Ch. 16b Pulse Processing: Active Pulse Shaping

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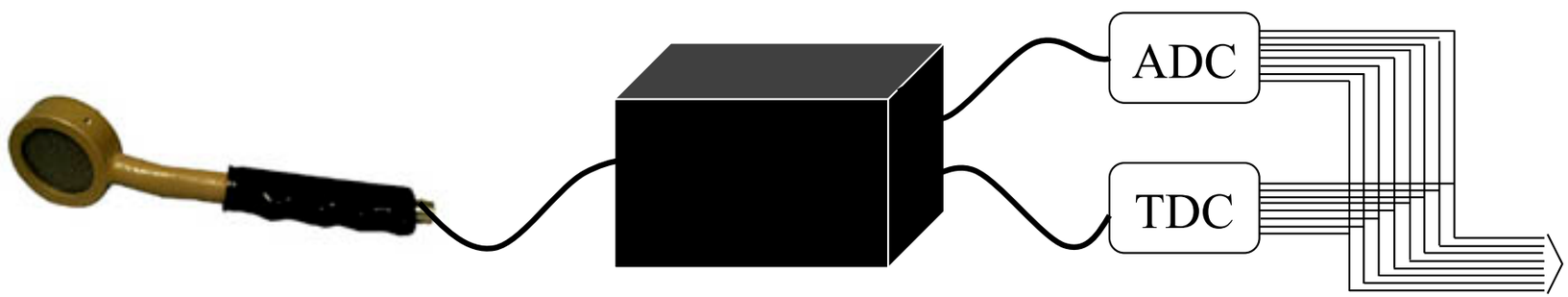
Why shape signals anyway?
The goal is to measure the charge created in the detector by the primary radiation and to maintain the time relationships of signals.

Modular electronic components are available for "analogue" and "time" to digital conversion. Detectors vary by experiment.

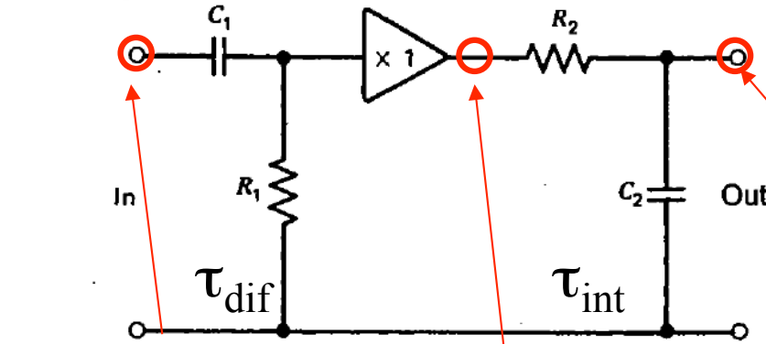
Pulses from detectors are generally small and either:
- Step functions, sharp rise, long pedestal or tail
- Very fast (sharp in time)

Time differences are best measured with logic pulses.

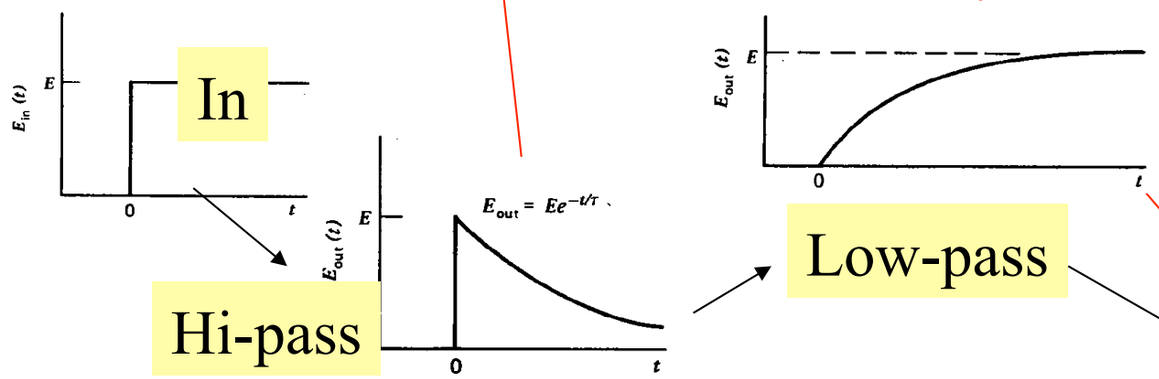


Pulse Processing: CR-RC shaper

Fig. 16.11 Knoll, 3rd Ed.



Recall the effect of a poor quality cable on a step function signal: combination of high & low pass filters



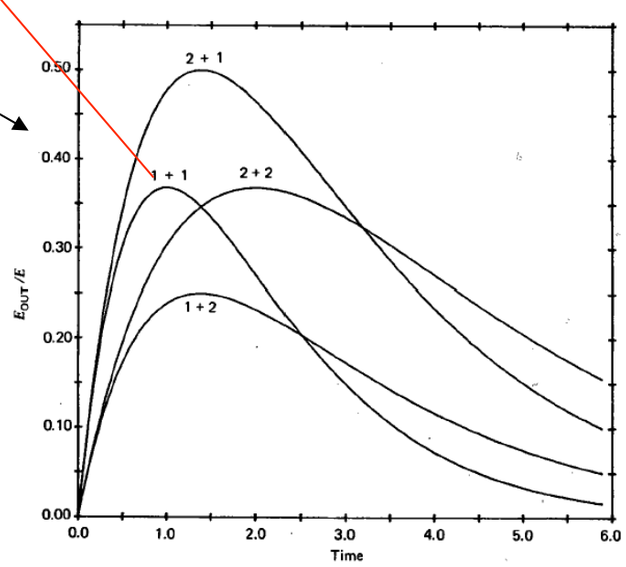


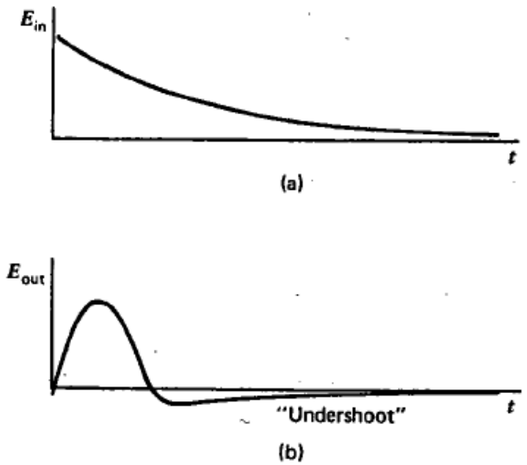
Fig. 16.12 Knoll, 3rd Ed.

Problem 16.11
In Knoll, 3rd Ed.

$$V_{out} = V_{in}\left(\frac{\tau_1}{\tau_1 - \tau_2}\right)\left(e^{-t/\tau_1} - e^{-t/\tau_2}\right)$$

$$V_{out} = V_{in}\left(\frac{t}{\tau}\right)e^{-t/\tau} \quad for \; \tau_{int} = \tau_{dif} = \tau$$

Pulse Processing: Pole Zero



$$\frac{V_{undershoot}}{V_{dif}} \approx \frac{\tau_{dif}}{\tau_{in}}$$

Common problem is that the input signal is not the step function signal that the amplifier is expecting ...

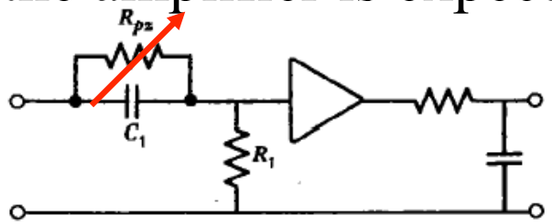
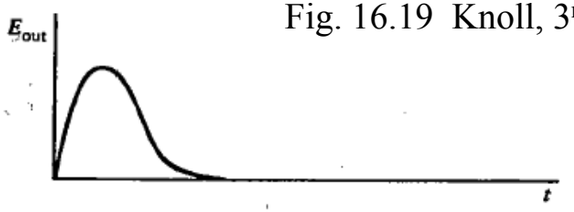
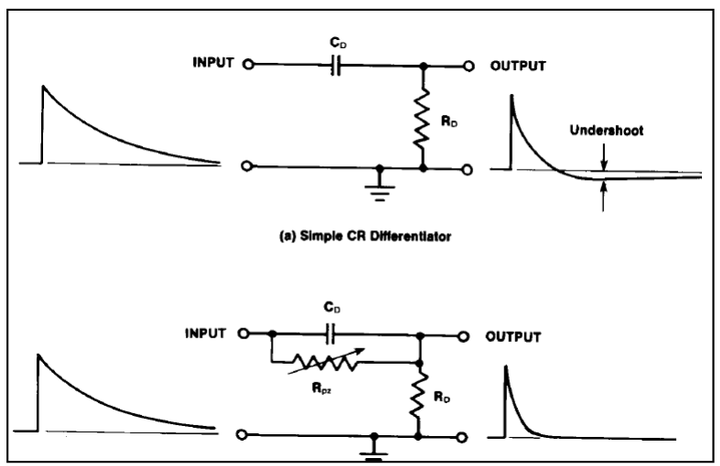


Fig. 16.19 Knoll, 3rd Ed.

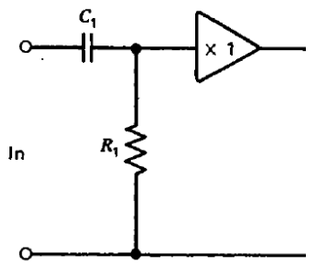


Silicon preamplifier:
~50 μs → 2% for τ = 1 μs

Organic Scintillator & Phototube:
~ 1 μs → 100% for τ = 1 μs



Pulse Processing: Baseline restoration



Charge injected onto C_1 must be cancelled (drained off) by current through R_1 (amp has $Z \sim \infty$)

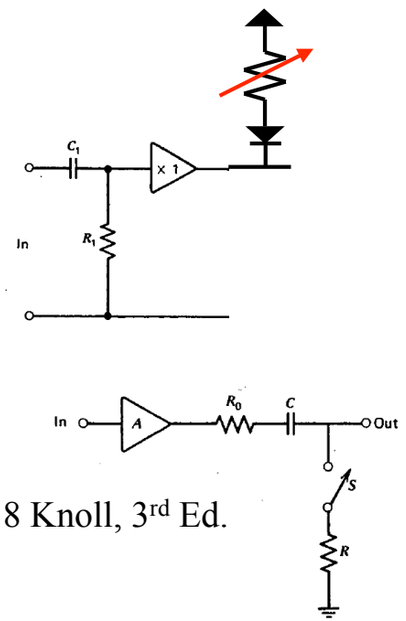
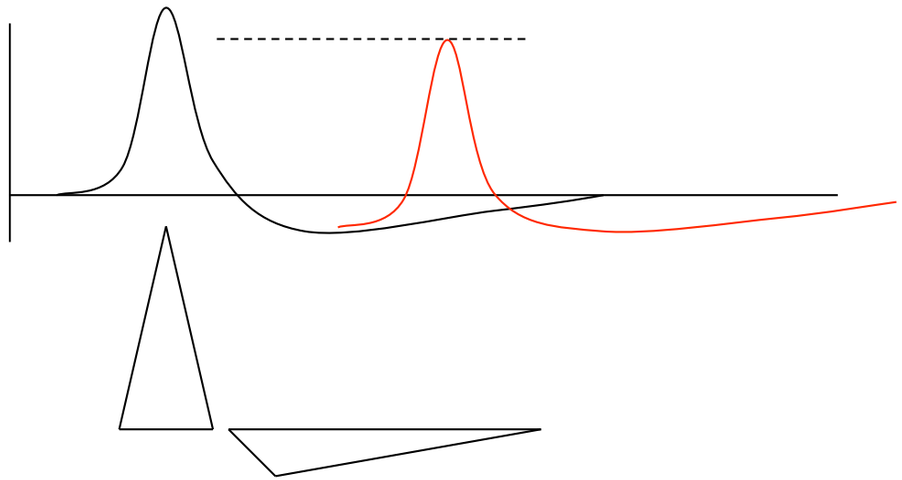
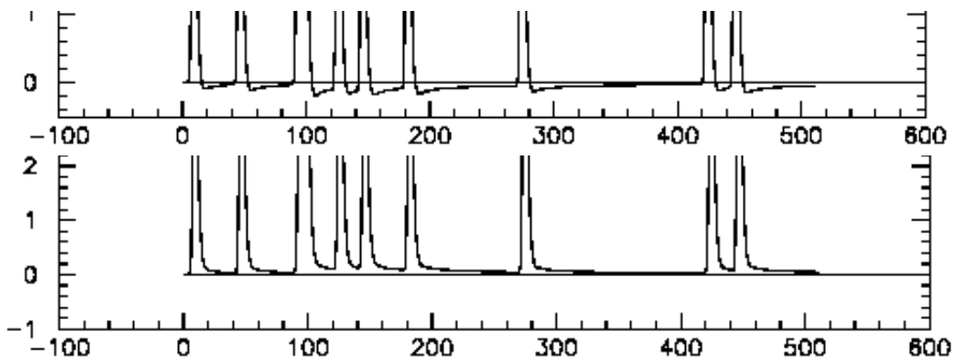


Fig. 16.18 Knoll, 3rd Ed.

A different problem with a similar symptom ... Baseline shift





Pulse Processing: Making Bipolar Pulses

Add a stage to differentiate the unipolar signal.

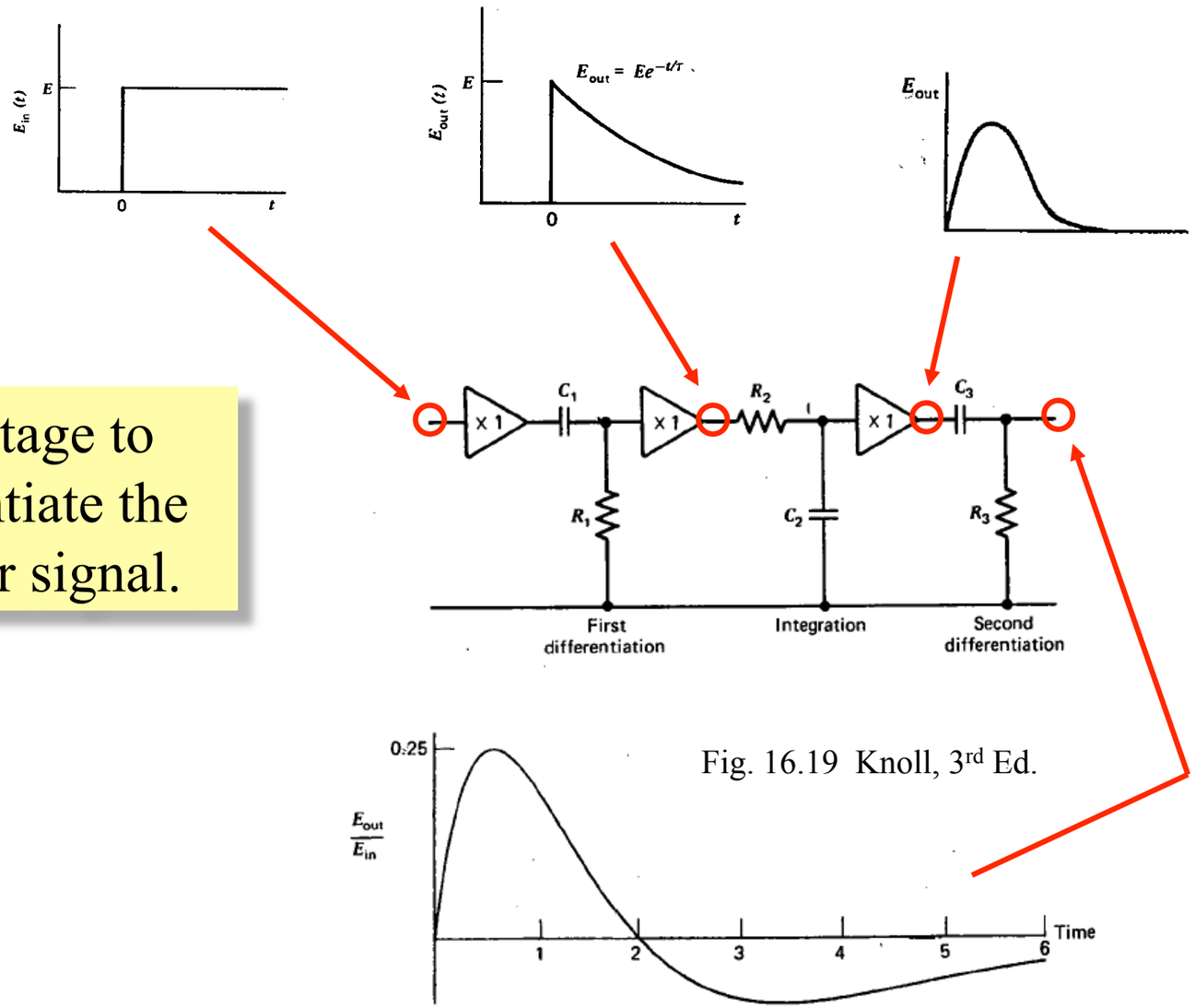


Fig. 16.19 Knoll, 3rd Ed.

Pulse Processing: Delay-line Clipping

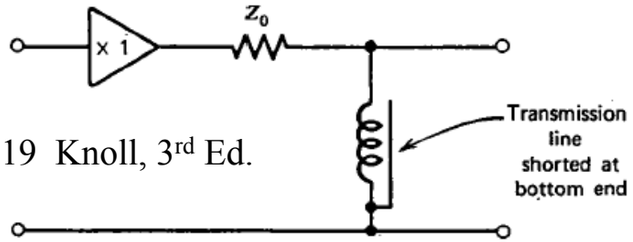
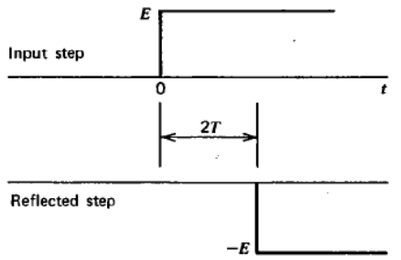
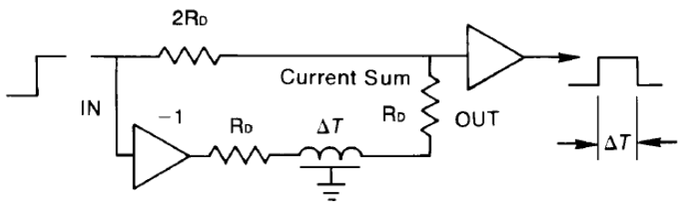
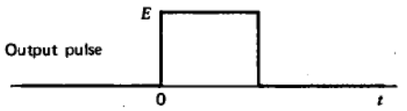


Fig. 16.19 Knoll, 3rd Ed.







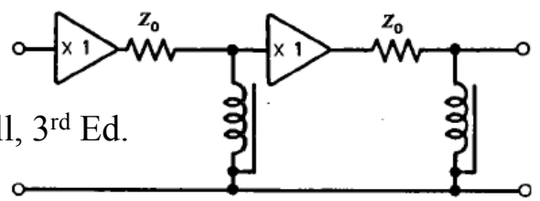
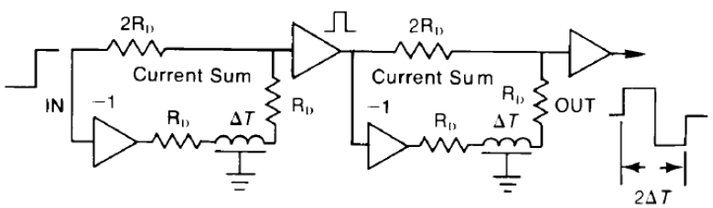
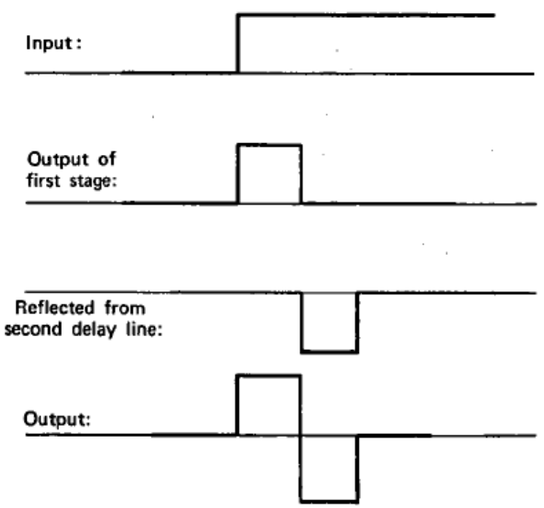
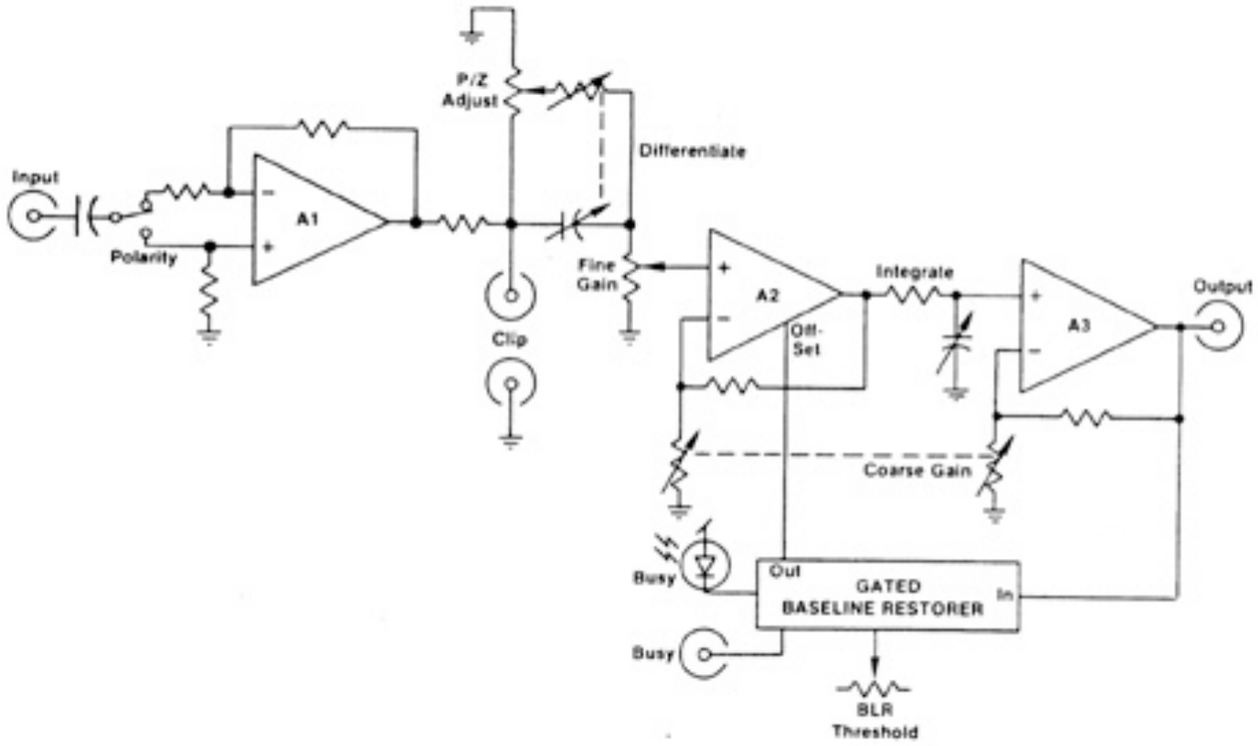


Fig. 16.22 Knoll, 3rd Ed.

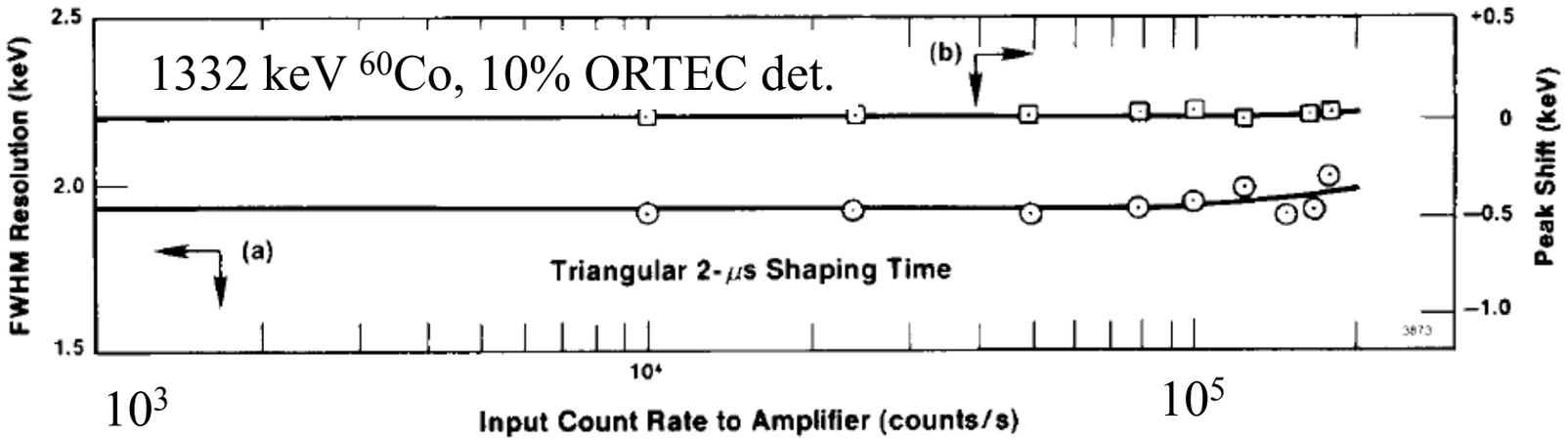




Pulse Processing: timing-filter amp



Pulse Processing: Question



The figure shown above is used by ORTEC to advertise the quality of the baseline restorer in a particular linear amplifier. The figure shows the peak shift (upper curve, right scale) and the resolution (lower curve, left scale) for the ^{60}Co line as a function of counting rate. Compare the indicated shaping time of the amplifier to the mean time between pulses arriving at the input at 10^5 counts/s.