Status of ppg analysis

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ϕ rad meeting
LNF-29-9-06

Outline

- Small Angle:
  - Where we are
  - Work in progress:
    - Efficiencies/background
    - π/μ discrimination
    - DC trigger (for the ratio)
  - Time schedule
- Large Angle:
  - Where we are (Efficiencies/background)
  - Work in progress (systematics)
  - Time schedule
- Issues:
  - energy/momentum calibration
  - Off peak data

▪Small Angle Analysis:absolute measurement

Signal

Background

$$\frac{d\sigma_{\pi\pi\gamma}}{ds_\pi} = \frac{1}{L}\frac{1}{\varepsilon_{Sel}\cdot\varepsilon_{Acc}}\frac{N^{obs} - N^{bckg}}{\Delta s_\pi}$$

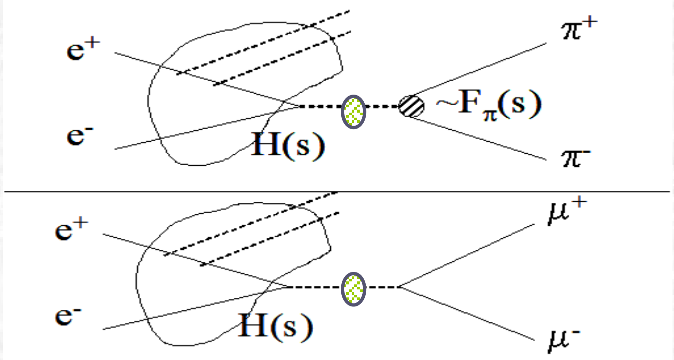
Luminosity

Selection Efficiency

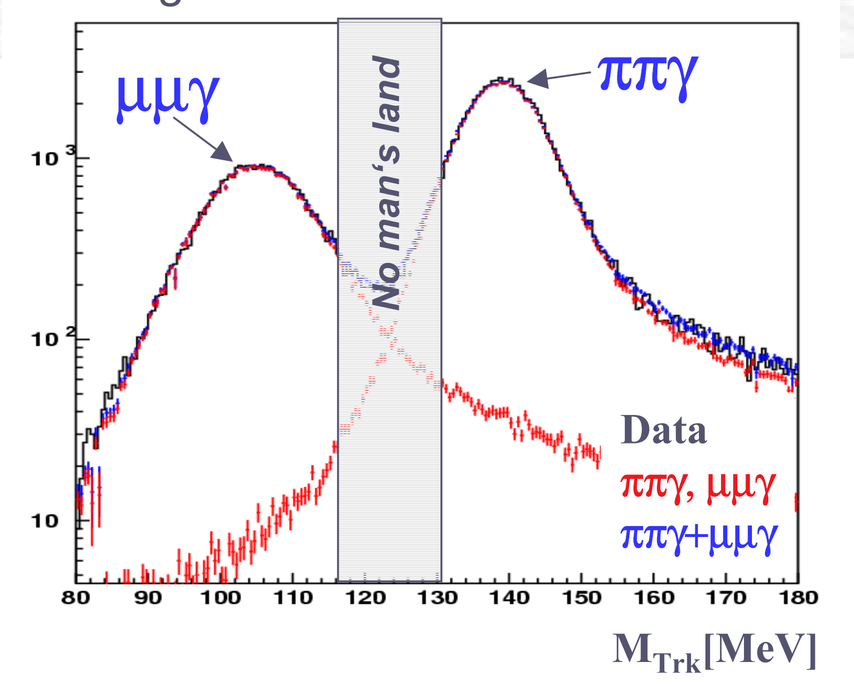
Acceptance

▪Small Angle Analysis:ratio

$$\sigma_{\pi\pi}^{Born}(s') \approx \frac{d\sigma_{\pi\pi\gamma}^{obs} / ds'}{d\sigma_{\mu\mu\gamma}^{obs} / ds'} \sigma_{\mu\mu}^{Born}(s')$$



Pions and muons are separated using a cut in trackmass:



Some Effects will cancel out in the ratio:

~~Luminosity (LA Bhabhas)~~	~~0.6%~~	
~~Vacuum polarization~~	~~0.2%~~	
FSR corrections	0.3%	
~~Radiator function~~	~~0.5%~~	
Total theoretical Error 0.9%	X 0.3%	

➔requires to select $\mu\mu\gamma$ events with similar precision as $\pi\pi\gamma$!!

Strategy can be different from the absolute measurement!

SA: Analysis chain

1. Selection: $\pi\pi\gamma$ (m_{trk} > 130 MeV), $\mu\mu\gamma$ (m_{trk} <115 MeV)
2. ε_{FILFO}: *obtained from unbiased control sample* √
3. Background subtraction: *fitting MC histograms to data* √
4. ε_{mTRK} and ε_{mMISS}*: from MC*
5. $\varepsilon_{Likelihood/TCA}$: *we use the .or., so it is ≈100%*
6. ε_{Vertex}, $\varepsilon_{Tracking}$
7. $\varepsilon_{Trigger}$

} *From data control sample*

} Work in progress (items 4–7)

8. Acceptance-Correction, Luminosity, etc…

9. Details: unfolding, FSR contamination, etc…

▪Background Subtraction

•**dN/dm_{TRK}** data are fitted with MC samples of $\pi\pi\gamma$, $\mu\mu\gamma$, $\pi\pi\pi$ and $ee\gamma$ in slices of $M_{\pi\pi}^2$.

• Normalization for $ee\gamma$ is fixed to 1 (the contamination is << 1%)

$$\begin{aligned} Data(M_{Trk}) = par(1) \cdot MC_1(M_{Trk}) \cdot WT_1(M_{Trk}) + \\ par(2) \cdot MC_2(M_{Trk}) \cdot WT_2(M_{Trk}) + \\ par(3) \cdot MC_3(M_{Trk}) \cdot WT_3(M_{Trk}) + \ldots \end{aligned}$$

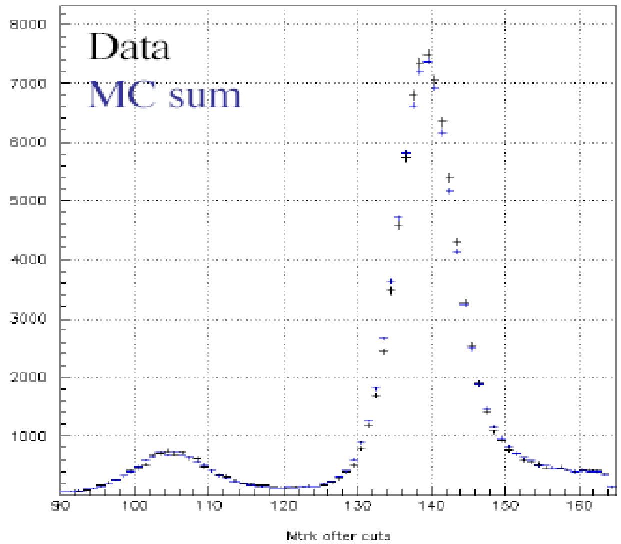
The WT are defined as

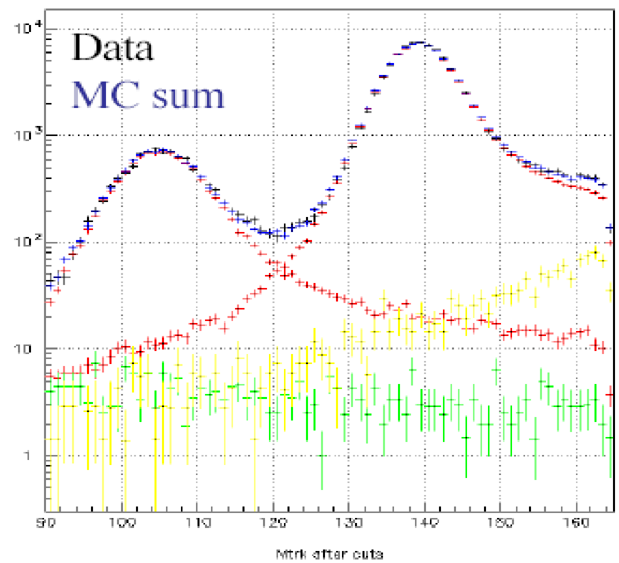
$$WT_J(M_{Trk}) = \varepsilon_{FILFO}(M_{Trk}) \cdot \underbrace{\frac{L_{Data}}{L_{MC,J}} \cdot \frac{1}{LSF}}$$

These are constants, which could be also absorbed in the par(J)

J is the index of the MC source.

Background contamination: 4 sources





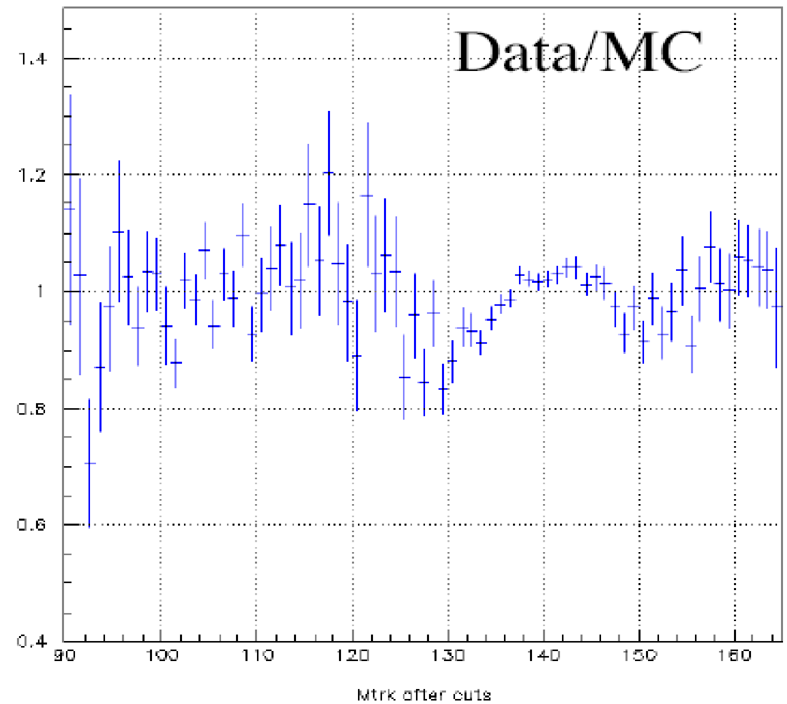
0.48-0.50 GeV^2

$\pi\pi\gamma$

$\mu\mu\gamma$,

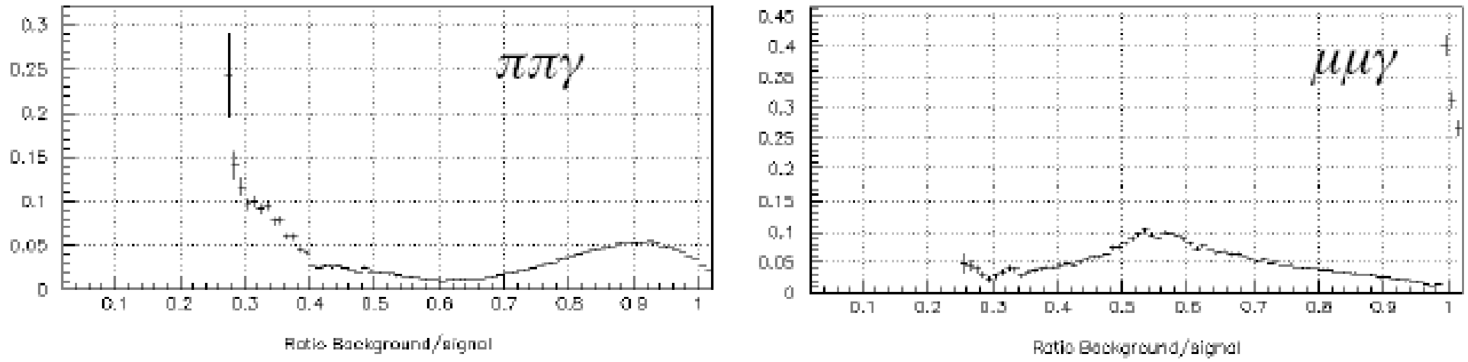
$\pi\pi\pi$,

Bhabha



Background contamination: Results

Ratio Background/Signal with stat. error:



Result has been put in cvs-repository on phidec11/user/sma/ppg|mmg, together with a kumac applies FILFO-eff and background subtr. to the spectra for $\pi\pi\gamma$, $\mu\mu\gamma$.

To be done:

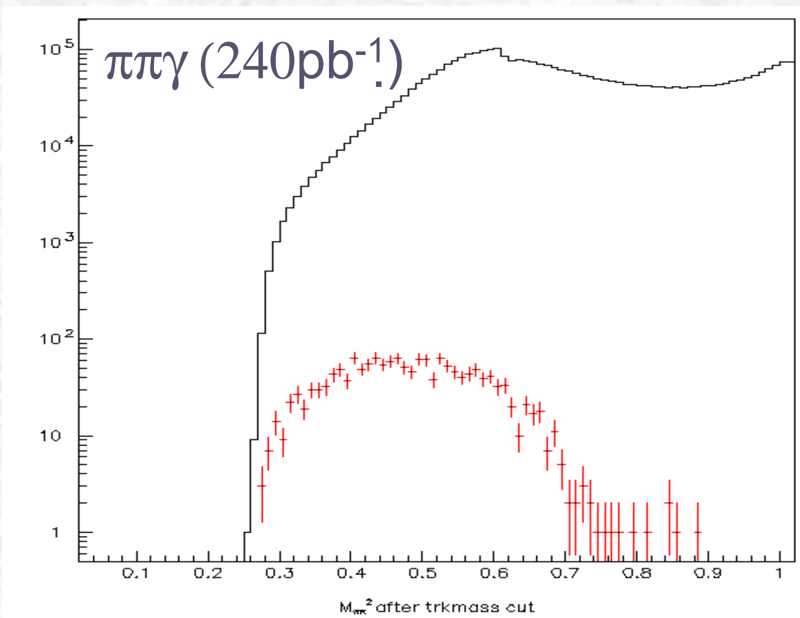
- systematic errors
- understand large χ^2

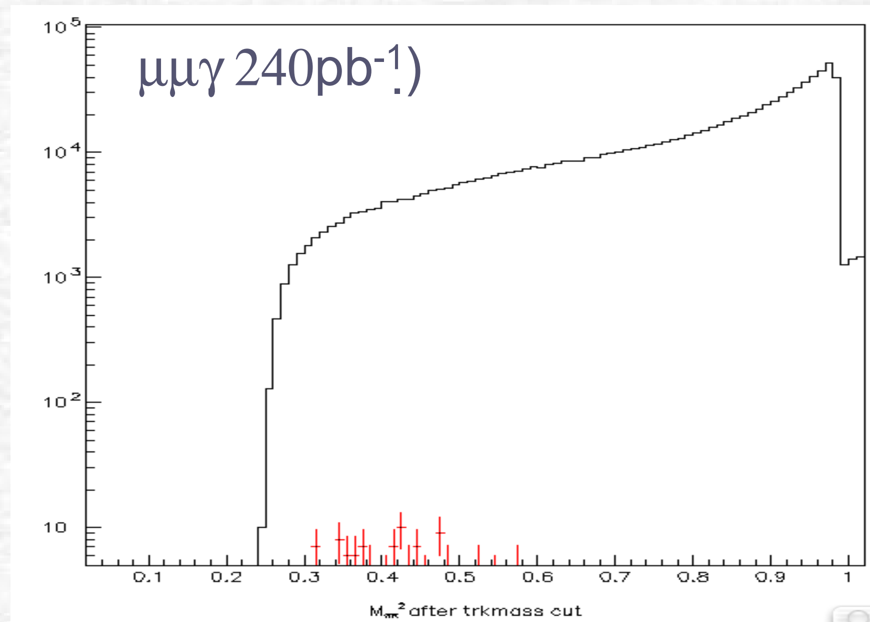
•Other contributions?

See next slide

Further backgrounds?

In order to understand whether there could be some further backgrounds, apply the selection cuts on ntuples from all_phys 2002 (mk0,mkc,drn,drc - no m3p, since they are already taken into account in the fit)



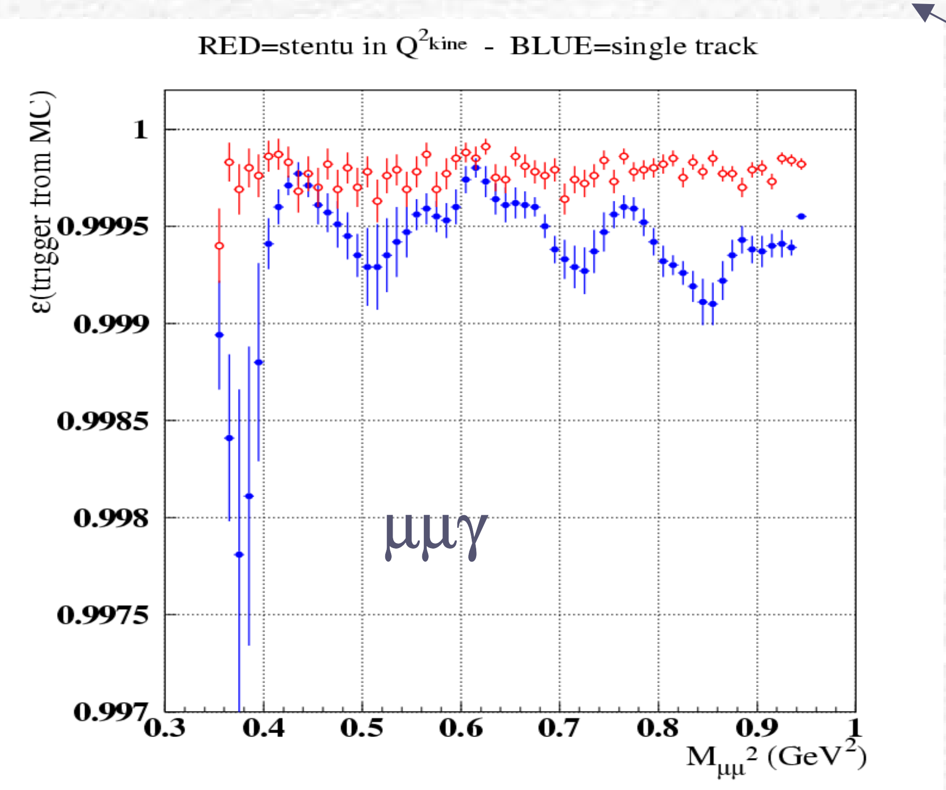


Caveat: 2002 all_phys production is done with DBV-18, and was done with only the old PPGTAG. Since new PPGTAG is slightly different

- Run on dsts from 2005 all_phys
- Run on mrcs from 2002, recreating ECLS bank…

Trigger efficiency

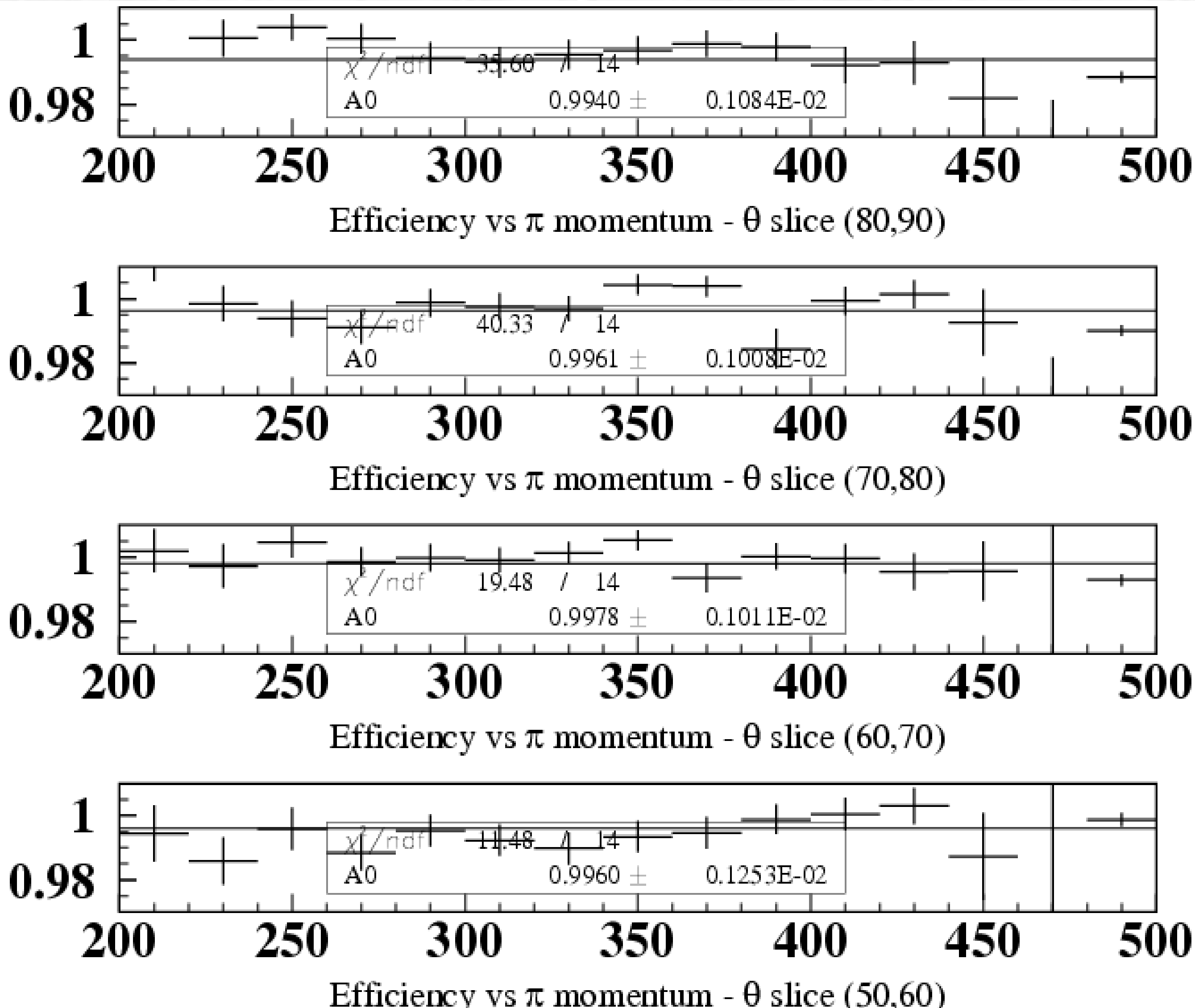
•Differences between data and MC up to 0.8% for μμγ and 1% ππγ (single particle method) (see presentation at KPW06)
•Relative differences between single particle method and MC "true" in agreement for μμγ, but **2%** (!!!) for ππγ



To be understood !

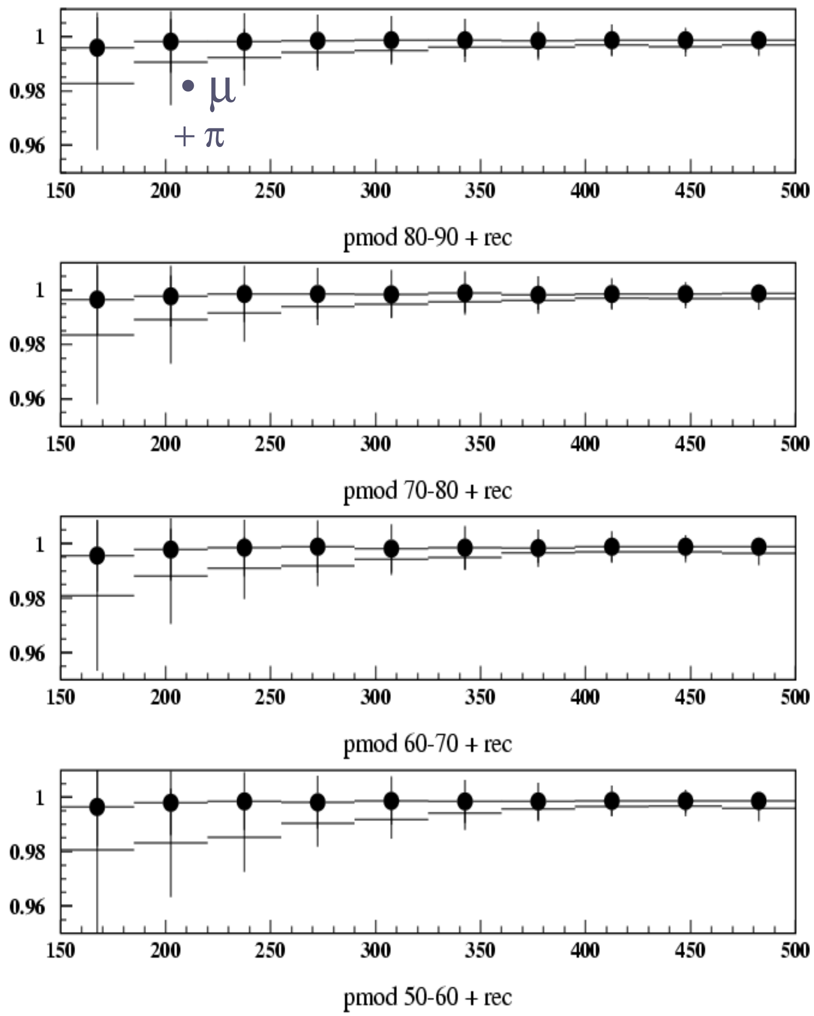
Tracking efficiency: ratio data/MC ππγ

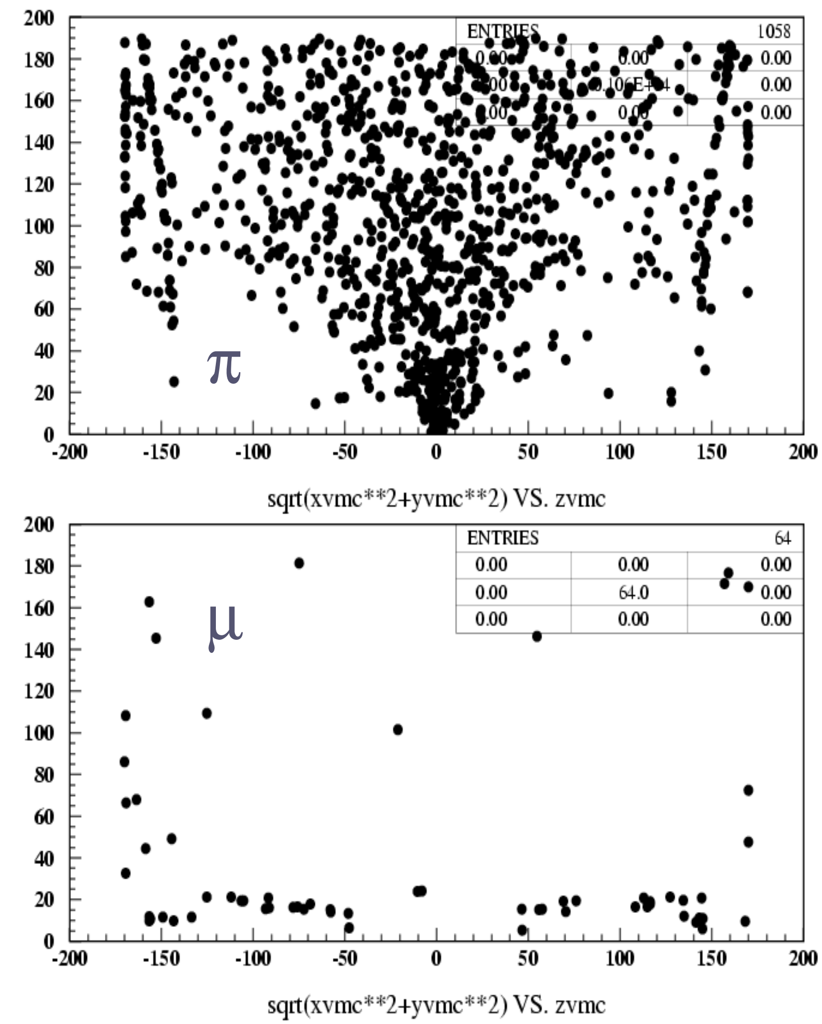
the agreement is on the level of 0.5-0.6%, at maximum, much more $\pi^+\pi^-$ statistics from raw could help in curing the 450-500 momentum region



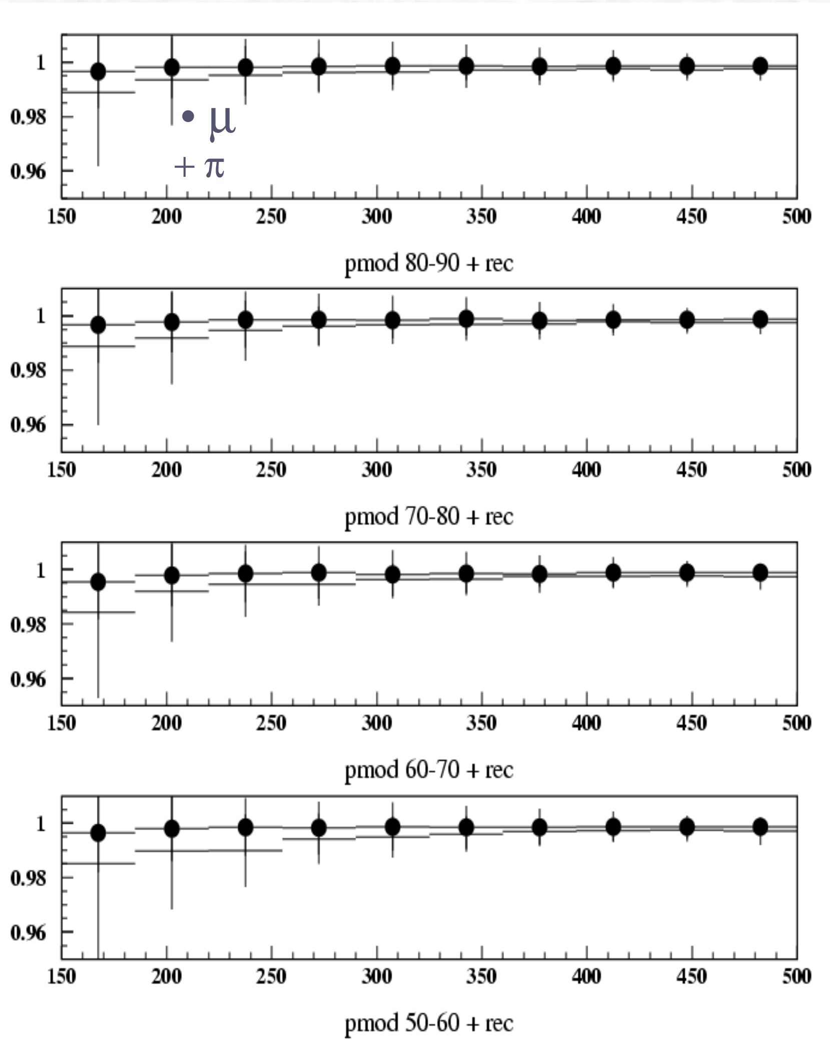
Tracking efficiency: $\pi\pi\gamma$ vs $\mu\mu\gamma$ (MC)

~10% π decays in DC





Tracking efficiency: $\pi\pi\gamma$ vs $\mu\mu\gamma$ (MC)



Requiring π to decay outside the DC

Trackmass/Missing mass Efficiency (1)

The following cuts apply to $\pi\pi\gamma$ and $\mu\mu\gamma$ events:

$\pi\pi\gamma$

On PPGTAG Level:

- $150 < |p_1| + |p_2| < 1020$ MeV
- $80 < M_{Trk} < 400$ MeV
- $-220 < \Delta E_{miss} < 120$ MeV

On Analysis Level:

- $130 < M_{Trk} < 220$ MeV
- "Elliptical" cut to reject $\pi\pi\pi$ events

$\mu\mu\gamma$

On PPGTAG Level:

- $150 < |p_1| + |p_2| < 1020$ MeV
- $80 < M_{Trk} < 400$ MeV
- $-220 < \Delta E_{miss} < 120$ MeV

On Analysis Level:

- $M_{Trk} < 115$ MeV

Efficiency is evaluated from MC (ppgphok3, pho5mmg). PPGTAG request is dropped, and the criteria for PPGTAG are recreated "by hand" in order to separate vertex requirements from kinematical cuts.

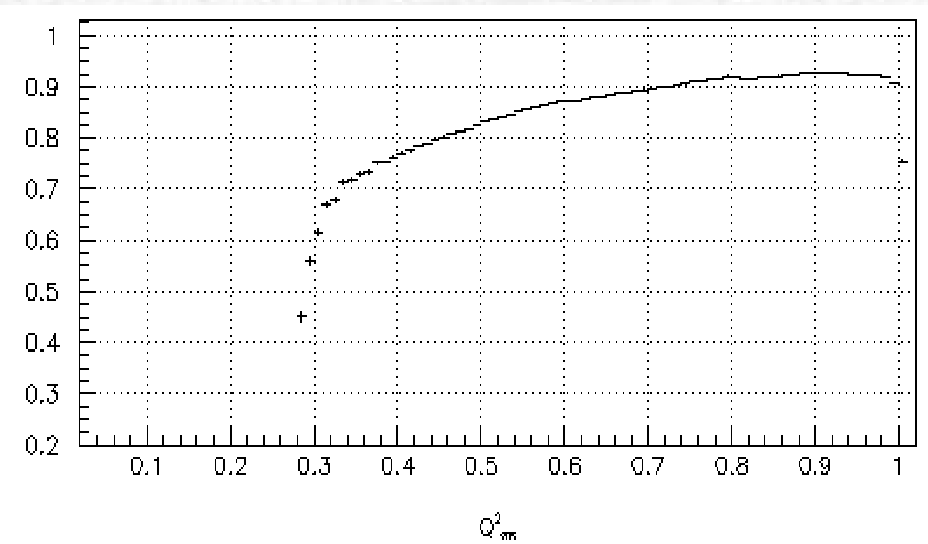
No change in efficiency whether or not applying the weights obtained from the background fit to the MC spectra for $\pi\pi\gamma$ and $\mu\mu\gamma$

Efficiency correction on the spectrum is applied right after the FILFO-corr. and the background subtraction.

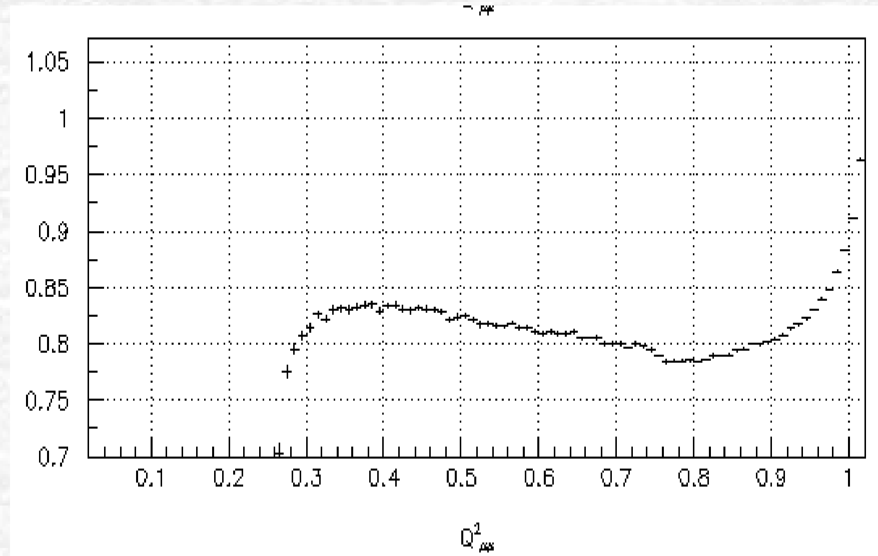
Trackmass/Missing mass Efficiency (2)

First results:

$\pi\pi\gamma$



$\mu\mu\gamma$



MC reproduces very well the data distributions in M_{Trk} (thanks to Valeriani/Bini corrections) - some discrepancy outside the ρ peak. Has still to be verified also for ΔE_{miss}.

Further checks include the dependence on rad. corrections (FSR) in the MC…

New developments:

- π/μ discrimination
- DC trigger for the ratio

π/μ discrimination

- A clean sample of muons useful for
  - Efficiencies
  - Background
- The idea is to discriminate pions/muons for single track, according to the different interaction with the calorimeter

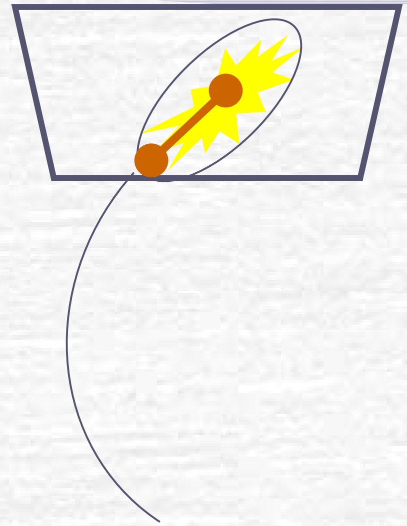
MLP method

- Multi-Layer Perceptrons is a type of Neural Network widely used. It is interfaced with PAW/HBOOK. Already used in KLOE by Marianna T. .
- It is both simple and based on solid mathematical grounds. Input quantities are processed through successive layers of "neurons". There is always an input layer, with a number of neurons equal to the number of variables of the problem , and an output layer, where the perceptron response is made available

MLP method

- The layers in between are called "hidden" layers. With no hidden layer, the perceptron can only perform linear tasks (for example a linear discriminant analysis, which is already useful).
- trained with a desired answer = 1 for signal and 0 for background, the approximated function is the probability of signal knowing the input values.

Discriminant variables:MC



- 4 discriminant variables were selected:
  - $V1 = E_{clu}/E_K(m_\mu)$
  - $V2 = |d_{clu}-d_{ext}|$
  - $V6 = \beta = L/cT_{clu}$
  - $V11 = dT = T_{CLU} - L_{TRK}E(m_\mu)/pc$

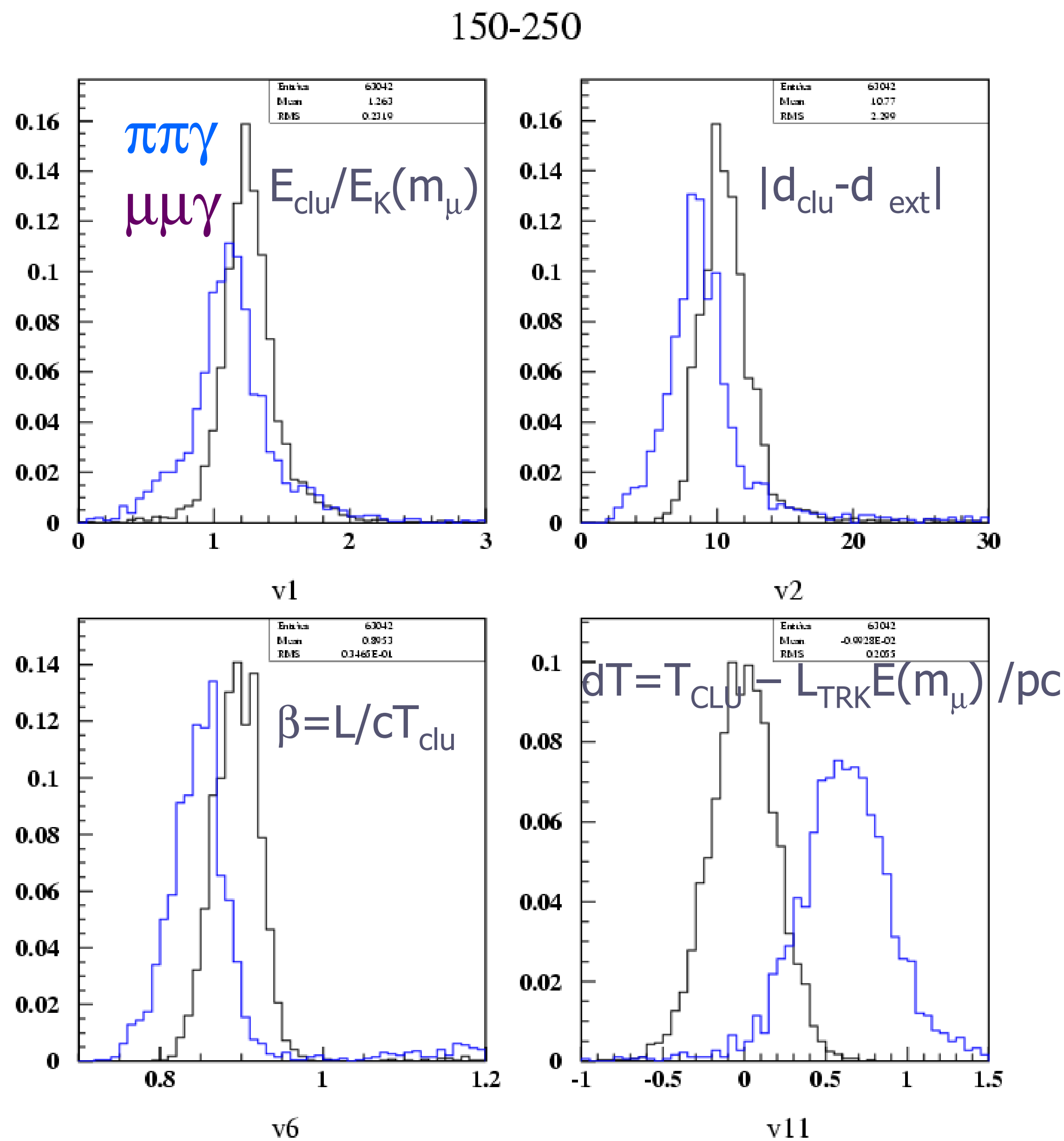
$L_{TRK} = L_{F.H.} + L_{D.C.} + L_{extp} + D_{clu}$

- The cluster is the most energetic associated to the track (within 60cm). Newextratom is used
- The track is required to satisfy the ppg acceptance:
  - $50<\theta<130$, (PT>160 MeV *or* |PZ|>90 MeV)
  - $r_{FH}<50cm$, rhoP.C.A.<8cm, $|Z_{PCA}|<7cm$
- The vtx is not required (information from DTFS)

} Condition on the candidate trk

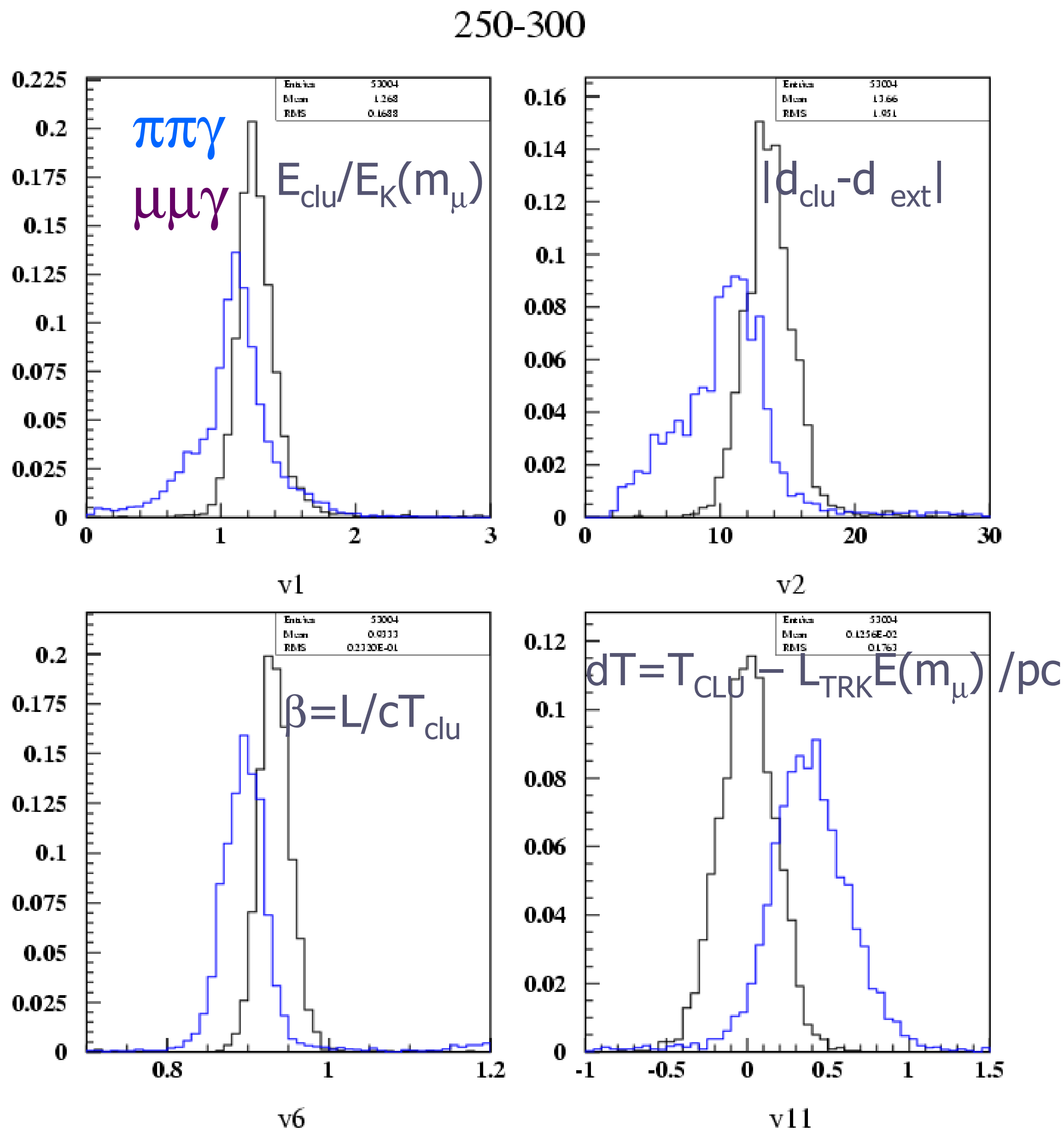
Discriminant variables:MC

150<p<250



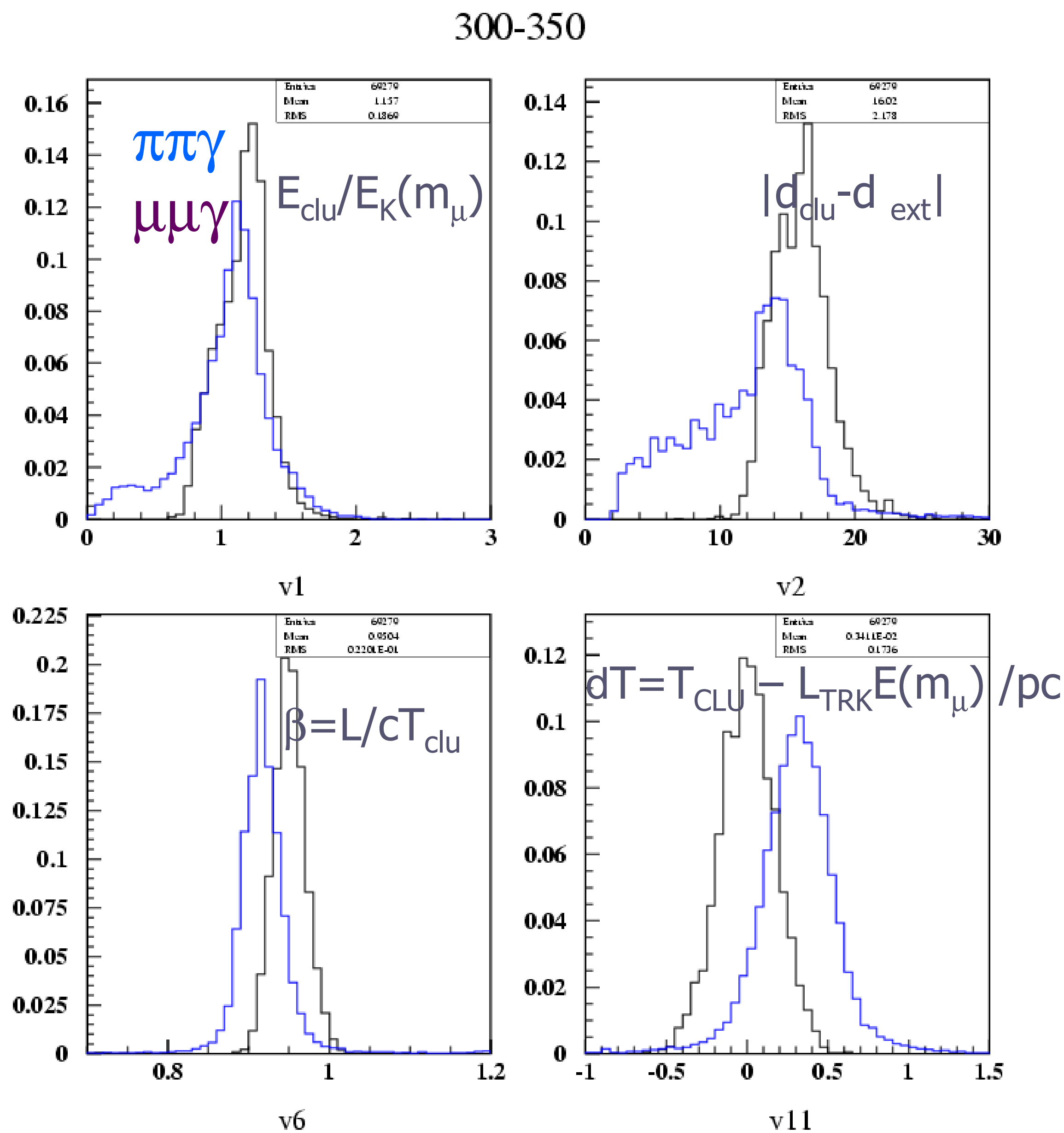
Discriminant variables:MC

250<p<300



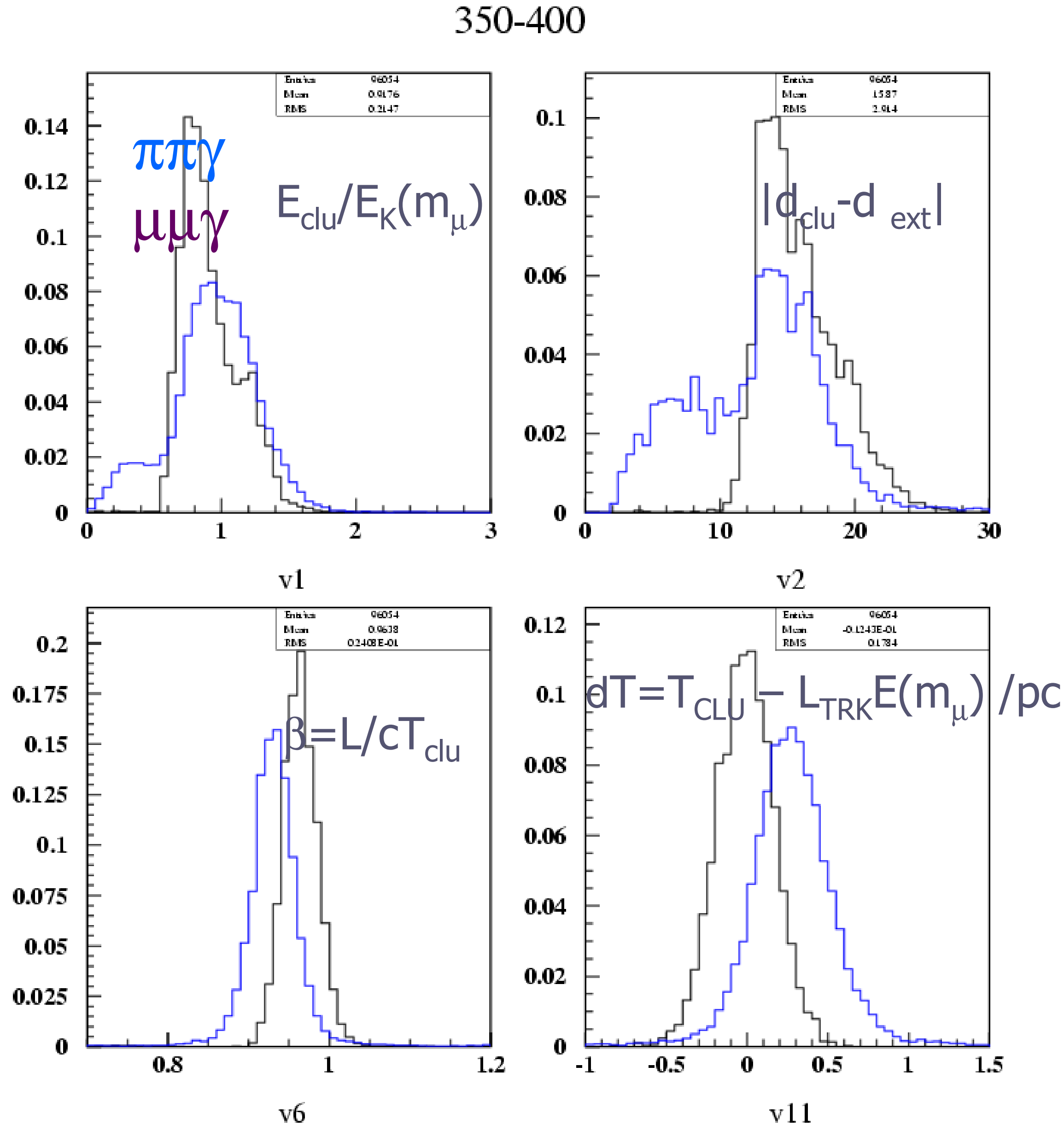
Discriminant variables:MC

300<p<350



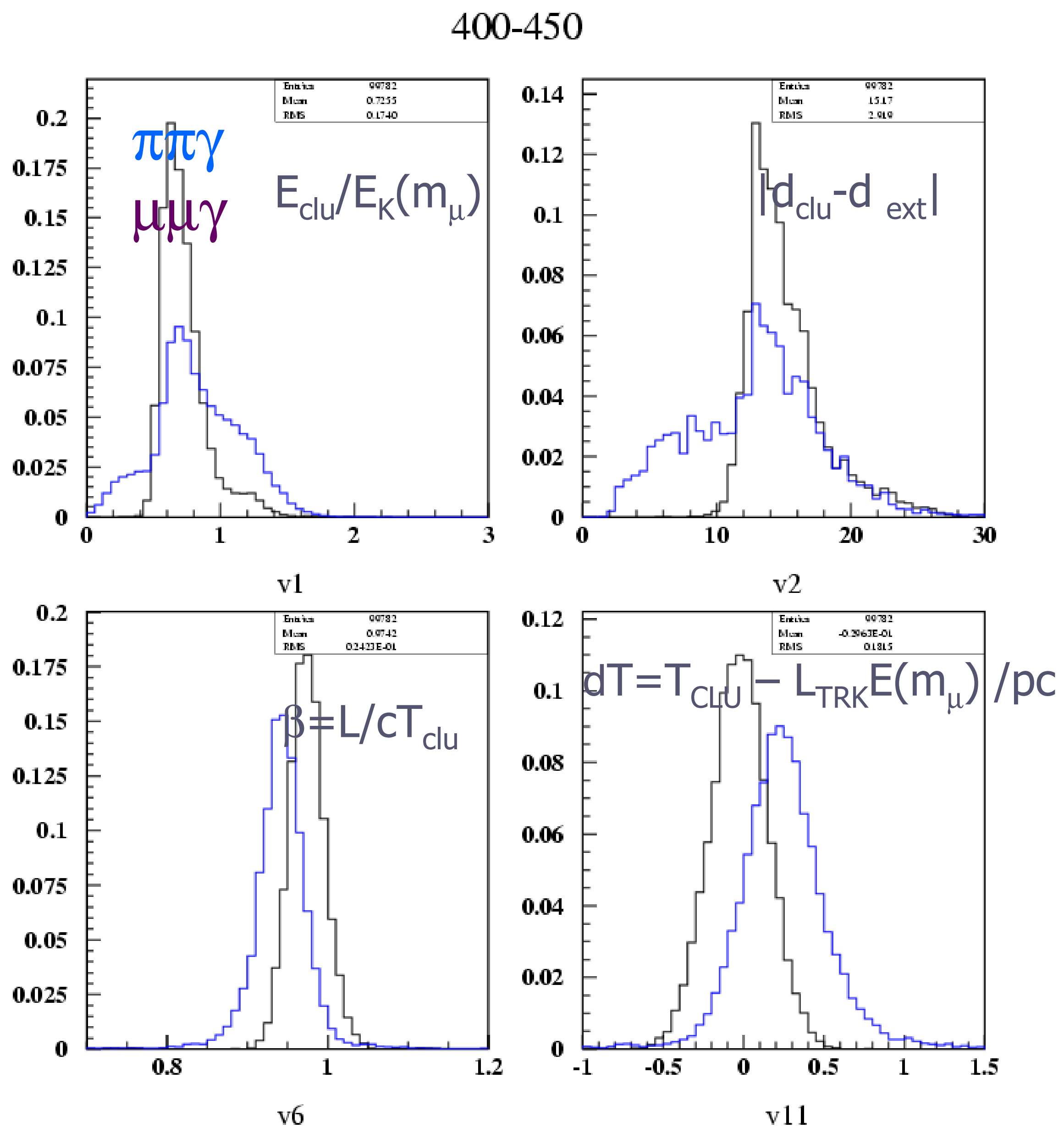
Discriminant variables:MC

350<p<400



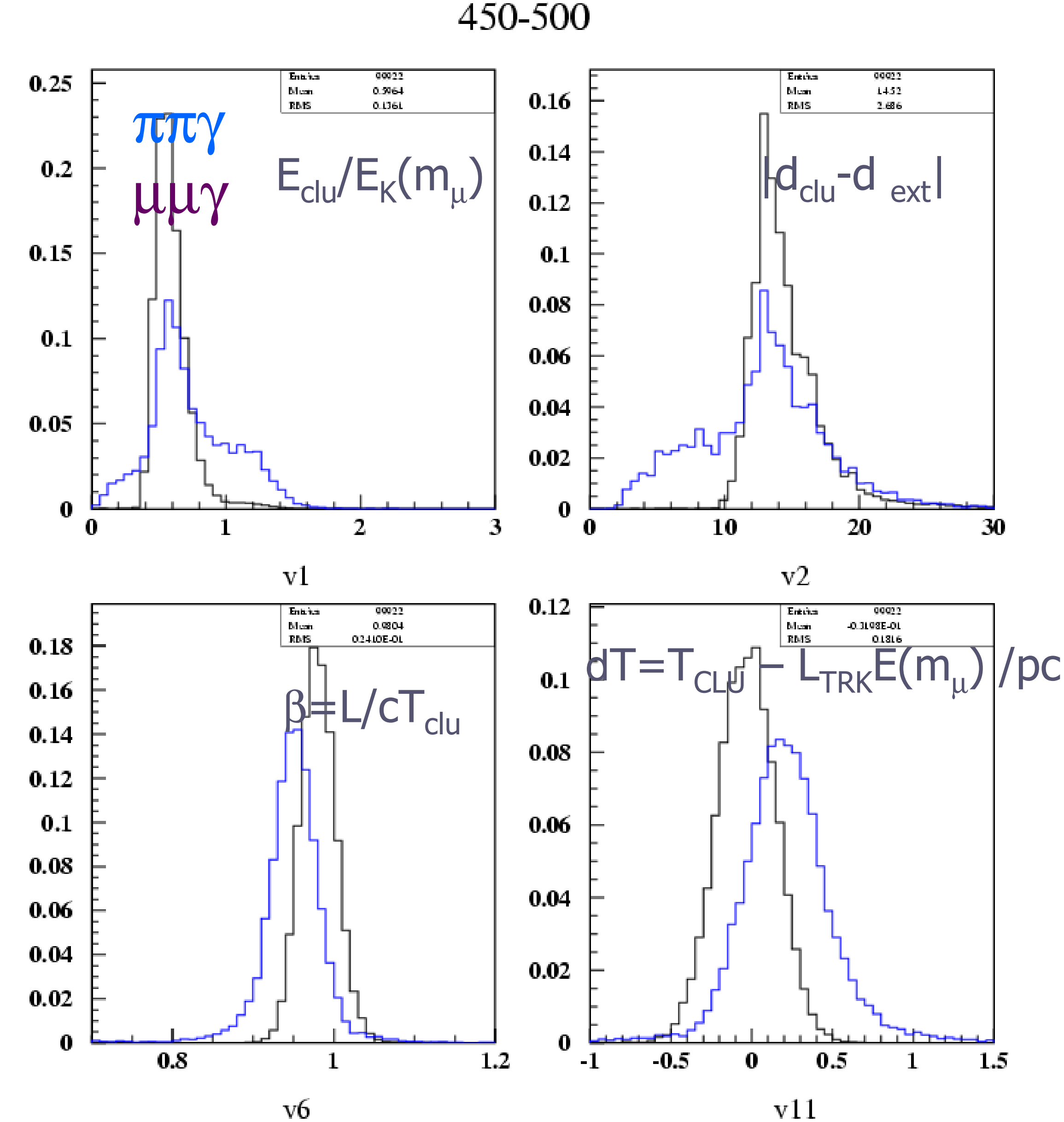
Discriminant variables:MC

400<p<450



Discriminant variables:MC

450<p<500



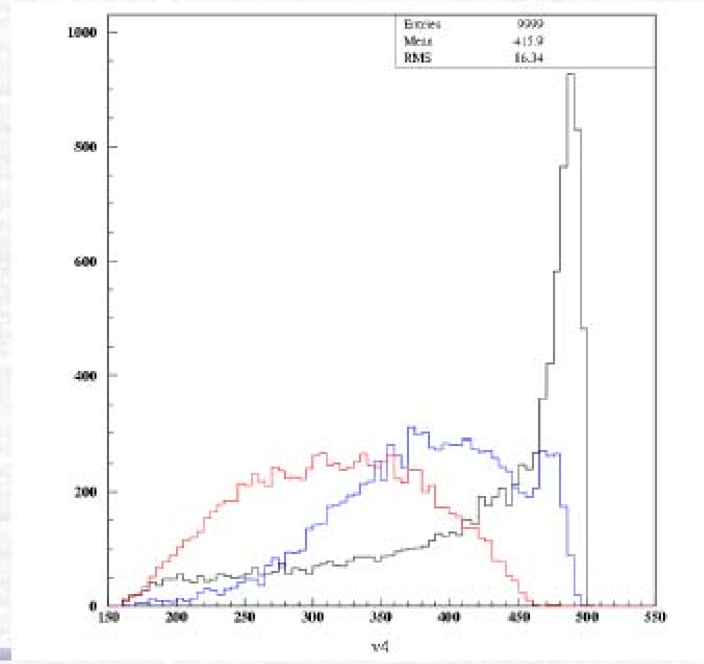
Training MLP on data/MC

- 3π (selected by rhopitag) and $\pi\pi\gamma+\mu\mu\gamma$ (selected by ppgtag) data and MC have been used to study the discriminant variables;
- METHOD: select/clean the sample with a tagging track and study the calorimeter answer for the other (candidate) track, WHICH must satisfy conditions in slide 20
- The MLP output will be trained/defined on the candidate track. Since the tracking information are taken from DTFS bank, the existence of the vtx is not a bias (checked also with MC).
- Issue: get rid of Bhabha contamination

Training MLP on data/MC

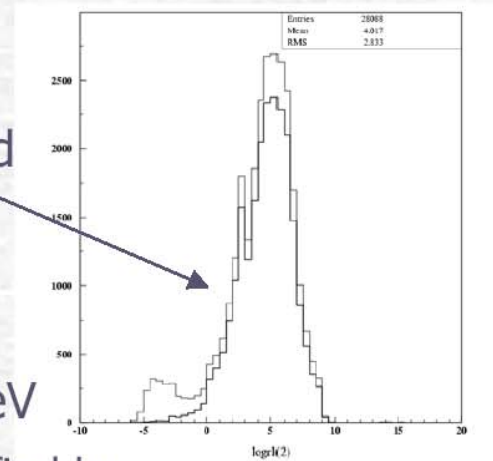
- Strategy:
  - Construct the MLP in bin of momentum: 150-250 first bin; 250-500 5bins of 50 MeV width each
  - Pion: Use 3p up to 450 MeV. Use ppg MC/pp for the bin 450-500.
  - Muons: No clean sample aivalable from data. Use MC

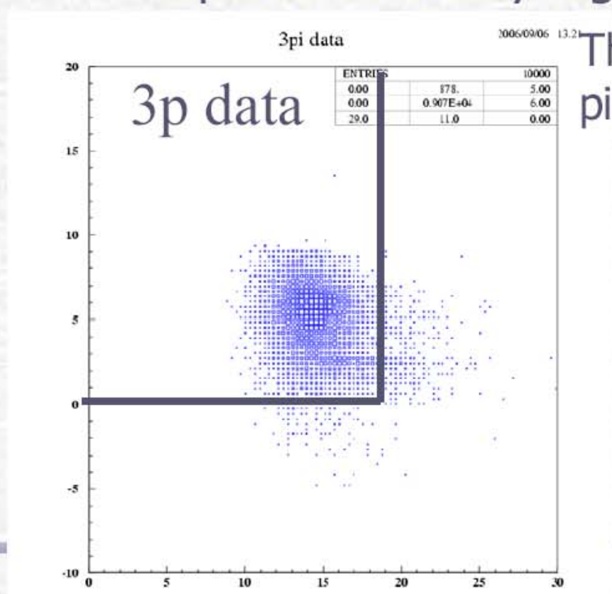
- To use MC on muons is not a big problem, for two reasons:
  - Comparisons data/MC for pions are excellent (see later)
  - The construction of the MLP can be done iteratively, starting with MC at step 0 (details later)
  - All the results will refer to >0 track (tag track is <0)



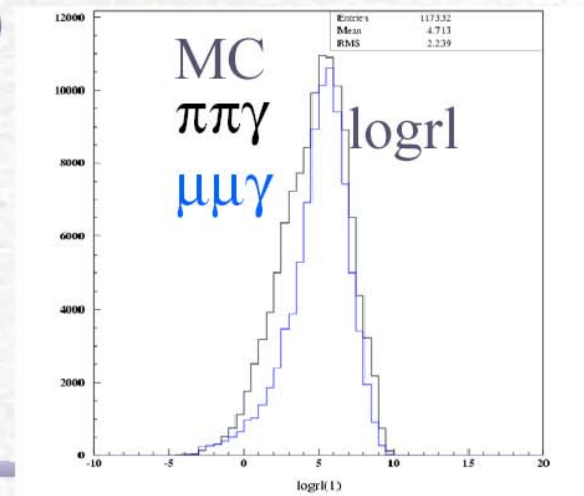
Discriminant variables:3π control sample

- 3π sample can be used to train the mlp on π, in the range 150 MeV-450 MeV.
- The tag track is required to have logr>2. The other track (candidate track) is the one studied for the mlp output.
- As additional condition (to discriminate about Bhabha's) the candidate track (track 1) is required to satisfy logr>0 and $<dE_{DC}><18$ MeV

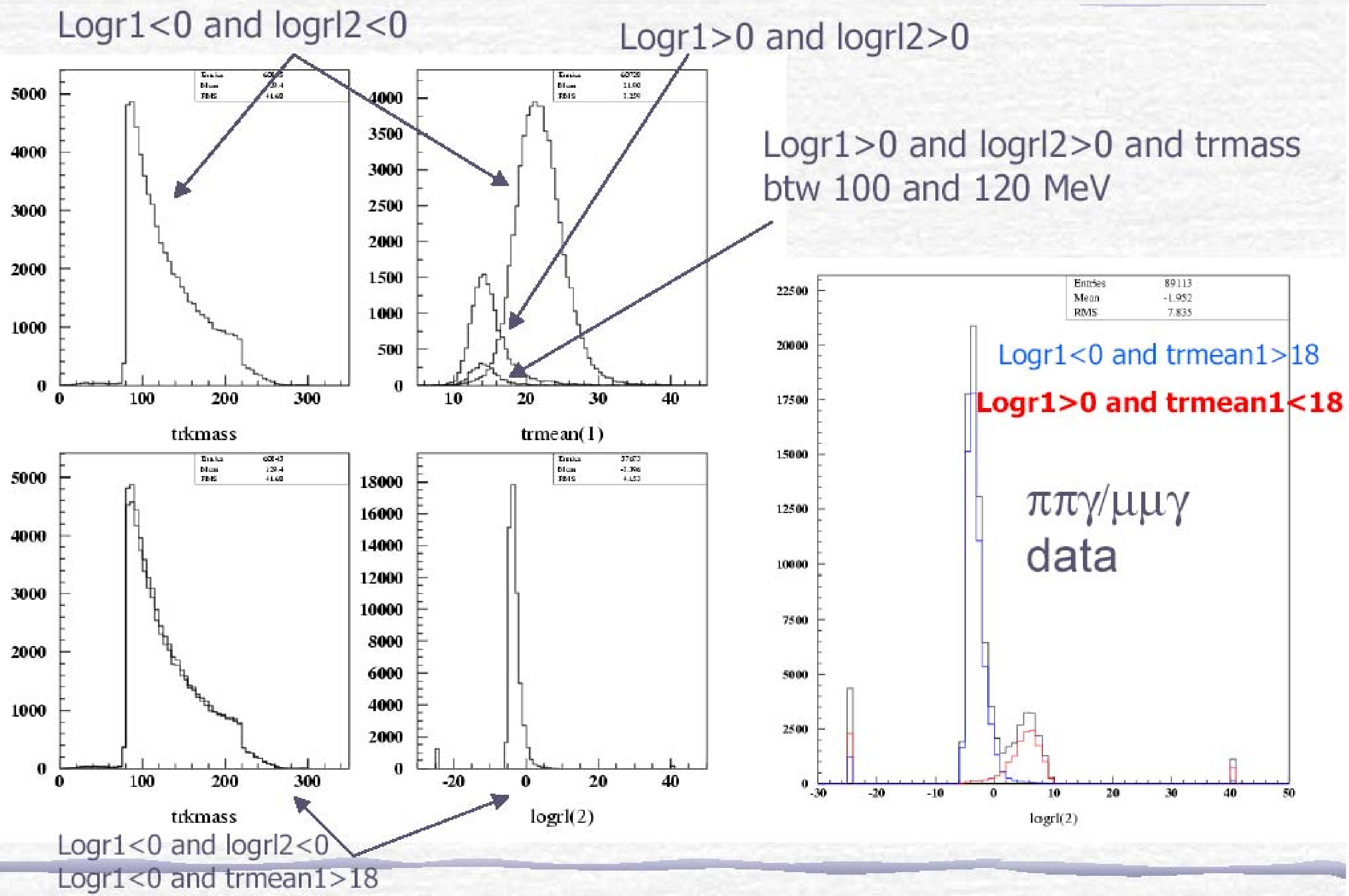




This condition is largely satisfied by pion/muon tracks (ε>95%)

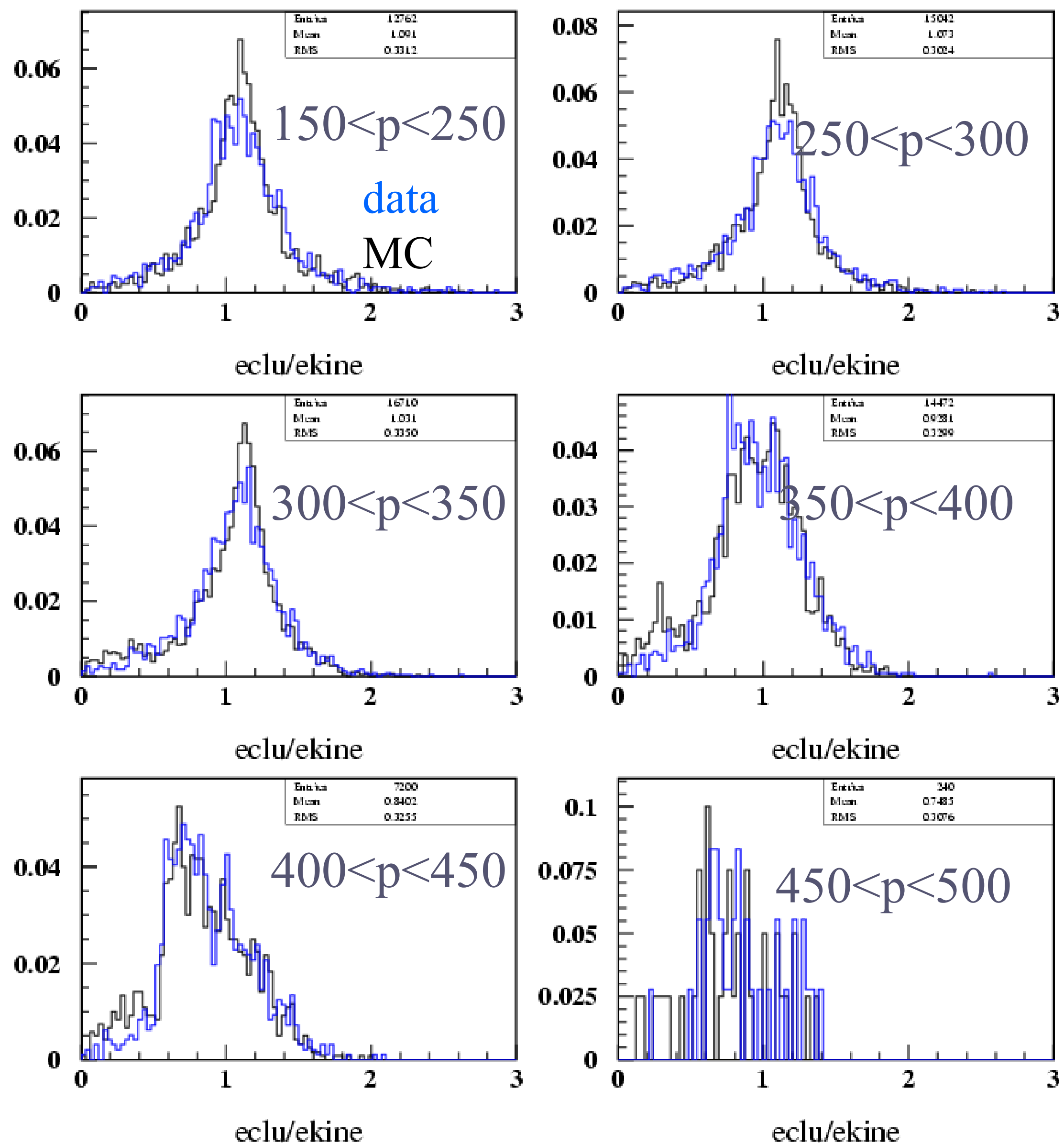


Bhabha rejection



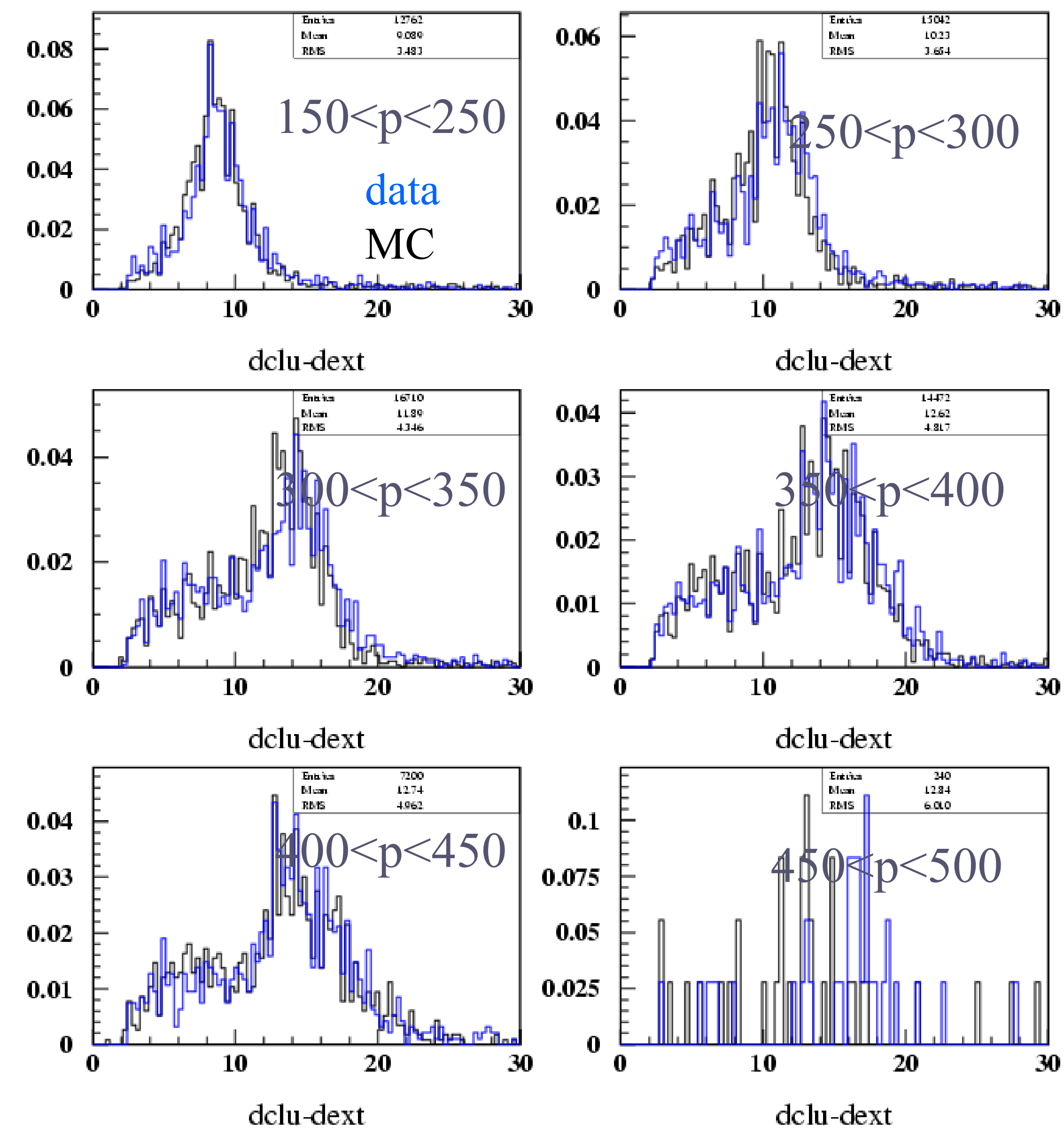
Discriminant variables:3π data vs MC

- $E_{clu}/E_K(m_\mu)$



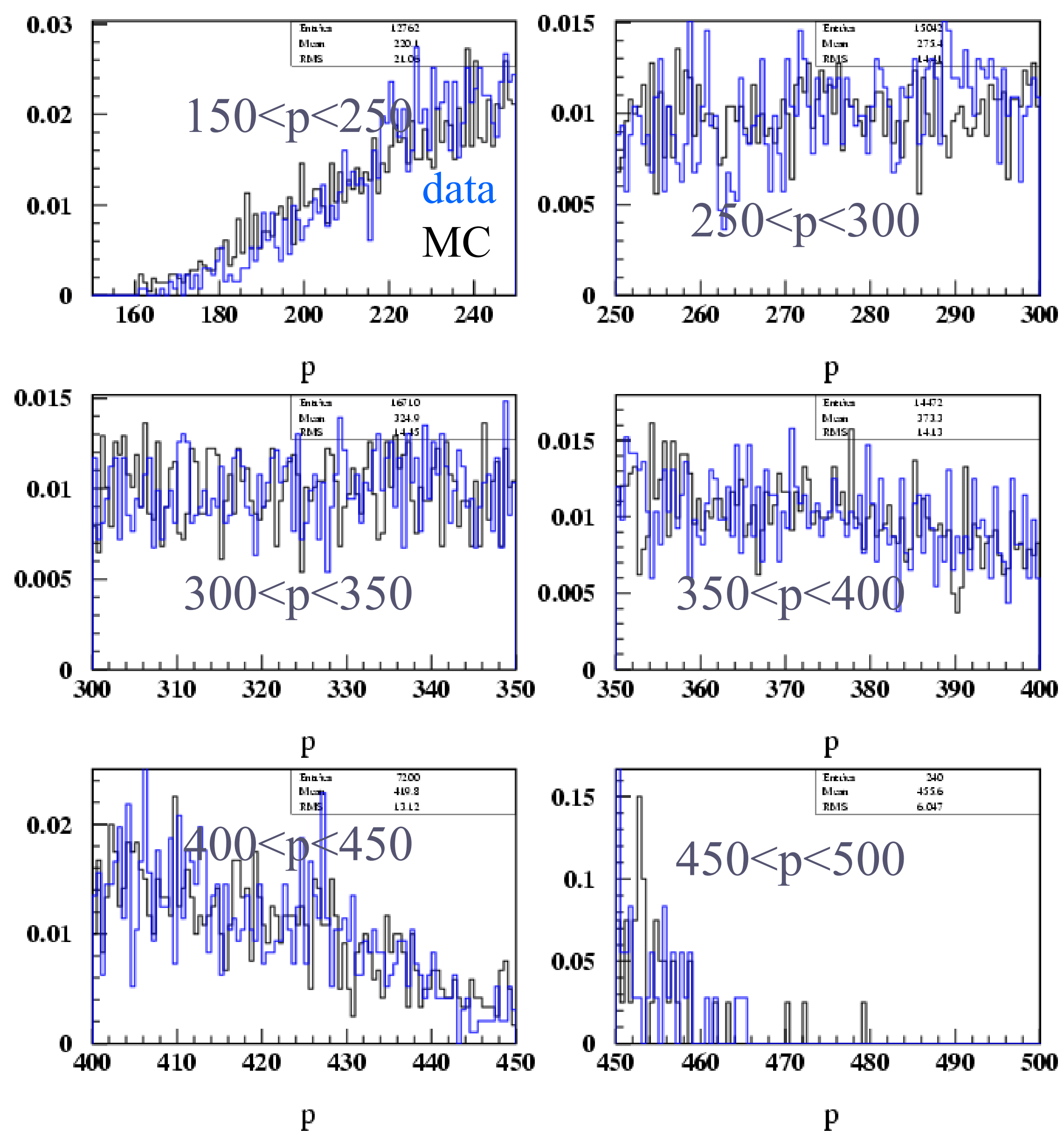
Discriminant variables:3π data vs MC

$|d_{clu}-d_{ext}|$



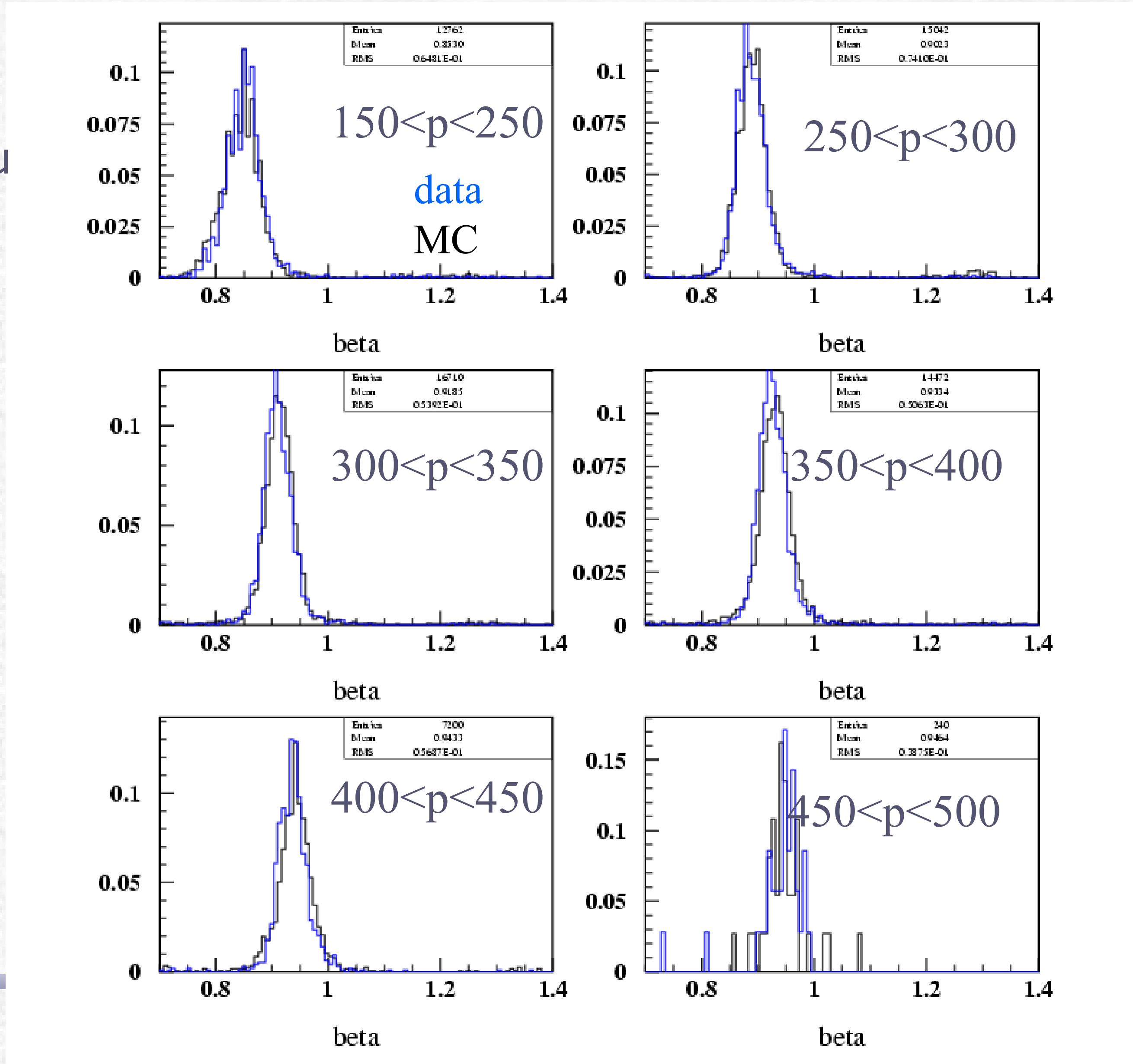
Discriminant variables:3π data vs MC

Momentum



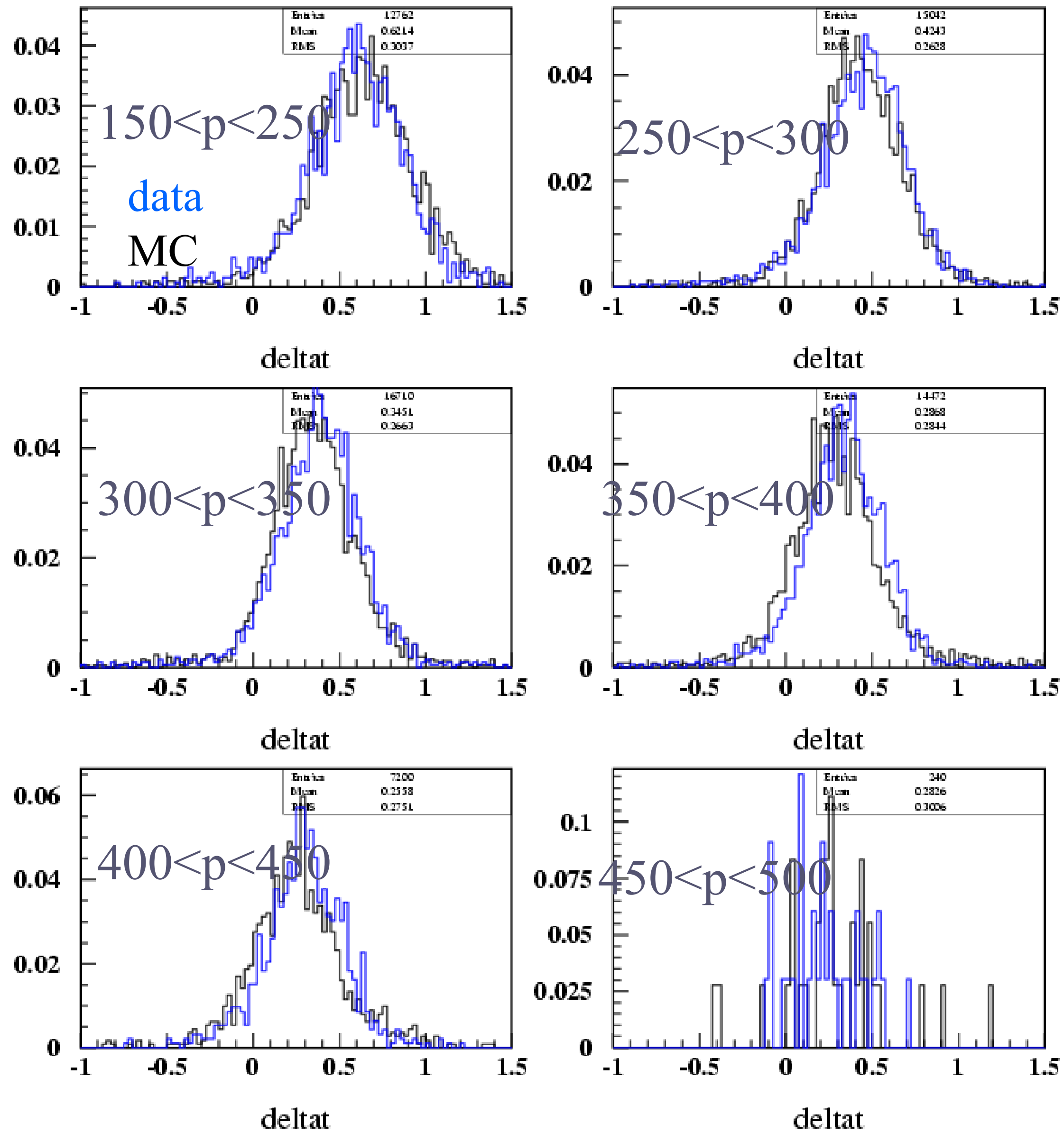
Discriminant variables:3π data vs MC

$\beta = L/cT_{clu}$



Discriminant variables:3π data vs MC

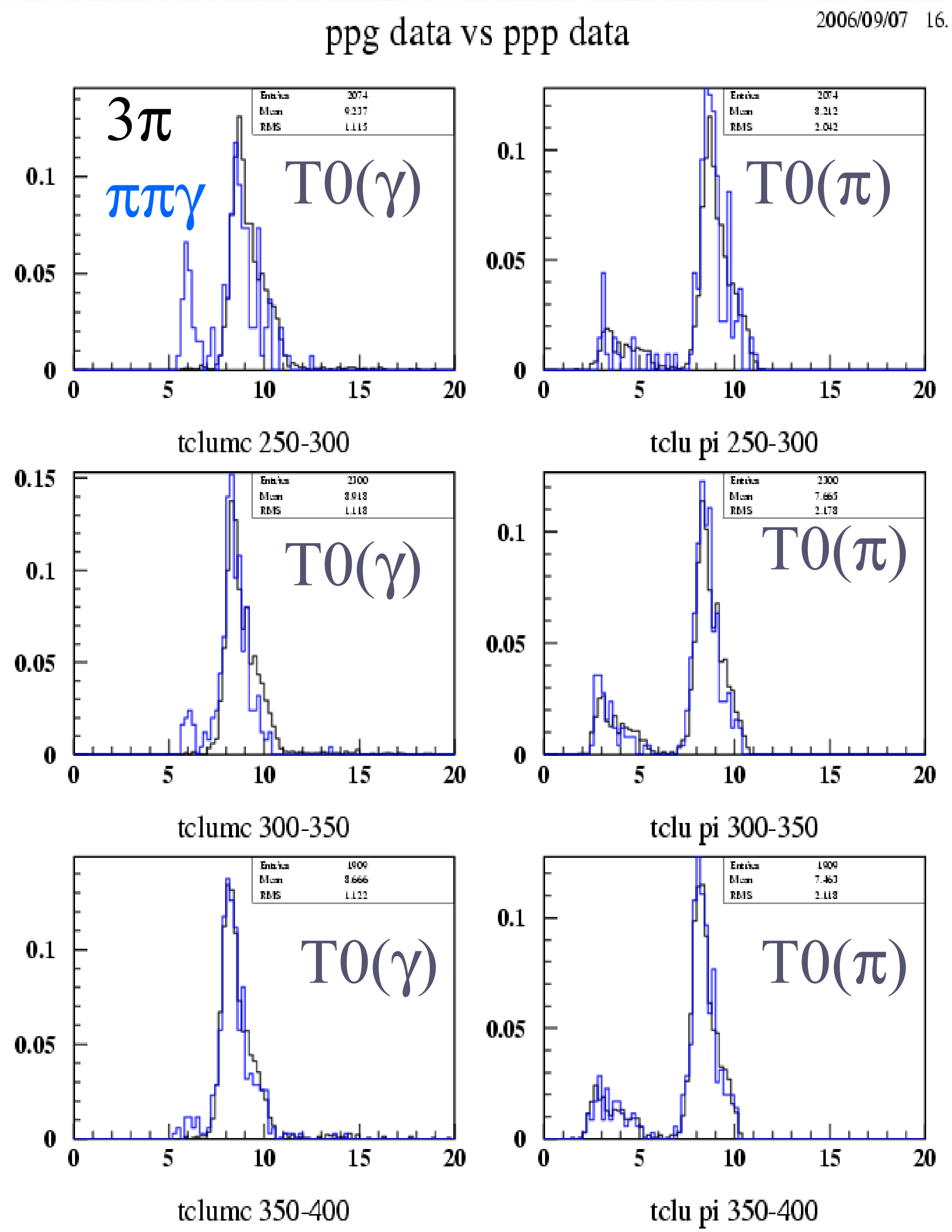
$dT = T_{CLU} - L_{TRK}E(m_{\mu})\ /pc$

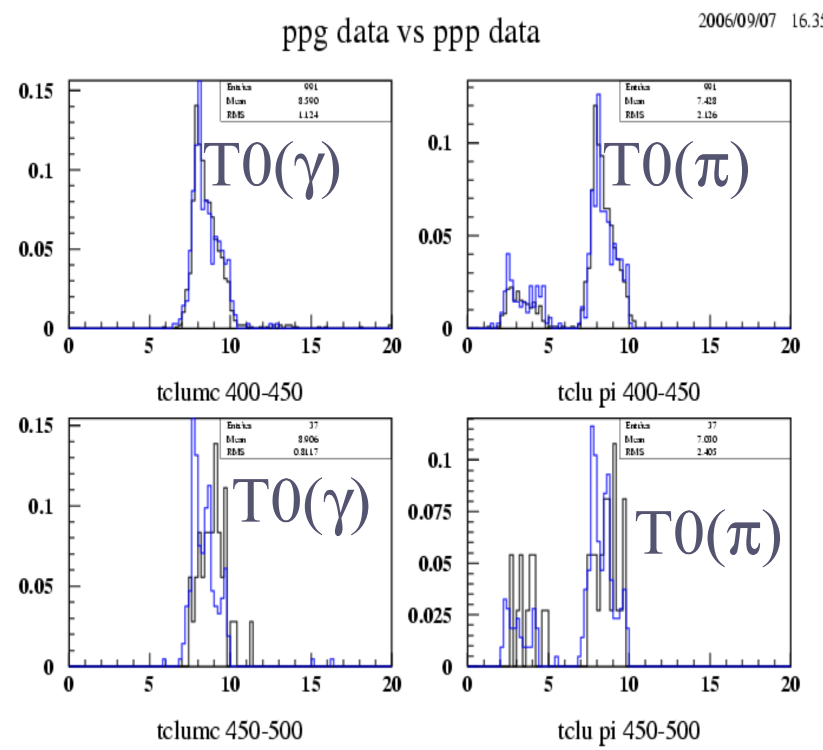


Needs t0 step1 correction?

- In the barbara’s likelihood the time of the cluster is corrected in the pion/electron hypothesis
- In principle this can be done also in our case. However there is not so much need for this correction (see next plots)

Needs t0 step1?



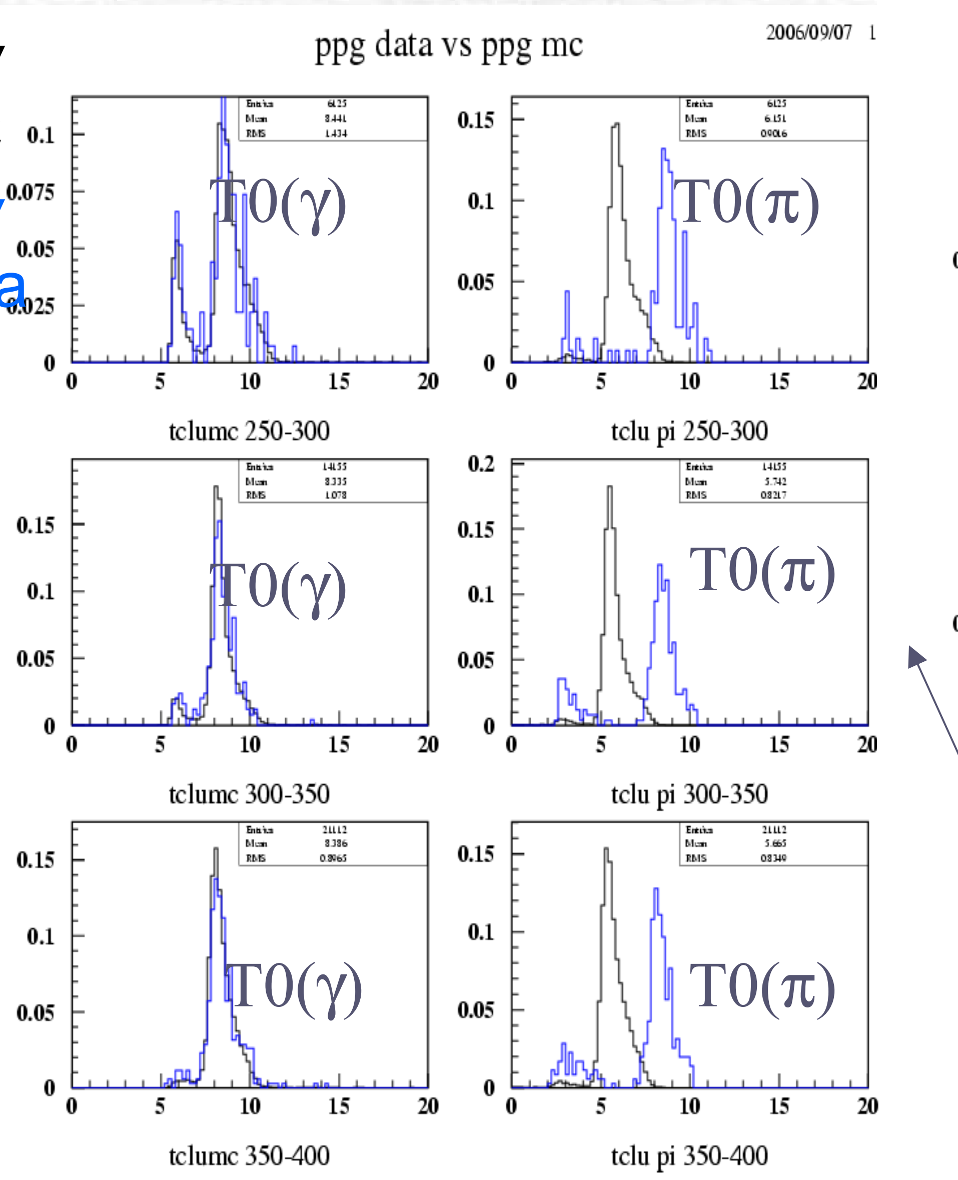


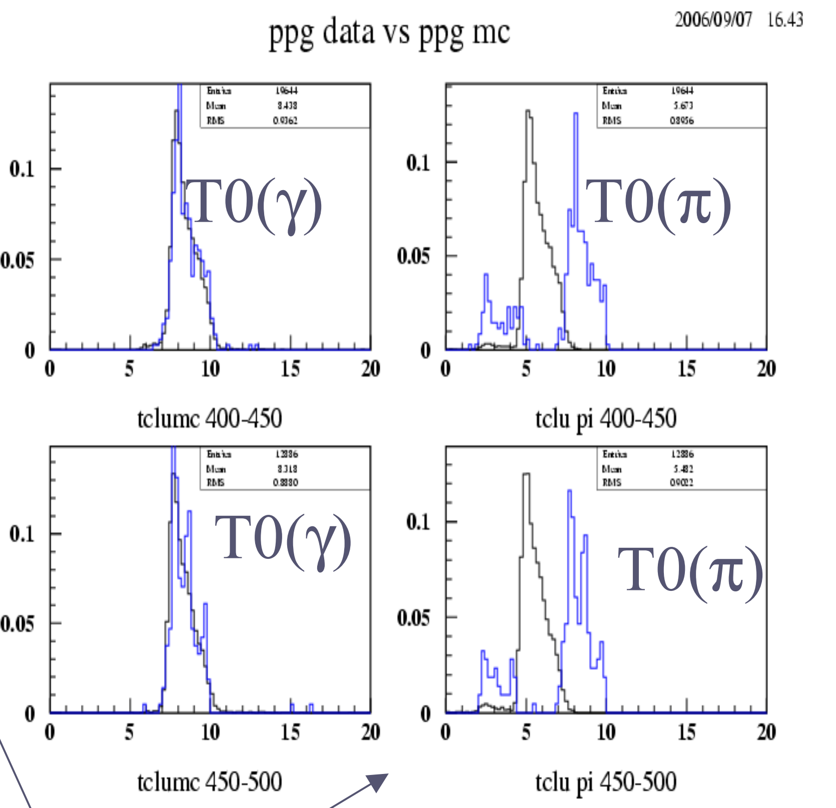
Ppg are selected by a cut on 130<mtrk<150, and by requiring the tagging track logrl>0.and. Trmean<18

Needs t0 step1?

ππγ MC

ππγ data



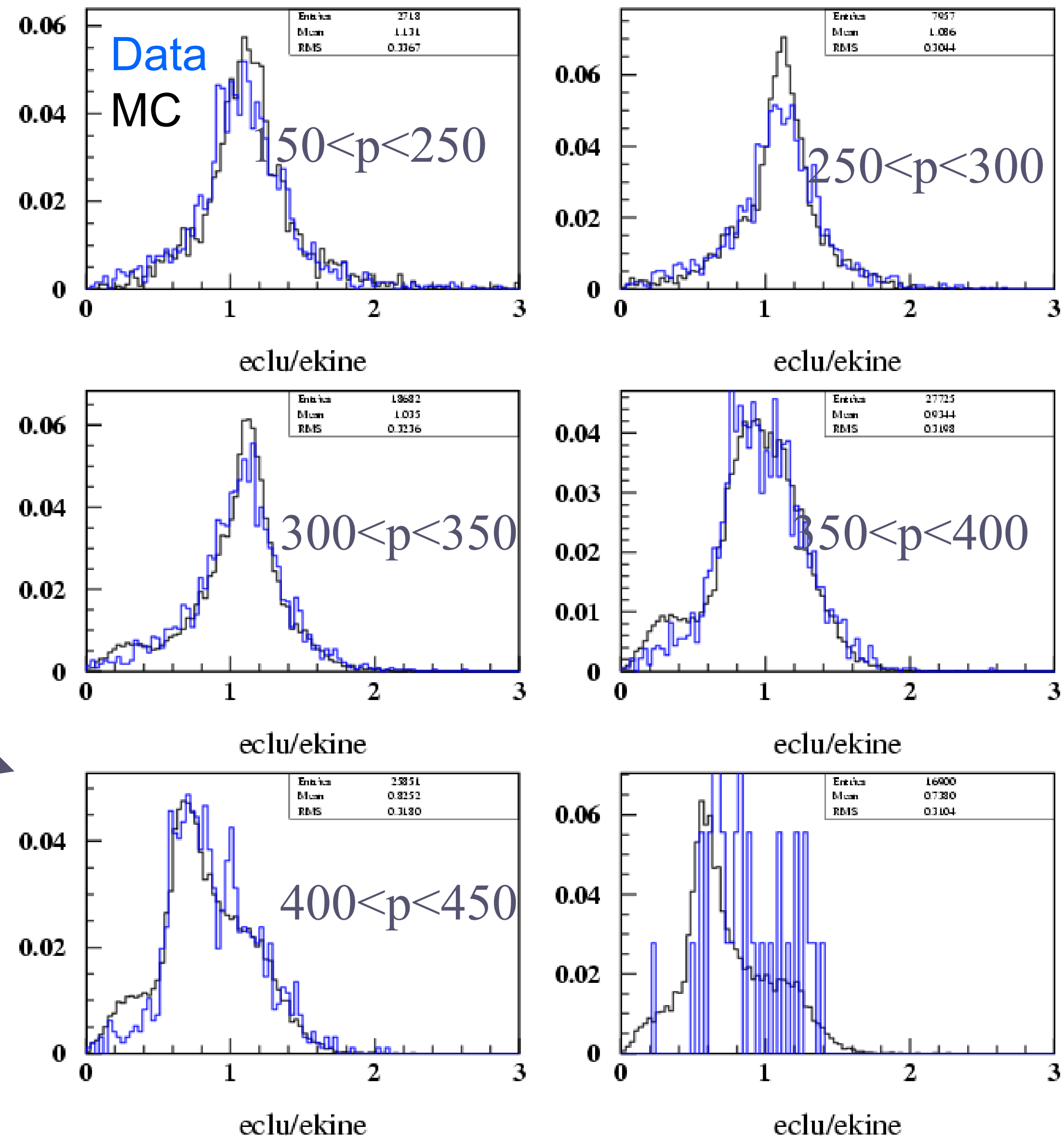


Effect of T0 step1 for MC???? Not clear….Important to check

Discriminant variables:3p(data) vs ppg(MC)

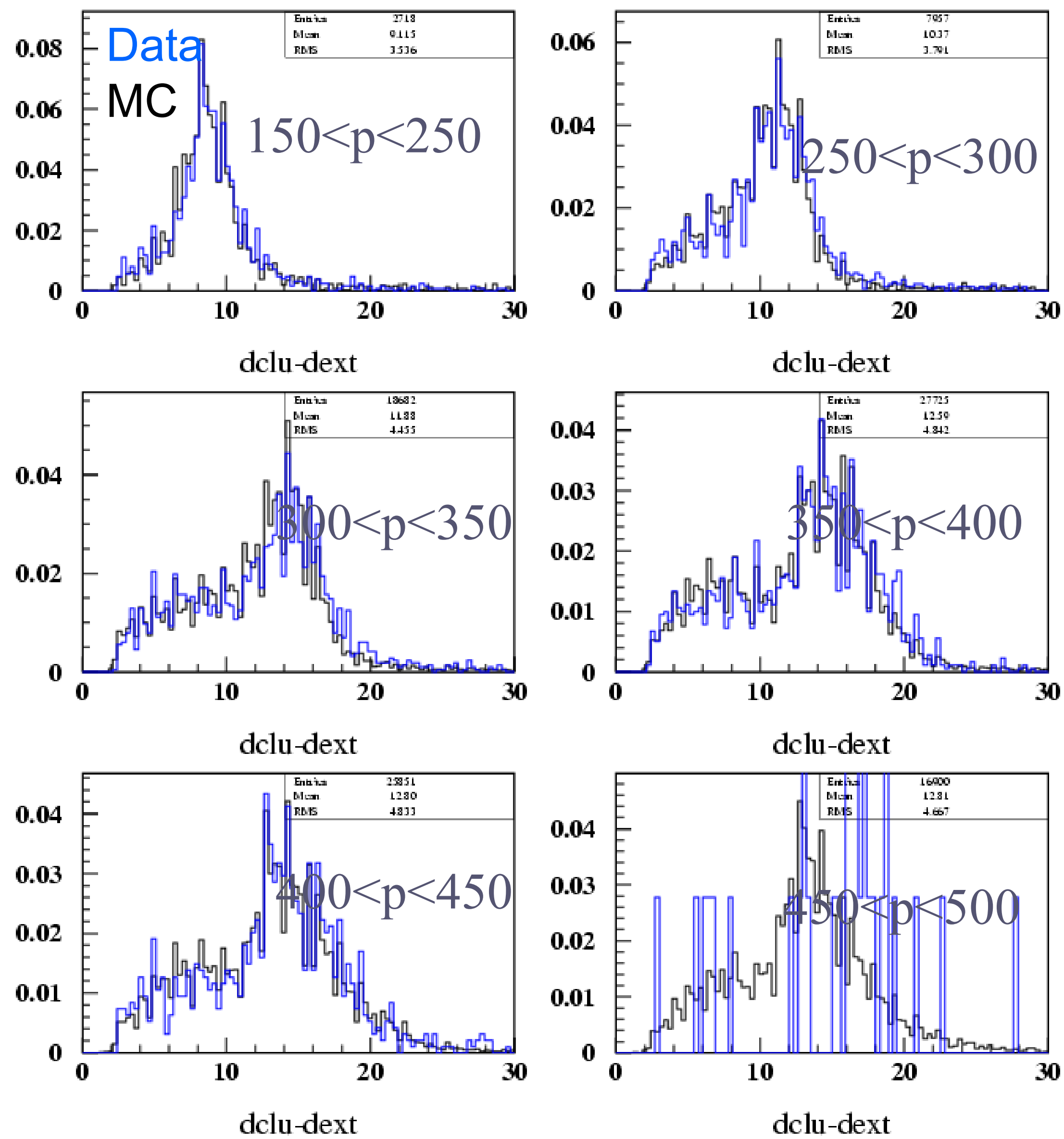
- $E_{clu}/E_K(m_\mu)$

punch-trough



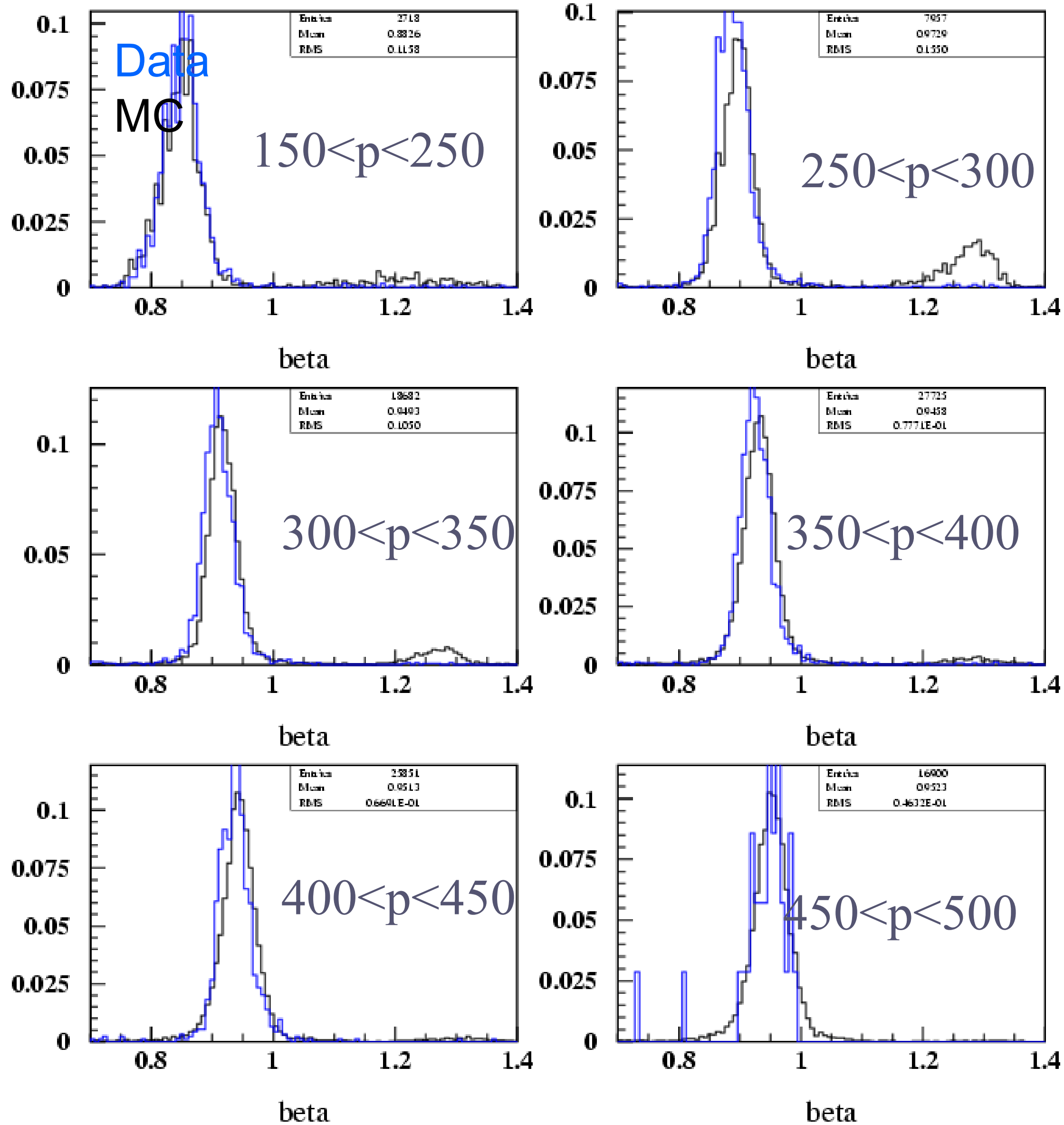
Discriminant variables:3p(data) vs ppg(MC)

$|d_{clu}-d_{ext}|$



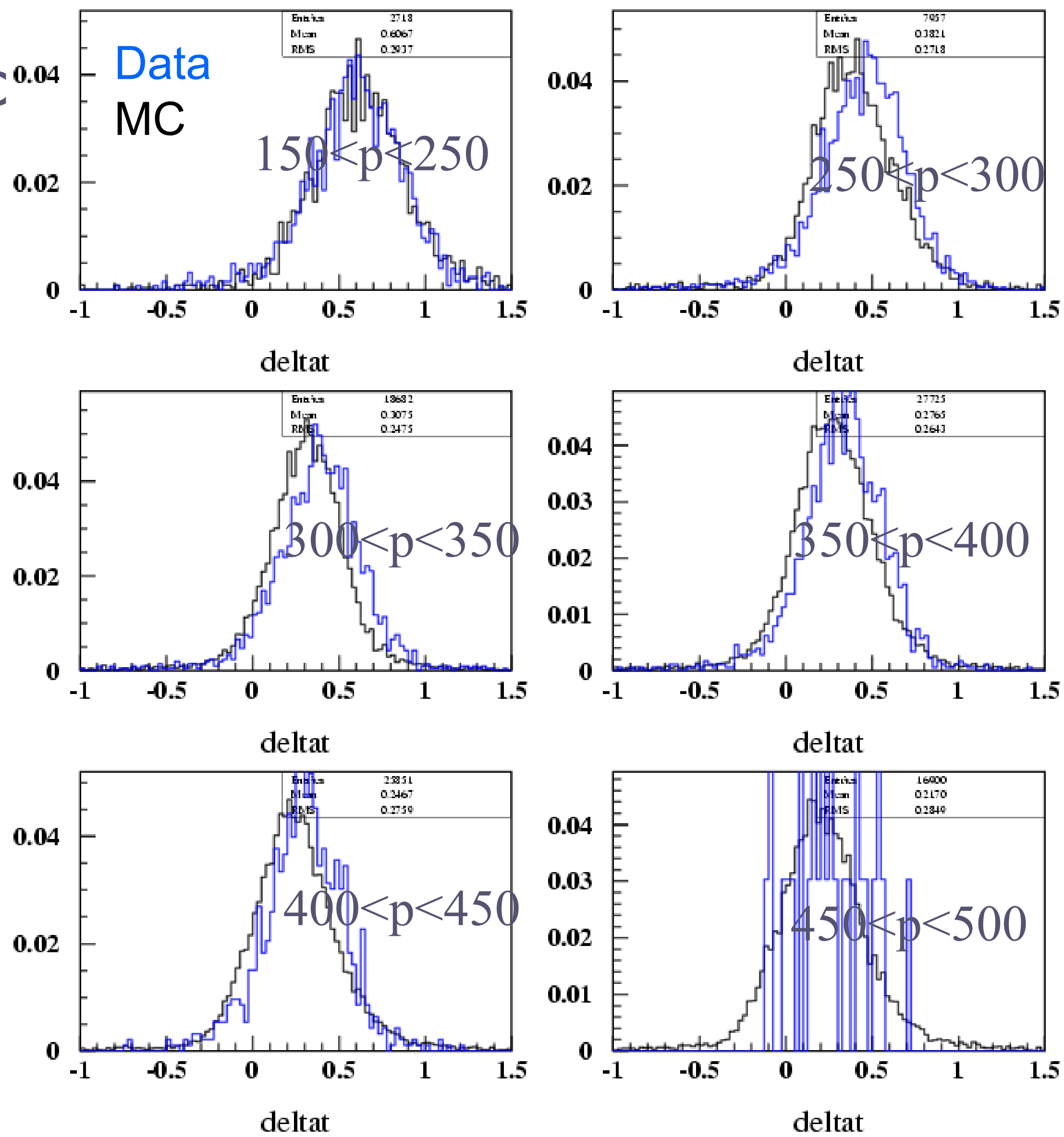
Discriminant variables:3p(data) vs ppg(MC)

$\beta = L/cT_{clu}$



Discriminant variables:3p(data) vs ppg(MC)

$dT = T_{CLU} - L_{TRK} E(m_{\mu}) / pc$

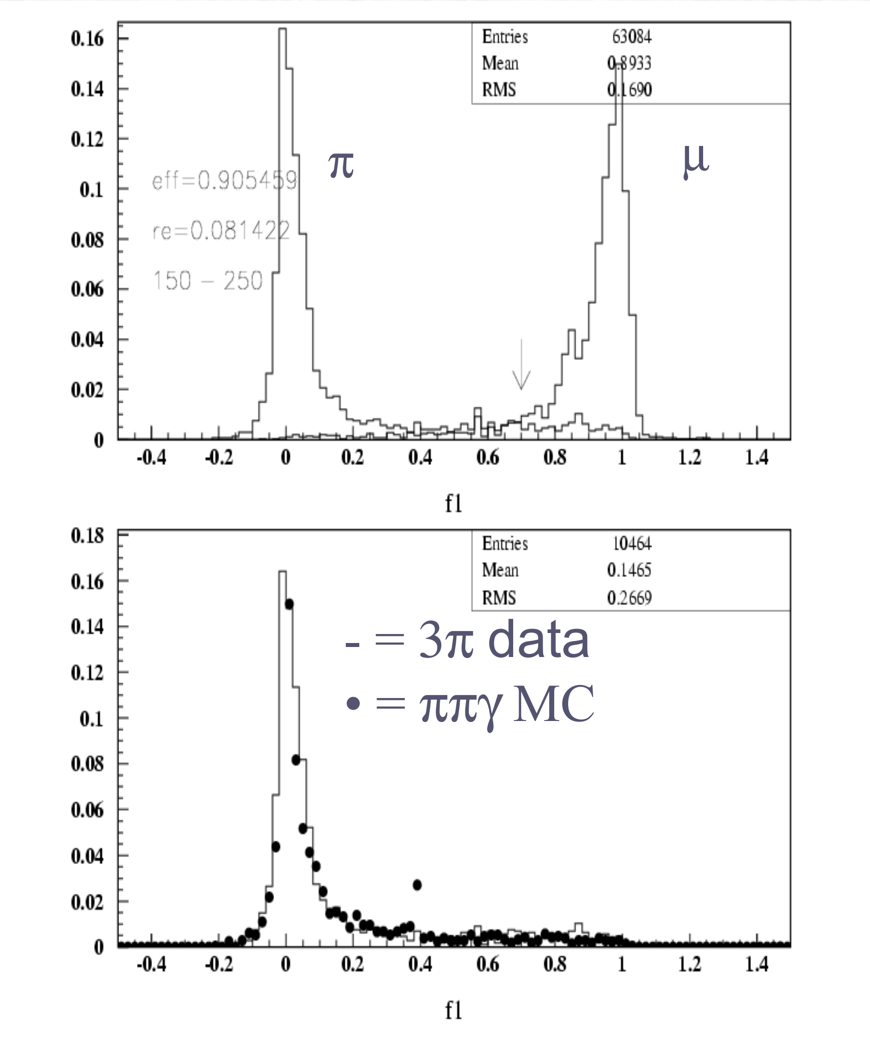


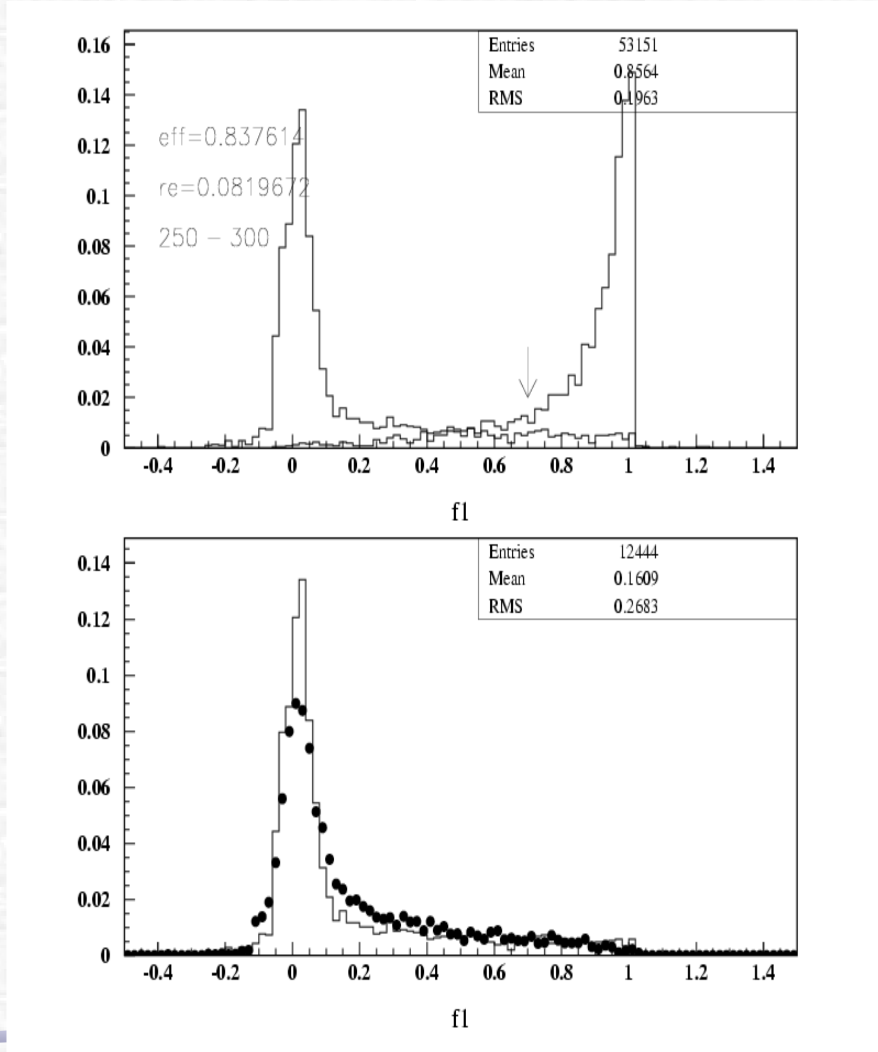
Construction of MLP (π^+/μ^+)

- π training:
  - 150-450 from data (3π)
  - 450-500 from MC ($\pi\pi\gamma$)

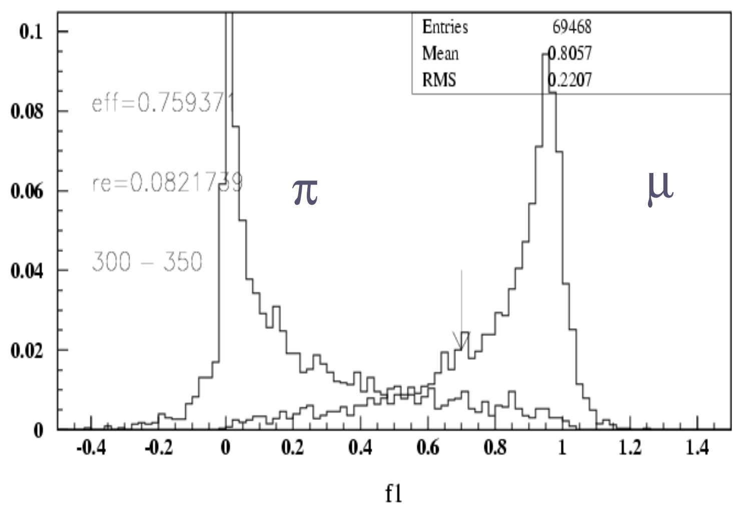
- μ training from MC

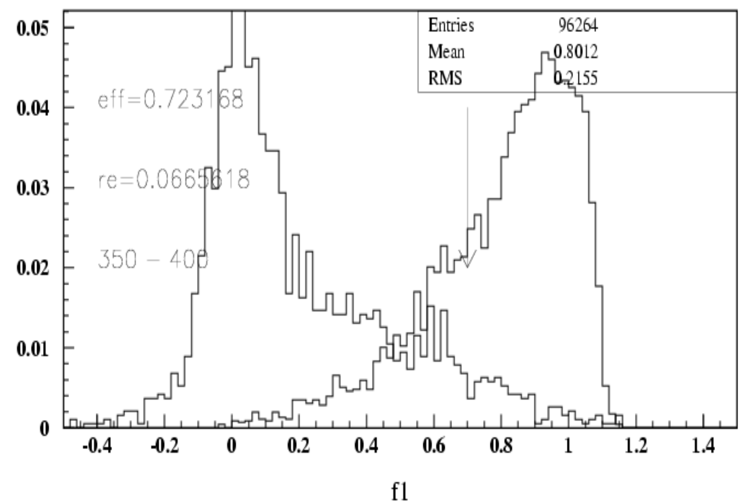
MLP output: 150-300 MeV

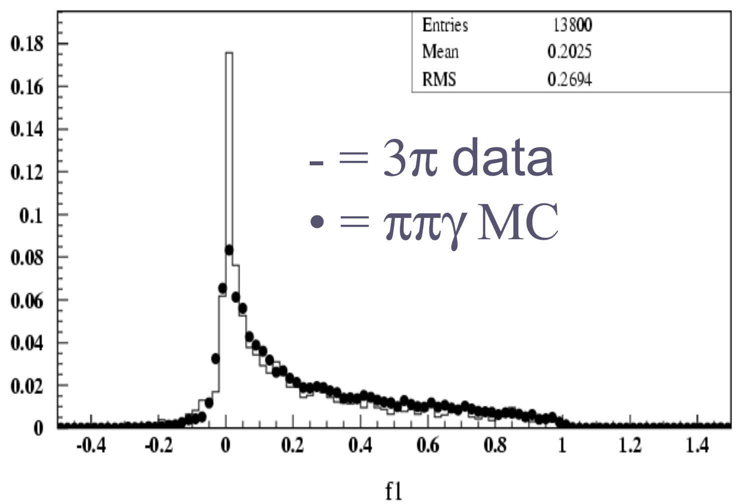


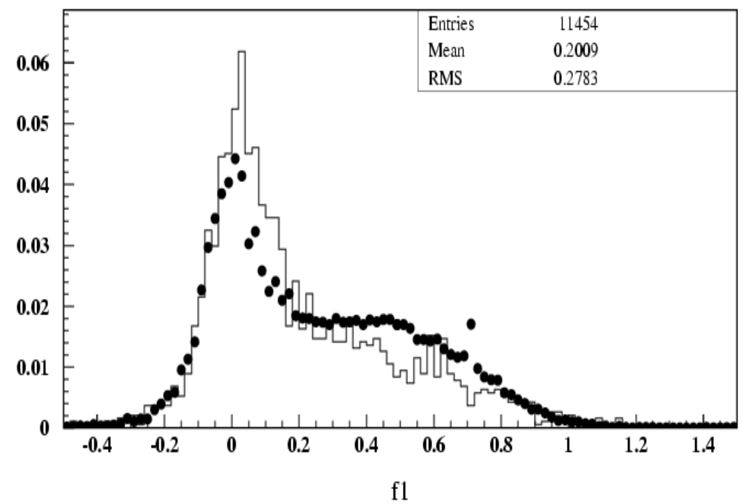


MLP output: 300-400 MeV

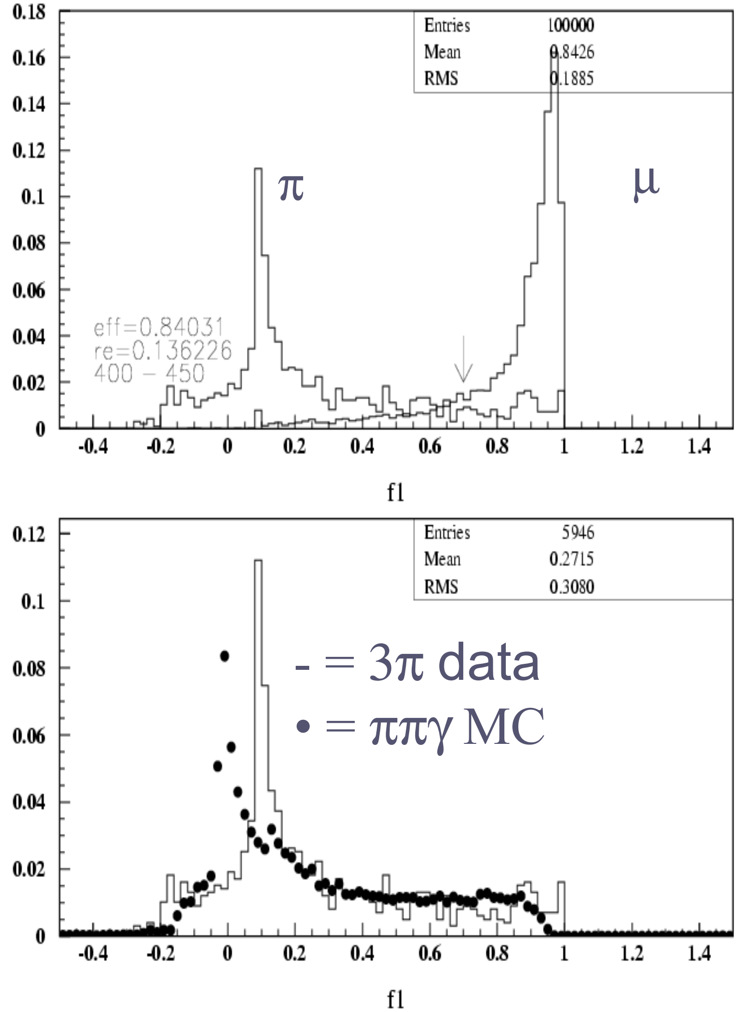


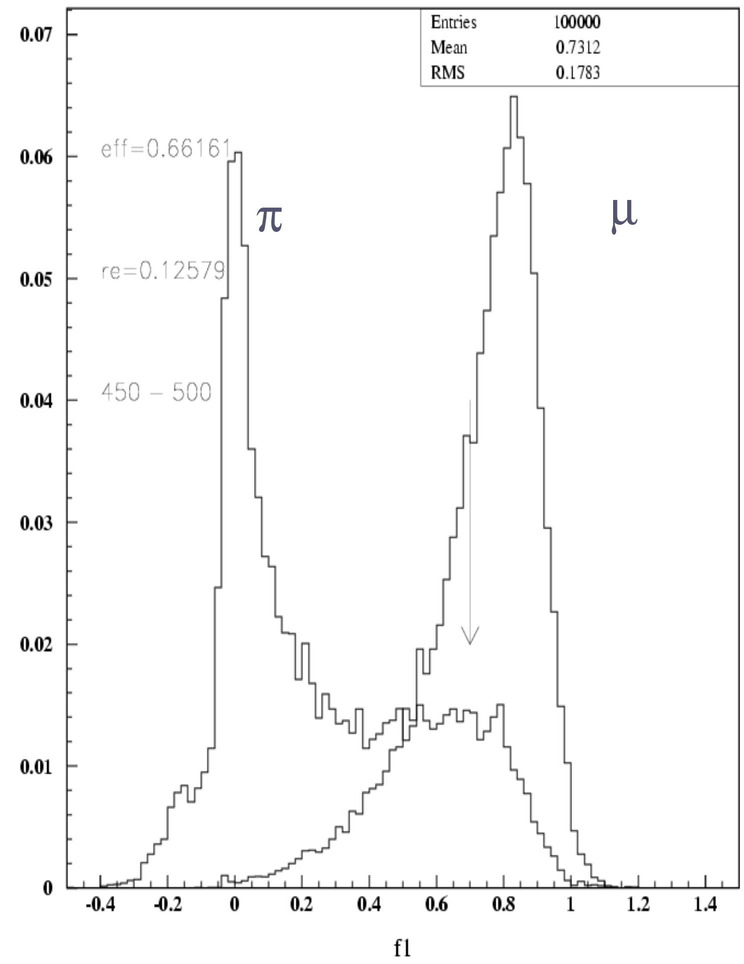






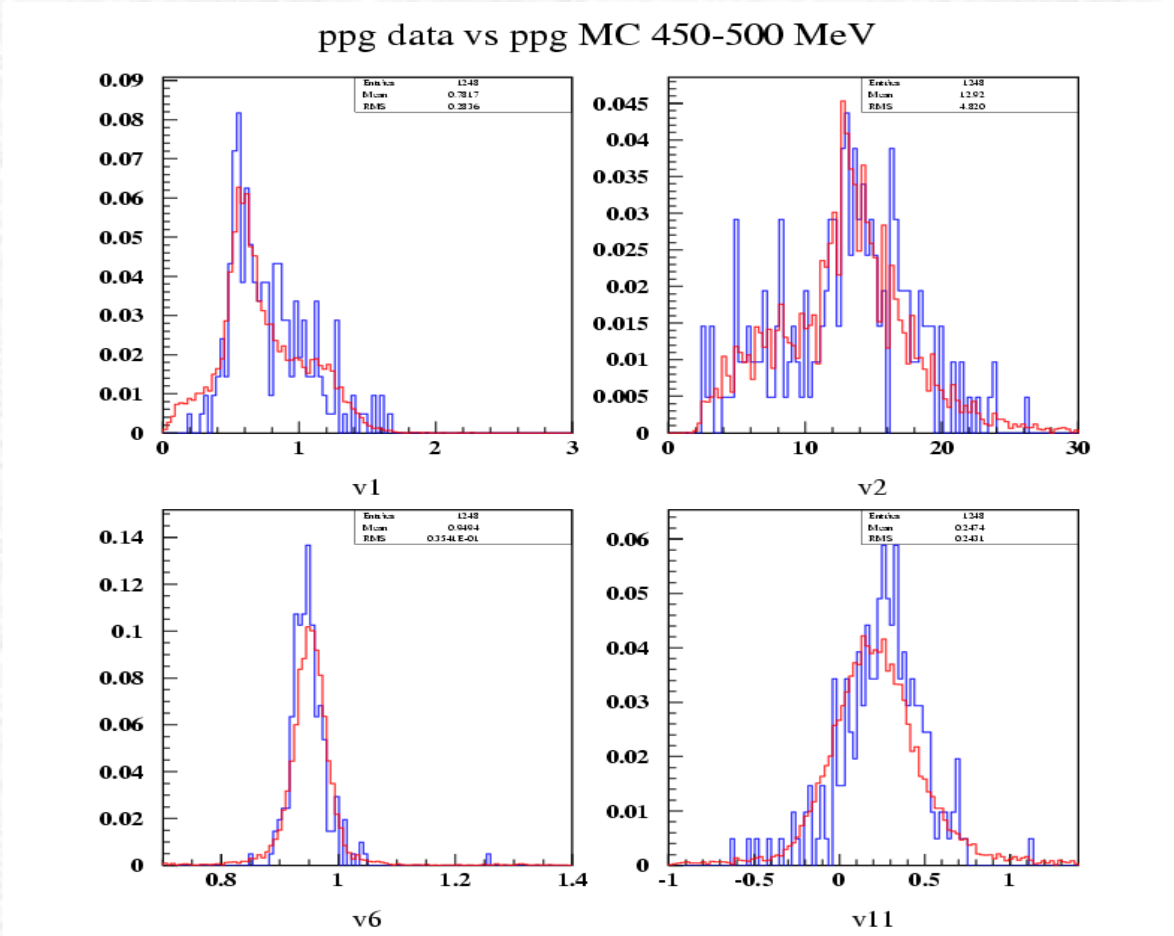
MLP output: 400-500 MeV





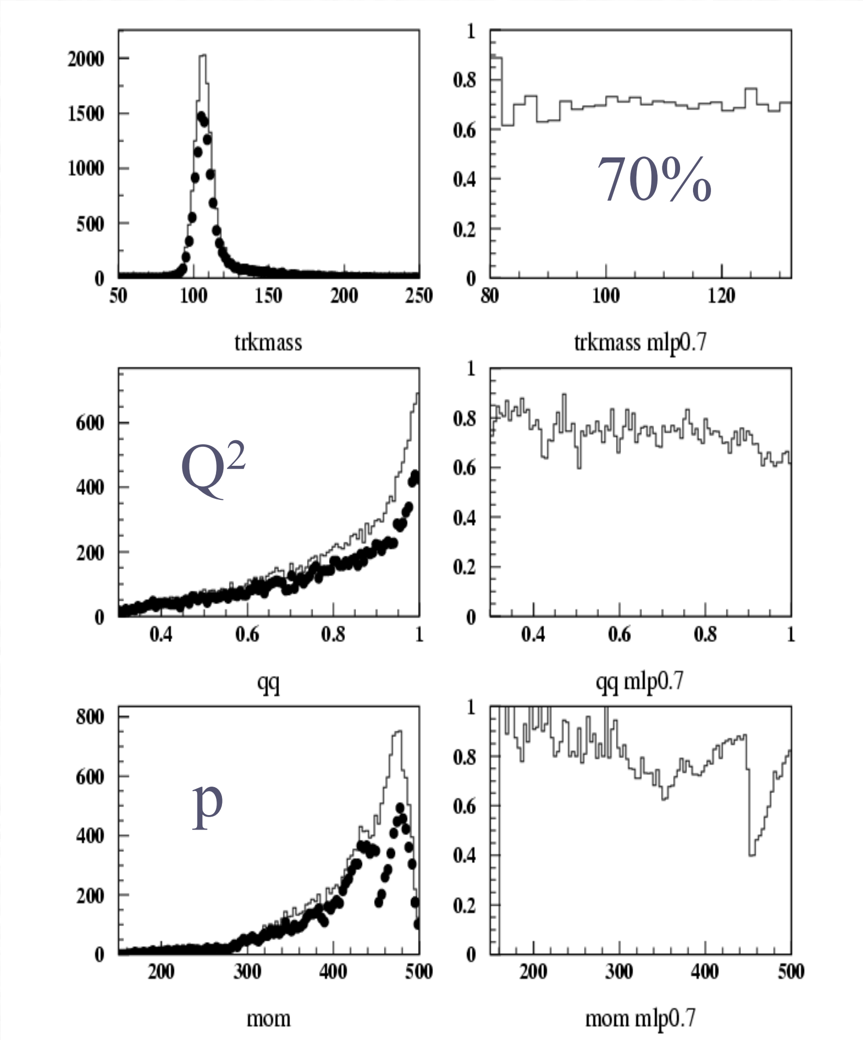
MLP output: 450-500 MeV

- Comparison data/MC for $\pi\pi\gamma$

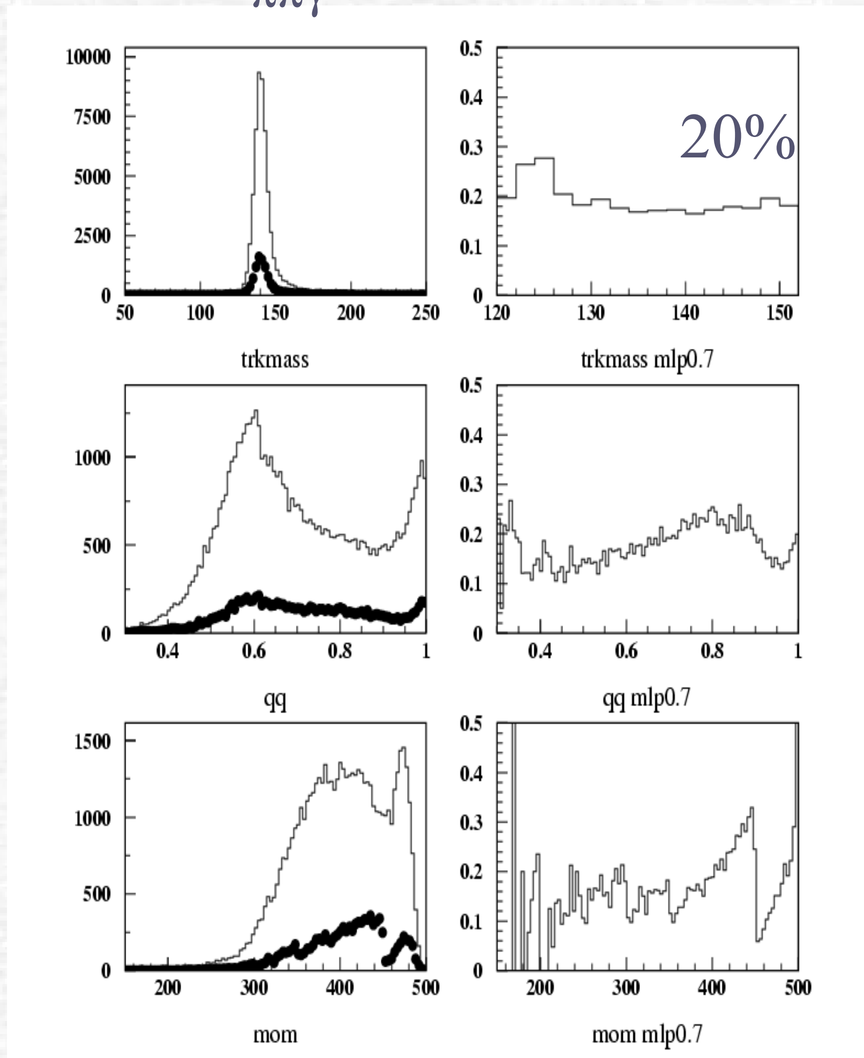


MLP output: efficiency

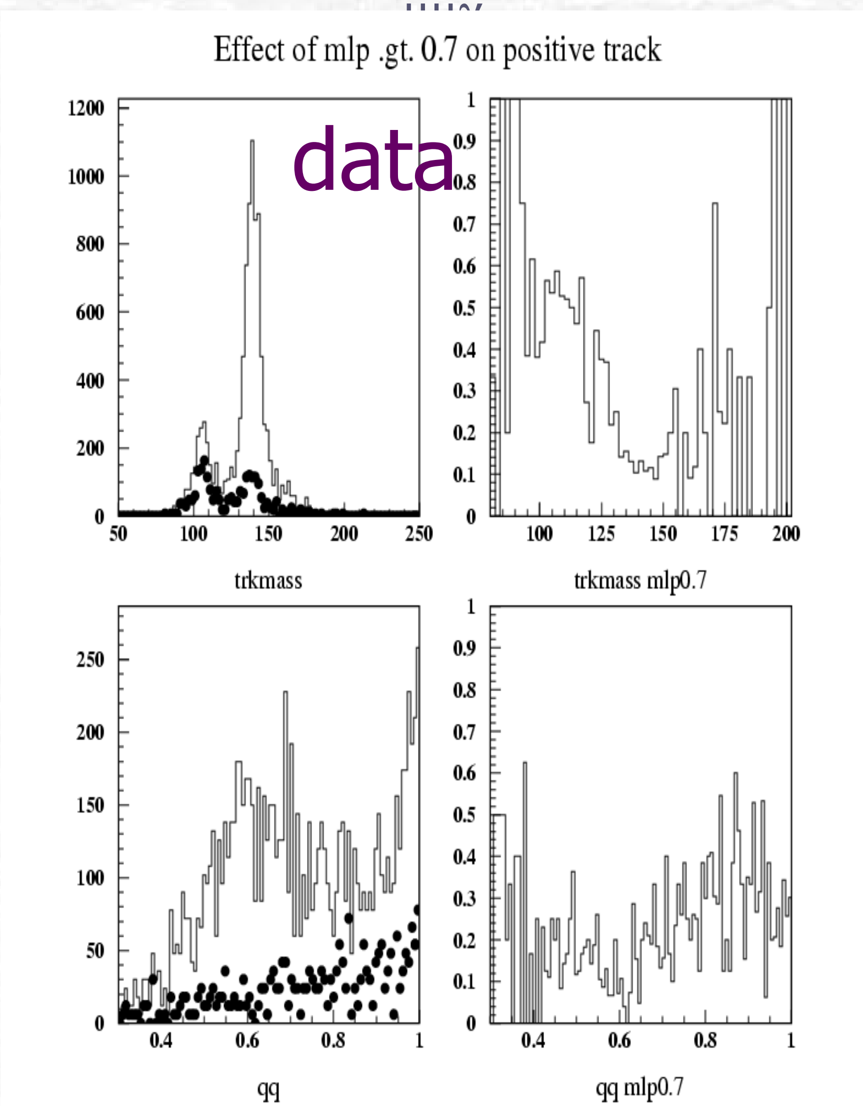
μμγ

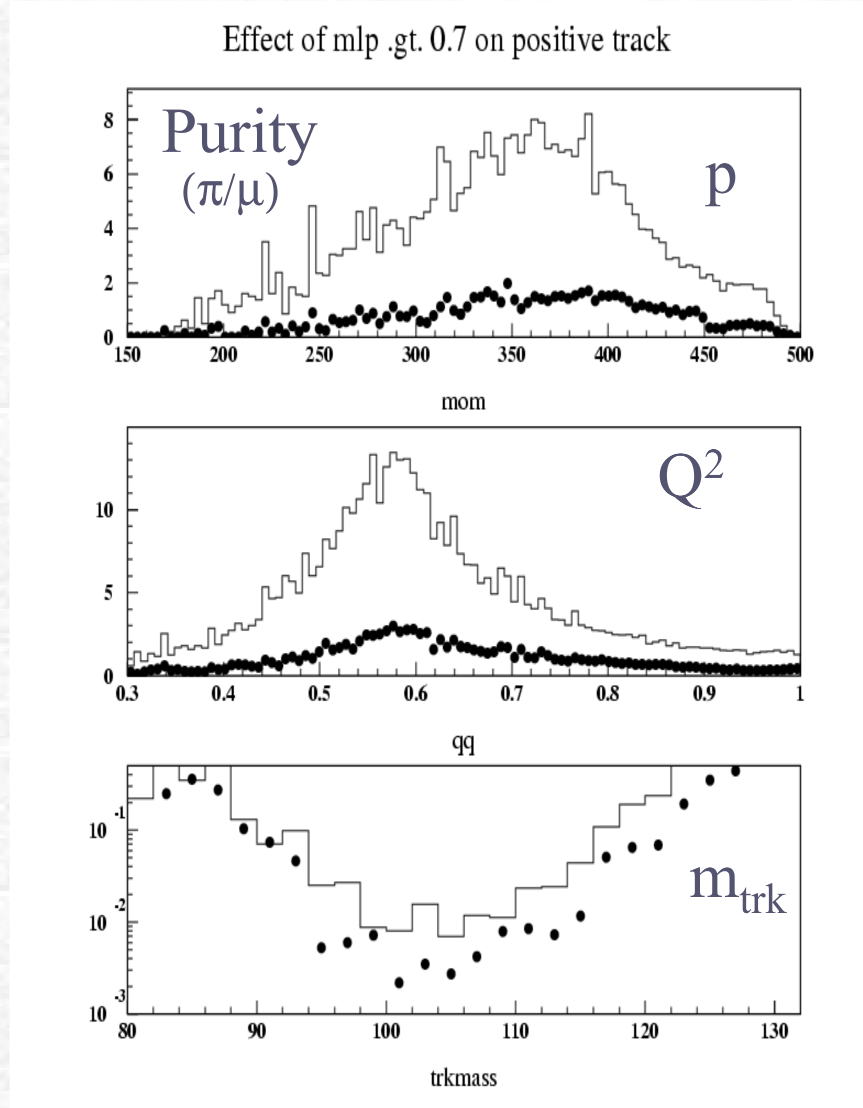


ππγ



MLP output on data and purity





Results look promising…

A look at the DC trigger in 2002: $\pi^+\pi^-\pi^0$

$$N_{EMC} = \varepsilon^{trg}_{EMC} N_{TOT}$$

$$N_{DC} = \varepsilon^{trg}_{DC} N_{TOT}$$

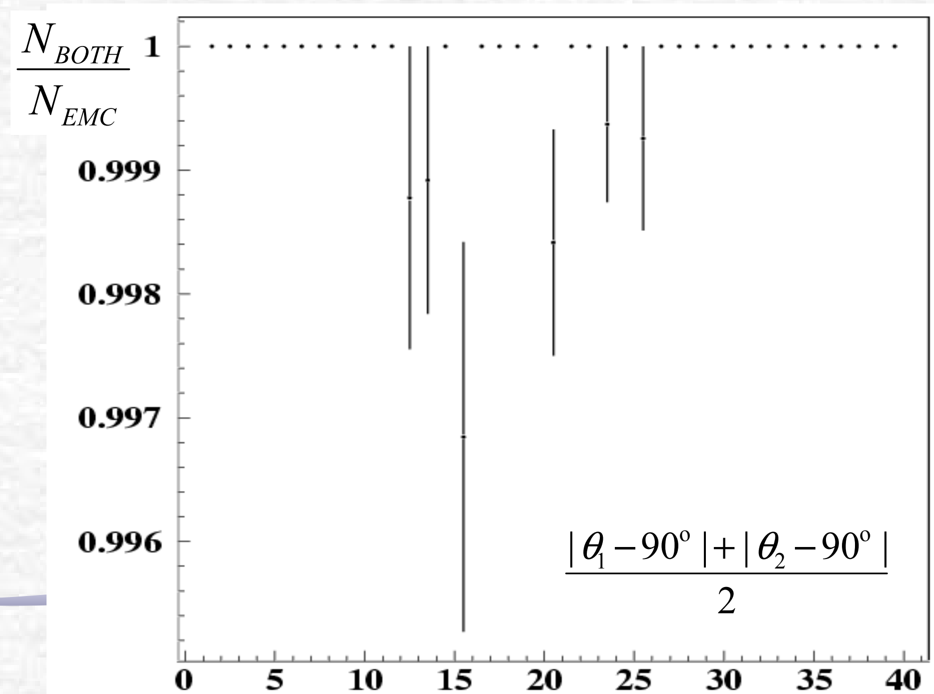
$$N_{BOTH} = \varepsilon^{trg}_{EMC} \varepsilon^{trg}_{DC} C_T N_{TOT}$$

$$\frac{N_{BOTH}}{N_{EMC}} = \varepsilon_{DC}^{trg} C_T$$ (DC-EMC corr.)

- this estimate hints for high DC trigger efficiency
- no dependence on the polar angle of the track is observed

1. 2002 $\pi^+\pi^-\pi^0$ sample: **runs 26566-592, 26617-644, 26658-673**
2. only events with 2 photons, each with $E_\gamma > 100$ MeV
3. if α = angle btw the photons, $\alpha > 15^o$, to be sure that 2 sectors are fired
4. $50^o < \theta_\pi < 130^o$, for both tracks (as in our event selection)

preliminary



▪Exploiting the ratio: a naive expectation

define

$$\varepsilon_{Ratio} = \frac{N_{DC}}{N_{TRG}} = \varepsilon_{DC} \frac{N_{TOT}}{N_{TOT}(1 - N_{FAIL}/N_{TOT})}$$

we expect dramatic cancellations to take place: use the same sample of the selection

we expect the overall trigger inefficiency N_{fail}/N_{tot} ~ 1%-4%

$$\frac{\varepsilon_{Ratio}^{\pi\pi\gamma}}{\varepsilon_{Ratio}^{\mu\mu\gamma}} = \frac{\varepsilon_{DC}^{\pi\pi\gamma}}{\varepsilon_{DC}^{\mu\mu\gamma}} \left(1 + \left.\frac{N_{FAIL}}{N_{TOT}}\right|_{\pi\pi\gamma} - \left.\frac{N_{FAIL}}{N_{TOT}}\right|_{\mu\mu\gamma} + O\left[\left(\frac{N_{FAIL}}{N_{TOT}} \right)^2 \right] \right)$$

$\mathcal{O}(1)$

difference from 1 can be checked from MC

▪Efficiencies from data

data sample size:

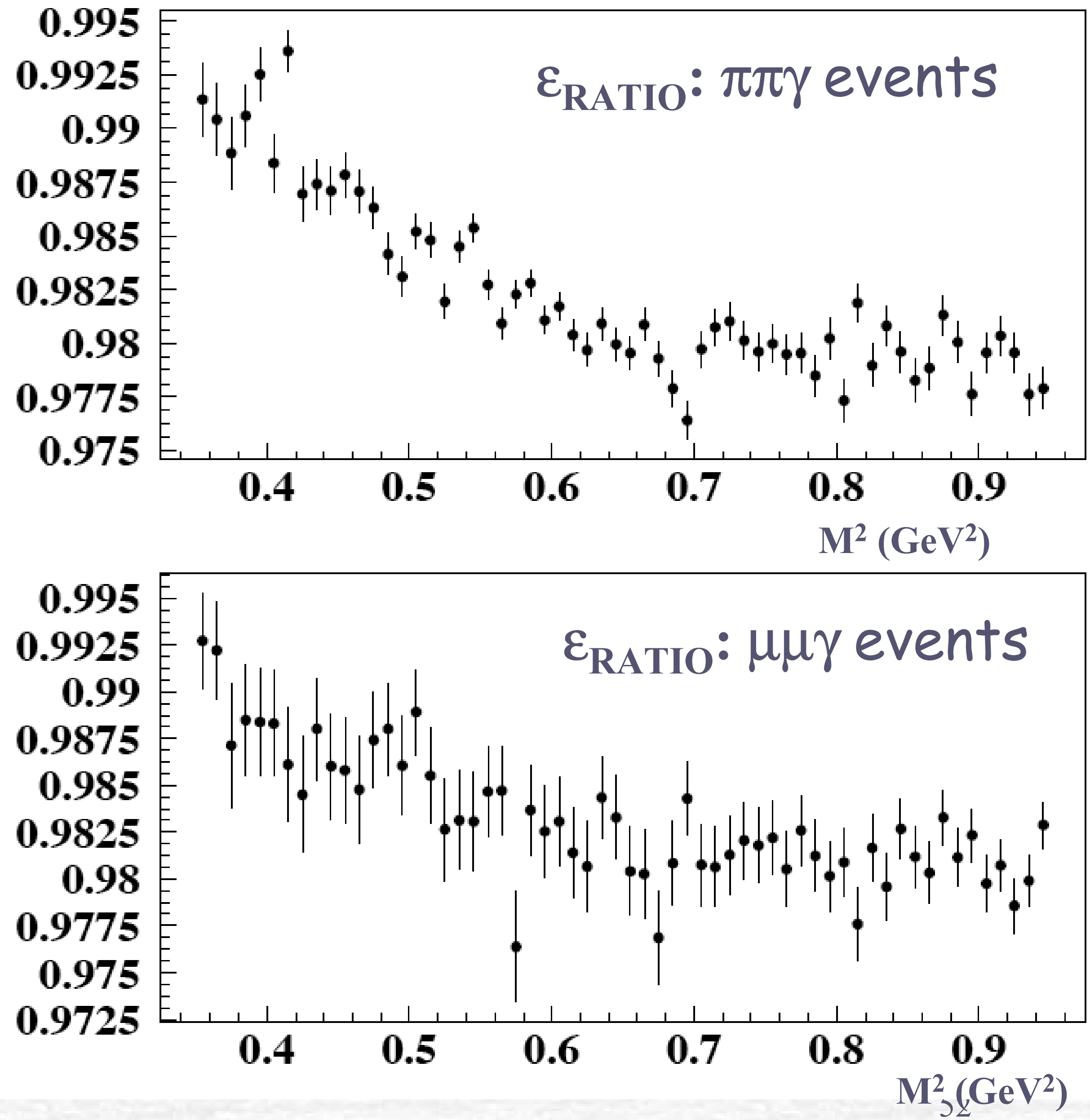
L ~ 53 pb^{-1}

usual small angle

selection from PPG

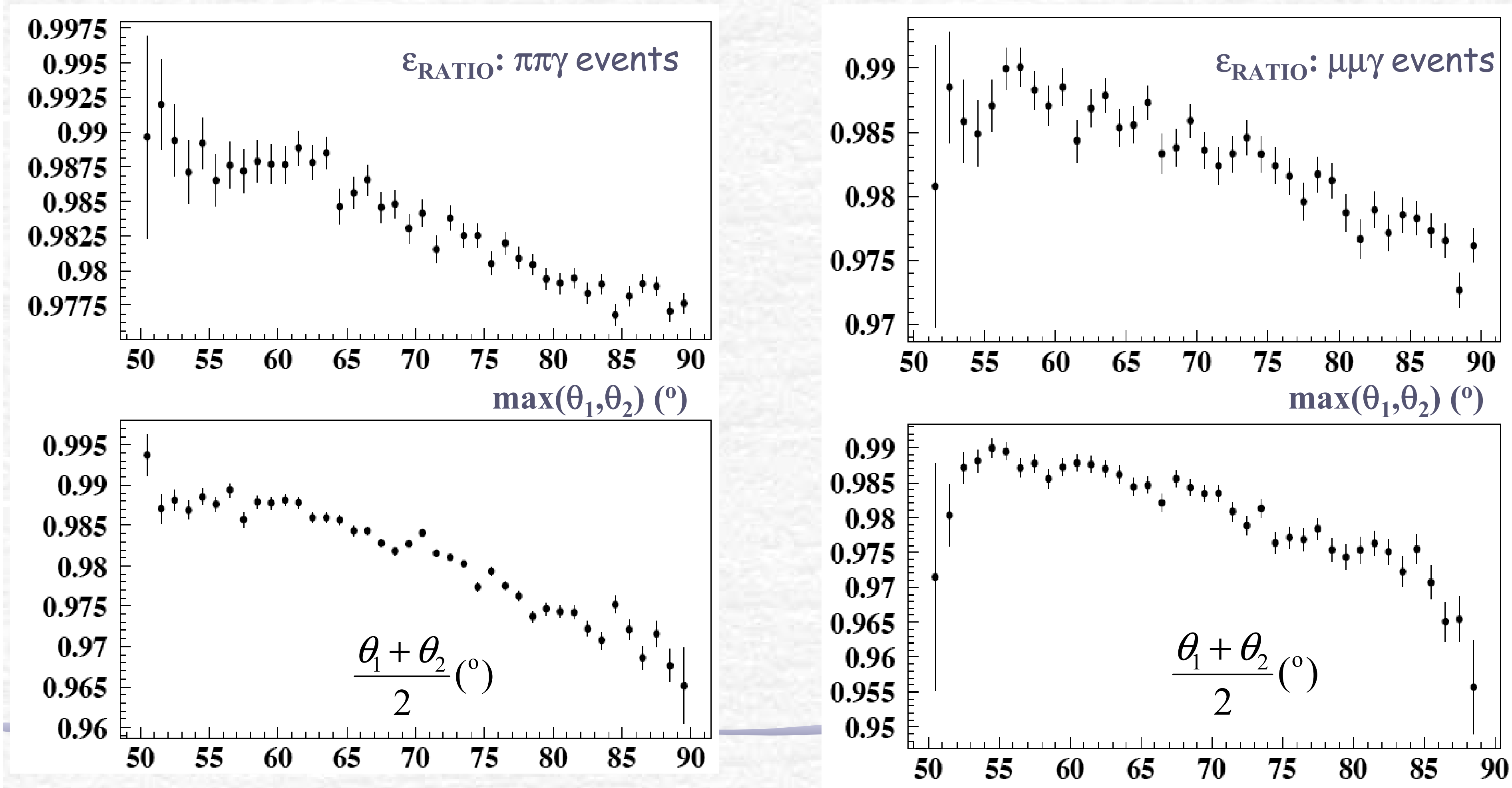
dst's

Low momentum ⇒ lower radius ⇒ higher hits



▪Angular studies

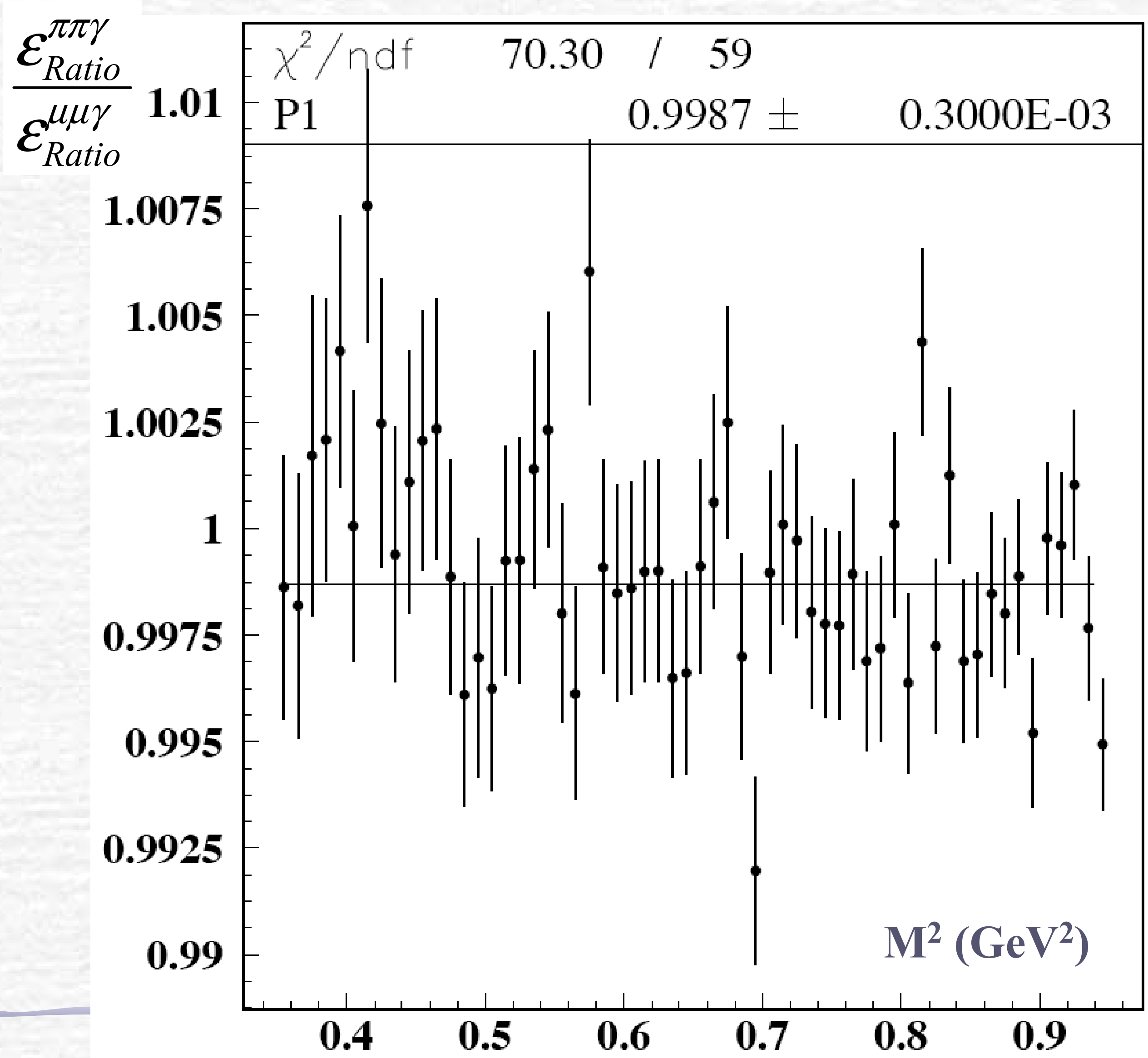
the <u>same trend</u> seems confirmed both μμγ and ππγ events <u>independently</u> from the distributions: $\sin^2\theta$ vs. $(1+\cos^2\theta)$



▪What is the final correction?

very promising
preliminary studies,
if confirmed
trigger systematics
gets negligible

we want to use it
in the ratio



S.A. “possible” time schedule

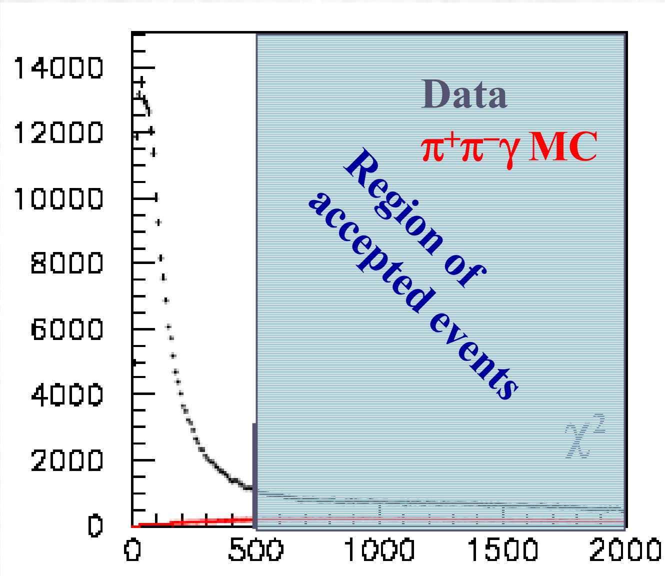
- Small Angle:
  - Absolute measurement:
    - “Well known” strategy. Efficiencies to be completed soon. Systematics need careful evaluation (for example momentum calibration).
  - Ratio:
    - The strategy could be different from the abs. meas.
    - Many cancellations.

- We would try to arrive to a comparison “absolute” vs “ratio” by the end of the year. Preliminary comparison can be obtained (hopefully) for the Sci.Com. in November, without detailed study of the systematics

Status of the $\pi^+\pi^-\gamma$ large photon polar angle analysis

Radiative decays meeting
29.09.2006

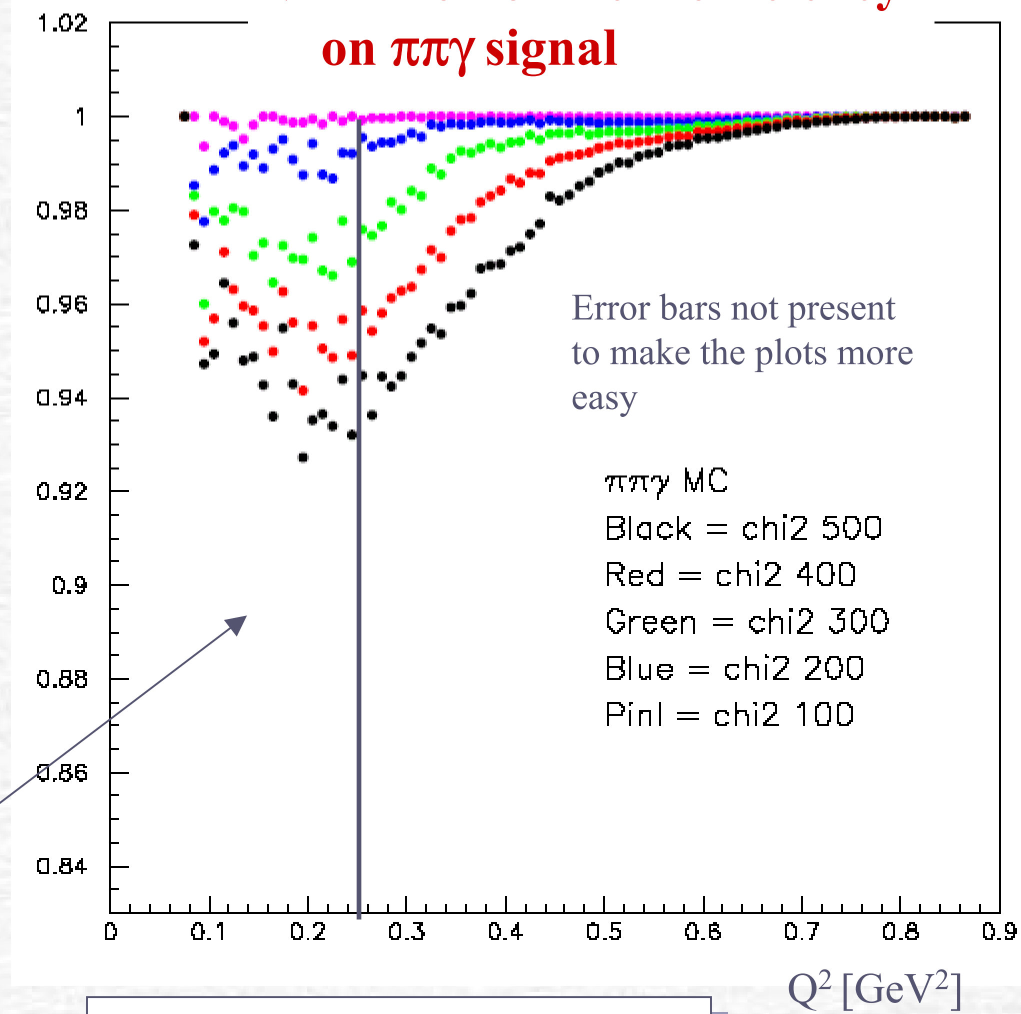
Kinematic fit: tuning and systematic error



So far $\chi^2_{\pi\pi\pi} > 500$
we lose up 7% at low Q^2

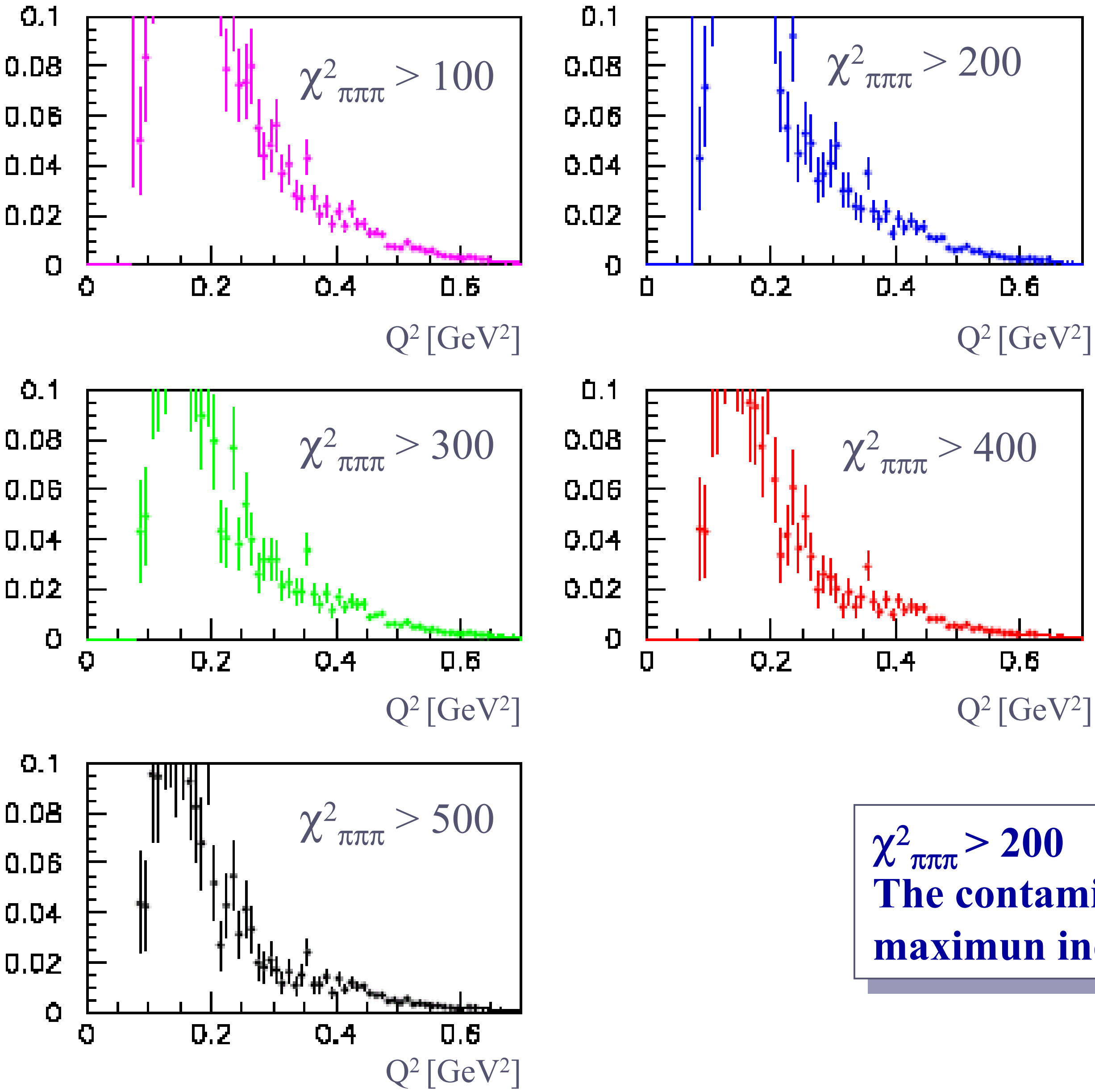
Tricky region

Variation of the inefficiency on $\pi\pi\gamma$ signal



The inefficiency becomes negligible moving towards lower values of $\chi^2_{\pi\pi\pi}$

Variation of 3π contamination



At 0.2 GeV^2

$\chi^2_{\pi\pi\pi} > 500$: 4% of 3π

$\chi^2_{\pi\pi\pi} > 200$: 6-8% of 3π

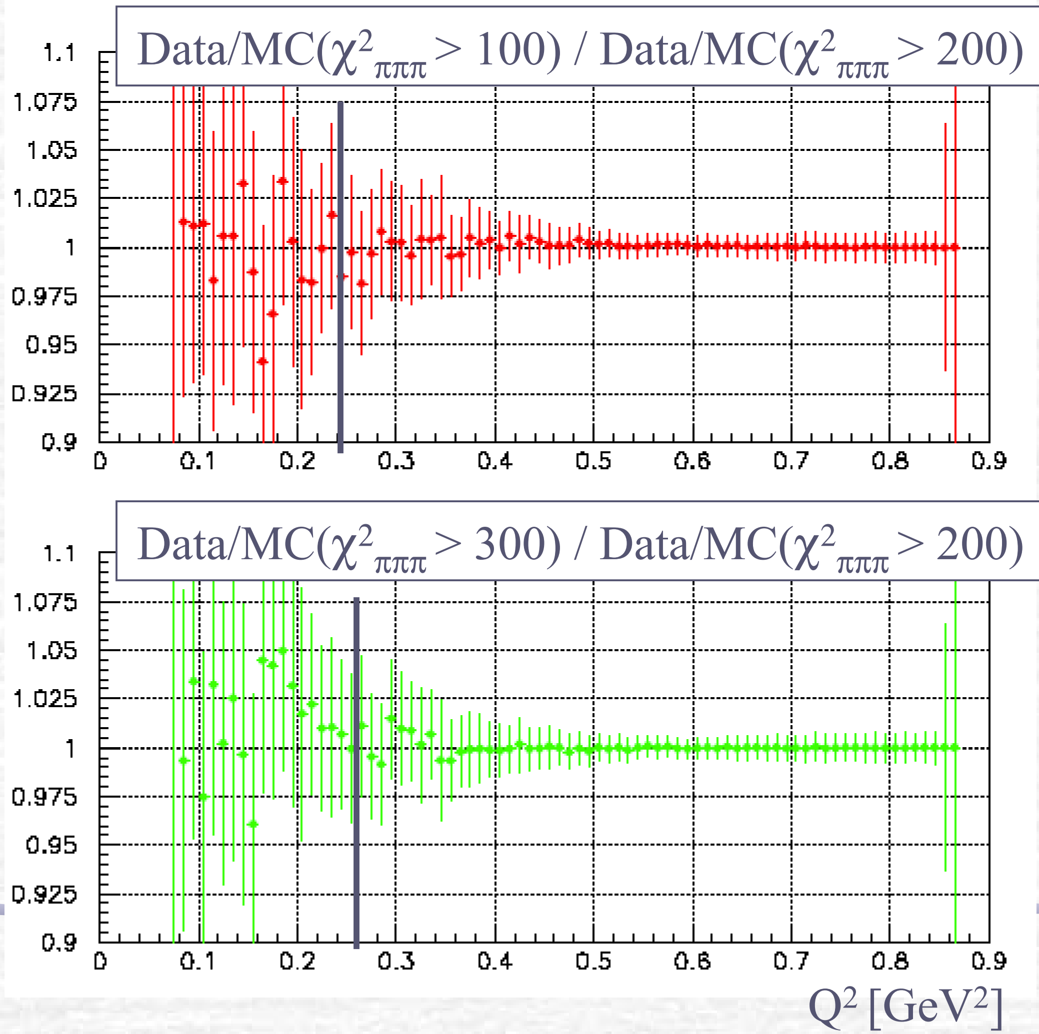
If the 3π-MC describes well the data, we can stay with this amount of background

$\chi^2_{\pi\pi\pi} > 200$
The contamination gets double, but the maximun inefficiency on ππγ is 1%.

After all the Large Angle analysis cuts and different values of χ^2 comparison DATA / MC

No big effect on the ratio data/MC moving the cut

Moving the cut on $\chi^2_{\pi\pi\pi}$ within the value 200 +/- 100
and comparing the effect on DATA / MC agreement

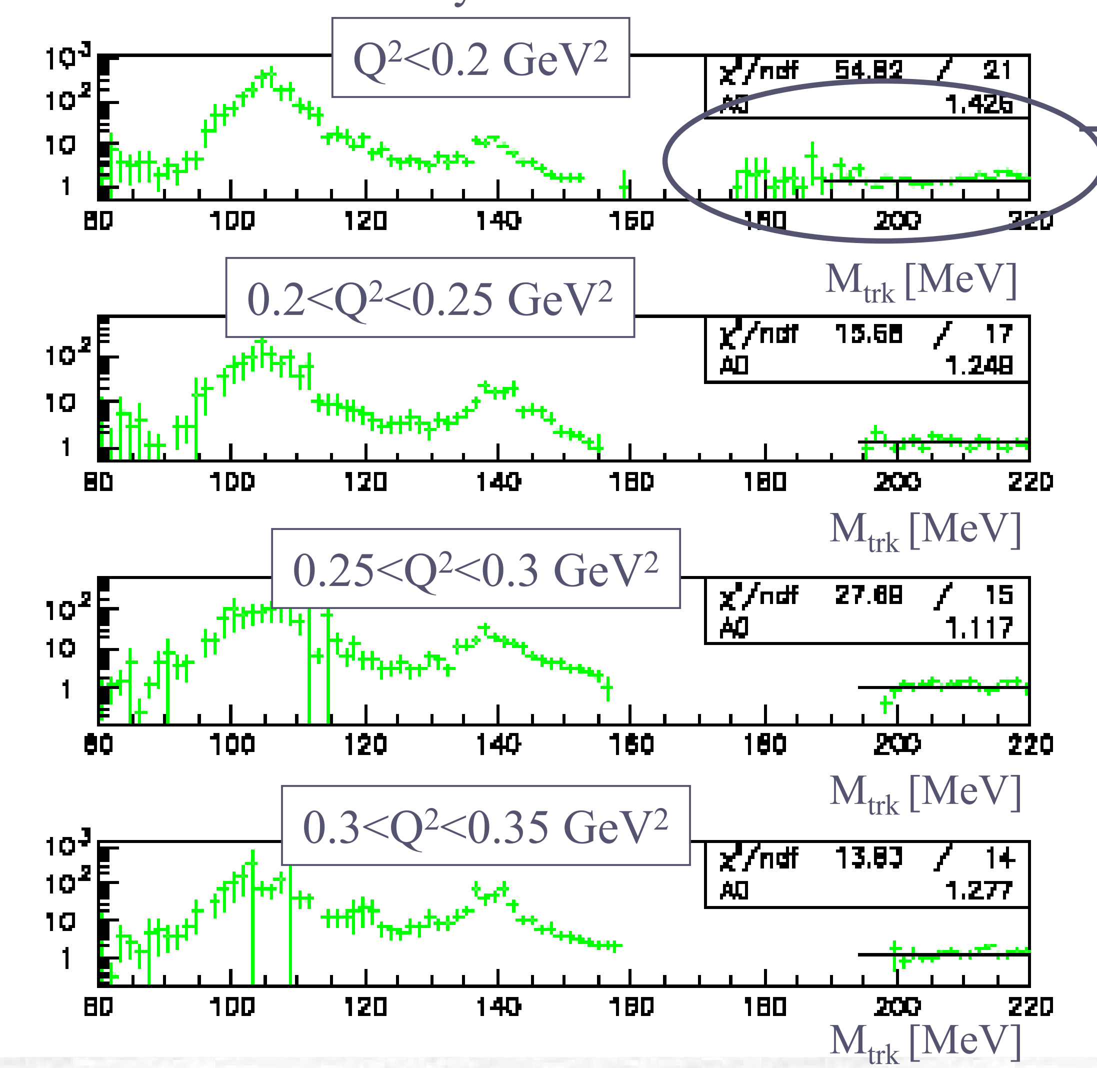


Systematic error on this cut computed as the inefficiency on the signal times the DATA/MC discrepancy: negligible

3π background: re-weighting

Trackmass distribution in slices of Q^2: 3π back underestimated from MC

To evaluate the correction factor to apply to the MC: data/MC ratio at high values of the trackmass where only 3π contribute



In this region only 3π.
Fitting with a straight line data/MC ratio:
scale factor to multiply the 3π-MC
(for each slice of Q^2)

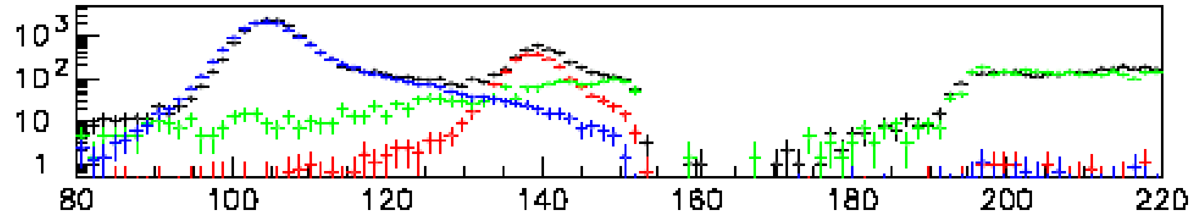
In average 20% difference between data and MC

After the riscaling very nice agreement

see the next slides

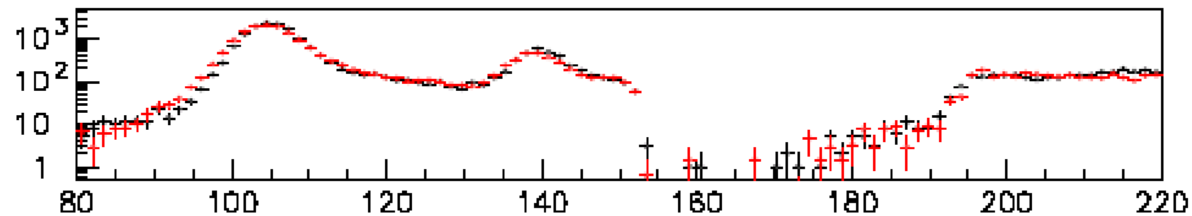
To check the riscaling of the 3π MC: trackmass in bin of Q^2

$Q^2 < 0.2\ GeV^2$



M_{trk} [MeV]

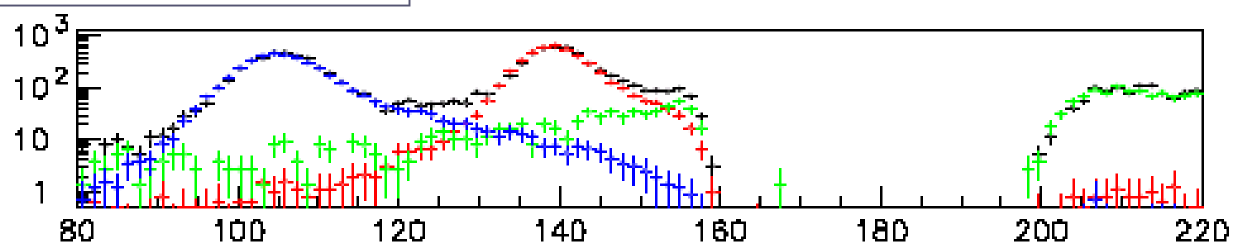
Black = data
Red = ππγ-MC
Green = 3π
Blue = μμγ-MC



M_{trk} [MeV]

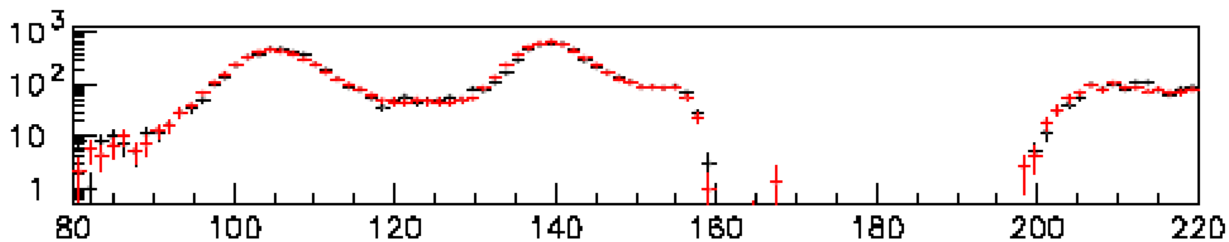
Black = data
Red = MC total

$0.3< Q^2 < 0.35\ GeV^2$



M_{trk} [MeV]

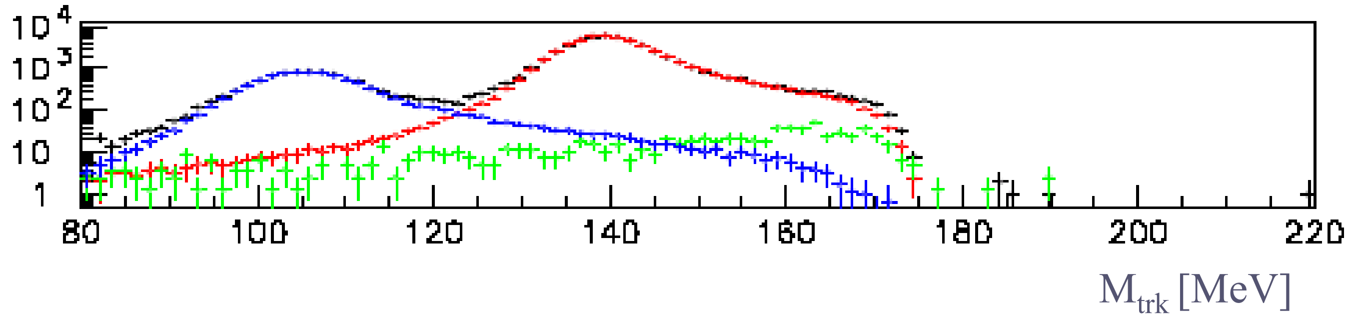
Black = data
Red = ππγ-MC
Green = 3π
Blue = μμγ-MC



M_{trk} [MeV]

Black = data
Red = MC total

$0.5 < Q^2 < 0.55\ GeV^2$

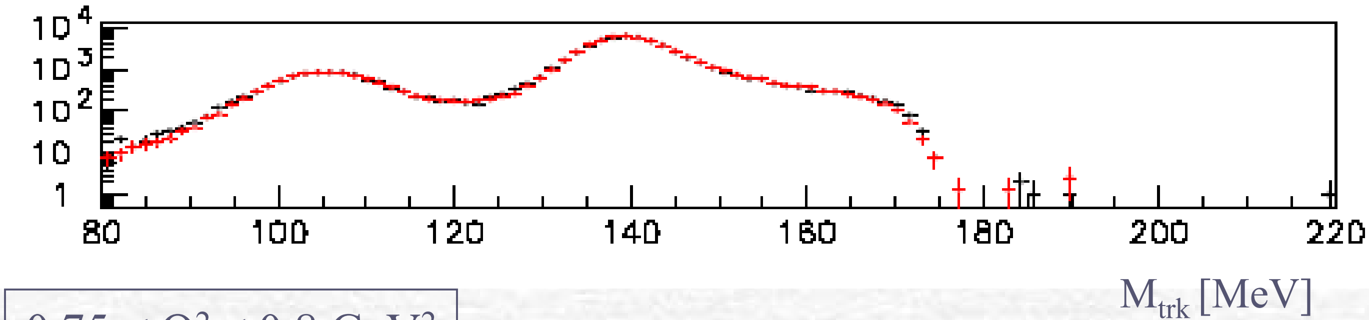


Black = data

Red = ππγ-MC

Green = 3π

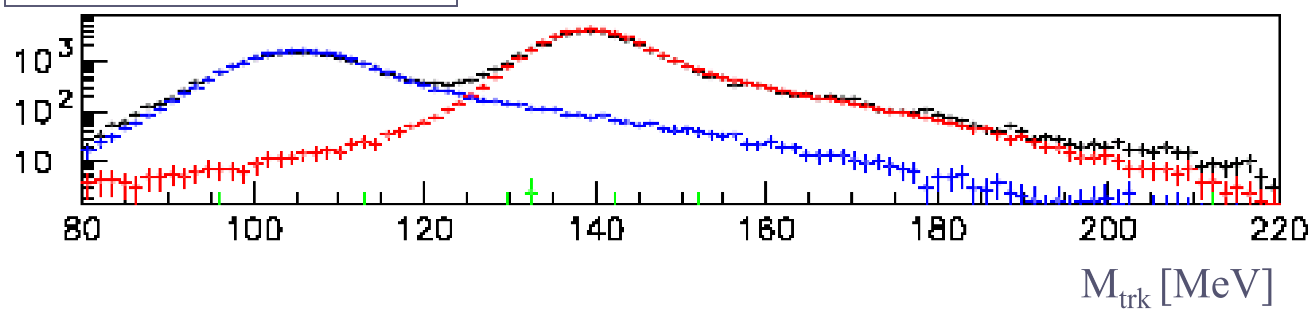
Blue = μμγ-MC



Black = data

Red = MC total

$0.75 < Q^2 < 0.8\ GeV^2$

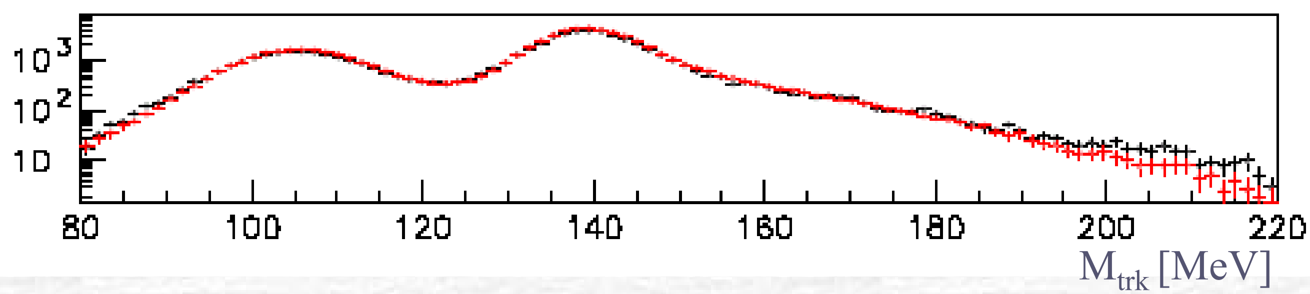


Black = data

Red = ππγ-MC

Green = 3π

Blue = μμγ-MC



Black = data

Red = MC total

Ω angle: tuning

Shift systematically the Ω cut and look at the difference DATA/MC

Black = standard Ω

Red = standard Ω-0.5°

Green = standard Ω+0.5°

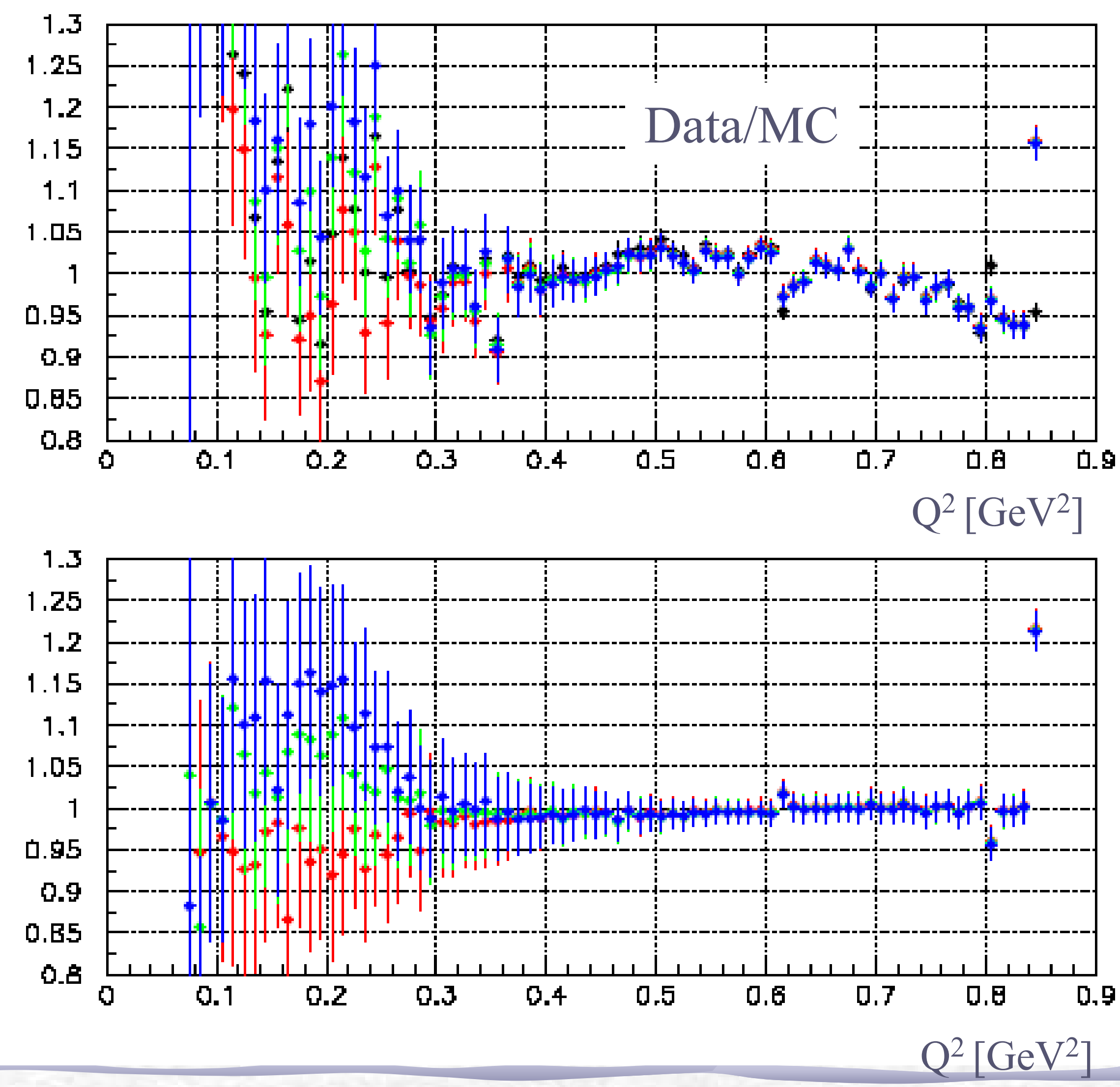
Blue = standard Ω+1°

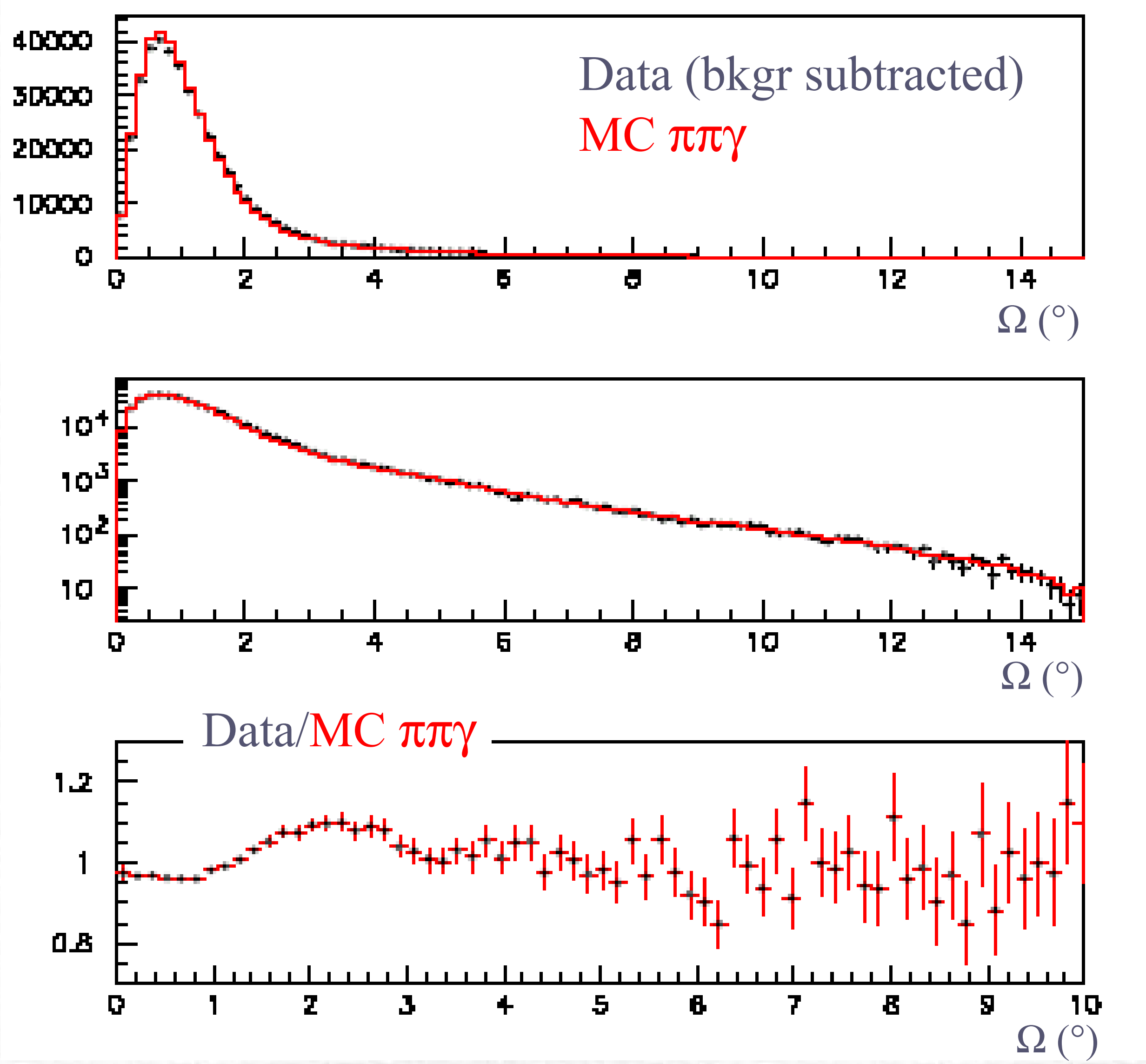
Compare the DATA/MC ratio shifting Ω

Red = data/MC[Ω-0.5°]/ data/MC[Ω]

Green = data/MC[Ω+0.5°]/ data/MC[Ω]

Blue = data/MC[Ω+1°]/ data/MC[Ω]

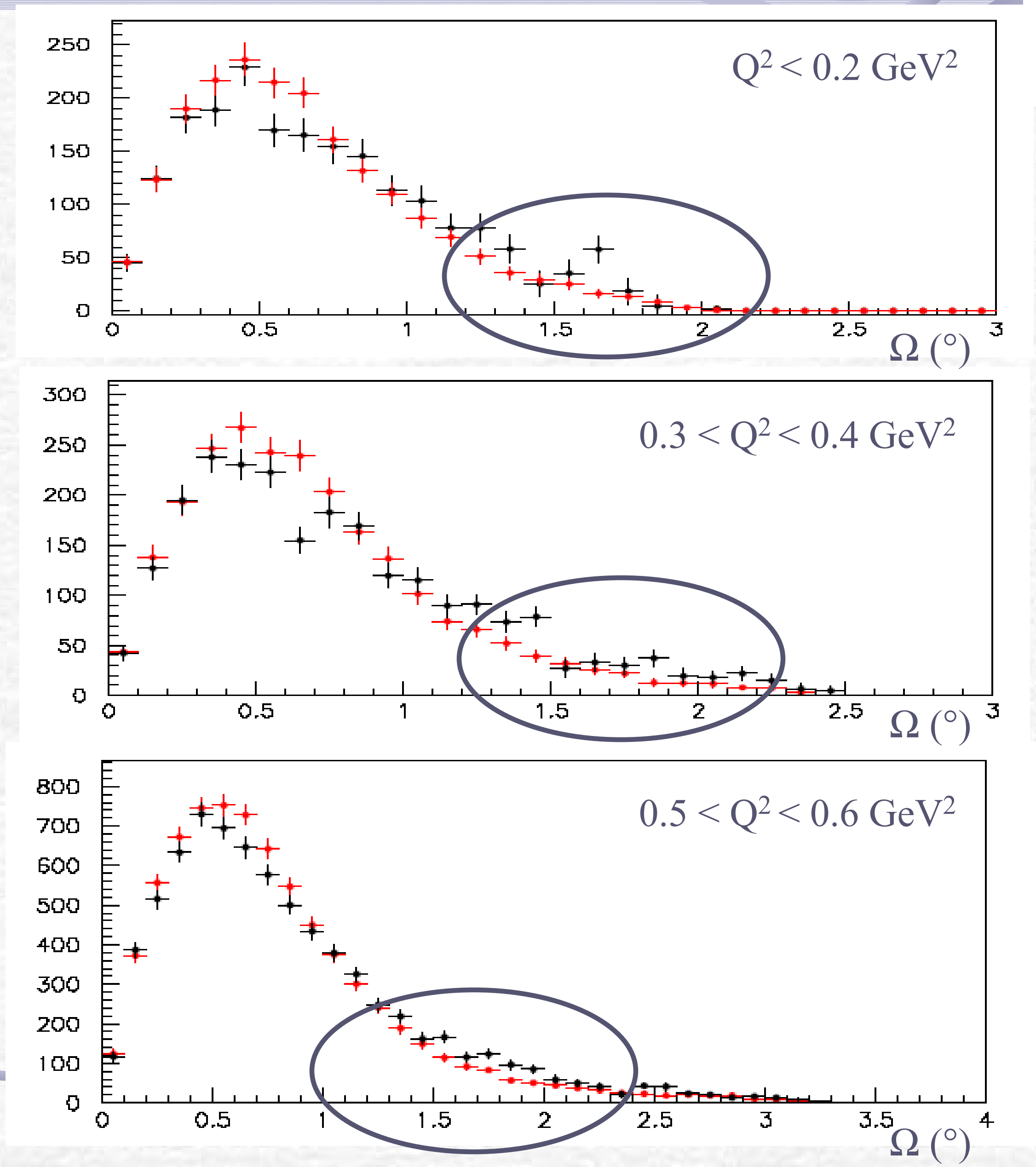




Nice agreement on the tail
(good simulation of 3π background from MC)
Not as nice on the peak

In order to understand: Ω distribution in bin of Q^2

Black = data – residual bkgr
Red = ππγ-MC

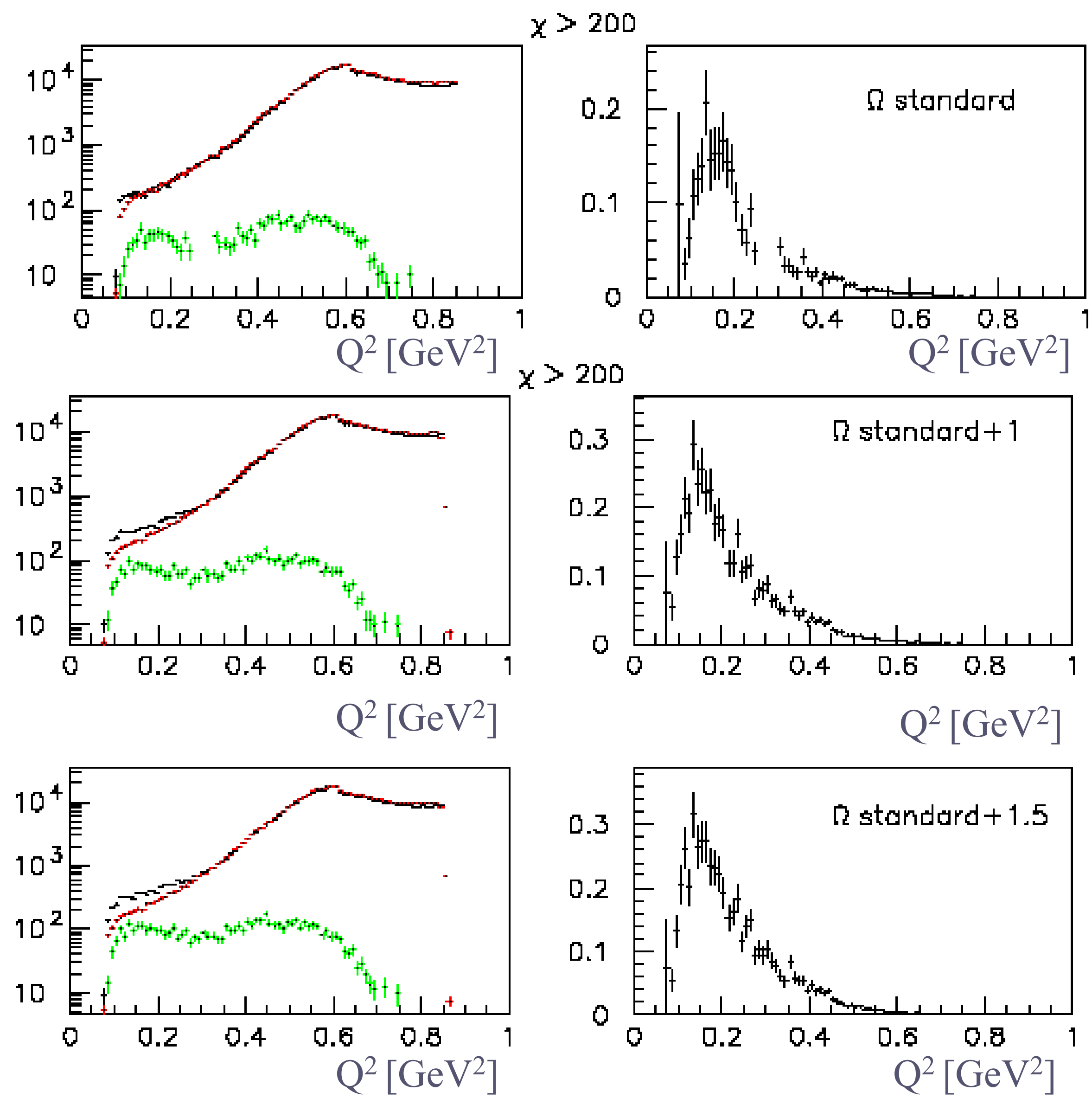


3π have been re-weighted

It does not look a problem of background

Systematic effects?

Further check on trackmass DATA/MC varying the Ω cut. The $\pi\pi\gamma$-MC does not reproduce accurately the Ω-angle variable. **The solution is to make the cut looser in order to include as less effects as possible**.



Black = data

Red = ππγ-MC

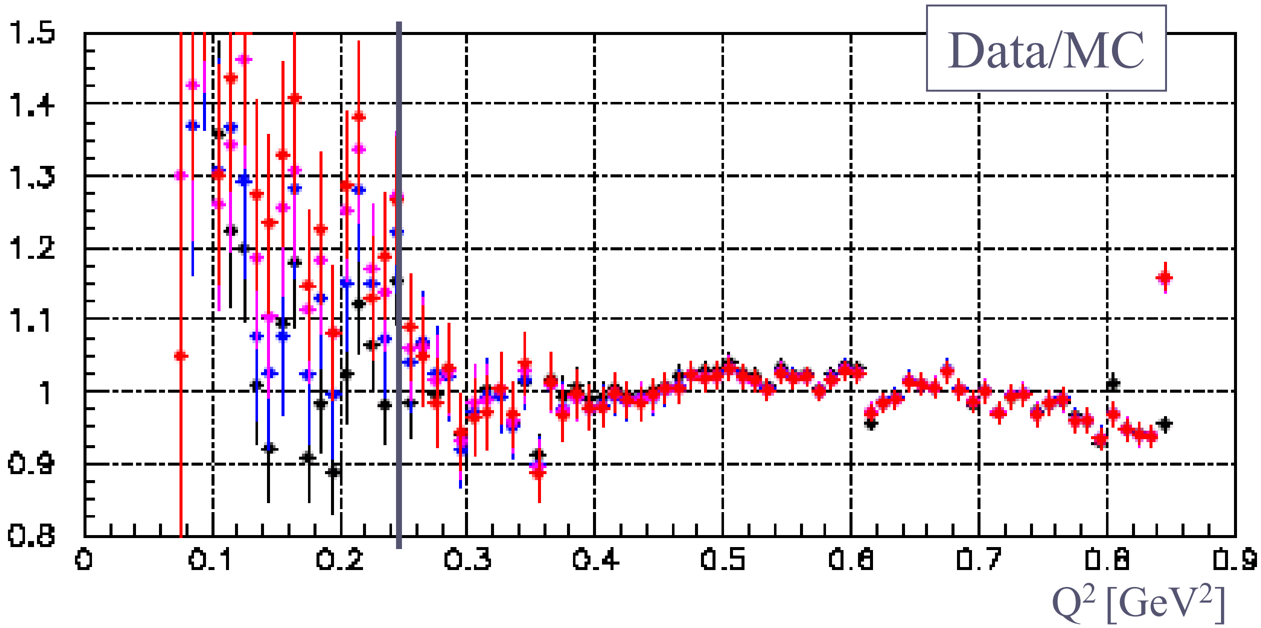
Green = 3π-MC (re-weighted)

Cut fixed at Ω standard+1.5°

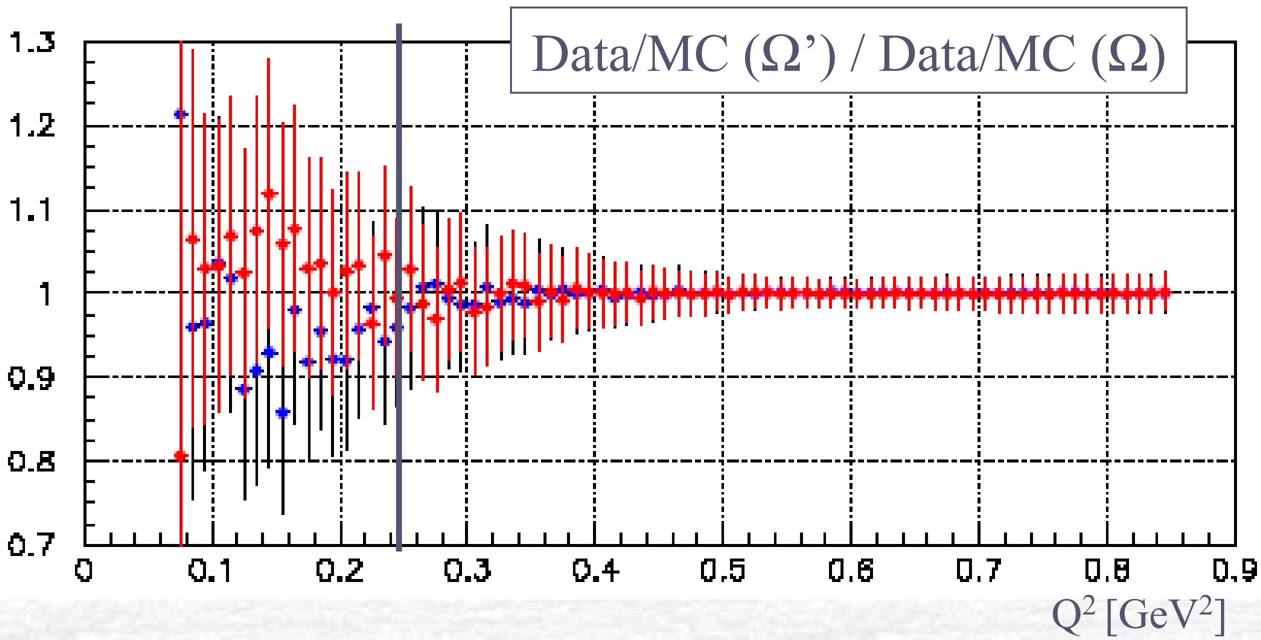
- The contamination from 3π gets double but MC describes well the background
- The systematic on the cut is more under controll

Data/MC comparison

New Ω cut = standard +1.5°



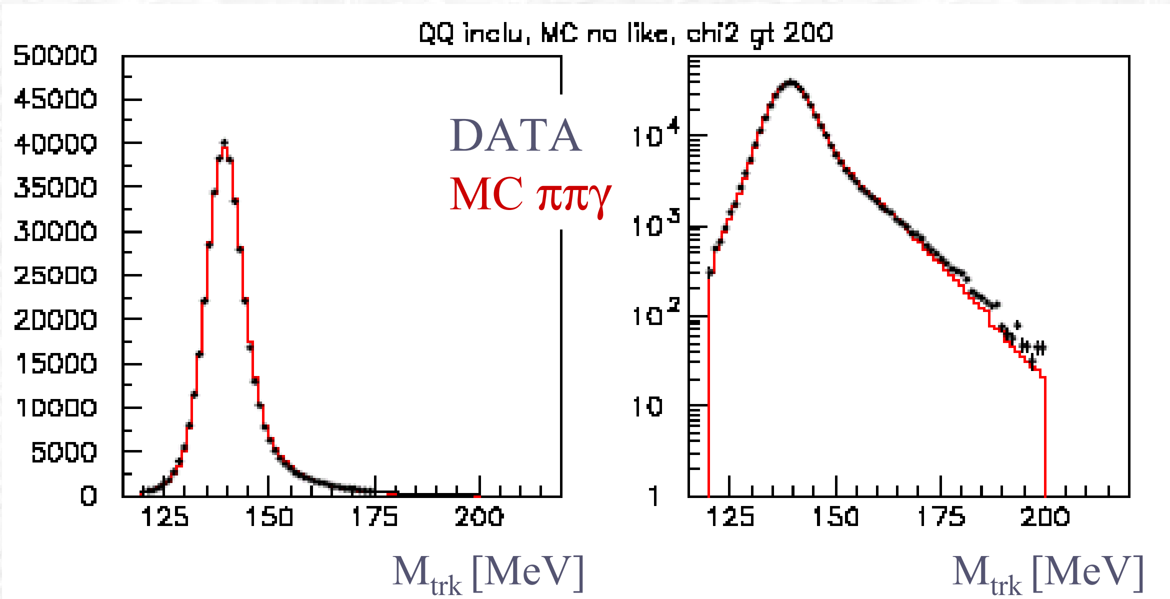
Blue = new Ω
Black = new Ω-0.5°
Red = new Ω+0.5°



Blue = data/MC[Ω-0.5°]/ data/MC[Ω]
Red = data/MC[Ω+0.5°]/ data/MC[Ω]

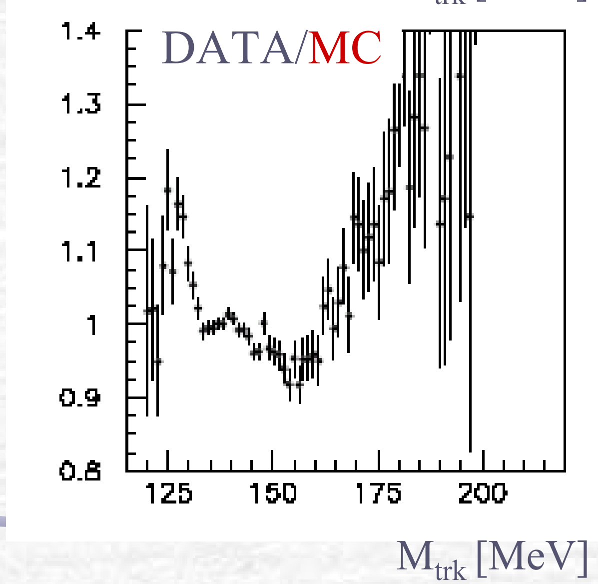
There is still an effect bewteen 0.25 and 0.3 GeV^2 but much smaller with respect what we got with the old Ω cut

Trackmass: systematic error



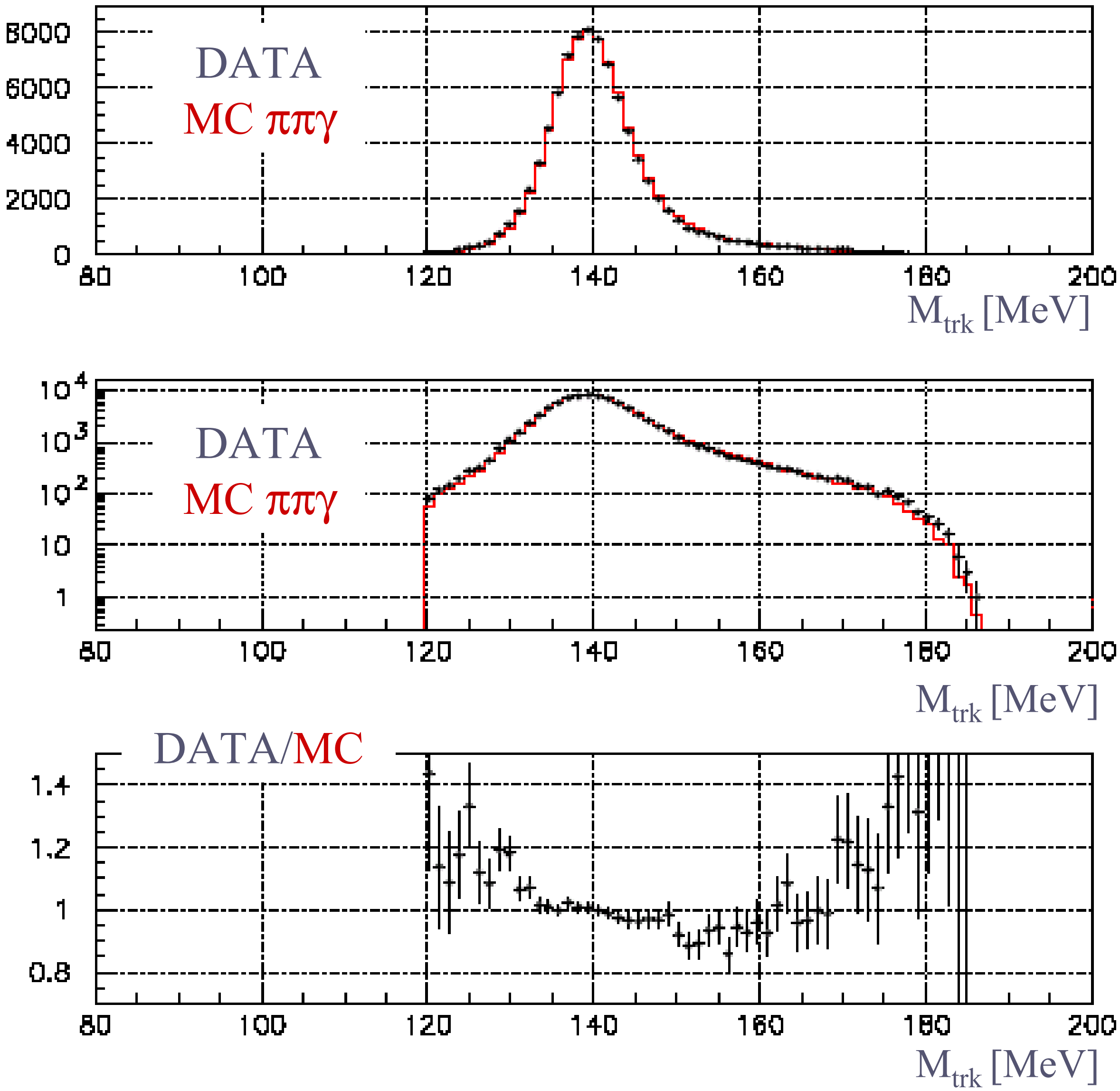
Quite good agreement in the central region
some discrepancy on the tails

Can be this explained by the presence of background?



To check wheter the bump is due to background, we plot the comparison on the ρ peak (see next slide)

Moving to the ρ peak cleanest region of Q^2



Discrepancies remain the same: hint that background cannot justify the difference data/MC

Systematic error associated to this cut

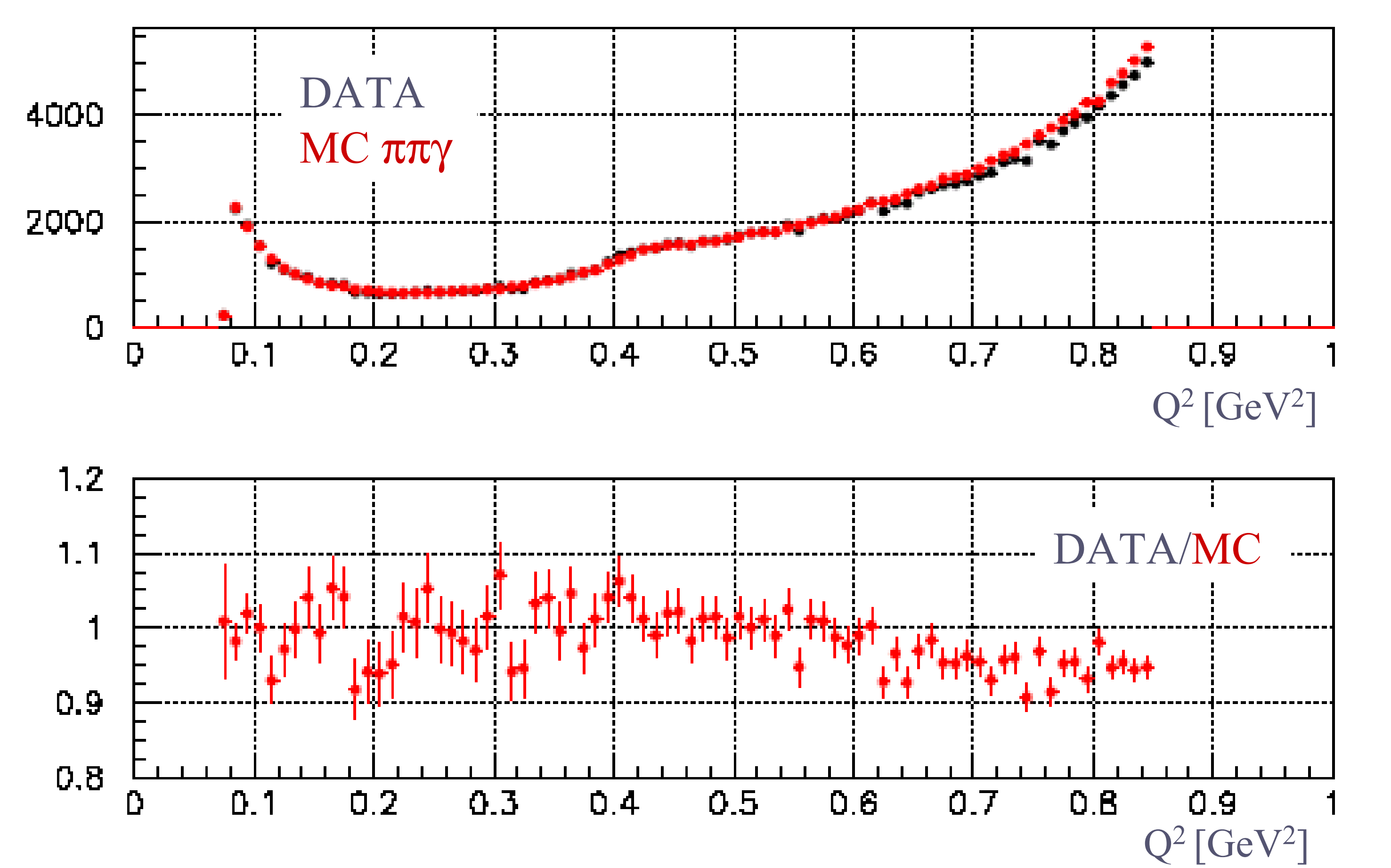
Fraction of the event which fall in the 'discrepant regions' multiplied by the discrepancy N(tot) = 430100

$N(M_{trk} < 130MeV) = 16080$
15% average discrepancy
$\rightarrow N^*(M_{trk} < 130MeV) = 2412$
→ 0.5% error

$N(M_{trk} > 170MeV) = 4401$
20% average discrepancy
$\rightarrow N^*(M_{trk} > 170MeV) = 880$
→ 0.2% error

Muon subtraction: systematic error

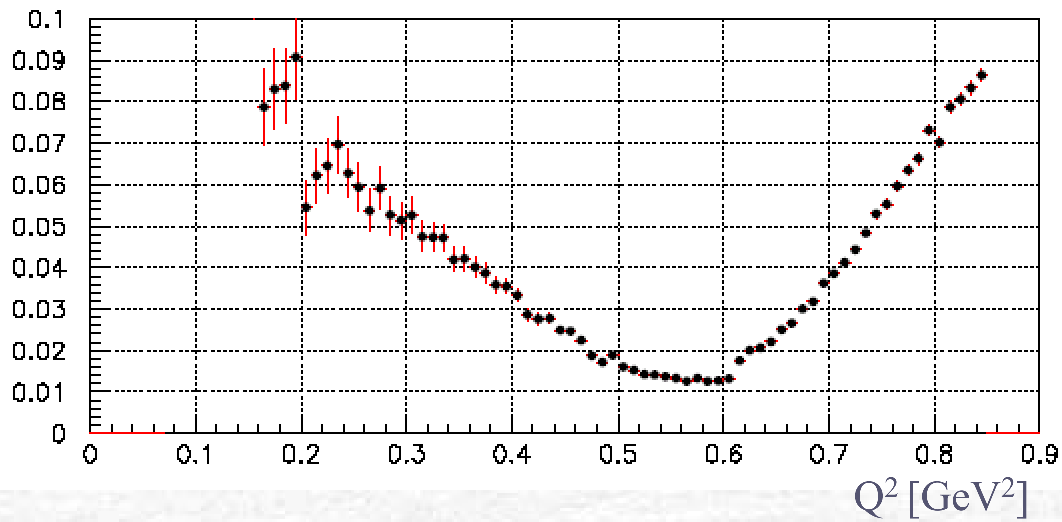
Sample of muons selected with Mtrk < 120 MeV



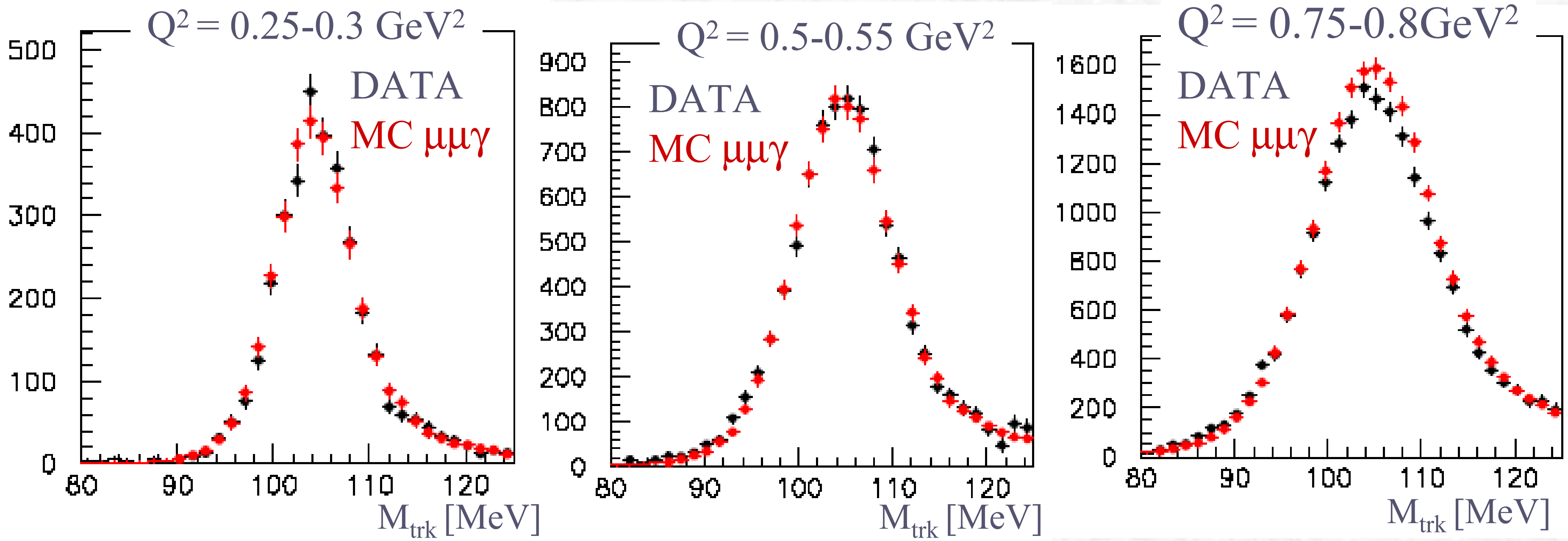
Good agreement except at high Q^2, discrepancy up to 5%

Look at the muon peak in the trackmass and compute the difference in number of events Data and MC. Multiplied this difference by the contamination for each Q^2 bin: systematic error on this background

Muons contamination after the whole selection



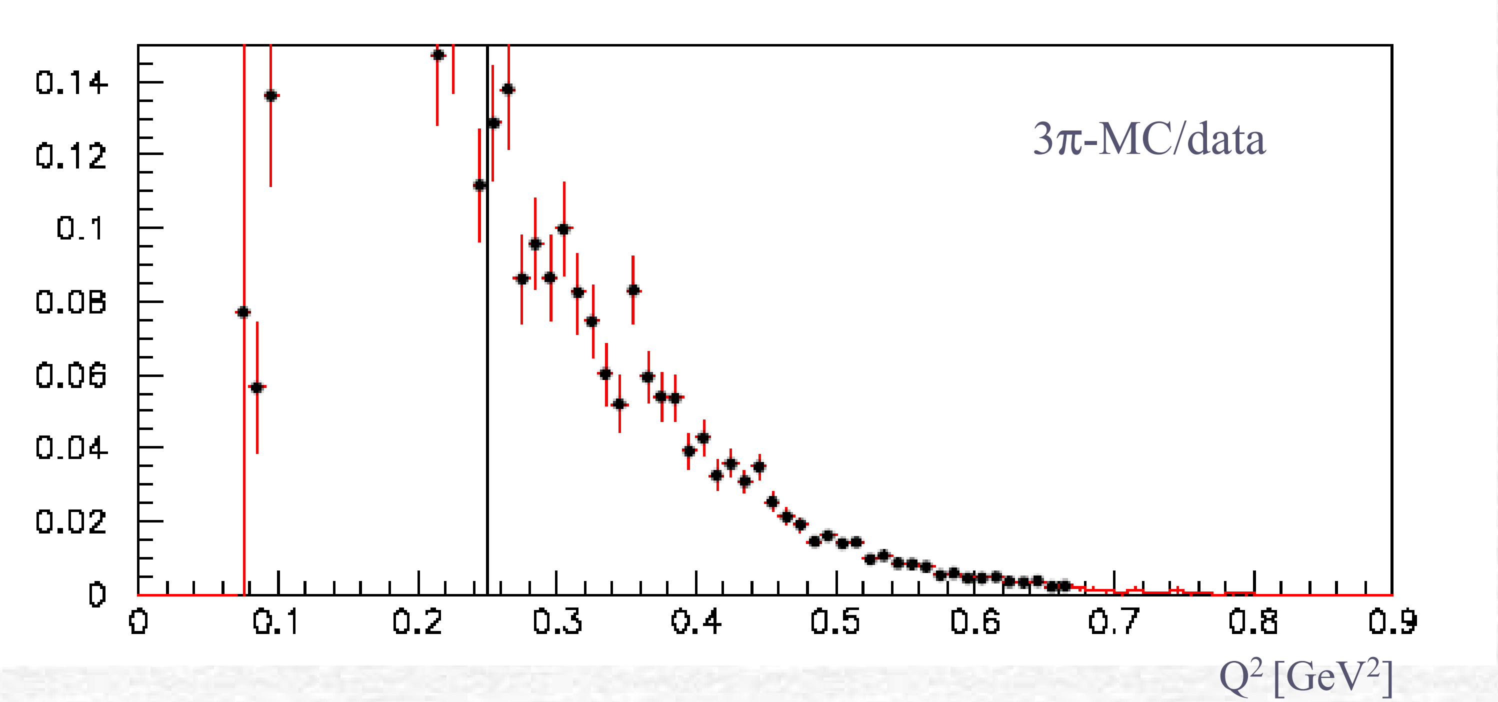
DATA MC μμγ comparison



With this procedure a systematic error on μμγ subtraction maximun at high Q2 with a value of 0.4%. Much smaller at low Q^2

3π subtraction: systematic error

Amount of residual 3π in the spectrum



Error on the fit (used to reweight 3π) times contamination:
Maximun error: Q^2 = 0.25-0.35 GeV^2, contamination ~0.1 × 0.06 = 0.006
Q^2 = 0.25-0 GeV^2, contamination ~0.03 × 0.1 = 0.003

Tracking efficiency: systematic error

Selection of 3π sample

Tagging track (from DTFS):

first hit radius < 50 cm, last hit radius > 170 cm,

PCA to the beam line with $|\rho_{pca}| < 8$ cm and $|z_{pca}| < 7$ cm,

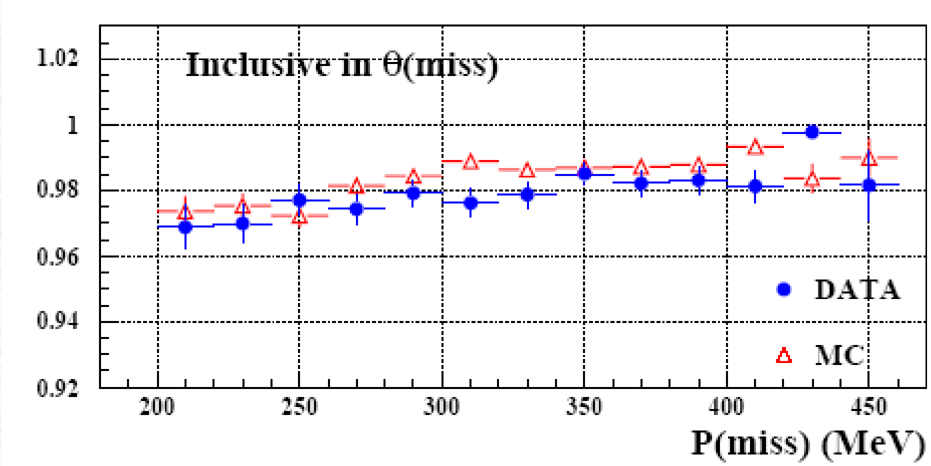
2 prompt photons (if more: the two with the closest invariant mass to $m(\pi^0)$)

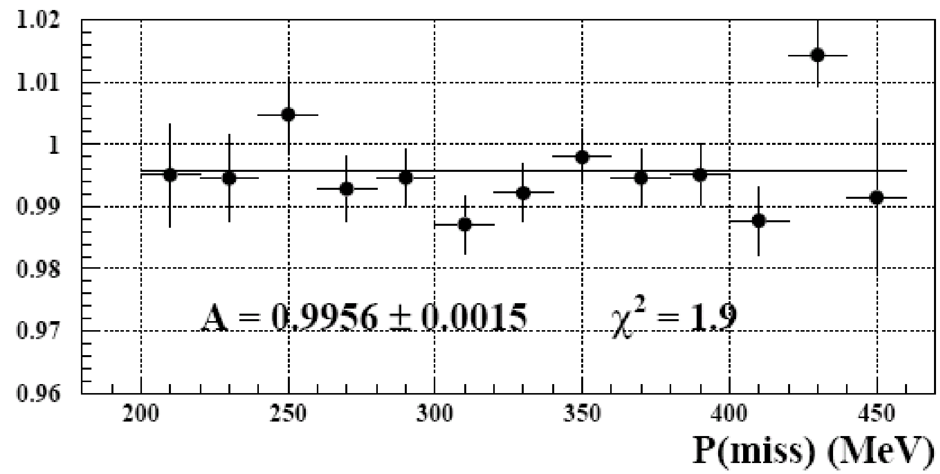
Evaluation of the missing momentum (PCA to the beam line)

Kinematic fit

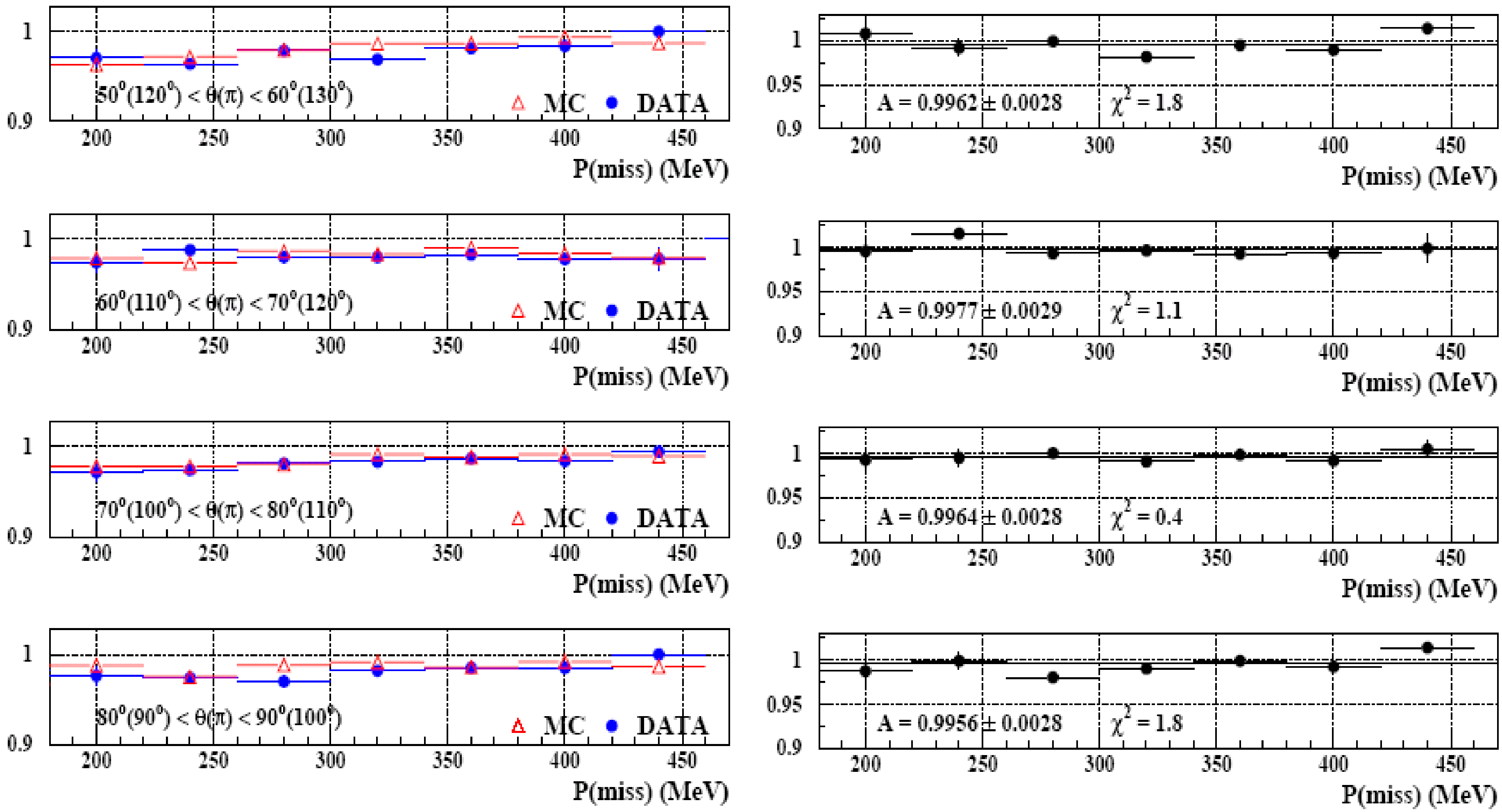
Single track efficiency

Test track: the detected track corresponding to the missing momentum





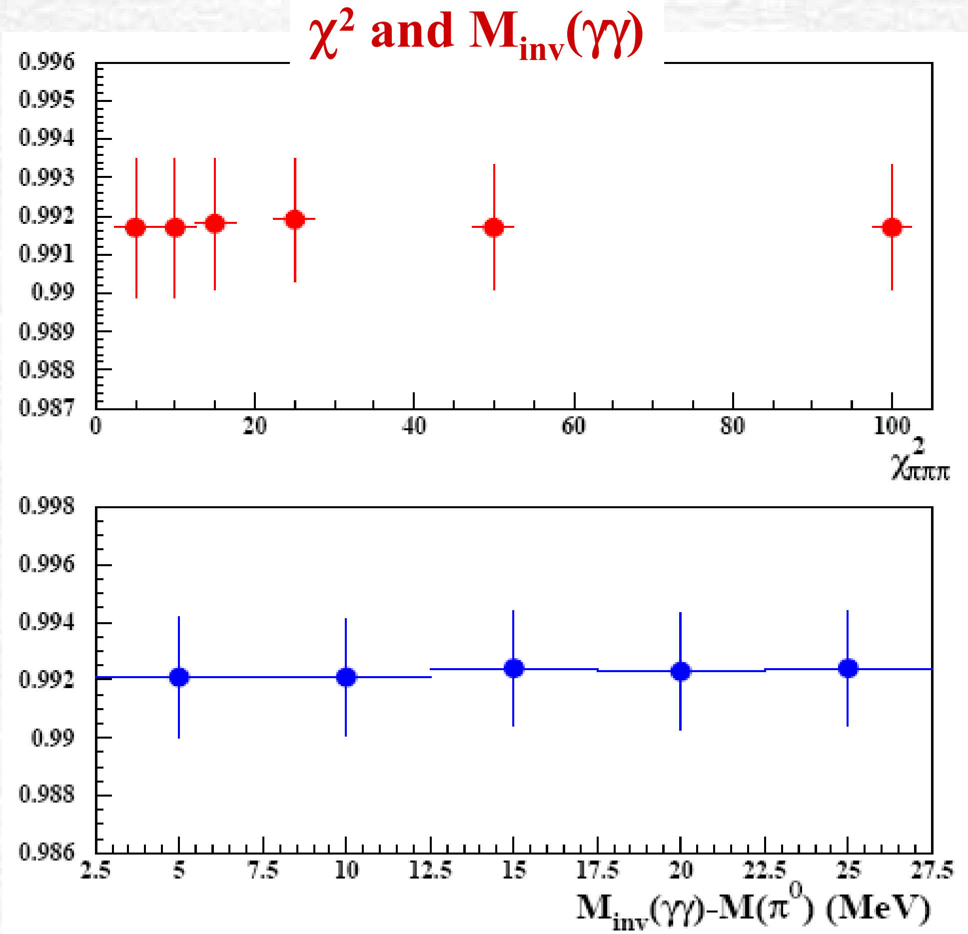
Ratio data/MC flat in the whole Q2 range. The difference data/MC ~0.6%

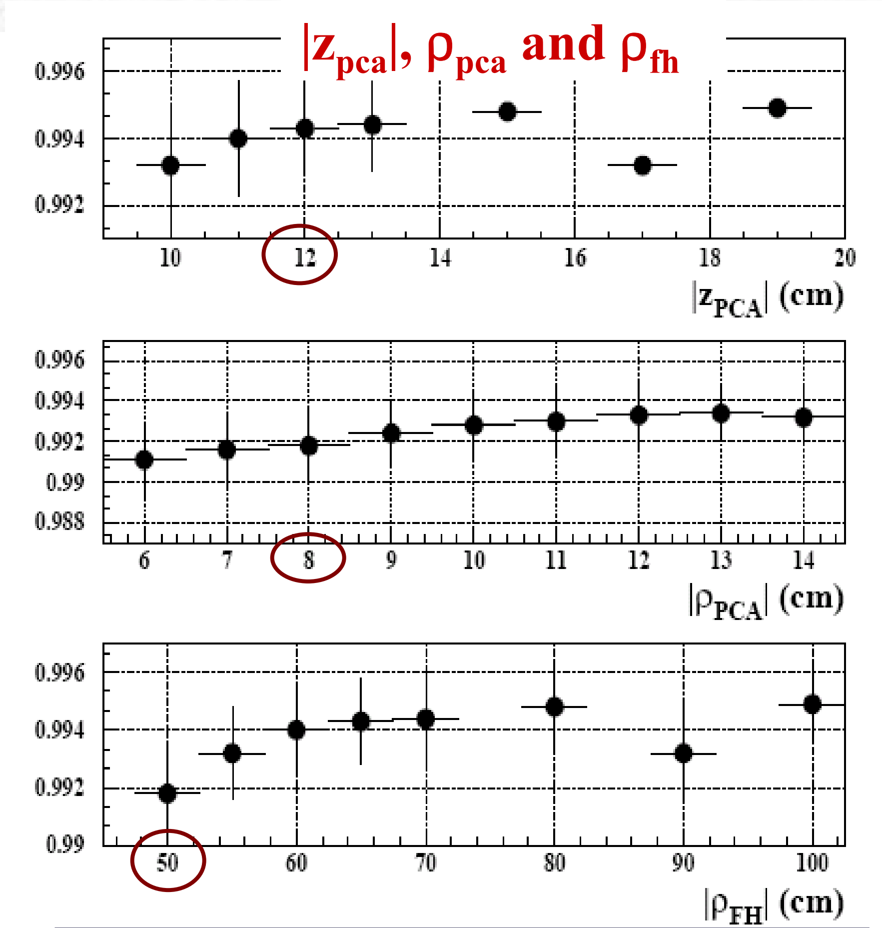


Flat in all the different slices of θ

Cuts used to select the sample systematically and individualy moved

1. For each different configuration tracking efficiency evaluate for data and for MC.
2. Compute the ratio and fit with a straight line.
3. variation of the parameter of the fit as a funcition of the variation of the single cut:





Not effect at all from the cut on the χ^2 and on the $M_{inv}(\gamma\gamma)$

Maximum difference 0.2-0.3%
This will be the systematic error associated to the tracking efficiency.

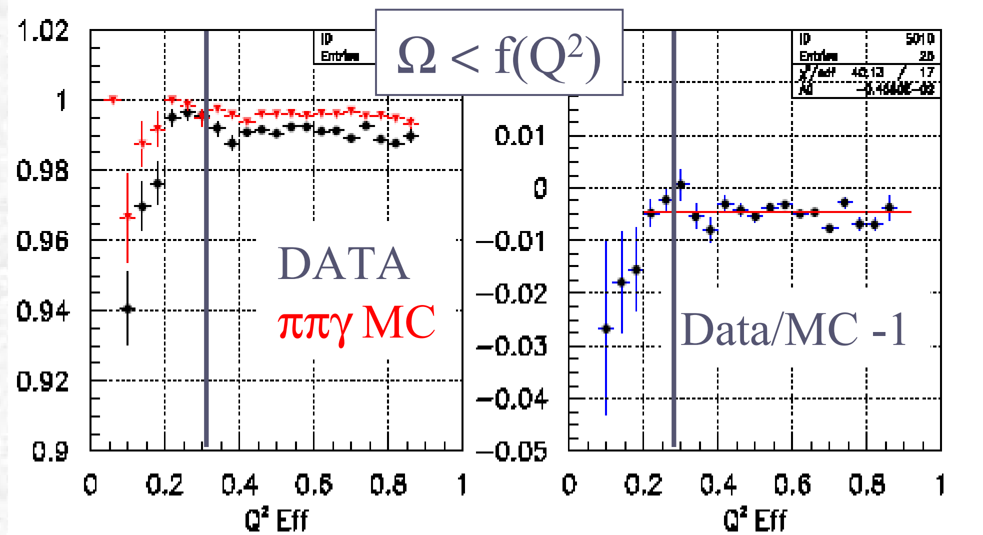
Vertex efficiency: systematic error

Selection of $\pi\pi\gamma$ sample

Candidate tracks (from DTFS):
- first hit radius < 50 cm,
- PCA to the beamline with $|\rho_{pca}| < 8$ cm and $|z_{pca}| < 12$ cm,
- cluster associated to the track (within 60 cm)

Home made likelihood: $L_{trk}/T_{cl}c$ and E_{cl}/P_{trk}

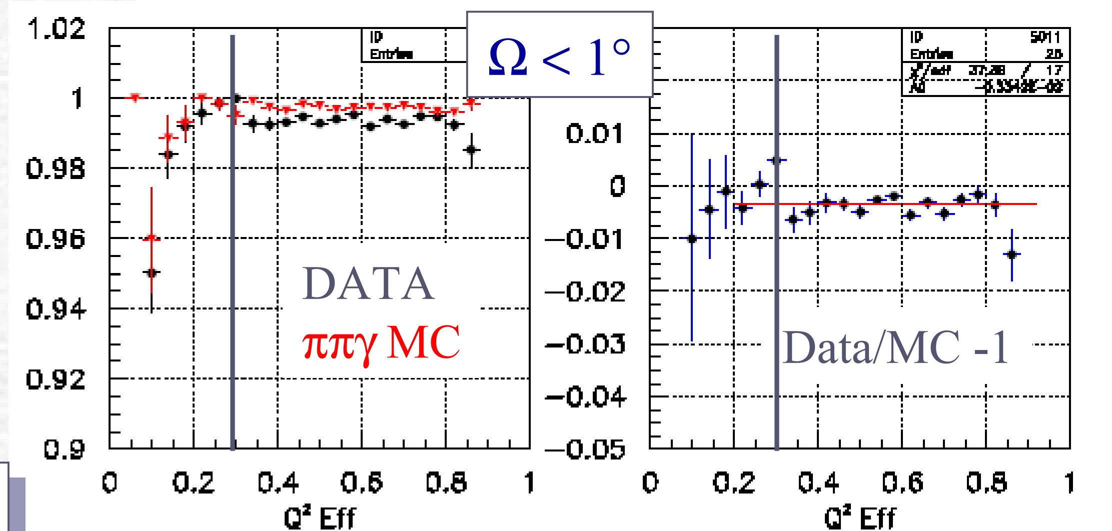
Acceptance cuts, Ω angle cut, Trackmass cut



… Below 0.2 GeV^2 some effects… Probably due to the 3π contamination (or probably not)

To understand: tighter cut on Ω

Changing Ω cut the efficiency changes in the threshold region…

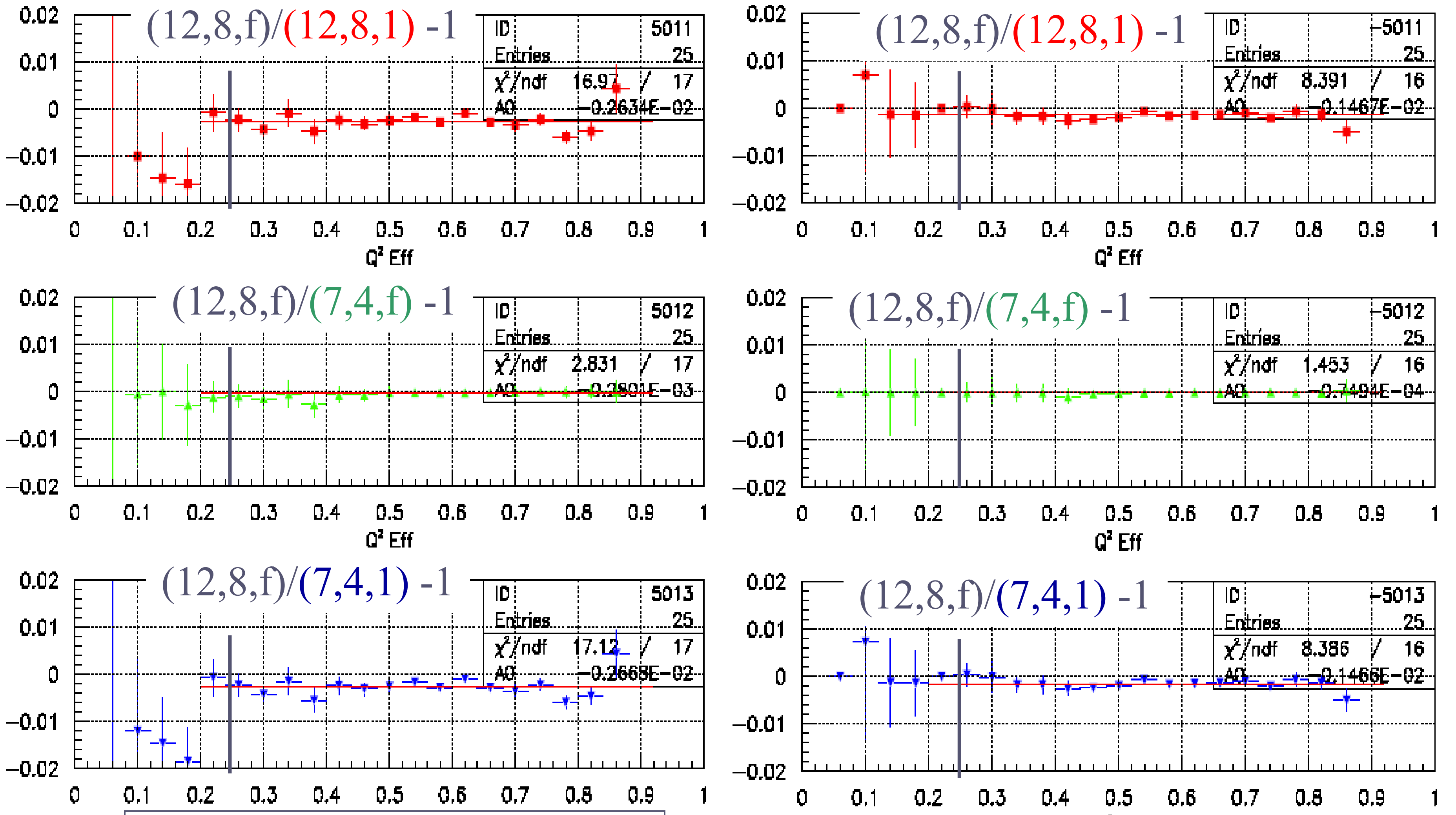


Efficiency performed with cuts $|\rho_{pca}| < 8$ cm, $|z_{pca}| < 12$ cm, $\Omega < 1°$
Difference DATA/MC: 0.3%

Cuts used to select the sample systematically and individualy moved

1. Z_{pca}: from 7 to 12 cm **2.** R_{pca}: from 4 to 8 cm,
3. Ω: 1° and f(Q^2) (the most sensitive variable)

(Z_{pca},R_{pca},Ω)/(Z_{pca}',R_{pca}',Ω')



Variation on efficiency at most at the level of 0.3% for DATA

Variation on efficiency at most at the level of 0.15% for MC

Conclusion and outlook

Analysis cuts tuning and systematic errors
Kinematic fit, Ω
Efficiency and systematic errors
Tracking, Vertex, Acceptance
Background and systematic error
$\mu\mu\gamma$, 3π
FSR correction and total efficiency
Phokhara 5 Ω

→ **1 month**

***f_0* contribution**
EVA collaboration
and
PHOKHARA collaboration

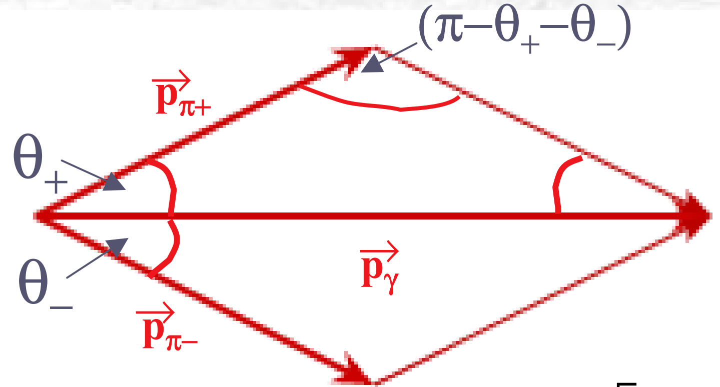
→ **We are not alone and optimistic**

Calibration issue

How well do we know s', and is it really M_{xx}^2?

Assuming only 1 photon, one obtains

$$s' = s - 2\sqrt{s}\,E_\gamma$$



and with

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

$$s' = s - \sqrt{s}\,\sin[\pi - (\theta_+ + \theta_-)] \cdot \left[\frac{|\vec{p}_+|}{\sin\theta_-} + \frac{|\vec{p}_-|}{\sin\theta_+} \right]$$

θ_+,θ_- are the angles relative to the photon direction. Either constrain photon to be along z-direction, or tag it. More than 1 photon spoils relation in both cases. First checks on MC are in progress…

Outlook on off peak

We are starting to work on that (P.B.,S.M)