Fermilab

MULTIPARTICLE SPECTROMETER CALORIMETERS

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The Multiparticle Spectrometer calorimeter array is designed to provide a fast transverse momentum trigger in the range $2<P_t<8$ GeV/c. A calorimeter module is placed on each side of the beam line to detect particles around 90^o in the c.m. A third module is placed below the beam to detect particles which are more forward. A fourth module can be placed symmetrically above the beam, if necessary. The "90^o calorimeters" subtend an azimuth of 60-140 mrad in the lab corresponding (at 200 GeV/c) to 60^o-110^o in the c.m. The forward calorimeter subtends vertically 10-40 mrad in the lab corresponding (at 200 GeV/c) to 10^o-50^o in the c.m. (Figures 1, 2, 3). Each 90^o module consists first of an array of six lead sheets ½" thick (2 radiation lengths) and 60" tall by 32" wide. Behind each lead sheet are four slats of ¼" NE102 scintillators 60" tall by 8" wide. The six scintillators in line behind the lead are tied together into one phototube (RCA 6655A) at the top and one phototube at the bottom. Following the lead sheets are 15 steel plates 2" thick (1/3 collision length, 3 radiation lengths) with the same lateral dimensions. The same size scintillator slats are used as with the lead.

All 15 scintillators are tied to one phototube at the top (RCA 6655A) and one phototube at the bottom. The entire module is in a light-tight box on wheels and can be moved toward or away from the beam. The forward calorimeter module consists of six lead sheets ½" thick and 12 steel sheets 2½" thick, each 72" wide by 32" high. Behind the lead are four slats of ¼" scintillator 72" wide by 8" high. As with the forward calorimeter, these scintillators are tied to a phototube at each end. Behind each steel plate are four slats of scintillator the same size as behind the lead. All 12 scintillators are tied to a phototube at each end.

The lead portion of the calorimeter measures electron and photon energy while the thick steel back portion measures hadron energy. There are some hadron interactions which start in the lead and give pulses in both front and back sections (Figure 4). Both neutral and charged particles are detected by the calorimeter. The charged particle's momenta are measured by the spark chamber-magnet system. The position of neutrals is measured in one dimension by the modularity of the calorimeter slats (8") and in the other dimension by the ratio of phototube signals at the ends of the slats (Figures 5, 6). The vertical spatial resolution for 70 GeV/c is about ± 2". The energy resolution (preliminary) of the 90° modules is shown in Figure 7.

Phototube signals from modules are attenuated to make the pulse heights proportional to distance perpendicular to the beam. Then, all hadron signals are added to give a pulse whose height is proportional to hadron transverse momentum. The electron signals are similarly added to give a pulse proportional to electron and photon transverse momentum. Both of these signals are added to give a total transverse momentum trigger. By setting discriminator knobs, the transverse momentum range of electrons, hadrons, or both can be selected.

The sharpness of the trigger is determined by two factors. First, it is limited by the energy resolution of the modules. Secondly, it is smeared by the course spatial modularity perpendicular to the beam. In principle, by modulating the light transmission of the scintillators in two dimensions this last effect can be removed. In practice, the scintillators were sorted according to attenuation length and the shorter attenuation length modules were put closer to the beam.

Bi^{207} sources on scintillators are glued to each phototube for calibration. In addition, in each module there is a light source fibre optic guided to each phototube (built by C. Kerns).

SCHEMATIC PLAN VIEW – EXP. 110 MULTIPARTICLE SPECTROMETER

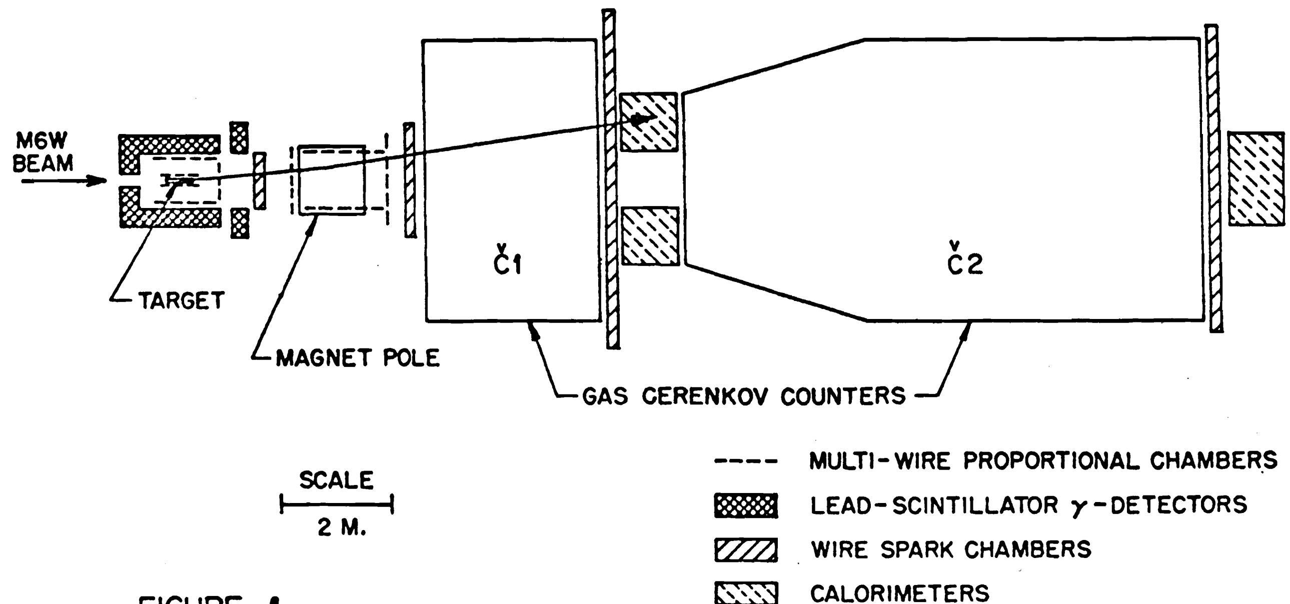


FIGURE 1

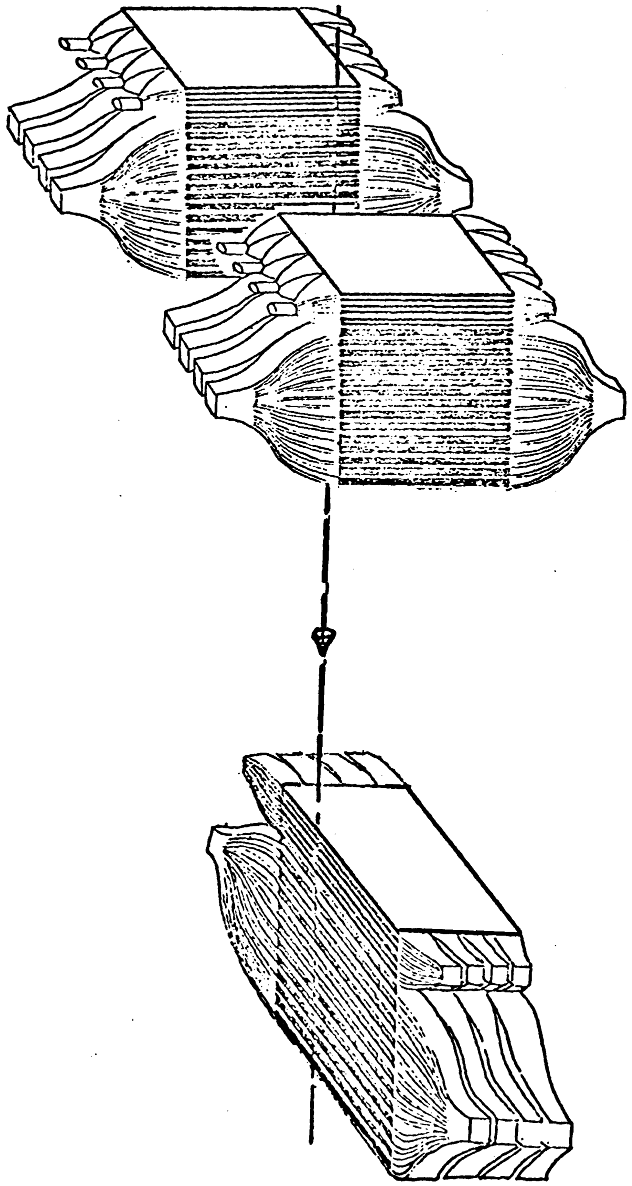


Fig. 2

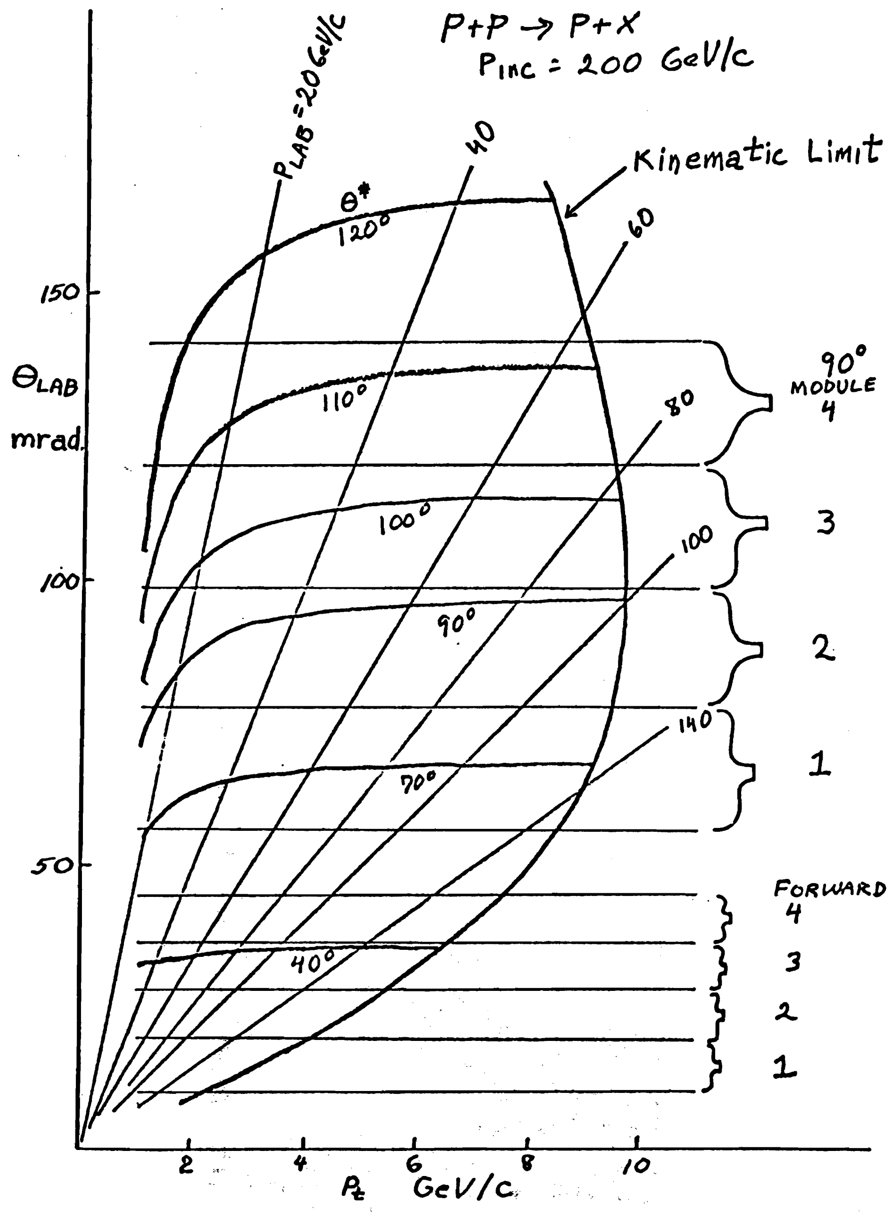

P+P → P+X
P_INC = 200 GeV/c
P_LAB = 20 GeV/c
40
60
80
100
140
Kinematic Limit
θ*
120°
110°
100°
90°
70°
40°
150
100
50
θ_LAB
mrad.
90°
MODULE
4
3
2
1
FORWARD
4
3
2
1
2
4
6
8
10
P_t GeV/c

Fig. 4

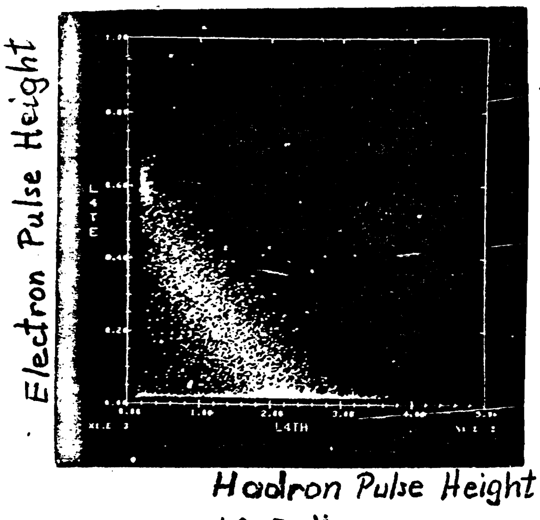

Electron Pulse Height
LATE
L4TH
Hadron Pulse Height
40 GeV

Fig. 4-a

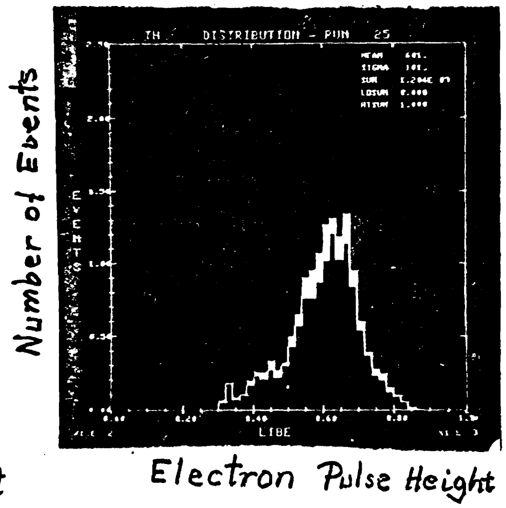
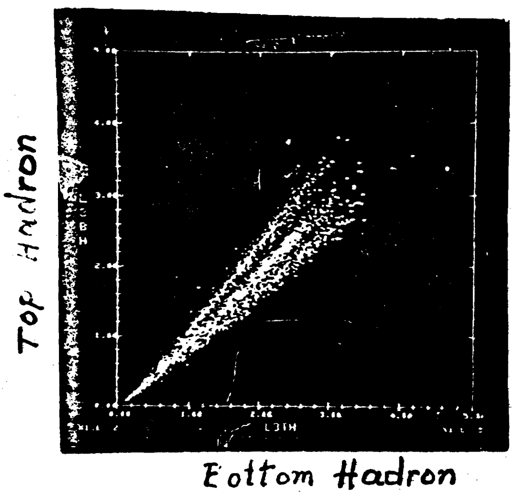
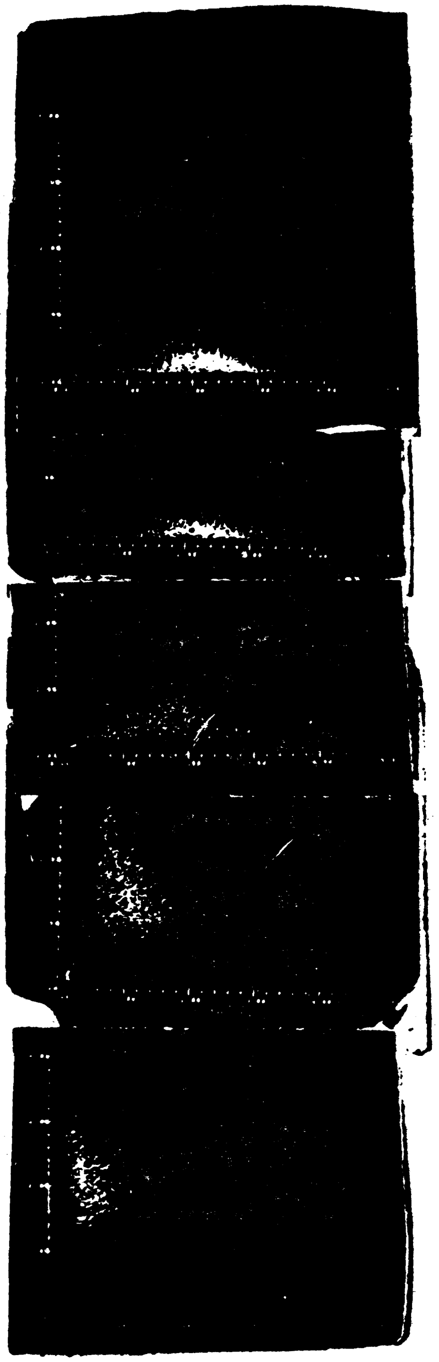

DISTRIBUTION - RUN 25
Number of Events
EVENTS
LIBE
Electron Pulse Height

Fig. 4-b


Top Hadron
L3TH
Bottom Hadron

LATERAL SHOWER EXTENT
40 GeV/c
hadrons



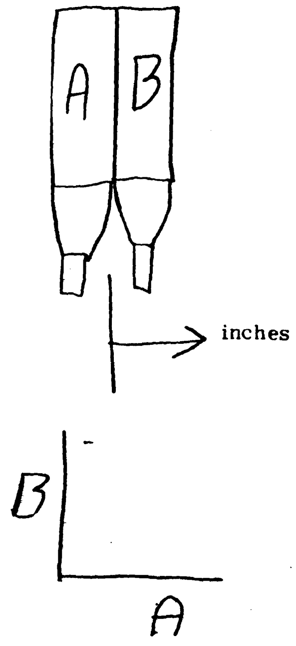
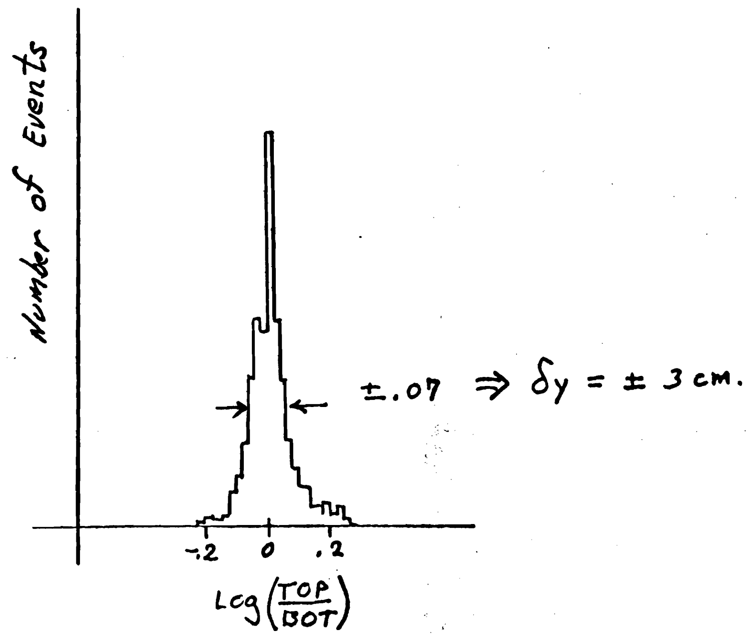


Fig. 5-b



$$\delta\left(\text{Log}\,\frac{\text{TOP}}{\text{BOT}}\right) = 2\,\delta\left(\frac{y}{\lambda}\right)$$

Fig. 6

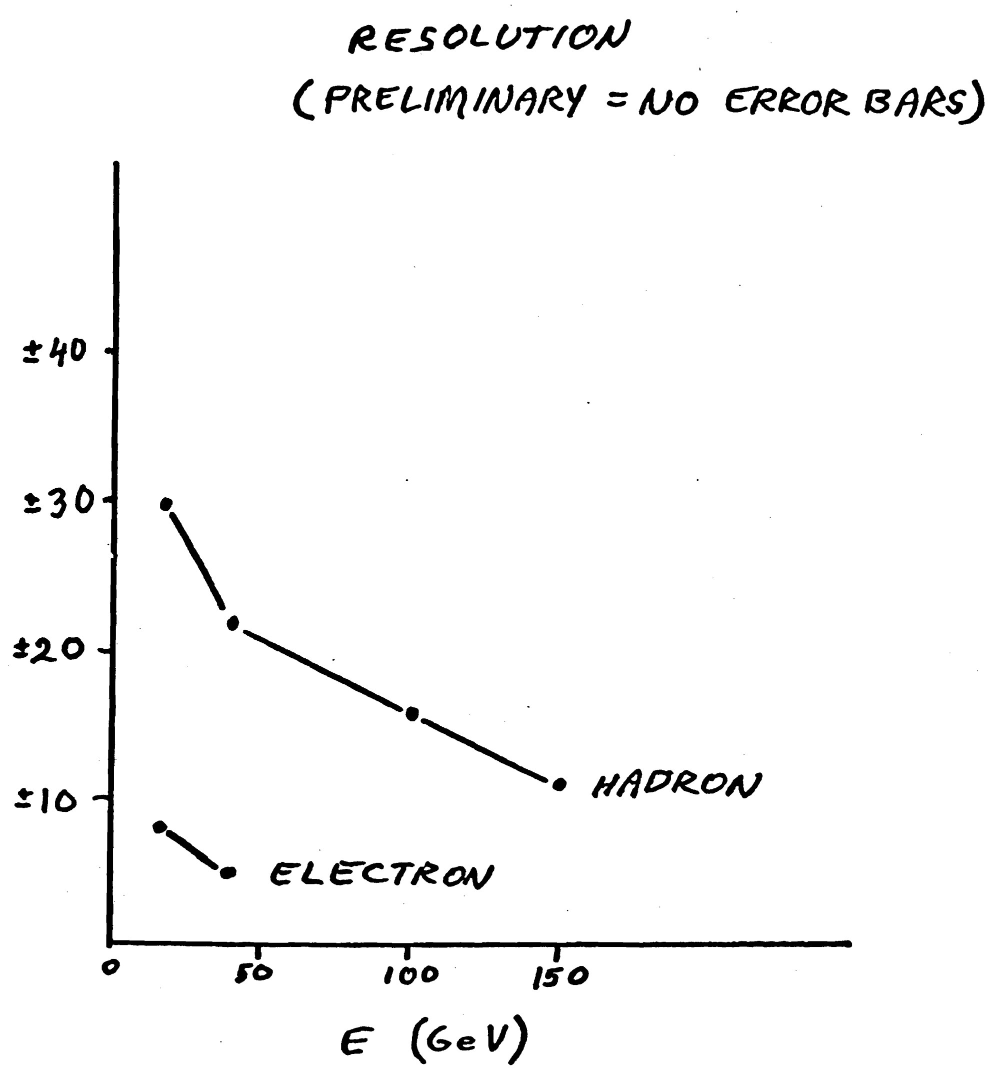

RESOLUTION
(PRELIMINARY = NO ERROR BARS)
±40
±30
±20
±10
HADRON
ELECTRON
0
50
100
150
E (GeV)

Fig. 7