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Simplified Numerical Approach for the Simulation of Hole Boring

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Many processes in relativistic laser plasma interactions, such as ion acceleration from solid targets, are influenced by the plasma pre-expansion happening in the last instants before the relativistic interaction begins. It is well known that the Doppler shift imprinted on the light reflected by a laser target carries information on the hole boring velocity, occurring when the laser pressure overruns the plasma pressure of the target [1]. Recently [2], our group showed that the Doppler shift is mostly dominated by the interaction of the laser pulse with the pre-expanded plasma region, as the critical plasma density is being pushed into the target by light pressure.

Based on that, we propose a method for the measurement of the preplasma's properties, through the analysis of the instantaneous wavelength of the beam reflected from an overdense plasma. This approach uses the influence of the preplasma conditions on the effect of hole boring, which impacts the movement of the critical density surface and the spectrum of the reflected laser. To retrieve the preplasma's properties from the instantaneous wavelength of the reflected beam, the laser plasma interaction needs to be well understood. For this, simulations utilizing the particle-in-cell approach (PIC) are often used. However, PIC simulations have the disadvantage that the influence of different effects on the reflected spectrum, such as self phase modulation, cannot be distinguished from the Doppler effect. Another drawback is the high computation power needed for these kind of simulations.

We present a simplified numerical approach that was developed to simulate the interaction between a high intensity laser and a short pre-expanded plasma. This approach can be used to investigate the impact of the different effects on the reflected light. Furthermore, the simulation can be computed on standard computers within a limited time frame. An overview of the simulation principle is given, and the results of this approach are compared to data obtained from 2D-PIC simulations.

[1] Zepf, M., et al. "Measurements of the hole boring velocity from Doppler shifted harmonic emission from solid targets." *Physics of Plasmas* 3.9 (1996): 3242-3244.

[2] Hornung, J. et al., this conference.

CLPU CENTRO DE LÁSERES PULSADOS

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