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Laser MegaJoule status and program overview

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The Laser Mega-Joule (LMJ) is part of the French Simulation Program developed by the Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA). The Simulation program aims to improve the theoretical models and data's used in various domains of physics, by means of high performance numerical simulations and experimental validations.

LMJ offers unique capabilities for the Simulation Program, providing an extraordinary instrument to study High Energy Density Physics (HEDP) and Basic Science (equation of state, atomic physics, nuclear physics …). The 176 laser beams of the facility, grouped in 22 bundles of 8 beams, will deliver a total energy of 1.4 MJ of 0.35 µm (3ω) light and a maximum power of 400 TW. Using a variety of pulse shapes, it will be possible to bring material to extreme conditions with temperature of 100's MK and pressures of 100's Gbar. One of the LMJ's goals is to obtain ignition and burn of DT fuel contained in a plastic capsule imploded by X-ray produced by the interaction of laser beams with a gold hohlraum (indirect drive approach) ; this Inertial Confinement Fusion (ICF) objective set the most stringent specifications on LMJ performance.

The operational commissioning of the LMJ occurred in October 2014 with the first bundle of eight beams ; this is the first LMJ experimental configuration, including 4 plasma diagnostics, among the six configurations that have been defined till the completion of the facility. Today, two bundles (16 beams, 2nd configuration) are operational and three others are mounted, ready to be activated next year. The mounting of LMJ will continue in the following years till the sixth and last configuration which corresponds to 22 bundles and more than 30 diagnostics.

The phase from the first to the sixth experimental configuration will permit to explore some of the experimental topics of the Simulation program: Hohlraum energetics ; Fundamental data (equations of states and opacities of materials) ; Radiation transport ; Implosion hydrodynamics ; Hydrodynamic instabilities ; and, at last, Fusion studies.

This period will be also useful for the handling of the facility, including training of the operational crew and control of performance (precisions, reproducibility…).

Since the operational commissioning of LMJ several experimental campaigns have been performed and some of them will be presented. They were dedicated to control of radiative energy in leaking hohlraums (laser entrance holes, diagnostic holes …); asymmetrically driven implosions inside hohlraums irradiated from one side, with correction on the capsule thickness to retrieve spherical implosion; hydrodynamic instabilities coming from a local defect on a planar target …

To complete the experimental capabilities of LMJ, a PW beam, the PETAL project, has been added to the LMJ's beams. It is a short-pulse (ps) ultra-high-power, high-energy beam (kJ). The first high energy test shots of PETAL have demonstrated the PW capabilities of PETAL with a record of 1.2 PW. Experiments combining LMJ and PETAL will start at the end 2017, giving the possibility to explore a new physics.

LMJ-PETAL is open to the academic communities. The academic access to LMJ-PETAL and the selection of the proposals for experiments is done through the Institut Lasers & Plasmas (ILP) with the help of the PETAL international Scientific Advisory Committee.

The LMJ-PETAL User guide provides the necessary technical references to researchers for the writing of experimental proposal to be performed on LMJ-PETAL. Regularly updated version of this LMJ-PETAL User guide is available on LMJ website at http://www-lmj.cea.fr/en/ForUsers.htm.

[1]The PETAL project is accomplished under the auspices of the Conseil Régional de Nouvelle Aquitaine, of the French Ministry of Research and of the European Union