Investigating the time resolution of germanium detectors

Elisabetta B. (TUM)
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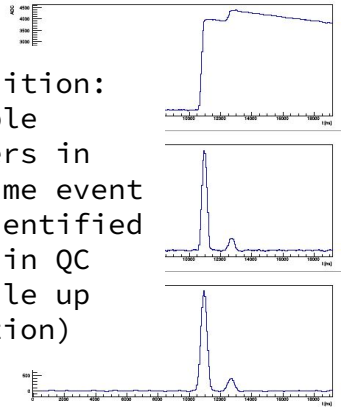
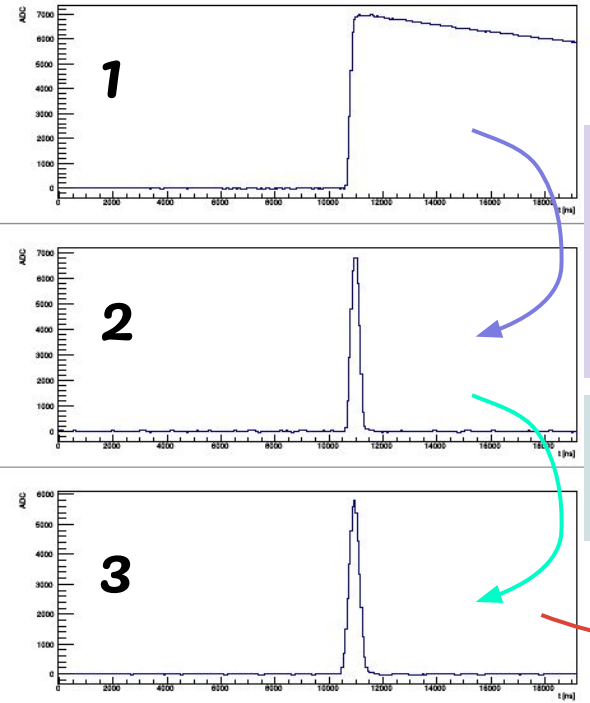
Time reconstruction in ALPACA (Ge detectors)



In addition: multiple triggers in the same event are identified (used in QC for pile up rejection)

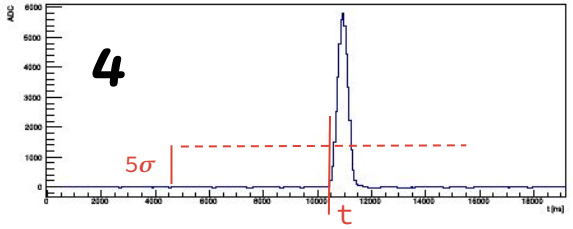
➔ Uses the GELATIO module GEMDFTTrigger (*JINST 6 P08013*)



Differentiation and deconvolution with exponential function (τ~50ns) (Moving Window Deconvolution, MWD, ~400 ns window)

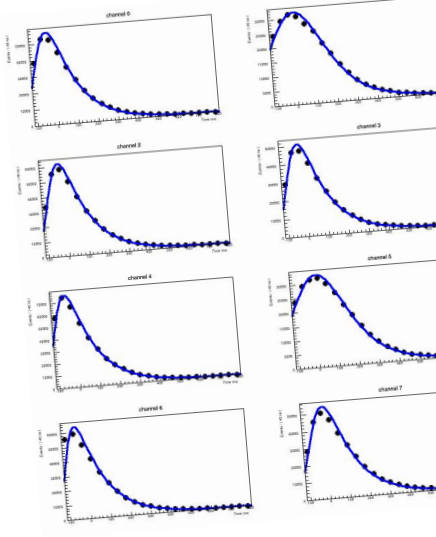
Integration (Moving Window Average, MWA, ~400 ns window)

Leading edge discriminator: the trigger time is the first sample above threshold



*threshold defined as 5 baseline sigma
*after the trigger the signal has to stay above threshold for a certain time (~200 ns)

Motivation

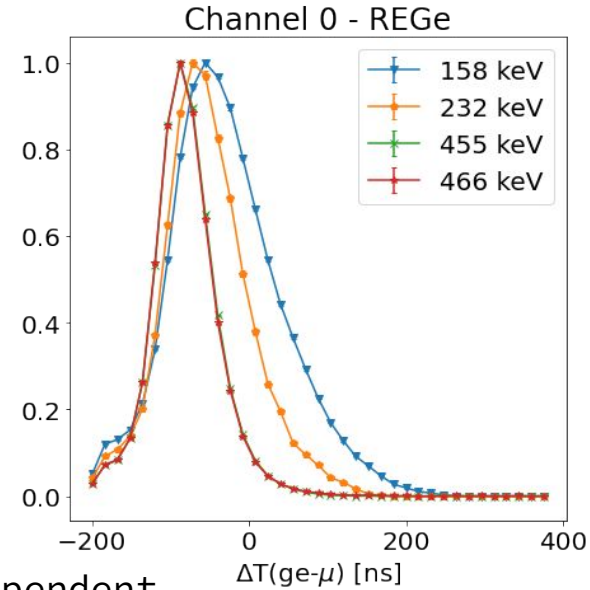


- I was trying to fit the time evolution of the de-excitation gammas including the time resolution of the germanium detectors with an exponential convoluted with a gaussian function (see collaboration meeting slides)
- Can we constrain the resolution term with our data? (Igor O.)
- Discussion at the collaboration meeting: we can look at the muonic X-rays in our data

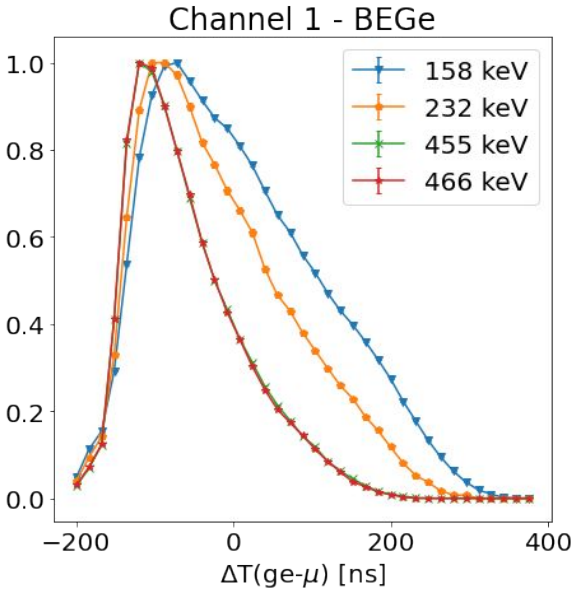
What I did

- Select 2 muonic X-rays from the M-series (close to the gammas' energies): 158.6 and 232.3 keV
- Select 2 muonic X-rays from the L-series (for comparison): 455.6 and 466 keV
- Fit the muonic X-ray over time (with bins of 16 ns)

Results: channel 0 (REGe) and channel 1 (BEGe)

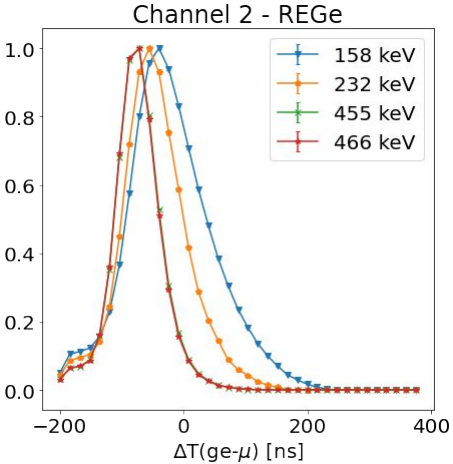


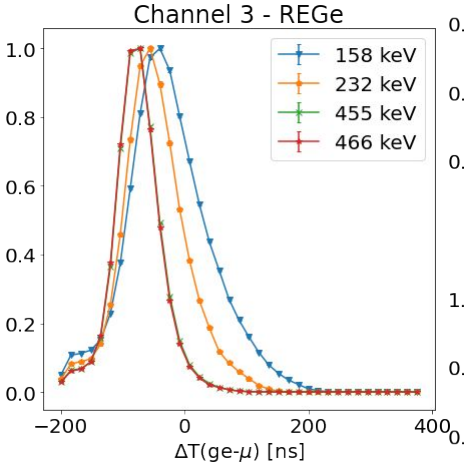
- Much worse time resolution in BEGe detectors
- Even larger deviation from Gaussian

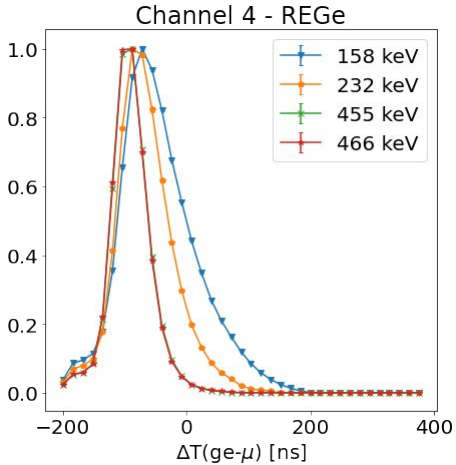


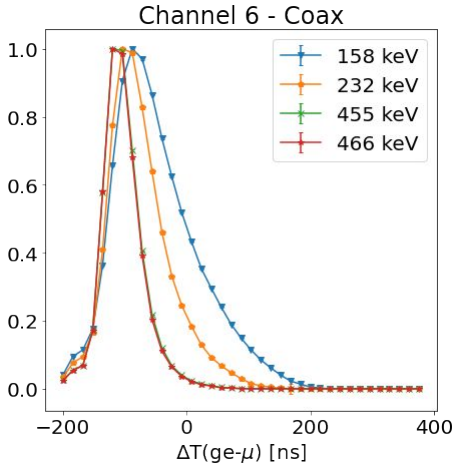
- Energy-dependent time resolution
- Non-gaussian shape especially at lower energies

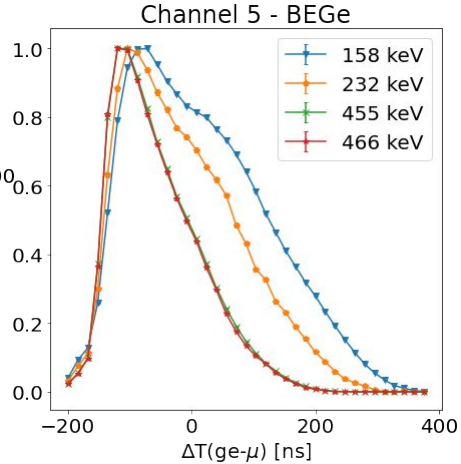
Other channels

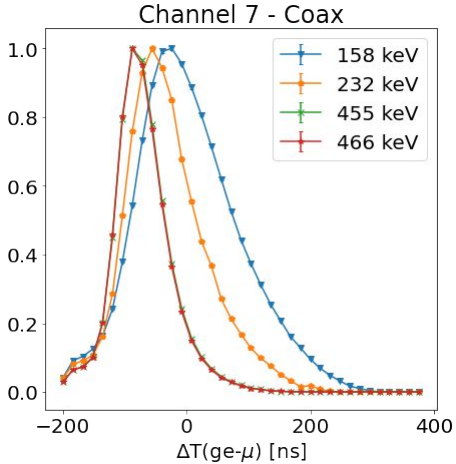






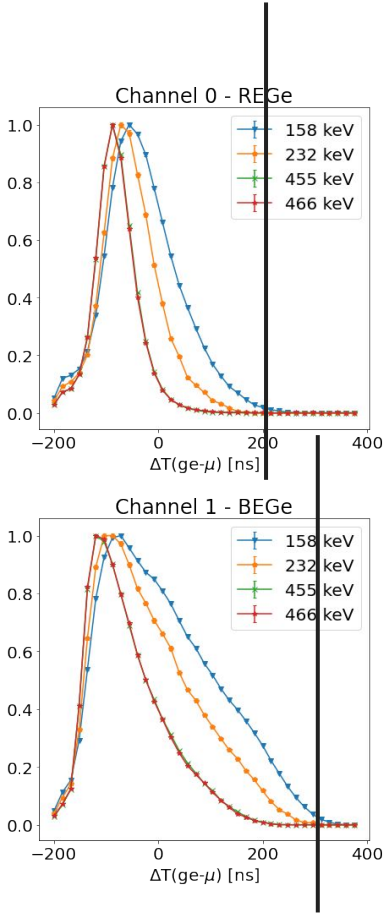






Conclusions

- My assumption of gaussian time resolution was wrong!
- Time resolution difficult to model: especially at low energy strong energy dependence
- Need a different strategy for the fit of the time evolution of gamma lines (total capture rate)
- E.g. I could set the lower edge of the fit range where the muonic X-rays are gone (taking into account differences among detectors)



Higher energy...

Nice plot for the conceptual paper maybe!