

Call for Proposals

Interdisciplinary Doctoral Program in Quantum Systems Integration

On November 24, 2021 the BMW Group and RWTH Aachen University signed a contract for an endowed chair for „Quantum Information Systems“ (QIS) within the Computer Science Department. The focus of the chair is on the holistic industrialization of quantum computing applications - and the resulting development of new business areas. The chair is concerned with the industrialization of quantum solutions and software-related aspects of system integration. The contract also includes a networking fund to support the integration of the endowed chair into the research environment at RWTH Aachen University and Forschungszentrum Jülich. In addition, a strong collaboration with a similar doctoral program that is installed at Technical University of Munich (TUM) is envisaged.

For this purpose, an interdisciplinary doctoral program in Aachen is to be established. The faculty members that supervise a doctoral student are the interface partners for the endowed QIS professorship.

1. Description of the research field

The aim of the doctoral program is to bring doctoral researchers together who work on e.g., software, algorithmic, reliability, machine learning, and application aspects of quantum computing in a broad sense. We particularly welcome doctoral projects that analyze and evaluate possible new business and application fields with industrial relevance, if possible with the potential to commercialize the technology in the medium term. The BMW Group can contribute concrete applications to provide problem cases for research including real data.

2. Type and aim of projects

This project call has been initiated jointly by the RWTH Aachen University and BMW Group and shall support projects with a strong footprint in computer science and interfaces with disciplines in physics and innovation management. The medium-term goal of the call is to meaningfully integrate the Chair 'Quantum Information Systems' endowed by the BMW Group in the CS Department into the Aachen/Jülich research ecosystem.

The call focuses on the following research areas:

- (i) *Theoretical Physics / Computer Science*: formalizes industrial applications to a mathematical formulation, and projects the formalization to algorithms and methods. Possible applications include quantum machine learning (e.g., generative models) for graph neural networks or PINNS (physics-informed neural network), optimization (e.g., maximum dependent set problems for sensor positioning), SAT/MAX-SAT using quantum algorithms, and numerical simulation (e.g., variational quantum linear solver for crash simulation).
- (ii) *Computer Science*: investigates the integration of quantum systems into industrial system architectures and develops system architectures for the integration of quantum accelerators into industry-oriented computation workflows based on the application projects. The components of such an architecture will be investigated. A working proof-of-concept will be realized to evaluate performance in terms of time and accuracy. Possible topics include e.g., software infrastructure for hybrid quantum-classical/parallel computing, middleware for E2E workflows for the integration of classical/quantum resources, and reliability of quantum software.
- (iii) *Innovation Management / Business Information Systems*: aims to investigate the success factors for deep-tech ecosystems using QC technology as an example and analyzes the dependency between the success of the ecosystem and the success of

the commercialization of the application. Possible topics include e.g., the role of QC in corporate next-generation computing strategy, and how the European tech ecosystem can accelerate the commercialization of QC.

3. Selection and evaluation criteria

The projects will be evaluated and selected by the following evaluation group:

- Prof. Dr. Carsten Honerkamp
- Prof. Dr. Mario Berta
- Prof. Dr. Ir. Dr. h.c. Joost-Pieter Katoen
- Prof. Dr. Frank Wilhelm-Mauch
- Prof. Dr. Hendrik Bluhm

Participants with guest status are Prof. Dr. Malte Brettel (Vice-Rector for Industry and Business Relations) and a representative from BMW Group.

The selection process may involve external experts.

The selection criteria for submitted proposals are:

- Originality (new, creative, explorative),
- Interdisciplinarity and/or cooperative nature (open for collaboration with other actors, disciplines and industry),
- Thematic fit in the relevant ecosystem of Jülich Aachen Research Alliance (JARA) and industrial applicability,
- Adequateness of research approach,
- Potential impact and possible valorization.

4. Funding

A minimum of five projects with one full-time doctoral student each will be supported. Eligible costs are staff expenses, travel costs, support for workshops and conferences, consumables and equipment. The total budget is 900.000€. As the funding may not cover all costs, the funded organizational units are requested to make appropriate matching contributions. Teaching duties of the doctoral students are possible but should be funded by other means.

5. General conditions

Proposals may be handed in by researchers from RWTH as well as from Forschungszentrum Jülich (FZJ). Joint proposals are also welcome.

Networking activities will take place at least twice a year together with Technical University of Munich (TUM) and the BMW Group. The cost of participation is covered by central funds.

Funding by this program does not set aside the relevant regulations for doctoral degrees in the Faculty of Mathematics, Computer Sciences and Natural Sciences of RWTH Aachen University.

6. Proposal structure and content

Length of proposal: 6 pages **max.** (excl. references), font size: Arial 11, line spacing: 1.5

- Applicant(s)
- Summary
- Current state-of-the-art
- Relevant preliminary work of the applicant(s)
- Goals and approach (methodology)
- Working plan
- Financial plan
- Potential interdisciplinary cooperation

- Expected impact on the research field and possible valorization
- References

Language: English or German

Proposals that do not comply with the formal criteria will be excluded from the reviewing process.

7. Important Dates:

- Deadline for submission: **2 May 2023**
- Notification: **1 August 2023**
- Intended project start: **1 October 2023**

8. Send your application via: <http://portal.ers.rwth-aachen.de>

Contact

For general questions concerning this call, please contact Mrs. Susanne Römmer (RWTH/ZHV), e-mail: ers@ers.rwth-aachen.de

For questions and information about quantum computing applications that are relevant to BMW, please contact Johannes Klepsch (BMW), e-mail: johannes.klepsch@bmw.de or Andre Luckow (BMW), e-mail: Andre.Luckow@bmwgroup.com