Preliminary Studies of Liquid Scintillator-Based Neutron Detection for muCF Experiments

The University of Osaka

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Purpose of n/γ separation

- In the fusion process such as $dt\mu \rightarrow \alpha + n + \mu + 17.6\ \mathrm{MeV}$, a neutron with an energy of 14 MeV is emitted.
- To confirm whether fusion occurs, detecting these neutrons is crucial.
- However, neutron detection is difficult due to a high background of gamma rays.

I am working on n/γ separation.

How to Separate Neutron and Gamma Rays

- Neutron Detector : Liquid scintillator NE213

- Data analysis : Pulse Shape Discrimination (PSD)
  - The interaction of neutrons with the scintillator material results in a slower release of light than gamma pulse.
    → Pulses from neutron has longer tail.

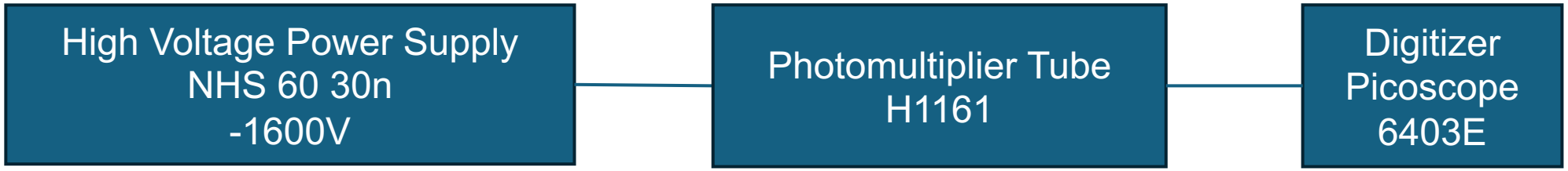
I am currently learning the PSD analysis technique.

Measurement by using gamma-ray source

Purpose

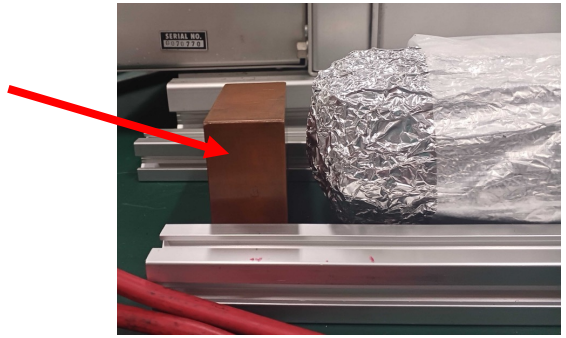
- To measure gamma-ray energy spectrum

Measurement system



Set up

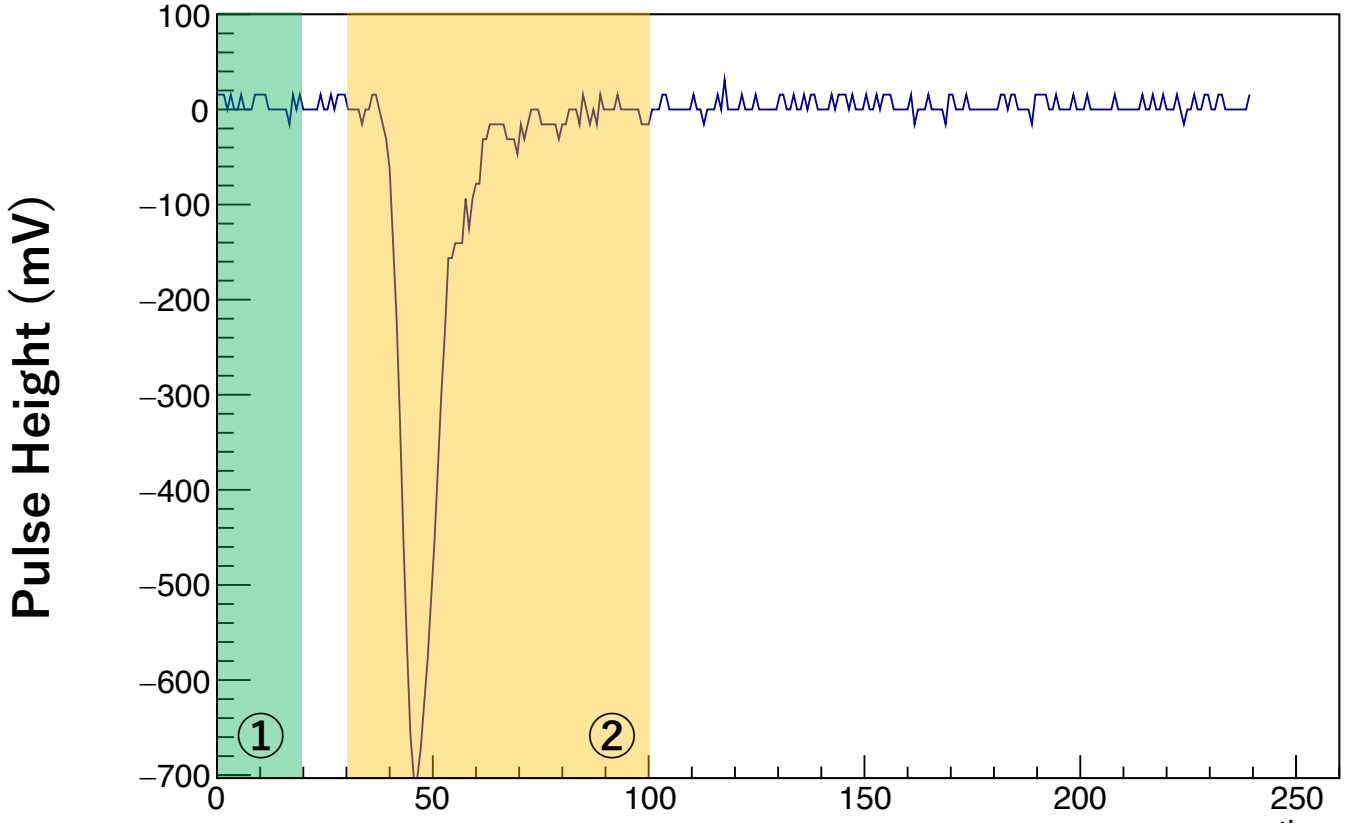
^{22}Na or ^{60}Co source inside collimator



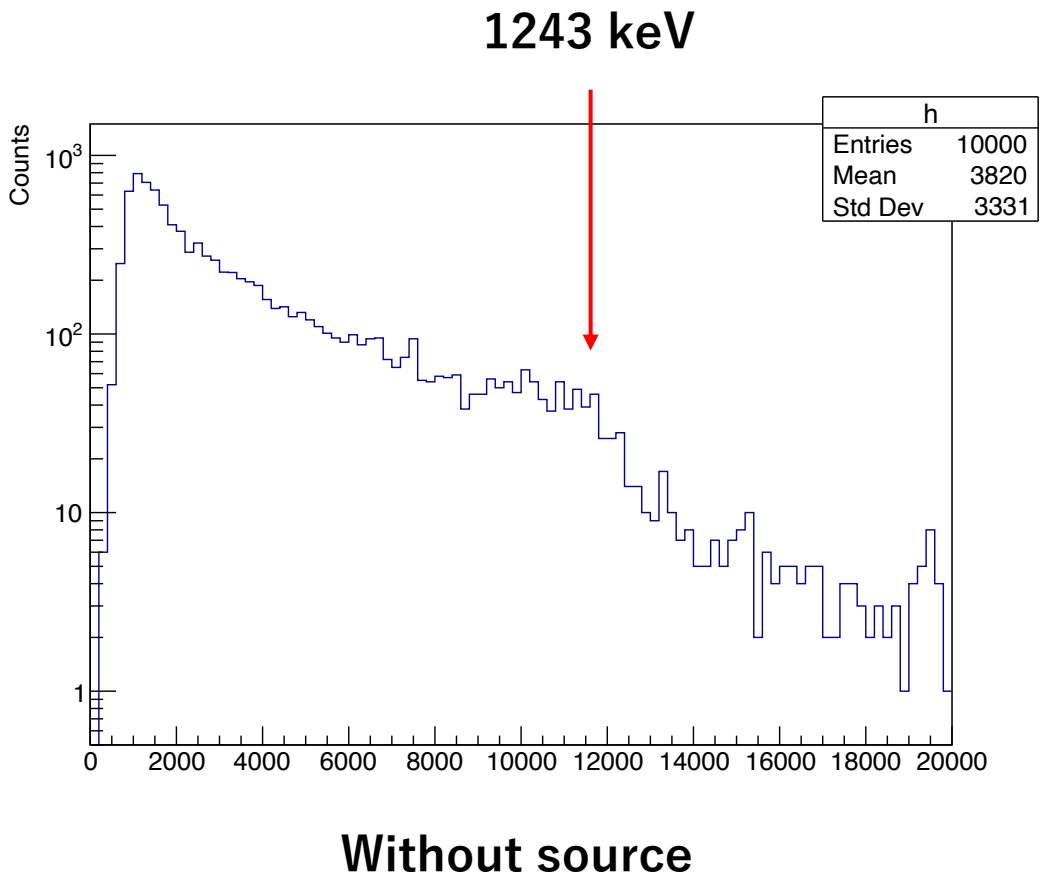
Waveform Integration

① Calculate the pedestal as the average of the first 20 sampling points.

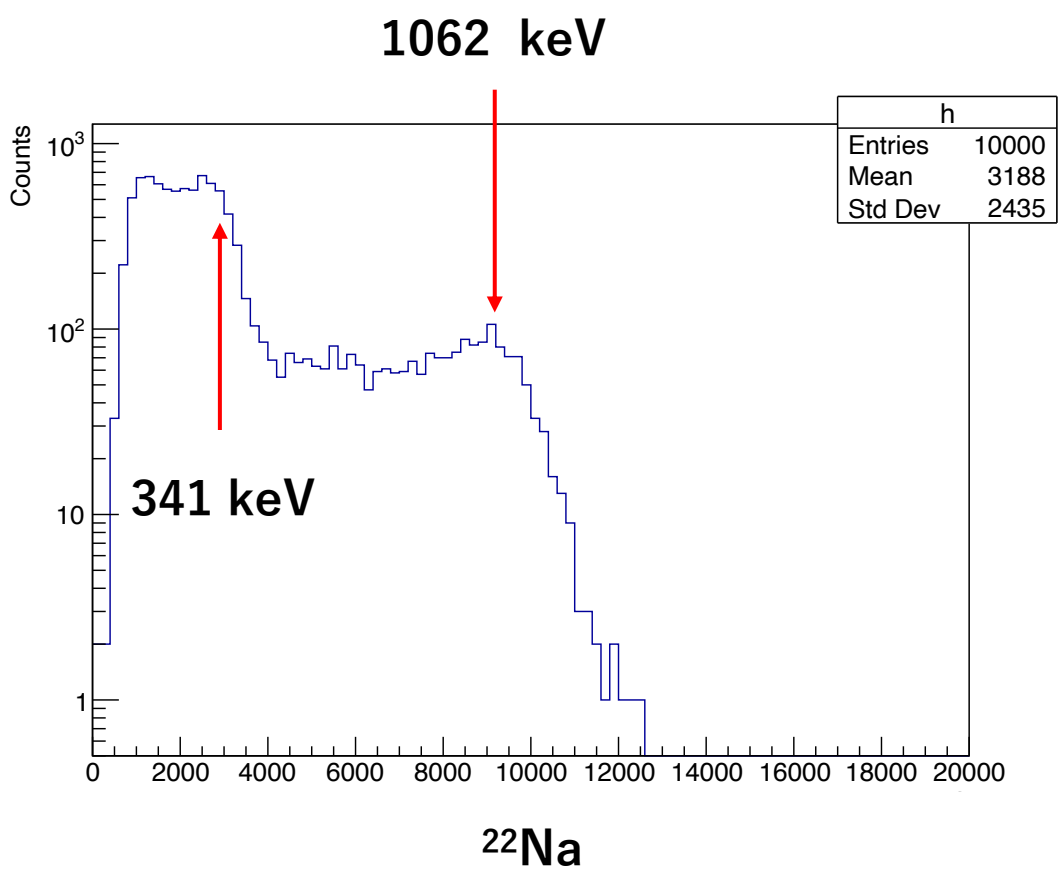
② Integrate the waveform from points 30 to 100 by summing the “voltage minus pedestal” values.



Compton Edge of ^{22}Na



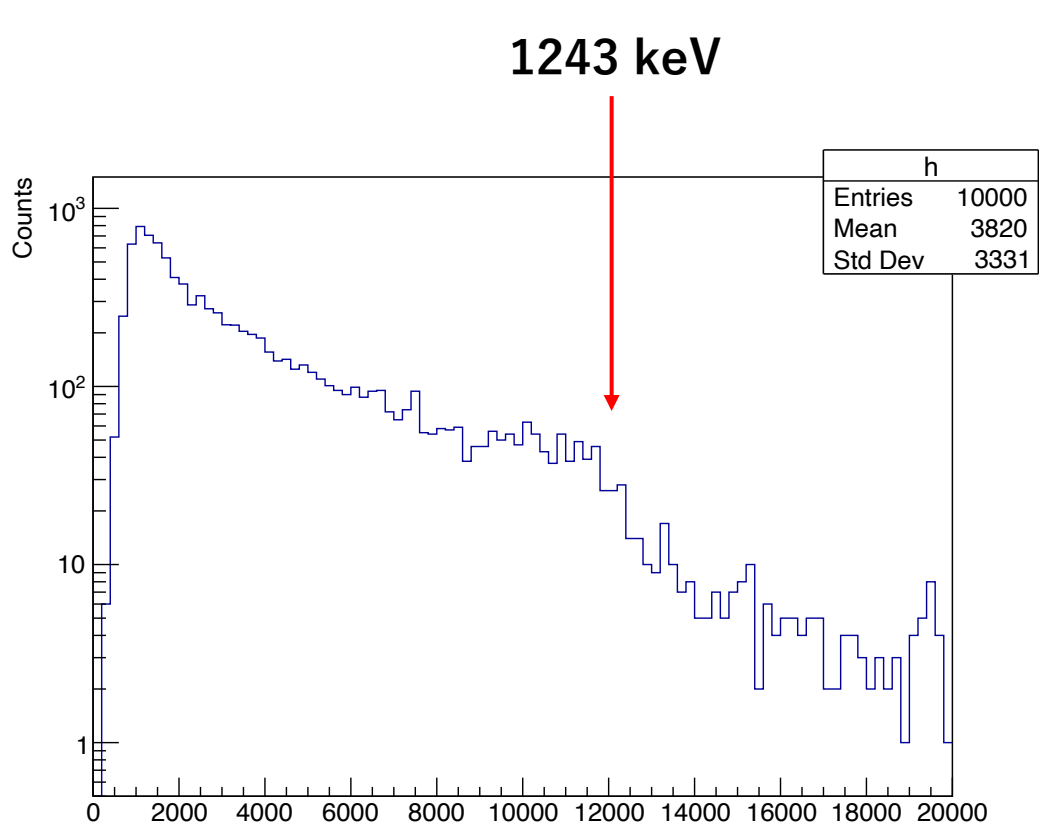
Without source



^{22}Na

The Compton edges corresponding to the 511 keV and 1275 keV gamma rays were identified.

Compton Edge of ^{60}Co



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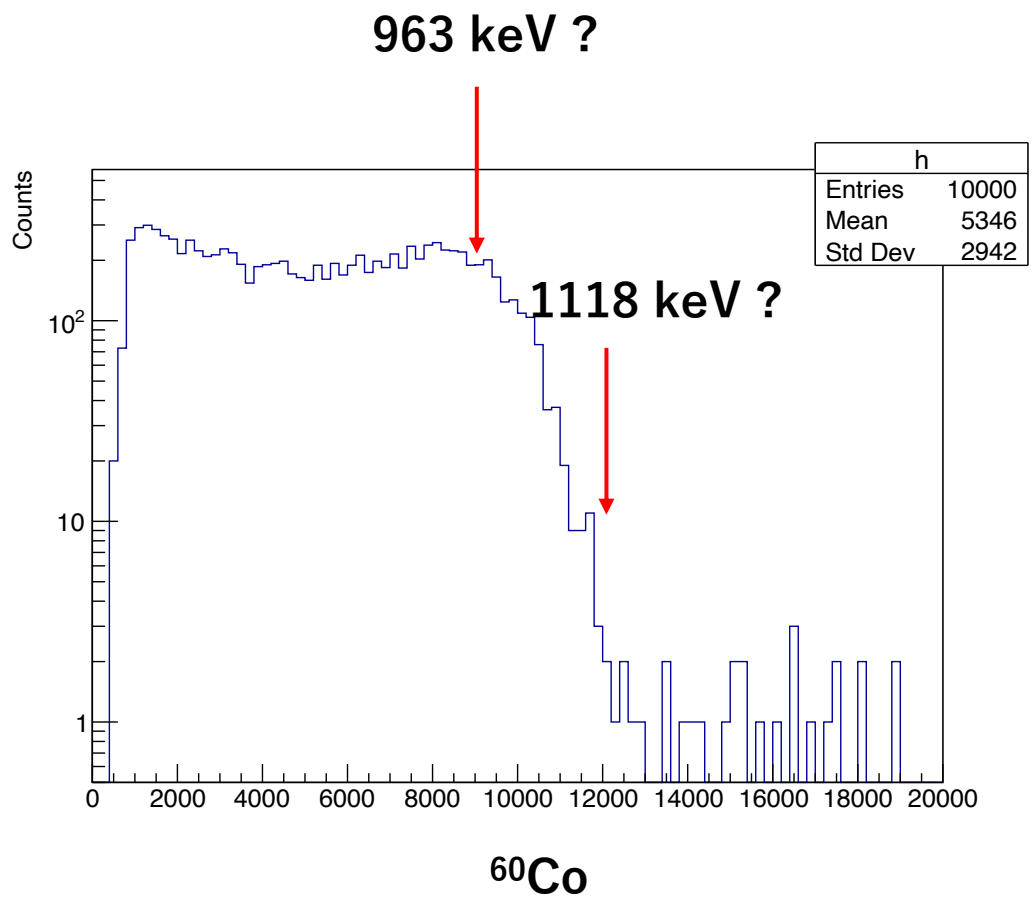


^{60}Co

Although not clearly visible, the expected Compton edges from the 1173 keV and 1332 keV gamma rays can be identified.

Measurement Using ^{241}Am-Be Source

Purpose

・Acquire data fpr practicing Pulse Shape Discrimination
→ ^{241}Am-Be source emits both neutrons and 4.4 MeV gamma rays.

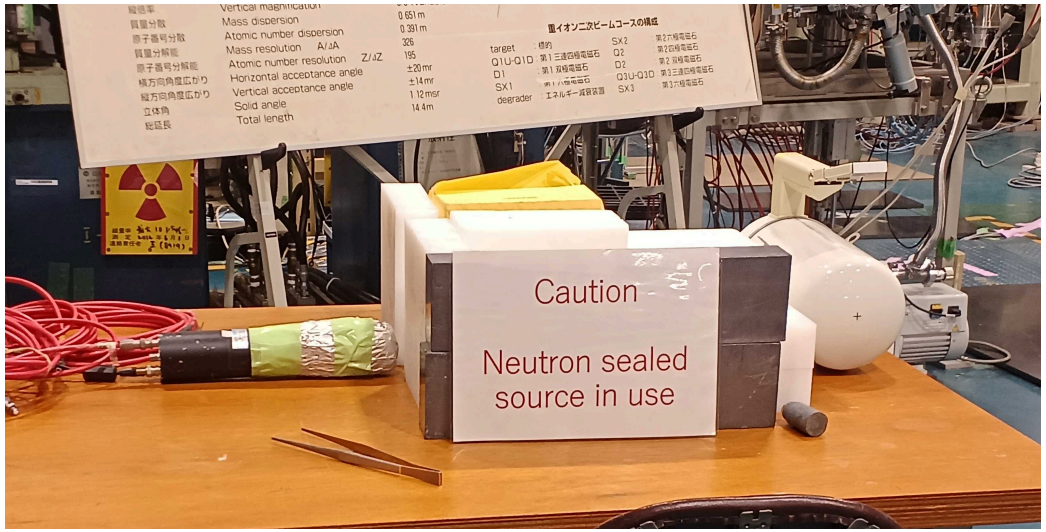
Measurement

・Place：Research Center for Nuclear Physics, The University of Osaka
・Date：June 16th, 2026

Measurement system

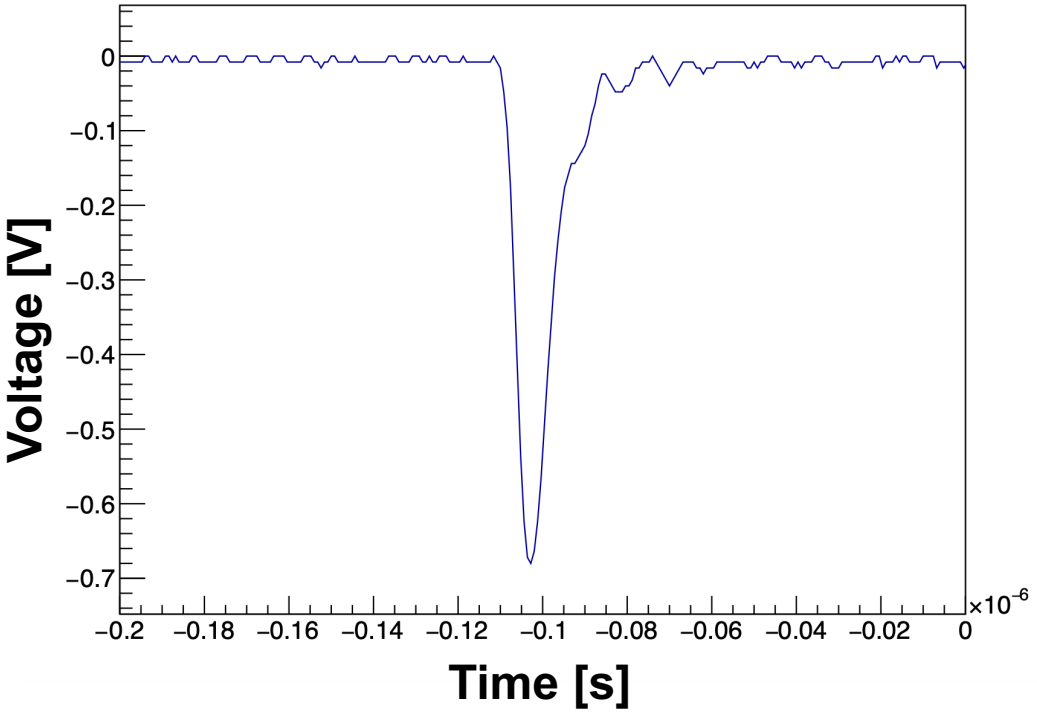
Measurement by using ^{241}Am-Be

Set up



Waveform data

Self-triggered acquisition



Data analysis is currently in progress.

Future Plans

Future plans

- Establish a neutron measurement environment
- Improve pulse shape discrimination (PSD) to detect neutrons over a wide energy range

Objectives

- Confirm whether fusion occurs
  → Detect high-energy neutrons up to 14.4 MeV
- Improve detection efficiency
  → Lower the detection threshold to below 100–200 keVee