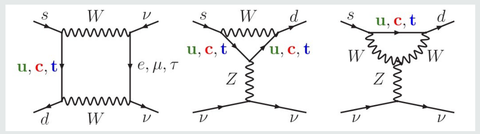
THE NA62 EXPERIMENT AT CERN

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

Measuring $K^+ \to \pi^+ \nu\bar{\nu}$ decay

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, complementary to LHC

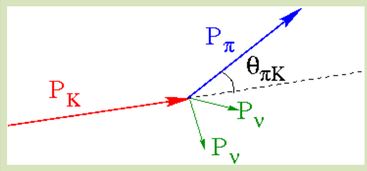
BR x 10^{10}	SM prediction	experiment
$K^+ \to \pi^+ \nu\bar{\nu}$	$0.781 \pm 0.075 \pm 0.029$	1.73 ± 1.10
$K_L \to \pi^0 \nu\bar{\nu}$	$0.243 \pm 0.039 \pm 0.006$	< 260

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% precision

- *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

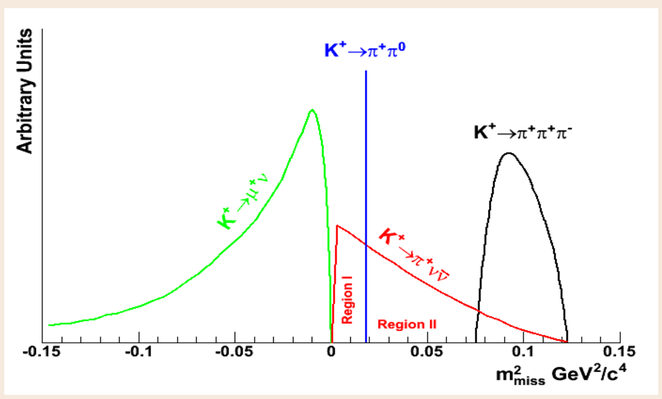
momentum
kaon tracker (GTK)
pion tracker (STRAW)

particle identification
kaon-ID (CEDAR)
π/μ/e-ID (RICH)

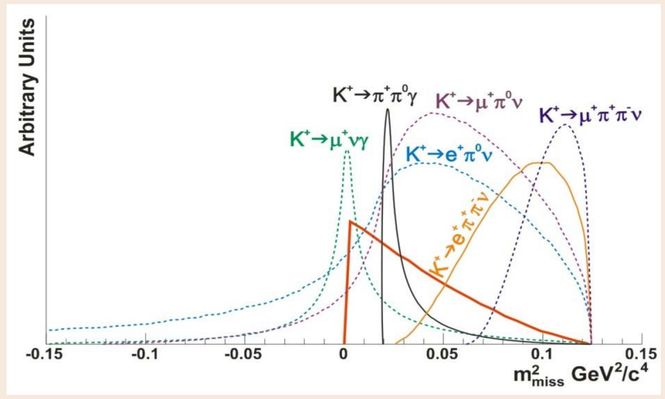
veto against
beam induced accidentals (CHANTI, CEDAR)
multiple charged particle decays (STRAW, CHOD)
photons and muons (LAV, LKr, SAV and MUV)

Background rejection

92% separated from signal by kinematic cuts



8% not separated by kinematic cuts



including particle ID and vetos

Decay mode	Events or signal fraction
$K^+ \to \pi^+ \nu\bar{\nu}$ Signal	55 events /year
$K^+ \to \pi^+\pi^0$	4.3 %
$K^+ \to \mu^+\nu$	2.2 %
$K^+ \to \pi^+\pi^-\, e^+\nu$	≤ 3 %
$K^+ \to \pi^+\pi^0\, \gamma$	~ 2 %
$K^+ \to \mu^+\pi^0\, \gamma$	~ 0.7 %
other 3 –track decays	≤ 1.5 %
$K^+ \to \mu^+(e^+)\, \pi^0\nu$, others	neg.
Expected background	≤ 13.5 %

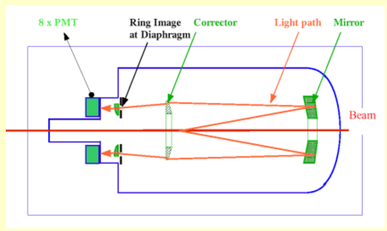
Schedule

- R&D completed in 2010
- 2010-2012: construction
- End 2012: first technical run
- Physics data taking to begin after CERN accelerators shutdown

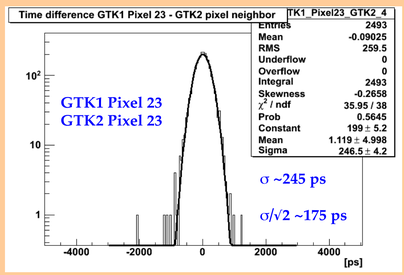
Detector setup

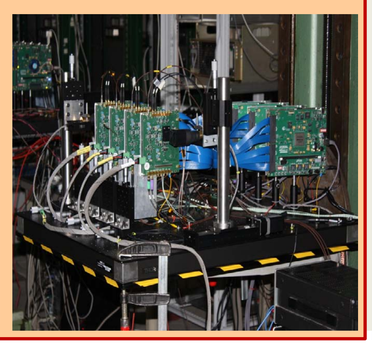
CEDAR

Gas differential Cerenkov counter (built for SPS beams) to tag beam kaon with *O*(~100) ps time resolution



GTK 3 hybrid silicon pixel detector stations (<0.5% X_0) with < 200 ps time resolution per station





LAV Large Angle photon Vetos

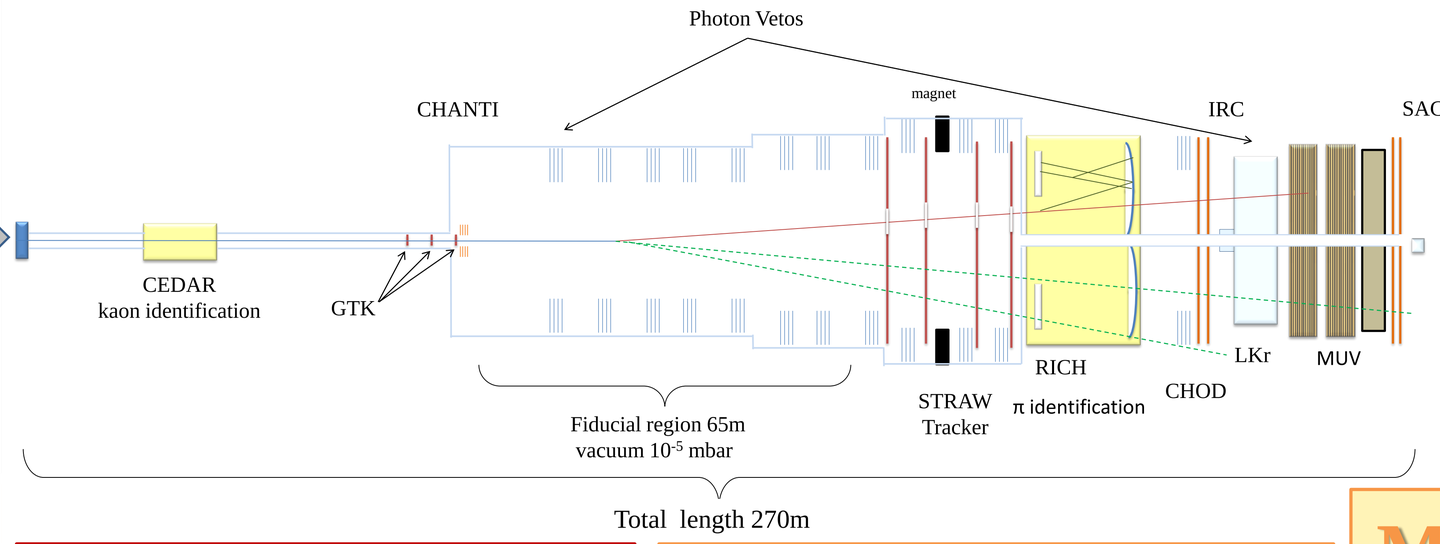
12 stations with 4/5 lead glass rings (blocks from OPAL @ LEP) in vacuum covering angular range 8.5 – 48 mrad

LKr 20T Liquid Krypton calorimeter (from NA48) & new readout as forward photon veto in range 1-8.5 mrad

Beam

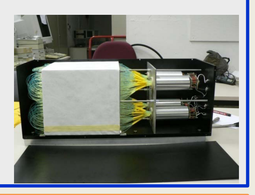
***Primary SPS Beam*:**
- 400 GeV/c protons
- 3×10^{12} protons/pulse
- 4.8/16.8 s duty cycle

***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



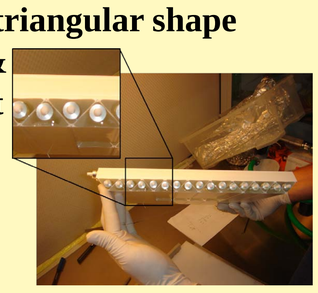
SAC/IRC

Small Angle / Inner Ring photon veto Calorimeters (lead-plastic scintillator) for angular region close to beam pipe below 1 mrad



CHANTI/CHOD

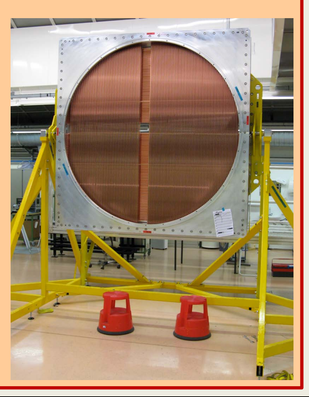
CHANTI: guard ring counters to veto beam induced inelastic interactions: triangular shape scintillators & SiPM readout



CHOD: scintillator hodoscope to
- **trigger on single charged particle**
- **veto multiple charged particle events**

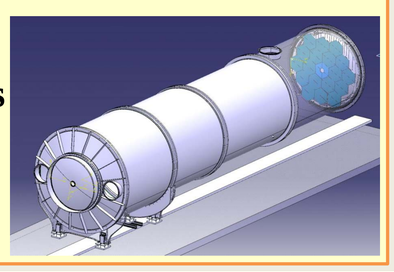
STRAW

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



RICH Neon gas Ring Imaging

Cerenkov counter, 18m long & 3m Ø
- **segmented 17m focal length mirror**
- **~2000 PM's**
- **time resolution better than 100 ps**
- **π/μ separation with <1% mis-ID**



MUV Muon Veto system

MUV1 (25 layers)/MUV2 (23 layers, from NA48): iron-plastic scintillator calorimeters

MUV3: after 80cm iron, 5cm thick single layer of scintillator tiles + PM readout, fast signal for trigger

TRIGGER L0 (Hardware level) → L1(single detector Software level) → L2(multi detector Software level)

~10 MHz (RICH, $\overline{\text{LKr}}$, $\overline{\text{LAV}}$, $\overline{\text{MUV}}$) ~1 MHz ~100 KHz → Few KHz