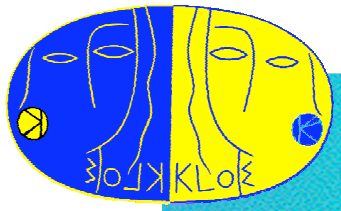


International Workshop
e+e- Collisions from phi to psi
February 27 - March 2, 2006

Progress on F_π with the KLOE experiment (untagged)

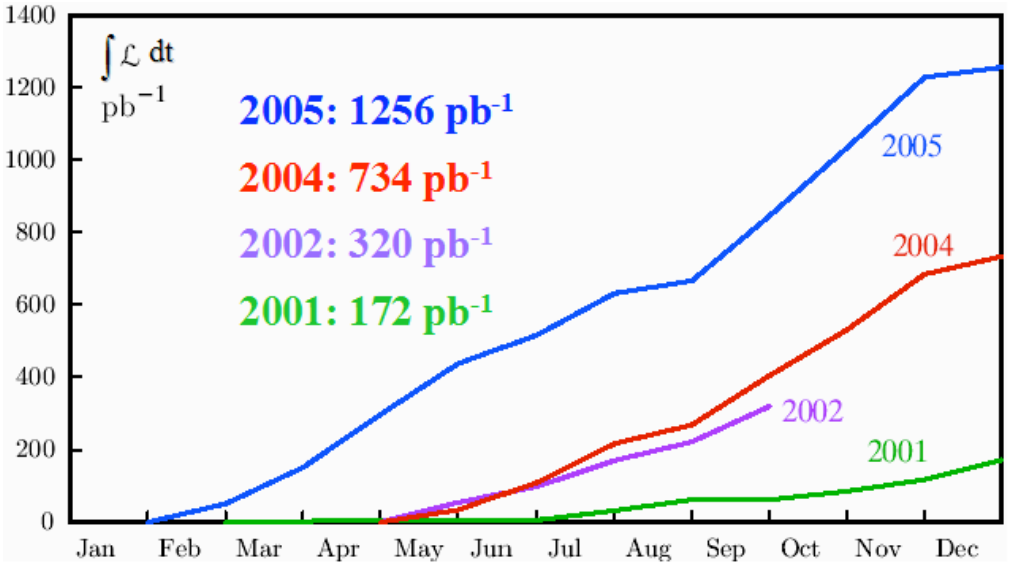
Stefan Müller-Federico Nguyen

LNF Frascati-Università Roma TRE

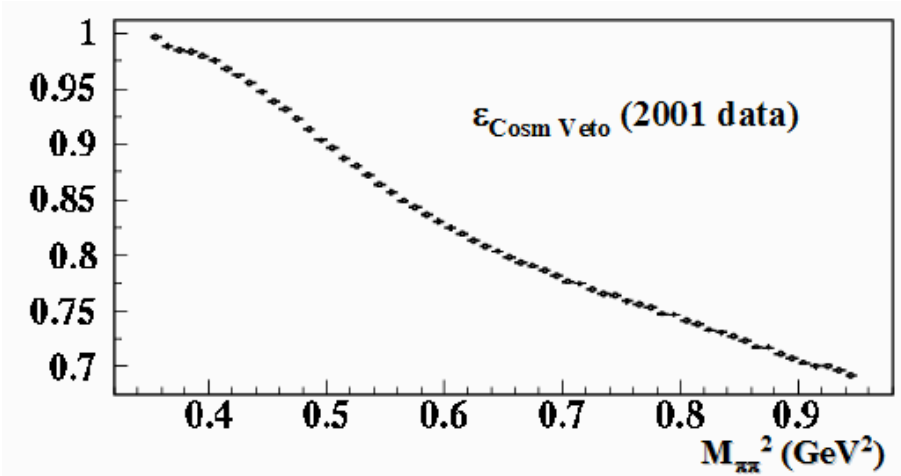
February 27th 2006

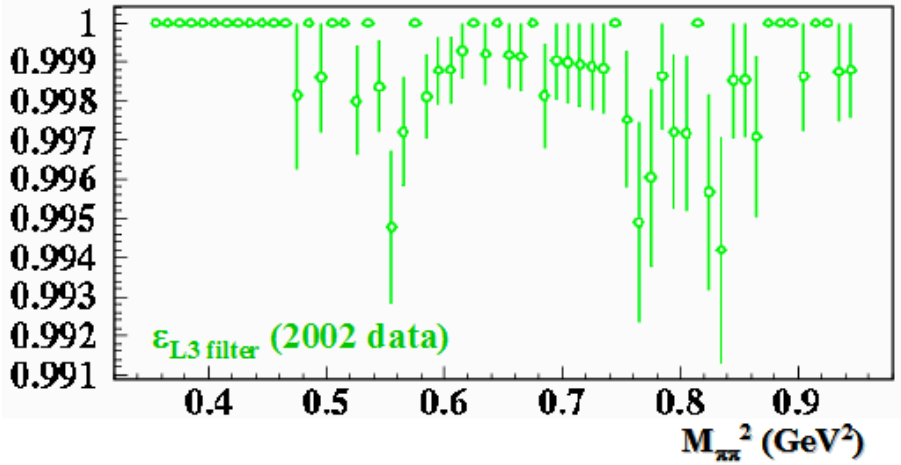
(For the KLOE collaboration)

Available KLOE data sets



in 2001, the veto of cosmic events (hardware) caused non-negligible inefficiency in □□□ events and made the measurement of □□□ events not feasible, from 2002 on, this effect is taken out



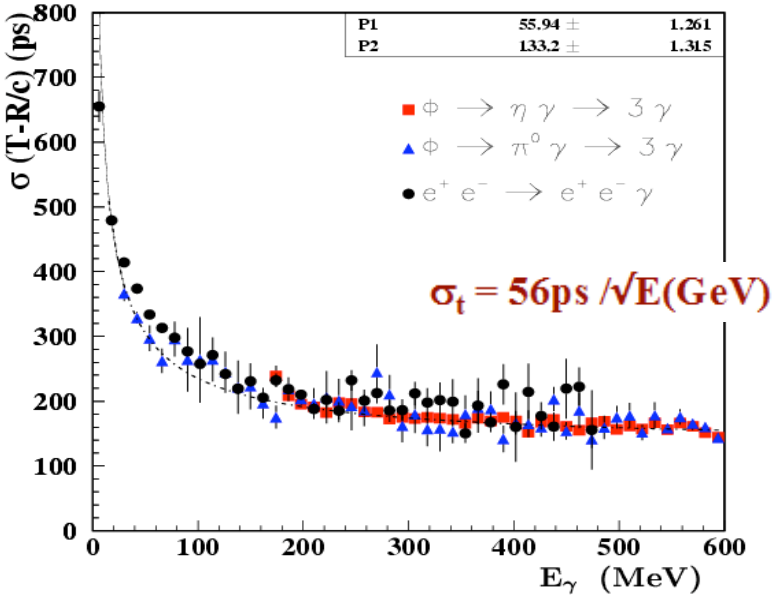


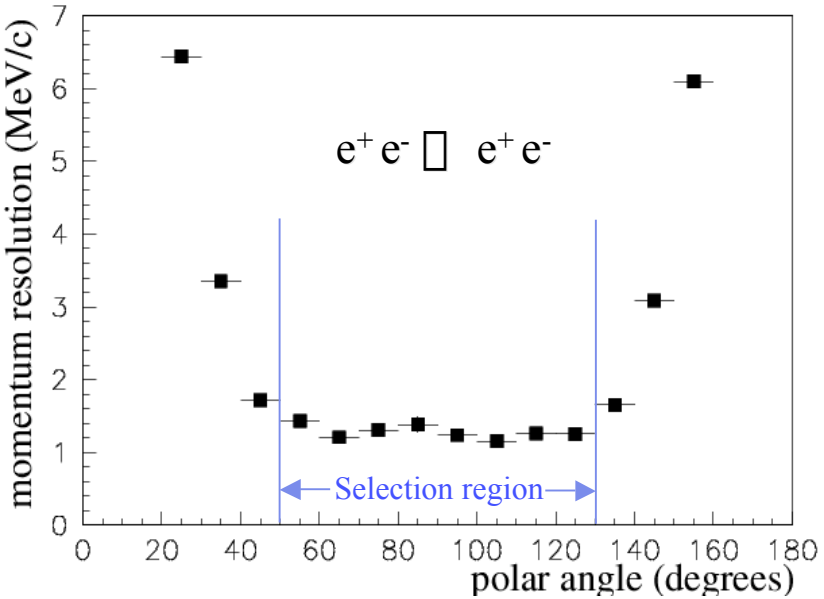
KLOE: performances for the □□□ analysis

Electromagnetic Calorimeter
Pb / Scintillating Fibres
Endcap + Barrel = 98% (4□)

Drift Chamber
4 m ∅, *3.3 m* length
90% He, *10%* i-C_4H_{10}

$\square_E/E = 5.4\%/\sqrt{E(GeV)}$





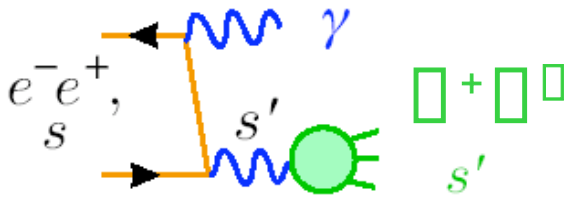
$\square_p/p = 0.4\%$ *(□ > 45°)*

$\square_{r\square} = 150\ \square m$, $\square_z = 2$ mm

$\square_{vtx} \sim 3$ mm, $\square_{M\square\square} \sim 1$ MeV

the whole structure is surrounded by a superconducting coil B=0.52 T

Fiducial volume



a) 1 and only 1 vertex ($|z| < 7$ cm, $_{xy} < 8$ cm) connected to 2 tracks

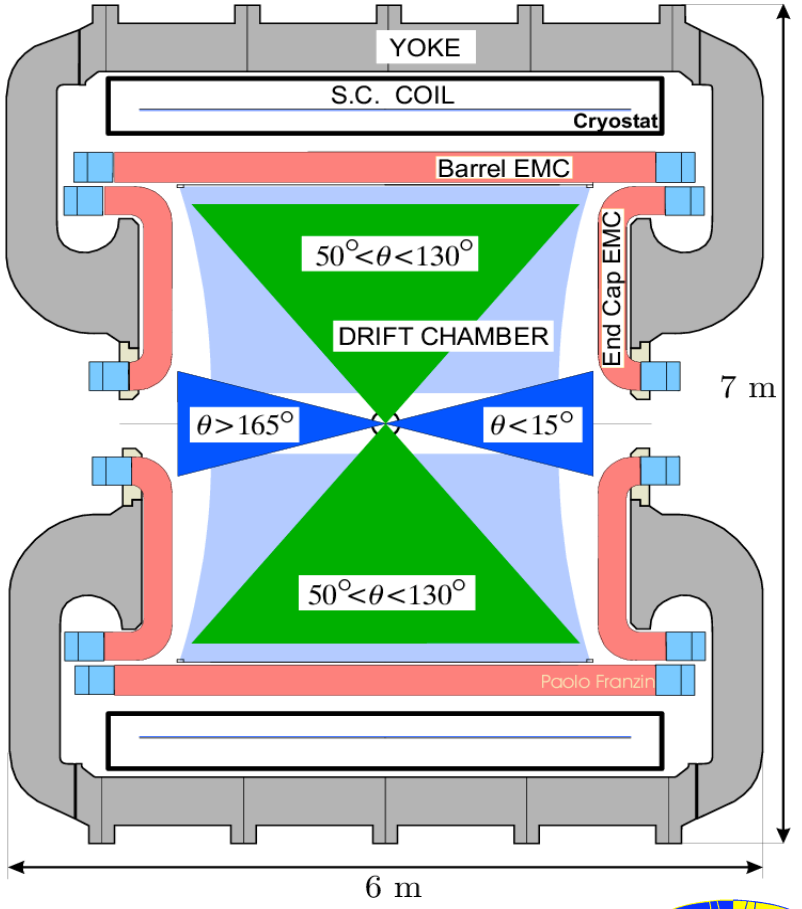
b) each track with $50^\circ < _{track} < 130^\circ$

c) small angle ($_{} < 15^\circ$)

no photon tagging: $\vec{p}_{} = \vec{p}_{miss} = (\vec{p}_{+} + \vec{p}_{})$

- ✓ high statistics for ISR (~ ^{2})
- ✓ low relative FSR contribution
- ✓ suppressed $\;\; ^+ \; ^0$ wrt the signal
- ✓ the threshold region is not covered

KLOE result (140 pb^{-1} of 2001) :
Phys. Lett., B606 (2005) 12

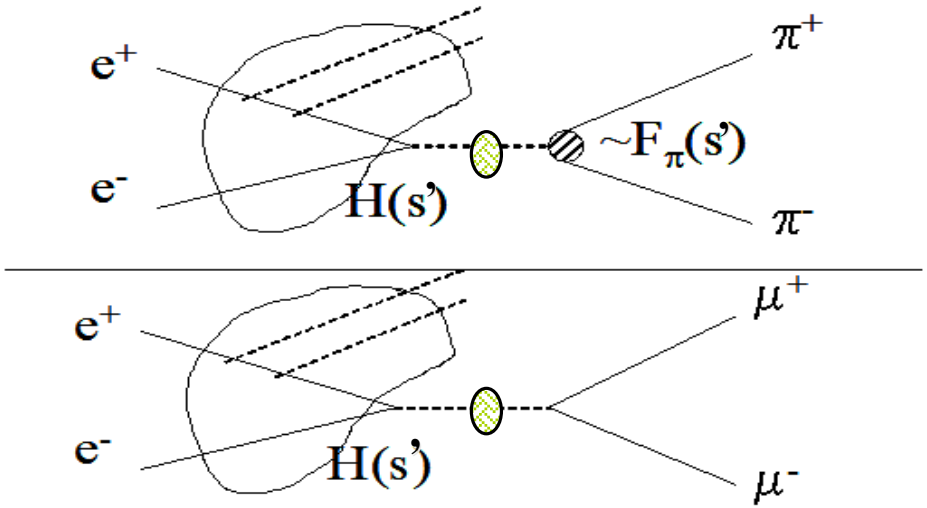


Normalization to □□□ events

benefits from normalizing to □□□ events,

in the limit of neglecting FSR effects:

$$\sigma^{Born}_{\pi\pi}(s) = \frac{d\sigma^{obs}_{\pi\pi\gamma}/ds}{d\sigma^{obs}_{\mu\mu\gamma}/ds}\,\sigma^{Born}_{\mu\mu}(s)$$



Luminosity: $0.5\%_{\text{theory}} \oplus 0.3\%_{\text{exp., Bhabha}}$

~~Luminosity~~	0.6 %
~~Vacuum Polarization~~	0.2 %
FSR resummation	0.3 %
~~Radiation function $H(s_\pi)$~~	0.5 %
Total theory systematics	0.9 %

- most of the theoretical systematic effects cancel out
- also improvements in experimental systematics to be expected

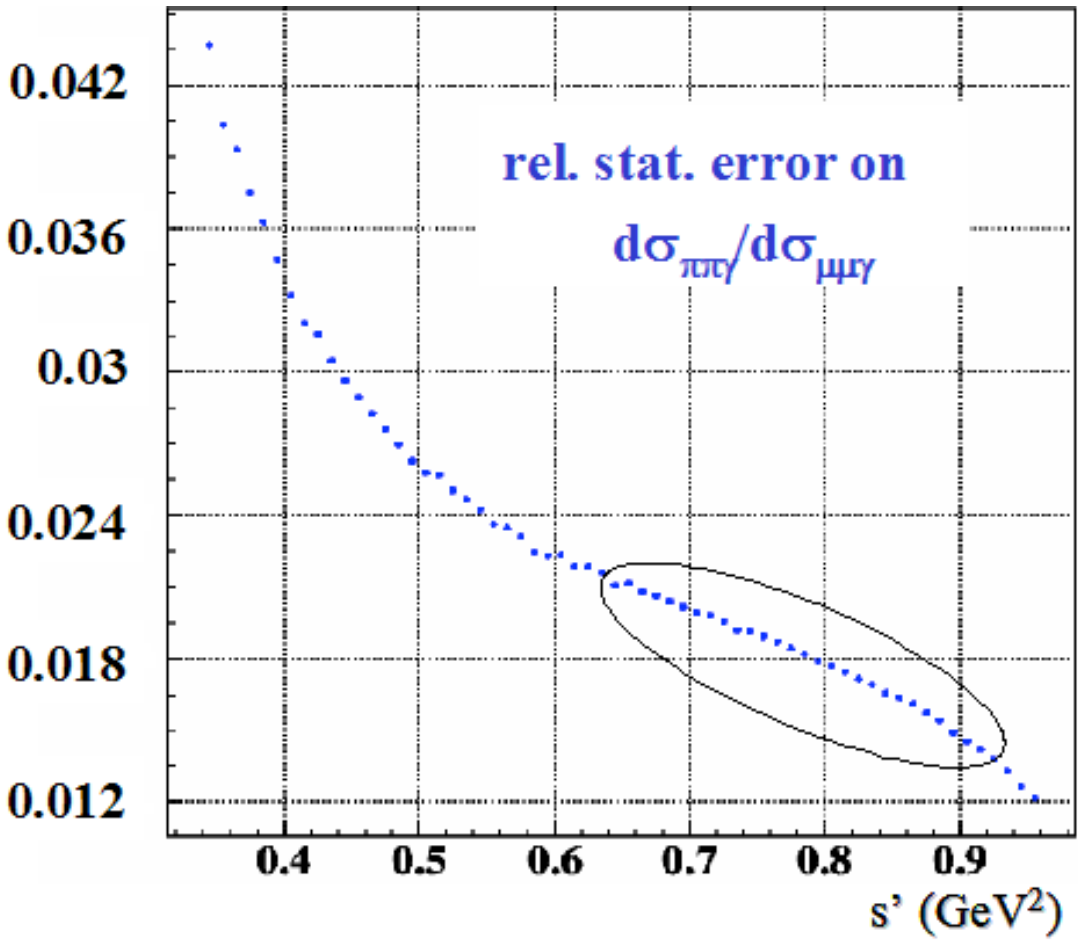
Statistical error

compared to the luminosity normalization with Bhabhas, statistical error becomes larger using muons, however it is a good cross check of the intriguing region because of the difference with data

estimate performed with **PHOKHARA-4**

H. Czyz et al.,
Eur.Phys.J.C39 (2005) 411

$\theta_{\gamma\gamma} < 15^\circ$, $50^\circ < \theta_{\gamma} < 130^\circ$, $M_{\gamma\gamma}^2 = 0.01$ GeV^2
$L = 240$ pb^{-1}, $= 50\%$ flat in s' , in both channels



Improvements wrt the published result

improved selection

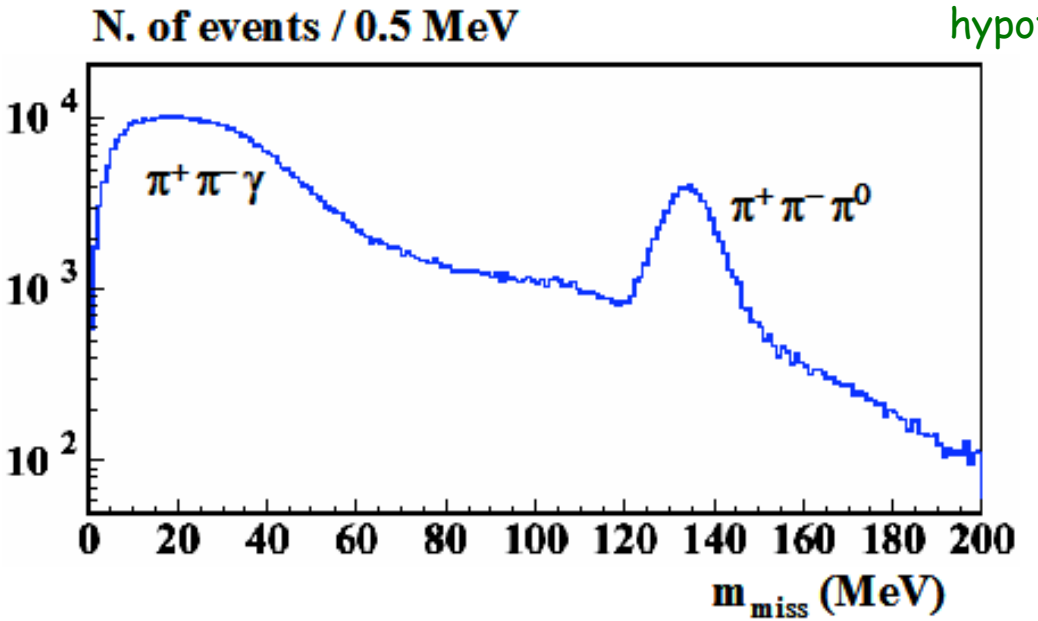
- enlarged m_{trk} acceptance, from 90 MeV to 80 MeV in order to accept muons
- improved offline background filter: eff. from 95% to 98.5% AND syst. error considerably lower
- events with m_{miss} > 120 MeV are downscaled with a factor 1/1000

m_{trk}, defined by 4-momentum conservation under the hypothesis of 2 equal mass tracks and one □

$$\left(\sqrt{s} - \sqrt{p_1^2 + m_{trk}^2} - \sqrt{p_2^2 + m_{trk}^2}\right)^2 - (p_1 + p_2)^2 = 0$$

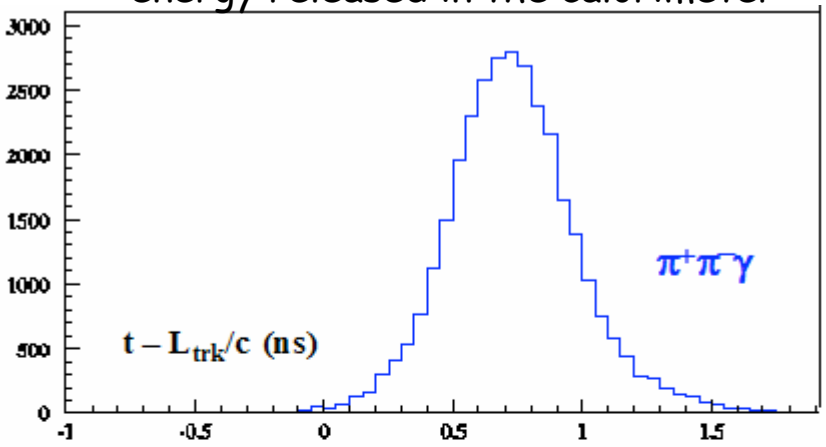
m_{miss}, defined by the 4-momentum conservation under the hypothesis of $e^+e^- \to \pi^+\pi^- X$

$$m_{miss} = \sqrt{E_X^2 - p_X^2}$$

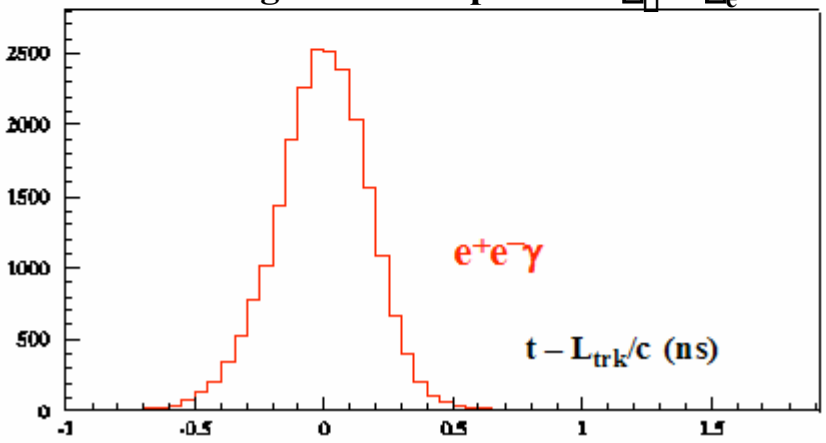


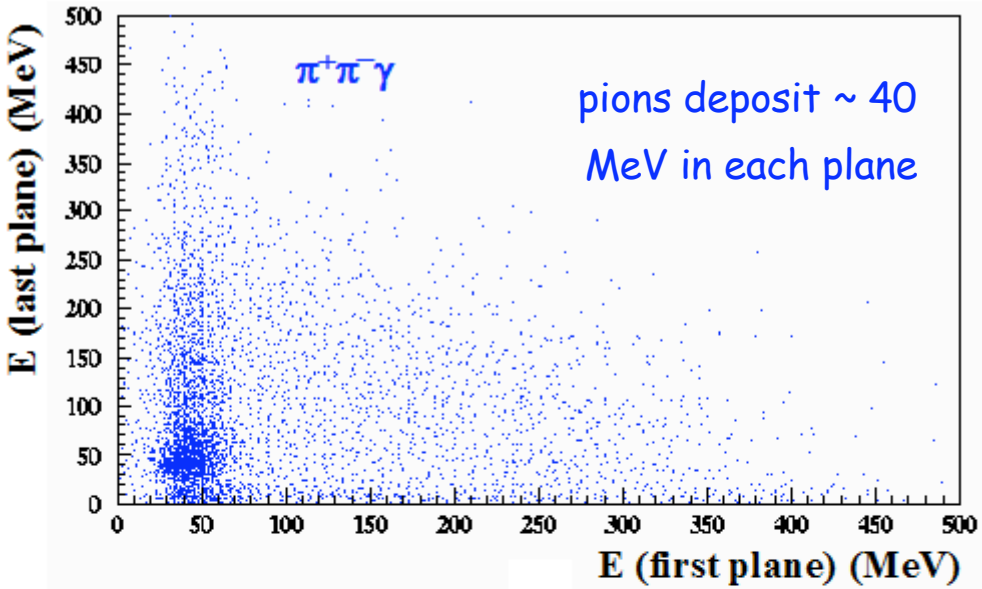
Discrimination □ vs. e: time and energy

□/e separation is performed using a particle ID function based on time and quantity and shape of the energy released in the calorimeter

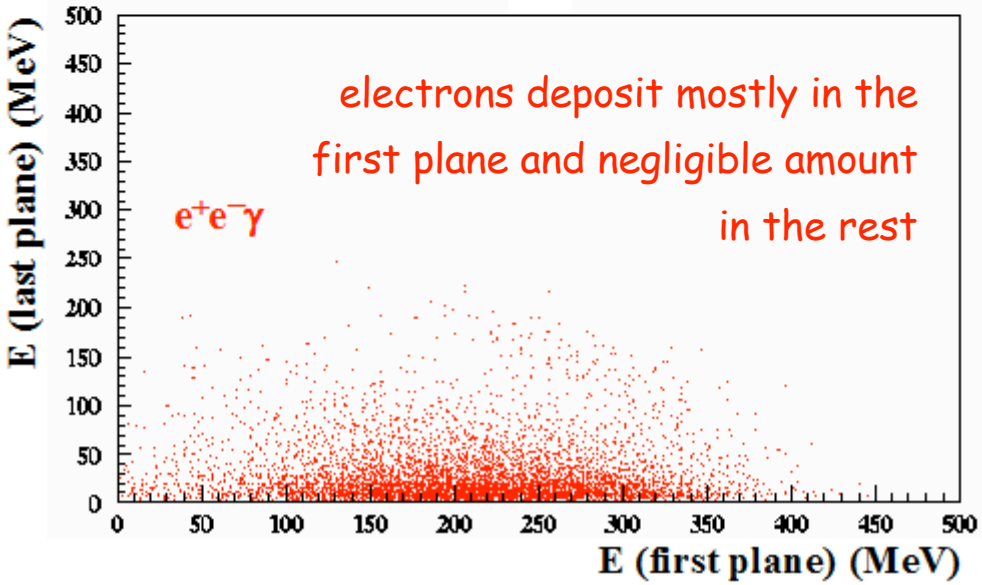


time of flight: for low p values $\beta_\pi \neq \beta_e \sim 1$



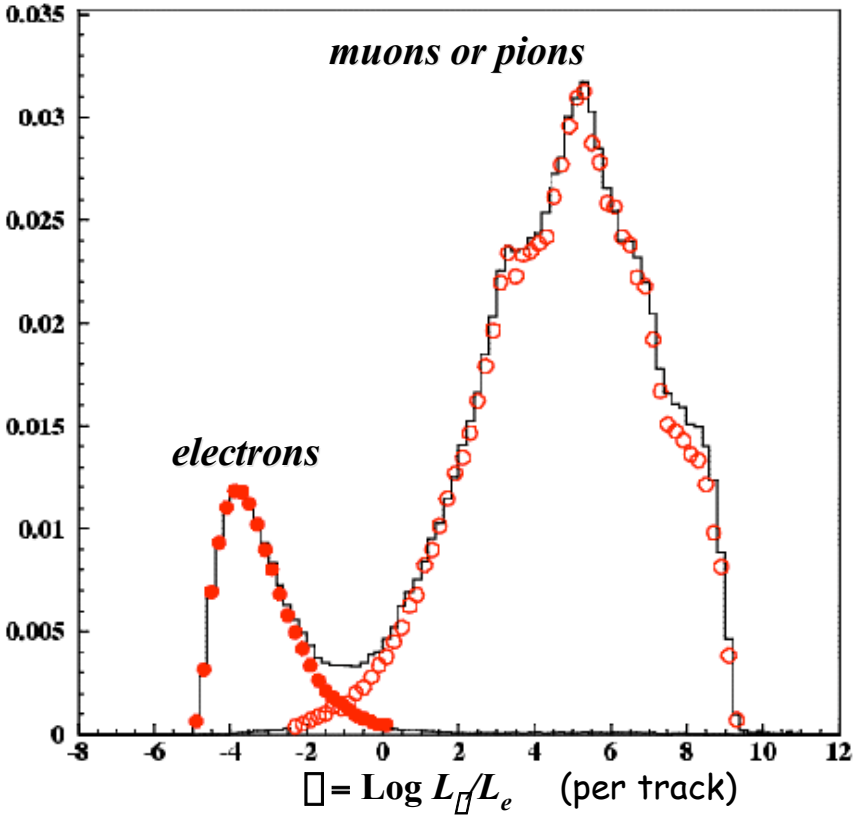


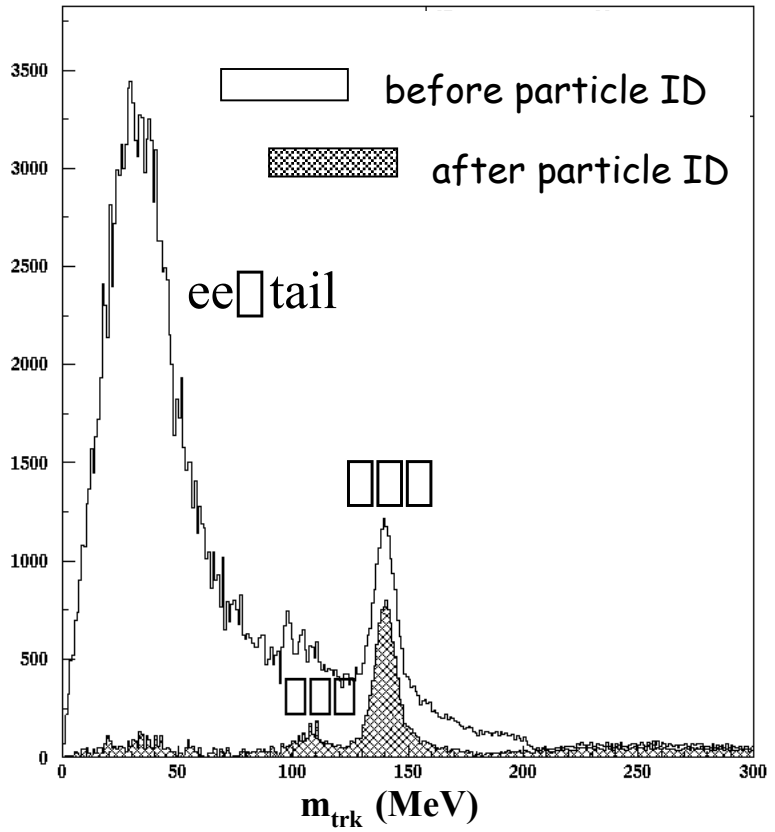
pions deposit ~ 40 MeV in each plane



electrons deposit mostly in the first plane and negligible amount in the rest

Discrimination efficiencies for □□□ and □□□





1) the procedure is tested

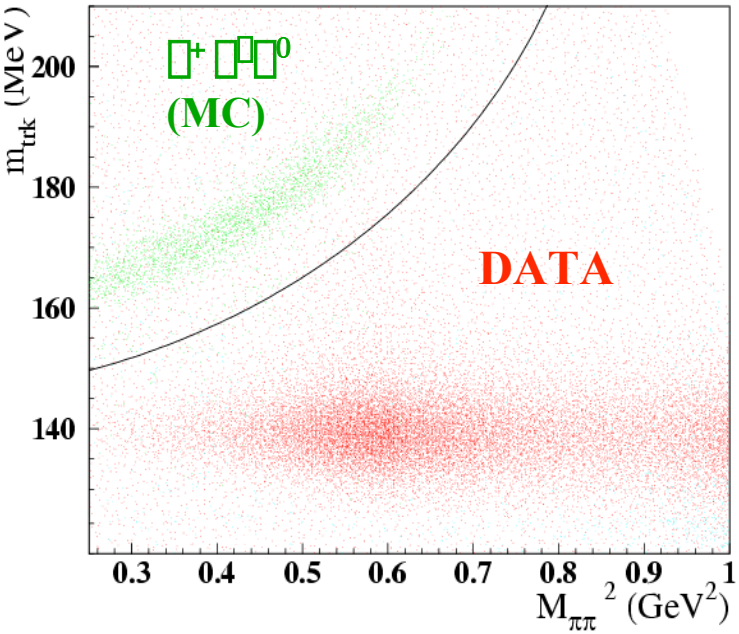
2) the event is selected if at least one of the 2 tracks is not identified to be an electron

it leads to a rejection power ~ 97% for $e^+ e^-$ □ $e^+ e^-$ events while keeping a selection efficiency > 99.8% for $e^+ e^-$ □ $□^+ □^-$, $□^+ □^-$ □ events

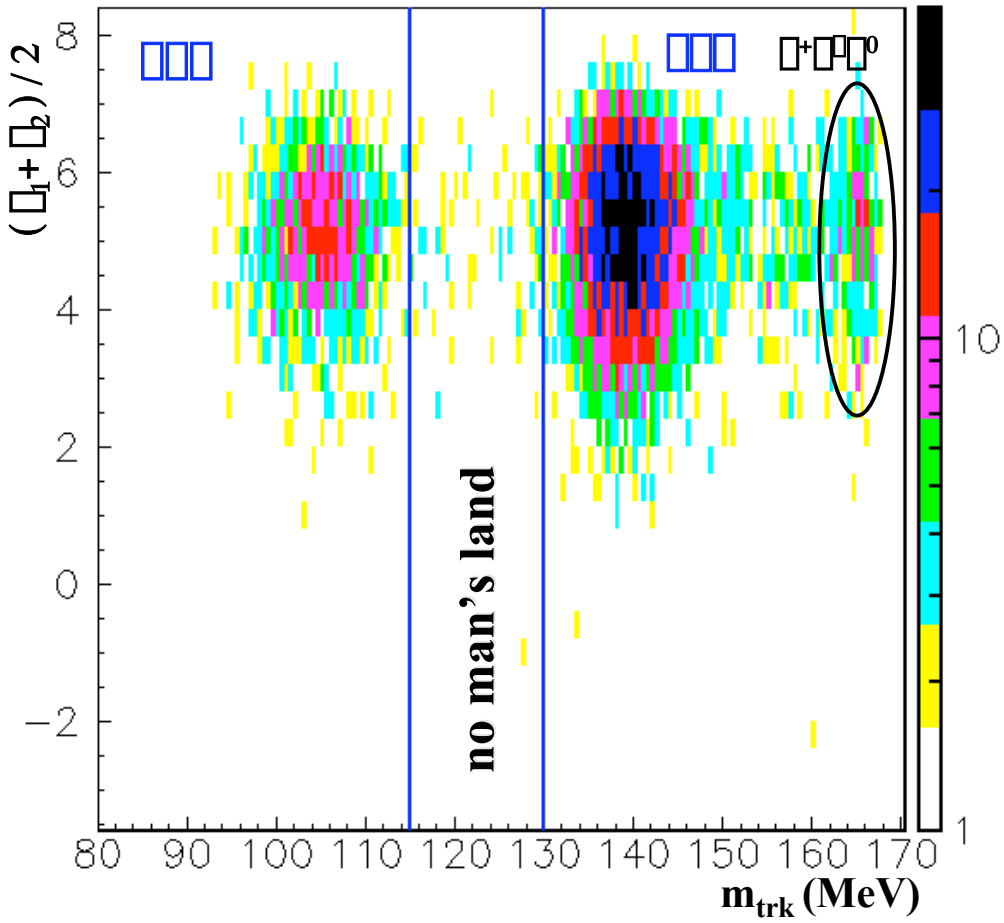
Definition of □□□ and □□□ events (I)

130 MeV < m_{trk} and inside the area, are □□□

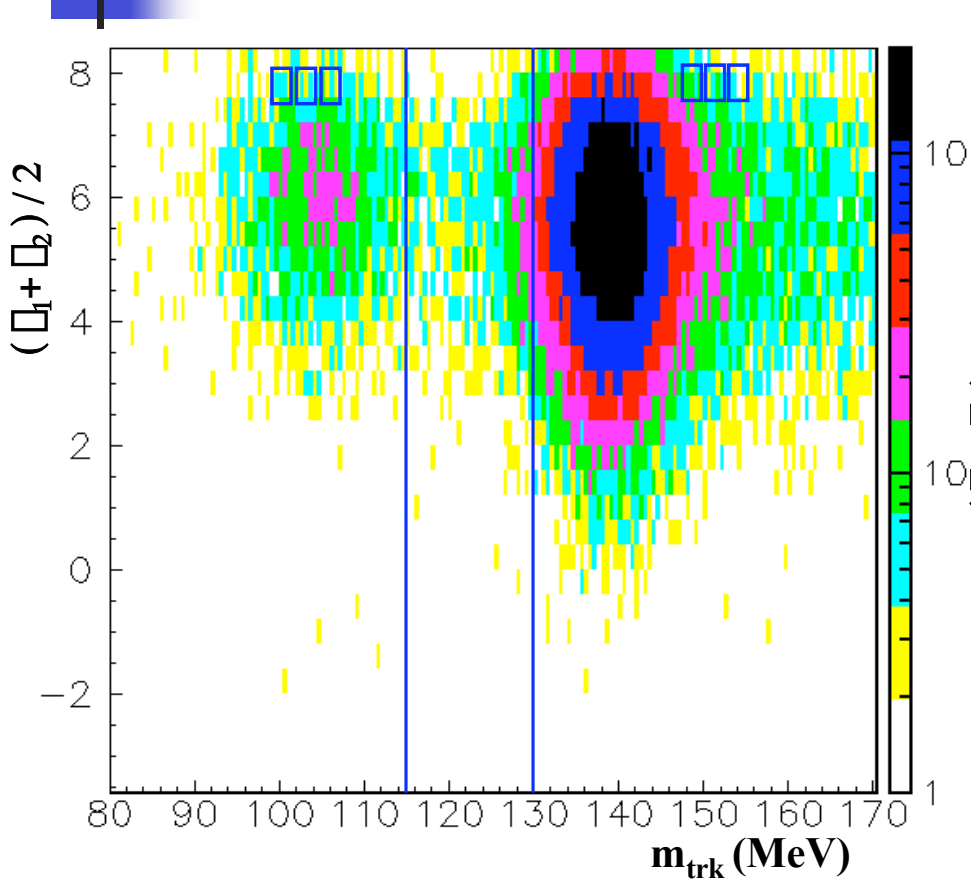
m_{trk} < 115 MeV are □□□

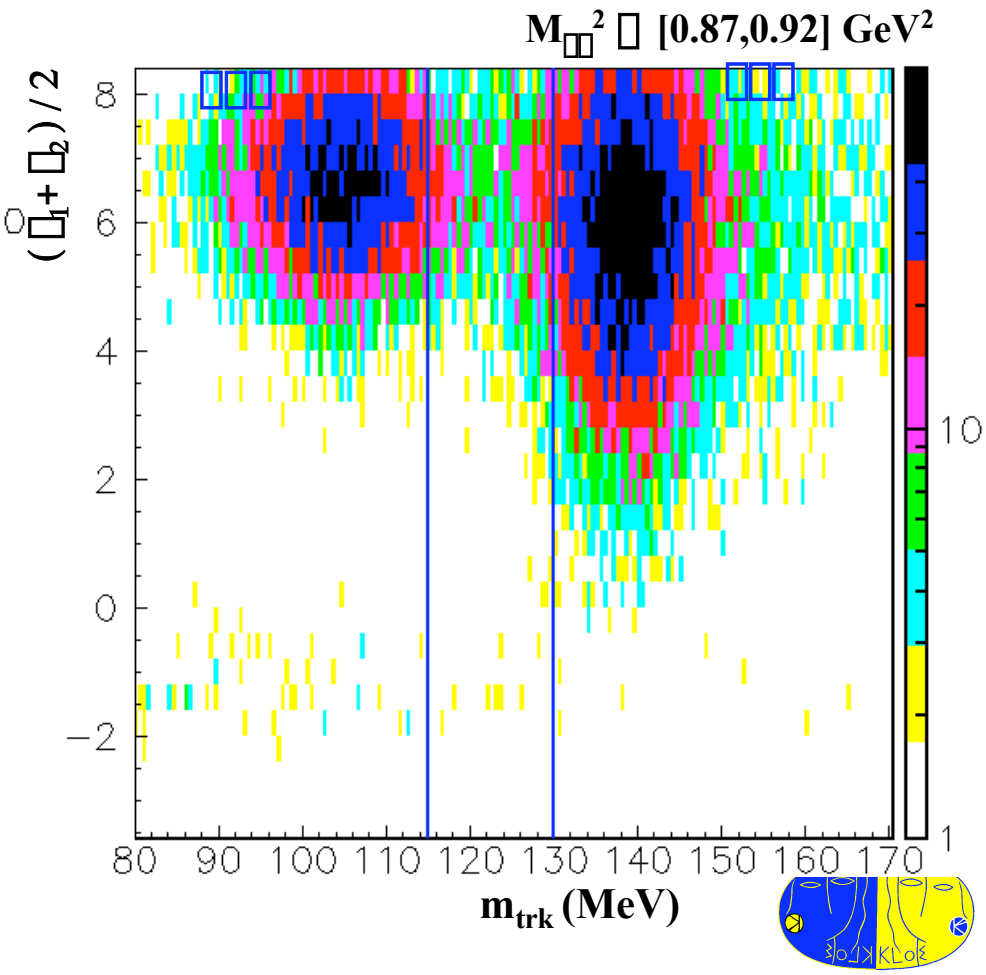


$M_{□□}^2$ □ [0.37,0.42] GeV^2

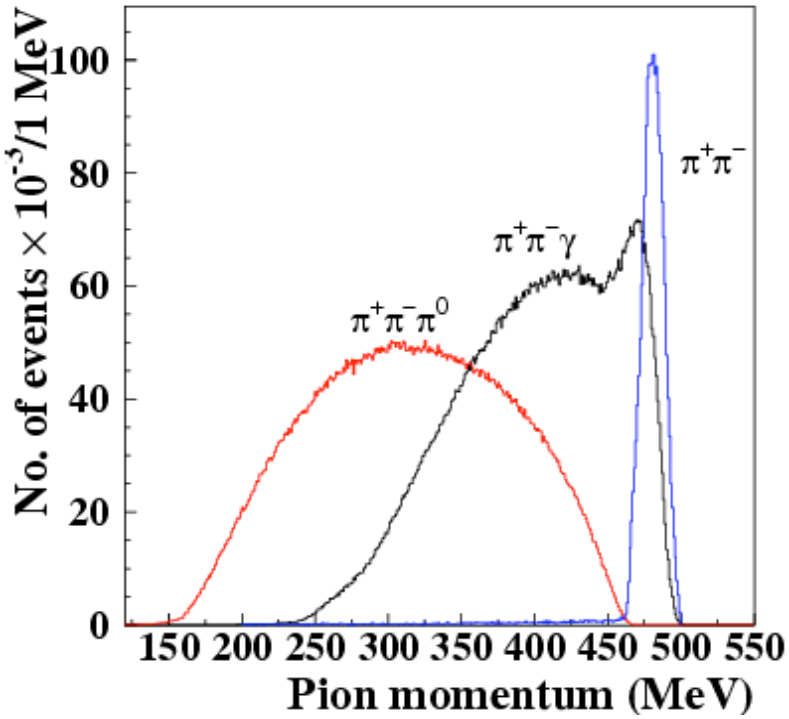


Definition of □□□ and □□□ events (II)





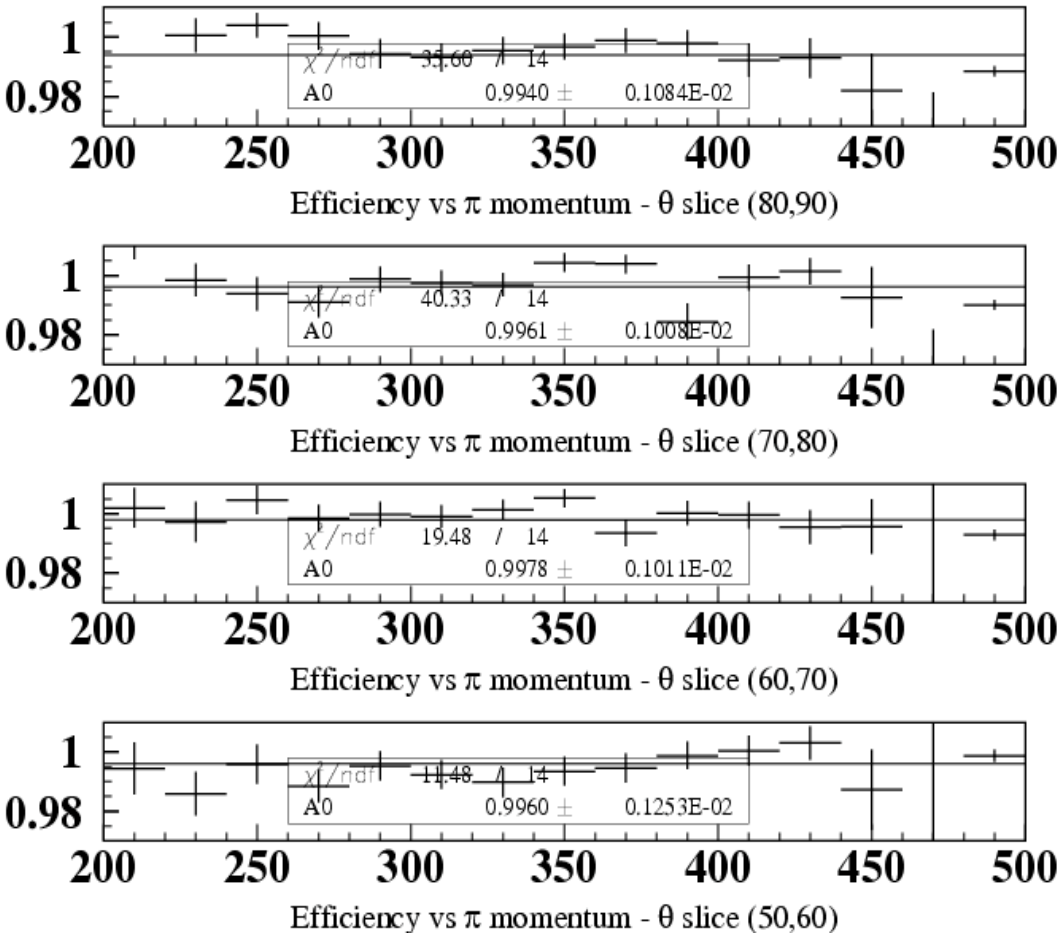
Tracking efficiencies for □□□ events



evaluated from data samples of □⁺□⁻ and □⁺□⁻□⁰ events, and from a MC sample of □⁺□⁻□ events, and compared

the agreement between data and MC is on the level of 0.5-0.6%

preliminary

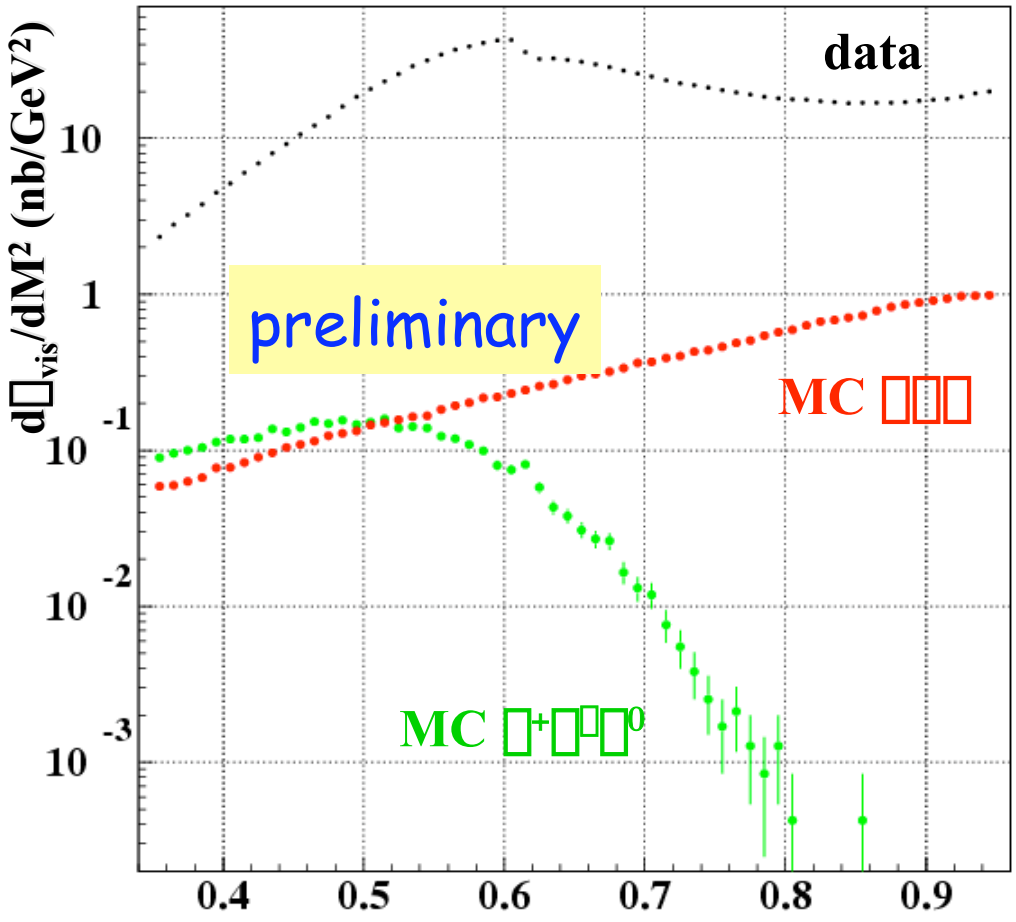


Background for the □□□ selection

background yields are estimated using MC distributions after the whole selection, normalized to the luminosity of the selected data sample

for data and 2 background sources:

$$\frac{d\sigma_{vis}}{dM^2} = \frac{1}{L}\frac{N_{Bin}}{\Delta M^2}$$



The "raw" □□□ spectrum

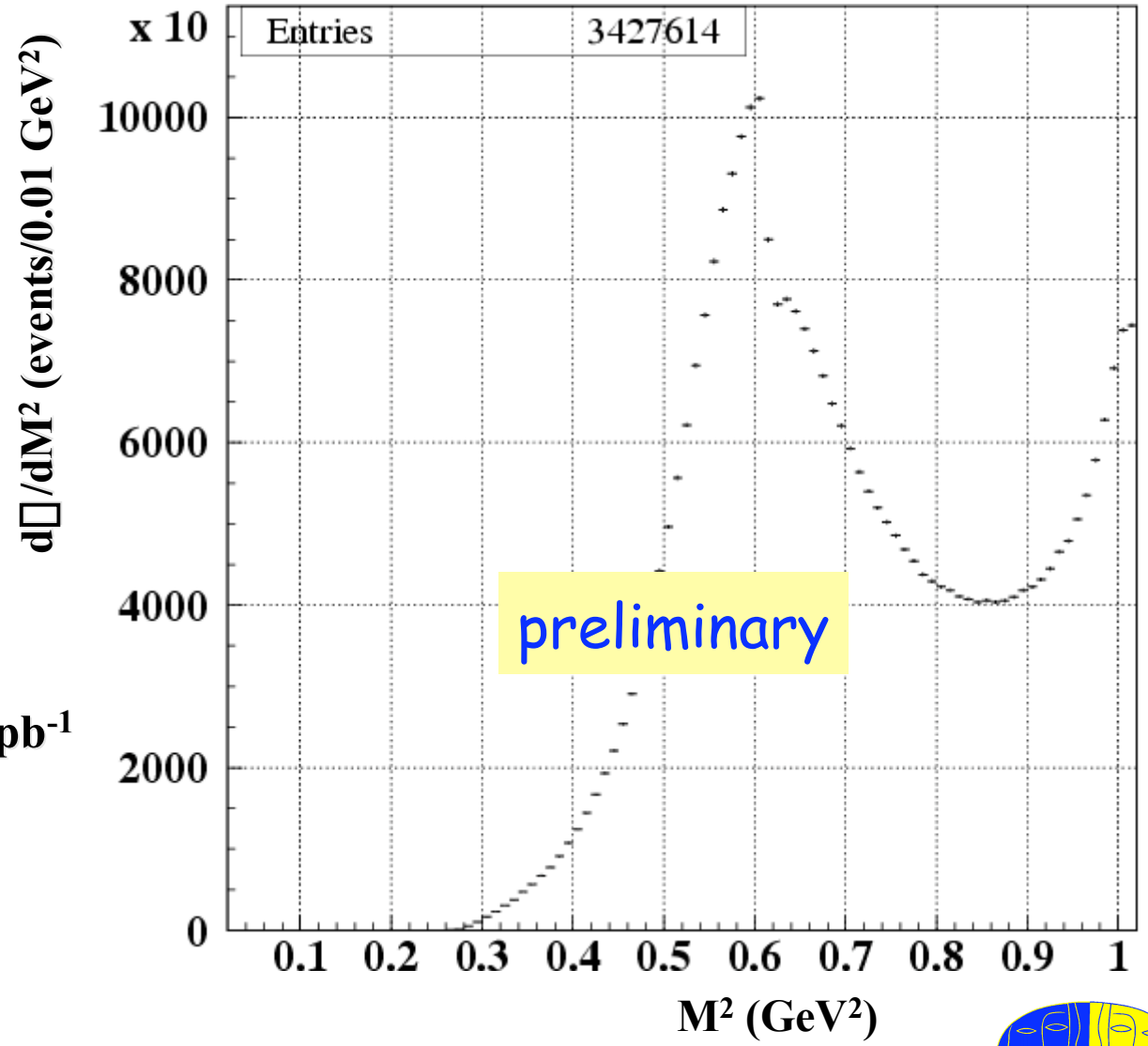
a) pion with 50° < θ_{track} < 130°

b) small angle □($\theta_{\pi\pi}$ < 15□)

c) **m_{trk} > 130 MeV and inside the area (m_{trk} vs $M_{\pi\pi}$)**

d) at least 1 track not to be identified as an electron

$\Delta M_{\pi\pi}^2$ = 0.01 GeV², L = 242 pb⁻¹ of data taken in 2002



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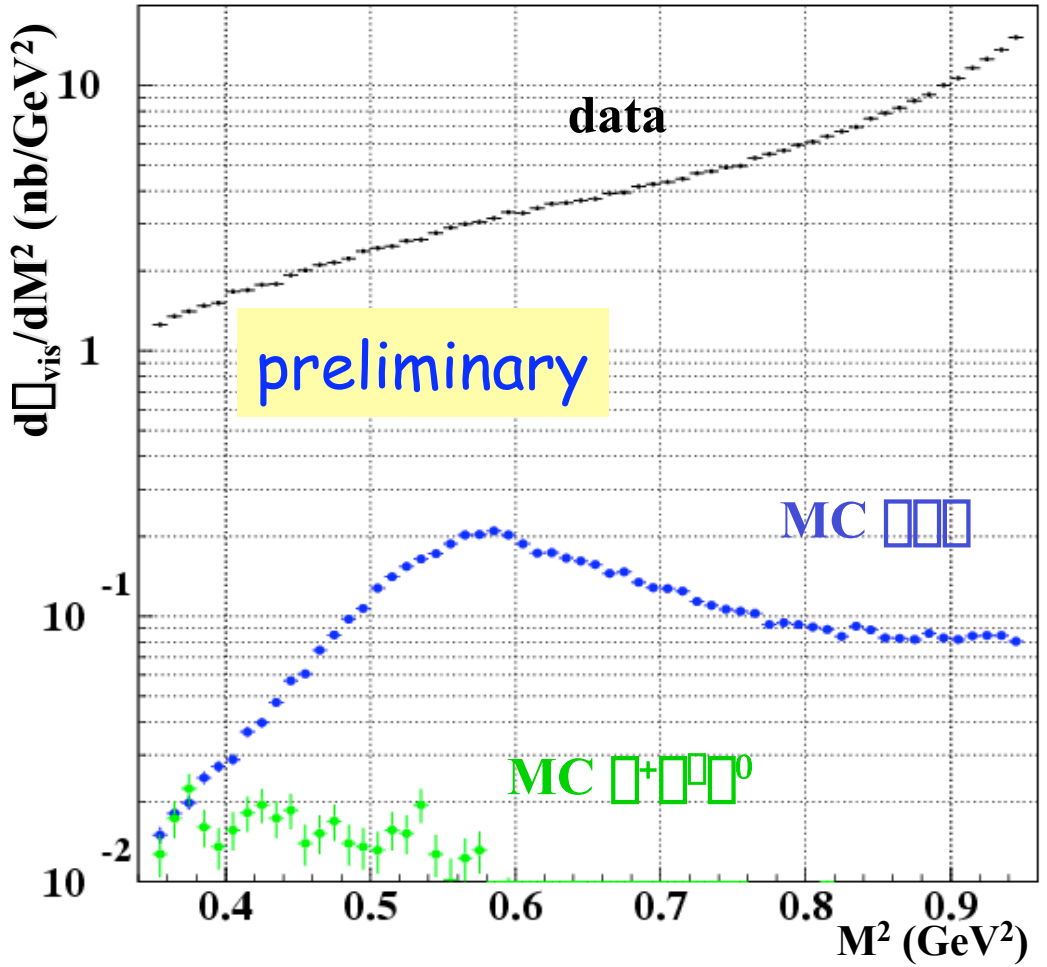


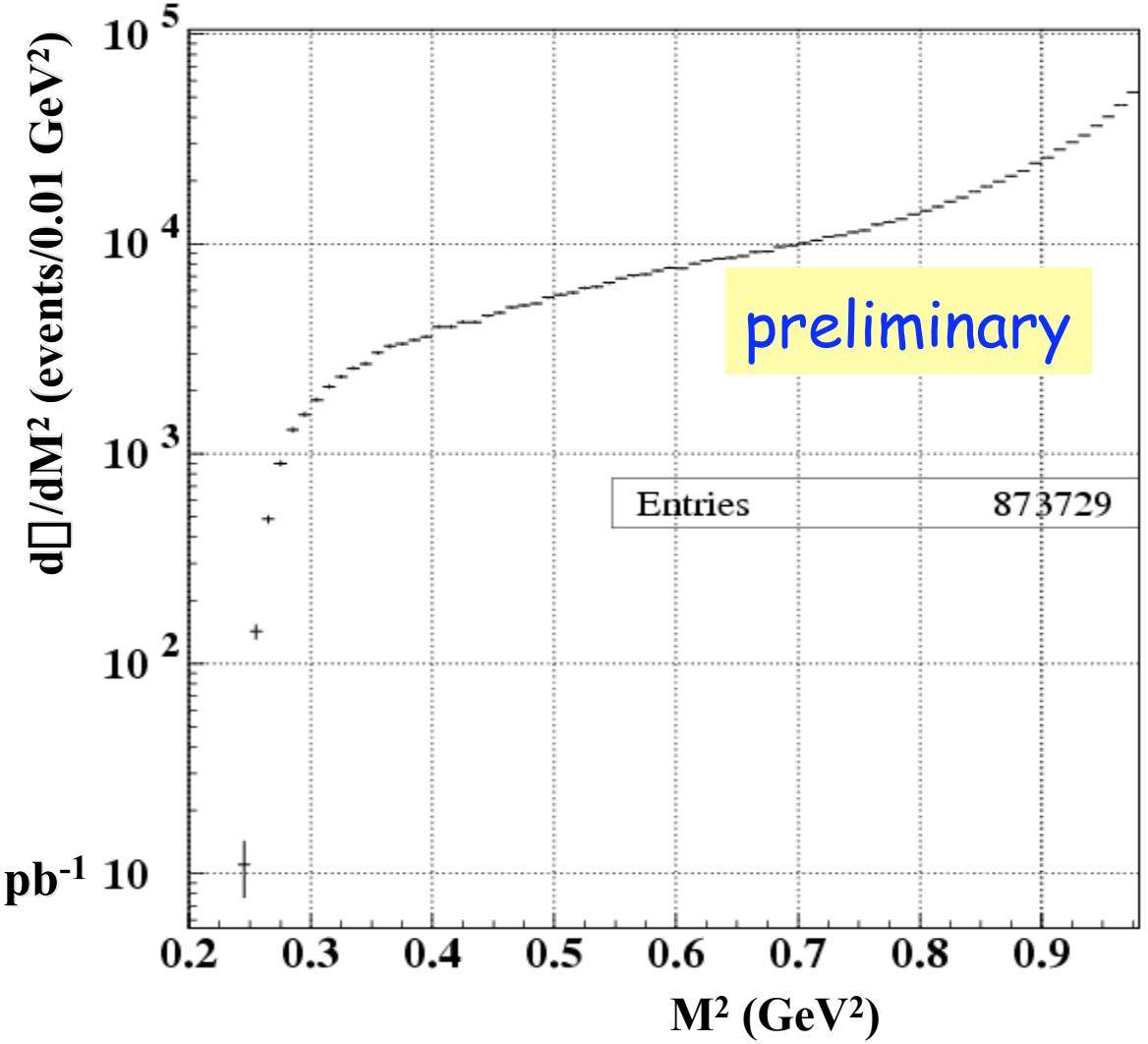
The "raw" □□□ spectrum

a) muon with $50^\circ < \theta_{track} < 130^\circ$

b) small angle □ ($\theta_{\gamma\gamma} < 15^\circ$)

c) m_{trk} < 115 MeV

d) at least 1 track not to be identified as an electron



$\Delta M_{\gamma\gamma}^2$ = 0.01 GeV², L = 242 pb^{-1} of data taken in 2002

Conclusions and perspectives

- the extraction of $F_{\square}$, from both the absolute measurement of ppg events and from the ratio of ppg to mmg events, is in an advanced state,
- these methods allow to cross check systematics,
- we are finalizing the estimate of the corrections and of the systematic uncertainties,
- good control of p/m/e discrimination,
- even on the theory side some improvements are expected

Results will come soon...

Please, stay tuned