DPP07-2007-001647

Abstract for an Invited Paper
for the DPP07 Meeting of
the American Physical Society

A Compact Double-pass Raman Backscattering Amplifier/Compressor[1]

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The resonant Stimulated Raman backscattering (SRBS) amplifier/compressor in plasma has been shown to move towards reaching ultra-high laser intensities [1,2]. However, the achieved energy transfer efficiency from pump to seed is still much below that predicted by theory [3]. We will present the enhancement of SRBS by introducing the proper plasma density gradient along the pump/seed interaction path. The energy transfer efficiency was significantly improved. The seed pulse was amplified by a factor of more than 10,000 from the input in a 2mm long plasma, which also exceeded the intensity of the pump pulse by almost 2 orders of magnitude. Moreover, this amplification was accompanied by very effective pulse compression, from 500 fsec down to 90 fsec, in a single pass. SRBS was further improved by a novel double-pass design, in which "left over" of the pump from the first pass and amplified seed were passed through the same plasma for another round of interaction. The energy transfer efficiency was increased by another factor of ~ 2 and the pulse was compressed down to$\sim$50 fsec without increasing the size and cost of the system. The crucial result of the two-pass experiment was a very significant improvement in the efficiency of the system, with a 6.4% energy transfer from the pump to the ultra-short pulses. This result was more than a factor of 6 improvements in comparison to the best of our previous results [2], which makes this SRBS amplifier/compressor close to a practical device.

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