§1. Theory and Simulation Researches on Laser Fusion Plasmas

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1.Introduction

Numerical modeling and simulation code development on multi-scale laser plasmas have been studied in this collaboration program. In particular, the ultra-intense laser plasma interactions and the integrated implosion and heating physics related to fast ignition are investigated by the PIC, Fokker Planck and Hydro simulations of NIFS, ILE, Osaka University, Setunann University, Hyogo Prefectual University, Kyushu University, and so on. In the following, issues and research status of the ultra-intense laser plasma physics and fast ignition research are described.

2.Simulation on Fast Ignition and Ultra-intense laser plasma physics

In the integrated simulation system for fast ignition, we have to describe global phenomena of implosion radiation hydrodynamics, high density plasma interactions with ultra intense laser and high energy particle generation and transport. As shown in the left of Fig.1. laser fusion with a cone shell target for fast ignition has two steps to produce hot dense plasmas. In the first step, the fuel shell is irradiated by nano second implosion laser and then a peta watt laser is injected into the cone to heat the compressed fusion fuel. In the right of Fig.1, a schematic plasma density at the maximum compression is shown together with corresponding simulation schemes. Since the patta watt laser plasma interaction in the cone target includes complex electro-magnetic phenomena, PIC simulation is necessary to describe the kinetic effects. By the ultra-intense laser, a high density relativistic electron beam is generated near the critical point and penetrates into over-dense region. The transport of the relativistic electron from the critical region to the imploded plasma is described by the Fokker Planck simulation.

The heated high density DT plasma will start to burn. The burning processes are simulated by ALE(Arbitrary Aurelian Lagrangian) hydro code. In our Fast Ignition Interconnected Integrated Code (FI3), the simulation data are transferred from one to others. The PIC simulation research groups are the Ishiguro's group at NIFS, the Taguchi's group at Setunan and Osaka University, Sakagami's group at Hyogo Prefectual University.

The one of the critical issues of fast ignition research is the intense relativistic electron transport. The ultra intense relativistic electron beam (REB) induces very strong magnetic fields through the electro-magnetic two stream instabilities when it interacts with dense plasmas[1]. Since the high energy particles propagate for a long distance, the large scale plasma simulations are also necessary for quantitative analysis of experiments.

Reference

[1] Sentoku,Y, Mima,K. etal.: Phys. Rev. Lett. **90** 1555001(2003).

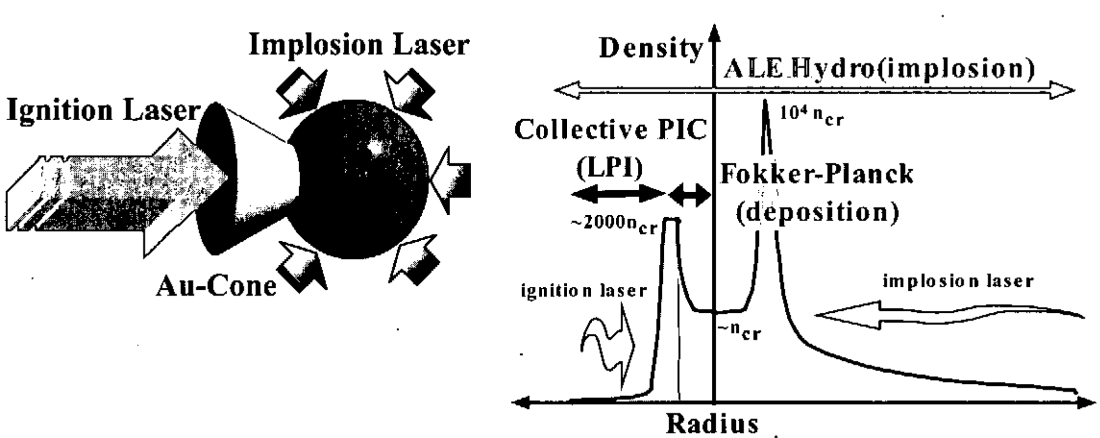

Fig. 1. Integrated code for cone-shell target.