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Monte Carlo Fragmentation Tuning for Jet Energy and Resolution Analysis

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Abstract

In order to extract both energy corrections and resolution for jets in the CDF Detector, we need to use Monte Carlo to simulate the response of jets in the detector. A major ingredient involved in the jet energy corrections and jet resolution is the non-linearity in the response of the detector to charged particles. We have therefore tuned the fragmentation in the SETPRT Monte Carlo routine to model the charged particle fragmentation observed in the 1988-1989 CDF data set. In addition, the CTC tracking efficiency in jets has been measured and parametrized, and introduced into the QFL tracking simulation.

Introduction

The jet energy corrections currently being used are based on 1987 data. Since in this data set the highest transverse energy (E_t) for the jets is only 250 GeV, the corrections were only calculated to 250 GeV. The 1988-1989 data set extends to 410 GeV; therefore it is necessary to recalculate these corrections to extend the range of validity. At the same time, we would like to extract the jet energy resolution from the simulation.

Much work has been done to tune the simulation to reproduce the results of the test beam.[1] The simulation as been tuned to reproduce the single pion response observed in the test beam as well as the non-linearity observed at lower pion energies. We therefore believe that if we can tune the simulation to reproduce the fragmentation observed in the 1988-1989 data, we can then trust the simulation to give the correct result for the jet energy corrections and jet resolution. This note is the result of that study.

Data and Simulation

To study the fragmentation we used the same data set currently being used for the inclusive jet cross section and dijet invariant mass measurements. This consists of approximately 4.31 pb^{-1} of jet data in the region above 120 GeV in E_t, and approximately 870.55 nb^{-1} of jet data in the region from 30–120 GeV. The high E_t data set came from spin production (QCS02), while the lower E_t data came from the QCD02 production.

The simulation was performed using the following path:

SIMJET SETPRT QFLANA JETCLU QTKEFF CENJET JETFRG.

1. SIMJET generated jets. It created two partons in a falling spectrum defined to match the spectrum measured in the inclusive jet cross section. The generated jets were also required to be within ± 0.9 in η.
2. SETPRT fragmented the jets. This routine has five adjustable parameters which we used to tune the fragmentation. During this study, we found it necessary to modify this routine to incorporate an E_t dependence into one of these five variables.
3. QFLANA simulated the detector response for the generated jets.
4. JETCLU clustered the simulated jets.
5. QTKEFF incorporated CTC tracking efficiency into the simulation by flagging tracks as "lost", on the basis of a parametrization of tracking efficiency in jet events.
6. CENJET filtered cosmic rays in the data and was therefore used on the simulation also.
7. JETFRG extracted and plotted the various fragmentation quantities we wanted to study.

Since the simulation only supplied two partons, we required our events from the actual data to be dijet events. This was done by requiring the following:

1. There must be at least two jets.
2. There must be no third jet with $E_t > 20\ GeV$.
3. The leading E_t jet and the second jet must be back-to-back in ϕ, within ± 30 deg.

4. The Z vertex was required to be within 60 cm of the center of the detector.
5. At least one jet was required to be in the central detector, $0.1 \leq |\eta| \leq 0.7$.

The jets were clustered with a cone size of 0.7 and tracks were required to be within the cone of the jet, and to have $P_t \geq 500\ MeV/c$. It should be noted that these same cuts were applied to both the simulation and the data.

Tracking Efficiency

The fragmentation distributions observed in data includes effects of CTC tracking inefficiency in jets. It was therefore necessary to measure this efficiency and incorporate it into our code (QTKEFF). The procedure for measuring the tracking efficiency is described below.

First, we started with real events having a jet in the central detector. The data came from both spin and production streams. Events were selected using the following criteria:

1. At least one jet in the central detector.
2. A second jet back to back in ϕ, within 30 deg.
3. The average jet energy, $(E_{t1} + E_{t2})/2$, greater than 15.0 GeV.
4. No third jet with $E_t > 15\ GeV$ or $E_t > 0.25 * (E_{t1} + E_{t2})\ GeV$.
5. η_{boost} and $\eta_{star} < 1.0$
6. A Z-vertex within 50.0 cm of the center of the detector.

Next, these events had a Monte Carlo track embedded into the central jet. We embedded a different Monte Carlo track into the same real event 30 times (saves some CPU). The Monte Carlo tracks had the following characteristics:

1. The Z distribution for the longitudinal momentum (relative to the jet axis) was flat between 0.0 and 0.4.
2. The transverse momentum (again relative to the jet axis) had an exponential spectrum with a average P_t of 0.7 GeV/c.
3. The pseudorapidity of the embedded track relative to the jet axis was required to be less than 0.8.

4. The azimuthal angle in the jet was randomized between 0 and 360 deg.
5. The Monte Carlo track exited the CTC at the full radius.
6. The charge of the track was randomized with equal contributions of $\pm$ charges.

To study the efficiency, we retracked (5.0 tracking) the events and determined how often we found the embedded track. A good track in the events was defined by the standard CTRSEL requirements and the requirement that the P_t was greater than 500 MeV/c. In each event, the Monte Carlo track was considered found if more than 25% of the hits on a good track matched the hits of the Monte Carlo track (generator level). That track was considered the embedded Monte Carlo track. If more than one track in the event satisfied this requirement, the track with the largest fraction of hits matching the Monte Carlo track was identified as the embedded Monte Carlo track.

We parameterized the tracking efficiency as a function of inter-track distance and jet E_t. The inter-track distance was broken down into XY (r, ϕ) and Z components. Table 1 shows the efficiency as a function of inter-track distance for jets with an average E_t of 80 GeV. The table is broken down into 11 bins in the XY direction ($0 - 3$ cm, $3 - 6$ cm, $6 - 9$ cm, ..., $27 - 30$ cm, > 30 cm) and 7 bins in the Z direction ($0 - 5$ cm, $5 - 10$ cm, ..., $25 - 30$ cm, > 30 cm). These distances are the *sum* of the inter-track distances at three different wire radii (wires 0, 36, 83). The values in the table have been "smoothed" by eye to give a monotonically increasing efficiency with XY and Z distances. We believe the uncertainty on each component is on the order of $5 - 10\%$.

Table 1 Track Efficiency in jets with $< E_t >= 80\ GeV$ ΔXY (3 cm steps) vs ΔZ (5 cm steps)											
	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	>30
0-5	0.62	0.75	0.78	0.80	0.84	0.85	0.88	0.90	0.91	0.91	0.91
5-10	0.65	0.77	0.79	0.82	0.85	0.87	0.89	0.90	0.91	0.91	0.92
10-15	0.67	0.78	0.81	0.84	0.87	0.90	0.90	0.91	0.91	0.92	0.92
15-20	0.69	0.79	0.83	0.85	0.88	0.90	0.90	0.91	0.91	0.92	0.92
20-25	0.71	0.80	0.84	0.86	0.89	0.89	0.91	0.91	0.91	0.92	0.93
25-30	0.73	0.82	0.85	0.89	0.90	0.91	0.91	0.92	0.92	0.93	0.93
>30	0.76	0.85	0.87	0.90	0.91	0.91	0.92	0.92	0.93	0.93	0.93

To determine the dependence on jet E_t, we repeated the measurement using a sample of jets with $E_t > 150\ GeV$. The results are shown in Table 2. Finally, we parameterize the tracking efficiency as follows:

$$\text{For } E_t(jet) < 80\ GeV: \quad 1 - Eff(I,J) = 1 - Eff(I,J)[80] - 0.001 \times (80 - E_t(jet))$$

$$\text{For } E_t(jet) > 80\ GeV: \quad 1 - Eff(I,J) = 1 - Eff(I,J)[80] - S(I,J) \times (80 - E_t(jet))$$

where $Eff(I,J)[80]$ is an element of Table 1. The slopes $S(I,J)$ are linear extrapolations between Table 1 and Table 2, element for element.

$$S(I,J) = (Eff(I,J)[80] - Eff(I,J)[170])/90.$$

The $S(I,J) * 100$ are given in Table 3. We have altered a few slope elements to smooth the results but these changes were very small.

Table 2 Track Efficiency in jets with $E_t > 150\ GeV$ ($< E_t >= 170\ GeV$) ΔXY (3 cm steps) vs ΔZ (5 cm steps)											
	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	>30
0-5	0.50	0.62	0.68	0.70	0.72	0.75	0.78	0.79	0.81	0.82	0.84
5-10	0.58	0.64	0.68	0.71	0.74	0.76	0.79	0.81	0.83	0.84	0.86
10-15	0.62	0.66	0.69	0.73	0.76	0.79	0.82	0.84	0.86	0.87	0.89
15-20	0.64	0.68	0.71	0.74	0.78	0.81	0.84	0.87	0.89	0.90	0.90
20-25	0.68	0.72	0.76	0.80	0.82	0.84	0.87	0.88	0.90	0.91	0.91
25-30	0.74	0.78	0.80	0.82	0.84	0.86	0.88	0.89	0.90	0.91	0.92
>30	0.78	0.80	0.81	0.82	0.85	0.87	0.88	0.90	0.91	0.92	0.93

Table 3 $S(I,J) = \Delta Eff(I,J)/\Delta E_t$ Values Multiplied by 100 ΔXY (3 cm steps) vs ΔZ (5 cm steps)											
	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	>30
0-5	0.14	0.14	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.10	0.08
5-10	0.10	0.13	0.12	0.12	0.12	0.12	0.11	0.10	0.09	0.08	0.07
10-15	0.06	0.13	0.13	0.12	0.12	0.12	0.09	0.08	0.06	0.06	0.03
15-20	0.06	0.12	0.13	0.12	0.11	0.10	0.07	0.04	0.02	0.02	0.02
20-25	0.03	0.09	0.09	0.07	0.08	0.06	0.04	0.03	0.02	0.02	0.02
25-30	0.02	0.04	0.07	0.07	0.07	0.06	0.03	0.03	0.02	0.02	0.01
>30	0.02	0.06	0.07	0.07	0.07	0.04	0.04	0.02	0.02	0.01	0.00

These efficiencies are given as a function of two-track separation. We believe the efficiency should be applied to both tracks. This is a best (and naive) guess and is probably not strictly true. Tables 1 and 2 roughly agree at the lower right (large inter-track distance) and disagree at small inter-track distances. The upper left element (smallest inter-track distance) is changing the fastest (see Table 3). At roughly 523 GeV observed E_t, our parameterization would predict 0 efficiency. We would expect the efficiency to flatten out at some lower E_t. We arbitrarily chose 400 GeV as the energy above which the efficiency does not change and this is incorporated in QTKEFF. This certainly enters as a systematic uncertainty. To study jets much greater than 400 GeV, we would need more statistics.

Fragmentation Variables and Tuning

In order to compare the data and simulation, the following quantities were used to tune the fragmentation:

1. The fragmentation Z, defined in the following ways:

   $$\begin{aligned} Z(P) &= P_{//}(Track)/P(Jet) \\ Z(E) &= P_{//}(Track)/E(Jet) \\ Z(T) &= P_{//}(Track)/\Sigma(P_{in\ cone}(Track)) \end{aligned}$$

   $P_{//}$ is the momentum of the track parallel to the jet axis. Each Z was plotted as $(1/N_{jets})(dN/dZ)$.

2. The number of tracks in the cone of the jet (Jet Multiplicity), was plotted as $(1/N_{jets})(Mult)$.

3. The number of tracks in the cone 90 deg away in ϕ from the jet, (Underlying Event Multiplicity). was plotted as $(1/N_{jets})(Mult_{Und})$.

4. The momentum perpendicular to the jet axis, of tracks in the cone of the jet, was plotted as $(1/N_{jets})(dN/dP_{\perp})$, and $P_{\perp}$ is the momentum of the track perpendicular to the jet axis.

5. The momentum perpendicular to the axis of a cone 90 deg away in ϕ from the jet, of tracks in a cone 90 deg away in ϕ from the jet, was plotted as $(1/N_{jets})(dN/dP_{\perp\ Und})$.

6. The P_t (relative to the beam axis) of the tracks in the cone around the jet, was plotted as $(1/N_{jets})(dN/dP_t)$.

7. The P_t of the tracks in the cone 90 deg away from the jet, was plotted as $(1/N_{jets})(dN/dP_{t\ Und})$.

8. The P_t flow of the tracks with respect to the lead jet in ϕ, which is the $\Delta\phi$ of the track with respect to the lead jet weighted by the P_t of the track.

9. The P_t loss flow of the tracks with respect to the lead jet in ϕ, which is the $\Delta\phi$ of the track with respect to the lead jet weighted by the amount P_t(loss) by the track due to the non-linearity.

10. The amount of energy loss in the jet due to the non-linearity in the central hadron calorimeter.

All of these variables were plotted in slices of jet E_t, so as to tune the fragmentation evolution.

SETPRT contains 5 variables which can be used to tune the fragmentation of jets. These variables are labeled in SETPRT as follows: XGEN(1), XGEN(2), SIGQT, SIGQT0, and CON2. XGEN(1) and XGEN(2) are used to describe the Field Feynmann fragmentation parameterization in SETPRT. SIGQT0 is used to define the transverse P_t for the underlying event. SIGQT is used to define the transverse P_t for the jet. CON2 represents the transverse fragmentation power. The default values of these variables are listed in Table 4, along with the "Final Tune "values. We tuned the these five variables until we saw agreement in the plots, listed above. This means that the means, sigmas and shapes of each plot in the simulation was in agreement with what we observed in the data. We tuned for jets with E_t ranging from 30–60 GeV and also for jets with E_t ranging from 120–150 GeV.

Table 4
SETPRT Tunes

Variable	Default Values	Low Values	High Values	Final Tune
XGEN(1)	0.950	0.950	0.950	0.950
XGEN(2)	7.000	7.500	7.500	7.500
SIGQT	0.275	0.275	0.600	0.250
SIGQT0	0.370	0.370	0.370	0.370
CON2	1.100	1.200	1.200	1.200

After examining the simulation at higher E_t's in comparison with the data, we found it necessary to make SIGQT a function of jet E_t. Knowing both the high (120–150 GeV) and low (30–60 GeV) E_t tunes, we then modified both SETPRT and JETGEN to scale SIGQT with jet E_t. These low and high values are also listed in Table 4.

Results and Conclusions

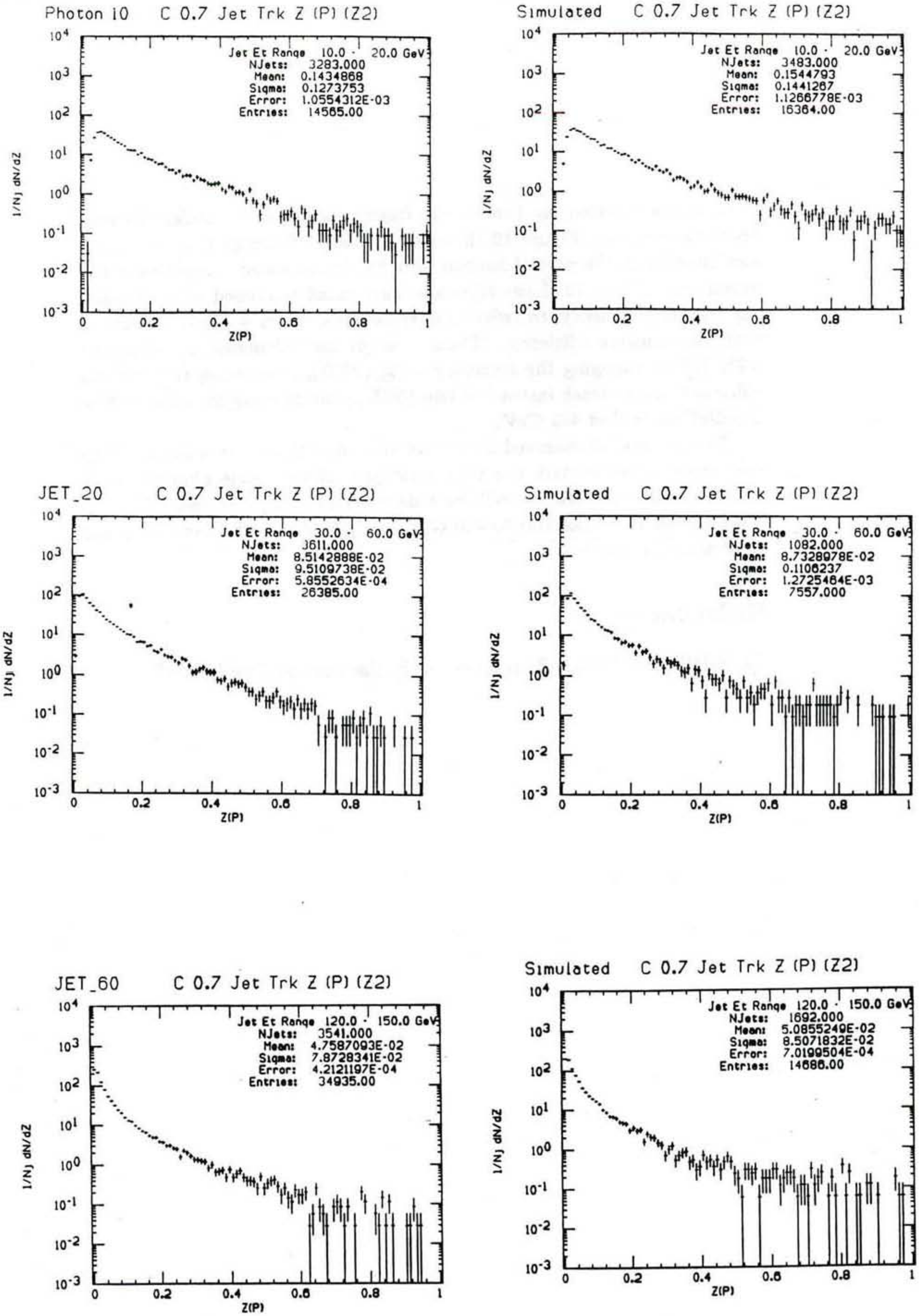
With the final modifications to SETPRT and JETGEN, we have tuned the fragmentation in SETPRT to agree with what we have observed in the 1988-1989 CDF jet data, over all jet E_t's. We then compared these results to the fragmenation observed in jets ranging from 10–20 GeV found in the Photon data sample. As can be seen in figures 1-11, the various fragmentation plots, in both simulation and data, agree at both low and high E_t.

The main reason for tuning the fragmentation is to model the non-linearity correctly. Figure 12 shows the percent of energy loss due to the non-linearity in the central hadron in both the data and simulation are in agreement. Figure 13 shows this same agreement combined with changing the tracking efficiency, to reflect the systematic errors we have associated with the tracking efficiency. These changes are: changing the efficiency +7% (1ST), changing the efficiency −7% (2ND), associating the tracking efficiency to one track instead of two (3RD), and pinning the efficiency at 250 GeV instead of 400 GeV.

This agreement observed in the simulation with the data for the fragmentation, together with the tuning in QFL of the single pion response, gives us confidence that we will be able to extract both jet energy corrections and jet resolution out to 450 GeV in E_t, and that the simulation will yield accurate results.

References

[1] CDF-1066, "Single Pion Response in the Central Calorimeter".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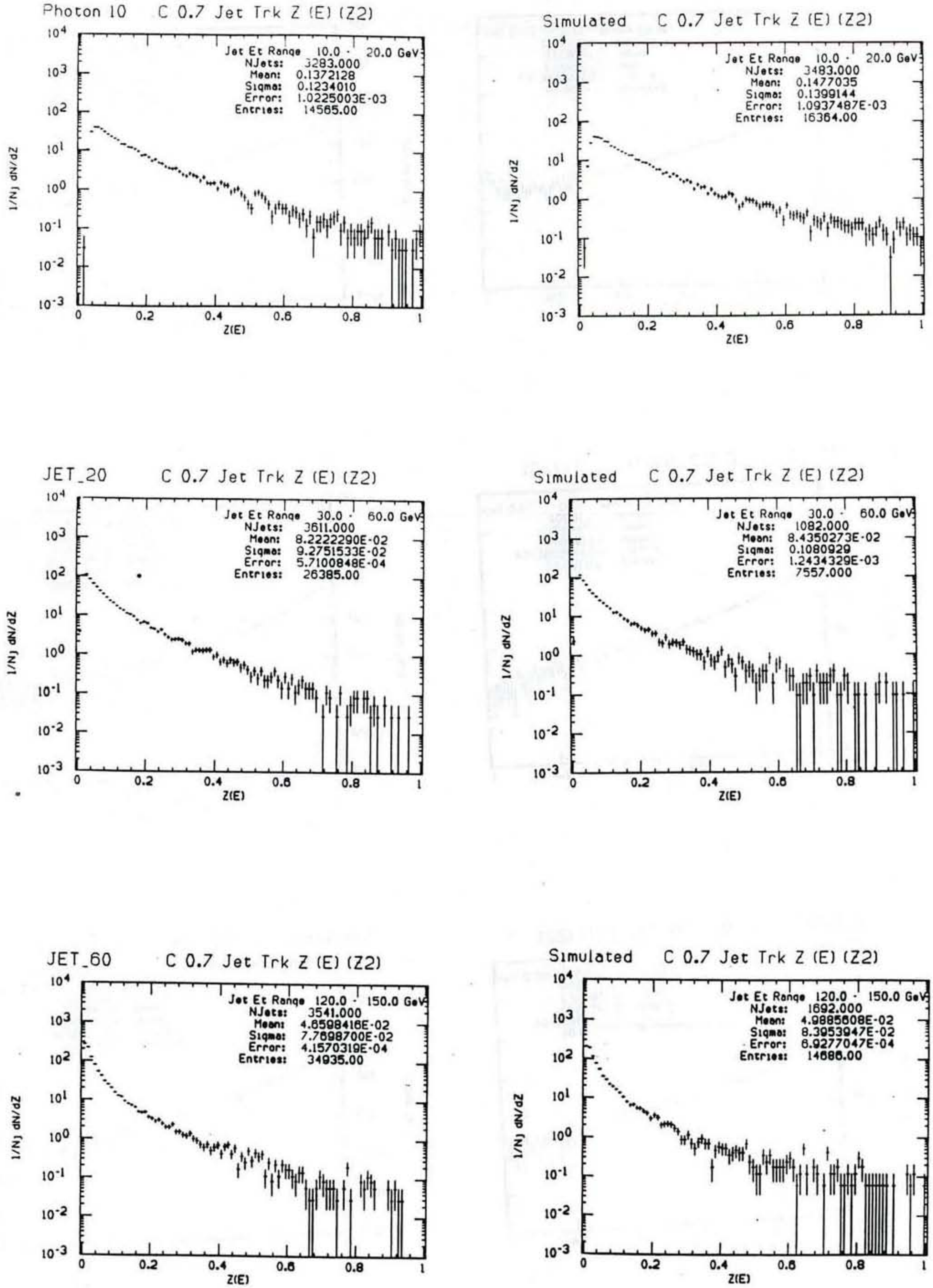
1/Nj dN/dZ
Z(P)

Figure 1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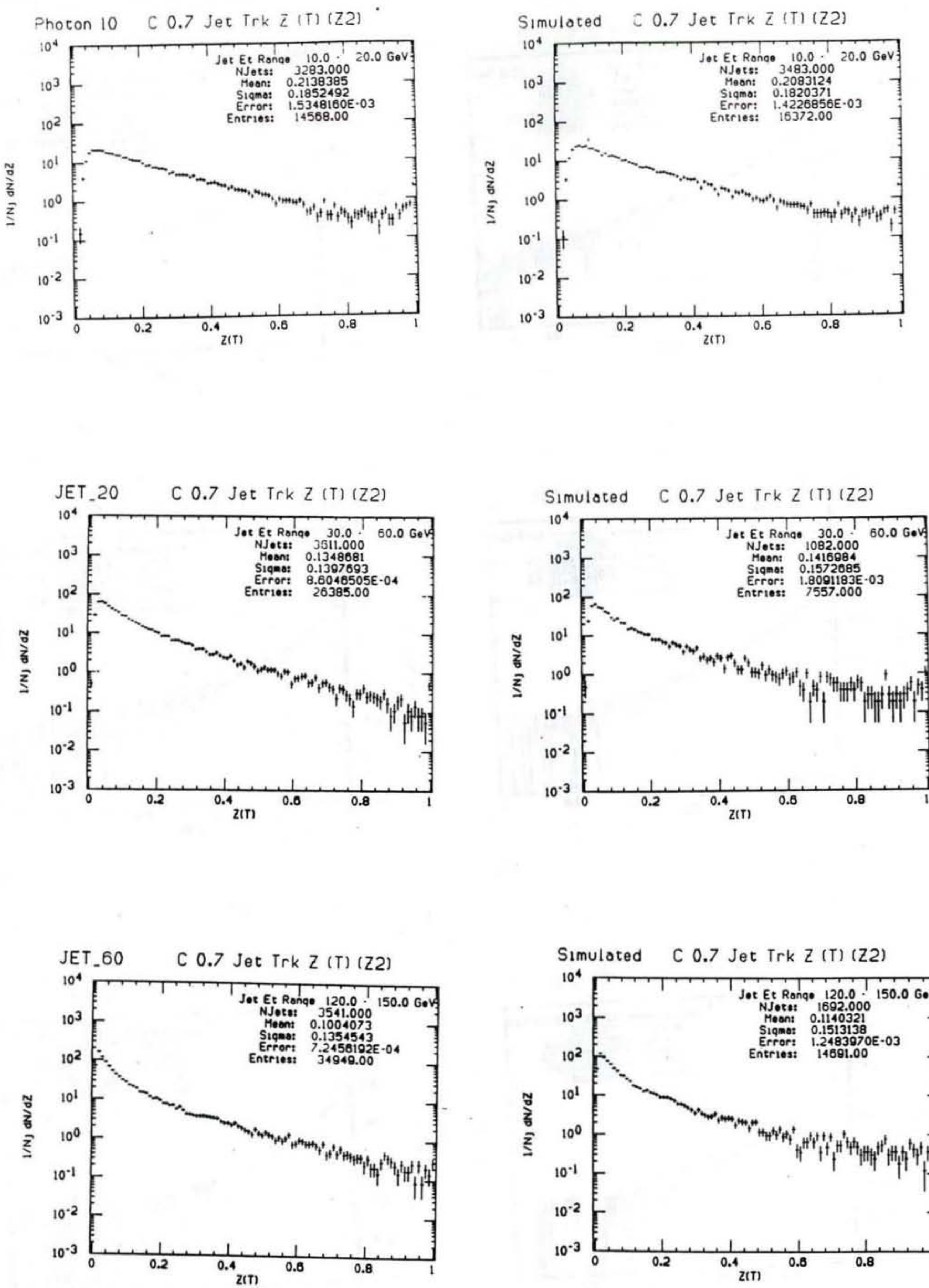
1/Nj dN/dZ
Z(E)

Figure 2



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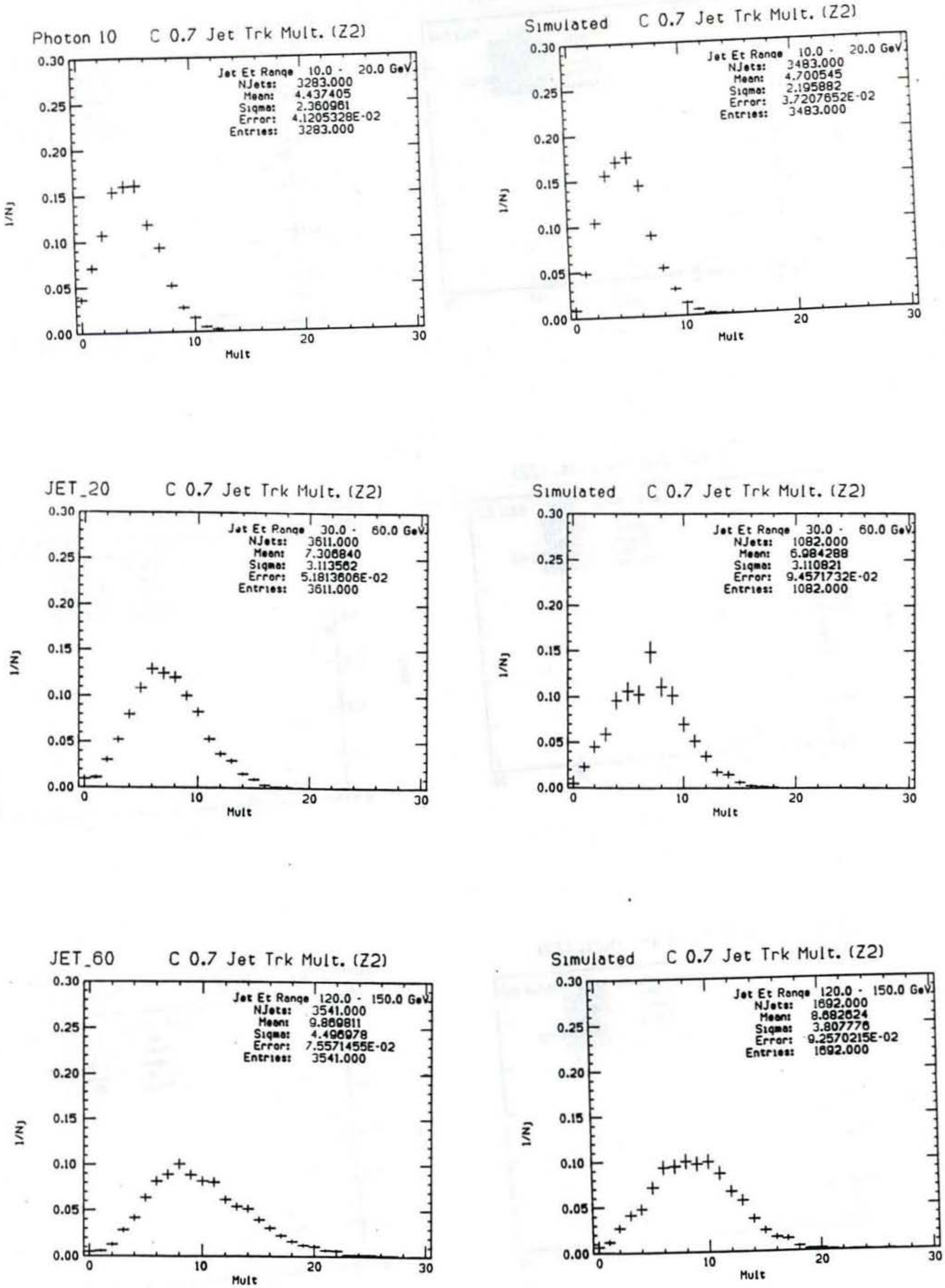
Z(T)

Figure 3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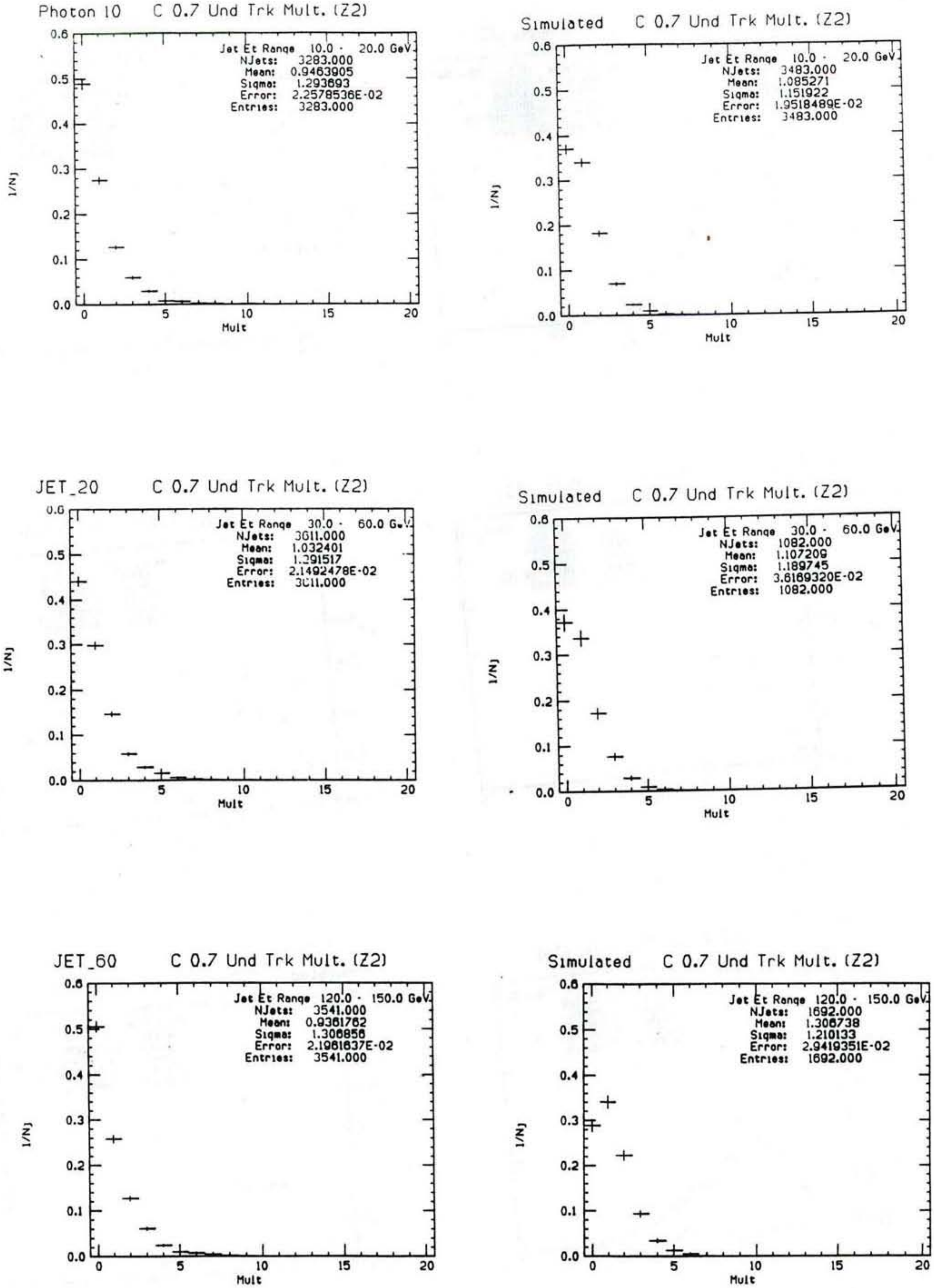
Mult

Figure 4



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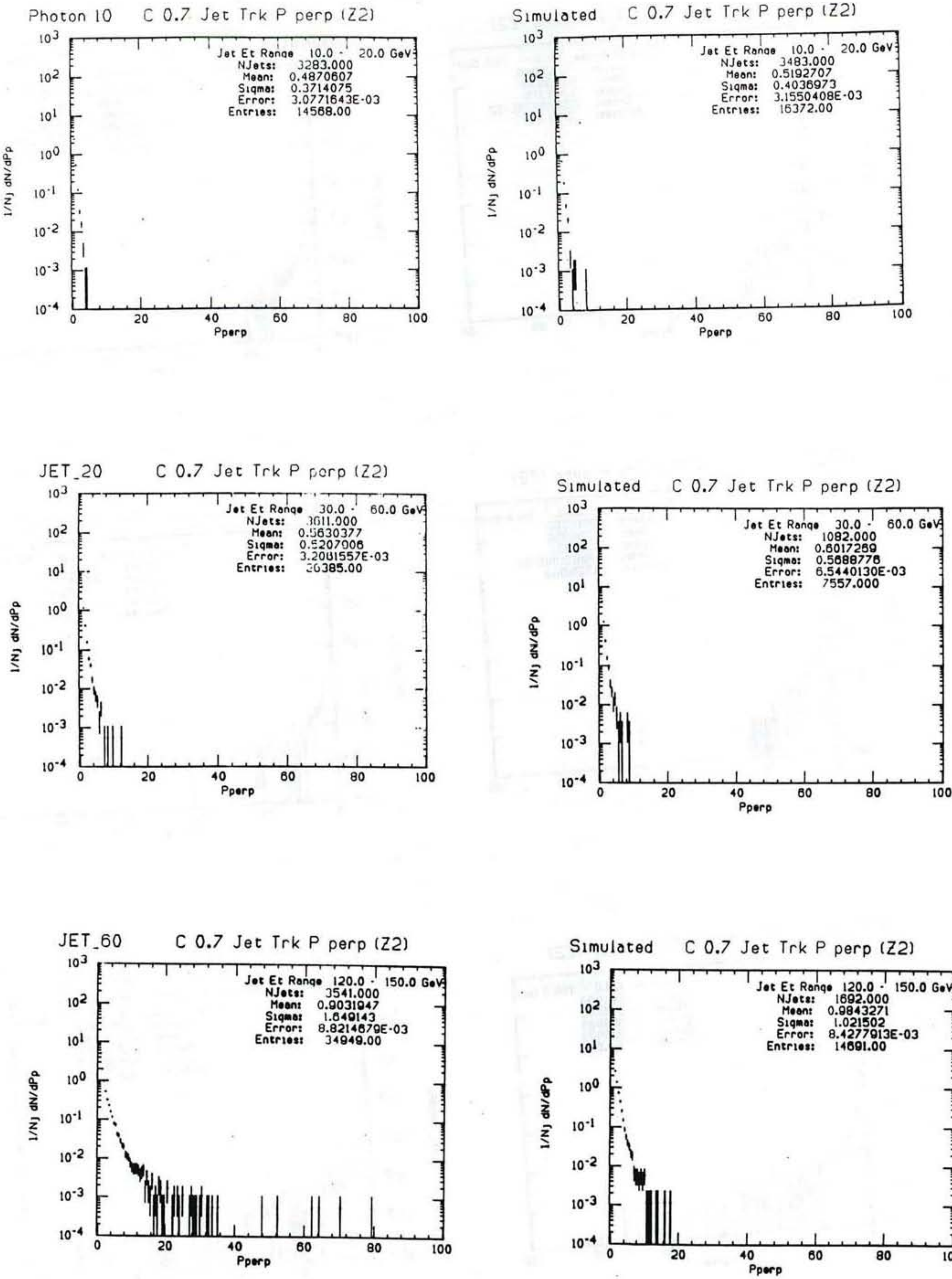
1/Nj
Mult

Figure 5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NJets: 3483.000
Mean: 0.5192707
Sigma: 0.4036973
Error: 3.1550408E-03
Entries: 16372.00
JET_20 C 0.7 Jet Trk P perp (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 3611.000
Mean: 0.5630377
Sigma: 0.5207006
Error: 3.2081557E-03
Entries: 26385.00
Simulated C 0.7 Jet Trk P perp (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 1082.000
Mean: 0.6017269
Sigma: 0.5688776
Error: 6.5440130E-03
Entries: 7557.000
JET_60 C 0.7 Jet Trk P perp (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 3541.000
Mean: 0.9031947
Sigma: 1.649143
Error: 8.8214679E-03
Entries: 34949.00
Simulated C 0.7 Jet Trk P perp (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1692.000
Mean: 0.9843271
Sigma: 1.021502
Error: 8.4277913E-03
Entries: 14691.00
1/Nj dN/dPp
Pperp

Figure 6

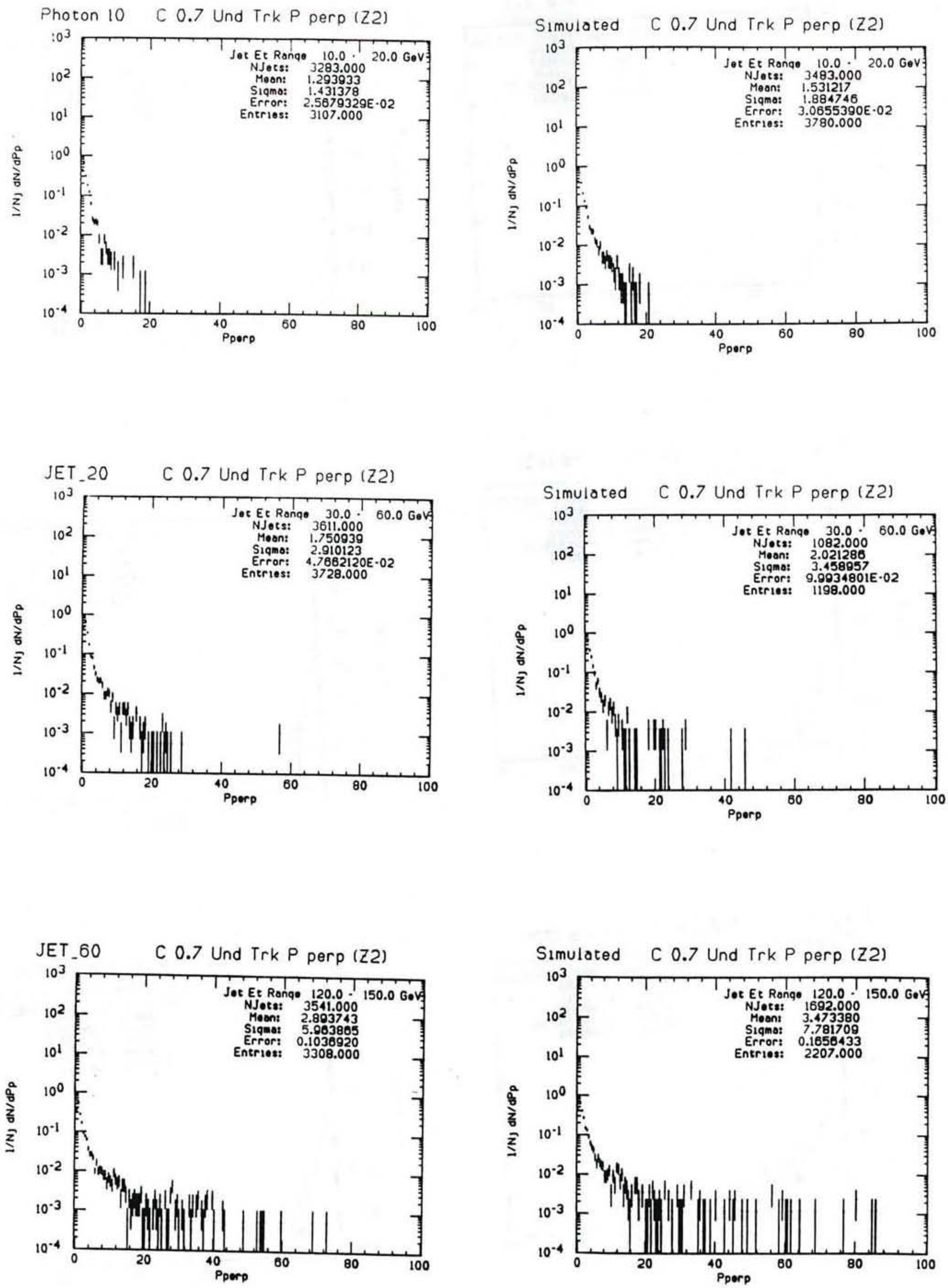

Photon 10 C 0.7 Und Trk P perp (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3283.000
Mean: 1.293933
Sigma: 1.431378
Error: 2.5679329E-02
Entries: 3107.000
Simulated C 0.7 Und Trk P perp (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3483.000
Mean: 1.531217
Sigma: 1.884746
Error: 3.0655390E-02
Entries: 3780.000
JET_20 C 0.7 Und Trk P perp (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 3611.000
Mean: 1.750939
Sigma: 2.910123
Error: 4.7662120E-02
Entries: 3728.000
Simulated C 0.7 Und Trk P perp (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 1082.000
Mean: 2.021286
Sigma: 3.458957
Error: 9.9934801E-02
Entries: 1198.000
JET_60 C 0.7 Und Trk P perp (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 3541.000
Mean: 2.893743
Sigma: 5.963865
Error: 0.1036920
Entries: 3308.000
Simulated C 0.7 Und Trk P perp (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1692.000
Mean: 3.473380
Sigma: 7.781709
Error: 0.1656433
Entries: 2207.000
1/Nj dN/dPp
Pperp

Figure 7

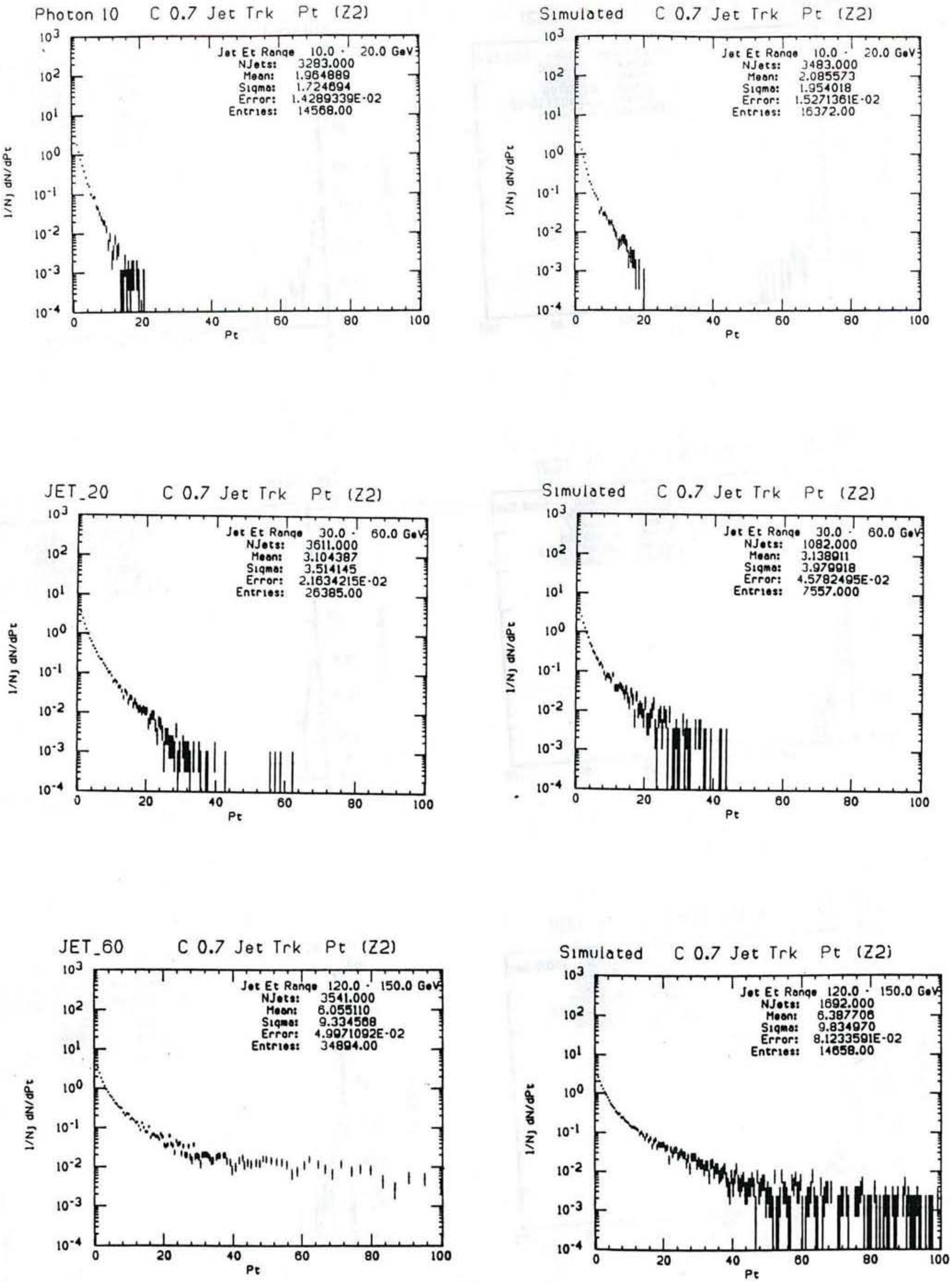
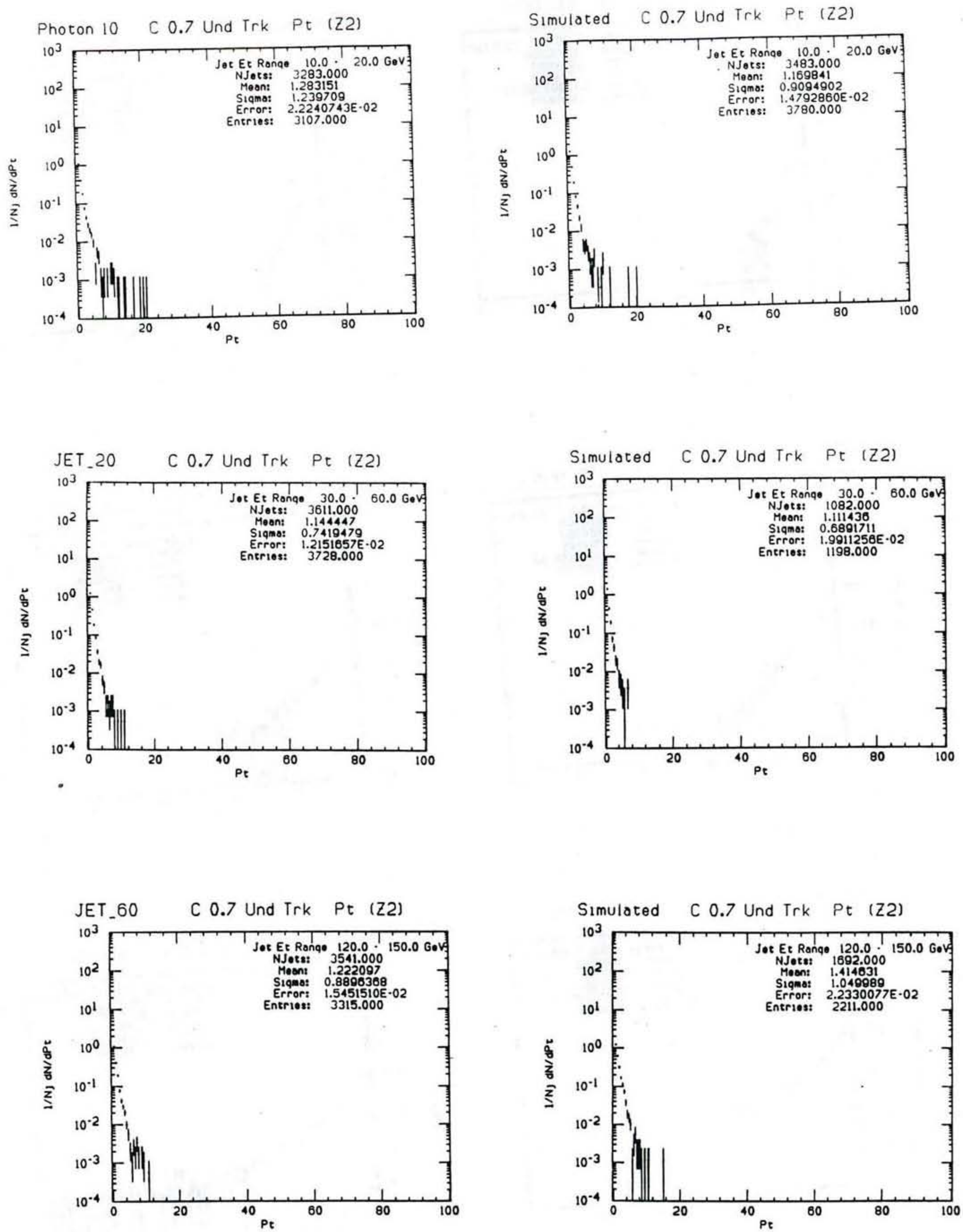

Photon 10 C 0.7 Jet Trk Pt (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3283.000
Mean: 1.964889
Sigma: 1.724694
Error: 1.4289339E-02
Entries: 14568.00
1/Nj dN/dPt
Pt
Simulated C 0.7 Jet Trk Pt (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3483.000
Mean: 2.085573
Sigma: 1.954018
Error: 1.5271361E-02
Entries: 16372.00
1/Nj dN/dPt
Pt
JET_20 C 0.7 Jet Trk Pt (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 3611.000
Mean: 3.104387
Sigma: 3.514145
Error: 2.1634215E-02
Entries: 26385.00
1/Nj dN/dPt
Pt
Simulated C 0.7 Jet Trk Pt (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 1082.000
Mean: 3.138911
Sigma: 3.979918
Error: 4.5782495E-02
Entries: 7557.000
1/Nj dN/dPt
Pt
JET_60 C 0.7 Jet Trk Pt (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 3541.000
Mean: 6.055110
Sigma: 9.334568
Error: 4.9971092E-02
Entries: 34894.00
1/Nj dN/dPt
Pt
Simulated C 0.7 Jet Trk Pt (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1692.000
Mean: 6.387706
Sigma: 9.834970
Error: 8.1233591E-02
Entries: 14658.00
1/Nj dN/dPt
Pt

Figure 8



Photon 10 C 0.7 Und Trk Pt (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3283.000
Mean: 1.283151
Sigma: 1.239709
Error: 2.2240743E-02
Entries: 3107.000
1/Nj dN/dPt
Pt
Simulated C 0.7 Und Trk Pt (Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 3483.000
Mean: 1.169841
Sigma: 0.9094902
Error: 1.4792860E-02
Entries: 3780.000
JET_20 C 0.7 Und Trk Pt (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 3611.000
Mean: 1.144447
Sigma: 0.7419479
Error: 1.2151657E-02
Entries: 3728.000
Simulated C 0.7 Und Trk Pt (Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 1082.000
Mean: 1.111436
Sigma: 0.6891711
Error: 1.9911256E-02
Entries: 1198.000
JET_60 C 0.7 Und Trk Pt (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 3541.000
Mean: 1.222097
Sigma: 0.8896368
Error: 1.5451510E-02
Entries: 3315.000
Simulated C 0.7 Und Trk Pt (Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1692.000
Mean: 1.414631
Sigma: 1.049989
Error: 2.2330077E-02
Entries: 2211.000

Figure 9

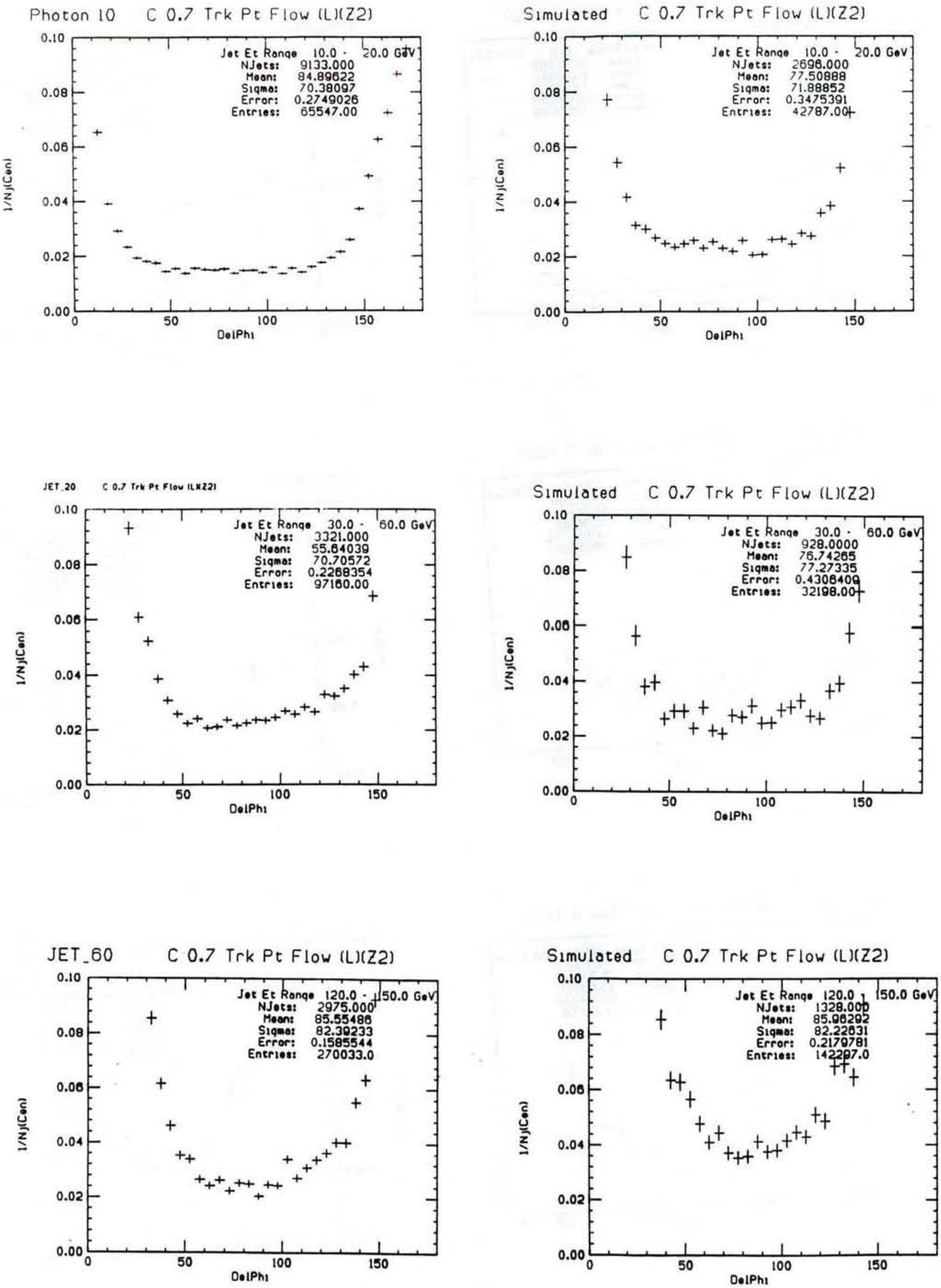
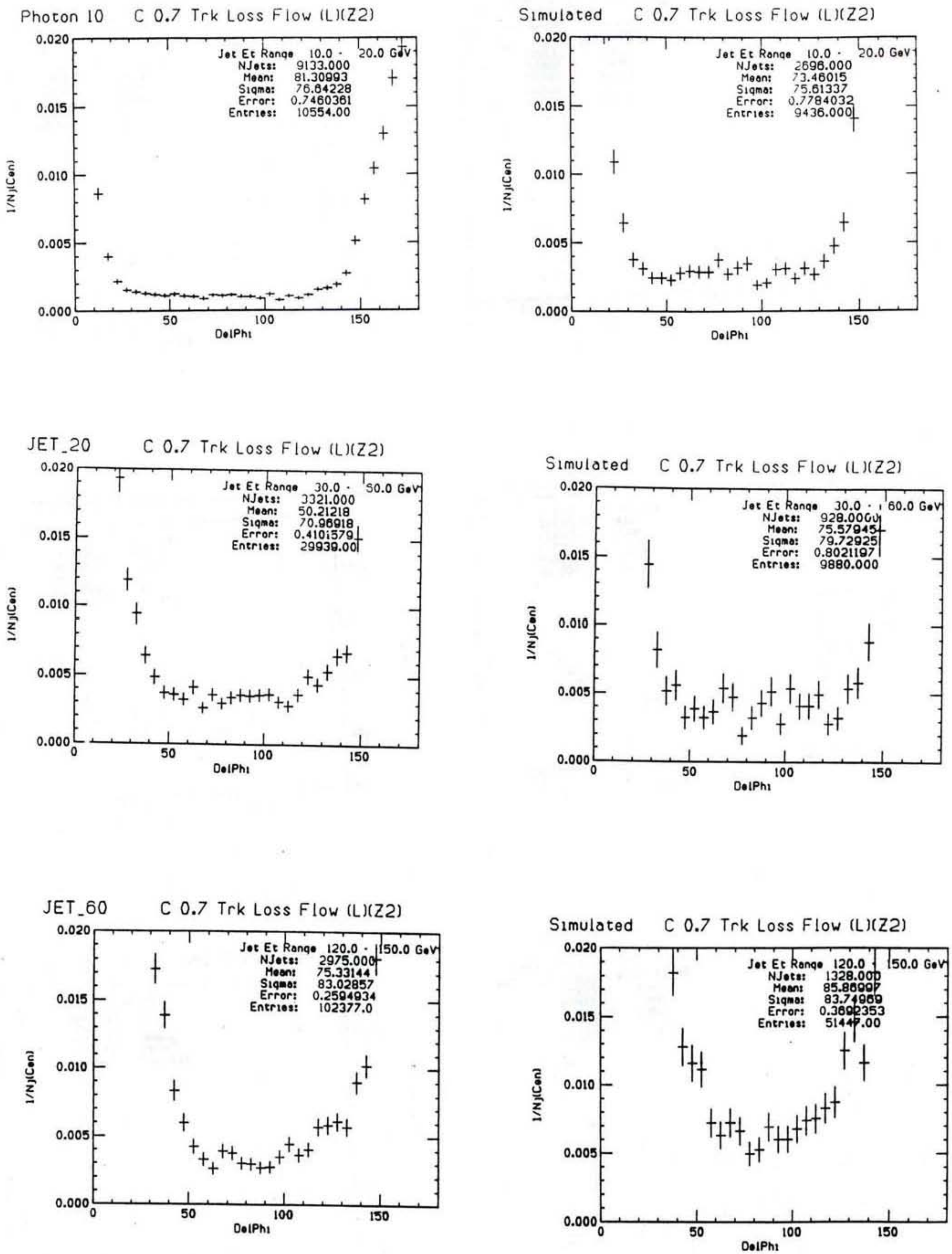
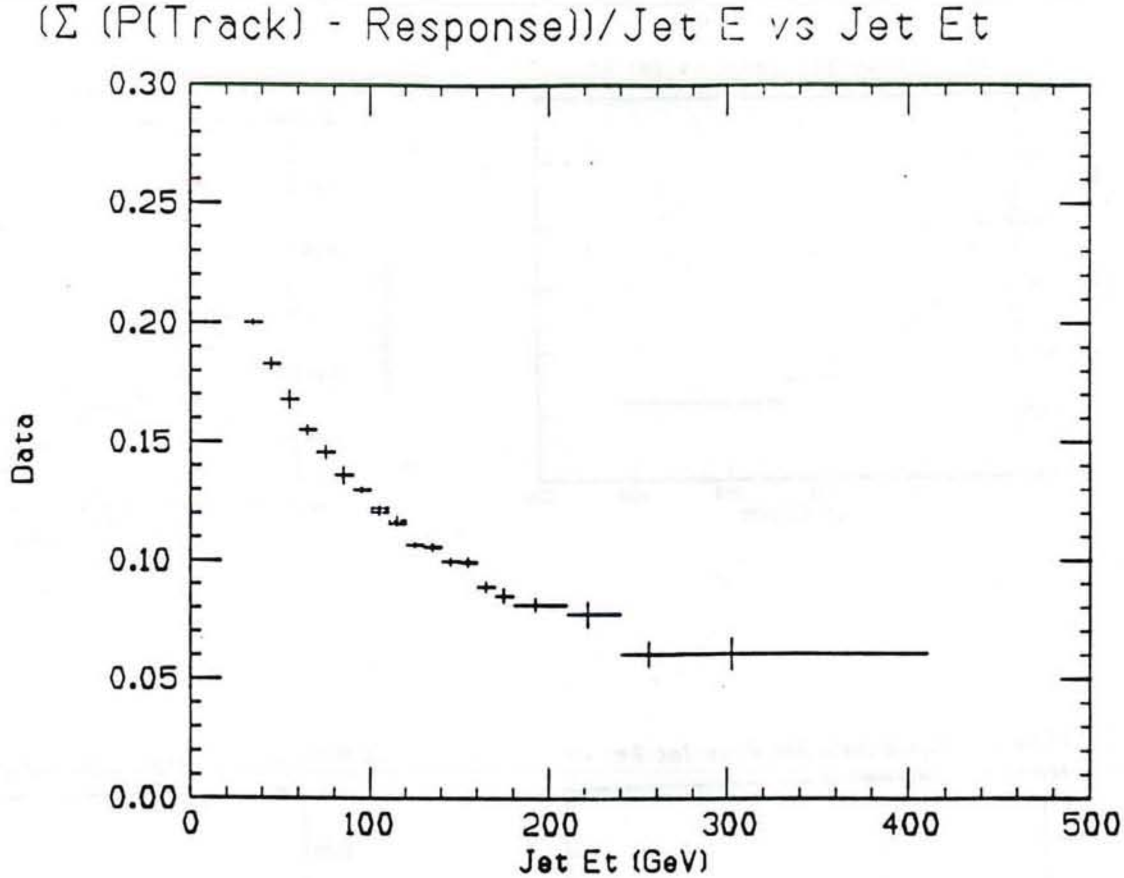

Photon 10 C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 9133.000
Mean: 84.89622
Sigma: 70.38097
Error: 0.2749026
Entries: 65547.00
Simulated C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 2696.000
Mean: 77.50888
Sigma: 71.88852
Error: 0.3475391
Entries: 42787.00
JET_20 C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 3321.000
Mean: 55.84039
Sigma: 70.70572
Error: 0.2268354
Entries: 97160.00
Simulated C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 928.0000
Mean: 76.74265
Sigma: 77.27335
Error: 0.4306409
Entries: 32198.00
JET_60 C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 2975.000
Mean: 85.55486
Sigma: 82.39233
Error: 0.1585544
Entries: 270033.0
Simulated C 0.7 Trk Pt Flow (L)(Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1328.000
Mean: 85.96292
Sigma: 82.22631
Error: 0.2179781
Entries: 142297.0
1/Nj(Cen)
DelPhi
0.00
0.02
0.04
0.06
0.08
0.10
0
50
100
150

Figure 10



Photon 10 C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 9133.000
Mean: 81.30993
Sigma: 76.84228
Error: 0.7460361
Entries: 10554.00
Simulated C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 10.0 - 20.0 GeV
NJets: 2698.000
Mean: 73.46015
Sigma: 75.61337
Error: 0.7784032
Entries: 9436.000
JET_20 C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 30.0 - 50.0 GeV
NJets: 3321.000
Mean: 50.21218
Sigma: 70.96918
Error: 0.4101579
Entries: 29939.00
Simulated C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 30.0 - 60.0 GeV
NJets: 928.0000
Mean: 75.57945
Sigma: 79.72925
Error: 0.8021197
Entries: 9880.000
JET_60 C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 2975.000
Mean: 75.33144
Sigma: 83.02857
Error: 0.2594934
Entries: 102377.0
Simulated C 0.7 Trk Loss Flow (L)(Z2)
Jet Et Range 120.0 - 150.0 GeV
NJets: 1328.000
Mean: 85.86997
Sigma: 83.74969
Error: 0.3692353
Entries: 51447.00
1/Nj(Cen)
DelPhi
0.000
0.005
0.010
0.015
0.020
0
50
100
150

Figure 11


(Σ (P(Track) - Response))/Jet E vs Jet Et
Data
Jet Et (GeV)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0
100
200
300
400
500

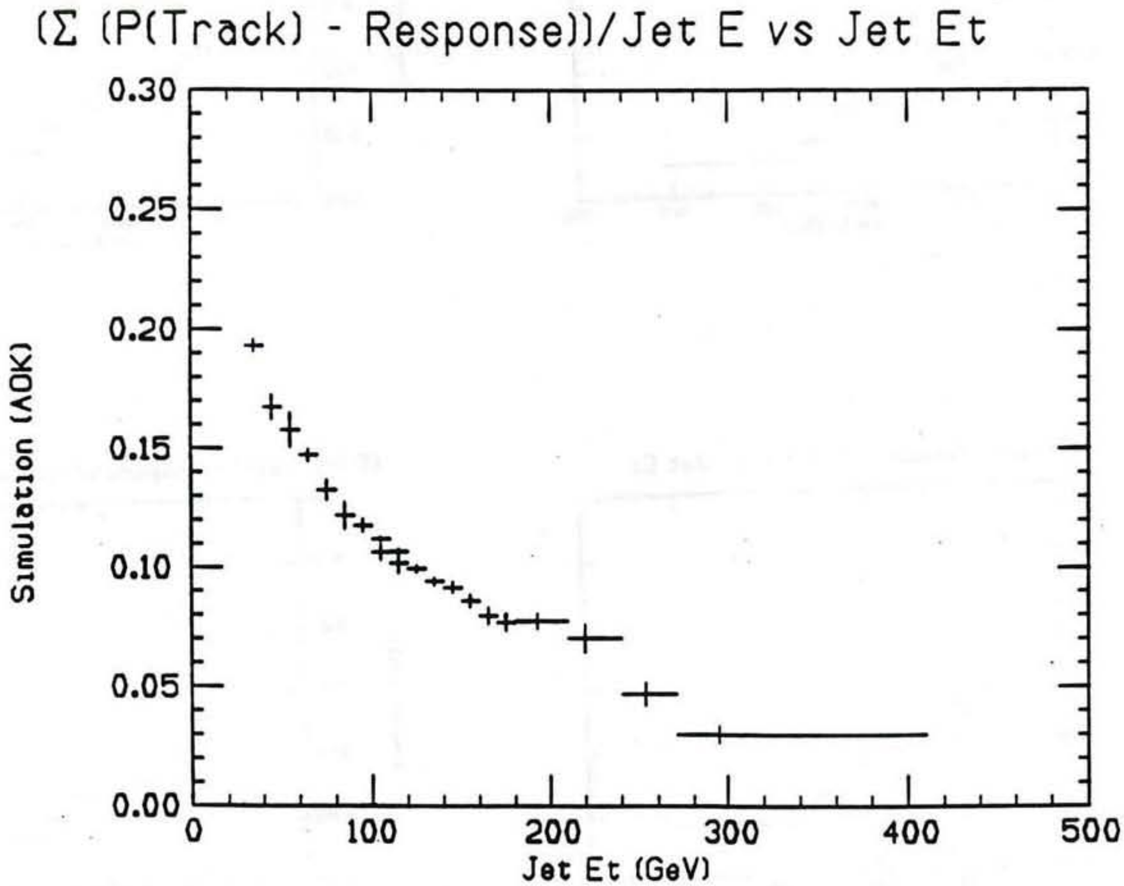

(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (AOK)
Jet Et (GeV)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0
100
200
300
400
500

Figure 12

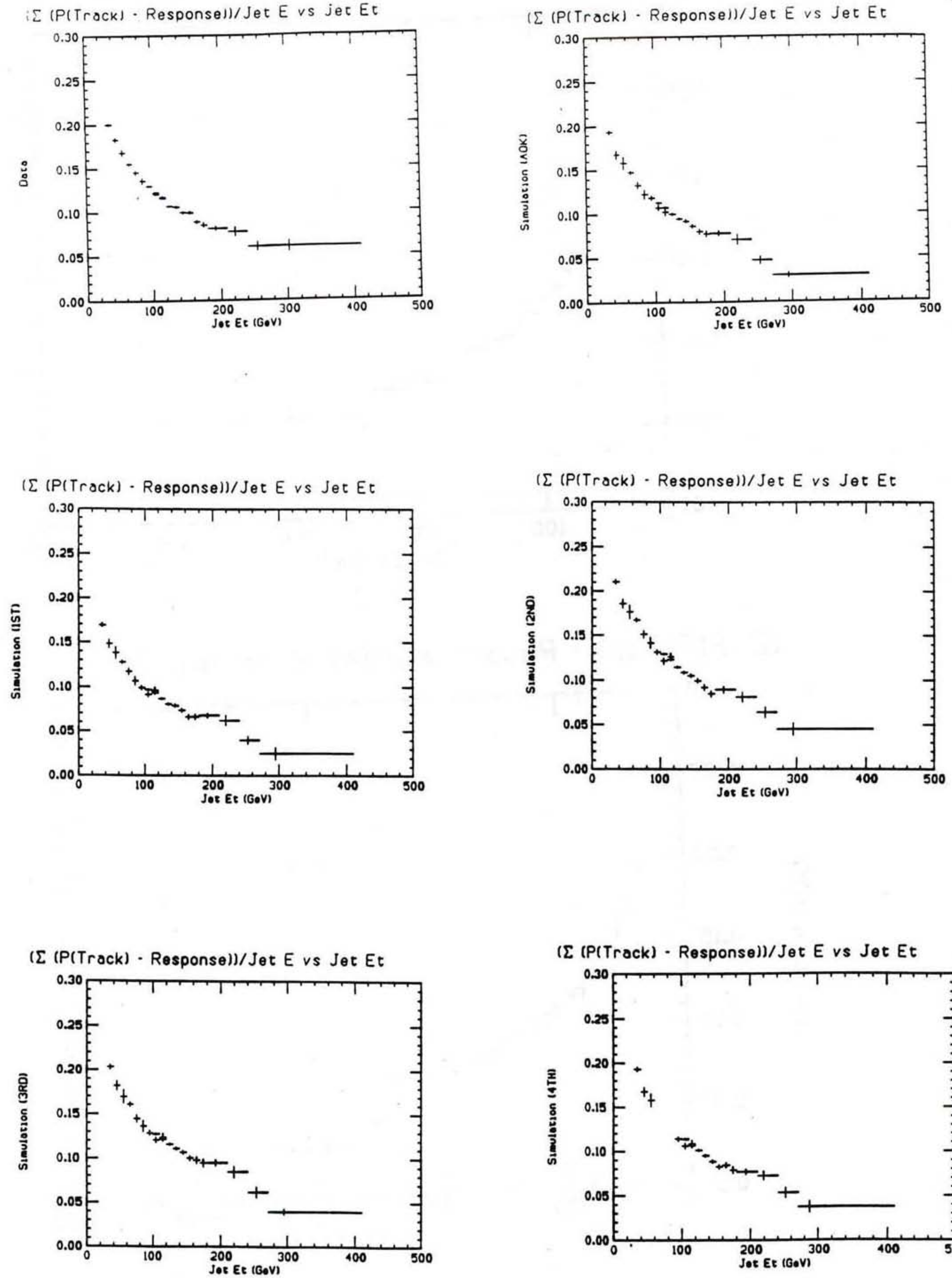

(Σ (P(Track) - Response))/Jet E vs Jet Et
Data
Jet Et (GeV)
(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (AOK)
Jet Et (GeV)
(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (1ST)
Jet Et (GeV)
(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (2ND)
Jet Et (GeV)
(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (3RD)
Jet Et (GeV)
(Σ (P(Track) - Response))/Jet E vs Jet Et
Simulation (4TH)
Jet Et (GeV)

Figure 13