9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Proton-boron nuclear reaction in plasma initiated by laser-accelerated protons both in pitcher-catcher and in-target scheme

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Compared with DT thermal nuclear fusion scheme, proton-boron fusion attracts less attention because it requires higher temperature for the maximum cross section and it is difficult to realize the energy gain over the bremsstrahlung loss. However, high power lasers open the path to fusion under non-equilibrium condition like fast ignition scenario but the fuel is boron. In this way, the protons will not only serve as the heating source but directly induce nuclear reaction. In this talk, we will introduce our recent results concerning the proton-boron nuclear reaction in plasma initiated by laser-accelerated protons with both pitcher-catcher and in-target schemes.

In the pitcher-catcher scheme, we experimentally created CHOB plasma (T~17 eV, ne~4·1020 cm-3) through heating a foam target with nanosecond-laser-induced hohlraum radiation in the soft x-ray regime. Intense proton beam was generated through target normal sheath acceleration mechansim based on high-power picosecond laser. In this way, we can have very good knowledge about the beam and target parameters. The preliminary results show that the reaction product yield is enhanced in plasmas compared with cold matter, and the yield increases with beam intensity non-linearly.

In the in-target scheme, we focused the picosecond laser into the porous-structured CHOB target. In comparison with laser-foil interactions, higher number of protons are observed along the target normal direction as well as in directions perpendicularly to the laser propagation direction. Higher-yield of pB nuclear reaction is corresponding obtained. This provides a perspective way for laser-driven pB nuclear reaction studies and compact α sources.