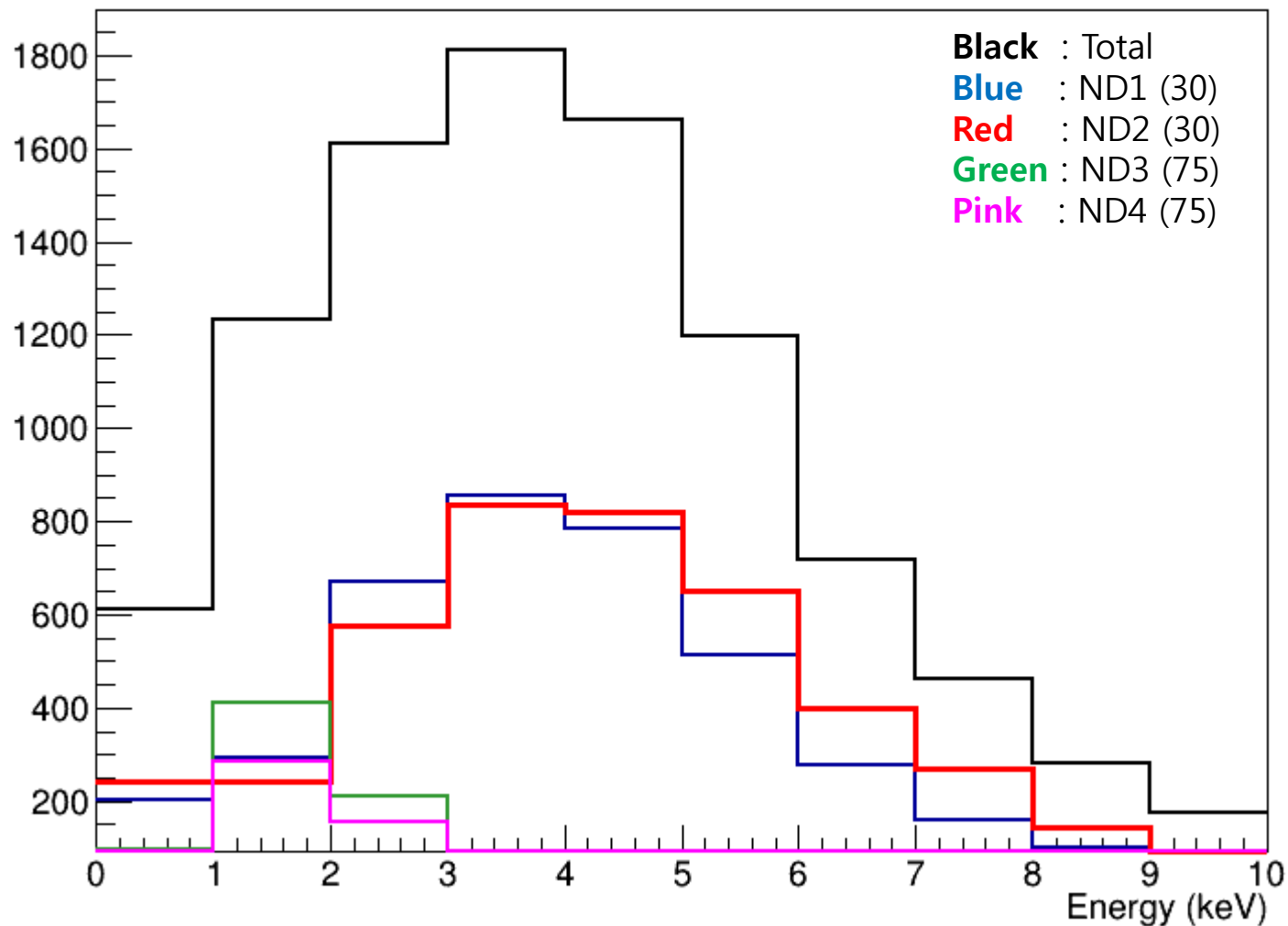
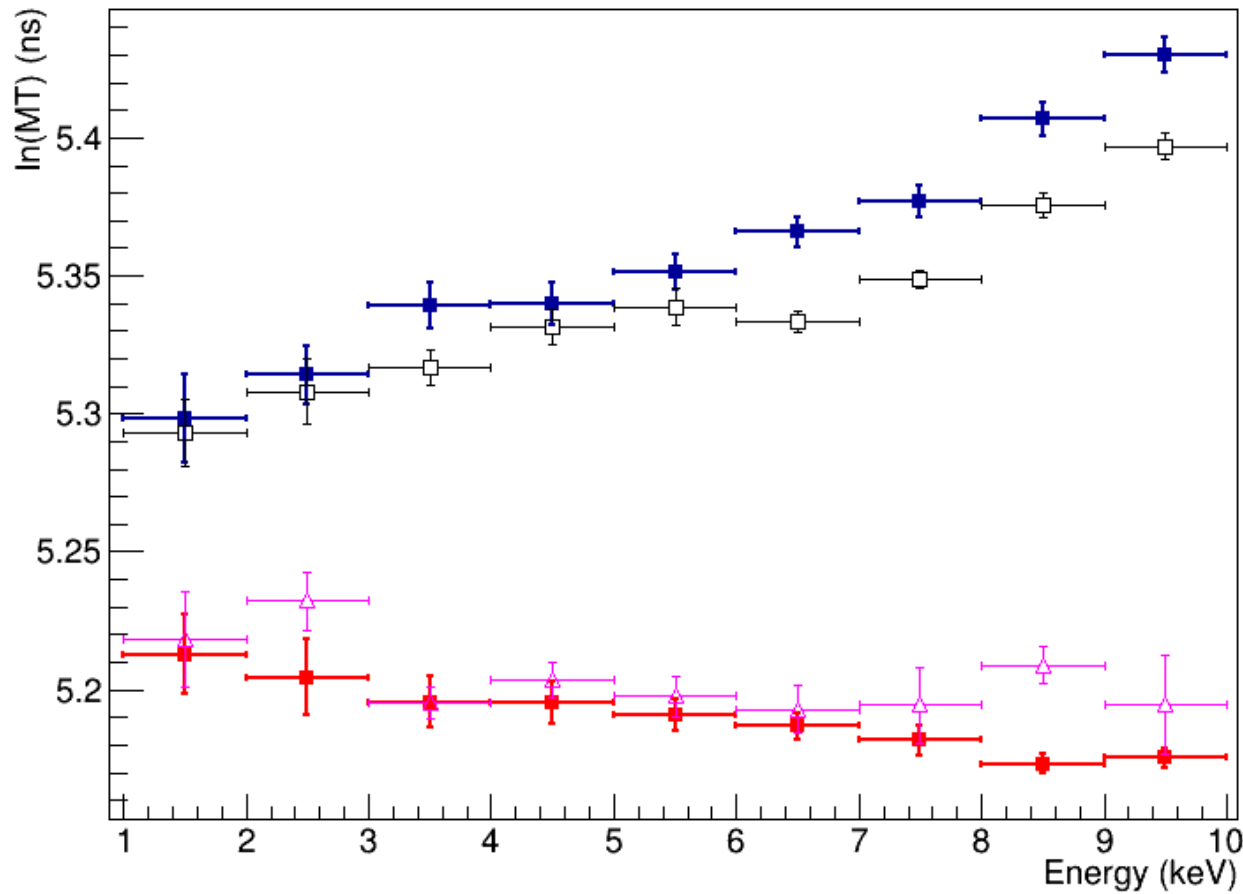


NaI deposit energy vs mean time

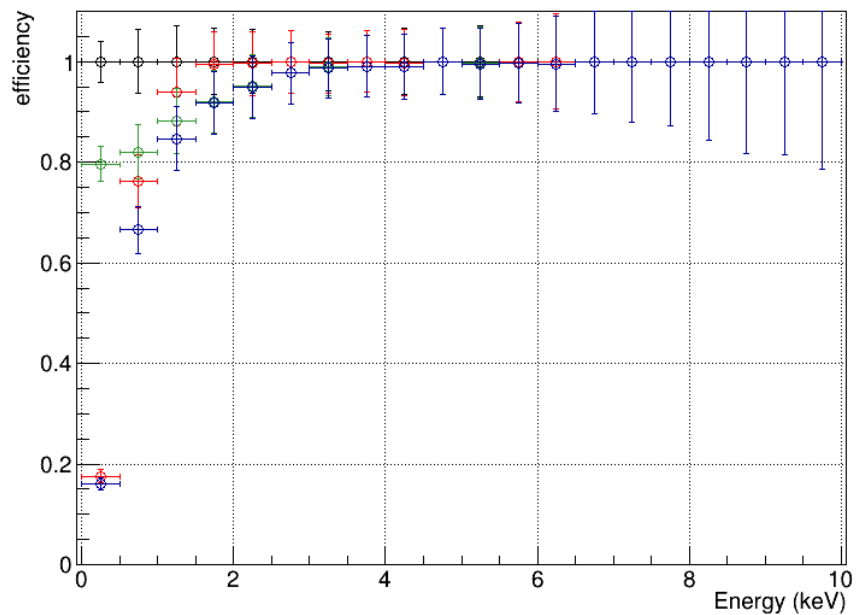
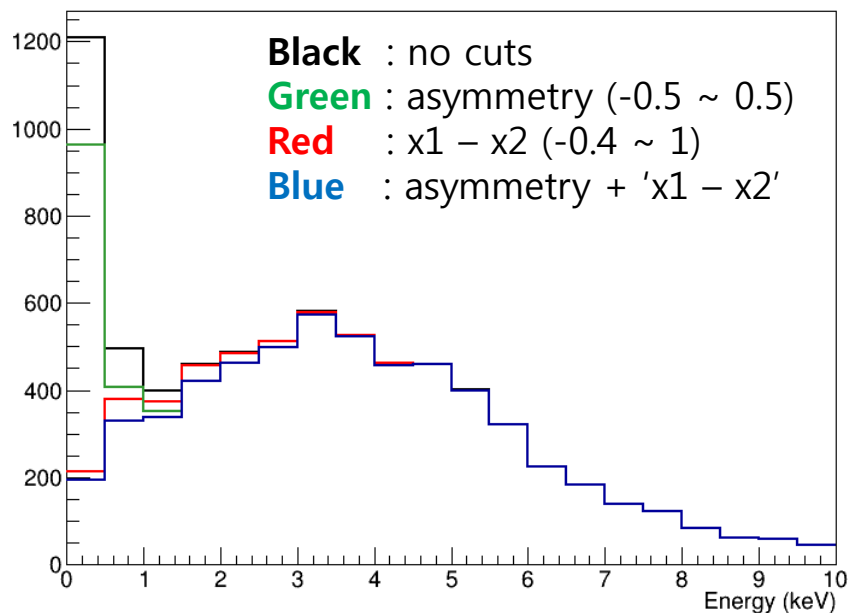


ln(Mean time) vs NaI deposit energy (for nuclear recoils)

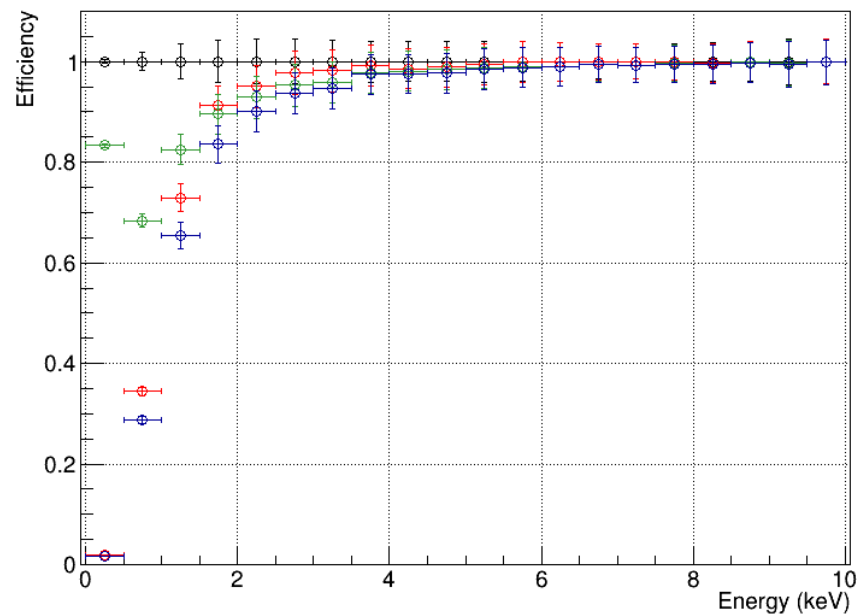
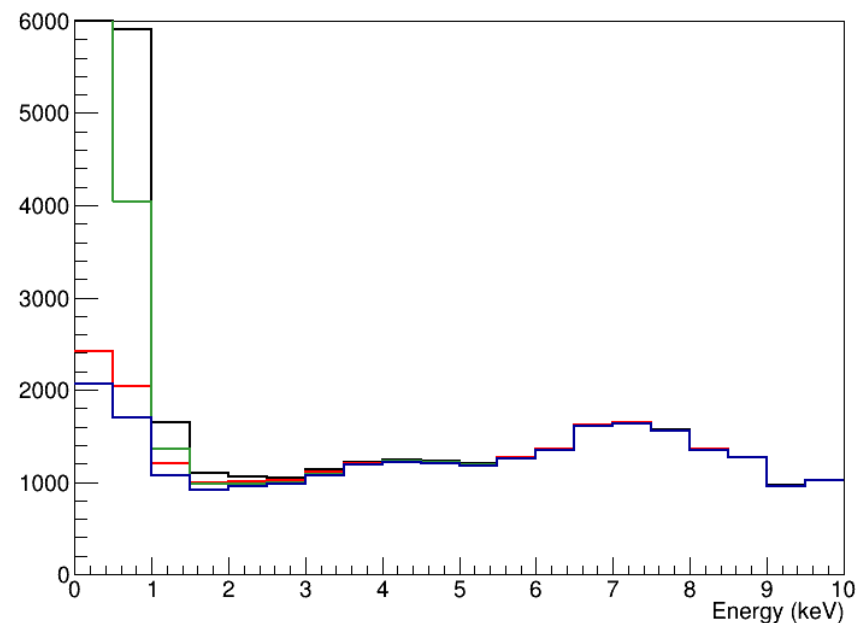


- Blue** : 400 MHz FADC, electron recoil
- Red** : 400 MHz FADC, nuclear recoil
- Black** : 500 MHz FADC, electron recoil
- Pink** : 500 MHz FADC, nuclear recoil

Nuclear recoil



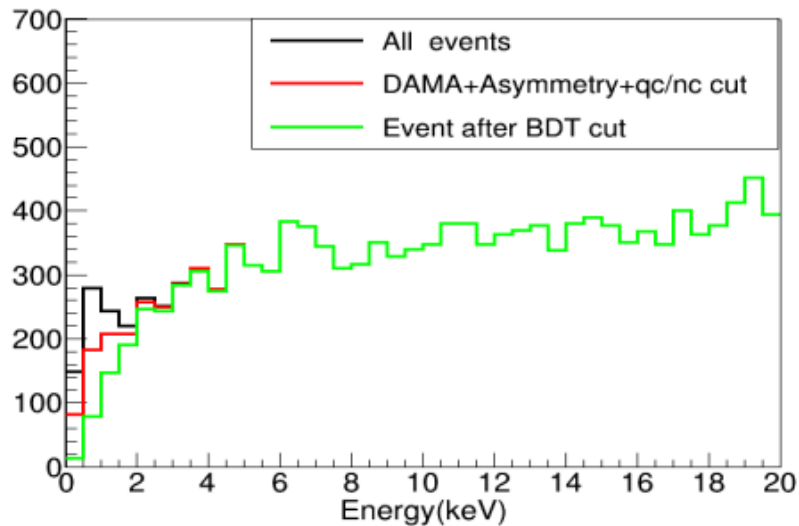
Electron recoil



Compton event and Efficiency calculation

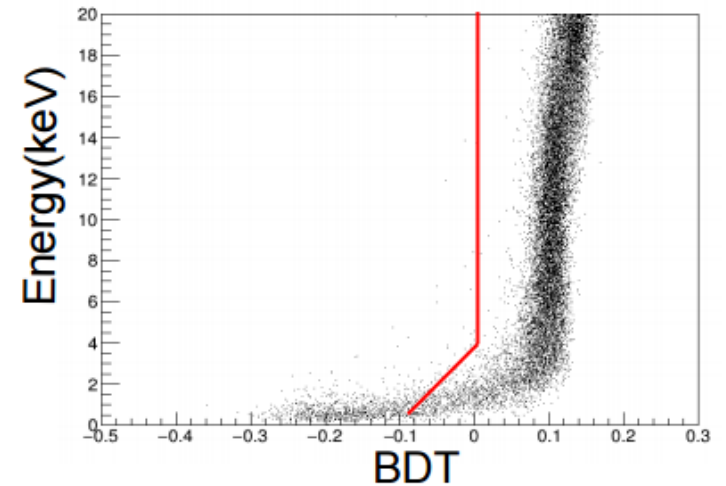
*Cosine data (with Co60)

Spectrum of Compton events in different cut

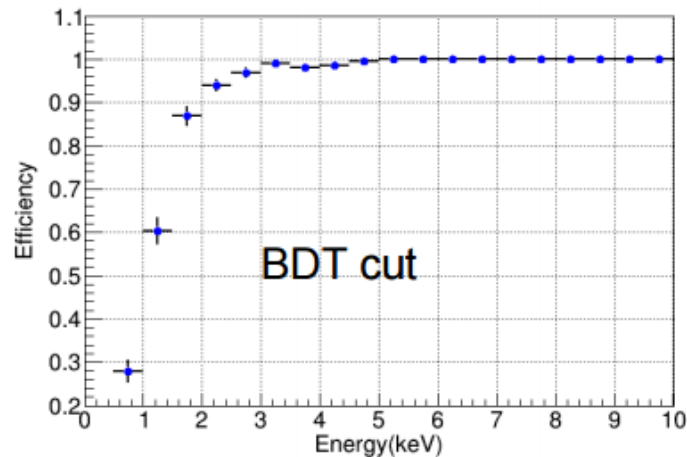
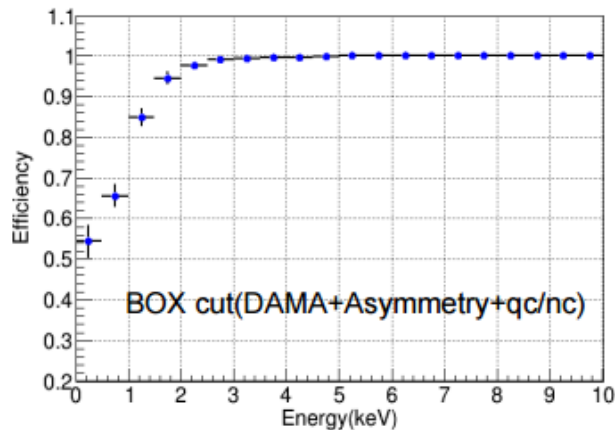


Apply the previous BDT training in Compton data

BDT vs Energy



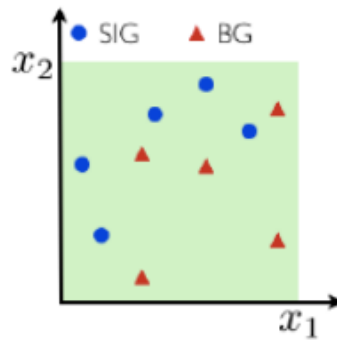
Efficiency variation



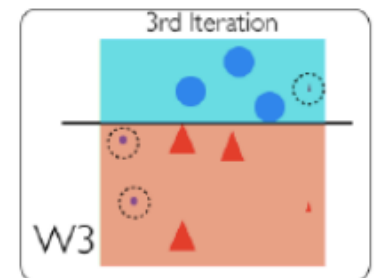
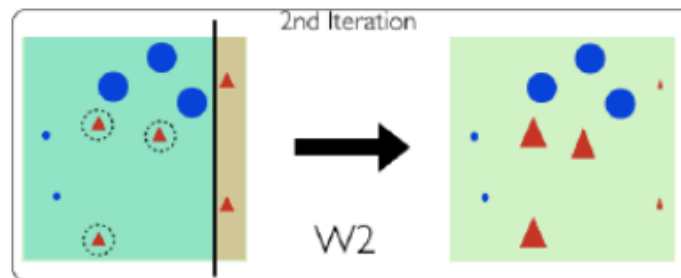
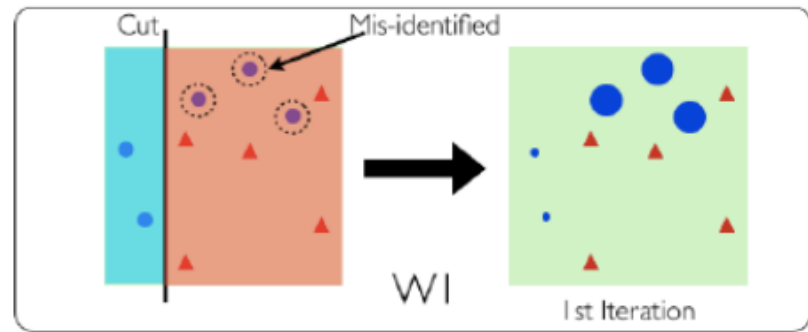
Boosted Decision Tree (BDT)

As the iteration goes on, the weights on the previous event sample are updated and the subsequent learner is trained on the weighted data set.

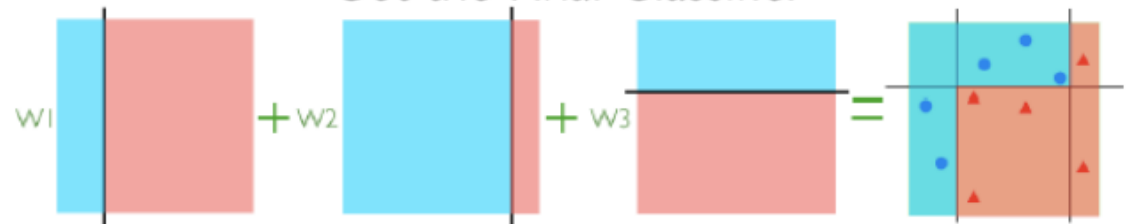
Eventually, a single classifier is obtained by combining the weak hypotheses with corresponding weights.



<Simple 2-D toy example>
Hypothesis : Straight Cuts
Multiple Iterations
Boosting : Give different weights when (mis)classified



Get the Final Classifier



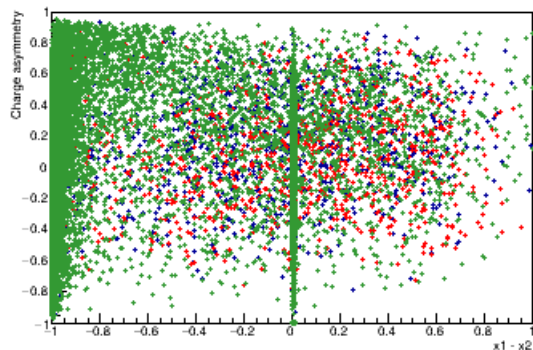
Nuclear recoil

	0~0.5	0.5~1	1~1.5	1.5~2	2~2.5	2.5~3	3~3.5	3.5~4	4~4.5	4.5~5
asym	0.797	0.821	0.882	0.919	0.951	0.977	0.990	0.991	0.989	1.000
x1-x2	0.176	0.762	0.940	0.993	0.996	1.000	0.997	1.000	0.998	1.000
Both	0.161	0.665	0.846	0.917	0.949	0.977	0.986	0.991	0.989	1.000

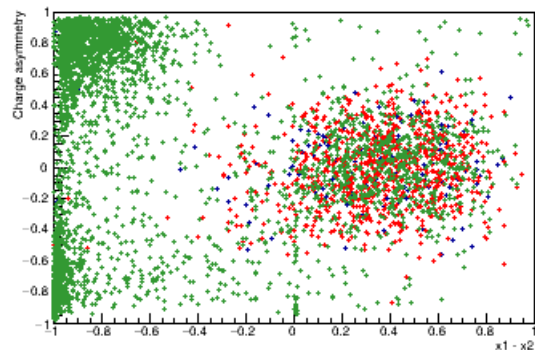
Electron recoil

	0~0.5	0.5~1	1~1.5	1.5~2	2~2.5	2.5~3	3~3.5	3.5~4	4~4.5	4.5~5
asym	0.832	0.684	0.825	0.895	0.929	0.953	0.958	0.978	0.981	0.984
x1-x2	0.019	0.344	0.729	0.912	0.951	0.977	0.982	0.992	0.986	0.989
Both	0.016	0.288	0.654	0.836	0.900	0.937	0.947	0.975	0.975	0.976

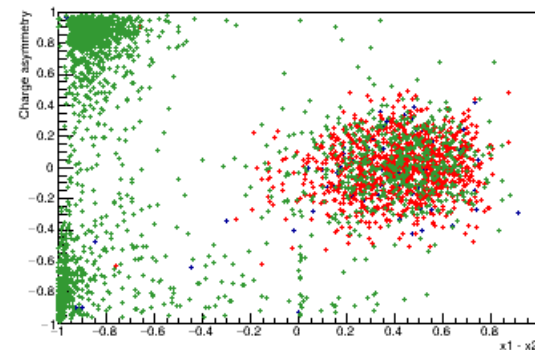
0~1 keV



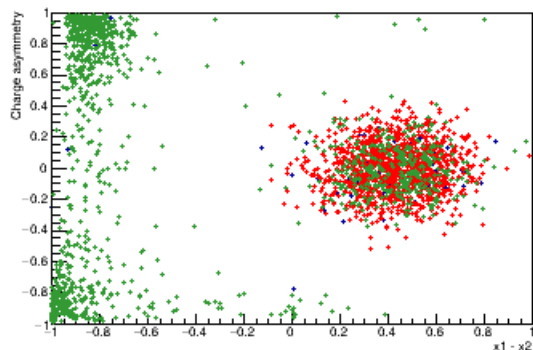
1~2 keV



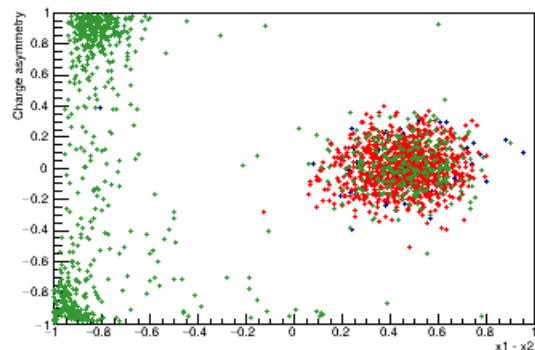
2~3 keV



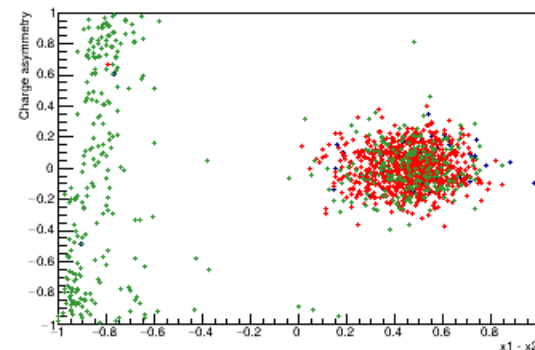
3~4 keV



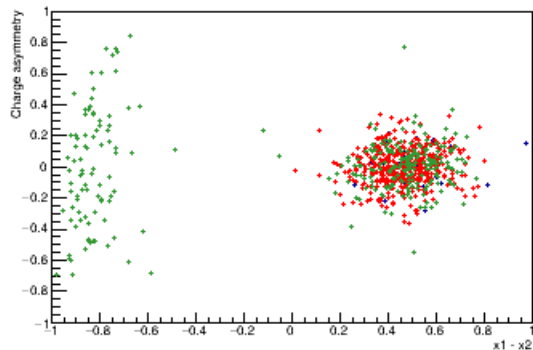
4~5 keV



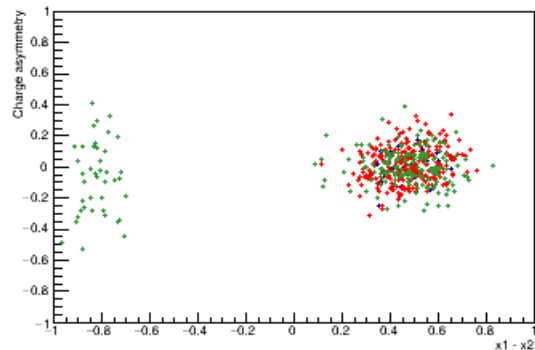
5~6 keV



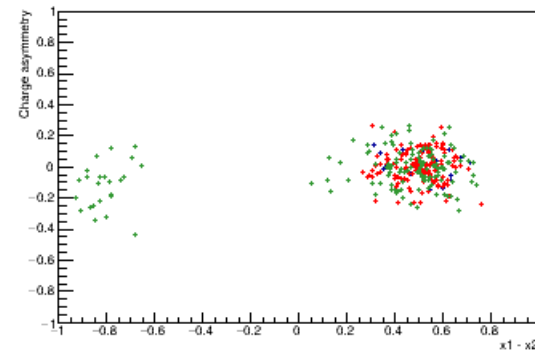
6~7 keV



7~8 keV



8~9 keV



X axis : $\text{pmt1.x1} - \text{pmt1.x2}$

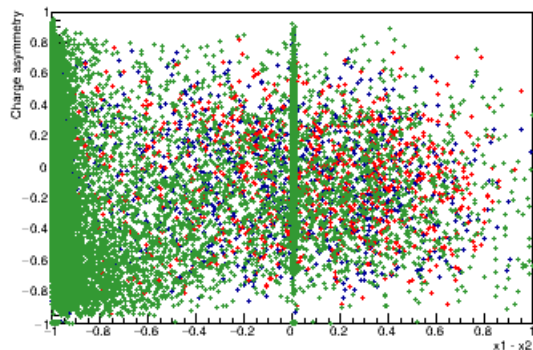
Y axis : PMT charge asymmetry

Green : no cuts applied

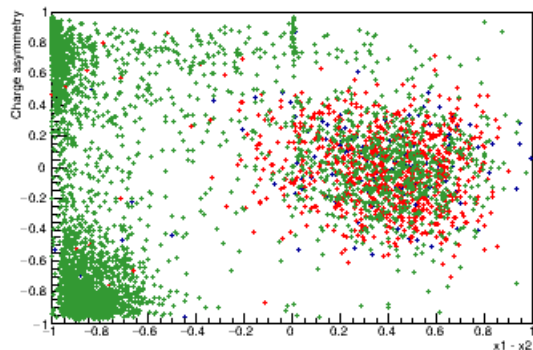
Blue : ND PSD

Red : ND PSD + TOF

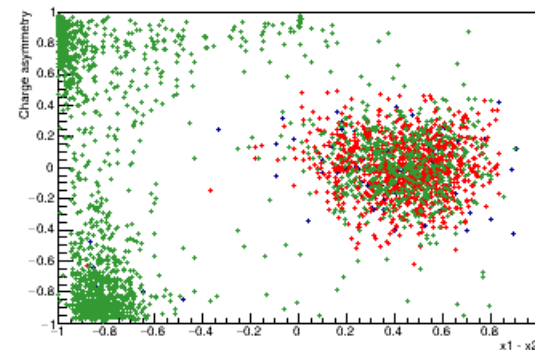
0~1 keV



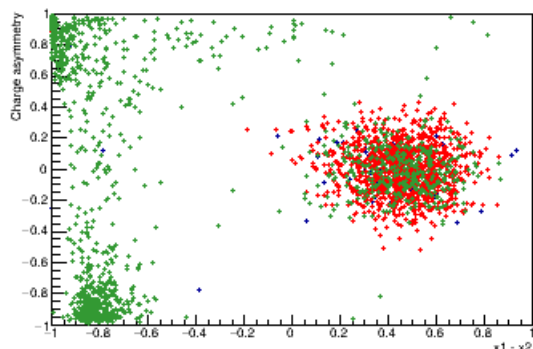
1~2 keV



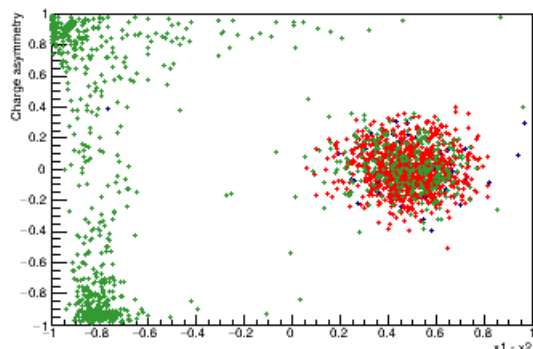
2~3 keV



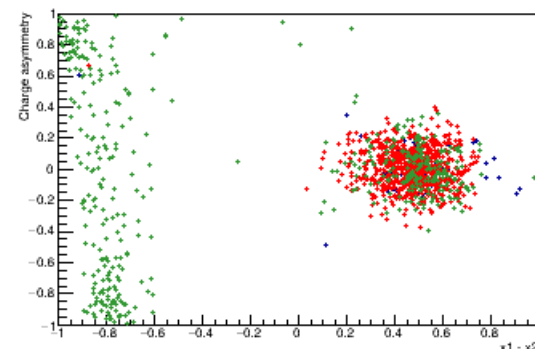
3~4 keV



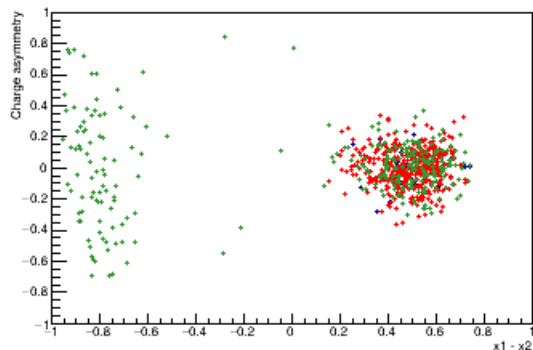
4~5 keV



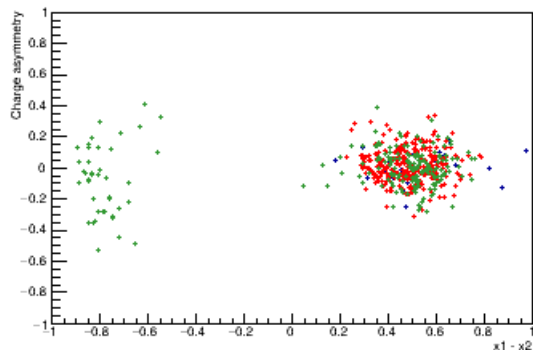
5~6 keV



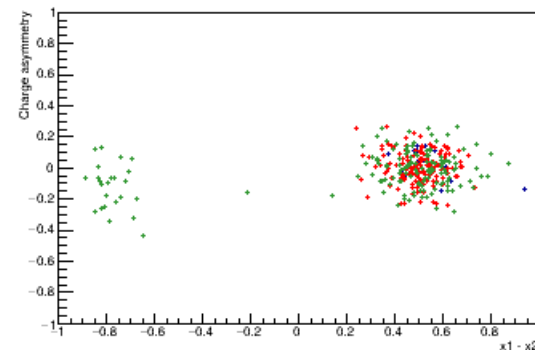
6~7 keV



7~8 keV



8~9 keV



X axis : pmt2.x1 – pmt2.x2

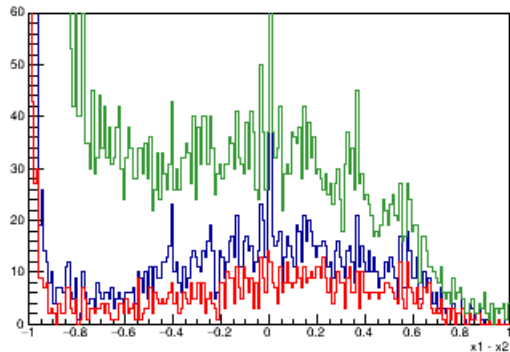
Y axis : PMT charge asymmetry

Green : no cuts applied

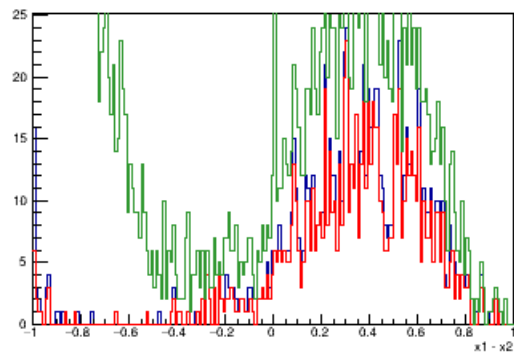
Blue : ND PSD

Red : ND PSD + TOF

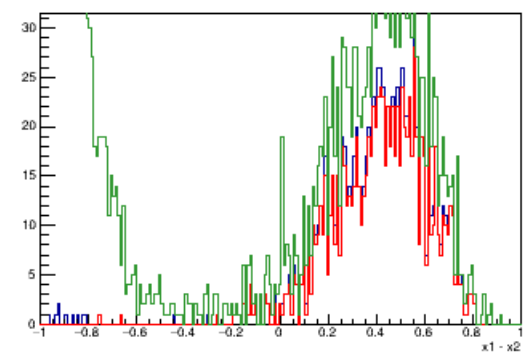
0~1 keV



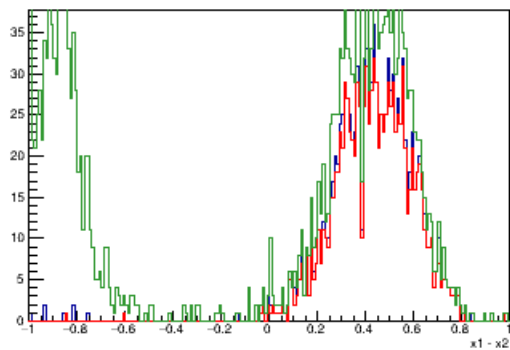
1~2 keV



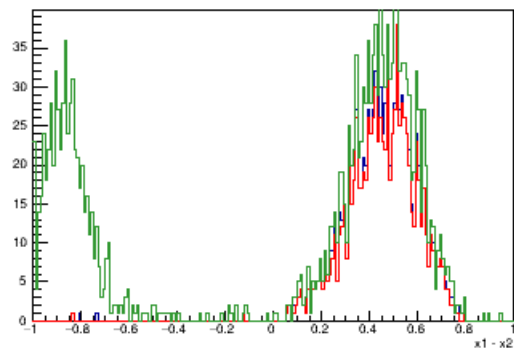
2~3 keV



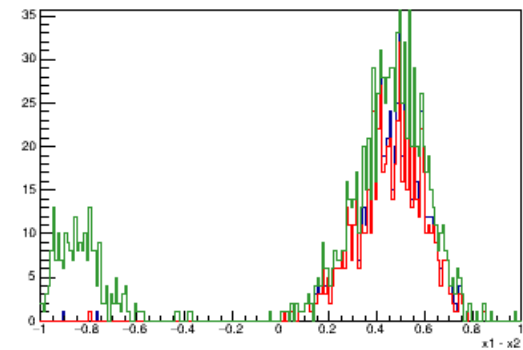
3~4 keV



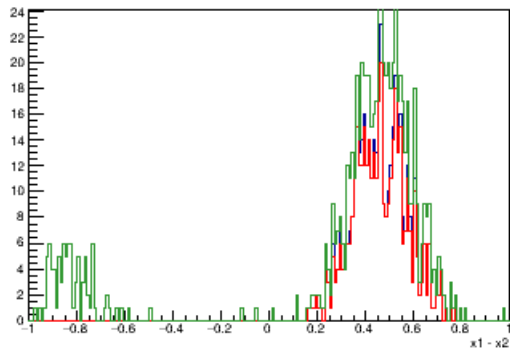
4~5 keV



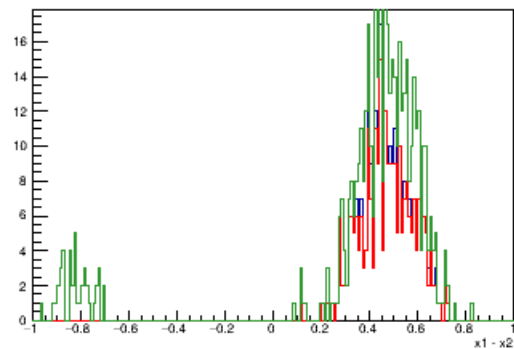
5~6 keV



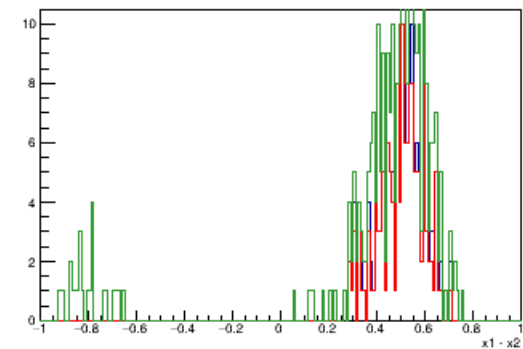
6~7 keV



7~8 keV



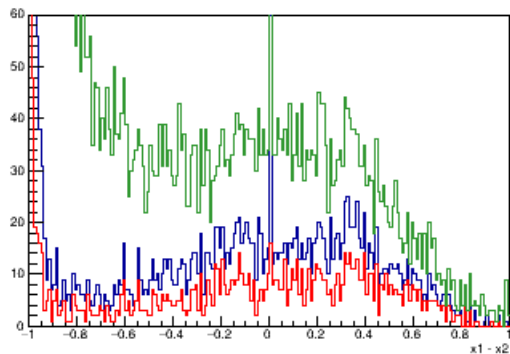
8~9 keV



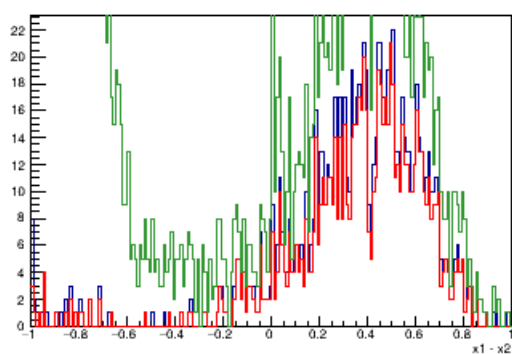
X axis : $\text{pmt1.x1} - \text{pmt1.x2}$

Green : no cuts applied
 Blue : ND PSD
 Red : ND PSD + TOF

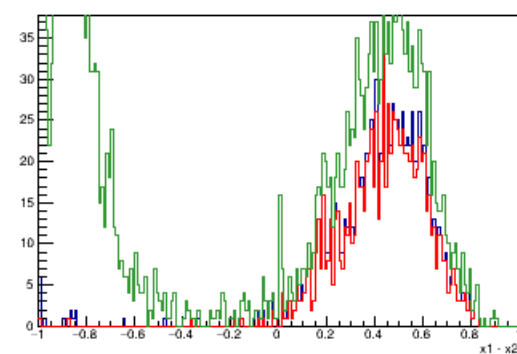
0~1 keV



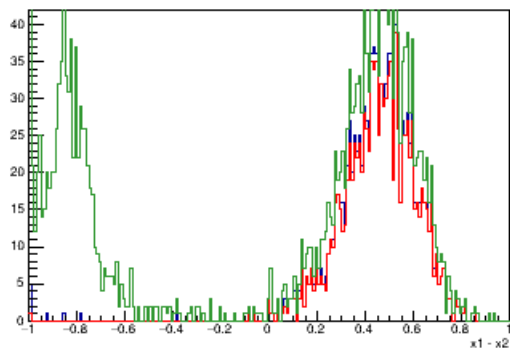
1~2 keV



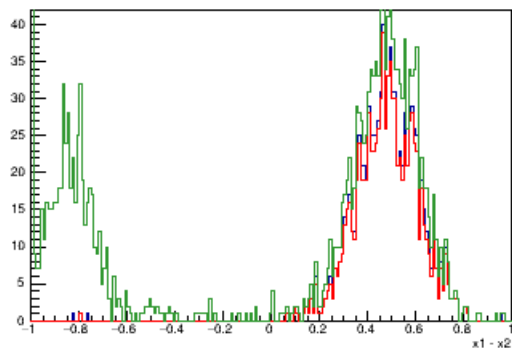
2~3 keV



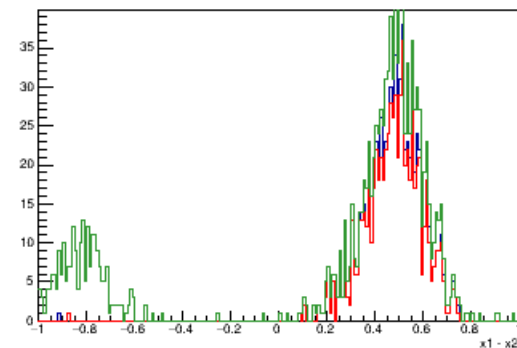
3~4 keV



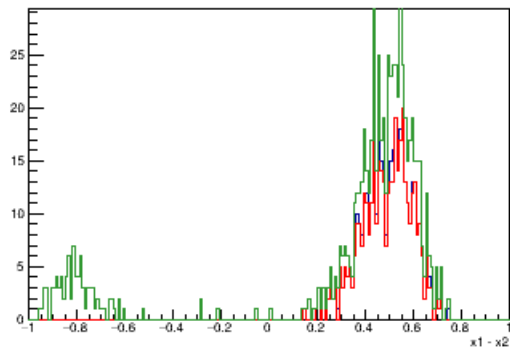
4~5 keV



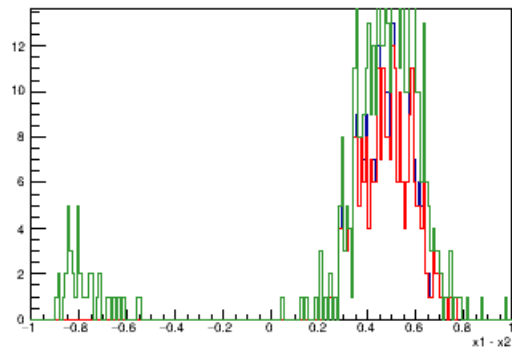
5~6 keV



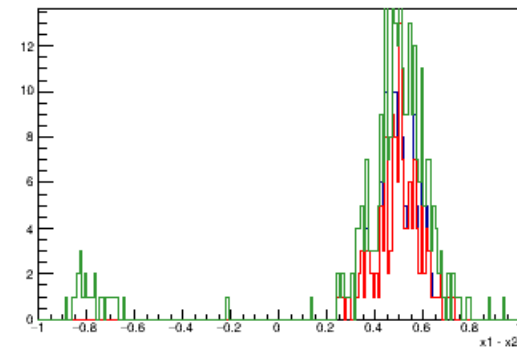
6~7 keV



7~8 keV



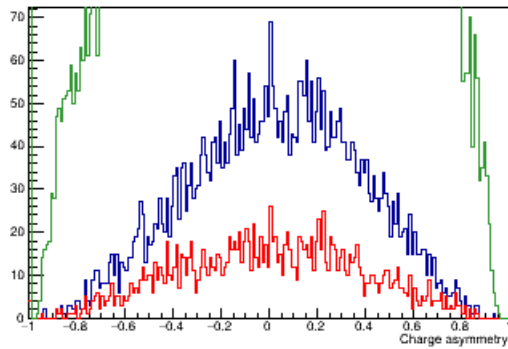
8~9 keV



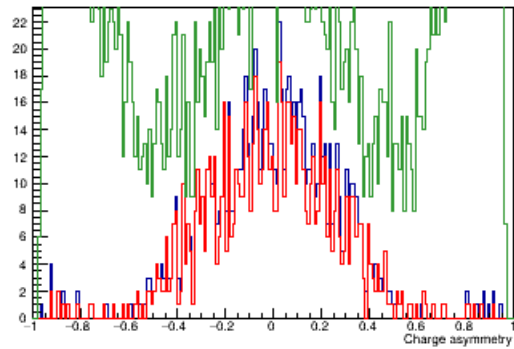
X axis : pmt2.x1 – pmt2.x2

Green : no cuts applied
Blue : ND PSD
Red : ND PSD + TOF

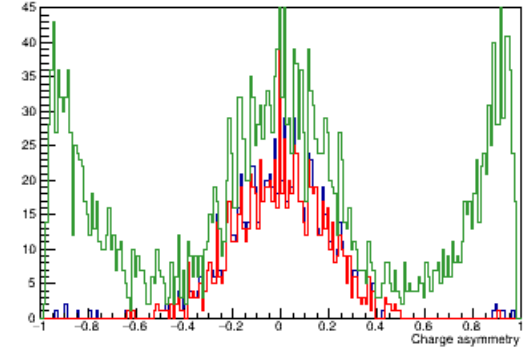
0~1 keV



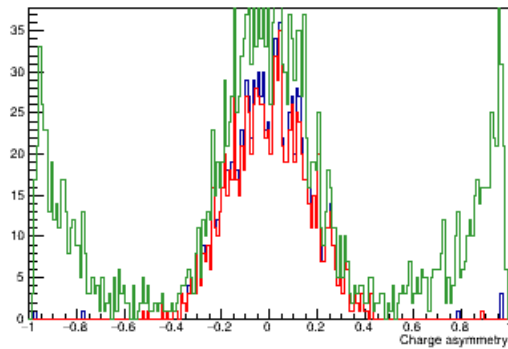
1~2 keV



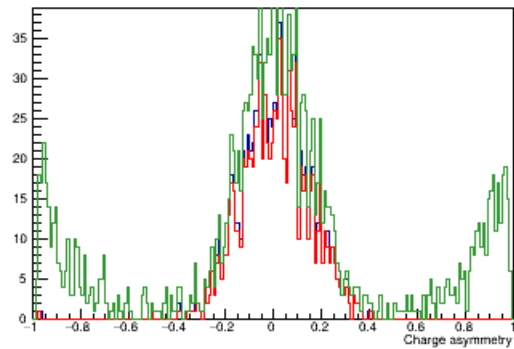
2~3 keV



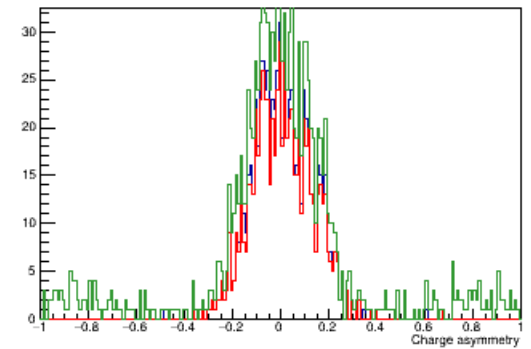
3~4 keV



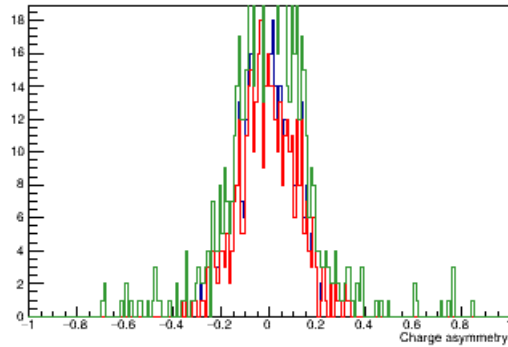
4~5 keV



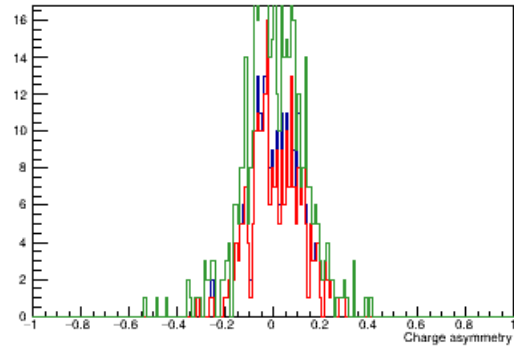
5~6 keV



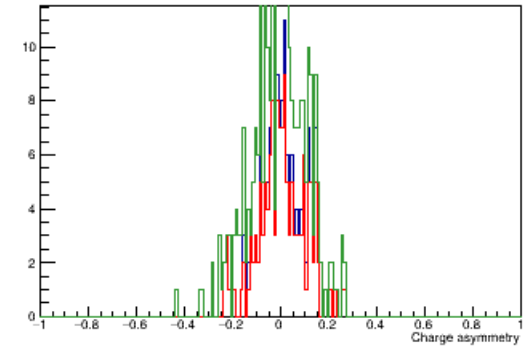
6~7 keV



7~8 keV



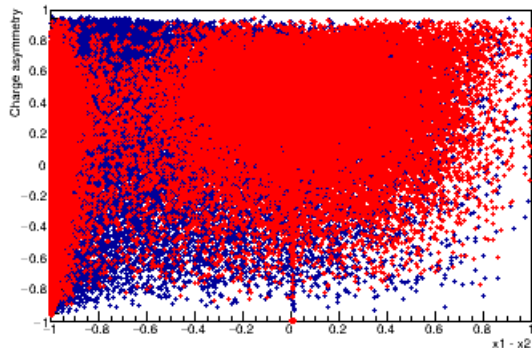
8~9 keV



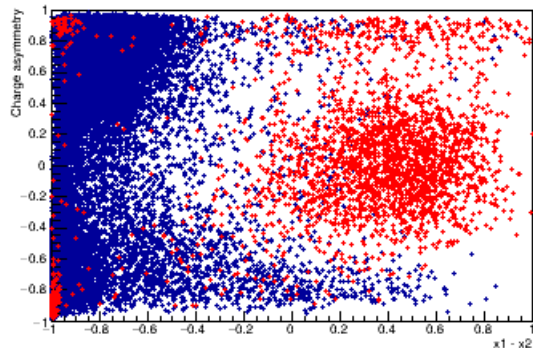
X axis : PMT charge asymmetry

Green : no cuts applied
Blue : ND PSD
Red : ND PSD + TOF

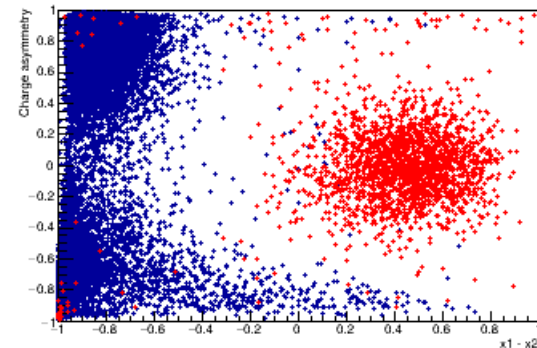
0~1 keV



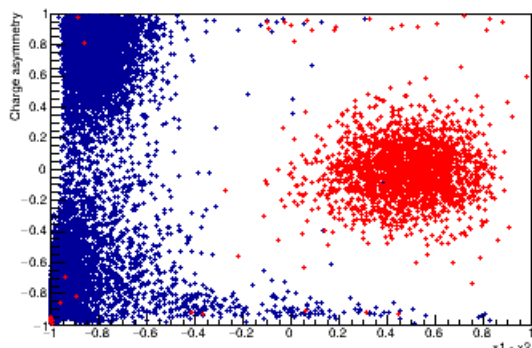
1~2 keV



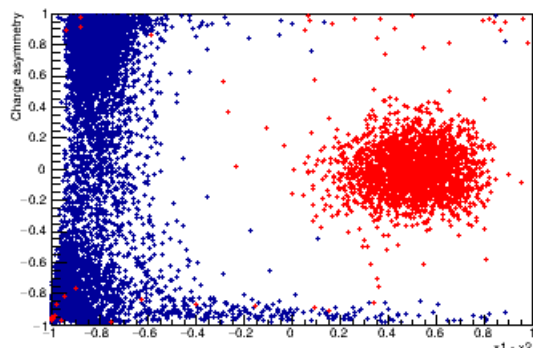
2~3 keV



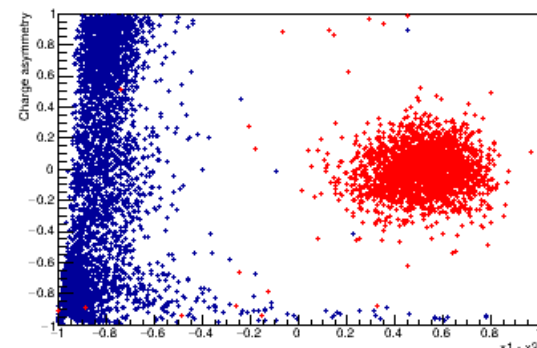
3~4 keV



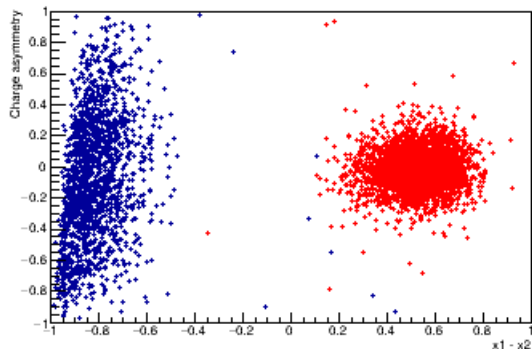
4~5 keV



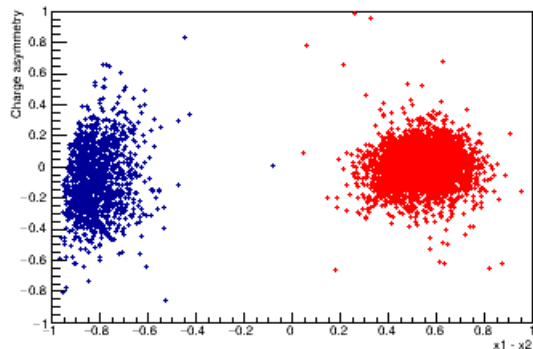
5~6 keV



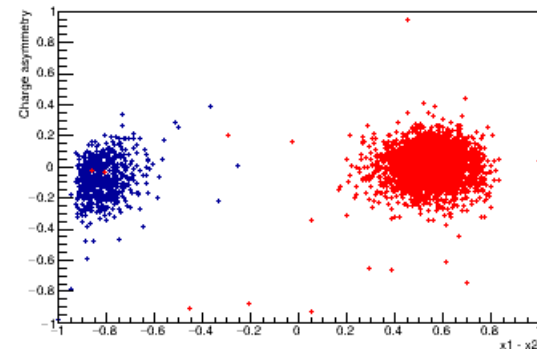
6~7 keV



7~8 keV



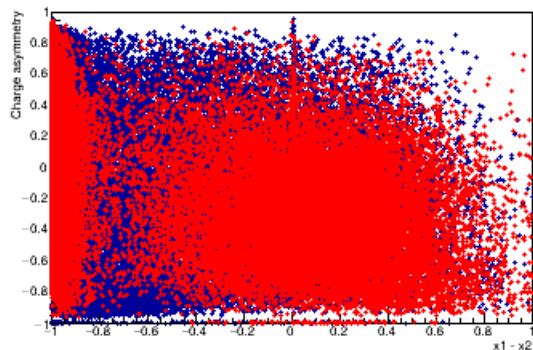
8~9 keV



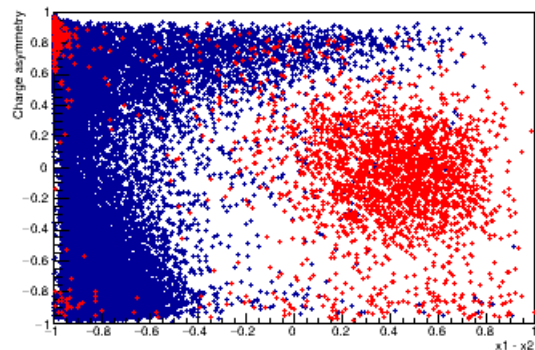
X axis : $\text{pmt2.x1} - \text{pmt2.x2}$
Y axis : PMT charge asymmetry

Blue : noise
Red : signal ($\text{nmt500} > 0.12$)

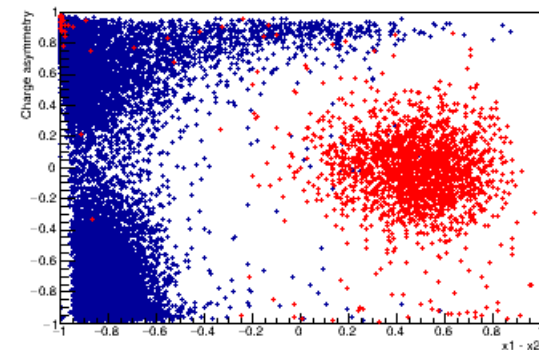
0~1 keV



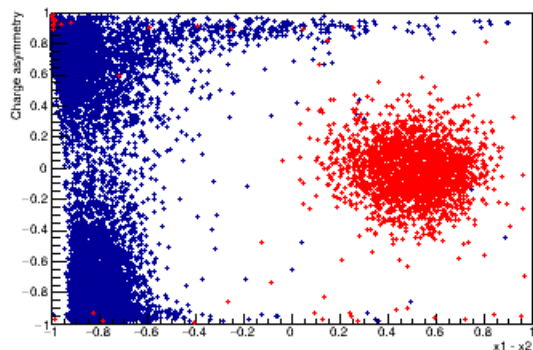
1~2 keV



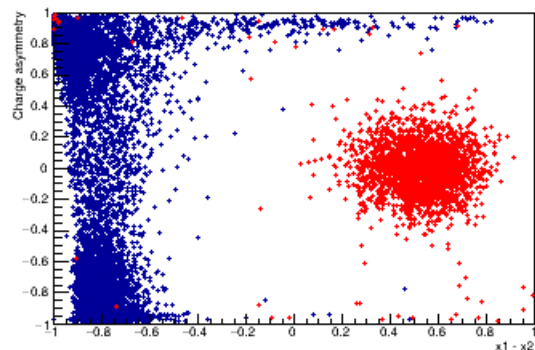
2~3 keV



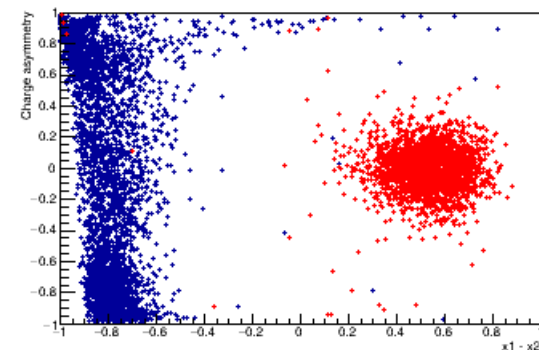
3~4 keV



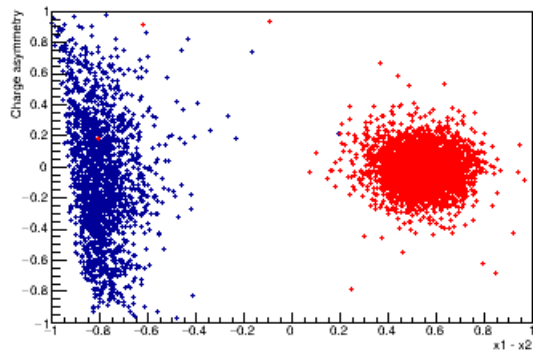
4~5 keV



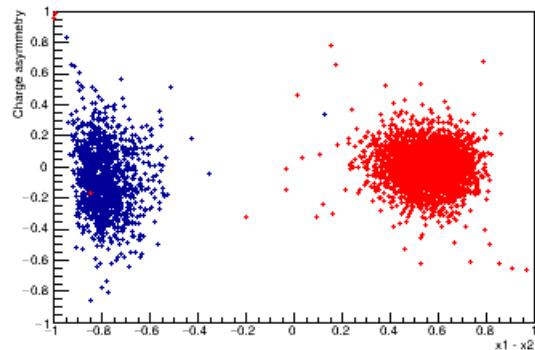
5~6 keV



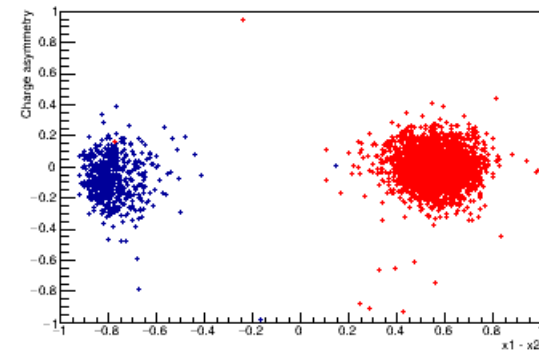
6~7 keV



7~8 keV



8~9 keV

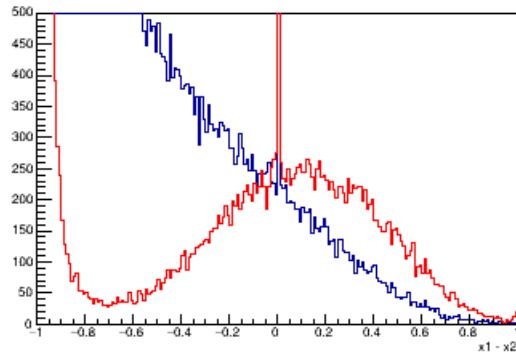


X axis : pmt1.x1 – pmt1.x2

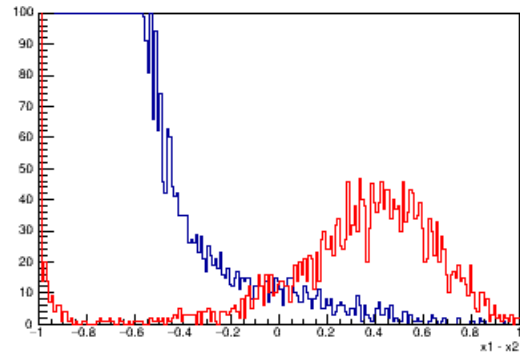
Y axis : PMT charge asymmetry

Blue : noise
Red : signal (nmt500>0.12)

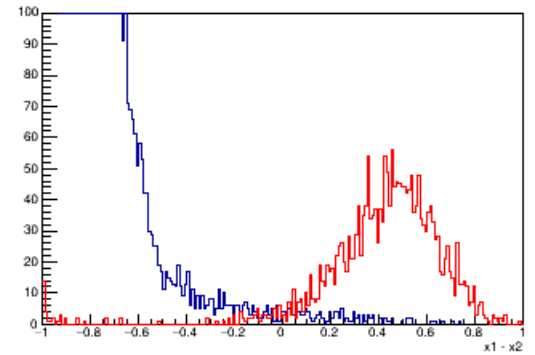
0~1 keV



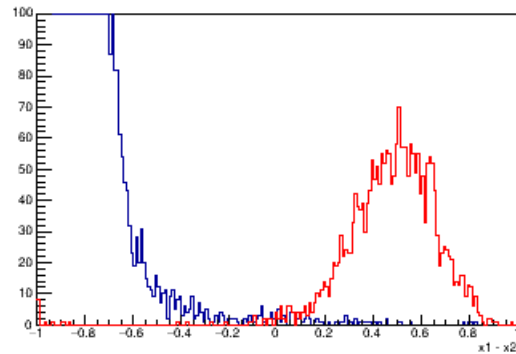
1~2 keV



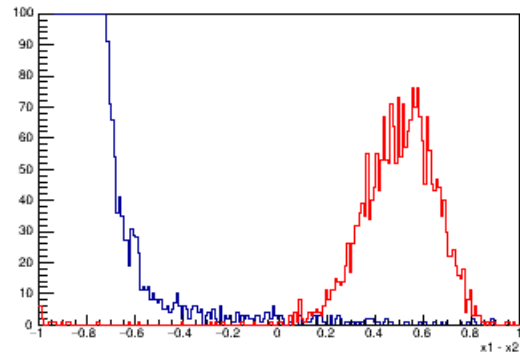
2~3 keV



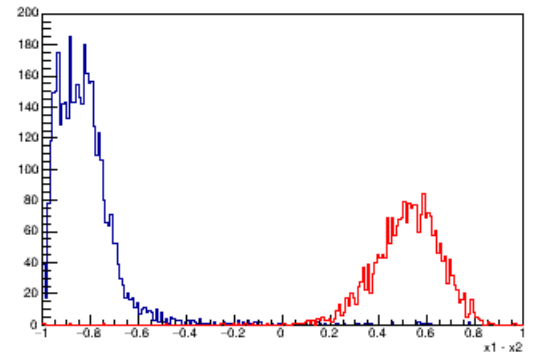
3~4 keV



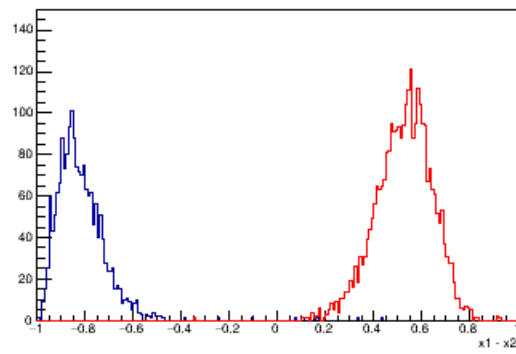
4~5 keV



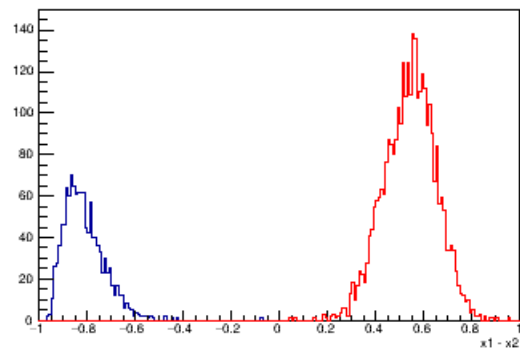
5~6 keV



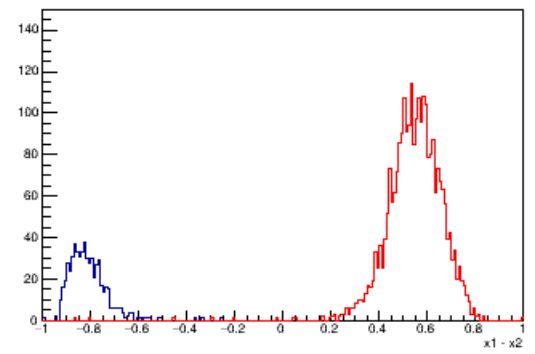
6~7 keV



7~8 keV



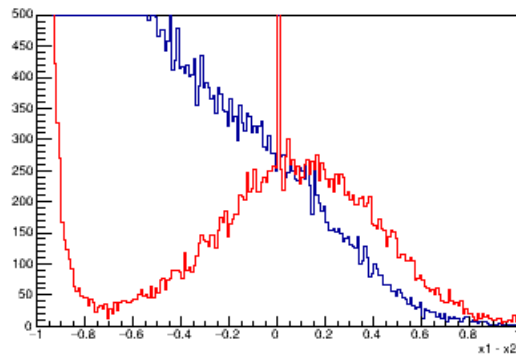
8~9 keV



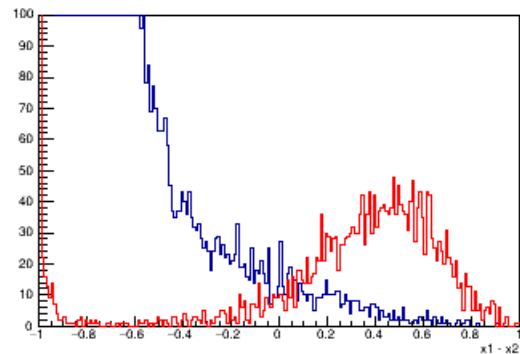
X axis : pmt1.x1 – pmt1.x2

Blue : noise
Red : signal (nmt500>0.12)

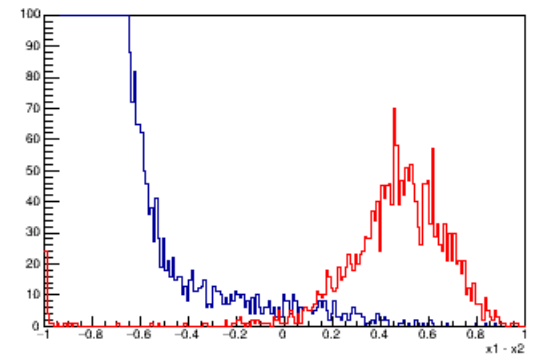
0~1 keV



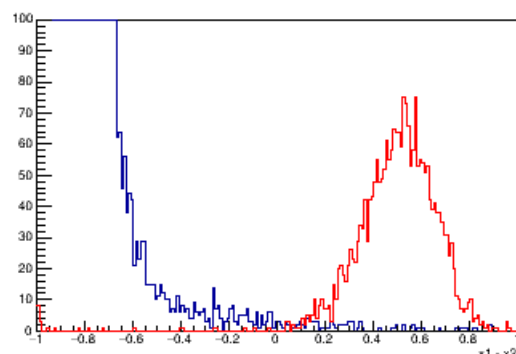
1~2 keV



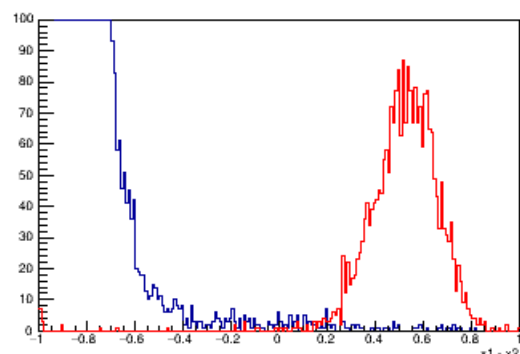
2~3 keV



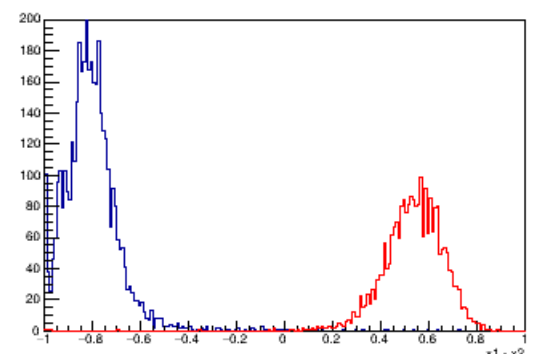
3~4 keV



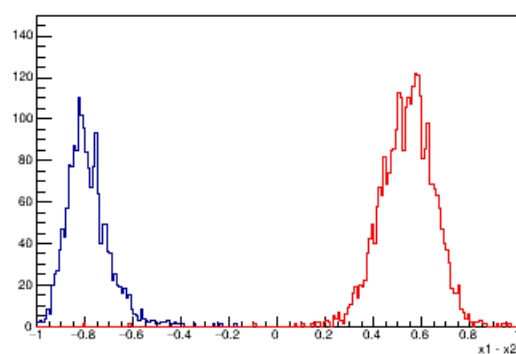
4~5 keV



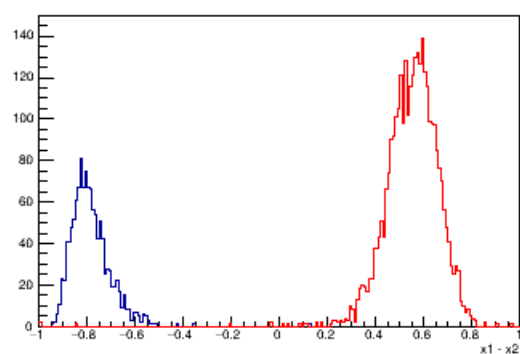
5~6 keV



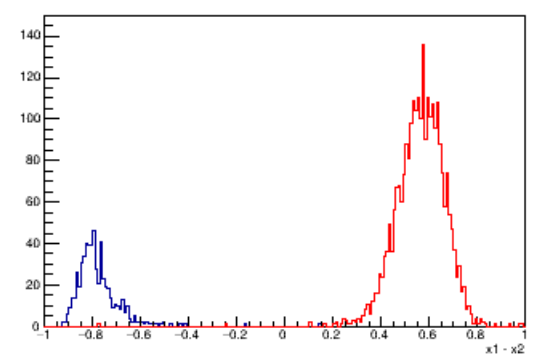
6~7 keV



7~8 keV



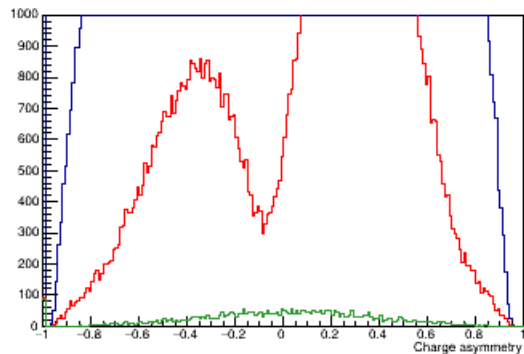
8~9 keV



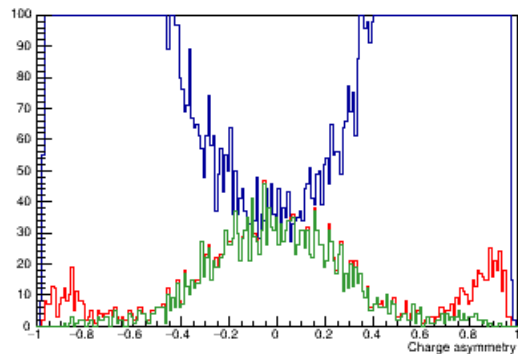
X axis : $\text{pmt2.x1} - \text{pmt2.x2}$

Blue : noise
Red : signal ($\text{nmt500} > 0.12$)

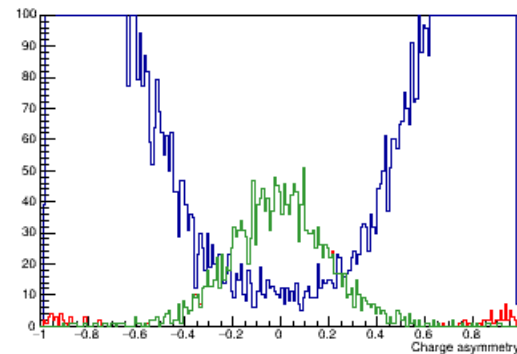
0~1 keV



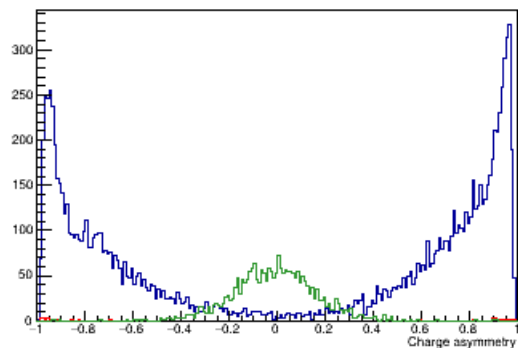
1~2 keV



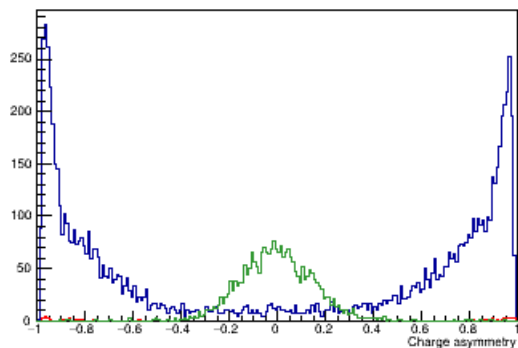
2~3 keV



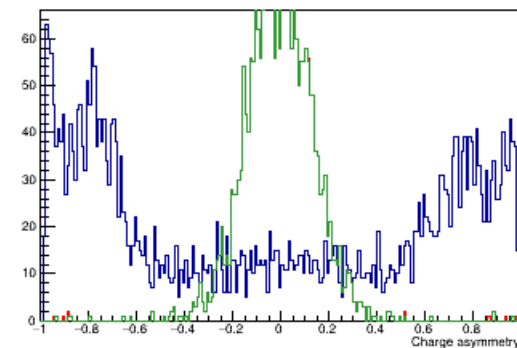
3~4 keV



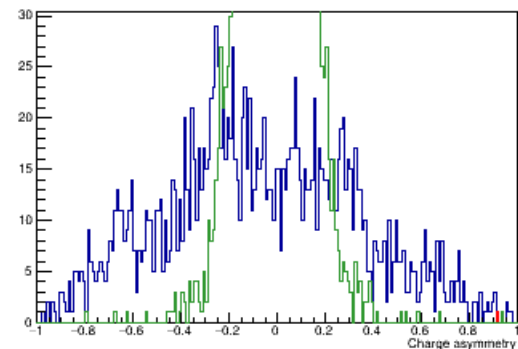
4~5 keV



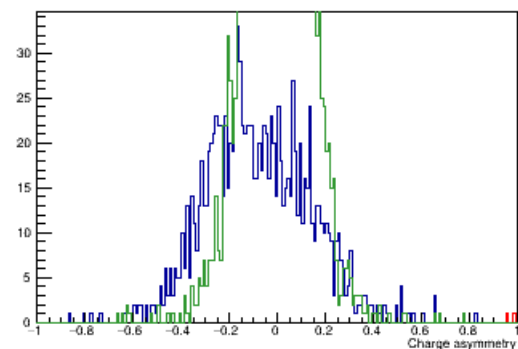
5~6 keV



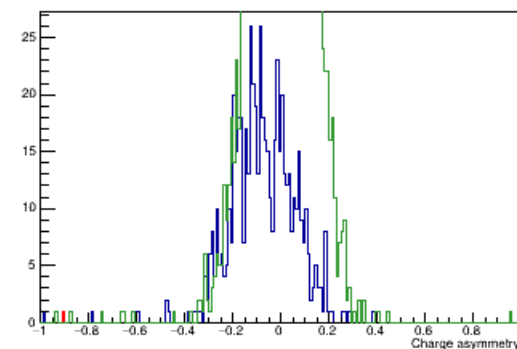
6~7 keV



7~8 keV



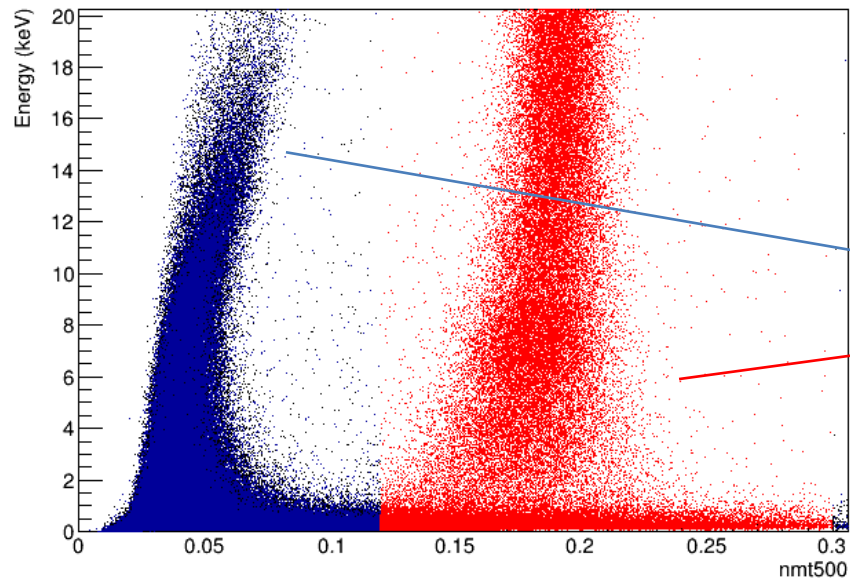
8~9 keV



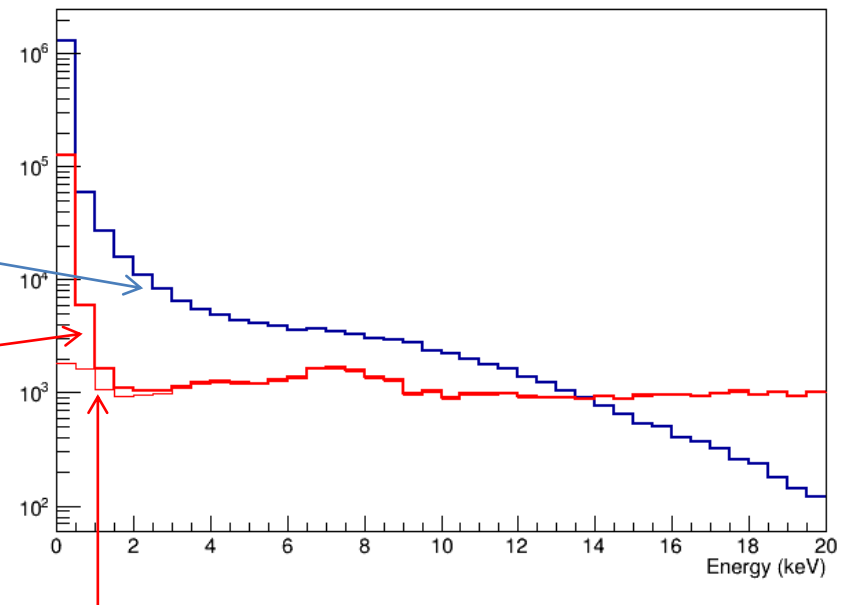
X axis : PMT charge asymmetry

Blue : noise
Red : signal (nmt500>0.12)
Green : signal + box cut¹⁶

Event selection for electron recoil events (Cs137 source, ~15 Hz)



nmt500 > 0.12 : signal



Applied box cut
(asymmetry : -0.5~0.5
x1 - x2 : -0.4~1)

NaI deposit energy vs mean time

