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Abstract for an Invited Paper
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Methods of Optimal Control of Laser-Plasma Instabilities Using Spike Trains of Uneven Duration and Delay (STUD Pulses)[1]

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We have recently introduced and extensively studied a new adaptive method of LPI control [1-5]. It promises to extend the effectiveness of laser as inertial fusion drivers by allowing active control of stimulated Raman and Brillouin scattering and crossed beam energy transfer. It breaks multi-nanosecond pulses into a series of picosecond (ps) time scale spikes with comparable gaps in between. The height and width of each spike as well as their separations are optimization parameters. In addition, the spatial speckle patterns are changed after a number of successive spikes as needed (from every spike to never). The combination of these parameters allows the taming of parametric instabilities to conform to any desired reduced reflectivity profile, within the bounds of the performance limitations of the lasers. Instead of pulse shaping on hydrodynamical time scales, far faster (from 1ps to 10 ps) modulations of the laser profile will be needed to implement the STUD pulse program for full LPI control. We will show theoretical and computational evidence for the effectiveness of the STUD pulse program to control LPI. The physics of why STUD pulses work and how optimization can be implemented efficiently using statistical nonlinear optical models and techniques will be explained. We will also discuss a novel diagnostic system employing STUD pulses that will allow the boosted measurement of velocity distribution function slopes on a ps time scale in the small crossing volume of a pump and a probe beam. Various regimes from weak to strong coupling and weak to strong damping will be treated. Novel pulse modulation schemes and diagnostic tools based on time-lenses used in both microscope and telescope modes will be suggested for the execution of the STUD pule program.

[1] B. Afeyan, http://meetings.aps.org/link/BAPS.2009.DPP.TO5.7, www.lle.rochester.edu/media/publications/
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[4] B. Afeyan and S. Huller, Submitted to Phys. Rev. Lett., 2013 and arXiv1304.3960.
[5] B. Albright, L. Yin and B. Afeyan. Submitted to Phys. Rev. Lett. 2013 and arXiv1304.4814.

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