Investigations on stability performance of beamline optics supports at BSRF

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Abstract

The stability of beamline optics directly affects the beamline's performances, such as coherence, focal size, position stability of the beam and so on, it has become a serious issue for a low emittance 4th generation light source. The vibration transmitting function of supports plays a big role in the stability performance of the optics. In order to find out a stable supporting structure, sever-al types of support structures were tested, and the trans-fer ratio were described. The result shows that wedge structures generally have a lower transfer ratio, and point contact support structures should be avoided.

Introduction

The beam position and focal size is often affected by beamline optics such as monochromators, mirrors, sample stages, optical tables, etc. They are usually sensitive to ground vibration, the vibration transfer ratio, or transfer function of their supporting structure determines their behavior under ground motion and vibration. In order to build better optics for HEPS, tests were carried out to find out what is the best for supporting an optic.

Test conditions

Most of the tests were carried out at BSRF, a first generation light source with 3 months of dedicated synchrotron mode every year. The ground vibration level is about 18 nm RMS.

The data was acquired by a DEWESOFT SIRIUSi 8xACC ADC, with DYTRAN 3192A and 3191A1 accelerometers. Sampling rate is usually set at 2000 or 3000Hz. The acceleration then was integrated into RMS displacement by a PC.

Mirror support

Figure 1 Test of a mirror support

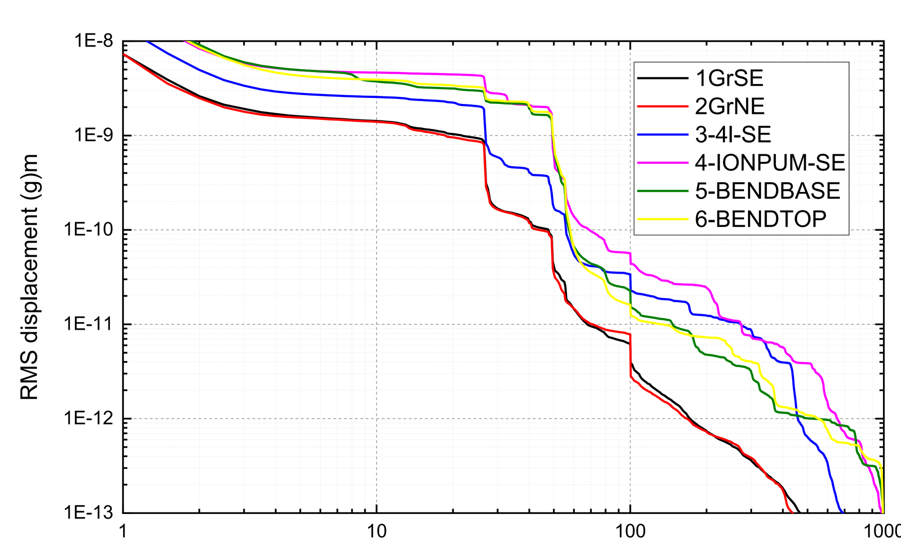

Figure 2 Integrated RMS displacement

This mirror support provides 6 DOF adjustment capability of a bending mirror. With eigenfrequencies spread from 8 to 33 Hz, it has a total transfer ratio of 1.76.

LAUE monochromator support

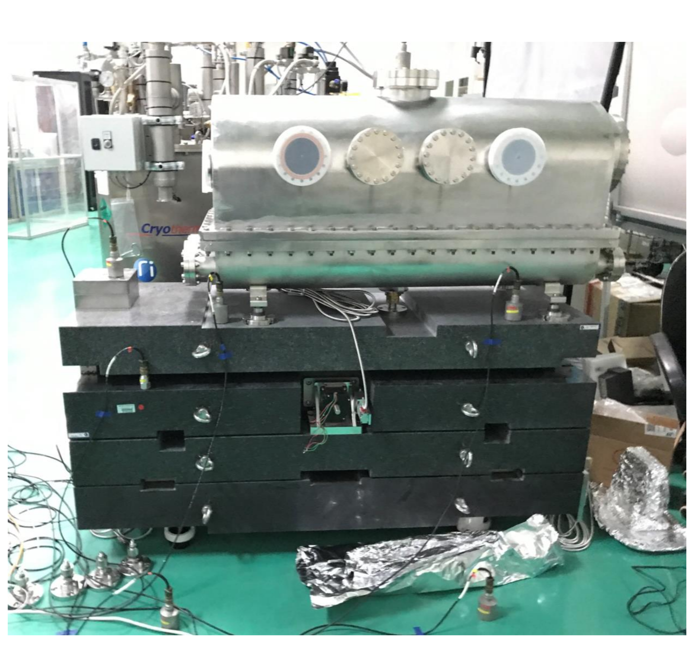

Figure 3 Test of a LAUE mono support

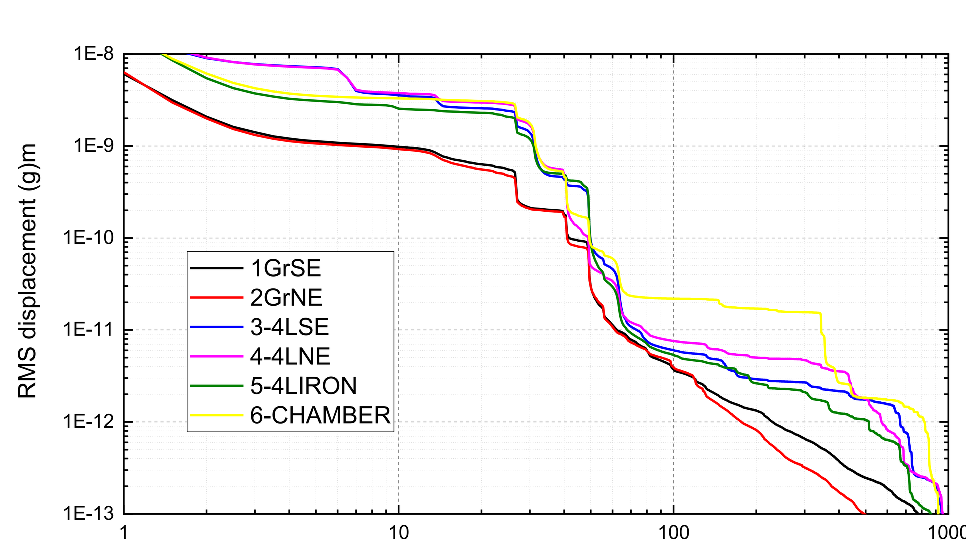

Figure 4 Integrated RMS displacement

The LAUE mono support provides 6 DOF adjustment capability of a the crystal assemblies. With a lowest eigenfrequency of 8 Hz, it has an overall transfer ratio of 6.5 from fourth layer to ground.

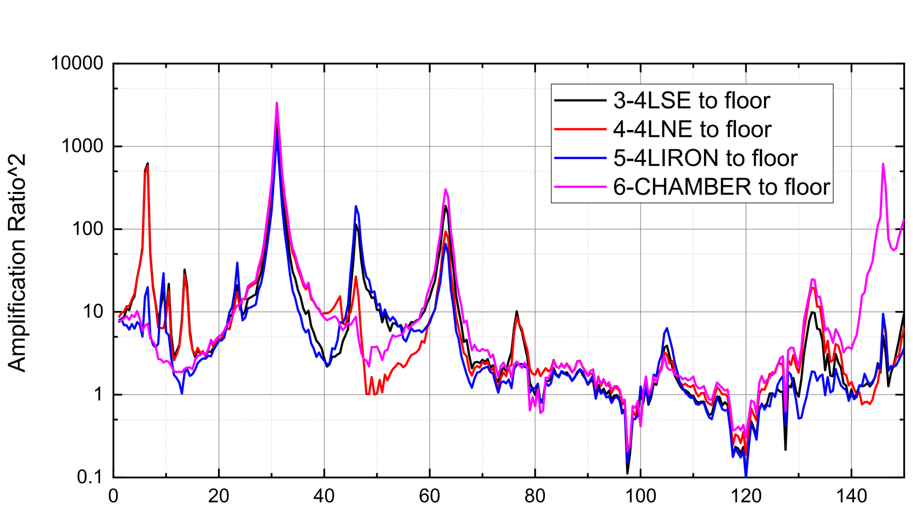

Figure 5 Amplification ratio

References

1. Jiao, Y., et al., The HEPS project. Journal of Synchrotron Radiation, 2018. 25(6): p. 1611-1618.
2. Hao Liang, Gang Cao, Lidan Gao et al, A High Heat Load Double Crystal Monochromator And its Cryo Cooling System for HEPS, in Proc. MEDSI'18, Paris, France, June. 2018, paper FROAMA05, pp. 430-434.
3. DEWESoft website, https://dewesoft.com
4. DYTRAN website, https://www.dytran.com/

Vertical direct drive spindle

The support of this granite table are 4 wedges. With an eigenfrequency of 66 Hz, it has an overall transfer ratio of 1.12 from granite table to ground.

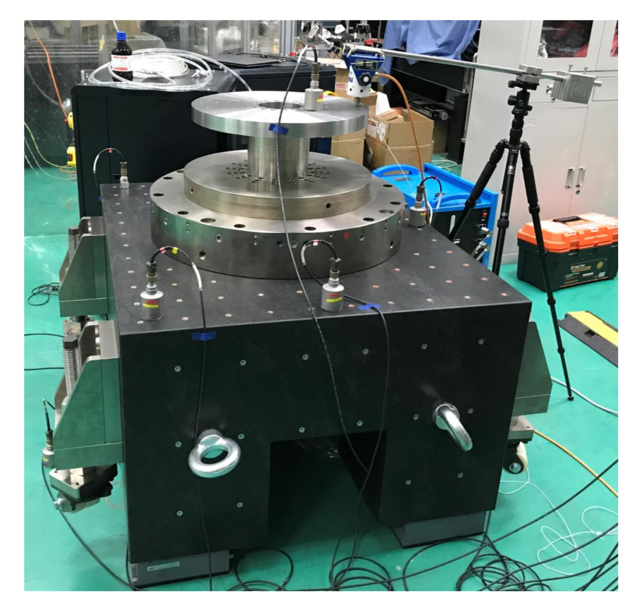

Figure 6 Vertical direct drive spindle

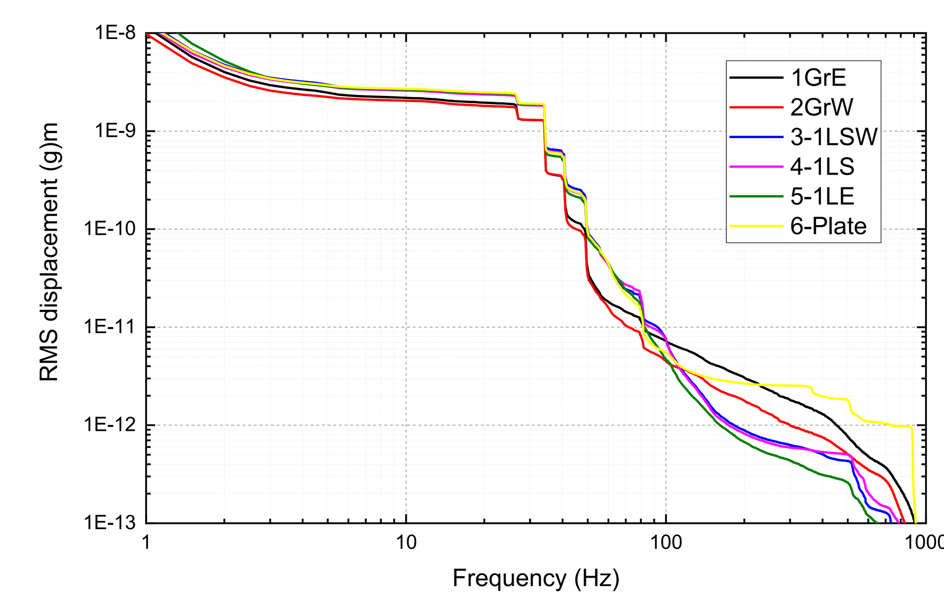

Figure 7 Integrated RMS displacement

Horizontal direct drive spindle

The support of this massive granite table are 4 wedges. With an eigenfrequency of 56 Hz, it has an overall transfer ratio of 1.21 from granite table to ground. Also 56Hz is very close to one of the peak noise of 51 Hz from the ground.

Figure 8 Horizontal direct drive spindle

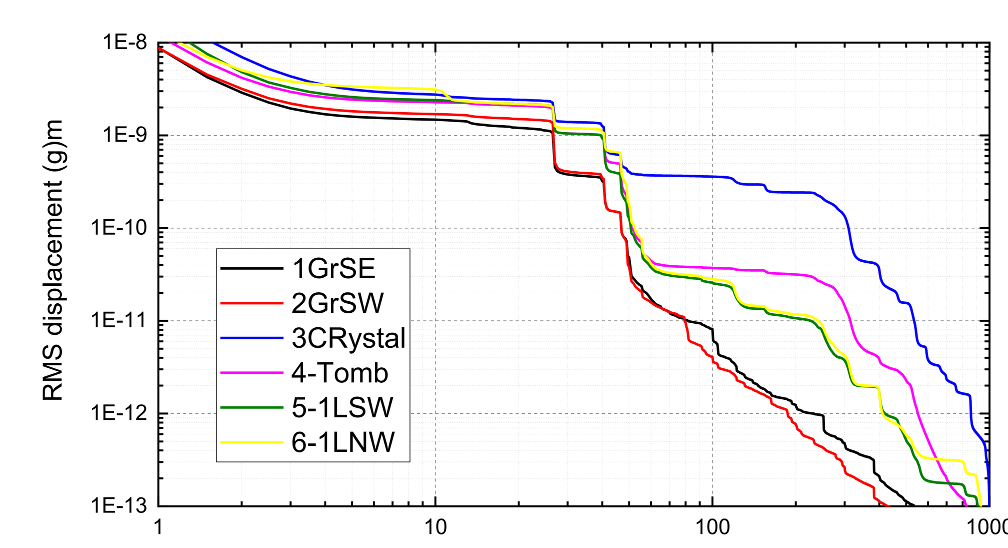

Figure 9 Integrated RMS displacement

DCM support

The support of this DCM granite table are 6 wedges. With an eigenfrequency of 8 and 31 Hz, it has an overall transfer ratio of 3 from granite table to ground.

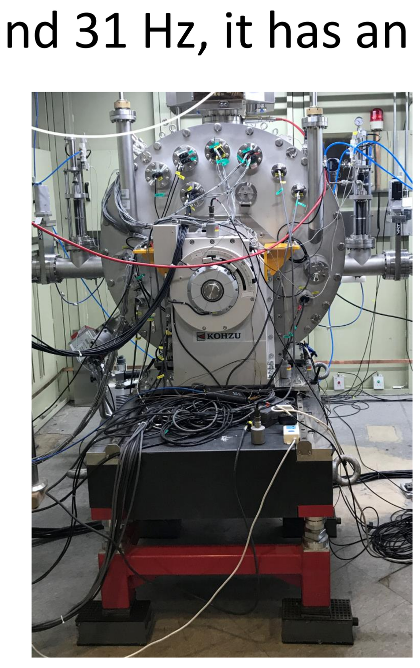

Figure 10 DCM under test

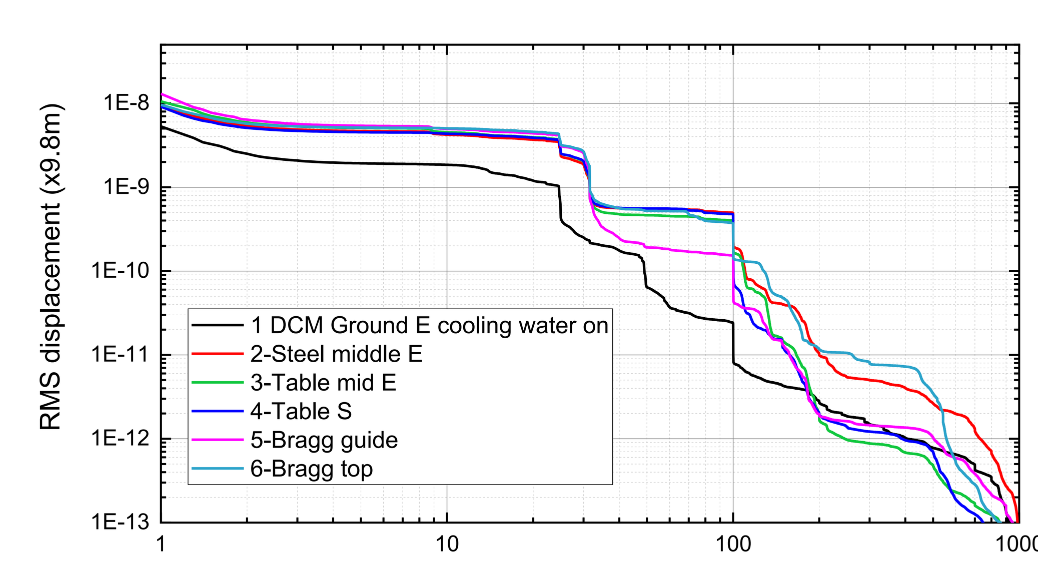

Figure 11 Integrated RMS vibration

Conclusion

By studying the transfer behavior of different supporting structures, it can be concluded that wedges combined with granite tables could be a good combination. In general an 1st eigenfrequency above 50Hz will provide a transfer ratio around or below 1.2 for the BSRF site. Also screw type levelers and point support should always be avoided for high stability optics.