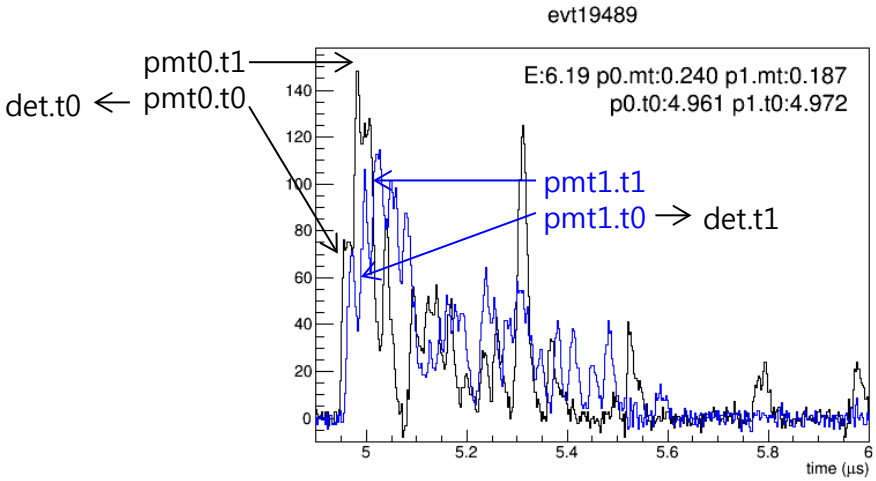
KIMS-NaI analysis

Kim, Kyungwon

2016. 8. 24.

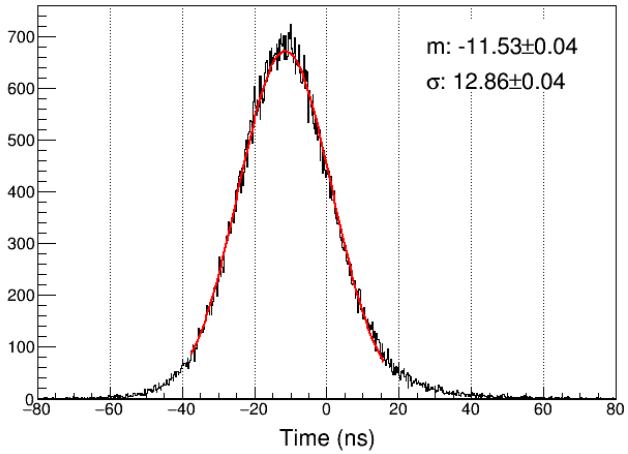
KIMS-NaI analysis – mean time

- $det.t0$

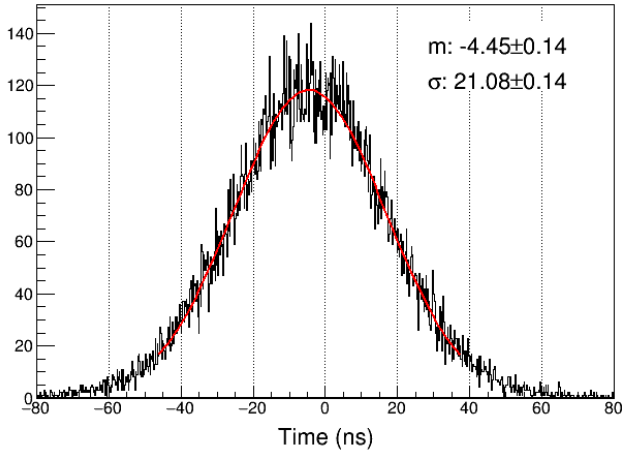


- $pmt0.t0 - pmt1.t0$

Gamma, small NaI002 crystal
(neutron calibration)



Gamma, large NaI002 crystal
(underground data)



KIMS-NaI analysis – mean time

- Mean time

$$pmt.mt = \frac{\sum A_i \times t_i}{\sum A_i}$$

A_i: charge of ith signal cluster
t_i: time of ith signal cluster

previous $$det.mt = \frac{(pmt0.mt + pmt1.mt)}{2} - det.start\_t$$

if t0 > trigger_t – 0.2 μs, start_t = t0
else, start_t = t1

→ modified

$$det.mt = \left(\frac{pmt0.mt - pmt0.start\_t}{2} + \frac{pmt1.mt - pmt1.start\_t}{2}\right)$$

H. W. Joo,

$$PMT1.cluster\_time = PMT1.cluster\_time - < \Delta t_0 >$$

$$det.mt = \frac{(pmt0.mt + pmt1.mt)}{2} - det.start$$

KIMS-NaI analysis – mean time

- Mean time

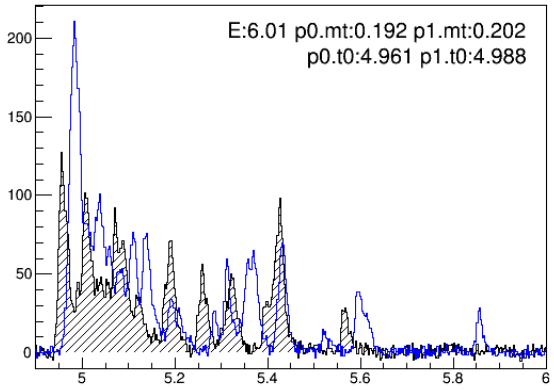
$$pmt.mt = \frac{\sum A_i \times t_i}{\sum A_i}$$

A_i: charge of ith signal cluster
t_i: time of ith signal cluster

previous det

$et.start\_t$ if t0 > trigger_t – 0.2 μs, start_t = t0
else, start_t = t1

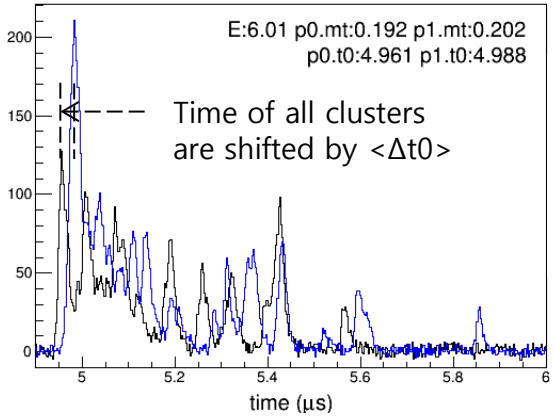
→ modified det



- Estimate mean time of each PMT → average
- No effect from t0 difference distribution

→ PMT.MT – t0

H. W. Joo, PM det

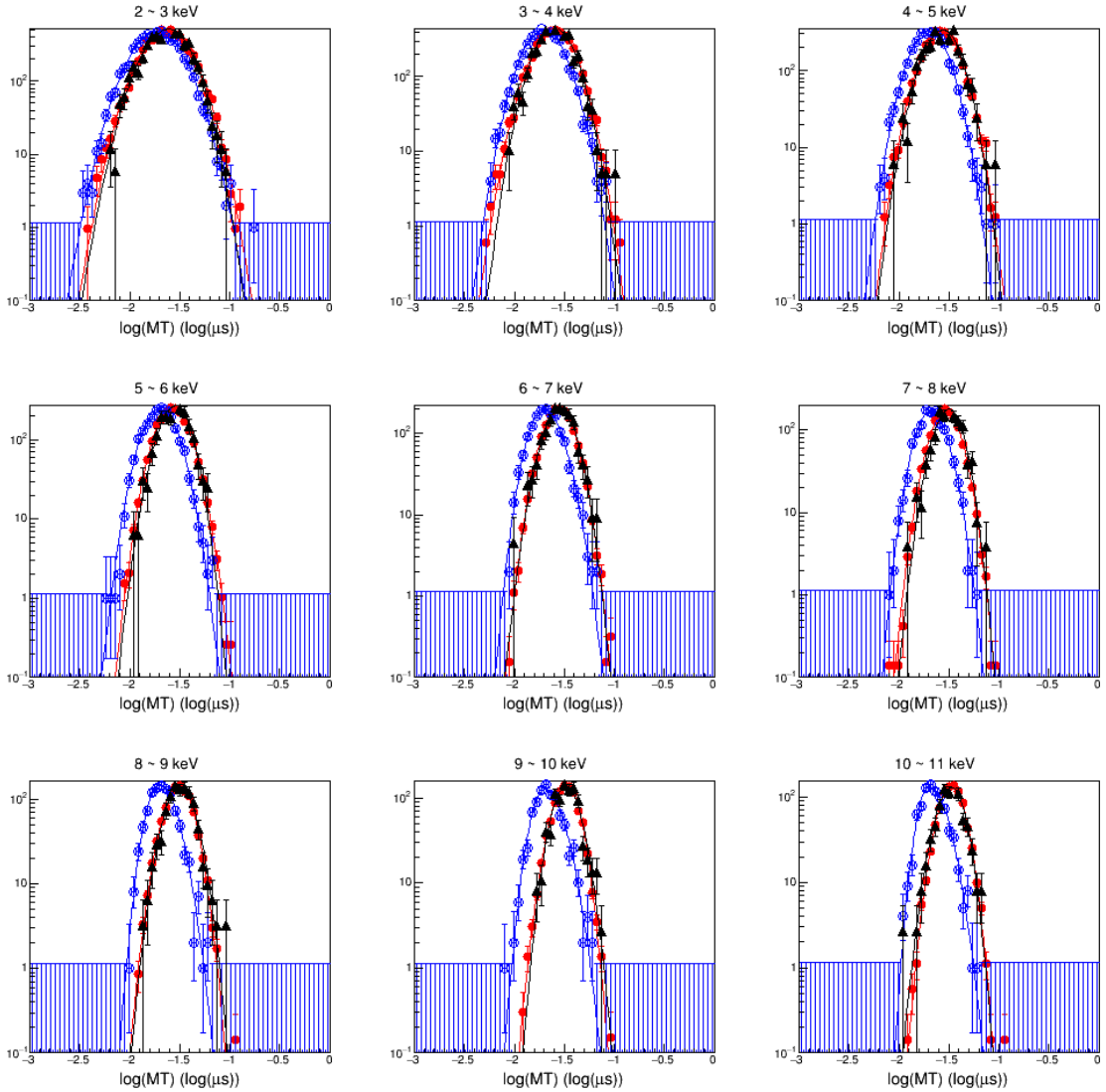


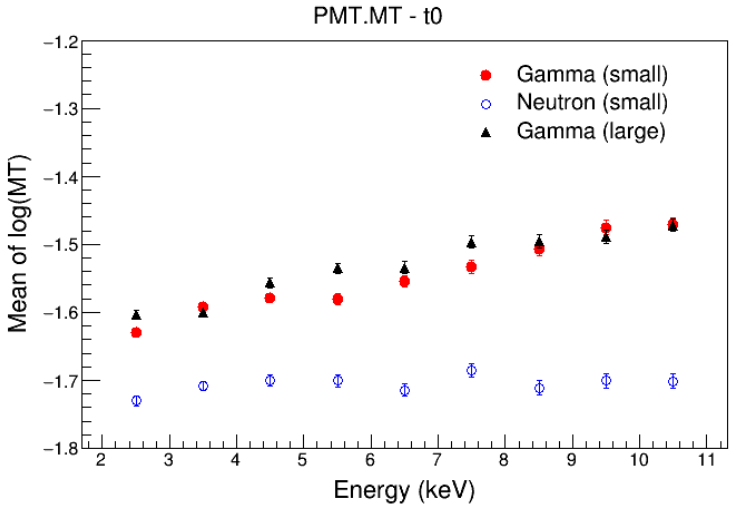
- Shift time of PMT1 cluster by <Δt0>
- <Δt0> = 0,

RMS of t0 difference distribution is remained.

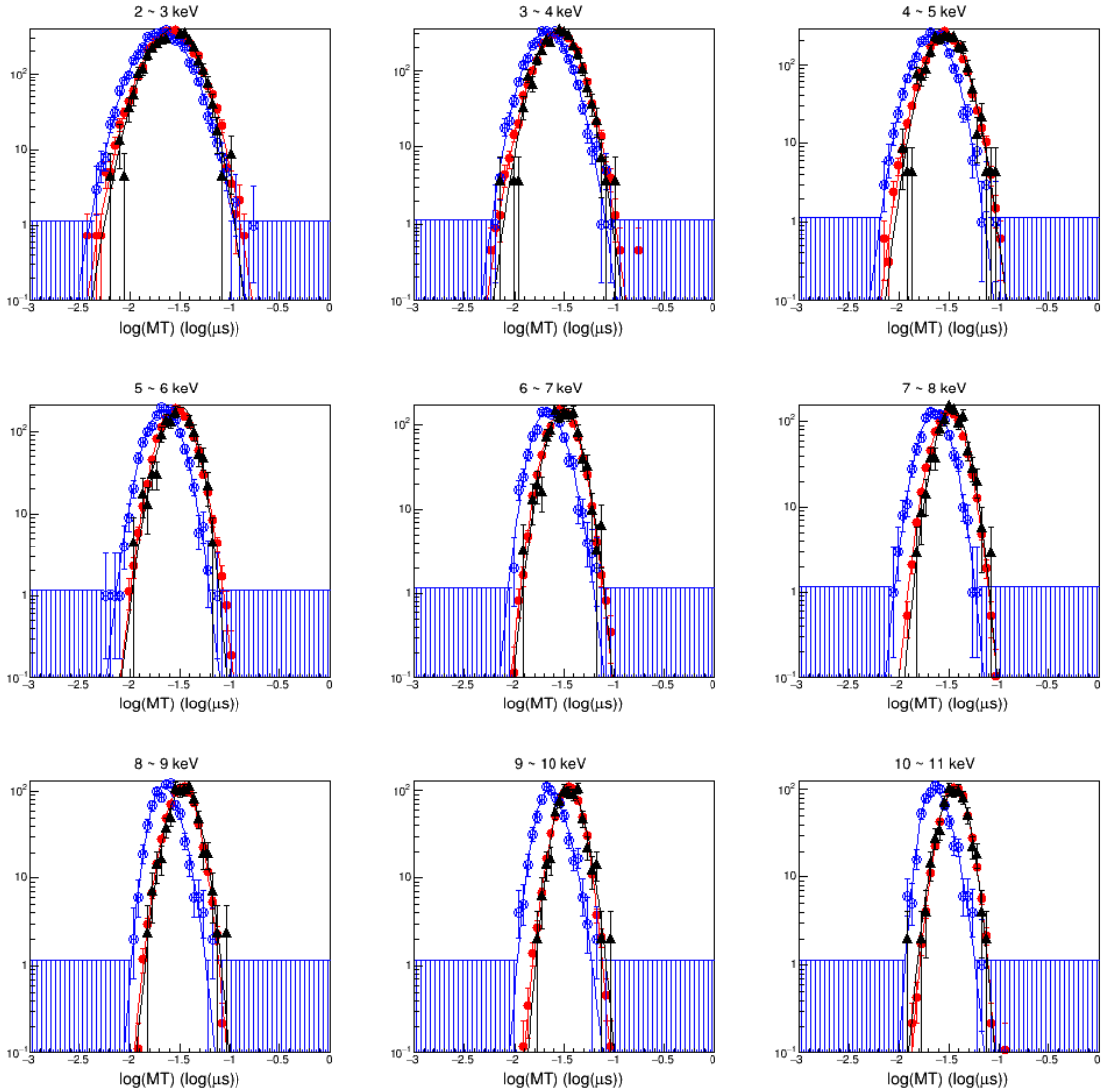
→ cluster.t – t0

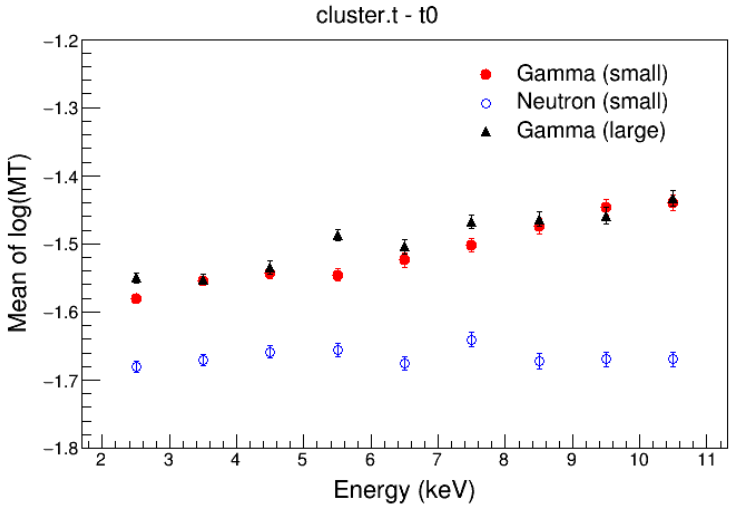
KIMS-NaI analysis – mean time (PMT.MT – t0)



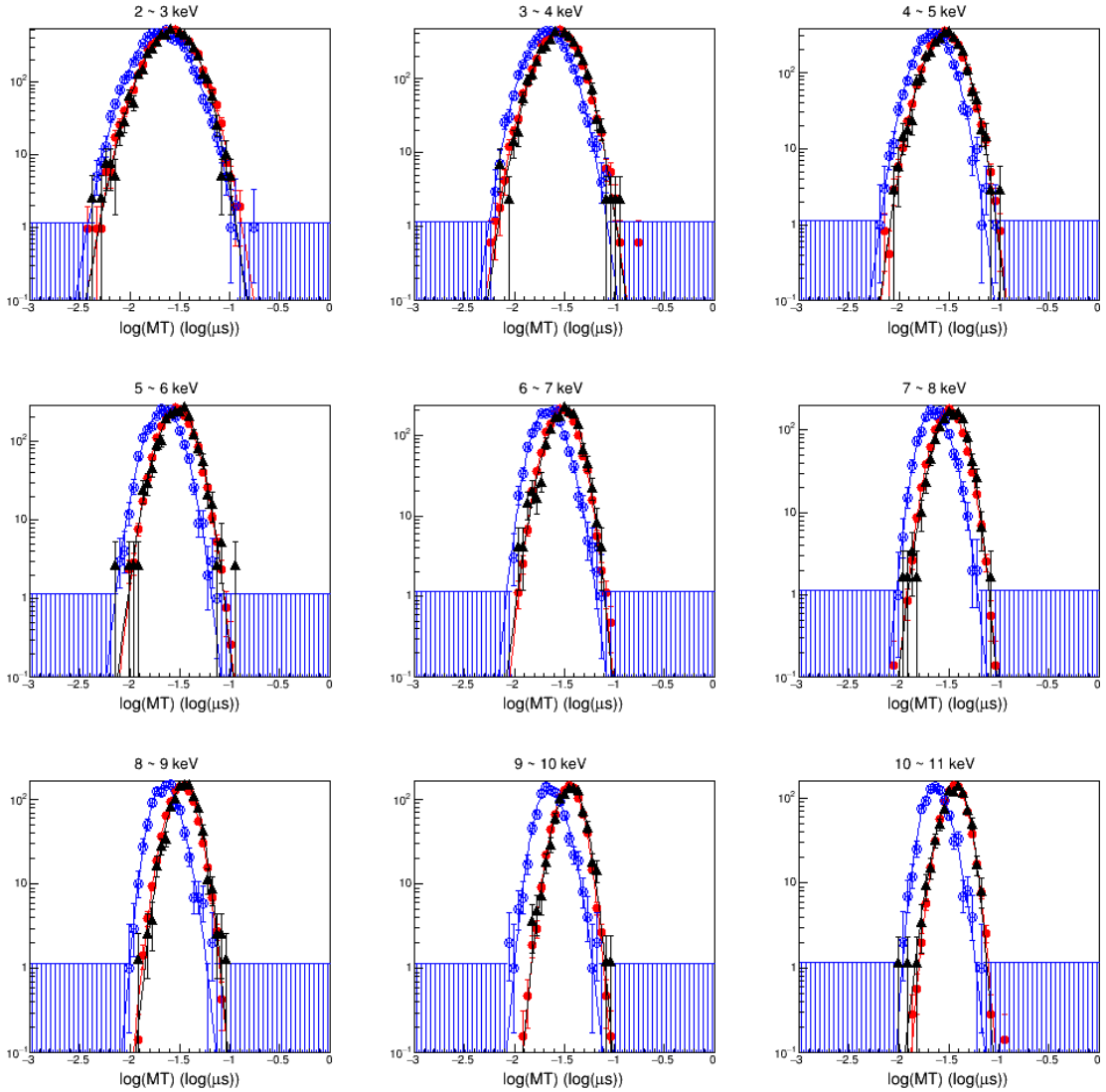


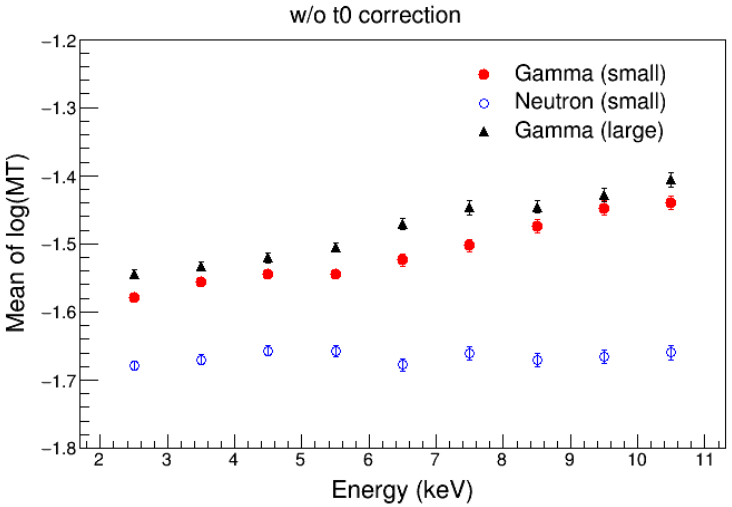
KIMS-NaI analysis – mean time (cluster.t – t0)



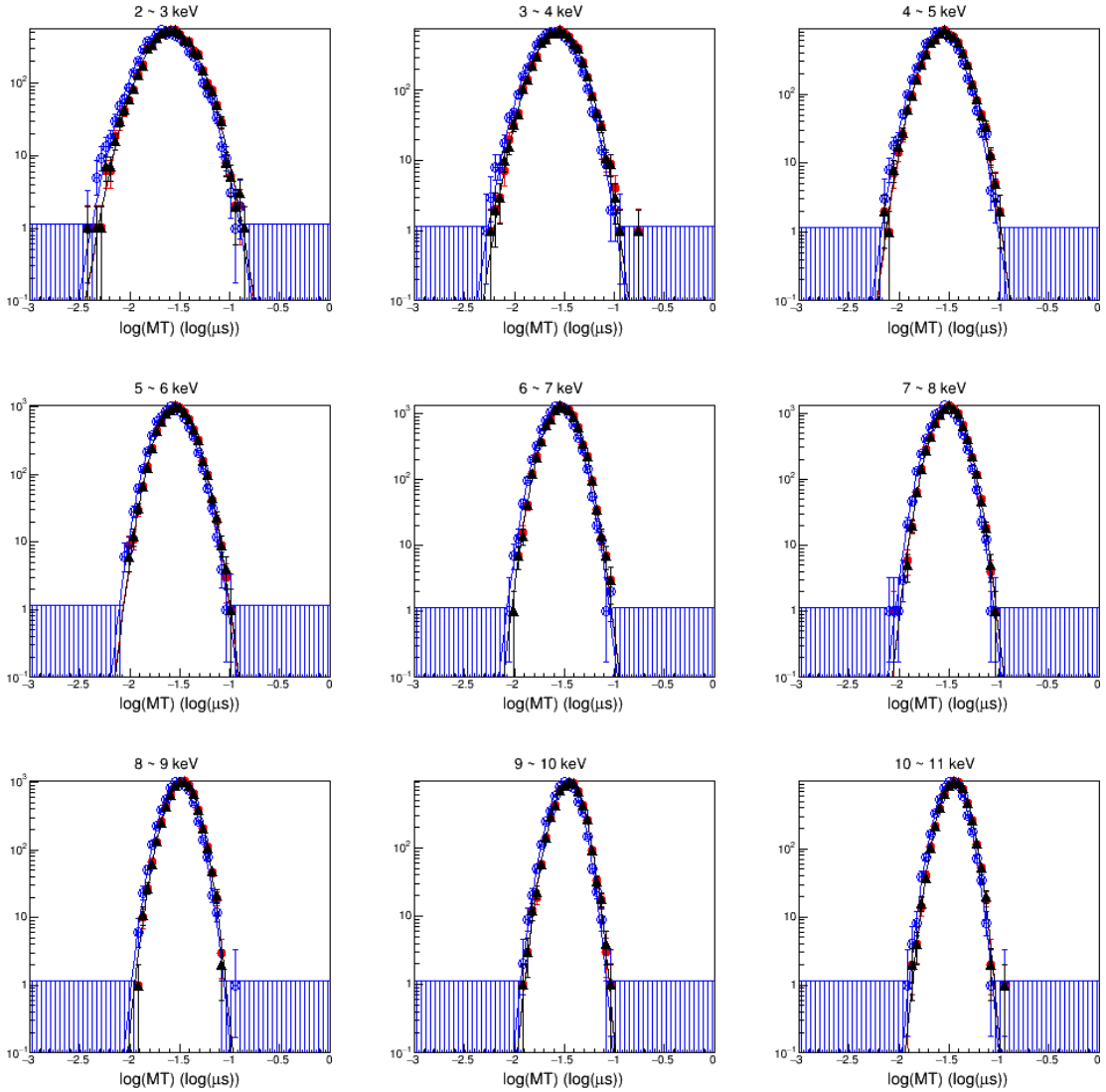


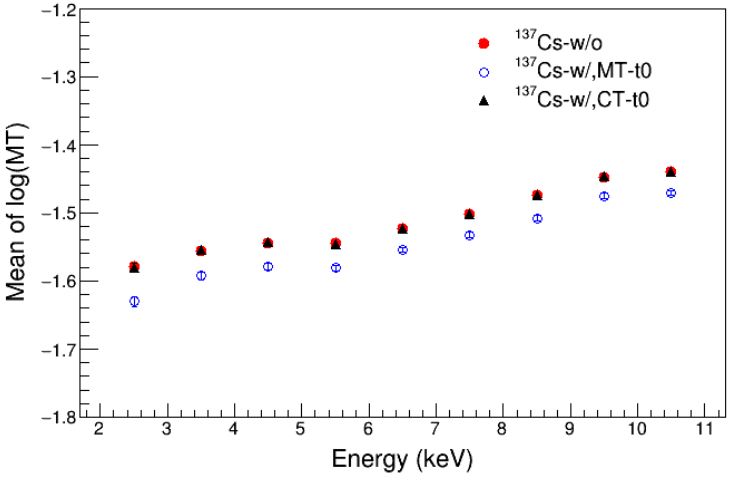
KIMS-NaI analysis – mean time (w/o correction)



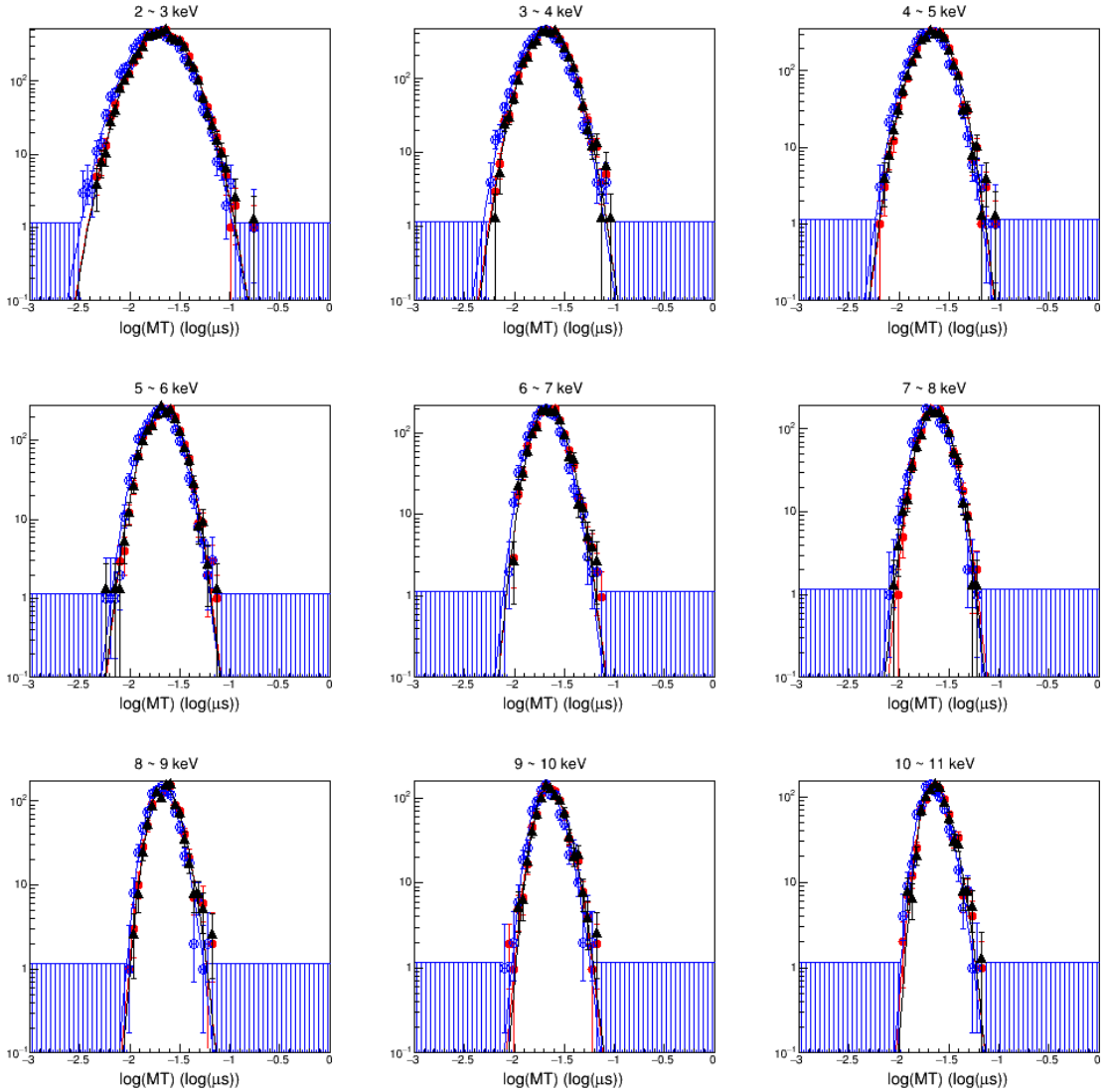


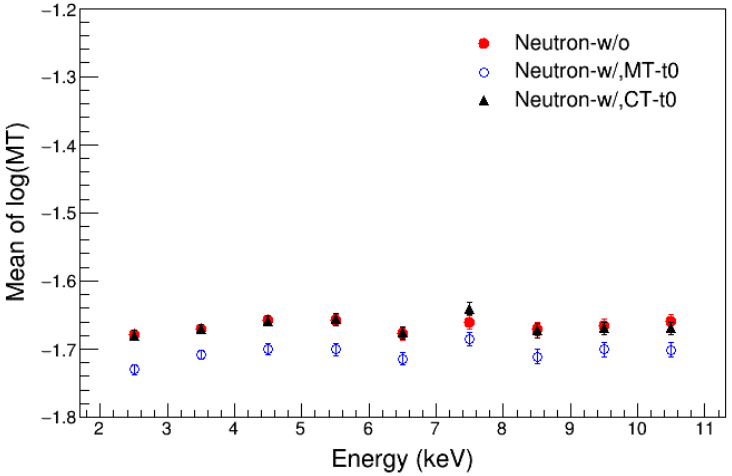
KIMS-NaI analysis – mean time (small crystal, gamma)



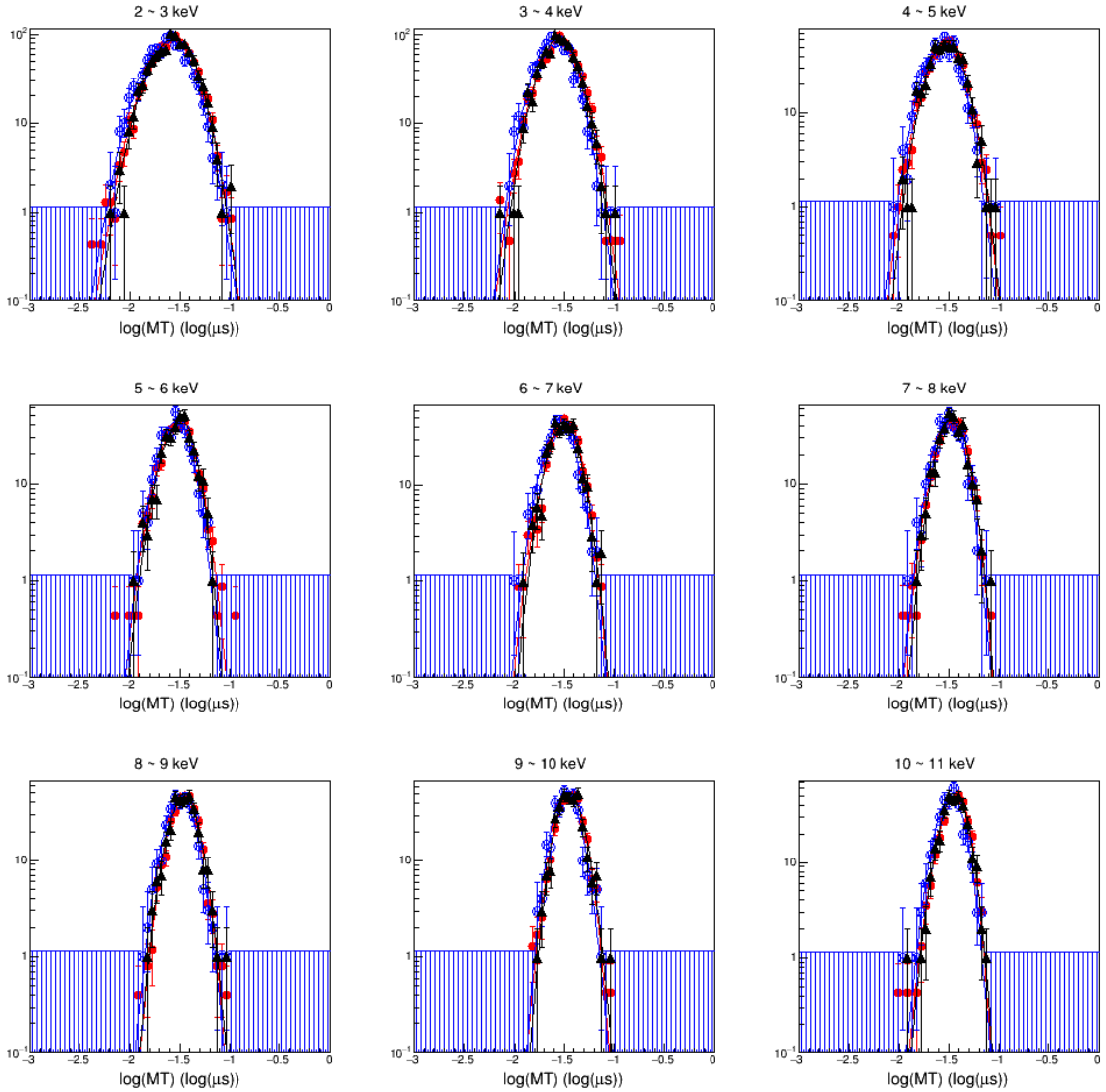


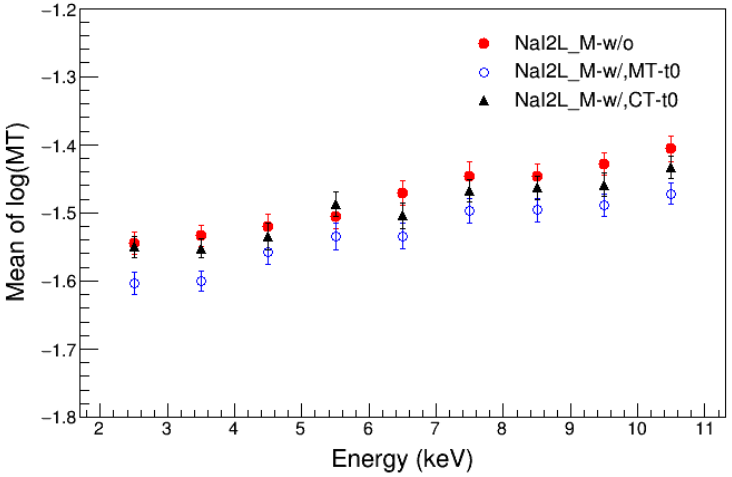
KIMS-NaI analysis – mean time (small crystal, neutron)





KIMS-NaI analysis – mean time (large crystal, gamma)





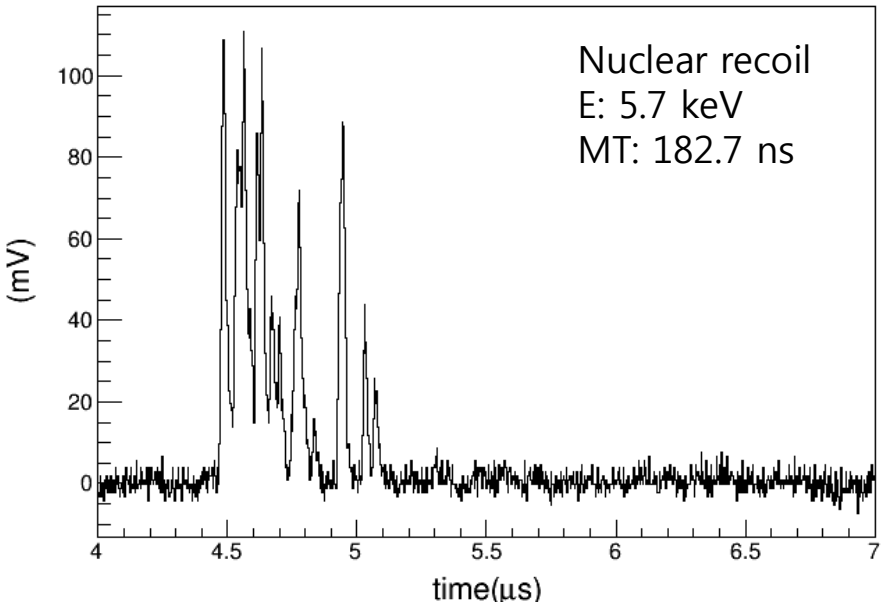
Plan

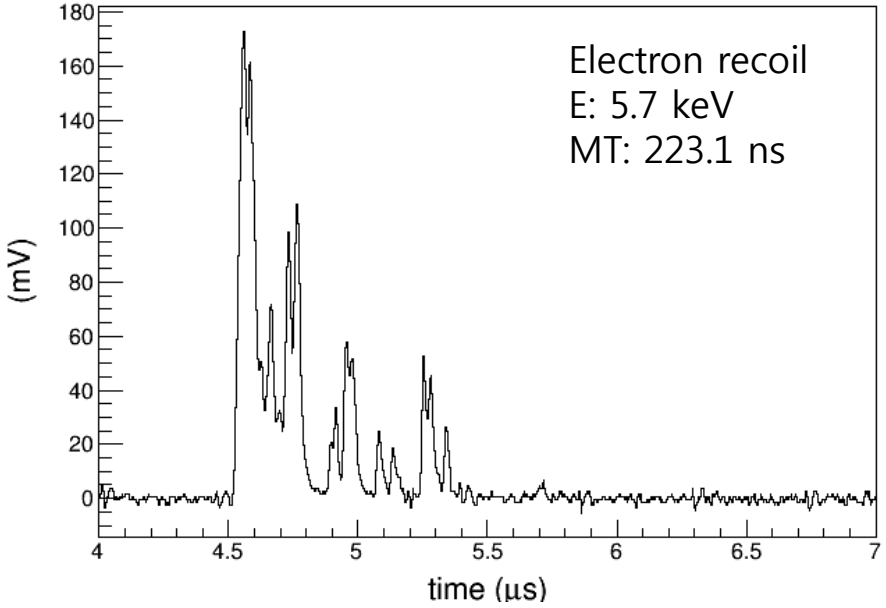
- Check noise rejection cut (asymmetry, charge ratio and additional cuts)
- Cut rejection efficiency

Backup slides

Signal in NaI(Tl) crystal

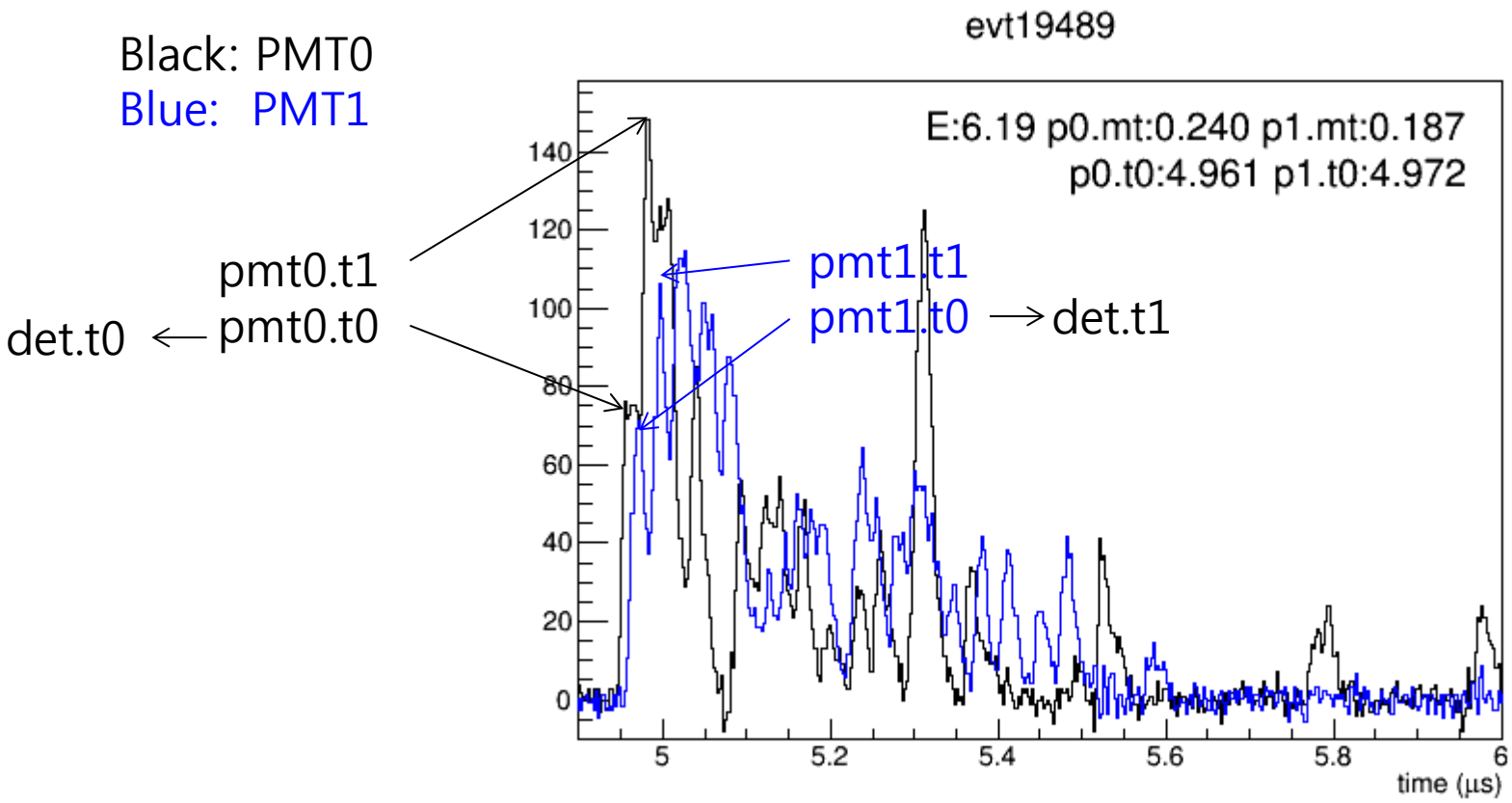
Scintillation signal in NaI(Tl) crystal





KIMS-NaI analysis

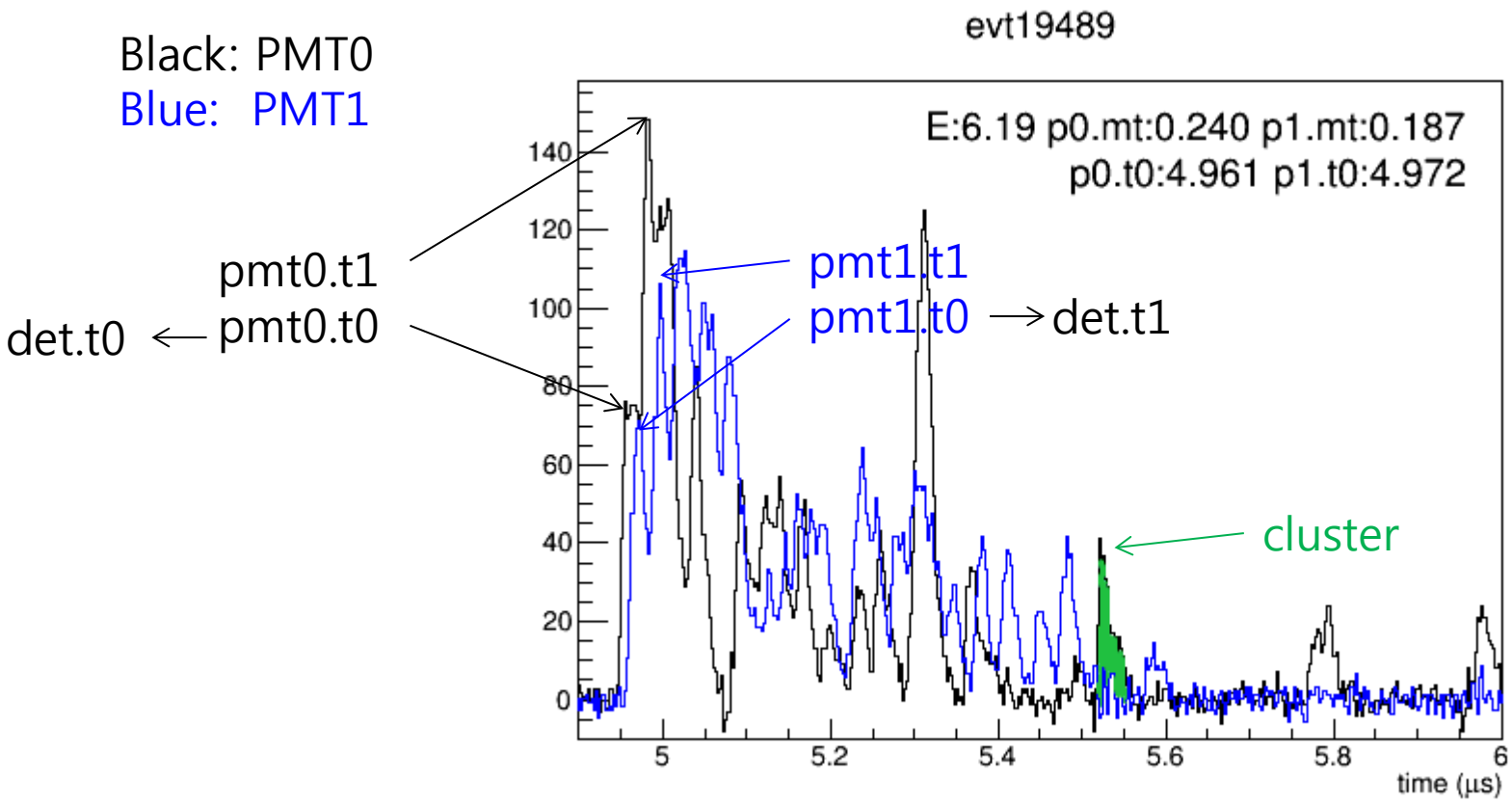
Black: PMT0
Blue: PMT1



t0: first cluster time
t1: second cluster time

KIMS-NaI analysis

Black: PMT0
Blue: PMT1



t0: first cluster time
t1: second cluster time

KIMS-NaI analysis – mean time

- Mean time

$$pmt.mt = \frac{\sum A_i \times t_i}{\sum A_i}$$

A_i: charge of ith signal cluster

t_i: time of ith signal cluster

$$det.mt = \frac{(pmt0.mt + pmt1.mt)}{2} - det.start\ position$$

$$det.mt = \left(\frac{pmt0.mt - pmt0.start\ position}{2} + \frac{pmt1.mt - pmt1.start\ position}{2}\right)$$

start position:

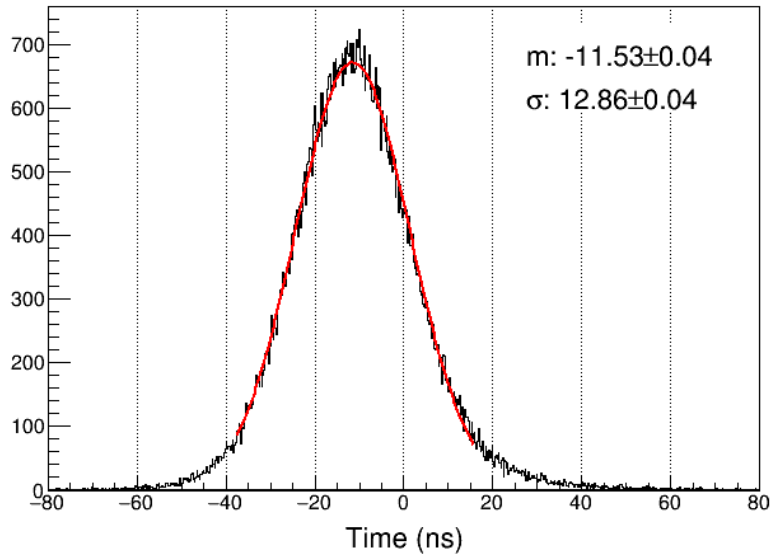
if t0 > trigger position – 0.2 μs, start position = t0

else, start position = t1

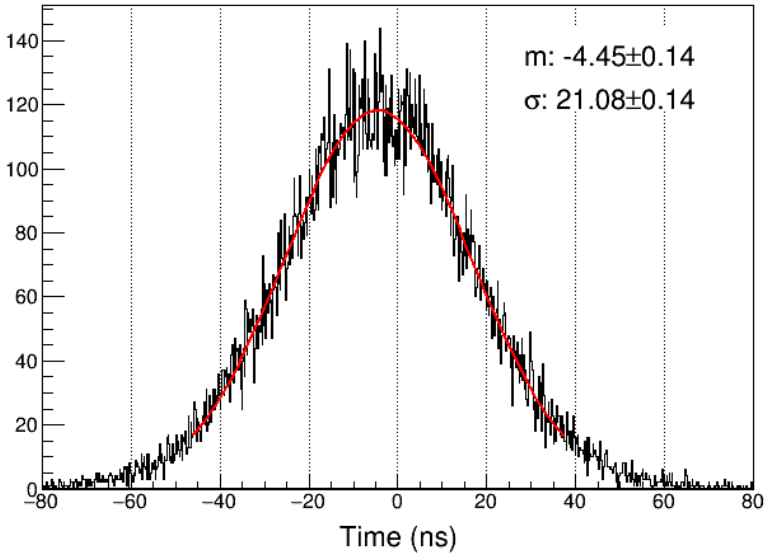
Time difference between first cluster in two PMTs

- $pmt0.t0 - pmt1.t0$

Small NaI002 crystal
(neutron calibration)



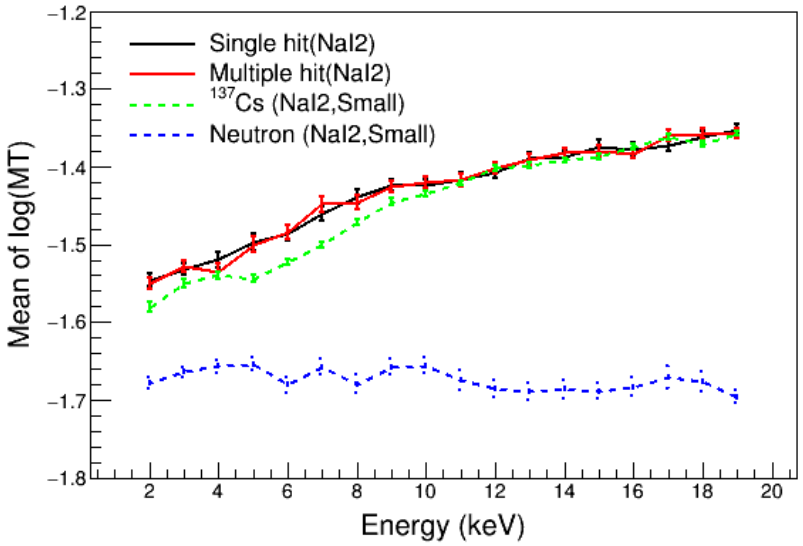
Large NaI002 crystal
(underground data)

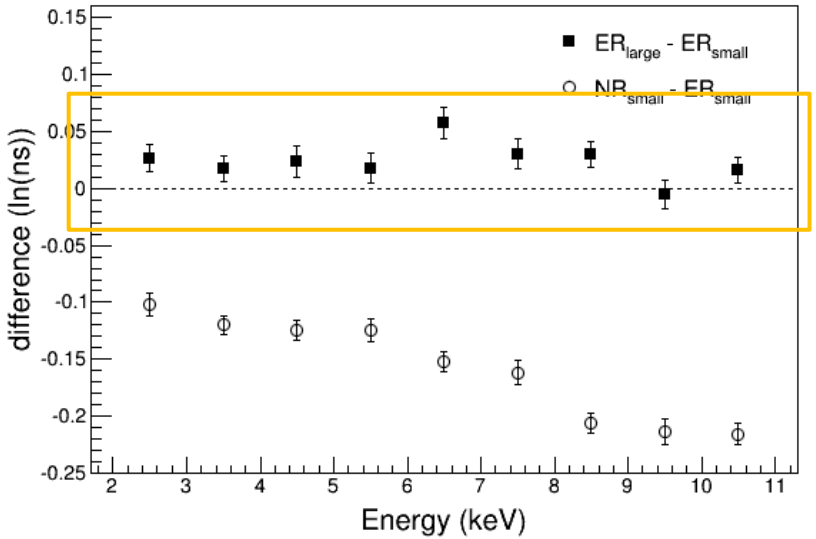


Mean of ln(MT) distribution (NaI002)

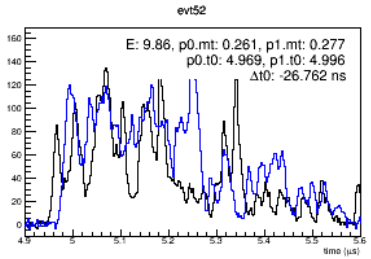
- NaI002

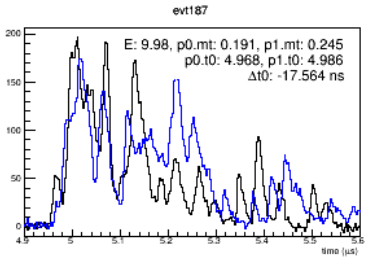
Mean_large - Mean_small

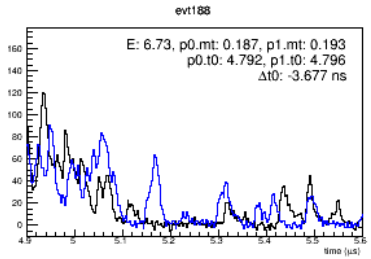


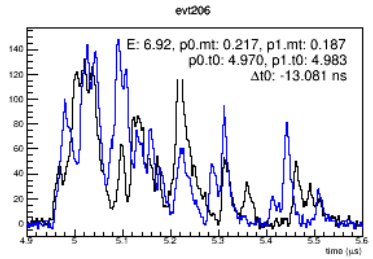


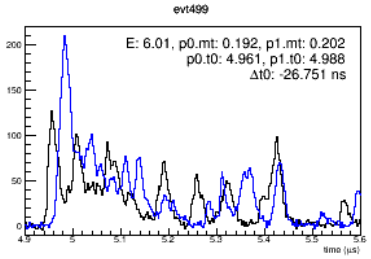
Signals (t0 difference)

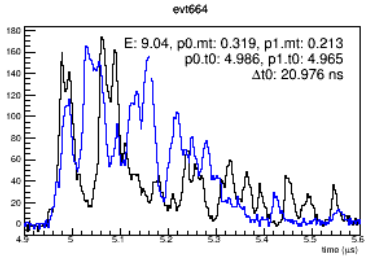


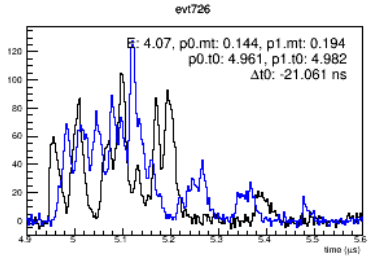


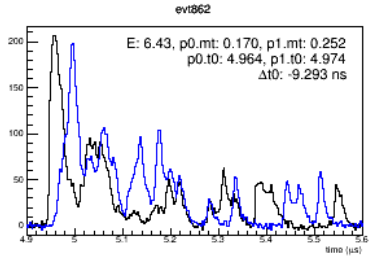


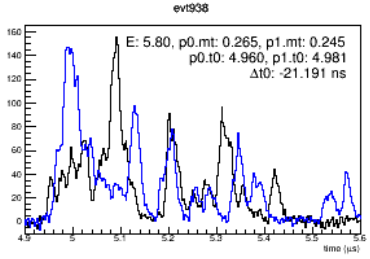


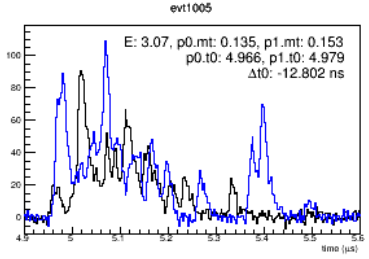


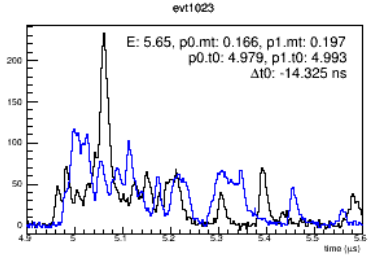


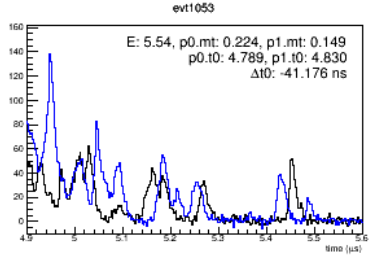


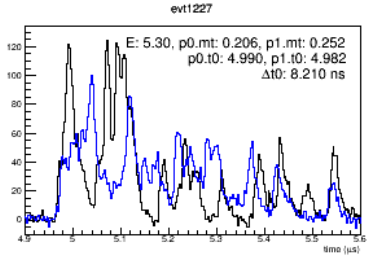


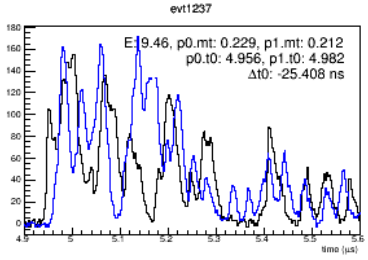


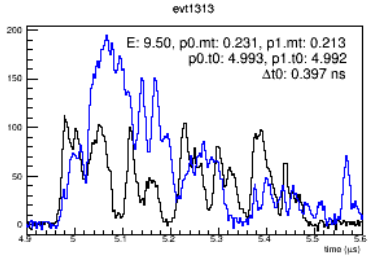


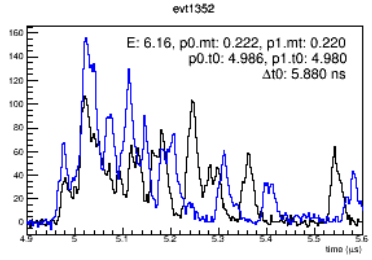




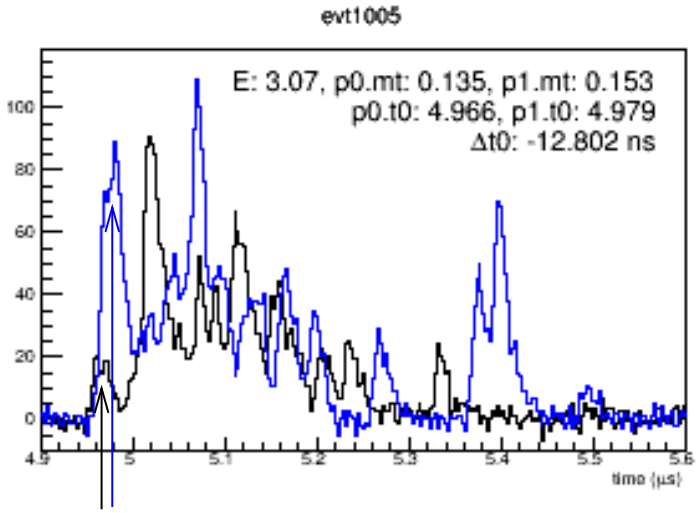


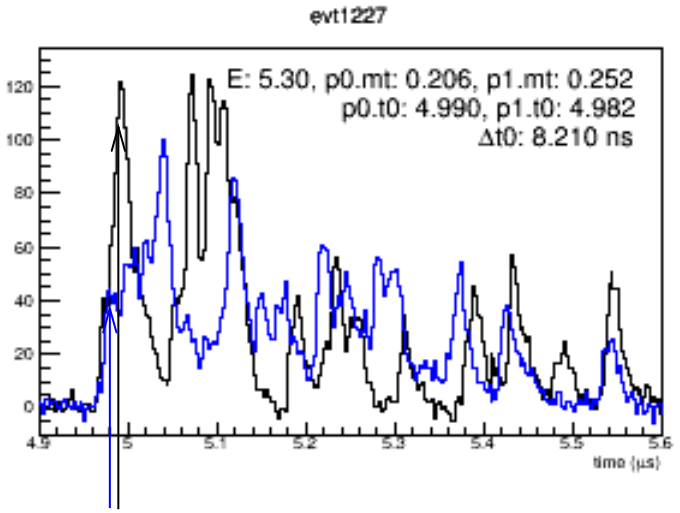


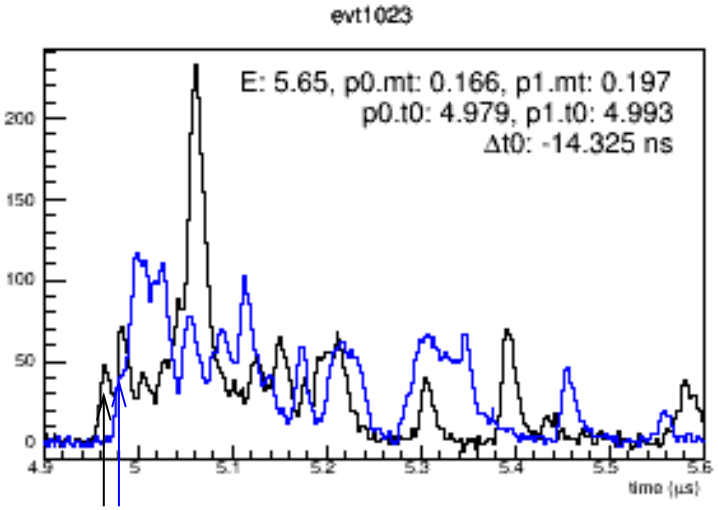




Signals (t0 difference)





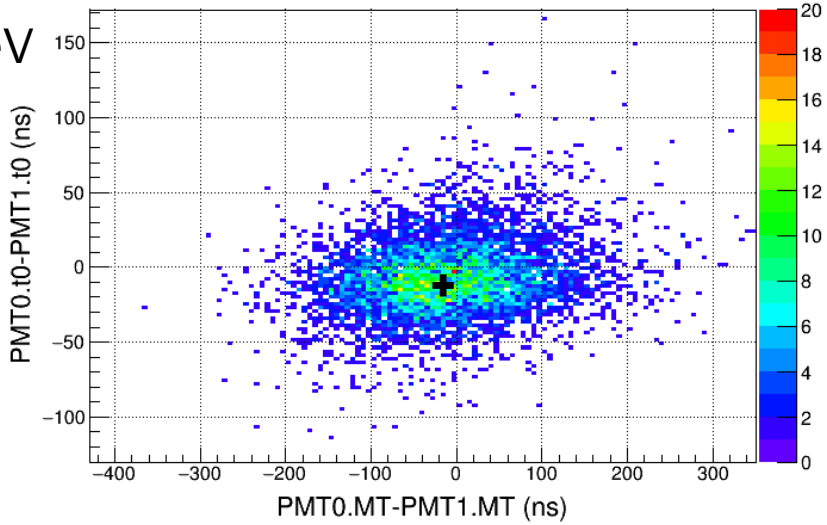


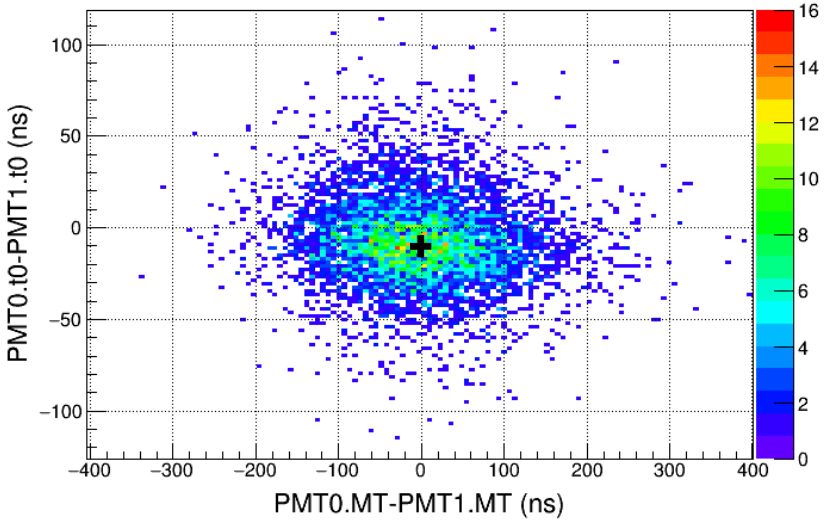
Start position correction

det.start_position

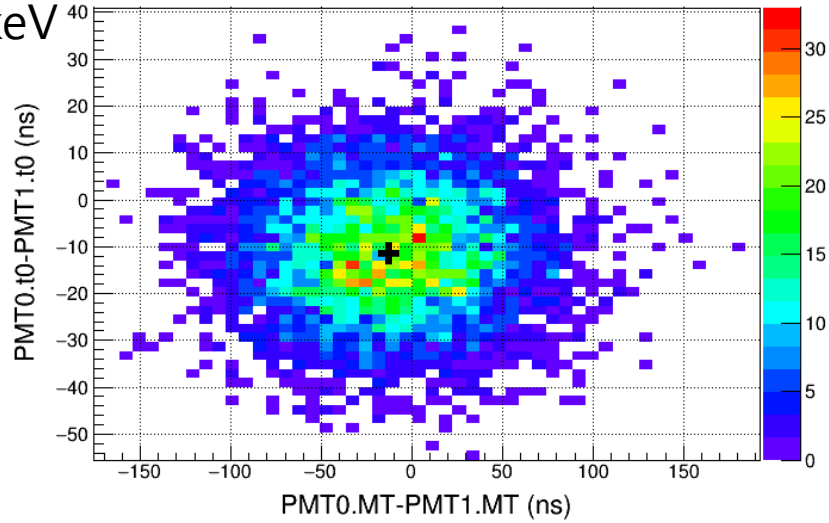
pmt.start_position

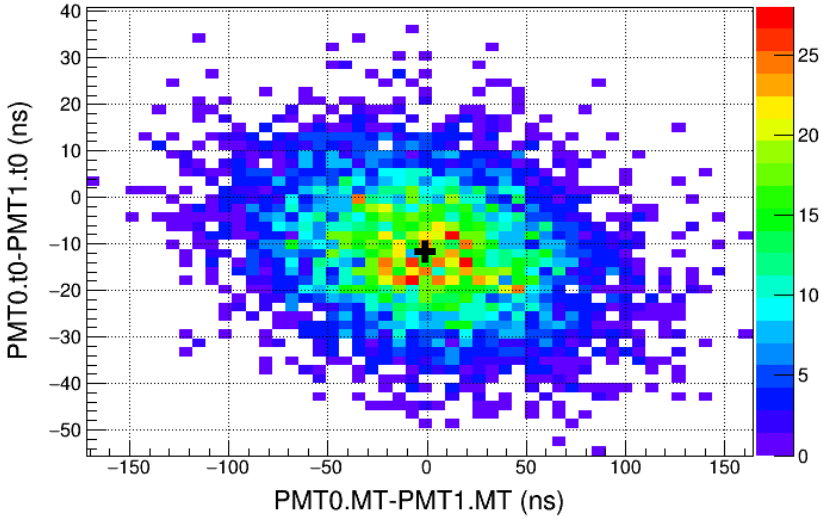
2 keV





10 keV





KIMS-NaI analysis – cluster

- Total charge sum
  (used for energy calculation and noise rejection parameter)

$pmt.qc = \sum A_i$ A_i: charge of ith signal cluster

$$det.qc = \frac{(pmt0.qc + pmt1.qc)}{2}$$

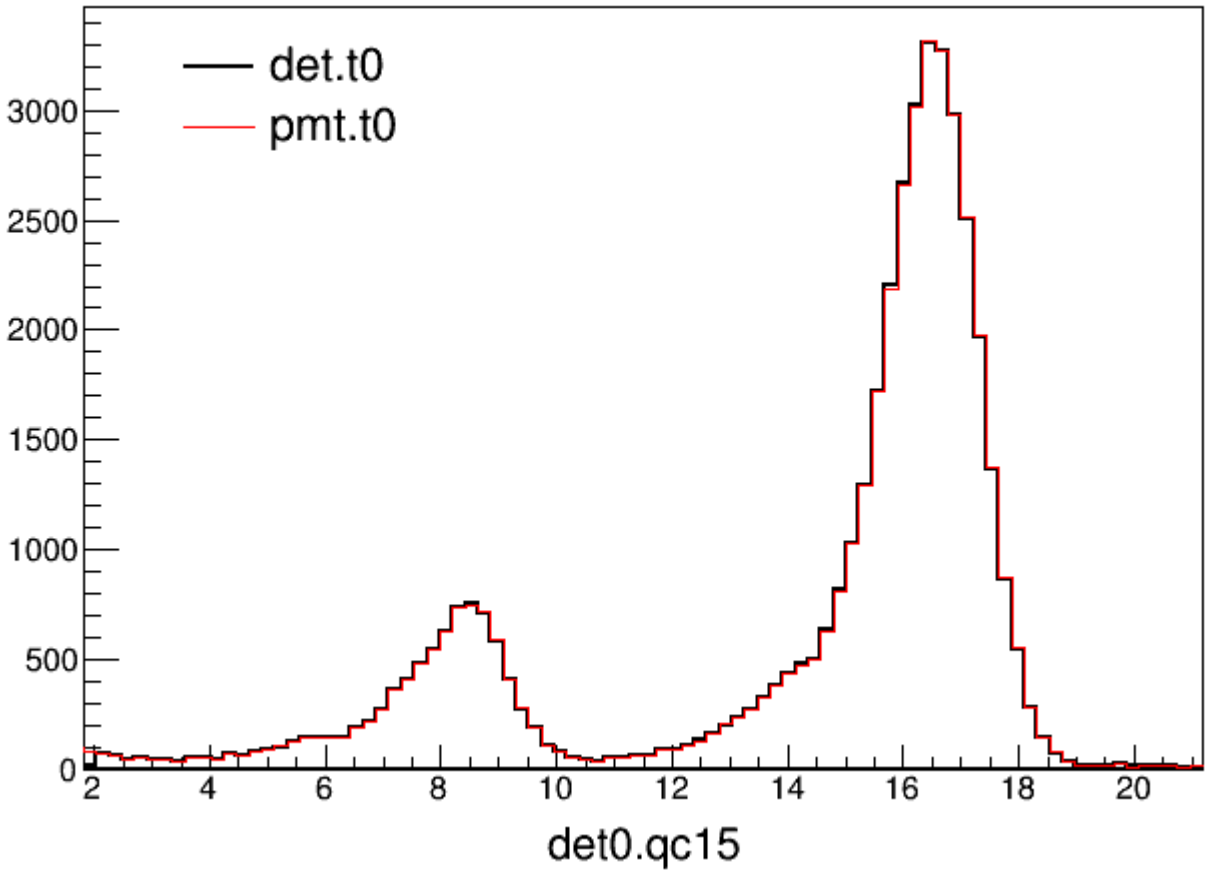
$\sum A_i$: Sum of cluster area

Under time of ith signal cluster below det.start_position + T

T: specific time window (ex: 1.5 μs, 5 μs etc.)

Start position correction – energy calculation

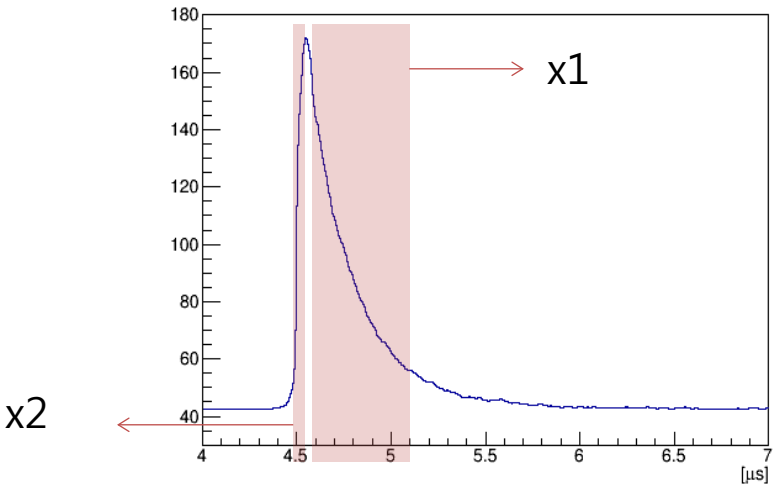
- Total charge sum → qc in 1.5 μs

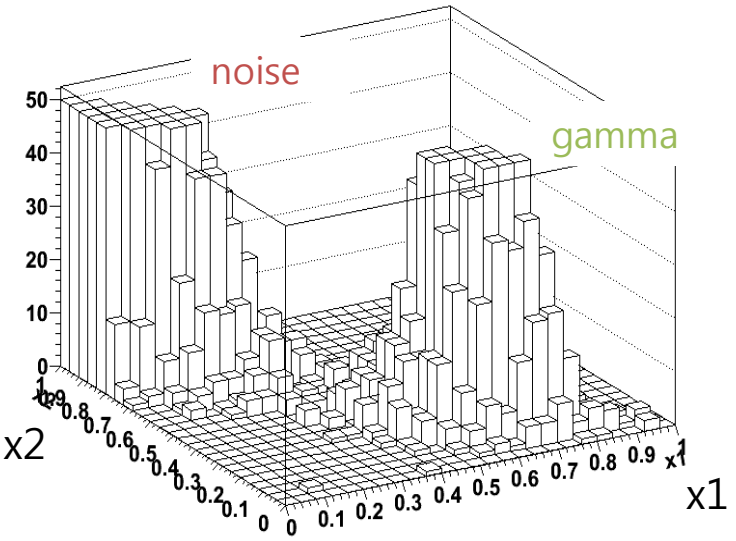


No effect on energy calibration

Start position correction – noise rejection parameter

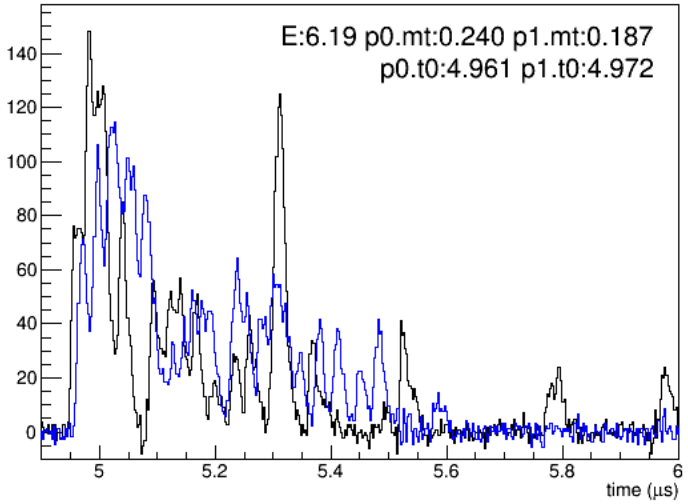
- Charge ratio





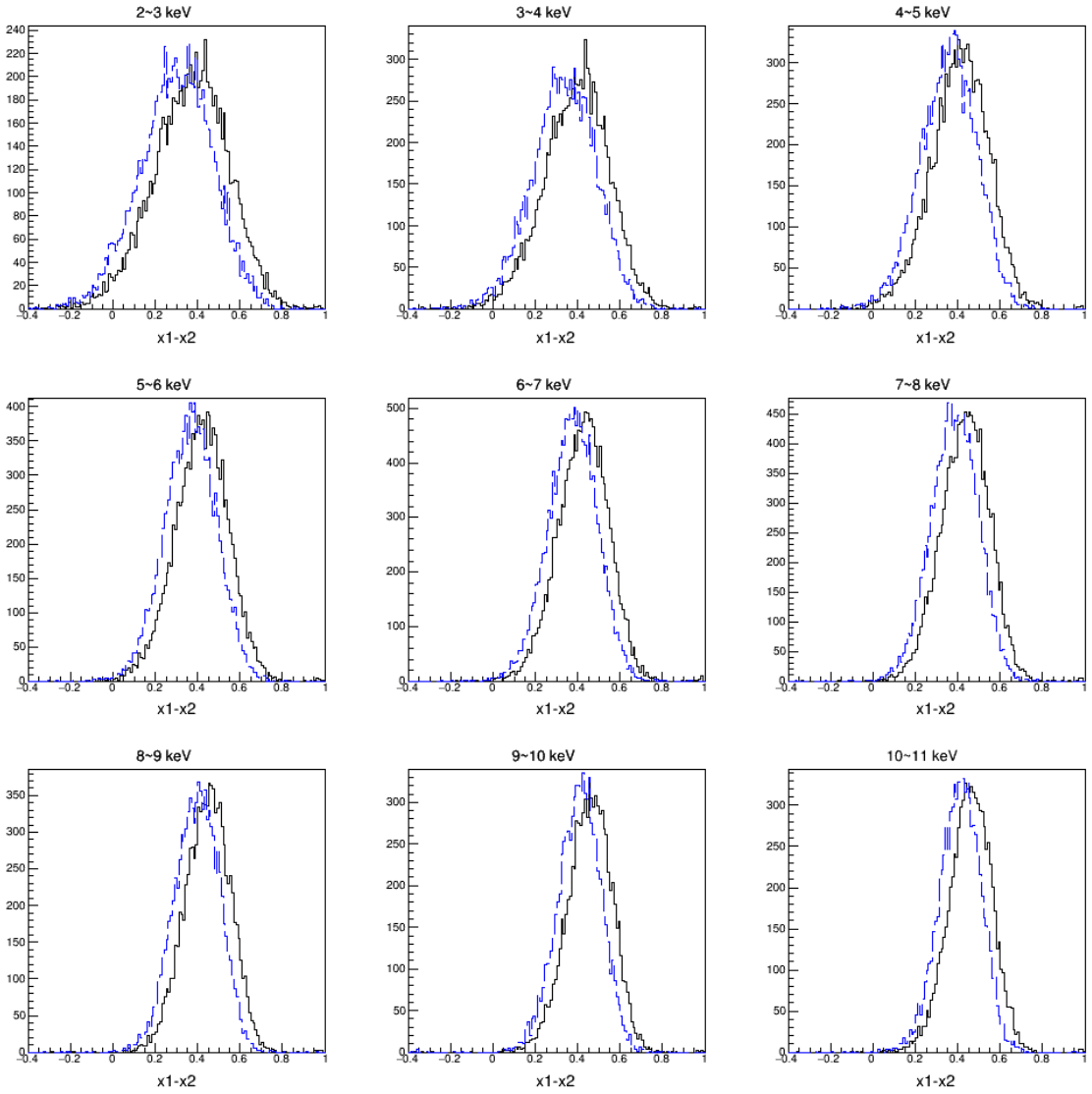
$$X1 = \frac{Area(100ns \sim 600ns)}{Area(0 \sim 600ns)}$$

$$X2 = \frac{Area(0 \sim 50ns)}{Area(0 \sim 600ns)}$$



Start position correction – charge ratio

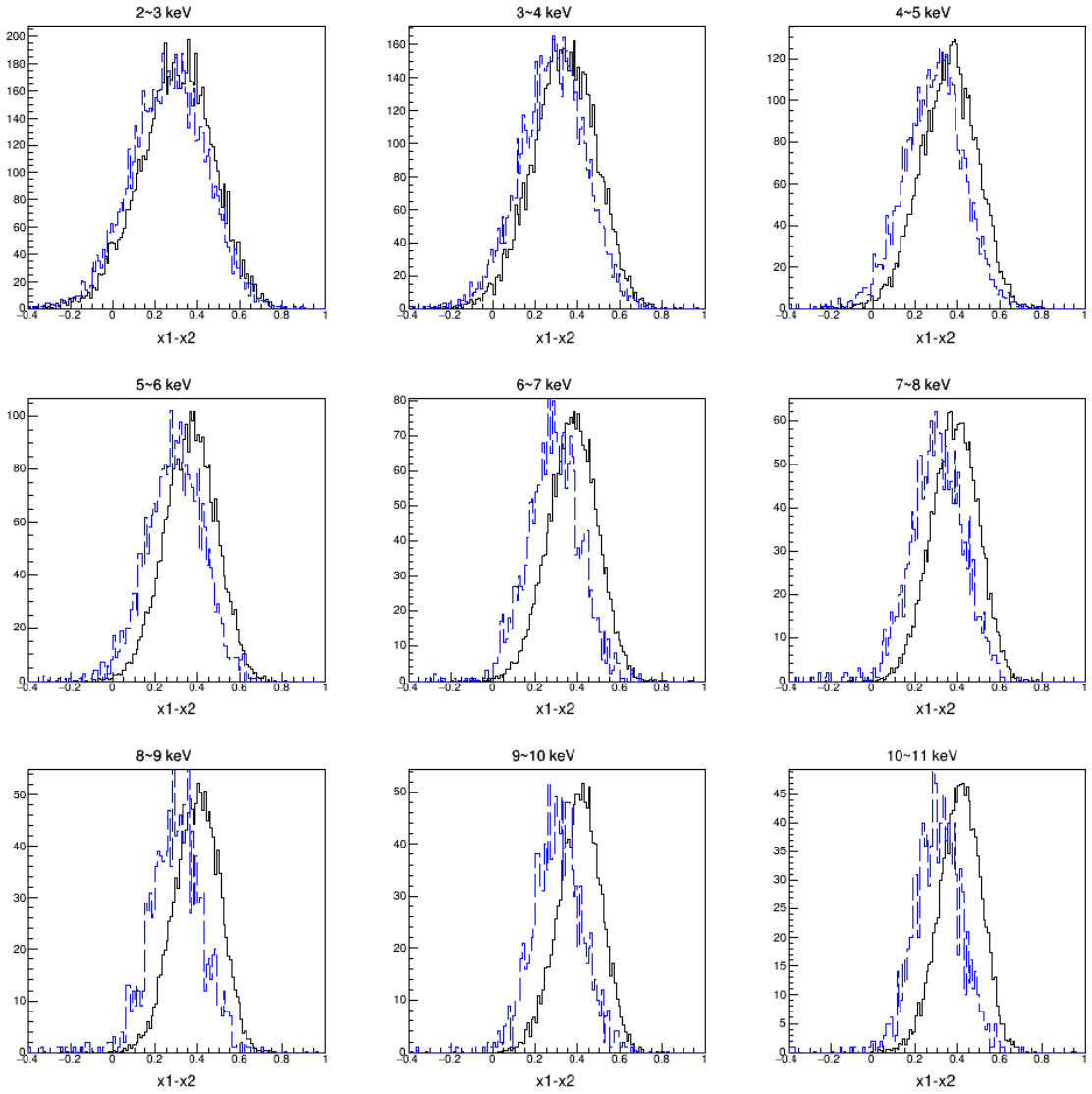
Black: det.t0
Blue: pmt.t0



x1-x2 values are changed.

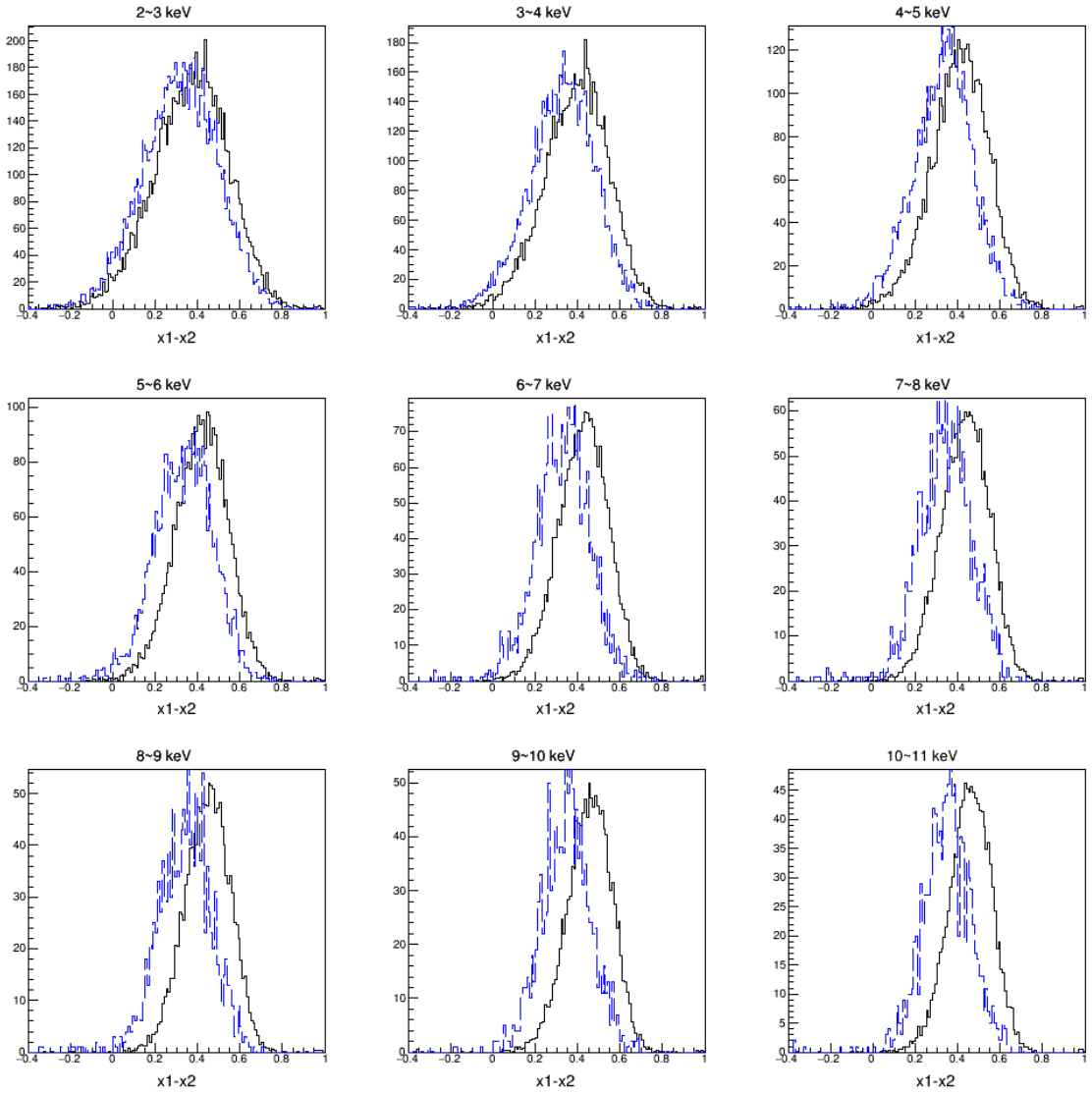
Charge ratio – gamma vs neutron (pmt.t0)

Black: gamma
Blue: neutron



Charge ratio – gamma vs neutron (det.t0)

Black: gamma
Blue: neutron



Plan

- Check mean time distribution in small and large crystal after start position correction