# AP6-0-INV

## Efficient cryogenic cooling methods for HTS (High Temperature Superconductor) applications; from stationary cooler to moving HTS coils

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An HTS system typically requires cryogenic temperature which is much lower than the critical temperature of the superconductor for its normal operation. In the case of modern applications of HTS coils, this demanded temperature is passively determined by not only the cryocooler as a cooling source but also the thermal connection mechanism between the cryocooler and the target HTS system. Regardless of HTS applications, an efficient thermal communication is, therefore, very important to reduce unnecessary temperature difference between cooling source and target and the resultant parasitic entropy load of the cryocooler. In many cases, the real cooling load is insignificant unless the superconducting coil is operating in a ramping or ac (alternating current) mode with relatively large current. The virtual cooling load which is originated from thermal conduction or radiation heat leak from room-temperature environment frequently becomes the dominant factor to determine the size of the cryocooler. This paper addresses rather peculiar thermal bridging issue for moving HTS system. Instead of utilizing stationary cryocooler and implementing a complex configuration of thermal communication to take heat from the moving HTS coil, an innovative on-board cryocooler concept is introduced and systematic conduction-cooling is proved to be possible for superconducting rotor. Due to the bulkiness and inherent inefficiency, GM or JT cryocooler is not appropriate for on-board cryocooler. If the magnitude of heat generation and parasitic heat leak is manageable as in this example, a two-stage Stirling cryocooler or Stirling-type pulse tube refrigerator shall be readily applicable for this purpose. The first stage is used for thermal anchoring and the second stage is for cooling HTS coil. As demonstrated in this paper, a close collaboration with adequate communication between cryocooler developer and superconductivity community can produce genuinely competitive application of HTS system.

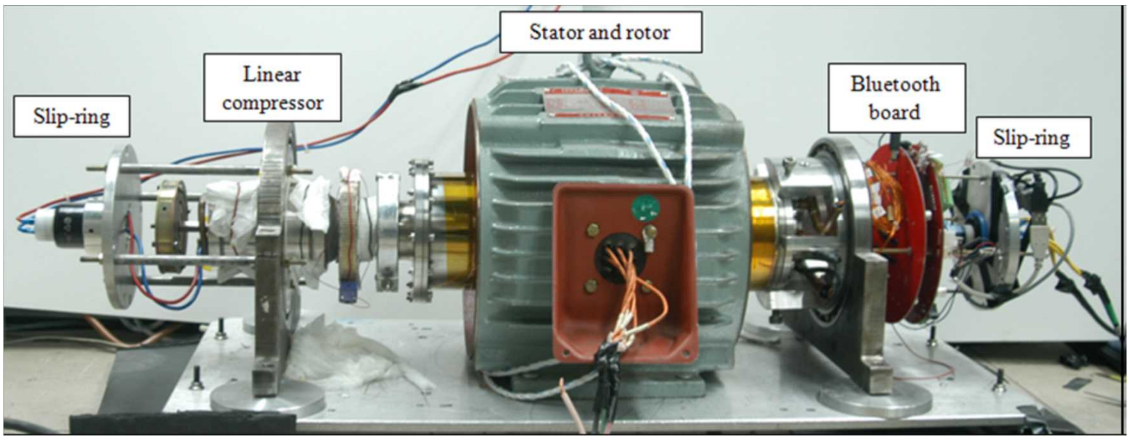


Fig. Superconducting rotor with onboard cryocooler

Keywords: Cryocooler, Entopy load, HTS coil, Parasitic heat leak, Thermal anchoring