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DIGITAL
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Press release

Research Campus Digital Photonic Production celebrates Day of Light 2023

Author: Eleni Blum

Light is our livelihood

Humans have been using fire for two million years. Humans have lived in the glow of electric light for over 100 years. Light is energy, light is heat, light is the foundation of life in our world as we know it. Light has changed humankind in essential areas of life: for example, in medicine, in communication, in energy production.

Light and curiosity about its secrets continue to drive science to this day: Exactly 63 years ago, on May 16, 1960, Theodore Maiman succeeded in using a laser for the first time. He developed a laser using a ruby, which has a high chromium content and absorbs green and blue light, while emitting red light. By flashing white light into a cylinder of ruby, Maiman excited electrons in the chromium. The green and blue wavelengths excited in this way were absorbed and consequently amplified the red wavelengths until the light pulse from the ruby was amplified to high power and resulted in a laser (cf. ETHW 2021). He thus gave the starting signal for an exciting new field of research that continues to shape the world today.

As part of the funding initiative "Research Campus - Public-Private Partnership for Innovation" of the German Federal Ministry of Education and Research BMBF, the Digital Photonic Production (DPP) Research Campus establishes a new form of long-term and strategic cooperation between science and industry "under one roof." On almost 6000 m² of office and laboratory space, chairs of RWTH Aachen University, the Fraunhofer-Institutes for Laser Technology ILT and for Production Technology IPT as well as almost 30 partner institutions from industry are jointly researching processes for generating, shaping and using light as a tool for tomorrow's industry.

Editorial:
Eleni Blum ⋮ Chief Operating Officer, Digital Photonic Production Research Campus ⋮ Mail: eleni.blum@llt.rwth-aachen.de
Phone +49 241-8906 383 ⋮ Campus Boulevard 79, 52074 Aachen ⋮ www.forschungscampus-dpp.de

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Laser technology at the Digital Photonic Production Research Campus in Aachen

The Digital Photonic Production DPP Research Campus uses bundled light, the laser, as a key technology to make production of the future more efficient and sustainable. The spectrum of light offers numerous possibilities for research to address the needs of mankind. Thus, the scientists of the DPP Research Campus have set themselves the task of fundamentally researching light- and laser-based technologies. This tool of light, the laser, makes it possible to structure, ablate, apply, melt, join and cut a wide range of materials.

Unique collaboration at the DPP Research Campus in Aachen

An innovation ecosystem is being created at the site in Aachen with scientific institutions

- Fraunhofer Institute for Laser Technology ILT,
- RWTH Aachen University with the Chair of Laser Technology LLT, the Chair of Optical Systems Technology TOS, the Chair of Digital Additive Production DAP, the Institute of Ferrous Metallurgy IEHK, the Aachener Zentrum für Leichtbau AZL and the Werkzeugmaschinenlabor WZL
- Access e.V. and
- the Fraunhofer-Institute for Production Technology IPT

as well as with thirty industrial partners[1].

In a unique strategic form of cooperation, funded by the Federal Ministry of Education and Research (BMBF), partners from science and industry work together under one roof and use a jointly created technical infrastructure to conduct basic research on an interdisciplinary basis. In parallel, a common knowledge base – the DPP Open Know-how-Pool – is being created to ensure the sustainable structural development of the DPP Research Campus. The core of this is not only a joint cooperation agreement, but also an IP agreement covering all topics within the DPP Research Campus. Within the Open Know-how Pool, the partners are systematically researching technologies, competencies, and components of laser technology in three competence fields: Digital, Photonic and Production. Furthermore, they are

[1] A detailed listing can be found on the homepage www.forschungscampus-dpp.de.

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integrating them into industrial process chains in two application fields: Additive Production and Subtractive Production.

In the current, second research funding phase, the DPP Research Campus is establishing a flexible and agile project organization. For this purpose, the employees meet for two one- to two-week sprints per half-year. This synchronizes the on-site times of the research campus' members and strengthens the dialogue among them.

A sprint team is typically interdisciplinary and consists of 3 to 8 employees from science and industry. Each sprint team pursues a specific, clearly defined sprint goal. The new sprint goals set every six months are SMART, which means Specific, Measurable, Attractive, Realistic, Timed. At the semi-annual plenary meetings held at the DPP Research Campus, the current 17 sprint teams present their key results and provide documentation of their work in the specially established intranet of the DPP Research Campus. In this way, they make the know-how developed in all sprint teams freely accessible and sustainably available to all partners of the DPP Research Campus.

Bringing light into the (research) darkness - Digital Photonic Production

The resulting findings and results developed at the DPP Research Campus are integrated into industrial process chains as prototypes.

"Our 17 sprint teams are strategically designed to deliberately cover more than one sub-area (digital, photonic, production) and to develop synergies," explains Dr. Christian Hinke, strategic director of the DPP Research Campus. "Our 17 sprint teams conduct fundamental research to pursue the goal of optimizing applications in everyday industry."

The processing of glass with lasers and the associated process diagnostics are relevant for our everyday life, e.g. for solar cells, conductor paths or the permeability of mobile phone frequencies. Multi-beam processing, the use of several laser beams, for example ultra-short pulsed (UKP) beam sources, offer potential for increased productivity, performance and efficiency in material processing (on metals such as copper).

The topic of control technology plays another major role in laser research: Laser modules can achieve high product quality in many application areas such as microstructuring, welding and cutting. However, to be profitably used industrially, most systems must be combined with optics, whose task is to shape

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and guide the laser beam. Consequently, a sprint team is developing a method with which all components of a laser setup can be controlled and synchronized. To this end, it is important to examine how well different basic principles used for beam shaping and guiding can be compared. This will provide valuable knowledge about both performance limits and potentials.

Also of importance is research on optics manufacturing and related technologies. One team is currently working on using a so-called diamond cutting process to enable application-oriented, specific beam shaping that works reliably even at high power densities.

In order to test and validate different approaches, the scientists are developing a variable motion system for large-area laser processing. An interdisciplinary sprint team is currently defining all the requirements of four different sprint teams and designing a system that meets the entire set of requirements. These teams are working on combining different beam shaping and deflection systems, to develop and test optomechanical modules and their control for cascaded scanning systems (systems connected in series).

Furthermore, research is being carried out on thermal process models for the control of laser radiation to realize optimum temperature control processes in material processing and thus to avoid susceptibility to errors.

In addition, laser light is used in sensor technology for process control and plays a decisive role in detecting defects. This makes it possible to optimize production time and costs, and to use machines flexibly.

Another group of the DPP Research Campus' sprint teams focuses on Additive Manufacturing (AM); among other things, it is researching the modulation of laser power for Laser Powder Bed Fusion (LPBF) and developing an optimized alloy that can then be used for AM (more stable and efficient). Scientists are also researching software-based methods for the automated design and manufacture of AM components. Finally, the entire AM process chain is to be mapped, documented and simulated since research into optimized methods for process characterization and machine transferability is also relevant for AM

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Key technology for the future - Successful research campus concept

The potential of lasers, and thus of light, for use in science is unparalleled. Laser and light-based technologies are the key to the future.

At the DPP Research Campus, research on and with the tool of light is already in full swing, as Lucas de Andrade Both, who is a PhD student at the DPP Research Campus in cooperation with the Chair of Laser Technology at RWTH Aachen University, notes:

"The research campus culture is a win-win scenario: Industry partners can present their needs and ambitions for specific laser processes, and the chair can in turn design and develop technological solutions."

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