

**Inauguration Day of the  
BICOCCA QUANTUM  
TECHNOLOGIES CENTER  
"Quantum Science and  
Technology: State-of-the-art  
and Perspectives"**

**Report of Contributions**

Contribution ID: 1

Type: **not specified**

## Registrazione

*Monday, 4 December 2023 09:00 (30 minutes)*

Contribution ID: 2

Type: **not specified**

## Saluti istituzionali

*Monday, 4 December 2023 09:30 (30 minutes)*

Contribution ID: 4

Type: **not specified**

## From Blue-Sky Research to Quantum Technologies - and back!

*Monday, 4 December 2023 10:00 (1 hour)*

Blue-sky research relies on pushing the boundaries of current technologies. In that way it serves as an inherent incubator for deep-tech innovations. A fantastic example is quantum technologies, which emerged as a serendipitous discovery from foundational questions on the very essence of quantum physics. Today, the performance provided by quantum technologies allow us to perform experiments in uncharted terrains of physics - thereby opening up a new era of fundamental science. I will discuss a particularly intriguing example, namely the current attempts to answer one of the big open questions in physics: do the laws of quantum physics also apply to gravity?

**Presenter:** ASPELMEYER, Markus (University of Vienna & Austrian Academy of Sciences)

**Session Classification:** Sessione mattutina

Contribution ID: 5

Type: **not specified**

## Semiconductor quantum dots as resource for photonic quantum technologies

*Monday, 4 December 2023 11:00 (45 minutes)*

In 1997, Peter Shor presented an algorithm for prime factorization in polynomial time on a quantum computer [1]. Since the security in classical cryptography relies on the mathematical complexity of prime factorization, a possible realization of a quantum computer threatens classical cryptography. To fix this problem there are two possible solutions. One is post-quantum cryptography [2] algorithms, which is still based on mathematical complexity. Here, the encryption is modified such that there is no known attack from a quantum computer. The other solution is quantum key distribution [3], which is solely based on physical principles. The latter solution is preferable, because it is genuinely secure – also in the future.

One concept to overcome the challenge of attenuation to establish long-distance quantum links is the quantum repeater [3] which needs a local memory or a fully connected cluster state [5], which probably needs a local qubit as well to build up the entanglement [6]. Spins in QDs are a promising platform, because their spins can be coherently controlled [7], entangled with emitted photons [8], or entangled with other distant spins [9]. We present our recent experimental developments on highly efficient, tunable self-assembled QDs in photonic structures for photonic quantum technologies.

- [1] P. Shor, SIAM J. Sci. Statist. Comput. 26, 1484 (1997).
- [2] C. Bennett and G. Brassard, Proceedings of IEEE International Conference on Computers, Systems and Signal Processing 175, 8 (1984).
- [3] D. J. Bernstein: Introduction to post-quantum cryptography, Springer 2009.
- [4] H.-J. Briegel, W. Dür, J. I. Cirac, and P. Zoller, Phys. Rev. Lett. 81, 5932 (1998).
- [5] K. Azuma, K. Tamaki, and H.-K. Lo, Nature Comm. 6, 6787 (2015)..
- [6] I. Schwartz et al., Science 354, 434 (2016).
- [7] D. Press D, T.D. Ladd, B. Zhang, Y. Yamamoto, Nature 456, 218 (2008).
- [8] A. Delteil et al., Nature Physics 12, 218 (2016).
- [9] K. De Greve, L. Yu, P. L. McMahon, J. S. Pelc, C. M. Natarajan, N. Y. Kim, E. Abe, S. Maier, C. Schneider, M. Kamp, S. Höfling, R. H. Hadfield, A. Forchel, M. M. Fejer, Y. Yamamoto, Nature 491, 421 (2012).

**Presenter:** HÖFLING, Sven (Julius-Maximilians-Universität Würzburg)

**Session Classification:** Sessione mattutina

Contribution ID: 6

Type: **not specified**

# Unlocking the Quantum Frontier: Harnessing the Power of Entanglement for Cutting-Edge Quantum Technology

*Monday, 4 December 2023 12:30 (45 minutes)*

This talk explores the intricacies of quantum entanglement, whether manifested between two distinct photons (non-locality) or within two degrees of freedom of the same photon (contextuality). The focus is on reviewing state-of-the-art integrated quantum photonic circuits that leverage inter or intra-photon entanglement. These circuits are designed for diverse applications, including operating quantum random number generators powered by LEDs, facilitating quantum ghost spectroscopy devices for mid-infrared absorption, enabling on-chip undetected photon quantum interference, and creating heralded single photon sources crucial for quantum simulators and quantum machine learning applications. Finally, I will delve into the exciting possibilities and future outlook of quantum entanglement and its applications.

The work is supported by Q@TN, a joint laboratory between University of Trento, Bruno Kessler Foundation, INFN and CNR through the financial contribution of Provincia Autonoma of Trento.

**Presenter:** PAVESI, Lorenzo (Università di Trento)

**Session Classification:** Sessione mattutina

Contribution ID: 7

Type: **not specified**

## **NQSTI Extended Partnership: Present Activities and Future Prospects**

*Monday, 4 December 2023 14:45 (25 minutes)*

The current structure and activities of the NQSTI Extended Partnership will be described with a look at future developments aiming at ensuring the consolidation of a national quantum ecosystem.

**Presenter:** VITALI, David (Università di Camerino)

**Session Classification:** Sessione pomeridiana

Contribution ID: 8

Type: **not specified**

## European and National Plans in Quantum Science and Technology

*Monday, 4 December 2023 15:45 (25 minutes)*

The evolution of the European Quantum Flagship and national plans for Quantum Technologies will be outlined

**Presenter:** CATALIOTTI, Francesco (CNR INO)

**Session Classification:** Sessione pomeridiana

Contribution ID: 9

Type: **not specified**

## Chiusura

*Monday, 4 December 2023 17:30 (30 minutes)*

Contribution ID: 10

Type: **not specified**

## **Building a full-stack quantum computer in an academic environment: Lessons from the WACQT center, Sweden**

*Monday, 4 December 2023 11:45 (45 minutes)*

The Wallenberg Centre for Quantum Technology (WACQT) is a 12-year research effort to advance quantum technologies in Sweden, largely carried out by Swedish universities. I will give an overview of the core project of the center, which is to build a full-stack quantum computer based on superconducting circuits. I will describe the status of the project and present some of the key results. I will also touch on the collaborative nature of the effort, the engagement of the Swedish industry, and the process of spinning off deep-tech startups from the center's activities. Finally, I will present some reflections on what we have been learning from running the Center and to what extent our model is exportable.

**Presenter:** GASPARINETTI, Simone (Chalmers University of Technology)

**Session Classification:** Sessione mattutina

Contribution ID: 11

Type: **not specified**

## Hardware platforms and theoretical methods for quantum computing

*Monday, 4 December 2023 15:10 (35 minutes)*

We present an overview of the current quantum computing landscape, from different hardware architectures to recent algorithmic and theoretical achievements. In particular, we present the current efforts in this direction within the Italian National Center for HPC, Big data, and quantum computing - ICSC.

**Presenter:** MONTANGERO, Simone (Università di Padova)

**Session Classification:** Sessione pomeridiana