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Potential clinical impact of laser-accelerated ion beams in cancer therapy

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Plasma-accelerated ion beams have lately advanced from mere proofs-of-principle experiments to what can now be called a maturing phase of new technologies: with higher intensity lasers, new target materials and particle injection schemes becoming available. We present some unique advantages of these beams in hadron cancer therapy:

These beams could be delivered at short pulses, with very high fluence, short inter-particle distance which then creates quite dense ionization track signatures (spurs, blobs, etc.) in target tumors. Hence at the micro-level, their RBEs could be much higher than those of standard ion sources from synchro-/cyclotrons.

Highly peaked "quasi-monoenergetic "beams could be achieved, making it ideal for fast energy switching in pencil beam scanning as a treatment delivery.

Well-collimated beams would be ideal for proximal normal tissue-sparing as in mini-beam grid scheme where entering beams get evenly split but become interlaced (due to multiple coulomb scattering) as they penetrate the tumor target volume, thus delivering full dose to the target volume but sparing the intervening normal tissues.

Lastly, looking into the future they provide compact, eventually more cost-effective clinical treatment machines that could deliver protons and other heavier ion species.

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