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Conceptual design of a compact synchrotron for proton-and-helium therapy facilities

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In recent years, proton and heavy-ion therapy has become increasingly widespread in clinical applications, and has emerged as one of the important means for cancer treatment. The commonly used particle types for this therapy are protons and carbon ions. However, further research into the biological effect has found that helium ions have both high biological effectiveness and small penumbra characteristics, which enable more precise locate of the tumor while also effectively killing tumor cells. And the highest energy of the helium ions used in therapy is 235MeV/u. Therefore, the equipment size and cost required for helium ions therapy will be significantly less than that for carbon ions therapy. To this end, this paper proposes a design for a helium-ion therapy synchrotron that also possesses the capability for proton therapy. The design employs eight ultra-high field dipole magnets to achieve a compact envelope function. Additionally, the design incorporates both multi-turn painting injection and mismatched injection methods in two directions, significantly minimizing the use of bump magnets. This results in a highly compact accelerator structure.

Footnotes

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