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C3Or3D-02: Low-noise thermal shielding around the cryogenic payloads in the Einstein Telescope

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The Einstein Telescope (ET) is a planned third-generation gravitational-wave detector that includes a low-frequency (LF) and a high-frequency (HF) laser interferometer. Cryogenic operation of ET-LF is imperative for exploiting the full scientific potential of ET, with mirrors operated at temperatures of 10 K to 20 K in order to reduce the thermal noise. Thermal shielding around the optics is essential to support the cool-down process and to decrease the heat load. Additionally in steady-state operation, mechanical vibrations must be kept to an absolute minimum in order to limit noise contributions from scattered light. We present a cooling concept for a thermal shield surrounding the cryogenic optics of ET-LF which considers rapid cool-down and low vibration in steady-state operation. During cool-down, cooling tubes enable the flow of supercritical helium, driving the shield temperature decrease by forced convection. For steady-state operation, the shield cooling mechanism is converted to static heat conduction in He-II within the same tubes. A first mechanical model is presented that fulfills the thermal and vibrational requirements. Thermal characteristics of the shield are demonstrated by means of analytical and numerical modeling results. Modal and dynamic analyses are performed to obtain natural frequencies and transfer functions.

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