SiPM with NaI/BGO Scintillators approach as Compton Suppressors for FIPPS

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Description

Thermal neutron capture gamma-ray spectroscopy and prompt gamma-ray spectroscopy of fission fragments are powerful tools to obtain detailed nuclear structure information. Thanks to EXILL success, FIPPS (Fission Product Prompt Spectrometer) has been installed permanently at the Institut Laue-Langevin (ILL) to continue these experiments.

- It consists of a pencil neutron beam surrounded by an 8 Ge clover array which has been commissioned recently.
- In its second phase, a recoil spectrometer based on a gas-filled magnet will be added.

As such, the signal from Anti-Compton Shields (ACS) cannot be read by conventional photomultiplier tubes (PMT). Could Silicon Photomultipliers (SiPM) be the answer? Our expectation is that the SiPMs could work due to the fact that they are immune to magnetic fields. The idea is to use them coupled with the BGO crystal used as ACS.

Objectives

- The understanding of working principles of PMTs, SiPMs and scintillators.
- Comparison of performances between PMTs and SiPMs using NaI and BGO crystals.
- The design of a BGO scintillator detector with SiPMs.
- To examine the possible development of an ACS using SiPMs and BGO crystal scintillators.

Experimental Sequence

The understanding of working principles of PMTs, SiPMs and scintillators.

Comparison between available commercial SiPMs.

Study of BGO crystals and SiPMs as Compton Suppressors.

Design of a detector using SiPMs with a BGO scintillator.

Assembly using a PMT, a BGO Crystal and the SiPM exposed to a Na-22 radioactive source.

Assembly using a PMT, a NaI(Tl) Crystal and the SiPM exposed to a Na-22 radioactive source.

Standard set-up for the detector’s experiments with the crystals and the PMs

Conclusion

Our detector is still in an experimental phase; as such, it does not yet have conclusive results due to different factors such as:

- High dark count pulses in the SiPM spectrum.
- Coupling problems between the SiPMs and the scintillating crystals.
- Low light yield output from the BGO crystals.
- Parameter settings while acquiring the spectrums.

It requires further development and behaviour understanding to achieve our goal of having an ACS working with the Ge detector array in FIPPS.

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