Measurement of R_K=BR(K→eν)/BR(K→μν) in the NA62 Experiment at CERN

PATRIZIA CENCI

INFN, Perugia (Italy)

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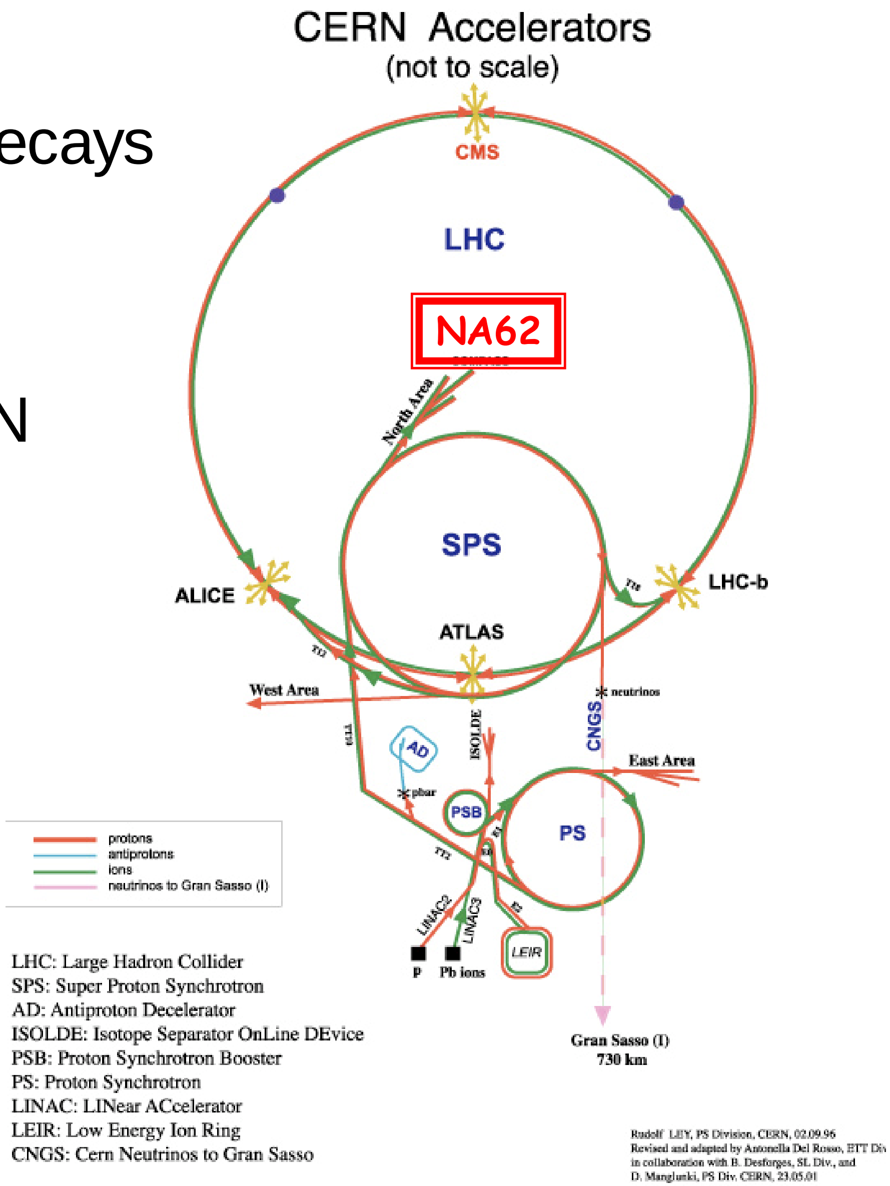
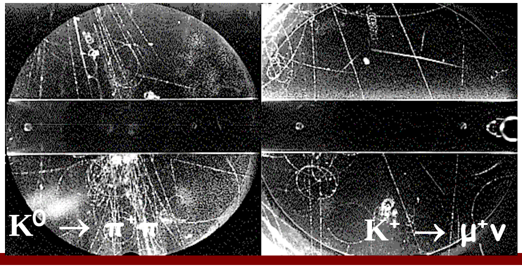
FONDAZIONE CASSA RISPARMIO PERUGIA

On behalf of the NA62 Collaboration

Outline

- Seeking New Physics: Rare Decays
- Kaons and New Physics
- The NA62 experiment at CERN (phase I)
- The Measurement of R_K
- Outlook and Summary





The Framework

Role and interplay of direct New Physics searches with the indirect searches performed at high intensity.

- *LHC: direct investigation of the TeV Energy Scale.*
- *Flavor Physics (e.g. Rare Decays):*
  - Explore the symmetry properties of new degrees of freedom at high mass scales "1-1000 TeV".
  - State of the art: single event sensitivity $\approx 10^{-12}$

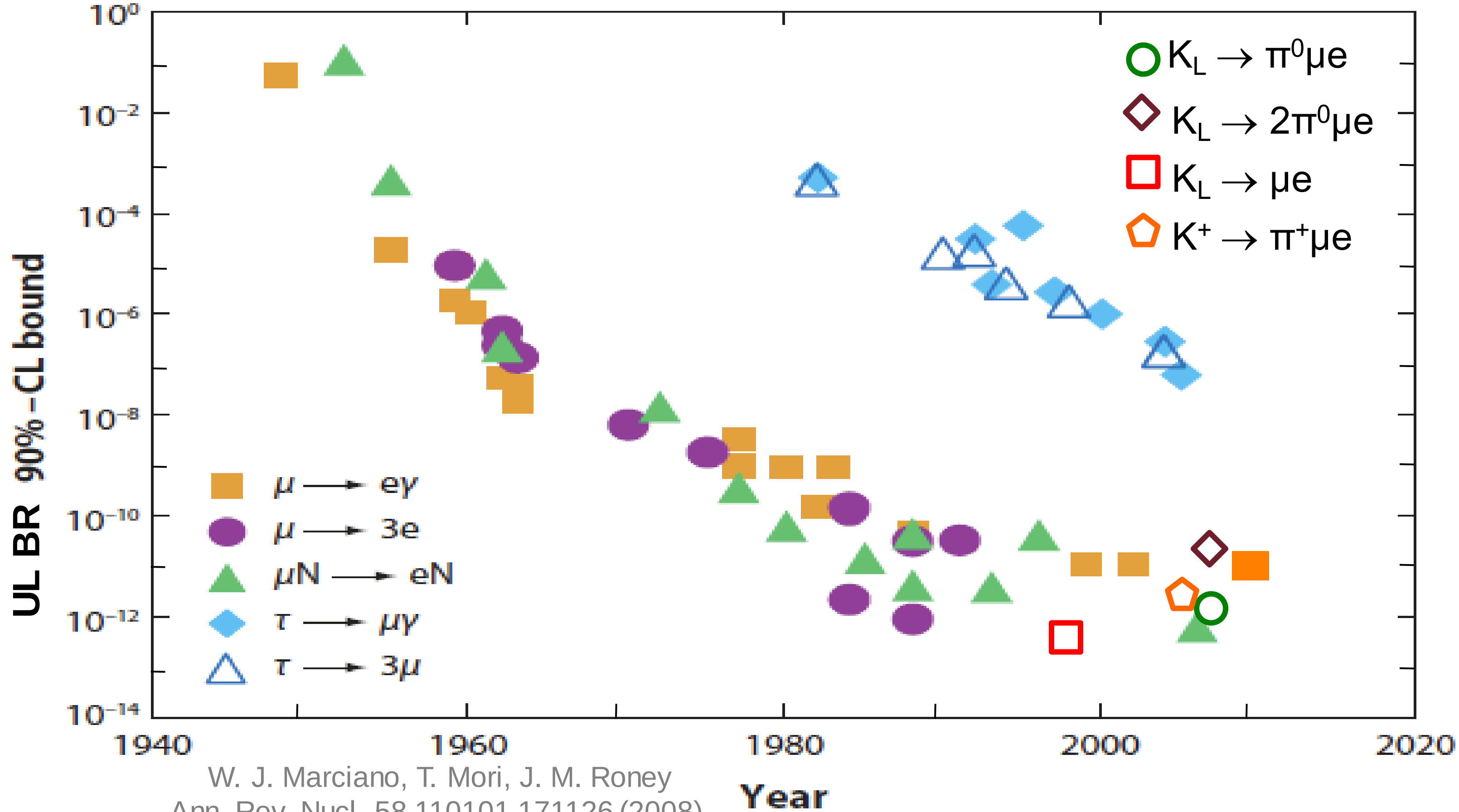
Seeking NP with rare decays of light particles: a selection of measured processes

		90%CL Upper Limit
Searches for explicit violation of the Standard Model ➔ ***Exotic or forbidden processes***	$K_L \to \mu e$ ➔ Lepton Flavour Violation	$< 4.7 \times 10^{-12}$
	$K^+ \to \pi^+ X^0$ ➔ Axions	$< 7.3 \times 10^{-11}$
	$\mu \to e\gamma$ ➔ Lepton Flavour Violation	$< 1.2 \times 10^{-11}$
	$\mu\text{-}N \to e\text{-}N$ ➔ Lepton Flavour Violation	$< 7 \times 10^{-13}$
Measurements of Standard Model parameters ➔ ***Evidence of NP in deviations from well calculated SM predictions*** ➔ ***High precision electroweak tests as powerful tool to probe SM***	$R_{\pi/K} = \Gamma(\pi^+/K^+ \to e^+\nu) / \Gamma(\pi^+/K^+ \to \mu^+\nu)$ ➔ Lepton Universality	R_π: $O(10^{-4})$ R_K: this talk
	$\pi^+ \to \pi^0 e\nu$ ➔ $\lvert V_{ud}\rvert$	$O(10^{-8})$
	$K_L \to \mu\mu$ ➔ $\lvert V_{td}\rvert$	$O(10^{-9})$
	$K^+ \to \pi^+\nu\nu$ ➔ $\lvert V_{td}\rvert$	$O(10^{-10})$
	$K_L \to \pi^+\nu\nu$ ➔ CP Violation	$< 6.7 \times 10^{-8}$

G. Anzivino, this conference

Seeking New Physics: LFV

A selection of LFV searches: a huge effort to find signatures of LFV transitions, forbidden or suppressed in the SM; sensitivity increasing with time (see also D and B and other mesons decays)



W. J. Marciano, T. Mori, J. M. Roney
Ann. Rev. Nucl. 58.110101.171126 (2008)

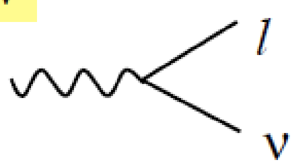
Lepton Universality

In Standard Model (SM) e-μ-τ have identical EW gauge interactions:

- ⇨ identical coupling constants for different lepton flavours
- ⇨ very accurate predictions
- ⇨ only difference in mass and coupling to Higgs boson

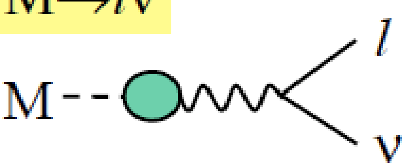
…unless New Physics (NP) violates Universality

W



$$R^{W}_{e/\mu} = \frac{\Gamma(W\to e\nu)}{\Gamma(W\to \mu\nu)} \propto \frac{g_e^{\,2}}{g_\mu^{\,2}}$$

$M \to l\nu$



$$R^{\pi}_{e/\mu} = \frac{\Gamma(\pi\to e\nu)}{\Gamma(\pi\to \mu\nu)} \propto \frac{g_e^{\,2}}{g_\mu^{\,2}} \frac{m_e^{\,2}}{m_\mu^{\,2}}$$

Measurements of Ratios of Weak Coupling Constants

MODE	g_e/g_μ	
π→eν/π→μν	0.9985±0.0016	PRL 68 (1992) PR D49 (1994) PRL 70 (1993)
K → eν/K→μν	1.0018±0.0026	➔ THIS TALK
τ→eνν/τ→μνν	0.9998±0.0020	EPJ C57 (2008)
νe-νμ	1.10±0.05	PL B179 (1986)
W decays	1.001±0.011	EPJ C57 (2008)
K → πeν/K→πμν	0.998±0.002	NP Proc. Suppl.181-182 (2008)

The ratio R_K

Very accurate Standard Model prediction of R_k (as well as R_π): theoretical uncertainties on individual decay rates due to hadronic contributions cancel in the ratio

$$R_K = \frac{\Gamma\left(K^{\pm} \to e^{\pm}\nu_e\right)}{\Gamma\left(K^{\pm} \to \mu^{\pm}\nu_\mu\right)} = \frac{m_e^2}{m_\mu^2}\left(\frac{m_K^2 - m_e^2}{m_K^2 - m_\mu^2}\right)^2 \left(1 + \delta R_{QED}\right) = \left(2.477 \pm 0.001\right) \times 10^{-5}$$

ChPT, O(e²p⁴)

[V. Cirigliano and I Rosell, Phys. Lett. 99, 231801 (2007 JHEP 0710, 005 (2007)]

Helicity suppression

Radiative corrections

Sub-permille (0.04%) accuracy of the SM prediction of R_K (<0.01% for $R_\pi = 1.2352(1) \times 10^{-4}$)

Helicity suppression of R_K might enhance the sensitivity to non-SM effects to a level accessible experimentally

A precise measurement of R_K (R_π) probes μ–e Universality providing a powerful test of SM

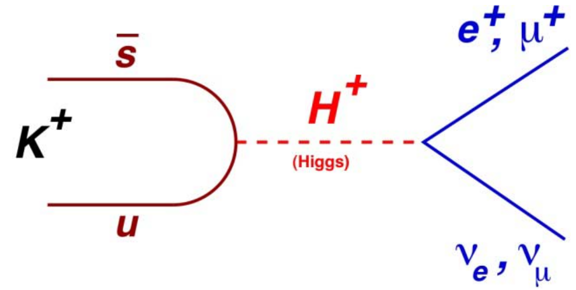
R_K beyond the SM: SUSY

SUSY (MSSM framework) produces sizeable effects to R_K**(SM)**

➔ R-parity is the source of Lepton Universality violating effects

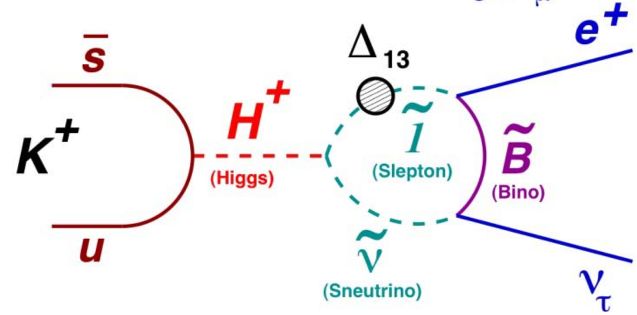
➔ 2 Higgs Doublets Model (A. Masiero, P. Parisi, R. Petronzio, PRD74 (2006) 011701, JHEP 0811 (2008) 042)

2HDM – tree level: K_{l2} proceeds via exchange of sizeable charged Higgs $H^\pm$ instead of $W^\pm$



2HDM – one-loop level: $H^\pm$ mediated LFV terms with emission of ν_τ are the dominant contribution to ΔR_K

$$R_K^{LFV} \approx R_K^{SM}\left[1+\left(\frac{m_K^4}{m_{H^\pm}^4}\right)\left(\frac{m_\tau^2}{m_e^2}\right)|\Delta_{13}|^2 \tan^6\beta\right]$$



Δ_{13} ➔ mixing parameter of superpartners of right-handed leptons

➔ LFV term connected to Helicity suppression in K_{e2}

$\tan\beta$ ➔ ratio of the two Higgs vacuum expectation values

At large $\tan\beta$ values with a massive $H^\pm$, LFV contributions dominate and produce sizable (O(1%)) effects to R_K

(Ex.: $\Delta_{31}=5\times10^{-4}$, $\tan\beta=40$ and $M_H=500$ GeV/c^2 ➔ $R_K^{LFV} = R_K^{SM}(1+0.013)$)

Experimental Status of R_K

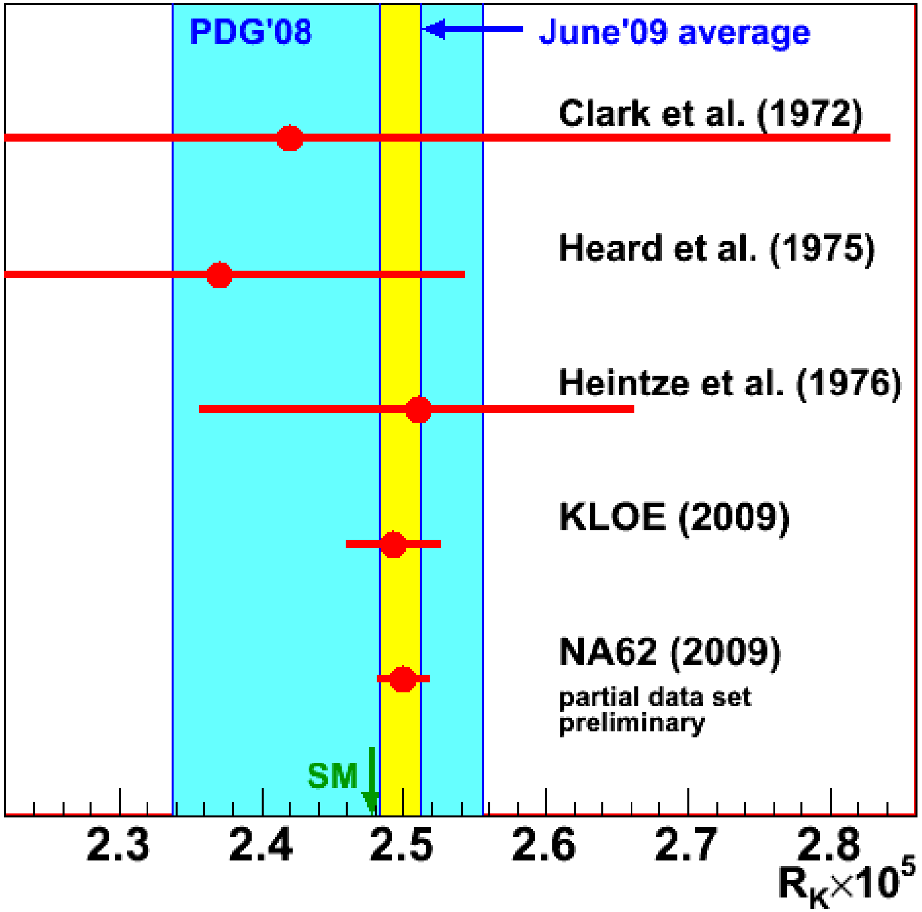
PDG'08 (1970s measurements):
$R_K=(2.45\pm0.11)\times10^{-5}$ ($\delta R_K/R_K=4.5\%$)

NA48/II (CERN) ➔ $\delta R_K/R_K \cong 2\%$ (2006)

New recent measurements:

2009: KLOE (LNF), 2001–05 data (final), 13.8K K_{e2} candidates, 15% background:
$R_K=(2.493\pm0.031)\times10^{-5}$ ($\delta R_K/R_K=1.3\%$)
(EPJ C64 (2009) 627)

2009: NA62 (CERN), 40% of 2007 data, 51.1K K_{e2} candidates, 9% background (preliminary result, Kaon'09):
$R_K=(2.500\pm0.016)\times10^{-5}$ $\delta R_K/R_K=0.7\%$.
(arXiv:0908.3858, 1005.1192)



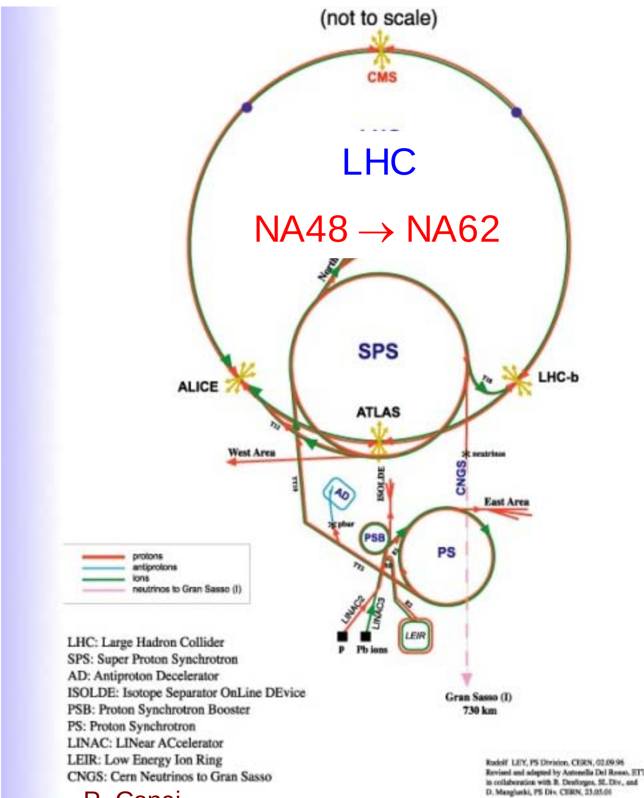
Now: NA62 final result (CERN-PH-EP-2011-004, arXiv:1101.4805)
same data set: ≈60K K_{e2} candidates ➔ $\delta R_K/R_K=0.5\%$

The NA62 experiment at CERN

CERN Accelerator Complex

The SPS at CERN provides protons at 400 GeV/c using a multi-turn, fast and slow, extraction system

The SPS is used as well as injector for the LHC accelerator



NA62 phase I

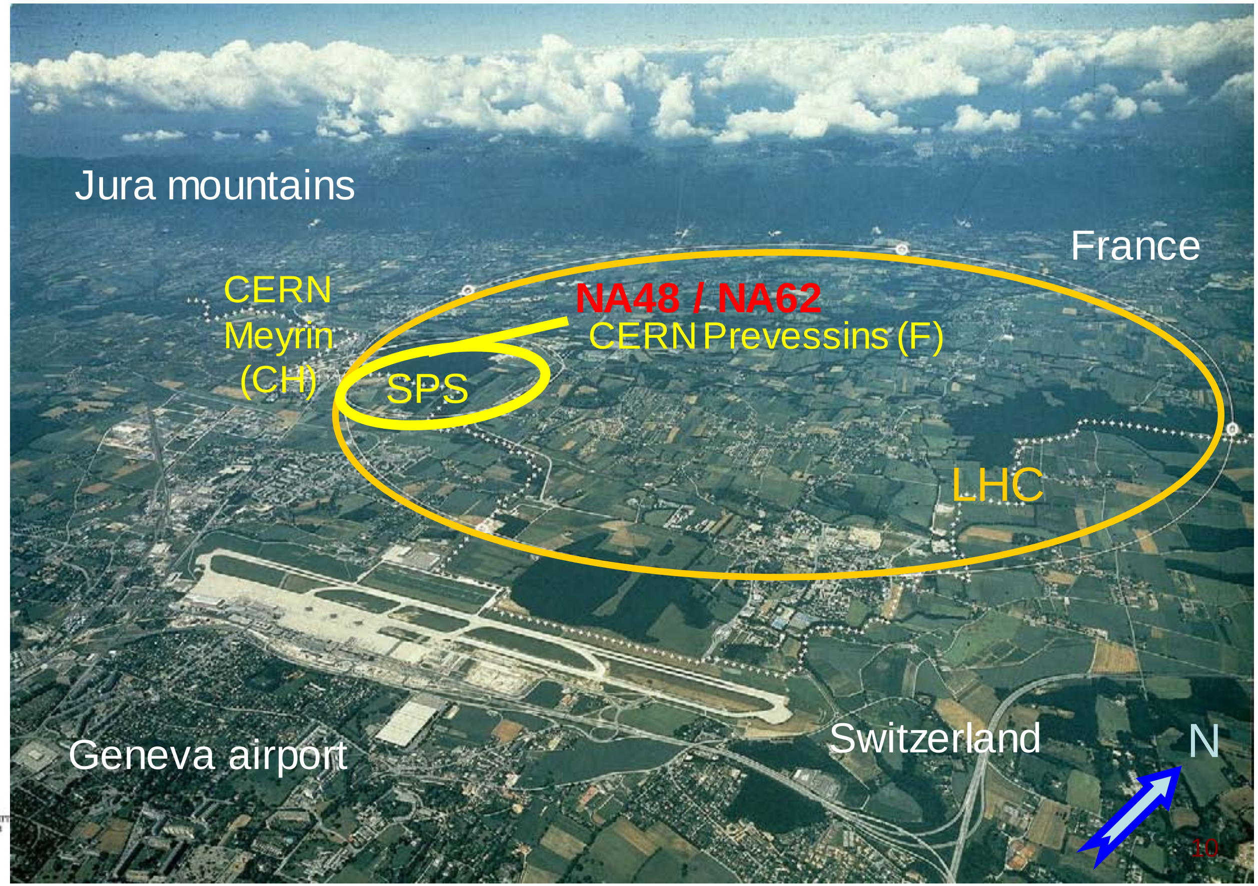
Measurement of R_K with a precision <1% (2007-08)

NA62 phase II

(G.Anzivino talk)

Measurement of the golden decay $K^+ \to \pi^+ \nu \bar{\nu}$ (first run: 2012)

The NA62 Collaboration (Phase I): *Birmingham, Bratislava, CERN, Dubna, Fairfax, Ferrara, Firenze, Frascati, Liverpool, Louvain, Mainz, Merced, Moskow, Napoli, Perugia, Pisa, Protvino, Roma I, Roma II, Saclay, San Luis Potosí, SLAC, Sofia, Torino, TRIUMF*



Running Conditions in 2007

Data taking conditions in 2007 optimized for a precision $K_{e2}/K_{\mu 2}$ measurement: a low intensity run with a minimum bias trigger

Primary SPS protons:
400 GeV/c
1.8×10^{12} p per SPS spill
(4.8 s / 14.4 or 16.8 s)

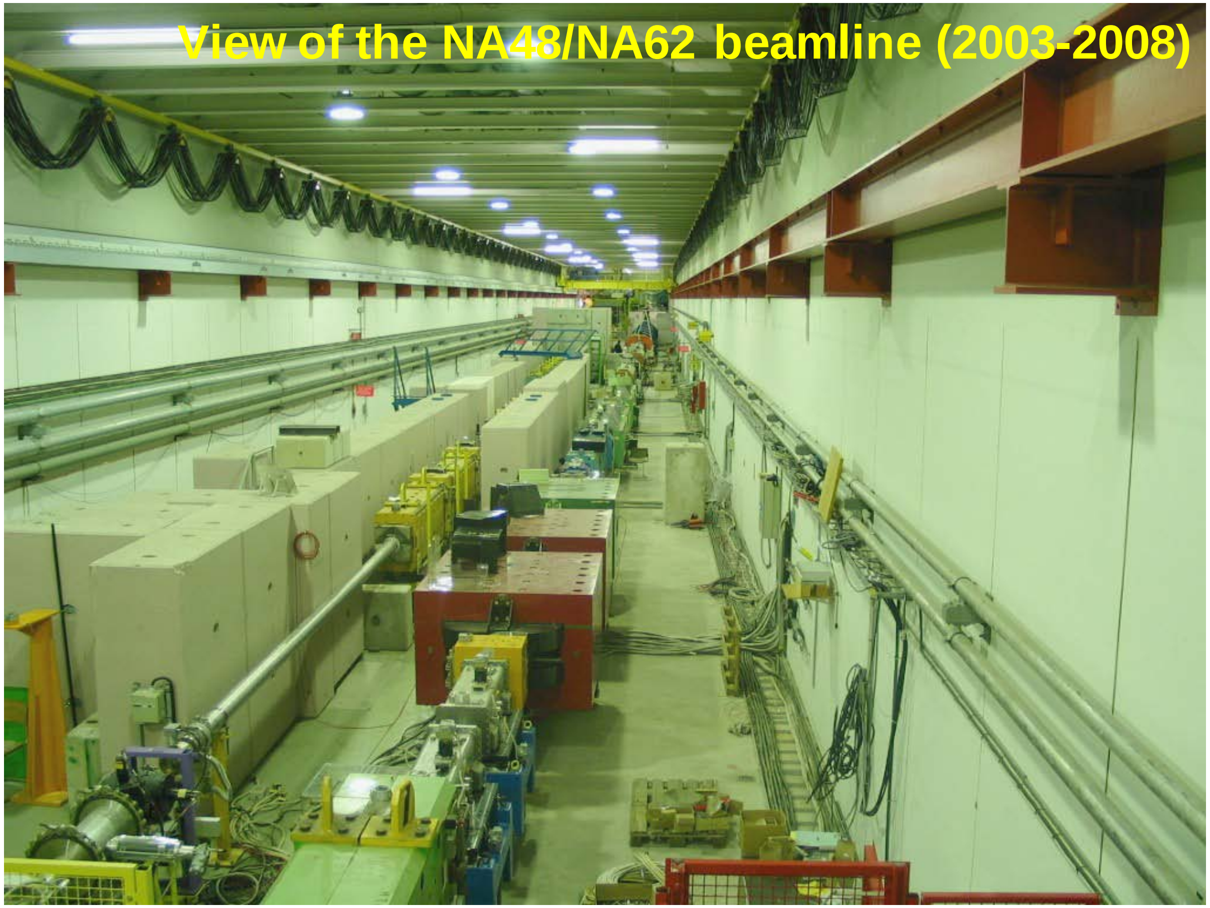
Unseparated secondary positive beam:
P = (74.0±1.4) GeV/c

Secondary beam flux:
2.5×10^{7} particles per SPS spill

Beam Composition:
$K^+(\pi^+)$ = 5%(63%);

Vacuum decay volume: 114m

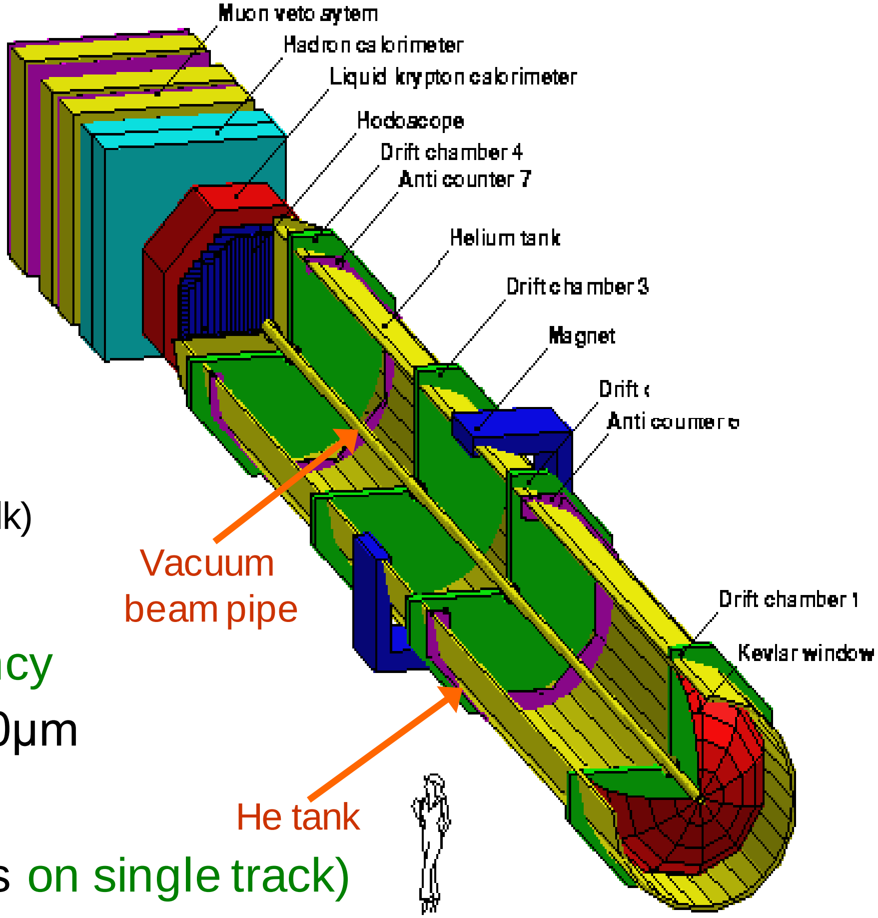
18% K^+ decays in vacuum tank at nominal momentum



The Data Taking for R_K

Running periods:

- 2007: 4 months (~400K SPS spills)
~300TB of raw data, ~90TB recorded;
- 2008 : 2 weeks
special data sets collected to optimize and reduce systematic uncertainties.



Detector: the NA48/II detector (M. Pepe talk)

Magnetic spectrometer

(4 DCHs, 4 view each): redundancy ⇒ efficiency

$\sigma(p)/p = 0.48\% + 0.009\%\ p\ [\mathrm{GeV}/c]$; $\sigma_{x,y} = 90\mu m$

Hodoscope

fast trigger and good time resolution (σ_t~200ps on single track)

Liquid Krypton calorimeter (LKr)

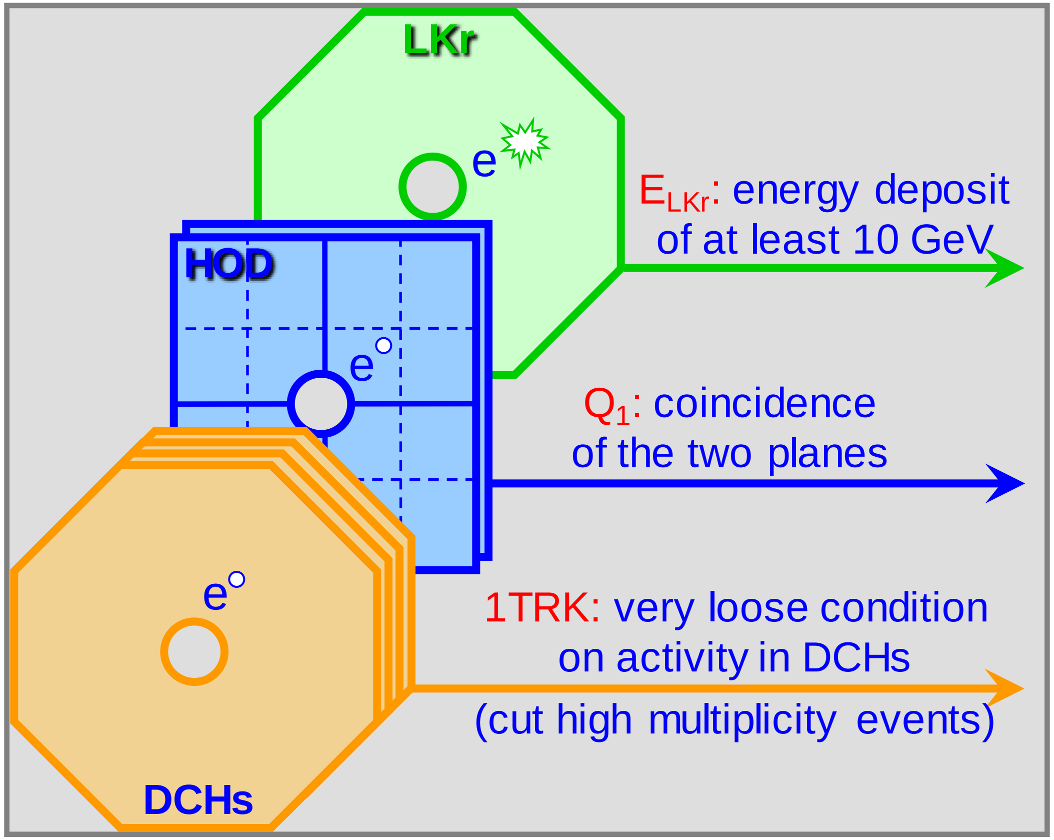
high granularity, quasi-homogeneous ⇒ γ veto

$\sigma(E)/E = 3.2\%/\sqrt{E} + 9\%/E + 0.42\%$ [GeV]; $\sigma_{x,y} = (0.42/\sqrt{E} + 0.6)$ mm

Decay volume is upstream

Trigger logic

NA62 trigger in 2007/08:



Minimum Bias trigger configuration used
(high efficiency, low purity)

K_{e2} condition: $Q_1 \times E_{LKr} \times 1TRK$
~10 Hz, purity ~10^{-5}

$K_{\mu 2}$ condition: $Q_1 \times 1TRK/D$
~0.5 MHz, dominated by beam halo muons, purity ~2%
downscaling D=150

Efficiency of K_{e2} trigger: check with $K_{\mu 2}$ & other control triggers

Different trigger conditions for signal and normalization samples

Analysis strategy

Count reconstructed $K_{e2}/K_{\mu2}$ candidates collected concurrently

- Fluxes cancel in the ratio: analysis does not rely on absolute K flux measurement
- Several systematic effects cancel at first order in the ratio
  (e.g. reconstruction/trigger efficiencies, time-dependent effects, beam simulation)

$$R_K = \frac{1}{D} \cdot \frac{N(K_{e2}) - N_B(K_{e2})}{N(K_{\mu2}) - N_B(K_{\mu2})} \cdot \frac{A(K_{\mu2}) \times f_\mu \times \varepsilon(K_{\mu2})}{A(K_{e2}) \times f_e \times \varepsilon(K_{e2})} \cdot \frac{1}{f_{LKr}}$$

$N(K_{e2}), N(K_{\mu2})$:	numbers of selected K_{l2} candidates
$N_B(K_{e2}), N_B(K_{\mu2})$:	numbers of background events;
$A(K_{e2}), A(K_{\mu2})$:	geometric acceptances (MC, no ID);
f_e, f_μ:	particle ID efficiency (measured, no MC);
$\varepsilon(K_{e2})/\varepsilon(K_{\mu2})$:	trigger efficiency;
f_{LKr}:	global LKr readout efficiency (only K_{e2});
D:	downscaling factor of the $K_{\mu2}$ trigger (D=150).

$N_B(K_{e2})$: the **main source of systematic errors** comes from K_{e2} background subtraction

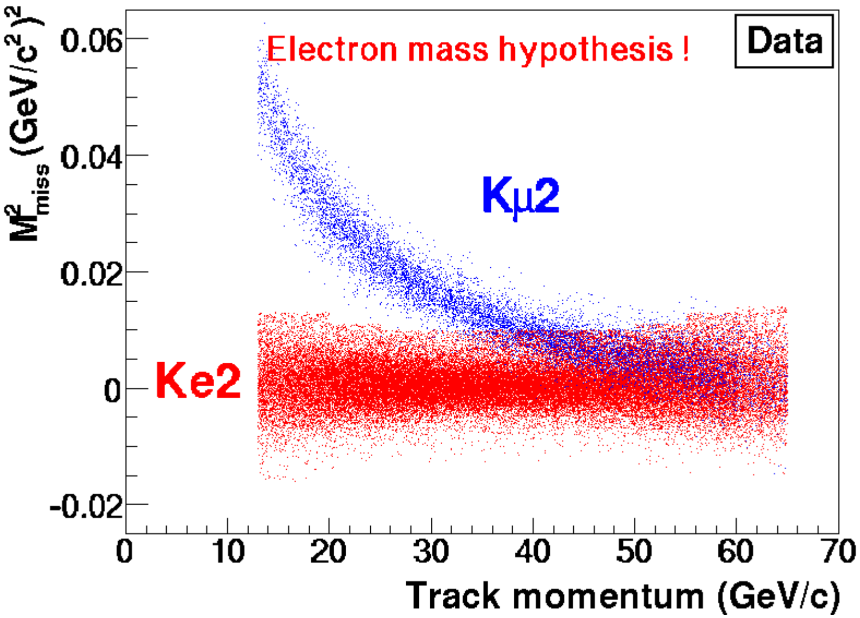
➔ count of events done independently in 10 lepton momentum bins
(owing to strong dependence of backgrounds and acceptance on lepton momentum)

- MC simulations used for the geometric acceptance correction
- PID, trigger, readout efficiencies are measured directly from data

K_{e2} and $K_{\mu 2}$ event selections

Large common part (similar topologies):

- one reconstructed track (lepton candidate);
- geometrical acceptance cuts;
- K decay vertex: closest approach between lepton track & nominal kaon axis;
- veto extra LKr energy deposition clusters;
- track momentum: 13GeV/c < p < 65GeV/c.



Kinematic identification: **M_{miss}^2 vs p_l**

Missing mass **$M_{miss}^2 = (p_K - p_l)^2$**

p_K: average value measured with $K_{3\pi}$ decays

→ $K_{e2}/K_{\mu 2}$ samples separation at p_{track} < 25 GeV/c

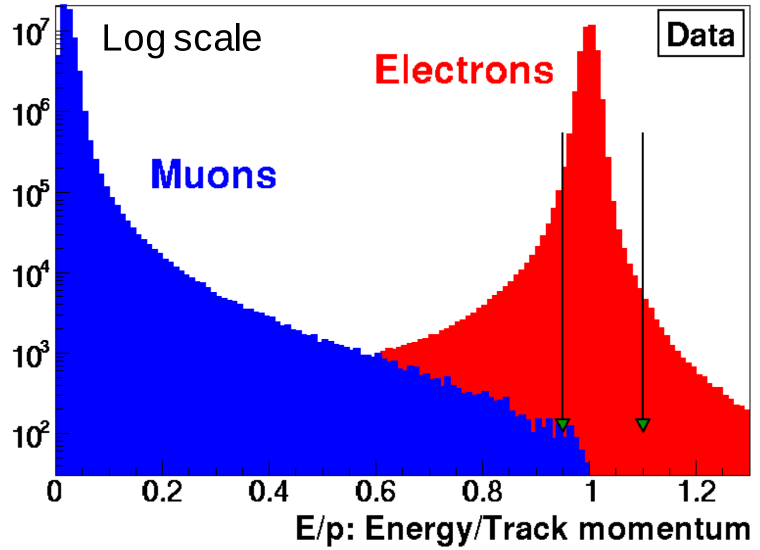
Particle ID: **E/p**

E/p = LKr energy/track momentum

(0.90 to 0.95) < E/p < 1.10 for **electrons**

E/p < 0.85 for **muons**

→ Powerful $\mu^{\pm}$ suppression in $e^{\pm}$ sample (~10^6)



Background to the K_{e2} sample

- $K^+ \to \mu^+ \nu$ with a μ^+ mis-identified as a e^+
  - *μ bremsstrahlung* ← **MAIN CONTRIBUTION**
  - *$\mu \to e$ decay in flight*
- $K^+ \to e^+ \nu \gamma$, SD+ component
- Beam halo muons
- $K^+ \to \pi^0 e^+ \nu$ with a non-identified π^0
- $K^+ \to \pi^+ \pi^0$ with a π^+ mis-identified as e^+ or followed by a Dalitz decay $\pi^0 \to ee\gamma$

Lower contributions:
B/(S+B) < per-mille

- After the events selection:
  - **≈60k K_{e2}** candidates
  - **≈18M $K_{\mu 2}$** candidates (beam halo μ: only background)

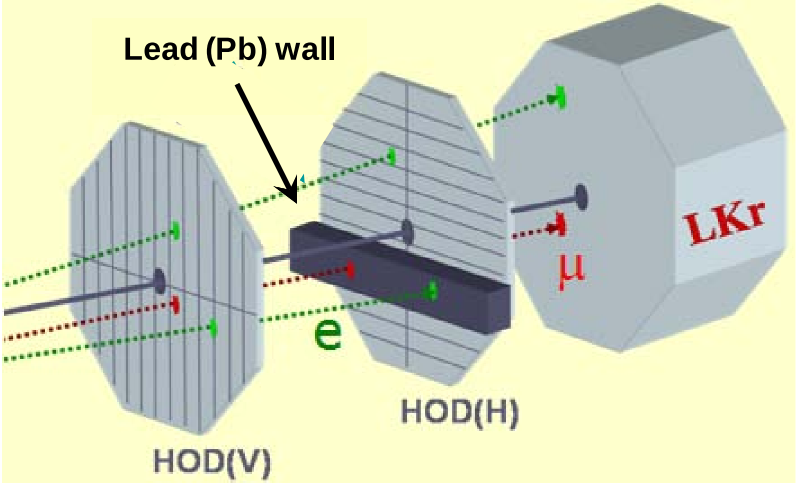
$K_{\mu 2}$ background in K_{e2} sample

The main systematics to R_K is due to $K_{\mu 2}$ background subtraction

Main background: muon bremsstrahlung

➔ high momentum μ^+ from $K_{\mu 2}$ are mis-identified as e^+ due to the emission of energetic photons: "catastrophic" energy loss in LKr associated to a μ track

Probabiliy $P_{\mu e} \sim 3\times10^{-6}$ (p-dependent)



Direct measurement of $P_{\mu e}$: dedicated $K^{\pm}$ run

➔ use a Pb wall in front of LKr to convert γ

➔ suppress high momentum e^+ due to $\mu\rightarrow e$ decays in flight (contamination $<10^{-8}$)

Thickness:	$9{,}2X_0$ (Pb+Fe)
Width:	240cm (=HOD size)
Height:	18cm (=3 counters)
Area:	~20% of HOD area
Duration:	~50% of R_K runs + special muon runs

$P_{\mu e}$ value corrected for:

→ μ ionization losses in Pb (low p)

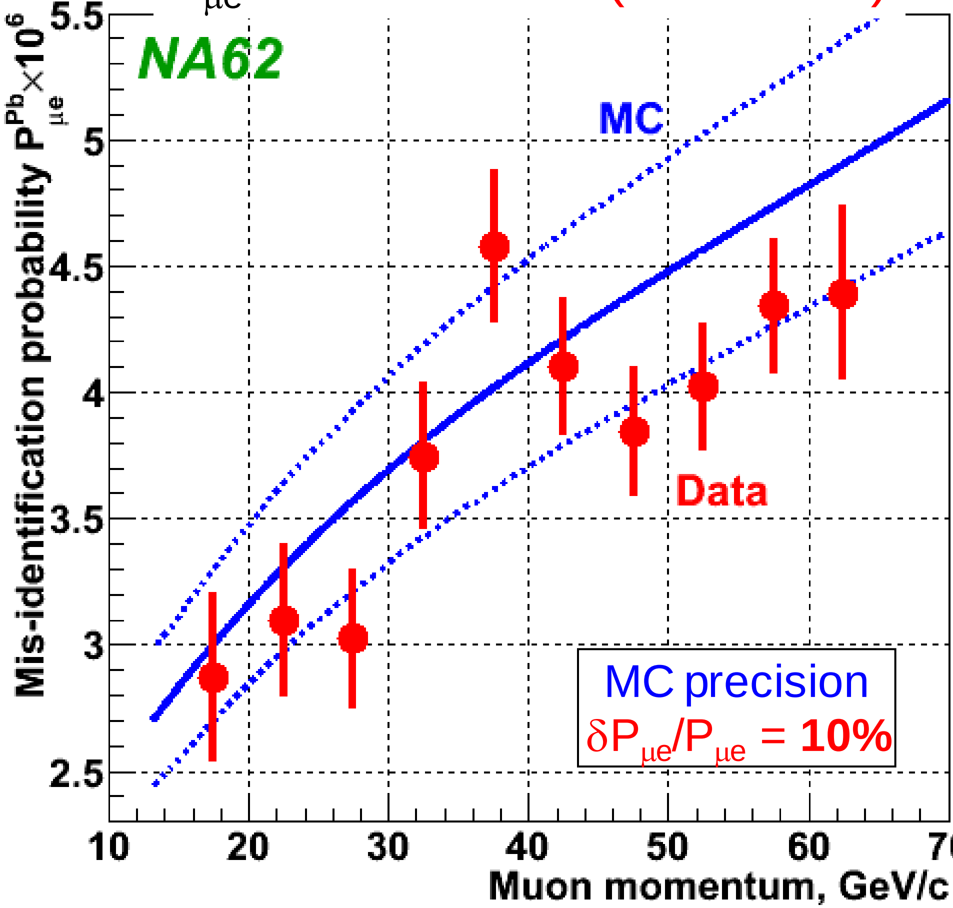
→ μ bremsstrahlung in Pb (high p)

Correction factor $f_{Pb}=P_{\mu e}/P_{\mu e}^{Pb}$ evaluated with a dedicated Geant4-based simulation

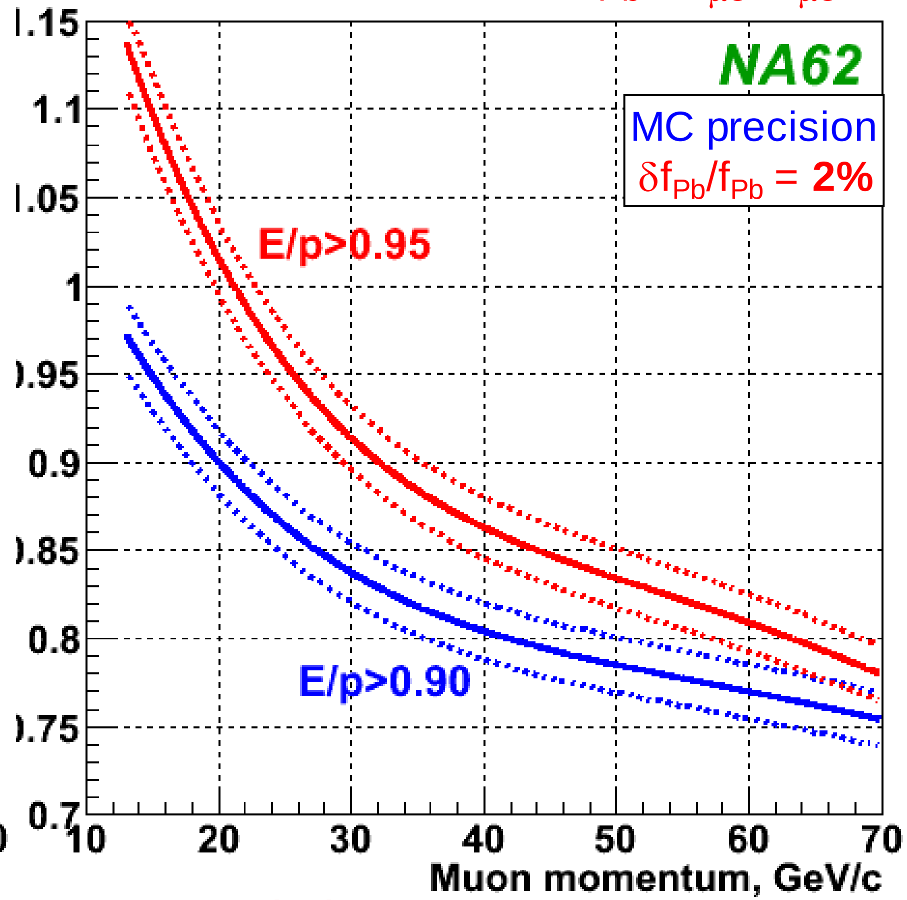
[Muon bremsttranlung: Phys. Atom. Nucl. 60 (1997) 576]

Muon mis-identification

$P_{\mu e}$ vs (Pb wall on)



Correction for Pb wall: $f_{Pb}=P_{\mu e}/P_{\mu e}^{Pb}$



Result: B/(S+B) = (6.11±0.22)%

N.B.: uncertainty is ~3 times smaller than the one obtained from simulation only

Uncertainties:

- Limited data sample (0.16%)
- MC correction (0.12%)
- M^2_{miss} vs P_{track} correlation (0.08%)

$K_{\mu 2}$ with $\mu \to e$ decay in flight

A huge background component, given the NA62 2007 run conditions, is, in principle, due to $\mu \to e$ decay in flight:

$N(K_{\mu 2}, \mu \to e \text{ decay})/N(K_{e2}) \sim 10$

This component is easly reduced, since muons from $K_{\mu 2}$ are fully polarized

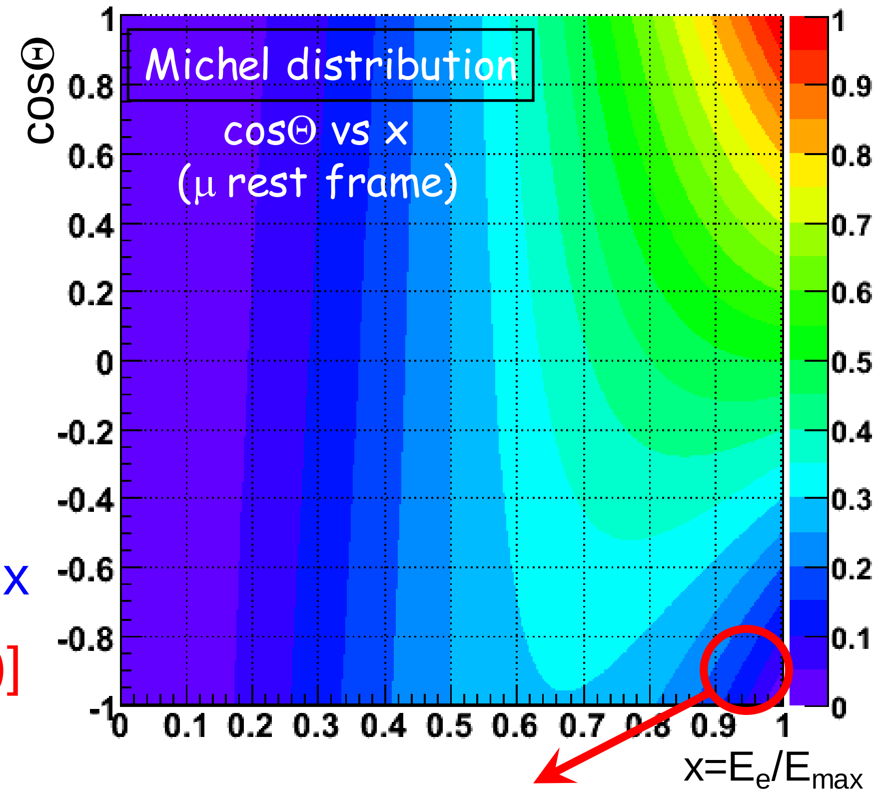
➔ **Michel electron distribution:** $\cos\Theta$ vs x

$$d^2\Gamma/(dx\, d(\cos\Theta)) \sim x^2[(3-2x)-\cos\Theta(1-2x)]$$

$$x = E_e/E_{max} \approx 2E_e/M_\mu$$

Θ: angle between p_e and the muon spin (all quantities defined in muon rest frame)

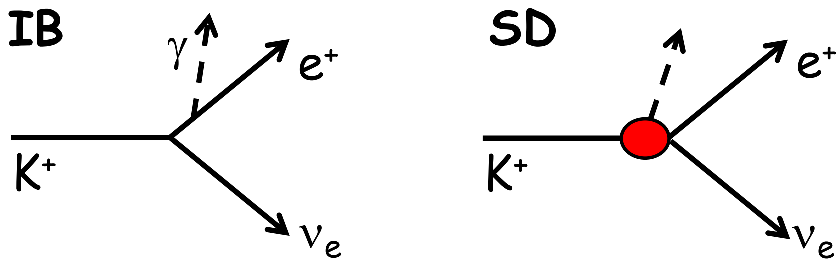
Result:
$B/(S+B) = (0.27 \pm 0.04)\%$



➔ Energetic forward positrons from $\mu \to e$ decay in flight are naturally suppressed by the muon polarisation
➔ Radiative corrections provide a further ~10% suppression

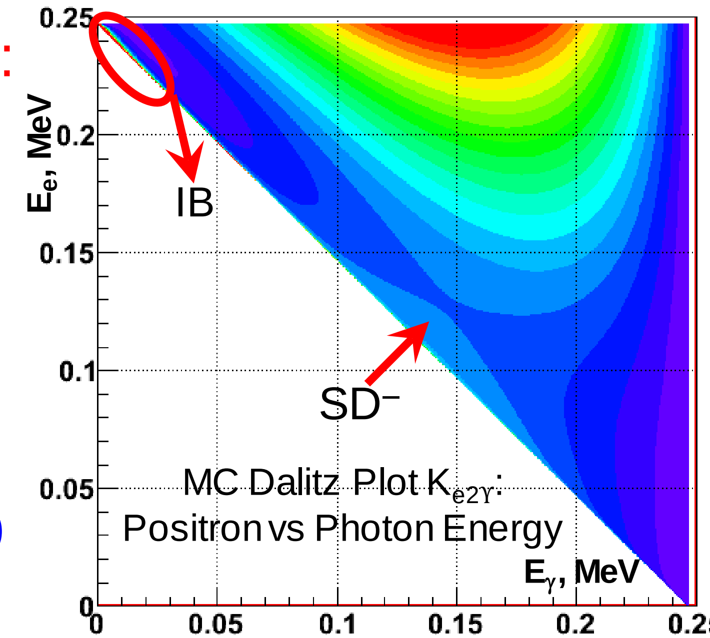
Radiative $K^+ \to e^+\nu\gamma$ process

R_K includes only IB radiation by definition:



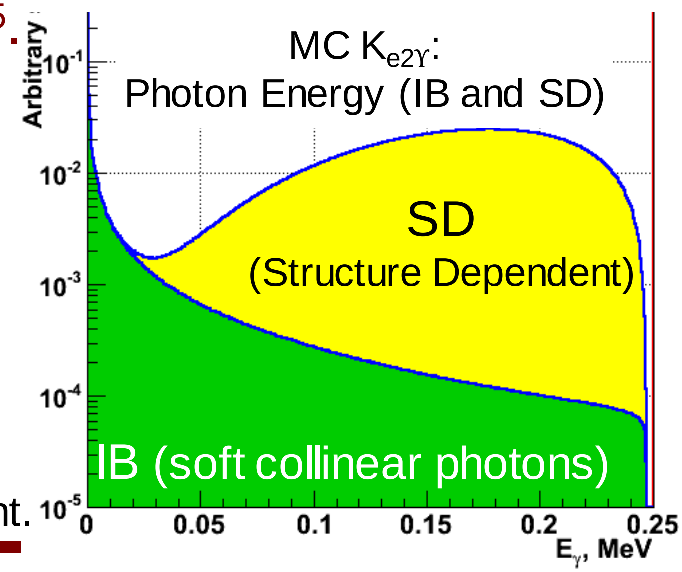
➔ SD radiation is non helicity suppressed

➔ SD+ component is a background source (lower contribution from SD-, negligible from Interference)



Present measurement: (KLOE: EPJ C64 (2009), EPJ C65 (2010))

BR(SD+, full phase space) = $(1.37\pm0.06)\times10^{-5}$.



SD+ background contamination:
B/(S+B) = $(1.07\pm0.05)\%$

➔ Uncertainty due to BR(SD+) measurement precision: use a conservative value ($3\times\delta BR_{KLOE}$) to accommodate the observed R_K variation w.r.t. LKr veto selection condition;
a new $K_{e2\gamma}$ (SD+) measurement is being performed by NA62: expected ×3 precision w.r.t. the present measurement.

Beam halo background

Electrons produced by beam halo muons via $\mu \rightarrow e$ decay can be kinematically and geometrically compatible with genuine K_{e2} decays

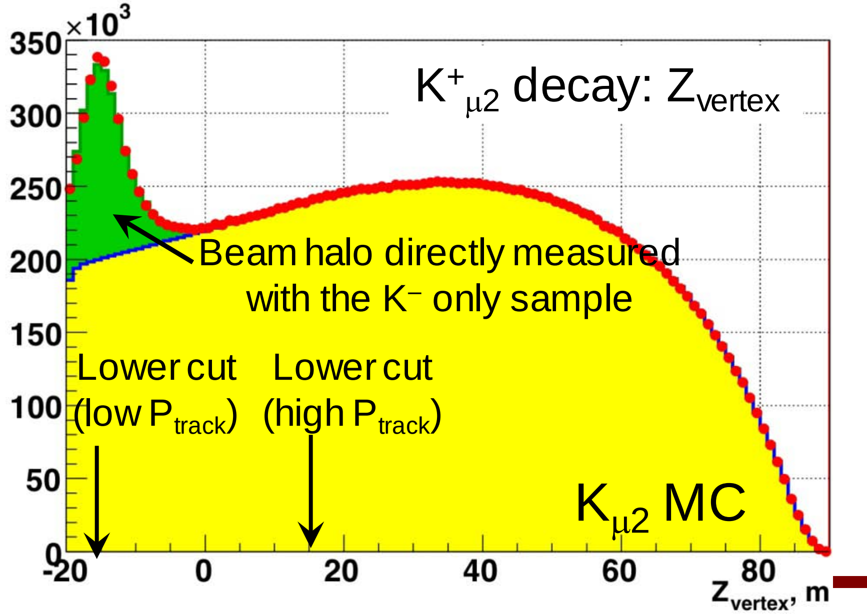
Measurement of the background due to beam halo muons: control samples

- ➔ Halo background is much higher for K^{-}_{e2} (~20%) than for K^{+}_{e2} (~1%).
- ➔ Halo background in the $K_{\mu 2}$ sample is considerably lower.
- ➔ Collected data samples: ~80% is K^{+} only, ~20% is K^{-} only.
- ➔ K^{+} halo component is measured directly with the K^{-} sample (and viceversa).
- ➔ Halo background strongly depends on decay vertex position and track momentum.
- ➔ The selection criteria (i.e. Z_{vertex}) are optimized to minimize the halo background.

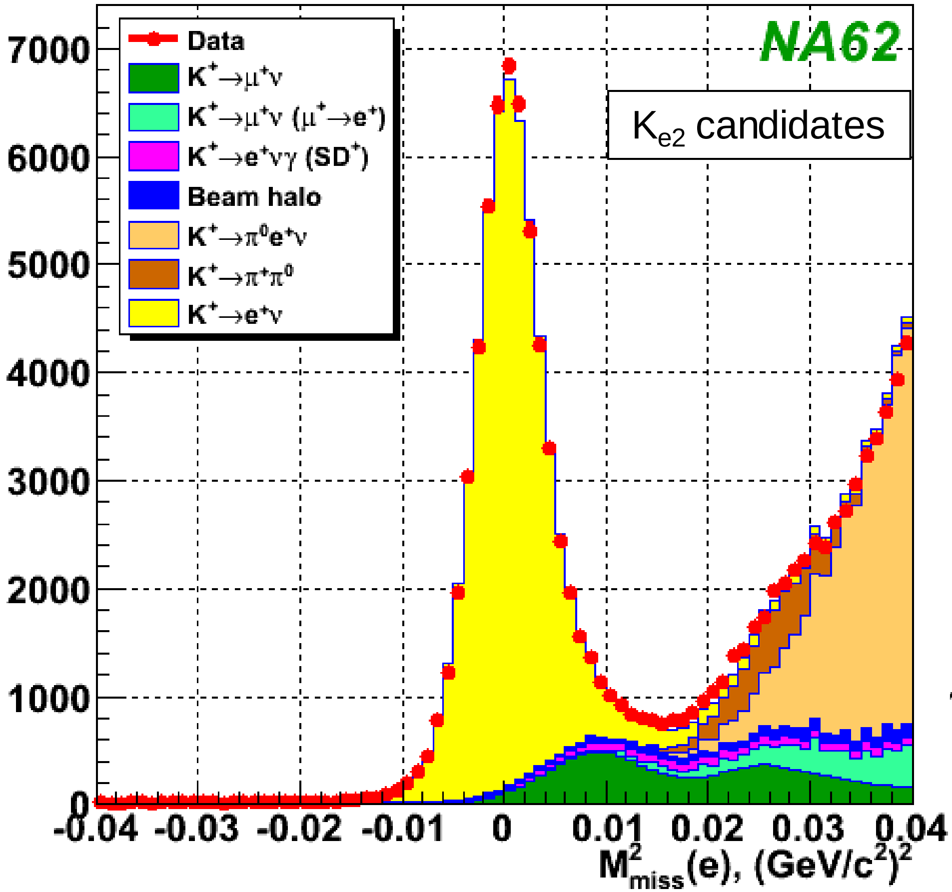
A sub-permille precision is achieved in the measurement of halo background:

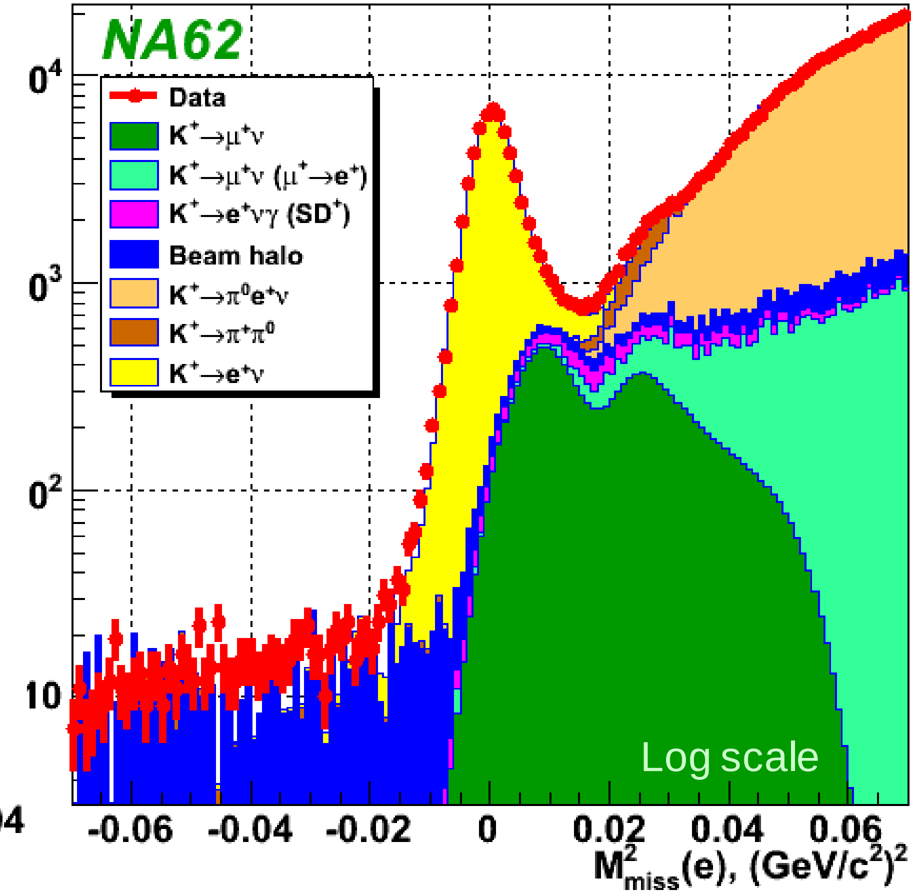
Result:
$B/(S+B) = (1.16 \pm 0.06)\%$

Uncertainty due to:
1) limited size of control sample;
2) π, K decays upstream vacuum tank.



K_{e2}: partial (40%) data set





59813 $K^+\to e^+\nu$ candidates

Positron ID efficiency: (99.27±0.05)%

B/(S+B) = (8.71±0.24)%

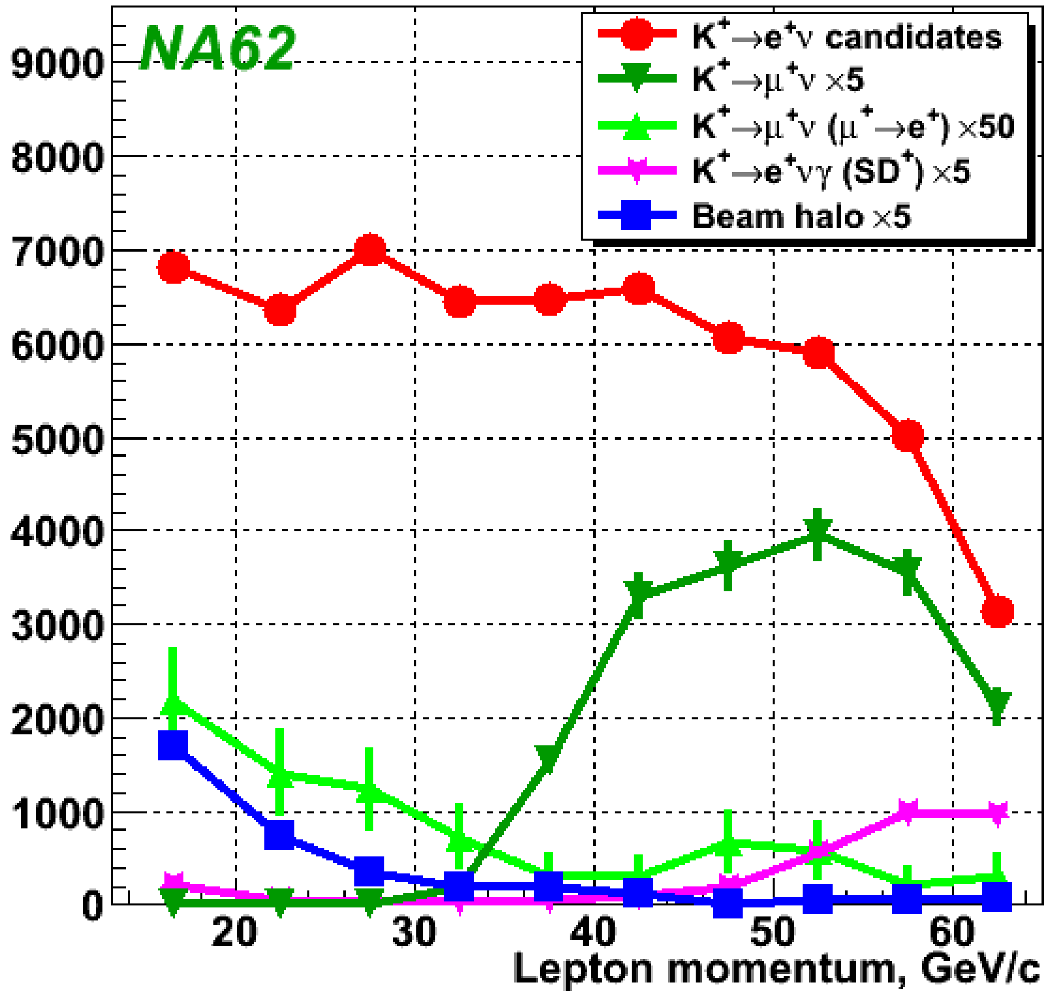
NA62 estimated total K_{e2} sample:

~120K K^+ & ~30K K^- candidates

Proposal (CERN-SPSC-2006-033): 150K candidates

Background events: summary

K_{e2} candidates and backgrounds in momentum bins



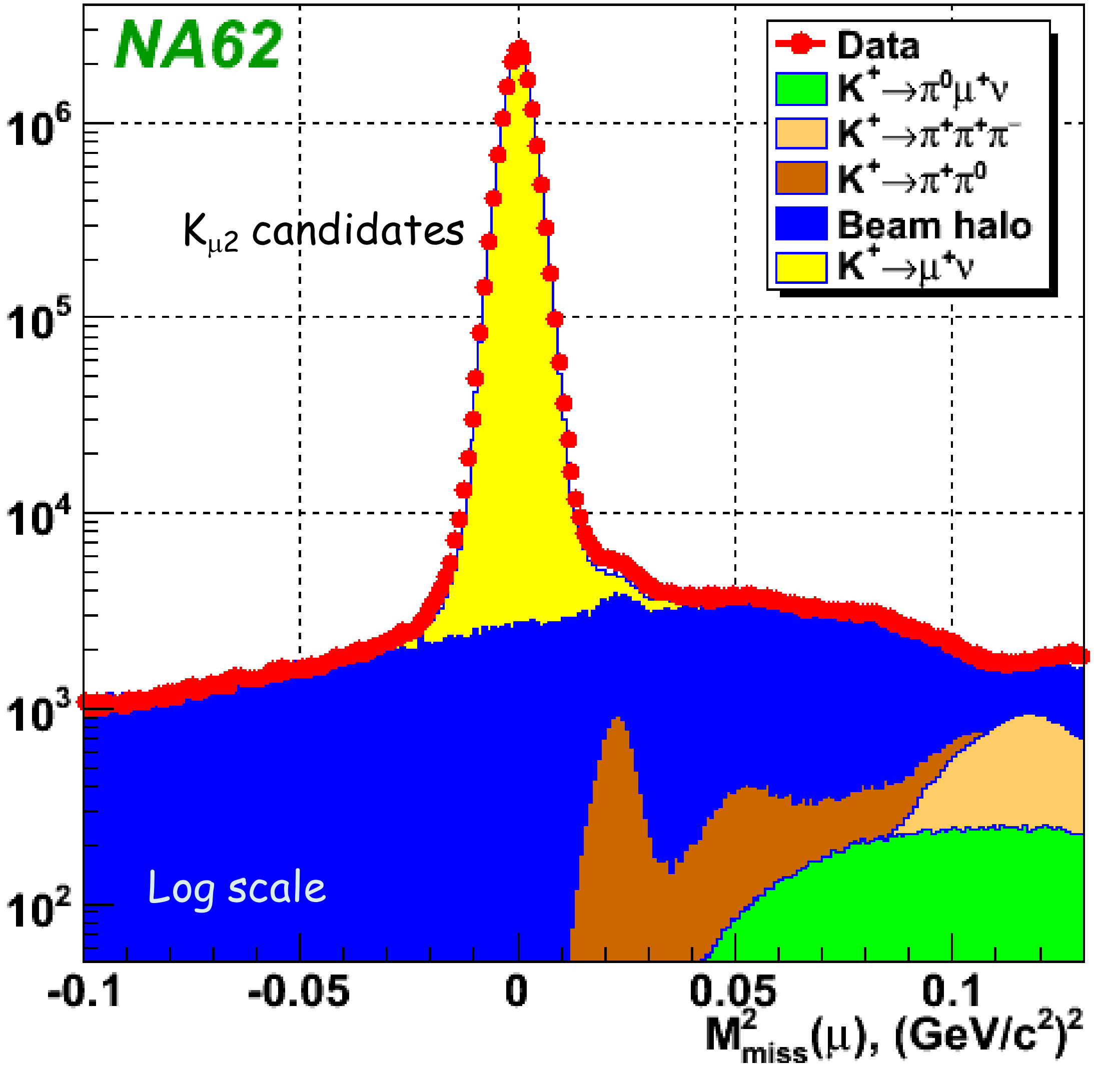
Lepton momentum bins are differently affected by backgrounds and thus the systematic uncertainties.

Background

Source	B/(S+B)
$K_{\mu2}$	$(6.11\pm0.22)\%$
$K_{\mu2}$ ($\mu\rightarrow e$)	$(0.27\pm0.04)\%$
$K_{e2\gamma}$ (SD^+)	$(1.07\pm0.05)\%$
Beam halo	$(1.16\pm0.06)\%$
$K_{e3(D)}$	$(0.05\pm0.03)\%$
$K_{2\pi(D)}$	$(0.05\pm0.03)\%$
Total	$(8.71\pm0.24)\%$

Selection criteria are individually optimized in each P_{lepton} bin

$K_{\mu 2}$: partial (40%) data set



The $K_{\mu 2}$ trigger was pre-scaled by D=150

Beam Halo:

- only significant background source in the $K_{\mu 2}$ sample, mainly at low μ momentum;
- same technique as K_{e2} is used for the measurement:

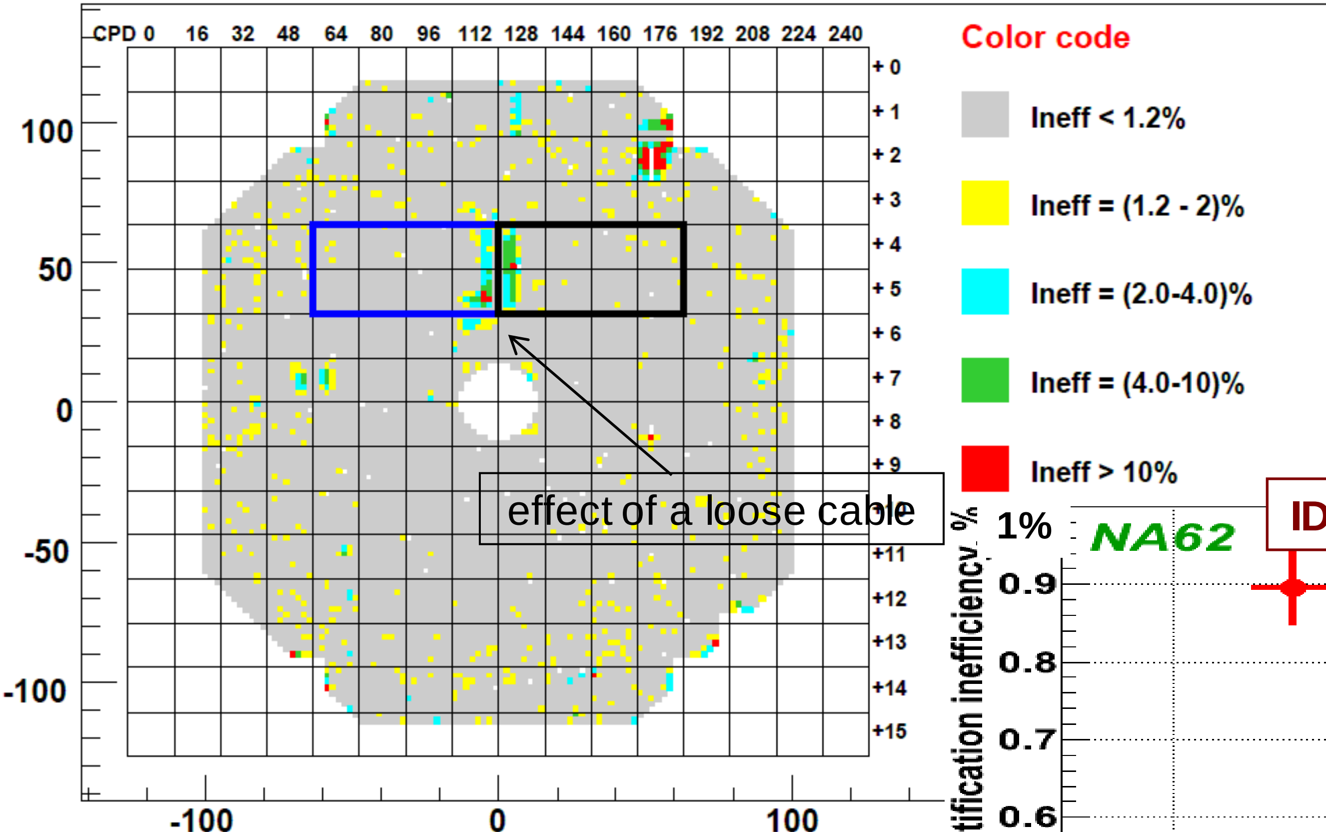
Background

Source	B/(S+B)
Beam halo	(0.38±0.01)%
Total	(0.38±0.01)%

1.803×10^7 $K_{\mu 2}$ candidates
with low background
B/(S+B) = 0.38%

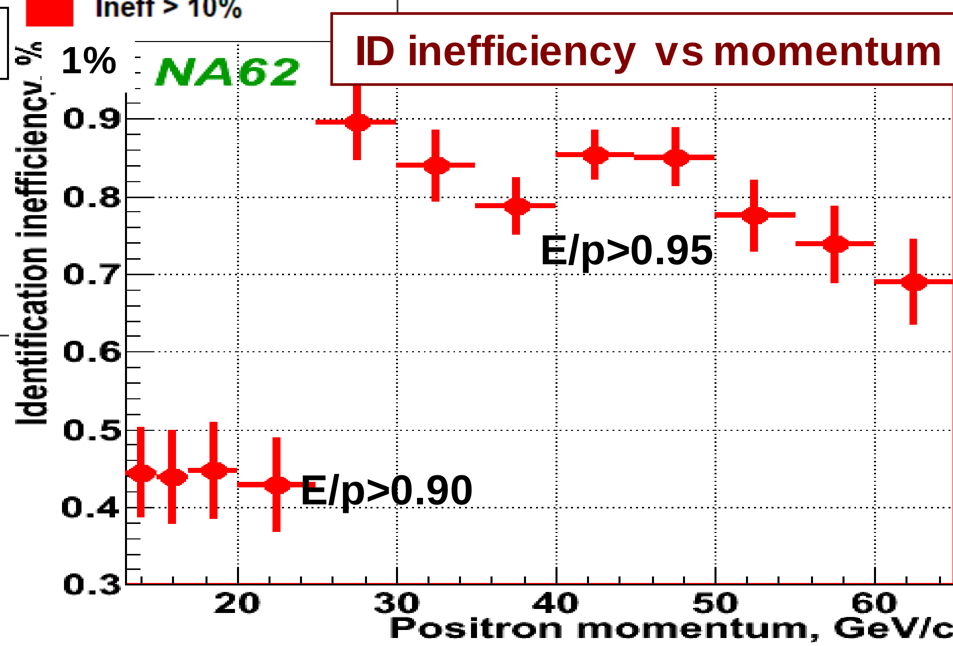
Systematic effect: positron ID

A typical LKr inefficiency map:



Positron ID efficiency:
measured with e^+ from $K^+ \to \pi e \nu$ and $K_L \to \pi e \nu$ samples (special runs) in lepton momentum bins

Average efficiency: (99.27±0.05)%



- LKr energy response is calibrated in every 2×2 cm² cell within acceptance;
- Global LKr readout efficiency measured with an independent readout system:

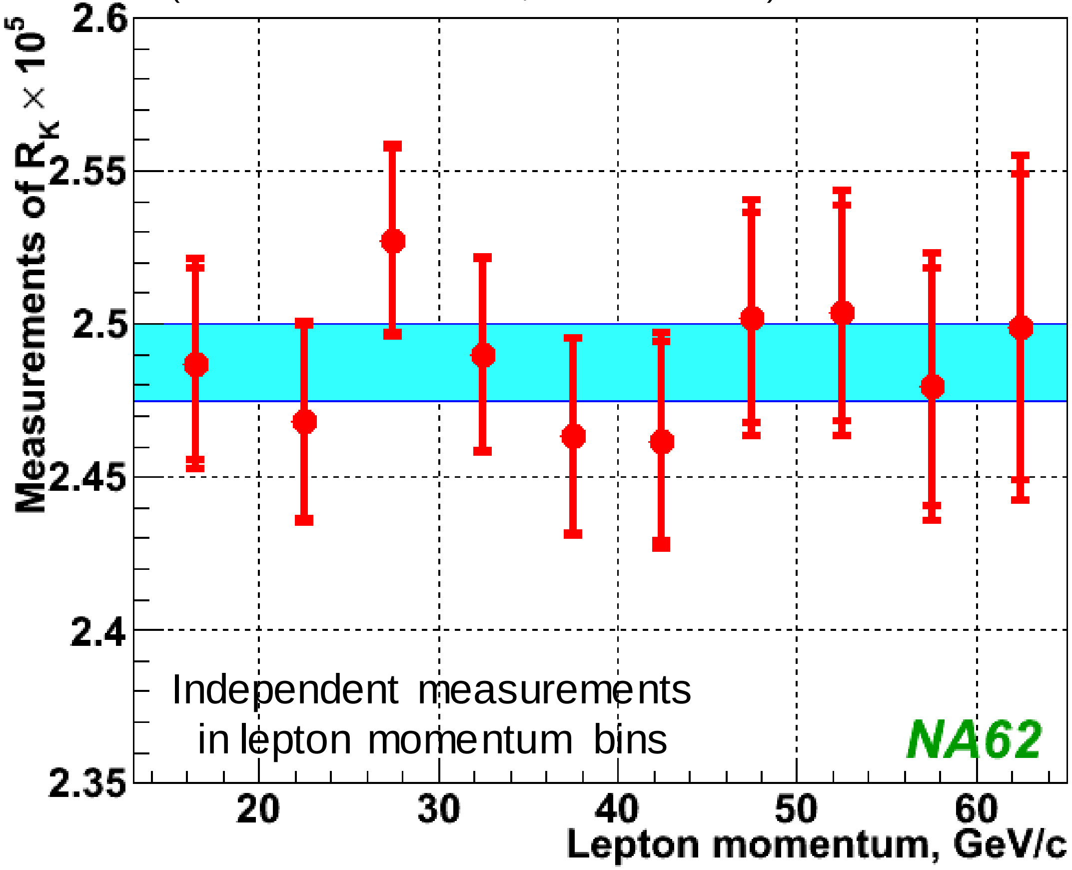
f_{LKr} = (99.80±0.03)%

NA62 final result (40% data set)

$$R_K = (2.487 \pm 0.011_{stat} \pm 0.007_{syst}) \times 10^{-5}$$

$$R_K = (2.487 \pm 0.013) \times 10^{-5}$$

(CERN-PH-EP-2011-004, arXiv:1101.4805)



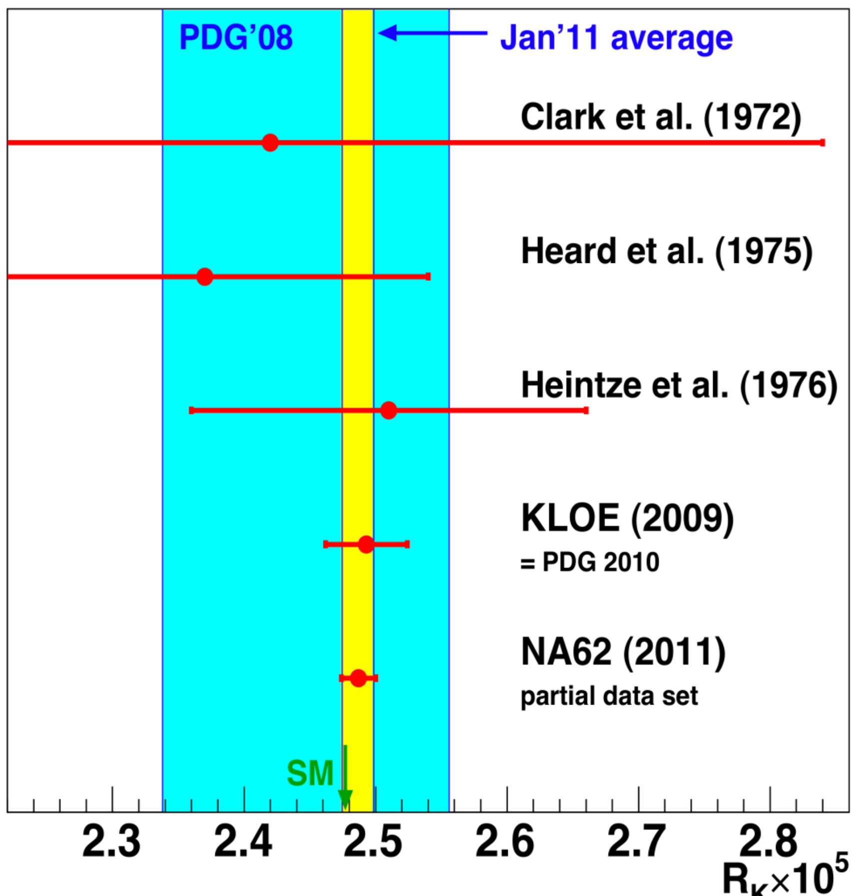
Systematic errors included, partially correlated

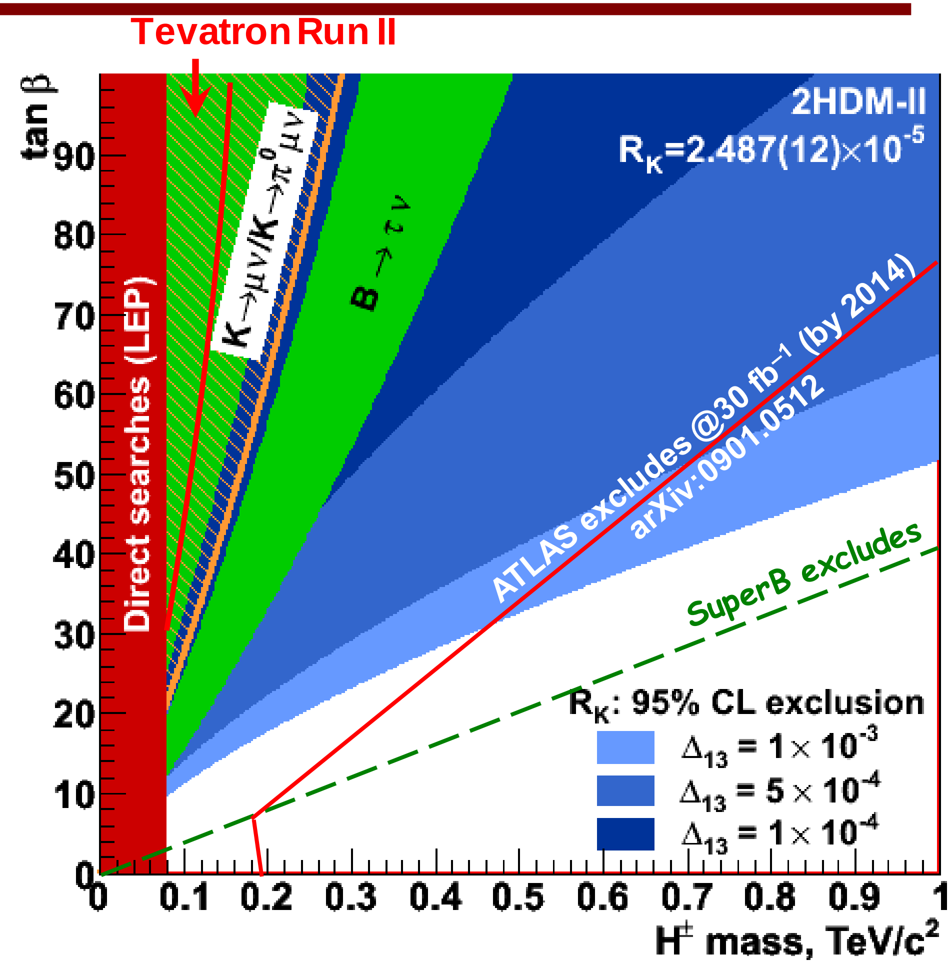
Uncertainties: (0.52% precision)

Source	$\delta R_K \times 10^5$
Statistical	0.011
$K_{\mu 2}$	0.005
$BR(K_{e2\gamma}\ SD^+)$	0.001
Beam halo	0.001
Helium purity	0.003
Acceptance correction	0.002
DCH alignment	0.001
Positron ID	0.001
LKr readout ineff.	0.001
1-track trigger	0.002
Total	**0.013**

Preliminary result: $R_K=2.500(16)\times10^{-5}$
Shift due to multi-photon corrections to the $K_{e2\gamma}$ (IB) decay.

R_K: the new World Average





World average	$\delta R_K\times10^5$	Precision
March 2009	2.467±0.024	0.97%
January 2011	2.487±0.012	0.48%

For non-tiny values of the LFV slepton mixing Δ_{13}, the sensitivity to $H^\pm$ in $R_K=K_{e2}/K_{\mu2}$ is better than in $B\to\tau\nu$

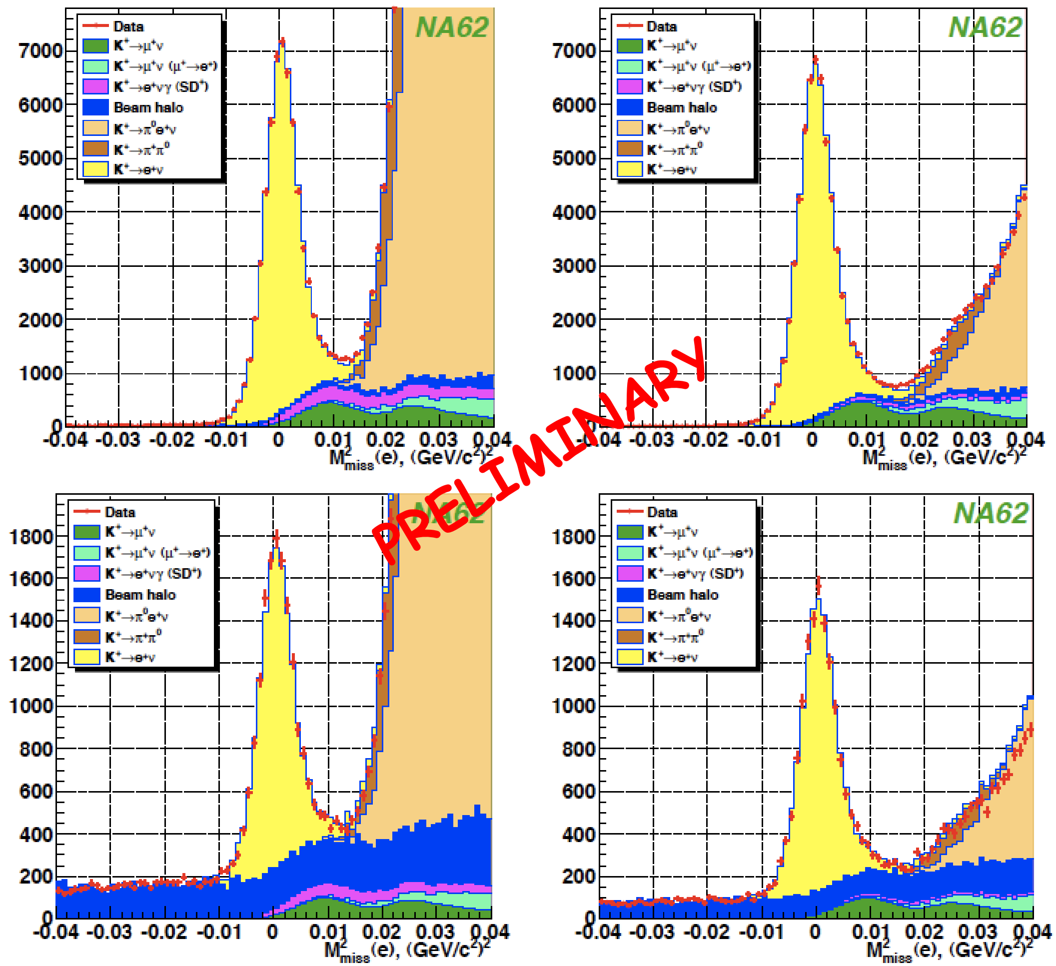
Outlook: the 2007 K_{e2} samples

NA62 data/MC comparison of the squared missing mass spectra [$M_{miss}^2 = (p_K - p_l)^2$] for the 4 samples of 2007 data, showing the differences in background conditions

PRELIMINARY (CERN-SPSC-2010-032; SPSC-SR-071; A. Ceccucci, 09.11.2010)

K⁺, Pb
≈62k K_{e2} candidates

K⁺, no Pb
≈60k K_{e2} candidates



K⁻, Pb
≈18k K_{e2} candidates

K⁻, no Pb
≈15k K_{e2} candidates

Outlook: 2007 data beyond R_K

NA62 analysis going on:

- $K_{e2\gamma}$: measurement of BR(SD$^+$), ×3 precision w.r.t. the present value;
- K^+_{e3}: rates and form factors;
- $K^\pm_{\pi\gamma\gamma}$ radiative decays.

A possible new analysis (to be evaluated yet):

- Search for a **sterile neutrino** ν_h in $K^+_{\mu 2}$ decays (M=50-350 MeV/c^2)
  - suggested by S.N. Gninenko, arXiv:1009.553 (19 January 2011):
    - attempt to reconcile puzzling neutrino oscillation results from LSND, KARMEN and MiniBooNE experiments
  - $K^+ \to \mu\nu_h$ signature: peak in the μ energy distribution (below that expected from ordinary $K_{\mu 2}$ decays) and/or in the missing mass spectra
  - Present limits come from stopped kaon experiment, better backgroud control from K decay in flight experiments
  - NA62 proposed as a good possibility for this search

Summary

Leptonic meson decays and their ratios are well-suited for stringent tests of the Standard Model.

$R_K=K_{e2}/K_{\mu 2}$ is sensitive to Lepton Flavour Violation in SUSY multi-Higgs models.

The NA62 data taking in 2007/08 was optimized for the R_K measurement.

The total NA62 K_{e2} sample is ~10 times the world sample, with excellent $K_{e2}/K_{\mu 2}$ separation (99.3% electron ID efficiency, 6% $K_{\mu 2}$ background)

A precision of 0.52% has been achieved on R_K the measurement by the NA62 experiment (phase I) at CERN, based on ~60k K_{e2} events (~40% of the total sample) and compatible with the SM predictions:

$$R_K = (2.487\pm0.013)\times10^{-5}$$

Future improvements on R_K:

1) the full 2007/08 data sample collected by NA62: $\delta R_K/R_K<0.4\%$
2) NA62 phase II (2012–2015), aiming at ~0.2% precision.