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M. Piccolo:

RECENT RESULTS FROM MAC

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RECENT RESULTS FROM MAC

by M. Piccolo
for the MAC Collaboration *

ABSTRACT

MAC is currently taking data at PEP at a c.m. energy of 29 GeV. Topics presented in this talk include the accurate determination of the values of R, a high statistics study of the muon pair asymmetry, inclusive leptons measurements, the first measure of the b lifetime, limits on the production of the selectron for masses up to 22-25 GeV, and the photon structure function.

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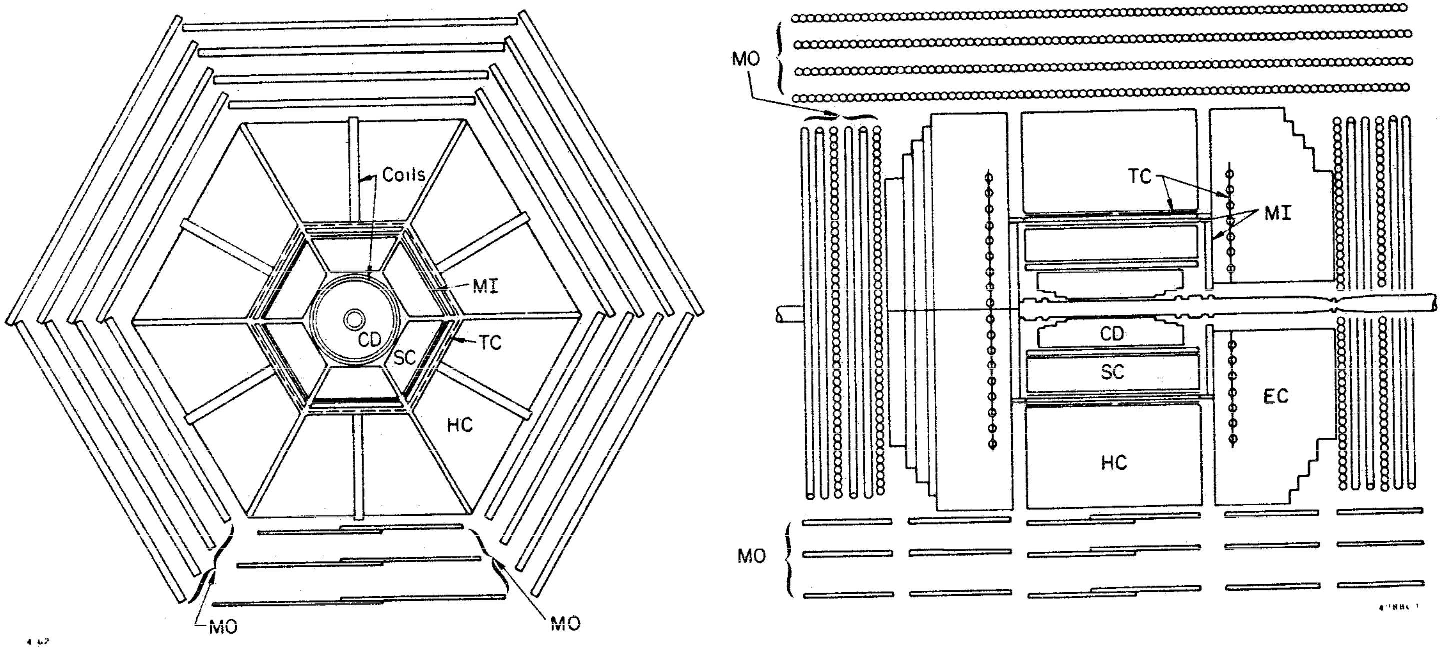
MAC Detector Components:

CD - Central Drift Chamber
SC - Shower Chamber (Central)
TC - Trigger/TOF Scintillators
HC - Hadron Calorimeter (Central)
EC - End-cap Shower and Hadron Calorimeters
MO, MI - Muon Drift Chambers
Coils - Solenoid and Toroid



1. MAC detector layout. The components are: CD central drift chamber, SC shower chamber, TC scintillators, HC central hadron calorimeter, EC end-cap calorimeter, MI, MO inner and outer muon drift chambers. Also indicated are the beam pipe, and the solenoid and toroidal coils.

1. INTRODUCTION

MAC is a large solid-angle device with charged particle tracking, lepton identification capability and total energy measurement, and has been described elsewhere.[1]

Briefly, it consists of a cylindrical drift chamber with 10 layers of wires, immersed in a magnetic field of 5.7 kGauss produced by a solenoidal coil, and surrounded by an electromagnetic calorimeter, a set of 144 scintillation counters, a hadronic calorimeter and muon chambers (Fig. 1). For the analysis described in this talk, here is a summary of the most relevant parameters.

The central drift chamber (CD in the following) has a spatial resolution per point of 200 μm, and a momentum resolution $\sigma(p\perp)/p\perp = 0.065\ p\perp$ ($p\perp$ in GeV/c); the inner radius is 12 cm. The electromagnetic calorimeter (S.C.) consists of lead-proportional wire chambers (PWC) sandwich in the central section and iron-PWC sandwich in the end caps. Each lead sheet is 2.5 mm thick, the total thickness is of $\sim$ 15 r.l. The energy resolution measured with Bhabha events (at 14.5 GeV) is $dE/E = 0.05$, which corresponds to about 20% at 1 GeV. The segmentation for the readout is 192 sectors in azimuth and 3 layers in depth; the z coordinate is measured by current division.

The hadron calorimeter consists of 91 cm of steel absorber interspaced with PWC for a total of about 5 absorption lengths. The steel plates are magnetized by toroidal coils to about 18 kGauss, providing a momentum measurement with $dp/p = 0.30$, practically independent of p. The calorimeters cover $\sim$ 98% of the total solid angle and are surrounded by 4 layers of drift tubes for tracking muons.

The data whose analysis I will describe here were collected at PEP, the SLAC e^+e^- storage ring, from November 1981 to June 1983. The total integrated luminosity is 143 pb^{-1}, all taken at a c.m. energy of 29 GeV. Almost 2/3 of all data were obtained after February 1983 when, thanks to the efforts of the machine group, a very valuable increase in the machine luminosity was achieved.

2. THE MEASUREMENT OF R

Due to the increased statistics and the improved understanding of the systematics, we have measured R, the ratio of the total hadronic cross section to the muon pair production, to a precision of 3%.

We have performed two independent measurements of R, one using only a "fiducial" volume in the central part of the apparatus where the backgrounds are minimal, and another one which makes full use of the large solid-angle coverage to decrease the model dependence of the efficiency calculation.

The first analysis was performed on a sample of 18,356 events, for a total integrated luminosity of 81 pb^{-1}; in the second analysis 22,778 events were studied, corresponding to 49 pb^{-1}. The results from the two methods are in good agreement and our best estimate for the value of R is:

$$R = 3.89 \pm 0.02 \pm 0.11 \quad .$$

The error is dominated by the systematic uncertainties with the main contributions coming from the luminosity measurement (1.7%) and from the evaluation of the radiative corrections (1.5% and 1.1% for the two analyses respectively).

3. MUON PAIR ASYMMETRY

In the Standard Model the interference between the electromagnetic and weak interactions gives rise to an asymmetry in the angular distribution of the muon pairs.[2] this effect is sensitive to the axial-vector part of the weak neutral current, to order αG we have[3] :

$$d\sigma/dcos\theta = \frac{\pi\alpha^2}{2s}[(1+a_1)(1+cos^2\theta)+2a_2cos\theta], \qquad (Eq.\ 1)$$

$$a_1 = g_v^e\, g_v^\mu\ \frac{1}{\pi\alpha}\ \frac{G}{\sqrt{2}}\ \frac{-s}{1-s/M_{Z^\circ}^2},\ and \qquad (Eq.\ 2)$$

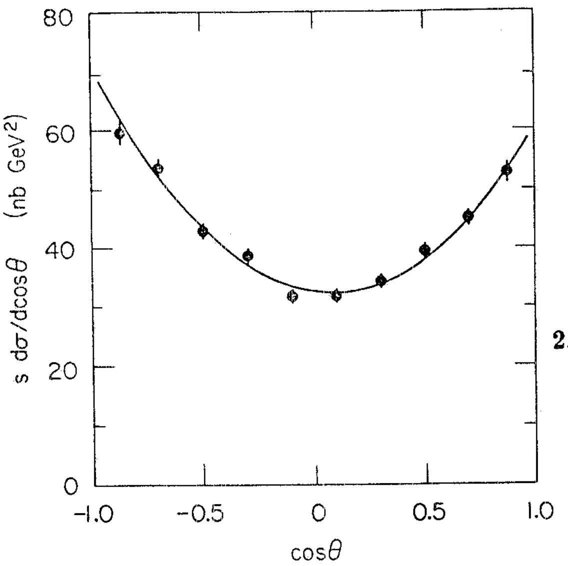
$$a_2 = g_A^e\, g_A^\mu\ \frac{1}{\pi\alpha}\ \frac{G}{\sqrt{2}}\ \frac{-s}{1-s/M_{Z^\circ}^2} \qquad (Eq.\ 3)$$

where θ is the angle between the incoming e^+ and the outgoing μ^+, and M_{Z° is the mass of the Z°. The asymmetry is given by:

$$A_{\mu\mu} = \frac{N^+ - N^-}{N^+ + N^-} = \frac{3}{4}a_2(1-a_1) \quad . \qquad (Eq.\ 4)$$

A forward-backward asymmetry is also expected from pure QED[4] : we have calculated the radiative corrections to Eq. (1) with the Monte Carlo (M.C.) program of Berends and Kleiss[5] to the order α^3. These terms produce a charge asymmetry of + 0.028 which has to be subtracted from the data in order to calculate the weak effect.

We have analyzed a sample of 10,258 events for a total integrated luminosity of 143 pb^{-1}; the background contamination from Bhabha ($<$ 0.3%) and tau pairs (0.8%) is evaluated to be 80 events. The differential cross section after radiative corrections is shown in Fig. 2.



2. Differential cross section of $\mu^+\mu^-$ pair production, after radiative corrections. The curve is the result of the fit.

In the assumption that $a_1 \ll 1$, we find the best fit value of a_2 from a maximum-likelihood calculation. The result is:

$$A_{\mu\mu} = -0.058 \pm 0.010 \pm 0.003 \quad ,$$

the systematic error is mainly due to possible Bhabha background.

The prediction of the Standard Model with $g_A^e g_A^\mu = 0.25$ and $M_{Z^\circ} = 90$ GeV is $A_{\mu\mu} = -0.060$ (including radiative corrections to the Z° exchange diagram).[6] The product of the axial-vector coupling constants from the fit is

$$g_A^e g_A^\mu = 0.24 \pm 0.04 \quad .$$

The ratio of the absolute cross section measured in MAC and the pure QED value

$(a_1 = a_2 = 0)$ is

$$\frac{\sigma_{meas}}{\sigma_{QED}} = 0.976 \pm 0.014 \pm 0.034 \quad ,$$

from which we find

$$g_v^e g_v^\mu = 0.07 \pm 0.11 \quad ,$$

the error is dominated by systematic uncertainties in the normalization.

4. HEAVY QUARK FLAVOR TAGGING

Semileptonic decays of D and B mesons provide a simple signature for $c\bar{c}$ and $b\bar{b}$ events. From the study of multihadronic events containing a lepton, several properties of the primary quarks can be inferred.

Since the b quark is much heavier than the c quark, leptons from the B decay tend to have a higher $p_\perp$ with respect to the thrust axis of the event, the direction of which is close to that of the B meson.

Experimentally, in order to obtain a sufficiently clean sample of muons and electrons, we have to impose a cut of 2 GeV/c in momentum; semileptonic branching fractions and fragmentation functions of the c and b quarks are then coupled and cannot be measured separately.

4.1 Inclusive Muons

In MAC a muon is seen as a particle penetrating through the hadron calorimeter and tracked in the external chambers. In order to reduce hadronic punch-through we use only tracks with $p > 2.0$ GeV/c.

We have performed several studies based on muons[7] ; the criteria used to identify a muon vary with the purpose of the analysis. The identification efficiency depends, of course, on the set of cuts applied: it can be as high as 80% if a contamination of 50% background can be tolerated, or as low as 50% if a "clean" sample is needed, as in the case of the b lifetime measurement.

We have already published an analysis[8] on a partial sample of hadronic events ($\sim$ 25,000 for a total integrated luminosity of 54 pb^{-1}) where a sample of 476 muons was used to study the fragmentation function $D_b(z)$, with

$$z = \frac{E_B + p_{//B}}{E_b + p_{//b}}. \qquad (Eq.\ 5)$$

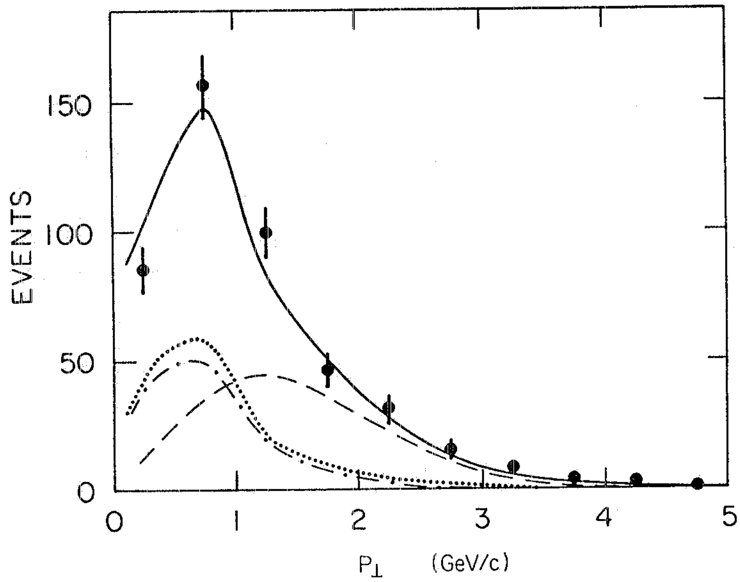
The $p_\perp$ distribution is shown in Fig. 3. From a simultaneous fit to the p and $p_\perp$ distributions we extracted the fragmentation function to be peaked at high value, with an average $<z> = 0.8 \pm 0.1$ (Fig. 4).

If one parametrizes $D(z)$ according to Peterson et al.[9] as

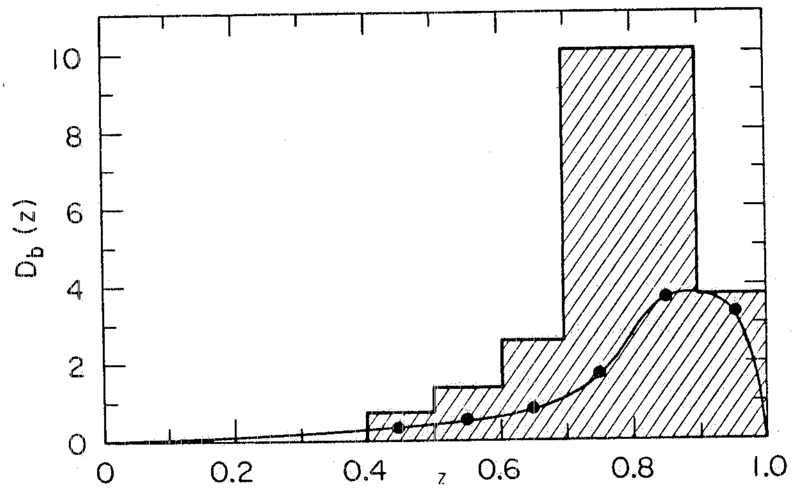
$$D(z) = \frac{1}{z(1 - 1/z - \frac{\epsilon}{1-z})^2} \quad , \qquad (Eq.\ 6)$$

the fit to our data gives $\epsilon = 0.008^{+0.037}_{-0.008}$.

We have now an updated analysis based on our complete sample of data ($\sim$ 69,000 events, 143 pb^{-1}), in which a sample of $\sim$ 1.500 muons are identified, with a background evaluated to be 42%. We assume for the c quark fragmentation Eq. (6) with $\epsilon = 0.4$,[10] and fit the data to find the semimuonic branching fractions:



3. $p_\perp$ distribution of muons with $b\bar{b}$ (dashed curve) $c\bar{c}$ (dot-dashed), background (dotted), and total (solid curve) predictions.



4. One standard deviation envelope of all b quark fragmentation functions with acceptable fits to the data. The curve represents function (2) for $\epsilon_b = 0.008$.

$$BR\,(b \to \mu X) = (12.3 \pm 1.8^{+1.7}_{-1.3} \pm 0.8)\%$$

$$BR\,(c \to \mu X) = (9 \pm 3)\% \quad .$$

The additional 0.8 error in $BR\,(b \to \mu X)$ takes into account the fact that its value changes from 11.3 to 12.9 as ϵ varies within its 68% confidence level range.

4.2 INCLUSIVE ELECTRONS

Electrons are identified as a track in the CD followed by consistent energy deposition in the shower chamber and no track in the hadron calorimeter. The selection criteria have been derived from the study of electrons in the detector (Bhabha and $ee\gamma$ events). In this analysis we consider only tracks with at least 1.8 GeV/c of momentum and in the central part of the detector ($|cos\theta| < 0.7$). We then require that the energy deposition in a narrow region around the track be consistent with the longitudinal development of an electromagnetic shower. More in detail, the set of cuts imposed are the following:

$$\frac{E_1}{p} \geq 0.1, \; \frac{E_{II}}{p} \geq 0.3, \; \frac{E_I + E_{II} + E_{III}}{p} \leq 1.8, \frac{E_{hc}}{p} \leq 0.12$$

where $E_I, E_{II}, E_{III}, E_{hc}$ are the energy left in each layer of the shower chamber and in the hadron calorimeter, respectively, p is the momentum measured in the CD. The identification efficiency is $\sim$ 60%, with a slight p dependence. In a sample of $\sim$ 60,000 multihadron events we observe 1540 electron candidates. The background comes essentially from three sources:

1. Early showering hadrons; the contamination has been calculated by M.C.[11] to be 1:230. We have performed a check using the 3-prong from τ decay, and found good agreement between data and Monte Carlo.
2. Overlap of a charged track with a shower from a hard photon; this effect has been also calculated by M.C.[12] Its effect is large in the low $p\perp$ region and decreases rapidly with $p\perp$.
3. Electrons from other sources; not all electrons come from the semileptonic decay of particles containing the c or the b quarks. There are cases in which a photon converts in the pipe but only one electron is tracked and appears to come from the primary vertex; there are electrons from the decay of the ψ or vector mesons, etc. The momentum distribution of these electrons is soft and the contribution in the high momentum range is negligible compared to 1) and 2).

From a fit to the $p\perp$ distribution, assuming the same c and b fragmentation functions as for the muon analysis, we find the following values for the semielectronic branching ratios:

$$BR\ (b \rightarrow eX) = (11.3 \pm 1.9 \pm 3.0)\%$$

$$BR\ (c \rightarrow eX) = (8 \pm 3)\% \quad .$$

These results must be considered preliminary, they are however, in good agreement with previously reported data from other experiments.[13]

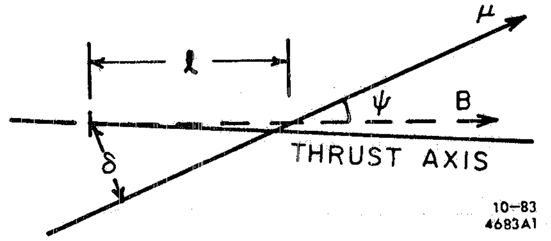
5. MEASUREMENT OF b LIFETIME

High $p\perp$ leptons are a good tag for $b\bar{b}$ events, as shown in Fig. 3; for $p\perp$ $>$ 1.5 GeV/c both the background and the contribution of the decay of charmed particles decrease rapidly. The lifetime of particles containing the b quark can then be inferred from the study of the distribution of the impact parameter of high $p\perp$ leptons.

For this analysis[14] we have used a sample of $\sim$ 50,000 multihadronic events. Muon candidates were defined as requiring that a track in the external drift chambers be matched in polar angle and momentum measurement to a track reconstructed in the CD,and to a segment reconstructed from the energy deposited in the calorimeters, with pulse heights compatible with those of minimum ionizing particles. For $p\perp$ $>$ 1.5 GeV/c the misidentification probability is 1:500, which corresponds to a background of (14 $\pm$ 7) % divided roughly into 6% from pion and kaon decays and 8% from punch-throughs.

Electron candidates were found in a slightly smaller sample of events, corresponding to 98 pb^{-1}, and were defined as in the analysis of inclusive electrons described above. With a cut at $p\perp$ = 1.5 GeV/c the background is (25 $\pm$ 8) %, almost entirely due to early interacting hadrons.

The sample of leptons so obtained consists of 155 muons and 113 electrons; for each of these tracks the impact parameter δ, as projected in a plane perpendicular to the beam axis, was measured. The flight path ℓ of the parent meson and the decay angle ψ were defined, in the same plane, as shown in Fig. 5. The quantity



5. Definition of the impact parameter δ. The dashed line is the (unknown) direction of the B mesons.

δ is defined with a sign: it is assumed to be positive if a particle emitted along the thrust axis, toward the intersection with the lepton track, would decay into the lepton in the forward direction.

Apart from the effect of the finite resolution, a true decay can produce a negative δ in two cases: if the lepton is emitted backward, or if its direction is in between the parent and the thrust axis. This dilutes the effect of a non-zero lifetime, Monte Carlo calculations show that the loss of sensitivity of the method is negligible for B mesons, while for the background the cancellation is nearly complete.

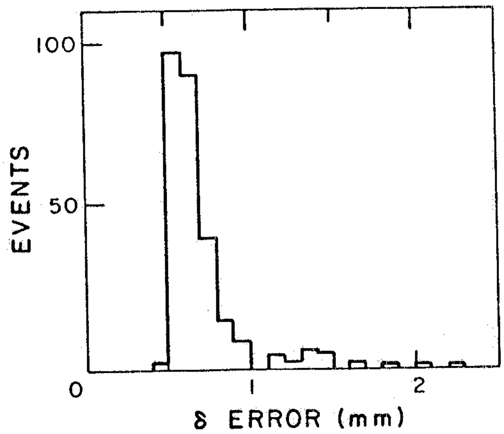
The lifetime can be related to the average value of the δ distribution:

$$< \delta >=< \beta\gamma \quad sin \quad \theta \quad sin \quad \psi > c\tau = \alpha c\tau \qquad (Eq. 7)$$

where θ is the polar angle of the lepton track.

The factor α can be calculated by Monte Carlo, the result is not practically affected by the hypothesis introduced for the production and decay of B mesons. The result is in fact quite insensitive to the B momentum: the decay angle ψ shrinks at the increase of the B momentum while the path length ℓ grows for the relativistic boost, and the two effects almost entirely compensate.

The error with which δ is measured depends on the accuracy in the extrapolation of the lepton track and on the effective size of the beam interaction area. The center of this area is known quite precisely and its position is monitored on a run-by-run basis from the study of the Bhabha events. We find that the effective rms beam size is $\sim$ 0.4 mm horizontally, and $\sim$ 0.1 mm vertically. The error in the extrapolation of the lepton direction is obtained from the error matrix in the fit to the track. The distribution of the global error in δ is shown in Fig. 6; tracks for which this error



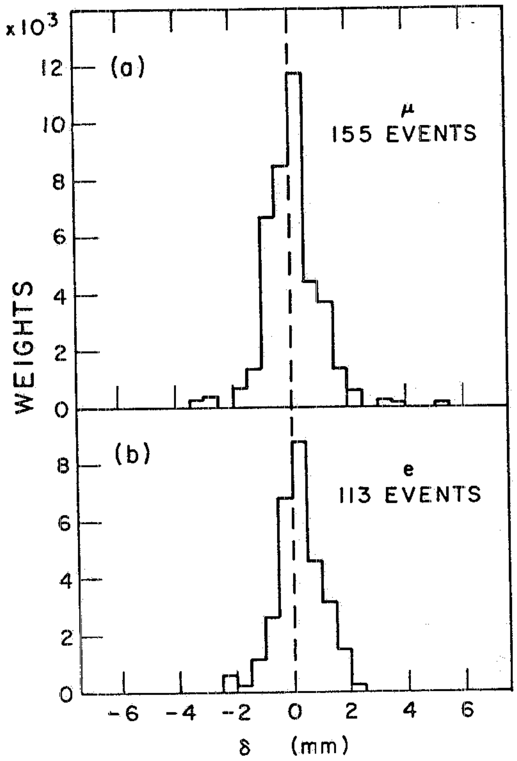
6. Distribution of the global error in the measurement of δ.

is bigger than 1 mm are rejected. The distribution of δ, weighted by the inverse of the squared error, is shown in Fig. 7 for muons and electrons separately. In both cases the average value is significantly different from zero:

$$< \delta_\mu >= (158 \pm 81)\mu m \qquad < \delta_e >= (174 \pm 75)\mu m \quad .$$

If we define f_b, f_c, f_{bg} as the fractions of $b\bar{b}$, $c\bar{c}$ and background events in the sample, and δ_c and δ_{bg} as the average values of δ expected for $c\bar{c}$ and background, we have:

$$< \delta >= f_b \, \alpha c \, \tau_b + f_c\delta_c + f_{bg} \quad \delta_{bg} \quad . \qquad (Eq. 8)$$



7. Distribution of δ: (a) muon sample, (b) electron sample.

The values of δ_c and δ_{bg} were obtained from Monte Carlo using the Lund Production Model[15] and the literature values of the charmed particles' lifetimes.[16] The heavy quarks' fragmentation function and semileptonic branching ratios were also taken to agree with the measured ones[17] : variations of these parameters do not affect sensibly the results, and are taken into account in the systematic errors used in the calculation of the b lifetime. (See Table I.) The results of the two independent samples are in good agreement. We finally introduce an additional uncertainty of 30 μm in σ to account for possible systematic bias, and we obtain the average:

$$\tau_b = (1.8 \pm 0.6 \pm 0.4)10^{-12} sec \quad .$$

We have performed several checks to study possible bias in the distribution of δ. A control sample was obtained using all tracks with $p > 2$ GeV/c and $p\perp >$ 1.5GeV/c in our multihadronic events. For these we expect $\delta = 20\mu$m if we use the Monte Carlo zero lifetime for the B particles, or $\delta = 30\mu$m if we use our measured τ_b. The distribution that we obtain with $\sim$ 18,000 tracks is shown in Fig. 8, the average value is:

$$< \delta > = (34 \pm 8)\mu m.$$

As a further test, we have used this impact parameter method to measure the τ lifetime, which has previously been measured using the vertex distribution of the 3-prong τ decay. We select 1-3 prong configurations of $\tau^+\tau^-$ events, and study the δ distribution of the one prong: we obtain from 2099 tracks, $< \delta > = 53 \pm 19\mu m$

TABLE I

Summary of parameters used to compute τ_b.

	μ sample	e sample
No. of events	155	113
f_b	0.72 ± 0.08	0.63 ± 0.07
f_c	0.14 ± 0.04	0.12 ± 0.05
f_{bg}	0.14 ± 0.07	0.25 ± 0.08
$\delta_c(\mu m)$	24 ± 11	19 ± 11
$\delta_{bg}(\mu m)$	26 ± 8	24 ± 6
α	0.43 ± 0.03	0.46 ± 0.03
$\langle \delta \rangle$ (μm)	158 ± 81	174 ± 75
$_b(10^{-12}sec)$	1.62 ± 0.87	2.00 ± 0.84

which corresponds to

$$\tau_\tau = (3.9 \pm 1.4).10^{-13} sec$$

in very good agreement with the previously measured values.[18]

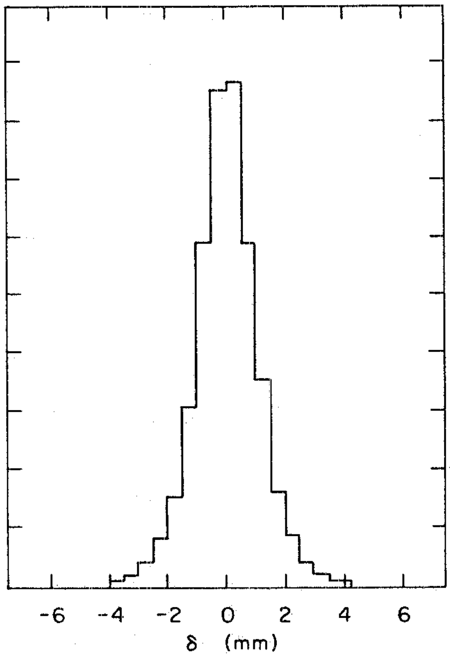
The b meson lifetime has been related by several authors to the quark mixing angles[19] ; for example Gaillard and Maiani[20] express τ_b as

$$\tau_b = \tau_b^o \frac{1}{(2.75 sin^2\gamma + 7.69 sin^2\beta - 5.75 sin^2\gamma) + O(sin^4\gamma, sin^4\beta)} \quad . \qquad (Eq.\ 9)$$

Where

$$\tau_b^o \sim \tau_\mu \left(\frac{m}{mb}\right)^5 \ \frac{1}{9} \sim 10^{-15} sec \qquad (Eq.\ 10)$$

is the lifetime expected for hadrons containing a b quark in absence of suppression due to small mixing between the second and the third generation. β and γ are the



8. Distribution of δ for the control sample.

angles in the K.M. matrix.

Together with the limit on $\Gamma(b \rightarrow e\bar{\nu}X_u)/(\Gamma(b \rightarrow e\bar{\nu}X_c)$ reported by the CUSB group at this Conference,[21] our result implies:

$$|sin\gamma| = 0.043 \pm 0.01 \text{ and}$$

$$sin\beta < 0.009 \text{ (95\% confidence level)} \quad .$$

6. SEARCH FOR SUPERSYMMETRIC PARTICLES

While the recent discoveries of the $W^{\pm}$ and Z° have proved the validity of the Standard Model, there is a lot of theoretical effort in order to provide schemes which go "beyond" this model.

One of the most attractive of these theories is Supersymmetry,[22] which provides a simple way to cancel the quadratically divergent diagrams contributing to the Higgs mass. SUSY introduces a symmetry between bosons and fermions, assigning to the same multiplet particles whose spin differs by 1/2 unit, so that fermions can be transformed into bosons, and vice versa.

In such a scheme, each known particle must have a supersymmetric partner: there must be a "photino" with spin 1/2, a "selectron" with spin 0, "sleptons," "squarks," and so on. Since up to now no boson-fermion mass degenerate pair has been observed, this supersymmetry must be broken; the mass values of the new particles, depend on how this breaking occurs.

Several breaking schemes have been proposed, some of them interesting from the experimental point of view, as they indicate SUSY particles to be light enough, to be within reach of present experiments. In the model proposed by Fayet,[23] for example, the masses of the SUSY partners of the fermions are bound to be less than 1/2 of the mass of the W.

Squarks and sleptons can be produced in e^+e^- annihilation: the pair production of scalar leptons or quarks via the processes

$$e^+e^- \to \tilde{e}\tilde{e},\ \tilde{\mu}\tilde{\mu},\ \tilde{q}\tilde{q} \qquad ,$$

would result in the presence of pairs ee, $\mu\mu$, or $q\bar{q}$ with missing energy and momentum, in excess of QED. Searches of this kind have already excluded sleptons for masses up to 15-16 GeV.[24] The measurement of R at PETRA also excludes 2/3 squarks up to 18.5 GeV/c.

Several processes[25] have been suggested in order to extend the sensitivity of the search up to masses higher than the beam energy. The processes considered are:

$$e^+e^- \to \tilde{\gamma}\tilde{\gamma}\gamma \qquad \text{and Process (1)}$$

$$e^+e^- \to e\tilde{\gamma}\tilde{e} \qquad \text{Process (2)}$$

$$\hookrightarrow \tilde{\gamma}e \qquad .$$

6.1 SINGLE PHOTON SEARCH

The cross section of Process (1) can be sensitive, at PEP energy, to selectron masses up to 60 GeV/c:

$$\frac{d\sigma}{dx\,dy} = \frac{4}{3}\,\frac{3}{M_{\tilde{e}}^4}\,\frac{S}{X(1-y^2)}\left[(1-X)\left(1-\frac{x^2}{2}\right)+\frac{x^2}{4}(1-x)y^2\right]\left(1-\frac{4m_{\tilde{\gamma}}^2}{s(1-x)}\right)^{3/2} \qquad (Eq.\ 11)$$

where

$$x = \frac{E_\gamma}{E_{beam}} \qquad , \qquad y = \cos\theta_\gamma \qquad . \qquad (Eq.\ 12)$$

The experimental signature for this kind of event is one photon and nothing else detected in the apparatus; background processes are:

$$e^+e^- \to e^+e^-\gamma \qquad \text{Process (3)}$$

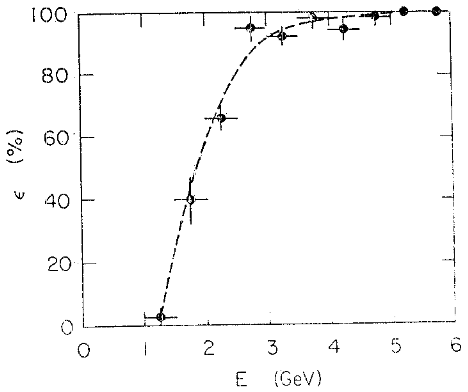
where both electrons escape detection because they are at small angles or

$$e^+e^- \to \gamma\gamma\gamma \qquad \text{Process (4)}$$

where only one photon is detected.

Both background processes can be substantially reduced requiring transverse energy balancing: if a γ is emitted at an angle θ with an energy E_γ, Processes (3) and (4) can be tagged because they will produce detectable particles at angles $\theta' \geq E_\gamma \sin\theta/(2E_b)$.

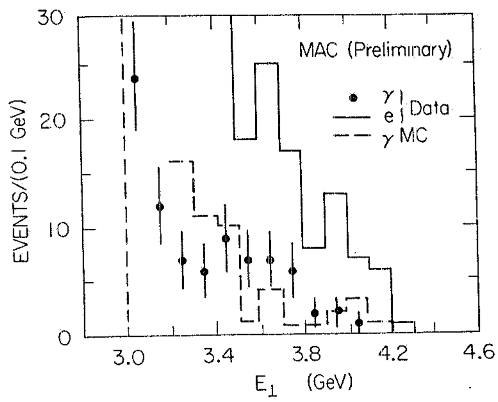
MAC has recently successfully tested a new trigger sensitive to Process (1) with efficiency 97% for γ energy above 2.5 GeV. This efficiency has been measured as a function of the γ energy using the $e^+e^-\gamma$ events in which two particles are detected in the end caps and another trigger is fired (Fig. 9).



9. Single photon trigger efficiency as a function of E_γ.

A search for single photon events has been performed using a sample corresponding to an integrated luminosity of $\sim 39pb^{-1}$. The selection criteria were the following: total energy deposited less than 20 GeV in the central S.C., less than 1 GeV in the hadron calorimeter, less than 0.5 GeV in the end caps; no end-cap scintillators fired and, of course, a clean CD ($<$ 15 hits, total); and subsequent eye scanning in order to reject cosmic rays, identify hot channels in the S.C., etc.

Possible candidates were required to have $|\cos\theta| \leq 0.8$ and to verticize in the origin. The transverse energy distribution of the candidates is shown in Fig. 10,



10. $E_\perp$ distribution of single photon event candidates.

together with the Monte Carlo simulation of Process (3), with a veto angle of 10°.

The absence of candidates for $E_\perp > 4.3$ GeV allows us to set a lower limit for the mass of the selectron at 25 GeV, with 90% confidence level.

6.2 Single Electron Search

Process (2) produces two electrons and two photinos in the final state, but only the one from the decay of the selectron can be detected in the apparatus, the other being emitted at too small an angle. If the photinos are stable or more in general can be considered neutrino-like as behavior in the apparatus, the signature for these events is given by events with only one electron detected.

A search for these kinds of events has been performed in the sample of data collected with the updated trigger. Candidates were required to have only one track in the CD with $|\cos\theta| \leq 0.8$, followed by an energy deposition of at least 2.5 GeV in the shower chamber. A limit of 1.0 GeV was imposed on the energy deposited in the end caps. All events satisfying these criteria and where the electron had more than 6 GeV energy were hand-scanned. The number of candidates was then restricted to 8 with the additional requirement that no end-cap scintillator had fired. No event with $E_{el} > 8.0$ GeV was found.

From the cross sections calculated in Ref. 25, one would expect about 7 events for $M_{Se} = 20$ GeV, and 3.4 events for $M_{Se} = 22$ GeV in our sample data.

This summer a new veto system is being installed in MAC extending the veto capability to 5° over the full azimuth and partial coverage of the region between 2° and 5°. Next year MAC will then be able to search for selectron masses up to 40 GeV.

7. PHOTON STRUCTURE FUNCTION

We have also studied the production of multihadrons arising from photon-photon collision under the so-called single-tag condition where one of the scattered beam electrons is detected. Combined with the central drift chambers, the end-cap electromagnetic shower chambers can efficiently tag energetic electrons down to 18°. The scattered electron is identified as a track with $162° > \theta > 18°$, associated with an electromagnetic shower energy in excess of 6 GeV.

To further remove other backgrounds from one-photon multihadron production and other two-photon processes, we impose in addition the following requirements:

— charged multiplicity (including the electron) > 4,

— the imbalance defined as $(|E_N - E_S|)\,/\,(E_N + E_S) > 0.3$, and

— thrust < 0.98.

Fiducial cuts were applied to the end-cap regions to remove inefficient areas. This resulted in a loss of about 1/3 of the solid angle in the polar region 18° ÷ 25°. The candidates were visually scanned to remove remaining Bhabha scattering events; 400 events were left after all these cuts. The remaining background from all sources has been estimated to be about 20% by Monte Carlo studies.

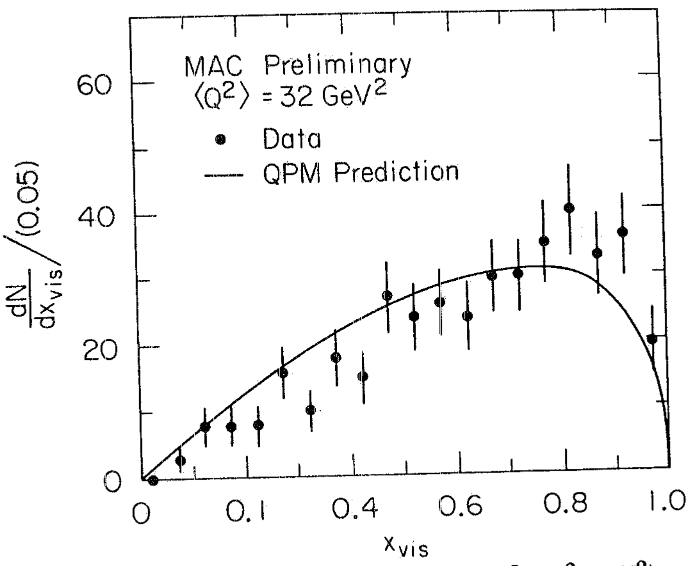
Since the mechanism of multihadron production is expected to be dominated by quark pair production which then fragments to hadrons, we have compared our results with the simple quark pair production model. After background subtraction and taking into account the detection efficiency, the number of observed events are in agreement with model calculations. The systematic error in the measurement and calculation is at the level of 30%.

Since the process resembles the deep-inelastic scattering of the electron off the real photon target, this measurement also constitutes a measurement of the structure function of the photon as a function of Q^2, the four-momentum-transfer squared of the electron.

The Q^2 of the scattered electron is given by:

$$Q^2 = 4E_bE' sin(\theta/2)^2 \qquad (Eq.\ 13)$$

where E_b is the beam energy, E' is the energy of the scattered electron and θ is the scattering angle of the electron. The distribution of the scaling variable $x = Q^2/(Q^2 + W^2)$, where W^2 is the invariant mass of the hadronic system, is shown in Fig. 11. In this spectrum the measured values of Q^2 and W were used. The



11. Distribution of $X_{vis} = Q^2/(Q^2 + W^2)$.

distribution has not been corrected for background and acceptance effects. However, it is in reasonable agreement with the simple quark parton model calculation. Since the photon structure functions are directly compared with theoretical prediction, we are in the process of converting the visible x distribution to the real structure function F_2.

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