PSD Tests

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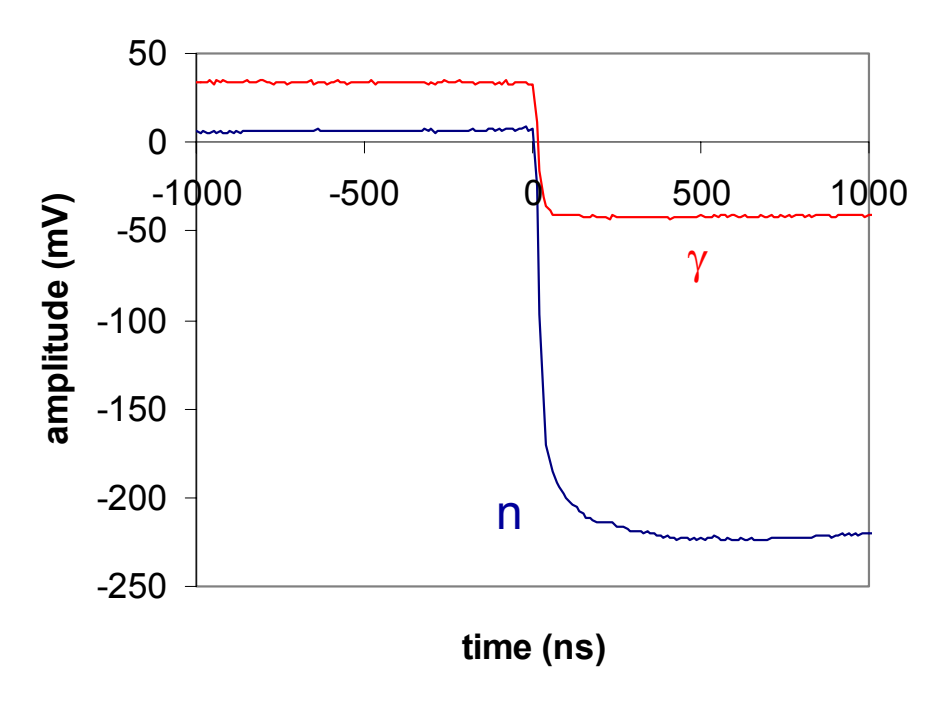
Prospects for Digital PSD for the NMIS



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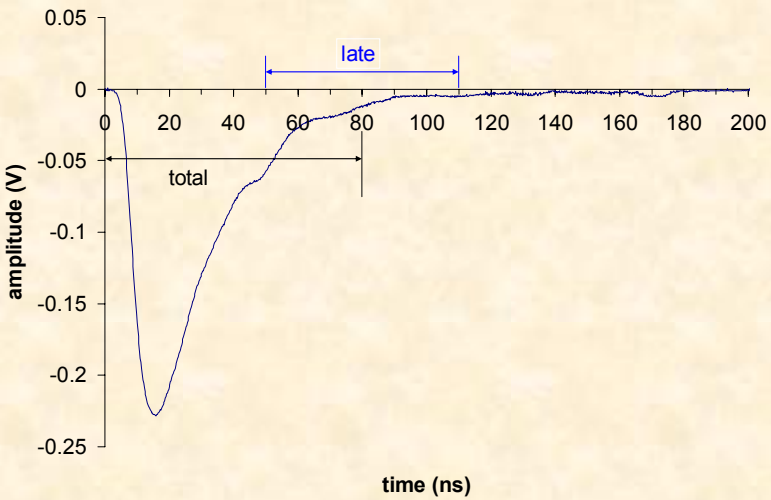
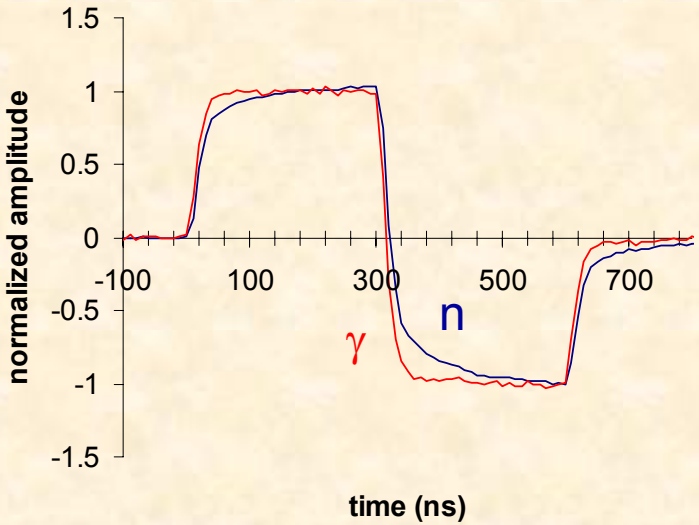
Conventional Methods

Charge Ratio

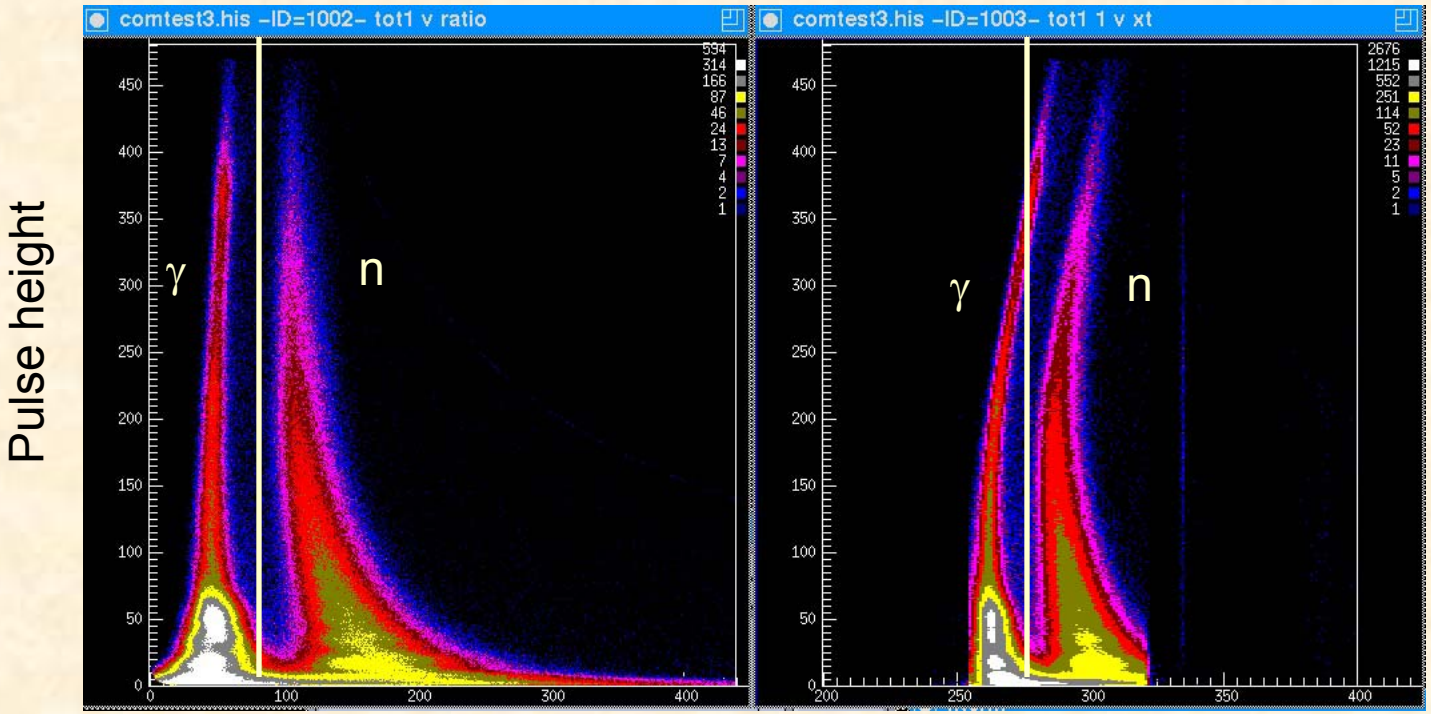


Crossover Time



Object of PSD with NE213 or BC501A scintillator is to pick out fraction of light in the slow (270 ns) component. This can be measured directly with gated integrators on delayed and total light (charge ratio) or converted by DDL shaping to a time difference (crossover time).

Typical Results



Charge Ratio

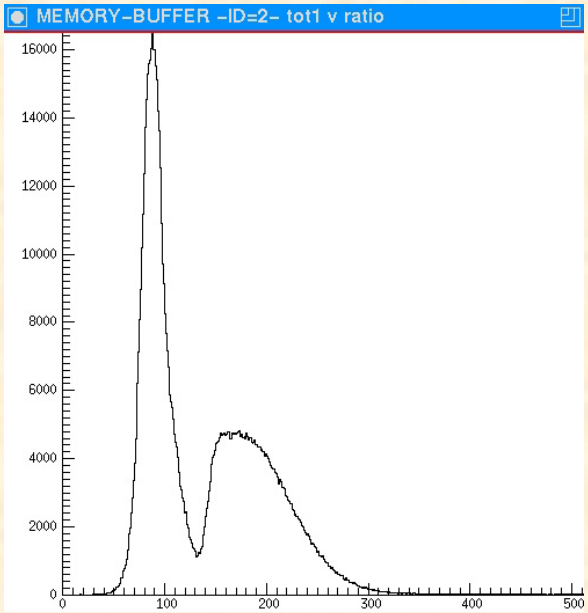
Crossover Time

Integrals Performed in FERA QDCs and Ratio Calculated in Software

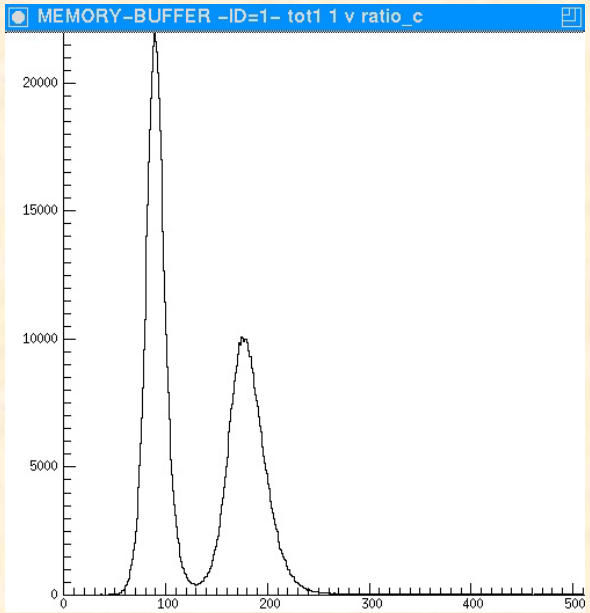
Crossover time Measured with Fast Comtec Model 2160A

Compatibility with NMIS

Raw ratio (>150 keVe)

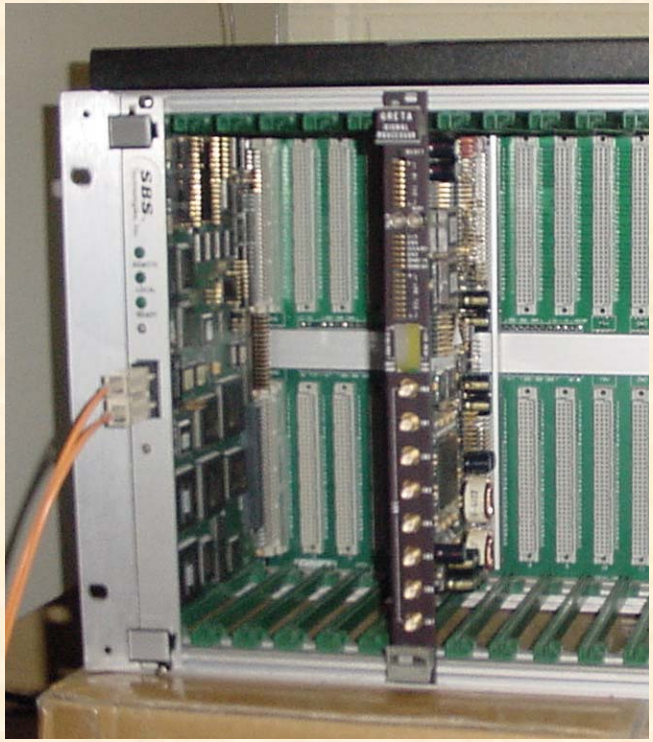


Corrected Ratio (>150 keVe)



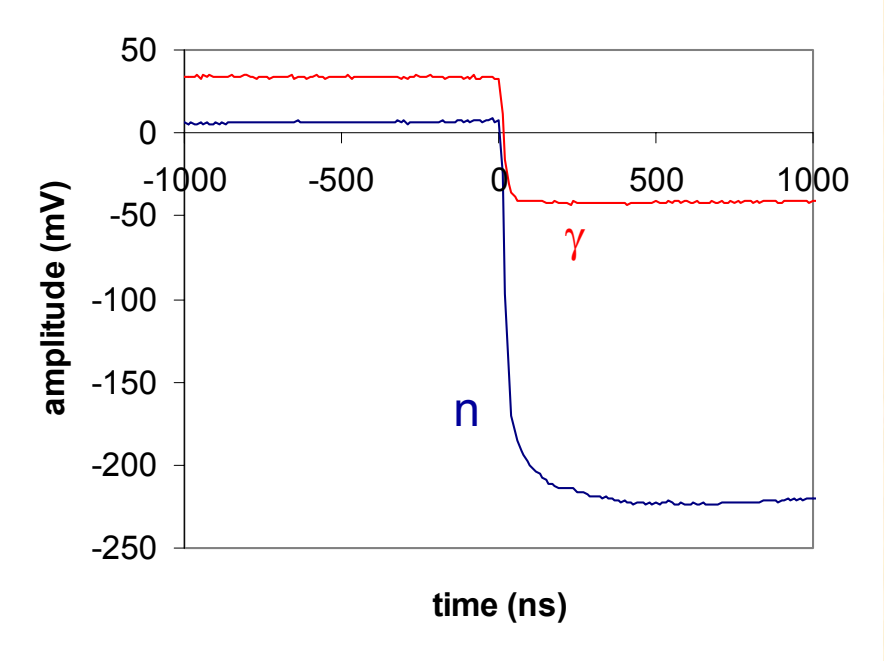
NMIS requires a hardware decision. Pulse height dependence of "neutron-ness" is a universal feature of PSD, and limits the quality and dynamic range of conventional hardware-performed PSD. In principle, best possible hardware decision can be made in a FPGA.

Feasibility of Digital PSD



Traces from gamma-rays (137cs) and neutrons and gamma-rays (pube) captured from the preamplified output of a 25x25x8 cm detector using a prototype GRETA signal processor (100 mhz, 12-bit flash ADC) and stored for analysis.

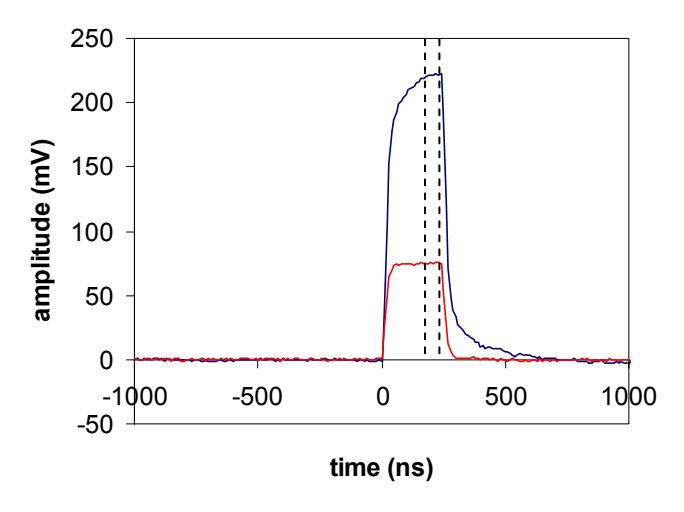
Representative Traces



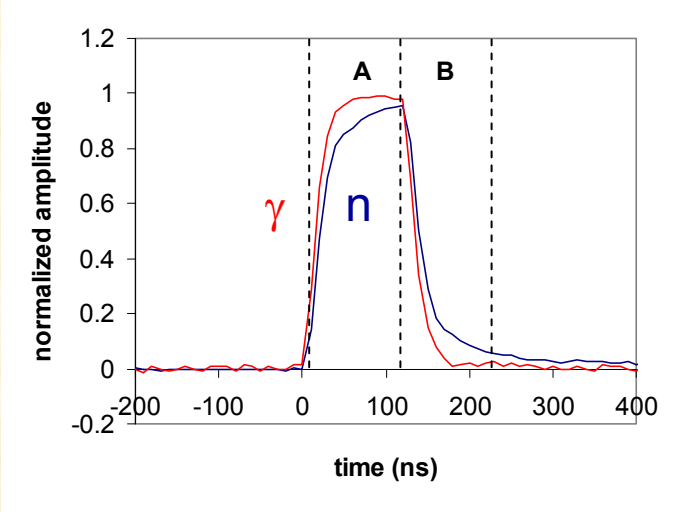
Typical neutron and gamma-ray traces taken during the test experiment. The long (270 ns) component, enhanced for neutrons, is visible to the eye in raw traces.

Extracting Pulse Attributes

Pulse Height

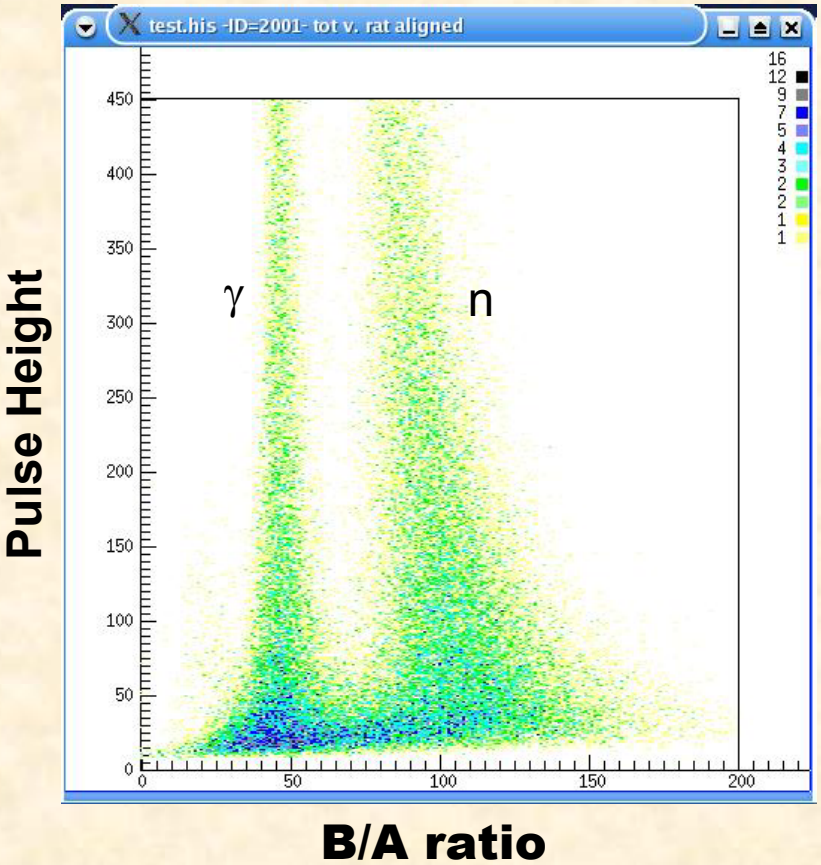


Particle ID



- Traces shaped in software (or FPGA) by simple arithmetic: in this case, by the difference between two channels in the raw trace
- Pulse heights extracted from sum of counts near end of rise on pulse with long shaping constant
- Pulse shapes extracted from B/A ratio for pulse with short shaping constant

Digital PSD Results

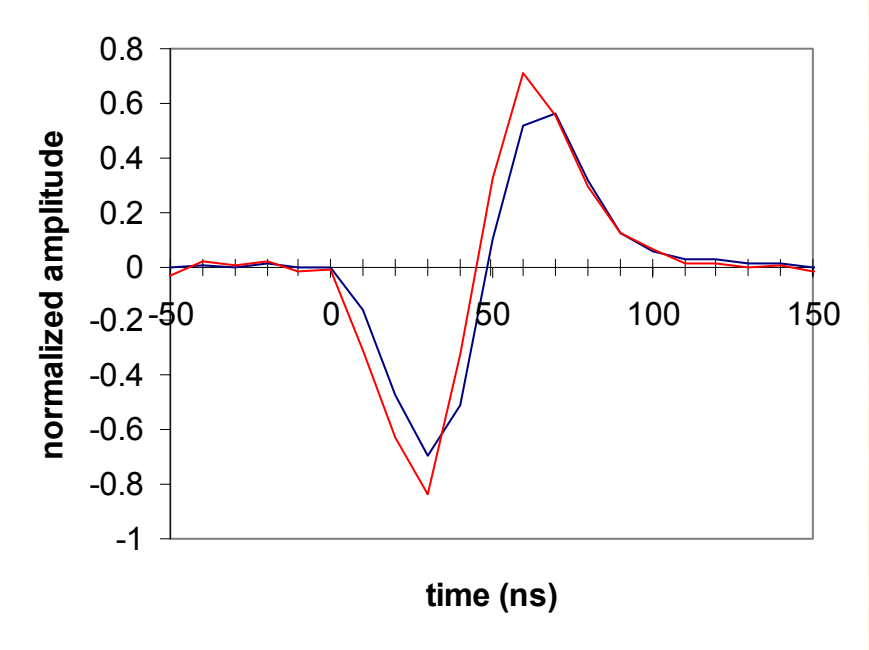


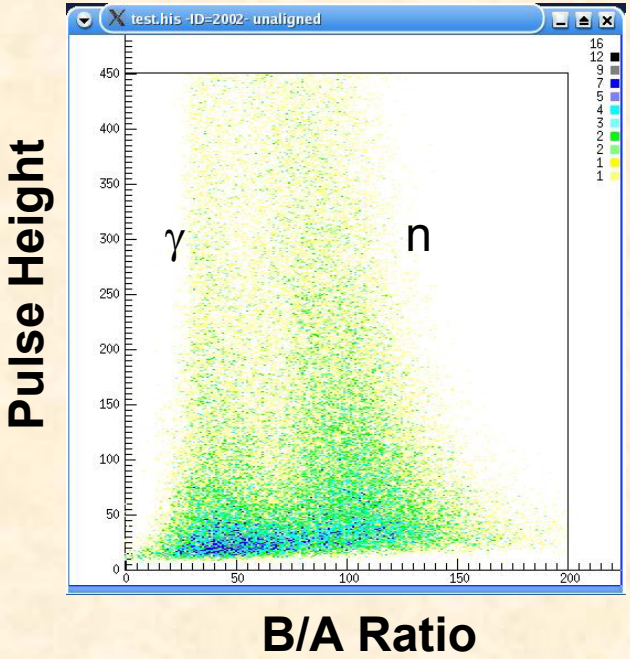
Initial results (based on 100 mhz 12-bit digitization) show PSD comparable to conventional methods

All manipulation of raw data in software can be performed in a fpga

Can performance be increased with increased adc speed or dynamic range?

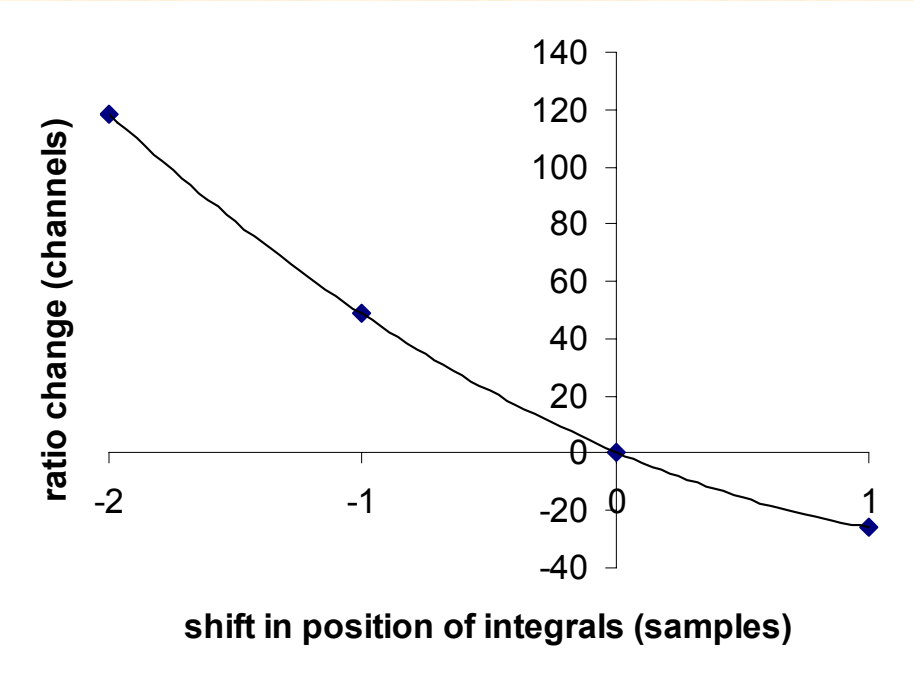
Timing





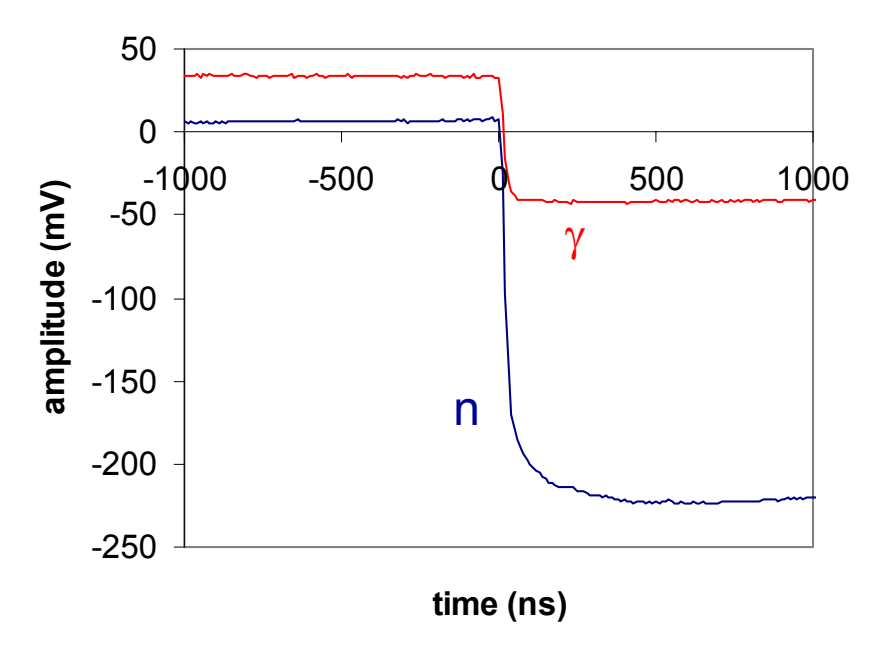
A and B integrals are aligned with respect to the crossover time of the bipolar-shaped pulse. For crossovers between samples, the values of the integrals are interpolated. If this is not done, little discrimination remains.

Timing Improvement



This shift in B/A ratio with shift in timing can be calibrated by deliberately shifting the integrals. This calibration gives us ¼ sample, or 2.5 ns, for the interpolated timing. Improvement possible with a 200 mhz ADC, where ¼ sample is ~1ns, the limit of what can be done with this detector.

Conclusions



Digital PSD is desirable in that the best possible hardware decision (accounting for pulse height dependence of pulse shape) can be performed in near real time

Performance of digital psd, based on digitizing the preamplified output of a pmt in a 100 mhz 12-bit adc, is comparable to conventional methods

Some improvement can be realized with a faster preamp and increased adc speed (200 mhz)