Pulse-height analysis

Pulse Height Analysis (PHA) is a technique which allows to detect and analyse (sort) peaks by amplitude (height).

•peak is the signature of event and contains information of interest.

two basic categories:

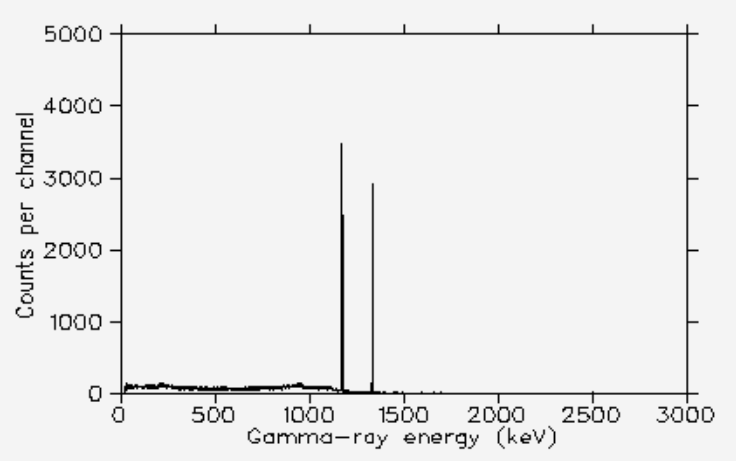
•Single Channel Analyser-
count pulses of a given amplitude and within narrow range

•Multi-Channel Analyser-
can scan the whole energy range and record number of pulses in each channel

Usual way of presenting information is by plotting a graph of counts versus pulse amplitude (height).

Sorting by height is equivalent to sorting by energy (amplitude is proportional to the energy).

example:



Consider situation when measured signal is a series of pulses (identical shape) corresponding to a series of events.

We want to know:

-the height of the pulses,

-time at which the peak is reached and

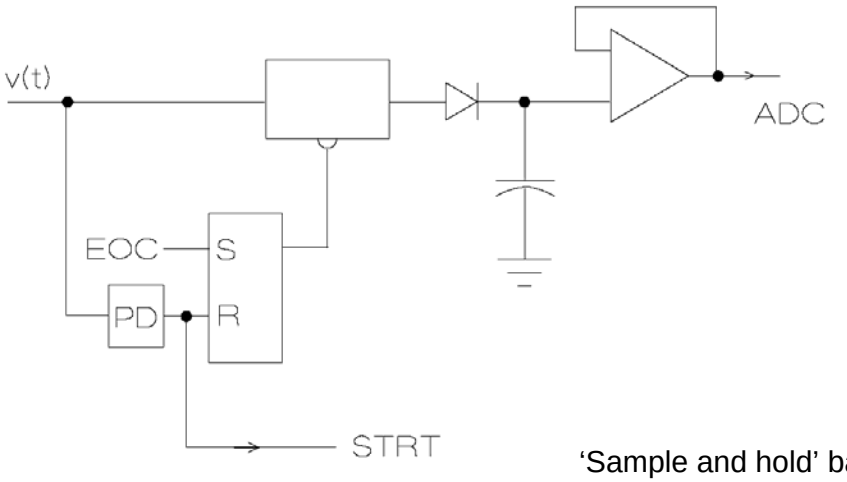
-distribution of pulses.

Let's talk about "height" and "time" first…

In case, when pulses are very short (microseconds duration)

need to:
1. hold height for analysis
2. detect that maximum has been reached

Diagram of the pulse-height detector



'Sample and hold' based

Once the conversion is completed the ADC contents are transferred to memory register and memory contents of the location at the address are incremented by one, indicating the even (pulse) with height in the interval.

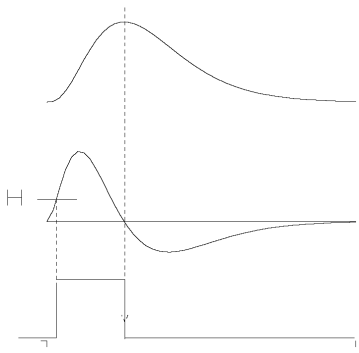
Principle of peak detection

•Input signal is differentiate;

•the derivative signal now crosses zero at time of maximum height;

•Schmitt trigger is used to detect cross-over point;

•Peak time is determined from the negative going edge of the trigger output;



Now, let's talk about the distribution of pulse heights….

The distribution of the height of the pulses is described by probability function p(h) defined so that the probability of occurrence of pulse with height between h and dh is:

$$dW = p(h)dh$$

Say, measurement is continued for a time T during which N events are rejected, then expected content of memory location n is:

$$N_n = N \int_{nV_o}^{(n+1)V_0} p(h)dh$$

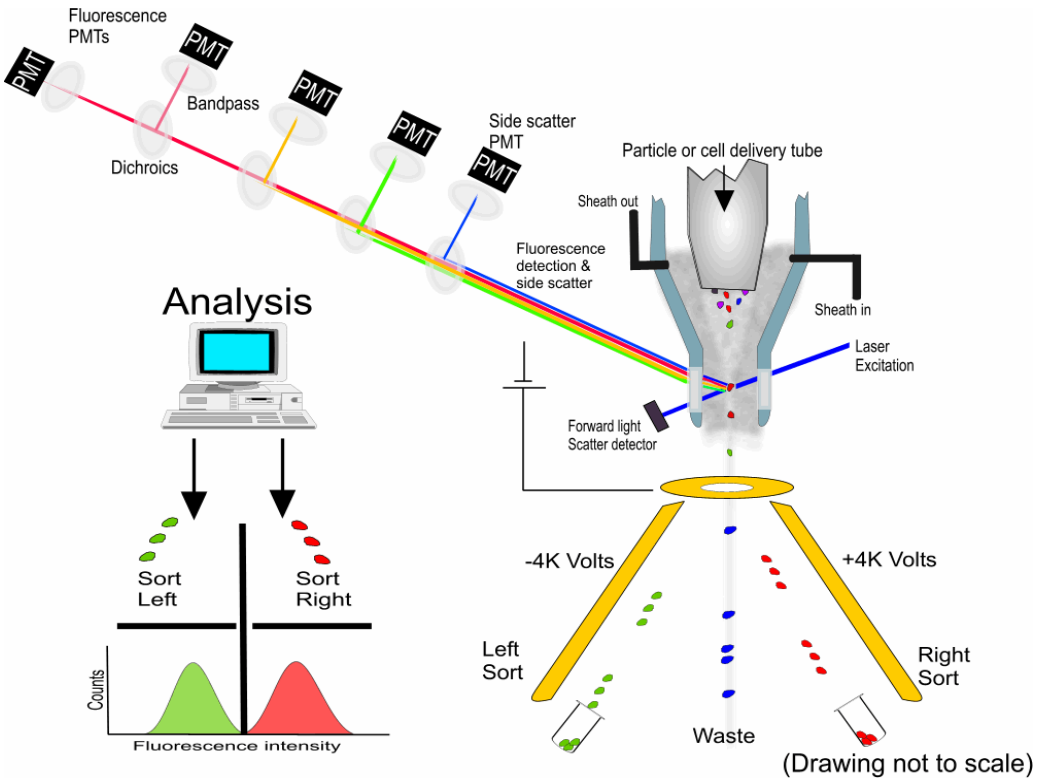
The data are in histogram approximating the probability density function.
The resolution of ADC (V_0) should be sufficiently small that probability function is constant over the integration interval dh.

Applications:

1. Flow cytometry –technique for examining microscopic biological particles (cells) suspended in fluid.

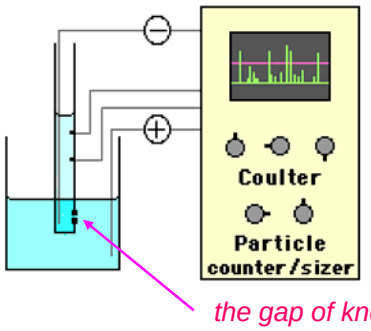
•Fluorescent chemicals found in the particle or attached to the particle may be excited into emitting light;
•The intensity of the fluorescence is determined by the content and proportional to the magnitude of the pulse (signal) from photodetector;
•The photodetector is coupled to a multi channel analyser;
•multi channel analyser determines the content in cell population.

see next slide



http://www.cyto.purdue.edu/flowcyt/educate/pptslide.htm

2. Coulter counter is an apparatus for counting and sizing particles (cells).



When particle passes through the gap between two electrodes, the resistance of the changes is detected and converted into a pulse (signal) the height of which provides information regarding particle size.

Coulter Counter is useful for larger microbes; fungi, yeasts, etc.
Not so useful with bacteria, get errors due to clumping, debris, etc.

http://www.science-projects.com/Coulter/Coulter.htm

Q: Why all the peaks are not the same height?

A: The reason is that these cells are not spherical.

Sometimes the disk-shaped particles go through the gap like a frisby (sideways), and they don't interrupt much current flow. At other times they might go through like a lemon-custard pie aimed at a clown, and that means a greater amount of momentary interruption of current.

2. Nuclear pulse spectroscopy

Interaction of radiation with particle result in a pulse the height of which is proportional to the energy deposited in the sensitive material of the detector