Development of High Purity Germanium Detector Techniques for Applications in Fundamental Research @ Universitaet Tuebingen

Pulse Shape Analysis for CDEX-1

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CDEX Collaboration

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Outline

- Experiment Configuration (brief)
- Data Analysis

a. Pulse Parameterize & Optimize

b. Data Check

c. Energy Calibration

d. Cuts

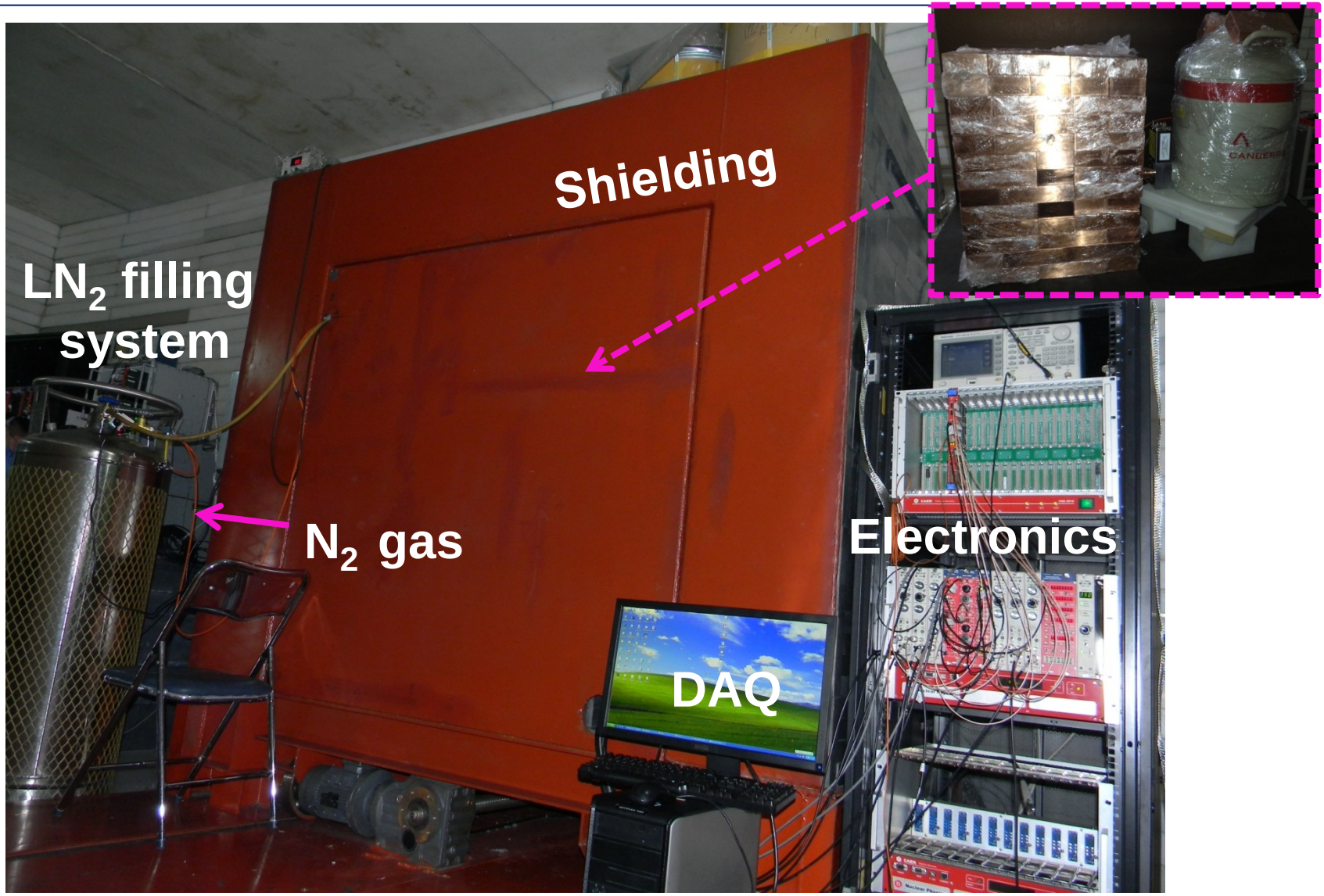
e. Correction Calculation

f. Spectrum Process

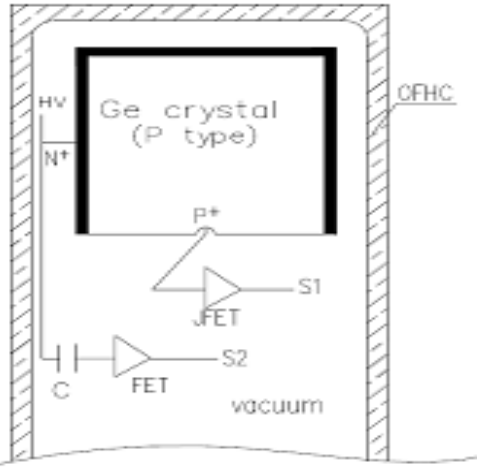
g. Predicted Physics Result (Exclusion Plot)

- Summary

Experiment Configuration



Schematic Diagram



Random Trigger

Signal Gen. — 0.05cps — Disc. — 255 — Logic OR — ~ 6cps — Trig. — FADC (100M)

1kg-PCGe
Inhibit — Disc. — 255 — Gate Gen. — 1ms — veto
Disc. — 24 — Gate Gen. — 200μs — Logic OR

S1_E1	Shaping AMP	6us_x250	ch0
S1_E2	Shaping AMP	12us_x250	ch1
S1_E3	Timing AMP	Out_10ns_x200	ch2
S2_E1	Shaping AMP	2us_x2.5	ch3
S2_E2	Shaping AMP	2us_x10	ch4
S2_E3	Shaping AMP	2us_x25	ch5
			ch6
			ch7

FADC (100M) V1724

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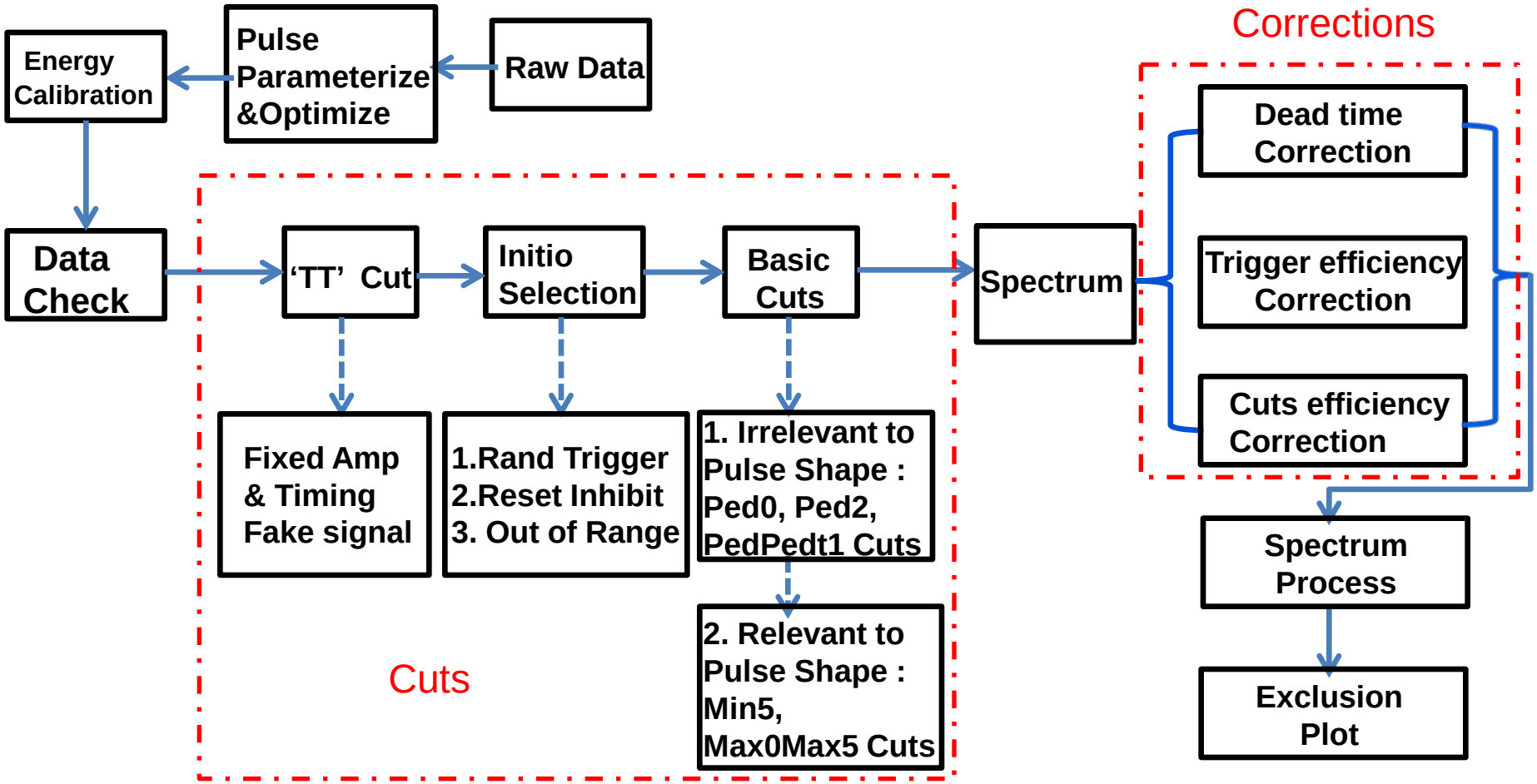
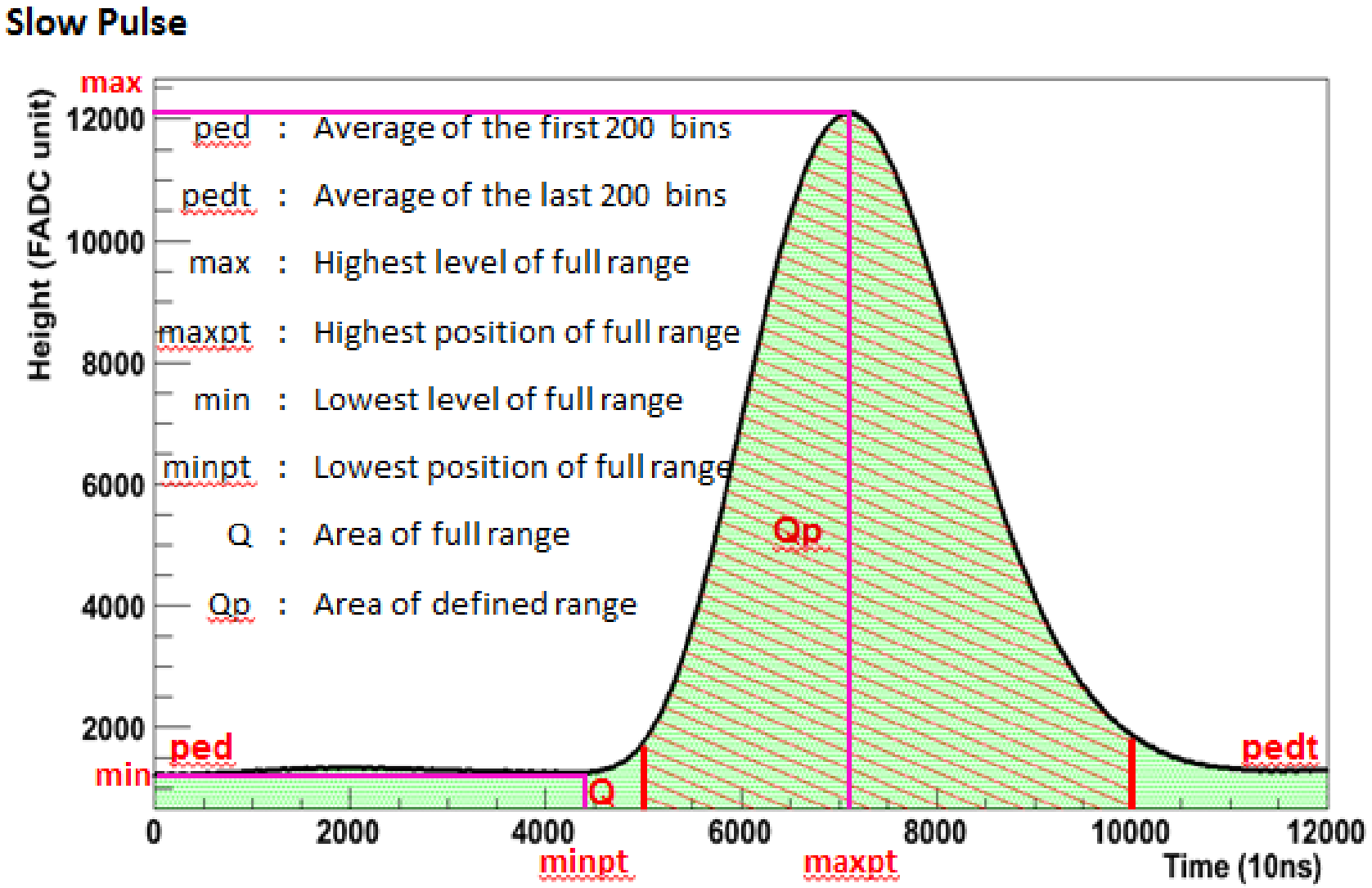
Data Analysis

Process:



Data Analysis: Pulse Parameterize & Optimize



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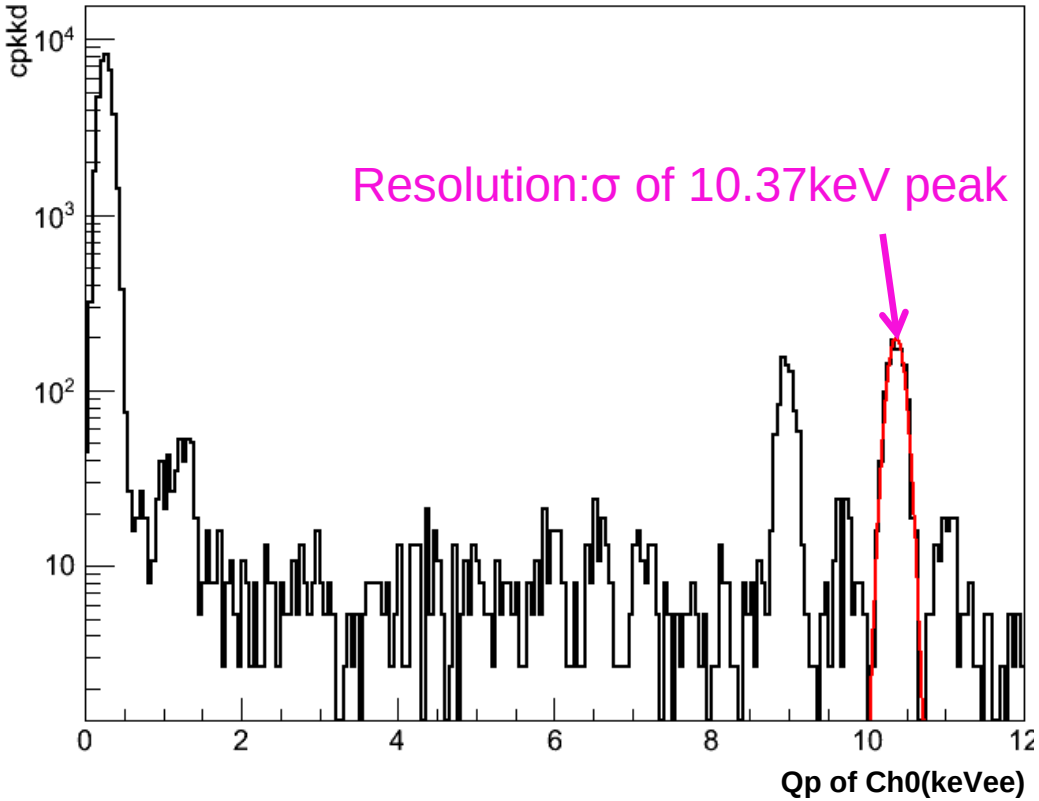
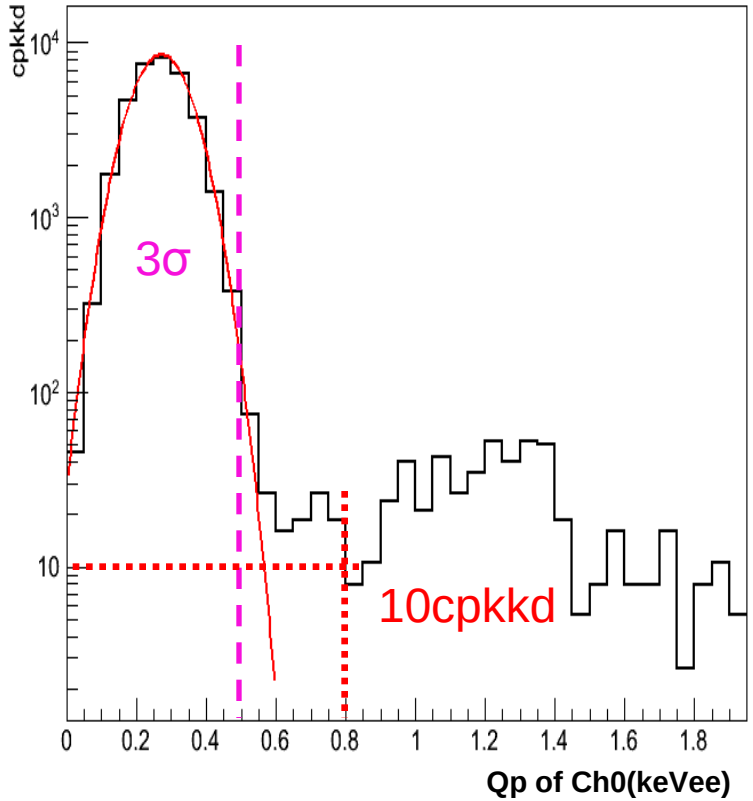
Data Analysis: Pulse Parameterize & Optimize

Three parameters were defined to select the range of Qp:

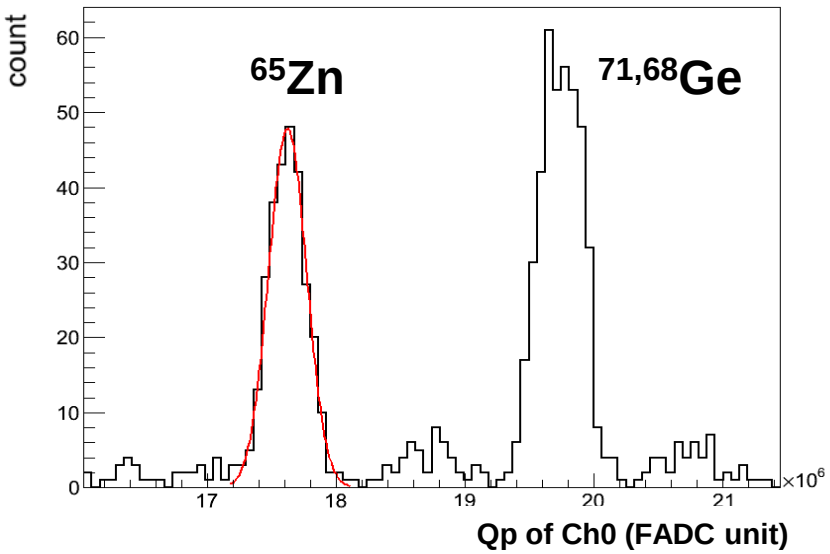


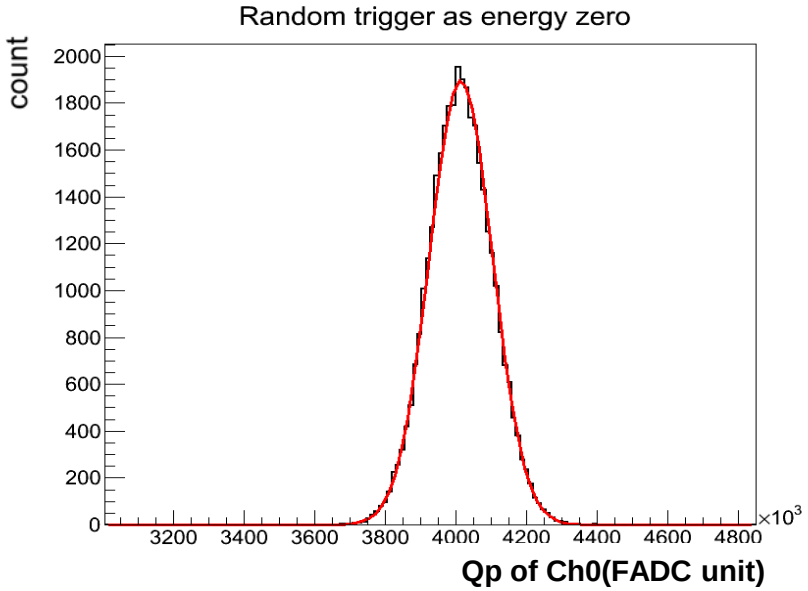


30μs window for Ch0 (ST=6μs); 40μs window for Ch1 (ST=12μs).

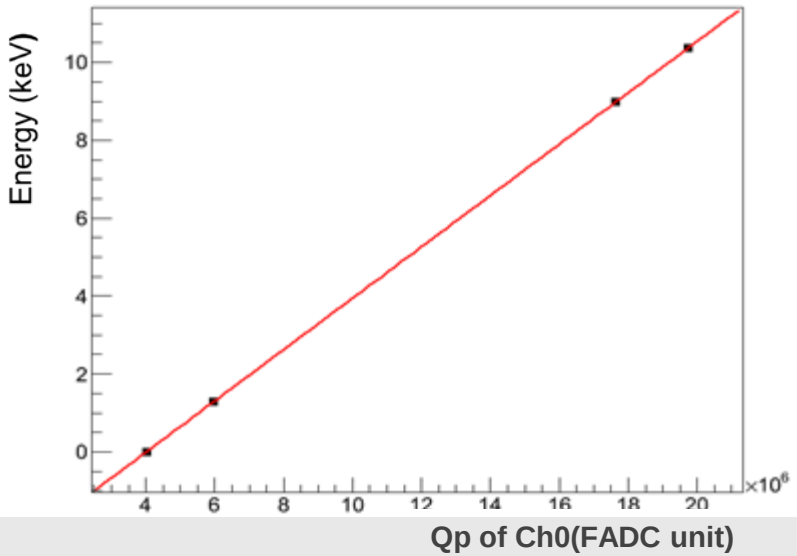
Data Analysis : Energy Calibration

Internal isotopes: x-ray peaks





X-ray	energy/keV
RT	0
$^{68, 71}$Ge	1.2977(LX)
^{65}Zn	8.98(KX)
$^{68, 71}$Ge	10.37(KX)



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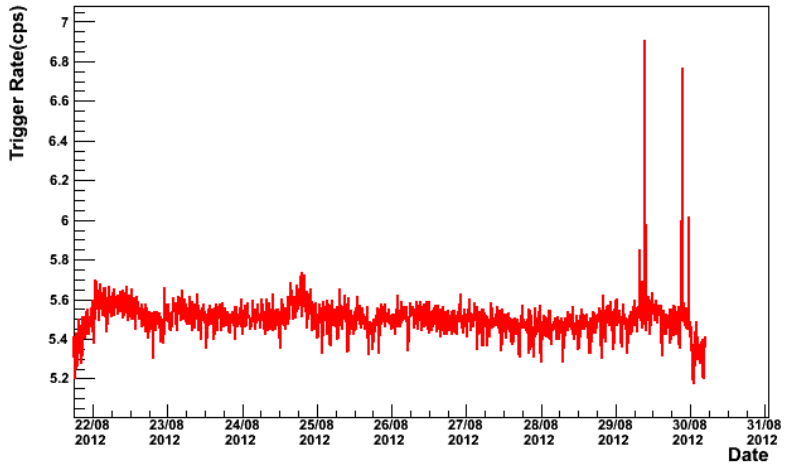
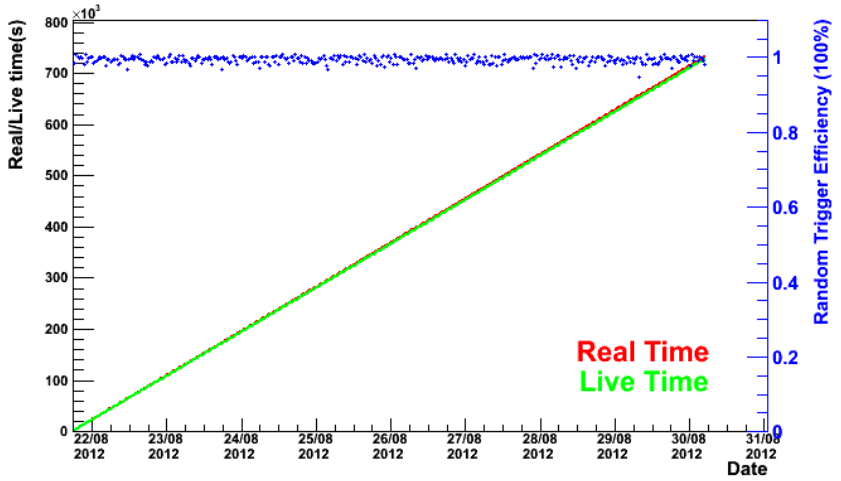
Data Analysis: Data Check

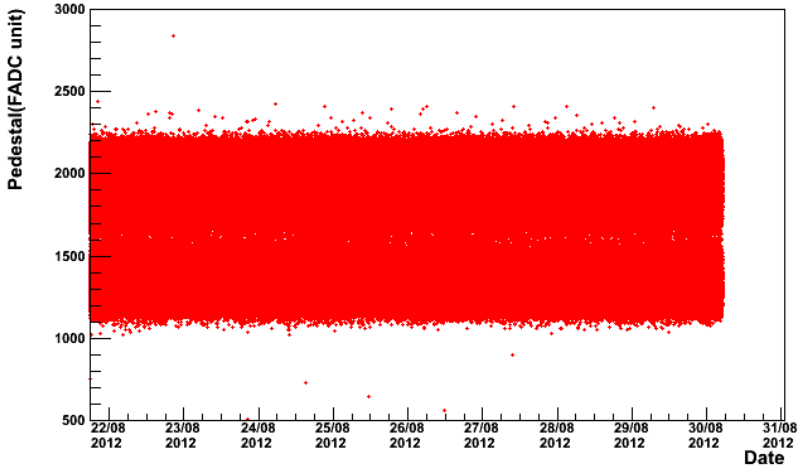
Trigger Rate per quarter run



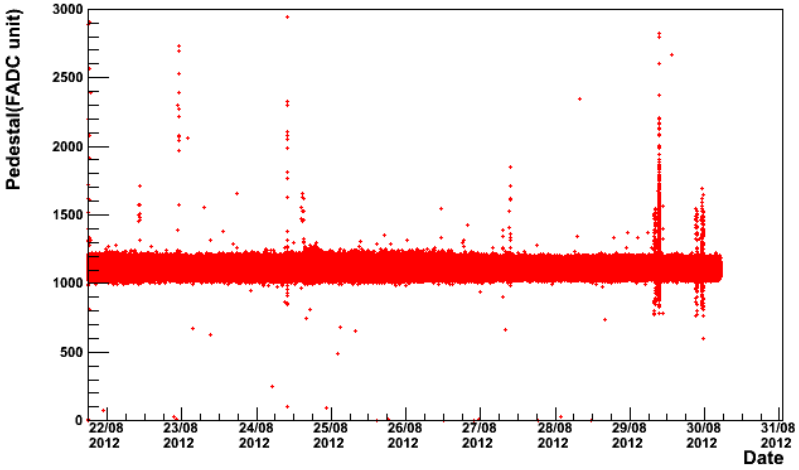
Real/Live time per run



Ped of Ch0 S1



Ped of Ch5 S2



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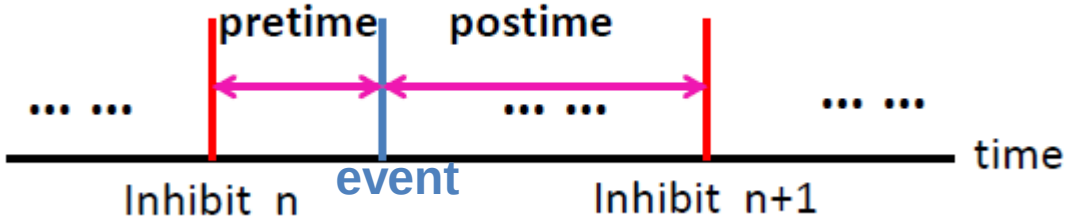
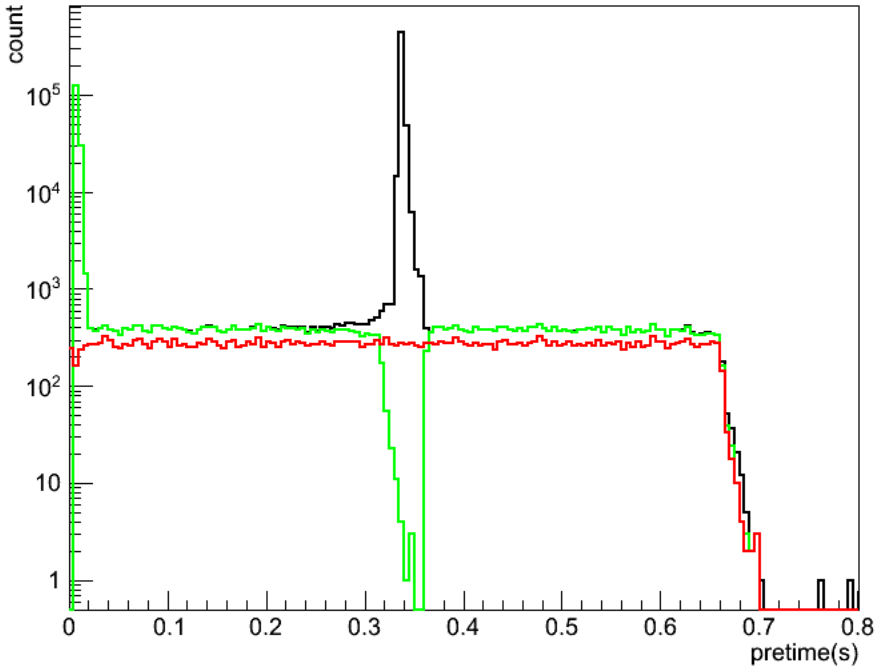
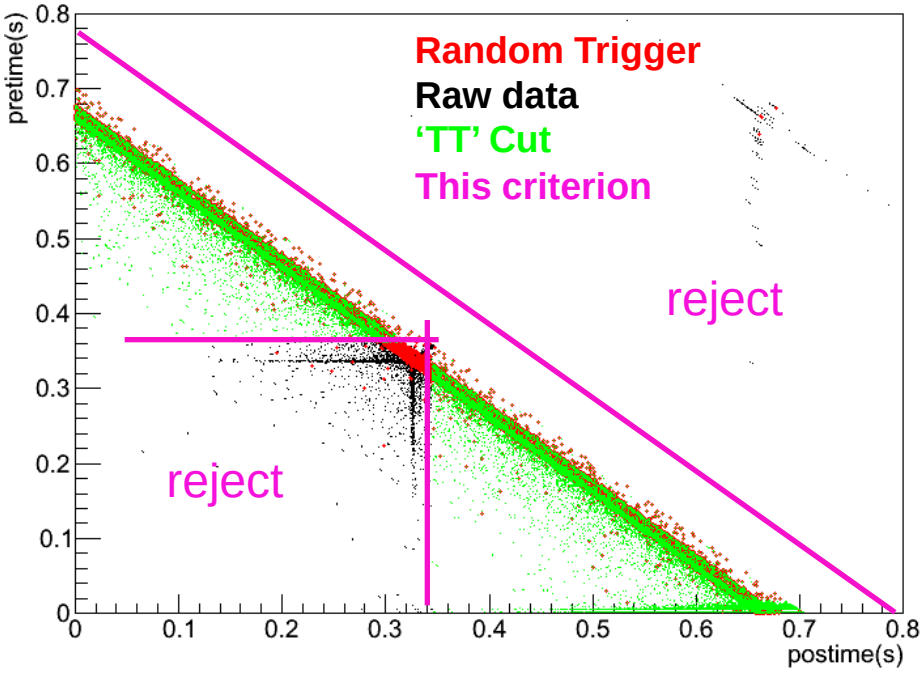
Data Analysis: Cuts

'TT' Cut | Initio Selection | Basic_1 Cuts | Basic_2 Cuts







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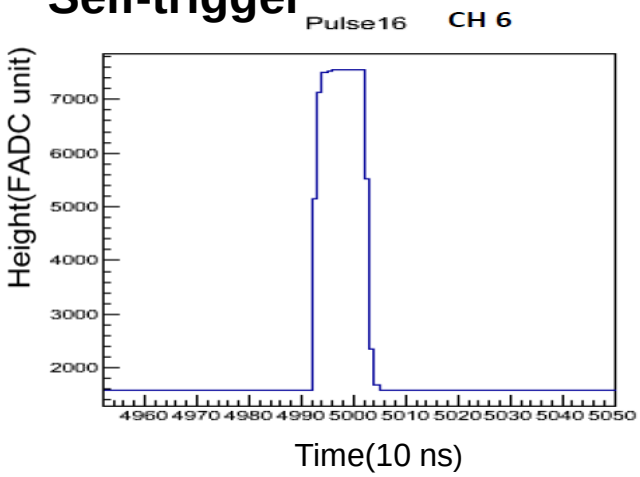
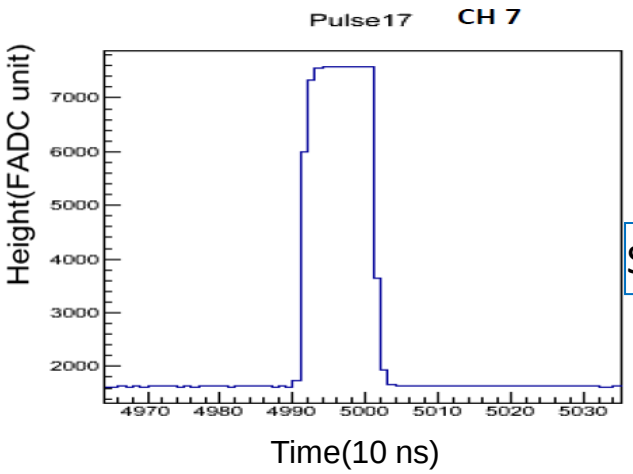
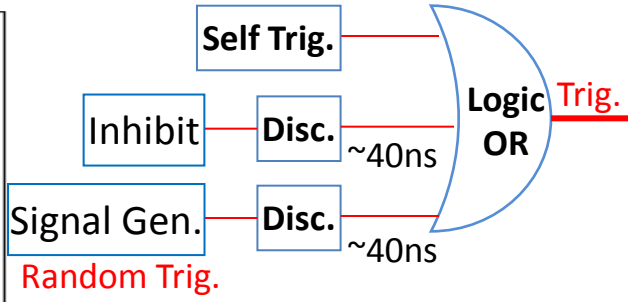
Data Analysis: Cuts

'TT' Cut → **Initio Selection** → Basic_1 Cuts → Basic_2 Cuts

Self-trigger

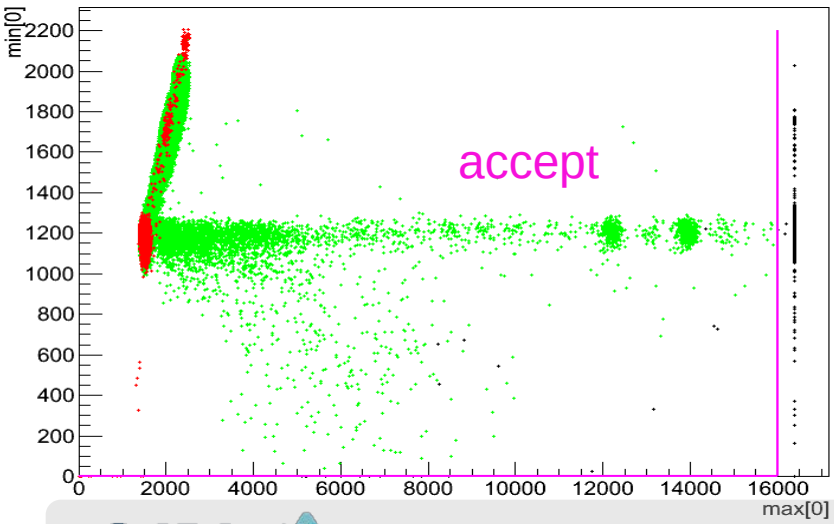


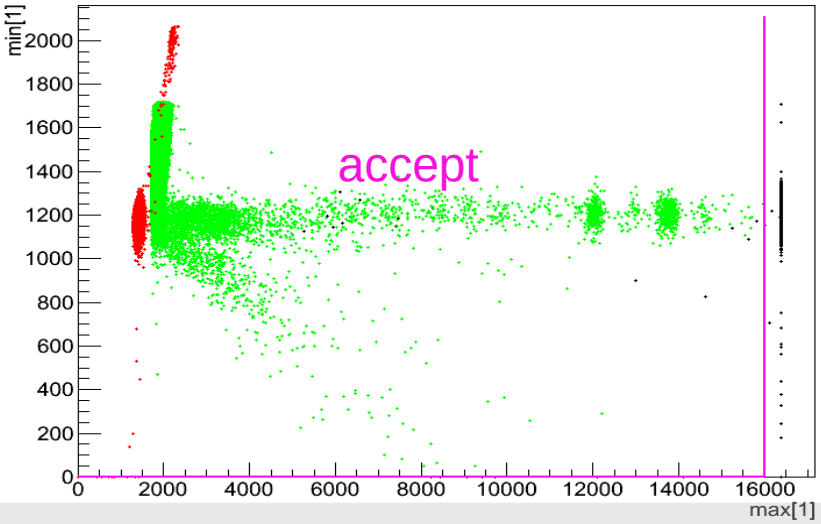




Random Trigger
'TT' cut
+ Initio Selections
This criterion

In Range





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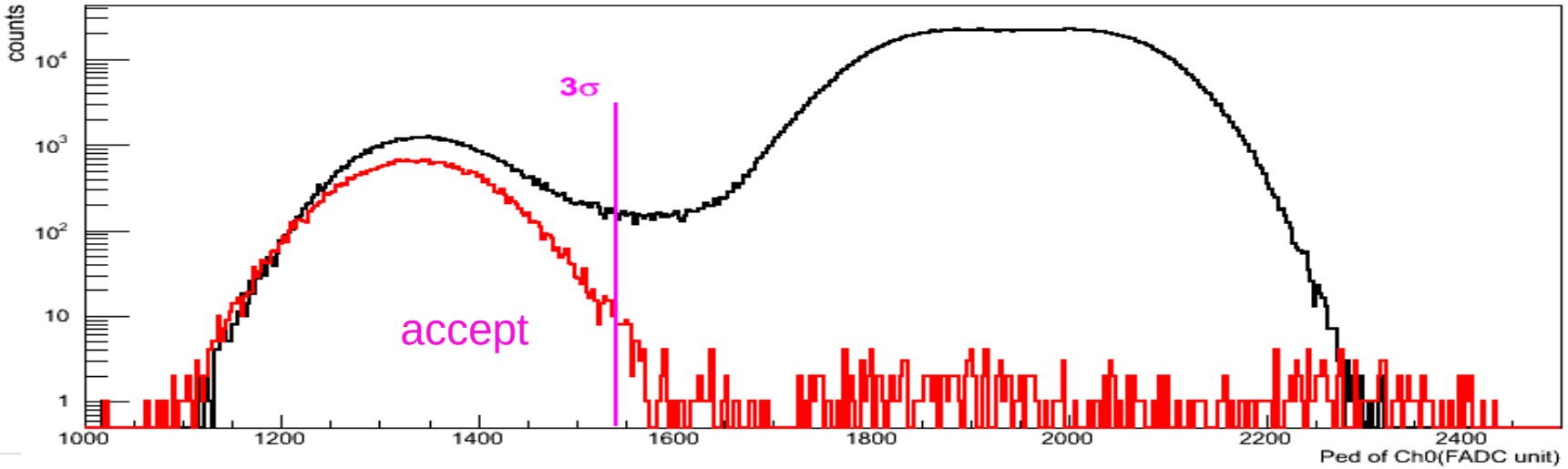
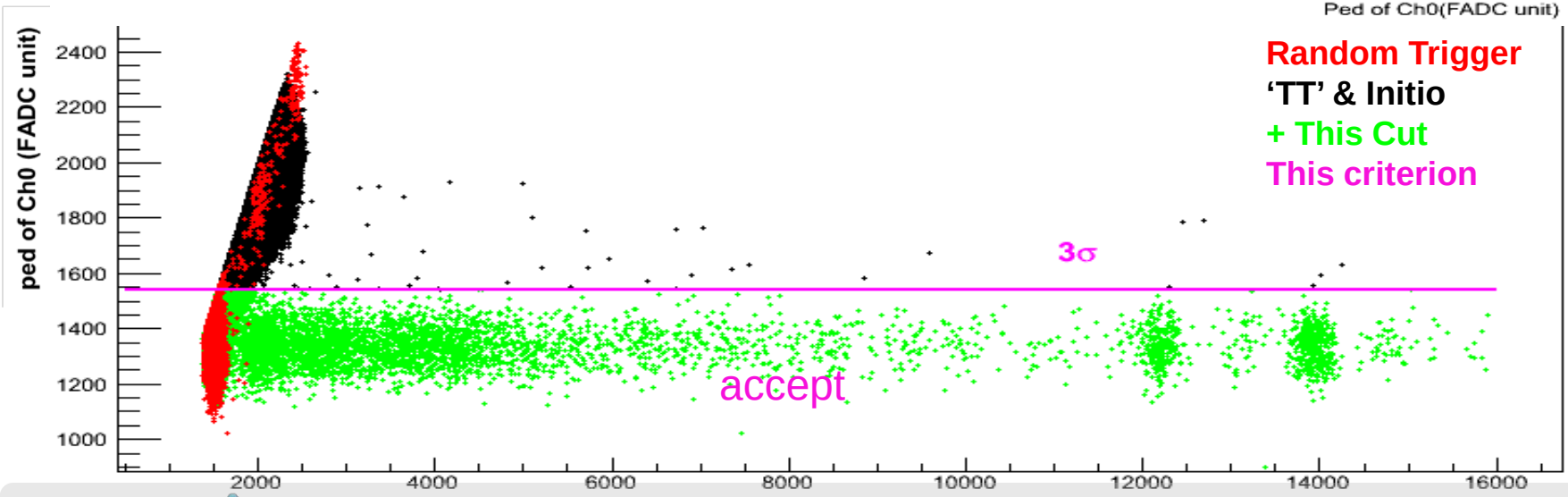
Data Analysis: Cuts

TT Cut — Initio Selection — **Basic_1 Cuts** — Basic_2 Cuts

Ped0: Pedestal cut of Ch0





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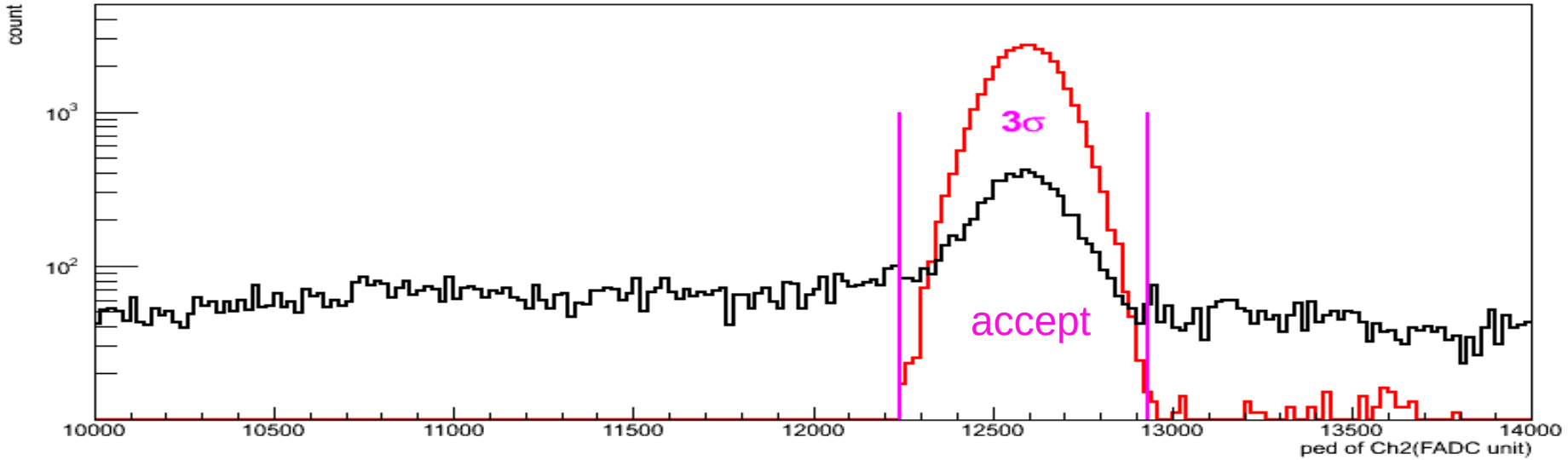
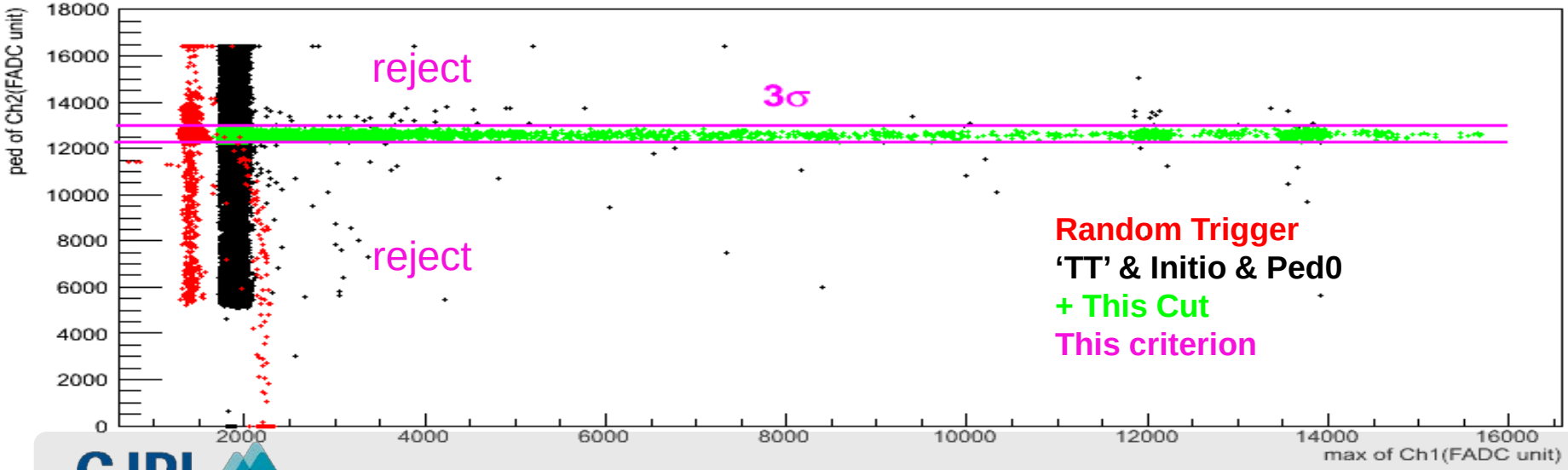
Data Analysis: Cuts

'TT' Cut | Initio Selection | **Basic_1 Cuts** | Basic_2 Cuts

Ped2: Pedestal cut of Ch2





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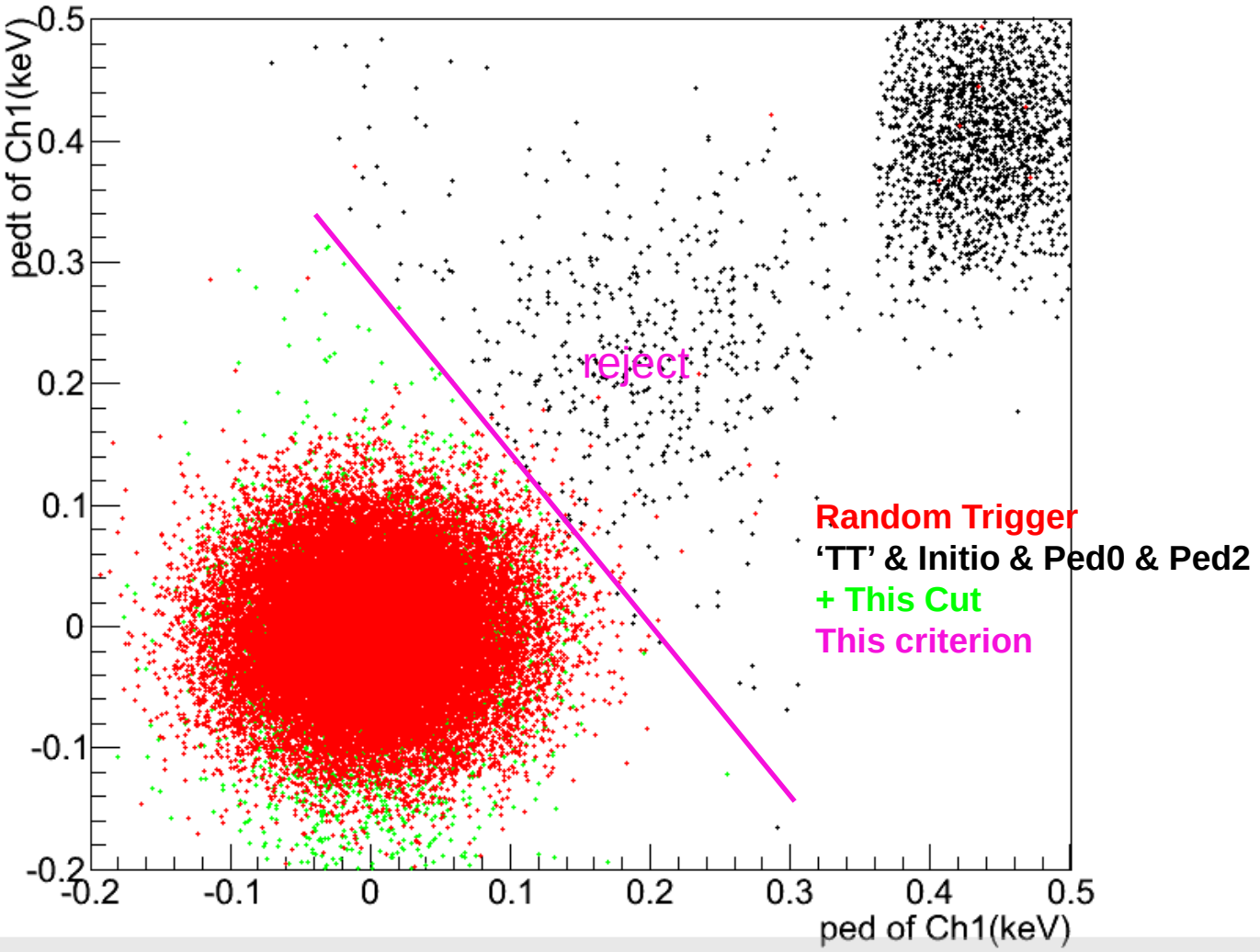
Data Analysis: Cuts

TT Cut → Initio Selection → **Basic_1 Cuts** → Basic_2 Cuts

PedPedt1：pedestal vs pedestal tail cut of Ch1



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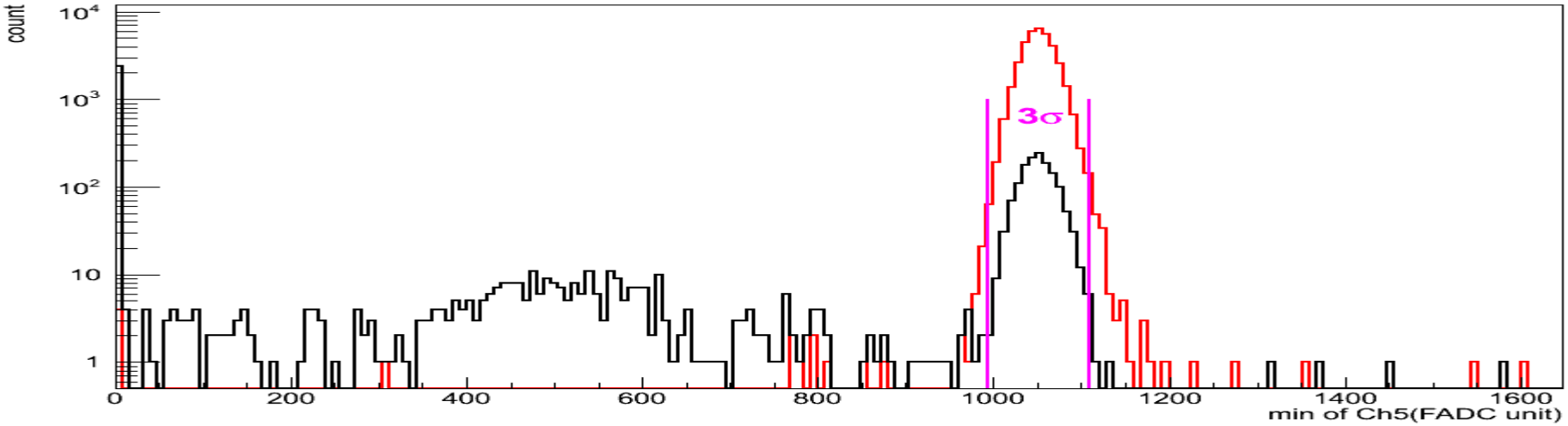
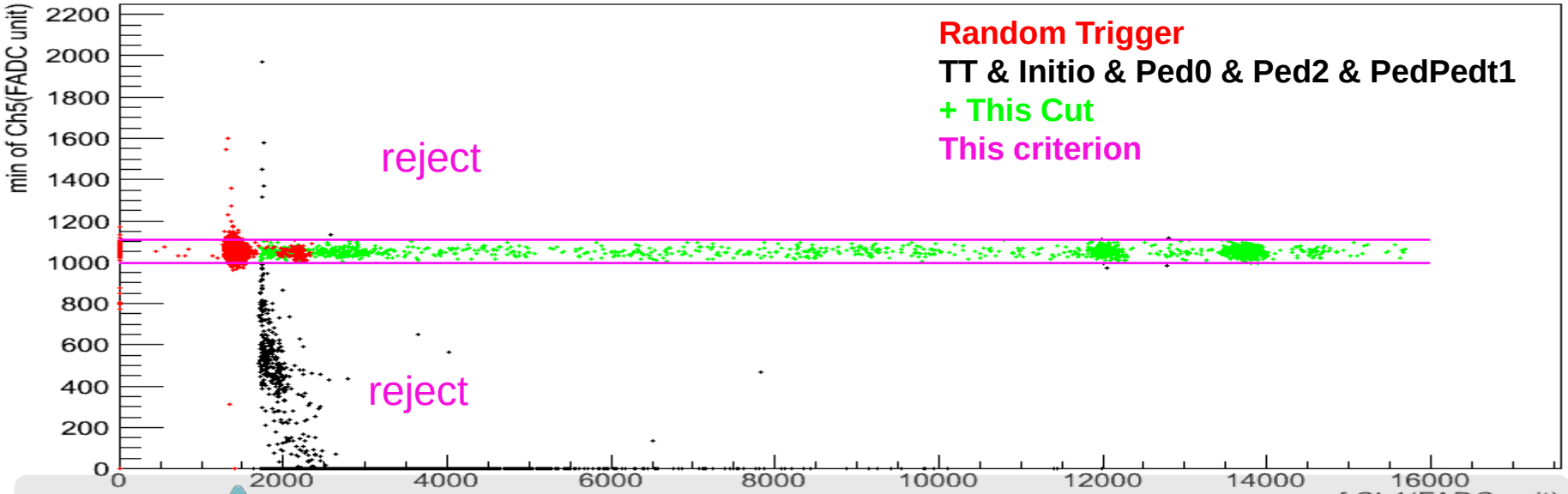
Data Analysis: Cuts

TT Cut → Initio Selection → Basic_1 Cuts → **Basic_2 Cuts**

Min5: Minimum cut of Ch5





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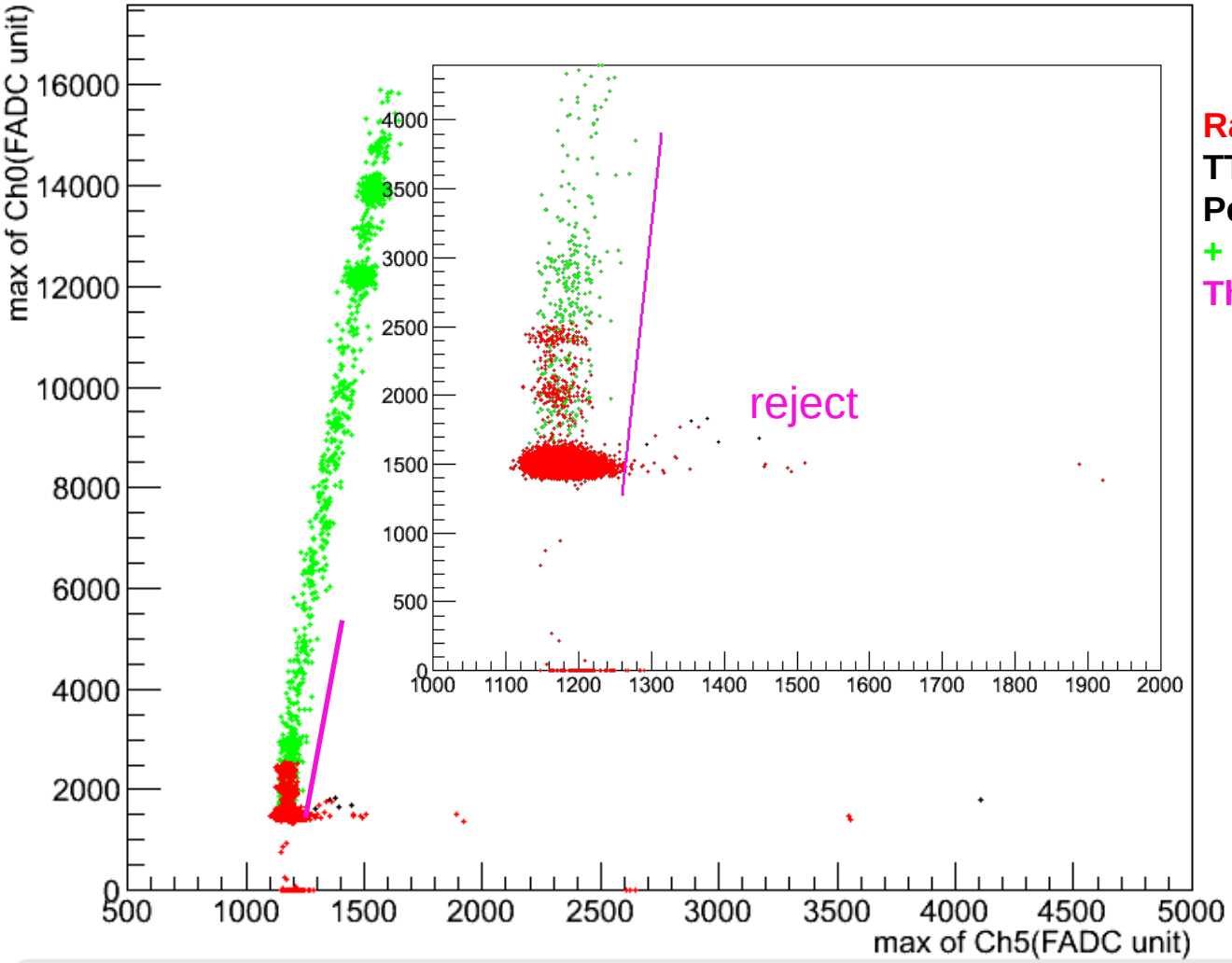
Data Analysis: Cuts

TT Cut | Initio Selection | Basic_1 Cuts | **Basic_2 Cuts**

Max0Max5: Maximum of Ch0 (S1) vs Maximum of Ch5 (S2) cut



Random Trigger
TT & Initio & Ped0 & Ped2 & PedPedt1 & Min5
+ This Cut
This criterion

Data Analysis： Correction Calculation

1. Dead time correction: measured by Random Trigger

$$\text{Dead}\,\textit{Time Correction} = \frac{N_{RanTg\_recorded}}{N_{RanTg\_triggered}}$$

Live-time: 18.1256 days;

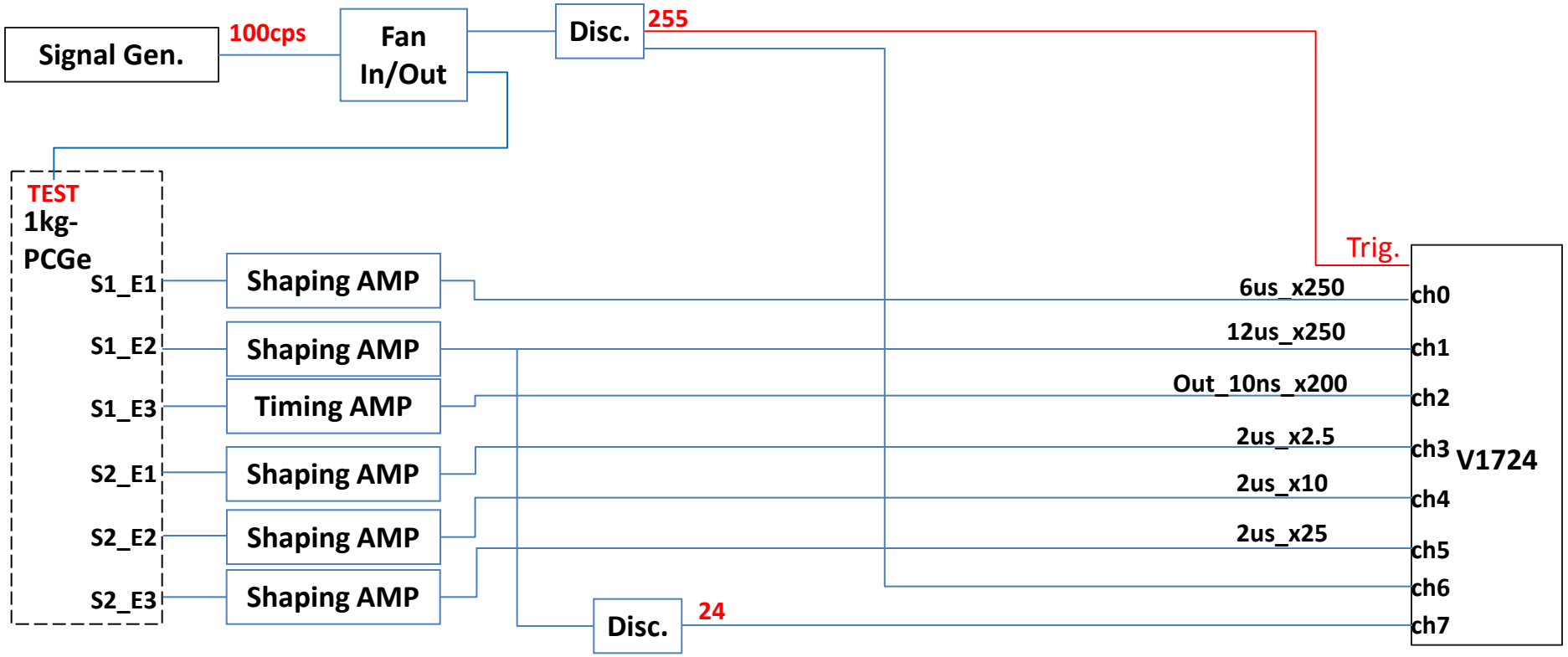
$N_{RanTg\_triggered}$ = 18.1256 * 86400/20 = 78303;

$N_{RanTg\_recorded}$ = 77904;

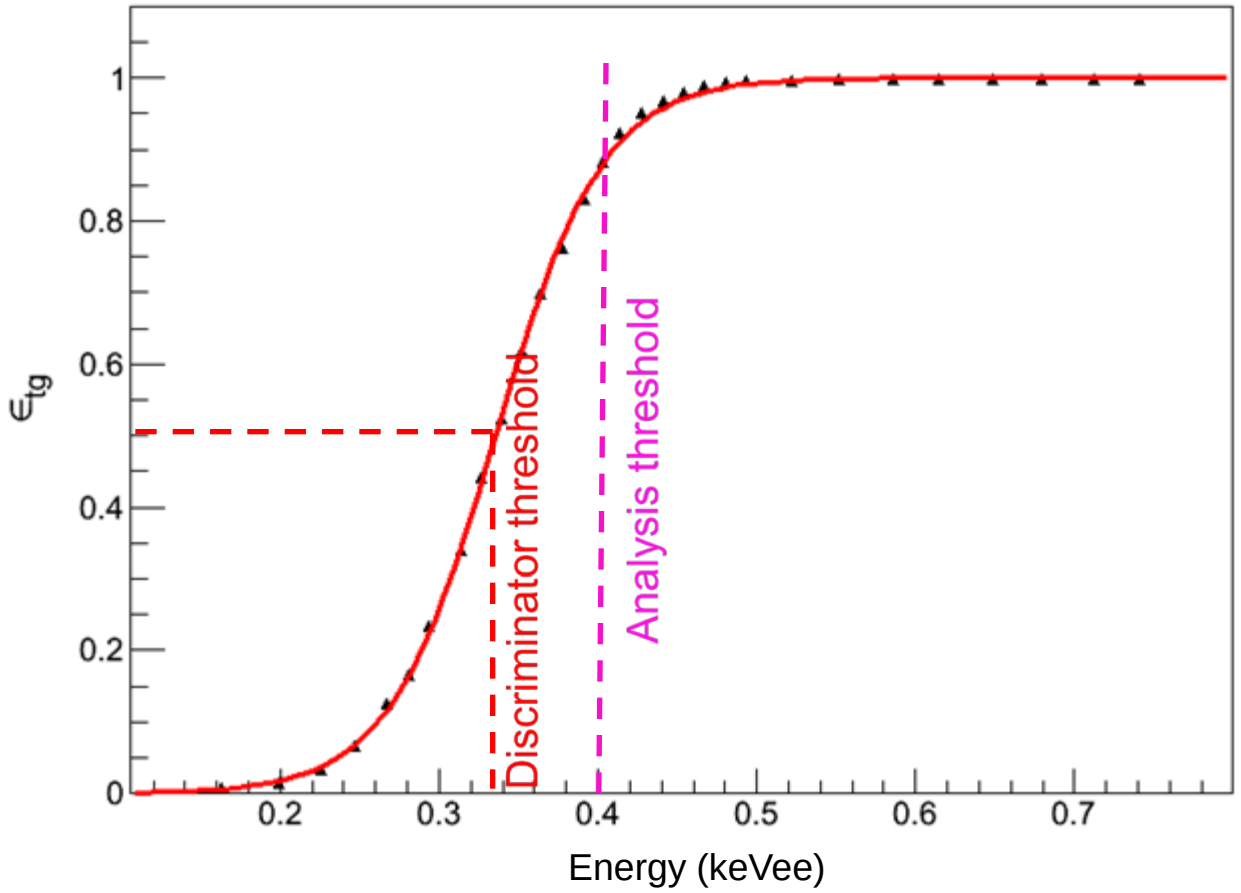
Dead *Time Correction = 99.5%.*

Data Analysis： Efficiency Correction

2. Trigger efficiency correction: Pulser



Data Analysis： Correction Calculation



Data Analysis： Correction Calculation

3. Cuts efficiency correction

$$Eff_1 = \frac{{}^{N}RanTg\_recorded\&TT\&Initio\&Basic1}{{}^{N}RanTg\_recorded} \qquad Eff_2 = \frac{{}^{N}RanTg\_recorded\&TT\&Initio\&Basic1\&Basic2}{{}^{N}RanTg\_recorded\&TT\&Initio\&Basic1}$$

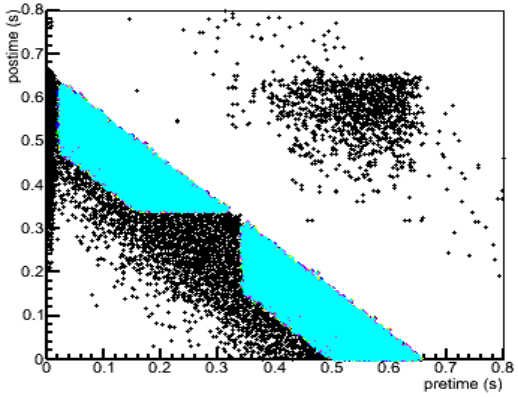
Eff_1 : measured by Random trigger.

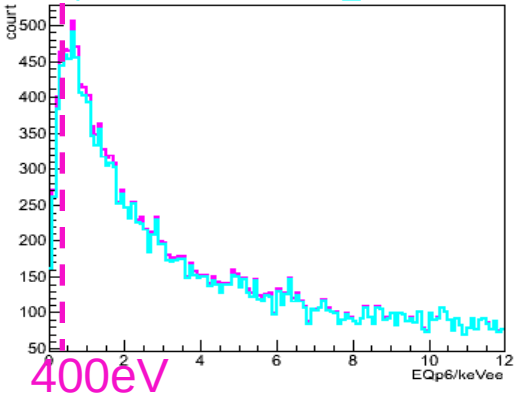
Eff_1 = 6933/77904 = 0.890

Eff_2 : calibrated by ^{241}Am source sample.

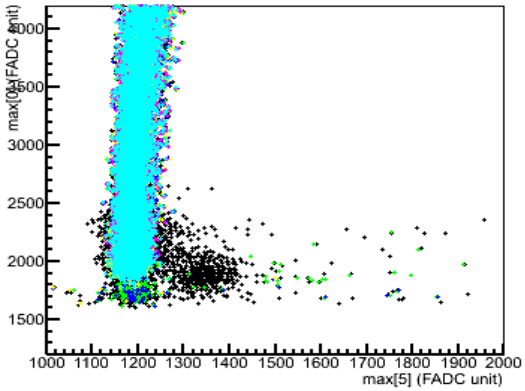
- Select physical events (Timing selection & cuts irrelevant to pulse shape)
- Applied the exact same Basic_2 cuts to the physical events.

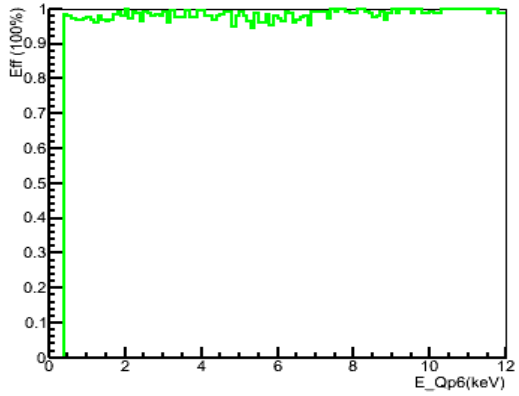
Purple: Selected sample spectrum
Cyan : spectrum with Basic_2 cuts





400eV





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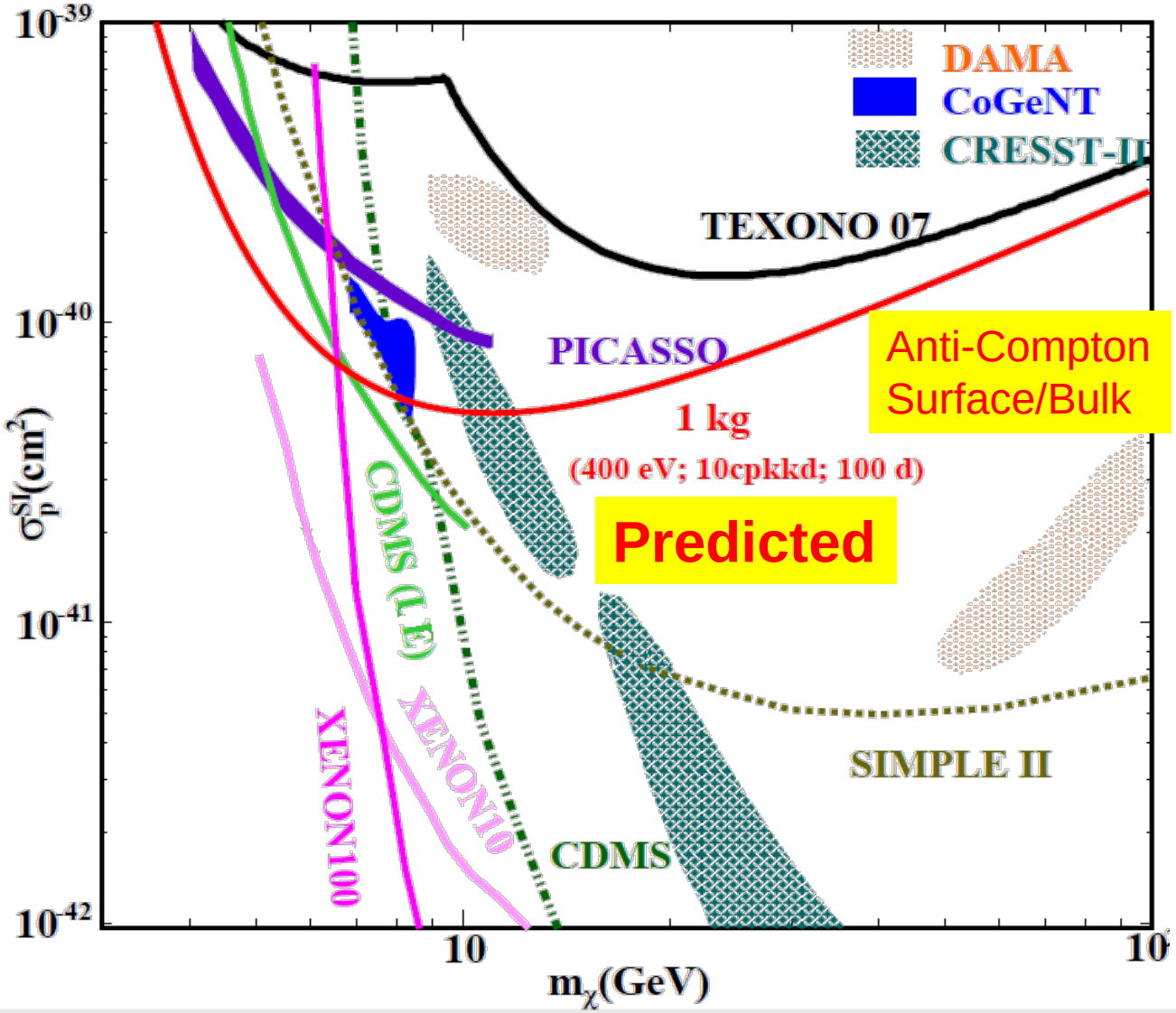
Data Analysis： Predicted Exclusion Plot



Summary

- Process of data analysis will be confirmed

  Correction calculation; Error bars;
- Background understanding
- Spectrum process will be optimized
- Anti-Compton & Bulk/Surface Discrimination

Thanks for

your Attentions & comments …

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