

# Christophe Vuillot

## Curriculum Vitæ

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## Research interests

I am interested in quantum error correction and fault-tolerant implementations of universal quantum computation using both discrete and continuous variable quantum systems.

## Employment

- 2021– **Permanent researcher (Chargé de Recherche)**, *Inria*, Nancy  
In team MOCQUA.
- 2019–2020 **Post-doc**, *Inria*, Paris  
In team COSMIQ, as part of the QCDA European project.
- 2017–2019 **PhD (2nd half)**, *TU Delft, QuTech*, Delft  
under the direction of Barbara Terhal. Thesis title:  
**Fault-Tolerant Quantum Computation: Theory and Practice**  
*Defense 15 January 2020.*
- 2015–2017 **PhD (1st half)**, *RWTH Aachen university, IQI*, Aachen  
under the direction of Barbara Terhal.

## Publications

- [1] Diego Ruiz, Jérémie Guillaud, Anthony Leverrier, Mazyar Mirrahimi, and Christophe Vuillot. *LDPC-cat Codes for Low-Overhead Quantum Computing in 2D*. Jan. 17, 2024. DOI: 10.48550/arXiv.2401.09541. arXiv: 2401.09541 [quant-ph]. preprint.
- [2] Vivien Vandaele, Simon Martiel, Simon Perdrix, and Christophe Vuillot. “Optimal Hadamard Gate Count for Clifford+T Synthesis of Pauli Rotations Sequences”. In: *ACM Transactions on Quantum Computing* 5.1 (Feb. 24, 2024), 6:1–6:29. DOI: 10.1145/3639062.
- [3] Christophe Vuillot, Alessandro Ciani, and Barbara M. Terhal. “Homological Quantum Rotor Codes: Logical Qubits from Torsion”. In: *Communications in Mathematical Physics* 405.2 (Feb. 20, 2024), p. 53. ISSN: 1432-0916. DOI: 10.1007/s00220-023-04905-4.
- [4] Louis Paletta, Anthony Leverrier, Alain Sarlette, Mazyar Mirrahimi, and Christophe Vuillot. *Robust Sparse IQP Sampling in Constant Depth*. July 20, 2023. DOI: 10.48550/arXiv.2307.10729. arXiv: 2307.10729 [quant-ph]. preprint.
- [5] Timothée Goubault de Brugière, Simon Martiel, and Christophe Vuillot. *A Graph-State Based Synthesis Framework for Clifford Isometries*. Dec. 13, 2022. DOI: 10.48550/arXiv.2212.06928. arXiv: 2212.06928 [quant-ph]. preprint.
- [6] Anthony Leverrier, Simon Apers, and Christophe Vuillot. “Quantum XYZ Product Codes”. In: *Quantum* 6 (July 14, 2022), p. 766. DOI: 10.22331/q-2022-07-14-766.
- [7] Christophe Vuillot and Nikolas P. Breuckmann. “Quantum Pin Codes”. In: *IEEE Transactions on Information Theory* (2022), pp. 1–1. ISSN: 1557-9654. DOI: 10.1109/TIT.2022.3170846.
- [8] Christophe Vuillot. *Planar Floquet Codes*. Dec. 14, 2021. DOI: 10.48550/arXiv.2110.05348. arXiv: 2110.05348 [quant-ph]. preprint.

- [9] B M Terhal, J Conrad, and C Vuillot. "Towards Scalable Bosonic Quantum Error Correction". In: *Quantum Science and Technology* 5.4 (Oct. 1, 2020), p. 043001. ISSN: 2058-9565. DOI: 10.1088/2058-9565/ab98a5.
- [10] Christophe Vuillot. "Fault-Tolerant Quantum Computation: Theory and Practice". TU Delft, 2020. URL: <https://repository.tudelft.nl/islandora/object/uuid%3A7cb715f4-eaf0-4526-8552-9f97cc864383>.
- [11] Christophe Vuillot, Hamed Asasi, Yang Wang, Leonid P. Pryadko, and Barbara M. Terhal. "Quantum Error Correction with the Toric Gottesman-Kitaev-Preskill Code". In: *Physical Review A* 99.3 (Mar. 2019), p. 032344. DOI: 10.1103/PhysRevA.99.032344.
- [12] Christophe Vuillot, Lingling Lao, Ben Criger, Carmen García Almudéver, Koen Bertels, and Barbara M. Terhal. "Code Deformation and Lattice Surgery Are Gauge Fixing". In: *New Journal of Physics* 21.3 (Mar. 2019), p. 033028. ISSN: 1367-2630. DOI: 10.1088/1367-2630/ab0199.
- [13] Victor V. Albert, Kyungjoo Noh, Kasper Duivenvoorden, Dylan J. Young, R. T. Brierley, Philip Reinhold, Christophe Vuillot, Linshu Li, Chao Shen, S. M. Girvin, Barbara M. Terhal, and Liang Jiang. "Performance and Structure of Single-Mode Bosonic Codes". In: *Physical Review A* 97.3 (Mar. 2018), p. 032346. DOI: 10.1103/PhysRevA.97.032346.
- [14] Christophe Vuillot. "Is Error Detection Helpful on IBM 5Q Chips ?" In: *Quantum Information and Computation* 18 (11&12 Sept. 2018), pp. 0949–0964. DOI: 10.26421/QIC18.11-12.
- [15] Nikolas P. Breuckmann, Christophe Vuillot, Earl Campbell, Anirudh Krishna, and Barbara M. Terhal. "Hyperbolic and Semi-Hyperbolic Surface Codes for Quantum Storage". In: *Quantum Science and Technology* 2.3 (2017), p. 035007. ISSN: 2058-9565. DOI: 10.1088/2058-9565/aa7d3b.
- [16] Earl T. Campbell, Barbara M. Terhal, and Christophe Vuillot. "Roads towards Fault-Tolerant Universal Quantum Computation". In: *Nature* 549.7671 (Sept. 2017), pp. 172–179. ISSN: 1476-4687. DOI: 10.1038/nature23460.
- [17] Erwan Faou, Fabio Nobile, and Christophe Vuillot. "Sparse Spectral Approximations for Computing Polynomial Functionals". July 2012. arXiv: 1207.3728 [math]. URL: <http://arxiv.org/abs/1207.3728>.

## Invited talks

- Jun. 2024 **Quantum Error Correction meets Operator Algebras**, *University of Oslo*, Oslo  
*Homological Quantum Rotor Codes: Logical Qubits from torsion*, [C. Vuillot](#) (speaker), A. Ciani and B. Terhal
- Feb. 2024 **Advances in Quantum Coding Theory**, *Simons Institute*, Berkeley  
*Homological Quantum Rotor Codes: Logical Qubits from torsion*, [C. Vuillot](#) (speaker), A. Ciani and B. Terhal  
Recorded: <https://www.youtube.com/live/-RB279uitAs?feature=shared>
- Jan. 2024 **804. WE-Heraeus-Seminar**, *Physikzentrum*, Bad Honnef  
*Robust sparse IQP sampling in constant depth*, L. Paletta, M. Mirrahimi, A. Leverrier, A. Sarlette and [C. Vuillot](#) (speaker)
- Jun. 2023 **Leti Innovation Days 2023**, *Maison MINATEC*, Grenoble  
*50 Ways Towards Fault-tolerant Quantum Computation*, [C. Vuillot](#) (speaker)
- Jun. 2021 **Colloquium Physique et Mathématique**, *IRMA*, Strasbourg  
*The Challenge of Universal and Fault-Tolerant Quantum Computation.*, [C. Vuillot](#) (speaker)
- Apr. 2019 **BQIT:19**, *University of Bristol*, Bristol  
*Quantum Error Correction with the Toric-GKP Code*, [C. Vuillot](#) (speaker), H. Asasi, Y. Wang, L.P. Pryadko and B.M. Terhal.  
Recorded: <https://youtu.be/OI1xUYVok2M>

- Feb. 2019 **Qiskit camp**, *IBM Watson Research center*, Yorktown Heights  
*Is error detection helpful on IBM 5Q chips?*, [C. Vuillot](#) (speaker)  
Recorded: <https://youtu.be/Vr8K1owe4YQ>
- Nov. 2018 **GT IQ (GdR IM)**, *Loria*, Nancy  
*Quantum Error Correction with the Toric-GKP Code*, [C. Vuillot](#) (speaker), H. Asasi, Y. Wang, L.P. Pryadko and B.M. Terhal.
- Nov. 2018 **QCDA kickoff meeting**, *Inria*, Paris  
Two talks : *Quantum Error Correction with the Toric-GKP Code*, [C. Vuillot](#) (speaker), H. Asasi, Y. Wang, L.P. Pryadko and B.M. Terhal and a *Tutorial on Continuous Variable Systems in Quantum Mechanics*, [C. Vuillot](#) (speaker)

## Contributed talks

- Jan. 2024 **QIP 2024**, *Taipei International Convention Center*, Taipei  
*Robust sparse IQP samplint in constant depth*, [L. Paletta](#) (speaker), M. Mirrahimi, A. Leverrier, A. Sarlette and C. Vuillot
- Jul. 2023 **TQC 2023**, *Universidade de Aveiro*, Aveiro  
*Optimal Hadamard gate count for Clifford+T synthesis of Pauli rotations sequences*, [V. Vandaele](#) (speaker), S. Martiel, S. Perdrix and C. Vuillot.
- Jul. 2019 **QEC19**, *University College London*, London  
*Quantum Pin Codes*, [C. Vuillot](#) (speaker) and N.P. Breuckmann.  
Recorded: [https://youtu.be/55a8SYm2d\\_U](https://youtu.be/55a8SYm2d_U)
- Jul. 2018 **TQC 2018**, *University of Technology*, Sydney  
*Quantum Error Correction with the Toric-GKP Code*, [C. Vuillot](#) (speaker), H. Asasi, Y. Wang, L.P. Pryadko and B.M. Terhal.
- Sep. 2017 **QEC 2017**, *University of Maryland*, College Park, MD  
*Hyperbolic and semi-hyperbolic surface codes for quantum storage*, with N.P. Breuckmann, [C. Vuillot](#), E. Campbell, [A. Krishna](#) (speaker) and B.M. Terhal .

## Awards & Scholarships

- 2018 **IBM Q Best Paper Award**, *1st place*, for [14]  
For the highest-impact scientific papers by a master student, PhD student or postdoctoral researcher using the IBM Q Experience and Qiskit as tools to achieve the presented results. (\$1500)
- 2010–2015 **Normalien**, *ENS Rennes*, Rennes  
Four-year scholarship from ENS Rennes, awarded through national competitive exams. (Full time salary)

## Project Leading

- 2023 – 2028 **PEPR HQI**, *Workpackage leader*
- 2022 – 2028 **PEPR NISQ2LSQ**, *Workpackage leader*
- 2022 – **Inria Associate Team QASAR**, *team leader*

## Organization

- Aug. 2024 Workshop on fault-tolerant quantum technologies in Benasque, Spain.
- Jun. 2023 – QASAR international online seminar on fault-tolerant quantum computation, once every two weeks, (~ 29 attending on average).
- Mar. 2023 Workshop on Quantum LDPC Codes in Pont-à-Mousson (NISQ2LSQ).

- 2023 – Member of the scientific board of the GdR TeQ.
- 2017–2019 Journal Club on quantum information at TU Delft, QuTech.
- 2017 Journal Club on quantum information at RWTH Aachen university, IQI.

## Supervision

- 2022 – **PhD Student**, *Diego Ruiz*, CIFRE Alice&Bob-Inria, Scaling up a bosonic quantum processor for quantum information processing applications  
co-supervising with Mazyar Mirrahimi (Inria), Jérémie Guillaud (Alice&Bob) and Anthony Leverrier (Inria).
- 2022 – **PhD Student**, *Louis Paletta*, Inria Paris, Autonomous error correction with cat-qubits  
co-supervising with Mazyar Mirrahimi (Inria), Alain Sarlette (Inria) and Anthony Leverrier (Inria).
- 2022 **Intern**, *Louis Paletta*, Inria Paris, Quantum error mitigation for cat-qubits  
co-supervising with Mazyar Mirrahimi (Inria), Alain Sarlette (Inria) and Anthony Leverrier (Inria).
- 2021 – **PhD Student**, *Alexandre Guernut*, Inria, Efficient Fault-Tolerant Quantum Computation with Quantum LDPC Codes  
co-supervising with Emmanuel Jeandel (Univ. Lorraine).
- 2021 – **PhD Student**, *Vivien Vandaele*, CIFRE ATOS-CNRS, Optimisation du calcul quantique tolérant aux fautes par le ZX-Calculus  
co-supervising with Simon Perdrix (Inria) and Simon Martiel (ATOS).
- 2021 **Intern**, *Alexandre Guernut*, LORIA, Topological concatenation of 2D color codes

## Teaching

- Winter–2024 **Quantum Information**, *Université de Lorraine*, Nancy  
M1 course with S. Perdrix
- Winter–2023 **Quantum Information**, *Université de Lorraine*, Nancy  
M1 course with S. Perdrix
- Winter–2022 **Quantum Information**, *Université de Lorraine*, Nancy  
M1 course with S. Perdrix
- Spring–2021 **Quantum Information**, *Télécom Paritech*, Paris  
M1 course
- Winter–2021 **Quantum Information**, *Université de Lorraine*, Nancy  
M1 course with S. Perdrix
- Spring–2018 **Quantum Information Theory**, *TU Delft*, Delft  
Master level, tutorial sessions. Teacher: M. Caspers
- Winter 2016 **Electrodynamics**, *RWTH Aachen university*, Aachen  
Bachelor level, helping students with their assignments. Teacher: B. Terhal
- Summer 2016 **Quantum Information Theory**, *RWTH Aachen university*, Aachen  
Master level, conception of the exercises and tutorial sessions. Teacher: D. DiVincenzo
- Winter 2015 **Quantum error correction seminar**, *RWTH Aachen university*, Aachen  
Two lectures.
- 2012–2013 **Introduction to programming with Maple**, *Lycée Henri IV*, Paris  
MPSI students (equivalent to first year bachelor), Conception of the exercises and tutorial sessions.

## Reviewing activities

Nature, Nature communications, npj quantum information, ITCS, IEEE Transactions on Information Theory, TQC conference, QIP conference, Rinton Press Quantum Information & Computation, IOP Quantum Science and Technology, Quantum, IEEE Transactions on Applied Superconductivity, ANR

## Education

- 2015 **Research internship**, *Caltech, IQIM*, Pasadena, Supervision: T. Vidick  
*Construction of approximate ground state projections*, Mar.–Aug.
- 2014–2015 **Master**, *Paris Diderot University*, Paris  
Parisian Master of Research in Computer Science (MPRI).
- 2014 **Research internship**, *University of Innsbruck, IQOQI*, Innsbruck, Supervision: C. Kraus and M. Baranov  
*Competition between Hamiltonian and dissipative dynamics in topologically ordered fermionic systems*, Apr.–Aug.
- 2013–2014 **1st year Master**, *ENS Cachan*, Cachan  
Physics, theory, experiment and modeling (PHYTEM).
- 2012–2013 **Year off**  
Musical studies.
- 2012 **Research internship**, *University of Waterloo, IQC*, Waterloo, Supervision: Z. Ji and D. Leung  
*Competition between Hamiltonian and dissipative dynamics in topologically ordered fermionic systems*, Apr.–Aug.
- 2011–2012 **1st year Master**, *ENS Rennes*, Rennes  
Computer science.  
**Licence**, *Université de Rennes 1*, Rennes  
Physics.
- 2011 **Research internship**, *University of Rennes 1, IRMAR*, Rennes, Supervision: E. Faou and F. Nobile  
*Sparse spectral approximations for computing polynomial functionals*, May.–Jul.
- 2010–2011 **Licence**, *ENS Rennes*, Rennes  
Computer science.
- 2008–2010 **MPSI/MP\***, *Lycée Henri IV*, Paris  
Preparatory classes to the French national competitive exams for the Grandes Écoles.
- 2008 **French Baccalauréat**  
Mention très bien.

## Family

Two children born in 2019 and 2022