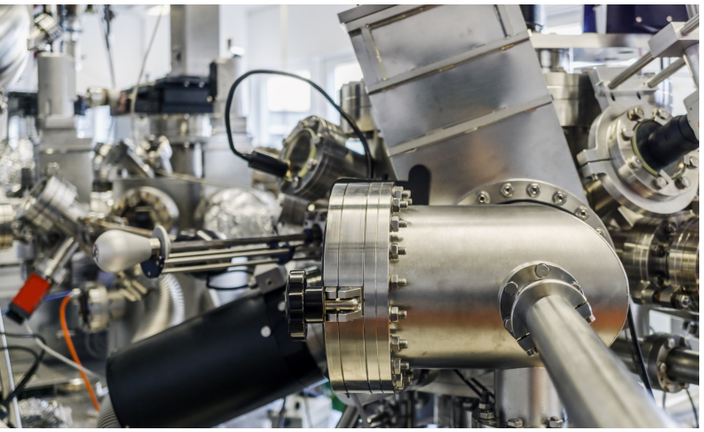
Vibration Decoupling for Dilution Refrigerators

This invention mechanically decouples the sample holder from the surrounding cryostat, making it ideally suited for quantum computing and particularly vibration sensitive measurement applications. Unlike previous solutions, it combines virtually indefinite continuous operation time at constant low temperature with minimal mechanical noise and easy handling – and can be retrofitted in most commercially available cryostats.



IP RIGHTS
International application filed
2024

Minimal vibration transfer from cryostat to sample

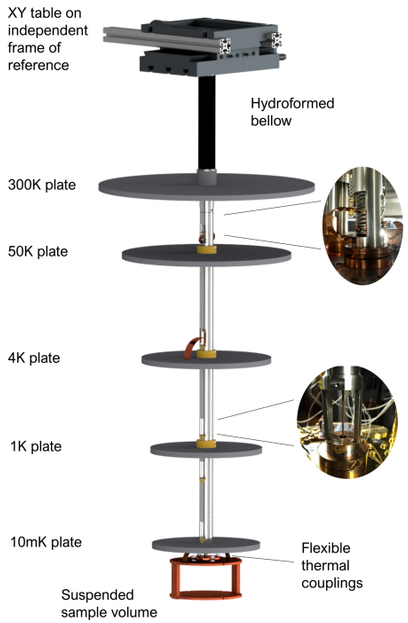
In quantum computing, any outside disturbance can destroy the coherence of the qubits. Various low-temperature detectors are also highly vibration sensitive. This is addressed by both mounting the sample holder independently from the surrounding cryostat and incorporating mechanical damping towards the external mount.

01 Possible upgrade for commercial cryostats with minimal impact on the size of the available sample volume

02 In dry cryostats, almost no vibrations are transferred to the sample even when the pulse-tube cooler is on

03 Multi-stage thermal insulation and mechanical damping ensure minimal interference from external support

04 Laboratory-scale tested prototype available



The carefully designed multi-stage composition of the pendulum support simultaneously ensures both mechanical decoupling and a minimal transfer of heat from the less cold stages of the cryostat towards the sample

REFERENCES:

Patent appl. WO2025011829A1

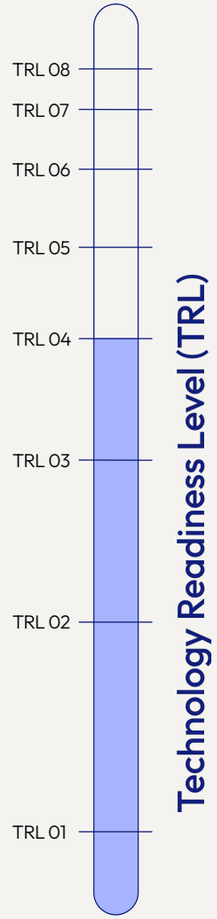
Wex et al. arXiv 2501.04471

CHALLENGE

Due to the cumbersome handling and need for a continuous supply of expensive coolant in conventional wet cryostats, dry cryostats, with pulse-tube coolers doing the pre-cooling at the push of a button, have grown ever more popular. However, these come at the cost of additional vibrations within the cryostat itself. Thus, especially vibration-sensitive applications require pausing the pulse-tube cooler and relying on passive insulation. This is of course not possible for indefinite periods of time.

INNOVATION

In this patent-pending system, the sample holder is hanging freely inside the cryostat, effectively decoupling the two. The connection to the external mount consists of multiple stages of mechanically damping and thermally insulating components. In order to reach target temperature <10 mK, the support incorporates additional radiation shielding as well as mechanically flexible thermal bridges to select stages of the cryostat. A lab-scale prototype has been in use by the inventors for more than a year supporting several different use cases. Resulting mechanical noise is at least as low as for wet cryostats.



01 Basic principles observed · **02** Technology concept formulated · **03** Experimental proof of concept · **04** Technology validated in lab · **05** Technology validated in relevant environment · **06** Technology demonstrated in relevant environment · **07** System prototype demonstrated in operational environment · **08** System complete and qualified

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Bayerische Patentallianz GmbH
Dr. Sindre Haugland
shaugland@baypat.de
+49 (0)89 5480177-17
Prinzregentenstr. 52
80538 München