Production of petawatt laser pulses of picosecond duration via Brillouin amplification of nanosecond laser beams

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Previous studies have shown that Raman amplification in plasma is a potential route for the production of petawatt pulses of picosecond duration at 351 nm [1]. Laser pulses with these parameters are invaluable for Fast Ignition Fusion and High Energy Density Physics/Astrophysics experiments. In this paper we show, through analytic theory and multi-dimensional particle-in-cell simulations, that such pulses can also be obtained through Brillouin amplification of a short seed laser beam off a long pump beam at moderate intensity. We have identified a narrow but well-defined parameter regime where we achieve pump-to-probe compression ratios of up to 100 and peak laser fluences over 1 kJ/cm² with 50% efficiency. Scaling laws governing the optimal parameter space for pump beam, seed beam and plasma will be derived using a self-similar model for Brillouin scattering, and verified via simulations. A comparison with Raman amplification will be made, to determine which scheme is most suitable for which purpose.

References