Proficiency of High Quality of Photonics Master's Degree Program

A bachelor program represents a fundamental course of studies that provides the most important skills, background and theories of subjects.

The inherent difference of the Photonics Master Degree program compared to a corresponding bachelor program is that existing knowledge will be enhanced and new consolidated findings will be created.

- In respect of optical communication engineering the bachelor program for example explains: "Why light propagates along a fiber?" or "How does dispersion deteriorate system performance?" The master subject **"Optical Fiber Communication" provides consolidated knowledge of: "Why does light to some extent also propagate outside the fiber core and what are the consequences?" or "How can we handle fiber dispersion to guarantee signal integrity and thus realize long-haul transmission links?"**

- In the master course unit **"Advanced Image Processing", we focus on the algorithms of image processing and its applications.** Knowledge of hardware components (camera, CCD, CMOS) is a prerequisite provided in bachelor program.

- Quantum physics is typically not subject in bachelor courses of engineering. However, quantum phenomena play an important role in many fields of engineering, primarily in photonics and quantum computation. The compulsory master course unit **"Quantum Optics" is the first and so far only lecture at Aalen University addressing subjects of quantum physics** on the necessary state of the art theoretical level. The lecture is customized for the specific needs of engineers providing Hilbert space mathematics and the theoretical quantum physical background so that engineers with a bachelor degree in optoelectronics, optics, electronics, physics or computer science have the same starting position.

- Many principles of laser technologies are based on nonlinear optics. The compulsory master course unit **"Nonlinear Optics and Lasers"** focusses on the design and optimization of nonlinear optical devices. In contrast to lectures on nonlinear optics which are typically part of advanced physics course units at other universities this lecture gives not just an introduction and theoretical descriptions of nonlinear optical phenomena but **provides in particular the mathematical methods and engineering tools necessary for example to select and optimize nonlinear optical crystals** playing a key role in laser technology.

- Because master students without background on lasers need an introduction to the principles of laser physics, the optional course unit **"Laser Technology"** starts with first principles. However, in contrast to the lecture on this subject of the

bachelor course the **mathematical description of laser phenomena is in the foreground**, in particular differential rate equations and their mathematical solution. The important and mathematically challenging field of statistical optics and coherence addressed in the master course isn't part of the bachelor course at all. The same is true for the design of laser resonators. The lab part of the lecture comprises advanced experiments which are not part of the bachelor program either.

- The lectures on **"Optical Design"** also start with a compact introduction to the principles and analysis tools of optical design strategies. Students with no background of optics have to successfully pass the lecture on "Fundamental Optics" before they may participate in lectures of "Optical Design". In contrast to bachelor course units on this subject the master course **focus on project work where students have to design, analyze and optimize optical systems** with the professional design software ZEMAX and CODE V in a **self-reliant** way.

- The lectures on **"Physical Optics"** deal with the mathematical description of optical problems. The students will **learn to describe experimental findings in a fundamental way**. In comparison to the bachelor course a certain abstraction level is needed. Thus the students are trained with respect to their analytical approaches.

- The lecture on **"Simulation of Sensor Systems"** enable the students to utilize the Matlab-software in order to solve engineering tasks. Thereby the goal is to **develop algorithms** for example for image evaluation or **3D metrology based on optical sensors**. As one has to take the whole optical system into account, this is clearly above a bachelor level.

As a consequence of the above-mentioned characteristics a master graduate

- is able to understand and handle **complex problems and experiments**
- has an increased ability to **abstract thinking**

Methodically we emphasize on **self-reliant learning** by guided seminars and projects.