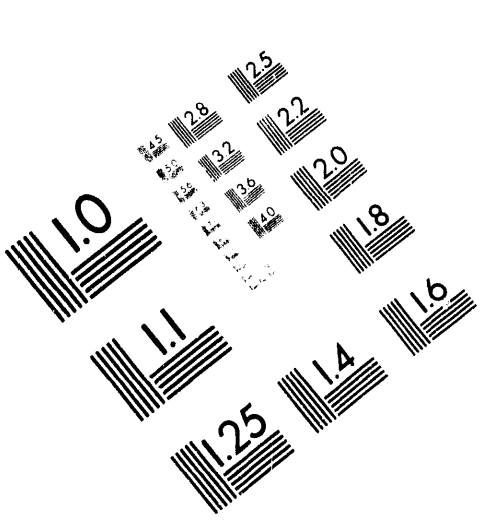

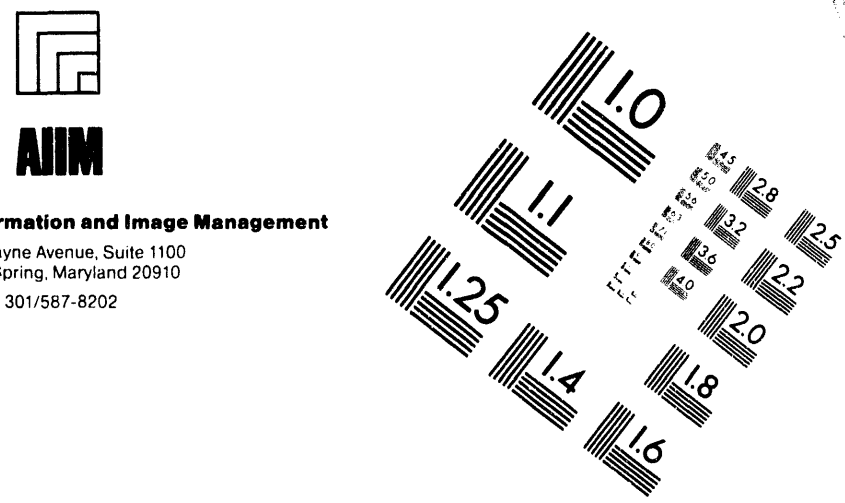

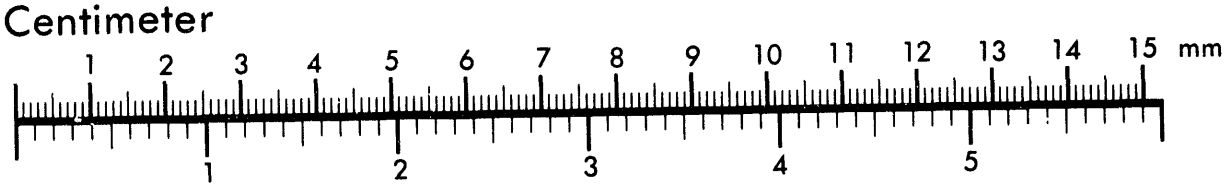

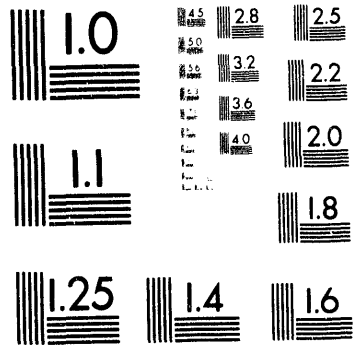

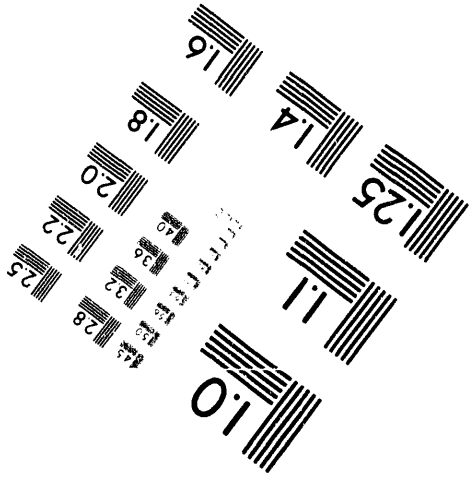

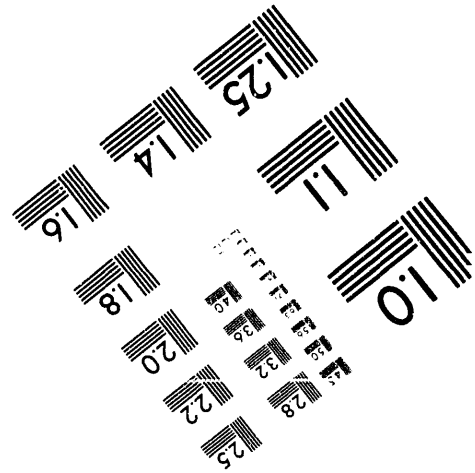

1 of 1

DOE/ER/40560--4B

EXPERIMENTAL STUDY OF WEAK INTERACTIONS BY PRECISION MEASUREMENT OF RARE KAON DECAY

Progress Report

for period October 1, 1992 - April 30, 1993

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April 1993

Prepared for

THE U.S. DEPARTMENT OF ENERGY

AGREEMENT NO. DE-FG02-90ER-40560 Task B

PROGRESS REPORT

Task B: Precision Experimental Study of Weak Interactions with the Neutral Particle Beam line at the KTeV experiment.

A) Search for Direct CP and CPT violation:

With the first observation in 1964 of CP violating decays came the search for the origins of this process. Since that time no direct evidence has been found for CP violation other than the rare CP violating decay in the original discovery. The search for direct evidence of CP violation concentrates around measuring the quantity Real(ε'/ε) in the 2π decay of the long lived K^0. Here at The University of Chicago research into this high precision measurement has been going on in the Fermilab experiments E731, E773 and is being planned for the new KTeV experiment E832. This work is being done in collaboration with the NSF funded group led by Bruce Winstein. The final results from the existing data sets have been published this year [L.K. Gibbons et al., Phys. Rev. Lett 70 (1993) 1203]. They are consistent with no evidence for direct CP violation, thus encouraging further more precision measurements planned in the new experiment.

A similar search for CPT violation by measuring the phase difference ϕ_{00}-ϕ_{+-} is also being done with the data, but thus far with E732 data no evidence for CPT violation was seen [L.K. Gibbons et al., Phys. Rev. Lett. 70 (1993)1199]. The analysis of our DOE supported graduate student Bernhard Schwingenheuer, is funded by this grant. He is doing a more detailed search with the data from E773 which had an active regenerator specifically designed for a much better measurement. This active regenerator was built in previous years on this grant request by our Research Associate Sunil Somalwar. It was a phenomenal success and shows signs of an ability to measure the CPT violating phase difference to within 0.5 degrees. Another year of work is needed before that will be completed. It is also expect to measure the charged mode phase ϕ_{+-} to better than half a degree with the same data set which

might yield evidence for a super weak phase difference theory.

B) Rare Kaon search for further CP violation evidence:

The original CP violation discovery is the observation of a rare, then thought to be forbidden, decay of the K_L into 2π which violates the CP symmetry. Depending upon what explanation for CP violation is appropriate other Rare Kaon decays should occur. One such decay that is being searched for is K_L into $\pi^0 e^+ e^-$. The search for this decay was the motivation for the experiment E799 which currently places a limit of less than $1x10^{-11}$(90%C.L.). This experiment and searching for this decay along with a host of other rare decays will continue as part of the KTeV experiment. This part of the experiment is being done in collaboration with Prof. Y. Wah and a full description can be found in Task J of the report to DOE. Half time of our Research Associate Nickolas Solomey is concentrated on the development of a large area Transition Radiation Detector to distinguish electrons from other charged particles. The proper operation of this detector in front of the electromagnetic calorimeter is essential to doing better rare Kaon decay searches and is also necessary for the Hyperon Physics described below.

Our DOE supported student Greg Makoff has finished his thesis on the K_{e4} rare decay. Almost 1000 events of this decay were found in the analysis of E731 data giving a branching ratio measurement of 4% and a first ever measurement of the form factors parametrizing this decay. These decays because of their complicated decay distributions provide a means to test theories of low energy phenomenology. With a sufficient number of these decays it was possible to study the phase shifts associated with the final state pions. Here a 17% measurement of the parameter L_3 in the $O(p^4)$ lagrangian was obtainable. This work has been completed apart from a small detail of the form factor systematic errors [G. Makoff et al., A Study of the Decay K_L into $\pi^+\pi^0 e^- \nu$,accepted for publication in Phys. Rev. Lett.].

PUBLICATIONS

New Measurements of the Neutral Kaon Parameters Δm, τ_S, $\phi_{00} - \phi_{+-}$, and ϕ_{+-}, L.K. Gibbons, A.R. Barker, R.A. Briere, G. Makoff, V. Papadimitriou, J.R. Patterson, B. Schwingenheuer, S.V. Somalwar, Y.W. Wah, B. Winstein, R. Winston, M. Woods, H. Yamamoto, E.C. Swallow, G.J. Bock, R. Coleman, J. Enagonio, Y.B. Hsiung, E. Ramberg, K. Stanfield, R. Tschirhart, T. Yamanaka, G.D. Gollin, M. Karlsson, J.K. Okamitsu, P.Debu, B. Peyaud, R. Turlay and B. Vallage, Phys. Rev. Lett 70,1199 (1993).

Measurement of the CP-Violation Parameter Re (ε'/ε), L.K. Gibbons, A.R. Barker, R.A. Briere, G. Makoff, V. Papadimitriou, J.R. Patterson, B. Schwingenheuer, S.V. Somalwar, Y.W. Wah, B. Winstein, R. Winston, M. Woods, H. Yamamoto, E.C. Swallor, G.J. Bock, R.Coleman, J.Enagonio, Y.B. Hsiung, E.Ramberg, K. Stanfield, R. Tschirhart, T. Yamanaka, G.D. Gollin, M. Karlsson, J.K. Okamitsu, P. Debu, B. Peyaud, R. Turlay and B. Vallage, Phys. Rev. Lett. 70 , 1203 (1993).

A Study of the Neutral K_{e4} Decay, G. Makoff, accepted for publication in Phys. Rev. Lett. (1993).

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