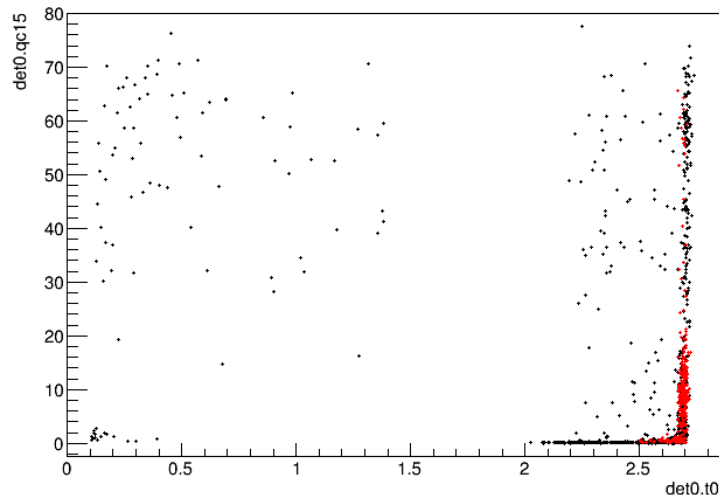


NaI deposit energy vs mean time of 1st cluster of NaI signal

PCT : (1,1,2)

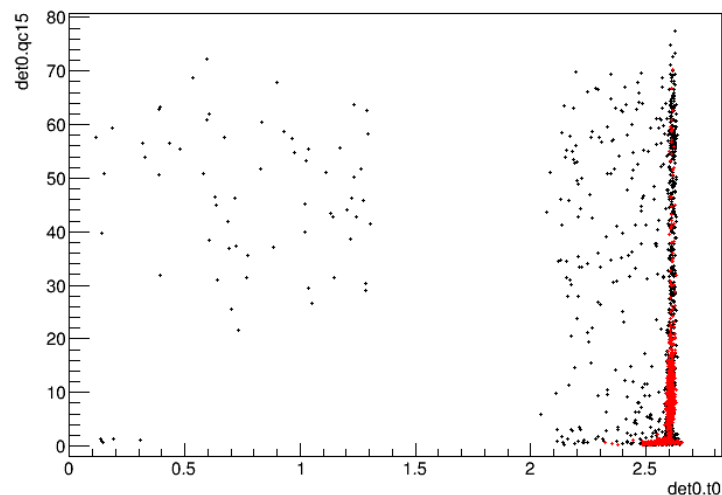
PCI : (200,200,200)



PCT : (2,2,4)

PCI : (200,200,400)

PWT : 100 ns



X axis : mean time of 1st cluster of NaI signal

Y axis : NaI deposit energy (keV)

Black : Applied PMT event selection cut

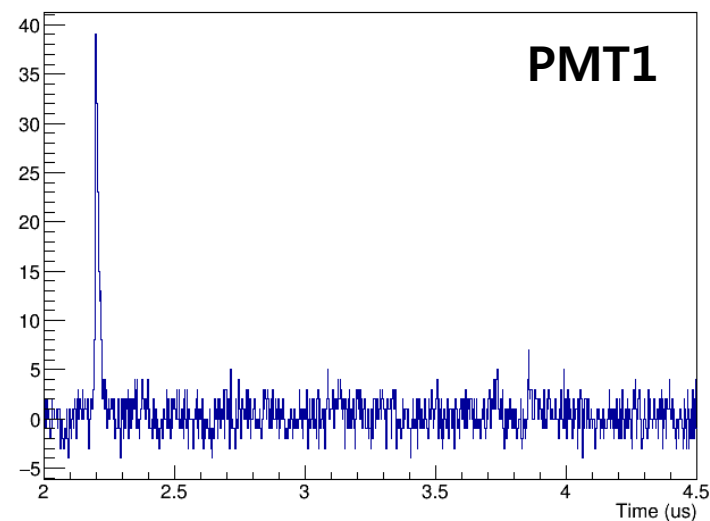
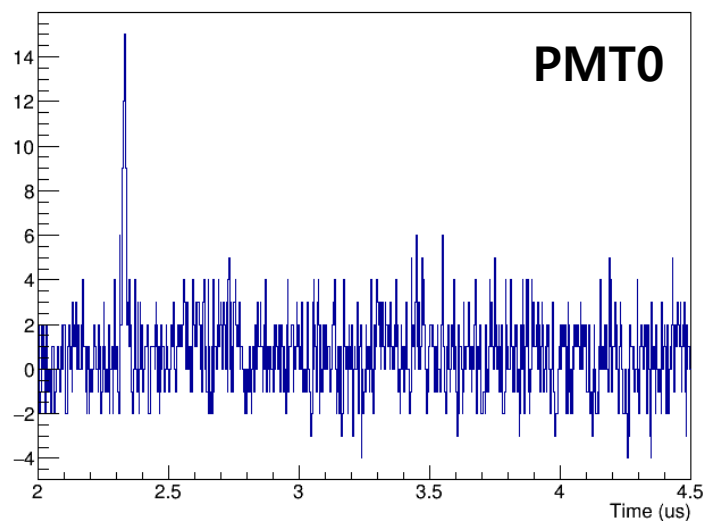
Red : Applied ND PSD / TOF cut

PCT : Pulse count threshold

PCI : Interval of pulse count threshold

PWT : Pulse width threshold

Junk events in PCT (1,1,2) trigger condition



**~ 30% of events have only 1 cluster in one of the PMT
(~ 10% of events have only 1 cluster in both PMT)**

Trg condition	DAQ rate	Neutron evt rate
PCT (2,2,4) only	1.48 Hz	0.14 Hz
PCT (1,1,2) only	6.43 Hz	0.42 Hz
PCT + PWT	3.19 Hz	0.41 Hz

For clusters with $\text{time0x}[n] < \text{det0.t0} + 1.5$

$$\begin{aligned} \text{MT} &= \frac{1}{2} * \left(\frac{\sum \text{clust00}[n] * (\text{time00}[n] - \text{det0.t0})}{\sum \text{clust00}[n]} + \frac{\sum \text{clust01}[n] * (\text{time01}[n] - \text{det0.t0})}{\sum \text{clust01}[n]} \right) \\ &= \frac{1}{2} * \left(\frac{\sum \text{clust00}[n] * \text{time00}[n]}{\sum \text{clust00}[n]} + \frac{\sum \text{clust01}[n] * \text{time01}[n]}{\sum \text{clust01}[n]} \right) - \text{det0.t0} \end{aligned}$$

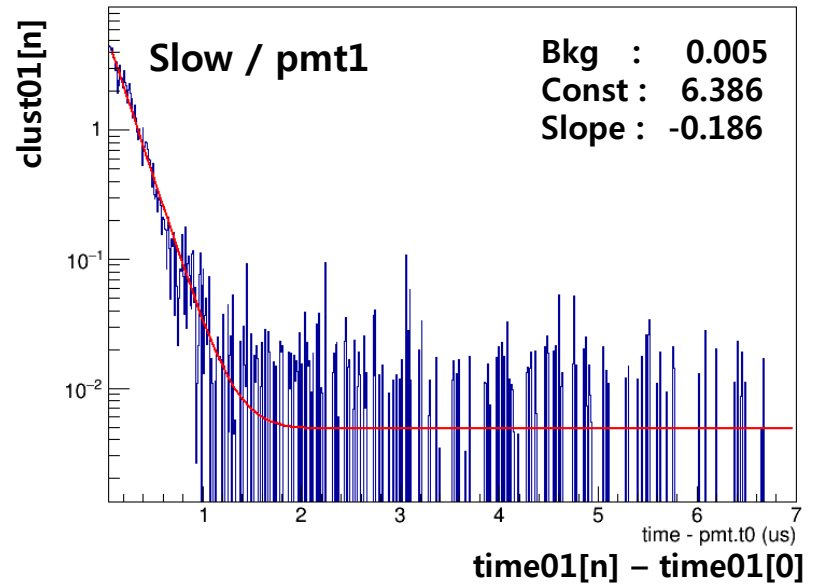
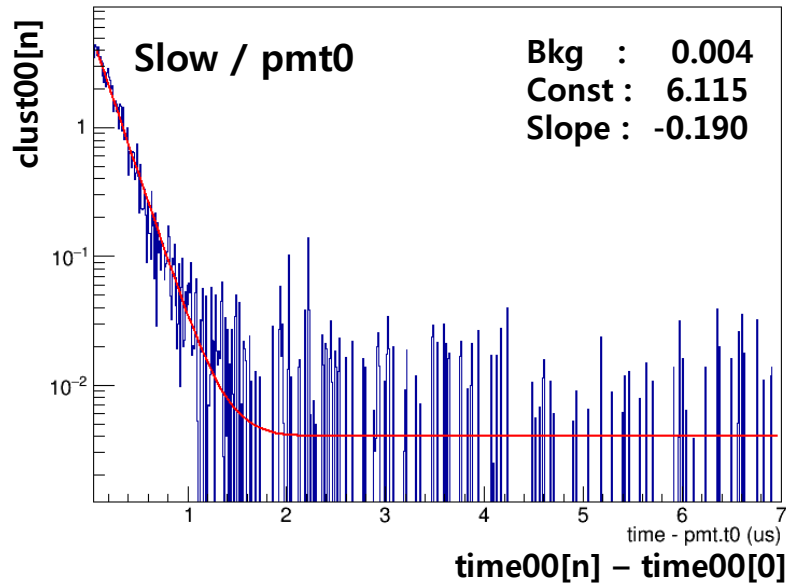
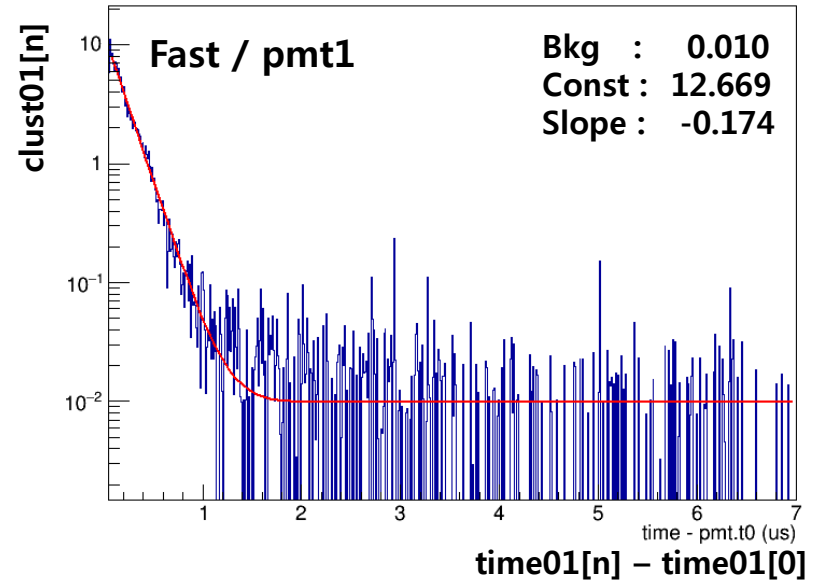
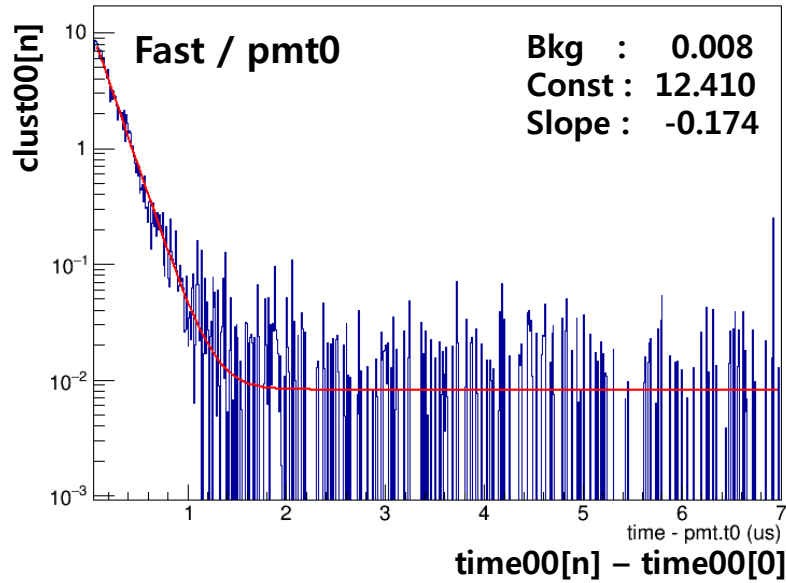
clust0x[n] : charge sum of n th cluster of PMT x

time0x[n] : mean time of n th cluster of PMT x

det0.t0 : mean time of 1st cluster of NaI signal

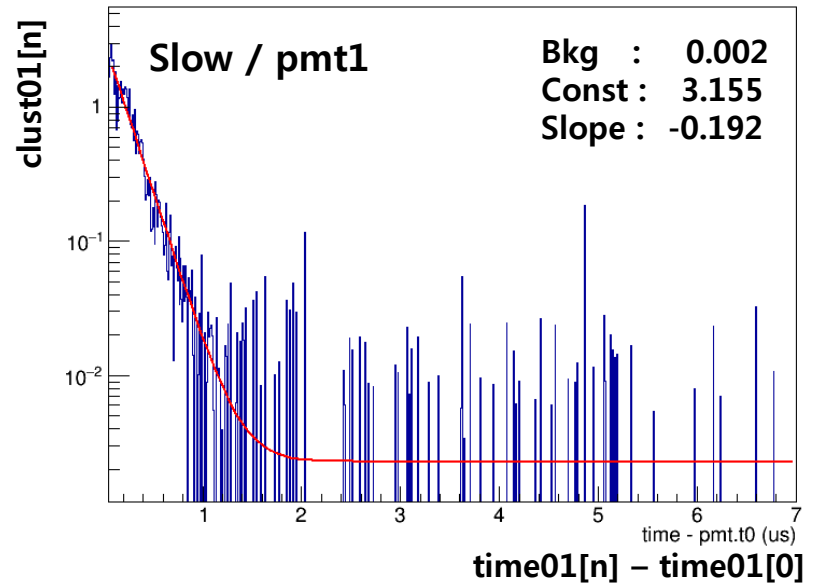
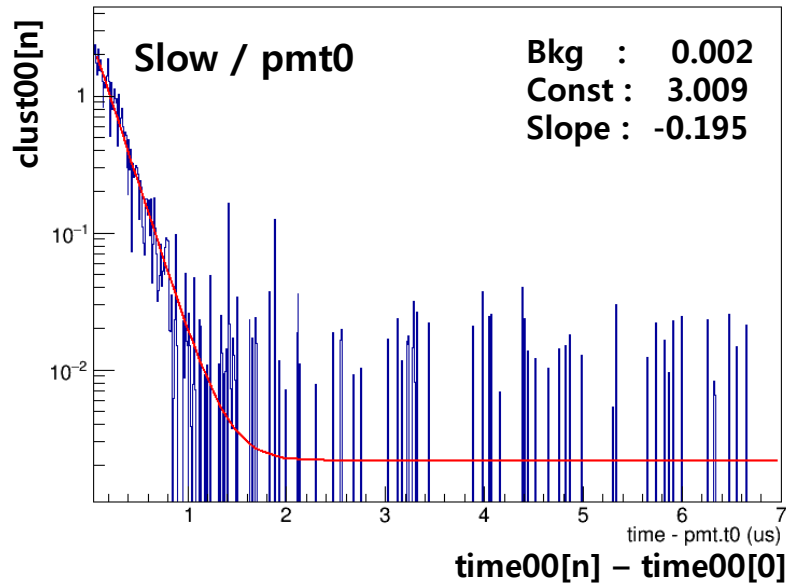
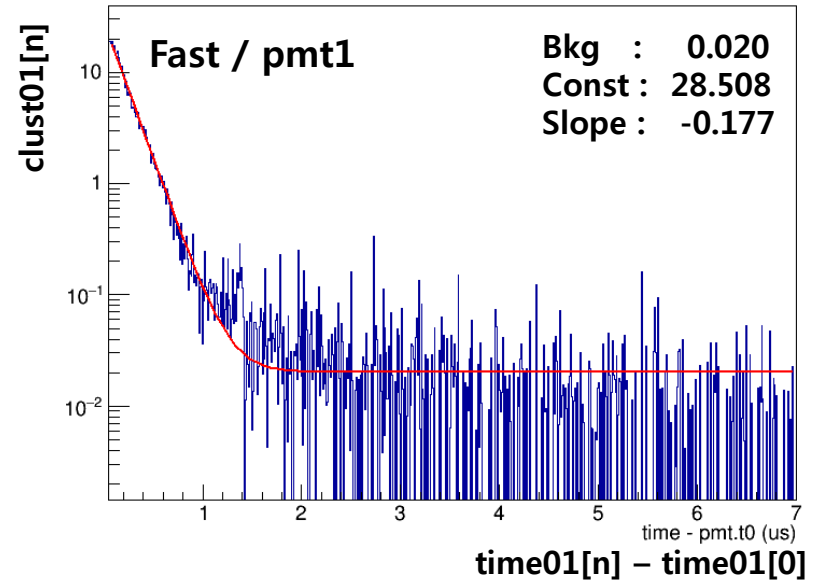
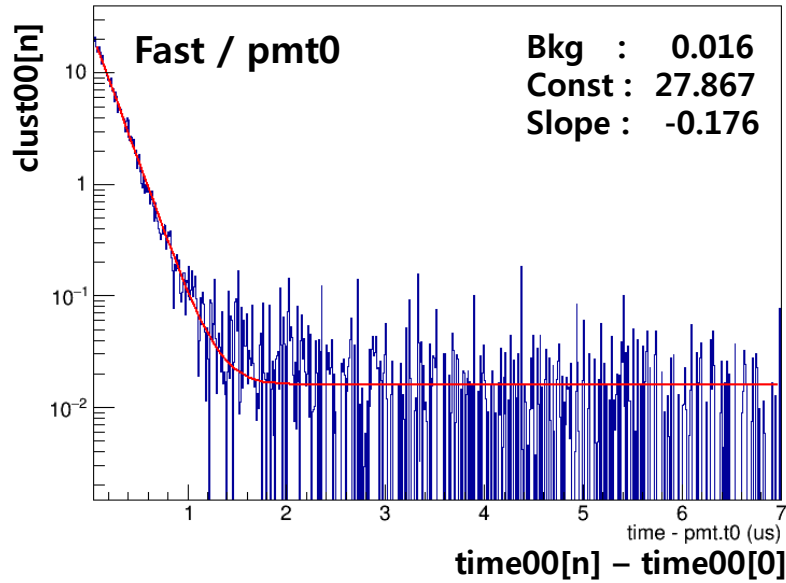
Cluster charge sum vs cluster time (3~4 keV)

$$\text{Bkg} + \text{Const} * \text{Exp}(x/\text{Slope})$$



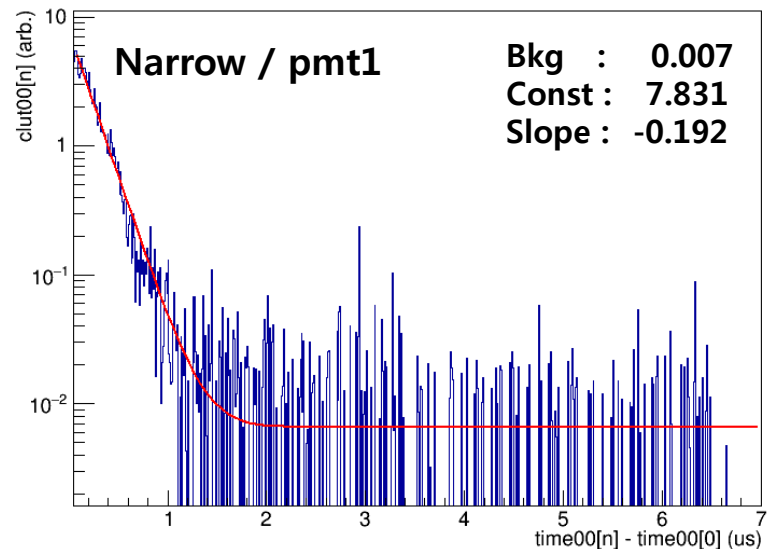
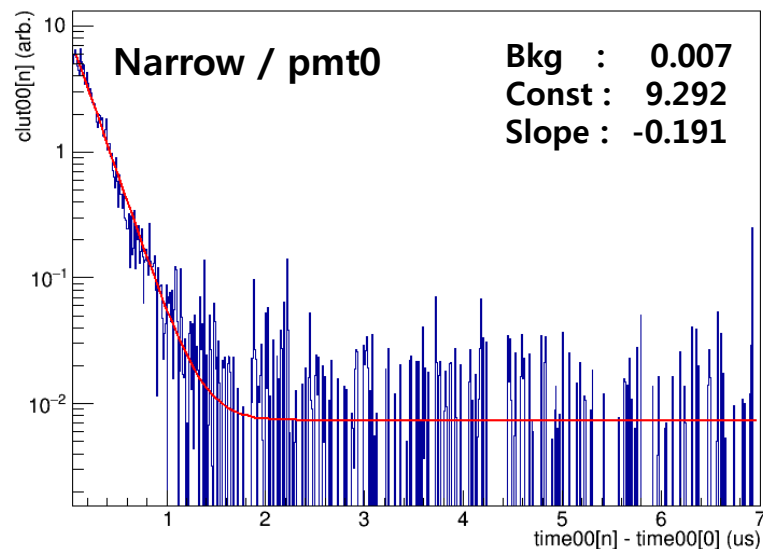
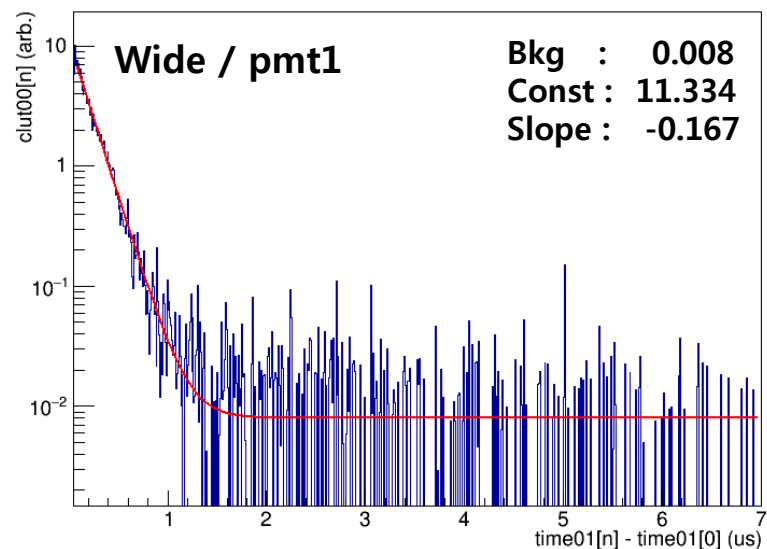
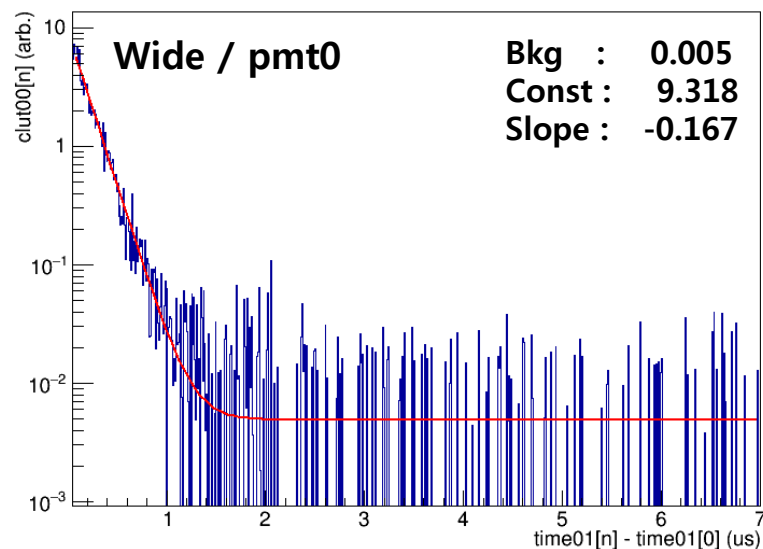
Cluster charge sum vs cluster time (4~5 keV)

$$\text{Bkg} + \text{Const} * \text{Exp}(x/\text{Slope})$$



Cluster charge sum vs cluster time (3~4 keV)

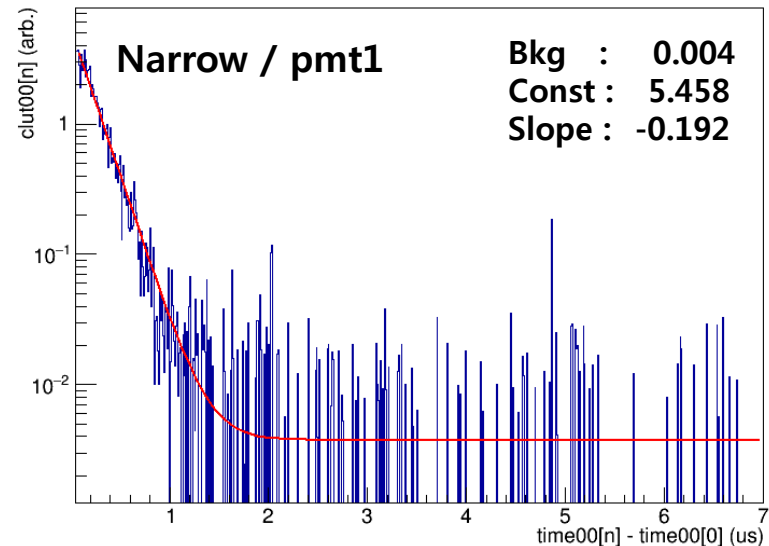
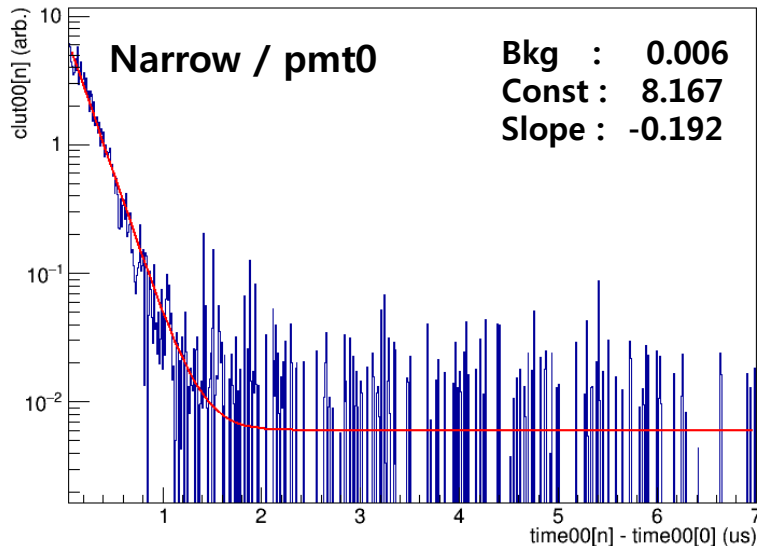
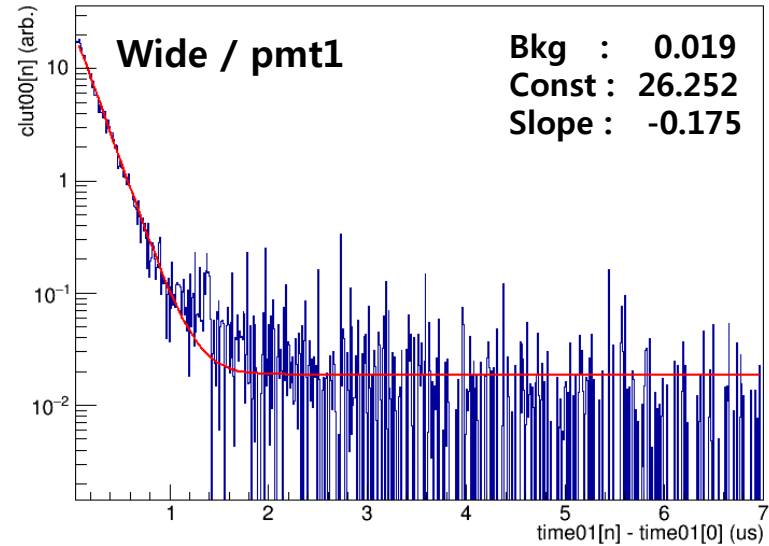
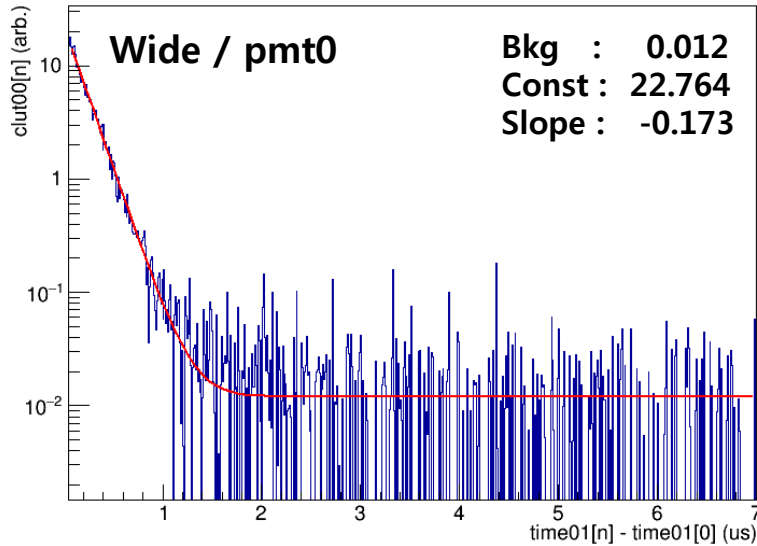
$$\text{Bkg} + \text{Const} * \text{Exp}(x/\text{Slope})$$



Wide : pmt.wt > 50 / **Narrow** : pmt.wt < 50

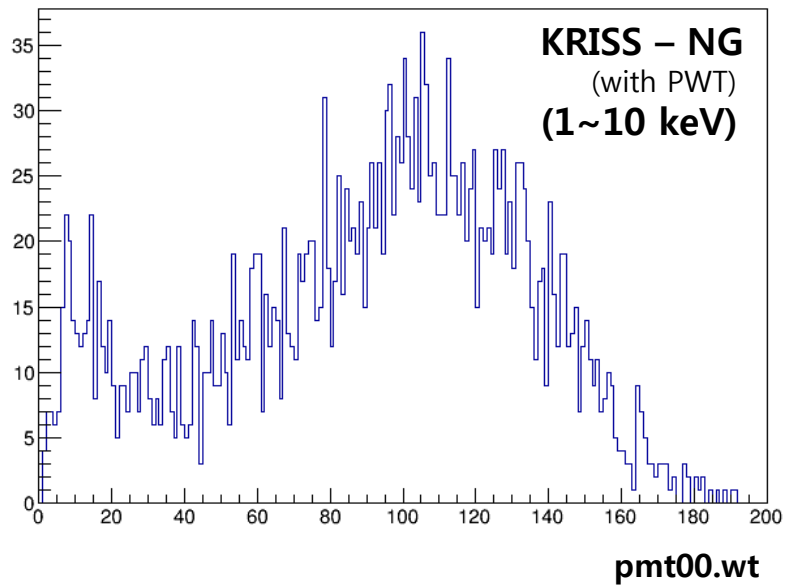
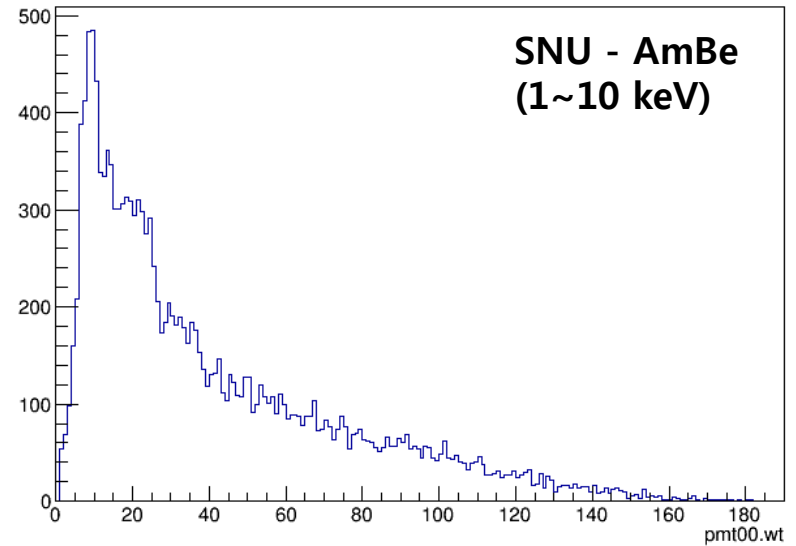
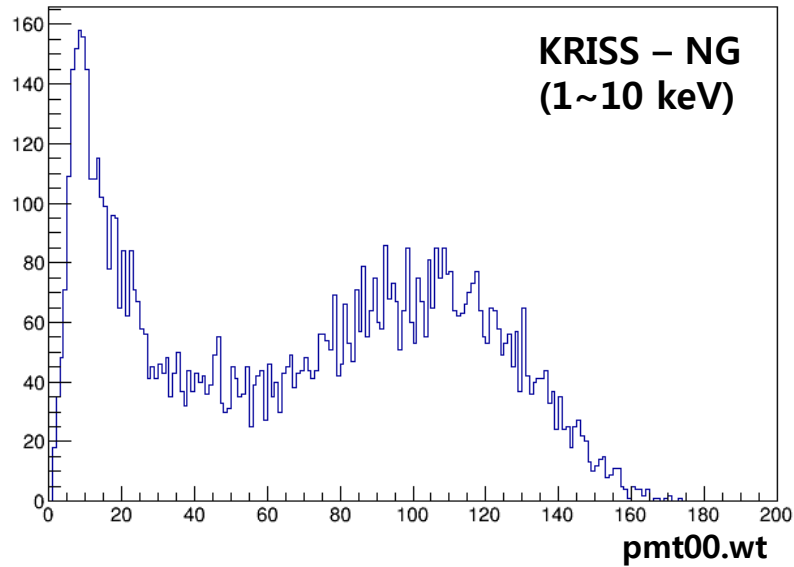
Cluster charge sum vs cluster time (4~5 keV)

$$\text{Bkg} + \text{Const} * \text{Exp}(x/\text{Slope})$$

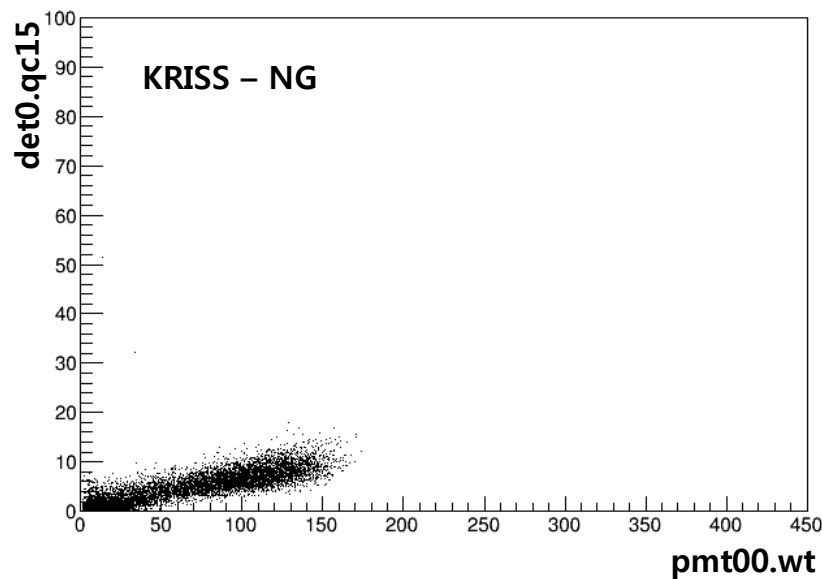
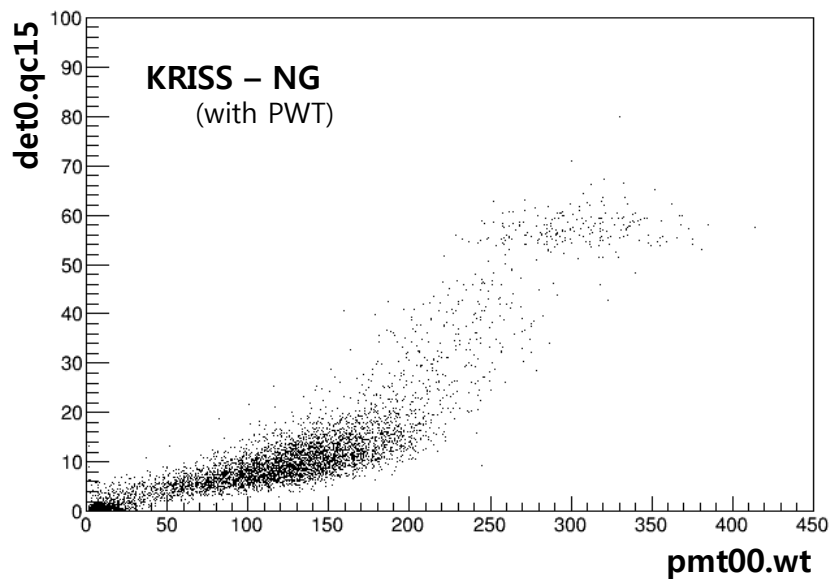
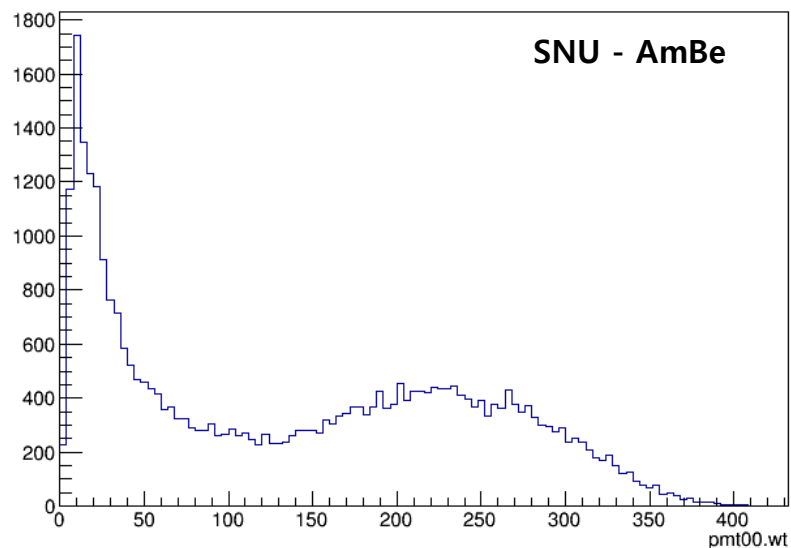
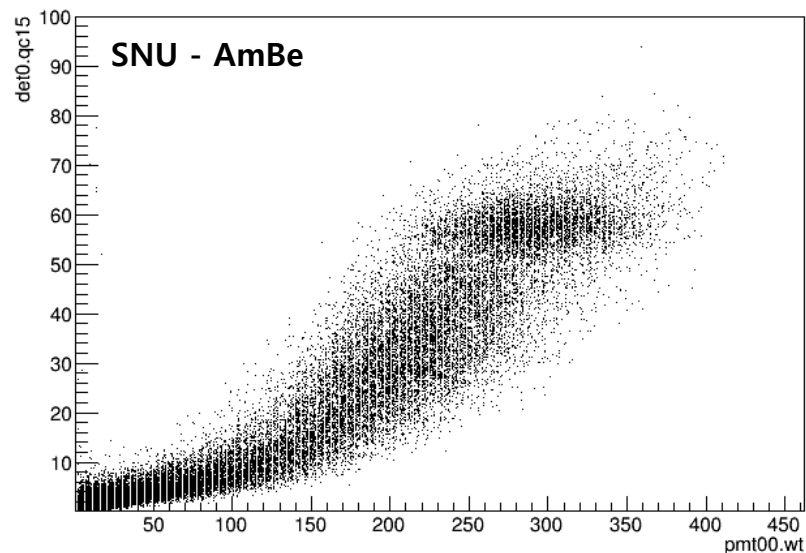


Wide : pmt.wt > 50 / **Narrow** : pmt.wt < 50

Pulse width

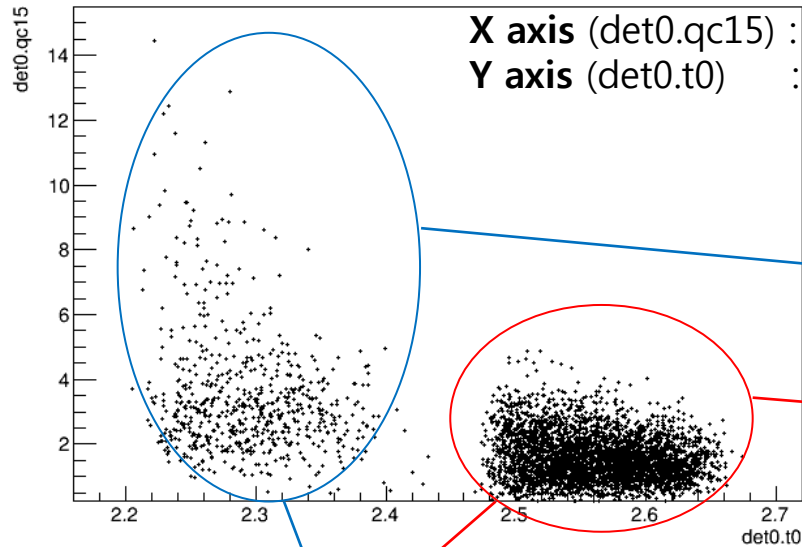


NaI deposit energy vs pulse width (SNU – AmBe)



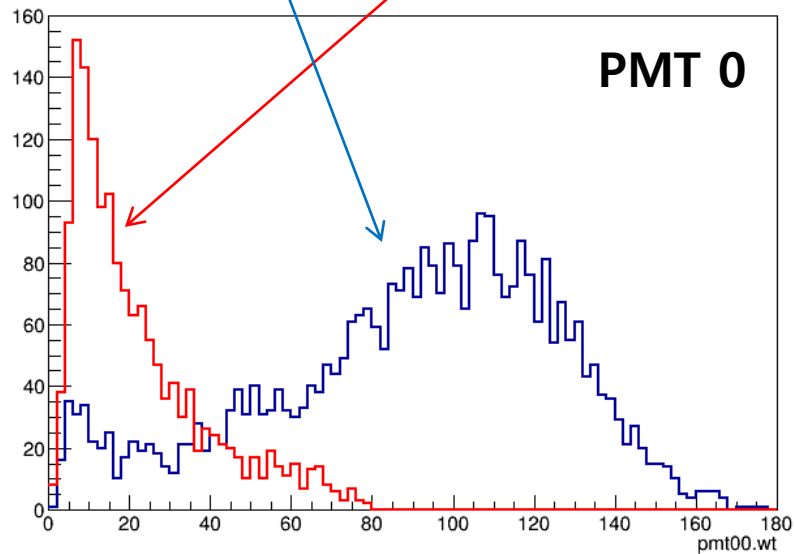
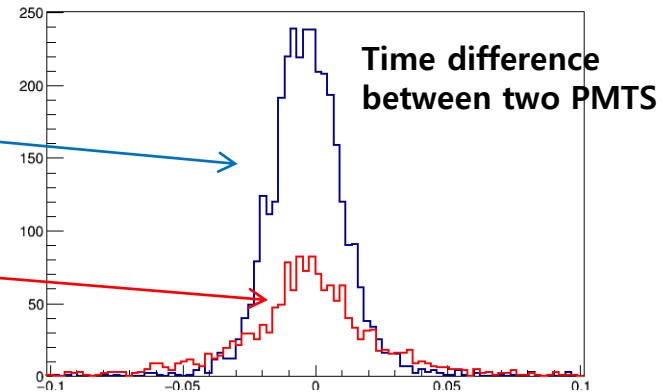
Backup Slides

NaI deposit energy vs det0.t0 & pulse width

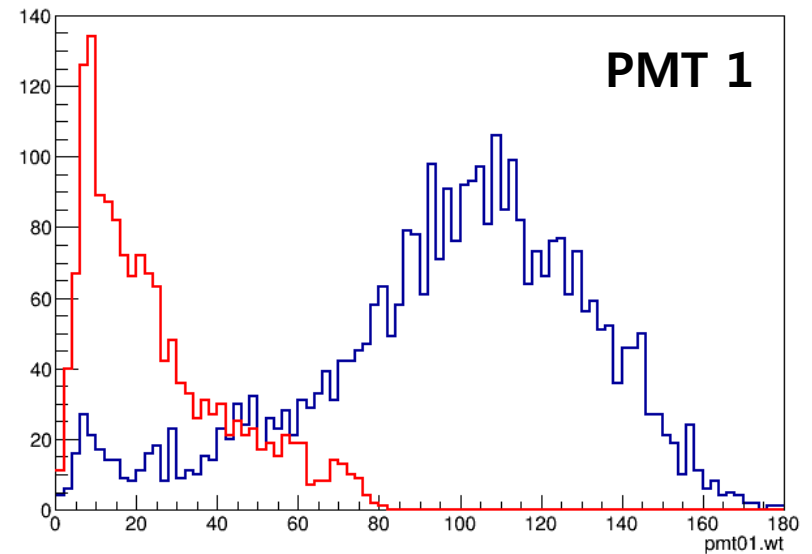


X axis (`det0.qc15`) : deposit energy on NaI within 1.5 μ s (keV)

Y axis (`det0.t0`) : mean time of 1st cluster of NaI signal



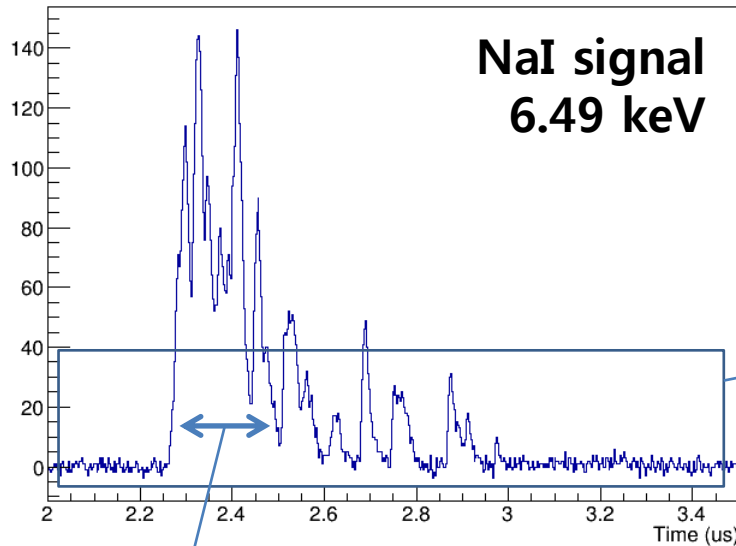
PMT 0



PMT 1

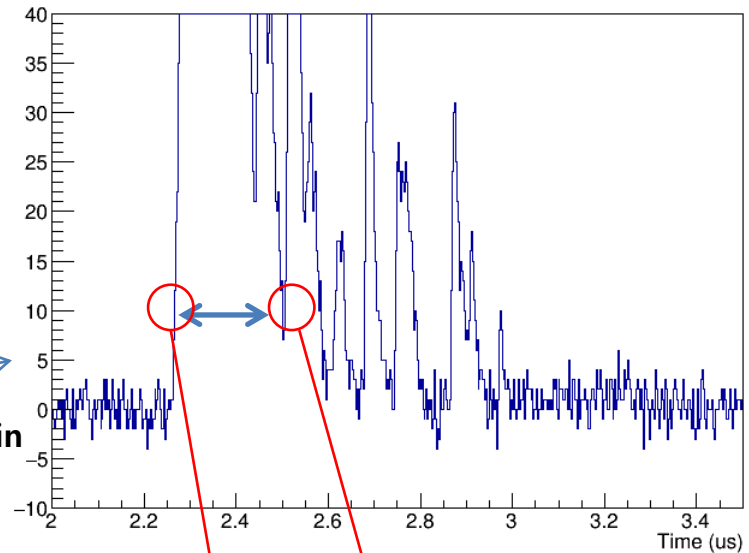
pmt.wt : Pulse width over threshold level (1 ch = 2.5 ns)

Pulse width over threshold



Pulse width over threshold
(threshold : 10 mV)

Zoom in



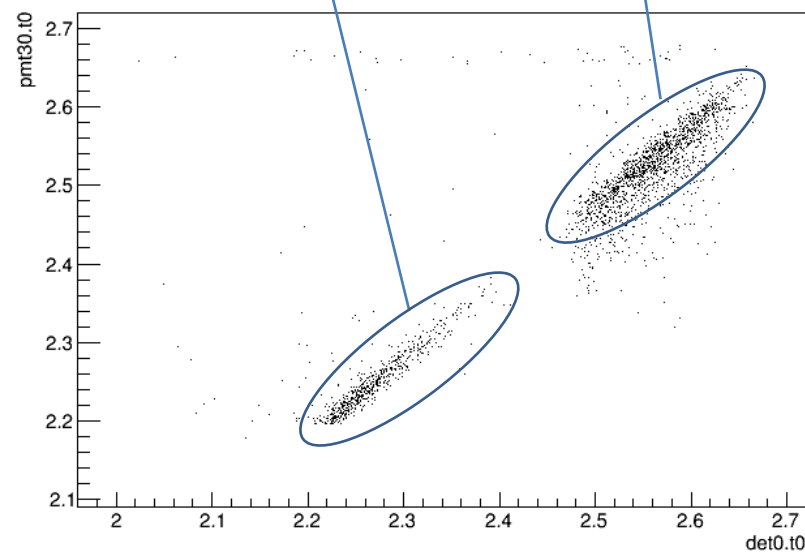
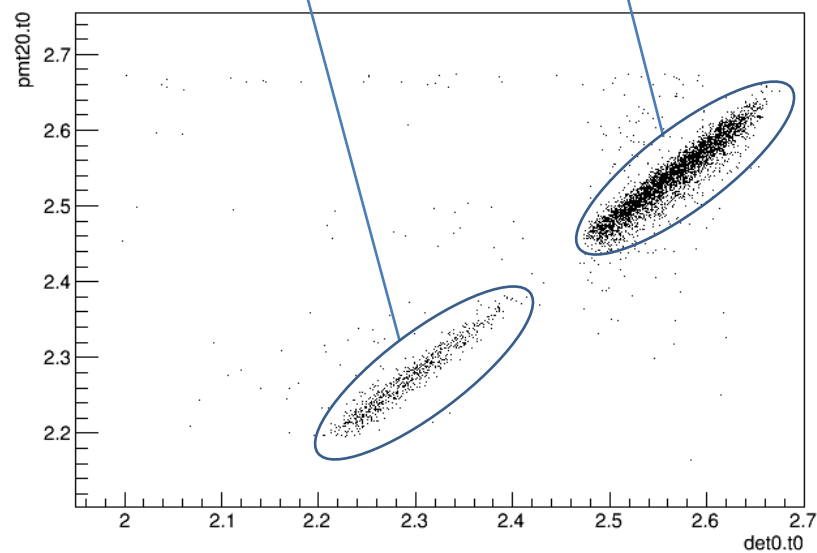
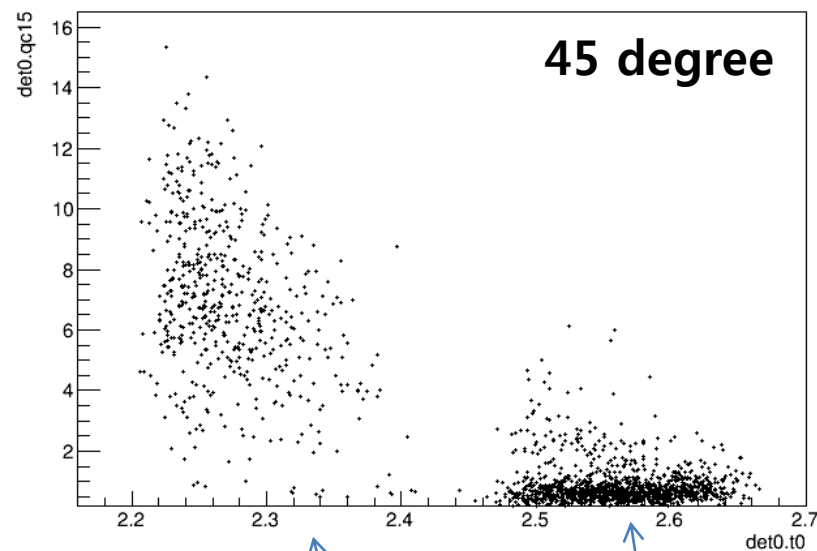
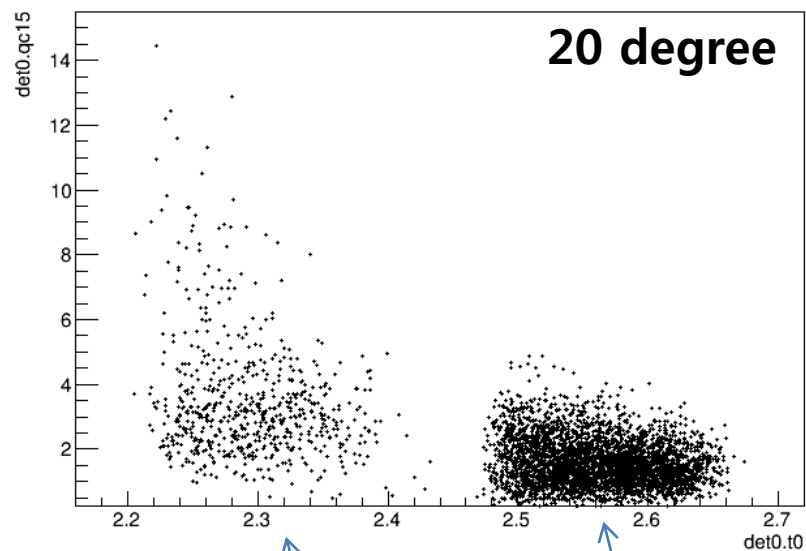
Second cluster is counted

First cluster is counted

Pulse is counted in FADC
whenever the pulse rising edge passes
the discriminator threshold level.

***Current Pulse count trigger in FADC**
: 2 or more pulses in each PMT in 200 ns
4 or more pulses in sum of PMTs in 400 ns

NaI deposit energy or ND.t0 vs det0.t0

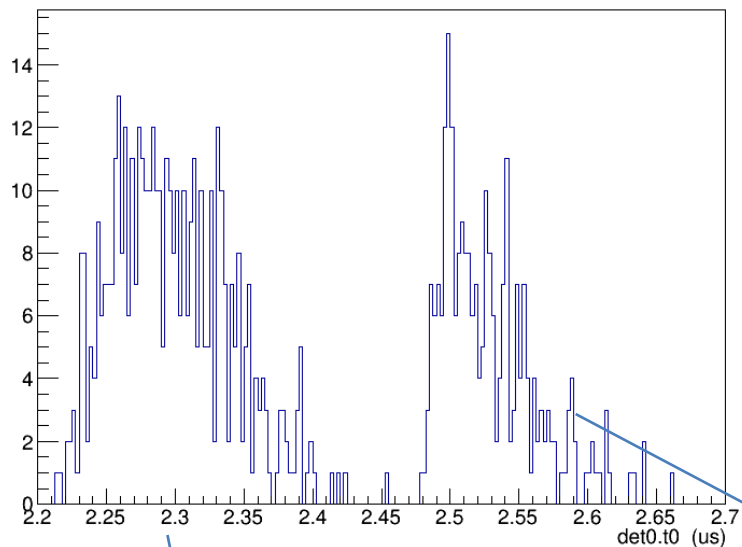


det0.qc15 : deposit energy on NaI within 1.5 us (keV)

det0.t0, pmt20.t0 : mean time of 1st cluster of NaI, Neutron detector signal

$\ln(MT)$ for $\text{det0.t0} > 2.45$ and $\text{det0.t0} < 2.45$ (setup2, 3~4 keV)

3 keV to 4 keV

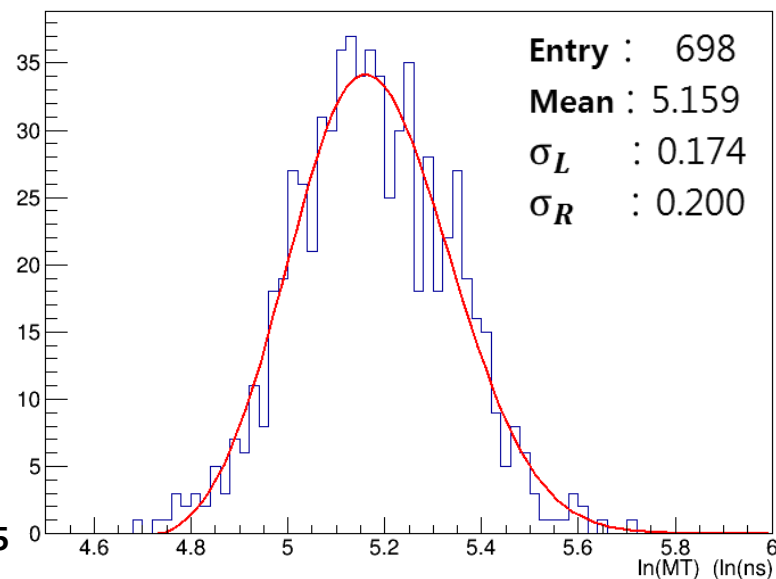


total



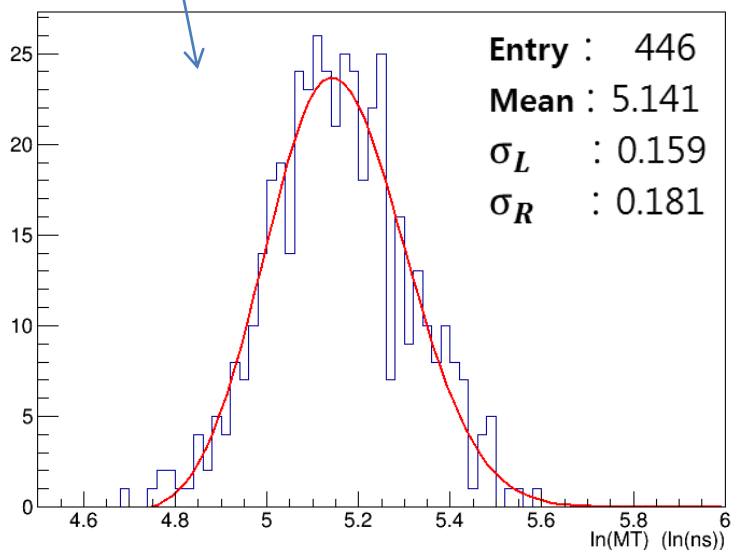
$\text{det0.t0} > 2.45$

(3 keV to 4 keV)

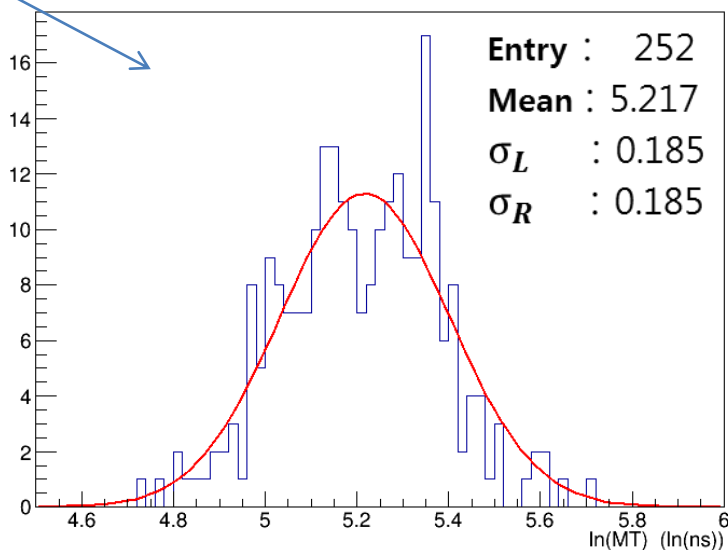


$\text{det0.t0} < 2.45$

3 keV to 4 keV

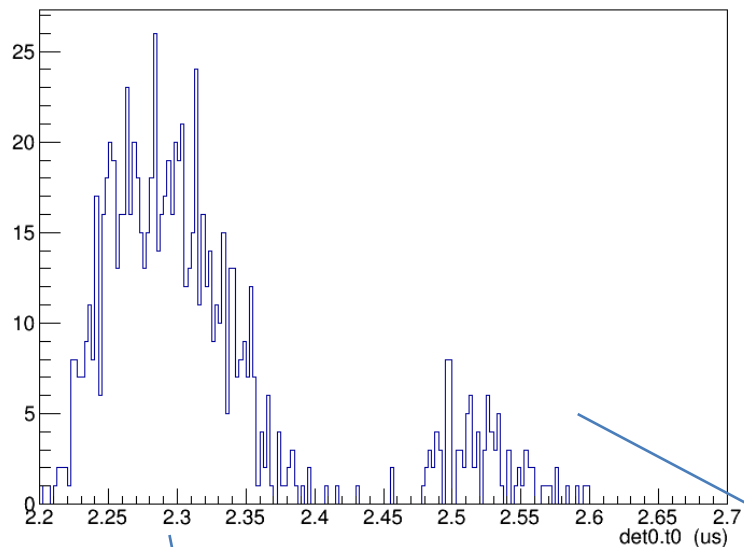


3 keV to 4 keV



$\ln(MT)$ for $\text{det0.t0} > 2.45$ and $\text{det0.t0} < 2.45$ (setup2, 4~5 keV)

4 keV to 5 keV

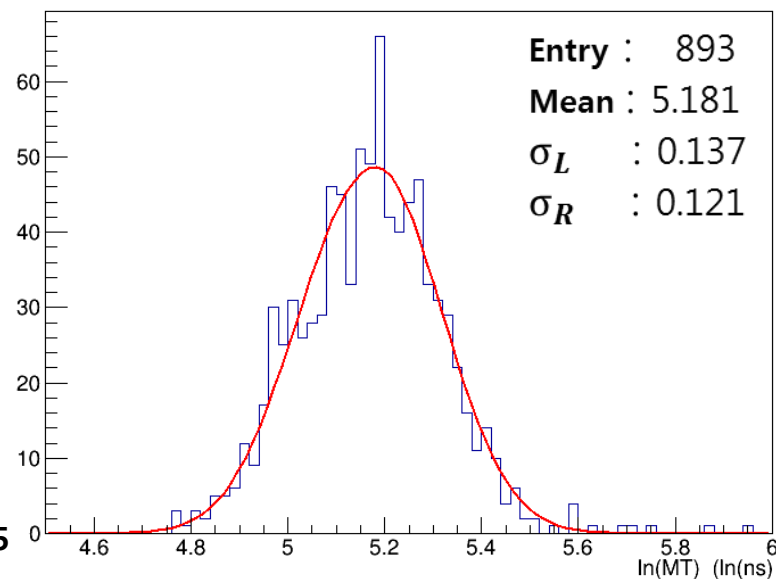


total



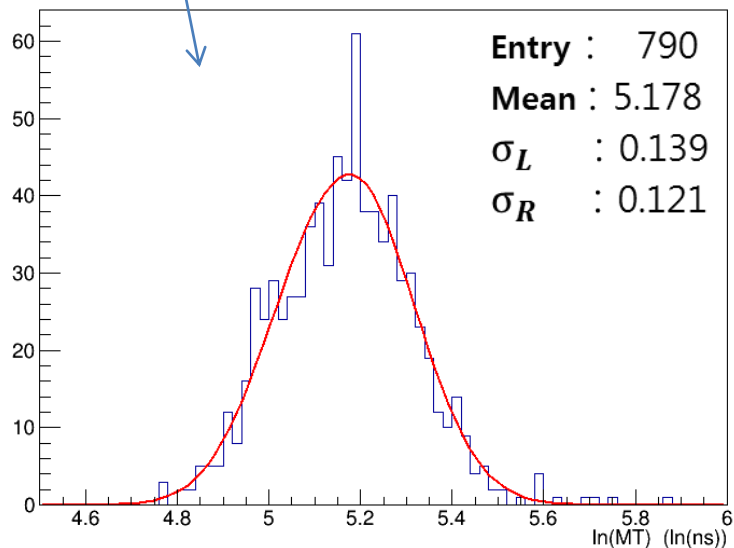
$\text{det0.t0} > 2.45$

(4 keV to 5 keV)

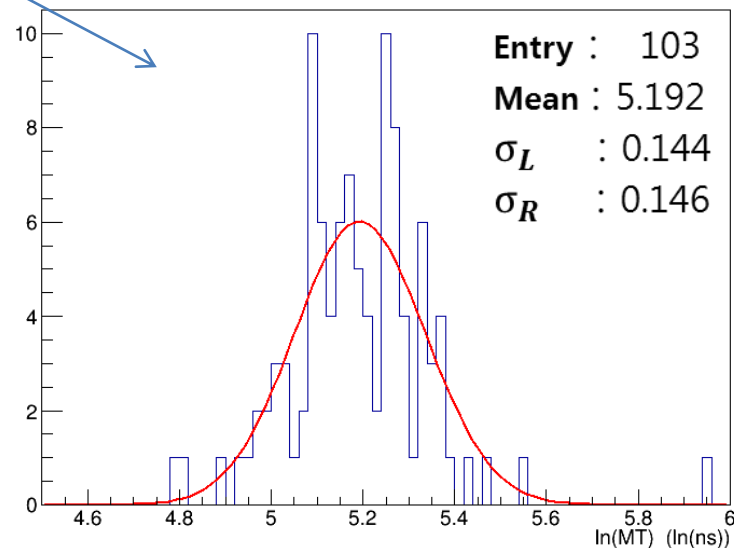


$\text{det0.t0} < 2.45$

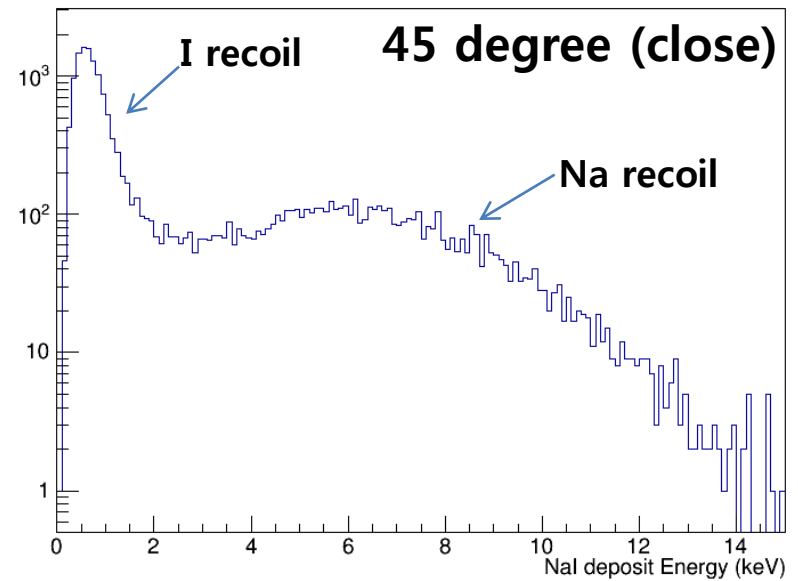
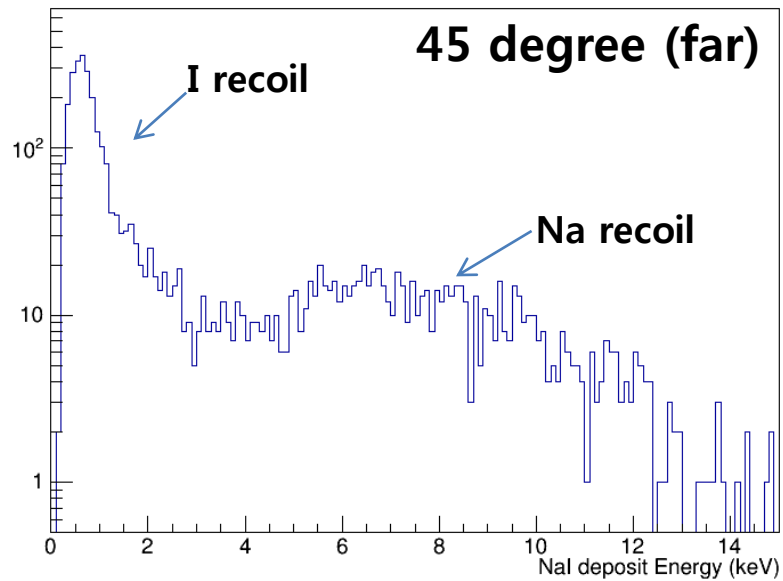
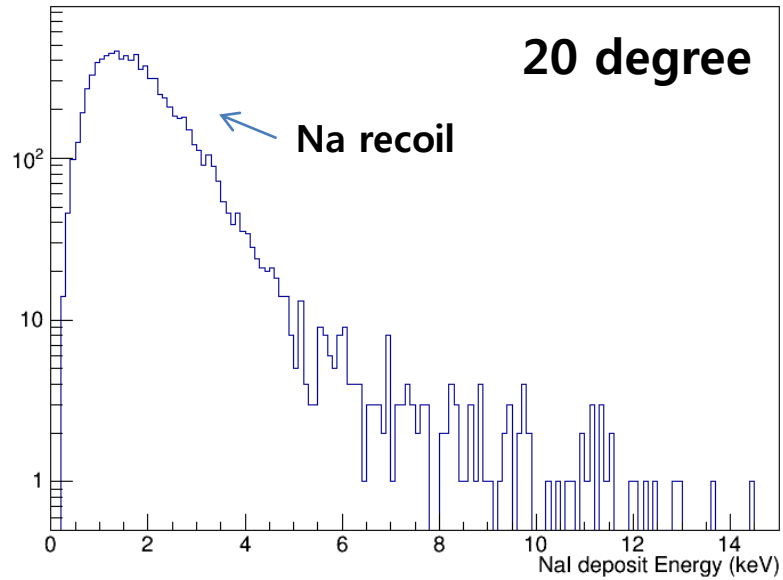
4 keV to 5 keV



4 keV to 5 keV

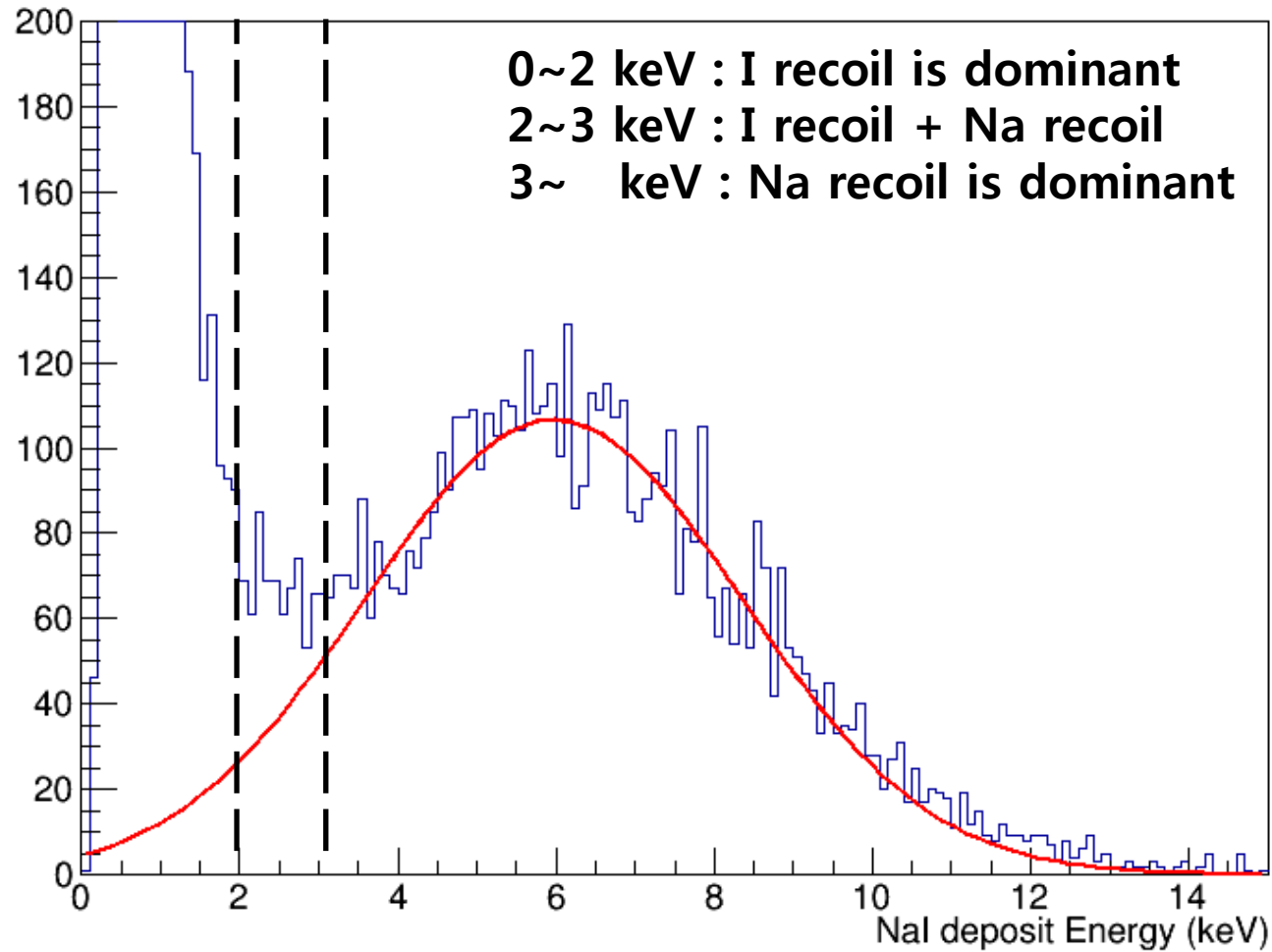


Deposit energy on NaI

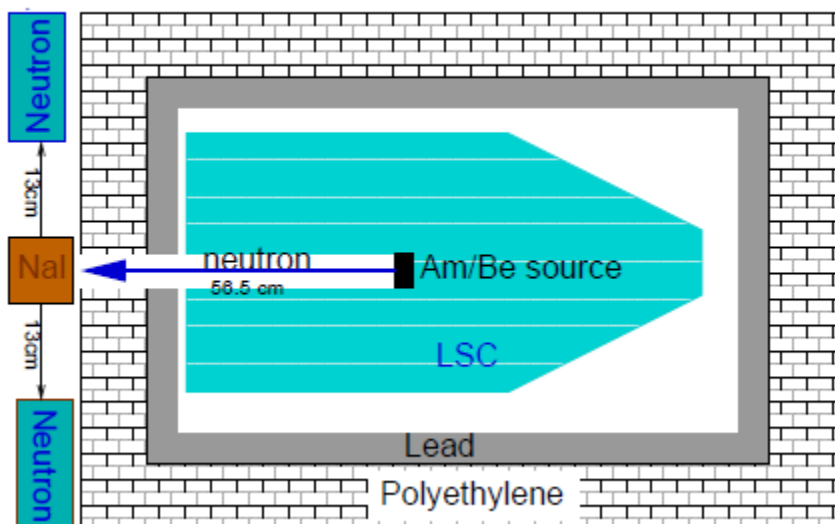


Deposit energy on NaI

ND3

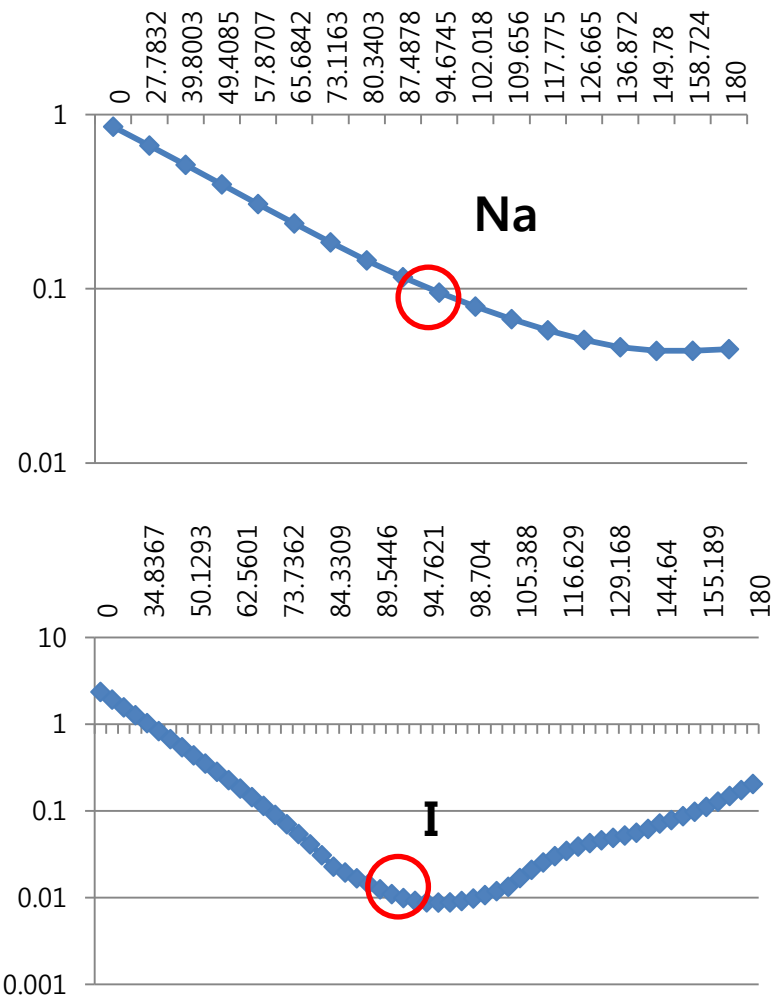


Am/Be experimental setup and cross section of Na and I

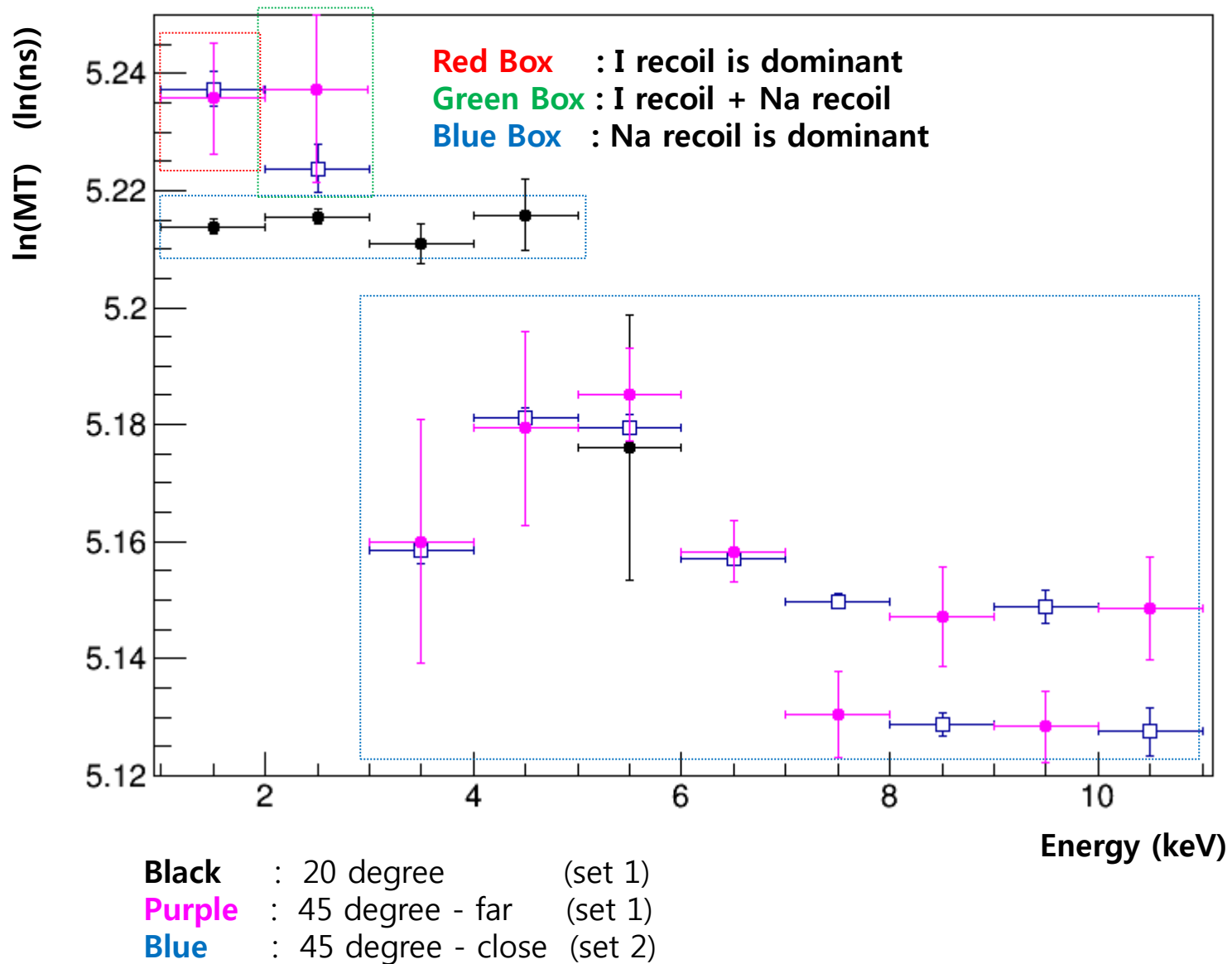


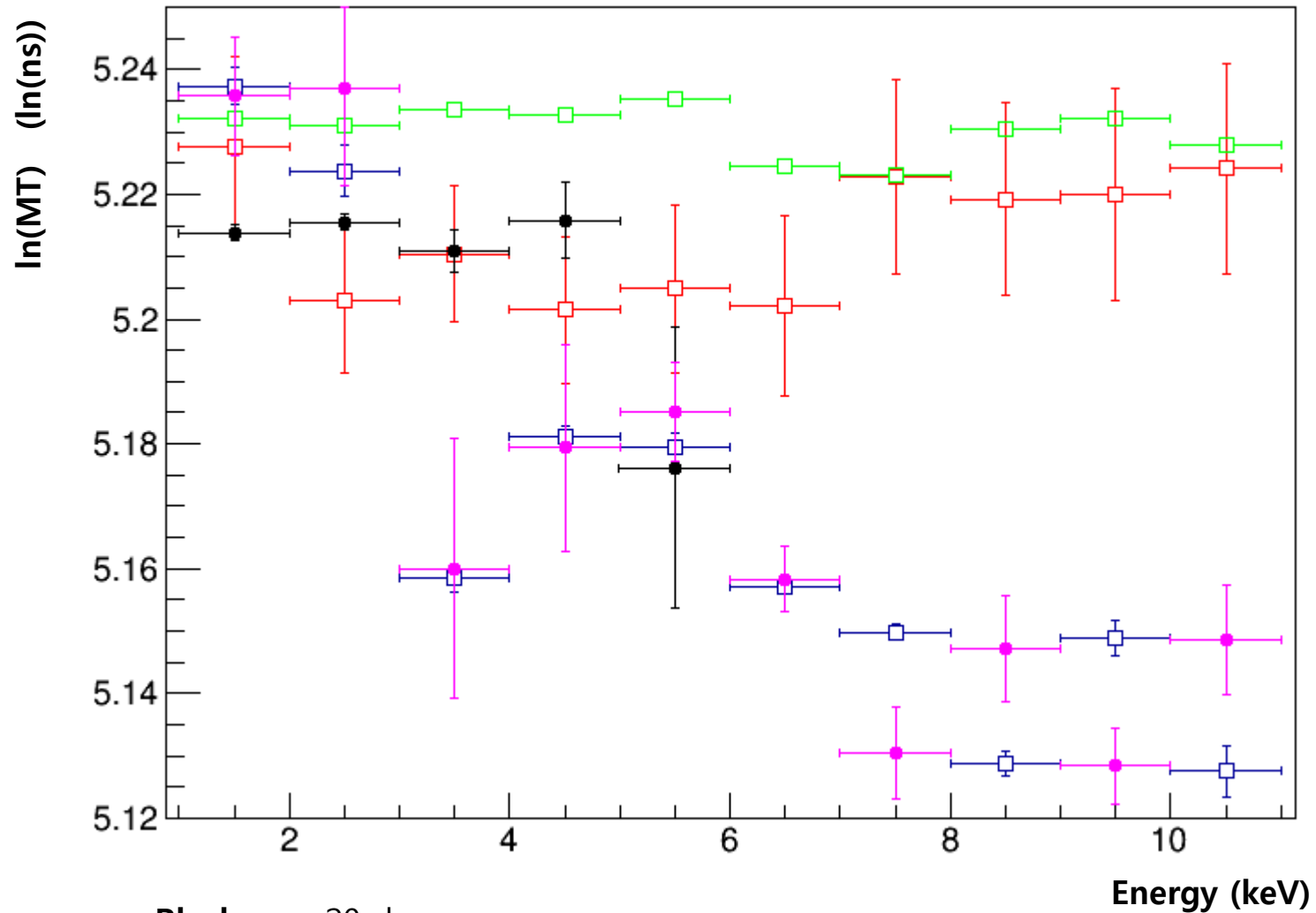
Calculated visible energy of
I recoil events < 10 keV

(energy of neutron < 8 MeV)



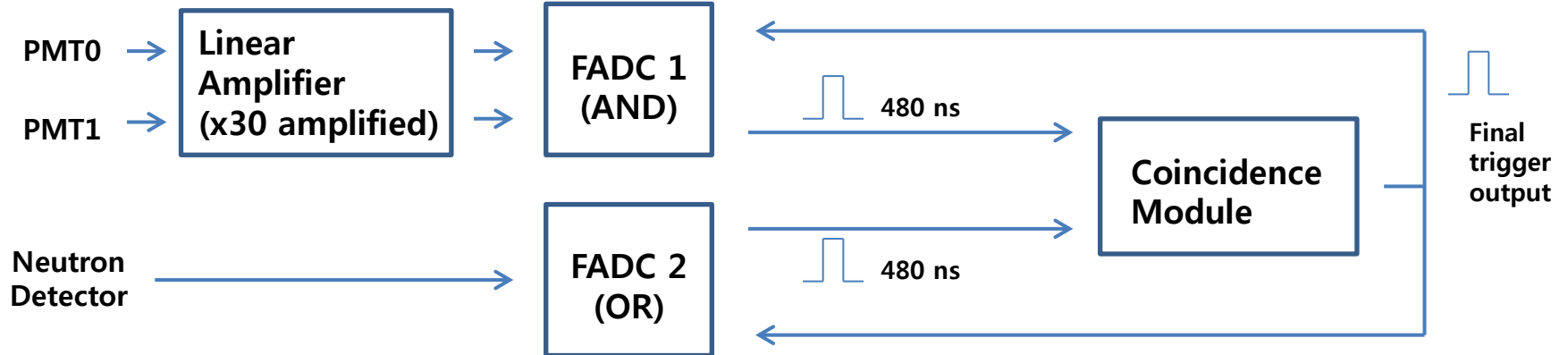
X axis : Neutron scattering angle
Y axis : Cross section
(data from ENDF)





- Black** : 20 degree
- Purple** : 45 degree - far
- Blue** : 45 degree - close
- Red** : Am/Be source / HSlee
- Green** : Am/Be source / My analysis code

Trigger logic



Threshold voltage

- PMT : 10 mV
- Neutron Detectors : 50 mV

Pulse width trigger for neutron detector

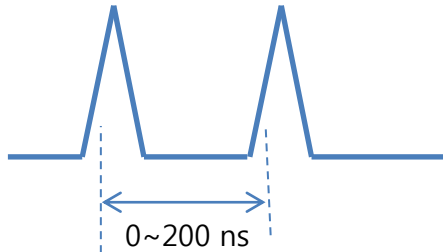
- Neutron detectors : 10 ns

Pulse count trigger for NaI crystal

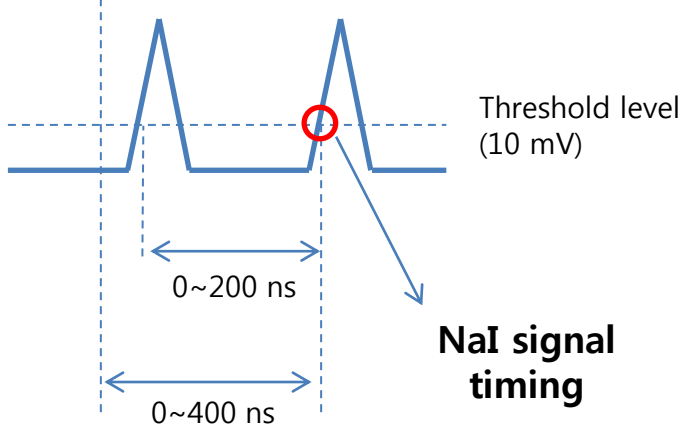
- Two or more pulses in each PMT
& Sum of pulse count of PMTs is larger than four within 400 ns

Trigger logic

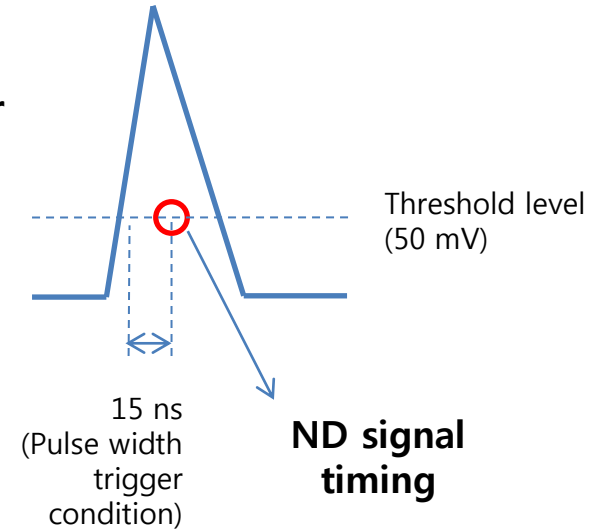
PMT0
Signal



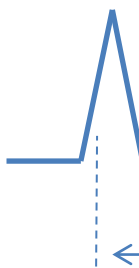
PMT1
Signal



Neutron
Detector
Signal

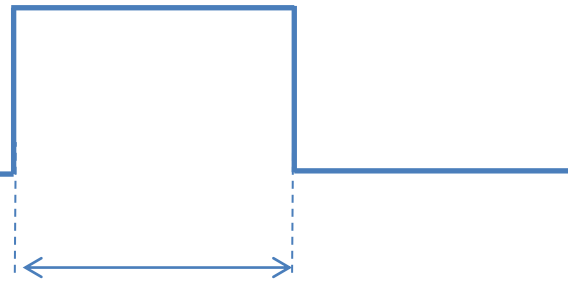


NaI or ND signal



~ 400 ns

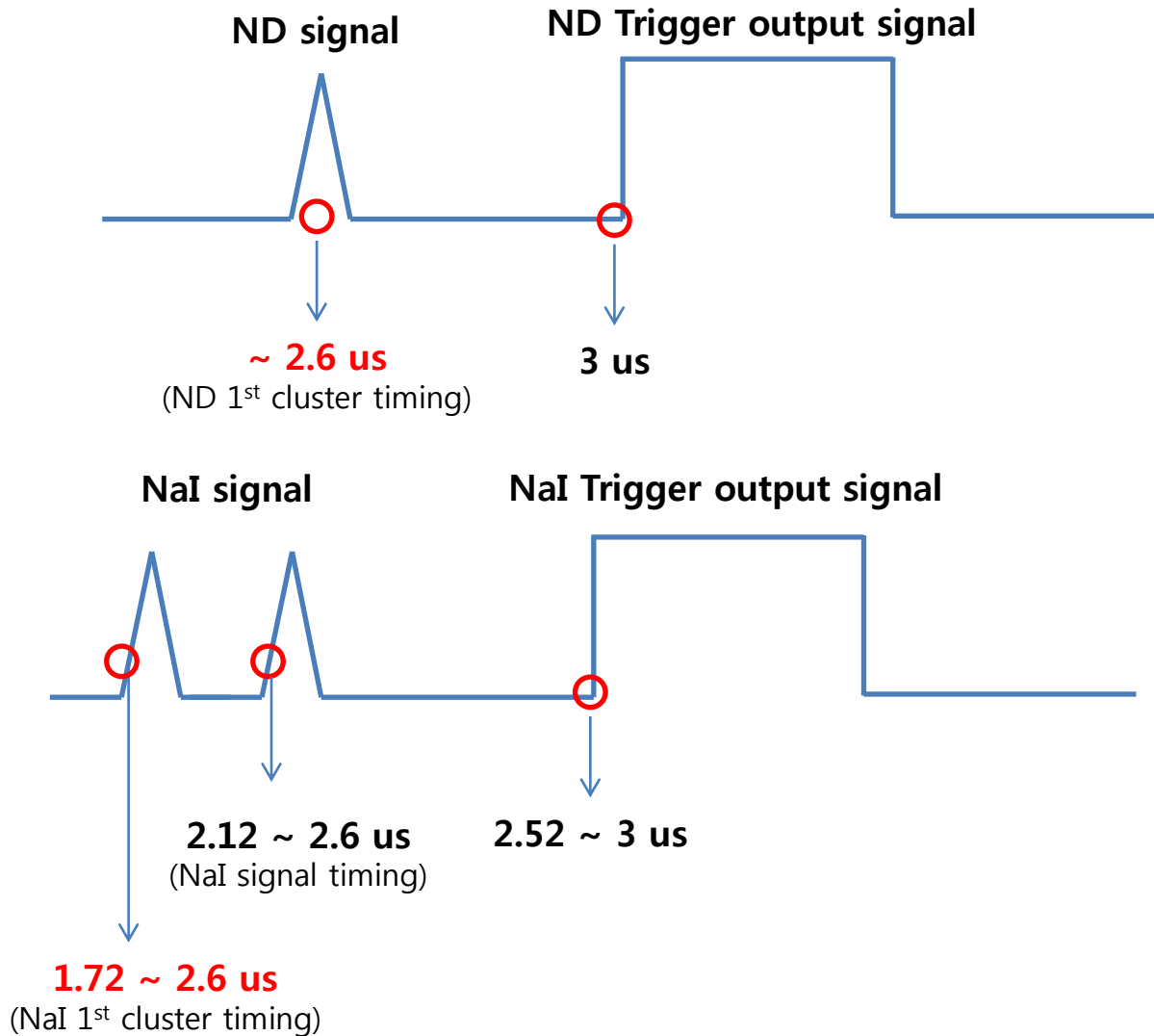
NaI or ND Trigger output signal



480 ns

Trigger logic

a) Neutron Detector signal trigger position을 결정



Trigger logic

b) NaI signal trigger position을 결정

