Invited

シングルショット共鳴分光を実現するレーザー駆動中性子源

° Zechen Lan, Yasunobu Arikawa, Mirfayzi Seyed Reza[1], Alessio Morace, Takehito Hayakawa[2], Yuki Abe, Tianyun Wei, Takato Mori, Takashi Kamiyama[3], Hirotaka Sato[3], Yuta Tatsumi, Mitsuo Nakai, Hiroaki Nishimura, Kunioki Mima, Shinsuke Fujioka and Ryosuke Kodama and Akifumi Yogo. (Institute of Laser Engineering, Osaka Univ., [1]Tokamak Energy Ltd, UK, [2]National Institute for Quantum Science and Technology, [3]Hokkaido Univ.)

1. Introduction

In recent decades, neutron resonance diagnosis technology has been developed and significantly concerned for non-destructive detection and isotope identification. As a new approach of neutron generation, the Laser-Driven Neutron Source (LDNS) has been reported to combine the ultra-short pulse duration and high flux[1)]. By setting a converter downstream from the laser-accelerated ion source, the high energy ions generate neutrons with an yield of up to ~10^{11} within 1 ns via nuclear reactions such as $^{9}Be(p,n)^{9}B$ and $^{9}Be(d,n)^{10}B$. By adding a moderator to the secondary target, the neutrons could be moderated to epithermal energy (~eV), providing a new approach to achieve neutron resonance diagnosis with high accuracy and small size. Therefore, the minimal change of neutron resonance peaks caused by Doppler broadening effect of atom temperature could be detected via single pulse of LDNS.

2.Experiment

The experiments were performed at ILE, Osaka Univ., Japan. The experimental setup is shown as Fig.1, the petawatt laser LFEX was focused on a deuterated polyethylene foil target as an ion acceleration source. A cylindrical beryllium encased by a high-density polyethylene (HDP) moderator was used as the epithermal neutron source. The resonance samples (Ta, Ag and In metallic foil) were set in the beamline. The neutron TOF detector was at 1.8 m far from the main target, consisted of a time-gated PMT and a ^{6}Li glass scintillator. We firstly measured resonance peaks at 3.81 eV of In, 4.28 eV of Ta and 5.19 eV of Ag respectively (Fig.2). Furthermore, the Ta plate was heated to higher temperatures (300K-600K) to demonstrate the Doppler broadening in the resonance peak. The experimental data shows the feasibility of isotope-discriminating atomic thermometer using a single shot of LDNS. More results will be reported in the presentation.

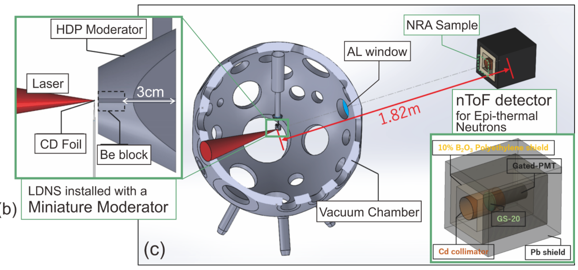

Fig.1 Experimental setup[1)]

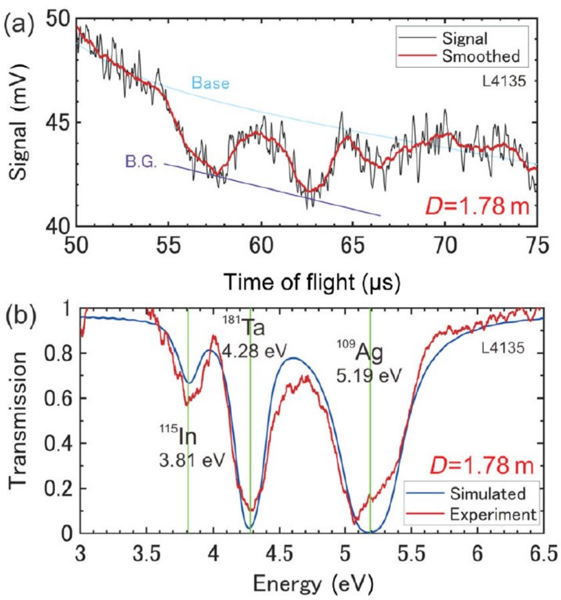

Fig.2 Experimental results[1)]

References

1) A. Yogo and Z. Lan et al., Phys. Rev. X 13 011011 (2023).