Fitting the ϕ-lineshapes for 2005-2006 data

Sebastian Matberg[1], Stefan Müller[2]
(with help from Marco Dreucci and Aleksei Sibidanov)

[1]Universität Bremen
[2] LNF

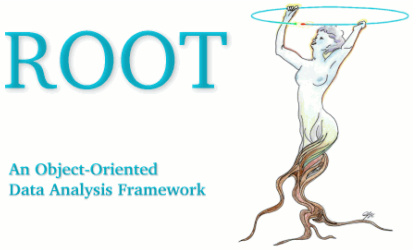
KLOE Phidec Meeting
26 April 2007, Frascati

Fitting the ϕ lineshapes:

-Based on Marco Dreuccis code (Dreucci@Capri)

-Theor. Parametrizations from Achasov et al., Yad. Fiz. 54, 1097 (1991)
- ISR-radiator from Nicrosini et al. (2. DAPHNE Handbook)

- Method has been implemented using ROOT and the TMINUIT-class calling Fortran routines (Thanks to Aleksei for help!).



-Data points taken from datarec counters of 4 channels:
- CHARGEDKAON
- KSCHARGED
- RHOPAI
- NEUTRALRAD

- normalized to VLAB luminosity
(eff.VLAB Cross section is accordingly scaled over √s using BABAYAGA@nlo)
- no correction for eff. or background correction is applied (yet)

- for 2005/2006, we have in total 6 points:
1000 MeV, 1010 MeV, **1018 MeV, 1019.48 MeV, 1023 MeV**, 1030 MeV

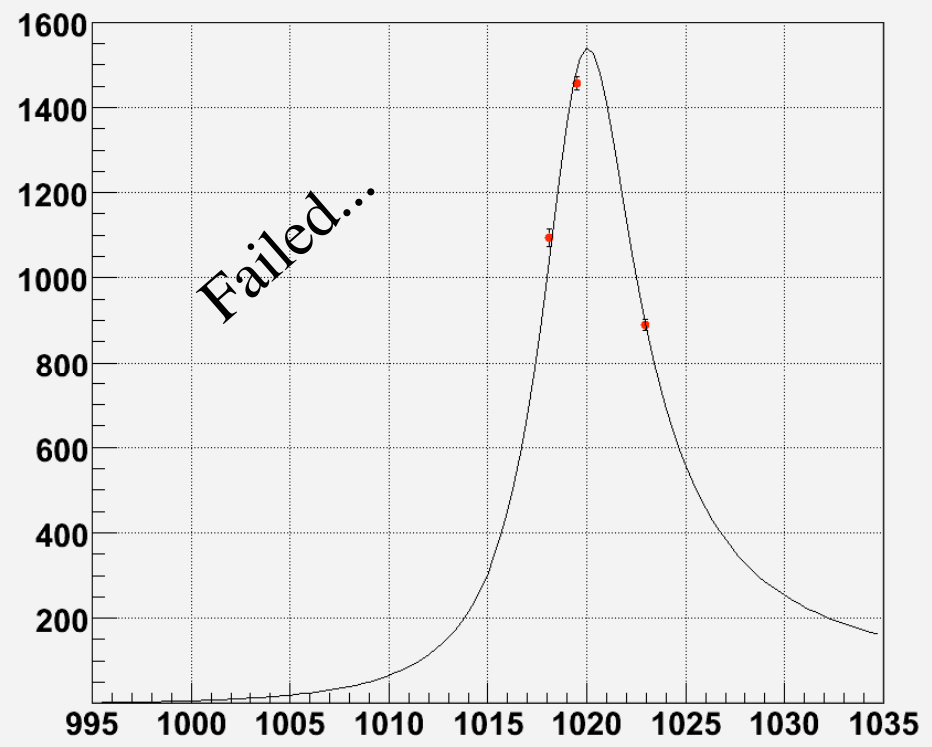
- Fit does not work with data points too much outside the phi, so we use only three points
(For 2002, the data points were 1017 MeV, 1019.5 MeV, 1022 MeV)

Fit result for 2005/06 scan data: MIGRAD, no BES

K^+K^-

ERR MATRIX NOT POS-DEF
FCN=10.4024 FROM MIGRAD **STATUS=FAILED** 318 CALLS 319 TOTAL
EDM=0.00126653 STRATEGY= 1 ERR MATRIX NOT POS-DEF

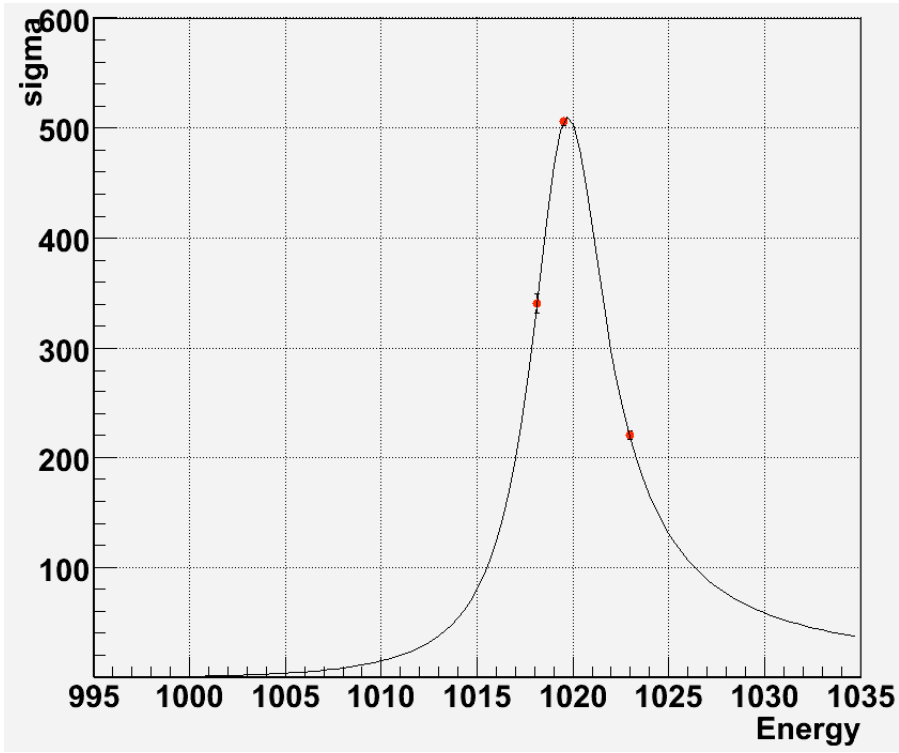
EXT PARAMETER NO.	NAME	VALUE	APPROXIMATE ERROR	STEP SIZE	FIRST DERIVATIVE
1	a1	1.92642e+03	5.80116e+00	-0.00000e+00	7.09170e-02
2	a2	1.02005e+03	8.21548e-02	-0.00000e+00	-8.04190e-01
3	a3	5.84489e+00	1.85715e-02	-0.00000e+00	-1.28881e+01



K_SK_L

FCN=1.74745e-05 FROM MIGRAD STATUS=CONVERGED 366 CALLS 367 TOTAL
EDM=2.44447e-05 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	a1	6.58652e+02	4.11639e+00	1.31619e-03	-1.37512e-03
2	a2	**1.01970e+03**	**3.92041e-02**	4.86231e-04	1.49580e-01
3	a3	4.70927e+00	5.38083e-02	7.74508e-06	-8.48055e-02

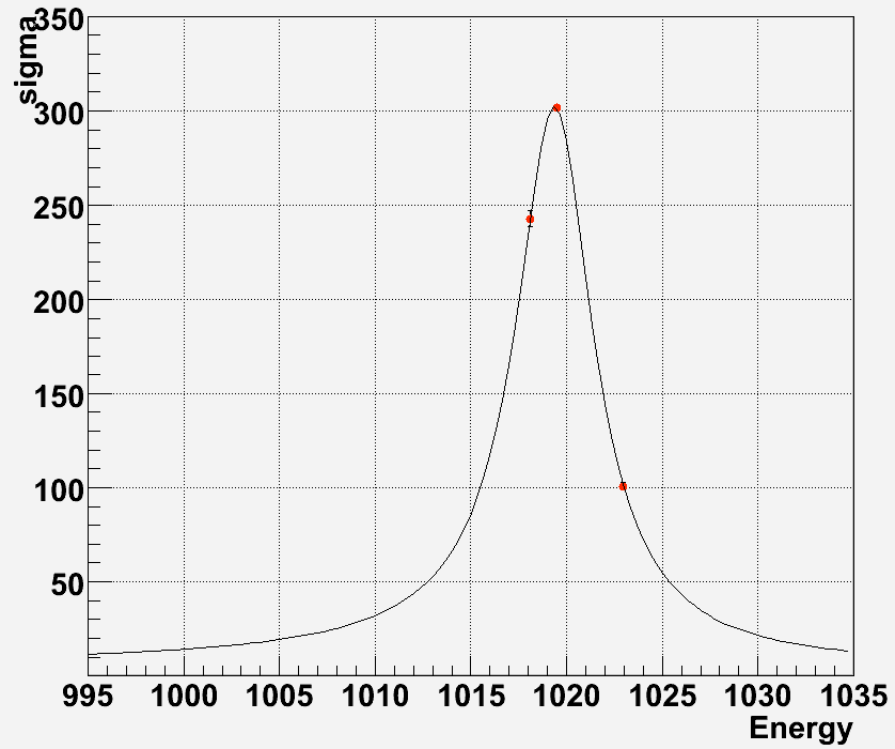


Fit result for 2005/06 scan data: MIGRAD, no BES

$\rho\pi$

FCN=1.38347e-05 FROM MIGRAD STATUS=CONVERGED 438 CALLS 439 TOTAL
EDM=9.80832e-05 STRATEGY= 1 ERR MATRIX NOT POS-DEF

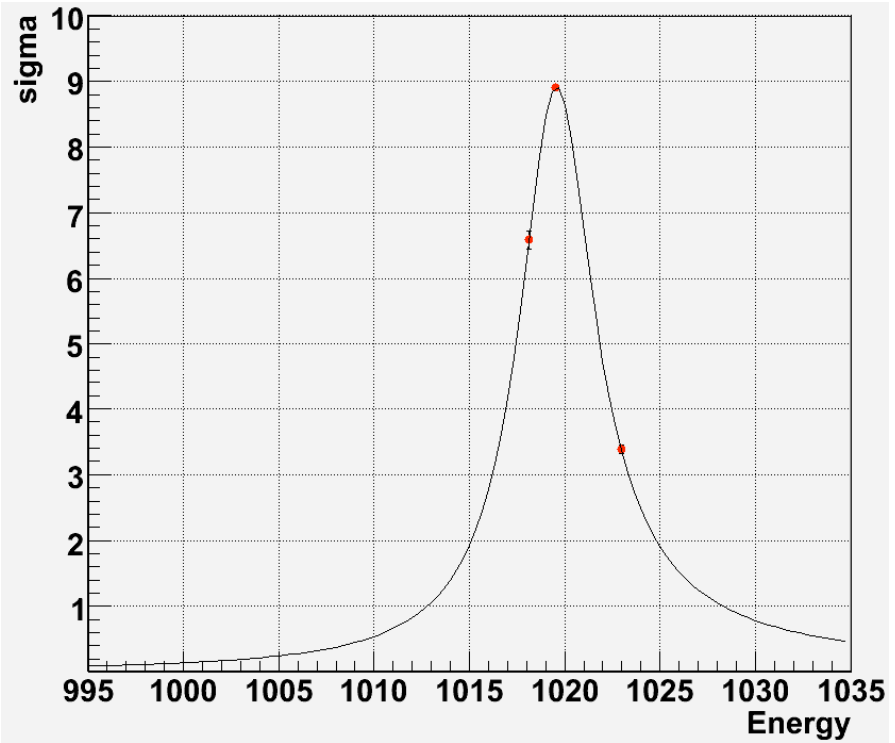
EXT PARAMETER NO.	NAME	VALUE	APPROXIMATE ERROR	STEP SIZE	FIRST DERIVATIVE
1	a1	3.56368e+02	1.18935e+01	5.01437e-04	2.92208e-04
2	a2	**1.01968e+03**	**1.04957e-01**	4.86220e-04	1.82039e-01
3	a3	4.84041e+00	5.45822e-01	6.26163e-06	-1.05287e-02
4	a4	4.91997e-02	3.36192e-03	1.15400e-06	-3.04704e-01
5	a5	3.79341e+00	5.62839e-01	2.16104e-05	2.66806e-02



neutralrad

FCN=3.91631e-05 FROM MIGRAD STATUS=CONVERGED 350 CALLS 351 TOTAL
EDM=2.29722e-05 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT PARAMETER NO.	NAME	VALUE	STEP ERROR	SIZE	FIRST DERIVATIVE
1	a1	1.12971e+01	2.73713e-02	1.46002e-05	-2.15507e-01
2	a2	**1.01969e+03**	**4.39948e-02**	4.86225e-04	-2.78331e-02
3	a3	4.77617e+00	2.99901e-02	1.06693e-05	-1.93880e-01



Results of 4 independent fits with 3 points:

	Mϕ–1019 (MeV)	Γϕ (MeV)
CHARGEDKAON	1.05±0.082	5.85±0.019
KSCHARGED	0.70±0.039	4.71±0.054
RHOPAI	0.69±0.044	4.84 ±0.055
NEUTRALRAD	0.68±0.105	4.78±0.030

MIGRAD did not converge!

Combined fit for 2002 data done by Marco:

Dreucci@Capri	0.45±0.03	4.19±0.04

M_ϕ PDG2006: (1019.46+-0.019) MeV ; Γ_ϕ PDG2006: (4.26 +-0.05) MeV

Conclusions:

- Procedure to fit the lineshape is ready
- Except for CHARGEDKAON, fit converges
- Preliminary result suggests a miscalibration in $\sqrt{s}$ of ca. 250keV
- To further improve, the full cross sections for the individual channels, including eff. and background corrections, are needed
- Then one could try
    - to use all 6 points in $\sqrt{s}$
    - check effect of different lineshape parametrizations
    - check effect of different radiator
    - …

...However, I myself will go on with the $\pi\pi\gamma$-analysis

Update on ππγ analyses

- New MC-Tuning by P. Beltrame
- Using UFO-events to check MC-Data agreement
- Vertex efficiency

KLOE Phidec Meeting
26 April 2007, Frascati

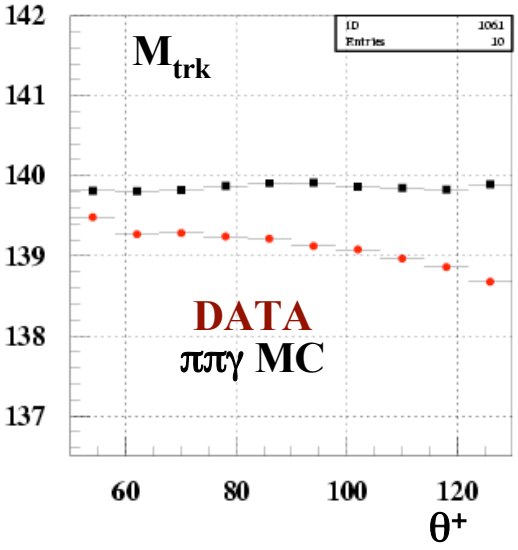
1. Tuning MC distributions to data:

- Small Angle acceptance cuts
- .or. of the Likelihood

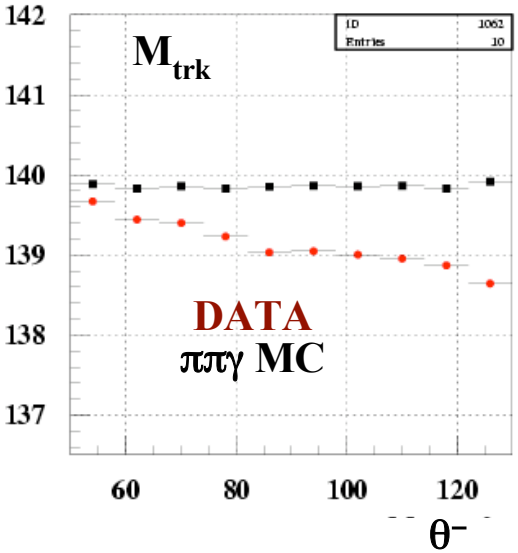
and

NO MC FINE TUNING

Mean value of Gassian fits in the range 135 – 145 MeV



The widths have almost the same trend for DATA and MC, but MC's widths are setting at ~ 2 MeV lower



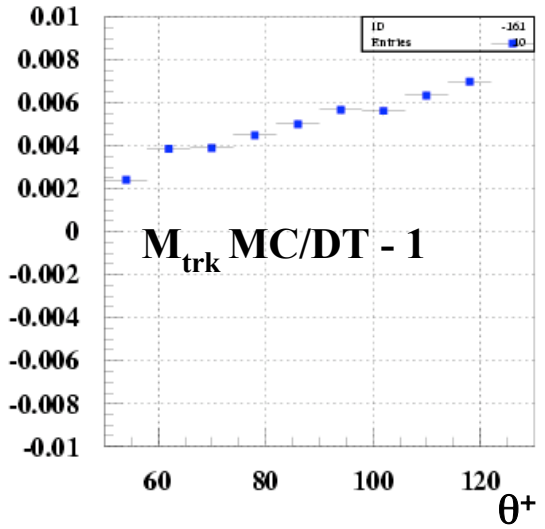
STRATEGY of the Fine Tuning

1. Shift the MC momenta to get a better agreement in the M_{trk} mean value

2. Smear the MC momenta for the widths of M_{trk} peak

Momentum shift

1. Look at the relative difference between DATA and MC



2. Find a fitting function for the shapes of the relative differences (on θ, ϕ and p, for the two different charges q)

$$F_{\vartheta}(q,\theta,|\vec{p}|)$$
$$F_{\phi}(q,\phi,|\vec{p}|)$$

3. Determine the parameters and the ¨absolute" correction function after iterative DATA-MC comparison

$$F_{corr} = (1+\alpha)F_{\vartheta}\cdot F_{\phi} - \beta\cdot M_{\pi\pi}{}^{2}$$

$$p_i = \frac{p_i}{F_{corr}} \qquad i = x, y, z$$

F_{corr} the same all the three component of each momentum... rather strange but it seems to work

$F_{\theta} = 1\pm O(10^{-3})$, $F_{\phi} = 1 \pm O(10^{-4})$

$\alpha = 1 \pm O(10^{-3})$, $\beta = O(10^{-4})$

Momentum smearing

1. Look at DATA and MC widths of the fit for $\pi\pi\gamma$ peak
2. See value and trend mainly as a function of $M_{\pi\pi}^2$
This part is the most B-V-like, only a better agreement on different $M_{\pi\pi}^2$ has been searched

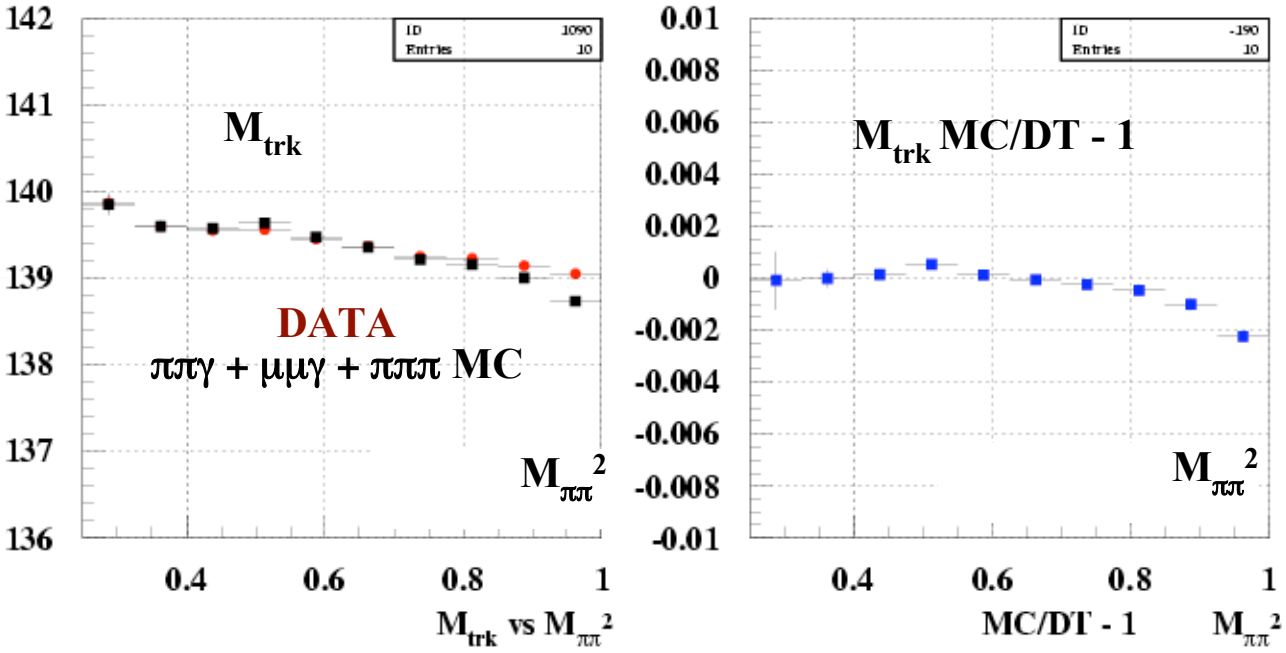
$$p_i = p_i \cdot F^k_{sme}(q, M_{\pi\pi}{}^2)$$

Same smearing function for the three momentum components of each charge (q), different functions for different $M_{\pi\pi}^2$ range

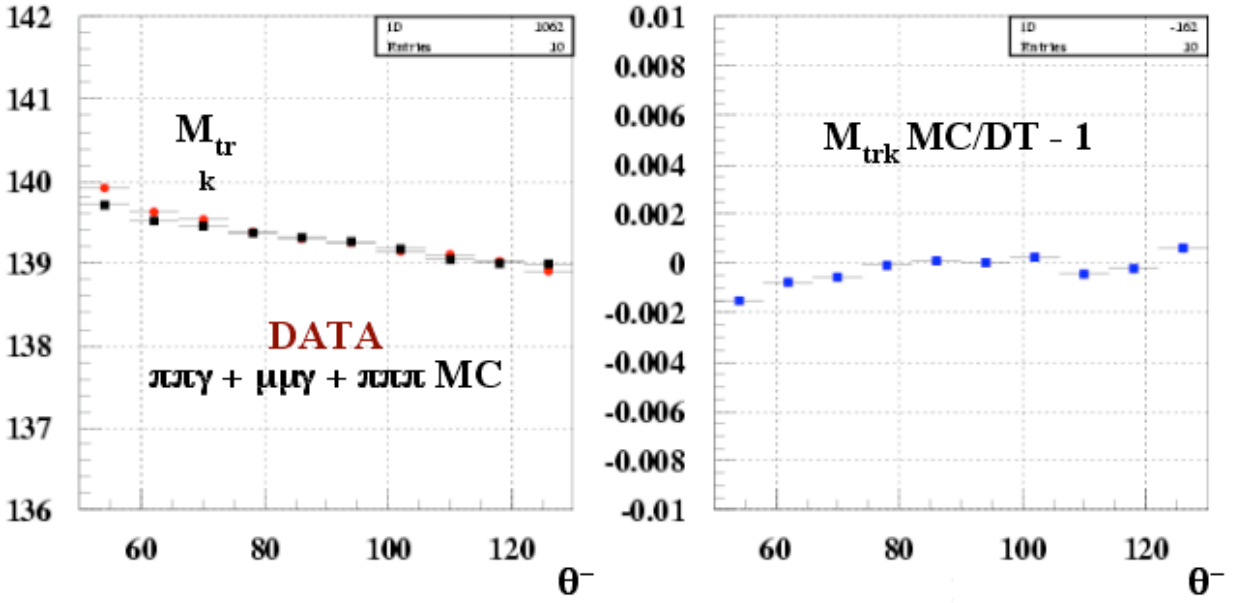
MAIN IDEA for the near future

1. Dedicate function for each p_i component
2. Dedicated fine tuning for $\mu\mu\gamma$ MC and for Large Angle
3. Smearing for Off Peak MC (after having precisely under control the $\sqrt{s}$ value and the momentum calibration)

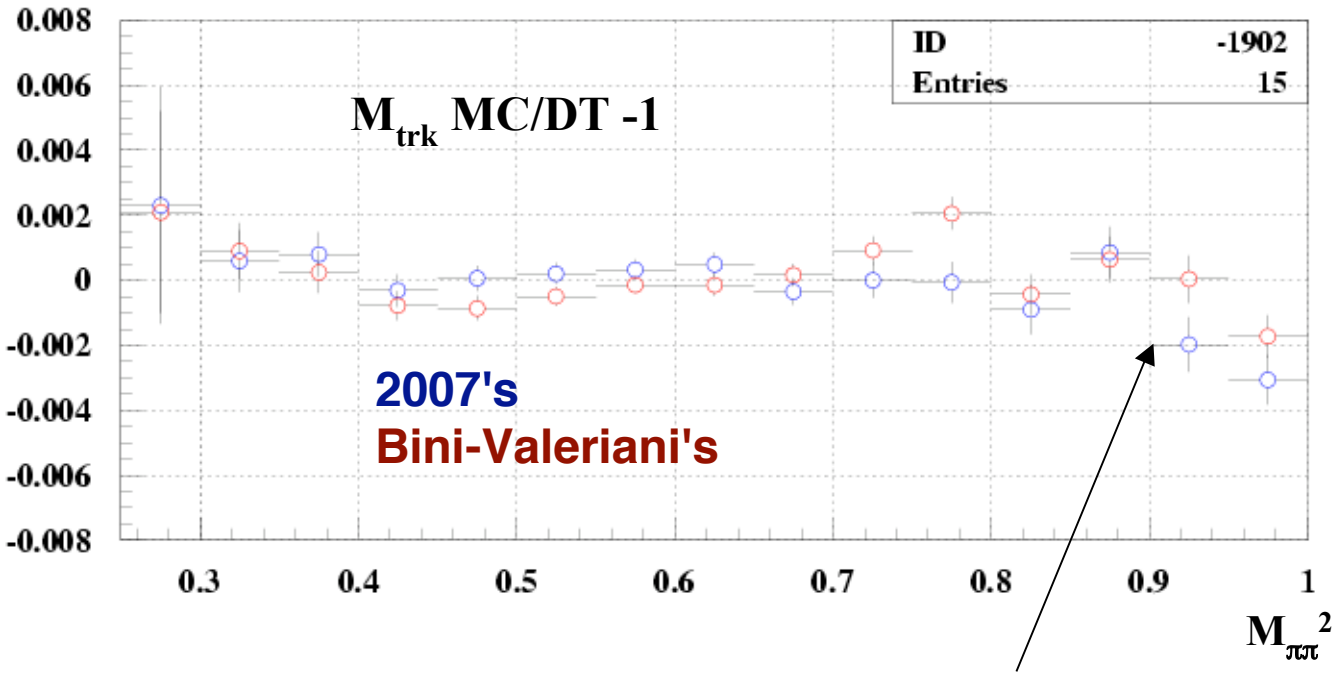
Agreement Data - MC:



ππγ + μμγ + πππ MC
Fit in the range 130–150 MeV
(MC channels tuned with the same functions)



Fast comparison between Bini-Valeriani's and 2007's procedures



... to be understood

- Small Angle acceptance
- Trackmass cut
- ρ peak ($0.55 < M_{\pi\pi}^2 < 0.65$)
only $\pi\pi\gamma$ MC
Fit in the range 135–145 MeV

NEXT STEP
Try to perform dedicate tuning function for each momentum component

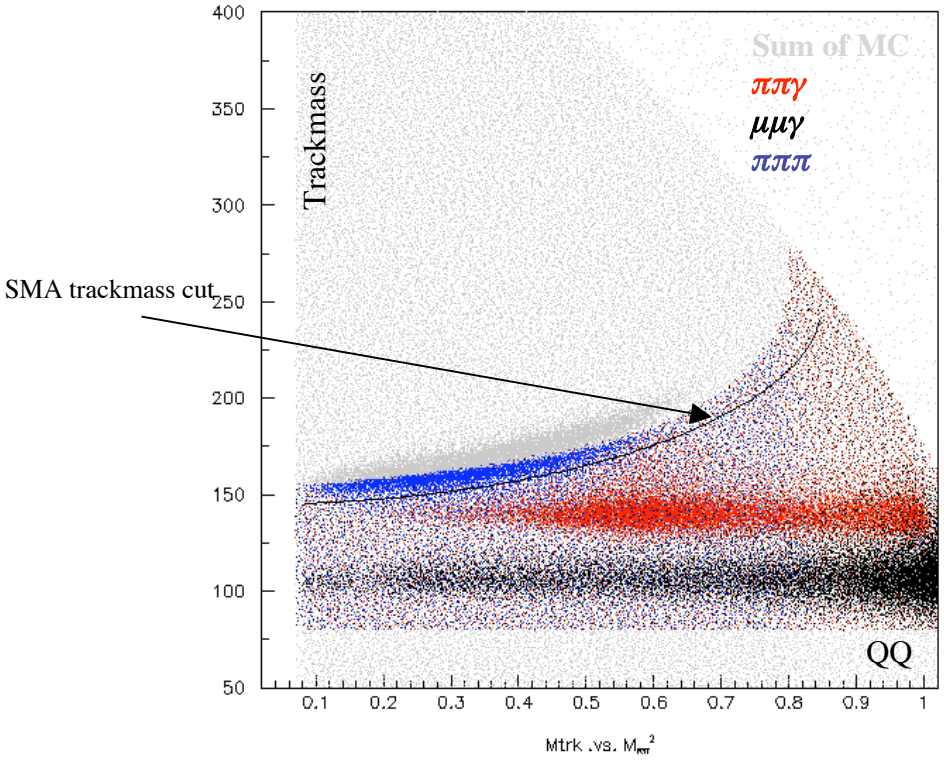
2. Fitting MC distributions to UFO-data:

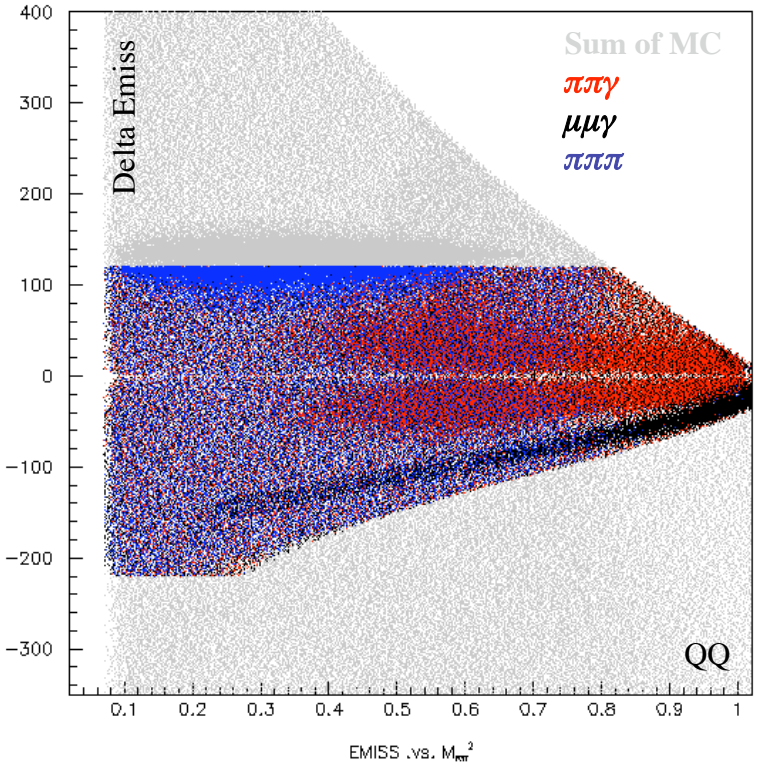
- Advantage: UFO events are independent from EVCL, full ppp-peak contained in ufo-data
- Disadvantage: Few statistics in 2002 (24.74pb^{-1} with downscale 1/20)

  MC is tuned with Paolos prescription (from 11.4.07) or Bini/Valeriani,
  Small angle cuts (apart from cuts in M_{Trk} and ΔE_{Miss}
  normally performed by PPGTAG).
  ...all UFO events are selected by FILFO - I ask for FILFO selection in MC (no big change).

- Goal: Verify how good MC reproduces the data also outside (small angle) analysis cuts

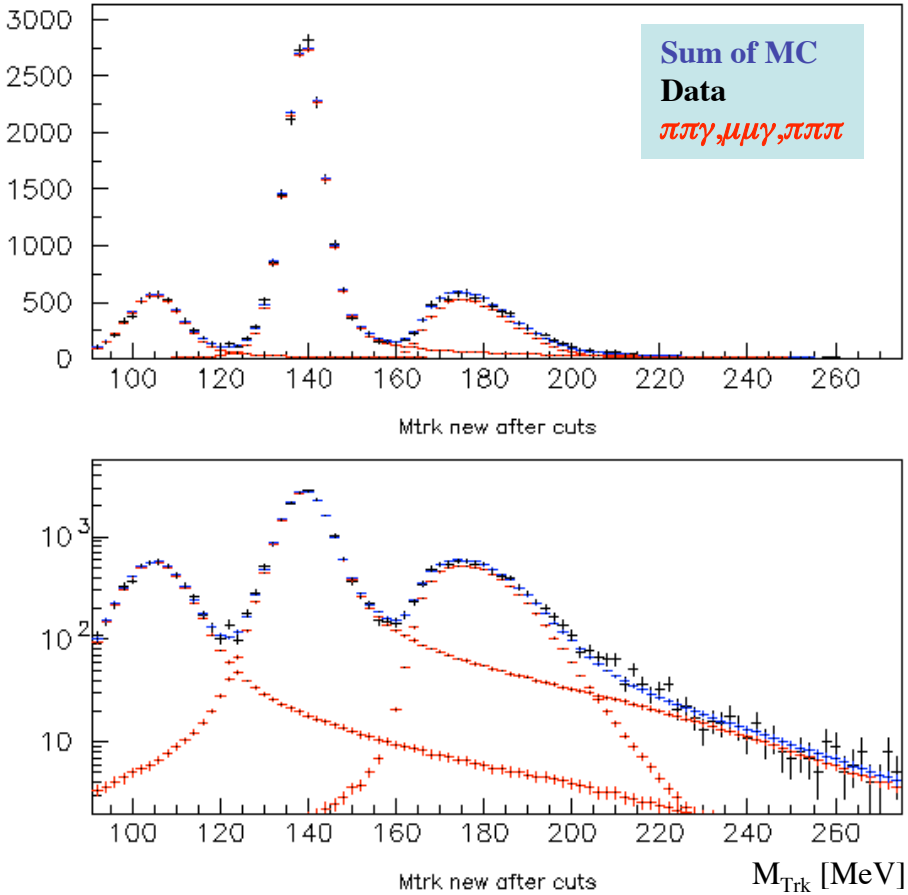
Effect of PPGTAG-cuts in M_{Trk} and ΔE_{Miss}:





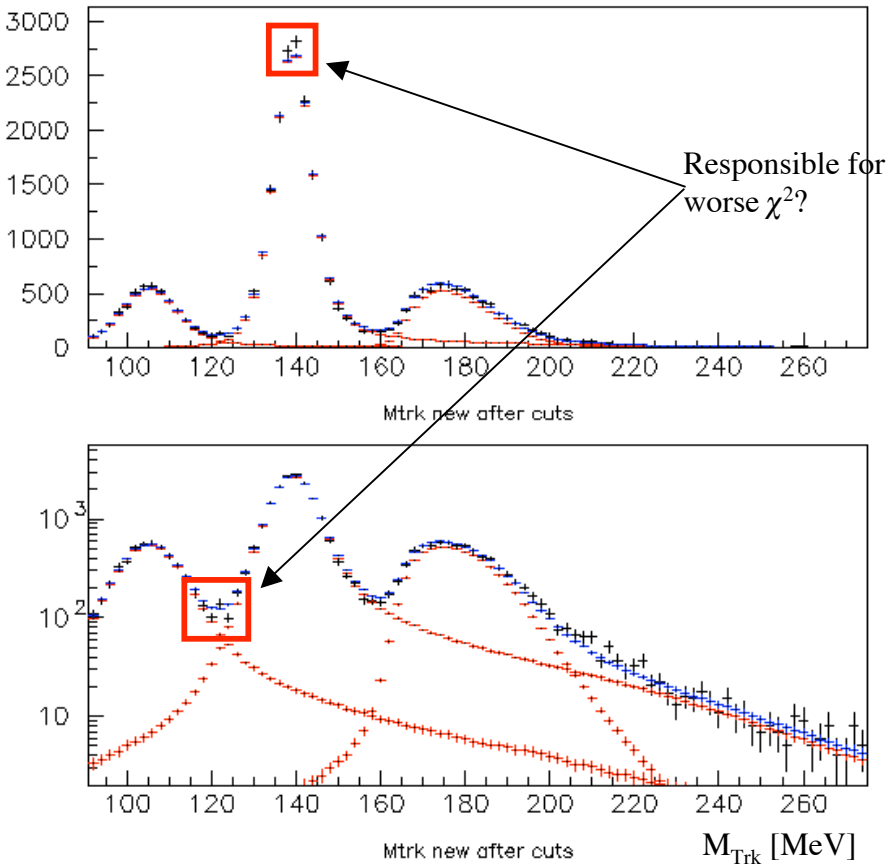
Fully inclusive in Q^2:

Beltrame-Tuning



Content of Histo for data: 30806
ppg weight: 1.03468 +- 0.00808
mmg weight: 1.00842 +- 0.015578
eeg weight: 1 +- 0
ppp weight: 0.960188 +- 0.01398
Chisquare/ndof 69.96 / 88
Chi2 Prob. 0.921397

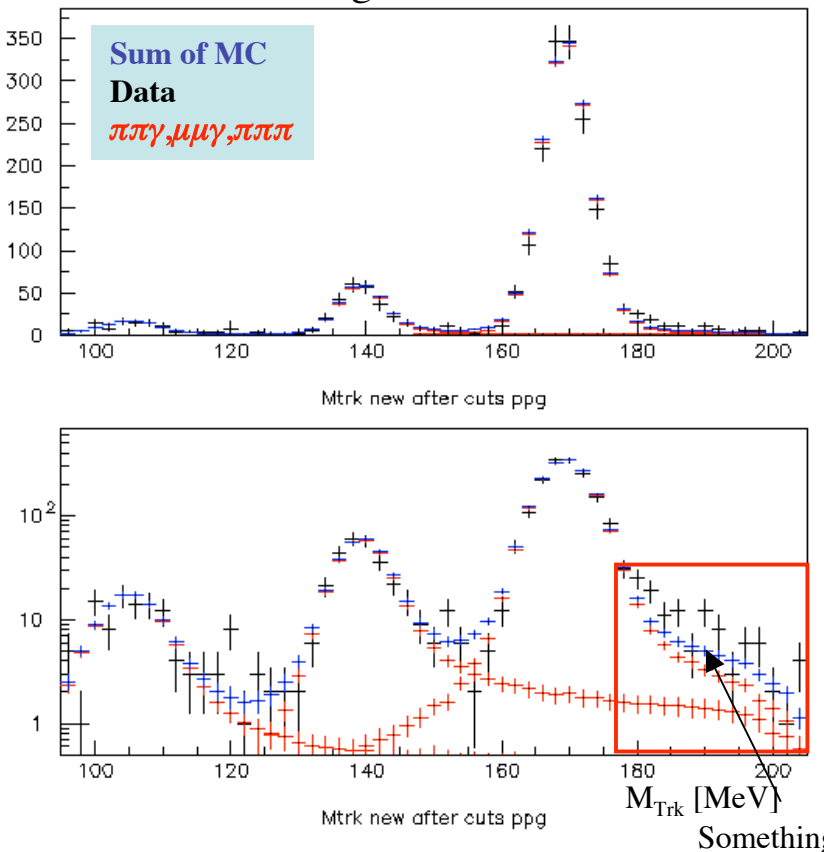
Valeriani/Bini-Tuning



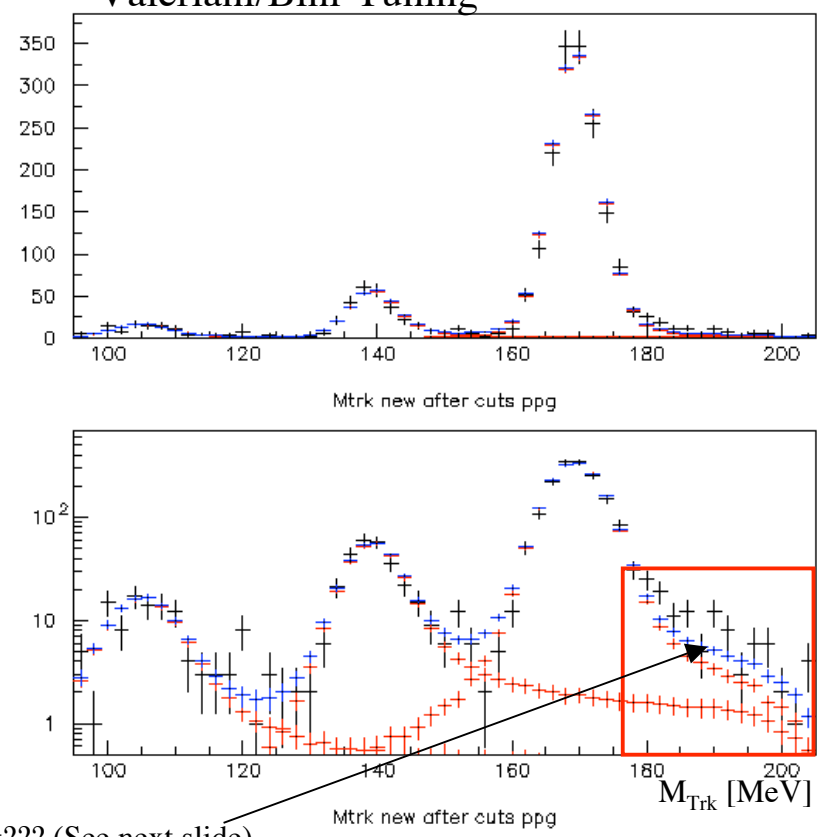
Content of Histo for data: 30806
ppg weight: 1.0364 +- 0.008086
mmg weight: 1.01101 +- 0.01564
eeg weight: 1 +- 0
ppp weight: 0.961896 +- 0.013996
Chisquare/ndof 93.37 / 88
Chi2 Prob. 0.32749

$Q^2 < 0.4\ GeV^2$:

Beltrame-Tuning



Valeriani/Bini-Tuning



Something missing??? (See next slide)

Content of Histo for data: 2131

ppg weight: 1.08204 +- 0.067984
mmg weight: 0.976144 +- 0.102296
eeg weight: 1 +- 0
ppp weight: 0.936772 +- 0.02385
Chisquare/ndof 65.46 / 51
Chi2 Prob. 0.0838208

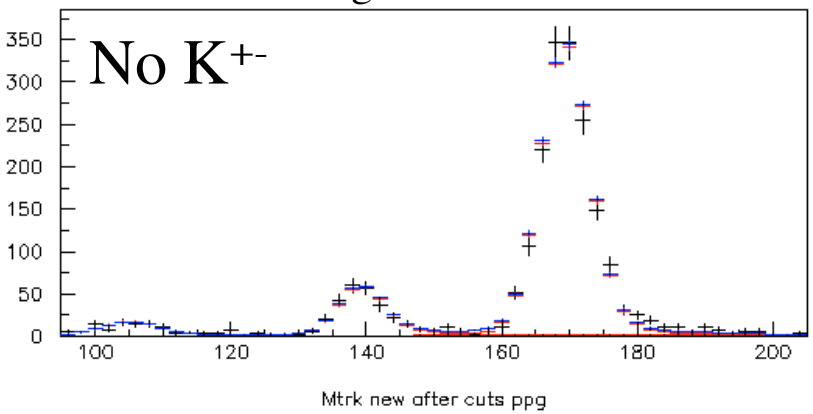
Content of Histo for data: 2131

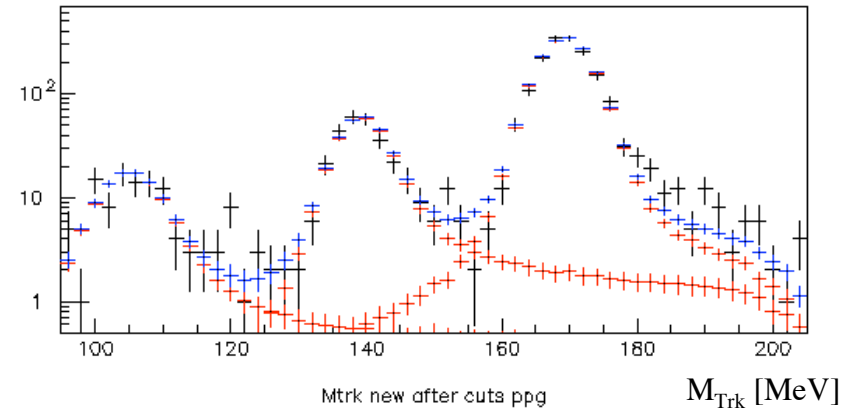
ppg weight: 1.08074 +- 0.067874
mmg weight: 0.980922 +- 0.102768
eeg weight: 1 +- 0
ppp weight: 0.939352 +- 0.023896
Chisquare/ndof 65.92 / 51
Chi2 Prob. 0.0780484

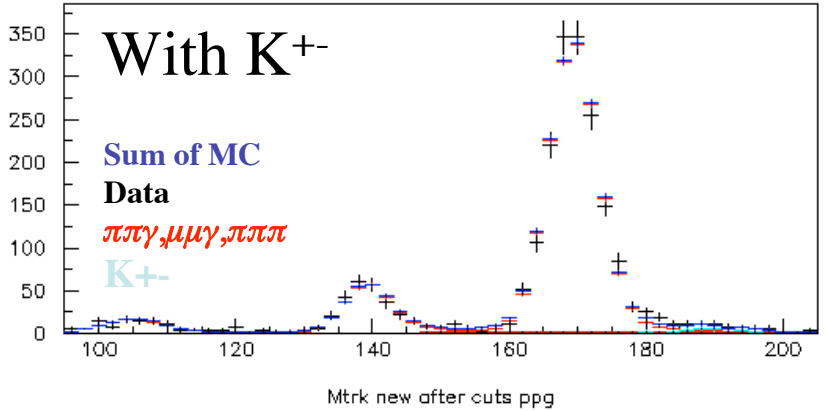
$Q^2 < 0.4\ GeV^2$:

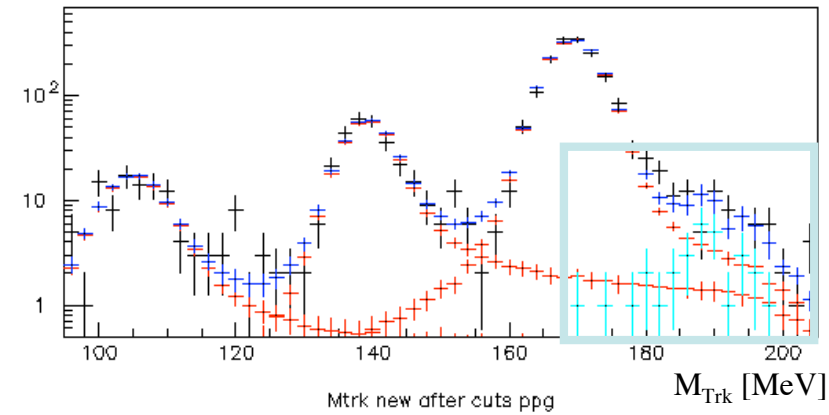
- Adding K+K- from all_phys2002 improves χ^2 a lot!
- Turns out all events are $K^{\pm} \rightarrow \mu\ \nu$

Beltrame-Tuning







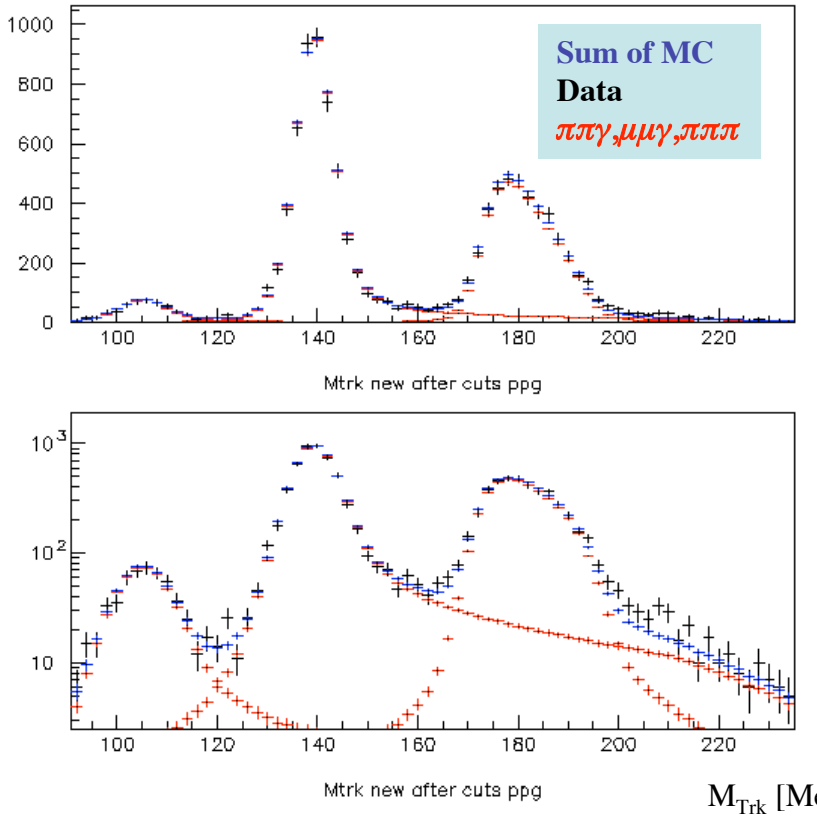


Content of Histo for data: 2131
ppg weight: 1.08204 +- 0.067984
mmg weight: 0.976144 +- 0.102296
eeg weight: 1 +- 0
ppp weight: 0.936772 +- 0.02385
Chisquare/ndof 65.46 / 51
Chi2 Prob. 0.0838208

Content of Histo for data: 2131
ppg weight: 1.05391 +- 0.06655
mmg weight: 0.957242 +- 0.100174
eeg weight: 1 +- 0
ppp weight: 0.923058 +- 0.023784
all phys weight: 1 +- 0
Chisquare/ndof 48.56 / 50
Chi2 Prob. 0.531291

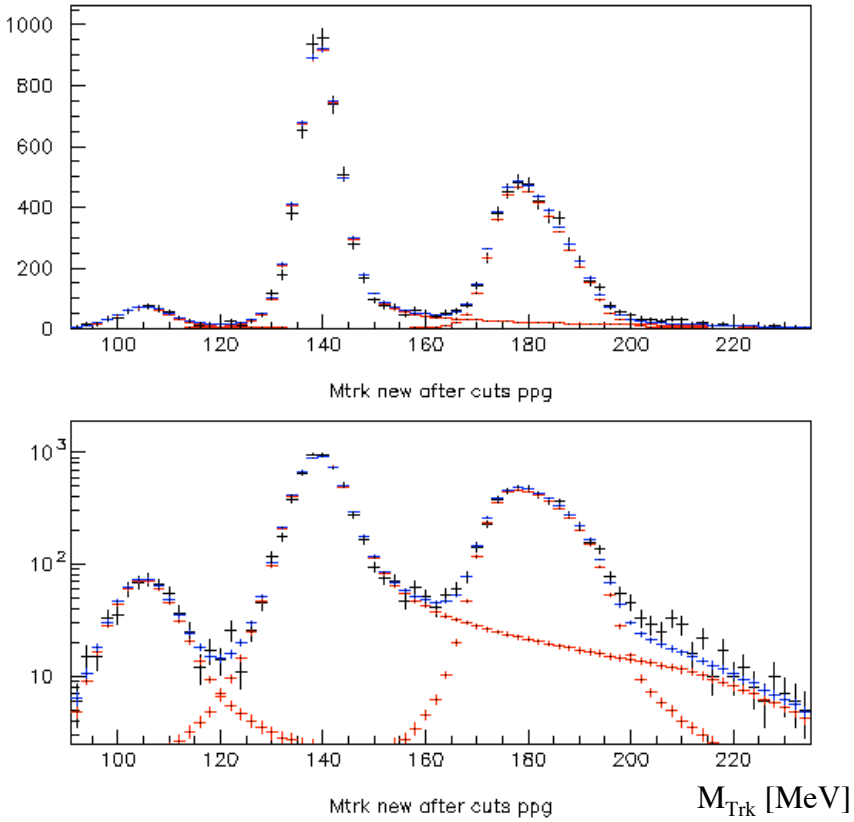
$0.4 < Q^2 < 0.6\ GeV^2$:

Beltrame-Tuning



Content of Histo for data: 10754
ppg weight: 1.02589 +- 0.014188
mmg weight: 1.01385 +- 0.048516
eeg weight: 1 +- 0
ppp weight: 0.958876 +- 0.016218
Chisquare/ndof 44.26 / 68
Chi2 Prob. 0.988631

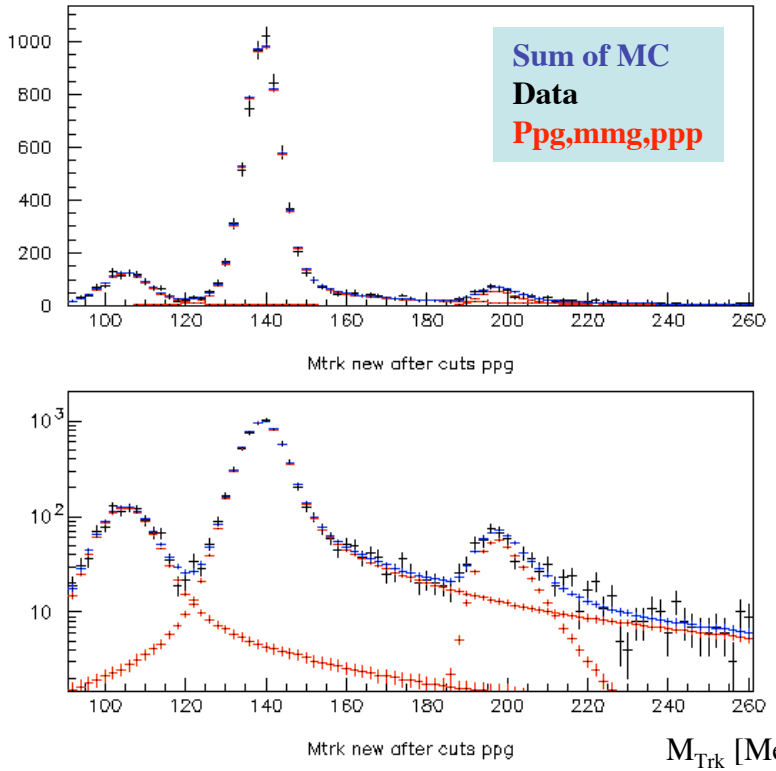
Valeriani/Bini-Tuning



Content of Histo for data: 10754
ppg weight: 1.02508 +- 0.014186
mmg weight: 1.00989 +- 0.048406
eeg weight: 1 +- 0
ppp weight: 0.962974 +- 0.016258
Chisquare/ndof 46.23 / 68
Chi2 Prob. 0.980074

$0.6 < Q^2 < 0.8\ GeV^2$:

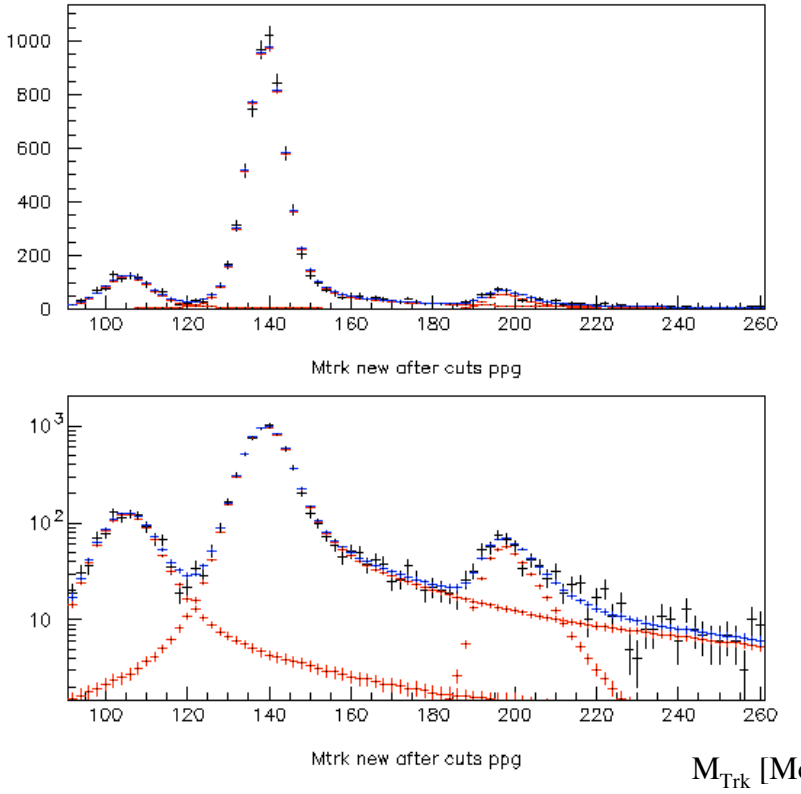
Beltrame-Tuning



M_{Trk} [MeV]

Content of Histo for data: 8580
ppg weight: 0.98761 +- 0.01249
mmg weight: 1.03095 +- 0.035398
eeg weight: 1 +- 0
ppp weight: 1.09396 +- 0.069042
Chisquare/ndof 40.73 / 81
Chi2 Prob. 0.999946

Valeriani/Bini-Tuning

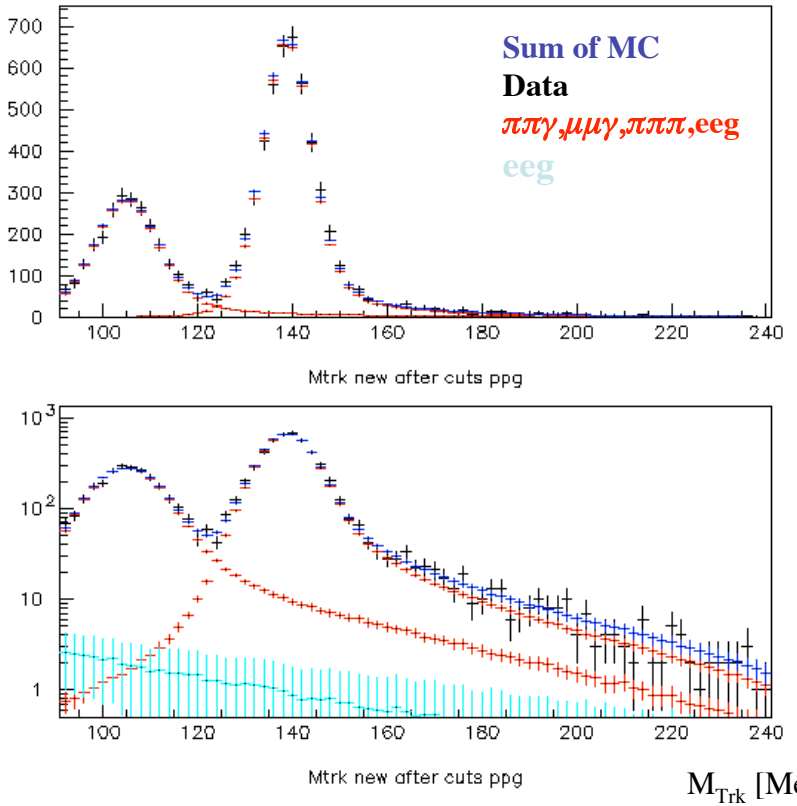


M_{Trk} [MeV]

Content of Histo for data: 8580
ppg weight: 0.986384 +- 0.012474
mmg weight: 1.02727 +- 0.03536
eeg weight: 1 +- 0
ppp weight: 1.09768 +- 0.06923
Chisquare/ndof 46.54 / 81
Chi2 Prob. 0.999249

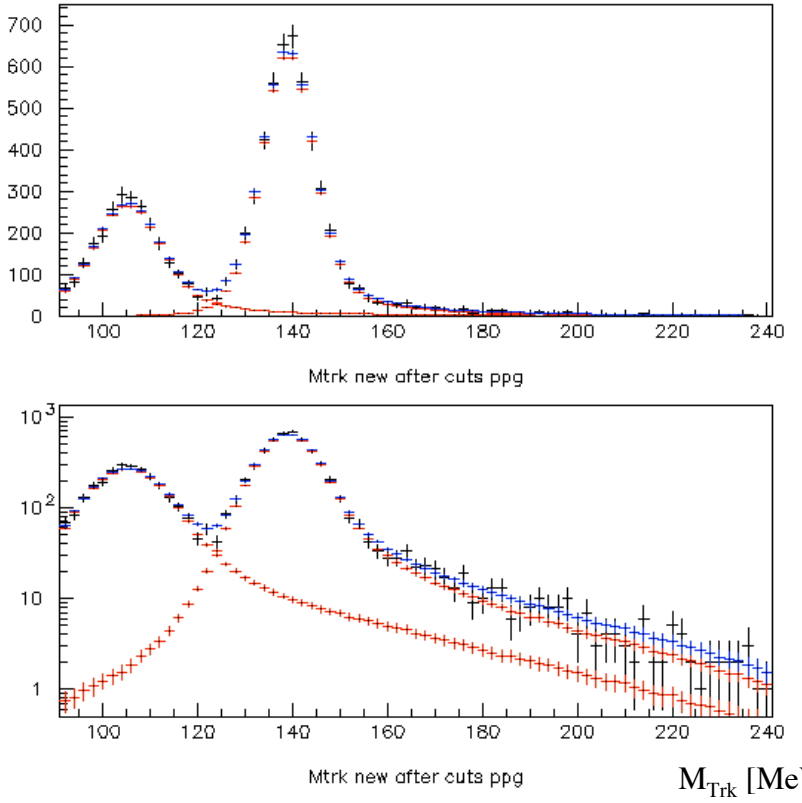
$0.8 < Q^2 < 1.0\ GeV^2$:

Beltrame-Tuning



Content of Histo for data: 7801
ppg weight: 0.975404 +- 0.014618
mmg weight: 0.993146 +- 0.02084
eeg weight: 1 +- 0
Chisquare/ndof 11.43 / 72
Chi2 Prob. 1

Valeriani/Bini-Tuning



Content of Histo for data: 7801
ppg weight: 0.981386 +- 0.014702
mmg weight: 0.997032 +- 0.020974
eeg weight: 1 +- 0
Chisquare/ndof 18.81 / 72
Chi2 Prob. 1

3. Prel. Results on Vertex efficiency (sma):

- The vtx efficiency is defined as:

$$\frac{\#\text{ of events with a good vtx}}{\#\text{ evts with (at least) a good couple of trks}}$$

- "Good" couple of tracks:

  3 levels (in cascade):

  - L0 = **both** tracks of opposite charge must satisfy acceptance cuts (TRKH)
  - L1 = L0 *and* (Like$_1$ or Like$_2$)
  - L2 = L1 *and* mtrk

- "Good" vtx:

  - a vtx with 2 trks of opposite q with ρ_{VTX}<8cm and |Z_{VTX}|<15 cm with the same dfts of the couple (a' la Paolo B.)

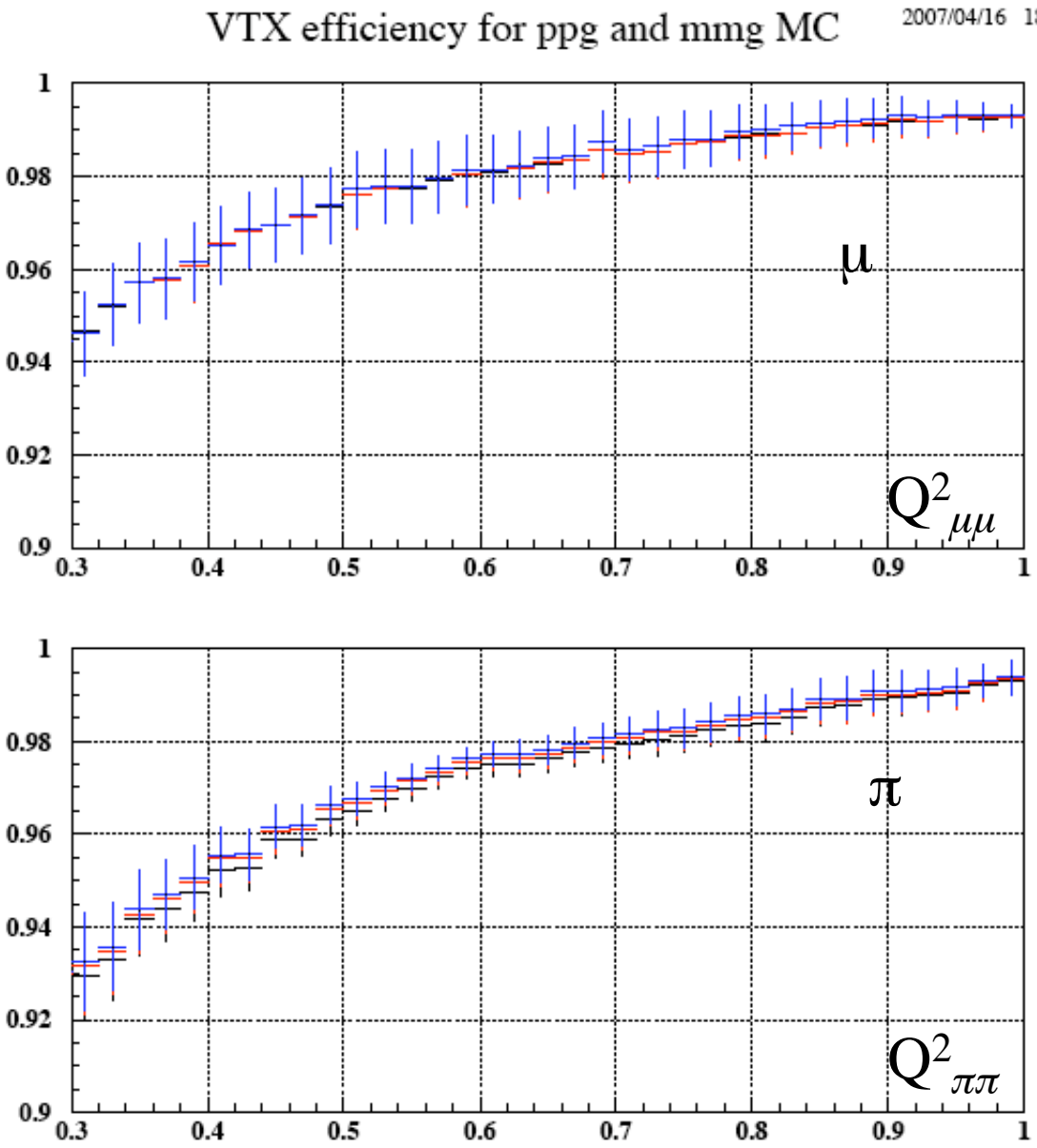
- TRKH = $\rho_{F.H.} < 50cm; \rho_{PCA} < 8cm; |z_{PCA}| < 7cm;$
  $40 < \vartheta_{\pi/\mu} < 140; \vartheta_{\Sigma} < 25 (\vartheta_{\Sigma} > 155)$

- LIKE$_i$ = Logrl>0 *and* ΔE<18 MeV (energy loss in DC) *and mlp* (-1<mlp<0.2 for π; 0.7<mlp<2 for μ)

- mtrk = 80MeV<m_{TRK}<120 for μ; 115MeV<m_{TRK}<300 for π

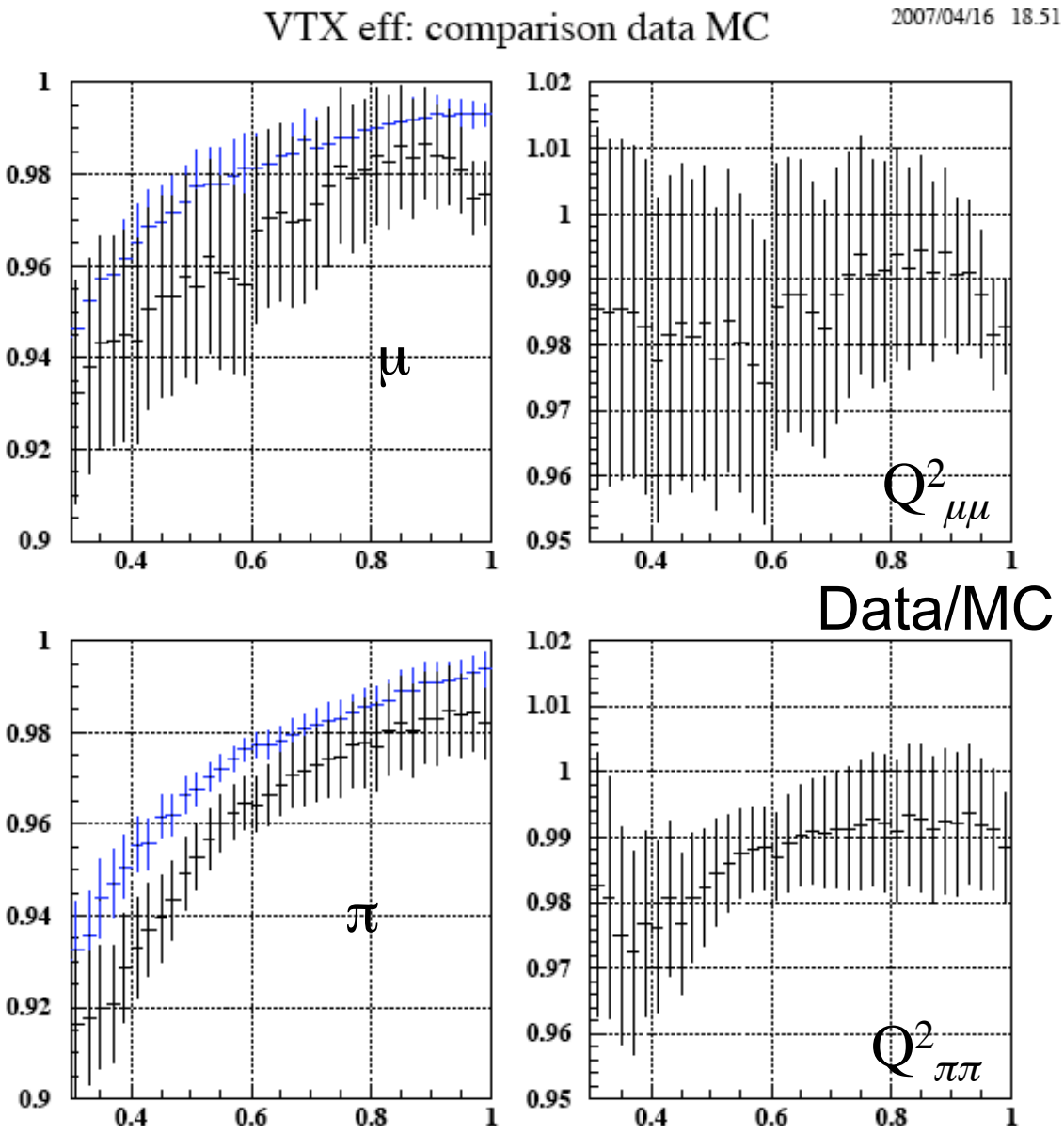
I require trg,filfo and new ppgtag (tracks)

Monte Carlo



Overimposed are the 3 lines corresponding to L0,L1,L2. No BIAS.

Choosing L2 selection

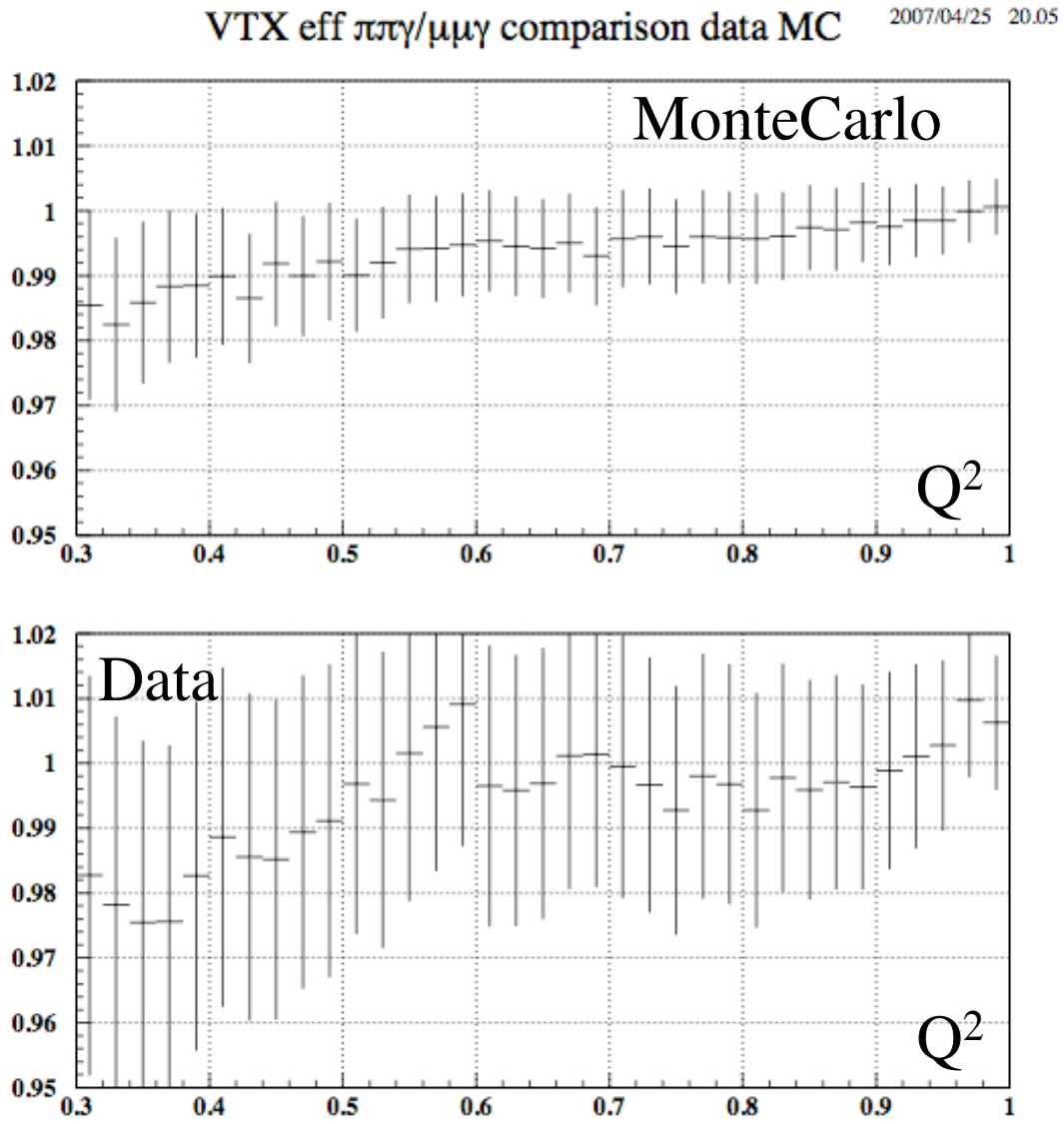


BLUE: MC

BLACK: data

Difference at 1%-2% to be investigated

Use ratio between pion and muon vertex eff. to correct in the determination of $|F_\pi^2|$ via the ratio of pion/muon events?



Conclusions:

- Paolo has improved the tuning of MC distributions done by Bini/Valeriani
- The new tuning of MC distributions improves the comparison data-MC, as can be seen from the fit to UFO-events
- An independent evaluation of the vertex efficiency for pions and muons has been performed

Work in progress/Future plans:

- Further develop the MC tuning, special treatment for muons, individual corr. for p_x,p_y,p_z
- Perform background fit with new tuning, see if weight-parameters for MC change
- Trackmass/Missing Mass eff. from MC with new tuning (UFO as cross check from data)
- **Calibration studies** using collinear events (both for 2002 and PoP data) and $\pi^+\pi^-\pi^0$-stream
- Acceptance studies