Spin based quantum computer and simulator SPINUS

Project ambition:

SPINUS project pursues a novel strategy for scalable solid-state quantum simulation and computation hardware based on nuclear spin networks and dipole-dipole entangled electron spin qubits. With a primary focus on scalability and overcoming the limitations of existing classical methods, SPINUS seeks to establish experimental platforms for quantum simulation (>50 quantum units) and quantum computation (>10 qubits), thus, developing an innovative quantum computer.

The project ambition spans across:

1. Groundbreaking R&I: SPINUS project will leverage recent advancements to build quantum simulators with >50 quantum units and room-temperature quantum computers with >10 qubits. SPINUS project is exploring novel concepts to enhance fidelity, scalability, and programmability using spin systems.

2. Cutting-edge materials: SPINUS project utilises isotopically engineered diamond and ultrapure silicon carbide to extend coherence times of optically active dopants, fundamentally improving spin-based quantum systems.

3. Collaborative ecosystem: SPINUS projects partners with Quantum Flagship initiatives and start-ups to drive innovation in European fabrication processes and supply chains, fostering the development of new quantum technology-related goods and services.

4. Intellectual property and publications: SPINUS project is expanding on its expertise in spin qubits and quantum materials to produce patentable technology and publish groundbreaking research.

Project facts

Start date
01/01/2024

End date
31/12/2027

Duration in months
48

Project budget
10 166 376.25 EUR

Grant Agreement
101135699

Call
HORIZON-CL4-2023-DIGITAL-EMERGING-01-CNECT

Topic
HORIZON-CL4-2023-DIGITAL-EMERGING-01-41
Investing in alternative quantum computation and simulation platform technologies

HE Research and Innovation Action (RIA)

Keywords
Quantum simulation/ Quantum computation/ Solid-state/ Nuclear spin networks/ Electron spin qubits/

Main objectives:

- Develop a quantum simulator using spin qubits in diamond and silicon carbide (SiC) materials, with the ambition to surpass classical simulation methods by achieving > 50 quantum units.
- Address scalability challenges to scale up the quantum simulator to > 1000 quantum units, thereby pushing the boundaries of current quantum simulation capabilities.
- Scale up platforms for solid-state quantum computing at ambient temperatures to > 10 fully programmable qubits.
- Development of a comprehensive software stack tailored to control, characterize, and read out quantum simulation and computation platforms.
- Identify use cases showcasing the potential of quantum technologies to demonstrate quantum advantage and revolutionize computational tasks.
- Foster and contribute to the growth of a European quantum and diamond ecosystems through international collaboration with relevant stakeholders.

Expected impact:

Quantum advancement:

SPINUS aims to demonstrate quantum simulators with >50 quantum units and quantum computers with >10 qubits, scaling them up to over 1000 units and 100 qubits respectively within two years post-project.

Investigating SiC as a platform could potentially exceed qubit/unit counts to over 100 and 1000, respectively, competing with existing technologies.

Economic/technological impact:

Maturing quantum processors via large simulators and diamond-based qubits could lead to widespread adoption of room-temperature quantum devices.

SPINUS paves the way for new applications in pharmaceuticals, materials science, finance, and cryptography, leveraging unique advantages of diamond-based quantum computers and establishing a European diamond ecosystem.

Innovation:

Quantum advantage could enhance climate modeling, improve environmental impact assessment, and lead to energy savings.

Scalable quantum systems may enable the discovery of new materials and drive economic expansion in the quantum technology sector.

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