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Shock Ignition Inertial Confinement Fusion: basic concepts and progress

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Direct-drive “Shock Ignition” is an interesting alternative to the classical approach to ICF investigated on NIF and could relax the problems met on the pathway to ignition, in particular due to hydrodynamic instabilities (Rayleigh-Taylor). In the conventional approach to ICF, hot electrons (HE) are dangerous because they induce target preheating making compression more difficult. In SI, however, HE generated by the final laser spike at the end of compression, when the accumulated target $<\rho r>$ is large enough, may increase laser-target coupling and strengthen the shock with a positive impact. Hence, their characterization is crucial for assessing SI feasibility. Within our Enabling Research EUROfusion Project on Shock Ignition, we are conducting experiments in Europe and the US to contribute answering these open questions.

In the talk, I will review the basic concepts of shock ignition and ten I will present the results from two series of experiments.

At the PALS laboratory in Prague we characterized HE produced by high-energy laser pulses of 300 ps at 1st and 3rd harmonics of the iodine laser (wavelength λ = 1315/438 nm, focused to intensities 9×10^{15} / 2×10^{16} W/cm^2). We studied the correlation of HE and Stimulated Raman Scattering (SRS) and assessed the impact of HE on target preheating and on shock dynamics. Results were compared to advanced hydro simulations done with the code CHIC that takes into account parametric instabilities and HE in a self-consistent way.

At the Omega facility in Rochester, we characterized HE with K-a spectroscopy and bremsstrahlung cannons. We performed experiments to assess the effect of HE on the performance of spherical implosions with a pulse shaping typical of IS. We also performed a plane experiment on the Omega EP system to characterize HE and evaluate their impact on preheating and shock dynamics which was diagnosed by time-resolved X-ray radiography.

This work contributed to our understanding of SI physics but also to consolidate a European research network on SI, serving as preparation for future experiments to be done on the LMJ/PETAL laser facility at the relevant energy scale.