Controlled Laser Wakefield Electron Acceleration Driven by Elliptically Shaped Femtosecond High Power Laser Beams

B. S. Rao[1], H. T. Kim[1,2], J. H. Shin[1], K. H. Oh[1], J. H. Jeon[1], and C. H. Nam[1,3]

[1]Center for Relativistic Laser Science (CoReLS), Institute for Basic Science, Korea

[2]Advanced Photonics Research Institute, Gwangju Institute of Science and Technology (GIST), Korea

[3]Department of Physics and Photon Science, GIST, Korea

We report on controlled laser wakefield acceleration driven by elliptically shaped ultra-short high power laser beam. For the experimental study 25-fs 150-TW laser pulses have been spatially shaped by passing them through an ellipse shaped hard aperture with ellipticity, e =1.5 (ratio of major-to-minor axis diameter) before focusing in a He gas jet target using a spherical mirror. The shaped laser beam produced elliptical focal spot and the orientation of the major radius of the focus w.r.t. to the laser polarization axis could be varied by rotating the hard aperture. The laser wakefield acceleration with the shaped laser beam produced more stable and higher energy electron beams than those without shaping, as shown in Fig. 1. We have demonstrated that the electron beam charge and beam profile could be controlled by simply rotating the orientation angle of the aperture. The observations clearly indicate that the shape of the laser focal spot affects the injection process as well as acceleration dynamics in the plasma bubble, which can be exploited to tailor electron beams for many applications.

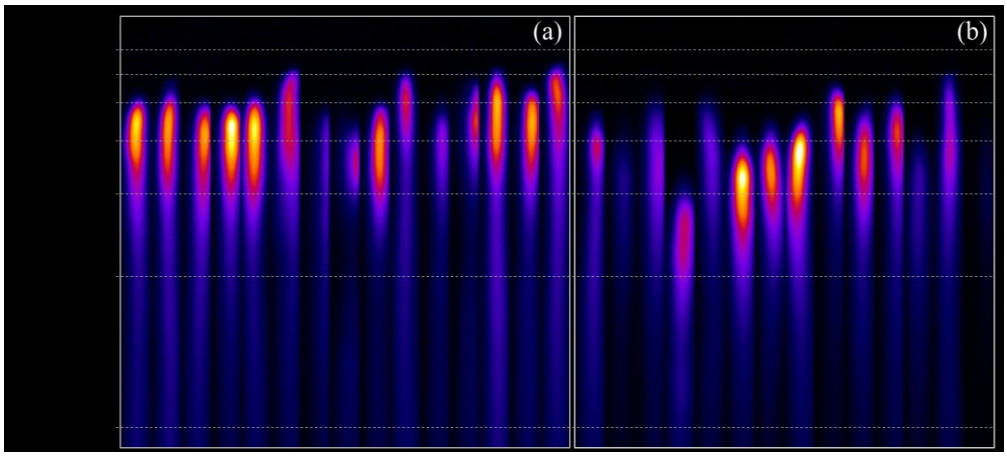

Fig. 1. Images of spectrally dispersed electron beam produced from 2.3mm long helium gas jet plasma at constant plasma density in series of consecutive shots (a) when the elliptically shaped laser beam with major axis along laser polarization was used, and (b) when a laser beam without shaping was applied with appropriately reduced energy to maintain similar laser strength parameter.