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# Radiative jet experiment on the LIL facility

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## Introduction

In december 2004, we have performed the first plasma experiments on the LIL facility, which is a prototype of a quadruplet ( 4 beams) of the future french laser Megajoule, at 351nm wavelength. The goal of these experiments was to demonstrate all functions of complex instrumentation, laser and diagnostics ; they consisted in the creation and propagation of a radiative jet.

## Experimental set up

The experimental design is shown on figure 1 : the target is a gold cone, of 120° of aperture angle ; the four beams of the LIL quad irradiates the inside of the cone, with a short (300 ps), 3,5 TW pulse. These experiments are similar to experiments carried out previously on the Nova laser in 1990 [1], and the GEKKO XII laser in 2000 [2].

The main diagnostics were soft X ray (< 400eV) images to observe self emission of the jet on a 90° axis, and hard X-ray (> 1 keV) images to observe plasma collision on the axis, on a 25° axis.

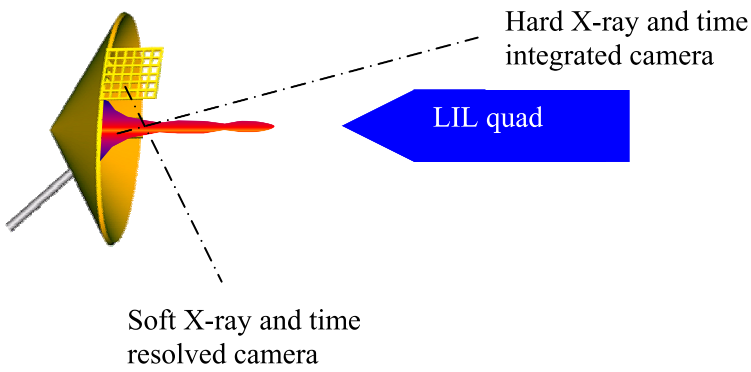


Figure 1 : experimental design

Interpretation of experiments with FCI2 hydrodynamic radiative code

When the laser ablates the wall of the cone, the hot plasma expands and collides on the axis ; then radiative losses cool the hot plasma and contibute to produce a high density jet which propagates away from the cone. In the simulations, performed with our 2D hydrodynamic radiative code FCI2, the jet is formed at 2.2 ns, and then propagates along the axis, increasing its length and width. The apparent structure of the self emission of the jet is similar at 2.3ns, in simulations and measurement (figure 2).


Figure 2 :
Comparison of jet self emission, issued from measurement (left) and simulation (right)

On one of the shots, we observed a deviation of jet that could be the signature of a misalignment between the quadruplet and the target, due to the unavailability at that time of the nominal alignment system. A plane simulation to mock up a real 3D configuration, with a 150 microns misalignment pointed out a deviation of about 13°, in agreement with the experiment.

More precisely, the position of the tip of the jet is pretty well reproduced by the simulations, although it is very sensitive to physical models. We have performed different simulations to test the sensitivity to the heat transport flux model : taking into account or not a non local module, and self generated magnetic field created at the periphery of the laser spots. Figure 3 shows that both tip position and jet velocity are sensitive to this modelisation, although all simulations results are inside the error bars (figure 3).

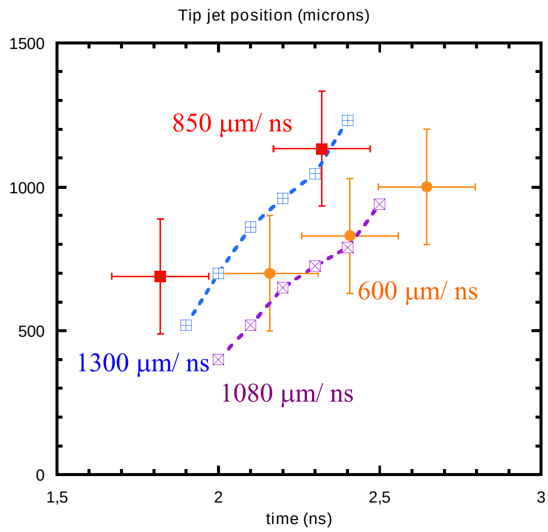


Figure 3 : Tip jet position in experiment and 2 simulations with different heat transport model
The origin is located at the base of the cone

The jet is formed far from the cone, at about 500 microns of its base, and it propagates along the axis up to the position of 1.2 mm.

The velocity of the jet, calculated from the position versus time, is higher in the simulations: about 1100 to 1300 µm/ns, compared to 600 to 900 µm/ns in the experiments.

The evolution of the jet length versus time is also well reproduced by both simulations, between 300 to 600 microns (figure 4).

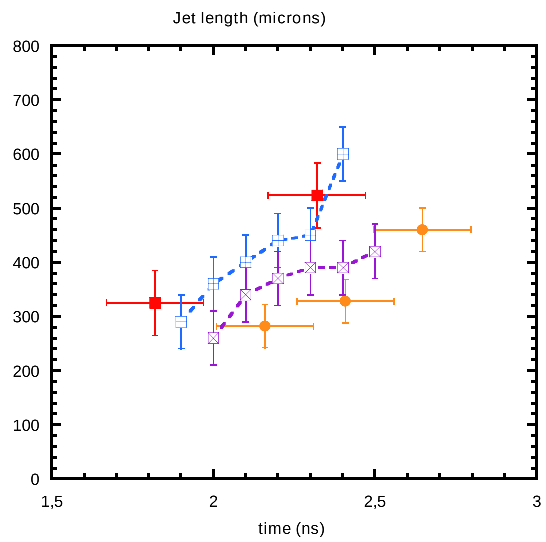


Figure 4 : Jet length in simulations and experiment. The origin is the base of the cone

## Conclusion

At the end of 2004, experiments were carried out to demonstrate the availability of LIL, a prototype of a LMJ quadruplet, as a facility to perform plasma physics experiments.

The creation of a radiative jet inside a glod cone was one of these very first experiments. The position and structure of the jet are in good agreement with the simulations performed with the CEA hydrodynamic radiative code FCI2.

During the year 2005, a series of action were undertaken to improve the quality of the beams and the alignment system. A complementary set of diagnostics was installed, to allow a new plasma experiments campaign, proposed and designed by the CELIA Laboratory [3] to measure the electron heat flux propagation in a CH planar target.

## References

[1] Farley and al., PRL, 83, 10, 1982 (1999)
[2] Shigemori and al., PRE, 62, 6, 8838 (2000)
[3] G. Schurtz and al., these proceedings