A. Indledende oplysning

Indsatsområde	**Metrologi for kvanteteknologi**
Institut	Dansk Fundamental Metrologi (DFM A/S)
Aktivitetens Titel	Kvantematerialer og -komponenter
versions nr.	2.1
Aktivitets periode	2026-01-01 til 2027-01-31
Kontaktperson	Sabbir Khan (skh@dfm.dk)

B. Ændringer fra forrige version

Idnr. For ændring	Beskrivelse af ændring
2.1.1	Updated with work plan for year 2.

C. Beskrivelse af aktiviteten

1. Target

Quantum technology is one of the key elements in DFM's strategy for the period 2025–2028. Specifically, the strategy states: *DFM's focus in the upcoming period will be the development of new measurement technology to support quantum hardware development, as well as testing and standardization. Furthermore, DFM will contribute to the implementation of quantum technology in industry*. Developing quantum materials and devices in collaboration with Danish stakeholders is thus a natural part of the overarching strategy.

DFM's core focus in this activity lies in the development of superconducting, semiconducting, and photonic materials and devices. DFM will aim to advance in-situ fabrication and processing techniques for quantum chips, ensuring precision and scalability. Additionally, DFM will work on in-situ metrology methods to enhance the quality and performance of quantum devices. These efforts aim to drive innovation and set new benchmarks in quantum technology.

2. Content

DFM's work will aim on advancing quantum technology through high-precision materials processing, device fabrication, and metrology techniques.

A key area of DFM's work involves processing ultra-pure silicon (Si) samples tailored for superconducting and photonic qubits, ensuring optimal performance and reliability in quantum applications. DFM will install new ultra-high vacuum Si-Ge cluster by 2026, which enables ultra-pure Si growth. DFM will be performing growth of high-quality III-V quantum dots, which are the foundational building blocks for photonics qubits devices. These quantum dots will be grown with a focus on precision and uniformity to meet the stringent requirements of advanced photonics applications.

DFM will fabricate in-situ Josephson junctions, a key component for superconducting qubits, using state-of-the-art techniques to enhance their functionality and integration into quantum systems. DFM will work together with existing foundry in Danish quantum eco-system to fabricate masks for in-situ superconducting qubit fabrication. DFM will design and simulate the mask and provide the mask design to commercial foundry for stencil mask fabrication.

Further, DFM will employ both in-situ and ex-situ metrology, including optical microscopy, scanning probe microscopy, and transmission and scanning electron microscopy, to ensure comprehensive quality control and material characterization. For insitu metrology DFM will add at least two metrology chamber by 2026 where different metrology devices will be added for sample measurements without breaking vacuum. For ex-situ metrology DFM will develop surface and dimension measurement protocol for both superconducting and photonic quantum devices.

3. Collaboration

DFM's work in this activity will be based on strong collaborative efforts with leading academic and industrial partners. DFM will closely collaborate with university partners, including the Niels Bohr Institute, DTU Nanolab, DTU Electro, DTU Physics, DTU Energy, University of Southern Denmark and Aarhus University, advancing through their expertise in quantum research and nanotechnology. Key quantum initiative partners, such as the Novonordisk Quantum Computing Program, Danish Chip Competence Centre, Quantum Denmark, and DIANA NATO Quantum Test Center, will also be part of the collaboration.

Additionally, we will work alongside prominent Danish industry partners, including Topsil, Sparrow Quantum, Conscience, Quantum Machines, and Quantum Foundry. These collaborations ensure the integration of research with practical applications, fostering the development of high-performance quantum devices and systems.

4. Relations to other projects

The activity will benefit from synergies with externally funded research and development projects, including:

IFD Grand Solutions: Deterministic Quantum Dots for Quantum Photonics, DeQD*
IFD Grand Solutions: Quantum Light Sources for Quantum Computing, QLight*
EMPIR/EPM: Metrology for superconducting qubits, MetSuperQ
EMPIR/EPM: Normating colour-centre-based quantum sensing technology towards industrial application and standards, NoQTeS
EMPIR/EPM: Digitalisation route for dimensional nano-metrology, DINAMO
EMPIR/EPM: Cryogenic RF measurement for quantum and semiconductor industry, Cryo-RF
Thomas B. Thriges Fond: Quantum-Secure Fiber-Coupled Underwater Communication for Next-Generation Maritime Defense (QMarD)
Eurostars: High speed and precision Direct Atomic Layer Processing for high-resolutionmicro/nano-fabrication, Gap4DALP*
*) indicates that the project is co-funded with RK contract funds.

Additionally, the activity will support the characterization needs for quantum materials and components arising from the Quantum Denmark initiative.

5. Advisory group

Advisory group meetings are held jointly for the entire "indsatsområde". The advisory group meets 1–2 times per year, in addition to bilateral meetings with group members, where DFM receives input on more specific matters. The advisory group is dynamic, and the composition of its members is continuously adjusted to align with the current tasks within the "indsatsområde". However, participation from at least two companies or industry associations and two research groups from Danish universities is ensured.

6. Dissemination of results

The project activities have been disseminated in EQTC conference, APS march meeting, NPL Quantum summit. DFM submitted 2 patents in the technology development in 2025 related to superconducting qubit & in-situ metrology. DFM will publish new paper on the technology development for in-situ fabrication and metrology in 2026.