

Tobias Stollenwerk

Research Group Leader

In between fundamental research experiences in Bonn and Jülich, my career included a meaningful detour into applied research at the German Aerospace Center (DLR) and NASA. At DLR, high impact publications were only marginally considered as a performance measure; hence the publication gap. However, I gained extensive expertise in interdisciplinary applied research, particularly in engineering applications, applied computer science, and software engineering. My focus shifted to quantum computation in 2016, inspired by repeated and in-depth research visits to NASA's Quantum Artificial Intelligence Laboratory. Over time, my interests evolved from quantum computing applications and software development to tackling close-to-hardware quantum algorithmic research challenges. This transition led me to my current role as a tenured research group leader at the Institute for Quantum Computing Analytics in Jülich. Drawing from this diverse background, I bring a broad understanding of applied quantum computing – from practical use cases to the limitations of real quantum hardware – and have developed the ability to collaborate seamlessly across disciplines such as physics, computer science, mathematics, and engineering.

Experience

- since 8/2022 **Group Leader, Quantum Algorithms (tenure)**, *Institute for Quantum Computing Analytics (PGI-12)*, Jülich Research Centre
Application focused quantum algorithms, error-aware compilation and algorithm design
- 4/2019- **Group Leader, Quantum Computing**, *German Aerospace Center (DLR)*
7/2022 Applications and algorithms for early quantum computers
- 2016, 2017, **Visiting Researcher (3, 4, 1.5, 1 months)**, *NASA Ames Research Center (USA)*,
2018, 2019 Quantum Artificial Intelligence Laboratory
Applications and algorithms for early quantum computers
- 1/2016- **Postdoctoral Researcher**, *German Aerospace Center (DLR)*
3/2019 Applications and algorithms for early quantum computers
- 11/2013- **Postdoctoral Researcher**, *German Aerospace Center (DLR)*
12/2015 Software development, geometry modelling, high performance computing

Education

- 1/2009- **PhD Research (Dr. rer. nat.)**, *Physics Institute, Bonn University, Germany*, Prof. Kroha,
9/2013 Theoretical condensed matter physics
Thesis: Ferromagnetic semiconductor-metal transition in heterostructures of electron doped Europium monoxide
- 4/2007- **Research Assistant**, *Physics Institute, Bonn University, Germany*, Prof. Kroha, Numerical
12/2008 photonics
- 10/2000- **German Diploma in Physics**, *Bonn University, Germany*, Theoretical Physics
3/2007 Thesis: Wannier function approach in photonic crystals

Research Interests

- Quantum Algorithms Application focused quantum algorithms: combinatorial optimization, machine learning, engineering applications, NISQ algorithms, early fault-tolerant regime, Hardware-Software Codesign
- Quantum Compilation and Error mitigation Error-aware compilation, close-to-hardware algorithm design, error-mitigation, circuit-cutting, diagrammatic methods

Invited talks(selection)

- 12/2024 2nd NRW Quantum Theoretical Computer Science Workshop, Paderborn, *Quantum Algorithms for Modal Analysis in Structural Mechanics*
- 9/2024 FEIN Colloquium Quantum Computing in Power Systems, Online (online), *State of the Art Quantum Computation*
- 7/2024 ZX-Seminar (online), *Measurement-based Quantum Approximate Optimization*
- 12/2022 Quantum Information Theory Workshop, Saarland University, *Diagrammatic Analysis for Parameterized Quantum Circuits*
- 9/2022 Group Seminar, Kliesch Group, University Düsseldorf, *Diagrammatic Analysis for Parameterized Quantum Circuits*
- 6/2022 Theory Colloquium, Institute for Theoretical Physics, Cologne University, *Diagrammatic Analysis of near-term Quantum Optimization Algorithms*
- 4/2022 ZX-Seminar (online), *Diagrammatic Analysis for Parameterized Quantum Circuits*
- 6/2021 Theory Colloquium, Institute for Theoretical Physics, University Hannover, *Quantum Approximate Optimization for Real-World Planning Problems*

PhD Supervisions

- Since 5/2024 Victoria Wadewitz, **Theo. Physics**, *Compilation, diagrammatic methods, superconducting circuit architectures*
- Since 1/2024 Nil Rodellas Gracia, **Theo. Physics**, *Quantum approximate optimization algorithms*
- Since 9/2023 Rivan Rugubar, **Theo. Physics**, *Quantum machine learning algorithms*
- Since 8/2022 Sven Danz, **Theo. Physics**, *Quantum algorithms for modal analysis in structural mechanics*
- Since 8/2022 Marco Schumann, **Theo. Physics**, *Quantum error mitigation*
- Since 8/2022 Leonhard Hölscher, **Theo. Physics**, *Quantum algorithms for Computational Fluid Dynamics*
- 2018-2023 Thorge Müller, **Theo. Physics**, *Quantum Approximate Optimization, (currently postdoctoral reseacher at DLR)*
- 2018-2022 Elisabeth Lobe, **Mathematics**, *Compilation for Quantum Annealers, (currently group leader at DLR)*

MSc and BSc Supervision (selection)

- 2024 Victoria Wadewitz (**Physics/Math**, Prof. von Delft, TU Munich) (currently PhD student with me)
- 2024 Krish Ramesh (**Physics**, Prof. Berta, RWTH Aachen)
- 2023 Gina Muuss (**Computer Science**, Prof. Mutzel, Bonn University) (currently PhD student in Amsterdam)
- 2018 Christopher Zachow (**Physics**, Prof. Gross, Cologne) (currently quantum computing staff at industry)
- 2018 Paul Timme (**Mathematics**, Prof. Mnich, Bonn)
- 2017 Elisabeth Lobe (**Mathematics**, Prof. Kaibel, Magdeburg) (now group leader at DLR)

Teaching (selection)

- 2024 Guest Lecture *Quantum Algorithms for Modal analysis in Structural Mechanics*, **Mechanical Engineering**, RWTH Aachen
- 2024 Lecture *Near-term Quantum Computation*, **Computer Science**, RWTH Aachen
- 2023 Lecture *Practical Quantum Computing Algorithms*, **Physics**, University Bonn
- 2023 Physics Lab Course for Computer Science Students *Programming Quantum Computers*, RWTH Aachen
- 2023 Workshop: *Programming Quantum Computers*, PhD retreat excellence clusters ML4Q, Eitorf

Publications

Preprints

- 2024 **Quantum combinatorial optimization beyond the variational paradigm: simple schedules for hard problems**. Tim Bode, Krish Ramesh, and Tobias Stollenwerk. *arXiv Preprint*. eprint: arXiv:2411.07646. URL: <https://arxiv.org/abs/2411.07646>.
- 2024 **Structure-inspired Ansatz and Warm Start of Variational Quantum Algorithms for Quadratic Unconstrained Binary Optimization Problems**. Yahui Chai, Karl Jansen, Stefan Kühn, Tim Schwägerl, and Tobias Stollenwerk. *arXiv Preprint*. eprint: arXiv:2407.02569. URL: <https://arxiv.org/abs/2407.02569>.
- 2024 **Quantum-Inspired Fluid Simulation of 2D Turbulence with GPU Acceleration**. Leonhard Hölscher, Pooja Rao, Lukas Müller, Johannes Klepsch, Andre Luckow, Tobias Stollenwerk, and Frank K. Wilhelm. *arXiv Preprint*. eprint: arXiv:2406.17823. URL: <https://arxiv.org/abs/2406.17823>.

- 7/2024 **Q(AI)²: Quantum Artificial Intelligence for the Automotive Industry.** Tobias Stollenwerk, Somtapa Bhattacharya, Michele Cattelan, Alessandro Ciani, Gabriele Compostella, David Headley, Johannes Klepsch, Matthias Klusch, Markus Leder, Antonio Macaluso, Kristel Michielsen, Dmytro Nabok, Anestis Papanikolaou, Alexander Rausch, Marco Schumann, Andrea Skolik, Sheir Yarkoni, and Frank K. Wilhelm. *KI - Künstliche Intelligenz*. DOI: 10.1007/s13218-024-00862-9. URL: <https://doi.org/10.1007/s13218-024-00862-9>.
- 3/2024 **Measurement-Based Quantum Approximate Optimization.** Tobias Stollenwerk and Stuart Hadfield. In: *2024 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*. 3 2024. Pp. 1115–1127. DOI: 10.1109/IPDPSW63119.2024.00183.
- 12/2023 **Optimal Flight-Gate Assignment on a Digital Quantum Computer.** Yahui Chai, Lena Funcke, Tobias Hartung, Karl Jansen, Stefan Kühn, Paolo Stornati, and Tobias Stollenwerk. *Phys. Rev. Appl.* 20. DOI: 10.1103/PhysRevApplied.20.064025. URL: <https://link.aps.org/doi/10.1103/PhysRevApplied.20.064025>.
- 9/2023 **Mean-Field Approximate Optimization Algorithm.** Aditi Misra-Spieldenner, Tim Bode, Peter K. Schuhmacher, Tobias Stollenwerk, Dmitry Bagrets, and Frank K. Wilhelm. *PRX Quantum* 4. DOI: 10.1103/PRXQuantum.4.030335. URL: <https://link.aps.org/doi/10.1103/PRXQuantum.4.030335>.
- 6/2022 **Diagrammatic Analysis for Parameterized Quantum Circuits.** Tobias Stollenwerk and Stuart Hadfield. In: *Proceedings 19th International Conference on Quantum Physics and Logic, QPL 2022, Wolfson College, Oxford, UK, 27 June - 1 July 2022*. Ed. by Stefano Gogioso and Matty Hoban. Vol. 394. EPTCS. 6 2022. Pp. 262–301. DOI: 10.4204/EPTCS.394.15. URL: <https://doi.org/10.4204/EPTCS.394.15>.
- 7/2021 **Quantum Annealing versus Digital Computing: An Experimental Comparison.** Michael Jünger, Elisabeth Lobe, Petra Mutzel, Gerhard Reinelt, Franz Rendl, Giovanni Rinaldi, and Tobias Stollenwerk. *ACM J. Exp. Algorithmics* 26.1. DOI: 10.1145/3459606. URL: <https://doi.org/10.1145/3459606>.
- 7/2021 **Embedding of complete graphs in broken Chimera graphs.** Elisabeth Lobe, Lukas Schürmann, and Tobias Stollenwerk. *Quantum Information Processing* 20.7. DOI: 10.1007/s11128-021-03168-z.
- 6/2021 **Agile Earth Observation Satellite Scheduling With a Quantum Annealer.** Tobias Stollenwerk, Vincent Michaud, Elisabeth Lobe, Mathieu Picard, Achim Basermann, and Thierry Botter. *IEEE Transactions on Aerospace and Electronic Systems* 57.5. DOI: 10.1109/TAES.2021.3088490.
- 9/2020 **Toward Quantum Gate-Model Heuristics for Real-World Planning Problems.** Tobias Stollenwerk, Stuart Hadfield, and Zhihui Wang. *IEEE Transactions on Quantum Engineering* 1. DOI: 10.1109/TQE.2020.3030609.
- 1/2020 **Quantum Annealing Applied to De-Conflicting Optimal Trajectories for Air Traffic Management.** Tobias Stollenwerk, Bryan O’Gorman, Davide Venturelli, Salvatore Mandrà, Olga Rodionova, Hokkwan Ng, Banavar Sridhar, Eleanor Gilbert Rieffel, and Rupak Biswas. *IEEE Transactions on Intelligent Transportation Systems* 21.1. DOI: 10.1109/TITS.2019.2891235.

- 9/2019 **TiGL: An Open Source Computational Geometry Library for Parametric Aircraft Design.** Martin Siggel, Jan Kleinert, Tobias Stollenwerk, and Reinhold Maierl. *Mathematics in Computer Science* 13.3. DOI: 10.1007/s11786-019-00401-y. URL: <https://doi.org/10.1007/s11786-019-00401-y>.
- 3/2019 **Flight Gate Assignment with a Quantum Annealer.** Tobias Stollenwerk, Elisabeth Lobe, and Martin Jung. In: *Proceedings of the First International Workshop on Quantum Technology and Optimization Problems*. Theoretical Computer Science and General Issues 9. Munich, Germany: Springer, 3 2019. URL: https://doi.org/10.1007/978-3-030-14082-3_9.
- 11/2016 **Experiences with Scheduling Problems on Adiabatic Quantum Computers.** Tobias Stollenwerk and Achim Basermann. In: *Proceedings of the 1st International Workshop on Post-Moore Era Supercomputing (PMES)*. Future Technologies Group Technical Report FTGTR-2016-11. Salt Lake City, USA, 11 2016. URL: <https://elib.dlr.de/110044/1/43.pdf>.
- 11/2015 **Theory of Curie temperature enhancement in electron-doped EuO.** Tobias Stollenwerk and Johann Kroha. *Phys. Rev. B* 92. DOI: 10.1103/PhysRevB.92.205119. URL: <https://link.aps.org/doi/10.1103/PhysRevB.92.205119>.
- 8/2011 **Thickness-dependent magnetic properties of oxygen-deficient EuO.** M. Barbagallo, T. Stollenwerk, J. Kroha, N.-J. Steinke, N. D. M. Hine, J. F. K. Cooper, C. H. W. Barnes, A. Ionescu, P. M. D. S. Monteiro, J.-Y. Kim, K. R. A. Ziebeck, C. J. Kinane, R. M. Dalgliesh, T. R. Charlton, and S. Langridge. *Phys. Rev. B* 84. DOI: 10.1103/PhysRevB.84.075219. URL: <https://link.aps.org/doi/10.1103/PhysRevB.84.075219>.
- 1/2011 **Local photonic modes in periodic or random, dielectric, and lasing media.** T. Stollenwerk, R. Frank, A. Lubatsch, O. Zaitsev, S.V. Zhukovsky, D.N. Chigrin, and J. Kroha. *Applied Physics B: Lasers and Optics* 105.1. DOI: 10.1007/s00340-011-4729-3.
- 8/2011 **Efficient construction of maximally localized photonic Wannier functions: locality criterion and initial conditions.** Tobias Stollenwerk, Dmitry N. Chigrin, and Johann Kroha. *J. Opt. Soc. Am. B* 28.8. DOI: 10.1364/JOSAB.28.001951. URL: <http://www.osapublishing.org/josab/abstract.cfm?URI=josab-28-8-1951>.

Fellowships

- DAAD Fellowship for summer school, United Kingdom, German Academic Exchange Service (DAAD), 2010

Project Acquisition

As Project Leader

- 2024 **Project Leader**, *Quantum Artificial Intelligence for the Automotive Value Chain*, BMBF Quanteninformatik, Funding Period: 2025–2028 (3 years)
Size: 3 million €
- 2022 **Project Leader**, *Quantum Computing Hardware-Software Co-design*, DLR QCI initiative, Funding Period: 2022–2025 (4 years)
Size: 4 million €
- 2022 **Project Leader**, *Quantum Computing Applications and Education*, DLR internal, Funding Period: 2022–2024 (3 years)
Size: 6 million €

- 2021 **Project Leader**, *Algorithms for near-term Quantum Computers*, DLR internal, Funding Period: Jan–Dez, 2021 (1 year)
Size: 0.5 million €
- 2016-2021 **Project Leader**, *Exploratory Research on near-term Quantum Computer Algorithms and Applications*, DLR internal, Funding Period: ongoing since 2016
Size: 0.3 million € per year
As Consortium Partner
- 2023 **Project coordinator at partner PGI-12**, *QuGrids: Quantum-based Energy Grids*, Profilbildung 2022, MKW, NRW
- 2022 **Principal Investigator at Consortium Partner DLR**, *EQUALITY – Efficient Quantum Algorithms for Industry*, European Quantum Flagship, left DLR after funding was approved, before project kick-off
- 2022 **Principal Investigator at Consortium Partner DLR**, *EQUIP – Error Correction for Quantum Information Processing*, European Quanteria Program 2021, left DLR after funding was approved, before project kick-off

Networking Activities

- 2021 **Coordinator**, *DLR Quantum Computing Expert Council*
- 2018-2022 **Member**, *Quantum Computing Industry Group*
- 2018 **Organizer**, *DLR Workshop on Quantum Computing for Applications in Science and Industry*
- 2021 **Organizer**, *DLR internal Workshop on Quantum Computing Applications and Software*
- 2021 **Organizer**, *DLR internal Workshop on Quantum Algorithms*