§19. Research on High Energy Density Laser Plasma Physics

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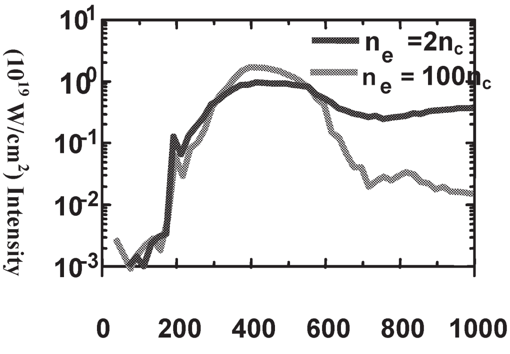
Since 2003, we continued to develop an Fast Ignition Interconnected Integrated code (FI3 code) to include appropriate physics in transport of relativistic electron in dense plasmas. A radiation hydrodynamic simulation with PINOCO [1] has been combined with a collective PIC simulation [2] and a Fokker Planck simulation [3] by using the inter net proto call DCCP [4]. As the demonstration of the FI3, we analyzed the imploded plasma heating processes in the cone target experiment [5]. We found in the analysis that an Au solid layer irradiated by a peta watt laser is highly biased to confine high density hot electron which is generated by strong two stream instability in relatively low density plasmas contacting the Au layer. As shown in Figs. 1 and 2, the heat flux from the cone tip to the imploded plasma continues at high level for a long time after the laser pulse and the main part of the heat flux is carried by sub-MeV electrons. We found that the plasma heating after the laser pulse is significant for a few pico second.

In a PIC simulation, it was also discovered that laser produced relativistic electrons are well confined on the plasma-vacuum interface when the laser incident angle is greater than 60 deg. This means that the relativistic electron heat transport is strongly inhibited on the solid target surface. This phenomena have been observed in a recent experiment at University Michigan[6]. By hybrid simulations, Weibel instability is further investigated. We found that the merging process of relativistic electron filaments is sensitive to electron beam cross section and total current. When the total current is much larger than the Alfven limit current, multi stationary filaments co-exist for a long time which means ion time scale. On the other hand, when the total current is not much larger than the Alfven limit current, filaments merge into a single filament. The detail of this result is shown by Matumoto in this Annual report.



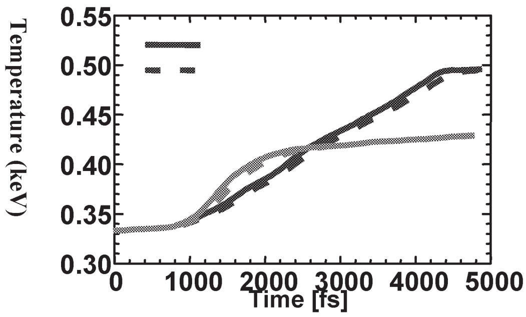


Fig. 1. Time dependent relativistic electron heat flux and heated core temperature

Reference

1) H. Nagatomo, et al., *Inertial Fusion Science and Applications 2001,* (*Proc. of IFSA 2001, Kyoto*), Elsevier, 140 (2001).

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3)T. Johzaki, et al., Ann. Prog. Rep. 2002, ILE, Osaka Univ., 95 (2003); T. Johzaki, et al., "*Integrated Simulations for Fast Ignition Targets*", to be published in Proc. of ITC-13.

4) H. Sakagami, et al., *Inertial Fusion Science and Applications 2003,* (*Proc. of IFSA 2003, Monterery*), ANS, 434 (2004).

5)R. Kodama, et al., *Nature*, **412**, 798 (2001); R. Kodama, et al., *Nature*, **418**, 933 (2002).

6) T. Lin etal, Private communication and poster session of APS DPP meeting 2004