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Amplification of short laser pulses by Stimulated Brillouin Backscattering

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Since high-power laser beams are needed as a driver for future laser plasma accelerators, there is an ongoing quest for novel techniques to obtain ever higher laser intensities.

In this field of research, plasma amplification has drawn much attention. This approach benefits from the fact that a plasma can sustain much higher intensities than a solid state amplifier. In a plasma, energy can be transferred from one laser pulse (pump) to another (seed), either via a high-frequency plasma electron wave (stimulated Raman backscattering, SRS) or via a low-frequency ion acoustic wave (stimulated Brillouin backscattering, SBS [1,2]).

In this contribution, we report on two experiments on amplification by SBS using pump and seed pulses counterpropagating in a preformed plasma. At the ELFIE laser facility (LULI, Palaiseau, France), short (700 fs, 35 mJ) seed pulses were amplified by longer high-energy (3…6 ps, 9 J) pump pulses.
The seed was amplified in the sc-SBS (strong coupling) regime where the plasma wave is a nonlinear oscillation forced by the pump laser. We observed that the process is less sensitive to competing mechanisms in this regime.
We also intend to report on a recent experiment at the ARCTURUS Ti:Sapphire laser system (ILPP, Düsseldorf, Germany). Its objective is to study the process for ultrashort seed pulses (30…200 fs) which simulations have shown to be favorable for amplification [3]. For the first time, we will also investigate the lower limit for the seed pulse duration for which the seed remains short.

[1] L. Lancia et al., Phys. Rev. Lett. 104, 025001 (2010)

[2] C. Riconda et al., Phys. Plasmas 20, 083115 (2013)

[3] S. Weber et al., Phys. Rev. Lett. 111, 055004 (2013)

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