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The Fast Piezo-Based Frequency Tuner for sc CH-Cavities*

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Abstract

Superconducting structures are very susceptible to external influences due to their thin walls and their narrow bandwidth. Even small mechanical deformations caused by dynamic effects like microphonic noise, pressure fluctuations of the liquid helium bath or Lorentz-Force-Detuning can lead to resonance frequency changes of the cavity which are much larger than the bandwidth. To compensate the slow and fast resonance frequency variations during operation a compact frequency tuner prototype equipped with a stepper motor and a piezo actuator has been developed at the Institute for Applied Physics (IAP) of Frankfurt University. In this contribution the tuner design and the results of first room temperature measurements of the tuner prototype are presented.

The Piezo-Based Frequency Tuner for sc CH-Cavities

Requirements

- Max. stroke of slow tuner 1 mm
- Required force of 600 N
- Tuner arm (pivot with mechanical advantage of ≈ 2:1)
- Harmonic drive gear reduction 50:1

- Piezo actuator ‚in series' with slow tuner arm
- Required stroke of at least 6 µm

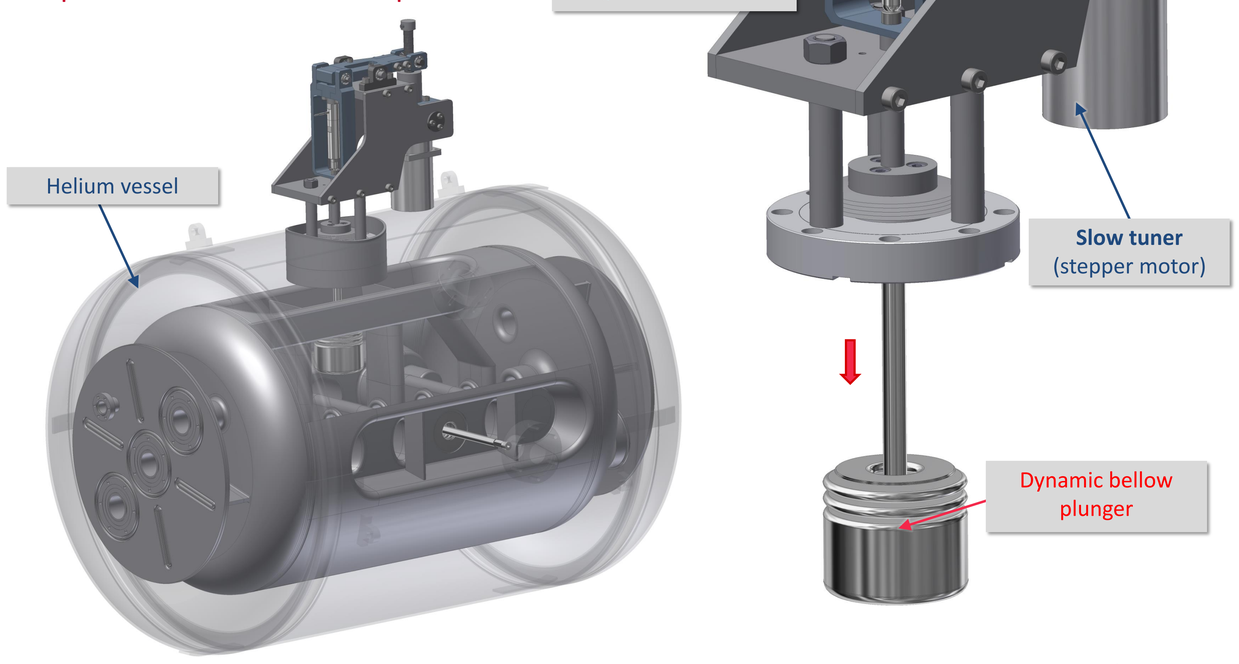


Figure 1: Piezo-based frequency tuner mounted on top of the helium vessel of the sc 325 MHz CH-Cavity (left) and complete frequency tuning system including the 3-cell dynamic bellow plunger (right)

Dynamic Bellow Tuner

- Dynamic capacitive bellow tuners are welded into the girders to act against fast frequency variations by changing their height

- First plunger type tuner in a sc cavity

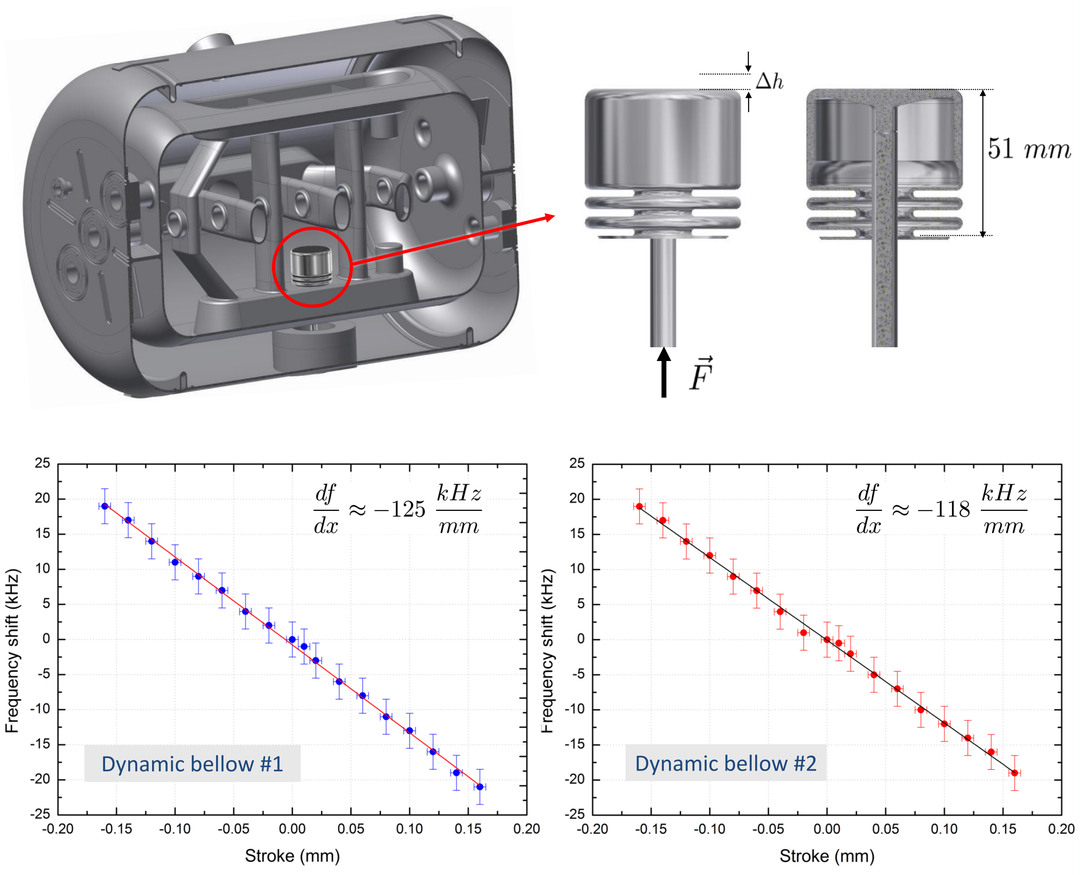


Figure 2: Measured frequency tuning range of the two dynamic bellow tuners of the sc 325 MHz CH-Cavity

Components of the Frequency Tuner Drive

- A part or the whole tuner is positioned at liquid nitrogen temperature and under vacuum

- Special materials and treatments are essential

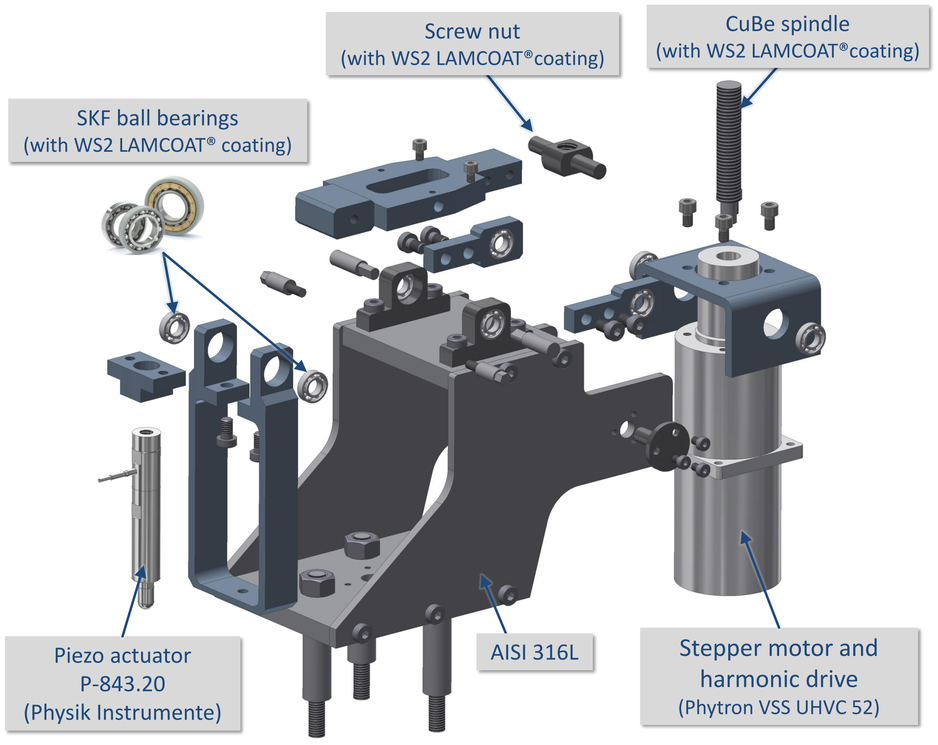
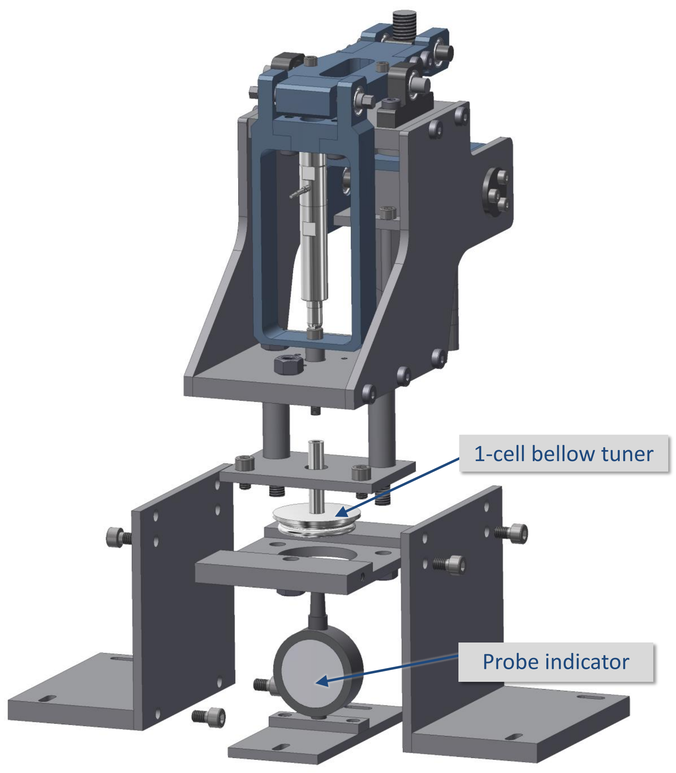


Figure 3: Main components of the frequency tuner drive system

First Room Temperature Measurements

- A frequency tuner prototype has been built to validate the drive concept

- The stroke of a 1-cell bellow tuner prototype made of niobium has been measured



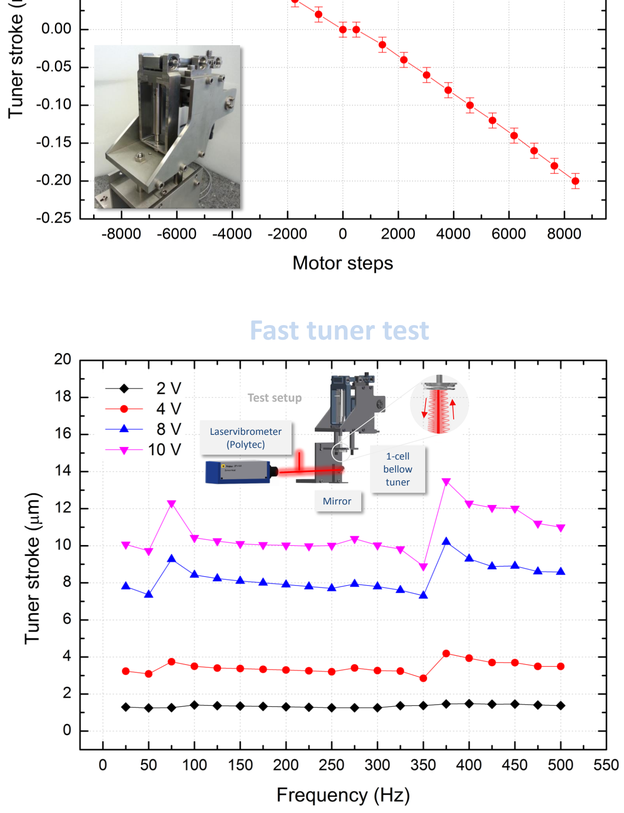


Figure 4: First room temperature measurement results of a dynamic frequency tuner prototype made of stainless steel