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Generation, and applications of stable, 100-500-MeV, dark-current-free beams, from a laser-wakefield accelerator[1]

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This talk will report the production of high energy, quasi-monoenergetic electron bunches without the low-energy electron background that is typically detected from self-injected laser-wakefield accelerators. These electron bunches are produced when the accelerator is operated in the blowout regime, and the laser and plasma parameters are optimized. High-contrast, high power (30–60 TW) and ultra-short-duration (30 fs) laser pulses are focused onto He-gas-jet targets. The high energy (300-400 MeV) monoenergetic (energy spread $< 10\%$) beams are characterized by 1–4-mrad divergence, pointing stability of 1–2 mrad, and a few-percent shot-to-shot fluctuation of peak energy. The results are scalable: the beam energy can be tuned by appropriate choice of acceleration length, laser power and plasma density. Three-dimensional particle-in-cell simulations show that these electron beams are generated when the accelerator is operated near the self-injection threshold, which suppresses dark current (continuous injection in the first bucket). Suppression of dark current is required to minimize noise, improve the quality of secondary radiation sources, and minimize shielding requirements for high repetition-rate operation. Also reported, is the application of this novel electron-beam source to radiography of dense objects with sub-millimeter spatial resolution. In this case, the energetic electron beam is incident on a 2"-thick steel target with embedded voids, which are detected with image plates. Current progress on the generation of GeV energy electron beams with petawatt peak power laser pulses, from the upgraded DIOCLES laser system, will also be discussed.

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