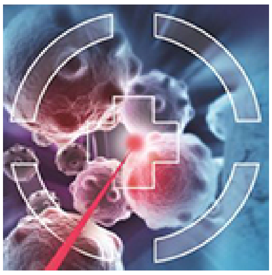

Contribution ID: **30** Type: **not specified**

Superconducting gantry for proton therapy and imaging

Wednesday, 4 September 2019 17:00 (20 minutes)

Introduction: Proton computed tomography can reduce uncertainties in proton therapy treatment planning. It requires a 330 MeV proton beam for full imaging of an adult body and the beam rigidity increases to 2.8 Tm (from 2.3 Tm at 230 MeV). If such rotating beam delivery system is to be placed in a hospital-based facility, superconducting technology must be employed to minimise the gantry weight and volume. A compact superconducting gantry of large energy acceptance is presented.

Methods: The initial gantry optics design was modelled in MAD-X, followed by the design of superconducting bending magnets. Canted cosine theta dipoles of 3.9 T central field were complete in Opera-3D software for electromagnetic simulations. Monte Carlo simulations of the full design, including the energy degrader mounted on the gantry, were performed in G4Beamline.

Results: An isocentric superconducting gantry for both proton therapy and proton computed tomography was designed. It is an achromatic design with normal-conducting quadrupoles and superconducting CCT dipoles. The gantry is equipped with a boron carbide energy degrader to minimise space requirements and downstream pencil beam scanning system.

Discussion/Conclusions: Whilst superconductivity ensures no significant volume reduction for typical proton treatment gantries, high field superconducting magnets are of benefit at higher energies. A compact large acceptance superconducting gantry can be placed in a conventional proton treatment room to deliver protons for both imaging and therapy. This improves the precision of treatment planning and allows for the patient's setup to remain the same for both procedures.

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