

$\eta \rightarrow \pi^+ \pi^- \gamma$ analysis

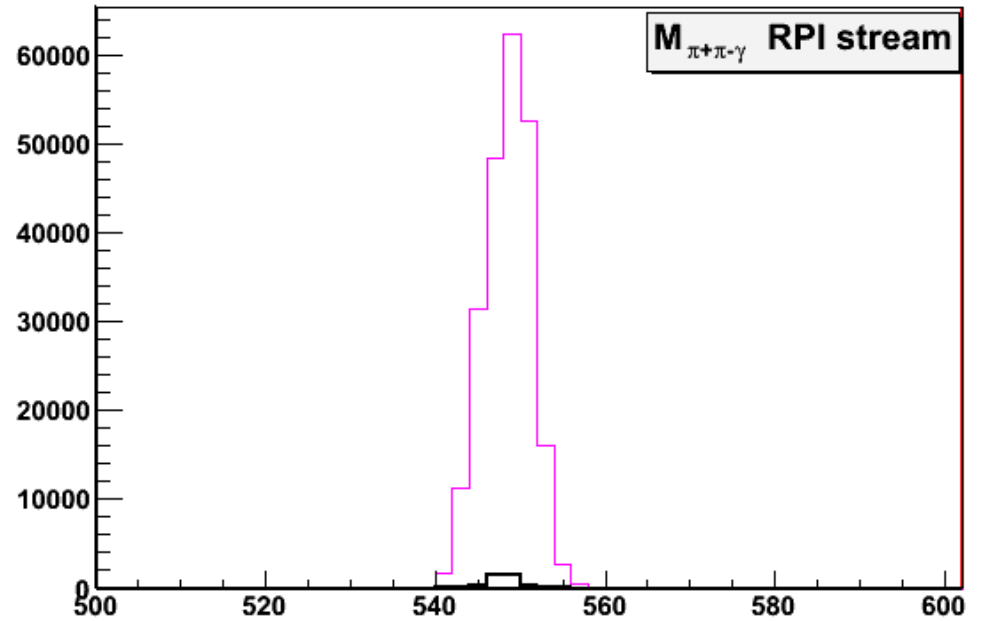
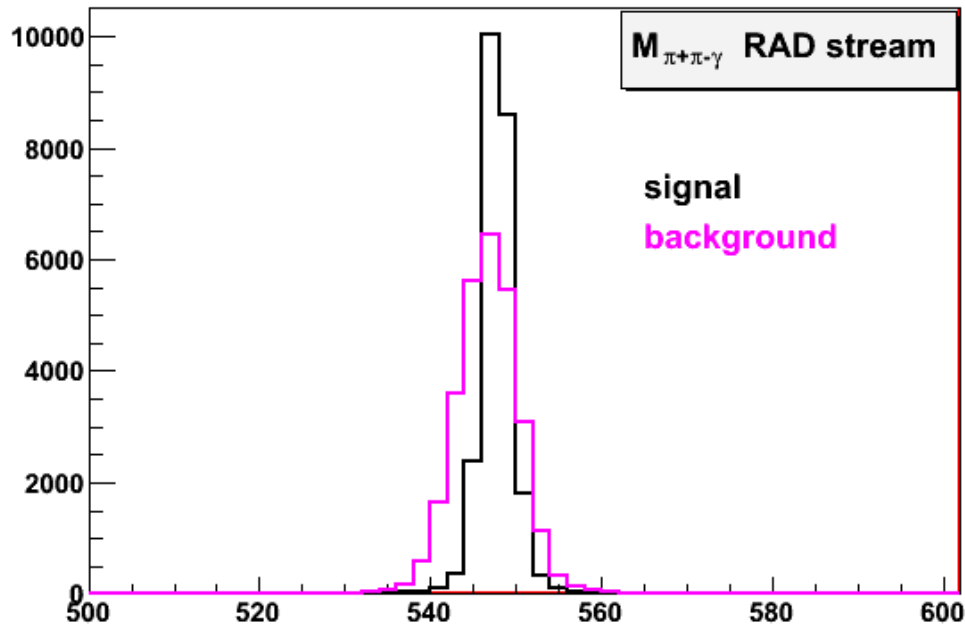
MC - experimental data comparison

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Recap from the last meeting

- ▶ Selecting streams: RAD and RPI
- ▶ Pre-selection:
 - ▶ ≥ 2 prompt photons $|t_{cl} - r_{cl}/c| < 5\sigma_t$
 - ▶ most energetic photon with $E_\gamma \geq 250$ MeV assumed recoil
- ▶ Track selection
- ▶ Kinematical constraints
 - ▶ Calculate E_γ^{recoil} from 2 body ϕ decay kinematics
 - ▶ Calculate γ_{eta} from η decay kinematics
 - ▶ $\gamma_{eta} : |E_t - P_t| < 10$ MeV
 - ▶ We should find cluster with OpAn < 0.2 rad to the calculated γ_{eta}

Efficiency and background reduction



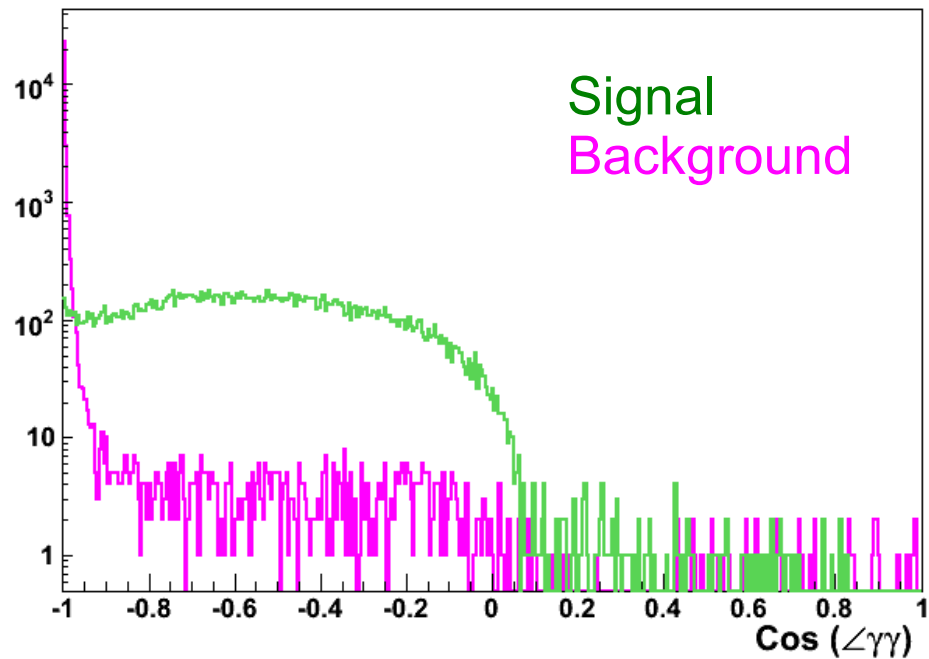
- RAD efficiency 41.7% (S/B ~ 1:1)
- RPI efficiency 6.6% (S/B ~ 1:60)

Removing background $\phi \rightarrow \pi^+ \pi^- \pi^0$

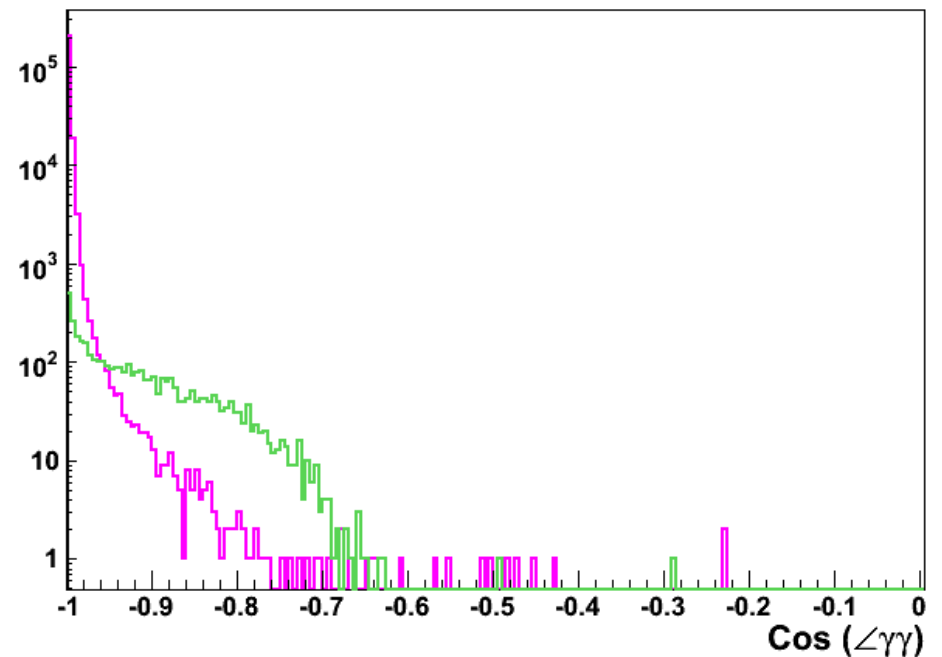
Calculate opening angle between γ_{eta} and γ_{phi} in π^0 rest frame

π^0 evaluated using tracks' information
assuming background reaction kinematics

RAD stream

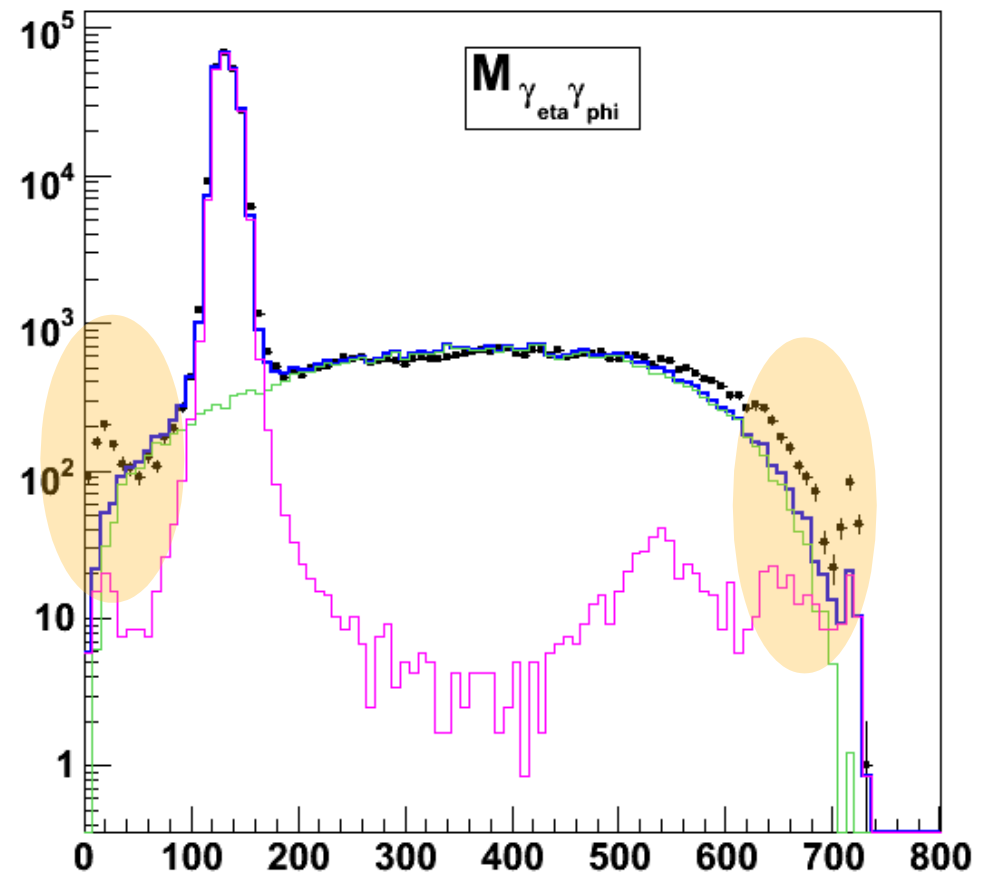
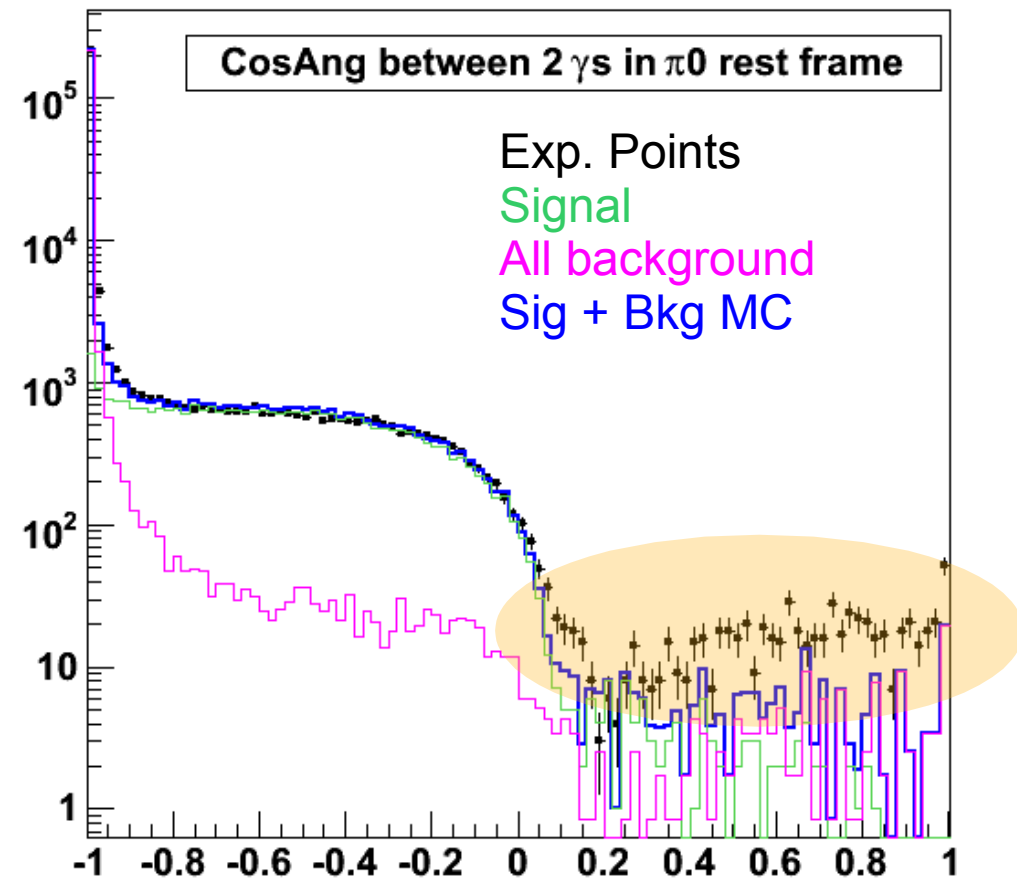


RPI stream

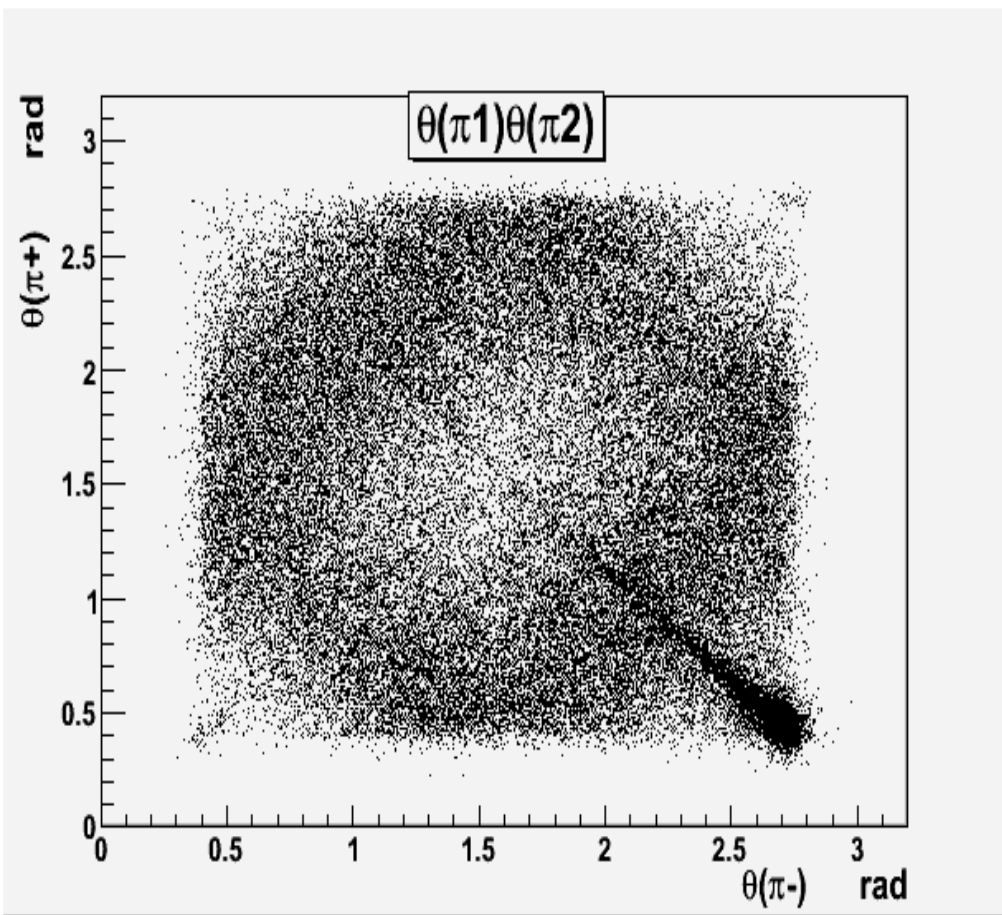


First try to describe the experimental data with Monte Carlo

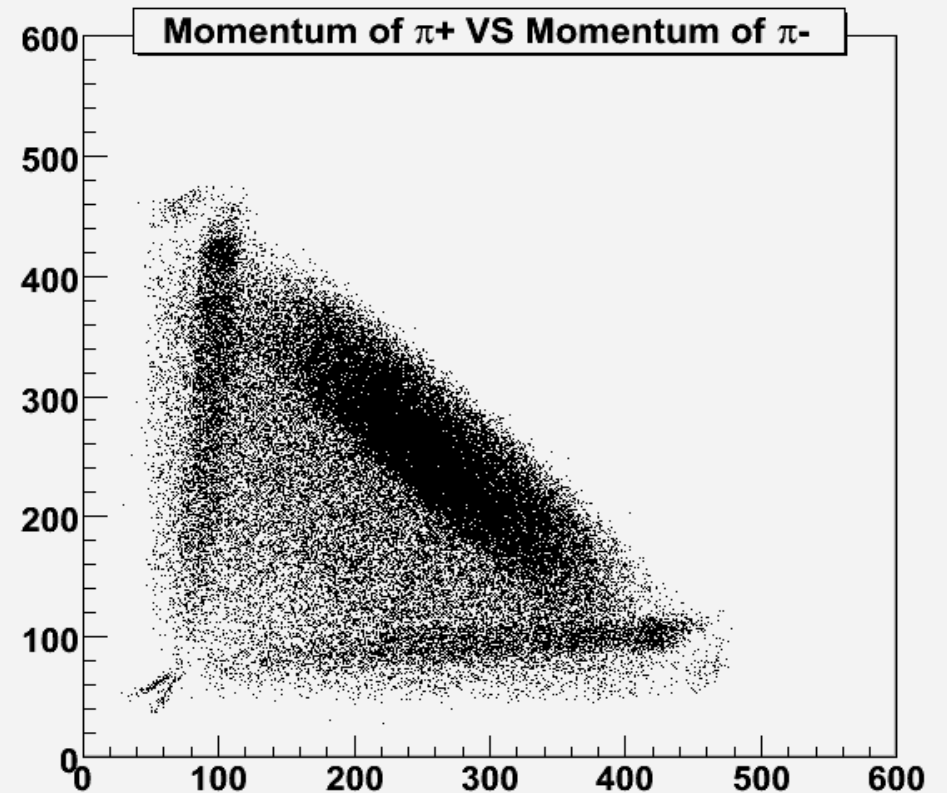
RAD + RPI stream selection $L_{\text{int}} \approx 30 \text{ pb}^{-1}$



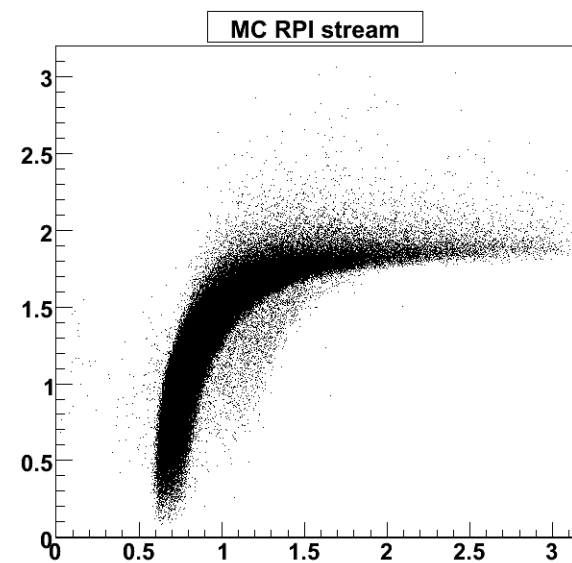
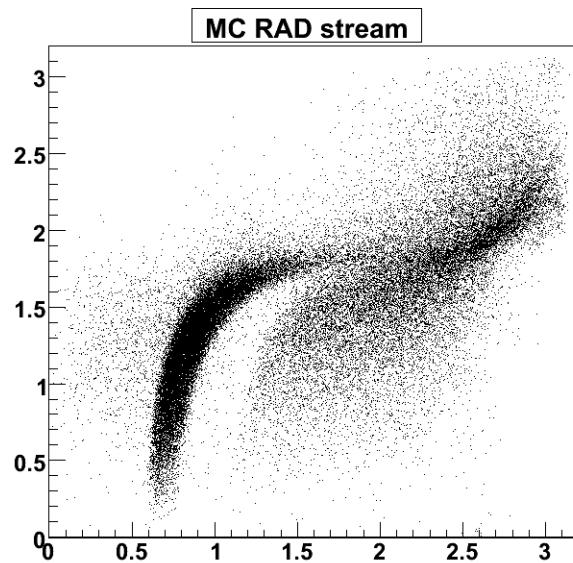
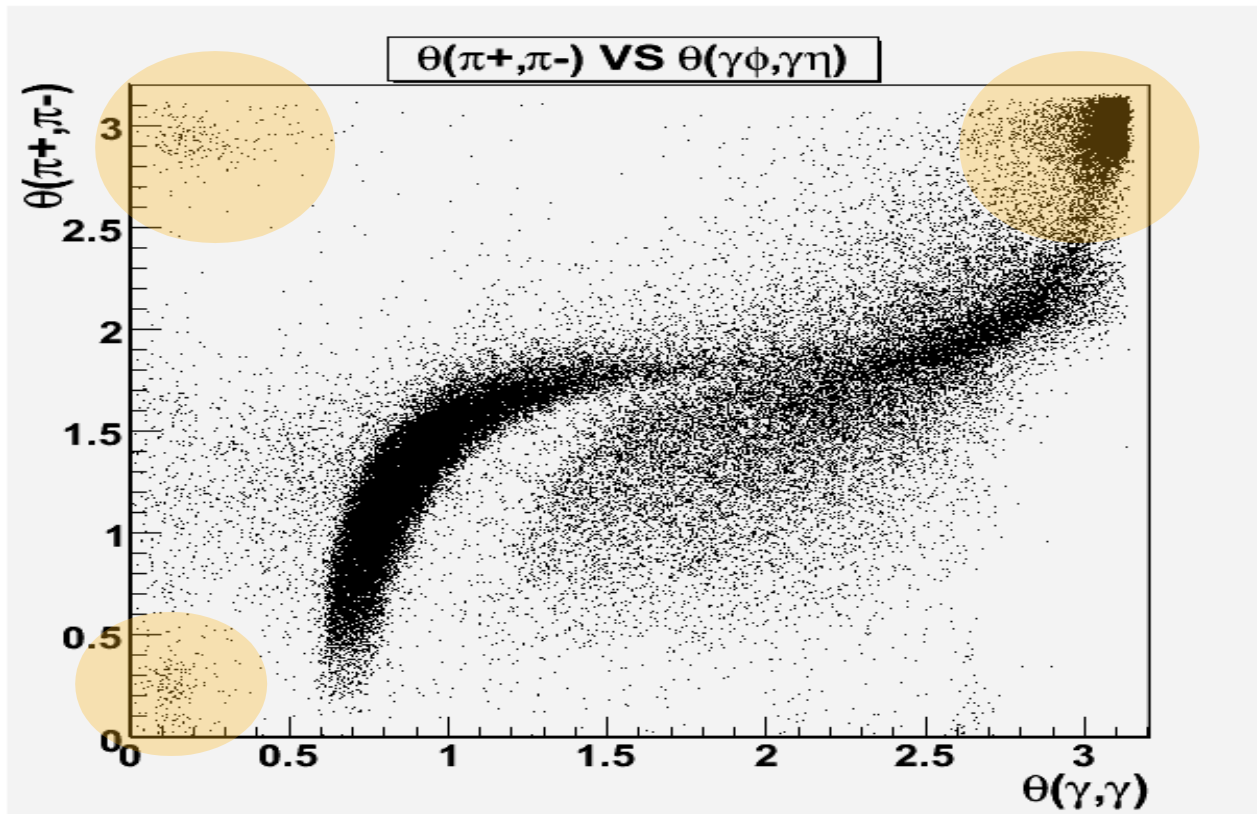
Unaccounted background



Significant contamination even after pre-selection cuts visible only in EXP. DATA (and not in allphys MC)



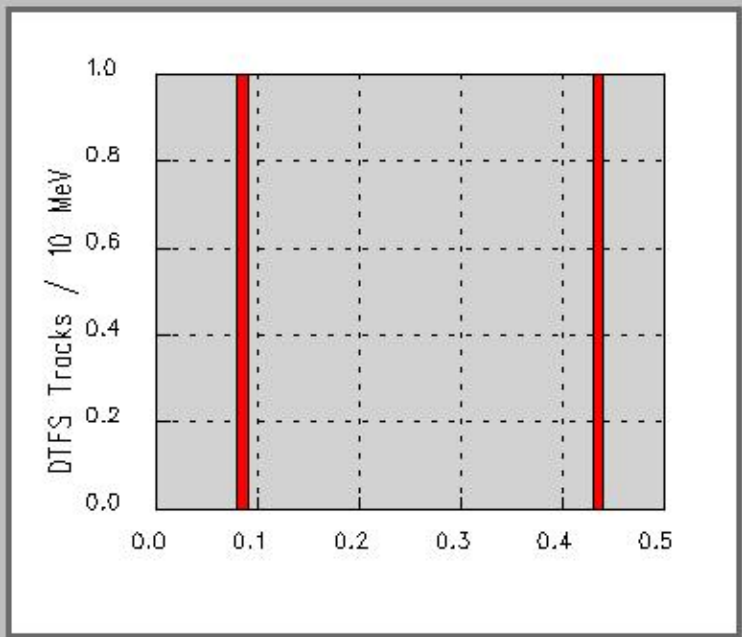
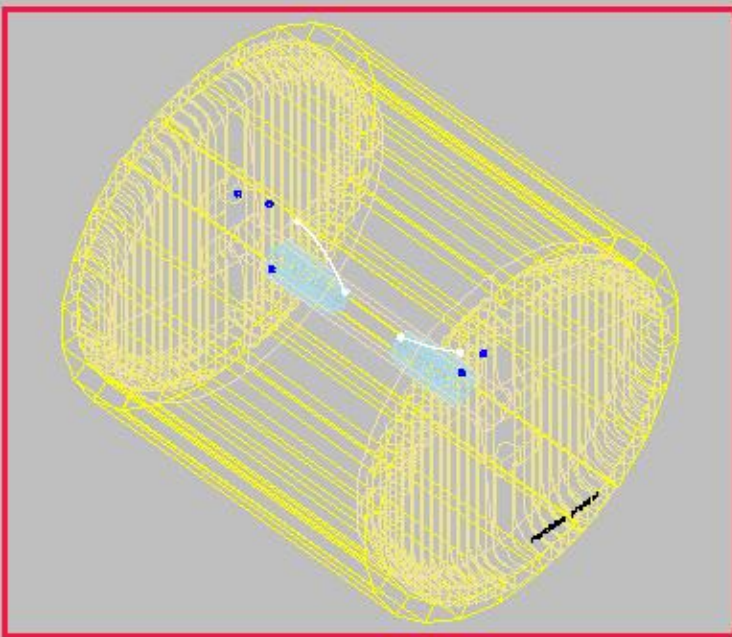
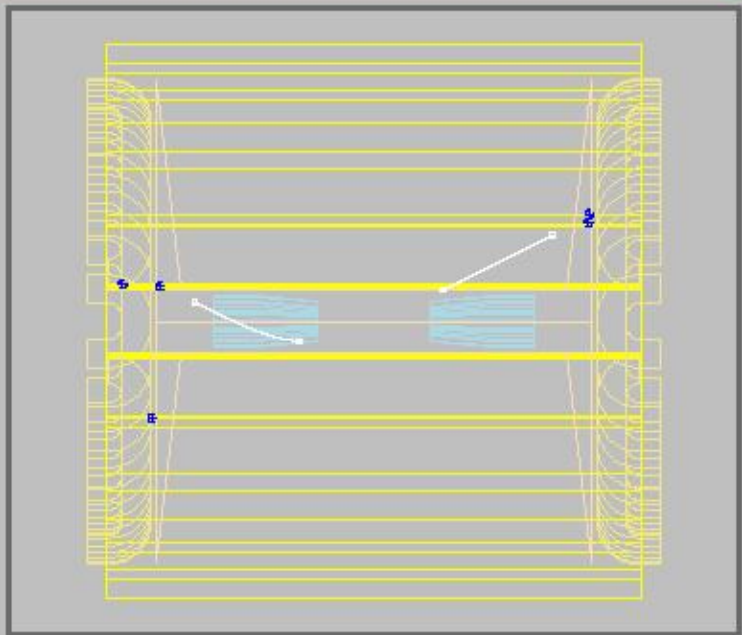
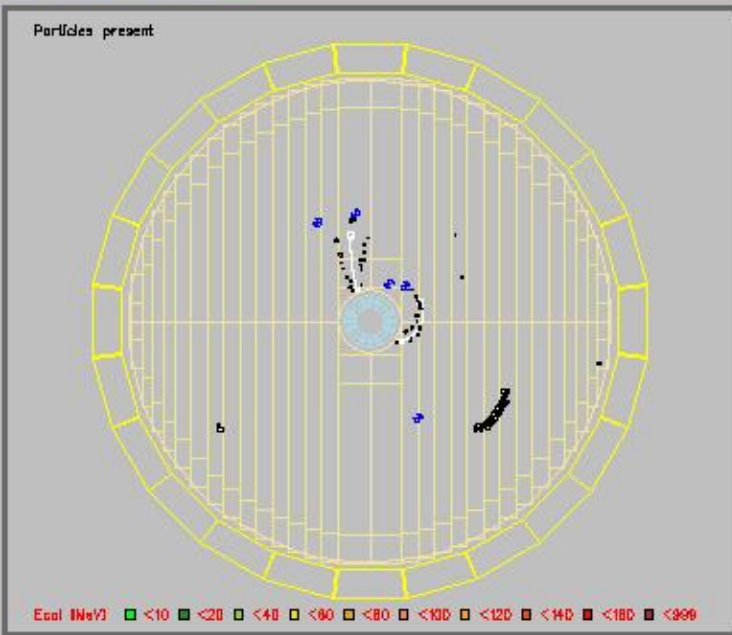
Unaccounted background



File Event Windows Display View A_C Help



Type Event informations :
 runNr 34406 eventNr 1522555 recordNr 15 inputMode (nil) inputSource yb34406.yb



CHARACTERISTICS:

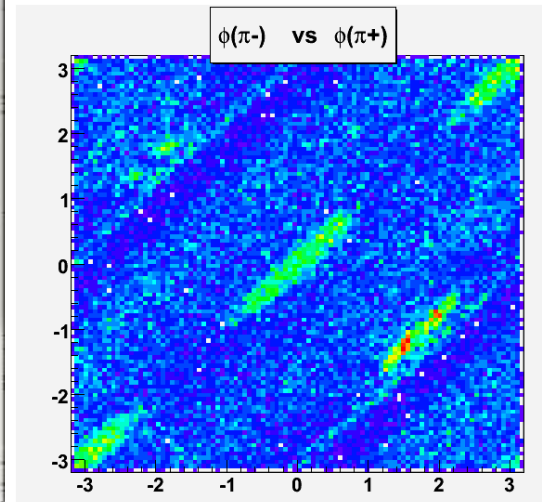
“ π^- ” always back
 “ π^+ ” always front

Cluster split in both directions

Momentum $\approx E_{\text{cluster}}$

Asymmetry in ϕ
 Effect only close to 90°

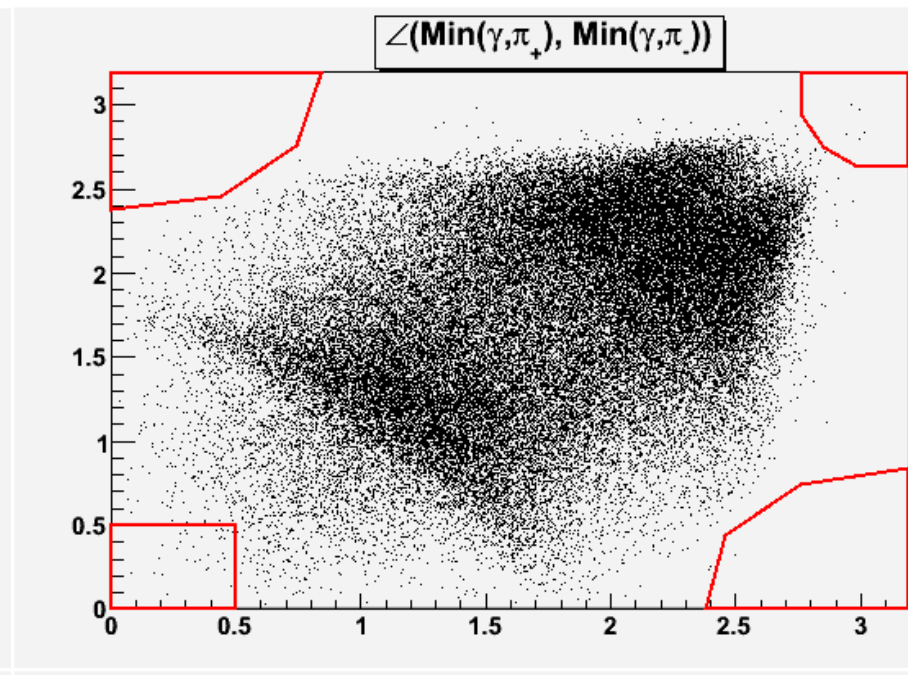
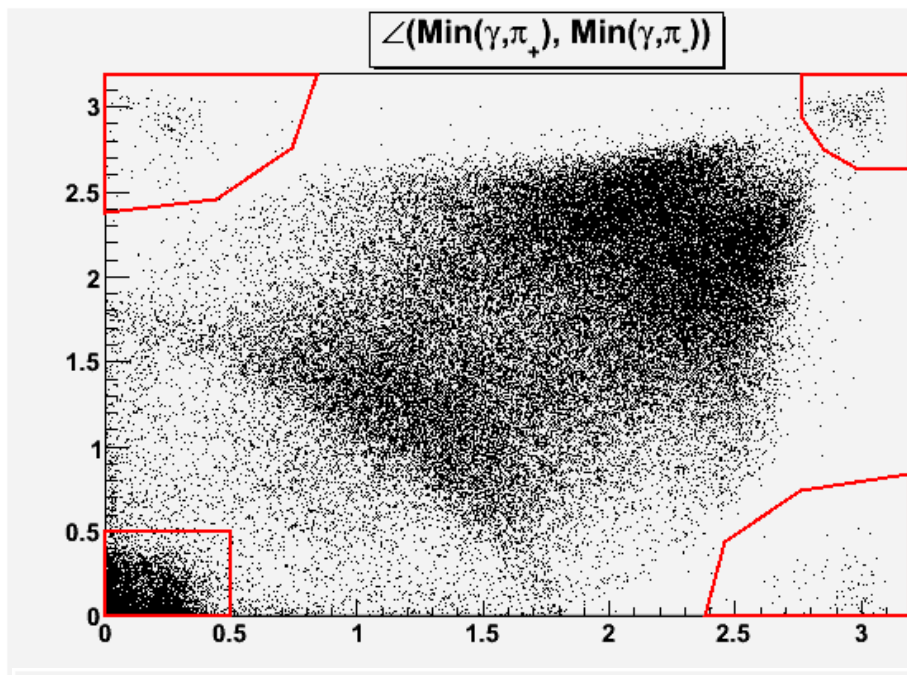
$e^+e^- \rightarrow e^+e^- (\gamma)$
 conversion on inactive material unaccounted for in simulation



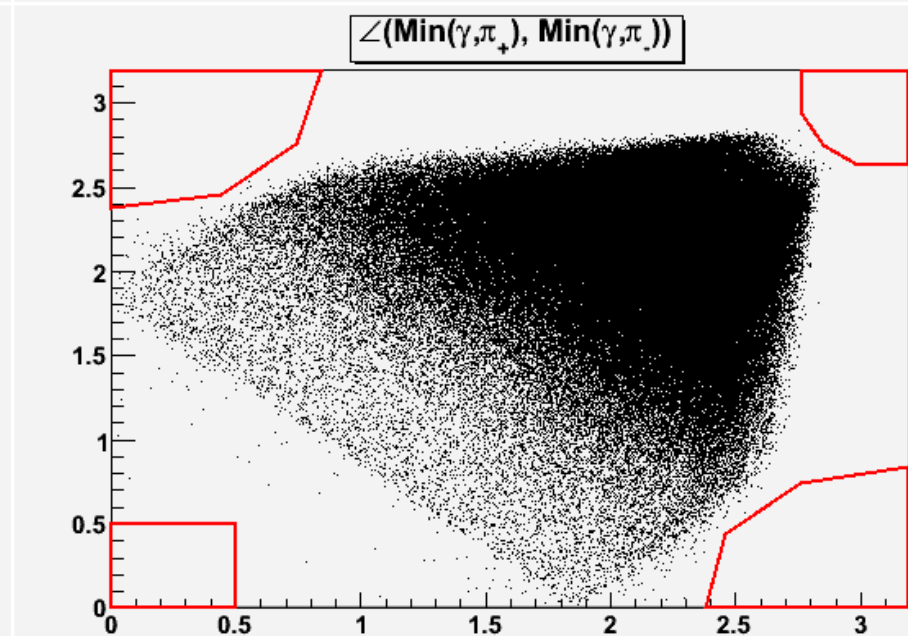
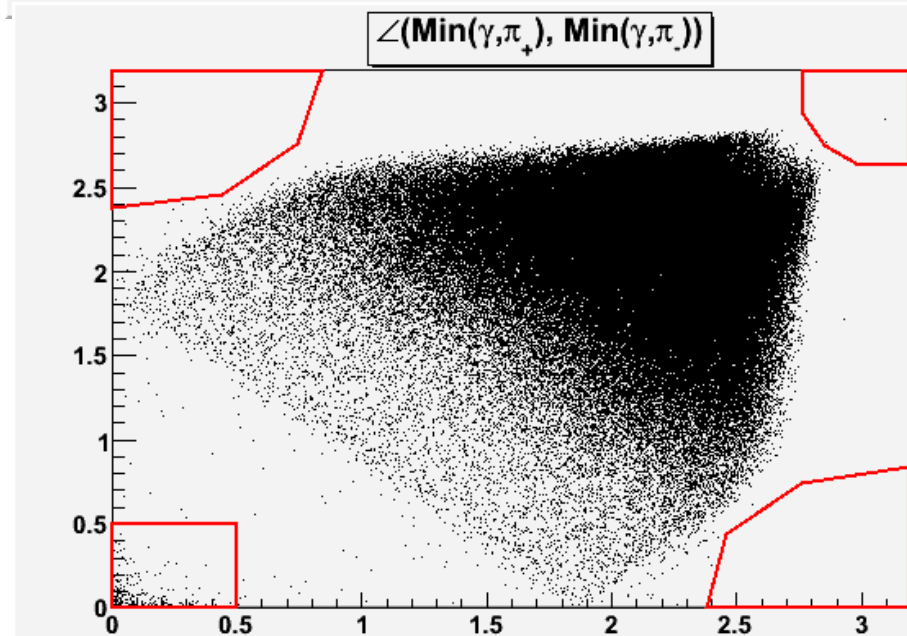
Experiment

Monte Carlo allphys

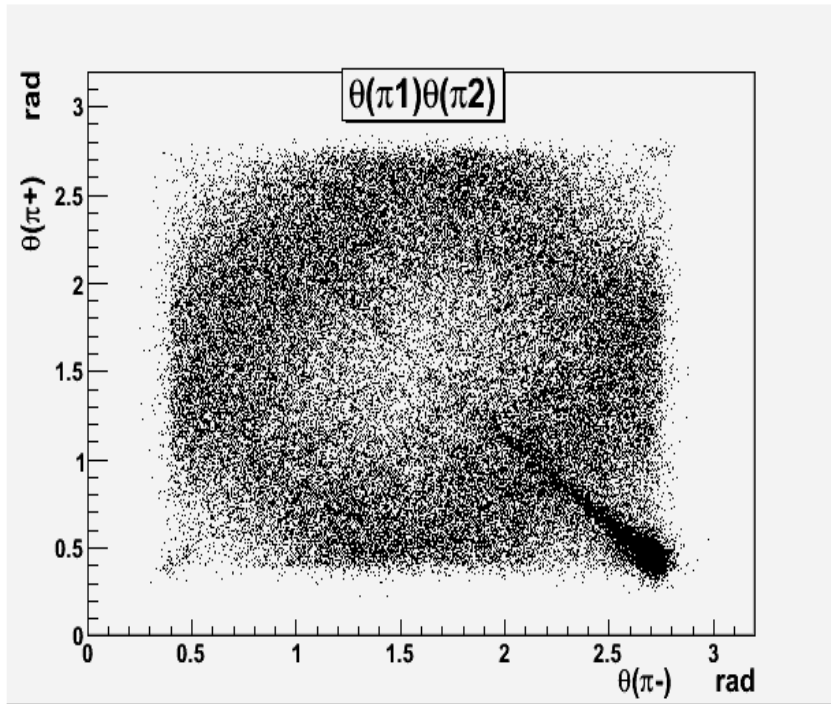
RAD



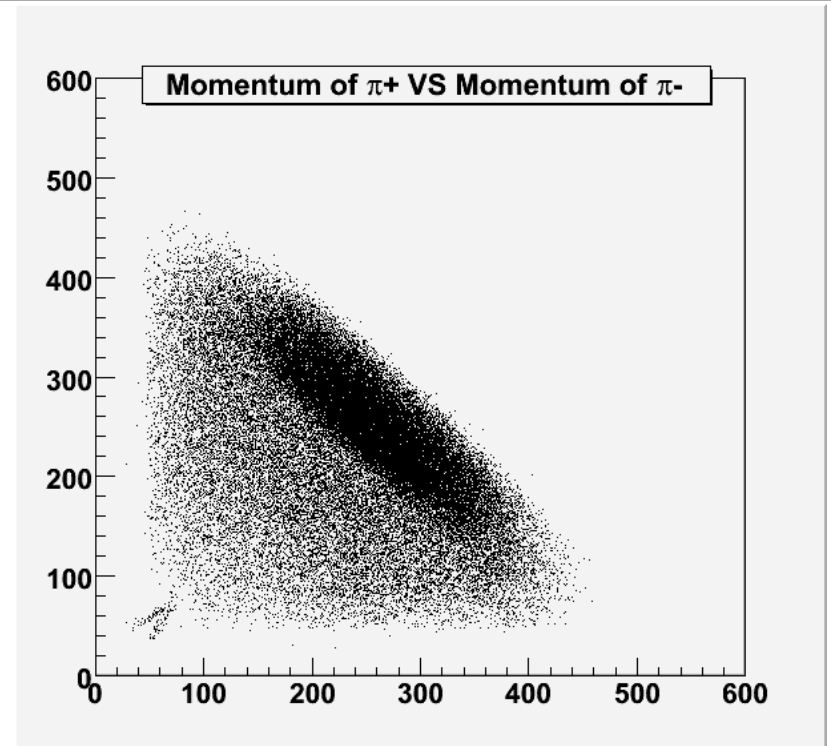
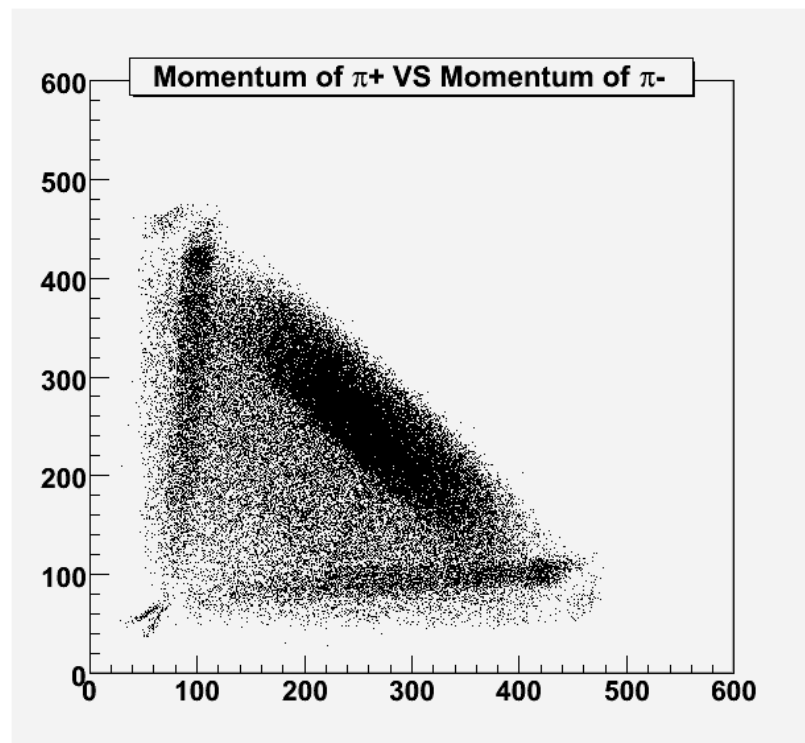
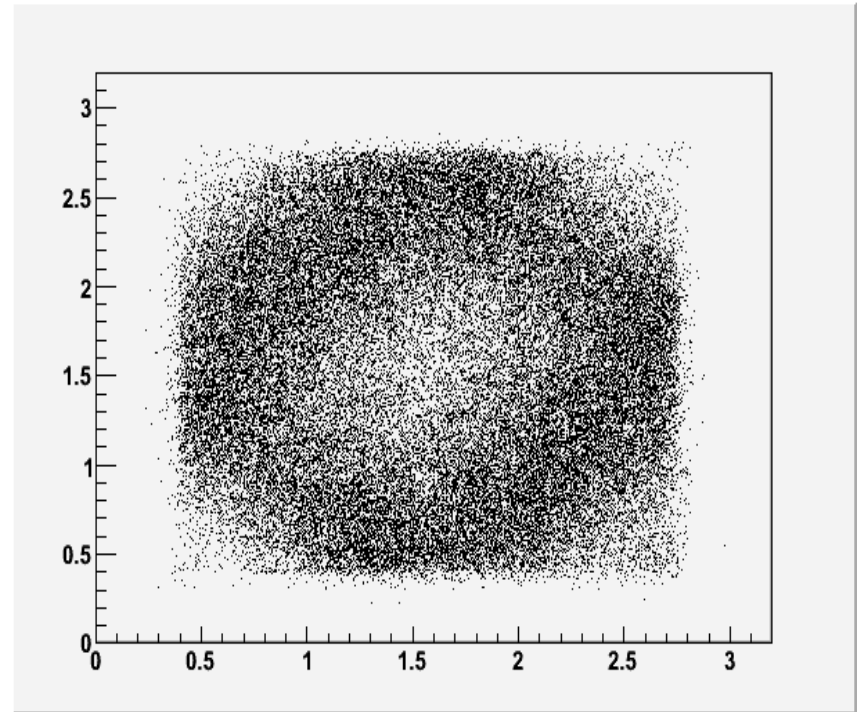
RPI



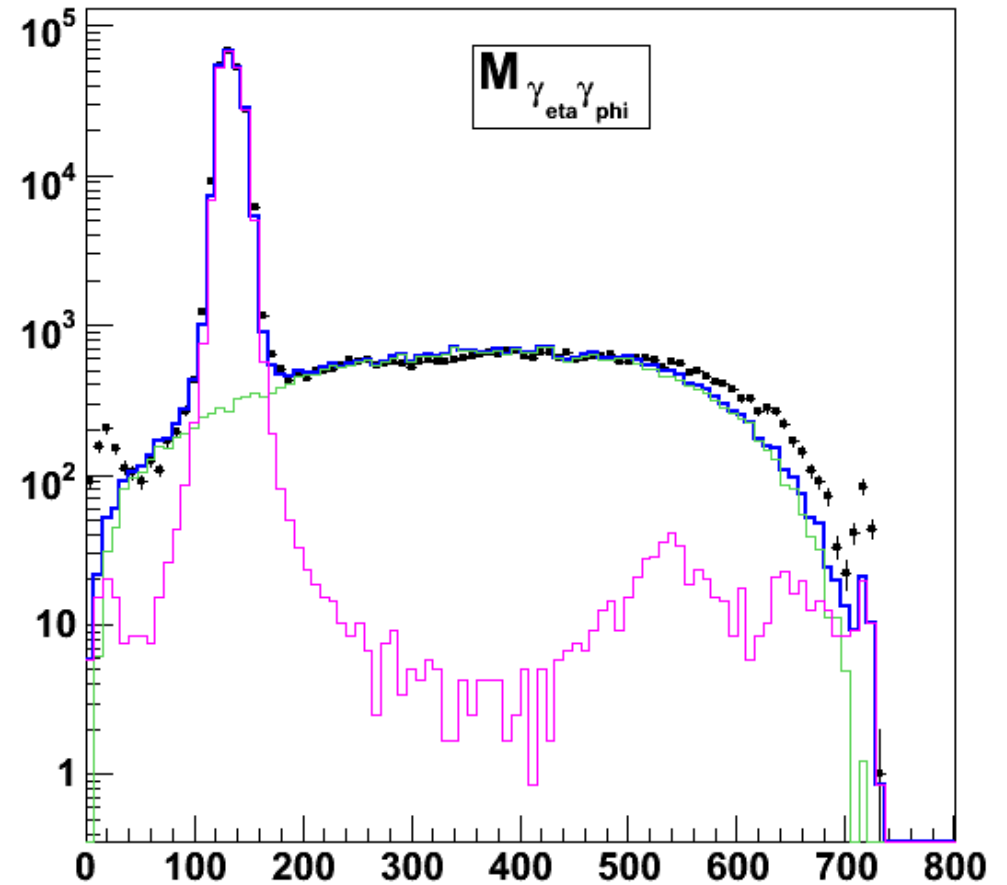
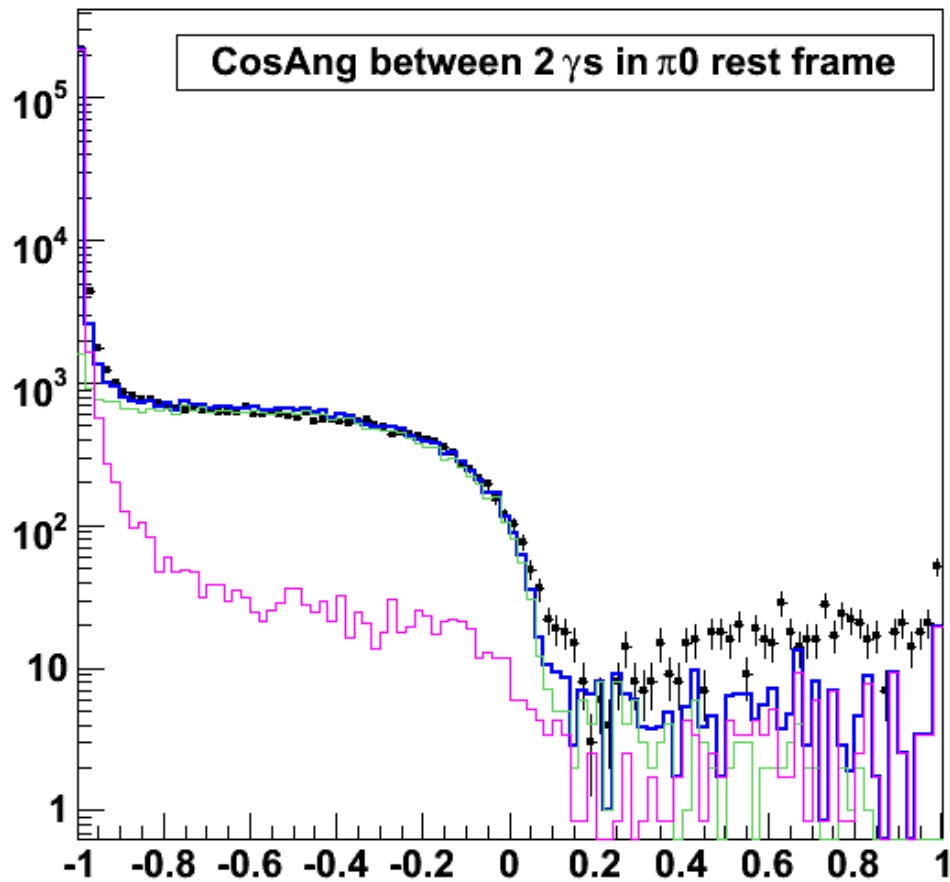
BEFORE THE CUTS



AFTER THE CUTS

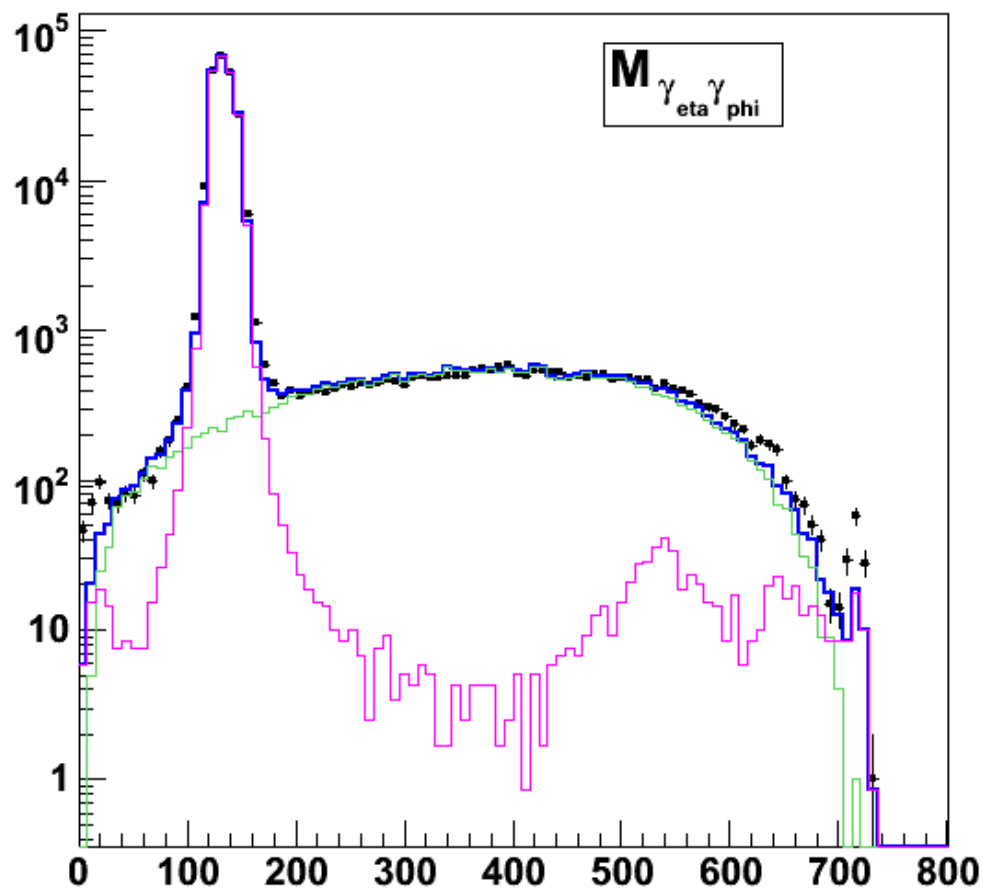
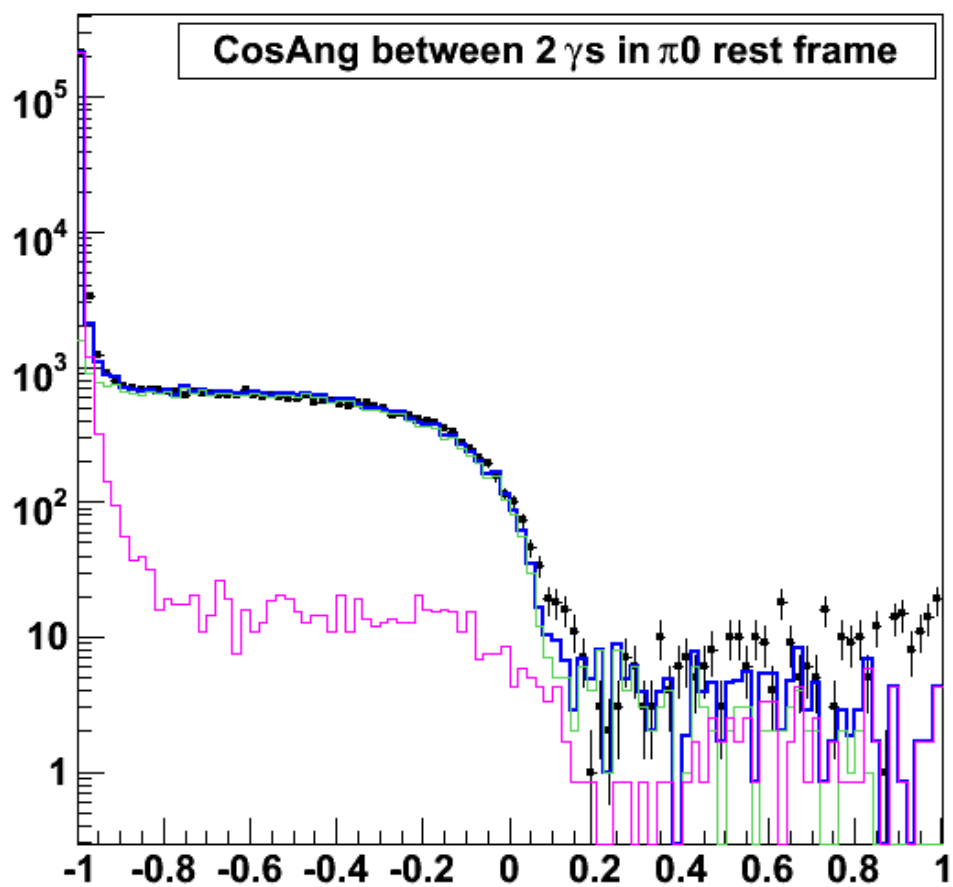


Before removing the strange background



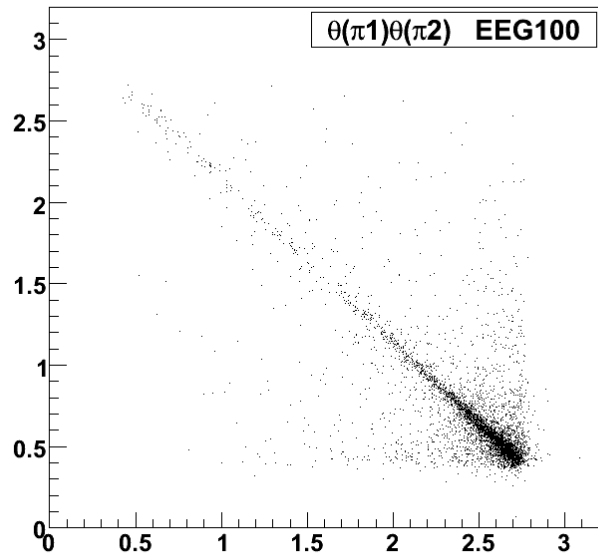
After removing the strange background

(signal rejection < 0.5 ‰)

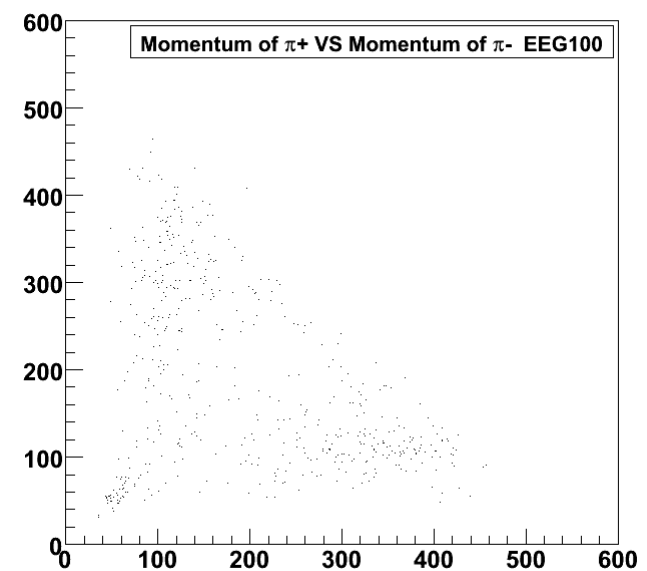
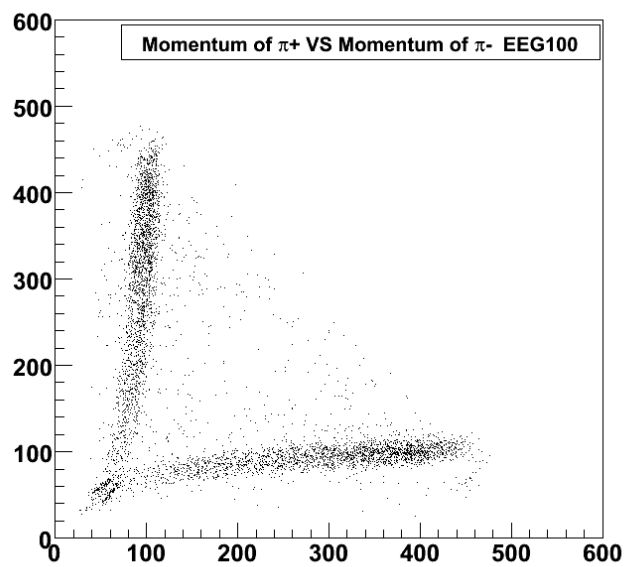
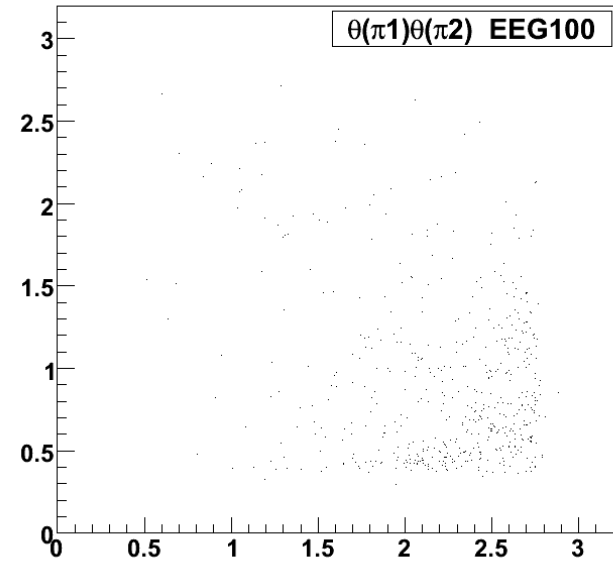


Quick look into $e^+ e^- \rightarrow e^+ e^- \gamma$ (MC “*eeg100*”)

Before the cut



After the cut

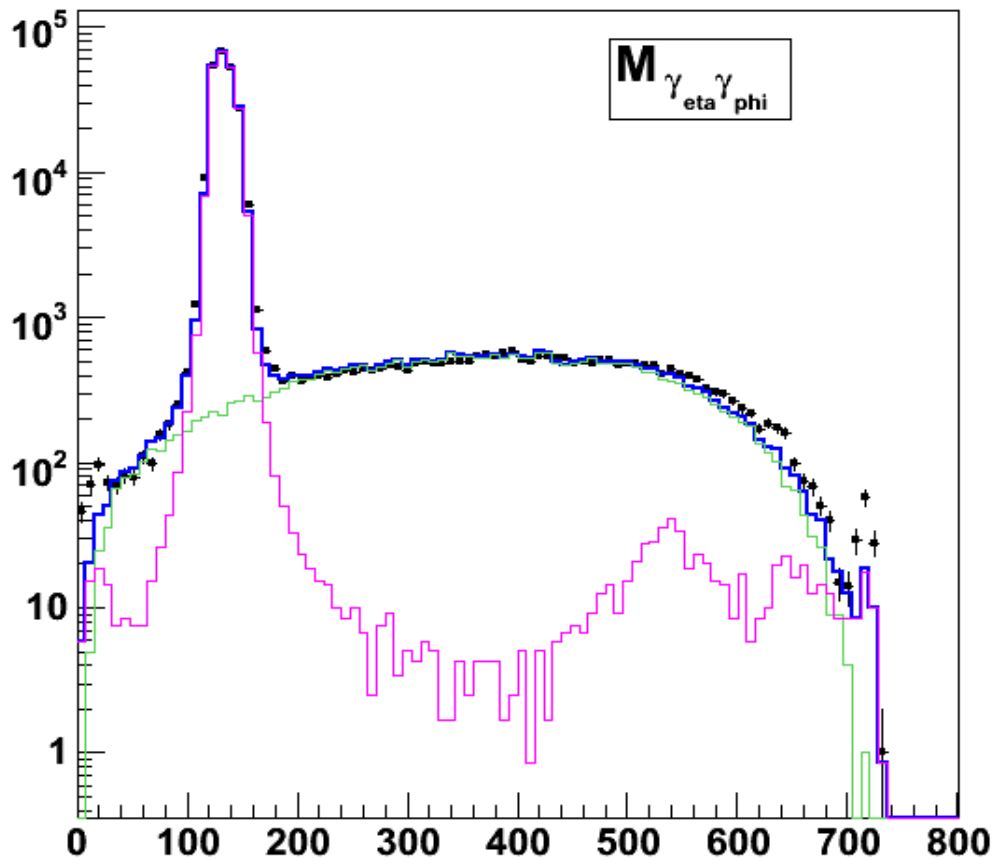


Contribution from

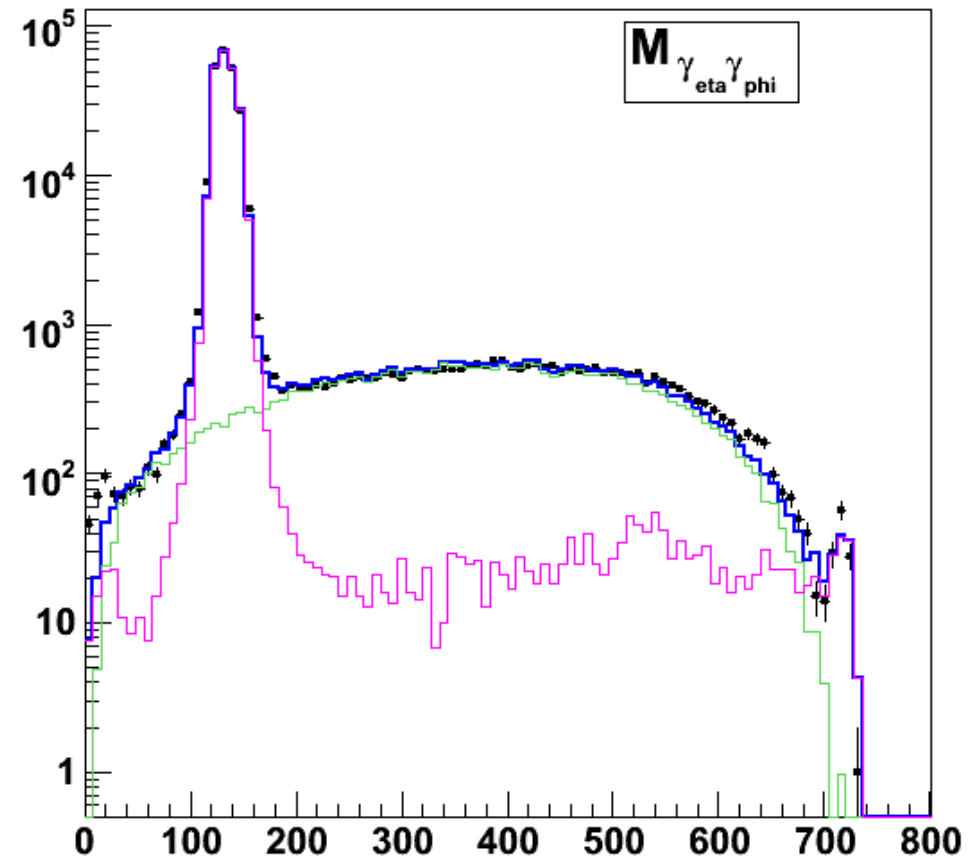
$$e^+ e^- \rightarrow e^+ e^- \gamma \quad (\text{MC "eeg100"})$$

5% contamination! (more studies needed)

only RAD+RPI



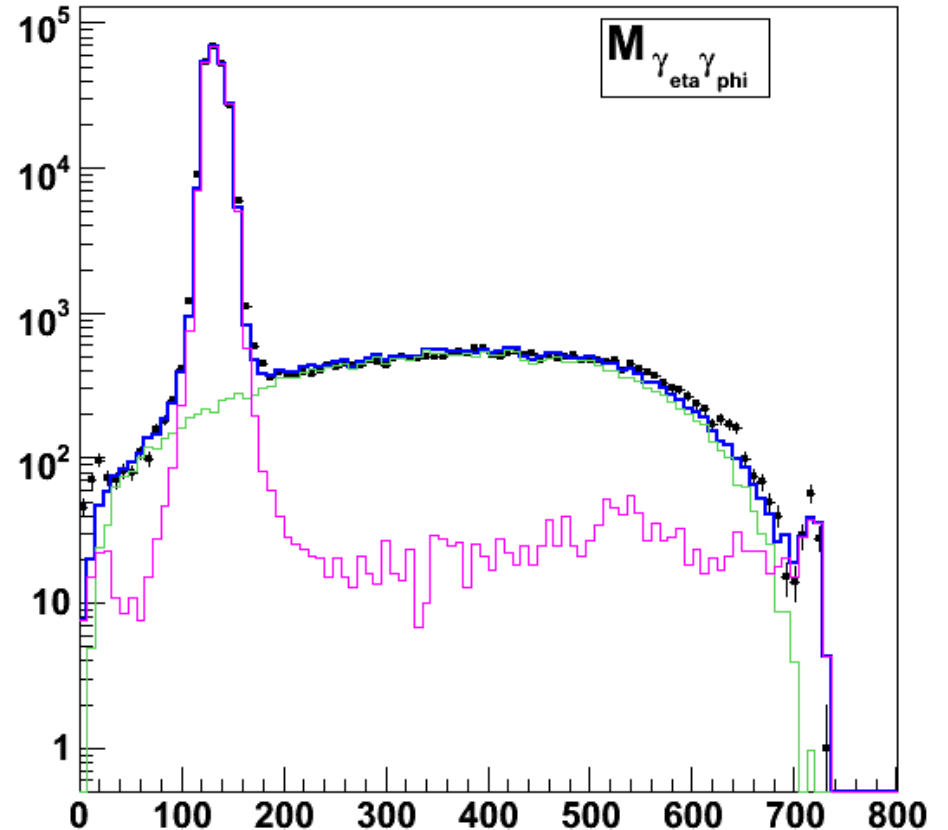
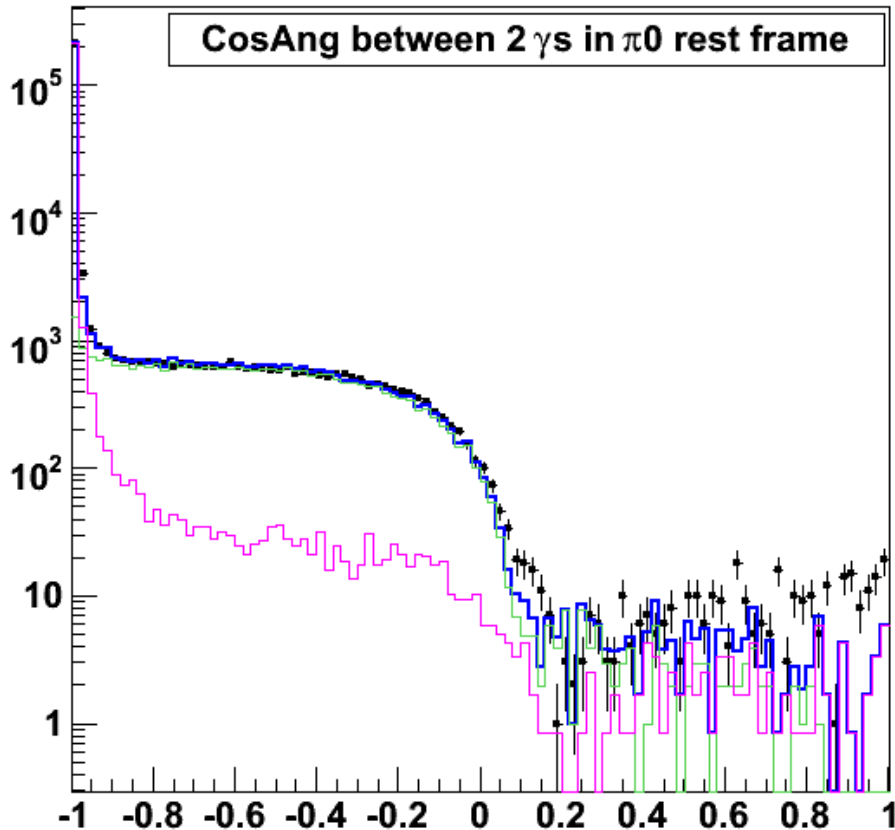
RAD+RPI+eeg100



Calculation of Branching ratio

Two separate fits to these 2 spectra
(MC included allphys + eeg100)

(only files analyzed in Exp/MC by all the streams were selected -
hopefully no miscounting/double counting)



Branching ratio

$$\text{BR} = \frac{N_{signal}^{fit}}{L * \sigma} \frac{1}{\epsilon}$$

$$L = 30927.6 \text{ nb}$$

$$\sigma = 41.7 \text{ nb}^{-1}$$

$$\epsilon = 0.444$$

$$N1 = 27253 \text{ (using fit to } \text{Cos}(\angle \gamma_{\text{eta}} \gamma_{\text{phi}}))$$

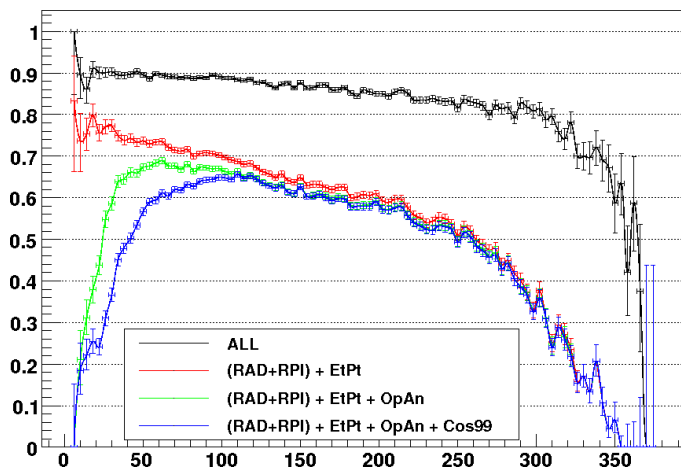
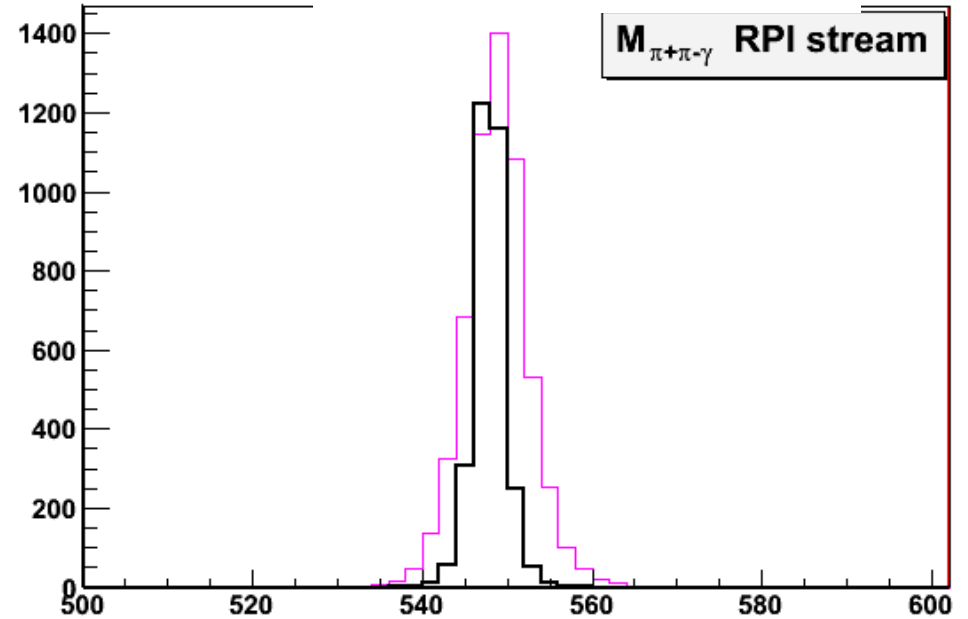
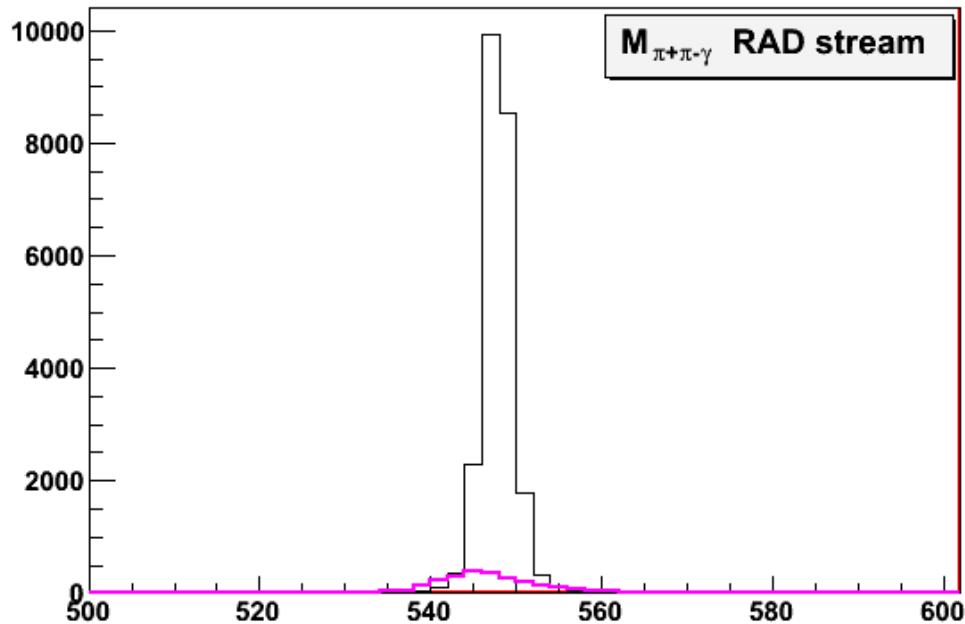
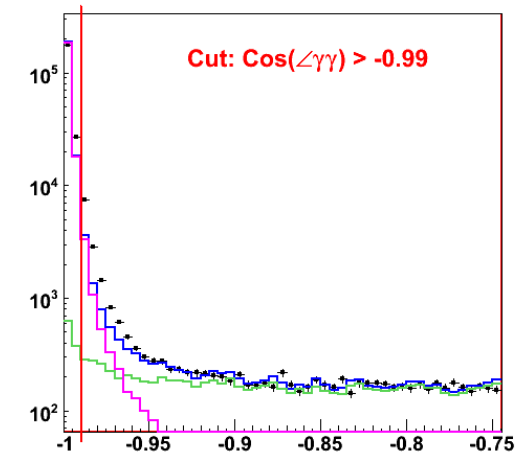
$$BR1 = 0.0476$$

$$N2 = 26490 \text{ (using fit to } M_{\gamma\gamma})$$

$$BR2 = 0.0463$$

$$\text{BR}^{\text{PDG}} = 0.0460 \pm 0.0016$$

Efficiency and background reduction after additional cut on $\text{Cos}(\angle\gamma\gamma) > -0.99$



- RAD efficiency 41.2% (S/B ~ 10:1)
- RPI efficiency 5.3% (S/B ~ 1:2)

Outlook

- The Branching Ratio $\frac{Br(\eta \rightarrow \pi^+ \pi^- \gamma)}{Br(\eta \rightarrow \pi^+ \pi^- \pi^0)}$
 - Aim: better than 1%
 - Full evaluation and systematics (cuts, pion and photon efficiencies)
- E_γ spectrum (also π^+/π^-)
 - Can we get efficiency curve from data?
 - Unfolding of the spectrum
 - Fitting models