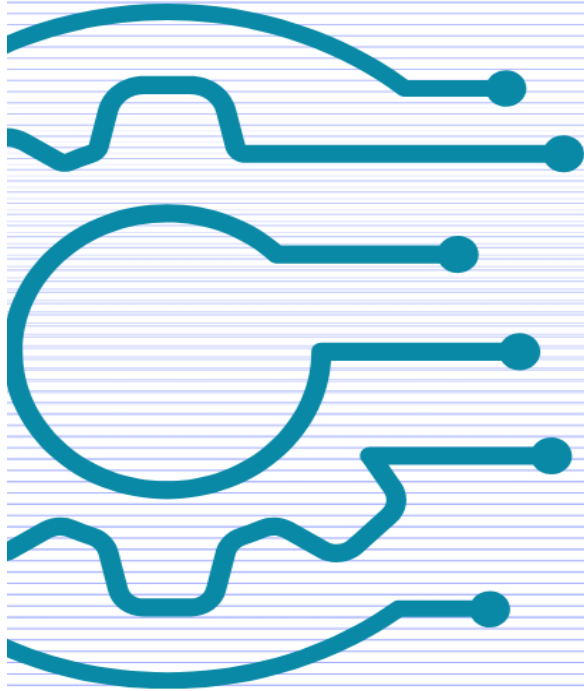




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CERN Main Auditorium



QUANTUM TECHNOLOGY CONFERENCE

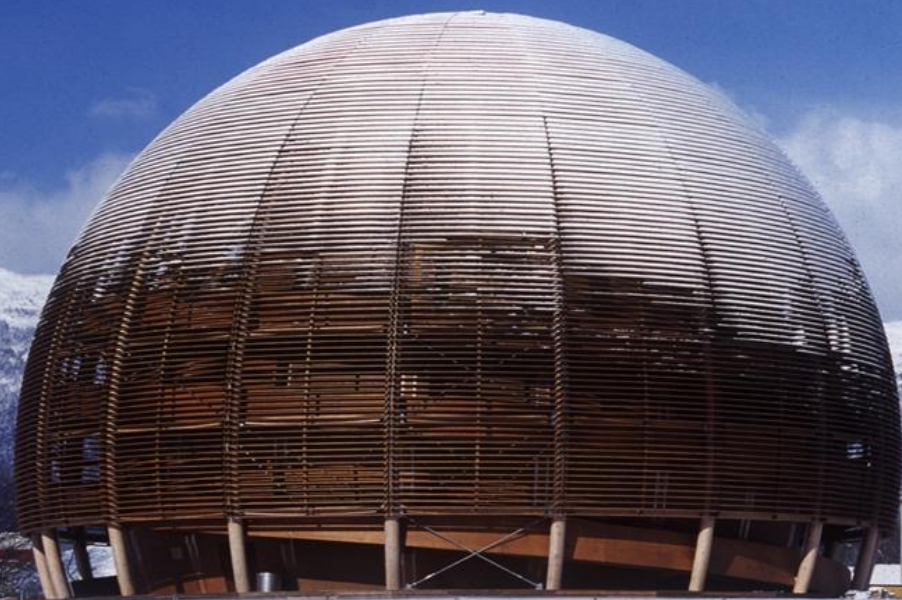
QT4HEP 20-24 January 2025



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WELCOME TO CERN!



«...a Swiss winter day..»
25 January 2005
cds.cern.ch



**QUANTUM
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**Build
expertise
through
collaborations**

**Evaluate impact
of QT on CERN
scientific
program**

**Identify CERN
technologies
that can
contribute to QT
development**



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Quantum Technology Initiative: Origins

2018

Openlab Workshop on Quantum Computing



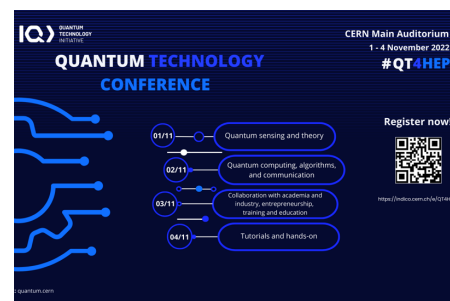
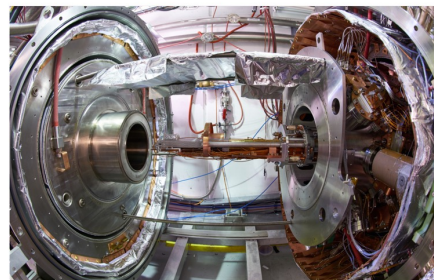
2020

Quantum Technology Initiative is approved

CERN meets quantum technology

The CERN Quantum Technology Initiative will explore the potential of devices harnessing perplexing quantum phenomena such as entanglement to enrich and expand its challenging research programme

30 SEPTEMBER, 2020 | By Matthew Chalmers



2022

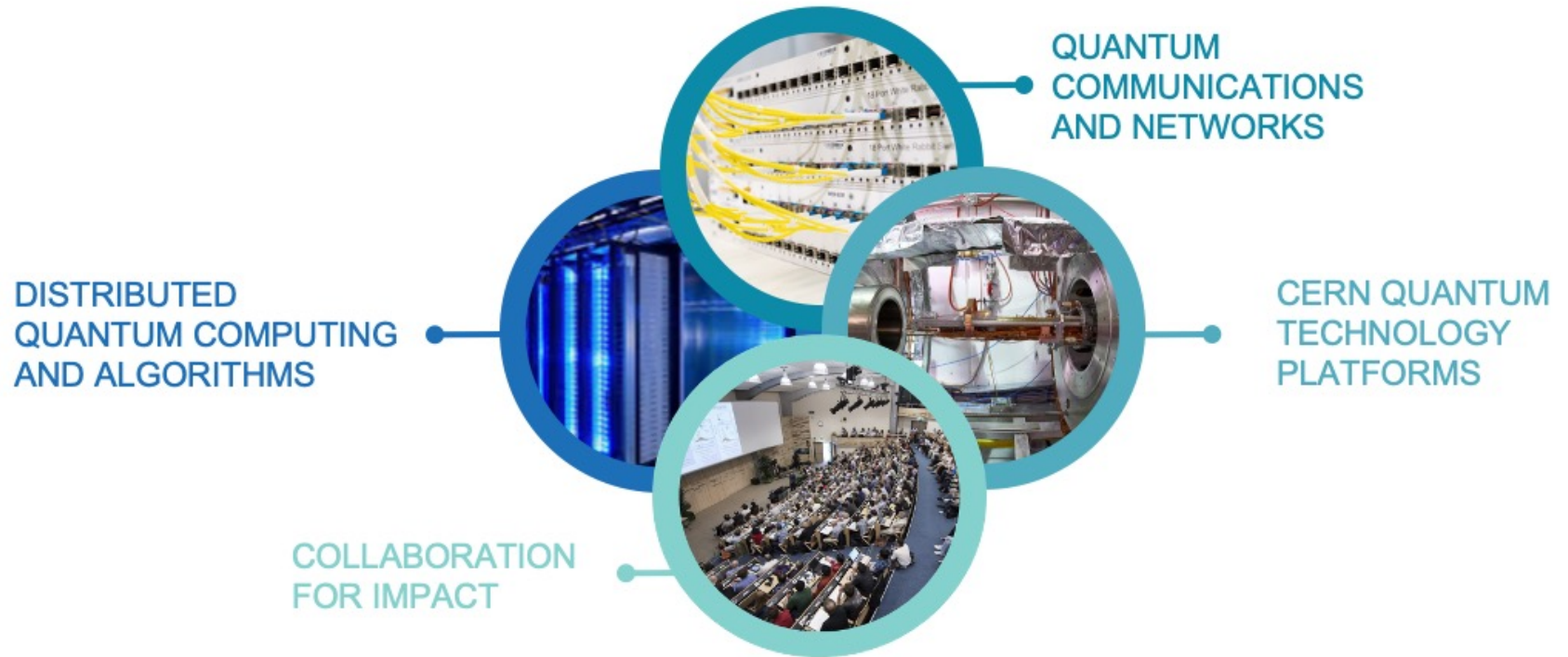
First edition of QT4HEP



2024

QTI Phase 2 starts!

Quantum Technology Initiative: Today



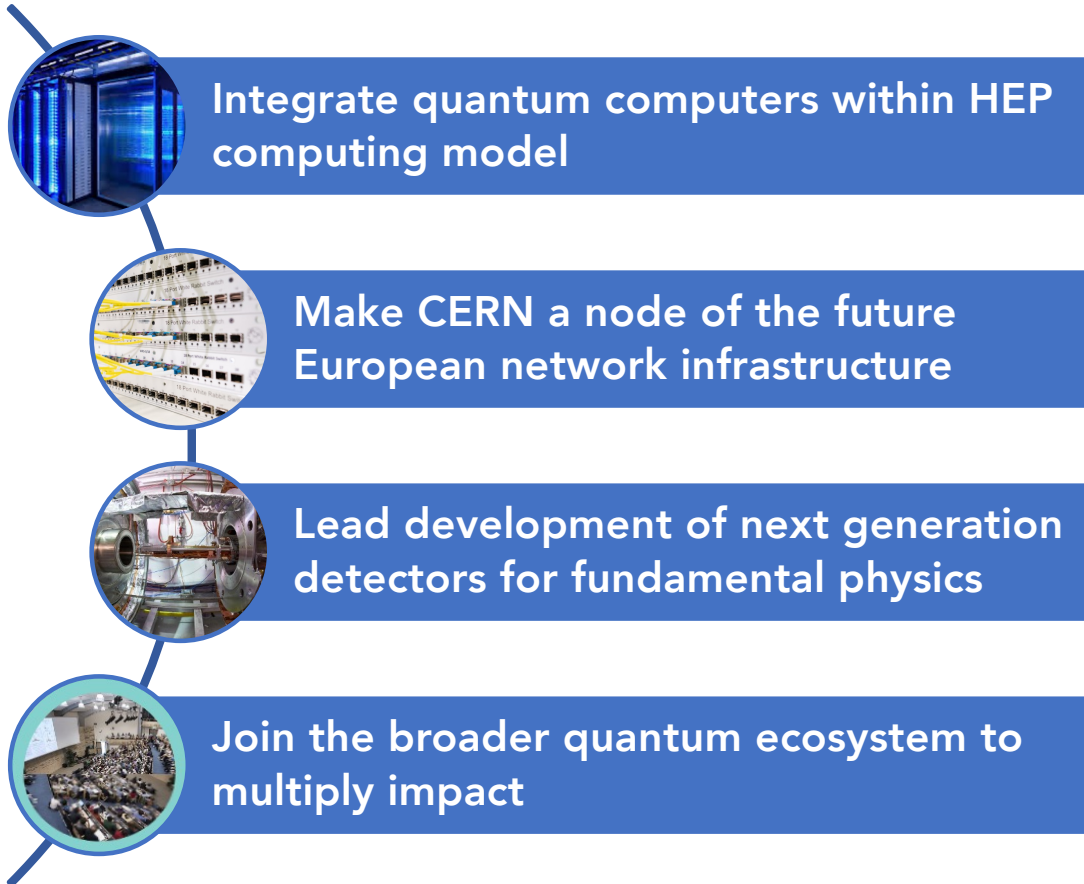
Our Goal: Design a coherent research plan that can evolve into a long term strategy on quantum technologies, aligned with CERN's traditional values of innovation, collaboration, and advancing knowledge for the benefit of humanity.



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QTI Objectives



Actions:

Develop hybrid algorithms for realistic applications;
Contribute to infrastructure development

Design Quantum Network demonstrators incorporating White Rabbit for time synchronization;
Characterize performance of communication protocols in realistic use cases

Develop superconducting RF cavities for sensing and computing applications;
Significant contribution to ECFA DRD5 program

Setup co-development partnerships with companies, institutes and other entities.



QTI Research contributes to CERN program

QTI Areas

CERN Program

Major QTI results



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QTI Research contributes to CERN program

QTI Areas

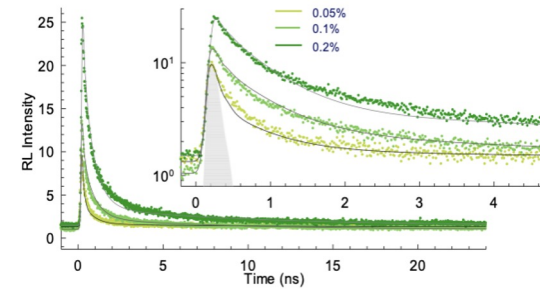
Quantum Sensing



CERN Program

**Accelerators
Technologies and
Future Detectors
R&D**

Major QTI results



Frank, I. J. C. **Investigation of Nanocomposite Scintillators and New Detector Concepts for High Energy Physics**, doi: 10.1109/NSSMICRTSD4912.6.2023.10337902.



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QTI Research contributes to CERN program

QTI Areas

CERN Program

Quantum Sensing



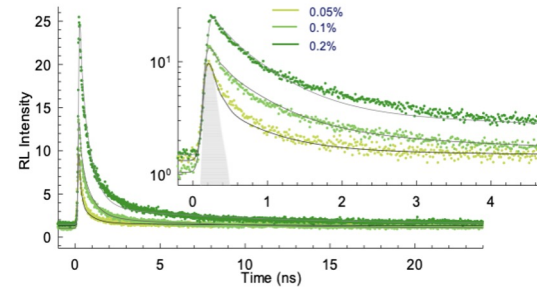
**Accelerators
Technologies and
Future Detectors
R&D**

Quantum Simulation



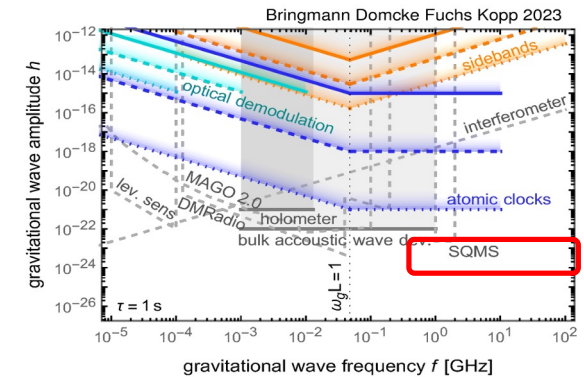
**Theory, Physics
Beyond Colliders**

Major QTI results



Frank, I. J. C. **Investigation of Nanocomposite Scintillators and New Detector Concepts for High Energy Physics**, doi: 10.1109/NSSMICRTSD4912.6.2023.10337902.

Bringmann, T., et al. "High-frequency gravitational wave detection via optical frequency modulation." *Physical Review D* 108.6 (2023): L061303.



QTI Research contributes to CERN program

QTI Areas

CERN Program

Quantum Sensing



**Accelerators
Technologies and
Future Detectors
R&D**

Quantum Simulation



**Theory, Physics
Beyond Colliders**

Quantum Computing

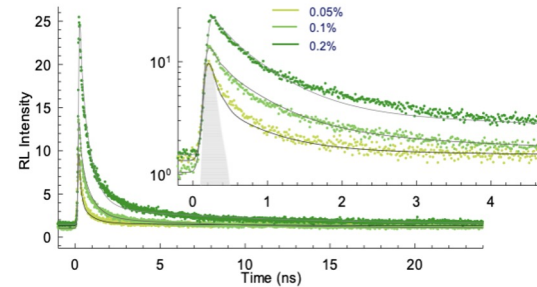


**Scientific Computing:
Algorithms, Distributed
Computing**

Quantum
Communication

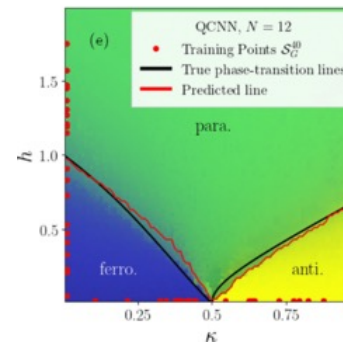
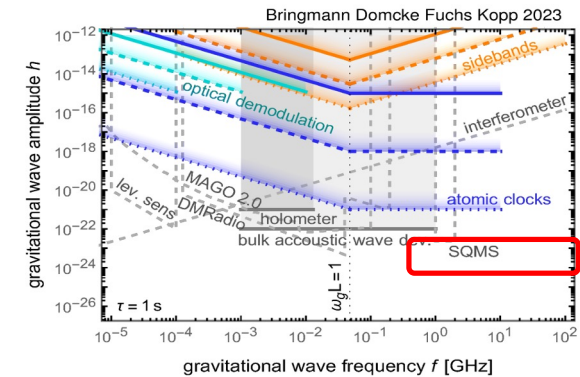


Major QTI results



Frank, I. J. C. **Investigation of Nanocomposite Scintillators and New Detector Concepts for High Energy Physics**, doi: 10.1109/NSSMICRTSD4912.6.2023.10337902.

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Monaco, S. et al. **"Quantum phase detection generalization from marginal quantum neural network models."** *Physical Review B* 107.8 (2023): L081105.

QTI Research contributes to CERN program

QTI Areas

CERN Program

Quantum Sensing



**Accelerators
Technologies and
Future Detectors
R&D**

Quantum Simulation



**Theory, Physics
Beyond Colliders**

Quantum Computing

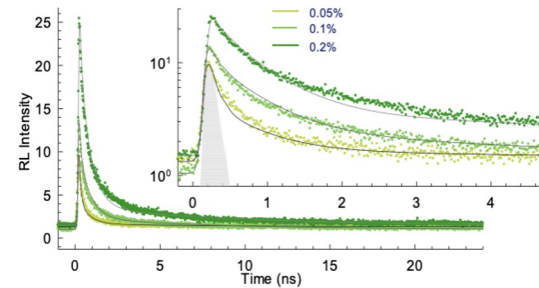


**Scientific Computing:
Algorithms, Distributed
Computing**

Quantum
Communication

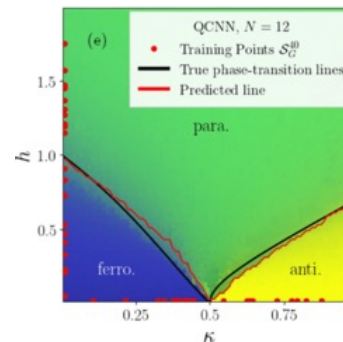
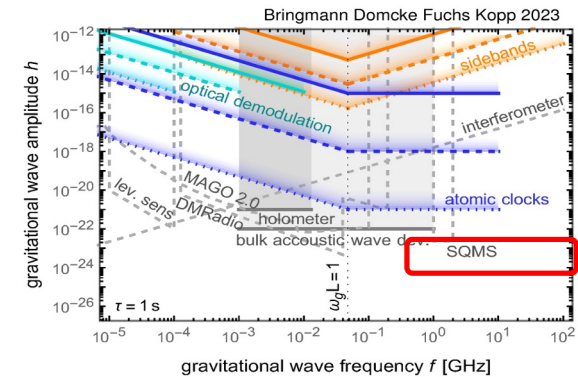


Major QTI results



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Monaco, S. et al. **"Quantum phase detection generalization from marginal quantum neural network models."** *Physical Review B* 107.8 (2023): L081105.

Foster a expert community studying usability of Quantum Computing for HEP

- Lead the creation of a new community of experts from the Member States and beyond
- Focus on concrete challenges of QC for HEP
- White Paper on a realistic roadmap in experimental and theoretical physics → a seminal paper!

QC4HEP ANNUAL MEETING on FRIDAY
(<https://indico.cern.ch/event/1484549/>)

Di Meglio, A. , *et al.* **Quantum Computing for High-Energy Physics: State of the Art and Challenges.**
PRX Quantum 5.3 (2024): 037001.



The screenshot shows the PRX Quantum journal article page. The title is "Quantum Computing for High-Energy Physics: State of the Art and Challenges" by Alberto Di Meglio *et al.*, published in PRX Quantum 5, 037001 on August 5, 2024. The page includes navigation tabs for "Roadmap" and "Open Access". Below the title, there are buttons for "Article", "References", "No Citing Articles", "PDF", "HTML", and "Export Citation". The abstract text is visible, starting with "Quantum computers offer an intriguing path for a paradigmatic change of computing in the natural sciences and beyond...". At the bottom of the abstract, there are three small thumbnail images and the text "Received 25 August 2023 Revised 29 March 2024 Accepted 25 June 2024".



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Open Quantum Institute (OQI)

TALK ON TUESDAY!



The Open Quantum Institute at CERN

- Driving values of **inclusivity, global scope, openness, focus on impact, and fostering collaborations**
- Leveraging QTI's mission to **explore the full potential of quantum technologies** and maximise their societal impact
- Strengthening CERN's profile as a scientific institution **addressing society's pressing challenges**



The work of OQI

- Accelerating applications for humanity
- Access for all
- Advancing capacity building
- Activating multilateral governance

<https://open-quantum-institute.cern>



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The logo for the QT4HEP Program features a large, stylized 'Q' on the left, transitioning from teal to blue. To its right is a vertical blue bar. Further right, the text 'QT4HEP' is stacked above 'Program' in a blue, sans-serif font. On the far right is a large, blue, stylized chevron symbol pointing to the right.

QT4HEP
Program

<https://indico.cern.ch/event/1433194>



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Welcome Introduction
500/1-001 - Main Auditorium, CERN
CERN QT12
500/1-001 - Main Auditorium, CERN
The European Commission Joint Research Centre's contribution to quantum and pre-Petra Scudo
Coffee break
500/1-001 - Main Auditorium, CERN
High-speed SNSPDs for clock-rate scaling in quantum networks
500/1-001 - Main Auditorium, CERN
Photon-number-resolving SNSPDs and their applications for quantum networks and [DQuantique]
Félix Bussières
Metropolitan-scale entanglement generation between quantum processors: from the Arian Stolk
Lunch
500/1-001 - Main Auditorium, CERN
The Entanglement Fabric: enabling distributed quantum computing with quantum networks
Simon J. Phoenix, Zeph Gringer, and Zeph Barker
Entanglement Networking Hardware: Driving Real-World Applications Beyond QKD [DQuantique]
500/1-001 - Main Auditorium, CERN
The Road to a Quantum-Connected World: Insights from Deutsche Telekom's Activities
500/1-001 - Main Auditorium, CERN
Building physics-centric Quantum Networks [Stony Brook University]
500/1-001 - Main Auditorium, CERN
Coffee break
500/1-001 - Main Auditorium, CERN
Open discussion session on synchronisation for quantum communication
500/1-001 - Main Auditorium, CERN

Quantum network technology – the second life of rare-earth crystals [Universitat de València]
81/R-003C - Science Gateway Auditorium C, CERN
Quantum computing roadmaps toward fault-tolerance
81/R-003C - Science Gateway Auditorium C, CERN
Coffee
81/R-003C - Science Gateway Auditorium C, CERN
The Quantum Internet: Applications, Challenges and Opportunities
81/R-003C - Science Gateway Auditorium C, CERN
The Open Quantum Institute (OQI)
81/R-003C - Science Gateway Auditorium C, CERN
Conference Photo
500/1-001 - Main Auditorium, CERN
Lunch
500/1-001 - Main Auditorium, CERN
Efficient Use of Quantum Computers for Collider Physics
81/R-003C - Science Gateway Auditorium C, CERN
Quantum Machine Learning with Physics-Informed and Symmetry-Aware Models
81/R-003C - Science Gateway Auditorium C, CERN
Prof. Fabio Maltoni - Quantum Observables in HEP
81/R-003C - Science Gateway Auditorium C, CERN
Coffee break
81/R-003C - Science Gateway Auditorium C, CERN
Jad Halmech - quantum simulation in lattice gauge theories and long-range quantum entanglement
81/R-003C - Science Gateway Auditorium C, CERN
The quantum life of a Feynman propagator as a qubit
81/R-003C - Science Gateway Auditorium C, CERN

Overview Quantum Sensors for particle physics	Steve
500/1-001 - Main Auditorium, CERN	09:00
Atom Interferometry	7fff
500/1-001 - Main Auditorium, CERN	09:45
High Tc superconducting particle detectors	Ilya Char
500/1-001 - Main Auditorium, CERN	10:00
Coffee Break	
500/1-001 - Main Auditorium, CERN	10:30
Superconducting Calorimeters	Prof. Sebast
500/1-001 - Main Auditorium, CERN	10:45
Chromatic calorimetry (quantum dots)	Yacine
500/1-001 - Main Auditorium, CERN	11:15
Nuclear clocks for fundamental and particle physics	Dr Ekke
500/1-001 - Main Auditorium, CERN	11:30
SRF / heterodyne cavity applications for axion searches	Seba
500/1-001 - Main Auditorium, CERN	12:00
Lunch	
500/1-001 - Main Auditorium, CERN	12:30
QSNET: network of quantum sensors for measuring the stability of fundamental constants	Leonid F
500/1-001 - Main Auditorium, CERN	13:30
Superconducting qubits as photonic sensors	Francesco De
500/1-001 - Main Auditorium, CERN	14:00
High-Q cavity quantum optics: high permittivity dielectric resonator for sensing applications	Antonio Cassin
500/1-001 - Main Auditorium, CERN	14:30
Magnetic techniques for quantum sensing using single molecule magnets in the NEMO experiment	Giuseppe Latino
500/1-001 - Main Auditorium, CERN	14:45
Towards realization of long-lived chains of circular Rydberg atoms for quantum simulation	Ankur
500/1-001 - Main Auditorium, CERN	15:15
Characterization of a Rubidium based Four Way Mixing Entangled Photon Pair Source with SNSPDs	Federica Facchin
500/1-001 - Main Auditorium, CERN	15:30
Highly Sensitive Optical Quantum Sensors	Dr Youn
500/1-001 - Main Auditorium, CERN	15:45
Coffee break	
500/1-001 - Main Auditorium, CERN	15:55
On multivariate polynomials achievable with quantum signal processing	Lorenzo L
81/R-003C - Science Gateway Auditorium C, CERN	16:00
Complementary polynomials in quantum signal processing	Dr Bjorn
81/R-003C - Science Gateway Auditorium C, CERN	16:15
Estimates of loss function concentration in noisy parametrized quantum circuits	Giulio C
81/R-003C - Science Gateway Auditorium C, CERN	16:30
Break	
81/R-003C - Science Gateway Auditorium C, CERN	16:45
Guarantees for smart initializations in variational quantum computing	Ri
81/R-003C - Science Gateway Auditorium C, CERN	17:00
Neural quantum states for lattice field theory	Thoma
81/R-003C - Science Gateway Auditorium C, CERN	17:15
Prospects for the quantum simulation of quark-gluon plasma	Claudia
81/R-003C - Science Gateway Auditorium C, CERN	17:30

Some recent progress in the description of atomic nuclei using quantum computing
500/1-001 - Main Auditorium, CERN
Engineering periodic boundary conditions with circuit cutting for hybrid quantum-classical algorithms
500/1-001 - Main Auditorium, CERN
Efficient Encoding of Quantum States for Hamiltonian Simulation of Quantum Chemistry
Reita Maeno
500/1-001 - Main Auditorium, CERN
Enhancing quantum field theory simulations on NISQ devices with hybrid quantum-classical algorithms
JAMES, ALLAN INGOLDBY
500/1-001 - Main Auditorium, CERN
Projected Entangled Pair States for Lattice Gauge Theories with Dynamical Fermions
500/1-001 - Main Auditorium, CERN
Fault-tolerant simulation of Lattice Gauge Theories with gauge covariant quantum circuits
500/1-001 - Main Auditorium, CERN
Coffee break
500/1-001 - Main Auditorium, CERN
Building quantum event generators through path integral based formulations
500/1-001 - Main Auditorium, CERN
Quantum Chemistry: Generation of wavefunctions for Fragmentation Functions
500/1-001 - Main Auditorium, CERN
Efficient calculation of Green's functions on quantum computers via tensor networks
Francesco Tacchini
500/1-001 - Main Auditorium, CERN
Learning to generate high-dimensional distributions with low-dimensional generative models
Cenk Tüysüz
500/1-001 - Main Auditorium, CERN
Towards quantum advantage with photonic state injection
500/1-001 - Main Auditorium, CERN
Closing
500/1-001 - Main Auditorium, CERN
Lunch
500/1-001 - Main Auditorium, CERN

DAY 1: COMMUNICATION

DAY 2: COLLOQUIA COMPUTING POSTERS

DAY 3: SENSING COMPUTING

DAY 4: COMPUTING

Quantum Computing Hackathon

Please note different location on Friday:

<https://indico.cern.ch/event/1433194/timetable/#20250124.detailed>

- IT Auditorium for the challenge presentation
- Breakout rooms in the IT Department

<https://aqora.io/events/cern-hep-challenge-2025>



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Some Practical Info

Mon-Wed-Thu in the Main Auditorium

- Coffee breaks served just outside
- Lunch tickets for the main cafeteria (R1) (16 CHF value, you should cover additional costs)

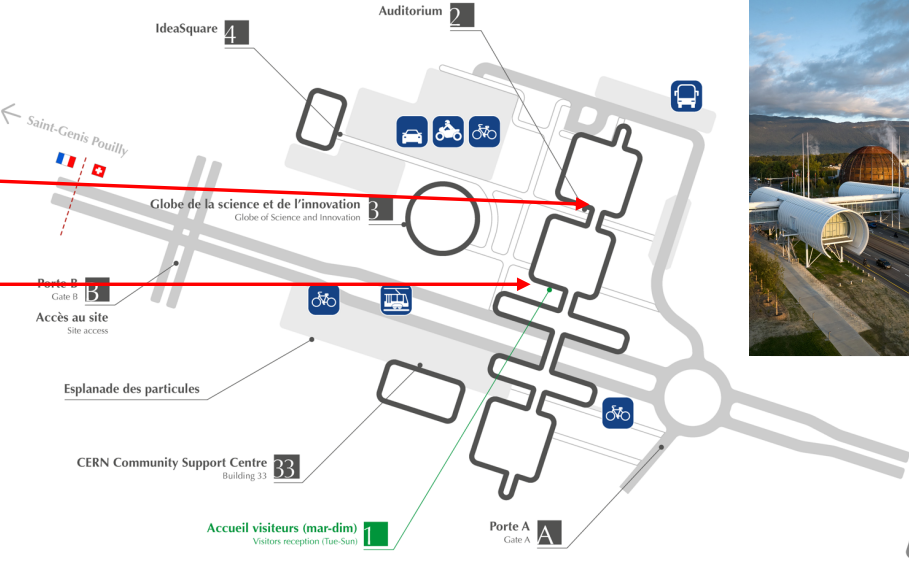
Tuesday we are at the Science Gateway

- Lunch is served there
- To visit the exhibitions use the public entrance.
- Conference badge will get you 10% discount at the CERN store

Conference Photo Tuesday before lunch

Poster Session and Conference Cocktail on Tuesday at the Science Gateway

- Don't forget to bring your poster there!



The map shows the CERN site layout with several key locations marked: IdeaSquare (4), Auditorium (2), Globe de la science et de l'innovation (3), Porte B Gate B (B), Accès au site Site access, Esplanade des particules, CERN Community Support Centre Building 33 (33), Accueil visiteurs (mar-dim) Visitors reception (Tue-Sun) (1), and Porte A Gate A (A). Red arrows point from the text to the Science Gateway area (Globe de la science et de l'innovation and Accès au site). Icons for car, bicycle, and bus are shown near various locations. A small inset photo shows the Science Gateway building at dusk.

Comment se rendre au CERN
How to get to CERN

Esplanade des particules 1217 Meyrin (Suisse - Switzerland)	cern.reception@cern.ch +41 (0)22 767 76 76 (Tuesday-Sunday)	Latitude 46.2331 N Longitude 6.0556 E	Tram 18 Bus 68 tpg.ch	Parking payant Paid car park	Parking vélos Bike parking	Parking motos Motorbike parking	home.cern
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Thank you



Enjoy the conference!