



Conducting research for a changing society: This is what drives us at Forschungszentrum Jülich. As a member of the Helmholtz Association, we aim to tackle the grand societal challenges of our time and conduct research into the possibilities of a digitized society, a climate-friendly energy system, and a resource-efficient economy. Work together with around 7,500 employees in one of Europe's biggest research centres and help us to shape change!

The Peter Grünberg Institute for Quantum Control (PGI-8) at the Forschungszentrum Jülich specializes in novel optimization strategies for emerging quantum technologies. These emerging technologies aim to provide transformative changes to our society, including how we think about information, and unlocking vast calculations for the natural sciences, logistical problem solving, and high-performance computation. Our group has pioneered the application of quantum optimal control methods to quantum computation and many-body quantum systems. This includes the development of physical models and model reduction techniques as well as algorithmic advances of in-situ optimization and machine learning to tackle the complex processes inherent to scalable quantum devices.

We are looking to recruit a

PhD position – Sample-efficient quantum gate calibration based on quantum optimal control

Your Job:

Among other applications, optimal control theory has proven its utility for the optimal calibration of quantum gates early on and has since been used routinely in experiments. The calibration is typically based on a figure of merit derived from experimental data, such as the average gate fidelity provided by the randomized benchmarking protocol. In realistic scenarios, these quantities however require a significant measurement effort to be estimated, especially in the high-precision regime relevant for fault-tolerant quantum computing.

You will investigate recent advances in characterization and benchmarking protocols for their suitability to provide efficient cost functions for the optimal control of gate calibration in full-stack quantum computers and simulators. Based on your assessment, you will develop new, sample-efficient optimal control approaches for gate calibration and test them in numerical simulations. You will pursue your research with the German research collaboration QSolid, <https://www.q-solid.de>, coordinated by Forschungszentrum Jülich.

The job will be advertised until the position has been successfully filled. You should therefore submit your application as soon as possible. We look forward to receiving your application via our

Online-Recruitment-System!

Questions about the vacancy?

Get in touch with us by using **our contact form**.

Please note that for technical reasons we cannot accept applications via email. www.fz-juelich.de

You will work with experts in quantum optimal control at Forschungszentrum Jülich (Dr. Felix Motzoi, Dr. Francisco Cardenas-Lopez), and in quantum characterization at the University of Cologne (Dr. Markus Heinrich). We aim at implementing your results in in-house experiments at Forschungszentrum Jülich.

You may consult the works by Dr. Felix Motzoi

<https://scholar.google.com/citations?hl=en&user=7xRpOKQAAAAJ> and Dr. Markus

Heinrich <https://scholar.google.de/citations?user=jU0JA0cAAAAJ> for an impression of the relevant research.

In this position you will:

- assess methods and ideas in quantum characterization for their sample efficiency and adapt them for quantum gate calibration
- develop techniques to simulate and control the dynamics for increasing system complexities
- implement and optimize the relevant quantum circuits on atomic and superconducting processors
- cooperate and actively work with experimental partners developing quantum processors using this technological platform
- design and implement optimization techniques for full-stack improvement of quantum algorithms
- model major sources of experimental error for control theory or for error mitigation techniques

Your Profile:

- Masters degree in physics (or in a related subject)
- Background and strong interest in developing theoretical models and methods as well as in implementing numerical optimization techniques
- Interest in working closely with experimentalists
- Detailed knowledge of quantum physics and experience with quantum technology
- Strong mathematical education, in particular in relation to linear algebra
- Strong programming experience
- Ability to effectively communicate in written and spoken English
- Ability to work autonomously and in close interaction within a team
- Most importantly: enthusiasm to explore uncharted territory, develop, and follow your own ideas

Our Offer:

We work on the very latest issues that impact our society and are offering you the chance to actively help in shaping the change! We offer ideal conditions for you to complete your doctoral degree:

- Opportunity to conduct research at the interface of theory and experiment in a world-leading group in quantum control
- Work in a highly motivated research group as part of an international and interdisciplinary working environment with access to outstanding computing facilities and connections to the best research institutions around the world
- Continuous scientific mentoring by your scientific advisor as well as feedback and wide-ranging expertise from the whole group in multiple facets of quantum technology and optimization
- Opportunity of participating in (international) conferences and project meetings
- Participation in overarching seminars including certificate
- The skills that you will acquire during your Ph.D. are in high demand both in academia and in high-tech companies: at present, there is significant government and private investment in the field of quantum technologies

- Opportunity to develop your strengths, e.g. through a comprehensive training programme; a structured programme including continuing professional development and networking opportunities specifically designed for Jülich's doctoral researchers by the Jülich Center for Doctoral Researchers and Supervisors (JuDocS): <https://go.fzj.de/JuDocs>
- 30 days of annual leave and provision for days off between public holidays and weekends (e.g. between Christmas and New Year)

In addition to exciting tasks and the collaborative working atmosphere at Jülich, we have a lot more to offer: <https://www.fz-juelich.de/en/careers/julich-as-an-employer/benefits>

The position is for a fixed term of 3 years. The salary is in line with pay group 13 (75 %) of the Collective Agreement for the Public Service (TVöD-Bund). In addition, an annual special payment is granted ("Christmas payment"), which amounts to 60 % of the monthly salary. Further information on doctoral degrees at Forschungszentrum Jülich (including its various branch offices) is available at <https://www.fz-juelich.de/en/careers/phd>. All information about the Collective Agreement for the Public Service (TVöD-Bund) can be found on the BMI website: <https://go.fzj.de/bmi.tvod>. The monthly salaries in euros can be found on page 66 of the PDF download.

We welcome applications from people with diverse backgrounds, e.g. in terms of age, gender, disability, sexual orientation / identity, and social, ethnic and religious origin. A diverse and inclusive working environment with equal opportunities in which everyone can realize their potential is important to us.