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Hub- and Site-cooling of MRI magnets using a mobile cryogenic system

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We present a compact, mobile pre-cooling cryogenic system (cooler) developed by Sumitomo Cryogenics as a solution that can significantly reduce helium losses associated with shipping medical MRI magnets globally. In contrast to conventional cold-shipping of MRI magnets, the cooler can enable MRI magnets to be shipped with the cryostat at room temperature, and then pre-cooled either during the installation at the hospital (site-cooling), or at a local facility (hub-cooling). This logistics model dramatically reduces the helium boil-off losses normally incurred when the MRI magnet is in transit. Compared to using liquid nitrogen for pre-cooling, the cooler pre-cools to a lower temperature (~ 25 K), which effectively eliminates the helium loss that is incurred when cooling the MRI cryostat further to 4K. An example of using the cooler at a hub-cooling facility in Brazil is discussed in this paper. This facility pre-cools warm-shipped magnets from a Siemens MRI factory in Shenzhen, China, using a prototype of the cooler technology. The cooler comprises of five separate mobile units with a compact footprint that enables its use in a standard MRI room. It uses helium gas as a heat transfer fluid in a closed-loop circuit between the magnet cryostat and four GM cryocoolers with heat exchangers that provide the cooling of the gas. The helium gas is circulated between the cooler and the MRI cryostat by means of a cryogenic centrifugal fan. The processes for MRI magnet pre-cooling, helium gas circuit cleaning and system performance test are fully controlled and automated by the system software.

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