European space scout

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Fragments of disintegrated spacecraft can damage or even destroy operational satellites. Credit: ESA

The growing quantity of space debris is a serious threat to satellites and other spacecraft, which risk being damaged or even destroyed. A new European space surveillance system is being developed to ward off the danger of collisions in orbit. Fraunhofer researchers are supplying the receiver for the radar demonstrator system.

Orbital space is like a busy highway, with countless satellites constantly circling Earth and occasional visits by stray asteroids, comets and meteorites. The region is also strewn with debris from human space activities such as burnt-out rocket stages and fragments of disintegrated spacecraft, which are transforming it into an orbiting junk yard. It is estimated that there are currently around 20,000 objects with a minimum diameter of ten centimeters in orbit around Earth, including

15,000 in the low Earth orbit at an altitude of between 200 and 2,000 kilometers. These objects travel at a speed of up to 28,000 kilometers per hour, which means even the smallest particles measuring a centimeter or less in diameter are capable of causing serious damage to any satellite they encounter, or even completely destroying it. Only two years ago, in February 2009, a retired satellite collided with one of the Iridium communication satellites. The International Space Station ISS has to perform four to five evasive maneuvers each year.

In the light of this potentially disastrous situation, the European Space Agency ESA decided to take concrete action by launching a Space Situational Awareness (SSA) program, which runs from 2009 through to the end of 2011, to create the basic framework for a new, European response to this problem. At present, Europe does not possess the necessary high-resolution radar systems capable of tracking all of the smaller items of space debris. For this, the experts have to rely on data supplied by the American Space Surveillance Network. The new European system is to be built up in stages between 2012 and 2019 at locations that have yet to be defined.

ESA has awarded a contract to the Spanish company Indra Espacio to design and construct a radar demonstrator. The company has in turn called on the services of the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg to help with the construction of the demonstrator – a contract valued at 1.4 million euros. The Spanish company will develop the transmitter array, leaving the Fraunhofer scientists to develop the receiver system. The Fraunhofer experts are experienced in the design of radar systems: they already operate the TIRA (Tracking and Imaging Radar) system to detect objects in space. “TIRA is a mechanically steerable system that can be used to obtain images of discrete objects in high resolution. The new surveillance system, by contrast, uses an electronically steerable, inertia-free antenna that can be positioned very quickly. Unlike TIRA, it can

observe a large number of objects simultaneously, detecting their position to a high degree of accuracy and sensitivity," says FHR department head Dr. Andreas Brenner. This is an essential requirement, given the objective of having from 15,000 to 20,000 objects on the radar for at least ten seconds each day. "Our receiver system, that uses a phased-array antenna as the sensor, is capable of capturing radar signals reflected by satellites and space debris in up to eight directions at the same time," says Brenner. In its final version, the surveillance radar will be able to detect objects in geostationary orbit at an altitude of approximately 36,000 kilometers above the surface of the Earth, but its power will be mainly concentrated on the low Earth orbit at an altitude of between 200 and 2,000 kilometers, where it will be capable of detecting particles of debris measuring down to a few centimeters in diameter. The data this system collects is likely to be of interest to numerous users, including not only European government departments and space agencies but also satellite operators, insurance companies, energy suppliers and telecommunications companies.

The demonstrator is scheduled for delivery to ESA at the end of this year. It will then undergo a one-year test phase. A decision on who will construct the full system has yet to be taken, but Brenner hopes that ESA will recognize the importance of his department's expertise and incorporate its know-how in the final version. In any case, the radar receiver's versatility is undeniable, and the core components are equally suitable for use in other applications such as air traffic control at airports.

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