A precision test of lepton universality in $K^+ \to l^+ \nu$ decays at CERN NA62

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Outline:

1) Physics motivation: leptonic kaon decays
2) Introduction to NA48/NA62 experiment at CERN
3) Data taking strategy and analysis method
4) Data analysis: backgrounds & systematic effects
5) Preliminary results
6) The future of the NA62 experiment
7) Conclusions

UNIVERSITY OF BIRMINGHAM

CERN

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Introduction

Searches for physics beyond the Standard Model

Energy Frontier (LHC, Tevatron)

Search for direct evidence:
production of heavy new particles.
Large colliders and detectors.

Rarity Frontier

Search for deviations from precise SM predictions in rare or forbidden processes.
Requires high precision and high beam intensity.

Sensitivity to new physics originates from virtual contributions involving new heavy particles at higher order loops.
Mass range: up to 100 TeV.

Physics programme at the Rarity Frontier
(pursued independently in kaon and B-meson sectors)
is complementary to direct searches for new particles
at the Energy Frontier

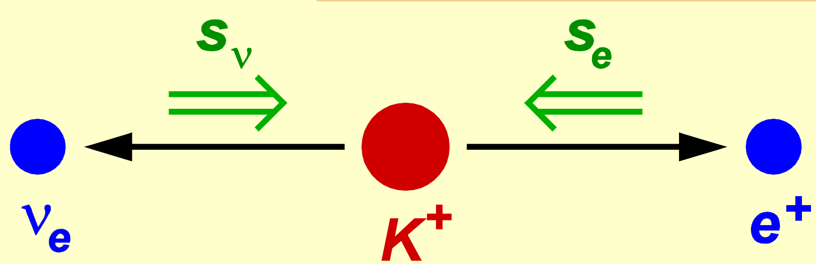
K_{l2} and π_{l2} decays in the SM

The basic observable sensitive to lepton flavour violation:

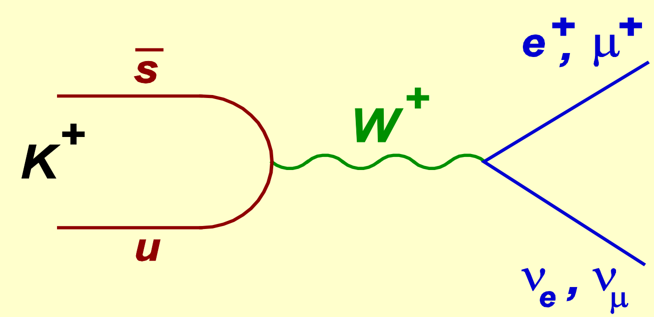
$$R_K = \frac{\Gamma(K^\pm \to e^\pm \nu)}{\Gamma(K^\pm \to \mu^\pm \nu)} = \frac{m_e^2}{m_\mu^2} \cdot \left(\frac{m_K^2 - m_e^2}{m_K^2 - m_\mu^2}\right)^2 \cdot (1 + \delta R_K^{\mathrm{rad.corr.}})$$

Helicity suppression ~10^5

Radiative correction (few %) due to $K^+ \to e^+ \nu\gamma$ (IB) process, by definition included into R_K



- Measurements of R_K and R_π have been long considered as tests of lepton universality.
- SM predictions: excellent sub-permille accuracy due to cancellation of hadronic uncertainties.
- Recently realized: helicity suppression of the electronic mode might enhance sensitivity of R_K to non-SM effects to an experimentally accessible level.



$R_K^{SM} = (2.477 \pm 0.001) \times 10^{-5}$

$R_\pi^{SM} = (12.352 \pm 0.001) \times 10^{-5}$

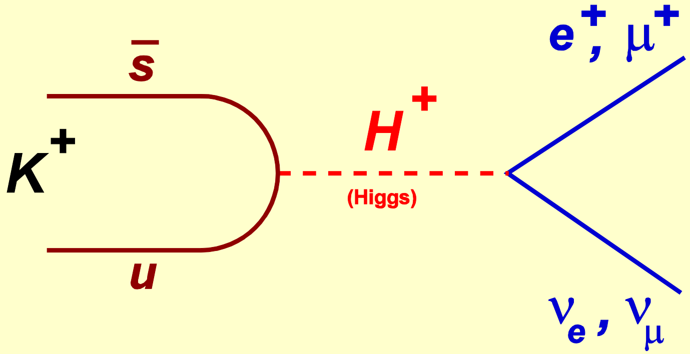
Phys. Lett. 99 (2007) 231801

$R_K = K_{e2}/K_{\mu 2}$ beyond the SM

MSSM – tree level (two Higgs doublets)

K_{l2} can proceed via exchange of charged Higgs H^+ instead of W^+

→ Does not affect the value of R_K

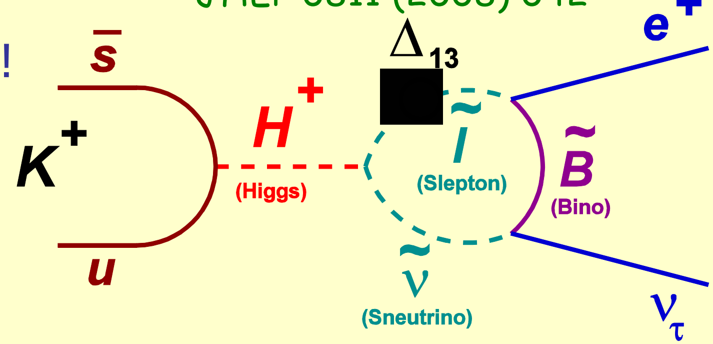


MSSM – other possible scenario

H^+ mediated lepton flavour violating contribution with emission of ν_τ

→ R_K enhancement can be experimentally accessible!

PRD 74 (2006) 011701, JHEP 0811 (2008) 042



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

A few percent effect in large (not extreme) $\tan\beta$ regime with massive charged Higgs

Example:

$(\Delta_{13}=5\times10^{-4}$, $\tan\beta=40$, $M_H=500$ GeV/c^2)

lead to $R_K^{LVF} = R_K^{SM}(1+0.013)$.

NB: analogous SUSY effects in pion decay are suppressed by a factor $(m_\pi/M_K)^4 \approx 6\times10^{-3}$

R_K & R_π: experimental status

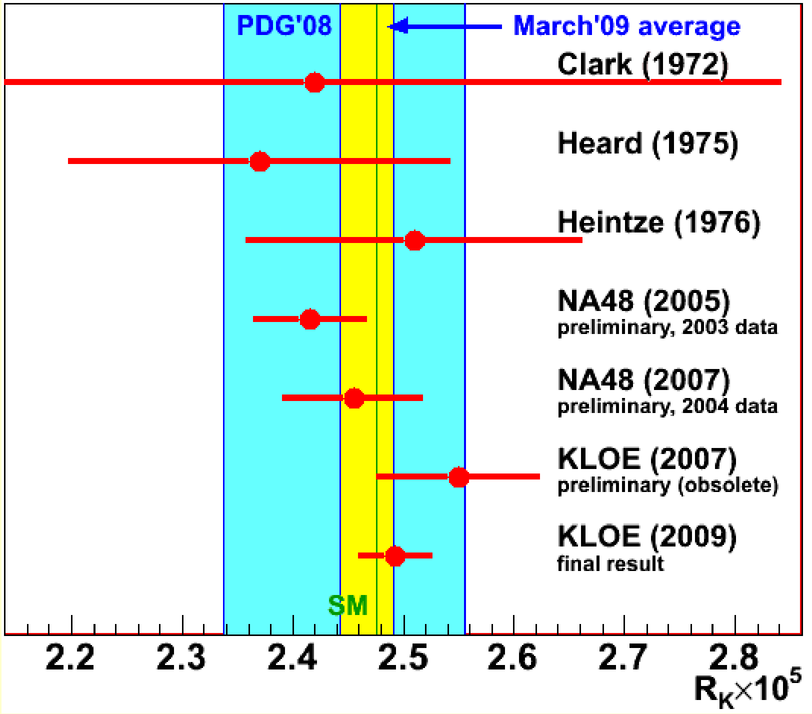
Kaon decays:

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

→ Recent improvement: KLOE (Frascati).
Data collected in 2001-2005,
13.8K K_{e2} candidates, 16% background.
$R_K=(2.493\pm0.031)\times10^{-5}$ ($\delta R_K/R_K=1.3\%$)
(arXiv:0907:3594)

→ NA62 (phase I) goal:
~150K K_{e2} candidates, <10% background,
accuracy $\delta R_K/R_K<0.5\%$ comparable to
expected non-SM contributions.

R_K world average (March 2009)

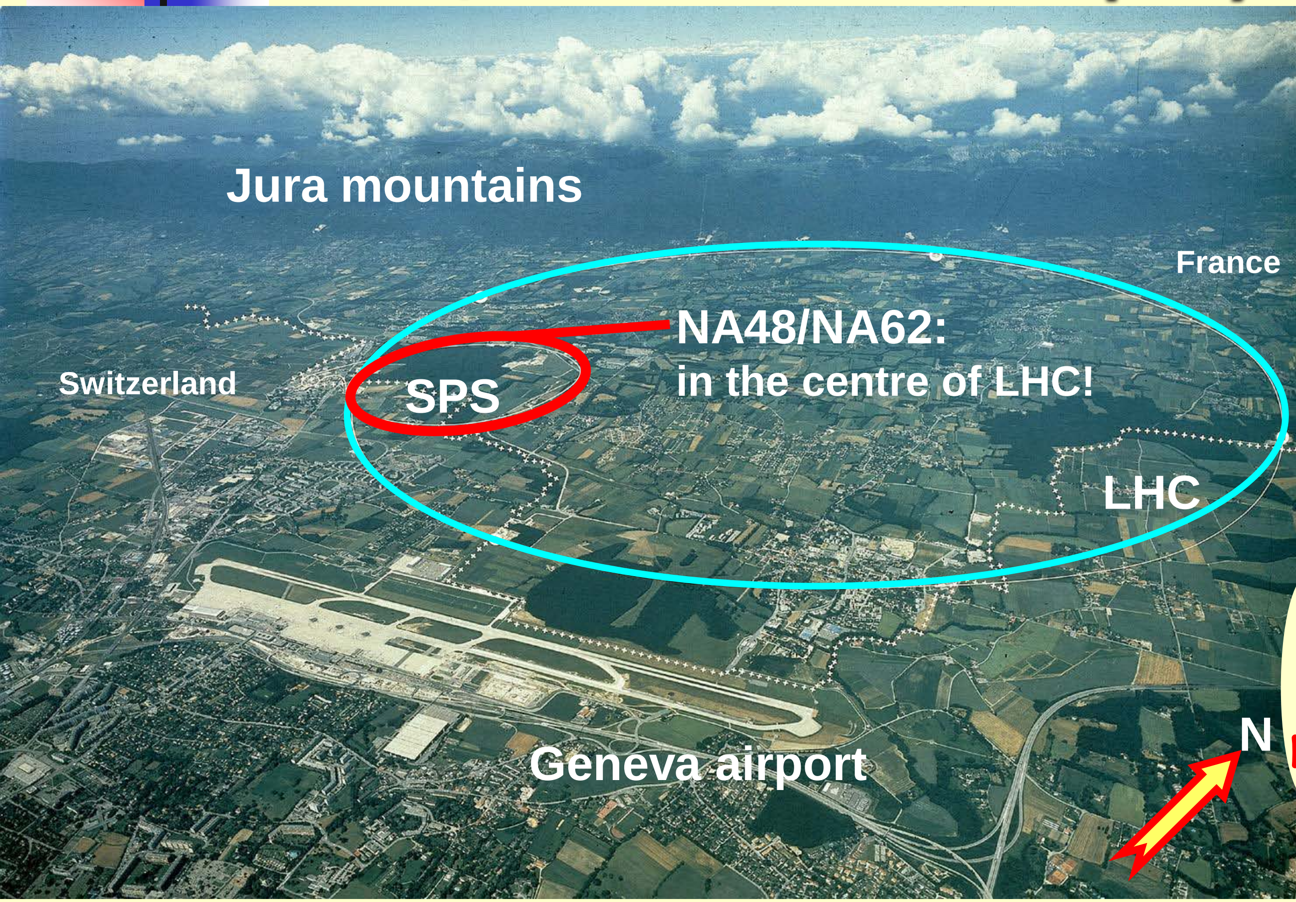


Pion decays:

→ PDG'08 average (1980s, 90s measurements):
$R_\pi=(12.30\pm0.04)\times10^{-5}$ ($\delta R_\pi/R_\pi=0.3\%$)

→ Future plans: TRIUMF proposal S1072,
$\delta R_\pi/R_\pi=0.06\%$ precision foreseen
Toshio Numao, PANIC'08 conference

NA48/NA62: kaon physics at CERN



NA48 (discovery of direct CPV)
- 1997: ε'/ε: K_L+K_S
- 1998: K_L+K_S
- 1999: K_L+K_S | K_S HI
- 2000: K_L only | K_S HI
- 2001: K_L+K_S | K_S HI

NA48/1
- 2002: K_S/hyperons

NA48/2
- 2003: K^+/K^-
- 2004: K^+/K^-

NA62 (phase I)
- 2007: $K^{\pm}_{e2}/K^{\pm}_{\mu2}$ | tests
- 2008: $K^{\pm}_{e2}/K^{\pm}_{\mu2}$ | tests

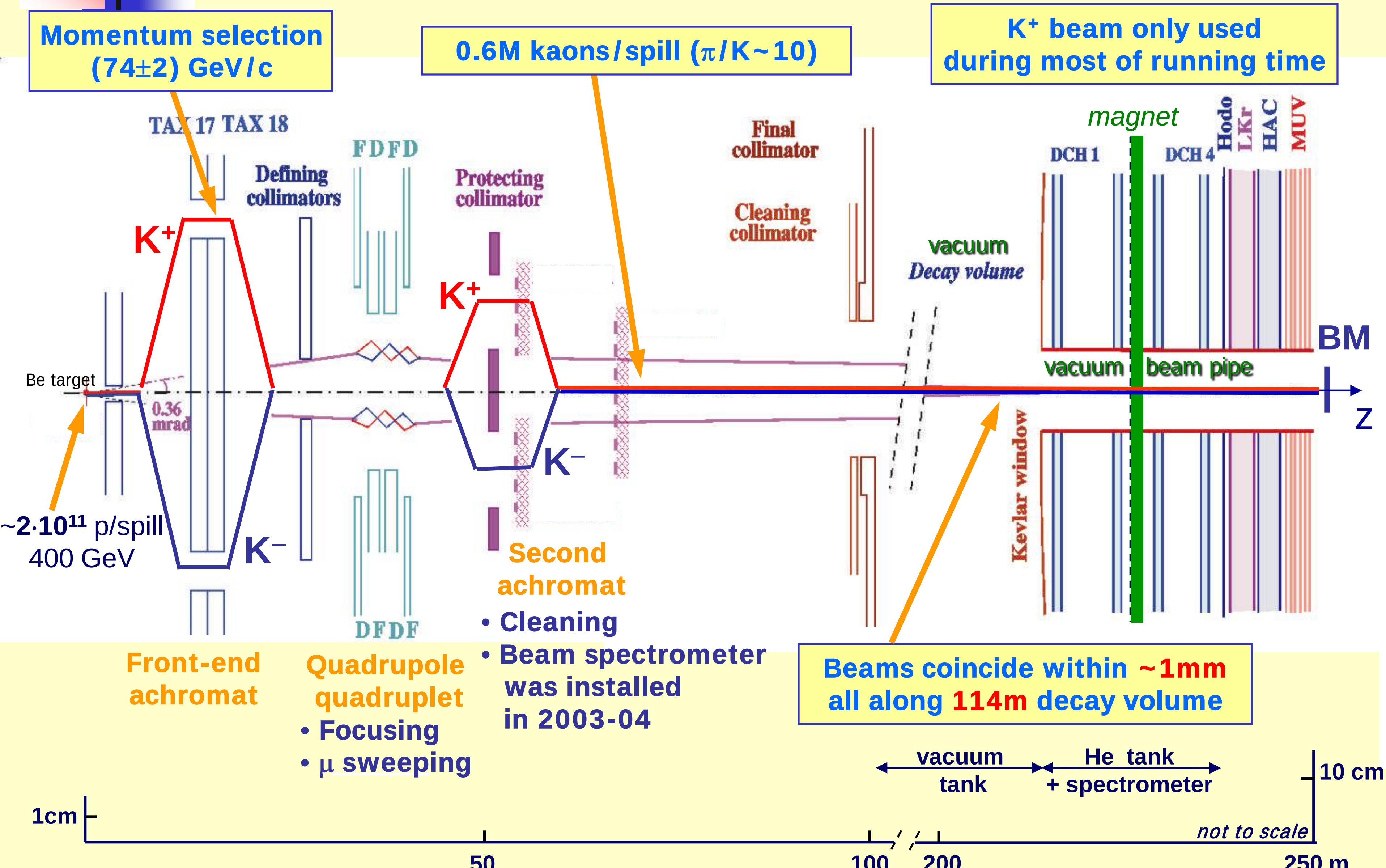
NA62 (phase II)
- 2006–2011: design & construction
- 2012–2014: $K^+\to\pi^+\nu\bar{\nu}$ data taking

NA62 phase I: Bern ITP, Birmingham, CERN, Dubna, Fairfax, Ferrara, Florence, Frascati, IHEP Protvino, INR Moscow, Louvain, Mainz, Merced, Naples, Perugia, Pisa, Rome I, Rome II, Saclay, San Luis Potosí, SLAC, Sofia, TRIUMF, Turin

NA48/NA62 $K^{\pm}$ beam line

Kaon decays in flight: beamline+setup are ~700 feet long

$K^{\pm}$ beam line in 2007



Momentum spectrum and K sign

Beam momentum:

NA48/2 beam line: capable of delivering simultaneous K^+/K^- beams (74 GeV/c in 2007)

Kinematic ID of the K_{l2} candidates:

$$M^2_{miss} = (P_K - P_l)^2$$

No beam spectrometer in 2007:
P_K is not measured, beam average used

Improvement of $K_{e2}/K_{\mu 2}$ kinematic separation

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Optimization of M_{miss}^2 resolution:
narrow momentum band beams ($\Delta P_K^{RMS}/P_K$=2%)

Kaon sign:

Beam halo background much higher for K_{e2}^- (~20%) than for K_{e2}^+ (~1%):

~90% of data sample: K^+ only.
~10% of data sample: K^- only.

K^+ ONLY and K^- ONLY samples: direct measurements of halo background using samples of K_{l2} candidates of the sign not present in the beam.

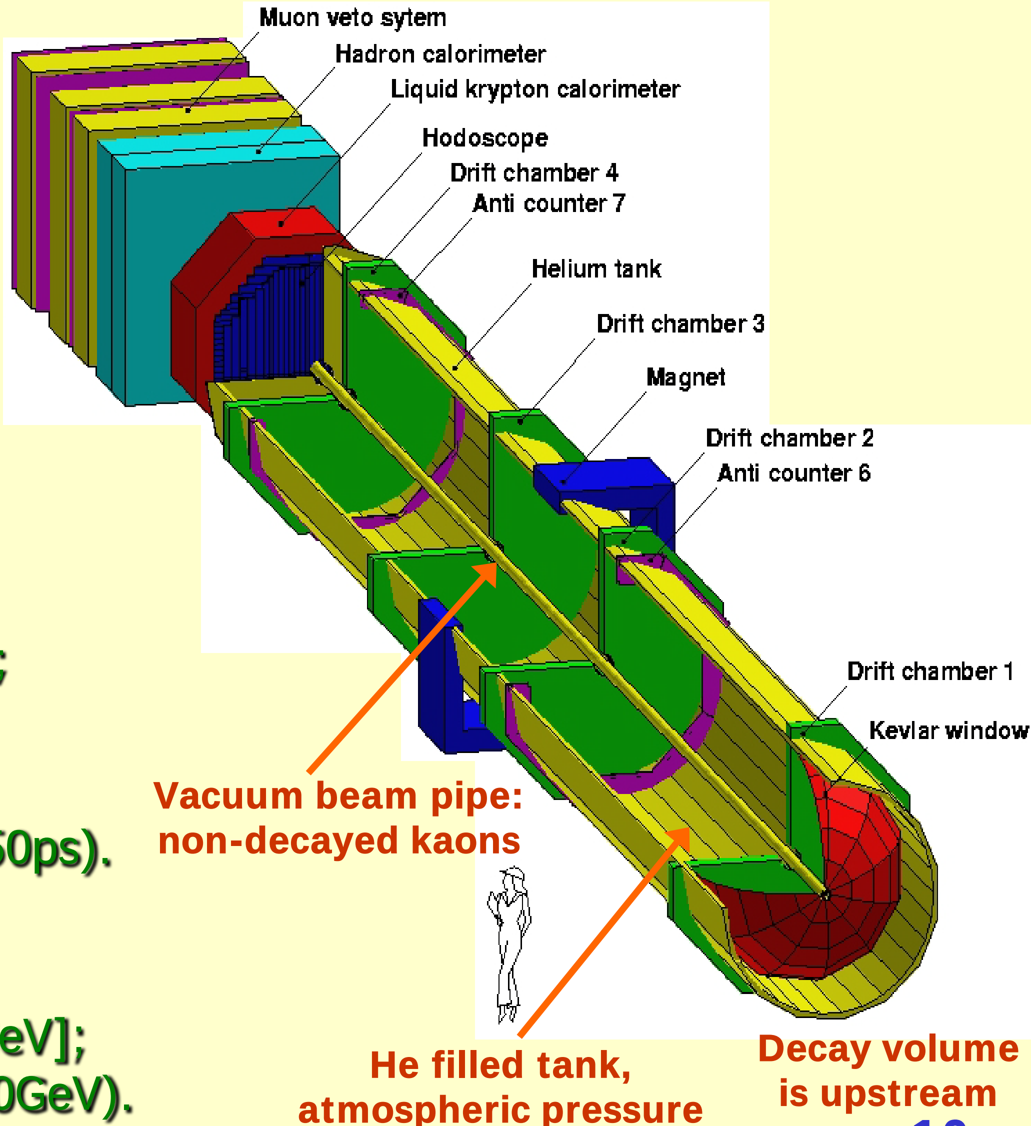
Data taking & detector: 2007/08

Data taking

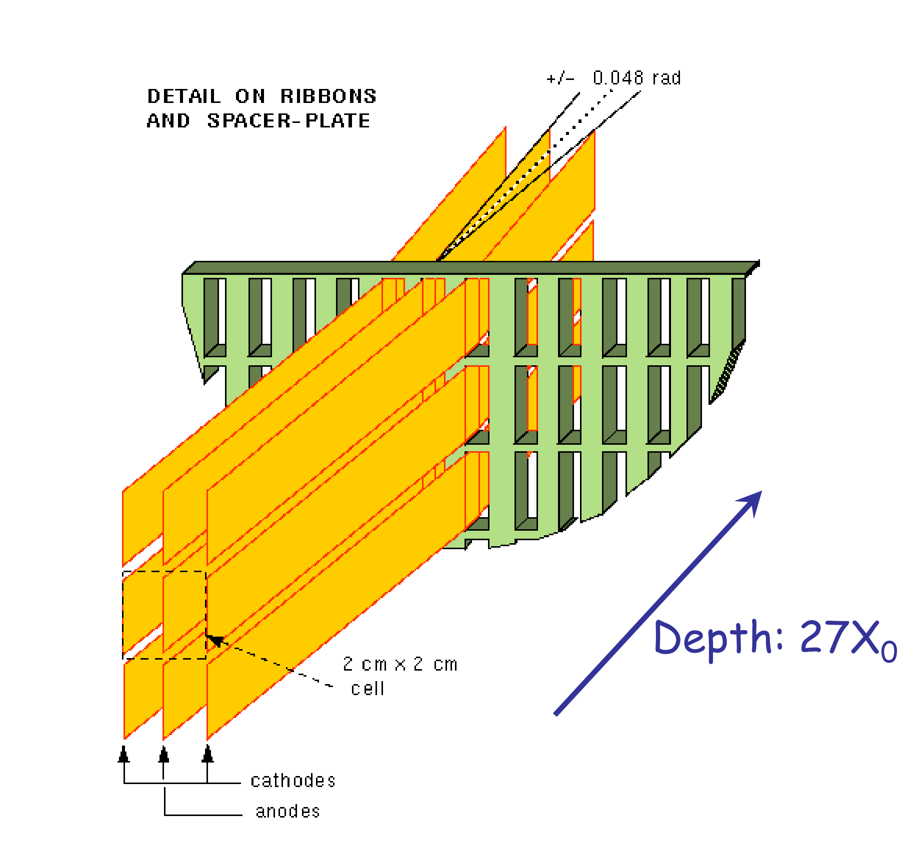
- Four months in 2007:
  ~400K SPS spills,
  ~300TB of raw data
- Two weeks in 2008:
  special data sets allowing reduction of the systematic uncertainties.

Principal subdetectors for R_K:

- Magnetic spectrometer (4 DCHs):
  4 views/DCH: redundancy ⇒ efficiency;
  $\Delta p/p = 0.47\% + 0.020\%{*}p$ [GeV/c]
- Hodoscope
  fast trigger, precise t measurement (150ps).
- Liquid Krypton EM calorimeter (LKr)
  High granularity, quasi-homogenious;
  $\sigma_E/E = 3.2\%/E^{1/2} + 9\%/E + 0.42\%$ [GeV];
  $\sigma_x = \sigma_y = 0.42/E^{1/2} + 0.6$mm (1.5mm@10GeV).



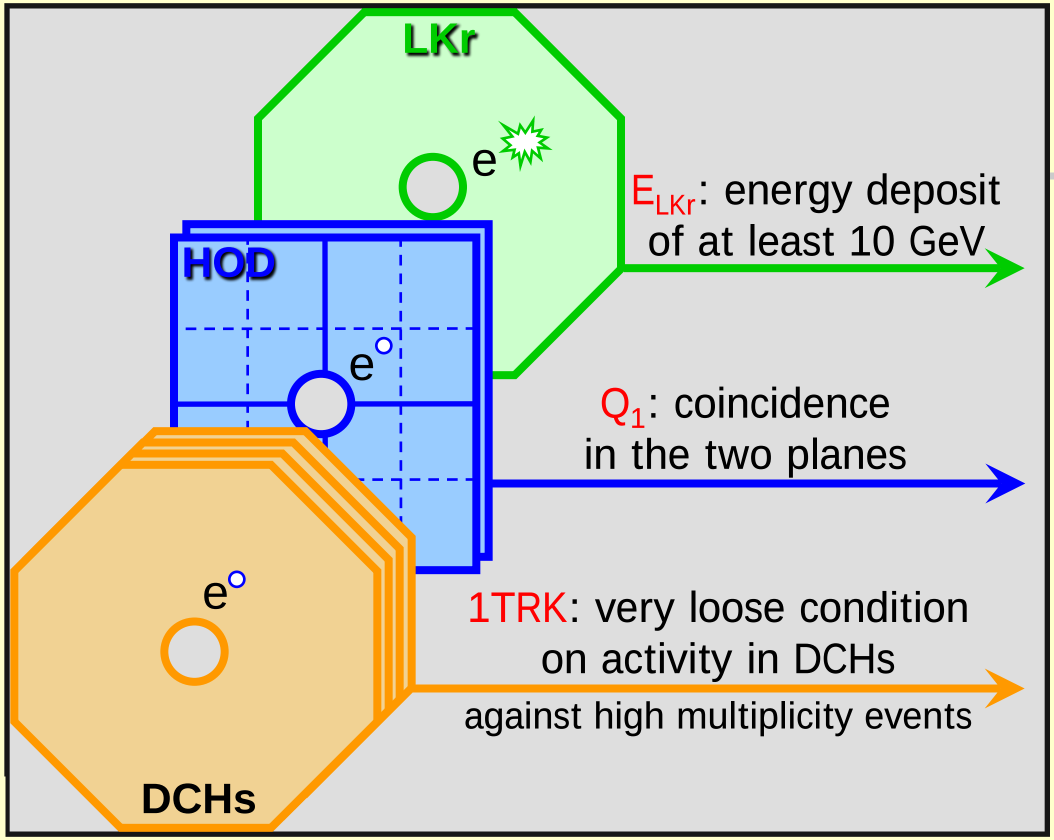
Electromagnetic LKr calorimeter



Transversal segmentation: 13,248 cells ($2\times2cm^2$), no longitudinal segmentation.

In the present analysis used for muon/electron identification and as a photon veto.

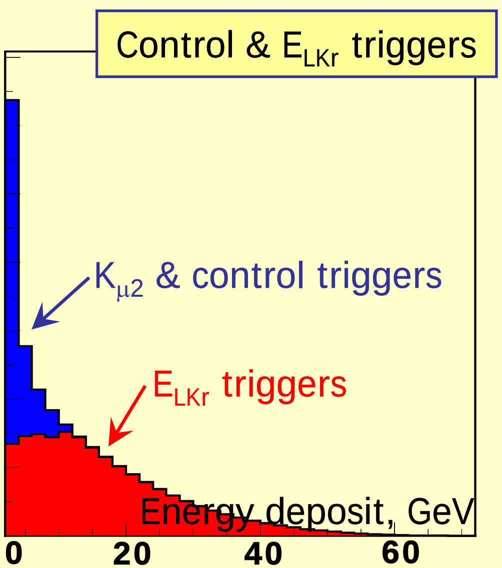
Trigger logic

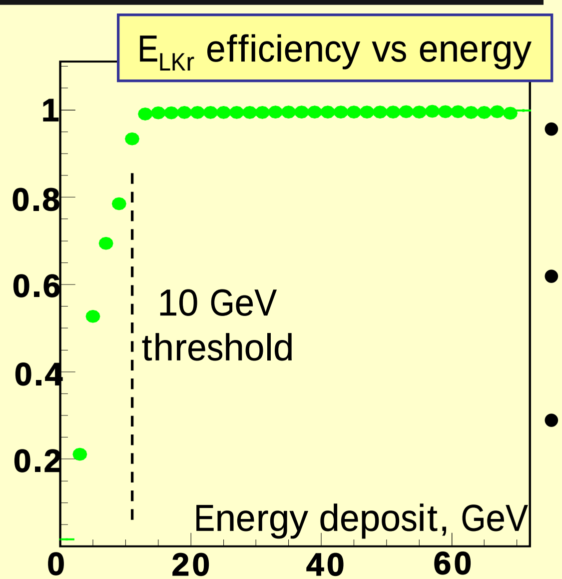


Minimum bias trigger used (high efficiency, but low purity)

$K_{\mu2}$ condition: $Q_1 \times 1TRK/D$, downscaling (D) 50 to 150. Purity ~2% (rate dominated by the beam halo).

K_{e2} condition: $Q_1 \times E_{LKr} \times 1TRK$. Purity $\sim 10^{-5}$.





- Efficiencies of the trigger components are monitored using control triggers.
- E_{LKr} inefficiency for electrons measured to be $(0.05 \pm 0.01)\%$ for $p_{track} > 15$ GeV/c.
- Different trigger conditions for signal and normalization modes.

Measurement strategy

(1) $K_{e2}/K_{\mu2}$ candidates collected simultaneously:

- the result does not rely on kaon flux measurement;
- several systematic effects cancel at first order (e.g. reconstruction/trigger efficiencies, time-dependent effects).

(2) 10 independent counting experiments in track momentum bins:

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

$N(K_{e2})$, $N(K_{\mu2})$:	numbers of selected K_{l2} candidates;
$N_B(K_{e2})$, $N_B(K_{\mu2})$:	numbers of background events; ⇒ main source of systematic errors
$A(K_{e2})$, $A(K_{\mu2})$:	MC geometric acceptances (no ID);
f_e, f_μ:	directly measured particle ID efficiencies;
$\varepsilon(K_{e2})/\varepsilon(K_{\mu2})>99.9\%$:	E_{LKr} trigger condition efficiency;
$f_{LKr}=0.9980(3)$:	global LKr readout efficiency.

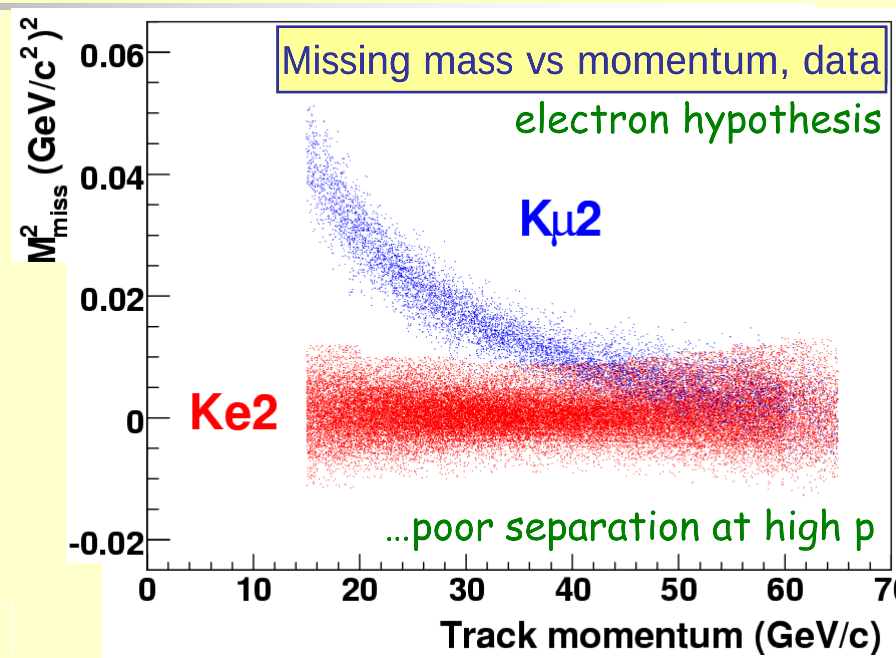
(3) MC simulations used to a limited extent only:

- Geometrical part of the acceptance correction (not for particle ID);
- simulation of "catastrophic" bremsstrahlung by muons.

K_{e2} and $K_{\mu 2}$ selection

Large common part (topological similarity)

- one reconstructed track;
- geometrical acceptance cuts;
- veto extra LKr energy deposition clusters;
- track momentum: 15GeV/c<p<65GeV/c;
- decay vertex defined as closest approach of track & nominal kaon axis.



Kinematic separation

missing mass $$M^2_{miss} = (P_K - P_l)^2$$

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

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

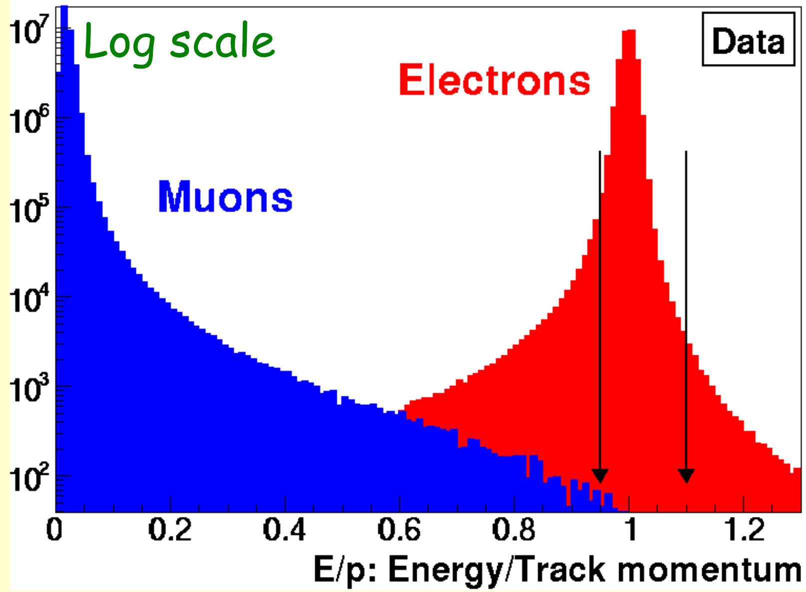
Separation by particle ID

E/p = (LKr energy deposit/track momentum).

0.95<E/p<1.10 for electrons,

E/p<0.85 for muons.

→ Powerful $\mu^{\pm}$ suppression in $e^{\pm}$ sample: $f \sim 10^6$



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

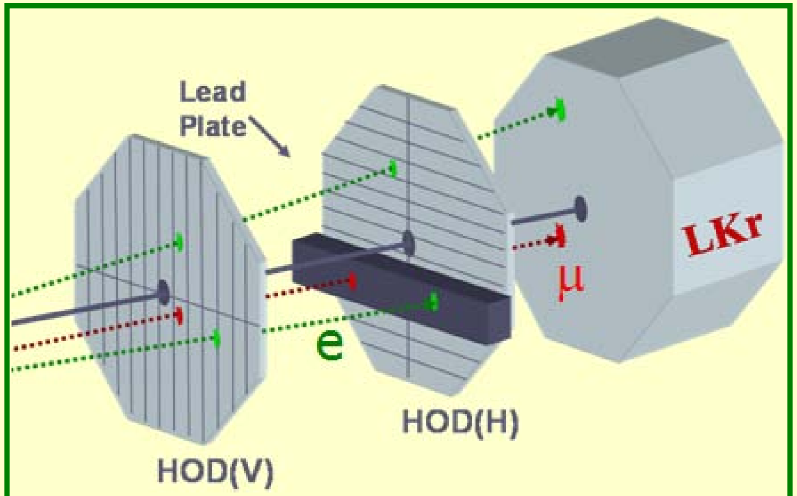
Background source:

"Catastrophic" energy loss by muons in LKr.
Muons with E/p>0.95 are identified as electrons.
$P(\mu \to e) \sim 3\times10^{-6}$ (and momentum-dependent).

$P(\mu \to e)/R_K \sim 10\%$:
$K_{\mu 2}$ decays represent a major background

Direct measurement of $P(\mu \to e)$ is required (based on pure muon samples) to validate theoretical bremsstralung cross-section in the very special high (E_γ/P_μ) region.

[Phys. Atom. Nucl. 60 (1997) 576]



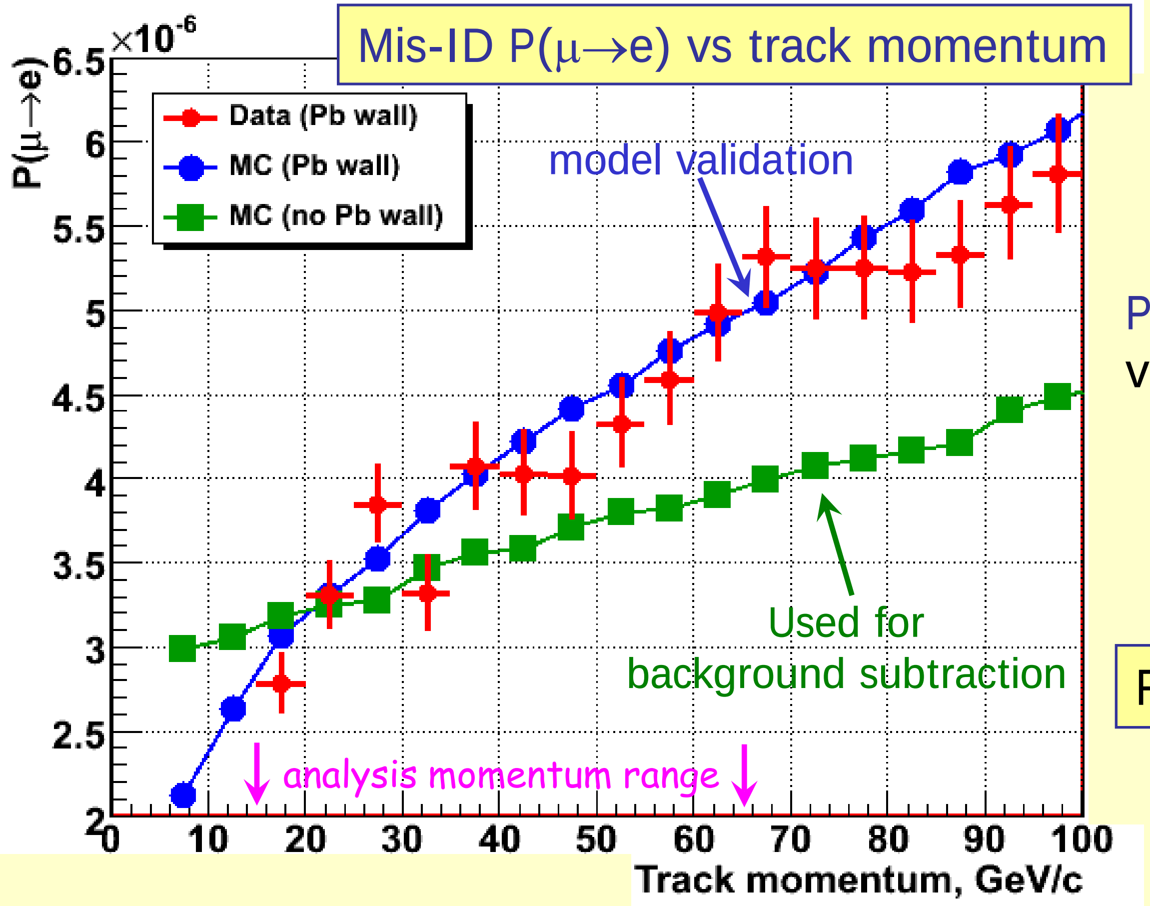
Thickness:	$\sim 10X_0$ (Pb+Fe)
Width:	240cm (=HOD size)
Height:	18cm (=3 counters)
Area:	~20% of HOD area
Duration:	~50% of R_K runs + special muon runs

Obtaining pure muon samples:

Pb wall ($\sim 10X_0$) between the HOD planes.
Tracks traversing the wall and having E/p>0.95 are pure muon samples (electron contamination $<10^{-7}$), with the $\mu \to e$ decay component (initially $\sim 10^{-4}$) suppressed.

$K_{\mu2}$ background (2)

P(μ→e): measurement (2007 special muon run) vs Geant4-based simulation



[Cross-section model:
Phys. Atom. Nucl. 60 (1997) 576]

Excellent data/MC agreement for the Pb wall installed!

P(μ→e) is modified by the Pb wall via two competing mechanisms:

1) ionization losses in Pb (low p);
2) bremstrahlung in Pb (high p).

→ a significant MC correction

Result: B/(S+B) = (6.28±0.17)%

(uncertainty is due to the limited size of the data sample used to validate the cross-section model)

Prospects:

- The 2008 special muon sample is twice as large as the 2007 one;
- Muons from regular $K_{\mu2}$ decays from kaon runs with the Pb wall installed.

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

For NA62 conditions
(74 GeV/c beam, ~100 m decay volume),

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

$K_{\mu 2}$ ($\mu \rightarrow e$) naïvely seems a huge background

Muons from $K_{\mu 2}$ decay are fully polarized:
Michel electron distribution

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

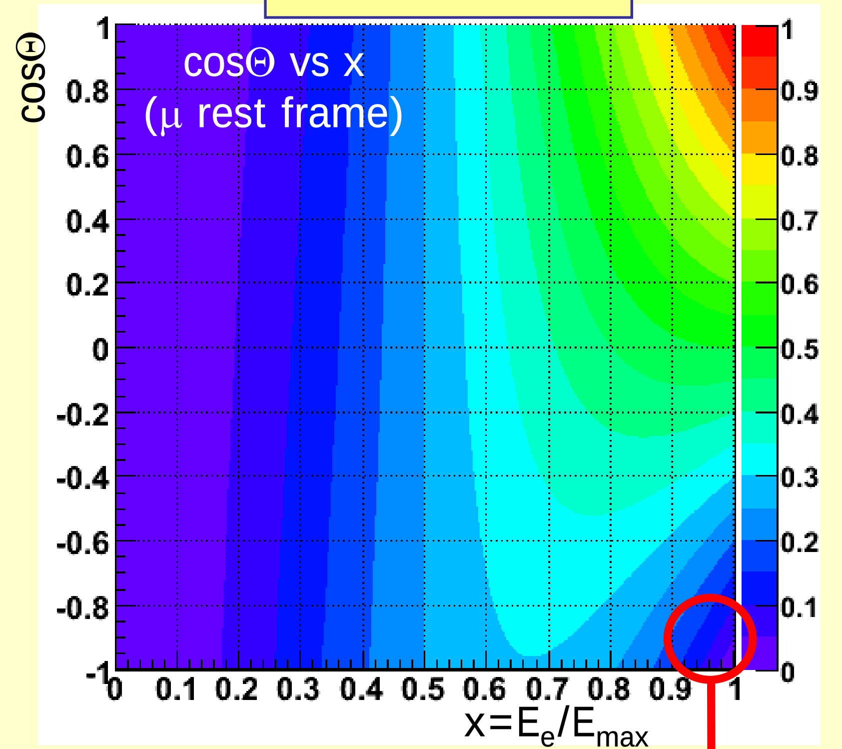
$x = E_e/E_{max} \approx 2E_e/M_\mu$,

Θ is the angle between p_e and the muon spin,
(all quantities are defined in muon rest frame).

Result: $B/(S+B) = (0.23 \pm 0.01)\%$

Important but not dominant background

Michel distribution

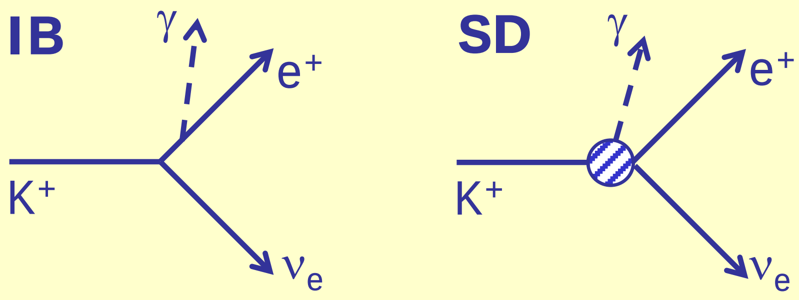


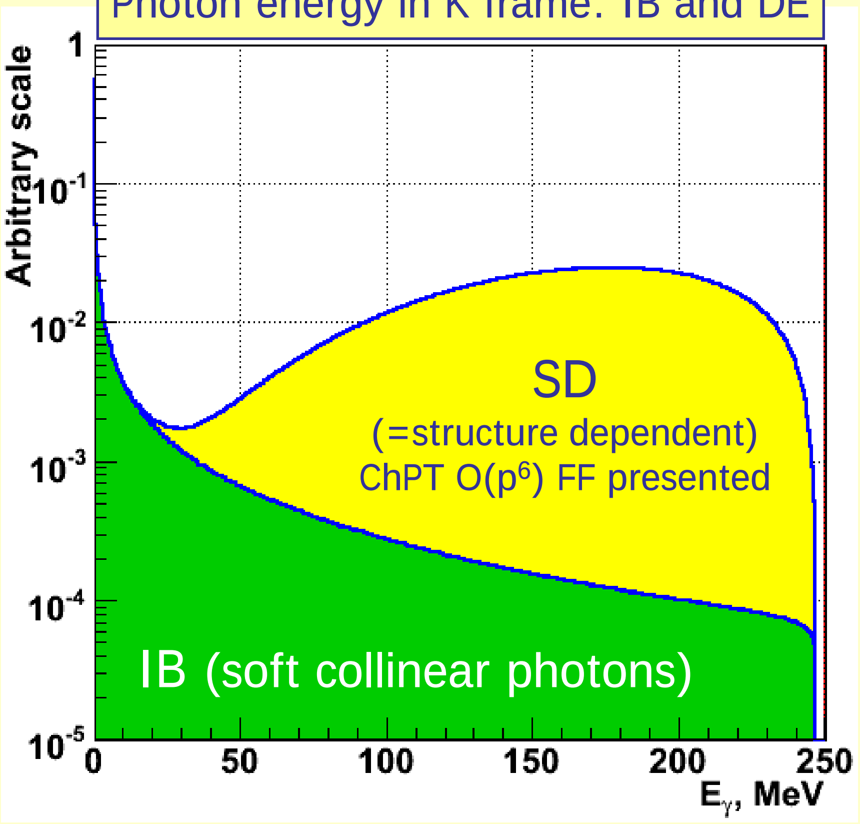
Only energetic forward electrons (passing M_{miss}, E/p, vertex CDA cuts) are selected as K_{e2} candidates: (high x, low $\cos\Theta$).

They are naturally suppressed by the muon polarisation

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

By definition, R_K is inclusive of the IB part only of the radiative $K_{e2\gamma}$ process





- The SD process treated as background.
- $K_{e2\gamma}$ (SD) is not helicity suppressed, and its rate is similar to that of K_{e2}.
- Known to a limited precision of ~15%.

(NB: a very recent 4% precision measurement arXiv:0907:3594 is not used in the present analysis)

Experiment: $BR=(1.52\pm0.23)\times10^{-5}$
(average of 1970s measurements)

Theory: $BR=(1.38–1.53)\times10^{-5}$ [PRD77 (2008) 014004]
(uncertainty due to a model-dependent form factor)

$K^+ \to e^+ \nu\gamma$ (SD) decay

Decay density:

$$\frac{d\Gamma(K\to e\nu\gamma)}{dxdy} = \underbrace{\rho_{IB}(x,y)}_{\text{helicity suppressed}} + \rho_{SD}(x,y) + \underbrace{\rho_{INT}(x,y)}_{\text{negligible}}$$

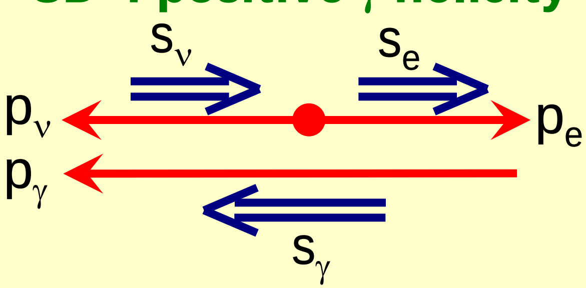
Kinematic variables (kaon frame): $x = 2E_\gamma/M_K, \quad y = 2E_e/M_K$

$$\rho_{SD}(x,y) = \frac{G_F^2|V_{us}|^2\alpha}{64\pi^2}M_K^5\left((f_V+f_A)^2 f_{SD+}(x,y) + (f_V-f_A)^2 f_{SD-}(x,y)\right)$$

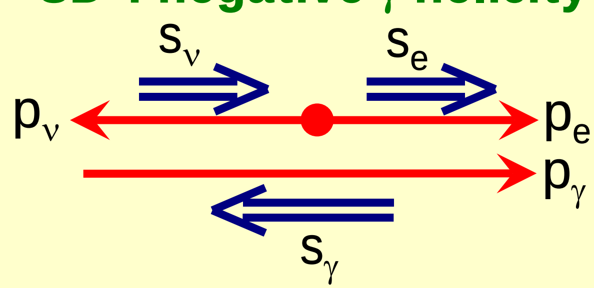
Two non-interfering contributions SD^+ and SD^-: emission of photons with positive and negative helicity

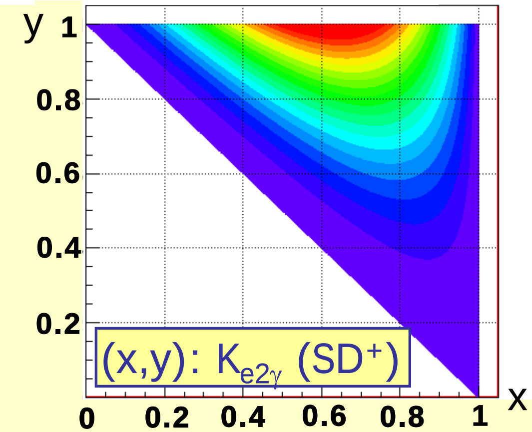
$f_V(x)$, $f_A(x)$: model-dependent effective vector and axial couplings

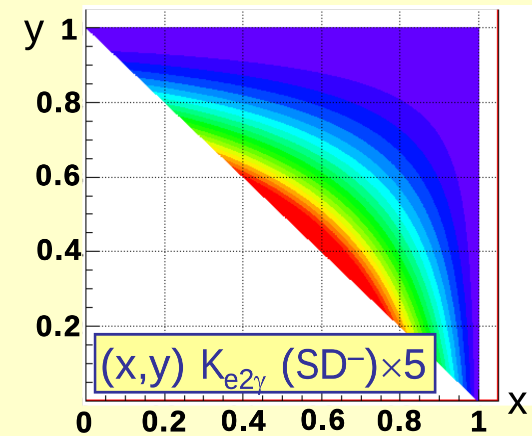
SD^+: positive γ helicity



SD^-: negative γ helicity

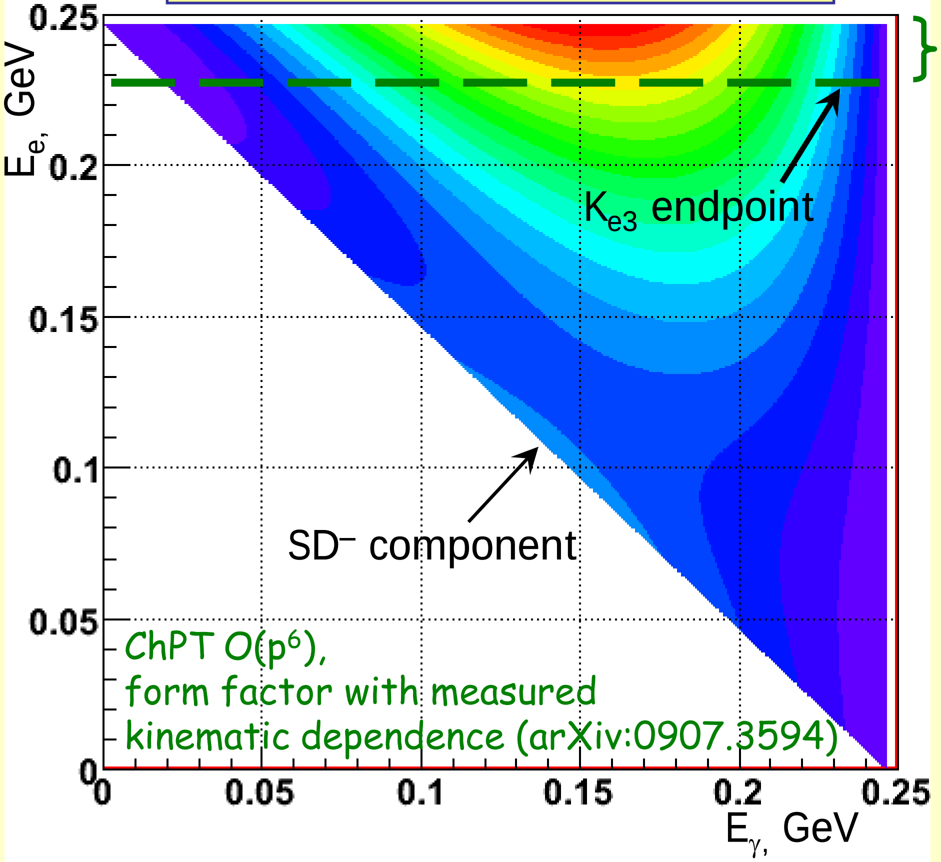






$K^+ \to e^+ \nu\gamma$ (SD$^+$) background

$K_{e2\gamma}$ (SD) Dalitz plot distribution



Only energetic electrons (E_e^*>230MeV) are compatible to K_{e2} kinematic ID and contribute to background

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This region of phase space is accessible for direct BR and form-factor measurement (being above the E_e^*=227 MeV endpoint of the K_{e3} spectrum).

$K_{e2\gamma}$ (SD$^-$) background is negligible, peaking at low $E_e = E_{max}/2 \approx 123$ MeV

SD background contamination

$B/(S+B) = (1.02 \pm 0.15)\%$

(uncertainty due to PDG BR, to be improved by NA62 & KLOE)

Beam halo background

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

Reminder

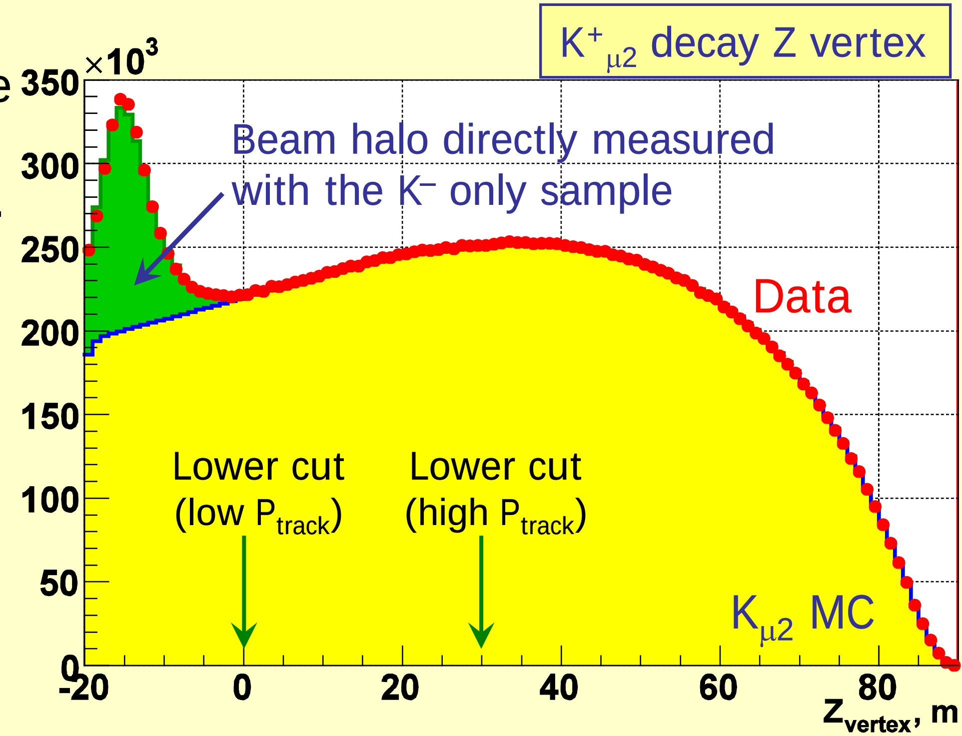
- Halo background much higher for K_{e2}^- (~20%) than for K_{e2}^+ (~1%).
- Halo background in the $K_{\mu2}$ sample is considerably lower.
- ~90% of the data sample is K^+ only, ~10% is K^- only.
- K^+ halo component is measured directly with the K^- sample and vice versa.

The background is measured to sub-permille precision, and strongly depends on decay vertex position and track momentum.

The selection criteria (esp. Z_{vertex}) are optimised to minimise the halo background.

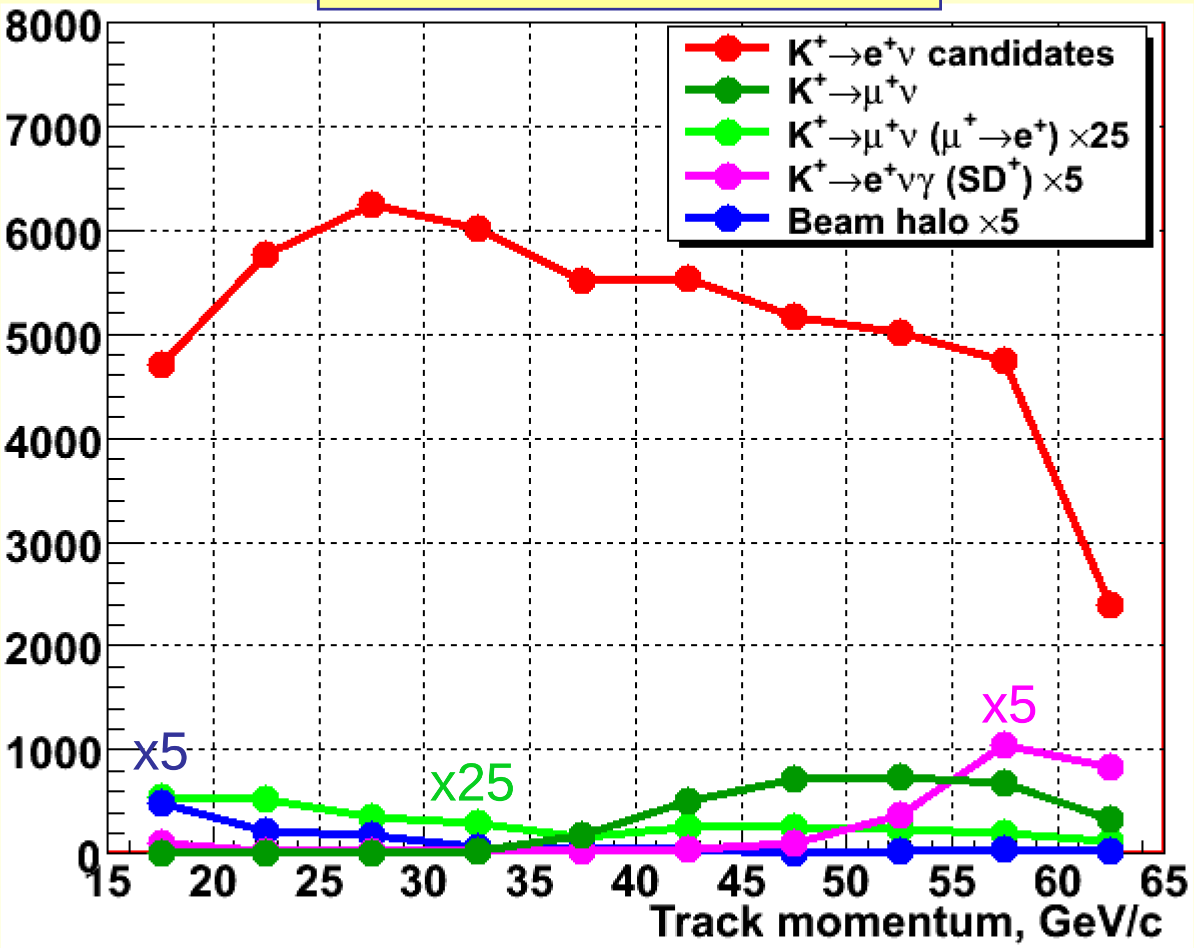
$B/(S+B) = (0.45\pm0.04)\%$

Uncertainty is due to the limited size of the control sample.



Backgrounds: summary

Statistics in momentum bins



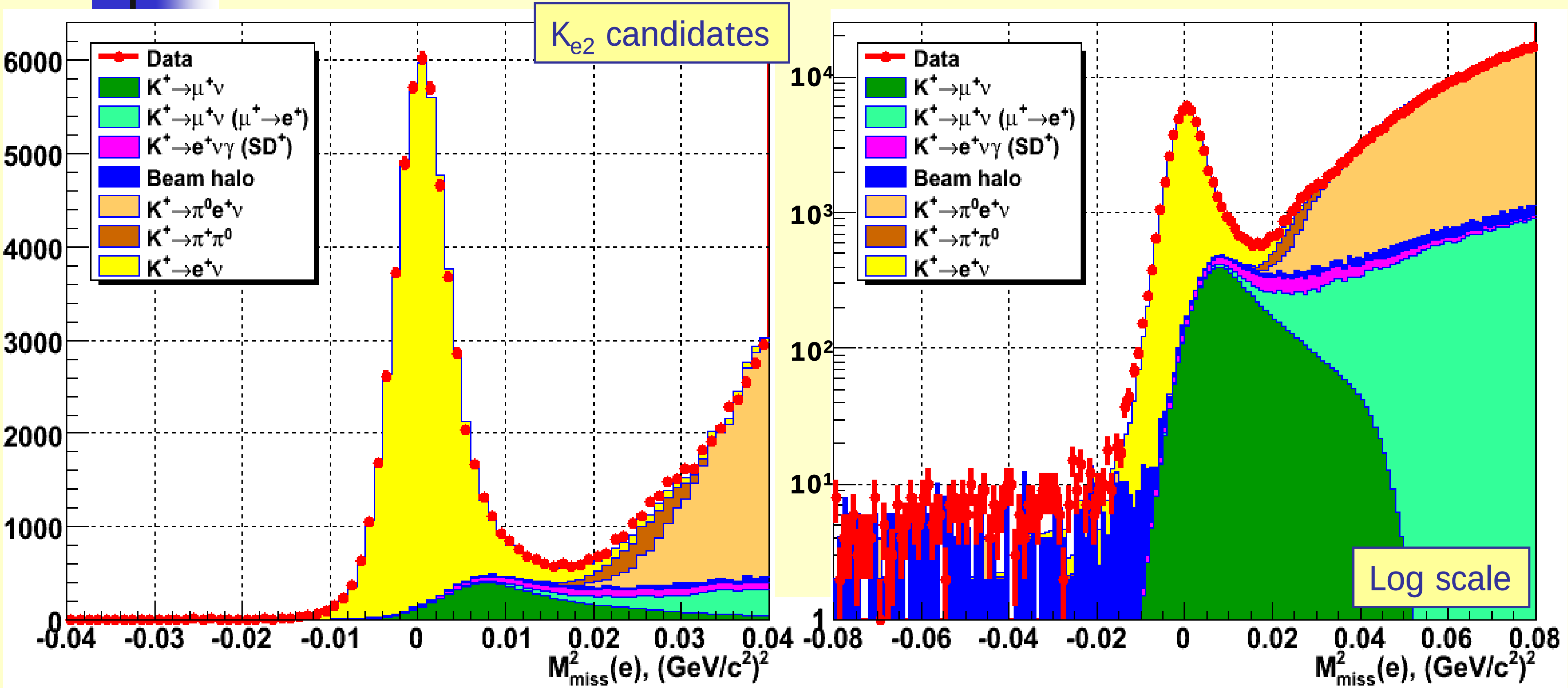
(selection criteria, e.g. for Z_{vertex} and M_{miss}^2, are optimised individually in each P_{track} bin)

Background summary

Source	B/(S+B)
$K_{\mu 2}$	(6.28±0.17)%
$K_{\mu 2}$ ($\mu \to e$)	(0.23±0.01)%
$K_{e2\gamma}$ (SD^+)	(1.02±0.15)%
Beam halo	(0.45±0.04)%
K_{e3}	0.03%
$K_{2\pi}$	0.03%
Total	(8.03±0.23)%

Record K_{e2} sample:
51,089 candidates
with low background
B/(S+B) = (8.0±0.2)%

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

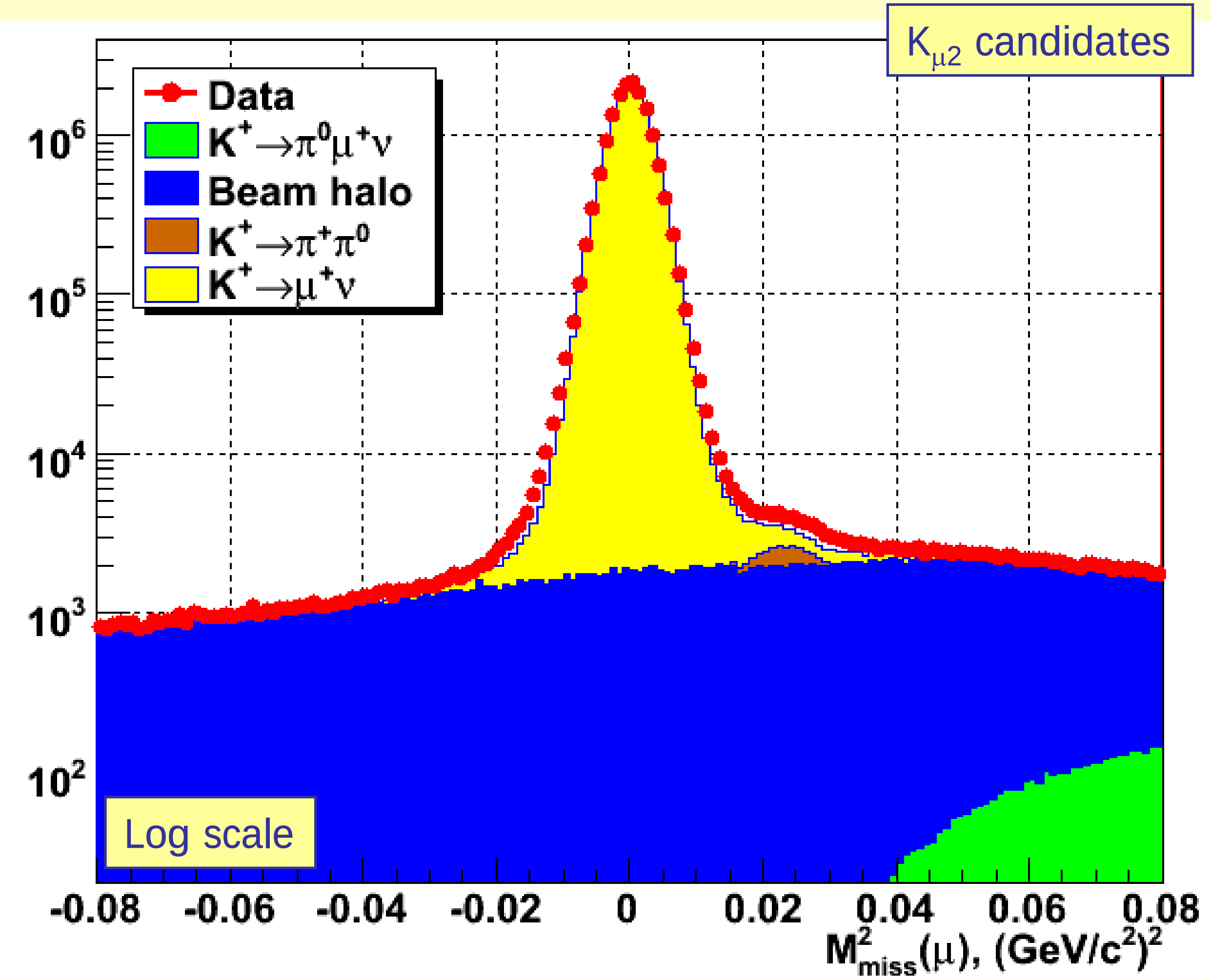


51,089 $K^+ \to e^+\nu$ candidates,
99.2% electron ID efficiency,
B/(S+B) = (8.0±0.2)%

cf. KLOE: 13.8K candidates (K^+ and K^-),
~90% electron ID efficiency, 16% background

NA62 estimated total K_{e2} sample:
~120K K^+ & ~15K K^- candidates.
Proposal (CERN-SPSC-2006-033):
150K candidates

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



15.56M candidates with low background B/(S+B) = 0.25%

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

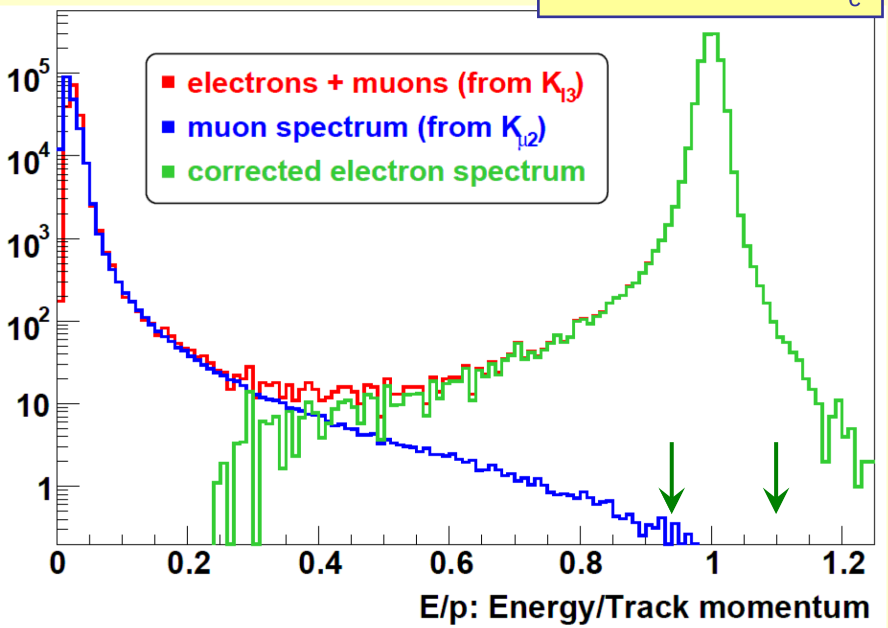
The only significant background source is the beam halo.

Electron ID efficiency (f_e)

Measured directly with samples of pure electrons:

- $K^{\pm}\to\pi^0 e^{\pm}\nu$ from main $K^{\pm}$ data taking (limited track momentum $p<50$GeV/c);
- $K_L\to\pi^{\pm}e^{\pm}\nu$ from a special 15h K_L run (wider track momentum range, due to broad K_L momentum spectrum).

Measurement of f_e



Measurement with $K^{\pm}\to\pi^0 e^{\pm}\nu$ decays:

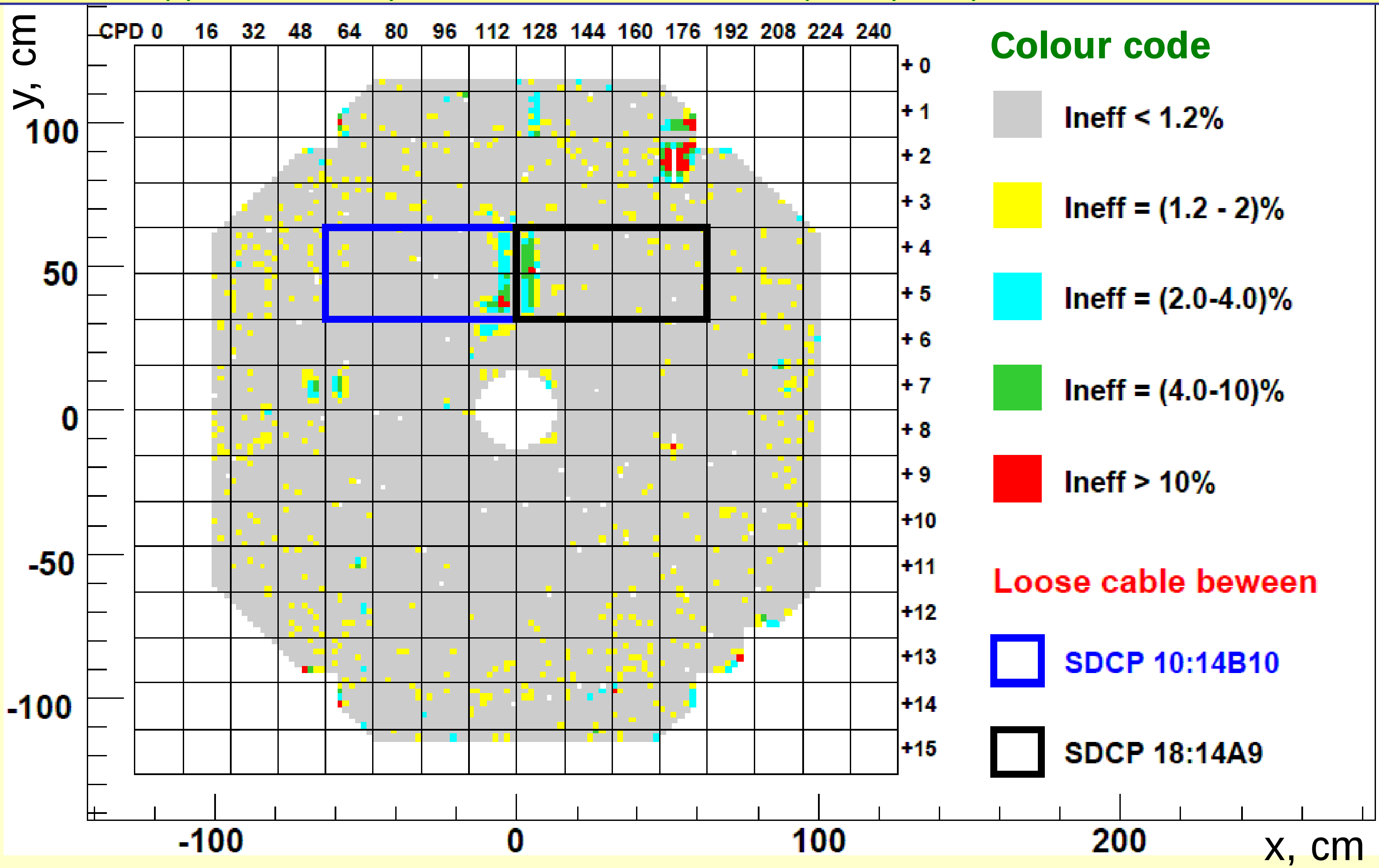
- Selected event sample consists of $K^{\pm}\to\pi^0 e^{\pm}\nu$ and some $K^{\pm}\to\pi^0\mu^{\pm}\nu$ events;
- To subtract the muon component, normalised muon E/p spectrum measured using the $K_{\mu2}$ sample is used.

Measurement with $K_L\to\pi^{\pm}e^{\pm}\nu$ is more difficult: the pion component also contributes to the spectrum.

Excellent agreement between $K^{\pm}$ and K_L methods.
Average f_e=99.15%, precision <0.1%, weak momentum dependence.

LKr inefficiency map

LKr efficiency is monitored vs time for every 2×2cm² cell within acceptance. A typical example of the inefficiency map is presented below.



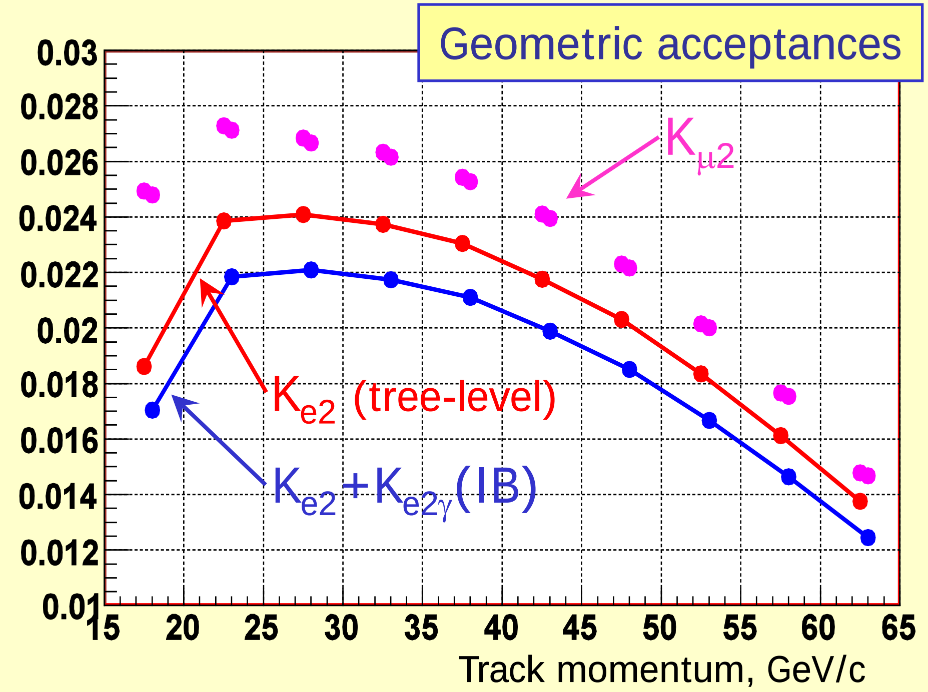
Higher inefficiency is at low momentum → room for optimisation

Other systematic effects

Geometric acceptance correction

- p_{track}-dependent, $A(K_{\mu 2})/A(K_{e2})\sim 1.3$;
- strongly affected by the radiative (IB) corrections to K_{e2};

  IB process simulated according to
  V. Cirigliano and I. Rosell,
  Phys. Lett. 99 (2007) 231801
- conservative systematic uncertainty for prelim. result: $\delta R_K/R_K=0.3\%$, due to approximations used in IB simulation.



Trigger efficiency correction

- E_{LKr} efficiency directly affects R_K;
- monitored with control trigger samples;
- conservative systematic uncertainty for preliminary result: $\delta R_K/R_K=0.3\%$ (due to dead time generated by accidentals).

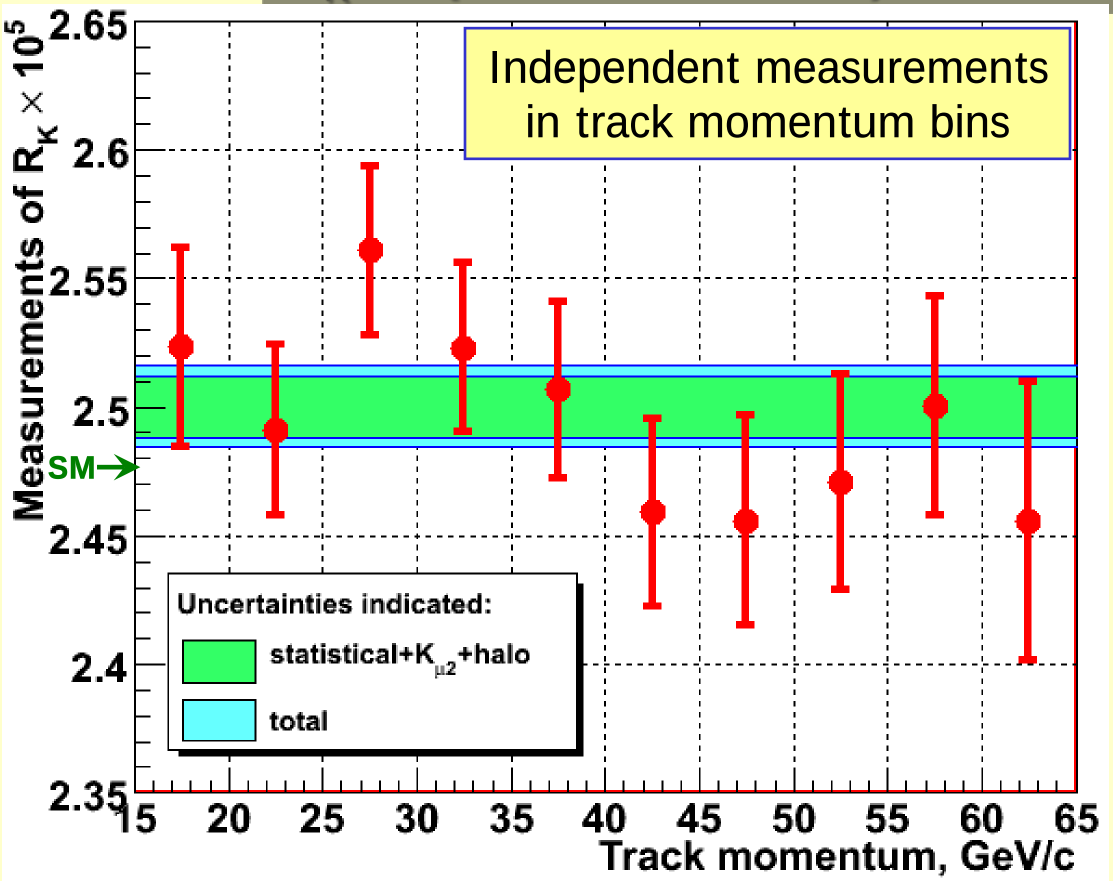
Global LKr efficiency

- Also affects the result directly;
- $f_{LKr}=(99.80\pm0.03)\%$ is measured directly using a parallel ('spy') calorimeter readout.

Preliminary result (40% data set)

$R_K = (2.500 \pm 0.012_{stat} \pm 0.011_{syst}) \times 10^{-5}$
$= (2.500 \pm 0.016) \times 10^{-5}$

(announced in June 2009)



Uncertainties

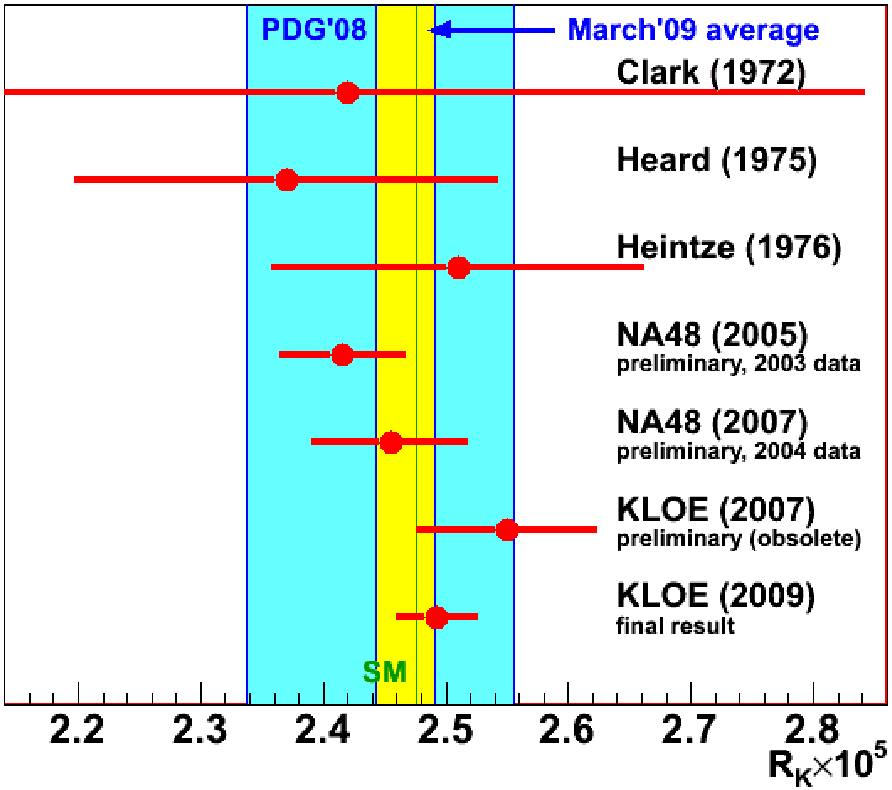
Source	$\delta R_K \times 10^5$
Statistical	0.012
$K_{\mu 2}$	0.004
Beam halo	0.001
$K_{e2\gamma}$ (SD^+)	0.004
Electron ID	0.001
IB simulation	0.007
Acceptance	0.002
Trigger timing	0.007
Total	0.016

(0.64% precision)

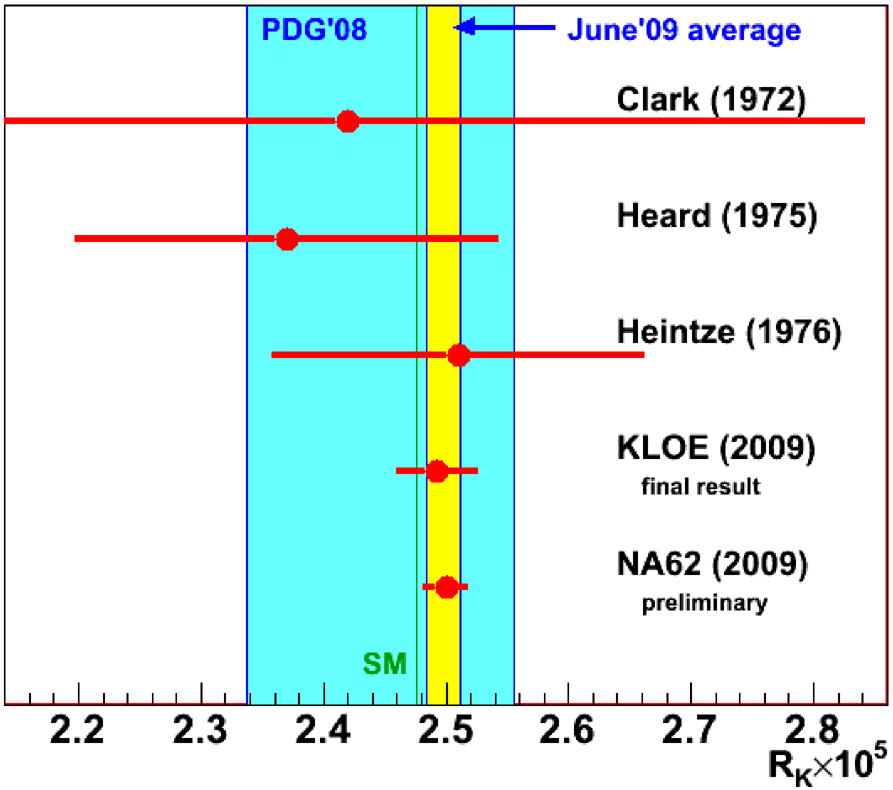
The whole 2007 sample will allow statistical uncertainty ~0.3%, total uncertainty of 0.4–0.5%.

Comparison to world data

March 2009



June 2009



World average	$\delta R_K \times 10^5$	Precision
March 2009	2.467±0.024	0.97%
June 2009	2.498±0.014	0.56%

(NA48/2 preliminary results excluded from the new average: they are superseded by NA62)

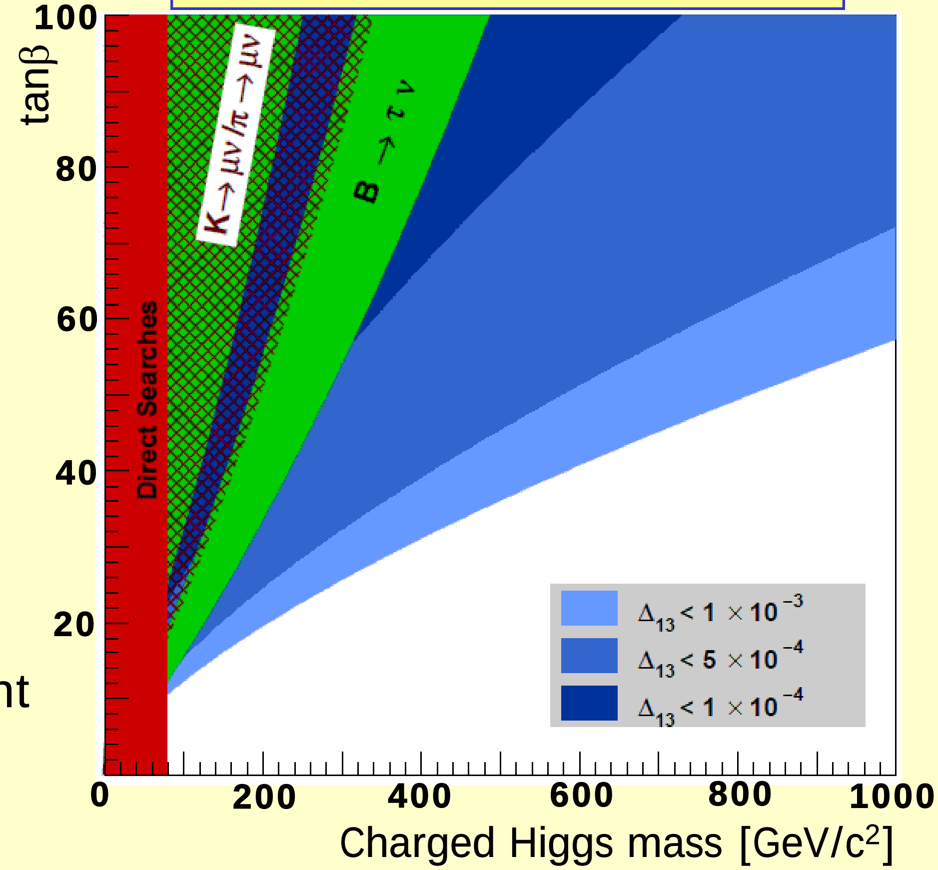
R_K: sensitivity to new physics

Exclusion limits at 95% CL
derived from the new R_K world average
are presented.

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

R_K measurements are currently in agreement with the SM expectation at $\sim 1.5\sigma$.
Any significant enhancement with respect to the SM value would be an evidence of new physics

(M_H, $\tan\beta$) 95% exclusion limits



The future of NA62: $K_{\pi\nu\nu}$

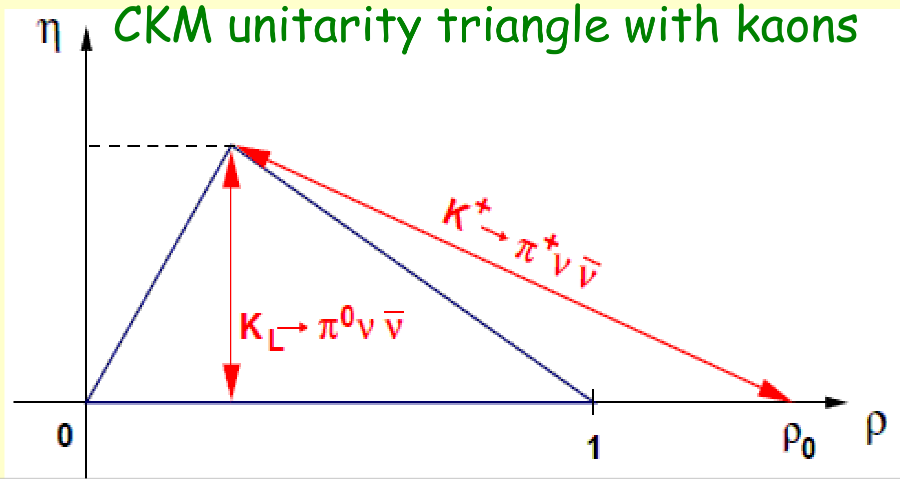
$K^+ \to \pi^+ \nu\nu$: theoretically clean, sensitive to NP, almost unexplored

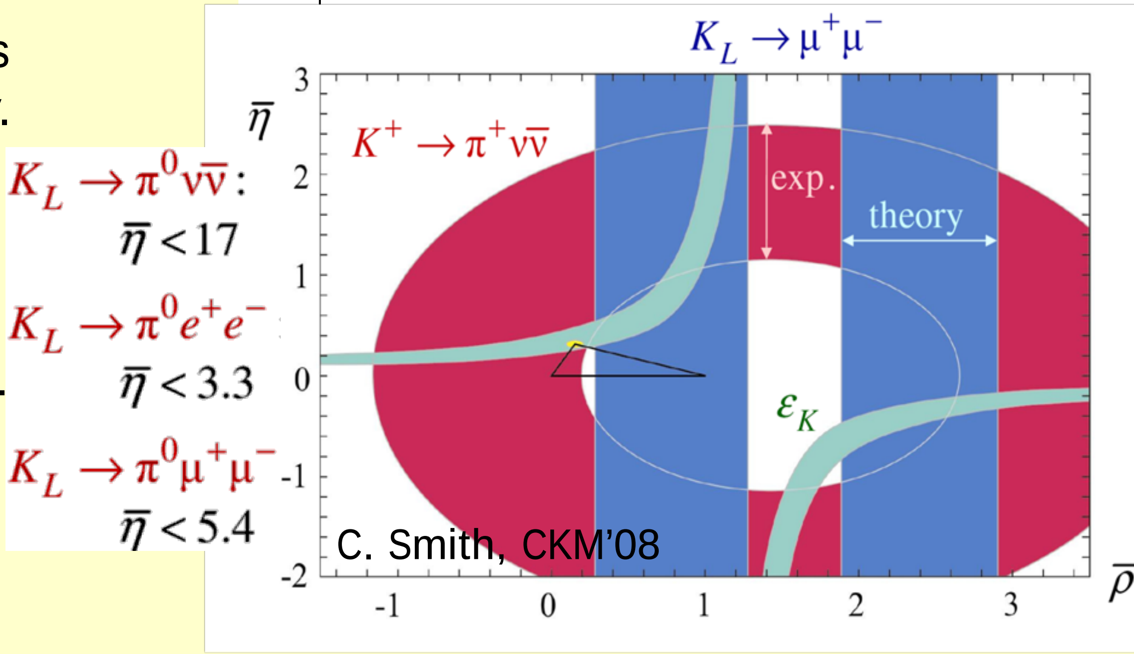
Branching ratio $\times 10^{10}$

	Theory (SM)	Experiment
$K^+ \to \pi^+ \nu\nu(\gamma)$	0.82 ± 0.08	$1.73^{+1.15}_{-1.05}$
$K_L \to \pi^0 \nu\nu$	0.28 ± 0.04	<670 (90% CL)

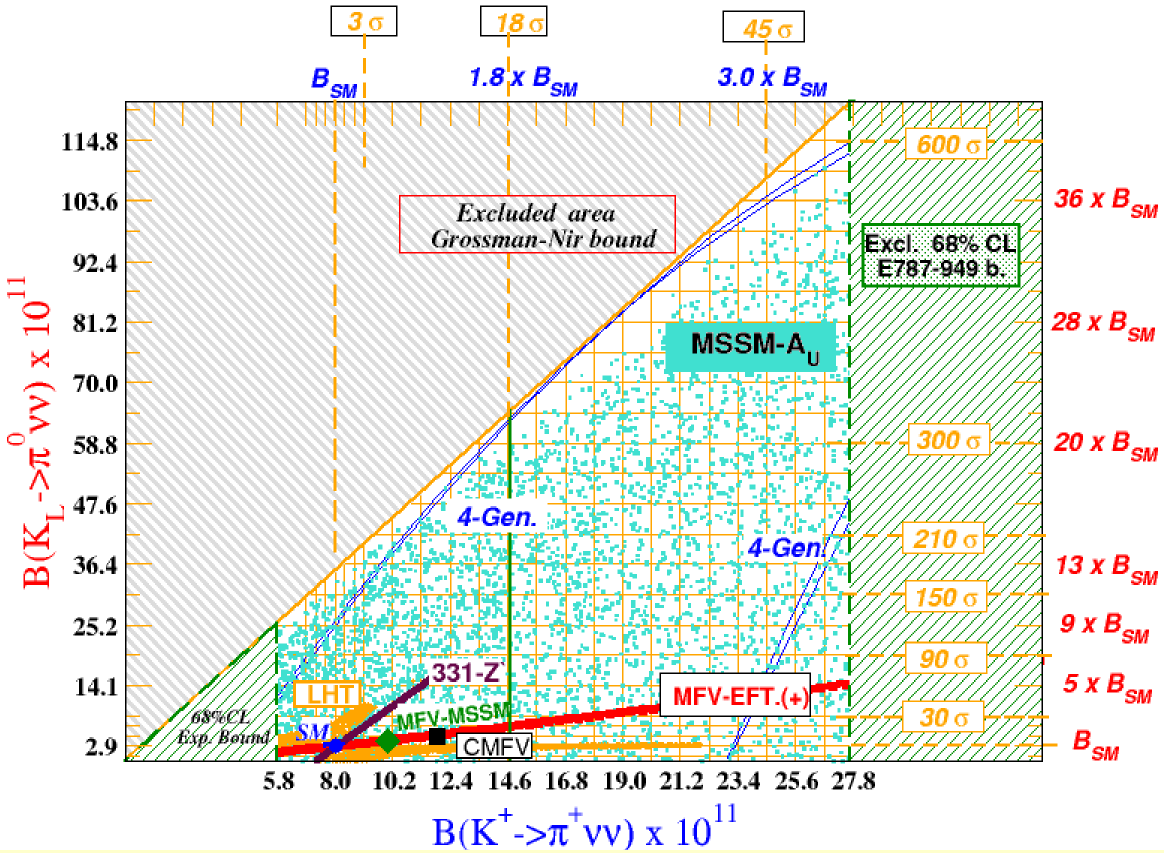
$$BR(K^+ \to \pi^+ \nu\nu) \sim |V_{ts}^* V_{td}|^2$$

- Ultra-rare FCNC process, proceeds via penguin and loop diagrams only.
- Hadronic matrix element is extracted from $K^+ \to \pi^0 e^+ \nu$.
- Exceptional SM precision not matched by any other loop-induced meson decay.
- Uncertainties mainly come from charm contributions.





Sensitivity of New Physics



BR($K^+ \to \pi^+ \nu\nu$) $\times 10^{10}$: selected models	
SM	0.82±0.08
MFV (hep-ph/0310208)	1.91
EEWP (NPB697 (2004) 133, hep-ph/0402112)	0.75±0.21
EDSQ (PRD70 (2004) 093003, hep-ph/0407021)	up to 1.5
MSSM (NPB713 (2005) 103, hep-ph/0408142)	up to 4.0

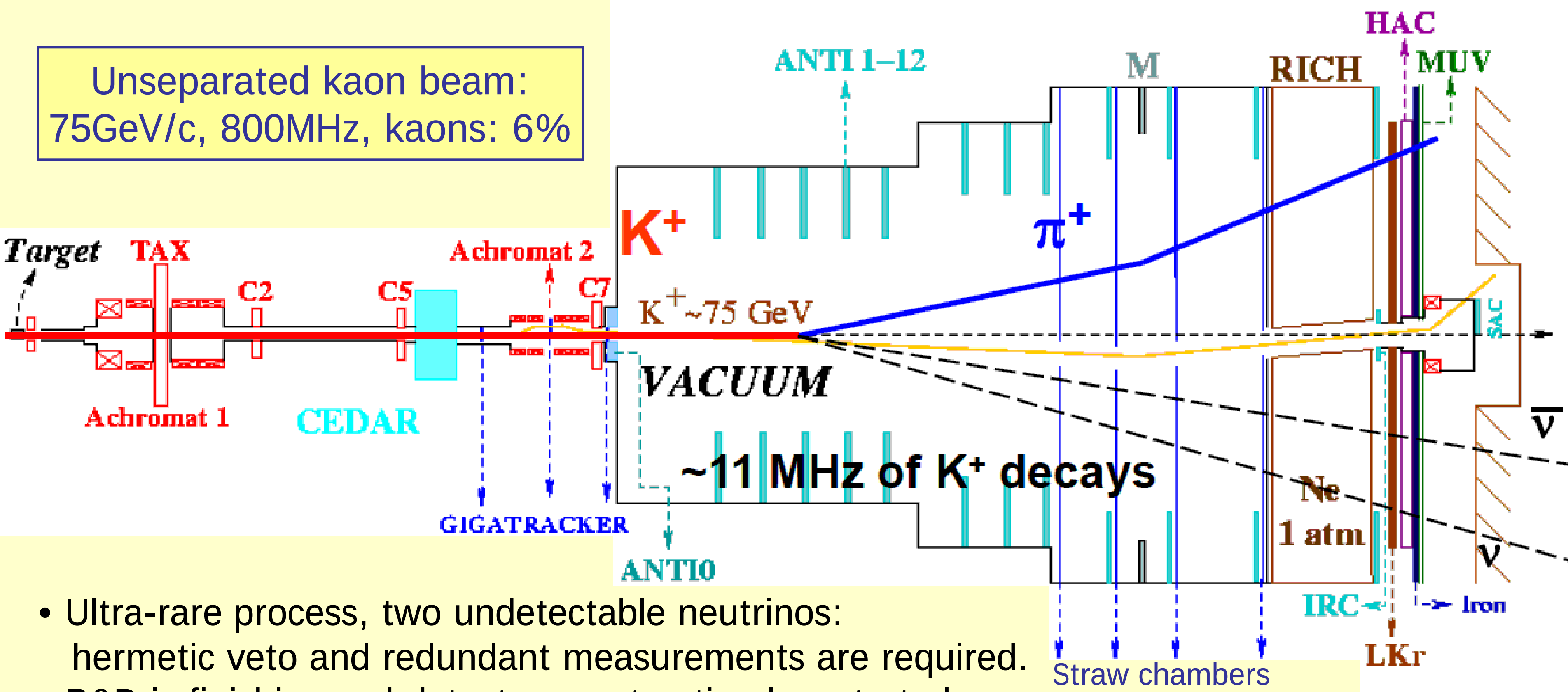
- Large variations in predictions for New Physics.
- Need a 10% precision measurement to provide a stringent SM test.

The NA62 collaboration aims to measure O(100) $K^+ \to \pi^+ \nu\nu$ candidates with ~10% background in 2-3 years of data taking

NA62 experiment (phase II)

Unseparated kaon beam:
75GeV/c, 800MHz, kaons: 6%

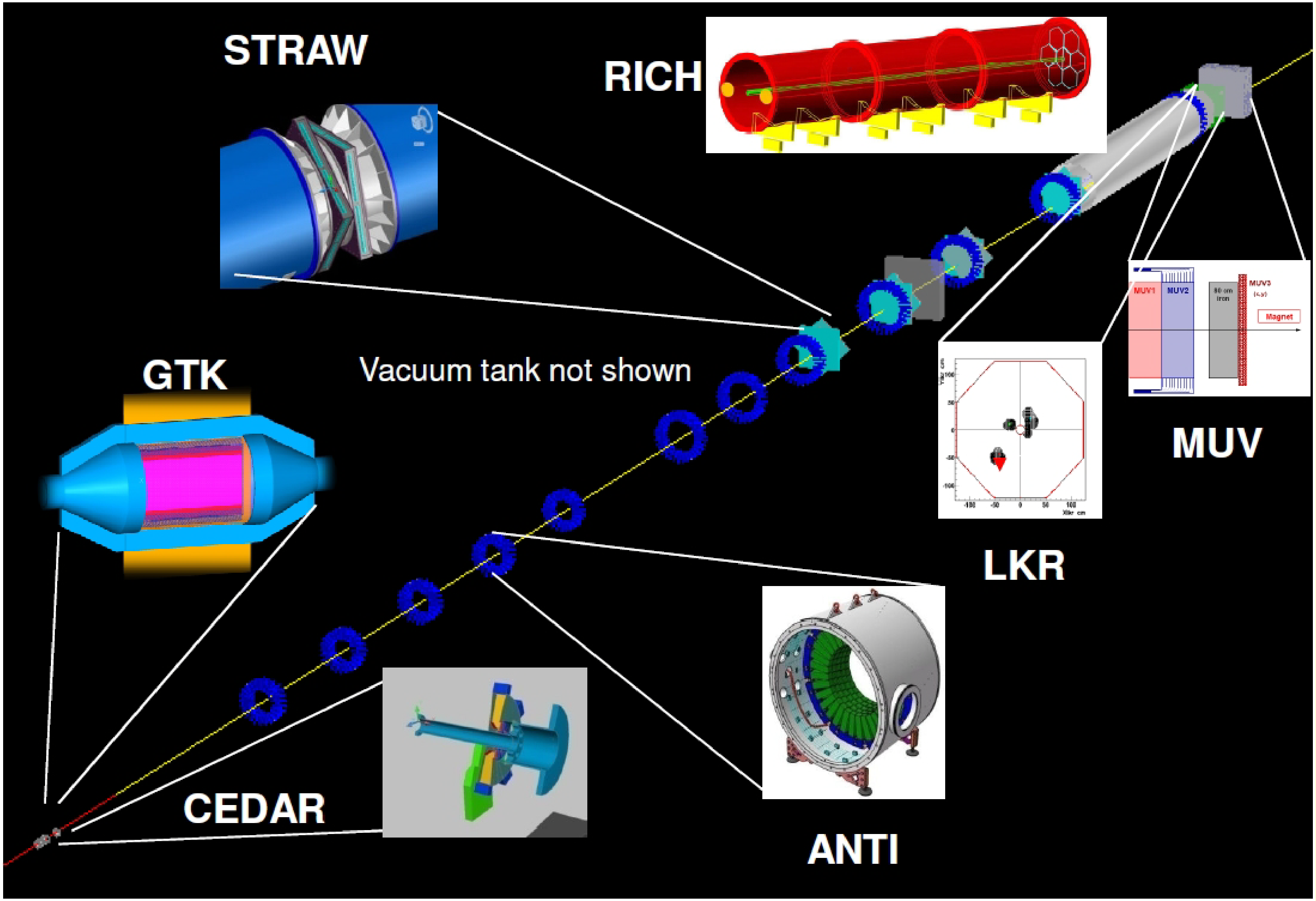
Not to scale!



- Ultra-rare process, two undetectable neutrinos:
  hermetic veto and redundant measurements are required.
- R&D is finishing, subdetector construction has started.

- Approved by the CERN research board in December 2008;
- Reviewed by PPAP in July 2009;
- SoI to be submitted to PPAN in November 2009.
  Signed by four institutes: Birmingham, Bristol, Glasgow, Liverpool.

NA62 event display



Conclusions & prospects

- Due to the helicity suppression of the K_{e2} decay, the measurement of R_K is well-suited for a stringent test of the Standard Model.

- NA62 data taking in 2007-08 was optimised for R_K measurement, and increased the world K_{e2} sample by an order of magnitude. Excellent $K_{e2}/K_{\mu 2}$ separation (>99% electron ID efficiency and $\sim 10^6$ muon suppression) leads to a low 8% background.

- Preliminary result based on ~40% of the NA62 K_{e2} sample $R_K = (2.500 \pm 0.016) \times 10^{-5}$ reached a record 0.7% accuracy, and is compatible with the SM prediction.
  Timely result: direct searches for New Physics at the LHC are approaching.

- Future of NA62: stringent SM test by measurement of the ultra rare decay $K^+ \to \pi^\pm \nu\nu$ with 10% precision, excellent prospects for R_K measurement at 0.1% level, extensive rare decay programme.