# NASA spacecraft blasts off on experimental mission to divert asteroid

November 24, 2021 Stephen Clark

**A SpaceX Falcon 9 rocket lifts off with NASA's DART asteroid deflection mission. Credit: NASA/Bill Ingalls**

A small NASA space probe blasted off from California early Wednesday aboard a SpaceX Falcon 9 rocket on a first-of-its-kind mission to change the orbit of an asteroid, pioneering a technique that may one day be used to divert an asteroid off of a collision course with Earth.

The $330 million Double Asteroid Redirection Test, or DART mission, is taking aim on a stadium-sized asteroid named Dimorphos. Next September, the spacecraft will slam into the asteroid at a speed of roughly 15,000 mph (24,000 kilometers per hour) to knock it slightly off course.

Scientists will use telescopes on Earth to measure how much the collision changes the orbit of Dimorphos around its larger companion asteroid, named Didymos. The data will allow scientists to determine how effective a kinetic impactor spacecraft might be against another asteroid that might pose a future threat to Earth.

DART is humanity's first planetary defense mission, part of a new NASA division established to find, characterize, and potentially protect Earth from asteroids in our region of the solar system.

"DART is a technology demonstrator," said Elena Adams, DART's mission systems engineer at the Johns Hopkins University Applied Physics Laboratory, which developed the mission for NASA. "We are demonstrating a variety of technology. The most important thing that we're demonstrating is the ability to impact an asteroid. Just to give you an idea of how hard that is, we are traveling 107 million miles to hit something that's 0.1 mile in size."

"What we're trying to learn is how to deflect a threat that would come in," said Thomas Zurbuchen, head of NASA's science mission directorate. "Rest assured, that rock right now is not a threat, and it will not be a threat before or after. Of all the near-Earth objects we know today, none of them are a threat within 100 years or so."

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Liftoff of SpaceX's Falcon 9 rocket with DART, humanity's first experimental mission to prove technology that could protect planet Earth from a threatening asteroid. spaceflightnow.com/2021/11/23/fal…

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The 1,358-pound (616-kilogram) DART spacecraft lifted off from Vandenberg Space Force Base, California, at 1:21:02 a.m. EST Wednesday (0621:02 GMT; 10:21:02 p.m. PST Tuesday) on top of a SpaceX Falcon 9 rocket.

Nine Merlin 1D main engines throttled up to full power to propel the 229-foot-tall (70-meter) launcher off the pad with 1.7 million pounds of thrust. After rocketing through a low haze layer, the



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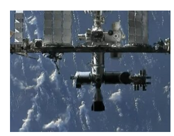
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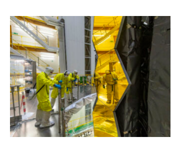
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Falcon 9 arced downrange through a clear sky toward the south-southeast from the Vandenberg launch base on California's Central Coast.

The first stage booster, designated B1063 in SpaceX's inventory, cut off and separated two-and-a-half minutes into the mission. The booster descended back through the atmosphere and made a propulsive landing on SpaceX's drone ship "Of Course I Still Love You" parked around 400 miles (650 kilometers) downrange from Vandenberg in the Pacific Ocean.

The landing completed the reusable first stage's third trip to space and back.

Meanwhile, the Falcon 9's single-use second stage burned its engine nearly six minutes to reach a preliminary parking orbit with the DART spacecraft. A second burn, lasting nearly a minute, started 28 minutes after liftoff to accelerate DART to a speed of more than 24,000 mph (39,000 kilometers per hour), placing DART on a trajectory to escape the trip of Earth's gravity.

The rocket deployed the DART spacecraft around 55 minutes into the mission. A live view from the launcher showed the probe receding from the Falcon 9 second stage.

DART was the first NASA interplanetary probe to launch on a SpaceX rocket.

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SpaceX says the Falcon 9 booster landed on the drone ship "Of Course I Still Love You" in the Pacific Ocean after launch with NASA's DART asteroid deflection mission.

The video cut out just before touchdown. This was the third flight for this booster.

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NASA later confirmed ground controllers established communications with DART, first through a European Space Agency antenna in Australia, then through NASA's own Deep Space Network station in Spain.

DART then unfurled two power-generating solar array wings to a span of more than 60 feet (19 meters) tip-to-tip. The roll-out solar arrays, made by Redwire, are the first of their kind to fly on a deep space mission, following previous use on the International Space Station.

Didymos and Dimorphos, the binary asteroid system targeted by DART, orbit the sun in an elongated path that occasionally bring them into Earth's neighborhood.

That classifies them as near-Earth asteroids, although scientists say there is no near-term threat from the pair. No space mission has ever explored Didymos and Dimorphos, but scientists who have observed them through telescopes say the asteroids are about a half-mile (780 meters) and 525 feet (160 meters) in diameter, respectively.

Scientists estimate there should be around 25,000 near-Earth asteroids the size of Dimorphos. An asteroid of that size that impacts Earth could wipe out a metropolitan area, causing mass casualties.

NASA says surveys have discovered around 40% of similar-sized near-Earth asteroids. Scientists have found more than 95% of the population of larger 1-kilometer-class (0.6-mile) near-Earth asteroids, which could wreak global damage if they hit our planet. The percentage is much lower for the smaller asteroids, but they pose a more limited risk.

NASA plans to launch its second planetary defense mission, an infrared telescope and follow-on to DART, in 2026 to find most of the undetected dangerous near-Earth asteroids.

"Our work right now with the DART mission is one possibility of what we might do if we found an asteroid on an impact course with the Earth," said Lindley Johnson, NASA's planetary defense officer. "So we're testing this kinetic impactor technique, where we just ram a spacecraft into the asteroid at high velocity to shave a little bit of speed off of its path, and that changes into the future."

A small speed adjustment could result in large changes in the asteroid's location years or decades into the future, meaning that with enough warning, a relatively compact spacecraft could be all that is needed to safeguard Earth from an impact.

"Our objective is to find these objects far way in time and far away from Earth, and to be able to enact this change in their orbit many years in advance, so it doesn't take much to change them at all," Johnson said.

**NASA's DART spacecraft during pre-launch processing at Vandenberg Space Force Base, California. One of the spacecraft's roll-out solar arrays is visible on the right. Credit: NASA/Johns Hopkins APL/Ed Whitman**

With an on-time launch Wednesday, DART's arrival at Dimorphos is tentatively set for Sept. 26, 2022, according to Adams.

Over the next 10 months, DART will prove out several new technologies that could be used on future deep space probes.

The NASA Evolutionary Xenon Thruster-Commercial, or NEXT-C, thruster is a technology demonstration component of the DART mission. Developed by NASA's Glenn Research Center and Aerojet Rocketdyne, the new thruster is an upgraded, more powerful version of ion propulsion system used on previous NASA space missions.

DART's NEXT-C thruster is not required for the craft to reach asteroid Dimorphos, but a series of "neutral" burns of the ion propulsion system over the next few months will demonstrate the engine for use on future probes.

Ion propulsion systems operate at low thrust, but they can fire continuously for months or years while consuming relatively little fuel. They work by accelerating ionized gas using electricity. In DART's case, the electricity will be generated by two roll-out solar panels, also a relatively new technology.

DART also carries flat radio antennas as another of the mission's tech demos.

The DART mission was supposed to launch in July, but NASA announced earlier this year that the launch would slip to November due delays in delivering the spacecraft's primary instrument and solar arrays.

NASA said the delay was caused by "technical challenges" associated with the spacecraft's Didymos Reconnaissance and Asteroid Camera for Optical navigation, or DRACO, imaging system, which needed to be reinforced to ensure it can survive the stresses of a rocket launch.

The DRACO camera will take pictures of the Didymos and Dimorphos asteroids just before impact, collecting information on the asteroids' locations to help DART navigate toward an aim point at the center of Dimorphos.

The delivery of the spacecraft's roll-out solar arrays was also delayed due to supply chain issues, partly blamed on the COVID-19 pandemic.

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DART separation confirmed!

NASA's Double Asteroid Redirection Test mission got a successful start with a launch from California aboard a SpaceX Falcon 9 rocket.

The spacecraft is now flying free of the launcher, heading into deep space.

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A small CubeSat provided by the Italian Space Agency rode to space with DART. It will deploy next September, about 10 days before impact with Dimorphos. The ridealong spacecraft, named LICIACube, will maneuver to a trajectory offset from DART, allowing it to safely fly by and watch the collision with a pair of optical cameras.

DART will take over autonomous control of its flight about four hours before smashing into Dimorphos. The spacecraft will use sophisticated on-board navigation algorithms derived from missile guidance systems, called Small-body Maneuvering Autonomous Real Time Navigation, or SMART Nav.

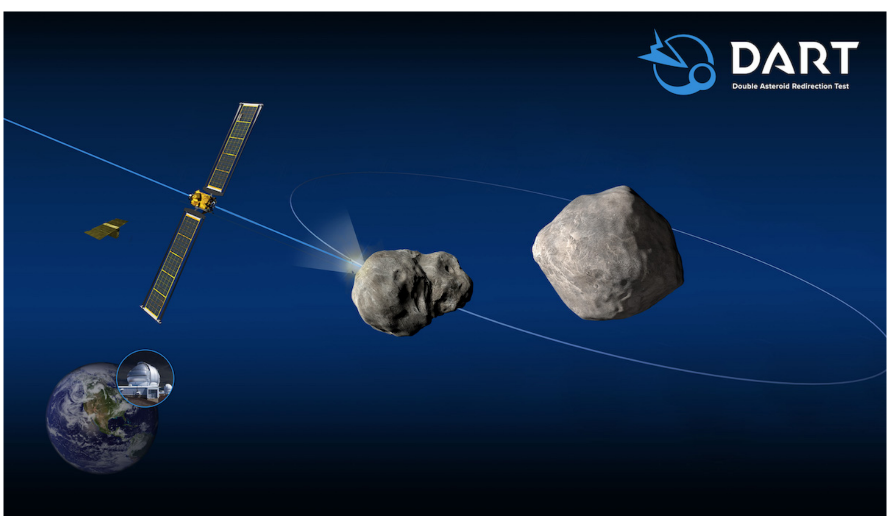
The corrections needed to guide DART in toward Dimorphos will be too fast for mission control to command, and there will be a 38-second communication delay from the asteroid's location to Earth, a distance of around 6.8 million miles (11 million kilometers).

Twelve hydrazine-fueled thrusters will steer DART on its final collision course.

DART will stream live video back to Earth from its DRACO cameras. Because of the high-speed approach and the small size of Dimorphos, the target asteroid will only be revealed in DRACO's view finder in the final hour before impact.

"At about four minutes out … we're finally starting to see the shape of Dimorphos, and then in four minutes we slam into it," Adams said. "So there's really not much time to react, and we've got to be right the first time."

The collision will destroy DART and likely leave a small crater on Dimorphos. Then comes telescopic observations to monitor the double asteroid for changes in its orbit.




**This graphic illustrates the major elements of the DART mission, showing the spacecraft's approach and collision with asteroid Dimorphos, while the Italian LICIACube ridealong satellite and ground-based telescopes observe the impact. Credit: NASA/Johns Hopkins University APLL**

Dimorphos currently circles its larger companion about once ever

11 hours, 55 minutes. Officials expect that orbital period to change by about 10 minutes from the transfer of kinetic energy caused by DART's crash.

"With that, we can do a lot of the analysis we need to determine the effectiveness of using kinetic impact as a tool, as one of the strategies, to protect Earth from asteroid impacts," said Ed Reynolds, DART's project manager at APL.

***Email the author.***

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