Compton Scattering Letter of Intent

This experiment aims to determine the gamma ray energy dependence on scattering angle, develop a probability distribution of Compton scattering based on the scattering angle, and experimentally confirm the electron’s rest mass of kg [1].

To measure incoming and scattered gamma-ray energy and detect coincident events, we will use a NIM module with signal analysis components. The PMT signal is first amplified to a readable voltage, then split into two paths:

1. **Trigger path**: The signal is sent into a discriminator that sends a trigger once a threshold voltage is reached, then both discriminators and directed into a fast coincidence module to detect coincident events.
2. **Measurement path**: Both amplified signals are sent to a linear gate stretcher for analysis.

This results in three output signals consisting of the coincidence trigger and both PMT signals. These are sent to a multichannel analyzer connected to a custom LabView program that records counts for a specified amount of voltage bins.

The experiment begins with energy and timing calibration of the scintillators using a LabView program that records counts over voltage, proportional to deposited energy.

* **Energy Calibration:** A 60Co source with distinct peaks will determine a conversion factor for voltage to energy measurements using linear regression [2].
* **Timing Calibration:** A 22Na source, emitting gamma rays in opposite directions, will allow to calibrate for timing discrepancies between the two PMT signals using delays [2].

This experiment has several safety considerations.

1. A large amount of lead is used and moved for data collection at different angles. Proper care must be taken to safely move the lead by wearing the lead-specific gloves and not dropping the bricks. All group members should wash their hands after each lab to remove any lead particles.
2. Multiple radioactive sources will be used in this experiment for calibration and scattering measurements. The sources must be properly signed in and out, and the apparatus should be ready to take data before sources are acquired to minimize the exposure time. They must be accounted for and not left unattended at all times and latex gloves should be worn when handling them.
3. High voltages are used to power the PMTs, so it is important that they’re always turned off when not in use.
4. The electronic modules should all be turned off before the NIM Bin is turned on or off.
5. The PMTs and scintillation crystals are fragile, so care should be taken with them.

# References

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| [1] | HandWiki, "Electron Rest Mass," Scholarly Community Encyclopedia, 31 October 2022. [Online]. Available: https://encyclopedia.pub/entry/31965. [Accessed 11 February 2025]. |
| [2] | ORTEC, "Experiment 10 Compton Scattering," AMETEK, [Online]. Available: https://www.ortec-online.com/-/media/ametekortec/third-edition-experiments/10-compton-scattering.pdf?la=en&revision=dc0de3b8-aacc-498f-adf5-610df8b47915&hash=41EE9FF9FB8303EC409C0023BE06A4C2. |