NEWS
RELEASE

Hamamatsu Photonics announces successful output of 100-joule laser pulses at a high repetition rate of 10 Hz

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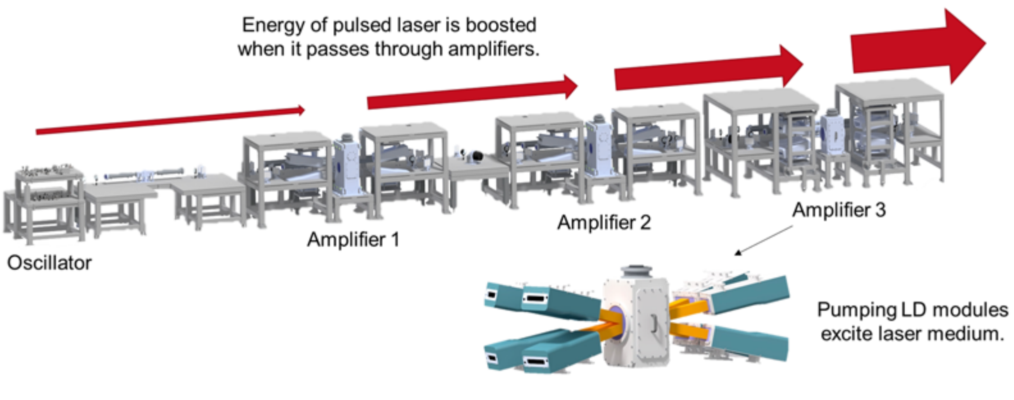
Hamamatsu Photonics has succeeded in producing laser pulses with energy of 100 joules (J) at a high repetition rate of 10 hertz (Hz). This was achieved by increasing the cooling capacity for the laser medium [(*1)] of the pulsed laser system and by optimizing the output of the laser diode (LD) module for pumping [(*2)].

To make laser fusion practical, the fusion fuel needs to be efficiently irradiated with a pulsed laser that produces as much as 1 megajoule (MJ) at a high repetition rate of 10 Hz. We believe that establishing this technology is an important milestone where the results from this study will help us move toward this goal.

We will present the results of this study at a symposium and general lecture at the “43rd Annual Meeting of the Laser Society of Japan” to be held at WINC AICHI (Nakamura-ku, Nagoya, Japan) from the 18th to the 20th January 2023.

*1: Laser medium is a material that stores energy from an outside source and amplifies the laser passing through it by imparting energy to the laser.

*2. Pumping is the process in which electrons in an atom or molecule are raised to a higher energy level due to light absorption.



Laser system for producing 100 J pulsed laser output at 10 Hz

The system uses several amplifiers to boost the energy of 10 Hz laser output from the oscillator from 1 μJ to 100 J.

Nuclear fusion is a reaction in which atomic nuclei are fused together to form a heavier nucleus, releasing a huge amount of energy in the fusion process. Laser fusion is a technology that creates nuclear fusion by irradiating fuel capsules containing deuterium and tritium with high-power lasers.

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Practical laser fusion requires pulsed lasers with energy as high as 1 MJ to irradiate the fusion fuel at a high repetition rate of 10 Hz. To accomplish this goal, we are engaged in research and development of high-energy, high-repetition-rate pulsed laser systems using laser amplifiers in which the laser medium is pumped by LD modules and highly efficiently cooled by helium gas.

In 2021, in collaboration with the New Energy and Industrial Technology Development Organization (NEDO), which is Japan’s national research and development agency, we developed a pulsed laser system that produces 250 joule laser pulses at 0.2 Hz with an average output power of 50 W, which is the world’s highest energy level among LD-pumped lasers. Since then, we have been working to increase the repetition rate. However, increasing the repetition rate also raises the temperature of the laser medium and degrades its optical characteristics. To cope with this situation, we improved the cooling mechanism for the laser medium to increase the flow of helium gas and in this way enhance the cooling capacity. We also optimized the output of the pumping LD modules to prevent the temperature of the laser medium from rising. This resulted in minimal deterioration of laser medium characteristics and successful output of a 100 J pulsed laser at 10 Hz with an average output power of 1 kW.

Results of this study confirmed the possibility of increasing the average output power by scaling up the laser system, and so helped us move forward to establish a technology to produce laser pulses of 1 kJ at 10 Hz, which we see as an important milestone on the road to practical laser fusion. These results are also expected to contribute to new research in the field of basic science.

As our next step, we will continue research and development to establish a technology to produce laser pulses of 250 J at 10 Hz.

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Two methods have been proposed to make nuclear fusion practical. One method utilizes confined magnetic fields and the other utilizes lasers. The method using lasers is considered more likely than the method utilizing magnetic fields to create a more compact fusion reactor and has been the subject of intense research and development efforts since the 1970s, mainly in the United States, Japan, and Europe. In major laser fusion research facilities throughout the world, large-scale demonstration experiments are being conducted using large-scale flashlamp-pumped laser equipment in order to achieve high gain for boosting the output energy to about 100 times the input energy. However, the number of laser irradiations is limited to several times a day due to the time needed to cool the laser medium. Current reasoning is that fusion reactions must take place at high repetition rates and the generated energy must be extracted continuously in order to make laser fusion practical. Our aim is to establish a technology to irradiate fusion fuel with a 1 MJ pulsed laser at 10 Hz.

●Main specifications

Parameter	100 J pulsed laser system	Unit
Maximum pulse energy(*)	100	J
Pulse repetition rate	10	Hz
Average power	1	kW
Pulse width	10 to 100	ns
Wavelength	1030	nm

* At a pulse width of 30 ns

External view of the laser system producing laser pulses of 100 J at 10 Hz