Measuring $|V_{td}|$ with E949 at BNL

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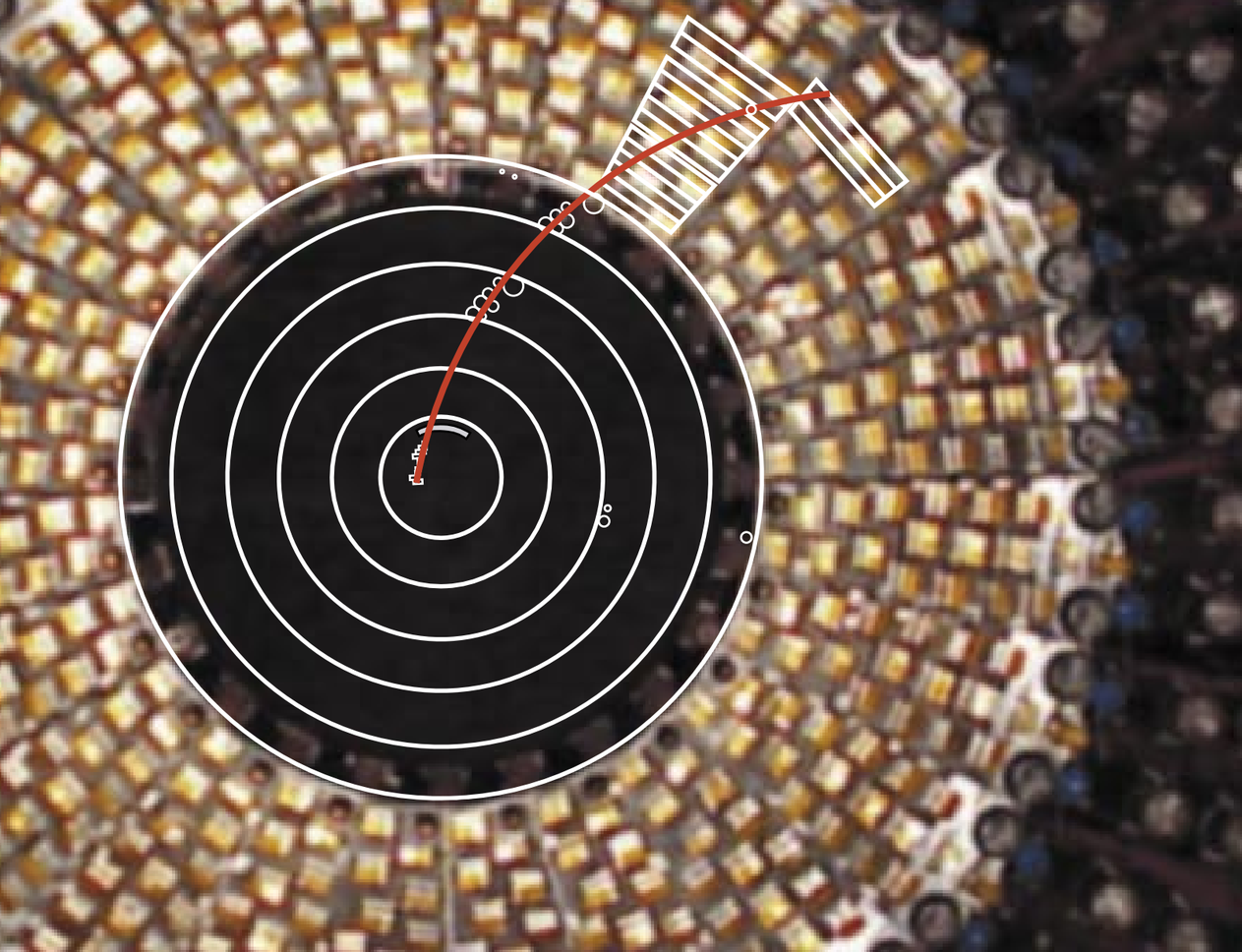
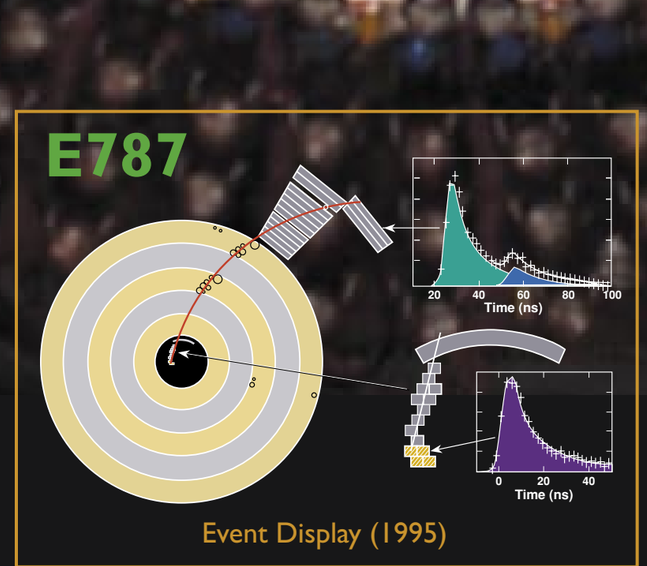
The E949 experiment at the Alternating Gradient Synchrotron at Brookhaven National Laboratory is an international collaboration of 70 scientists from the United States, Canada, Russia and Japan. This experiment follows the successful E787 discovery of $K^+\to\pi^+\nu\bar{\nu}$ with a detailed study of this mode at an order of magnitude improved sensitivity. The goal of E949 is to reach a sensitivity of 1×10^{-11} after 3 years of running at full intensity of the AGS during RHIC operations. E949 encompasses many improvements to the E787 apparatus which decrease backgrounds and allow for running at higher rates. The experience of E787 provides a high level of confidence in projecting the sensitivity of E949.

The $K^+\to\pi^+\nu\bar{\nu}$ decay is one of the 'Golden Modes' for study of CP violation and quark mixing, and along with the neutral analog $K_L\to\pi^0\nu\bar{\nu}$ can completely determine the CKM triangle. These modes have small theoretical uncertainty, allowing unambiguous extraction of quark mixing and CP violation parameters. The $K^+\to\pi^+\nu\bar{\nu}$ measurements are timely and important and complementary to those obtained from the B system. Measurement of $K^+\to\pi^+\nu\bar{\nu}$ directly complements the measurement of Bs mixing (e.g. from the Fermilab Tevatron), since the ratio $\Delta m_s/\Delta m_d$ also gives a clean determination of $|V_{td}|$. Any discrepancies in the values found in the K and B systems would be unambiguous indicators of new physics.

The E787 experiment presented evidence for the $K^+\to\pi^+\nu\bar{\nu}$ decay based on the observation of two clean events with an expected background of 0.15 ± 0.05 events at a branching ratio of $(1.6^{+1.8}_{-0.8})\times10^{-10}$. The result is consistent with the SM expectation of $B(K^+\to\pi^+\nu\bar{\nu}) = (0.8\pm0.1)\times10^{-10}$, but the central experimental value exceeds it by a factor of two.

The E949 experiment was approved by the U.S. Department of Energy's Office of High Energy Physics to run for 60 weeks. Funding for the first data collection run of 12 weeks has been received and data was collected in the spring of 2002. This brief run demonstrated the superior performance of E949 and achieved a sensitivity comparable to E787. The data from the pion momenta of 211<P<229 MeV/c has been analyzed and an additional $K^+\to\pi^+\nu\bar{\nu}$ event was observed. The new branching ratio, based on the 3 events observed by both E787 and E949, is $1.5^{+1.3}_{-0.9}\times10^{-10}$. At the measured central value of the branching ratio, the new event has a signal-to-background ratio of 0.9. The continued indication of a larger than expected branching ratio gives strong impetus for the completion of E949 to fully explore the possibility of new physics, or alternatively to make a precise measurement of the magnitude of V_{td}.





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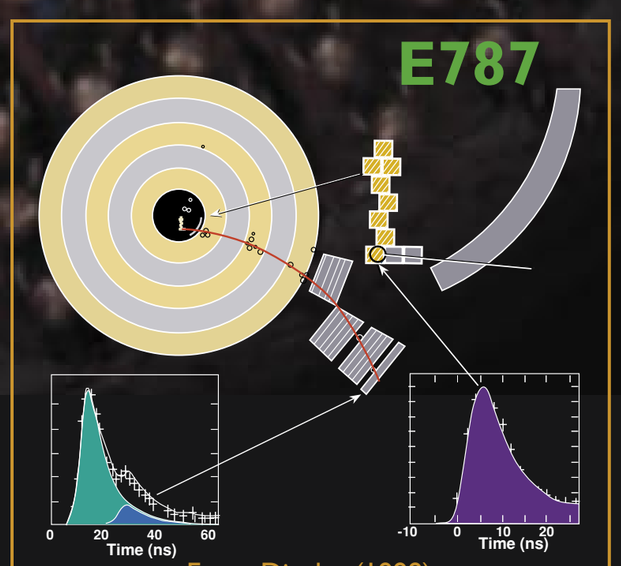

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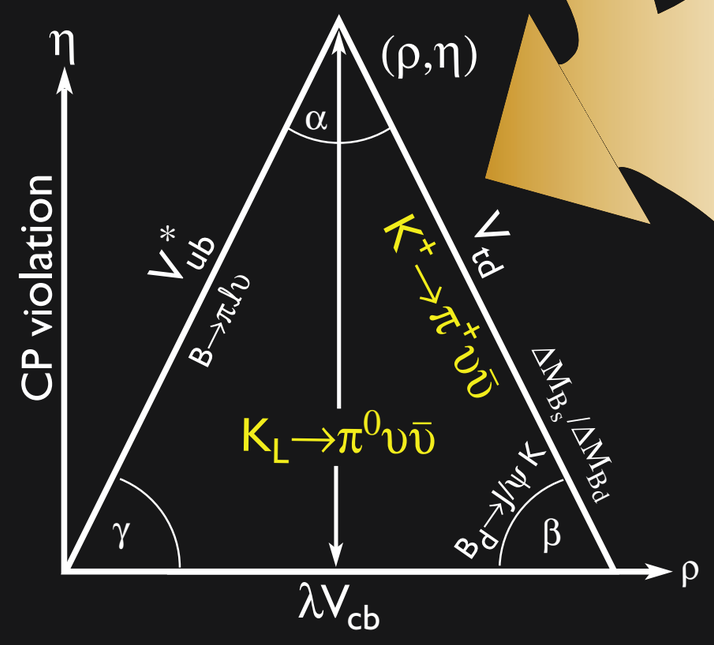

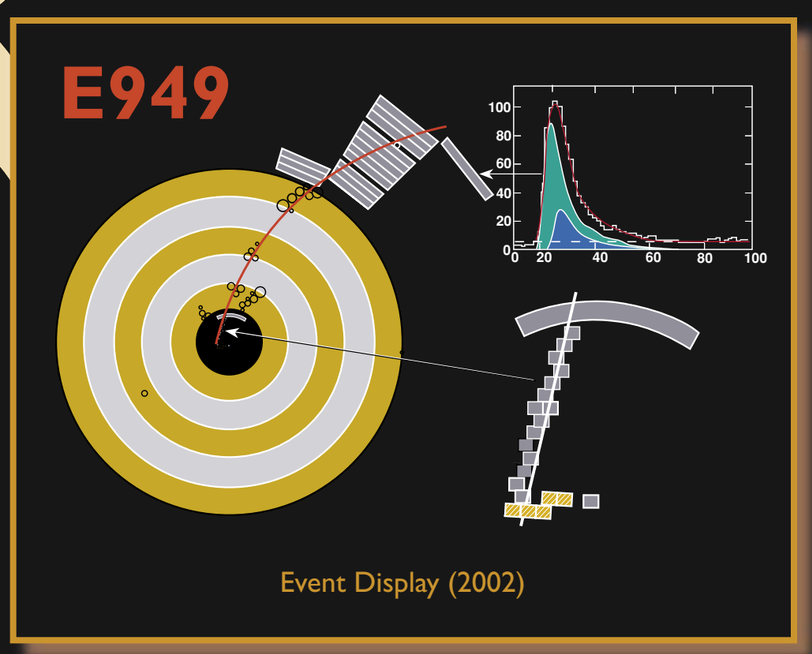
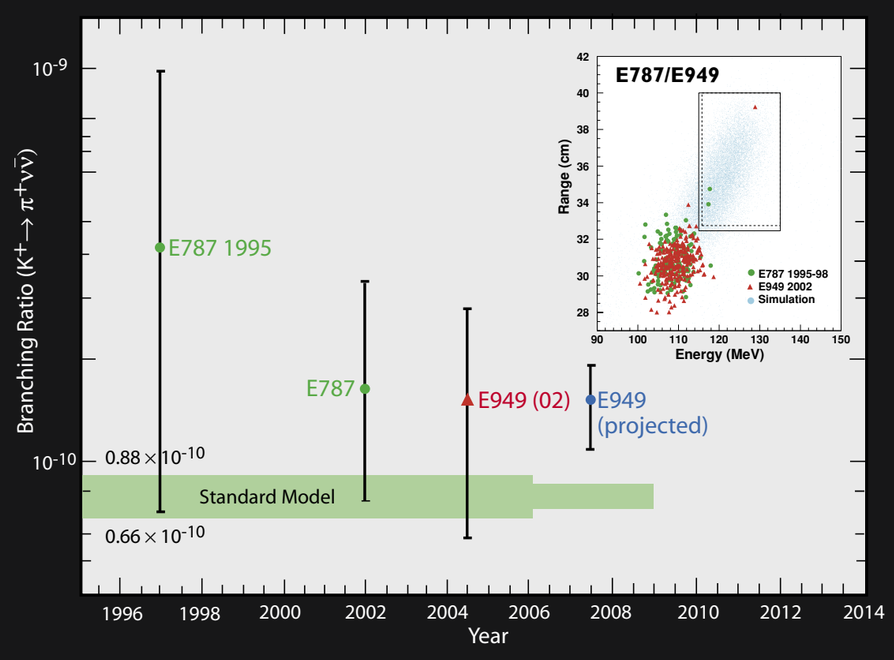
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