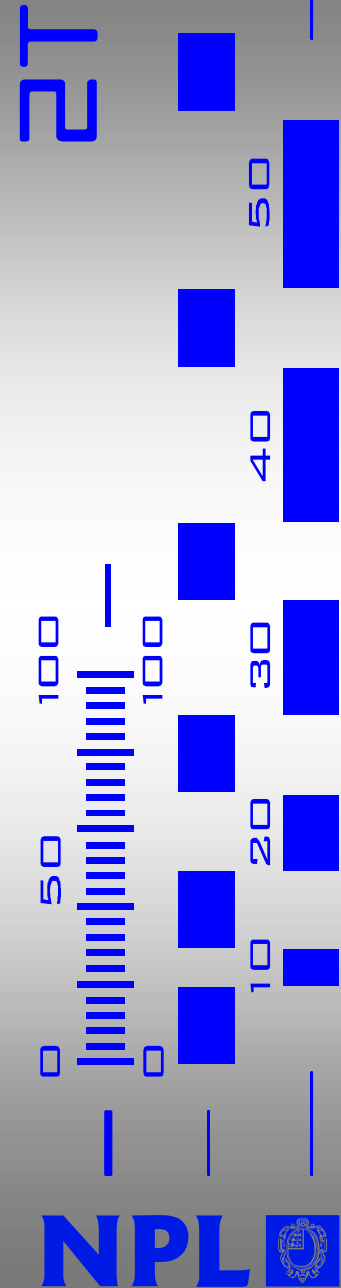


Neutron Users' Club, 12th Meeting

Pulse Risetime Measurements by Digital Methods

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NPL, October 2004



Pulse Risetime Measurements by Digital Methods

1. What we wanted to do
2. The equipment we used
3. Results & analysis
4. Further work

What we wanted to do

Distinguish neutron events from gammas in hydrogen-filled proportional counters (SP2 type).

Hydrogen-filled Proportional Counter (SP2)

- ◆ Spherical metal shell
- ◆ About 4 cm diameter
- ◆ Filled with hydrogen gas at 1, 3 or 10 atmospheres
- ◆ Thin wire at high voltage along axis to collect ionisation



Distinguishing neutrons from gammas

Usually done on the basis of amplitude.

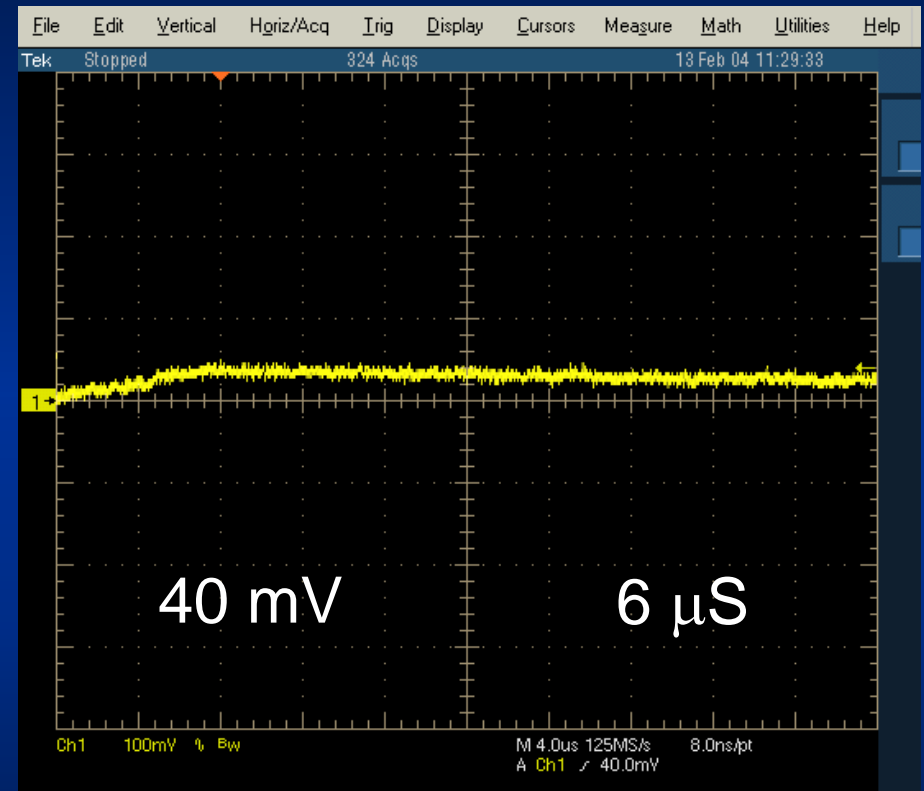
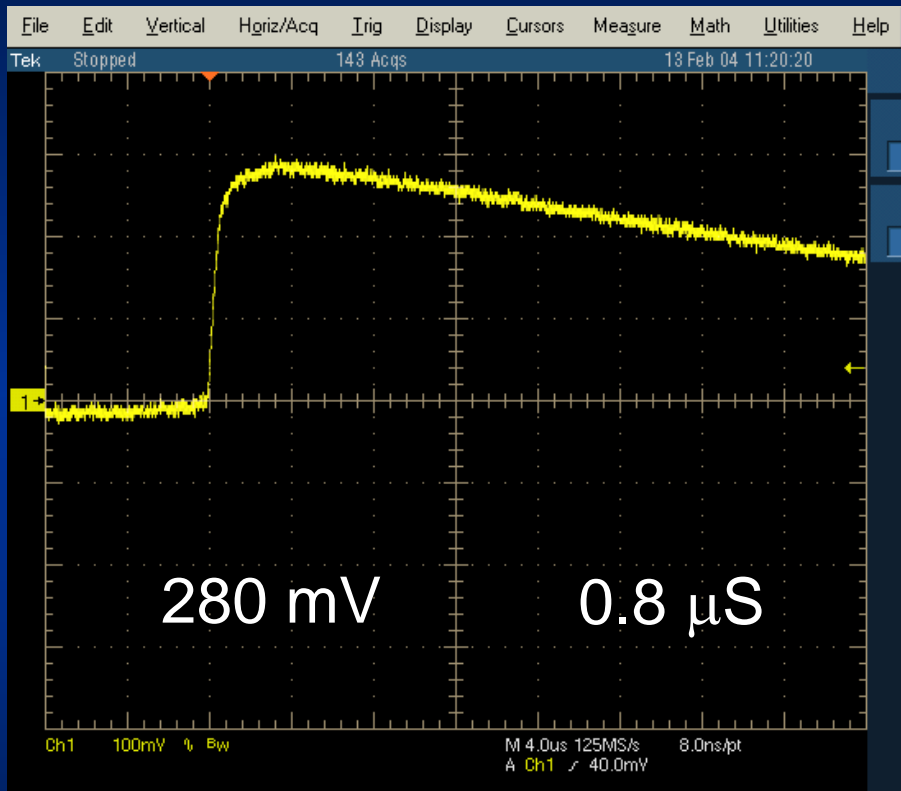
- ◆ Gammas have a small maximum amplitude.
- ◆ Anything above this must be a neutron.
- ◆ But we want to measure neutrons below this amplitude.

How?

By measuring the rise time (Pulse Shape Discrimination).

- ◆ Long rise time: gamma
- ◆ Short rise time: neutron

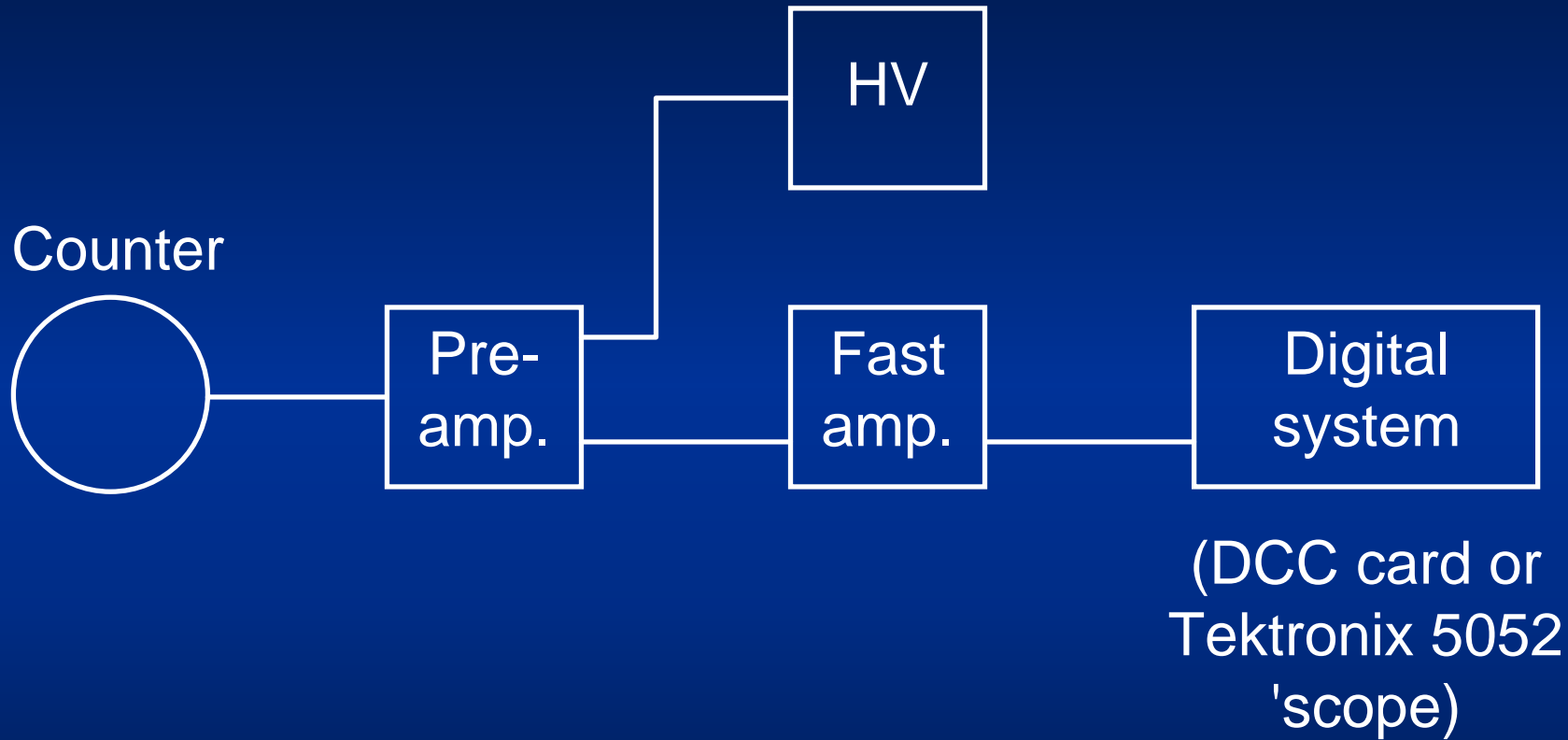
Two pulses from chamber



Why measure digitally?

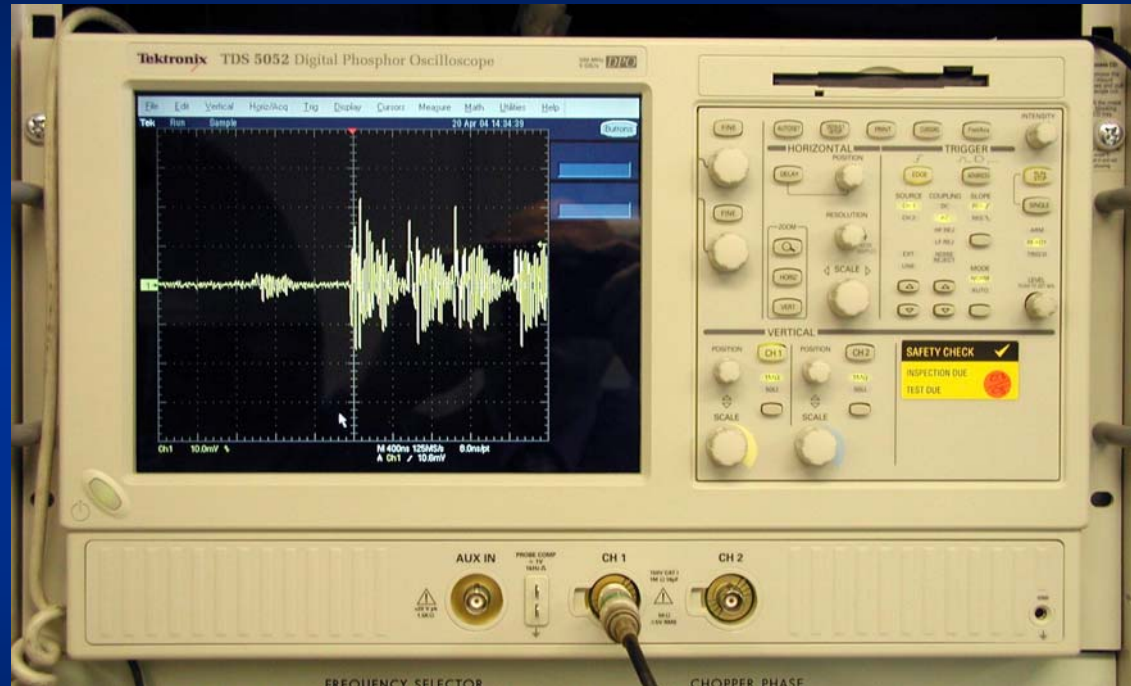
- ◆ Rise time measurement is difficult by conventional electronics, particularly if you want amplitude as well.
- ◆ Digital measurement of the pulse shape gives you the rise time directly, and the amplitude at the same time.
- ◆ New and interesting technique to try!

Electronics for digital measurement

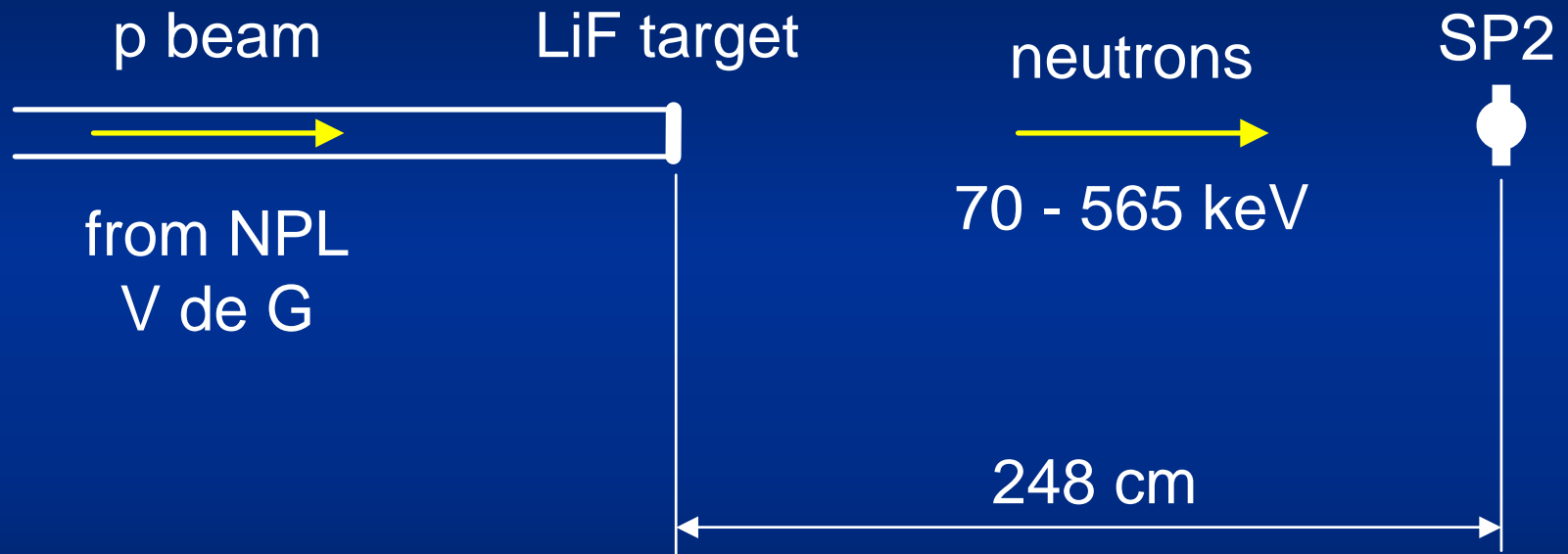


Tektronix 5052 digital oscilloscope

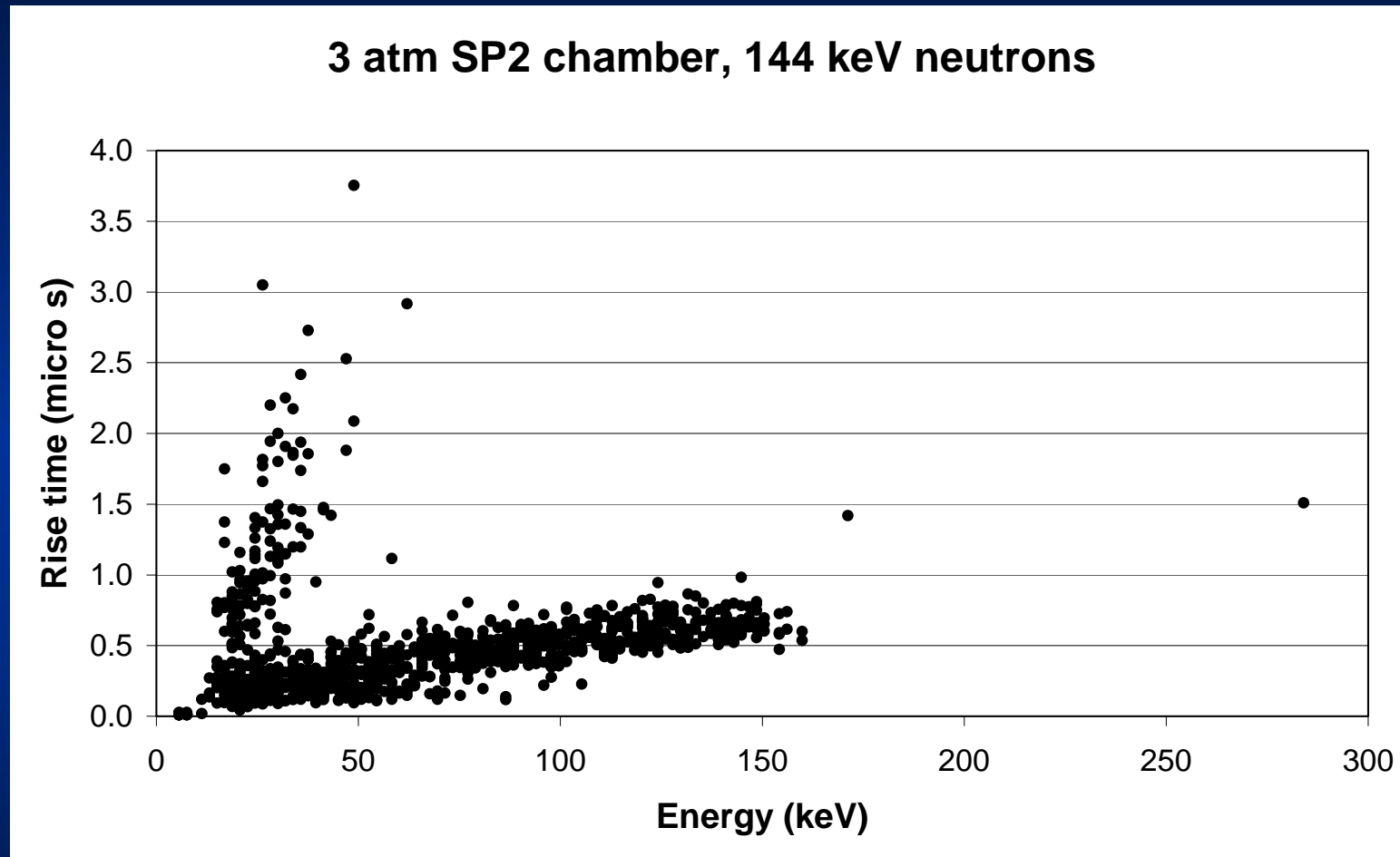
- ◆ Max 5 GS/s
- ◆ Bandwidth 500 MHz
- ◆ 2 Channels
- ◆ Built-in analysis capability, including amplitude and rise time



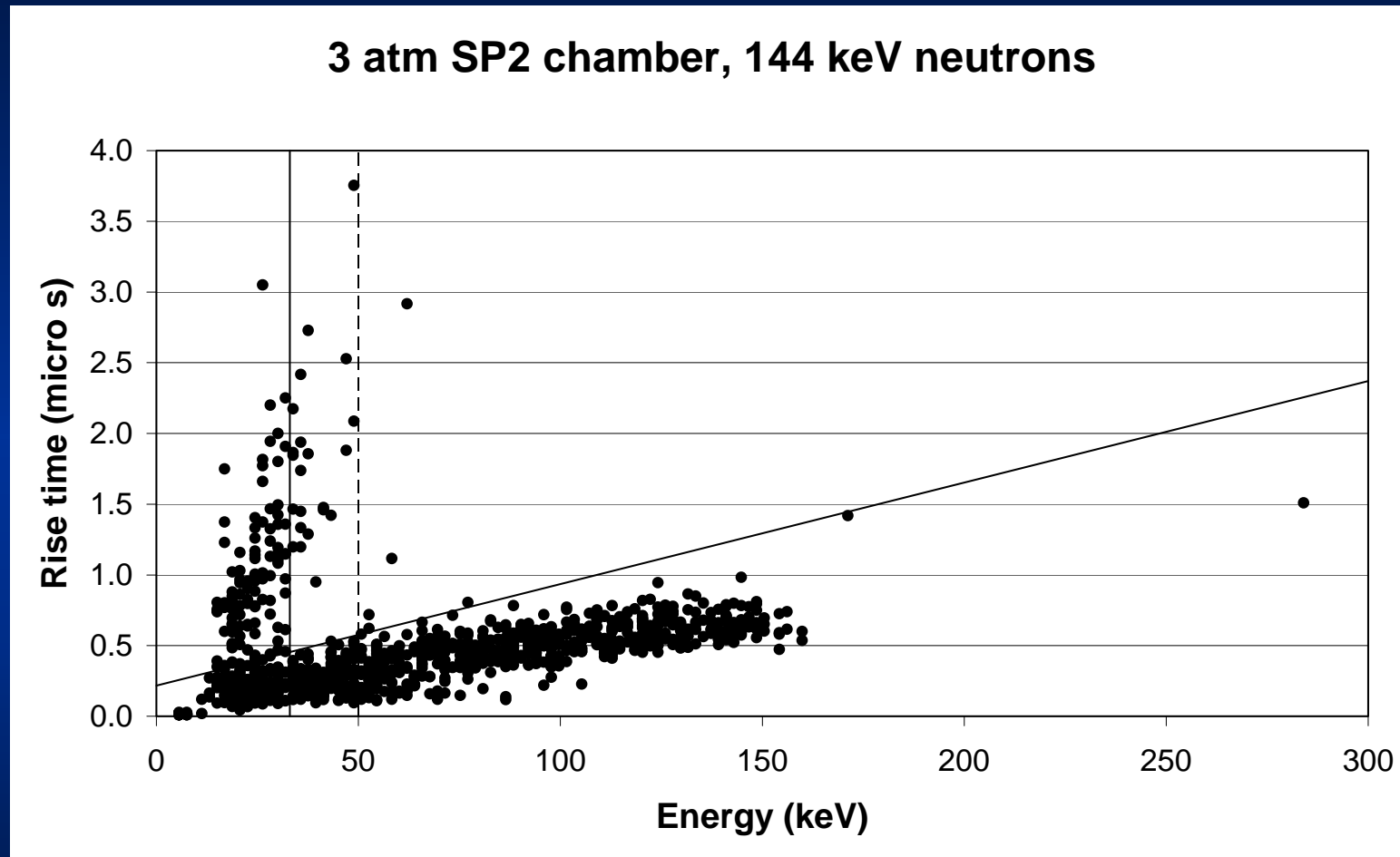
Experimental setup



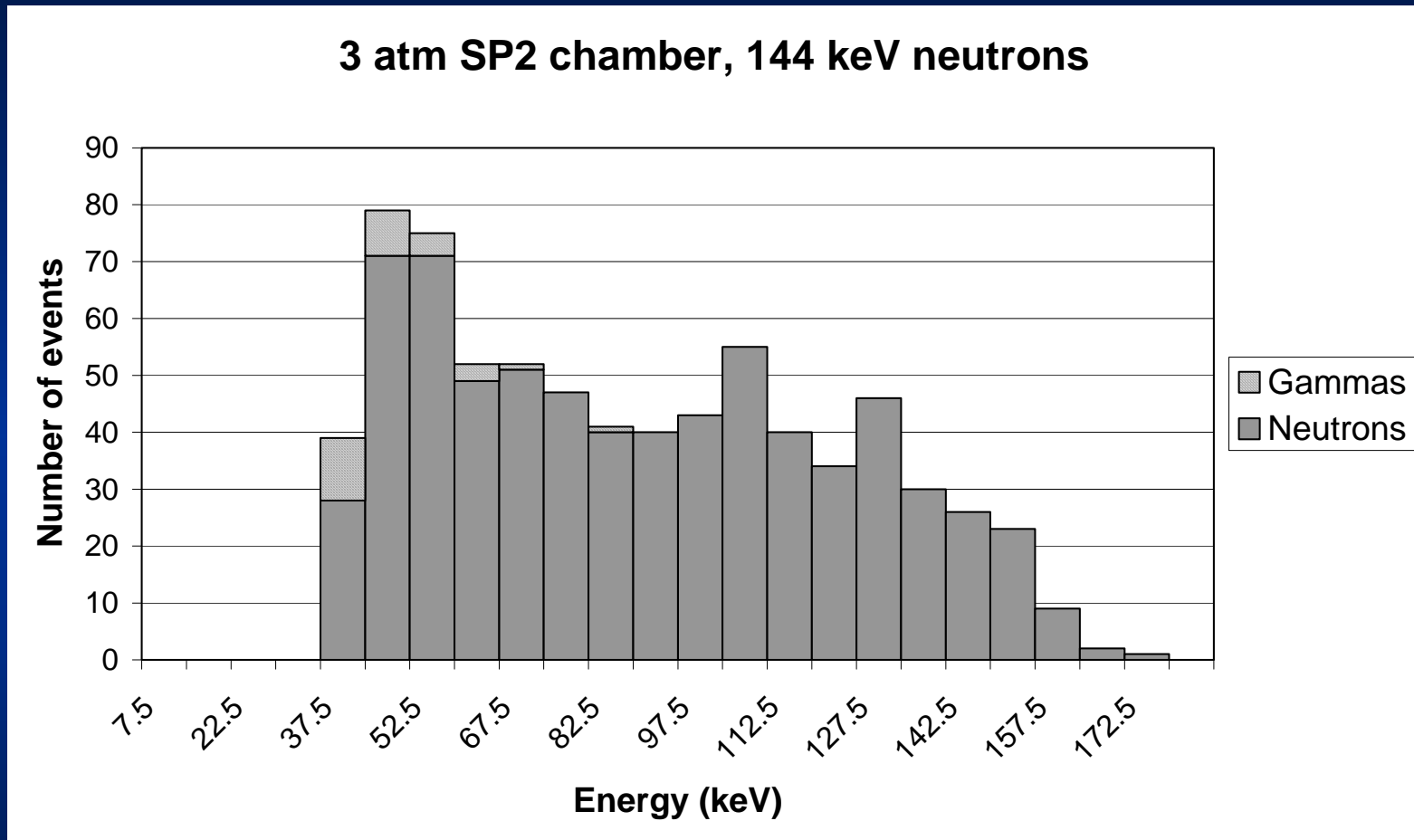
Scatter plot: Rise Time vs. Energy



Scatter plot: Rise Time vs. Energy



Amplitude distribution with n / γ separation

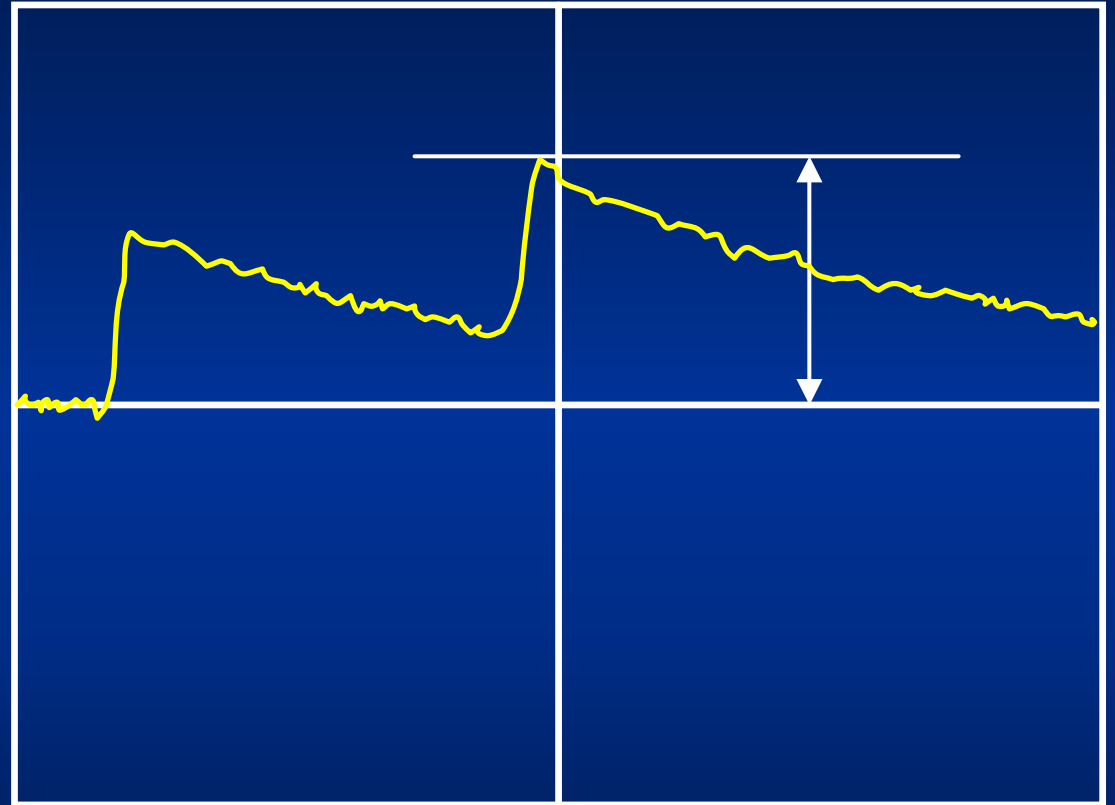


Further work

- ◆ Achieved separation down to about 20 - 30 keV. Can we go lower?
- ◆ No provision in our simple setup to reject unwanted frequencies.
 - Unwanted high frequencies : spikes on top of signal
 - Unwanted low frequencies : baseline jitter

Unwanted low frequencies: tail from previous pulse

Simple analysis
sees only one
pulse.



Possible solutions:

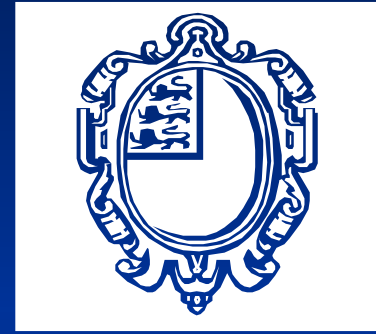
- ◆ Record the entire pulse shape, and use custom software to analyse it
- ◆ Apply a band pass filter (by hardware or software)

Have to catch up with > 50 years of development of conventional electronics.

Conclusions

- ◆ We have successfully separated neutron and gamma events in a proportional counter, using digital measurements of the rise time.
- ◆ Lowest energy improved from about 50 keV to 20 - 30 keV . It would be good to go even lower.
- ◆ Filtering of frequencies (by hardware or software), or specially-written analysis software, should help us to do this.

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