Master's Thesis

If you are interested in a cutting-edge interdisciplinary research on the interface of atomic physics, quantum optics, and Nano-photonics this is a proper project for you.

Within the scope of this Master's thesis, you will develop good theoretical understanding and experimental skills by working on an efficient integrated optical cavity embedded in an atomic vapor cell.

Some of the important milestones of this thesis are summarized as below:

- Fabrication of the Nano-beam cavity in Silicon nitride. The schematics of the designed cavity and its energy distributions at resonance are shown in Fig. 1. During your thesis, you are going to closely work with our fab. partners at IMS (Institute of Microelectronics Stuttgart) to fabricate this device. During this phase, you would acquire a profound understanding on Nano-cavities and learn about fabrication technology.

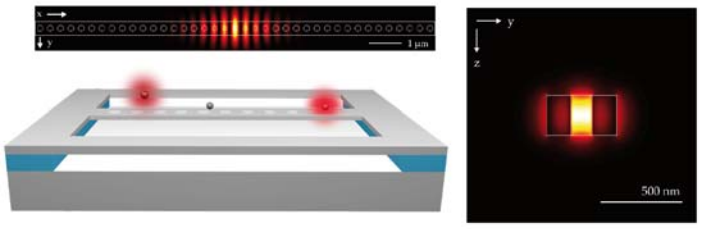

Figure 1. Schematics of the Nano-beam cavity and its mode profiles. [Curtesy of: M. Basic, Bachelor thesis, University of Stuttgart, September 2018].

- Optical measurement and characterization of the fabricated chip. While working on the device fabrication you would work on building a step to characterize the fabricated device in our lab. Figure 2 (top) shows the tentative optical setup for characterizing the device. In the lower panel, you can see a typical configuration of such an on-chip device where optical fibers are used for in/out-coupling.

- Embedding the chip inside a rubidium vapor cell.

- Theoretical studies and numerical simulations. To study the interaction of rubidium atoms with such a device a proper theoretical model must be developed. In collaboration with other group members and learning from the existing knowledge of the group, you will develop a Monte-Carlo-based algorithm to study the behavior of such hybrid system in the classical (i.e. many photons in the cavity) as well as the quantum regime, i.e. few photons in the cavity.

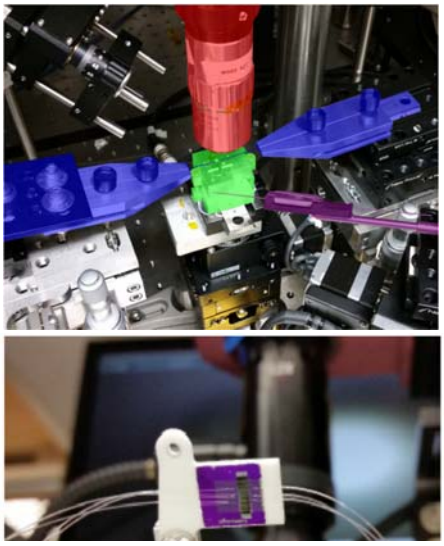

Figure 2. (top) Optical setup for device characterization. (bottom) A chip with multiple cavities addressed by optical fibers. [Curtesy of: A. McClung, PhD thesis, Caltech, June 2017].

For any additional information or questions about this project feel free to contact Prof. Dr. Tilman Pfau at t.pfau@physik.uni-stuttgart.de or Hadiseh Alaeian at alaeian@pi5.physik.uni-stuttgart.de