SuperB Calorimeter Simulation and Bakcground - Fwd PID effect studies

BG * Full Sim Session

SuperB Collaboration Workshop
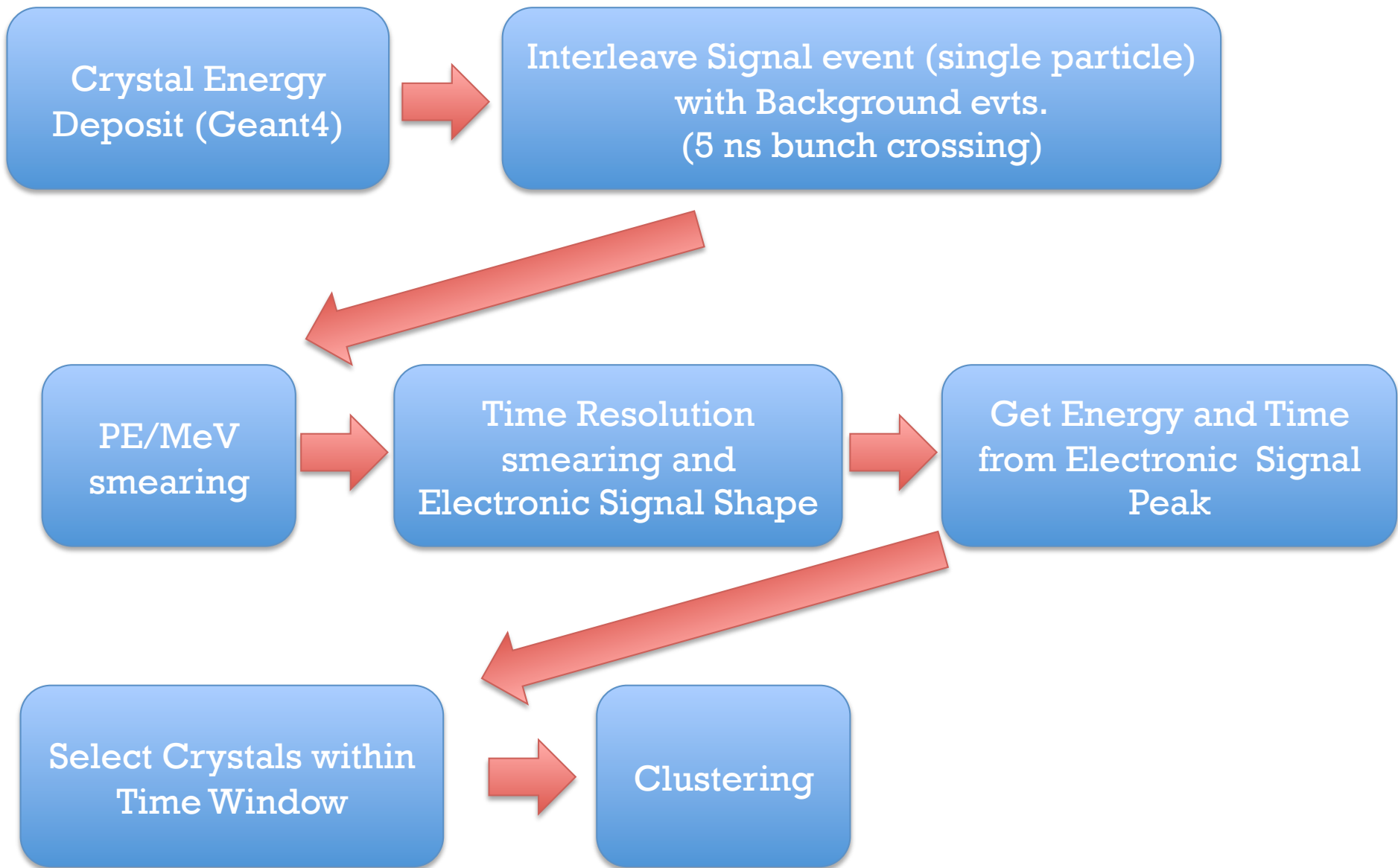
Frascati

06/04/2011

S. Germani

INFN Perugia
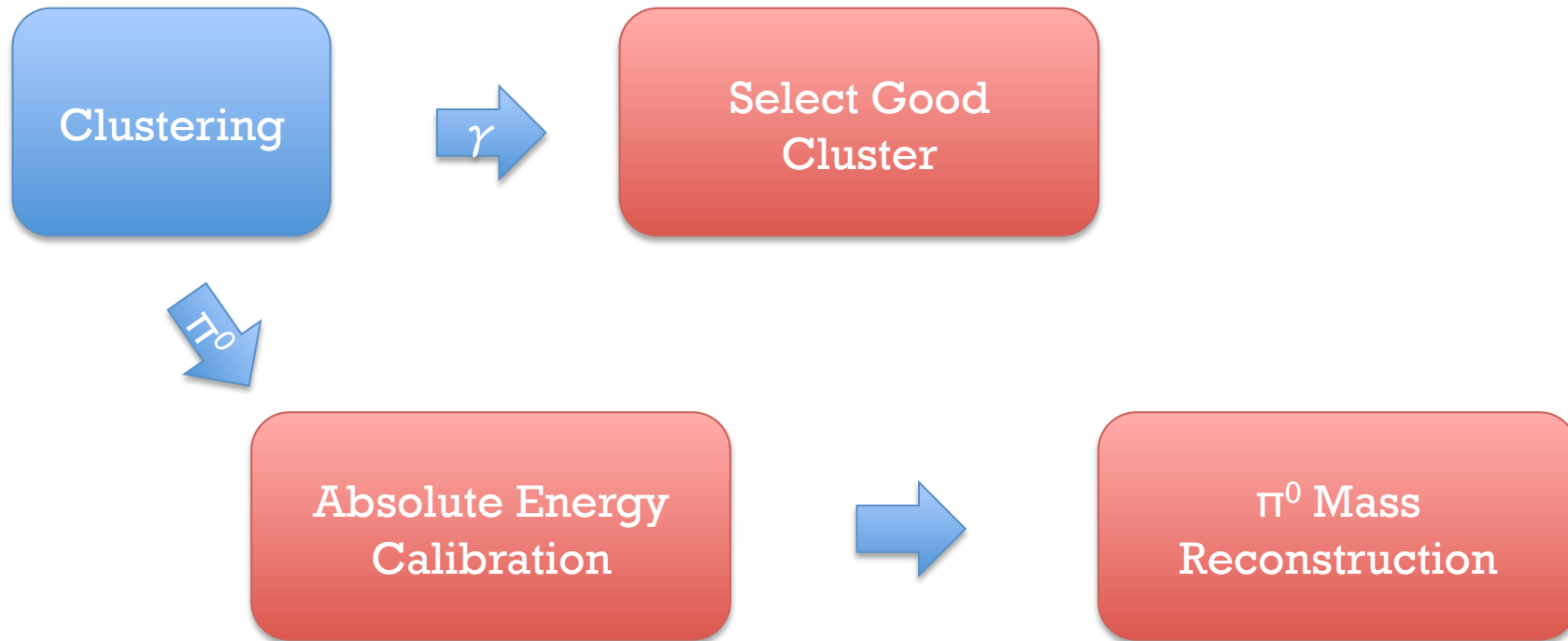
Intro

- Description of new calorimeter simulation work flow with bakground
  - Electronic signal shape and time resoltion added
  - Time selection
  - AbsolutebEnergy Calibration
  - π^0 Mass

- First results from Fwd PID effects on the EMC
  - Fwd PID – fTOF - FARICH comparison

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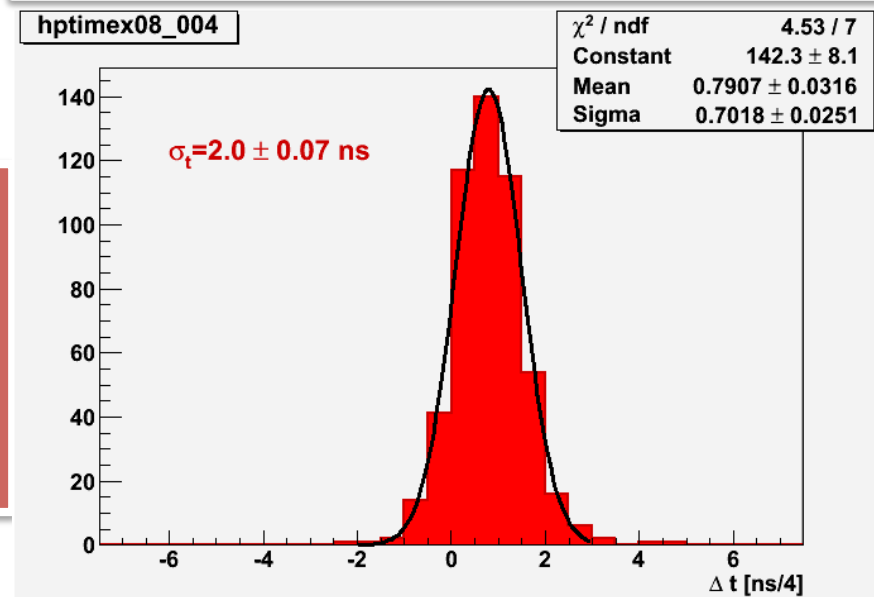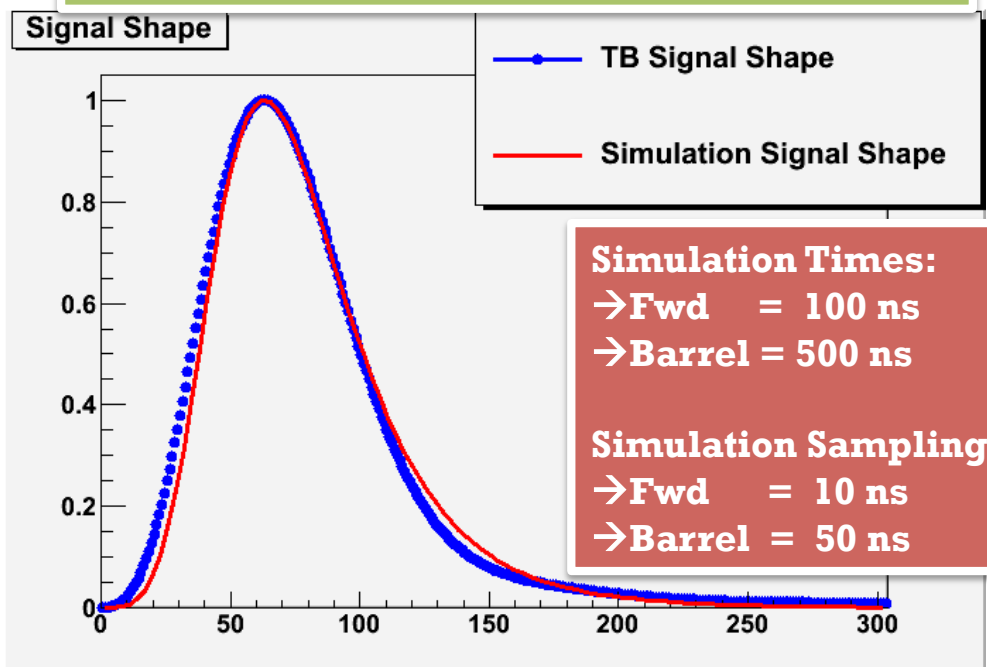
TB sampling rate was 250 MHz (4 ns)
Signal caracteristc time:
→Left part of signal shape is a Gauss function
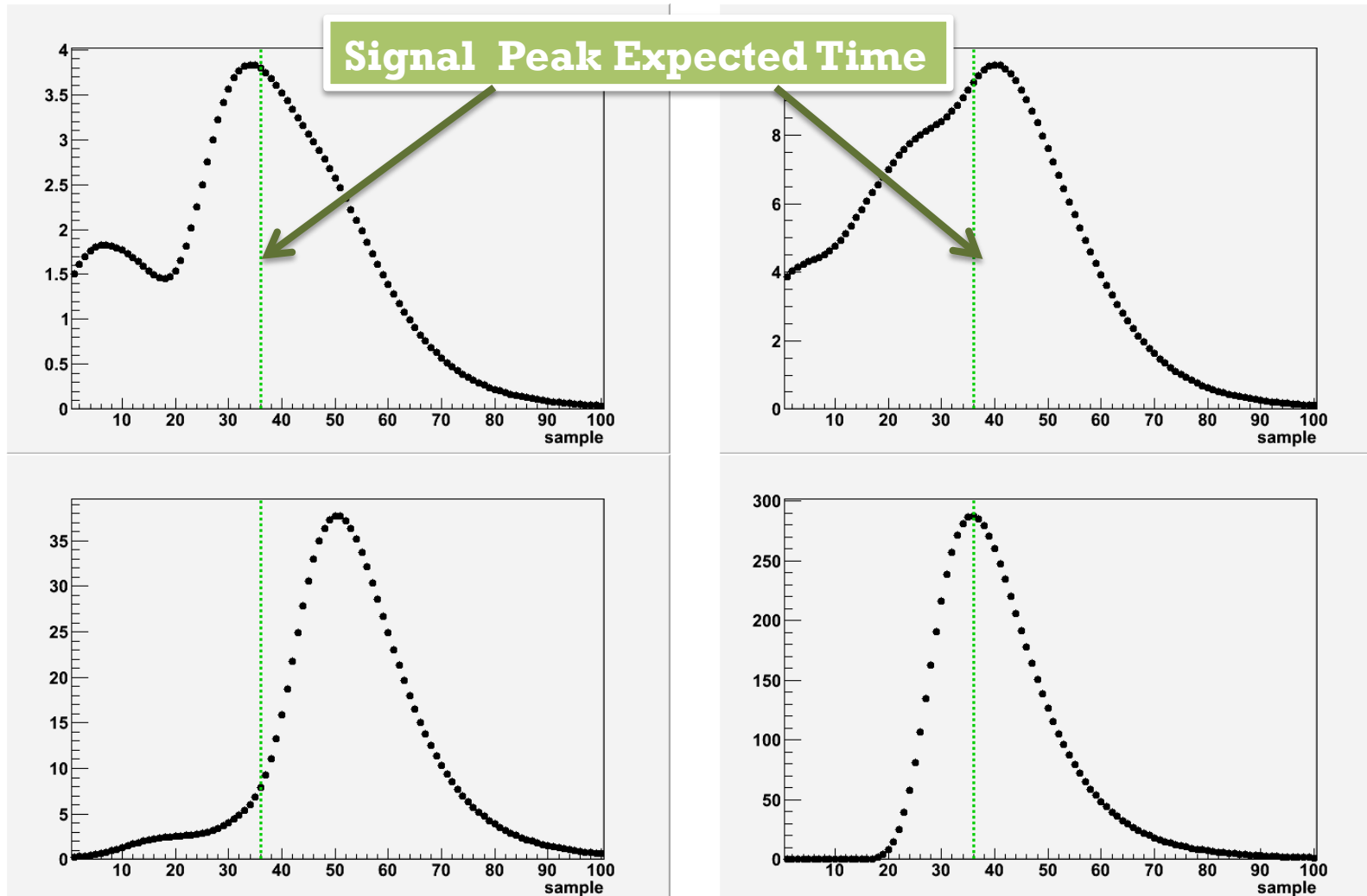→Caracteristic signal time is the σ
→TB time was 100 n

Time resoltion 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

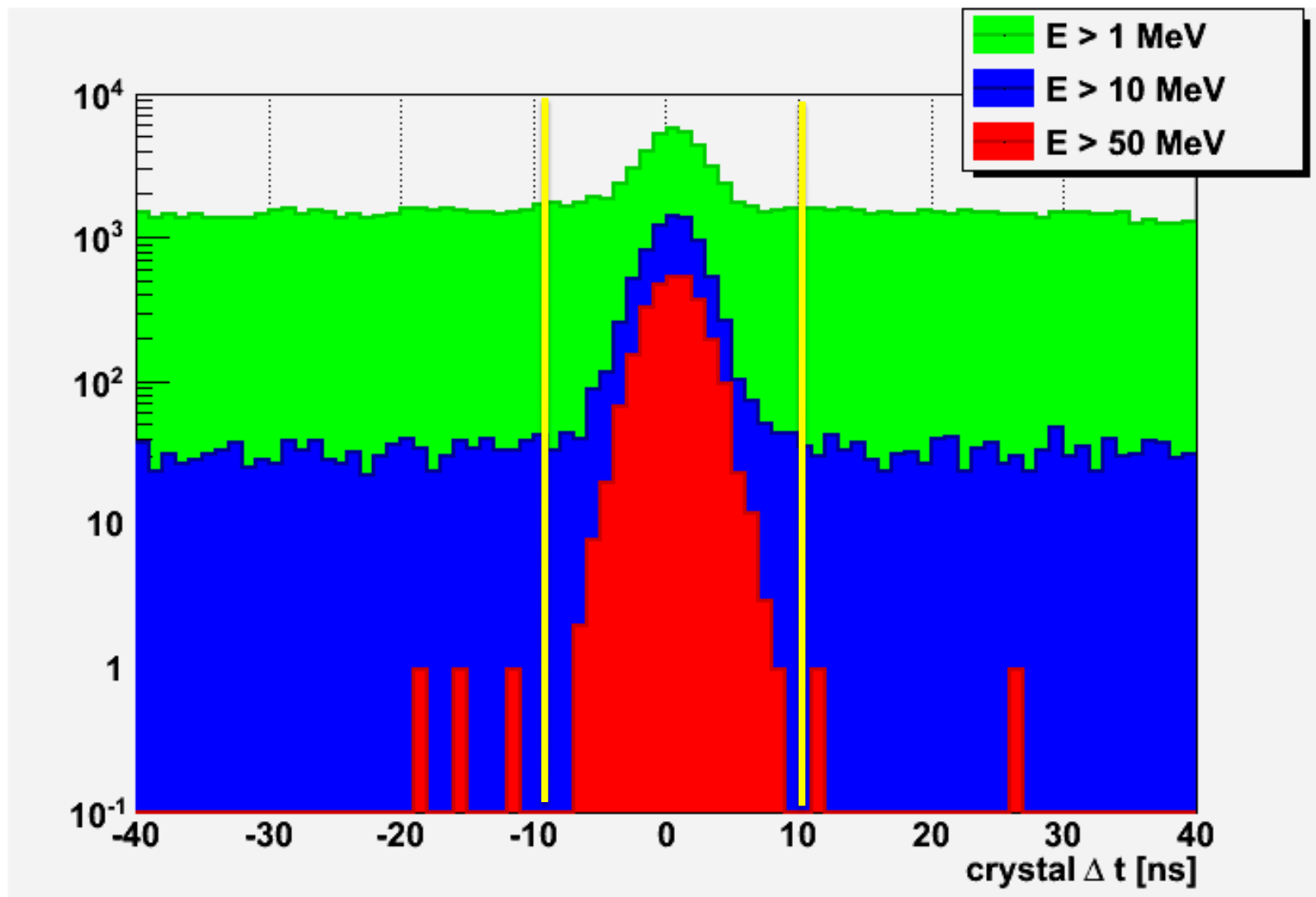| χ^2 / ndf	4.53 / 7
Constant	142.3 ± 8.1
Mean	0.7907 ± 0.0316
Sigma	0.7018 ± 0.0251

$\sigma_t = 2.0 \pm 0.07$ ns
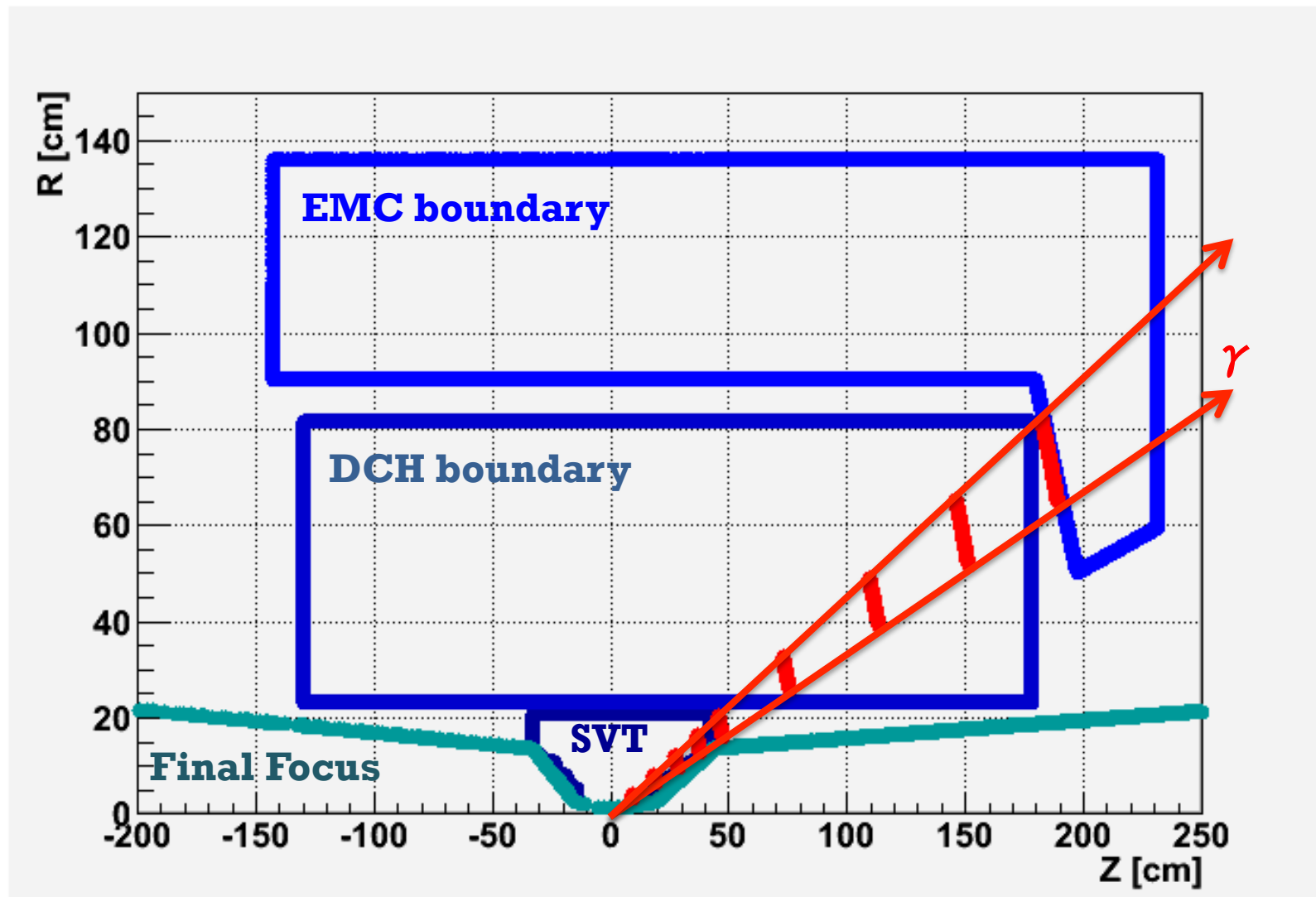
Δ t [ns/4]

Signals Examples with Background

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
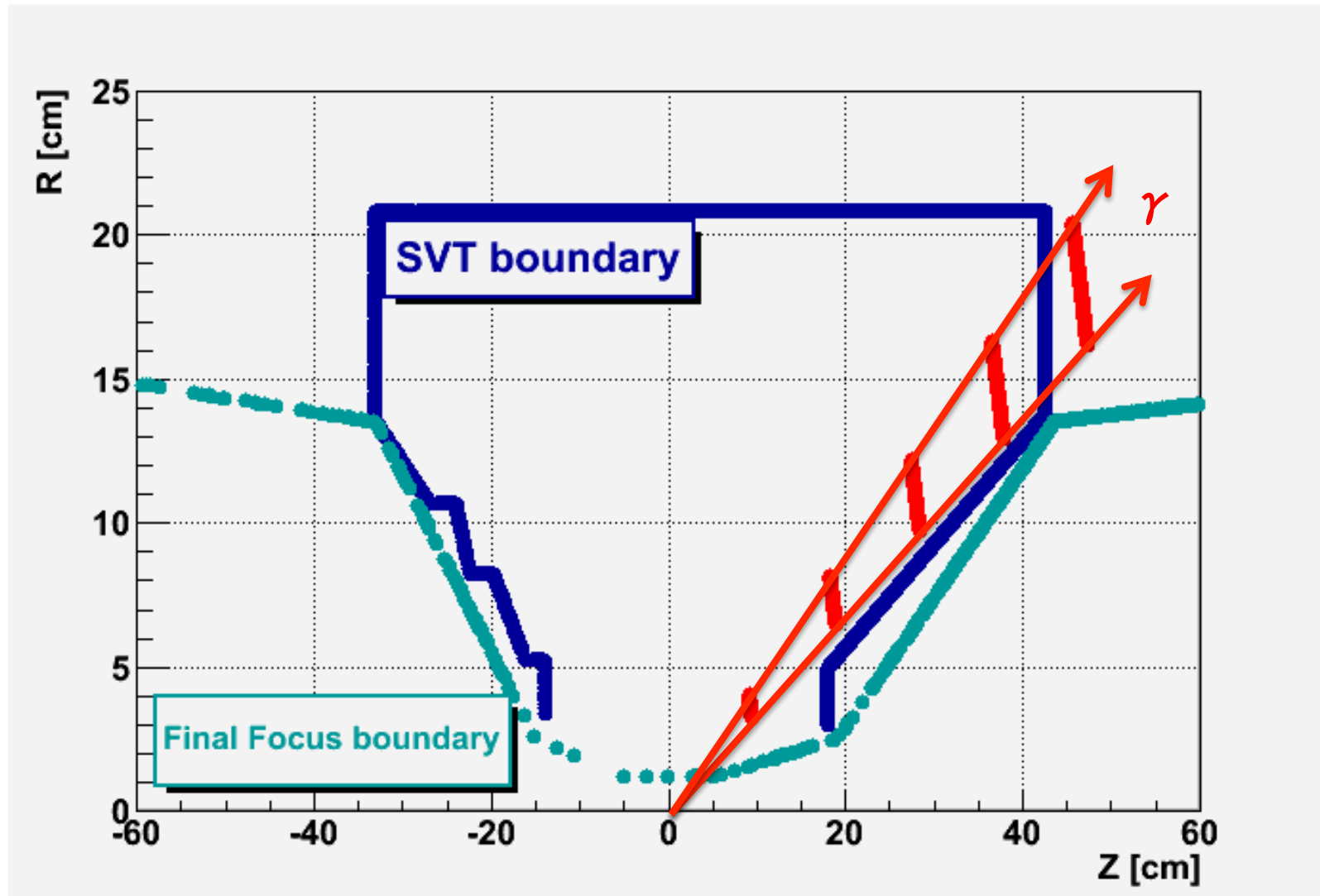

Crystal Signal Time from Peak of Signal Shape

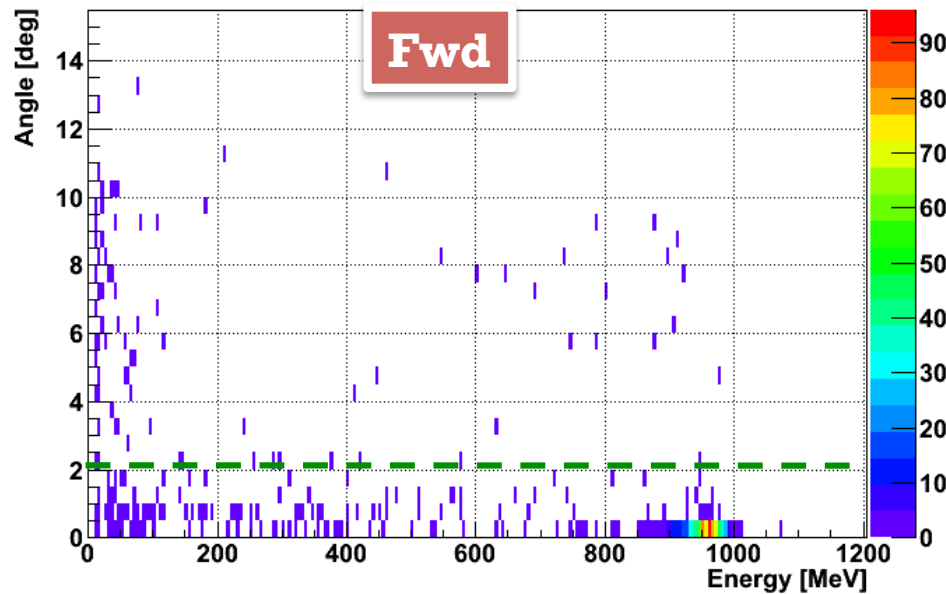# Fwd EMC Simulation :Beam Angle

Fwd EMC Simulation: Beam Angle (zoom)
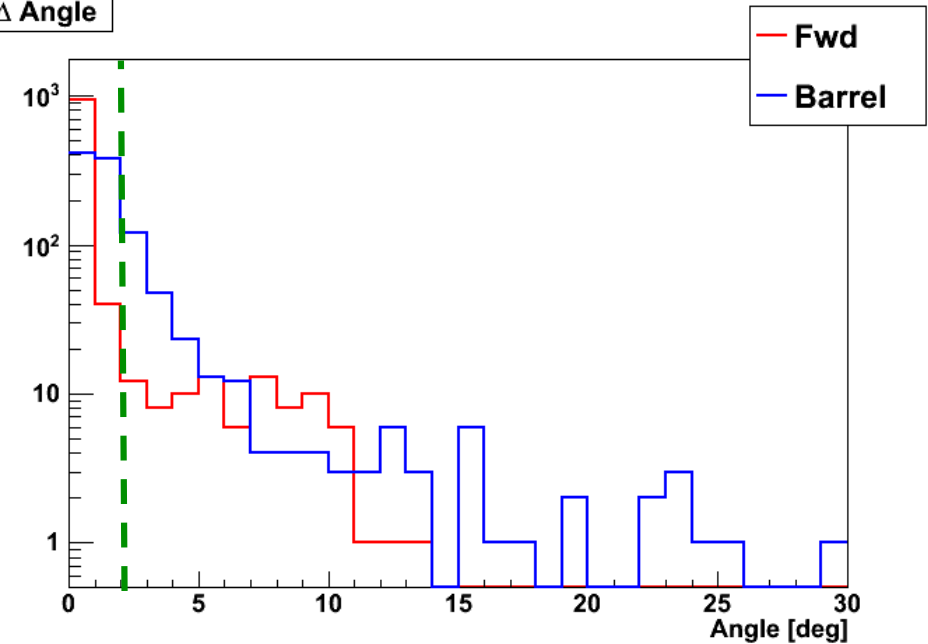
Cluster Angle and Selection for Photons

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

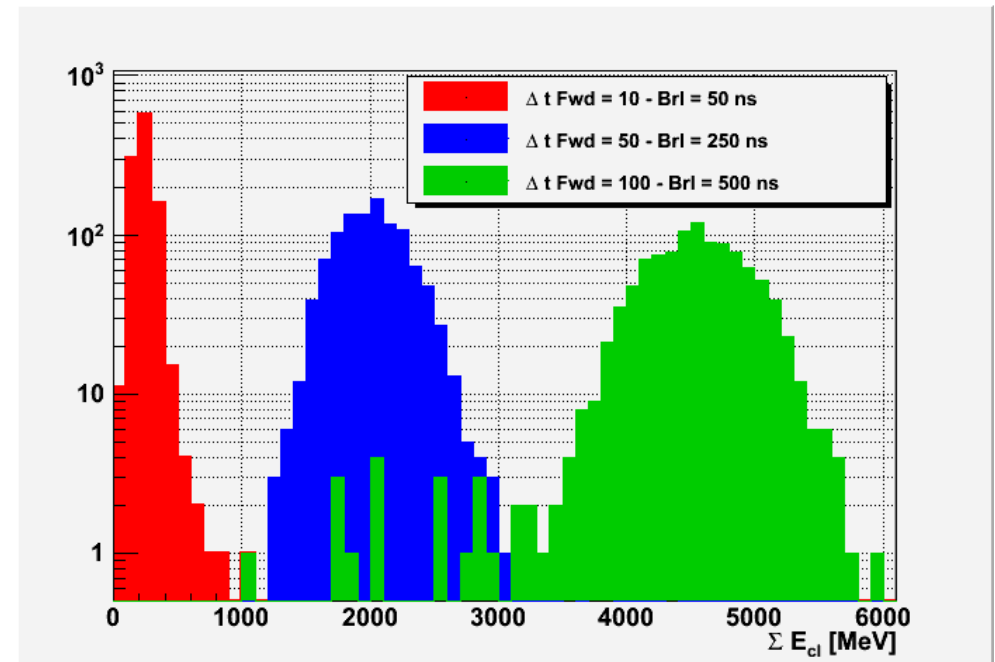Δ Angle vs Energy

Selected Cluster
Extra Clusters in Fwd

~12% Evts

Barrel

Δ Angle vs Energy

Selected Cluster
Extra Clusters in Barrel
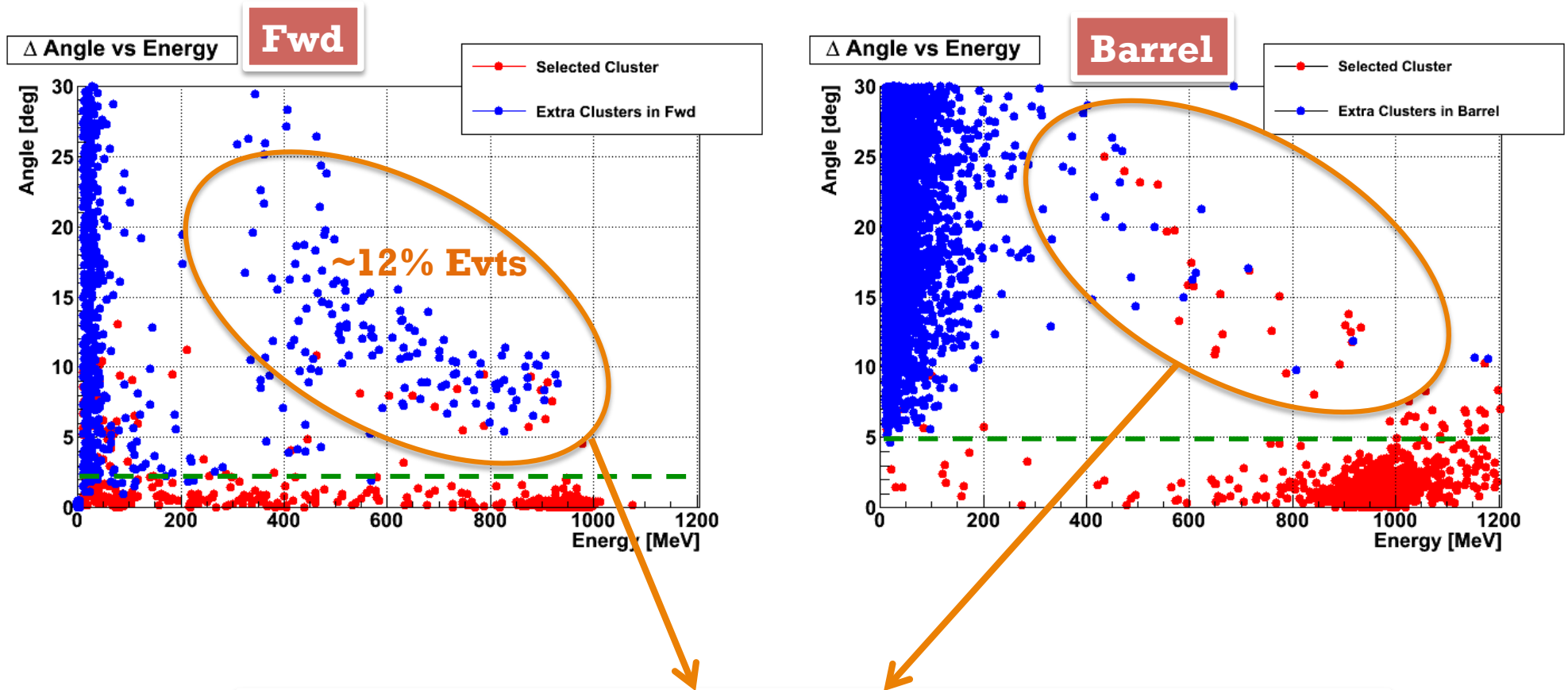
Clusters mostly realted to upstream converting photons
→Further investigation needed
→A fraction of these events may be recovered

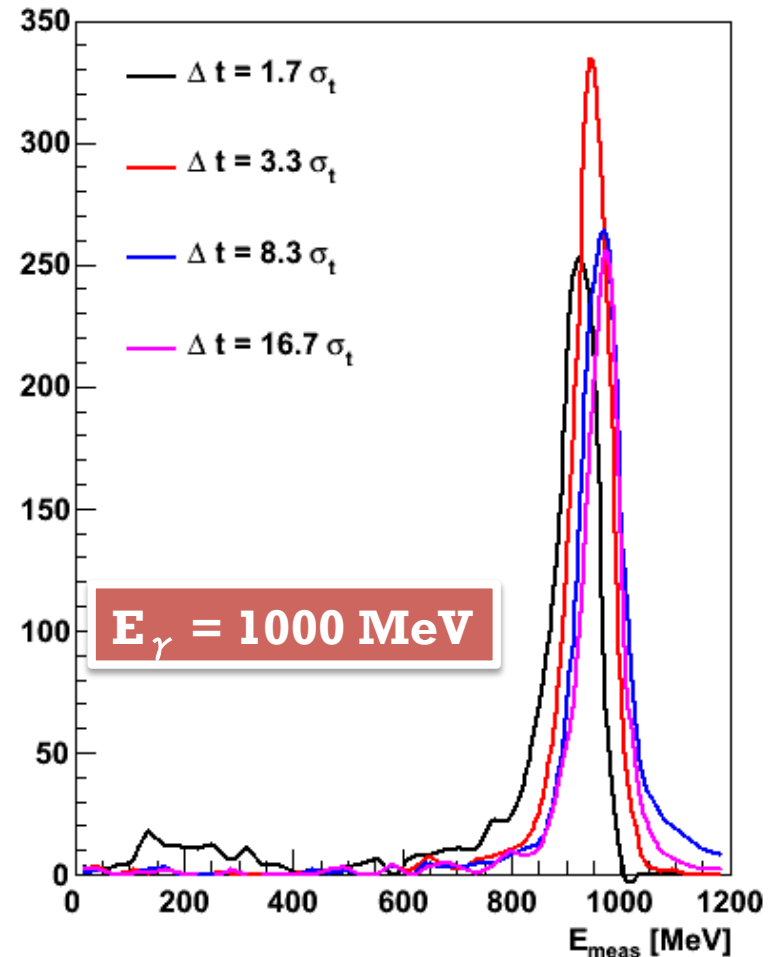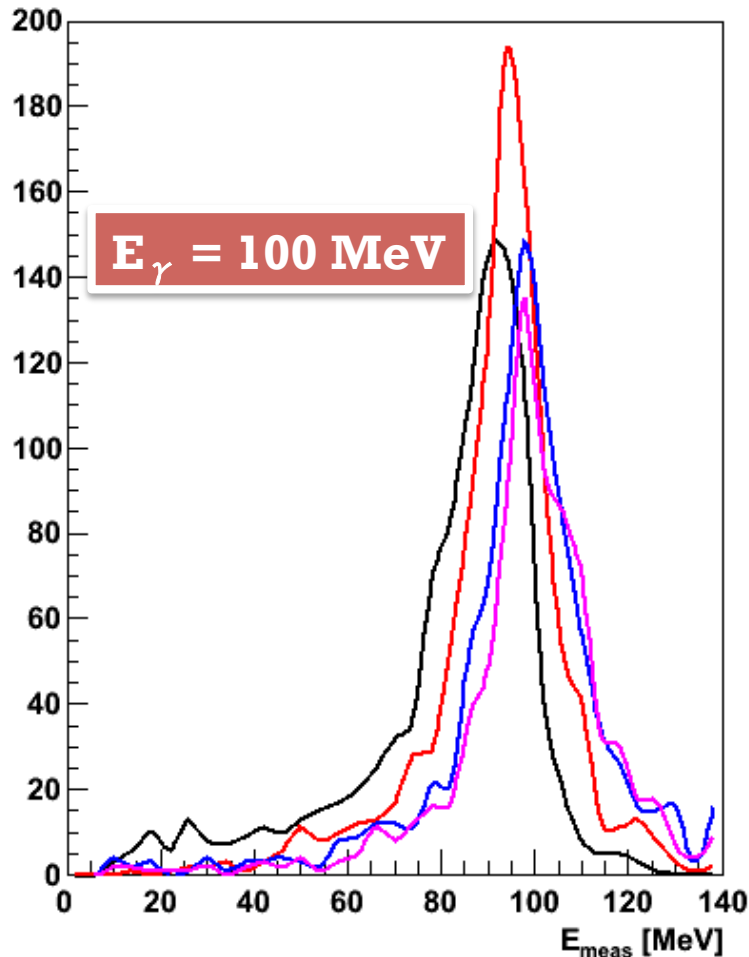# Crystal Time selection effects

Sum of selected crystal energy
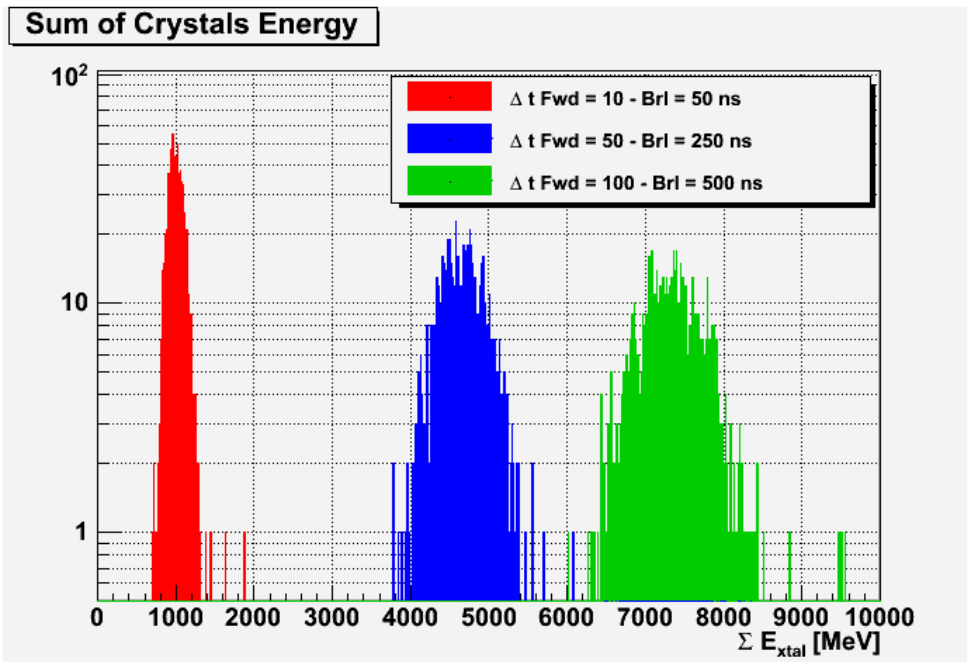
Sum of Cluster Energy

Crystal Time selection effect

Energy distributions for different time selection windows

E_γ = 100 MeV

$\Delta t = 1.7\,\sigma_t$
$\Delta t = 3.3\,\sigma_t$
$\Delta t = 8.3\,\sigma_t$
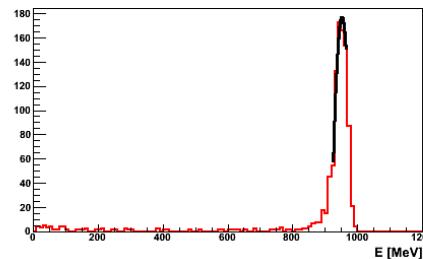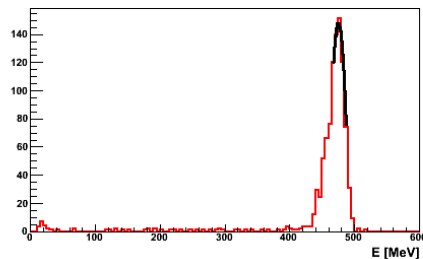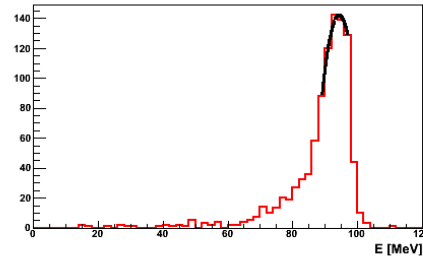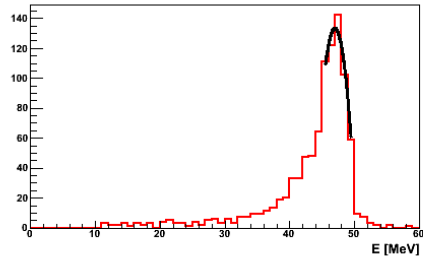$\Delta t = 16.7\,\sigma_t$

E_γ = 1000 MeV

Need to find the optimal time selection window to get all the good siganle and to reject as much background as possible

Time Resolution effect

Energy distributions for different time resolutions with optimized time windows
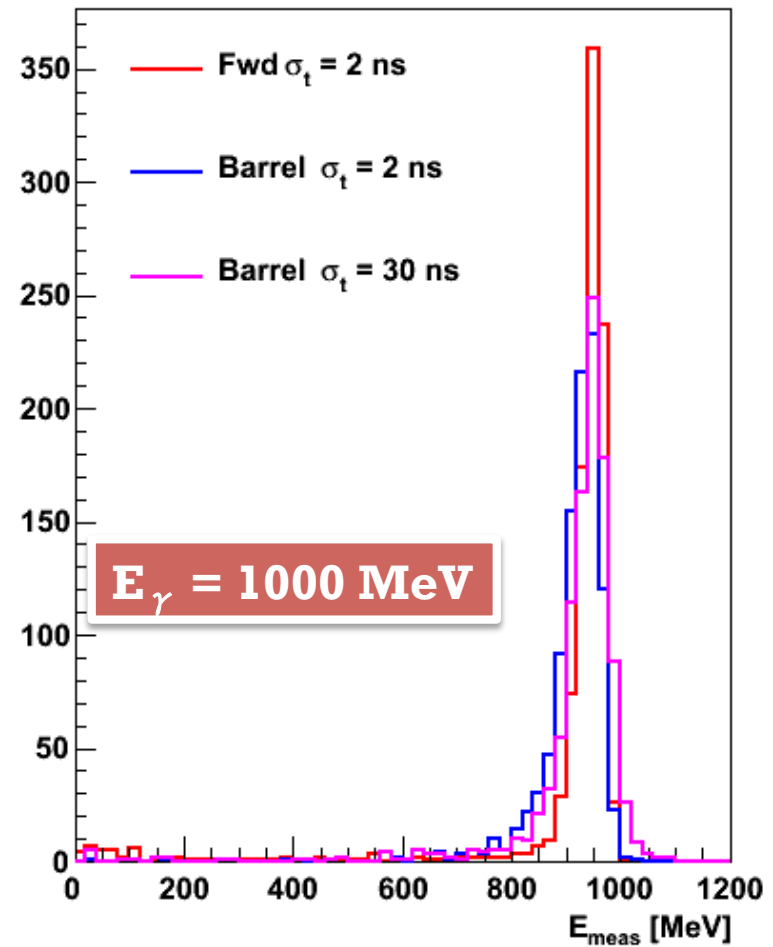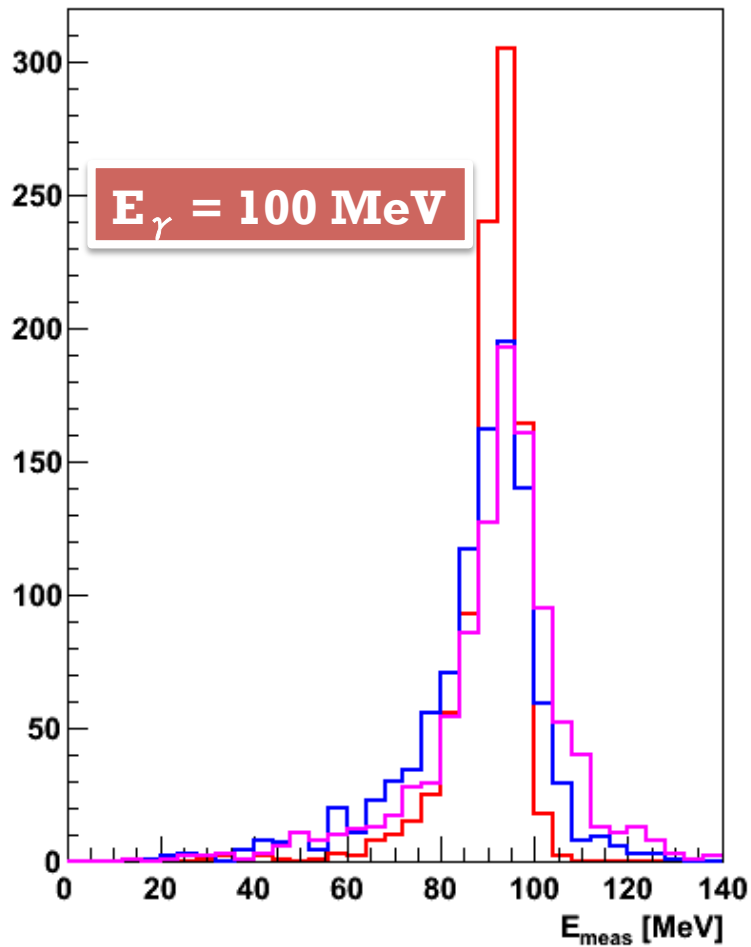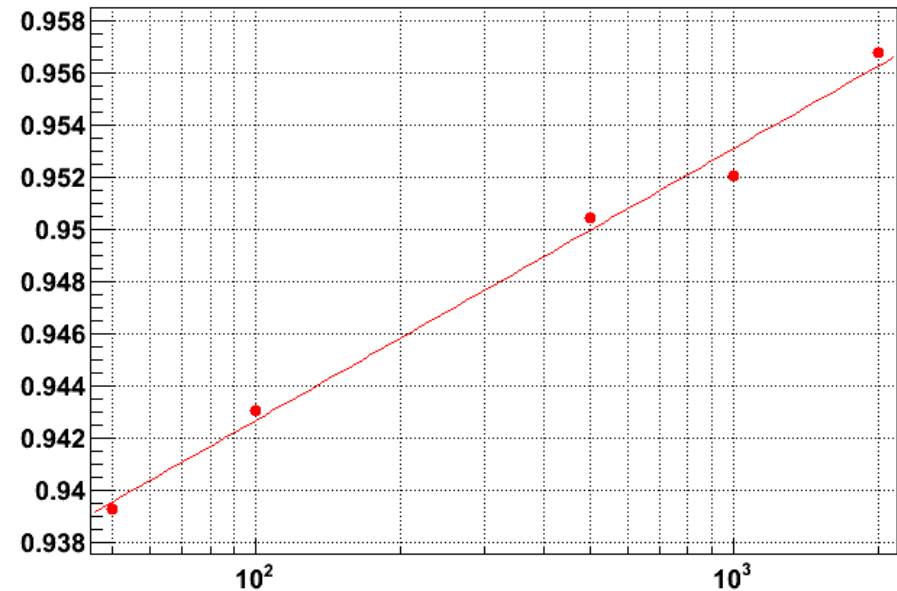
Absolute Energy Calibartion

To get absolute energy calibartion fit peak position at different energies

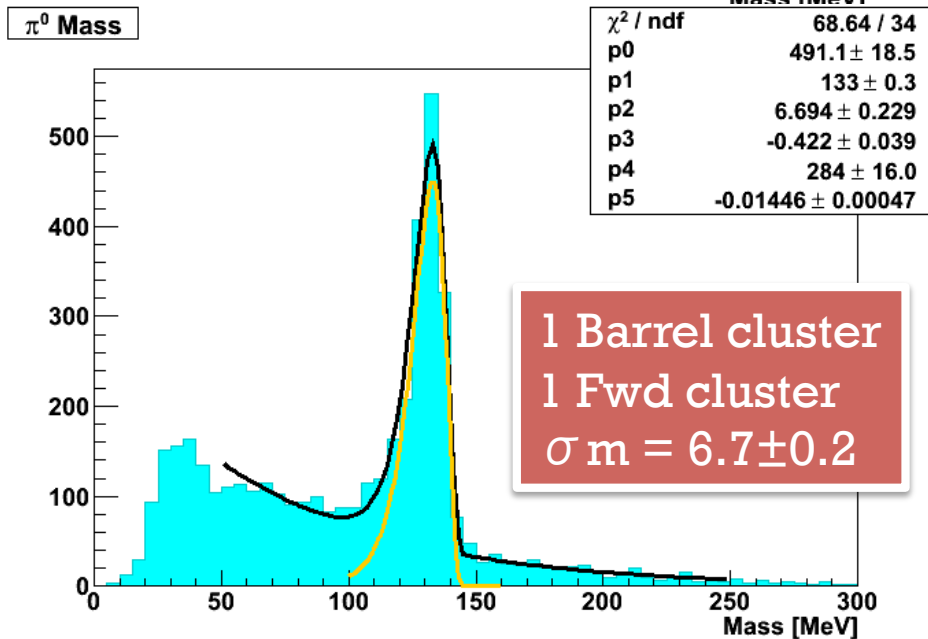Use 2° order log10(E) fit function for the calibartion

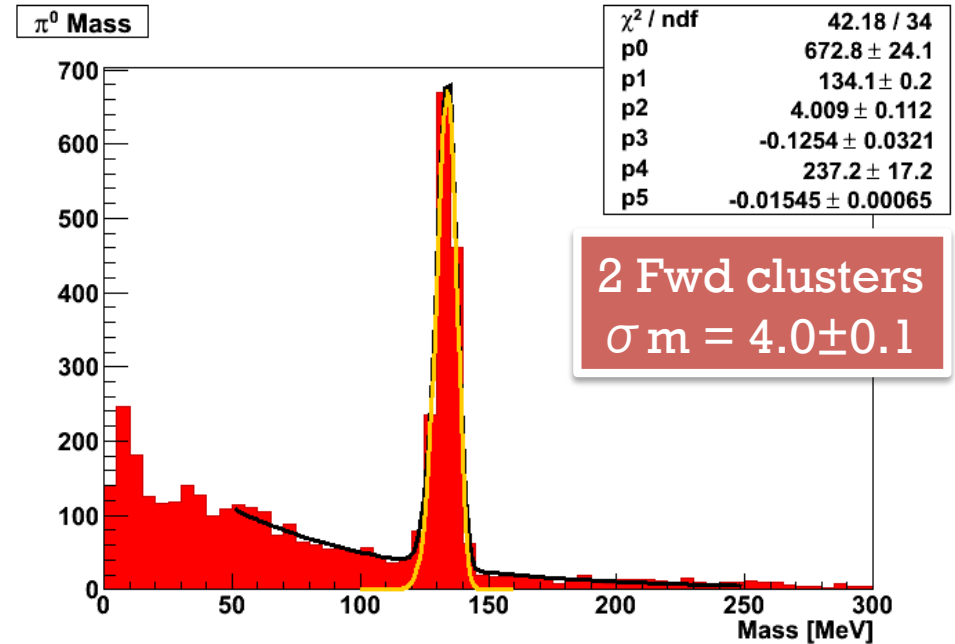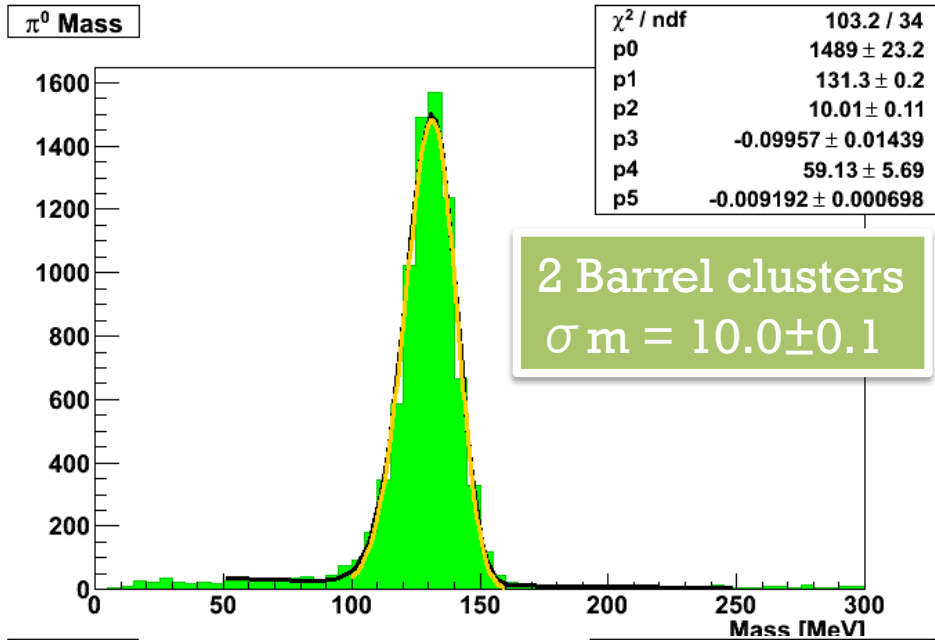Seem to be good enough
Not always perfect

Need more points but 1 calibartio / configuartio is time consuming

Graph

Pi0 Mass (No Bakground)

π⁰ Mass

χ² / ndf	103.2 / 34
p0	1489 ± 23.2
p1	131.3 ± 0.2
p2	10.01 ± 0.11
p3	-0.09957 ± 0.01439
p4	59.13 ± 5.69
p5	-0.009192 ± 0.000698

2 Barrel clusters
$\sigma\, m = 10.0 \pm 0.1$

π⁰ Mass

χ² / ndf	42.18 / 34
p0	672.8 ± 24.1
p1	134.1 ± 0.2
p2	4.009 ± 0.112
p3	-0.1254 ± 0.0321
p4	237.2 ± 17.2
p5	-0.01545 ± 0.00065

2 Fwd clusters
$\sigma\, m = 4.0 \pm 0.1$

π⁰ Mass

χ² / ndf	68.64 / 34
p0	491.1 ± 18.5
p1	133 ± 0.3
p2	6.694 ± 0.229
p3	-0.422 ± 0.039
p4	284 ± 16.0
p5	-0.01446 ± 0.00047

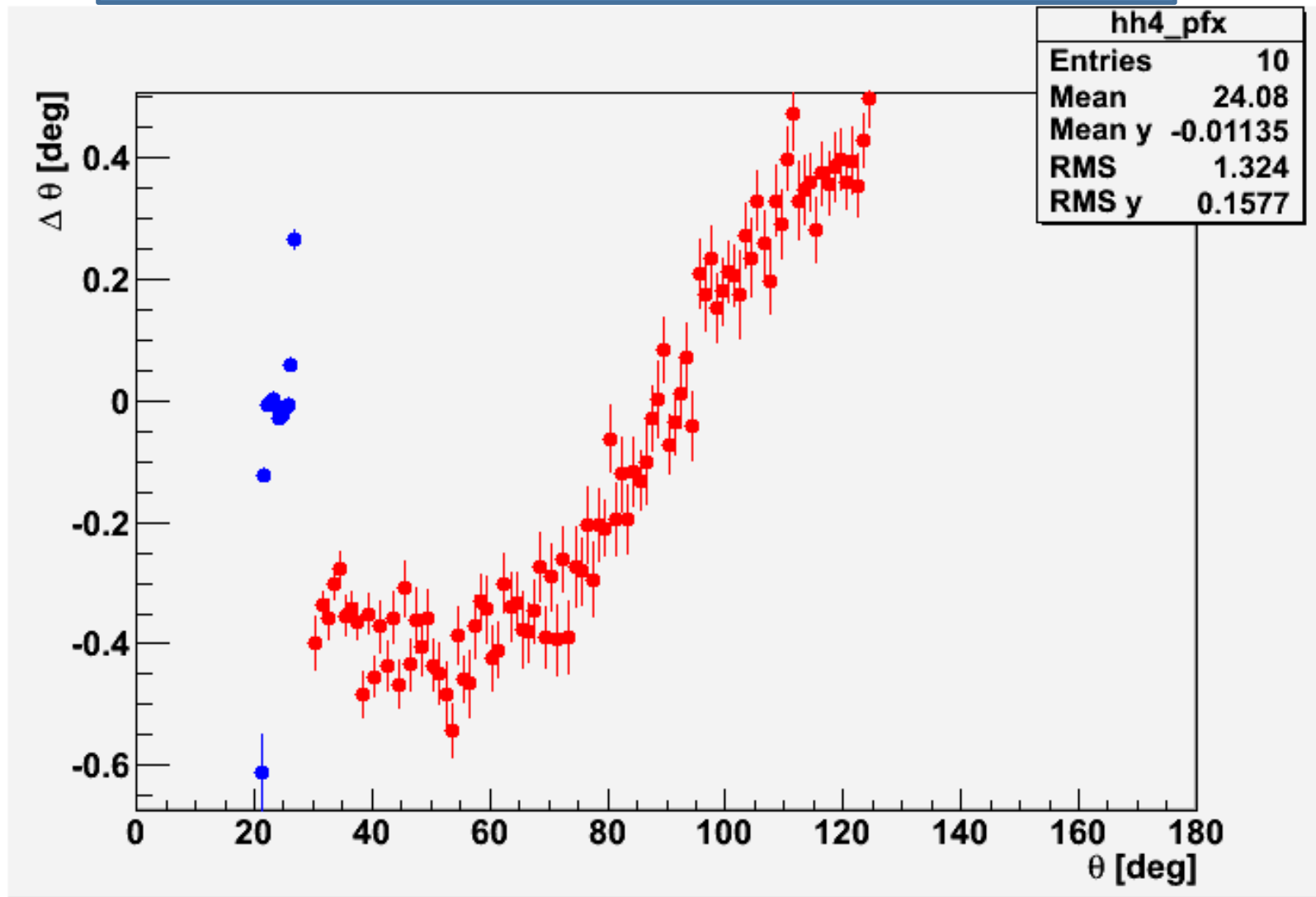1 Barrel cluster
1 Fwd cluster
$\sigma\, m = 6.7 \pm 0.2$

BaBar quotes a better mass resoltio for the CsI (7-8 MeV)

Maybe the problem is in the (missing) absolute theta calibration

Theta Correction (to be added)

Average of **Measured**-True Theta vs Theta for photons

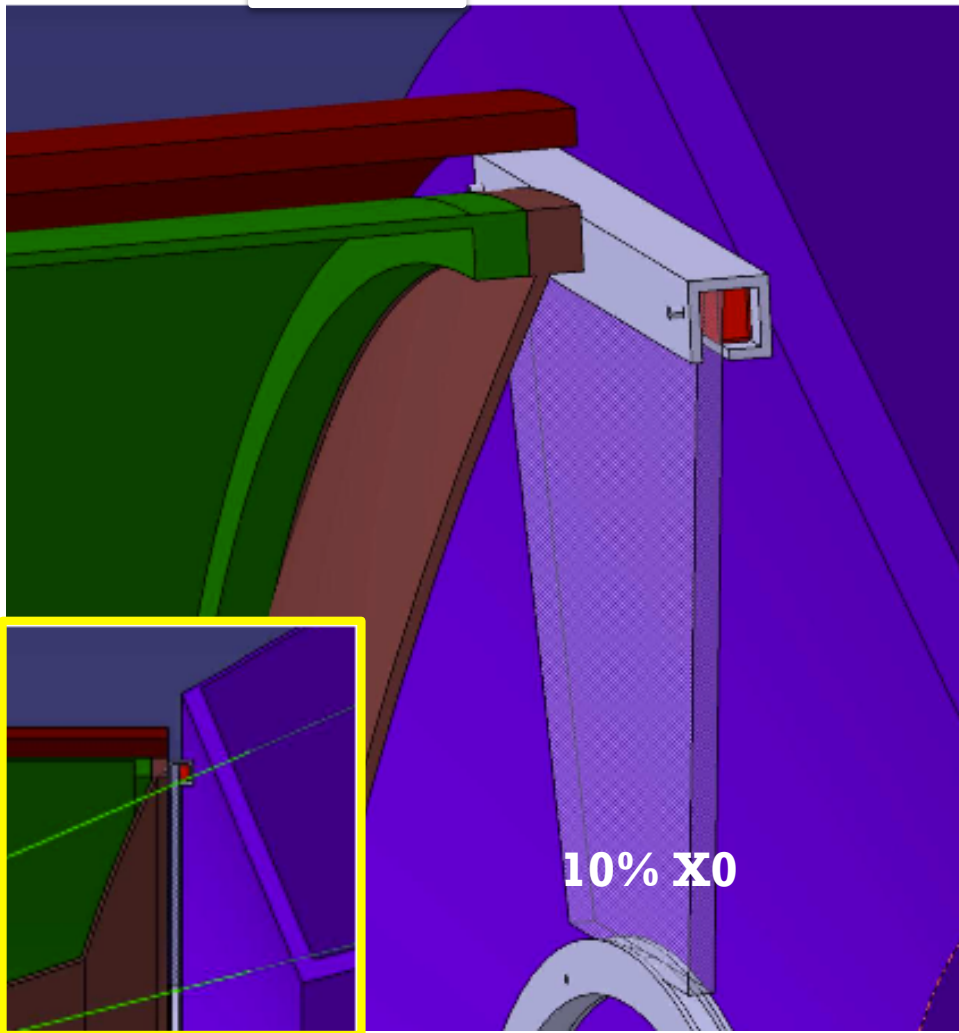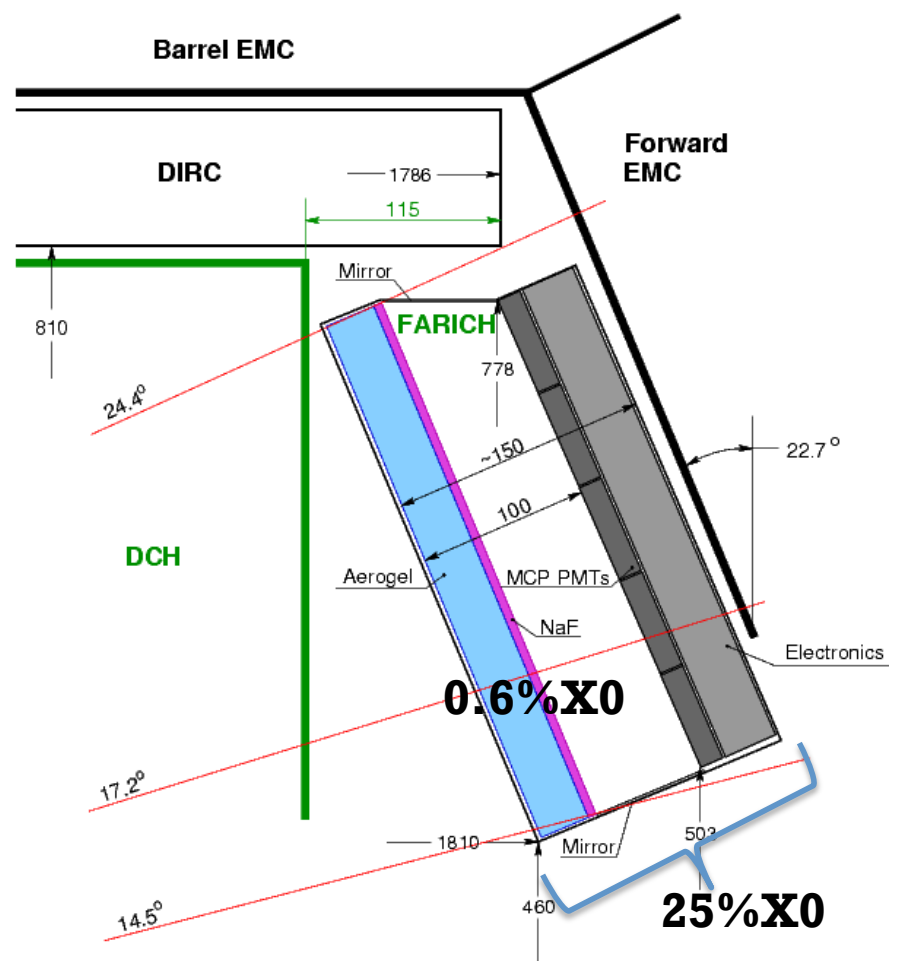| hh4_pfx	
Entries	10
Mean	24.08
Mean y	-0.01135
RMS	1.324
RMS y	0.1577

Absolute Theta calibration must be added

Fwd PID Effect Studies

Fwd PID geometry options

Fwd Emc Measured Energy Distribution
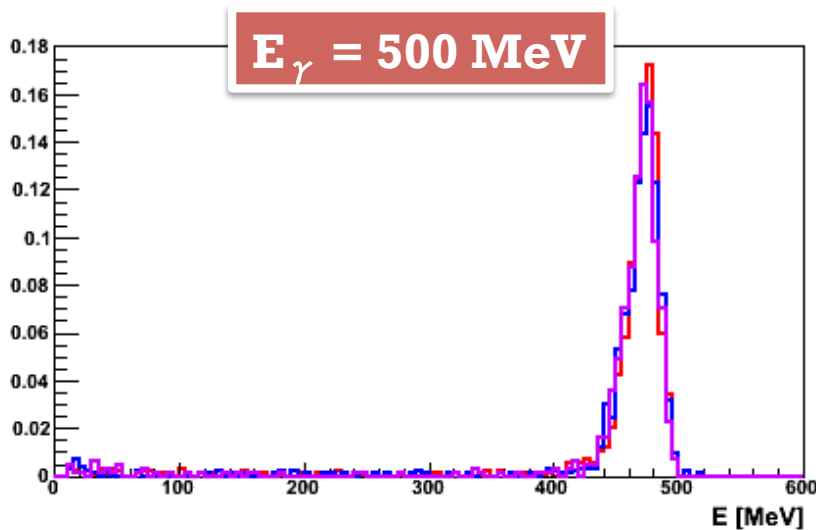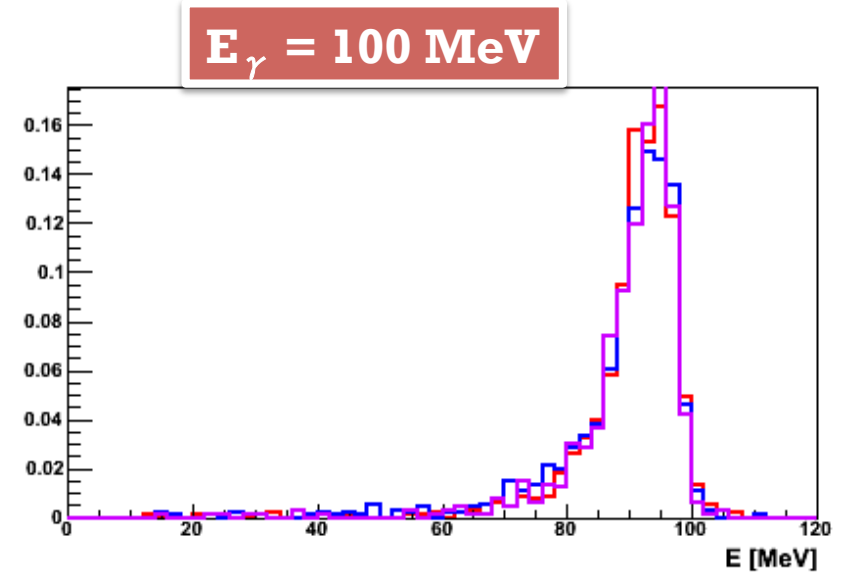

E_γ = 50 MeV

No Fwd PID
fTOF
FARICH

E [MeV]

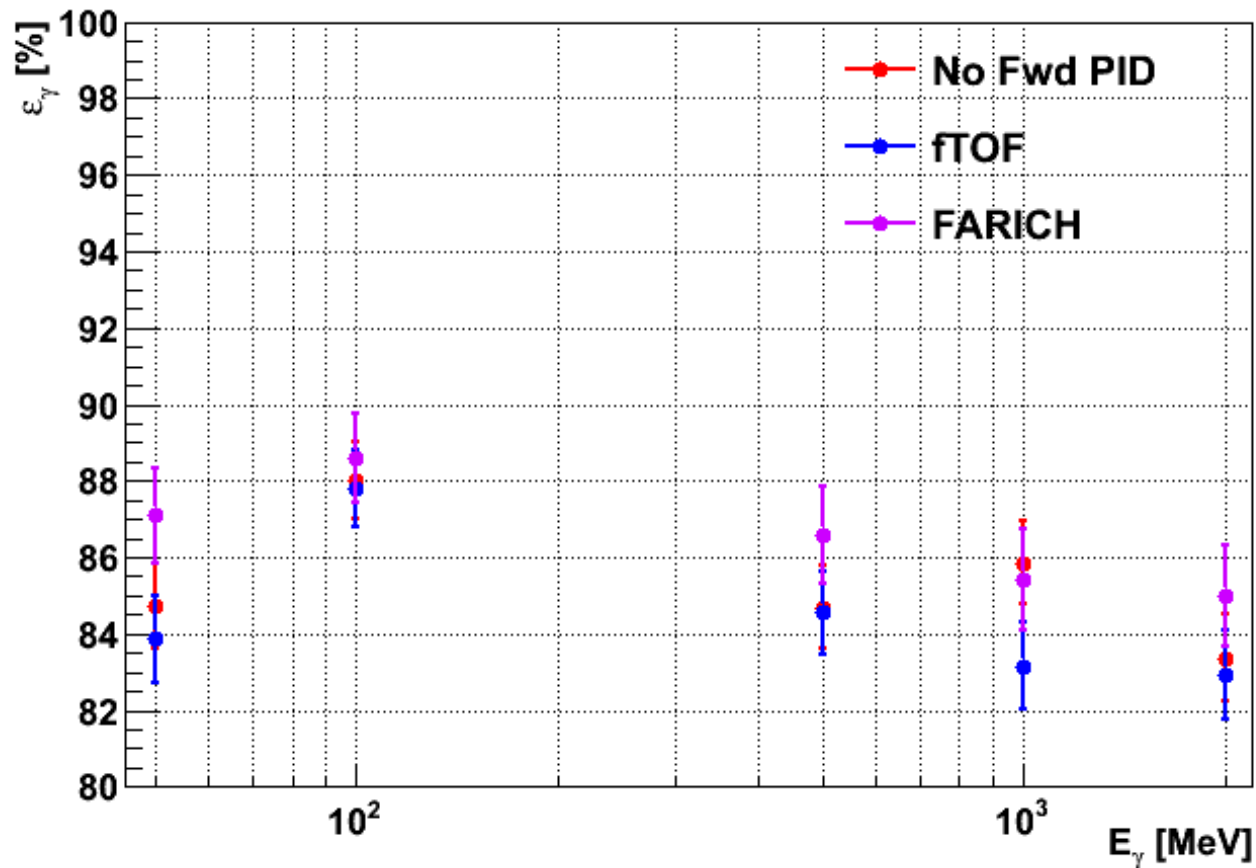E_γ = 100 MeV

E [MeV]

E_γ = 500 MeV

E [MeV]

E_γ = 1000 MeV
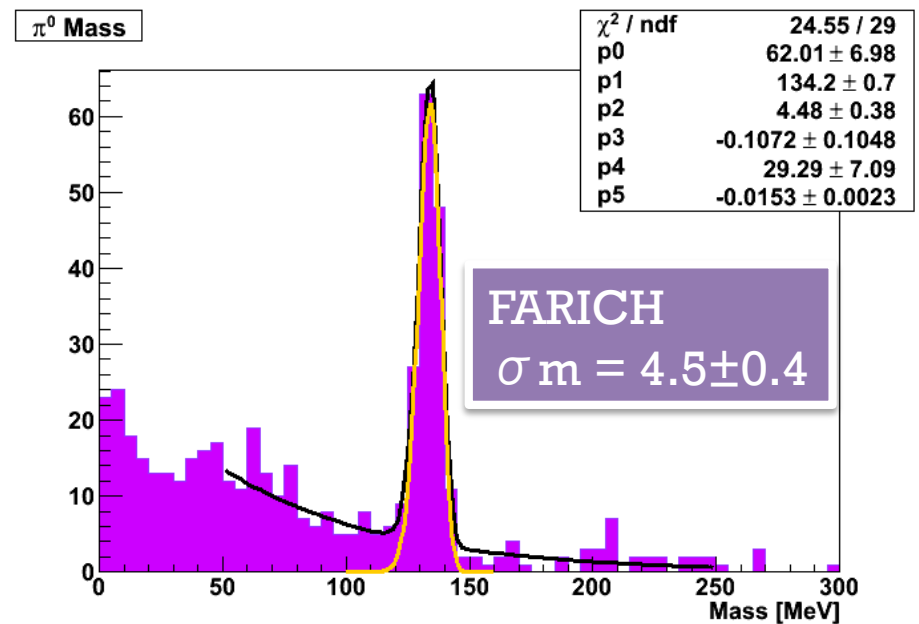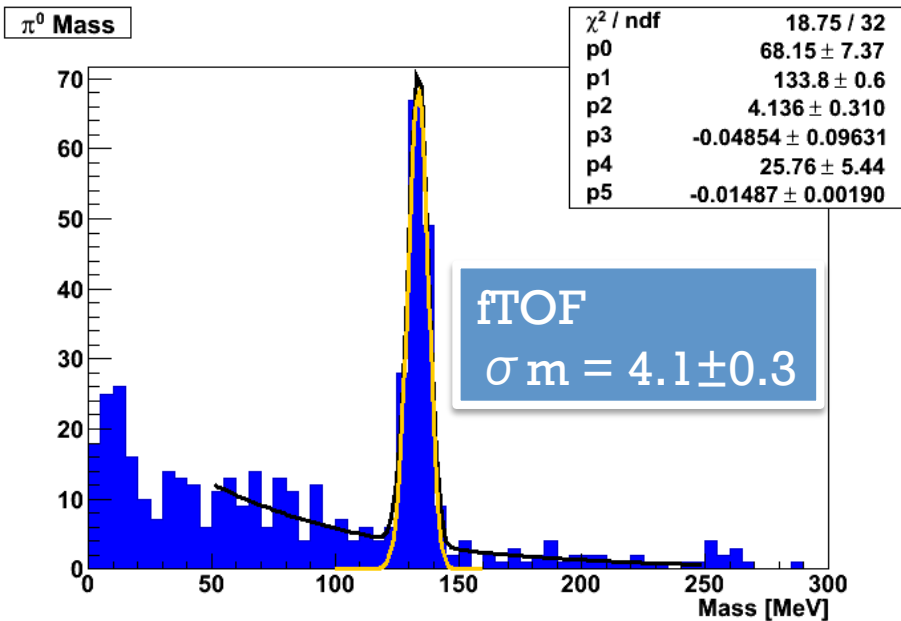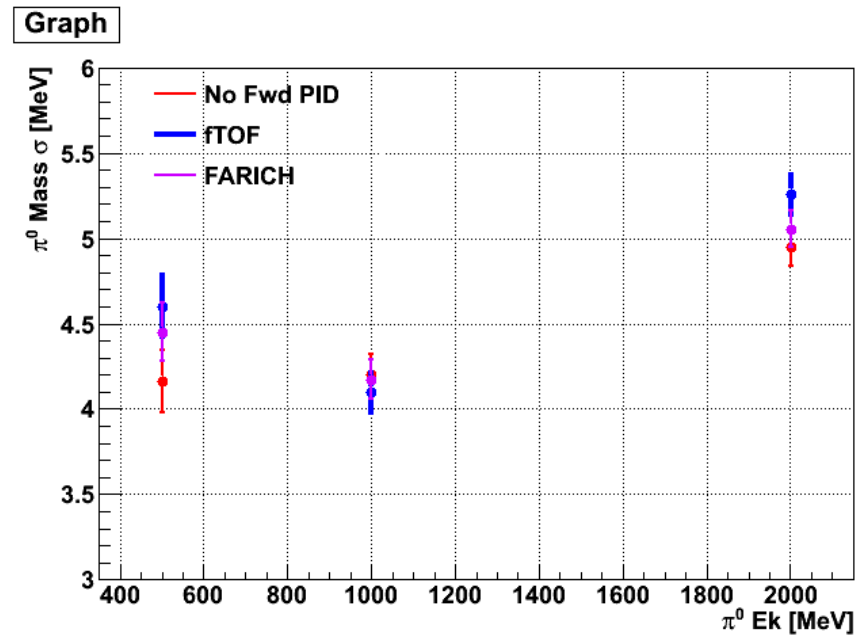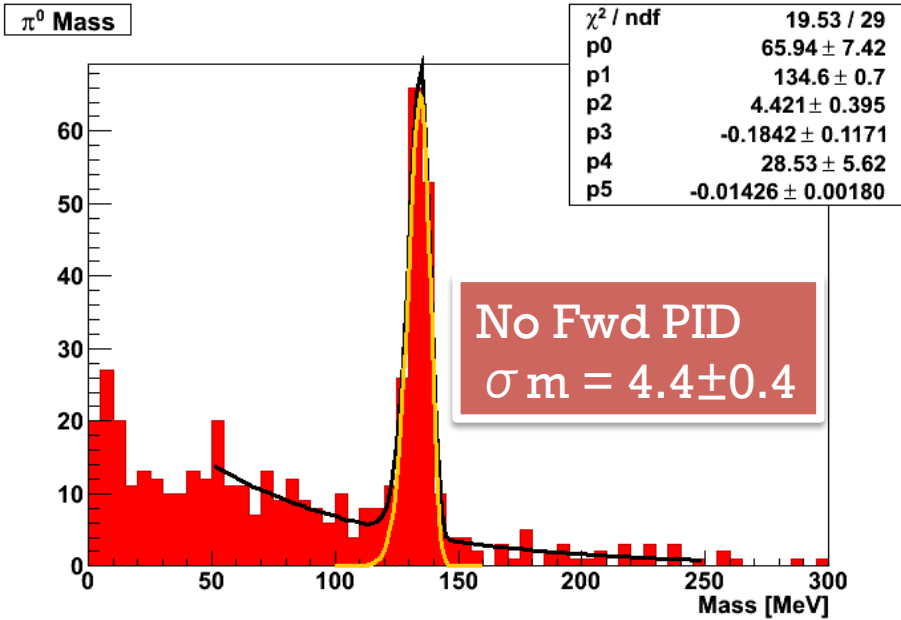
E [MeV]
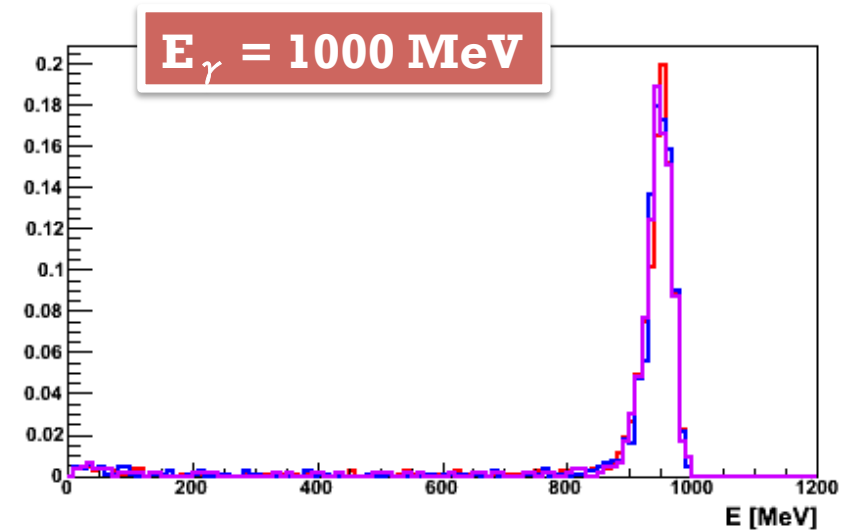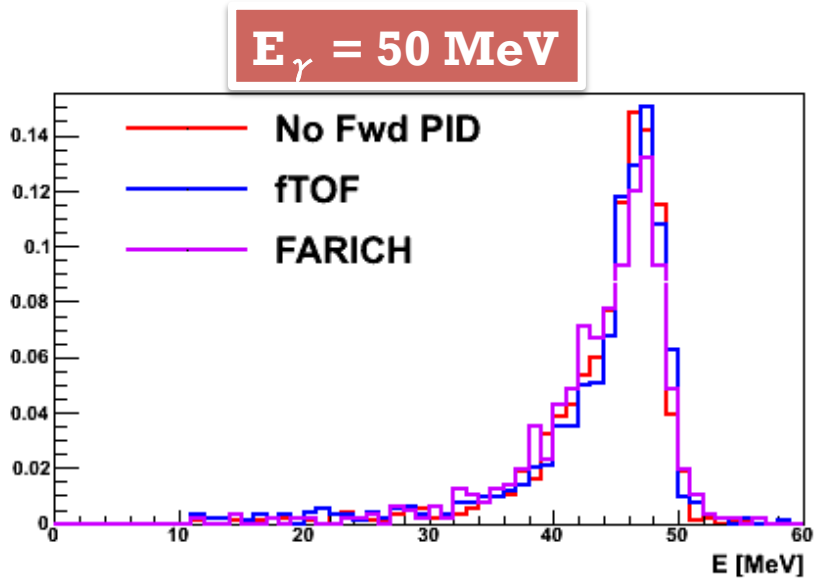
Fwd EMC Energy Resolution

Fwd EMC γ Efficinecy
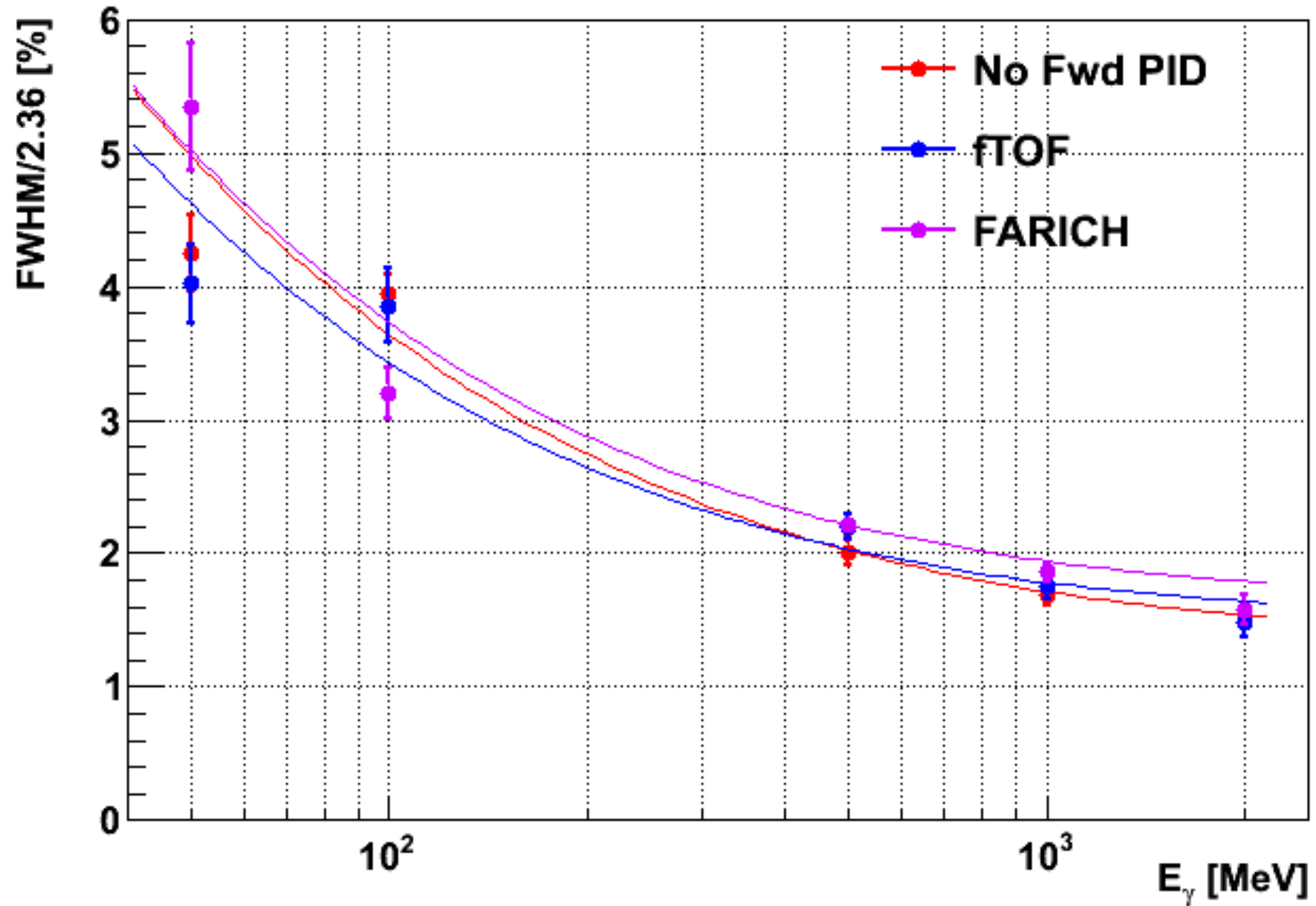
γ Efficiency vs Energy

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

Conclusions

- Simulation and Background
  - Starting from the testbeam experince LYSO crystals parametres used for the simulation should be reasonable
  - CsI simulation parameters need further investigation
  - Machinary to perform photons and pions study now in place
    - More detailed studies can be done
- TODO
  - Absolute angle calibration