Low-Vibration Cryogenic Cooling Projects at University of Twente Related to Einstein Telescope

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Cryogenic cooling is a well-known method for improving the resolution of detectors. Many of these require cryogenic cooling technology without introducing vibrations. Three different approaches can be followed to establish this low-vibration cooling: 1. Separation of the cooler from the detector by a convective loop; 2. switching off the cooler during measurements while stabilizing the detector temperature by means of a thermal energy storage unit; 3. developing coolers that operate without mechanically moving parts such as thermoelectric coolers. The University of Twente has many decades of experience in developing these low-vibration cooling technologies. The present paper will discuss the application of the latter two technologies in the development of the Einstein Telescope (ET).

First, we will discuss an optical test bench for the characterization and qualification of mirror coatings. One of the limiting factors determining the resolution of ET is the thermal activity of the mirror coatings. Therefore, the mirrors will be cooled, but then still the best coating will need to be developed. The test bench is cooled by a mechanical cooler. During measurements, this is cooler is shut off while a thermal energy storage unit (TESU) stabilizes the test bench. Gas-gap heat switches are used to insulate the cooler from the TESU, as well as to regulate the thermal flux from the measurement device.

Second, we will discuss a sorption-based Joule-Thomson (JT) cooling system that we currently develop together with industry to be installed at the Einstein Telescope Pathfinder (ETPF) in Maastricht (NL). The modular design has stages at 40 K (neon), 15 K (hydrogen), and 8 K (helium), offering cooling powers of 2.5 W, 0.5 W, and 0.05 W, respectively. Two systems are to be realized at ETPF and one to be placed in the ETPF Cryogenic Test Facility at the University of Twente.