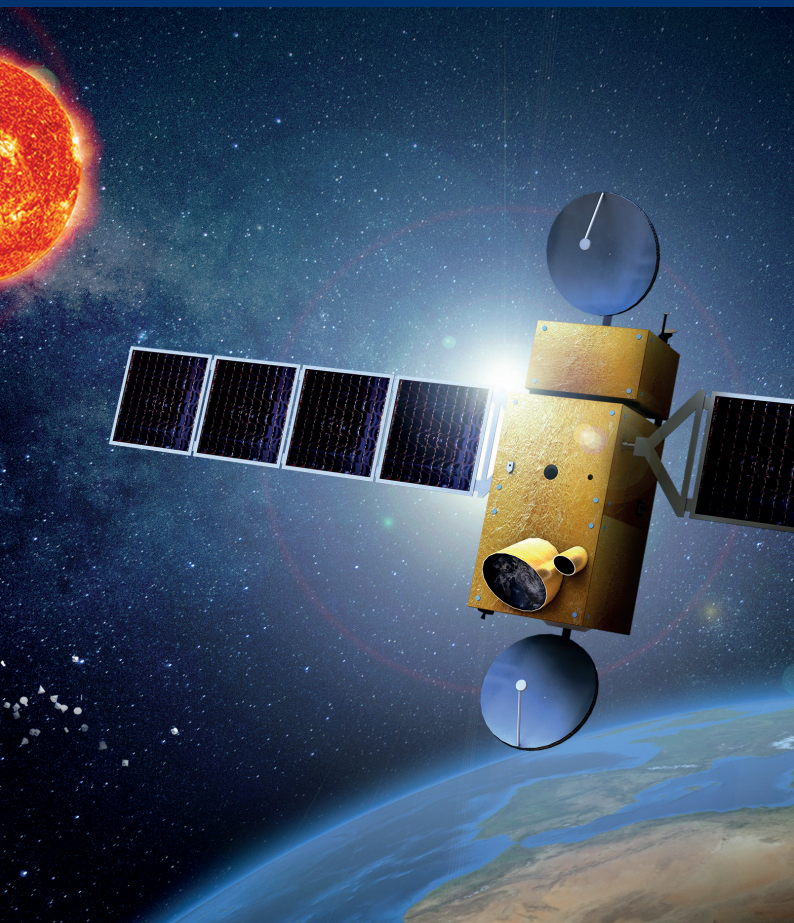
Fraunhofer
SPACE

OCTOBER 1-5, EXHIBITION HALL, BOOTH F70

INTERNATIONAL ASTRONAUTICAL CONGRESS BREMEN 2018



FRAUNHOFER SPACE ALLIANCE

Weather forecasts, navigation, real-time transmission for satellite TV or global Internet access – space industry applications and services have become an indispensable part of daily life, underpinning the importance of space technology for a modern industrialized society. In the Fraunhofer Space Alliance, the institutes pool their technological expertise in order to provide the industry and funding agencies such as the European Space Agency (ESA) and the European Commission with a central contact.

Fraunhofer acts as systems provider, developing a wide range of top-quality components, integrating them into an overall system and delivering that system to the customer. The sheer technological variety of the participating institutes enables the Fraunhofer Space Alliance to offer its customers a unique range of services. Its business units are Communication and Navigation, Materials and Processes, Energy and Electronics, Surfaces and Optical Systems, Protection Technology and Reliability and Sensor Systems and Analysis.

www.space.fraunhofer.de

EXHIBIT OVERVIEW

Fraunhofer Institute for Technological Trend Analysis INT

- Co-60 Irradiation Facilities

Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut EMI

- ERNST
- Hypervelocity impact crater and spallation damage
- Optical Bench
- Particle Impact Risk and Vulnerability Assessment Tool PIRAT
- PHILOS-SOPHIA
- Protection shield of the Columbus module of the ISS

Fraunhofer Institute for Laser Technology ILT

- Diode-laser pump modules for satellite-based free-space telecommunication
- Laser Powder-Bed Fusion
- Key Optical Components for Rugged Laser Systems
- Spaceborne optical parametric oscillator

Fraunhofer Institute for Surface Engineering and Thin Films IST

- CFK-Waveguide- Antennas
- Optical Coatings for Space Applications
- Coating Technology for components made by Additive Manufacturing

Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR

- GESTRA –
  German Experimental Space Surveillance and Tracking Radar
- TIRA (Tracking and Imaging Radar)

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM

- Quality management in adhesive bonding by process monitoring using the Aerosol Wetting Test
- Casted coils
- Functional printing
- Shape memory materials

Fraunhofer Institute for Material and Beam Technology IWS

- Section of outer rim
- Additively printed conducting paths
- Rocket Engine with aerospike nozzle
- Combustion chamber with swirl injectors

Further Information can be found here:

Fraunhofer Alliace Space

Virtual Satellite

Applied Research for Industrial Space Technology Bringing together the competences of 16 Fraunhofer Institutes, the Fraunhofer Space Alliance conducts applied research in the field of industrial space technology. The sheer technological variety of the participating institutes enables the Fraunhofer Space Alliance to offer its customers a unique range of services. This virtual satellite gives an overview of the Space Alliances select components and competences, both on a satellite and in a terrestrial context.

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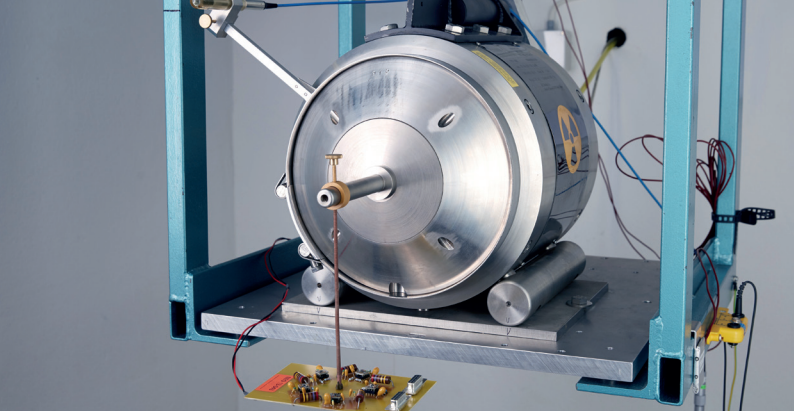

Fraunhofer INT

Co-60 Irradiation Facilities

The INT performs irradiation tests based on international standards and advises companies regarding radiation qualification and hardening of components and systems. The knowledge obtained in years of radiation testing is also used for the development of new radiation sensor systems. These activities are performed at irradiation facilities installed at the INT for example three in-house Co-60 facilities dedicated to irradiation testing. The exhibited replica illustrates the structure and functionality of such a Co-60 irradiation facility.

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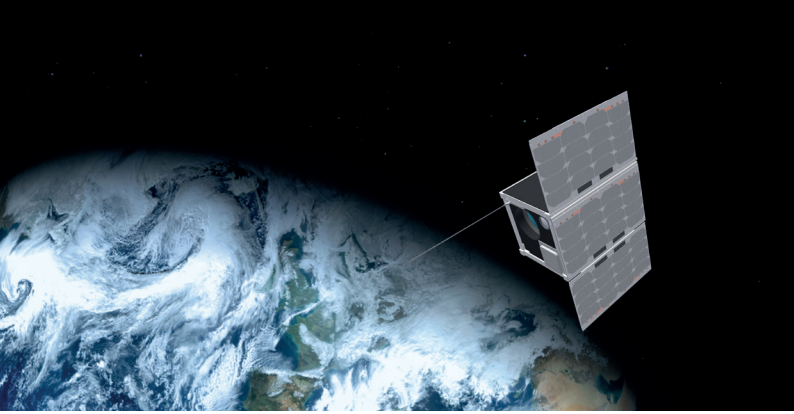

Fraunhofer EMI

ERNST

Fraunhofer EMI currently designs, integrates and tests the 12U nanosatellite platform ERNST (Experimental spacecRaft based on NanoSatellite Technology). ERNST is compliant to CubeSat requirements and the spacecraft bus is based on demonstrated CubeSat components where possible. The main objective of ERNST is to evaluate the utility of a 12U nanosatellite mission for scientific and military purposes. Possible civil applications: climate research, fire detection, determining temperatures on earth surfaces.

Hypervelocity impact crater and spallation damage

Impact crater in aluminum block to demonstrate the momentum of such impacts and the inferiority of monolithic shielding after impact from a 10 mm (1.4 g) aluminum sphere at 7 km/s.

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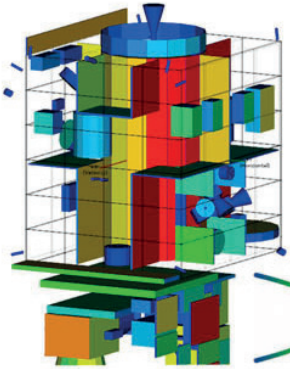


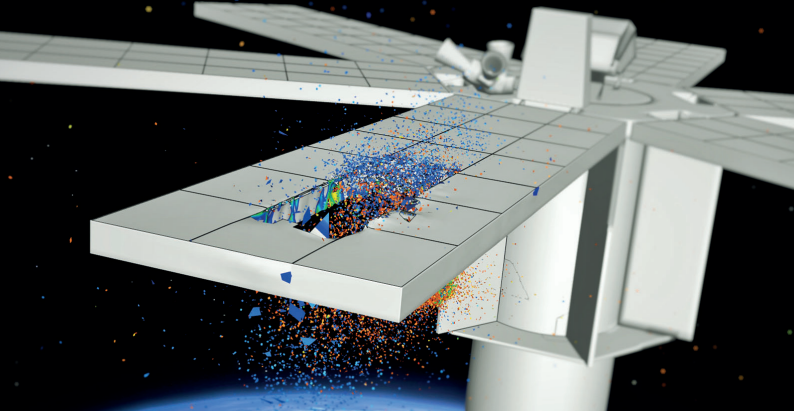
PIRAT

Optical Bench

Multidisciplinary Design optimized optical bench of the ERNST nanosatellite. The component integrates multiple payloads and is design optimized with combining both vibrational and thermal response objectives into a Multidisciplinary Design Optimization model. The sinus- and random response of the component against vibrational excitation from the launch system has been significantly improved. Simultaneously, the thermal compliance has been reduced and the radiator was structurally integrated into the optical mounting system to improve the efficiency of heat transport. The Additive Manufacturing has been carried out on an EOS M400 system in the aluminum alloy AlSi10Mg.

Particle Impact Risk and Vulnerability Assessment Tool PIRAT

Spacecraft design engineers use PIRAT to determine the „weak points“ in the satellite design with regards to hypervelocity impacts of space debris. PIRAT allows to define and to explore easily protection measures for particularly exposed components during early spacecraft design stages.



Fraunhofer EMI

PHILOS-SOPHIA

A highly sophisticated numerical simulation method and softAt Fraunhofer EMI, a highly sophisticated numerical simulation method and software, called PHILOS-SOPHIA, has been developed for the investigation of the fragmentation behavior of spacecraft by on-orbit collisions with space debris or other spacecraft.
The simulation part is based on the EMI-hydrocode SOPHIA, which has been under development at EMI for more than 15 years and is used at EMI to perform missile impact simulations at very high encounter velocities. SOPHIA has been extensively validated by comparison with experimental tests.
In the configuration part, a GUI-based Scenario Configurator is introduced, which allows to select predefined spacecraft objects or space debris objects from a database or to generate those, to define the collision scenario, and to prepare a batch mode simulation for parametric studies. The objects in the database are complete finite element models.
PHILOS-SOPHIA allows the visualization of the structural damage and allows to perform fragmentation analysis in terms of fragment number, area-to-mass ratio, mass distribution, velocity distribution, momentum transfer and other parameters.

Protection shield of the Columbus module of the ISS

Replica of the protection shield installed on the Columbus module of the International Space Station (ISS). The protection shield is based on the Whipple principle (two-plate shield) with additional, energy-absorbing material (Nextel, Kevlar) in between.
According to the Whipple principle, the incoming particle is fragmented at the first plate (bumper plate). The resulting fragments cloud distributes the energy of the impact over a larger area, allowing it to be picked up by the second plate („module wall“). Current shields such as the one shown here additionally incorporate energy absorbing materials (e.g., Kevlar, Nextel) as a second bumper. Such shields are called „Stuffed Whipple Shield.“

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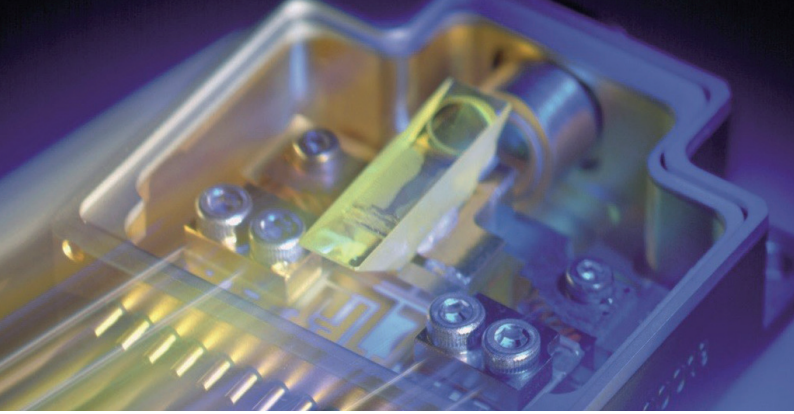

Fraunhofer ILT

Diode-laser pump modules for satellite-based free-space telecommunication

The use of diode-pumped solid-state lasers as transmitters for free-space satellite communication permits higher bandwidths at reduced transmission power than conventional microwave systems. The data is exchanged between individual satellites using laser communication terminals (LCT). In cooperation with Tesat Spacecom and the Ferdinand Braun Institute under a project assignment from the German Space Agency DLR with funds from the Federal Ministry of Economics and Technology (BMWi), the Fraunhofer ILT developed and built diode-laser pump modules for deployment in space. These modules meet the high requirements for module reliability, robustness and compactness, and their suitability for use in space was successfully verified by environmental tests including radiation, shock, vibration and thermal cycle tests. The pump modules are part of Tesat's LCT used for NFIRE, TerraSAR-X, Sentinel, Alphasat and EDRS.

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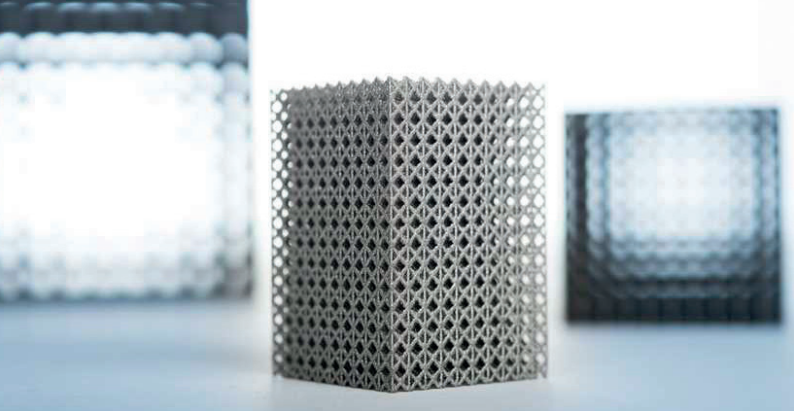
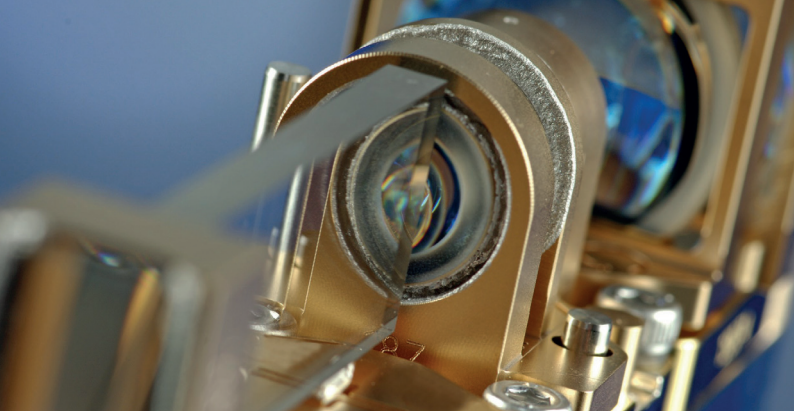


Laser Powder-Bed Fusion

Laser Powder-Bed Fusion makes it possible to produce complex functional components in a resource-efficient and economical manner. Indeed, manufacturing costs no longer depend on the complexity of the geometry, but only on the volume of the component to be built. Thus, the process offers a number of advantages over conventional manufacturing techniques and is suitable for applications in various industries such as the turbomachinery, aerospace, automotive and medical technology sectors. Fraunhofer ILT focuses on developing additive processes, innovative exposure concepts and machines as well as integrating these developments into industrial process chains. The institute's extensive system equipment consists of different commercial systems and self-developed, highly flexible laboratory plants. By bundling its know-how, also from the fields of laser beam source and optics development as well as process monitoring, Fraunhofer ILT creates tailor-made applications and innovations.



Fraunhofer ILT

Key Optical Components for Rugged Laser Systems

Many laser applications require a reliable long-term operation of the laser source in harsh environment. This means that the laser has to withstand temperature cycles and mechanical vibrations and shocks. This is especially true for industrial but also for space environment. With the goal to build a spaceborne LIDAR instrument that has to operate maintenance-free for more than three years a set of key optical components has been developed. In order to ensure long term stability especially when exposed to UV radiation, the key requirement is to avoid any organic material like adhesives or plastics. The soldering technique which is established for the mounting of laser diodes and laser crystals to heat sinks has been adapted for the mounting of mirrors, lenses, and nonlinear crystals for faraday isolators, pockels cells and frequency converters. Several thermal cycling tests between - 30°C and + 50°C as well as random vibration tests of 14 grms have been performed to validate the required robustness.

Spaceborne optical parametric oscillator

Within the scope of the French/German Climate Mission MERLIN, a satellite-based LIDAR system will be used to measure the detailed global methane concentration. The transmitter consists of a Q-switched Nd:YAG laser and an optical parametric oscillator, which converts the laser wavelength to a methane absorption line at 1645 nm. Beyond the demonstration of the required output parameters the packaging concept has to fulfill the challenging stability aspects of a space mission.

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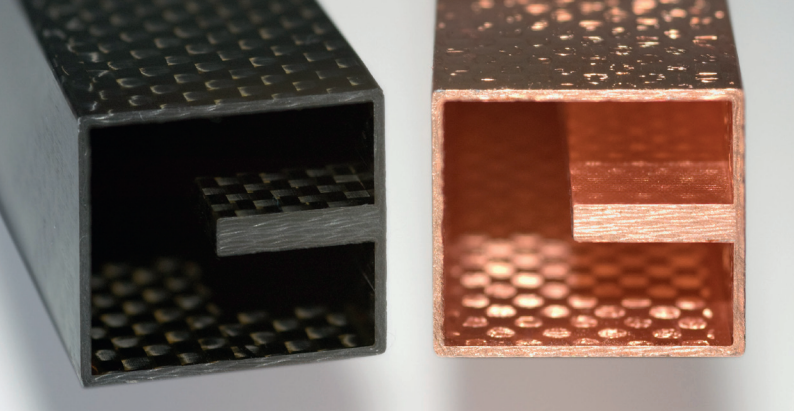

Fraunhofer IST

CFK-Waveguide- Antennas

The Fraunhofer IST presents waveguides consisting of metallized carbon fibre reinforced plastic (CFRP) for antennas of earth observation satellites. The requirements for antennas for satellite applications are high: a basic requirement in the aerospace industry is to save as much weight as possible. Conventional antenna materials such as copper are excluded for this reason. CFRP consisting of carbon fibres and resins is comparatively light and strong, but on the other hand it lacks the required electrical conductivity which has become the main focus of the Fraunhofer IST scientists. With a specially developed galvanic process, they succeeded in providing the waveguide with a thin conductive coating of copper inside and outside, which also withstands the extreme temperature fluctuations prevailing in space.

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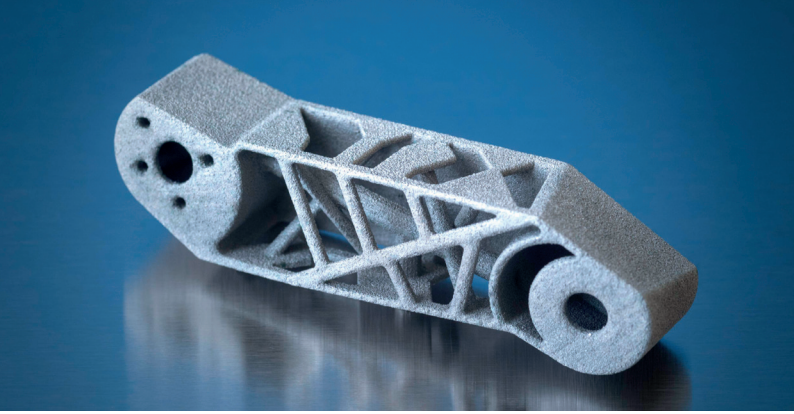
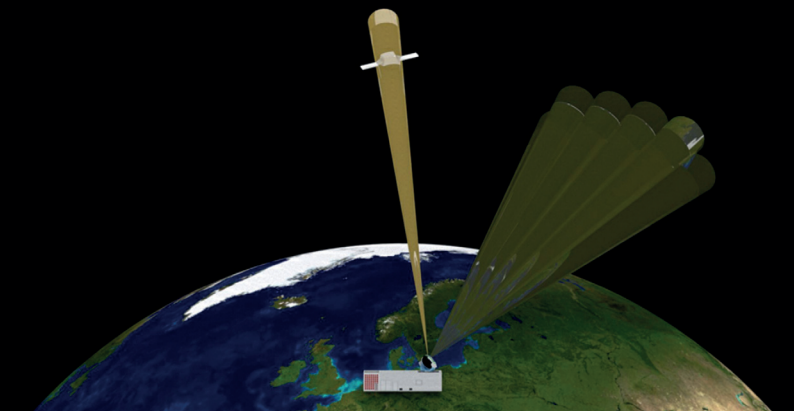


Optical Coatings for Space Applications

In the field of optical coatings for space applications the Fraunhofer IST presents multilayer optical filters on glass or polymers, narrow bandpass filters, edge filters and large area dielectric multilayer beam splitter coatings with low wave front error as well as a high glossy mirror of CFRP which imposes additional requirements are imposed on the base material:. It must not deform, even under the changing temperatures in outer space conditions, and in addition it must meet the optical requirements. To do this, the base material is modified.by the Fraunhofer IST.

Coating Technology for components made by Additive Manufacturing

Fraunhofer IST develops coating technologies for polymer components for space applications, which are made by Additive Manufacturing (AM). The main benefit is the weight saving of these parts of about 50% compared to metallic components manufactured by traditional processes such as turning, milling and the like. However, there are some severe drawbacks like outgassing in space, missing electrical conductivity or low mechanical stiffness. Coating of these parts with dense metallic layers can overcome these disadvantages.



Fraunhofer FHR

GESTRA – German Experimental Space Surveillance and Tracking Radar

GESTRA is a powerful experimental radar sensor for space observation. The Fraunhofer FHR is developing GESTRA to protect satellites in near-Earth orbit from the rapidly increasing amount of hazardous space debris. GESTRA is set up as a quasi-monostatic pulsed phased array radar, with transmitting and receiving units positioned about 100 m from each other. These units are integrated into two separate shelters, leaving them mobile for space observation as required, and can in theory be extended with different modules. Mechanical and electronic beam scanning with GESTRA allows exact and inertia-free antenna lobe alignment to the area of interest. Various innovative methods of observation, such as an optimized "Track-while-Mode", or the possibility of simultaneously looking in different directions by using digital multi-lobe formations, offer unique potential for generating a data catalog of all hazardous observable objects in orbit.

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TIRA (Tracking and Imaging Radar)

The radar system TIRA (Tracking and Imaging Radar) is the leading system in Europe for the observation and analysis of space objects. TIRA combines a highly dynamic 34-meter parabolic antenna with a tracking radar and an imaging radar. Due to the size of the antenna, the system is sensitive to weak signals and therefore allows the detection of small objects just a couple of centimeters in size.
Fraunhofer FHR works with cooperation partners such as the German Space Situational Awareness Center (Weltraumlagezentrum) or the ESA. Central tasks include, for example, support of all phases of space missions from start until re-entry, damage analysis and high-precision orbit determination for re-entry forecasts or for the prevention of collisions between satellites and space debris. The system therefore contributes to the protection of satellites and enhances awareness of the situation in near-Earth space.

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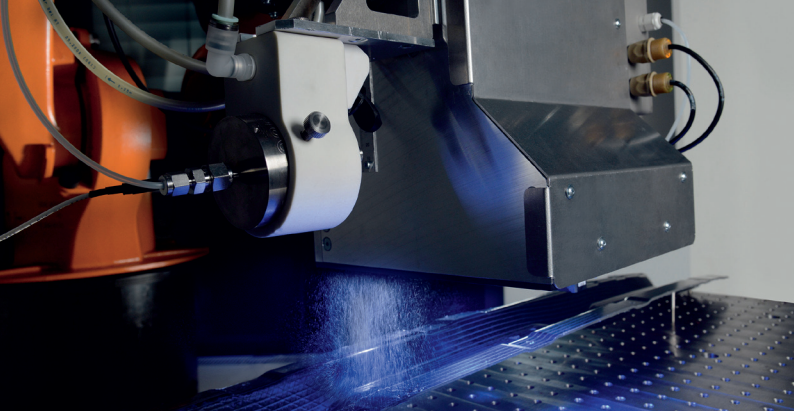

Fraunhofer IFAM

Quality management in adhesive bonding by process monitoring using the Aerosol Wetting Test

Adhesive bonding and coating processes applied in all sectors of industry depend on suitable surface properties of the processed parts. Contaminations and inappropriate pre-treatment result in bonds and coatings failing to meet short- and long-term quality requirements. Wetting properties of surfaces are key indicators allowing to determine bonding and coating properties.

The Aerosol Wetting Test, developed and patented by Fraunhofer IFAM, is used for automatic monitoring of the wetting properties of large surfaces at high lateral resolution in industrial production and also for laboratory studies.

An ultrasonic atomizer applies a defined water aerosol on substrates to be tested and, depending on their surface energy distribution, specific droplet patterns are formed. The droplet patterns taken by a camera and automatically analysed provide the crucial information about the local surface conditions.

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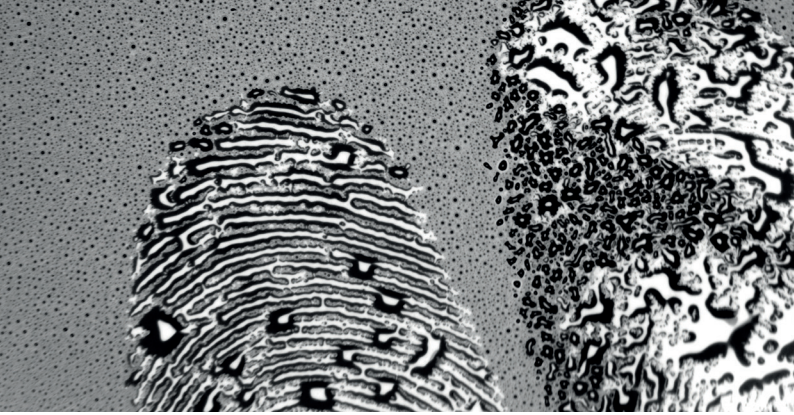

Casted coils

Casted coils allow to precisely adapt the conductor cross-section to the available space, resulting in both increased energetical efficiency and improved heat dissipation compared to conventional wire coils.

Functional printing

Weight- and space optimized integration of sensory, electrical, capacitive, and other functionalities is achieved by printing and applicating electronic structures on reinforcement fibre layers to be embedded in matrix systems thus providing function integrated FRP components.

Shape memory materials

Shape memory materials represent a group of smart materials, capable to memorize their original shape after external stimuli of different kinds. Application of these materials offers new design possibilities in industrial applications.

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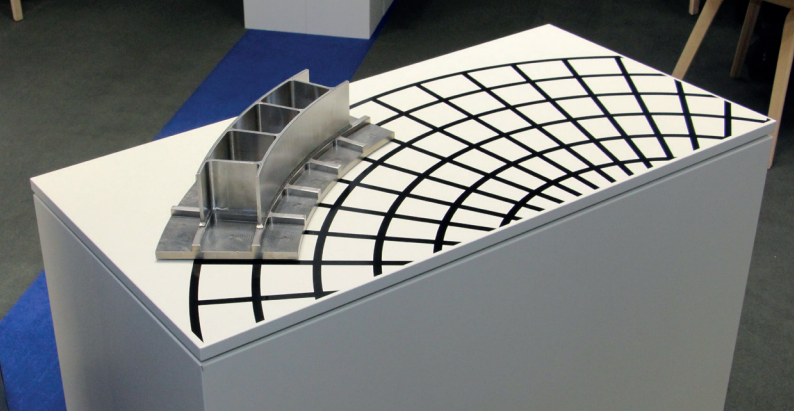

Fraunhofer IWS

Section of outer rim

The task of the Advanced Telescope for High-Energy Astrophysics (Athena) is to research temperature and energy flow in the universe. The European Space Agency (ESA) selected the under lying concept for the mission in 2013 as one of the most urgent scientific topics for a major future space mission.
Fraunhofer IWS provides an optical bench that is one of the three main components.

Additively printed conducting paths

- Non-contact, multilayer (dispenser printed) conducting paths and shielding
- Combination of silver polymer paste (DuPont) and polyamide-isolation paste (Creative Materials)
- On aluminium-oxide coated steel (3mm), by meas of high velocity oxygen fuel spraying

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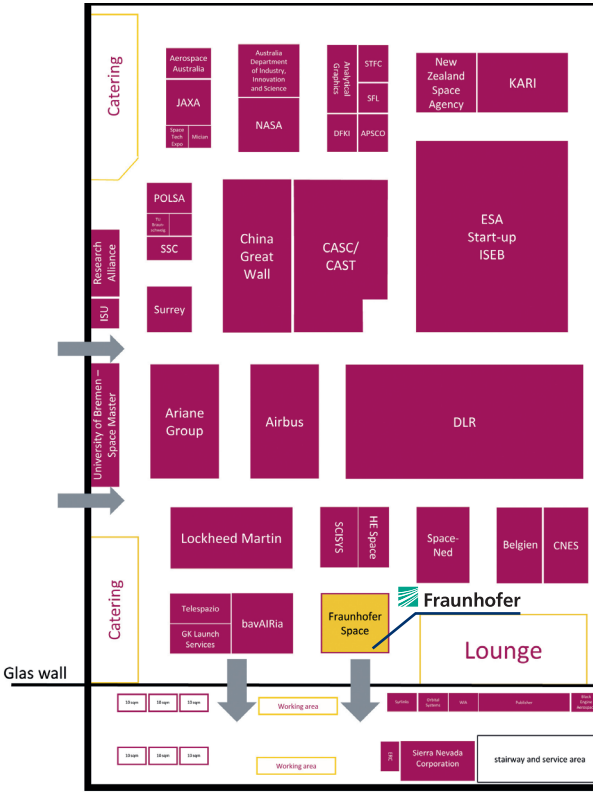
Rocket Engine with aerospike nozzle

- Rocket Engine with aerospike nozzle for liquid oxygen and methane
- Regenerative cooling of central spike and outer combustion chamber walls
- Thrust of approx. 16 kN, scalable 13 kN
- Thrist vector control by secondary fluid injection on the spike
- Material: Ti64Al4V
- Machine: Renishaw AM 400
- Process time: approx. 32 h
- Wall thickness down to 1 mm
- Integrated funtionalities by SLM

Combustion chamber with swirl injectors

- Hybrid manufactured combustion chamber by Laser Metal Deposition with powder
- demonstration of the potential of LMD for the extension of existing parts
- Swirl injectors by SLM
- Material: 316L (chamber), Ti64Al4V (injectors)

LOCATION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JAXA
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APSCO
New Zealand Space Agency
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POLSA
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China Great Wall
CASC/ CAST
ESA Start-up ISEB
Research Alliance
ISU
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Catering
Telespazio
GK Launch Services
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Lounge
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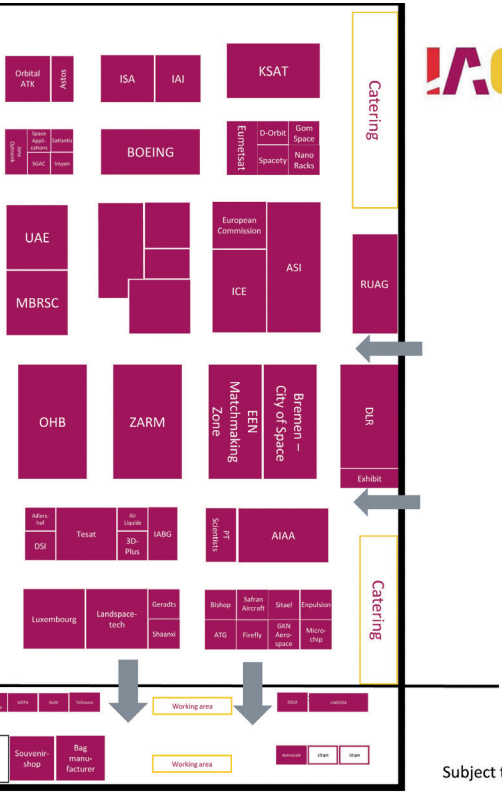
stairway and service area



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Subject to change

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