Focusing an intense relativistic electron beam for flash radiography

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Flash radiography is an imaging technique used at CEA and aimed to study dense objects in fast hydrodynamic evolution. In order to produce the X-rays required by the technique, a high energy (~20MeV) short duration (< 100ns) electron beam interacts with a high atomic number target foil [1]. The radiation are produced thanks to Bremsstrahlung effect in the foil. Focusing the electron beam on the target leads to a better resolution of the flash radiography image.

This work consists to study the focus of a relativistic electron beam (3.3MeV ; 60ns ; 1.9kA) thanks to a preformed plasma. This work is the continuation of the thesis of Thomas Lahens who has studied the propagation of an electron beam in a cylindrical glass full of helium gas and plasma [2]. He has shown that helium gas ($10^{-1} - 10^{-2}$ mbar) had an influence on the propagation of the electron beam comparing to vacuum ($\sim 10^{-6}\ mbar$) due to the ionization of atoms by the beam.

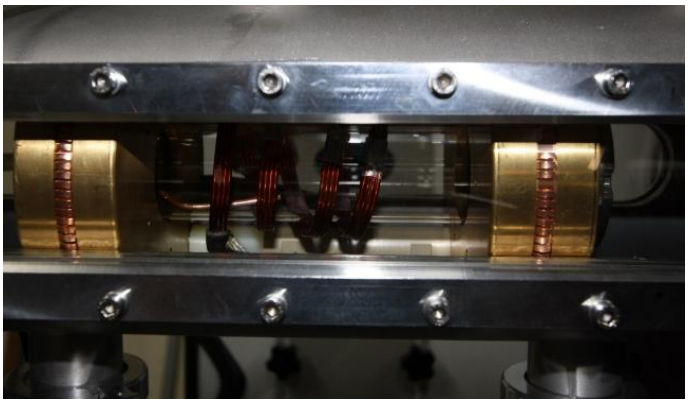

Figure 1 : *Experimental setup where the preformed plasma is generated*

In order to study the beam propagation in a preformed plasma, a high enough ionization degree is required to overcome the ionization of neutrals by the beam. Here we report how to produce a pulsed, low density plasma with ionization rate reaching $\sim 1\%$. A plasma at low pressure ($10^{-3} - 10^{-4}$mbar) is seeded by a high-voltage spark and further ionized by inductive heating in order to pre-ionize the gas before the propagation of the beam.

Références

[1] N. Pichoff, "Les nouvelles limites de la radiographie éclair." Clefs CEA n154, pp. 59-66.
[2] T. Lahens,Propagation d'un faisceau d'électrons relativistes intense de radiographieéclair dans un plasma froid. PhD thesis, Université de Bordeaux, 2019

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