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**Laser-driven wavebreaking, electron trapping, and mono-energetic beam production**[1]

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Recent breakthrough results reported in Nature[2] demonstrate that laser-plasma accelerators can produce high quality (e.g., narrow energy spread) electron bunches at the 100 MeV level that may be useful for numerous applications. More recently, high quality electron beams at 1 GeV were produced in experiments at LBNL using 40 TW laser pulse interacting with a 3.3 cm plasma channel[3]. In these experiments, the accelerated electrons were self-trapped from the background plasma, often attributed to the process of wavebreaking. Using a warm fluid model, a general analytic theory of wavebreaking has been developed that is valid for all regimes of interest, i.e., arbitrary temperature and phase velocity[4]. This theory indicates that the maximum electric field obtainable by a relativistic plasma wave is lower that previously calculated. The relation between wavebreaking and particle trapping is discussed, and various quantities, such as the fraction of electrons trapped (i.e., the dark current), are calculated[5]. A variety of methods for particle trapping relevant to present experiments, including 2D wavebreaking, density ramps, and laser injection, will be described[6]. Limitations from dephasing and pump depletion will be summarized. Also presented will be 2D and 3D simulations modeling the production high quality electron beams from laser-plasma accelerators.

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[2]C.G.R. Geddes et al., Nature **431**, 538 (2004); S.P.D. Mangles et al., ibid., p. 535; J. Faure et al., ibid., p. 541.
[3]W.P. Leemans et al., submitted.
[4]C.B. Schroeder et al., Phys. Rev. E bf 72, 055401 (2005).
[5]C.B. Schroeder et al., Phys. Plasmas **13**, 033103 (2006).
[6]G. Fubiani et al., Phys. Rev. E **73**, 026402 (2006).