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Gas cell target development for laser-plasma electron injector using OpenFOAM fluid dynamics solver and dedicated test bench

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Laser plasma acceleration [1] provides several advantages compared to conventional radio-frequency accelerators for electron source injectors: high accelerating gradients up to hundreds of gigavolts per meter (compactness) and short duration electron beams. However, the control of quality and stability of the produced electron bunches remains a challenge.

In this report we focus on the target design studies for the PALLAS project which aims to achieve reliability of conventional RF accelerators producing 150-200 MeV electron bunches in the injector stage, with a charge of 15-30 pC, at 10Hz with less than 5% energy spread. The laser pulse is provided by the LaseriX laser driver, yielding a 35fs laser pulse with 50TW peak field.

We present a two-chamber plasma cell design (N2-doped Helium and pure Helium) inspired from previous project [2] with electronic density in the range of 10^18cm-3. Optical measurements of the plasma channel and pressure measurements on a dedicated test bench are performed and compared with OpenFOAM [3] simulation results to validate our model. We then discuss our ability to confine the N2-dopant in the cell first chamber and the laser ablation lifetime. Finally, a review of the design in comparison with other laboratories experiments [4,5,6] is presented.

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