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Conceptual Design of kilo-Joule Laser Driver for Inertial Fusion Mini-Reactor CANDY

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Development of a kilo-Joule class diode-pumped solid-state laser (kJ-DPSSL) as a beam line of Mega–Joule class driver is necessary for realization of inertial fusion energy. We conceptually designed a kJ-DPSSL for an inertial fusion mini-reactor CANDY. The CANDY is the kJ-DPSSL driven integrated fusion mini-reactor based on fast ignition scheme. The driver consists of two implosion laser drivers in 0.5-micro-m wavelength and two heating laser drivers in 1-micro-m wavelength. Each beam irradiates 1 kJ-pulse energy at 10-Hz repetition rate. The implosion beam has a temporary tailored pulse shape and the heating beam has 0.2 to 10 ps pulse duration. The implosion and heating beams coaxially counter-irradiate a fuel pellet. These key components which construct kJ-DPSSL driver have been technologically and economically assessed based on our fusion research. We have started construction of repetitive inertial fusion experimental system based on the 20-J-DPSSL. The DPSSL KURE-I (12 J in 527 nm with 10 ns at 1 Hz)-pumped HAMA laser (3.8 J in 800nm with 100 fs at 1 Hz) is used for an inertial confinement fusion experiment as a feasibility study. Counter irradiation fusion driver consists of tailored-implosion pulses with heating ultra-intense pulses have been developed for optimization of fusion reaction. And physical studies about fast-heating and some technological developments of repetitive target injection have been achieved. These result indicate that development of the kJ-DPSSL dramatically progress study of reactor core physics, cryogenic pellet-injection and reactor wall. The assessment for feasible program has clarified the design criteria including the cost of diode, laser materials, and optics, as well as the lead time for the research, development and system construction.

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