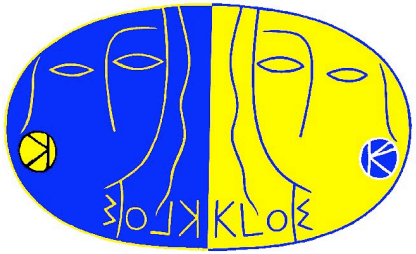
37th Meeting of the LNF Scientific Committee

1st December 2008

KLOE Analysis Report

Federico Nguyen - *INFN Roma TRE*

for the KLOE Collaboration



Analysis Achievements in 2008

10 published papers

1 submitted paper

2 drafts in writing

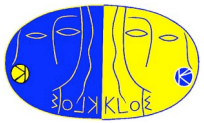
2 published reviews

"Precision Kaon and Hadron Physics with KLOE", Riv. Nuovo Cim.31(2008)531

"$|V_{us}|$ and lepton universality from kaon decays with KLOE", JHEP0804(2008)059

30 contributions to Conferences/Workshops

- hadronic σ
- hadron spectroscopy
- kaon physics



$\sigma(e^+e^- \to \pi^+\pi^-\gamma(\gamma))$ measurement

ACCEPTED by PLB:
ArXiv:0809.3950

Doctopic: Experiments ARTICLE IN PRESS PLB:25375

Physics Letters B ••• (••••) •••–•••

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Measurement of $\sigma(e^+e^- \to \pi^+\pi^-\gamma(\gamma))$ and the dipion contribution to the muon anomaly with the KLOE detector

KLOE Collaboration

1)
$$\frac{d\sigma^{obs}_{\pi\pi\gamma(\gamma)}}{dM^2_{\pi\pi}} = \frac{\Delta N_{Obs} - \Delta N_{Bkg}}{\Delta M^2_{\pi\pi}} \cdot \frac{1}{\varepsilon_{Sel}} \cdot \frac{1}{\int Ldt}$$

$d\sigma_{\pi\pi\gamma(\gamma)}/dM^2$ is obtained by subtracting background from observed event spectrum, divide by selection efficiencies, and ***int. luminosity***:

2)
$$\sigma_{\pi\pi}(s) \approx s \frac{d\sigma^{obs}_{\pi\pi\gamma(\gamma)}}{dM^2_{\pi\pi}} \cdot \frac{1}{H(s)}$$

Obtain $\sigma_{\pi\pi}$ from (ISR) - radiative cross section $d\sigma_{\pi\pi\gamma(\gamma)}/dM^2$ via theoretical radiator function H(s):

3)
$$|F_\pi|^2 = \frac{3s}{\pi\alpha^2\beta^3_\pi}\sigma_{\pi\pi}(s)$$

Relation between $|F_\pi|^2$ and the cross section $\sigma(e^+e^- \to \pi^+\pi^-)$

Consistent results on $\Delta a_\mu^{\pi\pi}$

ACCEPTED by PLB:
ArXiv:0809.3950

Systematic errors on $a_\mu^{\pi\pi}$:

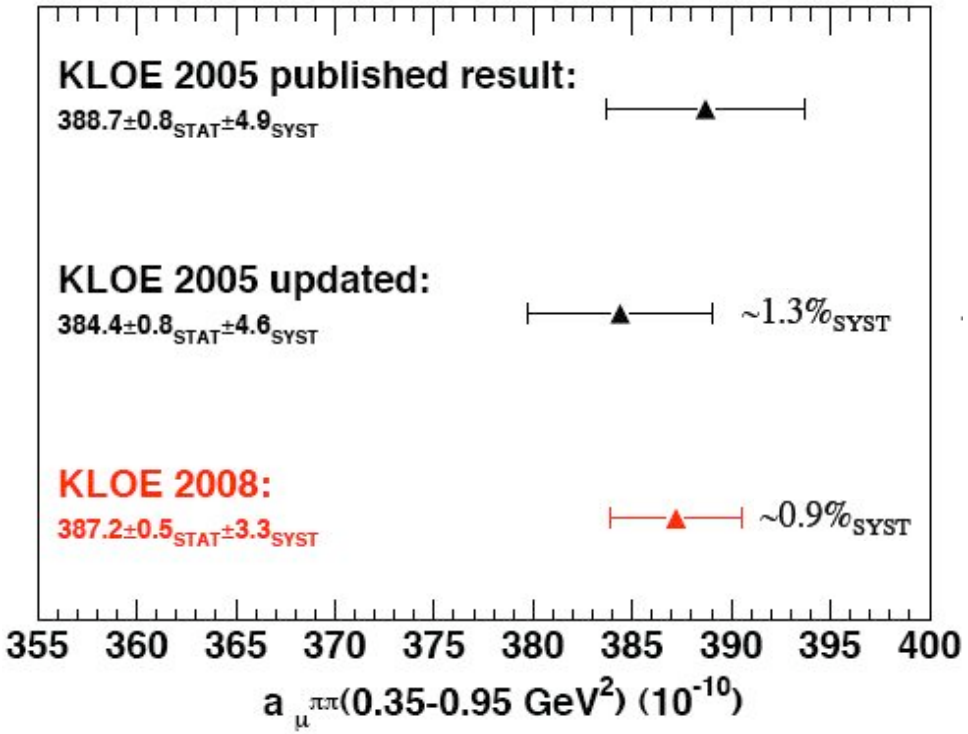
Reconstruction Filter	negligible
Background	0.3%
Trackmass/Miss. Mass	0.2%
π/e-ID and TCA	negligible
Tracking	0.3%
Trigger	0.1%
Acceptance ($\theta_{\pi\pi}$)	0.1%
Acceptance (θ_π)	negligible
Unfolding	negligible
Software Trigger	0.1%
$\sqrt{s}$ dep. Of H	0.2%
Luminosity($0.1_{th} \oplus 0.3_{exp}$)%	0.3%

experimental fractional error on a_μ = 0.6 %

FSR resummation	0.3%
Radiator H	0.5%
Vacuum polarization	0.1%

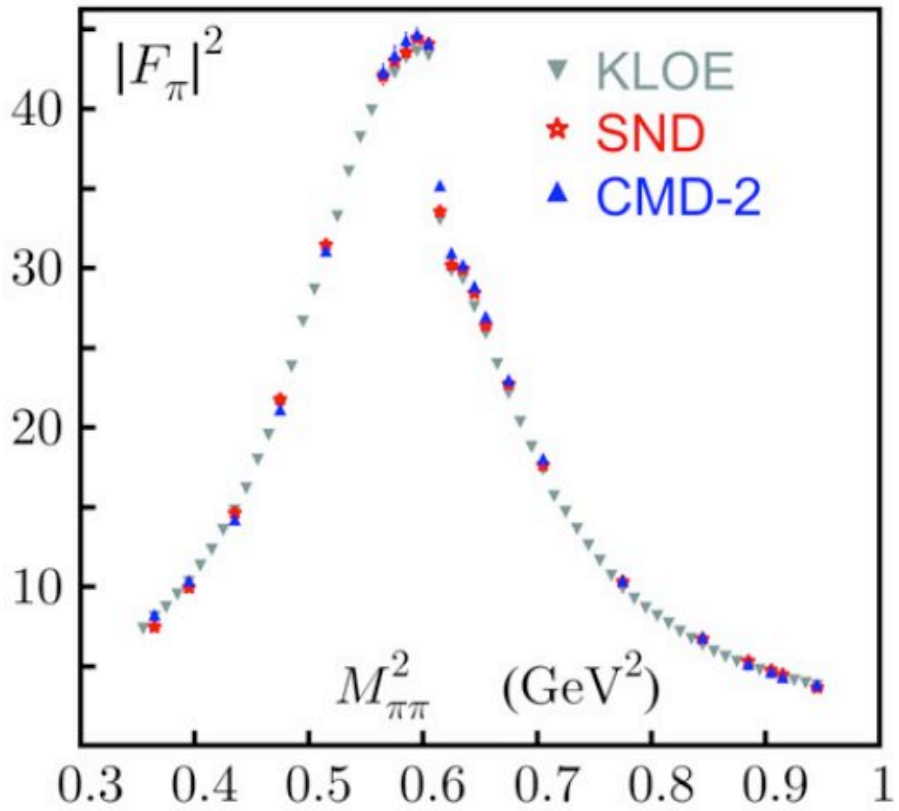
theoretical fractional error on a_μ = 0.6 %

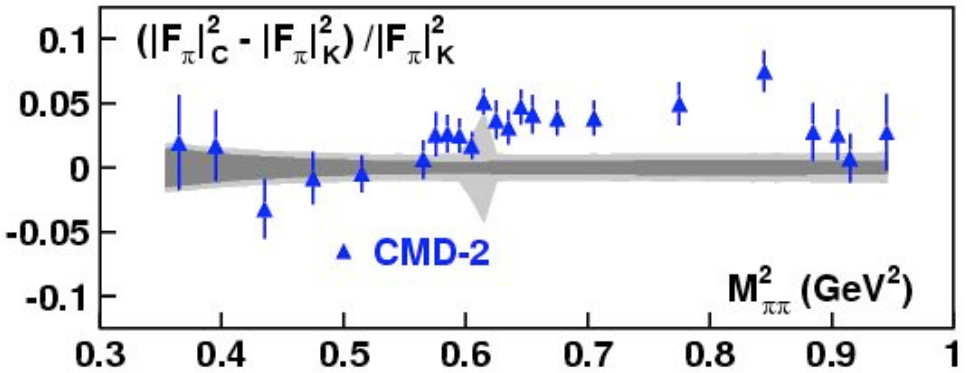
$$\Delta a_\mu^{\pi\pi} = \frac{1}{4\pi^3} \int_{0.35\mathrm{GeV}^2}^{0.95\mathrm{GeV}^2} ds\, \sigma(e^+e^- \to \pi^+\pi^-)\, K(s)$$

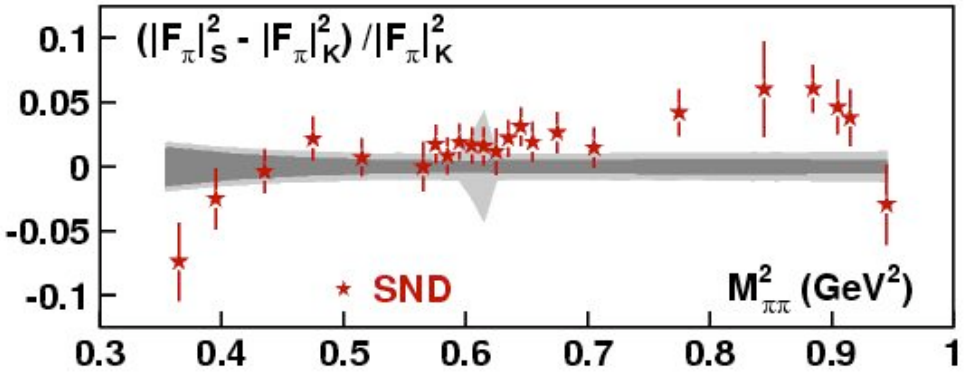


Comparisons on F_π

ACCEPTED by PLB:
ArXiv:0809.3950



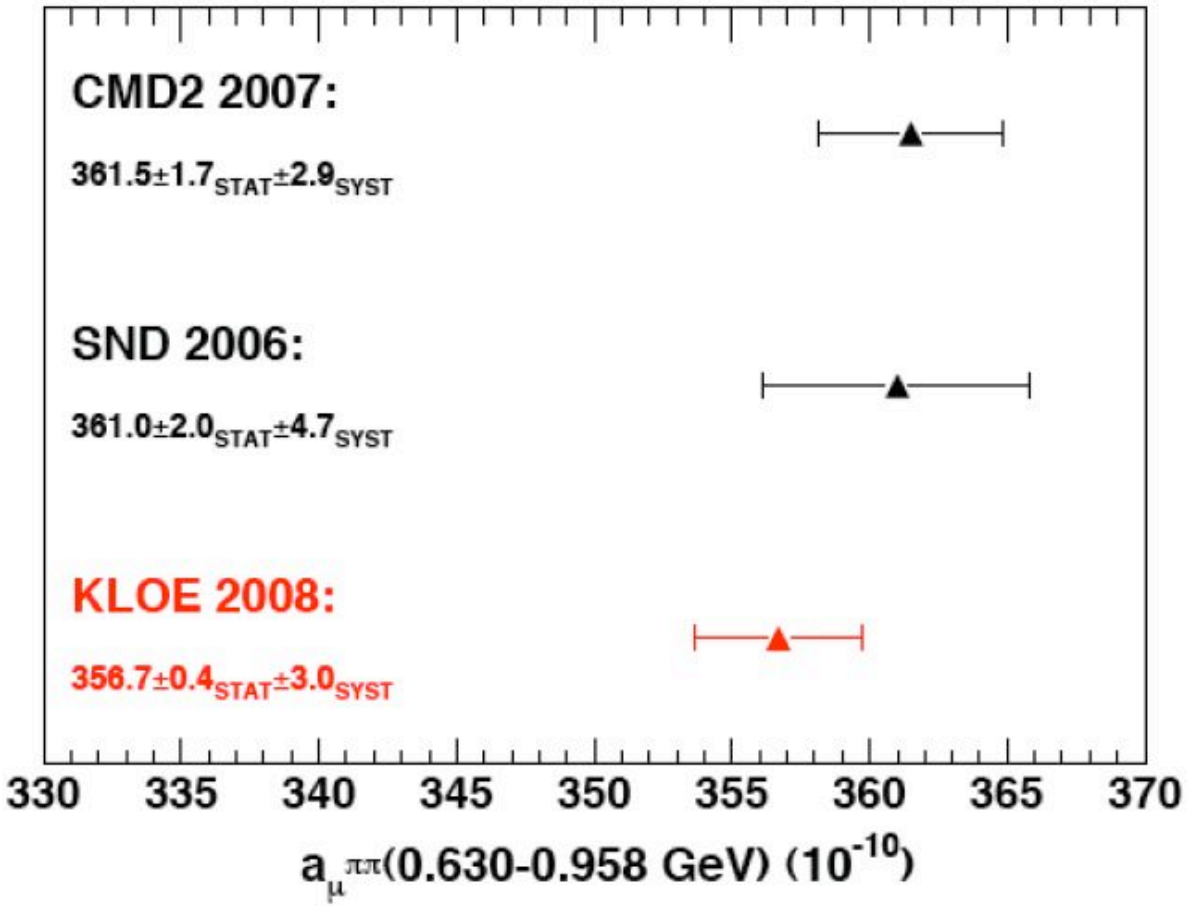




much better agreement in spectrum between different experiments than in the past

Recent comparisons on $\Delta a_\mu^{\pi\pi}$

ACCEPTED by PLB:
ArXiv:0809.3950

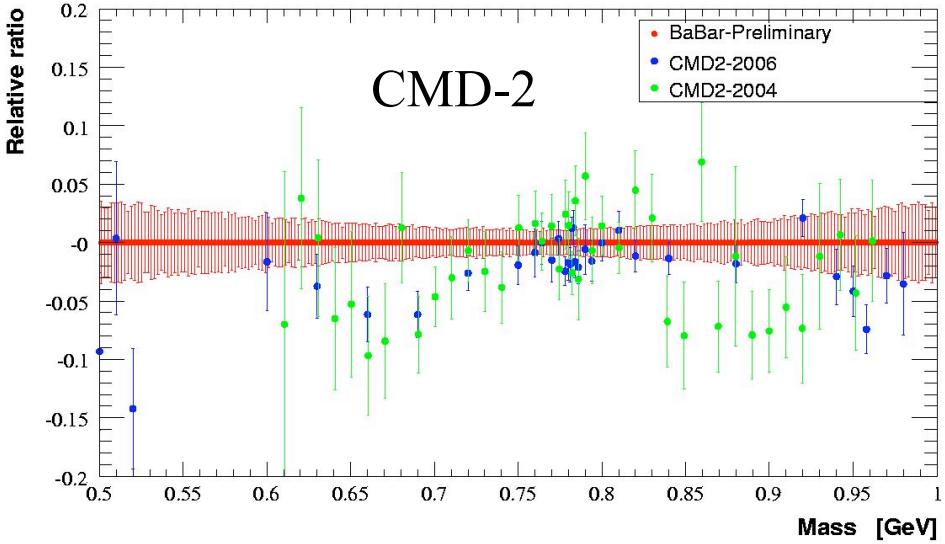


average value = 359.2 ± 2.1 with $\chi^2/\text{dof} = 1.24/2$

confidence level of 54%

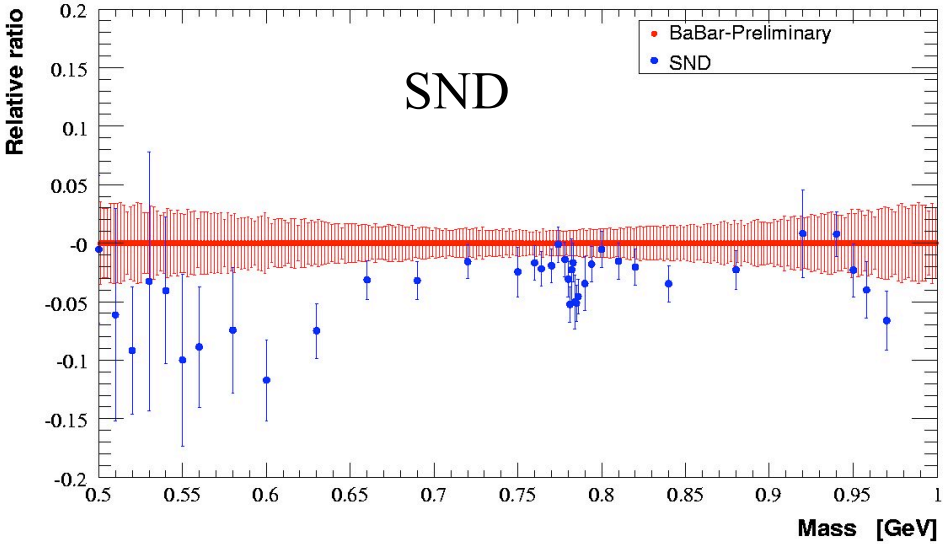
Recent comparisons on F_π

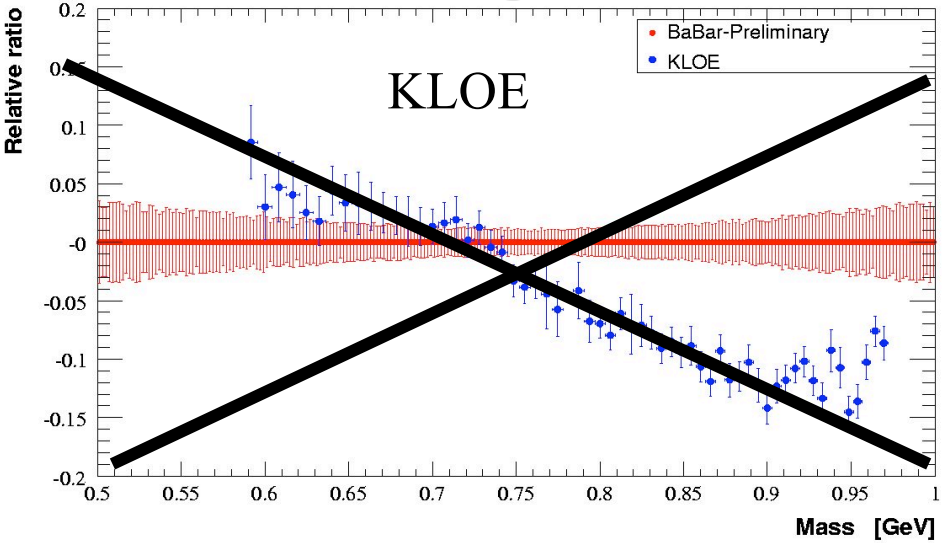
from M. Davier's talk at TAU 2008



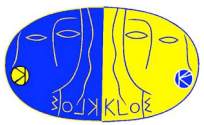
Wrong reading of our old published data points, i.e. lower bin edge instead of the central value

Please, ignore it!





- hadronic σ
- hadron spectroscopy
- kaon physics



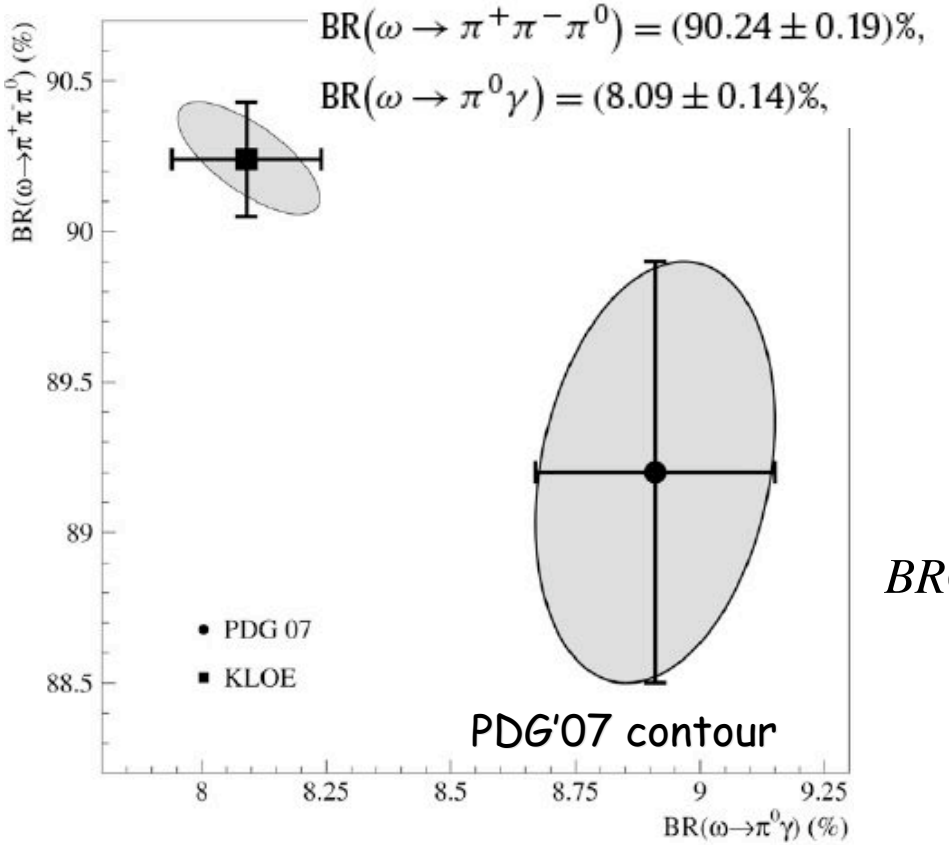
Main ω branching ratios

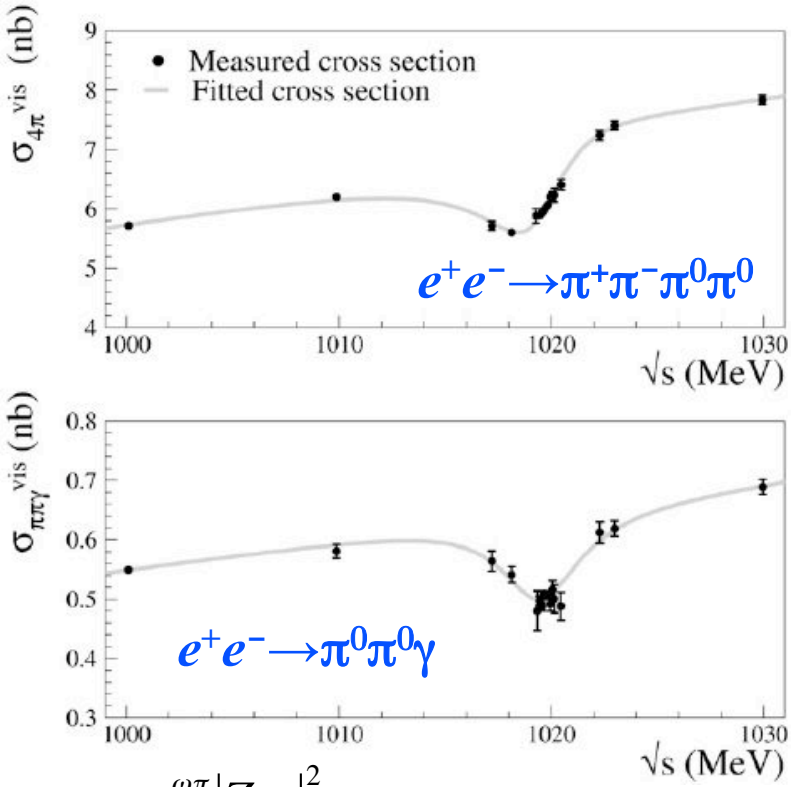
PUBLISHED: PLB669(2008)223

large interference between non-resonant $e^+e^- \to \omega\pi^0$ and $\phi \to \omega\pi$ decay

energy scan data ~ 600 pb^{-1} → measure x-sec & BR($\phi \to \omega\pi$).

$$\sigma(s) = \sigma_0(s) \cdot \left| 1 - Z \frac{M_\phi \Gamma_\phi}{D_\phi} \right|$$





$$BR(\phi \to \omega\pi^0) = \frac{\sigma_0^{\omega\pi} |Z_{4\pi}|^2}{\sigma_\phi} = (4.4 \pm 0.6) \times 10^{-5}$$

$$\mathbf{SND(2000): BR(\phi \to \omega\pi^0) = (5.2^{+1.3}_{-1.1}) \times 10^{-5}}$$

Search for $a_0(980)/f_0(980) \to K^0\bar{K}^0$

FINAL:
Writing the paper

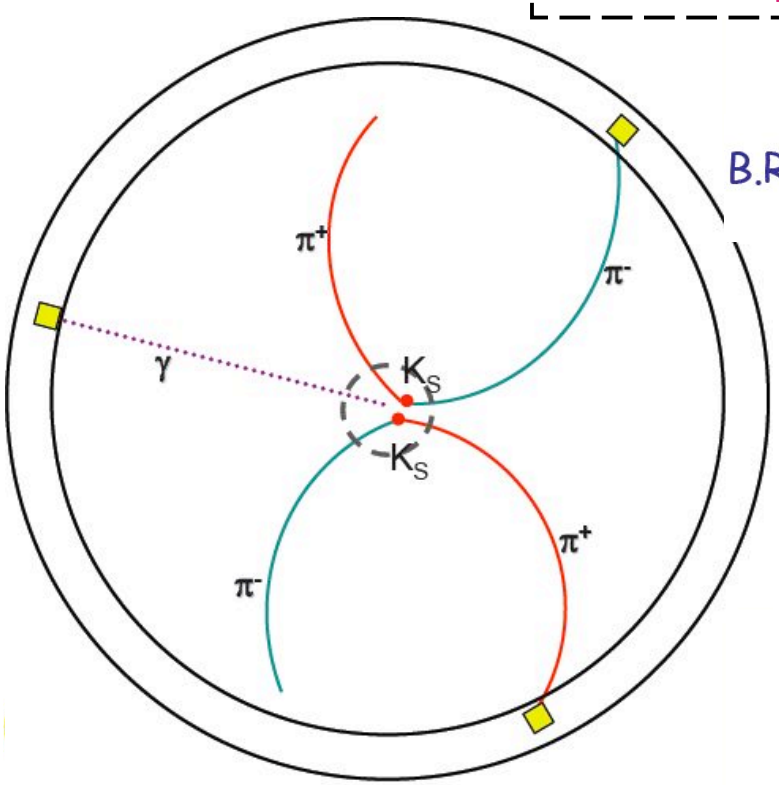
- ✓ probe of the internal structure of scalar mesons
- ✓ look for the decay $\phi \to K\bar{K}\gamma$ having the kaon pair $J^{PC} = 0^{++}$

$$\phi[J^{PC}=1^{--}] \to \underbrace{(K^0\bar{K}^0)}\gamma[J^{PC}=1^{--}]$$

$$\downarrow$$

$$\frac{1}{\sqrt{2}}\left(|K_S K_S\rangle - |K_L K_L\rangle\right)$$

look for $\phi \to K_S K_S \gamma \to \pi^+\pi^-\pi^+\pi^-\gamma$, $E_\gamma \sim 24$ MeV



$$B.R.(\Phi \to K^0\bar{K}^0\gamma) < \frac{UL(\mu_{sig})\ @\ 90\%CL}{\int Ldt \cdot \sigma(e^+e^- \to \Phi) \cdot \frac{1}{2} \cdot B.R.(K_S \to \pi^+\pi^-)^2 \cdot \varepsilon}$$

N_{obs}=5 observed events

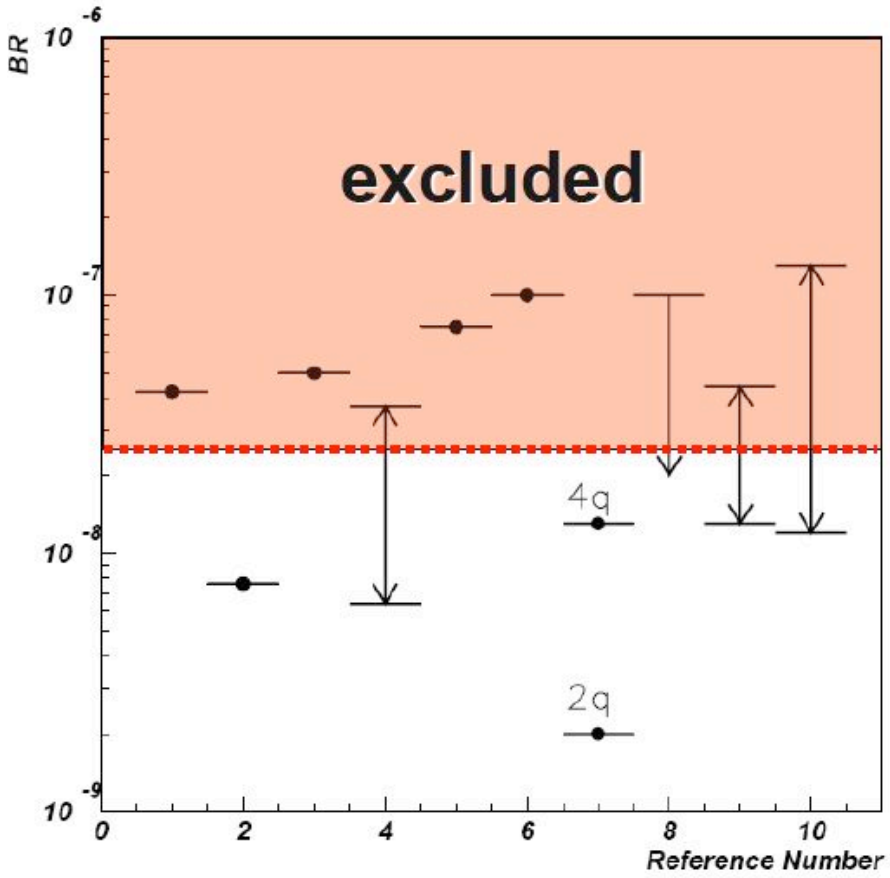
N_{bkg}=3.2 expected background events

$UL(\mu_{sig})$ at 90% C.L. = 6.79

Search for $a_0(980)/f_0(980) \rightarrow K^0\overline{K}^0$

FINAL:
Writing the paper

$B.R.(\phi \rightarrow (f_0 + a_0)\gamma \rightarrow K^0\overline{K}^0\gamma) < 1.7 \cdot 10^{-8}$ at 90% C.L.

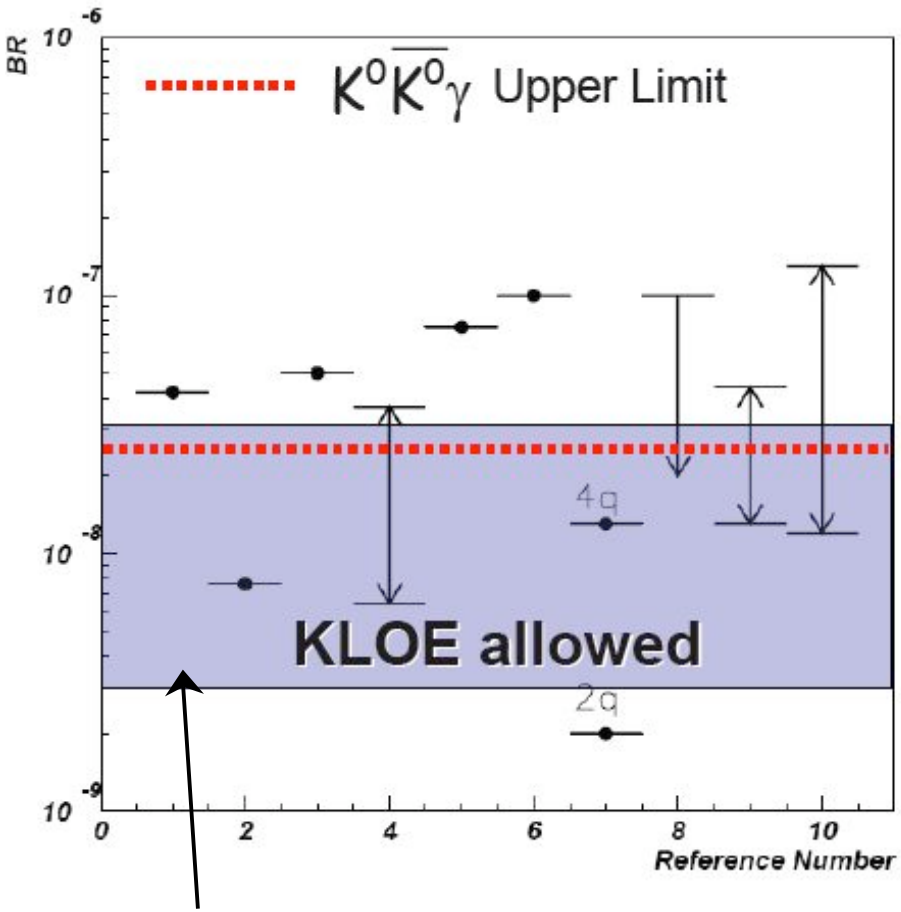


1. S.Fajfer, R.J.Oakes, Phys.Rev.D42 (1990) 2392
2. A.Bramon, A.Grau, G.Pancheri, Phys.Lett.B289, 97 (1992)
3. J.A.Oller Phys.Lett.B426, 7 (1998)
4. J.A.Oller, Nucl.Phys.A714 (2003) 161
5. R.Escribano, Eur.Phys.J.A31, 454 (2007)
6. S.Nussinov, T.N.Truong, Phys.Rev.Lett.63 (1989) 1349, Erratum 2003
7. N.N.Achasov, V.N.Ivanchenko, Nucl.Phys.B315, 465 (1989)
8. J.Lucio, J.Pestieau, Phys.Rev.D42 (1990) 3253
9. N.N.Achasov, V.V.Gubin, Phys.Rev.D64, 094016 (2001)
10. A.Gokalp, C.S.Korkmaz, O.Yilmaz, hep-ph/0702214

Search for $a_0(980)/f_0(980) \to K^0\overline{K}^0$

FINAL:
Writing the paper

$B.R.(\phi \to (f_0 + a_0)\gamma \to K^0\overline{K}^0\gamma) < 1.7 \cdot 10^{-8}$ at 90% C.L.



KLOE postdiction after fits of the

$\phi \to f_0\gamma \to \pi\pi\gamma$ and $\phi \to a_0\gamma \to \eta\pi\gamma$ spectra

1. S.Fajfer, R.J.Oakes, Phys.Rev.D42 (1990) 2392
2. A.Bramon, A.Grau, G.Pancheri, Phys.Lett.B289, 97 (1992)
3. J.A.Oller Phys.Lett.B426, 7 (1998)
4. J.A.Oller, Nucl.Phys.A714 (2003) 161
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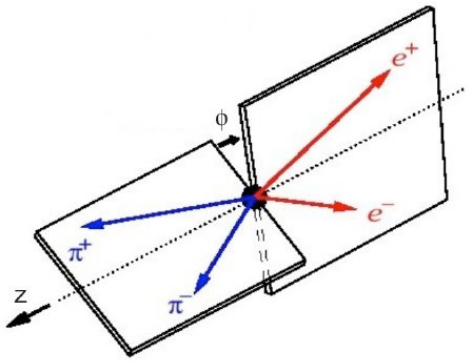
Measurement of BR($\eta \to \pi\pi ee(\gamma)$)

FINAL:
Writing the paper

Test of non-CKM CP violation

Mod.PhysLett.A17
1583-1588.2002

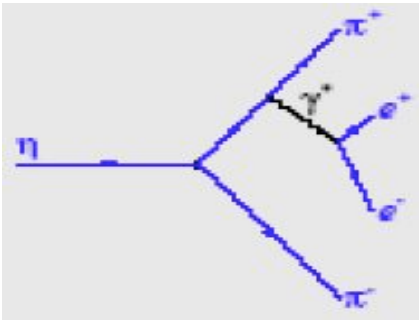
Angular asymmetry between ee and $\pi\pi$ planes, A_{CP}



$$A_\phi = \frac{N_{\sin\phi\cos\phi>0} - N_{\sin\phi\cos\phi<0}}{N_{\sin\phi\cos\phi>0} + N_{\sin\phi\cos\phi<0}}$$

SM value constrained by UL(BR($\eta \to \pi^+\pi^-$)):

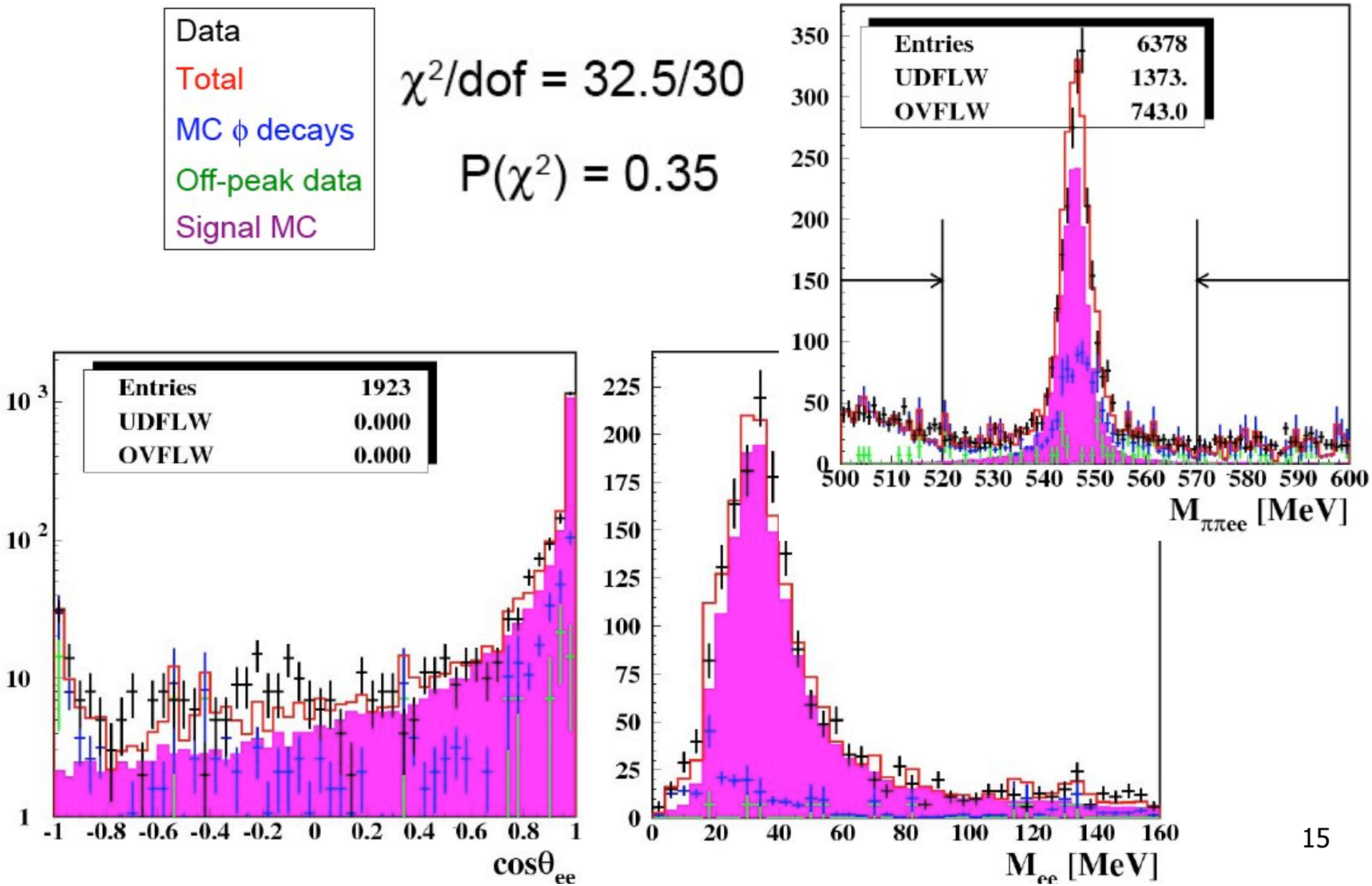
$A_{CP} < 10^{-4}$



the unconventional ~~CP~~ term increases A_{CP} up to 10^{-2}

Measurement of BR($\eta \to \pi\pi ee(\gamma)$)

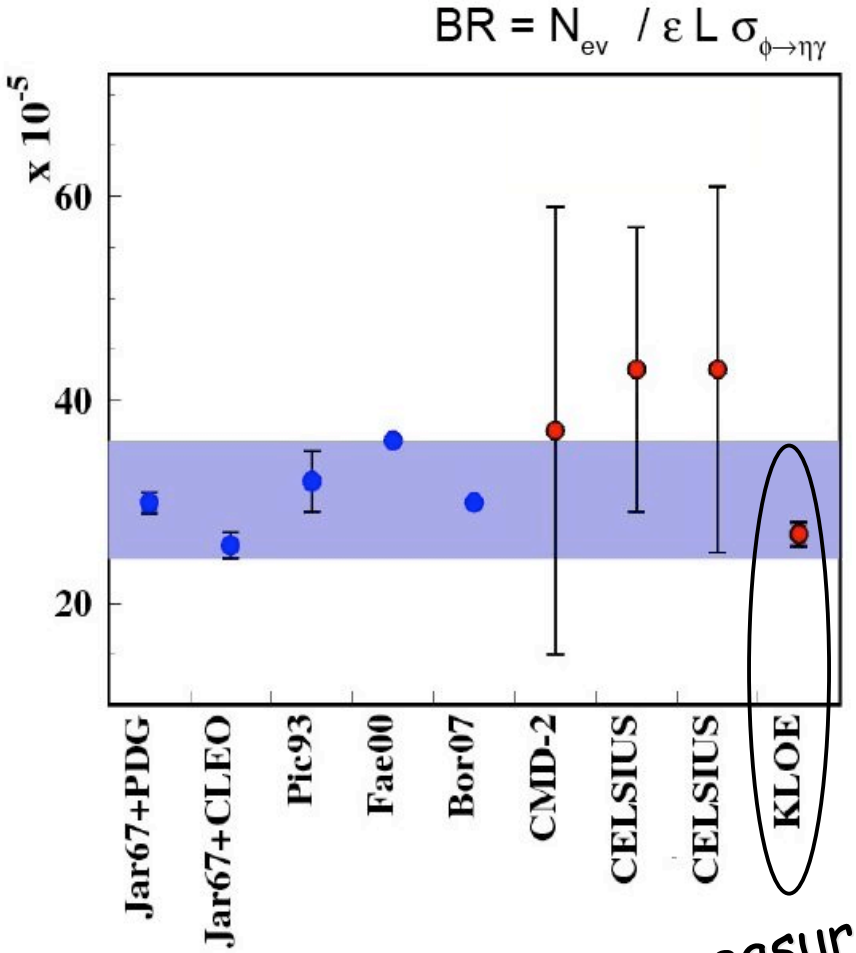
FINAL:
Writing the paper

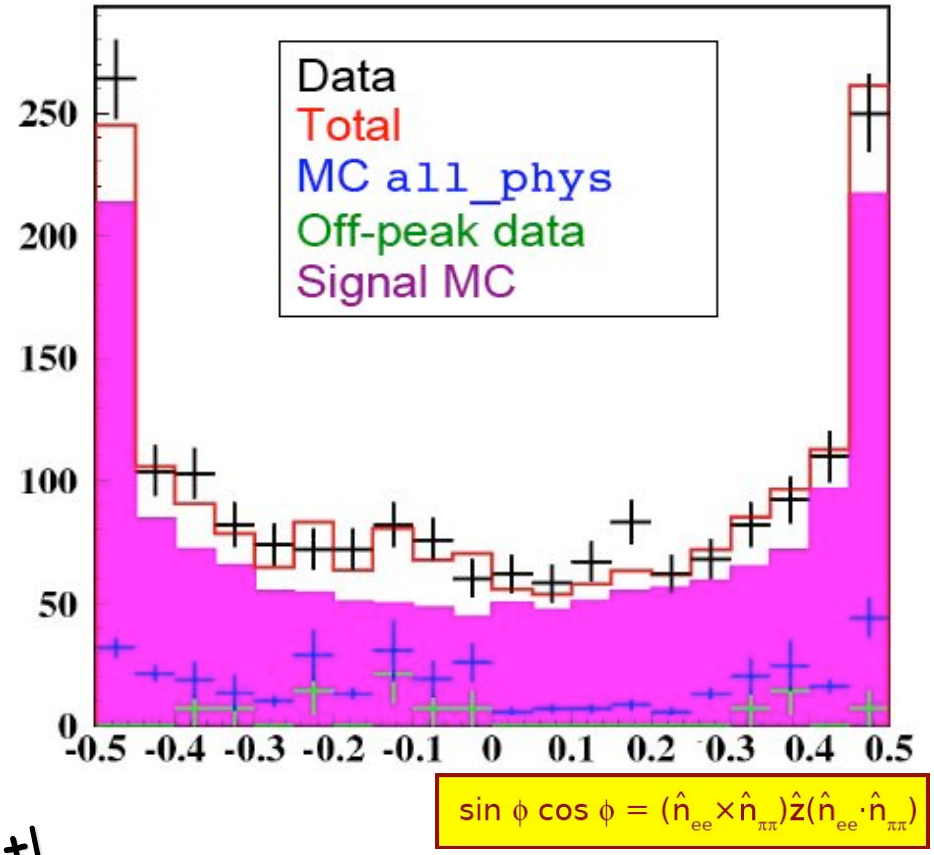


Measurement of BR($\eta \to \pi\pi ee(\gamma)$)

FINAL:
Writing the paper

$$BR(\eta \to \pi^+ \pi^- e^+ e^- (\gamma)) = (26.8 \pm 0.9_{Stat.} \pm 0.4_{Norm.} \pm 0.6_{Syst.}) \cdot 10^{-5}$$





1st measurement!

$$A_\phi = (-0.6 \pm 2.5_{Stat.} \pm 1.7_{Syst.} \pm 0.5_{Corr.}) \cdot 10^{-2}$$

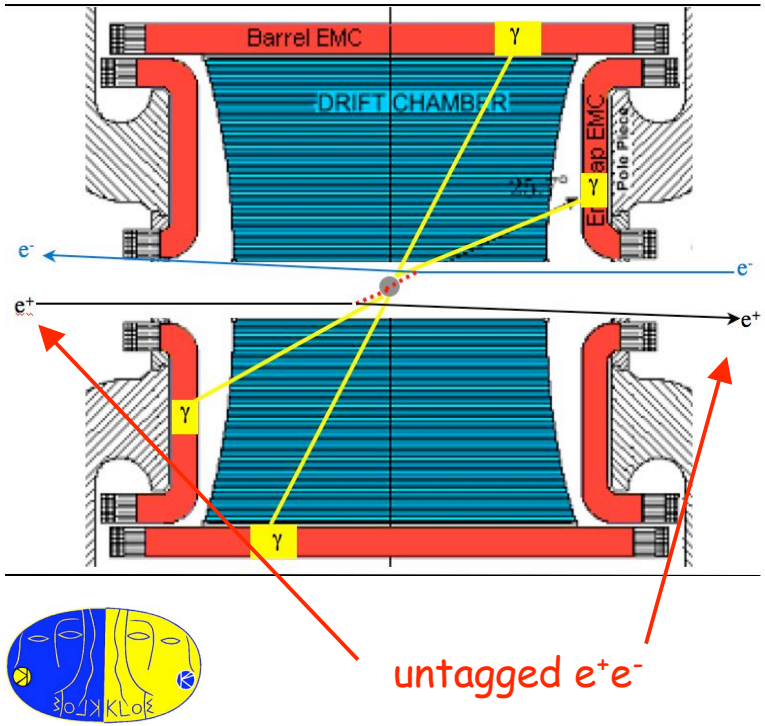
Search for $\gamma\gamma \to \sigma \to \pi^0\pi^0$

PRELIMINARY:
2nd best communication at SIF

long debate about the experimental evidence of the σ meson,

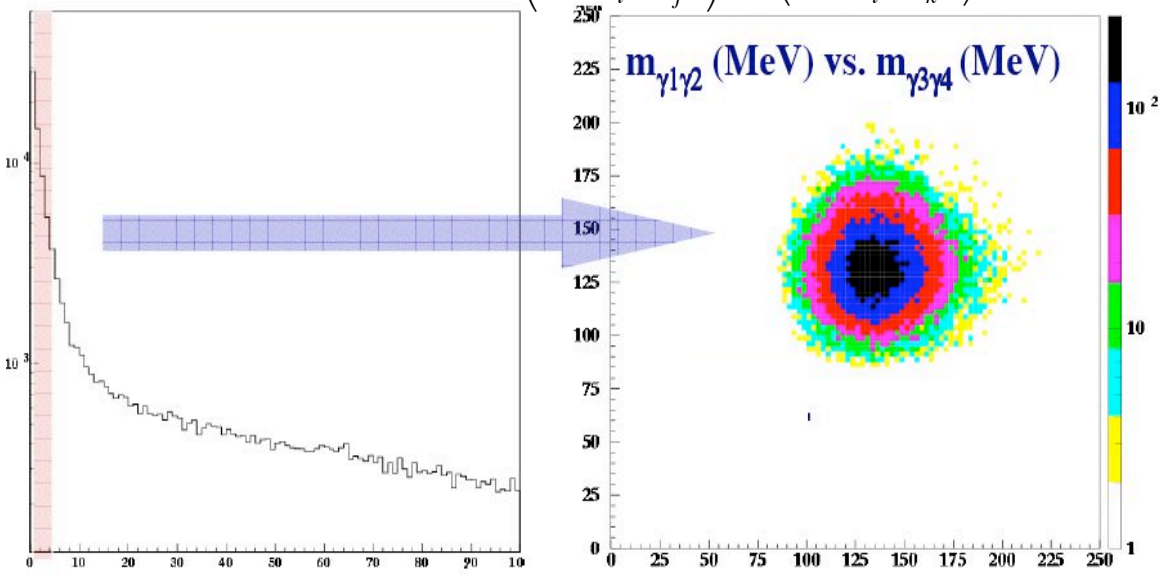
BES	$J/\psi \to \omega\sigma \to \omega\pi^+\pi^-$	$M = 541$ MeV, $\Gamma = 504$ MeV
CLEO	$D^0 \to K_S\sigma \to K_S\pi^+\pi^-$	$M = 513$ MeV, $\Gamma = 335$ MeV
E791	$D^+ \to \pi^+\sigma \to \pi^+\pi^+\pi^-$	$M = 478$ MeV, $\Gamma = 324$ MeV

$e^+e^- \to e^+e^-\pi^0\pi^0 \to e^+e^-4\gamma$ at $\sqrt{s} = 1$ GeV



from Off-Peak (suppressed ϕ decays) data

$$\chi^2_{pair} = \left(\frac{M_{ij} - m_{\pi 0}}{\sigma(E_i, E_j)}\right)^2 + \left(\frac{M_{lk} - m_{\pi 0}}{\sigma(E_l, E_k)}\right)^2 < 4$$

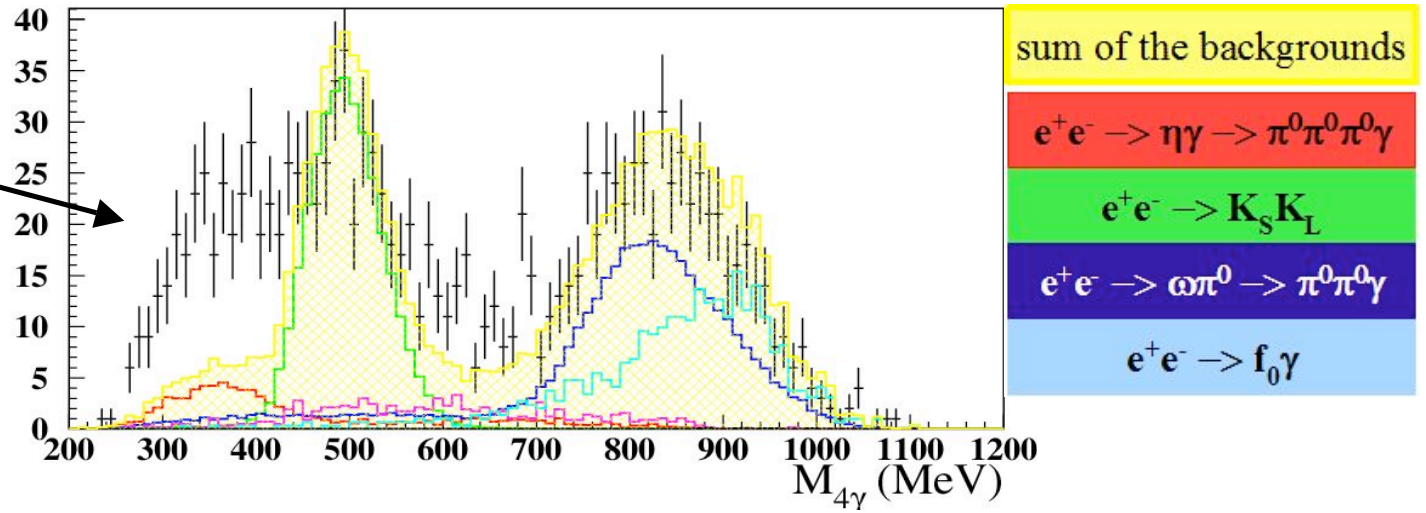


Search for $\gamma\gamma \to \sigma \to \pi^0\pi^0$

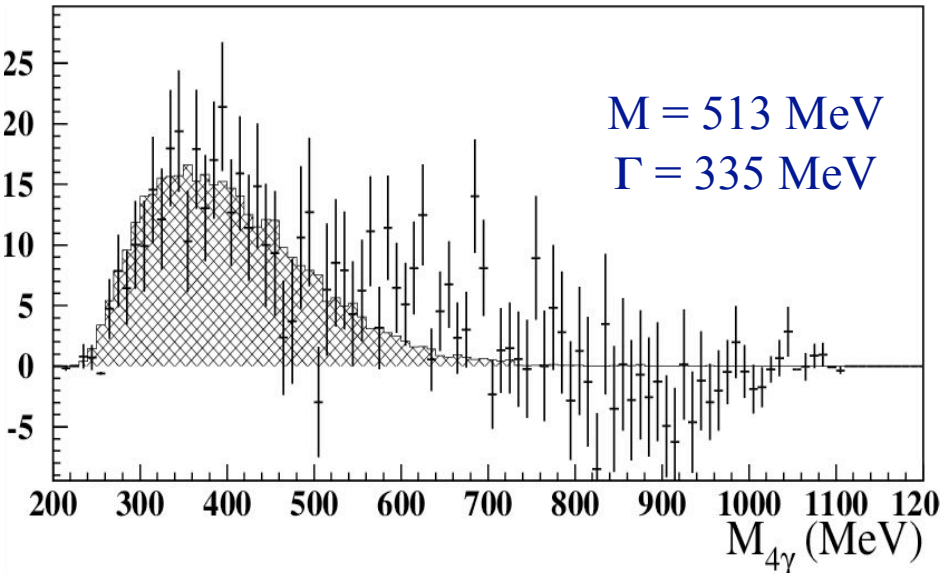
PRELIMINARY:
2nd best communication at SIF

χ^2/dof = 441/94

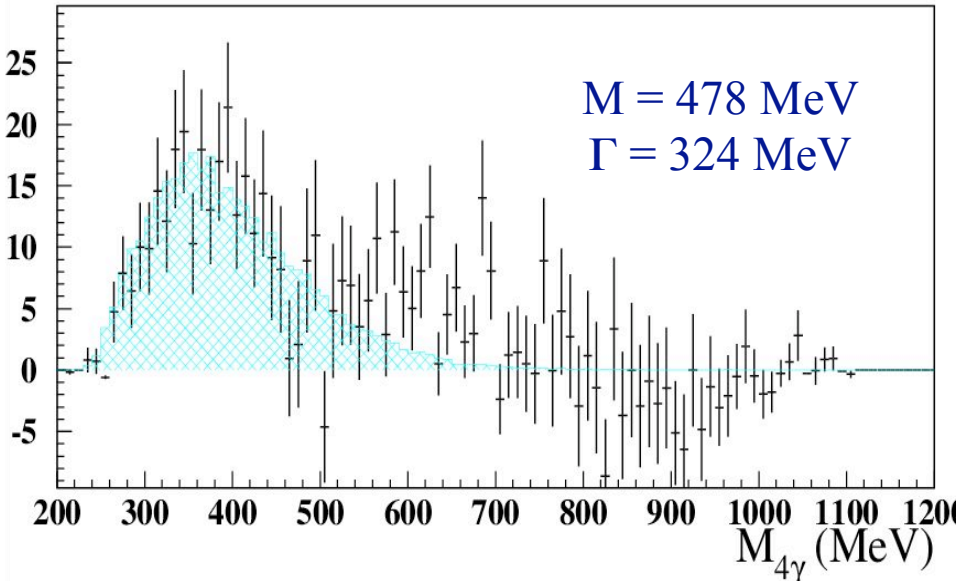
analysis done on 11 pb^{-1} (i.e. 1/20) of the whole off-peak data sample



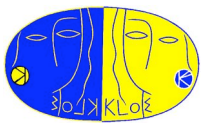
CLEO mass and width: χ^2/dof = 107/93



E791 mass and width: χ^2/dof = 111/93



- hadronic σ
- hadron spectroscopy
- kaon physics



Measurement of BR($K^{\pm} \to \pi^{\pm}\pi^0$)

PUBLISHED:
PLB666(2008)305

- New measurements were only available for BR($K_{\ell 3}$) and BR($K_{\ell 3}/\pi\pi^0$)
- For channels like $\pi\pi^0$ and $\pi^+\pi^+\pi^-$, fit rested heavily on Chiang '72
  Six BRs constrained by Σ BR = 1, but correlations unavailable
  No radiative corrections

$BR(K^{\pm}\to\pi^{\pm}\pi^0) = (21{,}18 \pm 0.28)\%$

$\sigma_{rel} \sim 1.3\%$

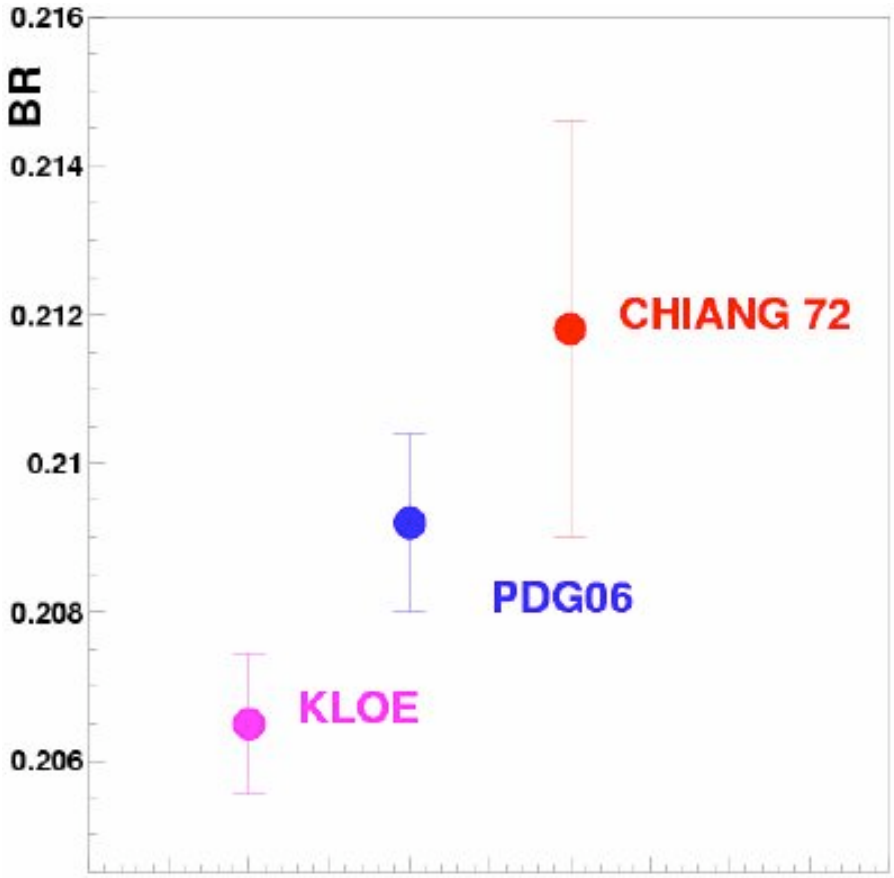
KLOE can measure absolute BRs:

- Normalization sample K^+ tagged by $K^-_{\mu 2}$
- Number of $K^{\pm}\to\pi^{\pm}\pi^0$ decays from fit to p^*_{π}, momentum of the charged decay particle in the K rest frame using m_{π}

$BR = (20.65 \pm 0.05_{stat} \pm 0.08_{syst})\%$

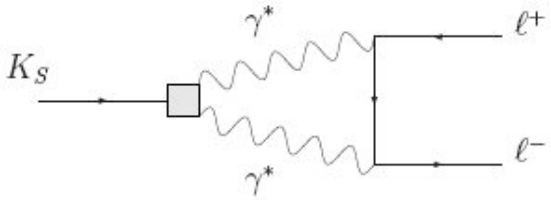
-1.3% respect to PDG'06

$\sigma_{rel} \sim 0.5\%$



Search for $K_S \to e^+ e^-$

SUBMITTED to PLB:
ArXiv:0811.1007



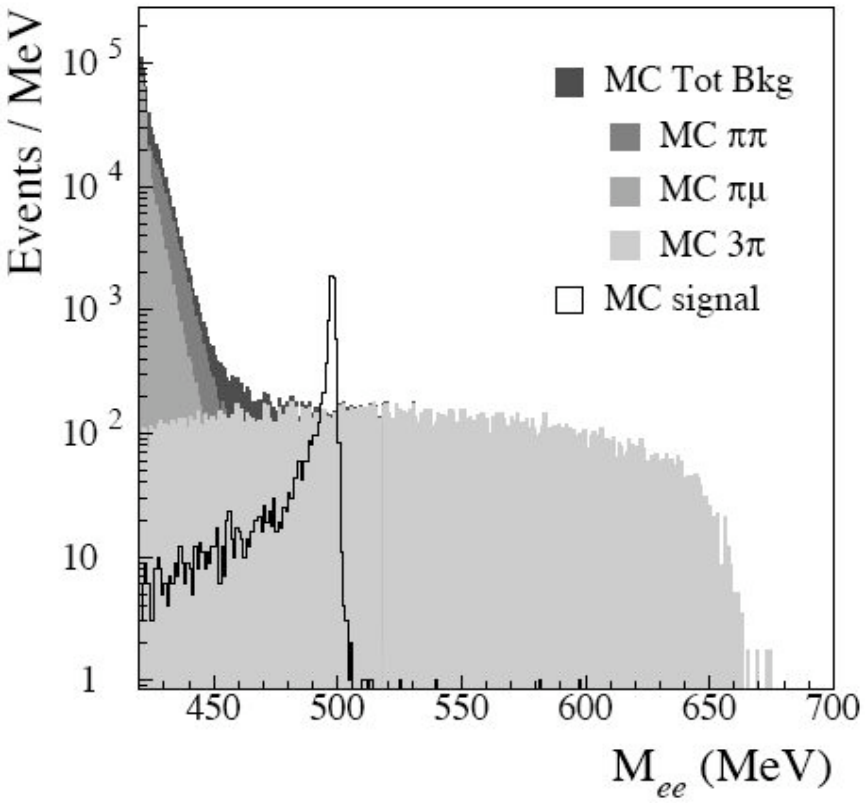
Using χPT O(p^4) we obtain the SM prediction for the branching ratio:

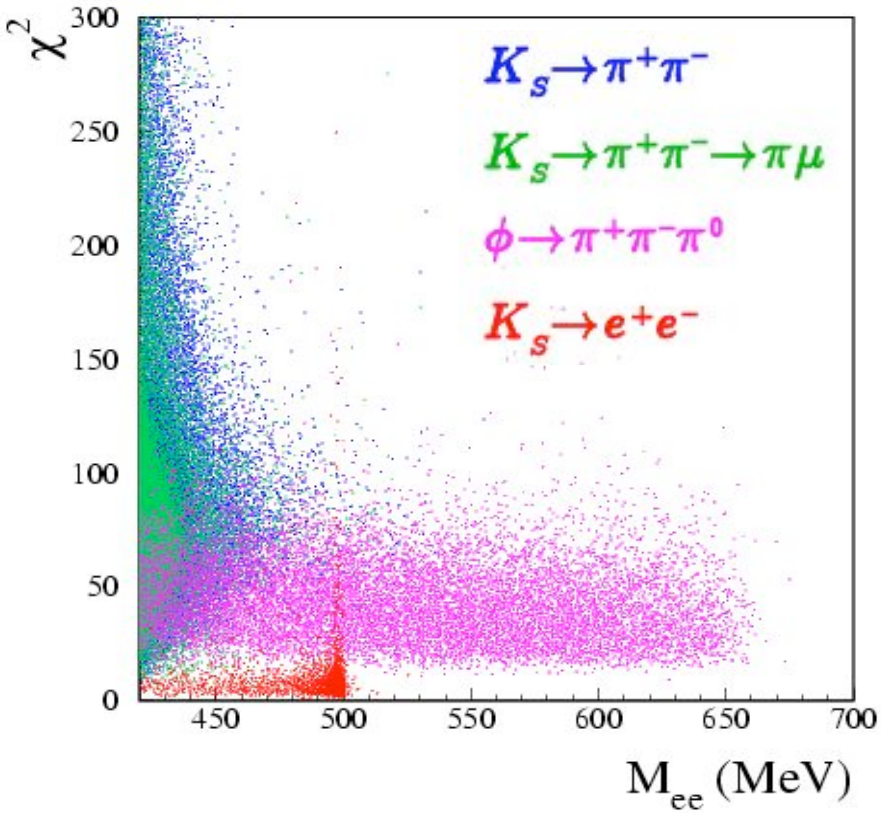
$$BR(K_S \to e^+e^-) \approx 2 \times 10^{-14}$$

The best experimental limit to date has been given by CPLEAR

$$BR(K_S \to e^+e^-) < 1.4 \times 10^{-7}, \text{ at } 90\% \text{ CL}$$

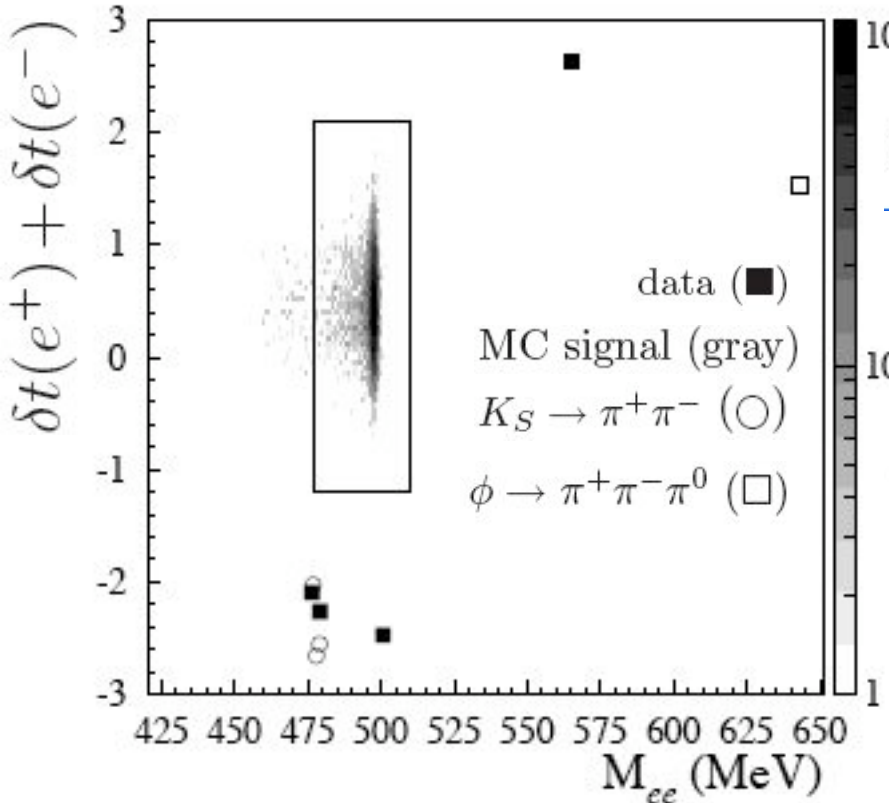
χ^2
- TOF
- E/p
- distance between cluster and impact point of the track on calorimeter.





Search for $K_S \to e^+ e^-$

SUBMITTED to PLB:
ArXiv:0811.1007



$$UL(BR) = UL(\mu_{sig}) \times \frac{\epsilon_{\pi\pi}(sele|tag)}{\epsilon_{sig}(sele|tag)} \times \frac{BR_{\pi\pi}}{N_{\pi\pi}}$$

$$\mathrm{UL}\left(\mathrm{BR}\left(K_S \to e^+e^-(\gamma)\right)\right) = 9 \times 10^{-9}, \text{ at } 90\%\,\mathrm{CL}$$

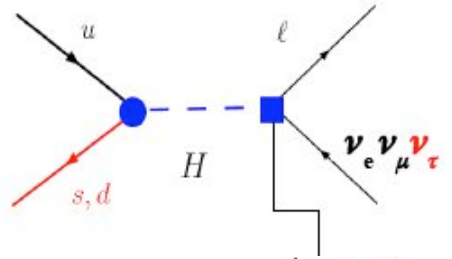
a factor 16 improvement wrt the CPLEAR result

In data sample we find $N_{obs} = 0$ and 0 events in MC BKG sample.

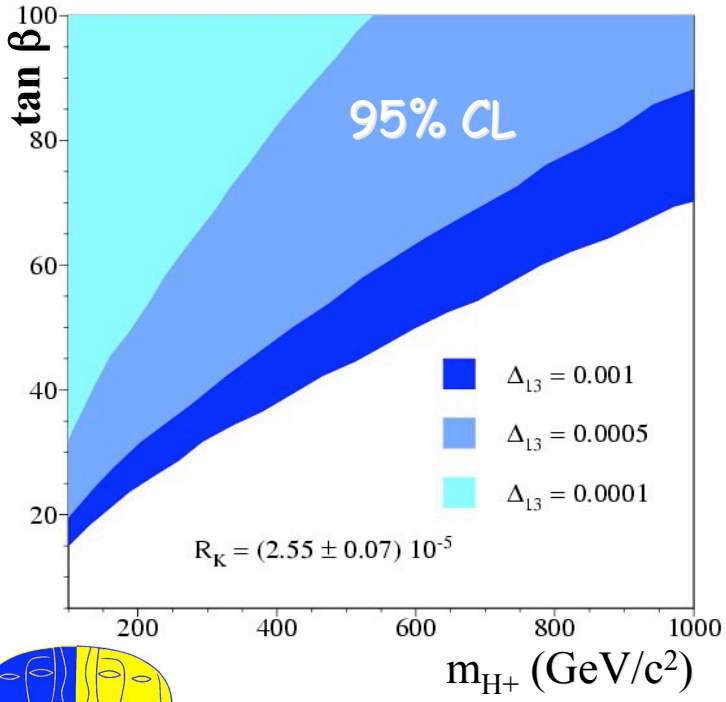
The Upper limit for the number of signal events μ_{sig} is: $UL(\mu_{sig}) = 2.3$ @ 90% CL

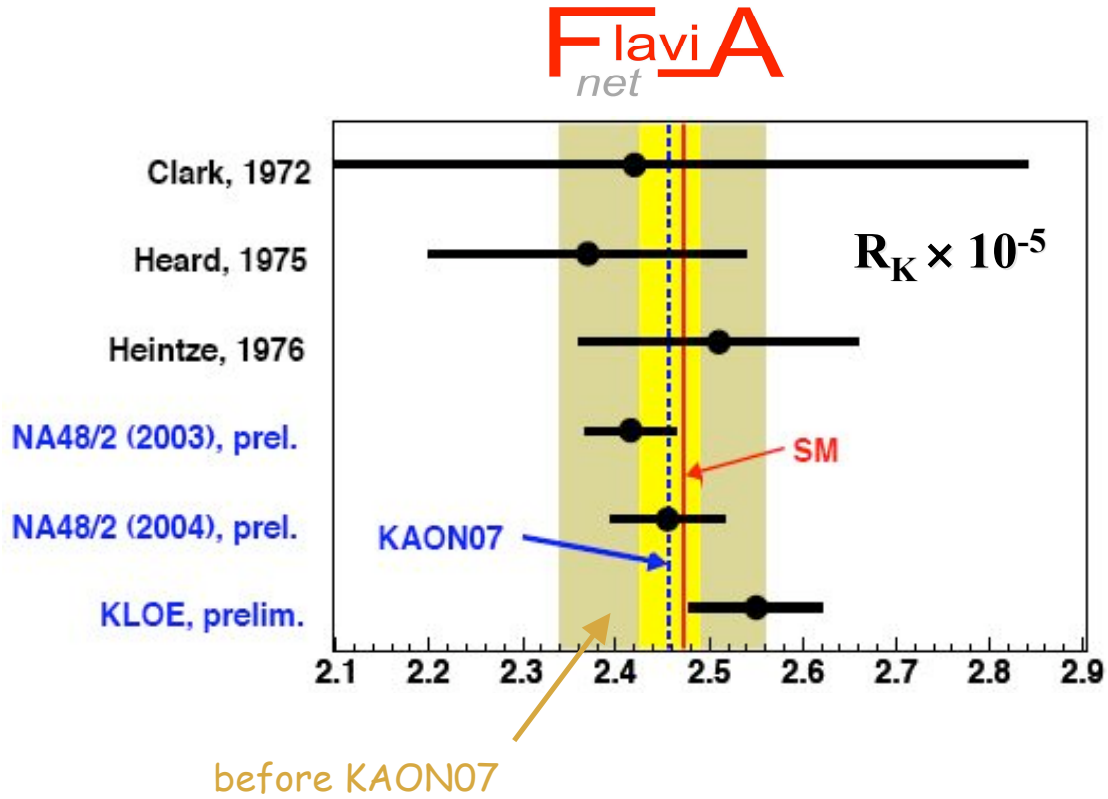
KLOE measurement of $K_{e2}/K_{\mu 2}$

PRELIMINARY:
ArXiv:0707.4623



$$R_K \approx R_K^{SM}\left[1 + \frac{m_K^4}{m_H^4}\frac{m_\tau^2}{m_e^2}|\Delta^R_{31}|^2 \tan^6\beta\right]$$





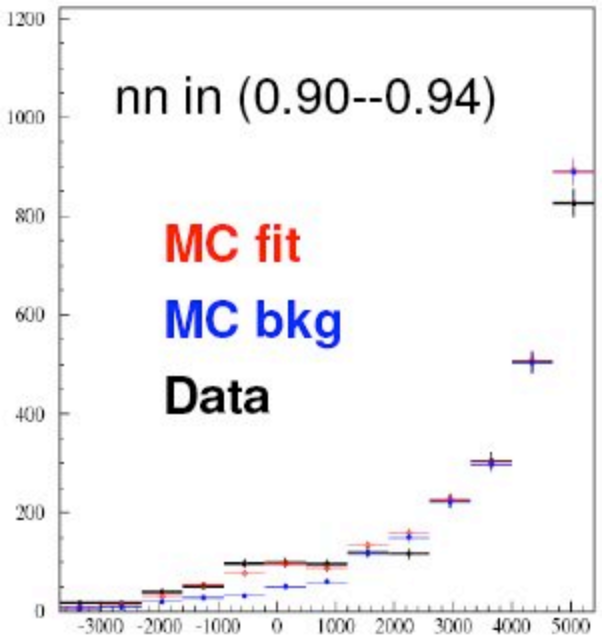
after KAON07

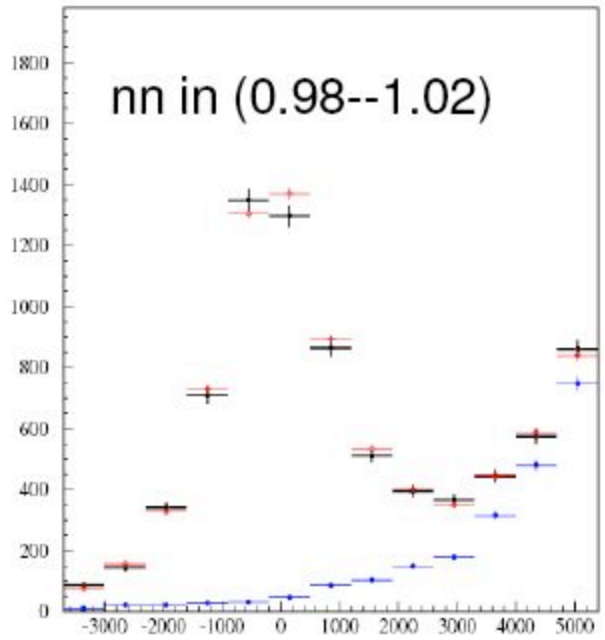
$R_K^{average} = 2.457(32) \times 10^{-5}$

KLOE perspectives on $K_{e2}/K_{\mu 2}$

Improved PID + better understanding of P_{lepton} measurement tails

~ 13K events selected with full statistics (2.2 fb^{-1})





$N(e^+) = 6901 \pm 98$

$N(e^-) = 6514 \pm 97$

frac. error 1.1%

see discusssion at the closed session

Expect fractional accuracy stat. ⊕ syst. < 1.3%

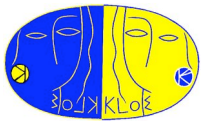
MC & Offline activities

✓ **Whole KLOE data sample reconstructed with the same Datarec Version, DBV26: COMPLETED**

✓ **Off-Peak data sample reconstructed with DBV27, where the only difference wrt DBV26 is a dedicated filter for $\gamma\gamma(\rightarrow\sigma,\eta)$ physics, otherwise rejected (large missing energy) by On-Peak filters**

✓ **MC productions dedicated to Ke2 analysis (according to 2004-05 data samples)**

✓ **new generator for $\eta \rightarrow e^+e^-e^+e^-$ and fixed s dependence in $a_1\pi,\omega\pi \rightarrow \pi^+\pi^-\pi^+\pi^-$**



Future plans

- hadronic σ

completion of F_π from large angle analysis (lower $M_{\pi\pi}$ region)

F_π from ratio of $\pi\pi\gamma$ to $\mu\mu\gamma$ events

F_π from off peak (suppressed ϕ decays) data

- hadron spectroscopy

analysis of $\eta\to e^+e^-e^+e^-$ and $\eta\to 3\pi^0$ (cusp effect?)

study of other η ($\to\pi\pi\gamma/\mu\mu\gamma/ee\gamma/\mu\mu/\pi^0\gamma\gamma$) channels

analysis of $\gamma\gamma\to\pi^0\pi^0$ to search for the $\sigma(600)$

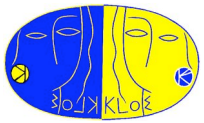
- kaon physics

finalize $K^+\to\pi^+\pi^+\pi^-$ and CPT tests from interferometry

semileptonic form factors in $K^\pm$ and K_L updates

updates of $K^\pm$ and K_L lifetimes

new (e.g. $K_S\to\pi\pi ee$) and updated (e.g. $K_S\to 3\pi^0$) rare K_S decays

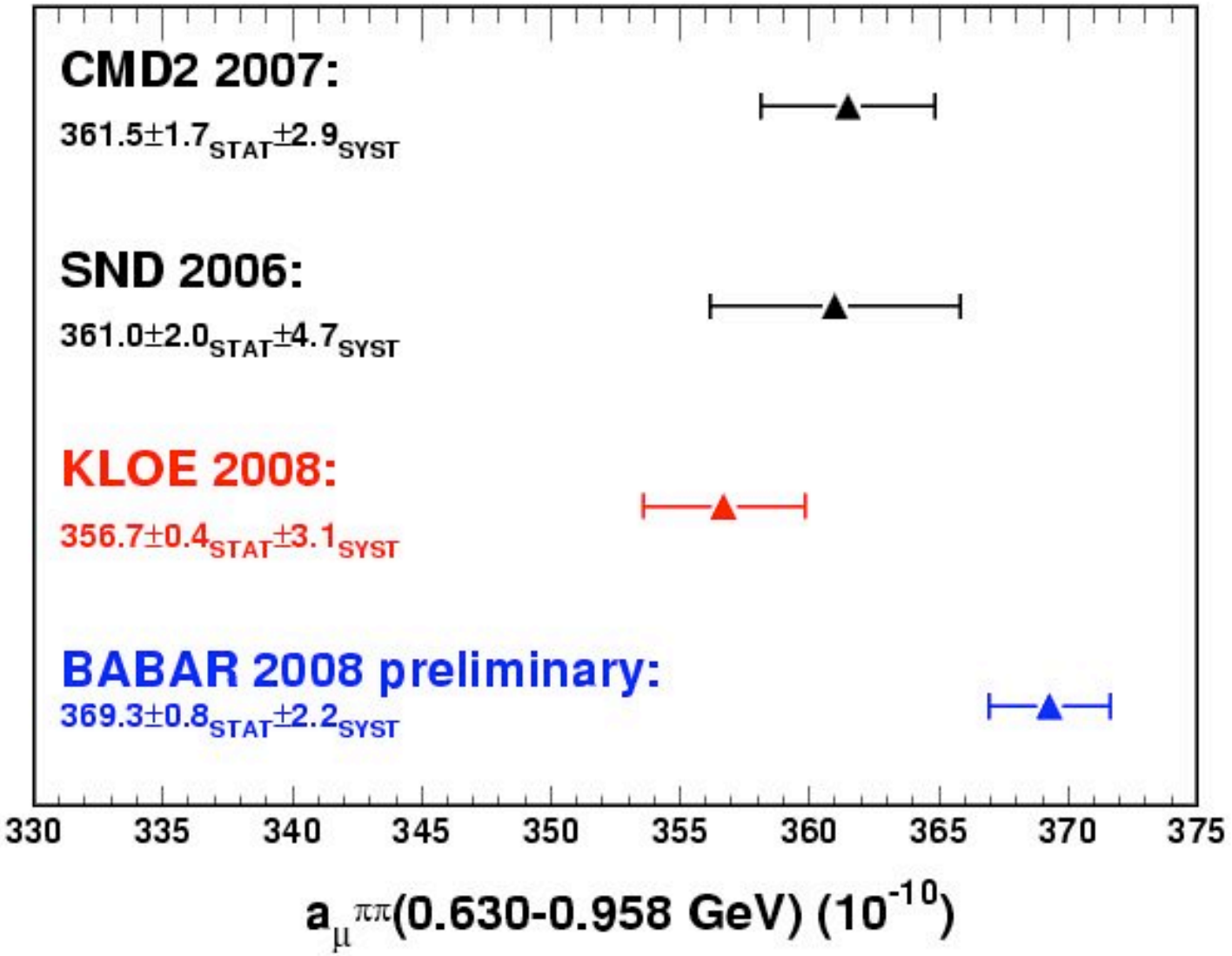



Conclusions?
we'll be back again...
INNSE
INNSE
B

SPARES

Recent comparisons on $a_\mu^{\pi\pi}$

ACCEPTED by PLB:
ArXiv:0809.3950



KLOE results on charged kaons

Constrained fit: $\Sigma BRi = 1$, accounting for BR vs τ dependence

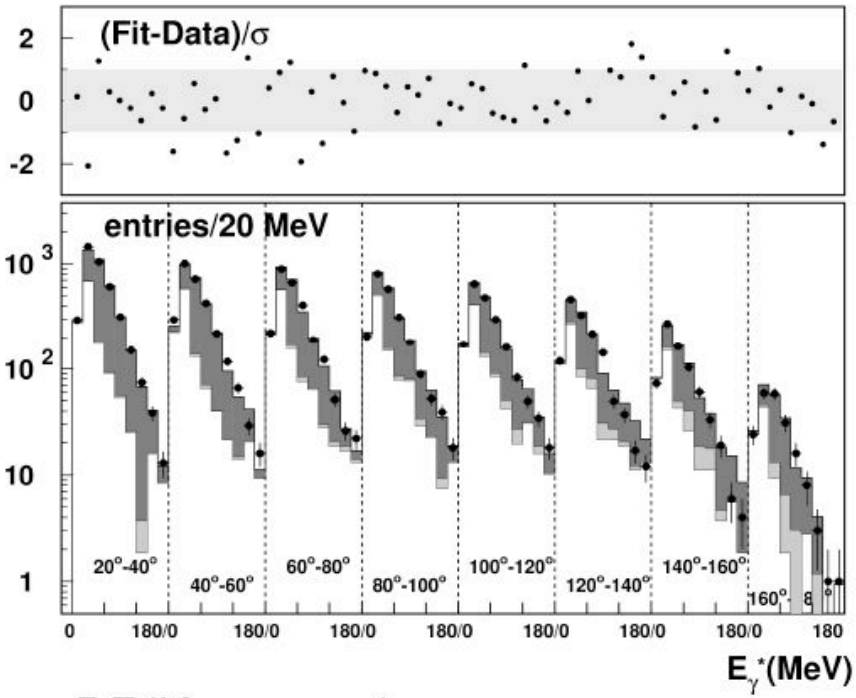
$BR(K^+ \to \mu^+\nu)$	0.6376(12)	0.2%
$BR(K^+ \to \pi^+\pi^0)$	0.2071(9)	0.4%
$BR(K^\pm \to \pi^\pm\pi^+\pi^-)$	0.0553(9)	input PDG '04
$BR(K^\pm \to \pi^0 e^\pm\nu)$	0.0499(5)	1.0%
$BR(K^\pm \to \pi^0\mu^\pm\nu)$	0.0325(4)	1.2%
$BR(K^\pm \to \pi^\pm\pi^0\pi^0)$	0.0177(3)	1.7%
$\tau(K^\pm)$	12.344(30) ns	0.24%

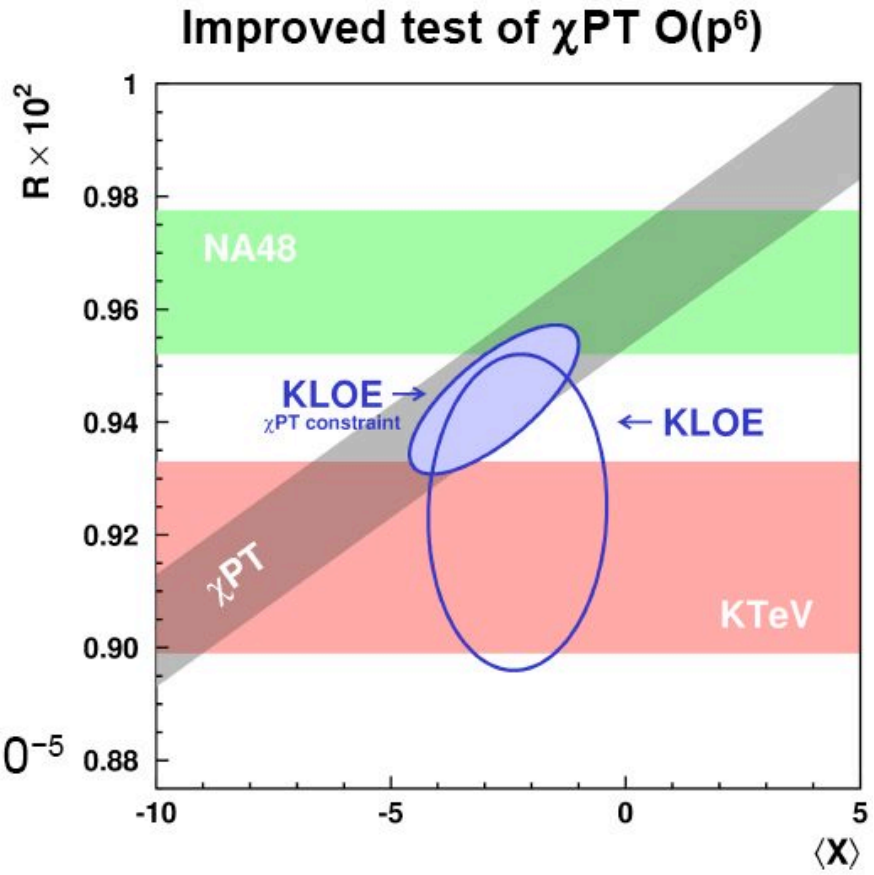
KLOE has an ongoing analysis

χ^2/d.o.f. = 0.60/1, CL = 44%

Measurement of $BR(K_L \to \pi e \nu \gamma)$

PUBLISHED:
EPJC55(2008)539





$$R = \frac{BR(K_L \to \pi e \nu \gamma)}{BR(K_L \to \pi e \nu)} = (924 \pm 23_{stat} \pm 16_{syst}) \times 10^{-5}$$

$$\langle X \rangle = -2.3 \pm 1.3_{stat} \pm 1.4_{syst}$$

Effective strength parameter describing direct emission

$E_\gamma^* > 30$ MeV $\theta_{e\gamma} > 20°$

The V_{us} master formula

Vector transition protected against ~~SU~~(3) corrections: [Ademollo Gatto]

$$\Gamma(K_{\ell 3(\gamma)}) = \frac{C_K^2\, M_K^5}{192\pi^3}\, S_{EW}\, G_F^2 |V_{us}|^2 \, |f_+^{K^0\pi^-}(0)|^2 \times I_{K\ell}(\{\lambda\}_{K\ell})\,(1 + 2\Delta_K^{SU(2)} + 2\Delta_{K\ell}^{EM})$$

with $K \in \{K^+, K^0\}$; $\ell \in \{e, \mu\}$, and:

C_K^2 1/2 for K^+, 1 for K^0

S_{EW} Universal SD EW correction (1.0232)

Inputs from theory:

$f_+^{K^0\pi^-}(0)$ Hadronic matrix element (form factor) at zero momentum transfer ($t = 0$)

$\Delta_K^{SU(2)}$ Form-factor correction for $SU(2)$ breaking

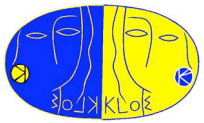
$\Delta_{K\ell}^{EM}$ Form-factor correction for long-distance EM effects

Inputs from experiment:

$\Gamma(K_{\ell 3(\gamma)})$ Rates with well-determined treatment of radiative decays:

- " Branching ratios
- " Kaon lifetimes

$I_{K\ell}(\{\lambda\}_{K\ell})$ Integral of dalitz density (includes ff) over phase space



Measurement of BR($K^{\pm} \to \pi^{\pm}\pi^0$)

PUBLISHED:
PLB666(2008)305

- New measurements were only available for BR($K_{\ell 3}$) and BR($K_{\ell 3}/\pi\pi^0$)
- For channels like $\pi\pi^0$ and $\pi^+\pi^+\pi^-$, fit rested heavily on Chiang '72
  Six BRs constrained by Σ BR = 1, but correlations unavailable
  No radiative corrections

BR($K^{\pm}\to\pi^{\pm}\pi^0$) = (21,18 ± 0.28)%

σ_{rel} ~ 1.3%

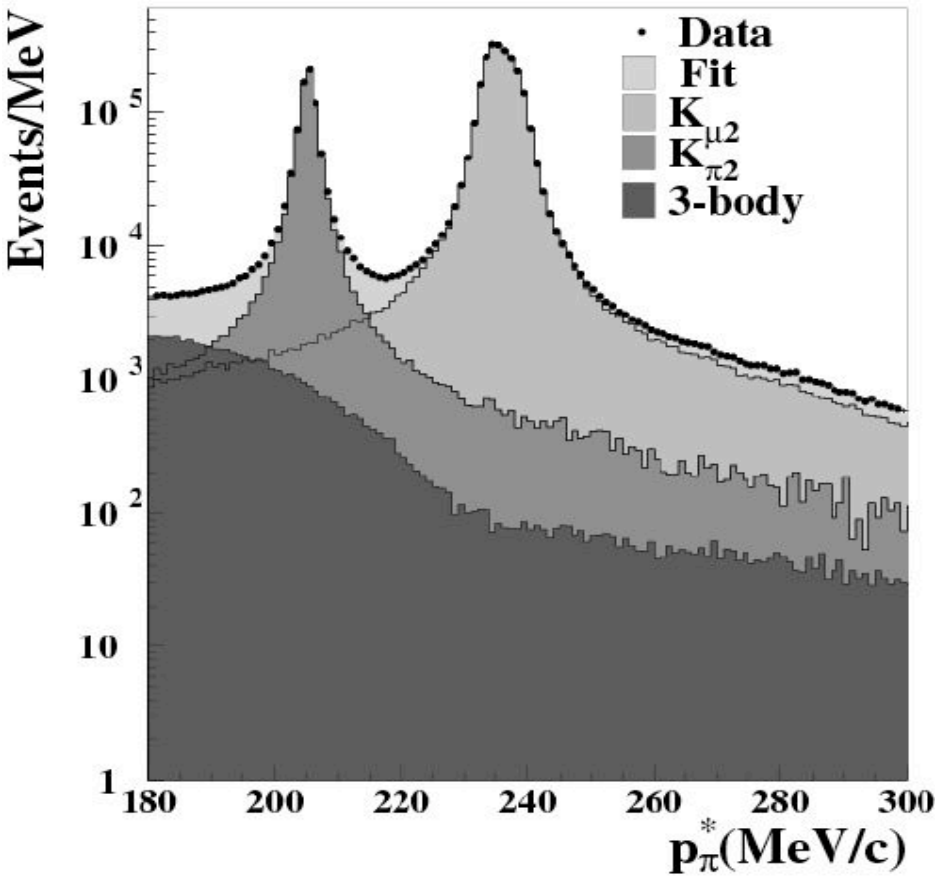
KLOE can measure absolute BRs:

- Normalization sample K^+ tagged by $K^-_{\mu 2}$
- Number of $K^{\pm}\to\pi^{\pm}\pi^0$ decays from fit to p^*_{π}, momentum of the charged decay particle in the K rest frame using m_{π}

BR = (20.65 ± 0.05$_{stat}$ ± 0.08$_{syst}$)%

-1.3% respect to PDG'06

σ_{rel}~0.5%



$\sigma(e^+e^- \to \pi^+\pi^-\gamma(\gamma))$ improvements

ACCEPTED by PLB:
ArXiv:0809.3950

PLB606(2005)12

Trigger	0.3%
Reconstruction filter	0.6%
Background	0.3%
M_{trk} cuts	0.2%
Particle ID	0.1%
Tracking	0.3%
Vertex	0.3%
Acceptance	0.3%
Unfolding	0.2%
Luminosity $(0.5_{th} \oplus 0.3_{exp})\%$	0.6%

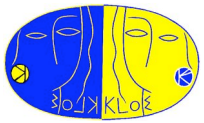
$\Sigma_{exp,2005} = 0.9\%(\oplus 0.9\%Th)$

This work (2008):

Trigger	0.1%
Reconstruction filter	-
Background	0.3%
M_{trk} cuts	0.2%
Particle ID	-
Tracking	0.3%
Vertex	-
Acceptance	0.1%
Unfolding	-
Software Trigger	0.1%
$\sqrt{s}$ dep. of H	0.2%
Luminosity $(0.1_{th} \oplus 0.3_{exp})\%$	0.3%

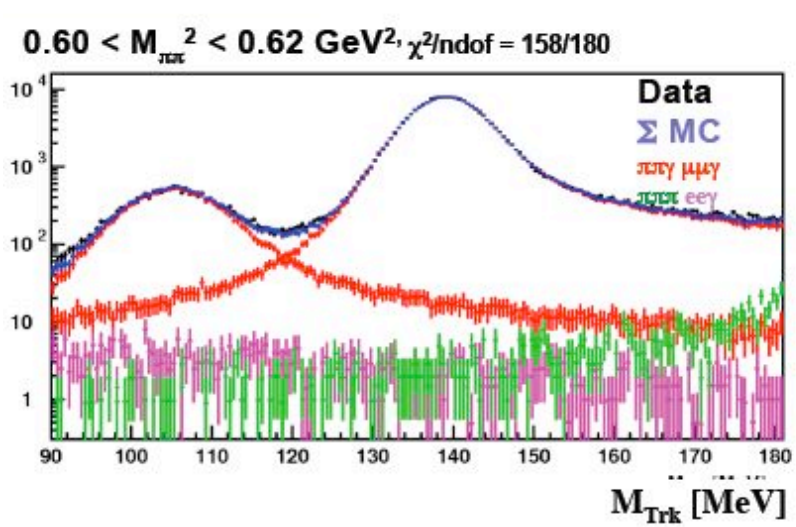
$\Sigma_{exp,2008} = 0.6\%\ (\oplus 0.6\%Th)$

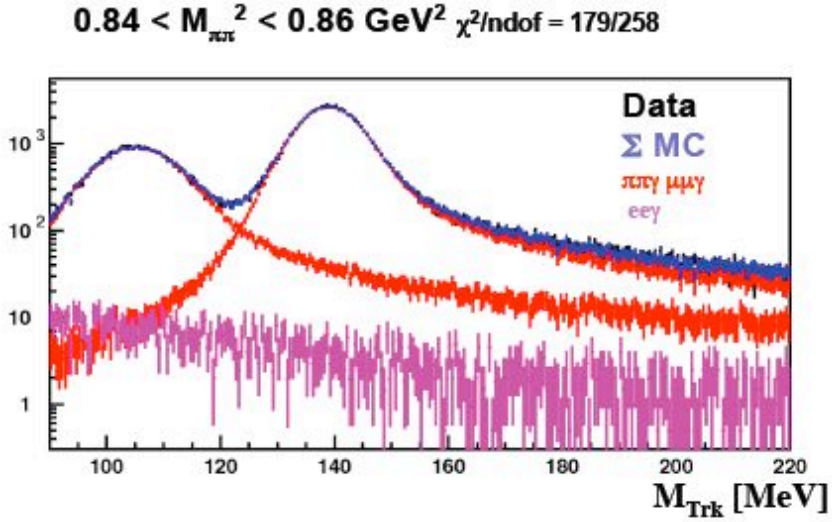
2008: efficiencies evaluated either from 2 different control samples or 2 independent methods

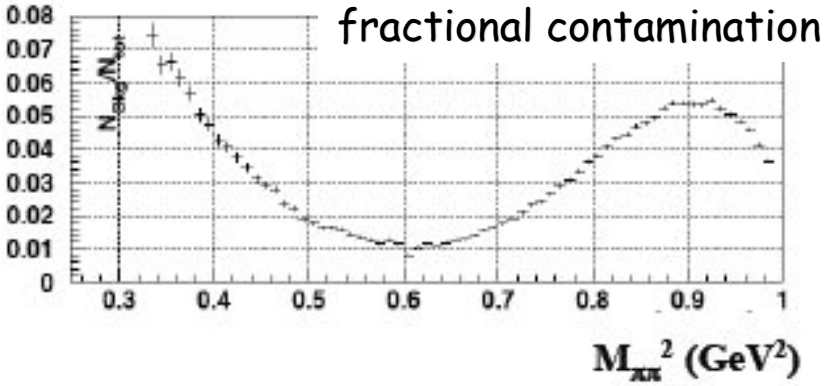


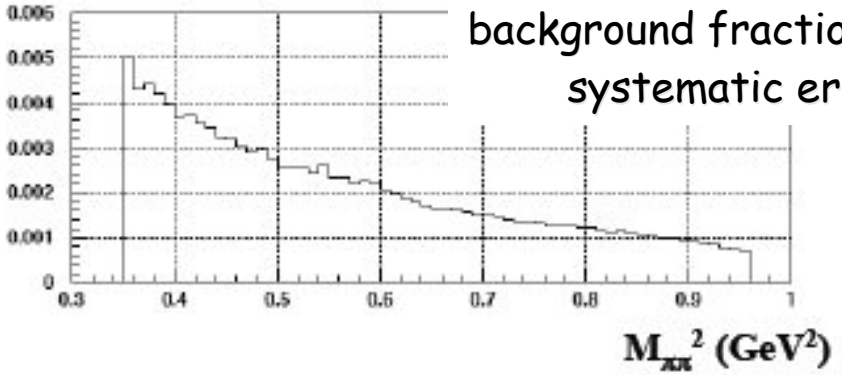
$\sigma(e^+e^- \to \pi^+\pi^-\gamma(\gamma))$ background

ACCEPTED by PLB:
ArXiv:0809.3950









$e^+e^- \to e^+e^-\pi^+\pi^-$ (Ekhara) *~ 0.8% at low $M^2_{\pi\pi}$*
$e^+e^- \to e^+e^-\mu^+\mu^-$ (Nextcalibur) *negligible*
$\phi \to f_0\gamma \to \pi\pi\gamma$ (Phokhara,Fasterd) *negligible*
$\phi \to \pi\rho \to \pi\pi\gamma$ (Phokhara,Fasterd) *negligible*
$e^+e^- \to \omega\gamma_{ISR} \to \pi\pi\pi\gamma$(Phokhara) *negligible*

Achievements in 2008

Precision Kaon and Hadron Physics with KLOE, Riv. Nuovo Cim.31(2008)531

$e^+e^- \to \pi^+\pi^-\gamma$	$\Delta a_\mu^{\pi\pi}$ to 0.9%	arXiv:0807.1612, 0809.3950	Accepted by PLB	ϕ to ψ, QCD08, ICHEP08, Tau08
$e^+e^- \to \omega\pi^0$		PLB669(2008)223		MoriondQCD
$\phi \to \eta\pi^0\gamma$	BR($\phi \to a_0\gamma$)	PLB 536(2002) 209	arXiv:0707.4609	SCADRONfest,PANIC08
UL $a_0/f_0 \to K_sK_s$	to 10^{-8}	arXiv:0707.4148, 0805.2521		QCD08,PANIC08
$\eta \to \pi^+\pi^-\pi^0$	Dalitz plot	JHEP 05(2008)006		Flavianet
$\eta \to \pi^0\pi^0\pi^0$	Dalitz plot	arXiv:0707.4137		Confinement08
$\eta \to \pi^+\pi^-e^+e^-$	BR to 4%	arXiv:0805.2521		Hadron07, Flavianet
$\gamma\gamma \to \pi^0\pi^0$	look for σ	SIF award paper		Italian Physical Society (SIF)

Achievements in 2008

$K_S K_L \to \pi^+\pi^-\pi^+\pi^-$	Quantum Interference	PLB642(2006)315	Update	HQL08
$K_S \to \gamma\gamma$	BR to 5.7%	JHEP05(2008)051		Flavianet,HQL08
$K_S \to e^+e^-$	UL to 10^{-8}	arXiv:0811.1007		
$K_L \to \pi e \nu \gamma$	BR to ~2%, DE component	EPJC55(2008)539		
$K^+ \to \pi^+\pi^0$	BR to ~ 0.3%	PLB 666(2008) 305		
$K^\pm \to \pi^0 l \nu$	BR's to ~ 1.2%	JHEP 02(2008)98		
$K^\pm$ lifetime	to ~ 0.4%: 2 independent methods	JHEP 01(2008)73	Update	IFAE08
$K^\pm \to e^\pm \nu$	BR's to ~ 1%	KAON 050(2008)		HQL08,ICHEP08, CKM08
V_{us}, LU	Unitarity at 0.1%	JHEP04(2008)059		Flavianet,HQL08,Beach08,ICHEP08,CKM08