NA62
---Measurement of K^+-$\pi^+\nu\nu$---

May 28, 2017

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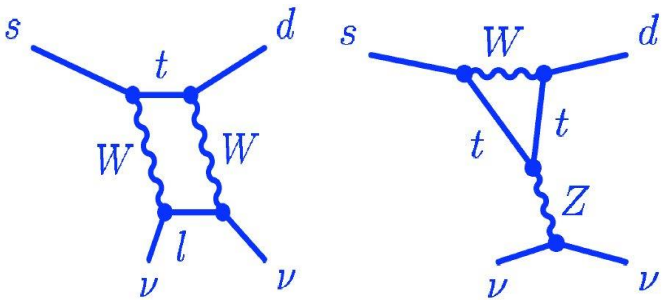
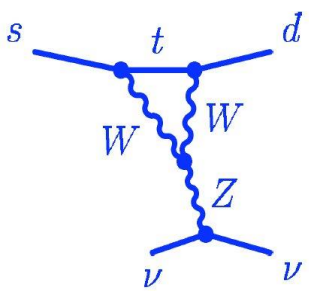
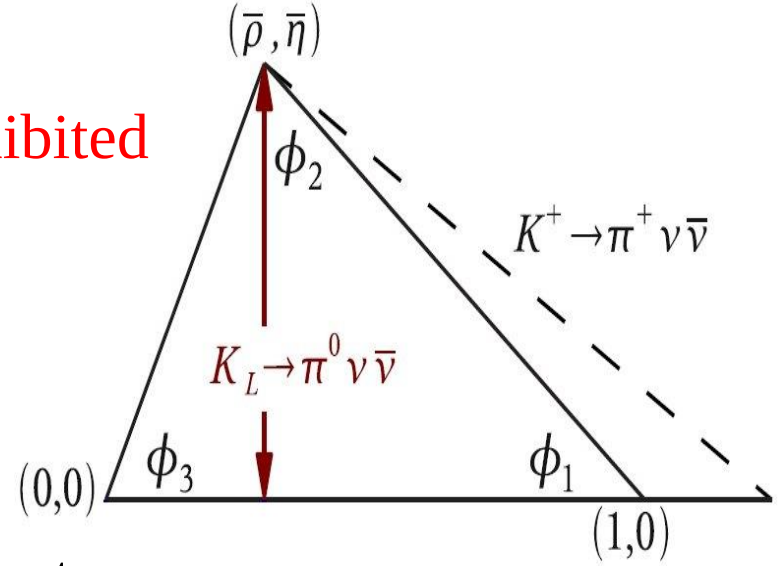
K→πνν̄ decays

u,d



Tree diag. prohibited

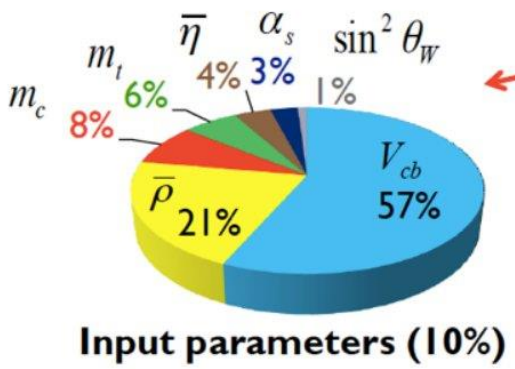




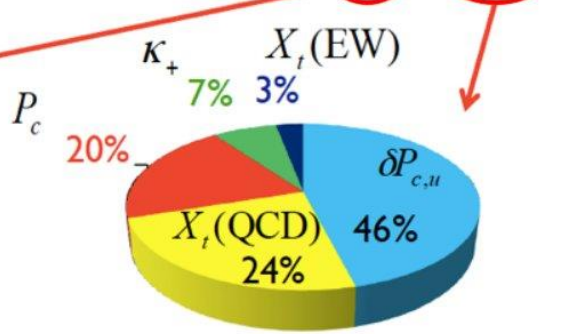
-K-πeν decay provides hadronic form factors.
-Calculated including the full 2-loop EW corrections.
-Uncertainties come from that of the CKM matrix.
-Uncertainty in the charm contribution in K^+ decay is 5 %.

Current theoretical prediction [1] [2]

$$\mathrm{BR}(K^+\to\pi^+\nu\bar{\nu}) = (7.81^{+0.80}_{-0.71}\pm 0.29)\times 10^{-11}$$

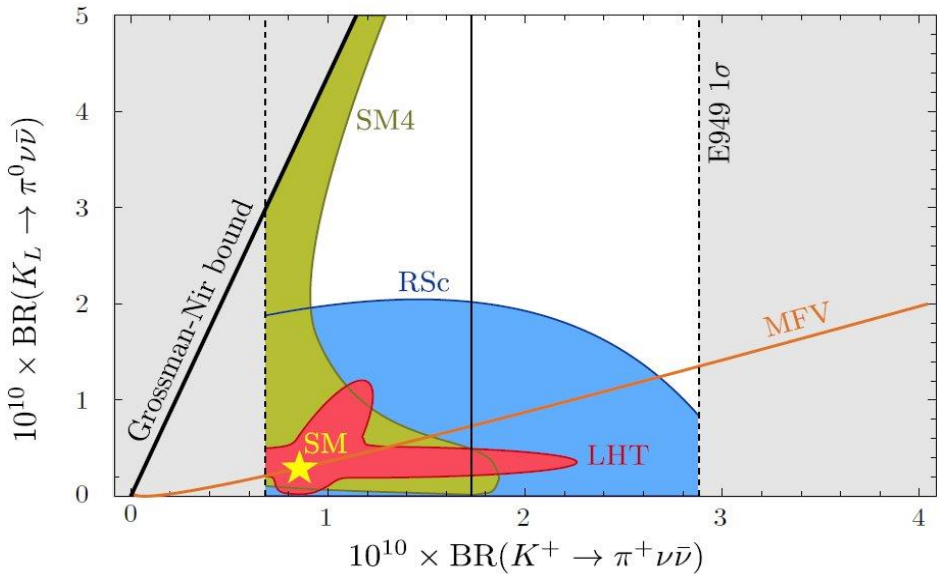


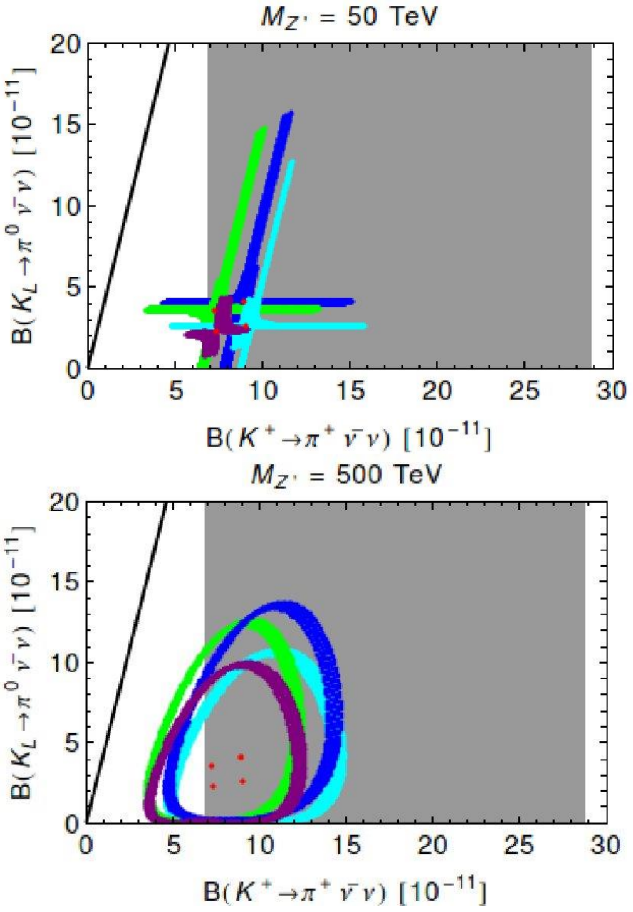
Input parameters (10%)



Theoretical uncertainty (4%)

K-πνν̄ beyond the Standard Model



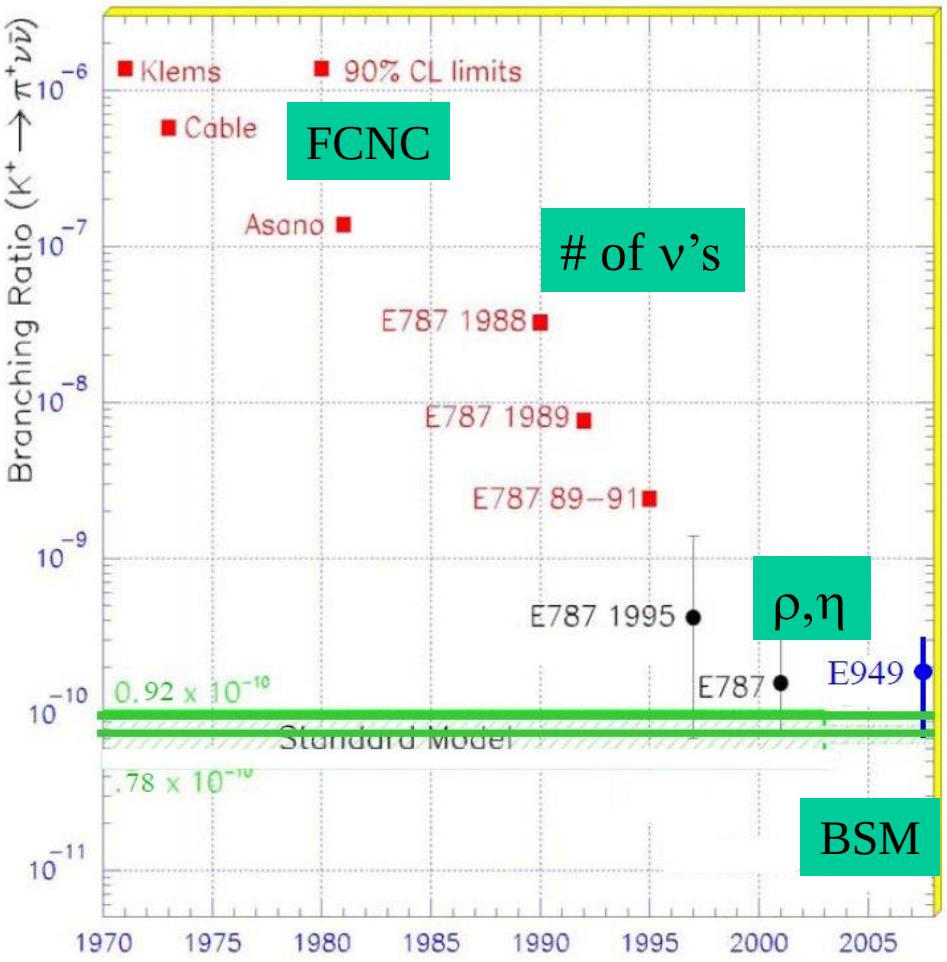


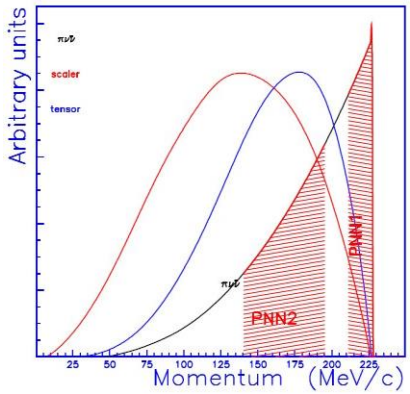
MFV: Minimal Flavor violation
LHT: Littlest Higgs with T-parity
SM4: SM with sequential 4th generation
RSc: Randall-Sundrum

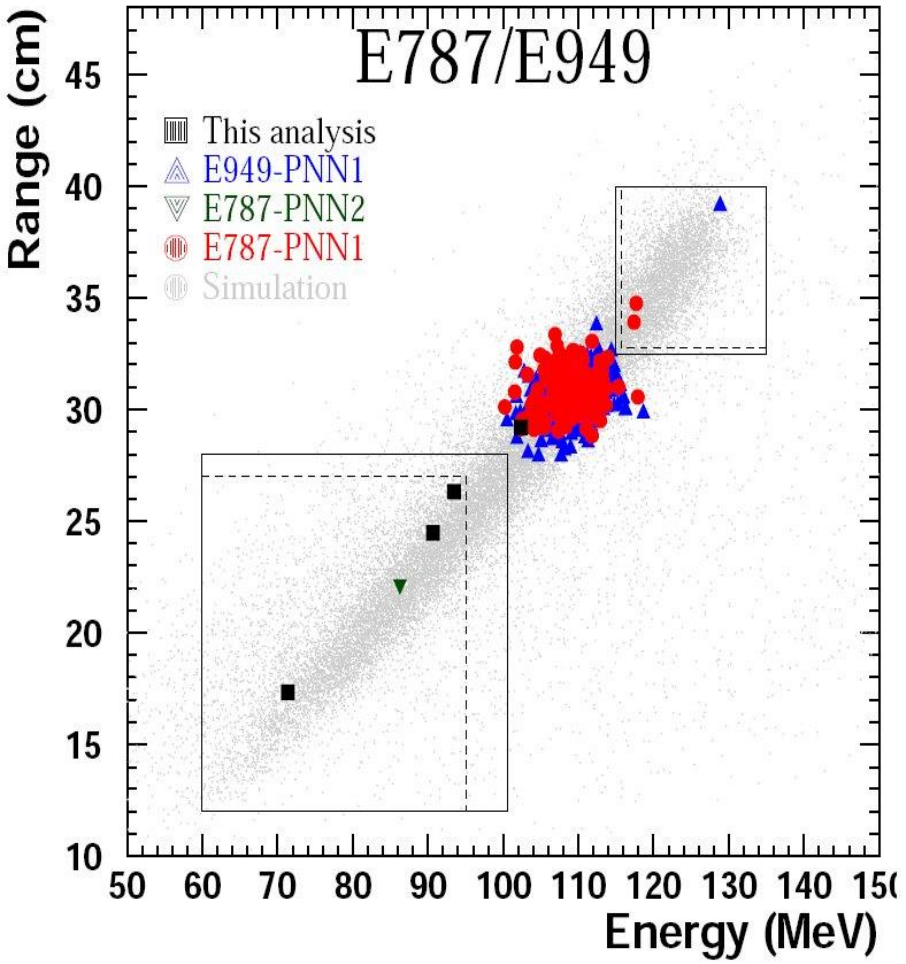
Straub, arXiv:1012.3893[hep-ph]

Heavy Z' Boson
Up: Left Handed Scenario
Down: L+R Scalar Scenario
Buras..., arXiv:1408.0728

K^+ decays







Present = $(1.73\ ^{+1.15}_{-1.05}) \times 10^{-10}$

K^+-$\pi^+\nu\bar{\nu}$ experiments

Signature: a single π^+

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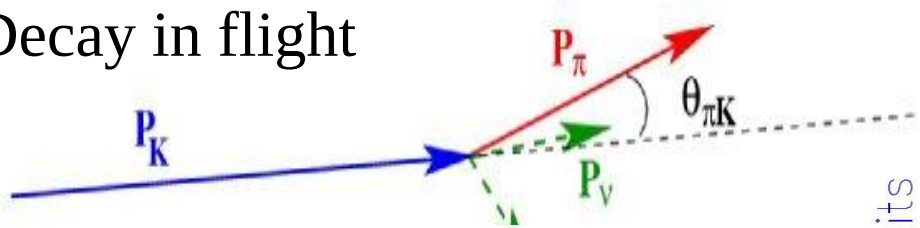
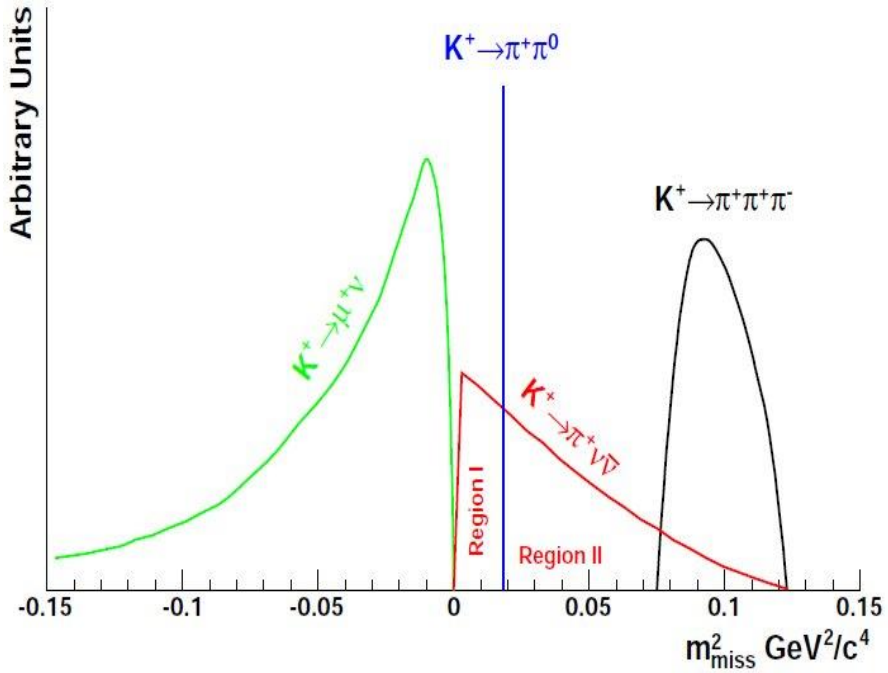
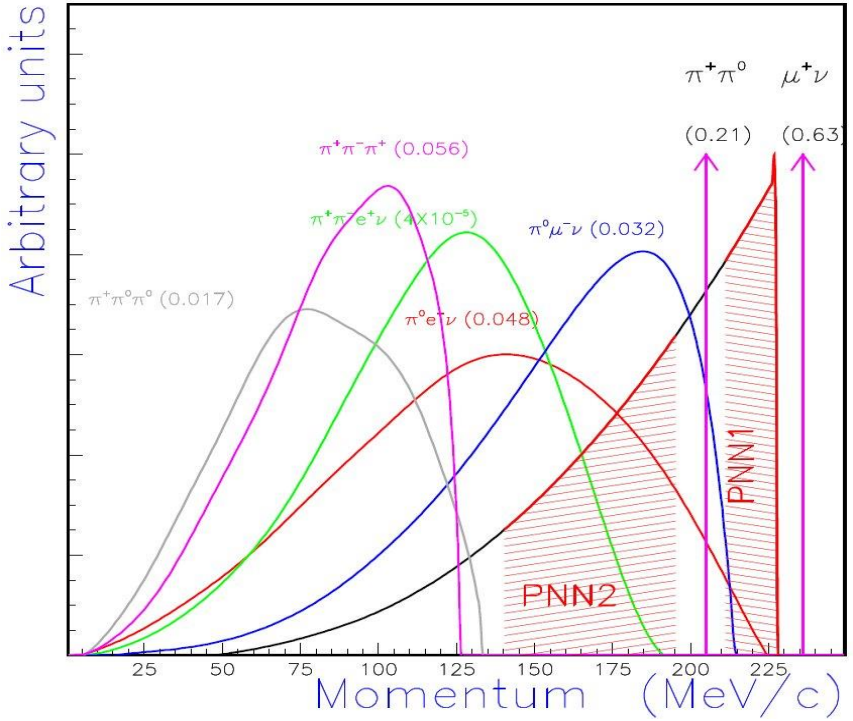
-Decay in flight





E787/949
-Decay at rest



Kinematics, particle ID, Photon veto

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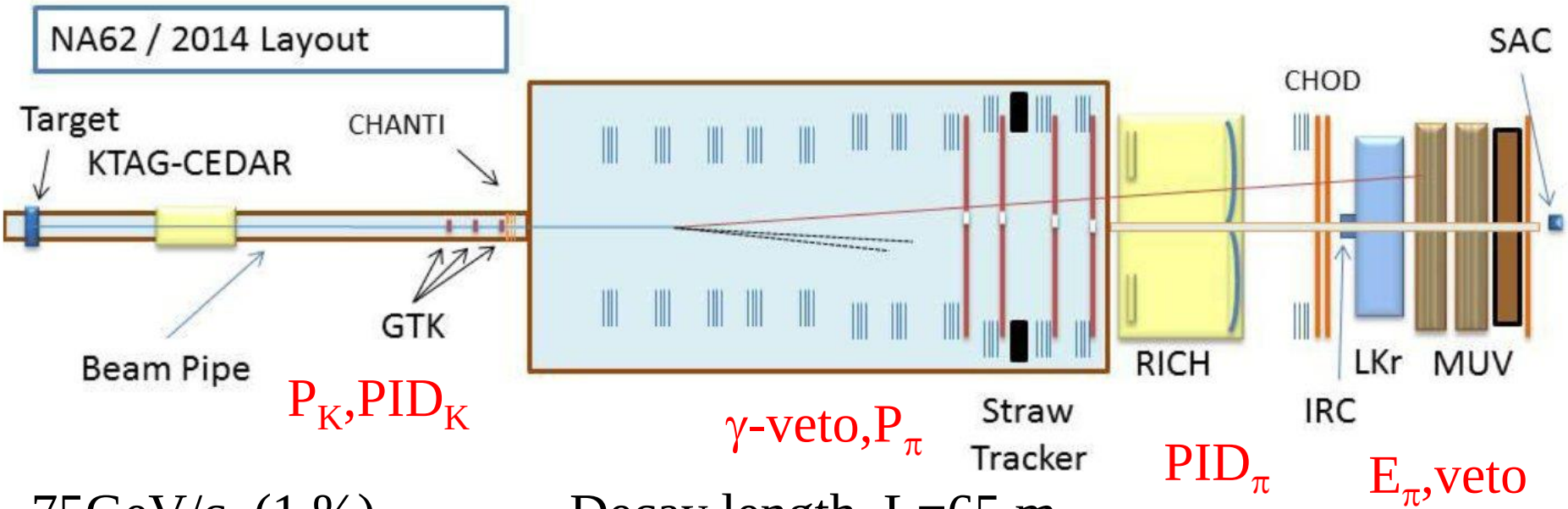

75GeV/c, (1 %)
(50MHz K's)

Decay length L=65 m
(6 MHz decays)

Kin. Rejection: 2×10^{-4} ($K_{\pi2}$), 7×10^{-5} ($K_{\mu2}$)
PID: 10^{-7} (μ/π)
PV: 10^{-8} for $\pi^0\rightarrow\gamma\gamma$

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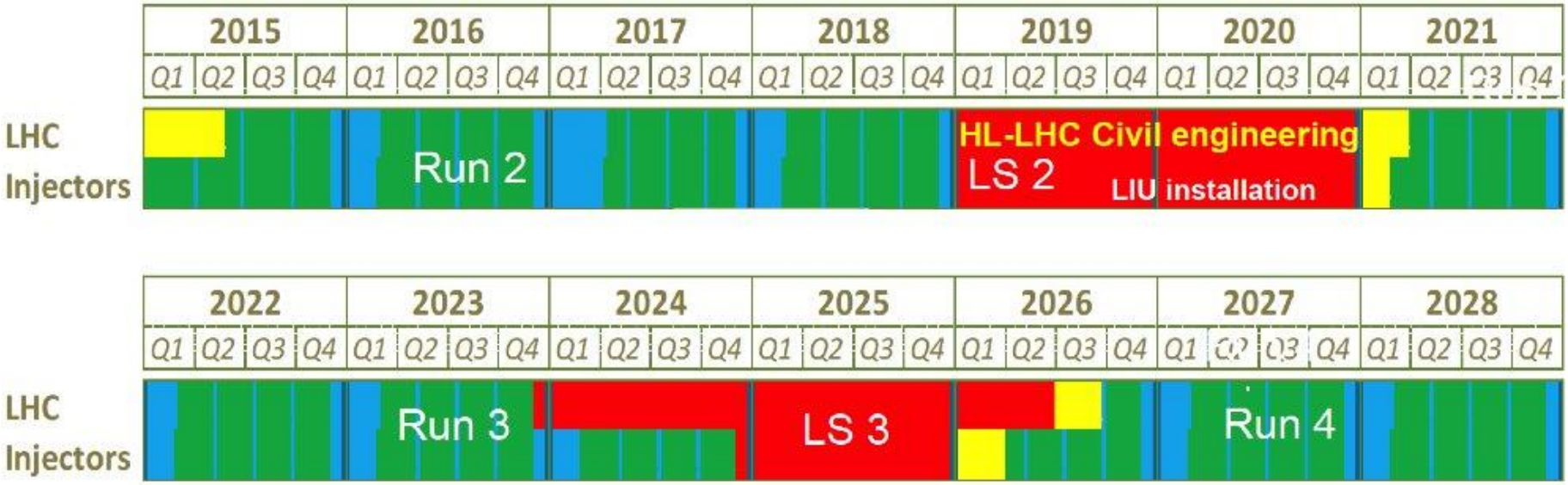
Decay		evt/year
$K^+ \to \pi^+ \nu\nu$ [SM] (flux 4.5×10^{12})		45
$K^+ \to \pi^+ \pi^0$	γ-veto, kin.	5
$K^+ \to \mu^+ \nu$	PID, kin.	1
$K^+ \to \pi^+ \pi^+ \pi^-$		< 1
$K^+ \to \pi^+ \pi^- e^+ \nu$ + other 3 tracks decays		< 1
$K^+ \to \pi^+ \pi^0 \gamma$(IB)		1.5
$K^+ \to \mu^+ \nu \gamma$(IB)		0.5
$K^+ \to \pi^0 e^+(\mu^+) \nu$, others		negligible
Total background		< 10

Further NA62 K Physics Program

Decay	Physics	Present limit (90% C.L.) / Result	NA62
$\pi^+\mu^+e^-$	LFV	1.3×10^{-11}	0.7×10^{-12}
$\pi^+\mu^-e^+$	LFV	5.2×10^{-10}	0.7×10^{-12}
$\pi^-\mu^+e^+$	LNV	5.0×10^{-10}	0.7×10^{-12}
$\pi^-e^+e^+$	LNV	6.4×10^{-10}	2×10^{-12}
$\pi^-\mu^+\mu^+$	LNV	1.1×10^{-9}	0.4×10^{-12}
$\mu^-\nu e^+e^+$	LNV/LFV	2.0×10^{-8}	4×10^{-12}
$e^-\nu\mu^+\mu^+$	LNV	No data	10^{-12}
π^+X^0	New Particle	5.9×10^{-11} $m_{X^0} = 0$	10^{-12}
$\pi^+\chi\chi$	New Particle	–	10^{-12}
$\pi^+\pi^+e^-\nu$	$\Delta S \neq \Delta Q$	1.2×10^{-8}	10^{-11}
$\pi^+\pi^+\mu^-\nu$	$\Delta S \neq \Delta Q$	3.0×10^{-6}	10^{-11}
$\pi^+\gamma$	Angular Mom.	2.3×10^{-9}	10^{-12}
$\mu^+\nu_h, \nu_h \rightarrow \nu\gamma$	Heavy neutrino	Limits up to $m_{\nu_h} = 350\ MeV$	
R_K	LU	$(2.488 \pm 0.010) \times 10^{-5}$	>×2 better
$\pi^+\gamma\gamma$	χPT	< 500 events	10^5 events
$\pi^0\pi^0e^+\nu$	χPT	66000 events	$O(10^6)$
$\pi^0\pi^0\mu^+\nu$	χPT	-	$O(10^5)$

Status/Schedule



2015 Engineering run

2016 First run with full detector

Lower intensity… Sensitivity 10^{-10}~10^{-11}

2017-2018 $K^+ \longrightarrow \pi^+ \nu\nu$ data taking + 2 years of analysis

2021- LFV, π^0 decays ?

2026- Neutral kaon decays ?

Present Activity of the Canadian Group:

Data taking

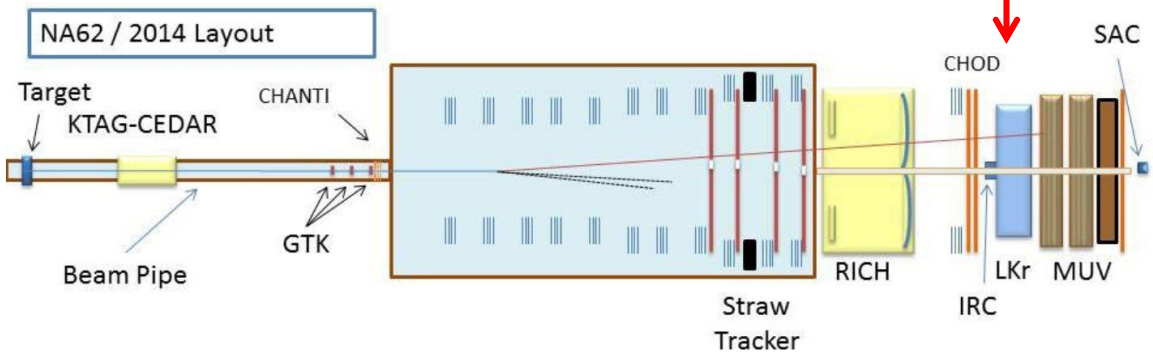
Analysis

-Photon veto efficiency

-Particle ID (muon suppression)

R&D

Purity monitor for the LKr calorimeter



-Convert the Liq.Xe TPC prototype

-Measure attenuation of pulse heights with drift distance.

Future Activity of our group:

- Data taking
- Data analysis and simulation
  - K^+-$\pi^+\nu\nu$ branching ratio and its background
  - Precise measurement of K-ev/K-μν
  - Neutral mode?

- Minor contribution to the upgrade
  - Liq.Kr purity monitor.

Canadian NA62 Resources

TRIUMF-UBC NA62 Group:

D. Bryman	UBC	
T. Numao	TRIUMF	
B. Velghe	TRIUMF	RA
?	TRIUMF	RA
?	UBC	M.Sc.

Financial support NSERC

Computing CERN, Westgrid

PIENU Experiment

Test μ-e universality at 0.05 % level via π^+-$e^+\nu$ /π^+-$\mu^+\nu$ branching ratio.
Sensitive up to 1000TeV mass scale for PS interactions.
Data taking in 2009 – 2012: recorded >5x10^6 π^+-$e^+\nu$ decays

Status:

Partial analysis of 2010 data:
R=(1.2344+-0.0023+-0.0019)x10-4. g_e/g_μ=0.9996±0.0012.

Final Analysis:

Expected statistical uncertainty 0.05%; systematic uncertainty <0.1 % by careful studies of the data and intensive Monte Carlo simulation. Final result 2017. Some by-products are also expected to come out with a similar time scale.

Resource

PIENU analysis group	3 staff, 2 postdoc, 1 student, 2 off-site
Financial	NSERC for FY2017
Computing	WestGrid