SuperB Calorimeter Simulation and Bakcground Fwd PID effect studies

SuperB DGWG Meeting

SuperB Collaboration Workshop

Frascati

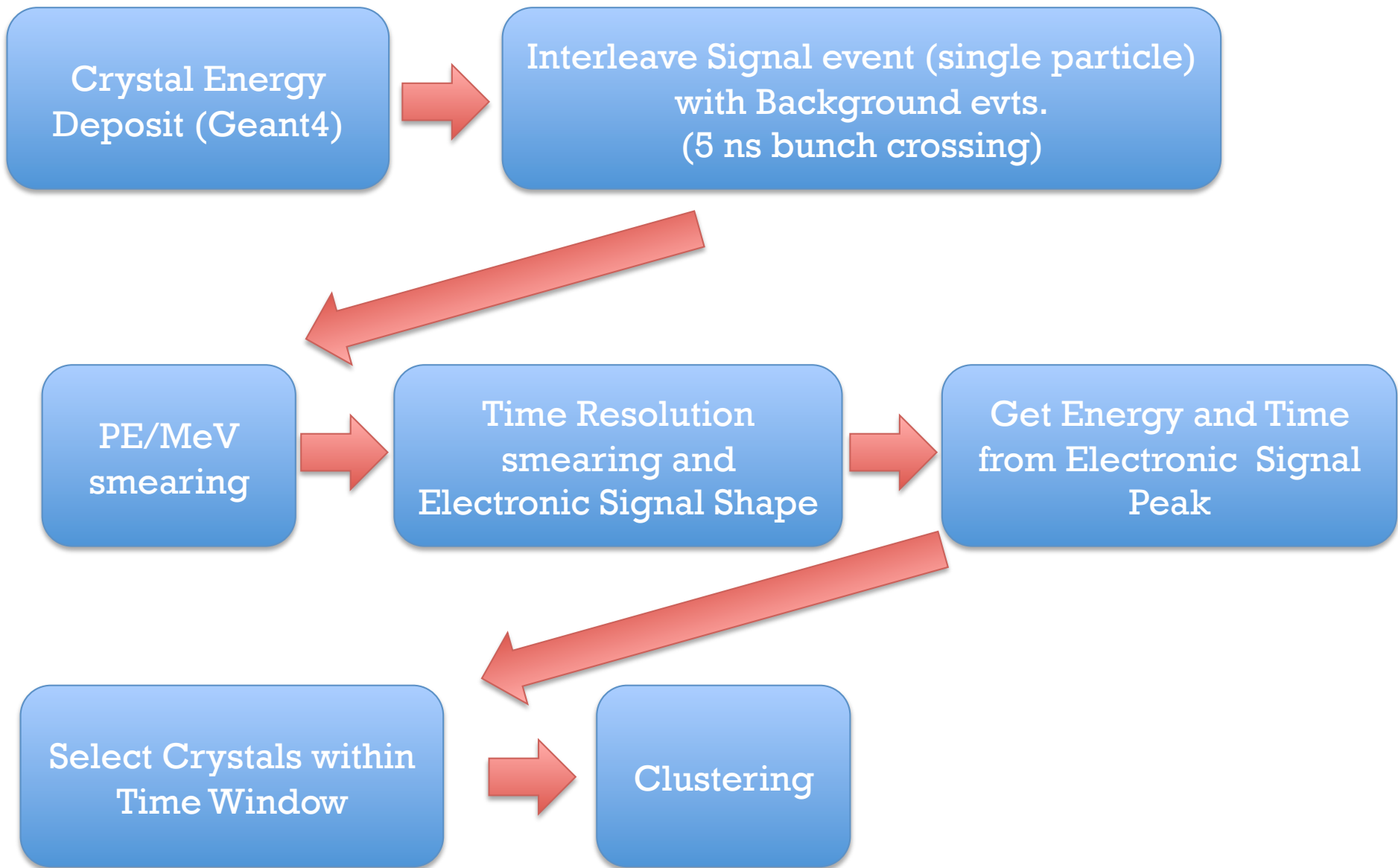05/04/2011

S. Germani
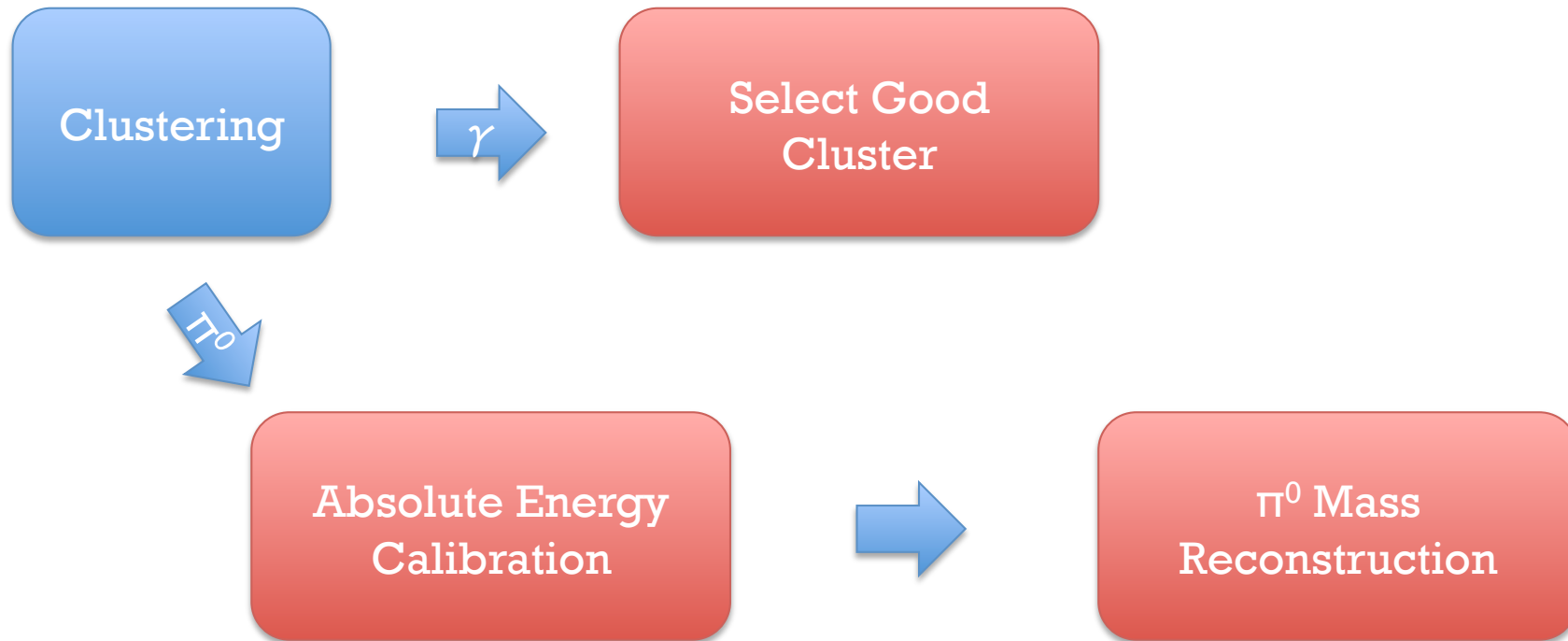
INFN Perugia

Outline

- ## Description of calorimeter simulation
  - Background, electronic signal simulation
  - Photons reconstuction and selection
  - Neutral pions reconstruction

- ## Fwd PID effects on the EMC
  - Fwd PID – fTOF - FARICH comparison
    - Photon Energy resolution and efficiency
    - Neutral Pions Massn Resolution and efficiency

Simulation Work Flow

Crystal Energy Deposit (Geant4)

→

Interleave Signal event (single particle) with Background evts. (5 ns bunch crossing)

PE/MeV smearing

→

Time Resolution smearing and Electronic Signal Shape

→

Get Energy and Time from Electronic Signal Peak

Select Crystals within Time Window

→

Clustering

Reconstruction Work Flow

Clustering

γ

Select Good Cluster

π^0

Absolute Energy Calibration

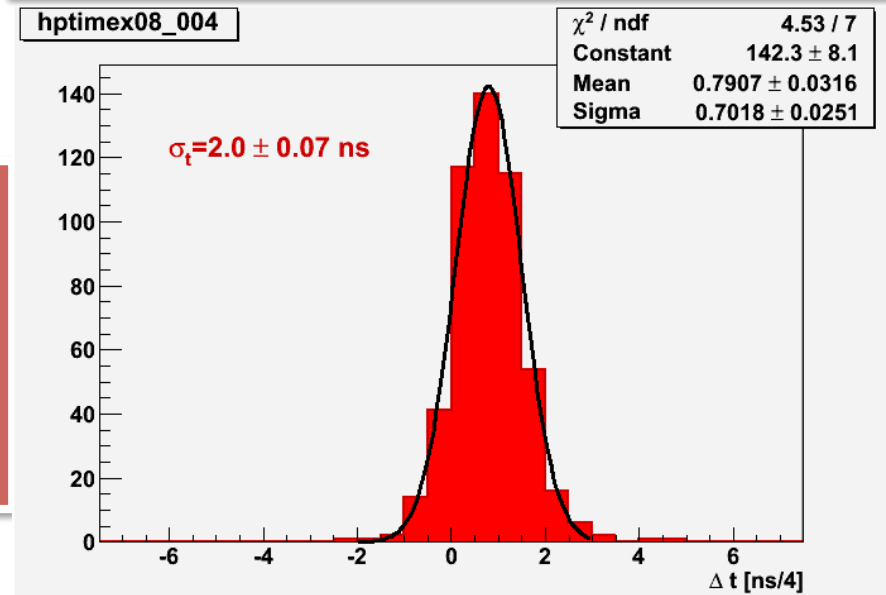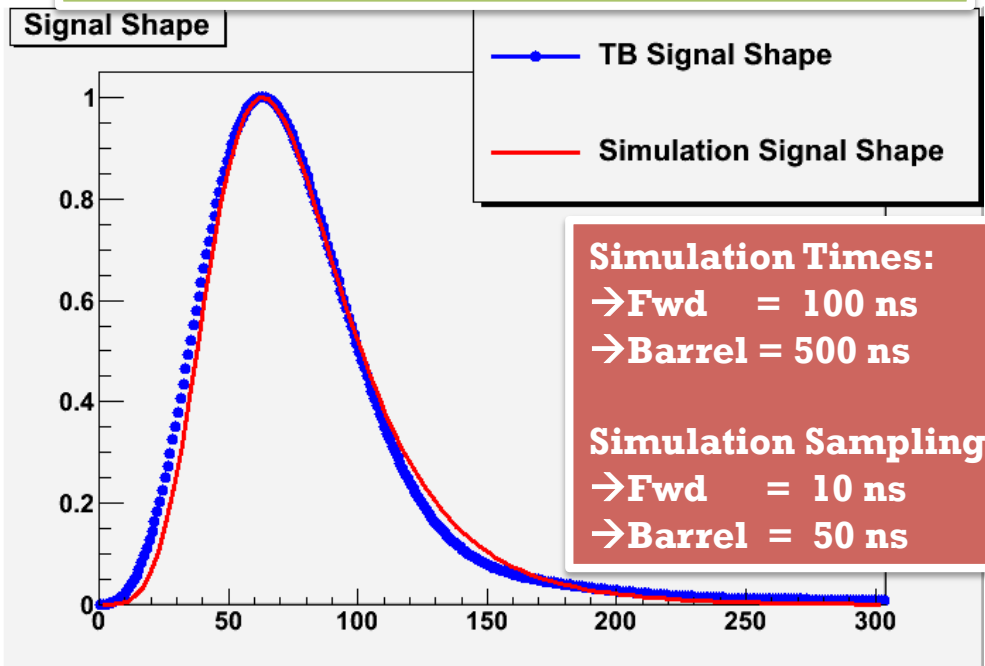π^0 Mass Reconstruction

Electronic signal simulation

Try to benefit as much as possible from the CERN T10 Test Beam to simulate the electronic readout performances:
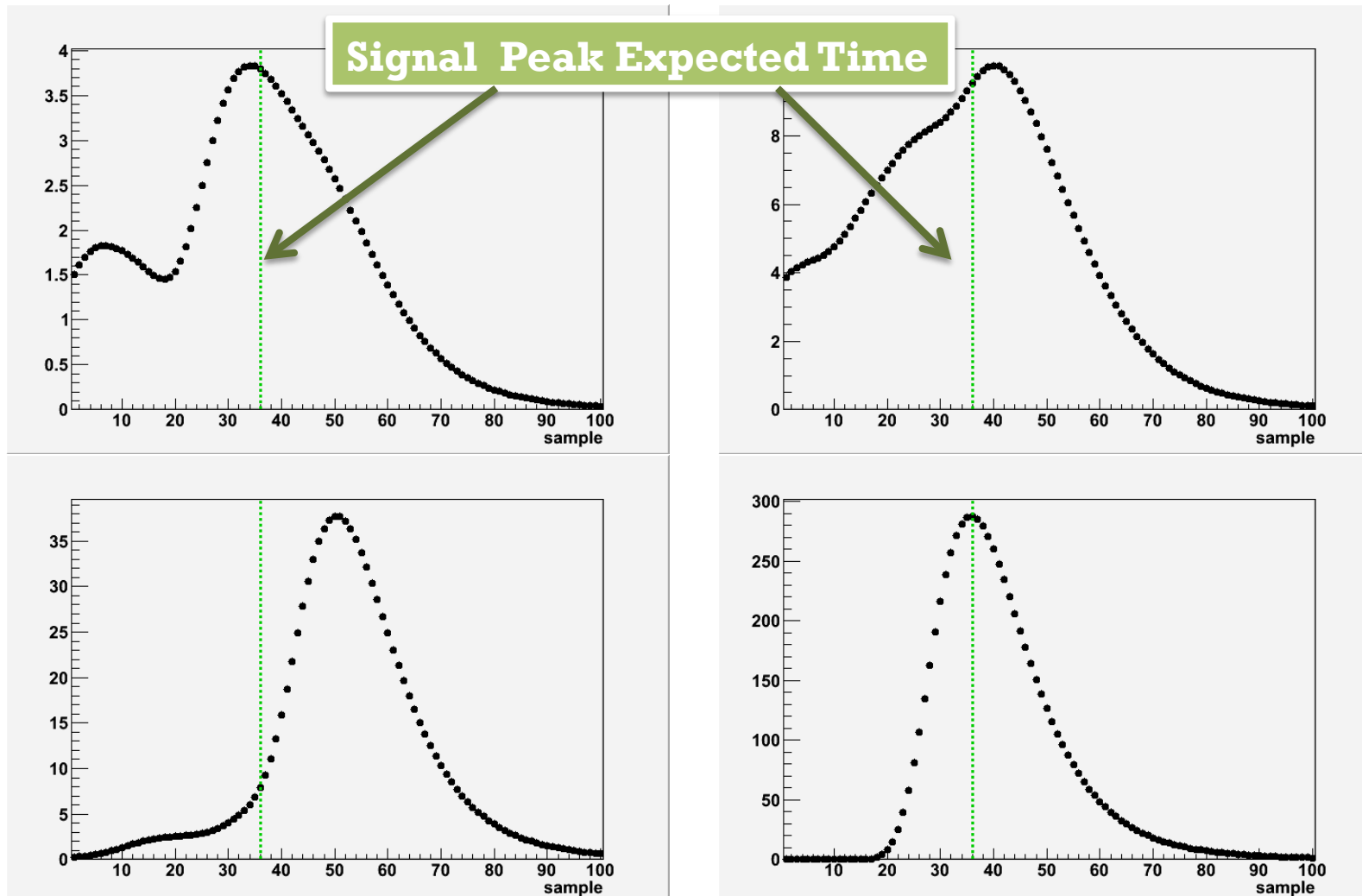→ **Signal Shape**
→ **Crystal Time Resolution**

TB sampling rate was 250 MHz (4 ns)
Signal caracteristc time:
→ Left part of signal shape is a Gauss function
→ Caracteristic signal time is the σ
→ TB time was 100 n

Time resolation using time difference between neighborour crystals
→ 4 ns sampling : 2 ns
→ 40 ns sampling : 2.2 ns

Sampling time has small effect on time resolution

Signal Shape

— TB Signal Shape
— Simulation Signal Shape

Simulation Times:
→ **Fwd   = 100 ns**
→ **Barrel = 500 ns**

Simulation Sampling
→ **Fwd   = 10 ns**
→ **Barrel = 50 ns**

hptimex08_004

χ^2 / ndf	4.53 / 7
Constant	142.3 ± 8.1
Mean	0.7907 ± 0.0316
Sigma	0.7018 ± 0.0251

$\sigma_t = 2.0 \pm 0.07$ ns

Δ t [ns/4]

Signals Examples with Background

Signal Peak Expected Time

The Background generates Eletronic Signal Pile-Up and Spurious Hits
The green line is the Expected Signal ("Trigger") Time
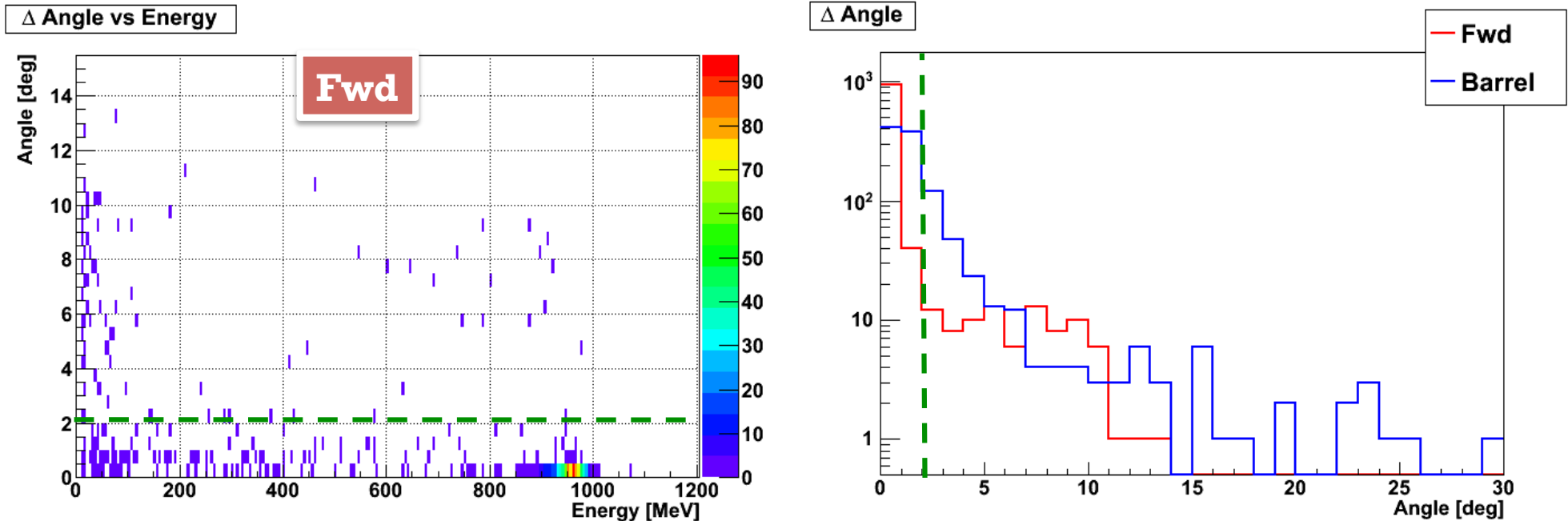
Fwd EMC Sim.: Crystals Signal Time

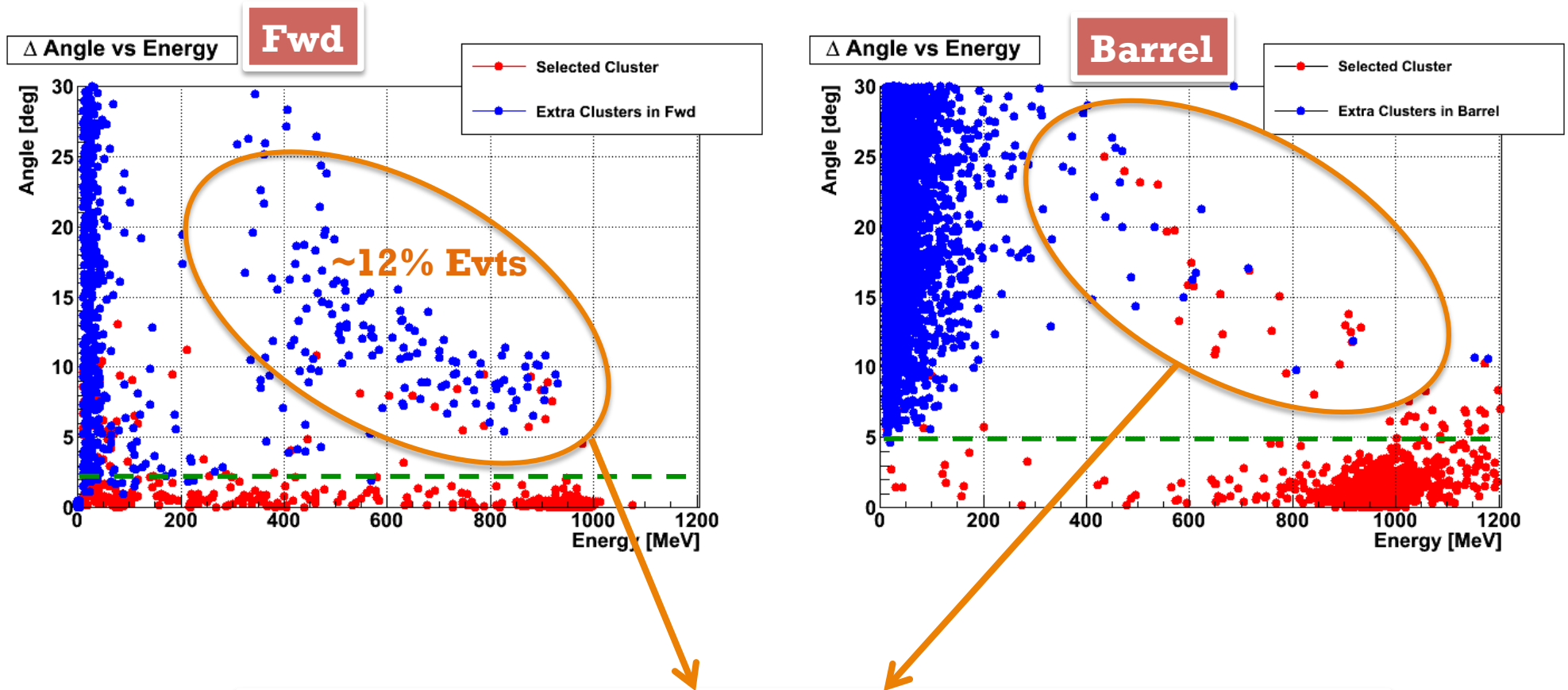**Crystal Signal Time from Peak of Signal Shape**
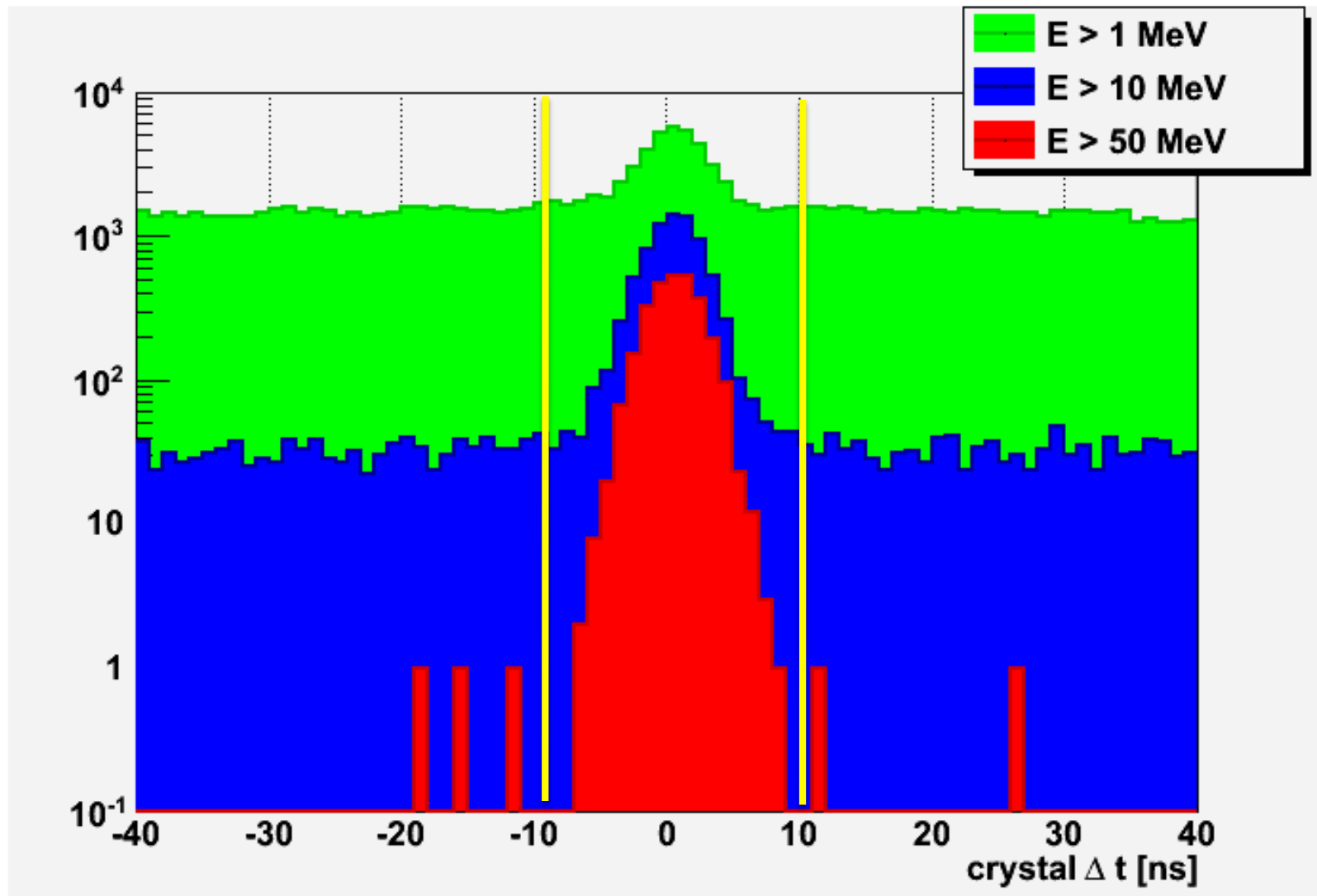
Single Photons Selection

The candidate photon is associated to the cluster with the smallest angle with respect to the MC truth

For the Fwd energy resolution only clusters with an angle < 2 deg are considered

Cluster Angle wrt Photon

Fwd

△ Angle vs Energy

Selected Cluster
Extra Clusters in Fwd

~12% Evts

Barrel

△ Angle vs Energy

Selected Cluster
Extra Clusters in Barrel

Clusters mostly realted to upstream converting photons
→Further investigation needed
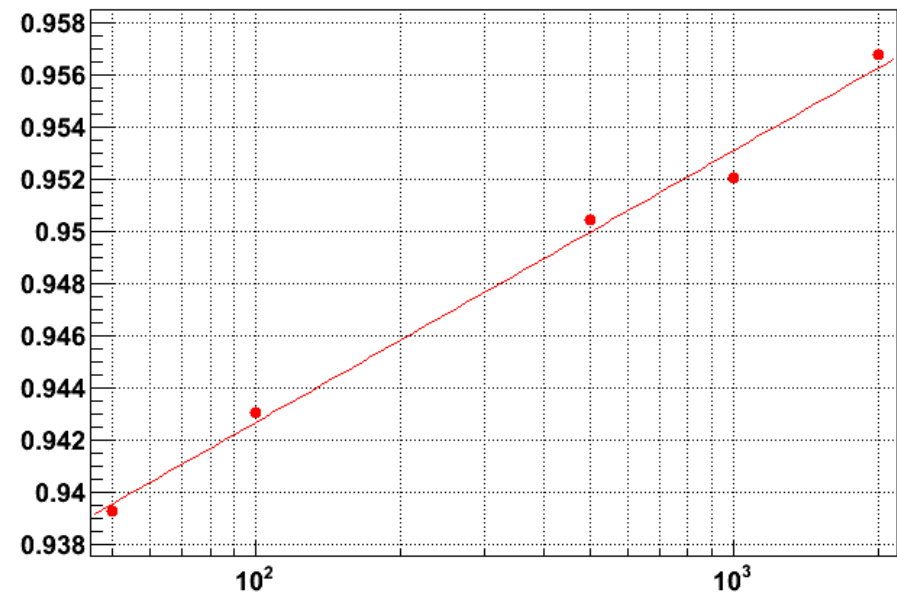**→A fraction of these events may be recovered**

π⁰ Reconstruction: Energy Calibartion
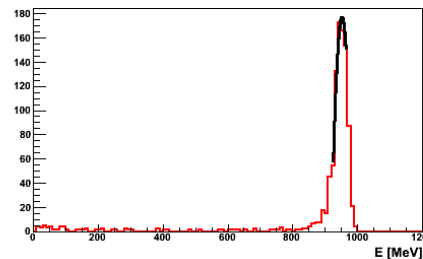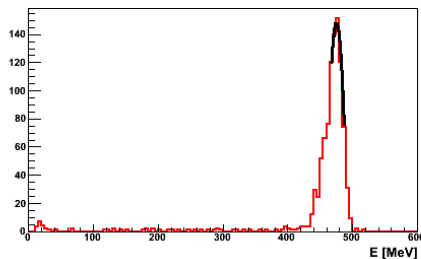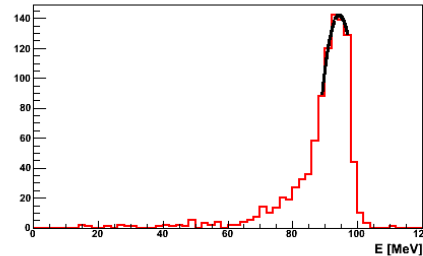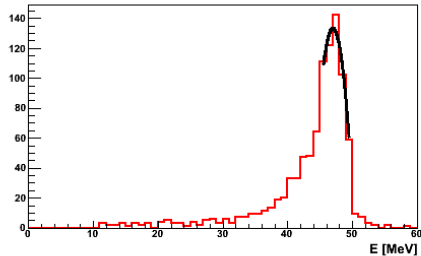
To get absolute energy calibartion fit peak position at different energies

Use 2° order log10(E) fit function for the calibartion
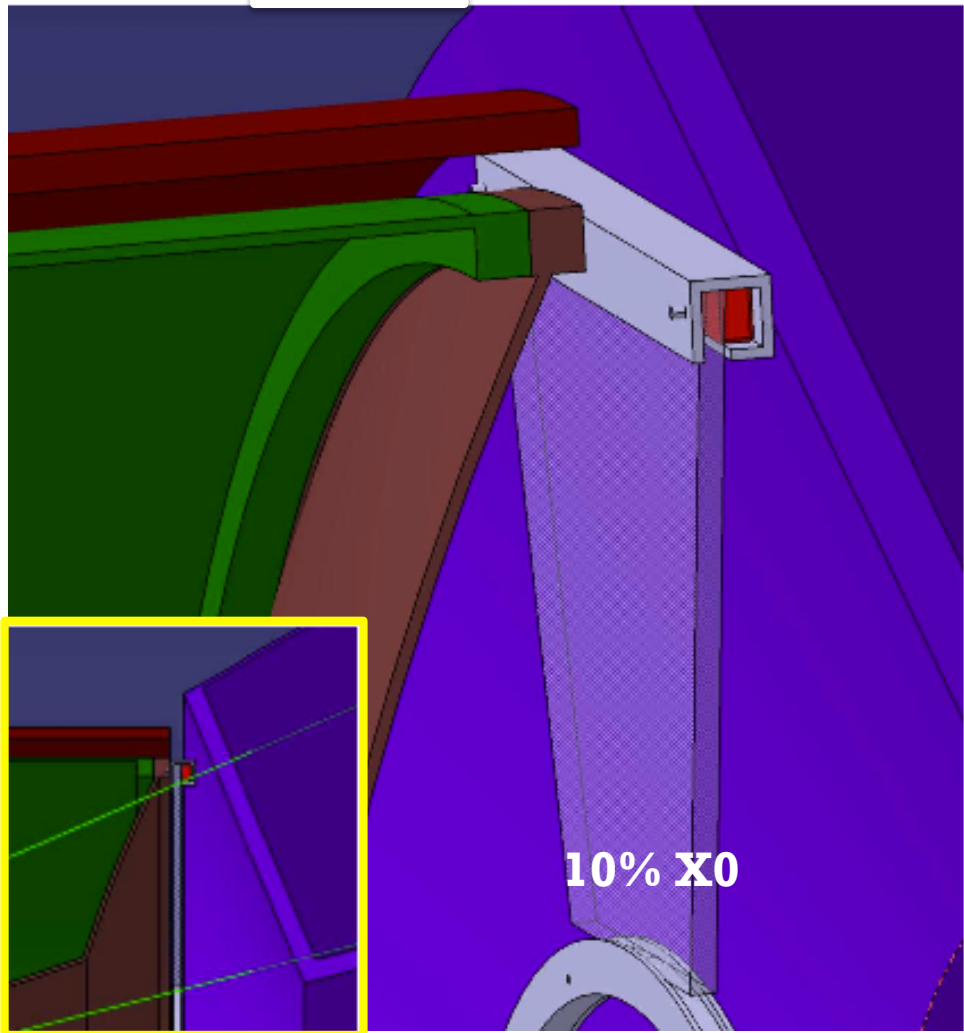
Seem to be good enough
Not always perfect

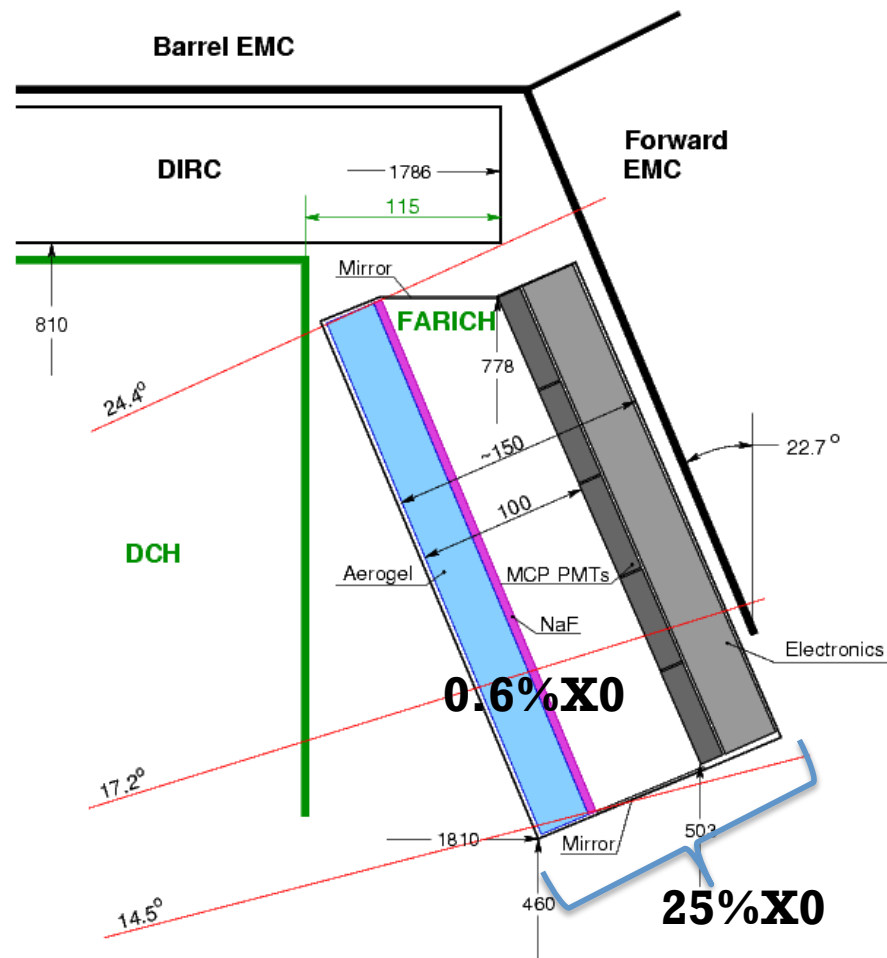Need more points but 1 calibartio / configuartio is time consuming
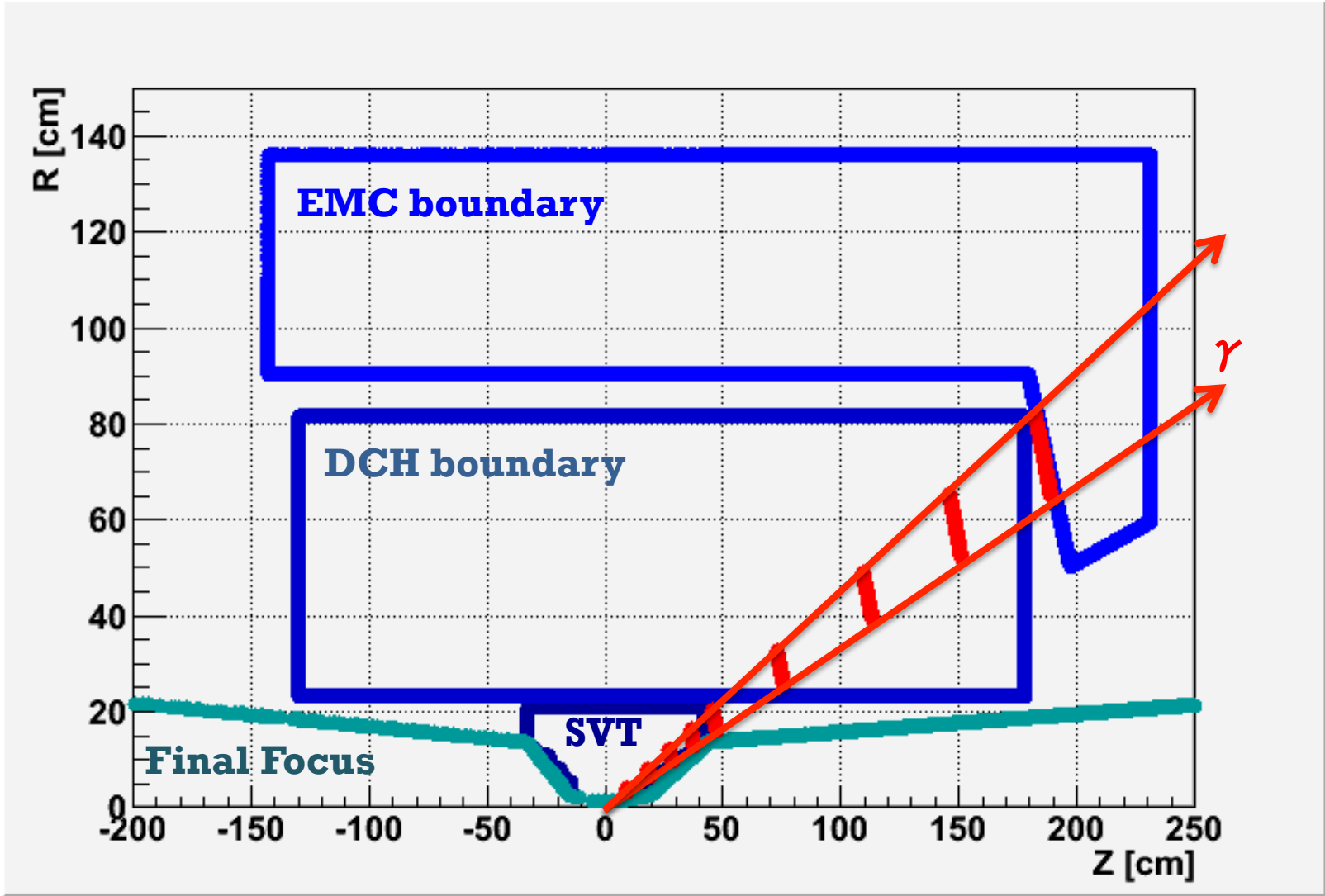
Fwd PID geometry options

fTOF

10% X0

FARICH

Barrel EMC

DIRC — 1786 — 115

810

24.4°

DCH

17.2°

14.5°

Mirror

FARICH

778

~150

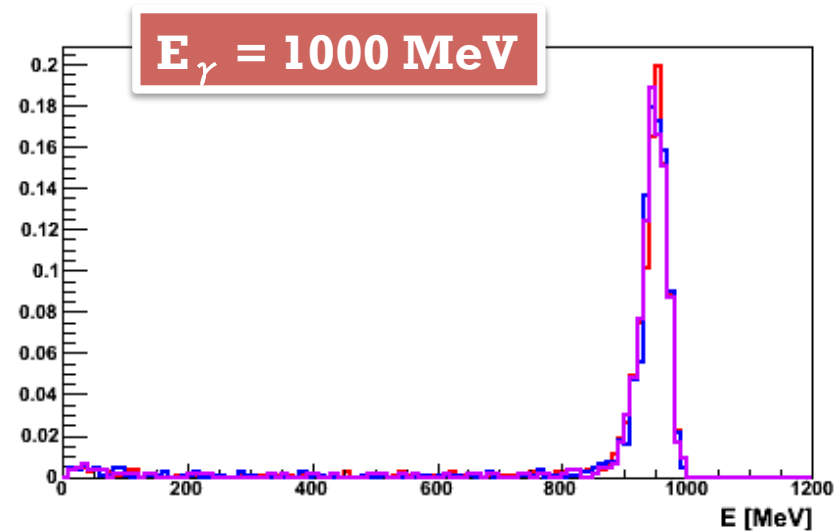100

Aerogel

MCP PMTs

NaF

Electronics

22.7°

0.6% X0

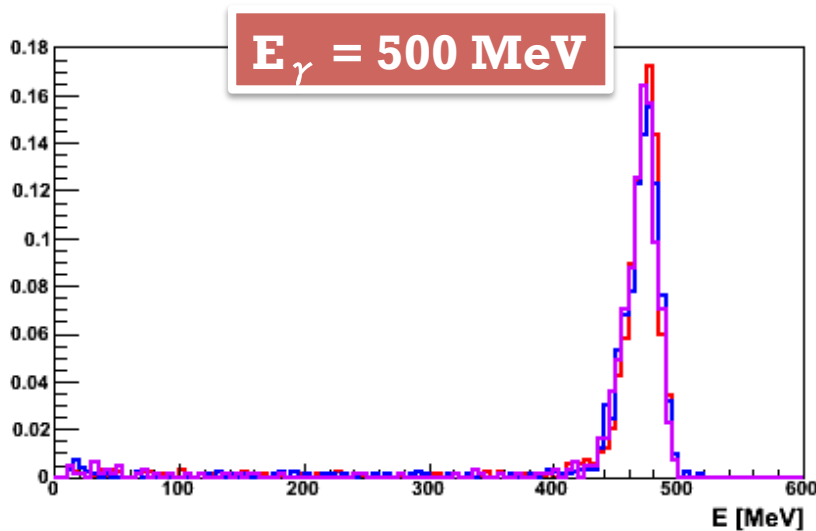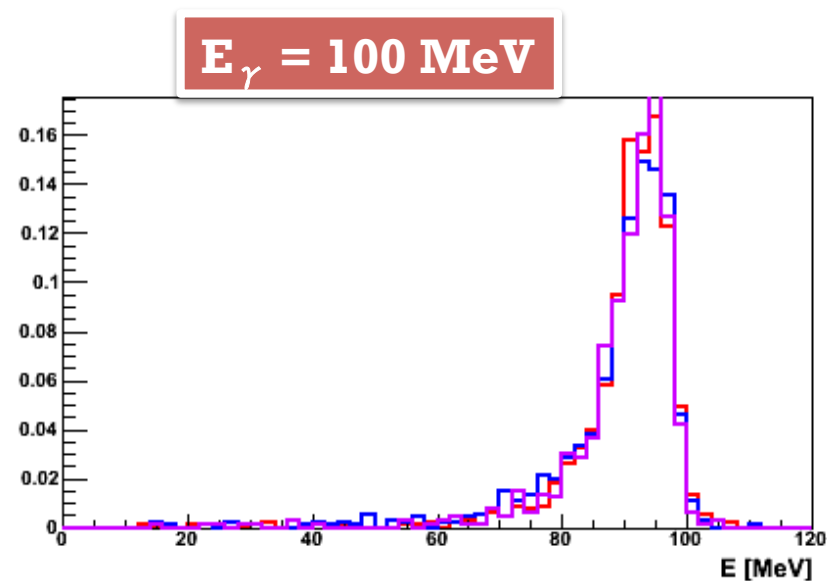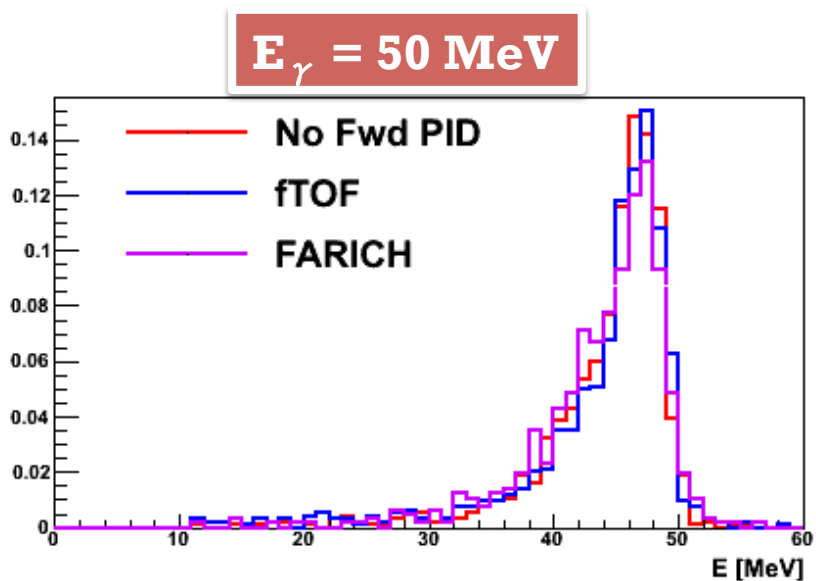1810 Mirror 503
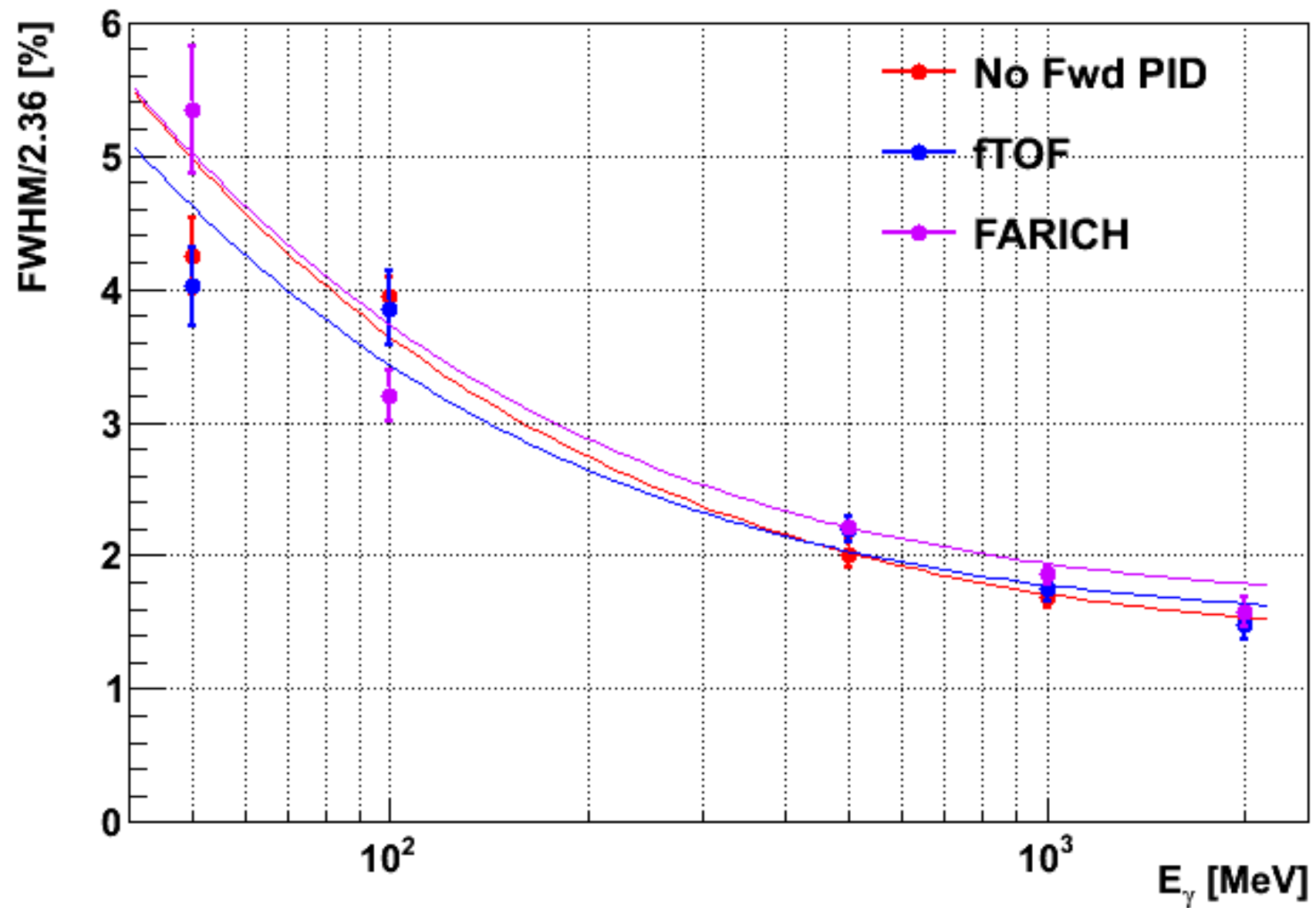
460

25% X0

Forward EMC

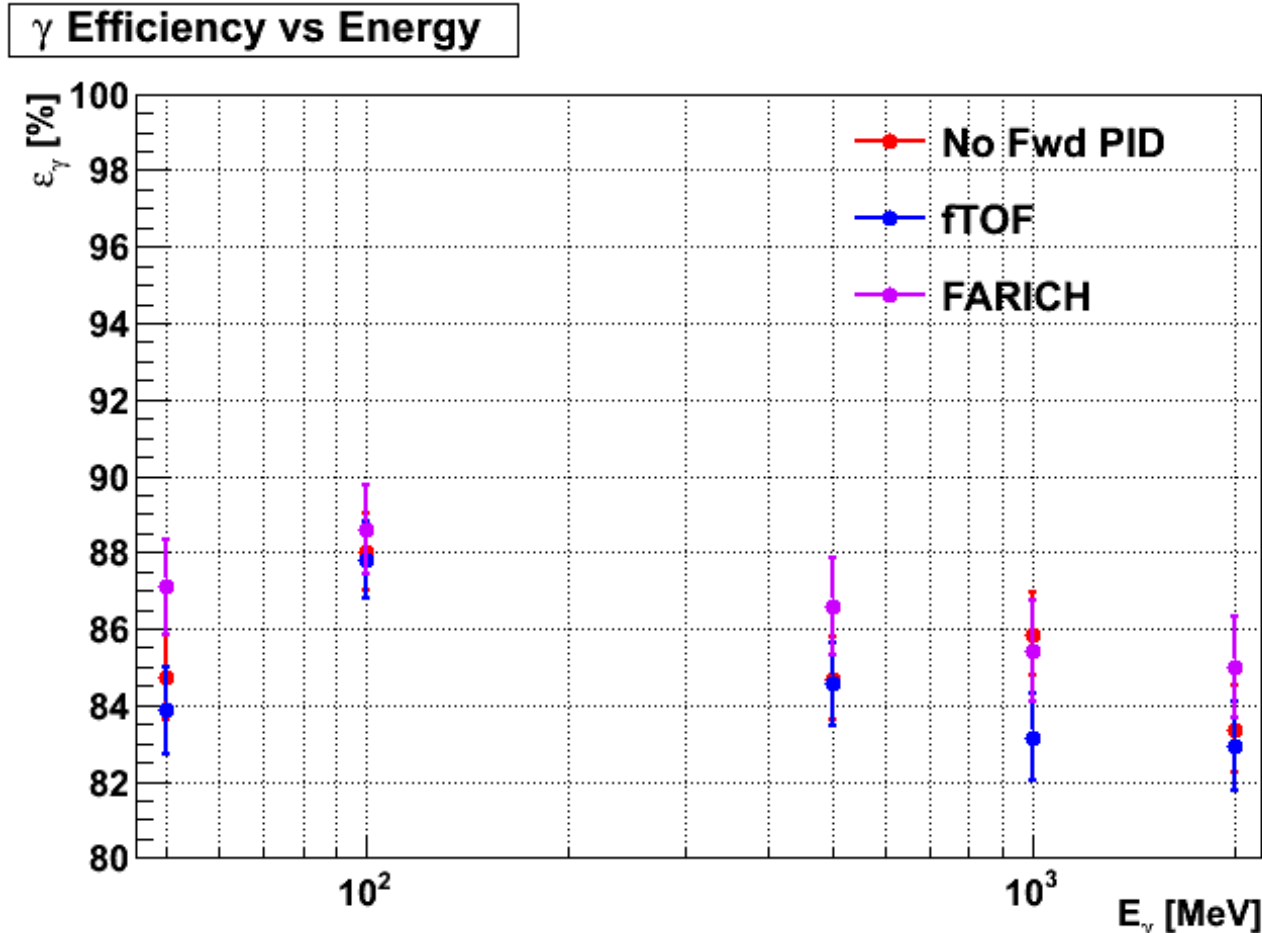# Fwd EMC Simulation :Beam Angle

Fwd EMC Simulation: Beam Angle (zoom)
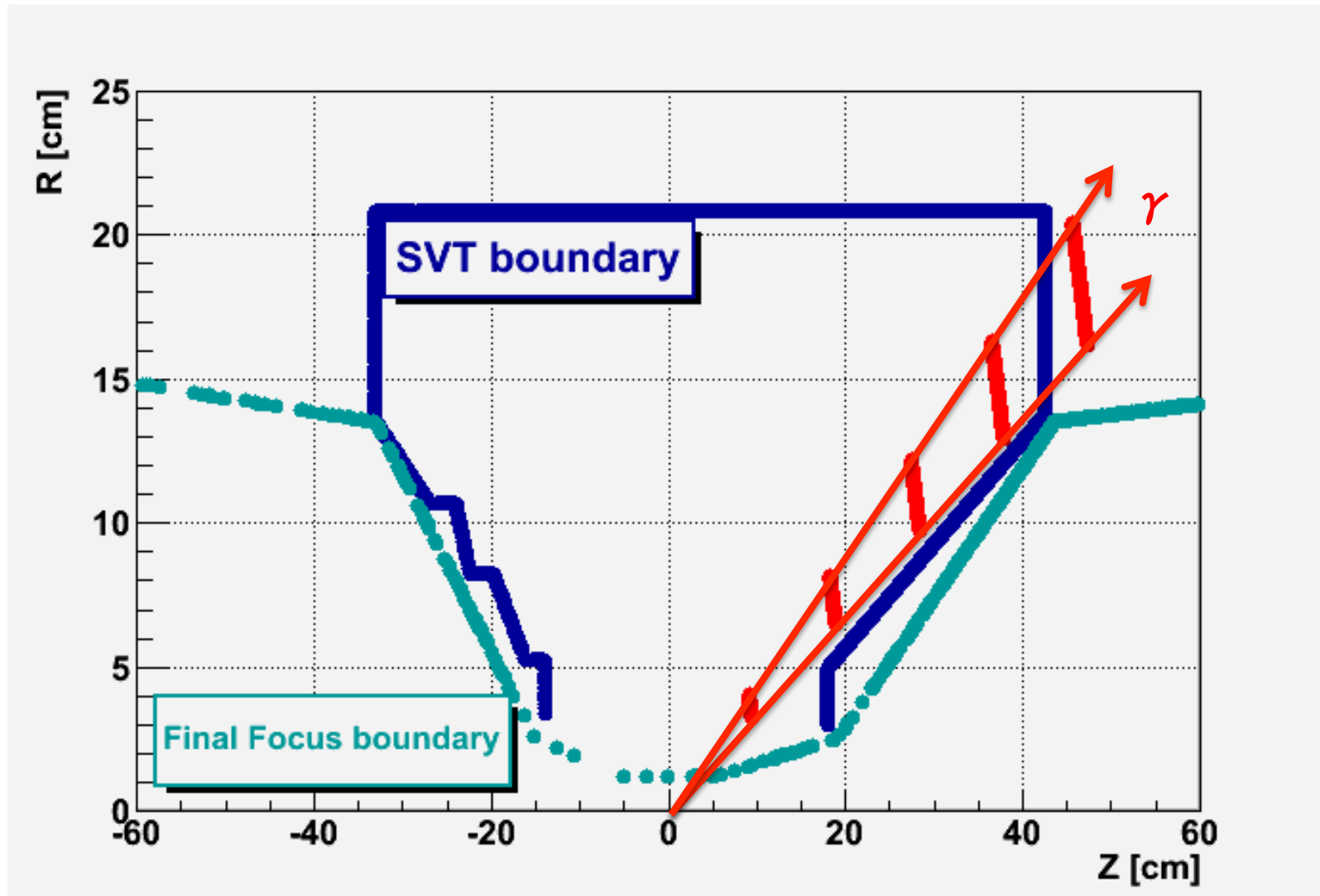
Fwd Emc Measured Energy Distribution
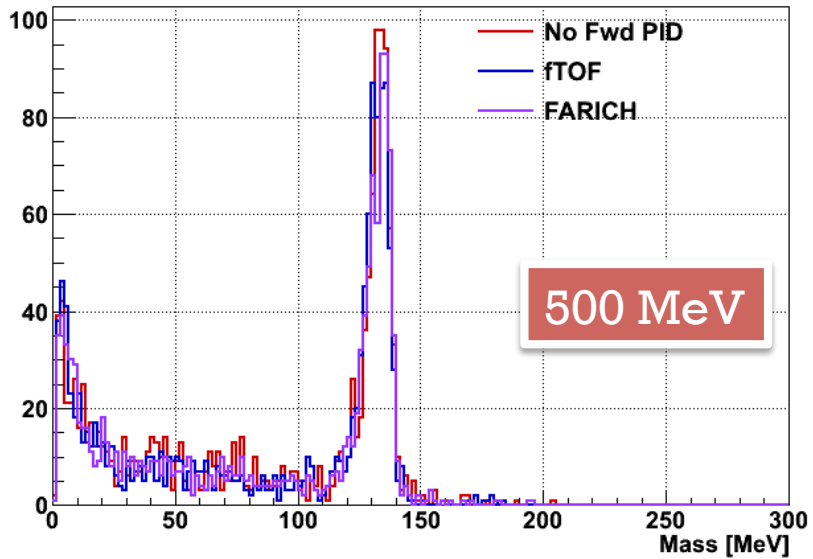
Fwd EMC Energy Resolution

Fwd EMC γ Efficinecy

γ Efficiency vs Energy

Due to the lack of tracking reconstruction with the angle selection some of the upstream converting photons are lost.
Clusters with angle-energy correlation for upstream converting γ @ 1 GeV are
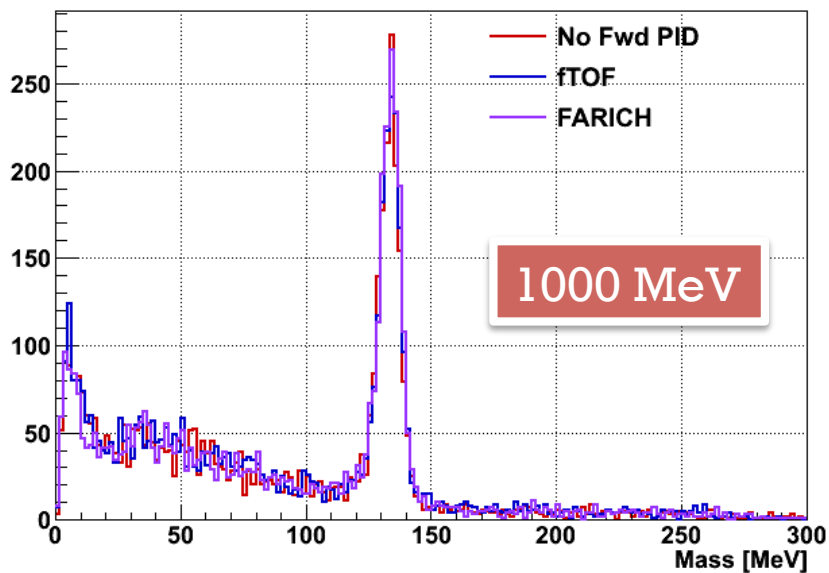~ 12% for No Fwd PID and FARICH
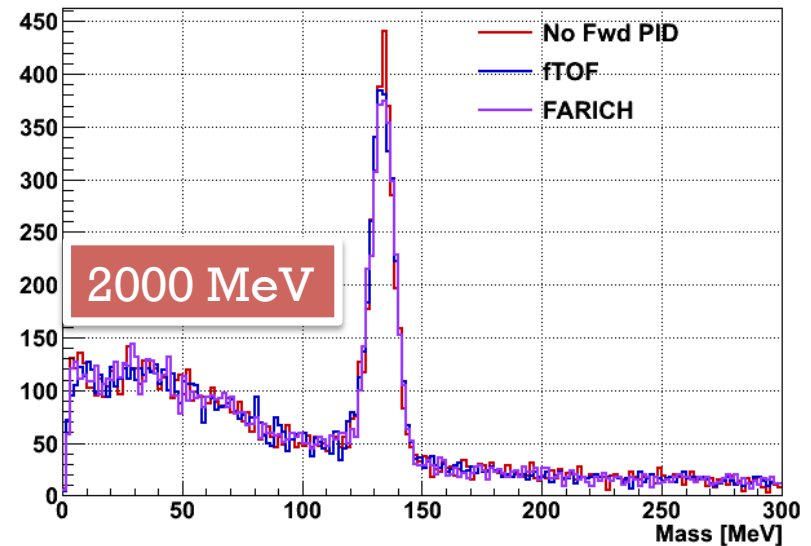~ 15% for fTOF

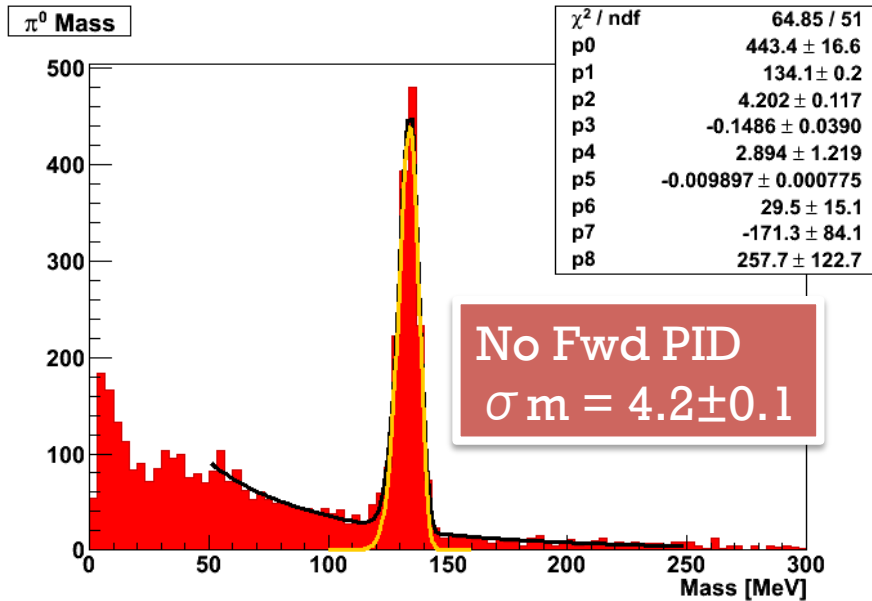# π⁰ Mass and Efficiency vs Energy

Mass from 2 photons from the Fwd

π^0 Mass

χ^2 / ndf	64.85 / 51
p0	443.4 ± 16.6
p1	134.1 ± 0.2
p2	4.202 ± 0.117
p3	-0.1486 ± 0.0390
p4	2.894 ± 1.219
p5	-0.009897 ± 0.000775
p6	29.5 ± 15.1
p7	-171.3 ± 84.1
p8	257.7 ± 122.7

No Fwd PID
$\sigma m = 4.2 \pm 0.1$

π^0 with Ek = 1 GeV
Both clusters in Fwd Endcap
Fit: Background + Novosibirsk

χ^2 / ndf	62.61 / 51
p0	451.9 ± 16.7
p1	134.4 ± 0.2
p2	4.095 ± 0.113
p3	-0.1587 ± 0.0391
p4	19.86 ± 4.31
p5	-0.01197 ± 0.00209
p6	0.2231 ± 0.4532
p7	-5.757 ± 1.024
p8	17.11 ± 2.04

fTOF
$\sigma m = 4.1 \pm 0.1$

χ^2 / ndf	87.95 / 51
p0	480.8 ± 17.3
p1	134.7 ± 0.2
p2	4.173 ± 0.113
p3	-0.1966 ± 0.0399
p4	33.26 ± 20.42
p5	-0.01469 ± 0.00416
p6	-1.851 ± 3.113
p7	5.919 ± 13.741
p8	0.4123 ± 18.0740
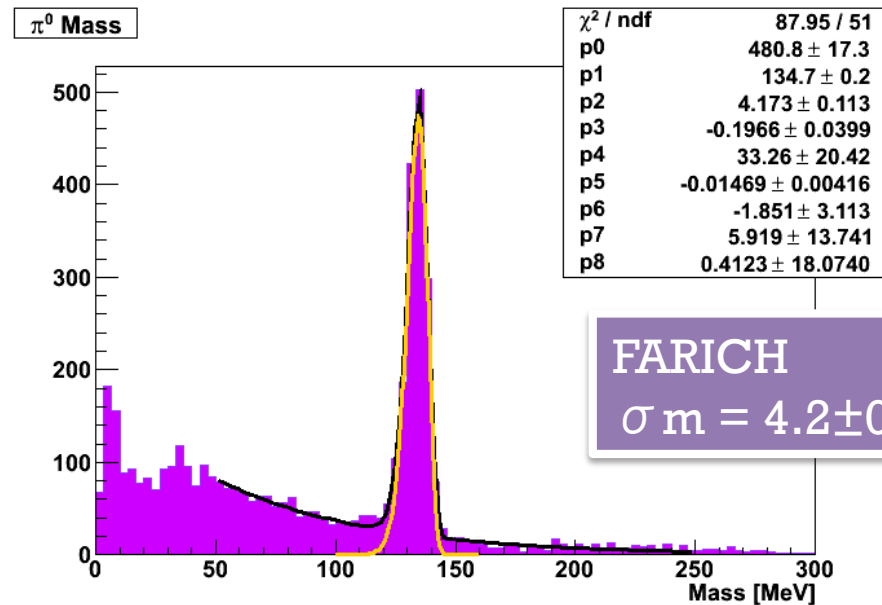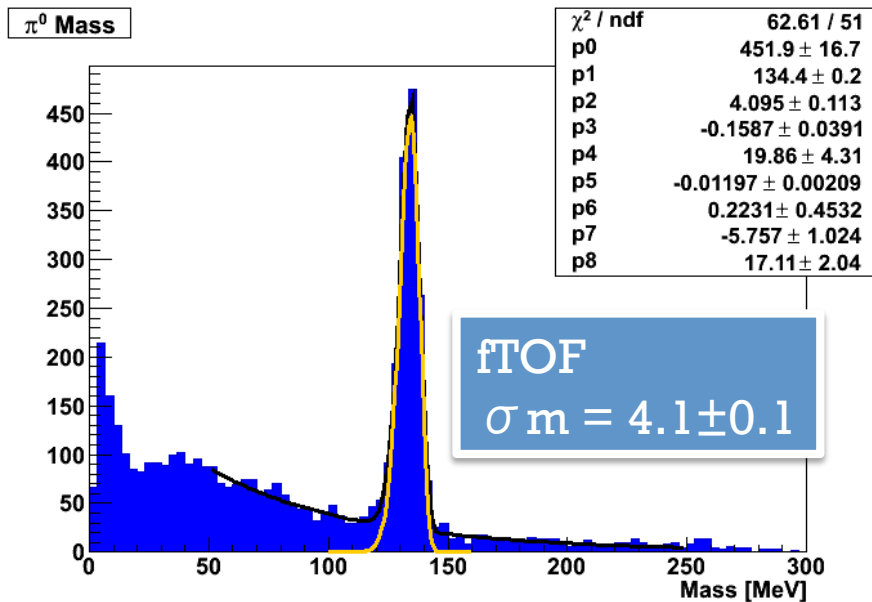
FARICH
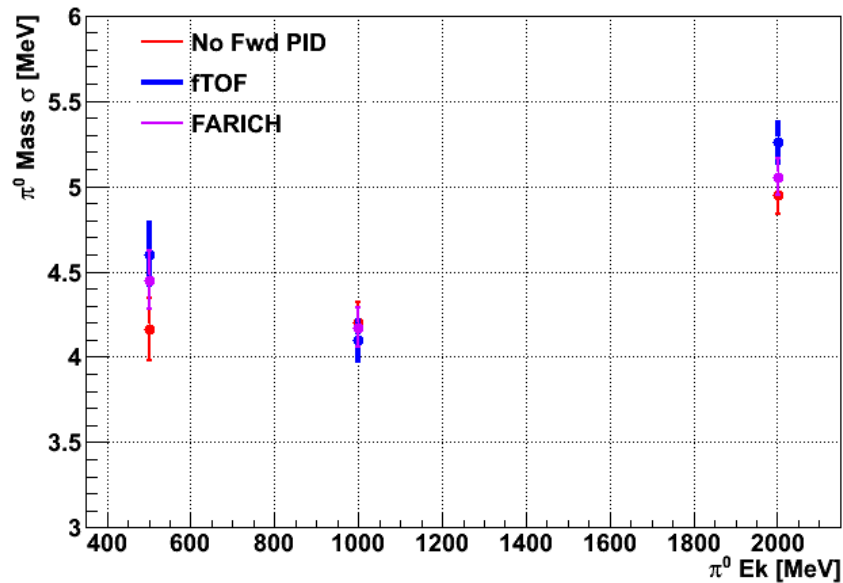$\sigma m = 4.2 \pm 0.1$

π^0 Mass and Efficiency vs Energy

2 Photons in the Fwd region

Mass resolution

Relative Efficiency
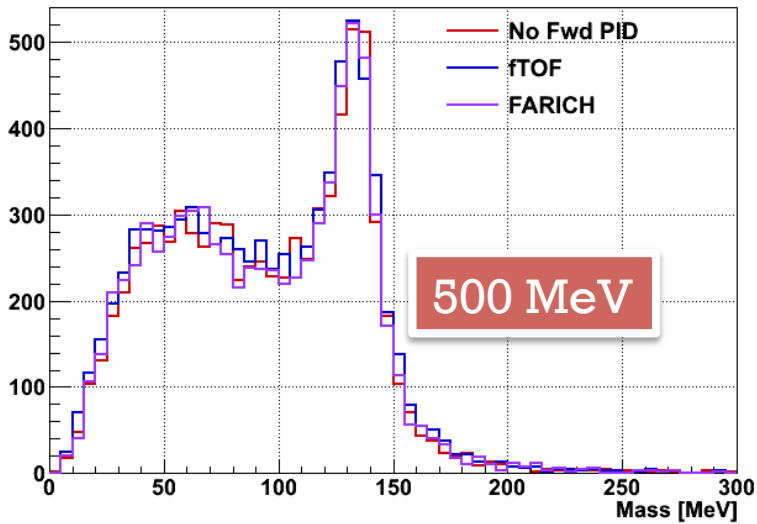
π^0 with Ek = 1 GeV
Both clusters in Fwd Endcap
Fit: Background + Novosibirsk

$\varepsilon_{\text{fTOF/NoPID}}$ = 98.0 ± 1.2
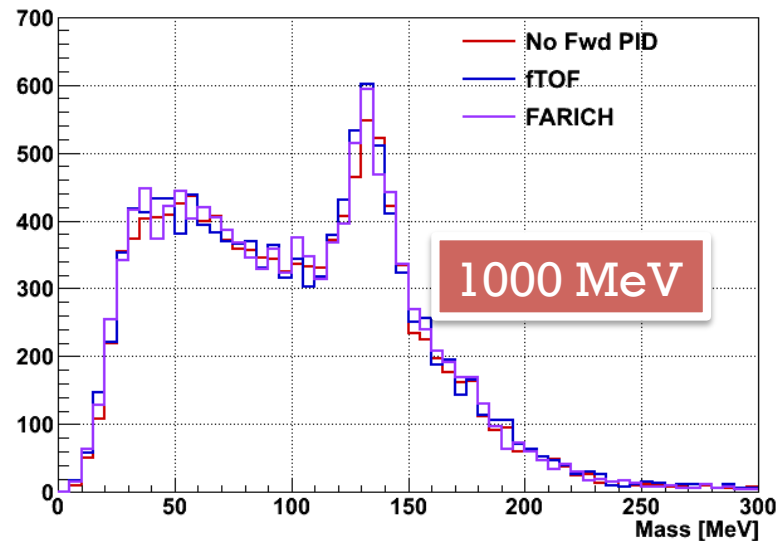$\varepsilon_{\text{FARICH/NoPID}}$ = 96.5 ± 1.5

π⁰ Mass and Efficiency vs Energy
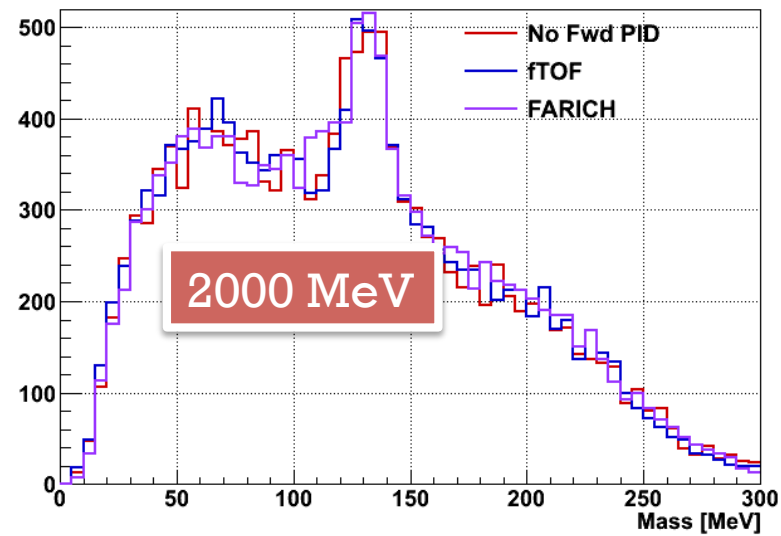
π⁰ Mass

500 MeV

Mass from 1 photin from the Barrel and 1 photon from the Fwd

Background shapes is difficult to fit correctly
Mass fit is not stable

π⁰ Mass

1000 MeV

π⁰ Mass

2000 MeV

Conclusions

- ## Fwd PID Effects on EMC

  - γ

    - fTOF and FARICH effects on photons energy resolution are negligible

    - FARICH effects on photon detection efficiency is negligible

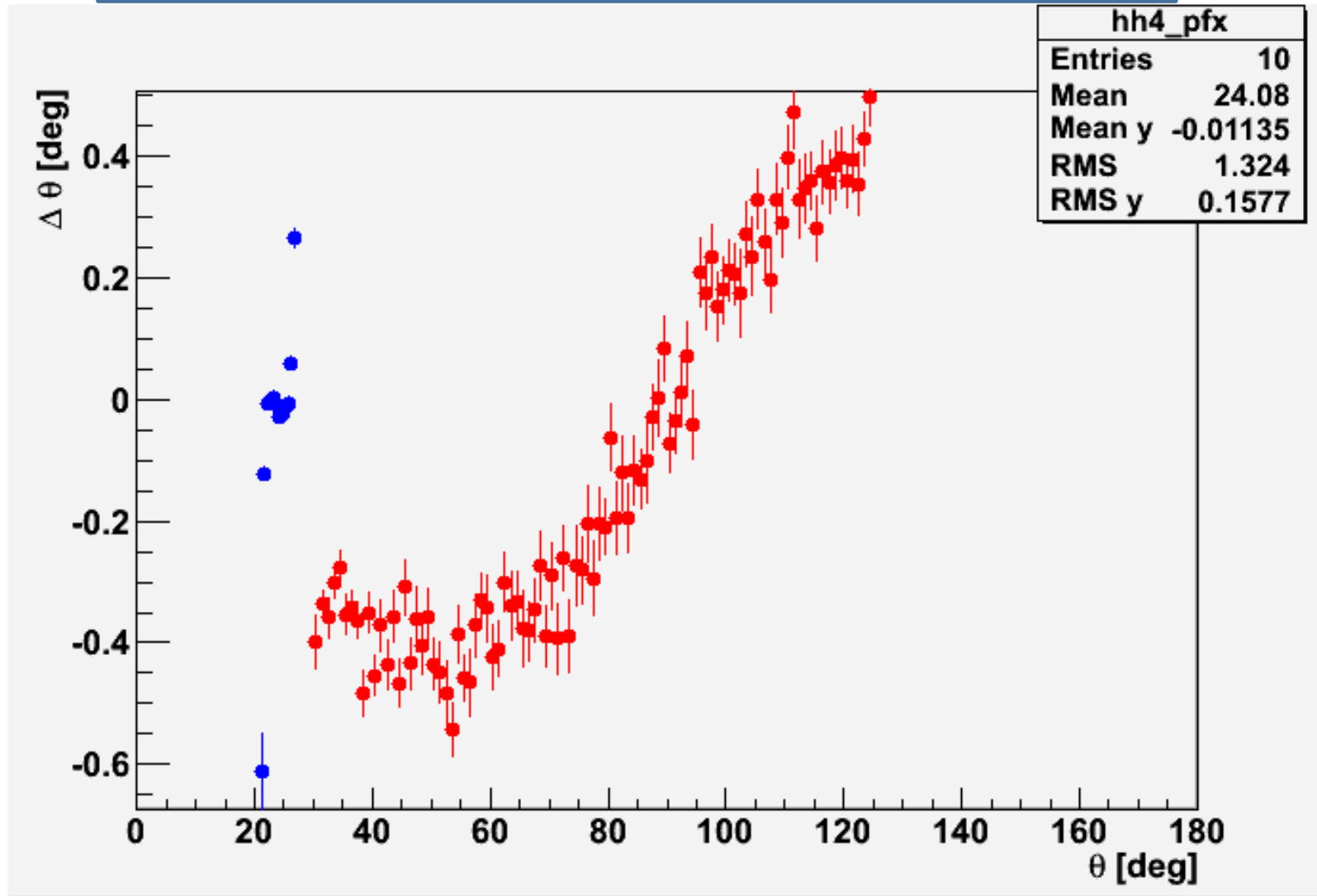   - fTOF effect on photon detection efficiency is very small

  - $\prod^0$

    - fTOF and FARICH effects on pions mass resolution are negligible

    - fTOF and FARICH effects on pions detection efficiency is small

Backup

Theta Correction (to be added)

Absolute Theta calibration must be added