In-target electron thermalization by the Weibel instability during intense irradiation of a thin Aluminium foil

C. Ruyer[1], B. Albertazzi[1,3], L. Lancia, V. Dervieux, P. Antici,
J. Böcker, S.N. Chen, M. Nakatsutsumi, L. Romagnani, R. Shepherd, M. Swantusch,
M. Borghesi, O. Willi, H. Pépin, M. Grech[1], C. Riconda[1], L. Gremillet[2], J. Fuchs[1]
[1] *LULI, École Polytechnique, CNRS, CEA, UPMC, 91128 Palaiseau, France*
[2] *CEA, DAM, DIF, France*
[3] *Graduate School of Engineering, Osaka University, Suita, Osaka 565-087, Japan*

Proton-radiography of the electromagnetic fields developing after irradiation of a 3μm-thickness Al foil by a high-intensity laser ($1-5\times10^{19}$W.cm^{-2}, 8μm focal spot, 700fs FWHM) was performed at the TITAN facility. The obtained radiographs (Fig. 1) evidence filamentary structures which may develop inside the dense target, 300μm away from the focal spot and a few picoseconds after the laser drive [1]. We have examined the scenario according to which the observed radiographs structures are due to self-magnetized current filaments triggered by the so-called Weibel instability [2].

For this purpose, large scale particle-in-cell simulations (CALDER) of the laser-plasma interaction and target thermalization have been performed. They demonstrate the ability of the laser-heated electrons to sustain a temperature anisotropy (and thus the Weibel instability) during their relaxation in the thin conducting foil far from the focal spot. A parametric resolution of the resistive dispersion relation [3] highlights the critical influence of the weak amount of collisions in explaining the main characteristics (wavelength, time scale and magnetic field) of the observed structures.

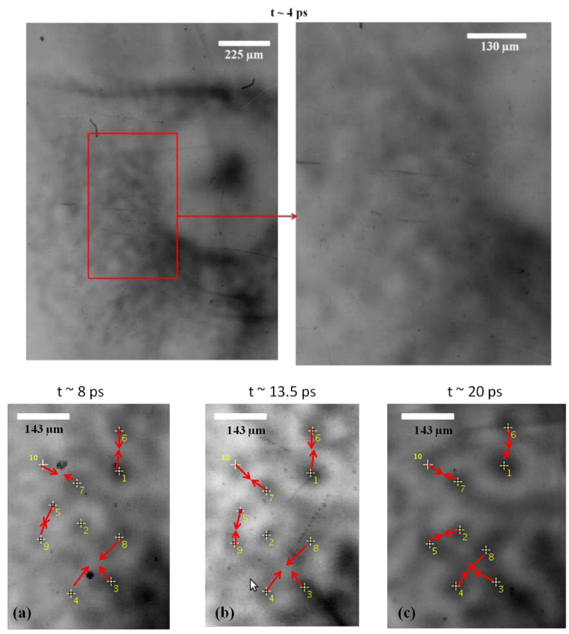

Figure 1: *Proton radiographs, 4, 8, 13.5 and 20ps after irradiation*

References

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[2] E. S. Weibel, Phys. Rev. Lett. **2**, 83 (1959)

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