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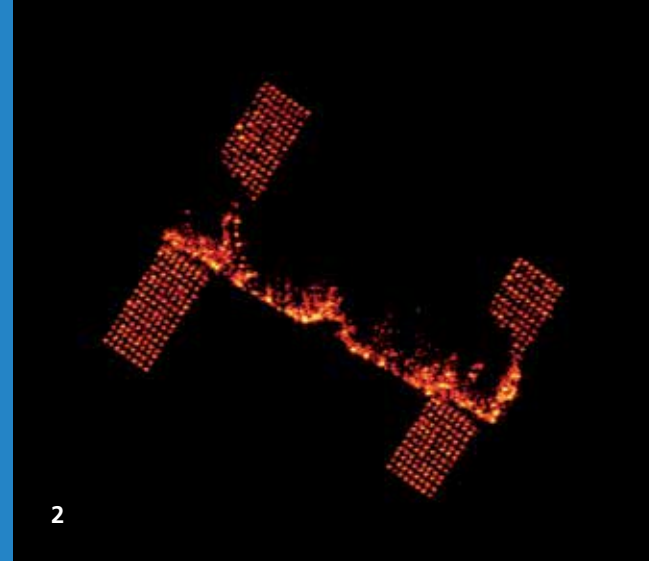
Projects:
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TITLE Control room of the
space observation radar TIRA
during a measurement.

Pictures

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Uwe Bellhäuser



SECURITY IN SPACE

Space-based infrastructure and satellite-based services are essential for modern societies. Fraunhofer FHR is one of the leading research institutes in the area of space reconnaissance. Space agencies from all over the world rely on the competence of the institute.

The scientists at Fraunhofer FHR have been researching near-Earth space for over thirty years. Radar is the most suitable sensor for this task as the observation conditions are quite unfavorable: radar can be used by day and night and in all weather conditions, it produces distance-independent, high-resolution images and can also detect objects traveling at high speeds.

The institute's space observation system TIRA, possesses capabilities that are unique throughout Europe. The radar images generated with the space observation radar are highly regarded by satellite operators and space agencies worldwide due to their richness in detail. In addition to the reconnaissance of orbital data for the purpose of collision prevention and re-entry forecasts, the scientists also carry out detailed technical investigations and damage analysis. With TIRA, Fraunhofer FHR can also provide important information in the satellite launching phase: the partners are keen to know if the satellite is on the correct orbital path and if it was commissioned correctly. The scientists at Fraunhofer FHR extract this information from radar data. In this way, the partners can quickly be provided with valuable know-how for the further course of the mission.

The researchers also focus on the development of technologies, processes and algorithms to ensure that radar can be used to extract a maximum of information on space

objects – from active satellites to space debris. Nevertheless, the scientific documentation of space situational awareness is very challenging. In addition to the 20,000 known and catalogued objects, there are countless smaller objects that have not yet been discovered. As relative speeds of up to 15km/s are possible in lower orbital paths, a particle just one centimeter in size could prove fatal for a satellite. The scientists carry out regular measurement campaigns to record the statistical distribution of these particles with a view to verifying and improving the models.

But the volume of traffic in orbit is increasing rapidly: providers, and in particular communication providers, intend to deploy swarms of small and micro-satellites in LEO (Low Earth Orbit, up to 2,000 km high) to bring mobile telephony and Internet to the remotest corners of the Earth. The first satellites of such constellations are already being launched into Earth orbit. This increase of traffic raises the in-orbit collision risk and put our satellites and astronauts on board of the International Space Station (ISS) in danger. A different type of radar is therefore necessary for seamless and continuous surveillance in space: phased arrays, i.e. electronically controlled array antennas, can conduct large-scale space surveillance around the clock. Using electronic beamforming, they can change their line of vision in a fraction of a second. Fraunhofer FHR is currently developing such a system, namely the German Experimental Space Surveillance and Tracking Radar (GESTRA)

for the German Aerospace Center (DLR). In addition to the ability to design the hardware needed for such a system, the institute also has the expertise necessary for the development of the corresponding radar operation control software. The development of complex algorithms for best possible processing of the signals from the received radar data is a further core competency. In the area of radar-based space reconnaissance, Fraunhofer FHR covers the entire system chain and can supply its partners with everything they require from a single source.

- 1 *Antenna quarter of the new space surveillance radar GESTRA.*
- 2 *ISAR image of Tiangong-2 docked with Tianzhou-1.*
- 3 *GESTRA is a high-performance phased array radar for space surveillance.*
- 4 *A glimpse inside: space observation radar TIRA.*



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