PRELIMINARY RESULTS FROM RECENT EXPERIMENTS AND FUTURE ROADMAP TO SHOCK IGNITION OF FUSION TARGETS

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In 2007 Betti et al. [1] proposed a novel approach to ICF. It consists of igniting the target by a very strong converging shock (P ≈ several hundreds of Mbar), produced by intense laser spikes (1e16W/cm2), which must hit the target at the end of the compression phase. The scheme represents a very attractive solution for the HiPER project since it maintains the advantages of direct drive, of separating the ignition and compression phases, and it is substantially compatible with present day laser technology (used to build NIF and LMJ). A proof of principle of shock ignition could be realized on LMJ within the next decade.

In the talk, I will present:
i) the results of preliminary experiments conducted at PALS in order to study shock generation and laser-plasma interaction in an intensity regime which is relevant for shock ignition, and ii) the status of the discussion within HiPER on the shock ignition roadmap, including the plan for future experiments on European laser facilities (PALS, LULI, Orion, LIL, etc) and for finally approaching SI demonstration on LMJ.

Experiments at PALS were done using two beams, with time duration 300ps. The first beam, at intensity I=1.2 e13W/cme2, was used to create a ≈ 1 mm preformed plasma, and the second, at I=1e16W/cme2, to create the final strong shock. Several diagnostics were employed to characterize both the preformed plasma (Phase 1), and the shock formation and laser-plasma interaction (Phase 2). In Phase 1, they included X-ray deflectometry and Optical interferomerty for the plasma density profile, and X-ray spectroscopy to get plasma temperature.

In Phase 2 Energy Encoded pin-hole camera to measure plasma extension, characterize its emission but also to give evidence of the presence of hot electrons; shock cronometry to measure the ability to produce a strong shock and the effect of the extended plasma corona on the laser-shock coupling; X-ray (K-a) imaging again for hot elecrtons, Optical spectroscopy and calorimetry to get the amount of backreflected light from parametric instabilities (SRS, SBS, TDP).

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[1] Shock ignition of thermonuclear fuel with high areal density Betti R, et al. Phys. Rev. Lett., 98, 155001 (2007)