DPP10-2010-000033

Abstract for an Invited Paper
for the DPP10 Meeting of
the American Physical Society

Detuning, wavebreaking, and Landau damping as limiting effects on laser compression by resonant backward Raman scattering

NIKOLAI YAMPOLSKY, Los Alamos National Laboratory

Plasma waves mediate high-power pulse compression, where the persistence of the plasma wave is critical. In this scheme, the plasma wave mediates the energy transfer between long pump and short seed laser pulses through backward Raman scattering. High efficiency of the plasma wave excitation defines both the overall efficiency of the energy transfer and the duration of the amplified pulse. Based on recent extensive experiments, it is possible to deduce that the experimentally realized efficiency of the amplifier is likely constrained by two factors, namely the pump chirp and the plasma wavebreaking [1]. The limits arise because for compression the frequency of the plasma wave should match the bandwidth of the instability and the plasma wave amplitude should be small enough to be sustained by plasma. Both the detuning and the wavebreaking effects can be suppressed by using low pump intensity in plasma having the appropriate density gradient [1]. When these constraints are avoided, Landau damping will be the main limiting factor. However, the Landau damping rate can be significantly reduced in the presence of a strong plasma wave. Currently, nonlinear Landau damping can be described within two recently developed models [2,3]. We show that these two different descriptions result in the same dynamics for the plasma wave amplitude. We use the quasilinear description of nonlinear Landau damping [3] to identify a regime where initially high linear Landau damping can be significantly saturated. Because of the saturation effect, higher temperatures can be tolerated in achieving efficient amplification. Significantly, the plasma temperature can be as much as 50% larger compared to the case of unsaturated Landau damping.

[1] N.A. Yampolsky et al., Phys. Plasmas 15, 113104 (2008).
[2] D. Benisti et al., Phys. Rev. Lett. 103, 155002 (2009).
[3] N.A. Yampolsky and N.J. Fisch, Phys. Plasmas 16, 072104 (2009).