Contribution ID: **889** Type: **Poster**

Fast ignition inertial confinement fusion with kilo-tesla magnetic field

Friday, 21 October 2016 08:30 (4 hours)

Here we report recent experimental results relevant to the fast ignition (FI) inertial confinement fusion assisted with external kilo-tesla magnetic field. We have experimentally observed generation of 0.6 kT of magnetic field by using laser-driven capacitor-coil scheme, short diffusion time (« 1 ns) of laser-generated magnetic field into a target material, reduction of the REB beam diameter by the factor of two and additional acceleration of a fusion plasma hyrdodynamics in the strong magnetic field. One of the critical problems facing the FI scheme is large divergence angle of the laser accelerated relativistic electron beam (REB). The application of a strong external magnetic field in the REB path to the fuel core is being investigated for controlling transport of the REB. Larmor radius of a 1 MeV electron, which heats efficiently the fuel core, is 6 µm in a 1-kT magnetic field. The radius is smaller than the typical radius of the REB at the generation point, thus a 1-kT magnetic field is enough for the REB guiding. Kilo-tesla magnetic field affects not only REB transport but also hydrodynamics of a fusion plasma by anisotropic thermal heat transport. Guidance of the REB using a 0.6-kT field in a planar geometry has been demonstrated. In this experiment, a 50 µm-thick plastic foil was put near the coil center, and the foil was irradiated by a short pulse laser to generate REB. Spatial distribution of the REB was observed as a coherent transition radiation (CTR) image and spectrum from its rear side. CTR emission size and intensity become smaller and stronger in the magnetic field compared to those without the magnetic field. The CTR spectrum indicate reduction of divergence of REB at its generation point.

Paper Number

IFE/1-2

Country or International Organization

Japan

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Session Classification: Poster EX/9, EX/10, TH/7, TH/8, IFE/1, MPT/1, FNS/1

Track Classification: IFE - Inertial Fusion Experiments and Theory