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Developments on the Laser-Driven Neutron Source and Single-shot Resonance Spectroscopy at ILE Osaka

Monday, October 6, 2025 10:00 AM (30 minutes)

The Laser-Driven Neutron Source (LDNS), a novel approach to neutron generation, has attracted significant attention due to its capability to produce neutron pulses with ultra-short duration and high flux [1]. In this presentation, we introduce our recent progress on high-flux neutron generation [1] and single-shot neutron resonance spectroscopy using LDNS [2]. In our experiments, the petawatt LFEX laser was focused onto a CD foil target to accelerate protons and deuterons. These accelerated ions subsequently interacted with a cylindrical beryllium target used as a neutron converter. Through nuclear reactions such as $^9\text{Be}(p, n)^9\text{B}$ and $^9\text{Be}(d, n)^{10}\text{B}$, neutrons were generated with yields up to $\sim 10^{11}$ per pulse and durations shorter than 1 ns [1]. The generated high-energy neutrons were moderated to epithermal and lower energy ranges (meV–eV) using a high-density polyethylene (HDPE) block. A neutron beamline of 1.8 m was developed to measure neutron resonance absorption peaks near 4.28 eV from a tantalum sample heated to various temperatures. The measured neutron resonance widths exhibited clear temperature dependence due to Doppler broadening. We have successfully demonstrated isotope-selective nuclear thermometry with LDNS in a single-shot mode. The correlation between resonance width and sample temperature was determined in the range from approximately 300 K to 650 K [2]. Such single-shot, resonance-based temperature measurements would be practically impossible with conventional accelerator-driven neutron sources due to insufficient neutron flux. Detailed experimental results and their implications will be discussed.

[1] Akifumi Yogo et al, PRX 13, 011011 (2023)

[2] Zechen Lan et al, Nat. Commun. 15, 5365 (2024)

Primary author: LAN, Zechen (ILE, Osaka Univ.)

Co-authors: Prof. IWAMOTO, Akifumi (ILE, Osaka Univ.); Prof. YOGO, Akifumi (ILE, Osaka Univ.); Dr MORACE, Alessio (ILE, Osaka Univ.); Prof. KODAMA, Ryosuke (ILE, Osaka Univ.); Mr YAMADA, Ryuya (ILE, Osaka Univ.); Dr MIRFAYZI, Seyed Reza (Tokamak Energy Ltd); Prof. FUJIOKA, Shinsuke (ILE, Osaka Univ.); Dr HAYAKAWA, Takehito (KPSI, QST); Dr WEI, Tianyun (KPSI, QST); Prof. ARIKAWA, Yasunobu (ILE, Osaka Univ.); Dr ABE, Yuki (Osaka Univ.)

Presenter: LAN, Zechen (ILE, Osaka Univ.)

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