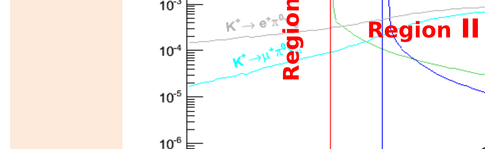
THE NA62 EXPERIMENT AT CERN

Birmingham, BNL, Bratislava, Bristol, Bucharest, CERN, Dubna, Fairfax, Ferrara, Florence, Frascati, Glasgow, Liverpool, Louvain, Mainz, Merced, Moscow, Naples, Perugia, Pisa, Prague, Protvino, Rome I, Rome II, San Luis Potosí, Stanford, Sofia, TRIUMF, Turin

Measuring $K^+ \to \pi^+ \nu\bar{\nu}$ decay with 10% of precision as a probe for New Physics

SM theoretical framework

- FCNC loop process, short distance dominated
- hadronic matrix element from the (isospin rotated) semileptonic decay
- theoretically clean $|V_{td}|$ dependence



Perfect probe for New Physics, still complementary to LHC

Tree-level FCNC by Z': Buras et al, JHEP 1302 (2013) 116
Littlest Higgs with T parity: Blanke et al, Acta Phys. Polon. B41 (2010) 657
MSSM non-MFV: Isidori et al, JHEP 0608(2006) 064
Custodial Randall-Sundrum: Blanke et al, JHEP 0903 (2009) 108

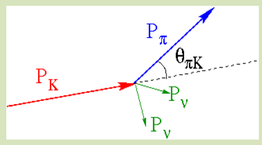
BR x 10^{10}	SM prediction	Experiment
$K^+ \to \pi^+ \nu\bar{\nu}$	0.781 ± 0.075 ± 0.029	1.73 ± 1.10
$K_L \to \pi^0 \nu\bar{\nu}$	0.243 ± 0.039 ± 0.006	< 260

Brod, Gorbahn, Stamou: PRD83(2011) 034030, arXiv 1009.0947
BNL E787/E949: PRL101 (2008) 191802, arXiv 0808.2459
KEK E391a: PR D81 (2010) 072004, arXiv 0911.4789

Measurement principle

Goal : measure BR with 10% accuracy

- *O*(100) SM events + systematics control at % level
- statistics = high intensity kaon beam + large signal acceptance
- systematics = large background rejection + redundancy



- technique: high momentum kaon decay in flight
- basic ingredients: precise timing & kinematic cuts
- signal signature : one K^+ track, one π^+ track
- kinematic variable : $m^2_{miss} = (P_K - P_\pi)^2$
- momentum measurement + particle-identification + veto

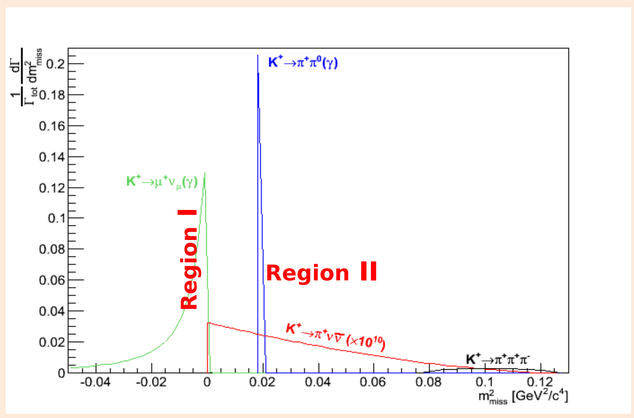
Momentum
Kaon Tracker (GTK)
Pion Tracker (STRAW)

Particle Identification
Kaon-ID (CEDAR)
π/μ/e-ID (RICH)

Veto against
Beam induced accidentals (CHANTI, CEDAR)
Multiple charged particle decays (STRAW, CHOD)
Photons and Muons (LAV, Lkr, IRC, SAC, MUV)

Background rejection

92% separated from signal by kinematic cuts



8% not separated by kinematic cuts

Including particle ID and vetos

Decay mode	Events (flux 4.5 10^{12} decays)
$K^+ \to \pi^+ \nu\,\nu$ Signal [SM]	45 events /year
$K \to \pi^+\pi^0$	5
$K^+ \to \mu^+\nu$	1
$K^+ \to \pi^+\pi^-\pi^+$	< 1
$K^+ \to \pi^+\pi^- e^+\nu$ + other 3–track decays	< 1
$K^+ \to \pi^+\pi^0\gamma$ (IB)	1.5
$K^+ \to \mu^+\nu\gamma$ (IB)	0.5
$K^+ \to \mu^+(e^+)\,\pi^0\nu$, others	neg.
Expected background	< 10

Schedule

- R&D completed in 2010
- 2010-2014: construction
- October-November 2014: Pilot run
- **July 2015-2018: Physics runs**

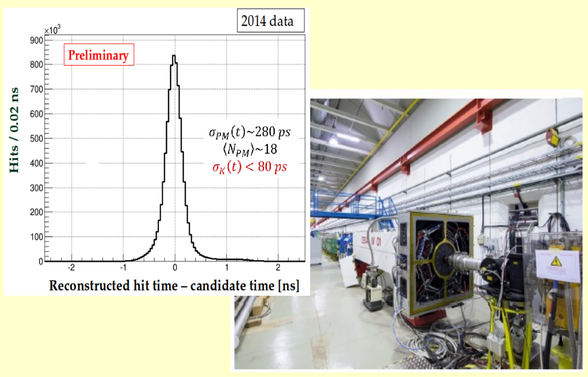
Trigger

- L0 (Hardware level)
- L1 (single detector Software level)
- L2 (multi detector Software level)

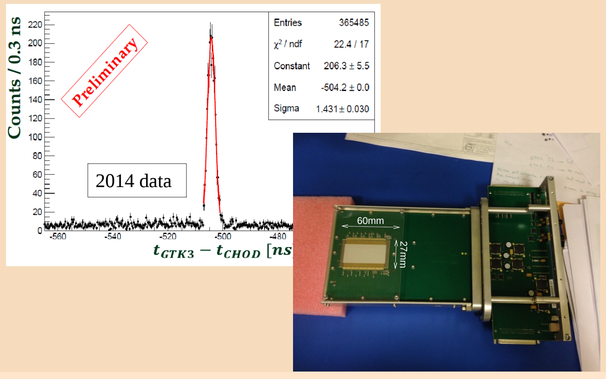
~ 10 MHz
~ 1 MHz
~ 100 kHz
~ few kHz

CEDAR/KTAG

Gas differential Cerenkov counter

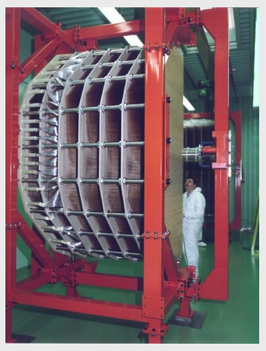


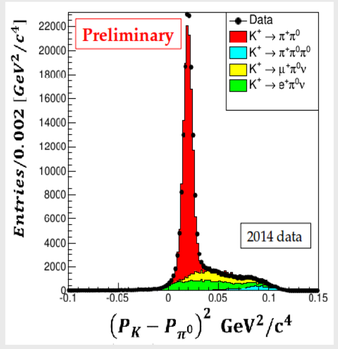
GTK 3 hybrid silicon pixel detector



LKr Liquid Krypton calorimeter

(angular range 1-8.5 mrad)





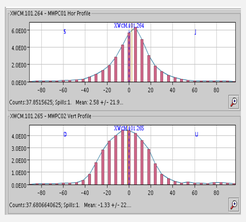
LAV Large Angle Vetos

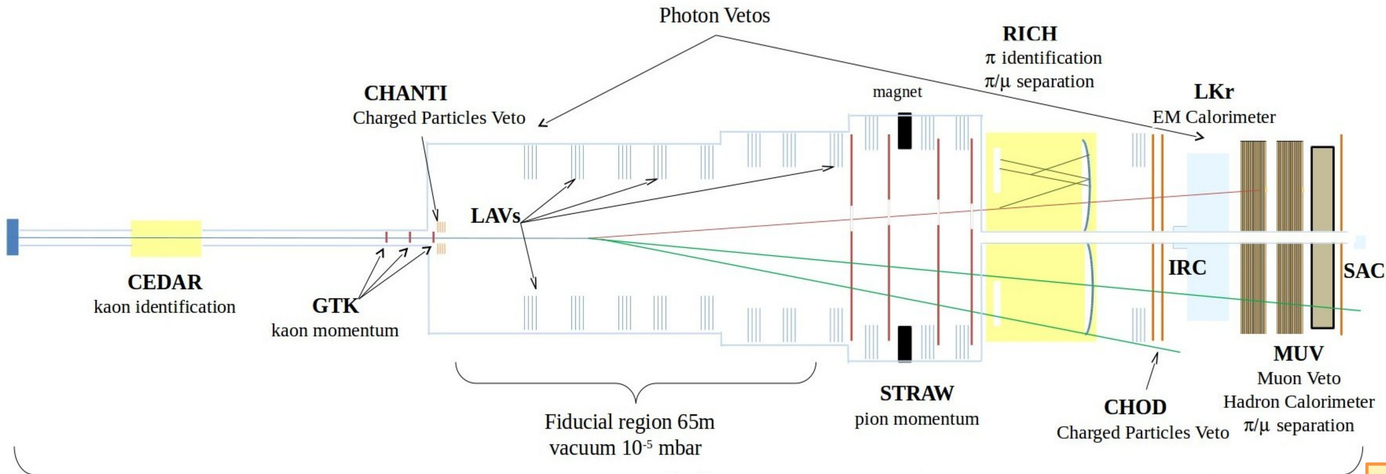
12 station with 4/5 lead glass rings in vacuum (angular range 8.5 – 48 mrad)

Beam

***Primary SPS Beam*:**
400 GeV/c protons
3×10^{12} protons/pulse
4.8/16.8 s duty cycle

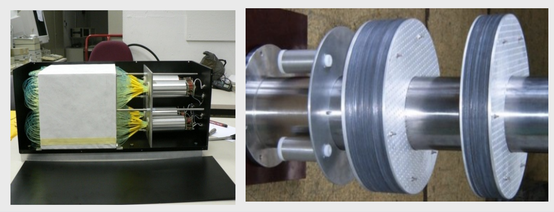
***Secondary Beam*: ~ 6% K^+**
p=75 GeV/c (Δp/p~1%)
beam acc.: 12.7 mstr
total rate: 750 MHz
4.5×10^{12} K^+decays/year





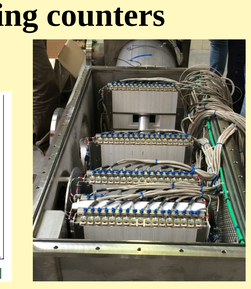
SAC/IRC

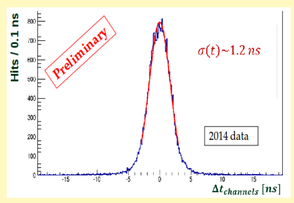
Small Angle / Inner Ring photon veto Calorimeters (lead-plastic scintillator) (angular range < 1 mrad)



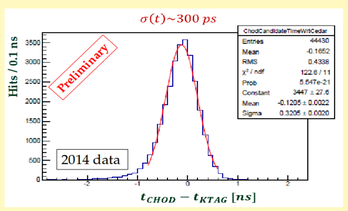
CHANTI/CHOD

CHANTI: guard ring counters scintillators



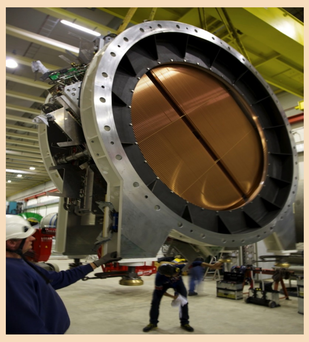


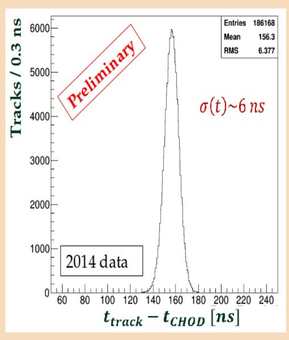
CHOD: scintillator hodoscope



STRAW

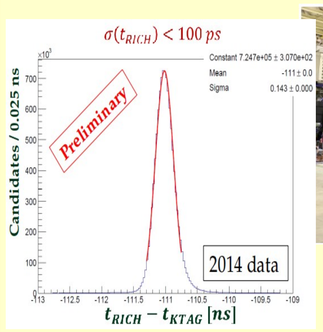
4 straw chambers (4 views each) operating in vacuum as tracker station of the magnetic Spectrometer





RICH Neon gas ring Imaging Cerenkov

- **18m long & 3m Ø**
- **Segmented 17m focal length mirror**



MUV Muon Veto system

MUV1 MUV2 : iron-plastic scintillator calorimeters
MUV3: after 80 cm iron, single layer of scintillator tiles