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Laser fusion subcritical research reactor with J-EPoCH facility

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A multi-purpose high repetition laser facility, the Japan Establishment for a Power-laser Community Harvest (J-EPoCH), at the maximum rate of 100 Hz is proposed. 12 laser beams with 8 kJ and a 5 PW laser are arranged for fusion experiments. As one of the applications, a laser fusion subcritical research reactor has been conceptually designed [1]. The research reactor consists of a replaceable core, a vacuum chamber, target delivery system and a vacuum pump with a tritium recovery system as shown in figure 1. A Large High Aspect Ratio Target (LHART) filled with gaseous deuterium-tritium (DT) fuel will be used and would yield 10^{13} neutrons per shot with subcritical fusion reactions [2]. The neutrons can be used for fusion reactor engineering research. Laser fusion experiments have advantages not to require a high vacuum and to equip a simple vacuum chamber. Therefore, experimental arrangements can be changed without any difficulties. To conduct a variety of fusion engineering research, a dedicated replaceable core for each purpose would be prepared. Two types of replaceable cores with neutron-thermal (n-t) conversion and tritium breeding materials are considered for the demonstration of fusion power generation and the study of tritium breeding, respectively. A shield is equipped at the inner layer to prevent the n-t conversion from the energy of debris and laser beams. According to calculations by the Particle and Heavy Ion Transport code System (PHITS) ver. 3.08 [3], the cores are designed.

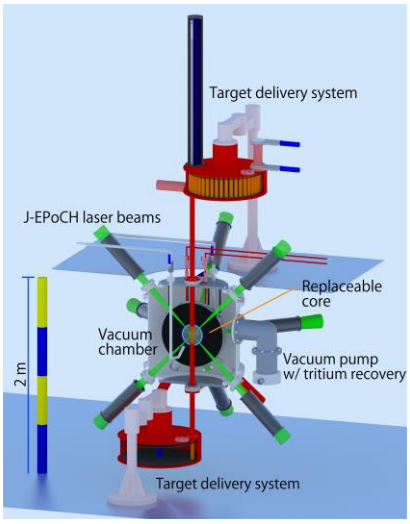

Figure 1 Conceptual drawing of the laser fusion subcritical research reactor.

Boron carbide, B_4C is selected as the n-t conversion material for the preliminary demonstration of fusion power generation. The core size is decided to convert more than 60 % of 14.1 MeV neutron energy to thermal energy. Figure 2 shows the energy deposition to the core from a DT fusion reaction. The core can harness 8.72 MeV thermal energy, which corresponds to 14.0 J/shot, from a 14.1 MeV fusion neutron. The first thermal fusion power generation of 14 W would be achieved by 1 Hz operation.

Lithium-lead (LiPb) is a candidate for the tritium breeding material used in the Laser Inertial Fusion Test (LIFT) reactor [4]. Instead of the B_4C layer for the n-t conversion, a LiPb layer is equipped in a core for tritium yield experiments. Figure 3 shows the tritium yield in the LiPb core. Total tritium yield is expected to be 9.1 x 10^{11} per shot.

The subcritical research reactor makes it possible to proceed to laser fusion engineering research.

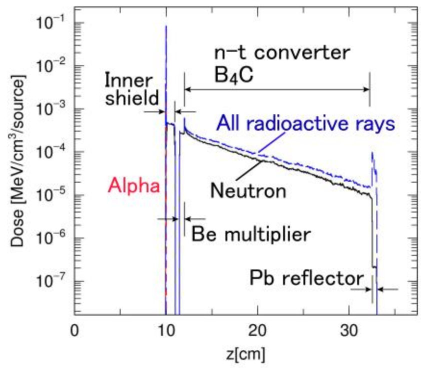

Figure 2 Energy deposition to the B_4C core [1].

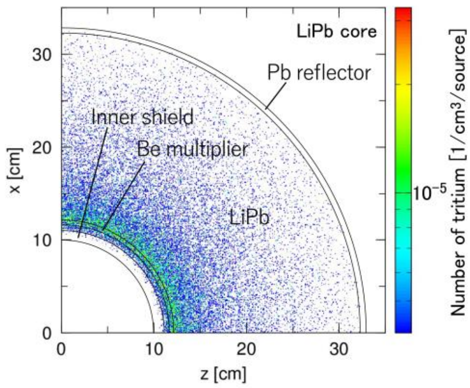

Figure 3 Tritium yield in the LiPb core [1].

The contents of this abstract are based on reference 1.

References

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