LIVERPOOL RADIOMETRICS

NuSPIN School

PRACTICAL 2b

SOME CAUSES OF POOR RESOLUTION AND THEIR RESOLUTION

Aims:

To demonstrate a number of system problems which might affect the proper functioning of a gamma spectrometry system

Objectives: After this practical you should

1. be familiar with the basic use of an oscilloscope.
2. be able to recognize different pulse shapes.
3. be able to recognize overloaded pulses and excessive base-line noise.
4. be aware of microphonics, and how to combat them.
5. recognize faults in the detector bias supply.

updated: 12/06/19

DEPARTMENT OF PHYSICS, UNIVERSITY OF LIVERPOOL, LIVERPOOL L69 3BX, TEL: +44 (0)151 794 6776, FAX: +44 (0)151 794 3348

43.1 The Oscilloscope and Pulses

It is useful to be familiar with the simple operation of an oscilloscope so that checks can be made to ensure that (a) pulses are passing, (b) the pulse is of the right type, (c) there is no overload, (d) there is no overshoot or undershoot, (e) base-line noise is not excessive.

43.1.1 Basics

You will use both a digital oscilloscope and the Prospect digital scope to complete this section. Pulse height is in volts on the Y-axis Pulse width is in seconds on the X-axis (this is the time-base), the Prospect software has arbitrary y units.

With a Co-60 source on the detector, take a preamplifier signal from the timing output on the detector into the oscilloscope. Practise twiddling the triggering control for optimum response; note the effect on the start of the pulse shape; note the triggering indicating light.

Ensure that the whole pulse is visible and note the indication that two major gammas are present. Practise moving voltage and time-base through the full range available.

43.1.2 Pulse shapes

Note the amplifier time constant: µs

Sketch and show dimensions of the following pulses:

preamp output (scope)

Digital amplifier

Prospect preamplifier bi

Digital amplifier

43.1.3 Some problems solved

a) You have already looked at *overshoot* and *undershoot* on unipolar pulses as part of the pole-zero correction procedure, and have learned how they are dealt with.

Undershoot and overshoot are corrected by:

1)

2)

b) While occasional *overload* from, for example, cosmic ray interactions, is almost inevitable, persistent overload from the sample gammas clearly must be avoided.

To demonstrate how this appears on an oscilloscope, increase the digital amplifier coarse gain while looking at the pulses on the Prospect oscilloscope.

an overloaded pulse:

c) *Base-line noise*.
Look at the output of the detector preamplifier. A reasonable system, properly set up, should show no more than 2-5 mV of noise, "grass", on the base line.

Switch the voltage range to a suitably sensitive scale and estimate the width of the base-line noise.

noise (estimated at 95%, i.e. 2σ): mV

A regular pattern on the base line could show either pick-up or faulty instrumentation.
Note that 50 Hz is one cycle per 20 ms.

43.2 A Miscellany;

43.2.1 High voltage

Sometimes the HV may drop or be mis-set or even fail completely, yet this may not be noticed. Charge collection in a detector with no bias may still be happening to some extent for some time; on some older detectors it can take several days for the volts to disappear completely.

To demonstrate the effect a change of voltage would have, turn the HV down (slowly and in stages), and collect a spectrum at each stage. Look at the position and shape of one peak as a function of voltage.

Observations:

Consider what mechanism might be responsible for the observed behaviour:

Now turn the HV down to zero. Wait for a couple of minutes and then collect a spectrum.
It may be useful for future reference to sketch the spectrum accumulated.

Spectrum with no applied bias voltage:

Log scaled axis (counts)

Linear scaled axis (counts)

43.2.2 Vibration

All germanium detectors are sensitive to vibration and microphonics to some extent; defective detectors may be excessively so.

Try tapping very gently (or better still, let the demonstrator do it) on the dewar casing while accumulating a spectrum.

Observe the pulses on an oscilloscope.

Observations:

Practical notes:

If you meet a persistent microphonics problem, try using

(a) a longer or shorter time constant, and/or

(b) the bipolar output of the amplifier.

(c) an anti-vibration support for the dewar.