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Influence of beam non-uniformity on fuel implosion in heavy ion inertial fusion

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In inertial confinement fusion (ICF) target implosion, the requirement for the implosion uniformity is very stringent, and the implosion non-uniformity should be less than a few % [1, 2]. Therefore, it is essentially important to improve the fuel target implosion uniformity. In general, the target implosion non-uniformity is introduced by a driver beams' illumination non-uniformity, an imperfect target sphericity, a non-uniform target density, a target alignment error in a fusion reactor, et al. In ICF, heavy-ion beam (HIB) driver accelerators have a high driver energy efficiency of 30~40% from the electricity to the HIB energy. In heavy-ion inertial fusion (HIF) the target gain of ~50 would be needed to construct a HIF fusion reactor system. The target implosion should be robust against the implosion non-uniformities for the stable reactor operation [3].

The minimum HIB number was studied in Ref. [4]. It was found that the minimum HIBs number would be 32 [4]. In HIF, it is usually assumed that 32 HIBs irradiate simultaneously on the fuel target. In this paper, we examine the influence of the irradiation timing error on the implosion and the fusion output energy in HIF.

Figure 1 shows the input pulse shape of HIB. The input energy is 4.6 MJ. The beam ion species is Pb. The particle kinetic energy is 8 GeV. In this study one HIB reaches the target surface with a time delay Δt as shown in Fig. 2, and the HIB delay would enhance the implosion non-uniformity. Figure 3 shows the non-uniformity histories of the DT fuel target ion temperature with no delay and with a delay of Δt = 1.0ns. Figure 4 shows the fusion energy gain versus the delay time Δt. In conclusion, the results in Figs. 3 and 4 present that the delay time Δt has an influence on the target implosion performance.

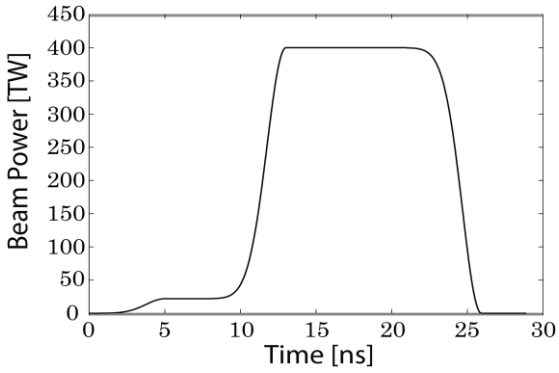

Figure 1. Input pulse shape of HIBs.

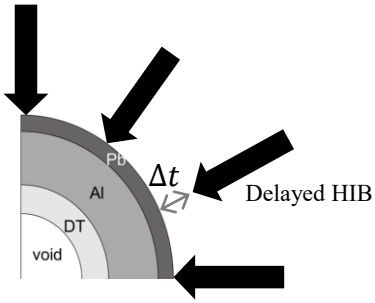

Figure 2. One HIB has an illumination delay Δt in this example case.

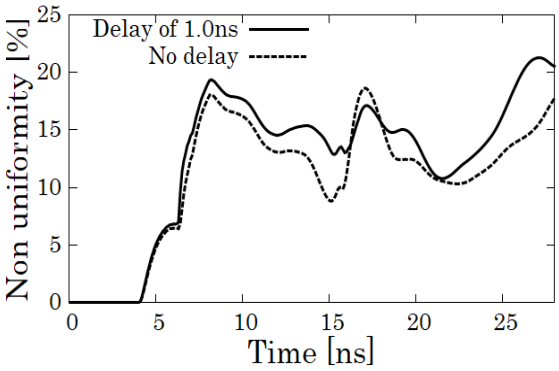

Figure 3. Non-uniformity histories of the target ion temperature.

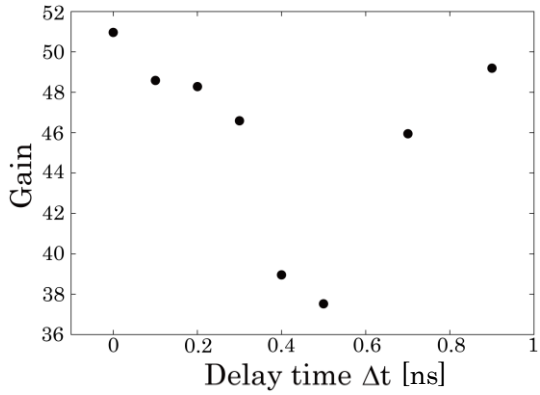

Figure 4. Fusion energy gain vs. the delay time Δt.

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References

1. M. H. Emery, J. H. Orens, J. H. Gardner, and J. P. Boris: Phys. Rev. Lett. 48 (1982) 253.
2. S. Kawata, and K. Niu: J. Phys. Soc. Jpn. 53 (1984) 3416.
3. S. Kawata, et al.: Matter and Radiation at Extremes 1 (2016) 89.
4. K. Miyazawa, et al.: Phys. Plasmas 12 (2005) 122702.