

## RESEARCH NEWS

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SPECIAL ISSUE

05 | 2018 || Page 1 | 4

### Free-form: quality leap in optical systems

**Optical free-form systems enable new applications with an extremely compact design. Due to the complex technology involved, the production of appropriate solutions was previously impossible or too expensive. The Fraunhofer Institute for Applied Optics and Precision Engineering IOF has further developed the technology to market maturity. Through collaboration with partners, a comprehensive technology platform has been created.**

Light is a universally employed energy source. Technologies and solutions that work with light are present in almost all industries and markets. Even science and research are unthinkable without optical systems. Spherical or aspherical optics have been predominant for many decades. In the age of digitization, short product cycles and miniaturization, though, optics also demand new functions and features. A particularly promising technology consists of so-called free-form optics. The optionally shapeable surface profiles enable new functions with significantly improved image quality. Another advantage is the particularly compact design.

A research team at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena has made decisive progress in this regard. Together with industry partners and the University of Jena, the IOF experts have explored the potential of free-form optical systems, presented innovative solutions and developed the manufacturing methods. From the high precision grinding of the lenses as well as the coating and finishing of the complex surfaces to the polishing of the lenses, the researchers had to solve a number of technical challenges.

Demonstrators verify the potential of the new technology: for example, as infrared optics for rescue teams, as special optics for space telescopes or as a driver assistance system. In addition, the free-form optical systems make new application scenarios feasible, such as in earth observation and weather monitoring, in environmental technology, as well as in the automotive and public safety sectors. Project leader and IOF researcher Dr. Ramona Eberhardt mentions a current example – night vision technology in cars: "Conventional technology would require a large number of cameras to record all the angles. Free-form optics enable the construction of cameras that combine different focal lengths and functions in a compact housing." The free-form optics are also ideal for the micro and nano-satellites of the future. They enable a folded beam path with fewer lenses, therefore saving weight and space.

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### **A holistic technology platform**

Although the idea of free-form optics is not new, it has so far not been widely accepted, since there have not been any coherent process chains for the economic production. This was therefore a central concern of the Fraunhofer project. Under the leadership of Eberhardt and her team, a holistic technology platform has been created in which numerous industrial partners, including companies such as Jenoptik and Asphericon, contribute their expertise. The manifold capabilities of the group cover the entire process chain – from development and design to production and system integration. The initiative received 14.4 million euro from the German Federal Ministry of Education and Research (BMBF) as part of the "Innovative Regional Growth Core" program.

The collaboration of the IOF team with its industrial partners was crucial for the success of the project. "For a functioning free-form optic, all of the partners have to work together and contribute their different skills," says Eberhardt. In addition, the consortium actively contributed to the design of the corresponding DIN standard "General description of surfaces and free-form surfaces".

The subject of free-form is also good news for the traditional optical industry in Thuringia. The project funded by the BMBF contributes significantly to strengthening the industry in Thuringia and the Jena region.

### **The „Research in the Group“ science award of the Stifterverband für die Deutsche Wissenschaft**

For the advancement of the technology, Dr. rer. nat. Ramona Eberhardt of the Fraunhofer IOF has received the "Research in the Group" science award of the Stifterverband für die Deutsche Wissenschaft. Among other things, the jury praises the economic impact as well as the novelty of the scientific-methodological approach and the progress in knowledge.

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**RESEARCH NEWS**

**SPECIAL ISSUE**

05 | 2018 || Page 2 | 4

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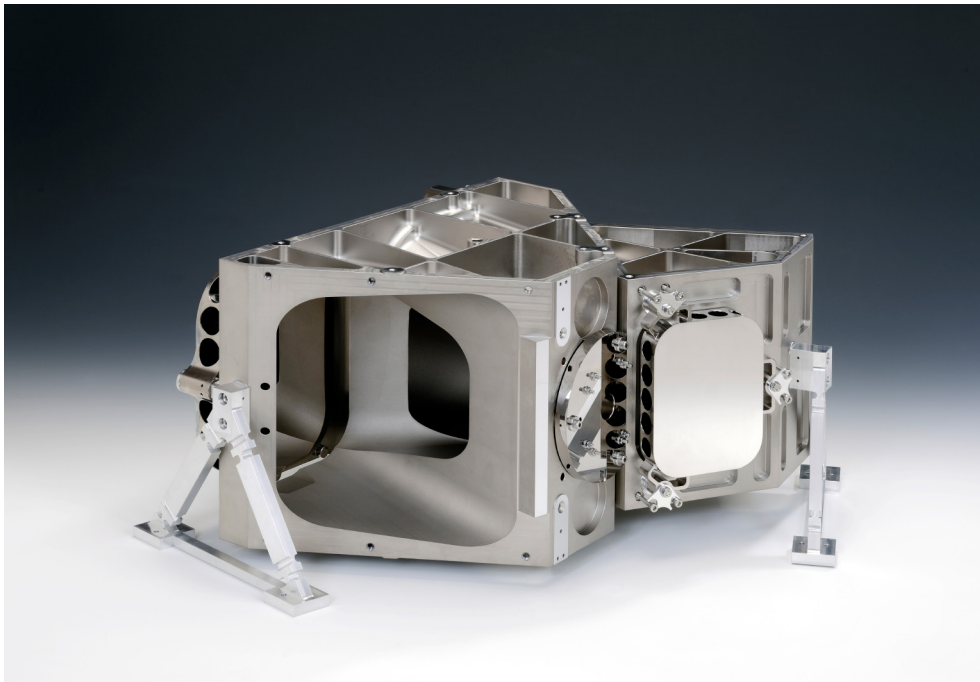


RESEARCH NEWS

SPECIAL ISSUE

05 | 2018 || Page 3 | 4

Team around Dr. Ramona Eberhardt (third from left), who, together with industrial partners and the University of Jena, researched the potential of optical free-form systems, presented innovative solutions and further developed production methods. © Fraunhofer / Walter Oppel



View into a lightweight housing of a metal optics. © Fraunhofer IOF / Michael Weimer

RESEARCH NEWS

SPECIAL ISSUE

05 | 2018 || Page 4 | 4

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