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## 60th anniversary of the laser: Jena research groups worldwide leading in laser development

**It is indispensable for the use of smartphones, for modern medical technology or applications in space: we are talking about lasers. It first saw the light of day exactly 60 years ago. To make this groundbreaking invention accessible to a wider public, UNESCO has declared the laser's birthday, May 16th, to be International Day of Light. The laser researchers of Jena, the city of light, are also celebrating this anniversary - numerous records have been set here over the past 22 years. To this day, Jena is at the forefront of research in the field of laser technologies.**

On May 16th, 1960, the team around Theodore H. Maiman at Bell Labs (USA) succeeded in realizing a laser for the first time. Applications were tested early on, e.g. in material processing or ophthalmology. The wealth of ideas for the use of the new precision tool subsequently increased inexorably. In only 60 years, the laser has become almost universal and indispensable for our daily life.

Laser technology also plays an important role in Jena, the city of light. For more than 20 years, researchers at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF and the Institute for Applied Physics at the Friedrich Schiller University of Jena have been working continuously to improve the parameters and application possibilities of lasers. Prof. Andreas Tünnermann is an experienced expert at the head of both institutes - in 2005 he himself was awarded the Gottfried Wilhelm Leibniz Prize for his work in the field of laser development.

Other renowned prizes were awarded to the deputy director of the Fraunhofer IOF, Prof. Stefan Nolte, for the use of ultrashort laser pulses in industrial production (German Future Prize 2013) and to the head of the "Fiber and Waveguide Lasers" research group at the Institute for Applied Physics, Prof. Jens Limpert, who received an ERC grant for the third time in 2019 for his research in the field of high-performance fiber laser systems.

On the occasion of the anniversary, Institute Director Prof. Andreas Tünnermann recalls the most important milestones in Jena's laser research: "There were many decisive developments. One of them is undoubtedly the coherent coupling of lasers for scaling the output, for which we in Jena stand worldwide. The demonstration of the laser in optical communication networks was also important for us. Without the laser, our digital society would probably not exist. But there are other examples, such as the use of the laser as a precise and wear-resistant tool."

**Editorial Notes**
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Besides the development of novel and groundbreaking fiber amplifiers, so-called "rod-type fiber amplifiers" in 2004, the Jena researchers have succeeded in the past decades in constantly raising the average output of high-power fiber lasers to new record levels. This happened in 2009, when an output power of > 2 kW was achieved for the first time using spectral beam combining (SBC). Further highlights followed, e.g. in 2019 when Prof. Jens Limpert's team succeeded in realizing an ultra-short pulse thulium fiber laser system with an average output power > 1 kW. Only at the beginning of this year, a novel 10 kW femtosecond laser system based on a coherent combination of laser beams (CBC) was presented at SPIE.Photonics West.

Despite the achievements so far, Institute Director Tünnermann indicates that the limit of what is feasible is far from being reached. "In the future, the laser will open up new wavelength ranges up to the X-ray range and thus enable new imaging methods in medicine, for example."

Intensive research is currently being carried out at the Fraunhofer-Gesellschaft on ultra-short pulsed lasers for industrial applications. In the "Cluster of Excellence Advanced Photon Sources" (CAPS), 13 Fraunhofer Institutes have joined forces to develop laser sources and process technology for outputs up to 20 kilowatts. Lasers of this kind could be used, for example, to make millions of tiny holes in aircraft wings, which would help to save fuel.

More and more advanced laser technologies are also needed in the field of quantum technologies. Practically all approaches to quantum technology require lasers to generate and query quantum states. This was the case with the "QuNET" project, for which the Fraunhofer-Gesellschaft, the Max Planck Society, and the German Aerospace Center have been building a pilot network for quantum communication in Germany since last year.

Experts, therefore, agree that the laser will continue to produce spectacular innovations in the future. Laser researcher Prof. Andreas Tünnermann puts it this way: "Although the laser is now 60 years old, it is always good for something new. There are always new surprising realizations of this old concept."

Further information about laser technologies "Made in Jena":

Laser Technologies at the Fraunhofer IOF:
https://www.iof.fraunhofer.de/de/geschaeftsfelder/lasertechnik.html

Laser Technologies at the Institute of Applied Physics (FSU Jena):
https://www.iap.uni-jena.de/fiber_waveguide+lasers.html

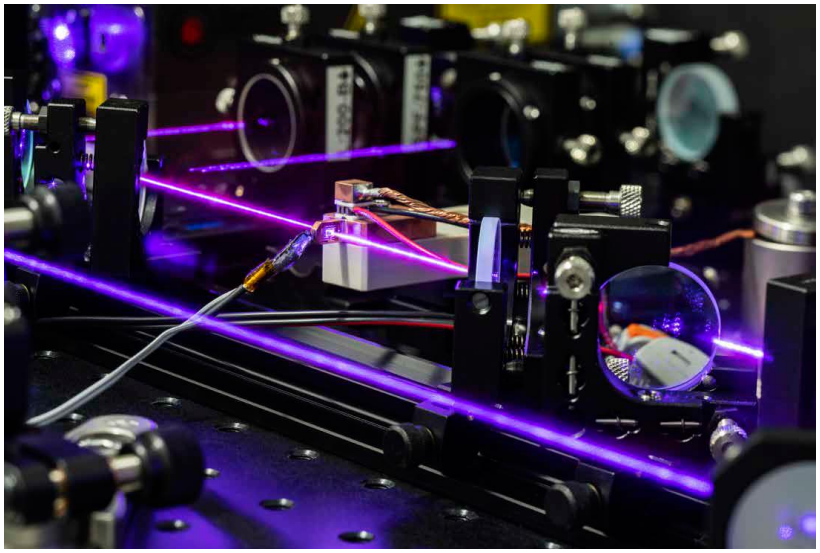

Fig. 1: During the investigation of a quantum optical imaging system, laser entangled photon pairs are generated. (Fraunhofer IOF)

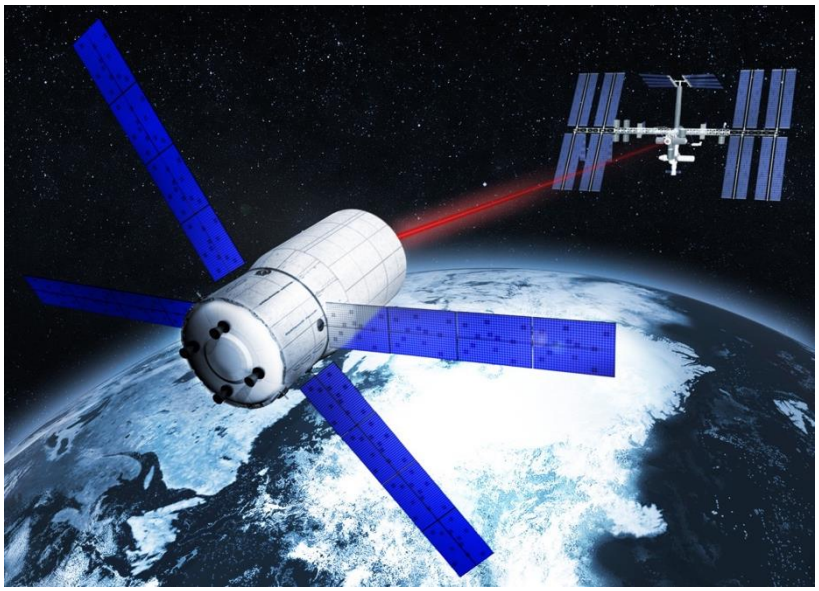

Fig. 2: A short-pulse fiber laser suitable for LIDAR applications (light detection and ranging) for the centimeter-accurate detection of space debris. (Fraunhofer IOF)

Fig. 3: The scaling of the multi-kW ultrafast fiber laser is based on the coherent combination of several individual beams.