THE OBSERVATION OF LEPTONS OF LARGE TRANSVERSE MOMENTUM

I. CERN-COLUMBIA-ROCKEFELLER-SACLAY COLLABORATION

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A search for electrons of large transverse momentum emitted from proton-proton collisions has been performed at the CERN ISR at a centre of mass energy $\sqrt{s} = 52.7$ GeV. Electrons are momentum analysed by a magnetic spectrometer and identified by a Cerenkov counter located inside the spectrometer (Fig. 1). A lead glass array [1,2] placed behind the spectrometer provides further electron identification and energy measurement. The apparatus is located at 90° with respect to the centre line of the incoming beam directions, the centre of mass motion being towards the detector (effective solid angle of .133 str).

An electronic trigger selected events which satisfied the following requirements: i) a coincidence between hodoscopes H_1', H_2', and H_3' indicating a charged particle transversing the magnetic field and incident on the lead glass; ii) a pulse from at least one of the eight cells of the gas Cerenkov counter, which had a threshold for charged pions of about 5.6 GeV/c and iii) an energy deposition in the lead glass array of at least 1.6 GeV.

Backgrounds that could have contributed to the events of interest consisted of: i) electrons from Dalitz decay of the π^0; ii) γ-ray conversion in the beam pipe, first spark chamber, or in the H_1', hodoscope; and iii) charged pions which somehow set the appropriate gas Cerenkov counter cell and interacted in the lead glass so as to deposit almost all of their energy.

Various cuts were applied off-line in order to reduce the backgrounds described above while at the same time maintaining good efficiency for events of interest. These requirements were: i) the energy distribution in the lead glass array was consistent with that expected for a real electron; ii) the charged particle had given a pulse height in H_1' corresponding to between 0.7 and 1.5 times minimum ionization and gave a spark in the first spark chamber in both x and y; iii) the momentum of the track and the energy deposited in the glass array must have agreed to within ± 30%. These

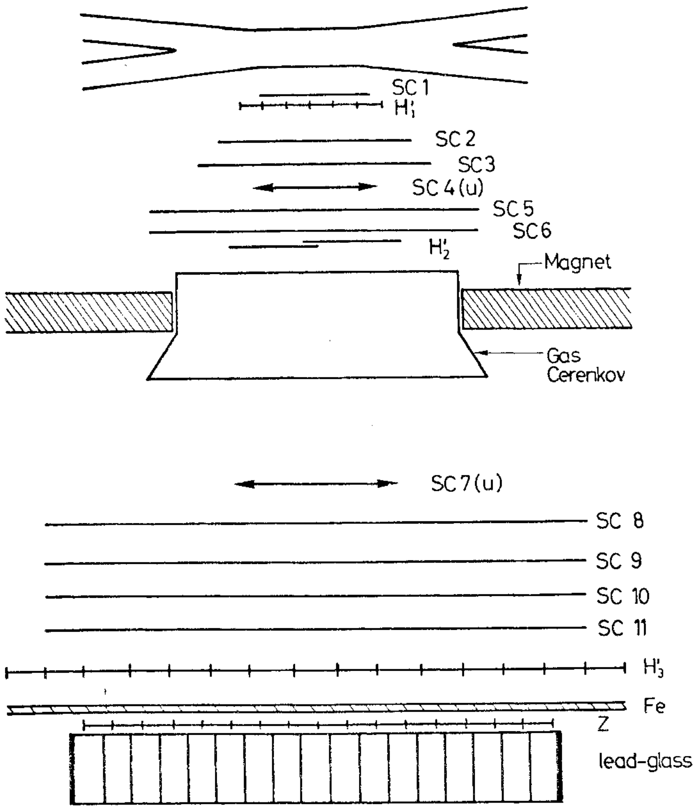

Fig. 1 Schematic diagram of the apparatus.

requirements resulted in an overall efficiency for single electrons of about 56%.

Dalitz decays and γ-ray conversions were suppressed by the requirement of single ionization in the H_1' counters. An experimental check was carried out to measure this background. Conversions were increased by inserting additional conversion material and extrapolating to zero thickness. The result is shown in Figure 2. The slope of the three points is seen to be very flat and, within errors, almost consistent with no change in the cross section at all. On the other hand, also plotted is the result obtained when two particles are required in the H_1' hodoscope. The steep slope obtained is what one would expect if all of the events were due to conversions. The contribution of this background was found to be 6.0 ± 4.0%. In addition, conversions in H_1' coupled with a random spark overlapping the track in the front chamber was empirically found to be .7±.2%.

A Monte Carlo computer programme was used to calculate the background contribution due to π^o-Dalitz decays. This programme was checked by comparing the prediction for conversions in the beam pipe with the event rates shown in Figure 2. The calculations agreed with the normalization error of the π^o spectrum used $^{2)}$. The background due to Dalitz decays was 5.6 ± 0.8%.

Charged pions were rejected by the combined requirement of a Cerenkov signal and equality of the magnetic and lead glass measurements. In addition, requiring that the particle shower in the iron before the Ƶ hodoscope resulted in a reduction of $\pi^\pm$ relative to $e^\pm$ of a factor of 2.4. By comparing the cross section with and without this requirement, it was found that the cross section after correction was reduced only by 14 ± 2%. This corresponds to an upper limit on $\pi^\pm$ background of 20%.

The corrected electron spectrum corresponding to electrons of either charge divided by 2 is given in Figure 3. Within statistical errors, the numbers of positive and negative particles are equal. For comparison, the inclusive π^o spectrum for $\sqrt{s}$ = 52.7 GeV obtained from CCR $^{2)}$ is also given. The electron spectrum is parallel within errors to the π^o spectrum and at a level of 1.3×10^{-4} relative to it. Due to different normalizations obtained by various groups at the CERN ISR for $\pi^\pm$ and π^o inclusive cross section measurements, this ratio could be in error by no more than a factor of 2.

A study was made of the vertical distribution of tracks at the interaction diamond for both charged

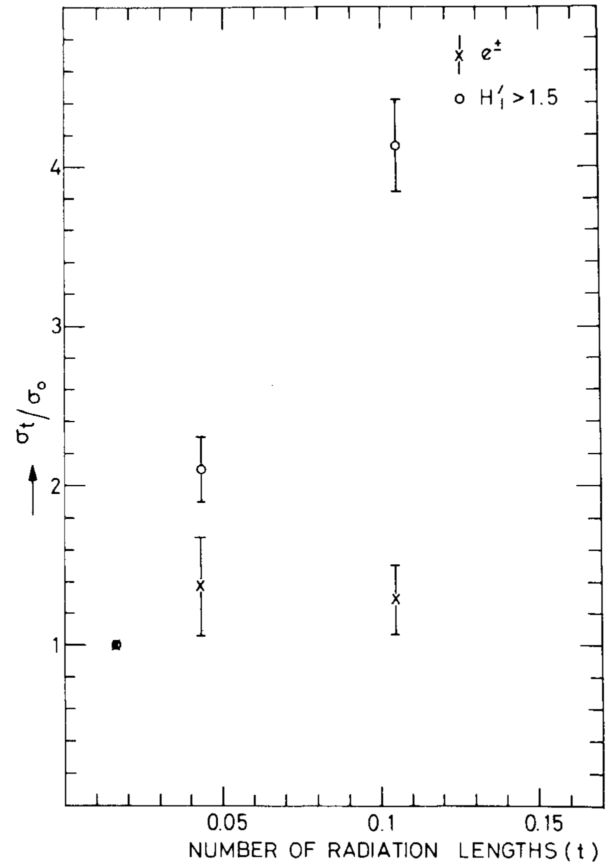

Fig. 2 The integrated cross section as a function of added converter thickness. This is given both for all cuts and for those events with two or more particles in H_1'.

pions and electrons. The fact that no broadening was observed for electrons indicates that any particle which may be decaying to give electrons must be short lived.

REFERENCES

1) J S Beale et al, Proc. Int. Conf. on Instrumentation for High Energy Physics, Frascati (ed. Laboratori Nazionale del CNEN, Frascati, 1973), p 415. To be published in Nuclear Instr. Methods.

2) F W Busser et al, Physics Letters 46B, 471 (1973).

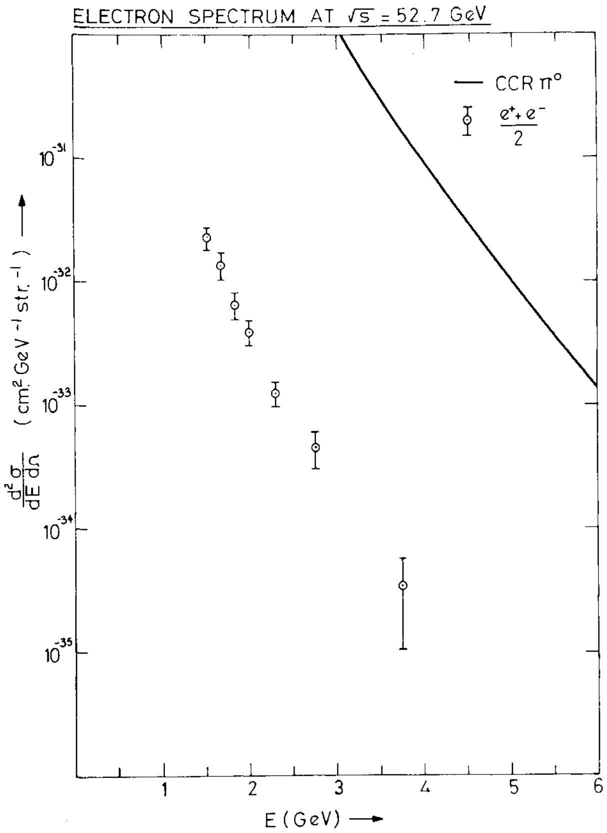

Fig. 3 The inclusive cross section, dσ/dEdΩ, for electrons of either charge divided by two and plotted as a function of E. Also shown is the CCR π^0 spectrum.[2)]

II. COLUMBIA-FNAL COLLABORATION

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We describe here the observation of directly produced, high transverse momentum electrons and muons in proton-beryllium collisions at 300 GeV. Candidates for sources of such "direct" lepton production are: i) virtual massive photons, ii) vector mesons; ρ,φ,ω,.... iii) intermediate bosons: $W^{\pm}, Z^0$, ... iv) charmed particles, v) heavy leptons.

The virtue of electron detection is the high resolution possible; this is important in maintaining sensitivity to "bumps" which would be generated by a two-body decay $V \rightarrow e + X$ at a transverse momentum of $P = M_V/2$. Muon detection has the complementary advantage of having backgrounds (π,K decay) which are lower by a factor of ∿4.

The apparatus is shown in Fig. 1. The extracted proton beam strikes a thin Be target, 0.22 mm wide and ∿ 10 cm long. A 9 mr x 9 mr aperature is defined by a tungsten-lined steel collimator 8.2m long, tapered to minimize wall illumination. The production angle was measured horizontally, and data were taken at 50 mr and 83 mr, corresponding to 65° and 93° in the center of mass system.

Particles are detected only after magnetic deflection in the vertical plane. The "point" source target and angle in the vertical plane after the magnet