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Depth- and Distance-Dependent Correlated Seismic Noise Analysis at LSBB and Implications of Newtonian Noise Mitigation for the Einstein Telescope

Correlated seismic noise and the resulting Newtonian noise (NN), pose a significant challenge for future gravitational-wave detectors like the Einstein Telescope (ET), especially for low-frequency gravitational-wave background (GWB) searches.
The body-wave-induced NN could significantly impact ET's sensitivity to GWB by orders of magnitude in its most sensitive frequency band.
This study characterizes correlated seismic noise over varying horizontal separations and depths at the Laboratoire Souterrain à Bas Bruit (LSBB) to assess this impact and inform about NN mitigation strategies as well as potential design choices (e.g. exact depth of the facility).
The seismic data is being collected utilizing three mobile seismometers alongside three fixed LSBB sensors to capture seismic field fluctuations at distances exceeding 250 m.
In this talk, we discuss results from the analysis that focuses on horizontal separations of approximately 275 m, 550 m, and 825 m, while also evaluating depth-dependent effects.
Coherence and cross-spectral density (CSD) analyses reveal strong seismic correlation below ~2 Hz, with significant correlation persisting up to ~40 Hz, particularly at the shortest (~275 m) separation relevant for ET's inter-detector distances.
This finding provides confirmation of the correlated underground seismic noise, which can be used to predict the resulting correlated NN.
These LSBB site specific results quantify the challenge posed by correlated seismic noise for ET's low-frequency GWB searches and provide essential input for developing and validating the effective NN cancellation strategies vital for ET.

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