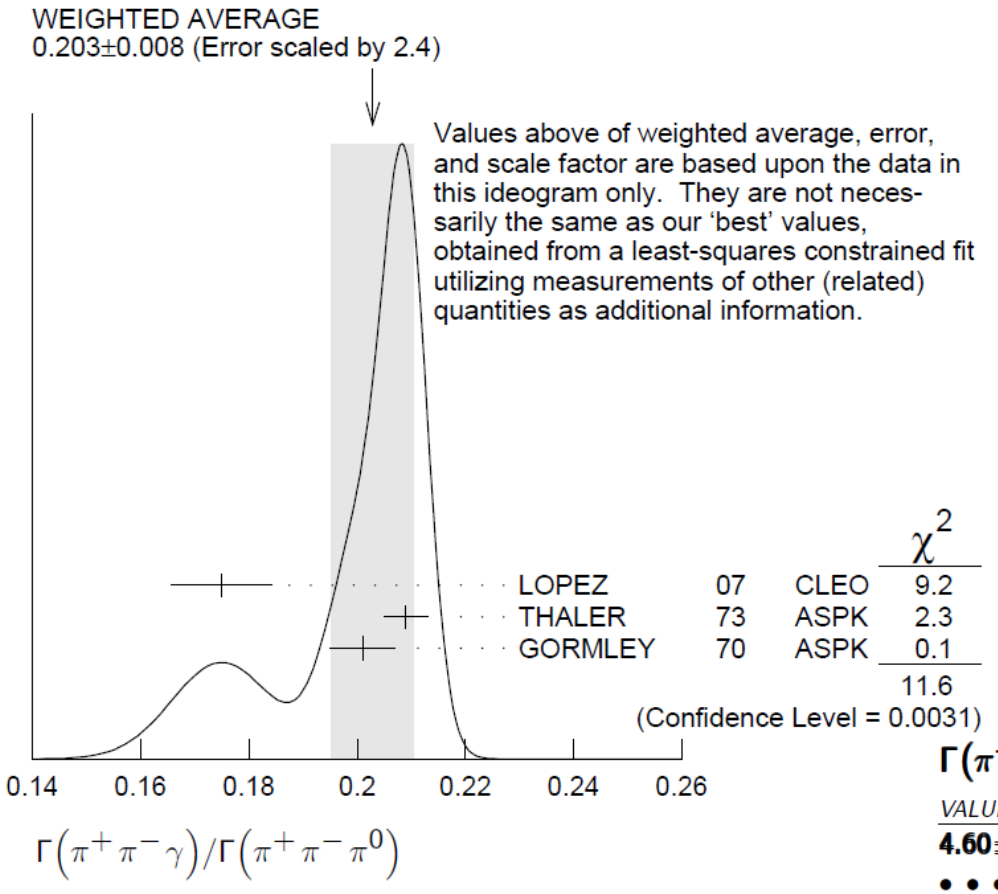
$\eta \to \pi^+\pi^-\gamma$ analysis
blessing for preliminary results
$\Gamma(\eta \to \pi^+\pi^-\gamma) / \Gamma(\eta \to \pi^+\pi^-\pi^0)$

Camilla Di Donato, Biagio Di Micco, Marek Jacewicz

Signal / background situation

reaction	X-section σ [μb]	Eta BR
$\phi \to \eta\gamma,\ \eta \to \pi^+\pi^-\pi^0$	9.94×10^{-3}	$(22.73 \pm 0.28) \times 10^{-2}$
$\phi \to \eta\gamma,\ \eta \to \pi^+\pi^-\gamma$	2.01×10^{-3}	$(4.60 \pm 0.16) \times 10^{-2}$
$\phi \to \eta\gamma,\ \eta \to e^+e^-\gamma$	0.30×10^{-3}	$(6.8 \pm 0.8) \times 10^{-3}$
$\phi \to \pi^+\pi^-\pi^0$	0. 46	



$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.60±0.16 OUR FIT Error includes scale factor of 2.1.					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.96±0.14±0.14	859	[18] LOPEZ	07	CLEO	$\psi(2S) \rightarrow J/\psi\eta$

[18] Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error.

$\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_{10}/Γ_9

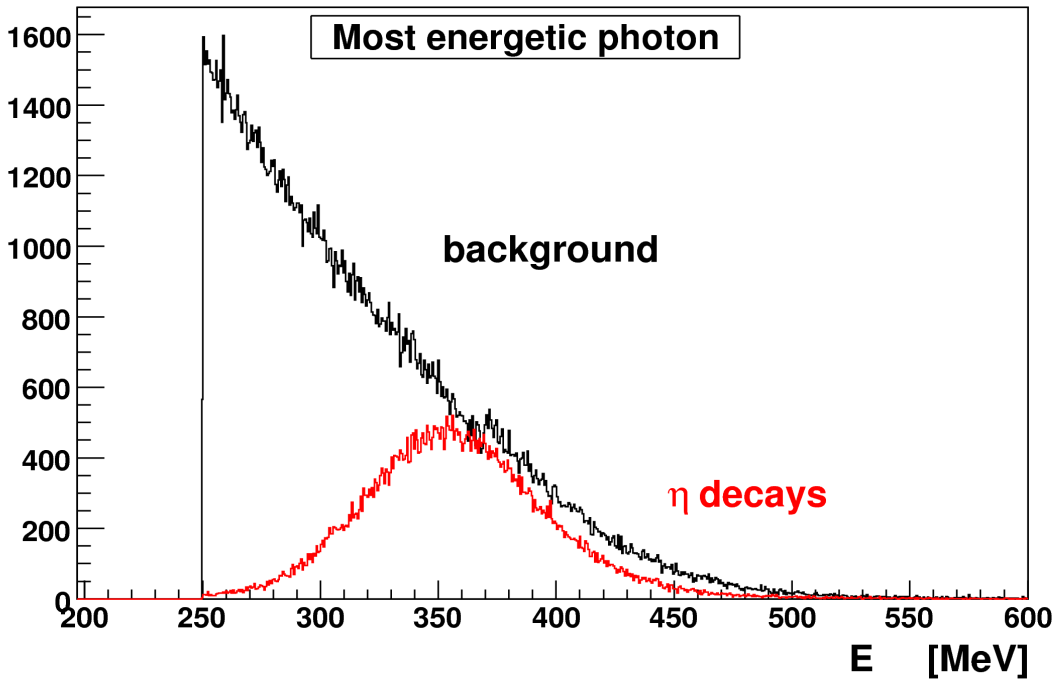
VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.202±0.007 OUR FIT Error includes scale factor of 2.4.					
0.203±0.008 OUR AVERAGE Error includes scale factor of 2.4. See the ideogram below.					
0.175±0.007±0.006	859	LOPEZ	07	CLEO	$\psi(2S) \rightarrow J/\psi\eta$
0.209±0.004	18k	THALER	73	ASPK	
0.201±0.006	7250	GORMLEY	70	ASPK	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.28 ±0.04		BALTAY	67B	DBC	
0.25 ±0.035		LITCHFIELD	67	DBC	
0.30 ±0.06		CRAWFORD	66	HBC	
0.196±0.041		FOSTER	65C	HBC	

selection 1

- Selecting streams: RAD and RPI
- ≥2 prompt photons $|t_{cl} - r_{cl}/c| < 5\sigma_t$, $\theta_{min} > 23^o$, $E_{min} = 3$ MeV
- most energetic photon with $E_\gamma \geq 250$ MeV assumed "radiative" (γ_ϕ)

  (95% correct assumption, this number increase with additional constraints)
- tracks (+/-) selected from track-bank based on PCA (no cut on total number of tracks)

	After selection cuts VERTEX	After selection cuts PCA
ALL	9629 (43%)	11550 (52%)
RAD	7877 (36%)	9271 (42%)
KPM	186 (0.8%)	359 (1.6%)
RPI	1336 (6.0%)	1493 (6.7%)



selection 2

- Kinematical constraints
  - Calculate E_{γ}^{recoil} from 2 body ϕ decay kinematics
  - Calculate γ_{eta} from η decay kinematics
  - γ_{eta} : $|E_t - P_t| < 10$ MeV
  - We should find cluster with OpAn < 0.2 rad to the calculated γ_{eta}

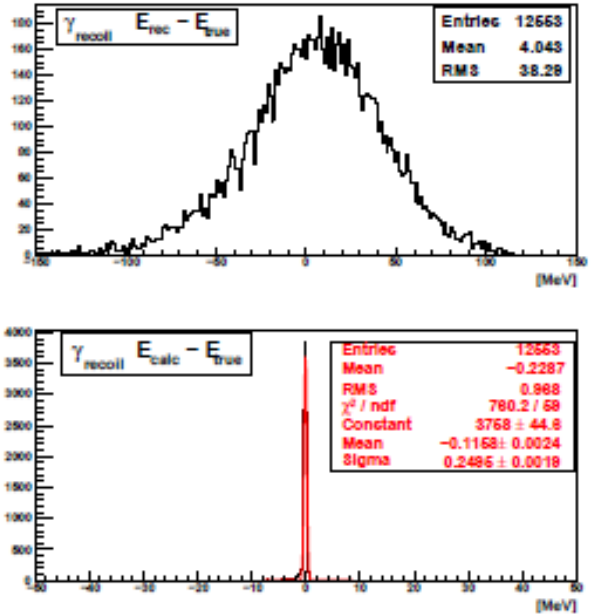
selection 3

- Good angular but bad energy resolution for photons
- Help with 2-body kinematics of $\phi \rightarrow \eta\gamma$

$$\vec{p}_\eta = \vec{p}_\Phi - \vec{p}_\gamma$$

$$E_\gamma = \frac{m_\Phi^2 - m_\eta^2}{2 \cdot (E_\Phi - \mid \vec{p}_\Phi \mid \cdot \cos\theta)}$$

where $\cos\theta$ is an angle between Φ and γ^{recoil}



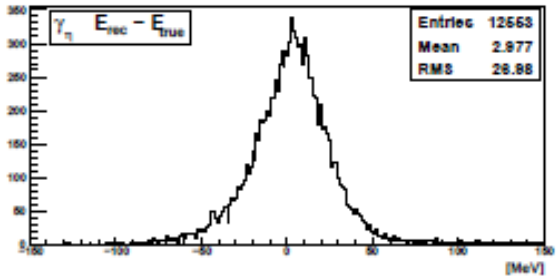
selection 4

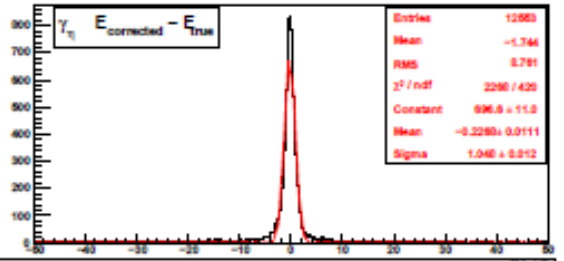
Having corrected the energy of the recoil photon we can calculate

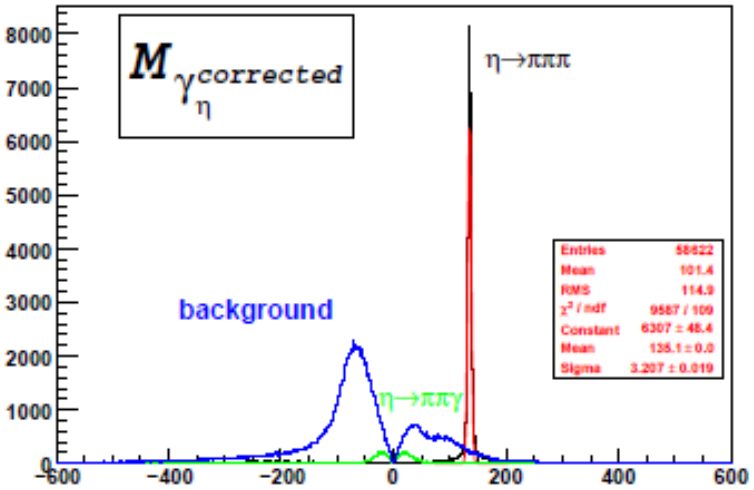
$$\mathbb{P}^{calc}_{\gamma_\eta} = \mathbb{P}_{\Phi} - \mathbb{P}_{\pi+} - \mathbb{P}_{\pi-} - \mathbb{P}^{recoil}_{\gamma}$$

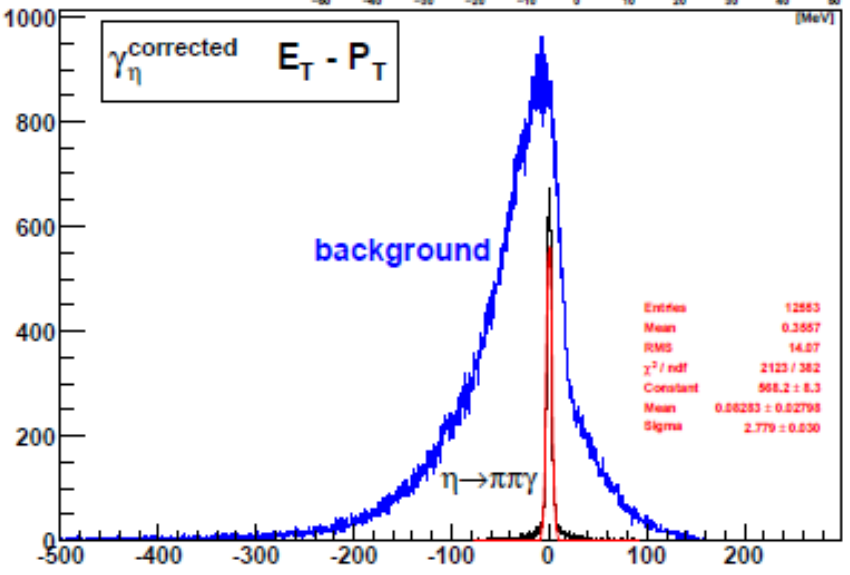
and look at the energy $E^{calc}_{\gamma_\eta}$:

Possible constraints:





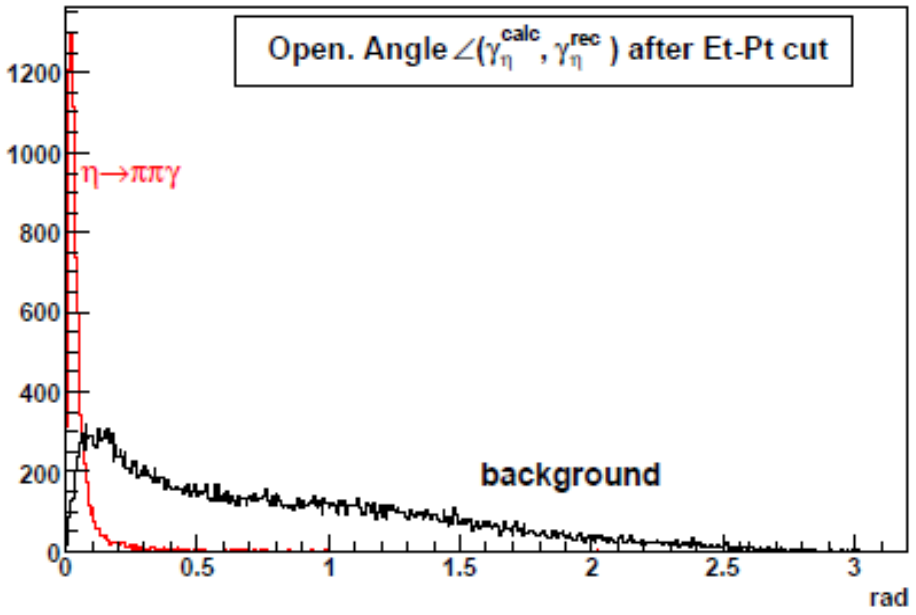




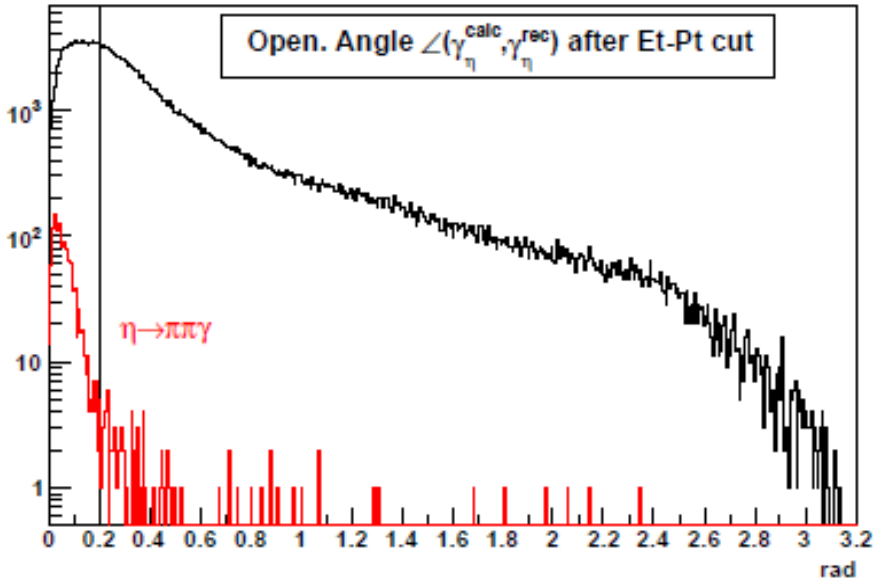
selection 5

- From candidates - neutral clusters, we select the closest to $\mathbb{P}^{calc}_{\gamma_\eta}$
- Opening angle to the calculated γ_η effectively rejects background

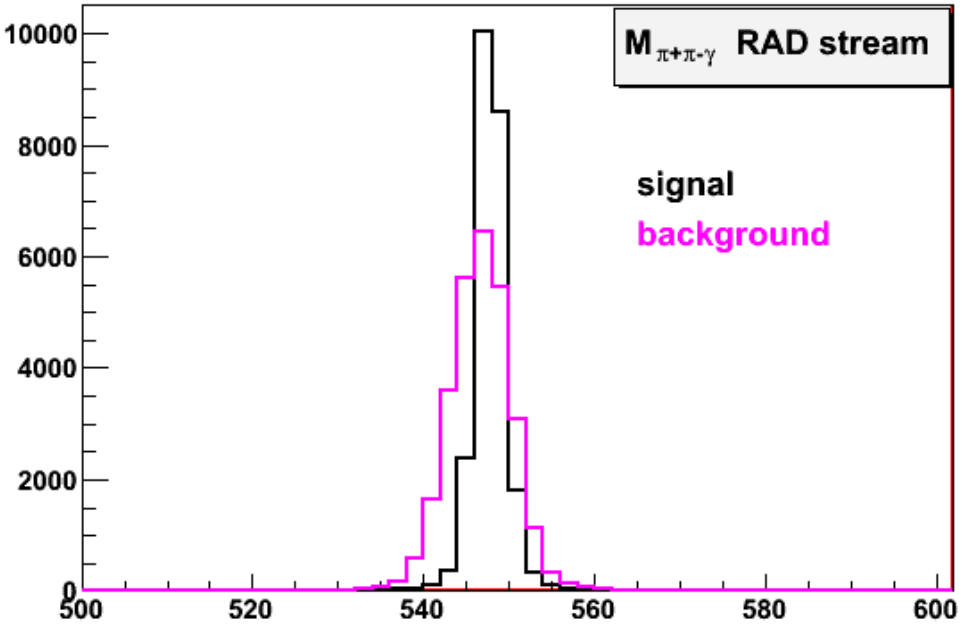
RAD STREAM

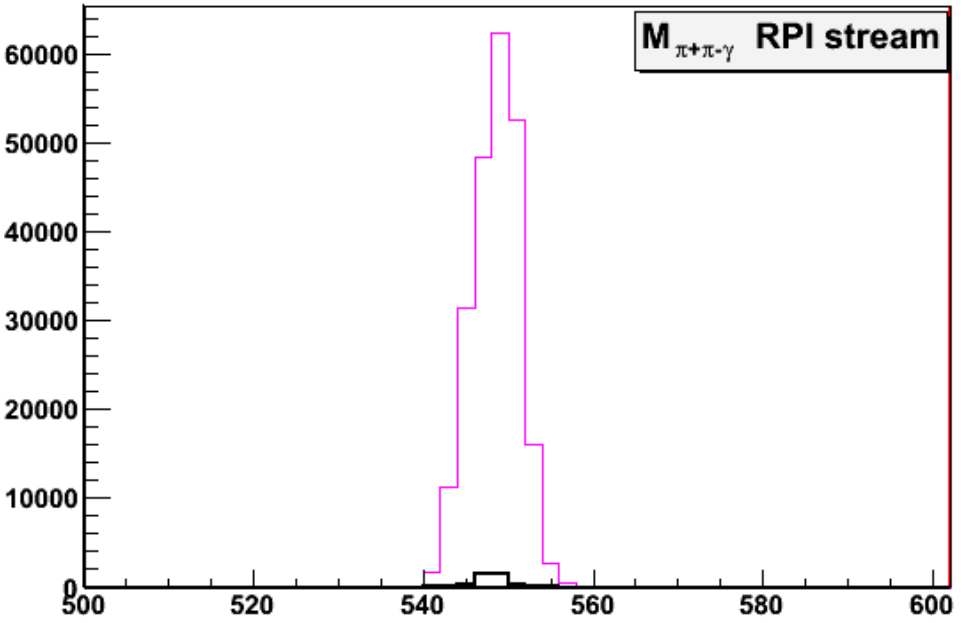


RPI STREAM



Efficiency and background reduction





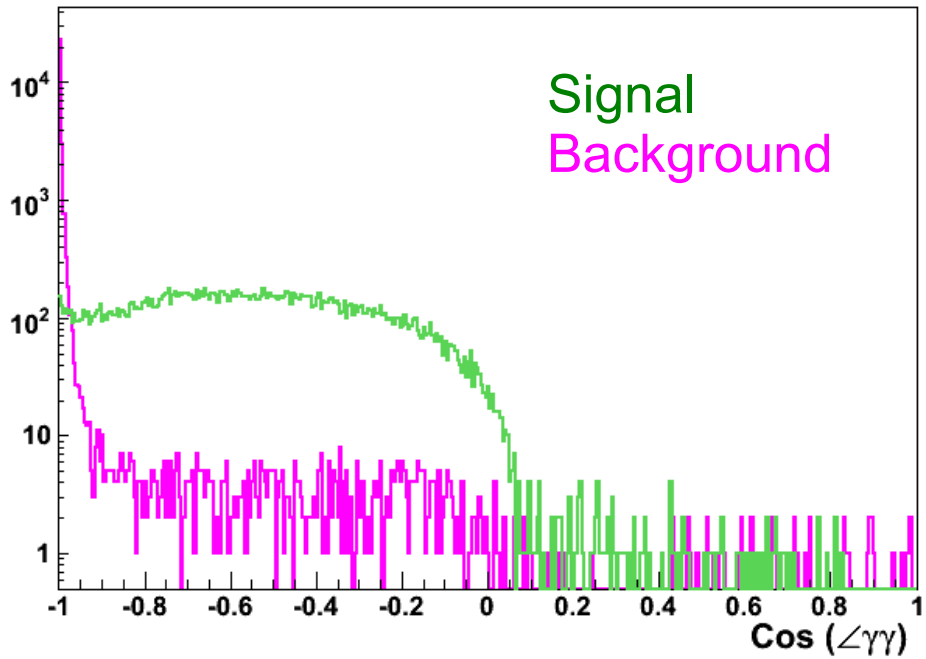
- RAD efficiency 41.7% (S/B ~ 1:1)
- RPI efficiency 6.6% (S/B ~1:60)

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

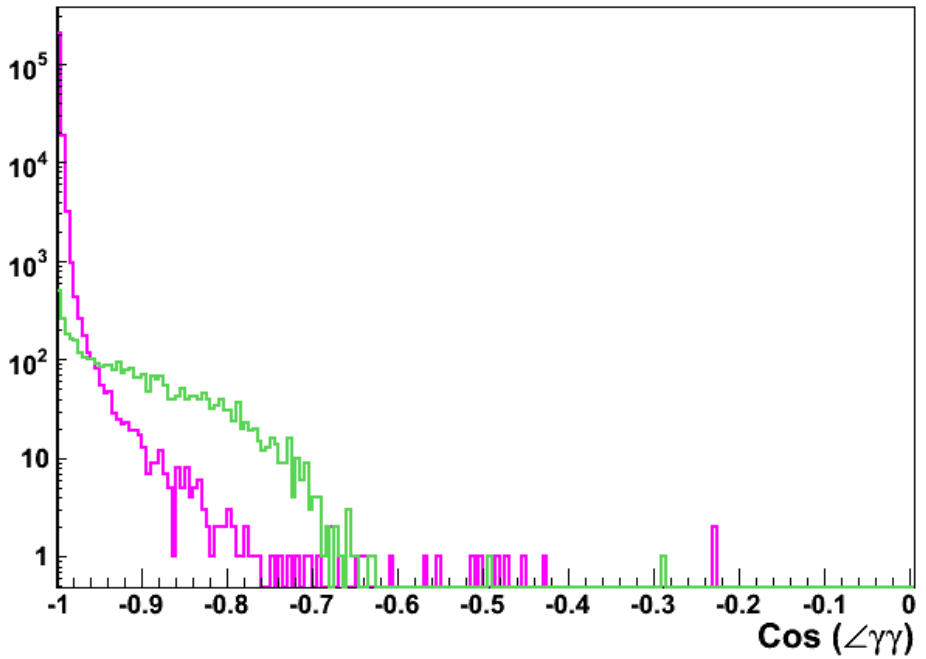
Calculate opening angle between γ_{eta} and γ_{phi} in π^0 rest frame

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

RAD stream

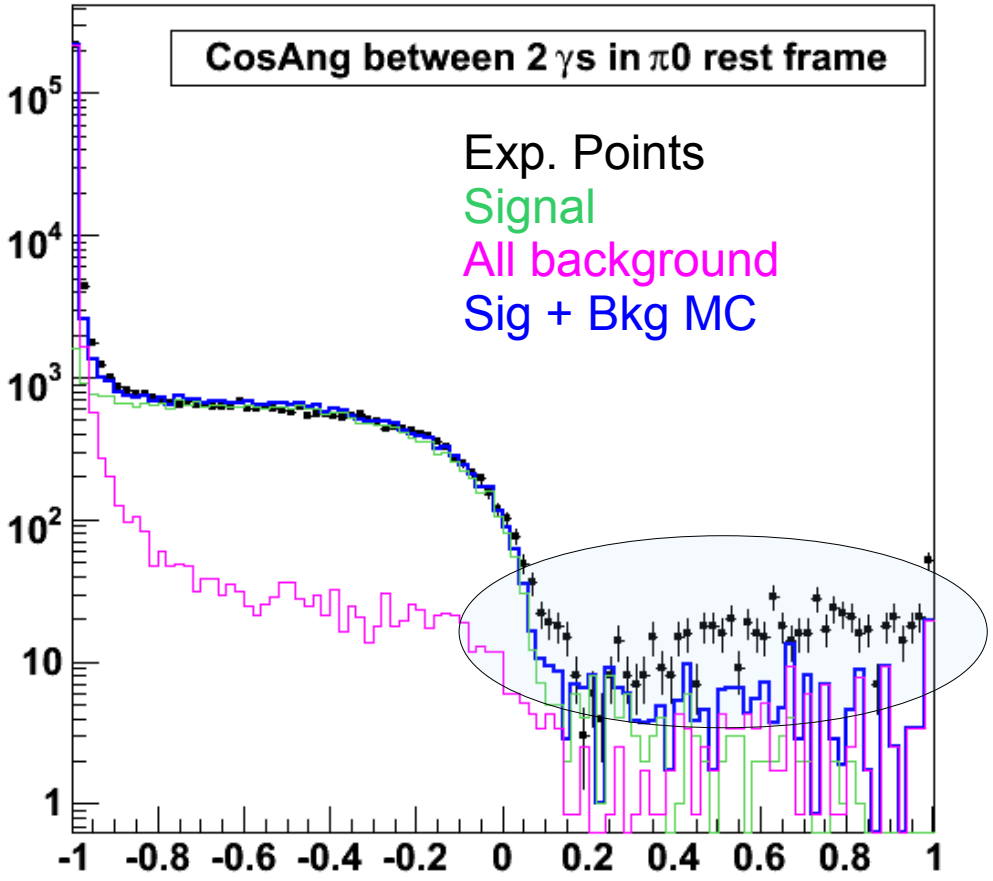


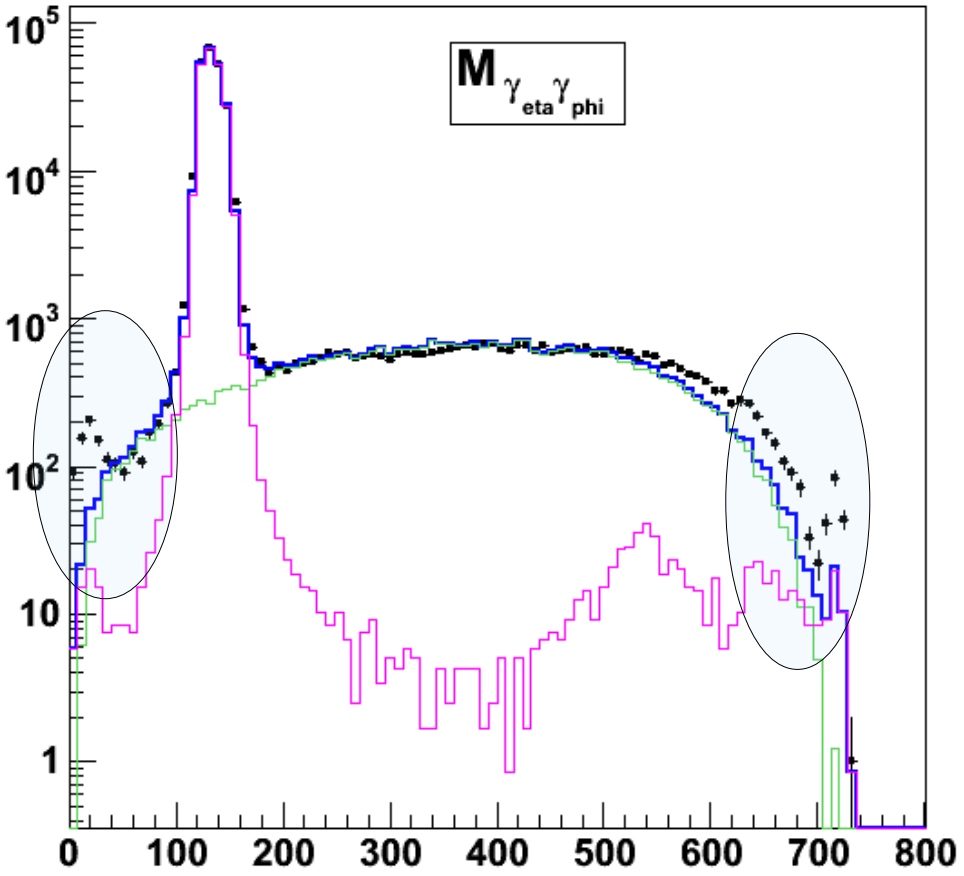
RPI stream



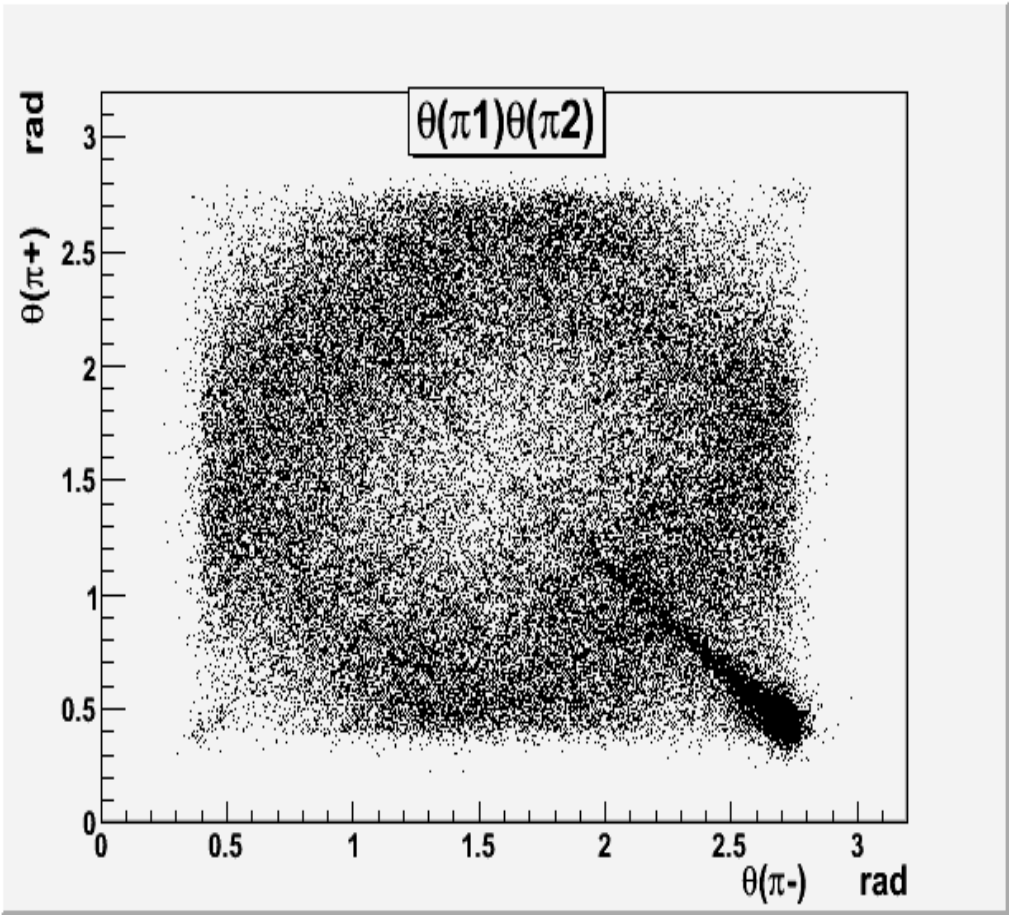
First try to describe the experimental data with Monte Carlo

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

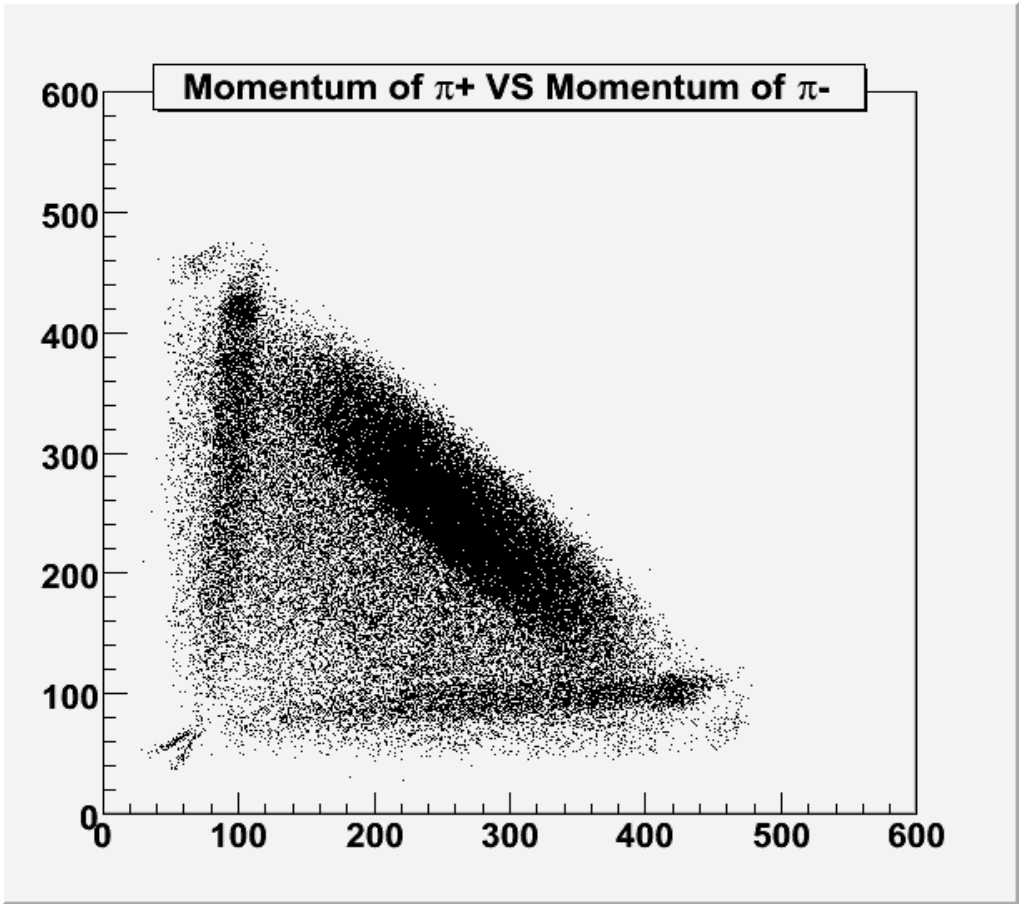


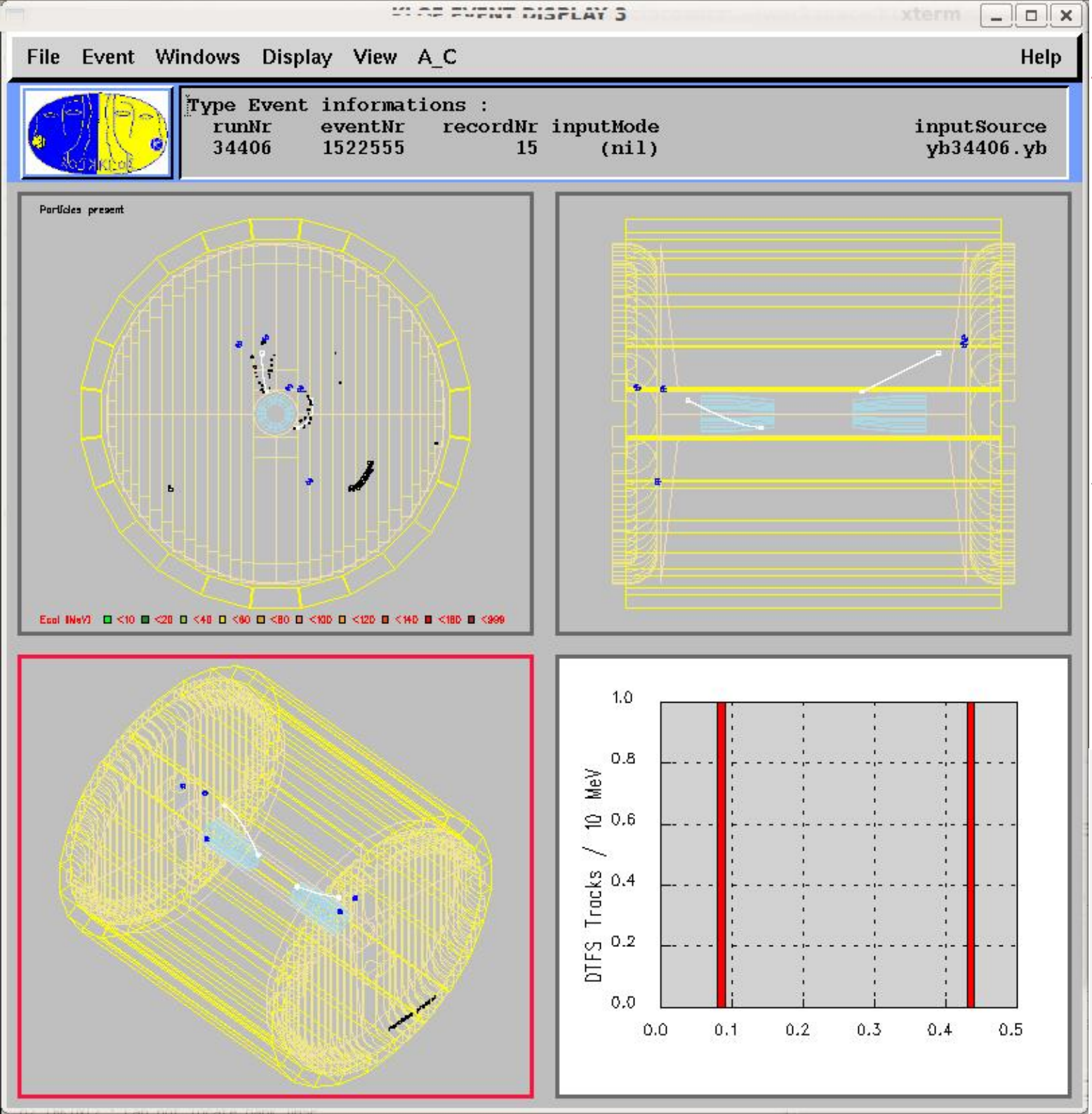


Unaccounted background



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





CHARACTERISTICS:

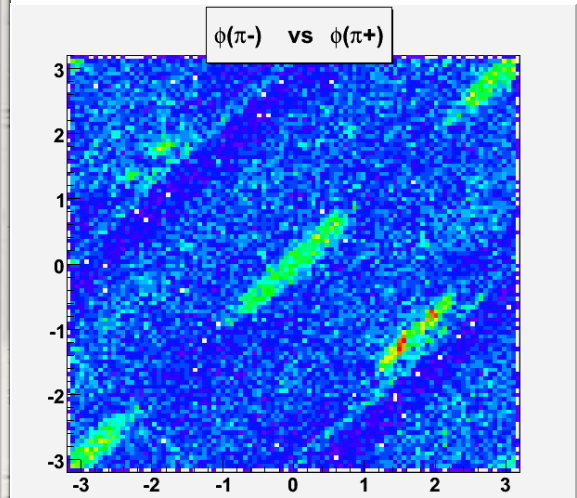
"π–" always back
"π+" always front

Cluster split in both directions

Momentum ≈ $E_{cluster}$

Asymmetry in ϕ
Effect only close to 90°

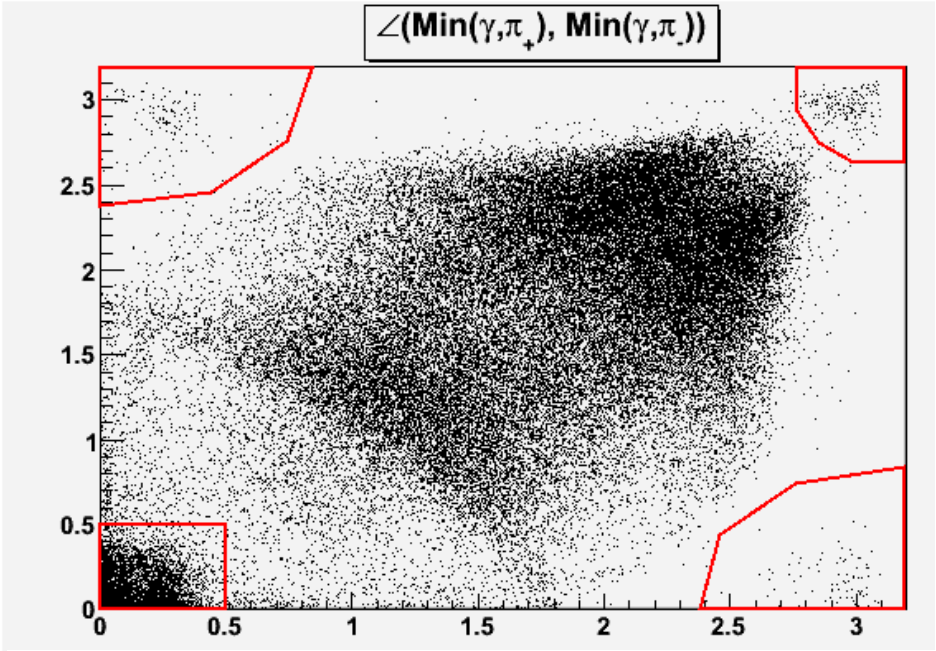
$e^+e^- \rightarrow e^+e^- (\gamma)$ conversion on inactive material unaccounted for in simulation

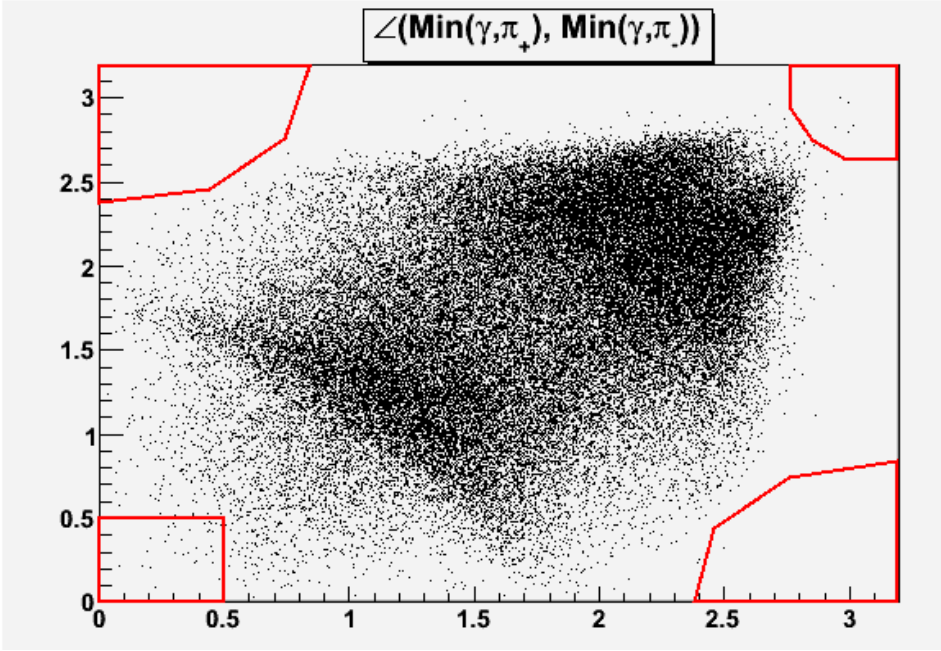


Experiment

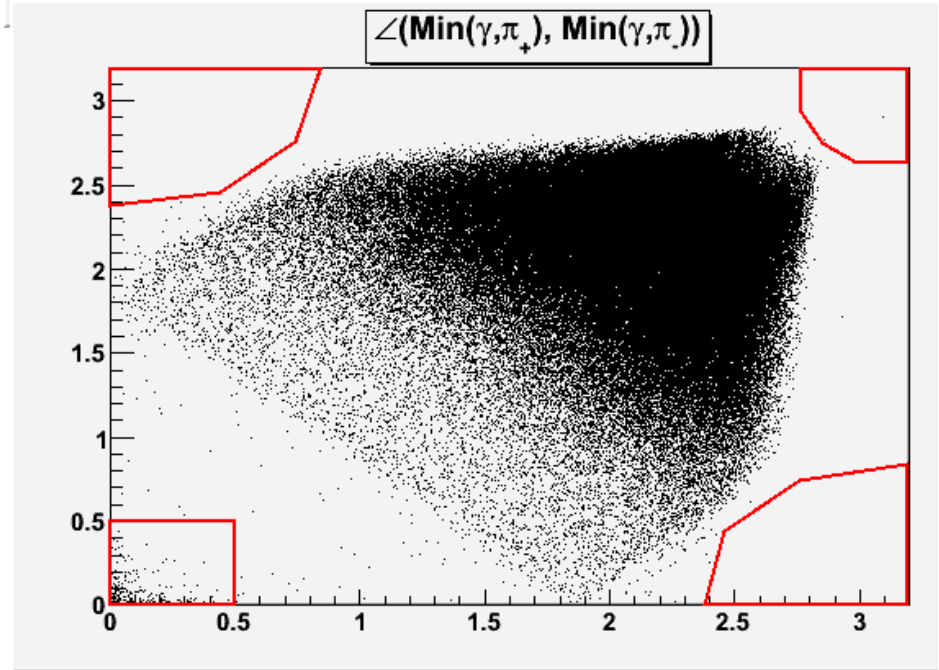
Monte Carlo allphys

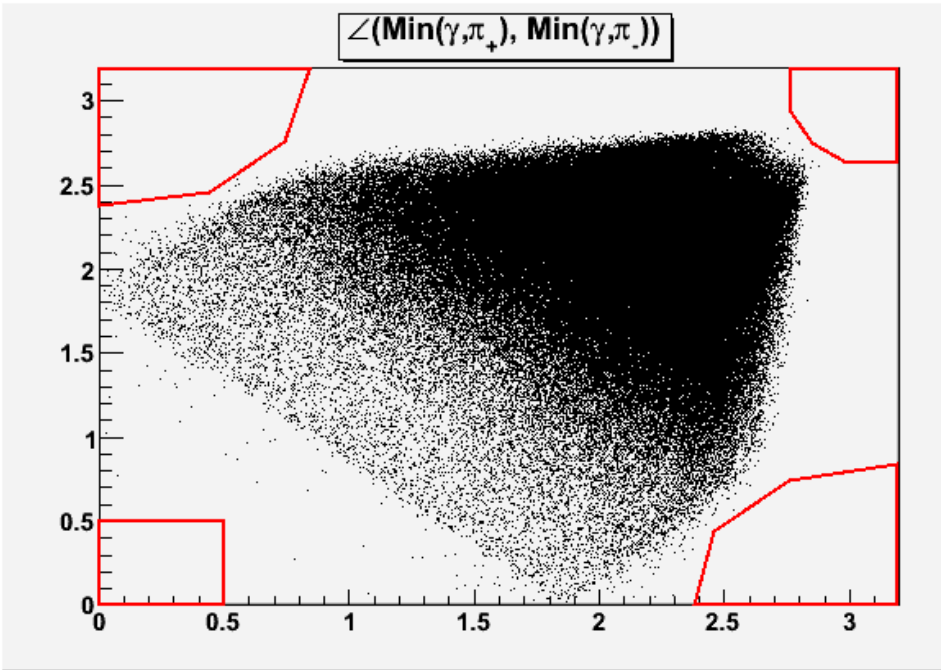
RAD



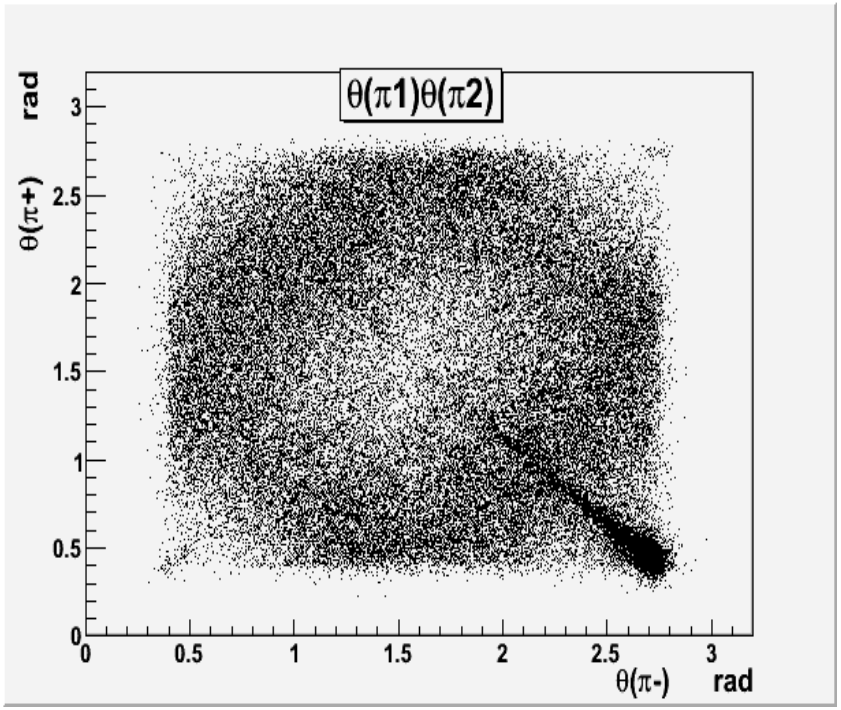


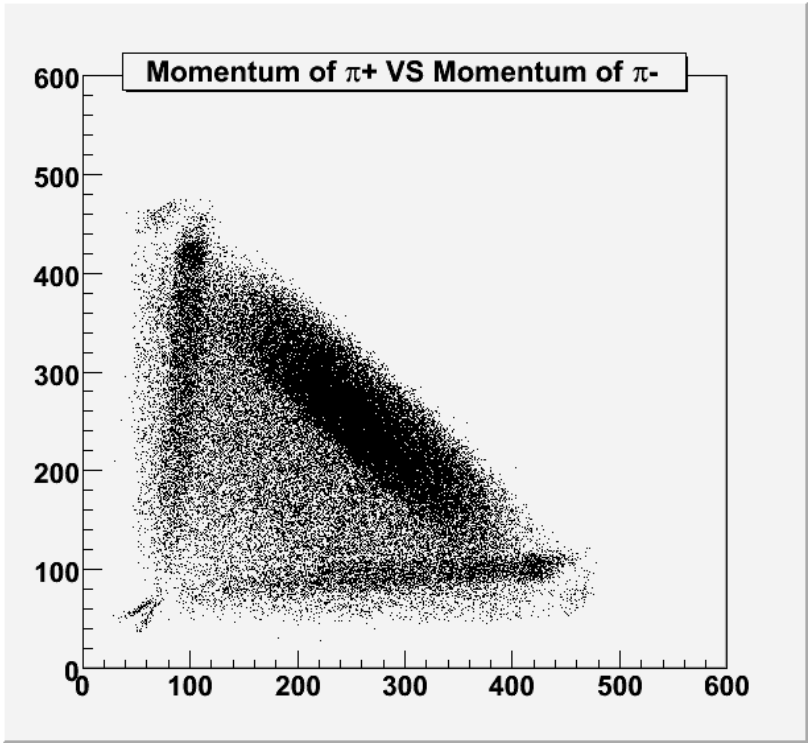
RPI



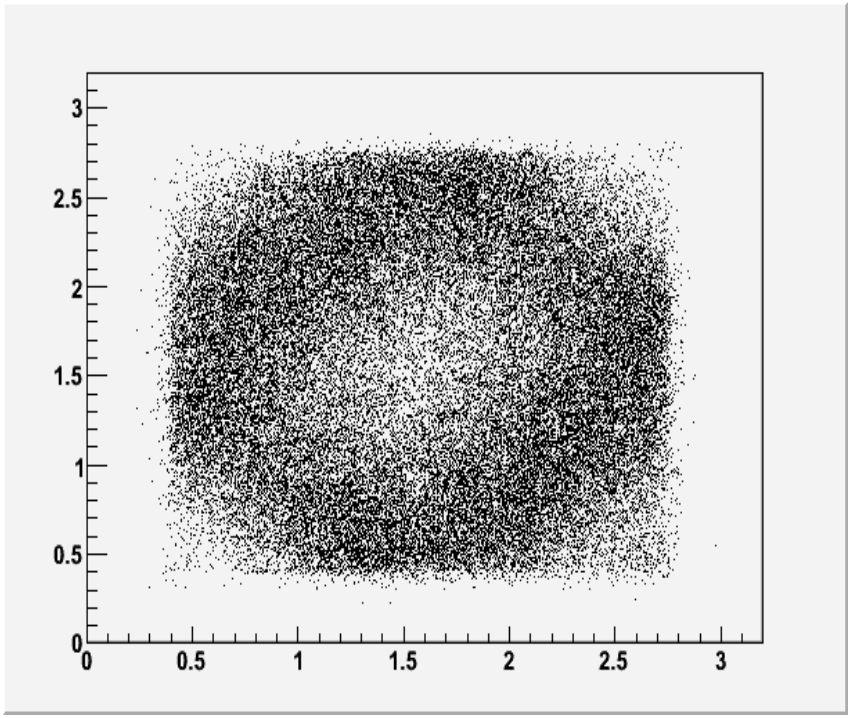


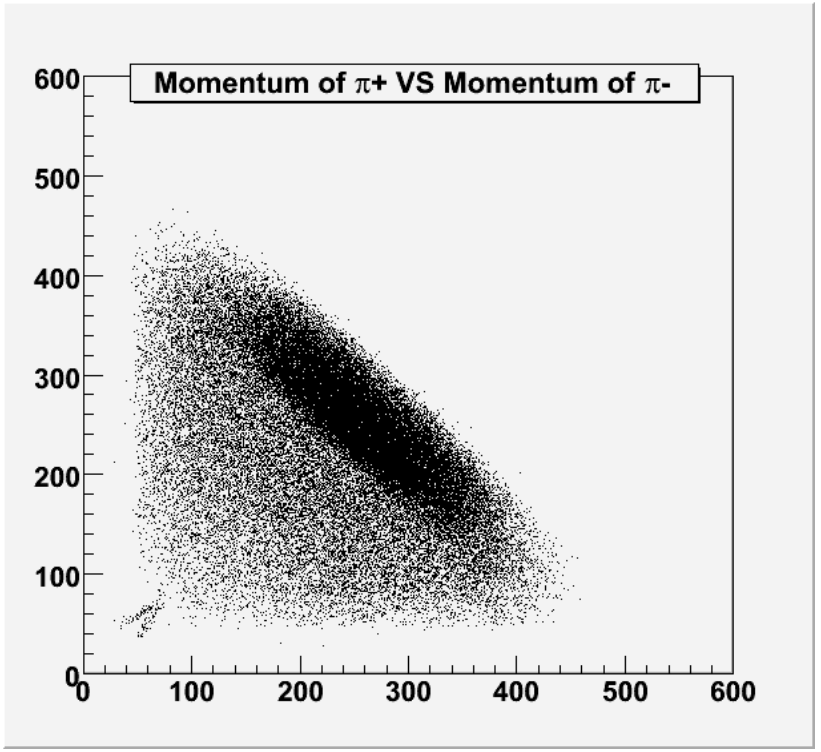
BEFORE THE CUTS





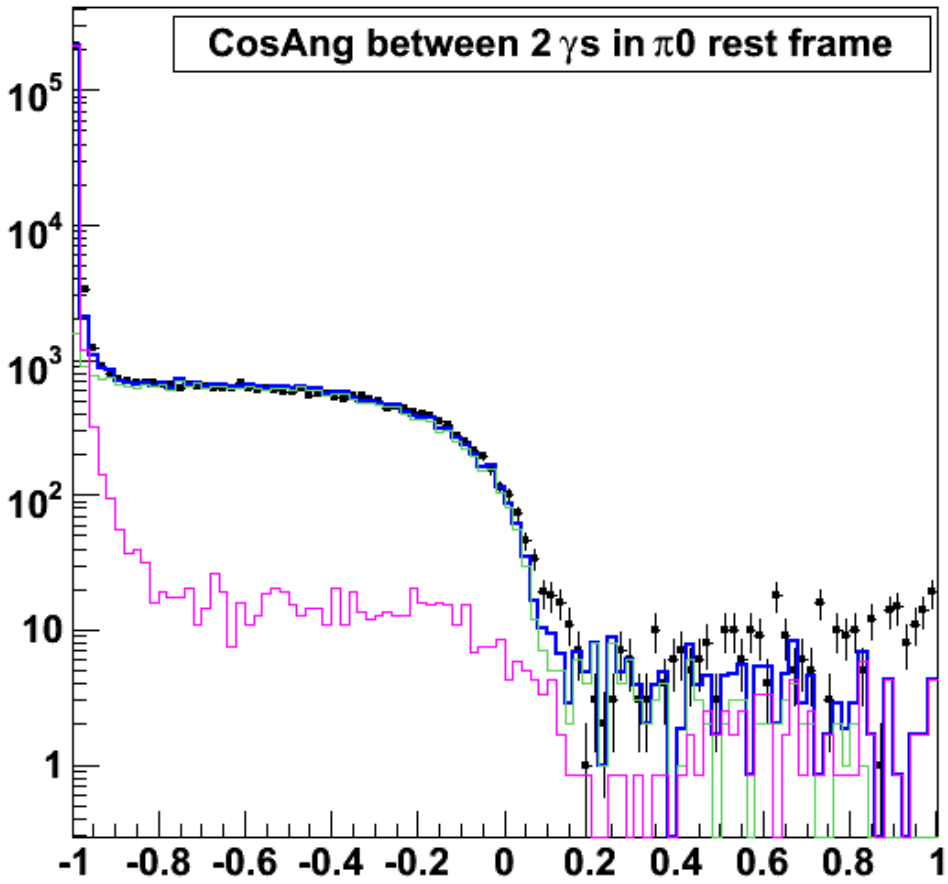
AFTER THE CUTS

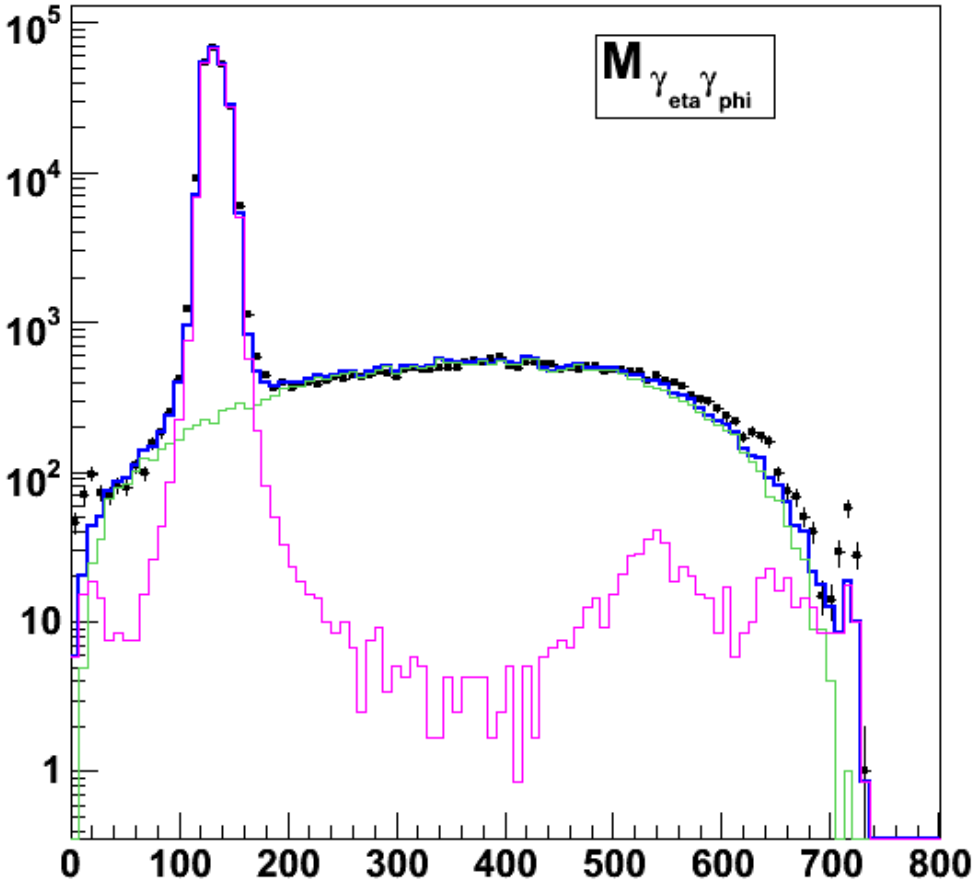




After removing the strange background

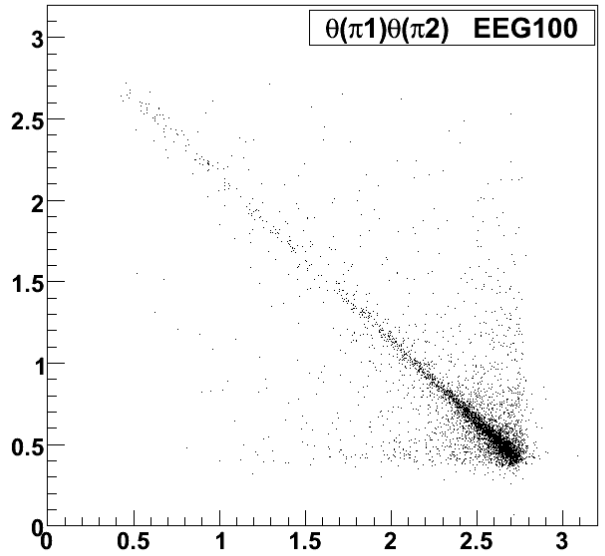
(signal rejection <0.5 ‰)

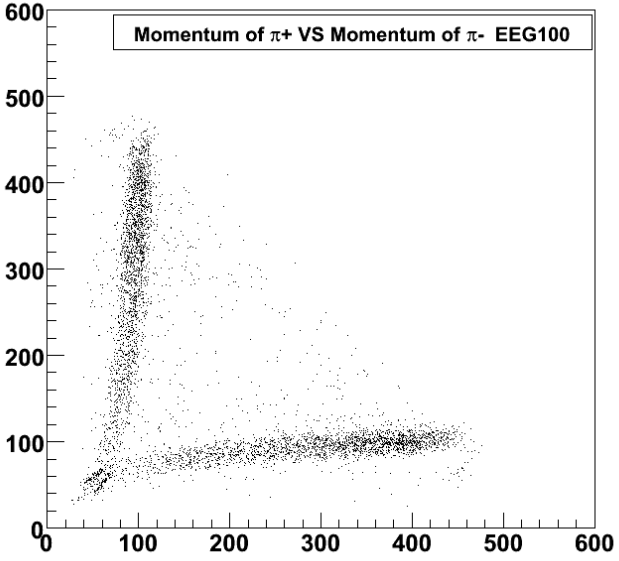




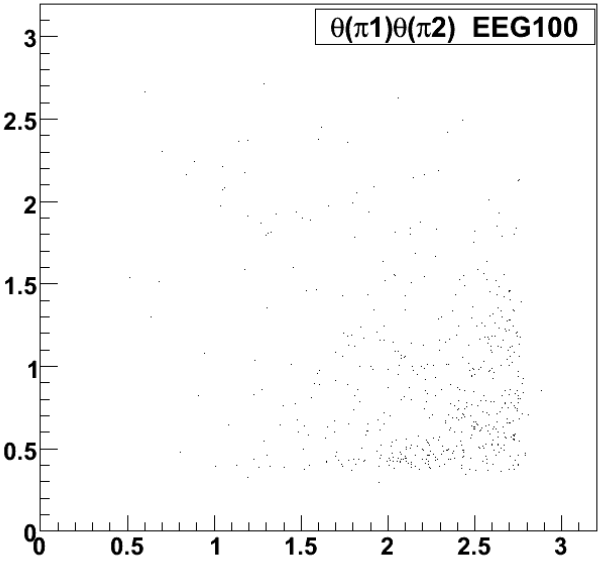
Quick look into $e^+ e^- \rightarrow e^+ e^- \gamma$ (MC "*eeg100*")

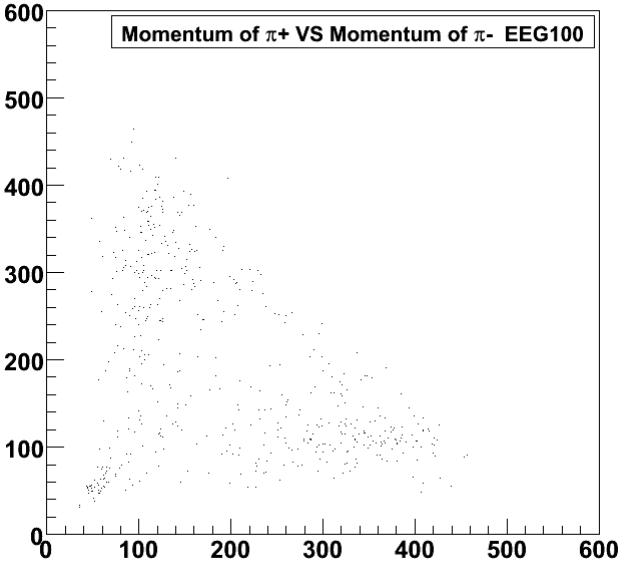
Before the cut





After the cut



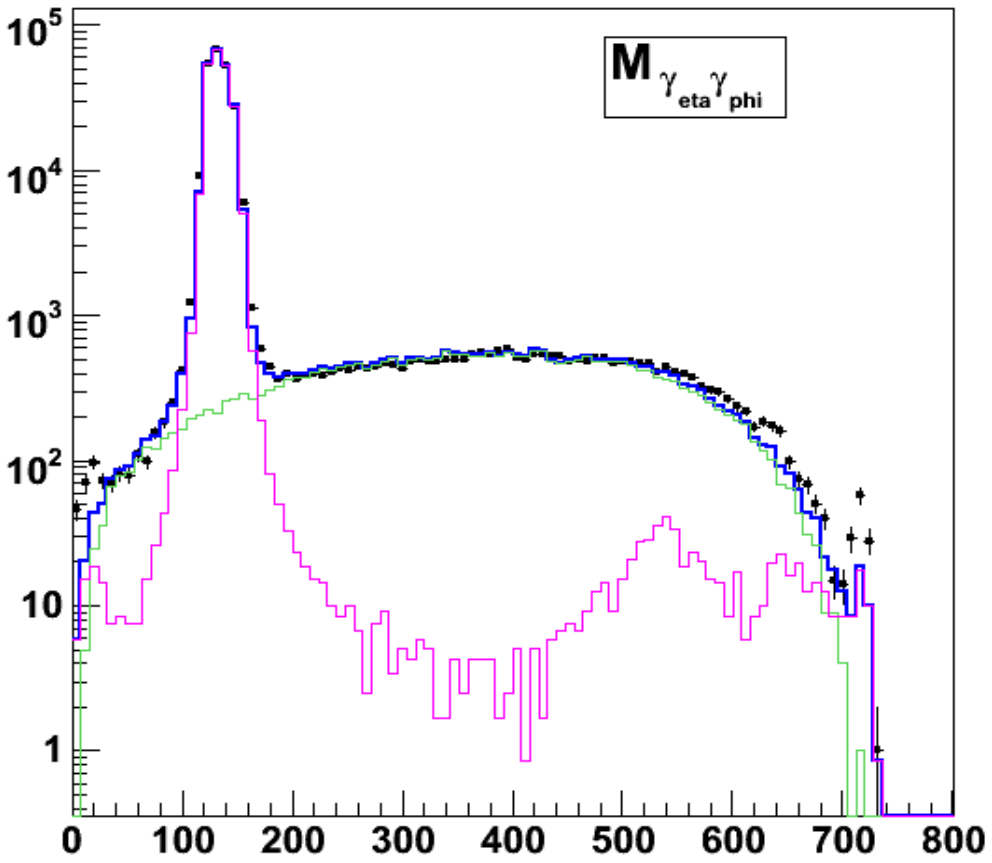


Contribution from

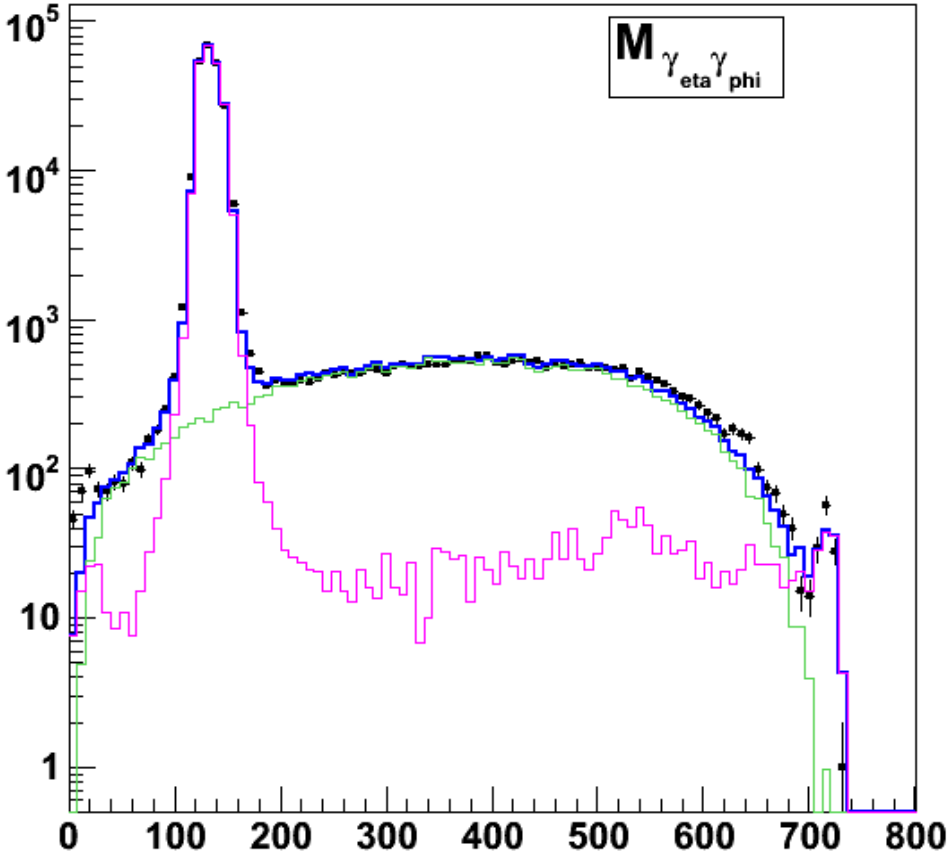
$e^+ e^- \rightarrow e^+ e^- \gamma$ (MC "*eeg100*")

5% contamination!

only RAD+RPI



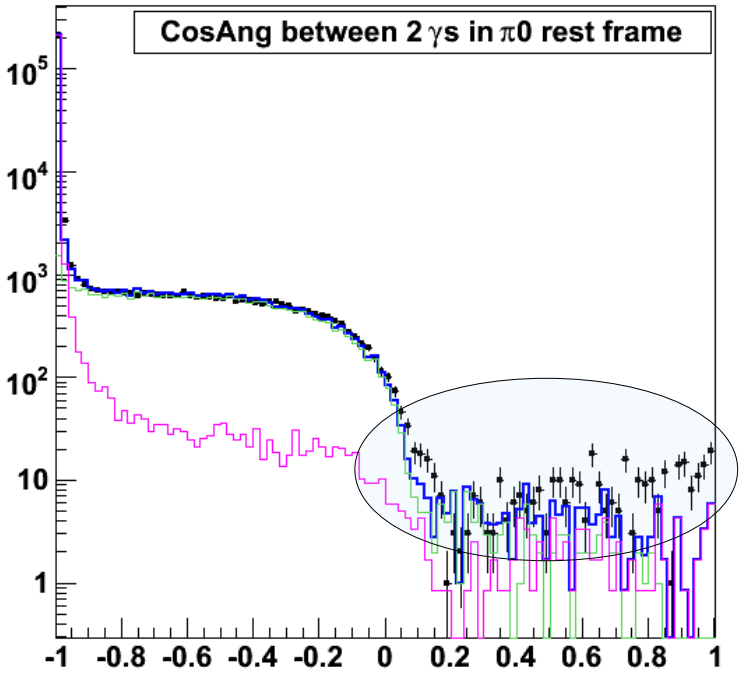
RAD+RPI+eeg100

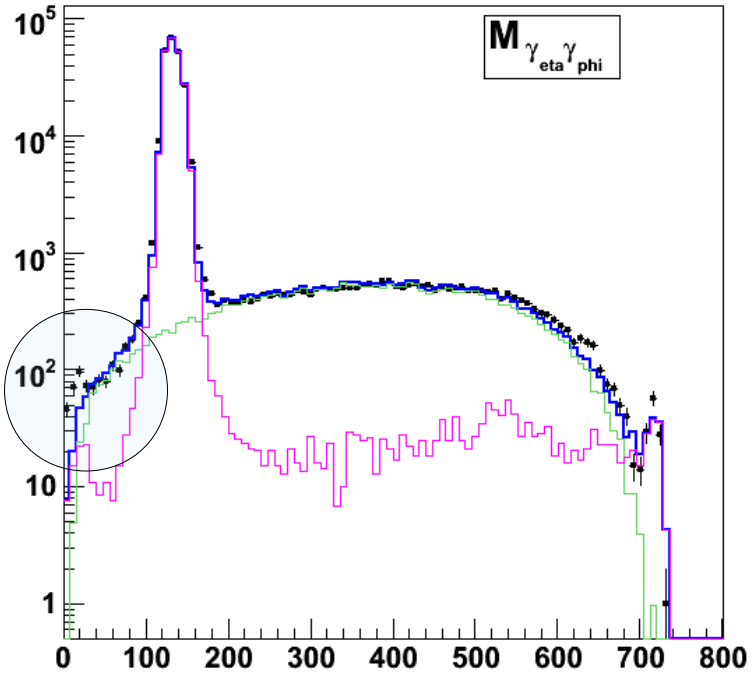


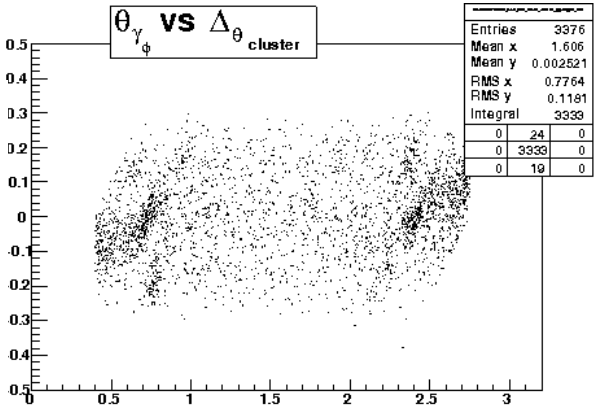
Barrel cut

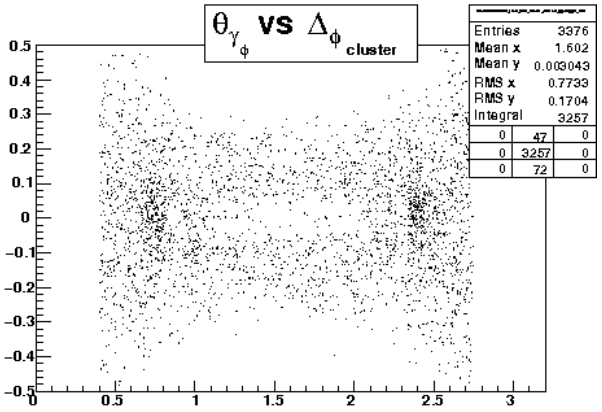
still small differences between MC and EXP

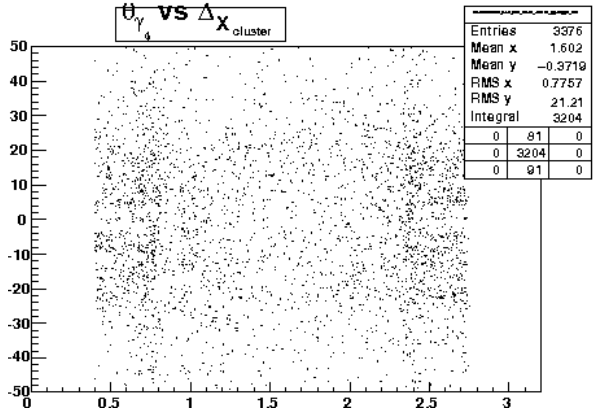
Effect visible in overlapping regions between barrel and endcaps

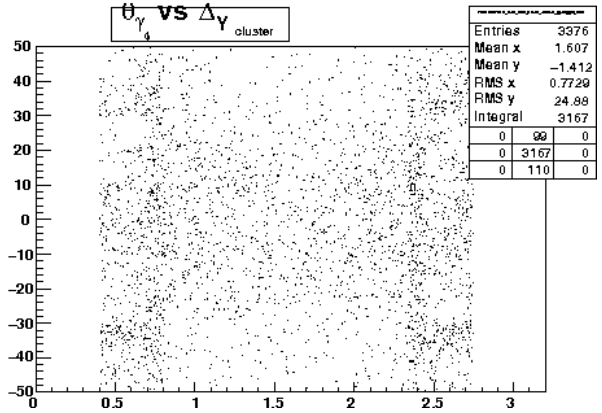




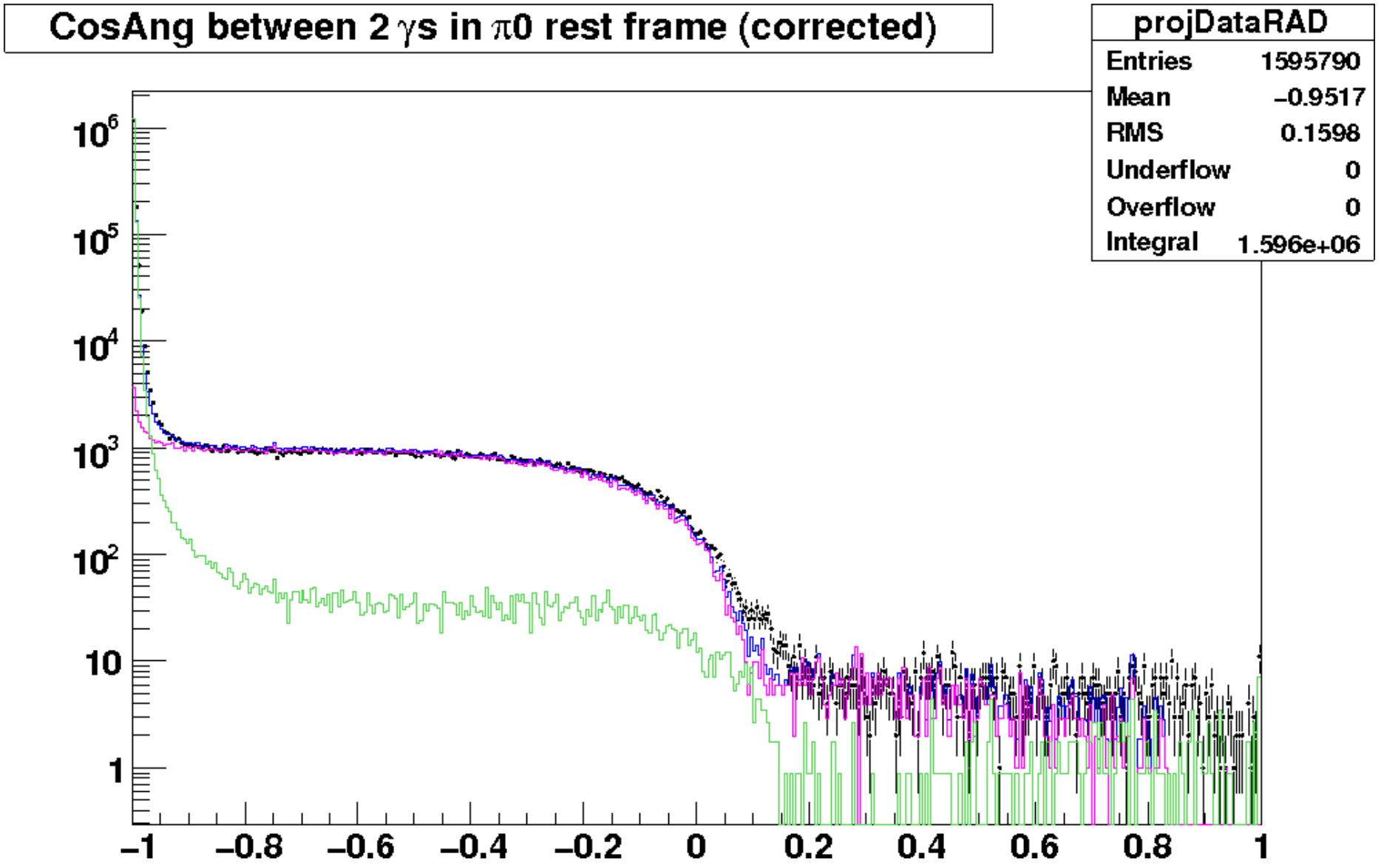




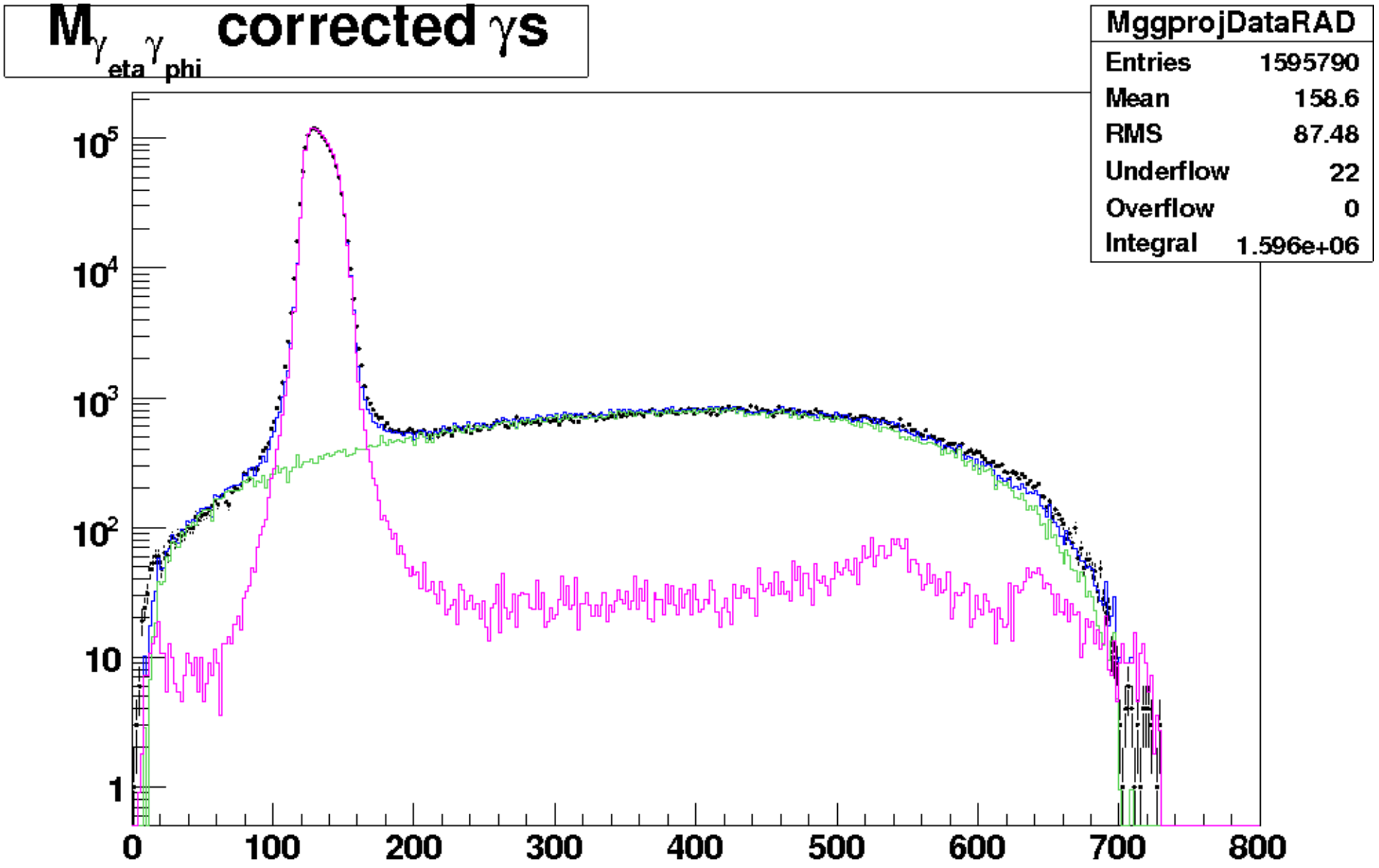




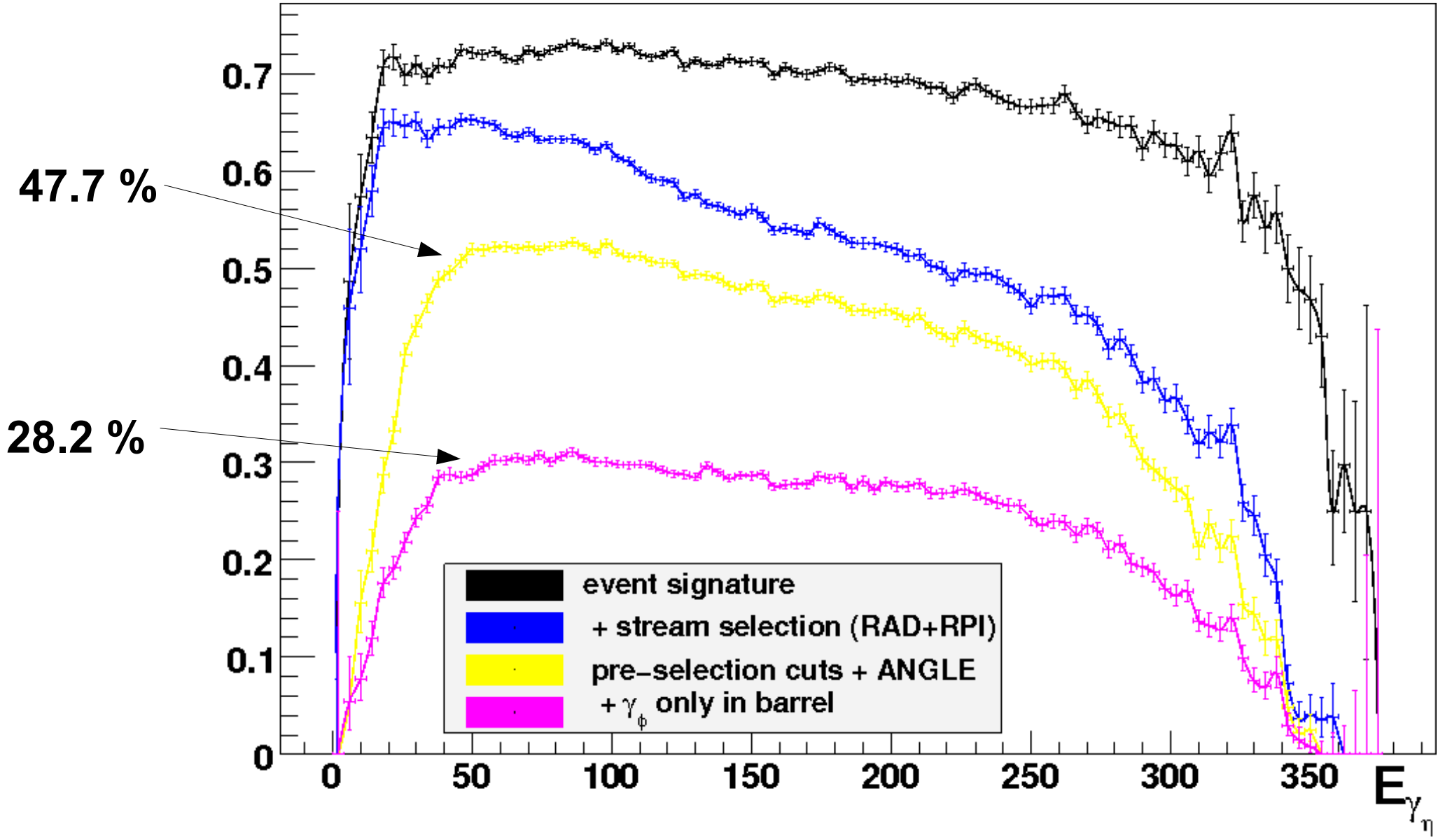
Barrel Cut – γ_{ϕ} is taken only from barrel, γ_{η} is taken from whole range



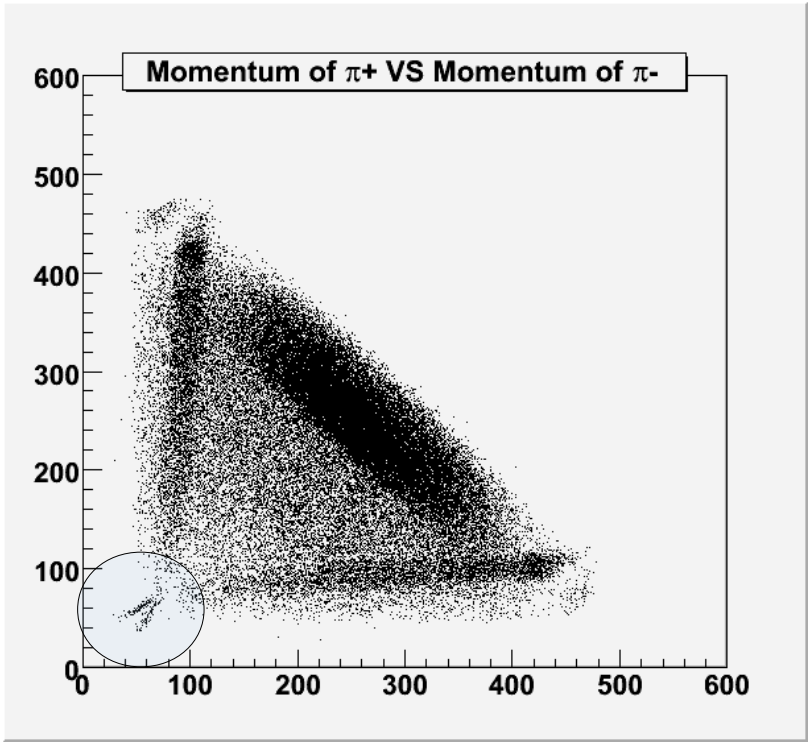
Barrel cut effect

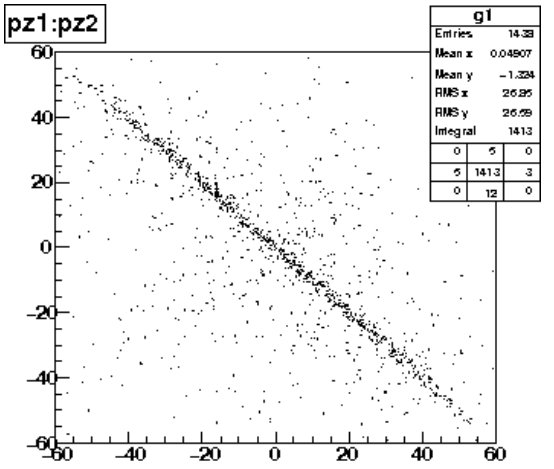


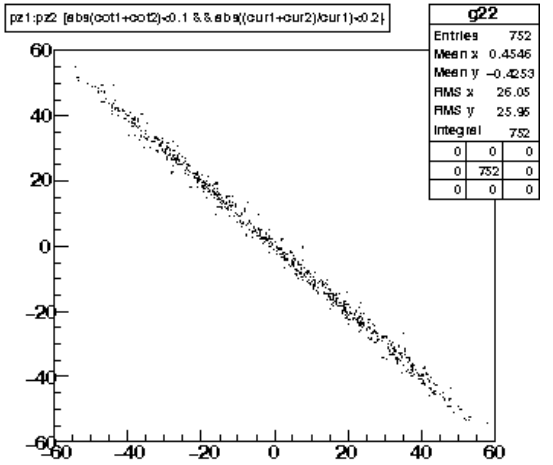
Efficiency after barrel cut

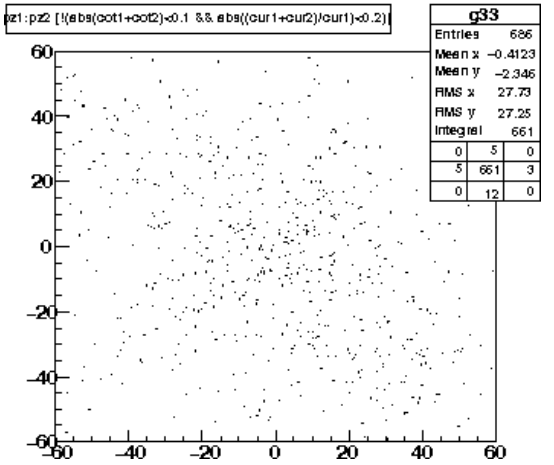


broken tracks









broken tracks faking pi+/pi- pair, momenta < 80 MeV

one can match them with θ angle, track curvature, P_t, P_z momenta

the events is removed totally if broken track is detected

selected statistics

- selecting only runs analyzed in RAD and RPI Exp/MC
- at the moment we are using only 2005: sample contains

  L = 1.18286 fb^{-1} (still available 2004 data with 0.51 fb^{-1})
- X-section for signal is $2x10^{-3}$ μb giving total number of expected events

  $N = 2.4 \times 10^{6}$
- With 28 % efficiency we expect 674000 events with stats error <1 %

Calculation of Branching ratio

Simultaneous fit to these 2 spectra

(MC included allphys + eeg100)

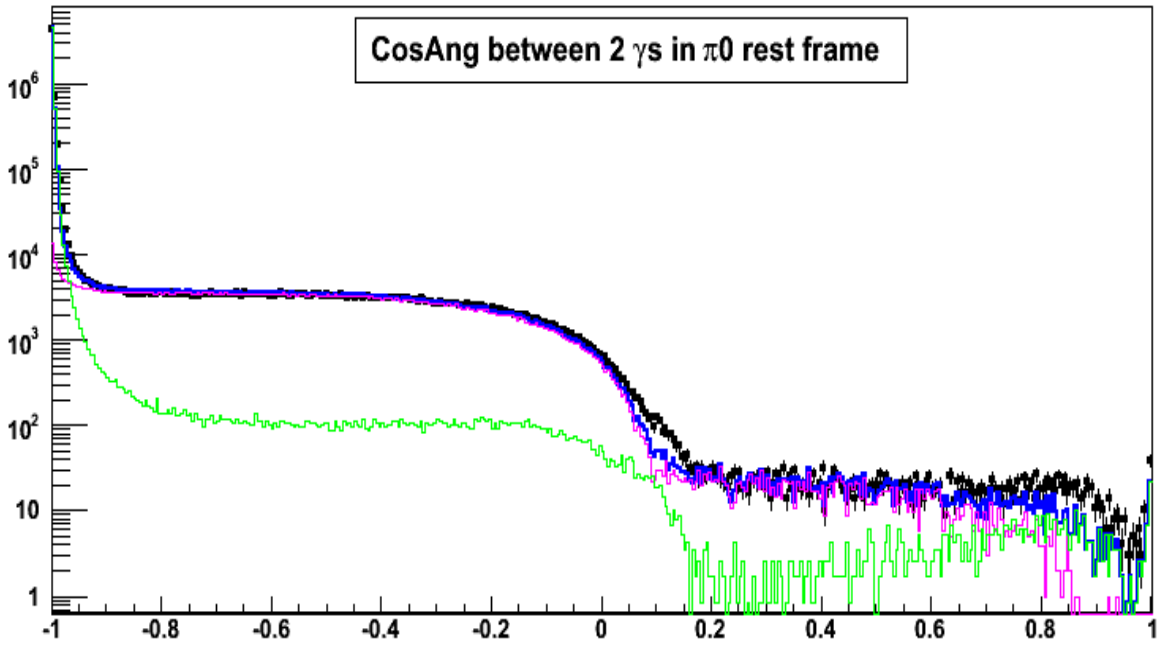
<u>On the plots:</u>

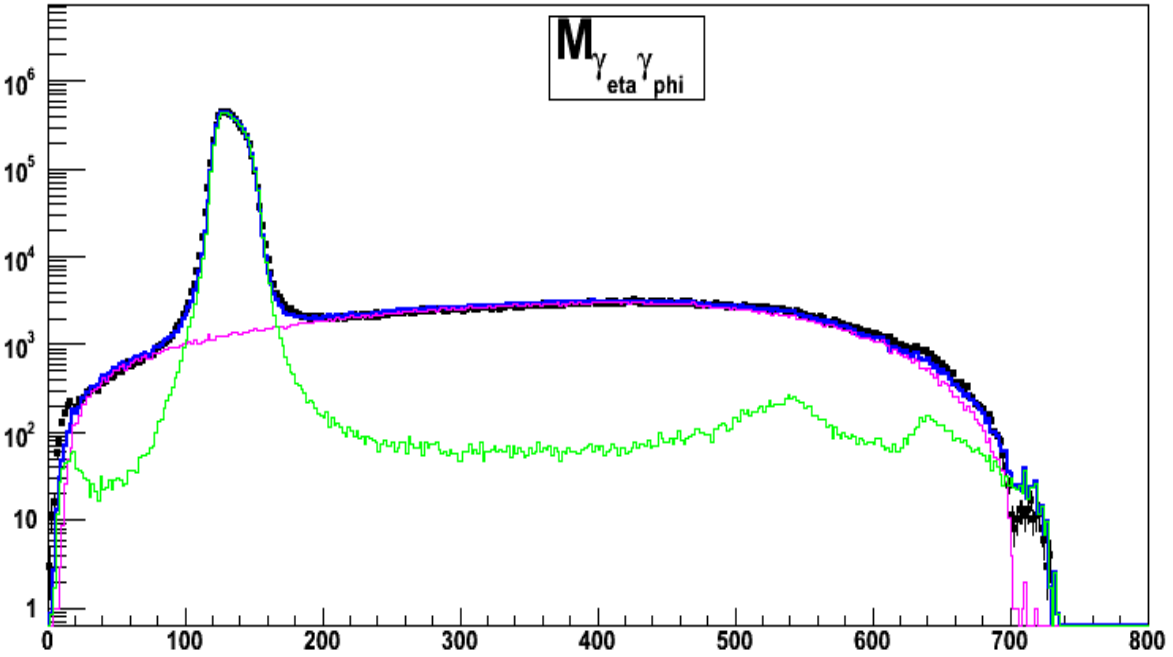
EXP DATA

SUM OF MC CONTRIBUTIONS

MC SIGNAL

MC BACKGROUND





Branching ratio

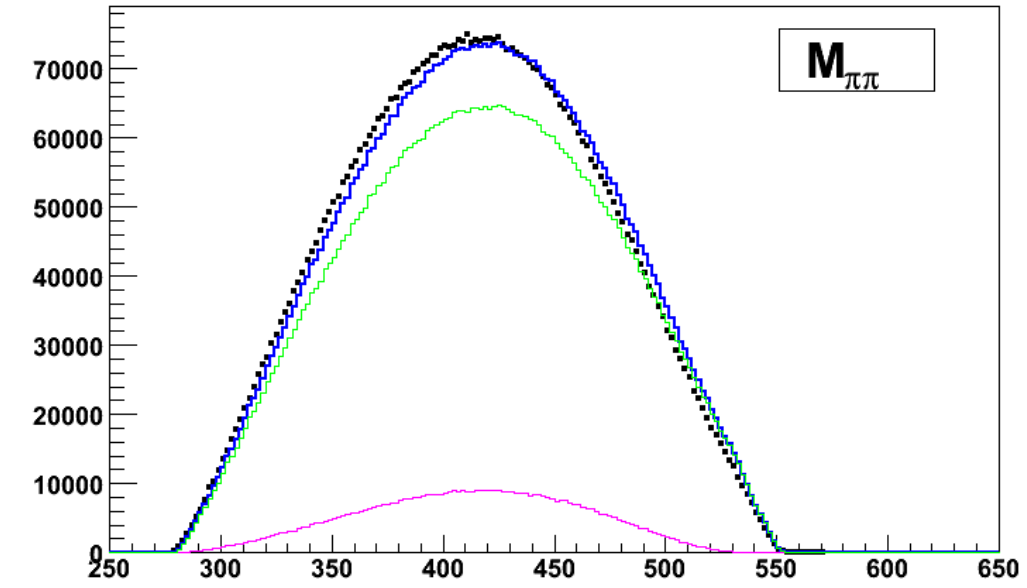
$$\mathrm{BR} = \frac{N_{signal}^{fit}}{L * \sigma} \quad \frac{1}{\epsilon}$$

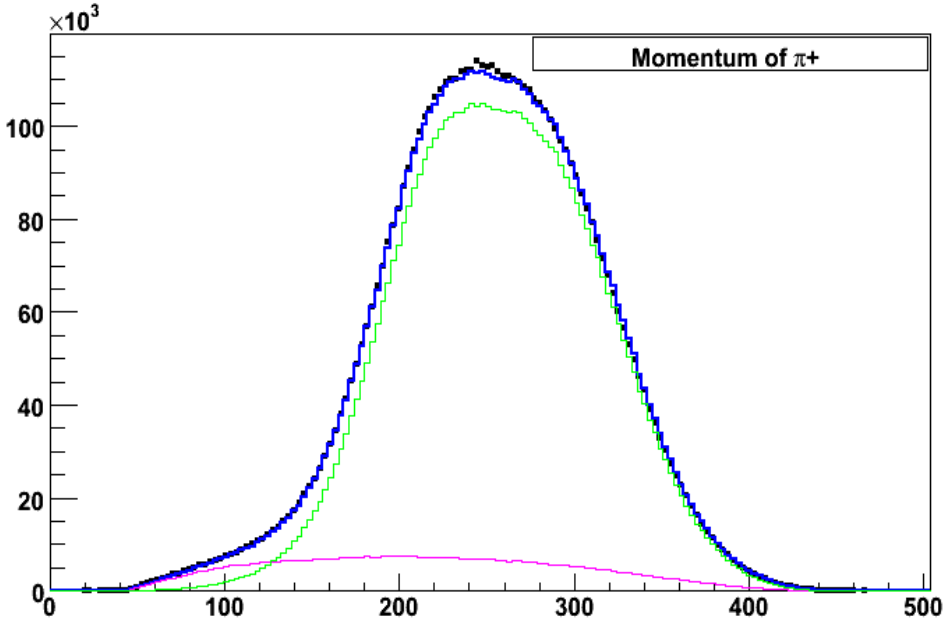
L = 1182855.41 nb^{-1}
σ = 41.7 nb
ε = 0.2832

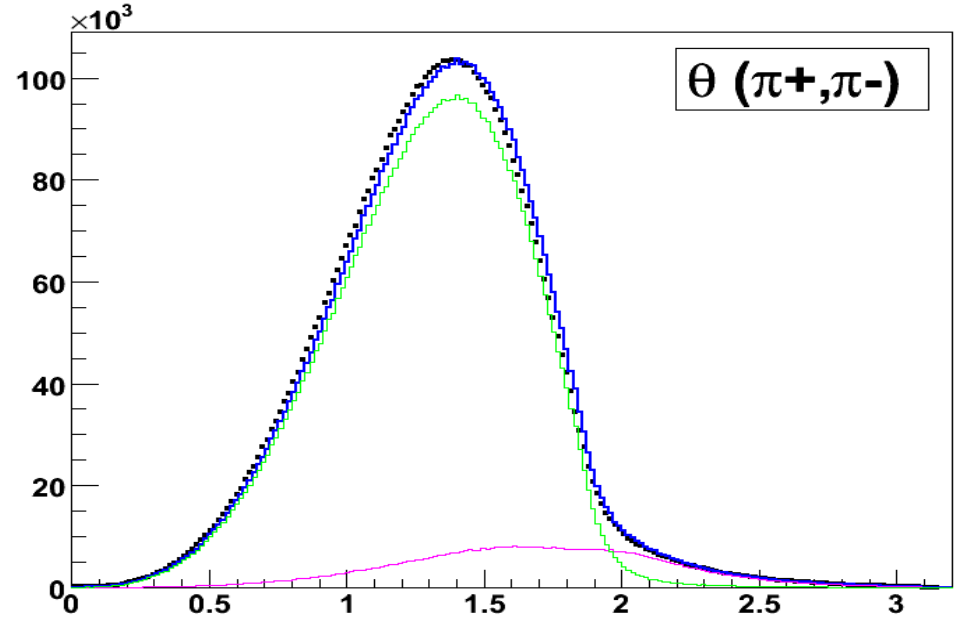
N = 611099.7

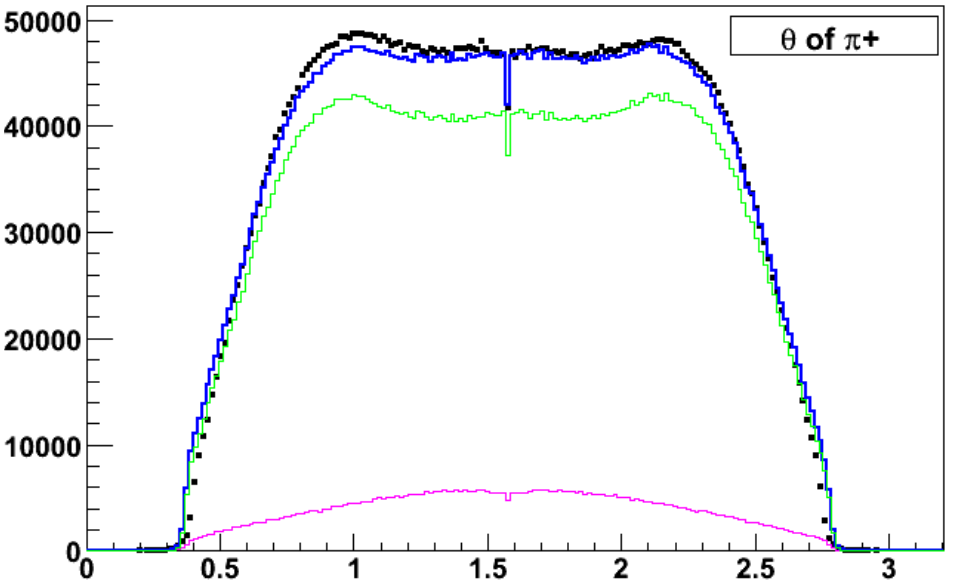
BR = 0.0437
stat. error σ_{stat} = 0.16 %

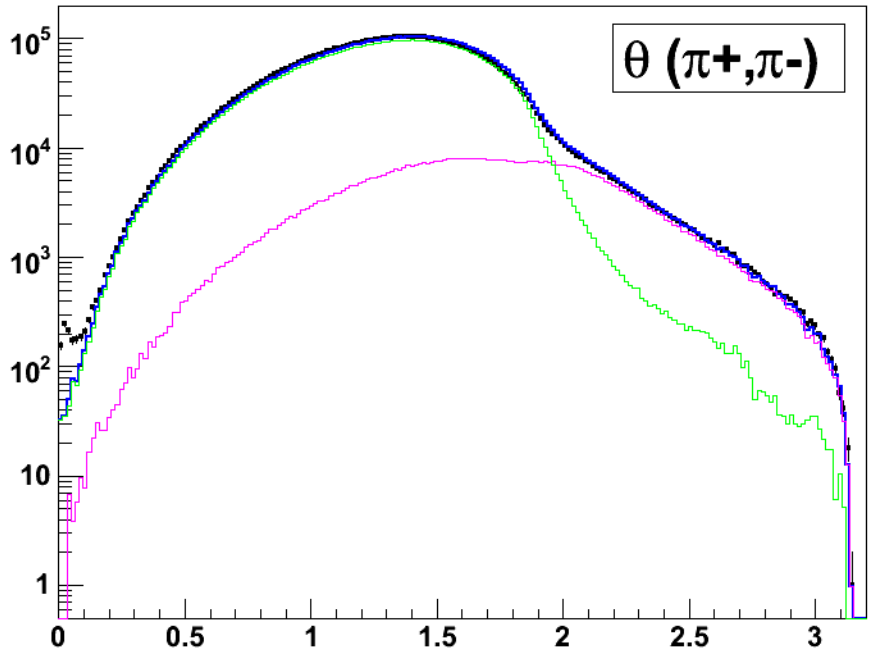
$$\mathrm{BR}^{\mathrm{PDG}} = 0.0460 \pm 0.0016$$

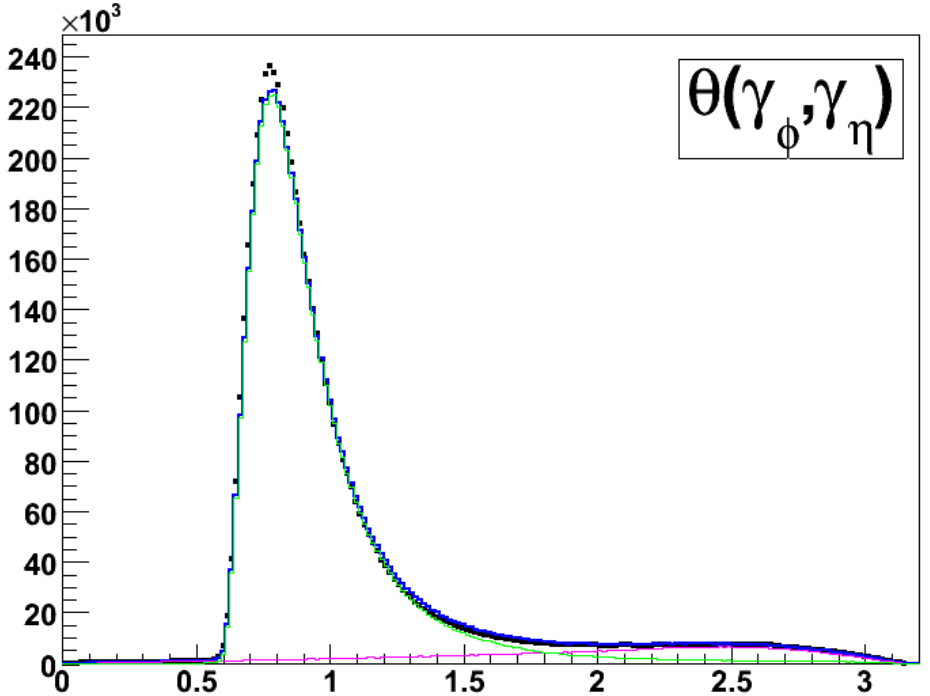

$M_{\pi\pi}$
70000
60000
50000
40000
30000
20000
10000
0
250
300
350
400
450
500
550
600
650

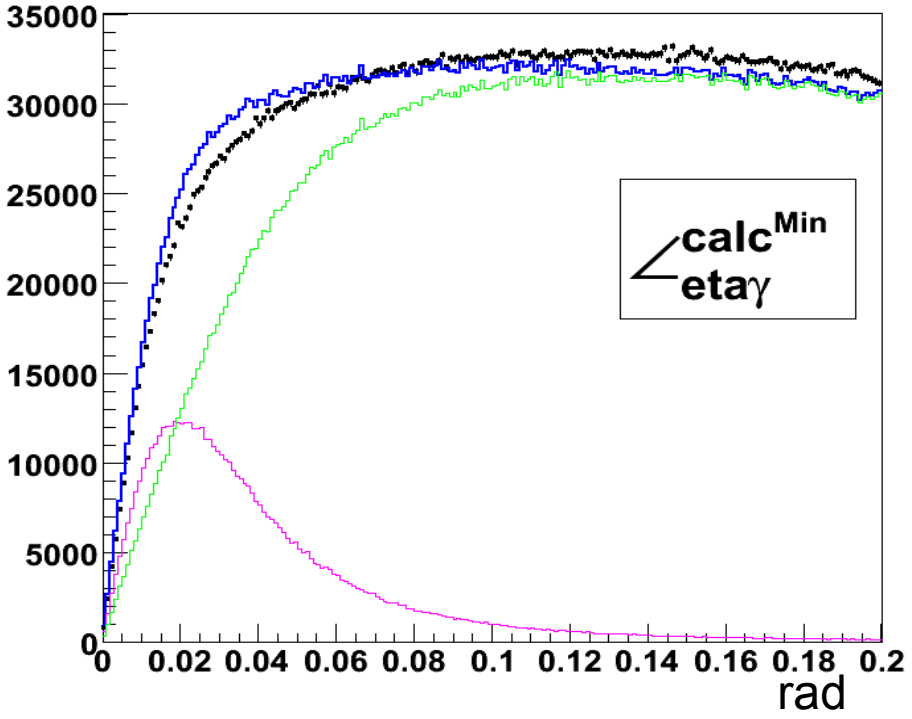

×10³
Momentum of π+
100
80
60
40
20
0
0
100
200
300
400
500

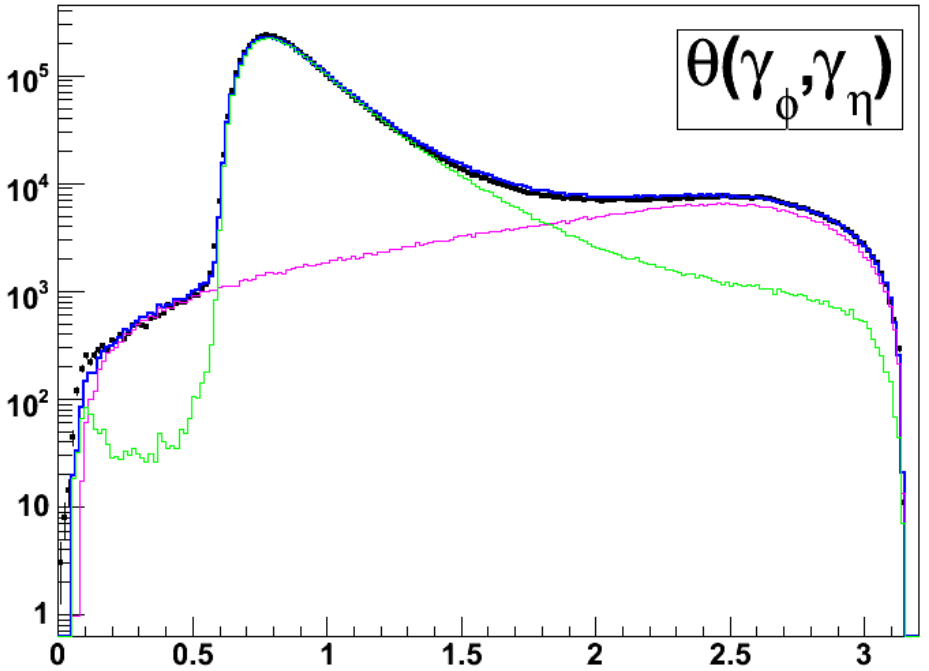

×10³
θ (π+,π-)
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3


θ of π+
50000
40000
30000
20000
10000
0
0
0.5
1
1.5
2
2.5
3


θ (π+,π-)


θ(γ_φ,γ_η)

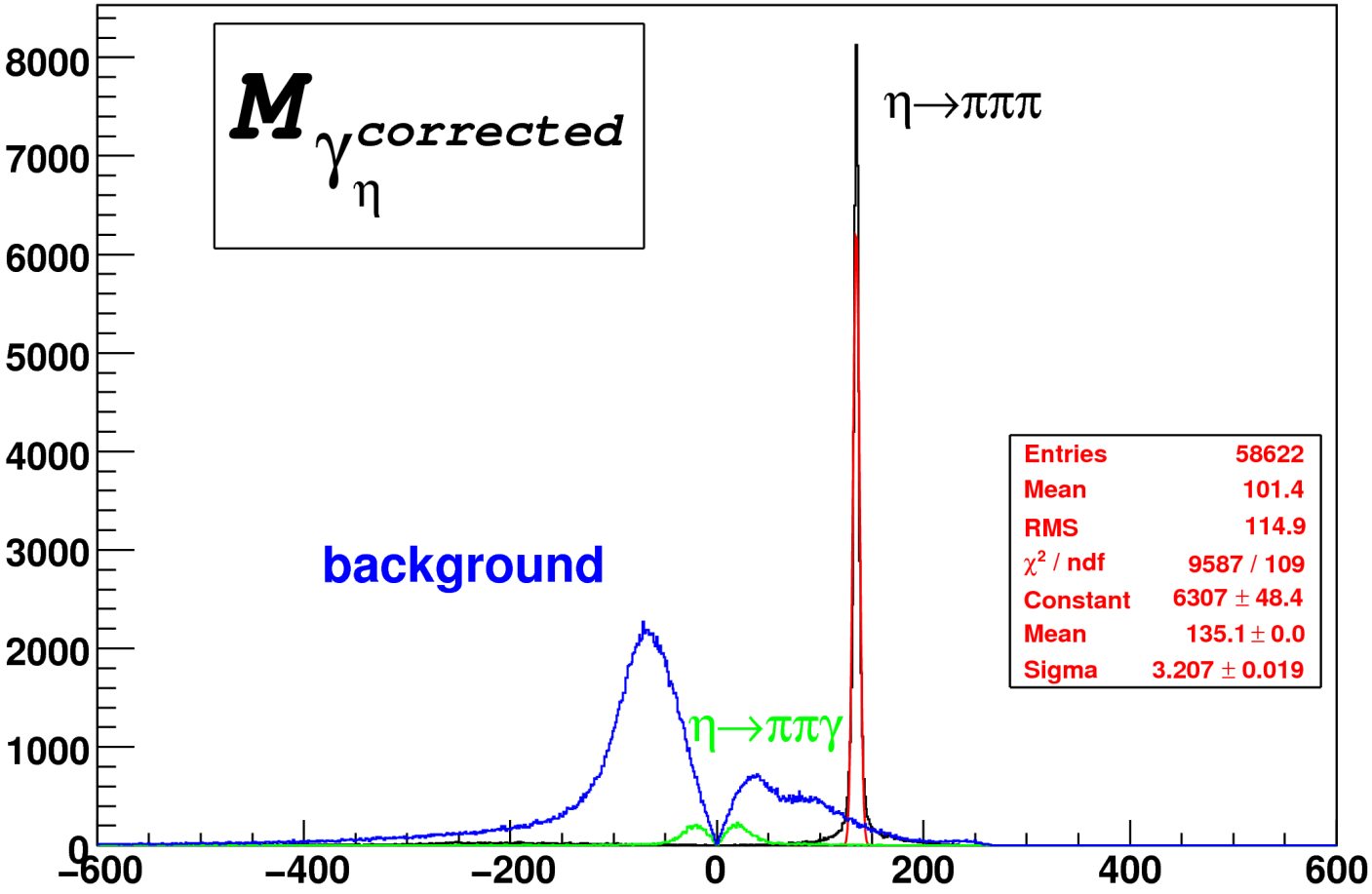

calc^Min
etaγ
rad


θ(γ_φ,γ_η)

Normalization to $\eta \to \pi^+\pi^-\pi^0$

- the same pre-selection (only RAD)
- calculate missing mass M of ($\phi - \pi^+ - \pi^- - \gamma_\phi$)

$|M - m_\pi| < 10\text{MeV}$



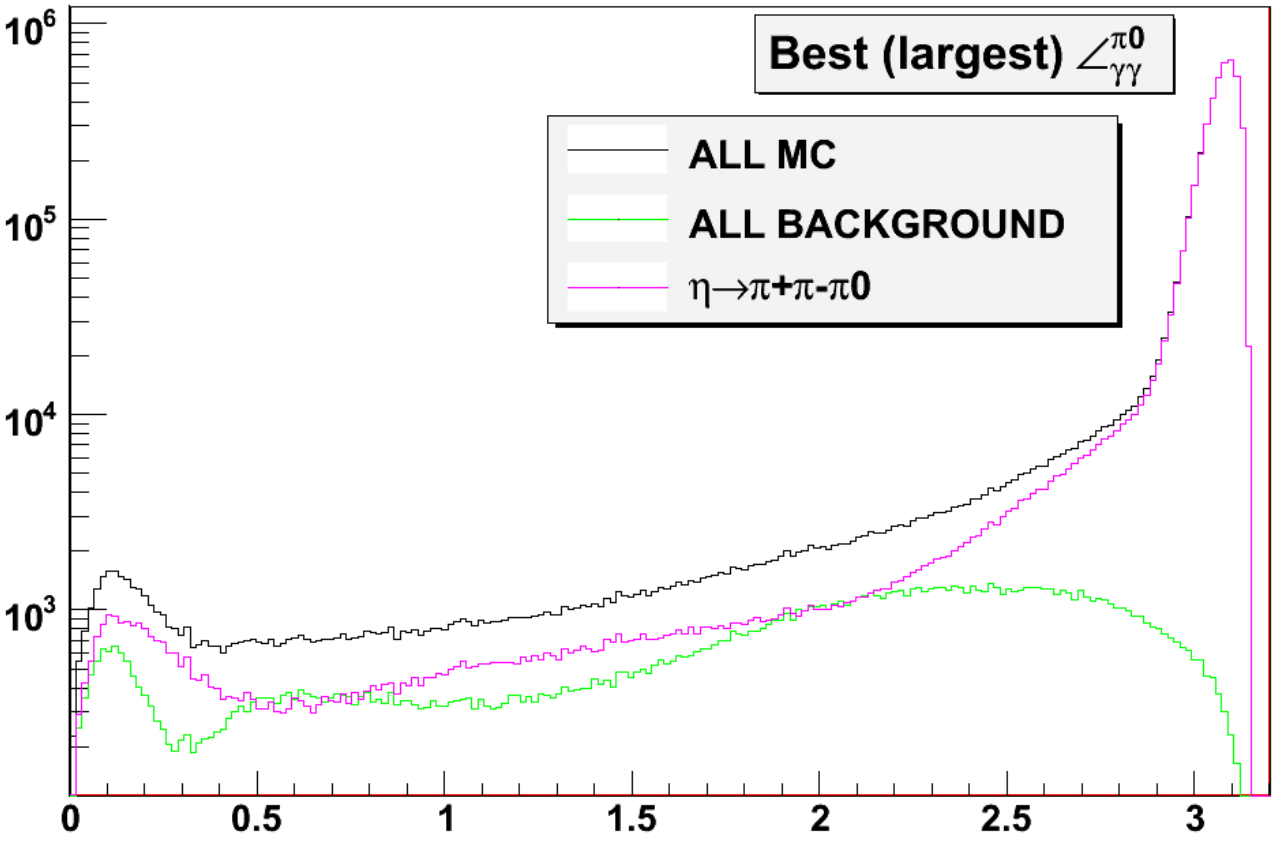
Normalization to $\eta \to \pi^+\pi^-\pi^0$

In the π^0 rest frame (π^0 calculated from DC) calculate angle between 2 γ (if more than 2 check all the combinations and choose largest)

selection: $\angle\gamma\gamma > 2.7$

AFTER:
Background/Signal
(allphys+eeg100)

B/S = 0.0057

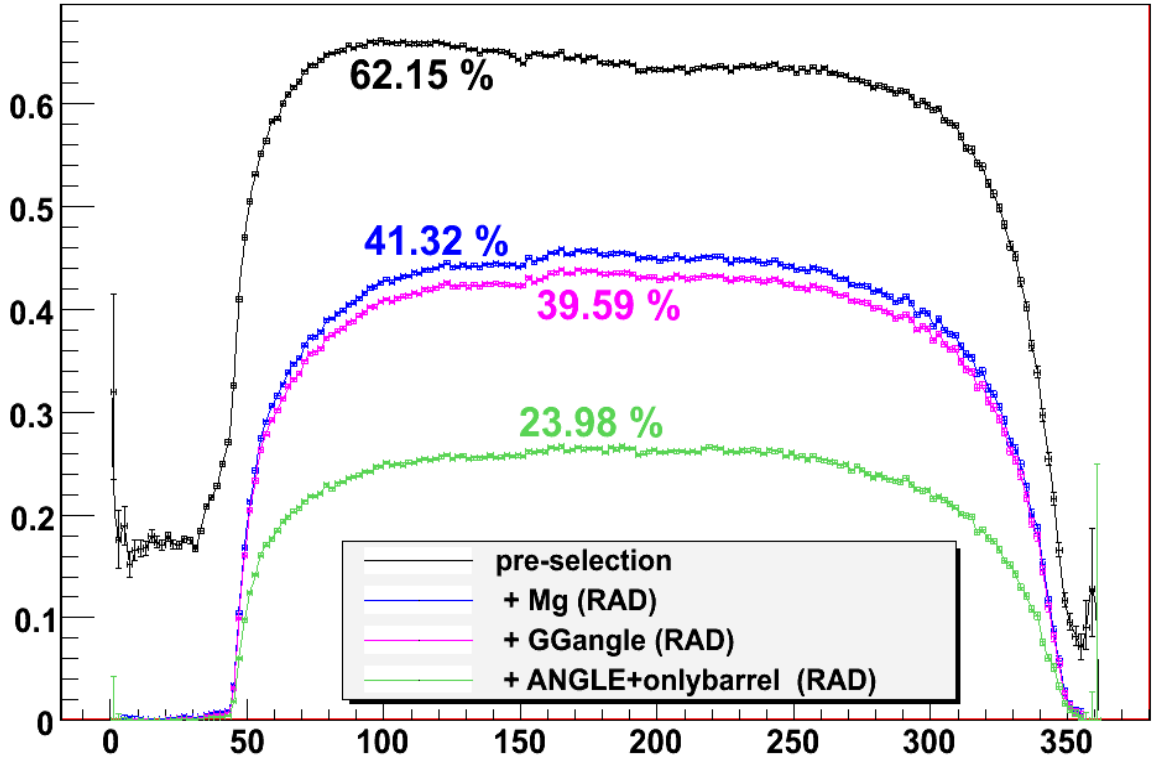


Normalization to $\eta \to \pi^+\pi^-\pi^0$

<u>CASE 1</u>

constraints: Mg + $\angle\gamma\gamma$,
Exp data: 4227594,
Efficiency: 39.59 %
B/S = 0.0054

BR = 0.2153



<u>CASE 2</u>

constraints: +ANGLE+ barrel,
Exp data: 2603608,
Efficiency: 23.98 %
B/S = 0.0057

BR = 0.2188

$\sigma_{stat} = 0.06\ \%$

$\sigma_{syst} = 1.6\ \%$ (from difference in BR)

Normalization to $\eta \to \pi^+\pi^-\pi^0$

CASE 1

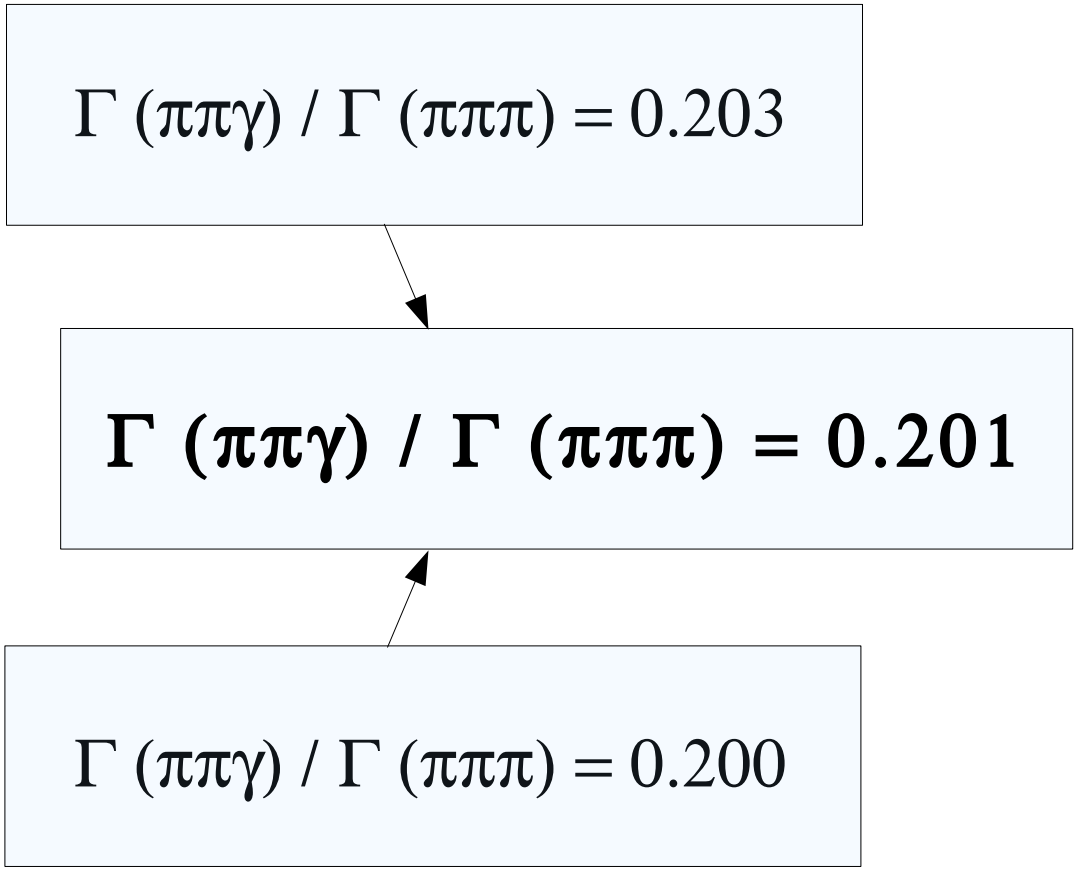
constraints: Mg + $\angle\gamma\gamma$,
Exp data: 4227594,
Efficiency: 39.59 %
B/S = 0.0054

BR = 0.2153

CASE 2

constraints: +ANGLE+ barrel,
Exp data: 2603608,
Efficiency: 23.98 %
B/S = 0.0057

BR = 0.2188



systematic error evaluation

(detail study done for $\eta \to \pi\pi\gamma$)

no kinematical fit

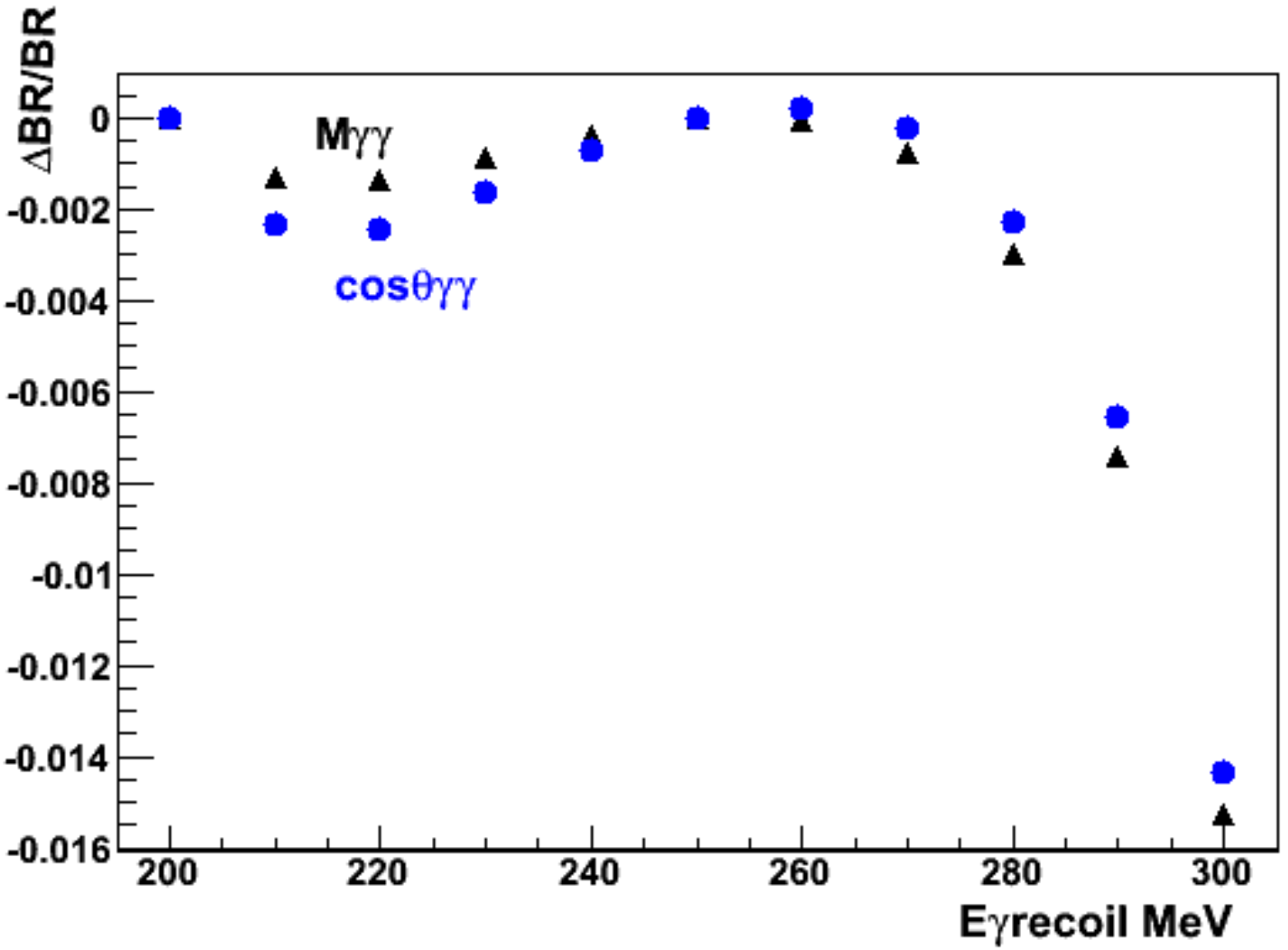
we avoid using energy from calorimeter

(only in the initial cluster selection)

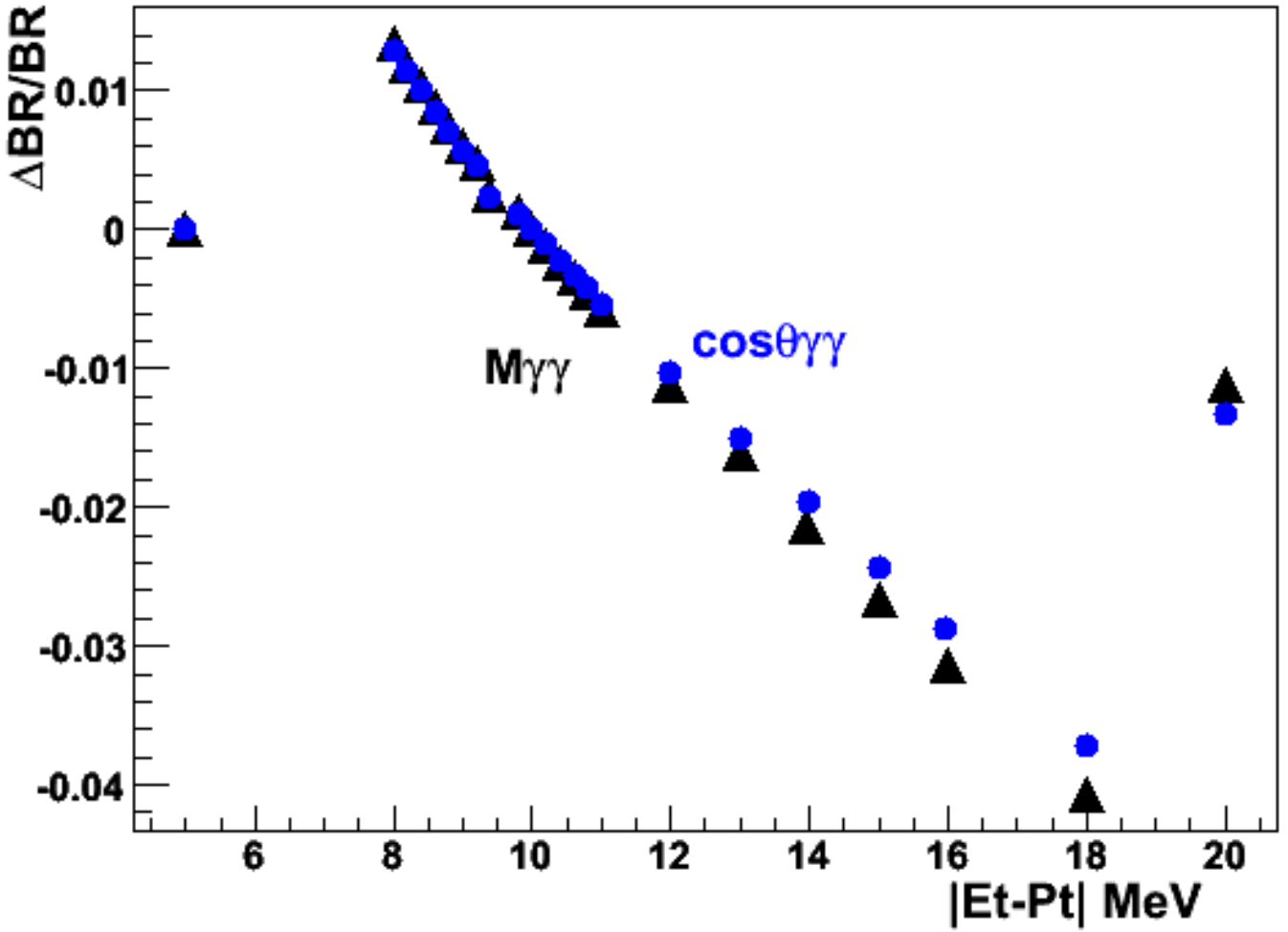
energies of photons were evaluated from pi+/pi- momenta

- List of used constraints:
  - most energetic photon with $E_\gamma \geq 250$ MeV assumed γ_ϕ
  - γ_{eta} : $|E_t - P_t| < 10$ MeV
  - OpAnMin < 0.2 rad
  - BhaBha rejection cuts (not yet evaluated)
  - Barrel constraint: γ_ϕ is taken only from barrel
- Seperate fit to two spectra, $M\gamma\gamma$ and $Cos\theta\gamma\gamma$ (two set of points on the plots)

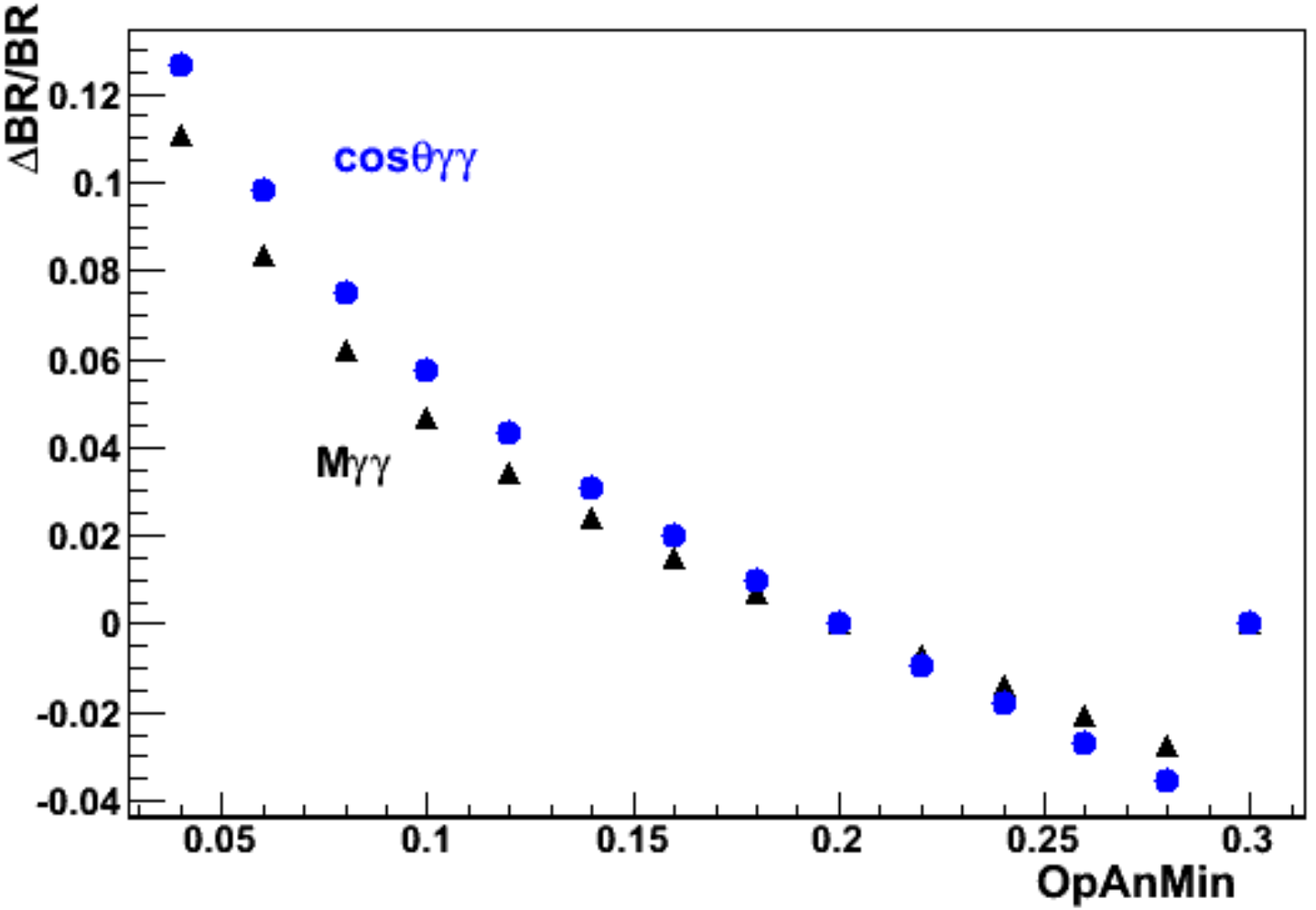
Eγ rad>250MeV



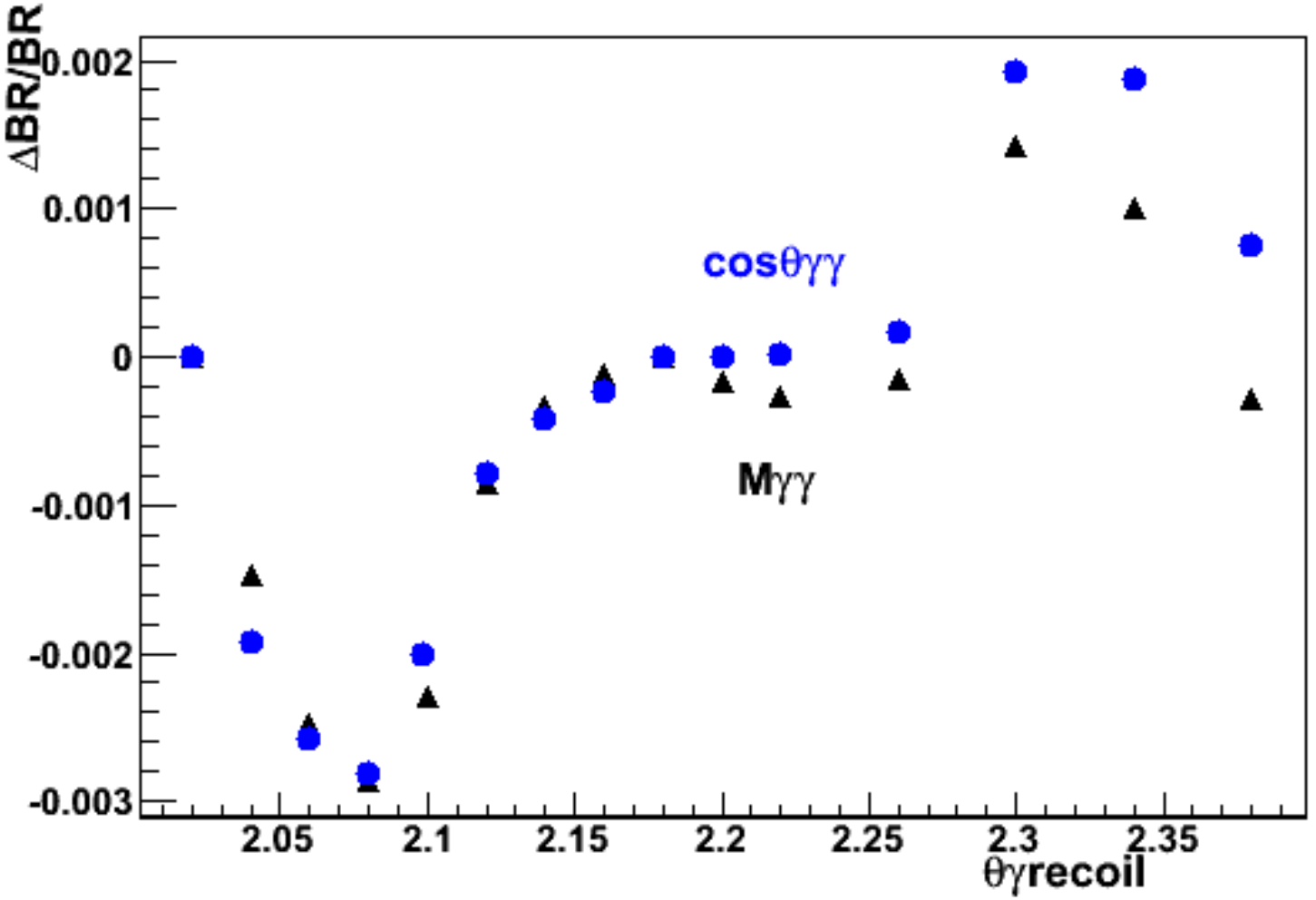
|Et-Pt|<10MeV


ΔBR/BR
0.01
0
-0.01
-0.02
-0.03
-0.04
6
8
10
12
14
16
18
20
|Et-Pt| MeV
Mγγ
cosθγγ

OpAnMin<0.2


ΔBR/BR
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
cosθγγ
Mγγ
0.05
0.1
0.15
0.2
0.25
0.3
OpAnMin

0.96<θ γ rad<2.18: barrel cut



Systematics

CUT	Δ CUT/CUT	Δ BR/BR
Eγ rad	±20%	-1.5%
|Et-Pt|	±20%	±1%
OpAnMin	±20%	±2%
θ γ rad(barrel)	±0.2(11°)	±0.3%

$\sigma_{syst} = 2.7\ \%$

PRELIMINARY RESULT

$$\frac{\Gamma(\eta \to \pi^+\pi^-\gamma)}{\Gamma(\eta \to \pi^+\pi^-\pi^0)} = 0.201(4) \pm 0.0004_{\text{stat}} \pm 0.006(3)_{\text{syst}}$$

$\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ **Γ_{10}/Γ_9**

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.202±0.007 OUR FIT	Error includes scale factor of 2.4.				
0.203±0.008 OUR AVERAGE	Error includes scale factor of 2.4. See the ideogram below.				
0.175±0.007±0.006	859	LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$
0.209±0.004	18k	THALER	73	ASPK	
0.201±0.006	7250	GORMLEY	70	ASPK	

|Et-Pt| (I)

|Et-Pt| MeV	ε (±0.0006)	Signal (fit cosθ γ γ) (±0.0013)	BR(cosθ γ γ)	Signal (fit Mγ γ) (±0.0013)	BR(Mγ γ)
5.0	0.2616	0.9471	0.0422	0.9294	0.0414
8.0	0.2797	0.9768	0.0436	0.9569	0.0427
8.2	0.2802	0.9783	0.0436	0.9584	0.0427
8.4	0.2807	0.9796	0.0437	0.9597	0.0428
8.6	0.2811	0.9812	0.0438	0.9613	0.0429
8.8	0.2815	0.9825	0.0438	0.9627	0.0429
9.0	0.2819	0.9839	0.0439	0.9640	0.0430
9.2	0.2822	0.9850	0.0439	0.9652	0.0431
9.4	0.2829	0.9873	0.0440	0.9675	0.0432
9.8	0.2832	0.9884	0.0441	0.9687	0.0432
10.0	0.2835	0.9896	0.0441	0.9699	0.0433
10.2	0.2838	0.9906	0.0442	0.9710	0.0433
10.4	0.2841	0.9918	0.0442	0.9722	0.0434

|Et-Pt| (II)

|Et-Pt| MeV	ε (±0.0006)	Signal (fit cosθ γ γ) (±0.0013)	BR(cosθ γ γ)	Signal (fit Mγ γ) (±0.0013)	BR(Mγ γ)
10.6	0.2843	0.9927	0.0443	0.9733	0.0434
10.8	0.2846	0.9937	0.0443	0.9743	0.0435
11.0	0.2848	0.9949	0.0444	0.9755	0.0435
12.0	0.2859	0.9997	0.0446	0.9807	0.0437
13.0	0.2868	1.0045	0.0448	0.9855	0.0440
14.0	0.2877	1.0089	0.0450	0.9906	0.0442
15.0	0.2883	1.0136	0.0452	0.9957	0.0444
16.0	0.2890	1.0181	0.0454	1.0003	0.0446
18.0	0.2901	1.0263	0.0458	1.0093	0.0450
20.0	0.2940	1.0027	0.0447	0.9808	0.0437

OpAnMin

OpAnMin	ε (±0.0006)	Signal (fit cosθ γ γ) (±0.0013)	BR(cosθ γ γ)	Signal (fit Mγ γ) (±0.0013)	BR(Mγ γ)
0.04	0.1753	0.8640	0.0385	0.8622	0.0385
0.06	0.2268	0.8919	0.0398	0.8885	0.0396
0.08	0.2515	0.9149	0.0408	0.9096	0.0406
0.10	0.2646	0.9324	0.0416	0.9244	0.0412
0.12	0.2719	0.9467	0.0422	0.9363	0.0418
0.14	0.2765	0.9587	0.0428	0.9461	0.0422
0.16	0.2795	0.9694	0.0432	0.9548	0.0426
0.18	0.2817	0.9796	0.0437	0.9625	0.0429
0.20	0.2834	0.9893	0.0441	0.9695	0.0432
0.22	0.2848	0.9985	0.0445	0.9766	0.0436
0.24	0.2860	1.0071	0.0449	0.9830	0.0438
0.26	0.2869	1.0158	0.0453	0.9895	0.0441
0.28	0.2876	1.0244	0.0457	0.9963	0.0444
0.30	0.2883	1.0338	0.0461	1.0042	0.0448

E_{γ}^{rad}

Egrad	ε (±0.0006)	Signal (fit cosθ γ γ) (±0.0013)	BR(cosθ γ γ)	Signal (fit Mγ γ) (±0.0013)	BR(Mγ γ)
200	0.2839	0.9913	0.04422	0.9704	0.04329
210	0.2838	0.9916	0.04424	0.9708	0.04330
220	0.2837	0.9917	0.04424	0.9709	0.04331
230	0.2837	0.9909	0.04420	0.9704	0.04328
240	0.2836	0.9900	0.04416	0.9699	0.04326
250	0.2835	0.9893	0.04413	0.9695	0.04325
260	0.2829	0.9891	0.04412	0.9696	0.04325
270	0.2819	0.9895	0.04414	0.9702	0.04328
280	0.2800	0.9915	0.04423	0.9724	0.04338
290	0.2764	0.9958	0.04442	0.9767	0.04357
300	0.2702	1.0035	0.04477	0.9843	0.04391

barrel cut θ γ rad

θ grad	ε (±0.0006)	Signal (fit cosθ γ γ)	BR(cosθ γ γ)	Signal (fit Mγ γ)	BR(Mγ γ)
0.76-2.18	0.3674	0.9885±0.0011	0.04410	0.9699±0.0011	0.04367
0.80-2.34	0.3515	0.9874±0.0012	0.04405	0.9686±0.0011	0.04321
0.84-2.30	0.3364	0.9873±0.0012	0.04404	0.9682±0.0012	0.04319
0.88-2.26	0.3199	0.9891±0.0012	0.04412	0.9697±0.0012	0.04326
0.92-2.22	0.3030	0.9892±0.0013	0.04413	0.9698±0.0012	0.04326
0.94-2.20	0.2944	0.9892±0.0013	0.04413	0.9698±0.0012	0.04326
0.96-2.18	0.2857	0.9892±0.0013	0.04413	0.9696±0.0013	0.04325
0.98-2.16	0.2769	0.9895±0.0013	0.04414	0.9697±0.0013	0.04326
1.00-2.14	0.2680	0.9897±0.0013	0.04415	0.9699±0.0013	0.04327
1.02-2.12	0.2591	0.9900±0.0013	0.04416	0.9704±0.0013	0.04323
1.04-2.10	0.2499	0.9913±0.0014	0.04422	0.9718±0.0014	0.04335
1.06-2.08	0.2406	0.9920±0.0014	0.04425	0.9724±0.0014	0.04338
1.08-2.06	0.2312	0.9918±0.0014	0.04424	0.9720±0.0014	0.04336
1.10-2.04	0.2219	0.9911±0.0015	0.04422	0.9710±0.0014	0.04332
1.12-2.02	0.2123	0.9910±0.0015	0.04421	0.9706±0.0015	0.330

Outlook

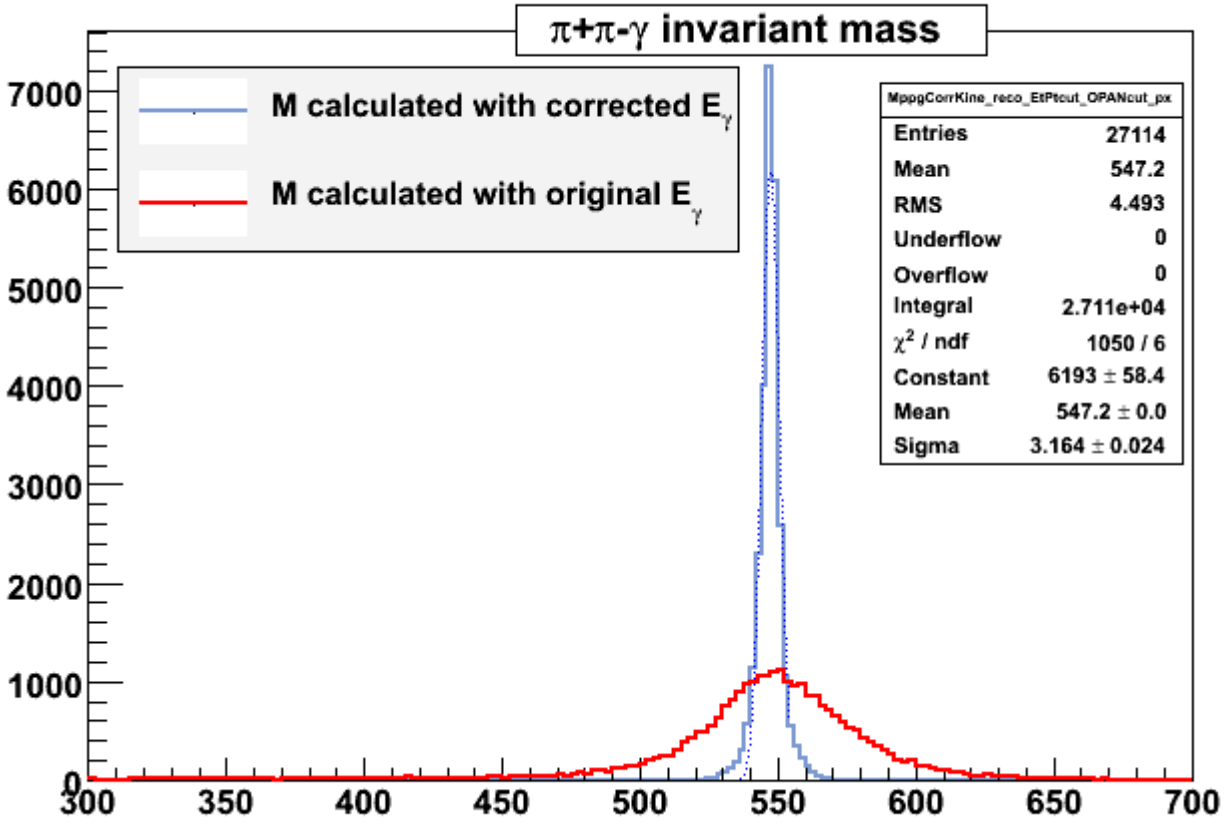
- The Branching Ratio $\frac{Br(\eta \to \pi^+\pi^-\gamma)}{Br(\eta \to \pi^+\pi^-\pi^0)}$
  - Aim: better than 1%
  - Full evaluation and systematics (cuts, pion and photon efficiencies)
- E_γ spectrum (also π^+/π^-)
  - Can we get efficiency curve from data?
  - Unfolding of the spectrum
  - Fitting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

Quick look into experimental data

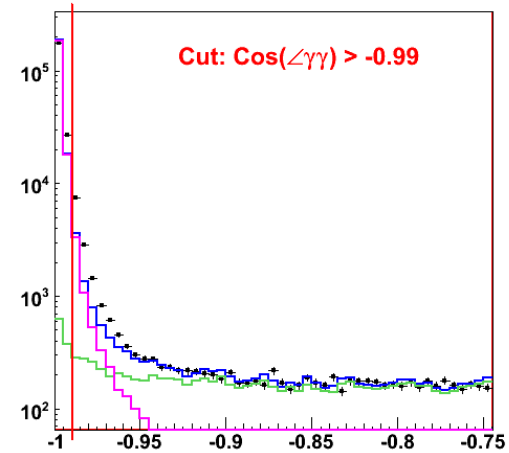
Data 2005 rad stream, runs: 34406 ÷ 34499, $L_{int} = 13.6\ pb^{-1}$

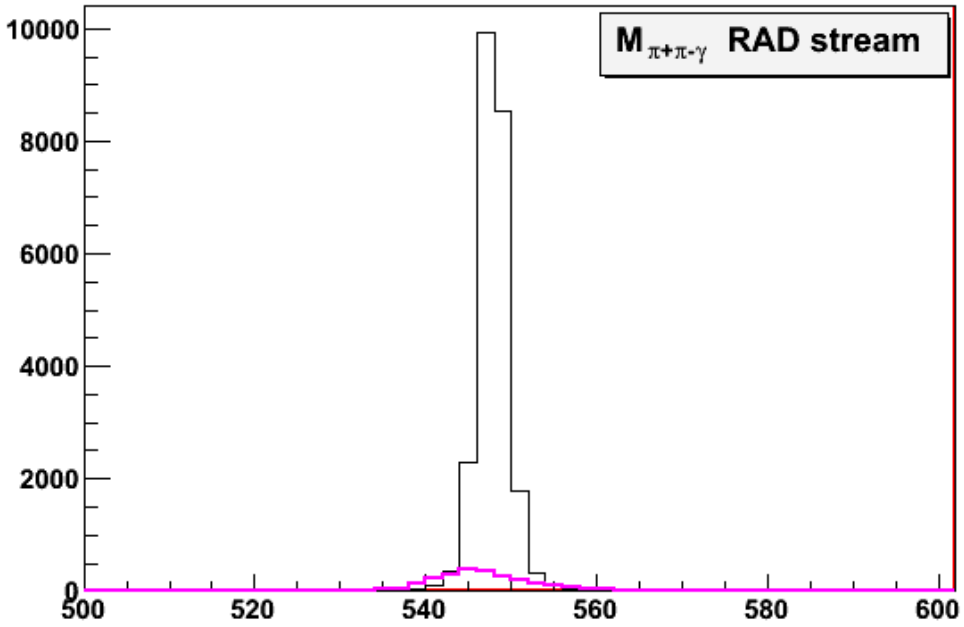
Expected number of $\eta \rightarrow \pi^+\pi^-\gamma$ in data ~ 28.000

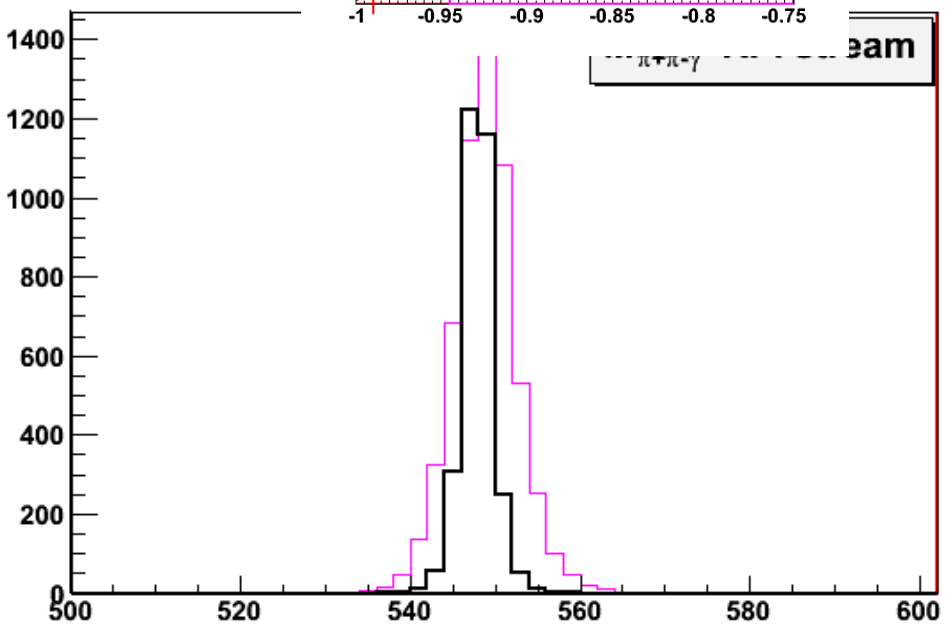
(From MC studies signal-to-background ratio after the cuts ~1:1)

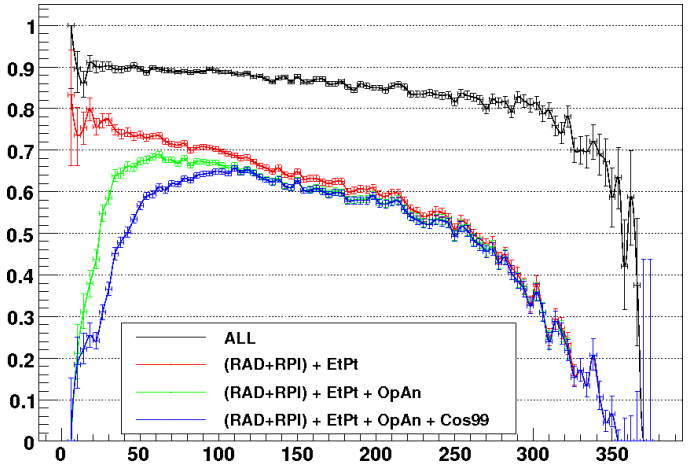


Efficiency and background reduction after additional cut on Cos(∠γγ)>-0.99

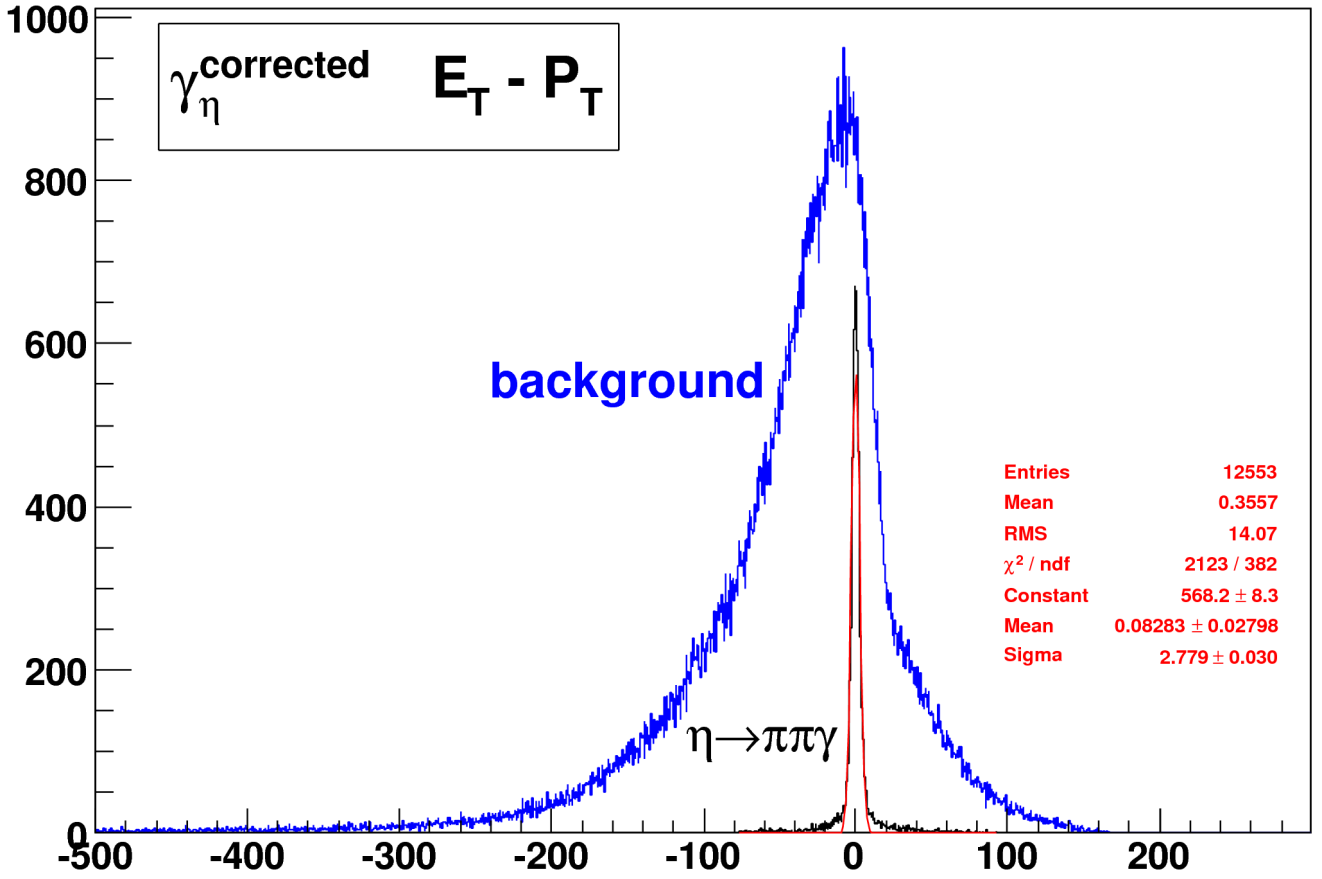


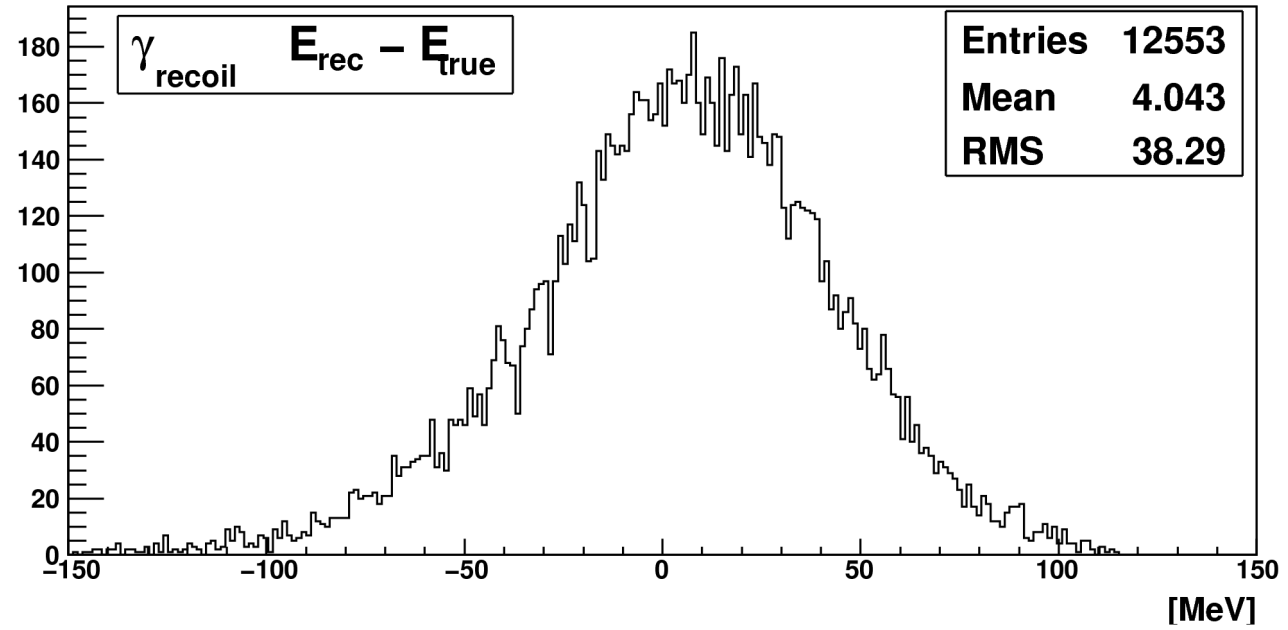


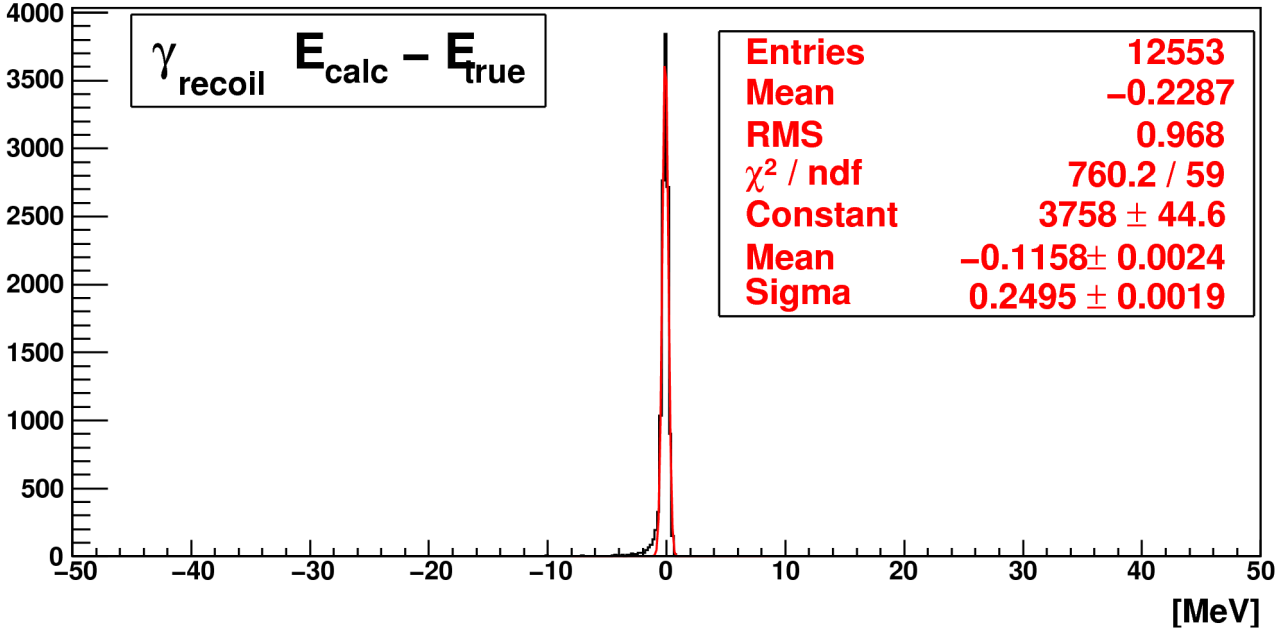


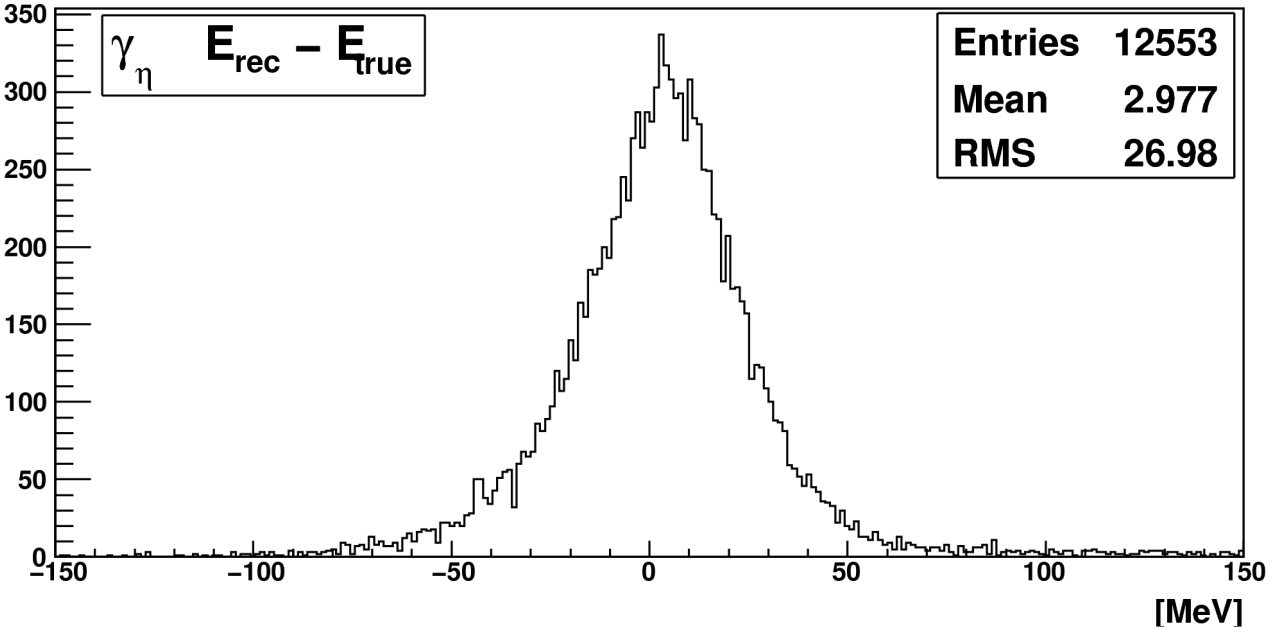


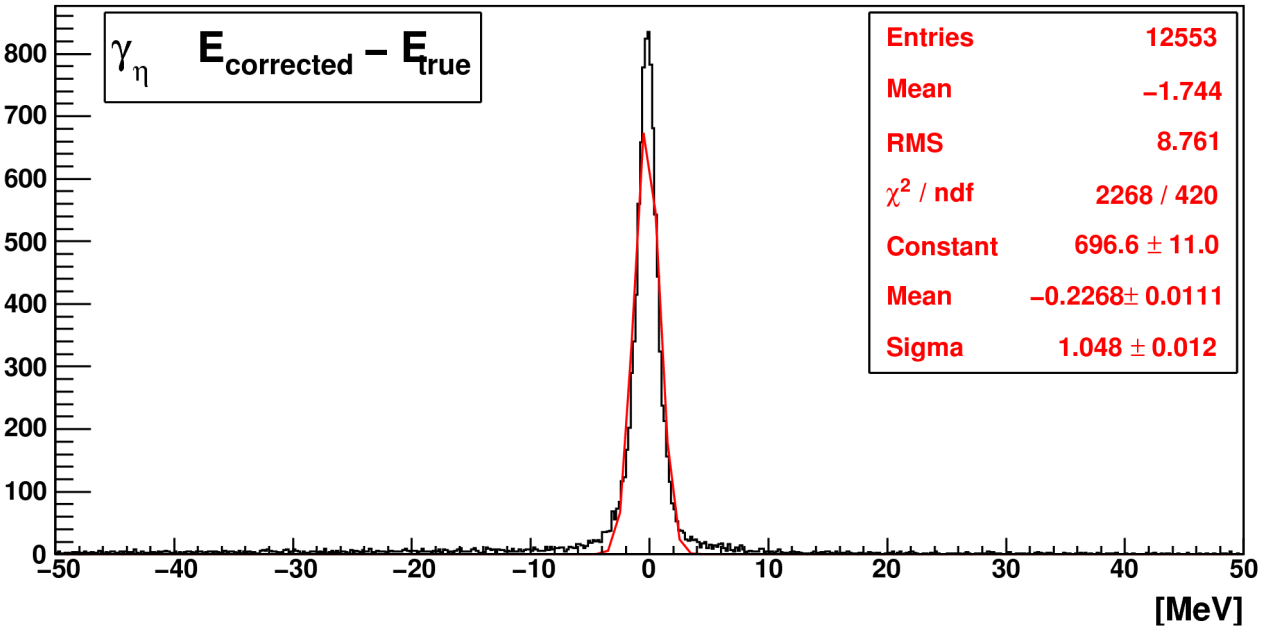
- RAD efficiency 41.2% (S/B ~10:1)
- RPI efficiency 5.3% (S/B ~1:2)

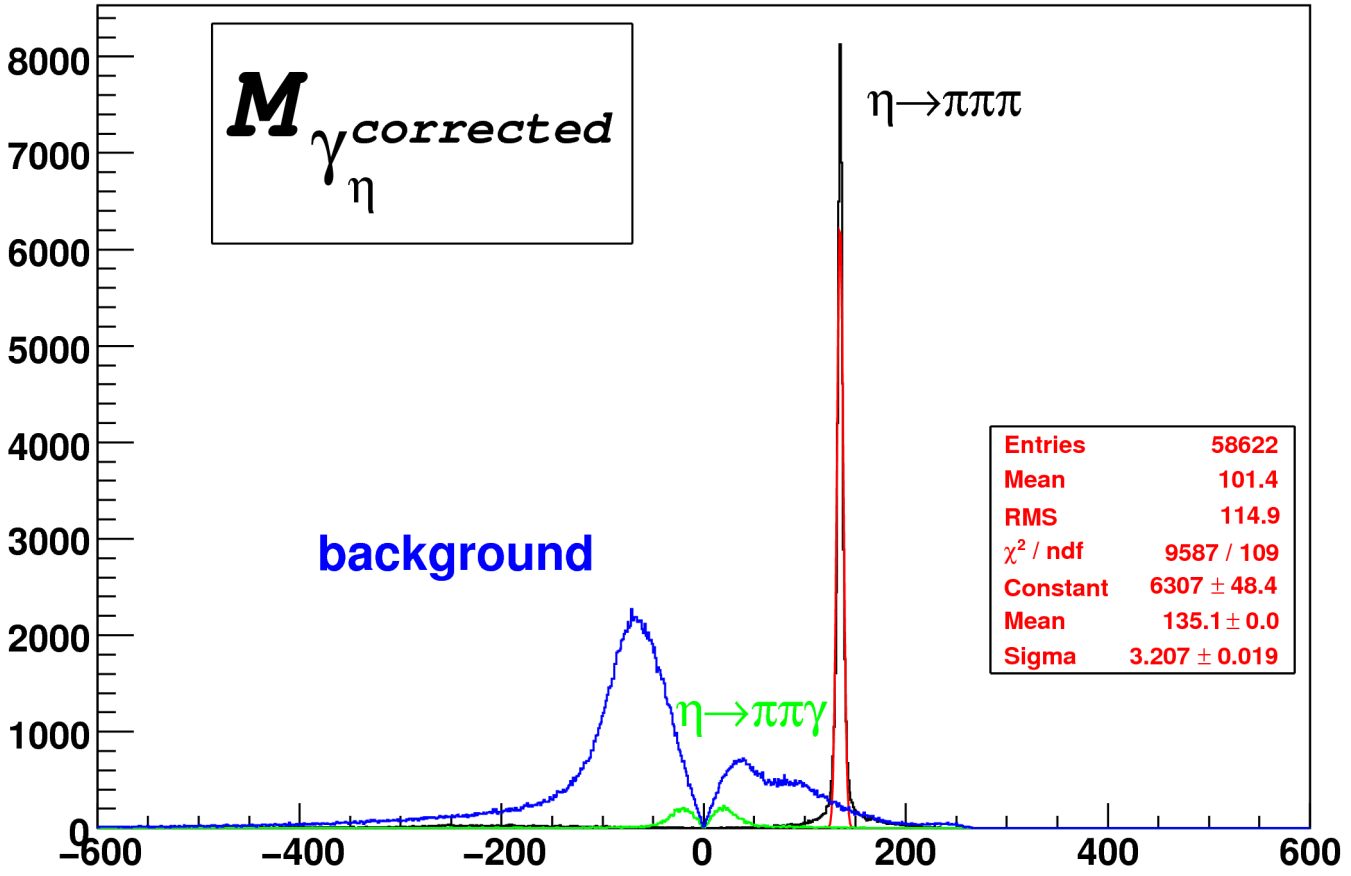

$\gamma_{\eta}^{corrected}$
$E_T - P_T$
background
$\eta \rightarrow \pi\pi\gamma$
Entries 12553
Mean 0.3557
RMS 14.07
χ^2 / ndf 2123 / 382
Constant 568.2 ± 8.3
Mean 0.08283 ± 0.02798
Sigma 2.779 ± 0.030
1000
800
600
400
200
0
-500
-400
-300
-200
-100
0
100
200


γ recoil
E rec – E true
Entries 12553
Mean 4.043
RMS 38.29
180
160
140
120
100
80
60
40
20
0
–150
–100
–50
0
50
100
150
[MeV]


γ recoil
E calc – E true
Entries 12553
Mean –0.2287
RMS 0.968
χ² / ndf 760.2 / 59
Constant 3758 ± 44.6
Mean –0.1158± 0.0024
Sigma 0.2495 ± 0.0019
4000
3500
3000
2500
2000
1500
1000
500
0
–50
–40
–30
–20
–10
0
10
20
30
40
50
[MeV]


γ_η $E_{rec} - E_{true}$
Entries 12553
Mean 2.977
RMS 26.98
350
300
250
200
150
100
50
0
−150
−100
−50
0
50
100
150
[MeV]


γ_η $E_{corrected} - E_{true}$
Entries 12553
Mean −1.744
RMS 8.761
χ^2 / ndf 2268 / 420
Constant 696.6 ± 11.0
Mean −0.2268± 0.0111
Sigma 1.048 ± 0.012
800
700
600
500
400
300
200
100
0
−50
−40
−30
−20
−10
0
10
20
30
40
50
[MeV]


$M_{\gamma_\eta^{corrected}}$
$\eta\to\pi\pi\pi$
background
$\eta\to\pi\pi\gamma$
Entries 58622
Mean 101.4
RMS 114.9
χ^2 / ndf 9587 / 109
Constant 6307 ± 48.4
Mean 135.1 ± 0.0
Sigma 3.207 ± 0.019
8000
7000
6000
5000
4000
3000
2000
1000
0
−600
−400
−200
0
200
400
600

Track selection

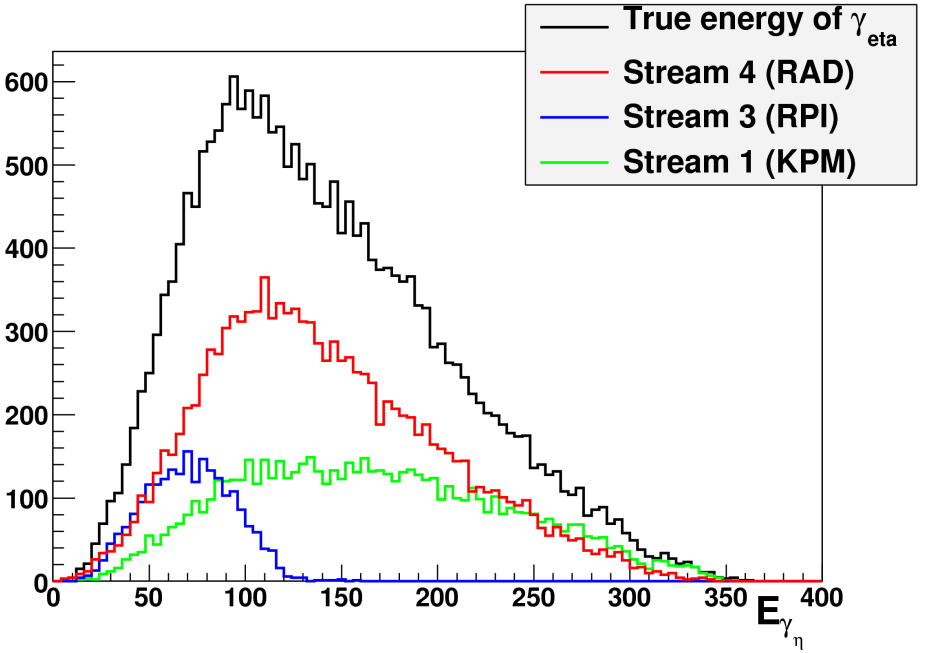
Tested selection based on the position of the first point of the track and

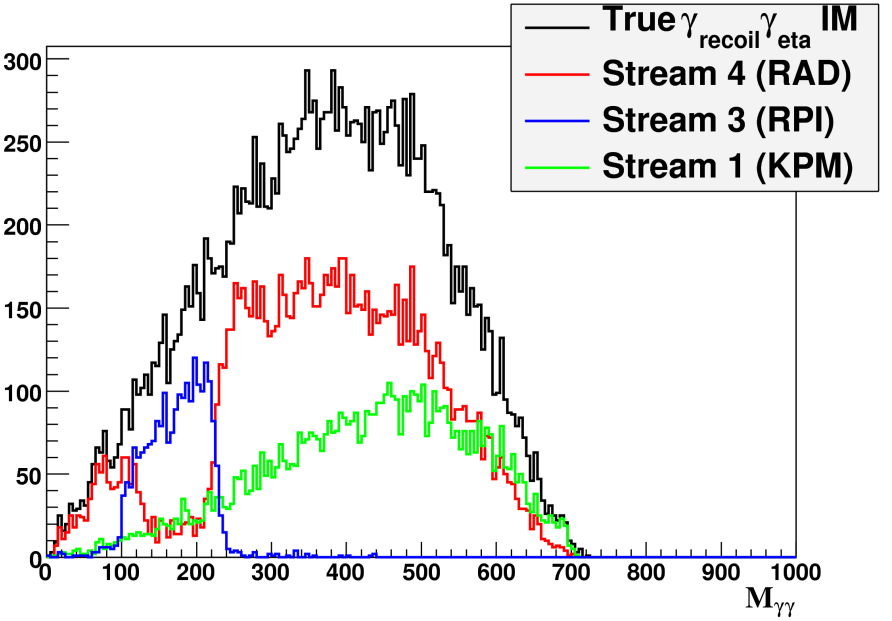
based on the distance to IP using track parameters from PCA (better!)

	All events	RAD	RPI	KPM
Total	17619	10916	1665	1210
$\pi^-\pi^+$	11759 (67%)	9112 (83%)	1544 (93%)	393 (32%)
$\pi^+\mu^-$	1056 (6%)	586 (5%)	33 (2%)	145 (12%)
$\pi^-\mu^+$	972 (5%)	540 (5%)	36 (2%)	150 (12%)

Event classification studies

Anti-coincidence in the event classification procedure sends our signal to two streams, RAD and RPI
Small part of the signals enters also KPM stream, but we decided to neglect this contribution, since the combination of the two first streams gives already rather flat efficiency behavior



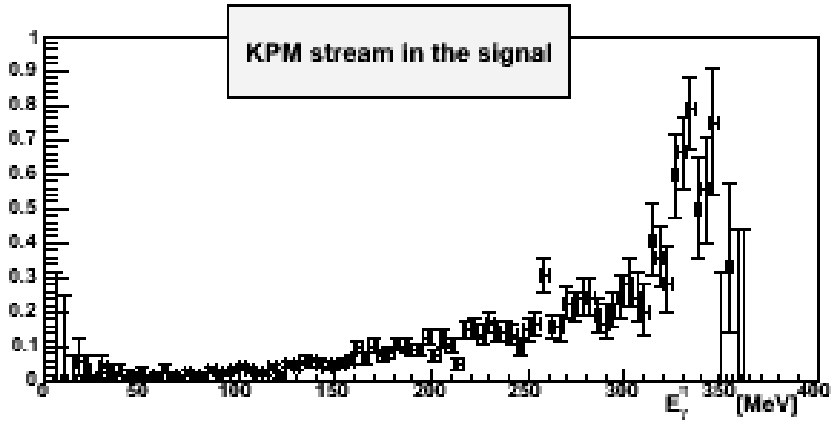


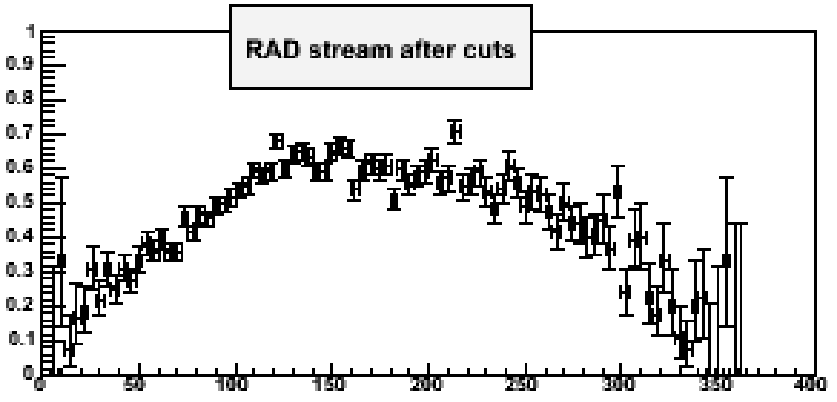
Total number of signal events at generation level 22131

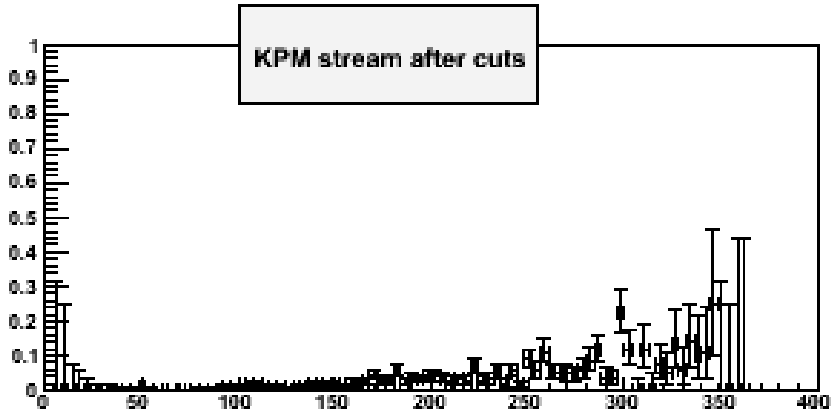
Signal processing with track selection from vertex bank:	Preselection	Event signature	|Et-Pt| < 10MeV	OpAn < 0.2
ALL	17619 (80%)	12553 (57%)	10321 (47%)	9629 (43%)
RAD	10916 (49%)	9430 (43%)	8284 (37%)	7877 (36%)
KPM	1210 (5.5%)	595 (2.7%)	255 (1.1%)	186 (0.8%)
RPI	1665 (7.5%)	1524 (6.8%)	1415 (6.4%)	1336 (6.0%)

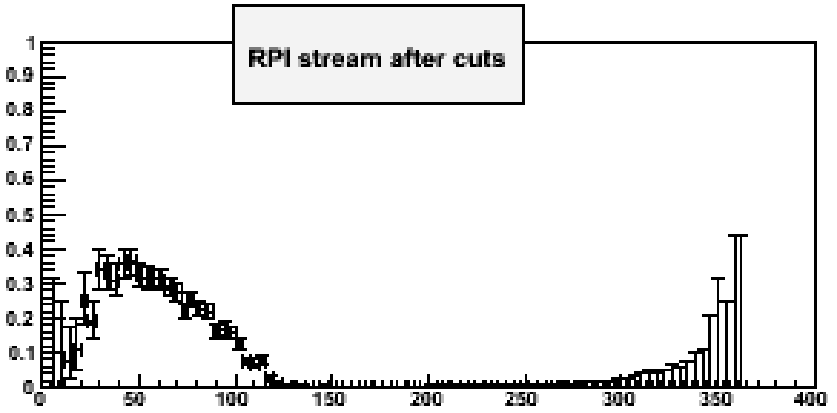
Signal processing with track selection from track bank based on PCA of the track:	Preselection	Event signature	|Et-Pt| < 10MeV	OpAn < 0.2
ALL	17619 (80%)	15335 (69%)	12499 (56%)	11550 (52%)
RAD	10916 (49%)	10904 (49%)	9771 (44%)	9271 (42%)
KPM	1210 (5.5%)	998 (4.5%)	475 (2.1%)	359 (1.6%)
RPI	1665 (7.5%)	1665 (7.5%)	1575 (7.1%)	1493 (6.7%)

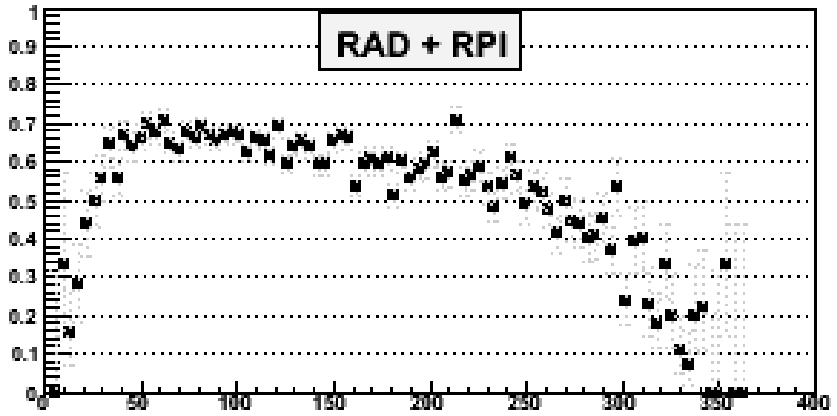
Efficiency with new track selection

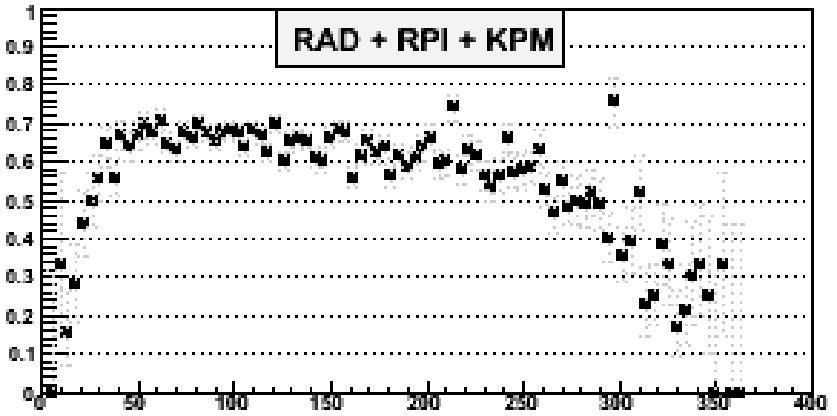












Unaccounted background