3D MHD SIMULATION OF CAPILLARY DISCHARGE FOR THE BELLA PROJECT

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The project BELLA (Lawrence Berkeley National Laboratory, Berkeley, California 94720, LBNL, USA) is aimed to create an experimental facility for further advancing the development of laser-driven electron acceleration [1]. BELLA’s unique attribute is the ability to use laser light to accelerate an electron beam up to 10 GeV level in a comparatively short distance of approximately one meter. The acceleration takes place during the propagation of a high power femtosecond laser pulse in the plasma formed in a capillary discharge. This capillary plasma forms a plasma channel able to guide the laser pulse, which in its turn forms a plasma wake wave that accelerates the injected electrons.

To achieve a good coupling of a laser pulse with the capillary wave guide it is necessary to have a tool for the simulation of a 3D electron distribution inside the capillary, near the open ends of the capillary as well as near the channels supplying neutral hydrogen into the capillary.

We use the MARPLE3D code [2] to perform such simulations. MARPLE3D is an Eulerian numerical tool designed for simulations of radiative magnetohydrodynamic (MHD) problems related to experiments with magnetically driven high energy density plasmas. Here we discuss two types of numerically investigated problems.

First, we simulate the 3D process of the capillary filling with a cold hydrogen before the discharge is fired through the side supply channels. The main goal of this simulation is to get a spatial distribution of the filling gas in the region near the open ends of the capillary. The real geometry is used for this and the next stage simulations, including the insulators, the supplying channels as well as the electrodes.

Our second, the main stage, is the 3D MHD simulation of the capillary discharge. Its main goal is obtaining a time-dependent spatial distribution of an electron density near the open ends of the capillary as well as inside the capillary. The simulation of the 1st stage determines the initial hydrogen density distribution for the capillary discharge simulation.

Main results of the simulations of two types will be presented at the conference.

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References

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