24P32

細孔充填型液体シンチレータを用いた核融合14 MeV中性子検出器の開発
Development of Directional 14 MeV-Fusion Neutron Detector using Liquid Scintillator Filled in Capillaries.

勅使川原 応恭[1], 高田 英治[2], 隅田 脩平[3], 篠原 孝司[4, 3],
西谷 健夫[5], 小川 国大[6, 7], 磯部 光孝[6, 7]
Masataka TESHIGAWARA[1], Eiji TAKADA[2], Shuhei Sumida[3], Kouji SHINOHARA[4, 3],
Takeo NISHITANI[5], Kunihiro OGAWA[6, 7], Mitsutaka ISOBE[6, 7]

[1]富山高等専門学校, [2]国立高等専門学校機構, [3]量子科学技術研究開発機構, [4]東京大学,
[5]名古屋大学, [6]核融合科学研究所, [7]総合研究大学院大学
[1]NIT, Toyama, [2]NIT, [3]QST, [4]Univ. Tokyo, [5]Nagoya Univ., [6]NIFS, [7]SOKENDAI

1. Introduction

In deuterium discharges in fusion plasma experimental devices, it is essential to estimate the behavior of D-T reaction-produced α-particles. In D-D plasma, a D-D reaction-produced 1 MeV triton, which is considered to simulate the α-particle, decelerates and undergoes a D-T reaction to emit a 14 MeV neutron. Therefore the generation rate of 14 MeV neutrons is measured to study the α-particles behavior with a scintillating optical fiber detector. This detector has excellent selectivity against low-energy neutrons and directionality for 14 MeV neutrons but cannot discriminate between neutrons and γ-rays using the pulse shape discrimination (PSD) technique. In this study, we devised a fast neutron detector that is directional to 14 MeV neutrons and can discriminate neutrons and γ-rays using the PSD method by filling capillaries with liquid scintillator. The directionality and PSD capability for fast neutrons were investigated by a fast neutron generator.

2. Methods

The detector consists of 144 capillaries (50 mm long and 2.0 mm in diameter) filled with liquid scintillator (EJ-301, Eljen technology) in an aluminum housing, which is coupled to the photomultiplier tube (H11934-100-10, Hamamatsu). The output signal was directly digitized by using a digitizer (DT5751, CAEN). The charge integration method was used for the PSD, where two time gates were applied to the pulse and the charges contained in each were integrated (Q_{short} [a.u.] and Q_{long} [a.u.]). To reveal the directionality of the detector, around 18 MeV neutrons generated by a fast neutron generator were irradiated from the direction of 0° to 90° to the detector. Moreover, to elucidate the capability to discriminate between neutrons and γ-rays, PSD was performed using $(Q_{long}-Q_{short})/Q_{long}$ as the PSD parameter.

3. Result and Conclusion

Fig. 1 shows the incident angle dependence of the Q_{long} distribution with pulse height>49 [mV]. The smaller the incident angle, the more the pulse count increases. Therefore, events with small incident angles can be selectively measured. However, the angular resolution is modest because the scintillation light is attenuated by multiple reflections with the wall of the housing. As shown in Fig. 2, PSD was performed for events with Q_{long}>300, and contributions from neutrons and γ-rays were extracted by fitting with the gaussian mixture model. In the future, we aim to improve the angular resolution by changing the housing material to increase the collection efficiency of scintillation light. In addition, PSD parameters can be optimized to better PSD performance.

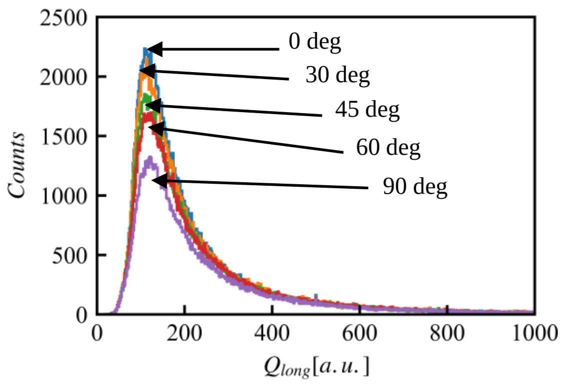

Fig.1 Q_{long} distribution as a function of incident angle of neutrons.

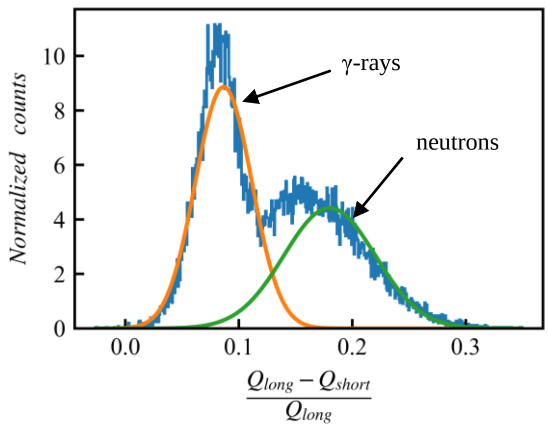

Fig.2 PSD parameter distribution of γ-rays and neutrons. The two peaks were fitted by the gaussian mixture model.