SuperB Calorimeter Simulation and Bakcground Fwd PID effect studies

EMC Meeting

SuperB Collaboration Workshop

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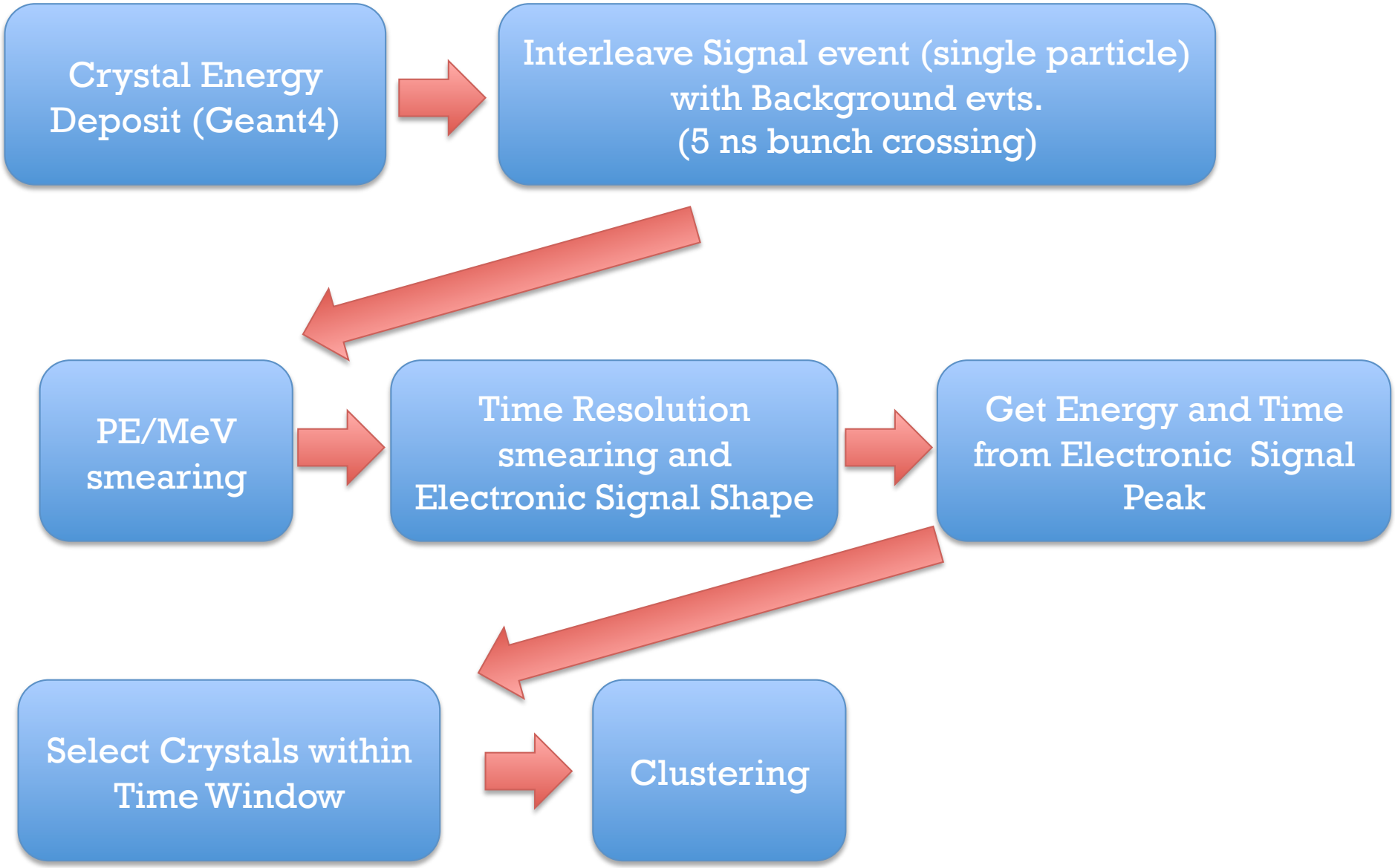
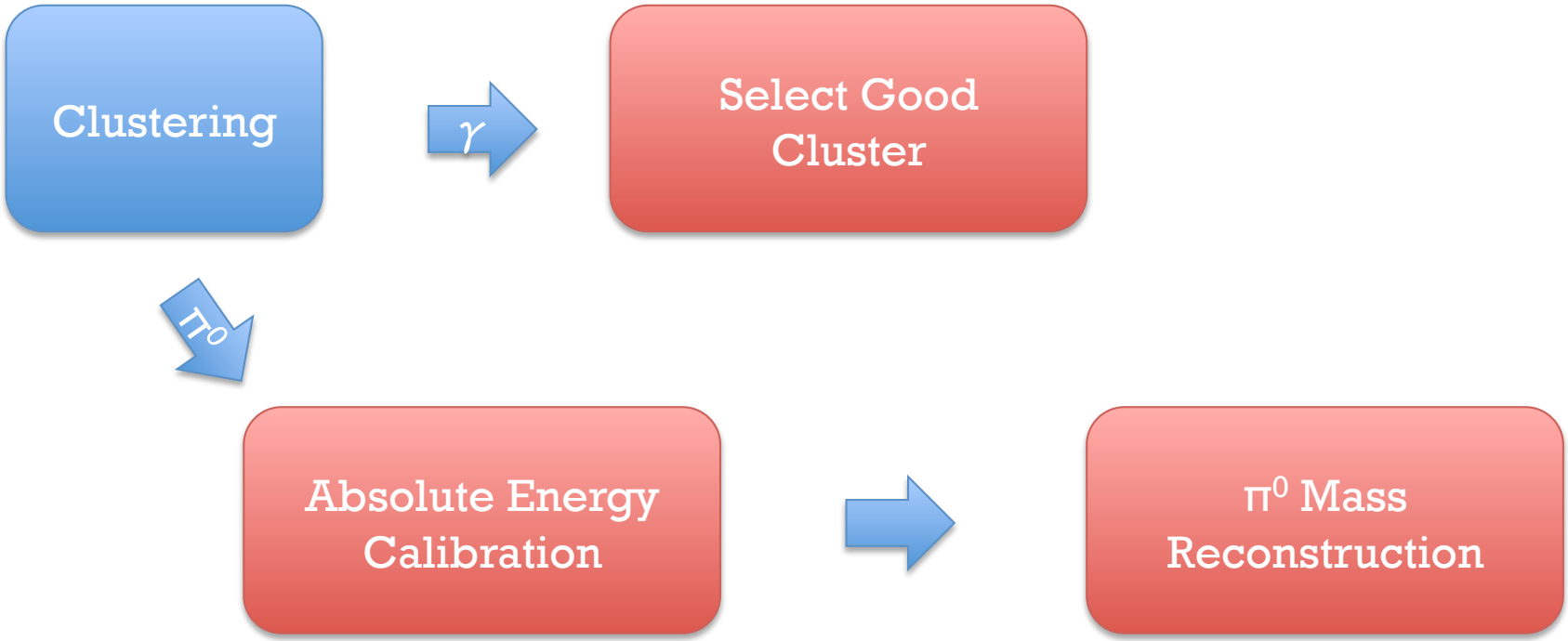
Intro

- 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
    - Photon Energy resolution
    - Neutral Pions Massn Resolution and efficiency

Simulation Work Flow

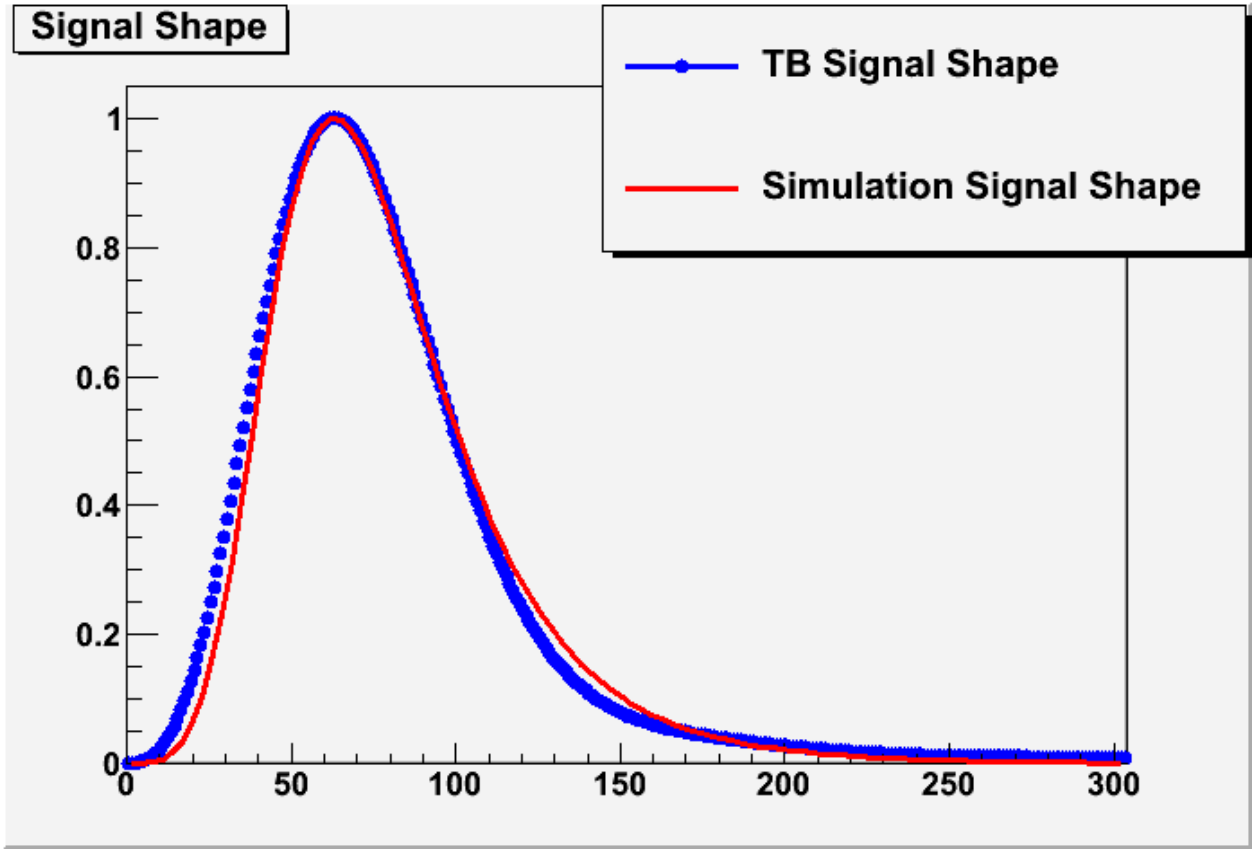


Reconstruction Work Flow



Signal Shape from Test Beam

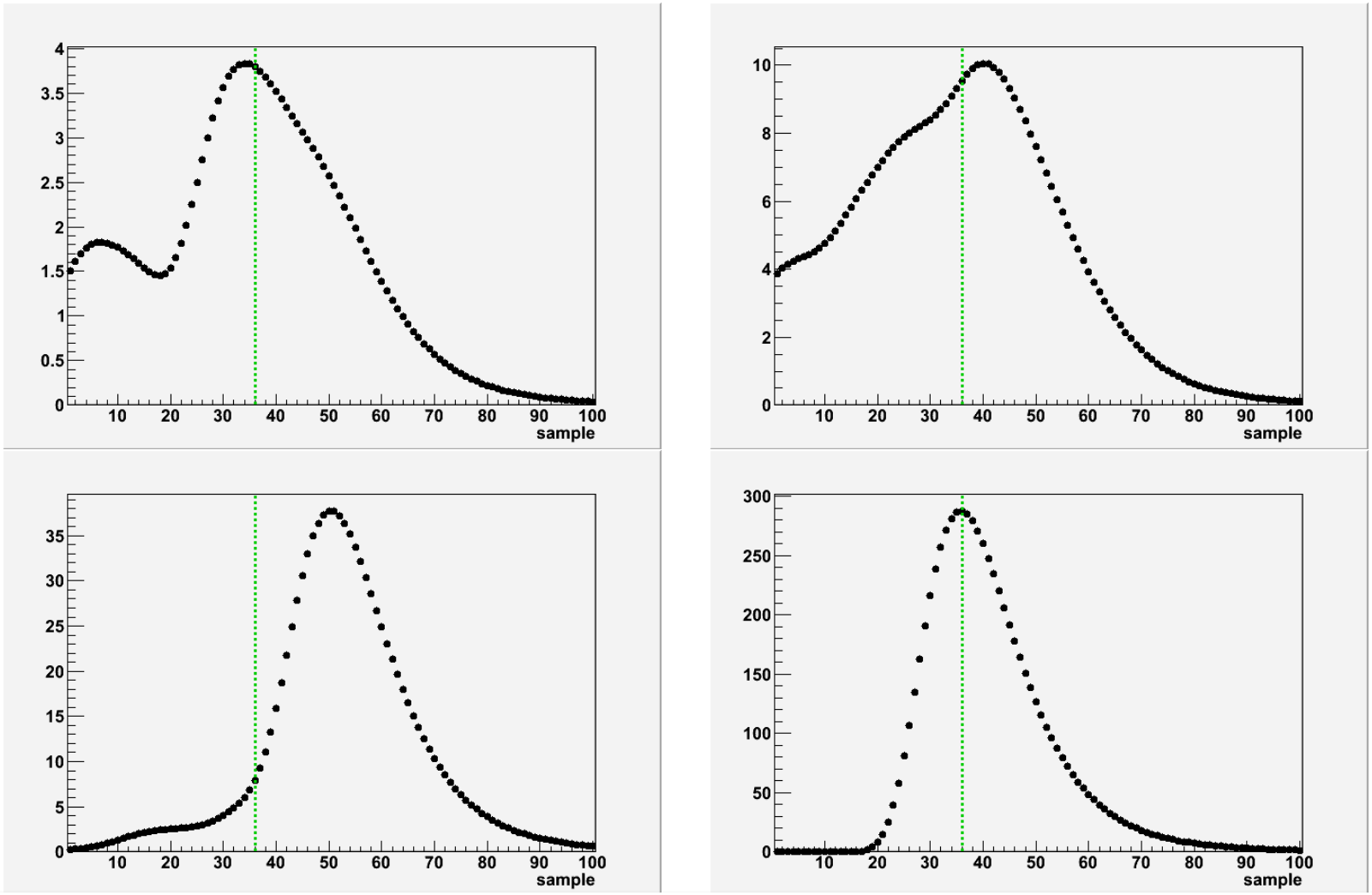
Electronic Signal shape taken from CERN T10 Test Beam data
TB sampling rate was 250 MHz (4 ns)
Signal caracteristc time:
→Left part of signal shape is a Gauss function
→Caracteristic signal time is the σ
→TB time was 100 ns



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

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

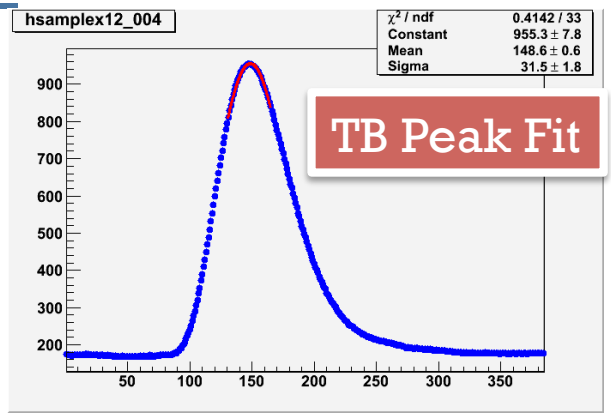
Signals Examples with Background



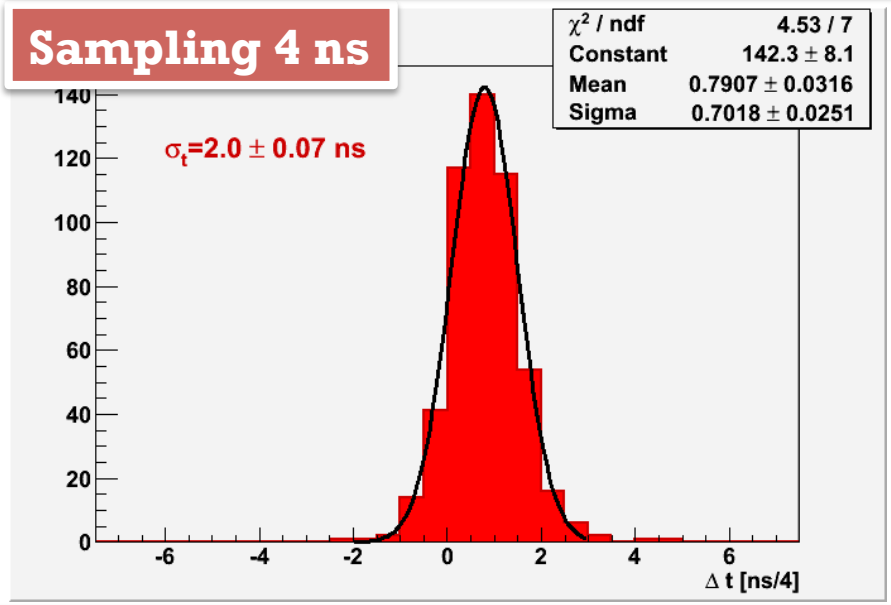
The Background generates Eletronic Signal Pile-Up and Spurious Hits
The green line is the Expected Signal ("Trigger") Time

Crystal Time Resoltion

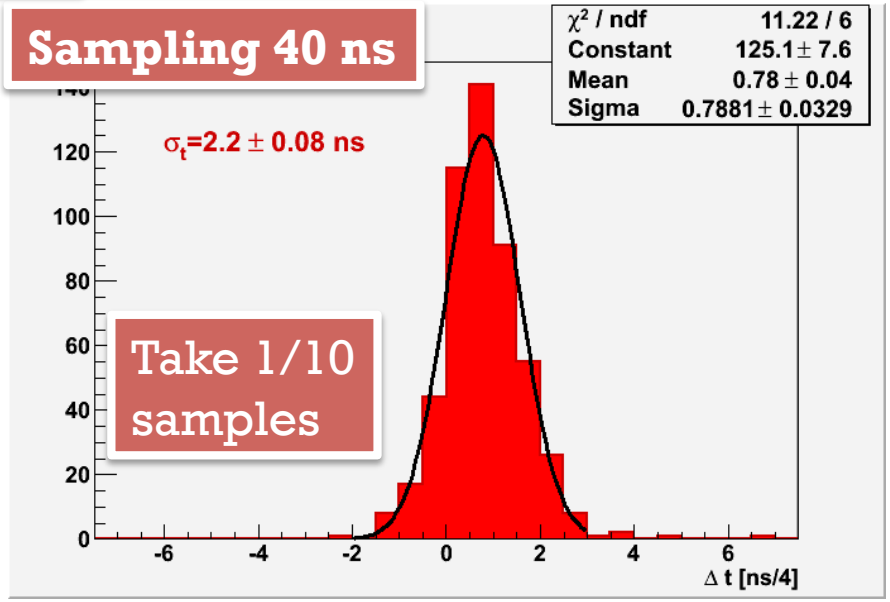
Crystal Time Resolution for LYSO taken from TB measuremnts:
→Take crystal time from signal peak fit
→Plot t(X1)-t(X2)
→Perform Gauss Fit
→ Time resolution = σ /sqrt(2)



Sampling 4 ns

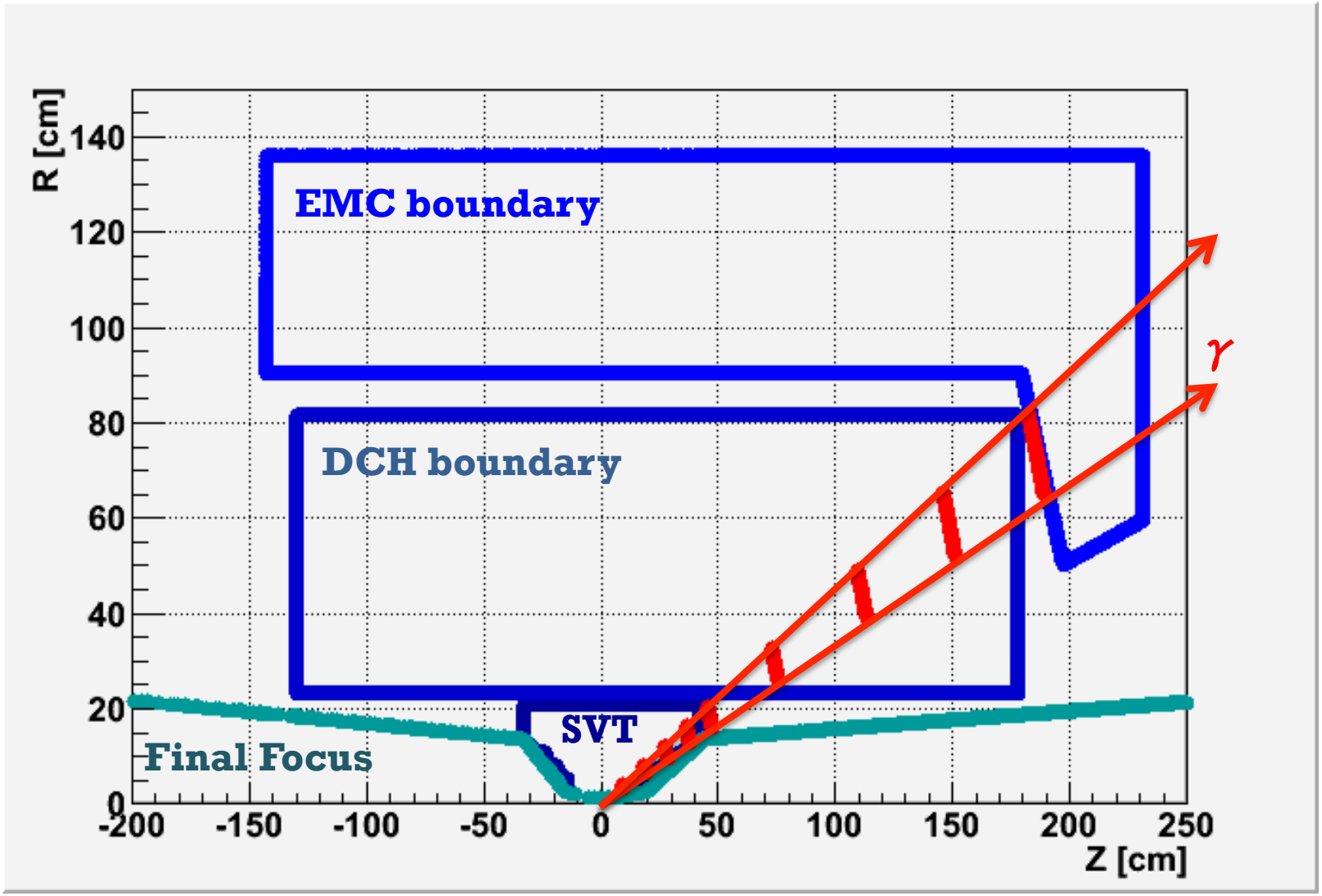


Sampling 40 ns

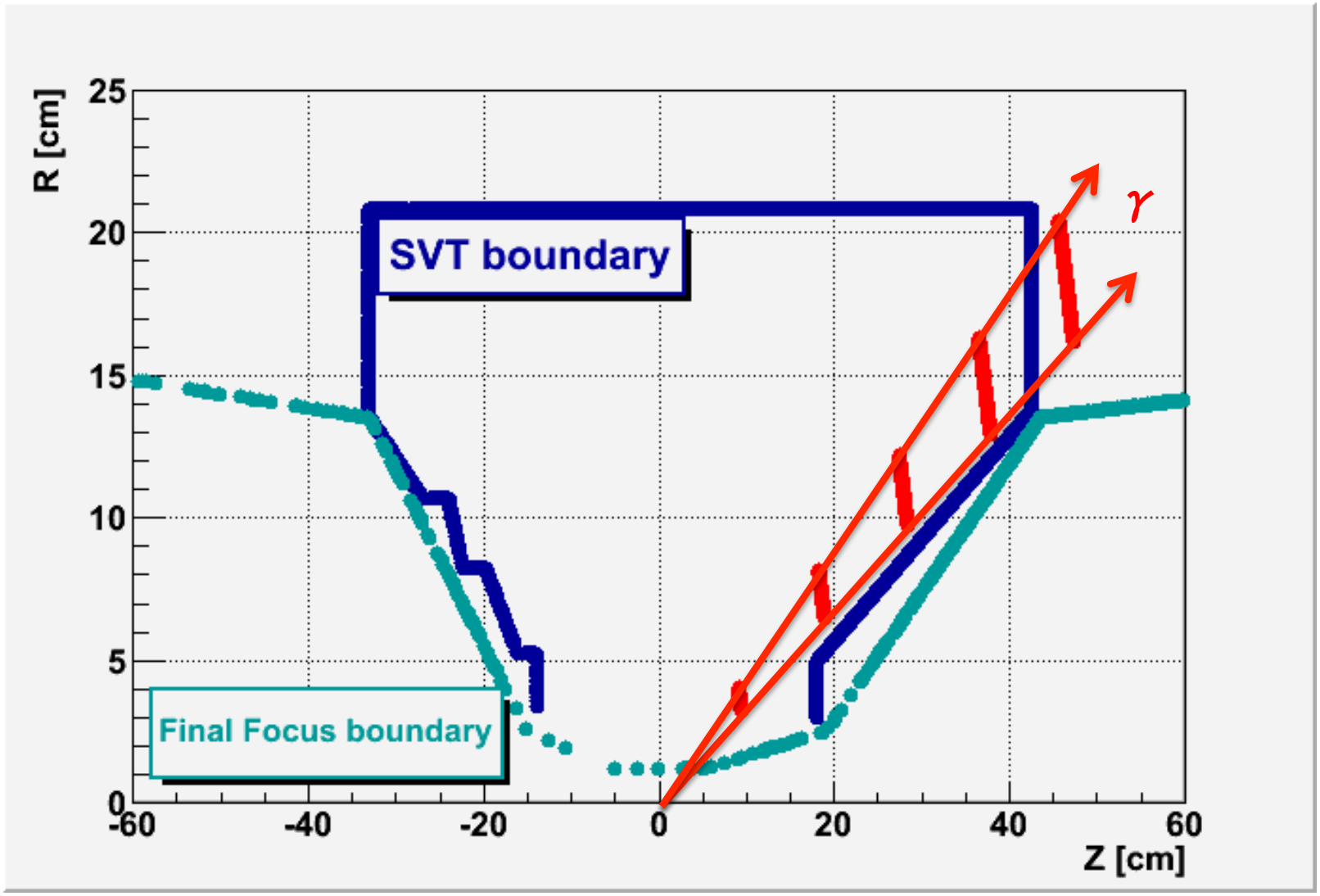


Simulation Time Resolution
→Fwd : 2 ns (sampling time effect is small)
→Barrel : Examples here use 30 ns
For Geomtry studies use 2 ns as Fwd

Fwd EMC Simulation :Beam Angle

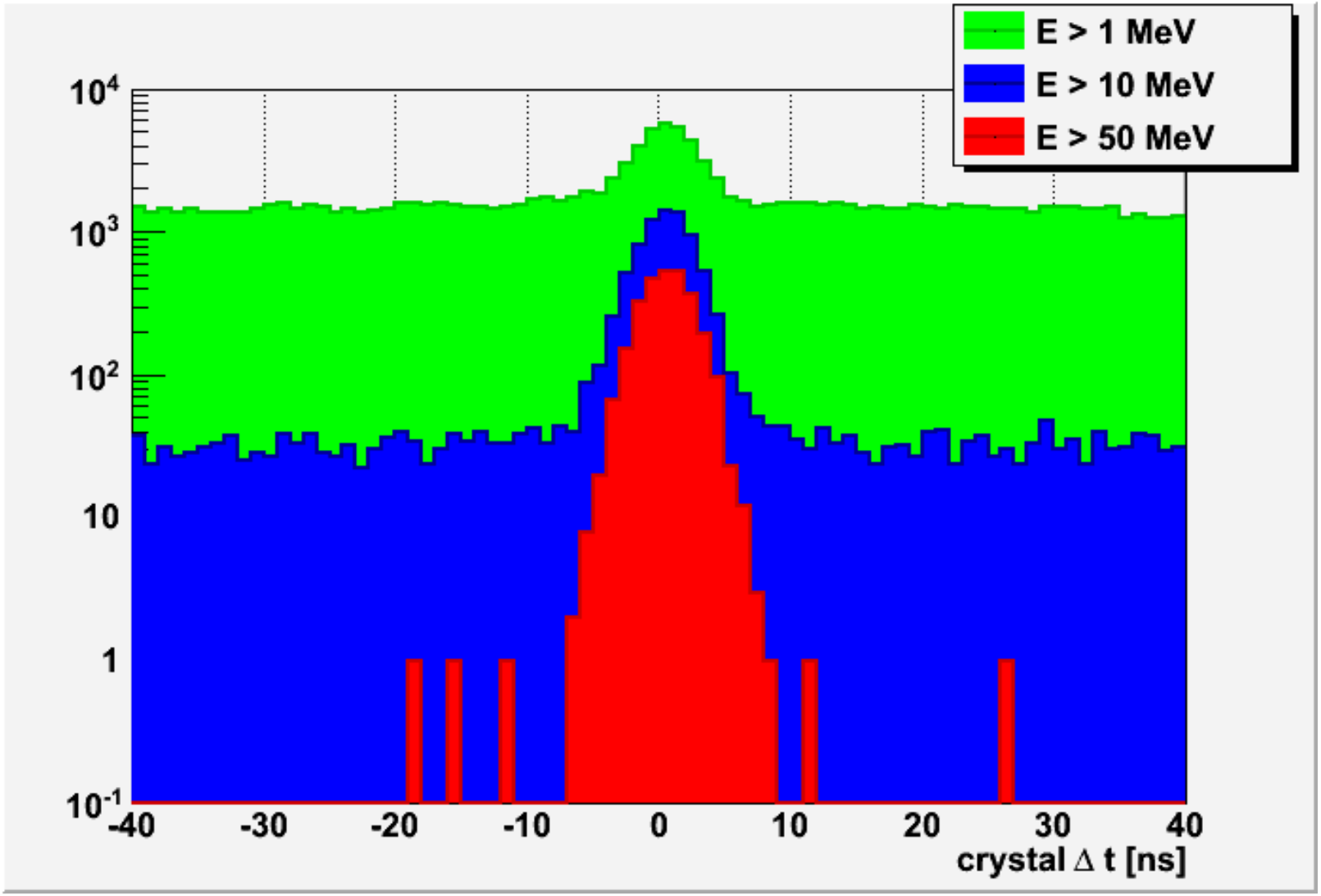


Fwd EMC Simulation: Beam Angle (zoom)



Fwd EMC Sim.: Crystals Signal Time

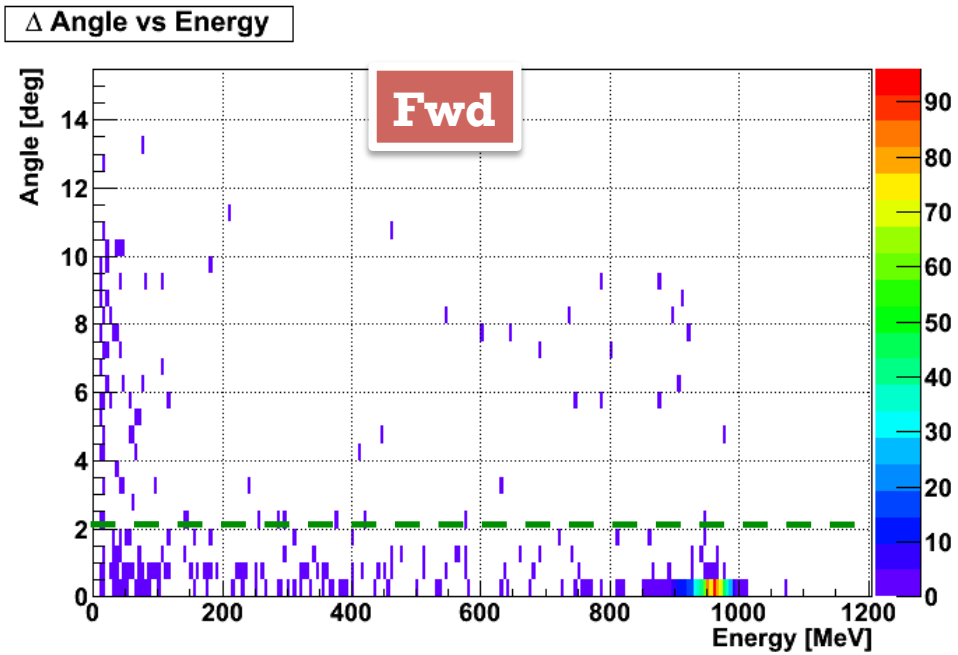
Crystal Signal Time from Peak of Signal Shape

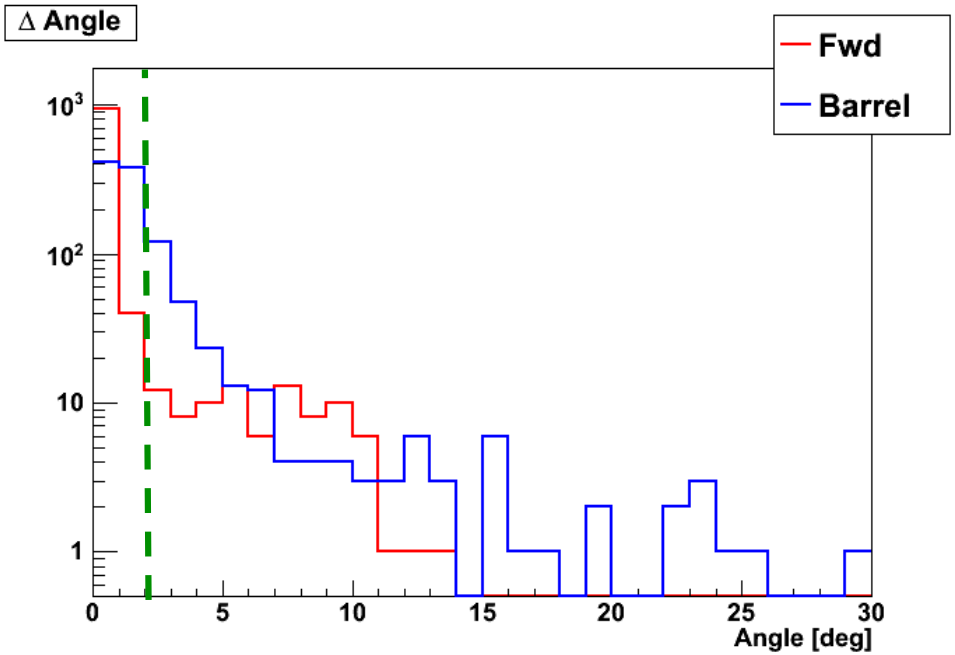


Cluster Angle and Selection for Photons

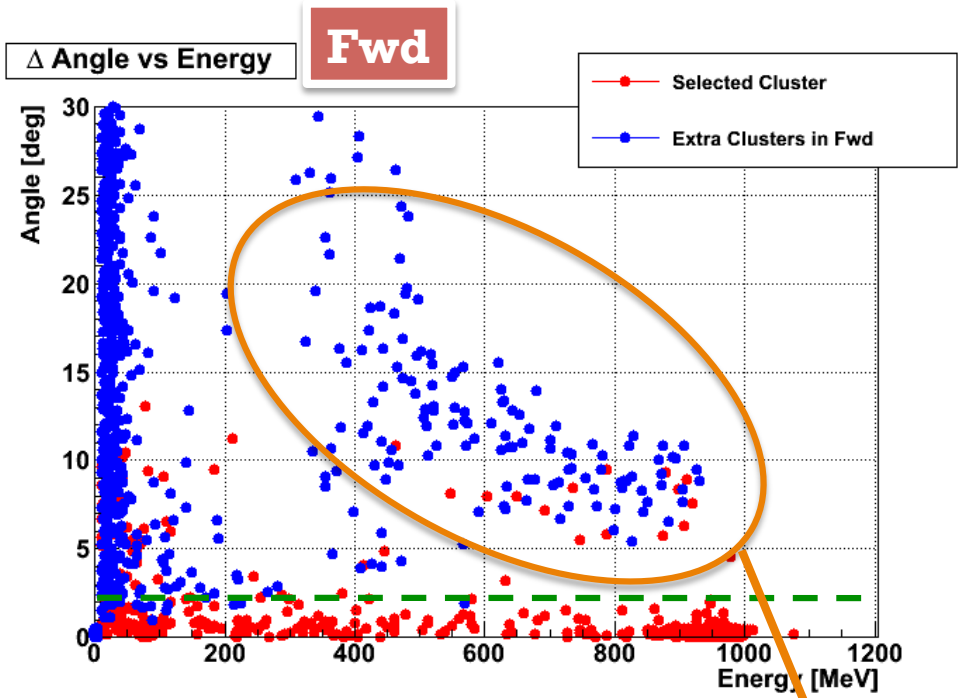
The candidate photon is associated to the cluster with the smallest angle with respect to the MC truth

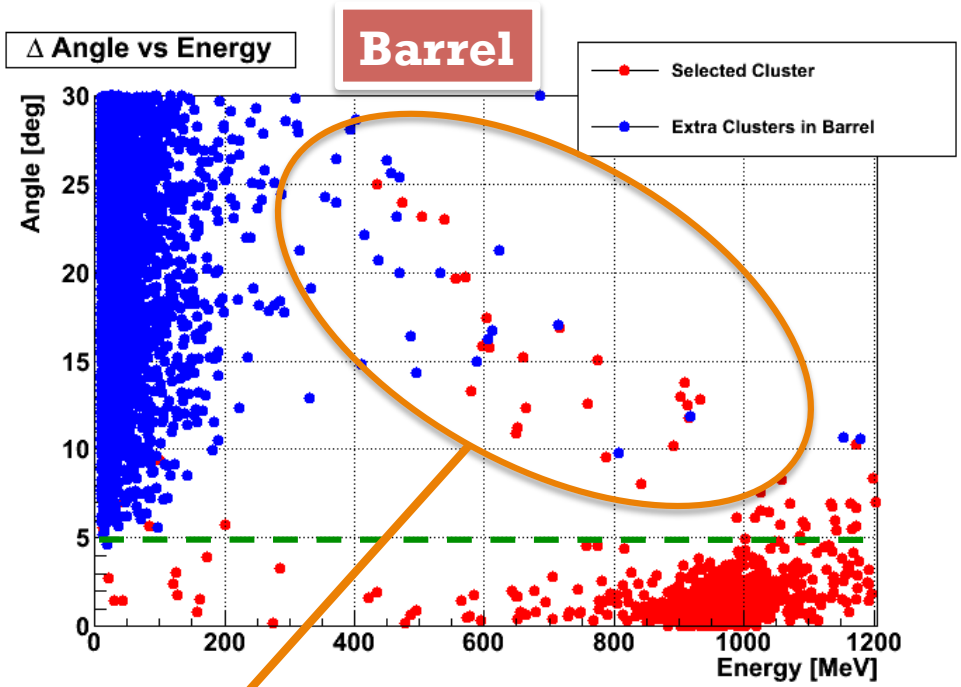
For the Fwd energy resolution only clusters with an angle < 2 deg are considered





Cluster Angle wrt Photon

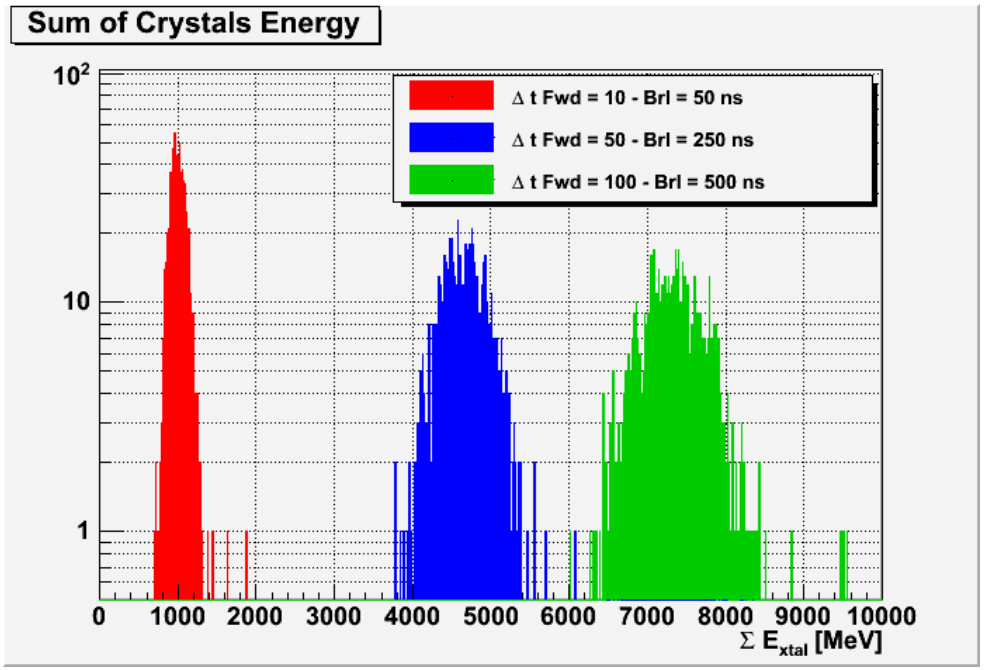




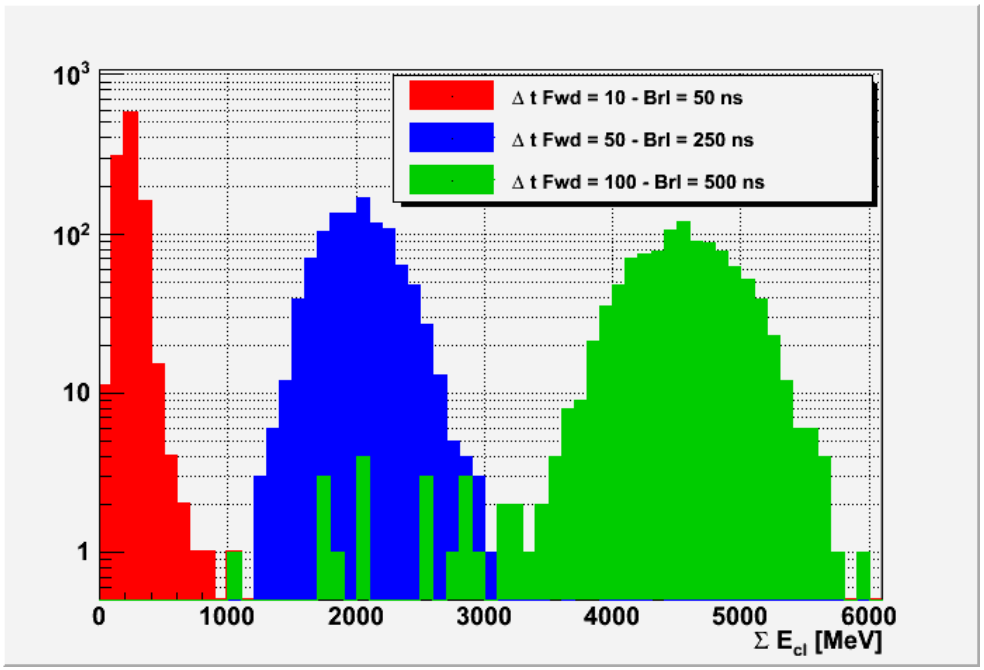
Clusters mostly realted to upstream converting photons
→Further investigation needed
→A fraction of these events may be recovered

Crystal Time selection effects

Sum of selected crystal energy

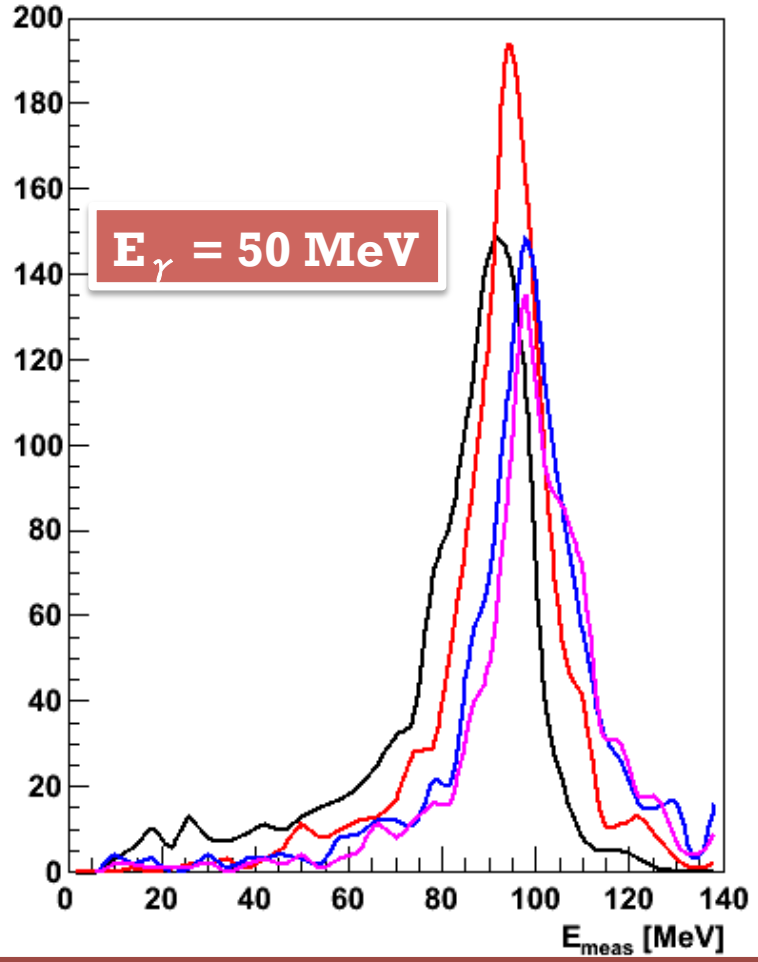


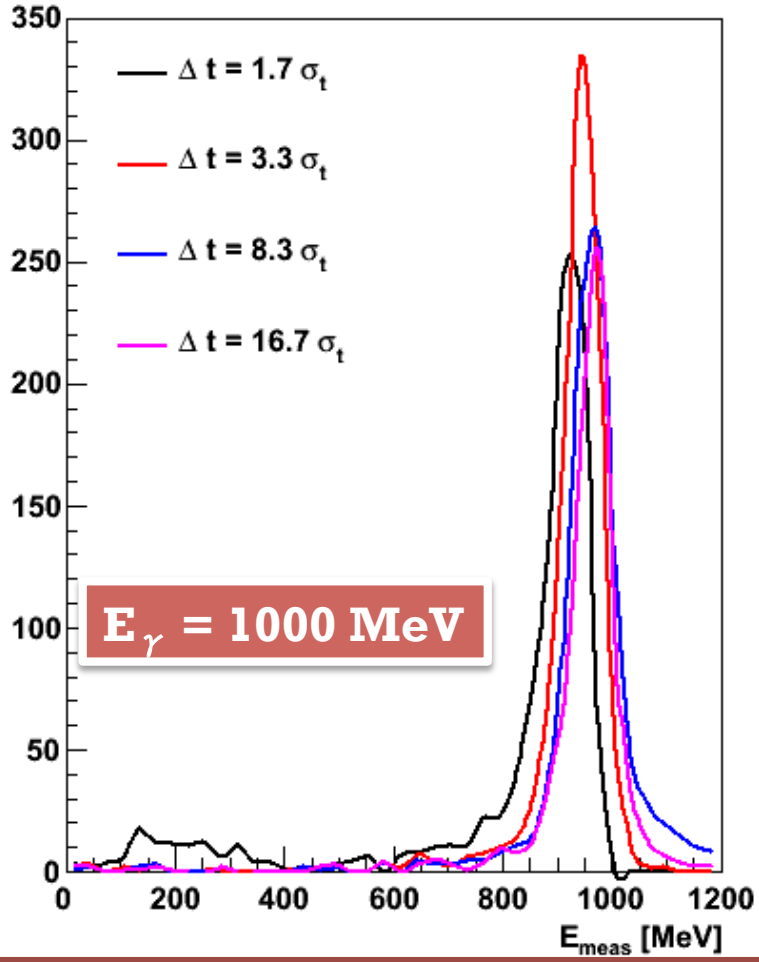
Sum of Cluster Energy



Crystal Time Selection Effect

Energy distributions for different time selection windows

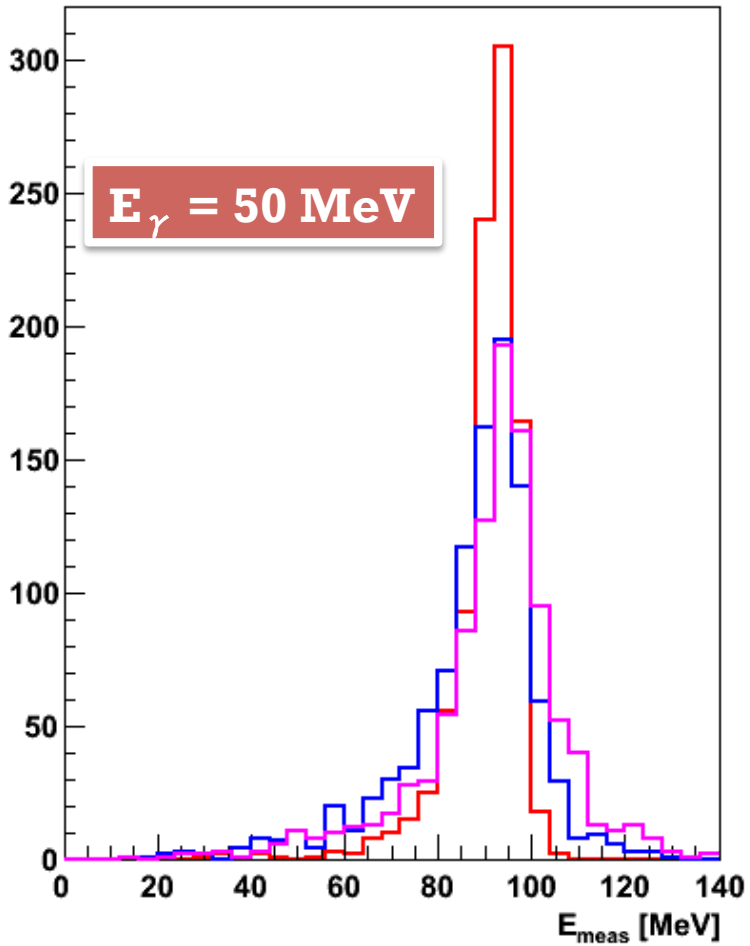


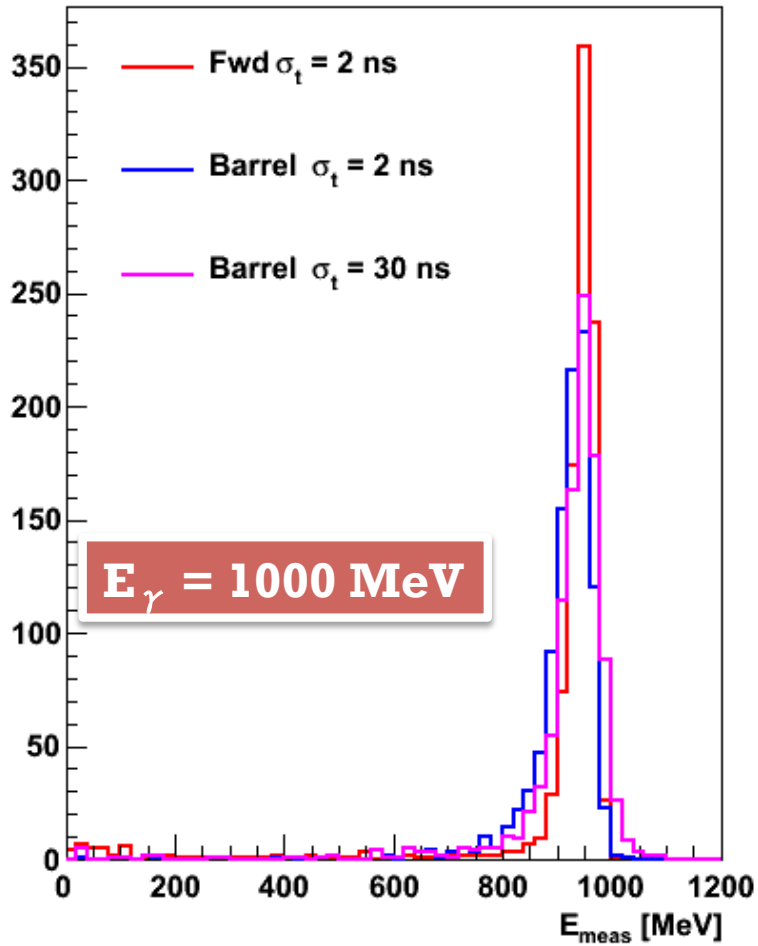


Need to find the optimal time selection window to get all the good siganle and to reject as much background as possible

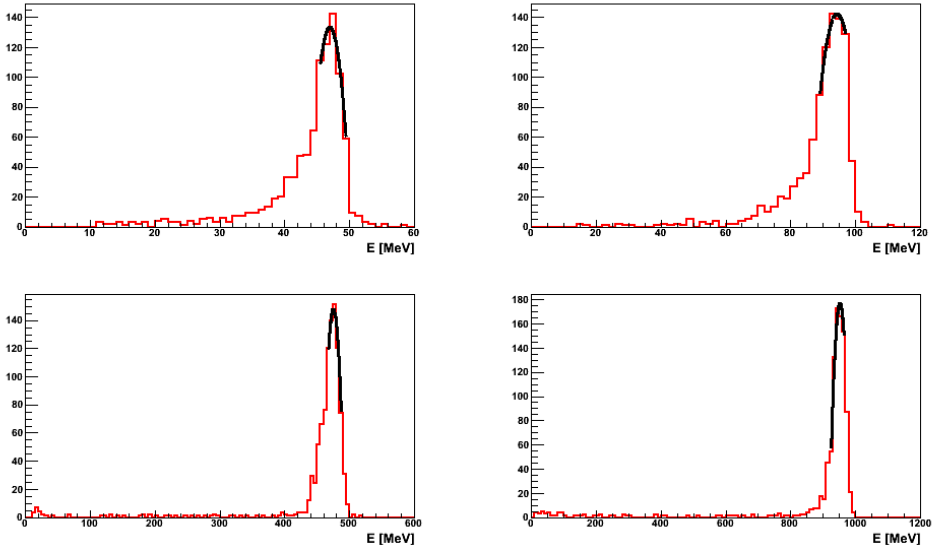
Measured Energy Distribution

Energy distributions for different time resolutions with optimized time windows





Energy Calibartion



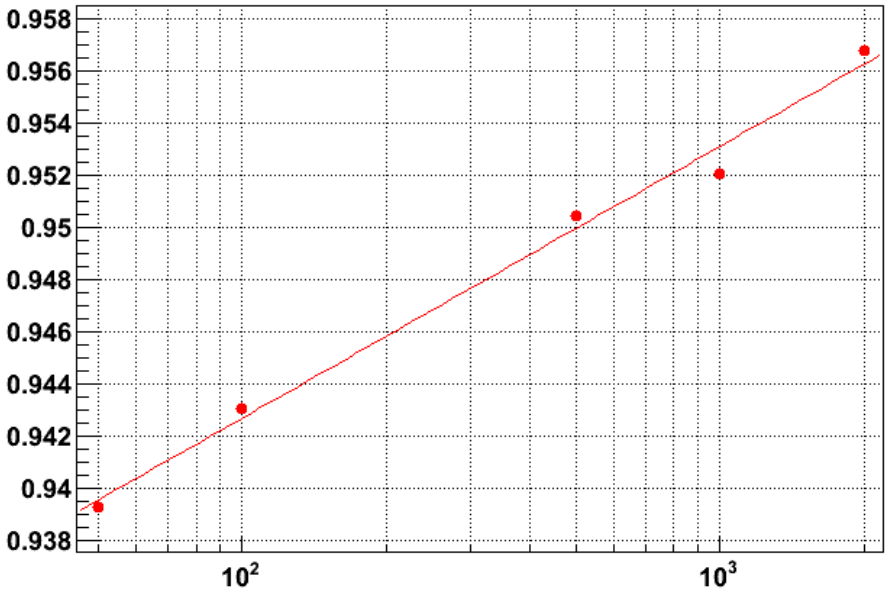
To get absolute energy calibartion fit peak position at different energies

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

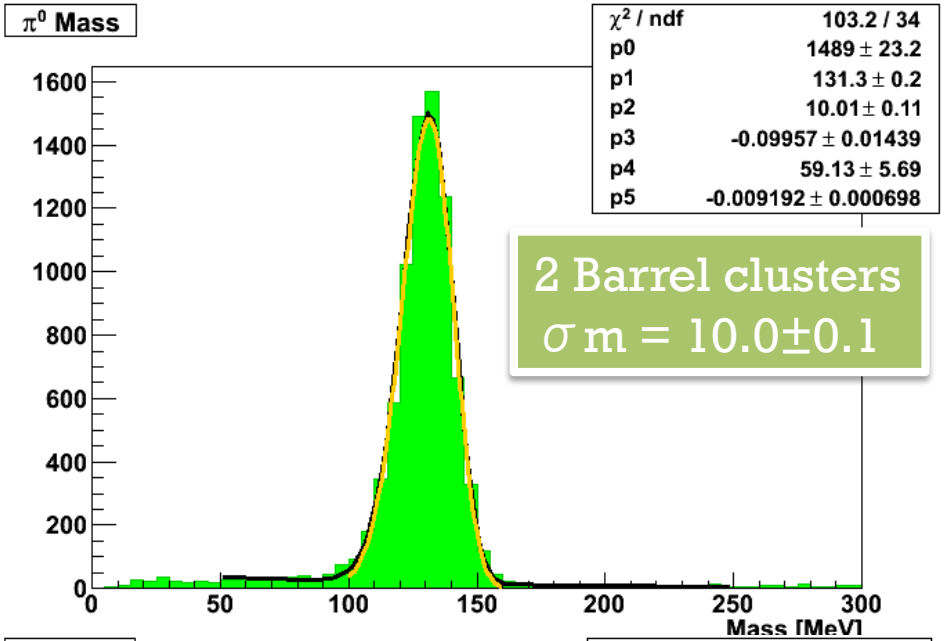
Seem to be good enough
Not always perfect

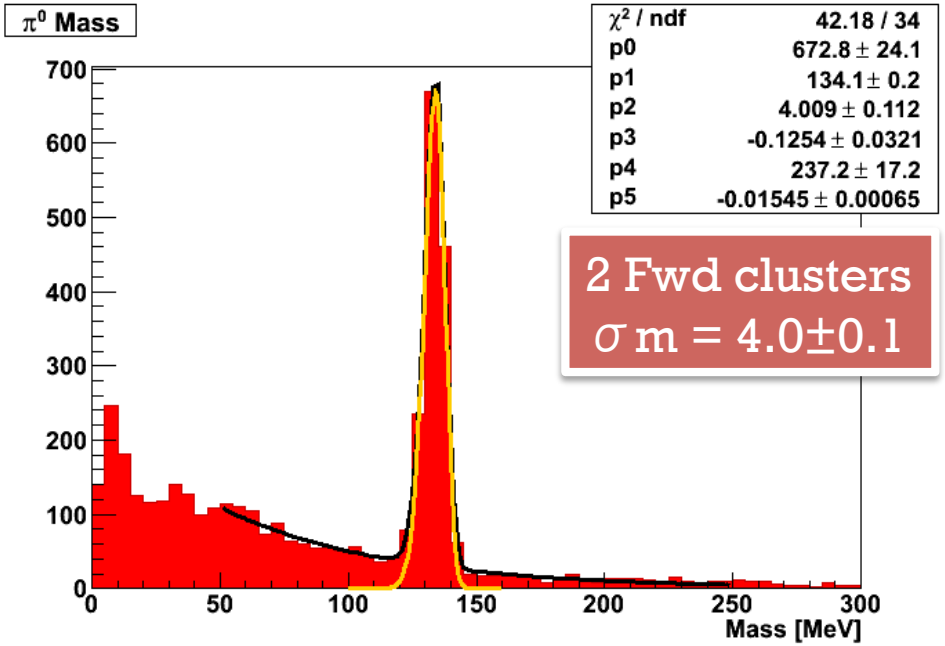
Need more points but 1 calibartio / configuartio is time consuming

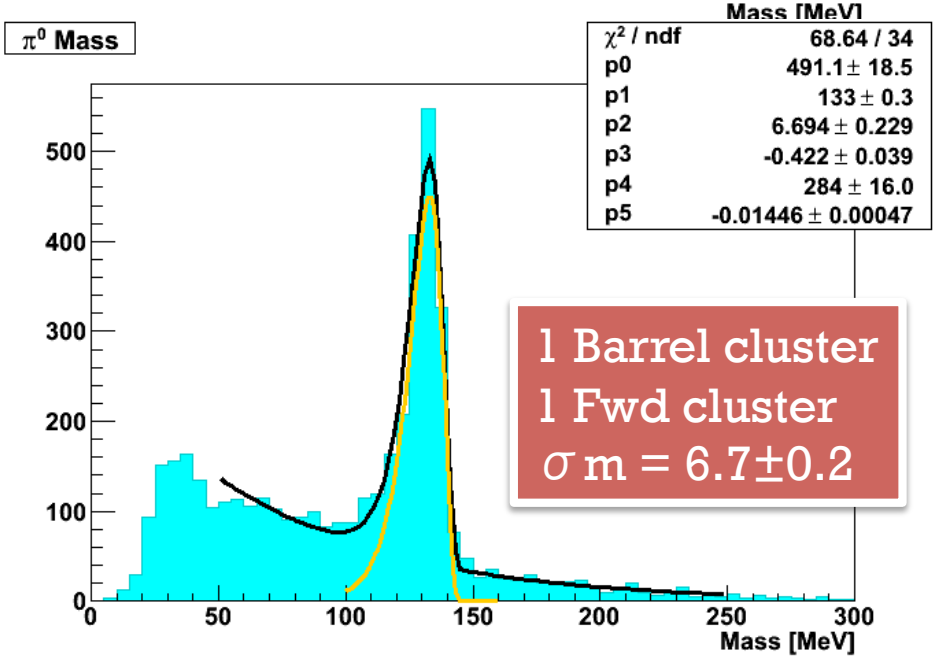
Graph



Pi0 Mass (No Bakground)





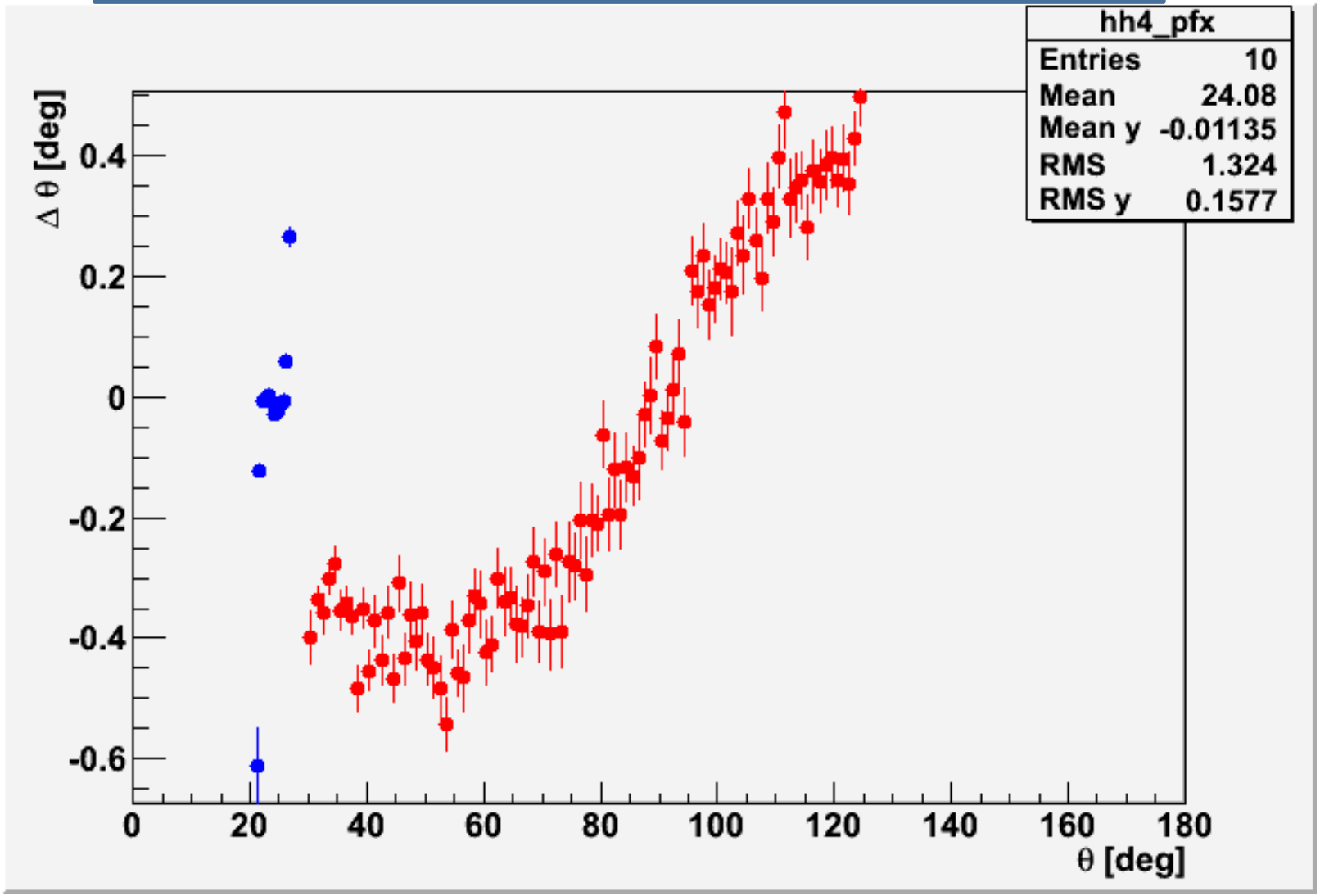


BaBar quotes a better mass resoltio for the CsI (7-8 MeV)

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

Theta Correction (to be added)

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

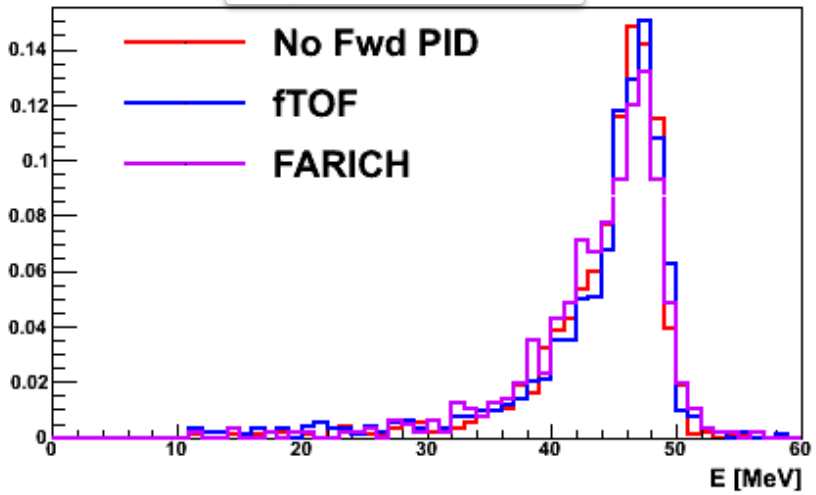


Absolute Theta calibration must be added

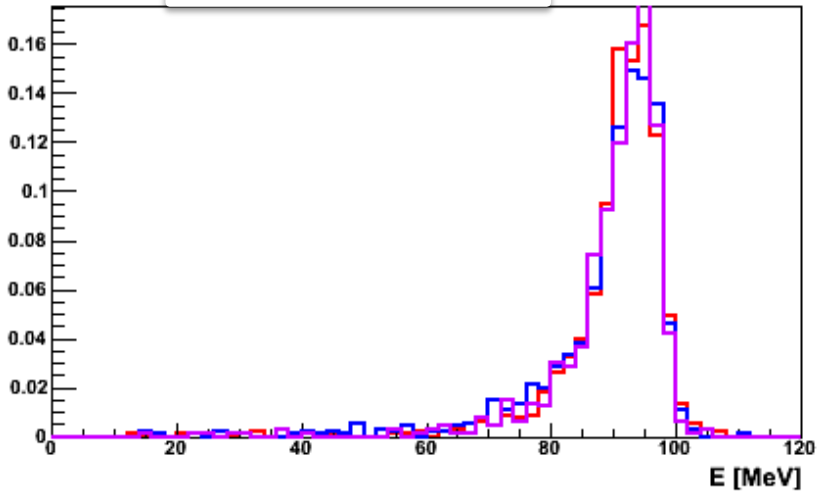
Fwd PID Effect Studies

Fwd Emc Measured Energy Distribution

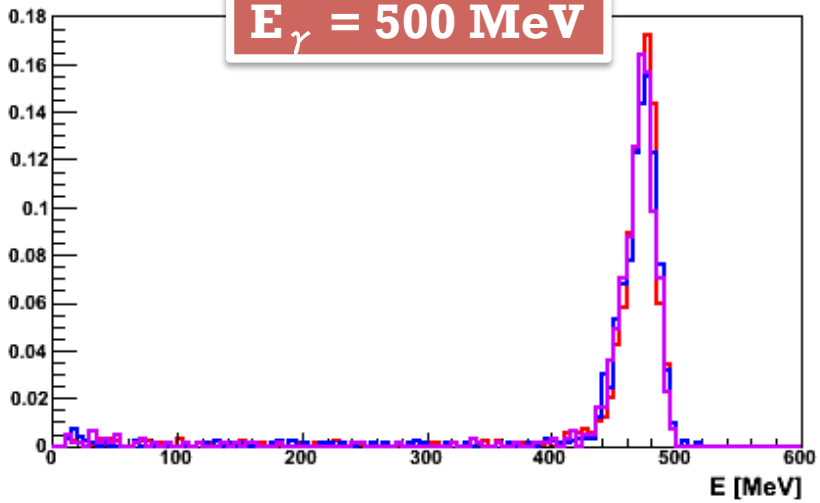
E_γ = 50 MeV



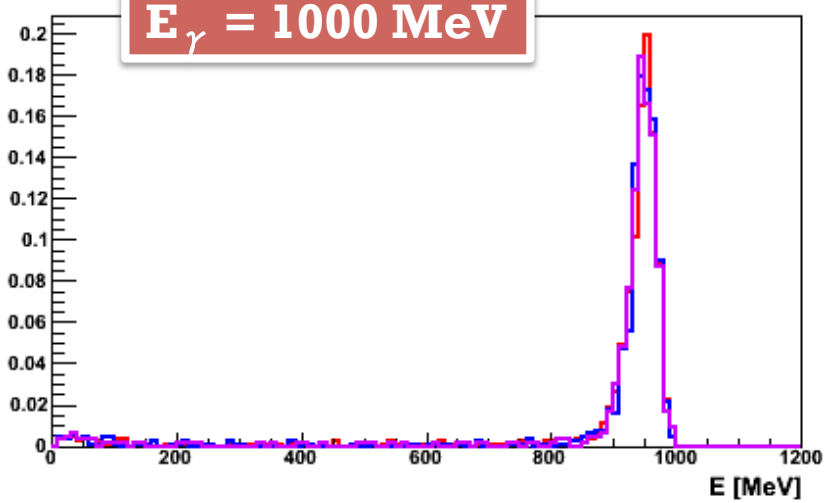
E_γ = 100 MeV



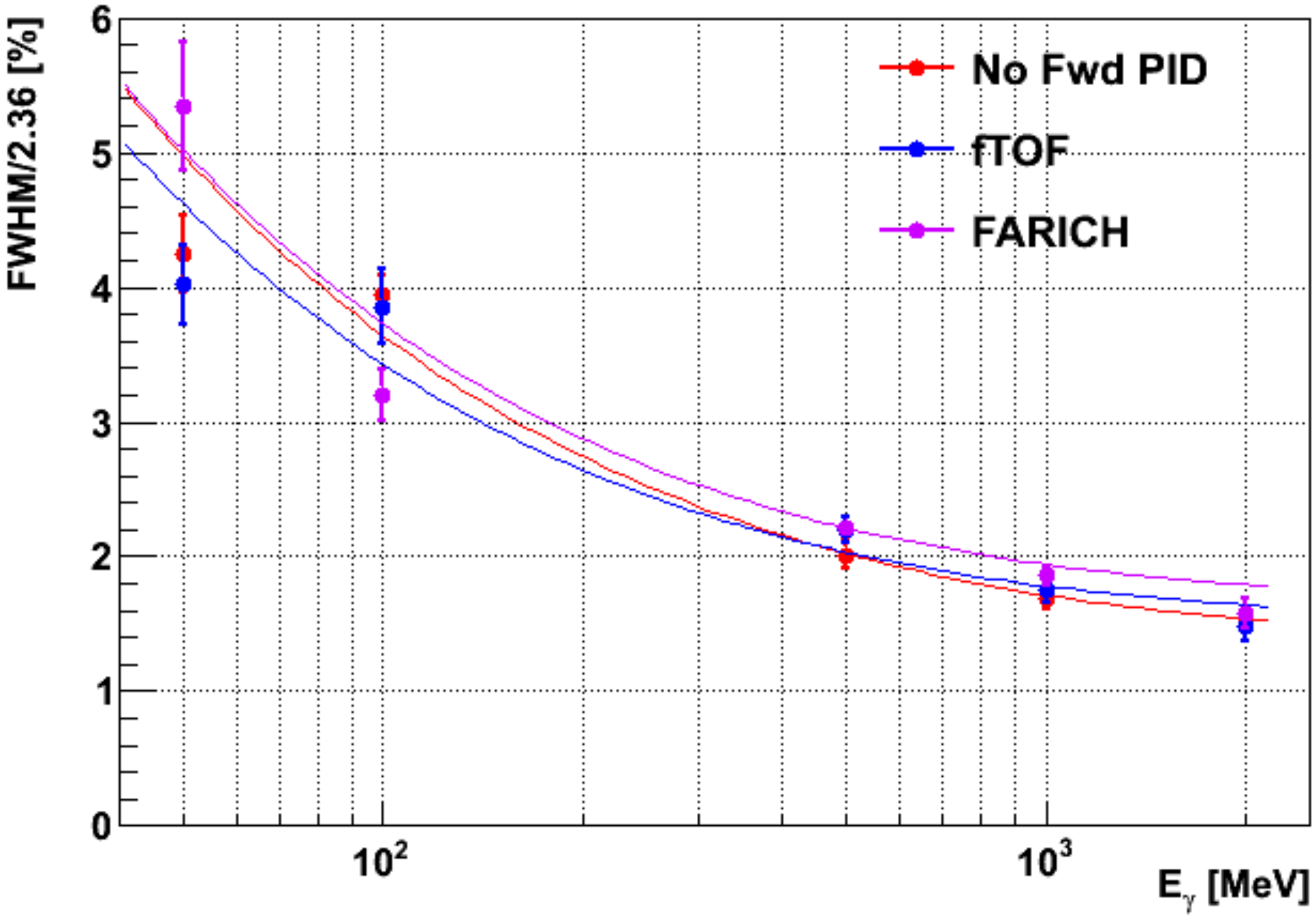
E_γ = 500 MeV



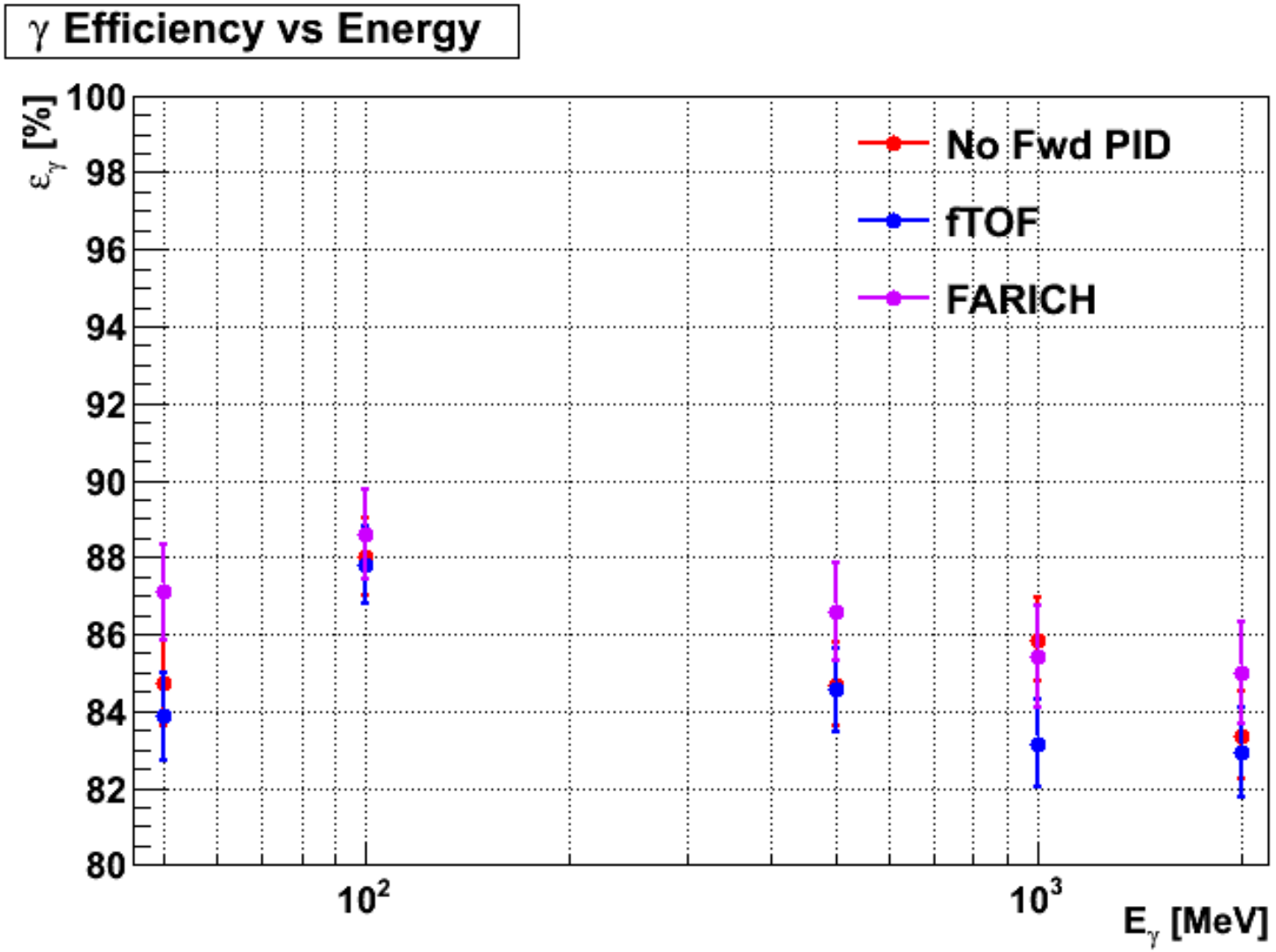
E_γ = 1000 MeV



Fwd EMC Energy Resolution

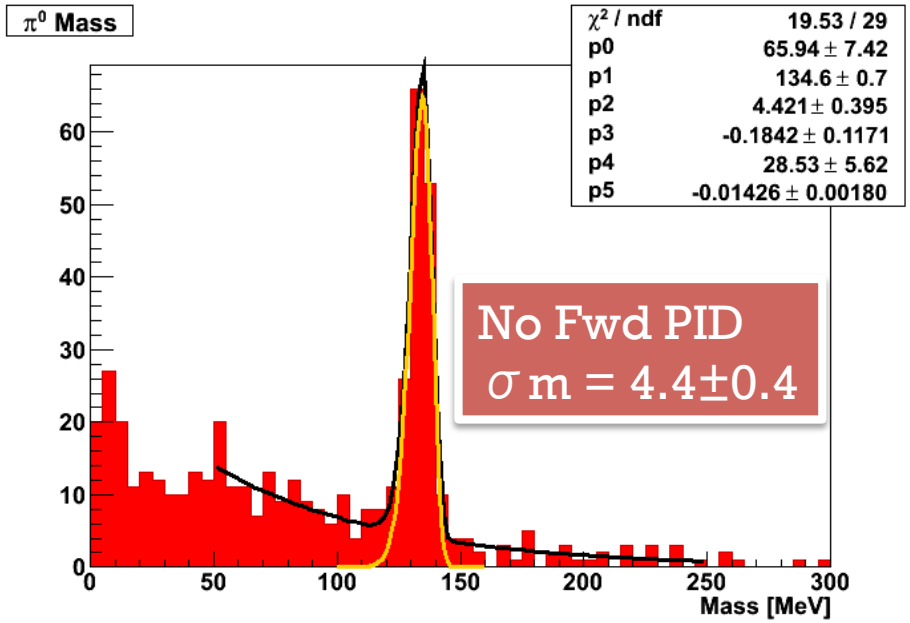


Fwd EMC γ Efficinecy



Due to the lack of tracking reconstruction some of the upstream converting photons are lost

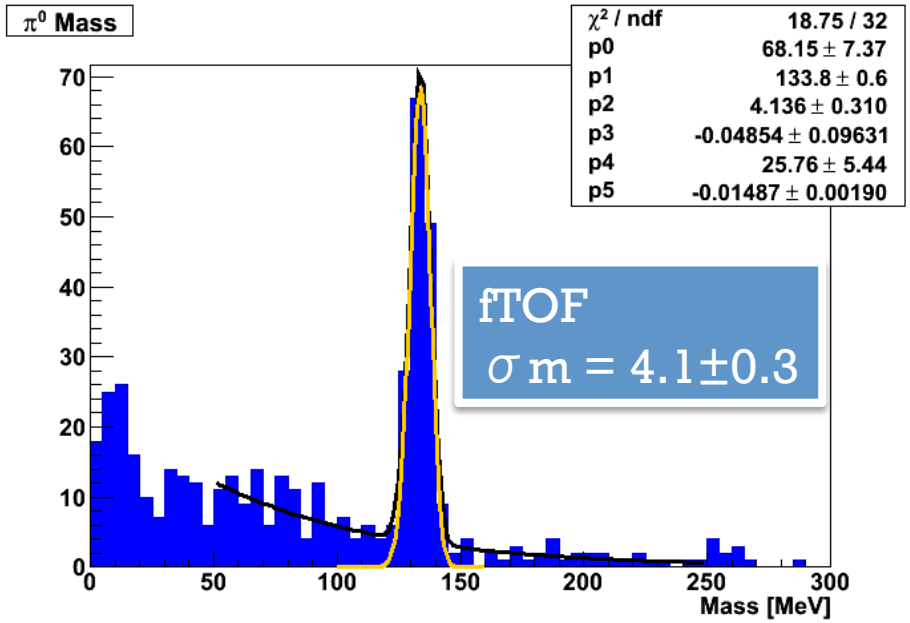
π^0 Mass

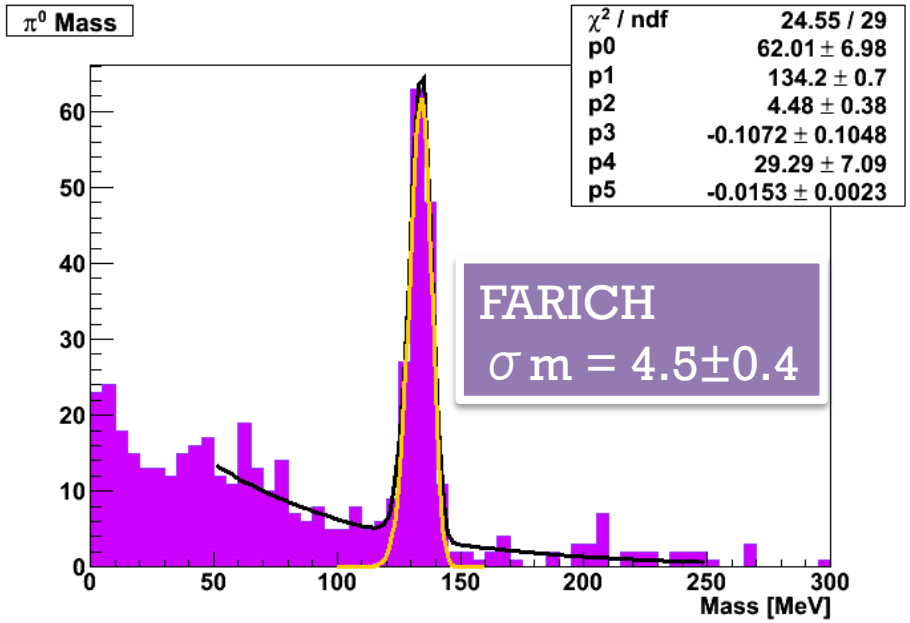


π^0 with Ek = 1 GeV
Both clusters in Fwd Endcap
Fit: Background + Novosibirsk

$\varepsilon_{\text{fTOF/NoPID}} = 98.0 \pm 1.2$

$\varepsilon_{\text{FARICH/NoPID}} = 96.5 \pm 1.5$





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
  -
- 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 very small
- TODO
  - Absolute angle calibration