**Description of work**

The Chair of Integrated Photonics (IPH) is starting a new activity together with the Quantum Technology Group (Prof. Bluhm) of the JARA Institute of Quantum Information focusing on the time interleaved (multiplexed) optical readout of quantum dots. Quantum information processing is an emerging field of research that gained significant attention during the last years from the research community and industry alike. The technology is expected to enable radically new approaches to data mining and computational problem solving due to its unique quantum based massively parallel computing mechanism.

Even though significant progress has been made for quantum computation units, the processing capability is currently limited to a few q-bits. To further extend the processing power, quantum interfaces are needed that connect individual quantum computation units while preserving the quantum nature of the information being processed.

The quantum interface proposed here is based on an optical fiber-interconnect technology, with the long term goal of enabling high-throughput interconnections between quantum computation units.

For this interface, quantum data is first transferred to optically active quantum dots embedded in a 2D optical cavity. The light emitted from the quantum dots is emitted into the cavity mode(s). The cavity is designed to emit the stored light perpendicular to the plane of the chip. This light can then be picked up by an optical fiber and be transmitted to a second cavity located on another quantum computation unit. This cavity then transfers the quantum information to the q-bits via the intermediate quantum dots. The figure below shows a schematic of the proposed cavity architecture (right) and the full optical quantum interface.

We are looking for a student interested in working on a Master thesis, whose topic it will be to design optical cavities facilitating the collection of photons emitted by quantum dots into optical fibers. The work comprises the photonic design of different cavity architectures based on 2D and 3D optical simulations as well as the light extraction device and its properties.

Finally, the candidate should generate layouts for test-structures. These test-structures will be fabricated and characterized after completion of this Master Thesis project and are not within its scope due to time constraints.

Required skillsets lie primarily in the realm of classical electromagnetics / photonics (e.g., as taught in the OTKI and OTKII ETIT lectures) and can be handled by an ETIT student. Students from physics programs are also very welcome to apply!

Interested candidates should e-mail Prof. Jeremy Witzens at jwitzens@gmail.com. Please include a grade transcript in your application.

We are looking forward to hearing from you!
At the Chair of Integrated Photonics, we are doing research on semiconductor based optical components and their integration into complex photonic systems in semiconductor chips. In particular, we focus on those devices and systems that can be fabricated on silicon substrates with CMOS compatible technology – so called Silicon Photonics – that enable scalable and low cost fabrication. These photonic integrated circuits (PICs) can be applied e.g. to optical communications, biosensing and other optical metrology / measurement systems.

The figure below shows a few examples of PIC solutions that have been realized at IPH. (a) shows a PIC based on silicon photonic technology and its integration into an optical communications transmitter/receiver module (b). The PIC contains 8 high-speed electro-optic modulators and photodetectors, each able to handle serial data rates of 25 Gbps, providing an aggregate bandwidth of 200Gbps via a single optical fiber. (c) is a system diagram of a PIC used as a switchable visible wavelength light source for fluorescent microscopy. It contains attenuators, switches and beam forming elements. (d) shows the switch system PIC fabricated in a silicon nitride PIC technology mounted in a module.