Instrumentação para Tecnologias Quânticas

[Superconducting Qubits]

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Brazilian Center for Research in Physics
NMR & Quantum Information

Tecnologias Quânticas

SUPERCONDUTORES

- Computação Quântica – Utilização de fenômenos quânticos para acelerar tarefas de computação;
- Comunicação Quântica - Utilização de fenômenos quânticos para tornar a comunicação a prova de invasão;
- Sensores Quânticos - Utilização de fenômenos quânticos em metrologia.

Simulações Quânticas – Utilização de recursos computacionais CLÁSSICOS para simular (calcular) a evolução de sistemas quânticos. Não existe fenômeno quântico em um simulador clássico. Há uma grande demanda por simuladores poderosos, mas eles NÃO fazem computação quântica.

World companies investing in Quantum: computing, communication, sensing, services and software in 2022

https://thequantuminsider.com/2022/09/05/quantum-computing-companies-ultimate-list-for-2022/

ATLANTIC
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atom
computing

IQM

EeroQ™
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bleximo

C12 QUANTUM ELECTRONICS

C12

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D-Wave
The Quantum Computing Company™

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OQC

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Universal Quantum

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QCi Ready-to-Run Quantum Systems

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qb quantum benchmark

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QUANTUM MACHINES

Qubit pharmaceuticals

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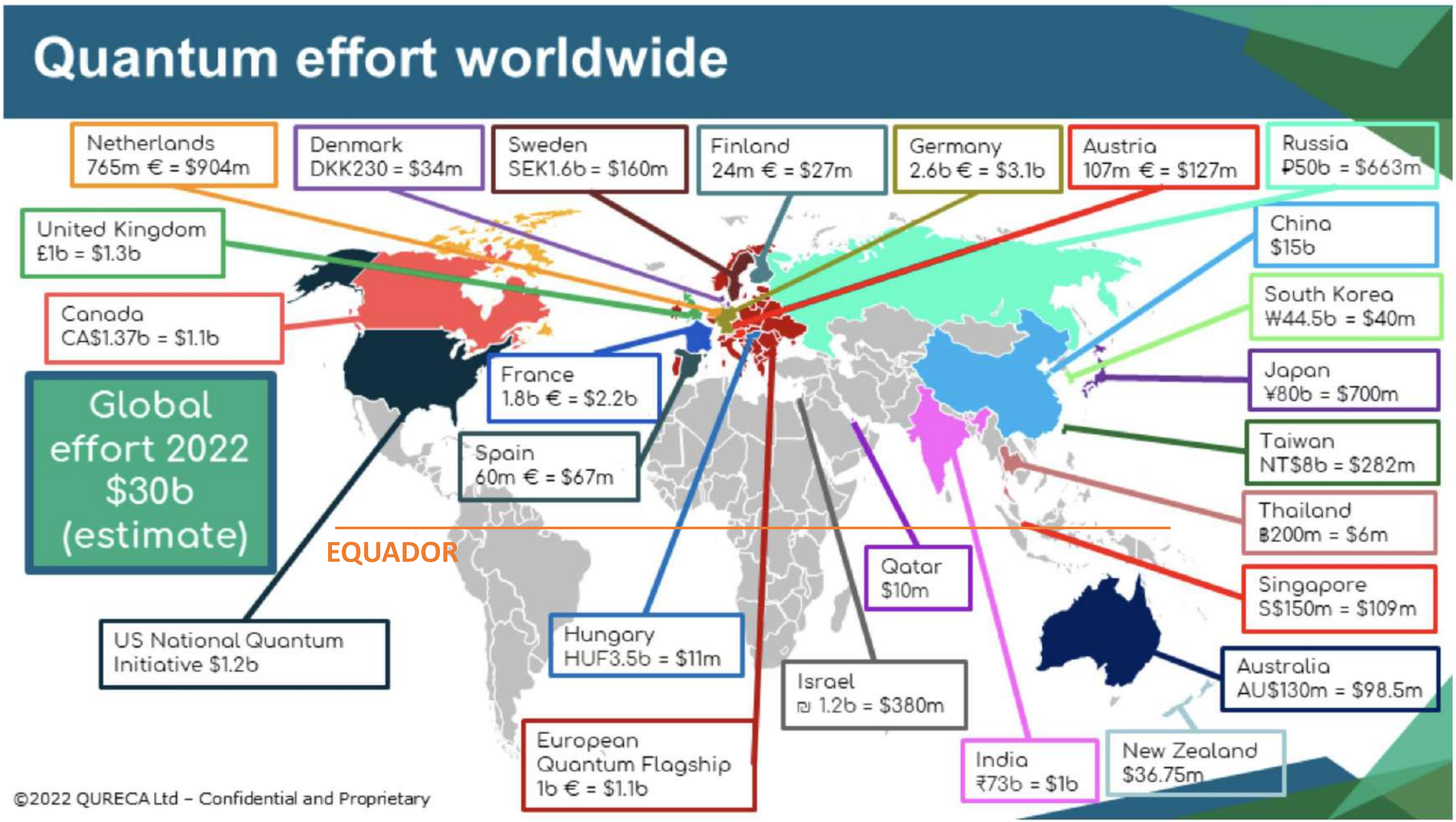
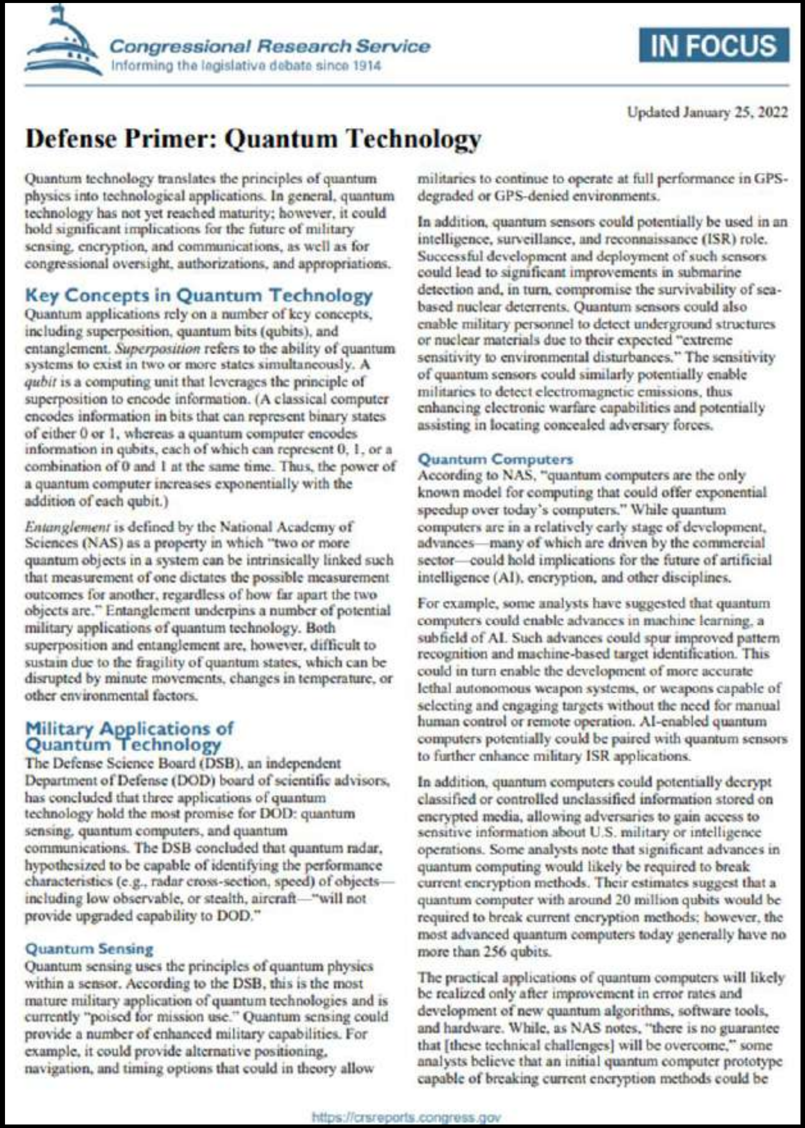


Overview of public funding in quantum technologies.

Os Militares estão Atentos!



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IN FOCUS

Updated January 25, 2022

Defense Primer: Quantum Technology

Quantum technology translates the principles of quantum physics into technological applications. In general, quantum technology has not yet reached maturity; however, it could hold significant implications for the future of military sensing, encryption, and communications, as well as for congressional oversight, authorizations, and appropriations.

Key Concepts in Quantum Technology

Quantum applications rely on a number of key concepts, including superposition, quantum bits (qubits), and entanglement. *Superposition* refers to the ability of quantum systems to exist in two or more states simultaneously. A *qubit* is a computing unit that leverages the principle of superposition to encode information. (A classical computer encodes information in bits that can represent binary states of either 0 or 1, whereas a quantum computer encodes information in qubits, each of which can represent 0, 1, or a combination of 0 and 1 at the same time. Thus, the power of a quantum computer increases exponentially with the addition of each qubit.)

Entanglement is defined by the National Academy of Sciences (NAS) as a property in which "two or more quantum objects in a system can be intrinsically linked such that measurement of one dictates the possible measurement outcomes for another, regardless of how far apart the two objects are." Entanglement underpins a number of potential military applications of quantum technology. Both superposition and entanglement are, however, difficult to sustain due to the fragility of quantum states, which can be disrupted by minute movements, changes in temperature, or other environmental factors.

Military Applications of Quantum Technology

The Defense Science Board (DSB), an independent Department of Defense (DOD) board of scientific advisors, has concluded that three applications of quantum technology hold the most promise for DOD: quantum sensing, quantum computers, and quantum communications. The DSB concluded that quantum radar, hypothesized to be capable of identifying the performance characteristics (e.g., radar cross-section, speed) of objects—including low observable, or stealth, aircraft—"will not provide upgraded capability to DOD."

Quantum Sensing

Quantum sensing uses the principles of quantum physics within a sensor. According to the DSB, this is the most mature military application of quantum technologies and is currently "poised for mission use." Quantum sensing could provide a number of enhanced military capabilities. For example, it could provide alternative positioning, navigation, and timing options that could in theory allow militaries to continue to operate at full performance in GPS-degraded or GPS-denied environments.

In addition, quantum sensors could potentially be used in an intelligence, surveillance, and reconnaissance (ISR) role. Successful development and deployment of such sensors could lead to significant improvements in submarine detection and, in turn, compromise the survivability of sea-based nuclear deterrents. Quantum sensors could also enable military personnel to detect underground structures or nuclear materials due to their expected "extreme sensitivity to environmental disturbances." The sensitivity of quantum sensors could similarly potentially enable militaries to detect electromagnetic emissions, thus enhancing electronic warfare capabilities and potentially assisting in locating concealed adversary forces.

Quantum Computers

According to NAS, "quantum computers are the only known model for computing that could offer exponential speedup over today's computers." While quantum computers are in a relatively early stage of development, advances—many of which are driven by the commercial sector—could hold implications for the future of artificial intelligence (AI), encryption, and other disciplines.

For example, some analysts have suggested that quantum computers could enable advances in machine learning, a subfield of AI. Such advances could spur improved pattern recognition and machine-based target identification. This could in turn enable the development of more accurate lethal autonomous weapon systems, or weapons capable of selecting and engaging targets without the need for manual human control or remote operation. AI-enabled quantum computers potentially could be paired with quantum sensors to further enhance military ISR applications.

In addition, quantum computers could potentially decrypt classified or controlled unclassified information stored on encrypted media, allowing adversaries to gain access to sensitive information about U.S. military or intelligence operations. Some analysts note that significant advances in quantum computing would likely be required to break current encryption methods. Their estimates suggest that a quantum computer with around 20 million qubits would be required to break current encryption methods; however, the most advanced quantum computers today generally have no more than 256 qubits.

The practical applications of quantum computers will likely be realized only after improvement in error rates and development of new quantum algorithms, software tools, and hardware. While, as NAS notes, "there is no guarantee that [these technical challenges] will be overcome," some analysts believe that an initial quantum computer prototype capable of breaking current encryption methods could be

https://crsreports.congress.gov

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Quantum technology for military applications

Michal Krelina

EPJ Quantum Technology 8, Article number: 24 (2021) | Cite this article

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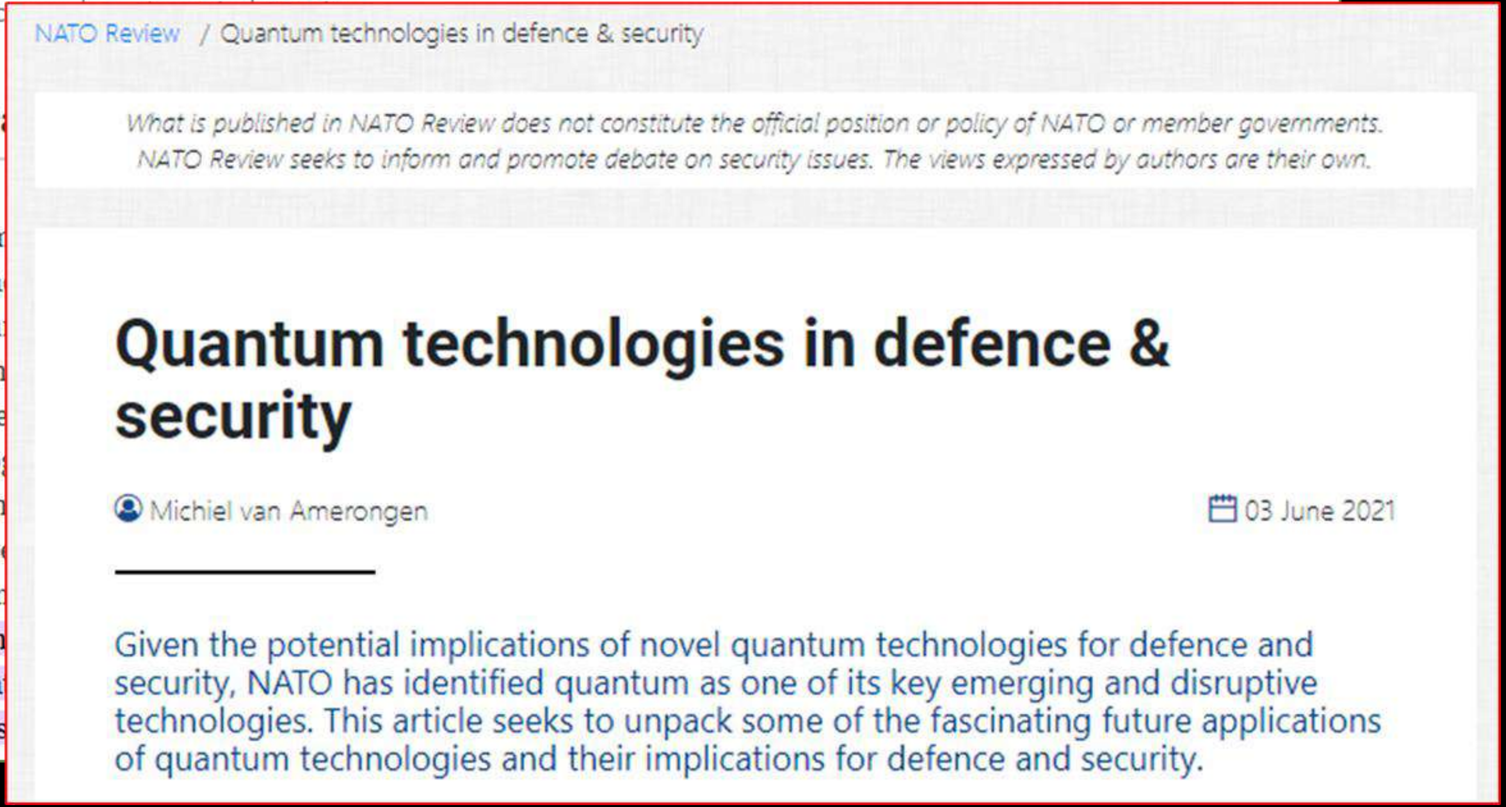

NATO Review / Quantum technologies in defence & security

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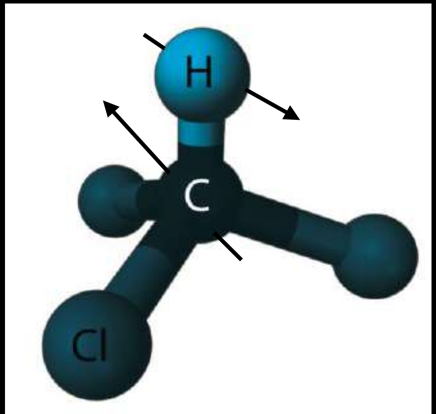
Quantum technologies in defence & security

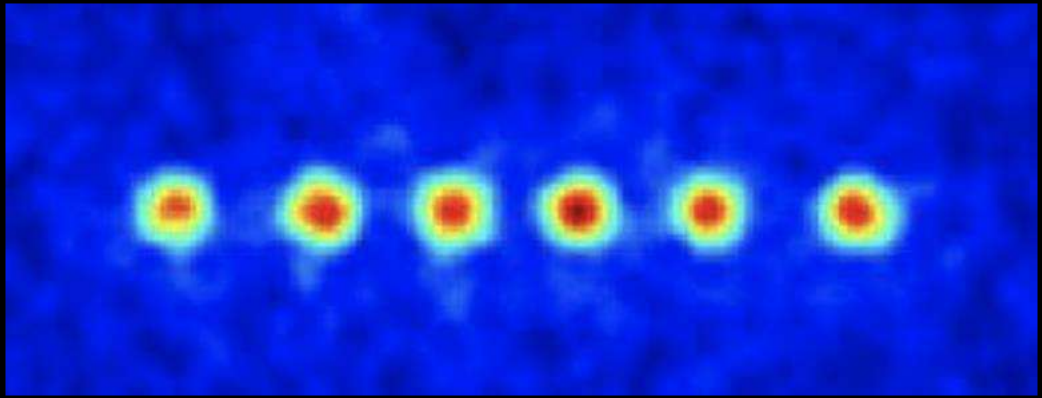
Michiel van Amerongen — 03 June 2021

Given the potential implications of novel quantum technologies for defence and security, NATO has identified quantum as one of its key emerging and disruptive technologies. This article seeks to unpack some of the fascinating future applications of quantum technologies and their implications for defence and security.

Natural and artificial qubits

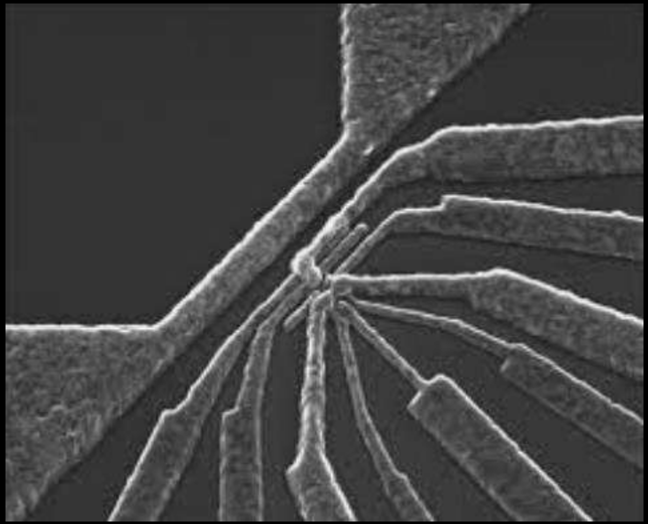


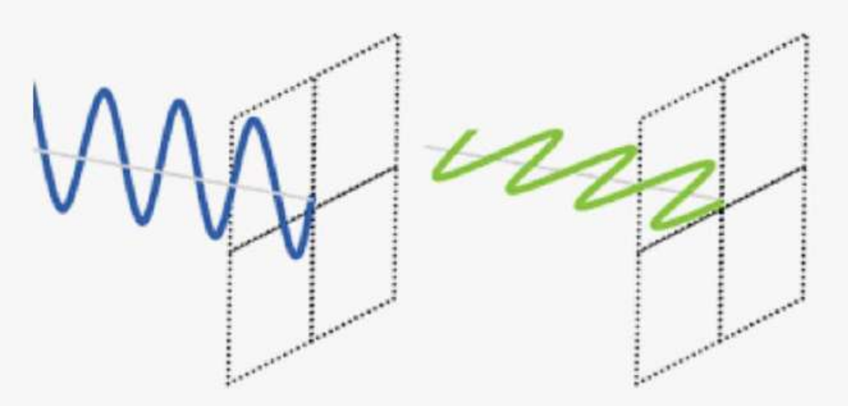
Nuclear spins
Small scale benchmark experiments



Trapped ions
Promising scalable technology

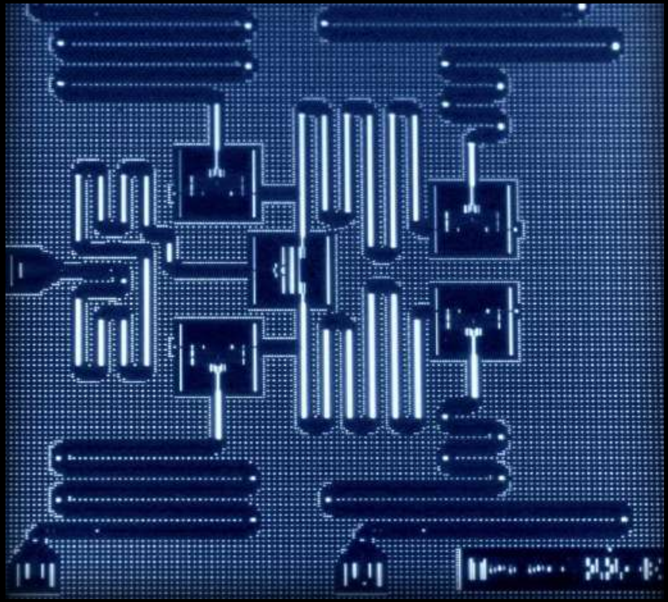
Quantum Dots
Promising scalable technology



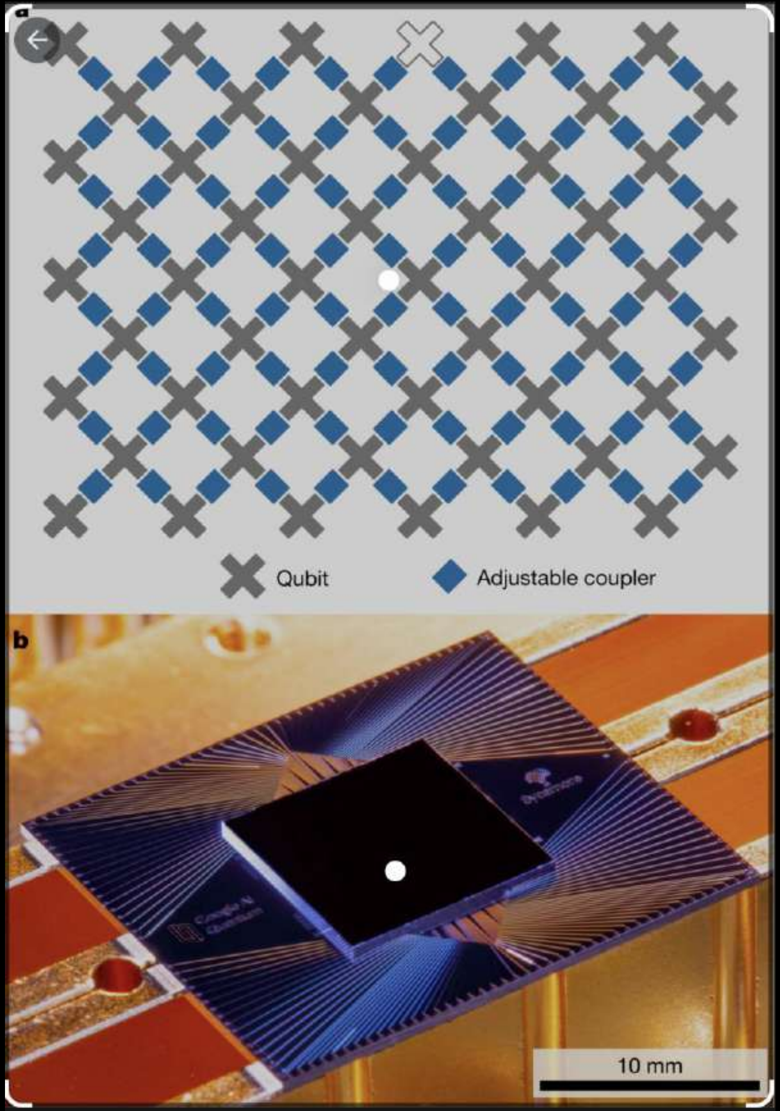


Fotons
Excellent for quantum communication

Superconducting qubits
Most sucessful technology so far



What is a Quantum Chip?

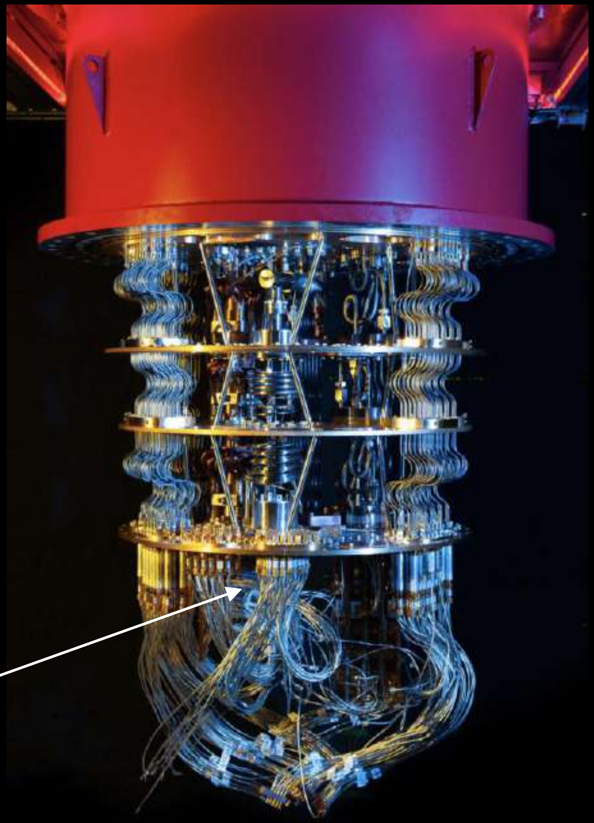


A device containing a certain number of qubits connected to one another which allows the external control of quantum states and the implementation of a a set of universal quantum gates, in order computation can be implemented.

A Quantum Nightmare…

- Low connectivity
- Error correction
- Control of noise

~ 10 mK



The State of Art:
What is inside it?

NATURE | VOL 431 | 9 SEPTEMBER 2004 | www.nature.com/nature

Strong coupling of a single photon to a superconducting qubit using circuit quantum electrodynamics

Não existe produto de inovação com alto valor agregado sem o conhecimento dos fenômenos básicos fundamentais!!

Cavity quantum electrodynamics for superconducting electrical circuits: An architecture for quantum computation

Alexandre Blais,[1] Ren-Shou Huang,[1,2] Andreas Wallraff,[1] S. M. Girvin,[1] and R. J. Schoelkopf[1]
[1]*Departments of Physics and Applied Physics, Yale University, New Haven, Connecticut 06520, USA*
[2]*Department of Physics, Indiana University, Bloomington, Indiana 47405, USA*
(Received 7 February 2004; published 29 June 2004; corrected 23 July 2004)

433 q-bits

INNOVATION PRODUCT ⟷ **BASIC SCIENCE!**

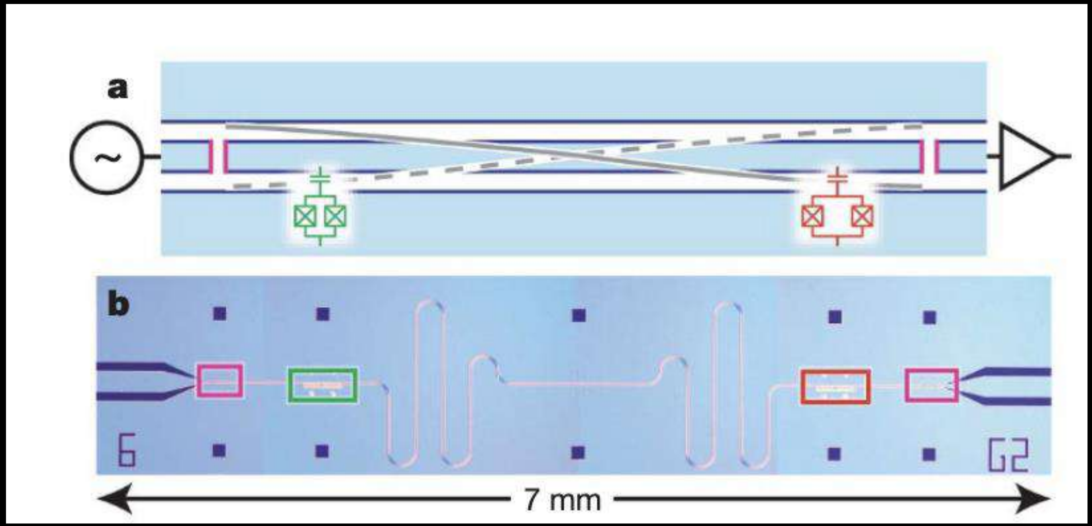
Vol 449 | 27 September 2007 | doi:10.1038/nature06184

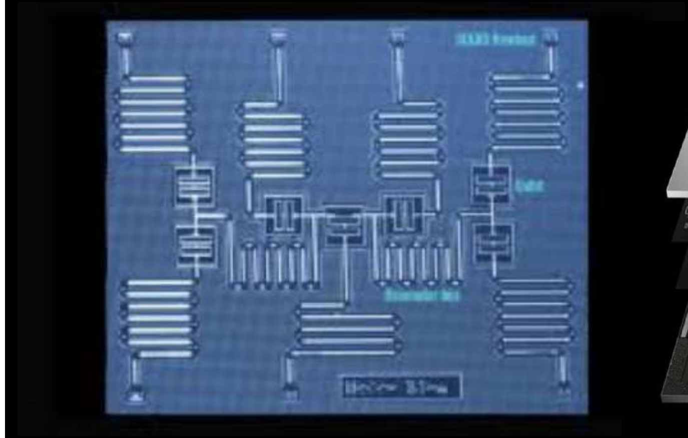
nature

LETTERS

Coupling superconducting qubits via a cavity bus

J. Majer[1]*, J. M. Chow[1]*, J. M. Gambetta[1], Jens Koch[1], B. R. Johnson[1], J. A. Schreier[1], L. Frunzio[1], D. I. Schuster[1], A. A. Houck[1], A. Wallraff[1]†, A. Blais[1]†, M. H. Devoret[1], S. M. Girvin[1] & R. J. Schoelkopf[1]





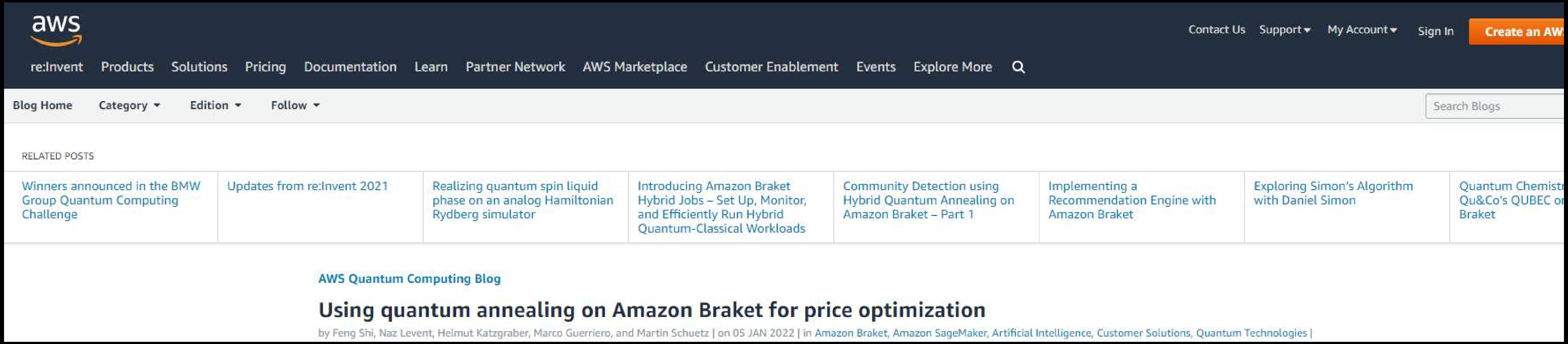
7 qubits

433 qubits

IBM

Rigetti

D-Wave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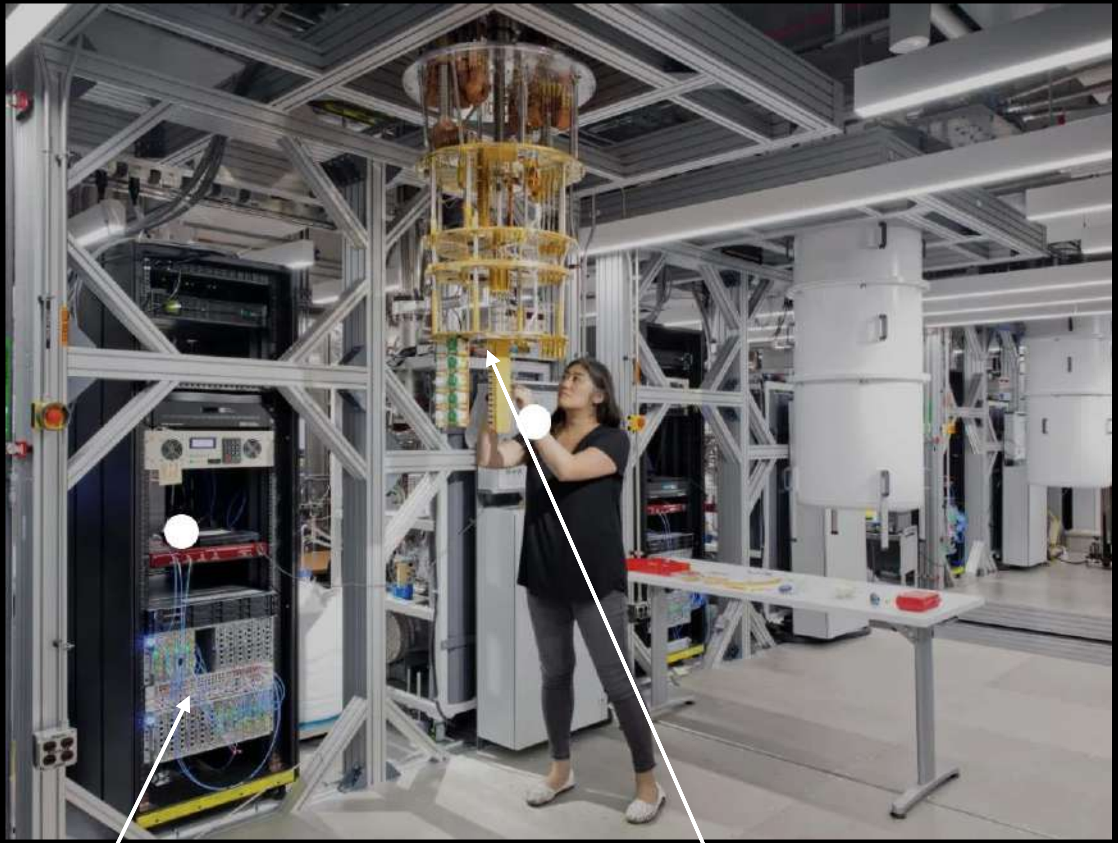
AWS Quantum Computing Blog

Using quantum annealing on Amazon Braket for price optimization

by Feng Shi, Naz Levent, Helmut Katzgraber, Marco Guerriero, and Martin Schuetz | on 05 JAN 2022 | in Amazon Braket, Amazon SageMaker, Artificial Intelligence, Customer Solutions, Quantum Technologies |

How to fabricate this stuff and how much it costs

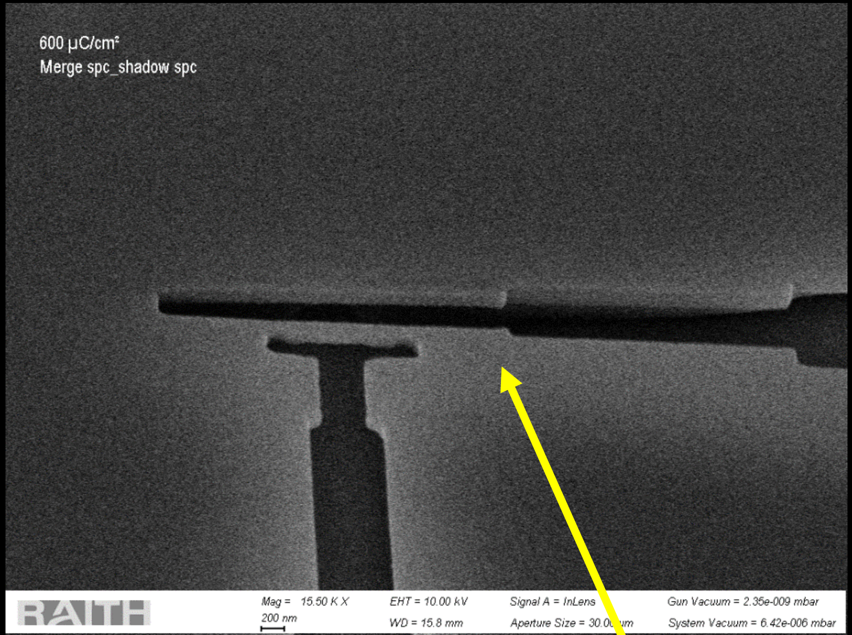
Fabrication of qubits (after design and numerical simulations: ~ U$ 1.5 mi

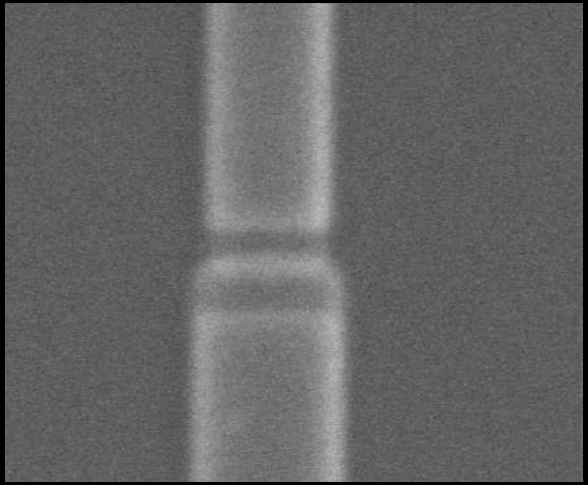


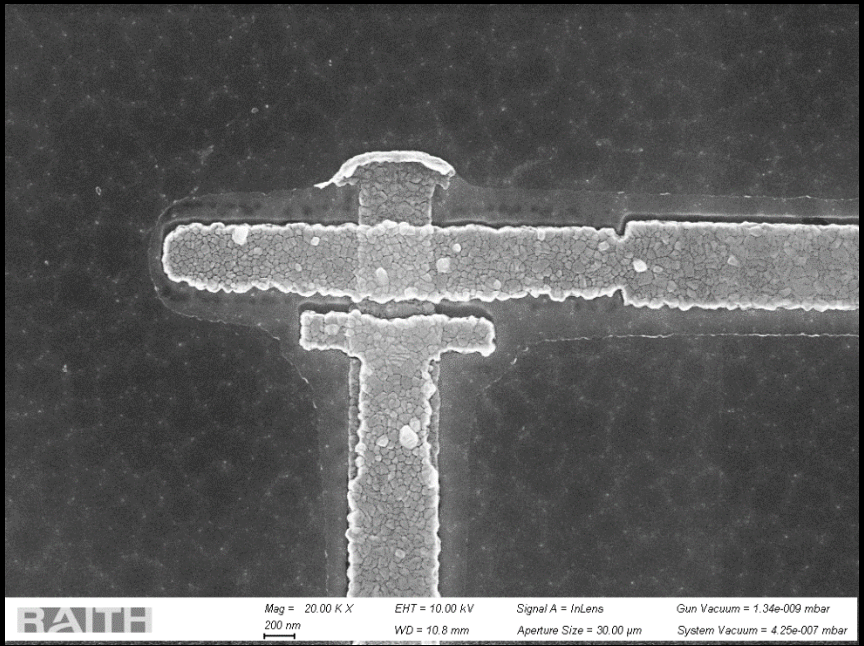
Electronics for control and data acquisition: ~ U$ 1.2 mi

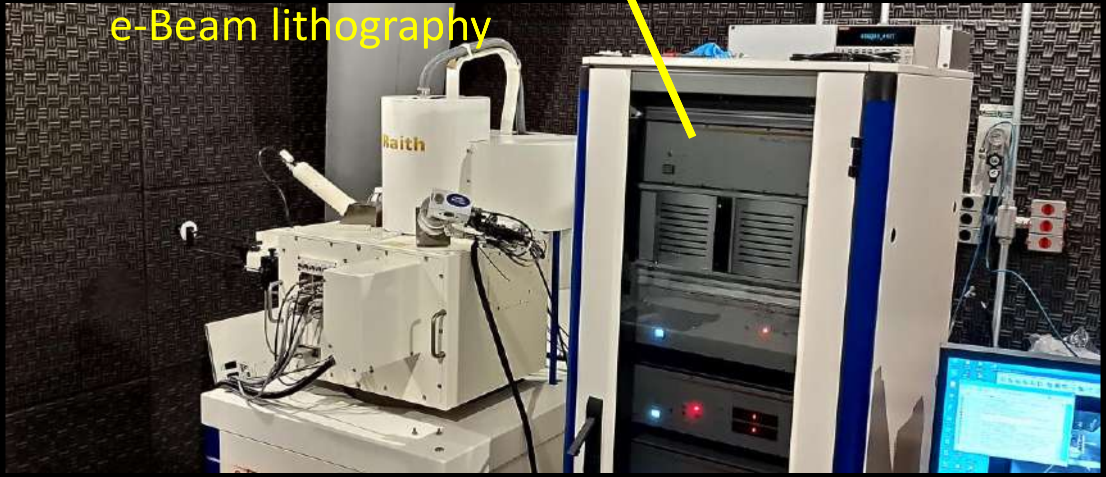
Dilution refrigerator
To cool the chip down to 10 mK: ~ U$ 1 mi

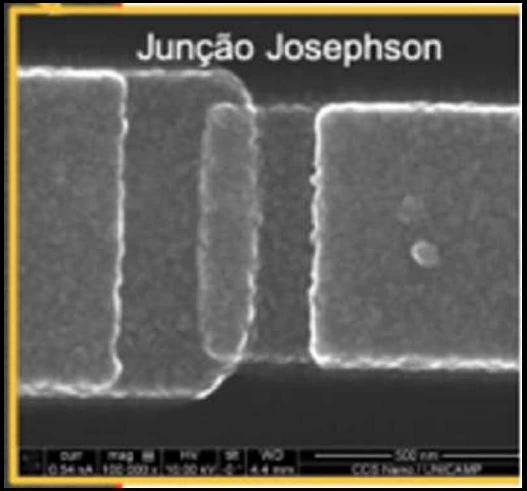
Josephson Junctions

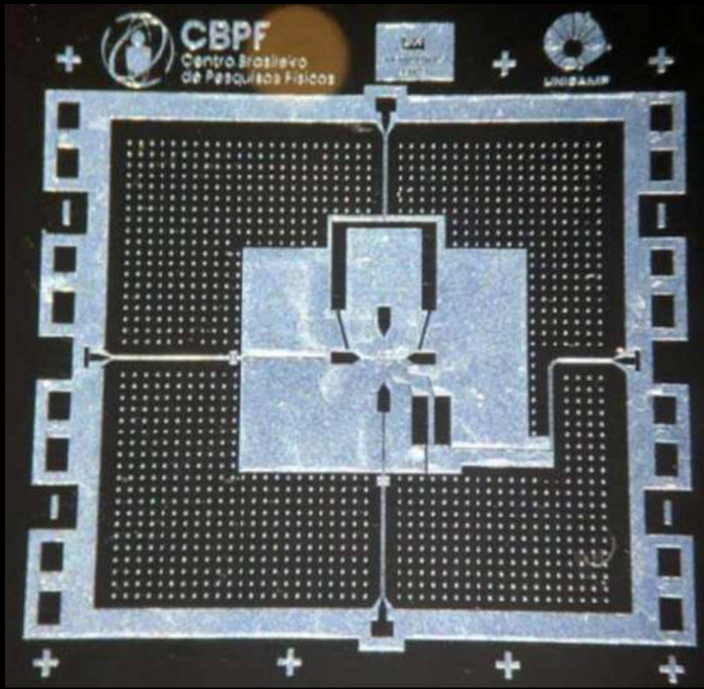












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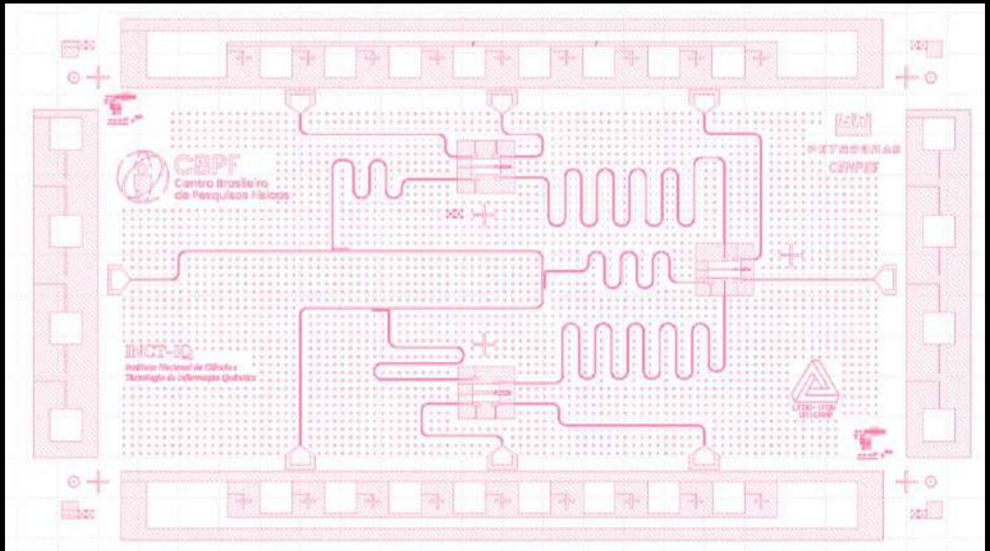

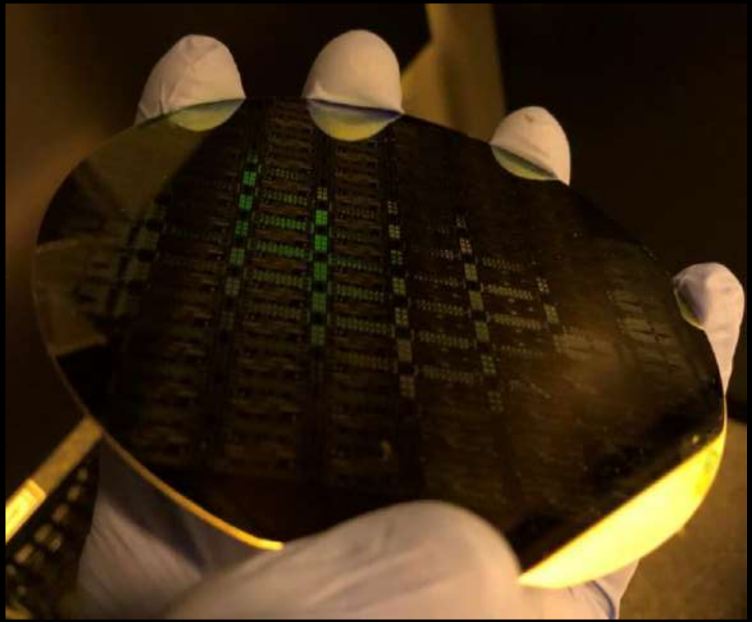

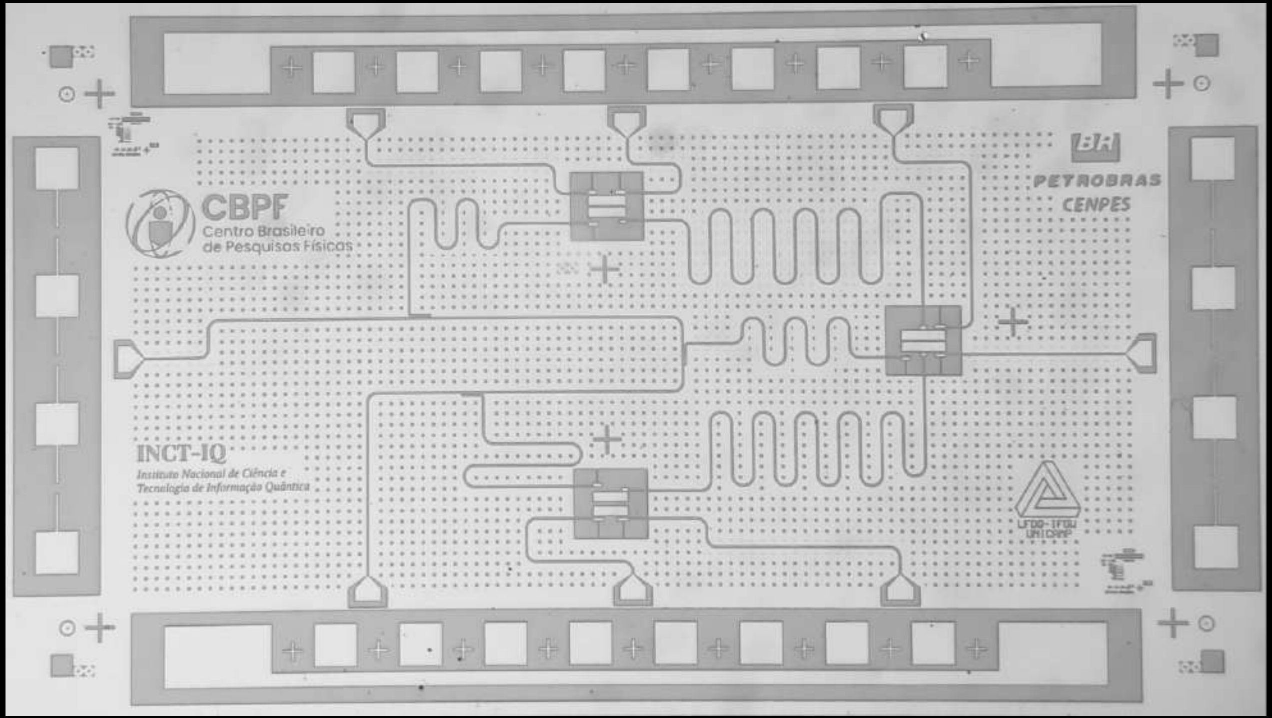

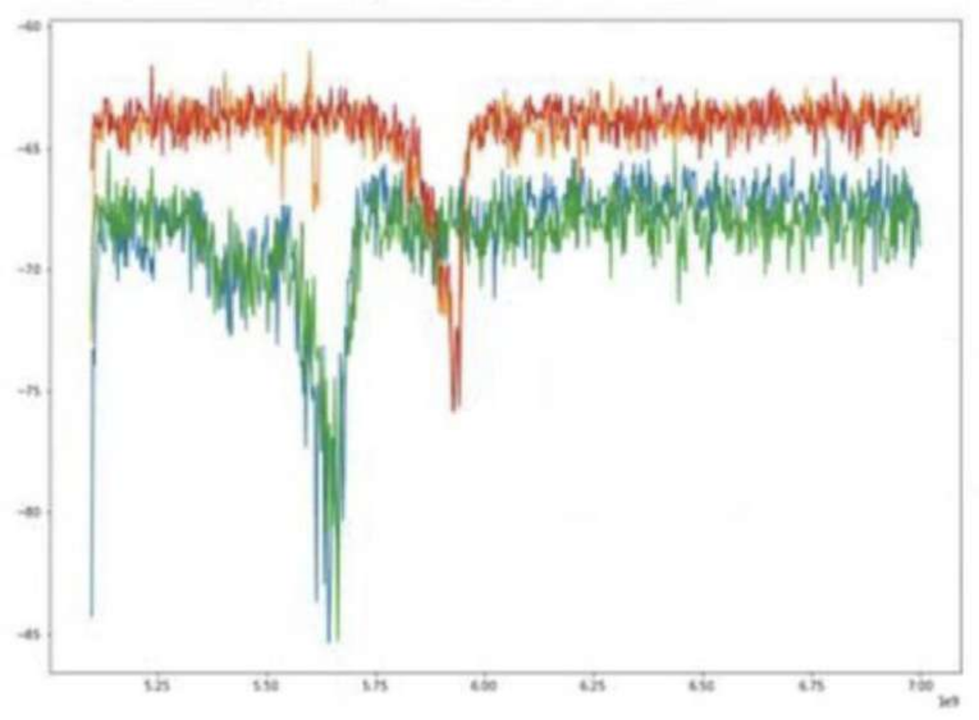

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SEMPI	SEMPI	CBPF	TRANSVERSAL	Finep	Infraestrutura para Fabricação de Dispositivos Supercondutores para Computação Quântica e Rede de Comunicação Quântica **APROVADA**	Encomenda	Centro Brasileiro de Pesquisas Físicas (CBPF)	23.000,00

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