PRESS RELEASE

Laser fusion – a promising market at LASER 2025

Laser-based inertial confinement fusion is a market that holds strategic value for the photonics industry. Its feasibility has already been demonstrated. In Germany, consortia from industry and research are forming to tap this climate-neutral and intrinsically safe energy source and create powerful supply chains for it. The state is providing over one billion euros to develop basic technologies for fusion power plants. Current approaches have great potential for innovation beyond fusion. Key players will meet at LASER 2025 for the application panel "Laser Fusion: Energizing photonics Industry". Led by the Fraunhofer ILT, it will shed light on the market potential and opportunities of fusion.

Laser-based inertial confinement fusion is making the leap from basic research to a technological development geared toward applications. Germany has set the course to develop this climate-neutral, round-the-clock energy source as quickly as possible. Sixteen consortia with a budget of 140 million euros have formed since the German government launched the program "Fusion 2040 - Research on the Way to the Fusion Power Plant" in spring 2024. Corporations, SMEs, start-ups, research institutes and universities are pooling their expertise to develop basic technologies for fusion power plants, marking the start of a research offensive that Germany will fund with over one billion euros by 2030. In addition, the participating companies are making private investments, the majority of whom come from the photonics industry and have recognized fusion as a strategic future market.

Application panel "Laser Fusion: Energizing Photonics Industry" at LASER

An application panel at the Laser World of Photonics will explore the potential for the photonics industry. Moderated by Dr. Jochen Stollenwerk, acting director of the Fraunhofer Institute for Laser Technology ILT in Aachen, the panel contains leading experts from industry and science who will discuss the state of the art, challenges and photonic solutions. The keynote speech on the panel "Laser Fusion: Energizing Photonics Industry" will be given by Prof. Constantin Haefner, Executive Board Member for Research and Transfer at the Fraunhofer-Gesellschaft. Until the end of 2019, he was Program Director for Advanced Photon Technologies at Lawrence Livermore National Laboratory in California, USA, where he was responsible for developing the world's most powerful laser systems, which were used to ignite a fusion plasma for the first time at the National Ignition Facility (NIF).

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Since moving to Germany, Haefner has contributed his expertise as an advisor to the German government on the Fusion Advisory Board of the Federal Ministry of Research, Technology and Space (BMFTR) and as head of the expert commission for laser fusion. In his keynote speech, he will shed light on the opportunities for Germany and Europe in the future market of laser fusion, also in light of the fact that German photonics companies have played a significant role as technology and hardware suppliers for the NIF, a contribution that should not be underestimated.

"Establishing efficient supply chains in photonics is the prerequisite to making a fusion power plant technically and economically feasible," says Haefner. A number of innovations are still needed on the way there. Due to the expected market size, these will extensively transform the current market for industrial lasers, laser applications and optics. The research and development underway could also have a short-term impact – in the form of spillover effects – on the photonics market.

Starting signal for the development of powerful supply chains

The first consortia in the "Fusion 2040" program have formed, sending out the starting signal for the necessary innovation campaign. The projects bring together players from the fields of photonics, optics and materials science and pool their expertise. They will focus on the development and production of highly efficient diode lasers and robust optical glass and crystals, all of which will be exposed to extreme loads in the continuous operation of commercial power plants. The components are to pump laser pulses at high frequency to the energy level required to convert a mixture of the hydrogen isotopes deuterium and tritium into plasma and ignite their fusion. For commercial operation, 10 to 20 targets per second must be ignited with this mixture. These targets – pinhead-sized spheres – and the first reactor wall also require further development. The latter is exposed to the neutrons released during fusion and the thermal radiation of the fusion plasma at over 150 million degrees Celsius. There are also areas for development in the tritium cycle and the – wherever possible additive – manufacturing of complex power plant components.

The consortia address all of these topics. It is foreseeable that there will be spillover effects upon other areas of photonics and their user industries. For example, one of the projects aims to significantly increase the power of diode lasers while at the same time greatly reducing costs by fully automating their production. If the consortium achieves its goals, diode lasers are likely to develop transformative – and in some cases disruptive – potential across all sectors. There is also demand from other markets for high-power beam sources and the optical glass required for fusion power plants. Furthermore, there is growing demand for lasers that can be used as secondary sources for generating EUV, neutron or X-ray radiation. Among other things, such lasers are in demand for combined X-ray and neutron imaging. The process is intended to enable users to make optical and material analyses of the contents through the walls of sealed drums and containers. Laser beam sources are the key to miniaturizing the particle accelerators required for this and integrating them into compact devices.

The basic physics works – paving the way for applications

The development of laser fusion itself has been progressing rapidly since December 5, 2022 at the latest, the day of the breakthrough at NIF. According to Haefner, the increasing use of AI will further accelerate the pace of innovation. AI is already being used to optimize the experiments in the US test facility: While the ignition of the fusion plasma at the end of 2022 released 3.15 megajoules (MJ), 1.5 times the laser energy required for ignition, the NIF reported an increase to 5.2 MJ at the end of 2024, and to 8.6 MJ in May 2025. The fusion thus released 4.13 times more energy than the laser had focused on the target. The successful experiments prove that the basic physics works. However, the facility is not designed for energy generation, but for plasma research. In its 192 parallel beam paths, the flash lamps and special glass pump the energy level of the laser pulses to the required level. However, NIF's system has to cool down after each ignition because neither the optical components, the laser system nor the materials of the combustion chamber are designed for continuous power plant operation.

On route to concepts and technologies suitable for power plants

Completely new designs are needed to make fusion technology usable in power plants. The German government launched the "Fusion 2040" program to develop these designs. Industry participation in the first calls for proposals was enormous. The partners have begun to develop optical, photonic and materials-science technologies for a fusion power plant. By 2030, more than one billion euros will be available for open-technology research: In addition to laser-based inertial fusion, magnetic fusion is also on the agenda. Along with research institutions, the consortia bring together manufacturers of lasers, optics, coating processes, increasingly AI-supported production technology as well as testing and software development in order to leverage the enormous potential of the photonic market of the future. The cooperation between industry and science combines knowledge, processes and supply chains, a joint effort that creates the basis for the commercial use of fusion. As an intrinsically safe energy source, it is set to develop alongside wind and solar energy to become a reliable building block of an energy system decoupled from the carbon cycle.

Image 1:
The “Laser Fusion: Energizing Photonics Industry” panel in Hall A2.561 brings together leading players from the future supply chains in photonics.
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Image 2:
Prof. Constantin Haefner, Executive Board Member for Research and Transfer at the Fraunhofer-Gesellschaft, will open the discussion with his keynote speech on the application panel “Laser Fusion: Energizing Photonics Industry”.
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Application Panel "Laser Fusion: Energizing Photonics Industry"
Date: Tuesday, June 24, 2025
Time: 10:30 - 12.00 a.m.
Venue: Hall A2.561

Chair:
Dr. Jochen Stollenwerk, Acting Director, Fraunhofer Institute for Laser Technology ILT

Panel featuring, among others:
Prof. Constantin Haefner, Executive Board Member for Research & Transfer, Fraunhofer-Gesellschaft
Dr. Ulrich Steegmüller, Chief Technology Officer (CTO) & Senior Vice President (SVP), ams OSRAM
Dr. Frank Nürnberg, Global Head of Sales Optics, HERAEUS Covantics
Alexander Ancsin, Managing Director (CEO), Layertec GmbH
Prof. Thomas Thiemann, Senior Vice President (SVP), Siemens Energy

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