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EX-Fusion's challenge for the realization of laser fusion system

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The experiment at the National Ignition Facility (NIF) of Lawrence Livermore National Laboratory achieved a fusion output of 1.35 megajoules, which is more than 70% of the laser input energy. This demonstrated that the ignition and burning of fusion fuel using a laser is achievable. For the realization of a commercial reactor, it is necessary (i) to improve the efficiency of fusion reaction generation, i.e., achieve a fusion power exceeding the laser input energy beyond 100, and (ii) to generate fusion reactions repetitively at 10s Hz while outputting the fusion energy as high-temperature heat, which is converted into electricity, hydrogen, and the other energy that can be used in a civilized society.

In Japan, as for (i), to improve the efficiency of fusion reaction generation, we are focusing on the fast ignition method, in which high-density fusion fuel is externally heated by a short pulse laser. Experiments are being conducted using the GEKKO XII and LFEX lasers at the Institute of Laser Engineering (ILE), Osaka University. The recent results [1] have been referred to in the summary of the world fusion research published by the Advanced Research Projects Agency-Energy (ARPA-E) [2].

As for (ii), high repetition rate laser fusion experiments, several programs are conducted in Japan. The Graduate School for the Creation of New Photonics Industries (GPI) demonstrated repetitive fusion neutron generations using a diode-pumped solid-state laser developed by Hamamatsu Photonics, through joint research with Toyota Motor Corporation and other partner institutions. They proposed laser mini-reactor CANDY that demonstrates fusion energy extraction at no-gain condition: fusion power is much lower than the input power [3]. In addition, the laser fusion strategy committee supported by the Inertial Fusion Energy Forum has formulated a policy that Japan laser fusion program focuses on repetitive laser fusion research and development [4] by supporting the Japan establishment for Power-laser community Harvest: J-EPoCH concept. Fusion engineering research will be conducted on laser fusion sub-critical reactor L-Spreme [5] by using J-EPoCH.

EX-Fusion, which is the first startup in Japan aimed at commercializing fusion energy, was founded by K. Matsuo, Y. Mori (GPI), and S. Fujioka (ILE) to consolidate the knowledge on laser fusion that has been cultivated to realize a commercial laser fusion reactor. We will initially focus on the development of a continuous target delivery and laser

engagement system, which is one of the fundamental technologies for future laser fusion commercial reactors. The key technology, 10-Hz beads injection and laser engagement system [6], has been transferred from GPI to EX-Fusion. By improving this technology with collaborators, our company will contribute towards high repetitive fusion neutron generation, as well as highly repeatable laser plasma experiments with high precision and statistics to get closer to the more profound physics of plasmas.

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