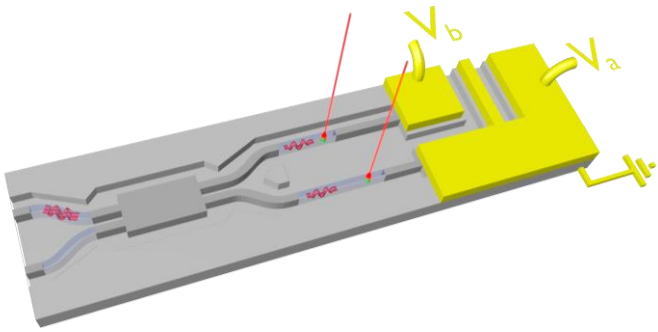
Development of integrated quantum circuits

Background: Integrated quantum nanophotonics offers enormous potential for the development of compact quantum circuits with high functionality. In the future, boson sampling and photonic quantum computers can be realized with such circuits. What is important here is the scalable integration of quantum emitters, which generate individual photons and couple them into waveguide systems with high efficiency. The quantum functionality is typically based on single-photon interference, which requires the emission of identical photons from the integrated emitters[1].



Schematic view of an integrated quantum circuit with two spectrally tunable quantum dots.

The project:

Within the master's thesis, integrated quantum circuits are to be developed to implement an on-chip Hong-Ou-Mandel (HOM) experiment. For this purpose, two quantum dots are to be deterministically integrated into a waveguide system using in-situ electron beam lithography. The structures must be electrically contacted to bring the two quantum dots into spectral resonance. In addition to the design and assistance in the manufacture of the integrated circuit, extensive optical and quantum-optical investigations are also to be carried out to demonstrate the desired functionality.

Your tasks:

- Numerical design and optimization of integrated quantum circuits
- Device fabrication using in-situ electron beam lithography
- Optical and quantum optical experiments to evaluate the properties of the fabricated quantum circuits and verify their functionality, with a focus on demonstrating on-chip HOM interference

What you can expect:

- Study a cutting-edge and exciting topic in quantum nanophotonics
- Deepen your knowledge of semiconductor materials, semiconductor quantum dots, optoelectronic components and modern simulation, nanotechnology and characterization methods of optoelectronic components.
- Deep insight into semiconductor nanotechnology by supporting fabrication of nanophotonic quantum light sources.
- Working in a friendly environment and discussing with other motivated and talented scientists daily
- We greatly value the importance of close training and support to students in all aspects.

Prerequisite:

- A strong ambition and passion to carry out a project.
- An open mind to learn new knowledges and tackle down the encountered problems.
- Having some basic knowledge in semiconductor quantum dots, optoelectronic components, and quantum optics is advantageous, but is however never as important as above!

Interested? Please contact: Stephan Reitzenstein, stephan.reitzenstein@physik.tu-berlin.de

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[1] S. Rodt & S. Reitzenstein, APL Photonics 6, 010901 (2021)