1. Introduction

Minimizing vibrations is essential in many experiments and for this reason the sensitivity to floor vibrations of two translational xyz stages is evaluated. One is a stack of 3 CBS10 positioners, the other the CS021, as shown in Figure 1. The measurements were performed by Jean-Baptiste Trebbia and Professor Brahim Lounis from the Nanophotonics group of the University of Bordeaux.



Figure 1: Photos showing the tested CBS10 configuration on the left and the CS021 on the right. Both offer xyz motion with the CS021 being capable of lifting weights up to 1 kg, compared to 200 grams for the CBS10 configuration

Both stages were tested in an open pulse tube cryostat at normal environmental conditions. The stage displacement was measured using an interferometer operating at a 1 kHz sampling rate, with a mirror mounted at the top of each stage, as can be seen in Figure 2. Since both the interferometer and the cryostat are placed on the same optical table, the interferometer measures the stage displacement with respect to the optical table. Measurements were made along the x-direction, which can be considered a worst-case approach as this is expected to be more sensitive to vibration than the z-axis.

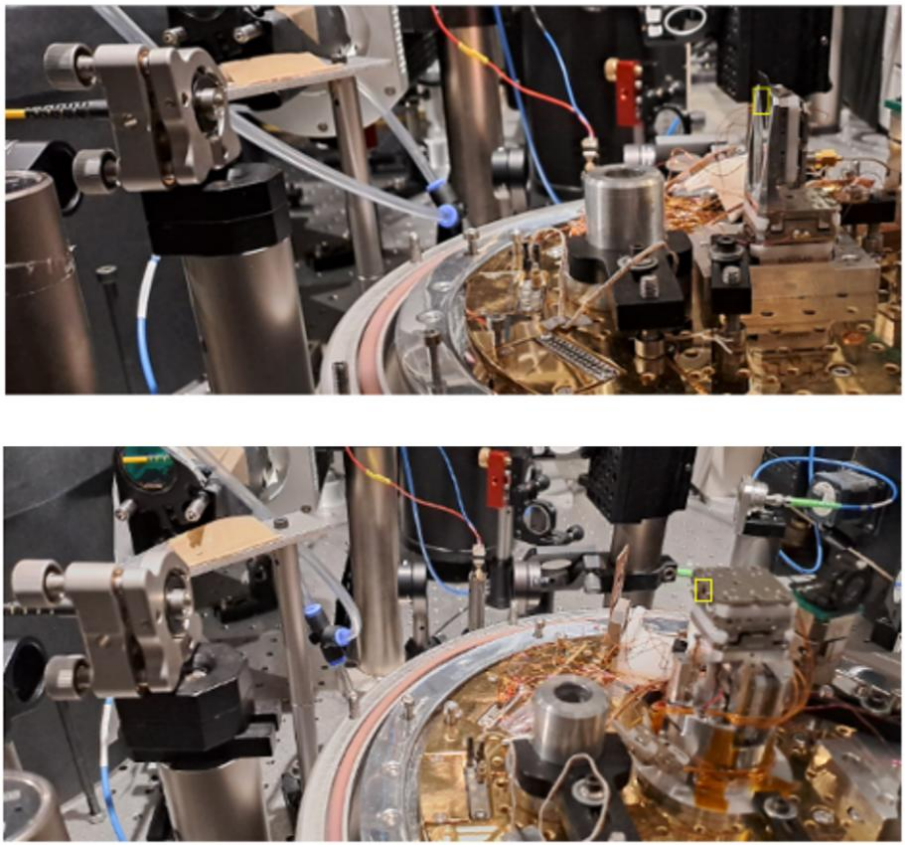


Figure 2: Photos showing the setup for the measurement of displacement of the translational xyz stages. The setup using the CBS10 and CS021 are shown top and bottom respectively. The yellow squares mark the location of the mirror.

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To evaluate the displacement of the stage, measurements were taken with the vibrating pulse tube both off and on. These results were then compared to similar reference measurements with a mirror mounted directly on the cryostat's cold plate as shown in Figure 3. This comparison allows the separation of the cold plate vibrations from stage vibrations.

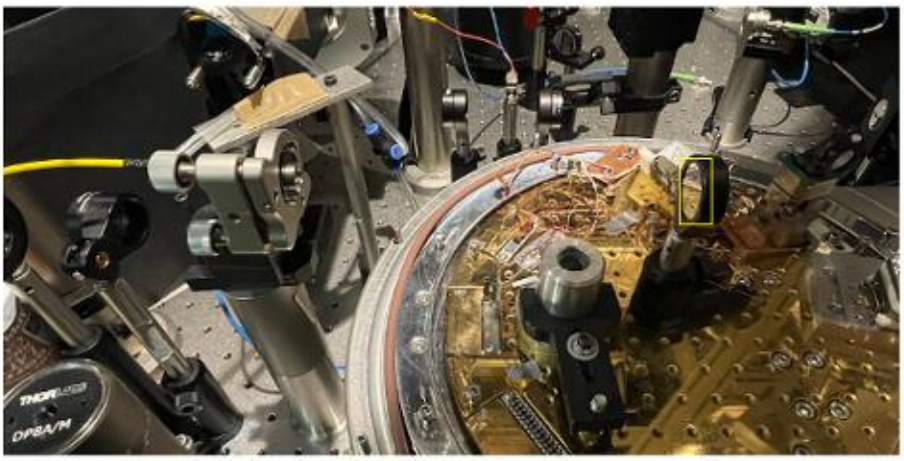


Figure 3: Photo showing the setup where the mirror is mounted directly on the cold plate. The yellow square shows the location of the mirror.

2. Cold plate measurements

Figure 4 shows the measurements, including the RMS value, taken with the mirror mounted directly on the cold plate. As expected, the vibrations measured are significantly stronger when the pulse tube is turned on. Fourier transforms were performed to obtain the displacement spectrum, also shown in Figure 5. The pulse tube introduces a series of excitation peaks with a base frequency of 1.7 Hz and extending through its higher harmonics up to 180 Hz.

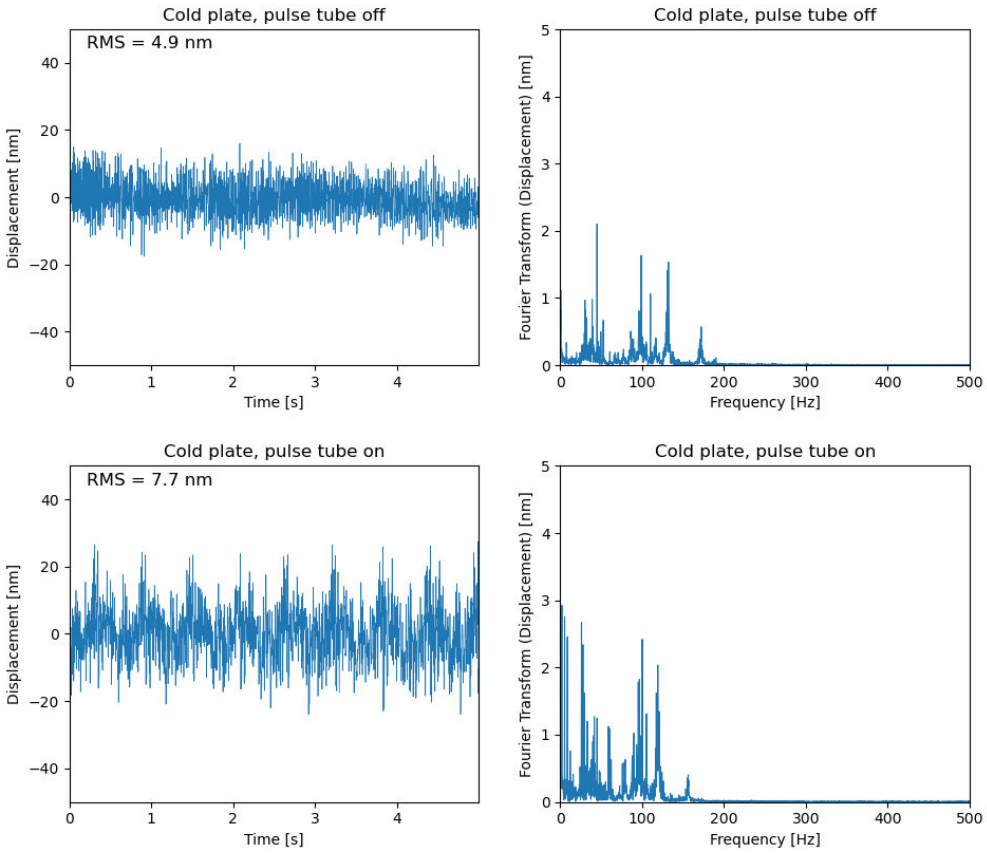


Figure 4: The graphs in the left column show the displacement of the cold plate with the pulse tube off and on. The right column shows the corresponding vibration spectrum for each measurement.

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3. CBS10 measurements

The first translational stage tested is the CBS10, configured for xyz translation. The measured vibration and the corresponding spectrum are shown in Figure 6. The RMS displacement for the CBS10 is near identical to the cold plate when the pulse tube is turned off, while the RMS displacement with the pulse tube turned on is only slightly higher. The vibration spectrum shows similar peaks as the cold plate, with only a small added peak at approximately 250 Hz.

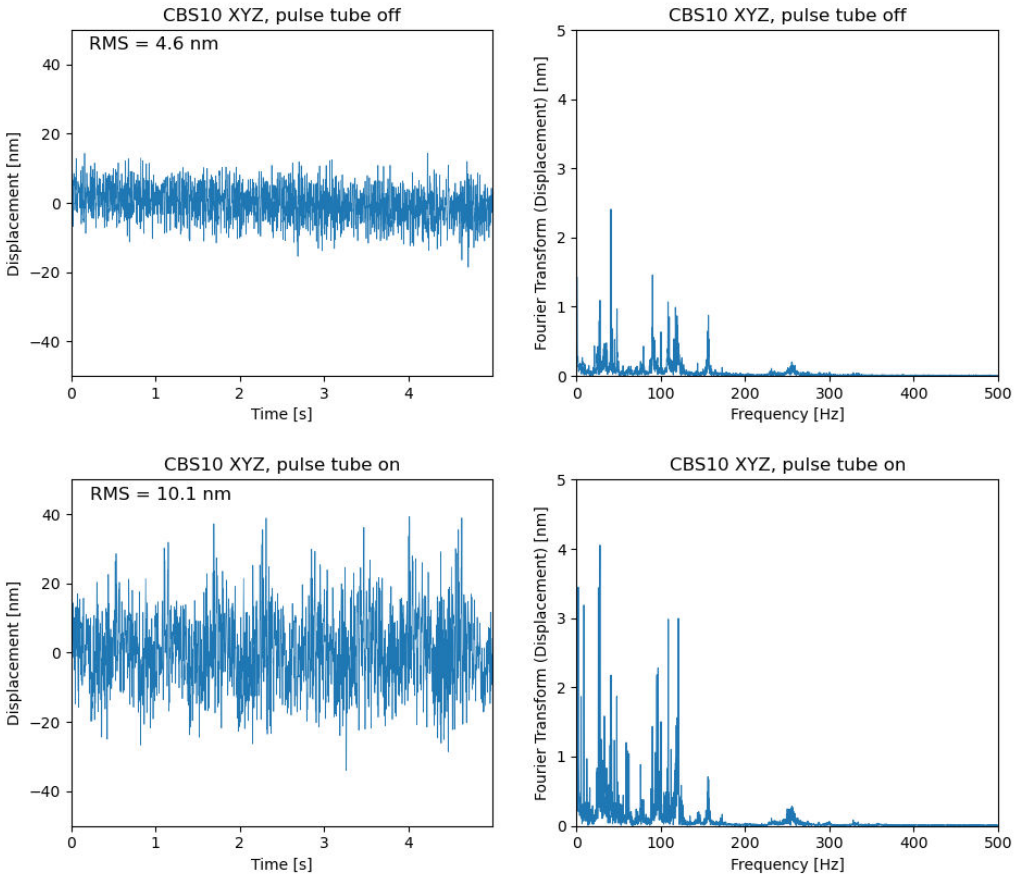


Figure 5: The left column displays the displacement of the mirror mounted on the CBS10 XYZ for the pulse tube off and on. The right column shows the corresponding vibration spectrum for each measurement.

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4. CS021 measurements

The second translational stage tested is the CS021 which has a significantly larger lifting capacity than the CBS10 configuration. The measured vibration and the corresponding spectrum are shown in Figure 6. The RMS displacement is slightly higher compared to the displacement of the cold plate, which is observed for both the pulse tube off and on. This effect is similar although somewhat stronger than observed for the CBS10. The vibration spectra show similar peaks as the cold plate, with the contribution just below 200 Hz shifted to just above. The response with the pulse tube on shows a dominant contribution at approximately 100 Hz.

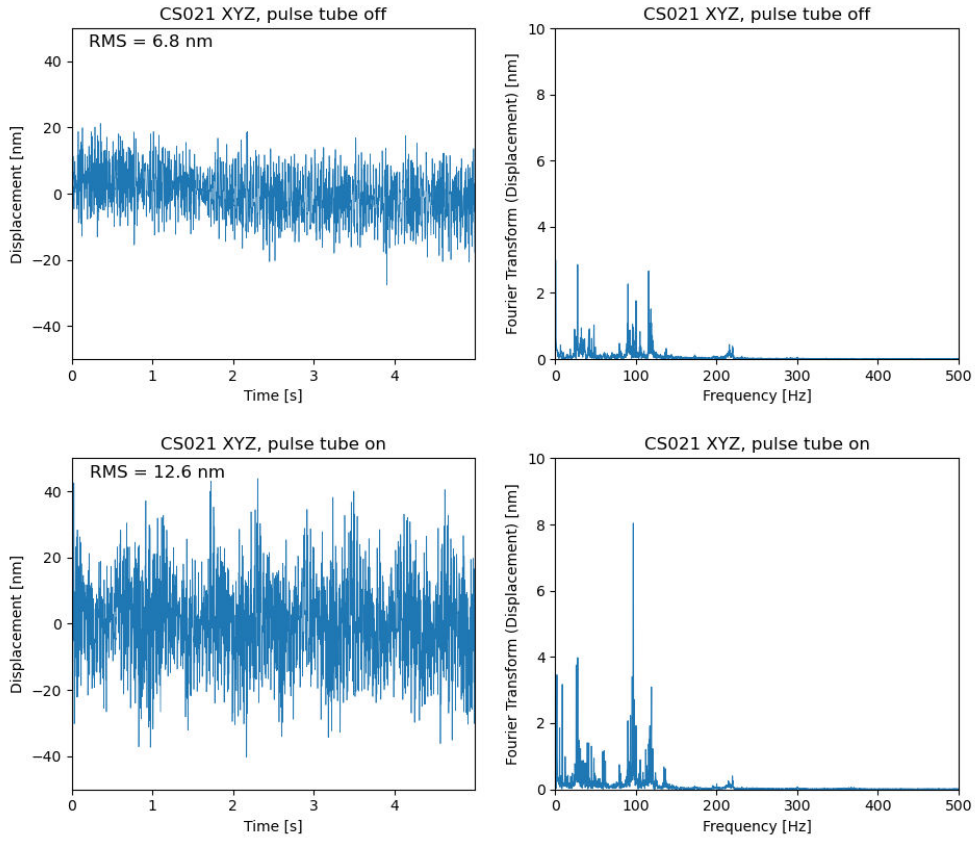


Figure 6: The left column displays the displacement of the CS021 for the pulse tube off and on. The right column shows the corresponding vibration spectrum for each configuration.

5. Summary and conclusion

An overview of the RMS values of the measured displacements is given in Table 1. The CBS10 shows no increase in displacement compared to the cold plate when the pulse tube is off, and only a small increase when the pulse tube is turned on. The displacement values for the CS021 are slightly higher, but still comparable to the CBS10. Both setups show a high degree of insensitivity to the cold plate vibrations.

As mentioned before, a worst-case approach was taken, and all measurements were made along the x-axis which is expected to be more sensitive than the z-axis.

	pulse tube off [nm]	pulse tube on [nm]
Cold plate	4.9	7.7
CBS10	4.6	10.1
CS021	6.8	12.6

Table 1: An overview of the RMS x-displacement values for the cold plate and the two stages, with the pulse tube on and off.

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