7th European Advanced Accelerator Conference

EAAC2025

Contribution ID: **457** Type: **Oral contribution**

TNSA proton beam focussing in a low-density plasma behind the target

Tuesday 23 September 2025 16:20 (20 minutes)

High-intensity lasers can accelerate protons through mechanisms such as target normal sheath acceleration, producing beams with picosecond pulse durations, high charge and low emittance. These beams are desirable for applications such as radiobiology, warm dense matter and radioisotope generation; however, for these applications to become viable, challenges that need to be addressed include reducing the high divergence of these sources (10s degrees) and achieving multi-Hz operation. Experiments have demonstrated that propagation of a proton beam through low-density media immediately behind the source can reduce the proton beam divergence by an order of magnitude, due to the generation of focussing magnetic fields [1]. This presentation will discuss recent experiments that have studied this focussing effect further using a multi-cm gas cell containing a low-density gas (10^16 –10^17 cm^-3) behind a foil target, producing beams with a divergence below 3°. A low-density plasma behind a target, through using liquid sheet targets or a low-density gas behind a solid target, presents an opportunity for the development of simple, low-divergence, high-repetition-rate compatible proton sources, ideal for applications.

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Session Classification: PS6: Ion acceleration and developments towards fusion

Track Classification: PS6: Ion acceleration and developments towards fusion