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C3Or3D-01: Einstein Telescope PathFinder Cooling System Architecture and Design

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The ETpathfinder (ETPF) is a reduced-scale prototype of the the Einstein Telescope Gravitational Wave observatory aimed at testing and advancing the required technologies. ETPF will have two Fabry-Perot Michelson Interferometer (FPMI) arms of which the mirrors are cryogenically cooled. Both are cooled by LN2 whereas one of the two has to be cooled further down to about 10 K by an additional cooling system. The high precision measurements of the third-generation laser-interferometry detectors in ETPF demand a cooling system with minimal vibrations during measurement phases. The University of Twente has proposed a modular cryochain design using a combination of sorption compressors and J-T cold stages. The design features a parallel cascade of 40 K neon, 15 K hydrogen, and 8 K helium stages, with cooling powers of 2.5 W, 0.5 W and 0.05 W, respectively. The compressor cells are cooled by a 70 K pumped liquid-nitrogen reservoir and the overall compressor input is 364 W. Because of the absence of mechanically moving parts, this cooler type has a minimum level of vibrations. The requirement in ETPF is that at the 8 K cold-tip the cooler vibration level should not exceed that of the seismic background at the ETPF site. In the most important bandwidth (2 - 20 Hz) the environmental vibration level is 30 nm pp (ASD = 4 nm/Hz). In parallel to the 10 K sorption-based cooler development, an ETPF Cryogenic Test Facility is currently realized at the University of Twente. Here, all cryogenic technologies and operating procedures for ETPF will be tested. The proposed sorption-based cryochain and the overall ETPF cooling system design will be presented, along with details on the upcoming testing and experiments.

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