Calibration sources for the commissioning and status of the simulation

Aurélie Bonhomme
CEA Saclay

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Calibration

Commissioning strategy

First order calibration. Maybe only inner target calibration is enough ?

- Available sources: ^{54}Mn, ^{60}Co, ^{124}Sb (and more !)
- On the basis of 3 tubes, 3 positions per tube, 3 sources... **27 runs**
- pe/linearity runs between each source ?
- Critical point: GC calibration. Using the target as veto ?
  $\rightarrow$ dedicated study based on simulation.

Calibration

Commissioning strategy

Duration needed to be able to calibrate the gamma catcher ?

Simulation study:

- Hard trigger on the sum of 4 PMs for the cells and the two short GCs and on the sum of 8 PMs for the two long GCs.
- Soft vetoes and cuts depending on the source to get a "clean" peak in each block

$\rightarrow$ Estimate of the duration needed to calibrate each region, assuming a **10 kHz hard trigger on source events** (bad scenario, to let a free place for backgound...) and asking for **10 000 counts in the interesting peak** in each detector block.

! Durations are here for background free runs. Source runs have to be interspersed with dedicated long background runs.

Simulation status

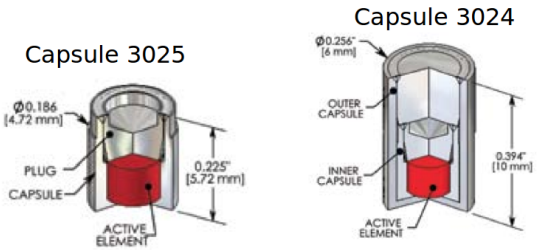
Internal tubes for sources

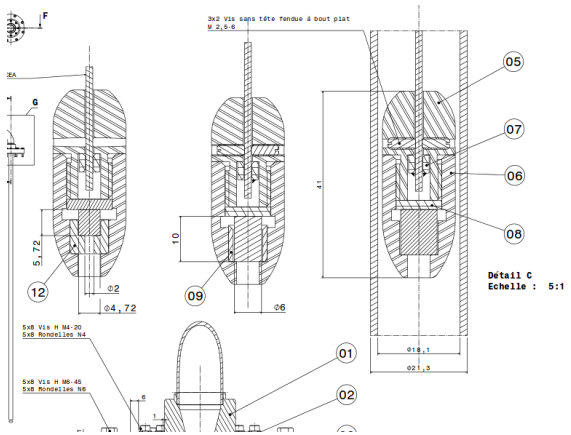
Tubes and sources loaders implemented in the simulation software, both from Saclay and LAPP designs.

If changes in the capsule geometry $\rightarrow$ has to be changed in the geometry.

Use the generator StereoCalibGenerator, providing the source, the tube and the position via a macro file. (presented in 21.07.16 simulation/analysis meeting).

- Capsule geometries:





Simulation status

Calibration sources

Implemented sources (defined with G4ParticleGun) :

Co60 - Simplified ^{60}Co source with 1.17 and 1.33 MeV isotropic gammas
Na22 - Simplified ^{22}Na source with 1.275 MeV gamma and 1 positron
Ge68 - Simplified ^{68}Ge source with 1 positron
Cs137 - Simplified ^{137}Cs source with 0.662 MeV gamma
Mn54 - Simplified ^{54}Mn source with 0.834 MeV gamma
AmBe - AmBe source with neutron energy spectra for different cases (only a neutron / a neutron and a 4.4 MeV gamma)

And using the G4RadioactiveDecay module :

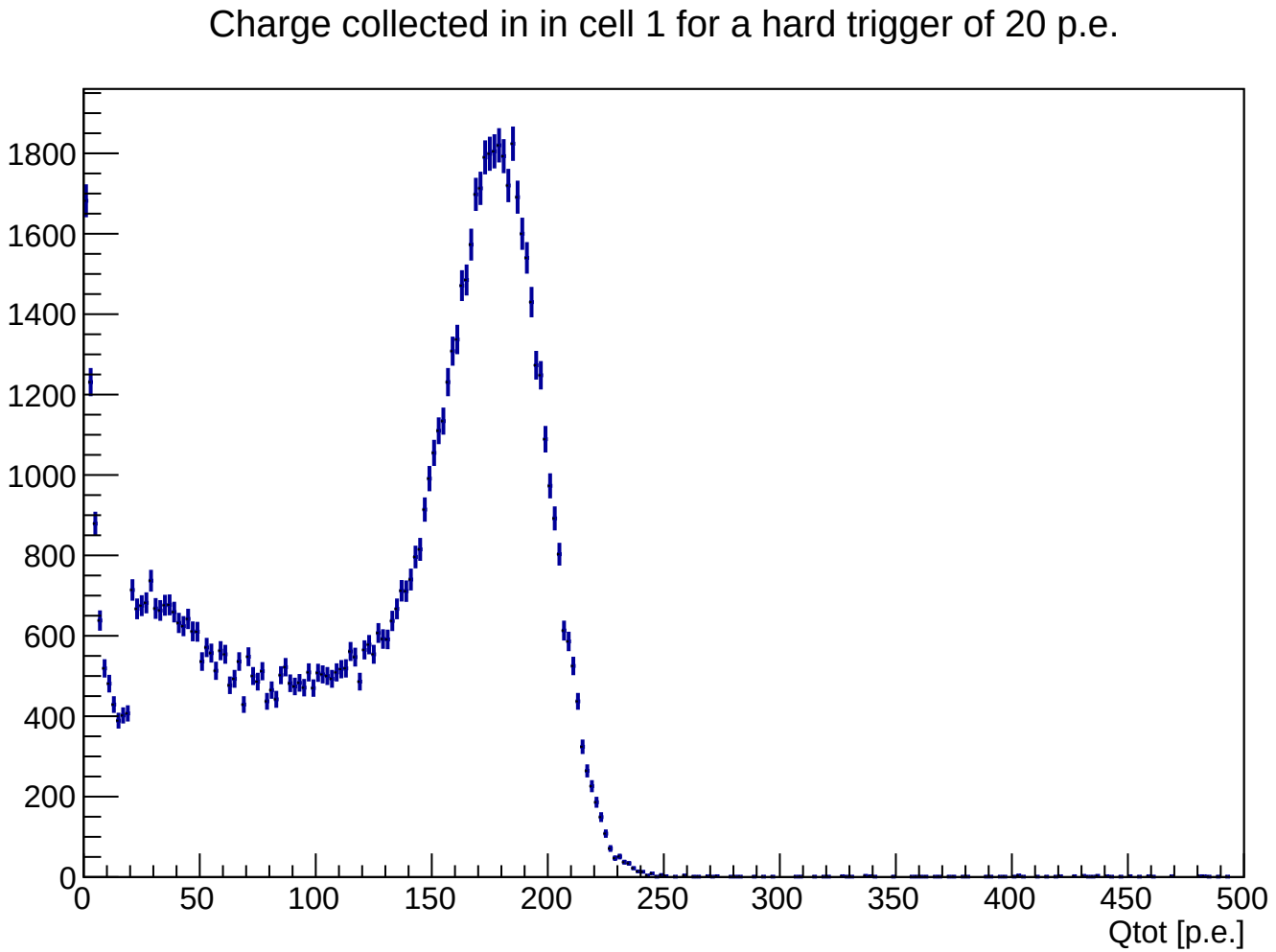
Co60_G4, Na22_G4, Ge68_G4, Cs137_G4, Mn54_G4, Sb124_G4

/!\ Pay attention to the rate when using these sources (decays with long period are managed by the DeferTrack)

Internal calibration simulation

Manganese source - spectrum after hard trigger

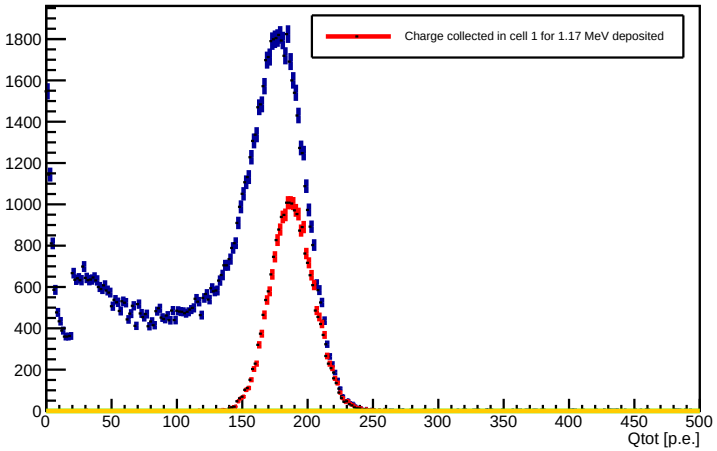
One single mono-energetic gamma at 834 keV.



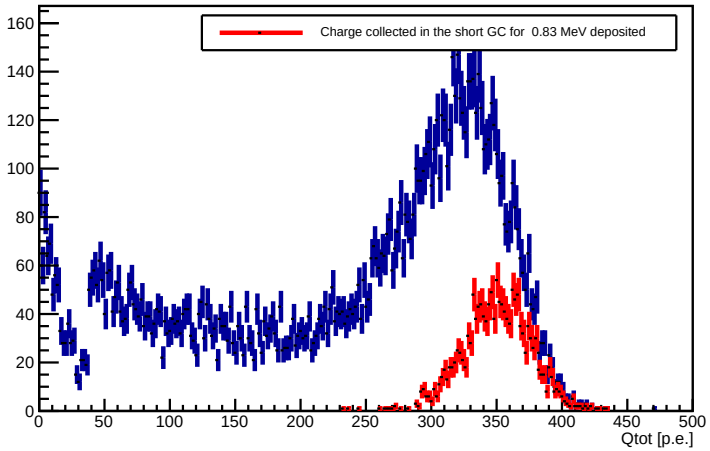
Internal calibration simulation

Manganese source - spectra after soft vetoes

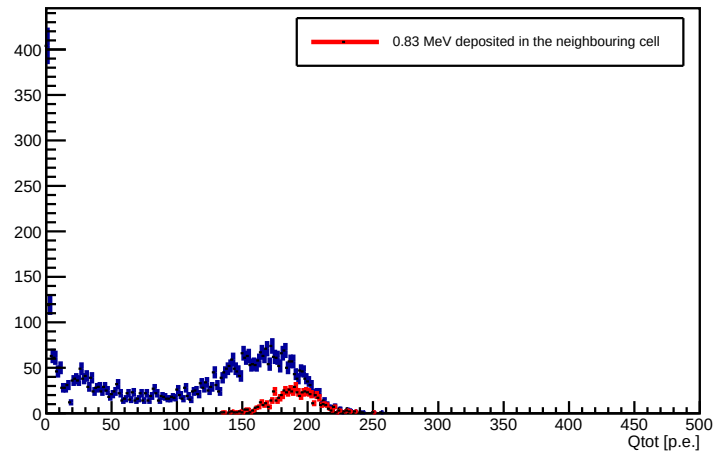
Charge collected in cell 1 with a veto on other cells of 40 p.e.



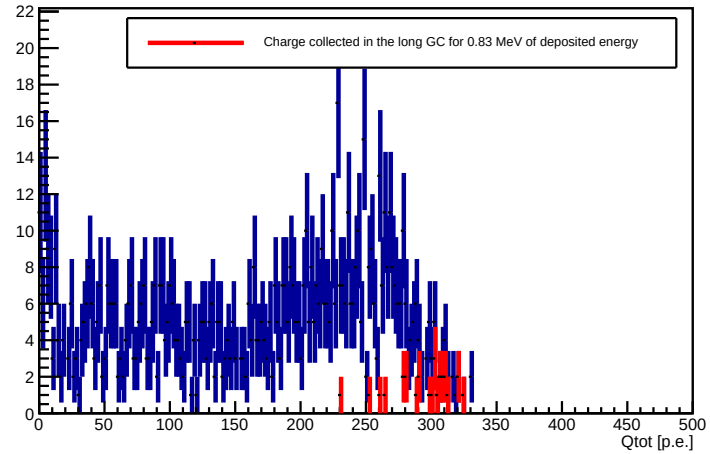
Charge collected in front GC with a veto on other cells of 40 p.e.



Charge collected in cell 2 with a veto on other cells of 40 p.e.



Charge collected in long GC with a veto on other cells of 40 p.e.



Internal calibration simulation

Manganese source

Pos	HardTrig	SoftVeto	Pic	Volume	% in peak	Time
mid	20	40	0.84	Cell	45.80	2
	20	40	0.84	Neighbouring Cell	1.70	58
	20	40	0.84	Short GC	4.58	21
	20	40	0.84	Long GC	0.40	270
bottom	20	40	0.84	Cell	35.40	2
	20	40	0.84	Neighbouring Cell	1.16	85
	20	40	0.84	Short GC	3.02	33
	20	40	0.84	Long GC	0.26	388

Table 1: Manganese source in cell 1

Pos	HardTrig	SoftVeto	Pic	Volume	% in peak	Time
mid	20	40	0.84	Cell	44.52	2
	20	40	0.84	Neighbouring Cell	1.72	58
	20	40	0.84	Long GC	0.42	239
bottom	20	40	0.84	Cell	33.45	2
	20	40	0.84	Neighbouring Cell	1.08	92
	20	40	0.84	Long GC	0.31	327

Table 2: Manganese source in cell 4

The long GC is the critical volume to callibrate, in terms of number of counts and of shape. With respect to the "truth" mean reconstructed charge for a full deposition in the volume :

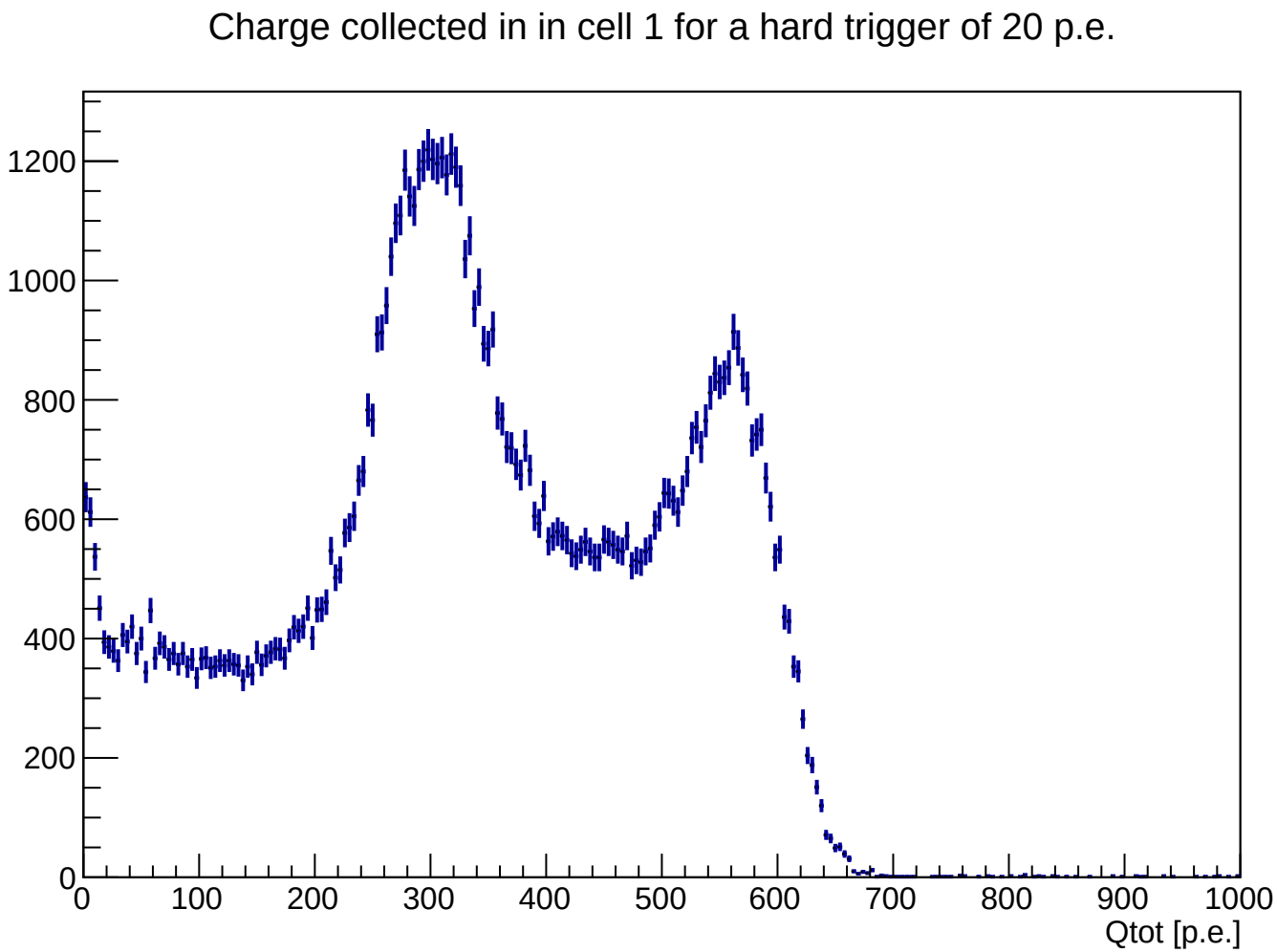
$<$ 10% bias for the cell itself, the neighbouring cell and the short GC

$\sim$ 20% bias for the long GC, depending on the shape.

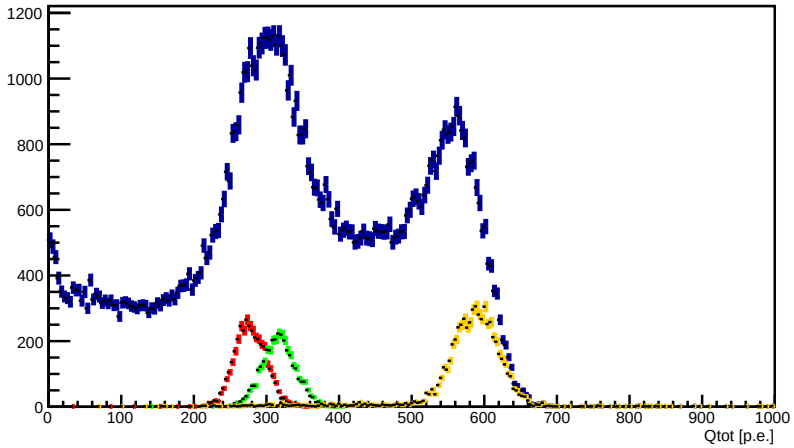
Internal calibration simulation

Cobalt - spectrum after hard trigger

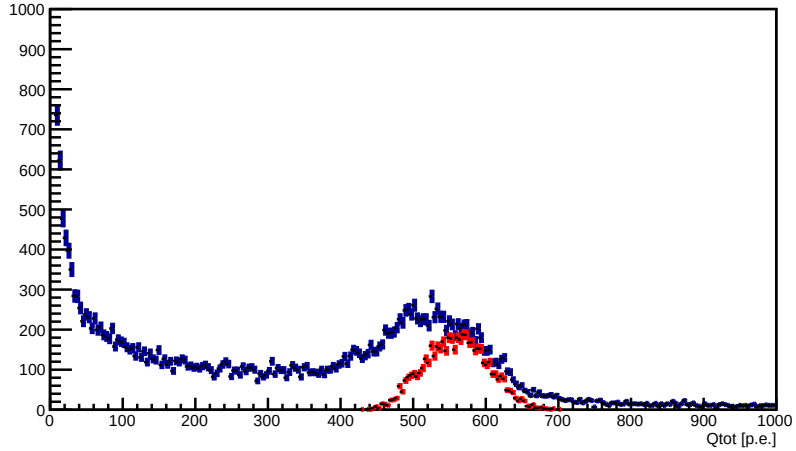
Two single mono-energetic gamma at 1.17 and 1.33 MeV.



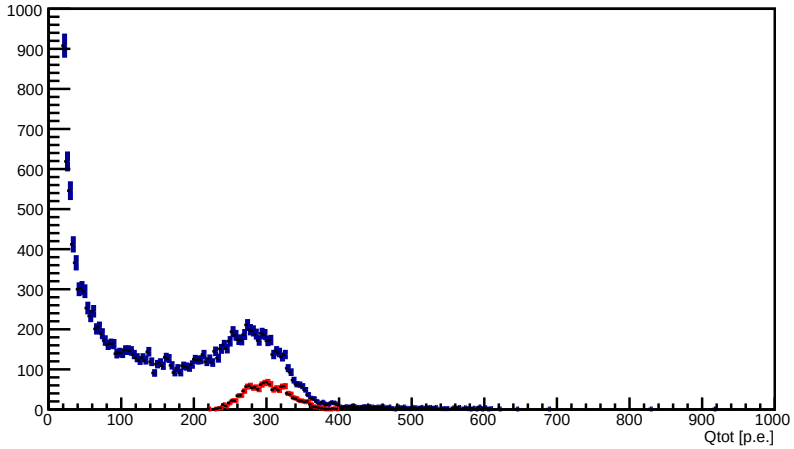
Charge collected in cell 1 with a veto on other cells of 80 p.e.



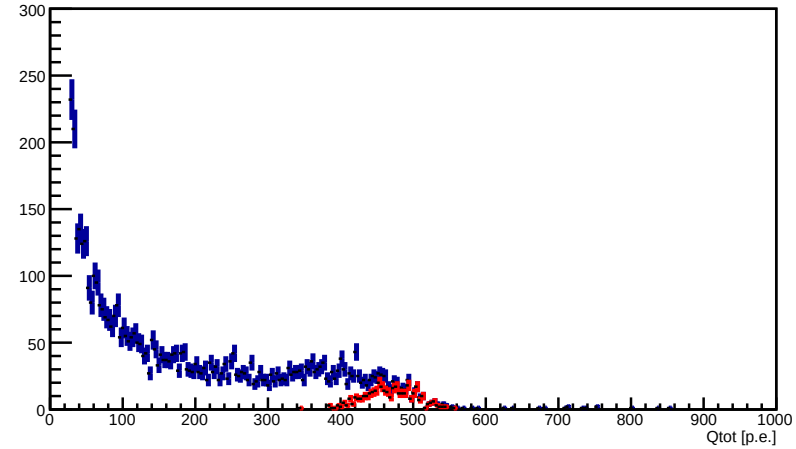
Charge in front GC for Q(cell)<350 p.e. with a veto of 80p.e. elsewhere



Charge cell 2 for Q(cell)<350p.e. with a veto of 80 p.e. elsewhere



Charge in long GC for Q(cell)<350p.e. with a veto of 80 p.e. elsewhere



Pos	HardTrig	SoftVeto	Pic	Volume	% in peak	Time
mid	20	80	1.2	Cell	25.99	3
	20	80	2.5	Cell	13.4	7
	20	80	1.2	Neighbouring Cell	4.51	22
	20	80	1.2	Short GC	10.10	9
	20	80	1.2	Long GC	1.02	97
bottom	20	80	1.2	Cell	27.5699	3
	20	80	2.5	Cell	7.08042	14
	20	80	1.2	Neighbouring Cell	3.2682	30
	20	80	1.2	Short GC	7.99362	12
	20	80	1.2	Long GC	0.819622	122
top	20	80	1.2	Cell	27.213	3
	20	80	2.5	Cell	11.7736	8
	20	80	1.2	Neighbouring Cell	3.49695	28
	20	80	1.2	Short GC	8.15069	12
	20	80	1.2	Long GC	0.797461	125

Table 3: Cobalt source in cell 1

Pos	HardTrig	SoftVeto	Pic	Volume	% in peak	Time
mid	20	80	1.2	Cell	13.992	7
	20	80	2.5	Cell	12.2726	8
	20	80	1.2	Neighbouring Cell	3.35088	29
	20	80	1.2	Long GC	0.870749	114
top	20	80	1.2	Cell	19.457	5
	20	80	2.5	Cell	12.1032	8
	20	80	1.2	Neighbouring Cell	2.78833	35
	20	80	1.2	Long GC	0.720064	138

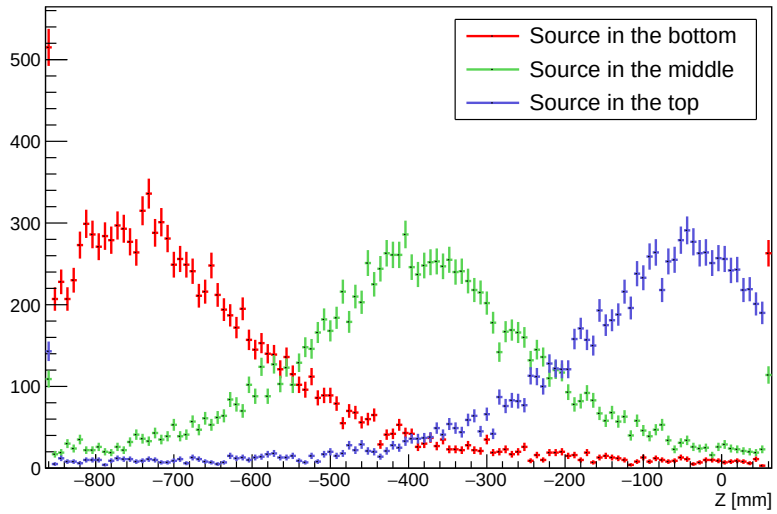
Table 4: Cobalt source in cell 4

Easier in shape for neighbouring cells. Long gamma catcher still critical in terms of shape.

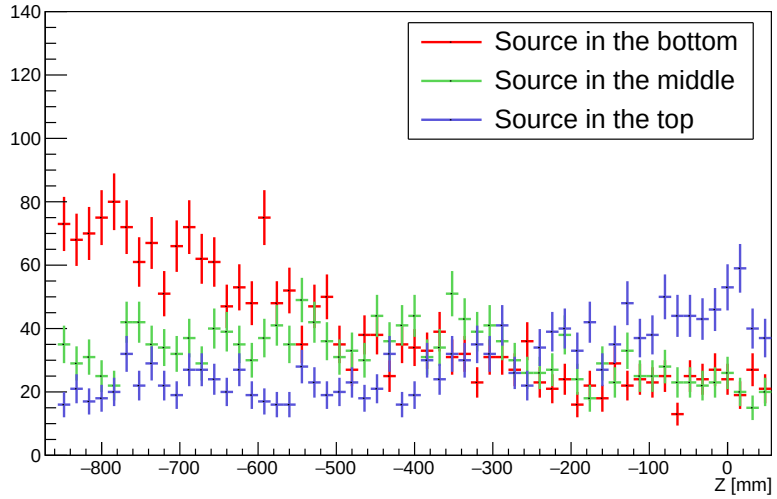
Additional possibility

Scanning the z-inhomogeneity

Bottom-up effect can be estimated using the fact that $\sim$ 1 MeV gammas have a 10 cm range in liquid.



(a) Events selected in the short GC



(b) Events selected in the long GC

Short GC (or neighbouring cell) = 12 cm from the tube.
Long GC = 45 cm from the tube.

Simulations available on **/sps/hep/stereo/CommissioningCalibSources**

Data tree copied in the output of the usual *analyzer* (simu_algo) to allow the use of the truth info: option "-d", true.

Tool used to compare simu/data ready, plot simple spectra. Includes a rough estimation of the light yield parameter.

Soft cuts to be implemented.

Conclusion

Internal inter-calibration possible for cells and short gamma catcher cells, harder for long GC (rate and shape : needs to rely on simulation) :
About 15' minutes for Mn source (threshold), less for Co (energy scale).

External calibration for long GC $\rightarrow$ reducing internal run duration to a few minues.