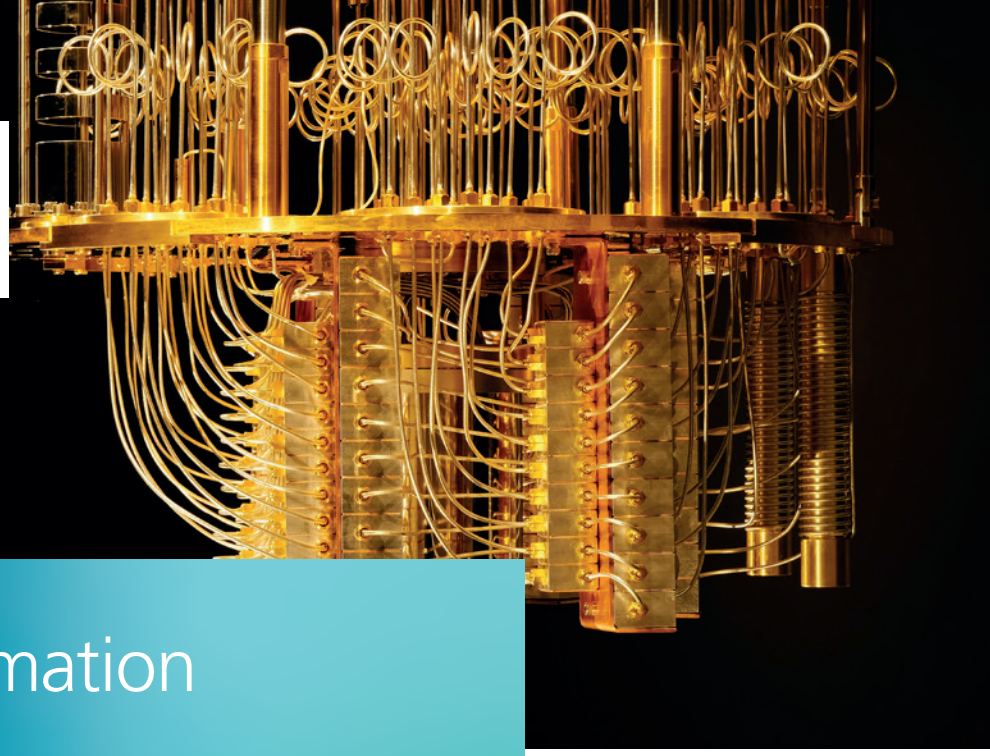
Fraunhofer IAF



Quantum information

Characterization of quantum hardware, error mitigation and portfolio optimization

The IBM Q System One at the Ehningen site enables a wide variety of research topics.
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Similarly to classical computers, quantum computers exhibit elementary gate operations, so-called quantum gates, which are executed on the underlying qubits. However, intrinsic errors occurring on novel quantum hardware are limiting the quality with which these gates can be realized. Therefore, a thorough characterization of gate errors provides the basis for the implementation of error mitigating protocols.

In the frame of the projects QORA and SEQUOIA, Fraunhofer IAF investigates how the errors of individual quantum gates can be characterized as efficiently as possible using different tomography procedures. Furthermore, IAF develops error mitigation methods in order to reduce the impact of gate and readout errors on the reliable execution of quantum algorithms.

2-qubit
Gate errors

Properties of the IBM Q system in Ehningen

- Single-qubit gate error: ~0.03 %
- Two-qubit gate error: ~1 %
- Readout error: ~1 %
- Quantum volume: 64

Characterization and mitigation methods

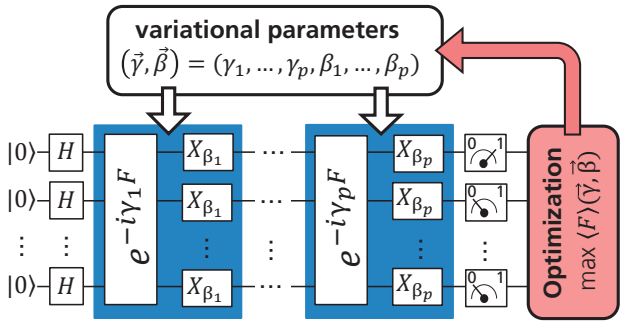
- Quantum process tomography
- Gate set tomography
- Randomized benchmarking
- Readout error mitigation
- Zero noise extrapolation

More information:

Quantum algorithms: portfolio optimization

Companies are increasingly confronted with the need to manage large and complex portfolios that already require massive use of information technology. The ability to make optimal decisions quickly is increasingly becoming a decisive competitive advantage. Quantum computers offer the prospect of outperforming conventional computers in the relevant optimization processes and could decisively accelerate portfolio-related decisions.

In the QORA project, Fraunhofer IAF is developing and testing such optimization methods on the IBM Q system in Ehningen. These methods are based on the Quantum Approximate Optimization Algorithm (QAOA), which combines classical and quantum computations.



Quantum circuit of the QAOA algorithm with classical optimization of the parameters $\vec{\gamma}$ and $\vec{\beta}$ © Fraunhofer IAF

Further applications

- Static and dynamic portfolio optimization
- Feature selection for classification algorithms
- Optimization of complex logistic processes
- Protein folding problems

Competence Center Quantum Computing Baden-Württemberg

Together with Fraunhofer IAO, we coordinate the Competence Center Quantum Computing Baden-Württemberg.

For partners from science and industry, we provide access to the IBM Quantum System One located in Ehningen (close to Stuttgart). Furthermore, the Competence Center is funding six collaborative research projects exploring technology, application scenarios and algorithms in order to advance application-oriented research in the area of quantum computing.

Training room of the Competence Center Quantum Computing at Fraunhofer IAF in Freiburg
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