Neutral pion decay « FastMC » for ECal

- Generate π^0 's uniformly in energy and angles
  between 0.75 and 5 GeV, 0 and 13°, 0 and 360°

- Decay into 2 photons at target location

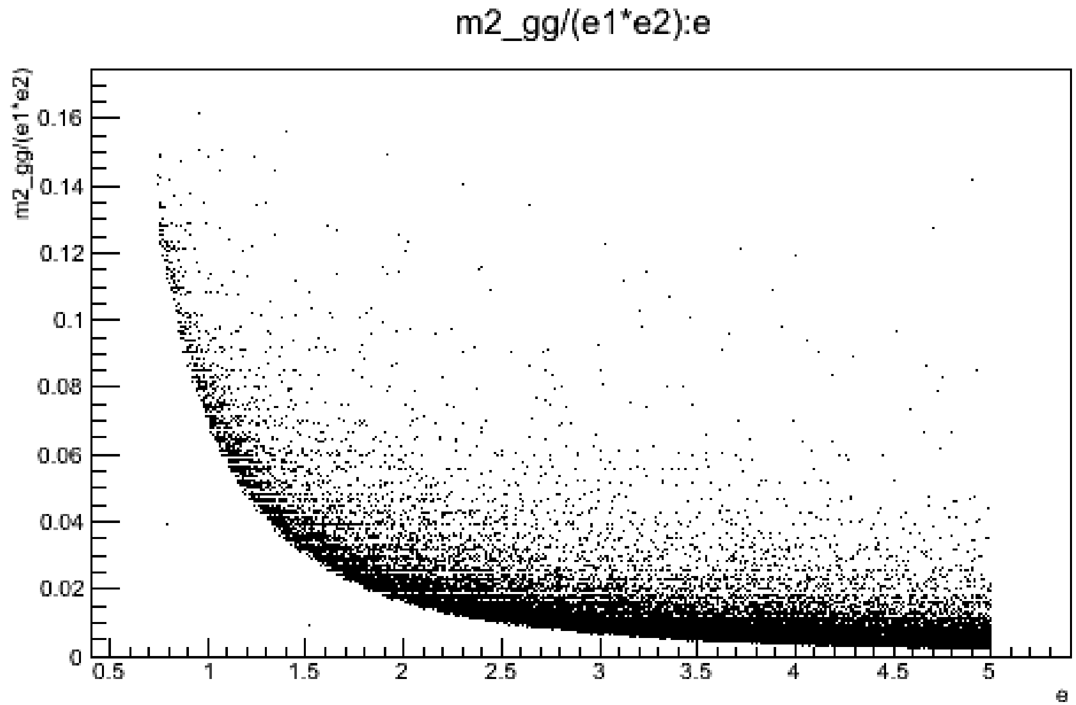
- Impose that the two photons hit Ecal

  Since there is a minimum opening angle between the two photons:
  $$\mathbf{\sin\theta_{min}/2 = m_\pi/E_\pi}$$
  there has to be a minimal pion energy
  below which at least one photon will miss ECal.
  It is easy to estimate before any simulation $\mathbf{E_\pi > 0.7}$ **GeV**

- Look at (approximate in case of trigger) invariant mass distribution depending on how photon angles and energies would be measured.

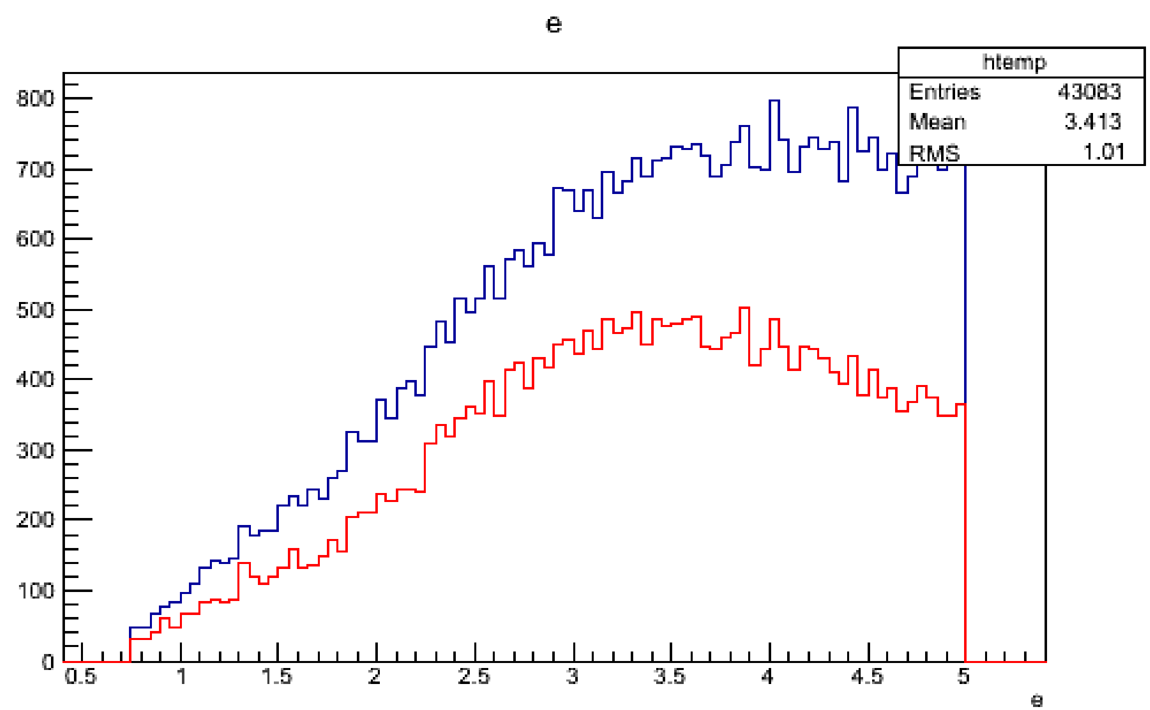
2-photon opening angle
$2*(1-\cos\theta_{12})$
vs
pion total energy

with the condition that the two photons hit ECal



Pion total energy distribution

(in red with the additional condition that one photon is on top and the other one on bottom)

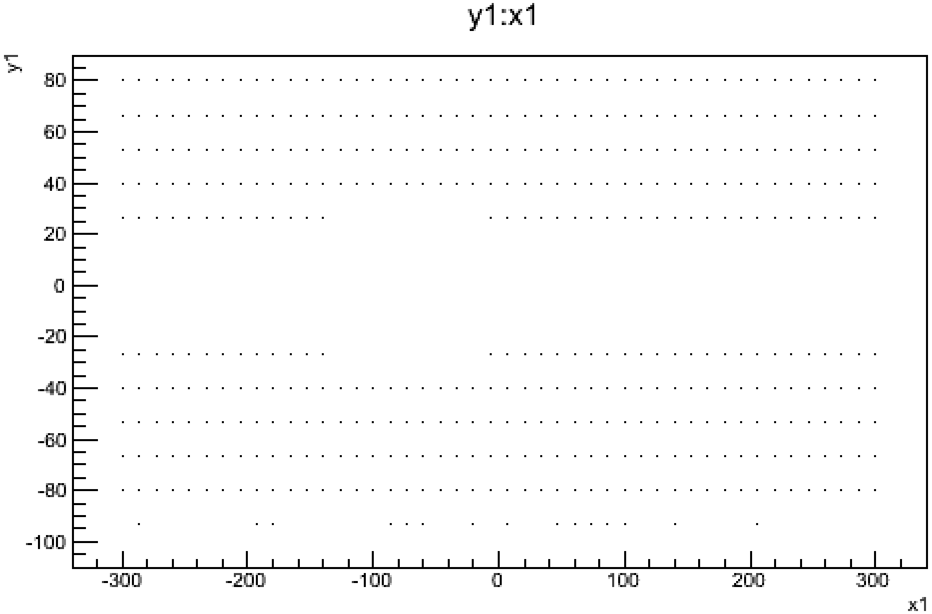


1) at trigger level

- Use (and test) small angle approximation for opening angle:

$$M^2_{\gamma\gamma} = 2\, E_1\, E_2\, (1 - \cos\theta_{12}) \approx E_1\, E_2\, [(x_1-x_2)^2 + (y_1-y_2)^2]/D^2$$

- Use center of max_hit crystal as photon coordinates



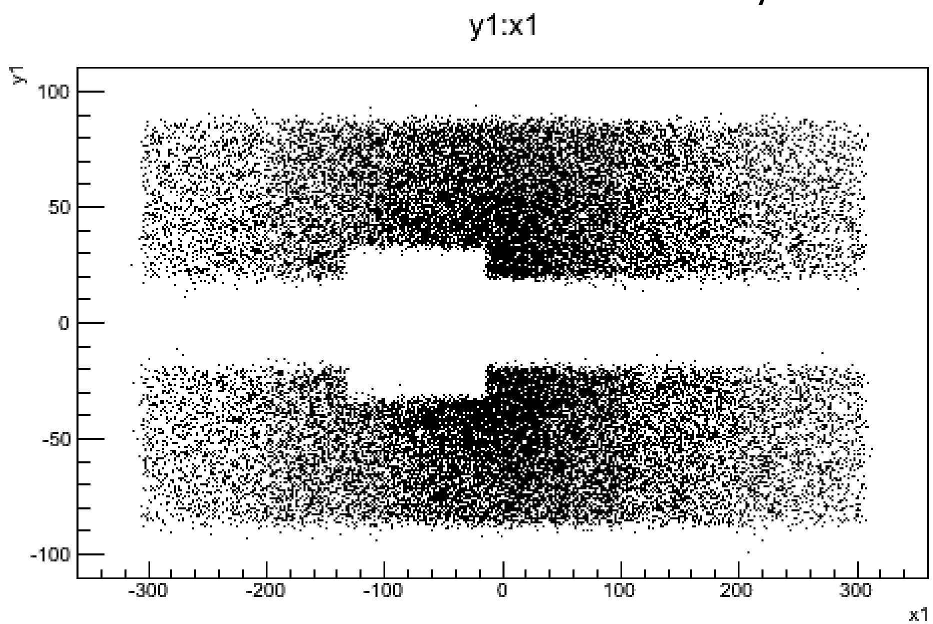
- Use best guess for energy resolution (see below)

$$\sigma/E = .050 \oplus .030/\sqrt{E} \oplus .014/E \quad (6\% \text{ at } 1\text{ GeV})$$

2) offline

- Calculate exactly the 2-photon invariant mass

- Use best guess for position resolution : $\sigma_x = \sigma_y = 2\ \mathrm{mm}/\sqrt{E}$



- Use best guess for energy resolution (see below)

$$\sigma/E = .024 \mathbin{++} .020/\sqrt{E} \mathbin{++} .010/E \quad (3.3\%\ \text{at 1 GeV})$$

Best guesses for Ecal resolutions $\sigma/E = a \oplus b/\sqrt{E} \oplus c/E$

	a: Fluctuations of energy leakage from the back + intercalibration	b: Photostatistics + fluctuations of lateral shower containment	c: Preamplifier noise	Quadratic sum at 1 GeV
DVCS/IC	0.024	0.033	0.019	4.5 %
HPS/Ecal Trigger level	0.050	0.030	0.014	6 %
HPS/Ecal Offline	0.024	0.020	0.010	3.3 %

	At trigger	$\sigma(m^2_{\gamma\gamma})$ *GeV^2*	Offline	$\sigma(m^2_{\gamma\gamma})$ *GeV^2*
Small angle approximation		**0.00014**		N/A
+ position resolution	Discrete 13.3 mm (crystal center)	**0.00129**	2 mm / $\sqrt{E}$	**0.00078**
+ energy resolution	6% @ 1 GeV	**0.00227**	3.8% @ 1 GeV	**0.00116**
$\sigma(m) = \sigma(m^2)/2m$		**$\sigma(m_{\gamma\gamma})$ = 8.4 MeV**		**$\sigma(m_{\gamma\gamma})$ = 4.3 MeV**

Suggested cuts for π^0 trigger

- Usual cluster conditions:
  minimal energy 0.15 GeV, minimal central hit 0.05 GeV

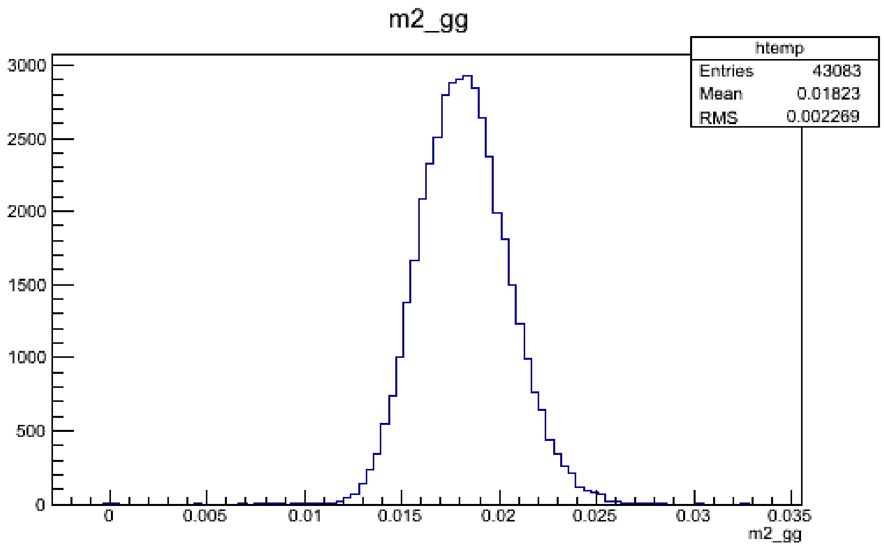
- Select the two highest energy clusters for the whole Ecal (no distinction top/bottom ?)

Note: if we impose 1 cluster on top, the other one at bottom, we loose about 1/3 of the π^0's thus generated, and with a bigger weight on the higher energies.

- Usual timing cut : two clusters within 12 ns of each other.

- Energy sum **$E_1 + E_2 > 0.8$ GeV**

- Calculate approximate invariant mass squared and use 2-sigma cuts:
  $0.00137 < m^2_{\gamma\gamma} < 0.00228$ GeV^2



All this + background to be checked with realistic simulation (Kyle,…)