AIMing a light across millions of kilometres

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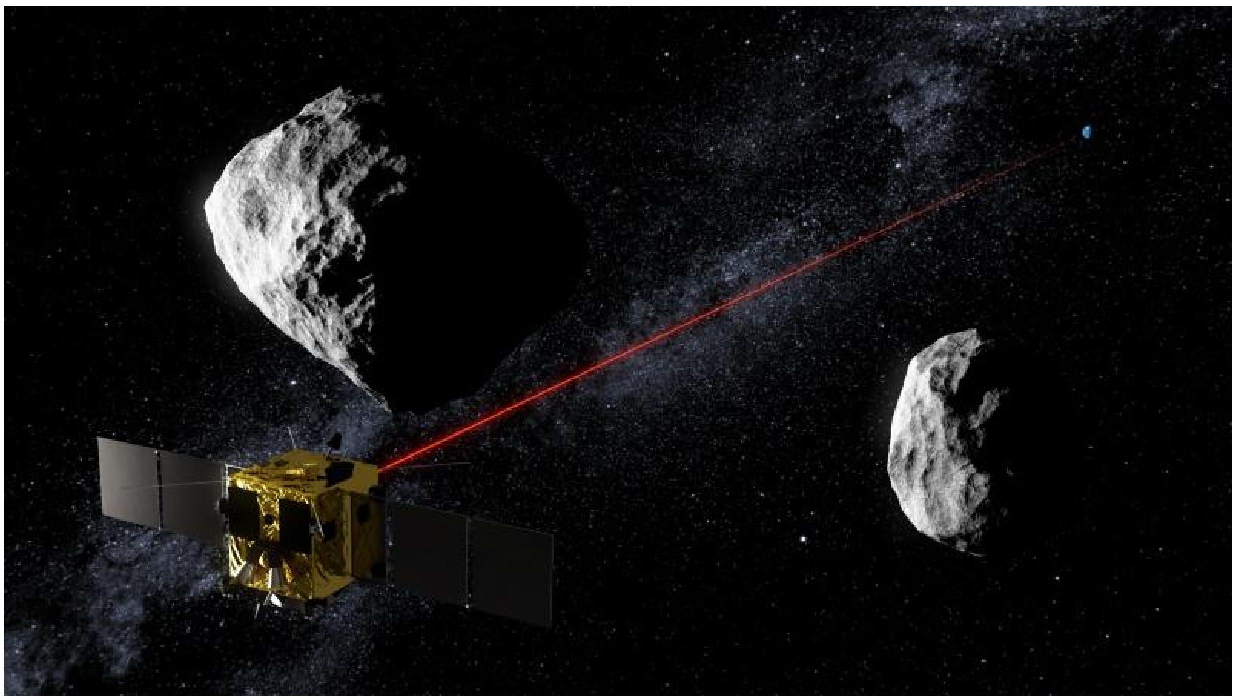


ESA's Asteroid Impact Mission concept, currently under study, would be humanity's first mission to a binary asteroid: the 800 m-diameter Didymos is accompanied by a 170 m-diameter secondary body. AIM would send science results back to Earth via a high-bandwidth laser link. Credit: ESA - ScienceOffice.org

Imagine beaming a light across millions of kilometres of empty space, all the way back to Earth. ESA's proposed Asteroid Impact Mission is intended to do just that: demonstrate laser communications across an unprecedented void.

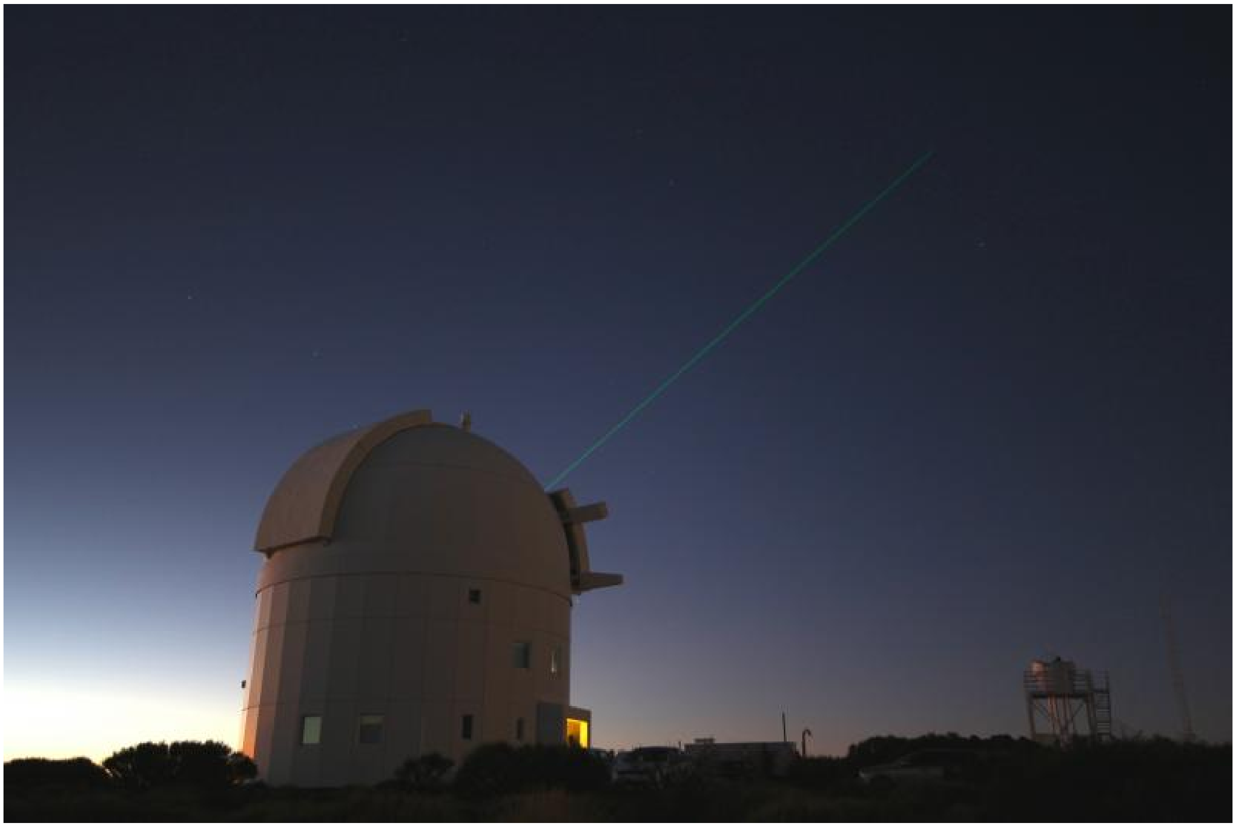
The Asteroid Impact Mission, or AIM, undergoing detailed design ahead of a final go/no-go decision by ESA's Ministerial Council in December 2016, is a deep-space technology-demonstration mission that would also be humanity's first probe to a double asteroid.

Among its innovative technologies, laser communications would return results to scientists several times faster than standard radio signals.

"Optical communications in general is not yet a well-established technology for space and ESA's European Data Relay System (EDRS) will be the first commercial application," explains ESA optics engineer Zoran Sodnik.

"In principle it works something like Morse code, with encoded rapid flashes on and off. ERDS with satellites in high orbits will use laser links to return environmental data from Europe's low-orbiting Sentinel satellites on a realtime basis, a technique previously demonstrated using ESA's Alphasat and Artemis telecom missions.

"In 2013 ESA's Optical Ground Station in Tenerife participated in a two-way contact with NASA's LADEE lunar orbiter, across 400 000 km.



ESA's Optical Ground Station laser tags ISS. Credit: Victor R. Ruiz

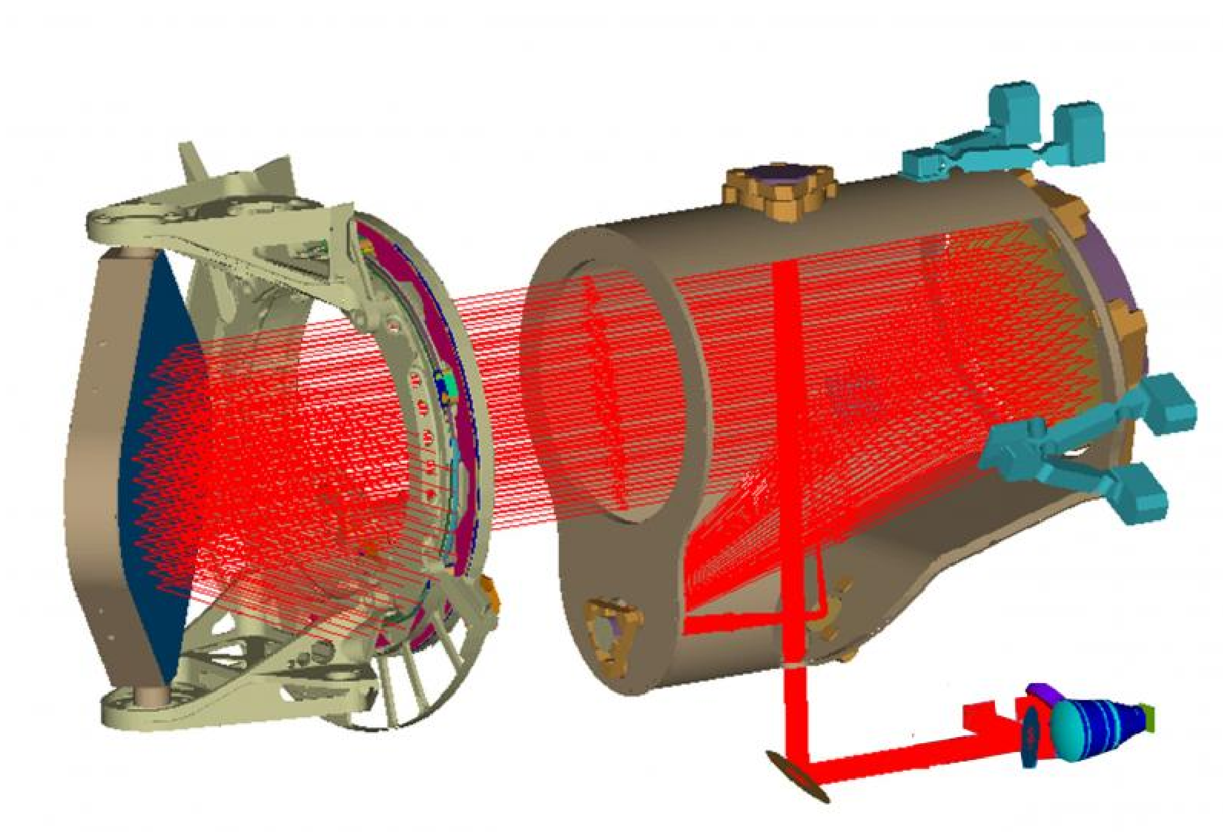
"But AIM will need to operate much further: we are benchmarking a maximum span of 75 million kilometres, or half the distance between Earth and the Sun. That might sound like a lot, but operating around Mars one day will involve much further distances still."

A laser beam shone back from AIM's 13.5 cm-diameter laser telescope at such a distance would have a ground footprint of about 1100 km – further than from London to Berlin. Also a lot but the equivalent radio beam radiating out across space would end up wider than our whole planet.

"The much higher frequency of laser light is what gives us higher directivity and as a result increased bandwidth," adds ESA laser engineer Clemens Heese.

"At the same time, many photons will get lost on the way, so we need to use sophisticated photon counting methods to detect the signal reliably using our receiver telescope of around 1 m diameter.

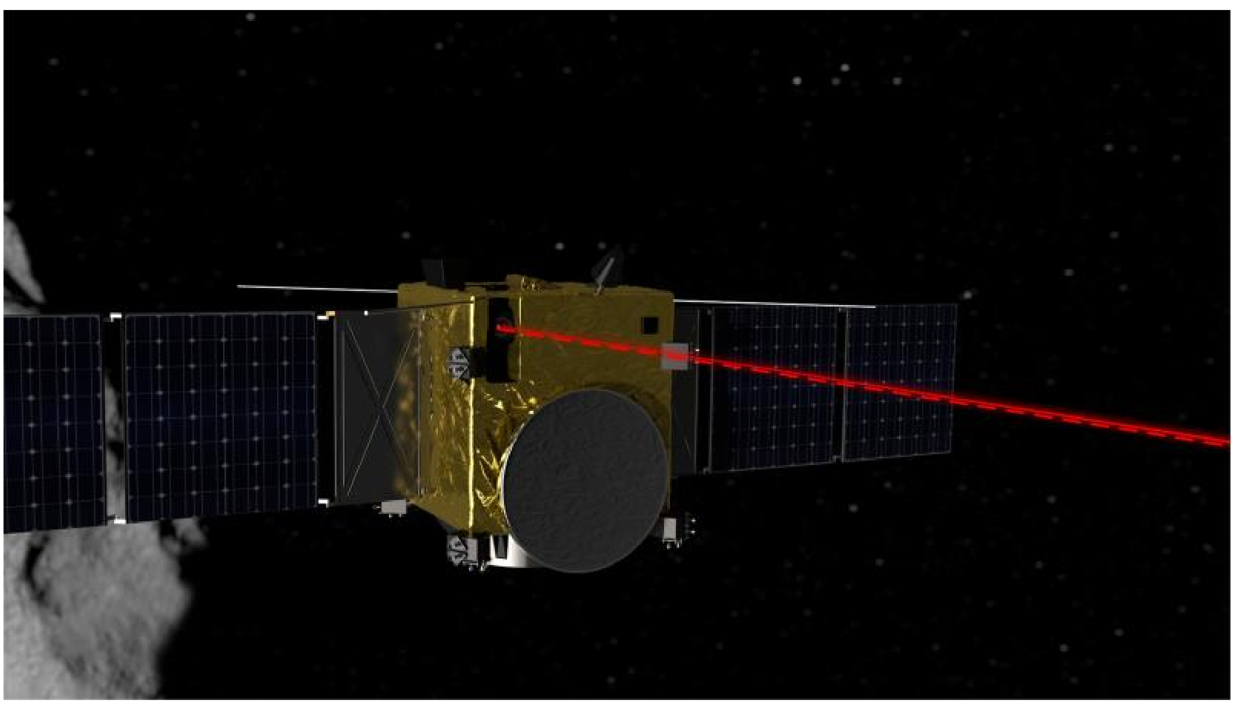
"While radio communications is a very mature technology and close to optimum efficiency, there's still lots of room for development with optical communications. So this is the way we need to go to really boost the quantity and speed of data we can deliver to scientists."



Optical ray tracing diagram of the Asteroid Impact Mission's laser-based optical communication terminal. The laser signal originates from the lens at bottom right, then spreads out to go out into space as a broad, 135 mm-diameter beam towards Earth. Credit: ESA/RUAG

To meet the challenge, ESA's AIM team this month issued technology pre-development contracts to industry to tackle key issues including telescope design, detector electronics and coarse and fine-pointing systems. To give an idea of the kind of pointing required, AIM will need to align with the signal from Earth to within the diameter of planet Mars seen in our terrestrial sky.

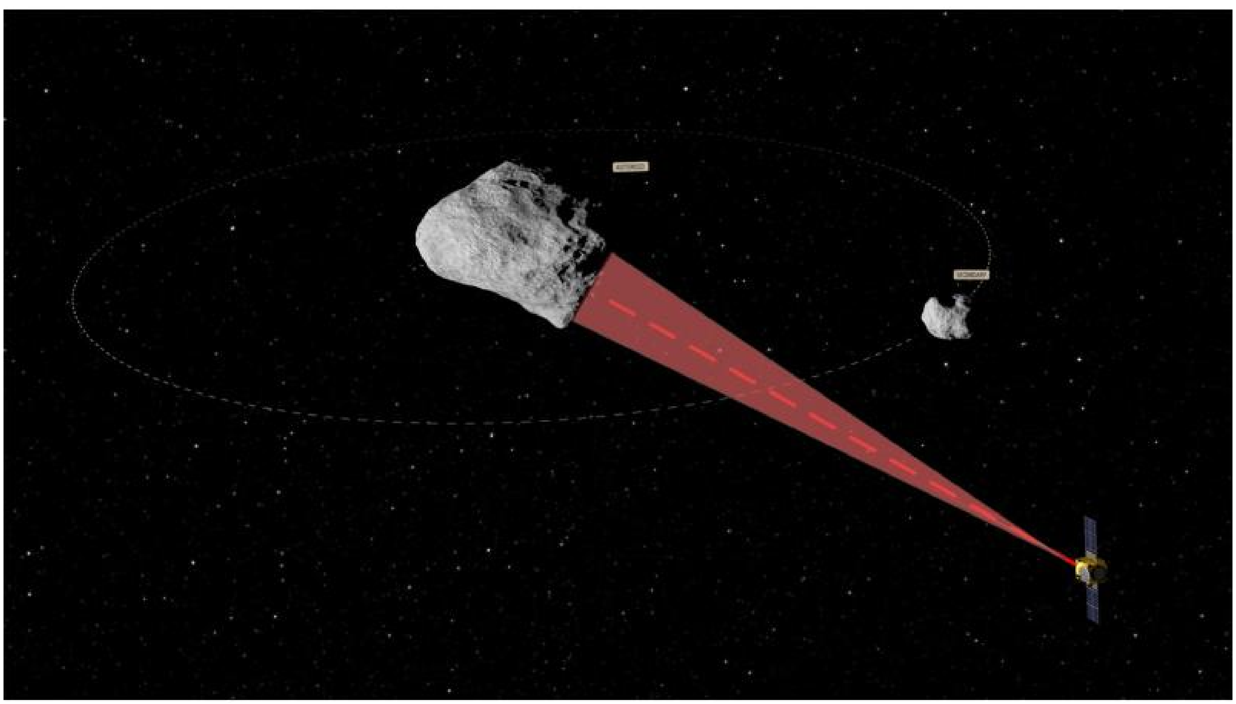
"At 39.3 kg, AIM's laser system will be one of the single largest payload items," explains Andres Galvez, heading ESA's General Studies Programme.



The Asteroid Impact Mission’s laser communication terminal in operation. It would be used not only for the high-bandwidth return of scientific data but also scientific purposes such as laser altimetry to map the asteroid. Credit: ESA - ScienceOffice.org

"We intend to gain maximum utility from it, by also using it for scientific purposes: the laser can also serve as an altimeter to chart the asteroid."

The system design is led by RUAG Space in Switzerland, building on its existing family of Optel laser communication terminals, the latest of which is tailored for direct-to-Earth downlinks from minisatellites.



ESA’s Asteroid Impact Mission will carry a powerful laser communication terminal to return scientific data to Earth. The laser can also be used for scientific purposes, such as laser altimetry to map the asteroid. Credit: ESA -

Provided by European Space Agency