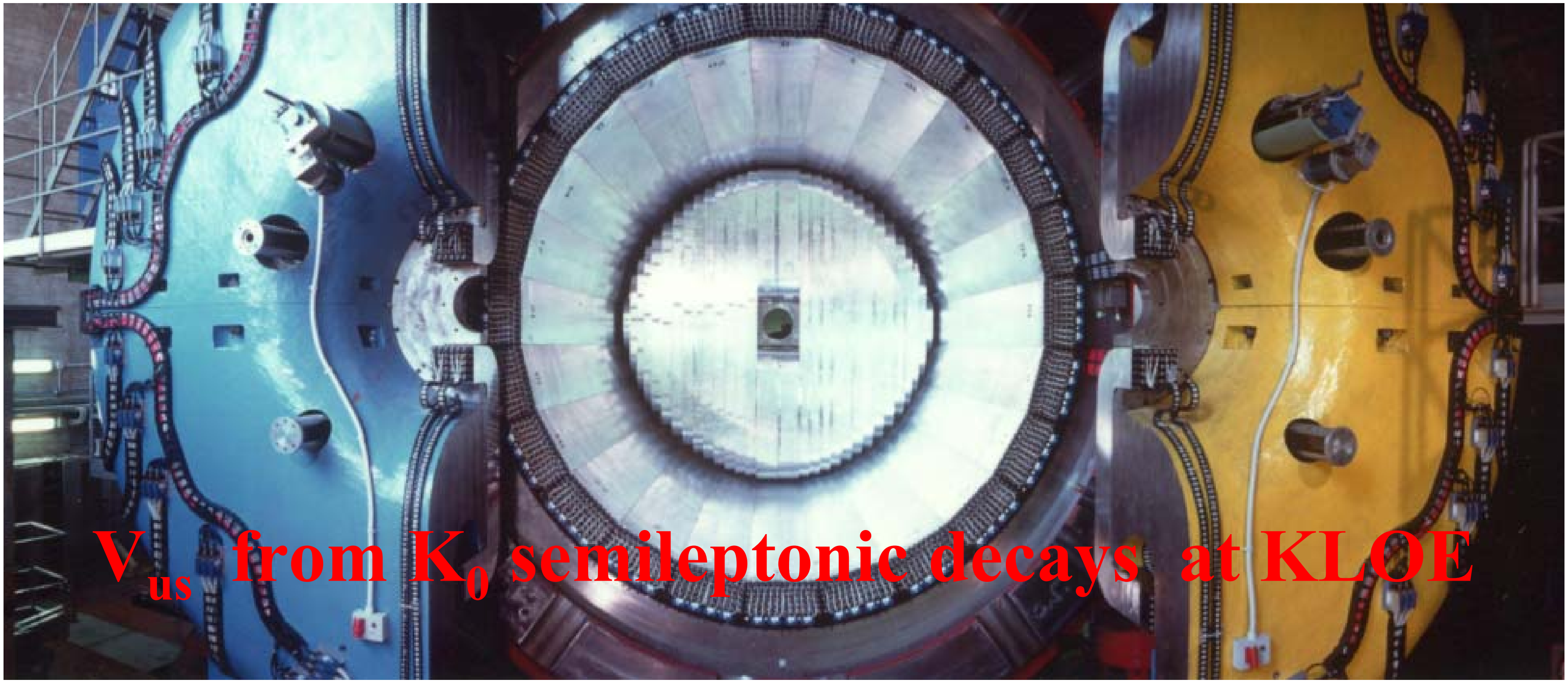


A.Antonelli (INFN/Frascati)
for the KLOE collaboration

Heavy Quarks and Leptons 2004

San Juan, Porto Rico, 1-5 June

Unitarity test of CKM matrix – V_{us}

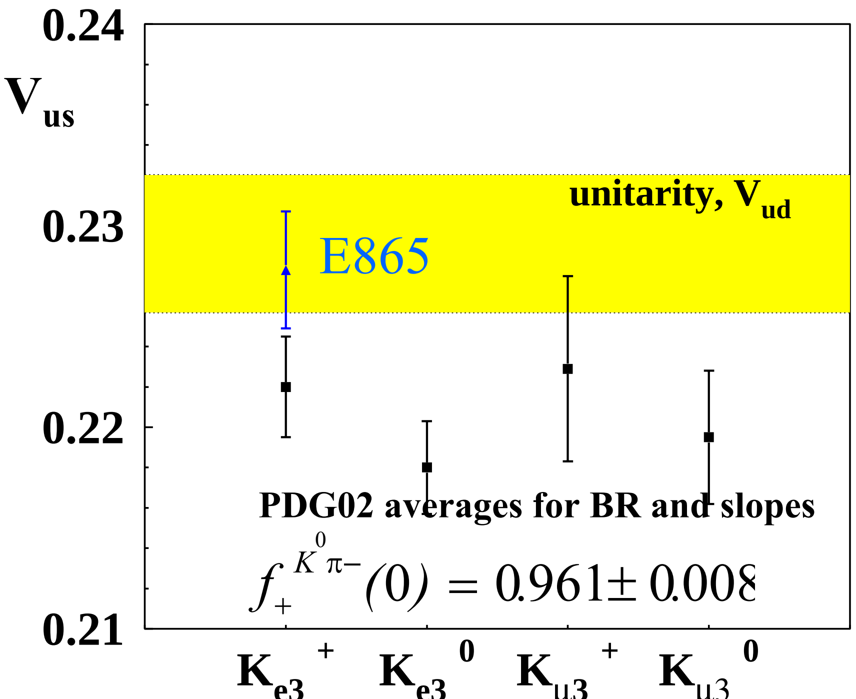
Most precise test of unitarity possible at present comes from 1st row:

$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 \sim |V_{ud}|^2 + |V_{us}|^2 \equiv 1 - \Delta$$

Δ = 0.0042 ±0.0019 PDG02

$2|V_{ud}|dV_{ud} = 0.0015$ from super-allowed $0^+ \rightarrow 0^+$ Fermi transitions, n β-decays:

$2|V_{us}|dV_{us} = 0.0011$ from semileptonic kaon decays (PDG 2002 fit)



Disagreement among K_{e3}

(Older measurements' inclusiveness of radiative processes uncertain)

$K_{\mu3}$ larger uncertainties

Both $K^\pm$ and K^0 must be measured

V_{us} from semileptonic decays

$|V_{us}|$ is extracted from K_{l3} partial decay widths

$$|V_{us}| \cdot f_+^{K^0\pi^-}(0) = \left[\frac{\Gamma_i}{\mathcal{N}_i\, S_{ew}\, I_i(\lambda_+,\lambda_0,0)}\right]^{1/2} \frac{1}{1+\delta^i_{SU(2)}+\delta^i_{e^2p^2}+\frac{1}{2}\Delta I_i(\lambda_+,\lambda_0)}$$

few 10^{-2}

where i runs over the four modes $K^{\pm,0}(e3)$, $K^{\pm,0}(\mu 3)$

- $N_i = \dfrac{G^2_\mu M^5_{Ki}}{192\pi^3} C^2_i$ [Ci=1($2^{-½}$) for neutral (charged kaon decays)]
- $f_+^{K0\pi-}(0)$ form factor at zero momentum transfer: pure theory calculation (χPT, lattice)
- $I(\lambda_+, \lambda_0, 0)$ phase space integral, S_{ew} short distance corrections (1.0232)
- $\delta^i_{SU(2)}$, δ_{e2p2} form factor correction due to isospin breaking (strong and electromagnetic)
- $\Delta I_i(\lambda_+,\lambda_0)$) phase space electromagnetic correction
- λ_+,λ_0 slopes (momentum dependence of the vector and scalar form factors)

V_{us} from semileptonic decays

exp th

$$\frac{\delta|V_{us}|}{|V_{us}|} = \boxed{\frac{1}{2}\left(\frac{\delta BR}{BR}\right)} \oplus \boxed{\frac{1}{2}\left(\frac{\delta\tau}{\tau}\right)} \oplus \boxed{\frac{1}{20}\left(\frac{\delta\lambda_+}{\lambda_+}\right)} \oplus \boxed{\frac{1}{30}\left(\frac{\delta\lambda_0}{\lambda_0}\right)} \oplus \boxed{\frac{\delta f_+(0)}{f_+(0)}}$$

$K^0 \to \pi e\nu$	0.3 % $\oplus$	0.4% $\oplus$	0.3%		0.8%
$K^\pm \to \pi e\nu$	0.6% $\oplus$	0.1% $\oplus$	0.3%		0.8%
$K^0 \to \pi\mu\nu$	0.5% $\oplus$	0.4% $\oplus$	0.8%	$\oplus$ 0.6%	$\oplus$ 0.8%
$K^\pm \to \pi\mu\nu$	0.9% $\oplus$	0.1% $\oplus$	1.5%	$\oplus$(1.-0.2%)	$\oplus$ 0.8%

PDG02 averages for BR, lifetime, and slopes

$\lambda_0 = 0.004 \pm 0.009$ PDG02

$\lambda_0 = 0.0183 \pm 0.0013$ (7%), from ISTRA+ 2003

EXP: Need to measure BR, lifetime, and slopes with good accuracy

TH : Need to improve estimate on f(0)

K_L decays – Present knowledge

Knowledge of 4 main K_L BR's at present dominated by 3 measurements:

$$\frac{\Gamma(K_L \to \pi^0\pi^0\pi^0)}{\Gamma(K_L \to \pi e\nu)} \text{ and } \frac{\Gamma(K_L \to \pi^0\pi^0\pi^0)}{\Gamma(K_L \to \pi^+\pi^-\pi^0)}$$, with ∼2% relative uncertainty [NA31]

$$R_{\mu/e} = \frac{\Gamma(K_L \to \pi\mu\nu)}{\Gamma(K_L \to \pi e\nu)} = 0.702 \pm 0.011$$ [Argonne HBC 1980]

3-σ discrepancy (∼**4%**) between measurement and expectation for $R_{\mu/e}$:

$R_{\mu/e} = 0.671 \pm 0.011$, direct measurement for K^+, from KEK-E246 2001

$R_{\mu/e}$ calculable from the slopes λ_+ and λ_0 of vector and scalar form factors:

0.670 ± 0.002, if $\lambda_0 = 0.0183 \pm 0.0013$, from ISTRA+ 2003

0.668 ± 0.006, if $\lambda_0 = 0.017 \pm 0.004$, from one-loop χPt

K_L lifetime is poorly known $\Delta\tau/\tau = 0.8\%$

$K^{\pm}$ decays – Present knowledge

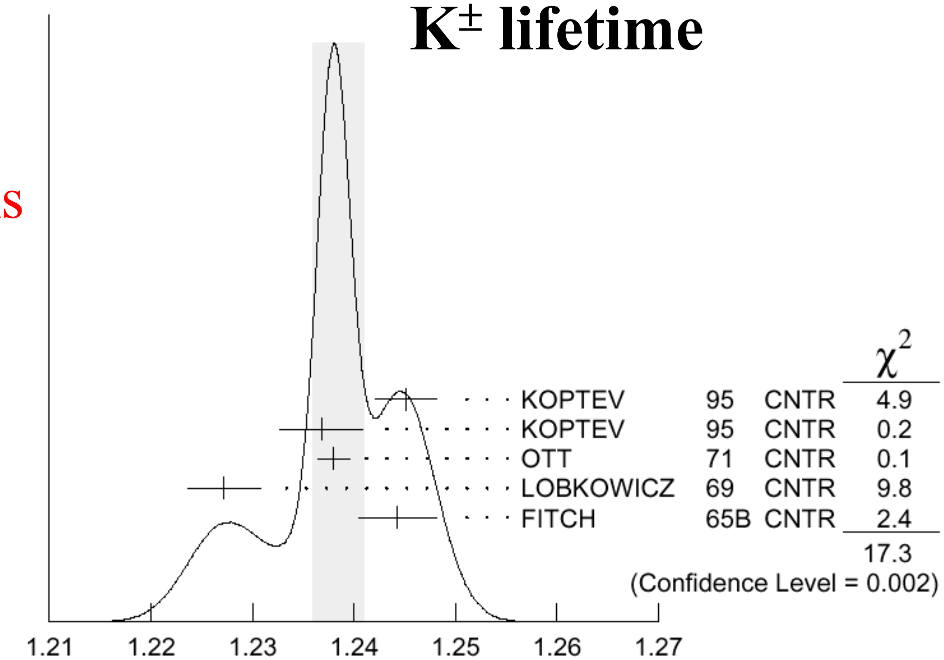
PDG02 BR dominated by a single experiment (Chiang 72)

New E-865 BR($K^+ \rightarrow \pi^0 e^+ \nu$) does not agree with PDG02 (2.2σ)

- not absolute BR
- use PDG for normalization

PDG avg. $\tau_{\pm}$ = 12.385 ± 0.025 ns
± 0.2%

$K^{\pm}$ lifetime

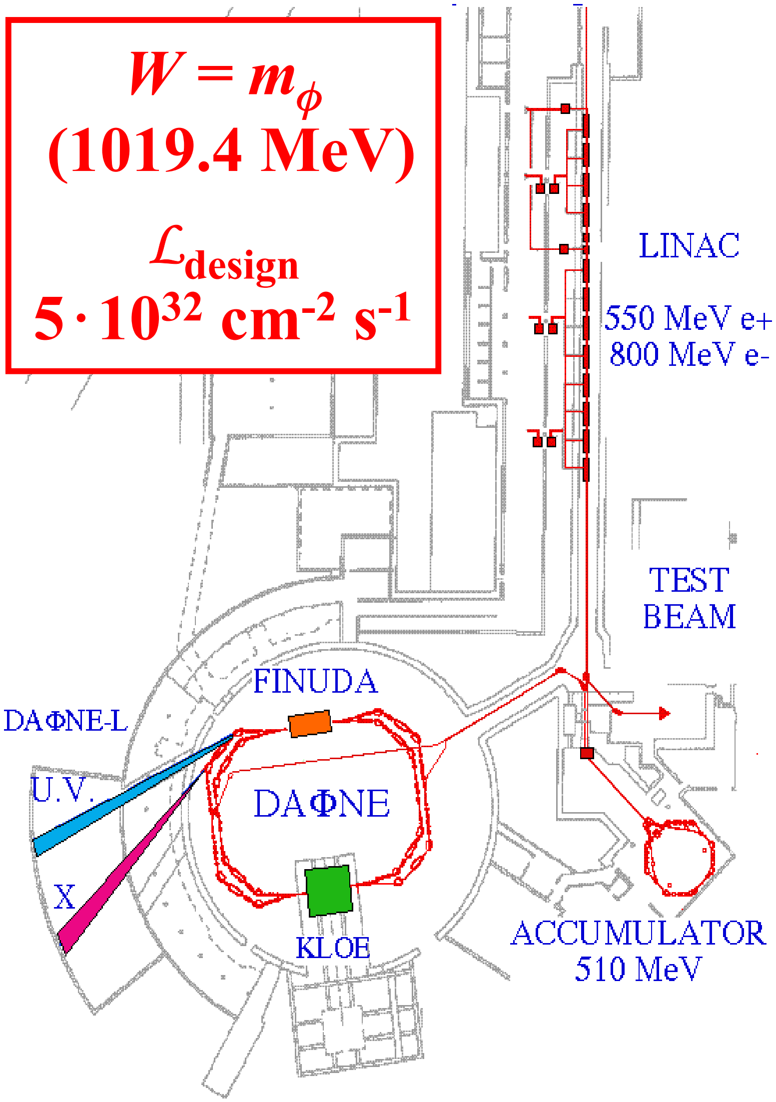


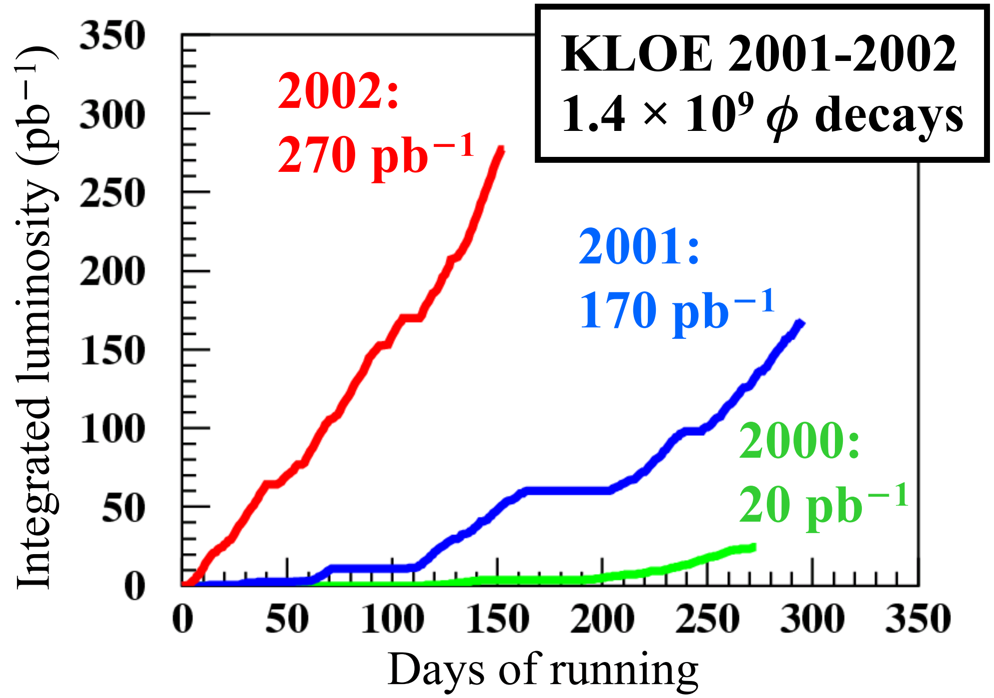
DAΦNE: the Frascati ϕ factory

$W = m_\phi$ (1019.4 MeV)

$\mathcal{L}_{\text{design}}$

$5 \cdot 10^{32}$ cm^{-2} s^{-1}





2002 best $\mathcal{L}_{\text{peak}}$ **7.8×10^{31} cm^{-2} s^{-1}**

2002 avg $\mathcal{L}$ **$\sim 4 \times 10^{31}$ cm^{-2} s^{-1}**

Machine upgrades for 2004:

$\mathcal{L} > 10^{32}$ cm^{-2} s^{-1} $\rightarrow$ 2 fb^{-1}/yr

Kaon production

The ϕ decay at rest provides monochromatic and pure kaon beams

- The KK pairs in the final state have the same quantum numbers as the ϕ, *i.e.*, they are produced in a pure $J^{PC} = 1^{--}$ state

K_S (K^+) ⟵ **Φ** ⟶ **K_L (K^-)** Contamination $\approx 10^{-10}$

$$|i\rangle \propto \frac{1}{\sqrt{2}}\left(|K_L,\mathbf{p}\rangle|K_S,-\mathbf{p}\rangle - |K_L,-\mathbf{p}\rangle|K_S,\mathbf{p}\rangle\right)$$

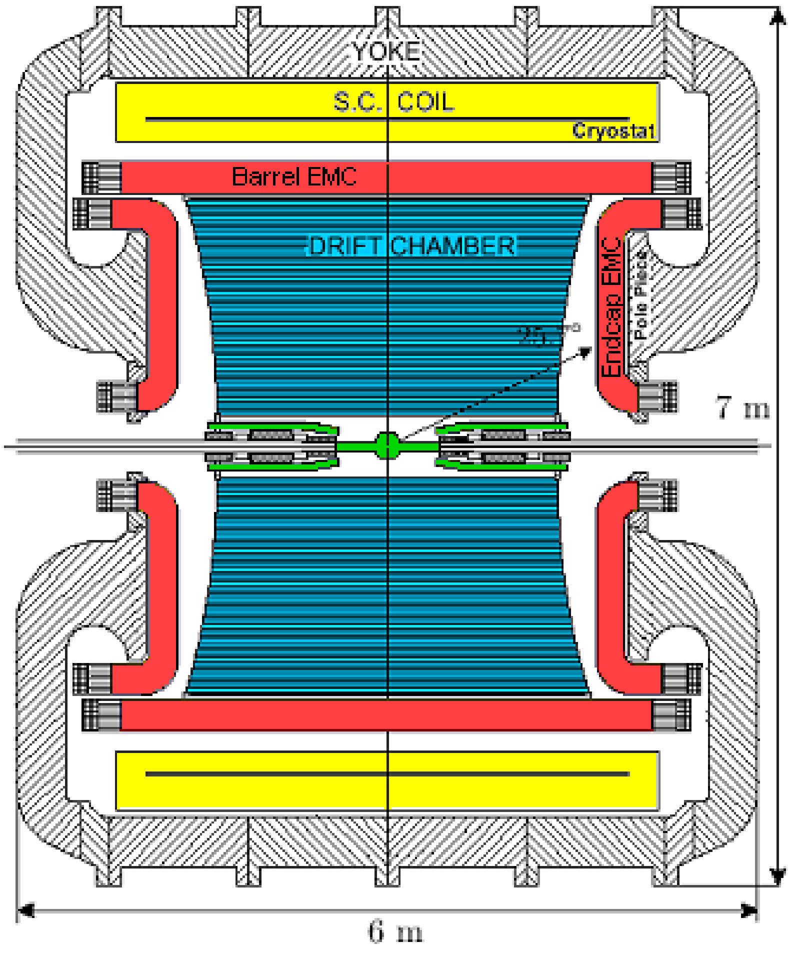
- **Tagging**: observation of $K_{S,L}$ signals presence of $K_{L,S}$
  - precision measurement of absolute BR's

- Interference measurements of K_SK_L system

K^+K^-
1.5×10^6 /pb^{-1}
p* = 127 MeV/c
$\lambda_\pm$= 95 cm

K_LK_S
10^6 /pb^{-1} ; p* = 110 MeV/c
λ_S = 6 mm **K_S decays near interaction point**
λ_L = 3.4 m **Large detector to keep reasonable acceptance for K_L decays (~0.5 λ_L)**

The KLOE experiment



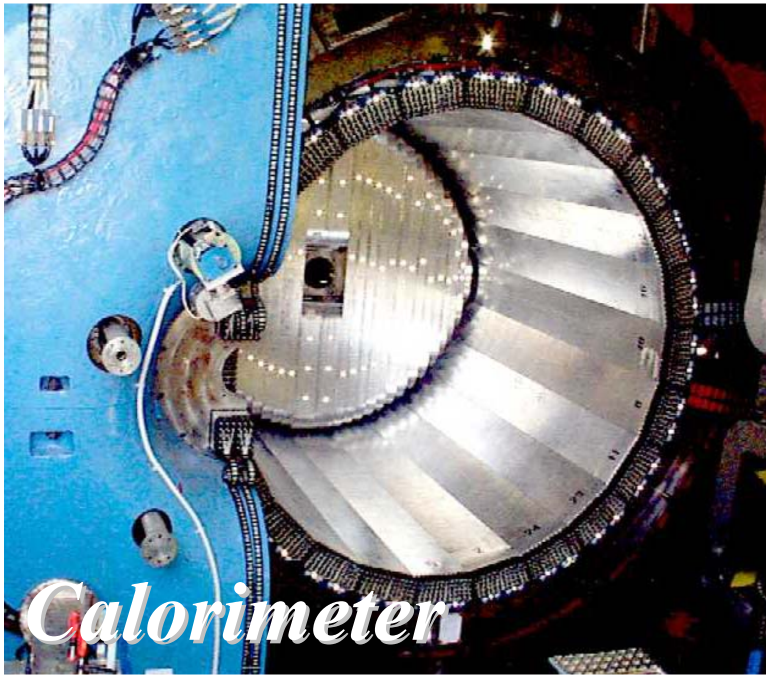
Be beam pipe (0.5 mm thick)
Instrumented permanent magnet quadrupoles (32 PMT's)

Drift chamber (4 m ∅ × 3.3 m)
90% He + 10% IsoB, CF frame
12582 stereo sense wires

Electromagnetic calorimeter
Lead/scintillating fibers
4880 PMT's

Superconducting coil (5 m bore)
$B = 0.52$ T ($\int B\,dl = 2$ T·m)

KLOE detector specifications



σ_E/E **5.7% /$\sqrt{E}$(GeV)**

σ_t **54 ps /$\sqrt{E}$(GeV) $\oplus$ 50 ps**
(relative time between clusters)

$\sigma_L(\gamma\gamma)$ **~2 cm** (π^0 from $K_L \to \pi^+\pi^-\pi^0$)

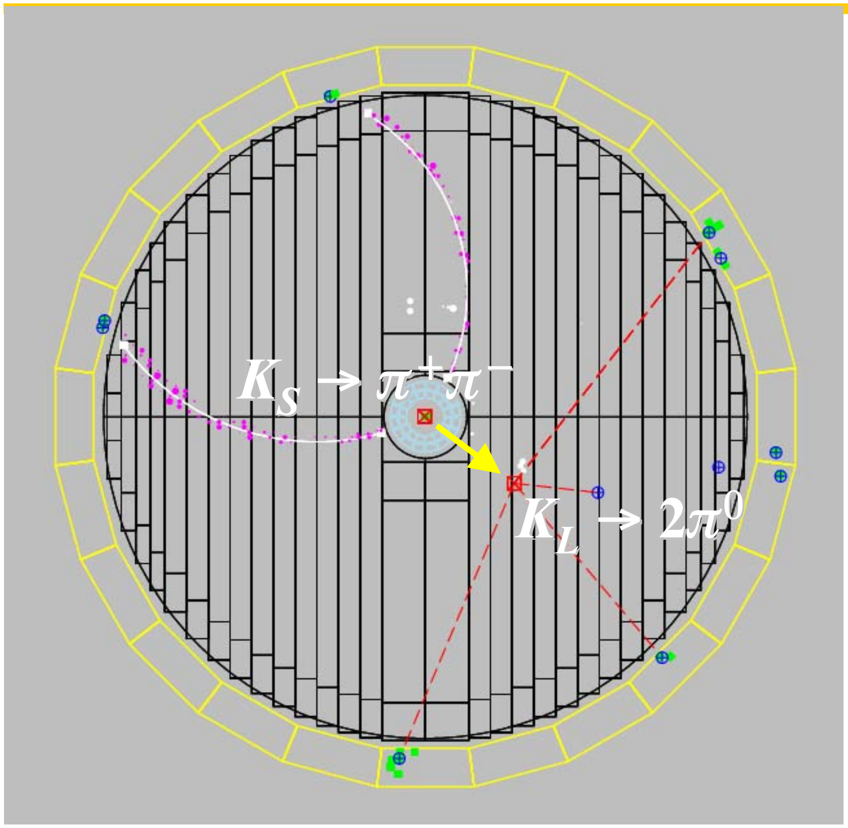
σ_p/p **0.4 %** (tracks with $\theta > 45°$)

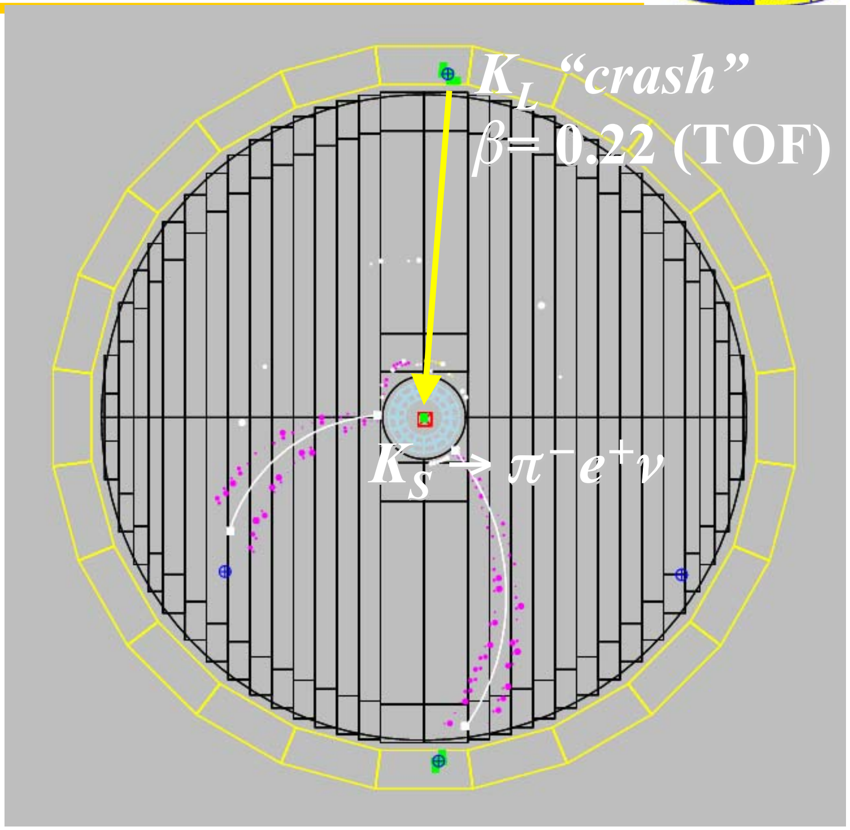
σ_x^{hit} **150 μm (xy), 2 mm (z)**

σ_x^{vertex} **~1 mm**

$\sigma(M_{\pi\pi})$ **~1 MeV**

Tagged K_L and K_S "beams"





K_L tagged by $K_S \rightarrow \pi^+\pi^-$ vertex at IP

Efficiency ~ 70% (mainly geometrical)

K_L angular resolution: ~ 1°

K_L momentum resolution: ~ 1 MeV

$4 \cdot 10^5$ tags/pb^{-1}

K_S tagged by K_L interaction in EmC

Efficiency ~ 30% (largely geometrical)

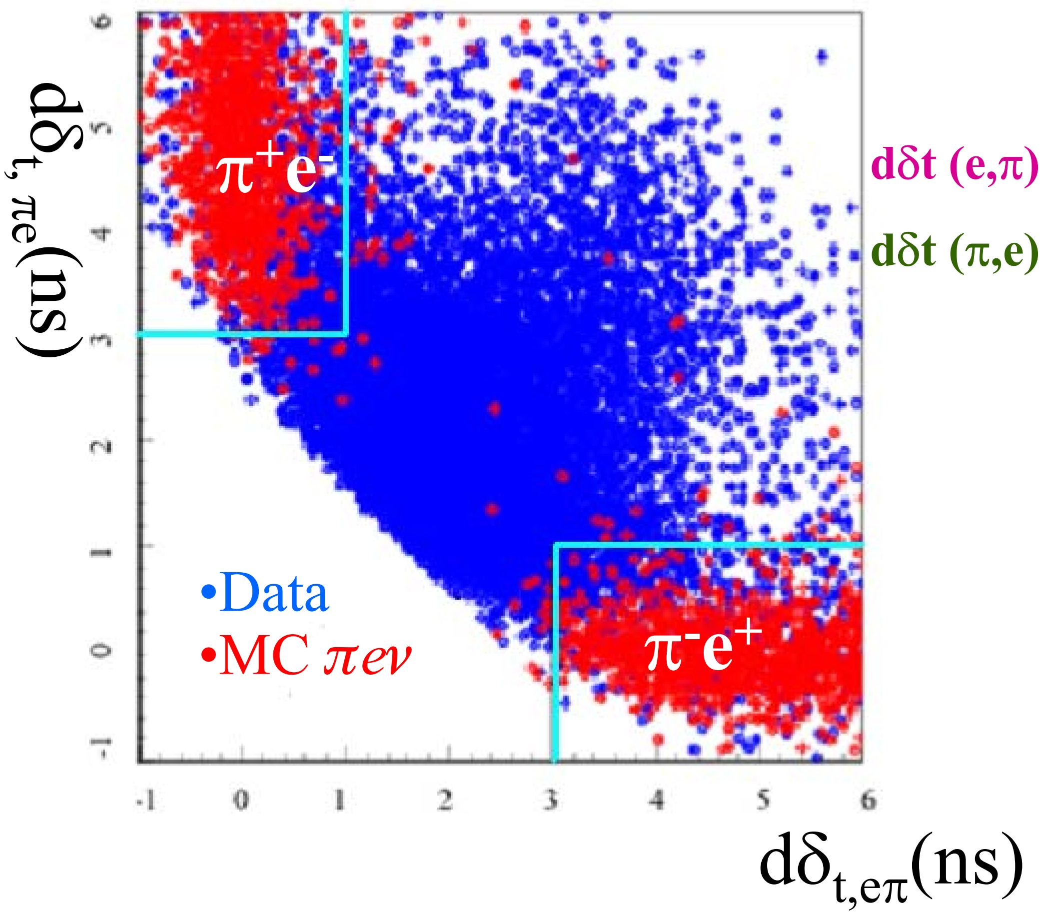
K_S angular resolution: ~ 1° (0.3° in ϕ)

K_S momentum resolution: ~ 1 MeV

$3 \cdot 10^5$ tags/pb^{-1}

Analysis of $K_S \to \pi e \nu$ decays

- K_{crash} tag + 2 tracks from IP with $M_{\pi\pi} < 490$ MeV (reject $K_S \to \pi\pi(\gamma)$)
- **TOF identification:** compare π-e expected flight times, reject ππ,πμ bkg



$d\delta t\,(e,\pi) = [t_-^{CLU} - t_+^{CLU}] - [L_1\,/c\,\beta(e) - L_2\,/c\,\beta(\pi)]$

$d\delta t\,(\pi,e) = [t_-^{CLU} - t_+^{CLU}] - [L_1\,/c\,\beta(\pi) - L_2\,/c\,\beta(e)]$

$\varepsilon_{2trk} \cong 33\%$

$\varepsilon_{tof} \cong 70\%$

$K_S \to \pi^- e^+ \nu, \pi^+ e^- \nu$

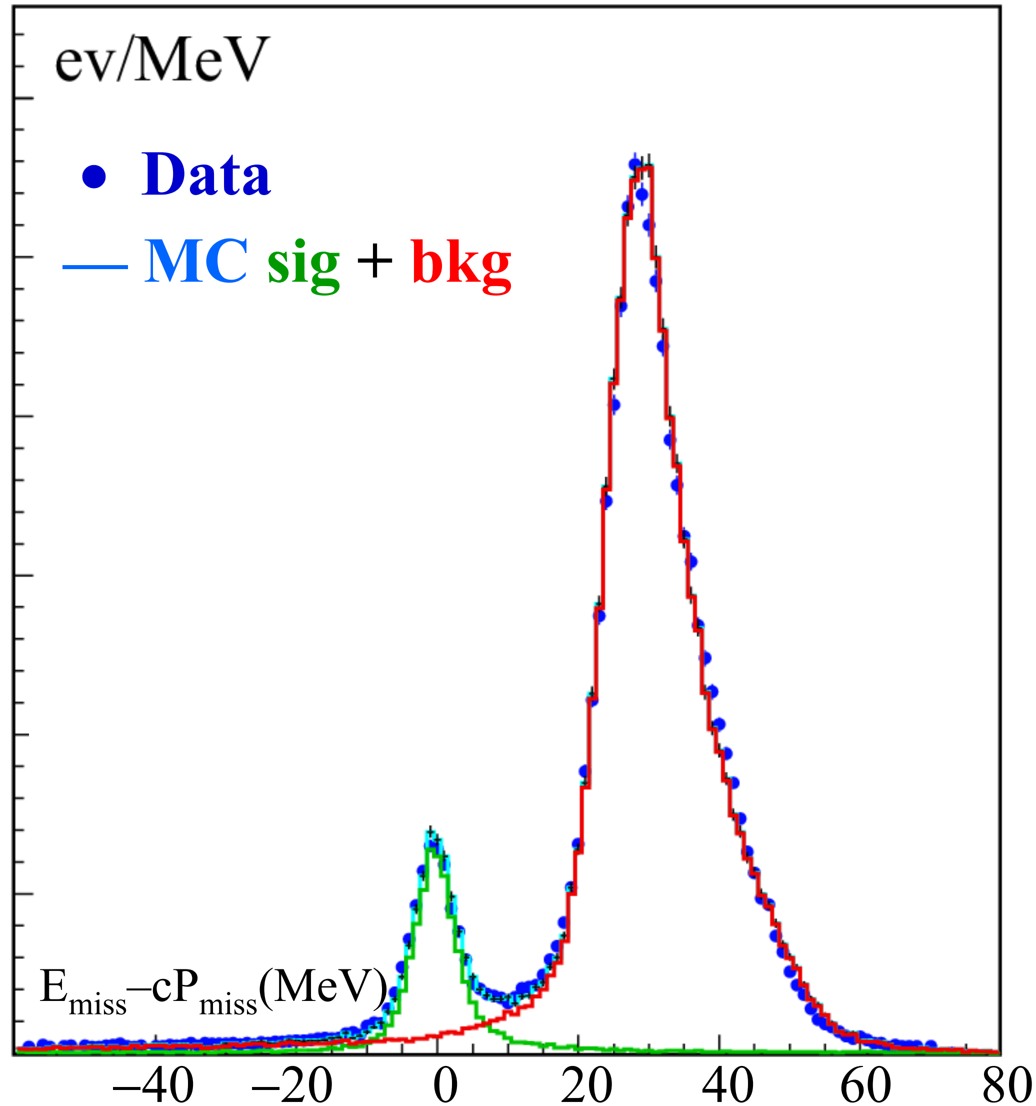
Kinematic closure: use K_L to obtain K_S momentum $\mathbf{P}_K$ and test for presence of neutrino:

$$E_{miss} = \sqrt{M_K^2 + P_K^2} - E_\pi - E_e$$

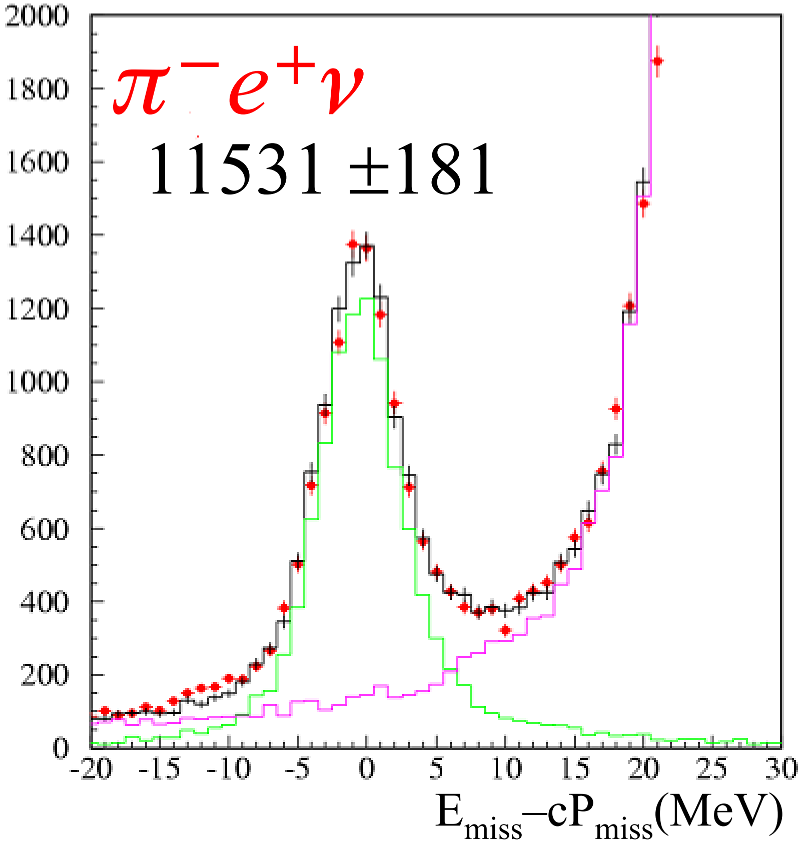
$$P_{miss} = |\mathbf{P}_K - \mathbf{P}_\pi - \mathbf{P}_e|$$

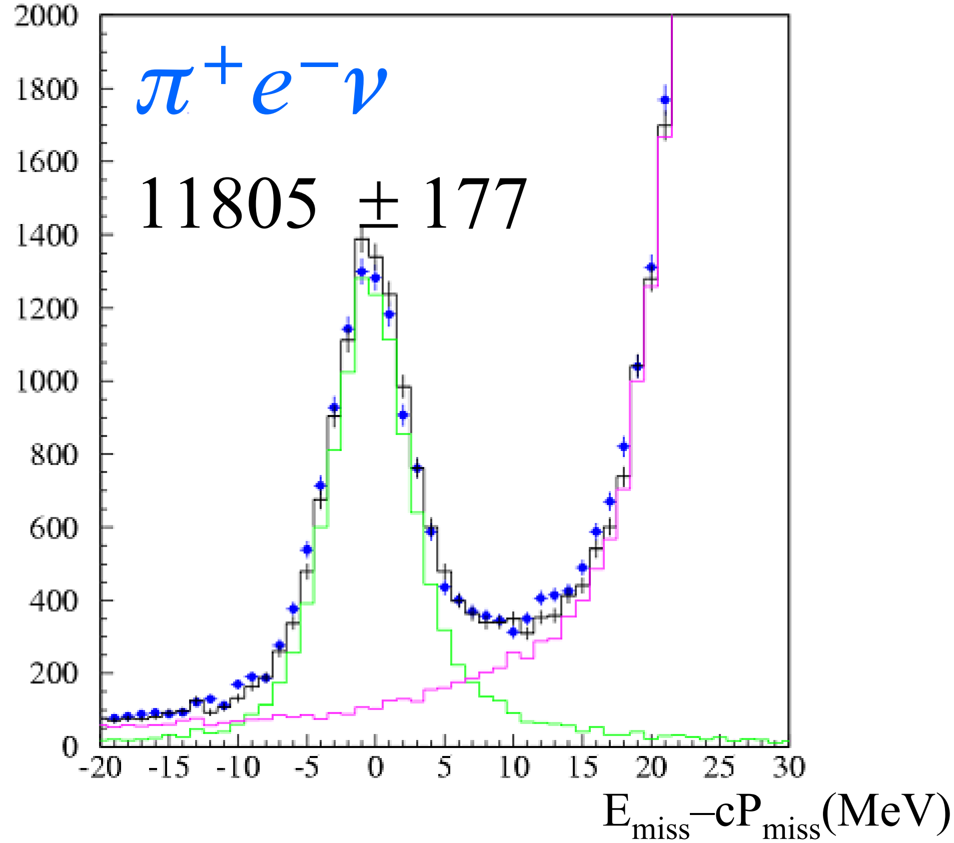
number of signal counts by fitting data to a linear combination of MC spectra for signal and background ($\pi^+\pi^-$)

IR-finite treatment of radiative effects in MC (no energy cutoff)



$K_S \to \pi^- e^+ \nu, \pi^+ e^- \nu$





Result sensitivity to fit interval well below present statistical uncertainty

Normalize signal counts to $K_S \to \pi\pi(\gamma)$ counts in the same data set

(use PDG03 for BR($K_S \to \pi\pi(\gamma)$)), dominated by KLOE measurement)

$K_S \to \pi^- e^+ \nu, \pi^+ e^- \nu$

Selection efficiency (given the tag) is evaluated by charge, using data control sample of $K_L \to \pi e \nu$ decaying close to IP:

$\varepsilon(\pi^- e^+) = (24.1 \pm 0.1 \pm 0.2)\%$; $\varepsilon(\pi^+ e^-) = (23.6 \pm 0.1 \pm 0.2)\%$

$BR(K_S \to \pi^- e^+ \nu) = (3.54 \pm 0.05_{stat} \pm 0.05_{syst})\ 10^{-4}$

$BR(K_S \to \pi^+ e^- \nu) = (3.54 \pm 0.05_{stat} \pm 0.04_{syst})\ 10^{-4}$

$BR(K_S \to \pi e \nu) = (7.09 \pm 0.07_{stat} \pm 0.08_{syst})\ 10^{-4}$

(Published result: $(6.91 \pm 0.34_{stat} \pm 0.15_{syst})\ 10^{-4}$ Phys.Lett.B535:3742,2002)

preliminary

evaluation of the systematics near completion

$$A_{S,L} = \frac{\Gamma(K_{S,L} \to \pi^- e^+ \nu) - \Gamma(K_{S,L} \to \pi^+ e^- \bar{\nu})}{\Gamma(K_{S,L} \to \pi^- e^+ \nu) + \Gamma(K_{S,L} \to \pi^+ e^- \bar{\nu})}$$

$A_S = (-2 \pm 9_{stat} \pm 6_{syst})\ 10^{-3}$ (never measured before)

($A_L = (3.322 \pm 0.058 \pm 0.047)\ 10^{-3}$, KTeV 2002)

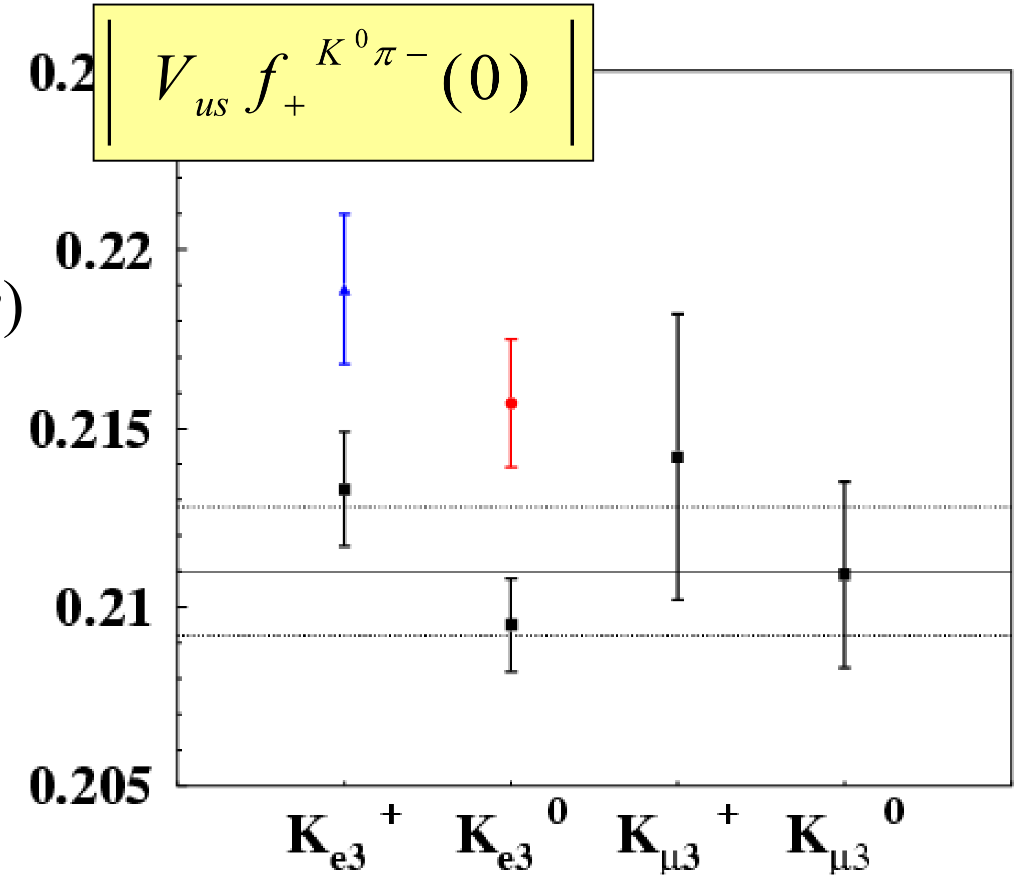
future: **next year run** $2\ fb^{-1} \to \sigma(A_S) \sim 3 \cdot 10^{-3}$

$K_S \rightarrow \pi e \nu$ - $V_{us} f_+^{K\pi}(0)$

Compare **our measurement of V_{us} $f_+^{K\pi}(0)$ from K_s** with:

- **PDG02** fit results for $\Gamma(K^+ \rightarrow \pi^0 l^+ \nu)$ and $\Gamma(K_L \rightarrow \pi^- l^+ \nu)$ (radiation effects not known)
- $\Gamma(K^+ \rightarrow \pi^0 e^+ \nu)$ **from E865 experiment**

CKMwg prescription is used to extract $\mathbf{V_{us}}$ $\mathbf{f_+^{K\pi}(0)}$ from the partial decay width



$V_{us}(K_{S,e3})$ $f_+^{K\pi}(0) = 0.2157 \pm 0.0018$

Our **preliminary** result agrees better with latest K^+ data, while showing a deviation from old K^0_{e3} data

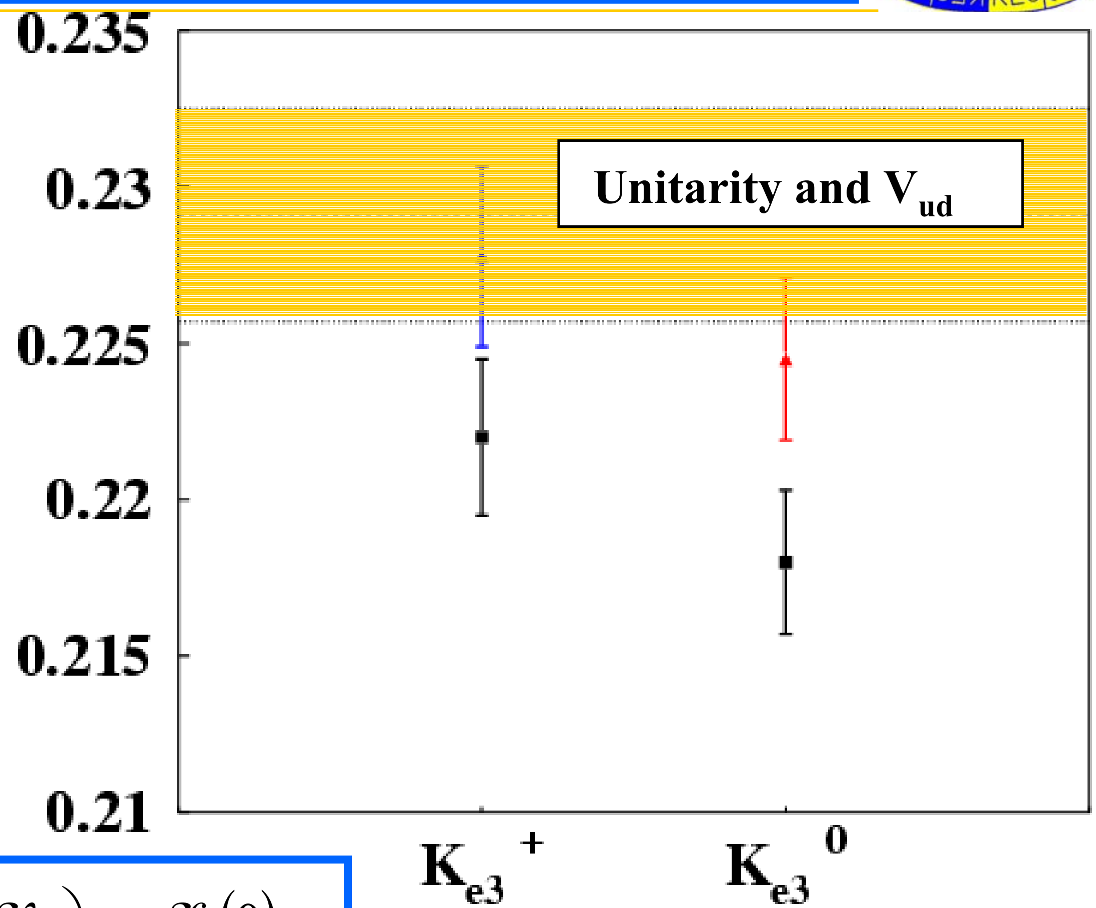
$K_S \to \pi e \nu$ - V_{us}

PDG02, CKMwg use

$$f_+^{K^0\pi^-}(0) = 0.961 \pm 0.008$$

from **Leutwyler, Roos**
Z.Phys. C 25 1984

- computed up to p^4 contr. in χPT
- confirmed by a lattice calculation (Isidori et al., **hep-ph 0403217**)



$$\frac{\delta|V_{us}|}{|V_{us}|} = \frac{1}{2}\left(\frac{\delta \mathrm{BR}}{\mathrm{BR}}\right) \oplus \frac{1}{2}\left(\frac{\delta\tau}{\tau}\right) \oplus \frac{1}{20}\left(\frac{\delta\lambda_+}{\lambda_+}\right) \oplus \frac{\delta f_+(0)}{f_+(0)}$$

0.7 % ⊕ 0.05% ⊕ 0.3% ⊕ 0.8%

$V_{us}(K_{S,e3}) = 0.2245 \pm 0.0026$

KLOE preliminary

K_L decays – Status and objectives

Precisely measure **absolute** branching ratios, with rel. accuracy < 1%

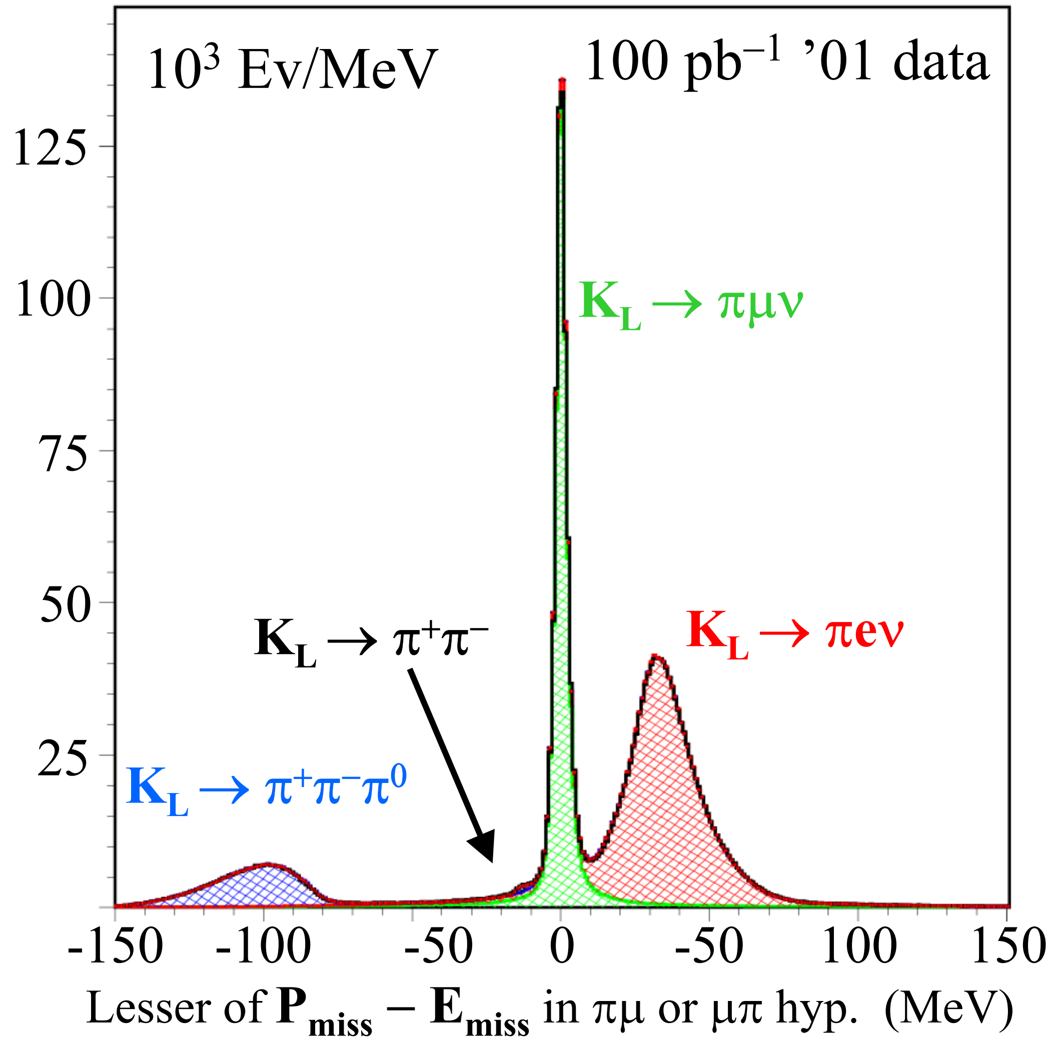
♦ K_L decay vertex in a fiducial volume in DC (given a $K_S \to \pi^+\pi^-$ tag)

♦ Kinematic identification using reconstructed momenta

$450 pb^{-1} \Rightarrow 3 \bullet 10^6\ K_{e3}$ events
$2 \bullet 10^6\ K_{\mu 3}$ events

In progress:

- Analysis with the new detailed MC with radiation and optimized EmC response to $\mu/\pi/K_L$
- Selection efficiency as a function of K_L vertex position and momenta of decay products



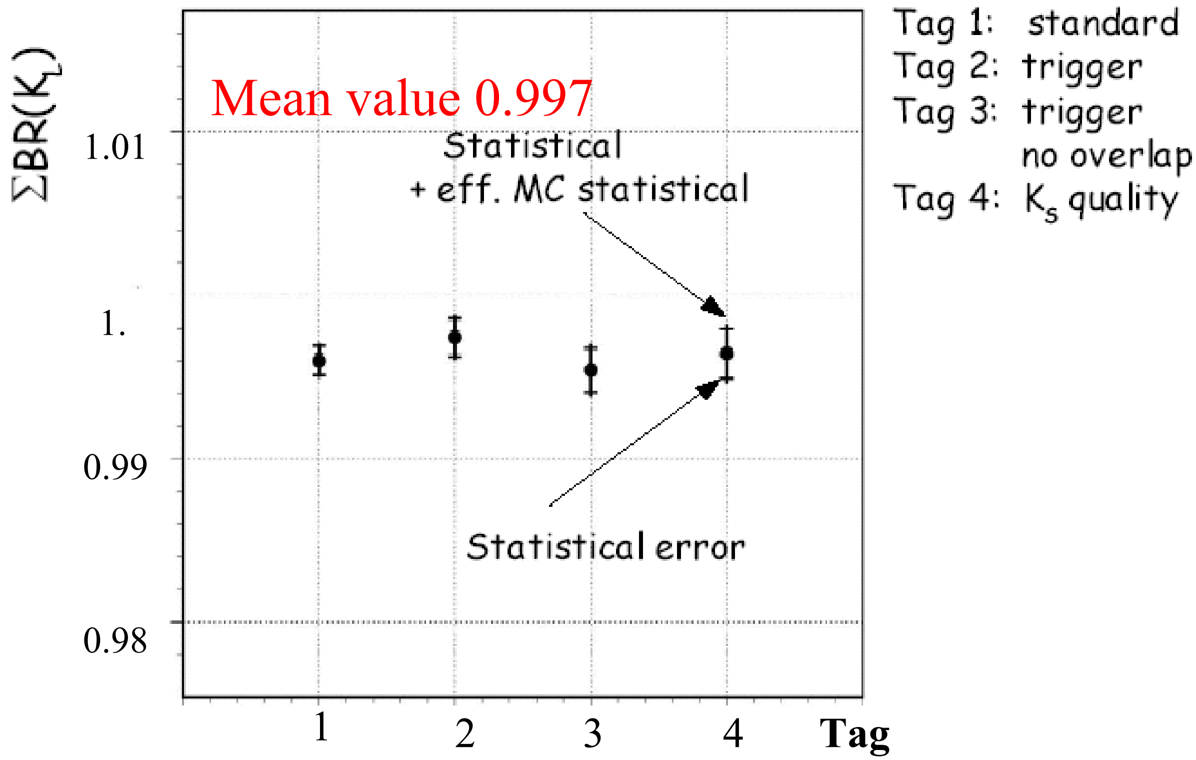
K_L decays – BR stability

• Obtain number of signal counts by fitting data to a linear combination of MC spectra for signal

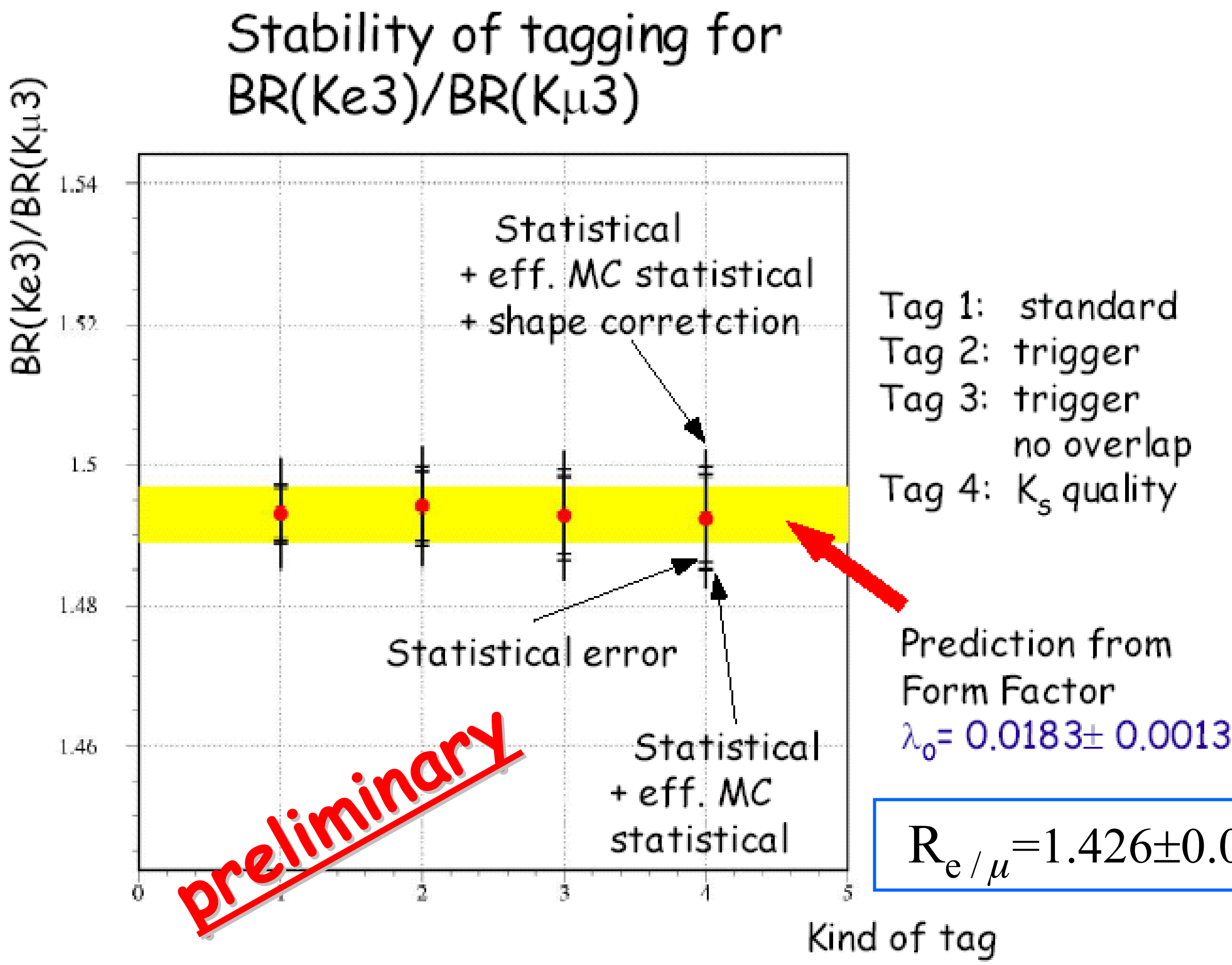
• Each BR obtained by normalizing signal counts to the number of tags:

• Tagging efficiency cancels out in the ratio except for O(1%), channel-dependent, tag-bias correction

Reliability of tag-bias correction checked by using various tag algorithms, with corrections ranging from 7% to 0.1%



K_L decays – BR stability



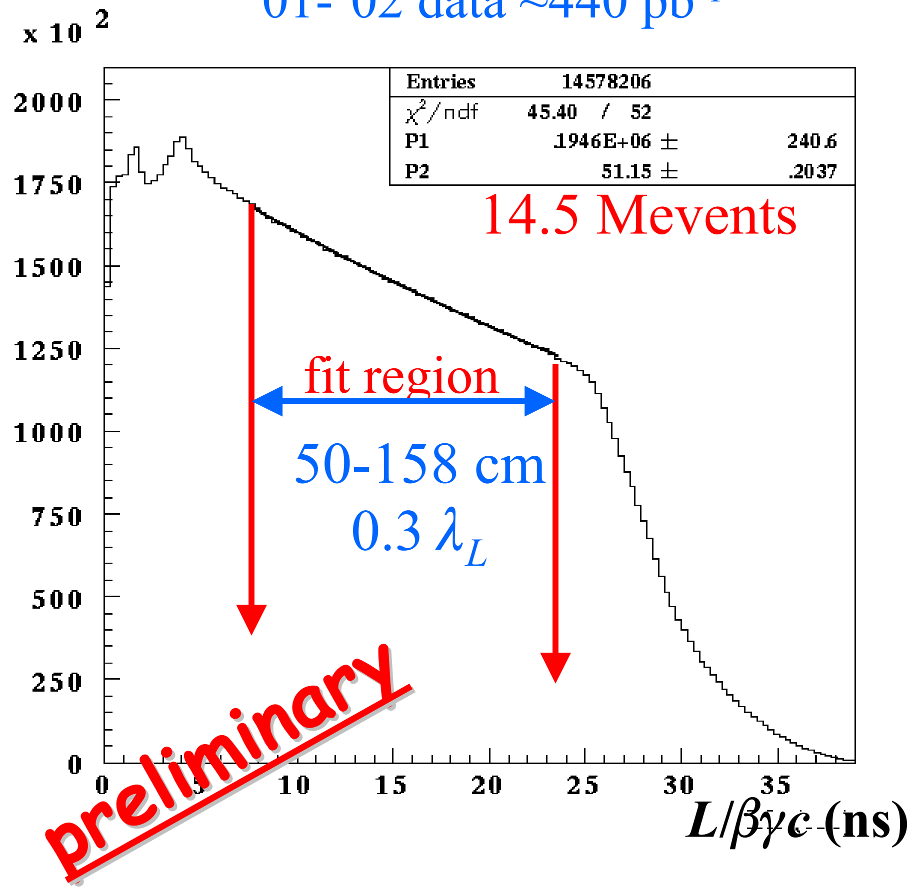
Tag 1: standard
Tag 2: trigger
Tag 3: trigger
no overlap
Tag 4: K_s quality

$R_{e/\mu}$=1.426±0.018 PDG02

K_L lifetime from $K_L \to \pi^0\pi^0\pi^0$

’01-‘02 data ~440 pb^{-1}

- tag with $K_S \to \pi^-\pi^+$
- at least 3 neutral clusters in EMC
- neutral vertex reconstruction and $3\pi^0$ selection



τ **(PDG) (fit) = (51.7 ± 0.4) ns**

τ **(Vosburg, 1972) = (51.54 ± 0.44) ns - 0.4 Mevents**

τ **(KLOE) = (51.15 ± 0.20stat) ns - 14.5 Mevents – 440 pb^{-1}**

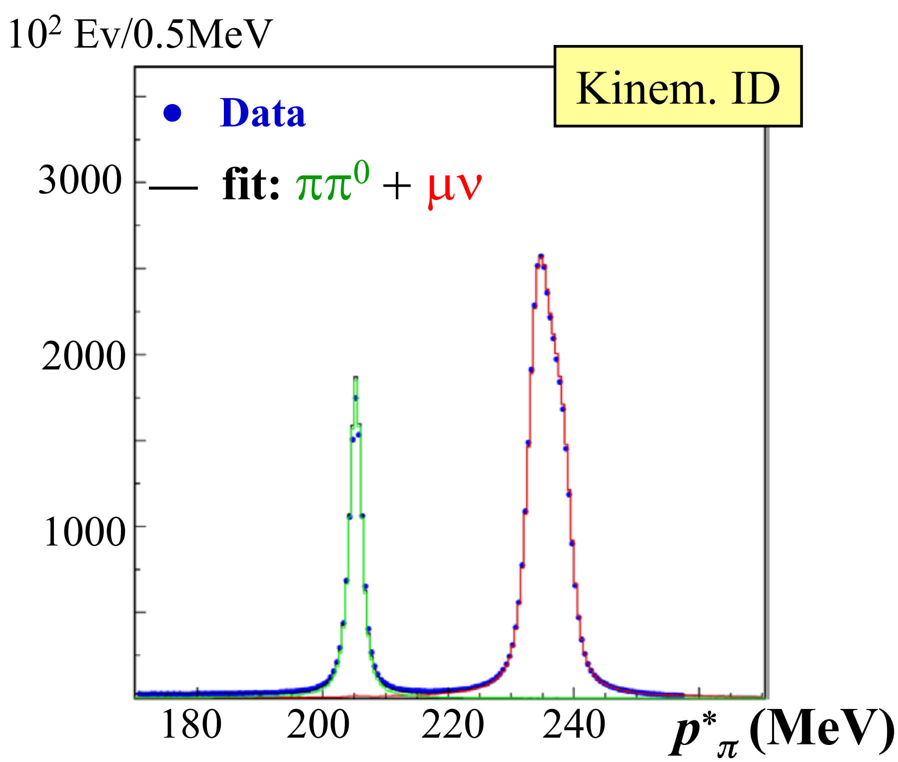
Systematics to be evaluated

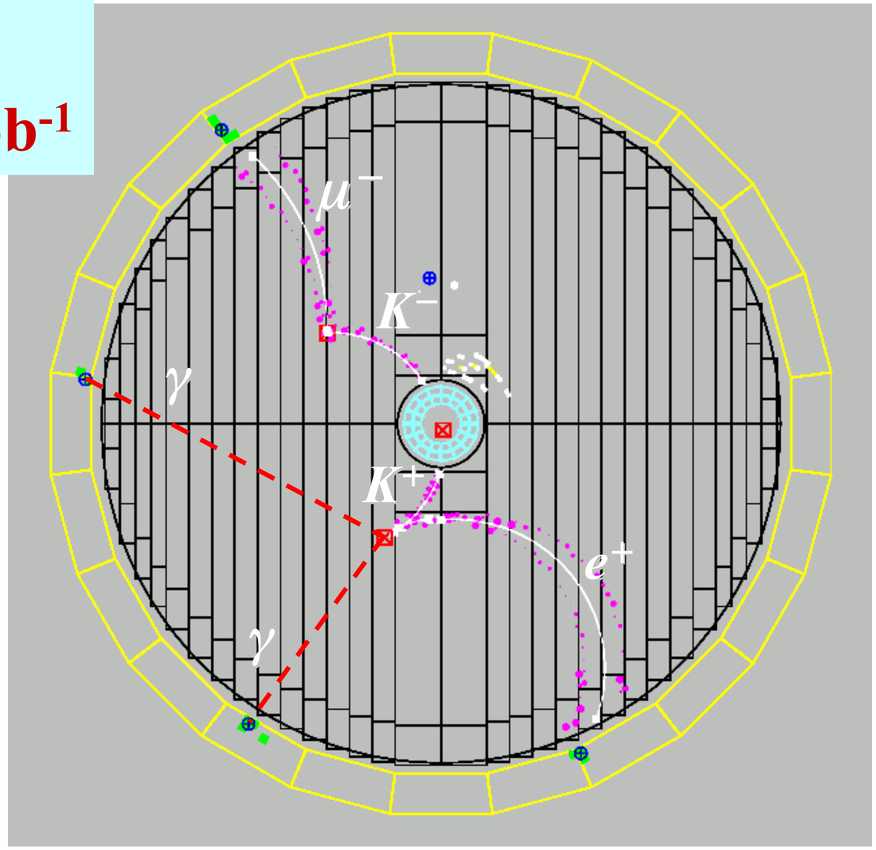
Charged kaon decays

Measure absolute BR's to < 1%:

K^+ beam tagged from $K^- \to \pi^-\pi^0$, $\mu^-\nu$

• Two-body decays identified as peaks in the momentum spectrum of secondary tracks in the kaon rest frame: **$6 \bullet 10^5$ tags/pb^{-1}**



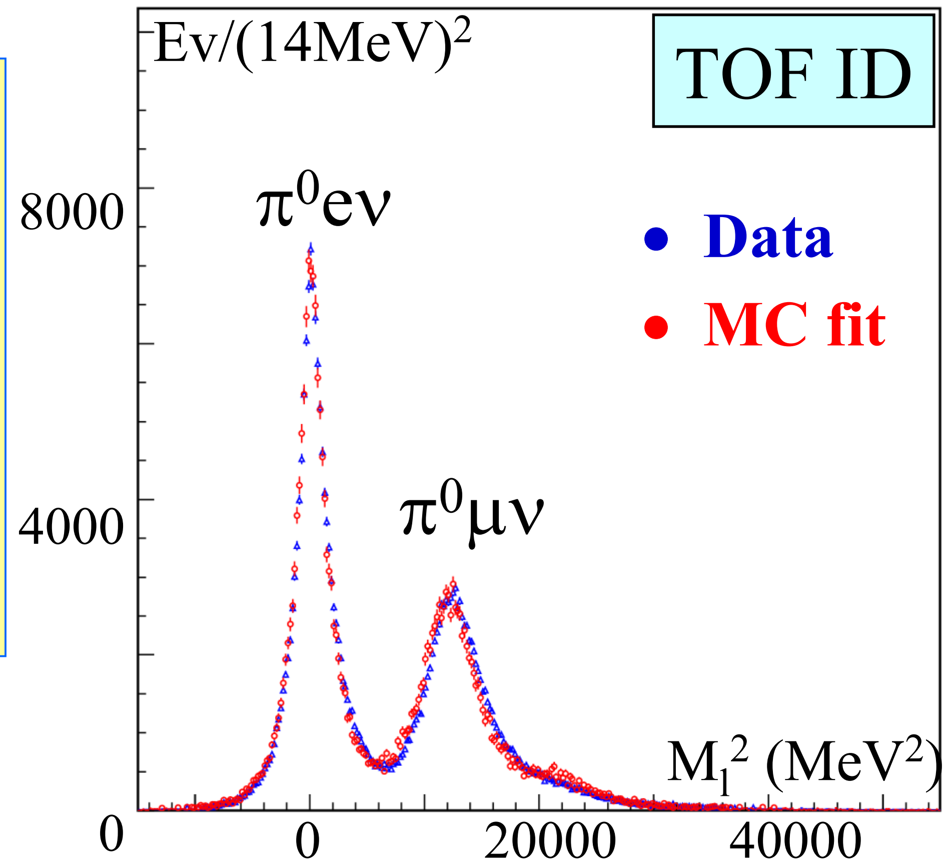


$K^{\pm}$ decays – Status and objectives

♦ After tag a dedicated reconstruction of $K^{\pm}$ tracks is performed, correcting for charged kaon dE/dx in the DC walls

- 1-prong kaon decay vertex in a given fiducial volume in DC
- Reject two-body decays by cutting on P^*_{π}
- π^0 search: 2 neutral clusters in EmC, with TOF matching the K decay vertex
- Obtain charged-daughter mass spectrum from TOF measurement:

$$t_l - L_l \cdot (E_l/p_l c) = \langle t_\gamma - L_\gamma / c \rangle$$



$450pb^{-1} \Rightarrow 3 \bullet 10^5\ K_{e3}$ events

In progress:

•Evaluation of selection bias due to interference from tagging decay

•Analysis with MC upgrade (radiative processes, optimized EmC response to π/μ)

K^+ lifetime

Tag with $K \rightarrow \mu\nu$

Measure L from $K \rightarrow \pi\pi^0$ vertex

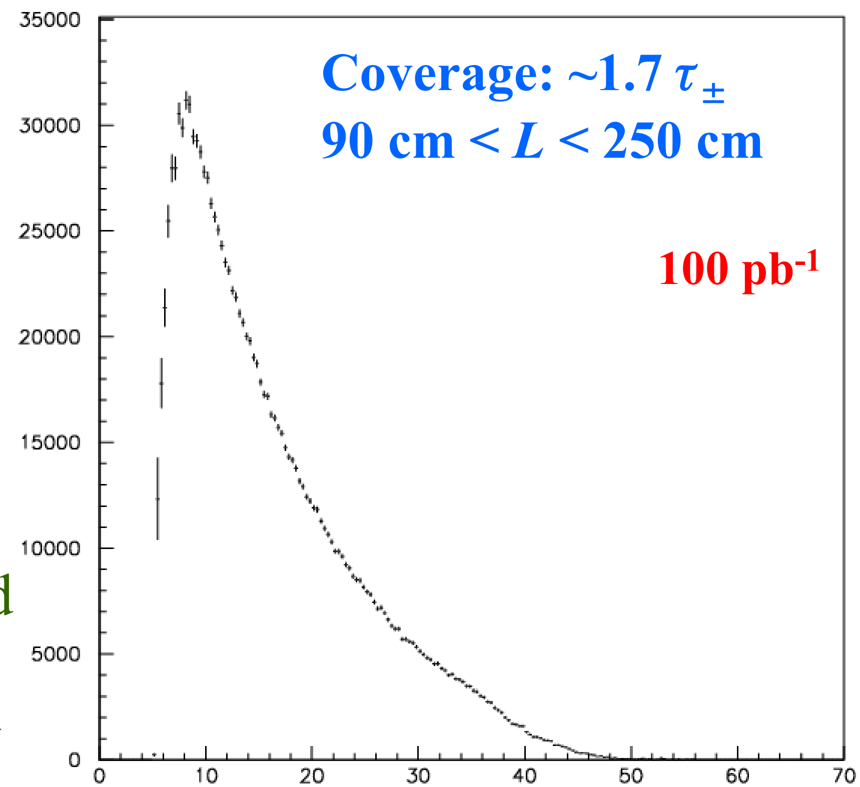
$\sigma_L(K\pi) = 3$ mm

450 pb^{-1} → 70 × 10^6 events

Measure decay time independently with $\pi^0 \rightarrow \gamma\gamma$ vertex:

$\sigma_L(\gamma\gamma) = 3$ mm (after kinematic fit)

Given the charged vertex resolution and the EMC time resolution, with present data, we can reach 0.2% (stat) accuracy on $\tau_{K\pm}$



$L_K/\beta\gamma c$ (ns)

In progress:

efficiency evaluation directly from data sample selected using EMC information + kinematic fit

Summary

KLOE is analyzing a unique data sample: 500 pb^{-1} of ϕ decays

- K_S semileptonic BR measured for first time with 1.4% accuracy allowing an independent measurement of V_{us}
- Measurement of K_L BR's and lifetime are near to completion, preliminary result for summer conferences
- Analysis of $K^{\pm}$, BR's, and lifetime in progress

KLOE expects to collect 2 fb^{-1} in 2004-2005

DAΦNE upgrades and 2004 running

New KLOE IR

- Rotation for low-β quads
- Decrease β_x and coupling
- Allow changes to KLOE field

Pole-shims on wigglers

- Eliminate octopole terms

Run plans

- Increase peak luminosity and reach $1.5 \cdot 10^{32}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$
- Restart by end of June with FINUDA first
- **Switch to KLOE in early fall and deliver > 1 fb^{-1} to KLOE**

2004 run plans

Expected DAΦNE performance

- Luminosity up to $\mathbf{2\times10^{32}\ cm^{-2}\ s^{-1}}$
- Lifetime **> 1 hr** (was 0.6 hr in 2002)
- 10 pb^{-1}/day, 200 pb^{-1}/month

DAΦNE run plans (from KLOE perspective)

- Start FINUDA data taking A.S.A.P
- 250 pb^{-1} for FINUDA in ~2 months
- Realistically restart KLOE towards end of year
- Run **KLOE** for **~1 year** with goal of collecting $\mathbf{2\ fb^{-1}}$

Physics vs. luminosity: perspectives

0.5 fb^{-1} $5\times10^8\ K_S K_L$	**KLOE today**	Limit on BR($K_S \to 3\pi^0$) at 10^{-7} level $K_S \to \pi e\nu$ charge asymmetry (A_S) to 10^{-2} V_{us} from $K_{\ell 3}$ decays at few $\times\ 10^{-3}$ level
2 fb^{-1} $2\times10^9\ K_S K_L$	**KLOE '04-'05**	Limit on $K_S \to 3\pi^0$ at 10^{-8} level A_S to 4×10^{-3} First studies of $K_S K_L$ system with interference
40 fb^{-1} $4\times10^{10}\ K_S K_L$	**Original KLOE program**	Re ε'/ε at 10^{-4} level Im ε'/ε at 10^{-3} level from $K_S K_L$ interference
200 fb^{-1} $2\times10^{11}\ K_S K_L$	**DAΦNE2**	High-precision studies of $K_S K_L$ system via interference measurements Competitive measurement of Re δ from A_S BR($K_S \to 3\pi^0$) and BR($K_S \to \pi^0\ell\ell$) to 20%

$K^+ \to \pi^+\nu\nu$, $K_L \to \pi^0\nu\nu$, and $K_L \to \pi^0\ell^+\ell^-$ probably not within reach

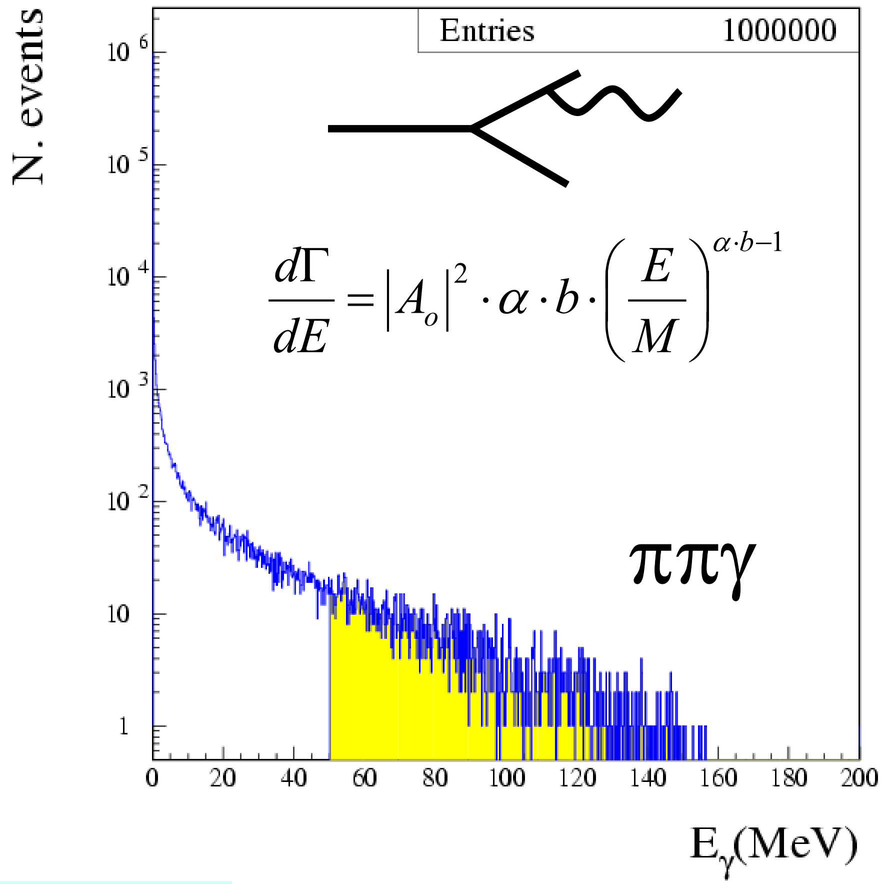
Generators for radiative K decays

Motivation: acceptance evaluation with accuracy better than 1%, shape of kinematic variables (*e.g.* E_{miss}-p_{miss} spectrum)

New MC generators for ππ **and Kl3 decays** including radiated photon, without any cutoff on the energy. The fraction of events in the tail is in agreement with present experimental knowledge:

$$\frac{BR(K_L \to \pi e \nu\gamma, E_\gamma > 30\,MeV\ \theta_{e\gamma} > 20°)}{BR(K_L \to \pi e \nu)} =$$

kTeV	$(0.908 \pm 0.015) \times 10^{-2}$
Bijnens et al	0.93×10^{-2}
MC	0.93×10^{-2}



$$\frac{BR(K_S \to \pi\pi\gamma, E_\gamma > 50\,MeV)}{BR(K_S \to \pi\pi)} =$$

E731	$(2.56 \pm 0.09) \times 10^{-3}$
MC	2.6×10^{-3}

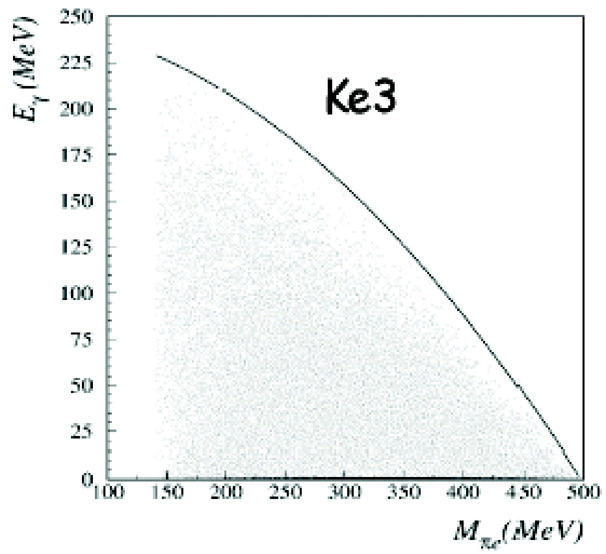
Generators for radiative K decays

Motivations:

efficiencies evaluation @ <1% accuracy

shape of kinematic variables

➡ no threshold on photon(s) energy



Use exponentiation method:

$$\frac{d\Gamma}{dE} = \frac{a_{-1}}{(E/M)} + a_0 + a_1\frac{E}{M} + \dots = \frac{M}{E}\left(a_{-1} + a_0\frac{E}{M} + a_1\left(\frac{E}{M}\right)^2 + \dots\right)$$

$$\frac{M}{E} \Rightarrow \left(\frac{M}{E}\right)^{1-\alpha b}$$

Correct behaviour for low energy photons, and small correction for higher energies (~ % since αb ~ 0.01).

Collaboration with G. Isidori

MC simulation

Simulated event samples statistically comparable to data

$\phi \to$ all 452 pb^{-1} at 1:5 scale ~300M events

$\phi \to K_S K_L$ 452 pb^{-1} at 1:1 scale ~500M events

Each run in data set individually simulated

$\sqrt{s}$, $\mathbf{p}_\phi$, $\mathbf{x}_\phi$, background, dead wires, trigger thresholds…

Inclusion of accidental activity from machine background

extracted from $e^+e^- \to \gamma\gamma$ events in data set

inserted run-by-run to match temporal profile of bkg in data

Tuning of calorimeter response simulation on μ, π, K_L

Suite of new generators introduced, particular emphasis on radiative processes

Form factors: λ_+, λ_0

- KLOE expected (only statistical accuracy with 400 pb^{-1}):
  - $\delta\lambda_+(K_L^{\mu 3})$: 2.0×10^{-4}
  - $\delta\lambda_0(K_L^{\mu 3})$: 2.8×10^{-4}

  - $\delta\lambda_+(K^{\pm}_{\mu 3})$: 2.6×10^{-4}
  - $\delta\lambda_0(K^{\pm}_{\mu 3})$: 3.5×10^{-4}

- q^2 resolution:
  - K_L : δp_π and δp_{lept} from DC, δp_L from δp_S and δp_ϕ
  - $K^\pm$: δp_K and δp_{lept} from DC, dominated by $\delta E_{\pi 0}$

- A 1% precision on $f_+^{K\pi}(0)$ requires $\delta\lambda_0$=0.001 ($\approx$ 5%)

Form factors: λ_+, λ_0

K^0_{e3}

$\lambda_+ = 0.0245 \pm 0.0012_{stat} \pm 0.0022_{syst}$ (CPLEAR) 365 kevts

6 Mevts

@KLOE (200 pb^{-1})

$\sigma_{stat} \approx O(10^{-4})$

$K^\pm_{e3}$

$\lambda_+ = 0.0293 \pm 0.0015_{stat} \pm 0.002_{syst}$ (ISTRA+) 130 kevts

$\lambda_+ = 0.0278 \pm 0.0017_{stat} \pm 0.0015_{syst}$ (KEK-E246) 100 kevts

0.4 Mevts

@KLOE (200 pb^{-1})

$\sigma_{stat} \approx O(10^{-3})$

KLOE can improve the actual measurements of λ_+ using both K^0_{e3} and $K^\pm_{e3}$ decays