Why Fraunhofer IAF?

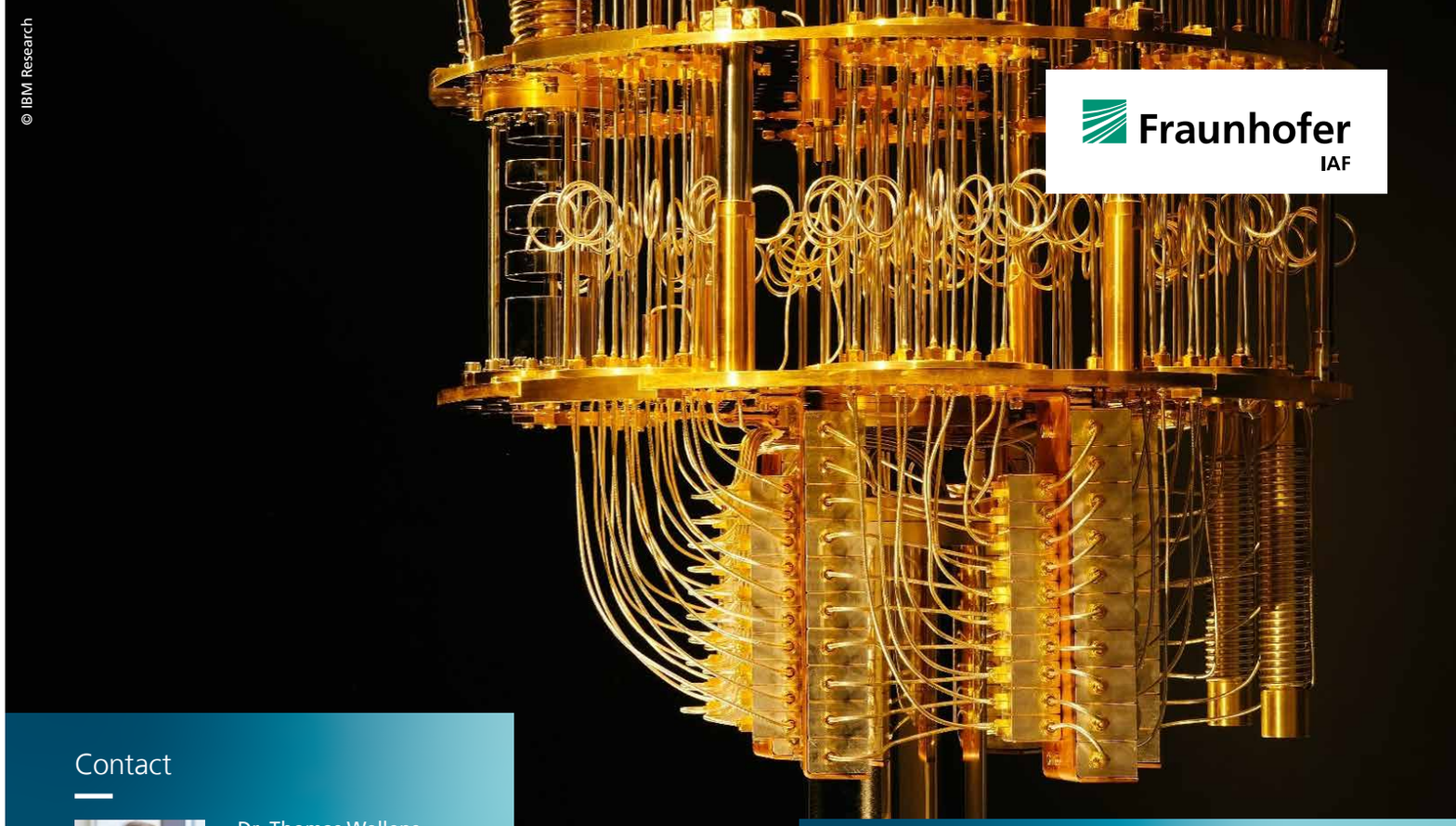
The quantum information at Fraunhofer IAF uses state-of-the-art methods to characterize qubits, quantum gates as well as quantum systems, develop reliable methods for error mitigation and optimize quantum algorithms for applications such as portfolio optimization.

The joint coordination of the Competence Center Quantum Computing Baden-Württemberg by Fraunhofer IAF and IAO also allows partners from industry and research to have exclusive access to the IBM Quantum System One near Stuttgart, Germany, and to gain data-secure hands-on experience with quantum computing.

What we offer:

- Characterization of qubits and quantum gates using quantum process tomography, gate set tomography and randomized benchmarking
- Further development of methods for reliable mitigation of readout and gate errors
- Optimization of quantum algorithms in the context of different applications
- Application-oriented training and access to the IBM Quantum System One in the context of the Competence Center Quantum Computing Baden-Württemberg (in cooperation with Fraunhofer IAO)

Would you like to learn more about our research activities and range of services in the field of quantum information? We will be happy to present our work and various cooperation opportunities to you in person.



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Characterization of quantum hardware, error mitigation and quantum optimization algorithms

Quantum information

Optimized algorithms for quantum advantage

At Fraunhofer IAF, researchers are setting the course for quantum computers to outperform classical computers in accomplishing complex tasks. To this end, Fraunhofer IAF uses various approaches to characterize quantum hardware, develop methods for reliable error mitigation and optimize quantum algorithms to pave the way for quantum computing to be applied.

Enabling quantum computing

Before the benefits of quantum computing technology can be exploited in practice, a number of challenges needs to be overcome. In addition to the construction and characterization of suitable hardware, the compensation of computational errors and the reliable implementation of appropriate quantum software are essential steps towards making quantum processors usable.

Fields of application

- Finance: Static and dynamic portfolio optimization
- Logistics: Optimization of complex processes
- Biotechnology and medicine: Simulation of protein folding
- Computer science: Feature selection for classification algorithms

Reliable quantum algorithms through hardware characterization and error mitigation

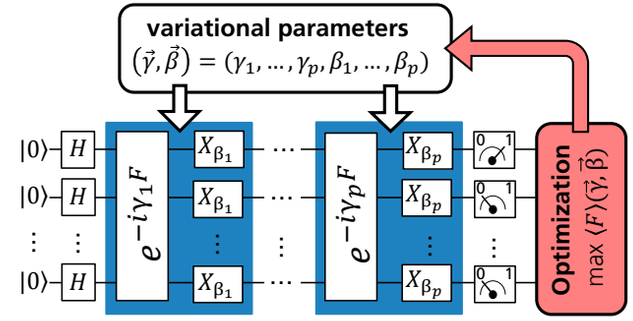
In order to be able to develop reliable quantum algorithms, Fraunhofer IAF explores possibilities of error mitigation. Quantum process tomography, gate set tomography and randomized benchmarking techniques are used to efficiently characterize individual qubits and quantum gates as well as their noise.

On this basis, the noise behavior of the entire quantum system can be characterized and simulated, which supports the development of efficient readout and gate error mitigation protocols. For this purpose, Fraunhofer IAF researchers use readout error mitigation based on classical postprocessing of the measured data as well as zero-noise extrapolation, which allows them to probabilistically determine expected noise-free values.

Portfolio optimization by quantum algorithms

One application area where quantum advantages could be achieved prospectively is optimizing the management of large and complex portfolios, for example in finance. The ability to make optimal decisions as quickly as possible is a clear competitive advantage. Such portfolio-related decisions could be significantly accelerated by the use of a quantum computer.

Fraunhofer IAF is developing and testing optimization methods on the IBM Quantum System One in Ehningen near Stuttgart, which is provided by the Fraunhofer-Gesellschaft and IBM. The researchers explore different variants of the Quantum Approximate Optimization Algorithm (QAOA), which combines classical and quantum physical calculations.



Quantum circuit of the QAOA algorithm (blue) with classical parameter optimization (red)

As part of the Competence Center Quantum Computing Baden-Württemberg, supported by the Ministry of Economic Affairs, Labour and Tourism Baden-Württemberg, Fraunhofer IAF and IAO offer partners from industry and academia in-depth training on quantum algorithms and provide exclusive access to the IBM Quantum System One for hands-on practice.