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P2.2013 Plasma bubble evolution related electron beam parameter estimation in laser wakefield acceleration

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Laser-wakefield acceleration offers a compact electron acceleration scheme for generating a multi-GeV electron beam, utilizing the high longitudinal electric field gradient induced by high intensity, ultrashort laser pulse. The bubble regime of the laser wakefield acceleration is one of the most recent and promising mechanism for generating quasimonoenergetic electron beams^1,2. In this work, we propose simulation based studies for plasma bubble evolution and corresponding electron beam quality parameters. The major focus of this work is to find out the dependency of the electron beam energy and quality on the shape of the bubble. The evolution of bubble with time, and correlation of bubble length (longitudinal and transverse radius) with the intensity of laser pulse has been revealed in this study. The results show that the bubble longitudinal length grows until the dephasing length but with different rate because of various determining factors (laser pulse focusing, beam loading, residual electrons, bubble velocity etc.). It has also been confirmed that the shape of the bubble cannot be predicted using fixed shape models as spherical or elliptical. Moreover, the simulation based findings predict that as the bubble traverses in plasmas, it evolves from spherical shape to the highly elliptical shape. And, as it approaches the dephasing length the eccentricity decreases further. A comparison of the electron beam parameters for different laser intensity has also been provided for future accelerator development.

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