



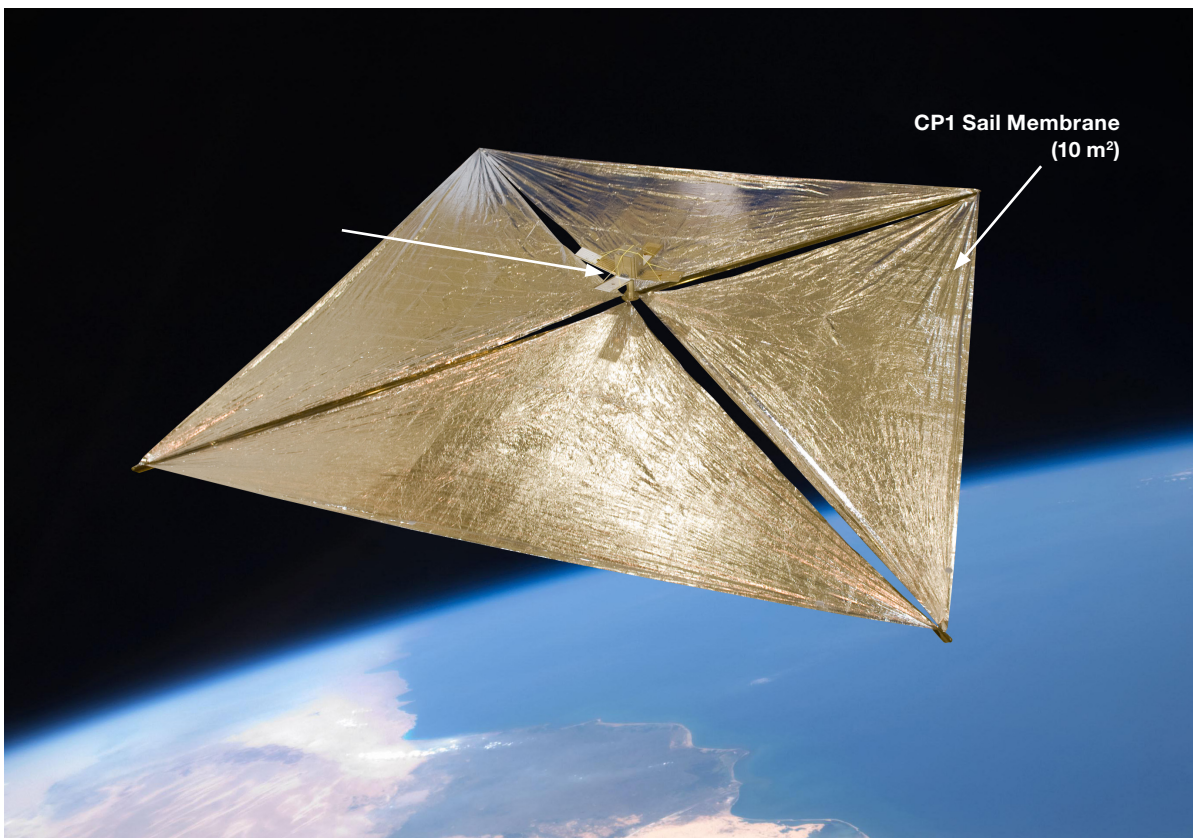
NanoSail-D

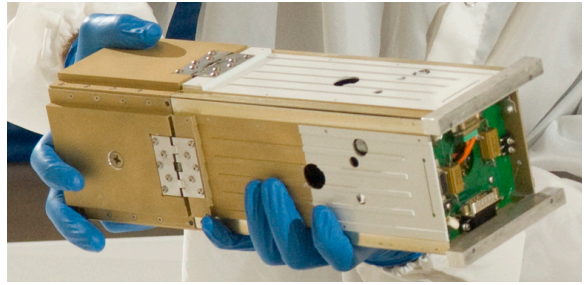
Solar sails use sunlight to propel vehicles through space much like sailboats rely on wind to push through the water. NanoSail-D is an experiment designed to validate solar sail capabilities developed and built by NASA's Marshall Space Flight Center, Huntsville, Ala., in collaboration with NASA's Ames Research Center, Moffett Field, Calif. The sail is made of an ultra-thin reflective polymer called CP-1. It is 7.5 microns thick and has a surface area of approximately 100 square feet when unfurled.

One of NanoSail-D's several mission objectives is to demonstrate the capability to deploy a large sail structure from a highly compacted volume without recontacting the spacecraft. NanoSail-D will accomplish this by deploying off the Fast,

Affordable, Science and Technology, or FASTSAT. This demonstration can be applied to deploy future communication antennas, sensor arrays or thin film solar arrays to power spacecraft.

The mission also will demonstrate and test the de-orbiting capabilities of solar sails. NASA hopes to one day use thin membranes to de-orbit satellites and space debris. Finally, engineers hope to successfully demonstrate solar sailing. While NanoSail-D's relatively low altitude means drag from Earth's atmosphere may dominate any propulsion from the sun, the nanosatellite remains a small first step towards eventually deploying solar sails at higher altitudes.





NanoSail-D (stowed configuration)



NanoSail-D (on orbit deployed configuration)

Solar Sails

Solar sails are a way to propel a spacecraft by relying on energy from the sun. The sail constantly captures streaming solar particles, called photons, with giant sails built from lightweight, reflective material. Over time, the spacecraft builds momentum from these particles' energy to provide thrust and travel in space. NanoSail-D will be the first solar sail deployed in low Earth orbit by NASA.

NASA engineers believe that solar sails have enormous potential because they take advantage of sunlight, and don't require chemical fuel spacecraft currently rely on. Less fuel translates into lower launch weight, which equates to lower launch costs, and fewer logistical challenges. Solar sails accelerate slowly but are capable of eventually reaching tremendous speeds. Space scientists consider solar sailing the only reasonable way to make interstellar travel a reality.

NanoSail-D's low altitude means drag from Earth's atmosphere will likely cause solar effects (in terms of propulsion from the sun) to be slight and hard to detect. However, NanoSail-D is still a small first step toward eventually deploying solar sails at much higher altitudes.

NanoSail-D

NanoSail-D is a unique solar sail – a “triple cubesat” that must conform to the size and weight constraints of the deployer from which it will eject. The NanoSail-D flight unit is 3.9 inches by 3.9 inches by 14.9 inches. The project is named NanoSail-D because it is a nano-class satellite and despite its large size when unfurled, it is a relatively small solar sail. The “D” stands for deploy, deorbit, demonstration, and drag, all of which tie in to NanoSail-D's mission objectives.

The NanoSail-D experiment has two major components:

- **Bus electronics:** The electronic system on the sail, responsible for deployment and communication, was provided by Ames Research Center. Its size is roughly 3.9 inches by 3.9 inches by 3.9 inches.
- **Sail subsystem:** The sail is made of an ultra-thin reflective polymer called CP-1. It is 7.5 microns thick and has a surface area of approximately 100 square feet. The sail is wound tightly around a central hub. When the sail deploys, four booms spring out to unfurl the sail and support its structure. The booms are each 7.2 feet long when fully deployed. The nine-pound sail subsystem was provided by ManTech/ NeXolve in Huntsville, Ala.

The sail uses eight lithium-ion batteries as a power source.

Mission and Deployment

NanoSail-D will launch in late 2010, from the Alaska Aerospace Corporation's Kodiak Launch Complex on Kodiak Island, Alaska. NanoSail-D will be one of six payloads on FASTSAT, a microsatellite bus that will be launched to space aboard a Minotaur IV launch vehicle operated by Orbital Sciences Corp., Chandler, Ariz. The launch vehicle is provided by the U.S. Department of Defense Space Test Program, part of the Space Development and Test Wing at Kirtland Air Force Base, N.M.

NanoSail-D will be ejected from the FASTSAT spacecraft bus seven days after launch.

After ejection from the container, an internal timer will start counting down. The sail is tightly wound around a spindle and packed in a small container. When the timer reaches zero, the four panels covering the sail and booms will open. Approximately 30-45 seconds later, four booms will spring out and NanoSail-D will start to unfold. Within just five seconds the sail will be fully deployed.

A good analogy is the booms work in the exact opposite way of a carpenter's measuring tape. A measuring tape is pulled out, which winds up a spring, and when let go is quickly pulled back in. For NanoSail-D, the booms are wound around a hub. The wound-up booms act like the spring, which, approximately seven days after launch, deploys the sail off the center spindle.

NanoSail-D will deploy into low-Earth circular orbit at an altitude of approximately 403 miles orbiting at 72 degrees. Because NanoSail-D will be at a low altitude, drag from Earth's atmosphere may dominate any propulsion from the sun. The orbital period is approximately 94 minutes.

The entire NanoSail-D mission duration will be between 70 and 120 days, depending on how quickly the sail falls out of orbit.

Launch History

The first attempt to launch and deploy NanoSail-D, was in August 2008 on a Falcon 1, a launch vehicle designed and manufactured by SpaceX of Hawthorne, Calif. The Falcon 1 experienced problems that resulted in the loss of the launch vehicle and payloads, including NanoSail-D.

NASA engineers constructed two NanoSail-D flight units, in case one failed or another launch opportunity became available. For the past two years, NASA engineers have refined the spare flight unit by correcting boom spool manufacturing problems and changing four internal bushings.

The planned orbit and duration of the new mission also have been modified. The orbit will be higher and circular for this mission. The change in orbit inclination will make NanoSail-D more visible to astronomers on the ground. Because of the orbital changes, the mission duration has also changed. The original mission was planned for seven to 14 days. The new mission is expected to last 70-120 days.

The NanoSail-D Team

The NanoSail-D project is managed for NASA by the Marshall Space Flight Center, which designed and built the payload in collaboration with the Nanosatellite Missions Office at Ames Research Center. The flight experiment is a combined effort by NASA, the U.S. Air Force Research Laboratory and Space Development and Test Wing at Kirtland Air Force Base, N.M., and the U.S. Army Space and Missile Defense Command and the Von Braun Center for Science & Innovation, both in Huntsville, Ala.

For more information about NanoSail-D visit:

http://www.nasa.gov/mission_pages/smallsats/nanosaild.html

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