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M1Or3E-03: [Invited] Qualification and test of space compatible superconducting current leads (REBCO) designed for adiabatic demagnetization refrigerators

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Space telescopes are required for many astrophysics observations, either to reduce atmospheric perturbation (in the infrared spectrum) or simply to make these detections possible (in the X-Ray spectrum for example). Several missions are in development, such as Athena. Athena is a mission of the European Space Agency (ESA), with additional international contributions, dedicated to X-Ray observation. One of its instruments, X-IFU, will use Transition Edge Sensors (TES) detects and precisely measure the energy of X-Ray photons. These sensors require a temperature of 50 mK to reach their ambitious sensitivity goals.
In space, this temperature can be reached using Adiabatic Demagnetization Refrigeration (ADR). A cooling system based on this technology is currently being developed for the X-IFU instrument. ADR is based on variation in magnetic field to achieve lower temperatures and produce a cooling effect. The magnetic field of the order of 1 T in a volume of 10s of cm3 is produced by a superconducting coil with high winding number and current limited to approximately 2 amps. Even though this current is low compared to most earth-based systems, metallic current leads to link the high- and low-temperature stages would cause high thermal loads, unacceptable for the limited capacity of the space cryogenic cooling chain. Therefore, a harness consisting of superconducting current leads is planned to reduce the thermal loads at the low-temperature stage.
As part of an ESA contract, our team designed, built and tested such a space compatible harness. This harness includes the electrical interfaces at both ends as well as mechanical support. Its development is geared toward the Athena/X-IFU needs and it is capable of operating between interfaces at 80 K and 4 K. The harness is based on industrially available Rare-Earth-Barium-Copper-Oxide (REBCO) High Temperature Superconductor (HTS) tapes. The tapes were laser-cut by our group to fulfill our specifications, Parylene coated and reinforced with Kapton laminate tape for mechanical and insulating purposes. After characterization of the single tapes, the assembled harness has been subjected to an extensive qualification sequence including thermal cycling and mechanical testing based on launch loads requirements. This paper will summarize the technical design choices for this space compatible HTS harness. It will discuss the test results and propose some perspectives for the next iteration of HTS current lead development.

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