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A focused very high energy electron beam for fractionated stereotactic radiotherapy

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Electron beams of very high energy (50–250 MeV) can potentially produce a more favourable radiotherapy dose distribution compared to state-of-the-art photon-based radiotherapy techniques. To produce an electron beam of sufficiently high energy to allow for a long penetration depth (several cm), very large accelerating structures are needed when using conventional radio-frequency technology, which may not be possible due to economical or spatial constraints. In this work, we show transport and focusing of laser wakefield accelerated electron beams with a maximum energy of 160 MeV using electromagnetic quadrupole magnets in a point-to-point imaging configuration, yielding a spatial uncertainty of less than 0.1 mm, a total charge variation below 1%. Focusing the electron beam enables control of the depth dose distribution and improved dose conformity. It is further shown that irradiation from many different angles allows for the precise dose delivery that is required for stereotactic radiotherapy treatment.

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