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A Proposal for

Tests of Time Reversal and CPT Invariance at LEAR.

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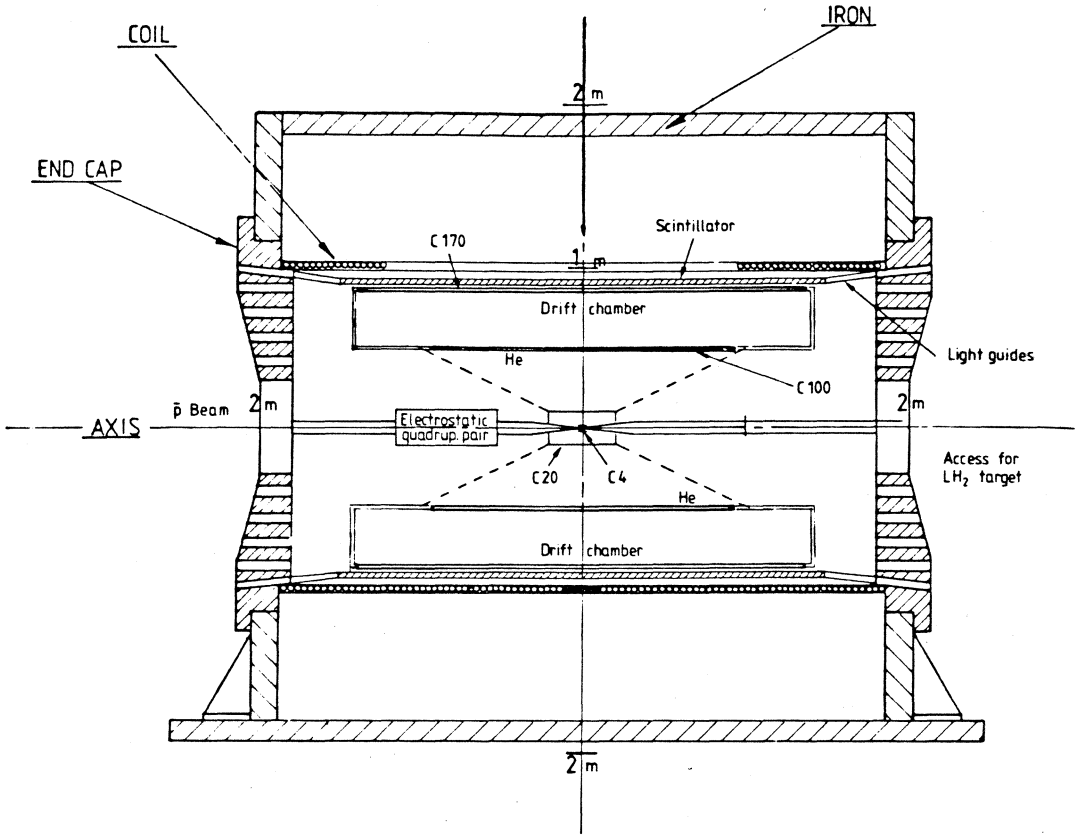
Abstract

Experimentally it is known that the symmetry principles of charge conjugation, C, and parity, P, are grossly violated by ordinary β-decay, and that the combined operation CP is violated at the level of 0.1% of the ($\Delta S = 1$) weak interaction. No experiments have yet shown that time reversal invariance T or CPT invariance, which is seen as a corner stone of relativistic field theories, are violated, or are valid at the level of 0.1% of the weak interaction.

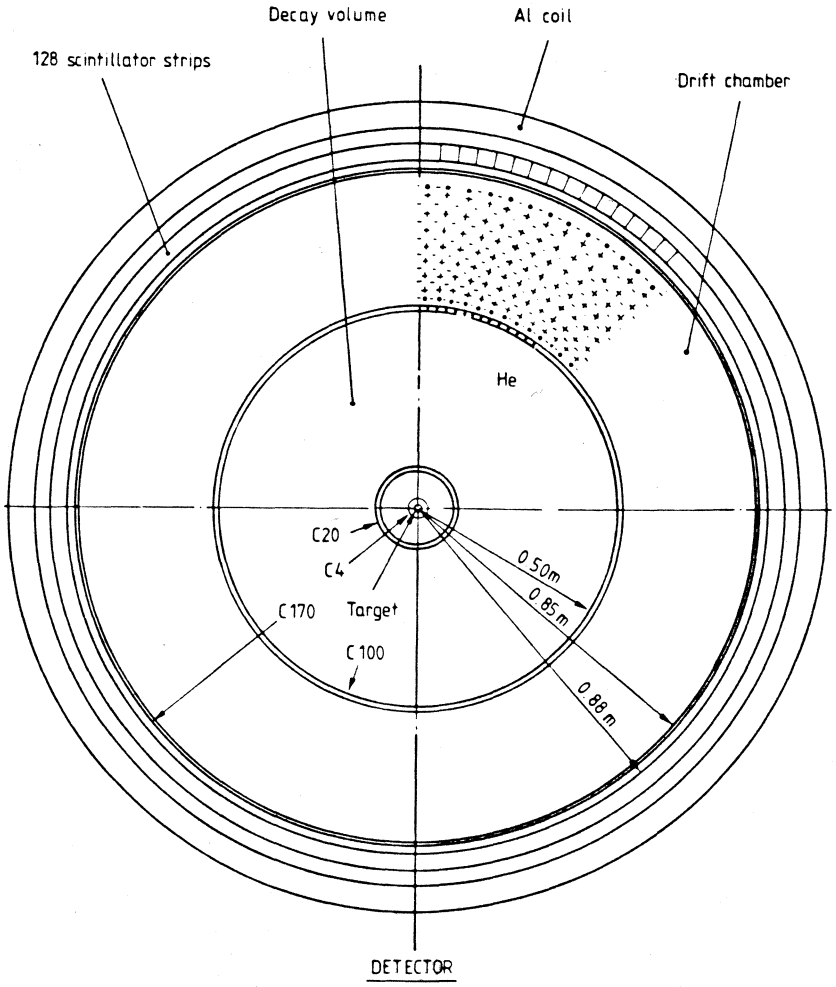
Tests of sufficient sensitivity and freedom from bias have been made possible by the high quality anti-proton beam available from LEAR. The annihilation $\bar{p}p$ at rest provides accurately equal numbers of K and $\bar{K}$, and it is the comparison of the various decays of these particles which directly tests the validity of the symmetry principles CP and CPT, and T in the form of detailed balance. The apparatus shown in the figure consists of two groups of cylindrical detectors separated by a decay volume. The central region (chambers C_4 and C_{20}) identifies the annihilation. The outer detectors (C_{100}, drift chamber, C_{170}, scintillators) locate any charged decay products. All detectors are contained in a solenoidal magnetic field of 0.3 T.

It is proposed to make these $K/\bar{K}$ comparison-tests of symmetry principles using $\sim 10^{12}\bar{p}$ to obtain the statistical accuracy indicated.

CPT	:	$(M_{K^\circ} - M_{\bar{K}^\circ})/(M_{K_L} - M_{K_S})$,	$\sigma \simeq 6 \times 10^{-4}$
CPT	:	$(\tau_{K^+} - \tau_{K^-})/(\tau_{K^+} + \tau_{K^-})$, c.f. the present limit $< 15 \times 10^{-4}$	$\sigma \simeq 1 \times 10^{-4}$
T	:	$K^\circ \to \bar{K}^\circ\, \nu.\, \bar{K}^\circ \to K^\circ$, c.f. the result of 65×10^{-4} expected from CPT invariance	$\sigma \simeq 4 \times 10^{-4}$
CP and CPT in $K_{\ell 3}$ decays:		$K^\circ \to \pi^- e^+ \nu\, \nu.\, \bar{K}^\circ \to \pi^+ e^- \bar{\nu}$, c.f. the present limit $< 3 \times 10^{-2}$	$\sigma \simeq 2 \times 10^{-4}$



MAGNET



DETECTOR