Protecting Mars Sample Return spacecraft from micrometeorites requires high-caliber work

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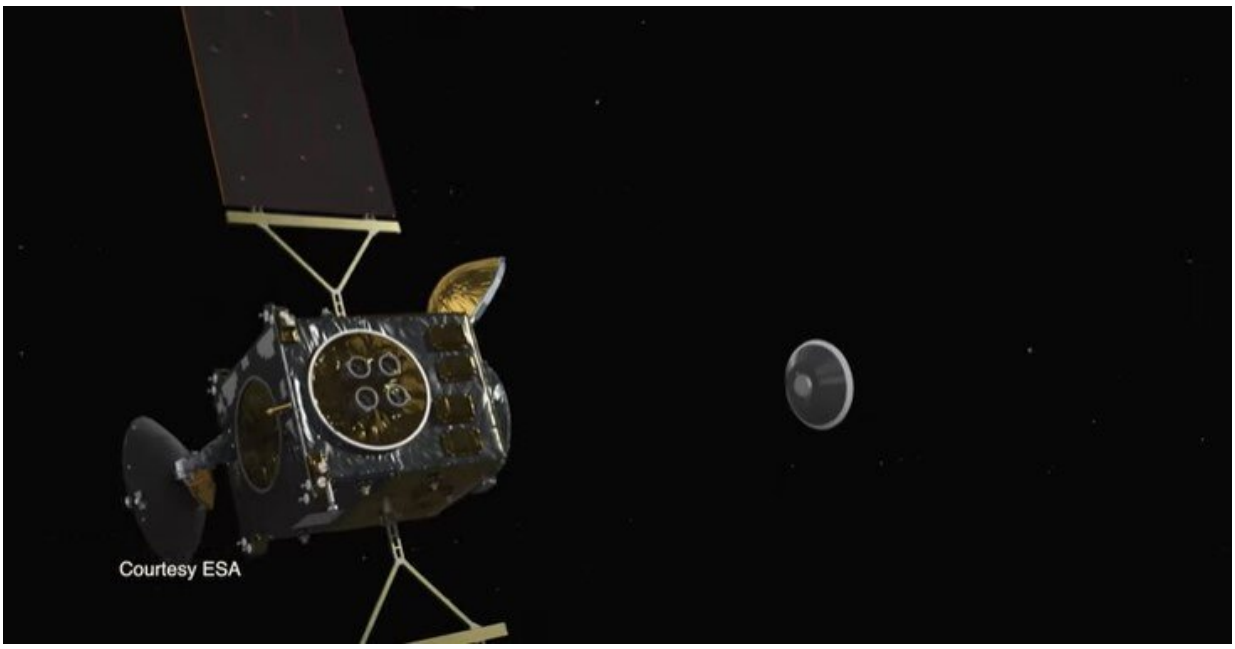

Credit: ESA

Micrometeorites are a potential hazard for any space mission, including NASA's Mars Sample Return. The tiny rocks can travel up to 50 miles per second. At these speeds, "even dust could cause damage to a spacecraft," said Bruno Sarli, a NASA engineer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Sarli leads a team designing shields to protect NASA's Mars Earth Entry System from micrometeorites and space debris. Recently, he traveled to a NASA lab designed to safely re-create dangerous impacts to test the team's shields and computer models.

Set far away from residents and surrounded by dunes, the Remote Hypervelocity Test Laboratory at NASA's White Sands Test Facility in Las Cruces, New Mexico, has supported every human spaceflight program from the Space Shuttle to Artemis. The lab also supports testing for the International Space Station, Commercial Crew, and Commercial Resupply programs.

The lab uses two-stage light gas guns to accelerate objects to speeds that simulate micrometeorite and orbital debris impacts on spacecraft shielding. The first stage uses gun powder as a propellent the way a standard gun does. The second stage uses highly compressed hydrogen gas that pushes gas into a smaller tube, increasing pressure in the gun, like a car piston. The gun's pressure gets so high that it would level the building if it were to explode. "That is why we hung out in the bunker during the test," said Sarli.

NASA's Remote Hypervelocity Test Laboratory is equipped with four two-stage light gas guns; two 0.17-caliber (0.177-inch bore diameter), a 0.50-caliber (0.50-inch bore diameter), and a 1-inch (1.00-inch bore diameter) gun at the facility. The 1-inch range is 160 feet long, from gunpowder breech to the end of the target chamber outside.

Engineers spent three days preparing for a one-second experiment. They used the lab's mid-sized high-pressure (50-caliber range) two-stage light gas gun that shoots small pellets 16 to 22 feet per second. "At that speed, you could travel from San Francisco to New York in five minutes," said Dennis Garcia, the 0.50-caliber test conductor at White Sands.

While the pellet's speed is fast, micrometeorites travel six to seven times faster in space. As a result, the team relies on computer models to simulate the actual velocities of micrometeorites. The slower rate will test their computer model's ability to simulate impacts on their shield designs and allows the team to study the material reaction to such energy.

Mars Sample Return is a multi-mission campaign designed to retrieve scientifically selected samples of rock and sediment that the Perseverance rover is collecting on the surface of Mars. Bringing those samples to Earth would allow scientist to study them using the most advance laboratory instruments-those that will exist in the coming decade and those in the decades to follow. The campaign is one of the most ambitious endeavors in spaceflight history, involving multiple spacecraft, multiple launches, and multiple government agencies. Goddard is currently designing and developing the Capture, Containment, and Return System that would deliver the Mars sample tubes back to Earth.

Provided by NASA

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