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Design and Test of a Bended Canted-Cosine-Theta Superconducting Magnet for a Laser Proton Radiotherapy System

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Proton therapy (PT) is a precise and efficient radiotherapy method in modern medical treatment, which can be focused on the lesion location to kill the tumor cells with little affection on the normal tissues and thus largely reduce the potential side effects. However, the proton therapy instrument is usually very huge with a large occupation in the space. In order to reduce the instrument scale, a petawatt level laser proton accelerator project is being conducted in China. This paper will report a bended Canted-Cosine-Theta (CCT) magnet which is a critical component in the proposed laser proton accelerator system. The CCT superconducting magnet was designed with a bended dipole magnet that had an equivalent arc $\pi/4$ with radius 1m, and two short quadrupole magnets were nested symmetrically at the dipole magnet ends. The warm bore of the magnet was 72mm, where a homogeneous transverse magnetic field that amounted to 2.5 T was required along the magnet bore and homogeneous magnetic field gradients 25 T/m were required at the magnet inlet and outlet. NbTi superconducting wire will be used on the coil winding and immersed in liquid helium environment. The magnet fabrication process will be presented in terms of the CCT mandrel manufacturing, winding, and assembling and the performance test will also be reported.

Index Terms—Superconducting magnet, proton accelerator, CCT magnet

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