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Technical Challenges for FLASH Proton Therapy

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There is growing interest in the radiotherapy community over the applications of FLASH radiotherapy, wherein the X-ray dose is delivered to the entire treatment volume in less than a second. Early pre-clinical evidence suggests that these extremely high dose rates provide significant sparing of healthy tissue compared to conventional radiotherapy without reducing the damage to cancerous cells. This interest has been reflected in the proton therapy community, with early tests indicating that the FLASH effect is also present with high dose rate proton irradiation. In order to deliver clinically relevant doses at FLASH dose rates, significant technical hurdles must be overcome before FLASH proton therapy can be realised, particularly for modern spot-scanning dose delivery.

The current state of the art in clinical proton therapy technology is discussed, along with the current specification for clinical FLASH proton therapy. The technical challenges are outlined for each of the existing accelerator and beam delivery technologies, with possible routes discussed by which the technology can evolve to meet these challenges.

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