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Design of synchrotron for proton flash radiotherapy

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Proton FLASH, which combines the advantages of a better spatial dose distribution of protons with the unique temporal effect of FLASH radiotherapy, is currently a hot topic of international research. Proton FLASH radiotherapy is technically demanding and currently lacks equipment support. There are only a few devices that have been modified to achieve small target section, fixed-energy penetrating irradiation by proton radiotherapy equipment, which cannot give full play to the advantages of proton spatial dose distribution. In this study, a series of innovative methods are proposed to manipulate the beam from the longitudinal dynamics level and to extract particles from the synchrotron, thus meeting the dose rate requirements for proton FLASH radiotherapy in a 1L volume in the target area. In combination with the splitting of small beam clusters, a synchrotron scheme for point scanning of proton FLASH radiotherapy is proposed for the first time. The synchrotron is used to control the number of particles required for a single scan point and to rapidly change energy, which solves the problems of long intervals between different energies and scan points of conventional point scanning and increases the dose rate in the target area. It provides a possible technical route to support the development of proton FLASH radiotherapy and enriches the application scenario of synchrotron.

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