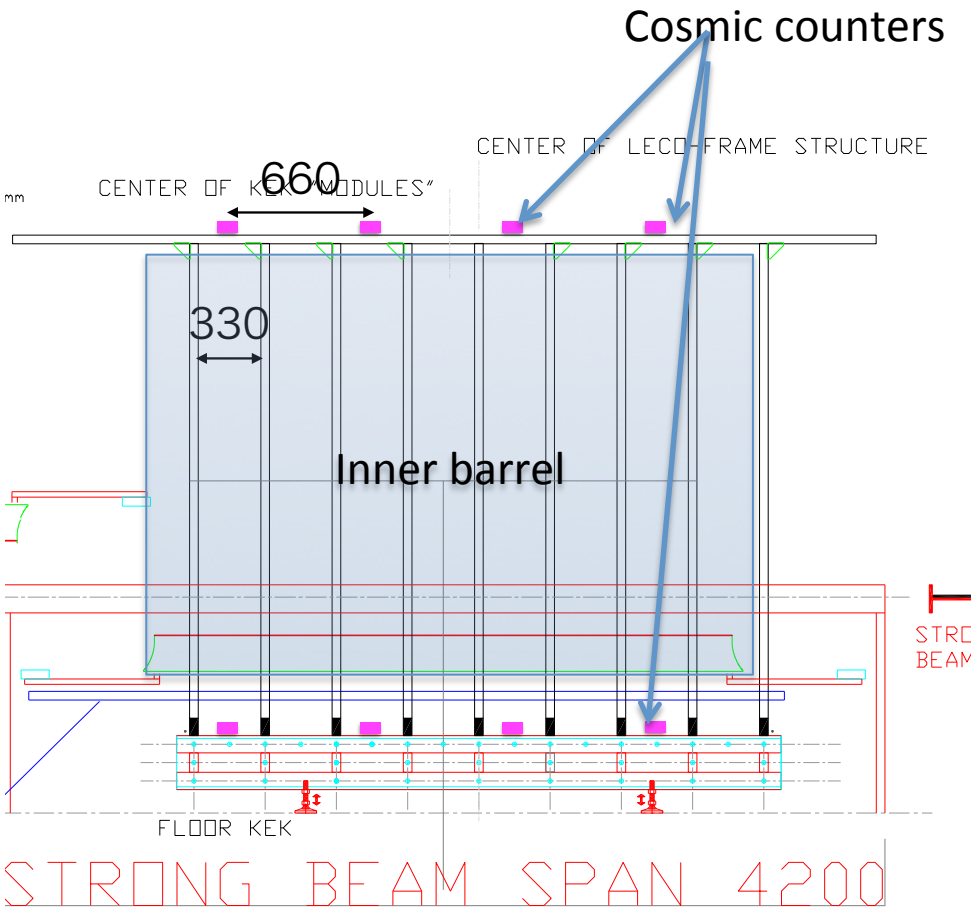
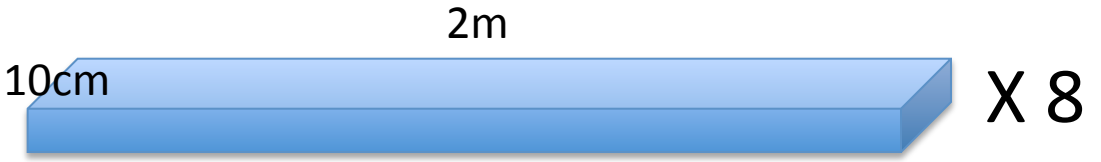
inner barrel cosmic ray data analysis

Data taking setup

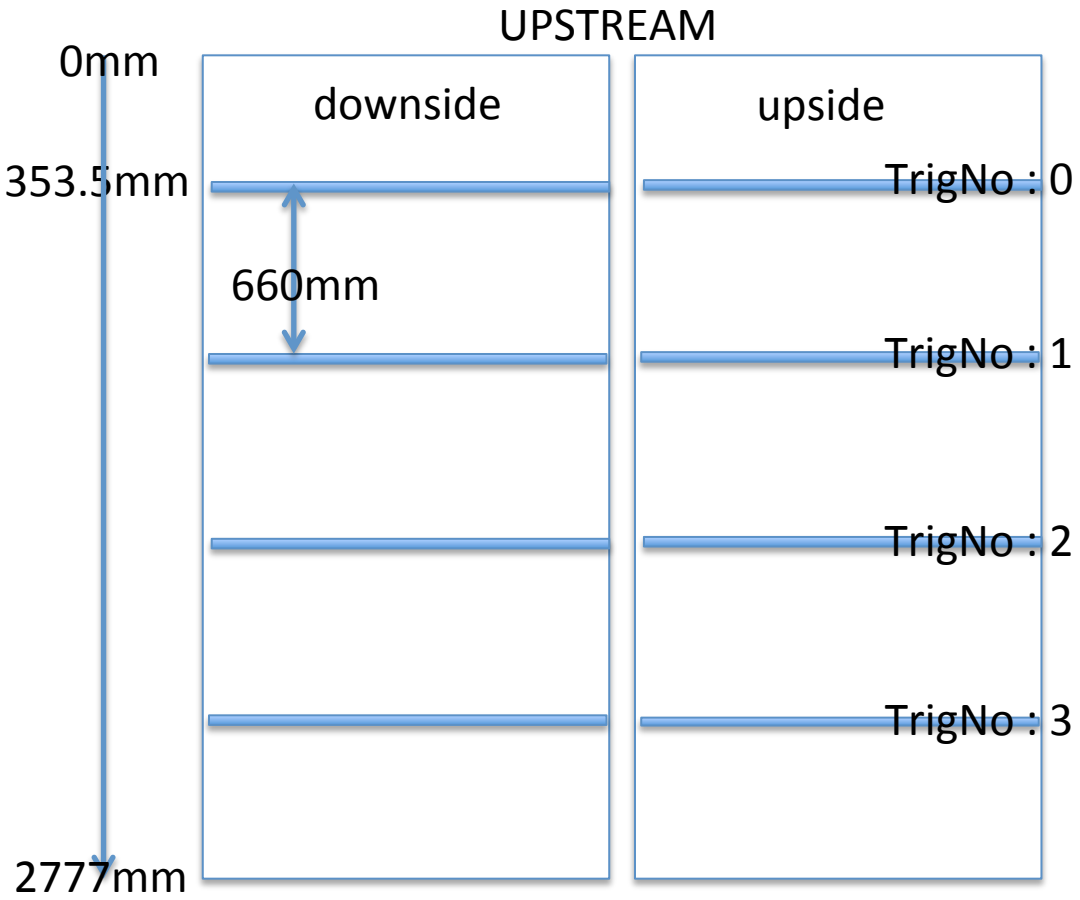
- FADC data acquisition system. (125MHz)
- Cosmic counter trigger system. (pink boxes)
  - 1 upstream && 1 downstream coincidence signal



Cosmic counter

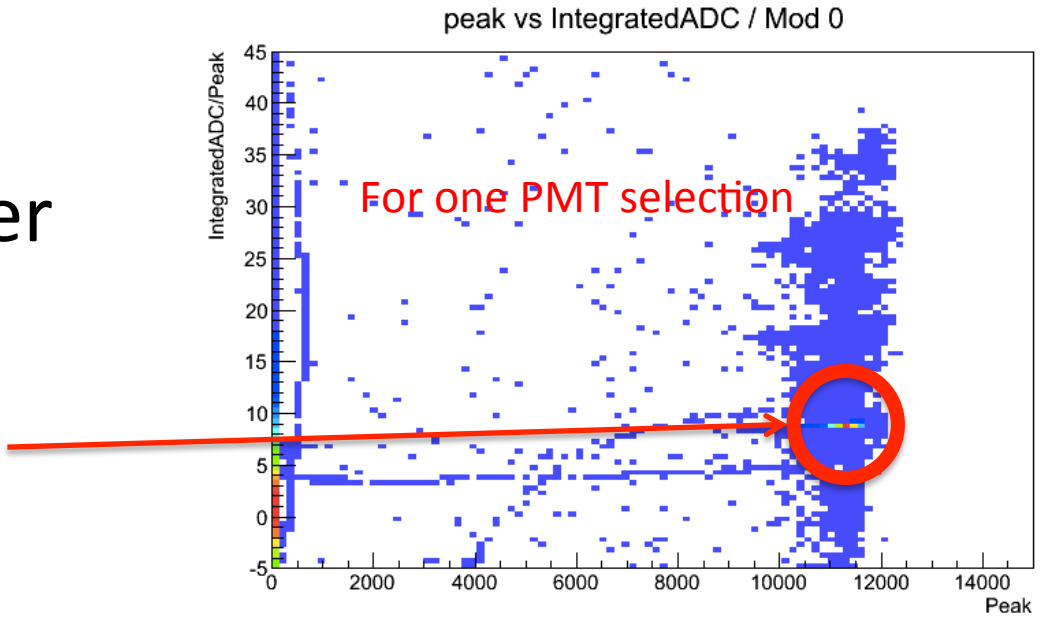


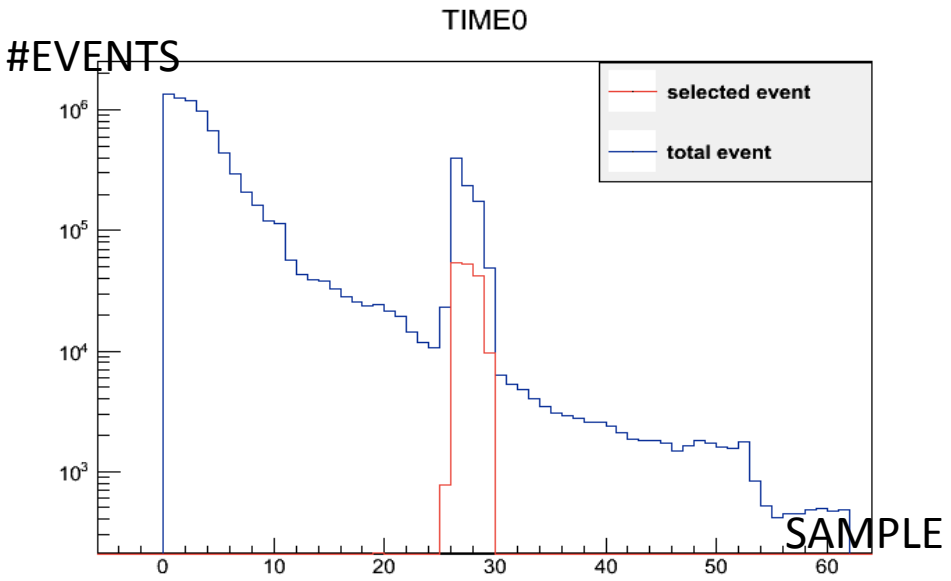
- 16 PMTs
- Both end read out for each scintillator



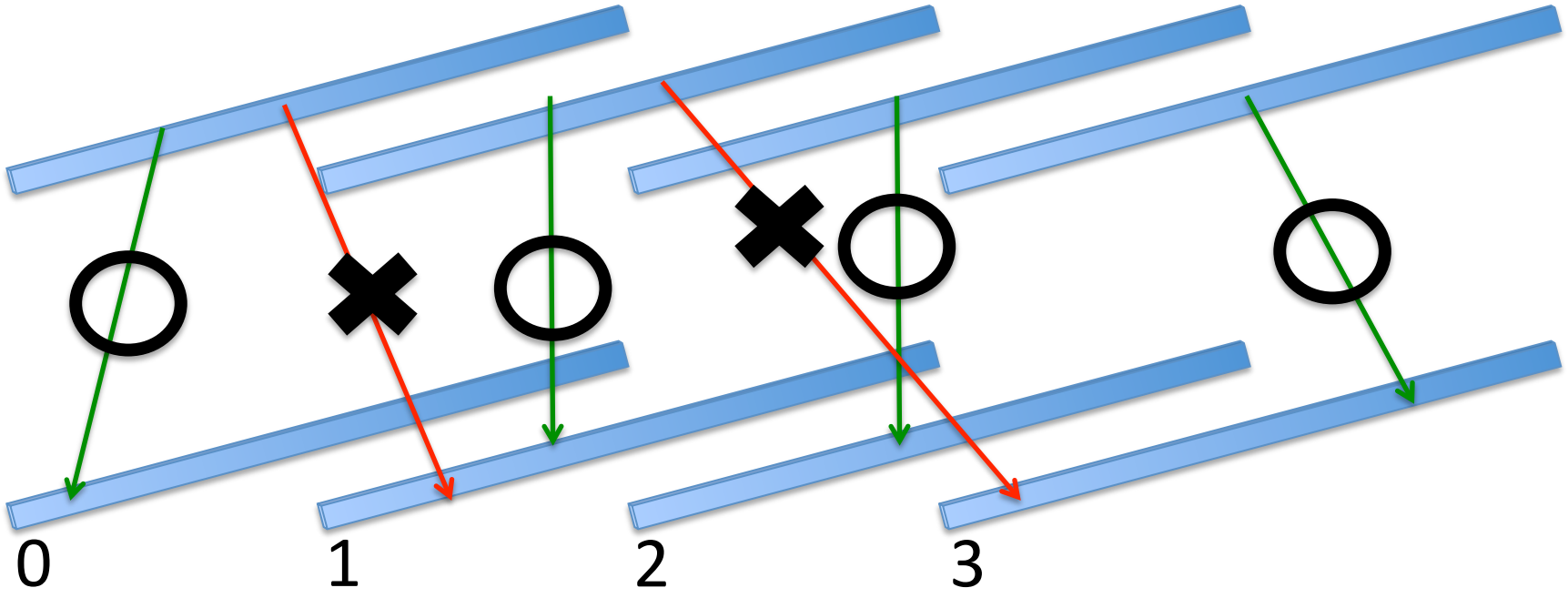
Cosmic counter data

- Take logic signal after discrimination
- Selection condition
  - Peak
    - Logic signal
  - Integrated ADC / peak
    - Stability of pulse shape
  - Coincidence with the other side PMT && Downside scintillator





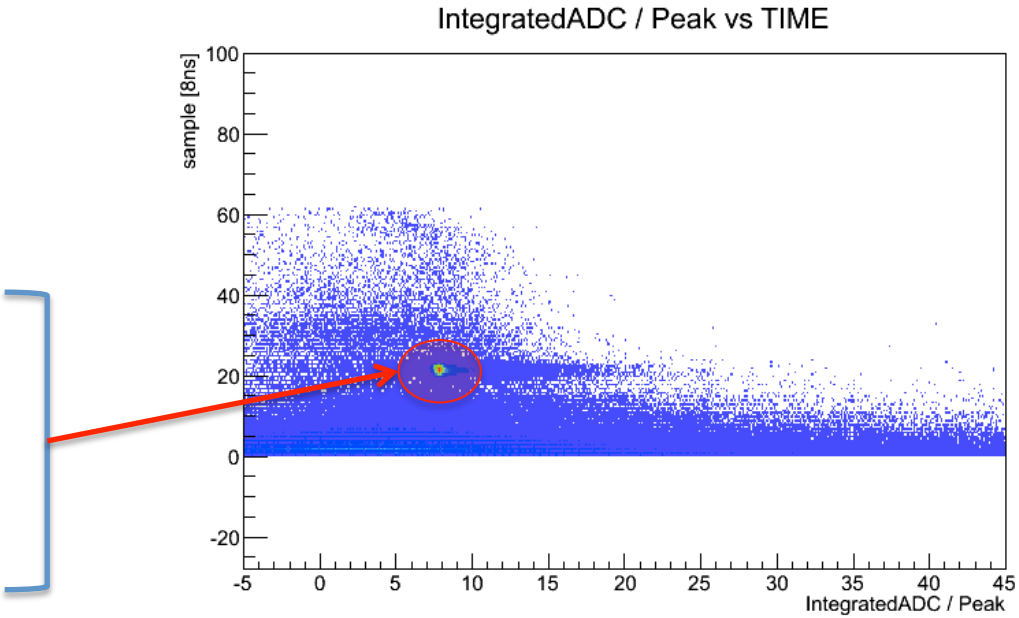
data selection

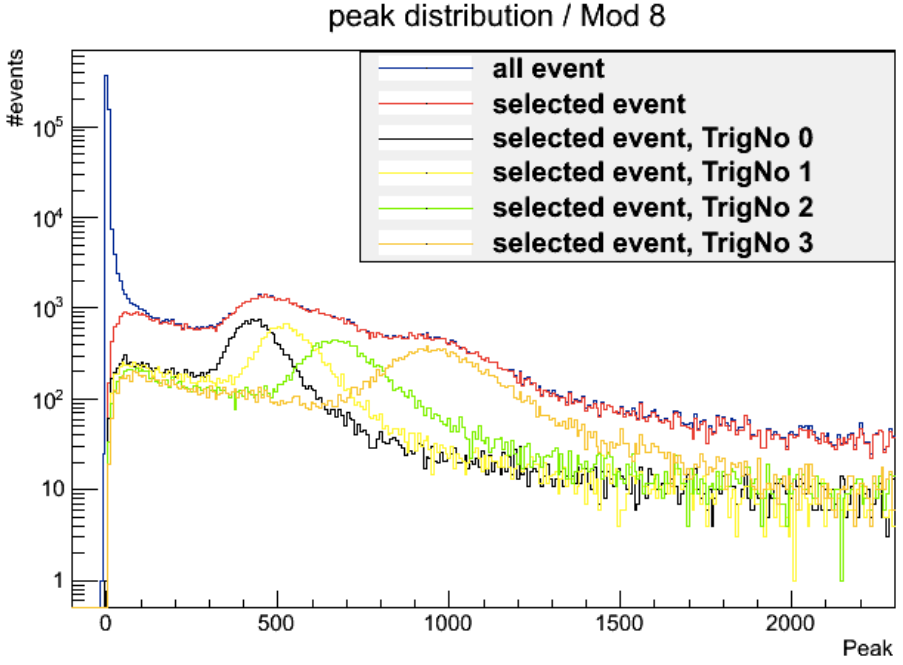


- Event selection mechanism
  - Upstream cosmic counter && downstream cosmic counter which have same beam direction position coincidence signal

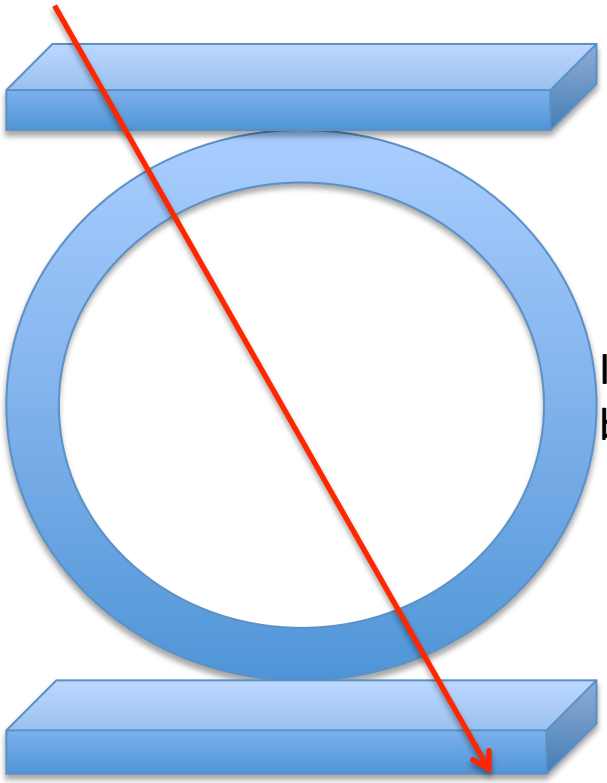
IB event Selection

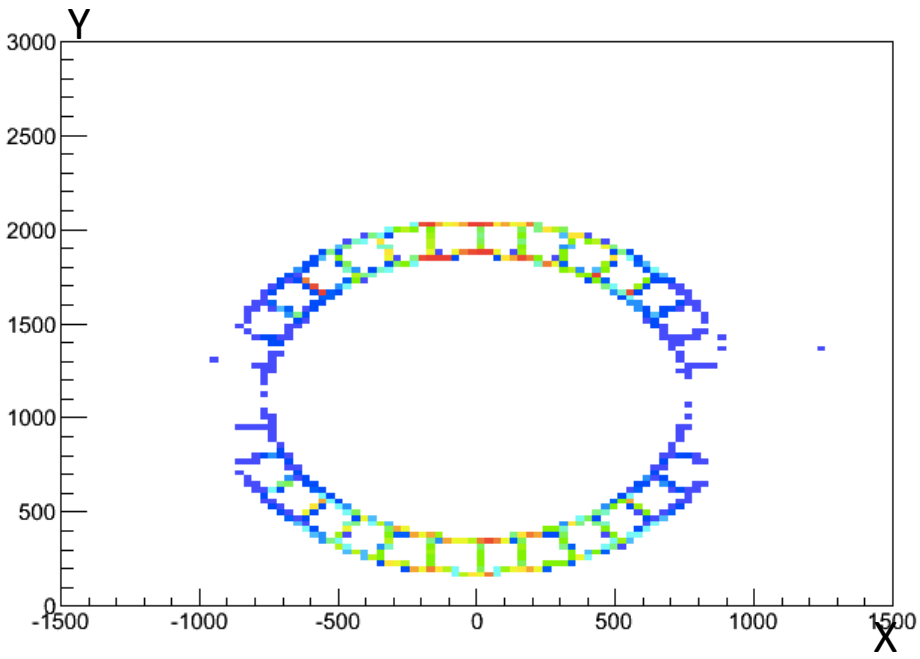
- Selection condition
  - Time
    - Delay timing
  - Integrated ADC / peak
    - Stability of pulse shape
- Peak distribution
  - After selecting, reduced backgrounds.
  - Landau distribution
  - Each distribution along position of 4 cosmic counters





Cosmic ray tracking

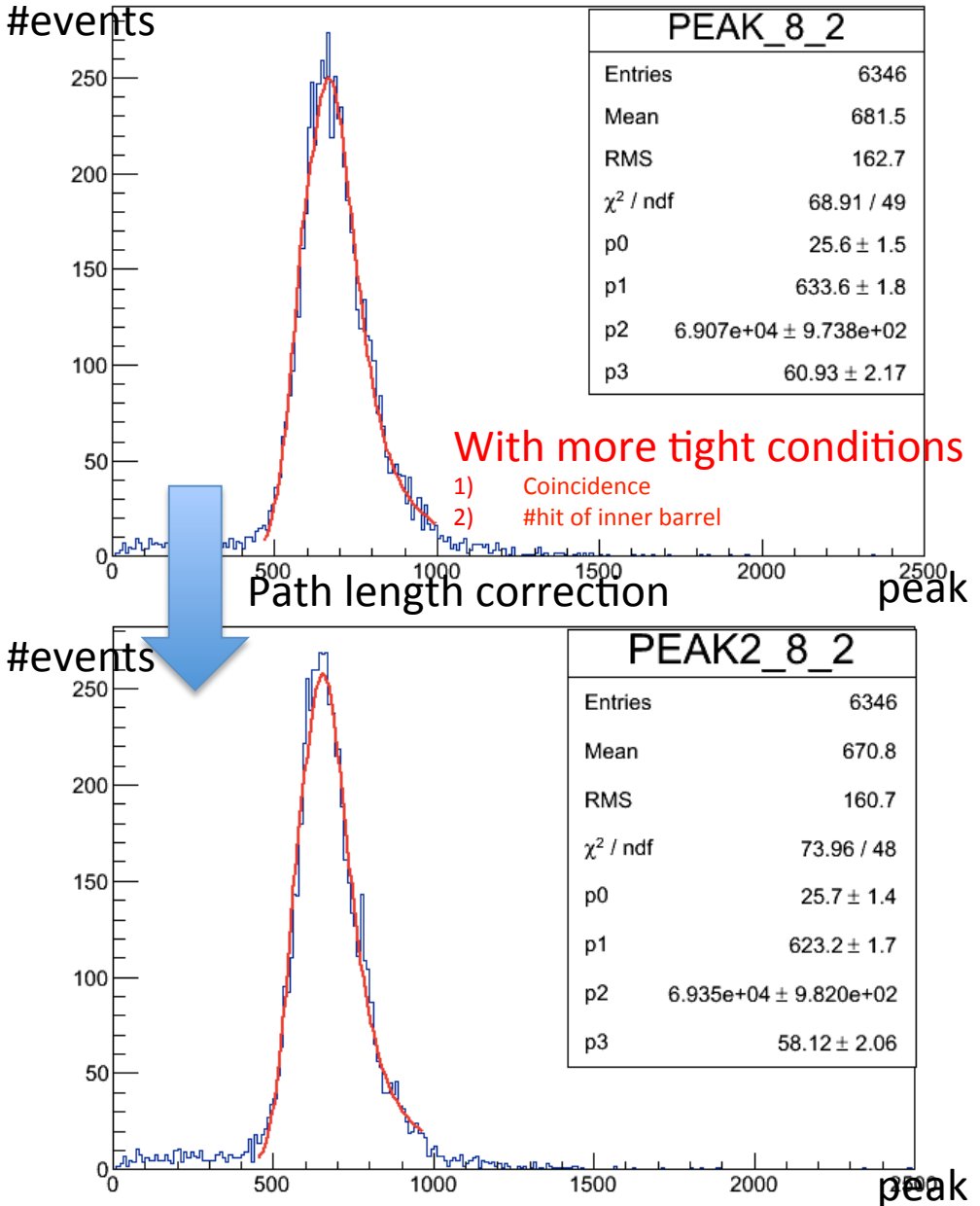




- Cosmic ray track from two cosmic counters
- Only 2hit event in inner barrel.
- Reconstructed cosmic ray position on boundary of inner barrel

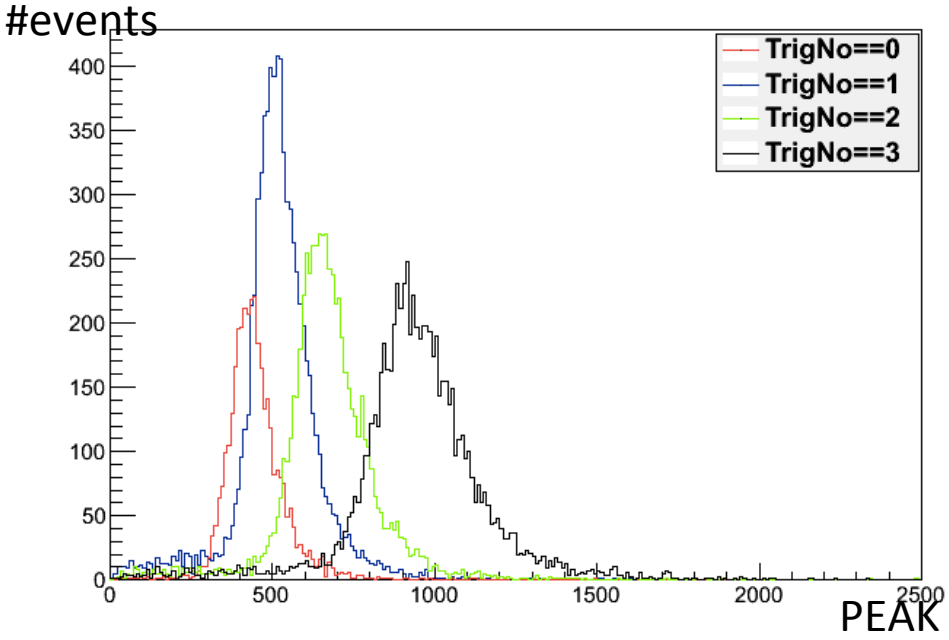
ADC spectra

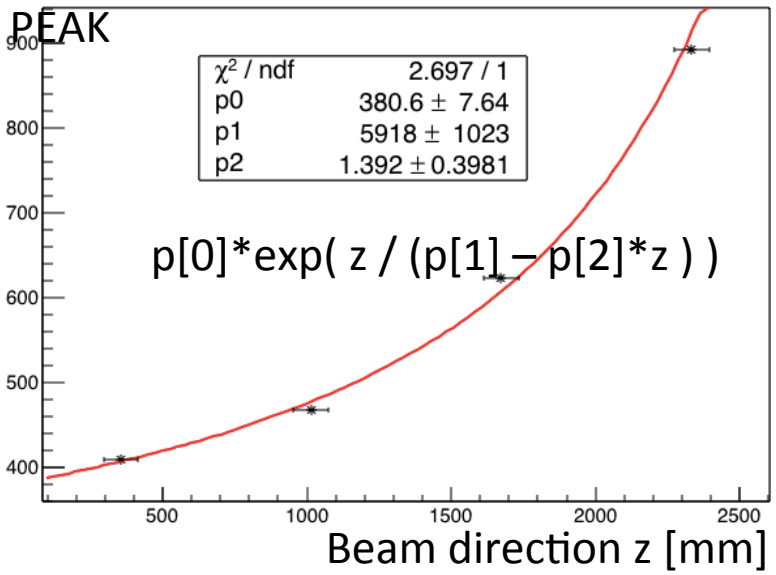
- Fit Function
  - Landau-gaussian convolution
- Path length normalization
  - ADC normalization with regard to path length of cosmic ray
  - Under 2% correction



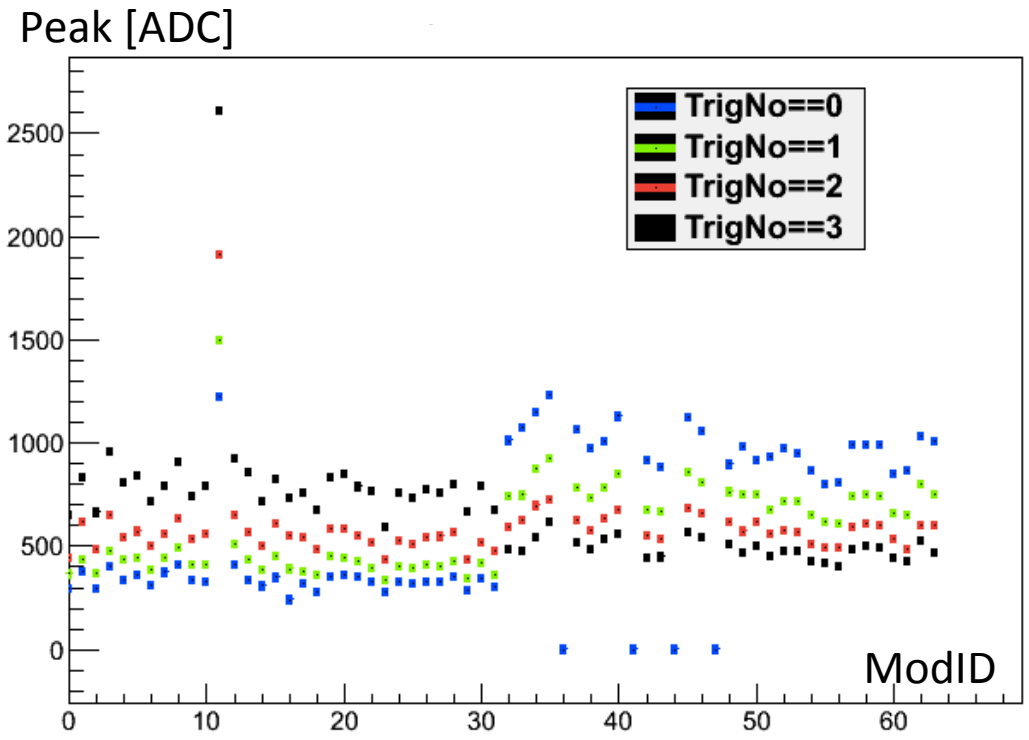
Attenuation

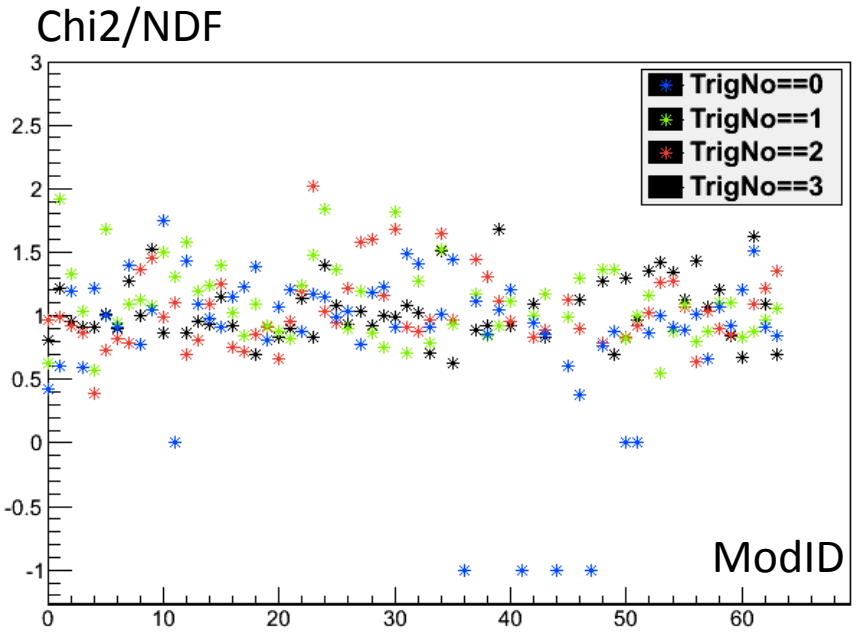
- Fit function
  - Effective exponential function (empirical)
- Only 4 data point
  - For each cosmic counter





MIP check for all PMTs

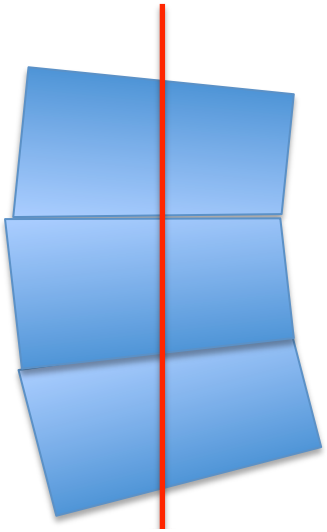




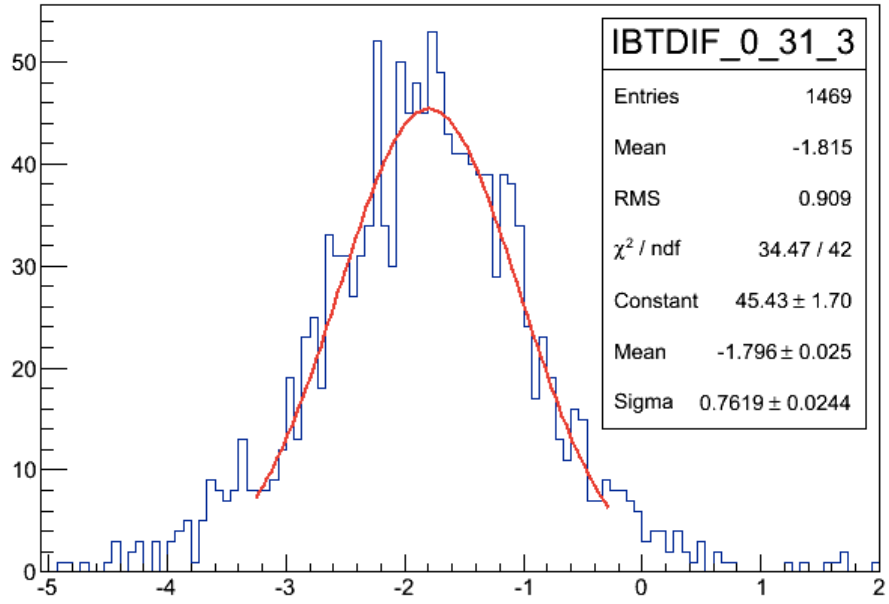
- One big gain mis-match (ch 11)
- 4 dead PMT (ch 36, 41, 44, 47)
- Fitting results of some PMTs are not good
  - Fitting MIP Peak distribution by hand

Timing resolution

- Track selection
  - Require continuous 3 modules hit
  - Get resolutions of
    - Mod0-Mod1
    - Mod0-Mod2
    - Mod1-Mod2
- Calculate each resolutions
  - Mod0 : 0.55ns
  - Mod31 : 0.52ns
  - Mod30 : 0.58ns



IBTDIF Mod1 : 0 / Mod2: 31 / TrigNo : 3

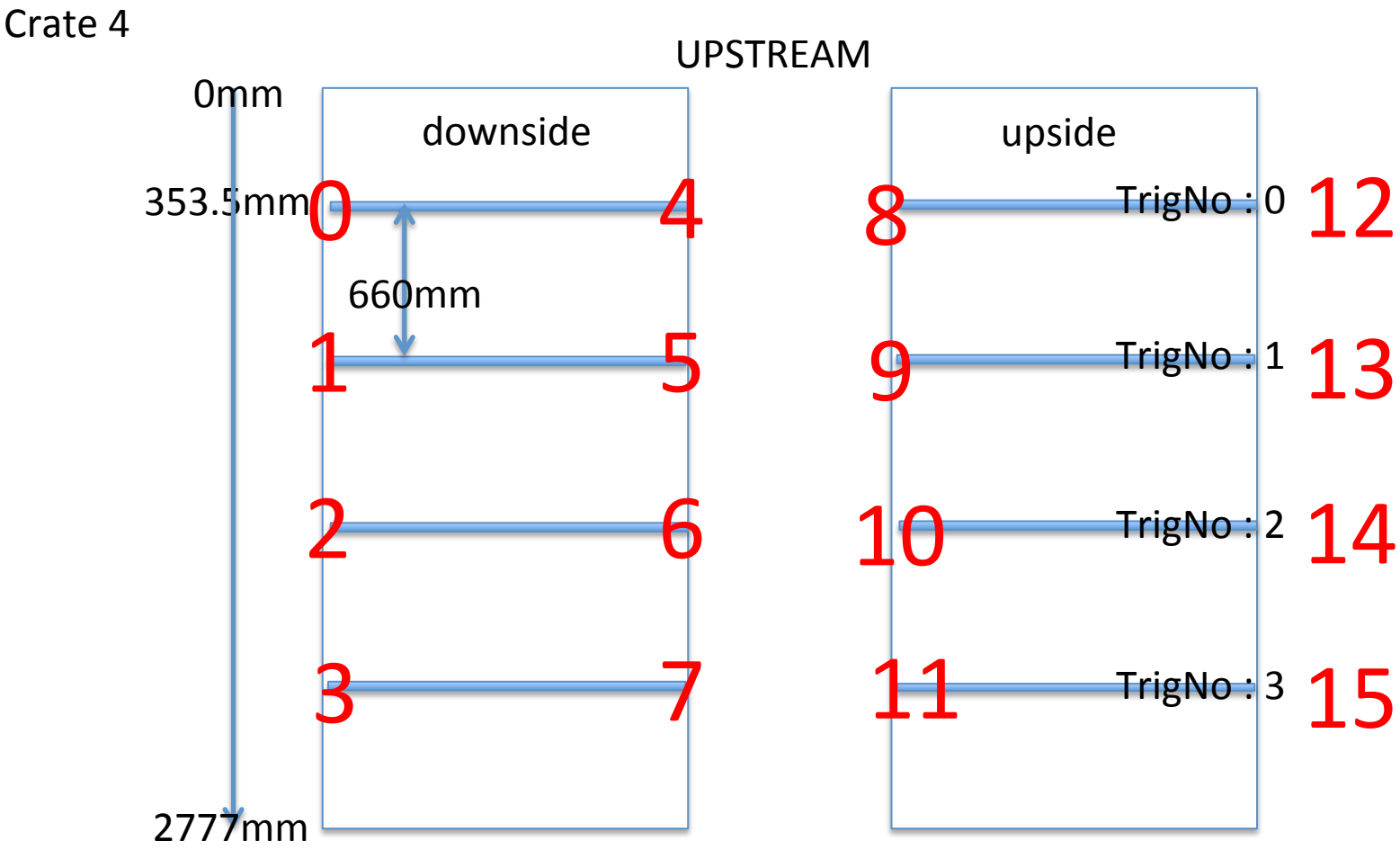


result

- Check MIP for possible module
  - One bit gain mis-matched PMT at downstream
  - 4 dead PMTs at upstream
  - Check attenuation effect
- Get timing resolution of modules @ MIP
  - ~0.6ns

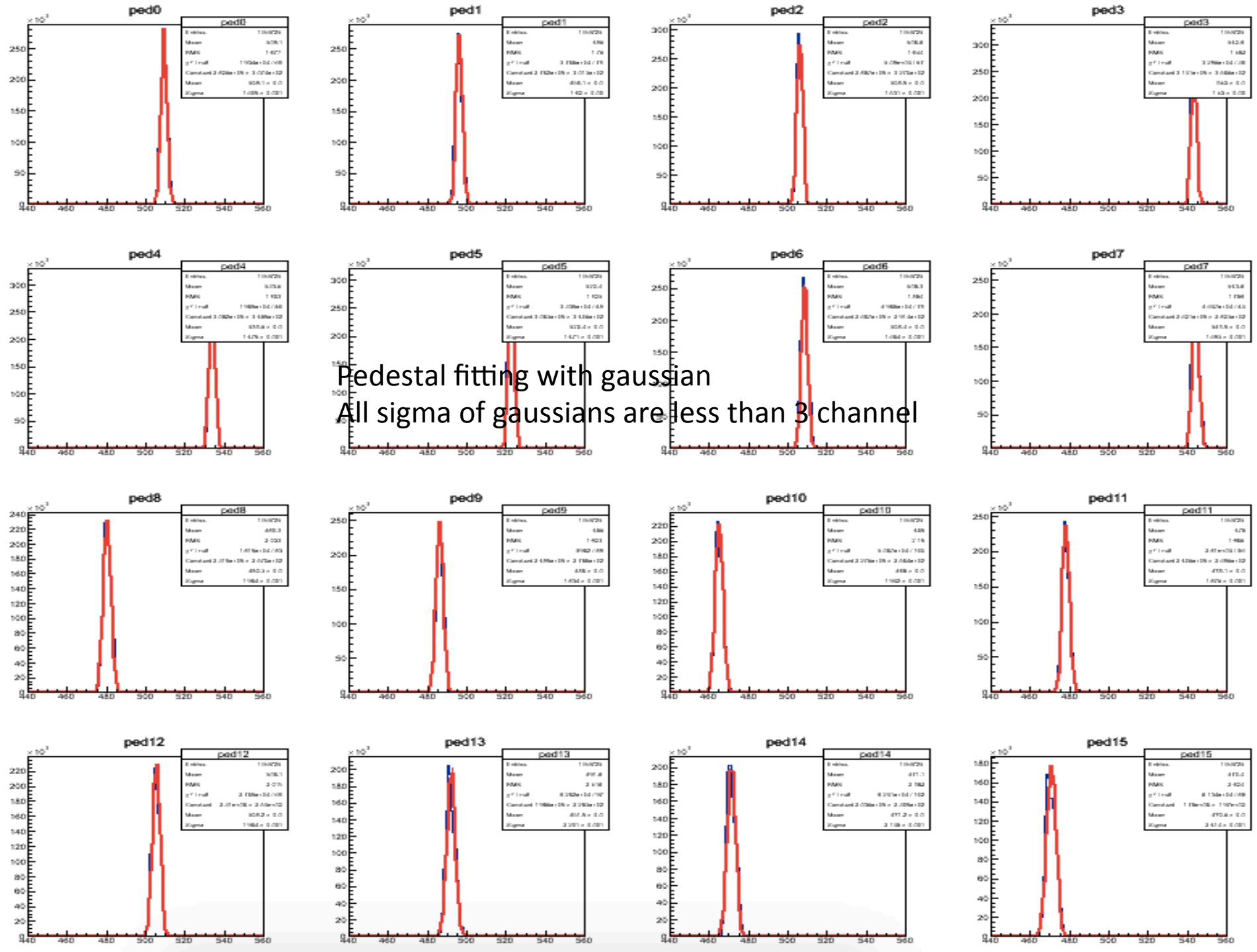
backup

Trigger PMT assignment



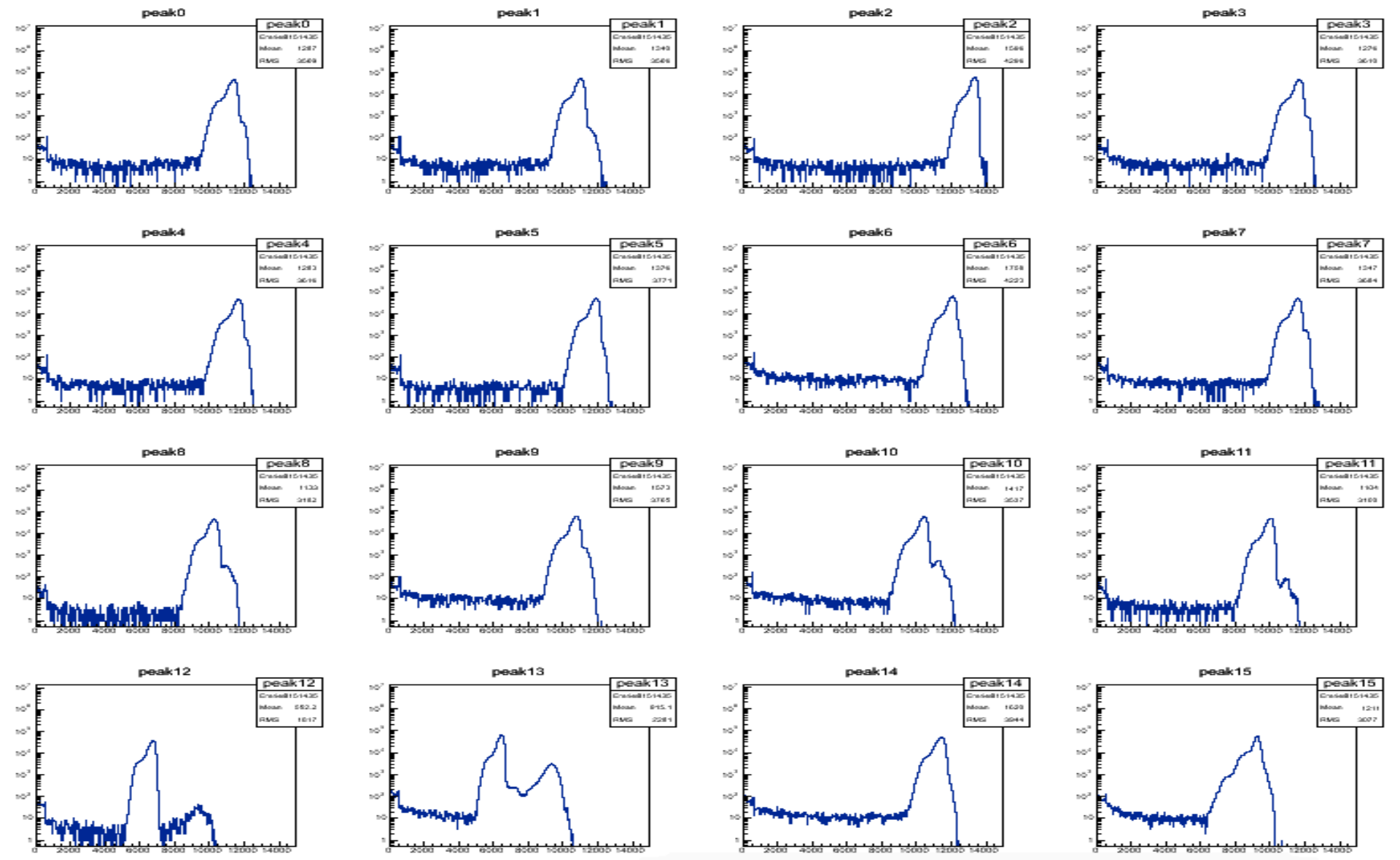
Inner barrel PMT assignment

- 0~31 : Downstream PMT
- 32~63 : Upstream PMT
- 36, 41, 44, 47 PMTs are broken
- Crate0~3

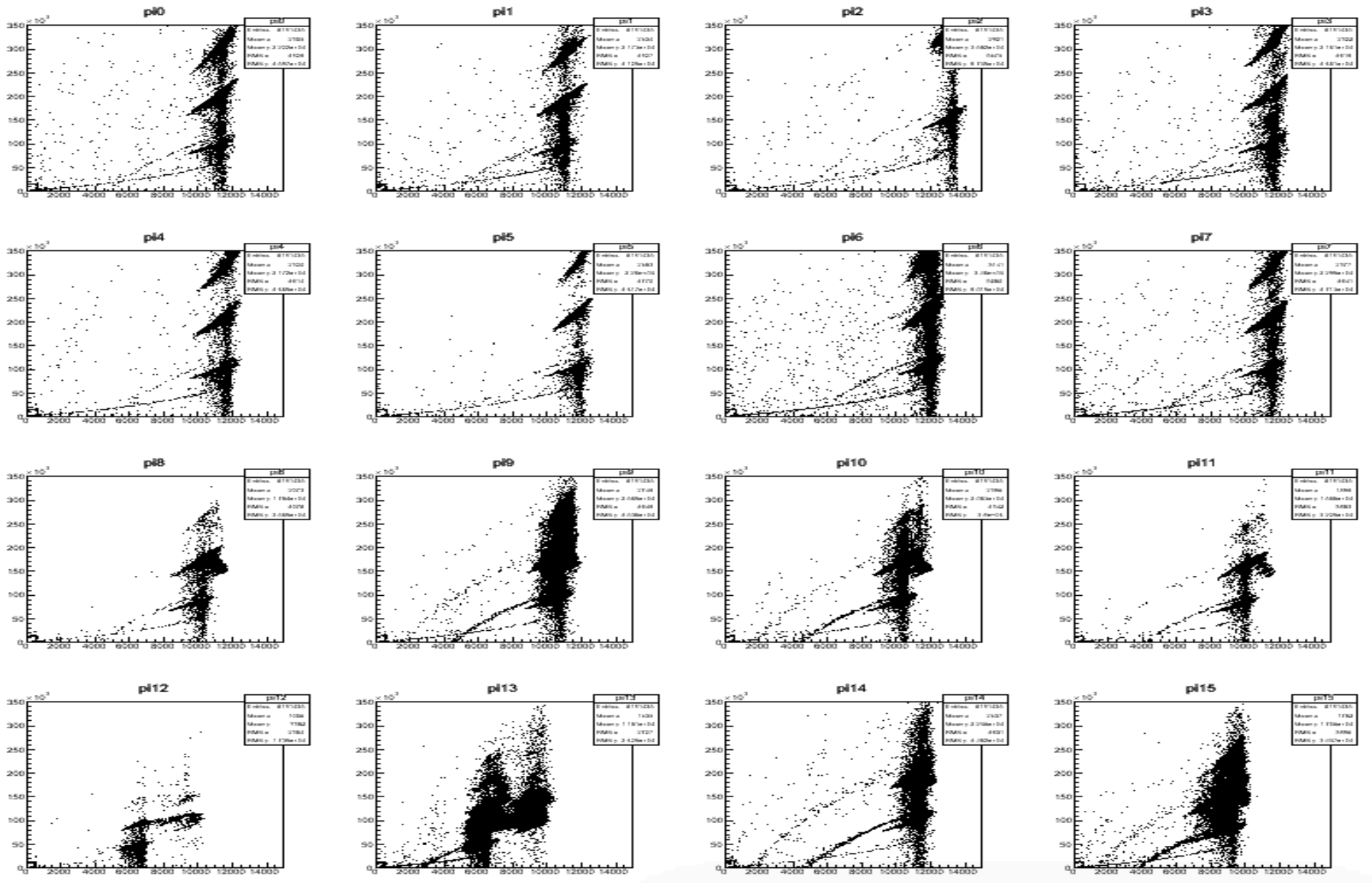


Pedestal fitting with gaussian

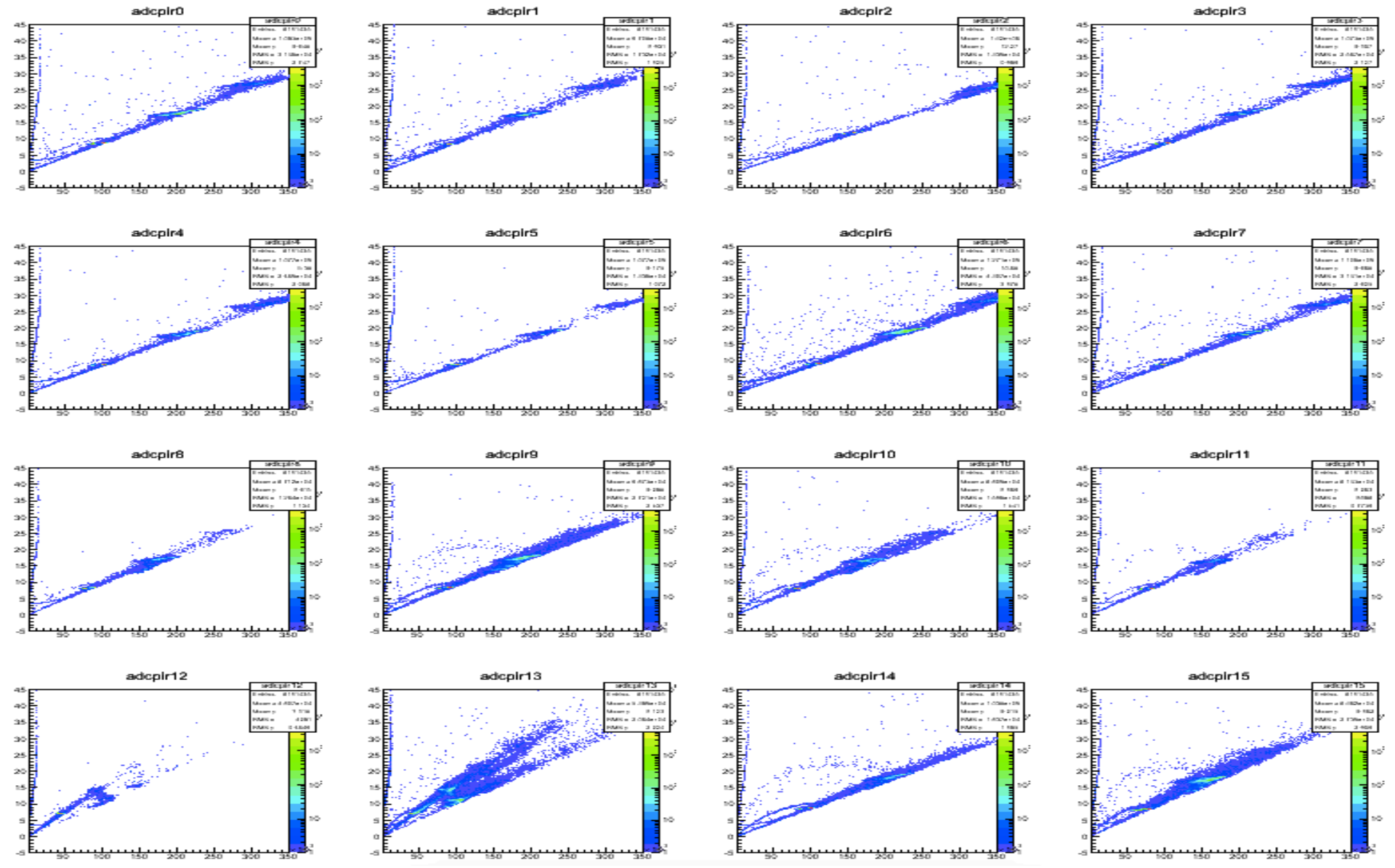
All sigma of gaussians are less than 3 channel



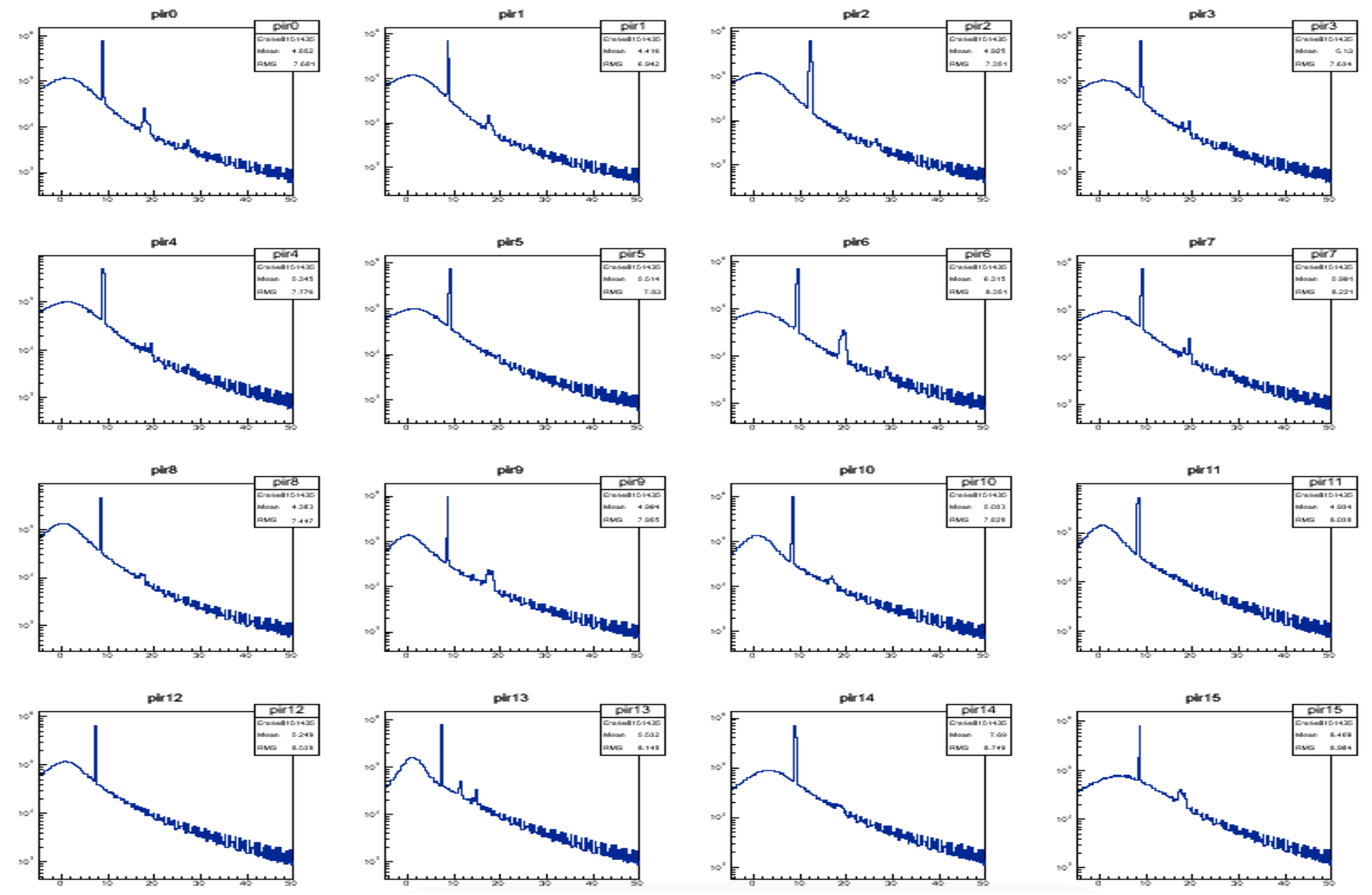
- Peak distribution (x-axis : peak, y-axis : # events)
- Ch12, ch13 have wired distribution,
  - Just select peak which has smaller value.



- Peak vs IntADC(x-axis : peak, y-axis : IntADC)
- Same peak with different ADC -> # of signal?
- Same ADC with different peak -> ??

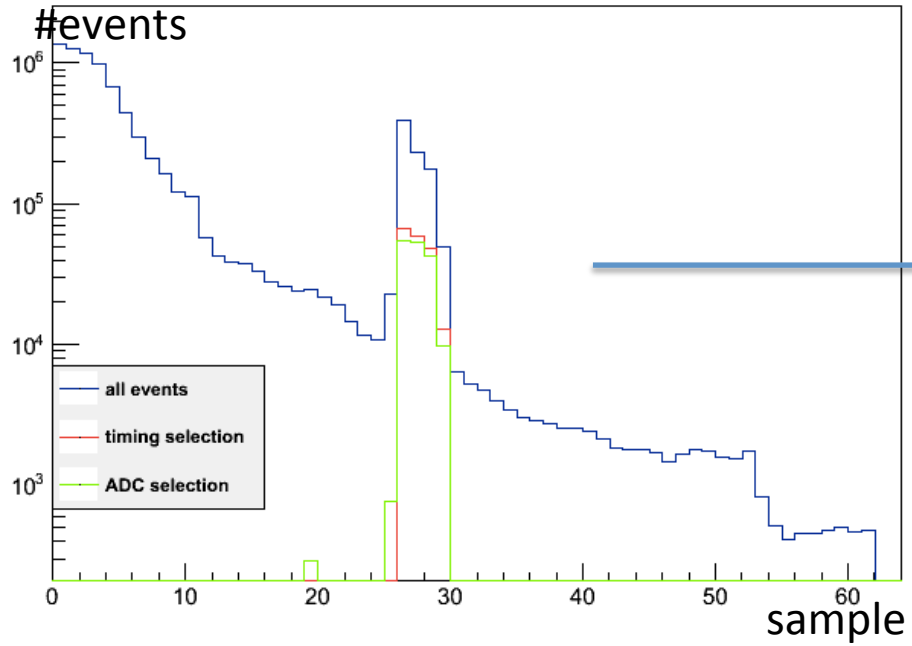


- X-axis : adc, y-axis : adc/peak



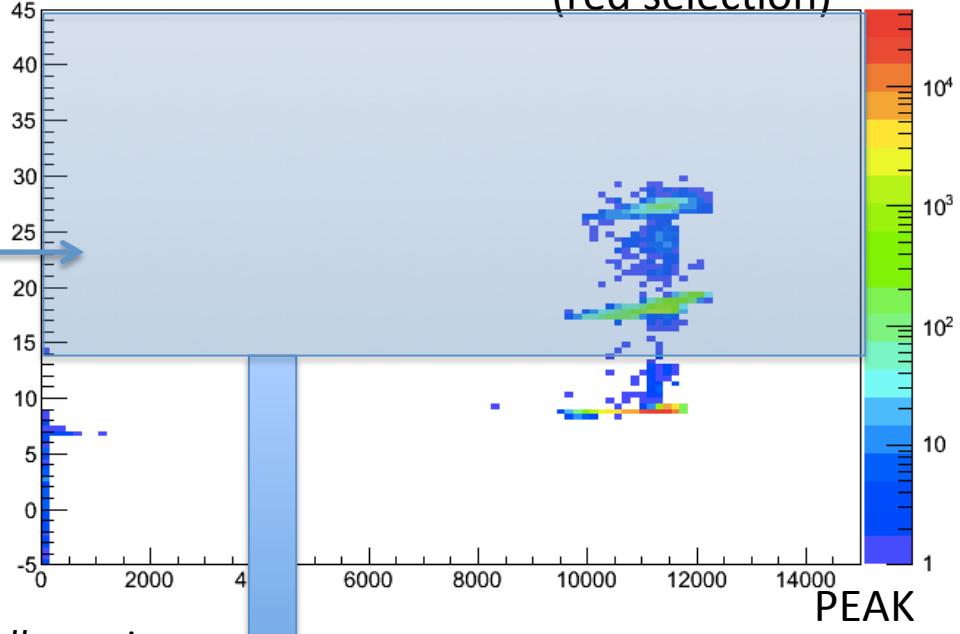
- IntADC / peak distribution (x-axis : peak, y-axis : #events)
- For ch13, there is unusual peak(same ADC with diff. peak)
- Select intADC/peak

Cosmic counter event selection



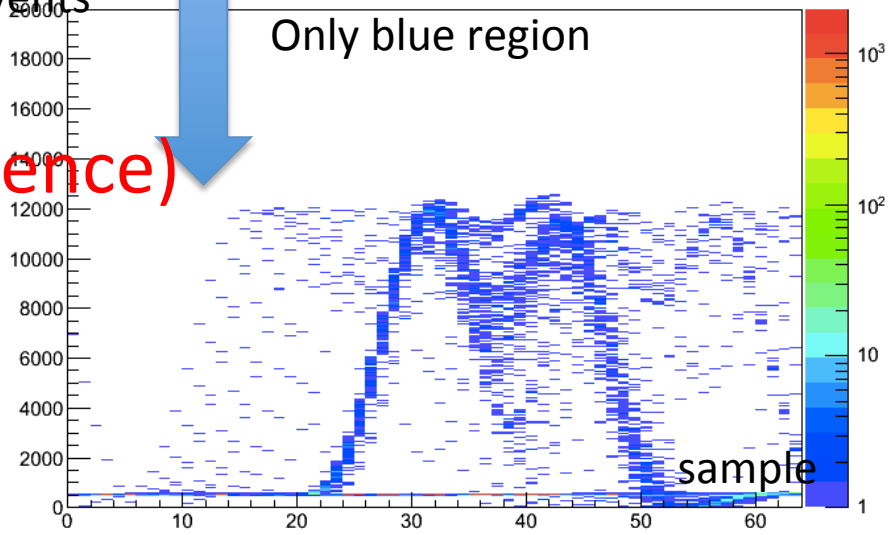
Int ADC / Peak

Timing selection
(red selection)



#events

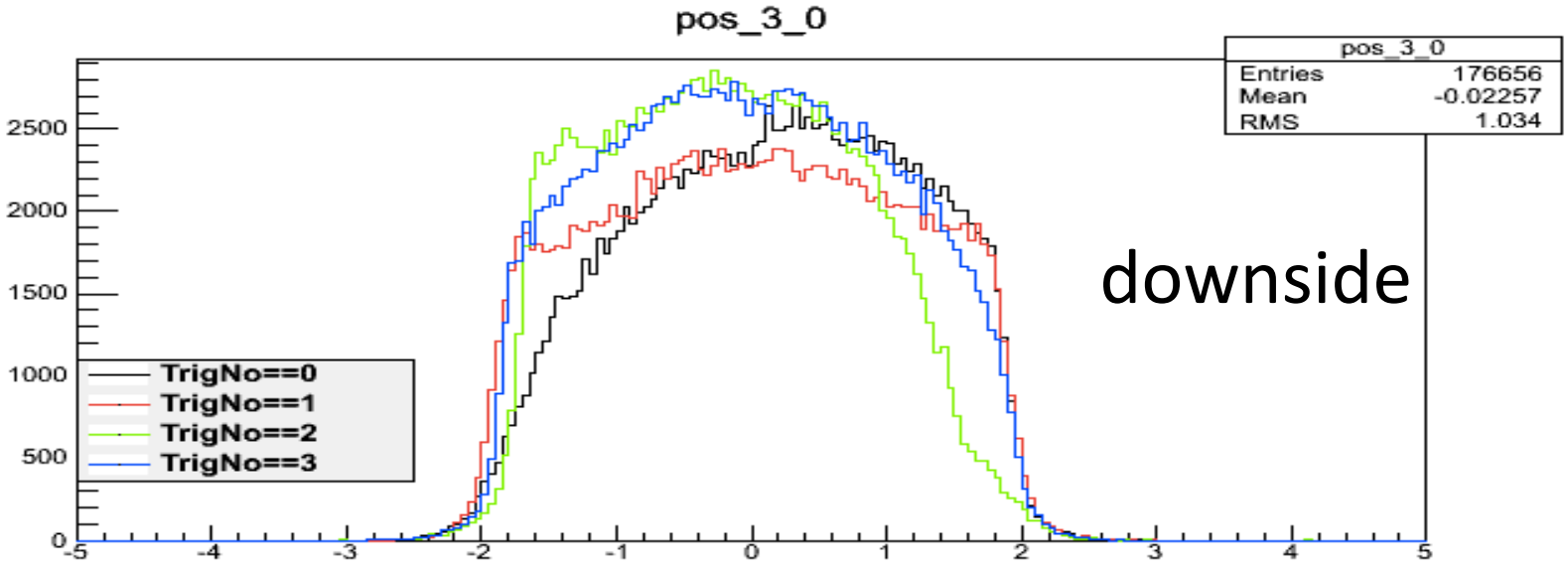
Only blue region

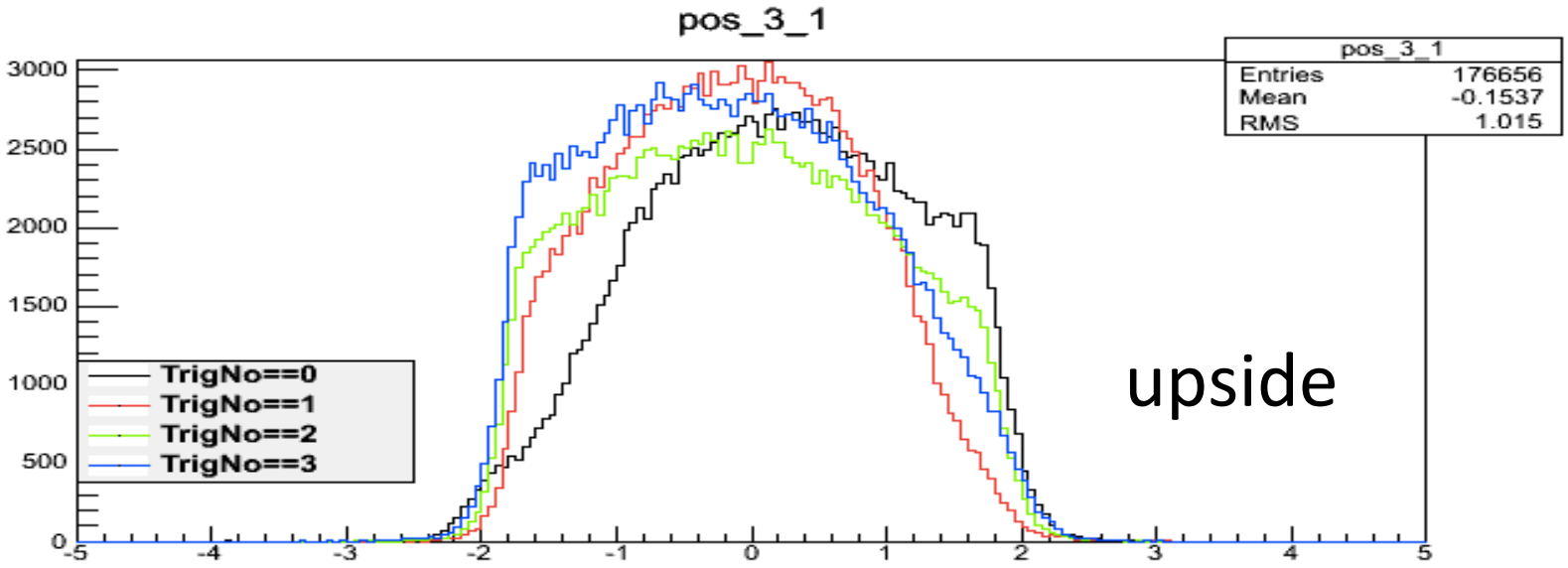


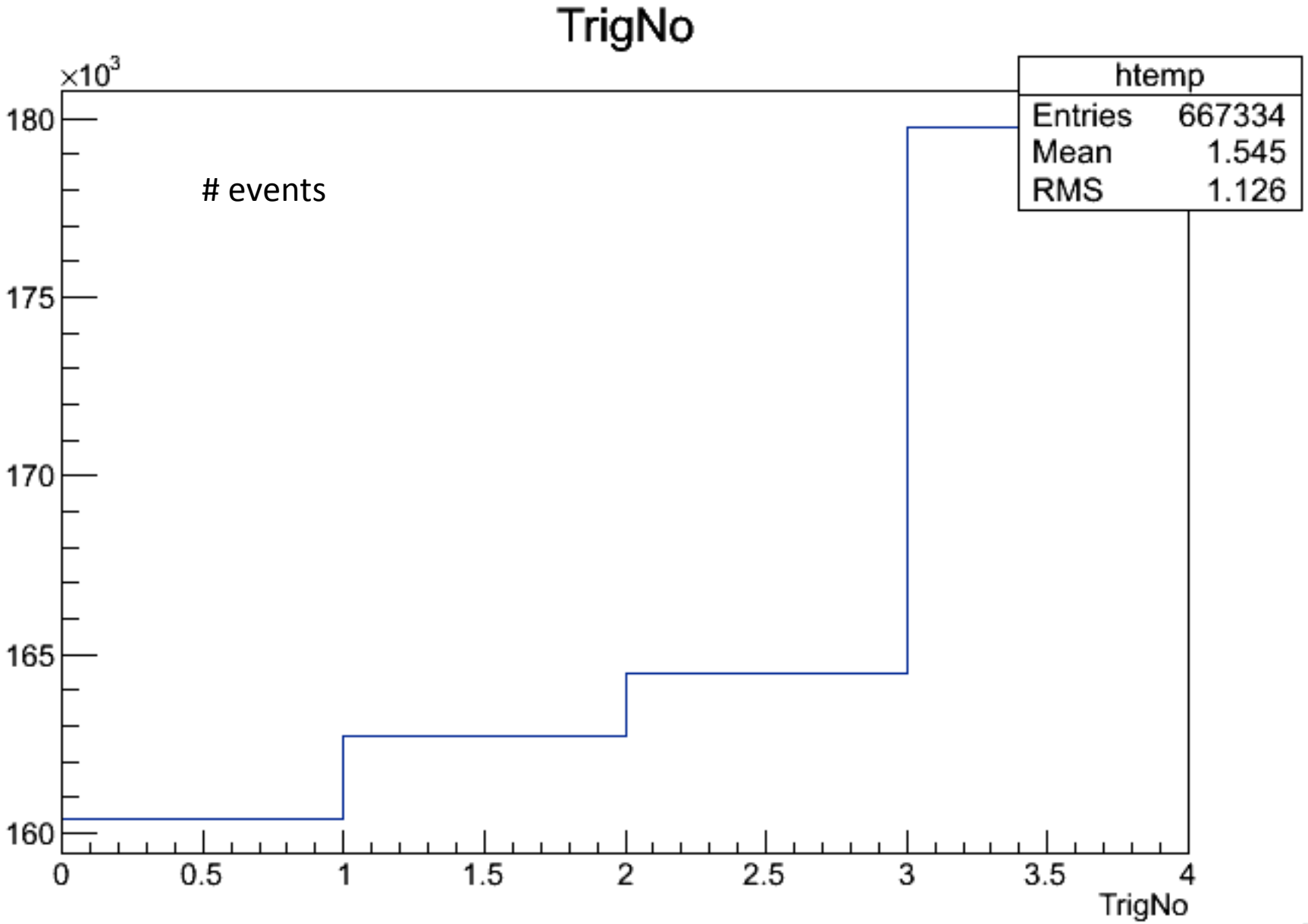
Selection with timing(4 coincidence)

-> some multiple logic signal

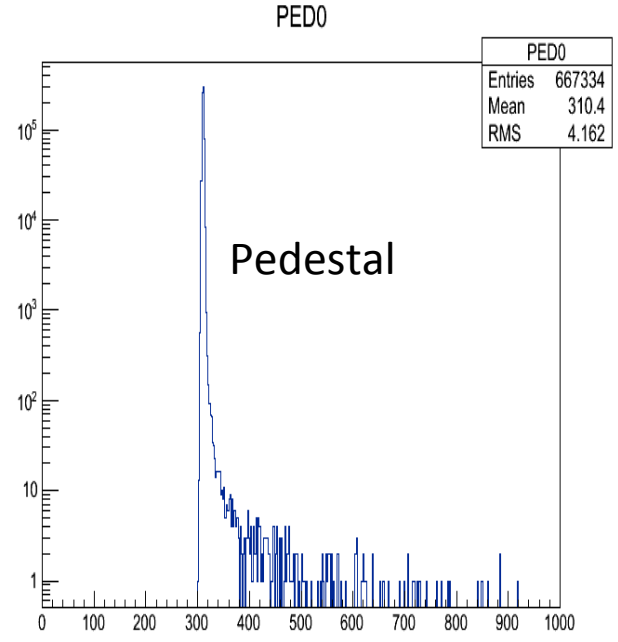
Cosmic counter timing difference

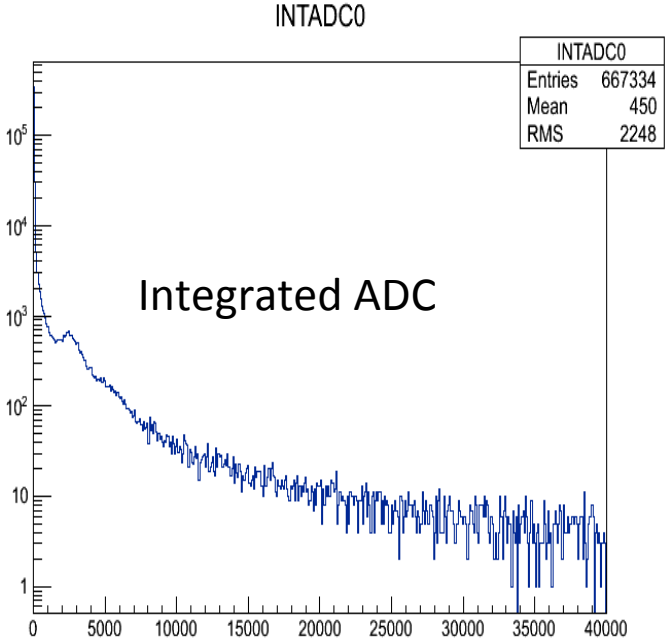


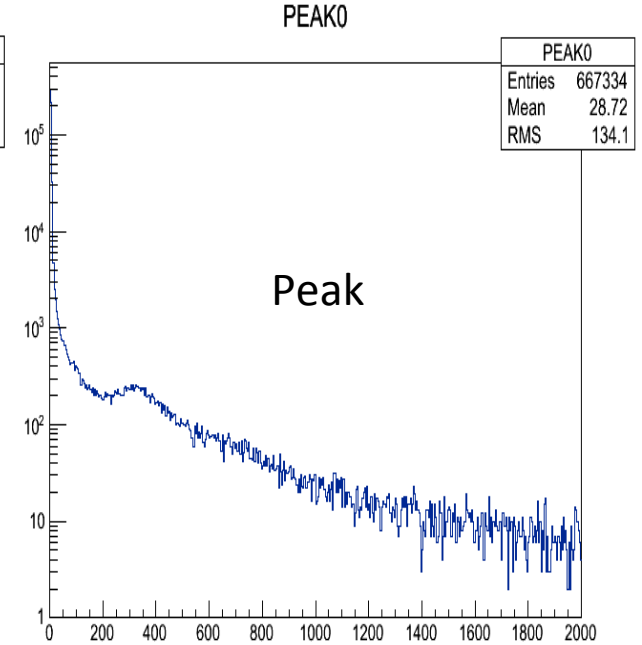


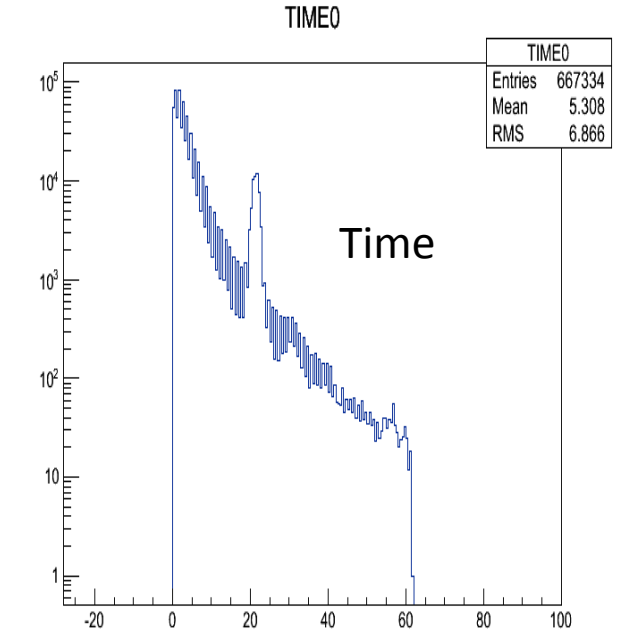

TrigNo
htemp
Entries 667334
Mean 1.545
RMS 1.126
events
×10^3
180
175
170
165
160
0
0.5
1
1.5
2
2.5
3
3.5
4
TrigNo

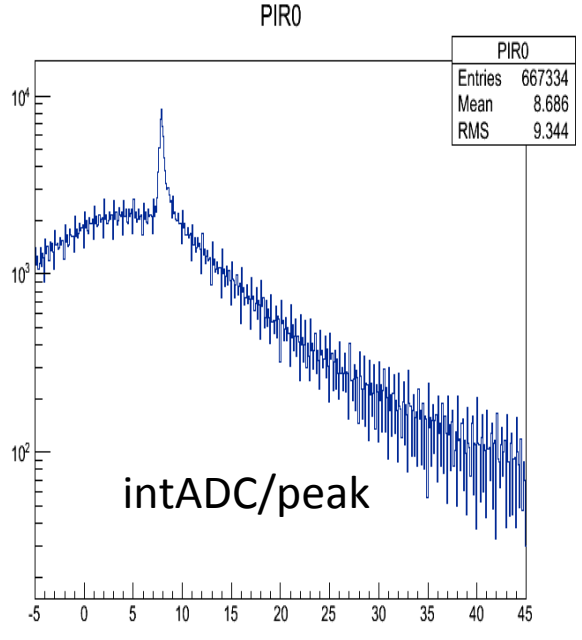
IB event selection (ch0)







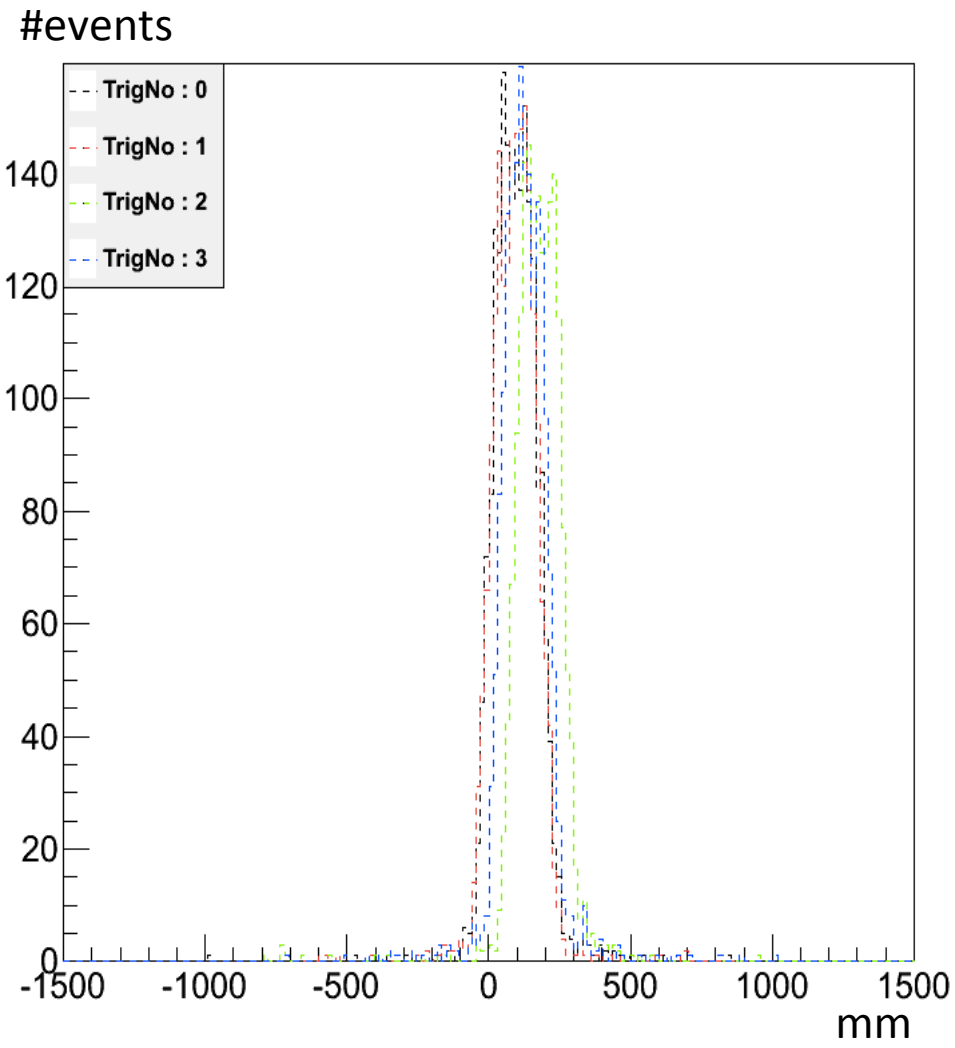




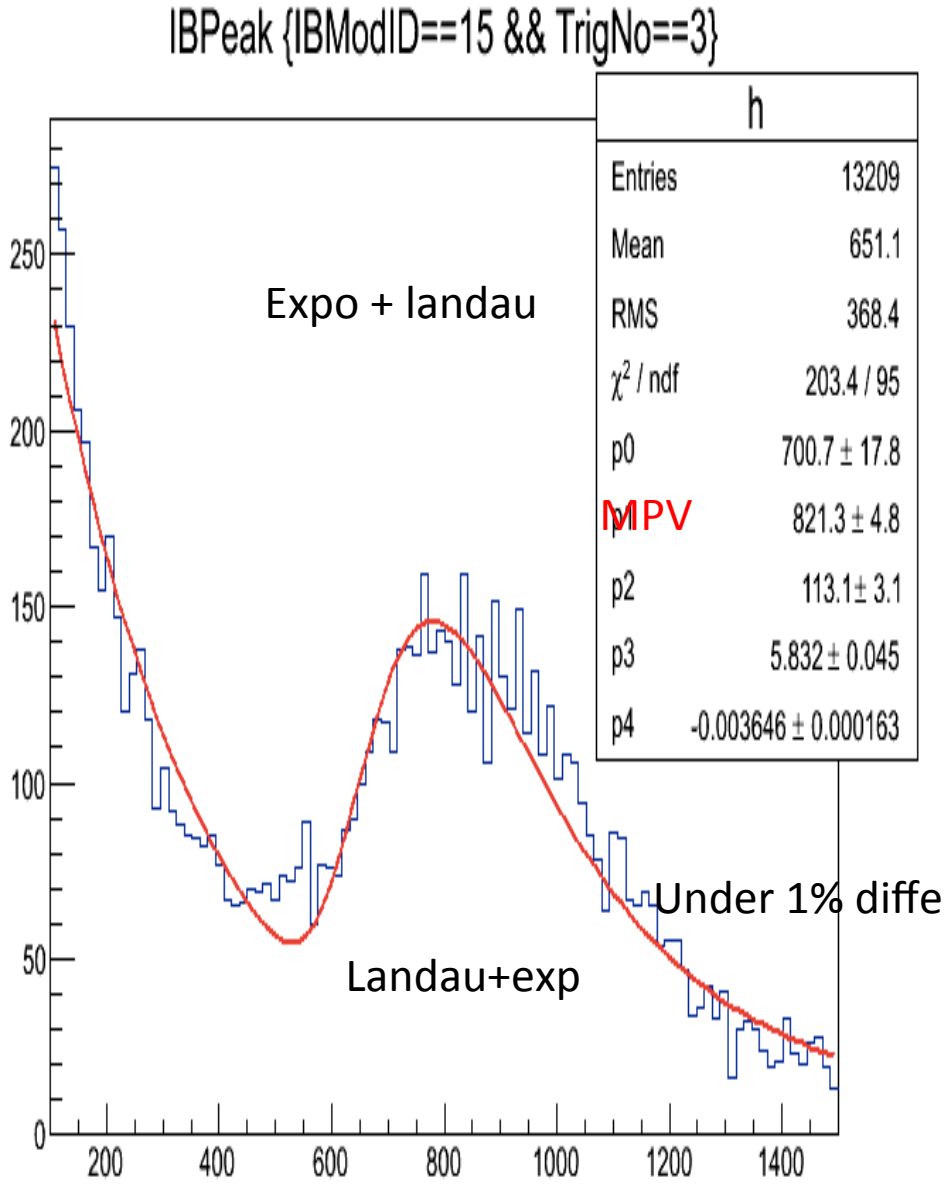
Pedestal : stable
IntegratedADC. Peak : there is MIP peak
Time, intADC/peak : variables to select real cosmic ray event

hit positions @ cosmic counter

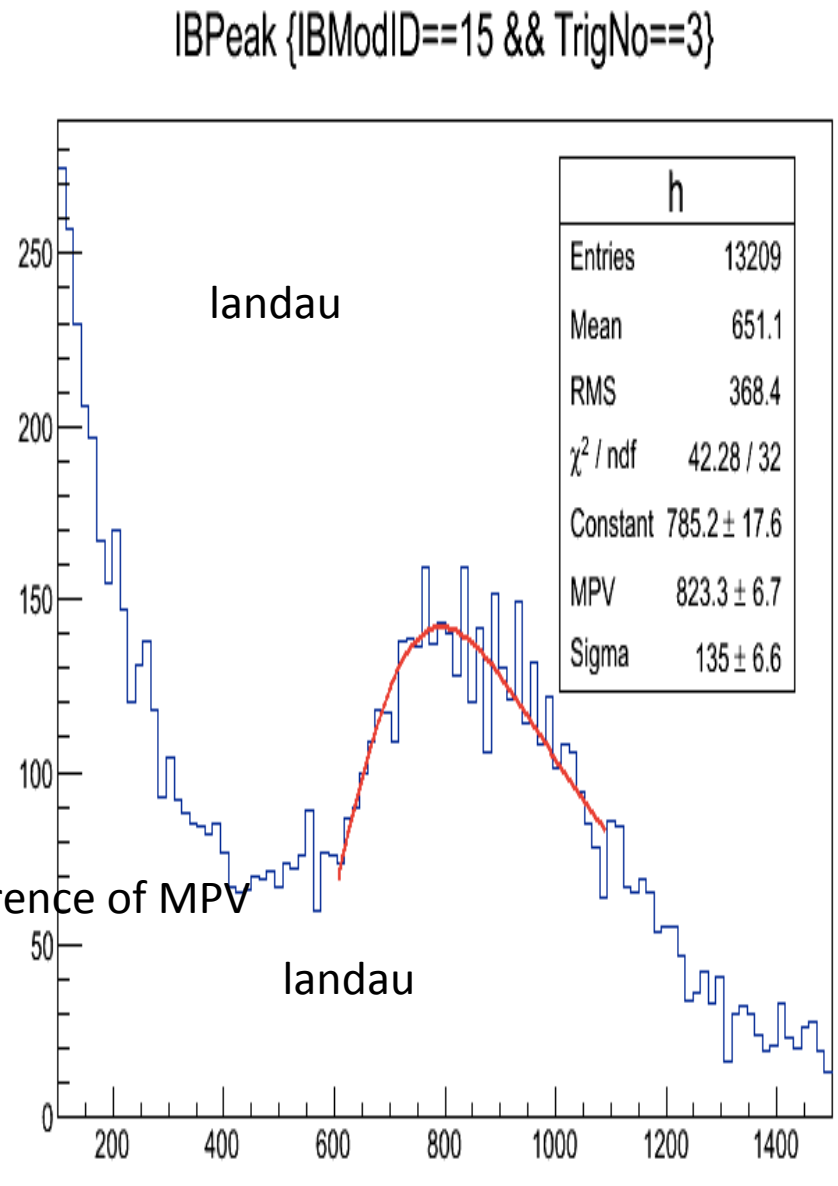
- Hit position distribution
  - Downside cosmic counter
- Require 2 inner barrel hit condition
  - ModID8 && ModID24



BG

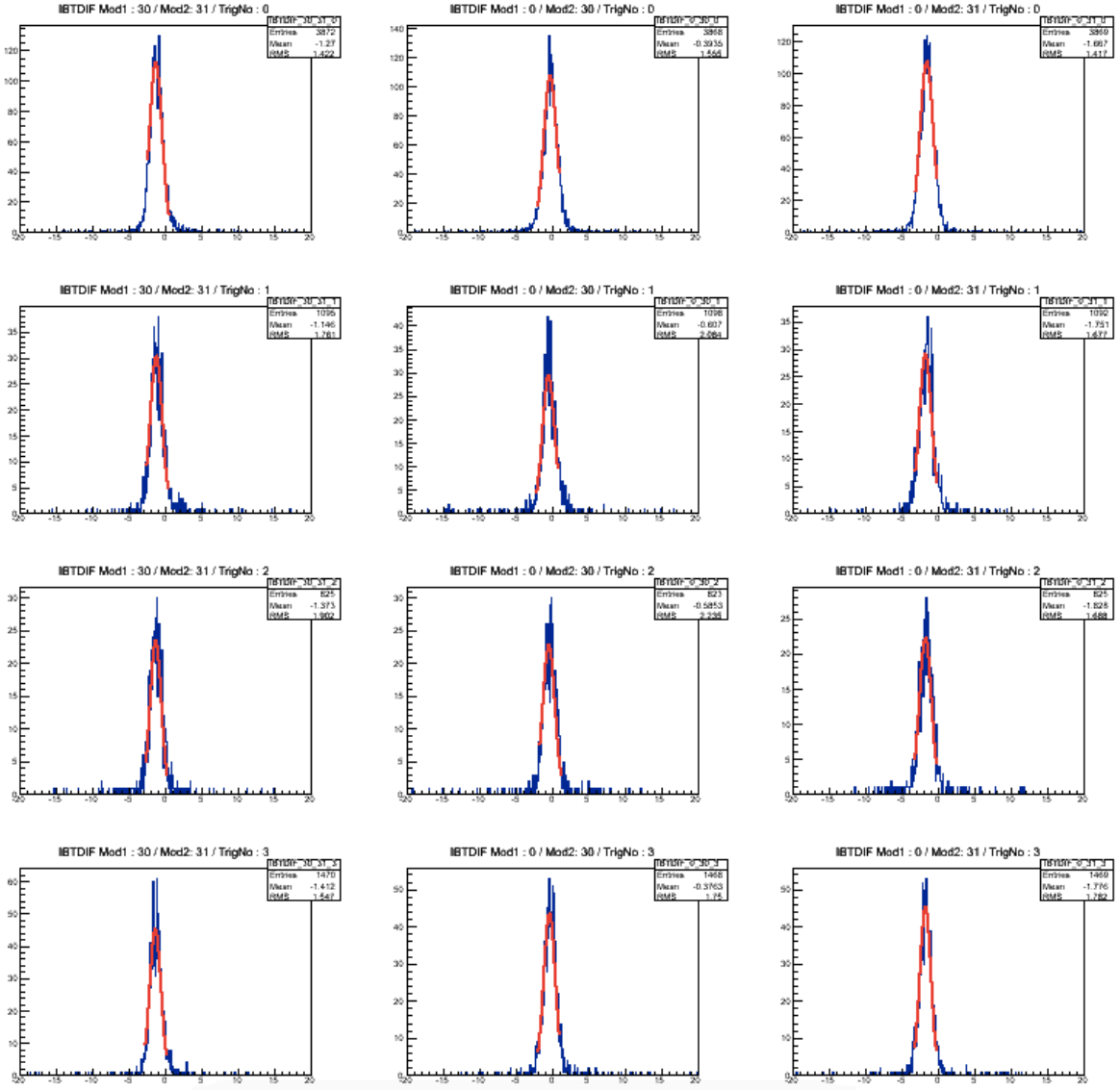


Under 1% difference of MPV

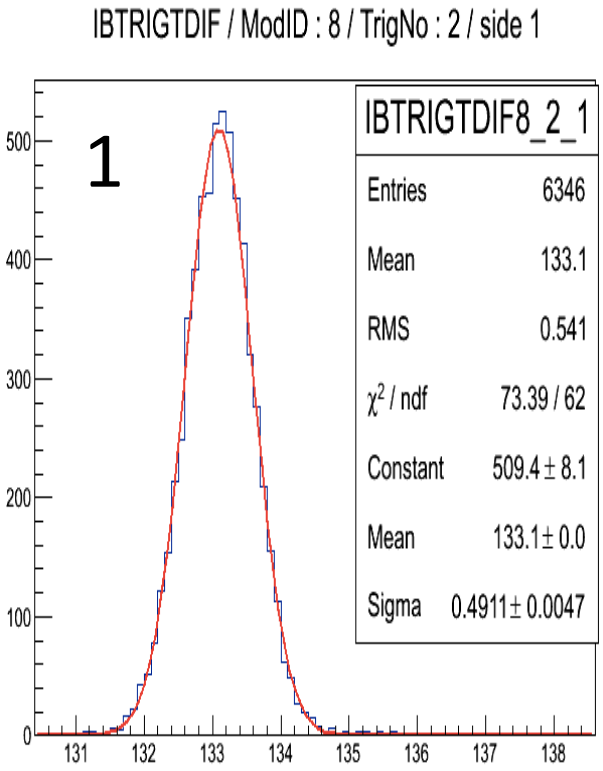


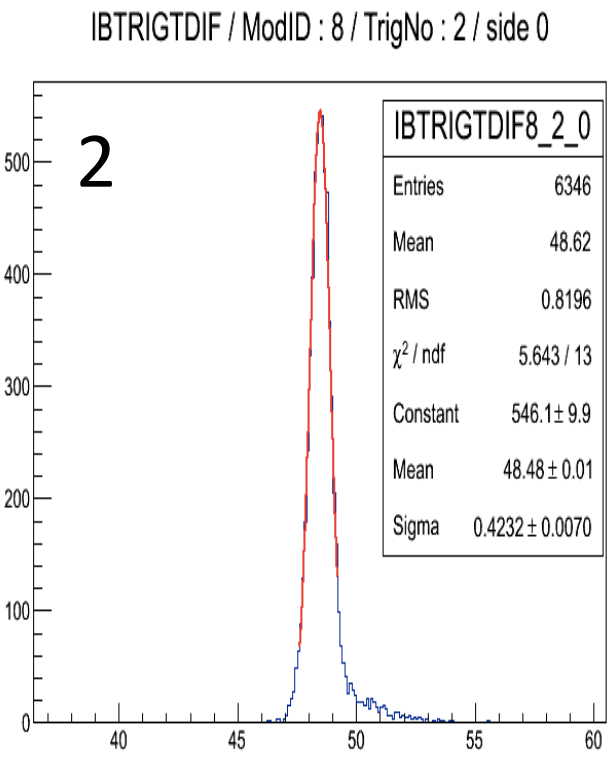
Timing resolutions

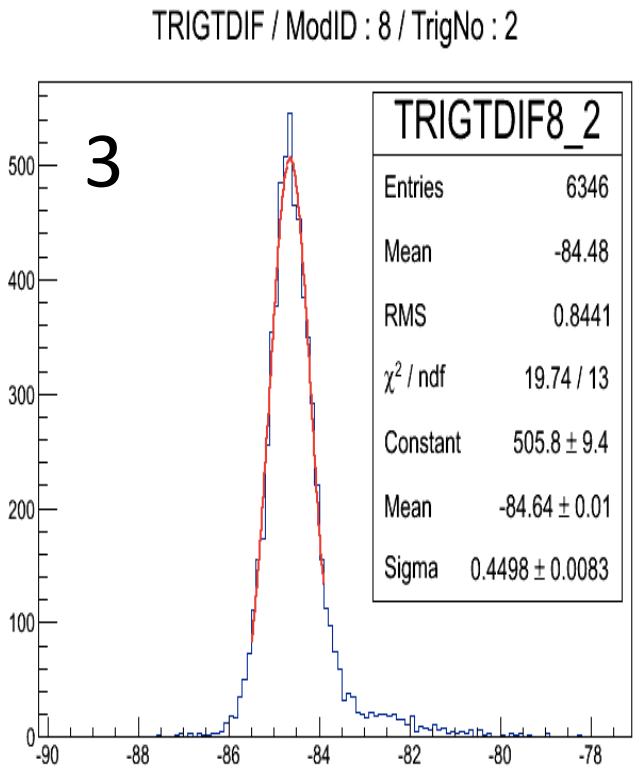
----------TrigNo : 0----------
ModID : 0 / resolution : 0.674198
ModID : 30 / resolution : 0.595822
ModID : 31 / resolution : 0.618283
----------TrigNo : 1----------
ModID : 0 / resolution : 0.613557
ModID : 30 / resolution : 0.596095
ModID : 31 / resolution : 0.599154
----------TrigNo : 2----------
ModID : 0 / resolution : 0.634848
ModID : 30 / resolution : 0.547371
ModID : 31 / resolution : 0.539864
----------TrigNo : 3----------
ModID : 0 / resolution : 0.557546
ModID : 30 / resolution : 0.582671
ModID : 31 / resolution : 0.519317



Mean timing resolution







- 1) Upside cosmic counter – inner barrel
- 2) Inner barrel – Downside cosmic counter
- 3) Upside cosmic counter – Downside cosmic counter
  - Inner barrel timing resolution : 0.3301 [ns]

TrigNo 0 problems

- discords
  - #events after cosmic ray tracking (p9)
  - Timing difference distribution (p22)