Energy Calibration of the $\bar{P}$ANDA Electromagnetic Calorimeter

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On behalf of IHEP/USTC group

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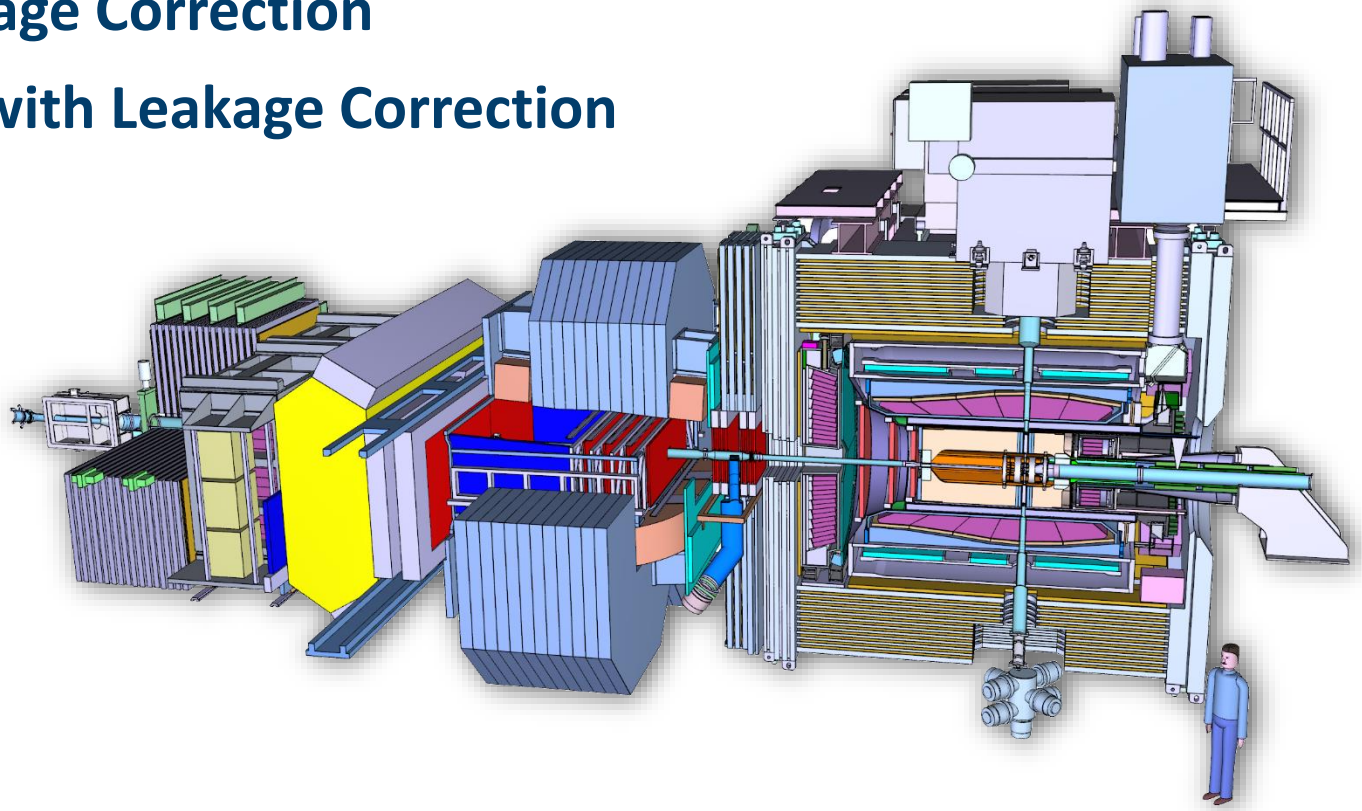
Outline

- PANDA EMC-Barrel
- Energy Calibration
- Energy Leakage Correction
- Calibration with Leakage Correction
- Summary

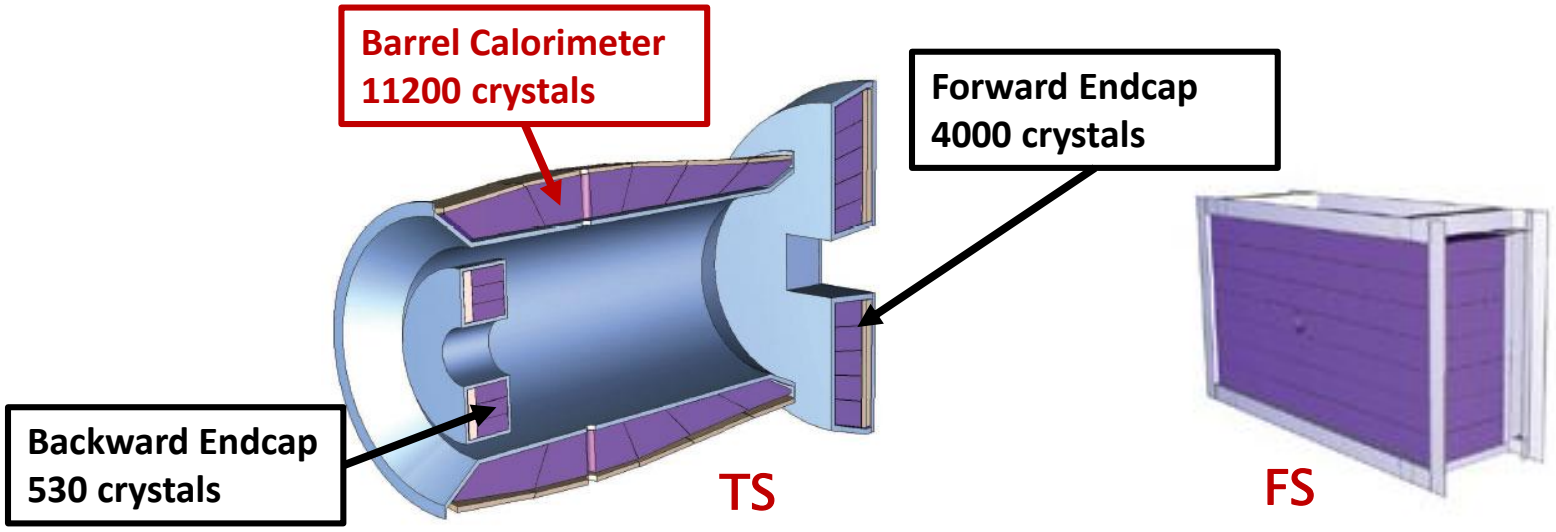


PANDA EMC-Barrel

- Energy measurement
- Position measurement
- Shower shape measurement
- Separation of γ/e and hadrons

PWO-II crystal:

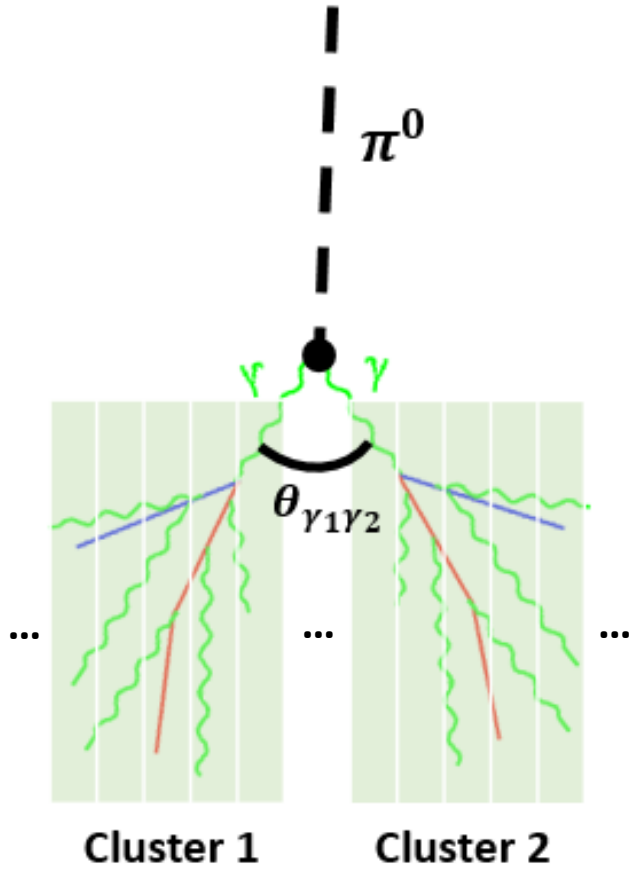
- Width ~ 2-3 cm (R_M ~ 2 cm)
- Length ~ 20 cm (X_0 ~ 1 cm)



Energy Calibration ($\pi^0 \rightarrow \gamma\gamma$)

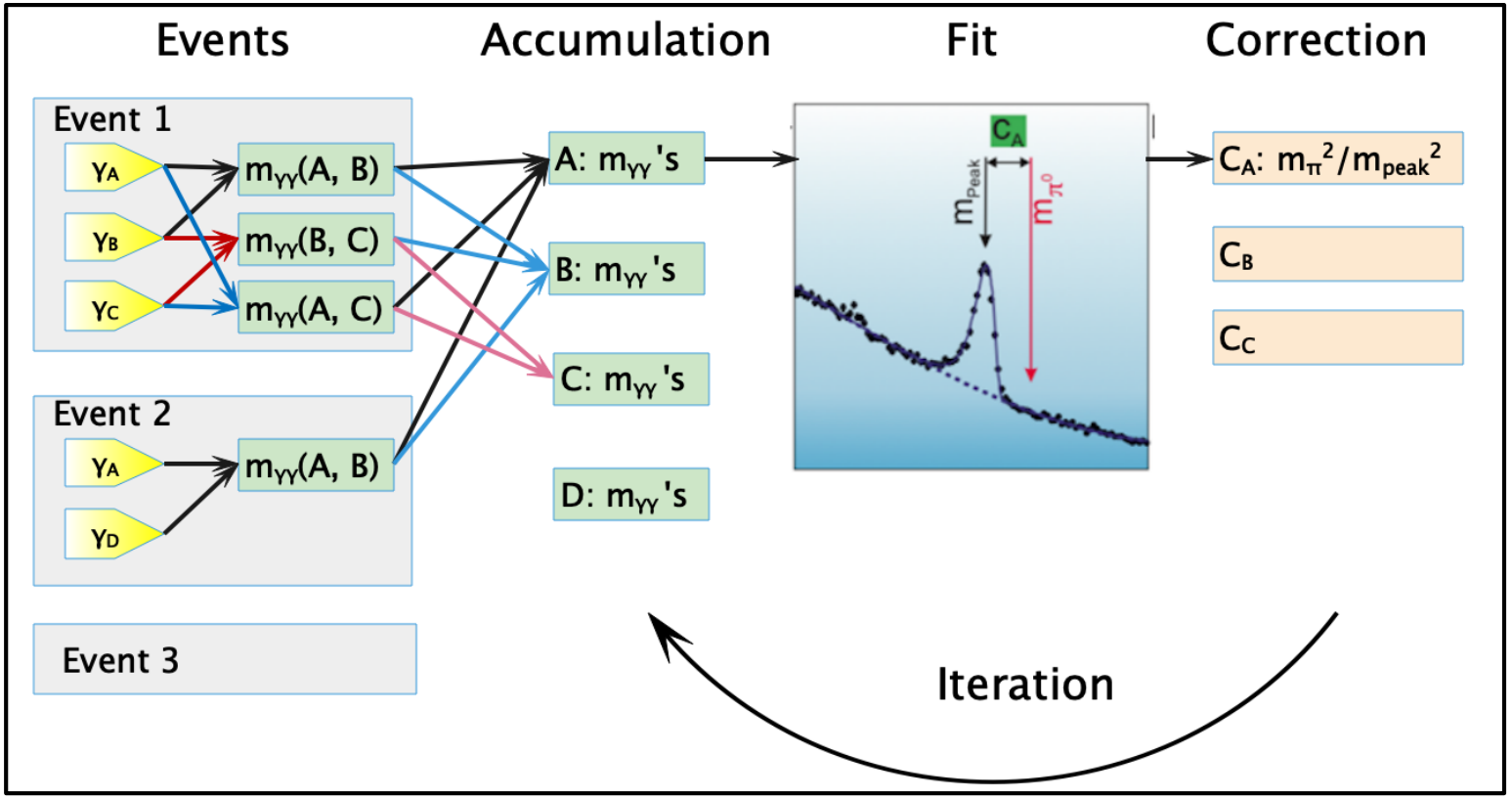
- Detection unit uniformity
- Pre-shower and Leakage
- Light yield non-uniformity
- …

The calibration will improve the energy resolution and correct the reconstructed energy to the true energy which can be used in physics analysis.



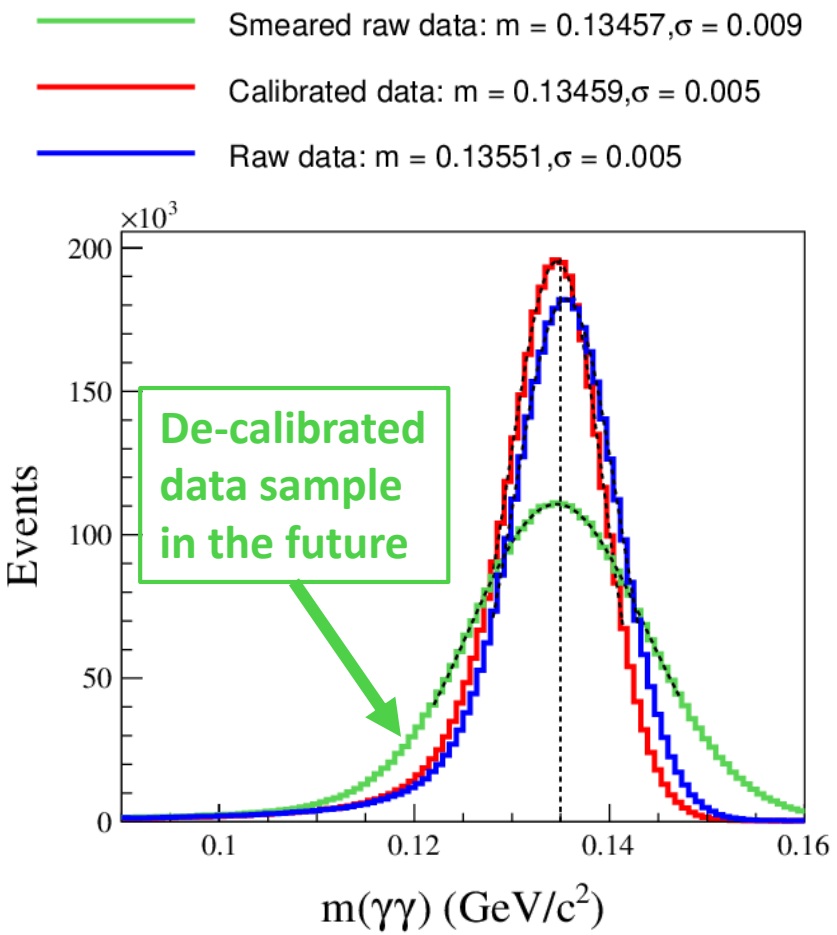
Energy Calibration ($\pi^0 \rightarrow \gamma\gamma$)

- Monte Carlo simulated sample of $\pi^0 \rightarrow \gamma\gamma$

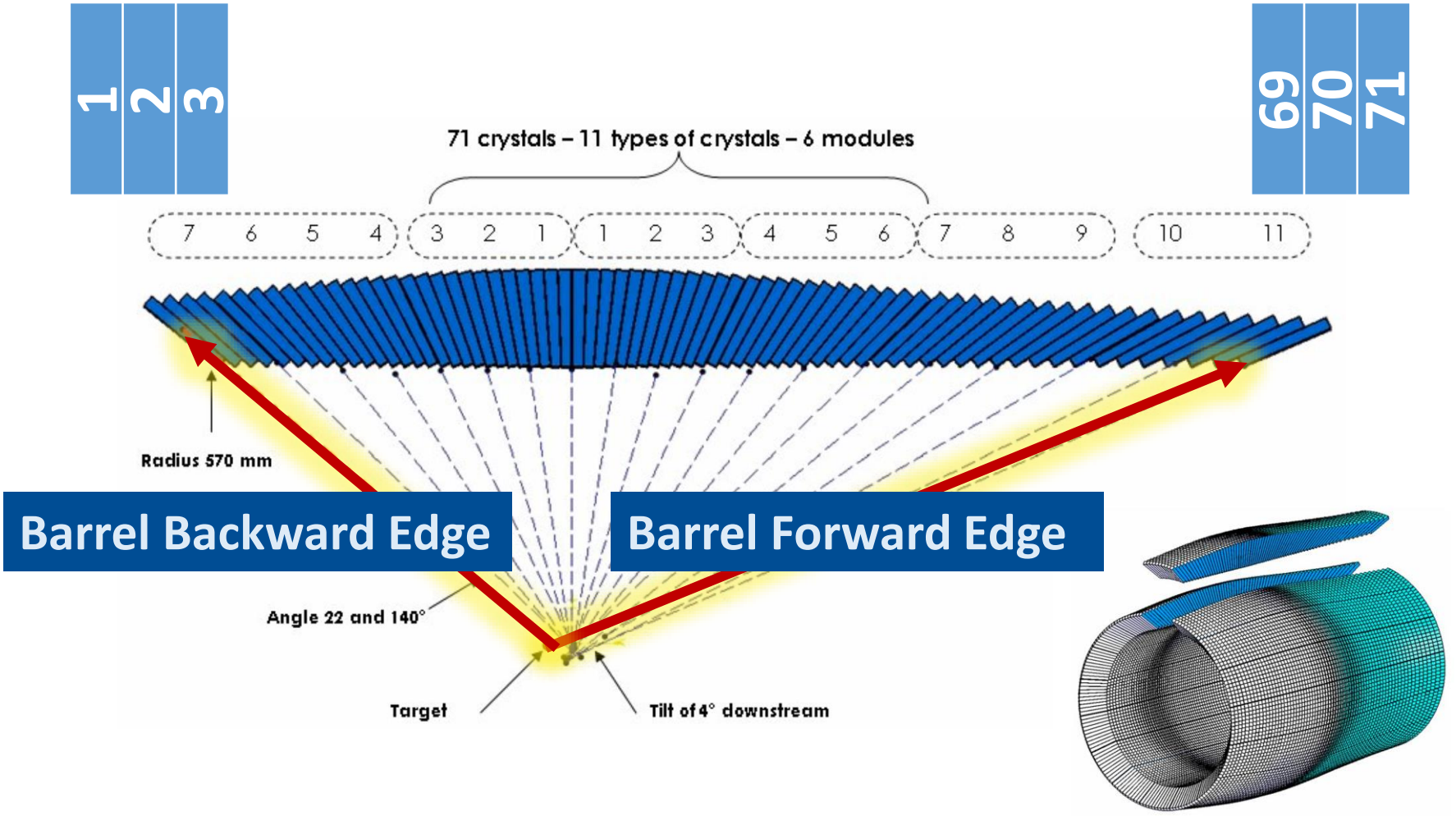


Energy Calibration ($\pi^0 \rightarrow \gamma\gamma$)

- The calibration algorithm can be applied to those crystals in the inner region of the calorimeter, and perfectly satisfy the requirement of PANDA experiment
- However, the calibration algorithm will suffer the energy leakage problem when applied to crystals in the edge region
- The energy leakage problem must be solved before doing calibration



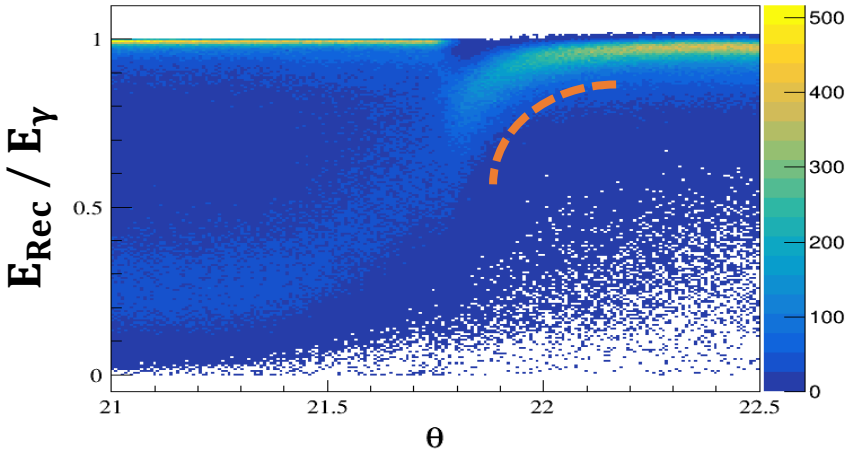
Energy Leakage Correction

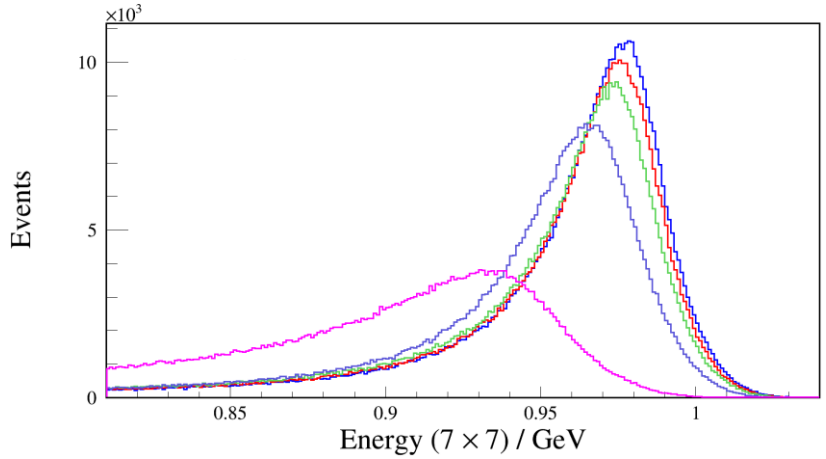


Energy Leakage Correction

- Influences of energy leakage :
  - Shower lost → energy shift
  - Statistics lost → bad resolution
  - …
- Solutions:
  - MPV shift
  - Estimate the leakages based on some features of the shower lateral development, such as the shape of the shower…

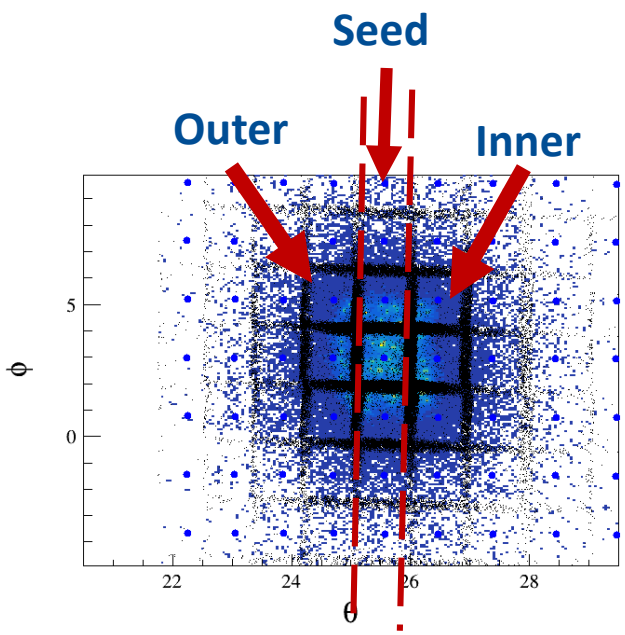
Monte Carlo simulated sample of single γ



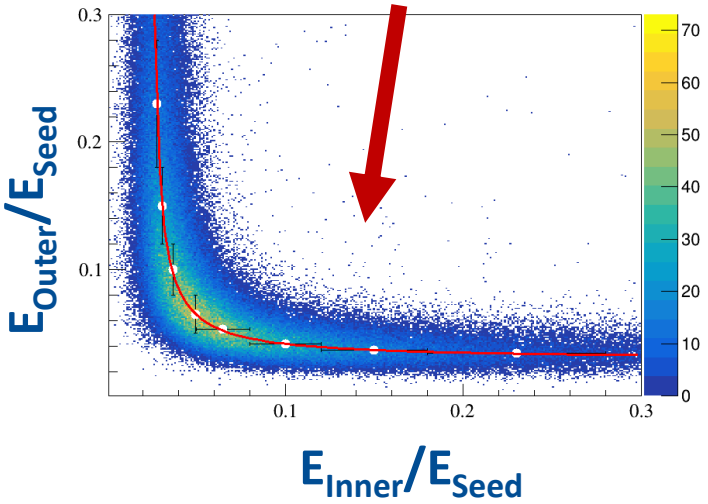


Energy Leakage Correction

- When a coming particle hit the edge of the EMC, the energy deposited in the outer side will not be detected.



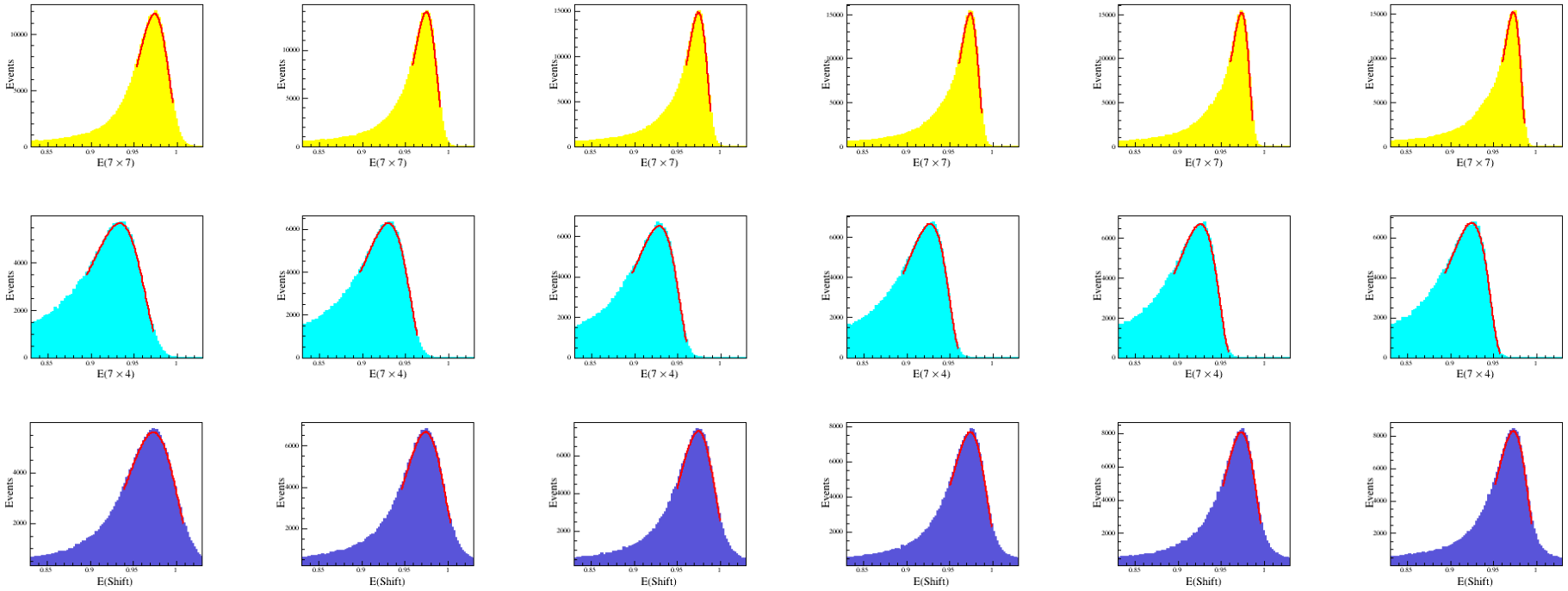
The energy deposited in the outer side (E_{Outer}) is missed for edge condition, but the ratio E_{Outer}/E_{Seed} can be obtained according to E_{Inner}/E_{Seed}



Energy Leakage Correction

No leakage Leakage Corrected

Crystal ID: 1

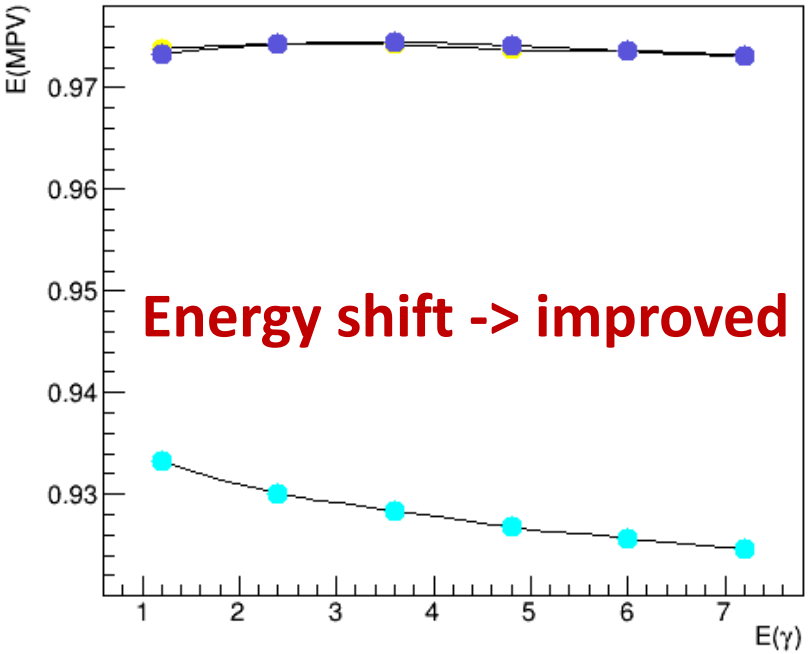


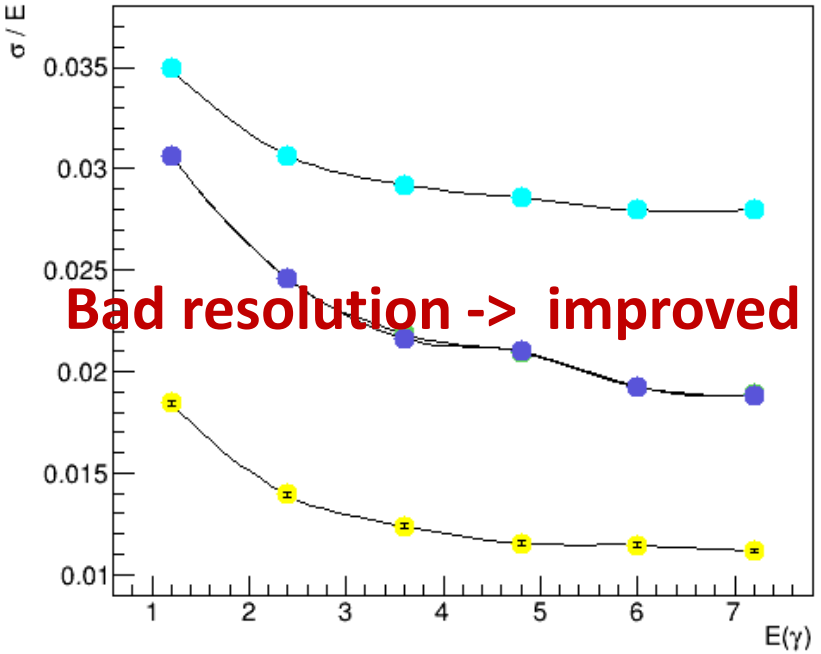
1.2GeV 2.4GeV 3.6GeV 4.8GeV 6.0GeV 7.2GeV

Energy Leakage Correction

No leakage Leakage Corrected

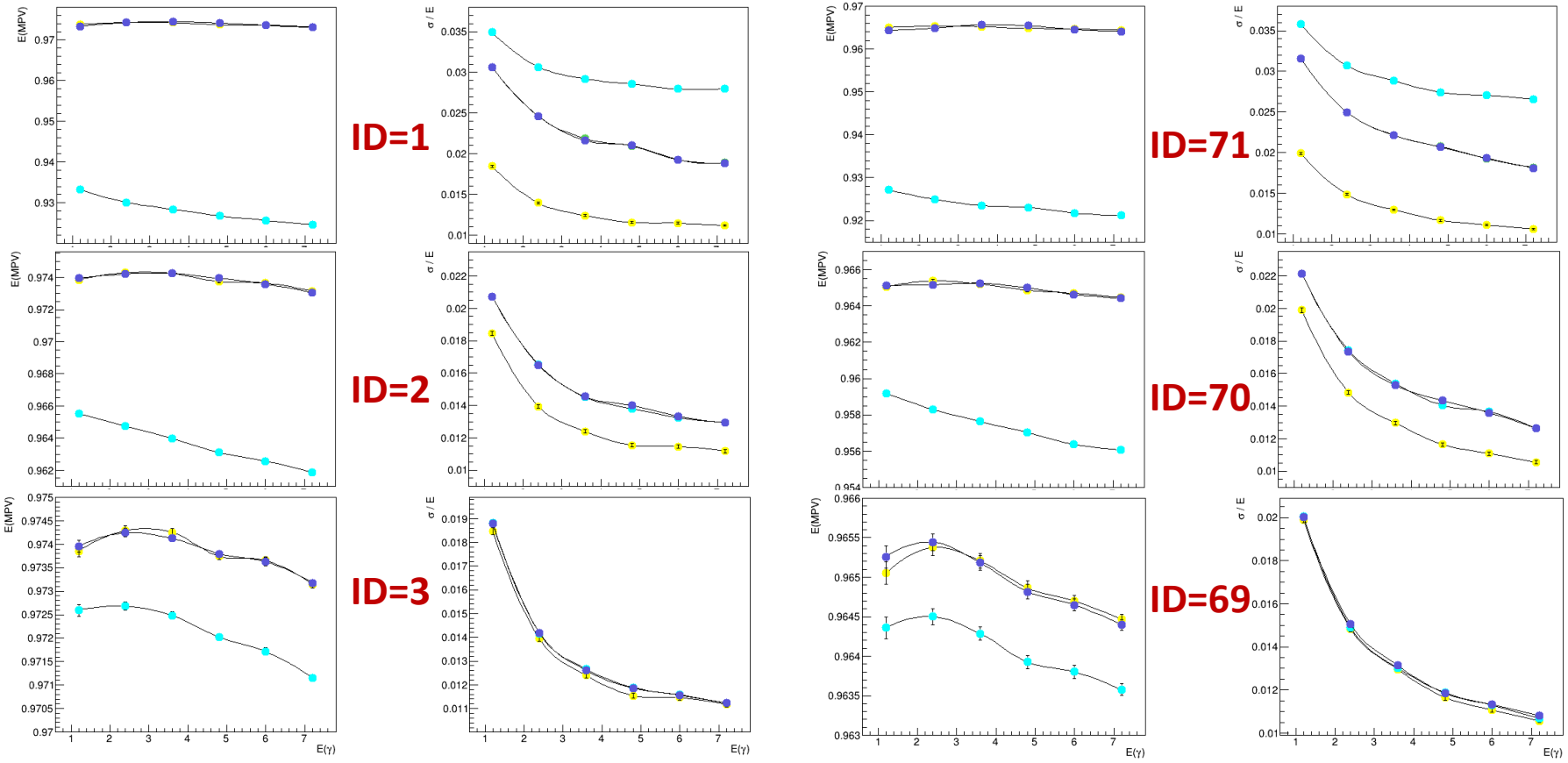
Crystal ID: 1



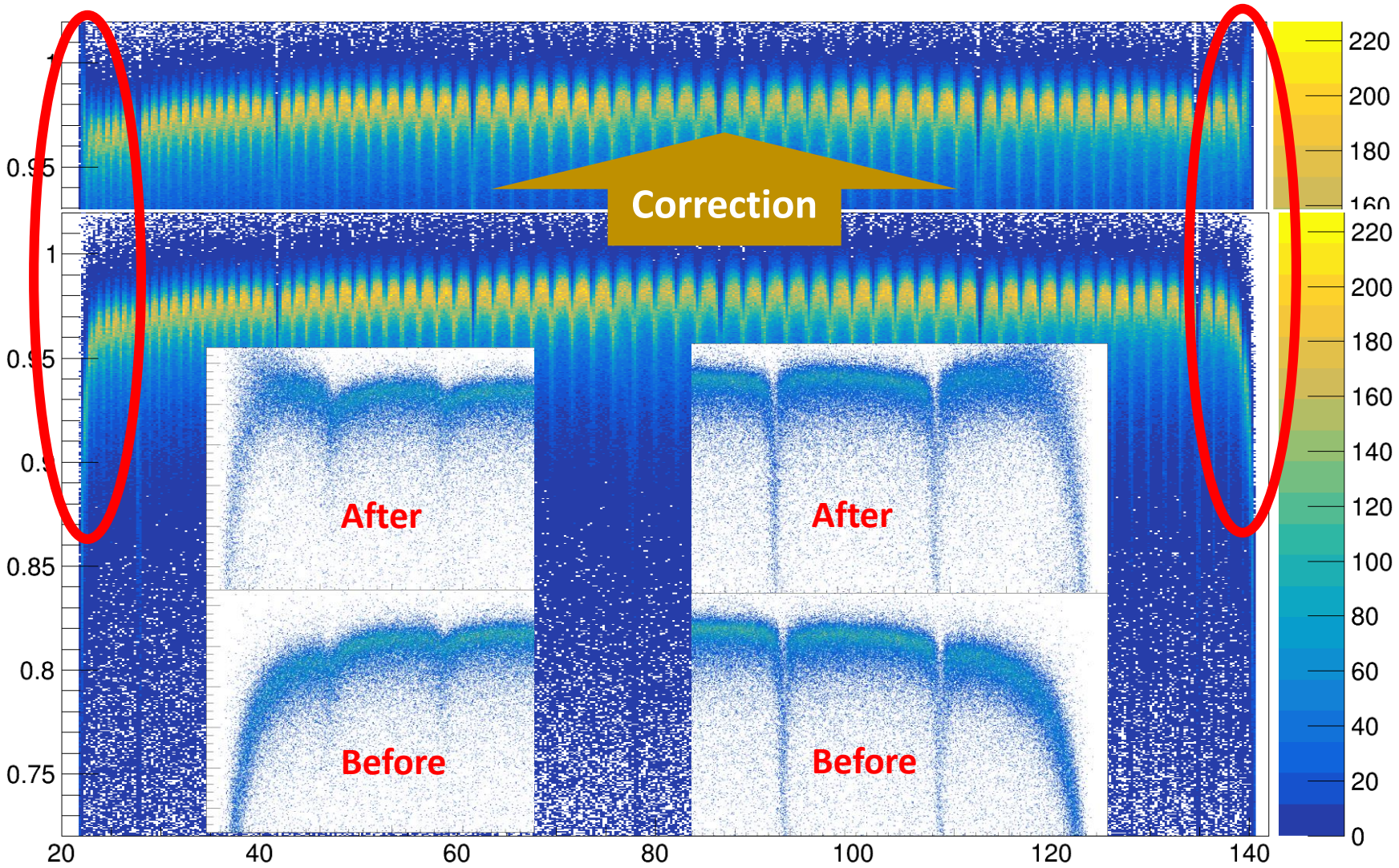


Energy Leakage Correction

outer 1 2 3 … No leakage Leakage Corrected … 69 70 71 outer

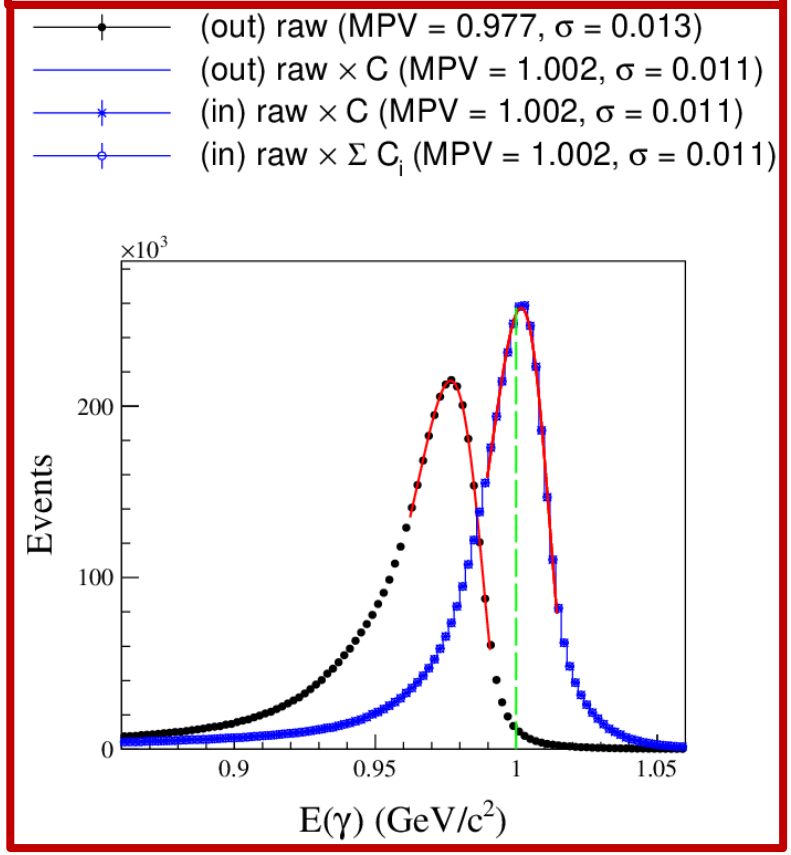


Energy Leakage Correction

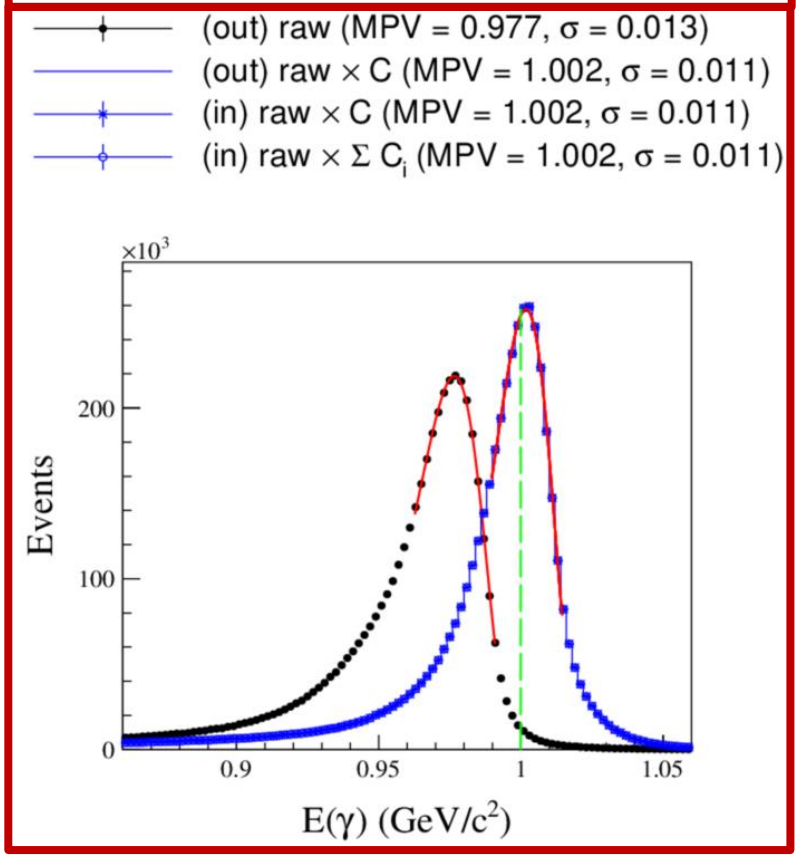


Calibration with Leakage Correction

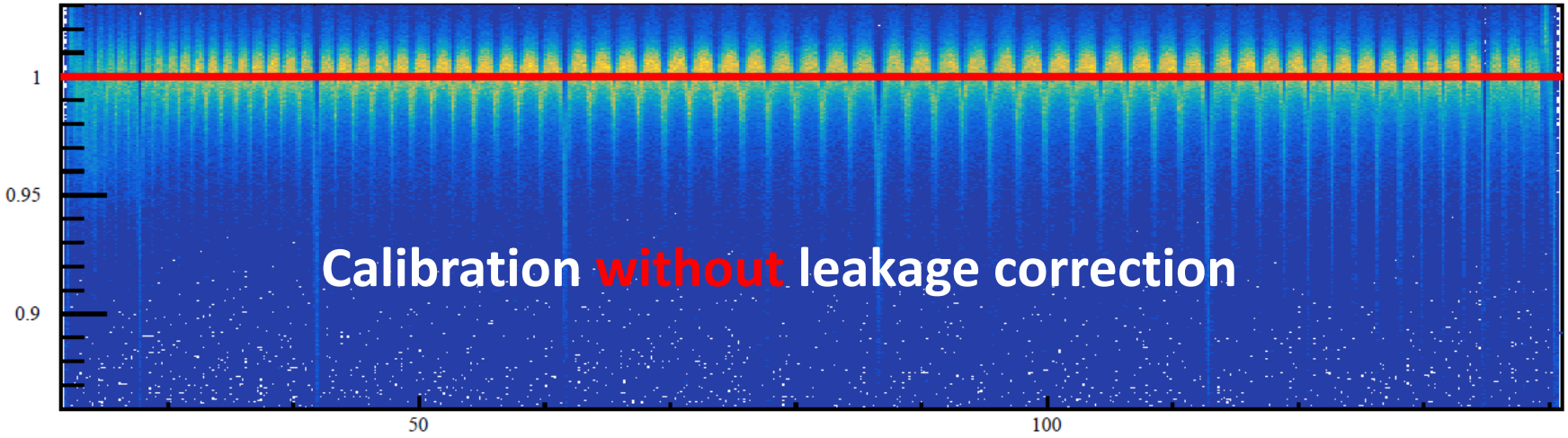
Calibration without energy leakage correction:
Calibration finished at 2nd iteration
mean = 1.00122, sigma = 0.0144185



Calibration with energy leakage correction:
Calibration finished at 2nd iteration
mean = 1.00097, sigma = 0.0147327



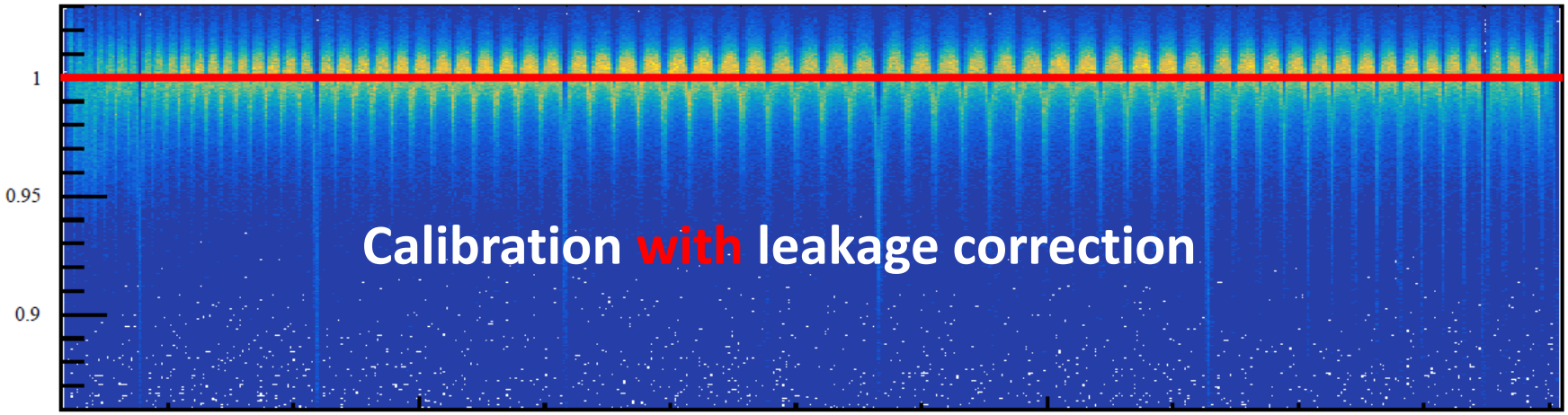
Calibration with Leakage Correction



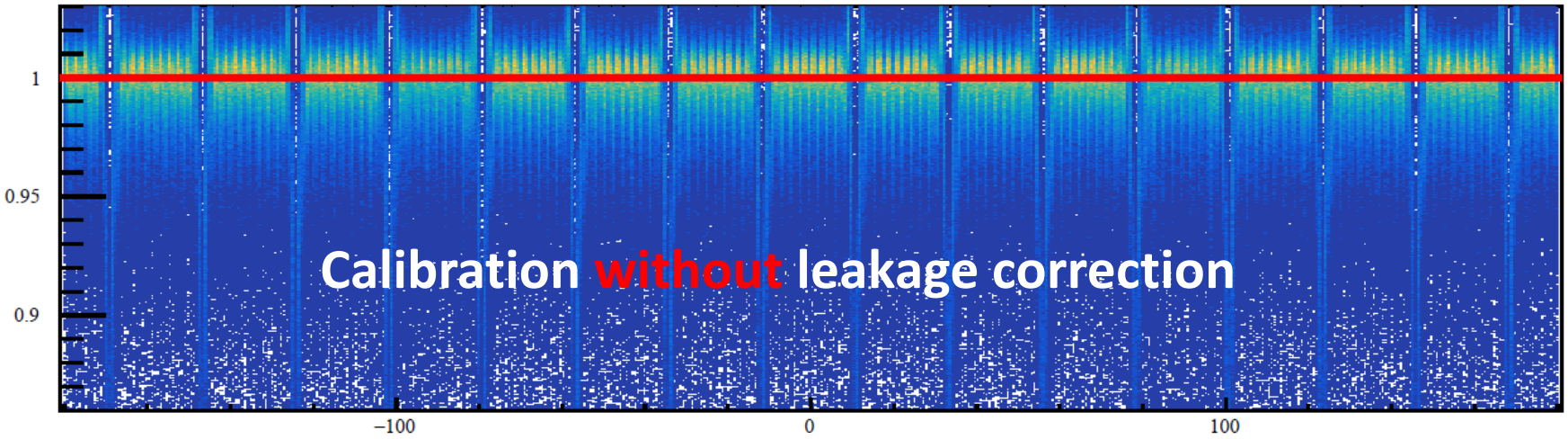
Forward

θ

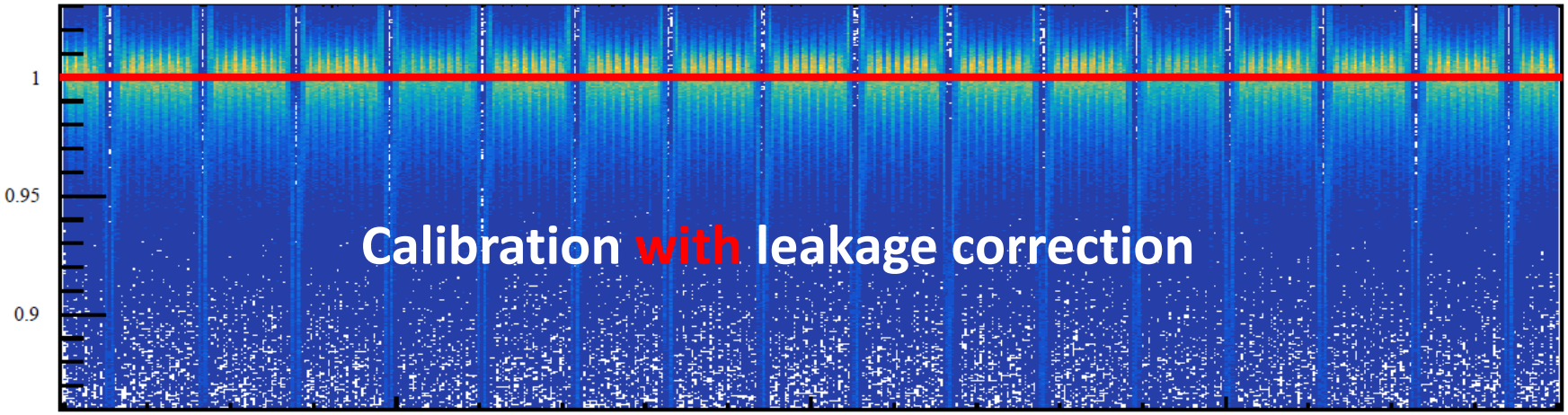
Backward



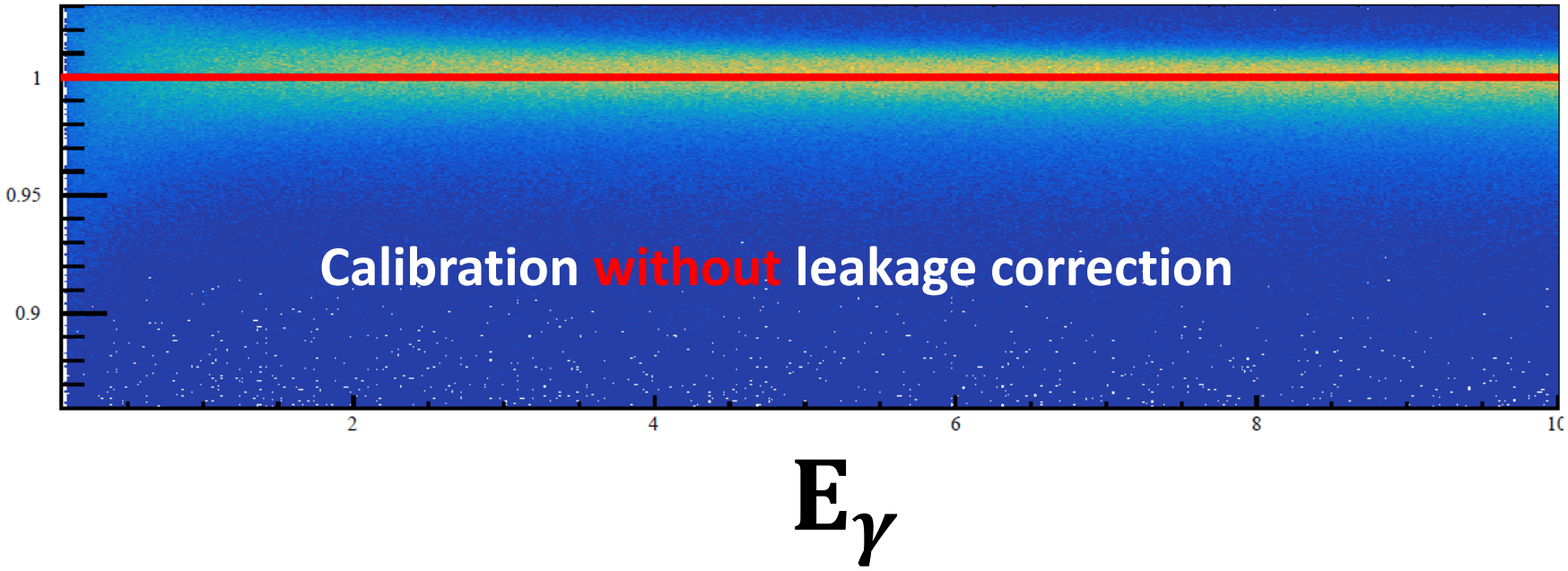
Calibration with Leakage Correction



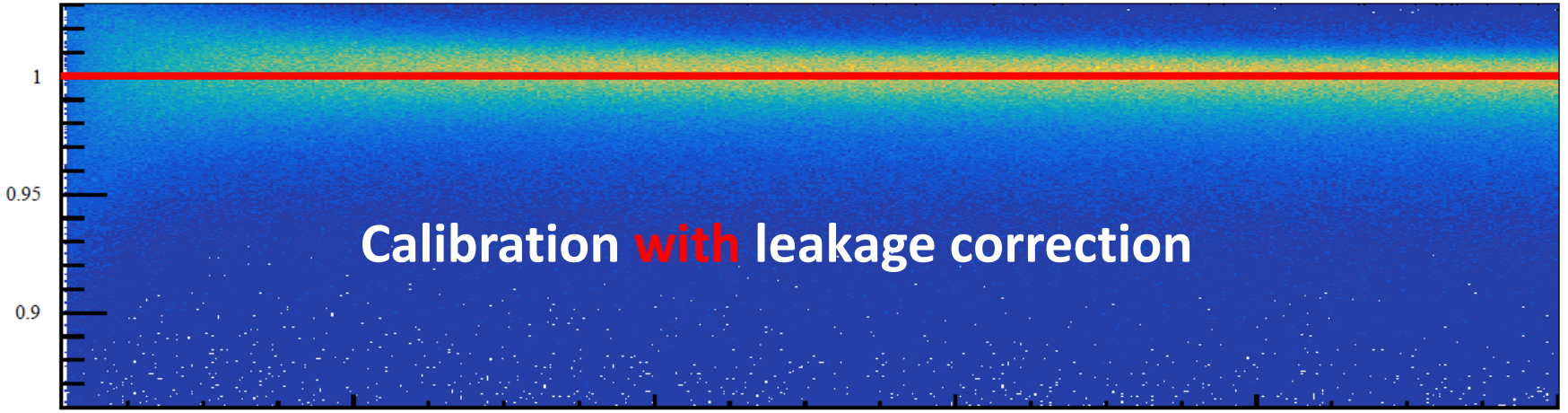
ϕ



Calibration with Leakage Correction

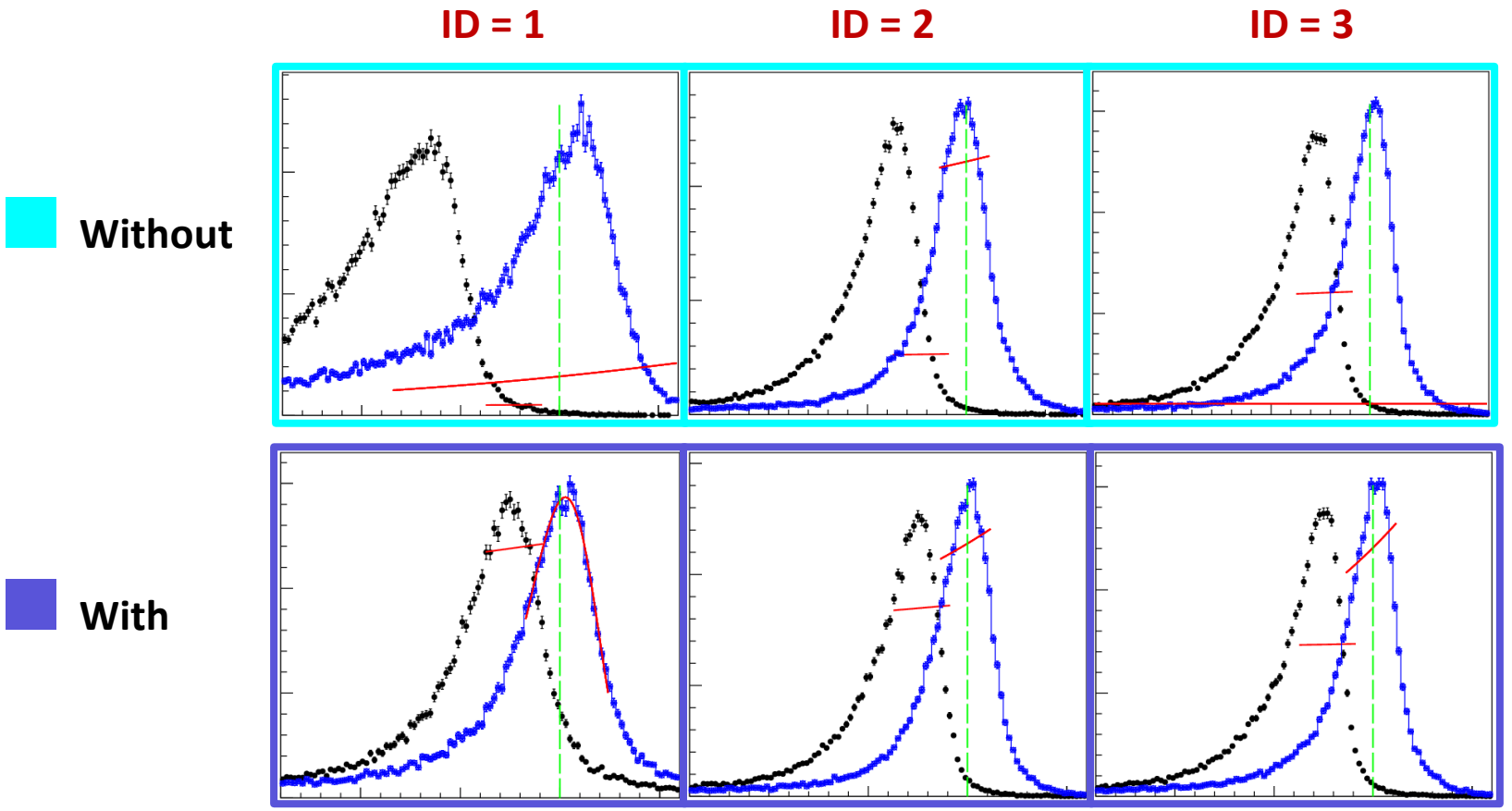


E_γ



Calibration with Leakage Correction

Backward Edge



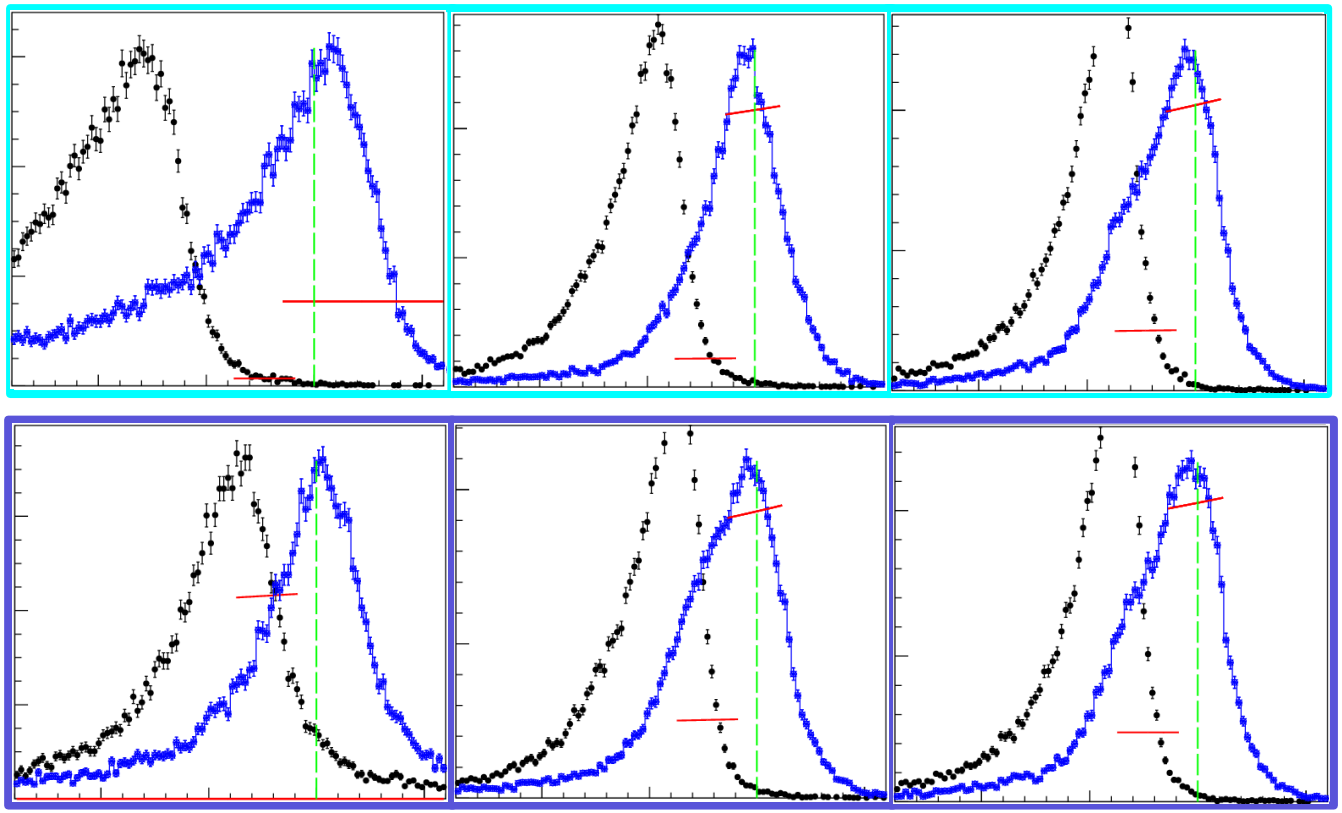
Calibration with Leakage Correction

Forward Edge

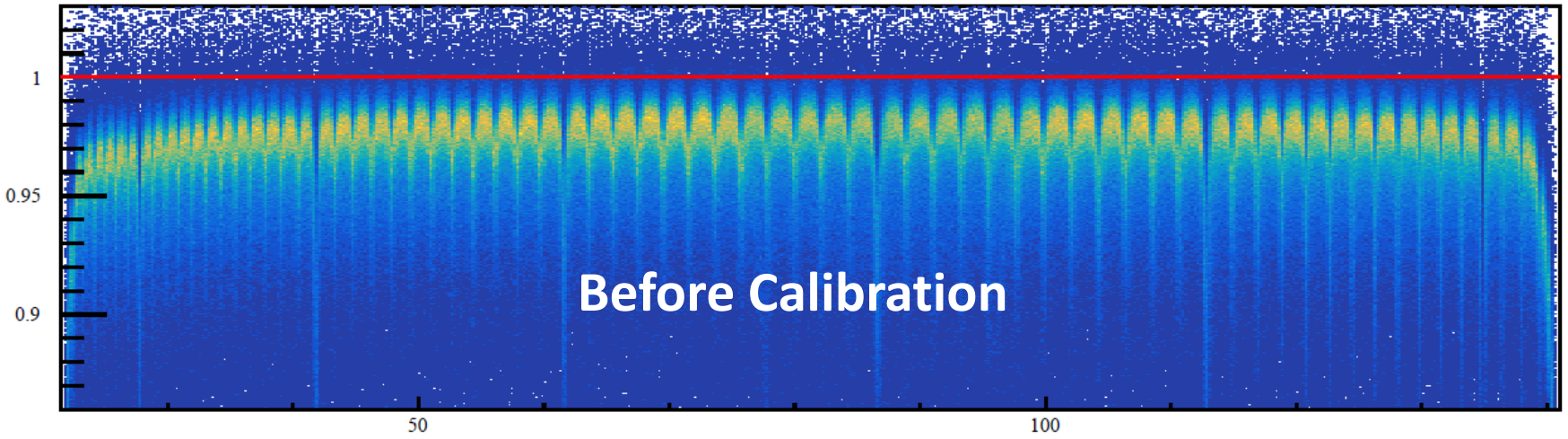
ID = 71 ID = 70 ID = 69

Without

With



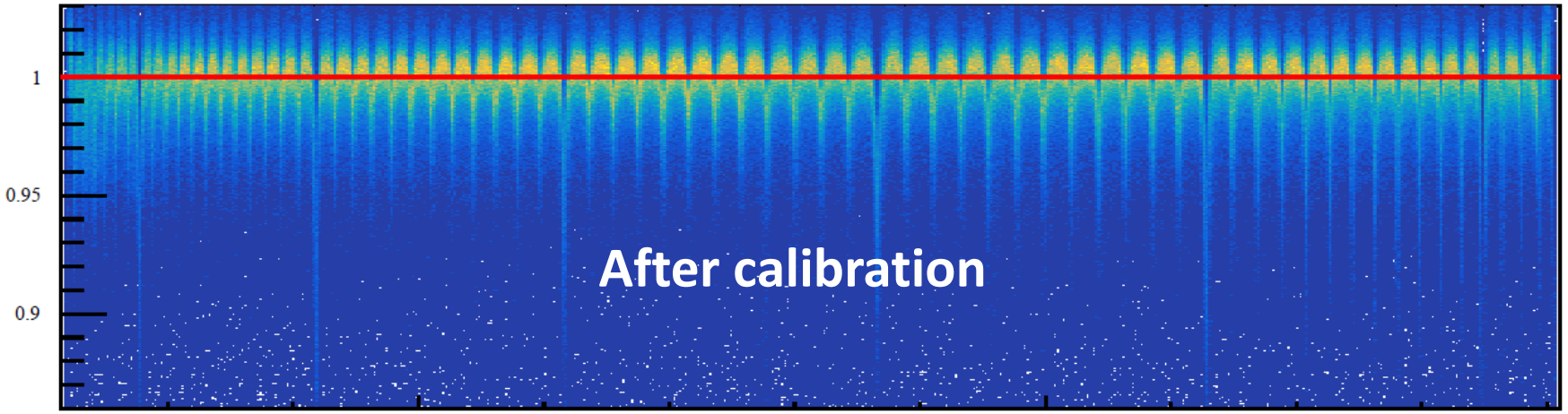
Calibration with Leakage Correction



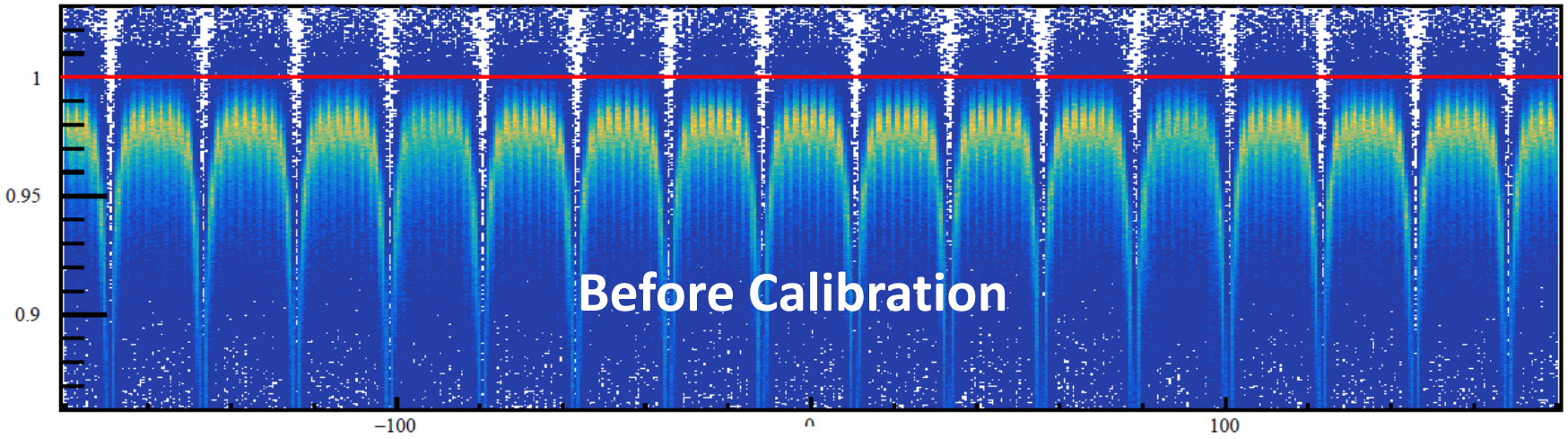
Forward

θ

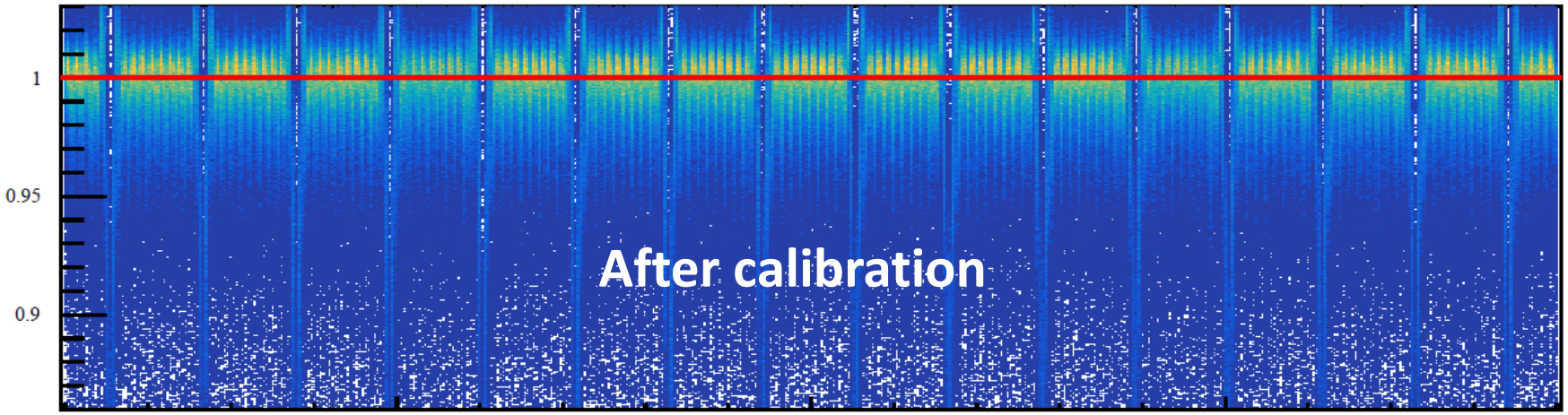
Backward



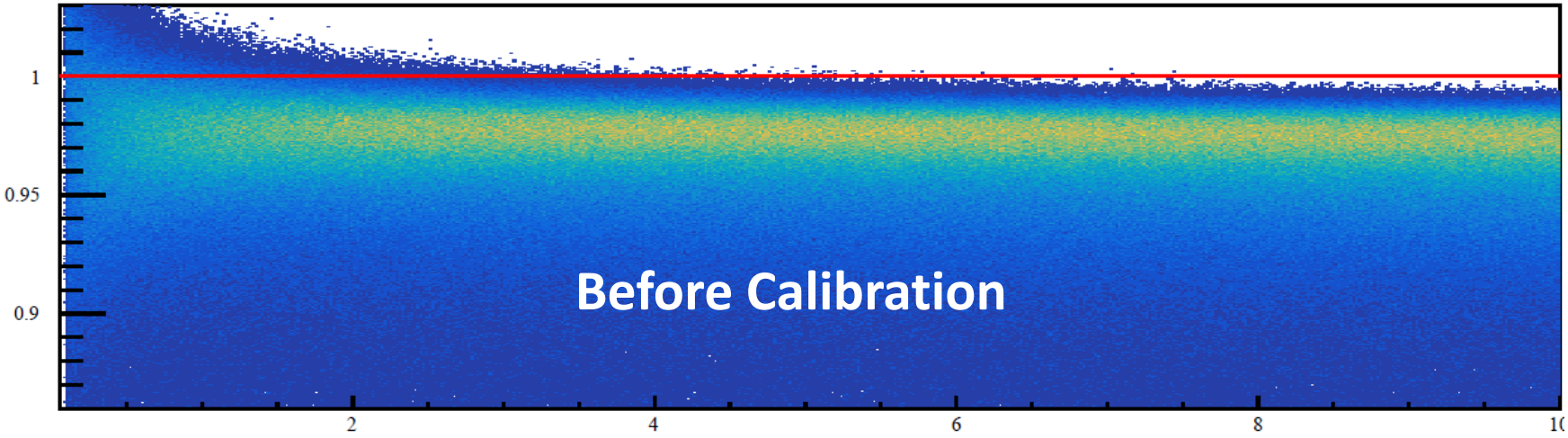
Calibration with Leakage Correction



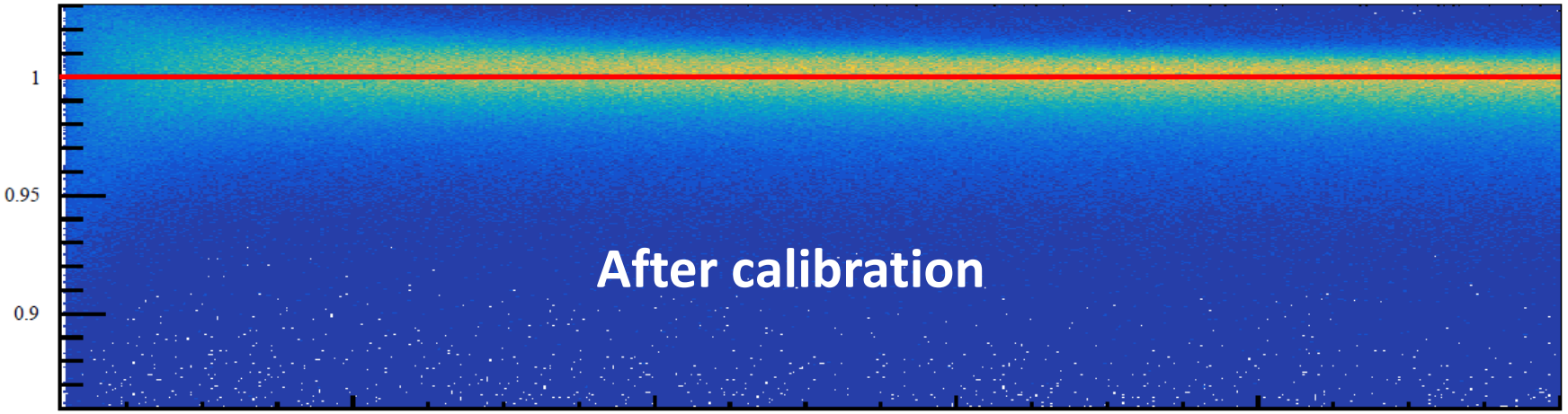
ϕ



Calibration with Leakage Correction

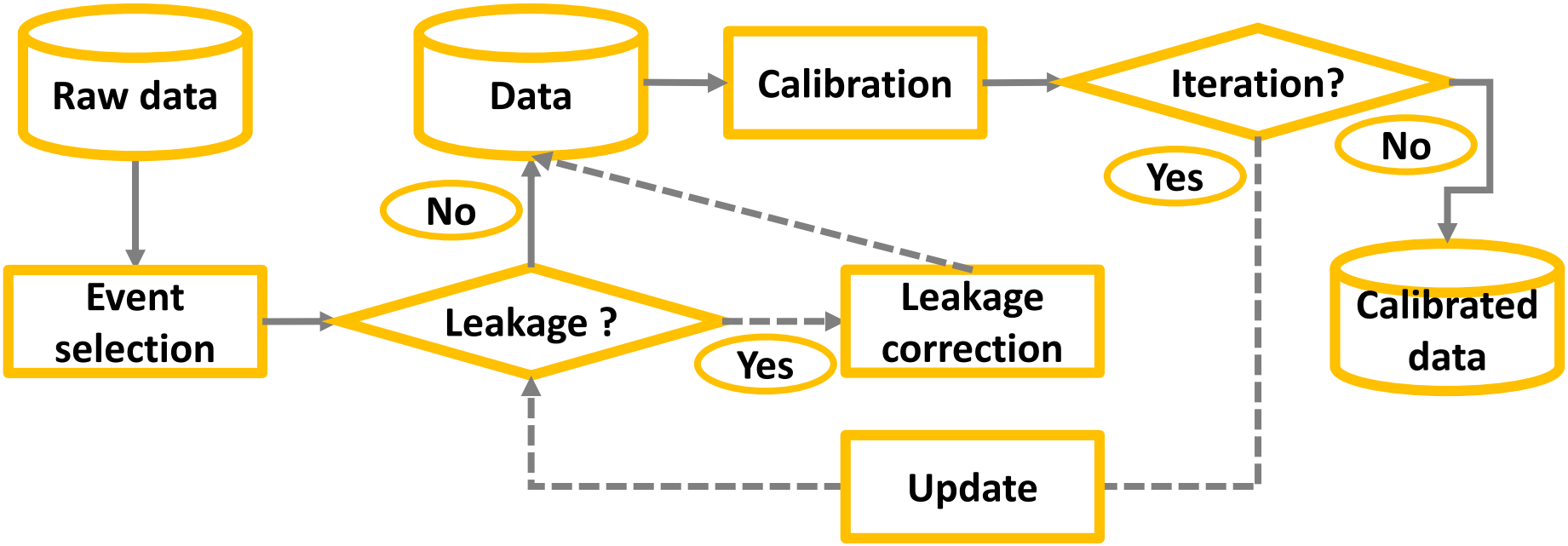


E_γ



Summary

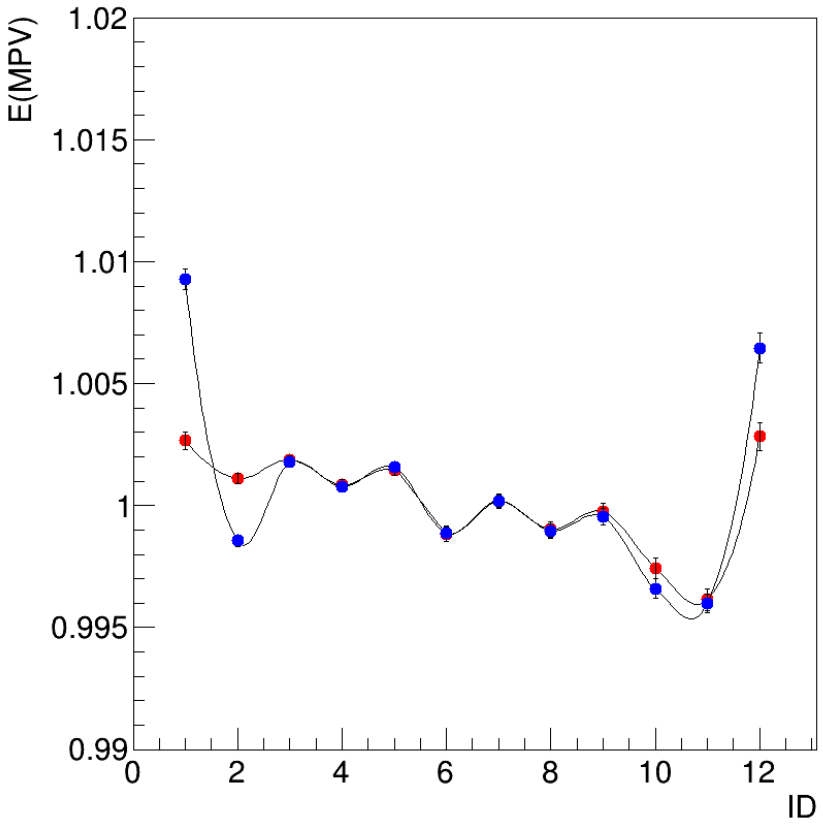
- A dedicated calibration algorithm is developed for the PANDA EMC, but it suffers the energy leakage problem;
- In order to improve the performance of the calibration algorithm, a solution for the energy leakage problem is presented.

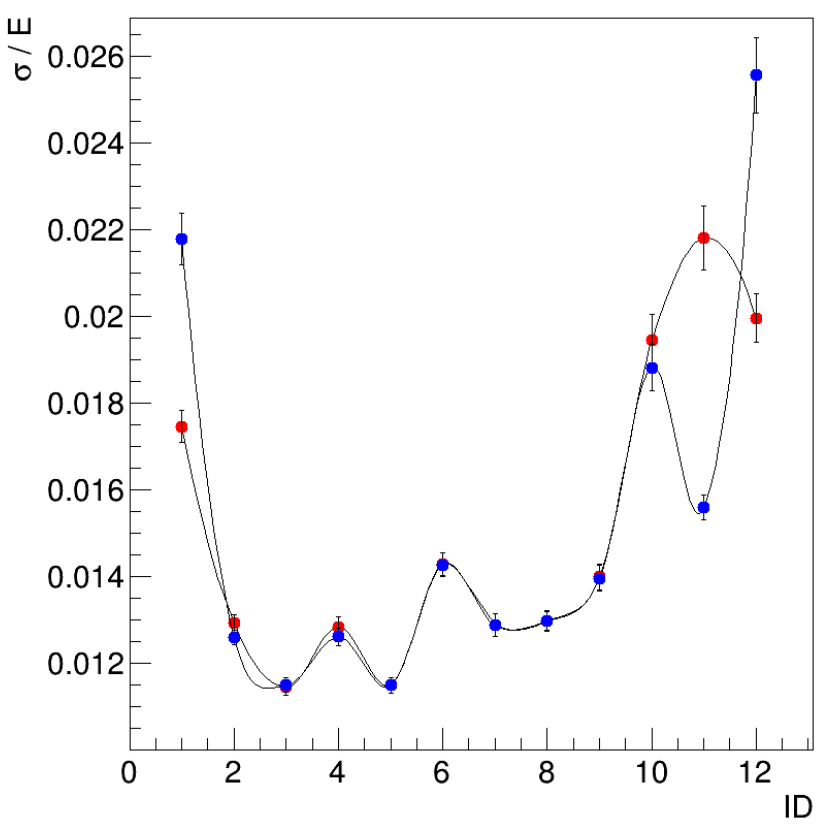


Thank you!

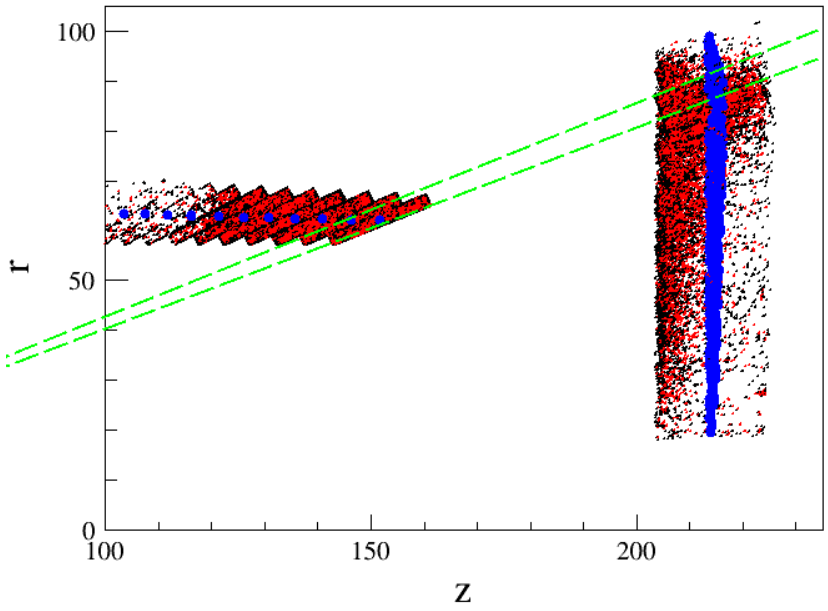
Backup

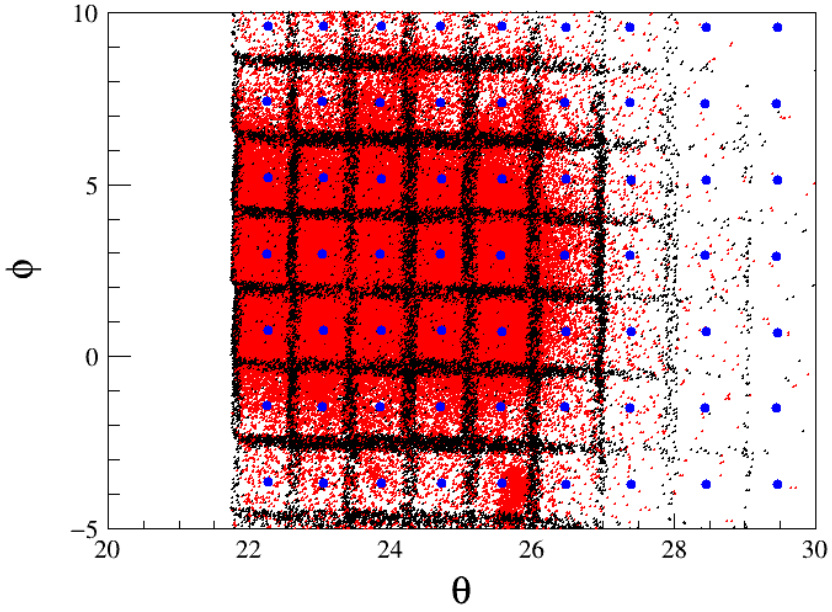
Backup


E(MPV)
1.02
1.015
1.01
1.005
1
0.995
0.99
0
2
4
6
8
10
12
ID

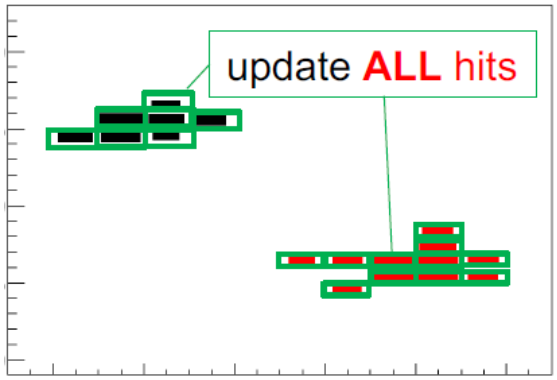

σ / E
0.026
0.024
0.022
0.02
0.018
0.016
0.014
0.012
0
2
4
6
8
10
12
ID

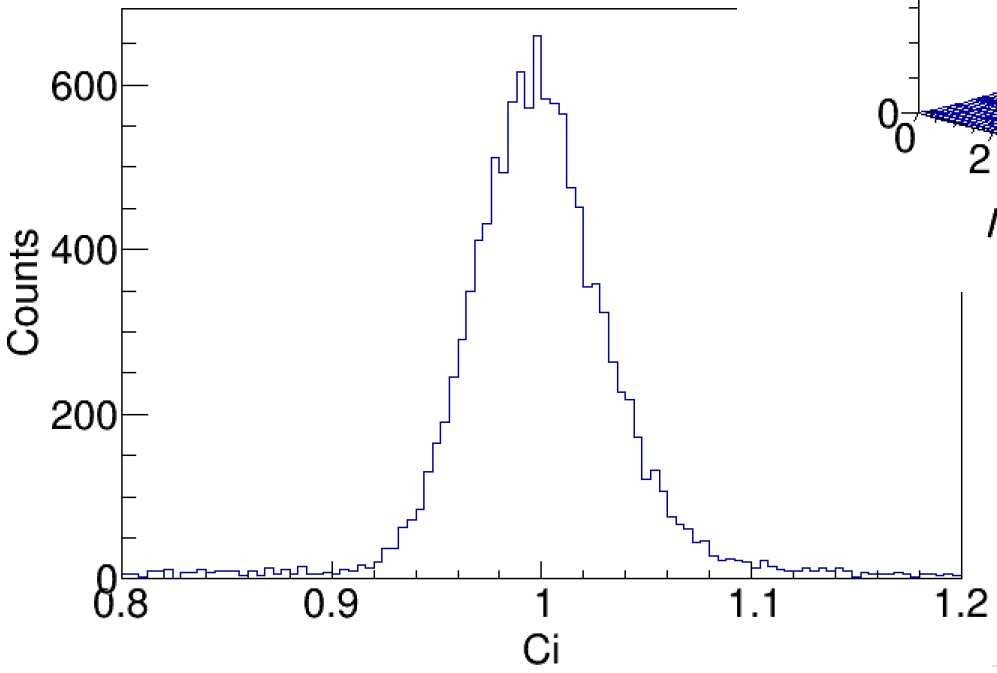
Backup

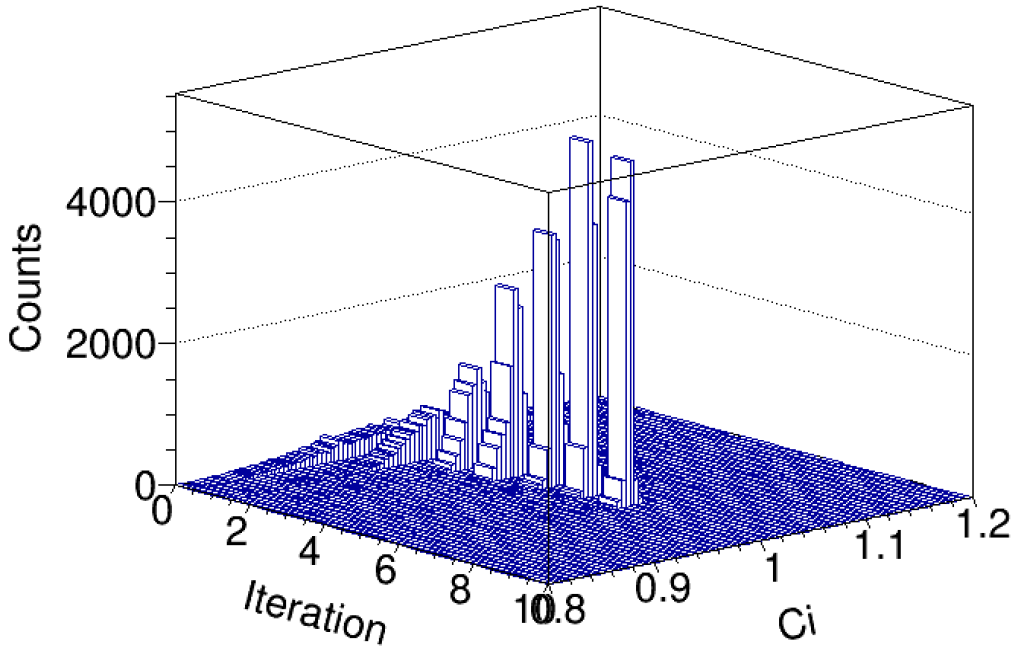




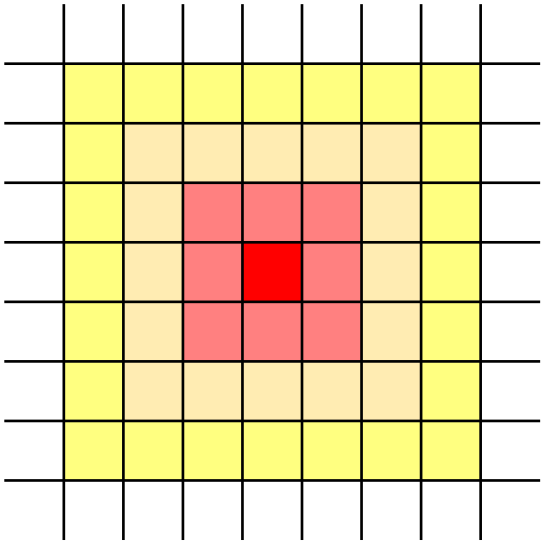
Backup

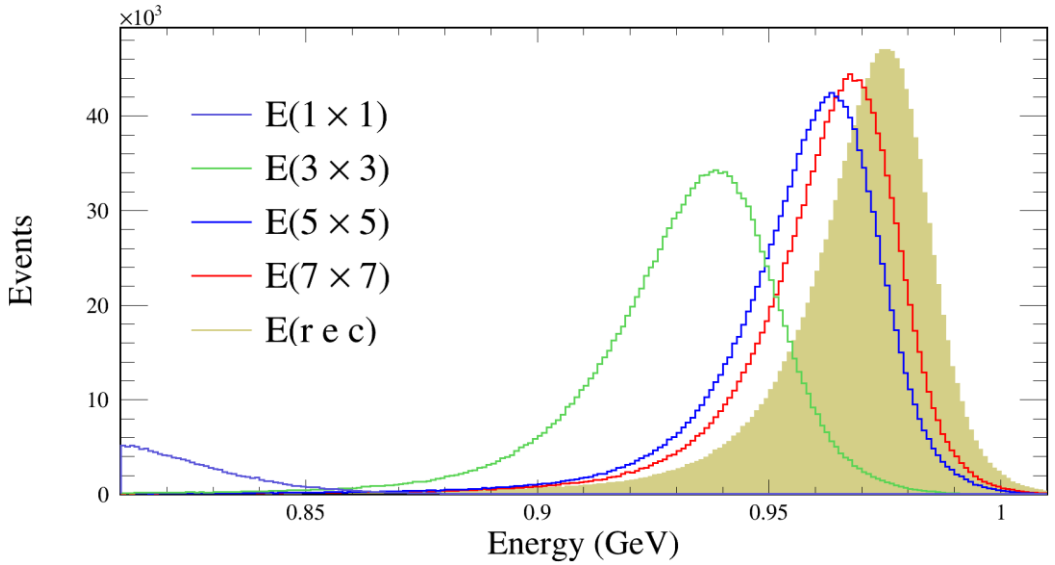

update ALL hits


Counts
600
400
200
0
0.8
0.9
1
1.1
1.2
Ci

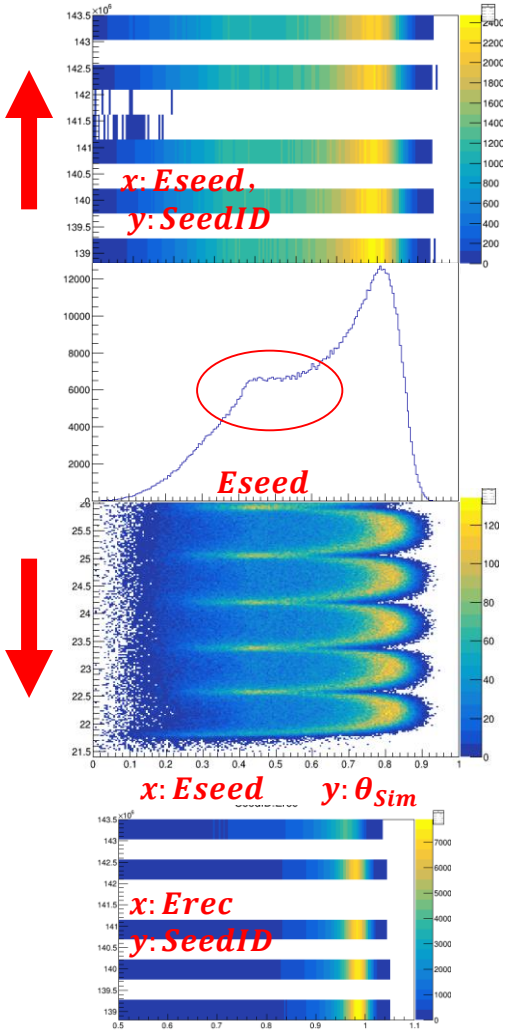

Counts
4000
2000
0
0
2
4
6
8
10
Iteration
0.8
0.9
1
1.1
1.2
Ci

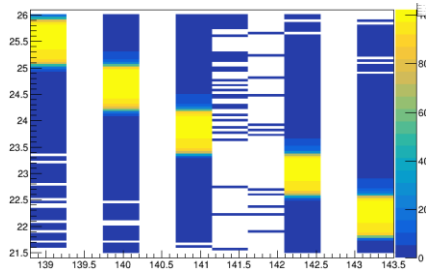
Backup

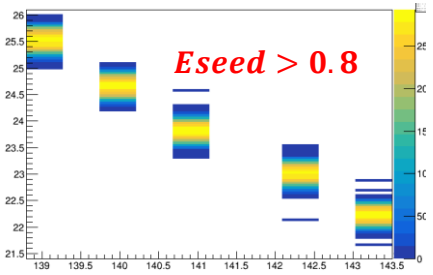


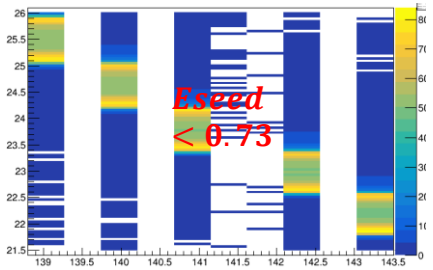

×10³
40
30
20
10
0
Events
E(1 × 1)
E(3 × 3)
E(5 × 5)
E(7 × 7)
E(r e c)
0.85
0.9
0.95
1
Energy (GeV)

Backup


x: Eseed,
y: SeedID
Eseed
x: Eseed
y: θ_Sim
x: Erec
y: SeedID




Eseed > 0.8


Eseed
< 0.73