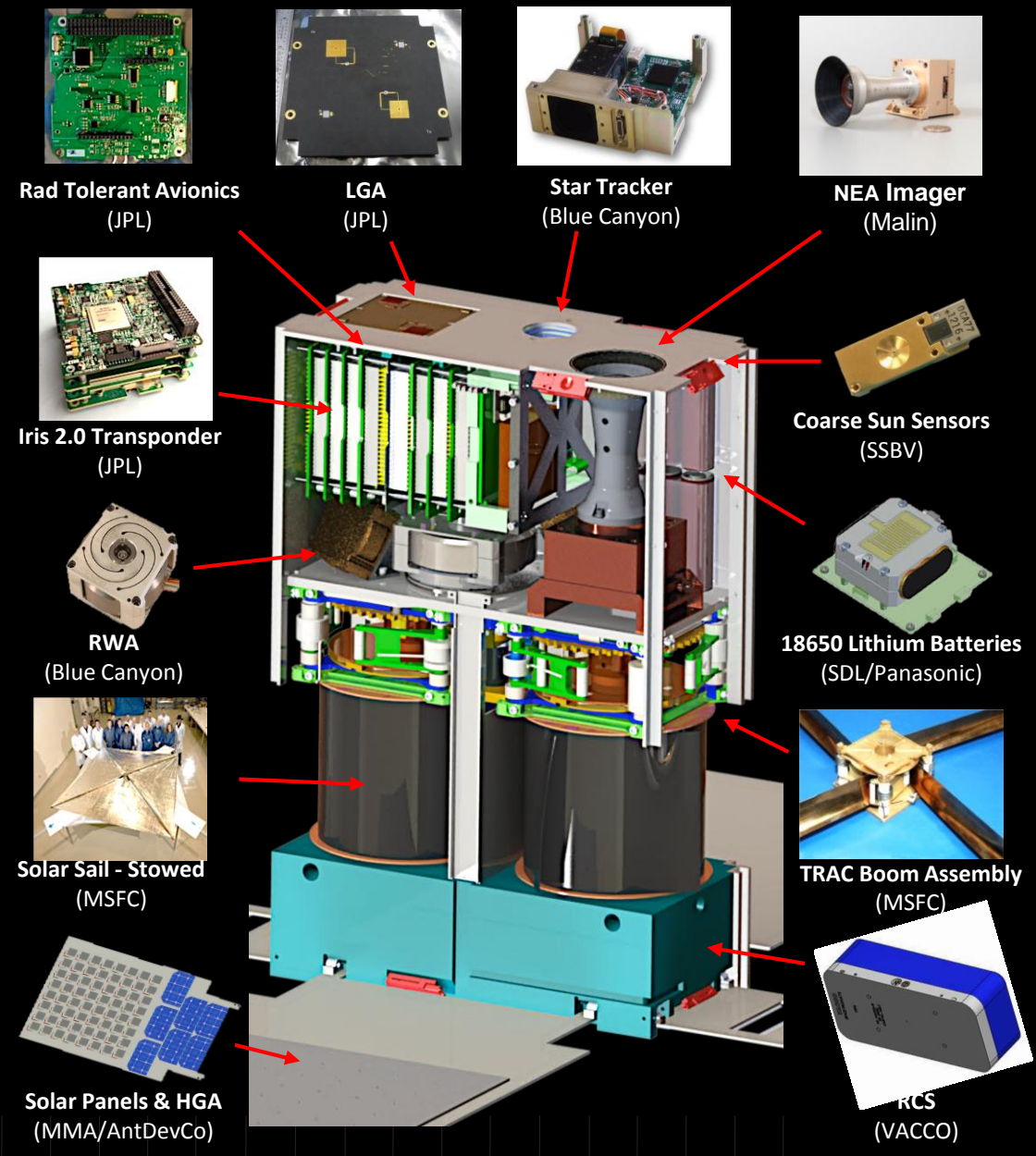


Solar Sail Volume Envelope





NEA Scout Flight System Overview



Rad Tolerant Avionics
(JPL)

LGA
(JPL)

Star Tracker
(Blue Canyon)

NEA Imager
(Malin)

Iris 2.0 Transponder
(JPL)

Coarse Sun Sensors
(SSBV)

RWA
(Blue Canyon)

18650 Lithium Batteries
(SDL/Panasonic)

Solar Sail - Stowed
(MSFC)

TRAC Boom Assembly
(MSFC)

Solar Panels & HGA
(MMA/AntDevCo)

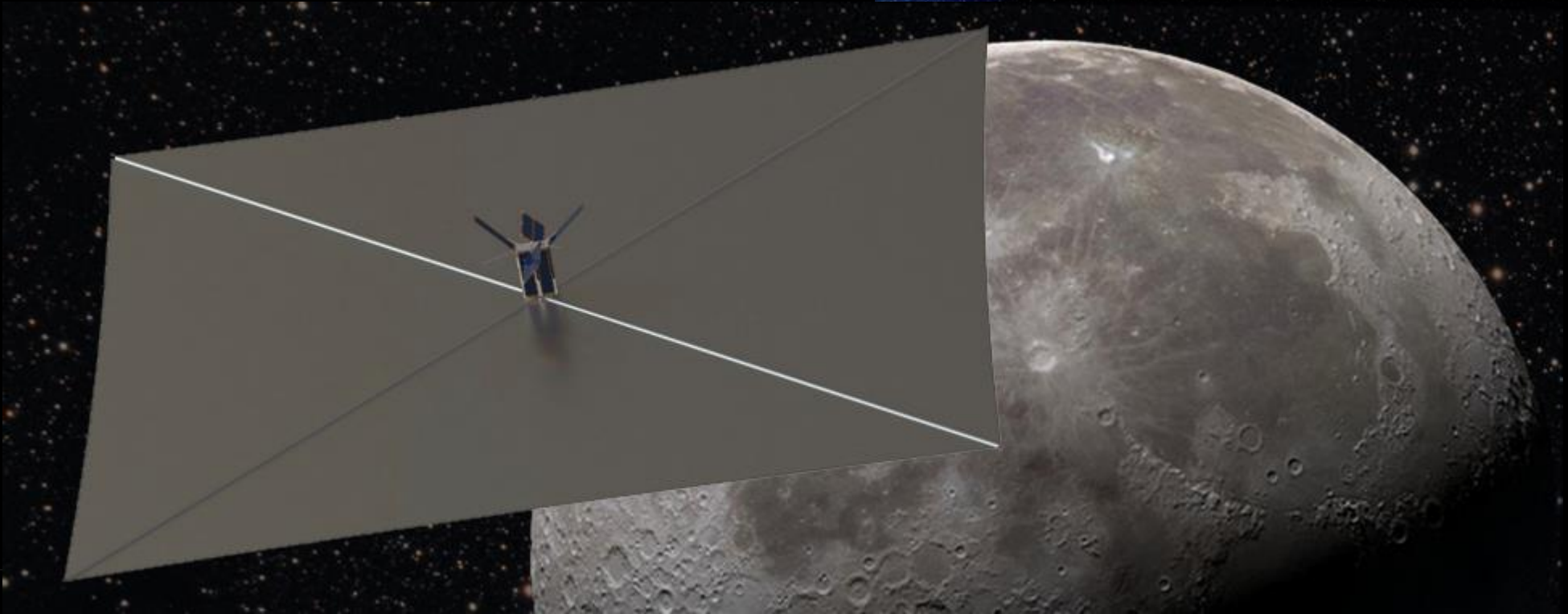
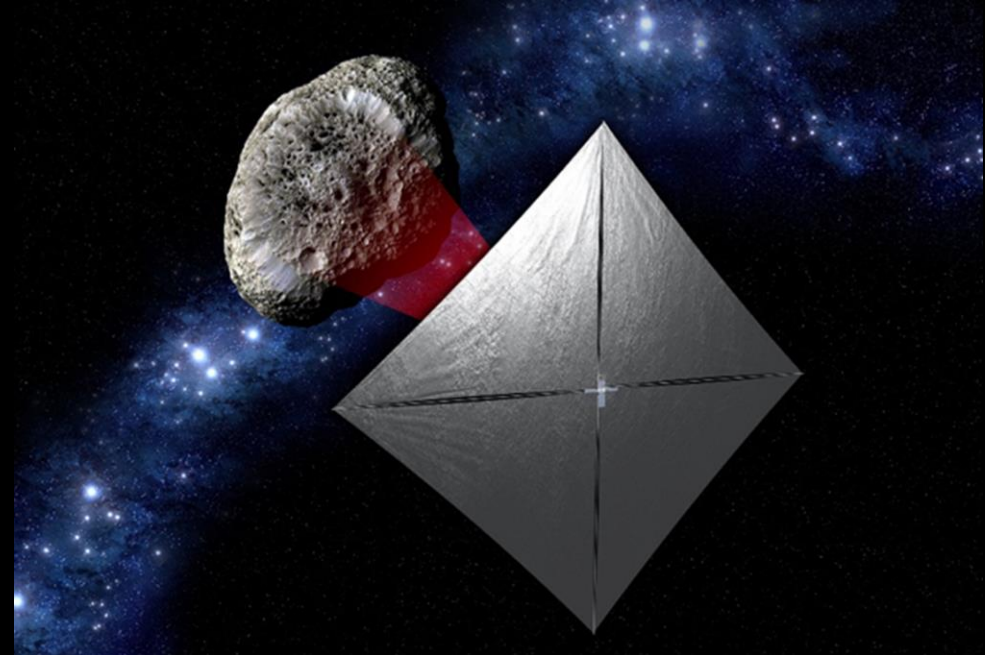
RCS
(VACCO)



NEA Scout and Lunar Flashlight



**Both Use Solar Sail Propulsion
and 6U CubeSats**





Lunar Flashlight Objective



Sunlight is reflected off the sail down to the lunar surface. Light reflected off the lunar surface enters the spectrometer to distinguish water ices from regolith.





Conclusions



MSFC develops space flight systems for human and robotic science and exploration

The Advanced Concepts Office is MSFC's starting point for future space missions within NASA

The Space Launch System began in ACO and one day carry humans well beyond Low Earth Orbit

NEA Scout and Lunar Flashlight will launch on SLS and demonstrate a new, low-cost capability for robotic exploration of the solar system