

Experimental Demonstration of Fast Neutron Absorption Spectroscopy Driven by Repetitive Laser Neutron Source

Reporter: Hao Xu

Supervisor: Wenchao Yan, Liming Chen

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Laser driven acceleration and neutron sources

Laser Wakefield Acceleration (LWFA)



Photonuclear reaction



Jang et al., Electron linear accelerator for medical radionuclide production(2023)



Xu et al., Nuclear Science and Techniques(2025)

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Fast Neutron absorption spectroscopy (FNAS)

Nondestructive detection



https://en.wikipedia.org/wiki/TNT Buffler et al., Radiation Physics and Chemistry(2004) Heritage reservation



Tang et al., Nuclear Science and Techniques(2024)

Potential solution for nuclear science puzzle







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Neutron signals by n-Time of Flight (n-ToF)

Single neutron counting (SNC) signal



$$E_n = \frac{1}{2} \cdot m_n \cdot \left(\frac{L}{\Delta t + \frac{L}{c}}\right)^2$$

$$\delta E_n = \sqrt{\frac{(\gamma + 1)^3 E^3}{m_0 L^2}} \delta t_n = 0.02 \text{ MeV } @0.5 \text{ MeV}$$

Reconstructed neutron energy spectrum with Mg





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Refined neutron spectrum with Mg absorber

Pulse shape discrimination (PSD) result



Neutron spectrum after PSD



- Absorber: 5cm Mg, with natural abundance
- Successfully extract photonuclear neutron signal from background
- The resonance structure (marked as star ★)is clear resolved and accurately positioned

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Fast neutron absorption spectroscopy analysis



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Discussion

What is the merits of Laser driven neutron source (LDNS) for FNAS?







Future work

• Q: Higher efficiency?

A: High frequency supersonic gas jet generator and differential chamber system

Q: Higher signal to noise ratio?

A: Better scintillator detector and advanced PSD technique etc. CLLB (Cs₂LiLaBr₆:Ce) scintillator with ANN

• Q: Higher resolution?

A: Optimized converter/absorber and detection system





Monzac et al., arXiv:2410.21309 (2025)

Greb et al., Instruments (2024)





Thank you for your listening!



GDR and Photonuclear process





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