

bigQ - Annual highlights 2021

Ultra-coherent mechanical oscillators

Quantum mechanics is considered a universal theory, meaning that it applies on all scales of the Universe. Nonetheless, we do not experience phenomena like superpositions at the macroscopic scale where our daily lives unfold, and it is largely unknown why this is the case. How large can things be and still show distinct quantum behavior? Such questions are at the core of the research in bigQ and one of the ways we pursue the answer is through quantum optomechanics. Here the interaction between mechanical motion and a light field is investigated at the quantum level with the goal of driving the mechanical system into a state that displays clear quantum features. A prerequisite for this is the availability of ultra-coherent mechanical oscillators. To this end, bigQ has collaborated with VILLUM Investigator professor Ole Sigmund at DTU Mechanical Engineering on applying topological optimization in the design of micromechanical oscillators. This work has enabled us to develop devices with record-high coherence and demonstrate an entirely new approach to designing ultra-coherent micromechanical devices.

D. Høj et al. *Ultra-coherent nanomechanical resonators based on inverse design*, *Nature Communications* **12**, 5766 (2022), <https://doi.org/10.1038/s41467-021-26102-4>

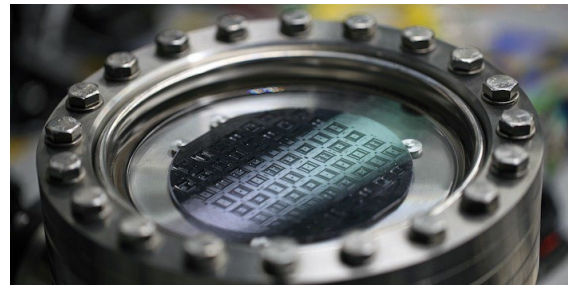


Figure 1: A 4-inch wafer full of mechanical oscillators being tested and characterized at bigQ.

NONGAUSS Winter School 2021

Since beginning of 2021, bigQ has had the pleasure of being a partner in the EU Twinning project NONGAUSS together with Palacky University Olomouc in the Czech Republic and Sorbonne Université in France. On December 13-17, bigQ organised the first PhD school in the project and brought together 45 participants from the partner universities for a week focused on non-Gaussian physics for quantum technology. Due to the pandemic, most of the lectures were given online. But in capable hands of 9 internationally recognized researchers from Denmark and abroad this posed no limitation for stimulating lively interaction with the students. Besides the purely scientific program, the school also sought to assist the future carrier of the participants by including a session on the MSCA Fellowship program facilitated by speakers from the EuroCenter, Ministry of Higher Education and Science.

A persisting issue for the quantum research community – and natural science in general – is the gender imbalance at all carrier levels. This topic is of great importance to NONGAUSS and was addressed during the Winter School in an invited talk on the topic by Prof. Anja C. Andersen, Copenhagen University.



Figure 2: Late-evening student presentation during the NONGAUSS Winter School 2021, held at Tivoli Hotel & Congress Center in Copenhagen.