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SHARP: A compact focusing system for medical applications using a diverging plasma lens

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For cancer radiotherapy the ability to precisely irradiate a small spot deeply inside the patient while minimizing the radiation exposure to surrounding tissues is desired. This can be accomplished by a round beam sharply converging towards a single spot, requiring a large beam size in both planes at the exit of the focusing system. Achieving this over a short distance using only quadrupole lenses is challenging; but by using a linear active plasma lens (APL) in defocusing mode, the beam can be quickly and non-destructively enlarged before focusing using quadrupoles. The position of the irradiation spot can also be scanned in 3D space through changing magnet settings. We will also study the wakefield effects in the lens, which might be detrimental to the use of such a system for irradiation. The SHARP project will develop and test this concept. Such a system can be used with very high energy electrons (100s of MeV), creating a Bragg-peak like spot without requiring a bulky proton accelerator and gantry, enabling the use of novel accelerator technology for compact radiotherapy facilities. If successful, SHARP will enable precision conformal radiotherapy, spatial fractionation, and potentially be useful for FLASH therapy.

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