Superconducting Quantum Circuits

Gerhard Kirchmair – Teresa Hönigl-Decrinis

14.01.2026

Nobel Prize 2025

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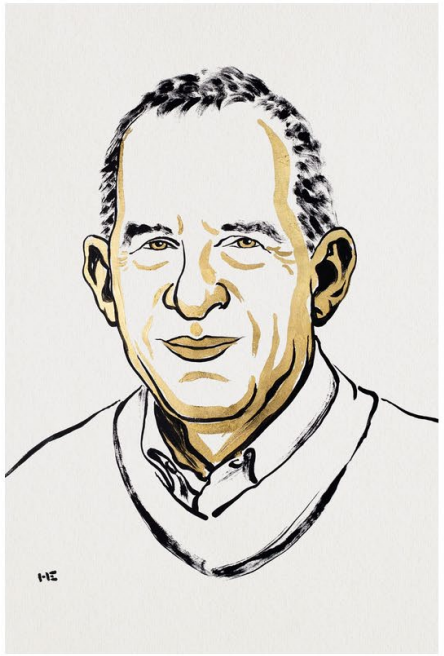
Ill. Niklas Elmehed © Nobel Prize Outreach

John Clarke

Prize share: 1/3



Ill. Niklas Elmehed © Nobel Prize Outreach

Michel H. Devoret

Prize share: 1/3

Ill. Niklas Elmehed © Nobel Prize Outreach

John M. Martinis

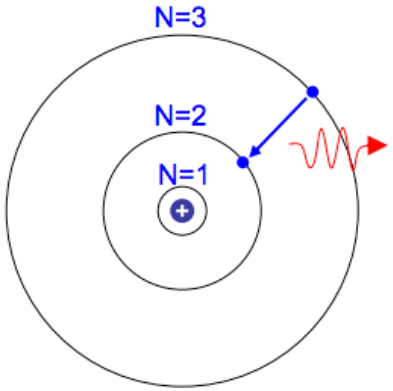
Prize share: 1/3

The Nobel Prize in Physics 2025 was awarded jointly to John Clarke, Michel H. Devoret and John M. Martinis "for the discovery of macroscopic quantum mechanical tunnelling and energy quantization in an (superconducting) electric circuit"

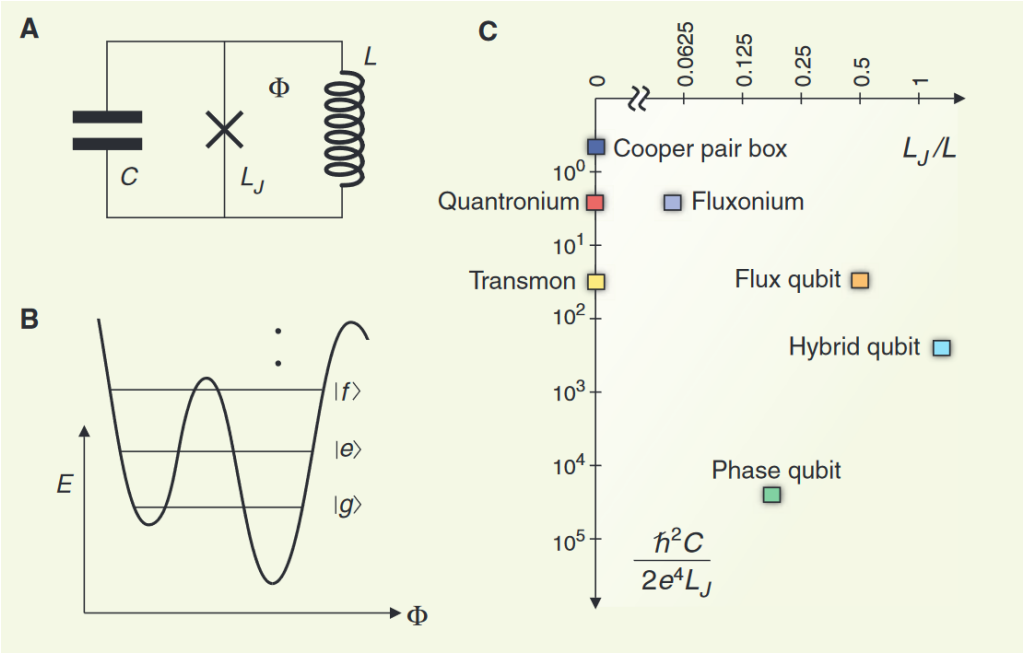
Nobel Prize in Physics 2025. NobelPrize.org. Nobel Prize Outreach 2026. Thu. 8 Jan 2026. <https://www.nobelprize.org/prizes/physics/2025/summary/>

Encoding of quantum bits (qubits)

Natural atom



Artificial atom



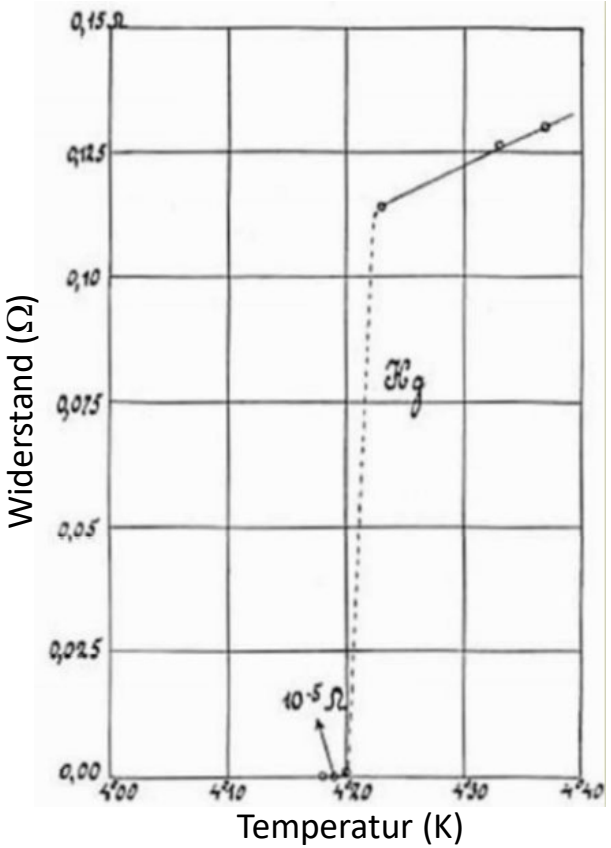
What we like about artificial atoms

- on chip
- fully controllable
- tunable
- strong coupling
- can explore regimes that are not found in natural atoms
- good candidates for new quantum technologies

Applications in

- Quantum computing, information processing
- Quantum optics
- Quantum sensors
- Metrology

Supraleitung

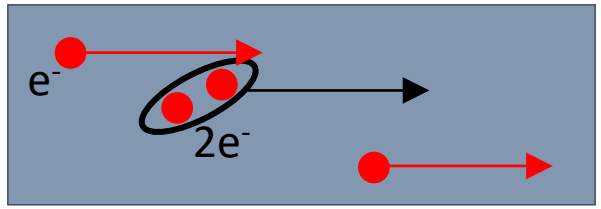


Kammerlingh Onnes, 26 Oktober, 1911

Physics Today, September 2010

Ein über hundert Jahre altes Phänomen

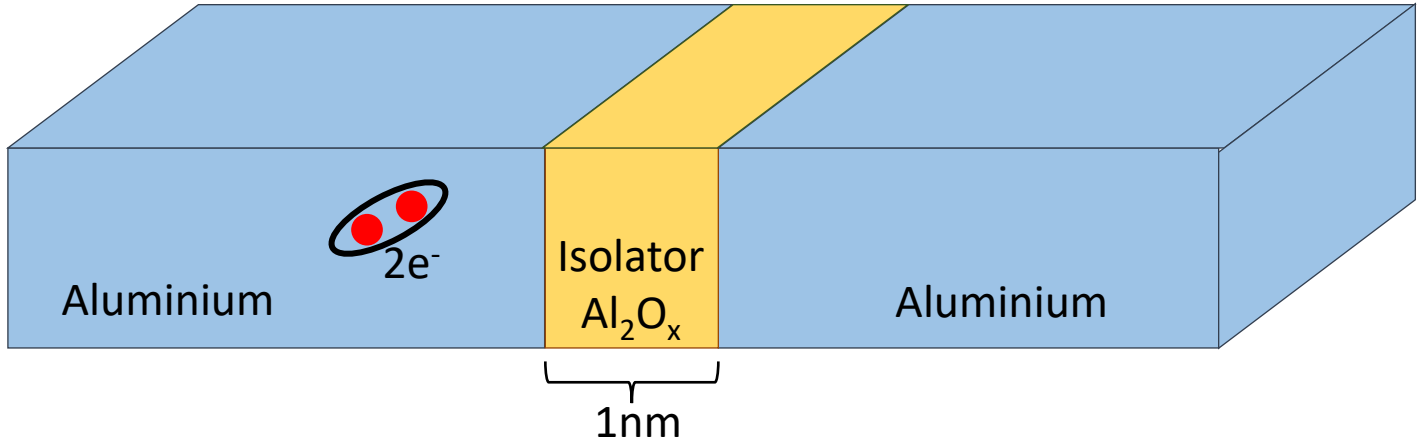
Elektronen bewegen sich paarweise, **verlustfrei** in einem Supraleiter (Cooper Paare)



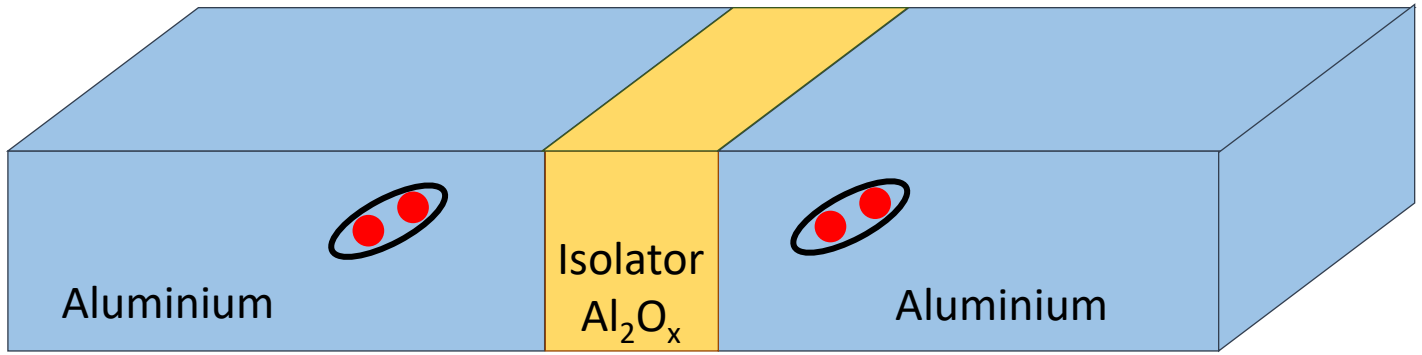
Aluminium, Niob, Quecksilber …

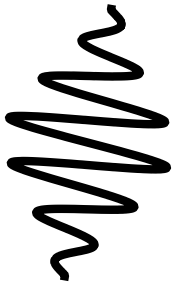
Temperatur < 1 K

Josephson Kontakt



Josephson Kontakt



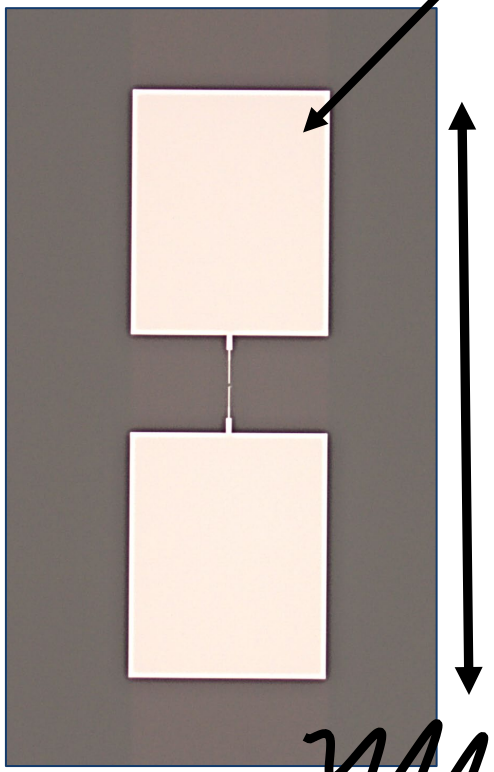


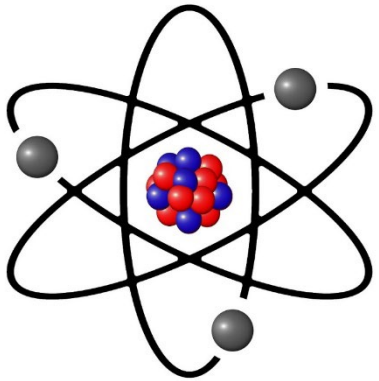
$h\,\nu$ Mikrowellen Strahlung

$\|0\rangle$	10000	10000
$\|1\rangle$	9999	10001

$|0\rangle + |1\rangle$ Cooper Paar an zwei Orten gleichzeitig!!

Fertiges Qubit – künstliches Atom





https://pixabay.com/de/illustrations/atom-symbol-zeichen-abstrakt-68866/

Superconducting Qubit‘s in Innsbruck

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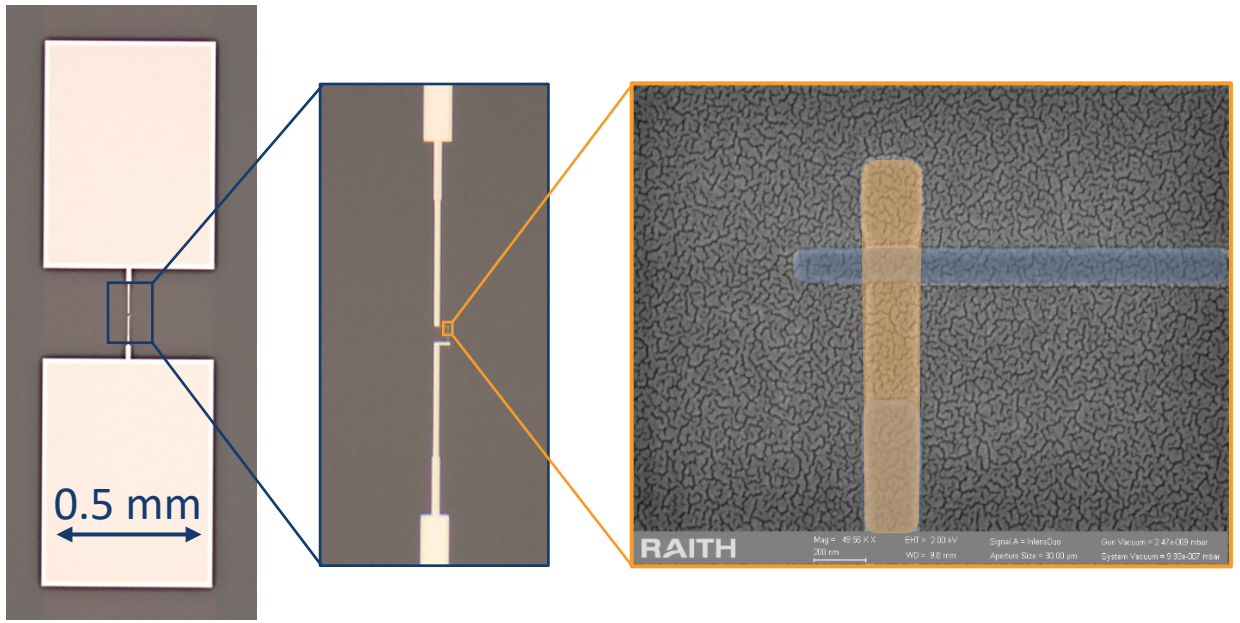
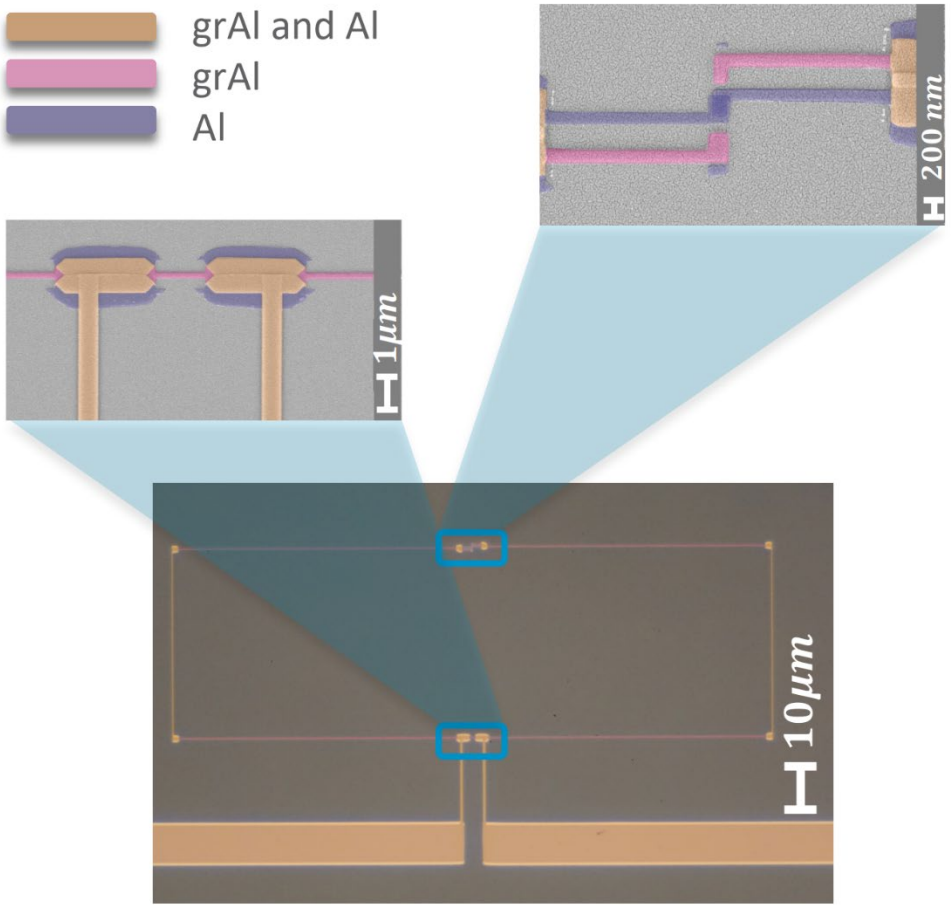
Transmon



Yale, MIT, IBM, Google, Saclay…

Fluxonium



Yale, KIT, Amazon…

How do you build a qubit - cleanroom

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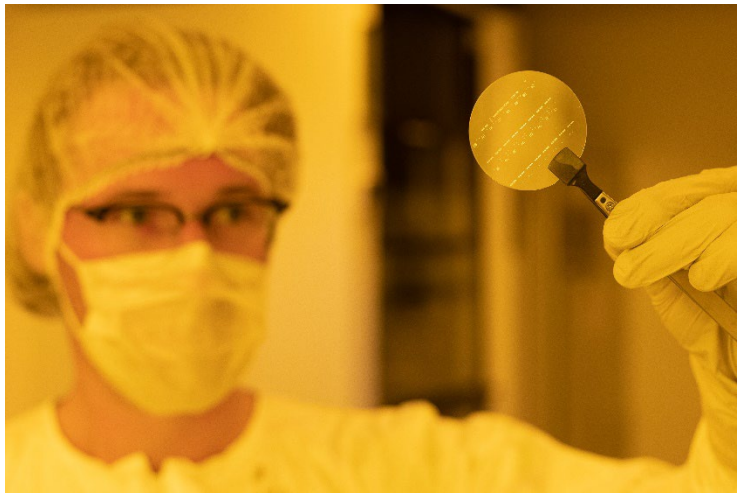

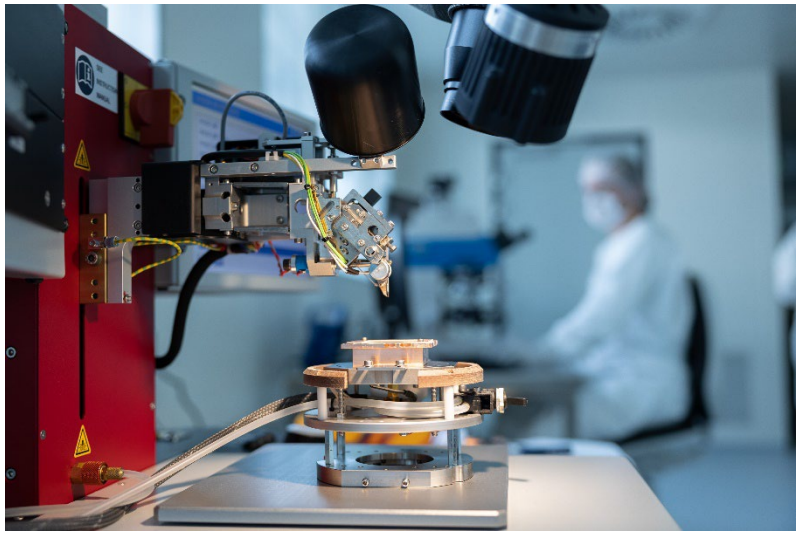

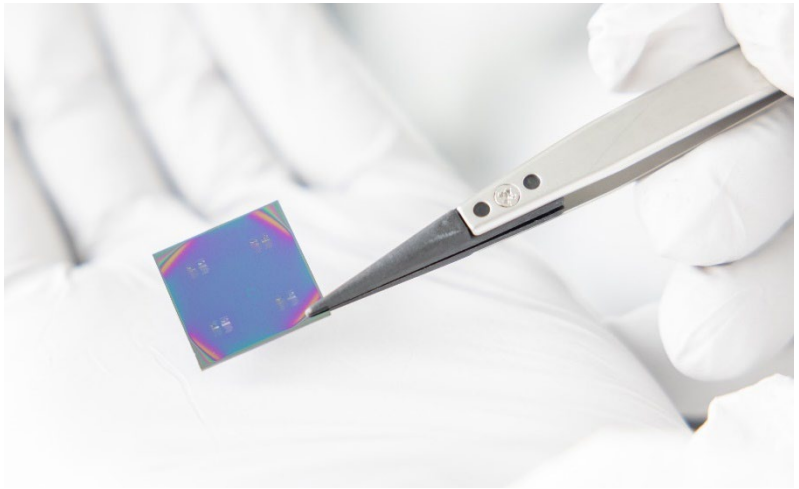

ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

IQI

Experimental Setups & Cryostat

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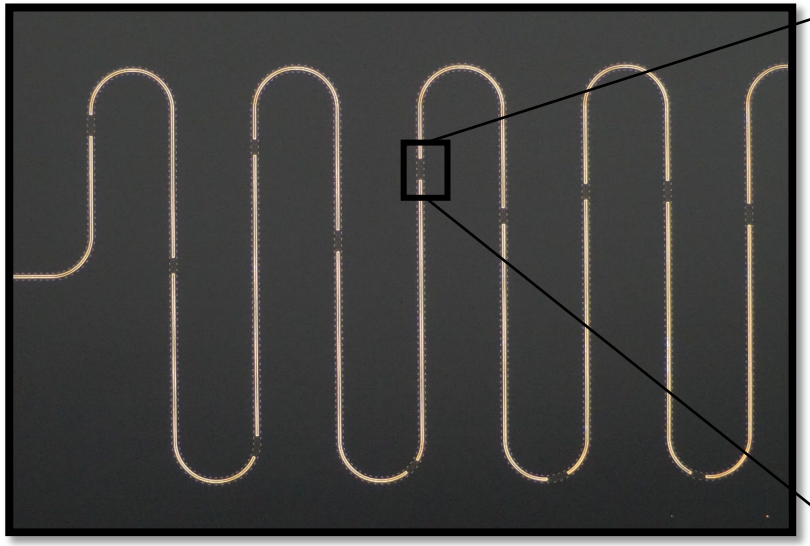

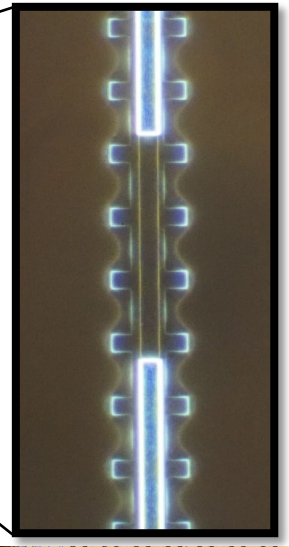

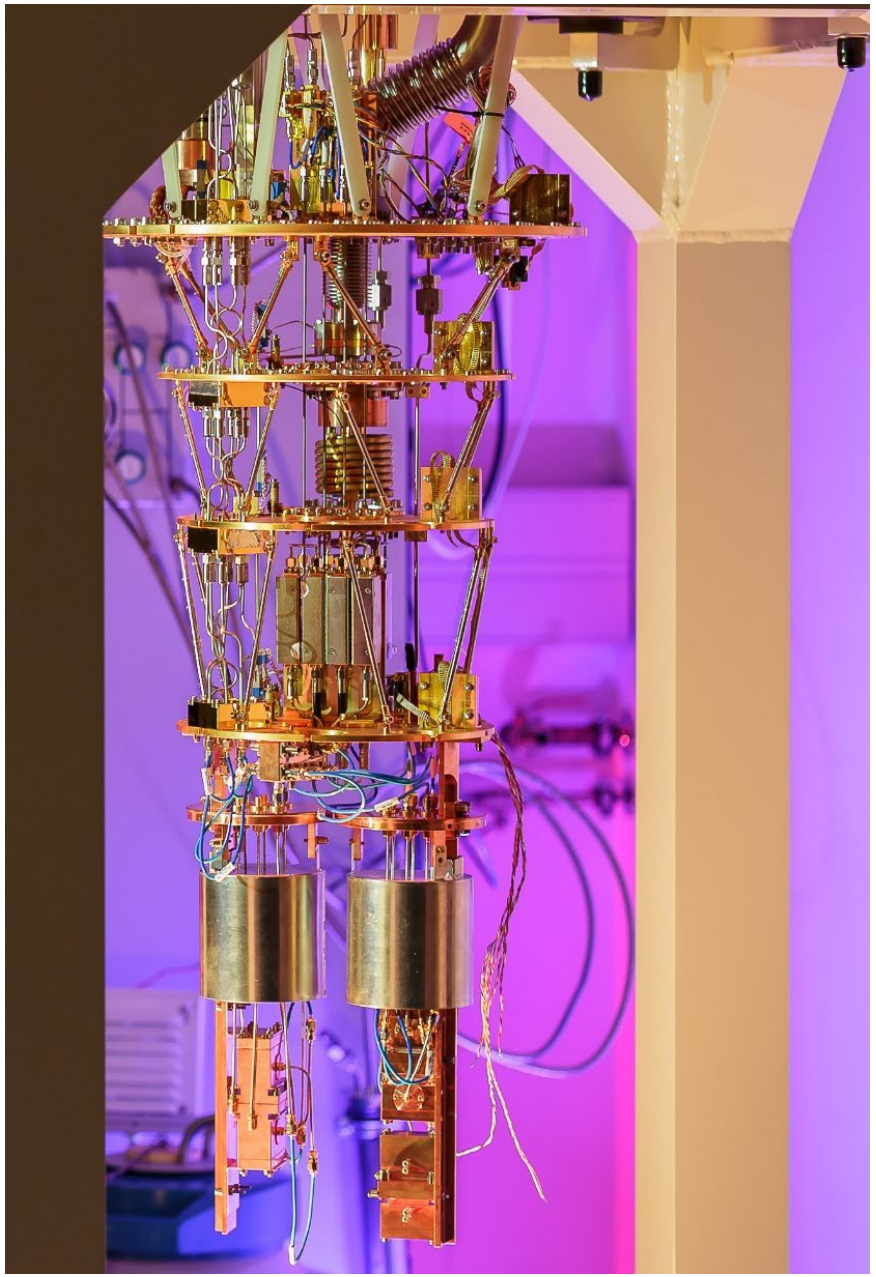

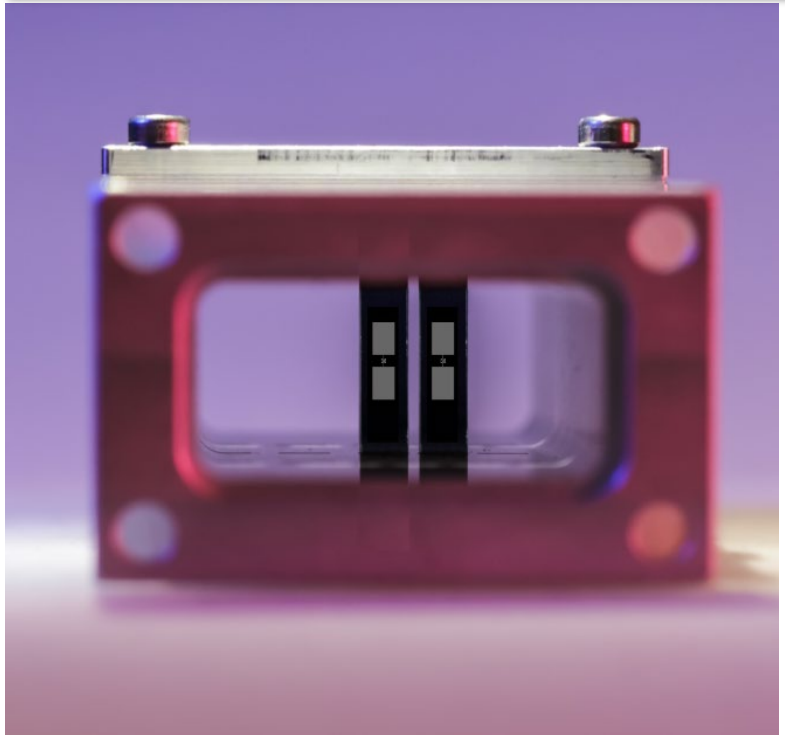

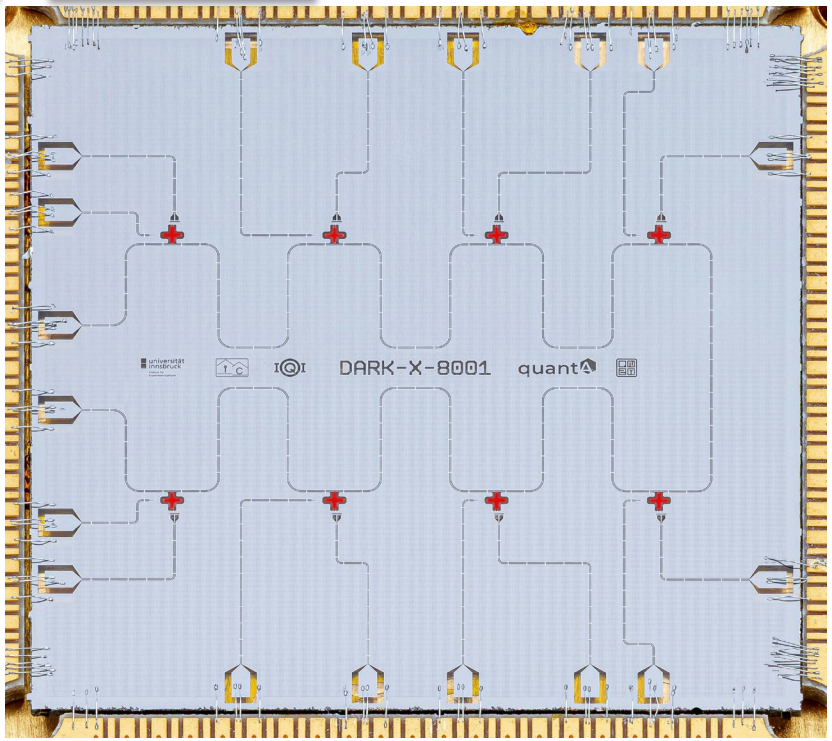

Opportunities in 2026

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- **BSc projects**
  - *The superconducting qubit zoo and their coherences*
    - E.g. Transmon, fluxonium,…
    - Literature review
  - *Waveguide Quantum electrodynamics with superconducting circuits – how to network quantum computers*
    - Literature review
- **MSc projects**
  - *Come and talk to us*

Contact

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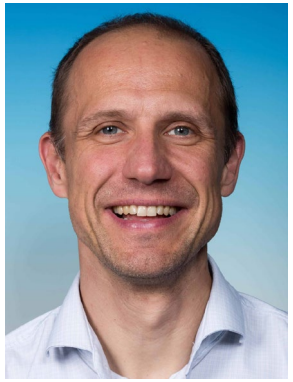

Innsbruck quantum Circuits team

Danke für die Aufmerksamkeit.