SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

T4.5-242

NaIL-detector characteristics as neutron detector and gamma detector

Monika Risse, Theo Köble, Thorsten Teuteberg, Hermann Friedrich

Business Unit Nuclear Security Policy and Detection Techniques,
Fraunhofer INT, Euskirchen, Germany

Fraunhofer INT

Fraunhofer Institute for
Technological Trend Analysis INT

INTRODUCTION AND MAIN RESULTS

Simultaneous gamma and neutron detection is valuable for verification tasks. The NaIL detector (NaI doped with ^{6}Li) allows both in a single device.

This presentation shows results from measurements with different neutron and gamma sources. With the NaIL detector, identification of different neutron sources is possible. Achieving good gamma spectra at the same time is challenging; optimal settings still need to be found.

SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

NaIL-detector characteristics as neutron detector and gamma detector

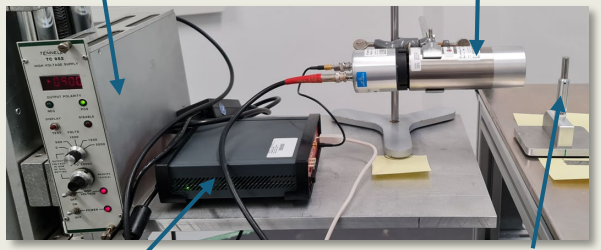
Monika Risse, Theo Köble, Thorsten Teuteberg, Hermann Friedrich

T4.5-242

Measurement Setup - PSD

high voltage power supply
+900 V

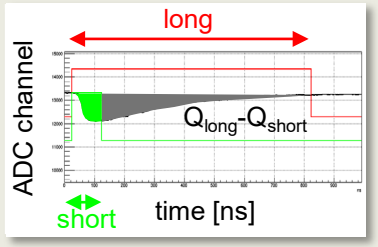
NaIL detector:
scintillator: ∅ 50 mm, lenght 50 mm
photomultiplier tube



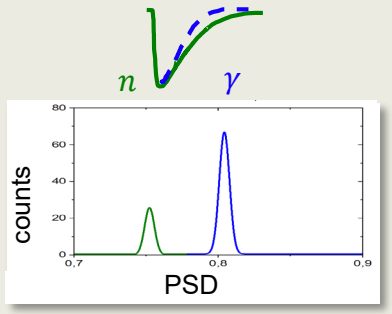
digitizer
CAEN DT5730S

source

Sodium iodide (NaI:Tl) is widely used for gamma detection. In NaIL (NaI:Tl,^{6}Li), neutrons are captured by ^{6}Li via the ^{6}Li(n,t)α reaction. With a high Q-value of 4.78 MeV, these signals are comparable to high-energy gamma photons. Neutron–gamma discrimination is achieved by pulse shape analysis (PSD).



pulse shape differs for n and γ

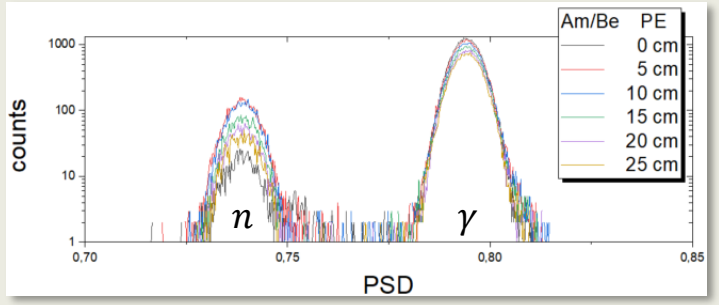


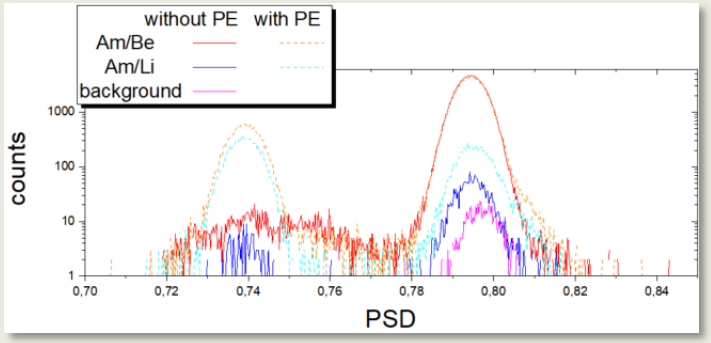
$$PSD = \frac{Q_{long} - Q_{short}}{Q_{long}}$$

Neutron Measurement – PSD

source	activity [Bq]	source strength [n/s]	n - energy [MeV]
DU	2.3e8	250	2-3
^{252}Cf	5.5e4	9000	2-3
Am/Li	4.3e10	53000	1
Am/Be	3.4e9	200000	4-5

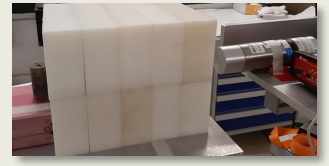
NaIL is specially sensitive to thermal neutrons: Use of polyethylene material PE is necessary.

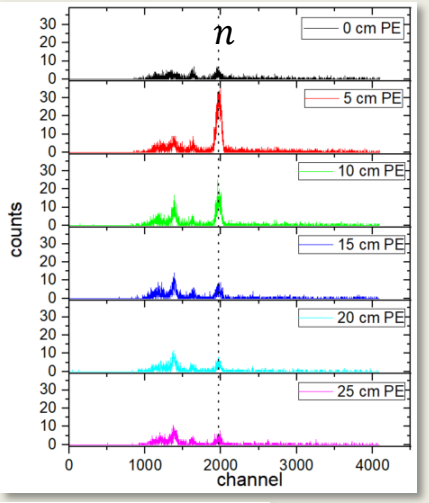




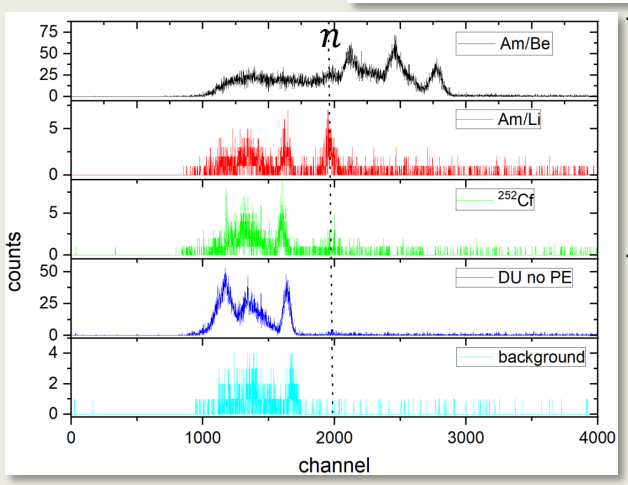
Neutron Measurement – Spectra

Am/Li source,
35 cm distance,
10 min





No PE:



35 cm
10 min

100 cm
3h

10 min

Different neutron sources can be distinguished.

Fraunhofer INT

SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

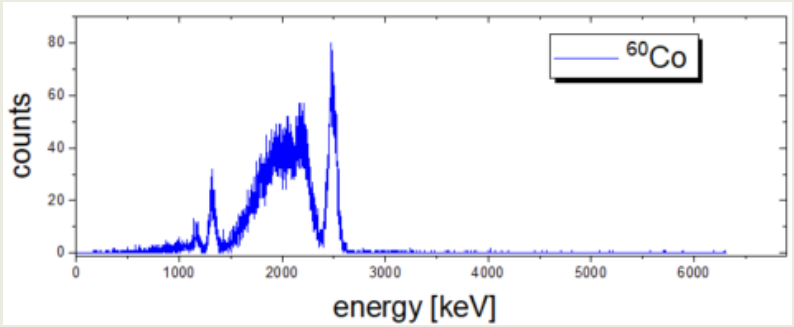
NaIL-detector characteristics as neutron detector and gamma detector

Monika Risse, Theo Köble, Thorsten Teuteberg, Hermann Friedrich

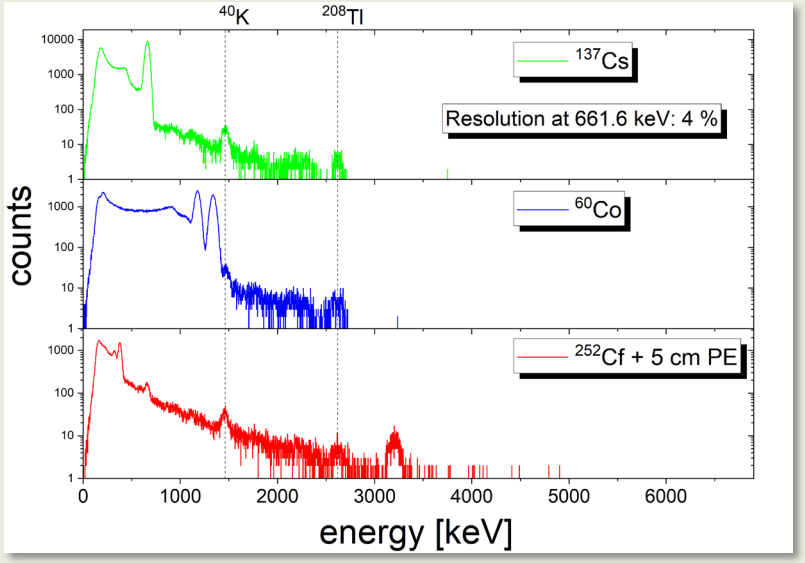
T4.5-242

Gamma Spectra – Settings dependent

Gamma spectrum with settings optimized for neutron measurements / PSD

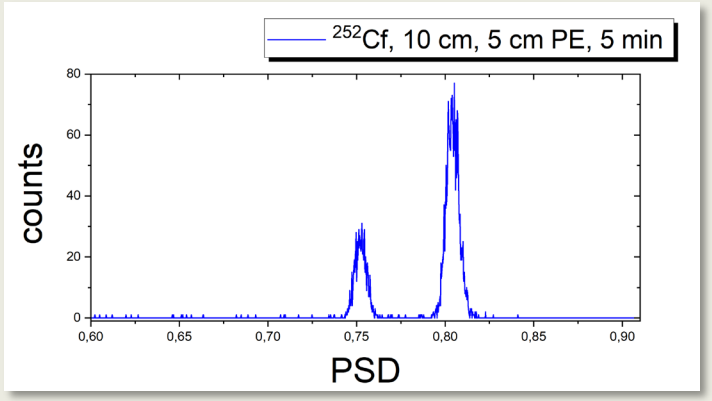


Gamma spectra with settings optimized for gamma measurements.

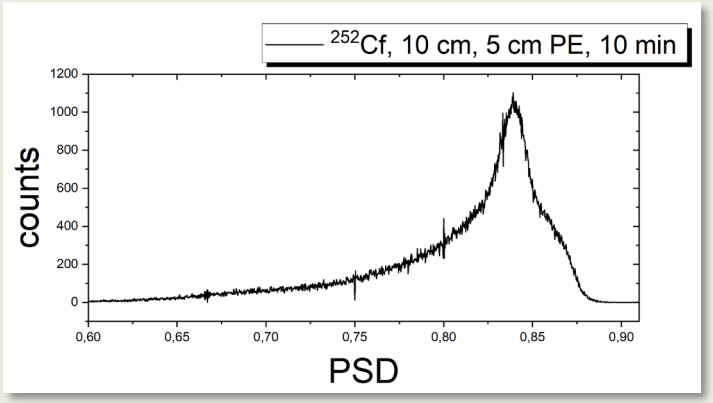


PSD Spectra – Settings dependent

PSD spectrum with settings optimized for neutron measurements / PSD.



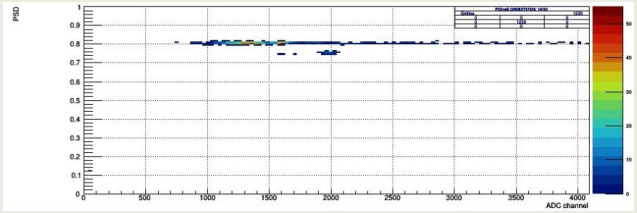
PSD spectrum with settings optimized for gamma measurements.



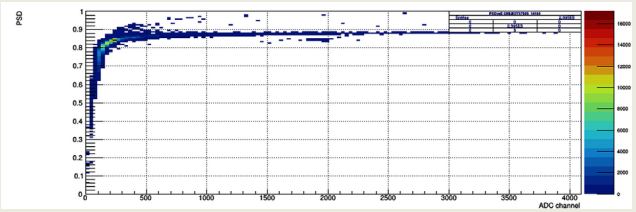
Results

The NaIL detector is well suited to determine in a single measurement whether neutron and/or gamma sources are present. Different neutron sources can be reliably identified. Optimum settings for neutron detection impair gamma spectra quality, while gamma-optimized settings yield good resolution but poor neutron PSD.

PSD vs. Channels with settings optimized for neutron measurements / PSD.



PSD vs. Channels with settings optimized for gamma measurements.



A balanced configuration is therefore required. With further optimization, the NaIL detector shows strong potential for on-site inspections combining neutron and gamma source identification.

Fraunhofer INT