Thermalization of 3 kA Current Leads Through a Remote Cooling Loop Using a Single-Stage Cryocooler

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Over the past few decades, cryocooler technology progressed significantly enabling higher cooling capacities to be reached. Therefore, this technology has become an interesting solution in the context of cooling large superconducting detector magnets for high-energy physics experiments. Cryocooler-based cooling systems promise compactness, modularity, and lower investment costs. The distance between the cryocooler and a cooled object constitutes a challenge. To address this obstacle, a remote cooling concept has been developed. It is based on the circulation of cryogen in a closed circuit which is cooled by a set of cryocoolers. This concept is applied to magnet current leads since they are a major source of heat load to a cold mass. Such leads require adequate thermalization and a highly efficient thermal interface between the cold finger and the circulating cryogen.

Gas-cooled High Temperature Superconducting current leads used for Low Temperature Superconducting magnet with an operating current of 3kA are studied. The current lead thermalization relies on a remote cooling system integrated with a commercially available single-stage cryocooler. The cryogen is helium gas, and it flows with a cold circulator through a brass heat sink where heat from the normal-conductive part of the current lead is intercepted. Subsequently, the gas is cooled in a high-purity copper cold plate attached to the cold finger of the cryocooler which provides an efficient thermal interface between the solid and the fluid.

In this study, an effort was made to optimize the current lead design and the associated cryogenic assembly. An overview of the design efforts along with the development of the demonstrator, including the cooling circuit assembly, the heat sinks, and the HTS-based gas-cooled current leads will be presented.