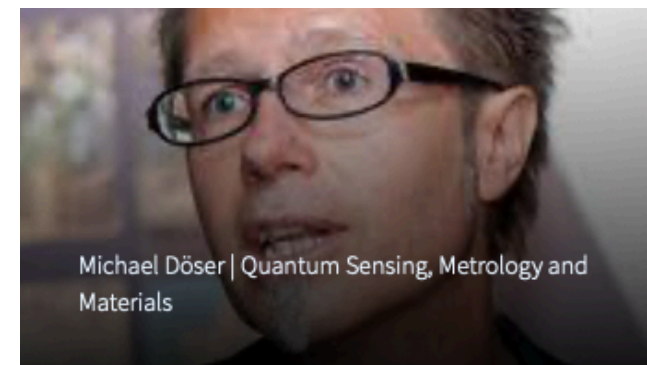# Quantum Technology Initiative (QTI)

Hub for Collaborative Developments in Quantum Information Science and Technology

Main Branches and Coordinators
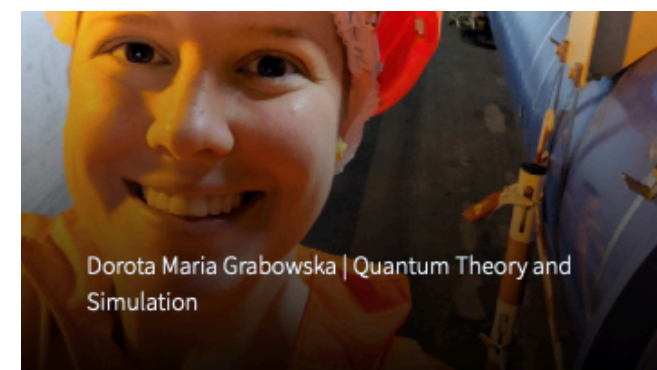
Michael Doser

Sensing, Metrology and Materials

EP Department

Michael Döser | Quantum Sensing, Metrology and Materials

Alberto Di Meglio

HEAD COORDINATOR

CERN OpenLab Head

IT Department

Alberto Di Meglio | Coordination & Quantum Communication and Networks

Sofia Vallecorsa

Computing and Algorithms
IT Department

Sofia Vallecorsa | Quantum Computing and Algorithms

Dorota Grabowska

Theory and Simulation
TH Department

Dorota Maria Grabowska | Quantum Theory and Simulation
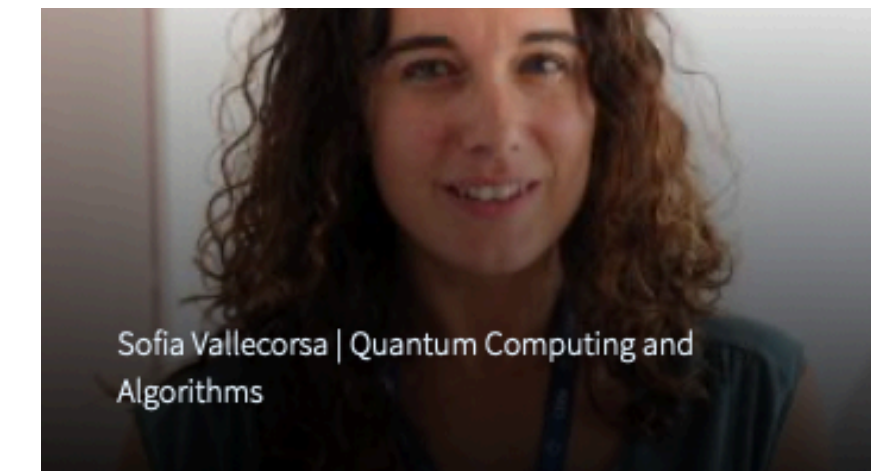
Amanda Diez Fernandez
Benjamin Frisch
Knowledge Transfer
IPT Department

Amanda Diez Fernandez | Knowledge Transfer

Benjamin Frisch | Knowledge Transfer
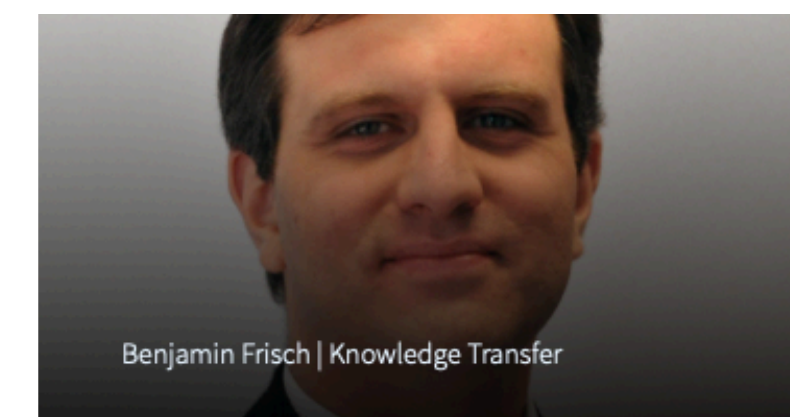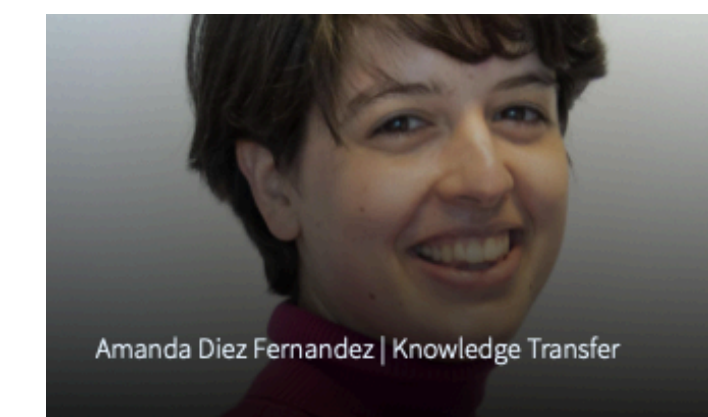
Please feel free to reach out to any and all the coordinators!

QUANTUM TECHNOLOGY INITIATIVE

High-Level Goals

Guiding CERN's involvement in the many rapidly advancing fields of quantum technologies

In the first year, we created a Roadmap Document to define and guide the activities of the Initiative during the first three years and lay the foundations for a continuing program

This Strategy is based on four top-level objectives

1. Scientific and Technical Development and Capacity Building

2. Co-Development

3. Community Building

4. Integration with National and International Initiatives and Programs

Roadmap Document has now been approved and released to the public!
https://doi.org/10.5281/zenodo.5553774

Theory + Simulation Branch

Four Top-Level Objects in the Roadmap Document

Identify possible applications of quantum simulations and support worldwide experimental efforts to probe and measure both Standard Model and beyond the Standard Model physics.

Applications of Quantum Technology To Particle Physics

Assist the computing and sensing activities in identifying theoretically promising regions of parameter space in which quantum technology could provide an advantage over classical methods.

Benchmark the current and potential performance of quantum simulations against state-of-the-art classical computations.

Host workshops, summer institutes and visitors, establishing global collaborations with other institutes, national labs and companies.

Theory + Simulation Branch

What We Are Actually Doing

Quantum Sensing

Develop novel phenomenological probes of the Standard Model and beyond

Current Projects

- Prospects for Fundamental Physics with Large Quantum Sensors (Matthew McCullough + DMG)
  - QTI Doctoral Student hopefully starting Jan. 2022
- Michael Dosser (Sensing Coordinator) is very interested in collaboration and would love to talk to some phenomenologists!

Quantum Computing

Develop new computational methods and algorithms to calculate properties of Standard Model and other QFTs

Some Current Projects

- Quantum Machine Learning for Monte Carlo Event Generation (C. Bravo-Prieto, J. Baglio, M. Cè, A. Francis, S. Carrazza and DMG)

- Dynamical Simulations of Lattice Gauge Theories (J. Baglio, M. Cè, A. Francis and DMG + IBM Zurich Partners)

- Resource Efficient Formulations of Lattice Gauge Theories (C. Bauer + DMG)

Quantum Computing

Three Interlocking Directions

Algorithmic Developments

How do we construct frameworks for calculating SM processes using quantum computational methods?

Examples from Current Projects

- Quantum Machine Learning for Monte Carlo Event Generation

Theoretical Developments

How do we formulate field theories in a quantum technology compatible way?

Examples from Current Projects

- Resource Efficient Formulations of Lattice Gauge Theories

- Dynamical Simulations of Lattice Gauge Theories

Benchmarking and Optimization

Which quantum hardware architecture is best suited for specific physics goals?

Examples from Current Projects

- Quantum Machine Learning for Monte Carlo Event Generation

Quantum Computing

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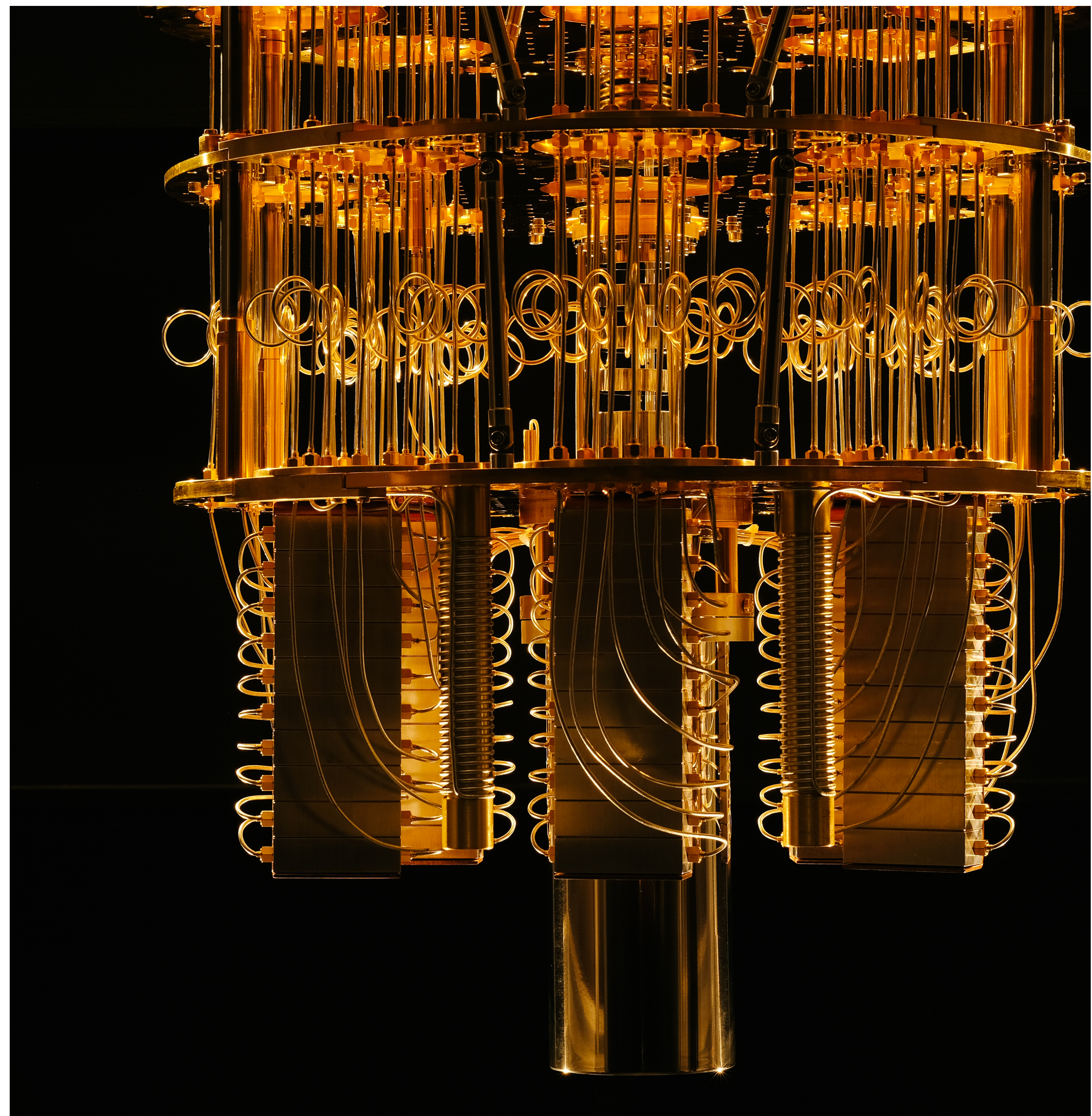*This mirrors what is done in the Lattice QCD community*

CERN Quantum Hub

We have access to real-world quantum computers!
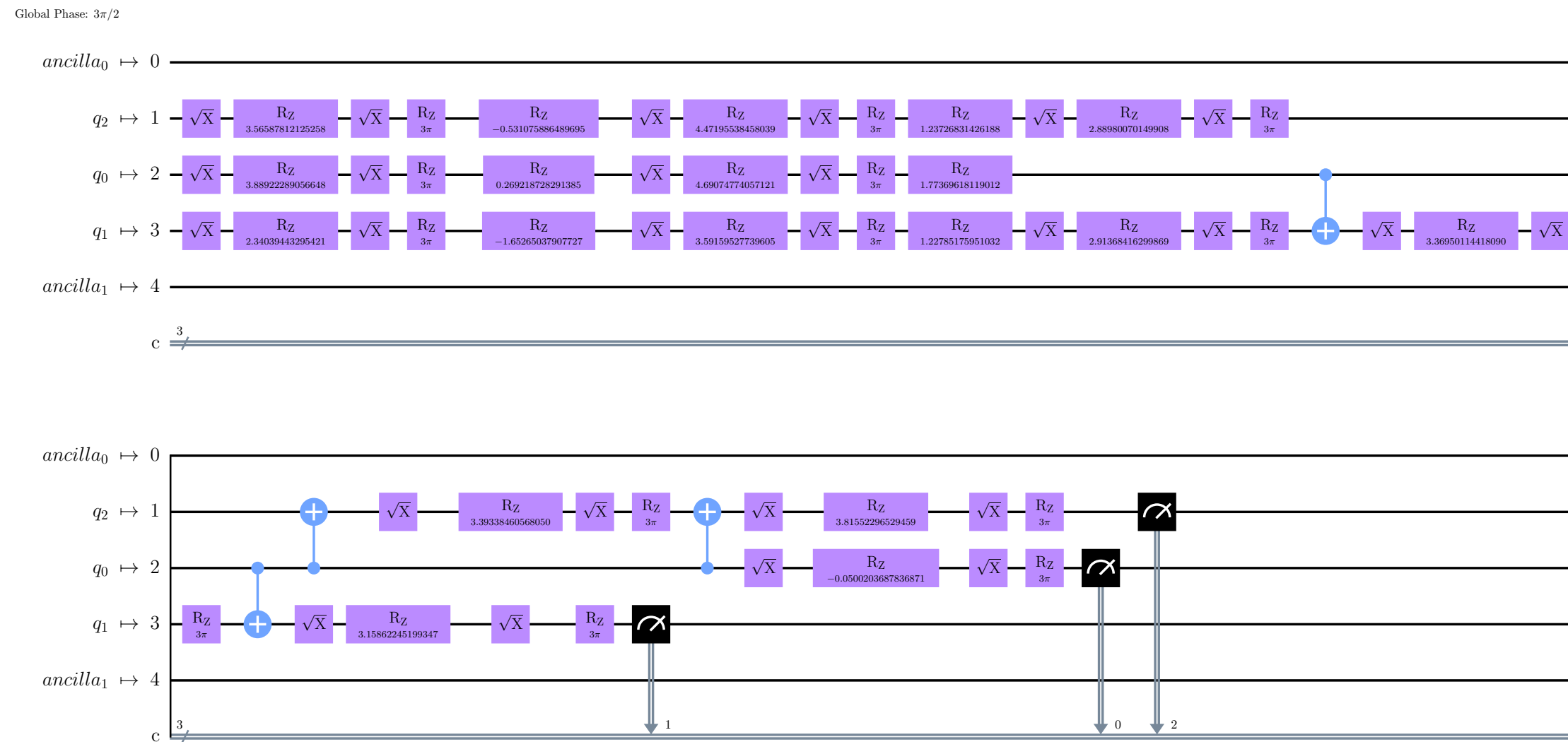
Circuit run on IBM Santiago for QML Paper

- CERN is a hub member of the Quantum Network

- Access to IBM Hardware based on quotas for Hub members and projects

- Currently looking for expressions of interest for new members

Upcoming Talks and Meeting

Multiple Chances to Learn More and Get Involved

Upcoming Quantum Talks

- Nov 11th: BSM Forum (M. Freytsis)

- Nov 17th: TH Colloquium (D. Grabowska)

- Nov 19th: QCD Lunch (QML Collaboration)

Meetings

- Weekly Meetings, Mondays 13h00

  - Mixture of Journal Club, discussion and external speakers

- Mailing List: th-dep-Quantum-Tech-meeting@cern.ch

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Documentation

- TWiki: https://twiki.cern.ch/twiki/bin/viewauth/CERNTHQT/WebHome (*access restricted to members of mailing list)

- TH Institute on Quantum Sensing and Quantum Computing: https://indico.cern.ch/event/1015866/

- Roadmap Document: https://doi.org/10.5281/zenodo.5553774

- QTI Website: https://quantum.cern

CERN | IQ QUANTUM TECHNOLOGY INITIATIVE

Questions and Discussion