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# *Investigation of vibrations attenuation with different frequency along HEPS ground*

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## Abstract

High Energy Photon Source (HEPS) has a strict restriction on vibration instabilities. To fulfil the stability specification, vibration levels on HEPS site must be controlled. The control standards are highly related with the vibration amplitude of the sources and the distance between sources and the critical positions. To establish reasonable regulations for new-built vibration sources, the decay patterns are investigated on HEPS site for different frequency noises. A series of experiments were conducted using shaker to generate vibrations with frequency from 1Hz up to 100Hz. The vibration attenuation on ground and slab were measured using seismometers and the attenuation law were analysed. Details will be presented in this paper.

## Introduction

The issue of vibrations in large scientific facilities is becoming increasingly prominent, with the random noise generated by these vibrations having a significant impact on equipment resolution and sampling efficiency. Controlling both internal and external vibrations is considered necessary. However, the widely used Bornitz model has limitations in accurately predicting vibrations due to the non-uniformity of the ground medium and the uncontrollability of random noise. Therefore, it is necessary to propose more reasonable prediction formulas based on measured attenuation data. The validity of the measurement data was ensured through self-noise measurements and comparisons with environmental noise levels and vibration amplitudes. Vibrations at different frequencies were generated using an shaker, and ground and floor vibrations were measured using a seismometer. This paper analyzes and presents the attenuation characteristics of these vibrations.

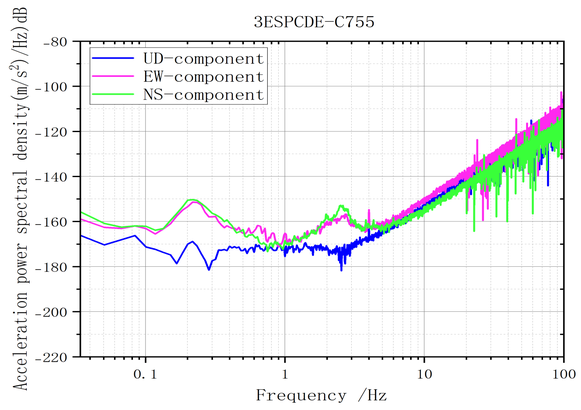
## Seismometer self-noise measurement

The three-sensor coherence analysis method is a seismic instrument self-noise analysis method based on correlation analysis. Its basic principle is that when three seismometers observe the same input signal, the correlated parts of the signal are removed, and the remaining parts are considered as the device's self-noise.

## Experimental data and analysis

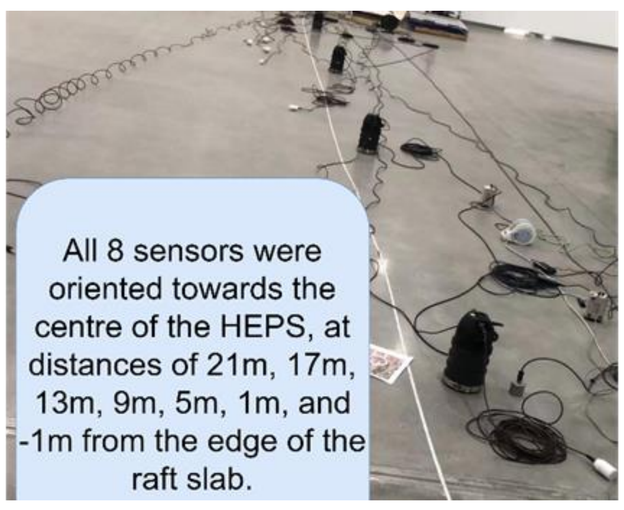
The self-noise of the equipment farthest away from the shaker is compared to the vibration amplitude and ambient tunnel noise generated by the shaker propagating through 170 metres distance, and the displacement power spectral density (PSD) on the ground in the vicinity of the shaker.

## Self-noise test site & Self-noise result of 3espcde



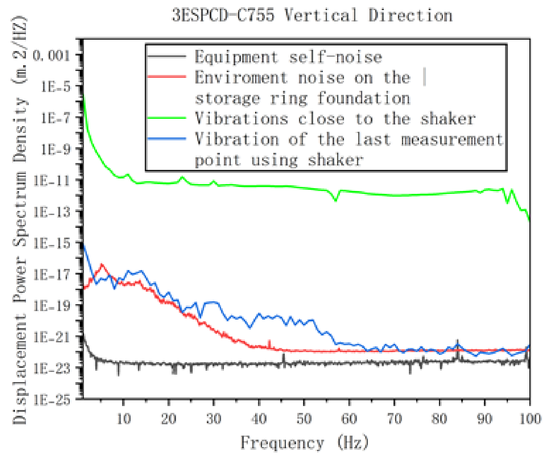

Results showed that the self-noise of the 3espcde's C755 device is much lower than the noise from the excitation signal and tunnel environment. This indicates that the signals observed by the device are reliable, and the vibrations generated by the shaker are consistent within the frequency range of 10Hz to 70Hz.

## Sensor positions

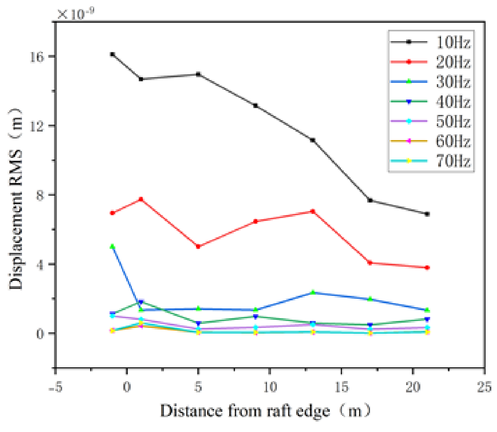



## Shaker position


## Displacement PSD comparison




## Attenuation of displacement response at different frequencies




## Conclusion

1. Vibrations above 70Hz generated by the shaker overlap with the ambient tunnel noise, indicating their equivalence after attenuation by the ground at a distance of 170m.
2. High-frequency vibrations decay faster than low-frequency vibrations. Vibrations in the 10-30Hz range still have high amplitudes after propagating 170m, while vibrations above 40Hz show a relatively flat decay curve.
3. Vibrations may experience amplification at certain frequency points when entering or propagating through a raft foundation, possibly due to reflection superposition between different materials during wave propagation.

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