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TRANSITION RADIATION FROM ELECTRONS AT 50 GeV

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ABSTRACT

An investigation to separate electrons from pions at 50 GeV using a transition radiation detector (TRD) is presented. The pulse height distribution from such a detector shows two peaks which correspond to pions and electrons respectively. The detector consisted of a large number of sandwich elements each of which was composed of a multiwire proportional chamber filled with argon gas and a stack of Mylar foil radiators. Ethafoam and styrofoam were also used as radiators. The observed energy spectra and application of the detector are discussed.

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We had reported earlier the observation of transition radiation from pions at energies from 100 to 250 GeV.[1] In the present investigation, we studied the separation of electrons from pions at 50 GeV using a TRD. The experiment was carried out in the M1 meson beam at the Fermi National Accelerator Laboratory.

The TRD consisted of a series of multiwire proportional chambers interlaced with transition radiators.[2] The chambers were 2.2-cm thick and 6" X 6" in area. The spacing of sense wires were 1.0 cm. All the sense wires of a chamber were connected together to give a single output from the chamber. The signals from the chambers were added in such a way so as to give either a geometric mean or an arithmetic mean value. This added signal was gated by a fast coincidence signal and stored in a pulse height analyzer. The fast coincidence signal was formed from Cerenkov counters[3] to identify pions or protons, a scintillator S_1 upstream of the detector and scintillators S_2 and S_3 downstream, and a shower counter[4] which identifies electrons in the beam. The scintillator S_3 was used as a veto counter to reject multiple particle events. The chambers were filled with a gas mixture of 90% argon and 10% methane. The detector detects the x-ray transition radiation as well as the ionization energy loss due to the primary charged particle. The system was calibrated with Fe^{55} and Cd^{109} sources.

In Fig. 1 (a), an overlap of two spectra with a 30-element system is shown. The system was gated by pion signals from Cerenkov counters and scintillators but without a shower counter so that the beam contained both pions and electrons. The percentage of electrons was 8%. The curve with the highest pion peak was taken with background radiators. The other curve was taken with transition radiators of Mylar foils, which shows two peaks:

a reduced pion peak and a broad electron peak. The transition radiator consisted of 100 foils of ½ mil Mylar for 15 chambers, and 50 foils of ½ mil and 50 foils of ¼ mil with 30 mil spacing for the other 15 chambers.

For comparison, two other kinds of radiators were used: a 4"-thick ethafoam polyethylene and a 4"-thick styrofoam. Yields of transition radiation for Mylar, ethafoam and styrofoam are respectively 0.91, 0.65 and 0.55 compared with the ionization loss signal of pions at 50 GeV. The densities of the radiators are 0.023, 0.020 and 0.025 g/cm^3 respectively. Ethafoam is a better radiator than styrofoam and can be conveniently used for large area applications, for example, to measure the energy spectrum of cosmic ray electrons where the protons produce the background electrons. Other investigations[5] on transition radiation using an electron beam only at lower energies and employing ethafoam, styrofoam and Mylar radiators have also been made.

The pulse height spectrum for a shower counter is shown in Fig. 1 (b). The electron peak appears at the high energy end of the spectrum. A shower counter[4] consisted of 16 units of 2-radiation length Pb and ¼"-thick scintillator which were viewed by two 60 AVP phototubes through light guides.

In Fig. 2 (a), a spectrum similar to Fig. 1 (a) but for pions only using background radiators is shown. At 50 GeV pions do not produce detectable transition radiation. A shower counter was used here which served to veto the electrons.

A spectrum of transition radiation from electrons using the shower counter is shown in Fig. 2 (b). The pion contamination in the spectrum is 11%. The Mylar radiators were used as in Fig. 1 (a). The ratio of average pulse heights of electrons to pions is 1.90. It is seen that the

electrons thus detected show a clean peak which is well separated from that of the pions. Further work to improve the detection system is in progress.

Acknowledgment

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REFERENCES

1. Luke C.L. Yuan, P.W. Alley, G.F. Dell, R. Keller, and H. Uto, to be published.

2. Luke C.L. Yuan, Proc. 12th Intern. Conf. on Cosmic Rays, Tasmania, Australia, 1971, Vol. 4, p. 1499; H. Uto, Luke C.L. Yuan, G.F. Dell, and C.L. Wang, Nucl. Instrum. Methods 97, 389 (1971).

3. S.M. Pruss, NAL Report No. TM-470, to be published; D.D. Yovanovitch, D.R. Rust, I. Ambats, R.A. Lundy, S.M. Pruss, C.W. Akerlof, Nucl. Instrum. Methods 94, 477 (1971); Cerenkov counter signals were provided us by D. Meyer and others.

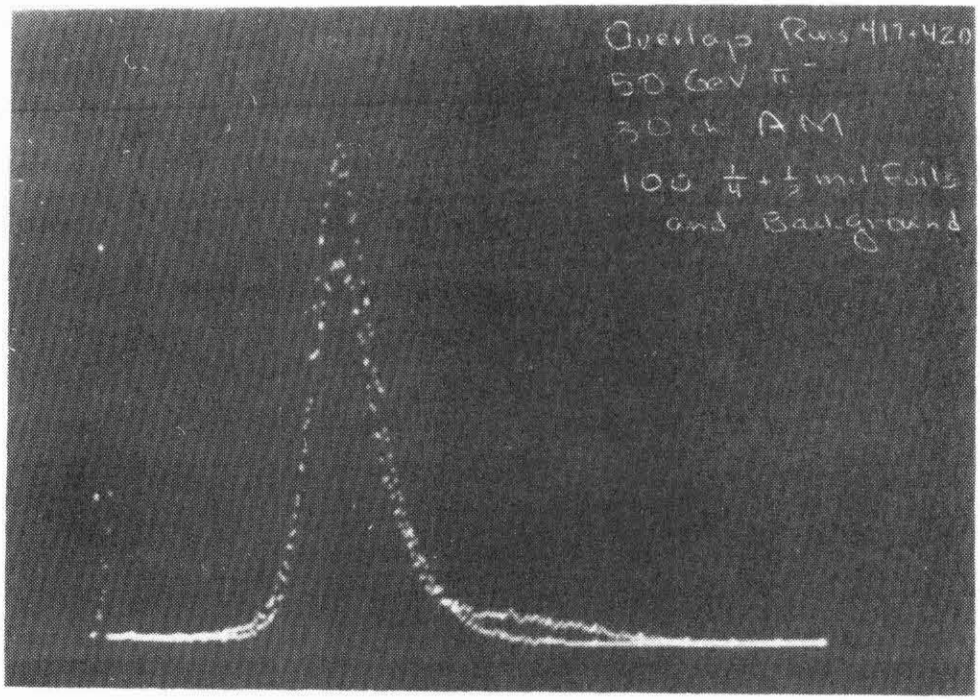
4. D. Yount and J. Knauer, to be published; the shower counter signal was provided us by them.

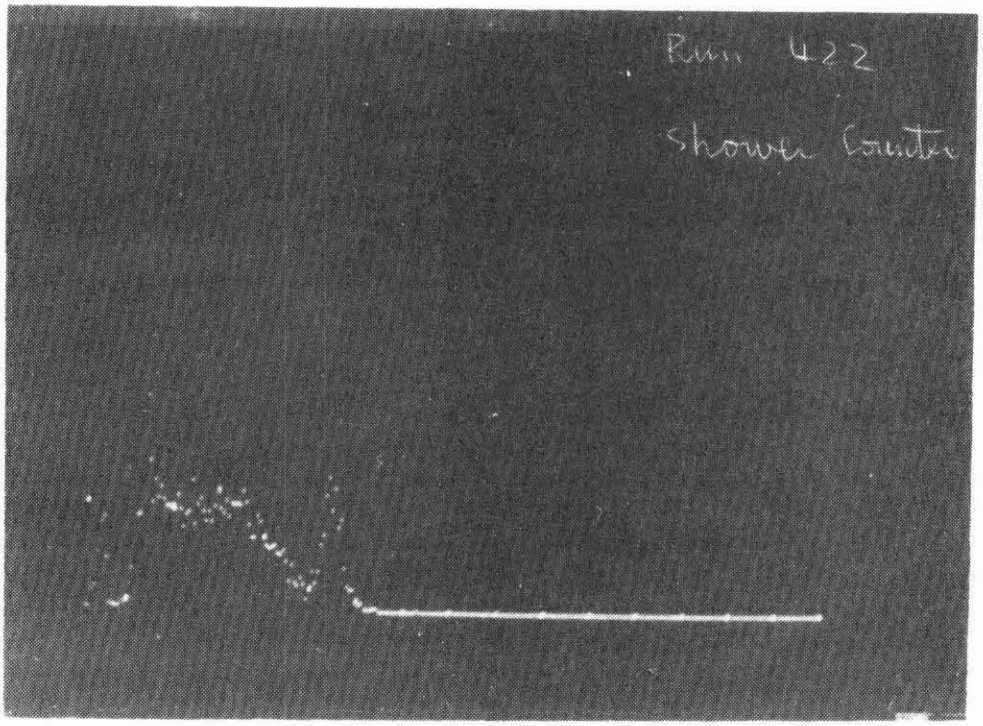
5. T.A. Prince, D. Müller, G. Hartmann, and M.L. Cherry, to be published.

FIGURE CAPTIONS

Fig. 1 (a) Overlap of two spectra with and without transition radiators. Beam contained both pions and electrons. The spectrum with transition radiators shows an electron peak at a higher channel. (b) Pulse height spectrum of the shower counter.

Fig. 2 (a) Pulse height spectrum for the pions using background radiators. (b) Pulse height spectrum for the electrons using transition radiators of Mylar foils. A small peak at a lower channel is due to pions of 11%.


Overlays Runs 417+420
50 GeV π⁻
30 ck AM
100 1/4 + 1/2 mil Foils
and Background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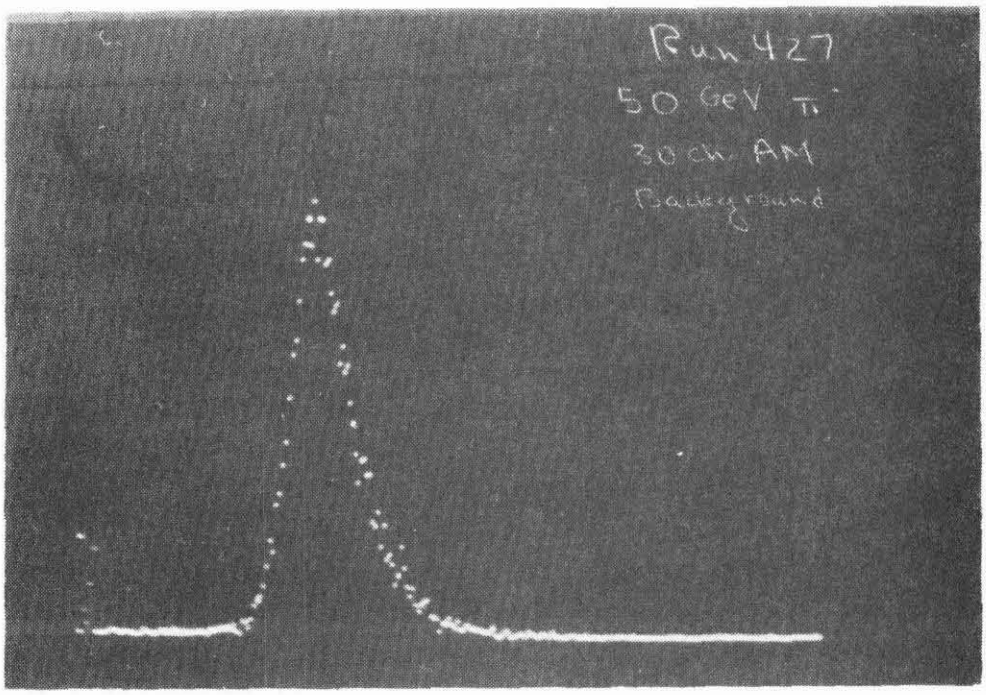
Shower Counter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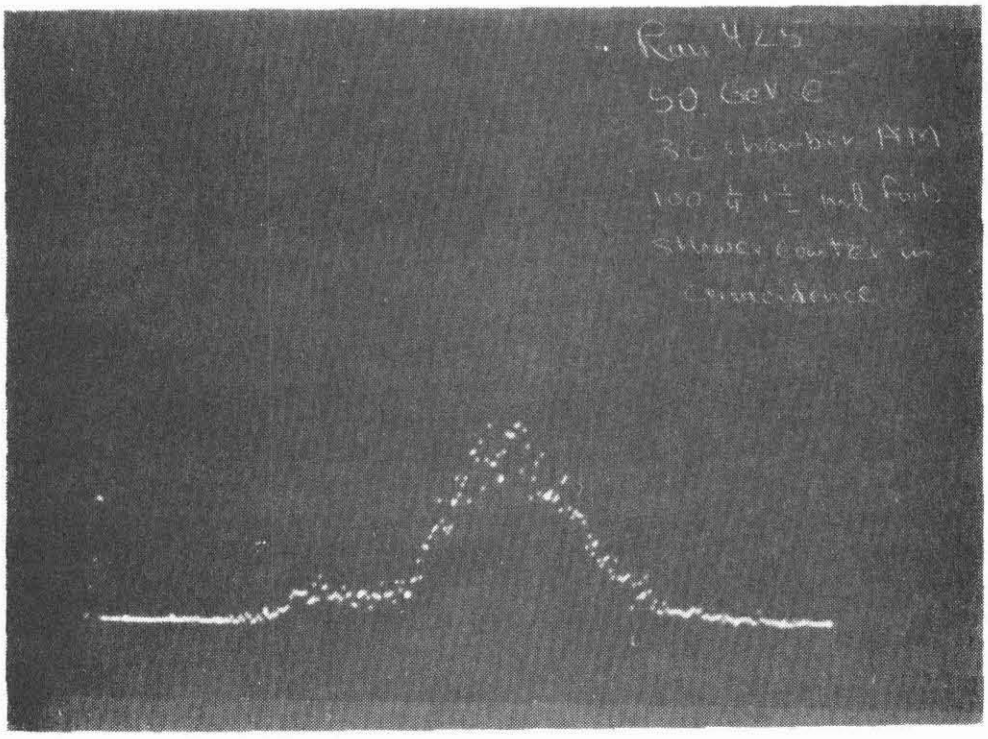
50 GeV π⁻
30 ch. AM
Background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50 GeV e⁻
30 chamber AM
100 1/4 + 1/2 mil foils
shower counter in
coincidence