NEWS RELEASE

Hamamatsu Photonics has completed a new beam line for laser fusion experiments that allows measurement of laser-induced pressures up to one million atmospheres.
This new beam line will accelerate research on high-repetition rate laser fusion.

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Hamamatsu Photonics has completed a new beam line that measures pressures up to one million atmospheres created by irradiating the target with a 100-joule class laser for laser fusion experiments. Based on the measurement results obtained here, we will optimize the laser irradiation conditions to boost the pressure exerted on the target to make it easier for nuclear fusion reactions to occur. This streamlined operation steps up the pace of basic and applied research into high-repetition rate laser fusion for accelerating the practical use of laser fusion.

Research results obtained from using this beam line facility will be presented at the international "27th IAEA Fusion Energy Conference (FEC 2018)" hosted by the International Atomic Energy Agency (IAEA) to be held in Ahmedabad, Gujarat State, India for 6 days from October 22 (Monday) to October 27 (Saturday).

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Hamamatsu Photonics has been developing high-power semiconductor lasers (laser diodes or LD) used as pump sources for laser fusion and also been engaged in basic and applied research on high-repetition rate laser fusion to cause nuclear fusion reactions to occur continuously. In the laser irradiation building we constructed in 2014, we have been conducting basic research into laser fusion plasma using a beam line consisting of a 100-joule class laser, laser beam transmission pipes, and a large spherical chamber. Because a nuclear fusion reaction is more likely to occur if the fuel is uniformly compressed by high pressure at about one million atmospheres, it is essential to improve the laser fusion environment for finding what pressure must be exerted on the fuel in order to optimize the laser irradiation conditions and raise the pressure even further.

The new beam line is equipped with our in-house manufactured streak camera capable of measuring how the pressure exerted on the target is changed by laser irradiation within an extremely short time of one hundred millionth of a second. We also improved the environment for boosting the pressure by adjusting the temporal fluctuations in the output of the 100-joule class laser. At present we have succeeded in boosting the pressure exerted on the target up to 300 thousand atmospheres. Further increasing the pressure exerted on the target up to one million atmospheres will make it easier for nuclear fusion reactions to occur. Aiming toward this goal, we will push ahead with basic and applied research into high-repetition rate laser fusion for achieving practical use of laser fusion. Also in laser processing such as laser peening for hardening metal surfaces by applying the peak pressure of shock waves generated by laser irradiation, we will make studies on the pressures on metals and processed results in order to optimize the laser irradiation conditions and enhance processing efficiency. Moreover, other possible applications include high-pressure synthesis where a laser-induced high pressure is applied to materials such as carbon to produce another substance.

Along with continually increasing the laser output power and repetition rate, we will prepare an experimental environment capable of applying pressure higher than one million atmospheres. We will also continue efforts to open up new industrial applications while pushing both basic and applied research on high-repetition rate laser fusion to still higher levels.

※Streak camera: A device designed for capturing optical phenomena occurring in an extremely short time to measure the temporal changes and spatial information on light intensity.

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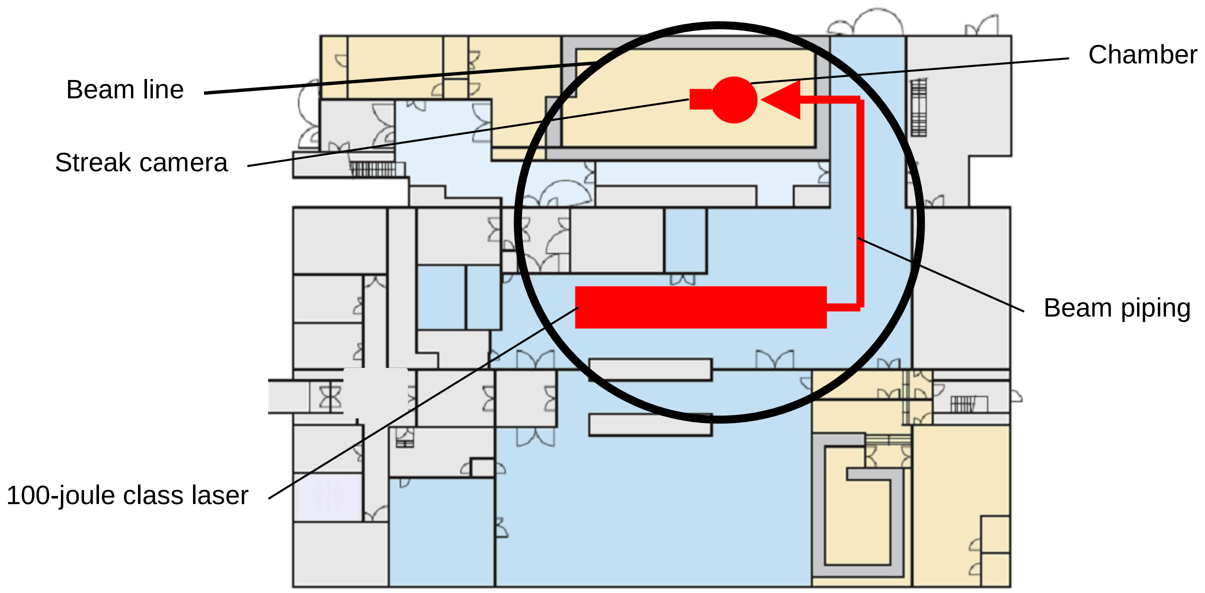
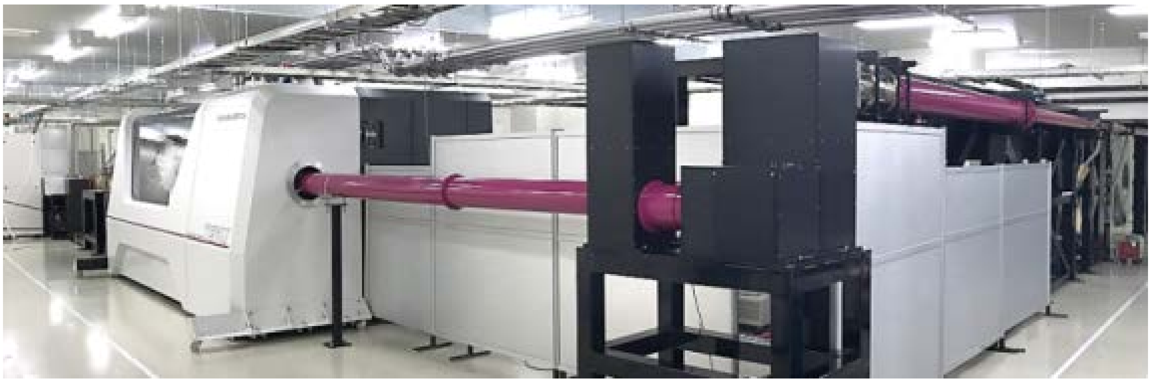
The sun generates its energy by nuclear fusion. Laser fusion is a method of initiating nuclear fusion reactions through heating and compressing deuterium-tritium fuel targets by irradiating laser beams onto them in order to create energy by utilizing the neutrons released by the fusion reaction. Experimental facilities for laser fusion are in operation in various countries around the world such as the US, France, UK, China, Korea, and Russia. Here Hamamatsu Photonics we started constructing a beam line from 2005 for high-repetition rate lasers that would prove the key to practical application of laser fusion. Also, in a joint effort with the Graduate School for the Creation of New Photonics Industries and Toyota Motor Corporation, we have conducted basic research since 2008 using a 10-joule laser to achieve practical use of laser fusion.

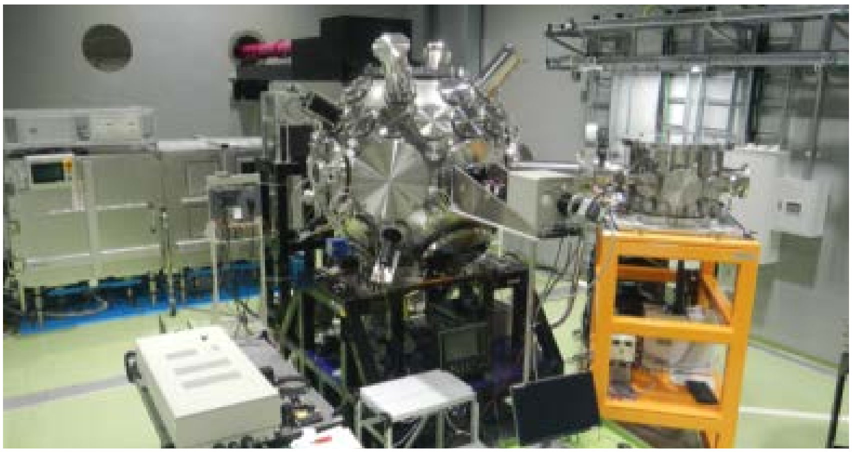
The pressure exerted on targets irradiated by laser beams is being measured at major laser fusion facilities throughout the world. These facilities use lamp-pumped lasers that produce one million joule class power to conduct large-scale experiments aimed at achieving high gains. The lamps used for pumping such powerful lasers must be cooled each time after pumping. This cooling usually limits the number of laser irradiations to just several times a day. Our laser fusion facility, on the other hand, utilizes a laser diode as a pump light source that converts electrical energy into light energy more efficiently and generates much less heat than lamp light sources. This streamlined operation allows our 100-joule class laser to emit beams once every two second, making it possible to acquire more experiment data and promote more efficient research.



Beam line configuration and layout



100-joule class laser (left in photo) and beam piping (purple pipes)



Beam piping (at rear in photo), chamber (at center in photo) and streak camera (at right of chamber)