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Differences and similarities between the wake excitation in the blowout regime for electron and laser drivers

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There has been much recent progress on accelerating electrons in plasma waves generated by short pulse lasers (LWFA) or electron/positron beam drivers (PWFA). For the laser case, simulations [1] and experiments [2,3,4] showed that 100∼200 MeV mono-energetic electron beams can be produced when 10∼30 TW lasers were sent through mm's of plasma. For the beam case, the E164x experiment at SLAC [5] showed more than 3Gev energy gain after a 28.5 Gev electron beam propagating through a 10 cm long plasma. In either case, the interaction between the driver and plasma is in the blowout regime where the driver pushes the plasma electrons outward forming an ion channel. We will present a nonlinear theory for how intense lasers or beam drivers create multi-dimensional plasma wakefields in this regime and also show the similarities and differences between wakes generated by two kinds of drivers. We will also show how this theory can be used to describe beam loading and how to optimize the transformer ratio for a beam driver. We will also discuss how to use this theory to design near term and futuristic PWFA and LWFA stages that approach the Tev energy range. Work supported by DOE grant nos. DE-FG03-92ER40727, DE-FC02-01ER41179, DE-FG02-ER54721and NSF Grant PHY-0321345. Simulations are done on at NERSC and Dawson cluster at UCLA.

[1] F.S.Tsung et al *PRL.*, **93**, 185002 (2004)
[2] Mangles et al, *Nature*, **431**, 535 (2004)
[3] Geddes et al., *Nature*, **431**, 538 (2004)
[4] Fauve et al., *Nature*, **431**, 541 (2004)
[5] M. Hogan et al., *PRL., to be published.*