

# NuSPIN School

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## Practical 4: HPGe Detector Analysis

**NAME :**

### **Aims and Objectives;**

To get an overview of the techniques used to analyse and characterise a segmented HPGe detectors.

### **After this practical you should be able to;**

- Identify the components of a detector scanning system.
- Sort digital detector data utilising the MTSort package.
- Identify key component of detector characterisation
- Edit the MTSort code to study charge collection parameters of an AGATA detectors.

This practical is divided into **3 sections**. Every student/group will start working through Section 1. Individual groups will be shown the detector scan setup within Section 2 while the other students continue with Section 1 or begin with Section 3.

### 1.0) Analysis of AGATA Scan Spectra

Login to the Linux PC with the Username: msc. Password: msc2010.

A set of pre-sorted AGATA spectra is located within:  
 /user3/msc/NuclearInstrumentation/AGATASCAN/

- 1) Open the MIDAS software, located in Applications → MIDAS Session. Select the Spectrum Viewer. Within the Spectrum Directory Browser, select directory /user3/msc/NuclearInstrumentation/AGATASCAN/

Select the following spectra for analysis within this practical:

- 2) **Fold:** bd\_fold

Calculate the ratio of Fold 1 events to multiple fold events.

Fold	Counts	Ratio Counts /Fold 1 Counts
1		
2		
3		
4		
5		

- 3) **MWD energy spectra:** mwd\_ag\_energy.(1-37)

Select the core energy spectra: mwd\_ag\_energy.37. In which channels does the photopeak occur?

Ch:  - Ch:

Identify the channels of the Compton edge:

Ch:  - Ch:

4) **Position gated spectra: position:**

This spectra is gated on position, fold 1 interactions and photopeak energy

Change the 2D contours (in View -> preferences -> 2D Contours) to view the spectra on a Base: 100. Using the tags, estimate the size of the front face of the detector crystal and the centre of segmentation by identifying the channels in which the detector edges occur:

Max X (mm) =	Min X (mm) =	X Size (mm) =	Segmentation Centre: X (mm) = Y (mm) =
Max Y (mm) =	Min Y (mm) =	Y Size (mm) =	

5) **Position and Ring Gated spectra: position\_ring\_fgate.(1-6):**

This spectra is gated by detector ring and Fold 1 events.

Select all of the position\_ring. spectra and view. Change the 2D contours to view the spectra on a Base: 50. Record the difference in intensity within each ring.

Ring	Intensity Region	Explanation
1		
2		
3		
4		
5		
6		

6) ***Photopeak Gated versus Compton Gated:***

The `position_ring` spectra are gated on the 662 keV photopeak of the  $^{137}\text{Cs}$  MWD Core spectra. The `position_ring_cgate` spectra are gated on the Compton edge of the  $^{137}\text{Cs}$  MWD Core spectrum.

Select and View: `position_ring.1`    `position_ring_cgate.1`  
`position_ring.4`    `position_ring_cgate.4`

Discuss the differences and similarities between the position gated energy spectra:

How does the detector response differ between these two energies of interest? What does this mean about charge sharing between two adjacent segments?

7) ***T30 risetime ring maps: pos\_core\_rise30.(1-6)***

These spectra are calculated from the baseline difference Core traces. The T30 value has been calculated from the traces within MTSort.

Select Ring 4: pos\_core\_rise30.4

What is the range of T30 values? Which area of the detector is the highest t30?

8) ***T90 risetime ring maps: pos\_core\_rise90.(1-6)***

These spectra are calculated from the baseline difference Core traces. The T30 value has been calculated from the traces within MTSort.

Select Ring 4 T90: pos\_core\_rise90.4

What is the range of T90 values? Which area of Ring 4 has the longest charge collection?

9) ***Image Charge Asymmetry: ac\_ica\_map.(1-6) :***

These spectra are calculated from the difference in the magnitude of transient signals generated in the two segments adjacent to the hit segment where the real hit occurs.

Select Ring 4 ICA: ac\_ica\_map.4

How does the image charge vary over the segments radially? How do they vary azimuthally?

## 2.0) Scanning System Components

There are two scanning tables setup in the Lab. A scanning table setups consists of:

- Parker scanning table arms
- Mounted Germanium Detector
- Associated Digital Electronics and cables, including power supplies and digitisers.

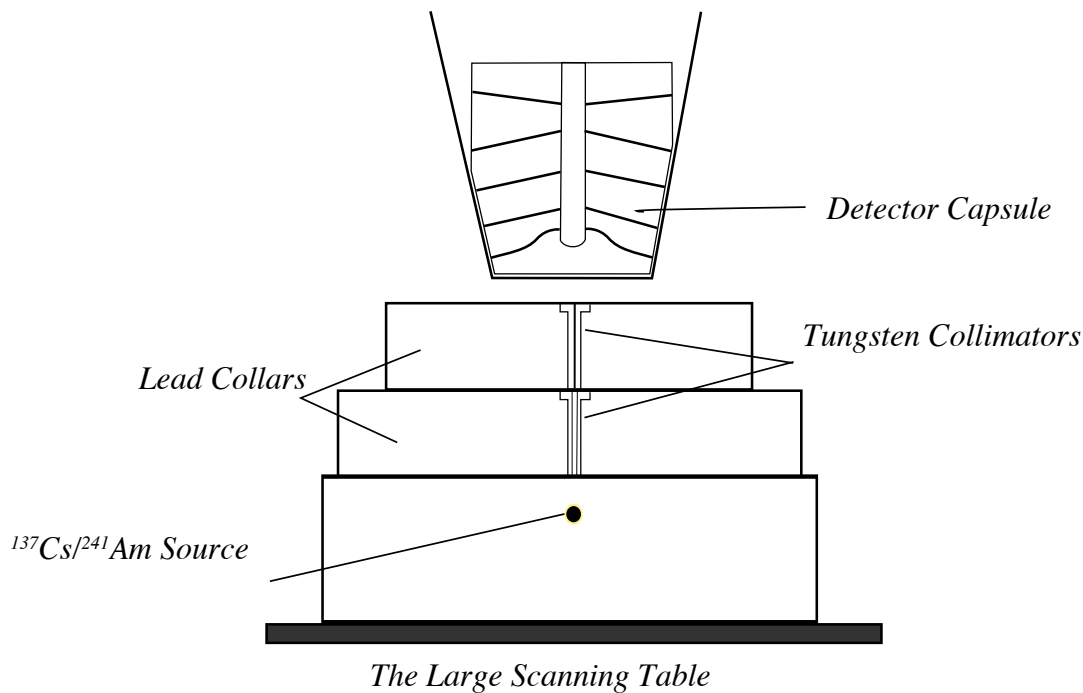
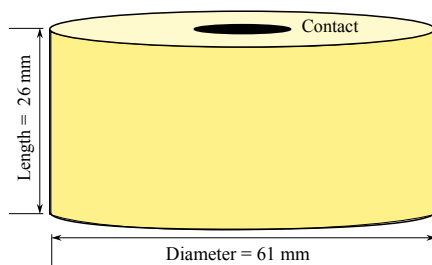


Figure 1.1

The large scanning table, shown in Figure 1.1, was used to acquire the AGATA data sets that will be analysed within Sections 1 and 3.

- 1) The small scanning table setup is used to acquire the BEGe scan data. This is the setup used to acquire the data set that you were shown as an example in Lecture 3.



*A BEGe Detector*

Figure 1.2

- 2) The demonstrator will point out the components of the small scanning table. The electronics chain for data acquisition on the small scanning table:

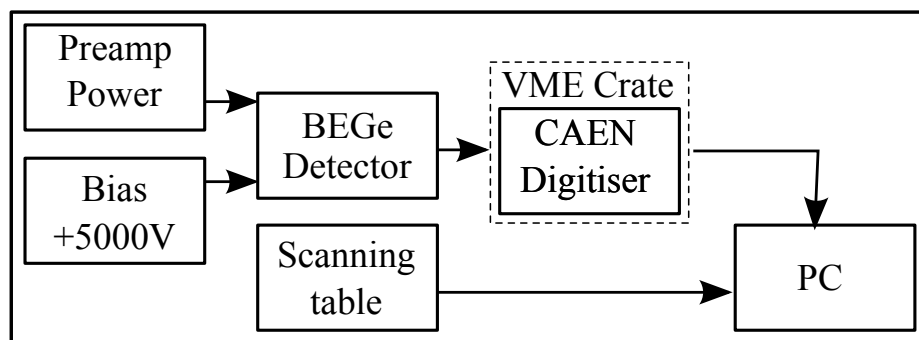


Figure 1.2

- 3) In the lab, identify the components of the small scanning table, which is set up scanning a BEGe Detector and a  $^{241}\text{Am}$  source.

Sketch the components of the small scanning system including the detector placement:

Observe the progress of the scanning table. The system is triggered by an external trigger, which is read into the CAEN digitiser cards. The cards and scanning table data is accessed by the data acquisition PC.

- 4) The demonstrator will show you the scan software, which is setup with the MIDAS software. On the data acquisition desktop, the *VXM Scanning Table Setup* window controls the scan parameters. Fill in the parameters of the scan:

Parameter	Value	Parameter	Value
Step Length (mm)		Step Duration (s)	
X Start (mm)		X Range (mm)	
Y Start (mm)		Y Range (mm)	

- 5) Within a MIDAS MTSort Session desktop, observe the online scan progress. In the spectrum browser window select the baseline difference calculated energy spectra, **energy\_bdo**, as calculated by the traces read in from the energy CAEN digitiser cards. In what range of channels does the photopeak occur?

Ch:		- Ch:
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- 6) The scanning table position can be observed within the **positiongated** spectrum. This spectrum is also gated on photopeak channel. Observe the progress of the scan as the scanning table increments over the surface of the detector.

Sketch positiongated spectrum.



### 3.0) Running MTSort and Characterisation of AGATA scan data

You will now run a sort program with scan data taken for AGATA detector B006 as it was setup on the Large scanning table. This data was acquired at 1 second per position. This data set is chosen for rapid sorting so that you can investigate features of scan data sorting.

The data is located in /net/nps4/d0/B006/R/. The run files begin with R1\_.

- 1) Setup the sort using the guide to “A Quick Guide to MTSort” has been provided. Follow those steps to start MTSort and select sortfile: `AGATABasic` along with `AGATACode.c`. Calibration coefficients for each channel have already been calculated for you.
- 2) Rename the MTSortfile `AGATABasic_[GroupInitials]`. Rename the c-code `AGATACode_[GroupInitials].c`.
- 3) Start a sort using the default options already included in the code. Observe that the `position_ring` spectra are filling before moving on to the next step.
- 4) Within the MTSort Setup Window, select Edit Sortfile -> `gedit`. Identify where the energy gates `low_en` and `high_en` are set in the code. Identify where they are used to gate on the position spectra. Open the MWD spectra, `mwd_ag_energy0.37` and verify that the gates correspond with the photopeak energy. If they are different, enter gates that correspond with the highest and lowest photopeak channel.

Ch:	-	Ch:
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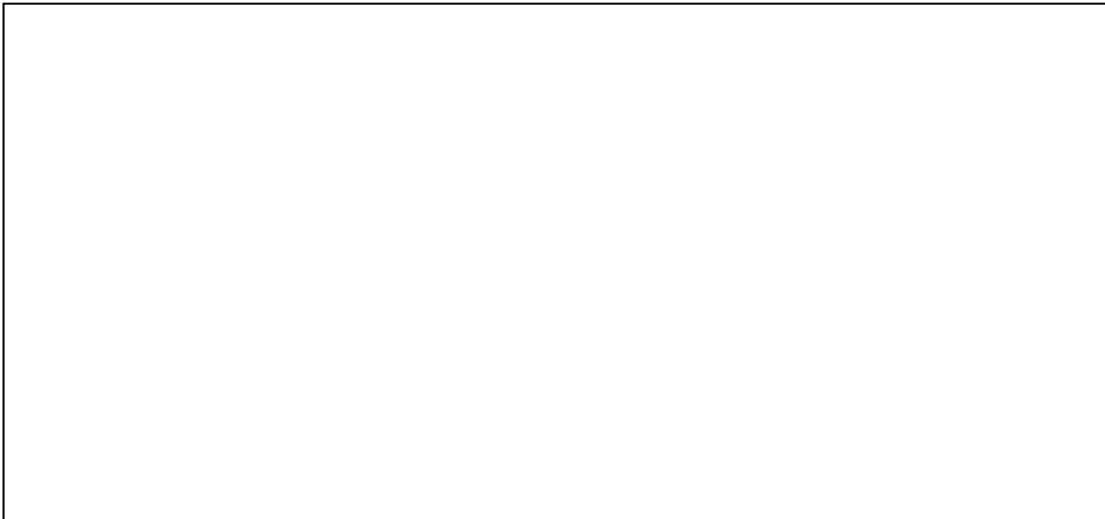
- 5) Within the MWD `mwd_ag_energy0.37` energy spectra identify the Compton edge of the 662 keV photopeak. In which channels does the Compton edge occur?

Ch:	-	Ch:
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- 6) Edit the sort code and rerun the sort to produce position and ring gated spectra for the Compton edge energies. You can call the spectra `position_ring_cgate`. How do these position gated spectra differ from that gated on the 662 keV photopeak? Compare `position_ring.1` and `position_ring_cgate.1` what are the differences in the spectra?



- 7) Edit the sort code and rerun the sort to produce position and ring gated spectra for Fold 2 events. You can call the spectra `position_ring_fold2`. How do these spectra differ from that gated on the 662 keV Photopeak? Compare `position_ring.1` and `position_ring_fold2.1` what are the differences in the spectra?



- 8) Within gedit, open the C code: `AGATA_[GroupInitials].c`. Go to the section of the code labelled “Is this energy statistically significant?”. This determines what is which events read from the digitisers are counted as real hits.
- 9) Change the threshold and observe how the fold count varies.

Threshold	Fold1	Fold 2	Fold 1/2
1			
2			
3			
4			
5			

What do you think the implications are to changing this threshold?

