Contribution ID: **112** Type: **Poster**

Sat-Mo-Po.02-09: Design of Conical-Canted-Cosine-Theta scanning magnet for heavy ion therapy

Saturday 5 July 2025 09:30 (1h 45m)

In heavy ion therapy, reducing not only the radius of the rotating gantry but also the size of the power supplies for the gantry's magnets is crucial to miniaturizing the facility. The rotating gantry primarily consists of several bending magnets and a downstream scanning system. The use of combined-function superconducting magnets and cosine-theta-type combined X-Y scanning magnets has already significantly reduced the gantry's rotating radius.

However, shortening the length of the beam delivery system by introducing cosine-theta-type scanning magnets significantly increases the nominal capacity of the power supplies. To address this issue while maintaining the same length of the beam delivery system, a canted-cosine-theta (CCT) scanning magnet is proposed. A typical CCT magnet consists of two layers of solenoids with opposite tilt angles. This configuration cancels the axial components of the magnetic field while adding the dipole components, thereby generating pure dipole fields over a wide bore region. Its magnetic field strength is independent of the bore size, making it particularly suitable for scanning magnets that require a large bore at the outlet.

In this study, a combined X-Y scanning magnet was designed by overlaying two CCT coil layers in orthogonal directions. The magnet has a conical shape and maintains consistent magnetic field strength from the small bore inlet to the large bore outlet, achieving high BL integration. In numerical analysis, this scanning system meets the requirements for a 200×200 mm irradiation field, a scanning speed of 40 mm/ms, and a length of the beam delivery system of 3.5 m, with a nominal current and voltage of 600 A and 600 V, or less, for 430 MeV/u carbon ions.

The results of structural analysis simulations for the CCT scanning magnet will be presented.

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Session Classification: Sat-Mo-Po.02 - Magnets for Other Medical Application III