HU-ACE NEWS LETTER

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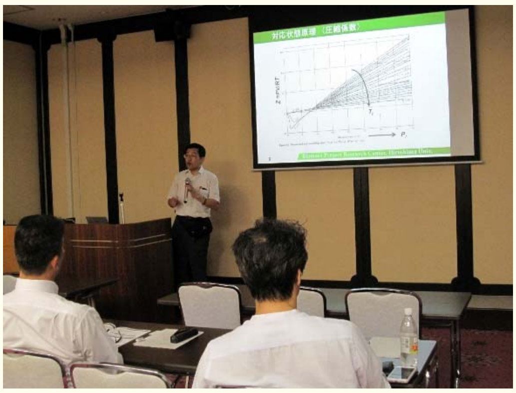
Activities of the Core

Sep. 9, 2019	The 77th Biomass Evening Seminar (co-organization)
Sep. 9-13, 2019	Marine Biotechnology Conference 2019
Sep. 12, 2019	The 21st Biomass Project Research Center Symposium
Sep. 17-18, 2019	Yamaguchi Univ. Special Lecture "Biomass and Thermodynamics"
Sep. 20, 2019	Mechanical System Seminar (co-organization)

Biomass Symposium

On September 12, 2019, we co-organized the Biomass Symposium. The theme was 'Frontier of Supercritical Water Gasification Explained from the Basics'. In March of this year, NEDO's five-year project was completed. In this symposium, along with the report of its outcome, the basics such as what supercritical water is and the features of supercritical water gasification were explained. Lectures were given by the members of the project: Prof. Matsumura who is also the vice president of HU-ACE, Mr. Kazuki Nakashima from Fukken Co., Ltd., and Dr. Takashi Noguchi who is the president of Toyo Koatsu Co., Ltd. At the end of the symposium, discussion was made on the problems to be solved in the future and possibilities of the technology. Based on the developed technology to suppress char, construction and operation of demonstration plant is awaited.



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Research Topics No.10

Realization of ultimate energy resource "laser fusion"

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Research fields: Engineering / Plasma Science / Computational Science
Keywords: Laser Plasma Physics / Numerical Simulation / Laser Fusion / High Energy Density Physics

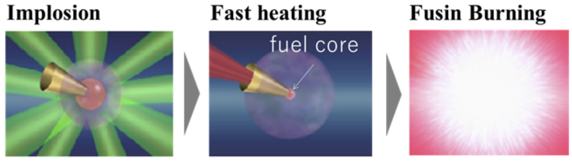
Abstract

Background

A thermonuclear fusion reactor is expected as an ultimate energy resource which is clean and safety. The research for realizing a fusion reactor started in 1960s. As for a laser fusion, one of the thermonuclear fusion scheme, the world's biggest facility was constructed in USA, and the research for realizing fusion ignition is being proceeded. Contrary to prior expectations, however, the fusion ignition has not been achieved yet. In the conventional laser fusion scheme, the fuel compression up to thousands-times solid density and the formation of ignition spot with the temperature of 100 million K are spontaneously done through the implosion process. The critical issue to prevent fusion ignition is the hydrodynamic instability. To solve the problem, a new scheme "fast ignition" has been proposed. In the fast ignition, the fuel heating process is separated from the implosion process. In addition, this scheme is expected to be more efficient fusion reactor compared with the conventional one. The research for fast ignition laser fusion is led by Japan.

Research Contents

In the fast ignition scheme, a pre-compressed fusion fuel is heated by a ultra-intense short-pulse laser (intensity ~10^{20} W/cm^2, duration ~10 ps), where a relativistic electron beam (REB) is generated in the laser-plasma interactions, and the REB heats the edge of the fuel core up to ignition temperature. The critical issue is the realization of efficient core heating. Together with the experiments in big laser facility, we are proceeding the theoretical and numerical research to understand the physical phenomena of the REB generation in relativistic laser plasma interactions, the REB transport, the core heating and the fusion ignition and burning, and to optimize the heating process to achieve the fusion ignition.



Compression of a fusion fuel by a high-power nano-second laser (several 100s kJ) | Fast heating of fuel core up to ignition temperature by ultra-intense pico-seconds laser (a few 100s kJ) | Explosive fusion burning

Principle of fast ignition laser fusion

Results

At the early integrated experiments at the Institute of Laser Engineering (now the Institute of Laser Science), Osaka University in 2013, the obtained heating efficiency (the ratio of injected heating laser energy to the core heating energy) was less than 1%. Such a low efficiency was due to the large beam divergence and too high energy of fast electrons. To solve the problems, we proposed the improvement of heating pulse contrast to reduce the fast electron energy, application of kilotesla class magnetic field to guide the fast electron beam to the fuel core and so on. After validation of these solutions by numerical simulations and fundamental experiments, in 2016 integrated experiments, we have successfully improved the heating efficiency up to ~8 %.

Reference

S. Sakata, S. Lee, H. Morita, T. Johzaki, et al., "Magnetized fast isochoric laser heating for efficient creation of ultra-high-energy-density states", Nat. Commun. **9**, 3937 (2018).