σ_{had}: a status report

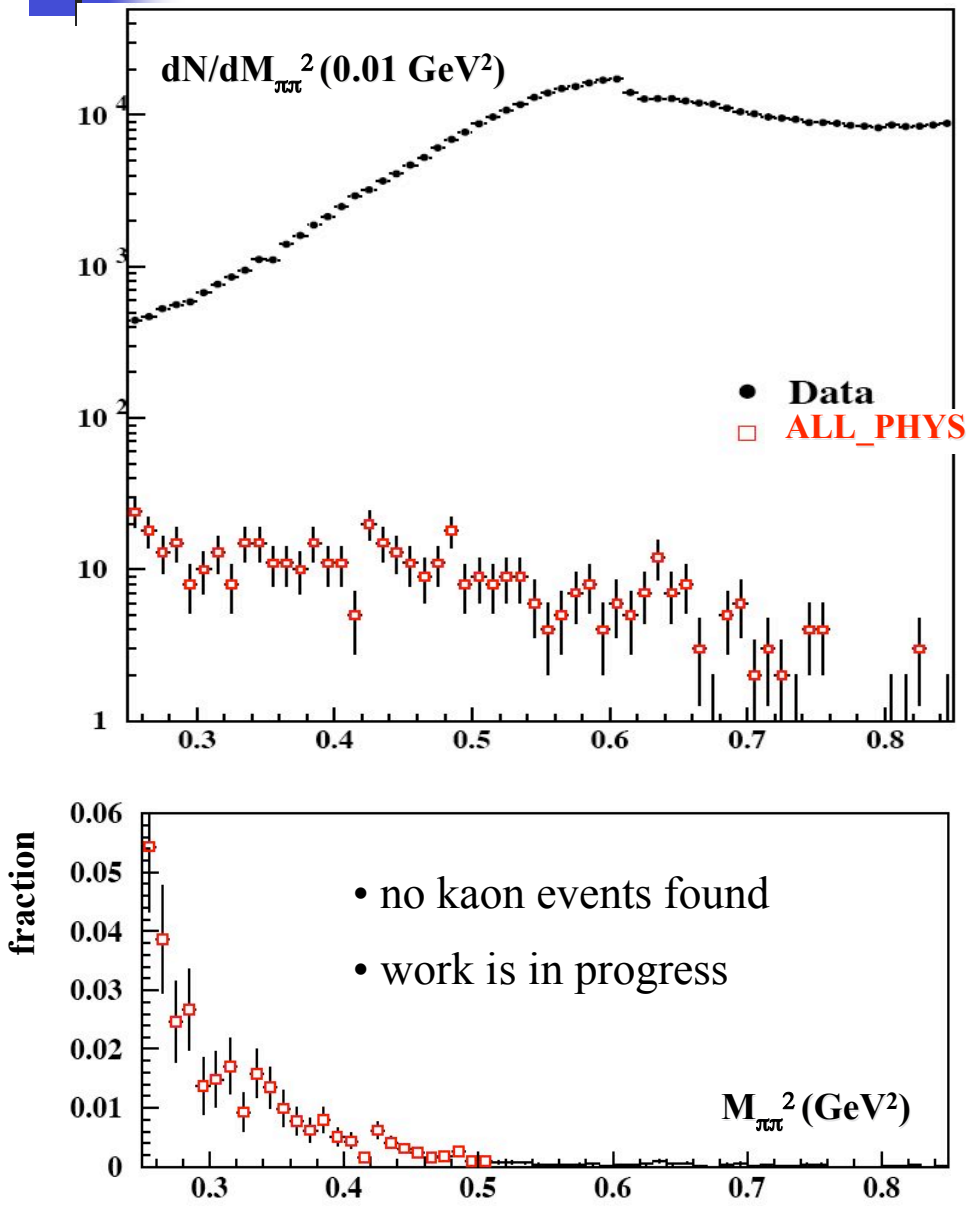
decays - 12/12/06

P. Beltrame, A. Denig, W. Kluge,
D. Leone, S. Müller, F. N., G. Venanzoni

1) Large Angle Analysis: background & acceptance
2) Off Peak Analysis: asymmetry
3) Small Angle Analysis: upgrades

Large Angle & Off PeaK Analysis

Large Angle selection on ALL_PHYS



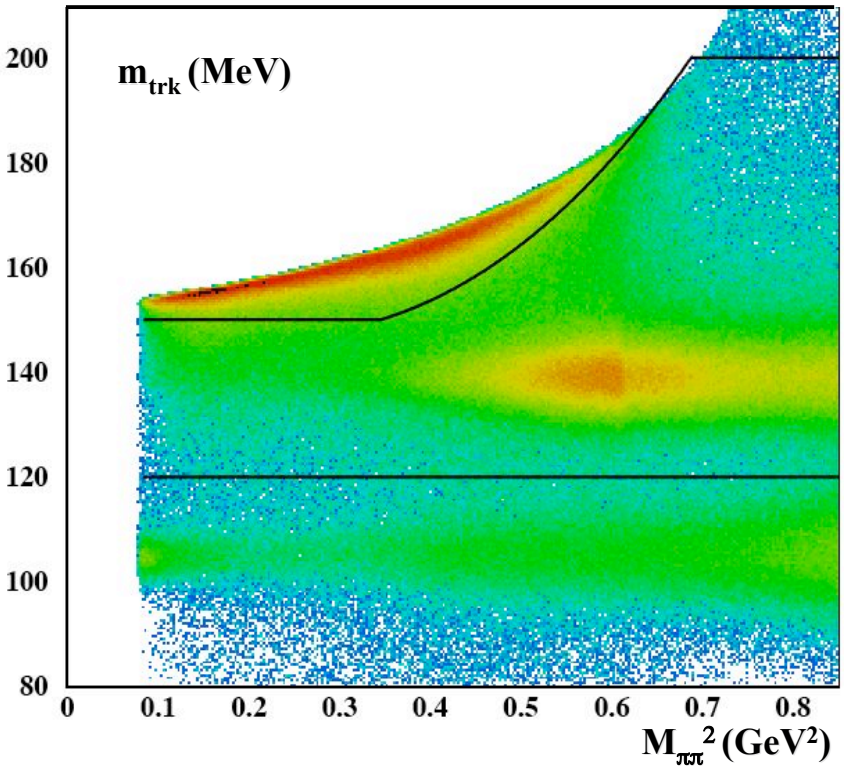
Pion tracks: $50^o < \theta_\pi < 130^o$

Photon: at least one with $50^o < \theta_\gamma < 130^o$ and $E_\gamma > 50$ MeV

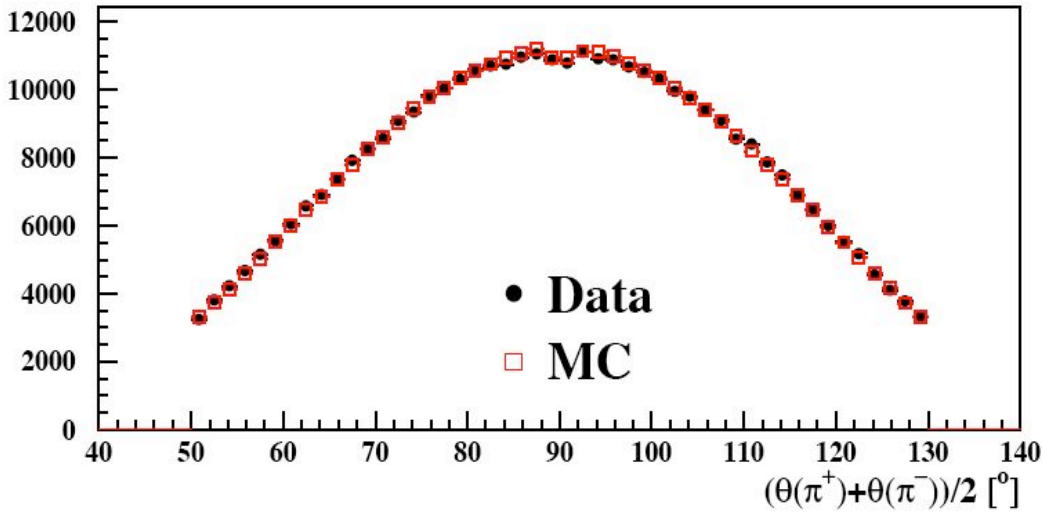
Kinematic fit cut: to reject $\pi^+\pi^-\pi^0$

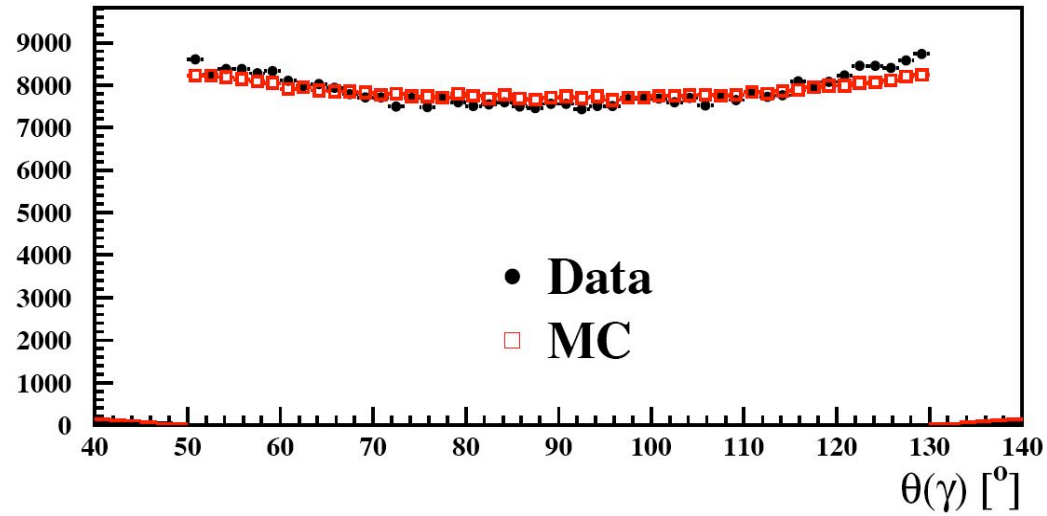
Ω angle vs E_γ cut: ∠ btw $\underline{r}_\gamma$ and $\underline{p}_{miss}$

Track mass:



Acceptance studies



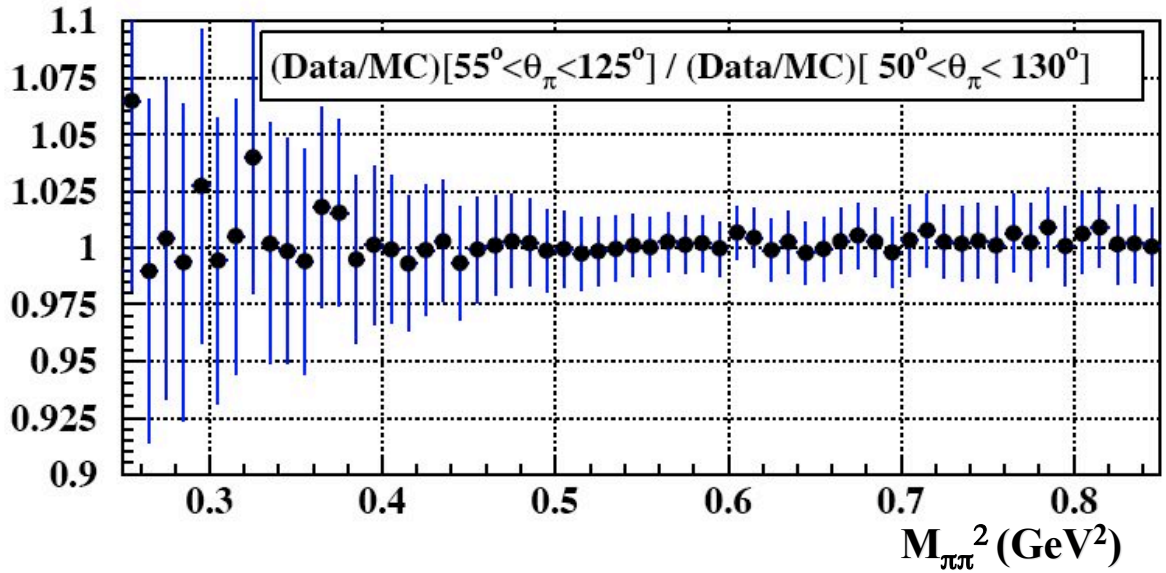


residual background contamination checked and evaluated as negligible for acceptance studies

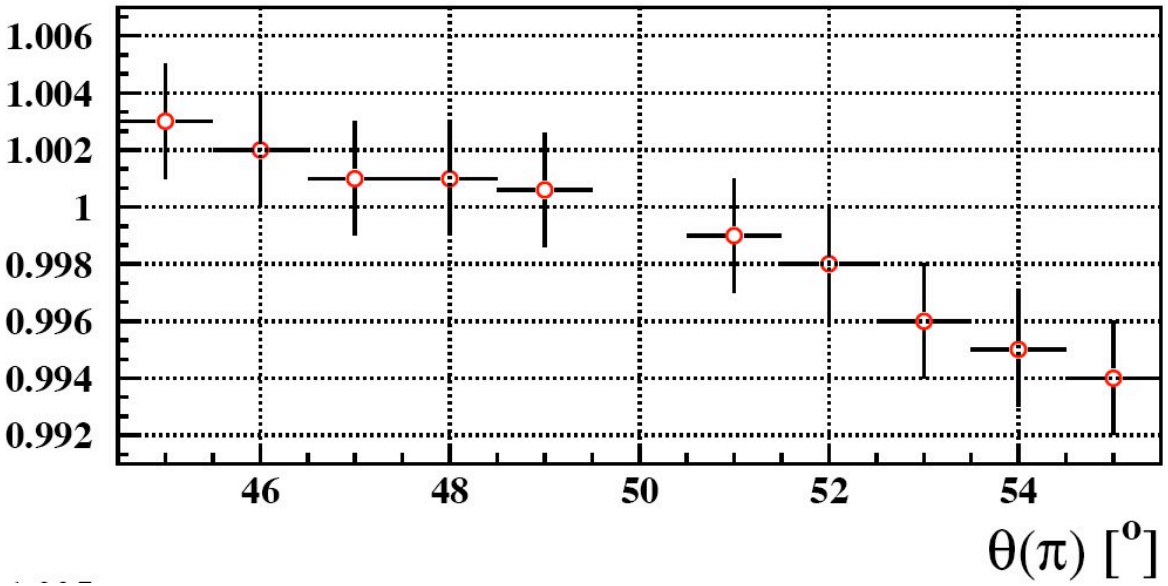
differences data-MC at the border of the selected fiducial volume are due to different resolutions

which effects to the $M_{\pi\pi}^2$ spectrum?

Systematics on the track polar angle

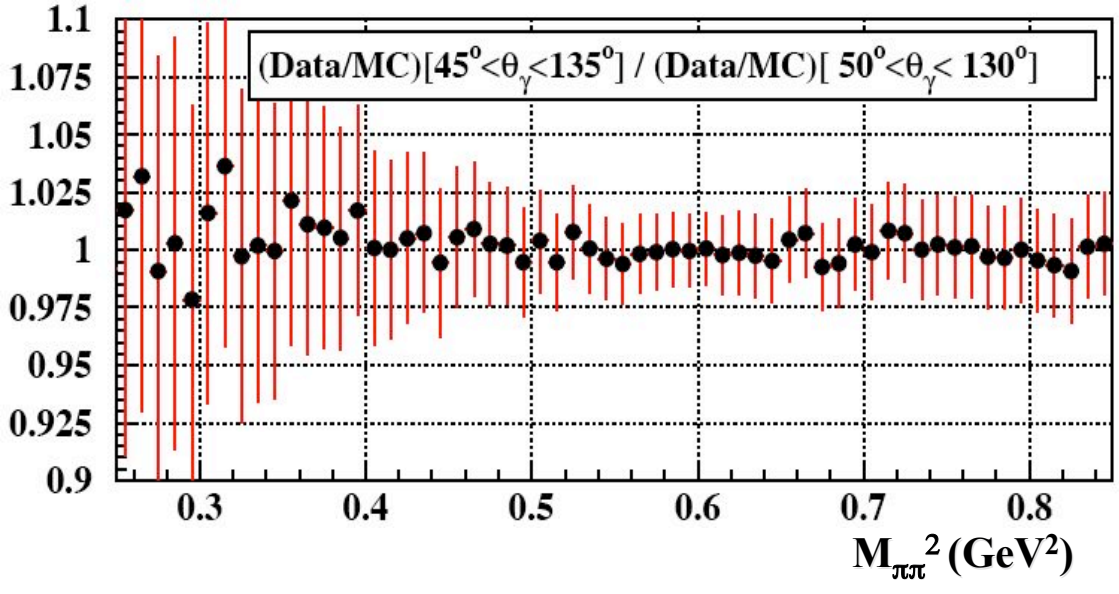


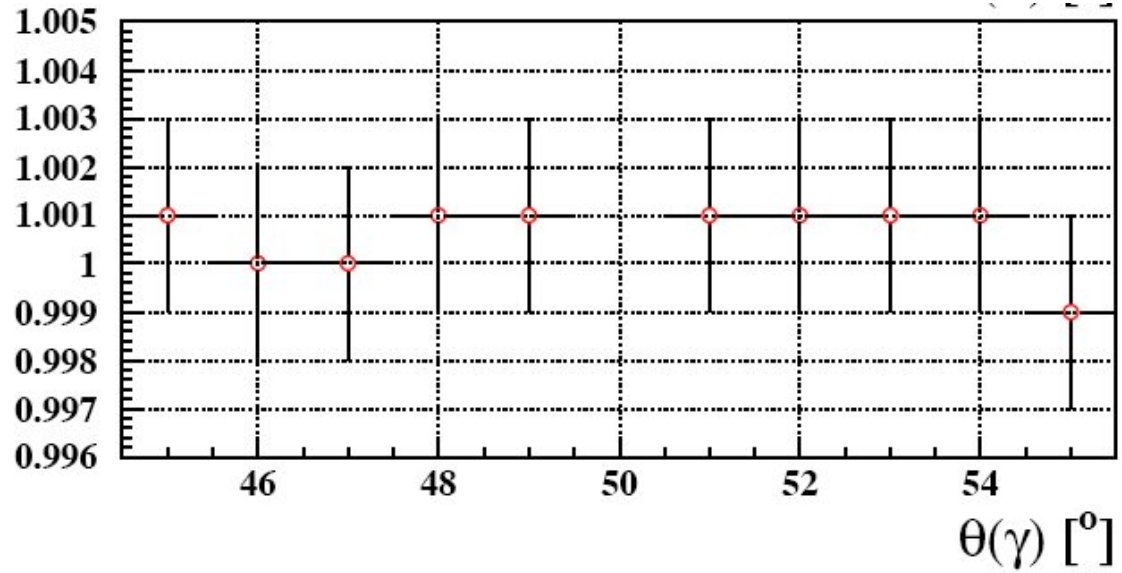
for a given angle θ_{cut}, the ratio data/MC is divided by that obtained with 50° and fitted with a constant term,



this is a function of θ_{cut} and gives an estimate of the systematic error

Systematics on the γ polar angle

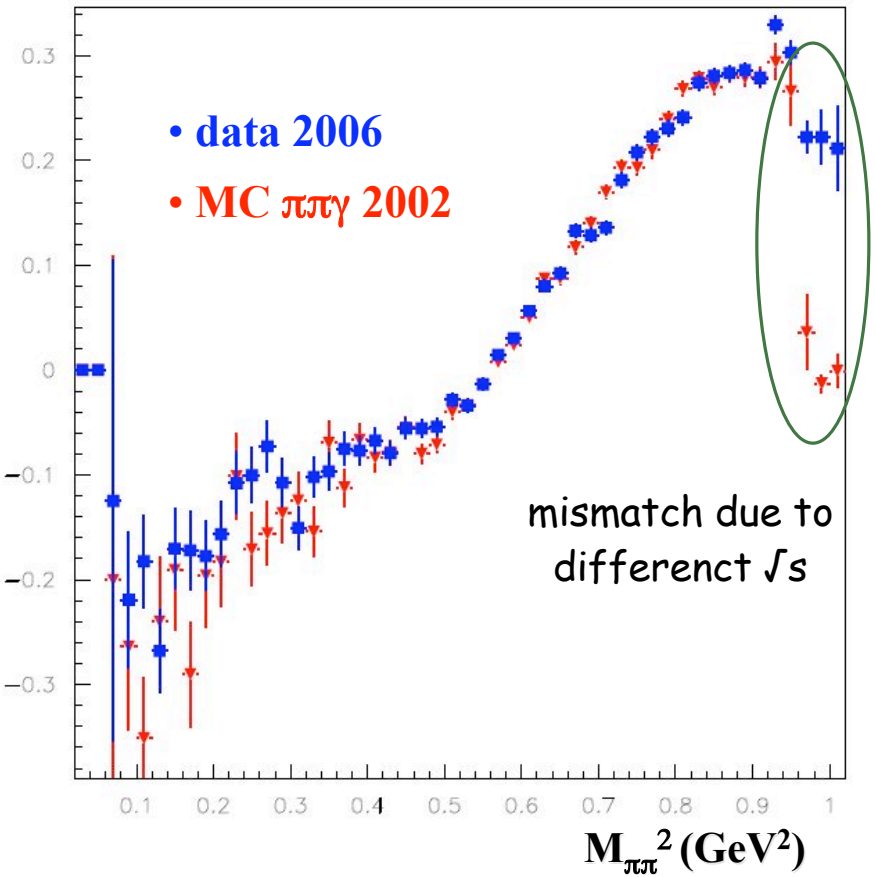




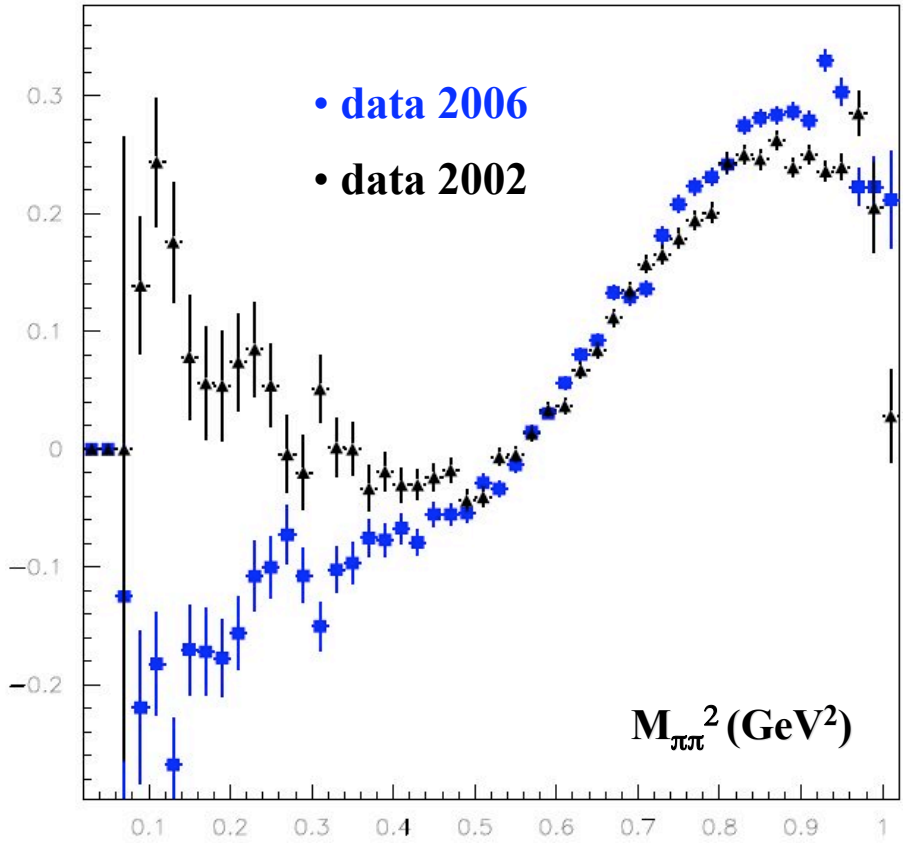
the same procedure has been applied to the photon polar angle: θ_{cut} to be varied more due to a little worse γ angle resolution

First glance at the asymmetry in the OPA

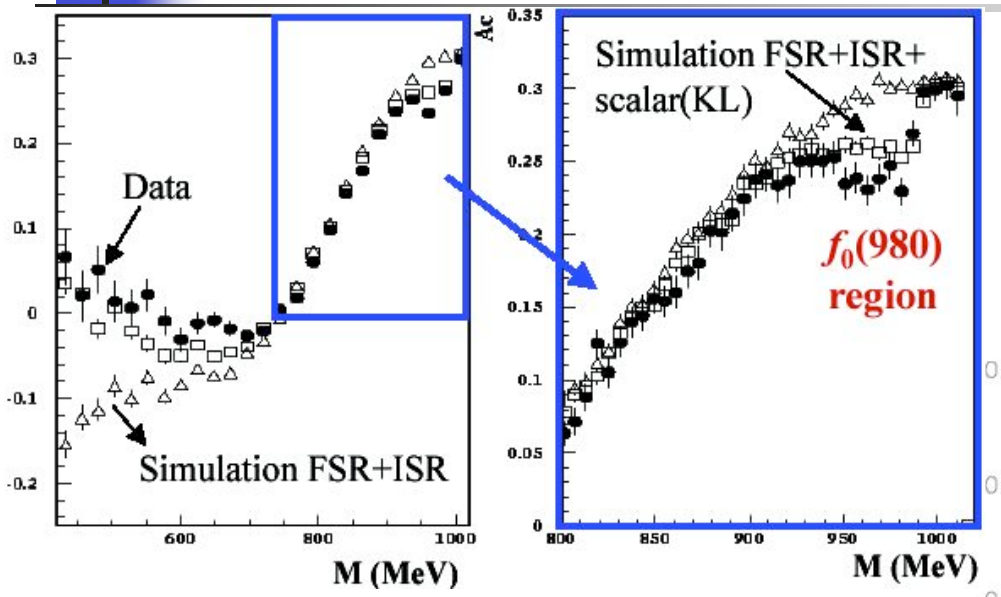
$$\mathcal{A}_{FB} = \frac{N(\theta_{\pi^+} > 90^\circ) - N(\theta_{\pi^+} < 90^\circ)}{N(\theta_{\pi^+} > 90^\circ) + N(\theta_{\pi^+} < 90^\circ)}$$



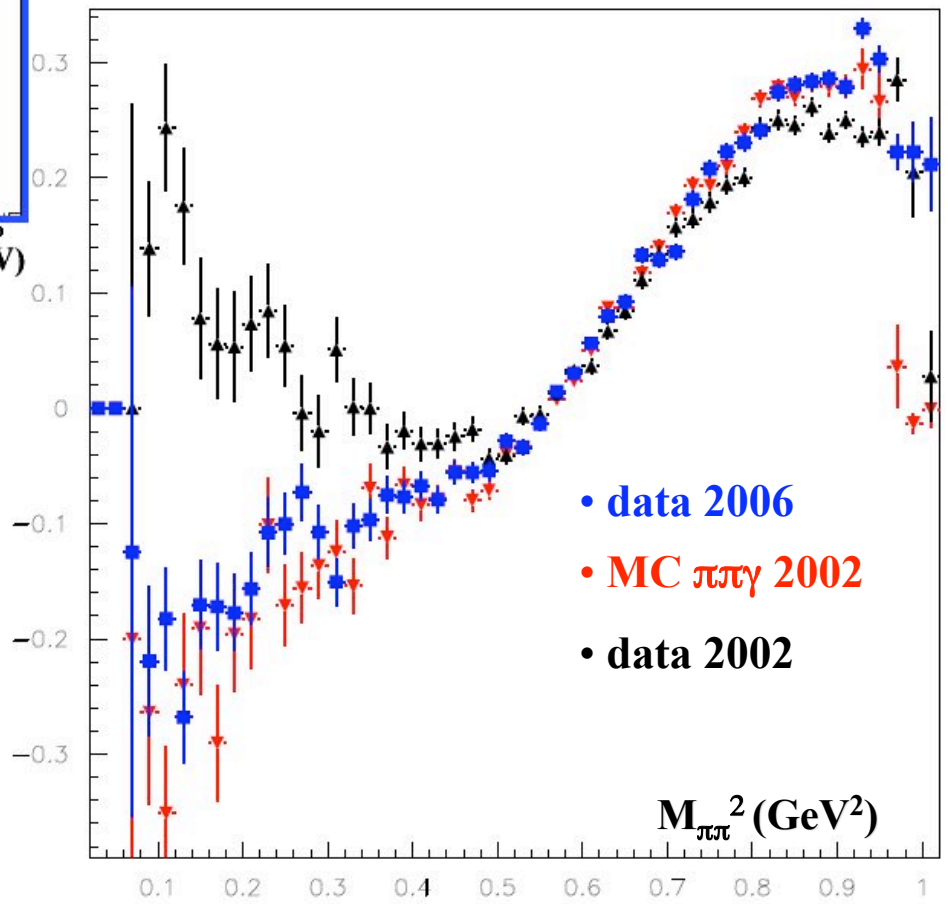
the asymmetry is used to study any FSR interference with ϕ processes: they are absent at first approx



Overall asymmetry comparison



from the $f_0 \to \pi^+\pi^-$ published paper

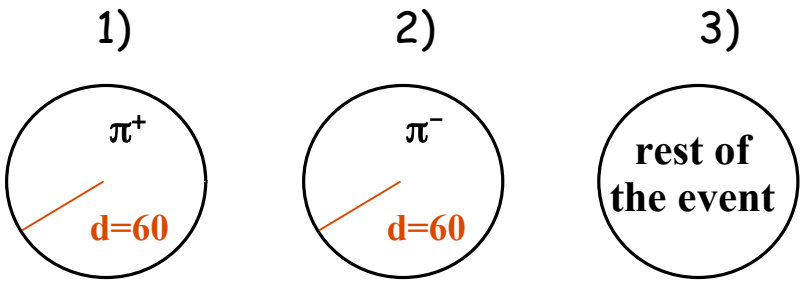


no resonant interfering effect has been observed after the LA analysis selection applied on Off Peak data

Small Angle Analysis:
ππγ & μμγ selections

Comparison single particle with bit

we are testing the method: both blue and red curves are from MC



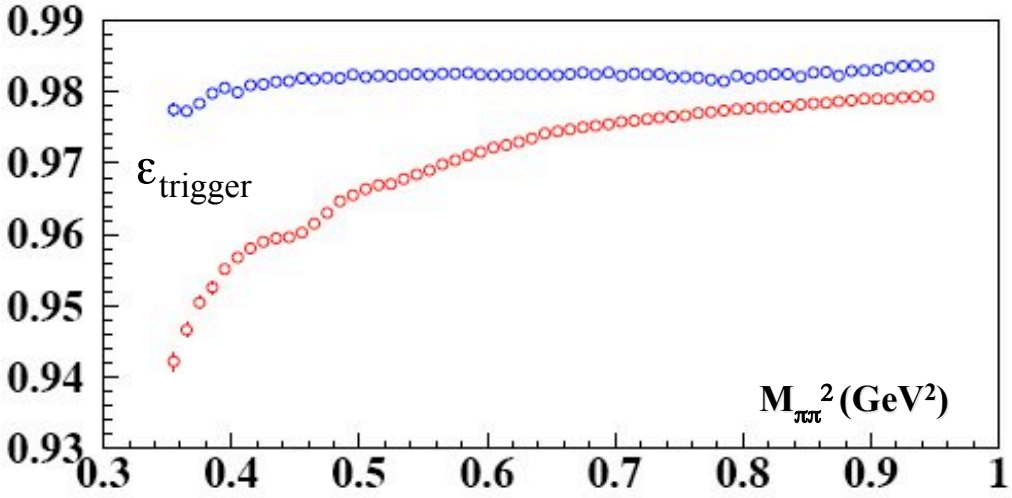
single particle: clusters are associated to pions if within 60 cm from the extrapolated track (consistent with the definition for the Likelihood)

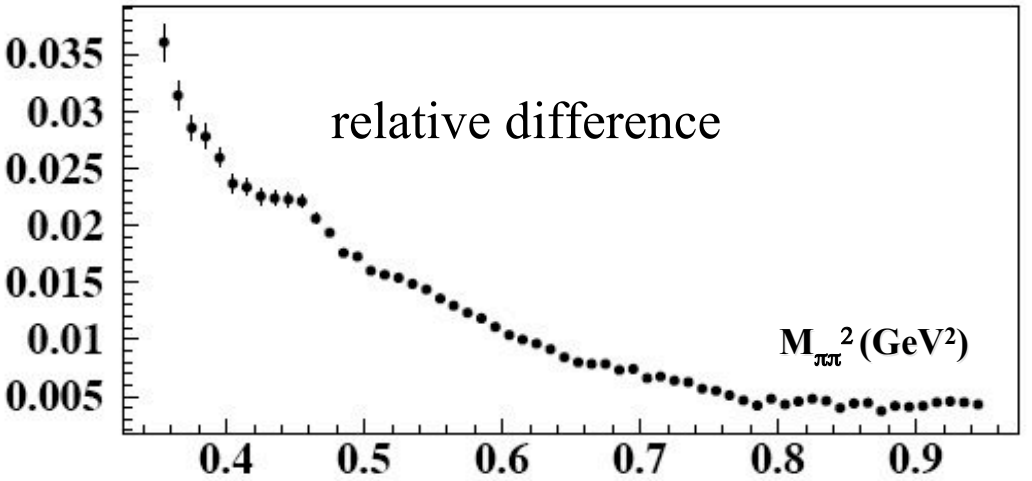
bit: the usual convention

2 = calorimeter only

4 = drift chamber only

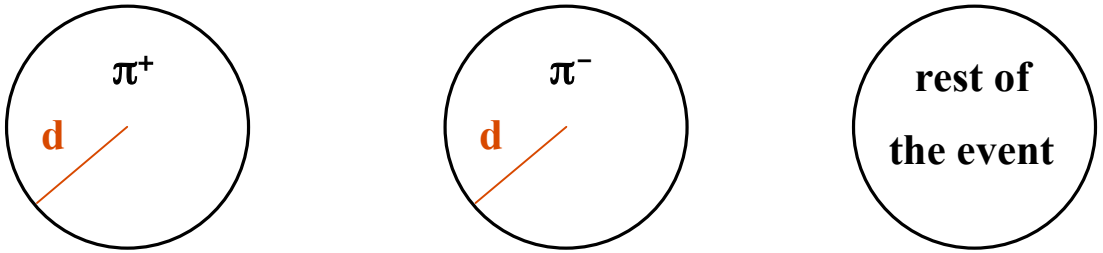
6 = calo AND dc





Single particle method: 1 step behind

- single particle method is used for estimating EMC trigger efficiencies from data
- classification of all fired sectors according to the cluster position wrt the extrapolated π track:



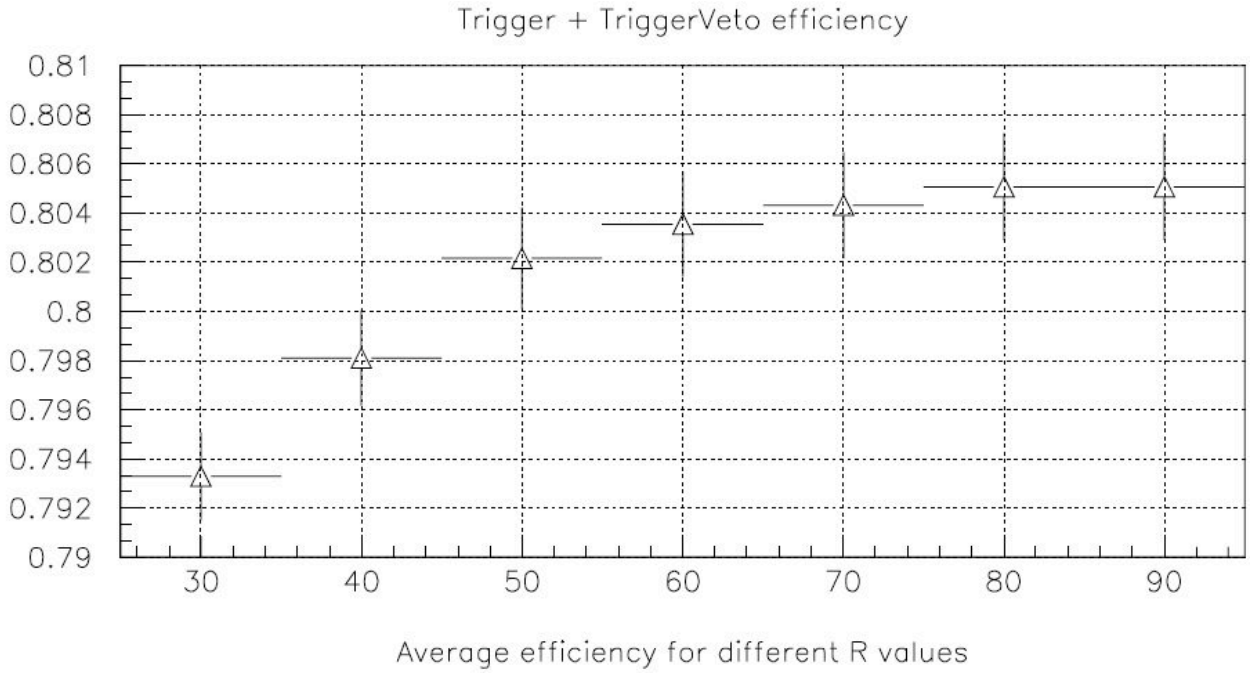
- then multiplicities are evaluated: e.g. $P_{+,-,r}(0,1,2)$=probability for the π^+, π^- or the rest of firing 0,1,2 trigger sectors
- assumption: single probabilities are independent no correlations among the categories
- single conditioned probabilities are built in an unbiased way,

  e.g. $P_+(0,1,2)$ is estimated as the probability provided that the rest OR the π^- have fired 2 trigger sectors

Single particle method at work

above assumptions allow the following formula (M. Incagli, KLOE Memo 278):

$$\varepsilon_{trigger}(M_{\pi\pi}{}^2) = 1 - P_1^+ \cdot P_0^- \cdot P_0^r - P_0^+ \cdot P_1^- \cdot P_0^r - P_0^+ \cdot P_0^- \cdot P_1^r - P_0^+ \cdot P_0^- \cdot P_0^r$$



data 2001: no significant difference in increasing the association sphere

it <u>has never been checked on MC</u>, because of not reliable a simulation before 2002

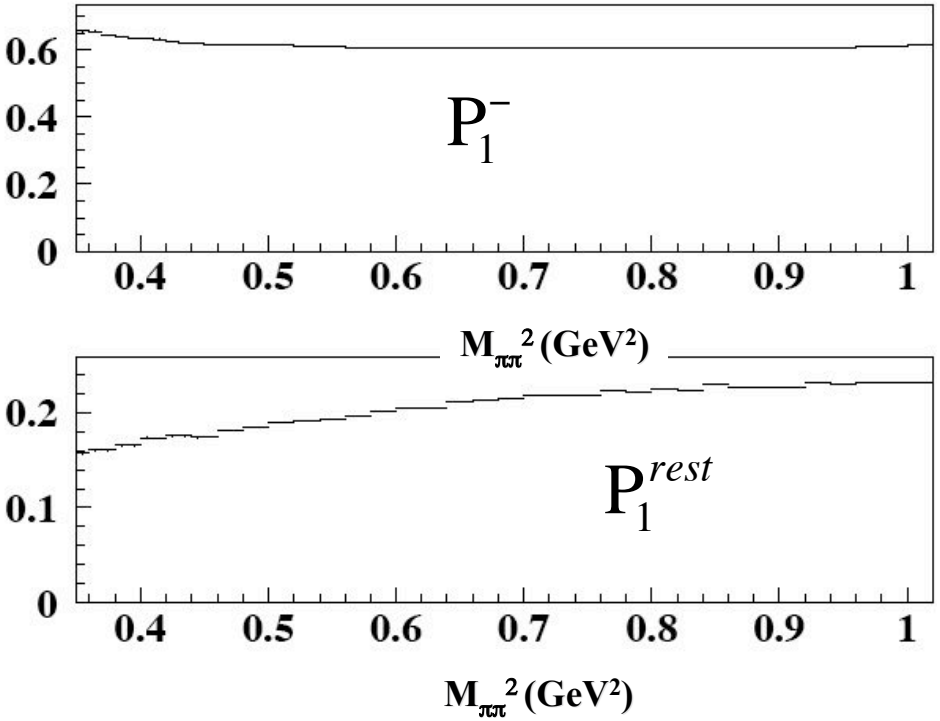
Back to the R=60 cm inefficiency with MC

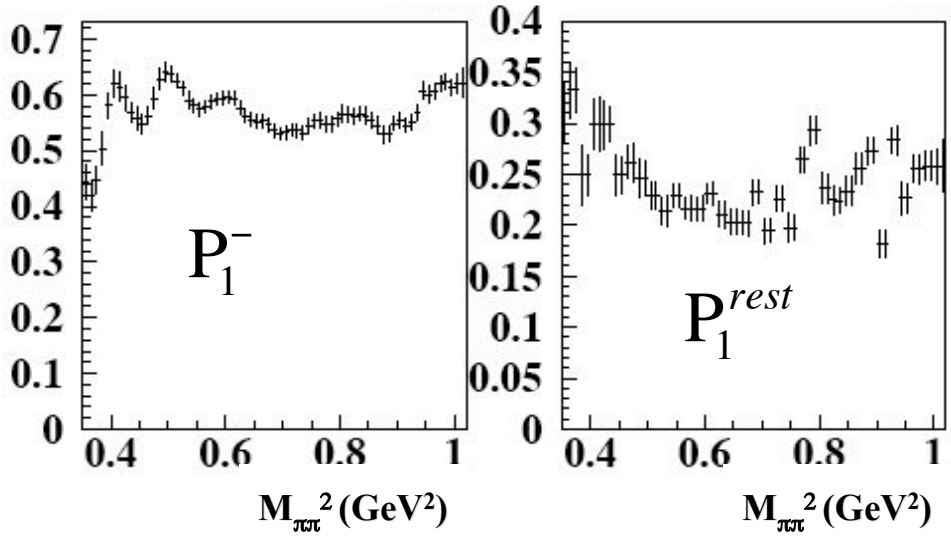
we evaluated P-(1) and Pr(1) also with

a sample with no sectors triggered by the π^+

while P-(1) is stable, Pr(1) is different: for the rest

a correlation with the presence of the π^+ is found



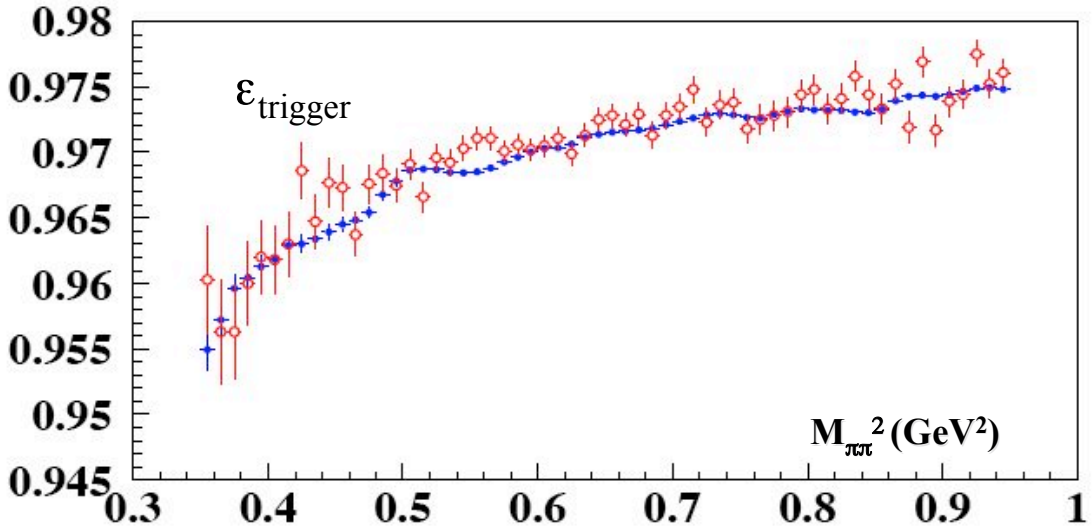


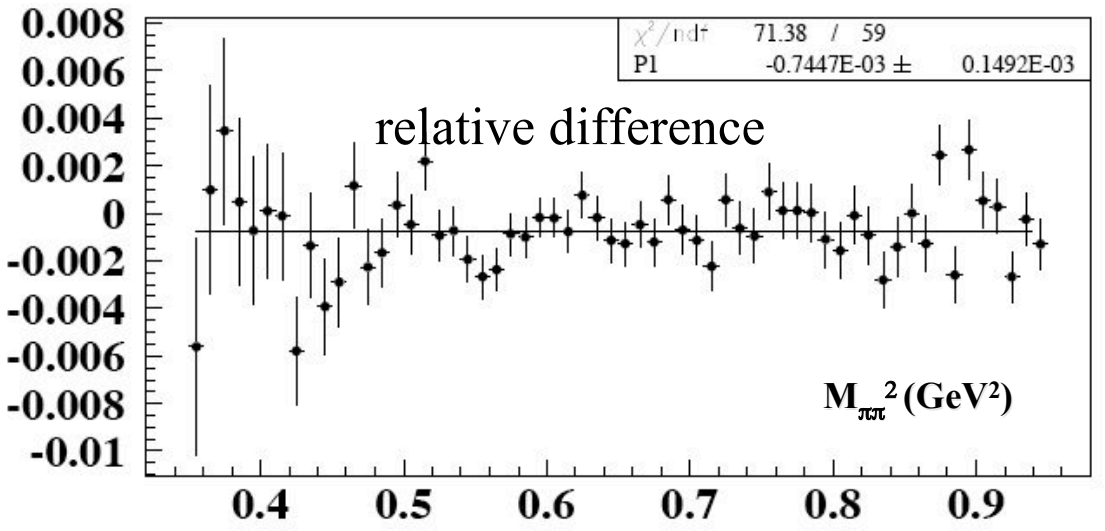
Trigger decision with pions only

comparison btw MC "truth", in which only events with pions triggering (i.e. ….) 2 sectors and the single particle method with the pions categories only

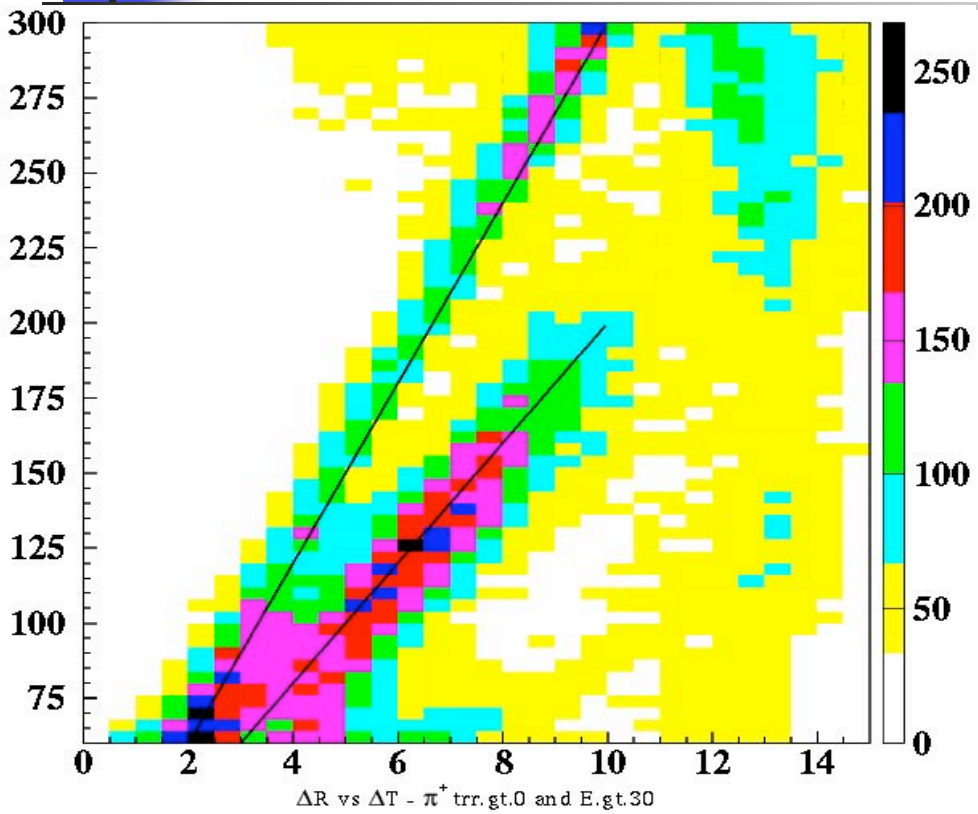
if this will be the final trigger configuration, the whole analysis will be conditioned on tracking (at first), extrapolation, trigger etc…

so we try to save the bit selection





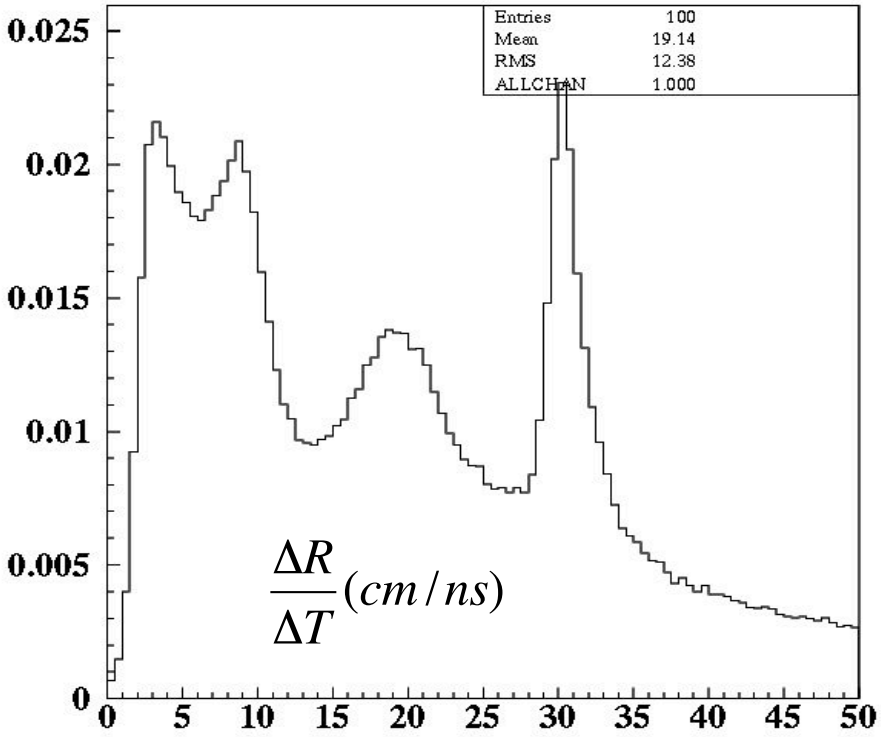
ΔR vs. ΔT for trr>0 and E>30 MeV – MC π+



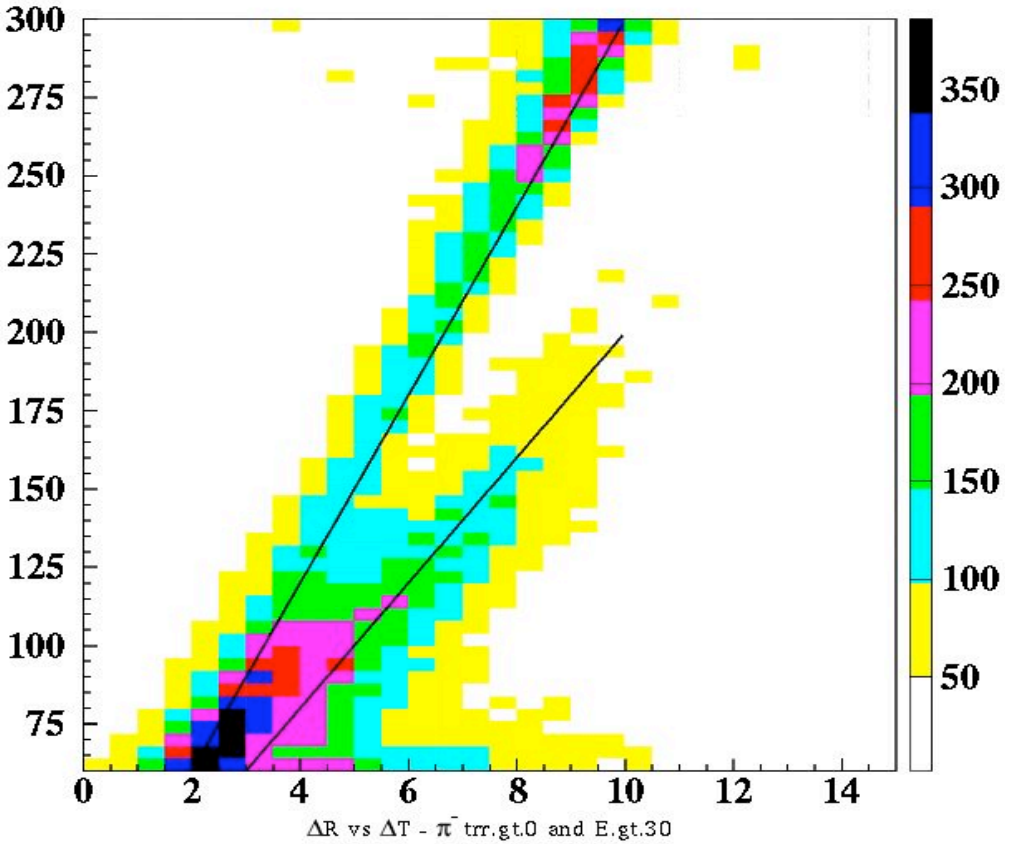
$$\Delta R = | \vec{x}_{clu} - \vec{x}_{ext} | (\mathrm{cm})$$

$$\Delta T = t_{clu} - t_{\max} (\mathrm{ns})$$

$\mathbf{t_{max}}$ = time of most energetic cluster within 60 cm from extrapolated point



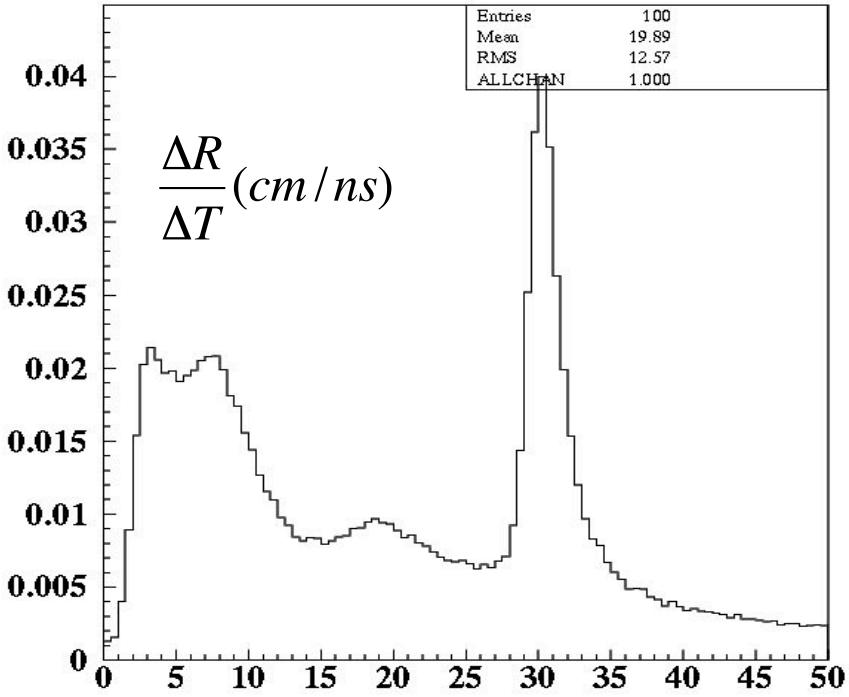
ΔR vs. ΔT for trr>0 and E>30 MeV – MC π-



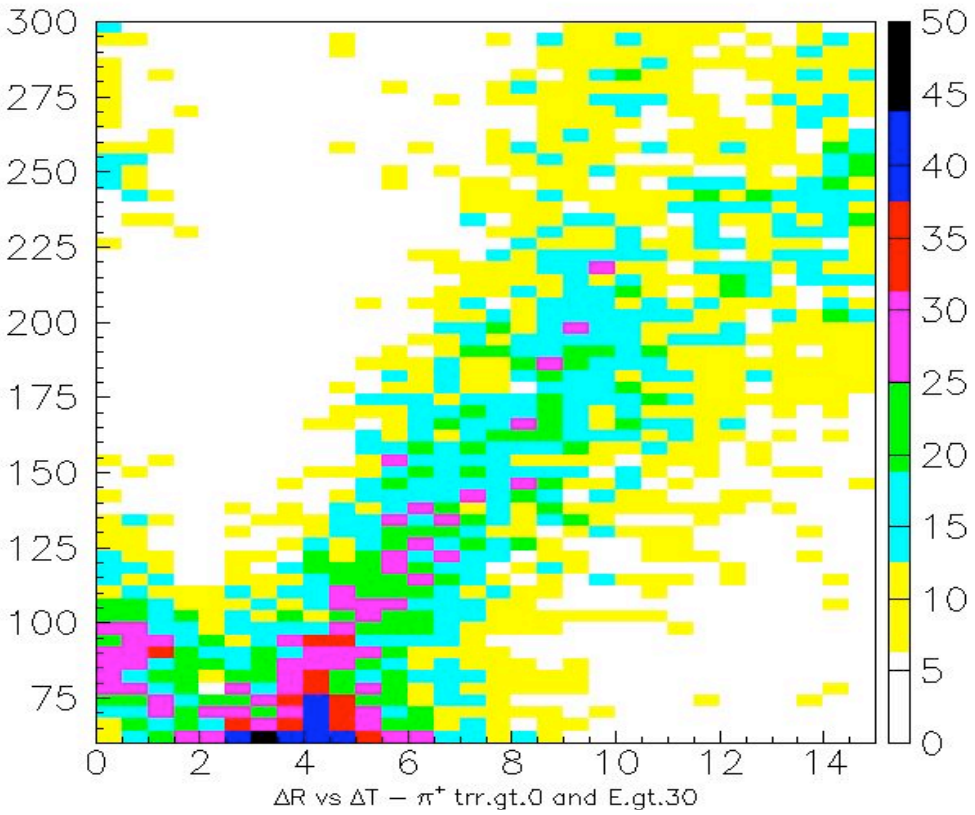
$$\Delta R = |\vec{x}_{clu} - \vec{x}_{ext}| \text{(cm)}$$

$$\Delta T = t_{clu} - t_{\max} \text{(ns)}$$

$\mathbf{t_{max}}$ = time of most energetic cluster within 60 cm from extrapolated point



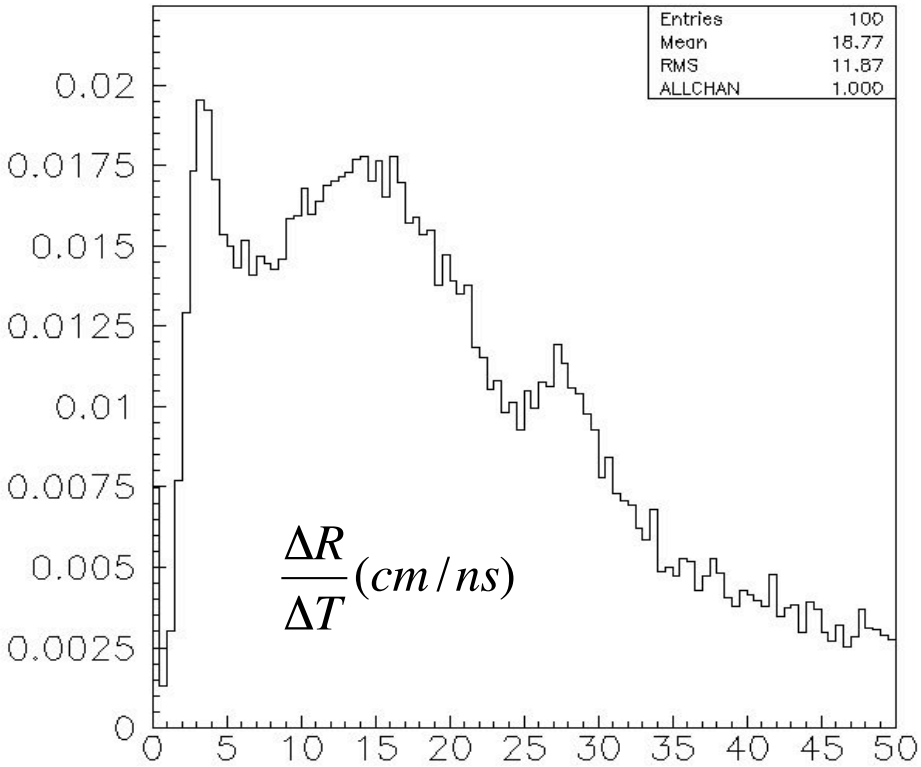
ΔR vs. ΔT for trr>0 and E>30 MeV – data π+



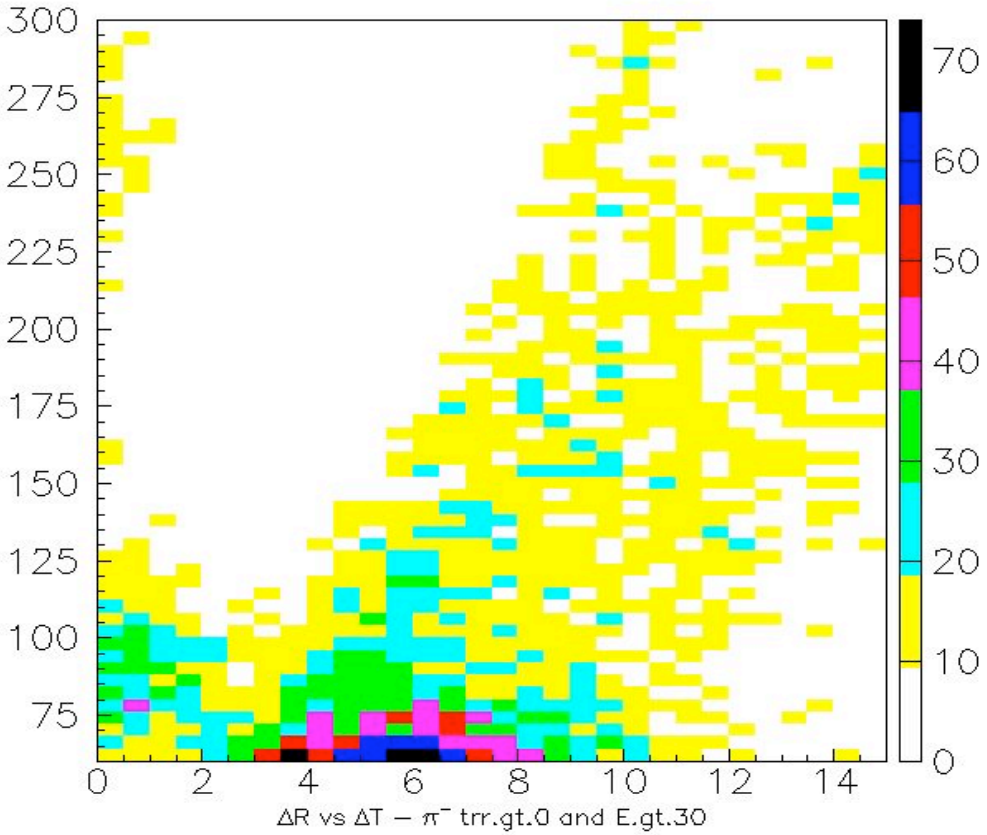
$$\Delta T = t_{clu} - t_{\max}\,(\mathrm{ns})$$

$\mathbf{t_{max}}$ = time of most energetic cluster within 60 cm from extrapolated point

$$\Delta R = |\,\vec{x}_{clu} - \vec{x}_{ext}\,|\,(\mathrm{cm})$$



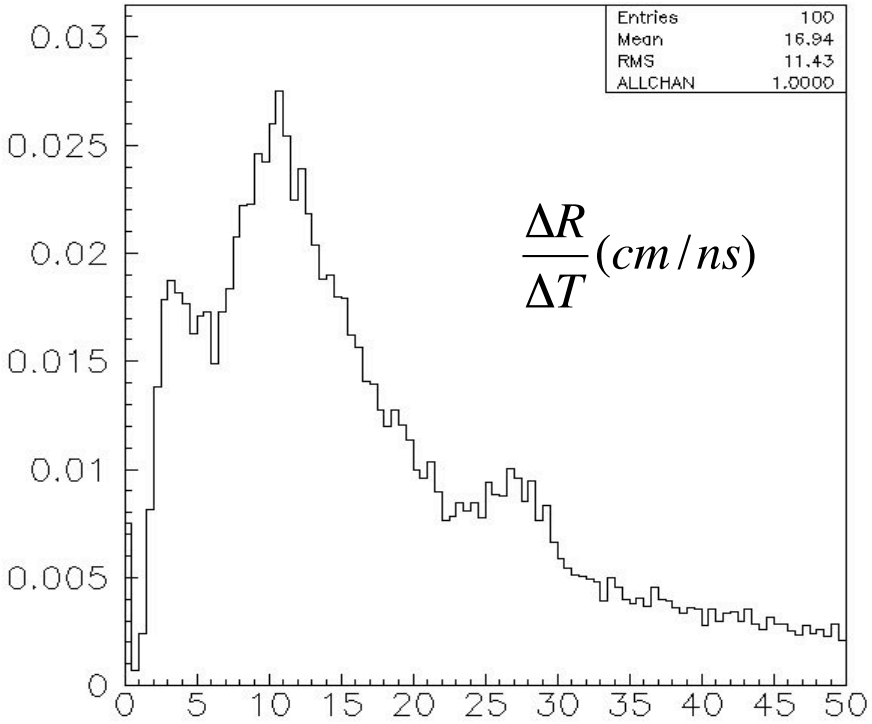
ΔR vs. ΔT for trr>0 and E>30 MeV – data π-



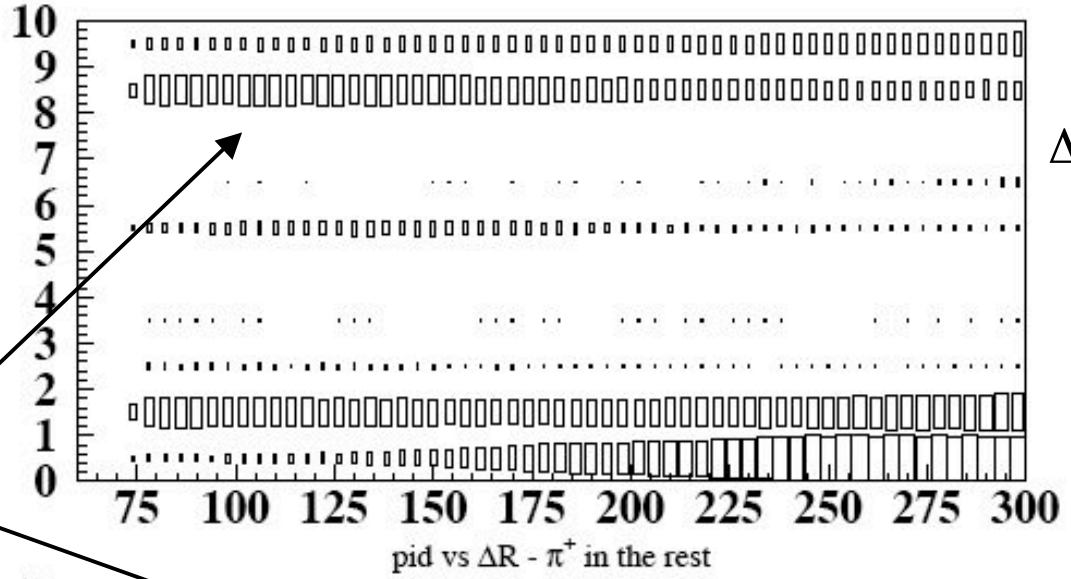
$$\Delta T = t_{clu} - t_{\max}\,(\mathrm{ns})$$

$\mathbf{t_{max}}$ = time of most energetic cluster within 60 cm from extrapolated point

$$\Delta R = |\,\vec{x}_{clu} - \vec{x}_{ext}\,|\,(\mathrm{cm})$$

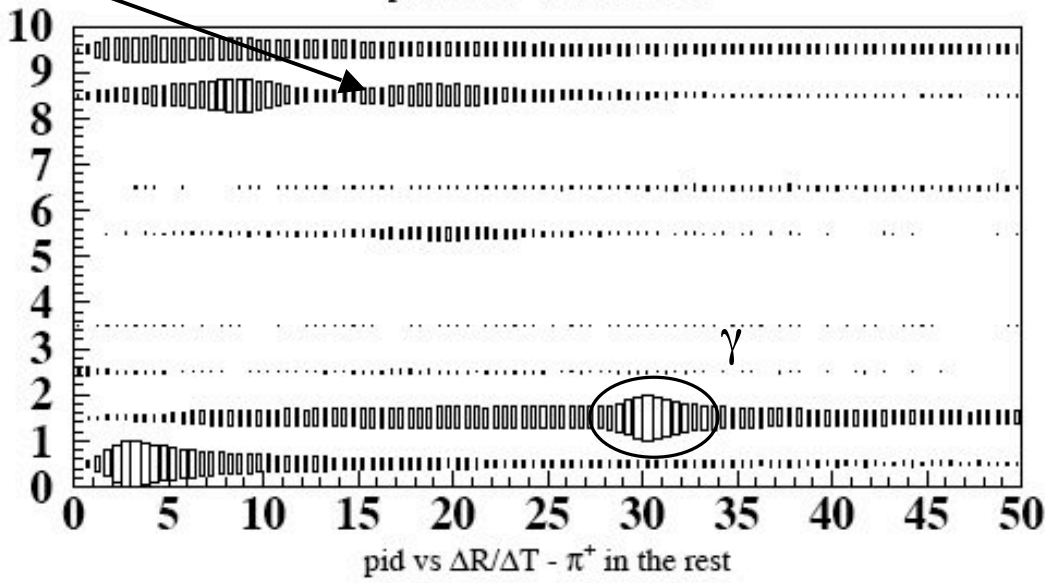


Cleaning the rest of the event



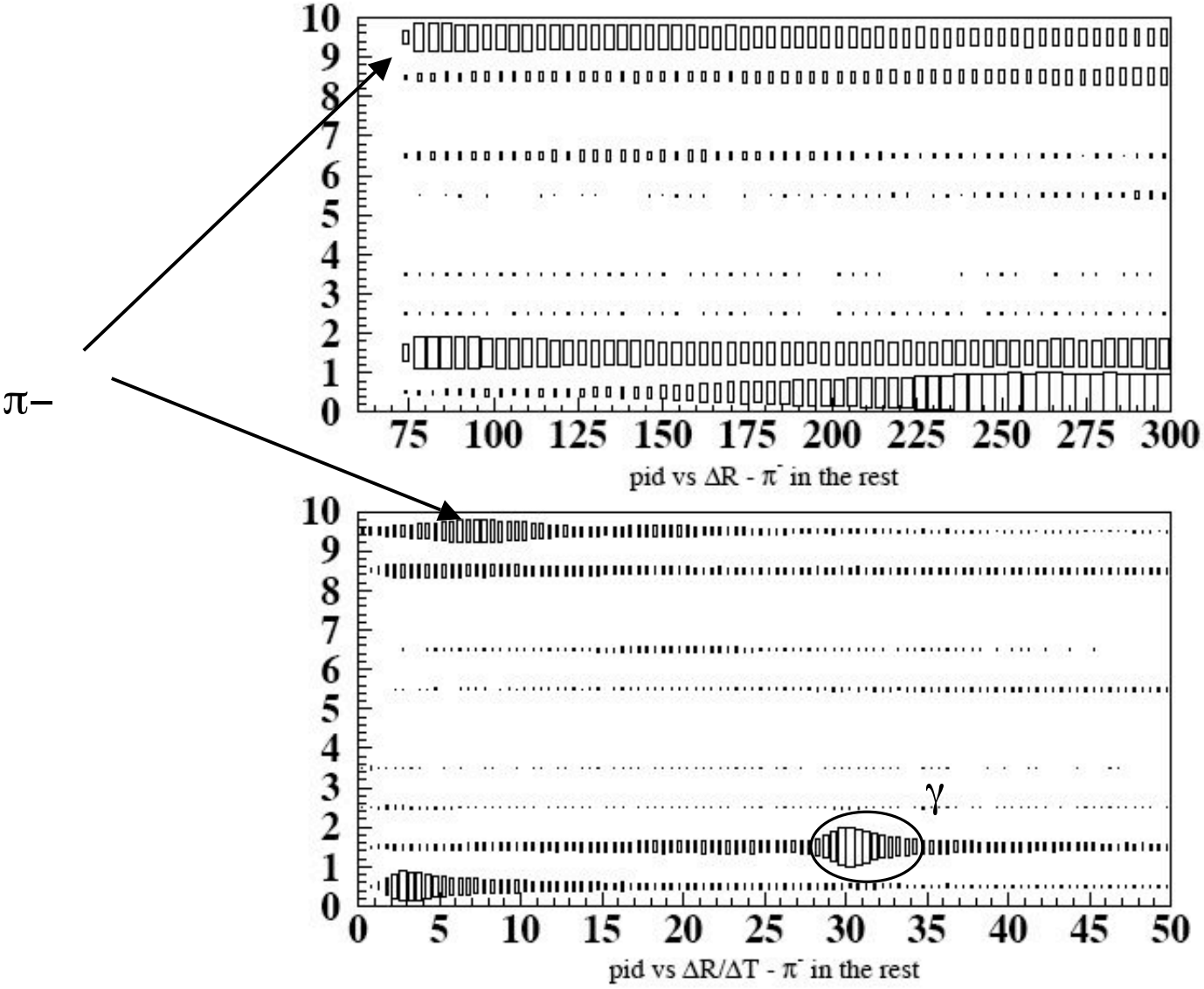
$\Delta R = |\vec{x}_{clu} - \vec{x}_{ext}|\,(\mathrm{cm})$

π+



$\frac{\Delta R}{\Delta T}(cm/ns)$

Cleaning the rest of the event



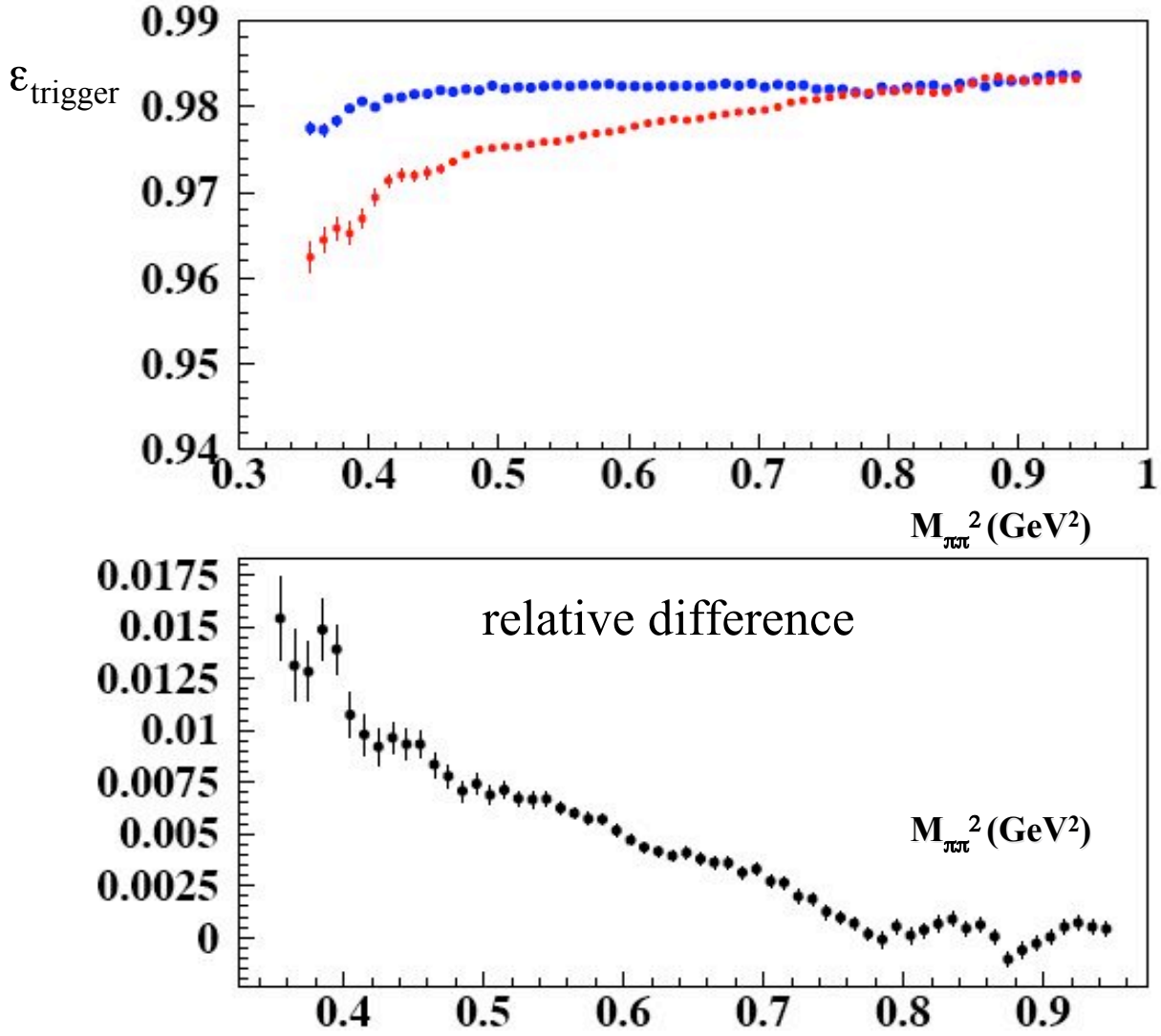
$$\Delta R = |\vec{x}_{clu} - \vec{x}_{ext}| \text{(cm)}$$

$$\frac{\Delta R}{\Delta T}(cm/ns)$$

A little better, at last…

still data must validate

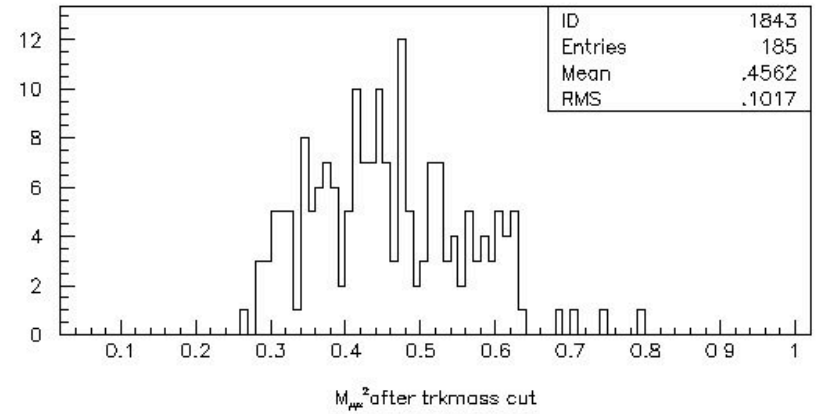
the final decision

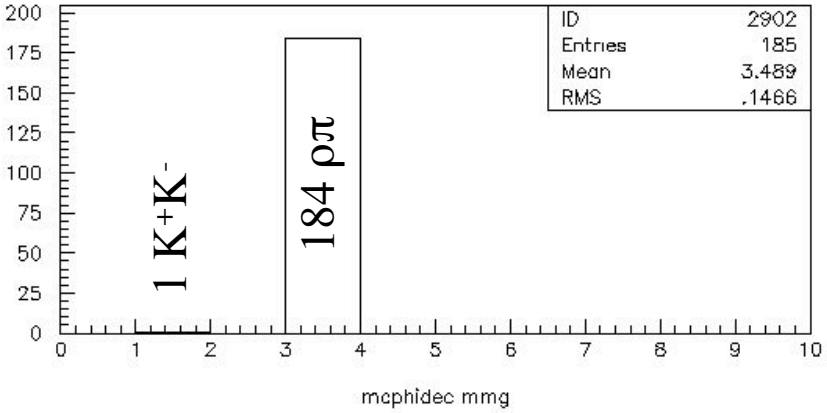


Small Angle selection on ALL_PHYS

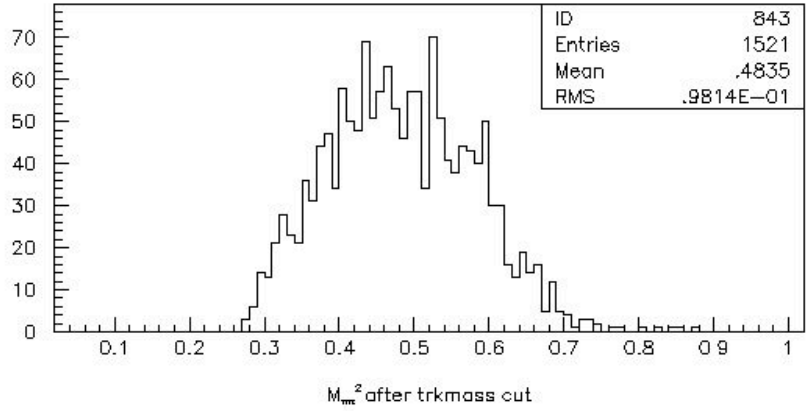
Refiltering 2002 all_phys runs with new ppgtag
+ Generator Info from EVCL bank (Lumi ca. 240pb^{-1}):

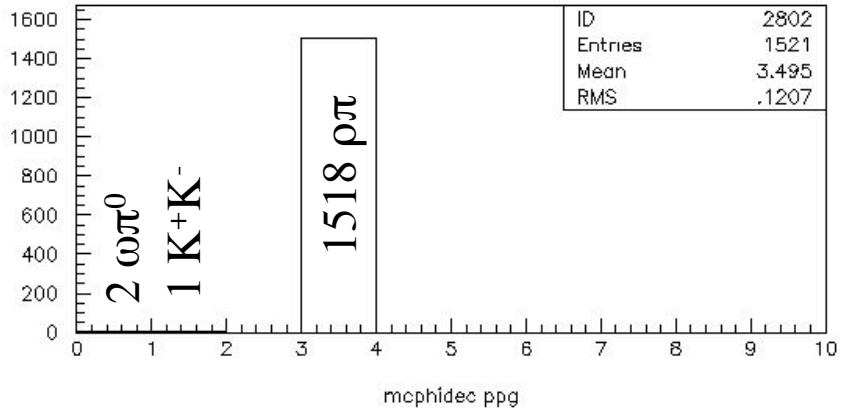
after $\mu\mu\gamma$ selection:





Events after $\pi\pi\gamma$ selection:





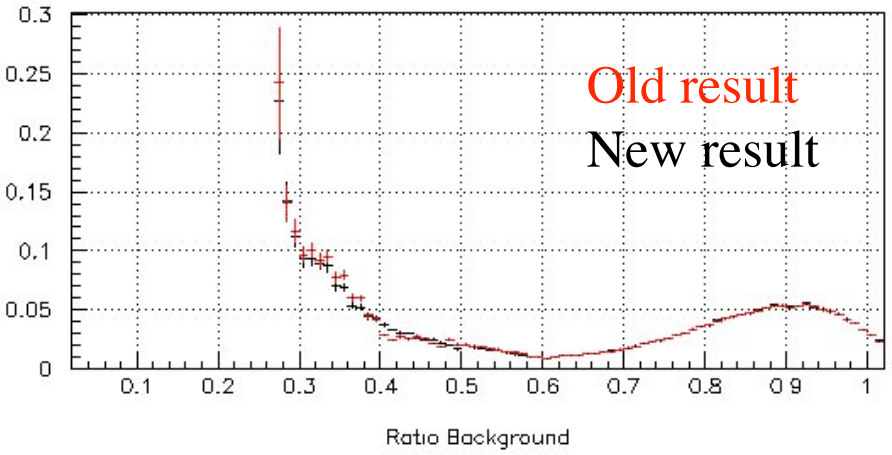
No additional background from phi-decays in all_phys MC ($\rho\pi$ background is already taken into account by background fit procedure) for small angle analysis.

Small Angle: background news

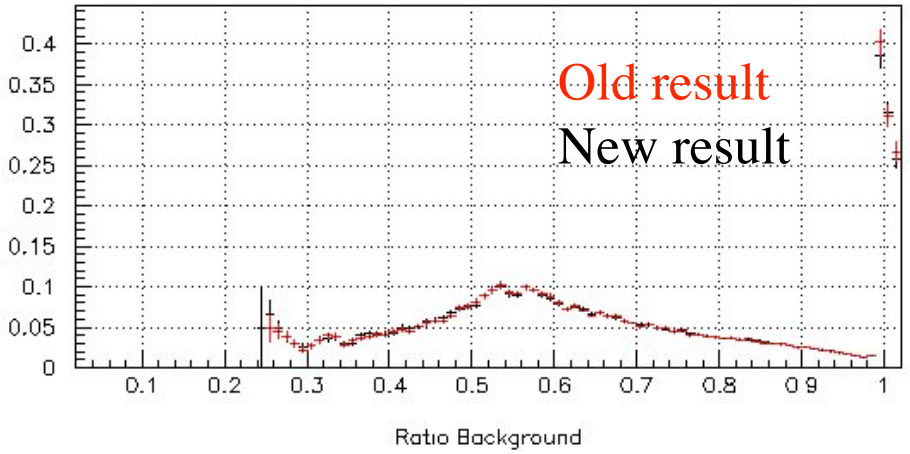
Background fit procedure rerun with the following modifications:

- smeared momenta (Bini-Valeriani corr.) for MC distributions
- account the errors on weight histograms (multiply weight to MC histos and error propagation „by hand“, instead of relying on `HMCMLL` in doing this

Ratio Bkg/Signal for $\pi\pi\gamma$ selection



Ratio Bkg/Signal for $\mu\mu\gamma$ selection

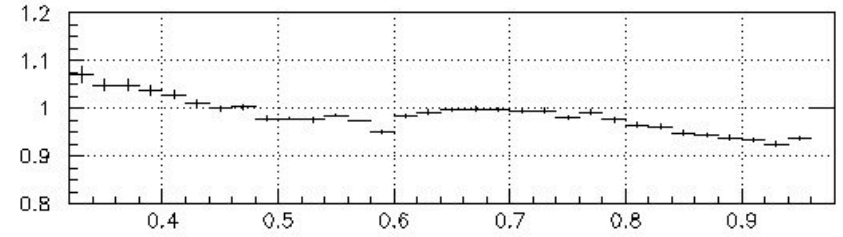


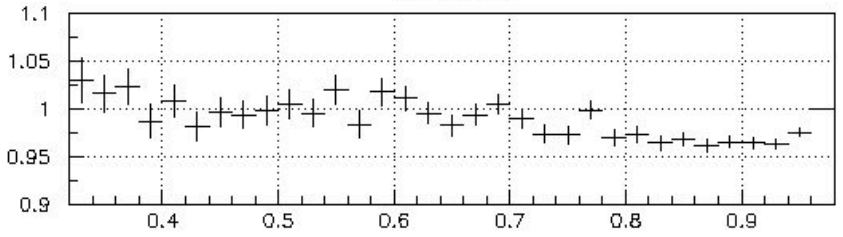
No big change in ratio - slightly less fluctuations for $\pi\pi\gamma$ selection at $M^2_{\pi\pi} < 0.4$ GeV^2 - but χ^2 of fit becomes much better (thanks to the error on Weight histograms)

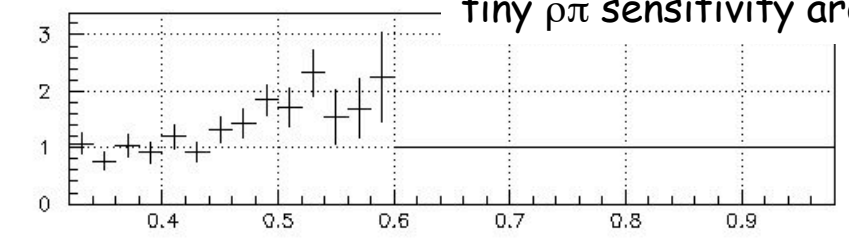
$\Rightarrow$

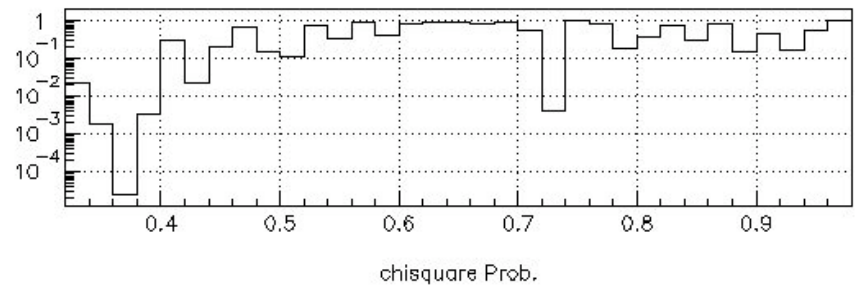
Fit results: weights for the MC's and χ^2

Muons:

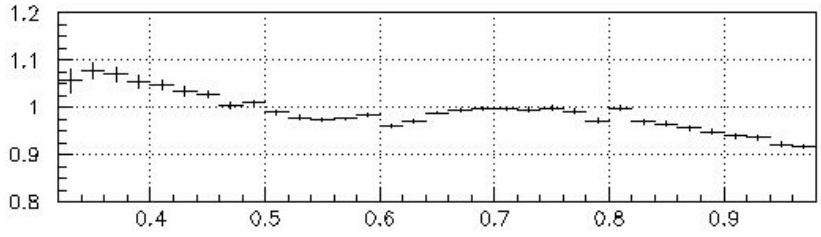


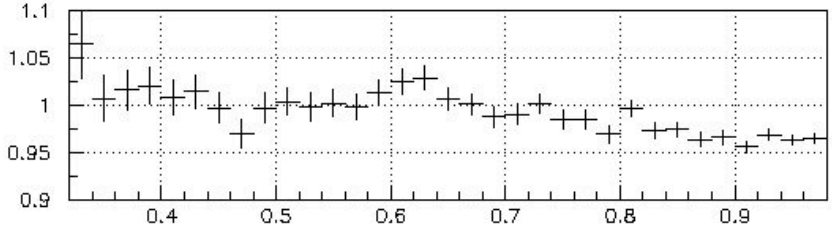


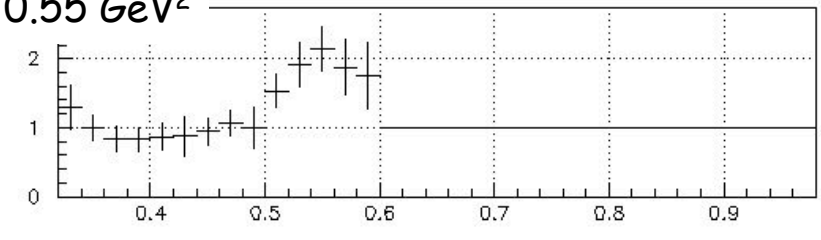


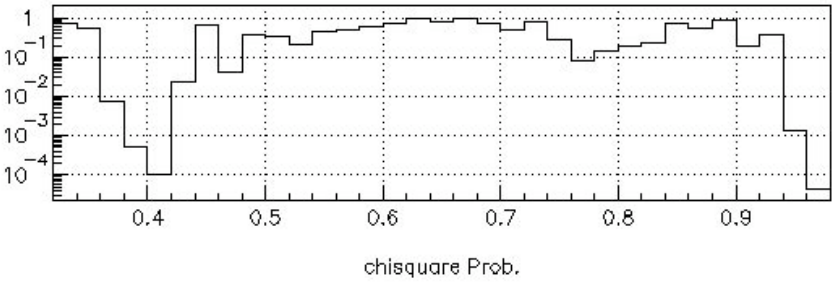


Pions:



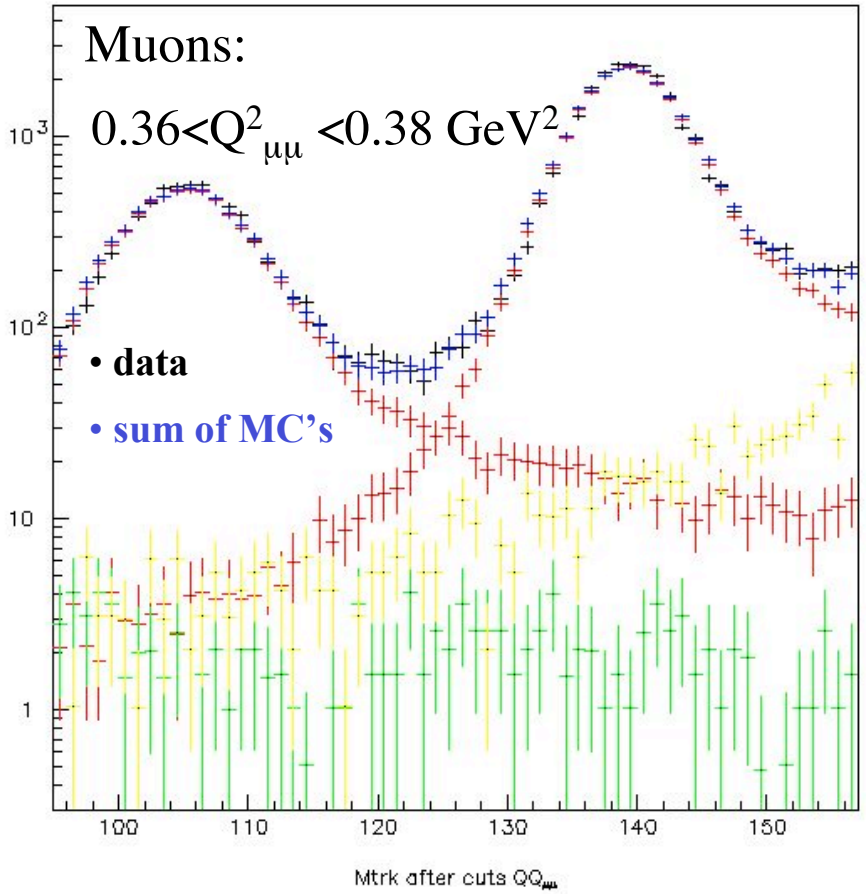




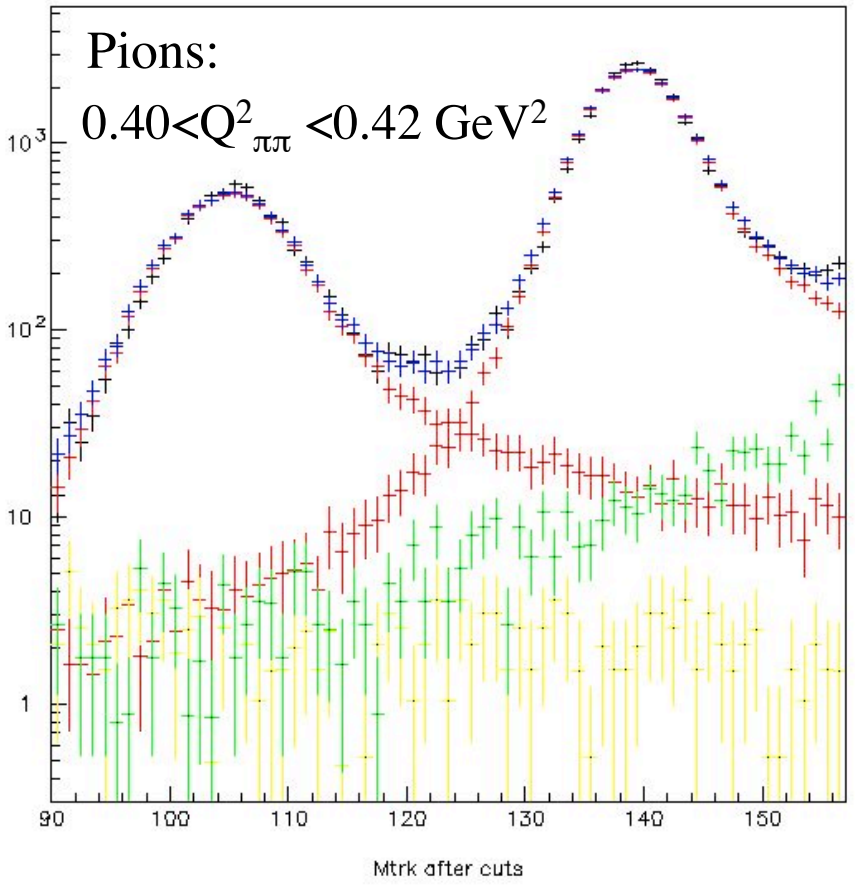


tiny $\rho\pi$ sensitivity around 0.55 GeV^2

Bad χ^2 bins: a zoom



ppg weight: 1.04876 +- 0.0109719
mmg weight: 1.02316 +- 0.0186909
eeg weight: 1 +- 0
ppp weight: 1.02493 +- 0.196403
Chisquare/ndof 112.37 / 58
Chi2 Prob. 2.45821E-05

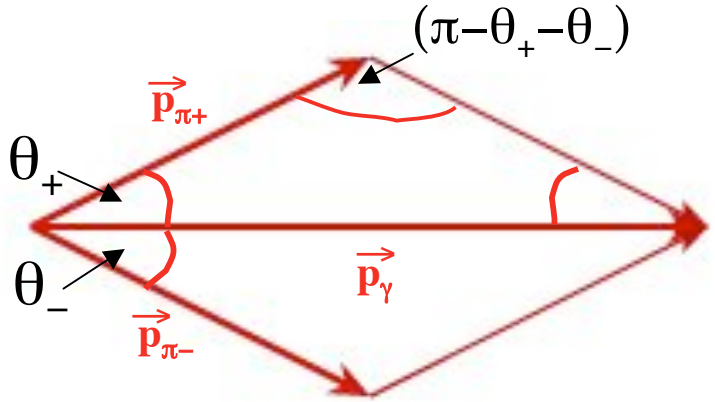


ppg weight: 1.04692 +- 0.0103084
mmg weight: 1.00856 +- 0.0179395
eeg weight: 1 +- 0
ppp weight: 0.867509 +- 0.197511
Chisquare/ndof 113.39 / 63
Chi2 Prob. 0.0001028

Two ways to define γ* momentum transfer

Hypothesis a):
Event consists of 2 charged pions + nγ from ISR

$$s' = M^2_{\pi\pi}$$

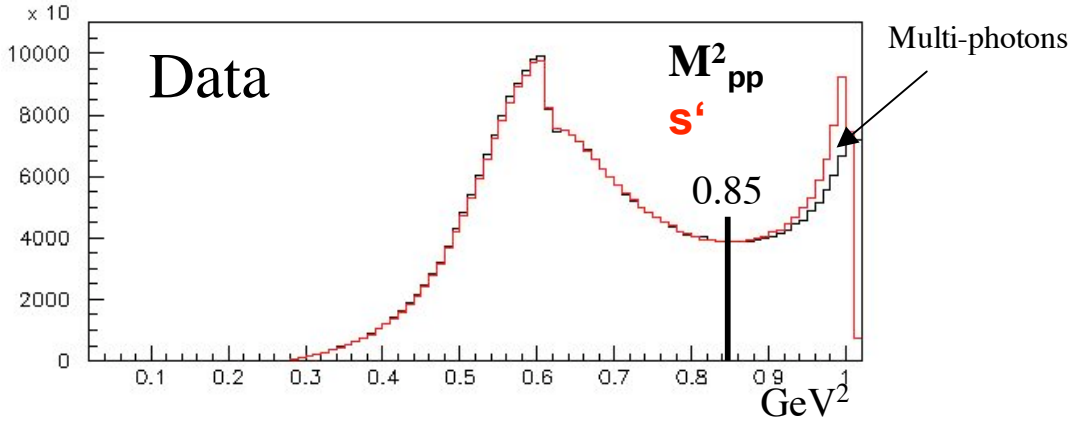


Hypothesis b):
Event consists of 2 charged particles + 1γ
(everything in LAB-System)

$$s' = s - 2E_{Beam}\cdot\sin(\pi-\theta_+-\theta_-)\left[\frac{|\vec{p}_+|}{\sin\theta_-}+\frac{|\vec{p}_-|}{\sin\theta_+}\right]+\vec{p}_{12}\cdot\vec{p}_\gamma$$

$$E_{Beam} = \frac{1}{2}\sqrt{s+|\vec{p}_\phi|^2}$$

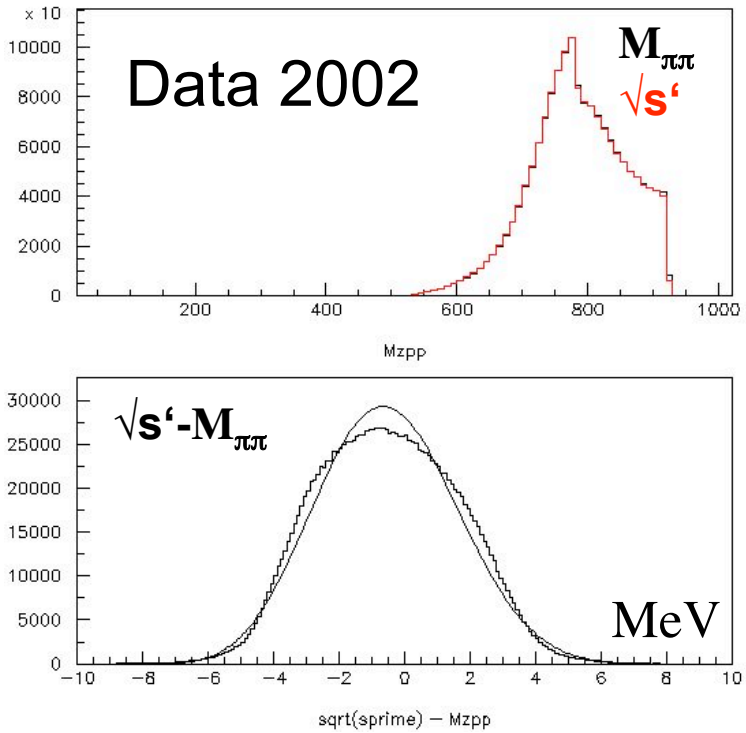
$$\vec{p}_{12} = (\vec{p}_{e^+}+\vec{p}_{e^-})$$
$$\vec{p}_\gamma = -(\vec{p}_+ + \vec{p}_-)$$

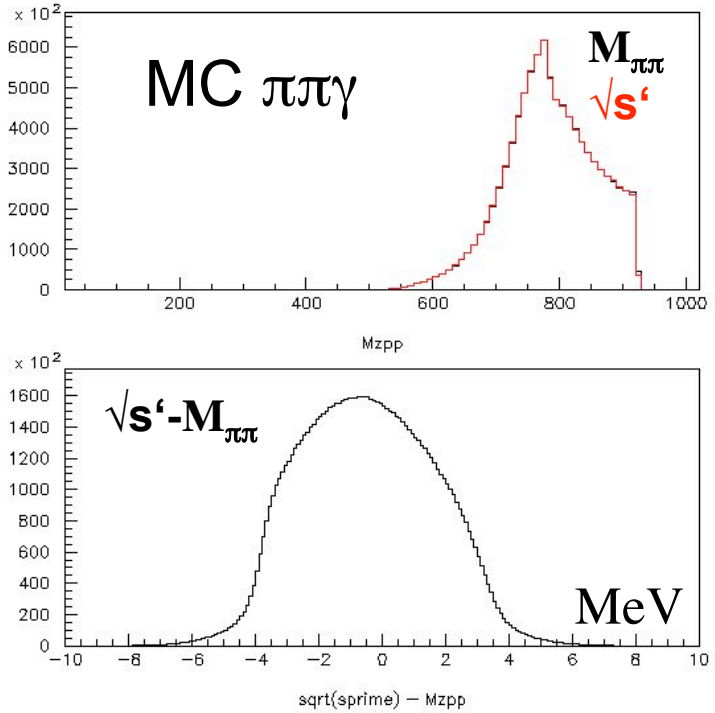


Discr. Effects from

- Multi photon events
- Muons
- (FSR)

Calibration check: preliminary





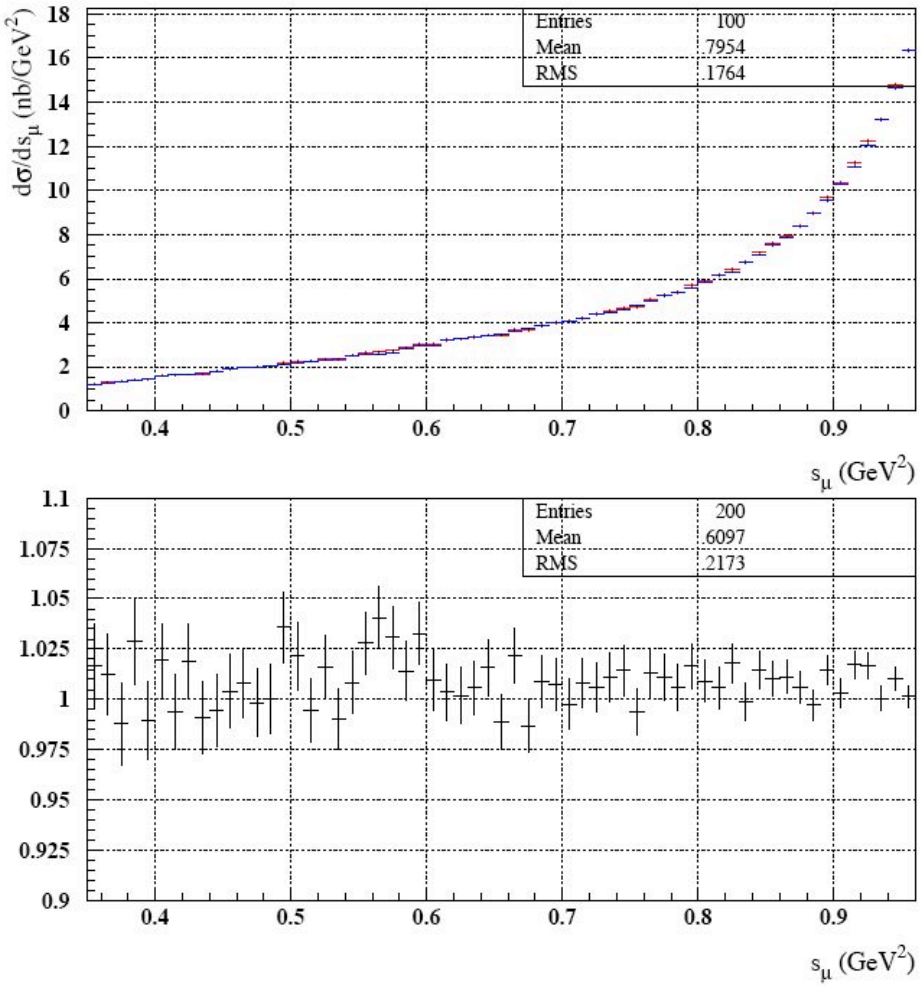
Cut on $M^2(s') < 0.85\ GeV^2$

$|M_{Trk} - 139.57\ MeV| < 5\ MeV$

small shift (ca. 1 MeV) visible in data

is well reproduced by MC

Comparison data-MC for μμγ



observed cross section:

corrected for FILFO

and background

the improvement with Sabaudia (1% vs 3%) is due to a more refined selection and new MC weights.

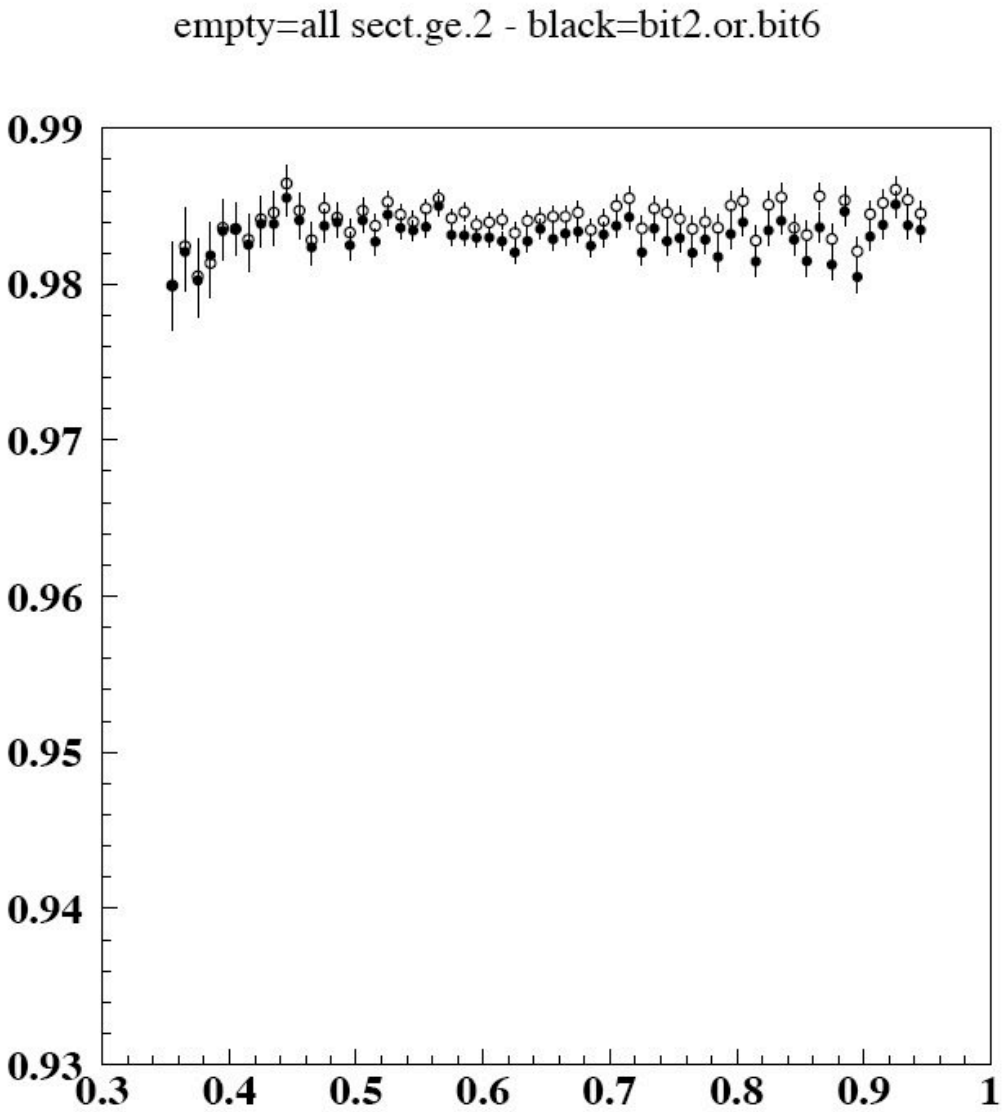
work is going on

Conclusions

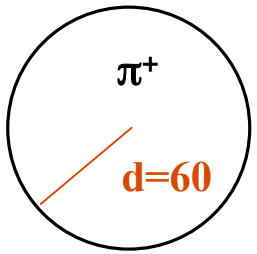
1) Large Angle Analysis: systematic uncertainty has been studied for acceptance and ALL_PHYS yield addressed
2) Off Peak Analysis: asymmetry has been studied as a benchmark observable
3) Small Angle Analysis: work in progress both on ppg and mmg selections

Many thanks to M. Palutan for a lot of discussions

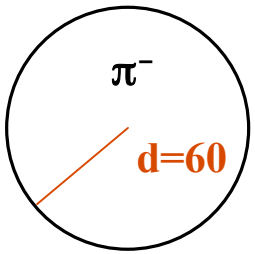
Other checks…



Other comparisons…

1) 

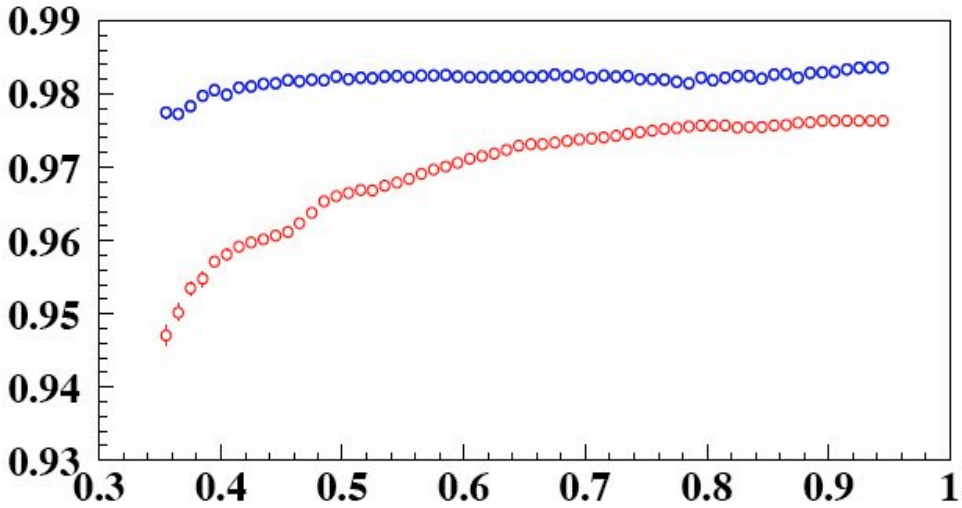
.or. d>60.and.PID=8

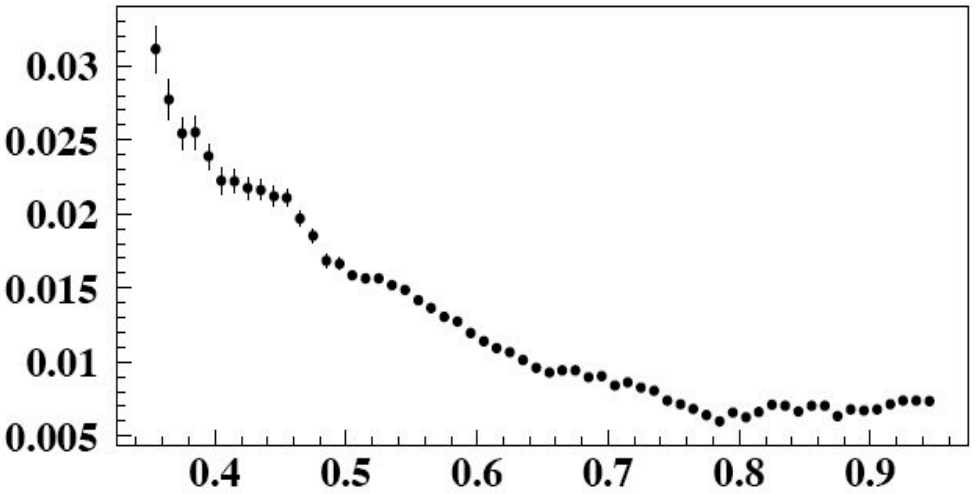
2) 

.or. d>60.and.PID=9

else

3) 



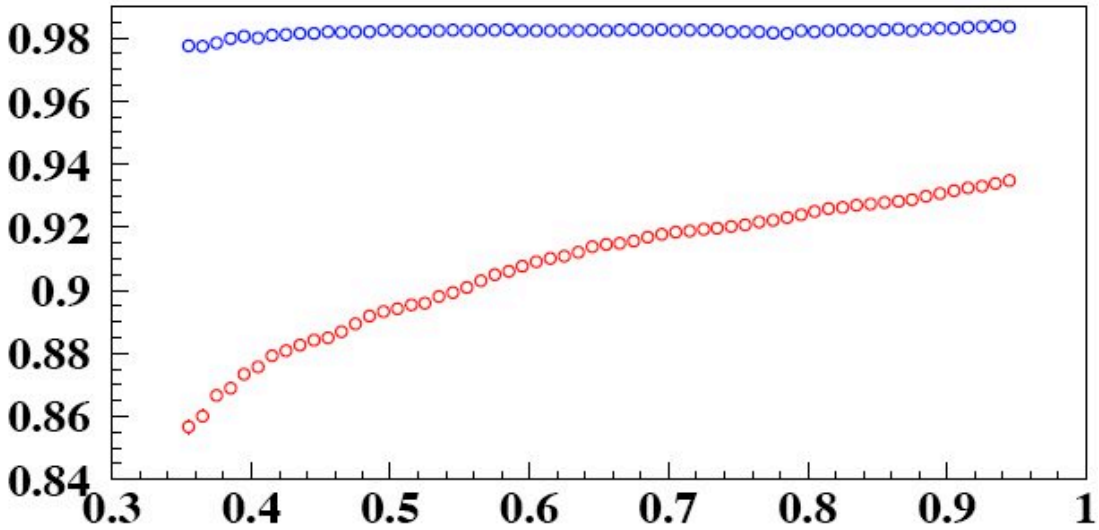


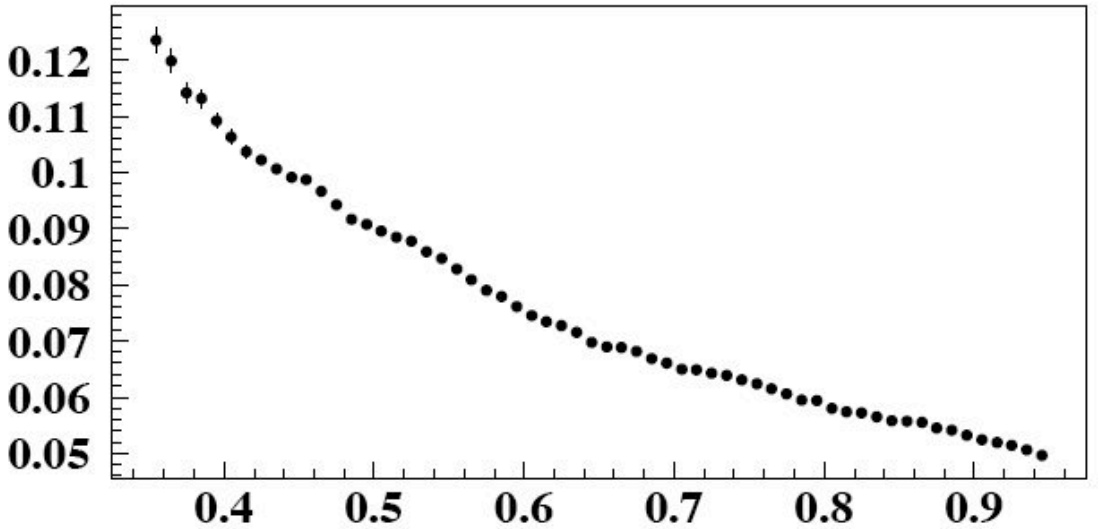
Other comparisons…

1) `PID=8`

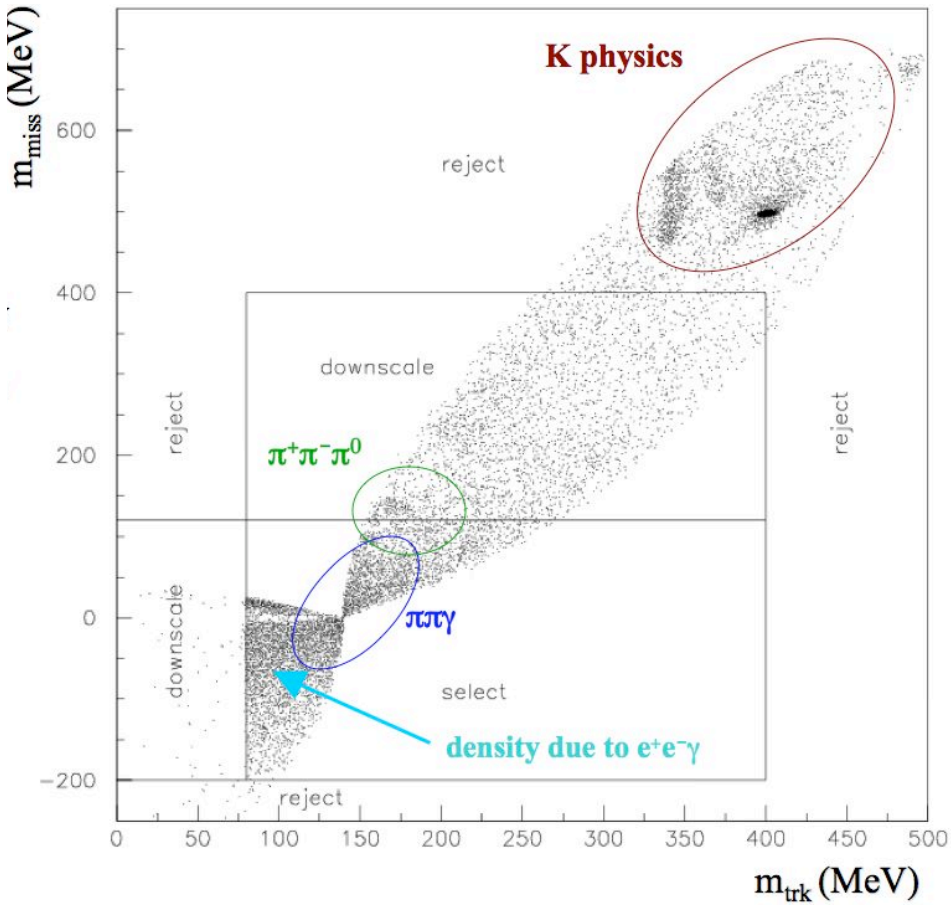
2) `PID=9`

3)
```
else
PID=1.or.PID=0
```

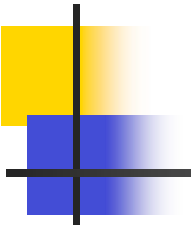




New ppgtag: very brief reminder



1. trackmass window enlarged,
   $m_{trk} > 80$ MeV instead of 90 MeV
2. downscale for events with m_{miss}
   $\in [120, 400]$ MeV is applied



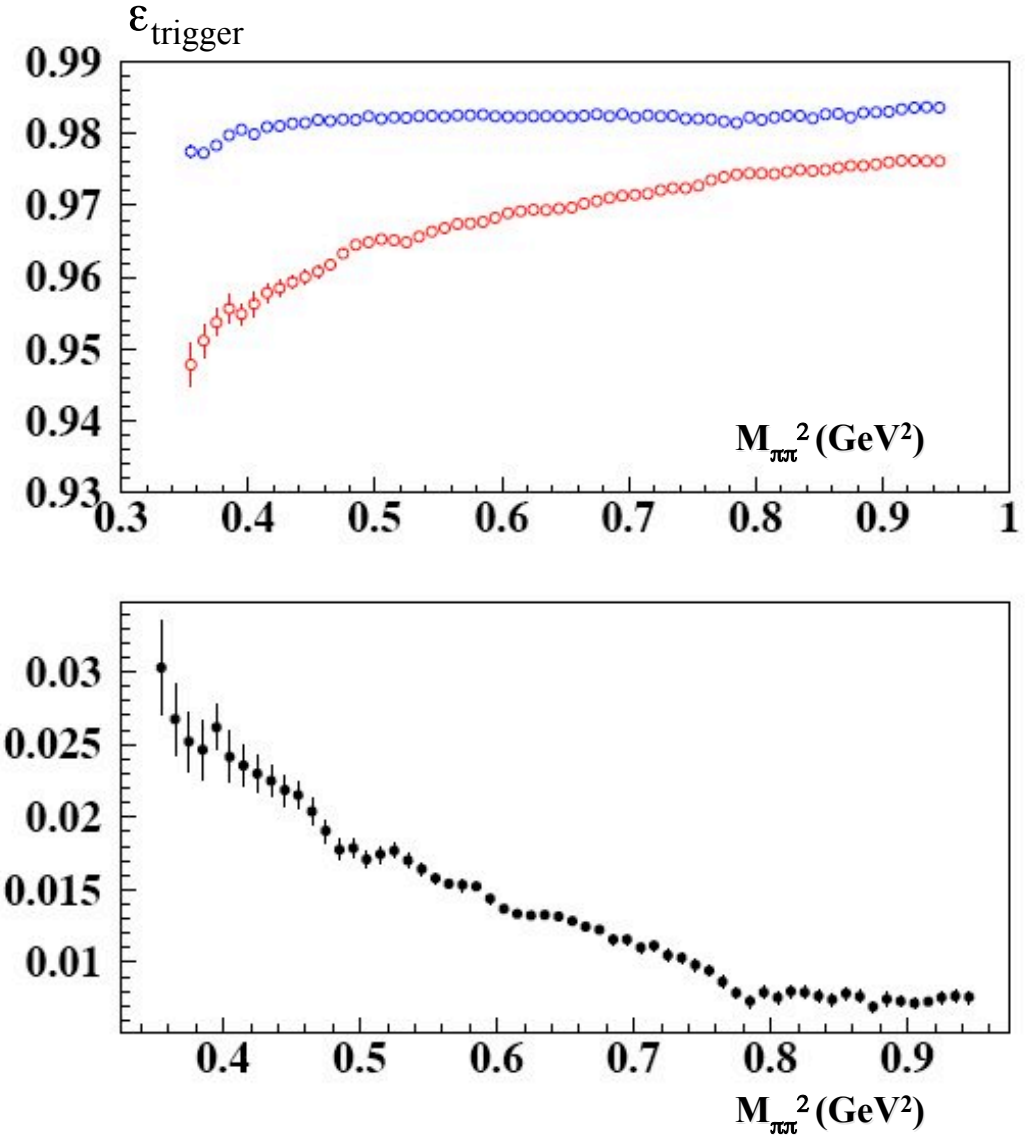
Background systematics: new PPGTAG

Comparison btw r90 and bit MC "truth"

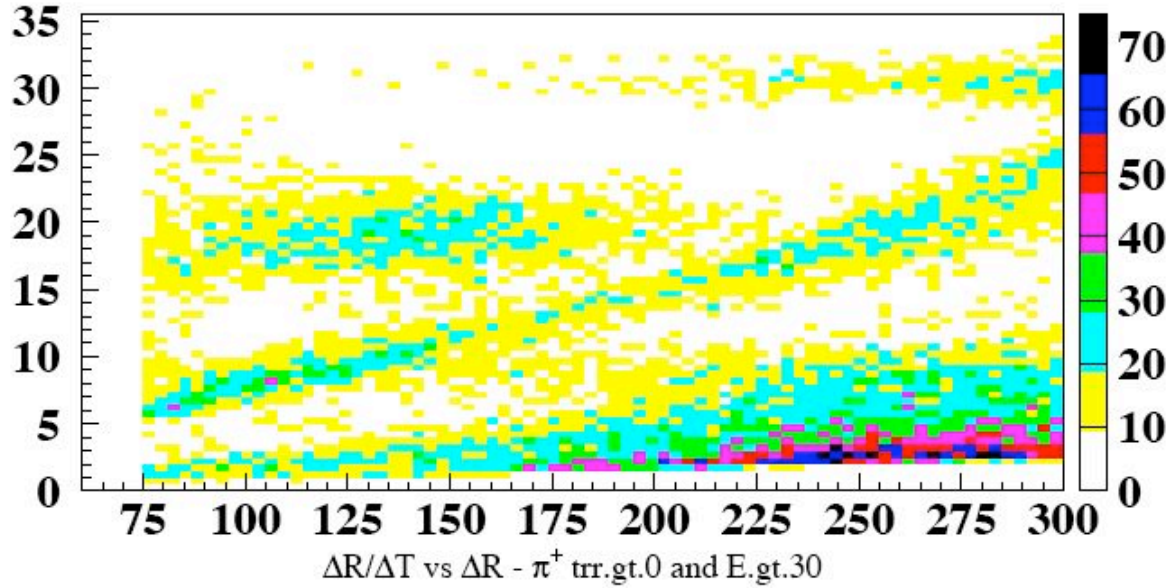
1) π^+ d=90

2) π^- d=90

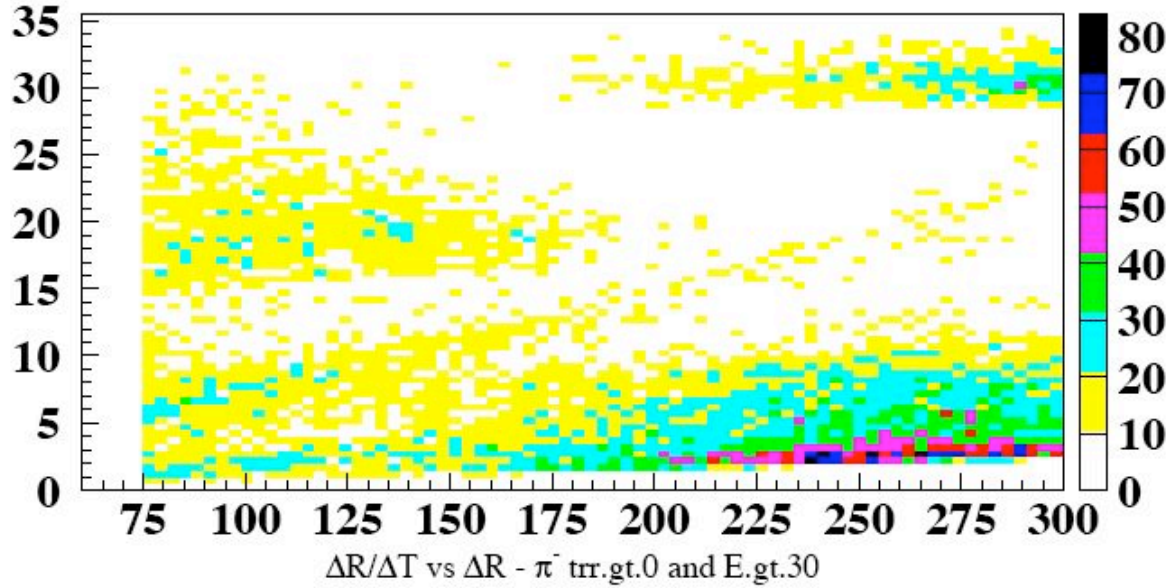
3) rest of the event



Cleaning the rest of the event



$\Delta R/\Delta T$ vs ΔR - π^+ trr.gt.0 and E.gt.30



$\Delta R/\Delta T$ vs ΔR - π^- trr.gt.0 and E.gt.30