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ET-LF Sensitivity limitations from vertical thermal noise

The Low Frequency interferometer of the Einstein Telescope will use cryogenic mirror suspensions with long pendulum providing horizontal attenuation to filter out the horizontal thermal noise generated by the seismic attenuation chain and by the heat links. They will be made of crystalline materials to minimize their own thermal noise generation.

It is almost impossible to make passive springs for low-frequency vertical attenuation with the crystalline materials necessary to limit their own internal thermal noise generation. As a result, the large vertical thermal noise injected on the upper mass of the cryogenic suspensions will be directly transmitted to the mirror.

Due to Earth's limited radius, even if the 10 km long beamlines were perfectly horizontal at the center, a minimum of 0.16% of that thermal noise will be transmitted to the interferometer direction and severely limit ET-LF sensitivity. This fraction grows significantly if the tunnels are longer and/or tilted, or if the mirror suspensions are not perfectly longitudinally symmetric.

A method to soften silicon springs using active feedback between an optical sensor and an electrostatic actuator is presented as a possible solution.

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