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## Toward a sub-kelvin cryogenic Fabry-Perot silicon cavity

We report the current development of a sub-kelvin Fabry-Perot silicon cavity. This devel-opment aims to reduce thermal noise-limited frequency instability and by this way address the cur-rent limitations of ultra-stable lasers, aiming to set the ground for the next generation of these devic-es with frequency instabilities below  $1 \times 10-17$  [1]. However, silicon cavities with crystalline mirror coatings at cryogenic temperatures have shown birefringence correlated frequency fluctuations [2], [3].

Our cavity (Fig. 1) is based on a spacer made from a monocrystalline silicon with optical axis aligned to the [111] axis. The size of the cylindrical spacer is about 18 cm in length and 20 cm in diameter. Mirrors with silicon substrates and Al0.92Ga0.08As/GaAs crystalline coatings are optically contacted [4]. We measured a room-temperature finesse of 220 000 and a TEM00 mode splitting due to the birefringence of the coatings of about 250 kHz. (Fig. 2)

To operate our cavity at sub-kelvin temperatures, we use a dilution cryostat able to reach 12 mK in unloaded operation with optical windows. Calculations based on the Stefan-Boltzmann law indicate that cooling by radiation alone would take excessive times with our spacer design, of order a year. To circumvent that, we propose to decouple the mechanical support and thermal manage-ment.

We propose to measure optical characteristics of our silicon cavity with crystalline AlGaAs coatings at subkelvin temperatures, as well as the sensitivity of our cavity to residual temperature fluctuations in the cryostat. We will also investigate the efficiency of our cavity cooling at sub-kelvin.

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