

E246 “Search for T violation in the  $K^+ \rightarrow \pi^0 \mu^+ \nu$  decay”

E470 “Measurement of direct photon emission in  $K^+ \rightarrow \pi^+ \pi^0 \gamma$ ”

Experiment E246 has searched for a T-violating transverse muon polarization ( $P_T$ ) in the  $K^+ \rightarrow \pi^0 \mu^+ \nu$  decay. In 2003 we finished the combination of two independent analyses by sorting all good events into three categories:--common events and two uncommon events. The null asymmetry  $A_0$ , the sensitivity  $A_N$  and other systematics such as the decay plane angular distribution of each data set were carefully checked and confirmed that all the data were of high quality. For the polarimeter analysis we adopted a new method to take into account the muon stopping distribution in the stopper explicitly. In this analysis,  $P_T$  is extracted differentially along the polarimeter axis  $y$  as shown in Fig.1 using a  $y$ -dependent analyzing power function  $\alpha(y) \sim AN(y)$  which is the asymmetry associated with the normal in-plane polarization. The integration of  $P_T(y)$  gives the result of

$$P_T = -0.0017 \pm 0.0023 (stat) \pm 0.0011 (syst)$$

corresponding to

$$\text{Im}\xi = -0.0053 \pm 0.0071 (stat) \pm 0.0036 (syst),$$

which shows no evidence for T violation within the experimental accuracy. This result improved the previous limit from BNL-AGS by a factor 3 as is shown in Fig.2, and can constrain model parameters of several non-standard CP violation models. In the actual analysis all the data were divided into three different periods of the experiment, each having similar experimental conditions and data size. The distribution of  $\text{Im}\xi$  was plotted as an ideogram (Fig.3) to show the good stability of the results. (Since  $\pi^0$  in  $K^+ \rightarrow \pi^0 \mu^+ \nu$  was detected not only as two  $\gamma$  but also as one  $\gamma$  with high energy, data were separately accumulated for 2 $\gamma$  and 1 $\gamma$  events.)

In E246 several byproducts could be analyzed using special-trigger runs for calibration and background studies. The transverse muon polarization in  $K^+ \rightarrow \mu^+ \nu \gamma$  was analyzed and the world's first data was published. Further accumulation of statistics gives  $PT(K_{\mu\nu\gamma}) = -0.0067 \pm 0.0143 (stat) \pm 0.00014 (syst)$ .

Experiment E470 was performed in 2001 using the same setup as E246 with a slight modification of the detector and trigger mode, aiming at the determination of the branching ratio for the direct photon emission (DE) in  $K^+ \rightarrow \pi^+ \pi^0 \gamma$  ( $K\pi 2\gamma$ ) in the dominant bremsstrahlung (IB). The DE branching ratio was already reported last year. In E470 also some other physics results could be obtained. A data of  $K^+ \rightarrow \pi^0 \pi^0 e^+ \nu$  ( $K_{e4}^{00}$ ) decays with 216 events (this is the world's largest data) were analyzed yielding the pion-pion scattering length  $a_0^0$  of the final state to be  $a_0^0 = 0.45 \pm 0.43$ .

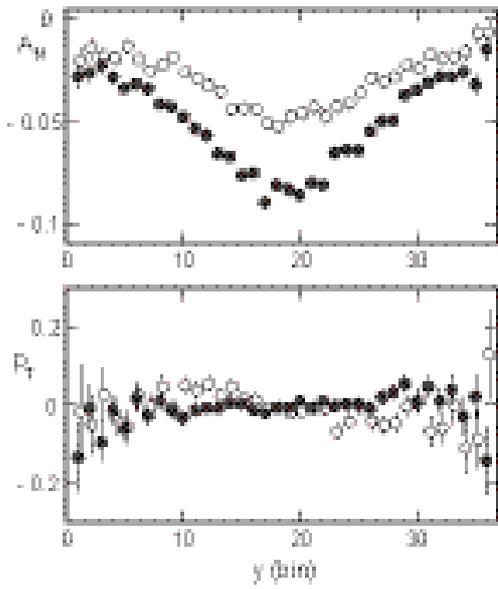


Fig. 1  $P_T$  distribution as a function of the polarimeter axis  $y$ . ( $\bullet$  are  $2\gamma$  and  $\circ$  are  $1\gamma$  events.)

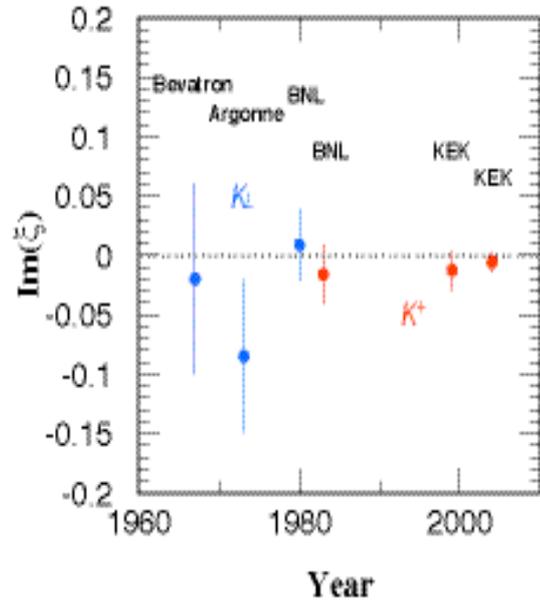


Fig. 2 History of  $P_T$  and our E246 result.

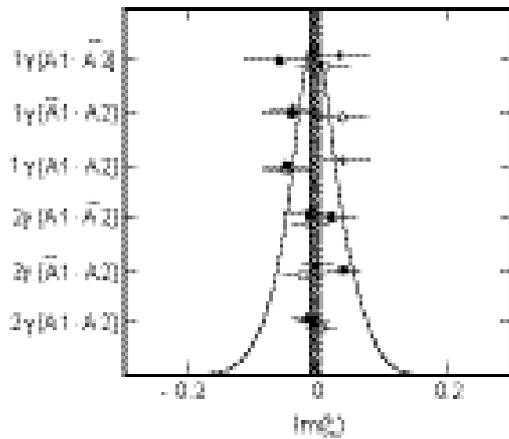


Fig. 3 Ideogram of  $\text{Im}\xi$  for the 18 data sets. ( $\bullet$  are data sets from 1996~1997,  $\circ$  are from 1998, and stars are from 1999~2000.)