NOON-SENS: Quantum sensing of biomolecules with NOON states | 1GS	**Start Date:** September 1st 2014

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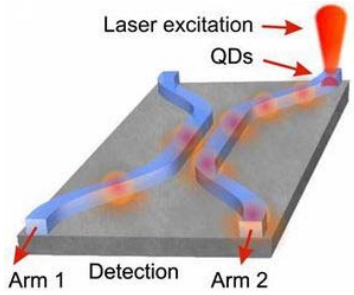

Abstract: The on-chip implementation of quantum photonic elements for chem/bio sensing strategies on the single photon level is a progressive research topic and under strong investigation by several groups. Semiconductor single quantum dots in combination with an on-chip rib waveguide structure can be used, in combination with the realization of basic logical elements, used for linear optical quantum circuits, for sensing applications at the quantum limit. Therefore we develop a photonic chip, which integrates quantum dot based single photon sources and a waveguide based Mach-Zehnder interferometer allowing for N00N-state generation via the Hong-Ou-Mandel effect. These non-classical light states will be coupled to a second chip with waveguide architectures dedicated to evanescent field sensing of biomolecules via phase changes accompanied by operation at ambient conditions. This sensing strategy enables a two times more accurate measurement of a phase change as possible within classical physics. Hence, detection of minute amounts of biomolecules like a-synuclein, as potential marker molecule for Parkinson's disease, paves the way for early detection of such neurodegenerative diseases.

Recent results: In a very recent proof-of-principle study, we presented an experimental realization of the generation of two-photon NOON states by using the radiative recombination of excitonic states in a single semiconductor quantum dot. Phase super-resolution and phase super-sensitivity have been observed.

- In addition, high-quality photonic integrated circuits on a GaAs platforms have been developed.
- Generation, guiding and splitting of triggered single photons from resonantly excited quantum dots in a waveguide circuits have been demonstrated.
- Furthermore, first sensing measurements have been performed in the mid-infrared spectral range using a thin-film GaAs/AlGaAs platform. The achieved results open new perspectives for the implementation of photonic quantum circuits for quantum sensing applications.

Publications:

Quantum dot single-photon sources for entanglement enhanced interferometry
M. Müller, H. Vural, C. Schneider, A. Rastelli, O.G. Schmidt, S. Höfling, P. Michler
Phys. Rev. Lett. **118**, 257402 (2017)

Mid-infrared spectroscopy platform based on GaAs/AlGaAs thin-film waveguides and quantum cascade lasers
Markus Sieger, Julian Haas, Michael Jetter, Peter Michler, Matthias Godejohann and Boris Mizaikoff
Anal. Chem., 2016, 88 (5), 2558-2562 (2016)

Generation, guiding and splitting of triggered single photons from a resonantly excited quantum dot in a photonic circuit
Mario Schwartz, Ulrich Rengstl, Thomas Herzog, Matthias Paul, Jan Kettler, Simone Luca Portalupi, Michael Jetter, and Peter Michler
Optics Express Vol. 24, Issue 3, pp. 3089-3094 (2016)

On-chip beamsplitter operation on single photons from quasi-resonantly excited quantum dots embedded in GaAs rib waveguides
U. Rengstl, M. Schwartz, T. Herzog, F. Hargart, M. Paul, S. L. Portalupi, M. Jetter and P. Michler Appl. Phys. Lett. 107, 021101 (2015)