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Anomalously High Momentum Tracks in Aleph

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1 Introduction

This note describes anomalously high momentum tracks measured in Aleph. The study of these tracks was motivated by their possible influence on the hadronic charge asymmetry measurement, where the charge of the parent quark is reconstructed by weighting the charged tracks in an event by their momenta. As the anomalously high momentum tracks will be leading tracks in their hemisphere they will dominate the hemisphere charge and thereby bias the charge flow, Q_{FB} (= Q_F - Q_B), for that event.

This note will be general, defining the type of tracks considered, noting their relative abundance, describing any asymmetries in their production, and describing how well the effect is reproduced in Monte Carlo.

2 Definition of Anomalously High Momentum Tracks

We analyse only hadronic events, and consider otherwise good tracks with momentum $p > p_{\rm cut}$, where $p_{\rm cut} = 30$ or 50 GeV. The definition of a good track will be the standard $Q\bar{Q}$ track cuts, namely number of TPC hits ≥ 4, $|d_0| \leq 2.0$ cm, $|z_0| \leq 10.0$ cm. In addition in order to compare to the Monte Carlo a p_t cut is made, $p_t > 200$ MeV.

Hadronic events are defined as having 5 or more good tracks with $E_{ch}/E_{cms} > 10\%$. For the data 1989 and 1990 events are used; 191,736 hadronic events are selected. In 1989 the TPC voltage is required to be on; in 1990 runs with a Run Quality rating of MAYB or PERF are used, where the MAYB runs have been checked to obtain reliable tracking information. The data is compared to a sample of 352,459 selected Monte Carlo events.

3 Frequency of Occurrence

Data and Monte Carlo have been compared using two p_t cuts, namely $p_t > 30$ GeV (*cut I*) and $p_t > 50$ GeV (*cut II*). Table 1 summarizes the occurrence of anomalously

high momentum tracks out of the sample of good tracks, for the two cuts. In the data subsample of events containing 1 or more such tracks, the average multiplicity of anomalously high momentum tracks is 1.013 (*cut I*) and 1.004 (*cut II*). At $p_{\rm cut} = 50$ GeV there are two data events with two such tracks; there are no data events and one Monte Carlo event with three such tracks. The number of high momentum tracks versus the number of good tracks in the event, is shown in Figure 1.

	(*cut I*)	(*cut II*)
No Tracks with $p > p_{\rm cut}$ - Data	4294	573
% Tracks with $p > p_{\rm cut}$ - Data	0.129%	0.017%
% Tracks with $p > p_{\rm cut}$ - M C	0.129%	0.019%

Table 1: Occurrence of anomalously high momentum tracks in data and Monte Carlo

The Monte Carlo reproduces the frequency of occurrence of these tracks, even at the highest momenta. Table 1 shows that only a small fraction of all good tracks have an anomalously high momentum: 0.13% (*cut I*) and 0.02% (*cut II*). The momenta of all tracks, and tracks with $p > p_{\rm cut}$, in data are shown in Figure 2.

4 Description of the Tracks with $p > p_{\rm cut}$

Tracks with anomalously high momenta are a result of known reconstruction problems such as track overlap and poorly fitted tracks due to a lower number of hits near segment boundaries. A scan of a subsample of events containing high momentum tracks (*cut II*) showed no unexpected sources. DALI displays of 2 example events with anomalously high momentum tracks are appended after Fig. 3.

In Table 2 four track characteristics are compared for the three types of tracks: i) good tracks passing *cut I*, ii) good tracks passing *cut II*, iii) good tracks. For the four quantities studied the average value found for *cut I* tracks is still fairly close to that obtained for good tracks. On the other hand the characteristics for *cut II* tracks are quite different. For example they typically have a lower number of TPC hits associated to them and often no ITC hits. The mean fractional error ($\langle\frac{dp}{p}\rangle$) for these tracks is almost one. Distributions of N_{TPC} and N_{ITC} for good and anomalously high momentum tracks are shown in Figure 3.

The presence of a track with anomalously high momentum does not cause an observable bias on the reconstruction of the other tracks in the event. There is no correlation between high momentum tracks and the overall multiplicity. The mean charged multiplicity for events with an anomalously high momentum track is the same, within errors, as for all other events.

No appreciable forward-backward asymmetry is seen in the tracks, except possibly for the highest momentum tracks. The asymmetries are given in Table 3. However as these tracks (*cut II*) only occur in 0.3 % of the events the possible shift on the

	Data			Monte Carlo		
	cut I	*cut II*	good tracks	*cut I*	*cut II*	good tracks
$\langle N_{TPC} \rangle$	15.69	9.28	16.76	15.59	9.50	17.18
$\langle N_{ITC} \rangle$	4.67	1.28	4.95	4.47	1.47	5.16
$\langle \chi^2/\nu \rangle$	2.24	5.69	1.56	2.67	5.87	1.54
$\langle \frac{dp}{p} \rangle$	0.19	0.90	0.05	0.20	0.85	0.05

Table 2: Track information for anomalously high momentum tracks

measured charge flow is less than 0.6×10^{-4}. This error on the charge flow is derived by comparing Q_{FB} measured in the full hadronic event when only including or excluding high momentum tracks. If the events containing a high momentum track are excluded from the analysis no significant change in Q_{FB} is observed with respect to the case where all hadronic events are analysed.

	cut I	*cut II*
Data	$1.8 \pm 1.1\%$	$8.8 \pm 3.6\%$
M C	$1.1 \pm 1.5\%$	$3.3 \pm 4.2\%$

Table 3: Forward-backward asymmetry of anomalously high momentum tracks

The occurrence of anomalously high momentum tracks is well reproduced in the Monte Carlo, which confirms the earlier statement that the sources of the high momentum tracks are well-known. When we look at the matching Monte Carlo truth information for these tracks, we find that the leading Monte Carlo "truth " track is a candidate to match an anomalously high momentum track in 20.31 % of the cases for (*cut I*), and in only 8.42 % of the cases for (*cut II*).

5 Conclusion

Tracks with anomalously high fitted momenta are seen in Aleph with a frequency of 1.3 per mille ($p > 30$ GeV) or 0.2 per mille ($p > 50$ GeV). These tracks are due to well-known difficulties in the track reconstruction and are reproduced correctly by the Monte Carlo. The effect of the presence of these tracks on the charge flow measurement is estimated to be less than 0.6×10^{-4}.

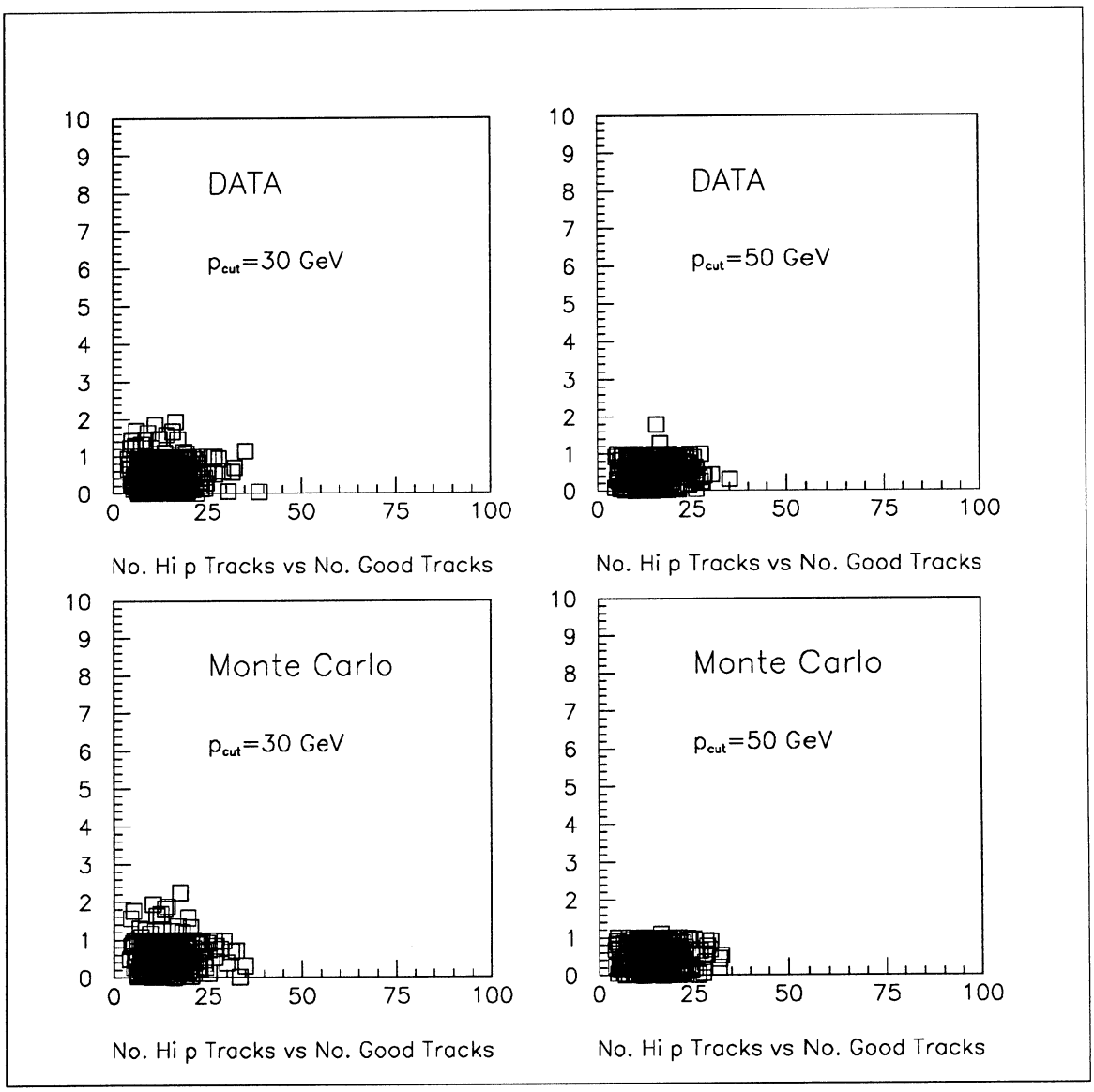


Figure 1: Number of anomalously high momentum tracks versus the number of good track, per event. The plots for p_{cut} =30 GeV are left, the plots for p_{cut} =50 GeV right. Data are on top, Monte Carlo on bottom.

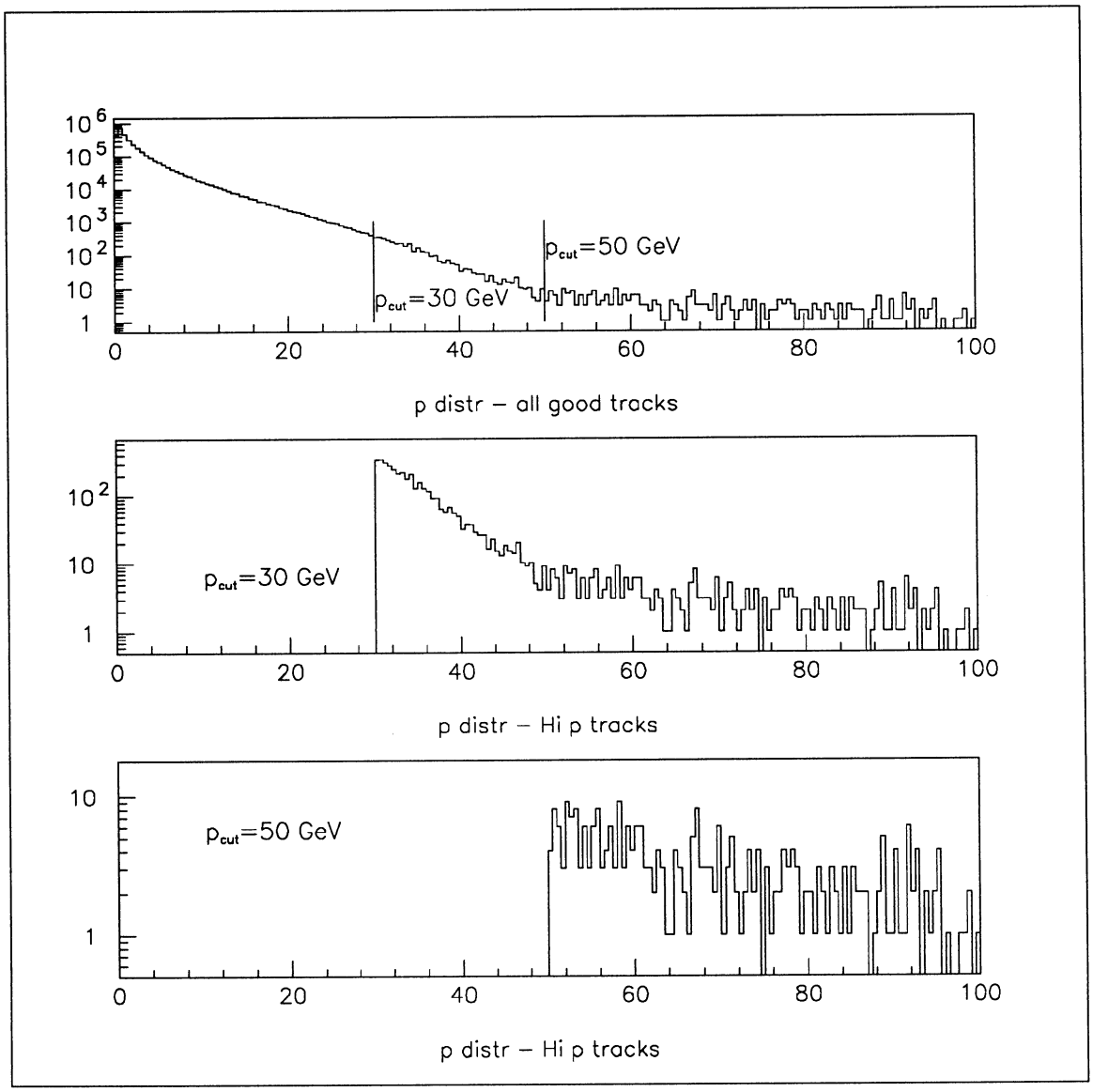


Figure 2: Momentum distributions in data. Top plot is for all good tracks, with the values of p_{cut} shown. The middle plot is the momentum distribution for tracks with p >30 GeV; the bottom plot for p >50 GeV.

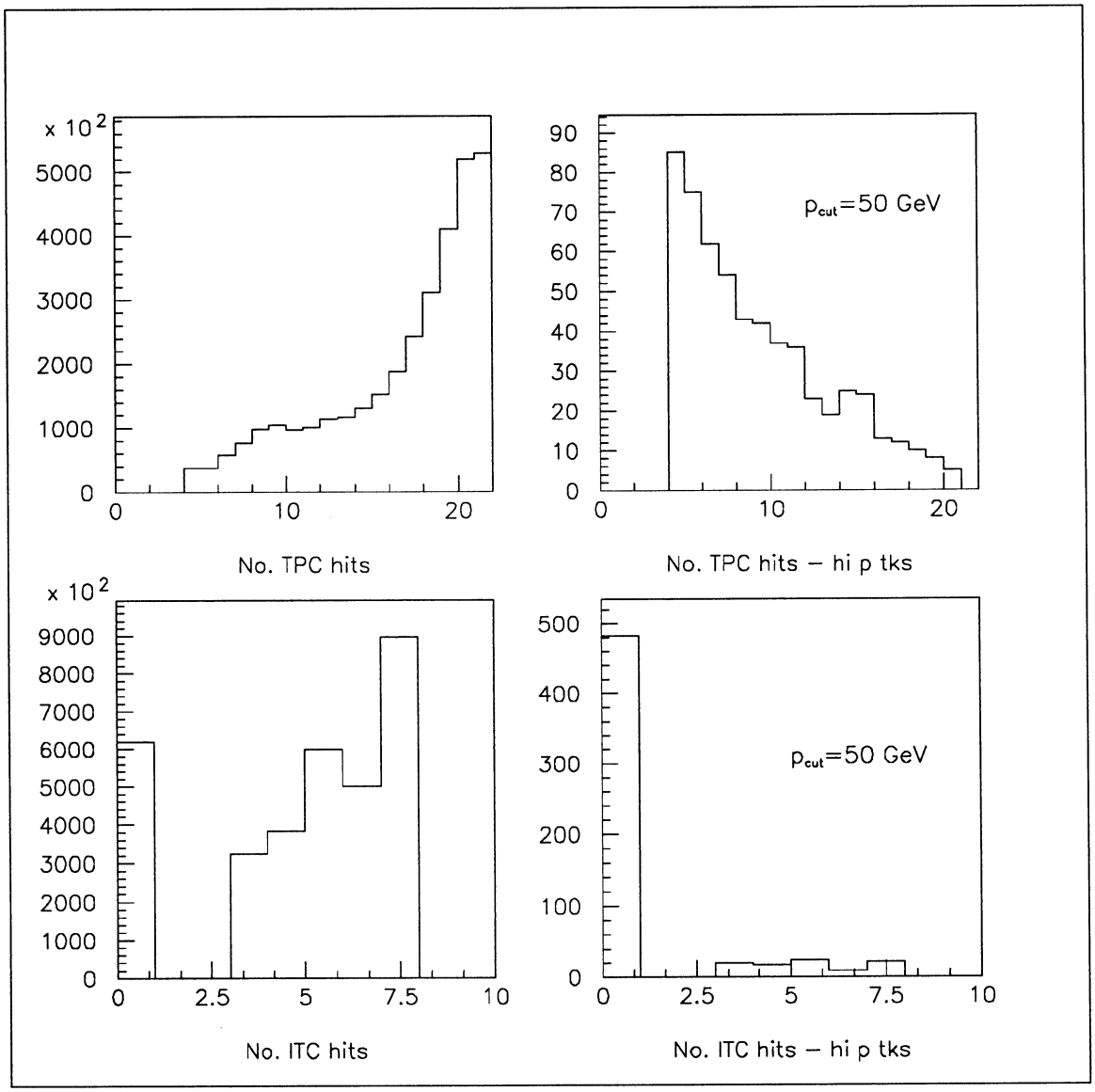
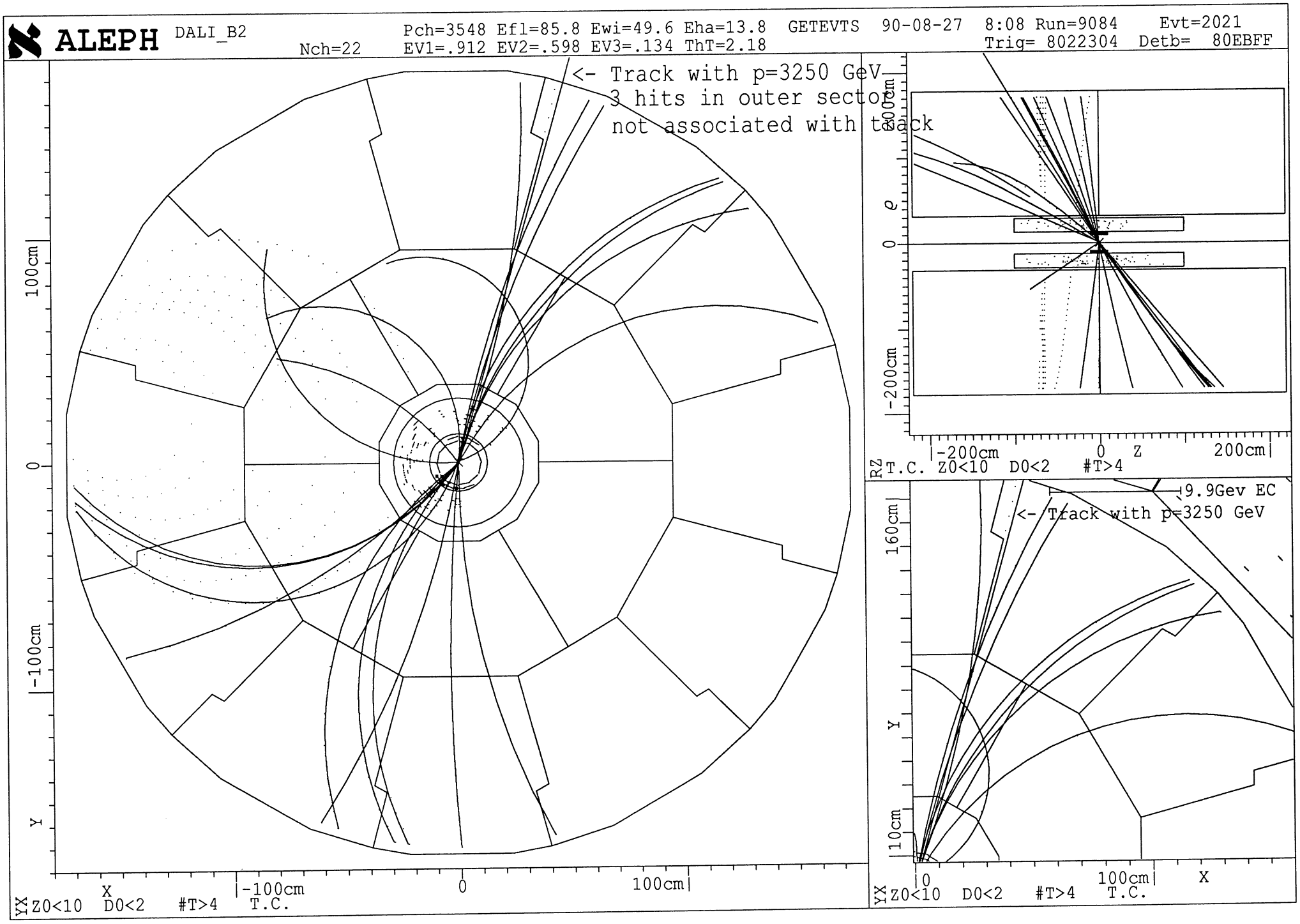
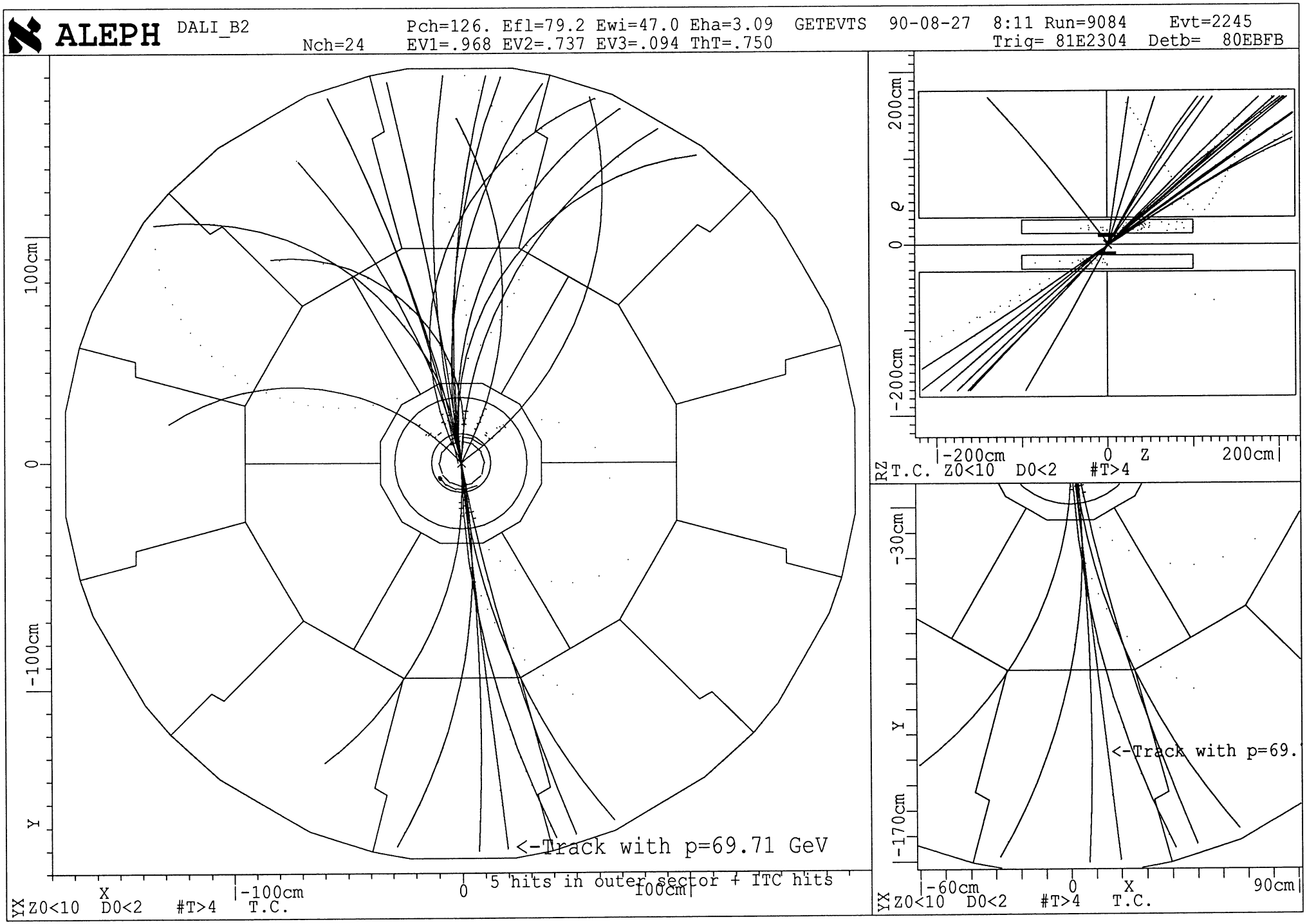


Figure 3: Distribution of the number of hits in the TPC (top) and ITC (bottom) for good tracks (left) and tracks with p >50 GeV (right).

Figure 4: [Following Pages] DALI displays of events with tracks having p >50 GeV .


ALEPH
DALI_B2
Nch=22
Pch=3548 Efl=85.8 Ewi=49.6 Eha=13.8 GETEVTS 90-08-27 8:08 Run=9084 Evt=2021
EV1=.912 EV2=.598 EV3=.134 ThT=2.18
Trig= 8022304 Detb= 80EBFF
<- Track with p=3250 GeV
3 hits in outer sector
not associated with track
100cm
0
-100cm
Y
X
-100cm
0
100cm
YX Z0<10 D0<2 #T>4 T.C.
200cm
0
-200cm
Z
-200cm
0
Z
200cm
RZ T.C. Z0<10 D0<2 #T>4
9.9Gev EC
<- Track with p=3250 GeV
160cm
10cm
Y
0
100cm
X
YX Z0<10 D0<2 #T>4 T.C.


ALEPH
DALI_B2
Nch=24
Pch=126. Efl=79.2 Ewi=47.0 Eha=3.09
EV1=.968 EV2=.737 EV3=.094 ThT=.750
GETEVTS 90-08-27 8:11 Run=9084 Evt=2245
Trig= 81E2304 Detb= 80EBFB
100cm
0
-100cm
Y
<-Track with p=69.71 GeV
5 hits in outer sector + ITC hits
YX Z0<10 D0<2 #T>4 T.C.
X
-100cm
0
100cm
200cm
0
-200cm
RZ
T.C. Z0<10 D0<2 #T>4
-200cm
0 Z
200cm
-30cm
-170cm
Y
<-Track with p=69.
YX Z0<10 D0<2 #T>4 T.C.
-60cm
0 X
90cm