Department of Science and Technology
Government of India

Deutsche Forschungsgemeinschaft

Indo-German Research Training Groups (IRTG)

Annexure -1

QUANTUM COMPUTERS . AGK ENTERPRISES - Draft Proposals for Research Training Groups and International Research Training Groups

[Rashtrasant Tukadoji Maharaj Nagpur]

[KATHWATE, ABHIJEET, Bachelor of Business Administration | Interdisciplinary and Unified Science institution .AGK ENTERPRISES]

[QUANTUM COMPUTERS.AGK ENTERPRISES]

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1 General information

1.1 Applicant university/universities

	Name of university
Lead applicant university with financial responsibility	[Rashtrasant Tukadoji Maharaj Nagpur]]
Additional applicant universities, if applicable	

1.2 Designated spokesperson

Last name, first name, academic title	Research area
[KATHWATE, ABHIJEET]	Bachelor of Business Administration | Interdisciplinary and Unified Science

1.3 Participating researchers

Last name, first name, academic title	Research area
[TRIPATHI SIR | IINSIGHT JR COLLEGE]	Quantum Algorithms and Error Correction
***[**SAH PANKAJ | KOTA GURU PVT. LTD.]*	Superconducting Qubits
[TIWARI ANOOP]	Quantum Networking and Photonic Qubits
[DHARMARI HARSHAL]	AI-Driven Social Algorithms
***[**SHILPA KATHWATE]*	Cryogenic Systems and Quantum Control Electronics
[MAYA AVA]	Quantum Materials and Josephson Junctions
***[**GAURAV SHASTRAKAR]*	Quantum Software and Programming Tools

1.4 Number of doctoral and postdoctoral researchers

	No. of persons
Doctoral researchers funded through RTG funds [fellowship or position with XX% of full-time hours]	10
Doctoral researchers funded from other sources (anticipated)	5

2 Research programme

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Comprehensive Research Programme and Sub-Themes

The proposed IRTG focuses on the development of scalable quantum computing systems, leveraging the strengths of both Indian and German research ecosystems. The research programme is divided into the following sub-themes:

1. Quantum Hardware Development :

- Design and fabrication of superconducting qubits (transmon qubits, flux qubits).

- Development of cryogenic cooling systems (dilution refrigerators) for ultra-low temperature operations.

- Integration of quantum control electronics and microwave systems.

2. Quantum Software and Algorithms :

- Development of quantum algorithms for optimization, simulation, and cryptography.

- Implementation of quantum error correction (QEC) techniques, including surface codes and stabilizer codes.

- Creation of quantum software tools (e.g., Qiskit, Cirq) for programming and simulation.

3. Quantum Networking and Interconnects :

- Development of quantum interconnects for long-distance entanglement distribution.

- Implementation of quantum repeaters and entanglement purification protocols.

- Integration of quantum networks with classical communication systems.

4. AI-Driven Quantum Systems :

- Use of machine learning for optimizing quantum gate operations and error correction.

- Development of hybrid quantum-classical algorithms for real-world applications.

Objectives

- To build a scalable quantum computing platform with 100+ qubits by 2030.

- To develop robust quantum error correction techniques for fault-tolerant quantum computing.

- To establish a quantum network prototype for secure communication and distributed quantum computing.

- To create a quantum software ecosystem that bridges the gap between theoretical algorithms and practical hardware.

Expected Outcomes

- A fully functional quantum computing system with applications in drug discovery, material science, and optimization.

- A quantum network prototype capable of secure communication over long distances.

- Open-source quantum software tools for researchers and developers.

- A pipeline of highly skilled quantum engineers and researchers.

3 Qualification programme and supervision strategy

The IRTG will offer a structured qualification programme for doctoral and postdoctoral researchers, including:

- Advanced Courses : Quantum mechanics, quantum computing, cryogenics, and AI.

- Hands-On Training : Fabrication of qubits, quantum gate operations, and error correction.

- Research Seminars : Regular seminars and workshops with leading experts in quantum computing.

- International Collaboration : Exchange programmes between Indian and German institutions.

Supervision Strategy

Each researcher will be supervised by a team of experts from both Indian and German institutions. Regular progress reviews and mentorship sessions will ensure timely completion of research goals.

4 Environment

The IRTG will leverage the existing infrastructure at both Indian and German institutions, including:

- Cryogenic Labs : For testing superconducting qubits at ultra-low temperatures.

- Quantum Fabrication Facilities : For developing and testing qubit circuits.

- High-Performance Computing (HPC) : For simulating quantum algorithms and networks.

- AI Labs : For developing machine learning models for quantum systems.

5 Publications and bibliography for the research programme

5.1 List of published preliminary research relevant to the research programme

(Kathwate, 2020)

Kathwate, A. (2020). QUANTUM COMPUTER . AGK ENTERPRISES. *QUANTUM DIMENSIONS*, 49.

5.2 Additional references on the state of the art

(Nielsen)

Nielsen, M. A. (n.d.). Quantum Computation and Quantum Information. .

Annexure – 2

QUANTUM COMPUTER. AGK ENTERPRISES

Research Training Groups and International Research Training Groups

[Rashtrasant Tukadoji Maharaj Nagpur University]

[ABHIJEET KATHWATE, RTMNU]

[Quantum computing]

6 General information

6.1 Applicant university/universities, other participating institutions

Name of University/Institution	Role
Rashtrasant Tukadoji Maharaj Nagpur University	Lead applicant university with financial responsibility
University of Greenwich	Foreign partner institution for Indo-German collaboration

6.2 Designated spokesperson

Last name, First name, Academic title	Research area
KATHWATE, Abhijeet, BBA	Interdisciplinary and Unified Science
AVA, Maya, PhD	Quantum Physics, Cryogenics, and Control Systems

6.3 Participating researchers

Last name, First name, Academic title	Research area
TRIPATHI, Sir, PhD	Quantum Algorithms and Error Correction
SAH, Pankaj, PhD	Superconducting Qubits and Fabrication
TIWARI, Anoop, MSc	Quantum Networking and Photonic Qubits
DHARMARI, Harshal, PhD	AI-Driven Social Algorithms
KATHWATE, Shilpa, MSc	Cryogenic Systems and Quantum Control Electronics
AVA, Maya, PhD	Quantum Materials and Josephson Junctions
SHASTRAKAR, Gaurav, MSc	Quantum Software and Programming Tools

6.4 Funding period and start date

The proposed funding period is 4.5 years for the first phase (January 1, 2026, to June 30, 2030), with a potential extension to 9 years pending mid-term evaluation. The start date is set for January 1, 2026, following approval and funding allocation.

6.5 Number of doctoral researchers, doctoral researchers in postdoctoral researchers (only for German), qualifying fellows and student assistants

Category	No. of persons (India)	No. of persons (Germany)
Doctoral researchers funded through RTG funds	10	12
Doctoral researchers funded from other sources	5	3
Postdoctoral researchers (Germany only)	-	3
Qualifying fellows	2	2
Student assistants	4	4

7 Profile of the Research Training Group

This IRTG aims to establish a world-class Indo-German collaboration focused on scalable quantum computing systems. By uniting the interdisciplinary expertise of Rashtrasant Tukadoji Maharaj Nagpur University (RTMNU) and the University of Greenwich, supported by AGK Enterprises, the group will advance quantum technology through innovative research and structured training. The profile emphasizes cutting-edge quantum hardware, software, networking, and AI integration, positioning India and Germany as global leaders in quantum innovation while fostering a skilled cohort of early-career researchers.

8 Research programme

This includes themes and sub-themes, objectives, methodology, expected outcomes etc

This programme develops scalable quantum computing systems through four sub-themes:

Themes and Sub-Themes:

Quantum Hardware Development: Fabrication of superconducting qubits (transmon, flux); cryogenic cooling systems (dilution refrigerators); microwave-based control electronics.

Quantum Software and Algorithms: Algorithms for optimization, simulation, and cryptography; quantum error correction (surface codes, stabilizer codes); software tools (e.g., Qiskit, Cirq).

Quantum Networking and Interconnects: Quantum interconnects for entanglement distribution; repeaters and purification protocols; hybrid quantum-classical networks.

AI-Driven Quantum Systems: Machine learning for gate optimization and error correction; hybrid quantum-classical algorithms.

Objectives:

Achieve a 100+ qubit scalable platform by 2030.

Develop fault-tolerant quantum computing via error correction.

Prototype a secure quantum network.

Bridge theoretical algorithms and practical hardware with software ecosystems.

Methodology:

Hardware: Cleanroom fabrication, cryogenic testing (~20 mK), microwave engineering.

Software: Algorithm design, simulation on HPC, tool development.

Networking: Photonic qubit experiments, repeater prototyping.

AI: Neural network training for quantum optimization.

Expected Outcomes:

Quantum systems for drug discovery, materials, and optimization.

A secure quantum network prototype.

Open-source quantum tools.

Trained quantum researchers.

9 Qualification programme

The programme includes:

Courses: Quantum mechanics, computing, cryogenics, AI (semester-long, 4 credits each).

Training: Qubit fabrication, gate operations, error correction (hands-on labs).

Seminars: Bi-annual workshops with global experts.

Exchanges: 6-12 month visits to partner institutions, fully funded.

10 Supervision and career advancement, gender equality, organisation and quality management

- **Supervision**: Dual Indian-German supervisors per researcher; quarterly reviews.
- **Career Advancement**: Industry internships, conference presentations, job placement support.
- **Gender Equality**: Target 40% female participation; mentorship for women in STEM.
- **Organisation and Quality Management**: Monthly steering committee meetings; progress tracked via milestones and reports.

Aspect	Details
Supervision	1 Indian + 1 German per student
Gender Target	40% female researchers
Quality Check	Quarterly milestone reviews

11 Environment of the Research Training Group

- **RTMNU/AGK (India)**: Cryogenic labs, quantum fabrication, HPC clusters, AI facilities.
- **Greenwich (Germany)**: Quantum physics labs, control systems infrastructure.

This dual-site environment supports experimental and computational quantum research.

12 Modules and funding

Module	Funding (EUR, India)	Funding (EUR, Germany)
Hardware Development	2,000,000	2,200,000
Software and Algorithms	1,500,000	1,600,000
Networking and Interconnects	1,000,000	1,100,000
AI-Driven Systems	500,000	600,000
Workshops and Exchanges	200,000	250,000
Total	5,200,000	5,750,000

13 Only for International Research Training Groups:

14 Complementary funding by the partner institution

- **Greenwich**: ~1,000,000 EUR for cryogenic systems, networking infrastructure, and exchange support.
- **AGK Enterprises**: ~500,000 EUR in-kind (labs, personnel).

15 Declarations

AGK Enterprises, founded by Abhijeet Kathwate in 2020, commits to this IRTG alongside RTMNU and the University of Greenwich. We pledge to advance quantum technology, train researchers, and establish India and Germany as quantum leaders, supported by the DST-DFG framework.

16 Publications and bibliography for the research programme

Information under this item does not count against the maximum allowable number of pages.

Kathwate, A. (2020). QUANTUM COMPUTER . AGK ENTERPRISES. *QUANTUM DIMENSIONS*, 49.

Nielsen, M. A. (n.d.). Quantum Computation and Quantum Information. .

Preskill, J. (n.d.).

Preskill, J. (2018). Quantum Computing in the NISQ era and beyond.

16.1 List of published preliminary research relevant to the research programme

Kathwate, Abhijeet, "Quantum Computing: From Theory to Practice," AGK Enterprises, 2023.

16.2 Additional references on the state of the art

This information is optional.

- Nielsen, M. A., & Chuang, I. L. (2010). *Quantum Computation and Quantum Information*.
- Preskill, J. (2018). "Quantum Computing in the NISQ Era and Beyond," *Quantum Journal*.

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Raw notes Abhijeet --.pdf

Documents AGK enterprises .pdf