SuNQC

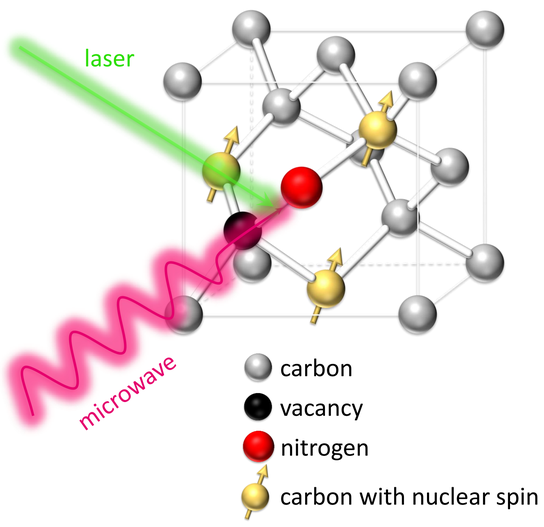
Quantum Computer Based on NV Centres in Diamond With Sulfur Doping

We are developing a quantum computer based on nitrogen-vacancy (NV) centres in diamond created by ion implantation. Using our patented sulfur doping technique, we aim to show the realization of NV centre arrays feasible to scale the quantum processor towards more than 50 qubits.

- NV Centres
- Quantum Computer

Advantages of NV-centre based quantum computers

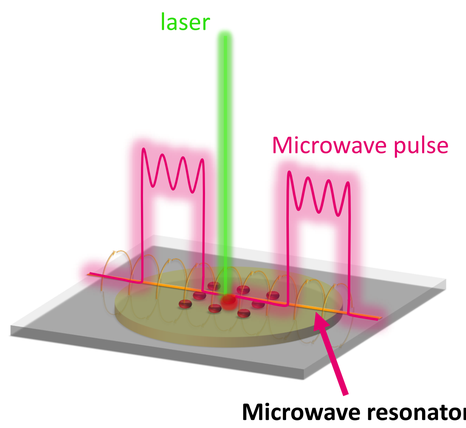
- **Working over a wide temperature range** due to the usage of isolated solid-state qubits
- **Highly scalable** due to a patented manufacturing process
- **Mobile** due to a compact design without additional operating equipment
- **Ecological** due to low energy and resource consumption



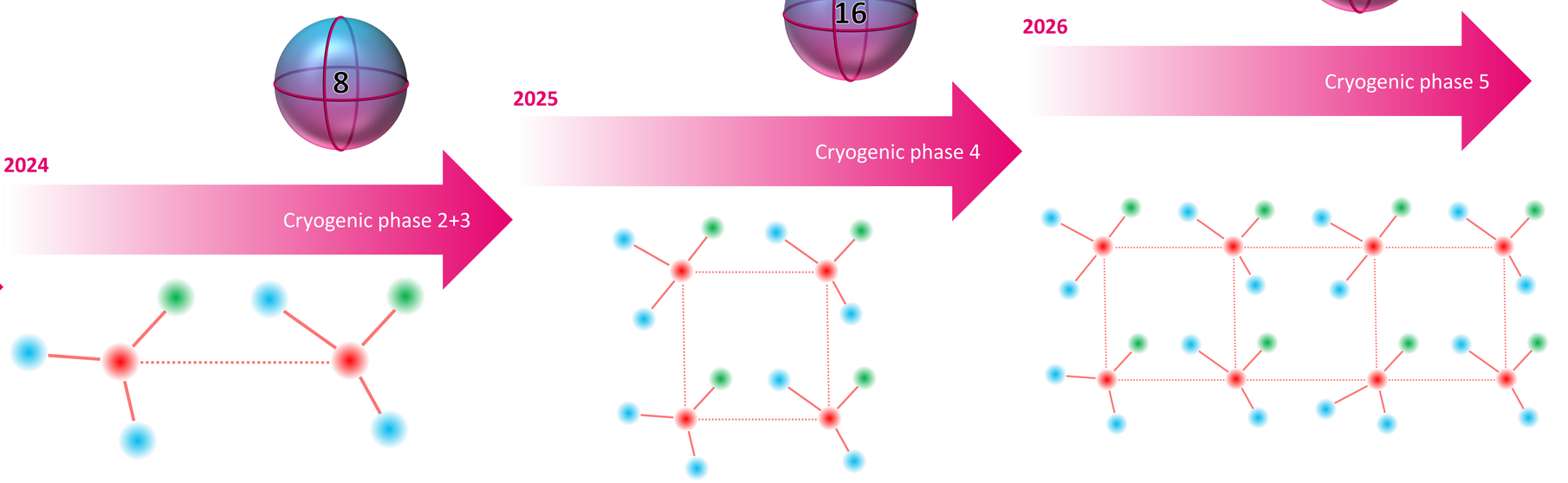
Working principle

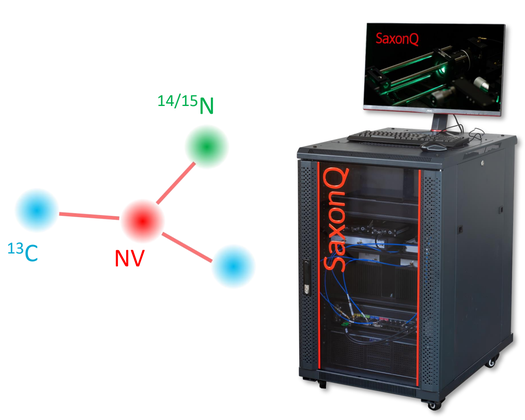
- Based on artificially created „atom“-like spin defects in solid-state crystals → NV centres in diamond
- Spin of electronic system of NV centres are used as qubits
- Additional qubits by nuclear spin of $^{14/15}$N or ^{13}C hyperfine coupled to the NV centre electronic spin
- Spin states of NV centres show different fluorescence/photocurrent intensities used for optical or electrical readout of the qubit state
- Initialization of NV centre qubits by illumination with green laser light via optical polarization cycle
- Manipulation of the electronic and nuclear spin qubits via microwave and radiofrequency pulses as quantum gates, applied via microwave resonators on diamond chip

Sulfur doped diamond chip with implanted NV centre array



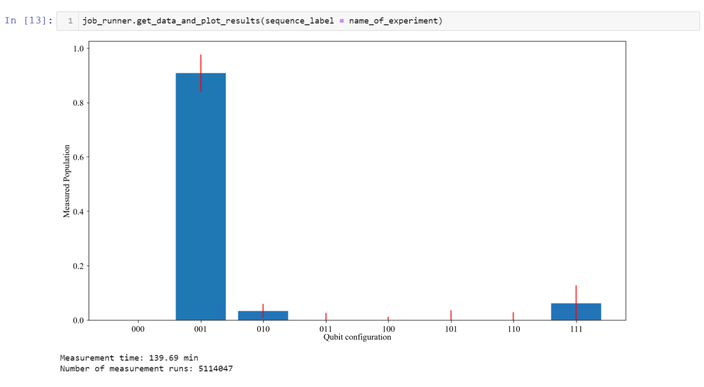
SuNQC Roadmap





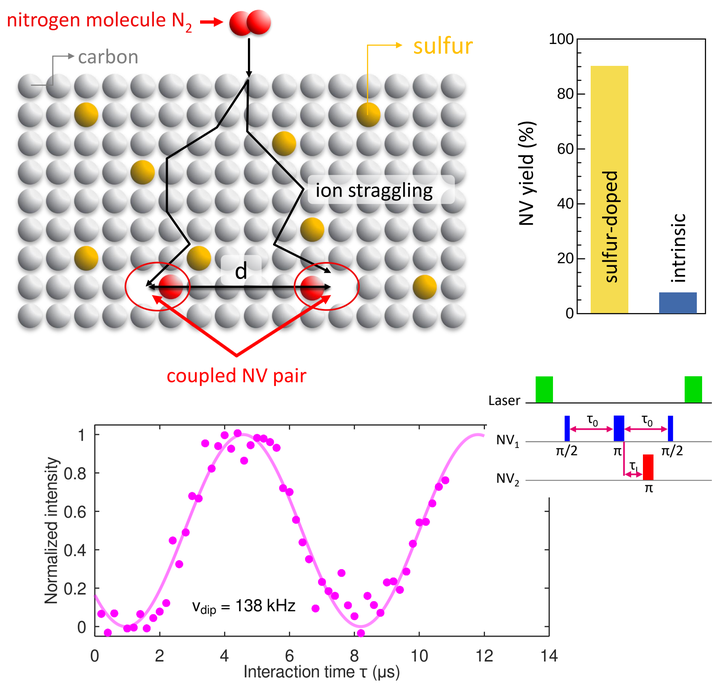
4-Qubit quantum computer demonstrator

- World’s first CE-certified quantum computer
- Mobile and working at room temperature
- First quantum computer accepted by the DLR QCI
- Universal set of quantum gates
- Native multi-qubit gates
- Automatic calibration of the quantum processor
- Intuitive user interface based on Jupyter Notebooks
- DLR cloud access via API soon available



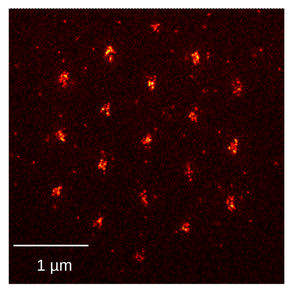
Scaling approach

- Implantation of closely spaced nitrogen atoms and annealing to realize dipolarly coupled NV centre arrays
- Sulfur doping to enhance NV centre creation yield from less than 10% without sulfur doping towards 90%
- Electrical readout of spin state of individual NV centres via spin-dependent photocurrent and crossed metal contacts

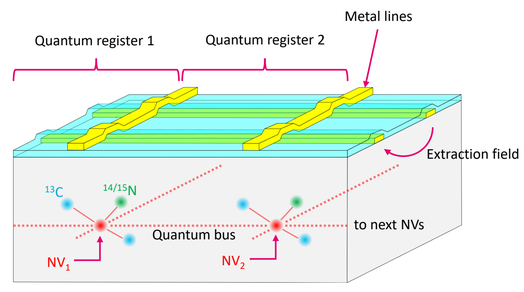


Open challenges

- Spatially precise implantation of nitrogen clusters
- Fabrication of nanometer-sized crossed metal lines for electrical readout
- Application of quantum error correction algorithms



S. Pezzagna and J. Meijer, Compr. Hard. Mater. **3**, 321 (2014)



Patent 10 2020 007 977 B4

Mehr Infos zu dem Projekt finden Sie auf unserer Website.

A project of

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Get in touch.
We enable quantum!

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