5g + 1g analysis

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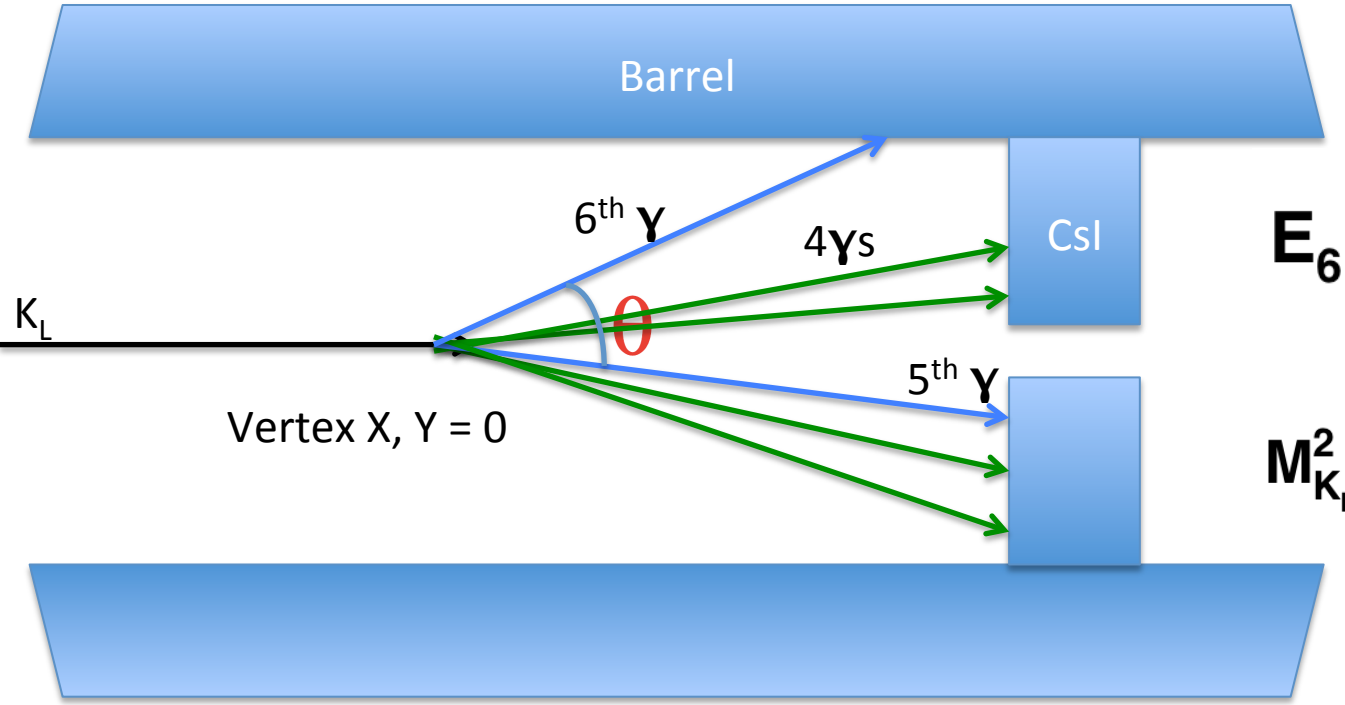
$K_L \to \pi^0\pi^0\pi^0$ Reconstruction Using 5γ on CsI and 1γ on Barrel



$$E_6 = \frac{M_\pi^2}{2E_5(1-\cos\theta)}$$

$$M_{K_L}^2 = \left(\sum_{i=1}^{6} E_i\right)^2 - \left(\sum_{i=1}^{6} \vec{p}_i\right)^2$$

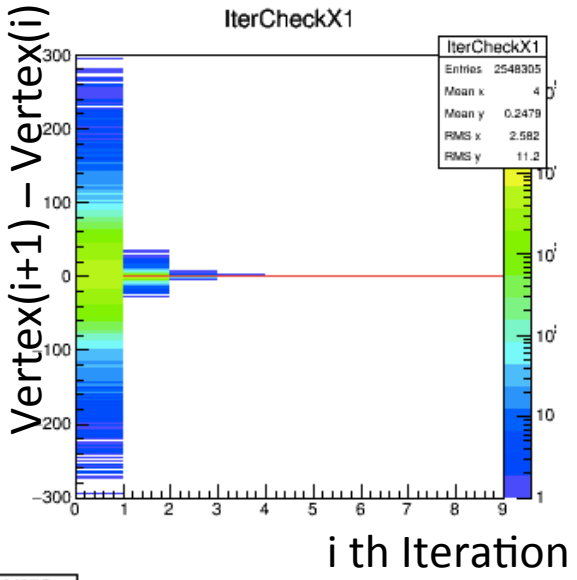
- $K_L \to \pi^0\pi^0\pi^0$ decay samples with 5γs on CsI and 1γ on Barrel
- Reconstruction of $2\pi^0$ from 4γs on CsI
- 1γ Reconstruction from hit information of Barrel (timing and Module ID)
- Reconstruction of the last π^0 from 1γ on CsI and 1γ on Barrel

Reconstruction of Vertex X, Y

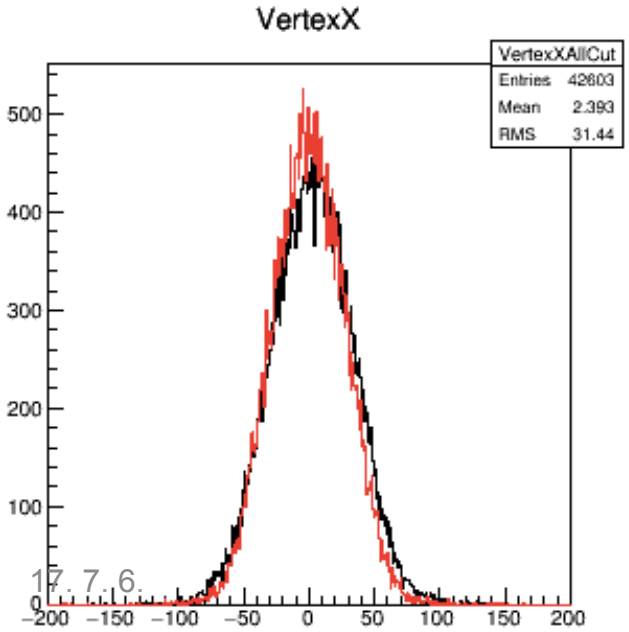
Vertex X,Y from C.O.E.

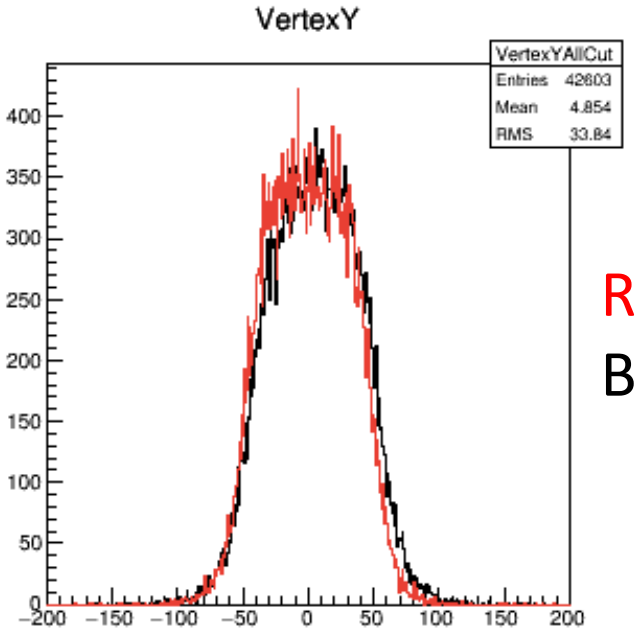
Reconstruction of Energy of incident gamma

Iteration (10 times)



i th Iteration

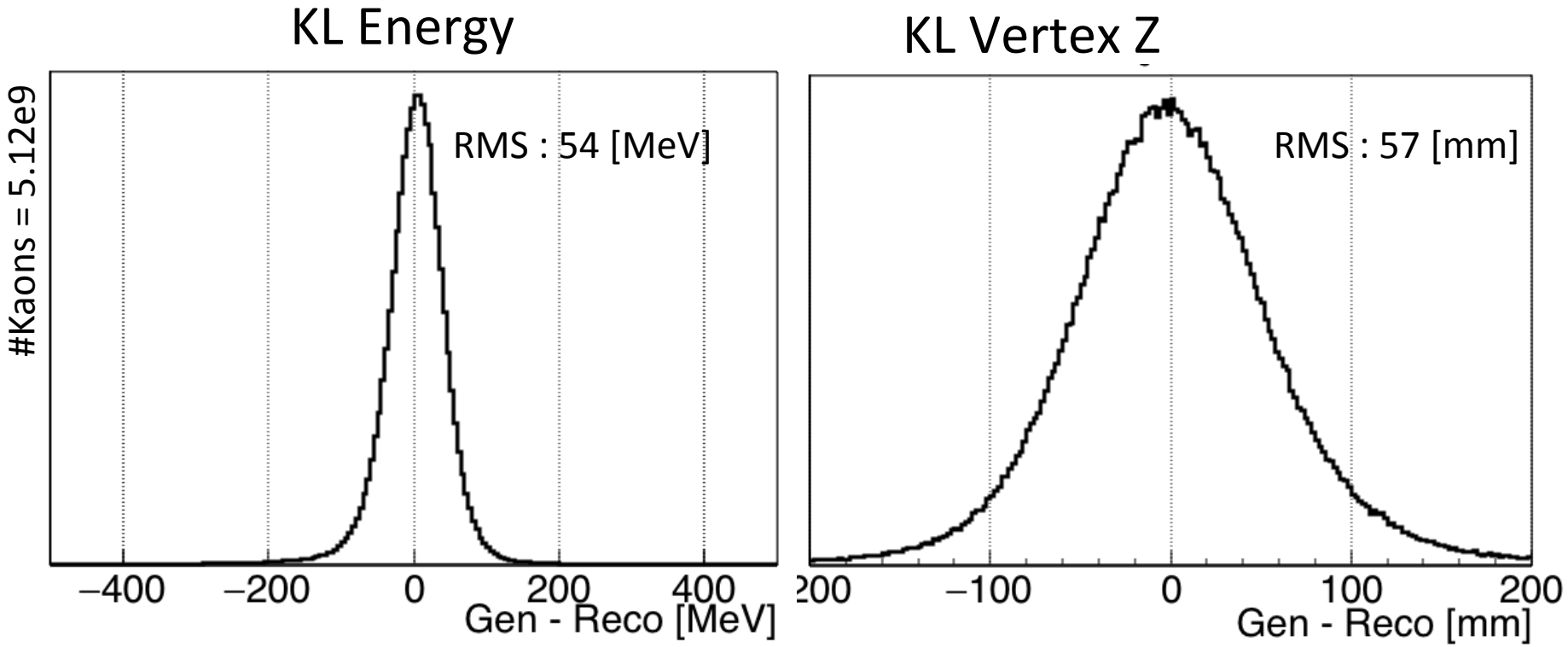




Red : M.C.

Black : Data(Run62)

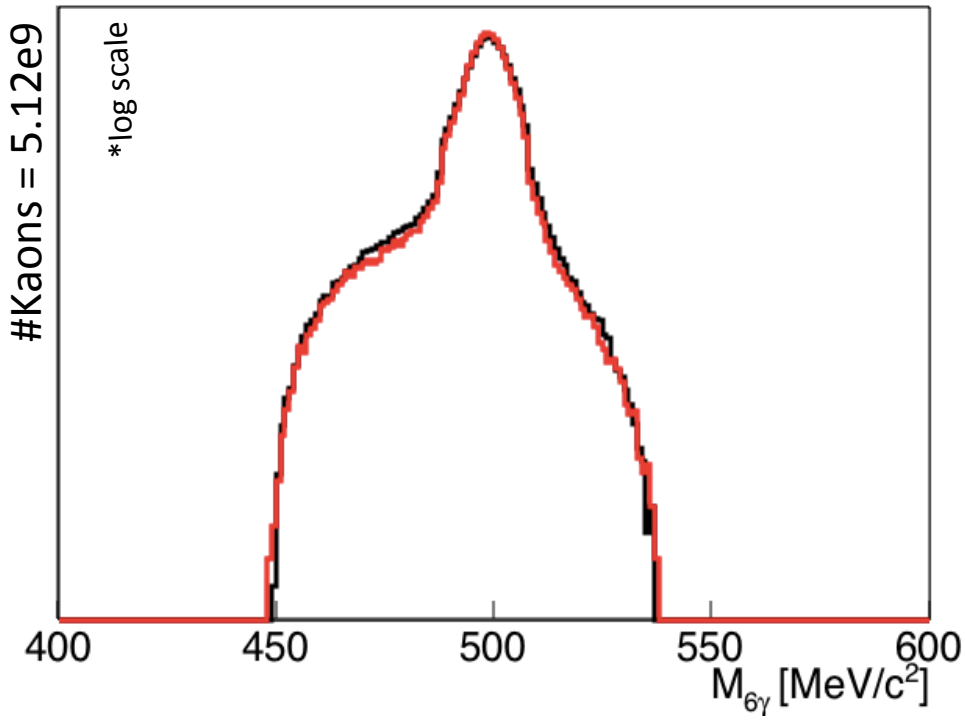
Reconstruction Result



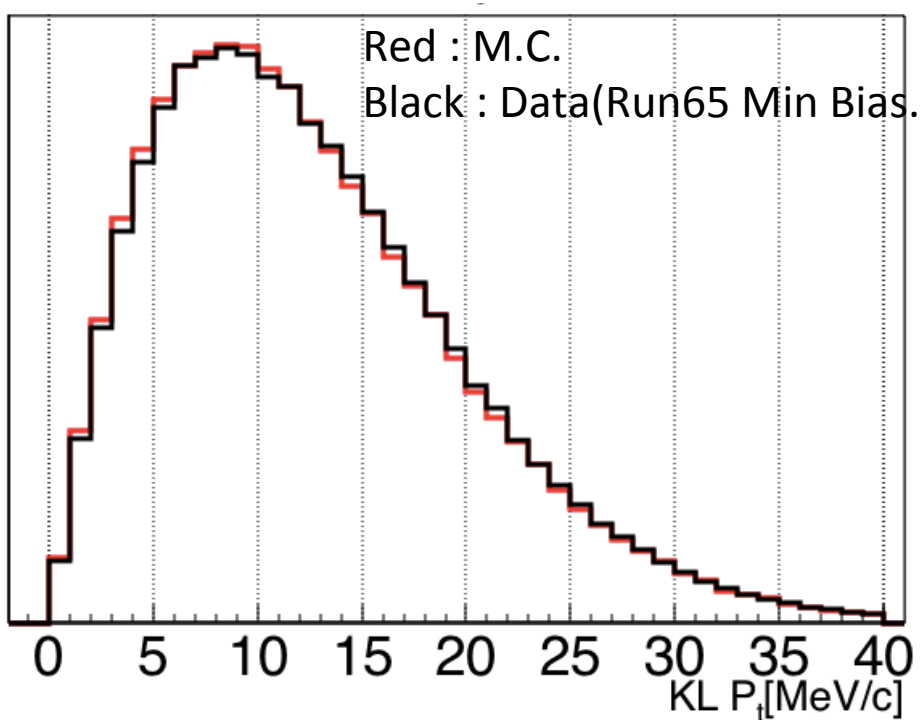
- KL3pi0 Generation

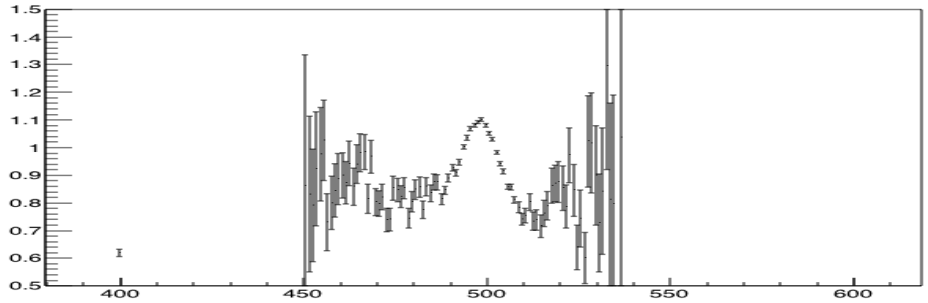
Data / M.C.

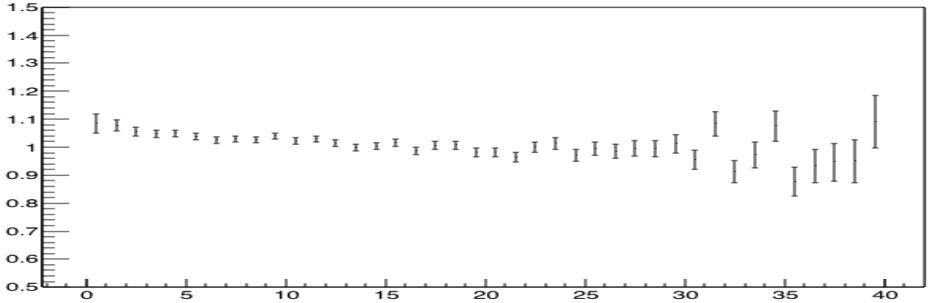
KL Mass



KL P_t







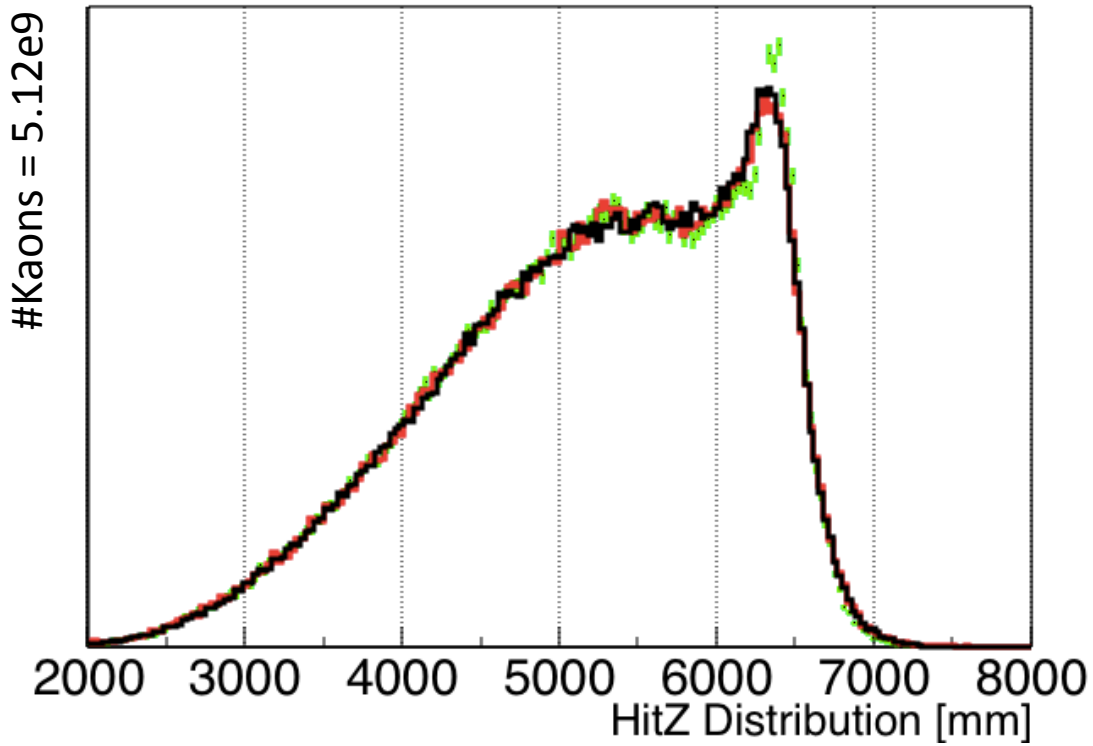
Response of Barrel

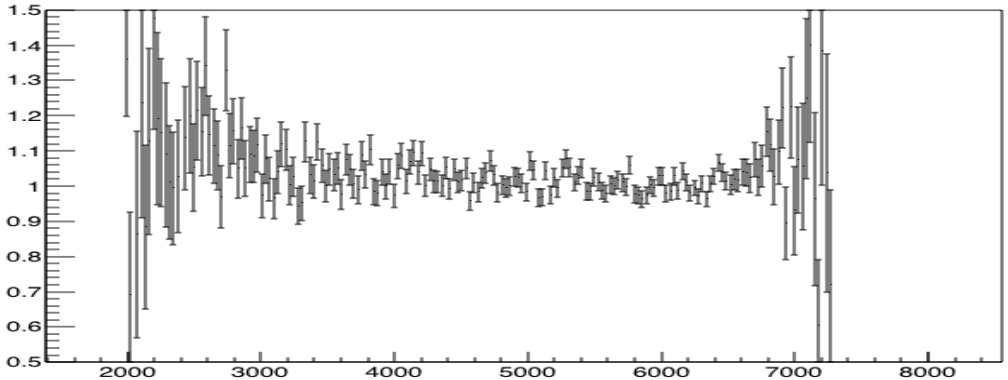
Red : M.C.
Black : Data(Run65 Min Bias.)
Green dot : M.C. w/o Resolution

Time Resolution is reproduced from result of analysis of cosmic-ray data

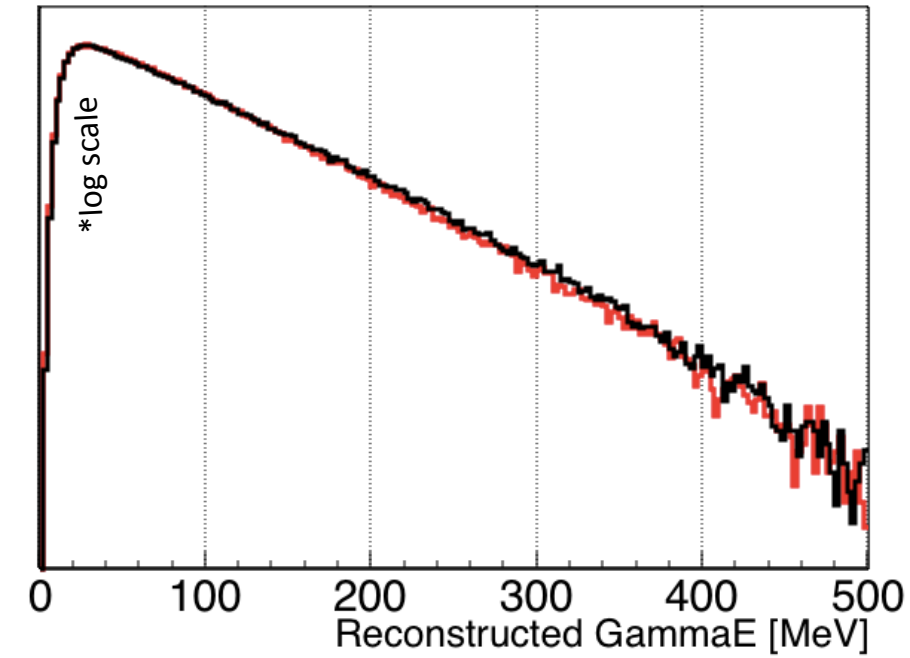
$$\sigma = \frac{\text{const}}{\sqrt{\text{EDep}}}$$

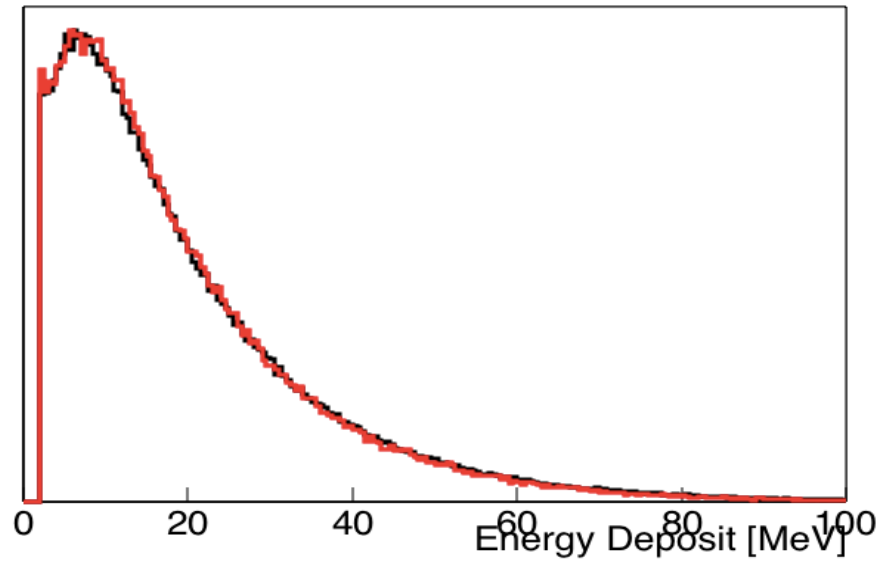
Where, const is
1.64 for MB
1.09 for IB

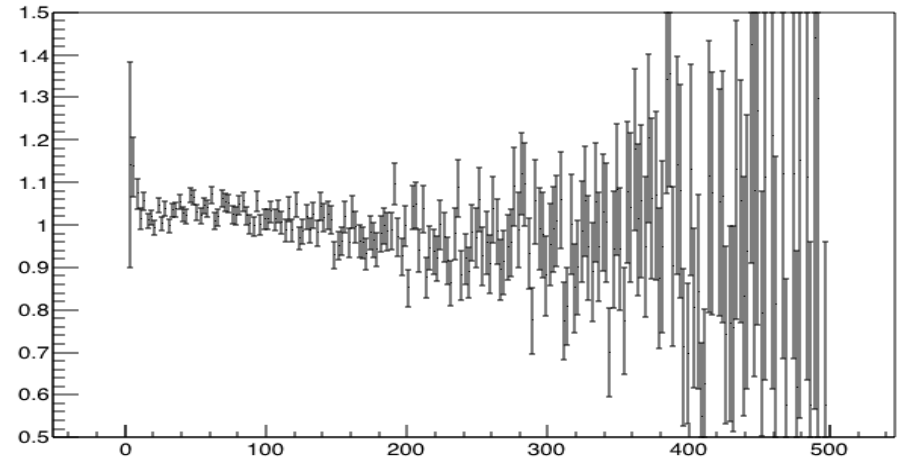


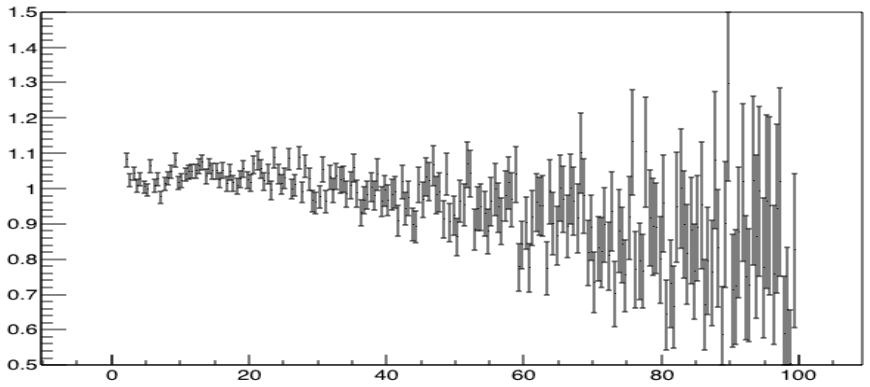


Response of Barrel (2)





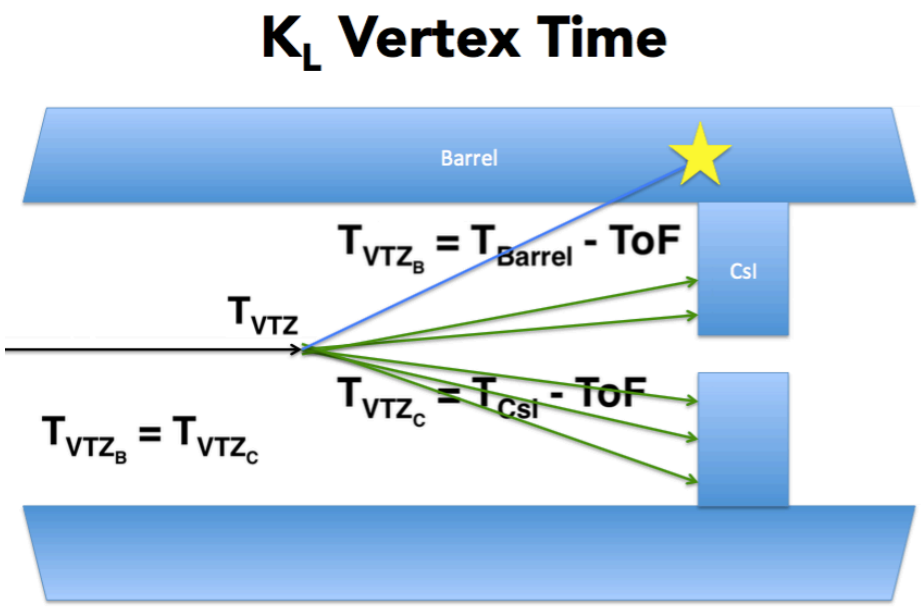


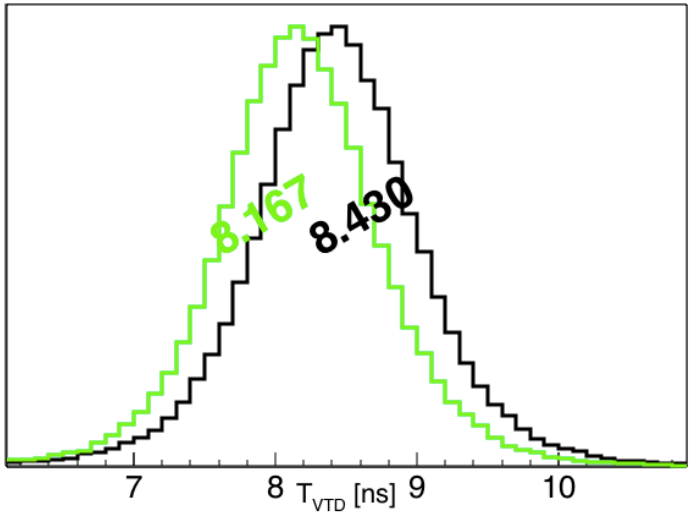


Measurement of Barrel Stability

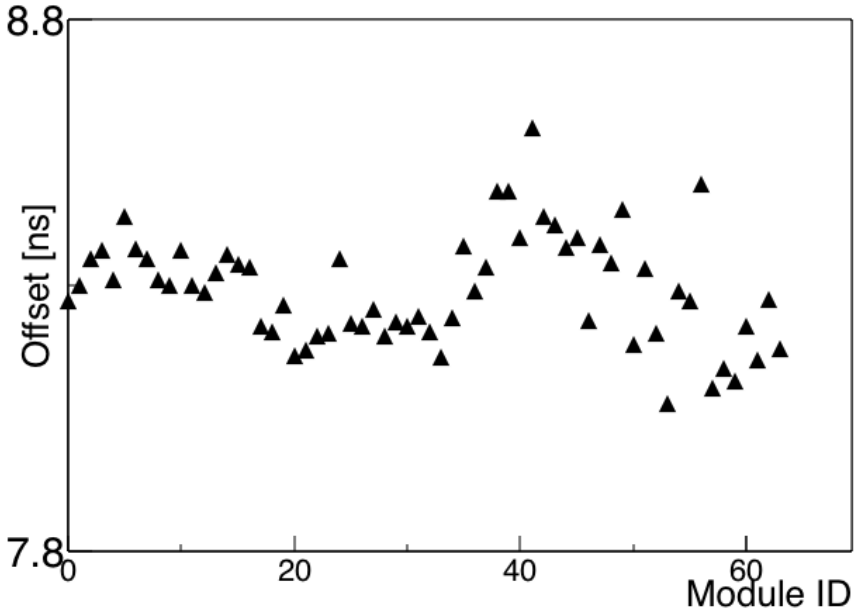
- Stability of Time and Energy of Barrel can be measured by 5g+1g analysis
- Timing Stability with Vertex Time Difference, $T_{VTD} = T_{VTZ\_Barrel} - T_{VTZ\_CsI}$
  - With assumption of CsI stability
- Energy Stability with Sampling Fraction
  - $\text{S.F.} = \frac{\text{Energy Deposit}}{\text{Gamma Energy}}$

Fine Time Calibration



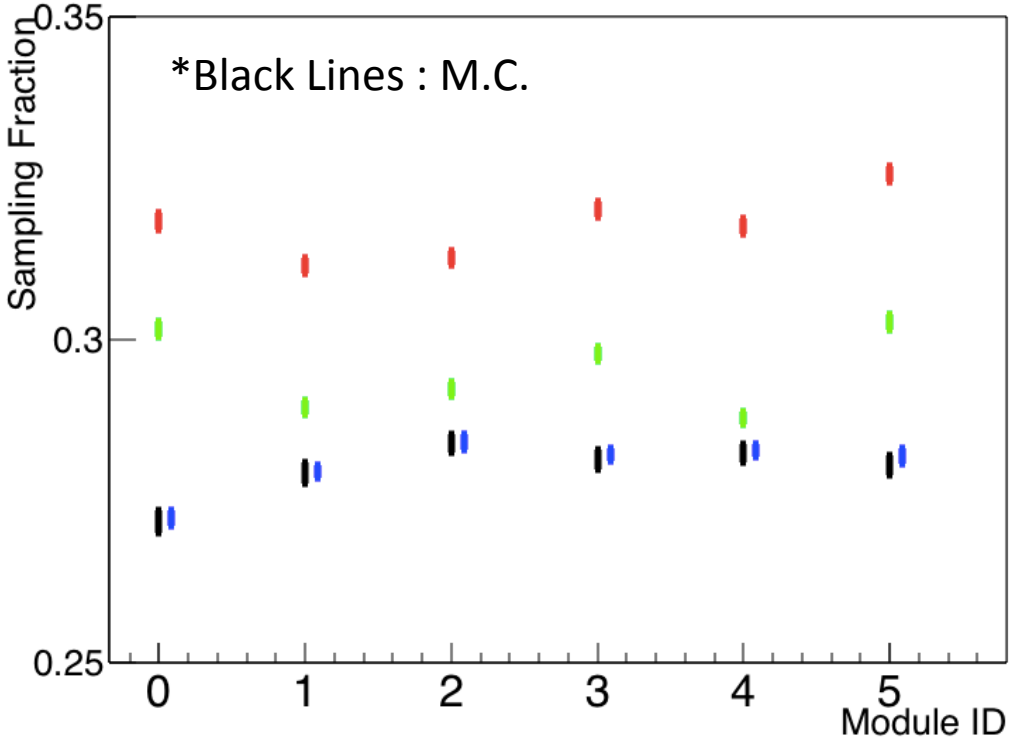


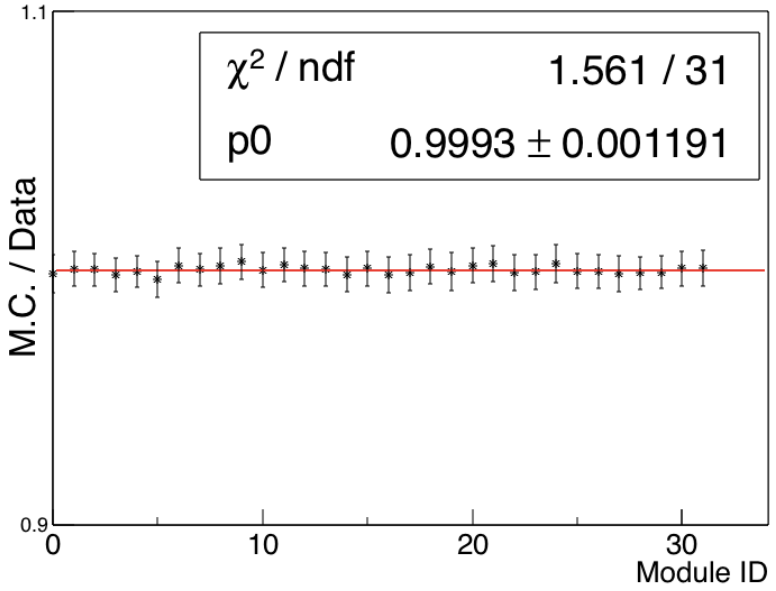
T_{VTD} ~ $Offset_{Barrel}$



With Normalization Trigger
Fine Time Calibration is implemented by arranging the centers of T_{VTD}

Fine Energy Calibration

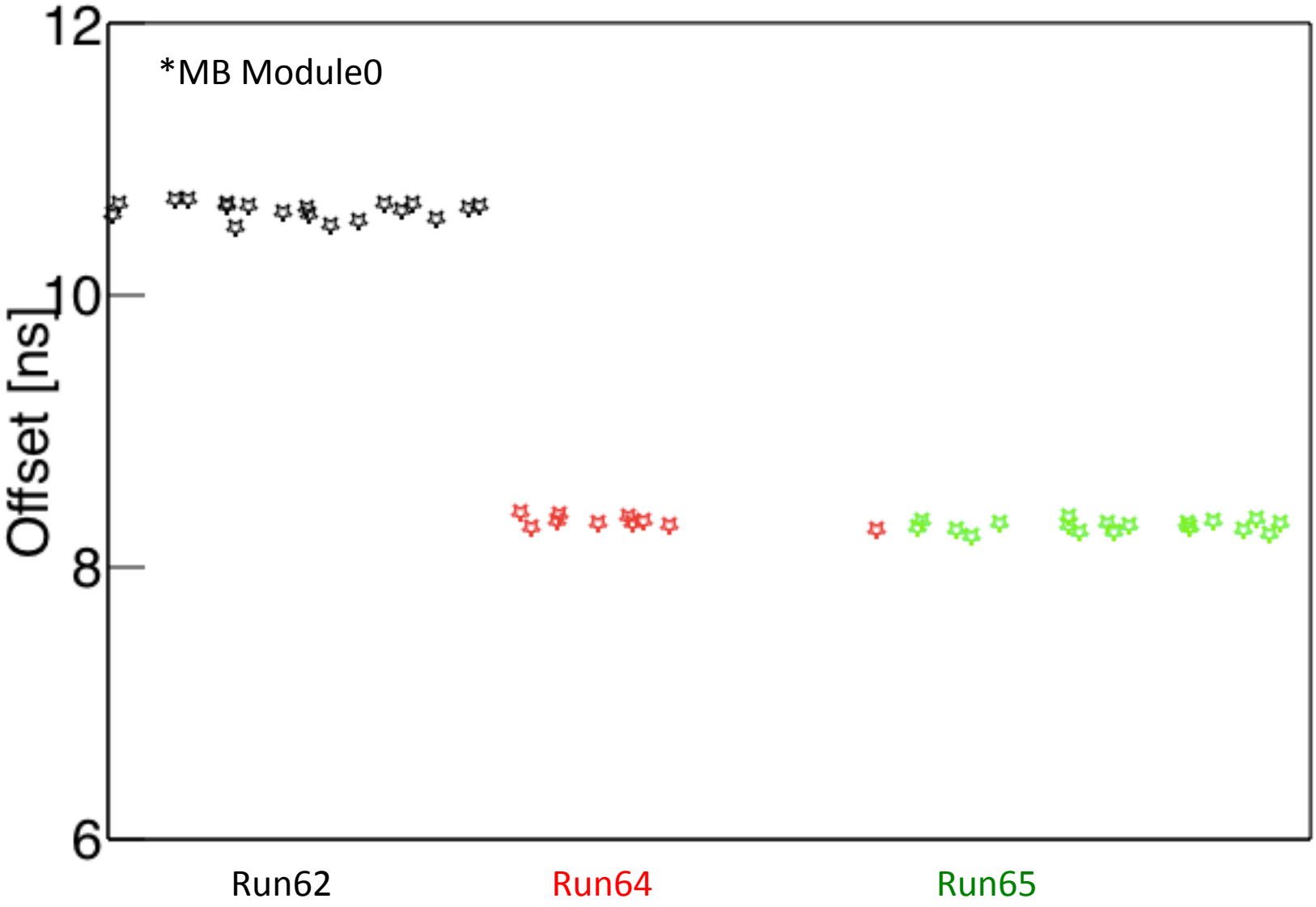




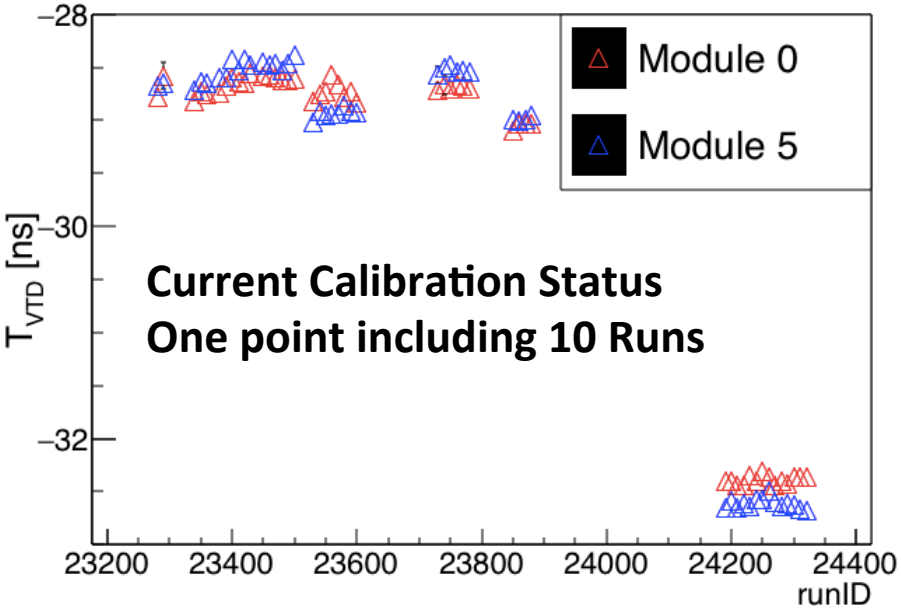
- Sampling Fraction gives detector response in large range of incident gamma energy

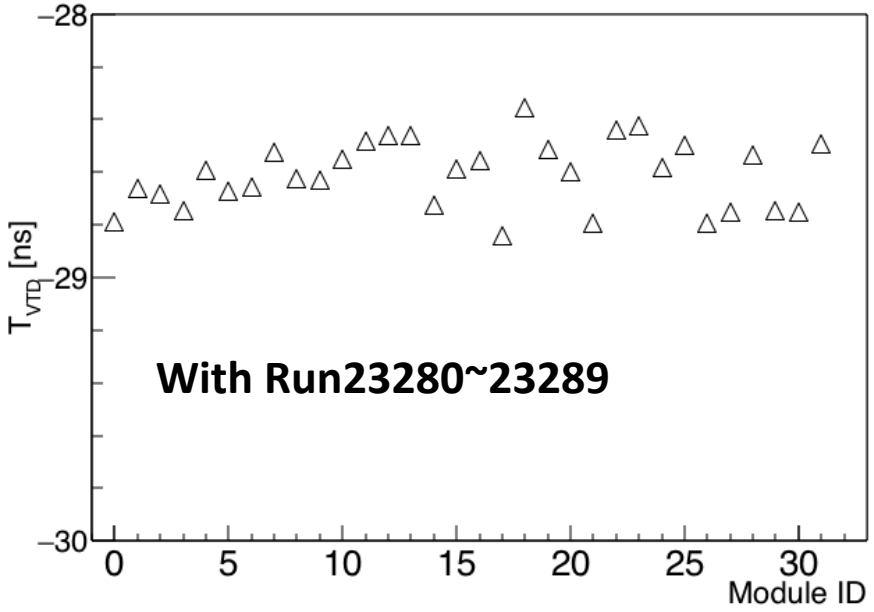
Moves	Changes
Red ➔ Green	Modification of Calib. w/ Cosmic Data
Green ➔ Blue	Fine Energy Calib. w/ Min. Bias. Data

Status of timing stability in 2015 Data



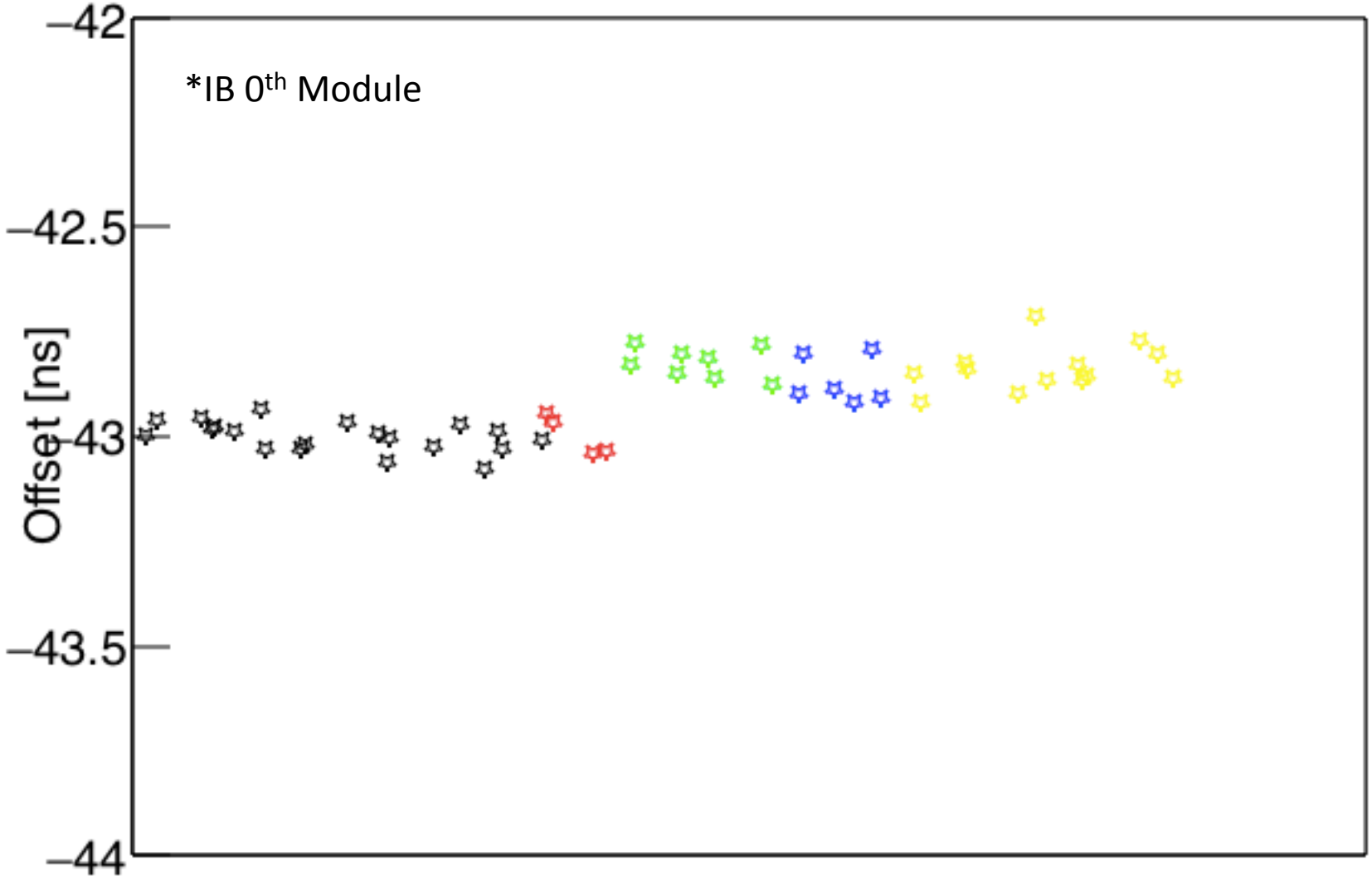
Correction on IB Timing in Run69



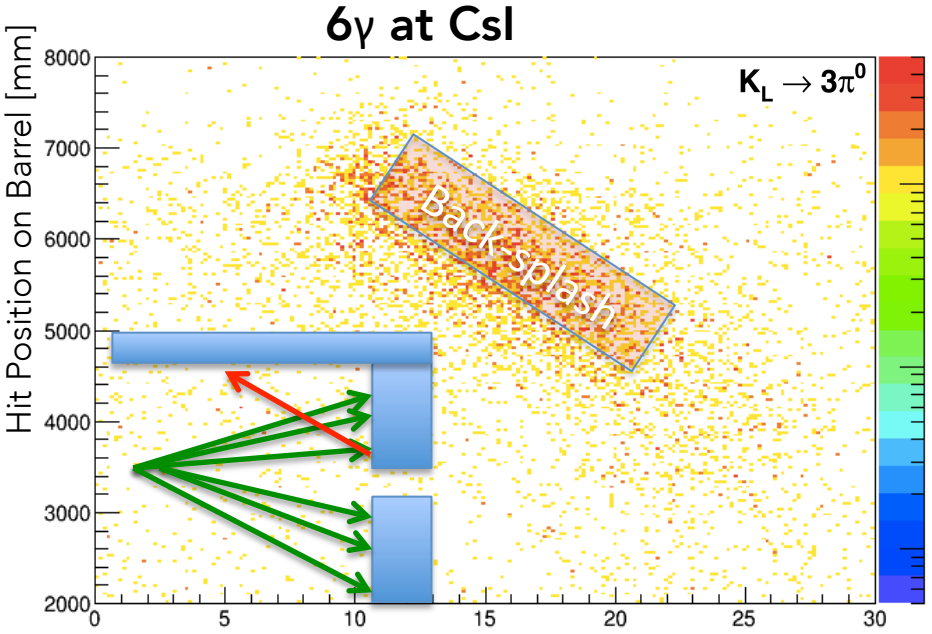


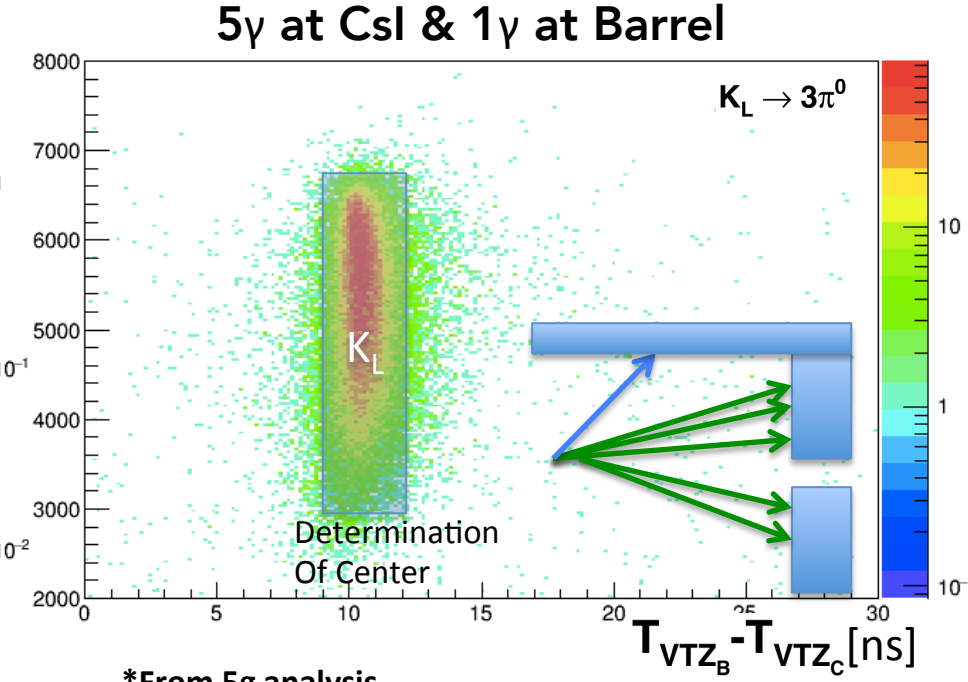
- Correction Factors for each module & each integrated 10 runs are prepared

Status of Run74 & Run75

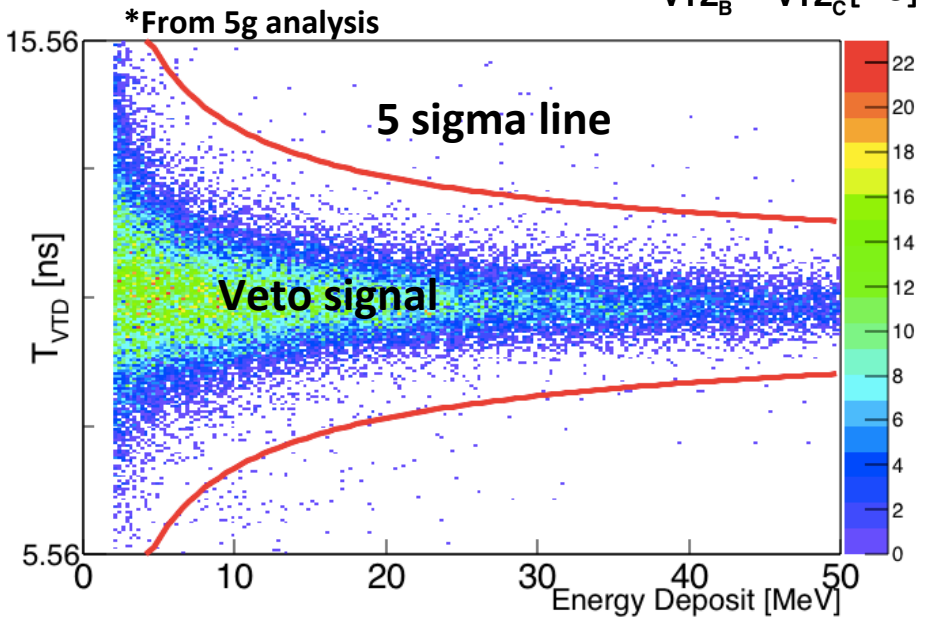


Property of Back Splash Event

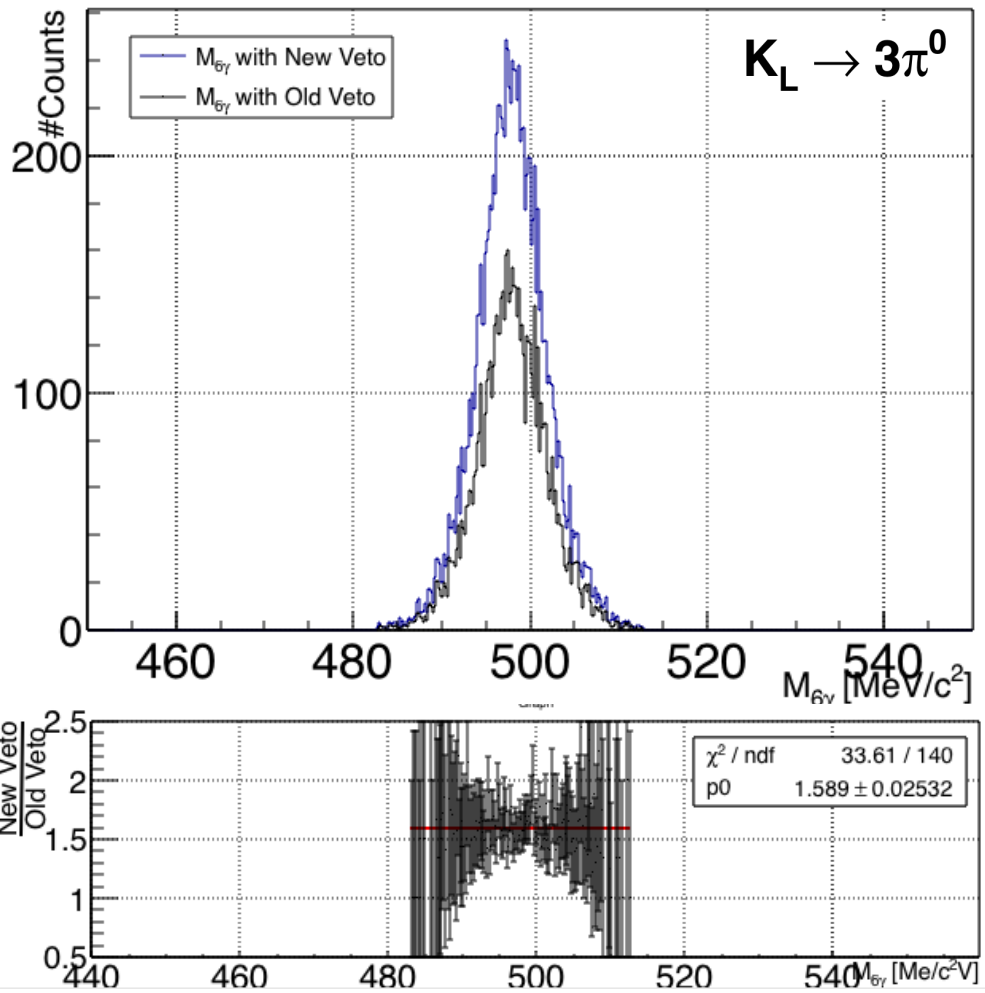


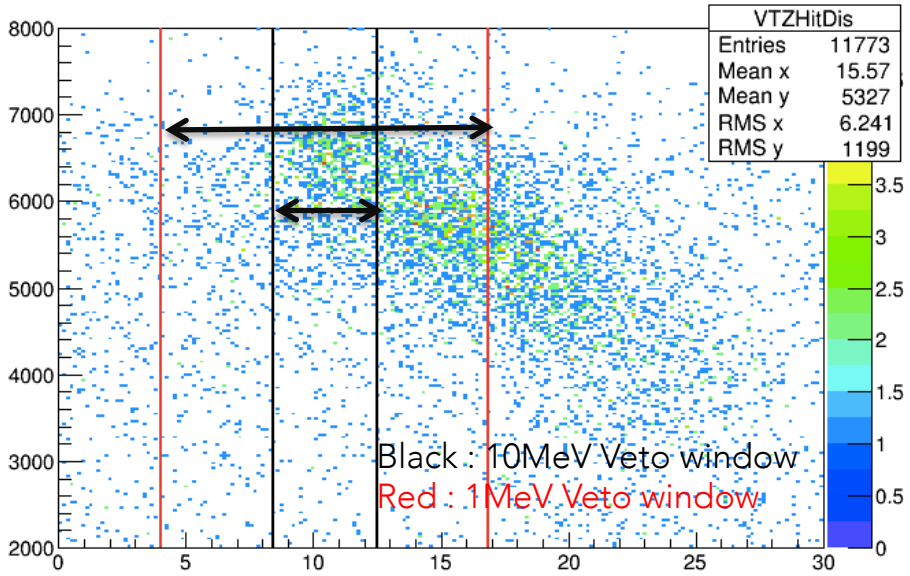


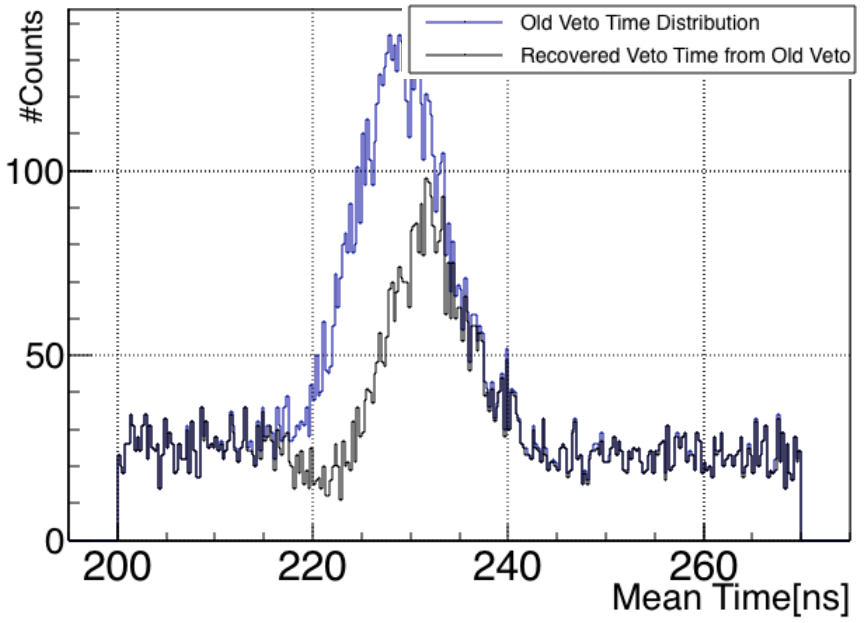
- Center of Veto timing from 5g + 1g analysis
- Variable veto window for timing according to deposited energy on Barrel



Back Splash Recovery at g6ana



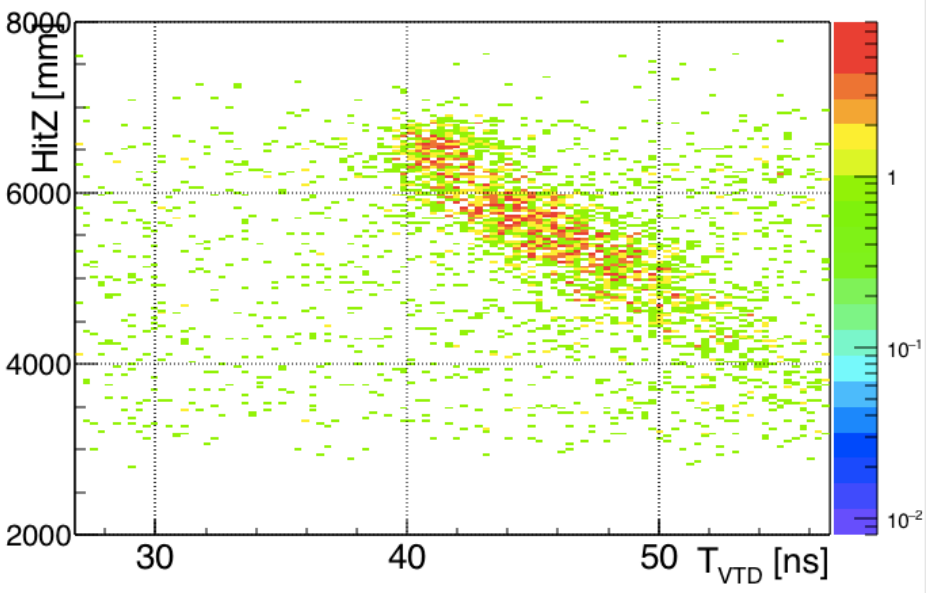


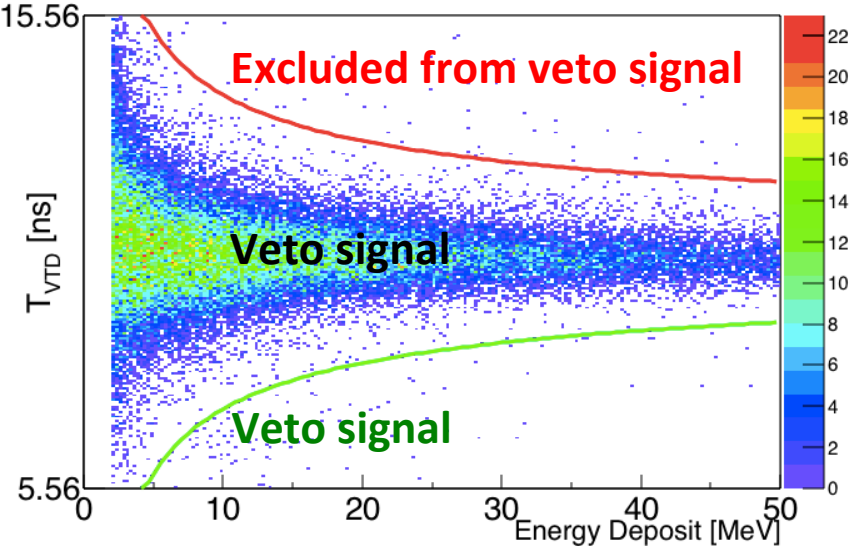


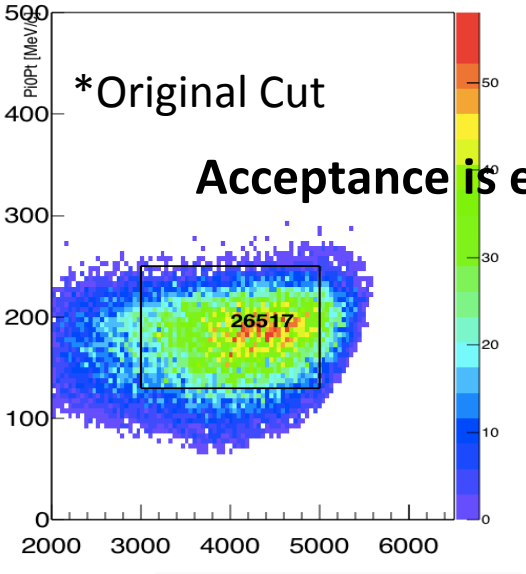
- 60% $K_L \to 3\pi^0$ Recovered

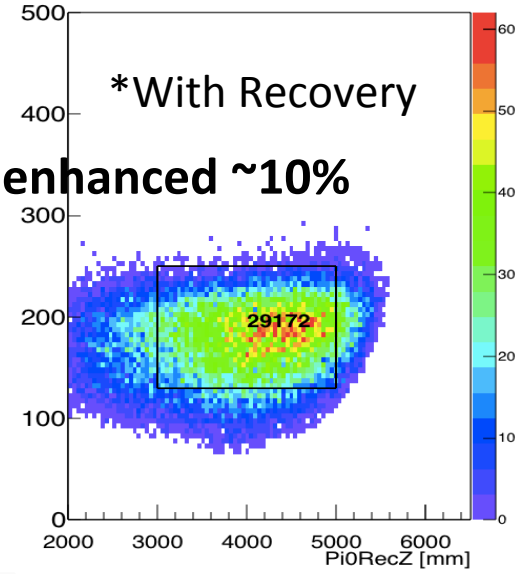
Back Splash @ KLpi0nunubar

- Preliminary selection
  - (CutCondition|0xc)==0xc
  - (AddCutCondition|0xc0)==0xc0
  - BPCVVetoEne < 1.0
  - MaxShapeChisq < 4.6
  - (MyVetoCondition|0x40)==0x40 (MB Hit accepted)
- Resolution is applied with regard to
  - Energy deposit on barrel
  - Gamma Energy



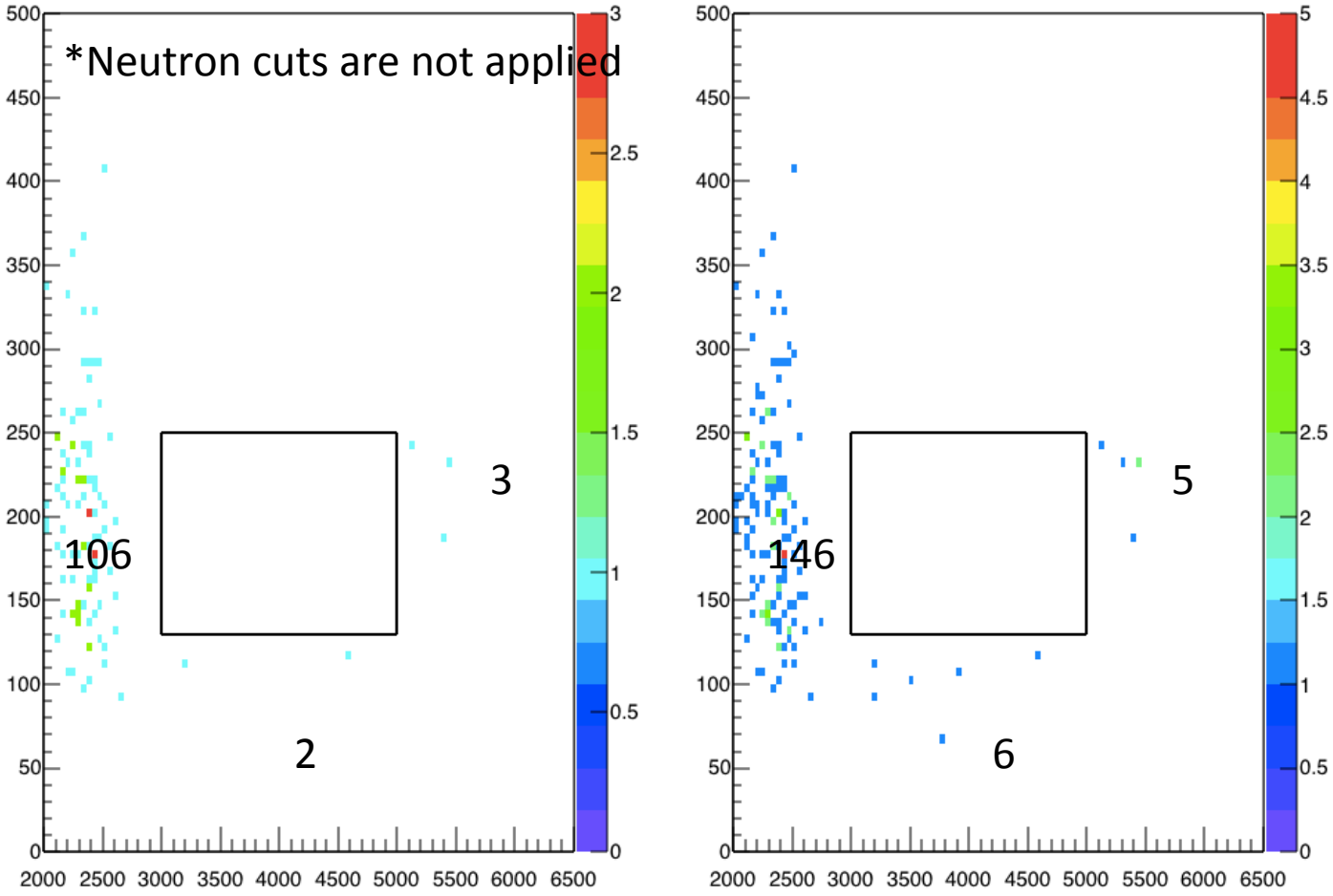






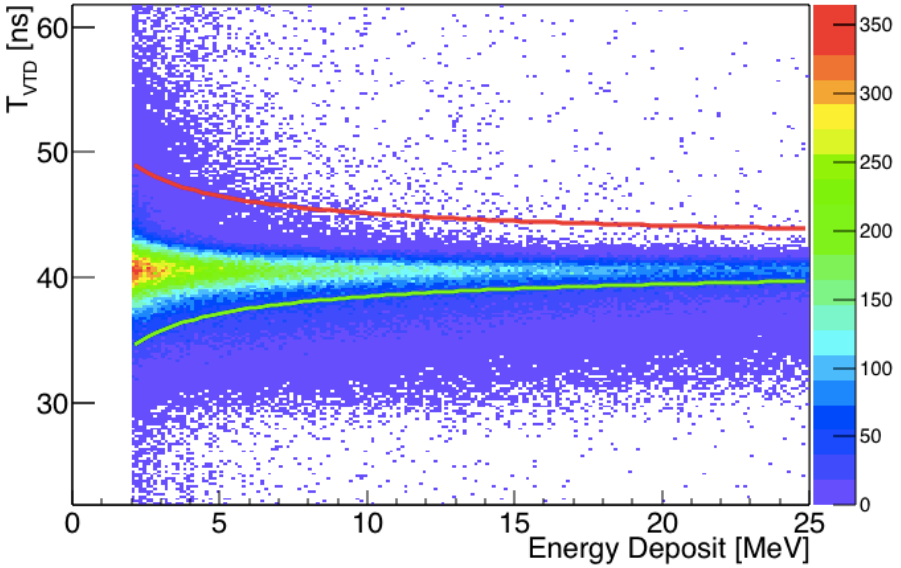
Acceptance is enhanced ~10%

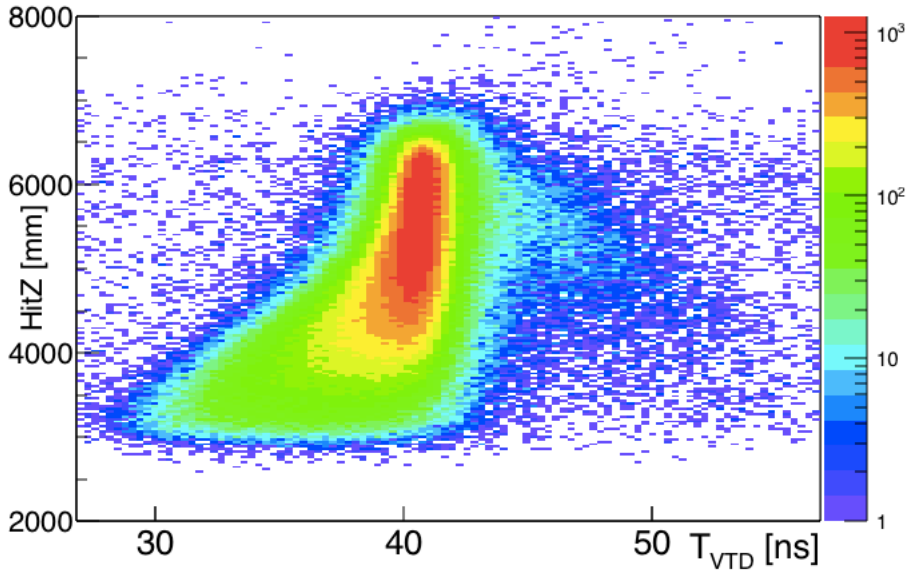
Back Splash Recovery @ Run62

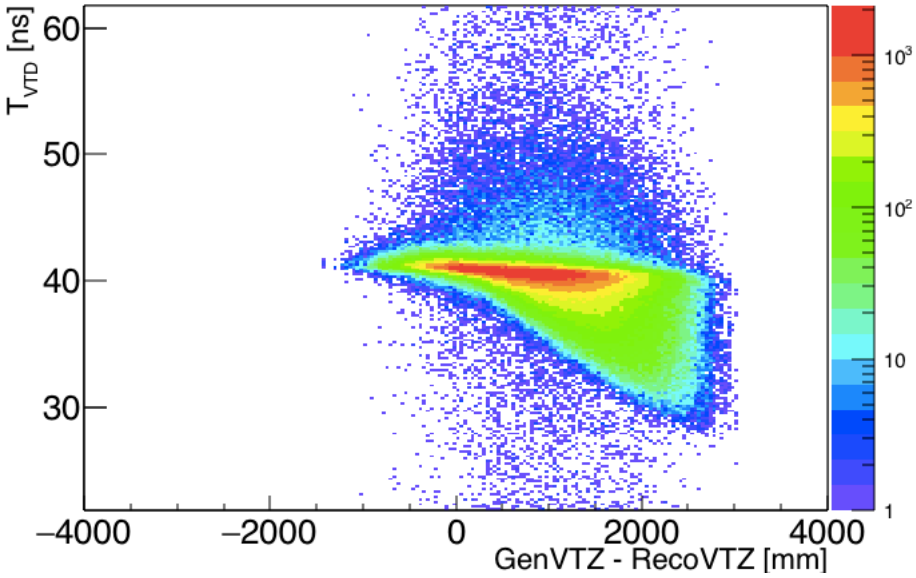


- Background events increased, too.

KL3pi0 Background Rejection

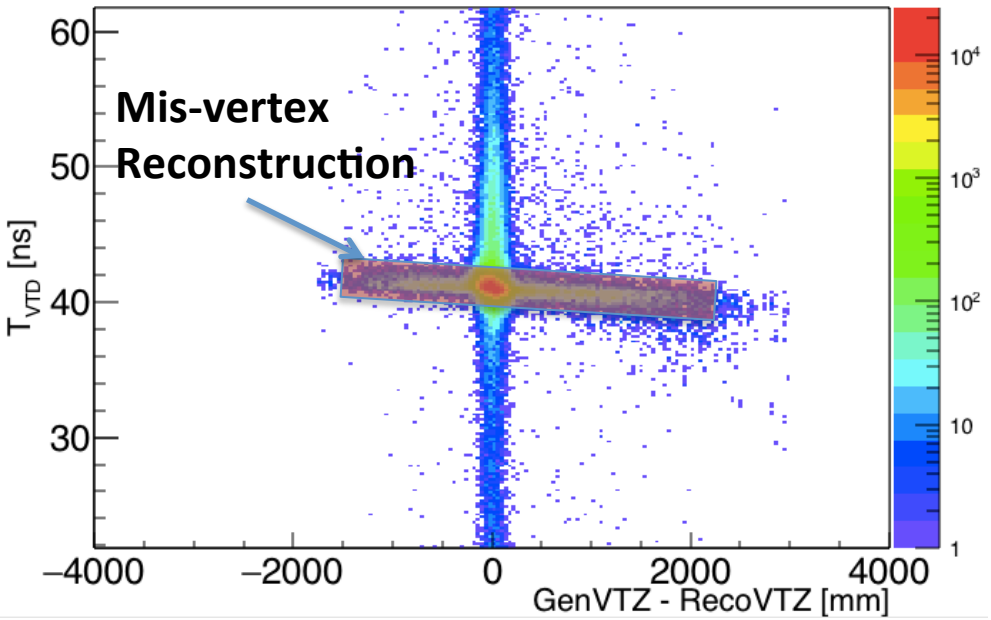


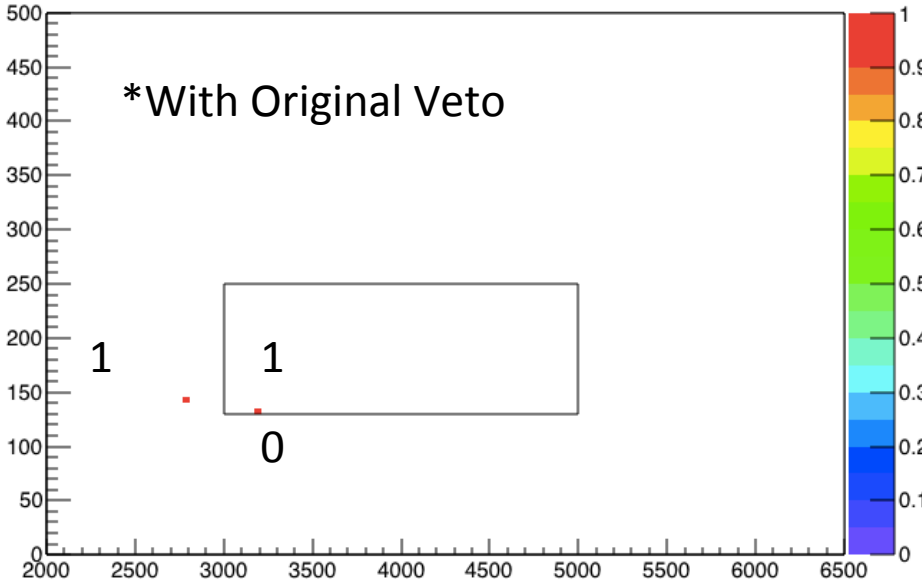


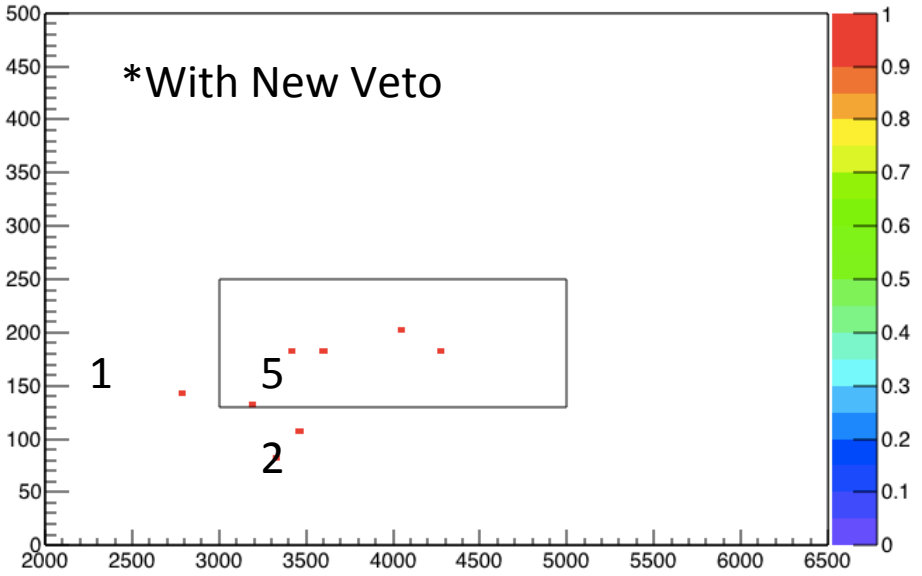


- Mis-reconstruction of vertex induces lower T_{VTD} than center
- Execution of veto with low part of T_{VTD}
- Full background rejection for 1.4e9 KL3pi0 events

KLpi0pi0 Background Rejection







- Mis-Vertex Reconstruction occur to not only upstream, but also downstream
- Statistics : 4e9 KLpi0pi0

Summary

- Response of Barrel Counters with well reconstructed gamma.
  - Good agreement between M.C. and Data.
  - Fine energy and timing calibration method.
- Time stability is confirmed.
  - Good stability for 2015 data
  - Correction Factors for Run69 are ready.
  - Quite stable in Run74 and Run75
- Recovery of the back-splash events
  - 10% larger acceptance is expected with variable veto window
  - KL2pi0 BG events increased due to wrong reconstruction of vertex
  - Without proper treatment of the mis-reconstruction, it is not applicable.