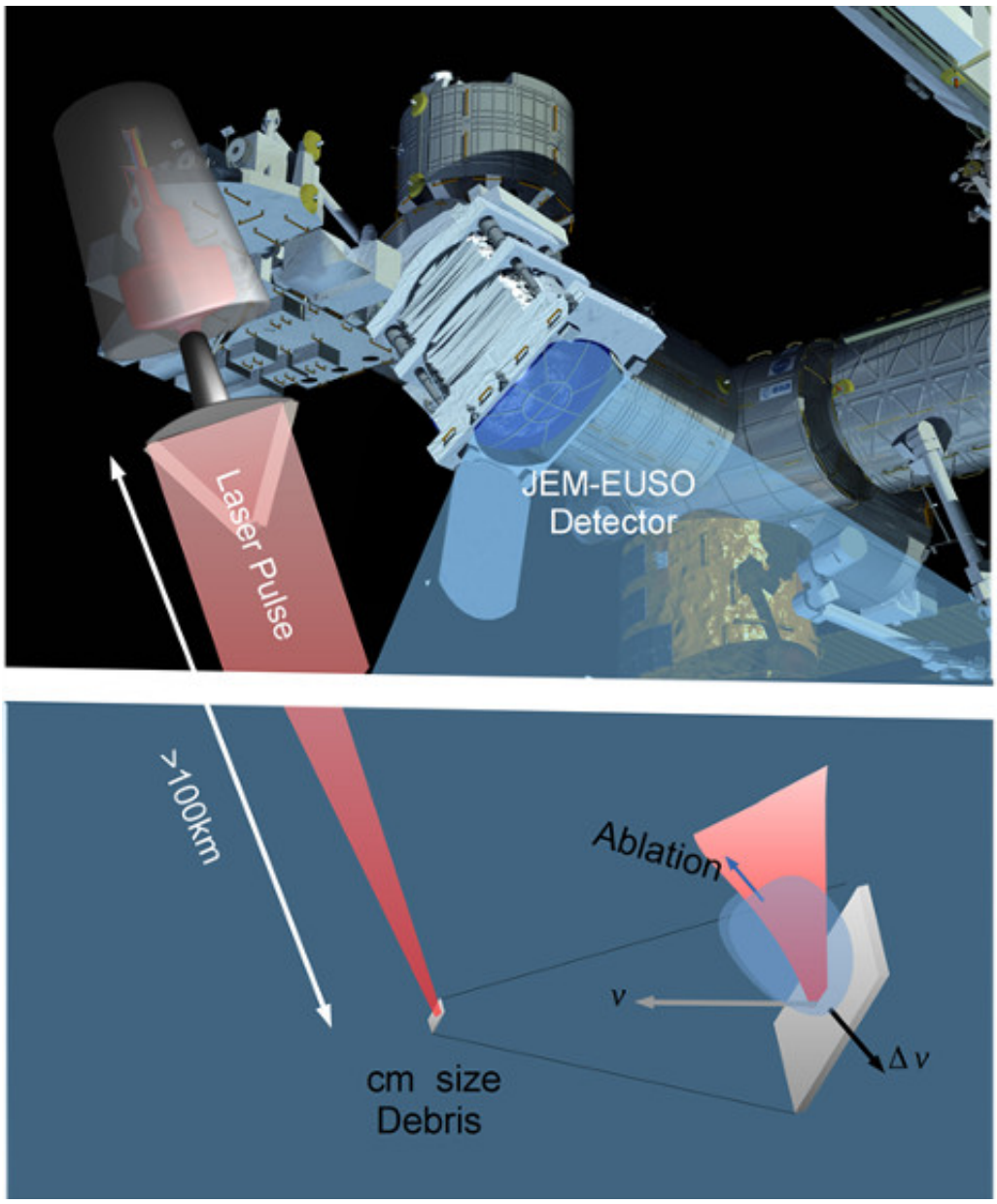
Demonstration designs for the remediation of space debris from the International Space Station

May 19 2015, by Nancy Owano



Schematic of the proposed system based on the EUSO telescope and a CAN laser system

Space Mom to all her little space cadets: "Look at this room, it's a mess. Somebody can get hurt just trying to move around these piles. Clean up your room, NOW." Unfortunately, the Great Room of Space has no such scene, only an Earth peopled with enlightened scientists who know they have to clean up the Great Room now, and are trying to figure out how. So what about a laser cannon to remove orbital debris?

RIKEN, Japan's comprehensive research institution, announced last month that an international team of scientists have put forward a blueprint for a space-based system that can address the problem of space debris.

NASA describes "orbital debris" as junk circling Earth, pieces from spacecraft. "Humans have been launching objects into space for more than 50 years. Most of those objects have fallen back to Earth."

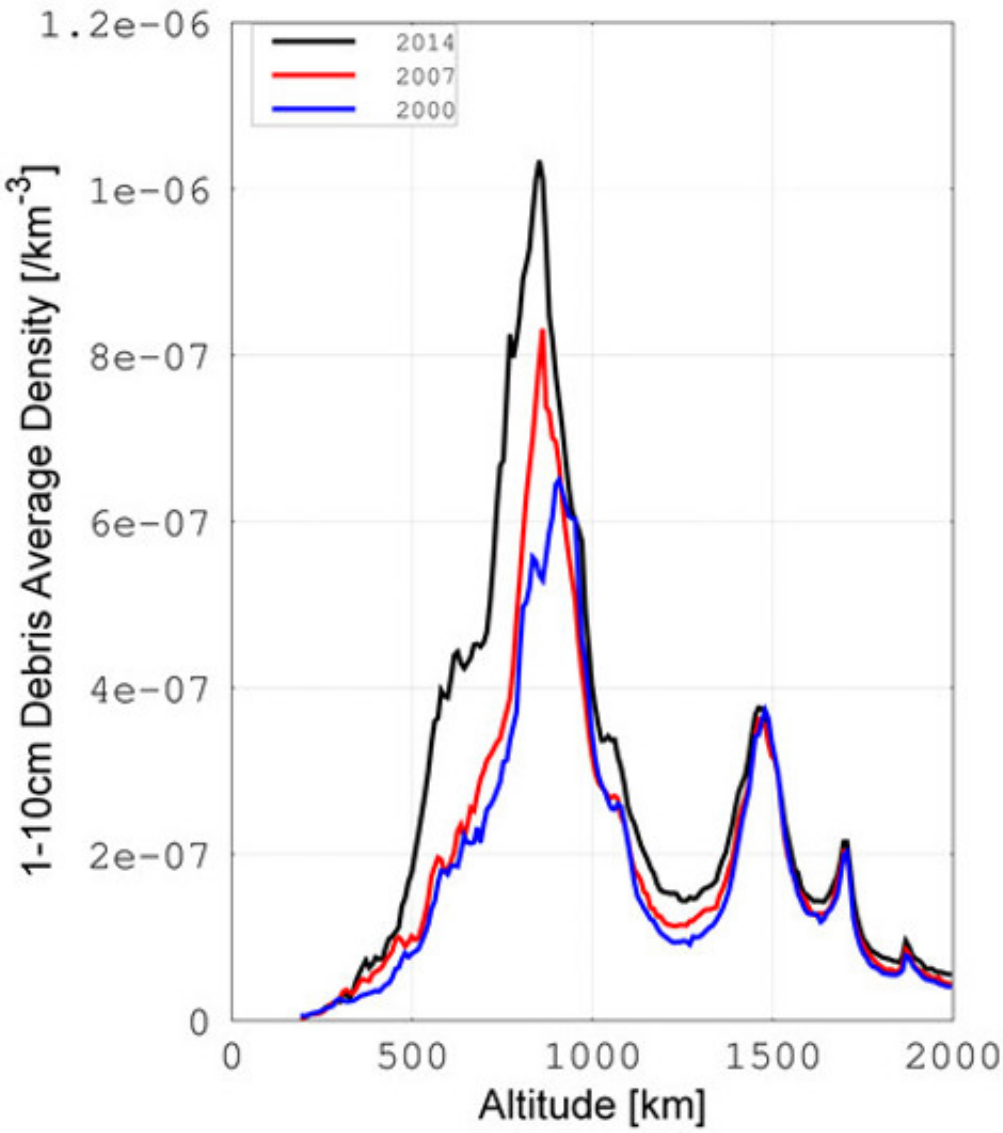
The RIKEN release said the scientists propose a combination of a telescope to detect objects and a laser system to remove the objects.

Space debris is no small problem. The Conversation last month stated: "Predictions show that if we don't tackle the problem of space debris then many of our most useful orbits will become too choked with flying fragments for satellites to safely occupy them." The RIKEN release said scientists calculate the total mass of space debris to be no less than 3,000 tons.

What is this junk, exactly? The mess ranges from derelict satellites to

rocket parts to small fragments. Coming up with a solution is important.

Most space junk is moving fast, said NASA. They travel at speeds up to 17,500 mph, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft.

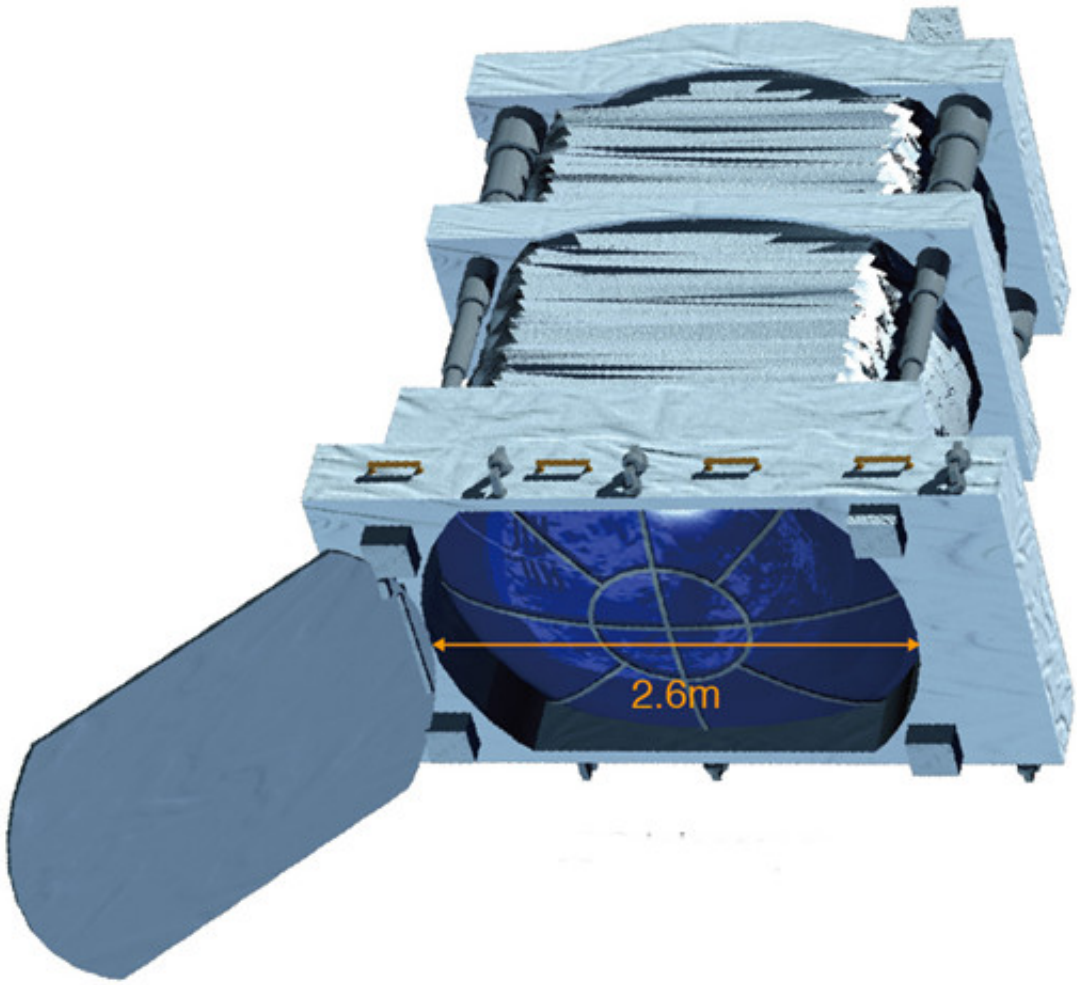


Graph showing how space debris is growing year by year

RIKEN said the scientists wish to adapt the EUSO telescope for a new telescope mission of detecting high-velocity debris in orbit near the ISS. Next, a laser can do the job of getting rid of the debris in shooting down the debris.

The debris-blasting laser which they have in mind is called a Coherent Amplification Network (CAN) laser, said *Space.com* contributor Charles Q. Cho. He said it is actually many small lasers working together and they generate a powerful beam.

As RIKEN explained, the CAN laser, originally developed to power particle accelerators, has "bundles of optical fibers that act in concert to efficiently produce powerful laser pulses." It achieves both high power and a high repetition rate. Combined, the telescope and laser will be (1) tracking down and (2) "deorbiting" debris.



The EUSO telescope. Credit: RIKEN

Cho described how it would work: "The scientists would use the laser to vaporize a thin film of matter off the surface of debris. The resulting high-speed plasma would act like a rocket plume, nudging the junk downward, and away from the space station to eventually burn up in Earth's atmosphere."

What's next? RIKEN said the group plans to deploy a small proof-of-concept experiment on the ISS, with a 20-centimeter version of the EUSO telescope and a laser with 100 fibers.

The scientists detailed their findings, which became available online on March 13, in the journal *Acta Astronautica*. The authors are from Japan, France, Italy and the United States.

More information: Demonstration designs for the remediation of space debris from the International Space Station, *Acta Astronautica*, Volume 112, July–August 2015, Pages 102–113

Abstract
We present here designs for a staged implementation of an orbiting debris remediation system comprised of a super-wide field-of-view telescope (EUSO) and a novel high efficiency fibre-based laser system (CAN). Initial proof of concept stages will operate from the International Space Station (ISS) where the EUSO telescope has been designed for operation as a detector of ultra-high energy cosmic rays. Equipped with 2.5 m optics and a field of view of ±30°, the EUSO telescope can also be utilised for the detection of high velocity fragmentation debris in orbit near the ISS. Further tracking, characterisation and remediation are to be performed by a CAN laser system operating in tandem with the EUSO telescope. For full scale versions of both instruments, the range of the detection/removal operation can be as large as 100 km. Utilising a step-by-step approach of increasing scale we present an analysis of implementation of: 1) Proof of principle demonstration of the detection by a mini-EUSO and operation of 100-fibre CAN laser technology as an ISS based prototype, 2) Technical demonstrator of debris-removal that consists of the EUSO telescope for the detection and a 10,000 fibre CAN laser for tracking and impulse delivery for debris re-entry, and 3) A free-flyer mission dedicated to debris remediation in a polar orbit with the altitude near 800 km. The integration of the two novel technologies aboard the ISS amounts to a novel approach as an immediate response to the serious space debris problem with the existing platform of ISS.