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Progress of a DPSSL based R&D facility TERU for IFE technology and industrial applications

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In the most recent study of inertial confinement fusion, the integration experiments to demonstrate ignition burn are planned using kilojoule to megajoule class laser beam lines in the world. These experiments are based on the "single-shot"experiment of which repetition rate is several-shots per day due to limitations of laser cooling time. A dozen shots every second are required to realize the inertial fusion energy (IFE) power plant. We focus on the development of high-energy and high-repetition-rate laser system to assess a continuous supply system of fuel pellets, a control system of the laser injection, and a feedback system linked with radiation measurements. Since 2010, we have initiated a construction of a 100-Joule class diode-pumped solid-state laser (DPSSL) based facility "TERU"(Trek on fusion Energy Roadmap toward Utopia) for research and development on component technologies and related industrial applications. TERU is the first laser facility for IFE research based on 100 J class DPSSL. Status of the current DPSSL is 50 J at 0.5 Hz. The laser amplifier head was designed to evaluate a high gain with high energy storage in the cryogenically cooled Yb:YAG ceramics. A small-signal-gain (SSG) of the Yb:YAG ceramics amplifier pumped by 400 kW has reached 20 with stored energy of 148 J at cooling temperature of 100 K. This is the highest SSG of the cryogenically cooled Yb:YAG ceramics amplifier storing energy over 100 J. This result becomes a benchmark of the high gain with stored energy performance to design the next kilo-joule-class cryogenically cooled Yb:YAG ceramics amplifier. We also start the laser irradiation experiment to explore the fundamental physics of implosion processes, e.g. plane target acceleration, which could replicate the implosion in laser fusion. In our preliminary experiment, a velocity of the aluminum plane target (a thickness of 20 □m) accelerated with 2.0×1012 W/cm2 laser irradiation was observed by VISAR measurement. The acceleration velocity reached 560 m/s. The acceleration velocity changing target thicknesses is stored as a database with repetitive laser irradiation. Such database will be useful for the target design and benchmark of hydrodynamics codes.

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