National Aeronautics and Space Administration

# Hitchhiking Into the Solar System:
## Launching NASA's First Deep-Space CubeSats

### Introduction

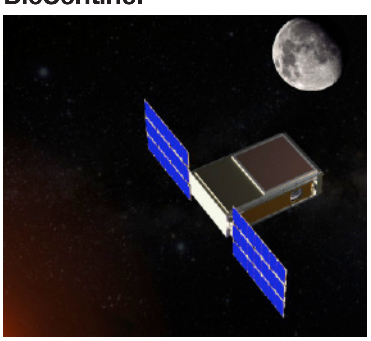
NASA is pioneering space through common capability and technology developments, enabling exploration and human expansion across multiple solar system destinations, including to an asteroid and Mars. This journey into deep space has begun with exploration systems testing and demonstrations on Earth and in space. Although uncrewed, the first flight of the Orion spacecraft in December 2014 was an initial step in demonstrating its ability to safely ferry astronauts beyond Earth into deep space. The next critical demonstration of NASA's deep space exploration capabilities will be on Exploration Mission (EM)-1 in 2018. This first flight of NASA's Space Launch System (SLS) rocket will launch an uncrewed Orion spacecraft to a stable orbit beyond the moon and return it to Earth. In addition to demonstrating NASA's new heavy-lift capability, SLS has the capacity to accommodate 11 6U-sized CubeSats, which will deploy once Orion spacecraft separation is confirmed and on a specified timeline based on their mission objectives.

**STRATEGIC KNOWLEDGE GAPS**

Strategic Knowledge Gaps, or SKGs, represent gaps in knowledge or information required to reduce risk, increase effectiveness and improve the design of robotic and human space exploration missions. NASA uses SKGs to help inform research and investment strategies, and prioritize technology development for human and robotic exploration.

NASA's Advanced Exploration Systems Division has selected three secondary payloads for further development to launch on SLS — hitchhiking into deep space. The major driver for selection of these CubeSats was the risk reduction they enable by addressing key Strategic Knowledge Gaps (SKGs). The three mission concepts, BioSentinel, Near-Earth Asteroid (NEA) Scout and Lunar Flashlight have completed early concept and engineering reviews and are proceeding into the next phases of development.

### BioSentinel

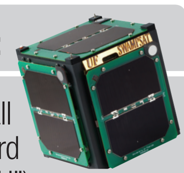


Artist's concept of BioSentinel Credit: NASA

The longest human duration in deep space was the 12.5 days the Apollo 17 crew spent on a round trip mission to the moon, and the longest low-Earth orbit (LEO) duration will be one year spent on the International Space Station by two crew members. As NASA plans to send humans farther into space than ever before, we have to understand the effects of the deep space environment on biological systems and devise countermeasures to mitigate the risks associated with deep space travel.

The BioSentinel mission will be the first time living organisms have traveled to deep space in more than 40 years and the spacecraft will operate in the deep space radiation environment throughout its 18-month mission. BioSentinel will use yeast to detect, measure and compare the impact of deep-space radiation on living organisms over long durations beyond LEO. Since the unique deep space radiation environment cannot be replicated on or near Earth, the BioSentinel mission is one way to help inform us of the greatest risks to humans exploring beyond LEO, so that appropriate radiation protections can be developed and those dangers can be mitigated.

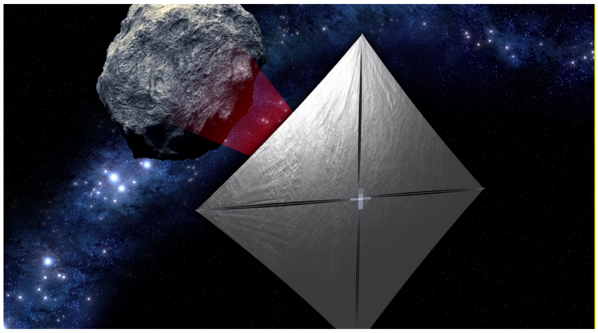
**Basic CubeSat Facts:**



CubeSats are very small satellites built to standard dimensions (Units or "U") of 10 cm x 10 cm x 11cm. They can be 1U, 2U, 3U, or 6U in size, and typically weigh less than 1.33 kg (3 lbs) per U.

NASAfacts

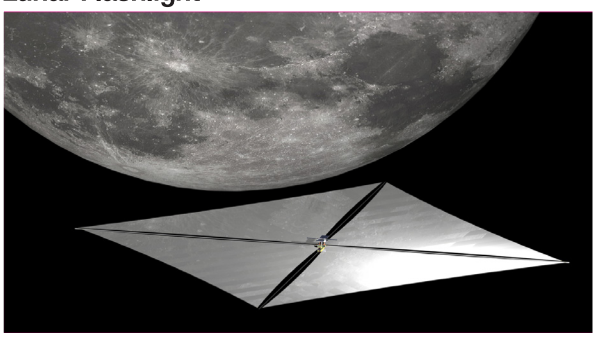
## NEA Scout



Artist's concept of NEA Scout. Credit: NASA

Before sending astronauts to any new space environments, it is important to send robotic scouts to survey the destination and learn about the risks and challenges they may pose to future human explorers. Near-Earth Asteroid Scout, or NEA Scout, will perform reconnaissance of an asteroid using a CubeSat and solar sail propulsion, which offers navigation agility during cruise for approaching the target. Propelled by sunlight, NEA Scout will flyby and observe a small asteroid (<300 feet in diameter), taking pictures and observing its position in space, the asteroid's shape, rotational properties, spectral class, local dust and debris field, regional morphology and regolith properties. NEA Scout's observations will directly assist in retiring the SKGs related to human exploration of asteroids. The data collected will enhance the current understanding of asteroidal environments and will yield key information for future human asteroid explorers.

## Lunar Flashlight



Artist's concept of Lunar Flashlight. Credit: NASA

Pioneering space will only be possible if humans can learn to live off the land. Resources at destinations in space, such as atmospheres, water ice and regolith, can be broken down into their component molecules and used as building materials, propellant, oxygen for humans to breathe and drinking water. This capability, known as in-situ resource utilization, or ISRU, is most useful for human explorers if the ISRU "power plants" are deployed to locations that are rich in the required resources. NASA's Lunar Flashlight will demonstrate this scouting capability from lunar orbit by performing multiple passes of the surface to look for ice deposits and identifying favorable locations for in-situ resource extraction and utilization. Lunar Flashlight will use a large solar sail, similar to the NEA Scout sail, to reflect sunlight and illuminate permanently shadowed craters at the lunar poles. A spectrometer will then observe the reflected light to measure the surface water ice. The spacecraft will continue to make repeated measurements over multiple points in the craters, creating a map of the surface ice concentration. This data will be correlated with previous mission data, providing crucial guidance to future mission planning.

## Pioneering Space

As humans pioneer space, NASA will continue to test and demonstrate the capabilities needed to mitigate risks to astronauts and spacecraft systems. EM-1 will be the first test of the integrated SLS and Orion and the CubeSats flown on the mission will perform in-space experiments and demonstrations that will actively advance the capabilities needed to take humans farther into space than ever before.

For additional information about the EM-1 Secondaries, visit: www.nasa.gov/exploration

National Aeronautics and Space Administration

**Headquarters**
300 E Street, SW
Washington, DC 20546
www.nasa.gov/centers/hq

**www.nasa.gov**

NP-2015-03-1483-HQ