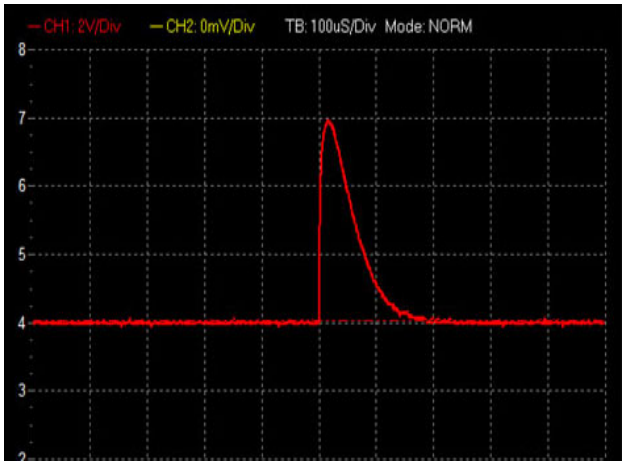
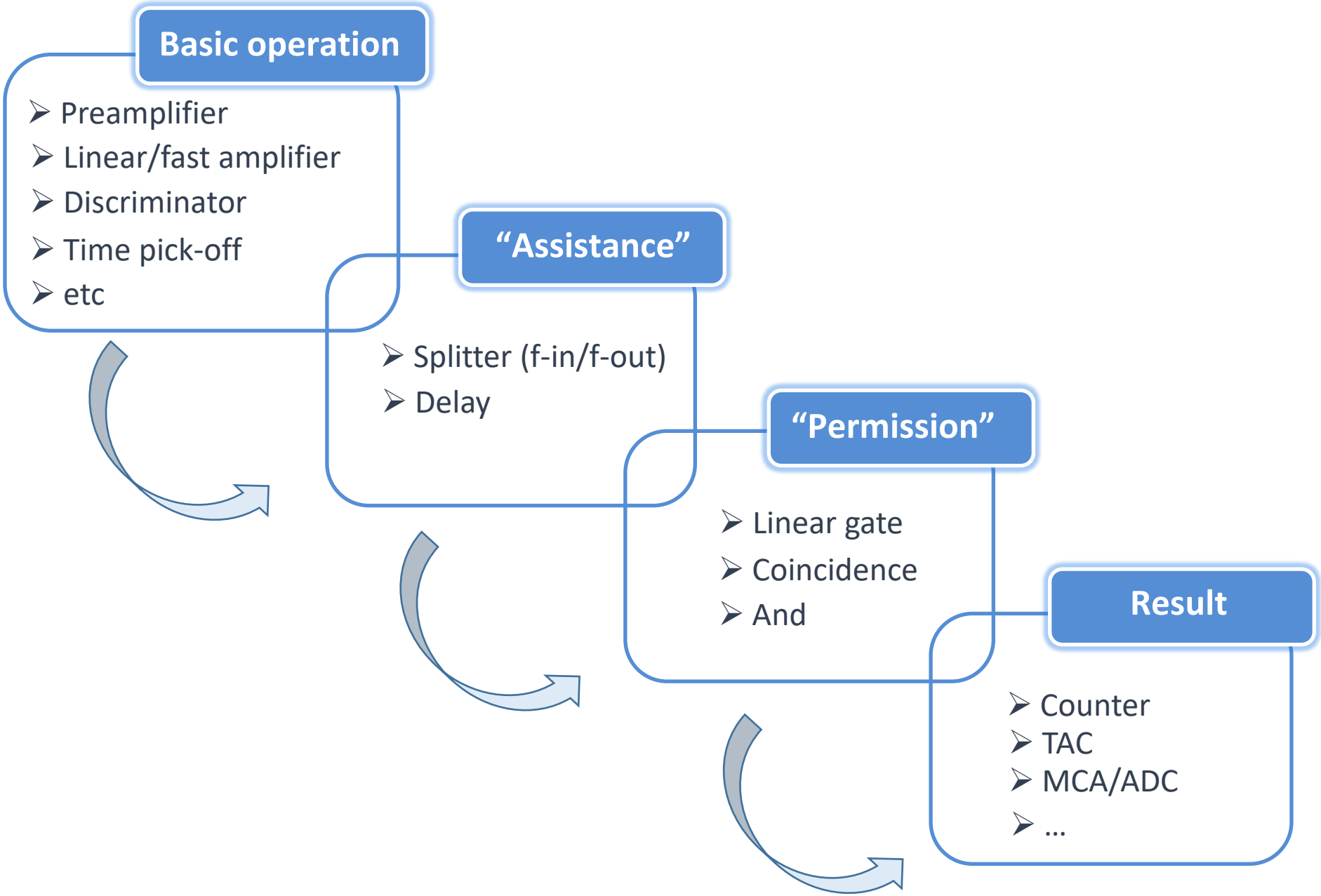
ELECTRONICS - 2b



Pulse-processing units: “rude” role classification



Results: Time-to-amplitude converter (TAC)

- The distribution of the time intervals between start and stop pulses

566 Time-to-Amplitude Converter

- For time spectroscopy in the range from 10 ns to 2 ms
- Valid Start and Valid Conversion outputs
- Selectable output delay and width
- Output synchronized with a stop or external strobe signal
- Provision to reject unwanted start input signals
- Positive or negative input signals

The ORTEC Model 566 Time-to-Amplitude Converter (TAC) measures the time interval between pulses to its start and stop inputs and generates an analog output pulse proportional to the measured time. Timing experiments requiring time ranges from 10 ns to 2 ms may be performed, giving the experimenter flexibility in analyzing random nuclear events that occur within a selected time range. Time ranges from 50 ns to 2 ms are provided via the front-panel controls.

ORTEC | AMETEK

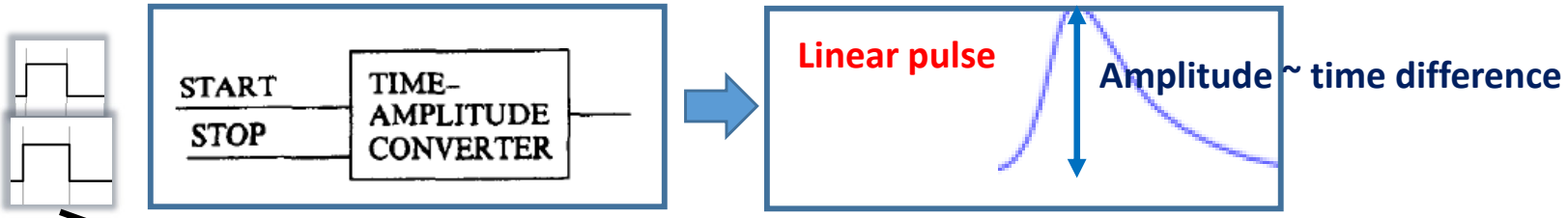
Results: Time-to-amplitude converter (TAC)

(multichannel spectroscopy)

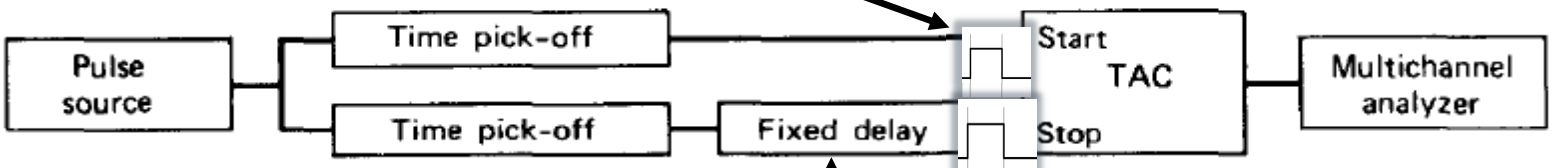
Recording time spectrum

- The distribution of time intervals between start and stop pulses (= output pulses of TAC)

2 Logic pulses



- In practice:



to avoid that half of the pulse would not be visible when it appears at the zero-value of the pulse height axis in the MCA (as is the case for pulses that are coincident)

Results: Multi-channel analyzer (MCA)

Pulse-height analysis system

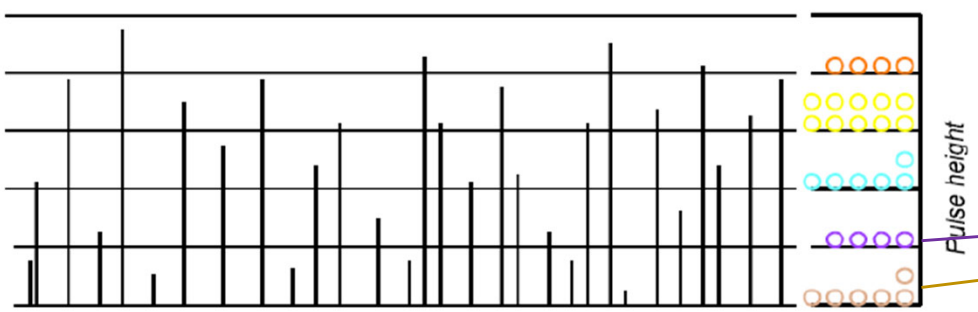


Figure 21: Train of pulses delivered at the output detector

events with the same pulse height (energy, time diff.) in a single channel

(multichannel spectroscopy)

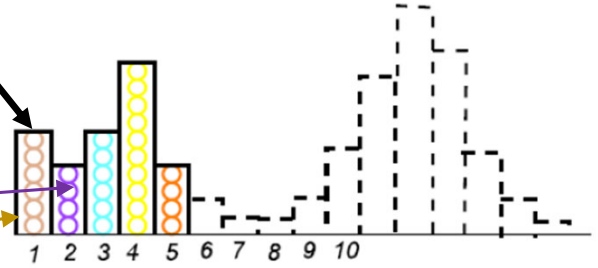


Figure 22 Pulse height spectrum

Results: Analog-to-Digital Convertor (ADC)

Pulse-height analysis system

(multichannel spectroscopy)

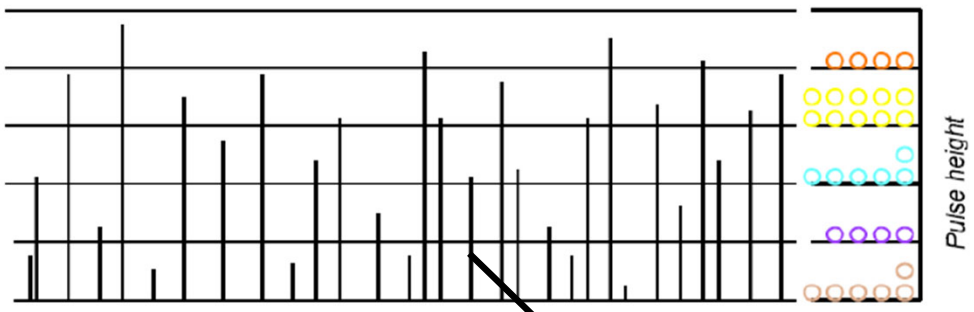


Figure 21: Train of pulses delivered at the output detector

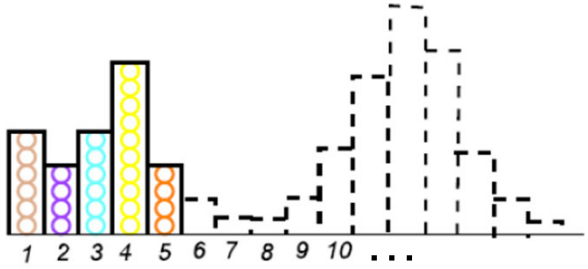


Figure 22 Pulse height spectrum

Analog-to Digital Converter (ADC)

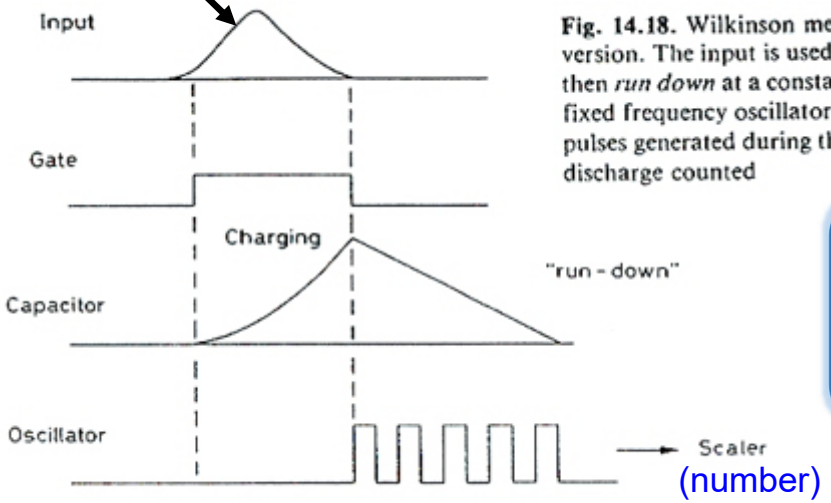
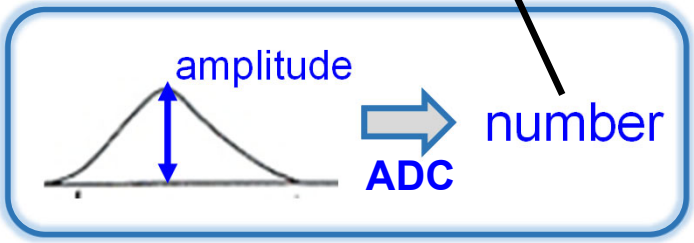


Fig. 14.18. Wilkinson method of analog-to-digital conversion. The input is used to charge a capacitor which is then *run down* at a constant current. At the same time, a fixed frequency oscillator is gated on and the number of pulses generated during the time it takes the capacitor to discharge counted



- The ADC converts analog info from the pulse train into digital format
- Registered number is proportional to pulse height

Results: Multi-channel analyzer (MCA)

Pulse-height analysis system

(multichannel spectroscopy)

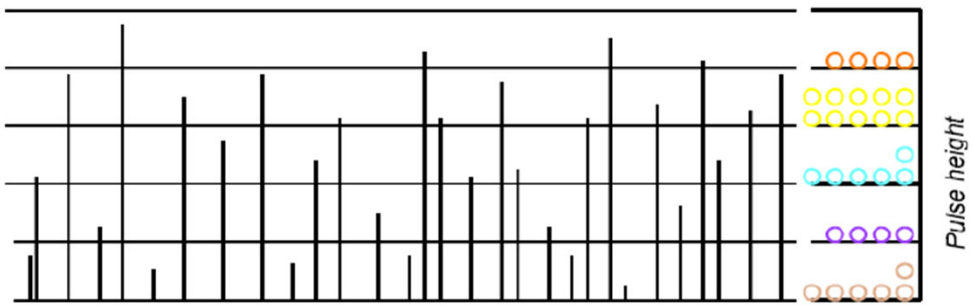


Figure 21: Train of pulses delivered at the output detector

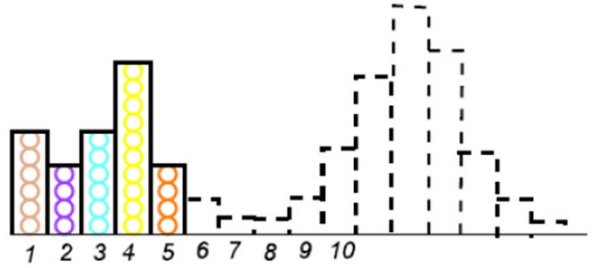
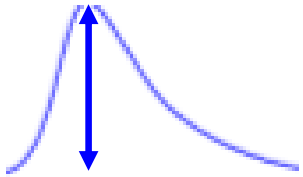
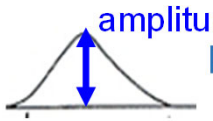


Figure 22 Pulse height spectrum

Linear pulse

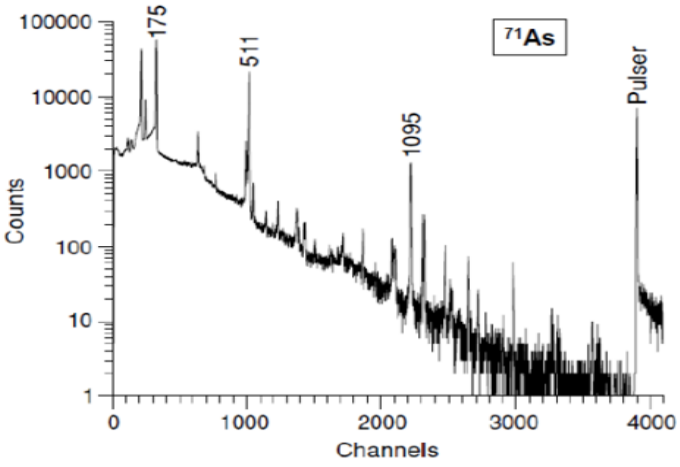


MCA
(contains ADC)



(©Canberra)

SPECTRUM

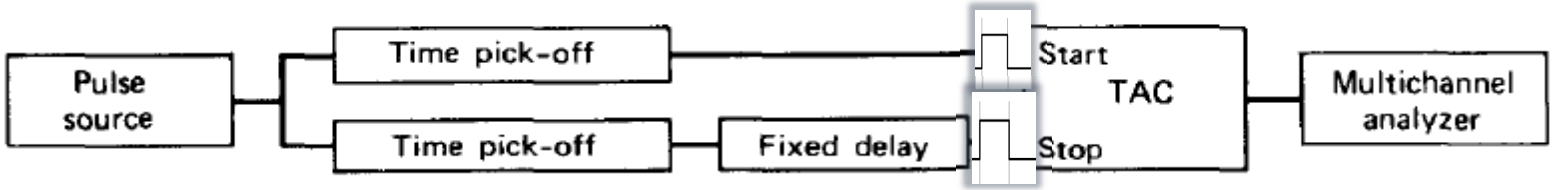


Results: Time-to-amplitude converter (TAC) - bis

(multichannel spectroscopy)

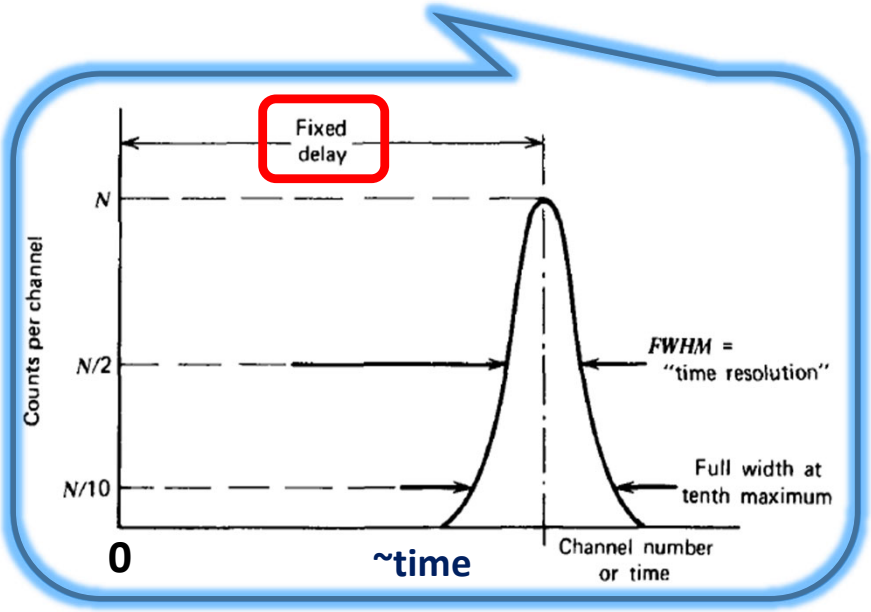
Recording time spectrum

- The distribution of time intervals between start and stop pulses (= output pulses of TAC) can be recorded by a multichannel analyzer (= time spectrum)

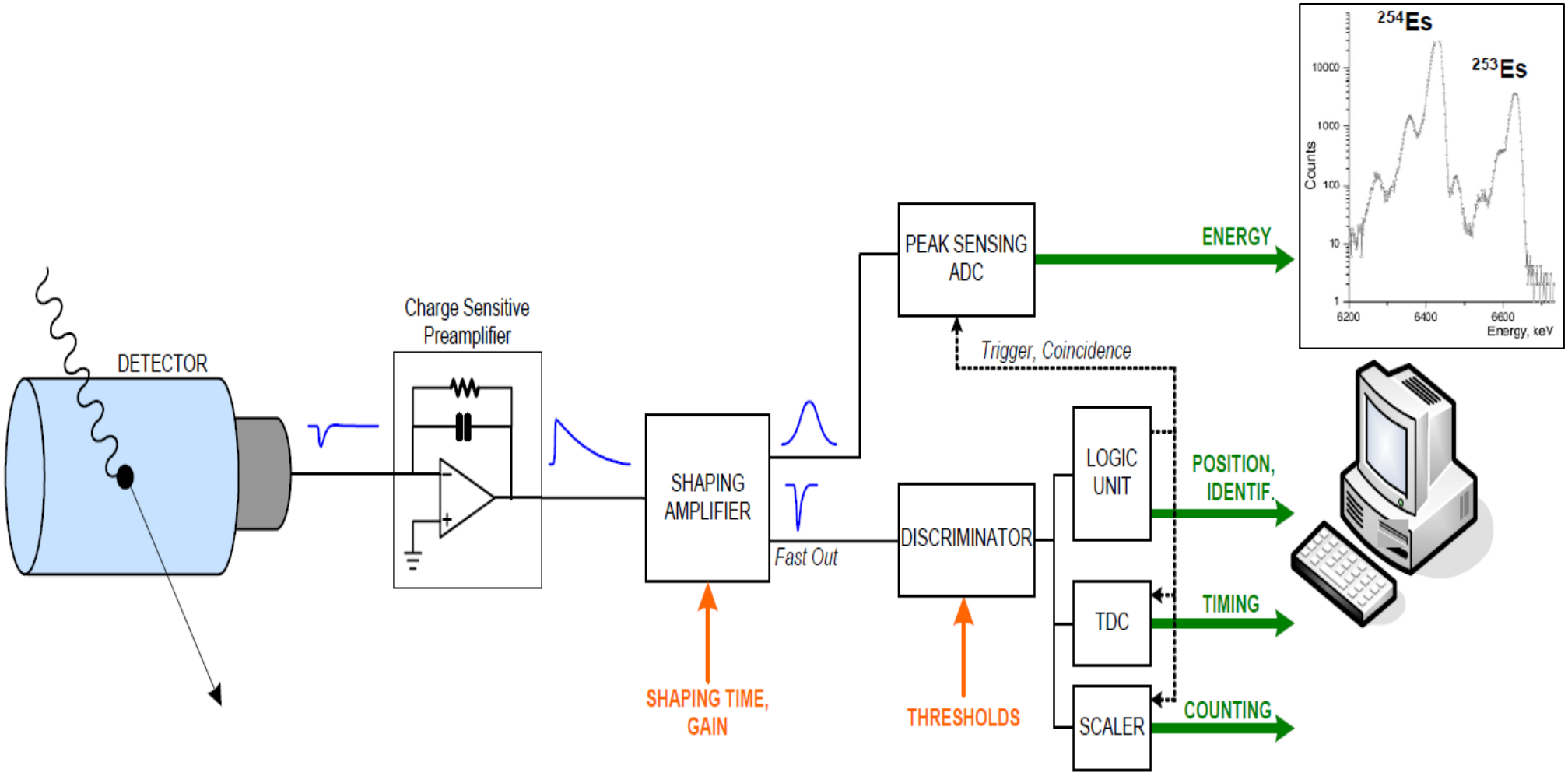


TAC -> **MCA** =

Time spectrum



Short summary



Pulse-processing: short summary of main players

Basic operation

- Preamplifier
- Linear/fast amplifier
- Discriminator (integral, differential(SCA))
- Time pick-off
- …

"Assisting"..

- Splitter (fan-in/fan-out)
- Delay
- Pulse generator, …

"Permission"...

- Linear gate
- Coincidence
- And/Or, ...

Result

- Counter
- TAC
- MCA/ADC
- …

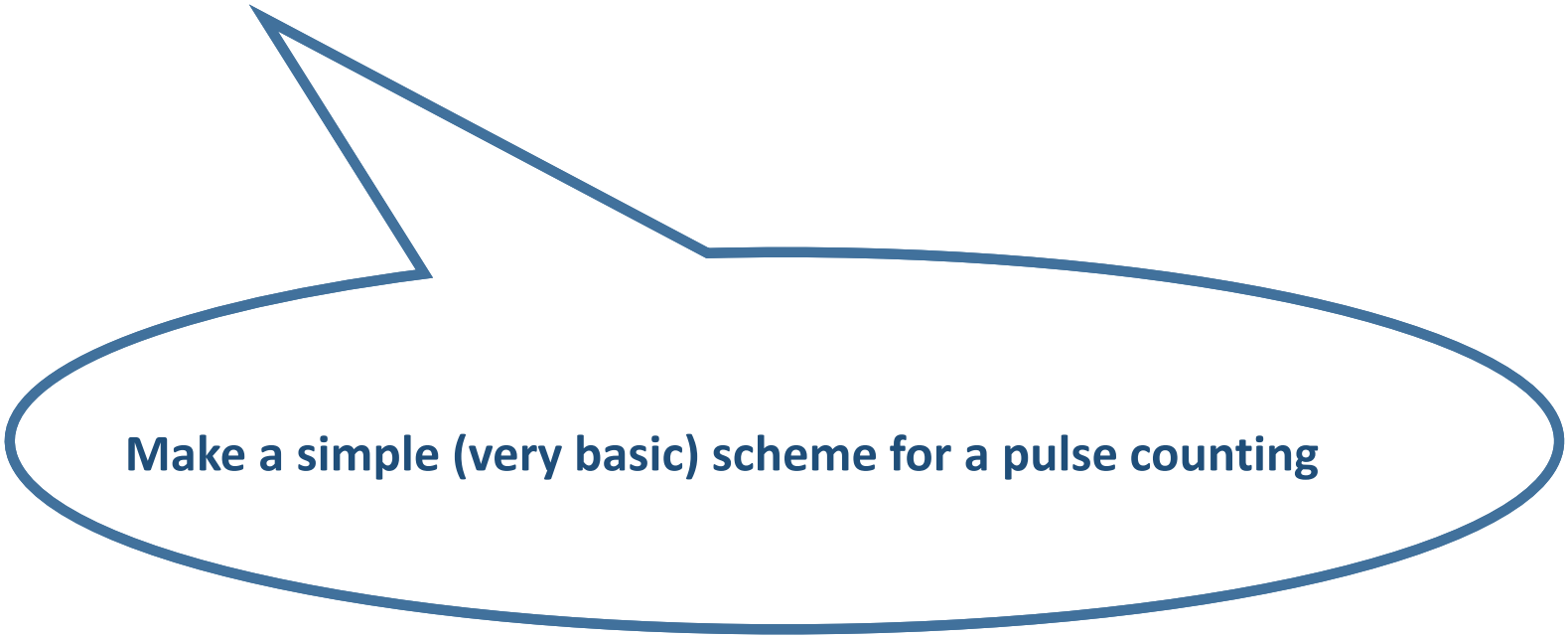
Information

Ⓐ Linear–Linear	In	Out
PREAMPLIFIER	Linear charge pulse from the detector	Linear tail pulse
LINEAR AMPLIFIER	Linear tail pulse	Amplified and shaped linear pulse
BIASED AMPLIFIER	Shaped linear pulse	Linear pulse proportional to amplitude of input pulse that lies above input bias level
PULSE STRETCHER	Fast linear pulse	Conventional shaped linear pulse of amplitude equal to input pulse
SUM AMPLIFIER	Two or more shaped linear pulses	Shaped linear pulse with amplitude equal to the sum of coincident input pulses
DELAY	Fast linear or shaped linear pulse	Identical pulse after a fixed time delay
Linear input / LINEAR GATE / Gate input	(1) Shaped linear pulse (2) Gate pulse	Linear pulse identical to linear input if gate pulse is supplied in time overlap
Ⓑ Linear–Logic	In	Out
INTEGRAL DISCRIMINATOR	Shaped linear pulse	Logic pulse if input amplitude exceeds discrimination level
DIFFERENTIAL DISCRIMINATOR (SINGLE-CHANNEL ANALYZER)	Shaped linear pulse	Logic pulse if input amplitude lies within acceptance window
TIME PICK-OFF (TRIGGER)	Fast linear or shaped linear pulse	Logic pulse synchronized with some feature of input pulse
Ⓒ Logic–Linear	In	Out
START / STOP / TIME–AMPLITUDE CONVERTER	Logic start and stop pulses separated by time Δt	Shaped linear pulse with amplitude proportional to Δt
Ⓓ Logic–Logic	In	Out
COINCIDENCE	Logic pulses at two or more inputs	Logic pulse if pulses appear at all inputs within a time interval τ (resolving time)
ANTI-COINCIDENCE	Logic pulses at two inputs	Logic pulse only if pulse appears at one input *without* pulse at second input within time τ
SCALER	Logic pulses	One logic pulse for every N input pulses

PREAMP	Shaping amplifier	Pulse generator	Delay
Fast amplifier	Time pick-off (pulse appearance time)	Fan-in/ Fan-out	TAC
Linear Gate	Integral Discriminator	Coincidence	MCA
ADC	Counter	Timer	Count rate meter
Differential Discriminator (single channel analyser - SCA)	Timing + SCA	Anti-Coincidence	AND

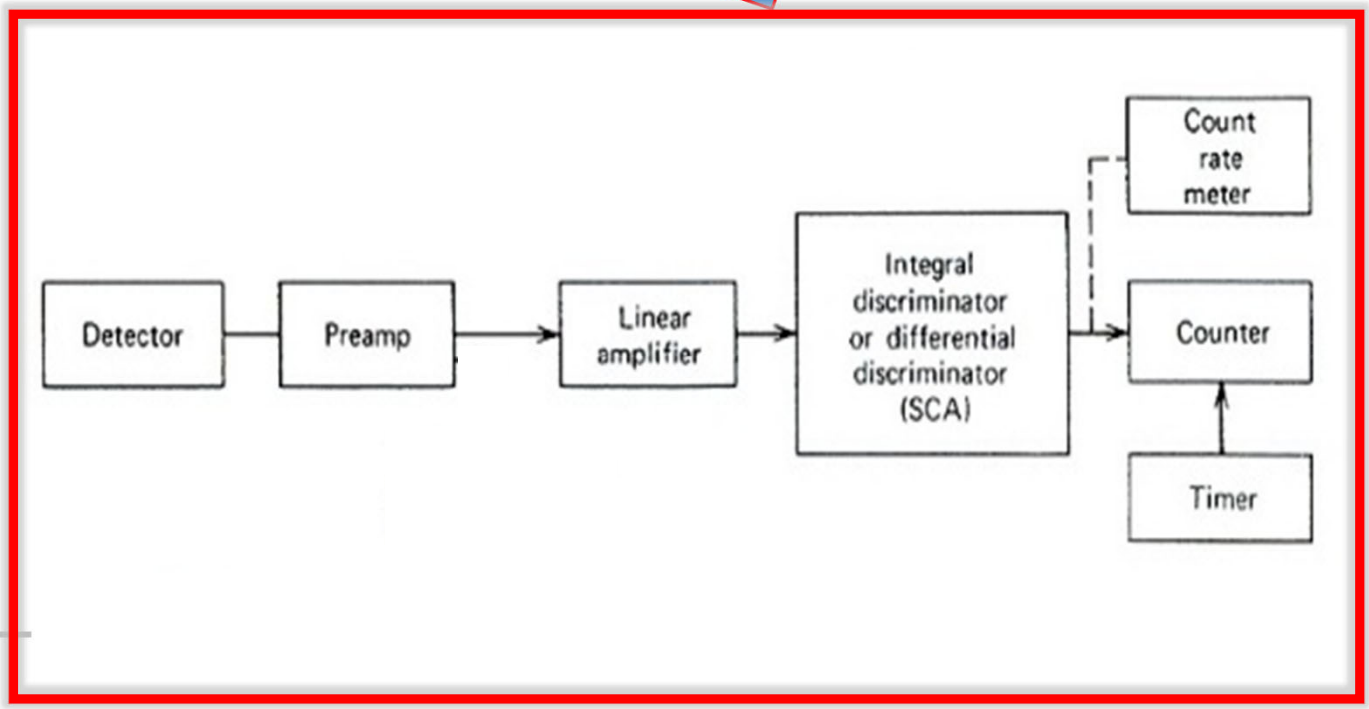
Applications

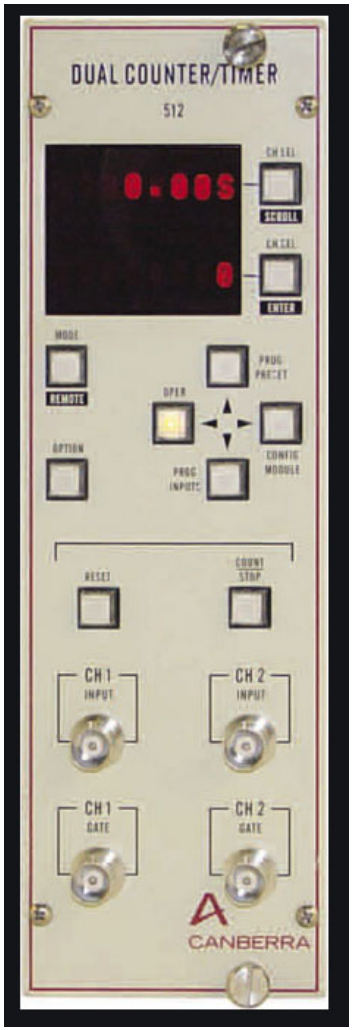
Starting with a small problem...



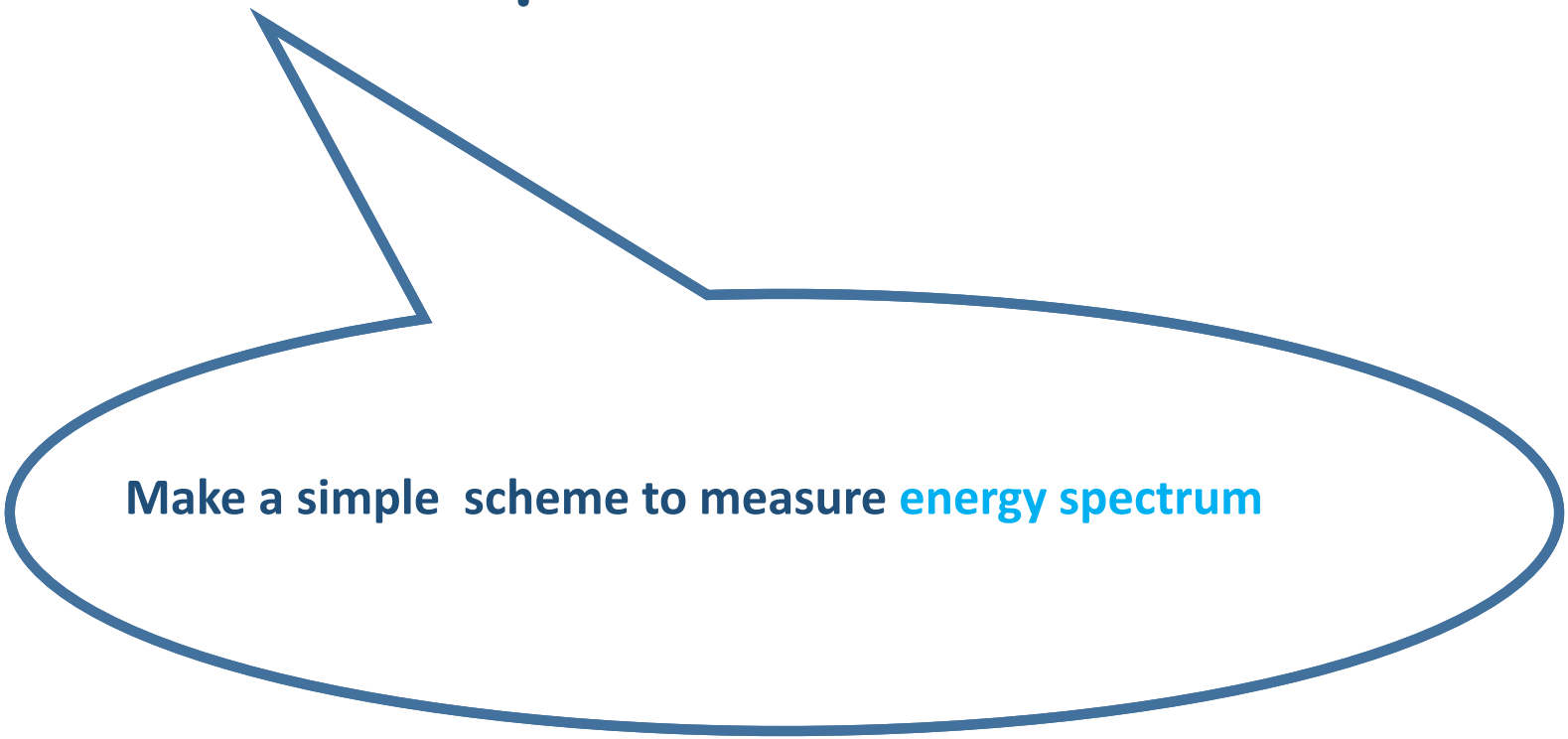
Starting with a small problem...

Make a simple (very basic) scheme for a pulse counting



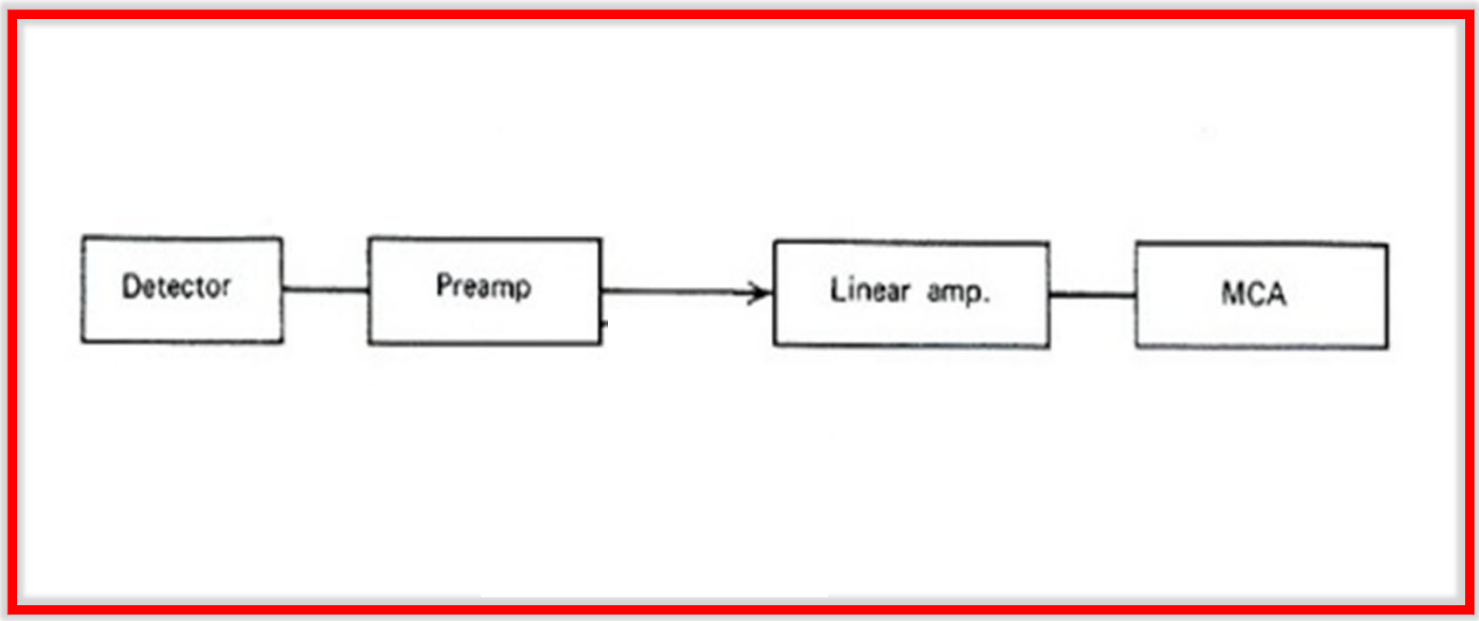


Another small problem...



Another small problem...

Make a simple scheme to measure an energy spectrum

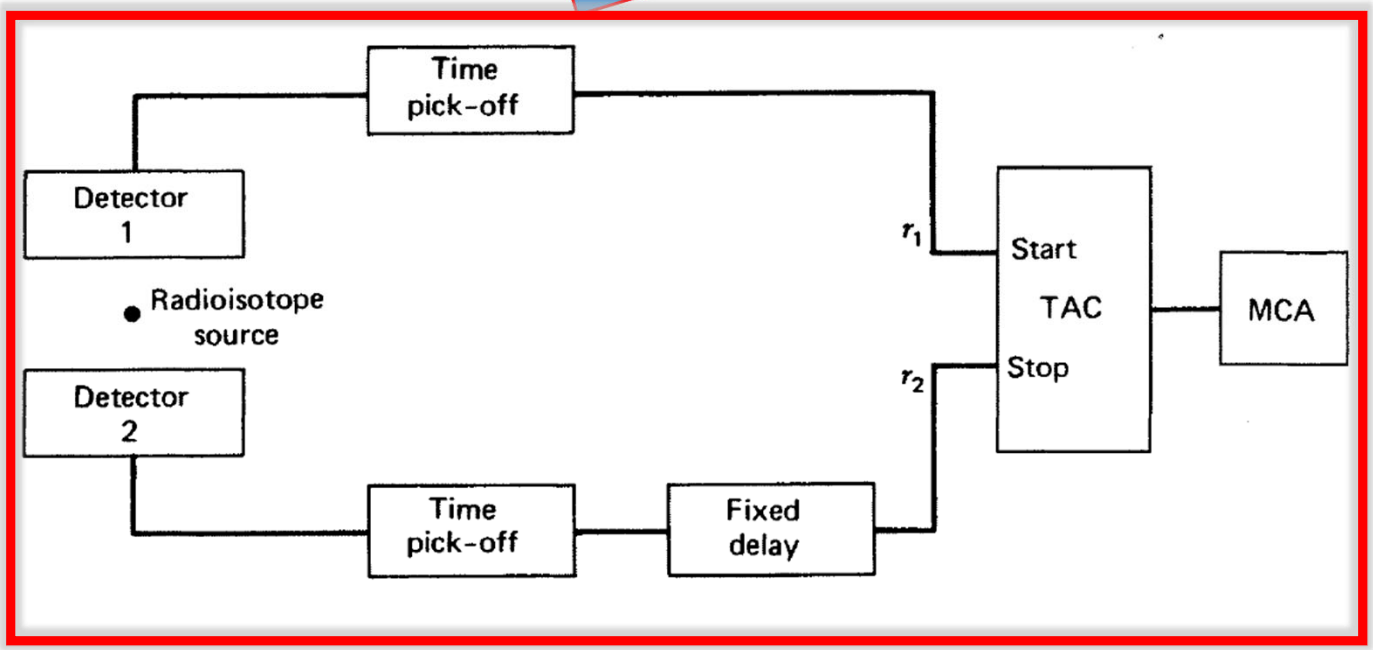


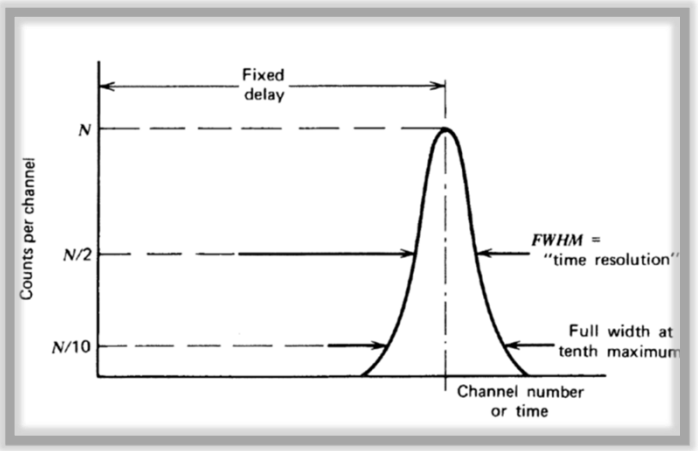
Approaching time measurements…

Make a simple scheme for recording multichannel
time spectra from a source emitting coincidence radiation

Towards time measurements…

Make a simple scheme for recording multichannel time spectra from a source emitting coincidence radiation





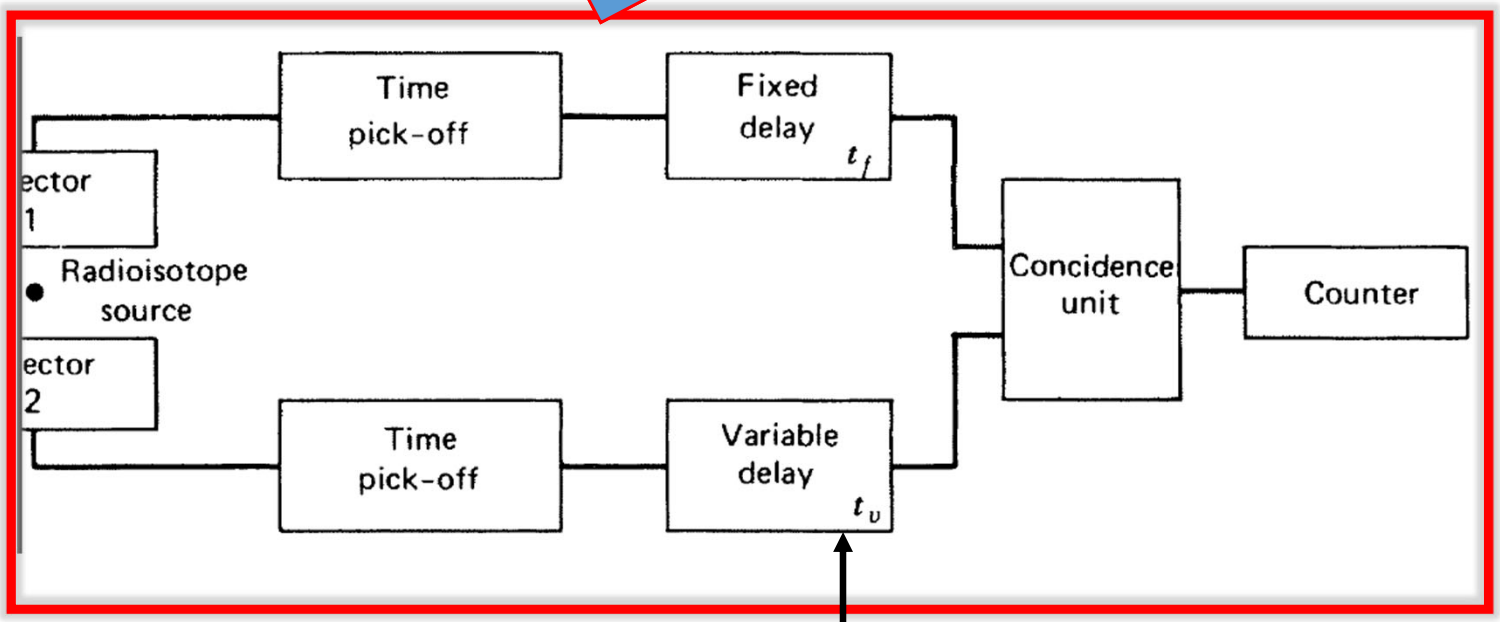
Explain the possible causes of constant background observed in a time spectrum when using a TAC.

Coincidence measurements…

Make a simple scheme for recording counts
from a source emitting coincidence radiation

Coincidence measurements…

Make a simple scheme for recording counts from a source emitting coincidence radiation

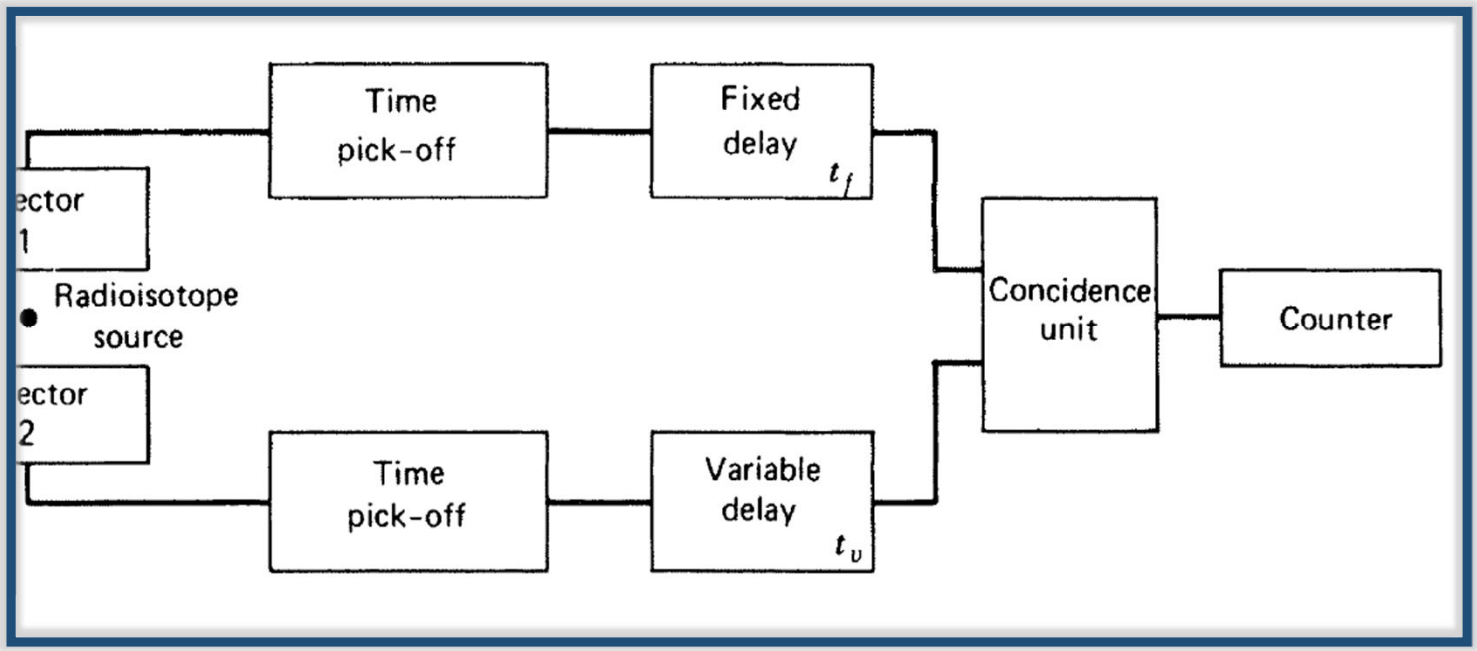


to make sure that two identical and simultaneous signals have spent the same time going through the electronics chain when they arrive at the TAC entrance

Coincidence measurements…

Make a simple scheme for recording counts from a source emitting coincidence radiation

…and MODIFY this for the case when pulse amplitude selection is desired

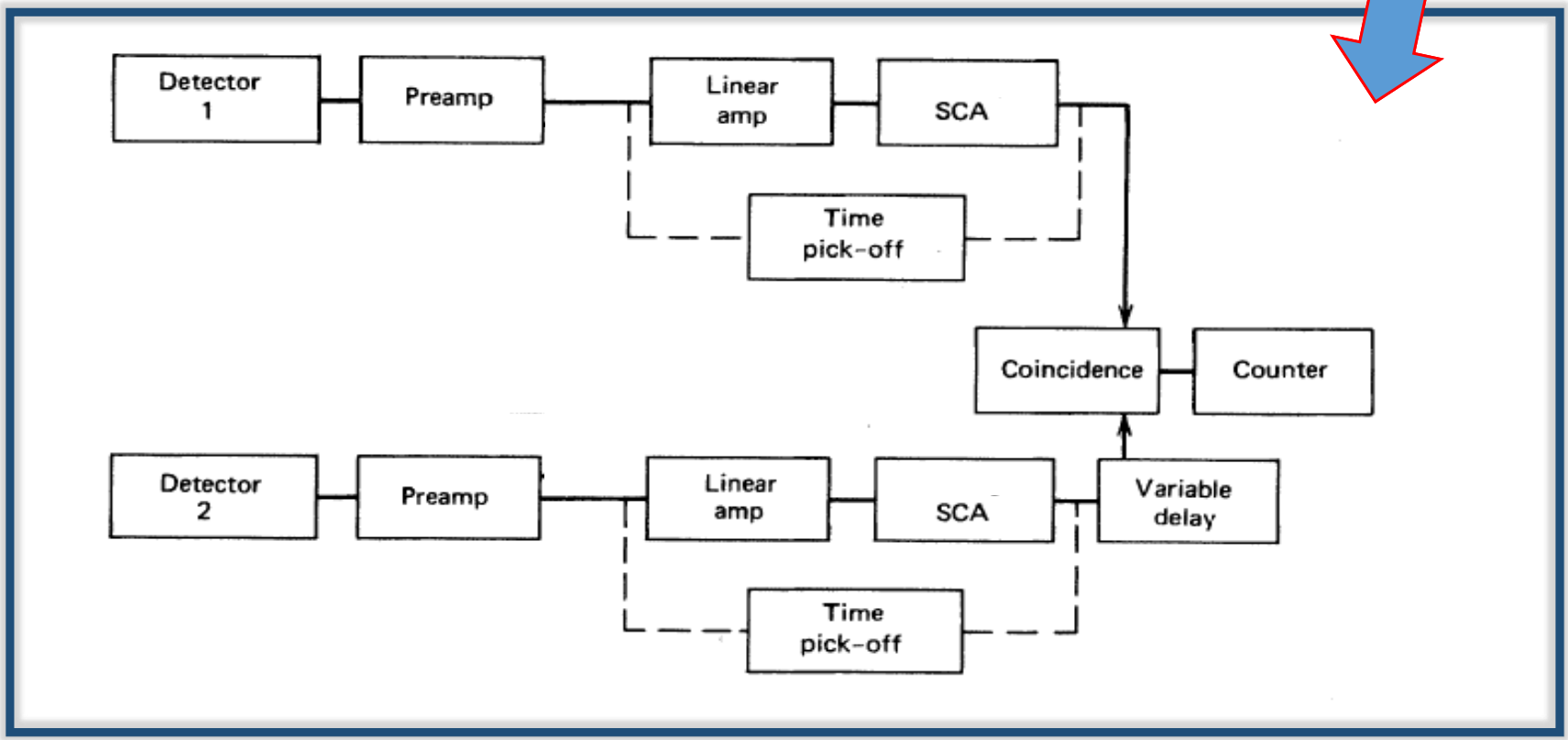


Counts "in time"

Coincidence measurements…

Make a simple scheme for recording counts from a source emitting coincidence radiation

…and MODIFY this for the case when pulse amplitude selection is desired

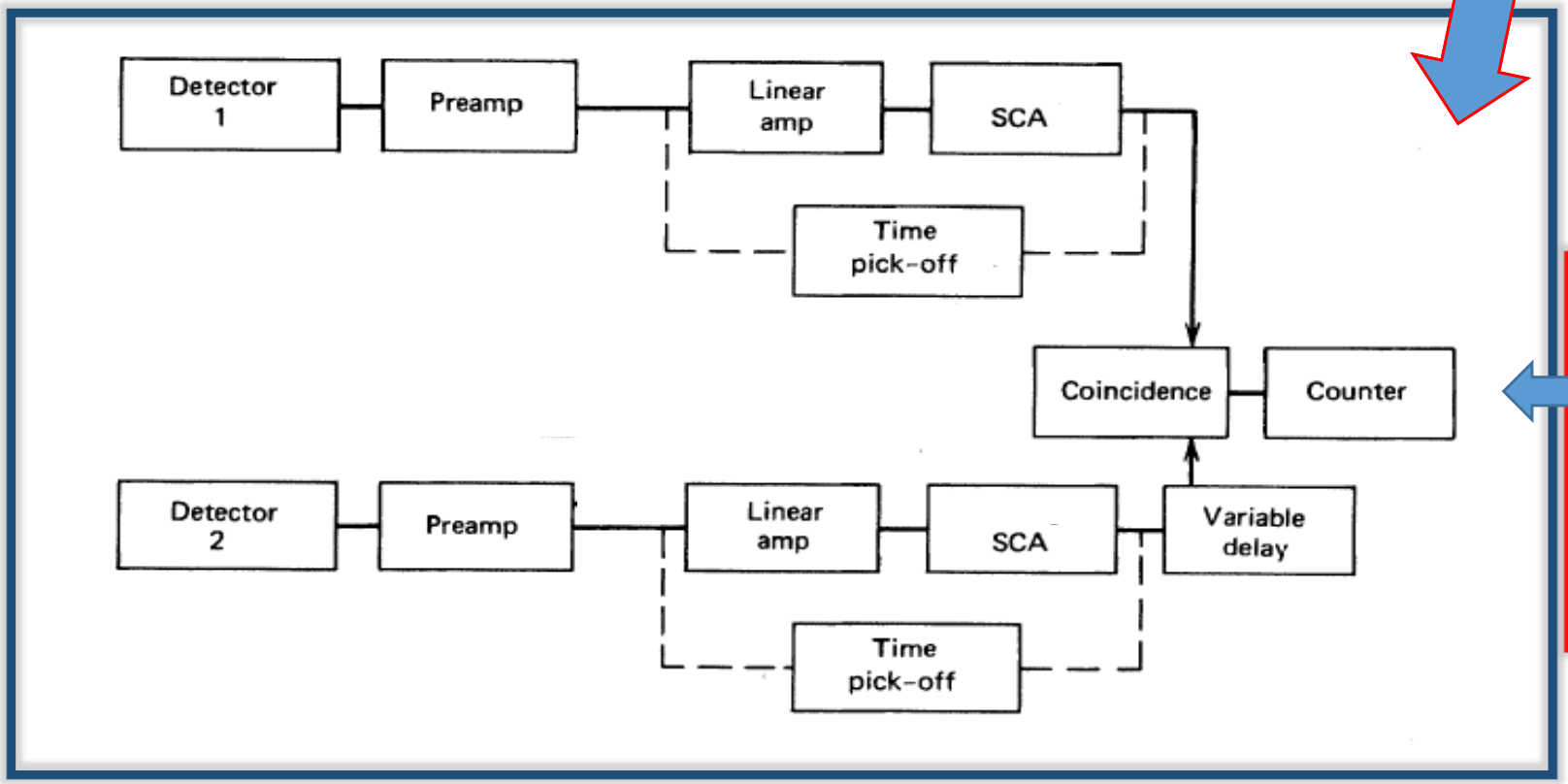


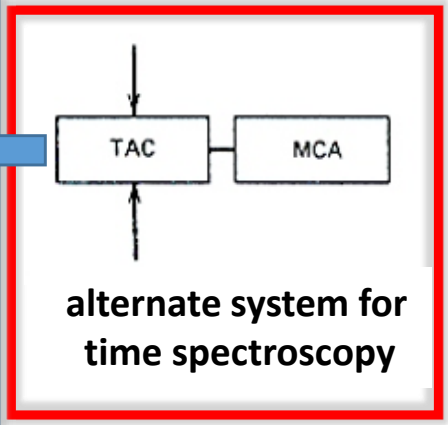
Counts "in time"

Coincidence measurements…

Make a simple scheme for recording counts from a source emitting coincidence radiation

…and MODIFY this for the case when pulse amplitude selection is desired





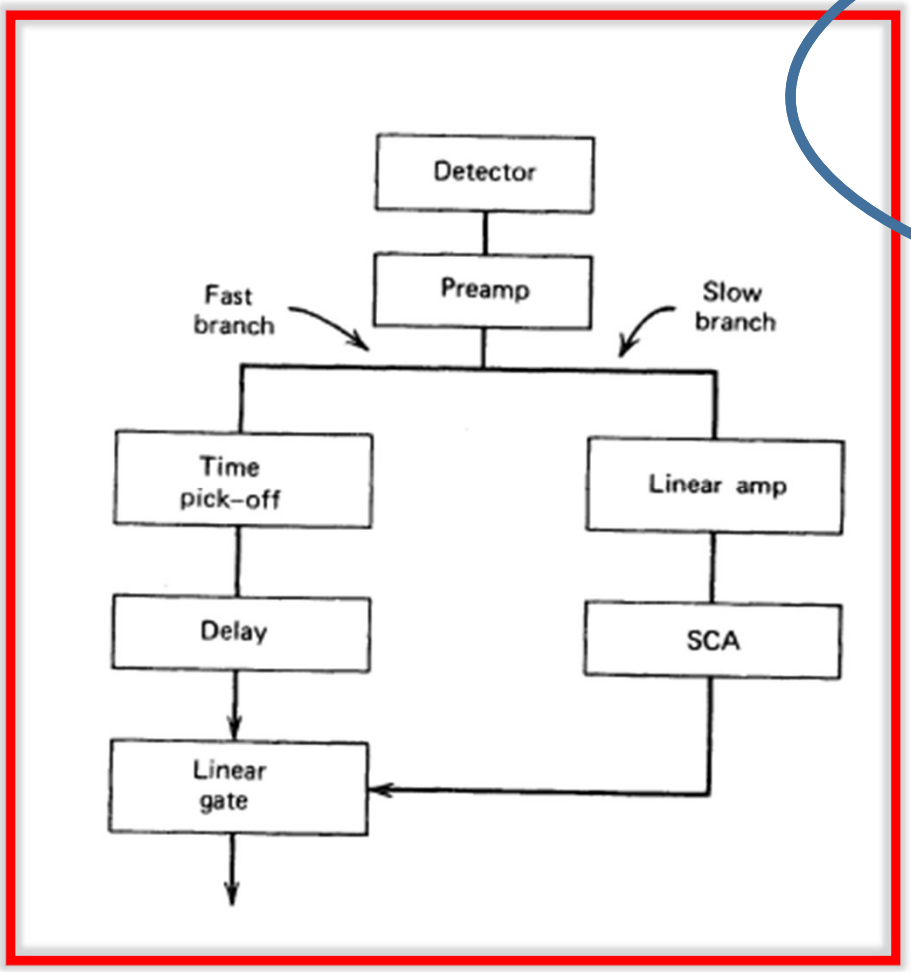
alternate system for time spectroscopy

When timing and amplitude is important

Make a fast-slow pulse-processing system
in which a slow amplitude branch is used
to select only those fast timing pulses
that correspond to events with certain amplitude

When timing and amplitude is important

Make a fast-slow pulse-processing system
in which a slow amplitude branch is used
to select only those fast timing pulses
that correspond to events with certain amplitude



Anticoincidences

Propose a detector setup and electronic scheme for suppression of the Compton edge of a gamma spectrum in a Ge detector.

Anticoincidences

Propose detector setup and electronic scheme for suppression of the Compton continuum of a gamma spectrum in a Ge detector