Status of Large Angle analyses (2002-2006)

P. Beltrame

- f_0 MC model checks

  (D. Leone)

- Status of $\pi\pi\gamma$ Cross Section with Off Peak data
- Status of Pion Form Factor measurement at 1GeV

  (with E. Solodov and P. Lukin collaboration)

Checks on f_0 MC models. Situation at LP07

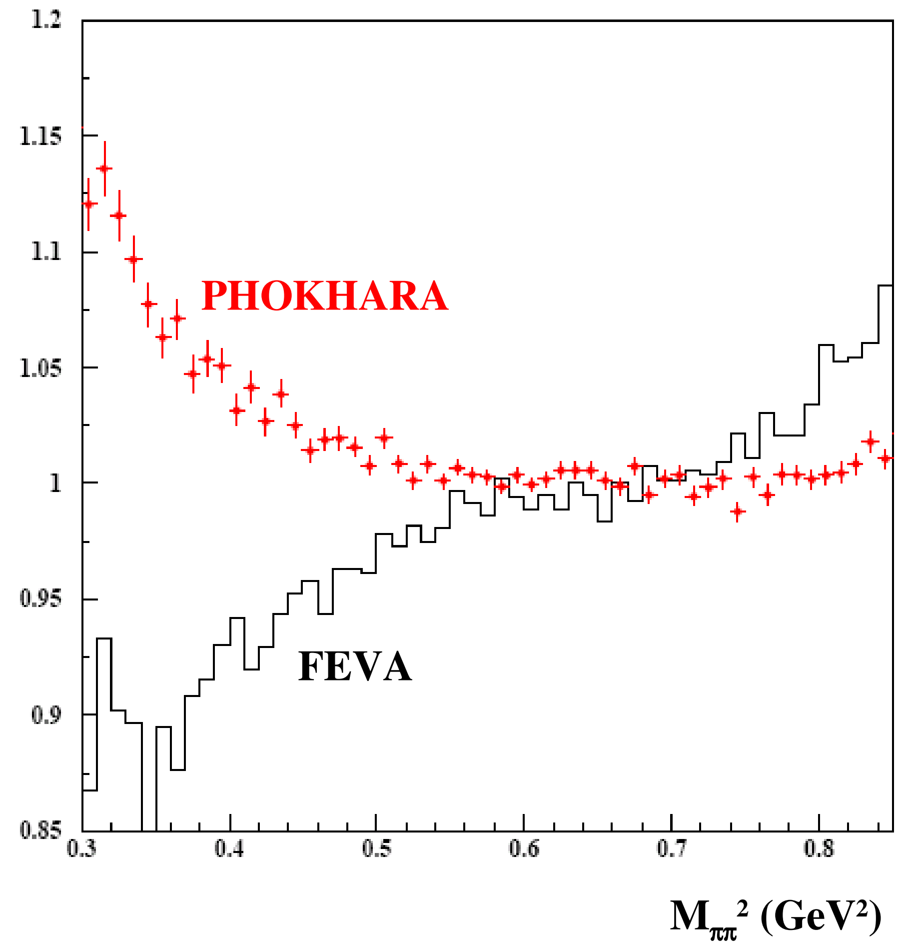
Scalar meson contribution

PHOKHARA

- very old Achasov's model (~5 years)
- no scalar and no VMD
- only $f_0(980)$ amplitude

FEVA

- Achasov's model (... with bug)
- contains σ, f_0, VMD
- parameters from Miscetti-Giovannella fit of $\phi \to f_0\gamma \to \pi^0\pi^0\gamma$ (according to the bugged Achasov's model)



Choice for the $M_{\pi\pi}$ spectrum:

- not correct for scalar meson contribution

- systematic error: discrepancy from not corrected spectrum and the corrected ones according to the two models

Checks on f_0 MC models. FEVA “cured”

parametrization of scalars ← Achasov

parameters from $\pi^0\pi^0\gamma$ fit ← Miscetti-Giovannella

Old = parametrization of scalars **bugged**

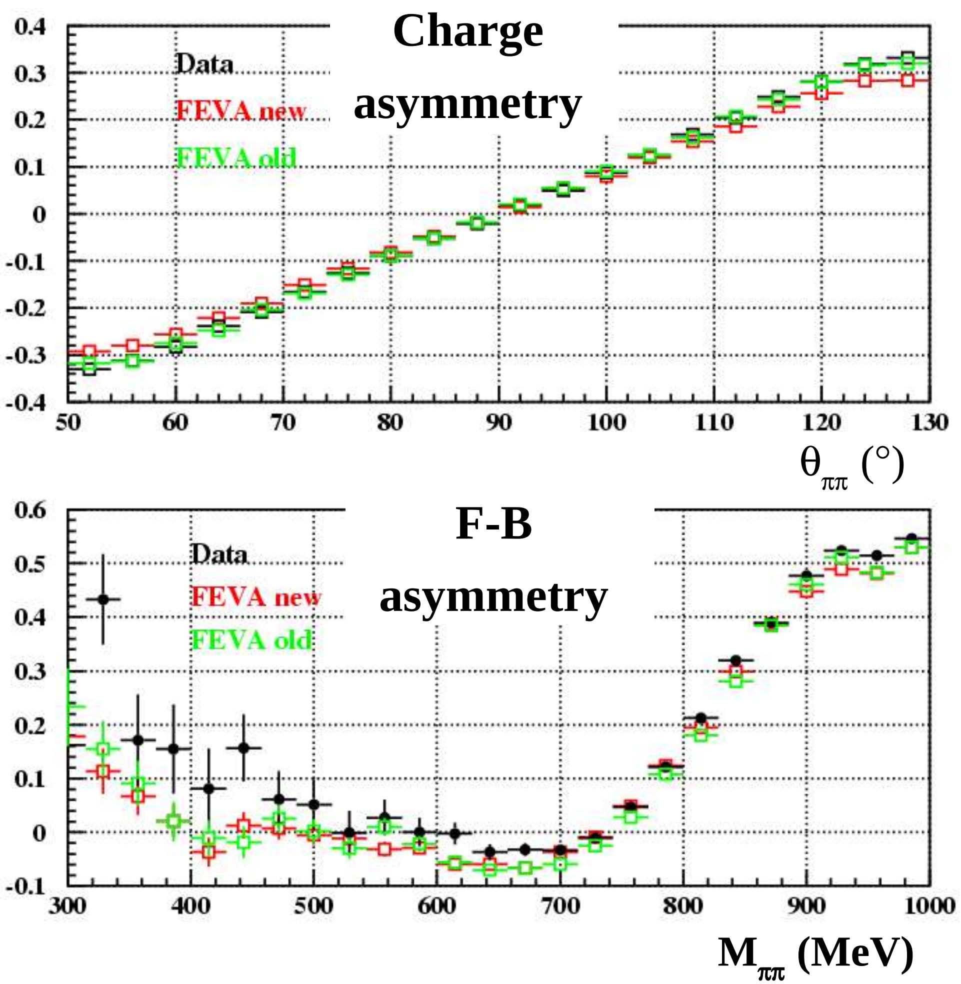
+ parameters from $\pi^0\pi^0\gamma$ fit

(with bugged model)

New = parametrization of scalars **cured**

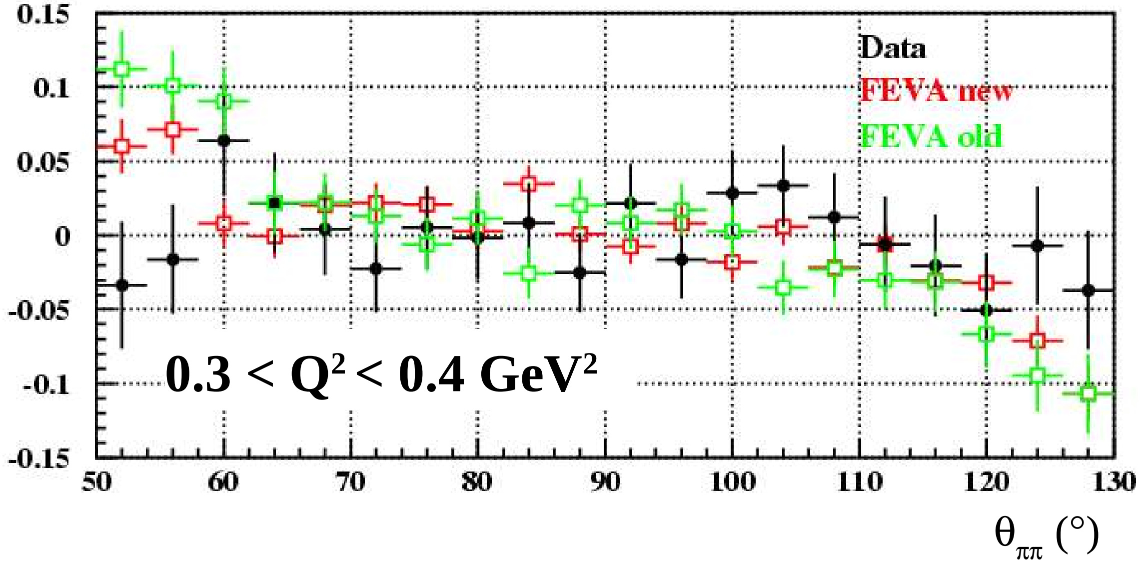
+ parameters from $\pi^0\pi^0\gamma$ fit

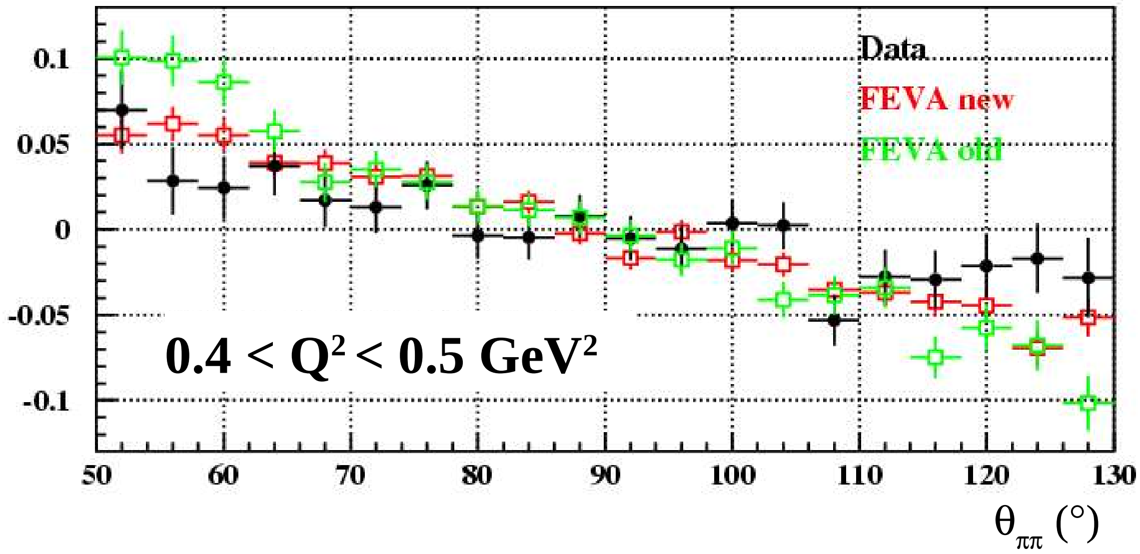
(with cured model)



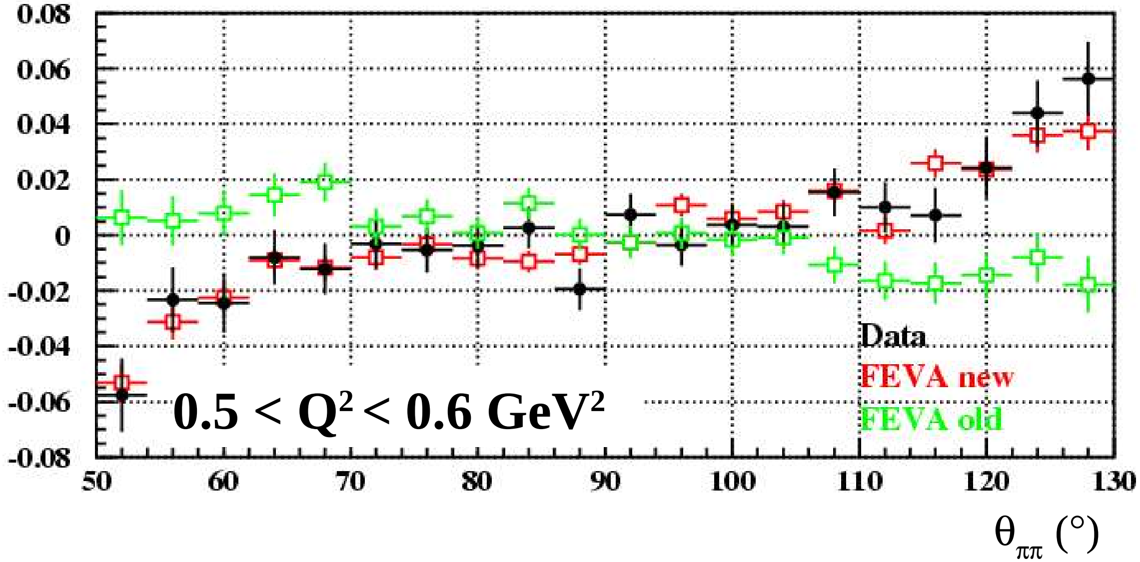
Checks on f_0 MC models. Charge Asymmetry

Check on Charge Asymmetry of cured FEVA (bins of Q^2)

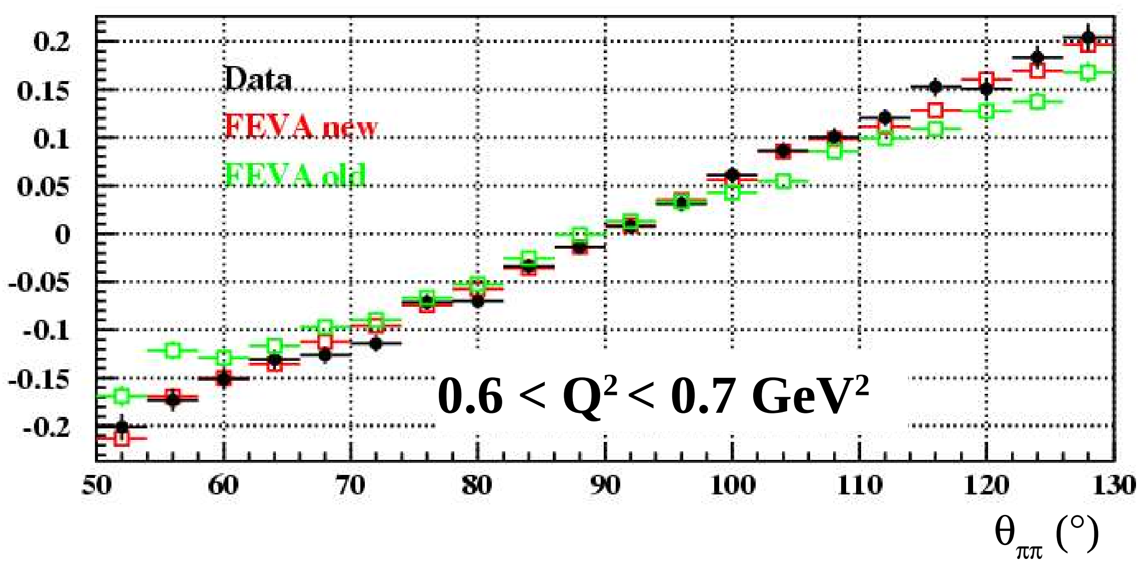




Check on Charge Asymmetry of cured FEVA (bins of Q^2)

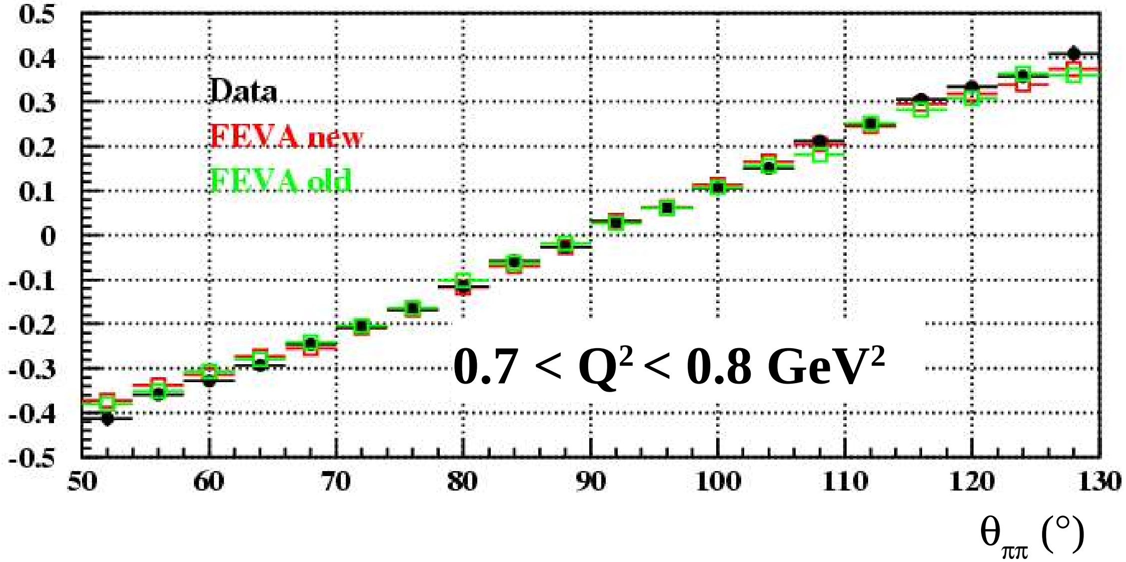


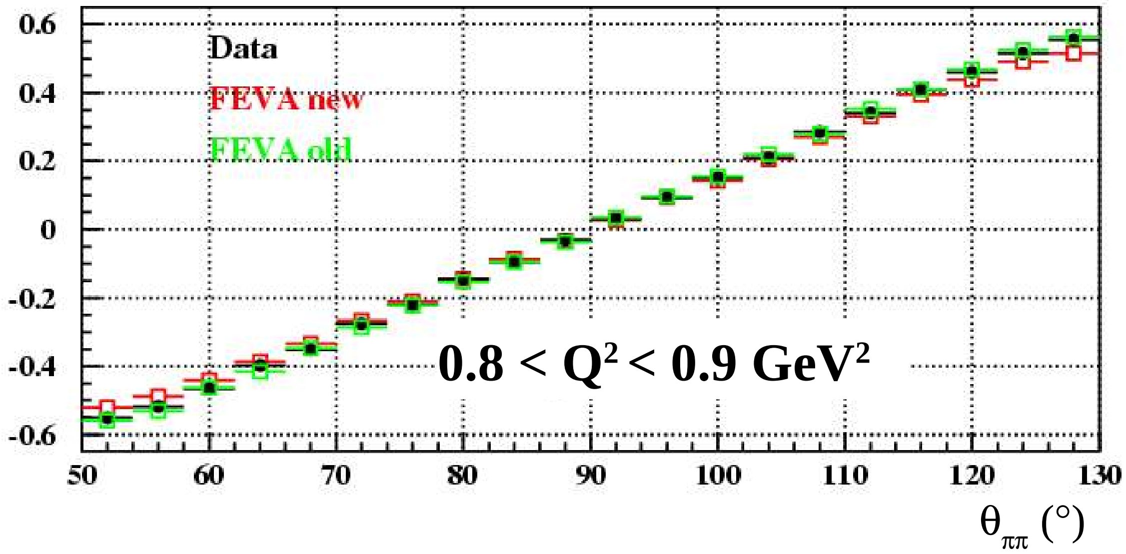
Cured FEVA better agrees with DATA



Checks on f_0 MC models. Charge Asymmetry

Check on Charge Asymmetry of cured FEVA (bins of Q^2)





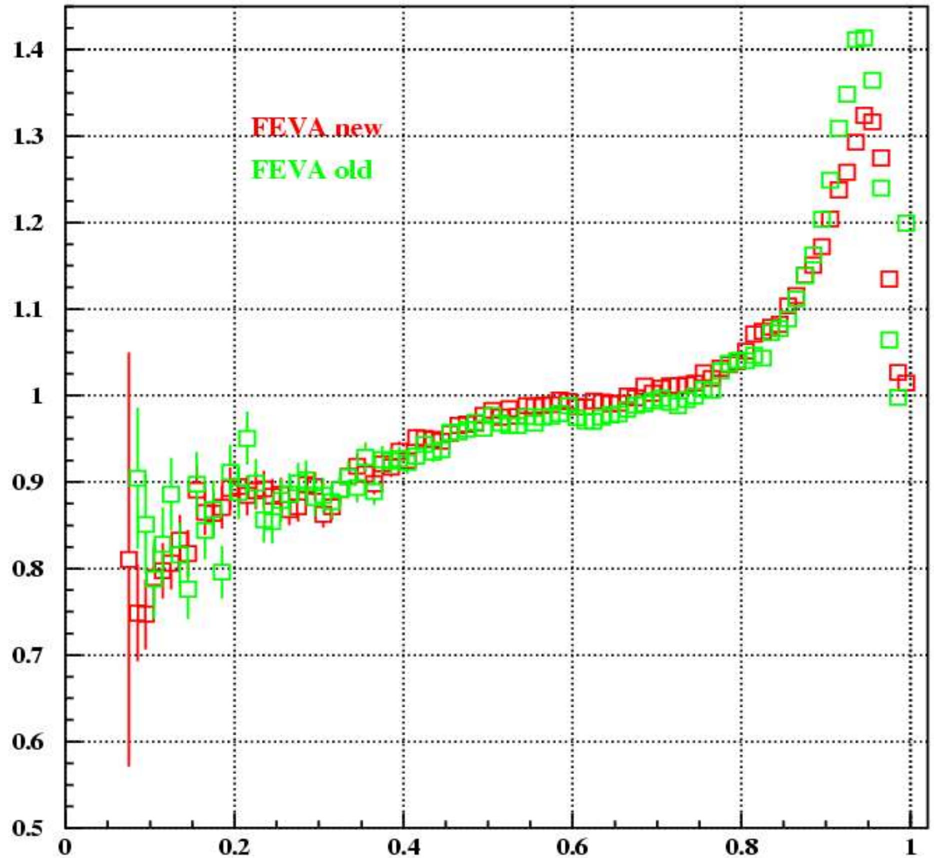
Checks on f_0 MC models. Scalars and VMD contribution

Scalar+VMD contribution

$\sigma(ISR+FSR+f_0+\sigma+VMD)/\sigma(ISR+FSR)$

Old FEVA = parametrization of scalars bugged + parameters from $\pi^0\pi^0\gamma$ fit (with bugged model)

New FEVA = parametrization of scalars cured + parameters from $\pi^0\pi^0\gamma$ fit (with cured model)



$M_{\pi\pi}^2$ (GeV^2)

difference between NEW and OLD at high $M_{\pi\pi}2$

Checks on f_0 MC models. Conclusions

- **Scalars and VM contribution is the only missing part to conclude LA2002**
- Using the "bug-free" Achasov model in FEVA the DATA-MC agreement in the **charge asymmetry** improves
- The f_0(980) contribution with the new Achasov model is unchanged in the **mass spectrum** at low Q^2 and changes at high Q^2
- Huge FEVA-PHOKHARA disagreement mass spectrum remains:
FEVA predicts a **DECREASE**, PHOKHARA an **INCREASE**... they are different things
- FEVA **without the VMD and σ** in much better agreement with PHOKHARA: the difference between the two generators is due to the VMD and σ contributions
- Proposal: FEVA is the better generator and should be used to subtract the scalar contributions

→ **Systematic error** for FEVA:

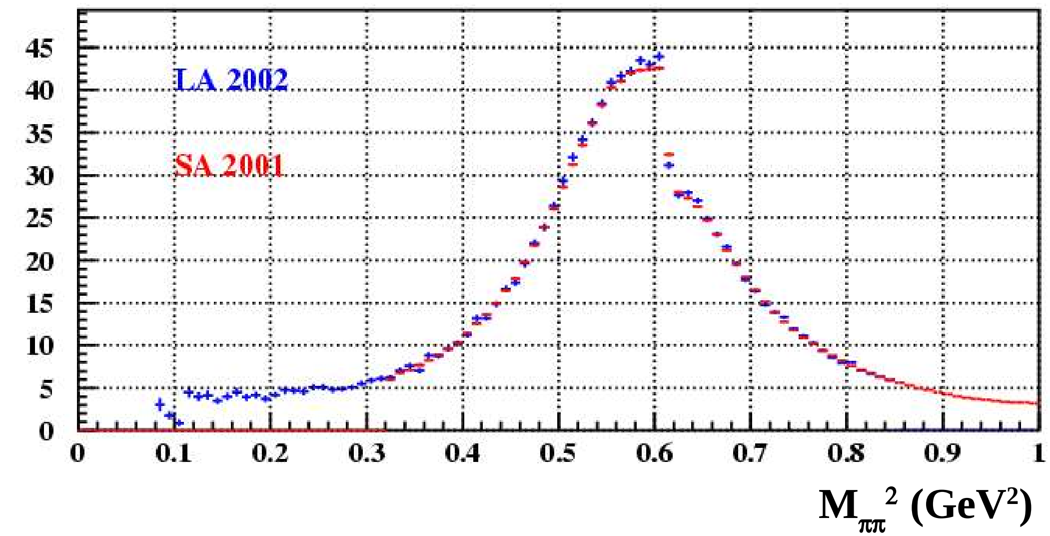
- changing parameters to find the best DATA-MC agreement in $M_{\pi\pi}$ in Charge Asymmetry
- moving around the best set of parameters look at $M_{\pi\pi}$ variation

Checks on f_0 MC models. Effect on Spectrum of cured FEVA

Comparison between

LA 2002 and SA 2001 updated

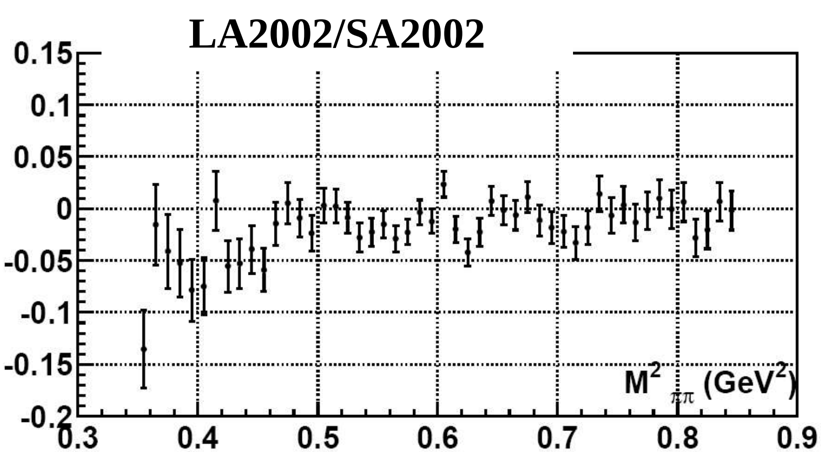
- **FEVA new** used to subtract scalar contribution from LA spectrum
- only statistical errors are reported

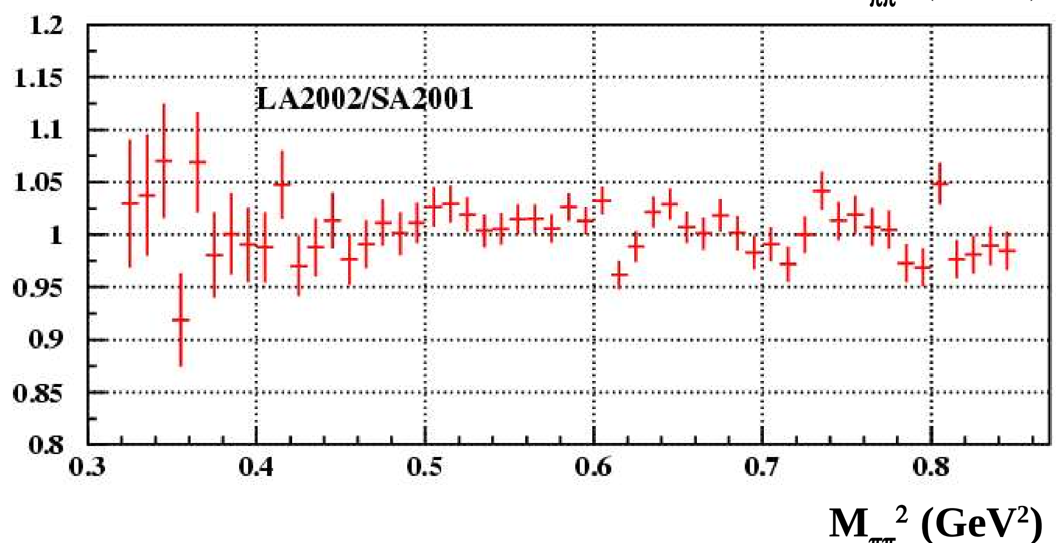


Previously:

LA 2002 with

FEVA old and PHOKHARA

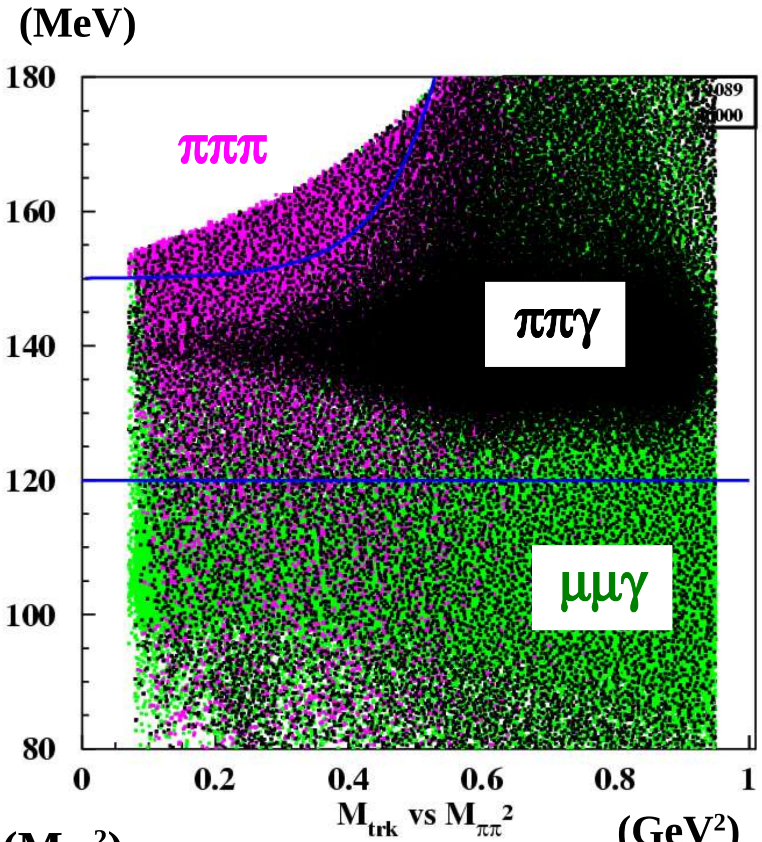




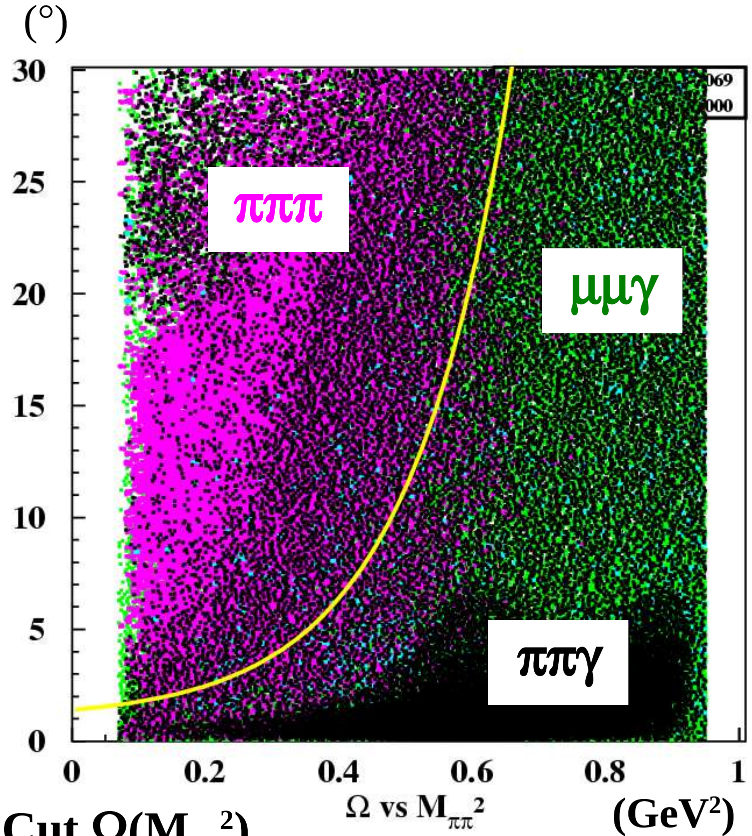
Good stability around one in the ratio

"Large Angle – like" analysis cut set: θ_γ **at large polar angle, Trackmass, Ω (angle between missing momentum and photon momentum),** `.or.` **of Likelihood**

Different *Upper* and *Lower* cuts (in M_{trk} and in Ω) have been tried: optimize Efficiency & Purity



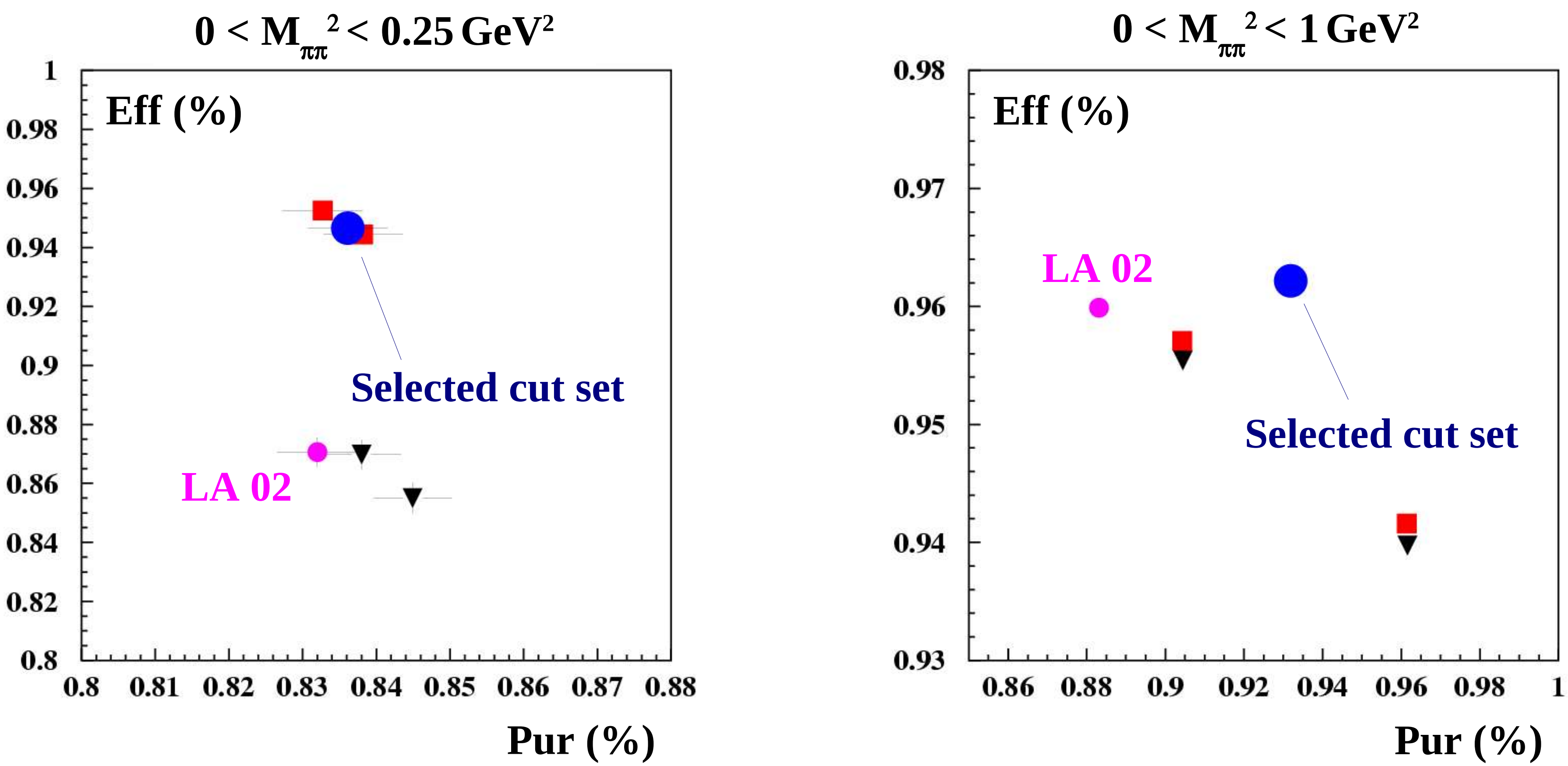
Cut Mtrk($M_{\pi\pi}^2$)
constant and exponential functions



Cut Ω($M_{\pi\pi}^2$)
exponential function

$\pi\pi\gamma$ Off Peak analysis. Analysis cuts: Efficiency and Purity

- MC samples, normalized to DATA luminosity (~ 230 pb^{-1})
- before the background fitting procedure
- M_{trk} and Ω cuts efficiency



■ ***Loose* Ω and varying Trackmass**

▼ ***Tight* Ω and varying Trackmass**

ππγ Off Peak analysis. Background rejection

Fitting procedure like in SA 2002 and LA analyses (see some S. Müeller presentation)

but... with **two approaches**

.OR.

- DATA and MCs (ππγ, μμγ, eeγ, πππ)
- **.or. of the Likelihood**
- fit DATA and MCs M_{trk} spectra

  → μμγ, eeγ, πππ amount

.XOR.

1st STEP

- DATA and MCs (ππγ, μμγ, πππ)
- **.xor. of the Likelihood**
- eeγ from DATA with .nor. of the Likelihood
- fit DATA and MCs M_{trk} spectra

  → eeγ amount

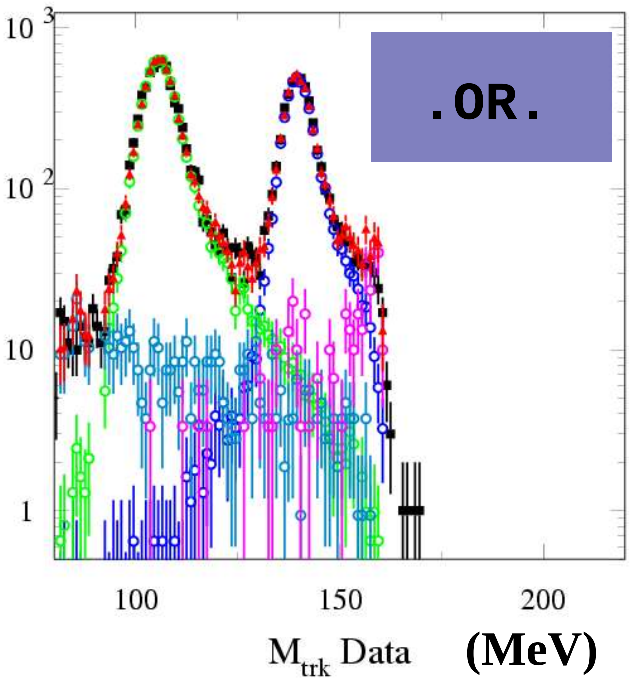
- subtract eeγ from **DATA in .or.** of the Likelihood

2nd STEP

- DATA (eeγ free) and MCs (ππγ, μμγ, πππ)
- **.or. of the Likelihood**
- fit DATA and MCs M_{trk} spectra

  → μμγ, πππ amount

$\pi\pi\gamma$ Off Peak analysis. Background rejection



DATA

$\pi\pi\gamma$

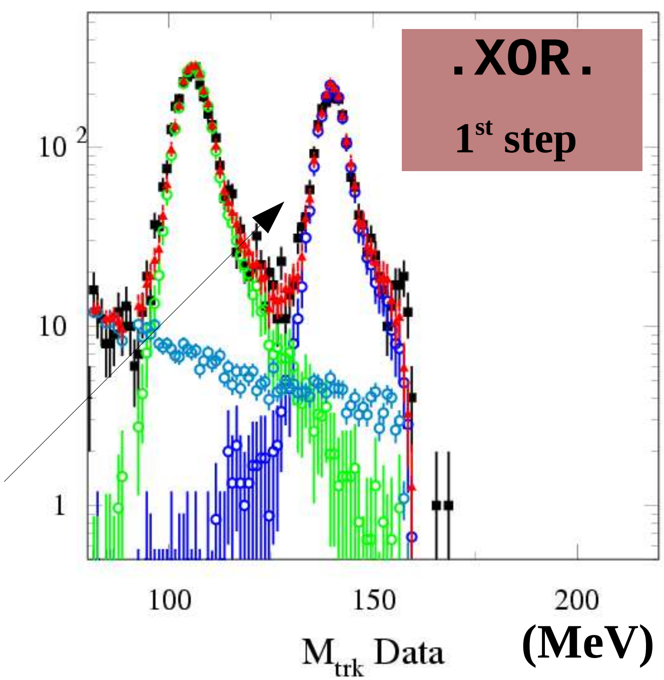
$\mu\mu\gamma$

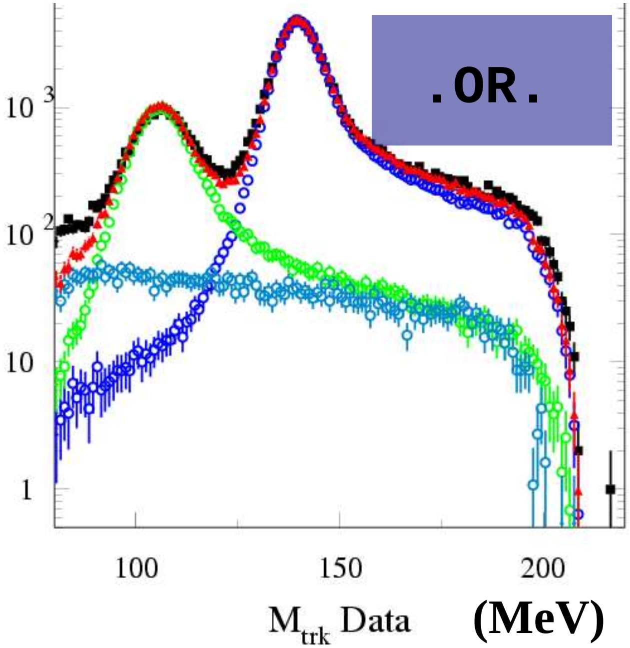
$ee\gamma$

$\pi\pi\pi$

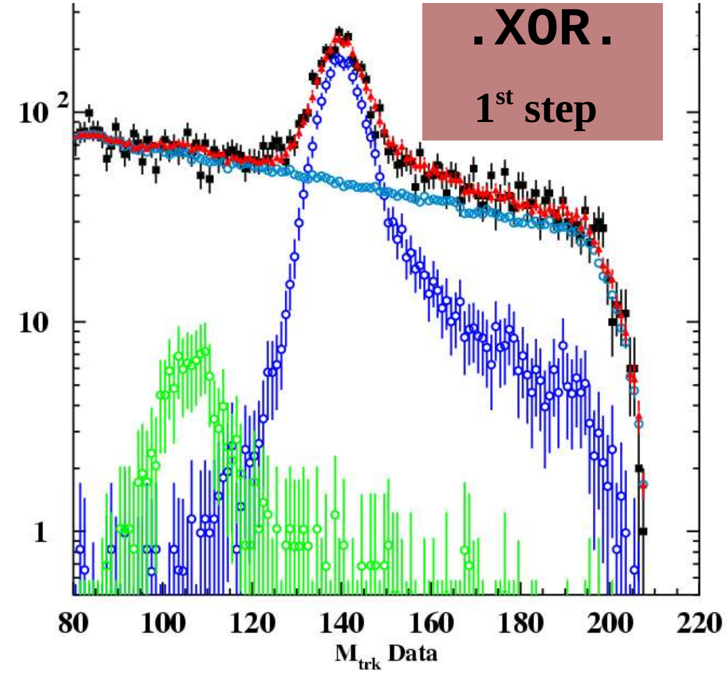
$0.25 < Q^2 < 0.3$ GeV^2

Likelihood efficiency to be checked at low $M_{\pi\pi}^2$

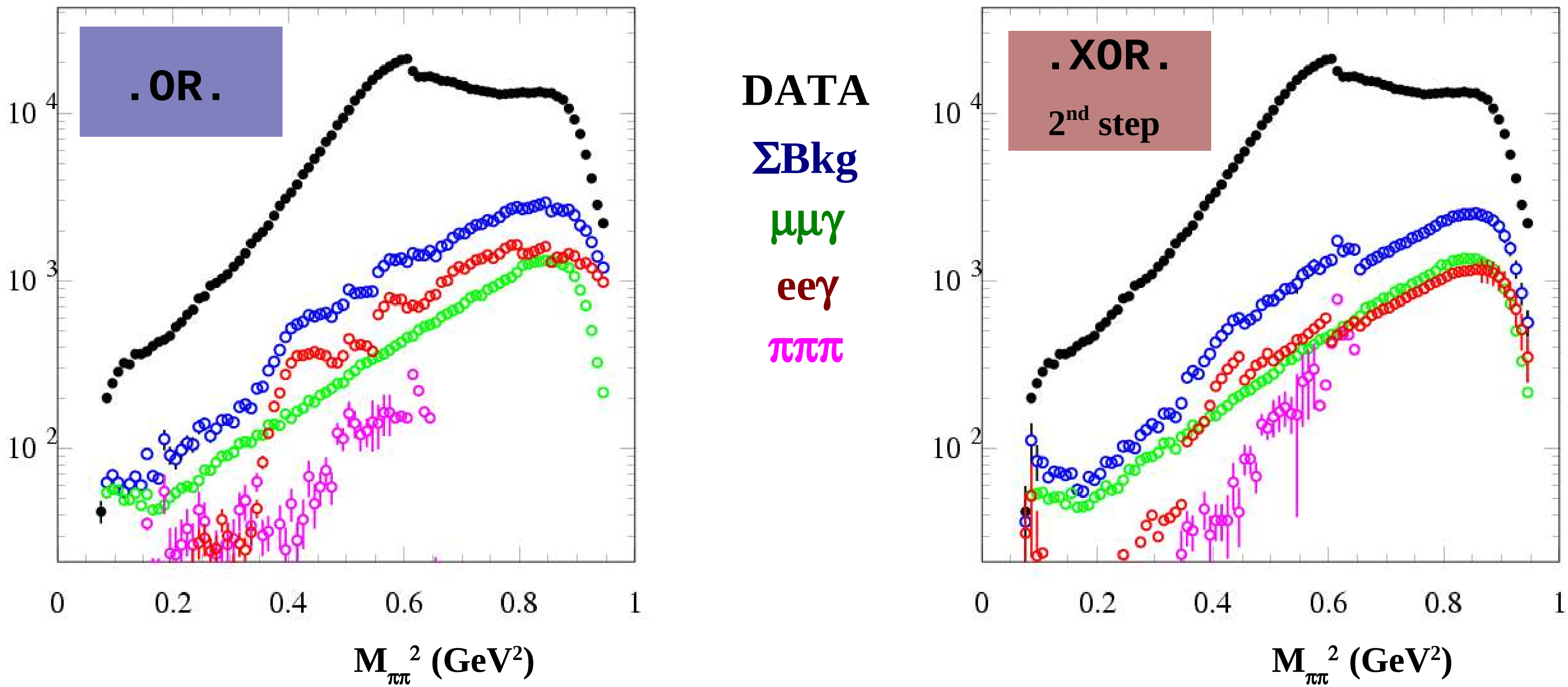




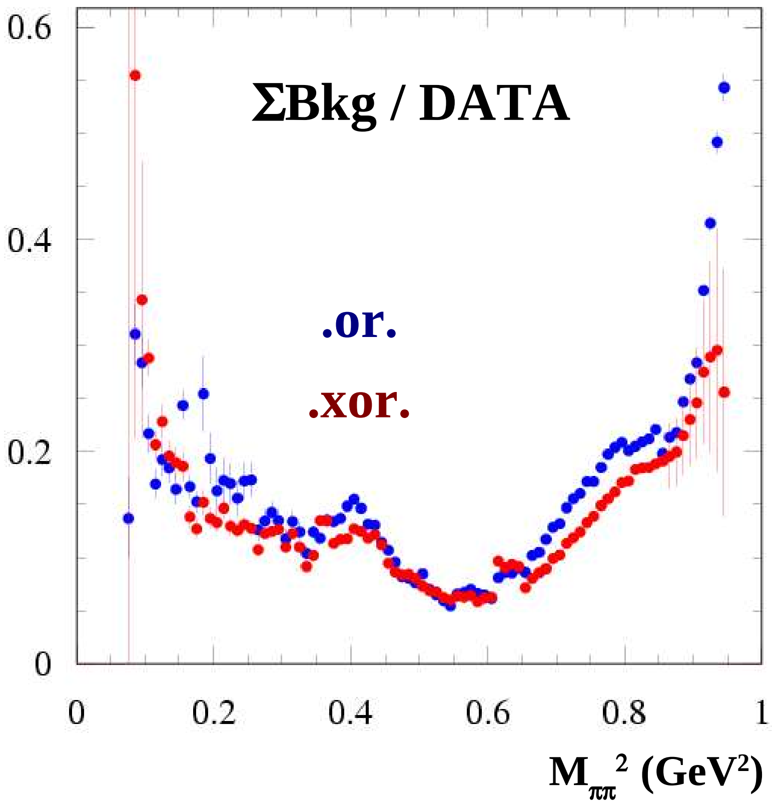
$0.65 < Q^2 < 0.7$ GeV^2



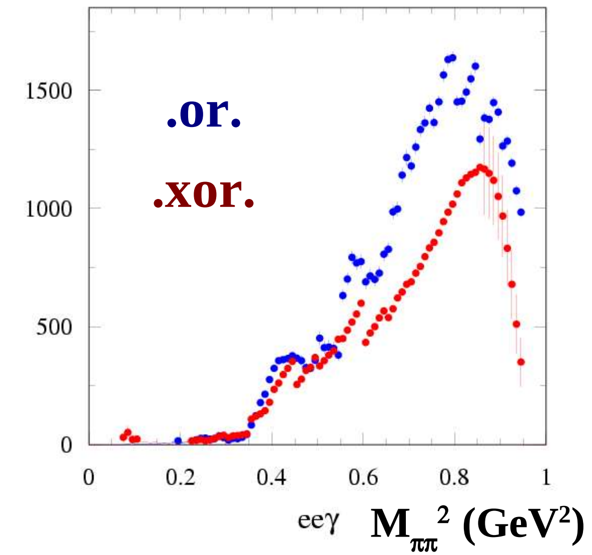
ππγ Off Peak analysis. Background rejection: outcomes

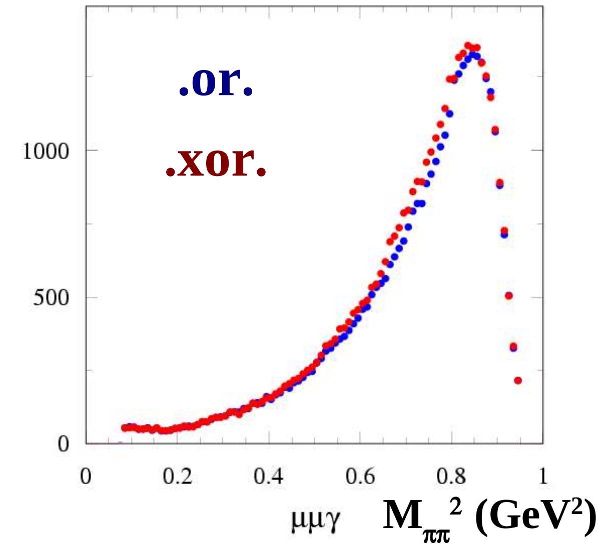


Final outcome of the two approaches...



differences from the two approaches due to the different estimated amount of eeγ



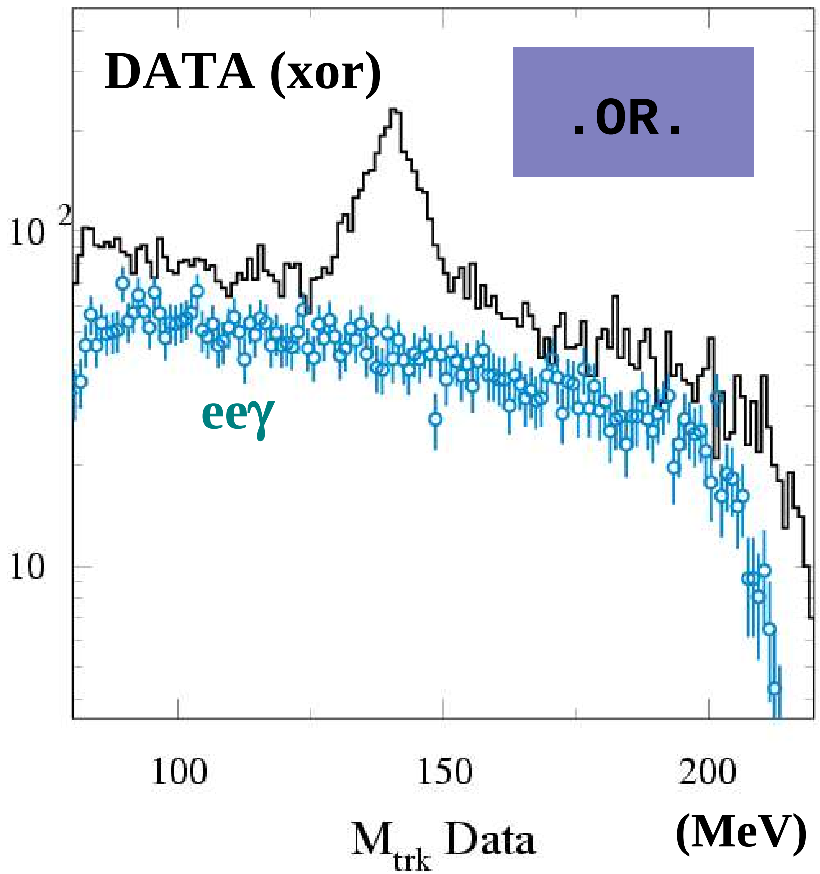


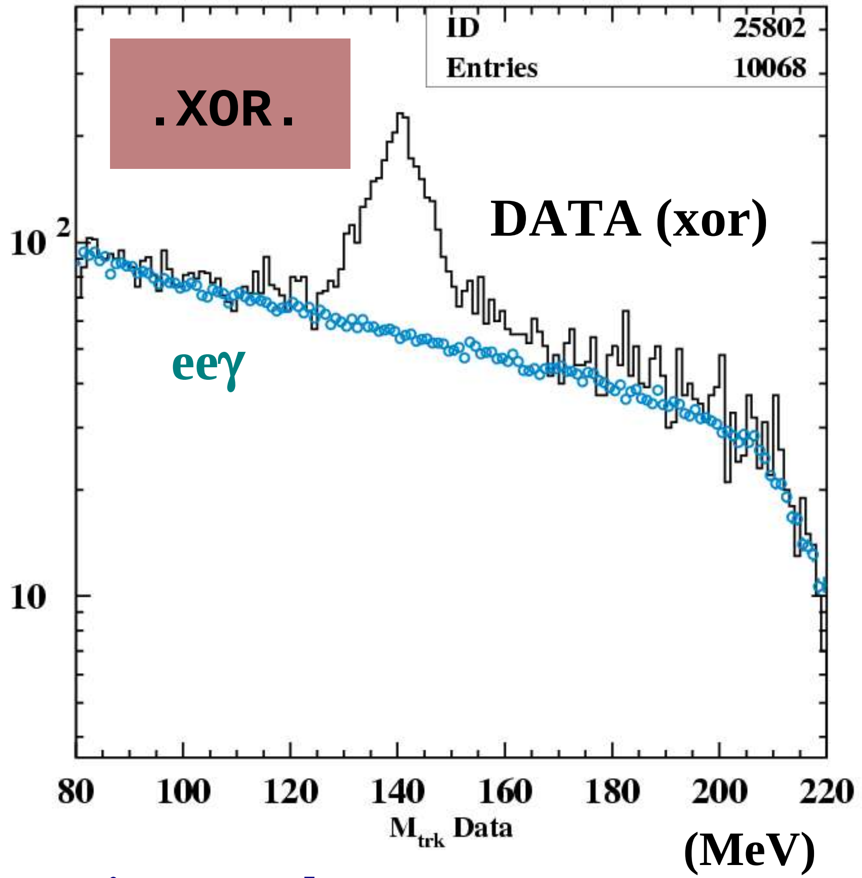
$\pi\pi\gamma$ Off Peak analysis. Background rejection: `.or.` &/or `.xor.`

Check the goodness of eeγ estimation after the two fit approaches

comparison between **eeγ at the final** step of the fit procedure and **DATA with `.xor.`** in slices of Q^2

$0.7 < Q^2 < 0.75$ GeV^2





Fitting with the `.xor.` gives much more sensitivity concerning the eeγ background source than the procedure using the `.or.`

$\pi\pi\gamma$ Off Peak analysis. Conclusion

- Main background sources: $\mu\mu\gamma$ and $ee\gamma$ (using the `.or.` of the Likelihood). Background from $\pi\pi\pi$ is not an issue

- Analysis cuts studied and fixed

- Background fit methods studied in a detailed way. “Very detailed” procedure to be finalized

- Likelihood efficiency at low Q^2 to be better understood

- Vetrex and trigger (hopeful easy) using 2002 tools

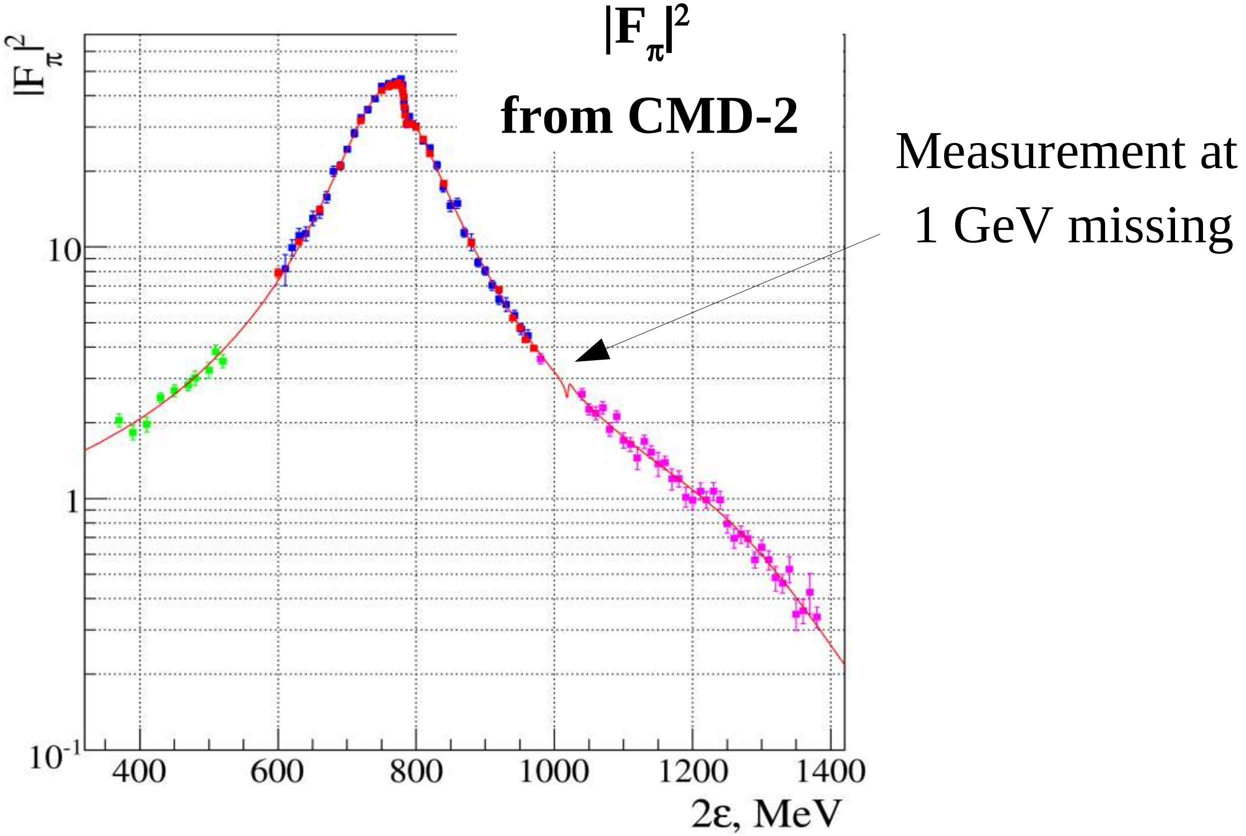
- Tracking efficiency:the main efficiency to be evaluated

F_π @ 1GeV. Motivations

- **Input in MC prediction for Charge Asymmetry study**
- **"Lever arm" for $F_\pi(s)$**
- **Actually there are no measurement**

→ Measurement with precision at ~3% would already be very useful

→ PoP physics



F_π @ 1GeV. Analysis steps

$$\sigma_{\pi\pi} = \frac{N_{\pi\pi}}{\int L\,\mathrm{dt}\cdot\epsilon_{\mathrm{cut}}\cdot\epsilon_{\mathrm{rad}}}$$

$N_{\pi\pi}$ and **ε_{cut}**

- Select collinear events: cuts on $|\Delta\phi|$, $|\Delta\theta|$, $|\Delta p|$
- Event ($\pi\pi$, $\mu\mu$) counting: DATA – MC comparison in $|p_{ave}|$ spectrum
- $\mu\mu$ subtraction: using MC
- effective efficiency cut from MC: acceptance + efficiency = ~70%
- `.or.` of the Likelihood

L

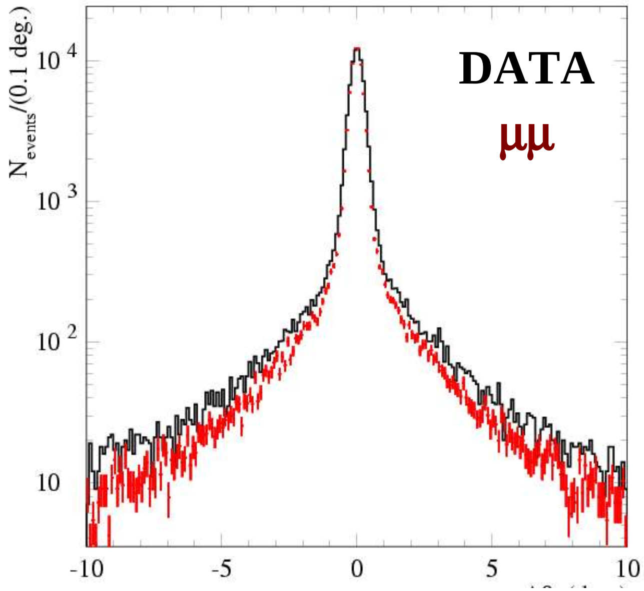
- Samples:
    - DATA: 2006 `stentu` with information from `DTFS` bank (8.4 pb^{-1})
    - $\pi\pi$ @ 1GeV: A. Sibidanov generator – A. Denig connection – `GEANFI` ($50\cdot10^3$ events)
    - $\mu\mu$ MC @ 1GeV: `Babayaga` ($200\cdot10^3$ events)

ε_{rad}

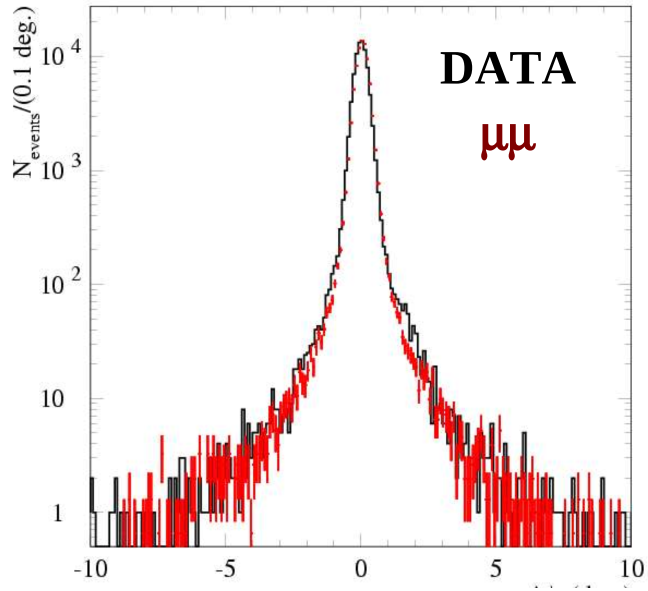
- Sibidanov generator stand alone

σ_{tot}(all cuts) / σ_{Born} = ~ 85%

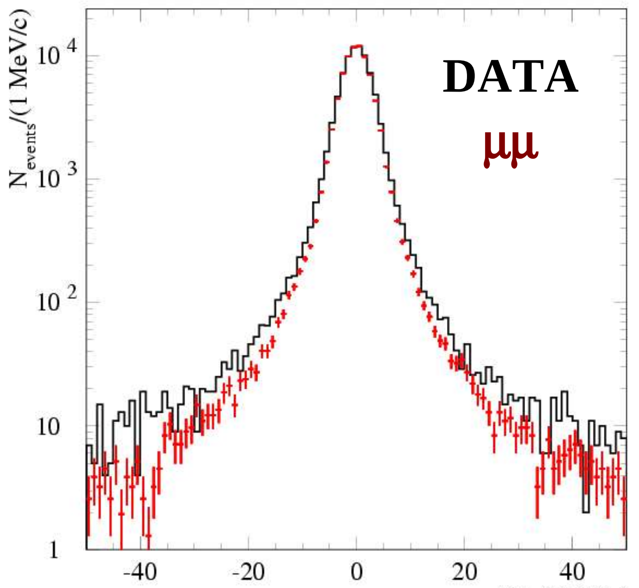
F_π @ 1GeV: Collinear Selection cuts



Δθ (°)



Δϕ (°)



Δp (MeV)

Acceptance region:

$50° < (\theta_1 + (180° - \theta_2)) /2 < 130°$

$\Delta\phi = \pi - | \phi^+ - \phi^- | < 2°$

$\Delta\theta = \pi - | \theta^+ + \theta^- | < 2°$

(to bee loosen ~3% inefficiency)

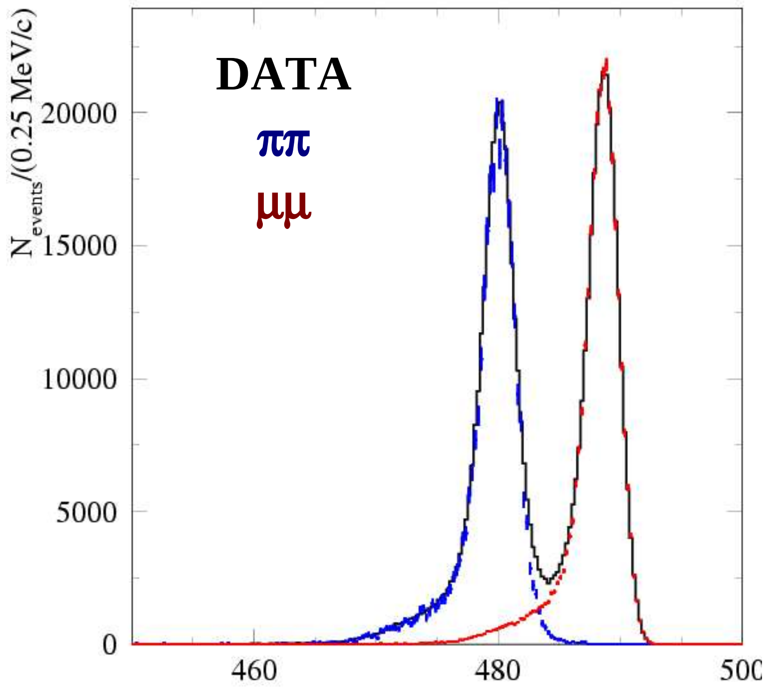
$\Delta p = |p_1| - |p_2| < 20$ MeV

F_π @ 1GeV: $|p_{ave}|$ spectra

For (ππ, μμ) event counting counting $|p_{ave}|$ spectra used

Cuts on acceptance and collinearity,

$|p_{ave}| = (|p_1| + |p_2|)/2$



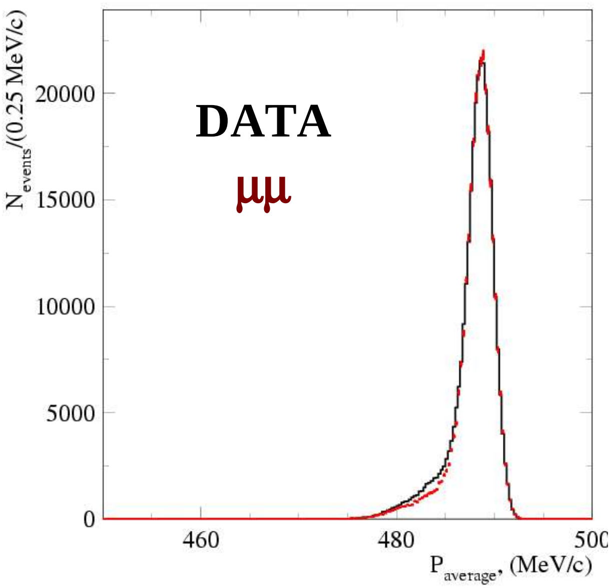
$|p_{ave}|$ (MeV)

Trackmass cut

M_{trk} < 115 MeV for μμ

μμ and DATA normalized to number of events

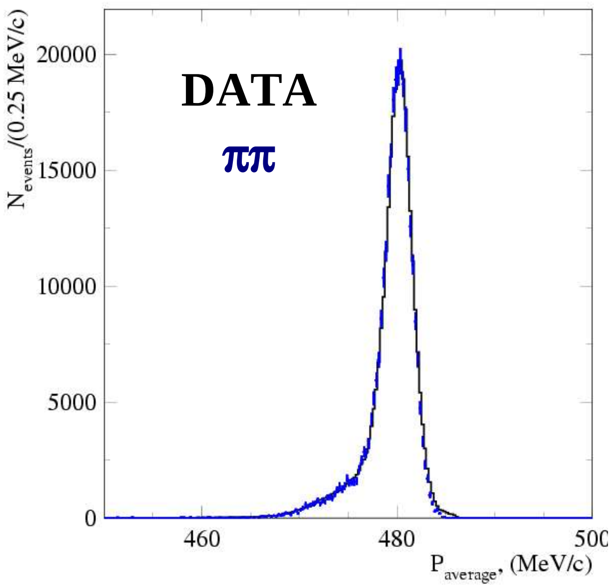
MC bigger of 2.9%



Trackmass cut

M_{trk} > 115 MeV for ππ

ππ and DATA normalized to number events



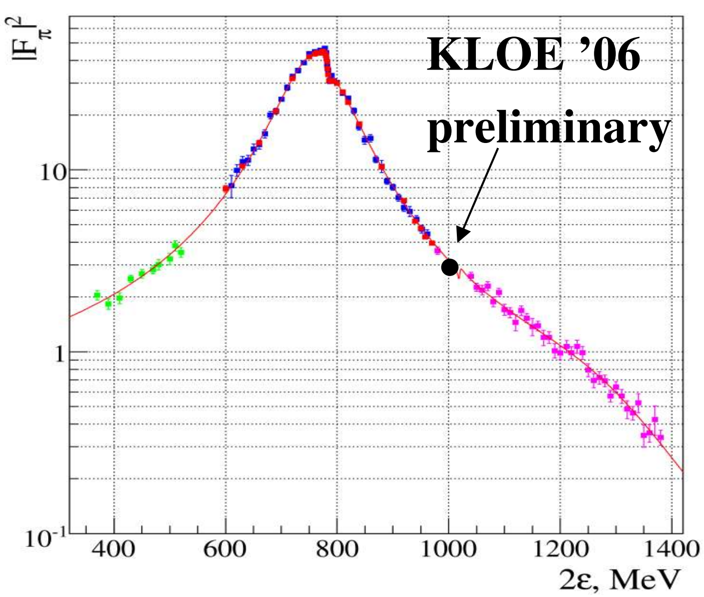
F_π@ 1GeV: preliminary results and conclusions

Extracted number of and events: $N_{\pi\pi} = 314.744$, $N_{\mu\mu} = 311.436$

- Muon yield is 2.9% lower as expectation from MC (BaBayaga vs. 2)
  - → Reason for this deviation unknown
  - (Data-MC difference efficiency? theoretical cross section wrong?)
  - → **take 3% as systematic error for actual precision**
- **KLOE Result $|F_\pi(s = 1.0\ GeV^2)|^2 = 3.23 \pm 0.01_{stat} \pm 0.10_{syst}$**
  - (within 1.2% agreement with CMD-2 fit = 3.19)

Outlook:

- fine tuning of MC smearing for collinear events
- include more MC statistics (already done!)
- more systematics studies (cut variation!)
- obtain tracking and trigger efficiency from data using self-triggering single-track events
- compute R-ratio $N_{\pi\pi} / N_{\mu\mu}$



→ 1% error definitely feasible (and easy?)