Adaptive Quantum Optics
Quantum Information Processing (AQO-QIP)

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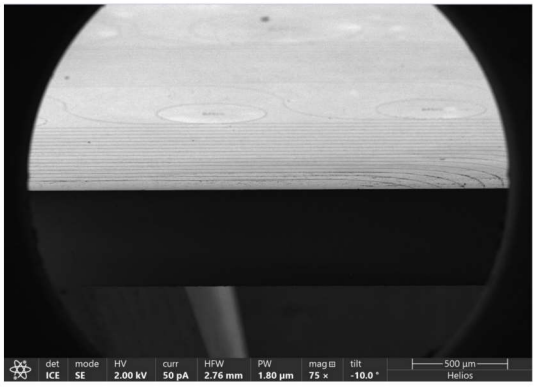
Introduction

At AQO-QIP we create, manipulate and detect quantum states of light.

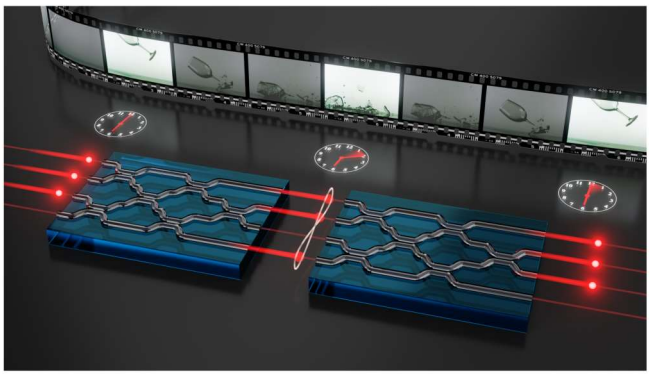
Quantum information can be encoded into these states and then processed in a way that outperforms classical computers! This we call a **Quantum Advantage.**

This requires very specialized hardware and a deep understanding of quantum optics, quantum information theory and photonics, but also many other field of physics in which we try to solve problems.

Fabrication



Experiments in Integrated Photonics



near term

Applications:

1) Photonic quantum simulations:

By encoding information in the photons, and some operation in the processor, we can simulate quantum systems!

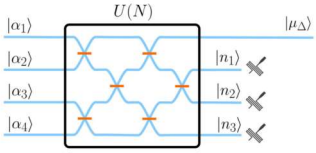
Check out our papers!

- Quantum thermodynamics [1]
- Loop quantum gravity [2]
- Verified Boson Sampling

2) Quantum Random Number Generation (QRNG):

Making use of the inherent randomness of quantum mechanics, we can create protocols for QRNG in a **secure** and **certifiable** way

3) Towards Universal Quantum Computing:

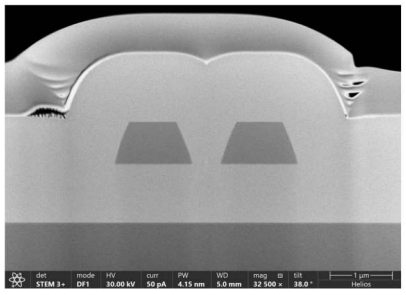


long term

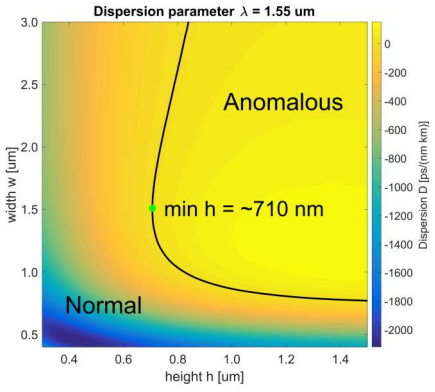
The ultimate goal of our group is to develop a fault-tolerant universal quantum computer.

Waveguides

We are working on the fabrication of thick, crack free stoichiometric Si3N4 waveguides.



Thick waveguides enable highly confined modes and dispersion engineering, relevant for nonlinear optics needed to realize for example single photon sources.



Conclusion

Photonics has positioned itself as a robust and scalable platform for quantum information processing, but there are still many challenges and open questions in the road to universal quantum computing.

We at AQO-QIP are at the forefront of this field both on the experimental and theoretical side.

[1] Somhorst, F.H.B., et al. Nat Commun 14, 3895 (2023).
[2] van der Meer, R. et al. npj Quantum Inf 9, 32 (2023).

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