Introduction

The trend in experiments at cryogenic temperatures is to require increasingly stable cavities. Attenuation of cold plate vibrations is essential to achieve best performance, especially when using the popular but mechanically noisy closed cycle cryostats. Measurements, with sample rates >2kHz, show that the CPSHR3 XYZ positioning stage offers excellent vibration attenuation because of its high mechanical resonance frequencies.

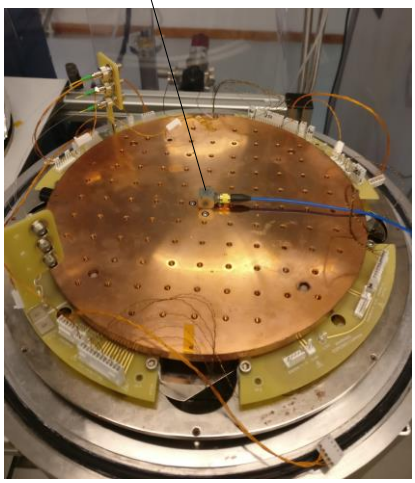
A reduction ratio of 1:24000 between RMS stage cavity stability and cold plate vibrations is obtained, without additional vibration isolation.

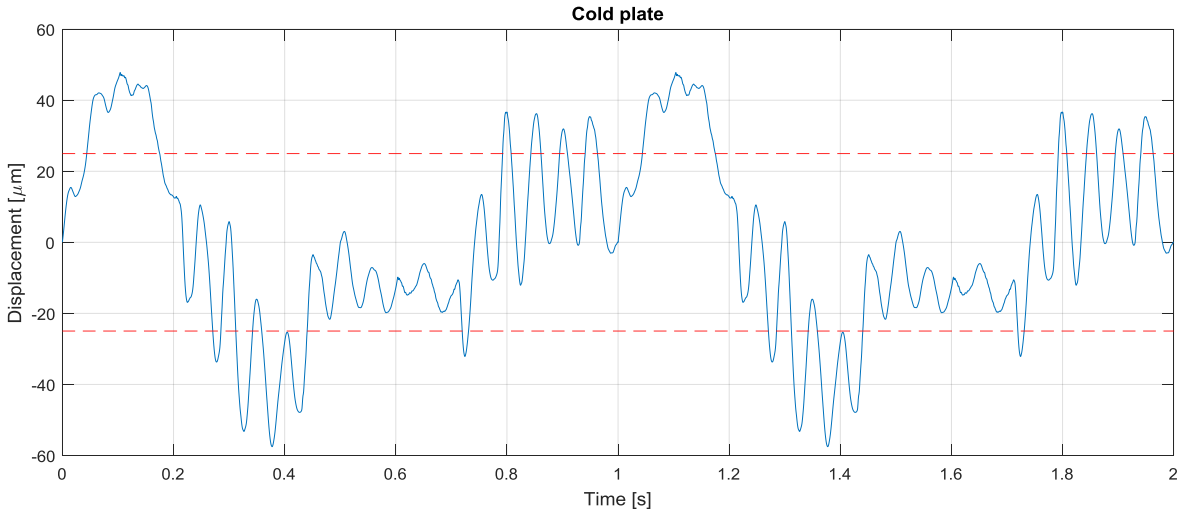
Cryostat cold plate vibrations

The attenuation performance of the stage is experimentally validated in a general purpose Gifford-McMahon cryostat. This cryostat is not optimized for low cold plate vibrations; it has a large sample area of ø300 x 300 mm and the cold plate is rigidly attached to the pulsing cryocooler. In fact, cold plate vibrations will be considerable higher than typical used closed cycle cryostats.

The cold plate vibrations are measured using an accelerometer, in ambient conditions, with running cryocooler, vacuum turbopump and pump of the water cooling circuit. Peak-peak values of 105 [µm] occur and were verified with additional measurements using a contact probe. The RMS vibration level is 24 [µm].

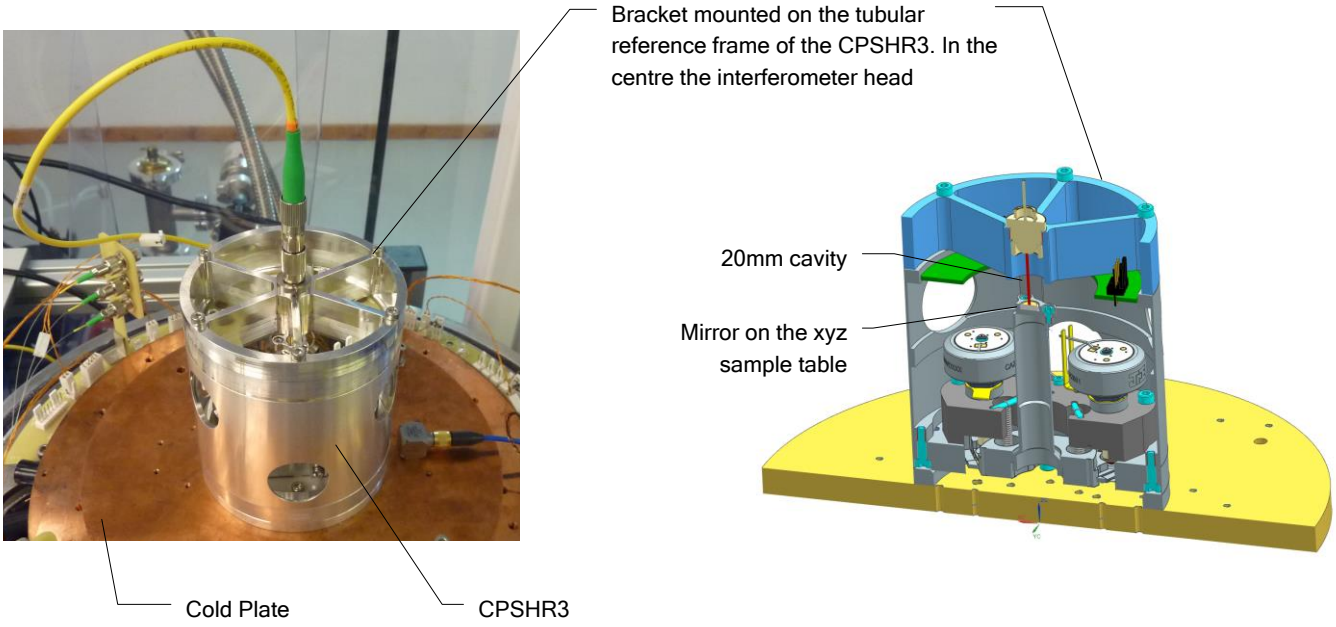
Cold plate vibrations are dominated by low-frequency disturbances from the cryocooler pulse frequency (~2 Hz) and the pump of the water cooling circuit (~20 Hz).

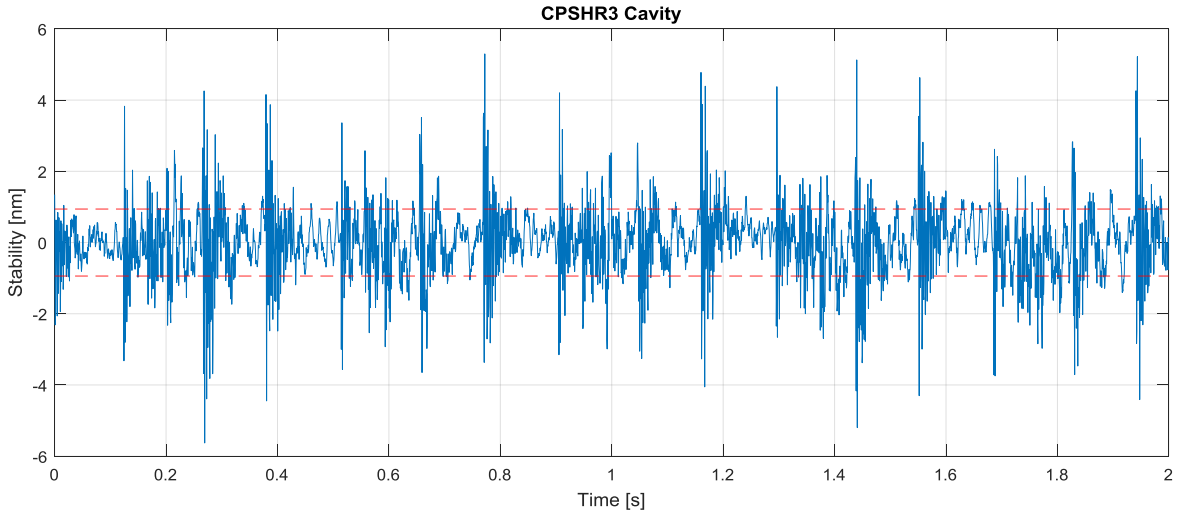




CPSHR3 cavity stability

A CPSHR3 xyz positioner is placed in the cryostat and a bracket holding an interferometer head is mounted on the outer tubular CPSHR3 frame. This so-called Reference Frame is rigidly connected to the cold plate and is the base of one end of the cavity. The other end of the cavity is a mirror on the sample table, which is not operated during measurements. This way a direct measurement of the 20 [mm] long cavity is possible, while operating the cryostat in the same manner as explained above. Peak-peak spikes of 11 [nm] occur, these are the result of higher dynamics in the cryocooler pulses. These pulses occur with a base frequency of 2Hz, but also contain higher frequencies. The RMS vibration level is 1 [nm]





Attenuation rate

The stability of the stage cavity is measured with an interferometer system. The **peak-peak** vibration level of the cavity is **11 [nm]**, resulting from a **105 [µm]** cold plate vibrations, giving an effective vibration attenuation rate of **≈1:10000. RMS** values are **1 [nm]** for cavity stability, resulting from **24 [µm]** cold plate vibrations, yielding **1:24000.** These attenuation rates are the result of CPSHR3 performance only, no additional vibration isolation is used.

Note: many commercially available closed cycle cryostats have been designed to have considerable lower cold plate vibrations than the big, general purpose cryostat used in these measurements. Cavity stability numbers can be expected to improve accordingly.