

BGO pulse shape studies

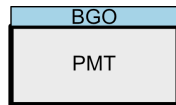
24/01/25

- ▶ Magali's test bench (Magali talk
<https://indico.in2p3.fr/event/33881/>)
- ▶ $2 \times 2 \text{ cm}^2$ BGO thin scintillator
- ▶ Acquisition with an oscilloscope
- ▶ Objective : Prepare the processing software for the test beam to be able to determine the decay time constants

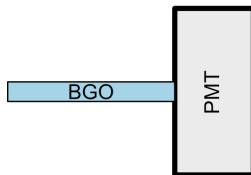
Runs

Available runs :

DataSet	Configuration	Content
13	A	Free running
14	A	Free running (10k)
15	A	Free running
16	B	Alpha Source Trigger issue
17 1k	B	Alpha Source (1k)
17 10k	B	Alpha Source (10k)
18	B	Free running, with ext. trigger



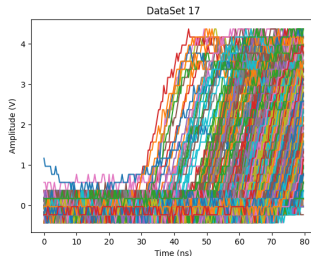
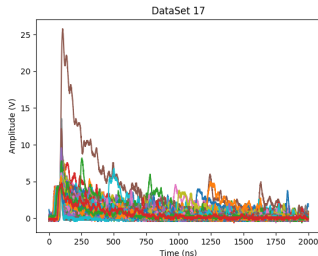
Configuration A



Configuration B

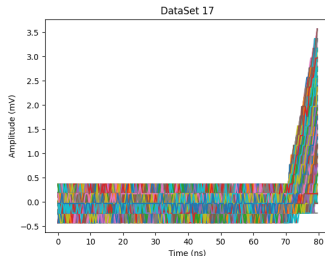
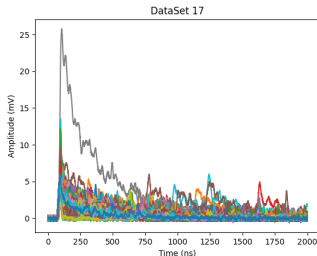
A note on the triggering

- ▶ With the actual trigger, the start of the signal is not clean
- ▶ Plague the time constant determination



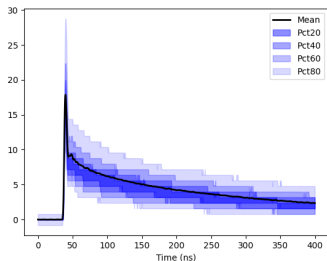
A note on the triggering

- ▶ Quickfix : Use a lower threshold (1.5 mV run<17, 0.5 mv run \geq 17) in the post-processing (software), use the mean value as a reference
- ▶ Need to be improved

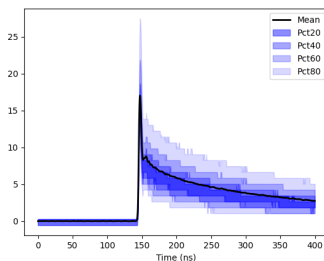


Free running runs

- ▶ Simple mean of all signals
- ▶ As expected $MPV < \text{mean}$
- ▶ Cherekov light in the PM glass
- ▶ Resolution affected by Limited by the oscilloscope LSB



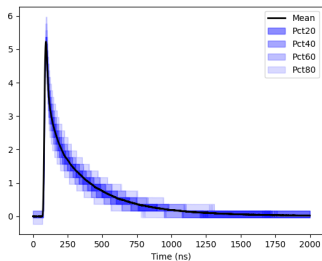
Run 13



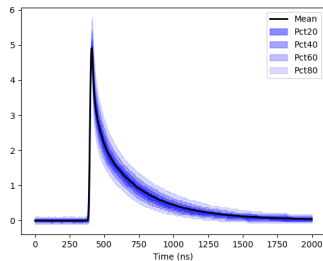
Run 14

Alpha source runs

- ▶ Simple mean of all signals
- ▶ Configuration B allows to get rid of the Cherenkov light



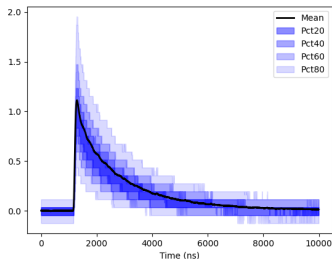
Run 17 10k



Run 17 1k

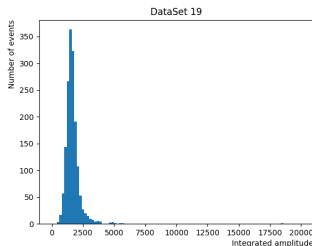
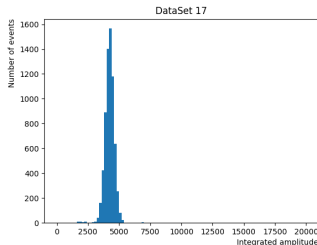
Muon runs

- ▶ Simple mean of all signals
- ▶ Configuration B allows to get rid of the Cherenkov light
- ▶ Trigger generated by two external scintillators in coincidence (muons selection)



Run 18

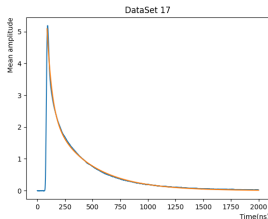
- ▶ Performed on dataset 17 and 18
- ▶ Use the python sherpa library and roofit
- ▶ Error defined as the std dev. of all signal/bin $/\sqrt{n}$ (oscilloscope binning not included)
- ▶ Fitted as the sum of 2 exponentials



Integrated amplitudes

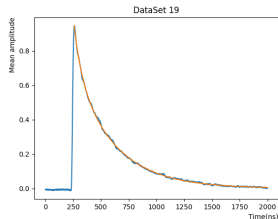
$$f(t) = A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2)$$

Run 17 10k :



A_1	2.41
A_2	2.67
τ_1	360.94
τ_2	45.8
χ^2	48.6

Run 18 :



A_1	0.698 ± 0.002
A_2	0.248 ± 0.002
τ_1	360.5 ± 0.5
τ_2	69.9 ± 1.2
χ^2	0.7

- ▶ S Gundacker et al, Phys. Med. Biol. 65 (2020) 025001 (20pp)
45.8 ns (8 %) 365 ns (92 %)
- ▶ W. Wolszczak, et al "Temperature Properties of Scintillators for PET Detectors: a Comparative Study" 2014
85 ns (7 %) 370 ns (93 %)
- ▶ "TIMING PROPERTIES OF BGO SCINTILLATOR"
Nuclear Instruments and Methods 188 (1981) 403 409
60 ns (10 %) 300 ns (90 %)

Conclusion

- ▶ Next step : move to ASM readout
- ▶ Model with two exponential not enough to reproduce the decay shape for alpha particle
- ▶ Model with two exponential can reproduce the decay shape for muons, consistent with the literature