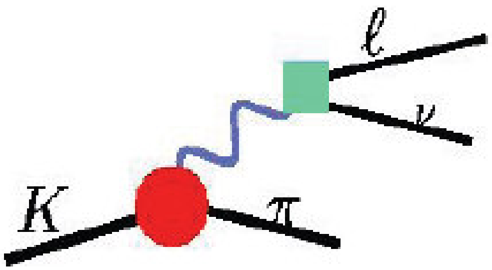
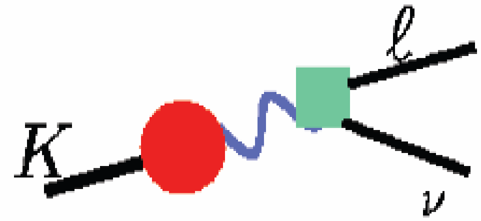
KLOE perspectives on kaon decays





- **Vus: K_S decays**
  K_L decays and lifetime
  $K^{\pm}$ decays and lifetime
  K_L and $K^{\pm}$ semileptonic form factors

- **Ke2/Kμ2.**

B. Sciascia, LNF INFN
for the KLOE collaboration

FlaviaNet meeting - Orsay, 14 November 2007

V_{us} *from* $K_{\ell 3}$ *decay rates*

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

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**

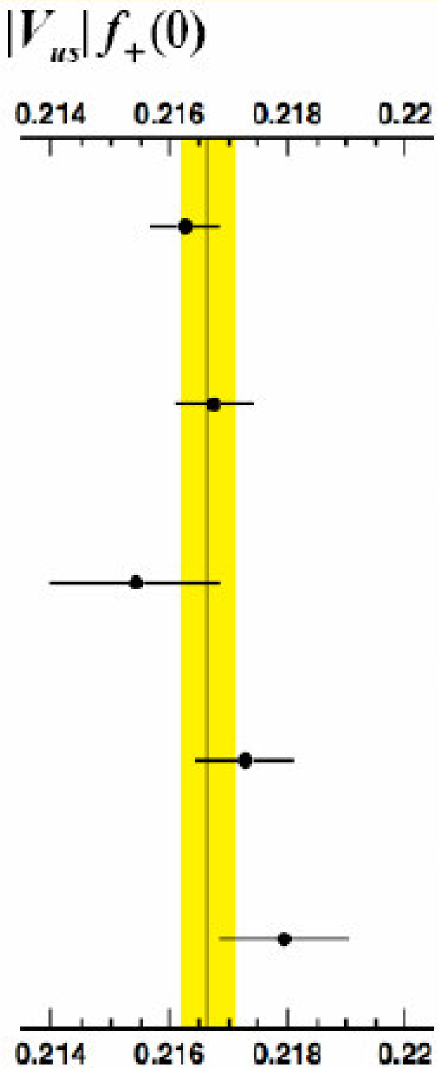
$I_{Kl}(\lambda)$ Phase space integral: λs parameterize form factor dependence on t :

K_{e3} : *only* λ_+ (or λ_+' λ_+'')

$K_{\mu 3}$: *need* λ_+ *and* λ_0

CT

V_{us} *from* $K_{\ell 3}$ *data – FlaviaNet@EPS'07*



FlaviA net Kaon WG

		% err	Approx. contrib. to % err from: BR	τ	Δ	Int
$K_L e3$	0.21625(60)	0.28	0.09	0.19	0.15	0.09
$K_L \mu 3$	0.21675(66)	0.31	0.10	0.18	0.15	0.15
$K_S e3$	0.21542(144)	0.67	0.65	0.03	0.15	0.09
$K^{\pm} e3$	0.21728(84)	0.39	0.26	0.09	0.26	0.09
$K^{\pm} \mu 3$	0.21794(111)	0.51	0.40	0.09	0.26	0.15

Average: $|V_{us}| f_+(0)$ = 0.21664(48) χ^2/ndf =2.88/4 (58%)

$BR(K_S \to \pi e \nu)$

BRs from KLOE tagged K_S beam, 1.2×10^8 events (20% of full data sample)

KLOE PLB 632 (2006)	$\mathbf{BR(K_S \to \pi e \nu)/BR(K_S \to \pi^+\pi^-) = 10.19(13) \times 10^{-4}}$
KLOE EPJC 48 (2006)	$\mathbf{BR(K_S \to \pi^+\pi^-) / BR(K_S \to \pi^0\pi^0) = 2.2459(54)}$ Averaged with KLOE '02

These two measurements completely determine main K_S BRs

$$\mathbf{BR(K_S \to \pi e \nu) = 7.046(91) \times 10^{-4}}$$

$$A_S = (1.5 \pm 9.6_{stat} \pm 2.9_{syst}) \times 10^{-3}$$
$$\lambda_+ = (33.9 \pm 4.1) \times 10^{-3}$$

Compare to results for A_L:
KTeV $(3.322 \pm 0.058 \pm 0.047) \times 10^{-3}$

With 2.2 fb^{-1} we will measure:
- **BR**: statistical error will be 0.5%; improve on the present syst. (0.7%)
- **A_S**: error dominated by statistics a factor ×2 better (4×10^{-3})

K_L *branching ratios and lifetime*

Absolute BRs: K_L decays tagged by $K_S \to \pi^+\pi^-$

(13×10^6 tagged, 10^5 -10^6 signal)

KLOE, PLB 632 (2006)

$BR^{(0)}(K_{e3}) = 0.4049(21)$

$BR^{(0)}(K_{\mu3}) = 0.2726(16)$

$BR^{(0)}(3\pi^0) = 0.2018(24)$

$BR^{(0)}(\pi^+\pi^-\pi^0) = 0.1276(15)$

at $\tau_L^{(0)} = 51.54$ ns, with $d\mathrm{BR}/\mathrm{BR} = 0.67\, d\tau_L/\tau_L$ (geometrical acceptance)

Correlations available

Update with ×5 available statistics (to be started).

KLOE results: set $\Sigma BR(i)=1$ and solve for τ_L
Fit to BRs: use unconstrained BRs with dependence on τ_L

Lifetime: measurement from an independent sample of 8.5×10^6 $K_L \to \pi^0\pi^0\pi^0$ events; uniform reconstruction efficiency over $0.4\tau_L$.

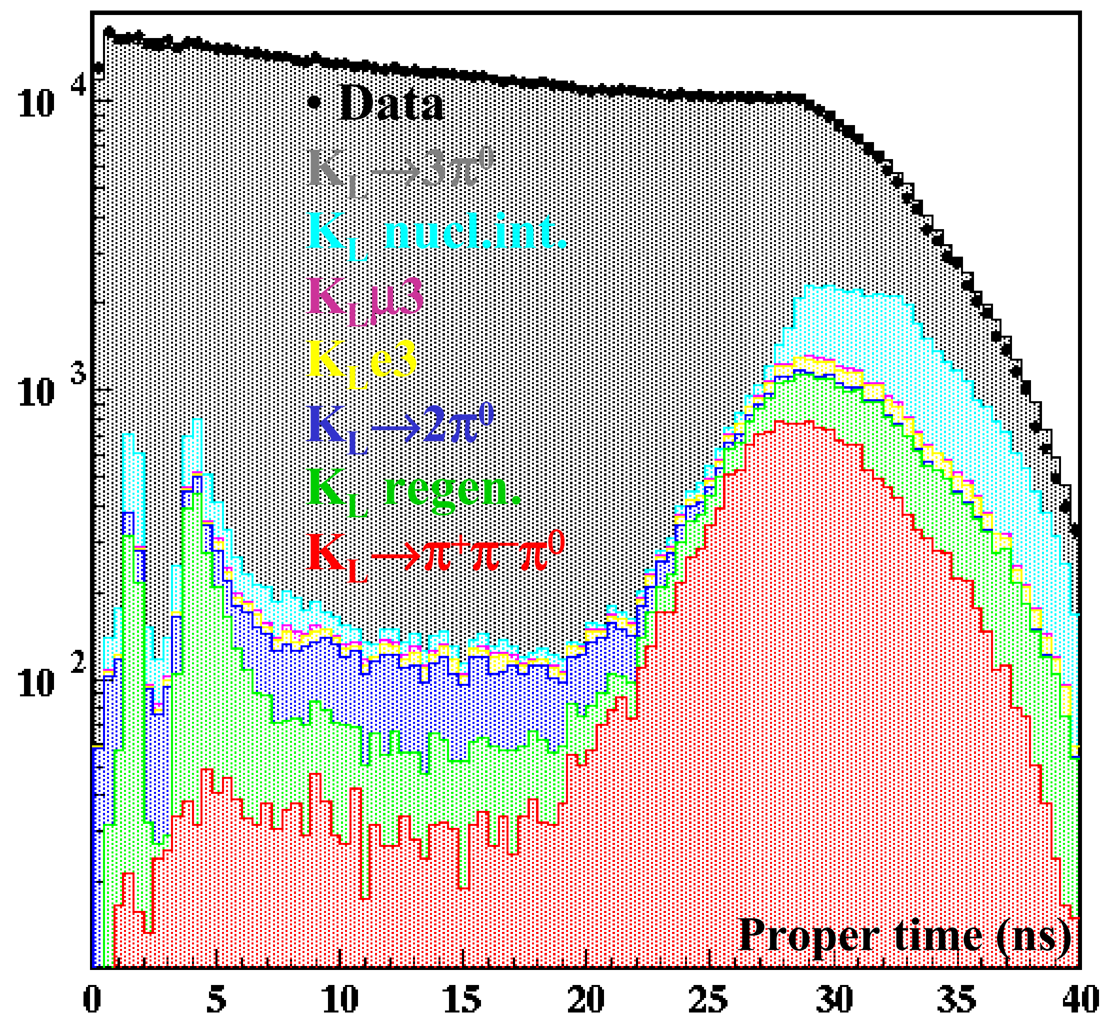
KLOE, PLB 626 (2005)

$\tau_L = 50.92(30)$ ns

Update with ×5 available statistics (work in progress).

K_L lifetime: update with 2 fb^{-1}

- Same technique used for the DIRECT measurement on 2001/2002 data ($K_L \to \pi^0\pi^0\pi^0$).
- Factor ×5 in statistics: at least a factor 2 better wrt the published stat. error (0.17 ns)
- Syst. error dominant (0.25 ns). Aim to at least a factor 2 better.
- Bkg less than 1%, in FV.



1) Improve quality of the neutral vertex algorithm (better agreement wrt MC).
2) Improve clustering algorithm
3) Study of background at the edge of FV (mainly $K_L \to \pi^+\pi^-\pi^0$ and K_L nuclear interaction) allow to extend the fit range (at least 27 ns instead of 24.8 ns)

$K^{\pm}$ *BR and lifetime measurements*

Absolute BR($K^{\pm}_{e3}$) and BR($K^{\pm}_{\mu3}$), tagging with $K^{\pm} \to \mu^{\pm}\nu$ and $K^{\pm} \to \pi^{\pm}\pi^{0}$: 8 measurements in total, each with 10^5

KLOE final
ArXiv: 0707.2532

BR($K^{\pm}_{e3}$) = 4.965(52)%
BR($K^{\pm}_{\mu3}$) = 3.233(39)%

at $\tau_{\pm}^{(0)}$ = 12 .385 ns, with $dBR/BR = -0.5 d\tau_{\pm} / \tau_{\pm}$

K± lifetime using two different methods:

$\tau_{\pm}$ from the K decay length, using tagged vertices in DC

$\tau_{\pm}$= 12.367(44)(65) ns

$\tau_{\pm}$ from the K decay time, using γ from $K^{\pm} \to \pi^{\pm}\pi^{0}$ decays

$\tau_{\pm}$= 12.391(49)(25) ns

KLOE preliminary
ArXiv: 0705.4408

$\tau_{\pm}$= 12.384(48) ns

Combined result, ρ = 0.34
Final result: $\Delta\tau/\tau$ = 0.25%

Absolute BR($K^{\pm} \to \pi^{+}\pi^{0}$). Use $K^{-} \to \mu^{-}\nu$ to tag 2-body decays. Count $K^{+} \to \pi^{+}\pi^{0}$ from decay-momentum spectrum.

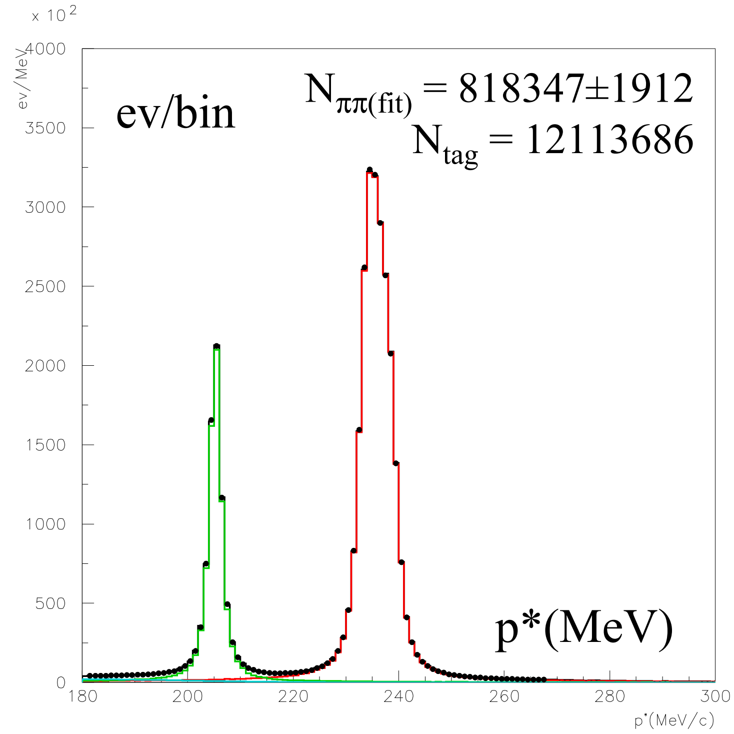
KLOE preliminary
ArXiv: 0707.4631

BR($K^{+}_{\pi2}$) = 0.20658(65)(90)

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

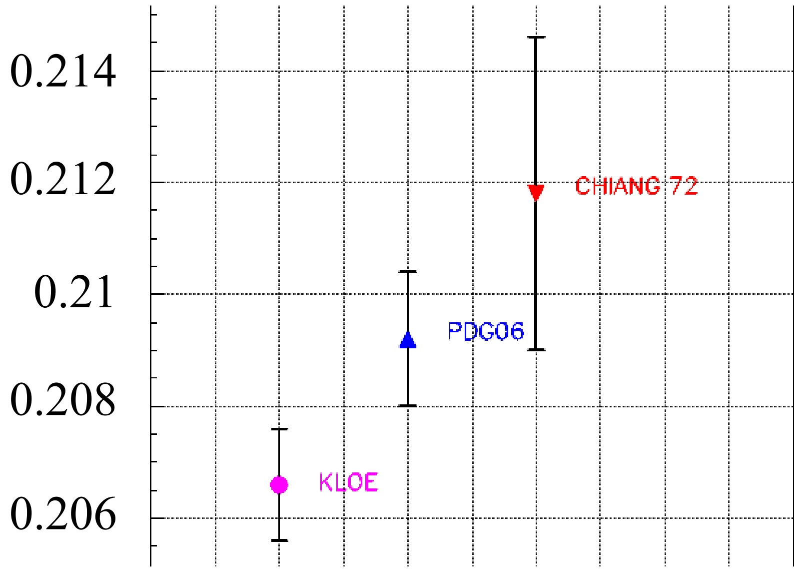
PDG fit '06 $BR(K^\pm \to \pi^\pm \pi^0) = (20,92 \pm 0.12)\%$ $\Delta BR/BR = 0.6\%$
CHIANG '72 $BR(K^\pm \to \pi^\pm \pi^0) = (21,18 \pm 0.28)\%$ $\Delta BR/BR = 1.3\%$
this decay enters in the normalization of $BR(K^\pm l3)$ by NA48, ISTRA+, E865

- Tag with $K^- \to \mu^- \nu$ decays.
- Determine the momentum of the charged decay particle in the kaon rest frame assuming m_π: p*.
- Selection efficiency measured on data.
- Count $K^+ \to \pi^+ \pi^0$ events fitting p* distribution with three contributions: $\mu\nu$ and $\pi\pi^0$ peaks from data control samples, 3-body decays from MC.

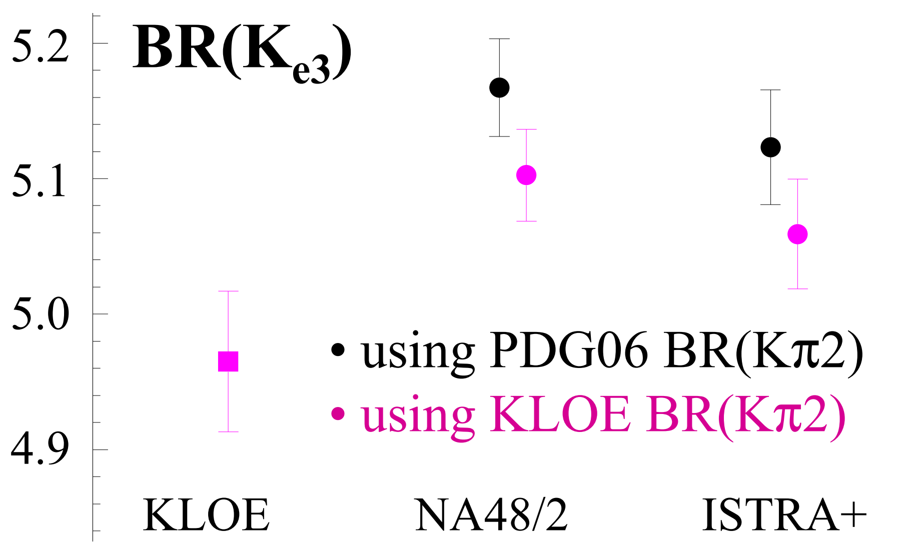


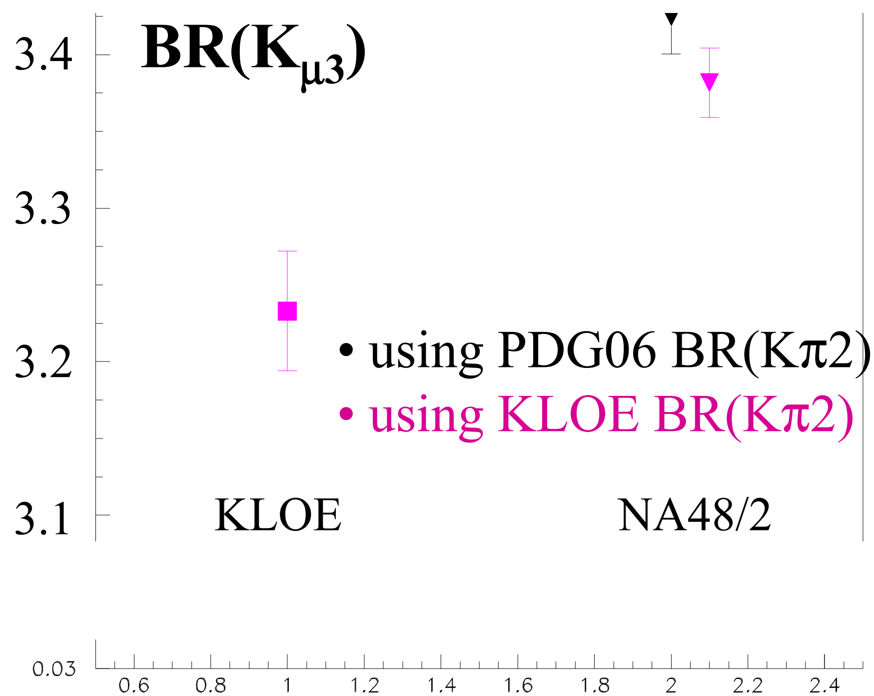
$BR(K^+ \to \pi^+ \pi^0(\gamma)) = (20.658 \pm 0.065_{stat} \pm 0.090_{syst})\%$
-1.3% respect to PDG 06 $\sigma_{rel} \sim 0.5\%$

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



Impact of the KLOE preliminary measurement wrt PDG06 fit value on the BR($K^{\pm}_{l3}$):
- measurements normalized to $K_{\pi 2}$ decays
- comparison with absolute BR($K^{\pm}_{l3}$) measurements from KLOE



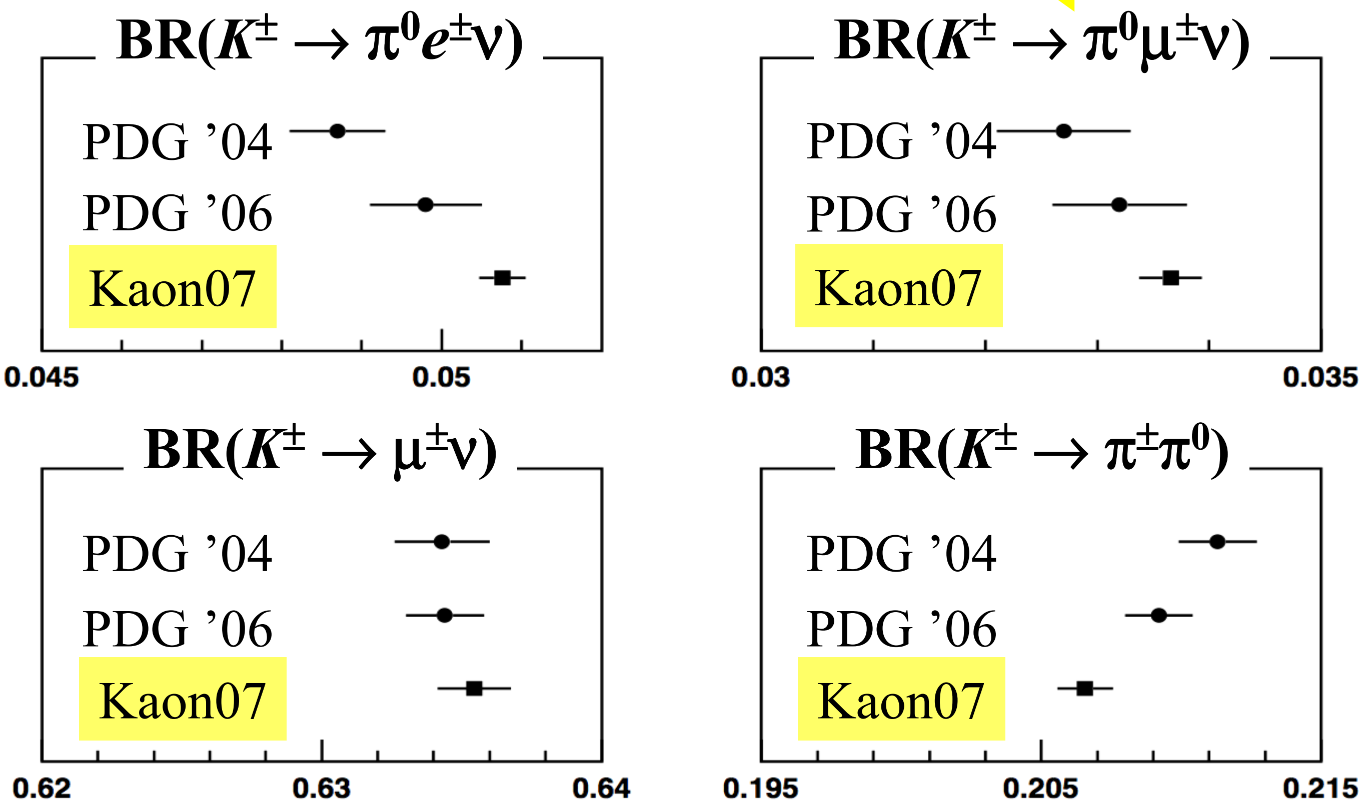


FlaviaNet fit to $K^{\pm}$ *BR and* $\tau_{\pm}$ *@KAON07*

@KAON07

- Not possible to fit only new $K^{\pm}$ data (unlike K_L)
- Only $K\ell3$, $K\ell3/\pi\pi^0$, $K\pi\pi^0\pi^0$ and $K\mu2$ measured recently
  - $K\ell3$ and $\pi\pi^0$ highly correlated in fit
  - New measurement of $\pi\pi^0$ is crucial

KLOE prel.



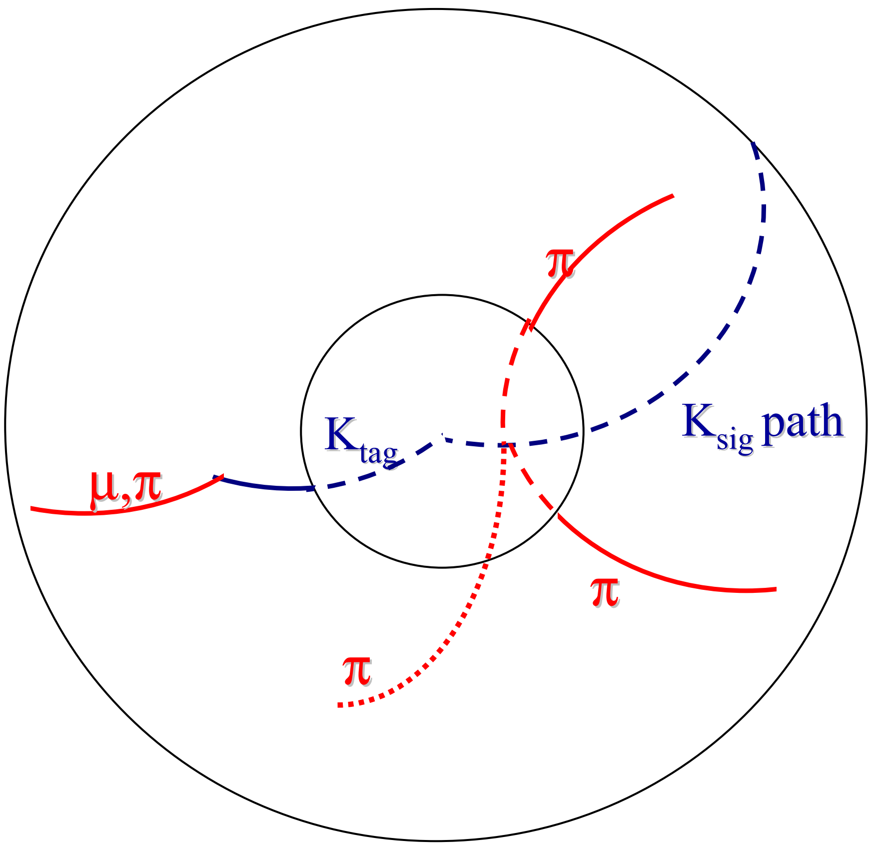
Fit rests heavily on Chiang (no radiative corrections, 6 BR constrained by $\Sigma BR=1$, correlations not available).
$BR(\pi^{\pm}\pi^{+}\pi^{-})$ needed to remove Chiang.

KLOE in prog.

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

PDG fit '06 BR($K\to\pi^+\pi^-\pi^+$) = (5,59 ± 0.03)% $\Delta BR/BR$ = 0.5%

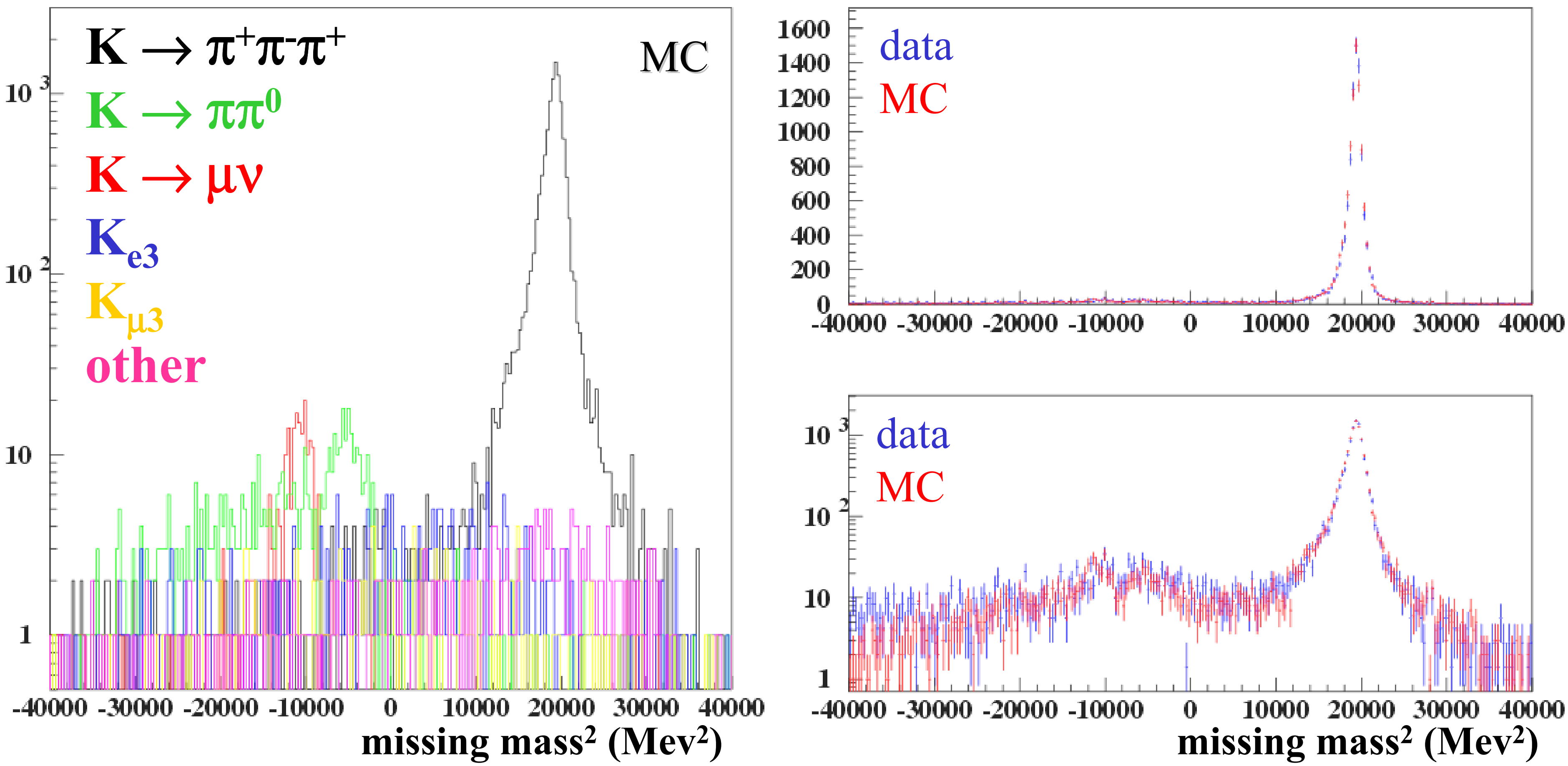
CHIANG '72 (2330 evts) BR($K\to\pi^+\pi^-\pi^+$) = (5,56 ± 0.20)% $\Delta BR/BR$ = 3.6%



- Tag with $K^{\pm}\to\mu^{\pm}\nu$ or $K^{\pm}\to\pi^{\pm}\pi^{0}$.
- Obtain the signal K path from the tag K track backward extrapolated to the I.P.

- Signal: require two tracks making a vertex along the K path before the inner wall of the DC.
- Look for the signal in the missing mass spectrum ($\sim m_{\pi}^{2}$).

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



Including tag and selection efficiency expect ~10^6 events (with ~2 fb^{-1});
statistical relative error at the permil level.

$K_{L\mu3}$ form factor slope λ_0

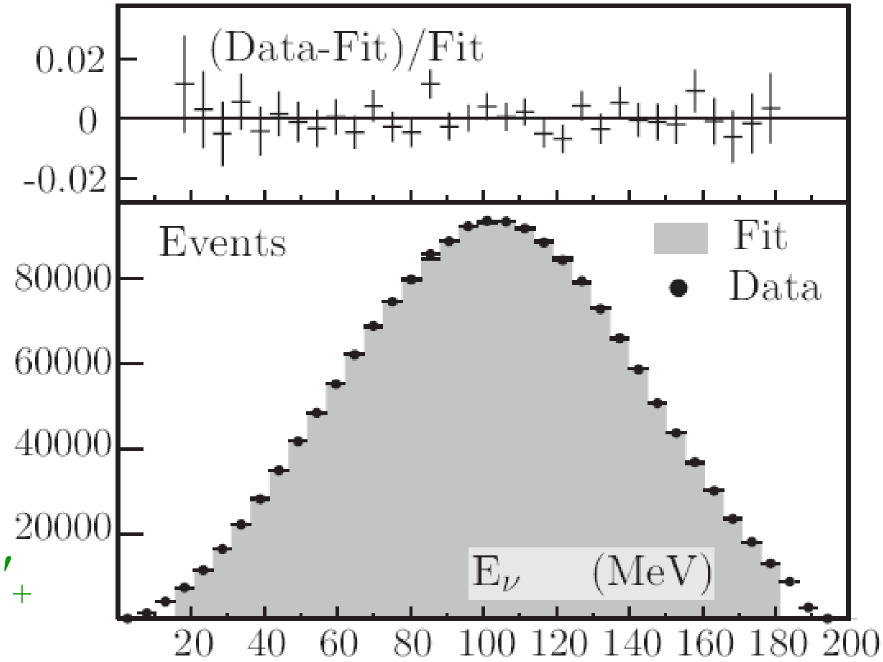
- Standard method: fit t-spectrum, $t=(p_K-p_\pi)^2$
- Difficult π/μ separation at low energy → problems in keeping low systematics on λ_0 (at the end of spectrum: +1% in signal counts implies +15% in λ_0).
- Fit E_ν spectrum: lose sensitivity ×2-3 on $\sigma_{stat}(\lambda_0)$; becomes ×1.3 if combined fit with K_Le3.

Obtain λ'_+, λ''_+, and λ_0 fitting $K_L\mu3$ data (correlation between λ_0' and λ_0'' = - 99.96%)

$$\lambda'_+ = (22.3 \pm 9.8_{stat} \pm 3.7_{syst}) \times 10^{-3}$$
$$\lambda''_+ = (4.8 \pm 4.9_{stat} \pm 1.6_{syst}) \times 10^{-3}$$
$$\lambda_0 = (9.1 \pm 5.9_{stat} \pm 2.6_{syst}) \times 10^{-3}$$

Combined fit with K_Le3 results for λ'_+ and λ''_+

$$\lambda'_+ = (25.6 \pm 1.5_{stat} \pm 0.9_{syst}) \times 10^{-3}$$
$$\lambda''_+ = (1.5 \pm 0.7_{stat} \pm 0.4_{syst}) \times 10^{-3}$$
$$\lambda_0 = (15.4 \pm 1.8_{stat} \pm 1.3_{syst}) \times 10^{-3}$$



FFe3 PLB 632 (2006)
FFμ3 final ArXiv: 0710.4470

$K_{L\mu3}$ form factor slope λ_0

Scalar form factor $f_0(t) = \tilde{f}_0(t)\, f_+(0)$ extrapolation at **Callan-Treiman** point:

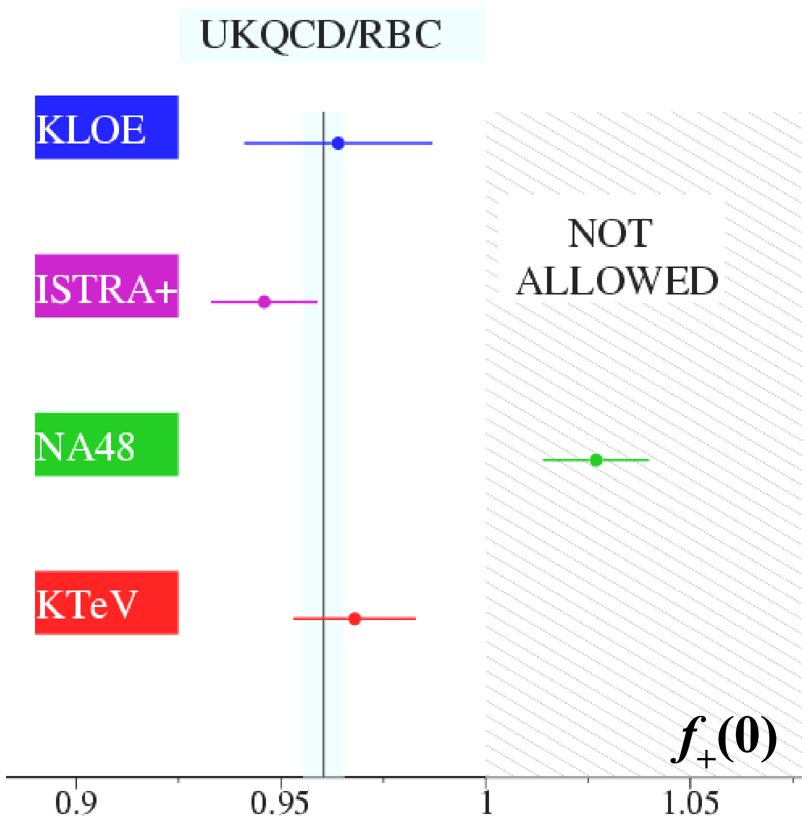
$$\tilde{f}_0(\Delta_{K\pi}) = \frac{f_K}{f_\pi}\frac{1}{f(0)} + \Delta_{CT}, \quad \Delta_{CT} \simeq -3.4\times 10^{-3}$$

$\tilde{f}_0(\Delta_{K\pi})$ is evaluated fitting $K_L\mu3$ with a dispersive parameterization.

$$\tilde{f}_0(t) = \exp\left(\frac{t}{\Delta_{K\pi}}\log(C - G(t))\right)$$

To fit we use a 3rd order expansion
(coefficients from Stern et al.)
Combined $K_L m3$ $K_L e3$ fit results:

$$\lambda_+ = (25.7 \pm 0.4_{\rm stat} \pm 0.4_{\rm syst} \pm 0.2_{\rm param})\times 10^{-3}$$
$$\lambda_0 = (14.0 \pm 1.6_{\rm stat} \pm 1.3_{\rm syst} \pm 0.2_{\rm param})\times 10^{-3}$$

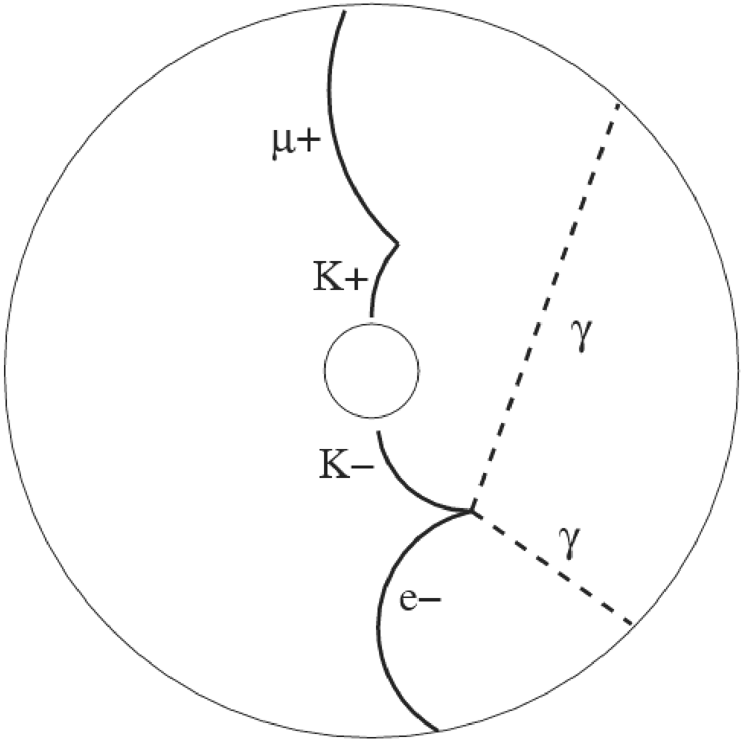


From CT, using f_K/f_π=1.189(7) [HP-UKQCD07]
obtain **$f_+(0)$=0.964(23)**

FFe3 and FFμ3 using $K^{\pm}$

• No ambiguity on lepton charge assignement (for both Ke3 and Kμ3)
• No π–μ ambiguity because of π^0 presence

→ **Fit of t spectrum, $t = (p(K)-p(\pi^0))^2$**



• **Using BR selection expect 2.9 M of Ke3 and 1.9 M of Kμ3 in 2001/5 data.**
- Modifying the tag wrt the BR(Kℓ3) measurements, we expect:

Ke3: up to 5.9 M
Kμ3: up to 2.5 M

Respect to BR analysis, need to improve purity at a cost of some efficiency.

Analysis just started, very good perspectives

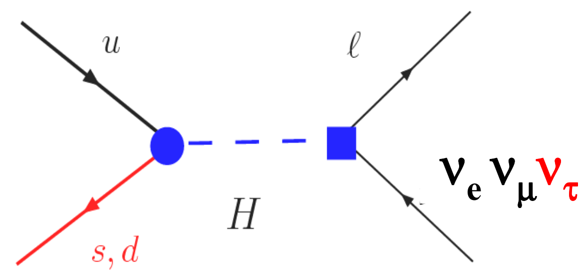
Lepton universality from $K_{e2}/K_{\mu2}$

SM: no hadronic uncertainties (no f_K) $\rightarrow 0.4\times10^{-3}$

In MSSM, LFV can give up to % deviations [Masiero, Paradisi, Petronzio]

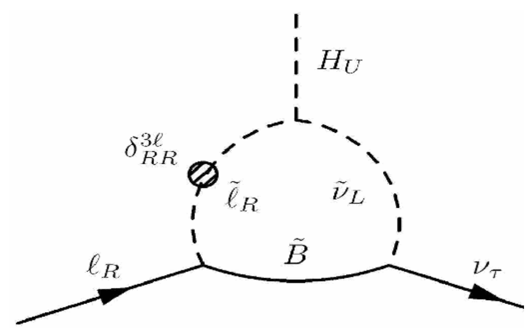
NP dominated by contribution of $e\nu_\tau$

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



with effective coupling:

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



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

1% effect (Δ^R_{31} ~5x10^{-4}, tanβ~40, m_H~500GeV) not unnatural

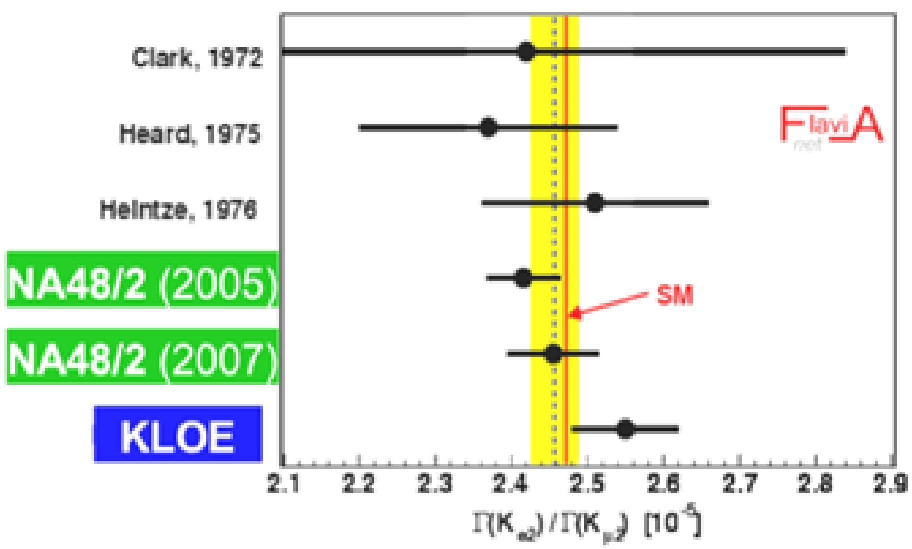
Present accuracy on R_K @ 6% ; need for precise (<1%) measurements

K_{e2} *result @KAON07*

KLOE presented a preliminary result with 2.7% uncertainty:

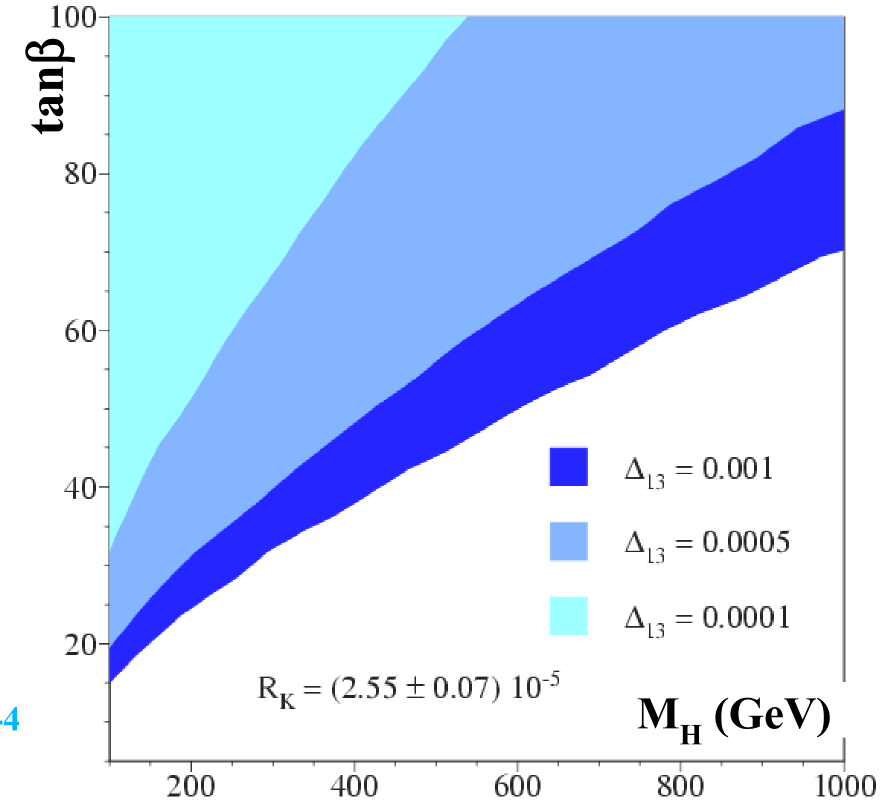
$R_K = 2.55(7)\times10^{-5}$

ArXiv: 0707.4623



95%-CL excluded regions in the $\tan\beta$ - M_H plane, for

$\Delta_{13} = 10^{-3}$, 0.5×10^{-3}, 10^{-4}



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

$\times$ 2 rejection from kinematics

$\times$ 2 MC stat *under processing*

$\times$ 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 (more than 100k events) [R. Fantechi, EPS HEP 2007]

Conclusions

$|V_{us}f_+(0)|$ determination using $K\ell3$ decays:

World average at the 0.2% level using five $K\ell3$ modes.

Good compatibility between different modes (χ^2/dof = 2.9/4).

KLOE goals for the next year:

- K_L lifetime, aiming to reach 0.2-0.3% accuracy
- BR(K_Se3) , aiming to reach 0.6% accuracy
- BR($K^\pm \rightarrow \pi^\pm\pi^+\pi^-$)
- Form factors of semileptonic $K^\pm$.

R_K:

KLOE can reach ~1% accuracy.

Additional information

Can we rely on our determination of $I(K_{l3})$?

1) Previous fit, all experiments

Slope parameters × 10^3			
λ'_+	=	24.82 ± 1.10	S=1.4
λ''_+	=	1.64 ± 0.44	S=1.3
λ_0	**=**	**13.38 ± 1.19**	**S=1.9**
χ^2/ndf	=	53/13 (10^{-6})	

Integrals	
$I(K^0e3)$	0.15454(29)
$I(K^+e3)$	0.15889(30)
$I(K^0\mu3)$	0.10209(31)
$I(K^+\mu3)$	0.10504(32)

2) All experiments but NA48 $K_{\mu3}$

Slope parameters × 10^3		
λ'_+	=	24.95 ± 0.83
λ''_+	=	1.59 ± 0.36
λ_0	**=**	**16.01 ± 0.79**
χ^2/ndf	=	12.2/10 (27.1%)

Integrals	
$I(K^0e3)$	0.15457(21)
$I(K^+e3)$	0.15892(21)
$I(K^0\mu3)$	0.10268(20)
$I(K^+\mu3)$	0.10565(21)

$\Delta[I(K\mu3)]$ = 0.6%! … but *Ke3*+*K*μ3 average gives $\Delta[V_{us}f_+(0)]$ = -0.08%

V_{us}/V_{ud} *from* $K_{\mu 2}$

Marciano '04

$$\frac{\Gamma(K^\pm \to \mu^\pm \nu(\gamma))}{\Gamma(\pi^\pm \to \mu^\pm \nu(\gamma))} = \frac{|V_{us}|^2 \, f_K^2 \, m_K \, (1 - m_\mu^2/m_K^2)^2}{|V_{ud}|^2 \, f_\pi^2 \, m_\pi \, (1 - m_\mu^2/m_\pi^2)^2} \times 0.9930(35)$$

Uncertainty from SD virtual corrections

HP/UKQCD '07
preliminary
arXiv:0706.1726

$f_K/f_\pi = 1.189(7)$

$N_f = (2+1)_{stag}$

Cancellation of lattice-scale uncertainties

PLB 636 (2006)

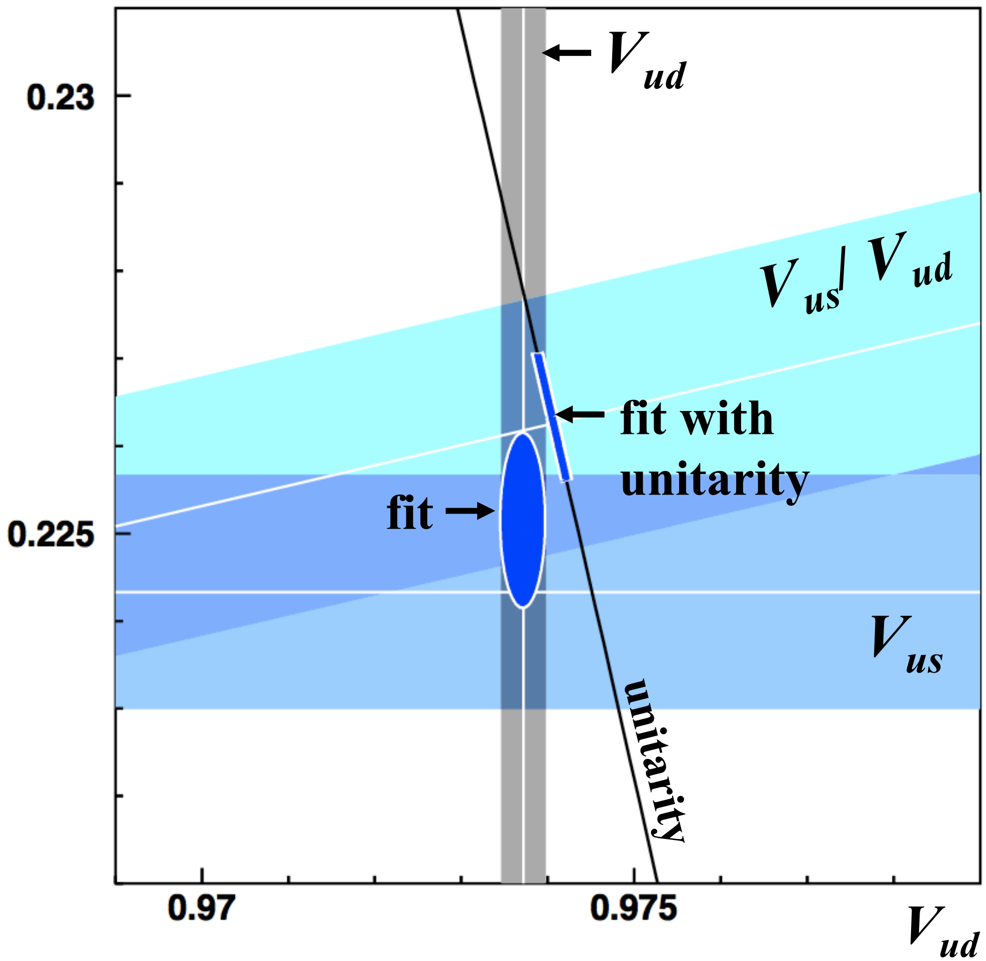
BR($K^+ \to \mu^+\nu(\gamma)$) = 0.6366(17)

Uses $K^- \to \mu^-\nu$ to tag 2-body K decays

Counts $K^+ \to \mu^+\nu$ from decay-momentum spectrum

$V_{us}/V_{ud} = 0.2323(15)$

V_{ud}, V_{us} and V_{us}/V_{ud}



Fit results, no constraint:

$$\mathbf{V_{ud} = 0.97371(26)}$$
$$\mathbf{V_{us} = 0.2252(10)}$$
$$\chi^2/\text{ndf} = 0.85/1\ (36\%)$$

Fit results, unitarity constraint:

$$V_{ud} = 0.97405(17)$$
$$V_{us} = 0.2263(7)$$
$$\mathbf{\chi^2/ndf = 3.8/2\ (15\%)}$$

Agreement with unitarity at 1.5σ

$K_{\mu 2}$: *sensitivity to NP*

Pseudoscalar currents, e.g. due to H⁺, affect the K width:

$$\frac{\Gamma(M\to\ell\nu)}{\Gamma_{SM}(M\to\ell\nu)} = \left[1-\tan^2\beta\left(\frac{m_{s,d}}{m_u+m_{s,d}}\right)\frac{m_M^2}{m_H^2}\right]^2$$

for M = K, π

Hou, Isidori-Paradisi

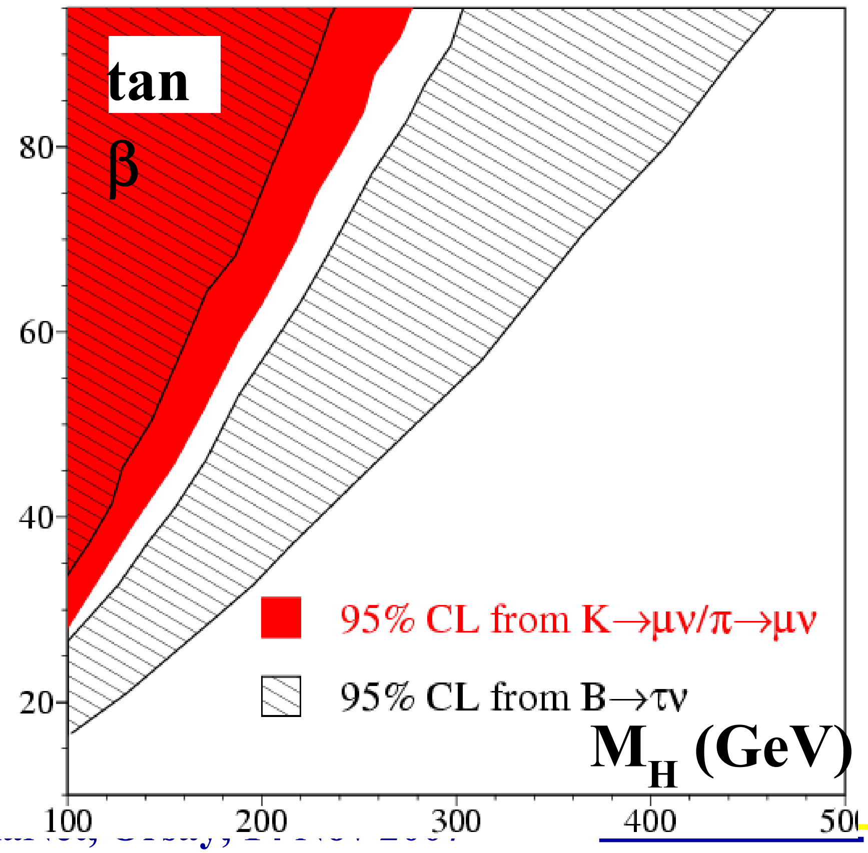
Expect 0.4% effect on K/π ratio wrt SM

The above effect is observable through measurement of $V_{us}(K_{\mu 2})/V_{us}(K_{l3})$

Using KLOE data, and assuming CKM unitarity for K_{l3} we get: **$V_{us}(K_{l3}) = 0.22635(86)$**

- **$V_{us}(K_{\mu 2}) = 0.22626(146)$**

Key issues to improve: $K_{\mu 3}$ *ff* and Callan-Treiman



Lepton universality from K_{l3}

For K_L and $K^{\pm}$ evaluate:

$$\frac{(R_{\mu e})_{\rm obs}}{(R_{\mu e})_{\rm SM}} = \frac{\Gamma_{\mu 3}}{\Gamma_{e3}} \cdot \frac{I_{e3}\,(1+\delta_{e3})}{I_{\mu 3}\,(1+\delta_{\mu 3})} = \frac{[|V_{us}|\, f_+(0)]^2_{\mu 3,\,{\rm obs}}}{[|V_{us}|\, f_+(0)]^2_{e3,\,{\rm obs}}} = \frac{g_\mu^2}{g_e^2}$$

Using only KLOE results get accuracy ~0.004:

K_L	$g_\mu^2/g_e^2 = 1.0054(44)$	cfr with	$g_\mu^2/g_e^2 = 1.0232(68)$ [PDG04]
K^+	$g_\mu^2/g_e^2 = 0.9924(54)$	cfr with	$g_\mu^2/g_e^2 = 1.0020(80)$ [PDG04]
Avg	$g_\mu^2/g_e^2 = 1.0005(38)$		

Compare with

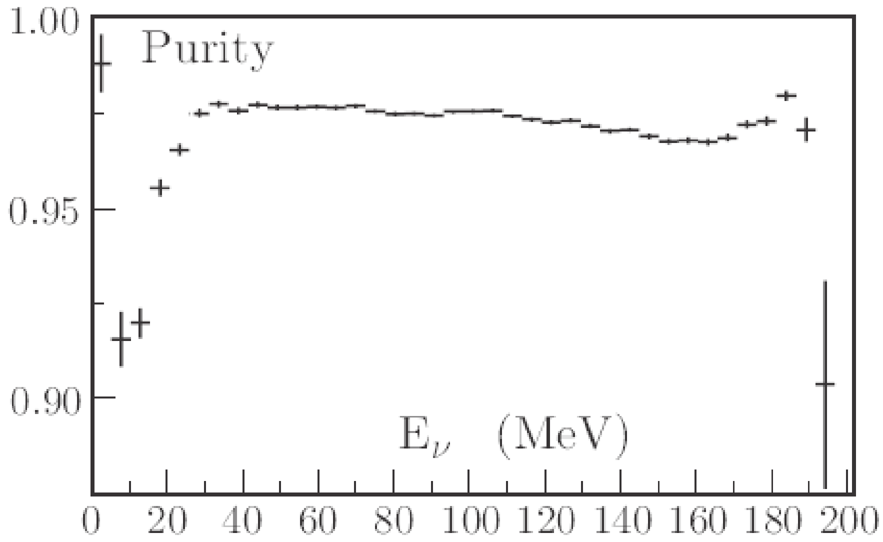
$\tau \to l\nu\nu$	$g_\mu^2/g_e^2 = 1.0005(41)$ [PDG07]
$\pi \to l\nu$	$g_\mu^2/g_e^2 = 1.0034(30)$ [Erler, Ramsey-Musolf '06]

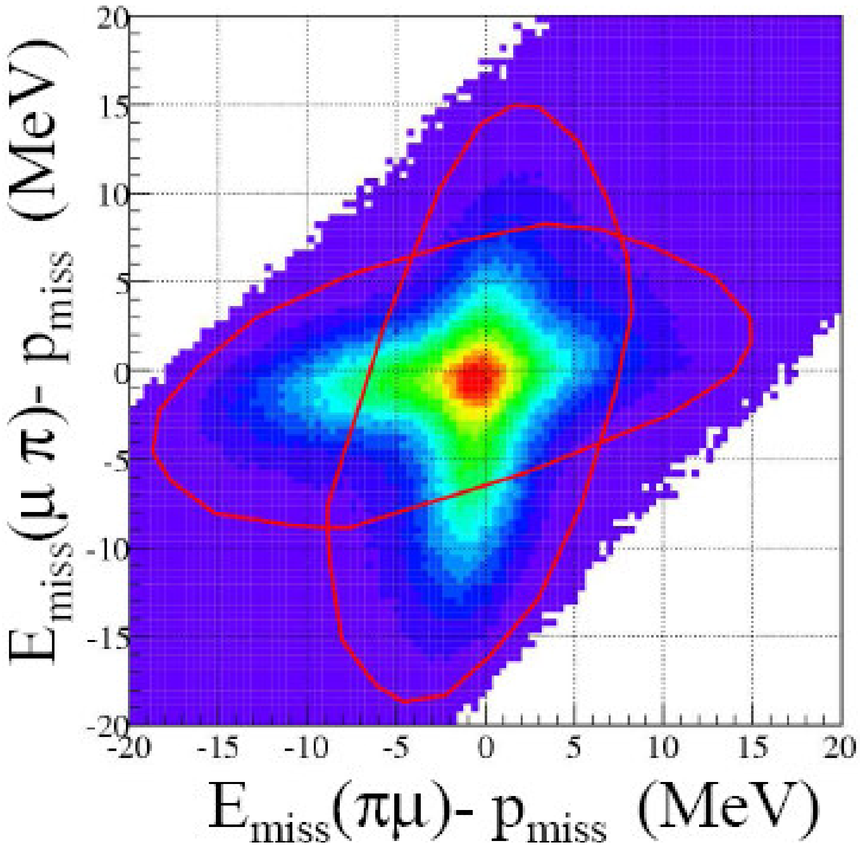
By averaging, can test equality of weak coupling for e and μ at 2×10^{-3}:

K, π, τ $g_\mu^2/g_e^2 = 1.0019(21)$

$K_{L\mu3}$ form factor slope λ_0

K_L tagged by $K_S \to \pi^+\pi^-$
Bkg rejection of $\pi^+\pi^-$, $\pi^+\pi^-\pi^0$ and Ke3
from kinematics cut on $E_{miss}(\pi^+,\mu^-)-p_{miss}$,
and $E_{miss}(\pi^+,\mu^-)-p_{miss}$
Contamination reduced to 1.5% using ToF
and NN trained on E/p and cluster shape.





π/μ ID with ToF is difficult at low energies λ_0 slope by fitting the E_ν distribution

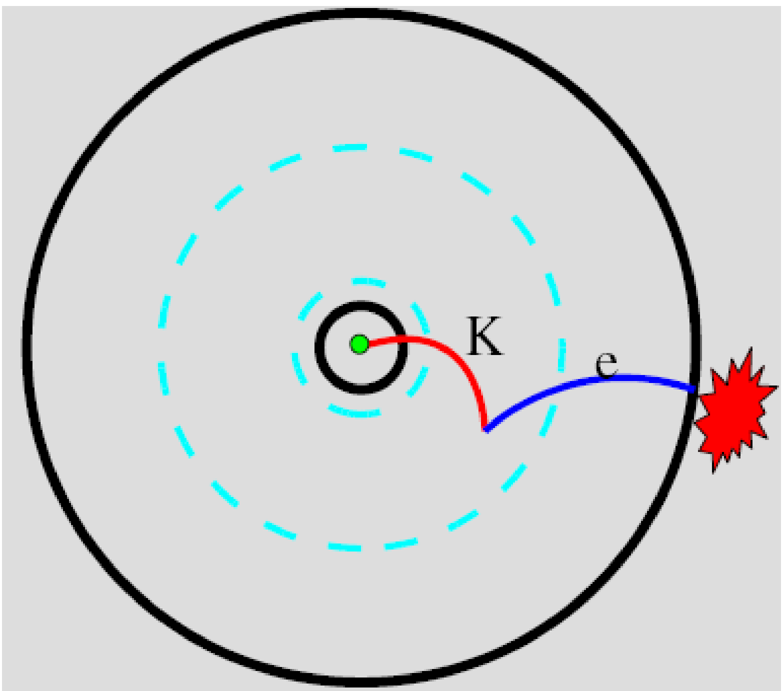
Searching for K_{e2} @ KLOE (I)

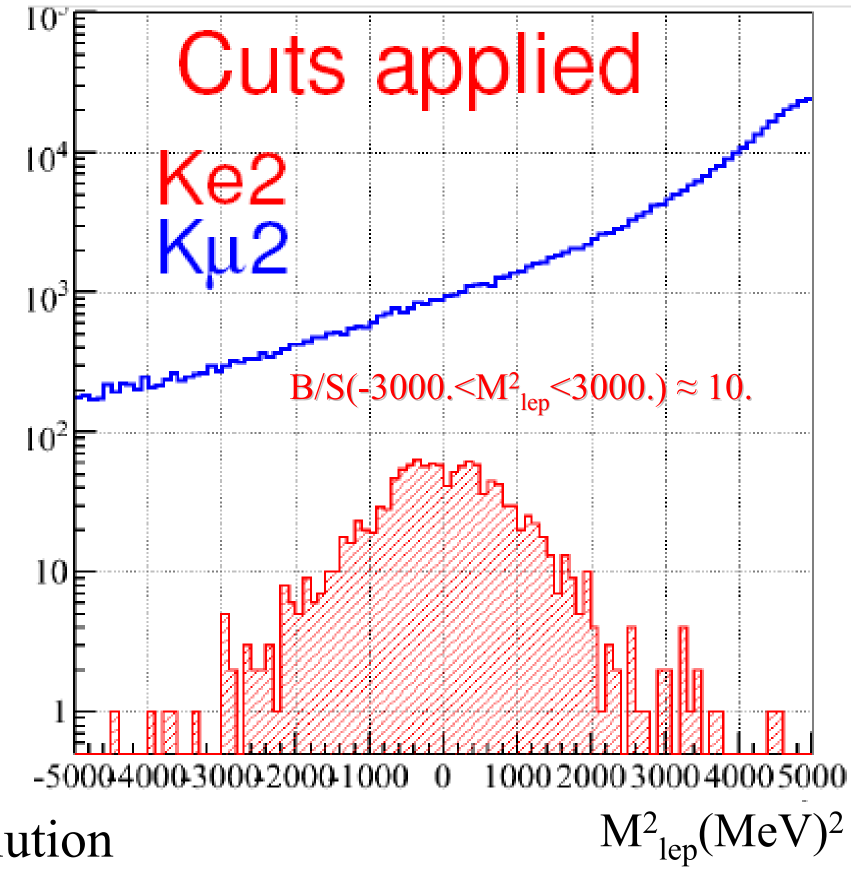
BR(Ke2)≈2x10^{-5}, expect 4x10^{4} events in KLOE data sample (2.3 fb^{-1})

perfom direct search for Ke2 without tag → gain ×4 of statistic

search for a vertex inside the Fiducial Volume (40<ρ_{xy}<150) cm

cuts on track quality for K$^{\pm}$ and secondary tracks, cuts on vtx quality



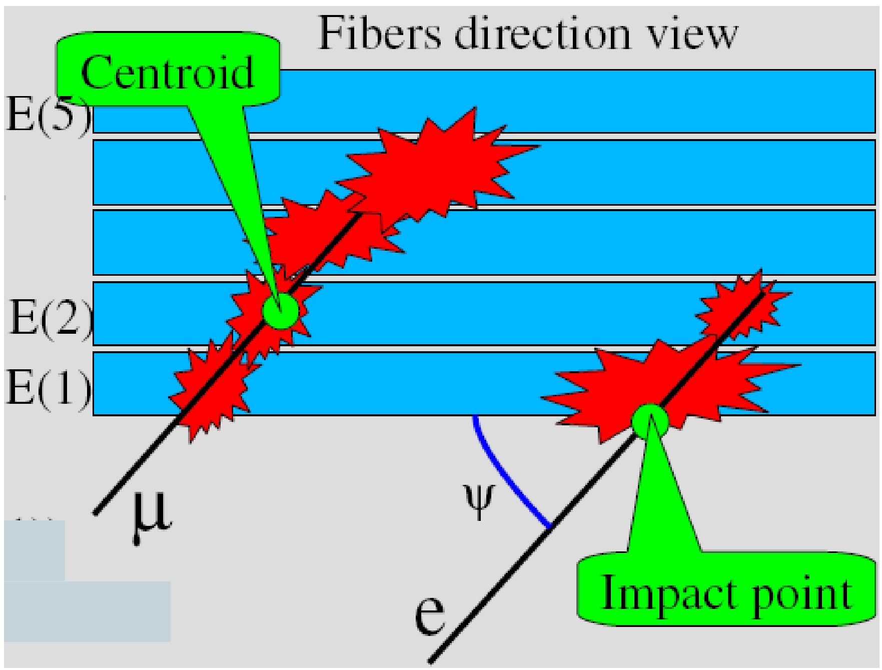


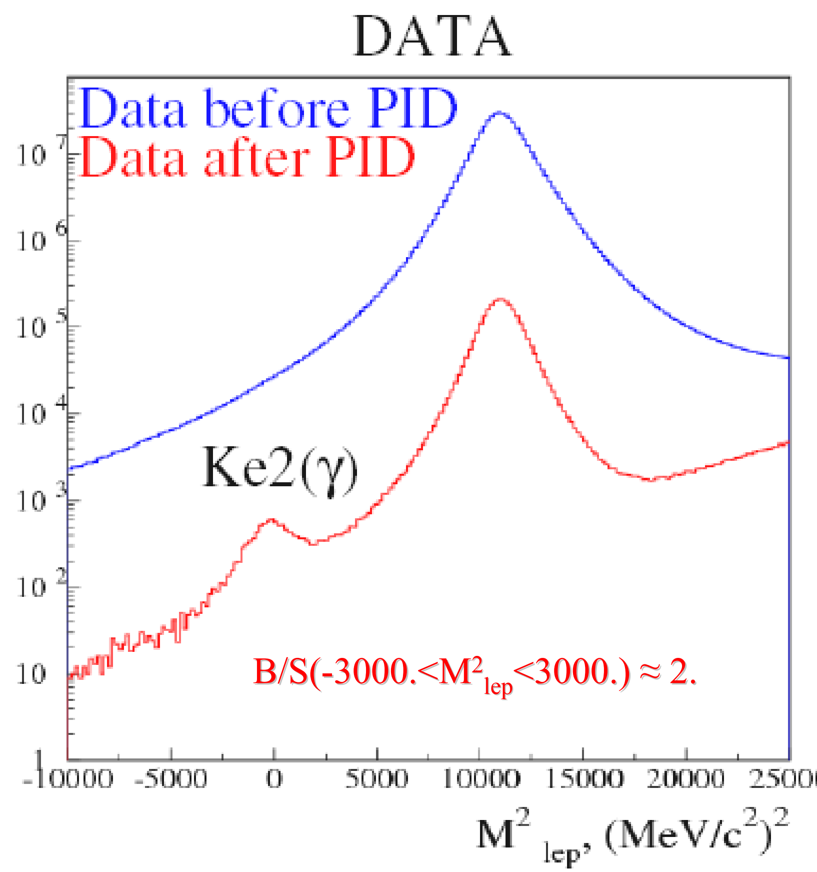
kaon momentum is measured with 1% resolution

close kinematics →we get M_{lep}

Searching for K_{e2} @ KLOE (II)

PID exploits the granularity of KLOE EmC shower profile along the particle path
variables used: $E^2_{RMS} = \Sigma_{i=1..N}(E(i)-\langle E\rangle)^2/N$, E/P, cluster shape





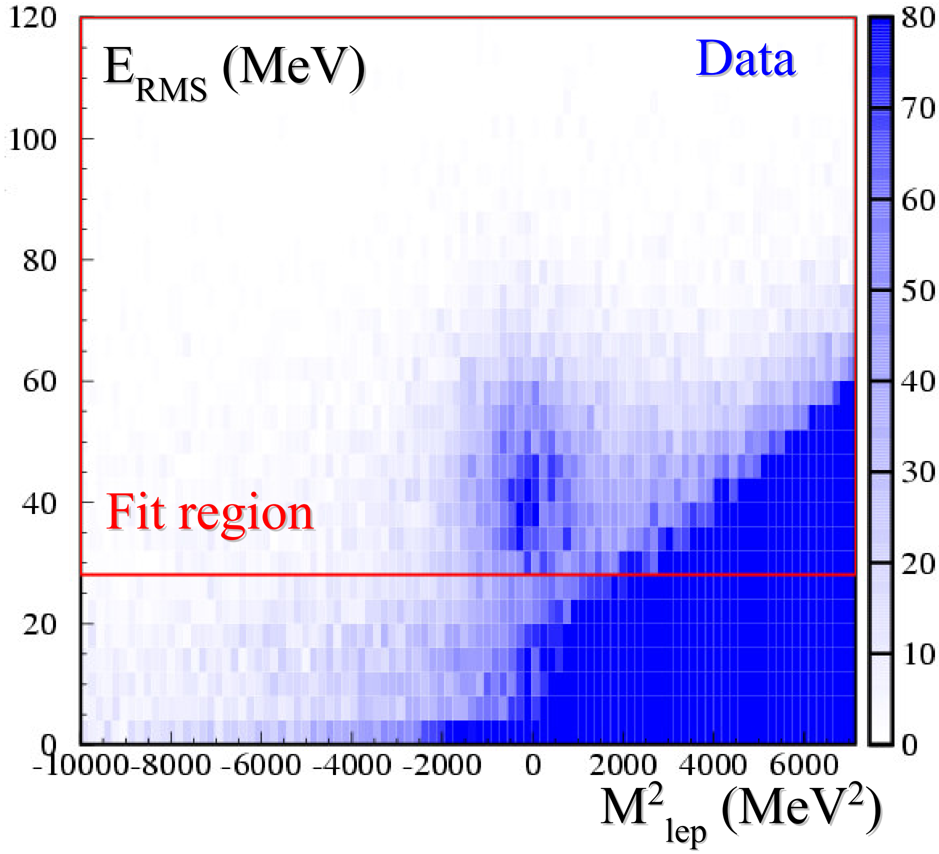
signal efficiency 0.647(6)
background rejection ~ 300

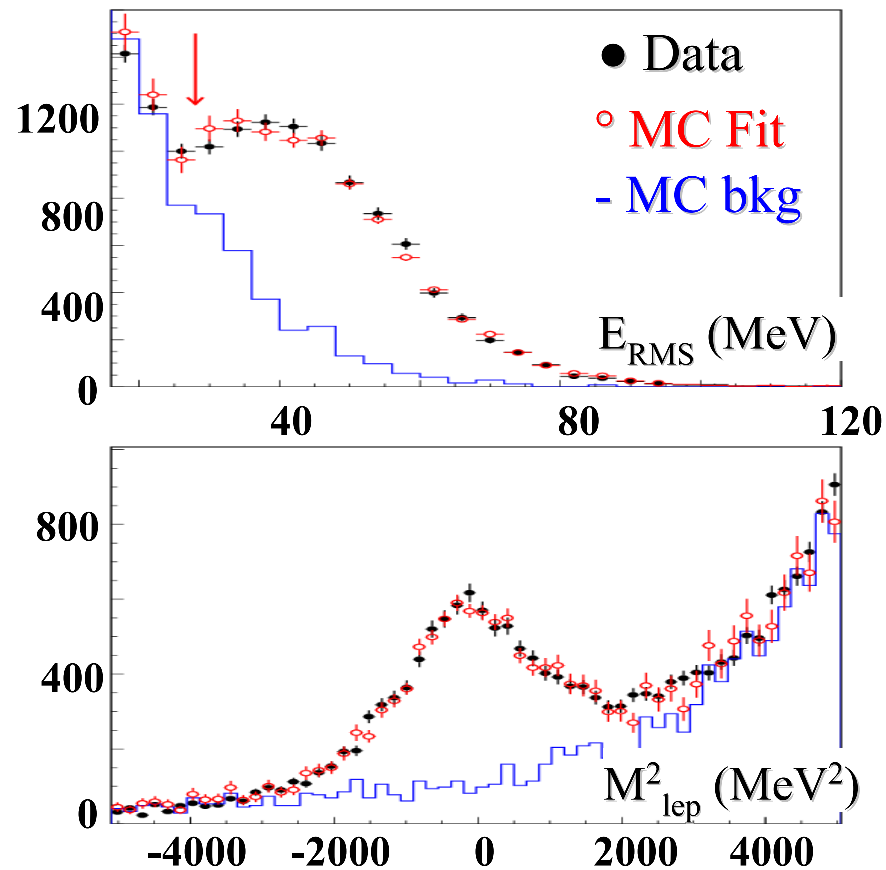
K_{e2} signal event counting

K_{e2} event counts: likelihood fit of M_{lep} vs E_{RMS}

input: MC shapes for $K_{e2(\gamma)}$ and background

fit parameters: # of K_{e2} and background, get 8090±160 observed evts





correct for ratio of K_{e2} and $K_{\mu2}$ trigger and vtx efficiencies, and for PID K_{e2} efficiency

Fit to K_L *BR and lifetime measurements*

18 input measurements:

- **5 KTeV** ratios
- **NA48** K_{e3}/2t and $\Gamma(3\pi^0)$
- **4 KLOE** BRs
- **KLOE**, **NA48** $\pi^+\pi^-/K_{l3}$
- **KLOE**, **NA48** $\gamma\gamma/3\pi^0$
- **PDG** ETAFIT for $\pi^+\pi^-/\pi^0\pi^0$
- **KLOE** τ_L from $3\pi^0$
- **Vosburgh** '72 τ_L

1 constraint: ΣBR=1

FlaviaNet fit

Parameter	Value	S
BR(*Ke3*)	**0.40563(74)**	**1.1**
BR(*Kμ3*)	**0.27047(71)**	**1.1**
BR($3\pi^0$)	**0.19507(86)**	**1.2**
BR($\pi^+\pi^-\pi^0$)	**0.12542(57)**	**1.1**
BR($\pi^+\pi^-$)	**$1.9966(67)\times10^{-3}$**	**1.1**
BR($2\pi^0$)	**$8.644(42)\times10^{-4}$**	**1.3**
BR($\gamma\gamma$)	**$5.470(40)\times10^{-4}$**	**1.1**
τ_L	**51.173(200) ns**	**1.1**

χ^2/ **ndf = 20.2/11** (Prob = 4.3%)

Fit results to $K^{\pm}$ *BR and lifetime*

31 input measurements:

- **5 older τ values in PDG**
- **2 KLOE τ**
- **KLOE BR($\mu\nu$)**
- **KLOE *Ke3*, *Kμ3* BRs**
- **ISTRA+ $K_{e3}/\pi\pi^0$**
- **NA48/2 $K_{e3}/\pi\pi^0$, $K_{\mu3}/\pi\pi^0$**
- **E865 K_{e3}/Kdal**
- **6 Chiang '72 BRs**
- **3 old $\pi\pi^0/\mu\nu$**
- **2 old *Ke3*/2 body**
- **3 *Kμ3/Ke3* (2 old)**
- **2 old + 1 KLOE results on 3π**

1 constraint: ΣBR=1

FlaviaNet fit

Parameter	Value	S
BR($\mu\nu$)	63.545(132)%	1.2
BR($\pi\pi^0$)	20.656(100)%	1.3
BR($\pi\pi\pi$)	5.5962(303)%	
BR($Ke3$)	5.0758(290)%	1.3
BR($K\mu3$)	3.3656(280)%	1.7
BR($\pi\pi^0\pi^0$)	1.7614(226)%	1.1
$\tau_{\pm}$	12.3840(193) ns	1.7

χ^2/ ndf = 52/25 (Prob = 0.11%)

Improves to χ^2/ ndf = 35/21 (2.7%)
with no changes to central values or errors, if 5 older $\tau_{\pm}$ measurements replaced by PDG avg (with S=2.1)