Abstract. The Laser Mégajoule (LMJ), is under construction by the French Commissariat à l’Energie Atomique (CEA) at CESTA laboratory near Bordeaux. The LMJ will be a cornerstone of the CEA “Simulation Program”. The LMJ is dedicated to high energy density physics experiments, and among these, to obtain ignition and fusion of the DT fuel inside targets. The laser system has been designed to meet the specifications needed for these experiments, in an overall optimization including the fusion target. The current status of the LMJ project is presented as well as its next milestones.

1. Introduction
LMJ’s laser system is composed of 240 neodymium glass laser lines arranged in 8 beams bundles. Focused as quadruplets of beams, it is designed to deliver pulses of up to 1.8 MJ total energy at 0.35 μm on target, after frequency conversion, with a peak power up to 550 TW depending on pulse shape. The pulse duration can be tuned between 0.2 and 25 ns and can be adjusted to the desired pulse shape.

A specificity of LMJ is the focusing system using a pair of gratings, one on each side of the two frequency conversion crystals. The second grating rejects the undesired wavelengths which are absorbed outside the target chamber. Combined with 0.5 nm bandwidth and a phase plate, the gratings also provide longitudinal smoothing by spectral dispersion.

Since its commissioning in 2002, The Ligne d’Intégration Laser (LIL), LMJ’s prototype, has demonstrated the performances of a quadruplet of beam lines [1]. It is now used to test technological improvements as well as for plasma experiments.

2. Building construction
The civil works are completed (figure 1). The first laser bay is ready for the first bundle assembly which begins in October 2007. The target chamber has been introduced in the target bay and positioned on its pedestal in November 2006. The facility building is in operation.

3. Laser system
All laser components and sub-systems are now fully designed. The feedback from experiments and tests on LIL has been used to make improvements on some of the designs.
Figure 1. LMJ building

Figure 2. Outline of a beamline

The detailed engineering of laser bays (figure 3) and beam transportation (figure 4) is completed and ready to begin the assembly.

Figure 3. CAD of a laser bay

Figure 4. CAD of beam transportation

3.1. Front end
The LMJ front end, composed of a fibered oscillator and a pre-amplifier module (PAM: regenerative cavity and high energy amplifier), has been fully tested and characterized. All specifications have been met: output energy, shot to shot stability, spatial beam quality. The beam quality has been improved by using an updated active spatial shaping: the ratio of peak fluence on mean fluence is significantly reduced, leading to a better overall efficiency of the beamline (figure 5).

3.2. Deformable mirror
The design has been modified in order to get a more flat top profile in near field. The new version uses 39 actuators (figure 6); it gives the same results of wave front correction well into the specifications as the previous version, and shows the expected improvement on beam homogeneity (figure 7).

3.3. Amplifier
The first LMJ amplifier vessel has been manufactured with its in line replaceable units. The production of the mechanical structures, under vacuum or under atmospheric pressure, has begun, and the first of them are installed in October 2007 in the first laser bay. The high level cleanliness facility used for the assembling, cleaning and characterization of the mechanical parts is in operation; it will also be used for maintenance.
3.4. Frequency conversion and focusing system (SCF)
A prototype of a LMJ SCF has been built and is now being tested. It retains all the main characteristics than the LIL version which gave good results, with a more robust design that will allow simpler and faster operation.

4. Target bay
The concrete structures of the target bay are completed, as well as the detailed engineering of the steel and aluminum frameworks and the mechanical structures such as the plasma diagnostic inserters supports (figure 8).

After its positioning on its pedestal, the concrete neutron shield has been placed on the target chamber.

The detailed engineering of the plasma diagnostics inserters (SID) will be completed in 2008. The plasma diagnostics will beneficiate from the feedback of the LIL diagnostics routinely used for plasma experiments since 2004.
The operating rules and procedures are being optimized using CAD models and full scale mock ups when needed.

Scale 1 prototypes of the different cryogenic units necessary to handle the cryogenic targets from their fabrication to LMJ’s target holder have been made and tested, demonstrating the feasibility of the whole process (figure 10). A thermal shroud is needed to insulate the target from the ambient temperature and must be removed a fraction of a second before the shot, without inducing perturbation of the target temperature nor vibration. Prototypes of the shroud and its fast removal system have been built; they will be tested at the end of 2007 and in 2008.

5. Conclusion
The LMJ civil works are now completed, and the assembly of the laser bundles begins. After the introduction of the target chamber in November 2006, the target bay is ready for the mounting of the first equipments.

Some improvements have been made on some laser sub-systems (front end, deformable mirror, frequency conversion and focusing system); these modifications have been tested and gave the expected results.

LMJ construction is on schedule for the first experiments at the end of 2012.

References
[1] JM. Di-Nicola et al, Journal de Physique, IV, vol 133, 595 (2006)