Numerical simulations on the plasma implosions in Double-Cone Ignition scheme using program MULTI-2D

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Double-cone ignition (DCI) scheme is a promising fast-ignition scheme for the realization of inertial fusion energy. DCI scheme employs two gold cones to guide the spherical implosion of plasmas with an aim to obtain highly compressed plasmas. The compressed plasma is heated to high temperature by magnetic field guided fast electron beams generated by PW laser pulses. The exist of gold cones make it a necessary to simulate the plasma implosion with two-dimensional hydrodynamic codes.

In this report, we present the two-dimensional simulations of the plasma implosions in the DCI scheme with the radiation hydrodynamics program MULTI-2D [2]. Numerical results indicate that the plasma shell in the gold cone can be ablated and imploded spherically when the laser irradiance have a good uniformity. During the imploding plasmas collide each other near the spherical center, the plasma density can be as high as 100 g/cc, and the maximum areal density can be more than 0.3 g/cm^2. These simulation results pave the way of fast-ignition for DCI scheme.

MULTI programs are a series of open source radiation hydrodynamics codes developed by Professor Ramis and others at the Polytechnic University of Madrid in Spain. It has been widely used in the research of laser fusion, Z-pinch fusion and heavy ion driven fusion. Among them, the MULTI-2D program is written in a mixed language of R94 and C. The latest upgraded version of MULTI-2D can solve multi-layer, multi-media and multi-physical problems on two-dimensional unstructured grids, and has the function of second-order arbitrary Lagrangian-Eulerian (ALE) variable remapping. The equation of state and opacity parameters are generated by MPQEOS program and SNOP program respectively.

Figure 1 shows the sketch of laser irradiation in DCI scheme. The plastic shell is held by the up and bottom gold cones. Laser beams are used to ablate and implode the plastic shell with finely tuned laser pulse shape, so that the plastic shell can be compressed and accelerated in a quasi-isentropic way. In the simulations, the plastic shell has a density of 1.1 g/cc, the gold cones have a density of 19.2 g/cc. Only a quarter of the whole cones are simulated during the calculations owing to the axial symmetry of the DCI scheme.

The plasma density distribution is plotted in figure 2. It can be observed that a density as high as more 100 g/cc can be achieved after the plasmas collide each other near the spherical center. The open space between the gold cones make the collided plasma have an isochoric structure rather than isobaric structure.

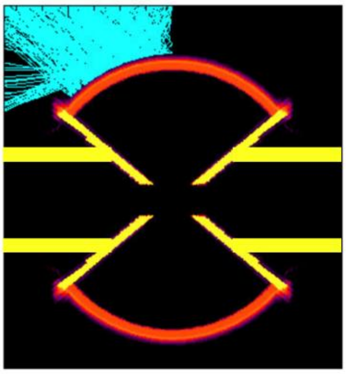

Figure 1 The sketch of laser irradiation in DCI scheme

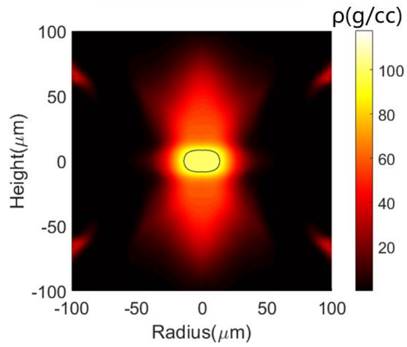

Figure 2 The density distribution after collison

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