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C4Or1B-04: Process Design for FRIB's Experimental System Cold Box

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The experimental system for the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU) has several segments. Following the acceleration through the three superconducting Linac segments, the heavy ion beam is guided through the target, a fragment pre-separator and (the A1900) separator segments. It can then be split and sent to various experimental vaults and instrumentation, e.g. S800 spectrograph, and the newly proposed High Rigidity Spectrometer (HRS). Presently, superconducting magnets at the target and fragment pre-separator segments, along with the Linac superconducting cryo-modules, are supported by FRIB's main helium refrigerator. The remainder of the cryogenic loads are supported by the legacy NSCL Cryogenic Refrigerator (a re-commissioned Bureau of Mines helium liquefier from the 1970's). Considering the operational stability of the accelerator, and maintainability of the entire cryogenic system at FRIB –it is logical to segregate the experimental system loads from the accelerator system loads. A new cryogenic refrigerator is planned to support the nominal operation of the experimental system loads, and stand-by (4.5 K) operation of the accelerator system loads during main refrigerator maintenance. This new refrigerator is planned to be able to support a combination of 4.5 K isothermal refrigeration, 4.5 K liquefaction and a non-isothermal 60 K thermal shield load. The thermodynamic process cycle design for this cryogenic refrigeration system is discussed, and its theoretical performance characteristics under various load conditions are studied. This paper outlines the findings from this process study and the key selection parameters for the major components, such as the warm compressors, turbo-expanders and heat exchangers.

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