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The Design of a Curved Cryostat for the 90° Superconducting Magnet

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Abstract—In order to enable the 90° curved Discrete Canted-Cosine-Theta (DCT) superconducting magnet for heavy ion Gantry to operate at low temperature normally, a 90° curved cryostat that can rotate on a rotating frame is developed. 18 voltage leads for quench detection and 7 temperature sensors for detecting temperature changes during cooling and excitation are arranged into the superconducting magnet. For the convenience of processing and welding, the outer Dewar and thermal shield of the cryostat are both welded from three cylinder bodies. The cryostat beam center tube passes through the center of the superconducting magnet, and the beam center tube is formed by bending a seamless stainless steel tube. There is a thermal shield center tube between the beam center tube and the inner wall of the superconducting magnet. To prevent contact between the inner wall of the magnet, the center tube of the beam, and the center tube of the thermal shield due to cold shrinkage deformation, a circular ring of material G10 is arranged in the gap between the tubes. The cryostat uses four high-temperature superconducting current leads, two of which are connected to the superconducting cables for power supply to the magnet, and the other two are connected to the copper wires for quench protection of the magnet. To ensure the stability of the superconducting magnet during rotation and the concentricity between the beam center tube and the beam axis, the superconducting magnet is fixed on the Dewar surface of the cryostat with 12 carbon fiber straps. A heat leakage calculation is conducted on the cryostat. The results show that the first stage heat leakage is 57W@50K, and the second stage heat leakage is 1.5W@4.5K. Therefore, two GM refrigerators are used for the superconducting magnet for the normal operation of superconducting magnet. Strength verification is conducted on the static, transportation, and rotation conditions of the cryostat (mainly at 0°, 60°, 90°, and 180°). According to the analysis results, 12 carbon fiber straps can ensure the stability of the superconducting magnet and ensure the concentricity of the beam center tube and the beam axis of the superconducting magnet during is within ±0.3mm during the rotation process. The 90° curved cryostat is being processed and assembled, and the relevant design parameters will be further verified by experiments.
Index Terms—90° curved cryostat, heat leakage, strength verification, curved superconducting magnet

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