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NEW PEP TAU AND B-LIFETIME RESULTS*

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New results on tau and B-lifetimes obtained at the PEP colliding beam ring are presented.

1. τ-LIFETIME RESULT FROM THE MAC DETECTOR

In the fall of 1984 the MAC detector was upgraded with the addition of a close in vertex detector. The vertex chamber consisted of three double layers totalling 324 thin-walled cylindrical drift tubes (straws) contained in a gas vessel, pressurized to 4 atm. The gas mixture was a highly quenched mix of 50% Argon, 49% CO_2 and 1% CH_4. The radii of the innermost and outermost detection layers were at 4.6 cm and 8.4 cm, respectively. The drift tubes had a resolution of 50 μm averaged over the tubes. The relative layout of the MAC tracking devices is shown in Fig. 1.

90 pb^{-1} of data were taken with the vertex chamber. Lifetimes were extracted from impact parameter distributions measured relative to the production point. The production point was found using, with appropriate weights, the interception of the other track(s) in the event and the beam ellipse.

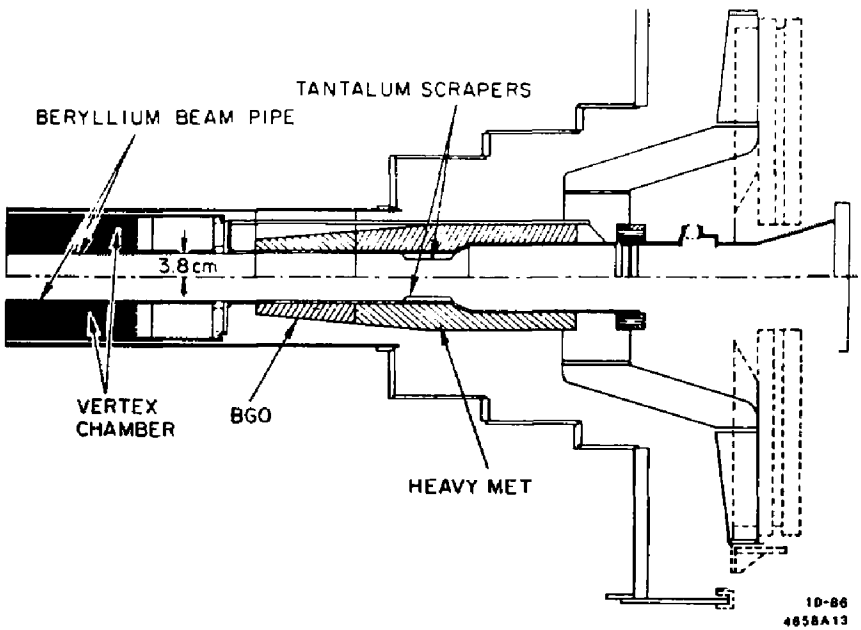

Figure 1. Layout of the MAC central tracking chamber and vertex detector relative to the beam pipe, shielding and active BGO shielding.

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Tracks selected for lifetime measurement were required to have momenta > 0.5 Gev/c, at least three hits in the vertex chamber and at least 7 hits in the central tracking chamber and finally they were required to have angles relative to the thrust axis > 2.5°. The final track sample consisted of 6,553 tracks.

The parent event composition was estimated to contain 96% $\tau^+ - \tau^-$ events, 2% multihadrons and 2% zero-lifetime backgrounds from two photon events. Figure 2 shows the measured distribution of impact parameters. The trimmed average for the distribution is 44.5 ± 2.4μm, corresponding to a τ-lifetime of $(2.86 \pm 0.17\ (stat) \pm 0.13\ (syst)) \times 10^{-13}$ sec. The result is in excellent agreement with the theoretical expectation of $(2.86 \pm 0.05) \times 10^{-13}$ sec based on the world-average electron branching ratio of $B_e = 0.179 \pm 0.003$ given at the Kyoto conference by Thorndike.

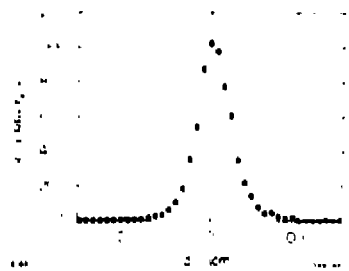

Figure 2. Impact parameter distribution for all selected tracks in the MAC τ-event sample.

2. B-LIFETIMES FROM THE MAC AND DELCO DETECTORS

New results are presently available from the MAC and DELCO detectors at PEP and further results from HRS and MARK II are expected.

A) MAC B-Lifetime Results

The MAC lifetime analysis used a new method using impact parameters of both the leptons and hadrons contained in a sample of events enriched in B-hadrons.

The sample was selected for events containing leptons with momenta > 2 Gev/c, $p_\perp$ > 1.5 Gev/c, calorimetric thrust > .72 and thrust axes with angles relative to the beam direction > 30°. Tracks used for the lifetime determination were required to have momenta > 0.5 Gev/c, at least seven hits in the CD, and subsequent to installation of the VC at least three hits in the VC. Projected angles relative to the thrust axis were required to be > 0.2 rad.

1558 tracks were found for data taken prior to the installation of the vertex chamber and 441 tracks were found for data taken with the vertex chamber. From MC studies it was estimated that 70% of the tracks originated from $b-\bar{b}$ production, 16% from $c-\bar{c}$ producion and 14% from light quark production.

The interaction point, to which impact parameters were referenced, was measured, as previously discussed in the τ lifetime measurement, by the interception of the other tracks in the event with the beam envelope. Figure 3 shows the impact parameter distribution obtained with the vertex chamber. Qualitatively there is a clear requirement for a non-zero lifetime to account for the distribution. The trimmed average for the impact parameter distribution is 129 ± 18 μm corresponding to a $\tau_b = 1.2 \pm 0.25\ (stat)$ ps. Data taken with the CD alone gave $\tau_b = 1.14 \pm 0.22\ (stat)$ ps.

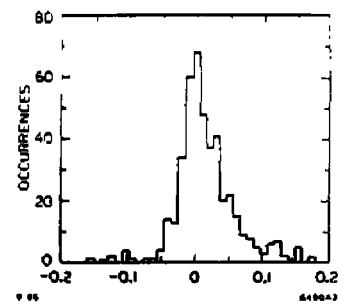

Figure 3. Histogram of impact parameters of tracks in the MAC b-event sample taken with the VC.

The combined result, including estimated systematics, was

$$\tau_b = 1.16 \pm 0.17\ (stat) \pm 0.07\ (sys)\ \text{ps}$$

with a conversion factor (microns to ps) systematic uncertainty of 15%.

B) DELCO B-Lifetime Results

Previously reported DELCO results were based on half their data sample. Their new results are based on their full data sample. Considerable effort has gone into understanding the systematic errors in their final result.

Their analysis is based on an accumulated luminosity of 214 pb^{-1}. B-decays are tagged by the presence of high $p_\perp$ electrons (> 1 Gev/c). While their resolution is modest (~ 230 μm on their impact parameter) the measurement is competitive due to the ability to cleanly identify electrons of low momenta. They estimated their B-lifetimes using a maximum likelihood fit to the impact parameters of the electrons.

Figure 4 shows the DELCO impact parameter distribution for their electrons. Table I summarizes the results of their track selection and gives their final best lifetime.

3 COMPARISON WITH OTHER MEASUREMENTS OF τ_b AND CONCLUSIONS

Figure 5 shows the B-lifetime measurements as they have progressed with time. Prior to the present results there was an apparent tendency for more accurate results to be associated with shorter lifetimes. The latest MAC and DELCO results however show a stable convergent result. We can conclude that, beyond reasonable doubt, the B-lifetime is ~ 1.2 ps.

The present lifetime measurements are global averages over charged and neutral decay modes. The present precision is now sufficient that the inherent uncertainties, arising from the absence of identification of decay modes, probably dominate the interpretation of the data and thus further real progress is likely to require qualitatively better experiments with the ability to identify specific decay modes.

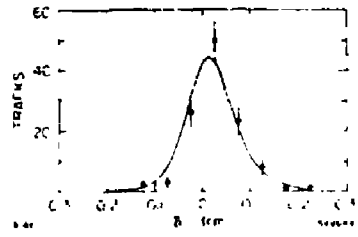

Figure 4 DELCO impact parameter distribution for electron tracks used to determine τ_b. The points with error bars are the data. The smooth curve is a Monte Carlo calculation based on the measured value of τ_b and the resolution used in the maximum likelihood fit.

Table I. Delco Results

B-REGION (p_t > 1 GeV)
of tracks = 113
δ = 259 ± 49(stat.)μm
τ_b = 1.17$^{+0.27}_{-0.22}$(stat.)$^{+0.12}_{-0.16}$(sys.)psec

Sources of Tracks in the B-Region	
b → e	0.70
b → c → e	0.09
c → e	0.17
background	0.04

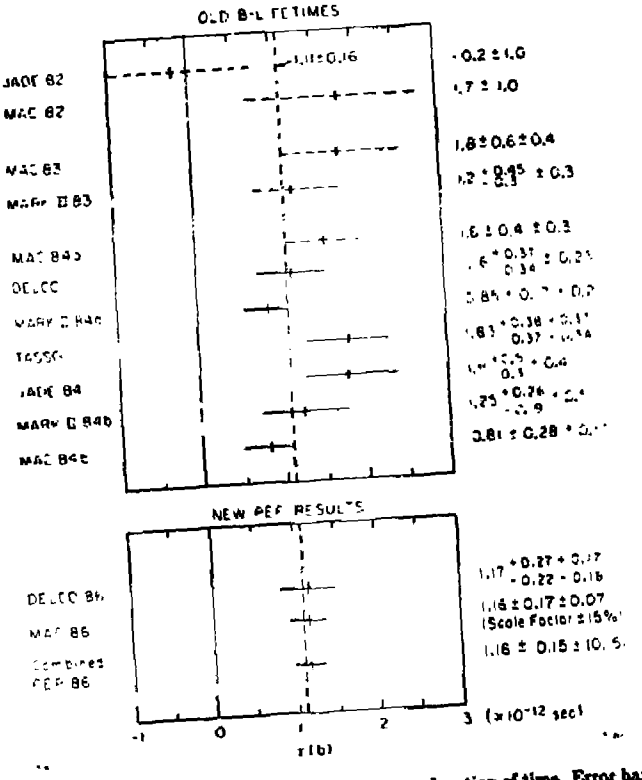

Figure 5. Summary of *B*-lifetime measurements as a function of time. Error bars are systematic and statistical errors combined in quadrature.

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