A Proposal for CKM R&D

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- A brief overview of:
  - The physics - a precision measurement of $K^+ \to \pi^+ \nu \bar{\nu}$
  - Detector
  - Collaboration
- Vacuum Veto R&D Plans
- Straw Tube Tracking R&D Plans
- Resources Required
- Summary

The Experimental Status of $K^+ \to \nu\bar{\nu}$

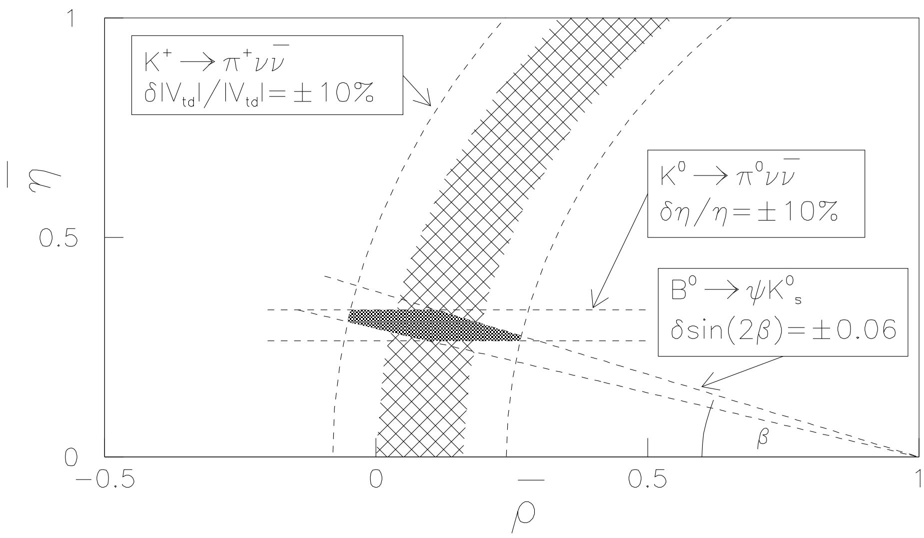
- Brookhaven Experiment E787
  - Stopped K^+ experiment
  - Reported 1 event from 1 good year of data taking
  - Background estimate of 0.08 ± 0.03 events
  - $BR = [4.2^{+9.7}_{-3.5} \times 10^{-10}]$
  - Consistent with Standard Model expectation $[0.9 \pm 0.3] \times 10^{-10}$
- CKM - Fermilab Proposal P905
  - Decay in flight experiment at Fermilabs Main Injector
  - On the order of 100 events with less than 10 background events in 2 years data taking, at the Standard Model level
  - Statistical error on $|V_{td}|$ of about $\pm 6\%$

- Brookhaven Proposal P949
  - Some modifications to existing apparatus
  - Increase beam on target to 10^{14} ppp
  - A 6000 hour run could obtain on the order of 10 events at the Standard Model level
  - Statistical error on $|V_{td}|$ of about $\pm 27\%$

Physics Motivation for CKM

- CKM's measurement of the branching ratio of $K^+ \to \pi^+ \nu\bar{\nu}$ translates to an uncertainty in $|V_{td}|$ of about 6% statistical and 8% theoretical.

- This measurement is complementary in the $\rho - \eta$ plane to the information obtained from $B^\circ \to \psi K_S$ and has approximately the same sensitivity.



Backgrounds to the Measurement

Background Source	Effective BR ($\times 10^{-12}$)
$K^+ \to \mu^+ \nu$	< 0.04
$K^+ \to \pi^+ \pi^\circ$	3.7
$K^+ \to \mu^+ \nu \gamma$	< 0.09
$K^+ A \to K_L X$ followed by $K_L \to \pi^+ e^- \nu$	< 0.14
$K^+ A \to \pi^+ X$ in trackers	<4.0
$K^+ A \to \pi^+ X$ in residual gas ($10^{-6} torr$)	< 2.1
Accidentals (2 K^+ decays)	0.51
Total	< 10.6

- The dominant background processes depend on the amount of material in the tracking region. We have thus identified straw tube chambers as our favored downstream tracking solution.

- To additionally suppress the prevalent decay mode $K^+ \to \pi^+ \pi^\circ$, we require complete and efficient photon veto coverage.

Photon Veto Development

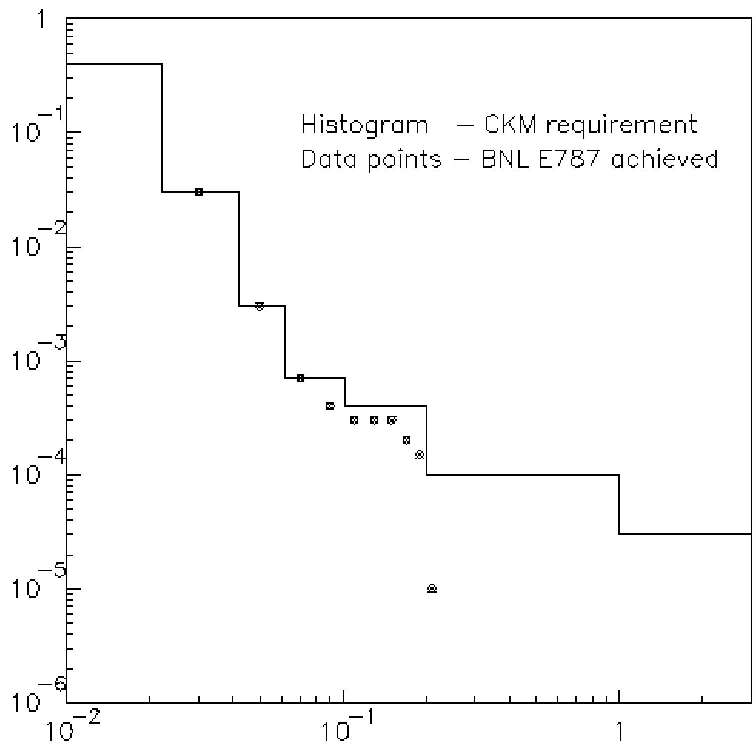
- Considerable engineering assistance is required to design this 40 meter long, 120 ton detector.

- The photon veto counters require the same low energy performance level as achieved in Brookhaven E787 over an active area approximately 20 times larger and in vacuum.

- An important goal of CKM R&D is to develop a fully engineered scalable prototype of photon vacuum veto modules during the next two years. We will then test these modules in the higher energy regime required for our experiment.

- Many of the same photon veto issues are important for KAMI, and we will coordinate our efforts with that group.

Photon Veto Requirements



Required Photon Veto Efficiency vs. Photon Energy (GeV)

Straw Tube Chamber Development

- The performance level we require of our straw tube chambers has been demonstrated in a large system in Brookhaven E871.
- CKM needs to establish a straw tube development effort at Fermilab to investigate the significant engineering questions of using this tracking solution in vacuum:
  - Minimize outgassing of structural materials into the vacuum.
  - Creating the necessary vacuum seal for the fragile straws.
  - Mechanical stability of the tracker during pumpdown.

Other Aspects of the R&D Proposal

- RICH Detectors: CKM will rely on two RICH detectors for additional kinematic rejection. These will be based on the successful design of the E781 RICH, but there are several engineering questions specific to CKM.

- Muon Veto: this detector identifies muons to provide additional rejection of the decay mode $K^+ \to \mu^+\nu$. It is important to test the muon identification inefficiency of a fully engineered prototype.

- Trigger and DAQ Electronics: CKM needs to have a low deadtime triggering and data acquisition system that can operate in the 12 MHz kaon decay environment.

Resources Requested

- The CKM collaboration needs to be established as an R&D program within the Physics Division. This designation serves three significant purposes:
  - It focuses and coordinates efforts at the laboratory and among the collaborators.
  - Outside collaborators can identify CKM as a recognized research project at Fermilab, which may help obtain funding and assistance through additional channels.
  - It will help attract new collaborators to the project.
- CKM requires engineering and monetary support over the next two years in order to advance a complementary measurement to $sin(2\beta)$ from $B^\circ \to \psi K_S$ in a timely manner.

Cost and engineering breakdown for CKM R&D

Project	FY99 Eng. (Yrs.)	FY00 Eng.	FY99 Cost	FY00 Cost
Photon Vetos	.5	.5	\$25K	\$50K
Straw Tubes	-	.5	\$20K	\$10K
RICH	.5	-	\$10K	\$10K
Muon Veto	.5	-	\$5K	\$5K
DAQ Electronics	.5	.5	\$5K	\$5K
Technicians	.5	.5	-	-
Foreign visitors	-	-	\$25K	\$25K
Travel			\$10K	\$10K
Total	2.5	2.0	\$100K	\$115K

Summary

- CKM (P905) is an experiment that will make a precision determination of the matrix element $|V_{td}|$ through the measurement of the branching ratio of $K^+ \rightarrow \pi^+ \nu \bar{\nu}$.

- This measurement complements the measurement of $sin(2\beta)$ from the B system.

- The designation of CKM as an R&D project at Fermilab will coordinate the future efforts of our international collaboration.

- The collaboration faces engineering problems at the current time that require support. International members of the collaboration can contribute to this effort.