Modelling of Laser-Plasma electron acceleration and X-ray radiation inside a capillary tube

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Laser-plasma acceleration of relativistic electrons above hundreds of MeV has been demonstrated in several places using TW or PW laser facilities. The physics involved of the injection of the electrons in the so-called bubble-regime and their further acceleration in the plasma wave is already well documented. There are, however, several issues that should be addressed in order to optimize the performances of a Laser Plasma Accelerator (LPA) for applications. In the present paper we will focus on specific guiding methods, using a capillary tube, allowing to accelerate electrons over several centimeters. Besides its capacity of guiding the high power infra-red laser beam, the inner-walls of the capillary tube acts as a diaphragm and also can reflect a part of the X-ray, betatron-like radiation emitted by relativistic electrons, yielding complex structures in the observation plane outside the plasma. Additional information can then be gained on the acceleration process by analyzing these structures.

We will present at the conference the results of our modeling of laser plasma acceleration of relativistic electrons in a capillary tube and of the generated X-ray radiation. This modeling has been performed through 2D PIC numerical simulations using the Warp code [2], the X-ray radiation being obtained through post-processing of the PIC-data. The theoretical data will be compared to experimental ones concerning both the energy spectra of the relativistic electrons and the X-ray diagnostics. Finally we will consider the acceleration process in a capillary tube over large distances in the context of multi-staged laser-plasma acceleration.