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MATCHING "MUON" TRACKS IN THE 15' BUBBLE CHAMBER TO THE EMI PROPORTIONAL CHAMBERS

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In this memo we report on the continuing use of non-interacting tracks[1] to show that the EMI indeed identifies muons and to locate the positions of the EMI multiwire proportional chambers (MWPC) relative to the 15' bubble chamber fiducials. The source of non-interacting tracks was the neutrino beam of 6 July 1974 which resulted when 400 GeV protons struck a target in front of the "triplet load" (set to focus 125 GeV mesons).

At UH and LBL we have scanned a total of 1342 frames from roll 18 (3400-4211, 6704-7235) for tracks passing all the way through the bubble chamber and having a direction within $\pm 20^{o}$ of the incident neutrino beam direction. At LBL tracks were measured on the Frankenstein and processed through geometric reconstruction with TVGP. The pass rate was 95%. At UH the measurements were made on the SWEEPNIK semi-automatic measuring machine and processed with the HYDRA geometry program. The pass rate was slightly lower (90%).

PROCEDURE - In order to predict which EMI chamber should have been hit by a given track in the bubble chamber (and where in the EMI chamber) we developed computer programs which project measured bubble chamber tracks through the magnetic field from the bubble chamber to the EMI and then calculate which chamber(s) should be hit and give the x and y coordinates in the chamber(s).

Then we compared these predictions with the predictions of an LBL program which calculates x, y coordinates in the EMI chambers by analyzing the EMI data. Figure 1 shows a typical result.

DATA SELECTION - For this study, only tracks with P > 10 GeV/c were used. After removing tracks that occurred on pulses when Experiment 1A fired their widegap spark chambers or that headed for locations in the EMI where there were no working chambers, a sample of 211 useful candidates remains. Of these, 163 are predicted to strike the EMI within 3 cm of the location of a good MWPC fitted location. (The efficiency of the EMI will be analyzed in another report, but we note that some of the beam spill was known to be out of time with the EMI during the run discussed here.)

RESULTS - A line through the center of the bubble chamber parallel to the beam direction goes through chamber #2. Only #2 and its immediate neighbors (#'s 21, 15, 7, 10 and 5) have enough statistics so that one can begin to draw some conclusions. Figures 2a and 2b show typical correlations between the predicted positions and the observed positions for two chambers.

Figures 3a and 3b are a summary (from LBL and UH data respectively) for all chambers of the deviations between predicted track position from the bubble chamber data and observed position from EMI data. These plots reflect deviations due to both random and systematic errors. The systematic difference between the LBL and UH Δy-distributions is now understood as resulting from the latter group's use of camera fiducials in the geometrical

reconstruction of the bubble chamber tracks. LBL used chamber fiducials only. Apparently the positions of the camera fiducials are not adequately known, or they move relative to the chamber body.

For the chambers with sufficient data, we have performed linear least-squares fits to the X_{EMI}-vs-X_{BC} and Y_{EMI}-vs-Y_{BC} plots. Results are given in Table I. If our a priori information on chamber positions and delay-line velocities were exactly correct, the fitted lines would have a slope of 1.00 and an intercept of 0.00. Significant deviations from these values would indicate systematic inaccuracies in our survey data. The RMS deviations from the fitted lines give an idea of our random errors and are a measure of the agreement to be expected when we "close the loop" and correct the survey data to give agreement between the EMI and the bubble chamber. For comparison, the RMS deviation expected due to multiple scattering alone is $\approx$ 0.5 cm, and the chamber accuracy is estimated to be 0.25cm.

CONCLUSION - The statistics of this test are quite limited and the hadron "contamination" introduces an element of uncertainty; within these limitations the EMI chambers tested performed exactly as expected. In fact, the EMI is already helping in the debugging of the geometric reconstruction programs. We are collecting more statistics, i.e., measuring more pictures taken with the "triplet load" and also with the broad-band ν beam.

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REFERENCES

[1]"Surveying the External Muon Identifier and the 15' Bubble Chamber with 250 GeV Mesons"; TM-509, University of Hawaii - LBL Group, E155.

Table I

CHAMBER	NUMBER OF DATA POINTS	X(HORIZONTAL)			Y(VERTICAL)		
		SLOPE	INTERCEPT	RMS DEV	SLOPE	INTERCEPT	RMS DEV
2	28	0.998	-0.13 cm	0.54 cm	1.007	0.11 cm	0.82 cm
5	26	1.016	-1.21 cm	0.53 cm	1.011	0.20 cm	0.90 cm
7	26	0.998	-0.05 cm	0.75 cm	0.997	1.07 cm	1.11 cm
10	34	1.000	-0.09 cm	0.63 cm	0.986	1.36 cm	1.07 cm
15	28	0.995	0.33 cm	0.62 cm	0.993	1.00 cm	1.18 cm
21	7	1.039	-0.29 cm	0.36 cm	0.989	.81 cm	0.34 cm

FIGURE CAPTIONS

Fig. 1: One fairly typical example showing an EMI chamber struck by four particles whose reconstructed coordinates are indicated by circles. A muon from the berm is extrapolated from its bubble chamber tracks to hit at the point marked X, very near one of the EMI signals. The identification of this particle as a muon is unambiguous despite the other background signals which could result from hadrons or non-beam muons.

Fig. 2: Plots of the EMI coordinates of identified muons against the corresponding coordinate extrapolated from the bubble chamber, for two chambers. Data from the LBL and UH analyses, which used different bubble chamber geometry programs but the same EMI data analysis program, are shown separately.

Fig. 3: Histograms of the deviations of the EMI coordinates from the extrapolated bubble chamber coordinates, integrated over all chambers. We note that the y-coordinate (vertical) shows a net displacement of about +1 cm for the LBL data (Fig. 3a) which probably results from an error in our EMI survey. These fits can be used to correct the survey. The UH data (Fig. 3b) are displaced about 0.5 cm downward in y, but this discrepancy is now understood as resulting from the latter group's use of camera fiducials whose positions are inadequately known.

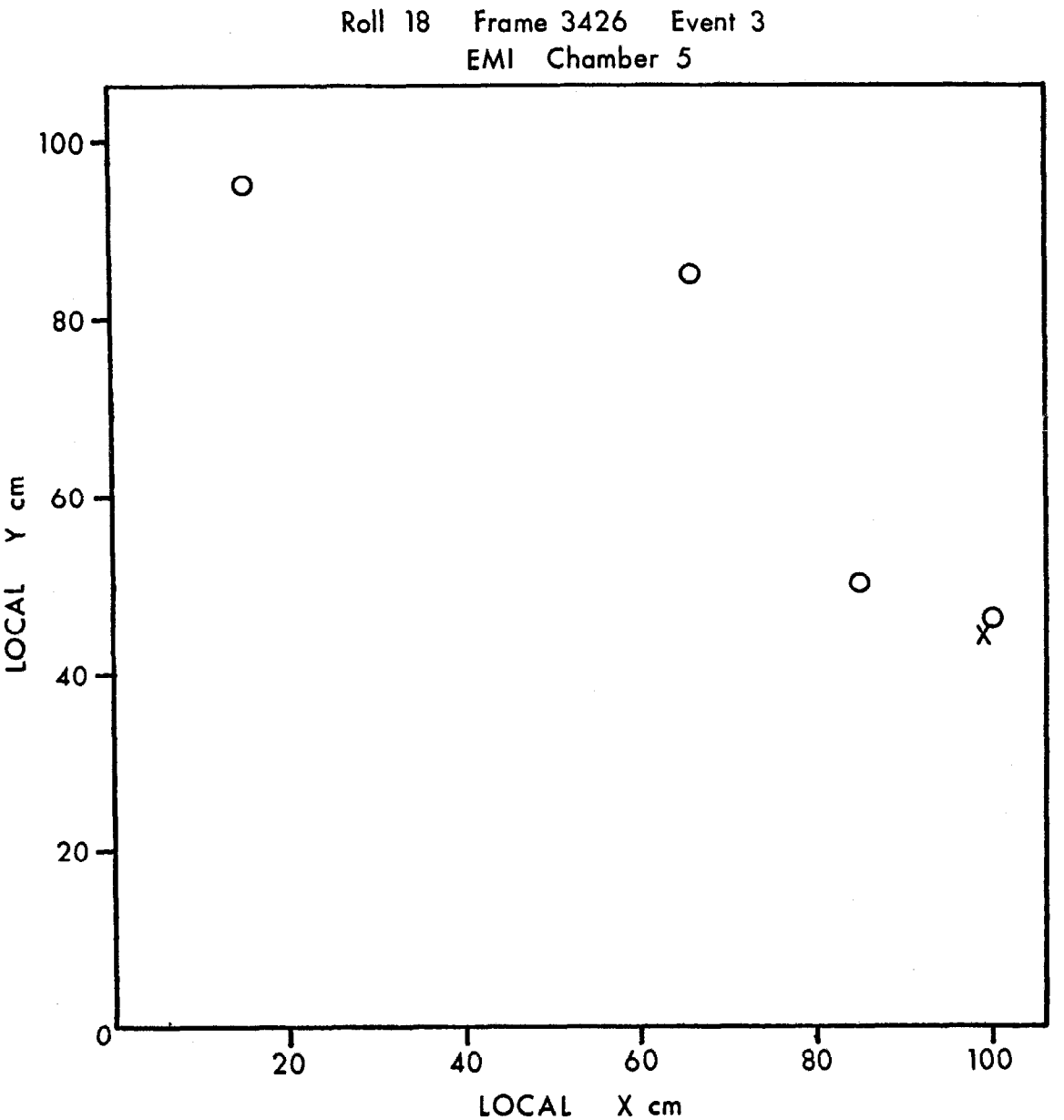

Roll 18 Frame 3426 Event 3
EMI Chamber 5
100
80
60
40
20
0
LOCAL Y cm
20
40
60
80
100
LOCAL X cm
O EMI Data
X Extrapolated B.C. Track

Figure 1

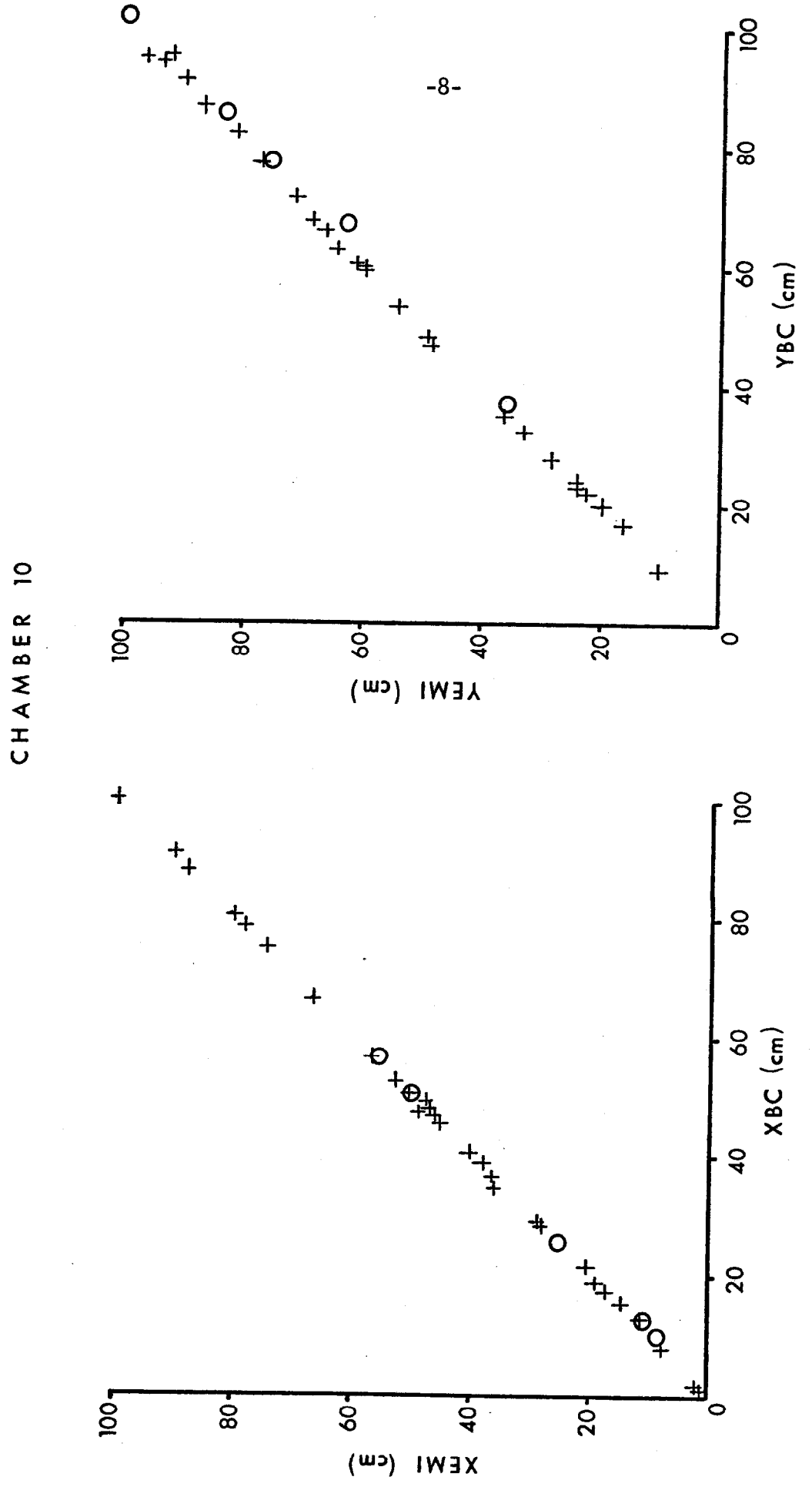


Figure 2a

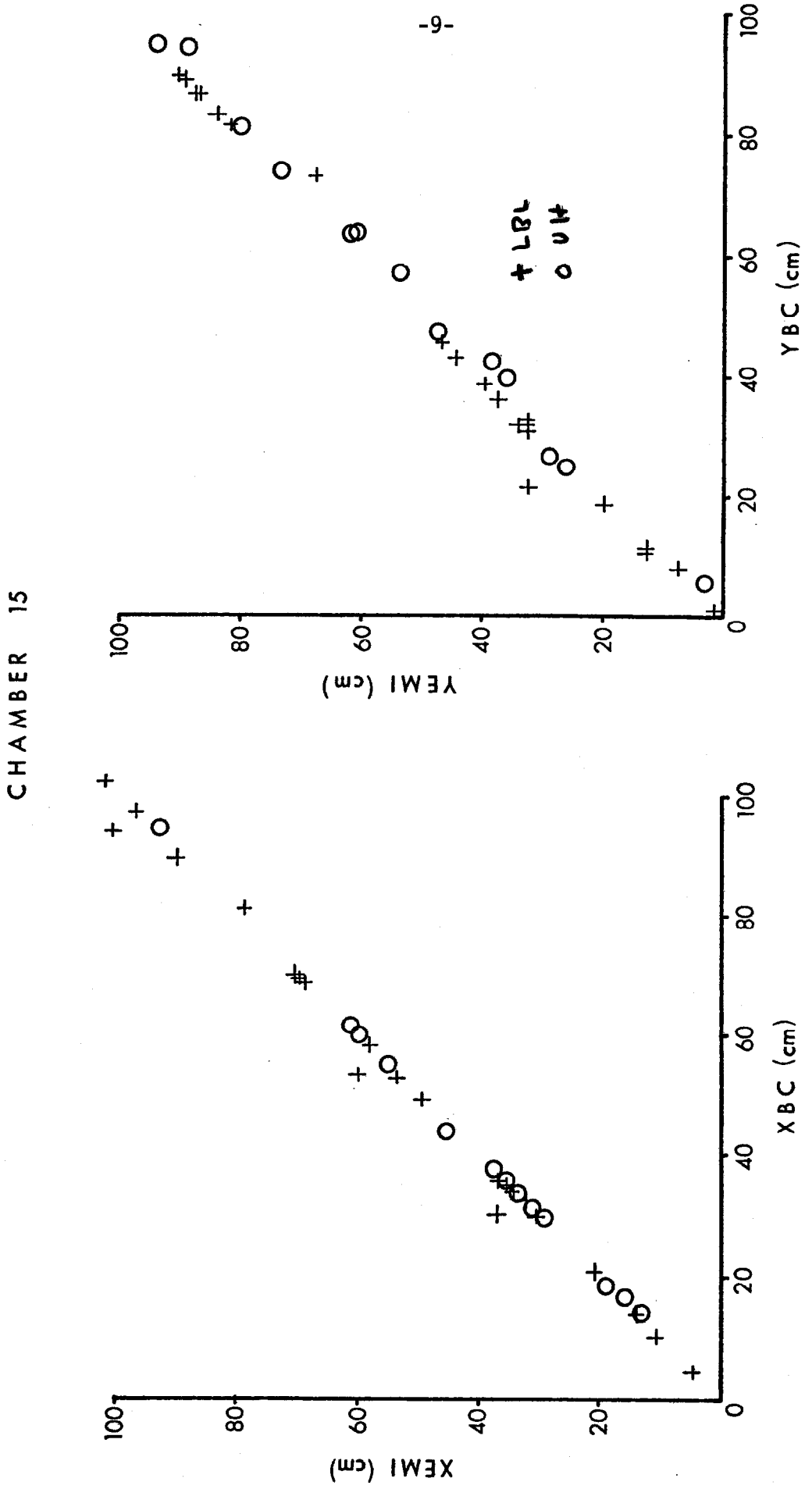
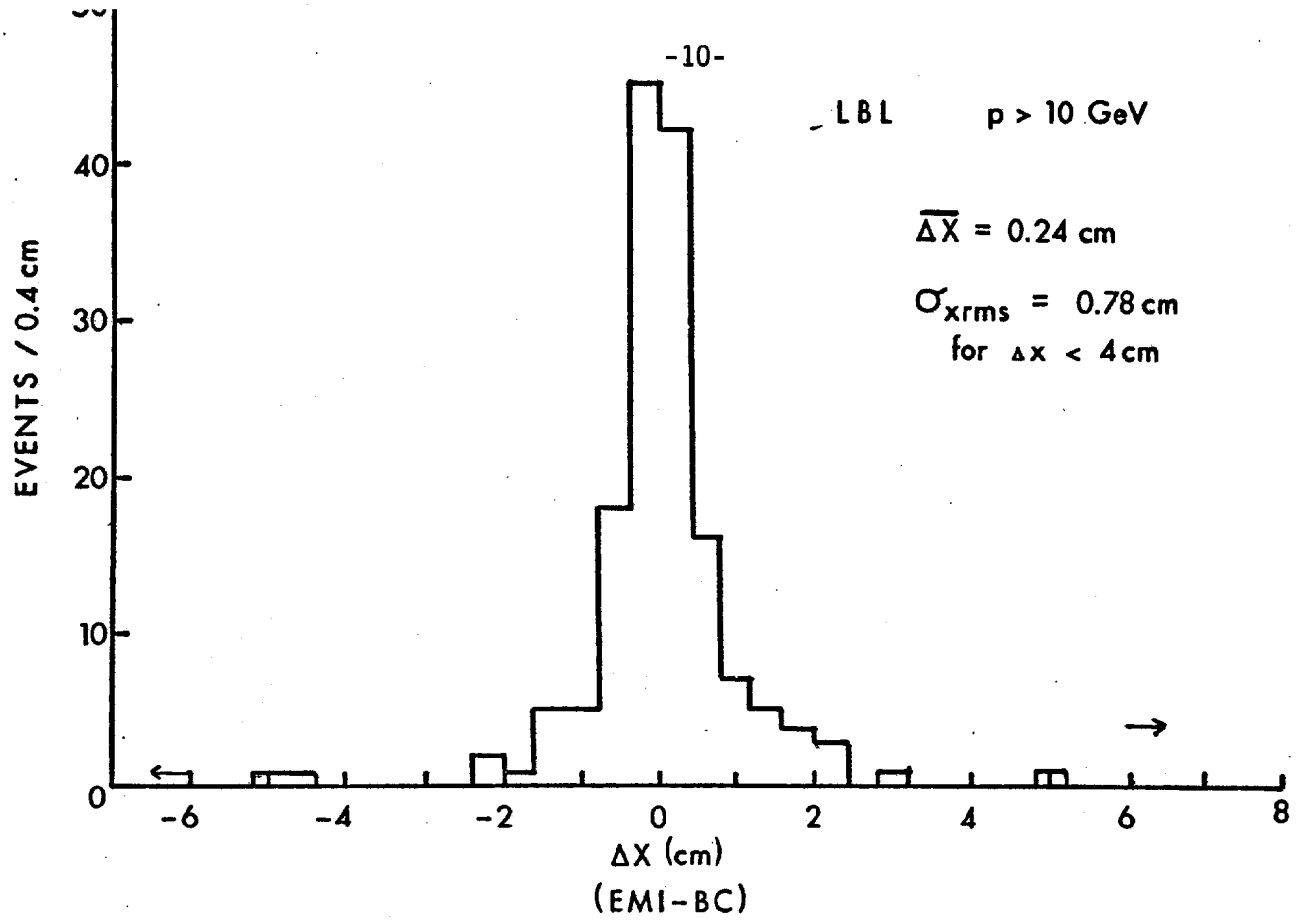


Figure 2b


LBL p > 10 GeV
$\overline{\Delta X}$ = 0.24 cm
σ_{xrms} = 0.78 cm
for Δx < 4 cm
EVENTS / 0.4 cm
ΔX (cm)
(EMI-BC)

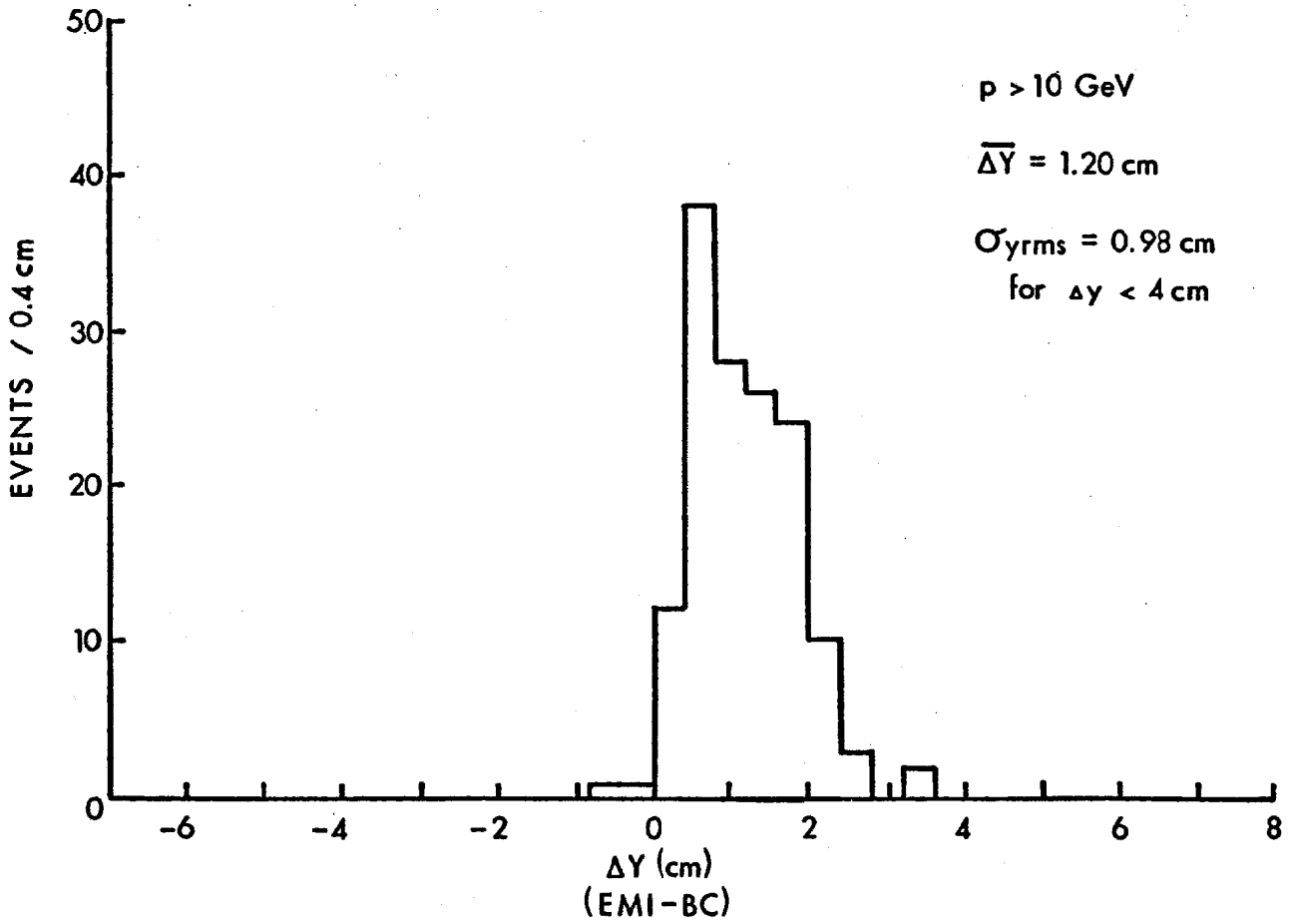

p > 10 GeV
$\overline{\Delta Y}$ = 1.20 cm
σ_{yrms} = 0.98 cm
for Δy < 4 cm
EVENTS / 0.4 cm
ΔY (cm)
(EMI-BC)

Figure 3a

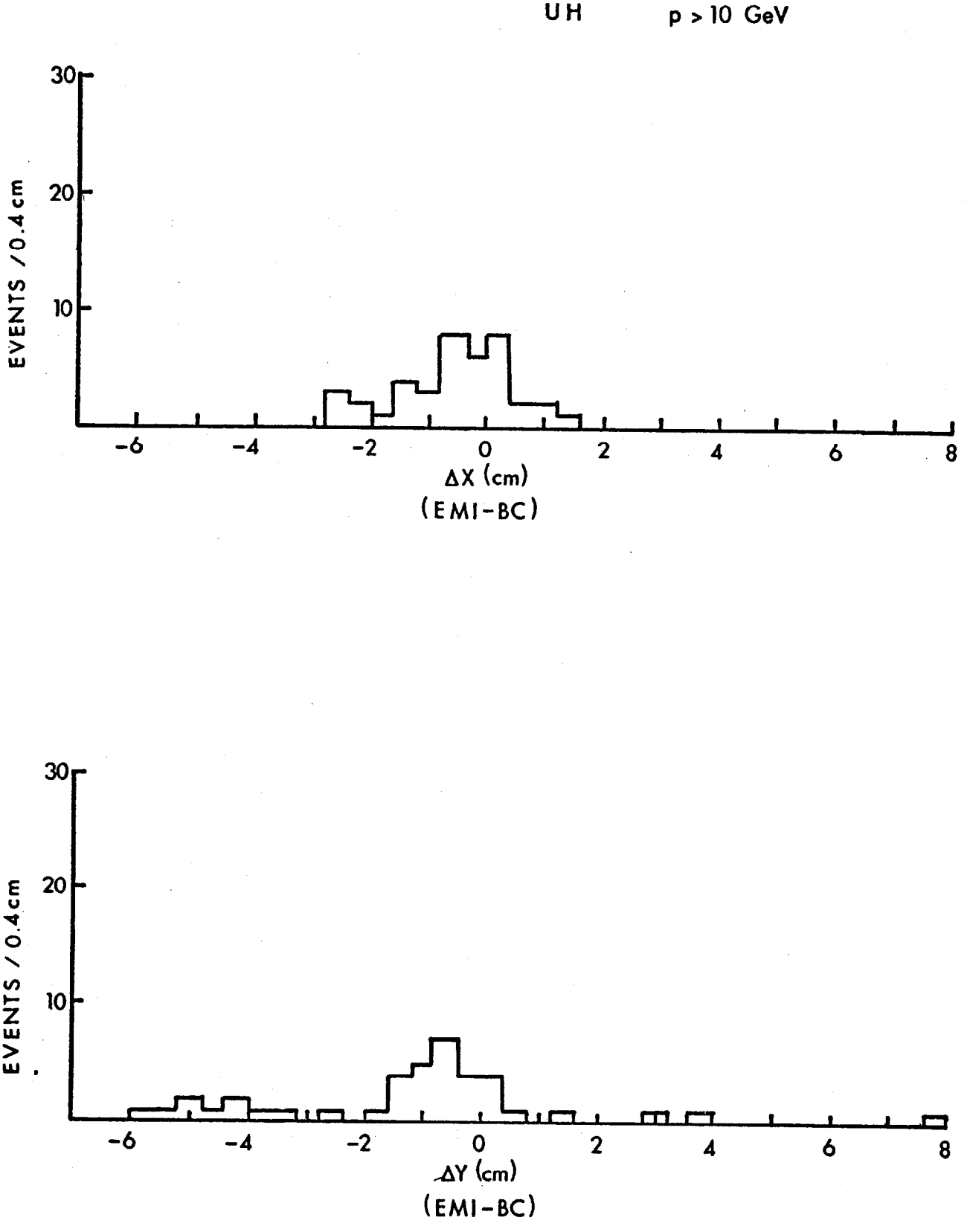

UH p > 10 GeV
EVENTS /0.4 cm
30
20
10
-6
-4
-2
0
2
4
6
8
ΔX (cm)
(EMI-BC)
EVENTS / 0.4 cm
30
20
10
-6
-4
-2
0
2
4
6
8
ΔY (cm)
(EMI-BC)

Figure 3b