

# Max Planck School of Photonics: Developing Curriculum and Outreach Measures for a Network of Excellence

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**Abstract:** The Max Planck School of Photonics is an interdisciplinary graduate school in Germany providing an integrated MSc and PhD program for international students. Aspects of curriculum development and outreach measures will be presented and discussed. © 2021 The Author(s)

## 1. Max Planck School of Photonics

Excellent students world wide are aiming for admission into the best-ranked universities in the world striving to do their graduate studies. Among these top institutions German universities are under-represented, which contrasts with the excellent ranking of Germany's research activities and economic strength. The reason is the German research system itself where a significant part of research is conducted within non-university research institutes. This also includes academic education where only the degree must be awarded by a university which in turn compromises the ranking. On the initiative of the Max Planck Society, the German Government is supporting a new scheme in which universities and research organizations such as the Max Planck Society, the Fraunhofer Society, the Helmholtz Association, and the Leibniz Association are forming topical schools as new platforms for graduate student education under the common roof of Max Planck Schools. One of them is the Max Planck School of Photonics (MPSP) [1].

The MPSP involves Fellows who are highly renowned scientists and establishes a research and education program that attracts the best students in the world. The MPSP integrates university groups in photonics from eight different German universities (Aachen, Erlangen-Nürnberg, Göttingen, Hamburg, Jena, Karlsruhe, München, Paderborn) and research groups from nine different institutes involving all four large German research organizations (Max Planck Society, Fraunhofer Society, Helmholtz Association and Leibniz Association). Graduate students are admitted as PhD candidates to the 5-year doctoral program at two levels: (1) after a bachelor's degree, starting with a 2-year study phase, which is compatible with well-known graduate schools worldwide, and (2) after a master's degree from outside the MPSP, allowing the PhD candidates to immediately enter the 3-year research phase of the doctoral studies. The PhD candidates receive full financial support during both phases of the program. The synergy comes from (i) concentrating the study phase at three teaching universities (Jena, Karlsruhe, Erlangen-Nürnberg), (ii) offering diversity of mentorship, (iii) holding joint photonics-related meetings, (iv) enabling short research visits at other MPSP locations, (v) providing a digital teaching platform connecting educational offers across all locations, and (vi) networking with industry. Currently 48 Fellows at different stages of their careers participate in the supervision and mentoring of 55 PhD candidates in both phases of the program.

The MPSP program offers broad support for research activities of its Fellows as well as the education of its graduate students. The focus of this contribution are measures and developments of the MPSP program that are specifically centered around the students during the application phase and during the academic education.

## 2. Outreach and Community Building Measures

In addition to the direct goals of the MPSP, the long-term objective is to strengthen the international optics and photonics community beyond the boundaries of the MPSP network. Specifically, the MPSP aims at:

1. Bringing more women and diversity into the optics and photonics community,
2. Motivating more young physicists/engineers to pursue a scientific career in optics and photonics, and
3. Promoting exchange between the (younger) photonics community worldwide.

These goals are pursued through online events such as lecture series, workshops, virtual conferences, and the creation of social (media) networks. In 2020, the MPSP established its "MPSP Lecture Series" where MPSP Fellows hold public lectures on their research. The "MPSP Coffee Breaks" are specifically aimed at young scientists. Master's students or PhD candidates present and discuss their research with peers. Students around the globe are invited to present and participate - all events are advertised beyond the MPSP network. To further increase the

audience reached, the MPSP cooperates with various student chapters of OSA and SPIE. In June 2021, for example, a lecture series named "#Photonics101" was launched together with the University of Glasgow Optical Society aiming to encourage undergraduates to pursue a career in photonics by presenting photonics research in short, entertaining talks. In 2020, the MPSP co-hosted a seminar on peer-reviewed publication organized by the OSA Student Chapter Erlangen and the IMPRS Physics of Light as well as a virtual panel discussion on gender equality in science organized by the OSA and SPIE chapters Jena. The MPSP has further taken up the topic of gender equality in science by organizing its own series of events. A panel discussion on "Women in Photonics" and a corresponding workshop empowering young females in photonics were organized. With this series of events, more than 50 young women with a physics and engineering background were reached, who continue to network in a social media group. The "Photonics Days Jena" are organized in cooperation with the Fraunhofer Institute for Optics and Precision Engineering for the third time in September 2021. This public career event connects young talents in optics and photonics with one another and with potential employers from the German industry.

A direct consequence of these community building events are a substantially broadened network and a significant increase in number and quality of qualifying application during the past two years.

### **3. Curriculum Development and Digital Teaching**

In the current pilot phase of the MPSP, the teaching universities Friedrich Alexander University Erlangen-Nürnberg, Friedrich Schiller University Jena and Karlsruhe Institute of Technology in Karlsruhe form the foundation of the MPSP study phase with their established master's degree programs. They have been training international students for this purpose in their individual, locally accredited master's degree programs for more than ten years. The first MPSP study phase PhD candidates were admitted to these programs in 2019. This is intended to create a pool of excellent master's graduates with outstanding professional qualifications who will subsequently pursue doctoral degrees on photonics topics within the MPSP at all MPSP locations. A central point of the MPSP's implementation concept is the convergence and synergetic combination of the diverse, already established location-specific educational elements into a common, internationally visible elite program. For the MPSP study phase, this includes the vision of a master's degree offered jointly by the three teaching universities, which also includes training modules from all other MPSP locations. Based on the experience of the past two-year initial phase of the program and the training of the first master students, it is already clear that the potential of the MPSP in the study phase can be better used by supporting the overarching character and realize a joint degree program of the three teaching universities. This approach addresses the narrow limits set by the established curricula and allows to support truly excellent master students adequately and individually, and to activate their outstanding potential as future photonics elite. Only the combination of the contents of the hitherto separate master's degree programs promises such a high-quality range of courses enabling the MPSP to be recognized as exceptional by the highest-performing international applicants and to compete with offers of highly ranked international universities.

A key element and the foundation of joint collaborative teaching and scientific exchange within the MPSP network of excellence are digital teaching tools and methods. The MPSP provides support for its Fellows in their basic teaching activities including every didactic and technical aspect of digital teaching, such as course format design, technical realization, target group analysis and distribution infrastructure. The MPSP also works on solutions for digital teaching problems that have no standard approach yet, such as a high-level solution for digital collaboration in laboratories at different locations. These solutions enable entirely new possibilities for collaboration in training by exploring the possibilities of the latest technology in the academic educational context. The MPSP creates proof-of-principle solutions and has the means to directly implement them in a large network. The size of this network and its level of excellence are unique in the field of photonics worldwide. This helps bring German photonics education to the top in a highly competitive global education market. The explorations in areas such as augmented-, virtual- and mixed-reality applications for high-technology teaching are unprecedented in the academic field of photonics. The MPSP digital teaching thus furthers valuable pioneering work beyond its own scope. This includes interaction beyond the first-mission academic activities of the MPSP, especially to place the topical context of photonics in society on a broader basis. This aspect seamlessly connects to the broad range of outreach activities and community building measures.

### **References**

[1] R. Geiss, J. Hengster, T. Kaiser, G. Leuchs, and A. Tünnermann, "Max Planck School of Photonics: research-oriented photonics education in a network of excellence throughout Germany," in Fifteenth Conference on Education and Training in Optics and Photonics: ETOP 2019, ETOP 2019 Papers (Optical Society of America, 2019), paper 11143 161.