HU-ACE NEWS LETTER

Advanced Core for Energetics, Hiroshima University

Vol.68 2022.8

Activities of the Core

July. 31-Aug. 4, 2022	Dr. Nishida, specially appointed professor, gave a lecture in a task leaders meeting of IEA.
Aug. 1, 2022	The 105th Hiroshima University Biomass Evening Seminar (co-organized).
Aug. 8-13, 2022	Dr. Nishida, specially appointed professor, gave a keynote lecture in the International Summer School of Naval Architecture, Ocean Engineering and Mechanics.

The first ground source heat pump system in HU under construction

The "J-Innovation HUB building", which has a three-storied RC structure, is now under construction within the Higashi-Hiroshima campus of Hiroshima University. Thanks to the great efforts of many people, a ground source heat pump (GSHP) will be used for the first time on campus, to provide air conditioning in a laboratory space on the first floor. Four ground heat exchangers that are 100m deep, containing plastic tubes called "U-tubes", were installed at the beginning of July. The GSHP system will be used from 2023 fiscal year.

The energy-saving effects are strongly influenced by energy management at the operational phase, rather than by adequate design and construction. HU-ACE will play a role in continuous data monitoring and operational improvement in order to achieve high energy performance in the GSHP system.

Issued by Advanced Core for Energetics, Hiroshima University

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Research Topics No. 34

Simulation study on fusion ignition and burning for realization of laser fusion reactor

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Research fields: Laser fusion, Laser high energy density physics
Keywords: laser fusion, laser plasma light source, laser particle acceleration

Abstract

Background: fusion plasma study for realization of ultimate energy source, laser fusion reactor

Nuclear fusion research began in the 1960s under the catchphrase "The Sun on the Ground!". To create a thermal fusion reaction, plasma should be heated up to about 100 million K. In addition, to utilize fusion energy, a sufficient number of reactions need to be created, which requires a certain density and confinement time of the plasma. In laser fusion, a spherical fusion fuel, several millimeters in size, is imploded thousands of times creating solid density by irradiating the fuel with a MJ-class laser, and explosive fusion burning is achieved in a very short time (~10^{-10} s) ,while the fuel remains in a high density state in its inertia. In August 2021, the world's largest laser facility, National Ignition Facility (NIF), USA reported that a fusion output of more than 30% of the input laser energy was obtained [1], which has pushed laser fusion research into the fusion burning region.

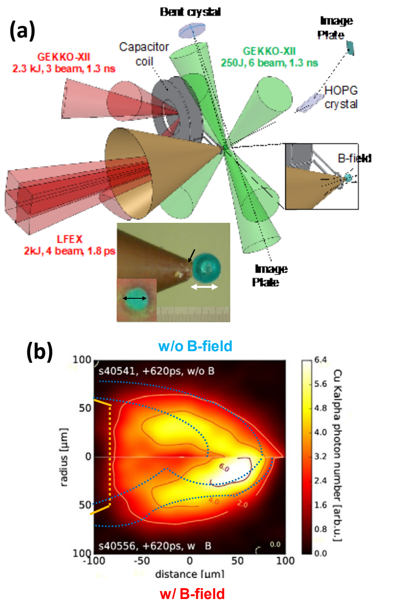
Methods: Clarification of ignition and burn dynamics and it's optimization through theory and numerical simulations

In ignition and burn phases of laser fusion, a multi-layer complex physical phenomena (energy transports by energetic fusion products and radiation emitted from high temperature plasma, thermal conduction, and plasma hydrodynamics) occurs in the spatiotemporal region of 100 μm and 100 ps. We are conducting research to clarify the ignition and burn dynamics and improve its efficiency by numerical simulations using codes developed by ourselves and theoretical analysis under domestic and international collaborations.

Results: Demonstration of effective core heating by externally-applied magnetic field

In the fast ignition laser fusion methods, a small part of compressed fusion fuel is heated up to ignition temperature by relativistic electron beam generated by relativistic laser-plasma interaction. One of the critical issues is "How can we efficiently heat a fuel core to ignition temperature?" Since a laser-generated electron beam has a large beam divergence, the beam diameter increases as it propagates, which inhibits local and efficient core heating. To solve this problem, we proposed external-magnetic field guiding, where the kilotesla-class magnetic field is externally applied to the core and the beam electrons are trapped by the magnetic field lines and guided toward the core. Based on prior theoretical and numerical research and fundamental experiments, we demonstrated a significant enhancement in heating efficiency by the external-magnetic field guiding (0.4% → 8%) [2-4].

Currently, we are trying to improve the theoretical and numerical modeling be able to make a more accurate prediction of ignition and burn dynamics, while also exploring more efficient implosion and ignition method.



(a)Schematic view of integrated experiments and (b)spatial profiles of Cu-Kα emission.

References

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