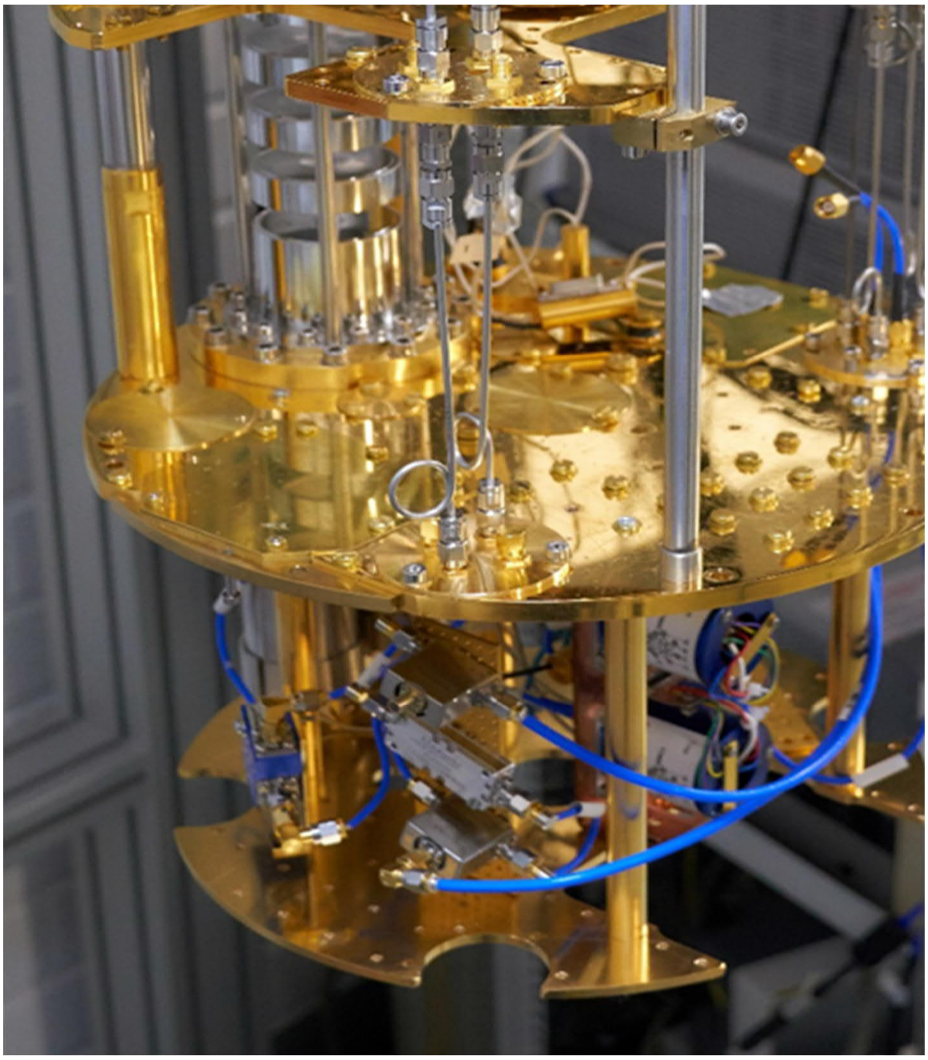

SUPERQUANT

MICROWAVE METROLOGY FOR SUPER-CONDUCTING QUANTUM CIRCUITS

SuperQuant project will lead the way to fundamental microwave metrology at cryogenic temperatures to support the booming quantum technology industry. We will trigger a paradigm change in this field by inter-disciplinary combinations of technologies, including superconducting quantum circuits, semiconductors, integrated and conventional photonics, and plasmonics. Our approaches will enable, e.g., a quantum standard of microwave power and a quantum-traceable cryogenic sampling oscilloscope with 1 THz bandwidth. One of our most ambitious goals is to develop an optically-integrated quantized arbitrary waveform generator that will enable energy- and cost-efficient generation of thousands of microwave signals at cryogenic temperatures.

SCIENTIFIC OBJECTIVES:

Optically-integrated Josephson Arbitrary Waveform Synthesizer with unprecedented bandwidth.

Cryogenic quantum-traceable 1 THz sampling oscilloscope.

Scattering-parameter measurements in situ at low temperatures.

New superconducting quantum sensors for microwave power.

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IMPACT & UPTAKE:

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Project homepage

EMPIR EURAMET
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

SUPERQUANT

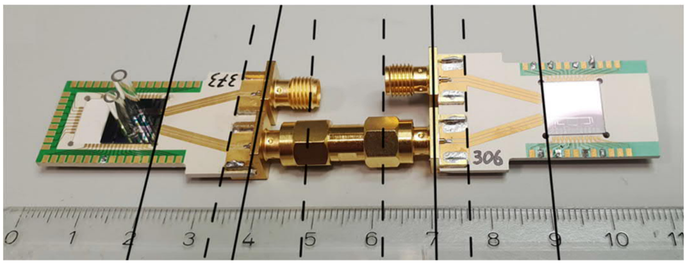
Need

All emerging solid-state approaches for quantum computing and many other quantum technologies rely on microwave signals. Yet, no established technology exists today that can perform accurate waveform generation and signal metrology under their operating conditions, i.e., at temperatures of 4 K and below.

Progress beyond the state of the art

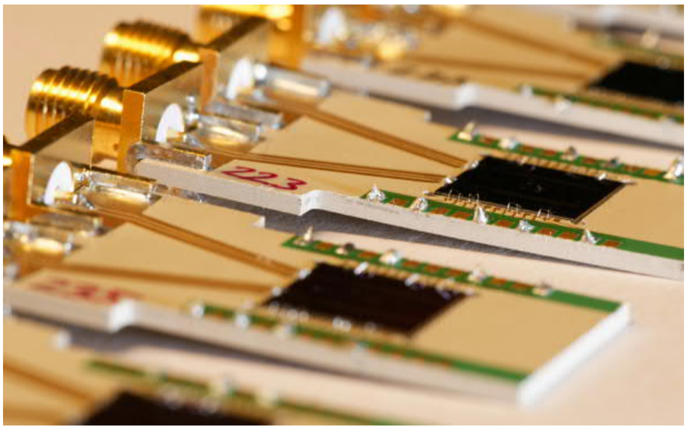
We lay the foundation for a wide microwave toolbox by developing cryogenic versions of existing room-temperature techniques as well as quantum-based cryogenic devices with superior accuracy:

- an optically-integrated Josephson arbitrary waveform synthesizer (JAWS) for cost-efficient generation of quantized arbitrary waveforms with a bandwidth exceeding 100 GHz.
- a cryogenic quantum-traceable 1 THz oscilloscope by employing electro-optic sampling and calibrating it with JAWS
- in-situ absolute quantum power sensors based on superconducting qubits.



Photograph of the cryogenic assembly optical pulse pattern generator with photodiode on the left with a glass tube for fibre mounting, and standard JAWS carrier and chip setup with SMA connector on the right.

Expected results and impact



By merging fundamental metrology with quantum technology applications, SuperQuant

- Promotes new quantum standards: an AC voltage standard up to microwave frequencies and an absolute microwave power standard.
- Establishes capabilities for accurate calibration in cryogenic environments of microwave signals, e.g., microwave power and ultrafast waveforms.
- Contributes to the study of new concepts and phenomena such as universality tests, new cooling techniques, new quantum sensors, and light-matter interaction at mK temperatures.

Consortium

NMIs: PTB; INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA; TÜBİTAK; VTT

Univs: ETH zürich; ROYAL HOLLOWAY UNIVERSITY OF LONDON; Tampere University; TU Delft; TOBB ETÜ Ekonomi ve Teknoloji Üniversitesi

SUPERQUANT

Welcome note

Welcome to the first newsletter of the SuperQuant Joint Research Project. The project started in September 2021 and will run for 3 years. As stated on the previous pages, the underlying goal of SuperQuant is to establish fundamental microwave metrology at cryogenic temperatures to support superconducting quantum technologies. To achieve this goal, we brought together a critical mass of four National Metrology Institutes (NMIs) and five universities in Europe who all bring key skills to the consortium.

Due to the Corona pandemic, we started with a purely online kick-off meeting last year, but had a first on-site meeting a short time ago (see below). As we are partly establishing new measurement capabilities, technical and scientific achievements will mainly be reported in the later course of the project. We all hope that we will be able to continue with on-site project meetings and have numerous in-person discussions during workshops and conferences. Please get in touch with us (see first page) if you are interested in joining the project as a stakeholder.

Mark Bieler

First on-site meeting of the SuperQuant project

Figure: After the first SuperQuant meeting day, participants had a refreshing 15-minute walk from VTT MIKES to the dinner restaurant with a view to the still partly frozen Baltic Sea. Photo: Antti Kemppinen.

SuperQuant arranged its first on-site project meeting at VTT MIKES (Espoo, Finland) on 7–8 April 2022. It was preceded and partly combined with the meeting of the Horizon 2020 project *aCryComm* (attojoule Cryogenic Communication, https://www.acrycomm.eu/), arranged at VTT MIKES on 6–7 April. The combined meeting of more than 30 participants enabled important interactions between the two projects that have a very strong mutual synergy. In addition to reporting and discussing the progress in the four technical work packages of SuperQuant during its first months, the meeting included visits to VTT's fabrication and measurement facilities. Lively and fruitful discussions both in the actual meeting and during breaks and dinner demonstrated the importance of long-awaited face-to-face meetings.