KLOE General Meeting '07

10-11 December 2007, LNF

Status report on $\pi\pi\gamma$ Large Angle analyses

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On Peak Analysis

2002 DATA

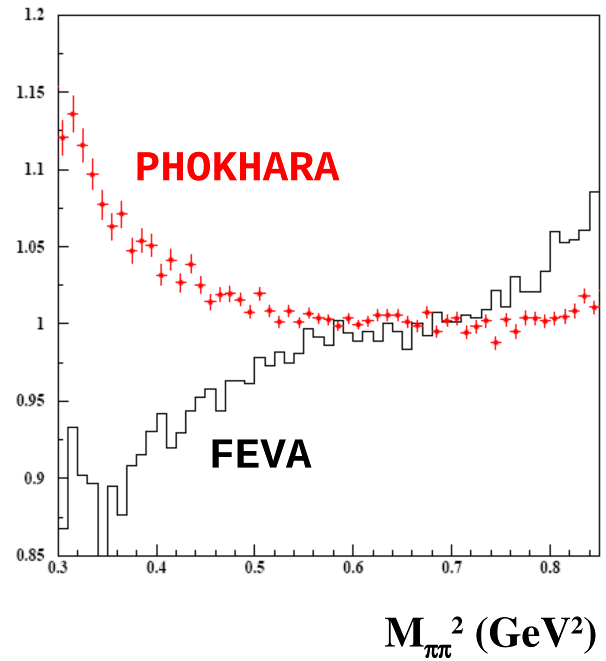
- Check on f_0 models in FEVA and PHOKHARA MC generators

Situation of FEVA and PHOKHARA (summer result)

PHOKHARA
- Kaon loop model
- no scalar and no Double Resonance contribution
- only $f_0(980)$ amplitude

FEVA
- New Achasov's model (... with wrong parameters)
- contains σ, f_0, Double Resonance contribution
- parameters from Miscetti-Giovannella fit of $\phi \to f_0\gamma \to \pi^0\pi^0\gamma$ (according to the “wrong parameters” Achasov's model)

Scalar meson contribution



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

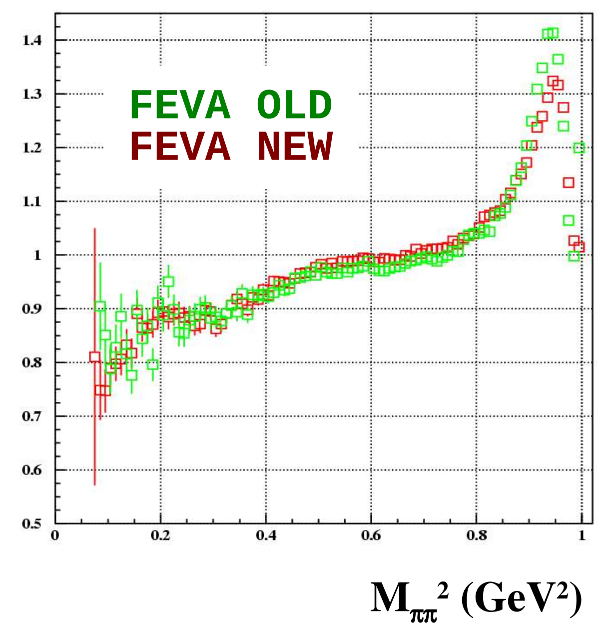
- central values: not corrected spectrum

- systematic error: difference from the MC models

Wrong parameter values in Achasov's model in FEVA cured

$\to$ cured parameters of model

$\to$ parametrs from $\phi \to f_0\gamma \to \pi^0\pi^0\gamma$ according to the fixed parameter values



Charge asymmetry in $M_{\pi\pi}^2$ slices (0.3-0.4 & 0.4-0.5 GeV^2)

FEVA

DATA

Old = wrong parameter values

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

New = cured parameter values

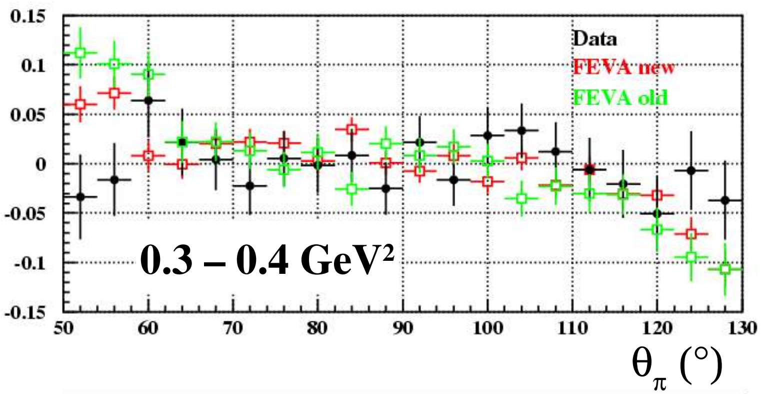
+ parameters from $\pi^0\pi^0\gamma$ fit

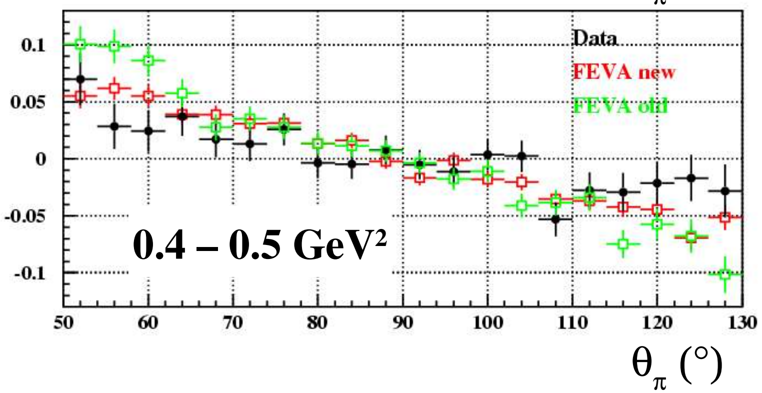
PHOKHARA

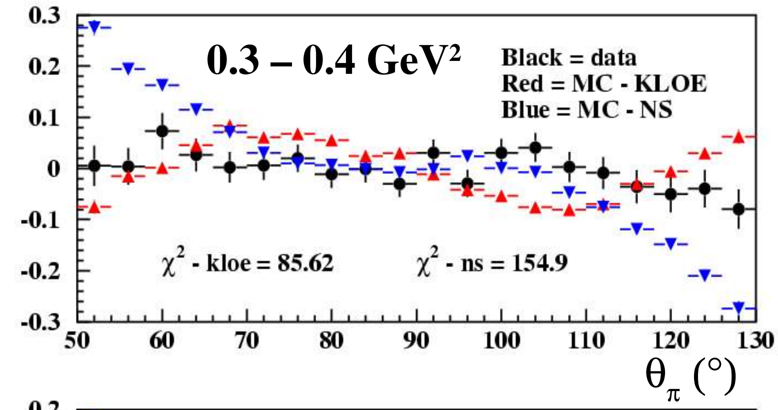
DATA

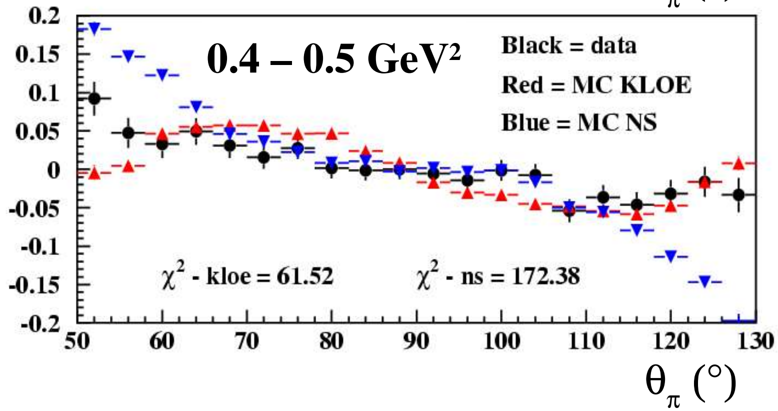
NS = No structure model

KLOE = 4 quarks model with better fit parameters from $\phi \to f_0\gamma \to \pi^+\pi^-\gamma$ analysis



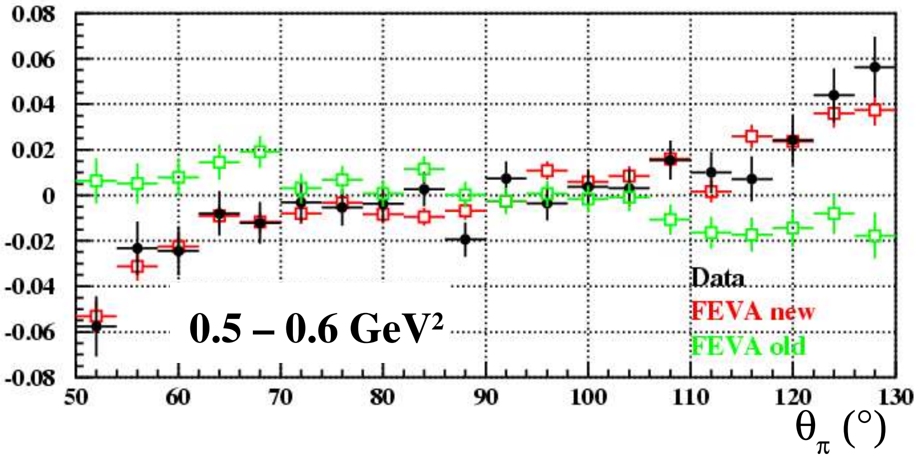


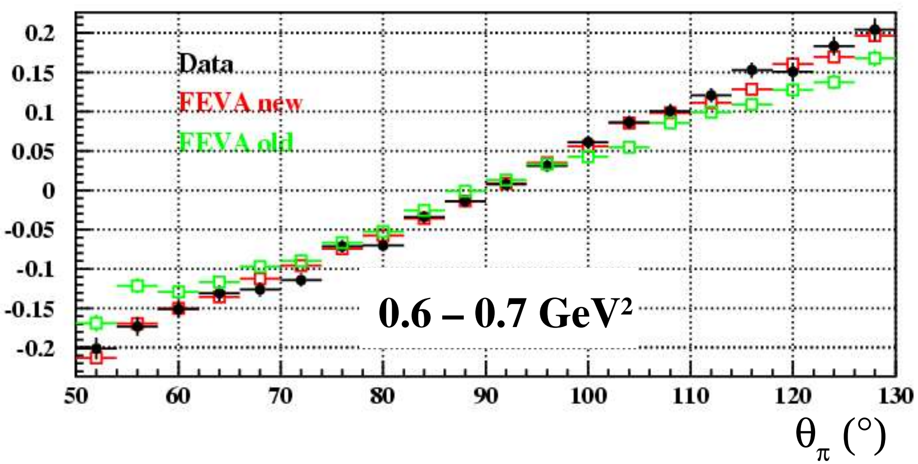




Charge asymmetry in $M_{\pi\pi}^2$ slices (0.5-0.6 & 0.6-0.7 GeV^2)

FEVA



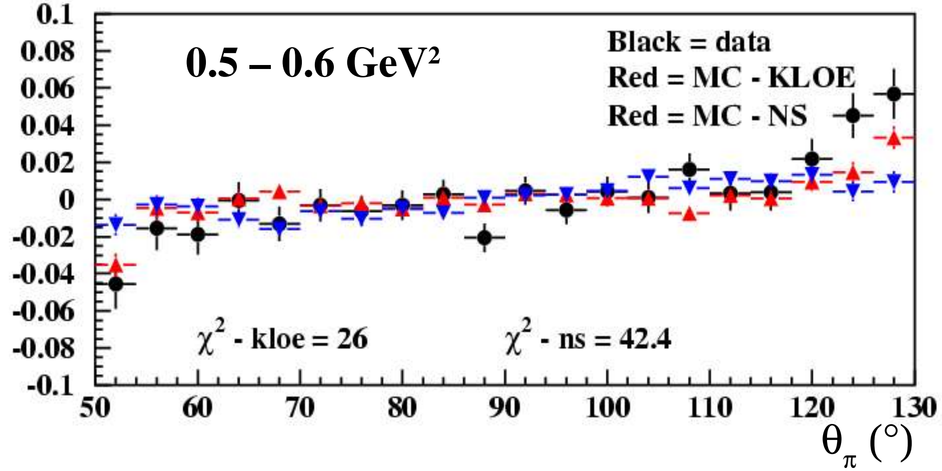


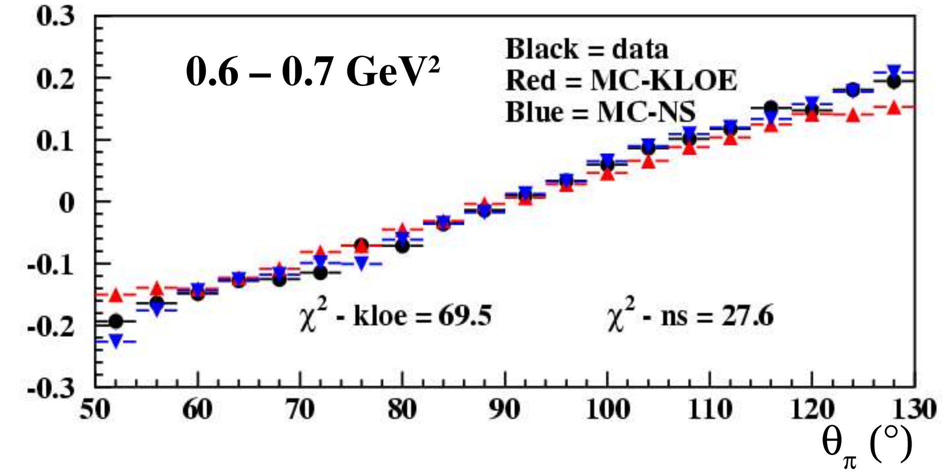
Cured FEVA

better agrees with DATA

then version with wrong parameters

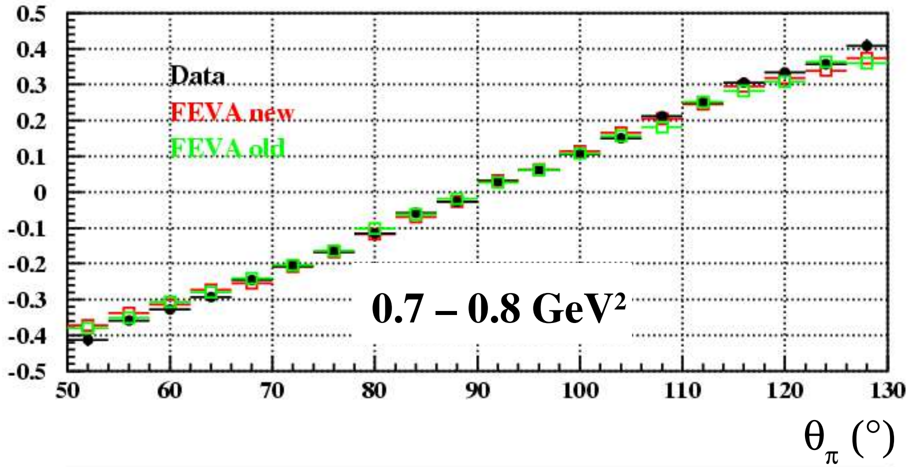
PHOKHARA

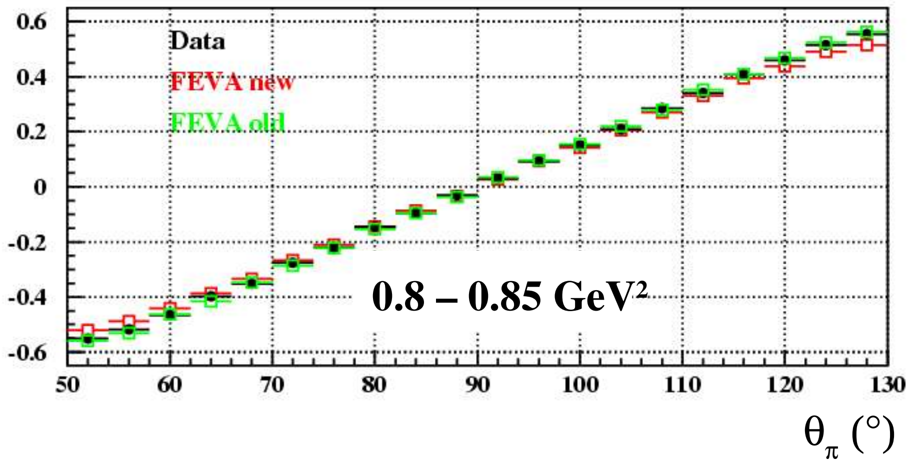


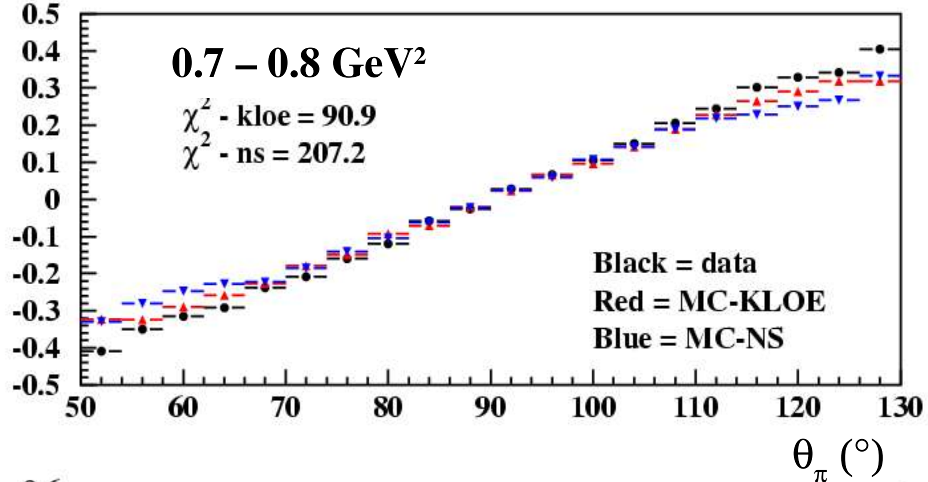


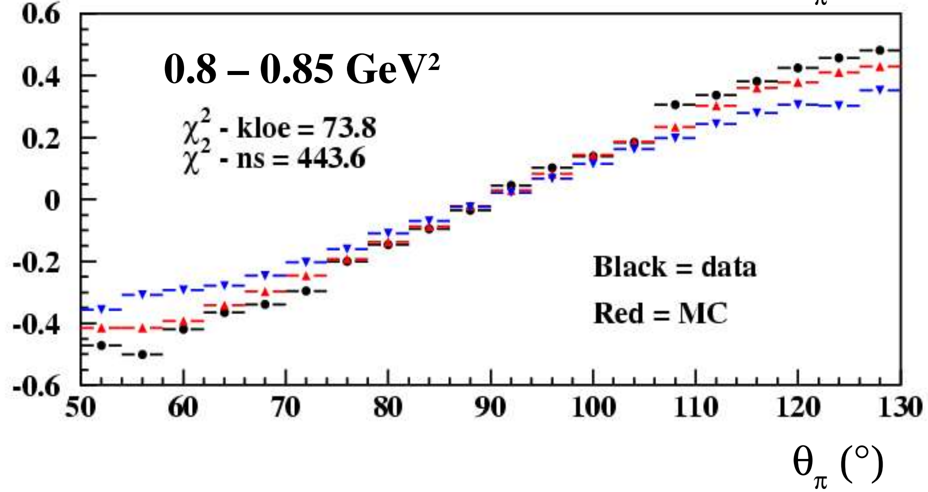
Charge asymmetry in $M_{\pi\pi}^2$ slices (0.7-0.8 & 0.8-0.85 GeV^2)

FEVA | **PHOKHARA**



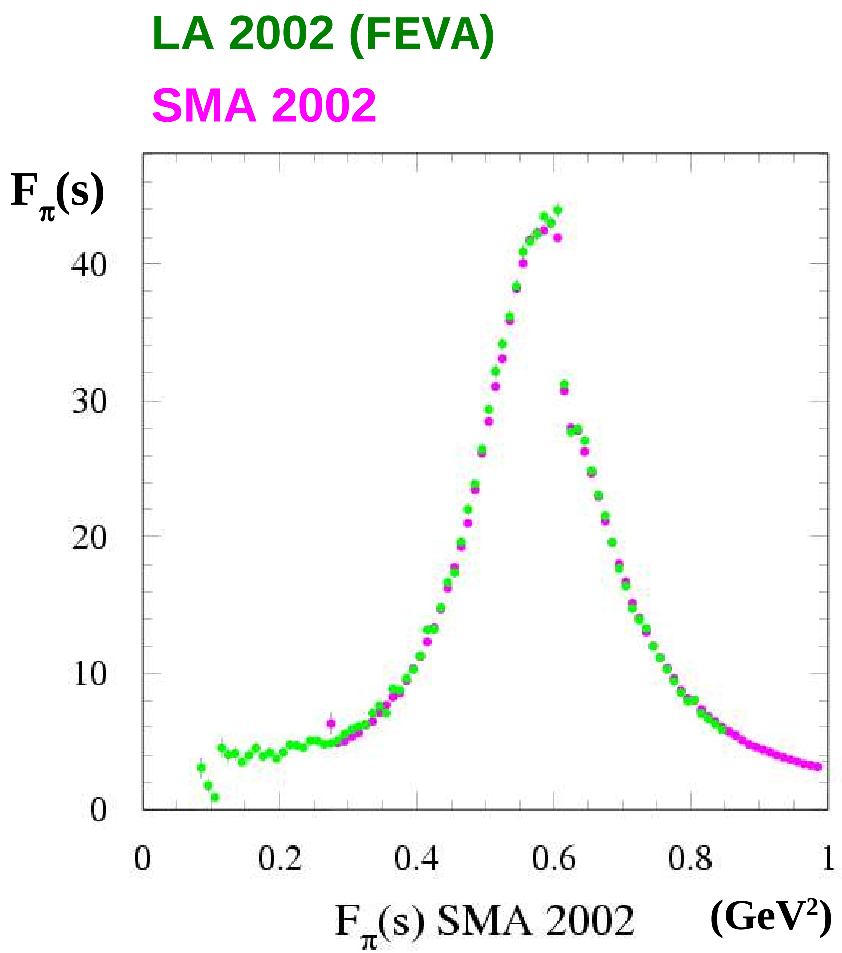


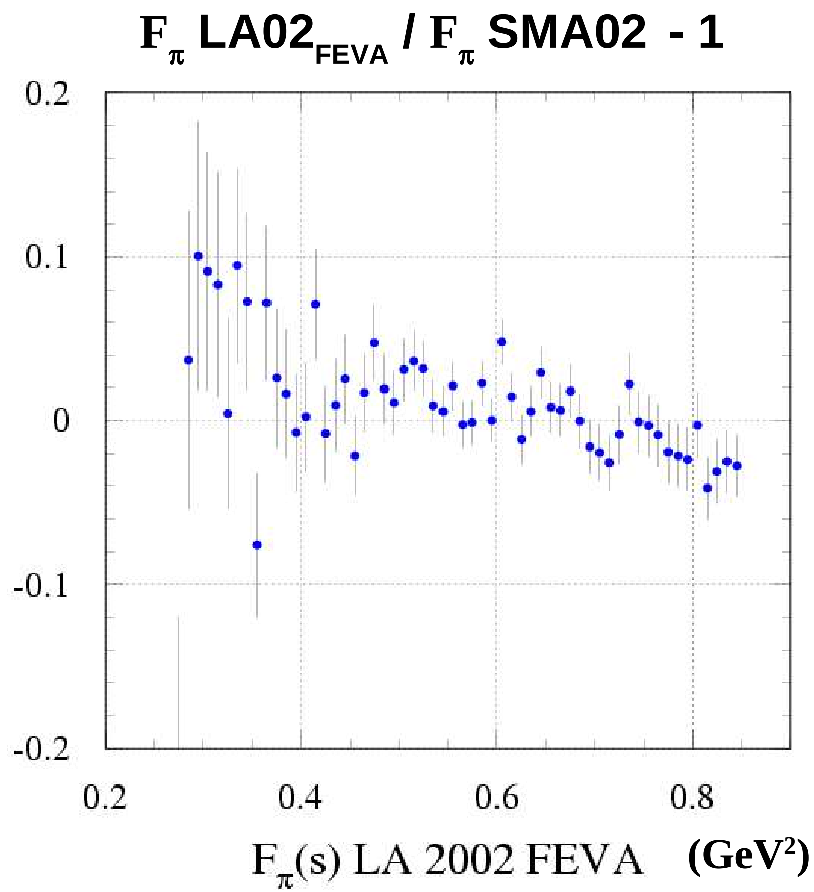




Both PH0KHARA and cured FEVA in good agreement with DATA

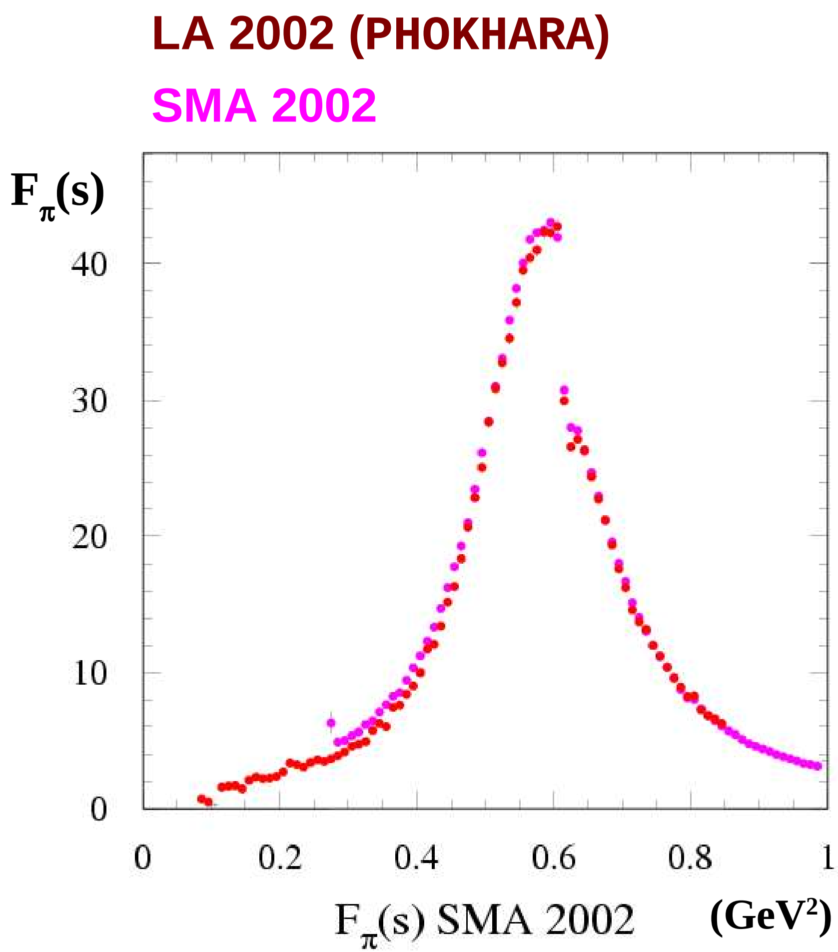
Comparisons of $F_\pi(s)$: LA 2002 (FEVA) and SMA 2002

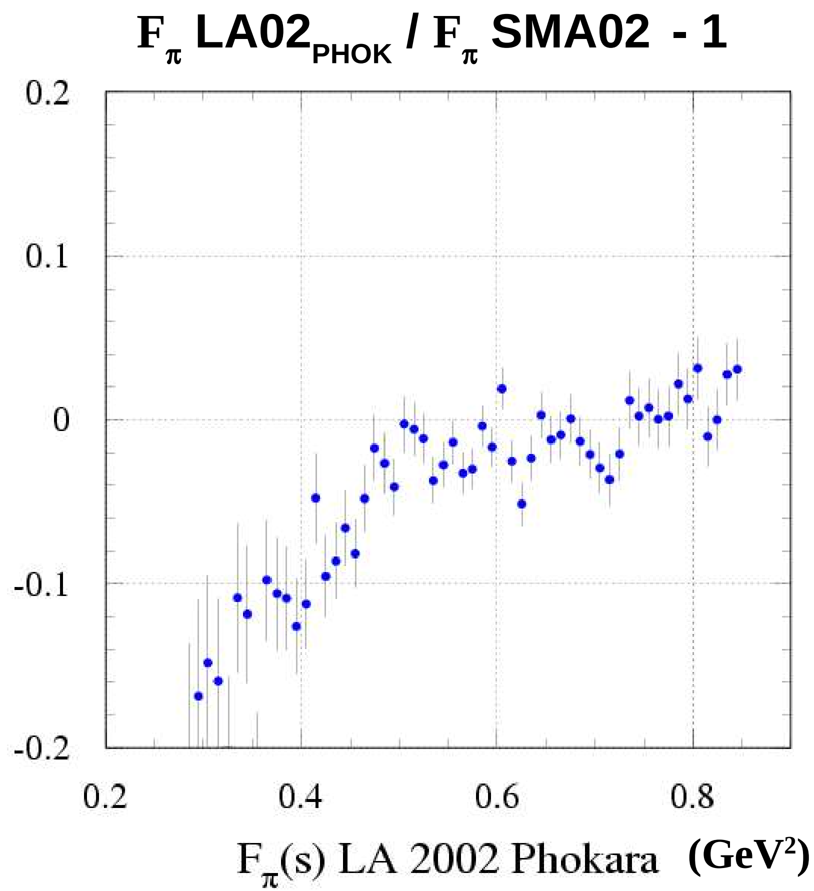




- Slope in relative difference
- Hint of underestimation of f_0 contribution by FEVA

Comparisons of $F_\pi(s)$: LA 2002 (PHOKHARA) and SMA 2002





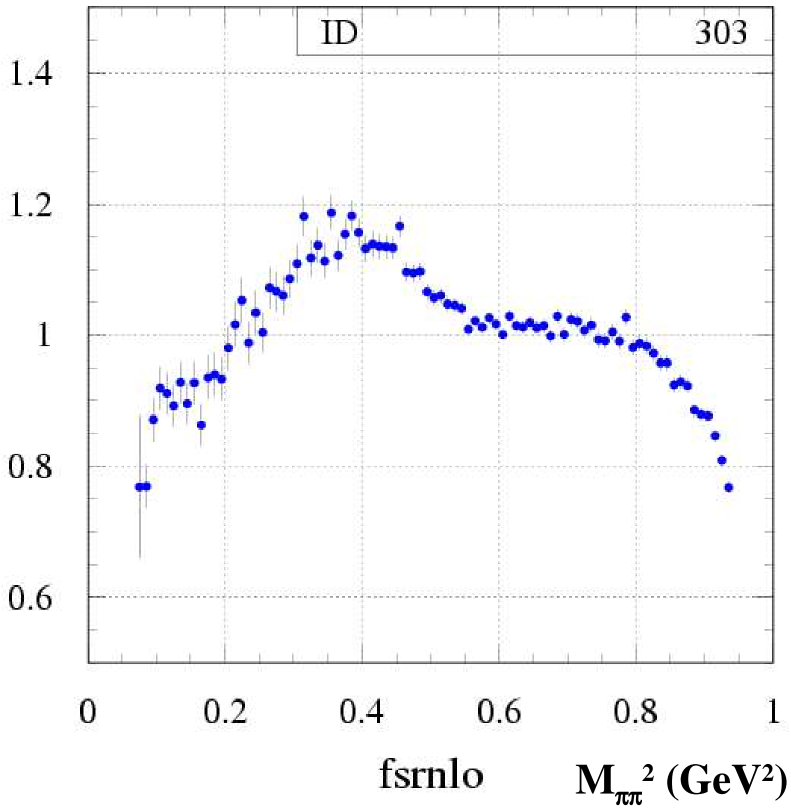
- Trend in relative difference (from -20% to 3%)
- Hint of overestimation of f_0 contribution by PHOKHARA

Influence of FSR-NLO on f_0(980) subtraction

- FEVA does not contain NLO correction
- PHOKHARA does

To check the impact of FSR-NLO on f_0 subtraction: **PHOKHARA5.1**

(ISR-LO + ISR-NLO + FSR-LO + FSR-NLO + f_0) / (ISR-LO + ISR-NLO + FSR-LO + f_0)



Large effect due to NLO (up to ~20%)
Systematic uncertainty to be added to the f_0(980) contribution

No Trackmass cut applied

Conclusion and outlook for f_0 issue

- **Scalars and Double Resonance contribution is the only missing part to conclude LA2002**
- Using the Achasov model with fixed parameter values 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 Double Resonance and σ** in much better agreement with PHOKHARA: the difference between the two generators is due to the Double Resonance and σ contributions
- For the given systematics the f_0(980) contribution can be extracted from standalone version
- Proposal: FEVA is the better generator and should be used to subtract the scalar contributions

→ **Systematic error** for FEVA:

- Missing NLO contribution in FEVA sizable effect, to be taken into account
- 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

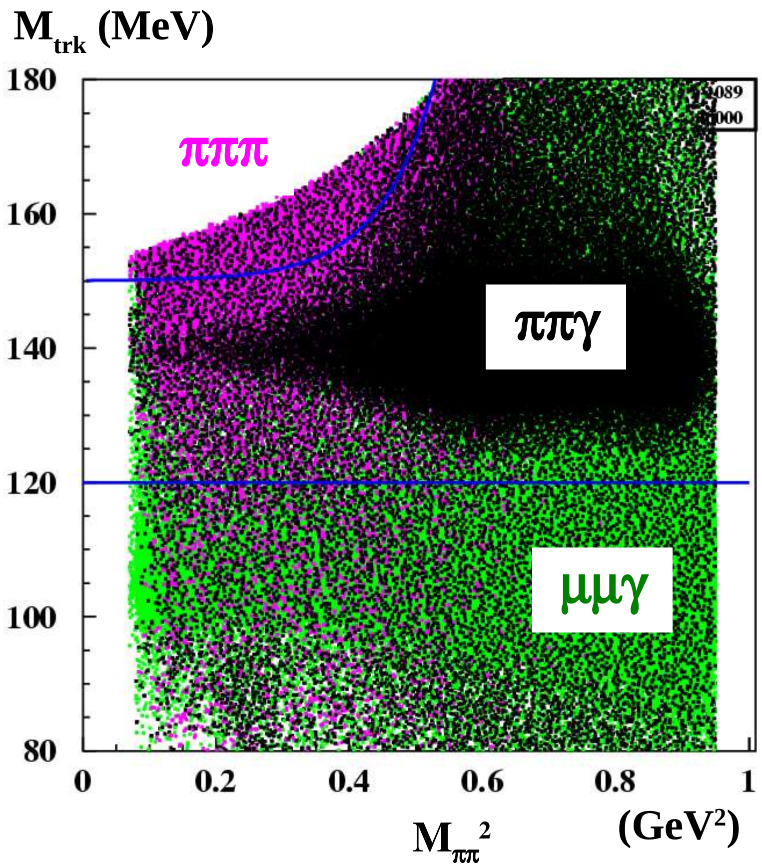
Off Peak Analysis

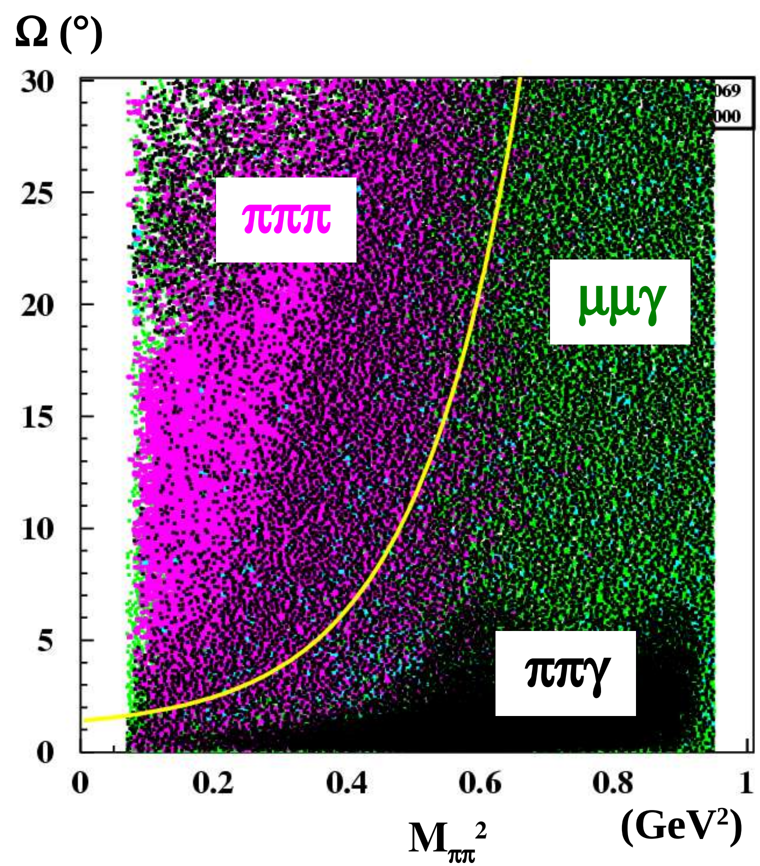
2006 DATA

- **Analysis cuts**
- **Background subtraction procedure**
- **$F_\pi(s)$ extraction** (VERY PRELIMINARY)

Analysis cuts

- $50° < \theta_\gamma < 130°$
- Trackmass: constant function (lower) and exponential function (upper)
- Ω (angle between missing momentum and photon momentum): exponential function
- `.or.` of (π-e) Likelihood





Cuts on M_{Trk} and on $\mathbf{\Omega}$ worked out optimizing

Efficiency & Purity

Background Subtraction: 1st Method (.OR.)

Fitting procedure to get precise agreement between DATA and MCs in Trackmass spectrum

Developed (with different contributions) for Small Angle 2002

For Off Peak $\rightarrow$ **two different approaches** (depending on the fit to estimate radiative BhaBha)

1st Method: `.OR.`

- M_{Trk} DATA spectrum in the `.or.` of Likelihood

- All the MC samples with `.or.` of the Likelihood

- Fit DATA and MCs M_{Trk} spectra in slices of $M_{\pi\pi}^2$ (0.5 GeV^2)

$\Rightarrow$ **weights** for $\mu\mu\gamma$, $ee\gamma$, $\pi\pi\pi$ MCs

* $ee\gamma$ can be obtained both from **MC 2002** and directly from **DATA with `.nor.`** of Likelihood

... Alternative method

Using the **.or. of the Likelihood** in the analysis:

ee   contamination is the misidentification of one of the EMC

$\Rightarrow$ ee   (**.or.**) $\equiv$ ee   (**.xor.**)

`.OR. = .AND. + .XOR.`

Try to fit the .XOR. gives more evident presence of BhaBha with respect to the .OR.

2nd Method: `.XOR.`

1st step

- M_{Trk} DATA spectrum in the `.xor.` of Likelihood

- $\pi\pi\gamma$, $\mu\mu\gamma$ and $\pi\pi\pi$ MC samples with `.or.` of the Likelihood

- Fit DATA and MCs M_{Trk} spectra in slices of $M_{\pi\pi}^2$ (0.5 GeV²)

$\Rightarrow$ **weights** for eeγ

$\rightarrow$ **SUBTRACT BhaBha contribution FROM DATA spectrum (in the `.or.`)**

2nd step

- M_{Trk} DATA(-BhaBha) spectrum in the `.or.` of Likelihood

- $\pi\pi\gamma$, $\mu\mu\gamma$ and $\pi\pi\pi$ MC samples with `.or.` of the Likelihood

- Fit DATA and MCs M_{Trk} spectra in slices of $M_{\pi\pi}^2$ (0.5 GeV²)

$\Rightarrow$ **weights** for $\mu\mu\gamma$ and $\pi\pi\pi$ MCs

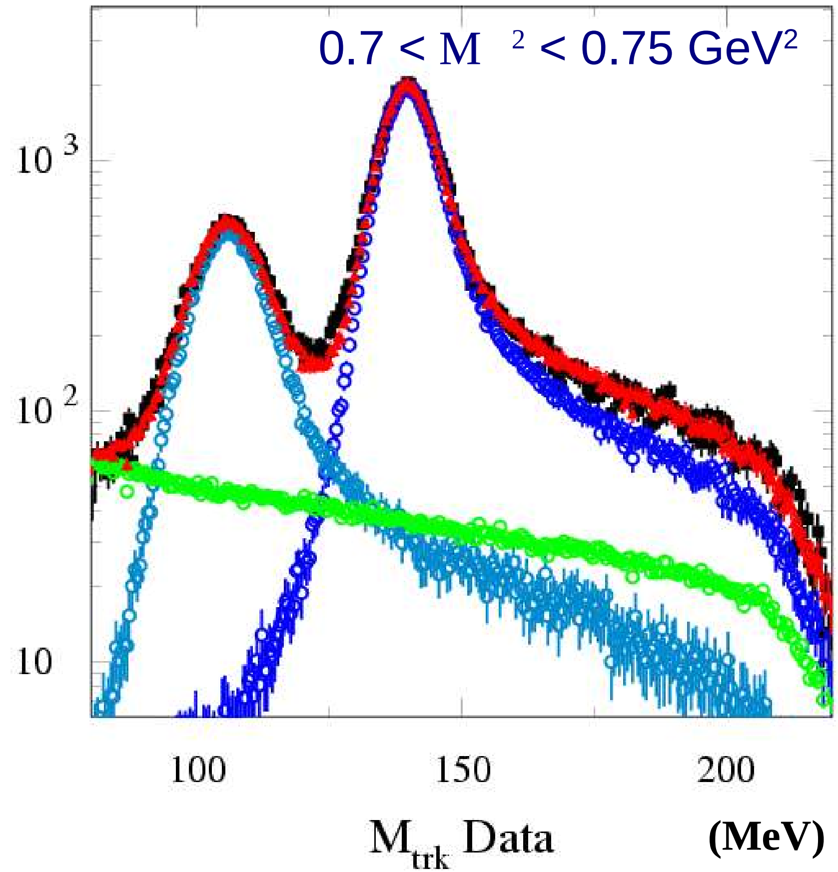
* eeγ can be obtained both from **MC 2002** and directly from **DATA with `.nor.`** of Likelihood

Background Subtraction: possibilities and first check

Method	Sample
OR	BhaBha from DATA
	BhaBha from MC 2002
XOR	BhaBha from DATA
	BhaBha from MC 2002

Different combinations of method and samples: comparison among them

Agreement between samples after fit and M_{trk} DATA shape for different $M_{\pi\pi}^2$ slices



DATA (.OR.)

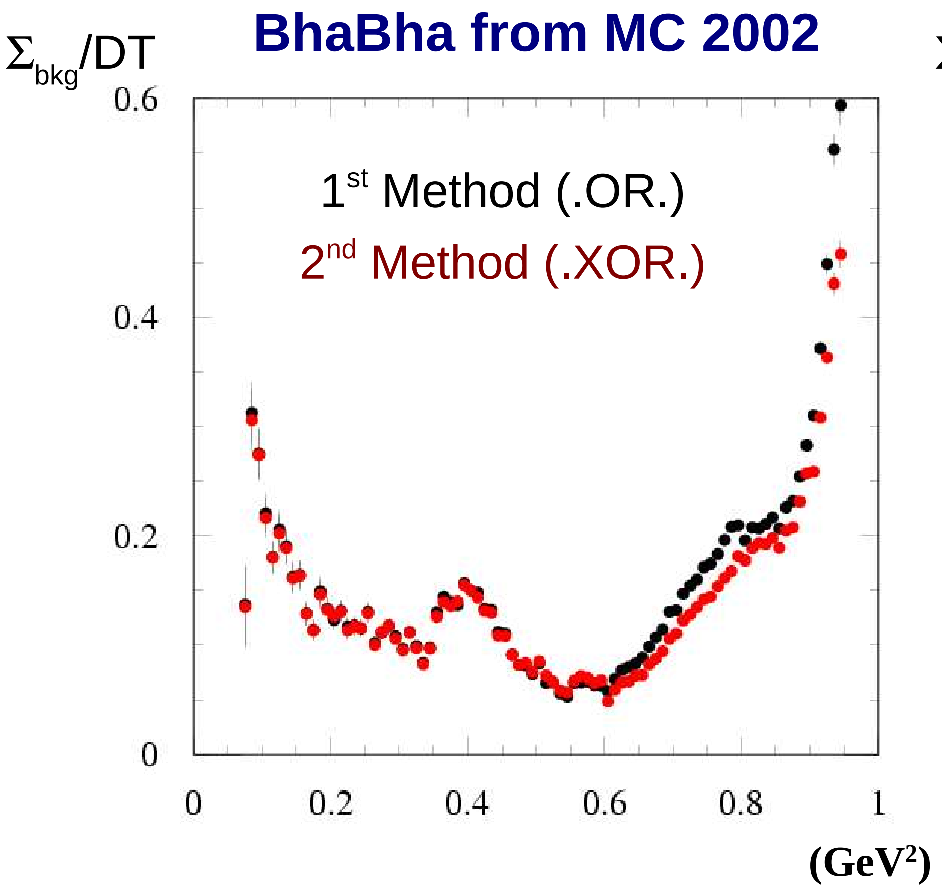
$\pi\pi\gamma$

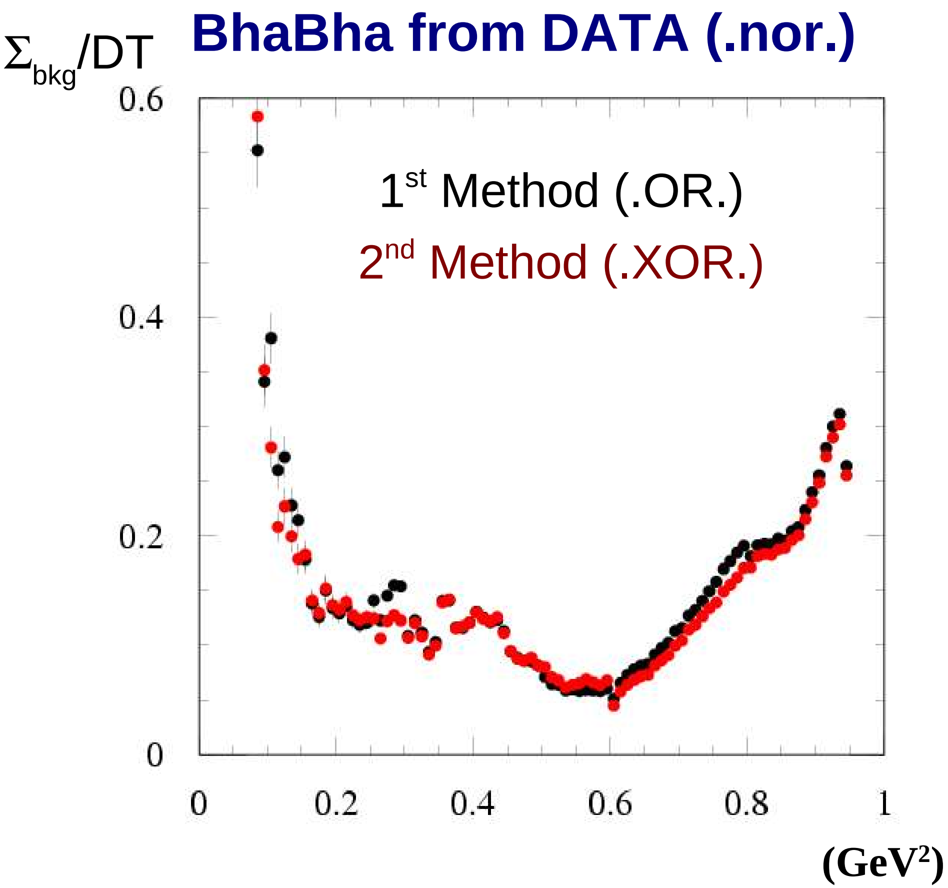
$\mu\mu\gamma$

eeγ from DATA

Sum

Background Subtraction: comparing the methods





Difference in background contribution to the spectrum, using different methods within the same sample

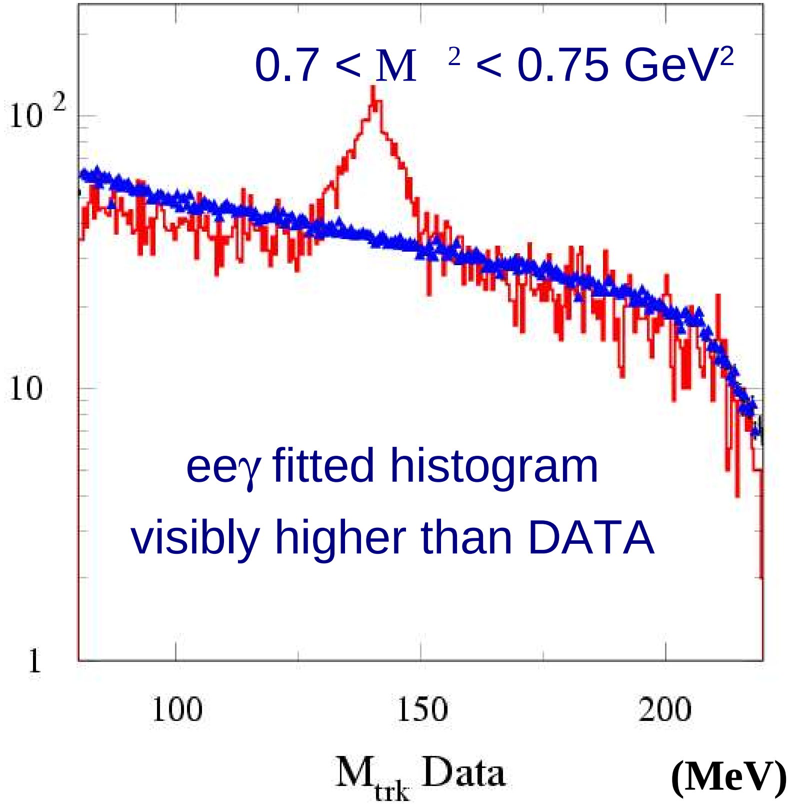
⇒ using MC 2002: difference in M^2 spectrum of ~5%

⇒ using DATA (.nor.): difference in M^2 spectrum of ~2-3%

Background Subtraction: making a choice

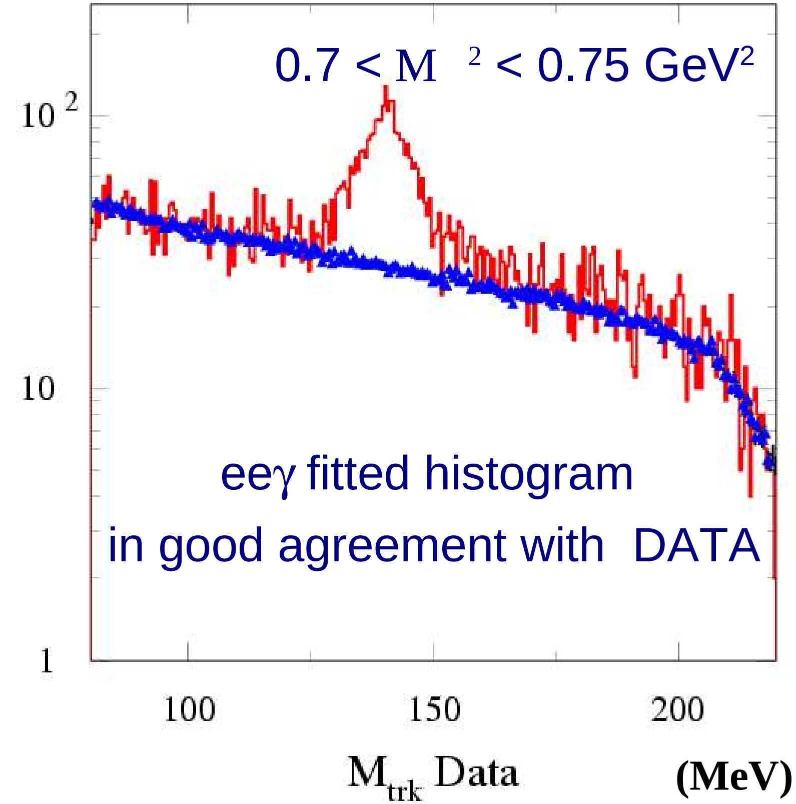
Comparing the agreement between BhaBha after fit and DATA with .xor.

BhaBha fitted using .OR.



DATA in .XOR.
eeγ from DATA

BhaBha fitted using .XOR.



1st Method (.OR.) seems to overestimate the eeγ contribution

Fitting BhaBha spectrum with .xor. gives better description of eeγ amount

2nd Method (.XOR.) and eeγ from DATA applied for the background subtraction

Preliminary extraction of $F_\pi(s)$ with PoP DATA

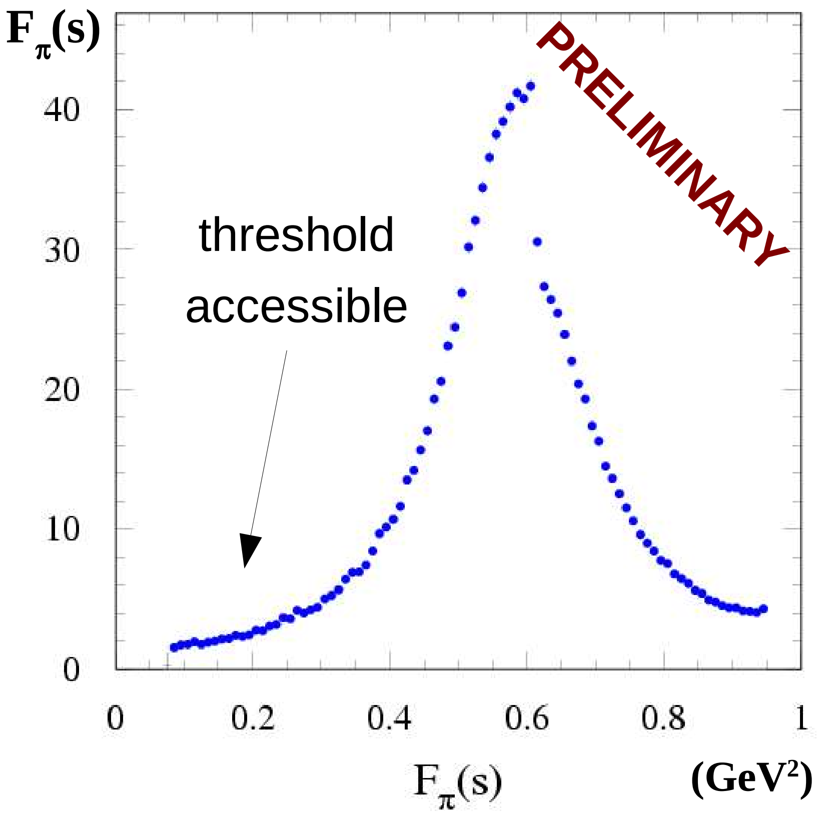
- Analysis cuts: one vertex with two associated tracks, .or. of the Likelihood, trackmass and missing angle cuts
- Background subtraction: 2nd Method with BhaBha from DATA
- Efficiencies: FILFO (from DATA) and Global Efficiency (from $\pi\pi\gamma$ 2006 MC)
- Integrated Luminosity normalization: ~234 pb^{-1} (DBV $\geq$ 25)
- Radiator Function: PH0KHARA5 at 1GeV
- Vacuum polarization: from Large Angle 2002 analysis
- FSR correction: to be refined (up to O(10%) at high

VERY PRELIMINARY

- only statistical errors
- estimate precision of ~3%

To be done:

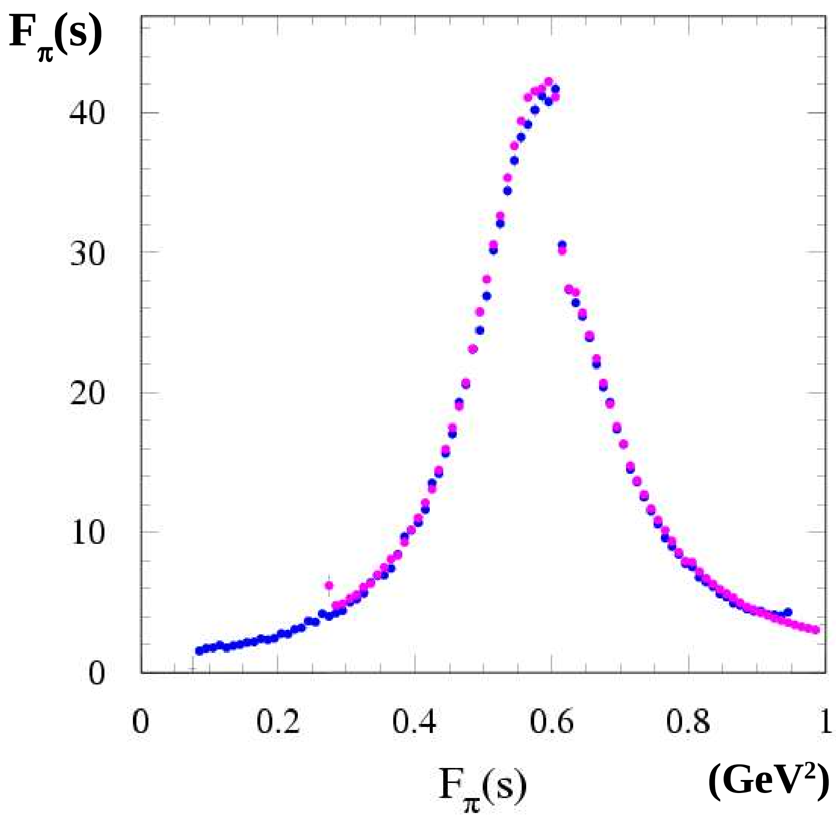
- precise evaluation of efficiencies
- FSR correction from PH0KHARA3Ω
- systematics evaluation

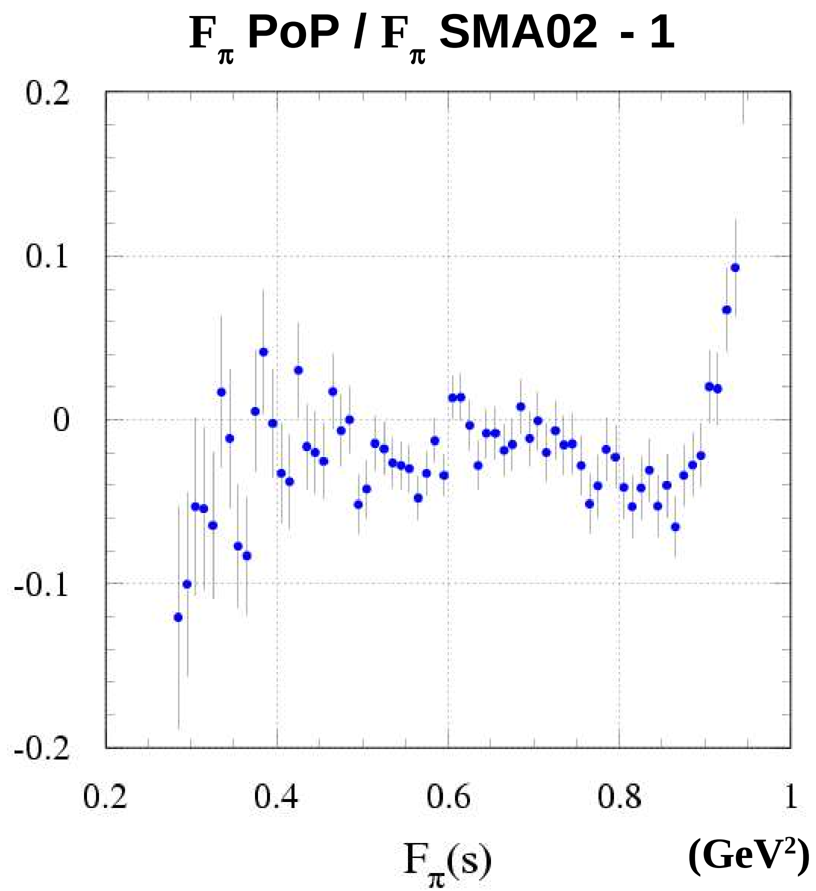


Some comparisons among $F_\pi(s)$: PoP and SMA 2002

Prelimanry PoP

SMA 2002





- Difference flat and well below 5% up to 0.9 GeV^2 (efficiency still to be evaluated from DATA)
- Trend for high $M_{\pi\pi}^2$ region: due to efficiency, Radiator Function, FSR correction... ?

Some conclusion for $F_\pi(s)$ PoP and outlook

What we have done:

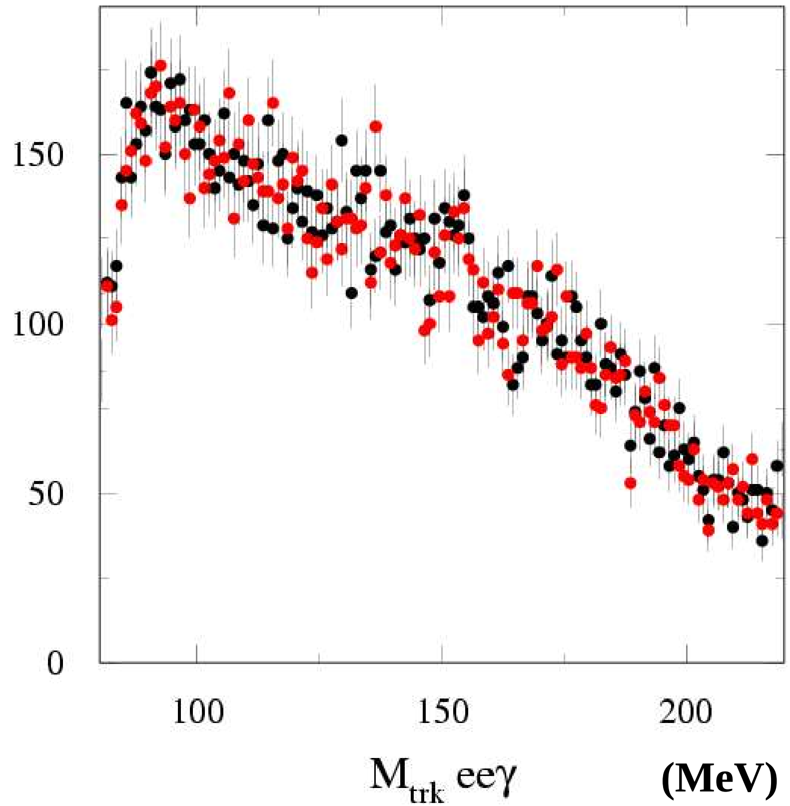
- Analysis cuts studied and fixed
- Main background sources: $\mu\mu\gamma$ and $ee\gamma$ (using the `.or.` of the Likelihood).
Background from $\pi\pi\pi$ is not an issue
- Background fit methods studied in a detailed way and finalized, choosing the .XOR. to fit radiative BhaBha. Waiting for $ee\gamma$ 2006 MC for a possible comparison with “BhaBha from DATA” method
- PrePreliminary Pion Form Factor with DATA @ 1GeV^2 extracted.
Already some hints to f_0 issue of Large Angle On Peak analysis

What is missing:

- Likelihood efficiency at low $M_{\pi\pi}^2$ to be better understood
- Vetrex and trigger efficiencies: (easy?) using 2002 tools
- Tracking efficiency: the main efficiency to be evaluated
- FSR evaluation

Pion Form Factor @ 1 GeV

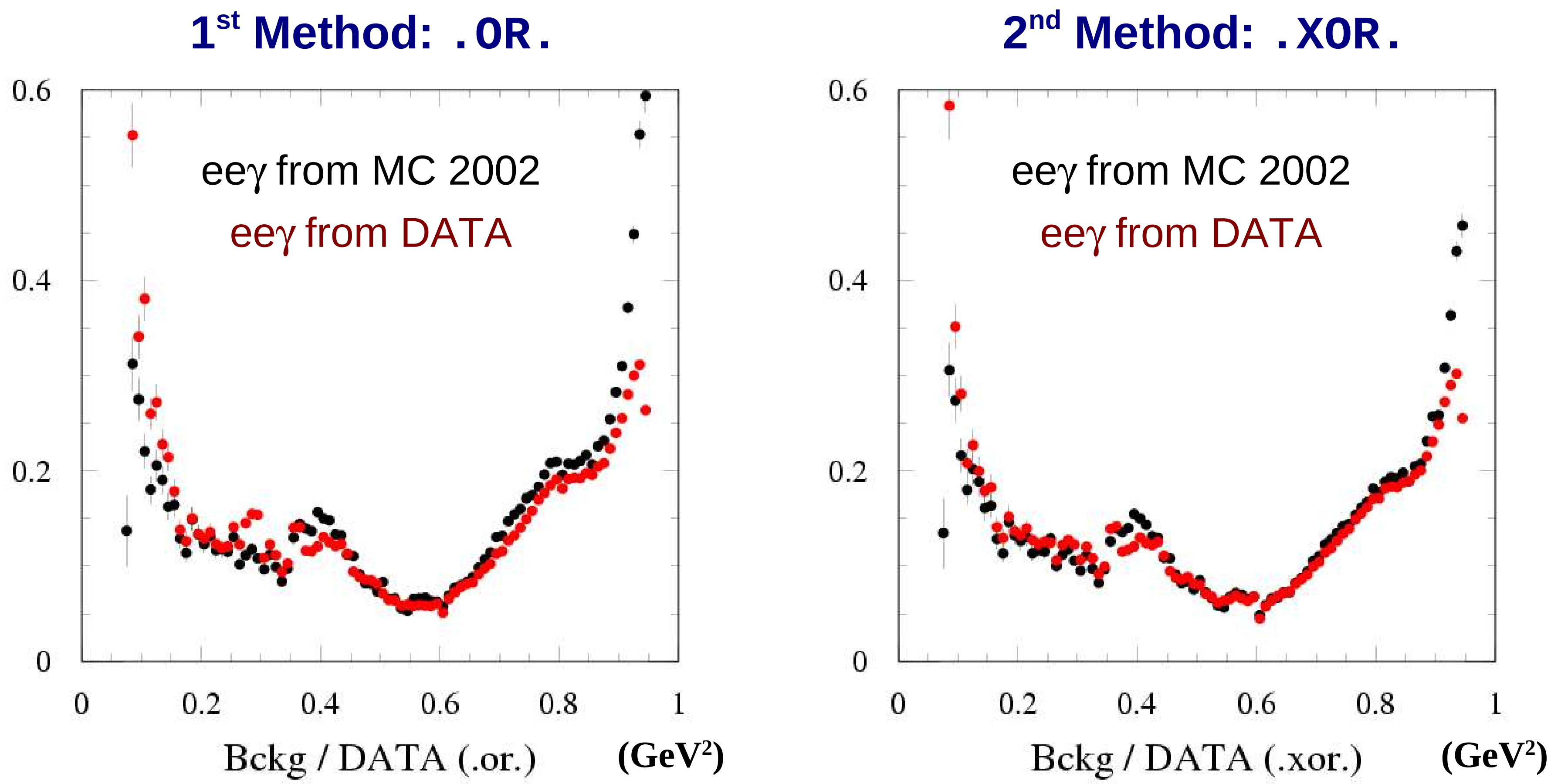
Spare slides



ee MC with .OR.

ee MC with .XOR.

Background Subtraction: comparing the samples



Visible discrepancy in background contribution to the spectrum, using different samples for radiative BhaBha (**DATA** or **MC**)

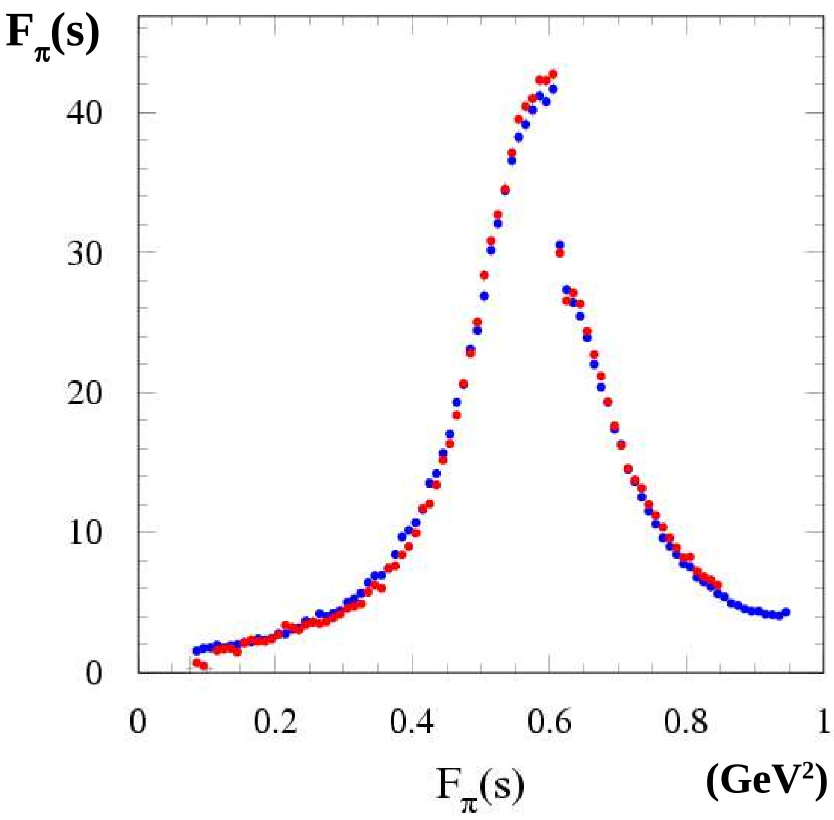
⇒ especially in the .or. method: difference in M^2 spectrum of ~10%

Some comparisons among $F_\pi(s)$: PoP and LA 2002 (PHOKHARA)

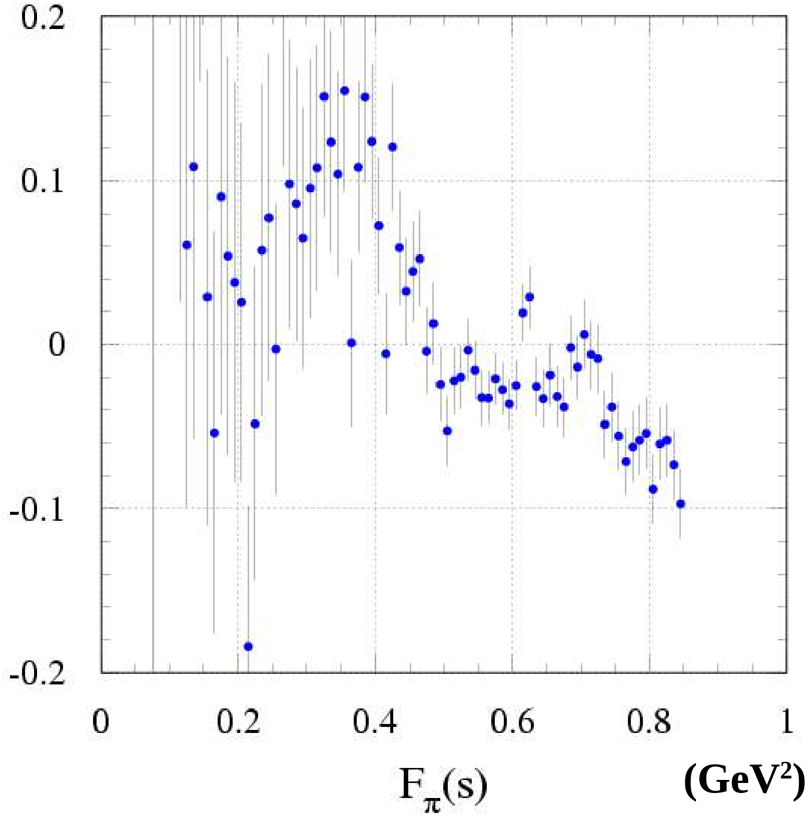
Prelimanry PoP

LA 2002

(PHOKHARA used for f_0 estimation)



F_π PoP / F_π LA02$_{\text{PHOKHARA}}$ - 1



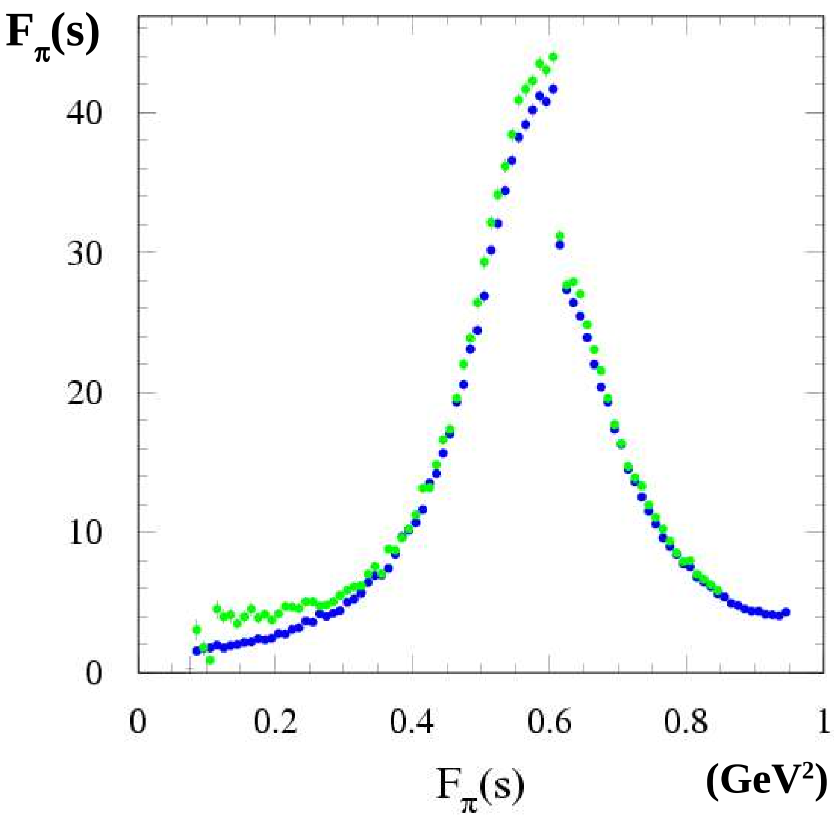
- Visible trend in relative difference between Off Peak and On Peak spectra
- Below 3% difference on the ρ-peak
- Hint on f_0 contribution: possible overestimation by PHOKHARA up to 15% discrepancy below 0.4 GeV^2

Some comparisons among $F_\pi(s)$: PoP and LA 2002 (FEVA)

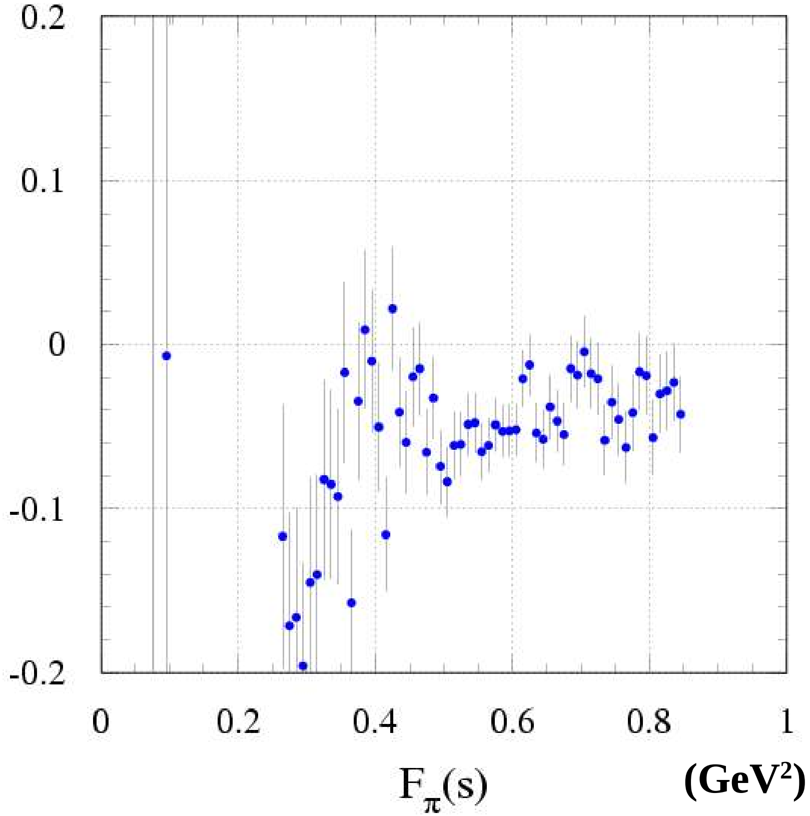
Prelimanry PoP

LA 2002

(FEVA used for f_0 estimation)



F_π PoP / F_π LA02$_{FEVA}$ - 1



- Visible shift (~5%) in relative difference (not yet efficiency evaluation from DATA for Off Peak spectrum)
- Ratio constant above 0.35 GeV^2
- Hint of underestimation of f_0 contribution by FEVA