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Gated MCA technique for demonstration of coincidence phenomena with a set of indigenously developed gamma spectrometers

We present the design of an indigenously developed coincidence gamma spectrometry setup with a custom built 1K Multi-channel Analyzer with an external trigger input. In addition to its own discriminator input signal generated from the shaped pulse fed to a comparator with an adjustable threshold setting, it also interprets a secondary trigger of configurable width supplied from another spectrometer's discriminator via a cable.

The setup records spectra only if both signals are true within a predefined time window, thereby enabling time coincidence measurements. This check occurs prior to the digitisation of the signal, so recorded spectra contain only events involving gamma rays incident on both spectrometers simultaneously.

The MCA processor operates with a 64 Mhz clock, and the associated step size for adjusting this window is 15ns. But, a minimum window of 500nS has been set in order to account for time jitter arising from the shaper signal variations as characterised by a 2GS/s oscilloscope.

The setup has been tested to verify the electron-positron annihilation peak from a 22-Sodium source where conservation of momentum dictates that the resultant two gamma rays must be emitted in opposite directions. A 22-Na point source was centrally placed between two spectrometers with their detectors facing each other over a 15cm gap. One of the spectrometers' discriminator output is shared with the other via a short cable, and spectra were acquired from both spectrometers for 40 minutes. While the ratio of the events triggered by the 1275 keV gamma ray to the the 511 keV annihilation gamma was observed to be 27781:137636(0.2) in the ungated spectrometer, the second spectrometer that had used the secondary trigger with a width of 600ns had recorded 137:9200(0.015) events in the same energy regions under coincidence conditions, thereby validating this approach. The 137 stray counts can be attributed to chance coincidence events. These were distributed across 600 channels, spanning more than 1 MeV, with no definite energy peaks that could be observed.

Preliminary tests for angular correlation showed coincidence events rapidly declining when the angle subtended by the spectrometers and the gamma source is changed by a few degrees from its optimal 180 degree arrangement.

The designed spectrometers are highly compact, and occupy a 112mm*60mm*31mm enclosure containing all electronics inclusive of the scintillator and detector, with USB connectivity. We have also designed an open-source software capable of handling two different spectrometers simultaneously, and configuring the secondary trigger on either, or both of them. The absence of expensive and bulky equipment makes this ideal for undergraduate labs where coincidence spectra can be quickly demonstrated.

Near future goals involve the design of a dual channel MCA with list-mode capability, and 15nS time resolution, to prepare a dedicated coincidence measurement unit.

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