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Progress on laser-driven experiments on Proton-Boron Fusion

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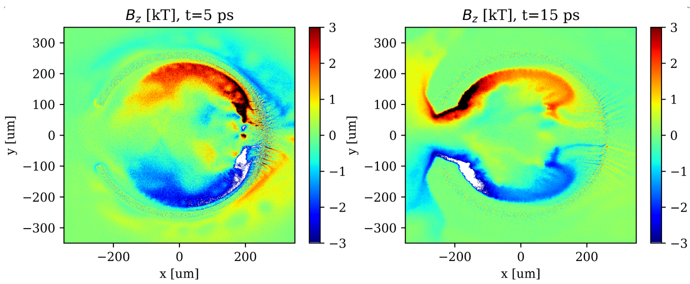
In recent years several experiments using lasers have been performed on the topic of Proton-boron (p-11B) fusion, which included several goals:

1) Understanding the physics of laser-driven Proton-Boron Fusion, and evaluating the challenges towards the utilization of laser-driven Proton-Boron Fusion for Energy
2) Optimizing existing diagnostics and developing new ones with the goal of performing more accurate measurements of the number of reactions taking place
3) Studying the possibility of developing high-brightness a-particle sources with applications to physics experiments and production of radioisotopes for medical use.

In the talk, I will present the results of recent experiments performed using the laser VEGA at CLPU in Salamanca, Spain, the laser Phelix at GSI Darmstadt, Germany, and the laser LFEX at the Institute of Laser Engineering of the University of Osaka in Japan.

In particular, two experimental campaigns were conducted at the LFEX laser facility using PW-class laser systems (energy ~ 1.2 - 1.4 kJ, duration 2.7 ps, intensity ~2-3 × 10^{19} W/cm^2) to investigate the impact of complex target geometries including spheres, cylinders, and wedges targets on α-particle yield. Our findings reveal that spherical targets produce an increase in α-particle yield up to two orders of magnitude that of flat targets of the same composition, with a notable shift in the α-particle spectrum towards higher energy values. Additionally, we successfully implemented a novel method for unambiguous α-particle detection using CR-39 detector within a Thomson Parabola spectrometer. Particle-in-cell (PIC) simulations with the Smilei code further elucidate the influence of self-generated magnetic fields on particle dynamics, highlighting the intricate relationship between target confinement and fusion efficiency. The figure shows the magnetic fields, calculated with SMILEI, inside the irradiated sphere at two different times (here the laser enters the sphere from a hole on the left side, at $x \approx -200\ \mu m$, and is focused on the inner surface at $x \approx +200\ \mu m$). These results provide valuable insights into the possibility of optimizing target designs for enhancing fusion yield and α-particle generation in pB fusion with possible application to developing laser-driven α-particle sources and a broader relevance to clean energy



production.

Magnetic fields in the sphere at two different times

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