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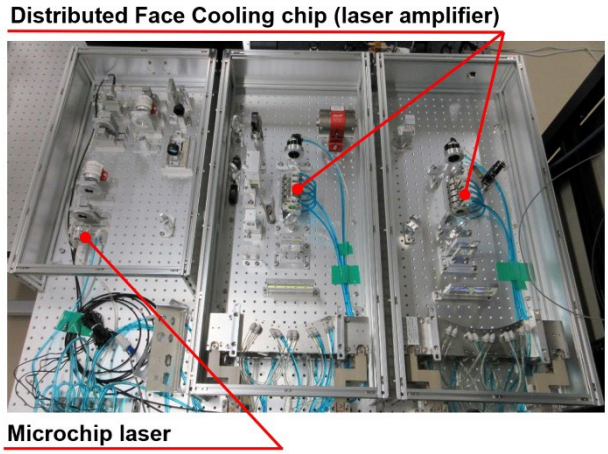
Mitsubishi Electric Develops Compact, High-energy Sub-nanosecond-pulse Deep-ultraviolet Laser System

Miniaturized design will support innovation in drug discovery, cancer treatment and other diverse fields



Sub-nanosecond pulsed deep-ultraviolet laser system

TOKYO, November 26, 2024 – Mitsubishi Electric Corporation (TOKYO: 6503) announced today that it has developed, in collaboration with the Institute of Physical and Chemical Research (RIKEN) and the Institute for Molecular Science (IMS) of the National Institutes of Natural Sciences, a high-energy short-pulse* (sub-nanosecond) deep ultraviolet (DUV) wavelength laser system that achieves an output energy of 235 millijoules, the world's highest class** pulse energy. The compact and portable laser system has been installed in a dedicated area of RIKEN's facility at IMS in Japan, where it will be used for accelerator research and development.

Sub-nanosecond pulses were achieved by using a microchip laser capable of generating extremely short pulses, and high energy output was realized by optimizing the beam diameter. In addition, co-developed their Distributed Face Cooling technology is implemented in a high-heat dissipation chip developed by RIKEN and IMS, enabling the joule-class laser to operate at room temperature, unlike conventional high-power lasers that

* Electromagnetic waves or light pulses that release energy in a very short period of time, typically with pulse durations of less than 1 nanosecond (one billionth of a second). By shortening the pulse duration, it is possible to increase the peak power even with the same amount of energy, making it useful for applications such as laser processing.

** According to Mitsubishi Electric's research as of November 26, 2024.

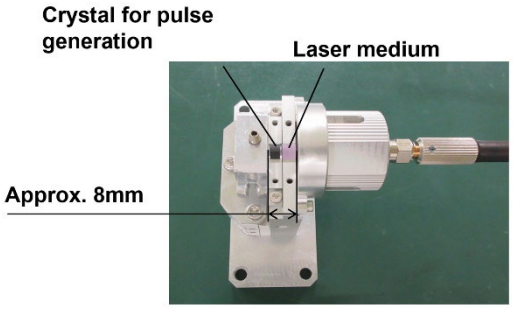
require low-temperature cooling.

Going forward, Mitsubishi Electric will continue to advance its laser acceleration technology and laser system miniaturization, thereby contributing to technological innovation in a wide range of fields.

Features

1) *World's top-class output for a short-pulse DUV laser*

- Adopts a short-pulse (approximately 1.7 billionths of a second) microchip laser as a key technology to achieve high output.
- After amplifying the laser pulse to 2 joules, the wavelength is converted to 266nm, which is the DUV wavelength. By optimizing the beam diameter and using highly durable optical elements that can withstand DUV laser radiation, a world's top-class output of 235 millijoules in sub-nanosecond pulses is achieved in the DUV range.

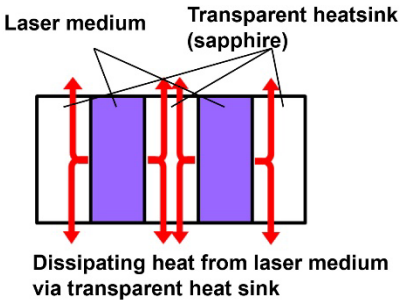


New microchip laser

2) *Enables high-energy lasers to operate at room temperature, contributing to laser miniaturization*

- As a countermeasure against the heat generation of the laser medium,*** which hinders the high output of laser devices, Mitsubishi Electric, RIKEN and IMS jointly developed the Distributed Face Cooling technology to alternately bond the laser medium with sapphire to serve as a transparent heat sink for cooling.
- By applying a unique room-temperature bonding technique to the junction of the laser medium and sapphire, the resulting bond is resistant to high-energy lasers.
- The amplification of laser light using high heat dissipation chips in which Distributed Face Cooling technology is implemented enables room-temperature operation of joule-class lasers, eliminating the need for a low-temperature cooling system and realizing a compact laser device measuring approximately 1.0 meter by 1.2 meters. In addition, pulse output is achieved at twice the frequency of competing laser systems, a significant advance in laser acceleration technology.

*** Special crystals or ceramics used for the amplification of laser light help to increase the output power and energy is the heat generated by the laser medium.



Distributed Face Cooling technology

Development Background

Accelerators, which are used in the development of new materials and drugs as well as particle beam radiation therapy for cancer, are devices that use a strong electric field to accelerate minute particles such as electrons and atoms. These devices exploit the ability of particles to penetrate deep into the human body or objects. However, because accelerators typically require large equipment, laser acceleration technology is being researched worldwide with the goal of miniaturizing accelerators. Furthermore, since laser acceleration requires high-power laser systems, even if laser acceleration is realized, the laser systems will still be large. Consequently, the large overall size of accelerators is a major challenge.

Large and costly laser systems are already widely used in fields such as laser processing and sensing. Lasers are also attracting attention in the field of nuclear fusion, but it is estimated that they will account for the majority of the construction costs of laser fusion facilities, further highlighting the need for high-power laser system miniaturization and cost reduction.

Future Development

Mitsubishi Electric is committed to advancing the development of laser acceleration technology and the miniaturization of laser systems, with the aim of achieving technological developments that increase the accessibility of accelerators for the development of new materials and drugs, and for particle beam radiation therapy for cancer. In addition, by further improving the miniaturization and integration of high-energy lasers, Mitsubishi Electric looks forward to contributing to wellness, carbon neutrality, safety and security, and the circular economy.

Reference

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About Mitsubishi Electric Corporation

With more than 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its “Changes for the Better.” The company recorded a revenue of 5,257.9 billion yen (U.S.$ 34.8 billion*) in the fiscal year ended March 31, 2024. For more information, please visit www.MitsubishiElectric.com

*U.S. dollar amounts are translated from yen at the rate of ¥151=U.S.$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2024