



FRONTIERS IN OPTICAL COHERENT AND ULTRAFAST SCIENCE

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A nugget from FOCUS:

Generation of 300 MeV Quasi-Monochromatic Electron Beams from Laser Wakefield

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Laser-driven plasma wakefield accelerators have the potential to become the next generation of particle accelerators because of the very high acceleration gradients, reaching several hundreds of GV/m. These fields are thousands of times greater than those in the conventional radio-frequency LINACS making plasma wakefield accelerators promising compact ultrashort source of electrons, x-ray and gamma radiation. Using the 30 fs, 40 TW Ti:sapphire Hercules laser at the University of Michigan, focused to the intensity of 10^{19} W/cm² onto a supersonic He gas jet, we observed quasi-monoenergetic electron beams with energy up to 300 MeV and an angular divergence of 10 mrad. We found that the initial plasma density significantly affects the resultant electron beam. For plasma densities ranging between 2×10^{19} to 3.5×10^{19} cm⁻³, quasi-monoenergetic electrons with energies from 80 to 160 MeV and a total charge of about 0.5 nC were produced. Lower plasma densities, around 1.5×10^{19} cm⁻³, produced quasi-monoenergetic electron beams with even higher energies, up to 320 ± 50 MeV, but with a decrease of the total charge to about 5 pC. 2D Particle In Cell (PIC) simulations, performed for the parameters close to the experimental conditions, show the evolution of the laser pulse in plasma, electron injection, and the specifics of electron acceleration observed in experiments. The trends observed in the experiment can be explained by the interplay of the laser beam self-focusing, laser pulse compression, particle trapping and dephasing in plasma.