Physics of Laser-Plasma Interaction and Shock Ignition of Fusion Reactions

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The Shock Ignition scheme is an approach for energy production that is chosen as a baseline in the European ESFRI project HIPER. This alternative scheme aims to achieve ignition in two subsequent steps: first, the target is compressed at a low implosion velocity and then a strong converging shock launched during the stagnation phase ignites the hot spot. The Shock Ignition scheme will be tested in the MegaJoule facilities NIF and LMJ. In this talk I will present the major achievements obtained during last 5 years [1, 2]. This concerns the laser-plasma interaction, demonstration of the crucial role of hot electrons in the shock generation, shock pressure amplification in the imploding shell, stabilization of the shell deformations and the ignition criterion.

The most prominent result confirming the credibility of this scheme is the recent demonstration of the possibility of generation of strong shocks due to the presence of hot electrons. The pressures exceeding 300 Mbar in the spherical geometry have been reported on the OMEGA facility [3] for the laser intensities exceeding \(3 \times 10^{15}\) W/cm\(^2\). More than 100 Mbar ablation pressures were obtained in the planar geometry on the LIL and PALS facilities.

The major theoretical results are: demonstration of an efficient laser spike absorption due to the stimulated Raman scattering and generation of intense fluxes of moderately energetic electrons; possibility of efficient generation of extremely high ablation pressures in a dense compressed shell due to the hot electron energy deposition; development of a rapid kinetic model permitting to describe the energetic particle transport in a radiation hydrodynamic code; ion kinetic effects in the hot spot formation and the fuel ignition and burn.

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References