

Measurement of $R_K = \text{BR}(K \rightarrow e\nu) / \text{BR}(K \rightarrow \mu\nu)$ in the NA62 Experiment at CERN

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 **INFN, Perugia (Italy)**

WIN'11

23rd International Workshop on
WEAK INTERACTIONS AND NEUTRINOS

Cape Town (South Africa)
January 31 – February 5 2011



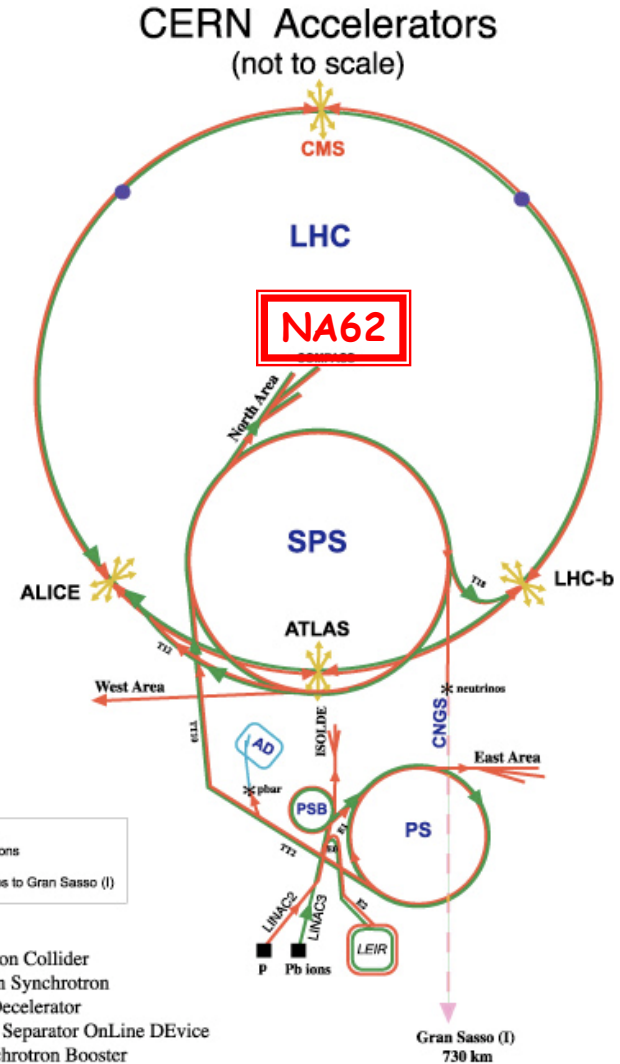
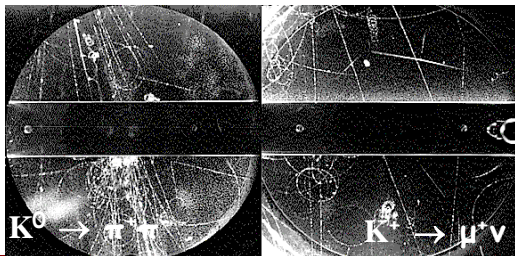
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On behalf of the NA62 Collaboration

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



Randolf LEY, PS Division, CERN, 02.09.96
 Revised and adapted by Antonella Del Rosso, ETT Div
 in collaboration with B. Desforges, SL Div., and
 D. Manglunki, PS Div, CERN, 23.05.01

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*

$K_L \rightarrow \mu e$ → Lepton Flavour Violation
 $K^+ \rightarrow \pi^+ X^0$ → Axions
 $\mu \rightarrow e \gamma$ → Lepton Flavour Violation
 $\mu\text{-N} \rightarrow e\text{-N}$ → Lepton Flavour Violation

$< 4.7 \times 10^{-12}$
 $< 7.3 \times 10^{-11}$
 $< 1.2 \times 10^{-11}$
 $< 7 \times 10^{-13}$

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*

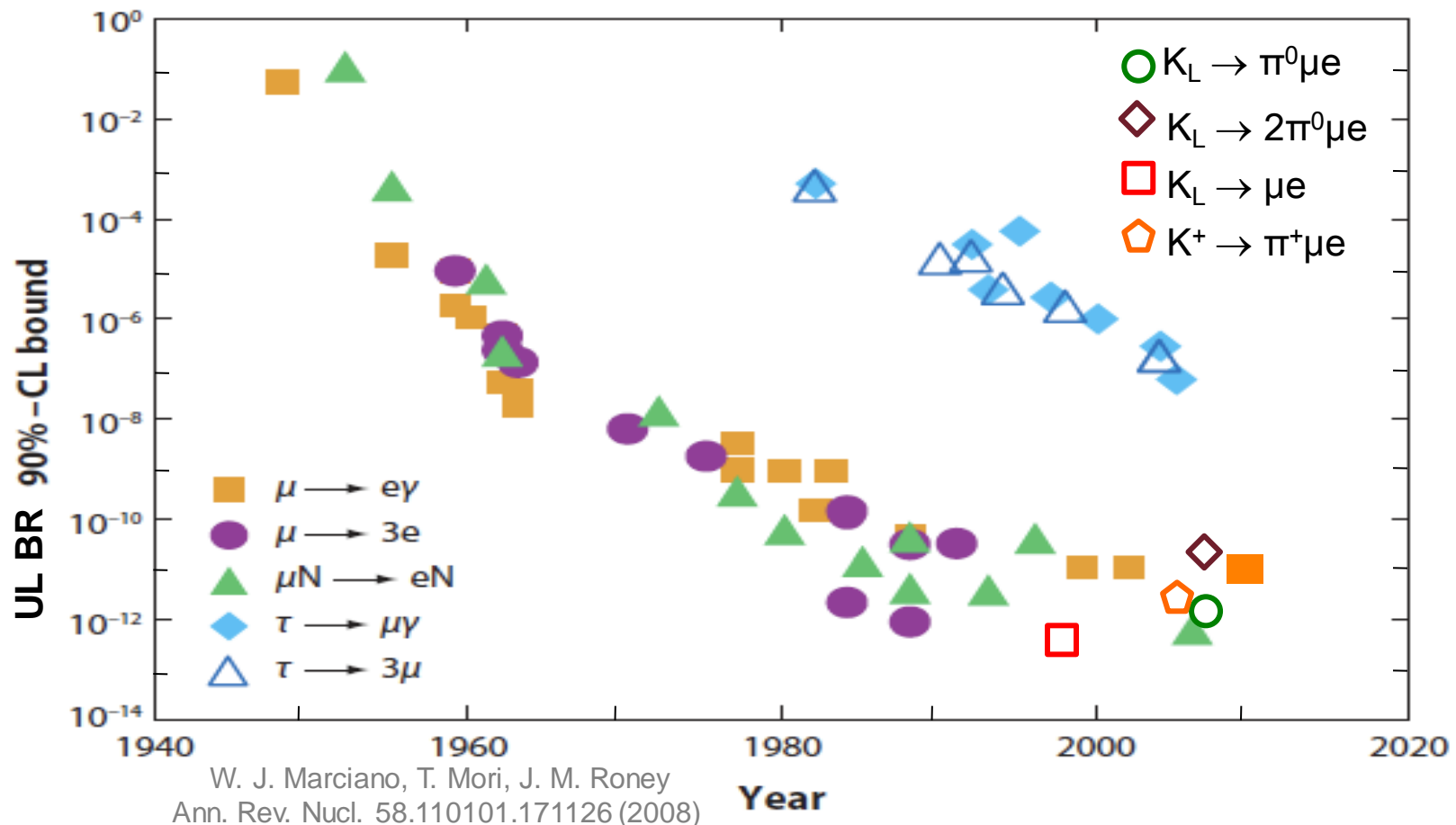
$R_{\pi/K} = \Gamma(\pi^+/K^+ \rightarrow e^+ \nu) / \Gamma(\pi^+/K^+ \rightarrow \mu^+ \nu)$
 → Lepton Universality
 $\pi^+ \rightarrow \pi^0 e \nu$ → $|V_{ud}|$
 $K_L \rightarrow \mu \mu$ → $|V_{td}|$
 $K^+ \rightarrow \pi^+ \nu \nu$ → $|V_{td}|$
 $K_L \rightarrow \pi^+ \nu \nu$ → CP Violation

$R_{\pi}: O(10^{-4})$
 $R_K: \text{this talk}$
 $O(10^{-8})$
 $O(10^{-9})$
 $O(10^{-10})$
 $< 6.7 \times 10^{-8}$

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)



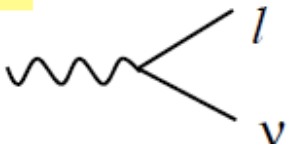
Lepton Universality

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

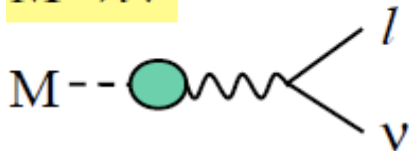
...unless New Physics (NP) violates Universality

W



$$R_{e/\mu}^W = \frac{\Gamma(W \rightarrow e\nu)}{\Gamma(W \rightarrow \mu\nu)} \propto \frac{g_e^2}{g_\mu^2}$$

M → lν



$$R_{e/\mu}^\pi = \frac{\Gamma(\pi \rightarrow e\nu)}{\Gamma(\pi \rightarrow \mu\nu)} \propto \frac{g_e^2}{g_\mu^2} \frac{m_e^2}{m_\mu^2}$$

Measurements of Ratios of Weak Coupling Constants

MODE	g_e/g_μ
$\pi \rightarrow e\nu / \pi \rightarrow \mu\nu$	0.9985 ± 0.0016
$K \rightarrow e\nu / K \rightarrow \mu\nu$	1.0018 ± 0.0026
$\tau \rightarrow e\nu / \tau \rightarrow \mu\nu$	0.9998 ± 0.0020
$\nu_e - \nu_\mu$	1.10 ± 0.05
W decays	1.001 ± 0.011
$K \rightarrow \pi e\nu / K \rightarrow \pi \mu\nu$	0.998 ± 0.002

PRL 68 (1992)
PR D49 (1994)
PRL 70 (1993)

→ THIS TALK

EPJ C57 (2008)

PLB179 (1986)

EPJ C57 (2008)

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

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

Helicity suppression

Radiative corrections

ChPT, $\mathcal{O}(e^2 p^4)$

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

➔ 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[±] instead of W[±]

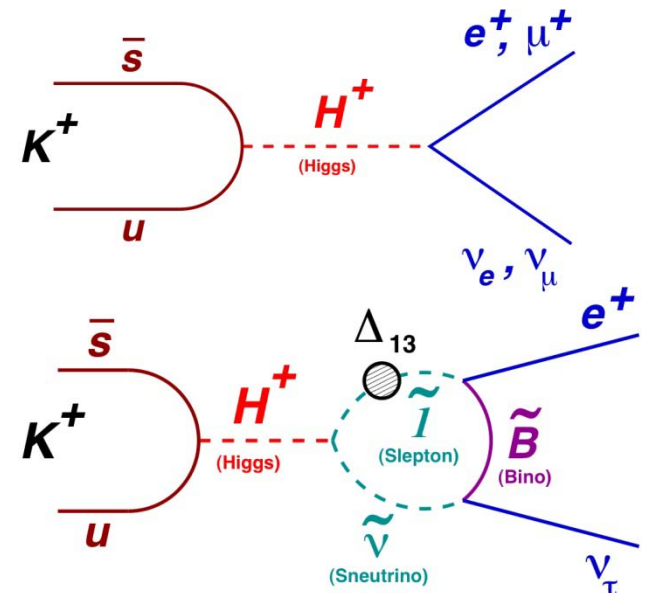
2HDM – one-loop level: H[±] mediated LFV terms with emission of ν_τ are the dominant contribution to ΔR_K

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

Δ₁₃ → mixing parameter of superpartners of right-handed leptons

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

tanβ → ratio of the two Higgs vacuum expectation values



At large tanβ values with a massive H[±], LFV contributions dominate and produce sizable (O(1%)) effects to R_K

(Ex.: Δ₃₁=5×10⁻⁴, tanβ=40 and M_H=500 GeV/c² → R_K^{LFV} = R_KSM (1+0.013))

Experimental Status of R_K

PDG'08 (1970s measurements):
 $R_K = (2.45 \pm 0.11) \times 10^{-5}$ ($\delta R_K / R_K = 4.5\%$)

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

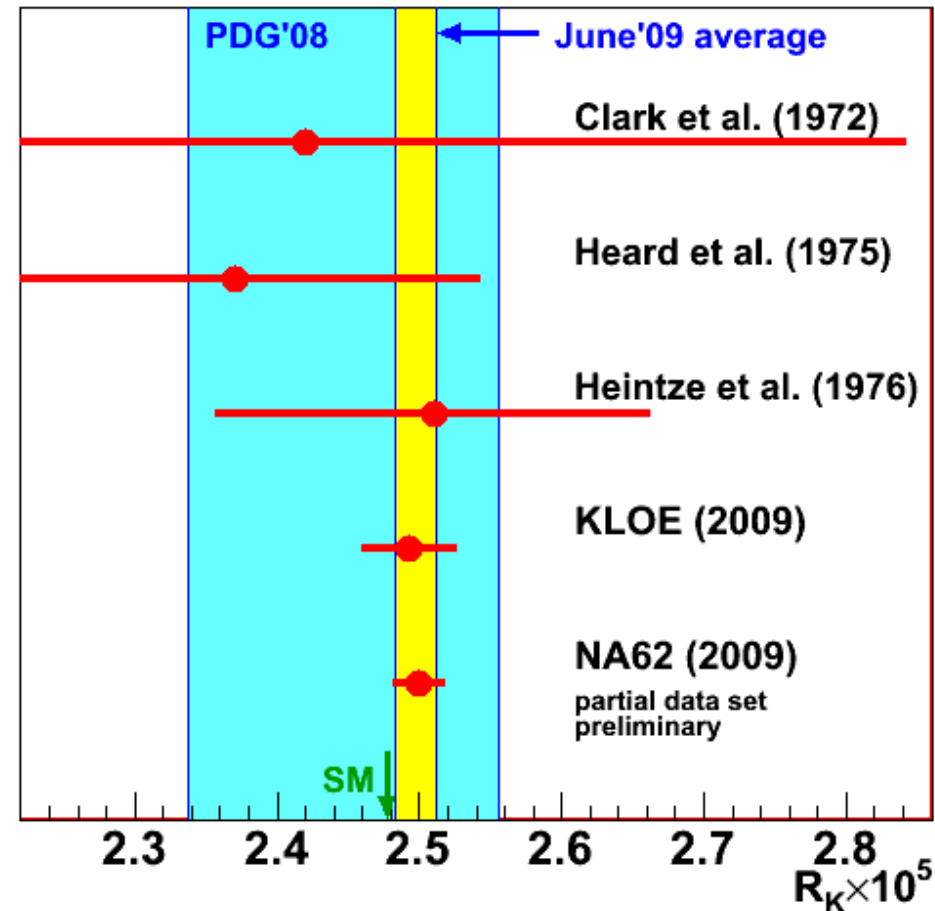
New recent measurements:

2009: KLOE (LNF), 2001–05 data (final),
13.8K K_{e2} candidates, 15% background:
 $R_K = (2.493 \pm 0.031) \times 10^{-5}$ ($\delta R_K / R_K = 1.3\%$)
(EPJ C64 (2009) 627)

2009: NA62 (CERN), 40% of 2007 data,
51.1K K_{e2} candidates, 9% background
(preliminary result, Kaon'09):

$R_K = (2.500 \pm 0.016) \times 10^{-5}$ $\delta R_K / R_K = 0.7\%$.
(arXiv:0908.3858, 1005.1192)

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



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

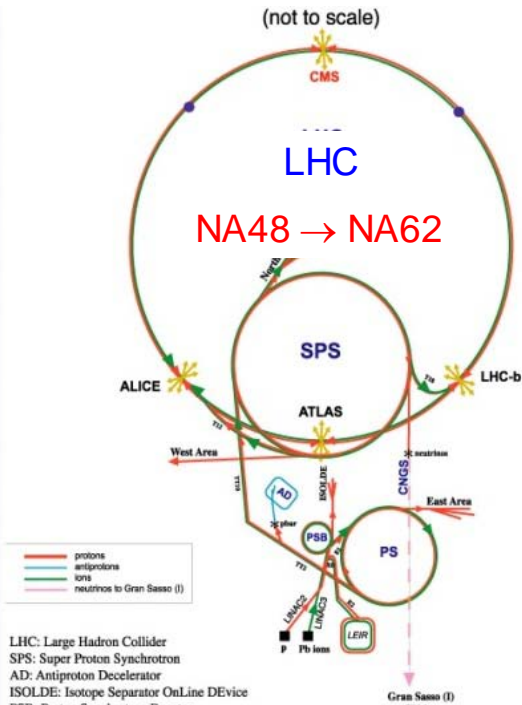
Measurement of R_K with a precision $<1\%$ (2007-08)

NA62 phase II

(G.Anzivino talk)

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

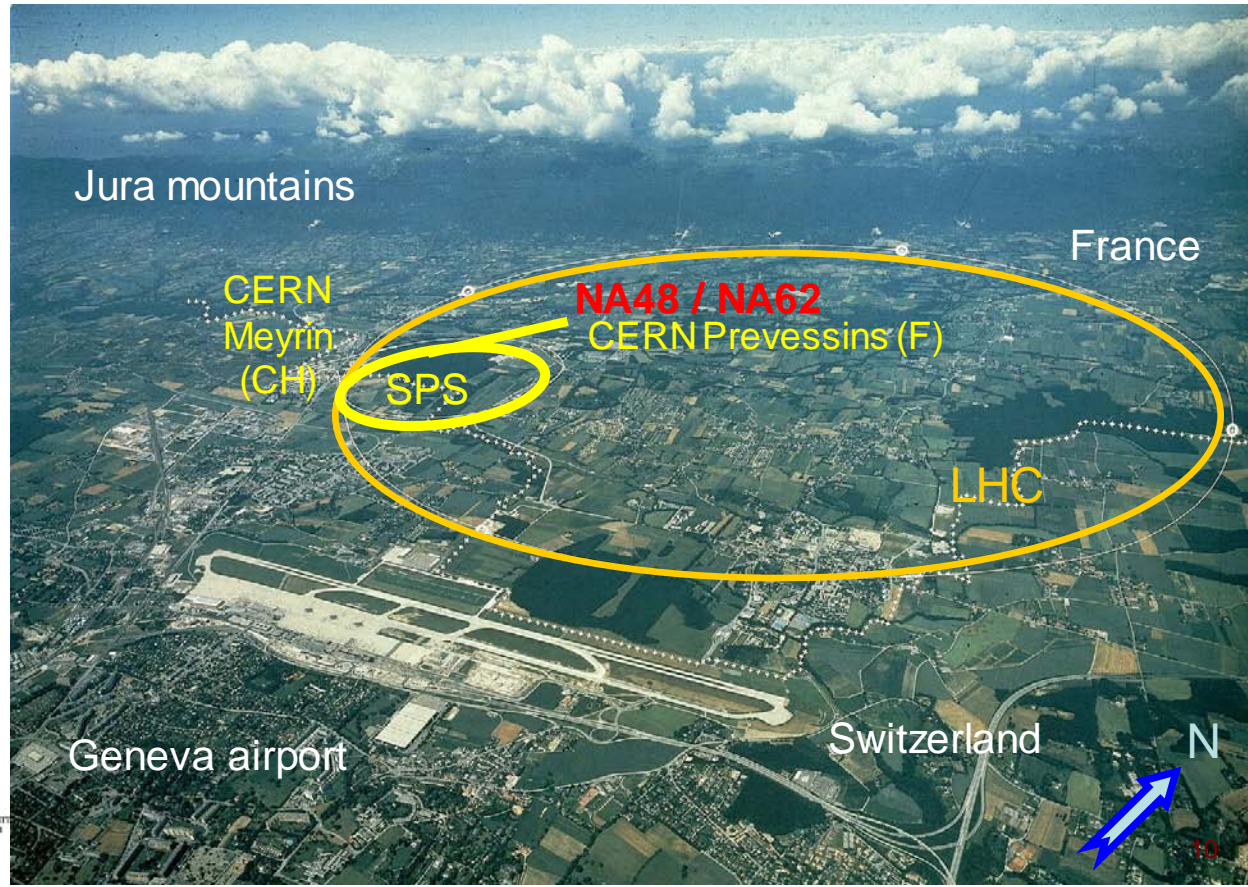
The NA62 Collaboration (Phase I): Birmingham, Bratislava, CERN, Dubna, Fairfax, Ferrara, Firenze, Frascati, Liverpool, Louvain, Mainz, Merced, Moskow, Napoli, Perugia, Pisa, Protvino, Roma I, Roma II, Saclay, San Luis Potosí, SLAC, Sofia, Torino, TRIUMF



LHC: Large Hadron Collider
 SPS: Super Proton Synchrotron
 AD: Antiproton Decelerator
 ISOLDE: Isotope Separator OnLine DEvice
 PSB: Proton Synchrotron Booster
 PS: Proton Synchrotron
 LINAC: LINear ACcelerator
 LEIR: Low Energy Ion Ring
 CNGS: Cern Neutrinos to Gran Sasso

P. Cenci

Reddit LEIR, PS Division, CERN, 02/09/96
 Revised and adapted by Alessandra Del Boca, ITT
 in collaboration with R. Donzel, R. D'Arcy, and
 D. Maguana, PS Div. CERN, 25/05/01



Running Conditions in 2007

Data taking conditions in 2007 optimized for a precision $K_{e2}/K_{\mu2}$ 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:

$P = (74.0 \pm 1.4)$ 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 \Rightarrow efficiency

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

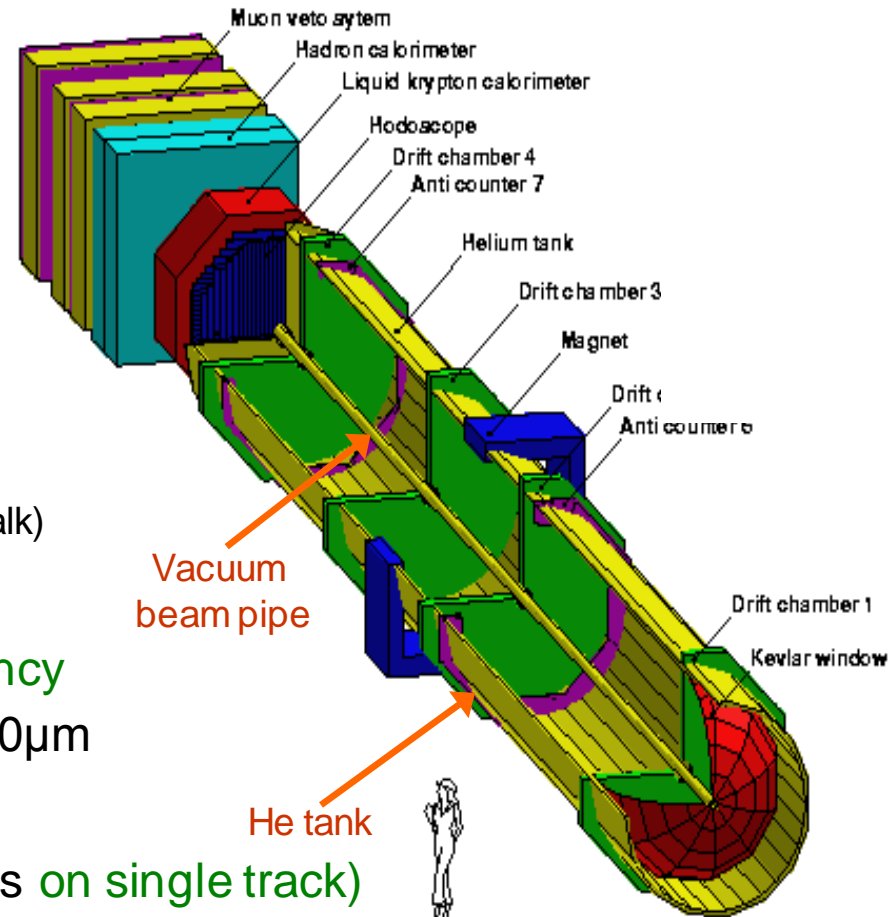
Hodoscope

fast trigger and good time resolution ($\sigma_t \sim 200\text{ps}$ on single track)

Liquid Krypton calorimeter (LKr)

high granularity, quasi-homogeneous $\Rightarrow \gamma$ veto

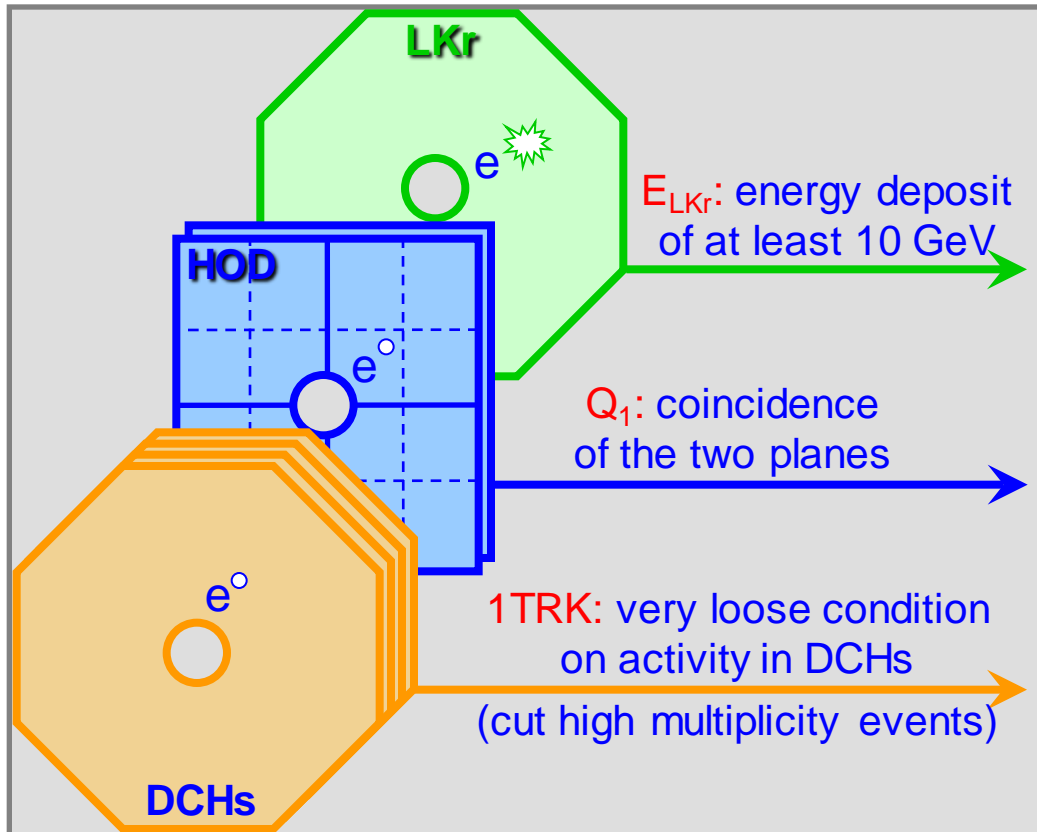
$$\sigma(E)/E = 3.2\%/\sqrt{E} + 9\%/E + 0.42\% \text{ [GeV]}; \quad \sigma_{x,y} = (0.42/\sqrt{E} + 0.6) \text{ mm}$$



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 $\sim 10^{-5}$

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

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

$N(K_{e2}), N(K_{\mu2})$:

$N_B(K_{e2}), N_B(K_{\mu2})$:

$A(K_{e2}), A(K_{\mu2})$:

f_e, f_{μ} :

$\varepsilon(K_{e2})/\varepsilon(K_{\mu2})$:

f_{LKr} :

D :

numbers of selected K_{l2} candidates

numbers of background events; \Rightarrow

geometric acceptances (MC, no ID);

particle ID efficiency (measured, no MC);

trigger efficiency;

global LKr readout efficiency (only K_{e2});

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

\rightarrow 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 $K_{\mu2}$ 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: $13\text{GeV}/c < p < 65\text{GeV}/c$.

Kinematic identification: M_{miss}^2 vs p_l

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

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

→ $K_{e2}/K_{\mu2}$ samples separation at $p_{\text{track}} < 25 \text{ GeV}/c$

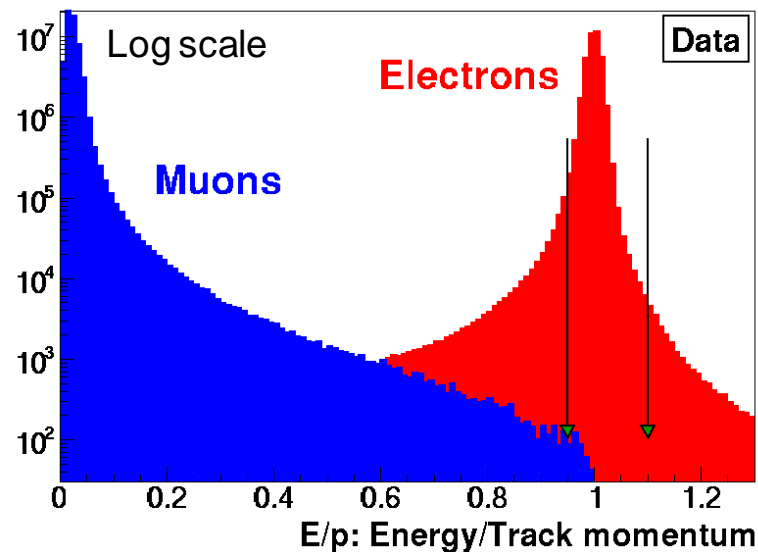
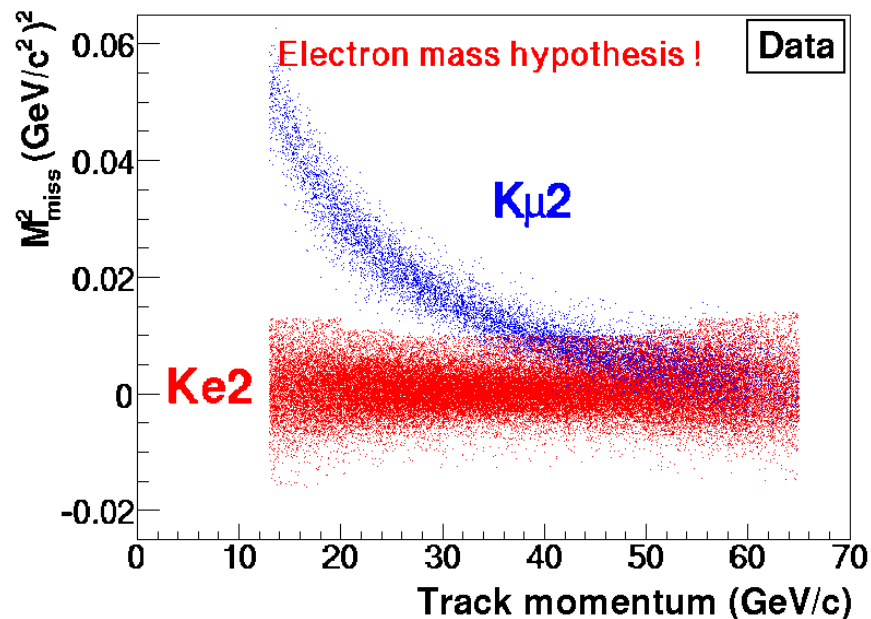
Particle ID: E/p

E/p = LKr energy/track momentum

$(0.90 \text{ to } 0.95) < E/p < 1.10$ for **electrons**

$E/p < 0.85$ for **muons**

→ Powerful μ^\pm suppression in e^\pm sample ($\sim 10^6$)



- $K^+ \rightarrow \mu^+ \nu$ with a μ^+ mis-identified as a e^+
 - μ bremsstrahlung ← MAIN CONTRIBUTION
 - $\mu \rightarrow e$ decay in flight
- $K^+ \rightarrow e^+ \nu \gamma$, SD+ component
- Beam halo muons
- $K^+ \rightarrow \pi^0 e^+ \nu$ with a non-identified π^0
- $K^+ \rightarrow \pi^+ \pi^0$ with a π^+ mis-identified as e^+ or followed by a Dalitz decay $\pi^0 \rightarrow e e \gamma$
- After the events selection:
 - $\approx 60k$ K_{e2} candidates
 - $\approx 18M$ $K_{\mu 2}$ candidates (beam halo μ : only background)

Lower contributions:
 $B/(S+B) < \text{per-mille}$

$K_{\mu 2}$ background in $K_{e 2}$ 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 misidentified as e^+ due to the emission of energetic photons: “catastrophic” energy loss in LKr associated to a μ track

Probability $P_{\mu e} \sim 3 \times 10^{-6}$ (p-dependent)

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

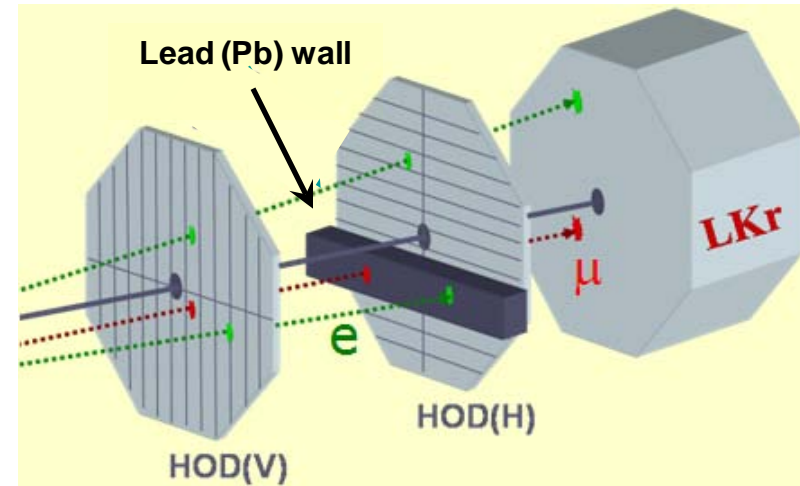
→ use a Pb wall in front of LKr to convert γ

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

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

→ μ ionization losses in Pb (low p)

→ μ bremsstrahlung in Pb (high p)

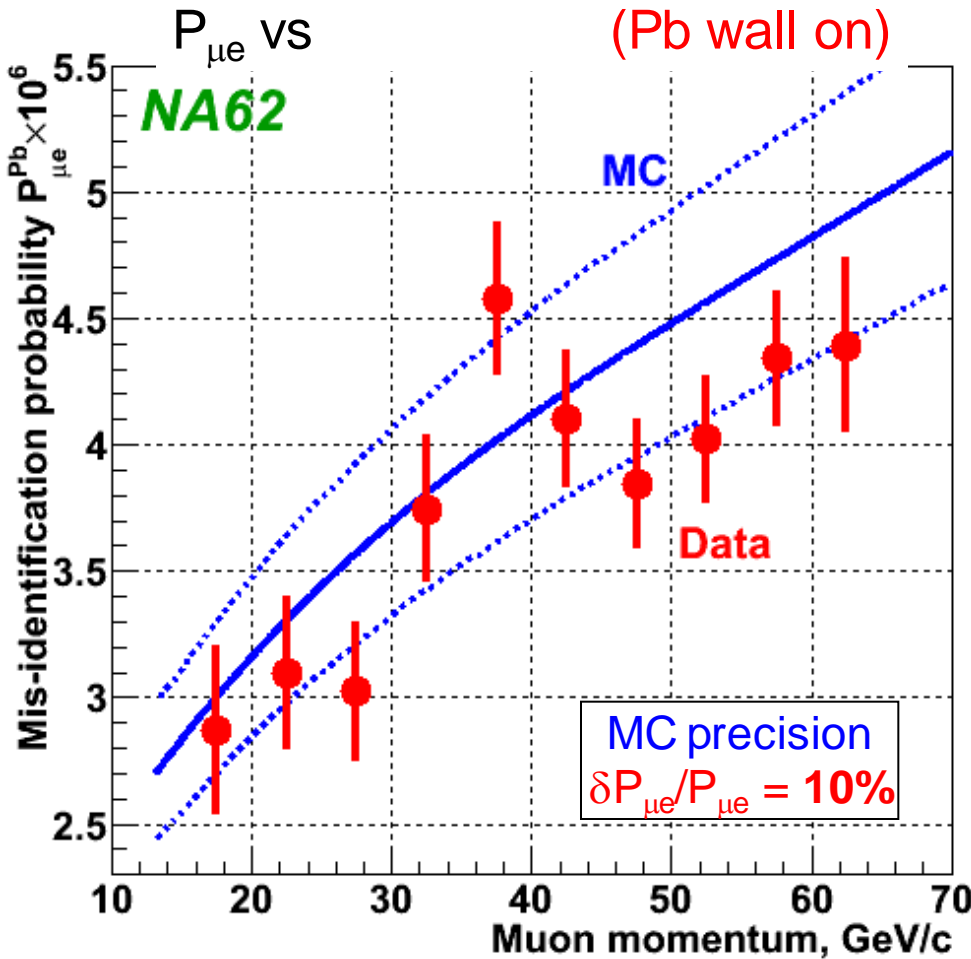


Thickness:	9,2 X_0 (Pb+Fe)
Width:	240cm (=HOD size)
Height:	18cm (=3 counters)
Area:	~20% of HOD area
Duration:	~50% of R_K runs + special muon runs

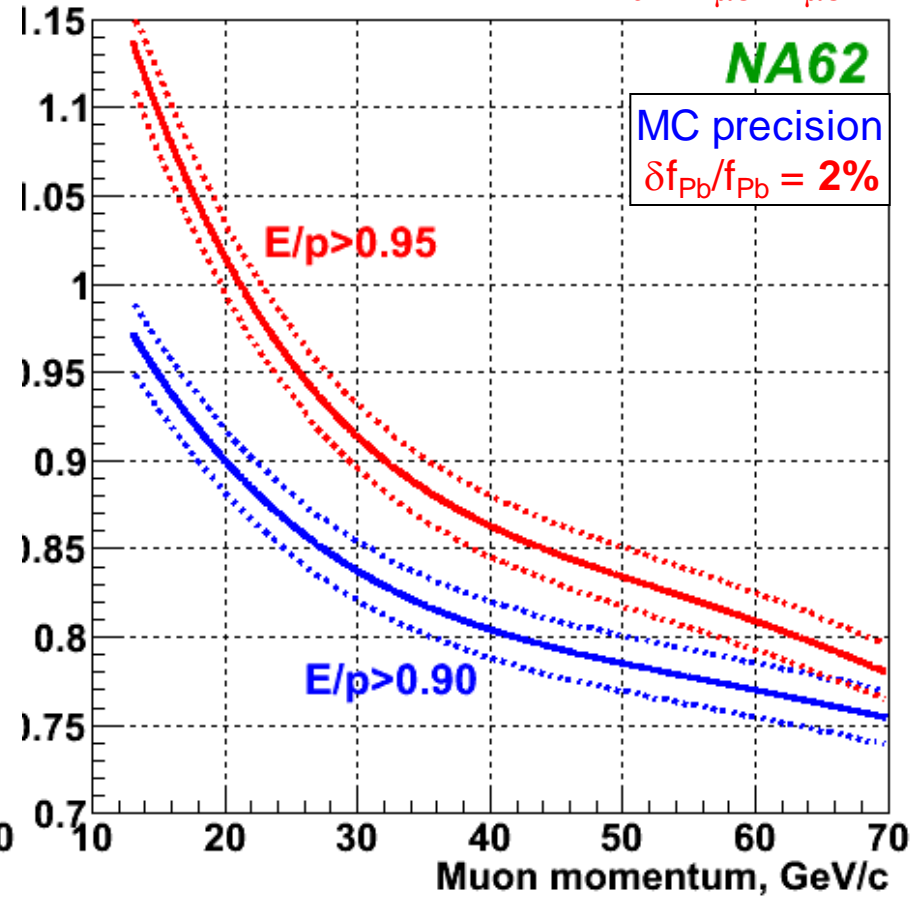
→ Correction factor $f_{Pb} = P_{\mu e} / P_{\mu e}^{Pb}$ evaluated with a dedicated Geant4-based simulation

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

Muon mis-identification



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



Result: $B/(S+B) = (6.11 \pm 0.22)\%$

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_{miss}^2 vs P_{track} correlation (0.08%)

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

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

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

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

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

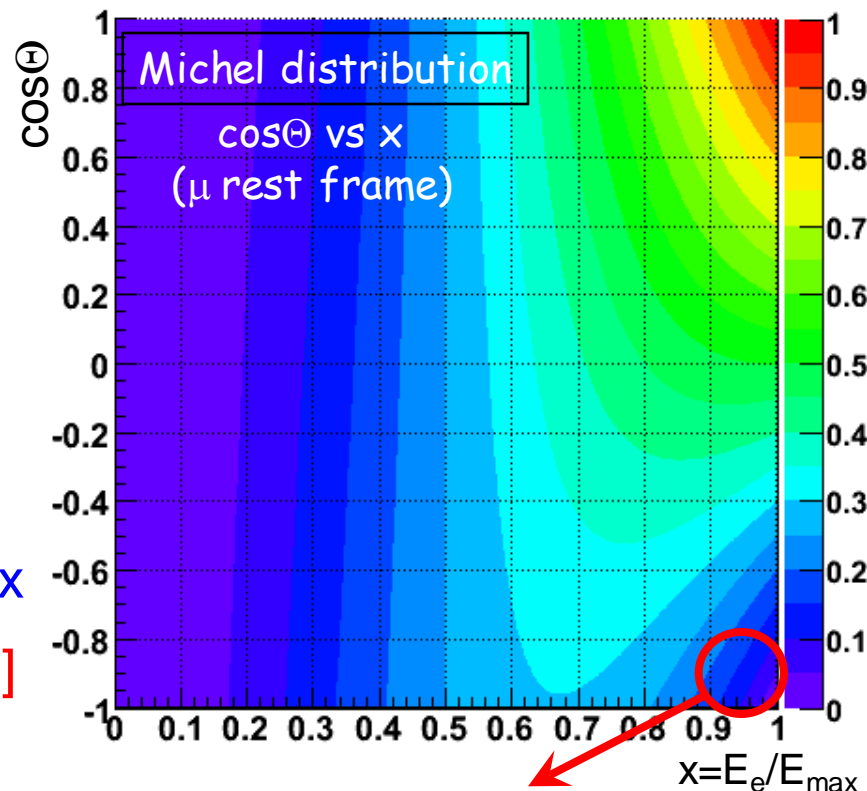
$$d^2\Gamma/(dx d(\cos\Theta)) \sim x^2[(3-2x)-\cos\Theta(1-2x)]$$

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

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

Result:

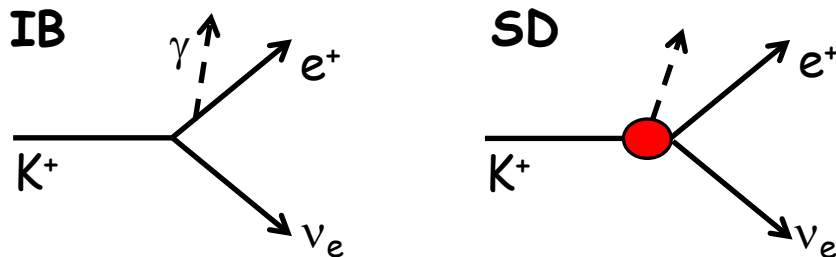
$$B/(S+B) = (0.27 \pm 0.04)\%$$



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

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

R_K includes only IB radiation by definition:



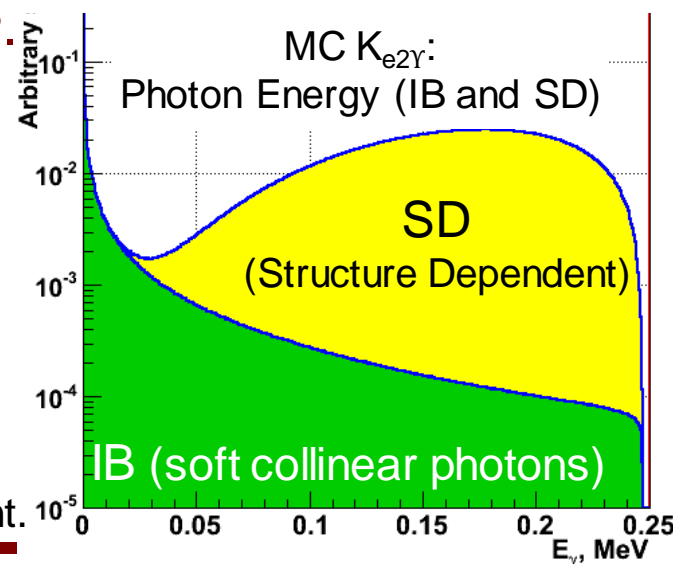
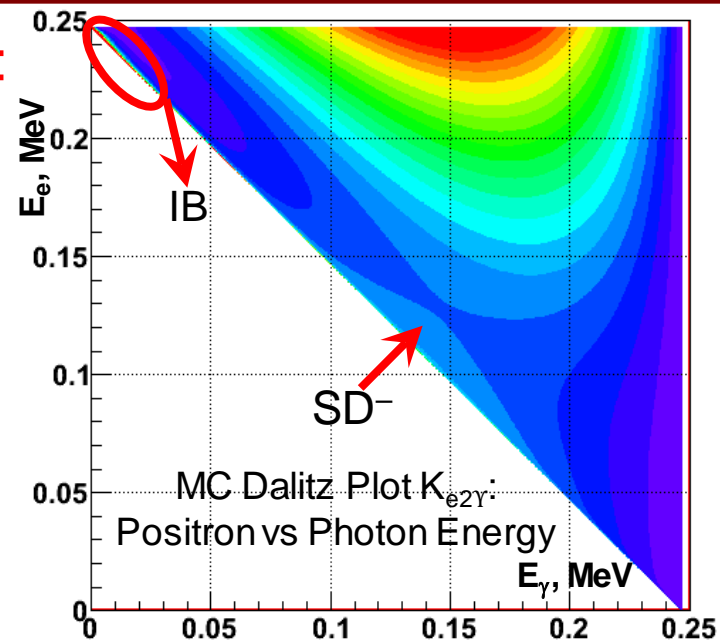
- SD radiation is non helicity suppressed
- SD⁺ component is a background source (lower contribution from SD⁻, negligible from Interference)

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

$$BR(SD^+, \text{full phase space}) = (1.37 \pm 0.06) \times 10^{-5}$$

SD⁺ background contamination:
 $B/(S+B) = (1.07 \pm 0.05)\%$

→ 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 $\times 3$ 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 $K_{\mu2}$ 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.

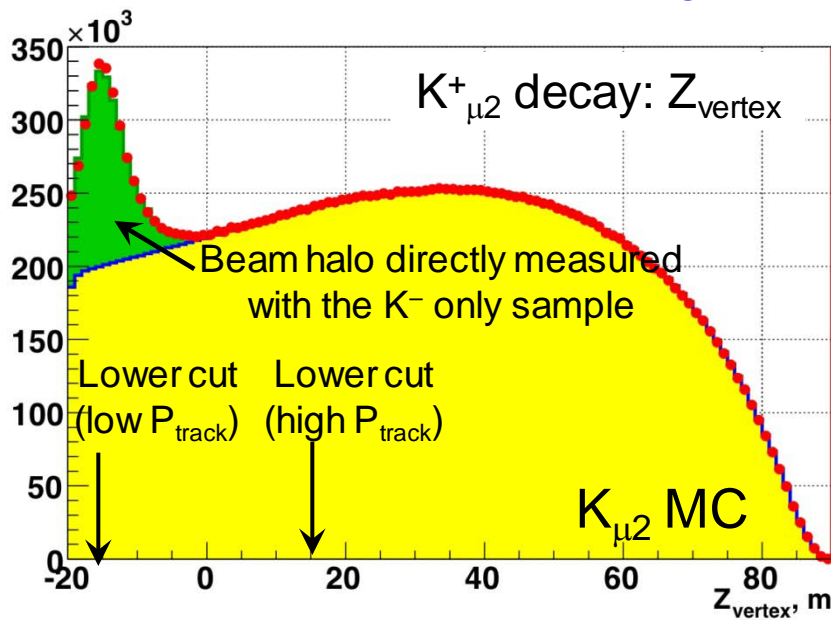
A sub-permille precision is achieved in the measurement of halo background:

Result:

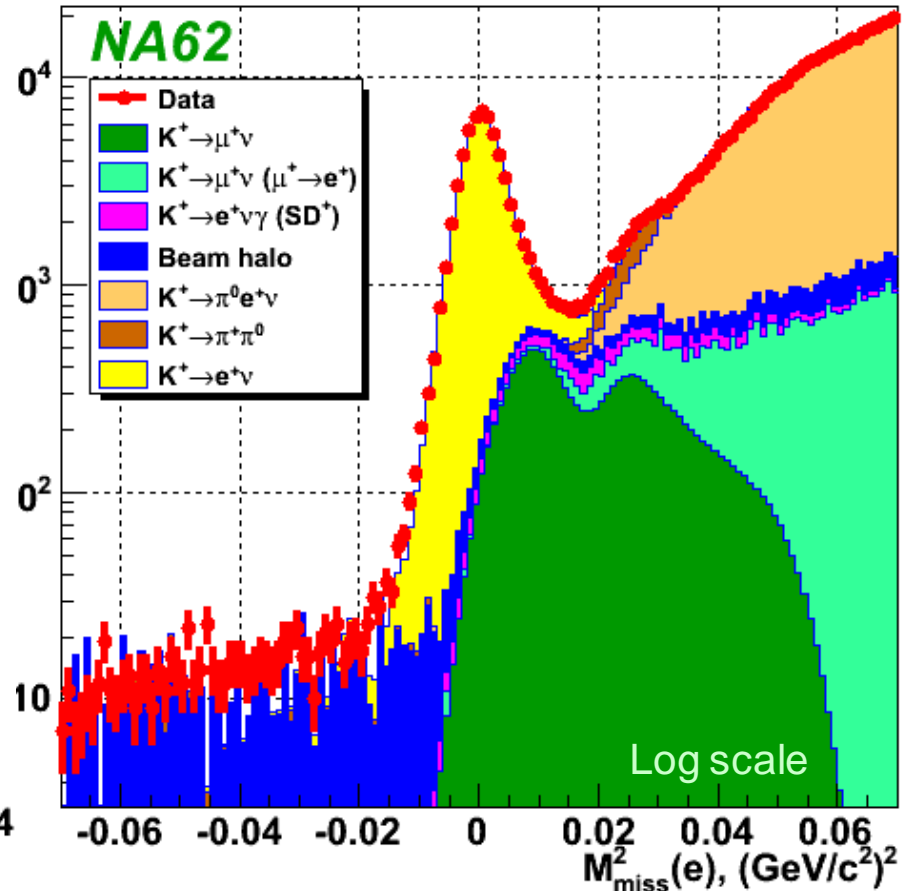
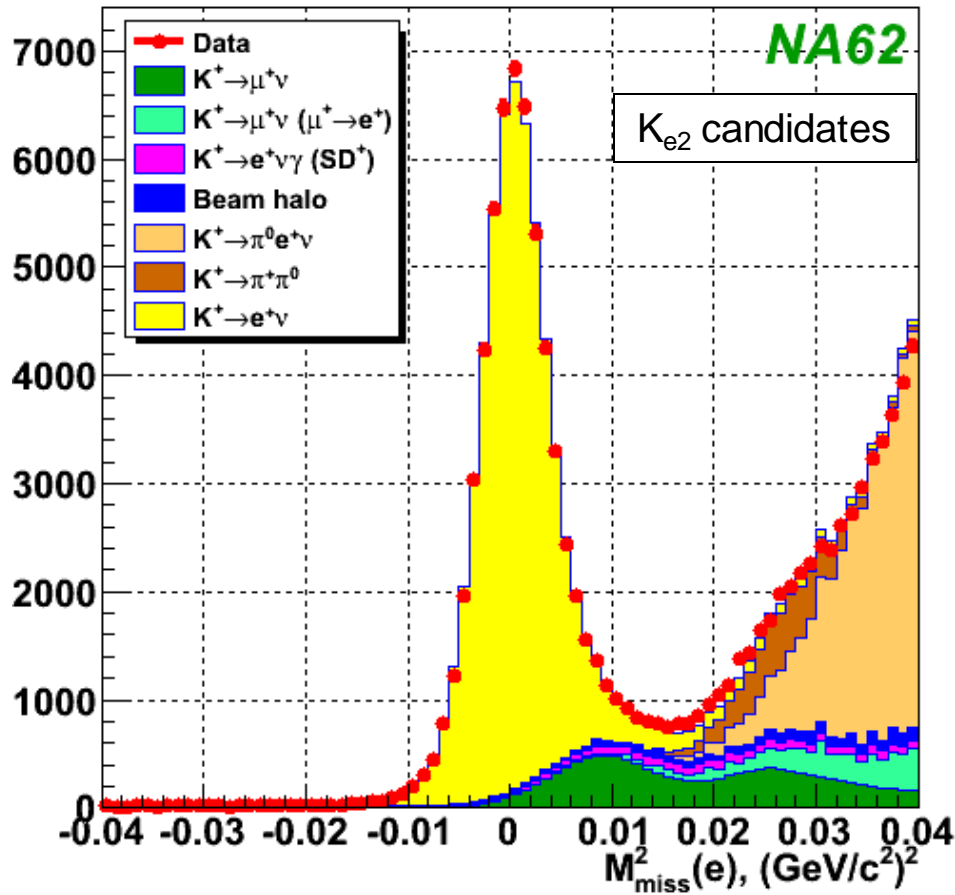
$$B/(S+B) = (1.16 \pm 0.06)\%$$

Uncertainty due to:

- 1) limited size of control sample;
- 2) π , K decays upstream vacuum tank.



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



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

Positron ID efficiency: $(99.27 \pm 0.05)\%$

$B/(S+B) = (8.71 \pm 0.24)\%$

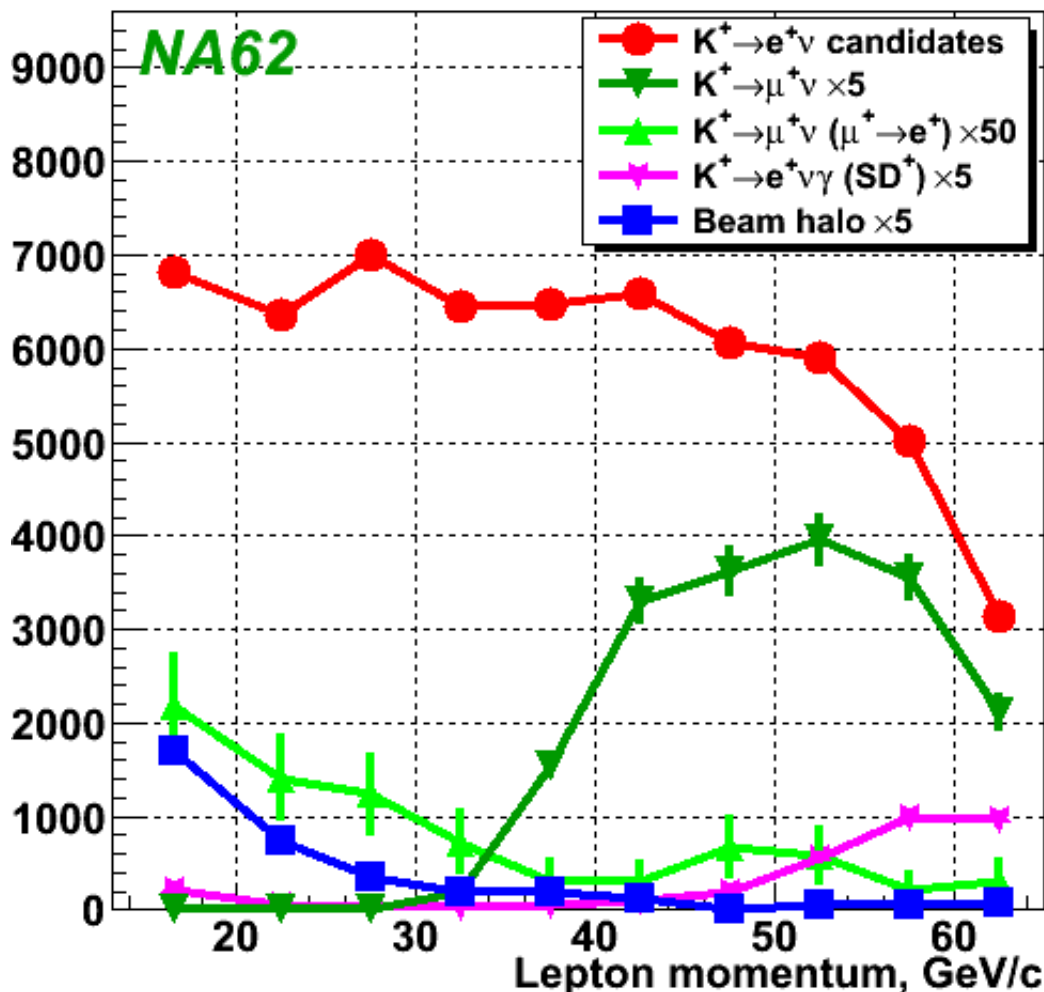
NA62 estimated total K_{e2} sample:

$\sim 120K$ K^+ & $\sim 30K$ K^- candidates

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

Background events: summary

K_{e2} candidates and backgrounds in momentum bins



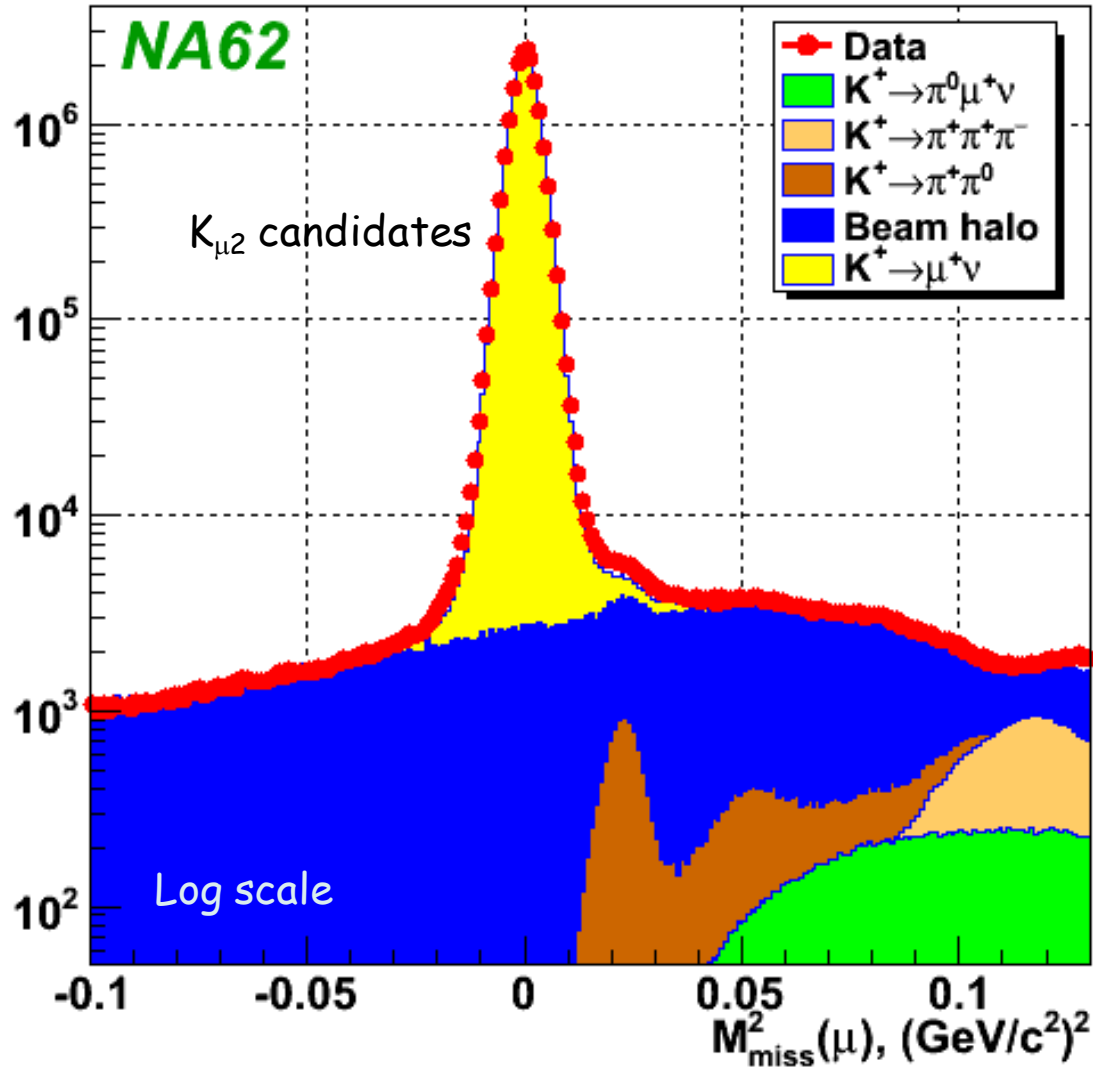
Lepton momentum bins are differently affected by backgrounds and thus the systematic uncertainties.

Background

Source	B/(S+B)
K _{μ2}	(6.11±0.22)%
K _{μ2} (μ→e)	(0.27±0.04)%
K _{e2γ} (SD ⁺)	(1.07±0.05)%
Beam halo	(1.16±0.06)%
K _{e3(D)}	(0.05±0.03)%
K _{2π(D)}	(0.05±0.03)%
Total	(8.71±0.24)%

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

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



Beam Halo:

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

Background

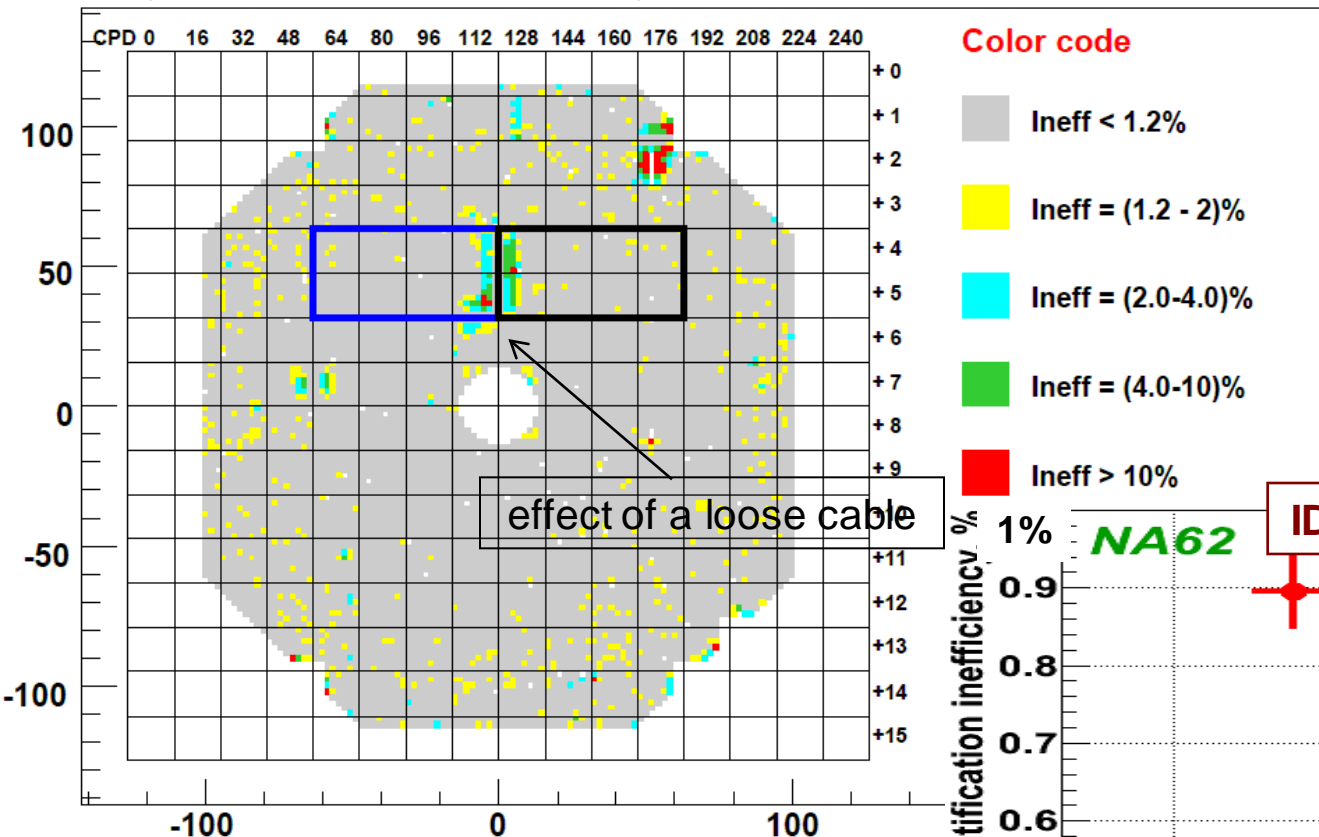
Source	B/(S+B)
Beam halo	$(0.38 \pm 0.01)\%$
Total	$(0.38 \pm 0.01)\%$

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

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

Systematic effect: positron ID

A typical LKr inefficiency map:

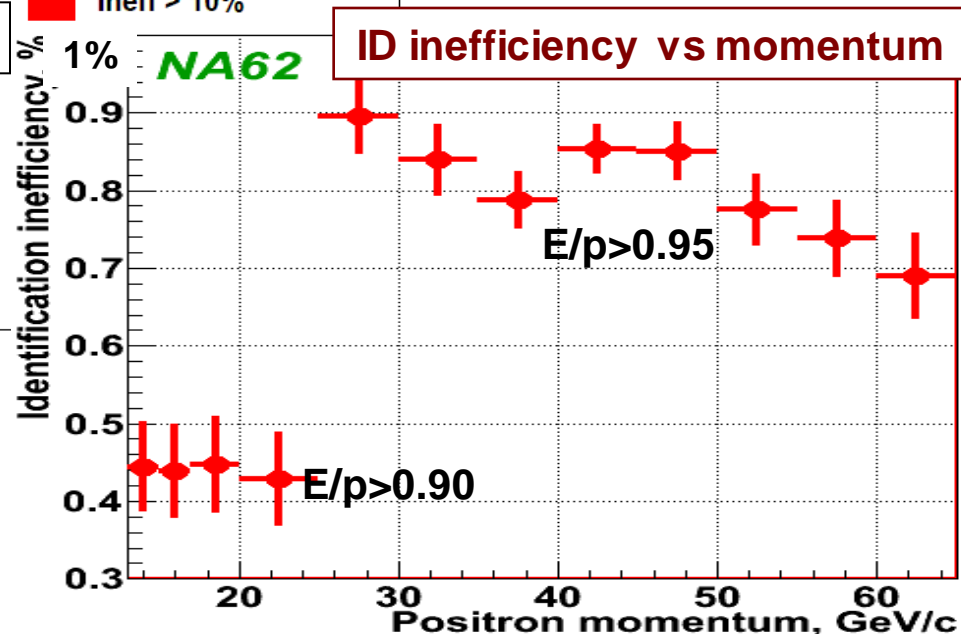


Positron ID efficiency:
measured with e^+ from
 $K^+ \rightarrow \pi e \nu$ and $K_L \rightarrow \pi e \nu$
samples (special runs) in
lepton momentum bins

Average efficiency:
 $(99.27 \pm 0.05)\%$

- LKr energy response is calibrated in every $2 \times 2 \text{ cm}^2$ cell within acceptance;
- Global LKr readout efficiency measured with an independent readout system:

$f_{\text{LKr}} = (99.80 \pm 0.03)\%$



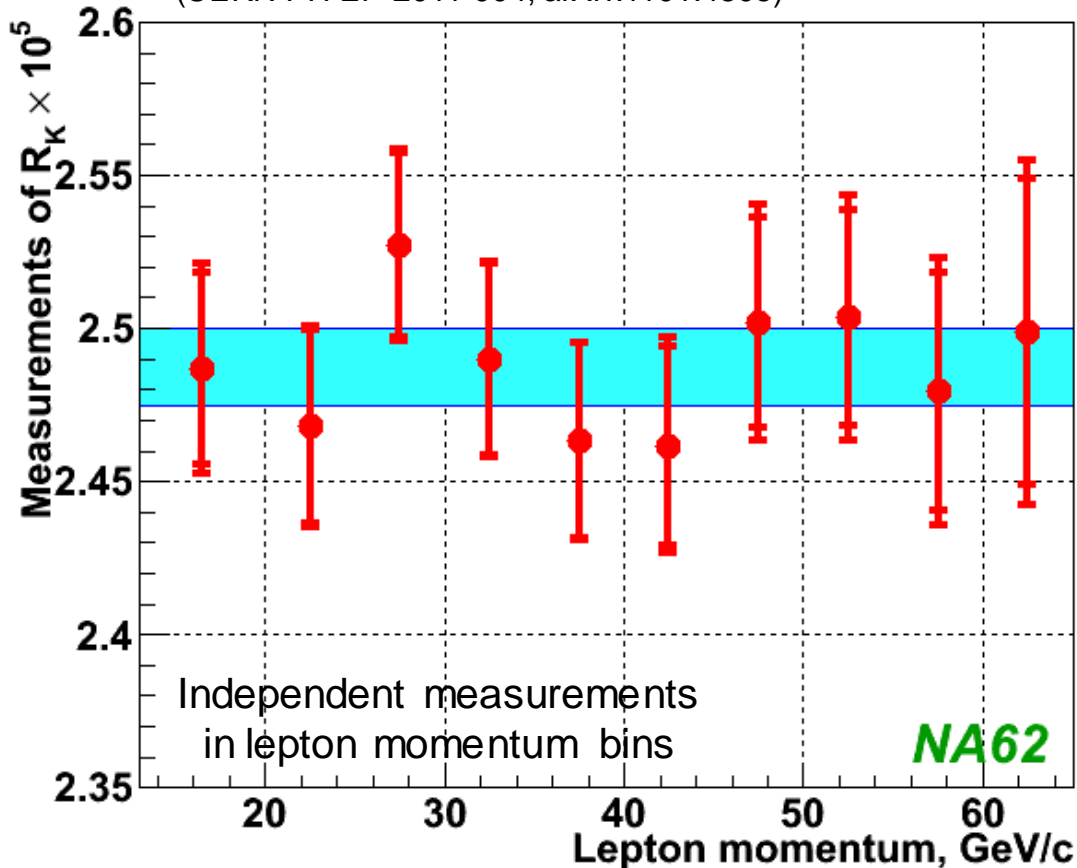
NA62 final result (40% data set)



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

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

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



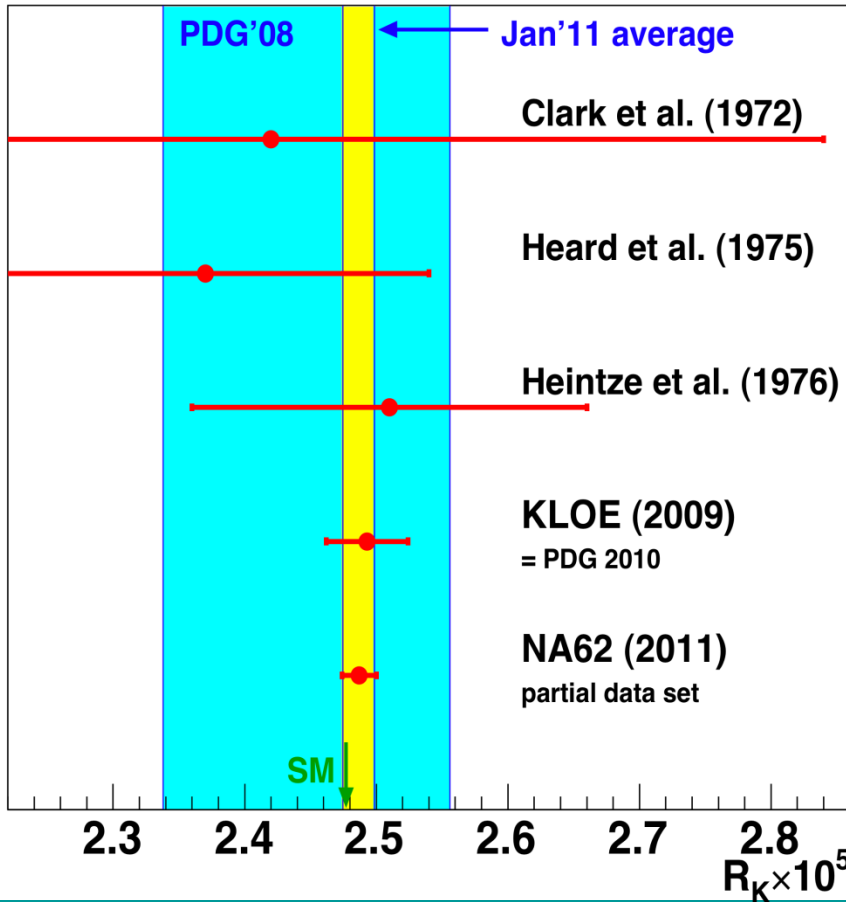
Uncertainties: (0.52% precision)

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

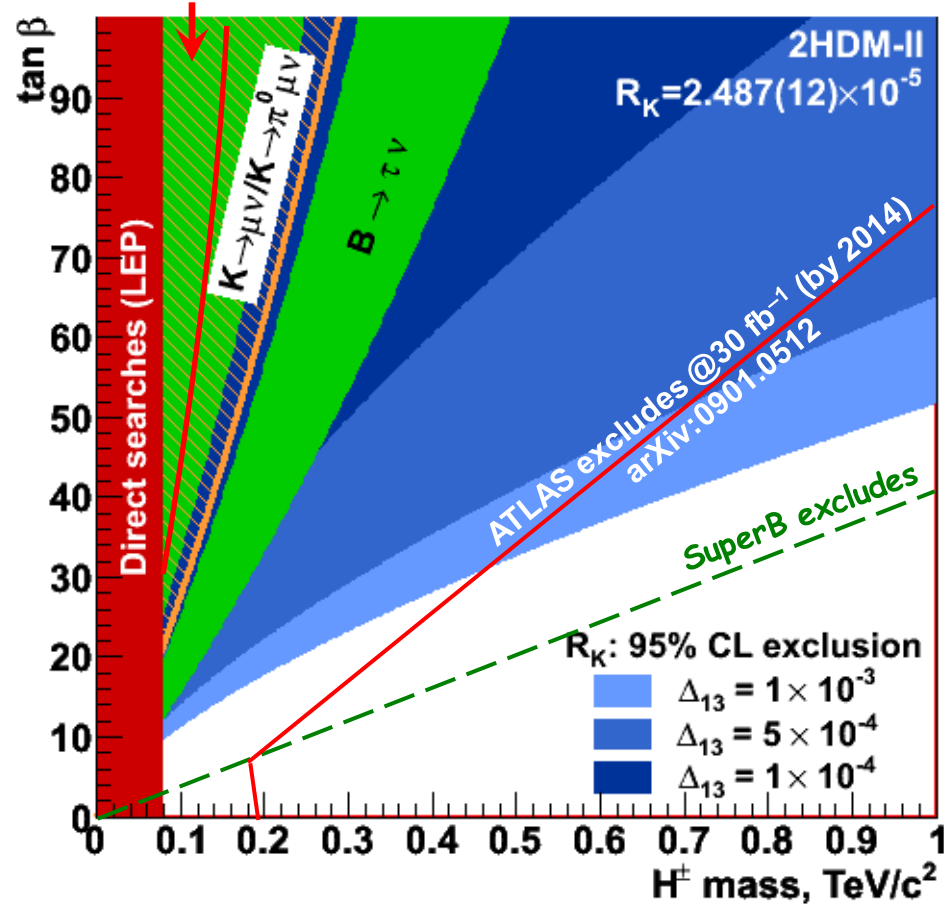
Preliminary result: $R_K = 2.500(16) \times 10^{-5}$
 Shift due to multi-photon corrections
 to the $K_{e2\gamma}$ (IB) decay.

Systematic errors included, partially correlated

R_K : the new World Average



Tevatron Run II



World average	$\delta R_K \times 10^5$	Precision
March 2009	2.467 ± 0.024	0.97%
January 2011	2.487 ± 0.012	0.48%

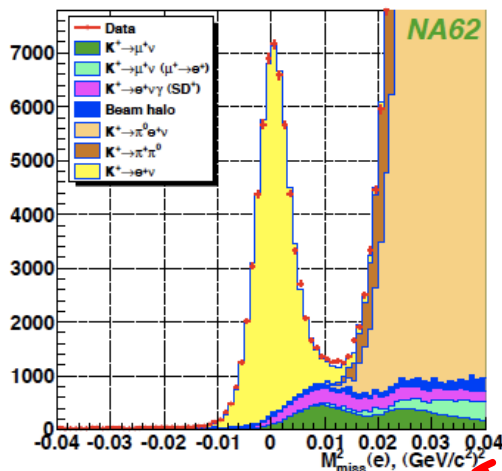
For non-tiny values of the LFV slepton mixing Δ_{13} , the sensitivity to H^\pm in $R_K = K_{e2}/K_{\mu 2}$ is better than in $B \rightarrow \tau\nu$

Outlook: the 2007 K_{e2} samples

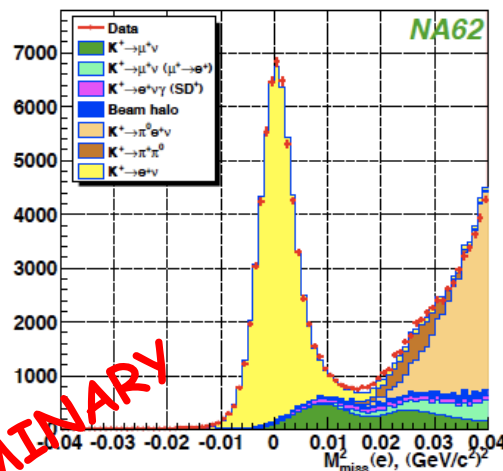
NA62 data/MC comparison of the squared missing mass spectra [$M_{\text{miss}}^2 = (\mathbf{p}_K - \mathbf{p}_l)^2$] for the 4 samples of 2007 data, showing the differences in background conditions

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

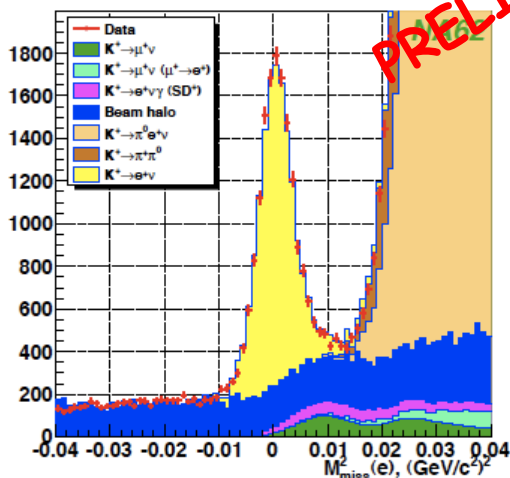
K^+ , Pb
 $\approx 62\text{k } K_{e2}$ candidates



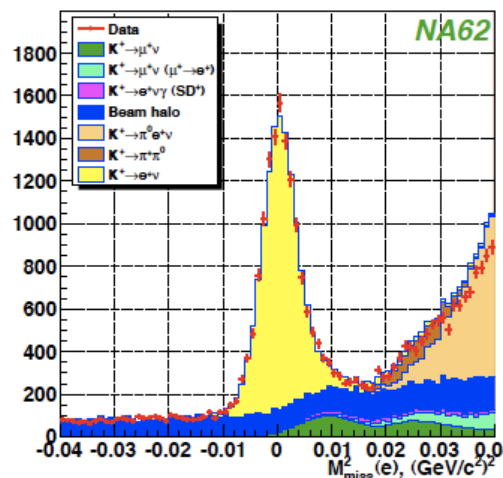
K^+ , no Pb
 $\approx 60\text{k } K_{e2}$ candidates



K^- , Pb
 $\approx 18\text{k } K_{e2}$ candidates



K^- , no Pb
 $\approx 15\text{k } K_{e2}$ candidates



NA62 analysis going on:

- $K_{e2\gamma}$: measurement of $BR(SD^+)$, $\times 3$ 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 ($M=50-350 \text{ MeV}/c^2$)
 - suggested by S.N. Gninenko, arXiv:1009.553 (19 January 2011):
 - attempt to reconcile puzzling neutrino oscillation results from LSND, KARMEN and MiniBooNE experiments
 - $K^+ \rightarrow \mu \nu_h$ **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 background 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.

$R_K = K_{e2}/K_{\mu2}$ 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 $K_{e2}/K_{\mu2}$ separation (99.3% electron ID efficiency, 6% $K_{\mu2}$ background)

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

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

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 $\sim 0.2\%$ precision.