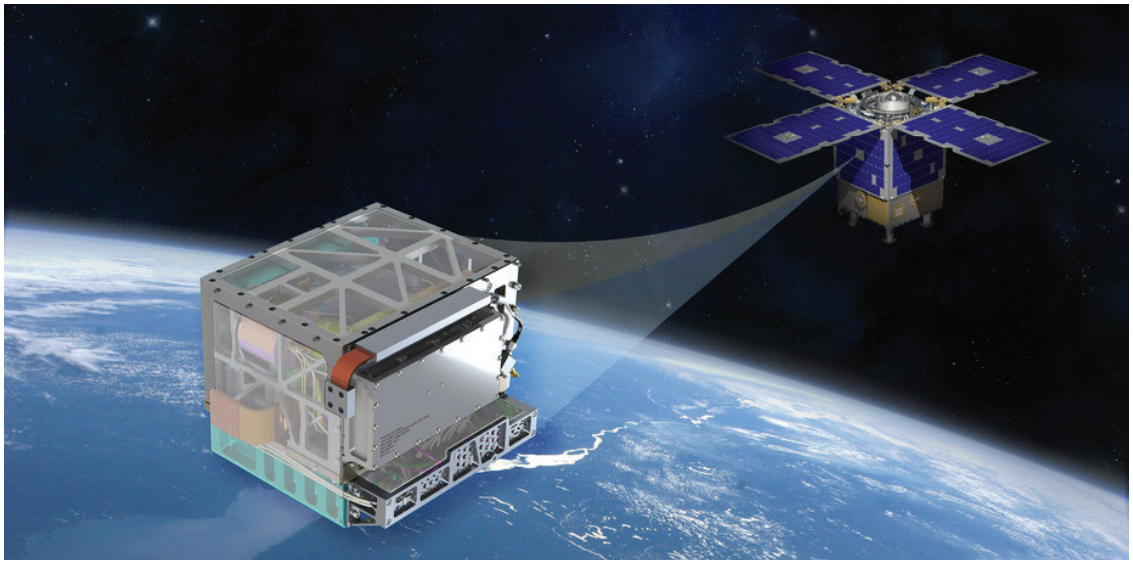
National Aeronautics and Space Administration

NASAfacts

Deep Space Atomic Clock

A New Frontier in Ultra-Precise Space Navigation



JPL's Deep Space Atomic Clock will fly aboard General Atomics' Orbital Test Bed satellite as a hosted payload. It will launch as part of the Department of Defense's Space Technology Program 2 (on a SpaceX Falcon Heavy rocket).

Know Your Place in Space Via Time

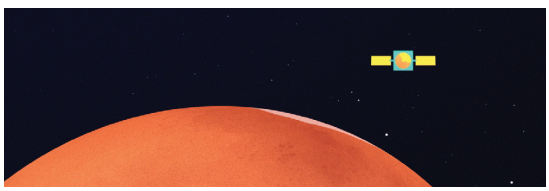
Since nautical ships first carried spring-wound chronometers, accurate timekeeping has been an essential part of navigation. Exact measures of time are especially critical for spacecraft, which journey far into the solar system. The Deep Space Atomic Clock, designed and built at NASA's Jet Propulsion Laboratory, represents an enormous advance towards improving deep-space navigation.

It's Atomic!

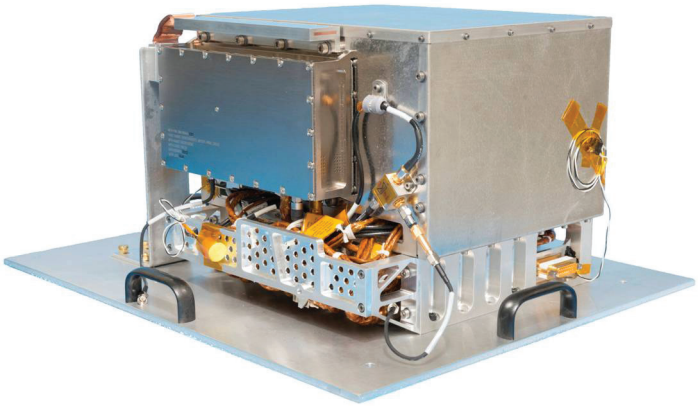
Since the 1950s, the gold standards for timekeeping have been ground-based atomic clocks. They are also the cornerstone of deep-space navigation for most space missions because of their fundamental role in navigation measurements. These clocks measure very stable and precise frequencies of light emitted by specific atoms, using them to regulate the time kept by more traditional mechanical (quartz crystal) clocks. This results in a clock system that can be ultrastable over decades. The new Deep Space Atomic Clock timepiece will use mercury ions to provide a measure of time that is stable to better than one microsecond per decade.

Making It Portable

Ground-based atomic clocks are phenomenally accurate, but their designs are too bulky, power-hungry and sensitive to environmental variations to be practical for spaceflight. They need to be miniaturized and toughened in order to venture off our planet. Deep Space Atomic Clock greatly enhances the performance of current space clock designs, and can virtually eliminate spacecraft clock errors. Deep Space Atomic Clock will enable a shift to a more efficient, flexible and scalable clock architecture that will benefit future navigation and radio science.



The new clock design will enable safer and more precise navigation to Mars and beyond.



The Deep Space Atomic Clock Demonstration Unit (shown mounted on a plate for easy transportation).

Deep Space Atomic Clock mercury ion trap housing with electric field trapping rods seen in the cutouts. This is where Deep Space Atomic Clock interrogates and measures the mercury ion resonance that is used to discipline a quartz crystal clock.

Launch in 2019

The Deep Space Atomic Clock is a demonstration unit and payload that is being hosted on the Orbital Test Bed spacecraft provided by General Atomics Electromagnetic Systems of Englewood, Colorado. It will launch in June 2019 to Earth orbit aboard the SpaceX Falcon Heavy rocket. NASA's Deep Space Atomic Clock will operate for at least a year to demonstrate the clock's functionality and utility for space navigation.

Key Facts

- Promises to be the most precise atomic clock ever flown in space — stability of better than one microsecond in a decade.
- Uses mercury ions (fewer than the amount found in two cans of tuna fish) to create a clock that is orders of magnitude more stable, while being less sensitive to magnetic fields and temperature changes than its predecessors.
- Will provide vastly improved navigation for traveling to and landing on other worlds.
- Accurate enough to measure the effects of gravity and relativity of other worlds — can measure the effects of Jupiter's massive gravitational pull on its moons in much less time than required by current approaches.
- Enabling device for onboard radio navigation for future exploration of our solar system by astronauts.

Mission Specifics

MISSION NAME:	Deep Space Atomic Clock Technology Demonstration Mission
LAUNCH DATE:	June 2019
MISSION DURATION:	One year
MASS OF INSTRUMENT:	16 kg/35 lbs
SIZE OF INSTRUMENT:	29 cm x 27 cm x 23 cm / 11 in x 10 in x 9 in

The Deep Space Atomic Clock project is sponsored by the NASA Space Technology Mission Directorate and managed by NASA's Jet Propulsion Laboratory in Pasadena, California.

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

For more information about the Deep Space Atomic Clock, visit:
www.nasa.gov/mission_pages/tdm/clock/index.html