Progress of p-11B Research for Fusion Energy at ENN

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Proton-boron (p-11B) fusion, an aneutronic pathway to clean energy, faces challenges including extreme plasma conditions, cross-section uncertainties, and unthermalized plasma physics. This work highlights ENN's advancements in three areas: reaction physics, fusion rate enhancement, and magnetic confinement integration.

Recent p-^{11}B cross-section measurements validate historical data while extending Rider's model [1] to high temperatures (hundreds of keV) and alpha-heating effects. Simulations [2] reveal a net energy gain window at electron temperatures >130 keV, with recirculating power loss minimized at $T_e/T_i \approx 0.5$, enabling Q-fusion >10. Fusion rate enhancement experiments [3] demonstrate a 30% increase in alpha yield using mixed hydrogen-boron targets under 120–260 keV proton beams. Theoretical study on fuel polarization for p-^{11}B will be presented.

In magnetic confinement systems, projections for the EHL-2 spherical torus [4] predict 1.5×10^{15} and 5×10^{14} alpha particles/s for thermal-thermal and beam-thermal reactions under 200 keV neutral beam injection. EXL-50U experiments [5] explore ICRH-NBI synergy, achieving 5×10^{8} alpha particles/s with 20 keV NBI and 1.5 MW ICRH. Diagnostics for alpha and gamma-ray detection are under development to support reactor control.

Collaborative efforts across accelerators, lasers, and magnetic devices underscore ENN's progress in addressing p-^{11}B fusion challenges. Key milestones include validating cross-sections, demonstrating nonlinear yield enhancements, and advancing reactor-relevant scenarios.

References

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