Status report on

$\eta \rightarrow \pi^+ \pi^- e^+ e^-$

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Outline

Tracking efficiencies

PID using TOF

Background studies

Small news

Conclusions

Tracking efficiency

using $\rho\pi$ sample work done together with A. De Santis

Sample selection

#tracks from IP = 1 or 2

tagging tracks checked for flips

One and only one cluster pair such that:

$t_{cl} - r_{cl}/c < \min(2\ ns, 3\sigma_t)$

$0.65 < \cos(\gamma\gamma) < 0.85$

$300 < E_{\gamma\gamma} < 600$ MeV

w/o associated tracks (Official TCLO)

self-triggering (on the barrel and $E_{cl} > 70$ MeV)

$|m_{\pi 0} - m_{\gamma\gamma}| < 40$ MeV

Efficiency on $\rho\pi$ stream ~ 0.09

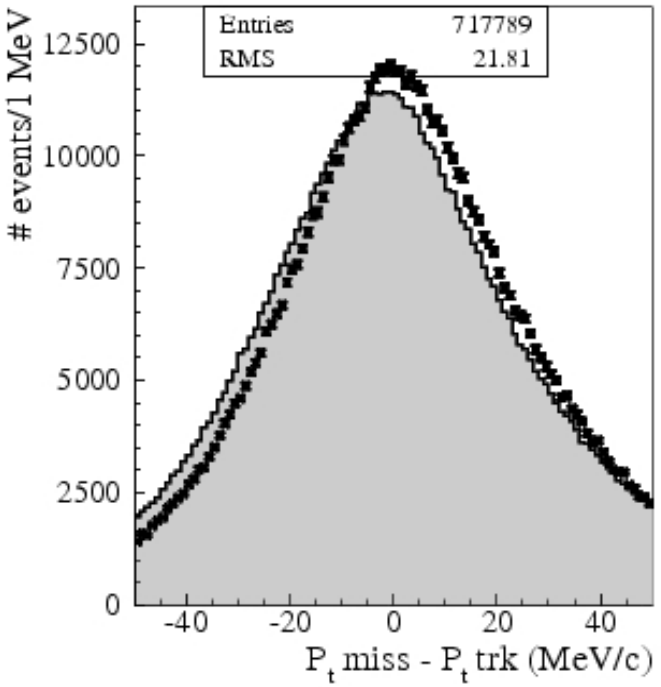
Sample purity ~ 0.994

Tracking efficiency

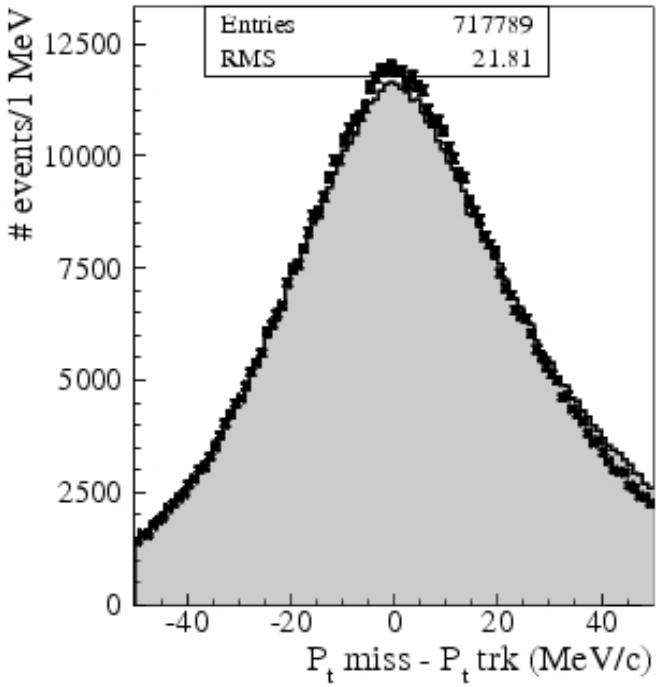
After $\gamma\gamma$ selection, kinematic fit to π^0 mass is applied

It improves the knowledge of the missing momentum

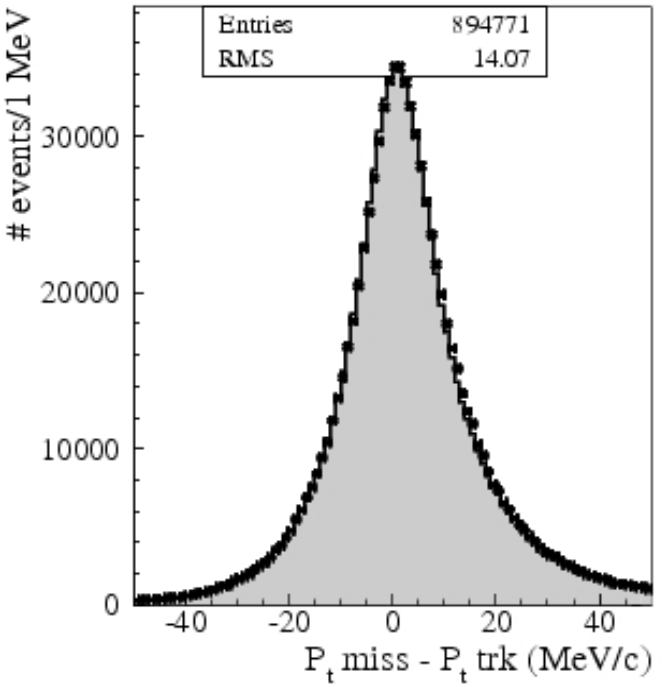
Cluster energy correction applied $E_{eff}=1.014\times E_{rec}$ (KM342)



Raw



Linearization



Linear. & Fit

Dots: data Filled: MC

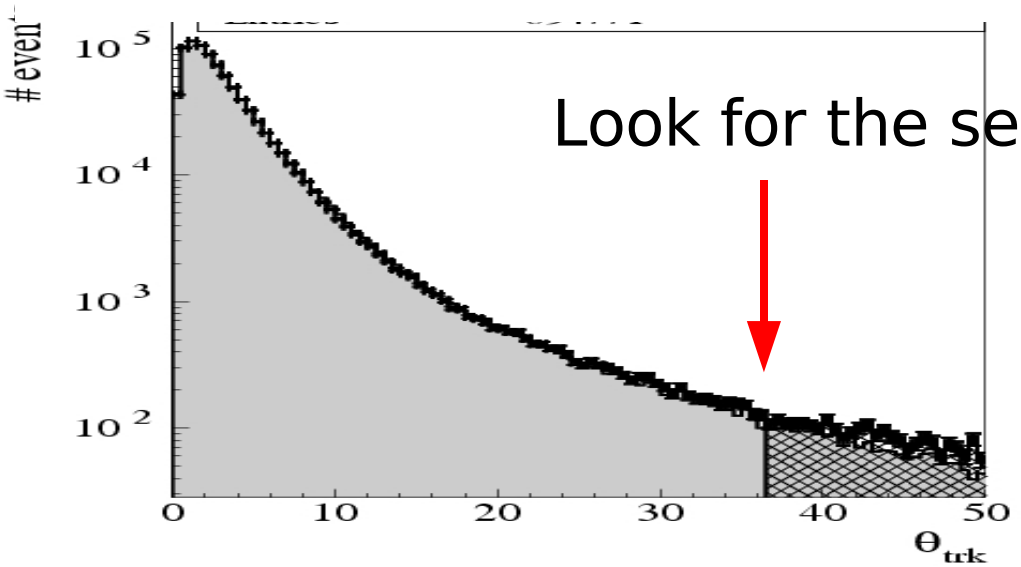
Tracking efficiency

Multiplicity has to be considered in efficiency evaluation

$$\varepsilon_{obs} = \frac{2N_2P(C_2)}{2N_2P(C_2) + N_1P(C_1)} = \frac{2\varepsilon_1^2}{2\varepsilon_1^2 + 2\varepsilon_1(1-\varepsilon_1)} = \varepsilon_1$$

Efficiency can be evaluated separately per charge

$$\varepsilon_{obs}^{\pm} = \frac{n(\pm\, track | \mp\ tag)}{n(\mp\, tag)} = \frac{P(C_2)}{P(C_2) + P(C_1^{\mp})} = \frac{\varepsilon_{1\pm}^2}{\varepsilon_{1\pm}^2 + \varepsilon_{1\pm}(1-\varepsilon_{1\pm})} = \varepsilon_{1\pm}$$

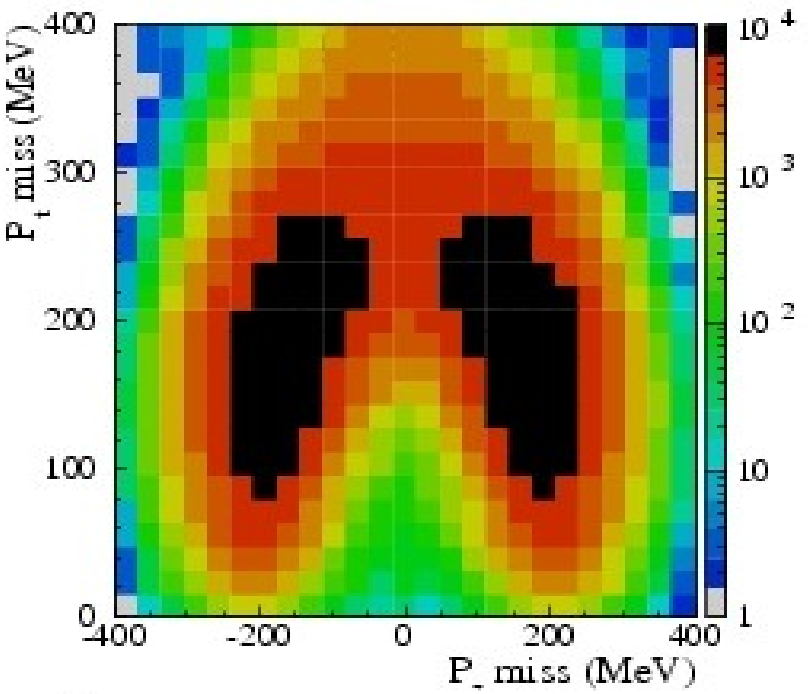


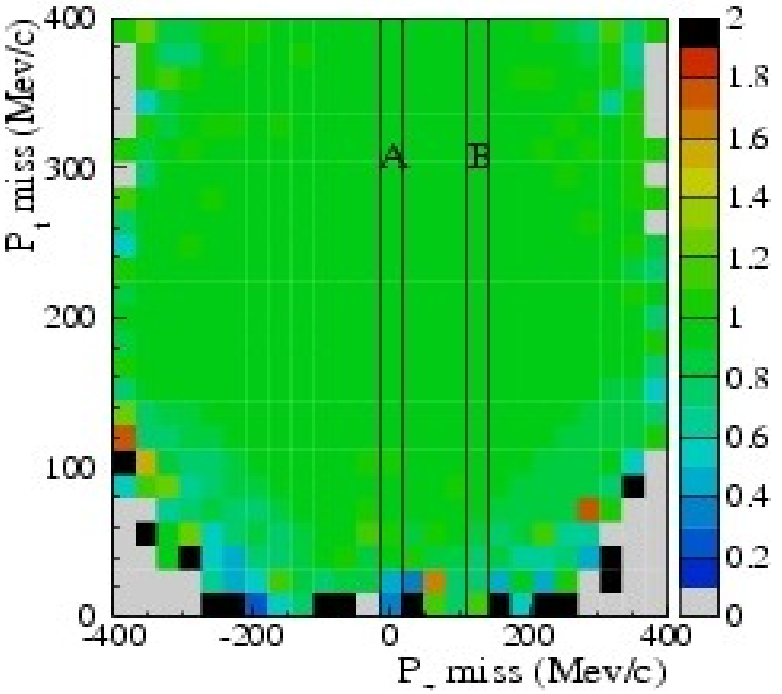
Look for the second track around the pointer

$\cos\theta_{trk} < 0.8$

Tracking efficiency

Data pointer

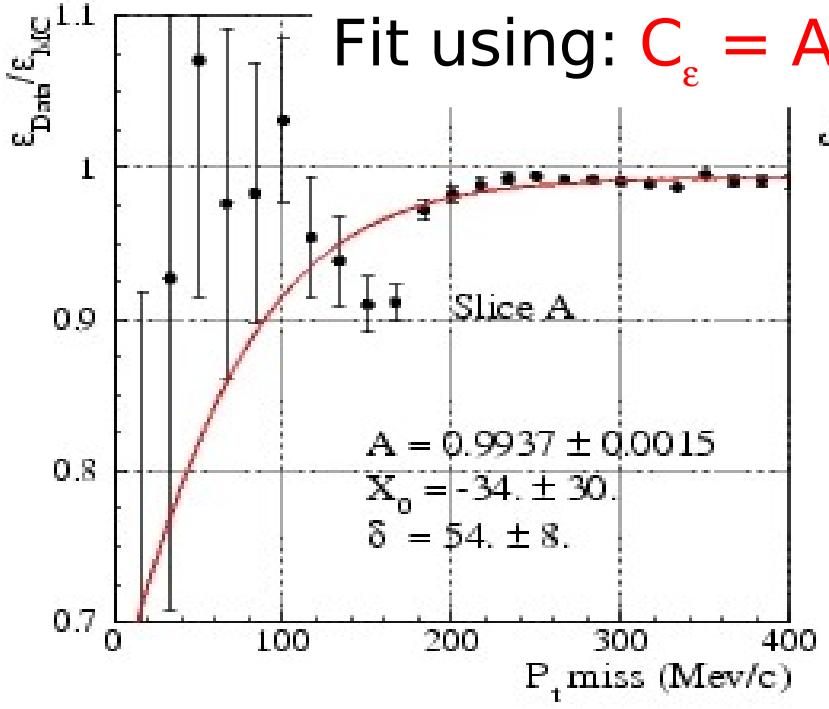


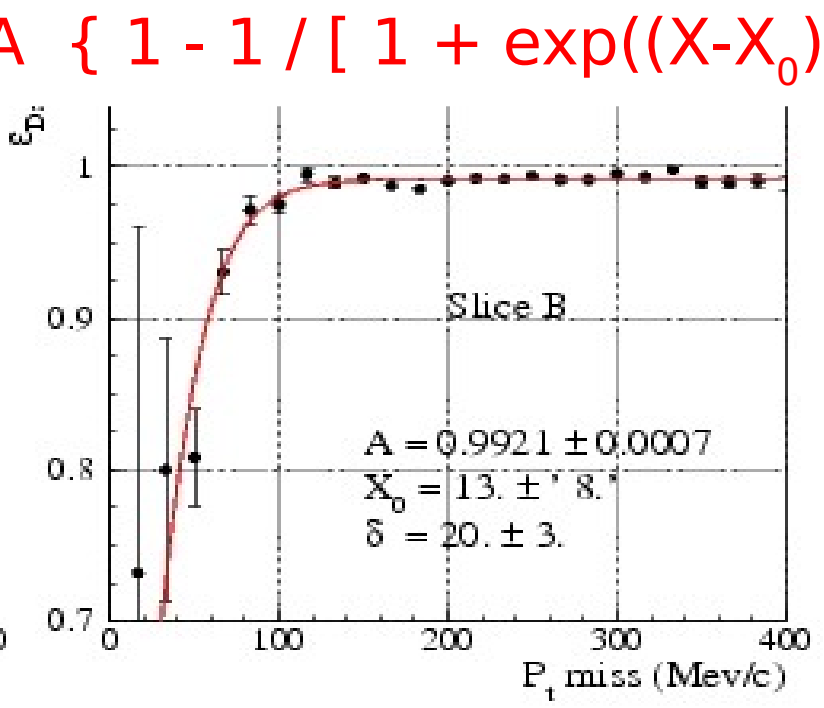


$\frac{\varepsilon_{Data}}{\varepsilon_{MC}}$

Fit using: $C_\varepsilon = A \{ 1 - 1 / [1 + \exp((X-X_0)/\delta)] \}$

$\frac{\varepsilon_{Data}}{\varepsilon_{MC}}$

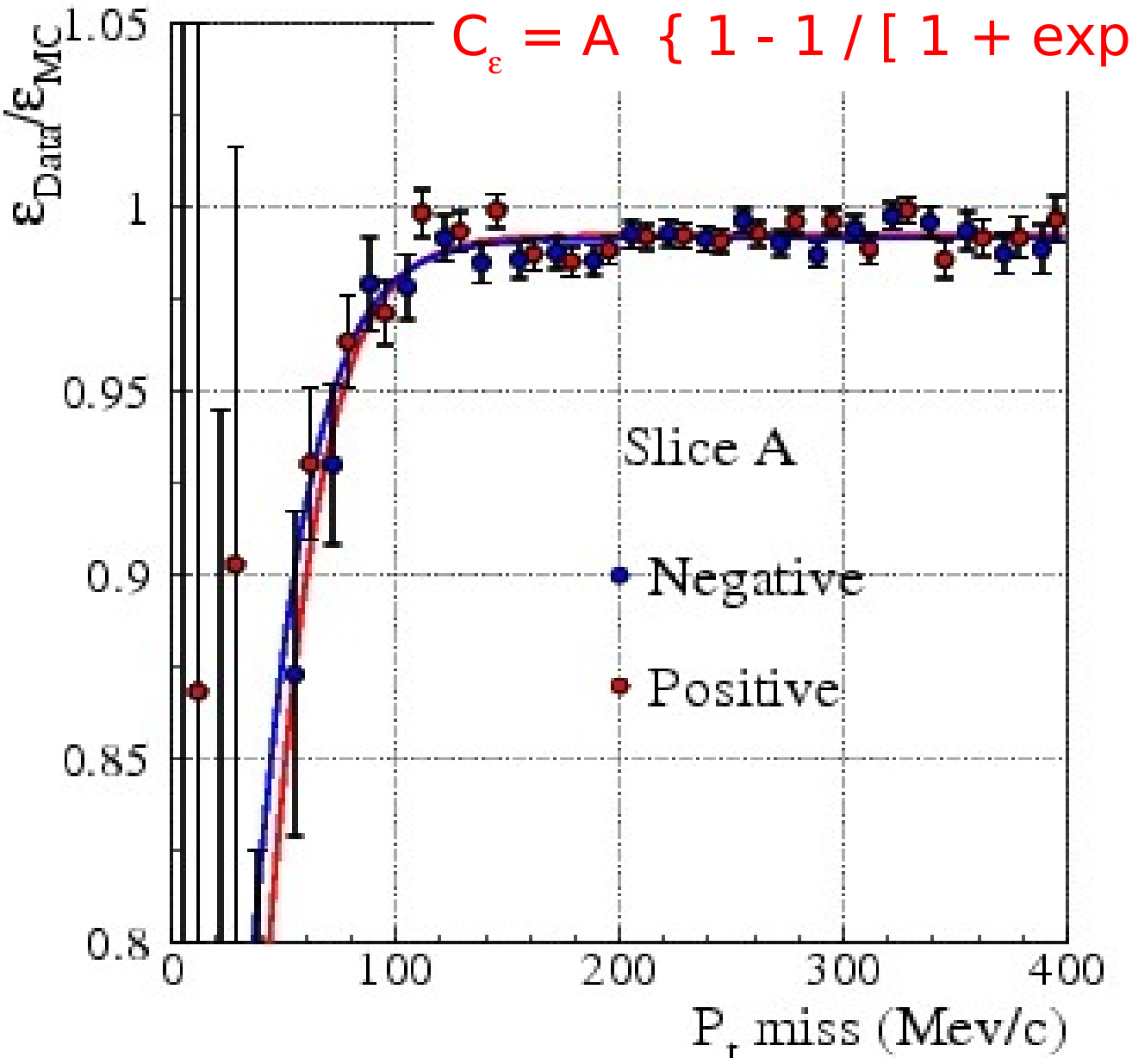




$\frac{\varepsilon_{Data}}{\varepsilon_{MC}}$

Tracking efficiency

$C_\varepsilon = A \ \{ 1 - 1 / [1 + \exp((X-X_0)/\delta)] \}$



Work finished

KLOE Memo 343

Code updated:
new ntuples
already
produced

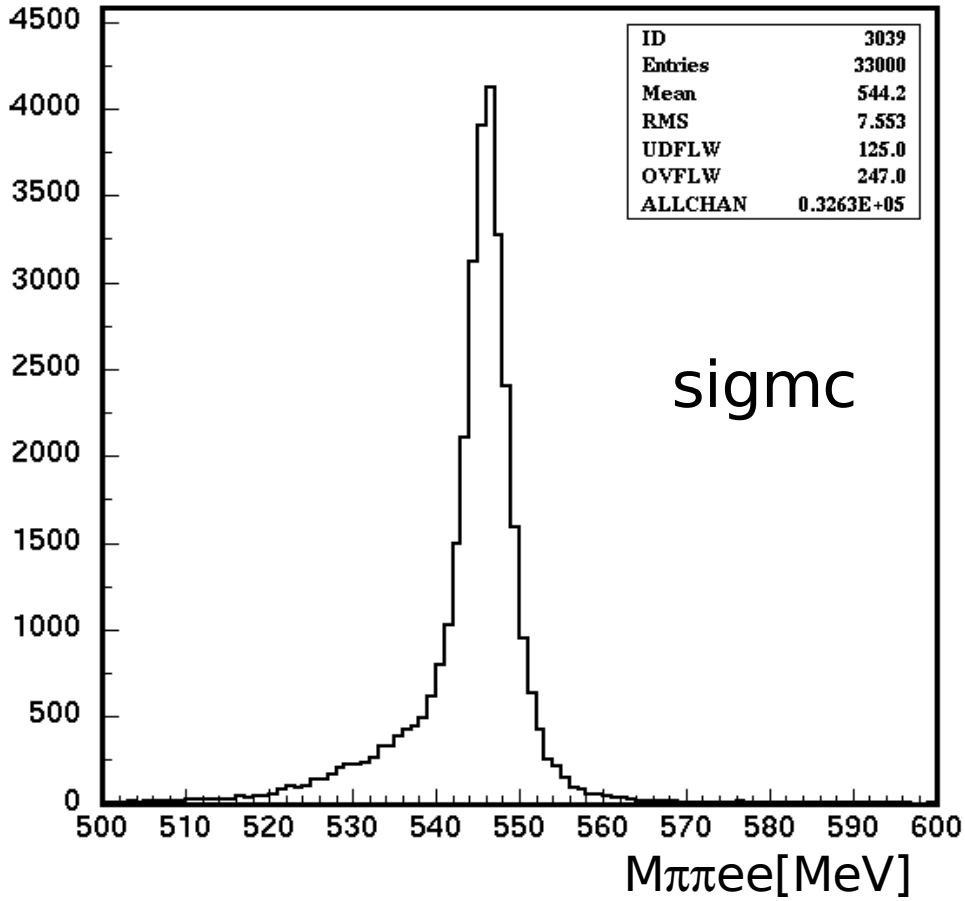
PID using TOF

Asymmetry in Mππee spectrum due to *wrong mass assignment*

Can be improved using TOF

We evaluate $\Delta t = t_{track} - t_{cluster}$ in both electron (Δt_e) and pion (Δt_π) hypothesis

#tracks	4	0.04
associated	>3	0.29
to cluster	>2	0.74
and fraction	>1	0.99

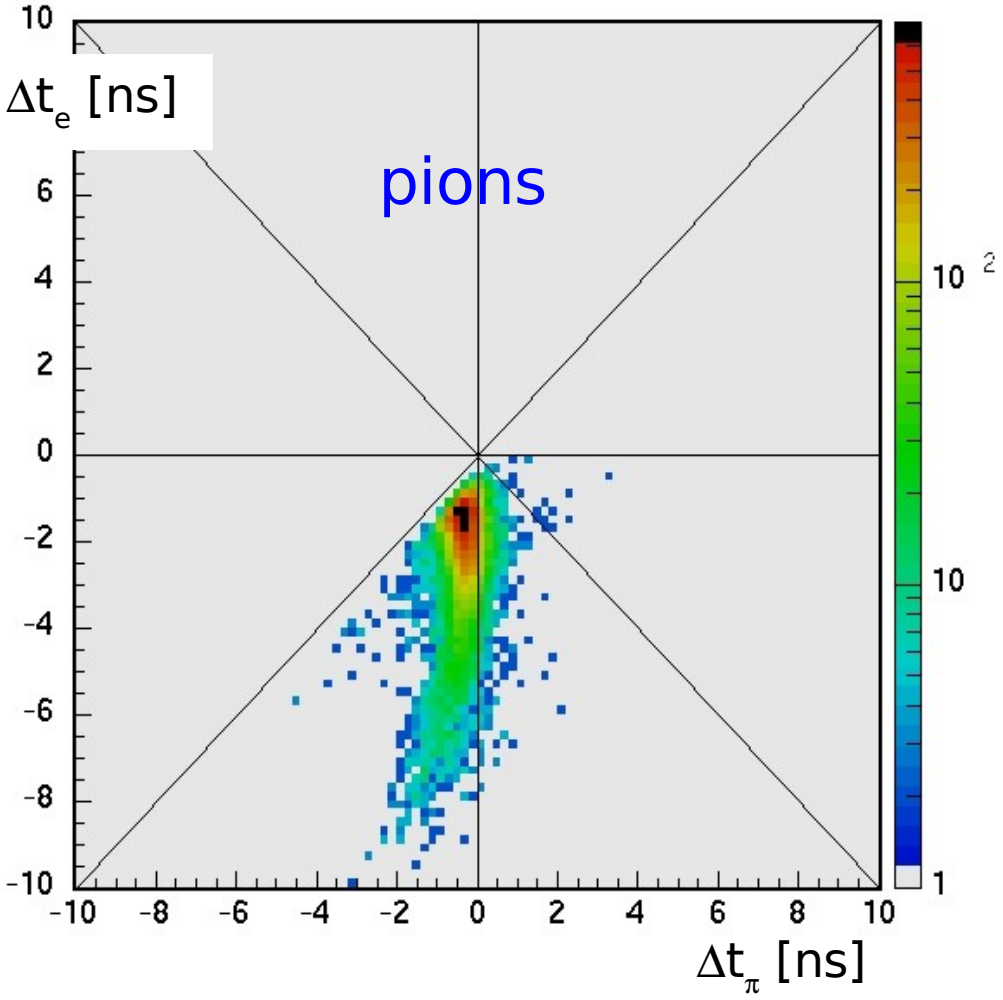


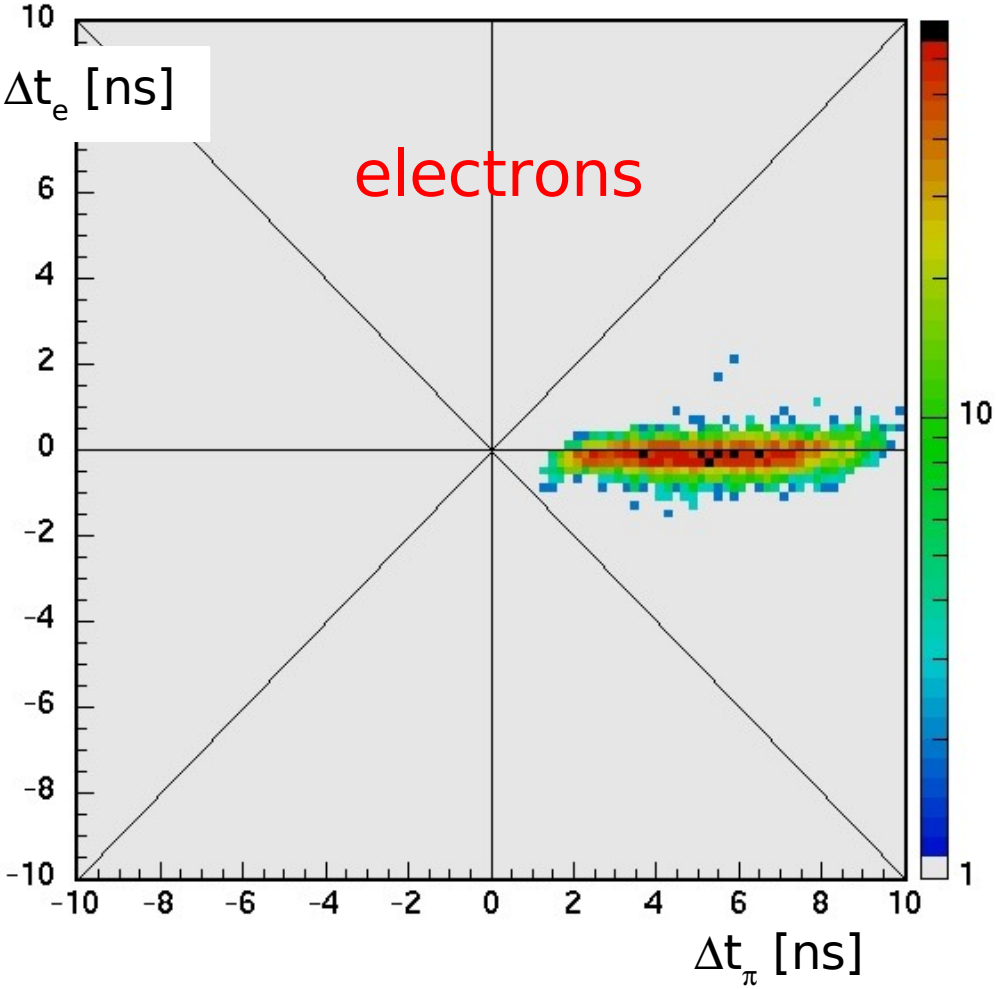
Also look for kink (i.e. decay)

Extrapolation to EMC using Spadaro's libraries

PID using TOF

Cool! Hm.... I mean.... powerful!





PID using TOF

Algorithm for mass assignment

T#1 = Track #1 T#2 = Track #2

1-Look for track pair having the same charge and extrapolation to the calorimeter (both tracks)

T#1 with kink
T#2 without kink
$\Rightarrow$
T#1=π
T#2=e

2-For all other tracks use Δt_e vs Δt_π to assign mass

3-Use pair's charge to solve ambiguities

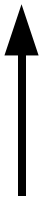
PID using TOF

Algorithm for mass assignment

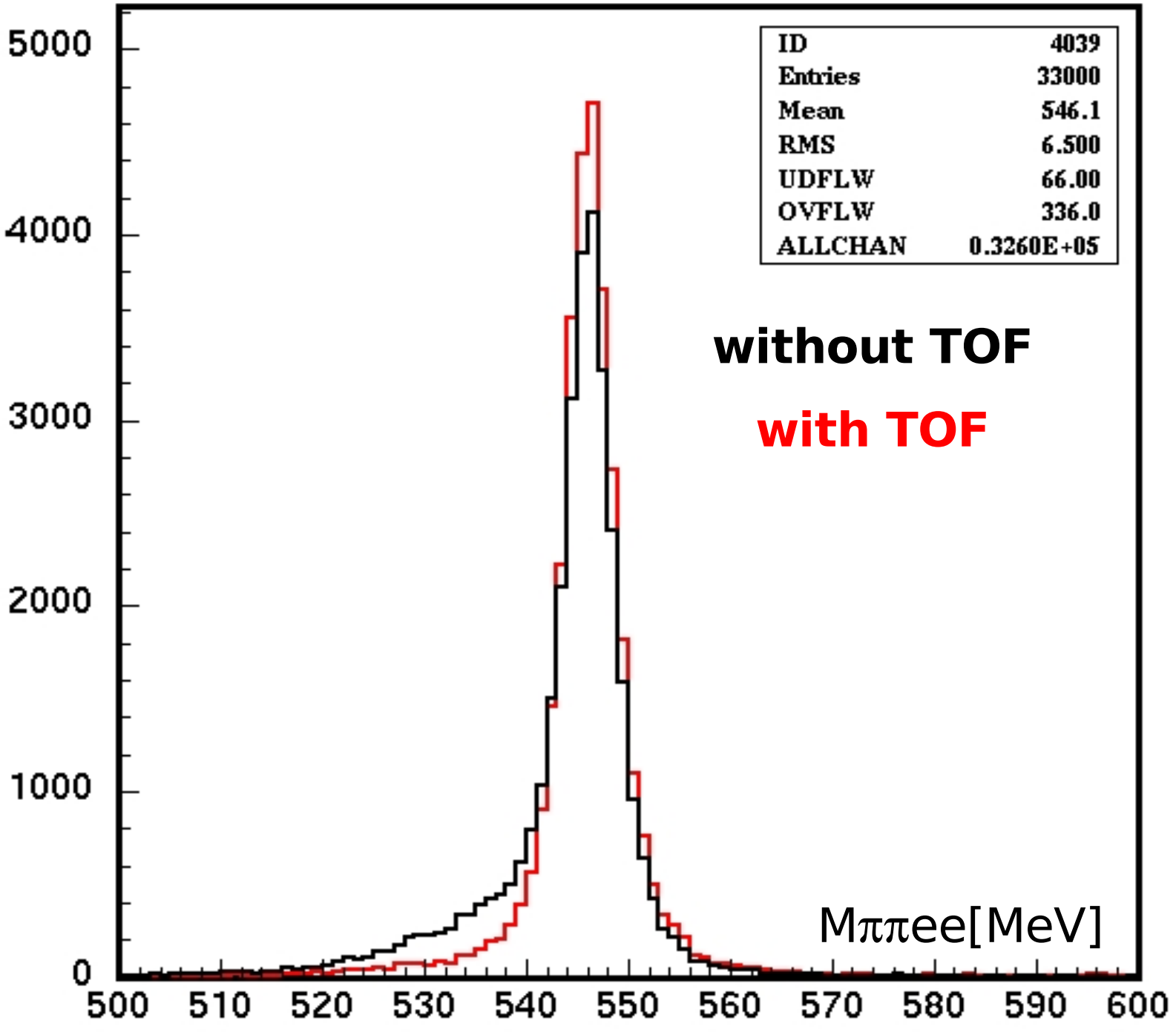
3-Use pair's charge to solve ambiguities

T#1	T#2	
e	e	min(Δt_e) $\Rightarrow$ e
e	π	ok
e	?	T#2 = π
π	e	ok
π	π	min(Δt_e) $\Rightarrow$ e
π	?	T#2 = e
?	e	T#1 = π
?	π	T#1 = e
?	?	if T#1 w/ kink and T#2 w/o kink $\Rightarrow$ T#1=π & T#2=e (and vice versa)

Ordered momenta are used for remaining assignment ambiguities



PID using TOF



Background studies

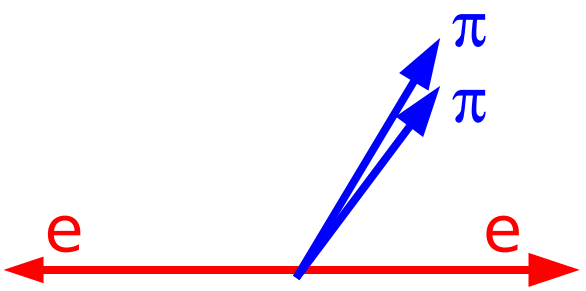
Simona started studying backgrounds

Aim: analysis cuts optimization

Background

non simulated

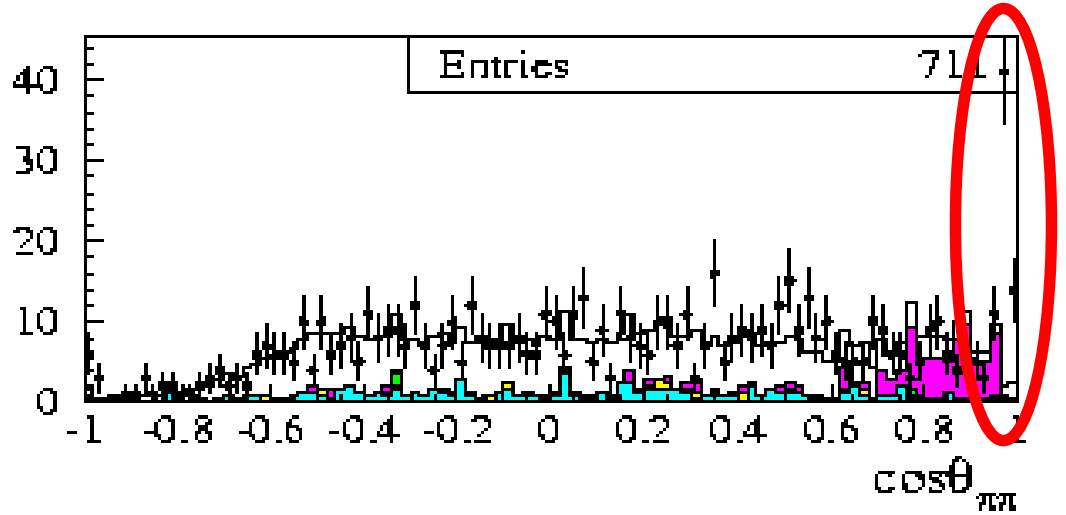
in all_phys found

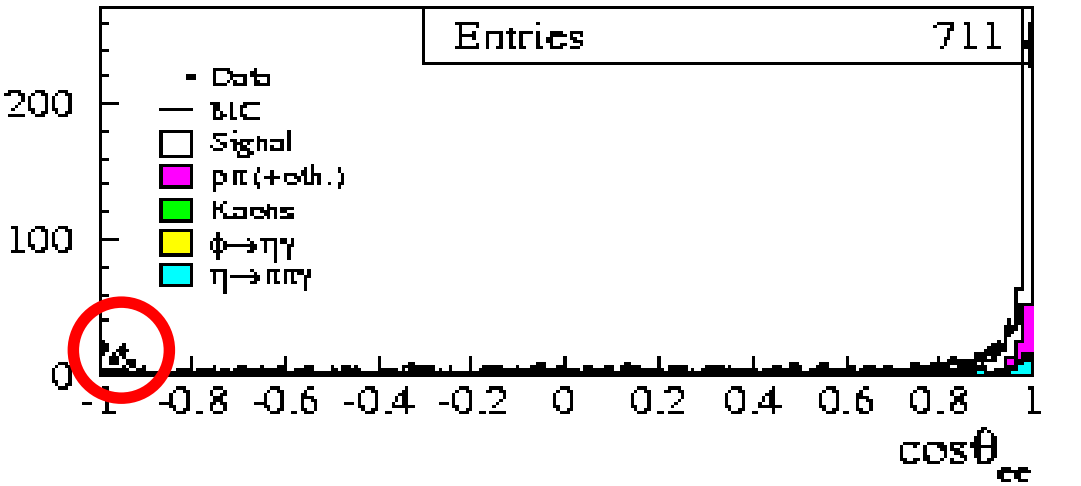


Radiative Bhabha?

$\pi\pi\gamma$ events?

Under investigation

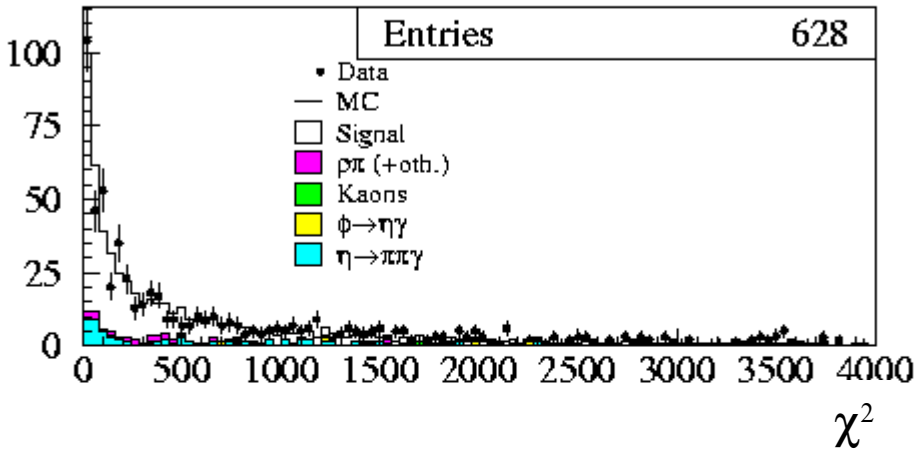


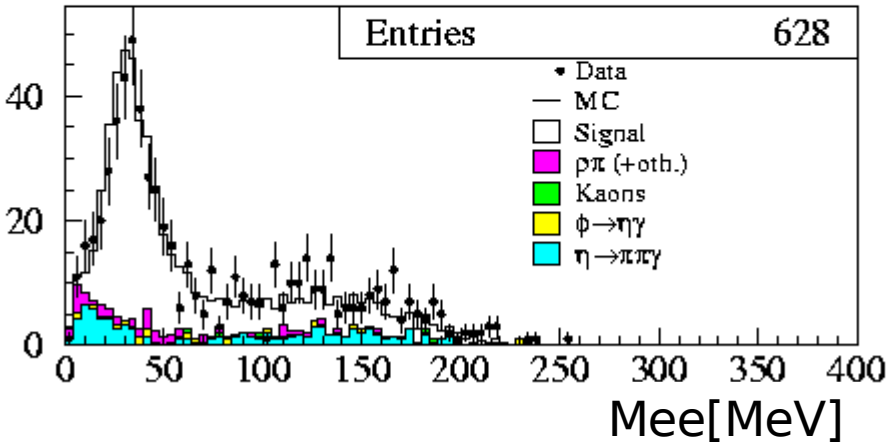


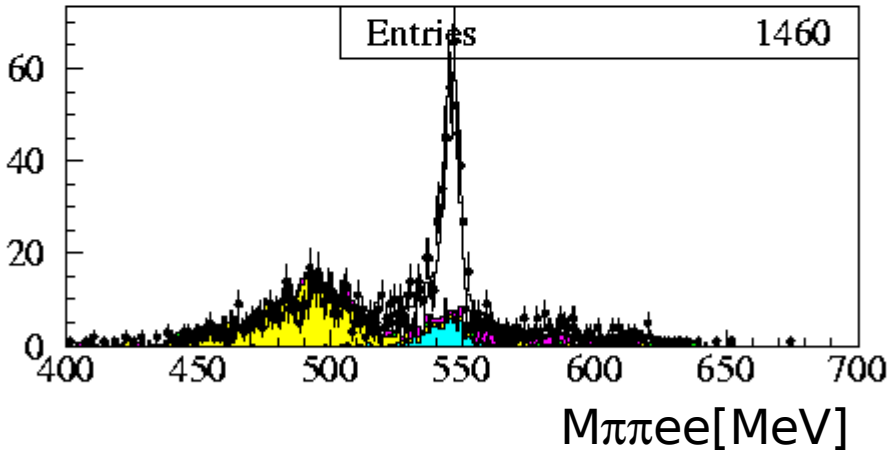
Background studies

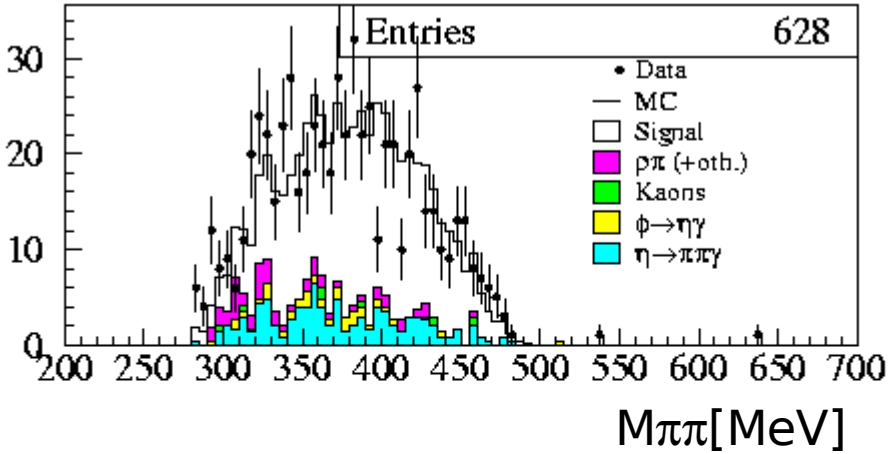
Anyway good MC-Data agreement after all cuts

(χ^2, momenta, conv@BP, Mππee, angular cuts)









Small news

MC all_phys2 and all_phys3 production finished;

ntuples already produced

eeg and ppg ntuples produced too

(backgrounds not simulated in all_phys)

Easter Bunny will bring 1 fb^{-1} of 2005 data

reprocessed with dbv-26

Conclusions

✔ Correction to tracking efficiency

✔ PID with TOF

✔ MC statistics increased

✔ Additional backgrounds ntuples

✘ Accidental cluster veto

✘ Merge all the new stuff together

Backup slides

Motivations

η structure, using virtual photon

Model comparison (VMD, χPT)

Test of CP violation: Gao model

Mod.PhysLett.A17
1583-1588.2002

Angular asymmetry between ee and $\pi\pi$ planes, A_{CP},

can be due to unconventional CPV mechanism

described by a T$\times$V 4 quarks operator with $\Delta s=0$.

Within SM constrained by BR($\eta\rightarrow\pi\pi$),

using the experimental upper limit: $A_{CP} < 10^{-4}$

using theoretical prediction: $A_{CP} \sim 10^{-15}$

CPV model predicts an upper bound of 10^{-2}

BR: theory & experiment

Jarlskog, Pilkuhn 1967	$0.0065 \times BR(\eta \to \pi^+\pi^-\gamma)$	
Using PDG06 $(30.5 \pm 0.7) \times 10^{-5}$	$(25.7 \pm 1.3) \times 10^{-5}$	Using CLEO '07
Picciotto, Richardson 1993	$(32 \pm 3) \times 10^{-5}$	
Faessler et al. 2000	36×10^{-5}	
Borasoy, Nissler 2007	$(29.9^{+0.6}_{-0.9}) \times 10^{-5}$	

CMD-2 (4 events)	$(37\ ^{+25}_{\text{-18 stat}} \pm 3_{\text{syst}}) \times 10^{-5}$
CELSIUS-WASA (16 events)	$(43 \pm 13_{\text{stat}} \pm 4_{\text{syst}}) \times 10^{-5}$

Data sample

79 pb^{-1} data 2002

512 pb^{-1} data 2004

110 pb^{-1} data 2005

46×10^3 pb^{-1} MC signal only

529 pb^{-1} MC all_phys 2004

1194 pb^{-1} MC all_phys 2005

Using mrc stream ETA4C tag

As for now, not used

More data reprocessing with DBV>26 is needed
Ongoing

More MC productions
allphys2: completed
allphys3: completed