Recent results from KLOE

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on behalf of the KLOE Collaboration
XLIII Rencontres de Moriond on
ELECTROWEAK INTERACTIONS AND UNIFIED THEORIES
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The KLOE experiment at DAFNE

Drift Chamber (90%He 10% isobutane)

$\sigma_p/p = 0.4\ \%$ (tracks with $\theta > 45°$)

$\sigma_x^{hit} = 150\ \mu m$ (xy), 2 mm (z)

$\sigma_x^{vertex} \sim 1$ mm

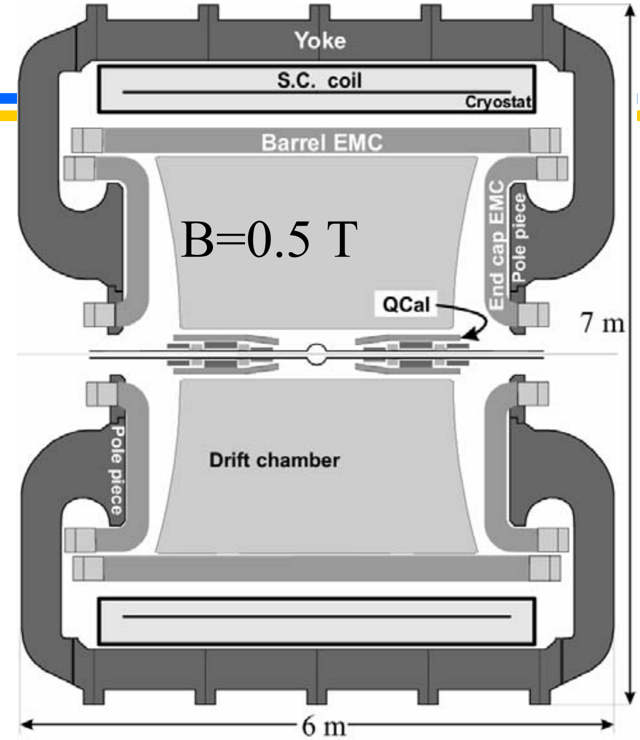
$\sigma(M_{\pi\pi}) \sim 1$ MeV

Electromagnetic Calorimeter (pb/sci)

$\sigma(E)/E = 5.7\ \%/\sqrt{E(GeV)}$

$\sigma(t) = 57\ ps/\sqrt{E(GeV)} \oplus 100\ ps$

$\sigma(x) \sim 1$ cm

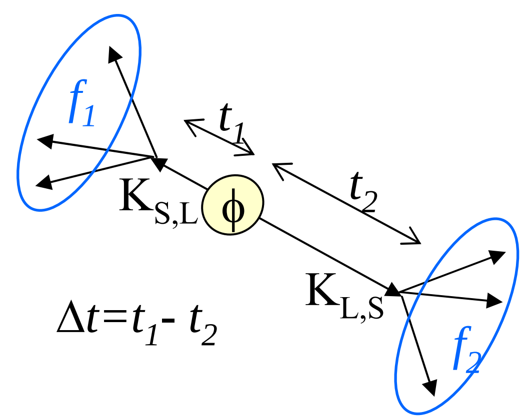


$\phi \to K^+K^-$	$\phi \to K_SK_L$
BR~50%	BR~34%
p=127 MeV	p=110 MeV
$\lambda_\pm$=95 cm	λ_s=0.6 cm λ_L=340 cm

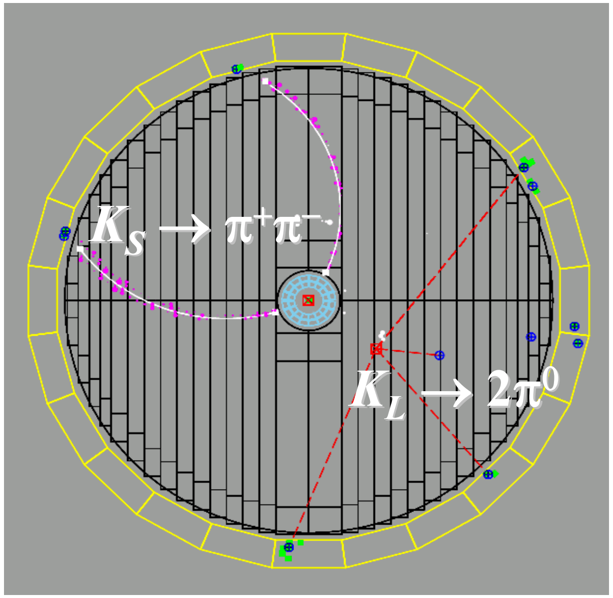
$L_{tot}=2.2\ fb^{-1}$; ~ $2.2\times10^9\ K_SK_L$

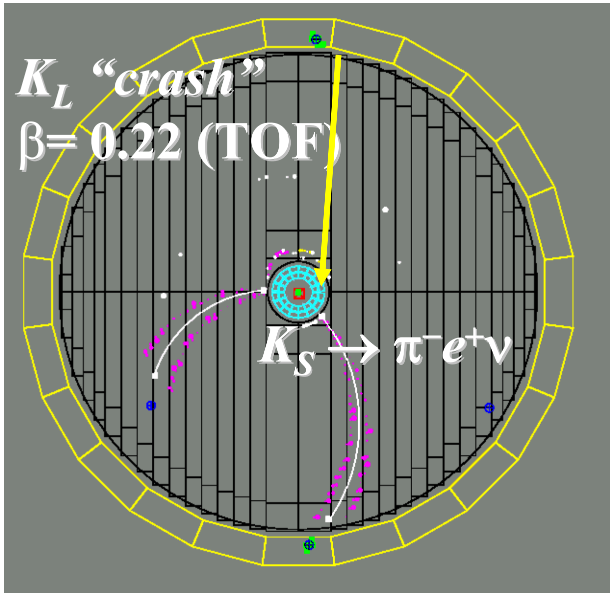
neutral kaon pairs produced in an antisymmetric quantum state with $J^{PC} = 1^{--}$

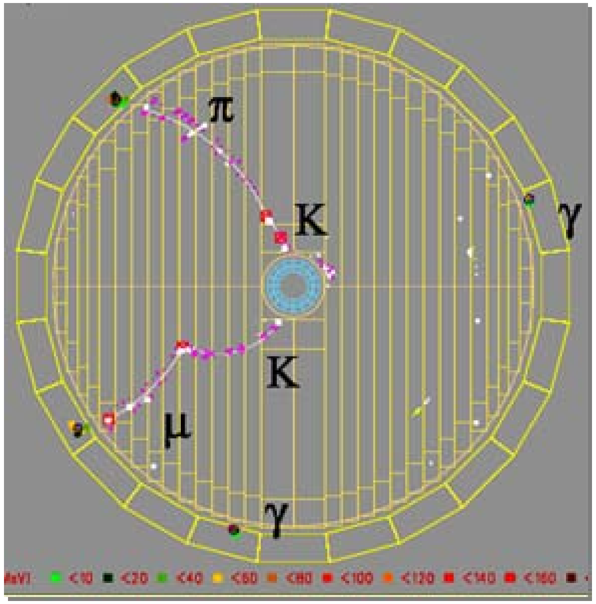
$$|i\rangle = \frac{N}{\sqrt{2}}\left[|K_S(\vec{p})\rangle|K_L(-\vec{p})\rangle - |K_L(\vec{p})\rangle|K_S(-\vec{p})\rangle\right]$$



Kaon tagging







K_L tagged by $K_S \rightarrow \pi^+\pi^-$
Efficiency ~ 70%
$\sigma(P_K)$ ~ 1 MeV

K_S tagged by K_L interaction in EmC
Efficiency ~ 30%
$\sigma(P_K)$ ~ 1 MeV
a pure K_S beam available

$K^\pm$ tagged by $K \rightarrow \mu\nu, \pi\pi$
identified by the secondary particle momentum in the K rest frame: $p^*(m_\pi)$
Trigger from the tag side.
ε_{Tag}~10%

Absolute BR's: $BR = N_{obs}/N_{tag}$

Interferometry with $K_S K_L \to \pi^+\pi^-\pi^+\pi^-$

$$I(\Delta t, \pi^+\pi^-\pi^+\pi^-) \propto e^{-\Gamma L|\Delta t|} + e^{-\Gamma S|\Delta t|} - 2(1-\zeta)e^{-(\Gamma S + \Gamma L)|\Delta \tau|/2}\cos(\Delta m \Delta t)$$

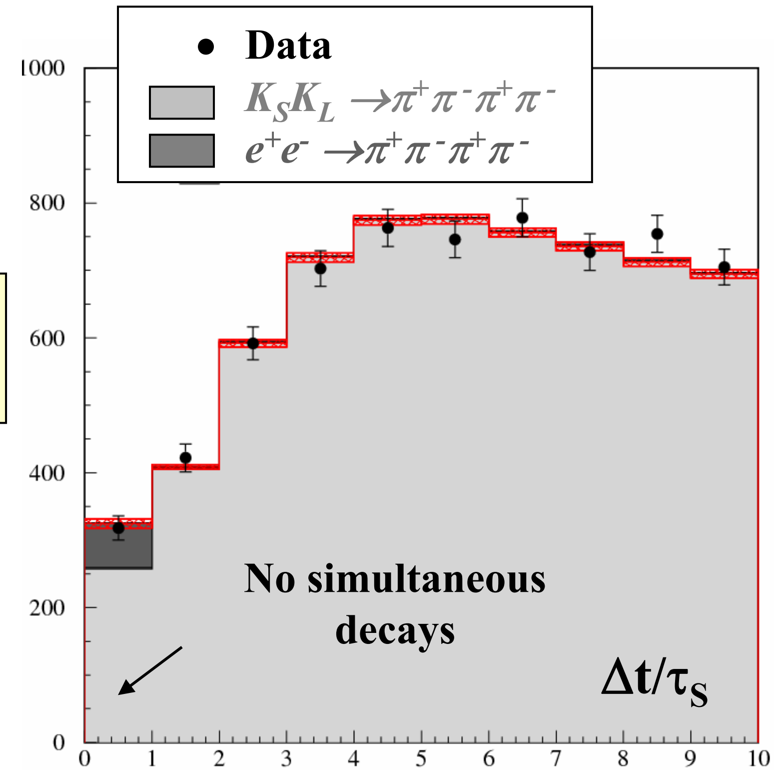
Preliminary results based on 1fb^{-1}

Decoherence parameters

$$\zeta_{S,L} = 0.009 \pm 0.022_{STAT}$$
$$\zeta_{0,0} = (0.03 \pm 0.12_{STAT}) \times 10^{-5}$$

CPLEAR : $\zeta_{SL} = 0.13 \pm 0.16$
$\zeta_{00} = 0.4 \pm 0.7$

BELLE : $\zeta_{00} = 0.029 \pm 0.057$



published results based on 328pb^{-1} PLB 642(2006) 315

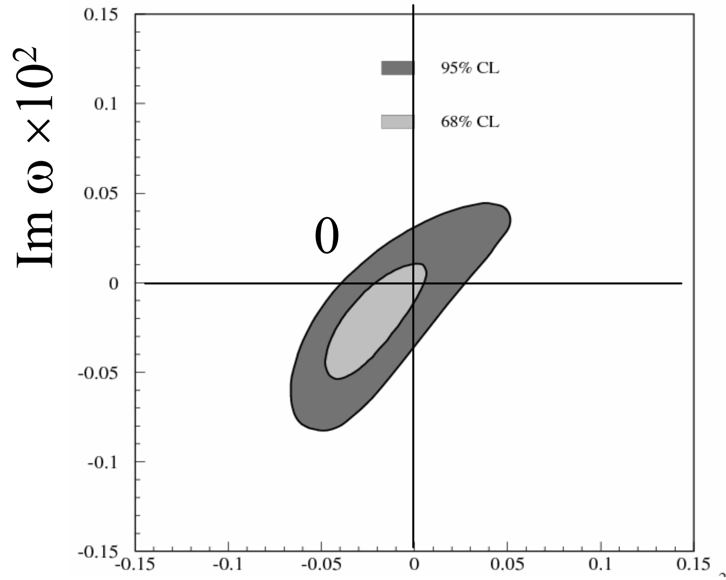
$$\zeta_{SL} = 0.018 \pm 0.040_{STAT} \pm 0.007_{SYST}$$
$$\zeta_{0\bar{0}} = (1.0 \pm 2.1_{STAT} \pm 0.4_{SYST}) \times 10^{-6}$$

$\phi \to K_S K_L \to \pi^+\pi^- \ \pi^+\pi^-$: CPT violation in correlated K states

In presence of decoherence and CPT violation induced by quantum gravity (CPT operator "ill-defined") the definition of the particle-antiparticle states could be modified. This in turn could induce a breakdown of the correlations imposed by Bose statistics (EPR correlations) to the kaon state [Bernabeu, et al. PRL 92 (2004) 131601, NPB744 (2006) 180]:

$$|i\rangle \propto (K_S K_L - K_L K_S) + \omega (K_S K_S - K_L K_L)$$

$|\omega|$ could be at most: $$|\omega| = O\left(\frac{E^2/M_{PLANCK}}{\Delta\Gamma}\right)^{1/2} \sim 10^{-3}$$

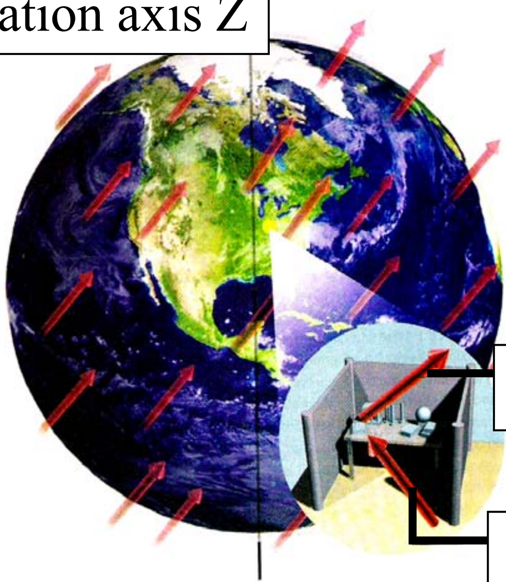


Preliminary results based on $1\,fb^{-1}$

$$\Re\omega = \left(-2.5^{+3.1}_{-2.3\,STAT}\right)\times 10^{-4}$$
$$\Im\omega = \left(-2.2^{+3.4}_{-3.1\,STAT}\right)\times 10^{-4}$$
$$|\omega| < 9.8\times 10^{-4} \quad \text{at } 95\%\text{ C.L.}$$

published results based on $328\,pb^{-1}$ PLB 642(2006) 315 $\quad |\omega| < 2.1\times 10^{-3}$ at 95% C.L.

CPT and Lorentz invariance violation



CPT violation based on spontantaneous breaking of *CPT* and Lorentz symmetry. (Standard Model Extension - SME)

Kostelecky PRD61 (1999) 016002,PRD 64 (2001) 076001

CPT violation in SME manifests to lowest order in δ (the other CPT violation parameters vanish at first order) and exhibits a kaon momentum dependence:

$$\overline{\delta}(|\vec{p}|,\theta,t) = \frac{1}{2\pi}\int_0^{2\pi}\delta(\vec{p},t)d\phi = \frac{i\sin\phi_{SW}e^{i\phi_{SW}}}{\Delta m}\gamma$$

$$(\Delta a_0 + \beta\Delta a_z\cos\chi\cos\theta +$$
$$\beta\Delta a_y\sin\chi\cos\theta\sin\Omega t +$$
$$\beta\Delta a_x\sin\chi\cos\theta\cos\Omega t)$$

Ω: Earth's sidereal frequency

χ: angle between the z lab. axis and the Earth's rotation axis

θ: polar angle of kaon momentum in the lab. system

$\Delta a_\mu = r_{q1}\, a_\mu^{q1} - r_{q2}\, a_\mu^{q2}$,

a_μ^{qi} CPT and Lorentz violating coupling constants for the two valence quarks in the kaon

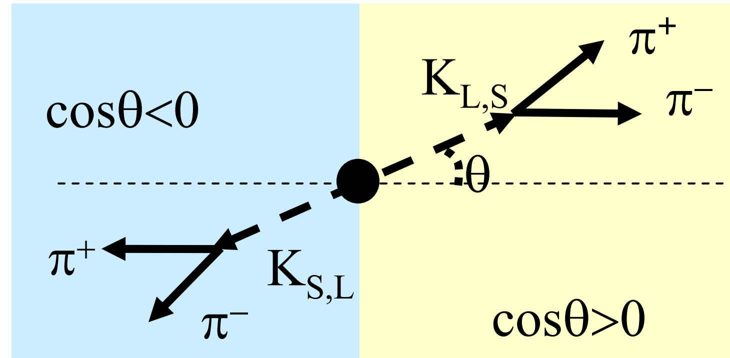
r_{qi} :factors for quark binding or other normalization effects.

Test of CPT and Lorentz invariance with $K_S K_L \to \pi^+\pi^-\pi^+\pi^-$

Δa_{XYZ} from $\phi \to K_S K_L \to \pi^+\pi^- \pi^+\pi^-$

fit to $I[\pi^+\pi^-(\cos\theta>0), \pi^+\pi^-(\cos\theta<0); \Delta t]$

(analysis vs polar angle θ and sidereal time t)

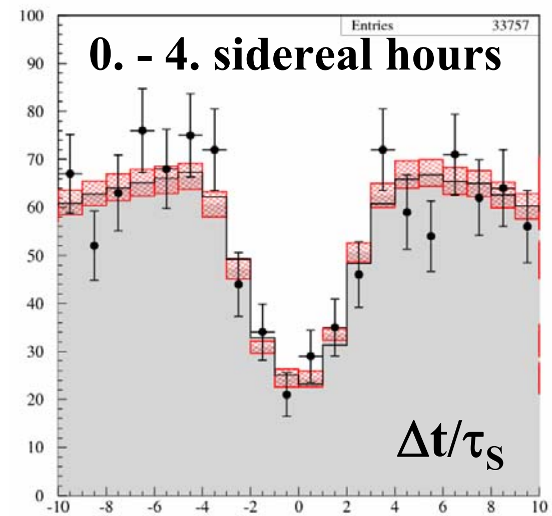


$$\eta_{+-} = \varepsilon - \delta(\mathrm{p}, \theta, \mathrm{t})$$

With L=1 fb^{-1} (**preliminary**):

Δa_x = (-6.3 ± 6.0) × 10^{-18} GeV
Δa_y = (2.8 ± 5.9) × 10^{-18} GeV
Δa_z = (2.4 ± 9.7) × 10^{-18} GeV

χ^2/dof=131/117



Δa_0 from K_S and K_L semileptonic charge asymmetries:

(symmetric polar angle θ and sidereal time t integration)

$$A_S - A_L \cong \frac{4\Re\left(i \sin \phi_{SW}\, e^{i\phi_{SW}}\right)\gamma_K}{\Delta m} \Delta a_0$$

with L=400 pb^{-1} (**preliminary**):

Δa_0 = (0.4 ± 1.8) × 10^{-17} GeV

KTeV : Δa_X, Δa_Y < 9.2 × 10^{-22}GeV @ 90% CL

BABAR $\Delta a^B_{x,y}$, (Δa^B_0 – 0.30 Δa^B_Z)~O(10^{-13} GeV)

V_{us} : unitarity and universality test

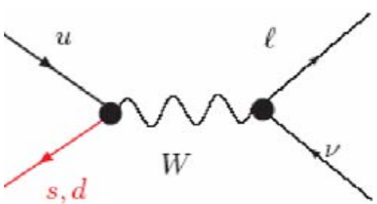
in SM, universality of weak coupling dictates

$$G_{CKM}^2 = (|V_{ud}|^2 + |V_{us}|^2)\, G_F^2 \text{ (from } \mu \text{ lifetime)} = 1/32\, (g_w^2/M_w^2)^2 \quad [V_{ub} \text{ negligible}]$$

we can test for possible breaking of the conditions

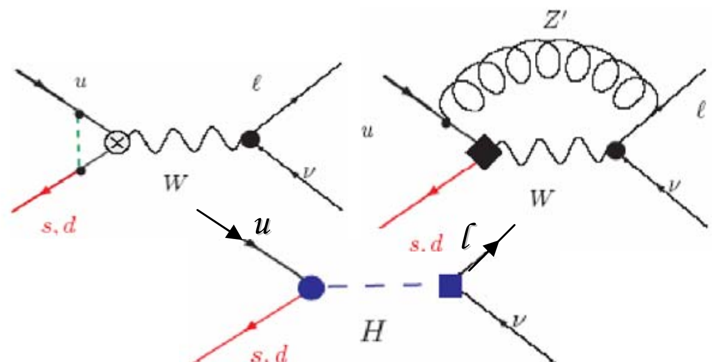
CKM unitarity $(|V_{ud}|^2 + |V_{us}|^2) = 1$ **Weak coupling Universality** $G_{CKM}^2 = (|V_{ud}|^2 + |V_{us}|^2)\, G_F^2$

Standard Model



$\propto G_F^2 |V_{uq}|^2$

+



$\propto G_F^2\, \varepsilon$

$\varepsilon \sim 10^{-3}$

$\varepsilon \sim 10^{-2}$

New Physics

V_{us} at 0.5% makes CKM unitarity test with kaons competitive to Electro-Weak precision test [$G_{e.w.} = 1.1655(12) \times 10^{-5}$ GeV^{-2}]

reference value $G_F = 1.166371(6) \times 10^{-5}$ GeV^{-2} (from μ lifetime)

V_{us} from K_{l3} decay rates

$$\Gamma(K_{l3(\gamma)}) = \frac{C_K^2 G_F^2 M_K^5}{192\pi^3} S_{EW} |V_{us}|^2 |f_+^{K^0\pi^-}(0)|^2 I_{Kl}(\lambda) (1+\delta_K^{SU(2)}+\delta_{Kl}^{EM})$$

with $K = K^+, K^0$; $l = e, \mu$ and $C_K^2 = 1/2$ for K^+, 1 for K^0

Inputs from theory:

S_{EW}	Universal short distance EW correction (1.0232)
$f_+^{K^0\pi^-}(0)$	Hadronic matrix element at zero momentum transfer (t=0)
$\delta_K^{SU(2)}$	Form factor correction for strong SU(2) breaking
δ_{Kl}^{EM}	Long distance EM effects

Inputs from experiment:

$\Gamma(K_{l3(\gamma)})$	**Branching ratios** with well determined treatment of radiative decays; **lifetimes**
$I_{Kl}(\lambda)$	Phase space integral: ls parameterize form factor dependence on t : K_{e3} : *only* λ_+ (or λ_+' λ_+'') $K_{\mu3}$: *need* λ_+ *and* λ_0

V_{us} from K_{l2} decay rates

Precise determination of the ratio $|V_{us}|/|V_{ud}|$ from $K_{\mu 2}$ and $\pi_{\mu 2}$ decay width.

$$\frac{\Gamma(K_{\mu 2(\gamma)})}{\Gamma(\pi_{\mu 2(\gamma)})} = \frac{|V_{us}|^2}{|V_{ud}|^2} \frac{f_K^2}{f_\pi^2} \frac{m_K (1 - m_\mu^2 / m_K^2)^2}{m_\pi (1 - m_\mu^2 / m_\pi^2)^2} (1+\delta)$$

Inputs from theory:

f_K, f_π — K and π decay constant

δ — EW correction

Inputs from experiment:

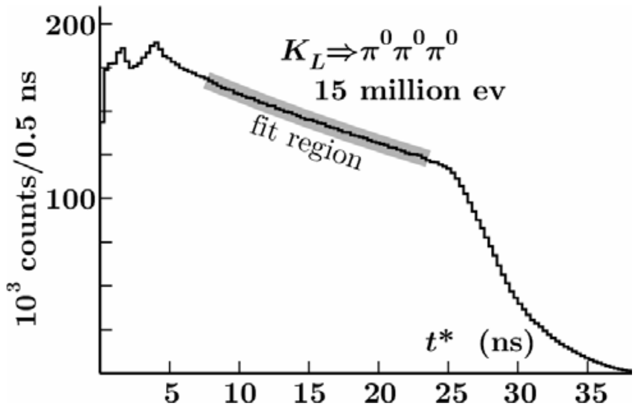
$\Gamma(K_{\mu 2(\gamma)})$ — **Branching ratios** with well determined treatment of radiative decays; **lifetimes**

Combine measurements from $K_{\mu 2}$ and K_{l3} to

- test electron-muon and lepton-quark universality
- test the unitarity of the CKM matrix
- put bounds on new physics

$K_{L,S}$ decays and K_L lifetime

We have combined all the published K_L and a K_S measurements taking into account all correlations



K_L results

$\chi^2/\text{dof} = 0.19/1$

BR(Ke3)	0.4008(15)
BR(Kμ3)	0.2699(14)
BR($3\pi^0$)	0.1996(20)
BR($\pi^+\pi^-\pi^0$)	0.1261(11)
BR($\pi^+\pi^-$)	$1.964(21)\times10^{-3}$
BR($\pi^0\pi^0$)	$8.49(9)\times10^{-4}$
BR($\gamma\gamma$)	$5.57(8)\times10^{-4}$
τ_L	50.84(23) ns

FF's from Ke3

$\lambda'_+ = 0.0255(18)$

$\lambda''_+ = 0.0014(8)$

FF's from Kμ3*

$\lambda_0 = 0.0140(21)$

*in this talk

Only non-KLOE input

BR($\pi^0\pi^0$)/BR($\pi^+\pi^-$)=0.4391±0.0013

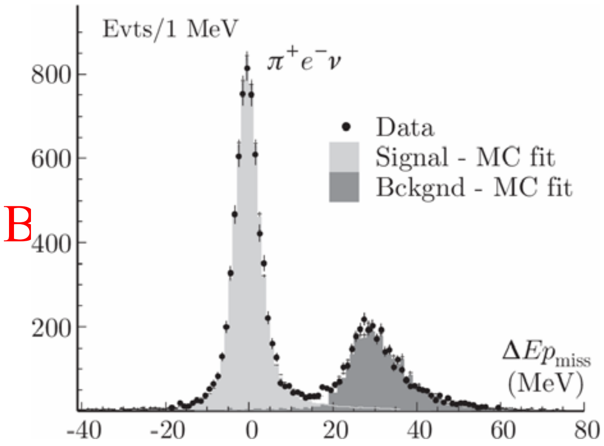
PDG ETAFIT

K_S results

BR($\pi^+\pi^-$)	69.196(51)
BR($\pi^0\pi^0$)	30.687(51)
BR($K_S e^-3$)	$3.517(58)\times10^{-4}$
BR($K_S e^+3$)	$3.528(62)\times10^{-4}$

The sum of measured K_S B

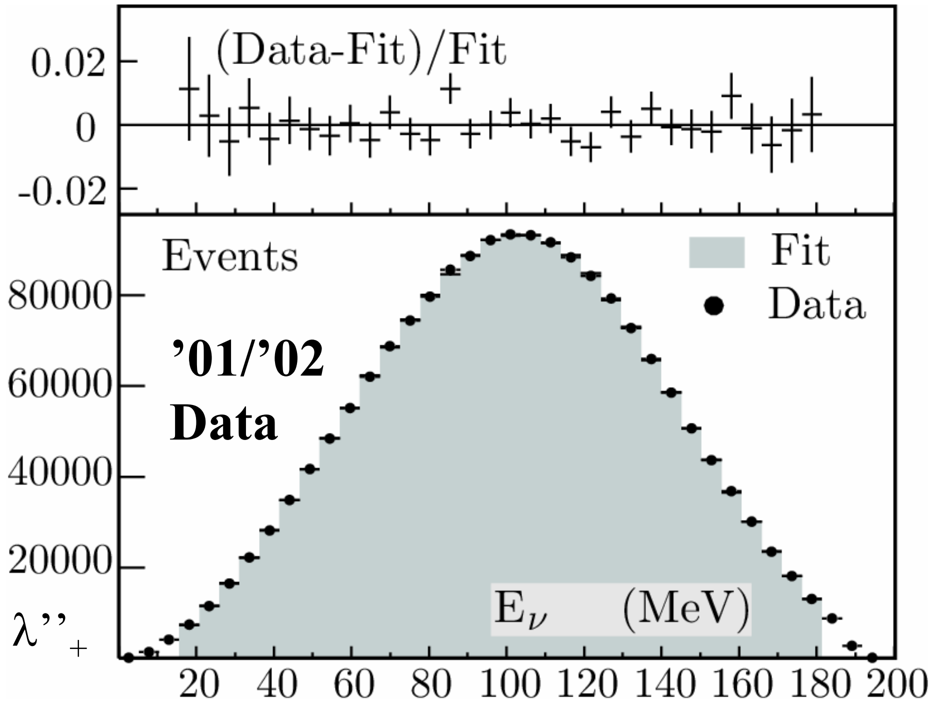
$\sum BR \approx 1-5\times10^{-4}$



Kμ3 form factor slopes

Kμ3 sensitive to both vector and scalar FF's

$$\tilde{f}_{+,0}(t) = 1 + \lambda'_{+,0}\frac{t}{m_\pi^2} + \frac{1}{2}\lambda''_{+,0}\left(\frac{t}{m_\pi^2}\right)^2$$



Standard method: fit t-spectrum, $t = (p_K - p_\pi)^2$

π/μ ID is difficult at low energies

λ_0 slope by fitting the E_ν distribution and combined fit with KLOE K_Le3 results for λ'_+ and λ''_+

K_L tagged by $K_S \rightarrow \pi^+\pi^-$

background rejection of $\pi^+\pi^-$, $\pi^+\pi^-\pi^0$ and K_{e3} from kinematics, TOF measurements & NN (based on on E/p and cluster shape) to 1.5%

1.8 million Kμ3 decays

impossible to measure λ_0'' due to large correlations between λ_0' and λ_0''

use of the linear rather than the quadratic parametrization gives $\lambda_0 \sim \lambda_0' + 3.5\,\lambda_0''$

➔ necessary a ff parametrization with t and t^2 terms but one parameter

$K\mu3$ beyond quadratic parameterization

New parametrizations based on dispersive relations (Bernard, Oertel, Passemar, Stern) and $K\pi$ scattering data exploit the **Callan-Treiman** relation for $f_0(t)$:

$$\tilde{f}_0(t) = \exp\left[\frac{t}{m_K^2 - m_\pi^2}\left(\ln C - G(t)\right)\right]$$

$$\tilde{f}_0(\Delta_K) = \frac{f_K}{f_\pi}\frac{1}{f_+(0)} + \Delta_{CT}$$

$\Delta_{CT} = -3.5 \times 10^{-3}$ $\Delta_{Kp} = m_K^2 - m_\pi^2$

Fit $K\mu3$ and Ke3 data using a approximated polinomial expression $f_0^{POLY}(t,\lambda_0)$ and $f_+^{POLY}(t,\lambda_+)$

Phase-space integrals change by 0.04% and 0.09% for Ke3 and $K\mu3$.

$\lambda_+ = (25.6 \pm 0.6_{\,STAT+SYST}) \times 10^{-3}$

$\lambda_0 = (14.0 \pm 2.1_{STAT+SYST}) \times 10^{-3}$

$\rho(\lambda_+,\lambda_0) = -0.26$

$\chi^2/ndof = 2.6/3$

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Consistency with lattice QCD

Using $f_K/f_\pi = 1.189(7)$ HP-UKQCD '07 ➡ **$f_+(0) = 0.967(25)$**

good agreement with lattice calculations $f_+(0)=0.9644(49)$ (RBC/UKQCD)

Update on Kμ3 form factor slopes

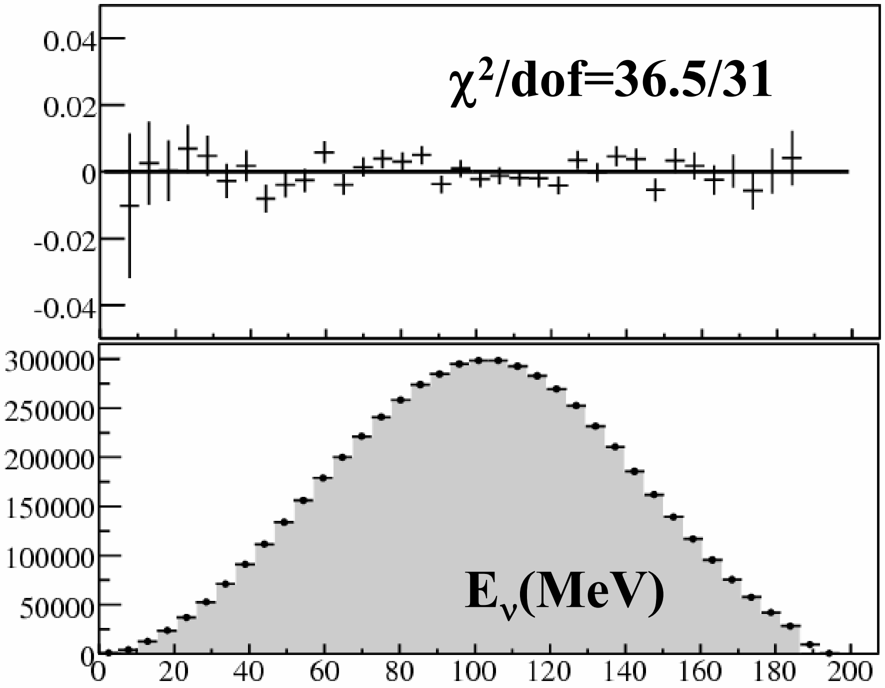
Preliminary results with ~1fb^{-1}

5.8 million Kμ3 decays selected

Sensitivity to all FF's parameters

$\lambda_+' = (25.7 \pm 5.1 \pm 2.5)\times 10^{-3}$
$\lambda_+'' = (2.9 \pm 2.5 \pm 1.3)\times 10^{-3}$
$\lambda_0' = (14.3 \pm 2.9 \pm 2.4)\times 10^{-3}$

$$\begin{pmatrix} -0.97 & 0.90 \\ & -0.80 \end{pmatrix}$$



Results obtained with dispersive relations for $f_{+,0}(t)$ averaged with published results

$\lambda_+ = (26.0 \pm 0.5_{\ STAT+SYST})\times 10^{-3}$
$\lambda_0 = (15.1 \pm 1.4_{\ STAT+SYST})\times 10^{-3}$

$K^{\pm}$ decays and lifetime

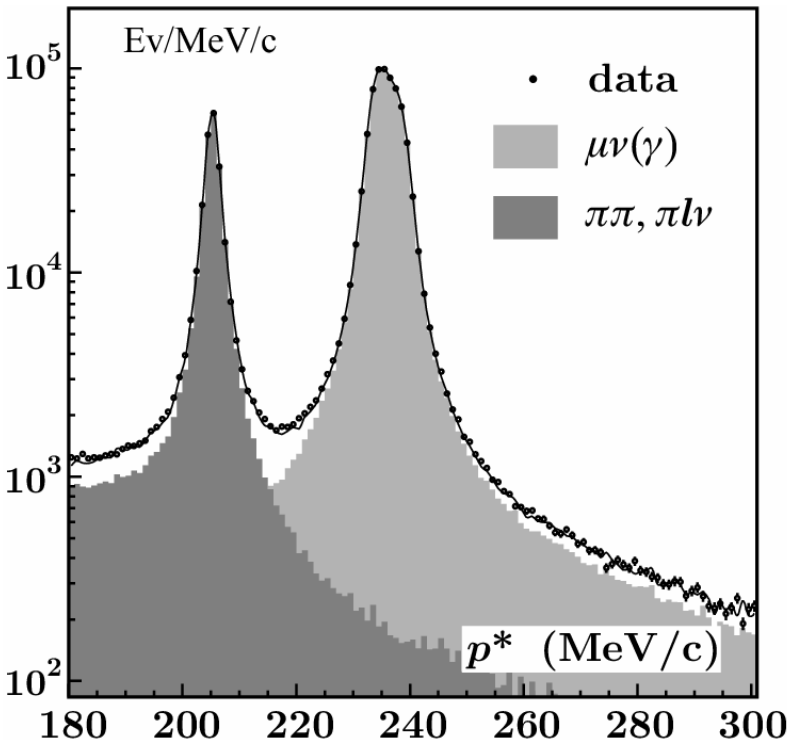
We have combined the recent published for $K^{\pm}{}_{l}3$:

$BR(K^{\pm}_{e3}) = (4.965 \pm 0.038 \pm 0.037)\times10^{-2}$

$BR(K^{\pm}_{\mu3}) = (3.233 \pm 0.029 \pm 0.026)\times10^{-2}$

and $\tau^{\pm}$ measurements:

$\tau_{\pm}=(12.347\pm0.030)$ ns

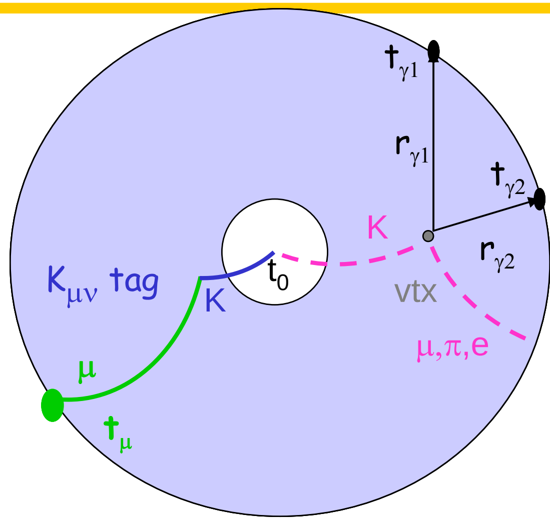


taking into account the BR's lifetime dependence

$BR(K^{\pm} e3)$	0.04972(53) *
$BR(K^{\pm} \mu3)$	0.03237(39) *
$\tau^{\pm}$	12.347(30) ns *
$BR(K^{+}\rightarrow\mu\nu)$	0.6366(17)
$BR(K^{+}\rightarrow\pi^{+}\pi^{0})$	0.02066(11) (preliminary) *

* in this talk

Measurement of the $K^{\pm}$ lifetime



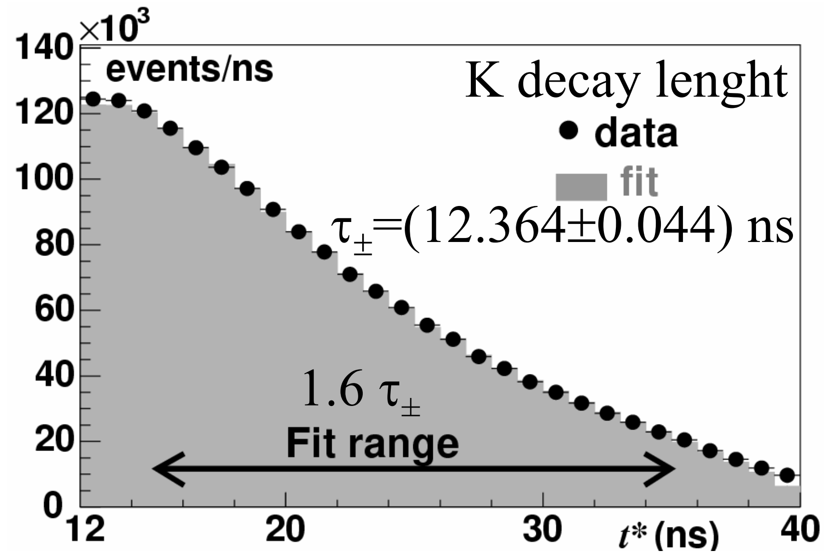
With 12 million tagged K, use 2 methods:

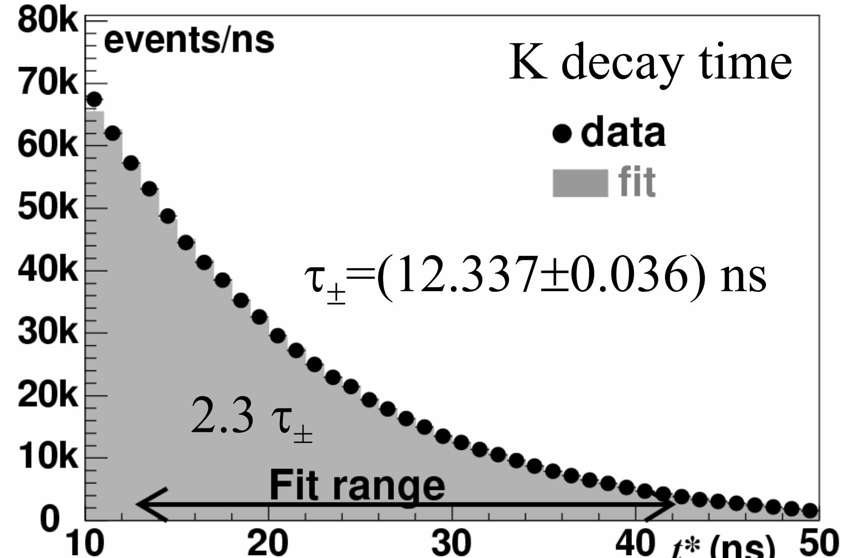
K decay lenght $t^{*} = \sum \Delta L / (\gamma_K \beta_K c)$

from DC info, taking into account dE/dX.

K decay time $t^{*} = (t_\gamma - L_\gamma / c) / \gamma_K$

from calorimeter info, measure photon time of flight using $K^{\pm} \rightarrow \pi^{\pm} \pi^{0}$





$\tau_{\pm} = (12.347 \pm 0.030)$ ns

$\tau_{-} / \tau_{+} = 1.004 \pm 0.004$

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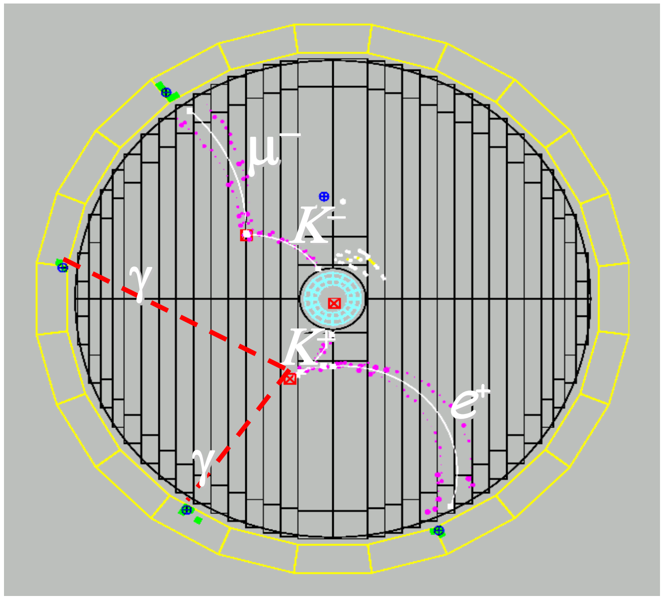
PDG average 12.385(25) ns but CL 0.2%

Measurement of the BR($K^{\pm}_{l3}$)



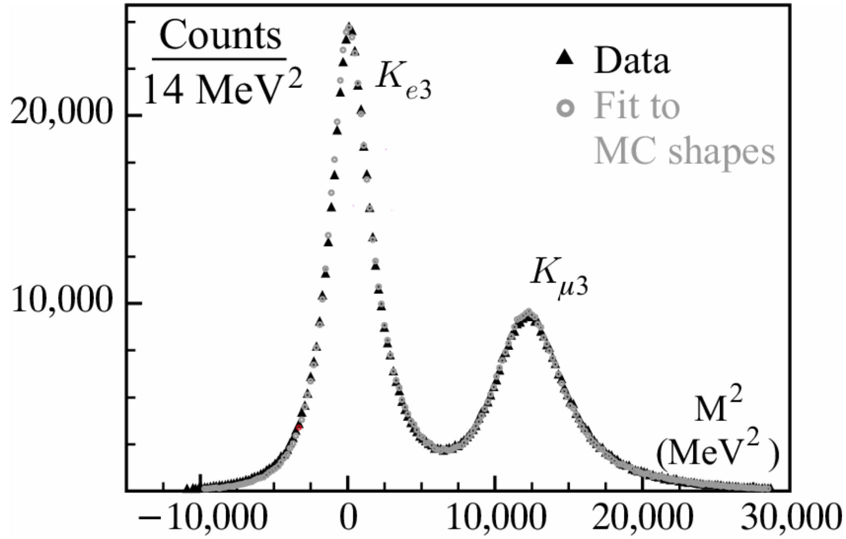
4 independent tag samples:

$K^{\pm} \to \mu\nu$, $K^{\pm} \to \pi^{\pm}\pi^{0}$

60 million tagged events.

Apply kinematic cuts to reject background. Reconstruct photons and measure t_K from tof.

Measure lepton mass from tof and track momentum measurement.



Counting from fit to m^2_1 distribution.

300,000 Ke3 and 160,000 Kμ3.

Using lifetime from KLOE:

$$m_l^2 = p_l^2 \left[\frac{c^2}{L_l^2} (t_l - t_K)^2 - 1 \right]$$

BR($K^{\pm}_{e3}$) = $(4.965 \pm 0.038 \pm 0.037)\times 10^{-2}$

BR($K^{\pm}_{\mu3}$) = $(3.233 \pm 0.029 \pm 0.026)\times 10^{-2}$

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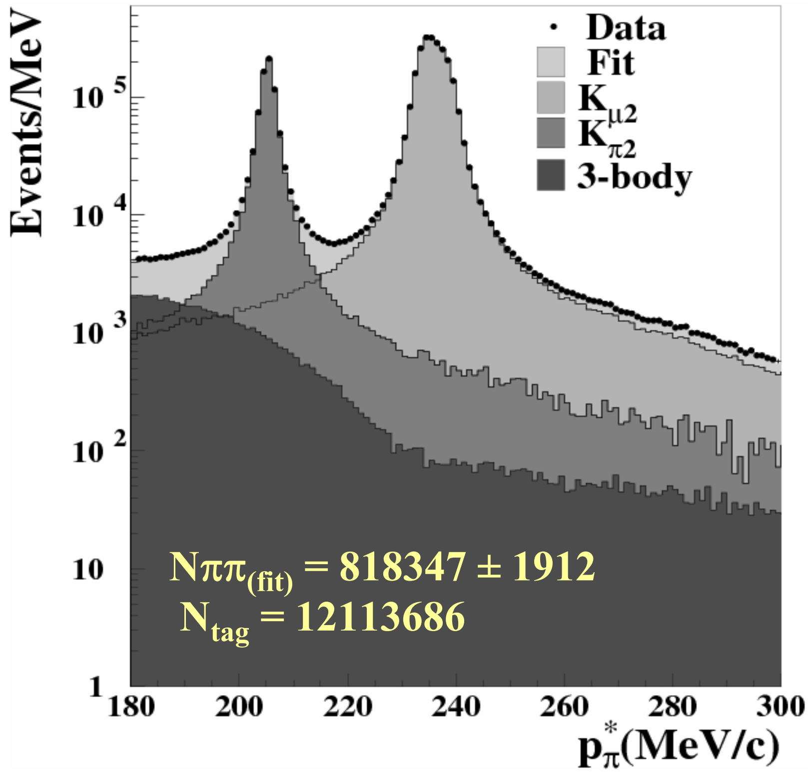
Measurement of the $BR(K^+ \to \pi^+\pi^0)$

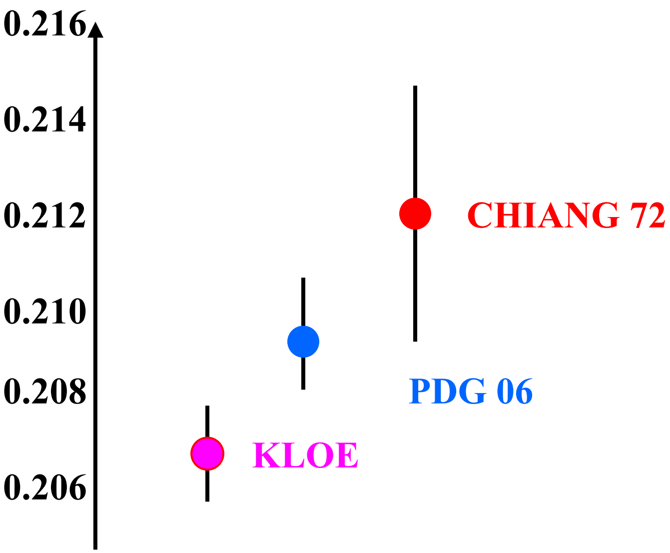
Crucial to perform fit of the $K^\pm$ BR's (closure of BR's)

Enter in the normalization of $K^\pm_{L3}$ by NA48,ISTRA+,E865, used for V_{us}

K^+ tagged by $K^- \to \mu^-\nu$ tag

- signal count from the fit the *p** distribution:
  $\mu\nu$ and $\pi\pi^0$ distribution from DATA control sample selected using calorimetric information only
  3-body decays from MC
- Track efficiency measured on data using $K^\pm \to \pi^0 X$





Preliminary results with 250 pb^{-1}

$BR(K^+ \to \pi^+\pi^0(\gamma)) = (20.658 \pm 0.065_{stat} \pm 0.090_{syst})\%$

-1.3% respect to PDG 06 $\sigma_{rel} \sim 0.5\%$

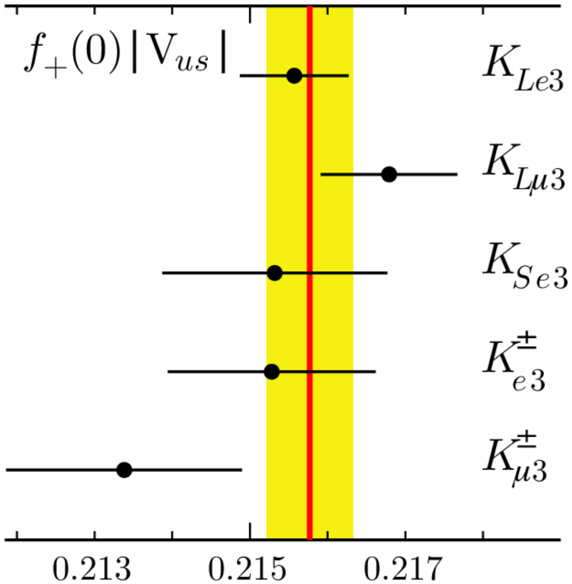
shifts NA48/2 and ISTRA+ $K^\pm_{L3}$ measurements

$V_{us} \times f_+(0)$ from KLOE: final results

(arXiv: 0802.3009)

Using BR(K_{l3}) 's, $\tau(K_L)$ and $\tau(K^\pm)$ from KLOE,
$\tau(K_S)$ from PDG and
ff's from dispersive relations

KLOE Avg:
$|V_{us}| f_+(0) = 0.2157(6)$
$\chi^2/\mathrm{ndf} = 7.0/4$ (13%)



Test of Lepton universality

$$r_{\mu e} = \frac{|f_+(0) \times V_{us}|^2_{\mu3}}{|f_+(0) \times V_{us}|^2_{e3}} = \frac{\Gamma_{e3}}{\Gamma_{\mu3}} \cdot \frac{I_{e3}(1+\delta_{e3})}{I_{\mu3}(1+\delta_{\mu3})} = \frac{g_\mu^2}{g_e^2}$$

$r_{\mu e} = 1.000(8)$

From π and τ decays → ±0.4%

V_{us} determination and unitarity test

From KLOE K_{l3}:

$|V_{us}| = 0.2237(13)$ using

$f_+(0) = 0.9644(49)$ (HPQCD/UKQCD)

From KLOE $K_{\mu2}$:

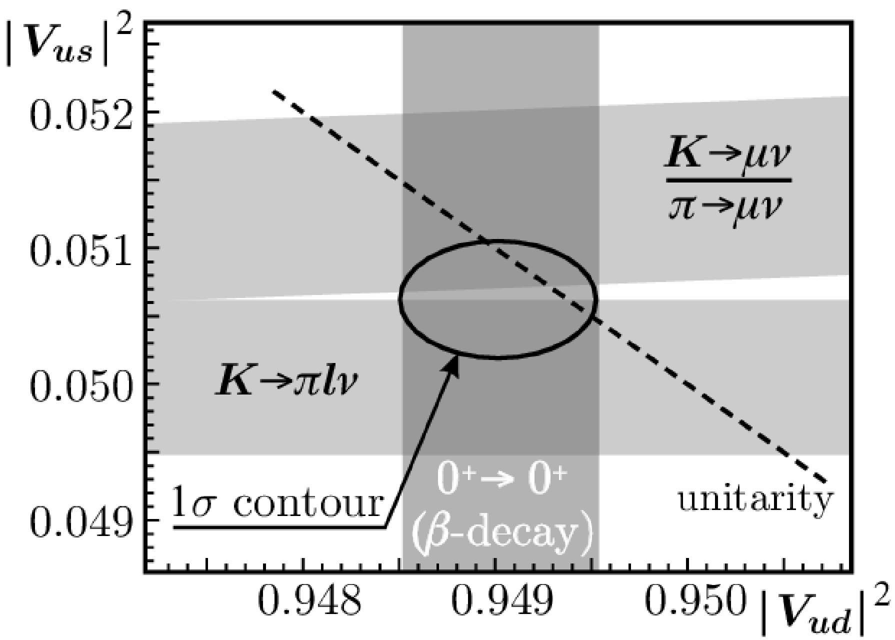
$|V_{us}|/|V_{ud}| = 0.2326(15)$ using

$f_K/f_\pi = 1.189(7)$ (HPQCD/UKQCD) and

$\Gamma(\pi \rightarrow \mu\nu)$:

From $0^+ \rightarrow 0^+$ nuclear β decays

$|V_{ud}| = 0.97418 \pm 0.00026$



$$V_{us} = 0.2249(10) \quad V_{ud} = 0.97471(26)$$

$$\chi^2/\text{ndf} = 2.34/1\ (13\%)$$

$1 - V_{ud}^2 + V_{us}^2 = -0.0004 \pm 0.0007$ (~0.6 σ)

Unitarity condition verified to 0.1%

$K_{\mu 2}$: sensitivity to charged Higgs

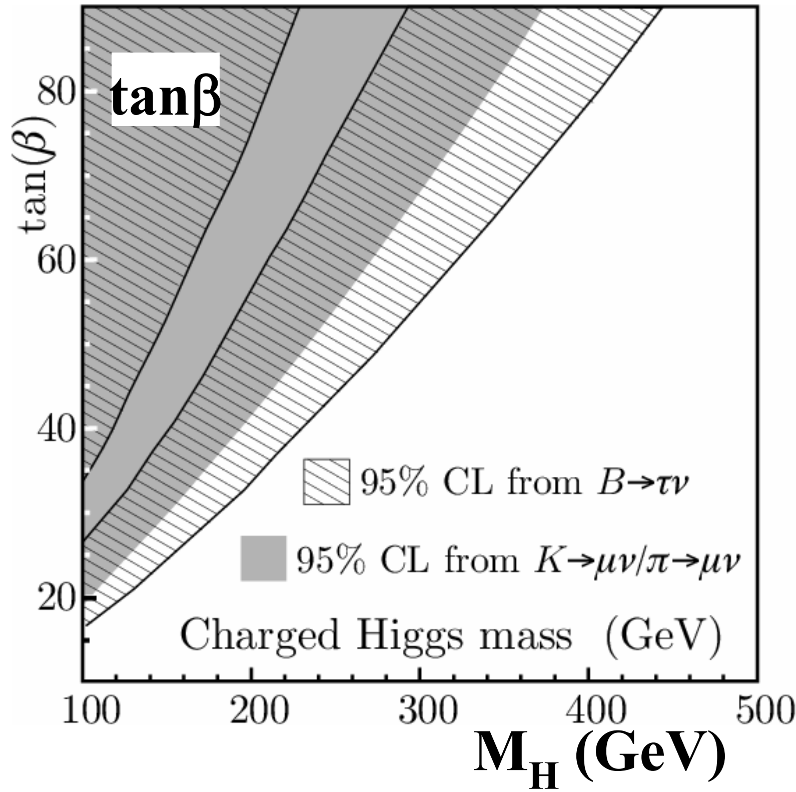
Pseudoscalar currents, e.g. due to H^+, or right-handed currents affect the K width and are observables through the measurement of

$$R_{l23} = \left| \frac{V_{us}(K_{\mu 2})}{V_{us}(K_{l3})} \times \frac{V_{ud}(0^+ \to 0^+)}{V_{ud}(\pi_{\mu 2})} \right|$$

Unity in SM, a H^+ exchange is expected to lower R_{l23}

$$R_{l23} = \left| 1 - \frac{m^2_{K^+}}{m^2_{H^+}} \left(1 - \frac{m^2_{\pi^+}}{m^2_{K^+}} \right) \frac{\tan^2\beta}{1 + \varepsilon_0 \tan\beta} \right|$$

(Isidori, Paradisi)



Using KLOE data, and assuming CKM unitarity for K_{l3} we get:

$R_{l23}=1.008\pm0.008$

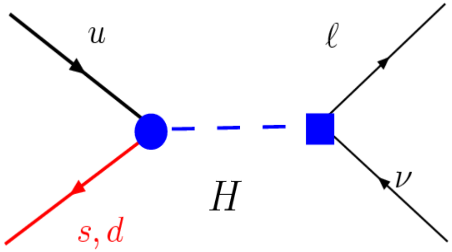
Lepton universality from $R_K = K_{e2}/K_{\mu 2}$

extremely well known within SM no hadronic uncertainties (no f_K) → 0.4×10^{-3}

in MSSM, LFV could give up to % deviations [Masiero, Paradisi, Petronzio]

NP dominated by contribution of $e\nu_\tau$

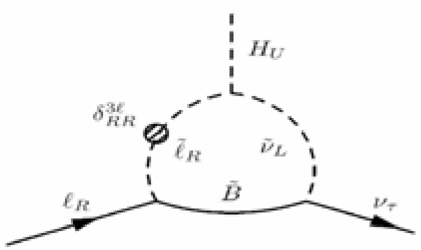
$$R_K \approx \frac{\Gamma(K\to e\nu_e)+\Gamma(K\to e\nu_\tau)}{\Gamma(K\to\mu\nu_\mu)}$$



$\nu_e\ \nu_\mu\ \nu_\tau$

with effective coupling

$$eH^{\pm}\nu_\tau \to \frac{g_2}{\sqrt{2}}\frac{m_\tau}{M_W}\Delta_R^{31}\tan^2\beta$$



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

1% effect ($\Delta^R_{31}\sim 5\times10^{-4}$, $\tan\beta\sim 40$, $m_{H+}\sim 500$ GeV) not unnatural

present accuracy on R_K @ 6% (PDG06) ➔ new precise measurements @ < 1%

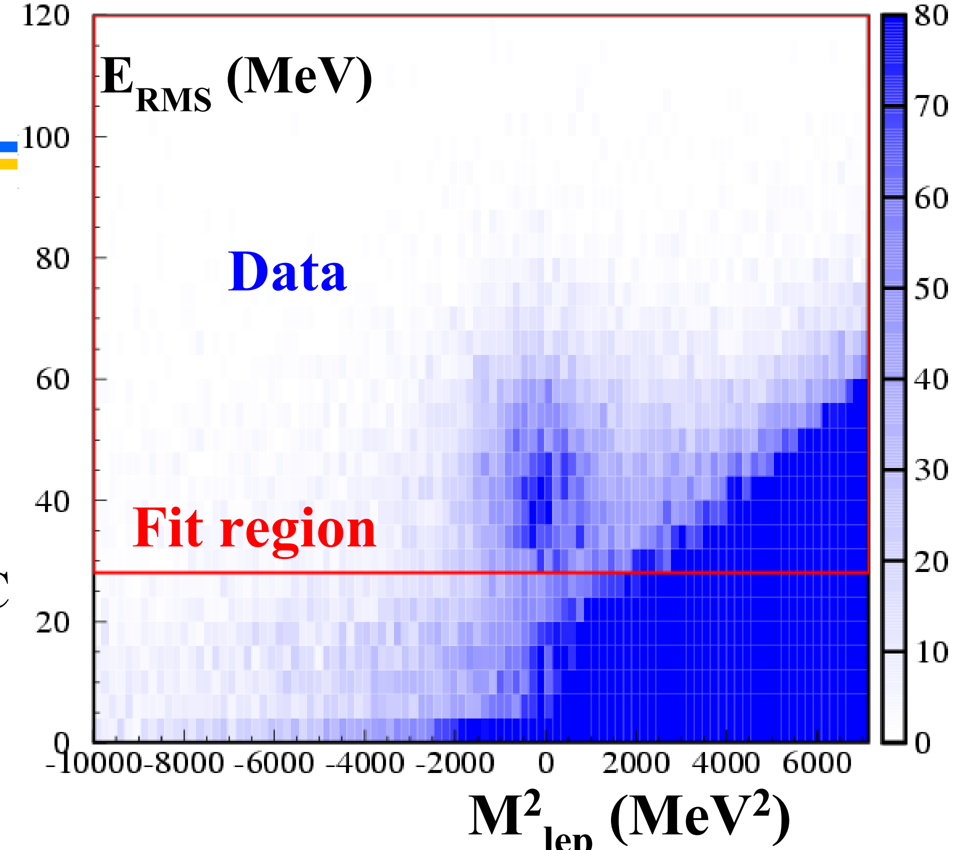
Counting K_{e2} events

Expect 4×10^4 events in KLOE data sample (2.3 fb^{-1})

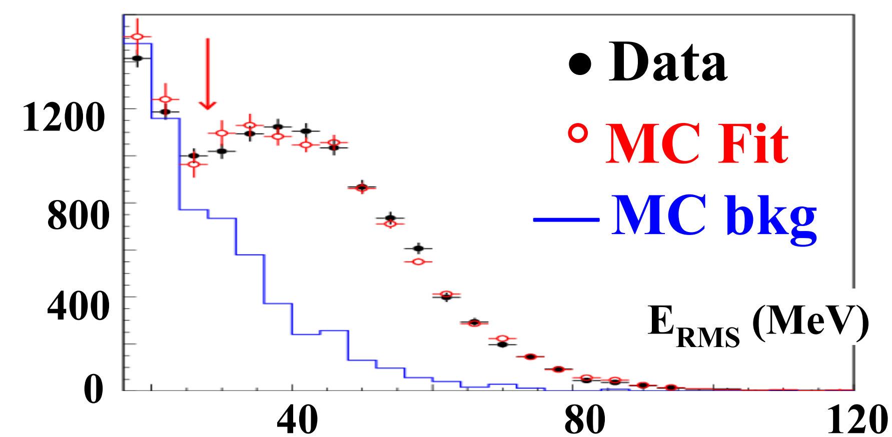
Perform direct search for K_{e2} without tag: gain × 4 of statistics

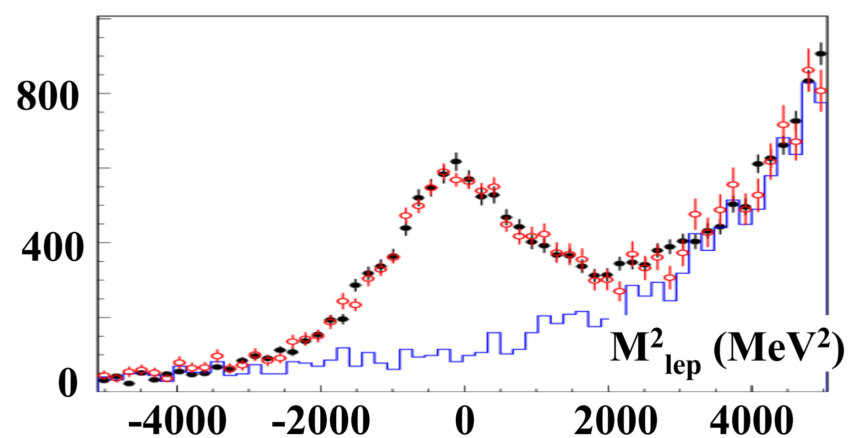
Background from Kμ2, selection using DC info (M_{lep}^2) and calorimeter PID (E_{RMS})

8090±160 observed events on 1.7 fb^{-1}



KLOE preliminary, ArXiv: 0707.4623



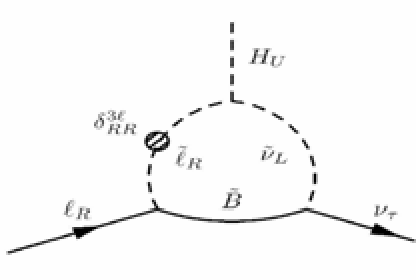


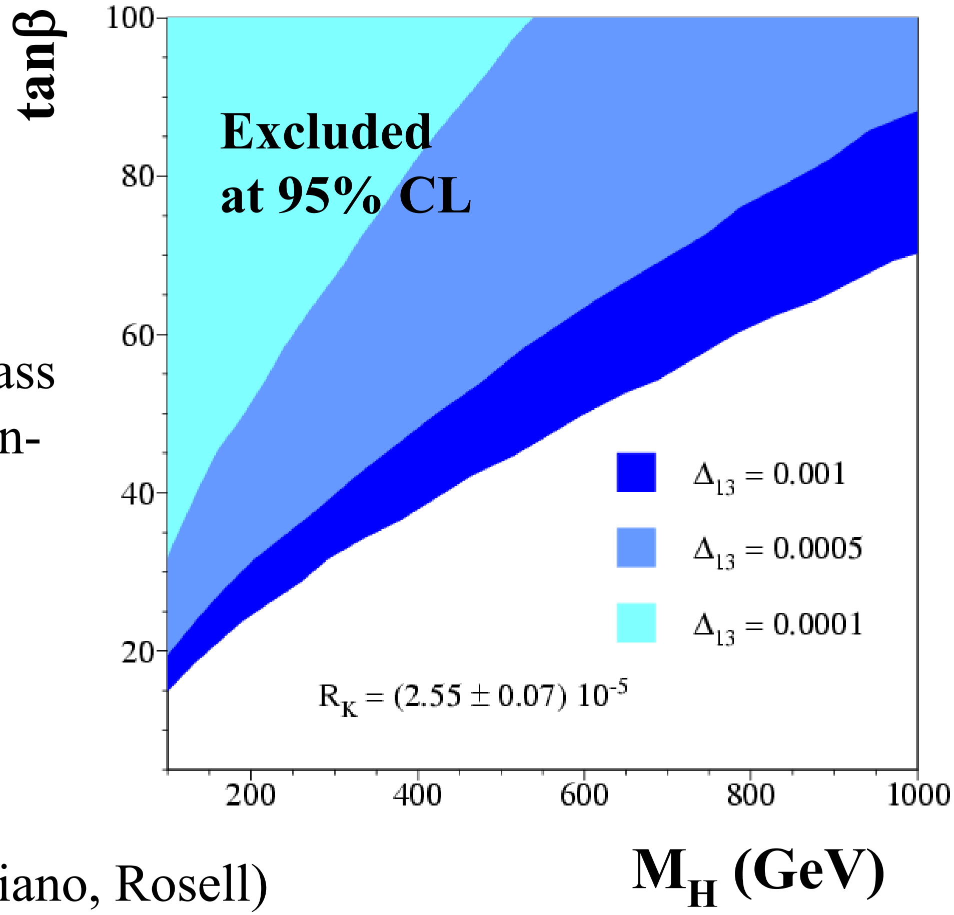
$R_K = K_{e2}/K_{\mu 2}$ preliminary result

KLOE preliminary result with 2.7% uncertainty

$R_K = (2.55 \pm 0.05 \pm 0.05) \times 10^{-5}$

We place bounds on the charged Higgs mass and tanβ, for different values of the slepton-mass matrix element Δ_{13}.





Agreement with SM $2.477(1) \times 10^{-5}$ (Cirigliano, Rosell) and NA48/2 preliminary $2.43(4) \times 10^{-5}$

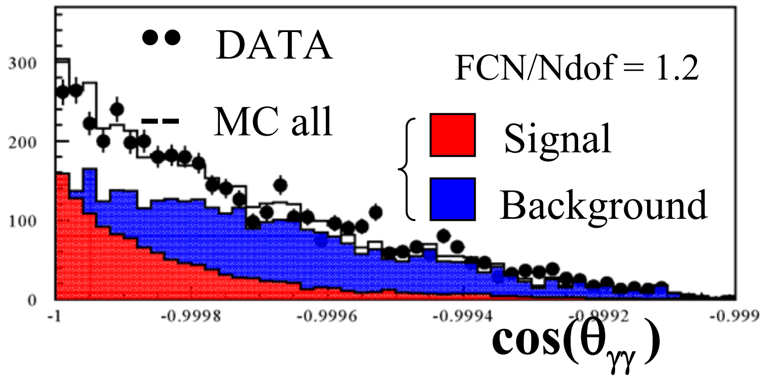
1% accuracy reachable increasing DATA sample analysed, CS and MC statistics

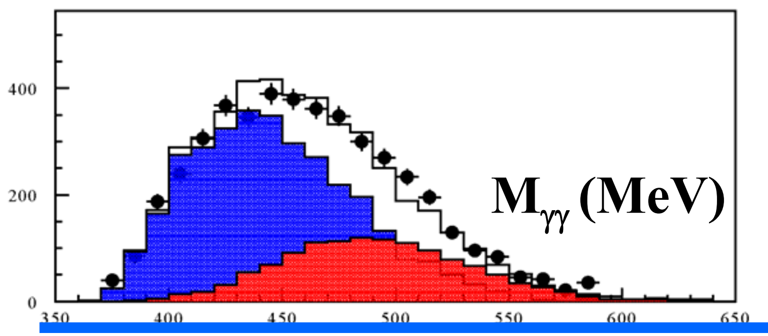
Measurement of $BR(K_S \to \gamma\gamma)$

Important test of χ^{PT}

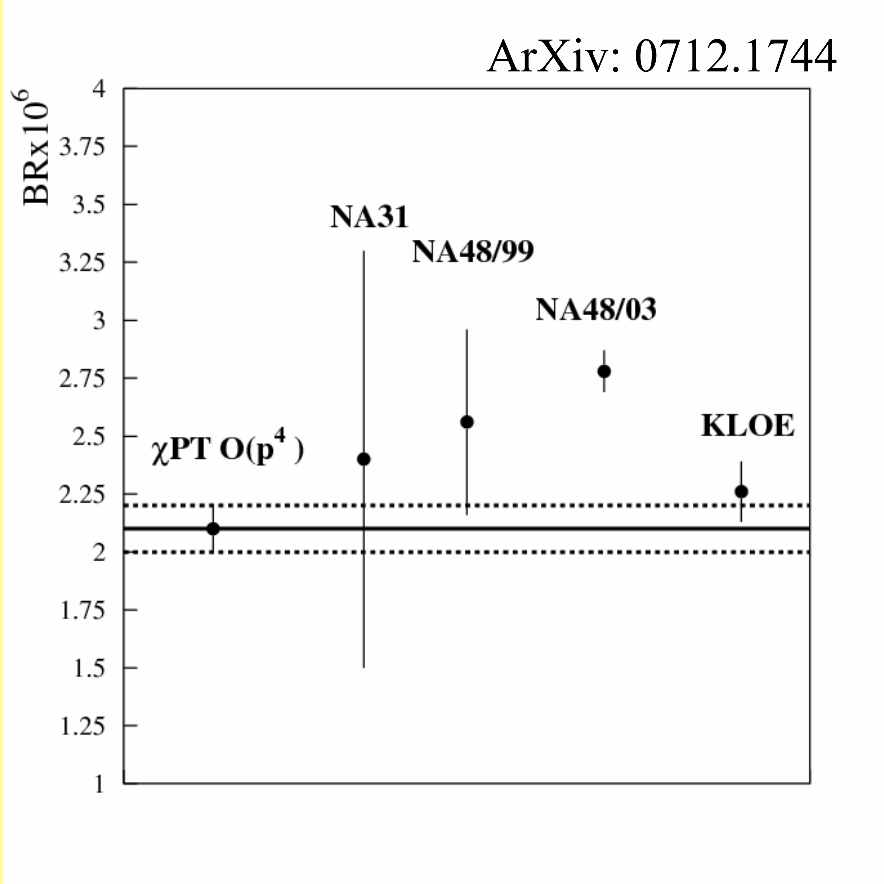
- K_S tagged by K_L crash
- count signal events fitting $M_{\gamma\gamma}$ and $\cos\theta^*_{\gamma\gamma}$ in the K_S cms

$$N_{sig} = 600.3 \pm 34.8$$





$BR = (2.26 \pm 0.12 \pm 0.06)\times10^{-6}$

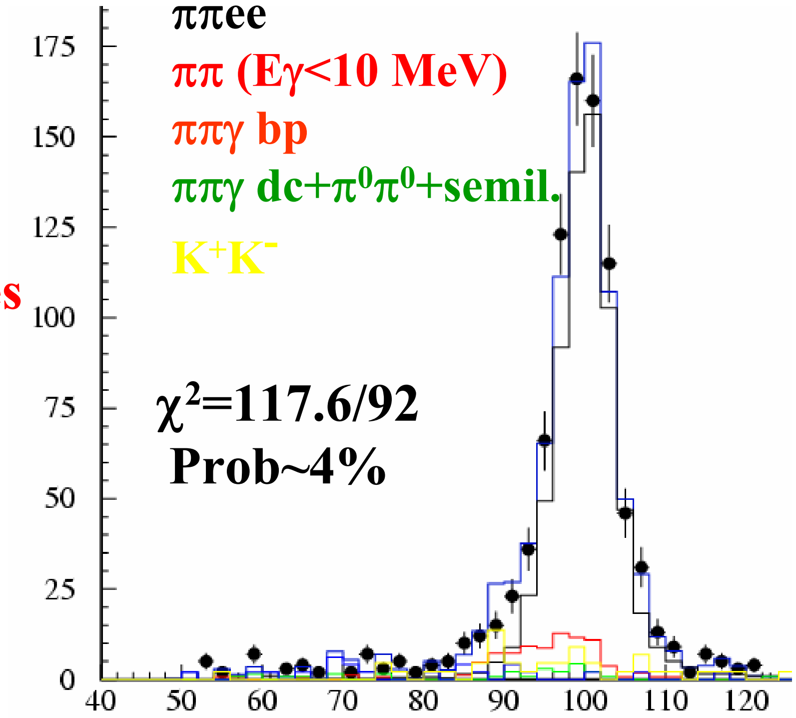


KLOE agrees with $\chi PT\ O(p^4)$

$BR(K_S \to \pi^+\pi^- e^+ e^-)$

Amplitude dominated by CP even IB component (needed to predict the CP violation in $K_L \to \pi\pi ee$)

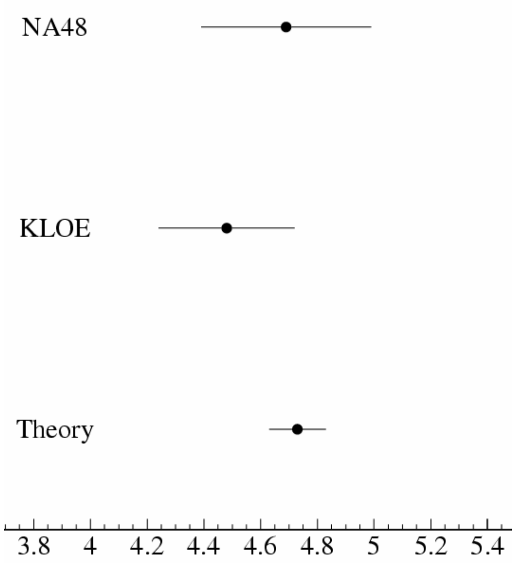
CP test through measurement of angular asymmetry between $\pi\pi$ and ee planes



K_S tagged by K_L crash

Fit the distribution of $(E_{miss}-P_{miss})_{\pi\pi ee}$

Normalize to the number of $K_S \to \pi^+\pi^-$



Preliminary results (900 pb^{-1})

$N_{\pi\pi ee}$=974±53

ε = 0.02359 ±0.00031

$BR=(4.48 \pm 0.24_{Stat} \pm 0.15_{Syst})\times 10^{-5}$

Asymmetry soon

Conclusions

$\mathbf{V_{us}}$

From BR (K_L3), FF's , the $\tau(K_L)$ and $\tau(K^{\pm})$
$\boldsymbol{f_+(0)\times|V_{us}|=0.2157\pm0.0006}$ with 0.3% accuracy

From K_{L3} and $K_{\mu 2}$: $|V_{us}|=0.2237\pm0.0013$ and $|V_{us}/V_{ud}|=0.2326\pm0.0015$ with 0.6% accuracy

first-row CKM unitarity to 0.1% (0.6σ)

Preliminary results on the FF parameters

LFV

$\mathbf{r_{\mu e} = g_\mu^2/g_e^2 = 1.000\pm0.008}$ from K_L3 decays
Preliminary results on the ratio BR($K\to e\nu$)/BR($K\to\mu\nu$)

NP

The measurement of BR($K_{\mu 2}$) and excludes a large region in the m_{H+}-tanβ plane.

Preliminary results with higher statistics dataset on CPT, Lorentz symmetry and QM tests

With the analysis of the full data sample (2.2 fb^{-1}) KLOE will further improve all results

KLOE and DAΦNE are going to be upgraded.

Spare

KLOE-2 at upgraded DAΦNE

Proposals to upgrade DAFNE in luminosity (and energy):

Crabbed waist scheme at DAFNE (proposal by P. Raimondi)

- increase L by a factor *O*(5)
- requires minor modifications
- relatively low cost

- Experimental test at DAFNE are running
- If successful KLOE-2 data taking could start already in 2009

KLOE-2 Physics issues:

- Neutral kaon interferometry, CPT symmetry & QM tests
- Kaon physics, rare K_S decays
- η,η' physics
- Light scalars, γγ physics
- Hadron cross section at low energy, muon anomaly
- (baryon electromagnetic form factors, $e^+e^- \rightarrow pp$, nn, ΛΛ)

KLOE-2 Detector upgrade issues:

- Inner tracker R&D
- Calorimeter, increase of granularity
- FEE maintenance and upgrade
- Computing and networking update
- γγ tagging system
- etc.. (Trigger,software, …)

Recent KLOE published results on kaons

Form factors

Ke3 FF	PLB636 (2006) 166	$d\lambda'/\lambda' \sim 7\%$ $d\lambda''/\lambda'' \sim 50\%$
Kμ3 FF	JHEP 12 (2007) 105	$d\lambda_0/\lambda_0 \sim 14\%$ $dI/I \sim 0.3\text{-}0.5\%$

Neutral Kaons

τ_L	PLB626 (2005) 15	$d\tau/\tau \sim 0.5\%$
K_L BR's	PLB632 (2006) 43	$dBR(\pi l \nu)/BR \sim 0.4\text{-}0.5\%$
$Ks \rightarrow \pi e \nu$	PLB636 (2006) 173	$dBR(\pi e \nu)/BR \sim 1.3\%$
$K_L \rightarrow \pi^+\pi^-$	PLB 638(2006) 140	$dBR\ (\pi\ \pi)/BR \sim 1.1\%$
$K_S \rightarrow \pi^+\pi^-, \pi^0\pi^0$	EPJ C48(2006) 767	$d(\Gamma(\pi^+\pi^-)/\Gamma(\pi^0\pi^0))/(\Gamma(\pi^+\pi^-)/\Gamma(\pi^0\pi^0)) \sim 0.2\%$
$K_S \rightarrow \pi^0\pi^0\pi^0$	PLB 619(2005) 61	upper limit on BR at 10^{-7}

Charged Kaons

$\tau^\pm$	JHEP 01 (2008) 073	$d\tau/\tau \sim 0.25\%$
$K^+ \rightarrow \mu\nu$	PLB632 (2006) 76	$dBR/BR \sim 0.26\%$
$K^\pm \rightarrow \pi l \nu$	JHEP Accepted	$dBR(\pi l \nu)/BR \sim 1.1\%$

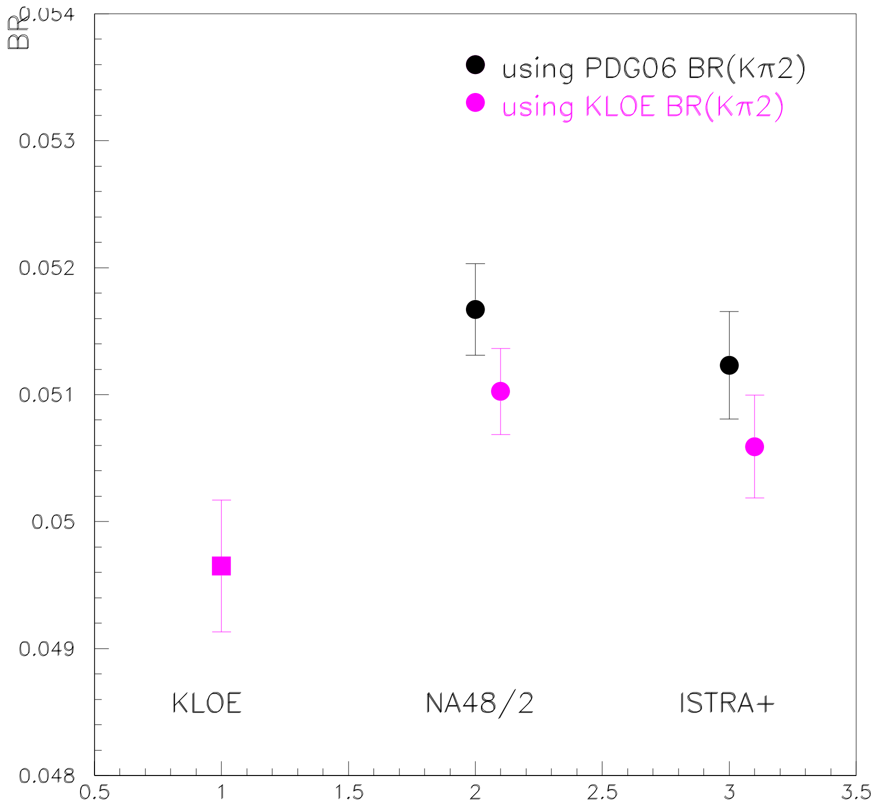
QM and CPT tests

Bell-Steinberger rel.	JHEP 0612(2006)011	CP and CPT violation parameters
$K_S K_L \rightarrow \pi^+\pi^-\pi^+\pi^-$	PLB 642(2006) 315	

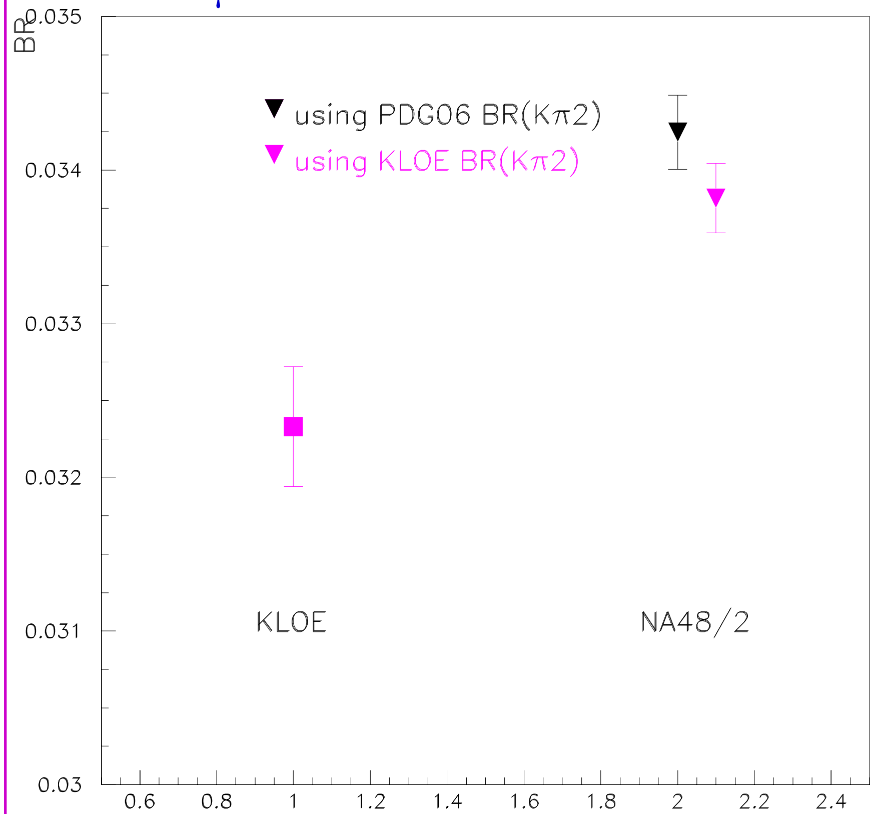
Measurement of the BR($K^+ \rightarrow \pi^+ \pi^0$)

impact of the new measurement wrt PDG 06 fit value on the BR($K^{\pm}_{l3}$) measurements normalized to $K_{\pi 2}$ decays and comparison with absolute BR($K^{\pm}_{l3}$) measurements from KLOE

BR(K_{e3})



BR($K_{\mu 3}$)



K_{e2} : perspectives toward 1% error

Present status

1.1% Signal counts/1.7fb^{-1}

0.7% Bkg subtraction

1.4% MC Bkg statistics

1.9% stat error

1.5% incomplete PID CS coverage

0.9% one-prong CS stat

0.9% TRG minimum-bias stat

2.0% syst error

To complete analysis

+30% of data under processing

+40% w recover of prompt K decays

× 2 rejection from kinematics

× 2 MC stat *under processing*

× 4-8 CS stat available, loosen PID cut

~ 0.5% using all data

Better control of trigger variables

Will push error @ 1% : final result will be compared with P326/NA62 measurement (100k events) [R. Fantechi, EPS HEP 2007]