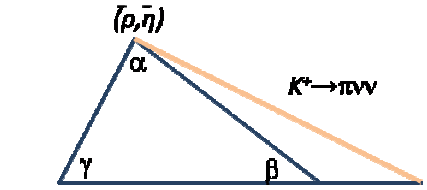
The Photon Veto System for the NA62 Rare Kaon Decay Experiment

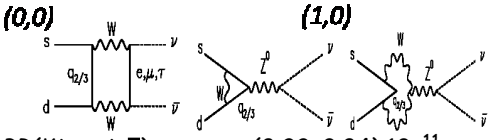
The NA62 Collaboration

(Bern ITP, Birmingham, CERN, Dubna, Fairfax, Ferrara, Florence, Frascati, Louvain, Mainz, Menlo P., Merced, Moscow, Naples, Perugia, Pisa, Protvino, Rome I&II, S.Luis Potosi, Sofia, Turin, Vancouver)

THEORY

- $K^+ \to \pi^+ \nu\bar{\nu}$ BR measures one side of CKM triangle
- Theoretical prediction depending on top (dominant) and charm contributions in loops





$BR(K^+ \to \pi^+ \nu\bar{\nu})_{THEORY} = (8.22 \pm 0.84) \cdot 10^{-11}$

$BR(K^+ \to \pi^+ \nu\bar{\nu})_{EXP} = (1.73^{+1.15}_{-1.05}) \cdot 10^{-10}$ (7 candidates)

E787/E949, Phys.Rev.Lett.101, 191082(2008)

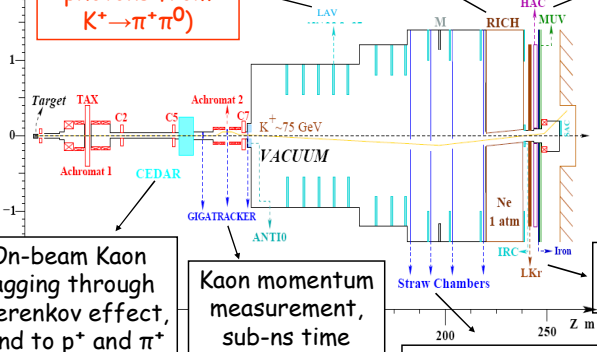
NA62

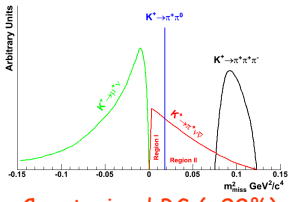
- Collect ~ 100 $K^+ \to \pi^+ \nu\bar{\nu}$ events with ~10% BG in 2 years
- High efficiency in rejecting photons and muons from Kaon decays

12 rings to veto particles (mainly photons from $K^+ \to \pi^+ \pi^0$)

π^+/μ^+ separation in K decays at 10^{-2} level for 15-35 GeV/c momentum

Additional π^+ tagging (μ^+ reco in MUV, π^+ energy deposit analysis in HAC)





Constrained BG (~92%)

On-beam Kaon tagging through Cherenkov effect, blind to p^+ and π^+

Kaon momentum measurement, sub-ns time resolution

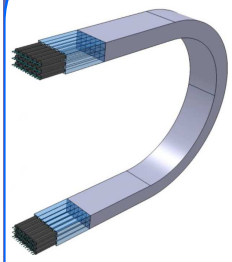
γ rejection at $[10^{-3}\text{-}10^{-5}]$ level for E_γ=[2.5-10] GeV

Track momentum and position measurement at < % level

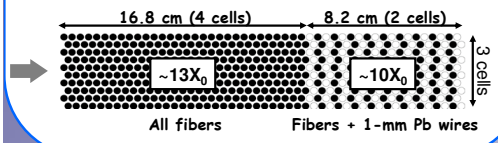
Large Angle Vetoes (LAV)

3 solutions were tested in order to comply with the experiment's requirements

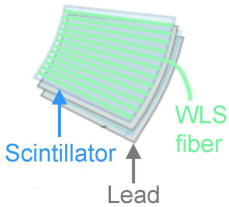
Lead + Scintillating fibers (KLOE-like)



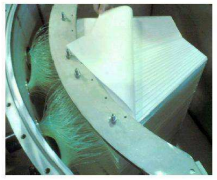
- Horseshoe shaped prototype built in Frascati
- 18 readout cells, 4.2 X 4.2 cm^2
- Final size, 1/3 of final radial thickness
- Fibers/lead+fibers longitudinally (4/2 cells)



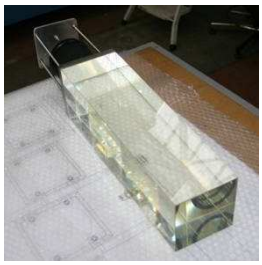
Lead + Scintillating tiles (CKM-like)



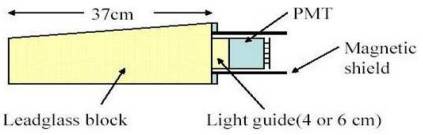
- Prototype (1/16 of a ring) from FNAL
- $16X_0$, scintillating tiles (5mm) + lead foils(1mm)
- Fibers in the tiles leading signals to PMs



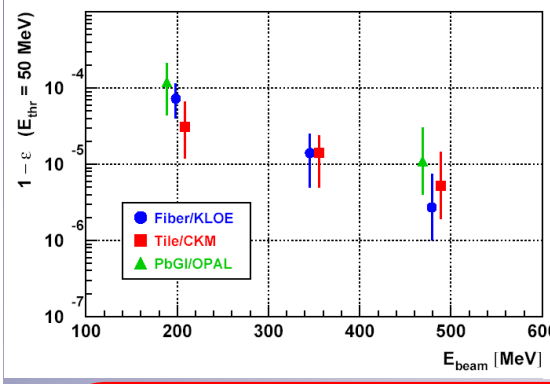
Lead glass crystals (from OPAL)

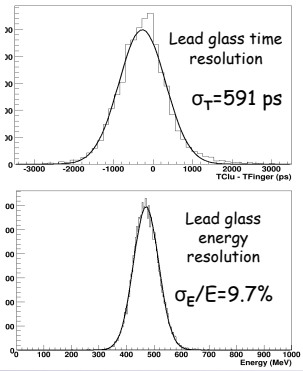


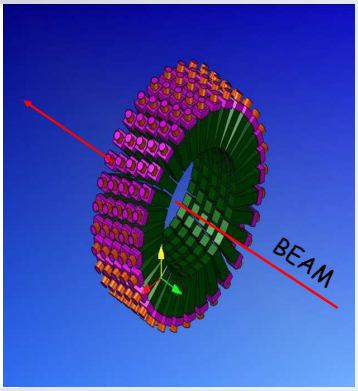
- ~10^4 crystals used in OPAL, 8 different crystal shapes
- ρ=5.6 g/cm^3, X_0=1.5cm,R_M=2.6 cm
- Crystal arrays tested in Frascati and Naples



Tests at BTF in Frascati in 2006/7 showed that all the 3 solutions met the experimental requirements; the lead glass option was chosen



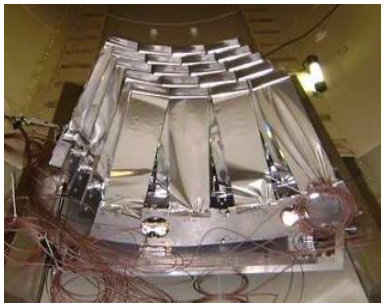


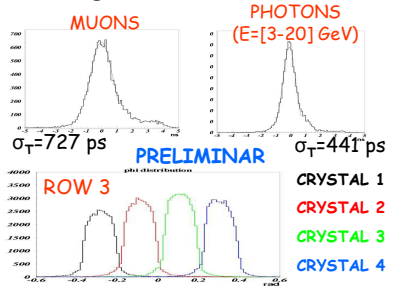


GEOMETRY AND SIGNAL

- Each of 12 stations made of 5 staggered crystal rings
- Each particle crosses at least 3 crystals (~20 X_0)
- Signals by Cherenkov effect, 1 PM for each crystal
- PMs due to operate in vacuum, mechanical stability and aging tests performed

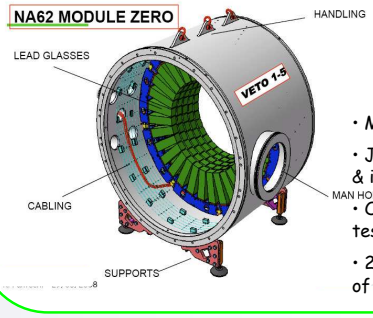
2008 TEST: in Sept/Oct 2008 a prototype (1/8 of a single station) was built and tested on beam at CERN using NA48/2 detectors

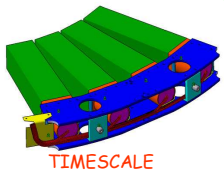




Hits in a crystal row vs φ (from NA48/2 DCHs) for μ^+ events

2009: Construction of module 0 (whole station) under way in Frascati





TIMESCALE

- Mar/Jun 2009: construction
- Jul/Aug 2009: shipping to CERN & installation
- Oct 2009: vacuum and beam tests
- 2010/11: construction and tests of all the stations

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