A LOW-TEMPERATURE TUNABLE MICROCAVITY FEATURING HIGH PASSIVE STABILITY

- User credentials: Yanik Herrmann, Julius Fischer and Ronald Hanson from QuTech and Kavli Institute of Nanoscience, Delft University of Technology
- JPE positioners used: JPE Cryo positioning stage high resonance CPSHR1-a placed on the passive vibration isolator JPE CVIP1

[1] Y. Herrmann, J. Fischer, et al., A Low-Temperature Tunable Microcavity featuring High Passive Stability and Microwave Integration, arXiv:2409.01857 [quant-ph] (2024)

The Experiment

Color centers in diamond, such as the Nitrogen-Vacancy center, have become a main candidate for quantum technologies such as quantum networks and quantum sensing. However, current implementations lack in efficiency due to the low collection of coherent photons from the color center. A tunable, fiber-based optical cavity can drastically improve this by two effects: the coherent photon emission rate is boosted by the Purcell-effect and the collection efficiency can reach high numbers due to the well-defined beam leaving the cavity and the high control over the mirror reflectivity. The full spectral and spatial tunability of the cavity makes it also extremely sensitive to vibrations on the picometer scale. Especially at cryogenic temperatures in a noisy, closed-cycle cryostat with a cold head and pumps running, this poses a difficult technical challenge.
With its high mechanical resonance frequency, the JPE cryo positioning stage CPSHR1-a in combination with a vibration-isolated cryostat (Figure 1) enabled a noise level, where cavity length fluctuations are tens of picometer. This performance is reproducibly reached and robust against setup modifications and experimental imperfections. The vibration level allows to efficiently couple diamond color centers to the cavity, facilitating new cavity-enhanced quantum optics experiments.
Further details can be found in [1].

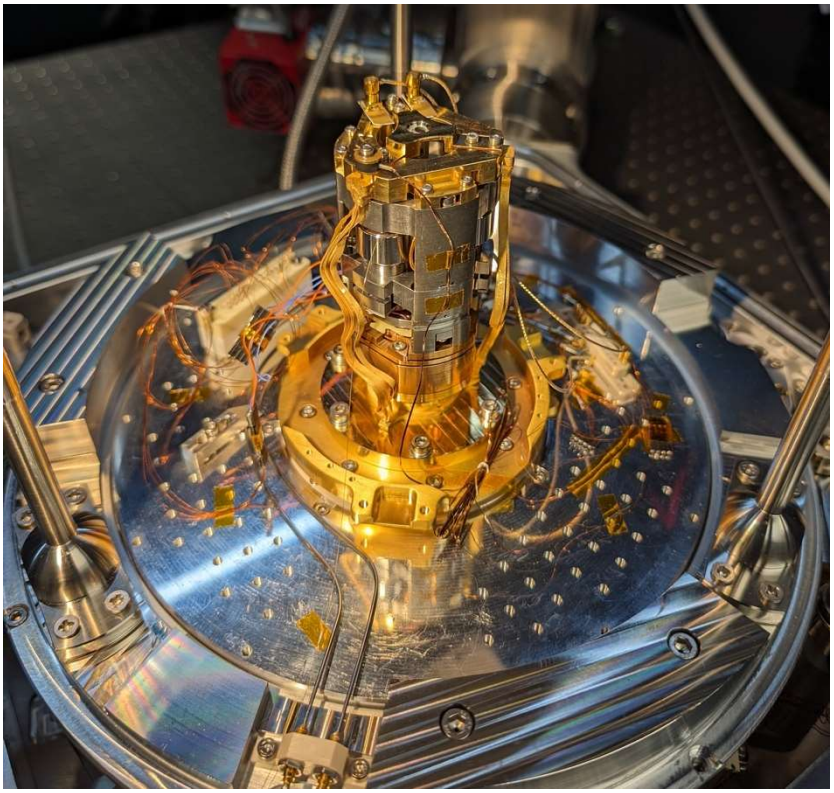


Figure 1. JPE positioning system on the vibration-isolated cryostat baseplate. The three spindle motors inside the Titanium frame move one of the cavity mirrors, made on the tip of an optical fiber. The other cavity mirror is fixed on the golden star-shaped holder on top of the stack.

JPE Aziëlaan 12, 6199 AG Maastricht-Airport, The Netherlands +31 (0) 43 3585 777 www.jpe.nl

© JPE. Subject to change without notice. All data are outdated by any new release.
JPE disclaims any liability with regard to the accuracy, completeness, and timeliness of the information provided.