E907 Momentum Resolution Study

Rajendran Raja

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Method:-We have generated 1000 120GeV/c pp events using Pythia. For each track, two other tracks were generated the first with 1.1 times the track momentum and the other with 0.9 times the track momentum. These two tracks were used to find two values of the derivative dx_i/dp at each chamber, where x_i is the x co-ordinate in the i^{th} chamber, and p the momentum of the parent track. The two values of dx_i/dp were averaged together to get the central dx_i/dp at the track. If we assume that all other track quantities are known and we are only determining the momentum resolution of the track, then the error matrix formula simplifies to

$$1/\sigma_p^2 = \Sigma_i (dx_i/dp)^2/\sigma_i^2$$

This enables one to determine the fractional momentum resolution σ_p /p as a function of momentum track by track. Multiple scattering is included, since Geant generates tracks in the presence of all interactions. (The special cases where the the two "differential tracks" tracks behave differently from the parent track due to Geant interactions and decay need careful treatment and has taken a significant amount of time.). The chamber resolutions σ_i are all taken to be 200 microns for this study. The momentum resolution thus obtained is clearly too optimistic, since it does not include the effects of the errors in the direction of the tracks. But this gives us an excellent way of studying the effect of chamber placement without smearing and fitting.

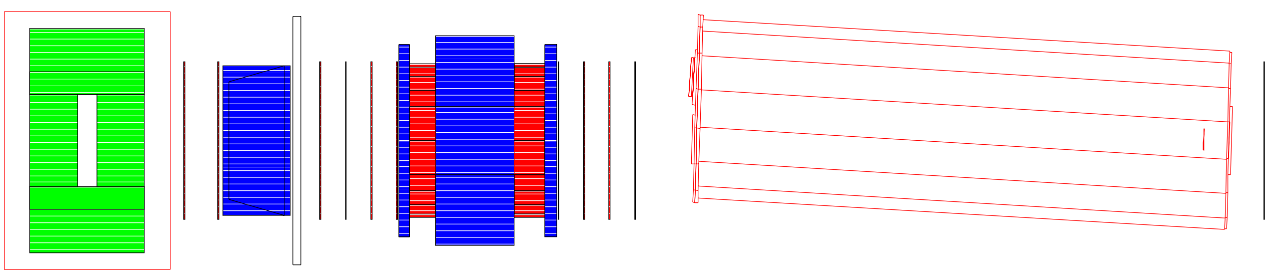
The chamber positions are given in the following table and illustrated in the following figure, which we include for completeness.

Geometry used:

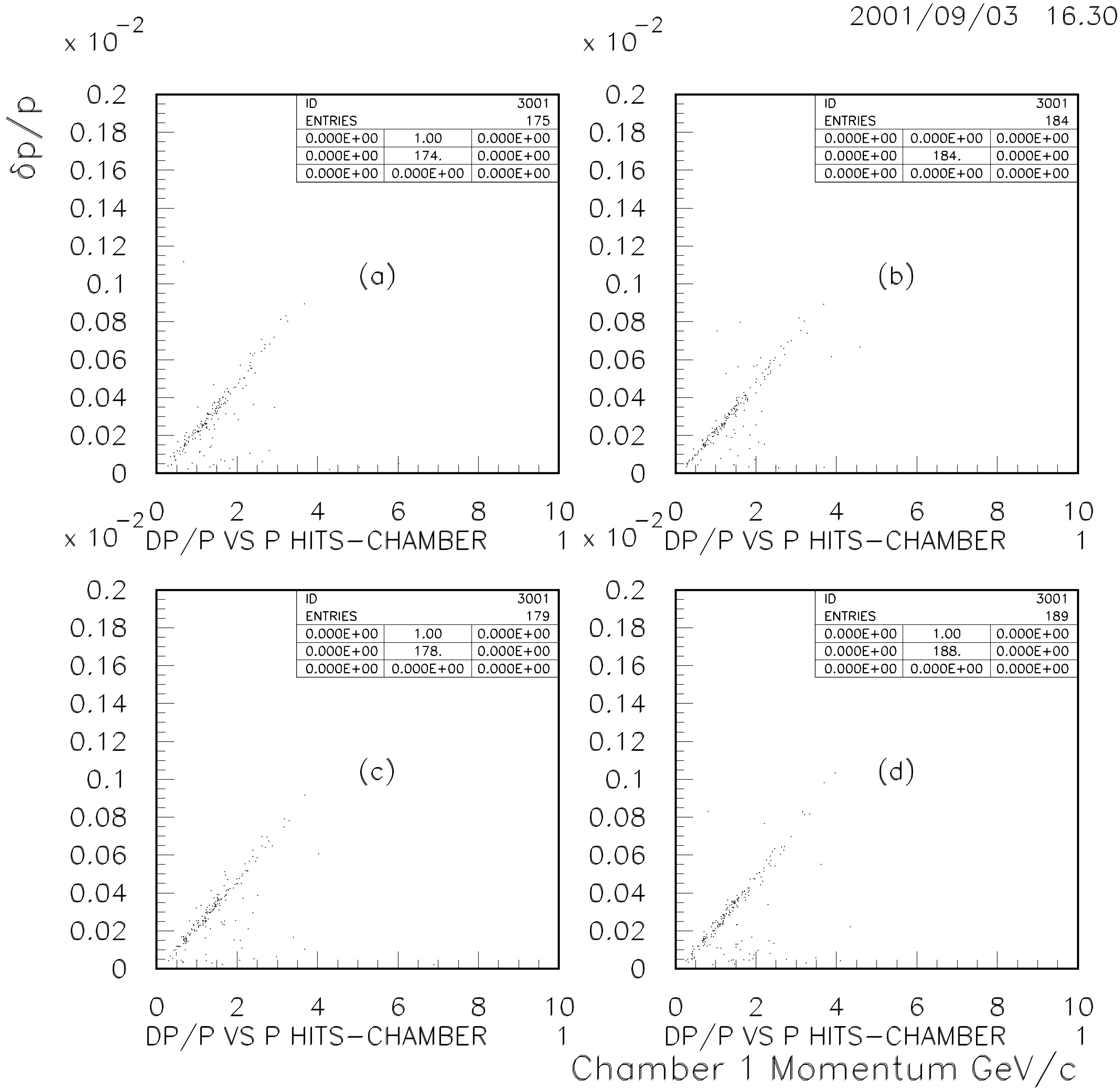
The following table gives the positions of the detectors in E907
this simulation. The mother volume is called CAVE and is a tube.
respect to the center of this tube in centimeters. The coordinate system employed i
axis along tube axis along the beam direction , y axis is vertic
forming a right handed coordinate system.

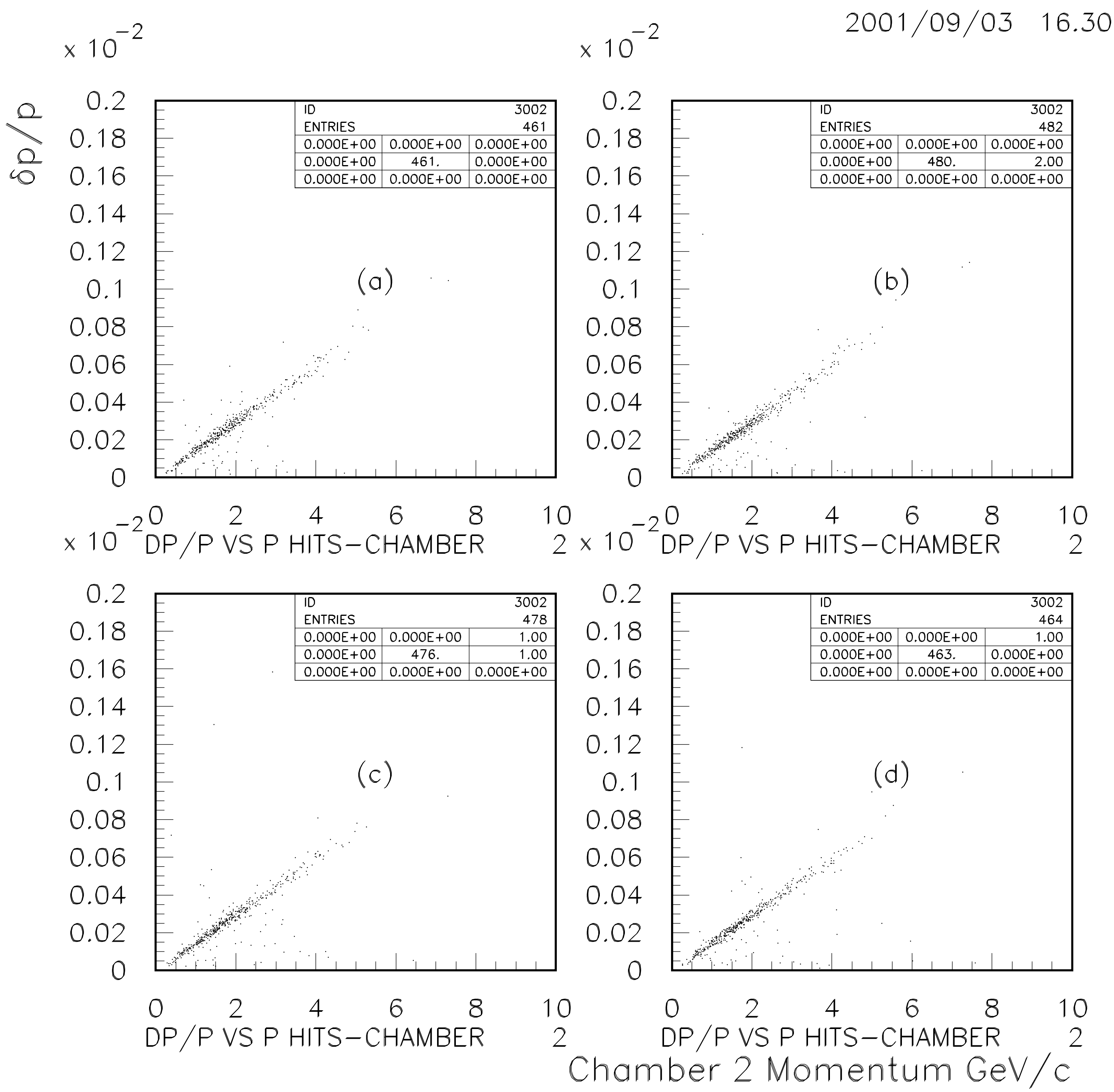
Object	Z position (cm)
Target	-843.5
Jolly Green Giant	-739.98
Rosy	12.998 vertical aperture=36" def
RICH	947.7
Chamber 1	-552.9
Chamber 2	-487.3
Chamber 3	-290.5
Chamber 4	-241.3
Chamber 5	-192.1
Chamber 6	-142.9
Chamber 7	168.7
Chamber 8	217.9
Chamber 9	267.1
Chamber 10	316.3
Chamber 11	1529.9
Chamber 12	1579.1

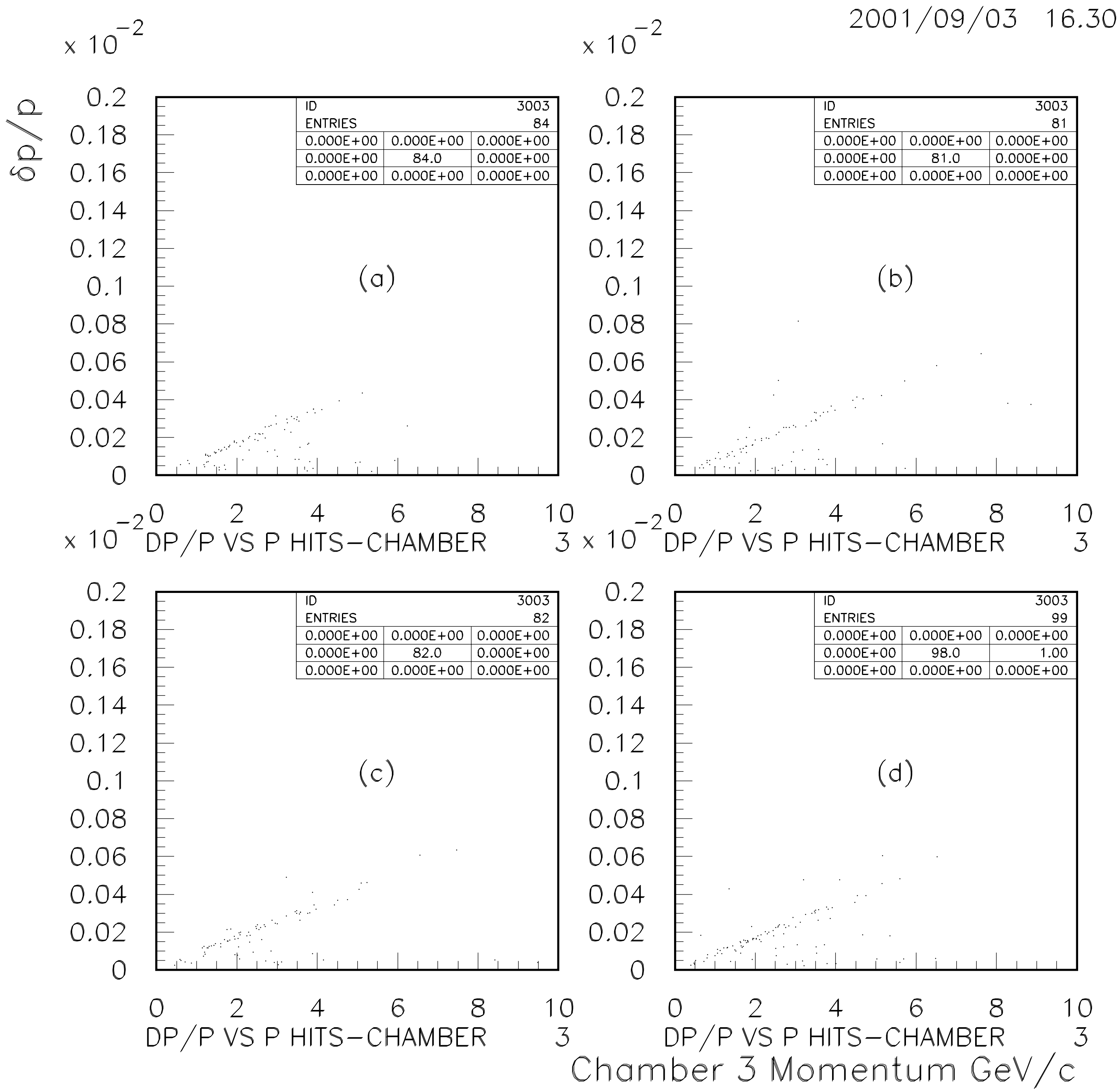
The following picture shows the experiment cut along a vertical
x=0

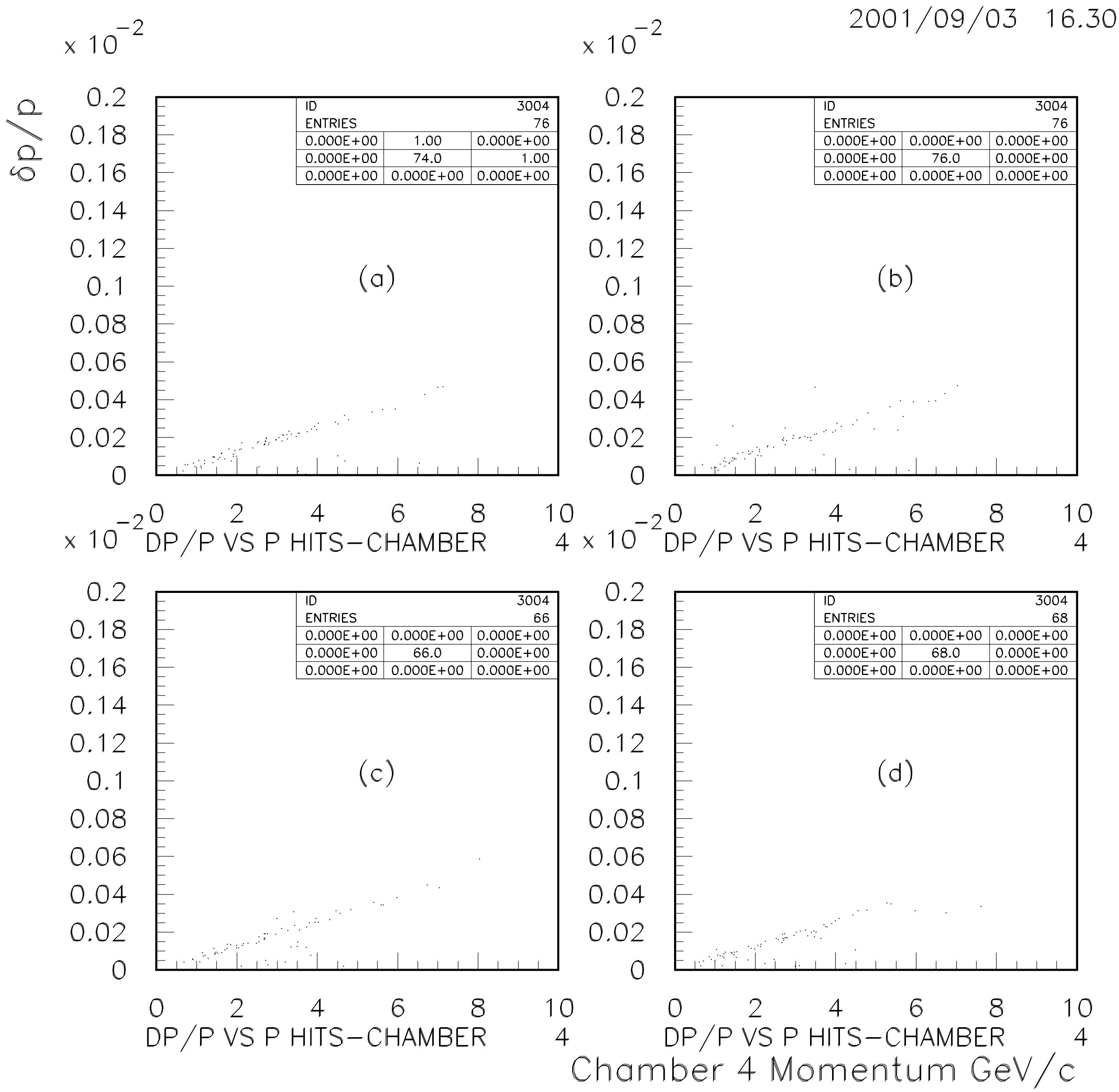


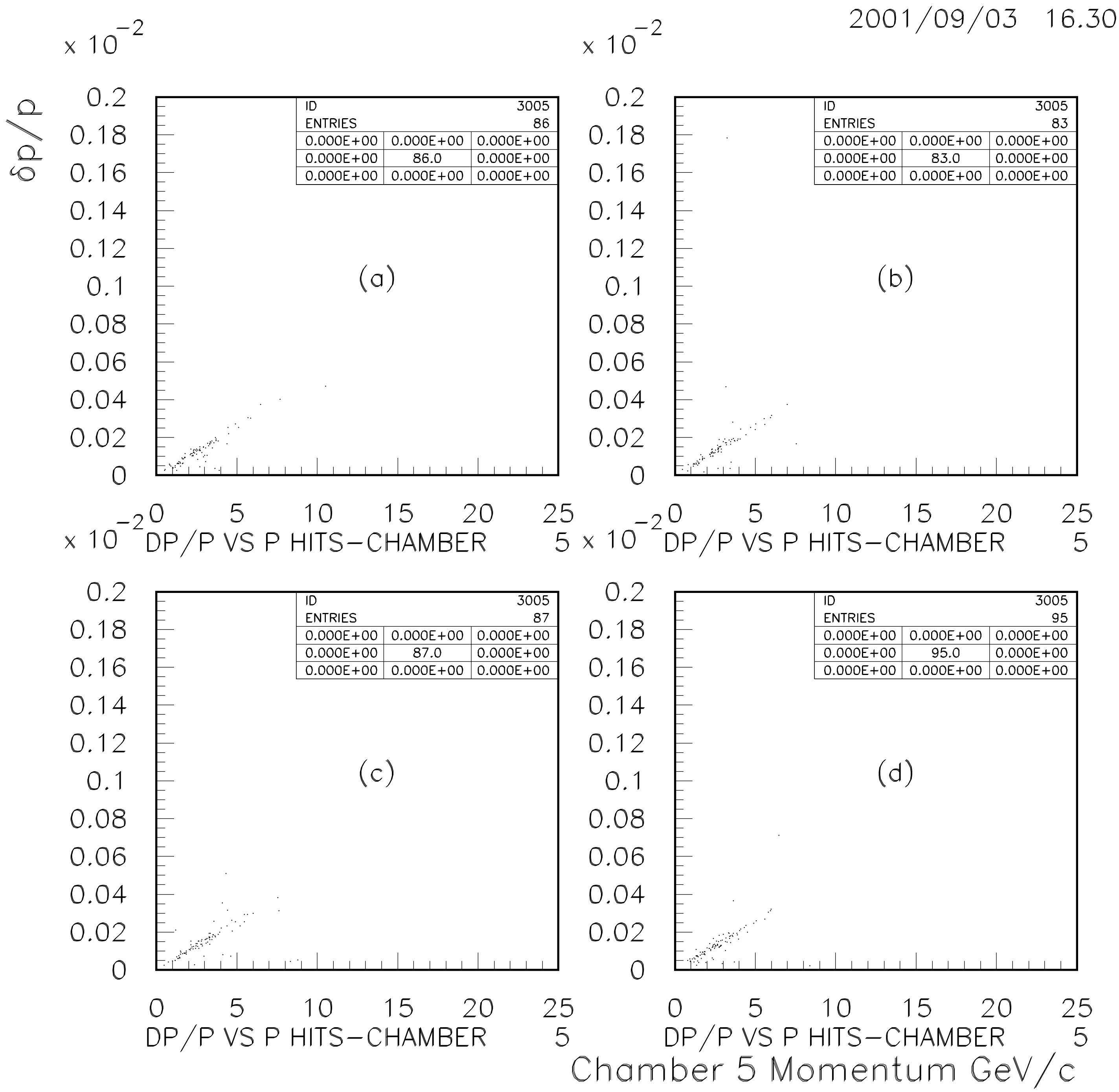
The following figures contain the fractional momentum resolution as a function of momentum for the 12 chambers. A track is plotted as being associated with a particular chamber if that is the last chamber hit by the track. The figures marked (a) are for ROSY field +1.2 Tesla, (b) for +0.6Tesla (c) for –0.6Tesla and (d) for –1.2Tesla. Clearly no difference is expected between the cases (a), (b),(c) and (d) for chambers upstream of ROSY, that is Chambers 1-6. It can be seen that the fractional resolution improves as more chambers come into play. TPC hits are included in all these plots. TPC is treated as 128 chambers in exactly the same way as the other chambers. The vertex z position of all tracks is constrained to smaller than –840cm to avoid particles that start in the middle of the TPC from strange particle decays.

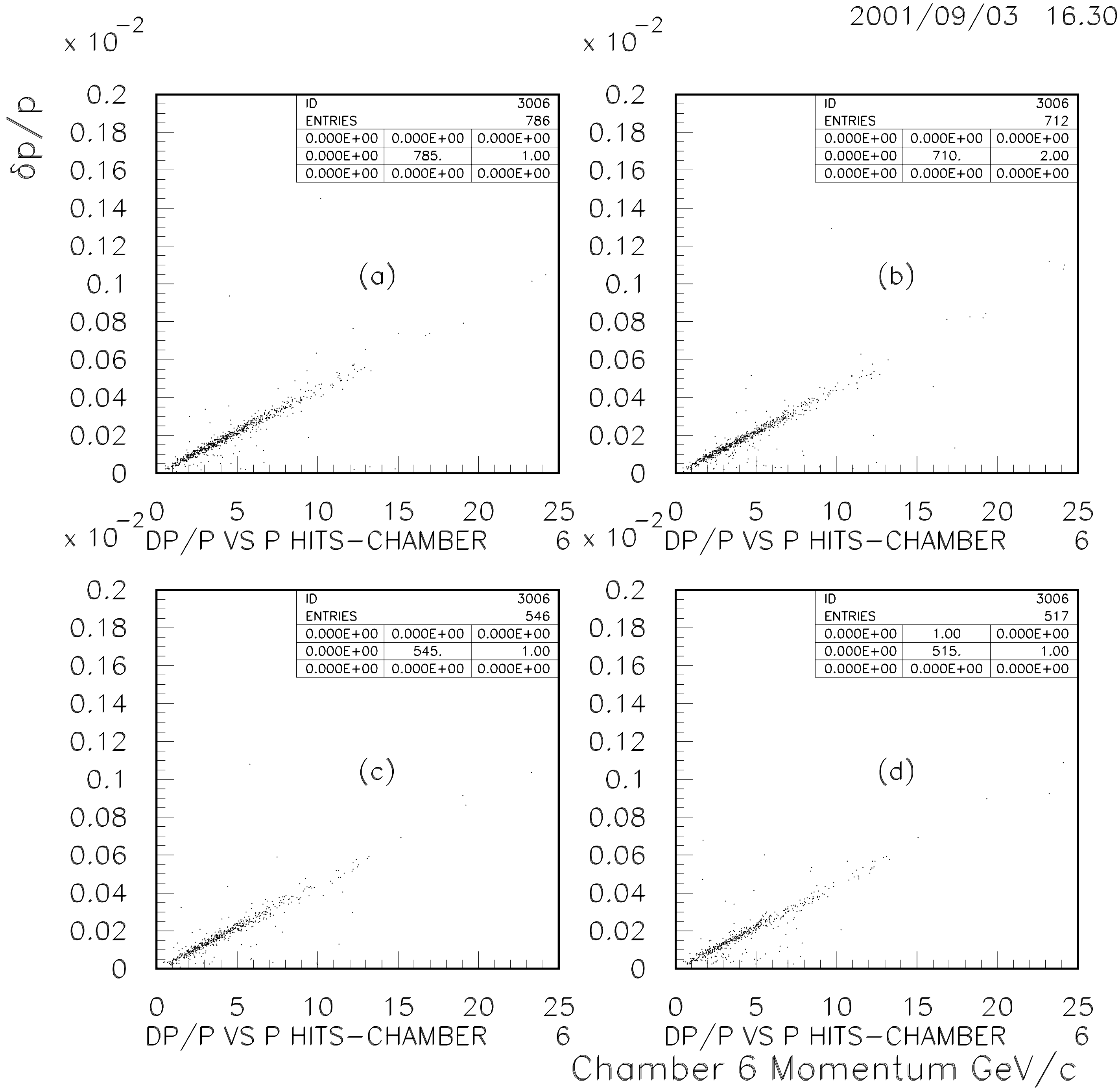

2001/09/03 16.30
δp/p
x 10^-2
ID 3001
ENTRIES 175
0.000E+00 1.00 0.000E+00
0.000E+00 174. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
ENTRIES 184
0.000E+00 0.000E+00 0.000E+00
0.000E+00 184. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
ENTRIES 179
0.000E+00 1.00 0.000E+00
0.000E+00 178. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
ENTRIES 189
0.000E+00 1.00 0.000E+00
0.000E+00 188. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 1
Chamber 1 Momentum GeV/c


2001/09/03 16.30
x 10^-2
δp/p
ID 3002
ENTRIES 461
0.000E+00 0.000E+00 0.000E+00
0.000E+00 461. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 482
0.000E+00 0.000E+00 0.000E+00
0.000E+00 480. 2.00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 478
0.000E+00 0.000E+00 1.00
0.000E+00 476. 1.00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 464
0.000E+00 0.000E+00 1.00
0.000E+00 463. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 2
Chamber 2 Momentum GeV/c

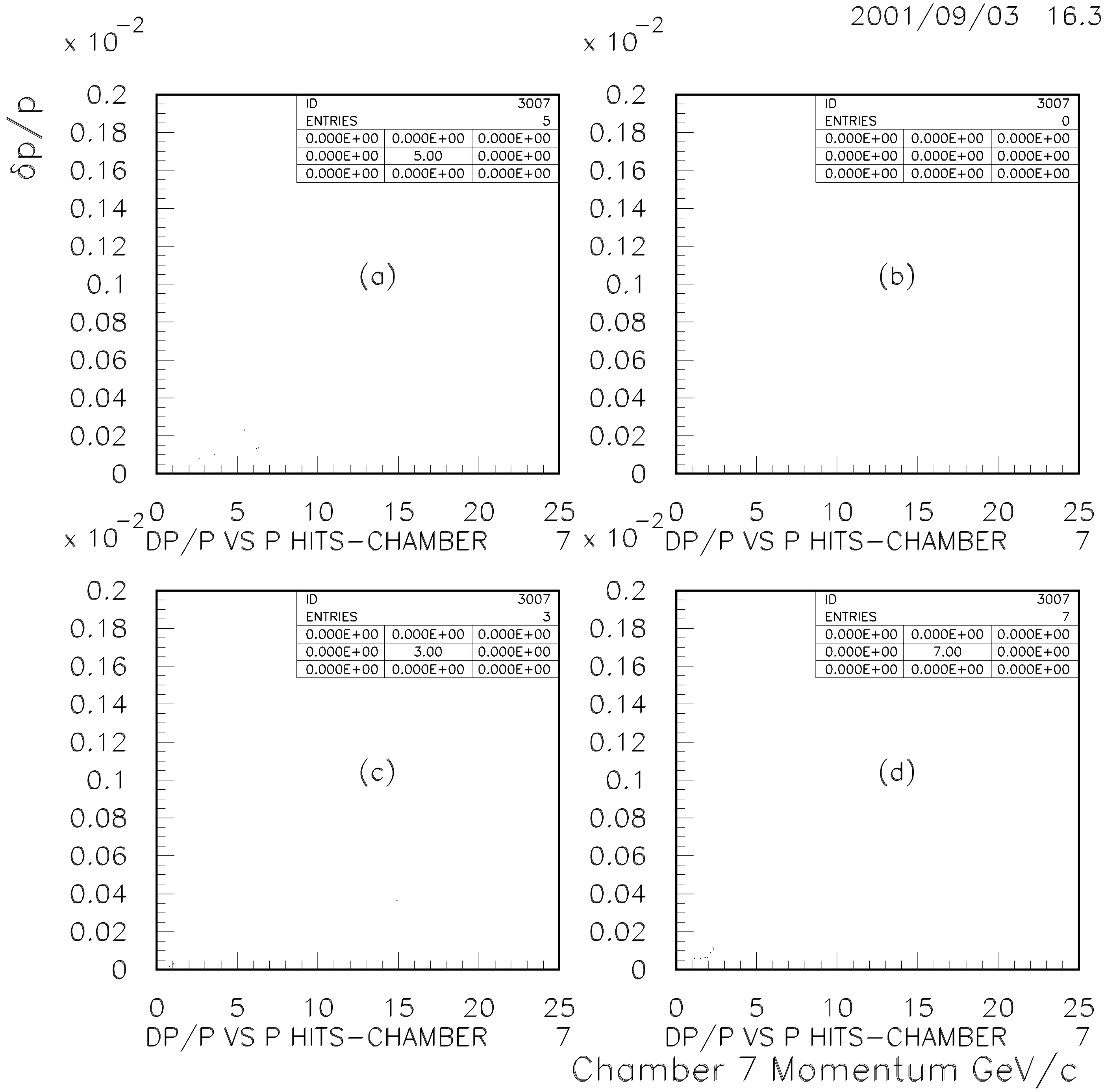

2001/09/03 16.30
δp/p
x 10^-2
ID 3003
ENTRIES 84
0.000E+00 0.000E+00 0.000E+00
0.000E+00 84.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 3
ID 3003
ENTRIES 81
0.000E+00 0.000E+00 0.000E+00
0.000E+00 81.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 3
ID 3003
ENTRIES 82
0.000E+00 0.000E+00 0.000E+00
0.000E+00 82.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 3
ID 3003
ENTRIES 99
0.000E+00 0.000E+00 0.000E+00
0.000E+00 98.0 1.00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 3
Chamber 3 Momentum GeV/c

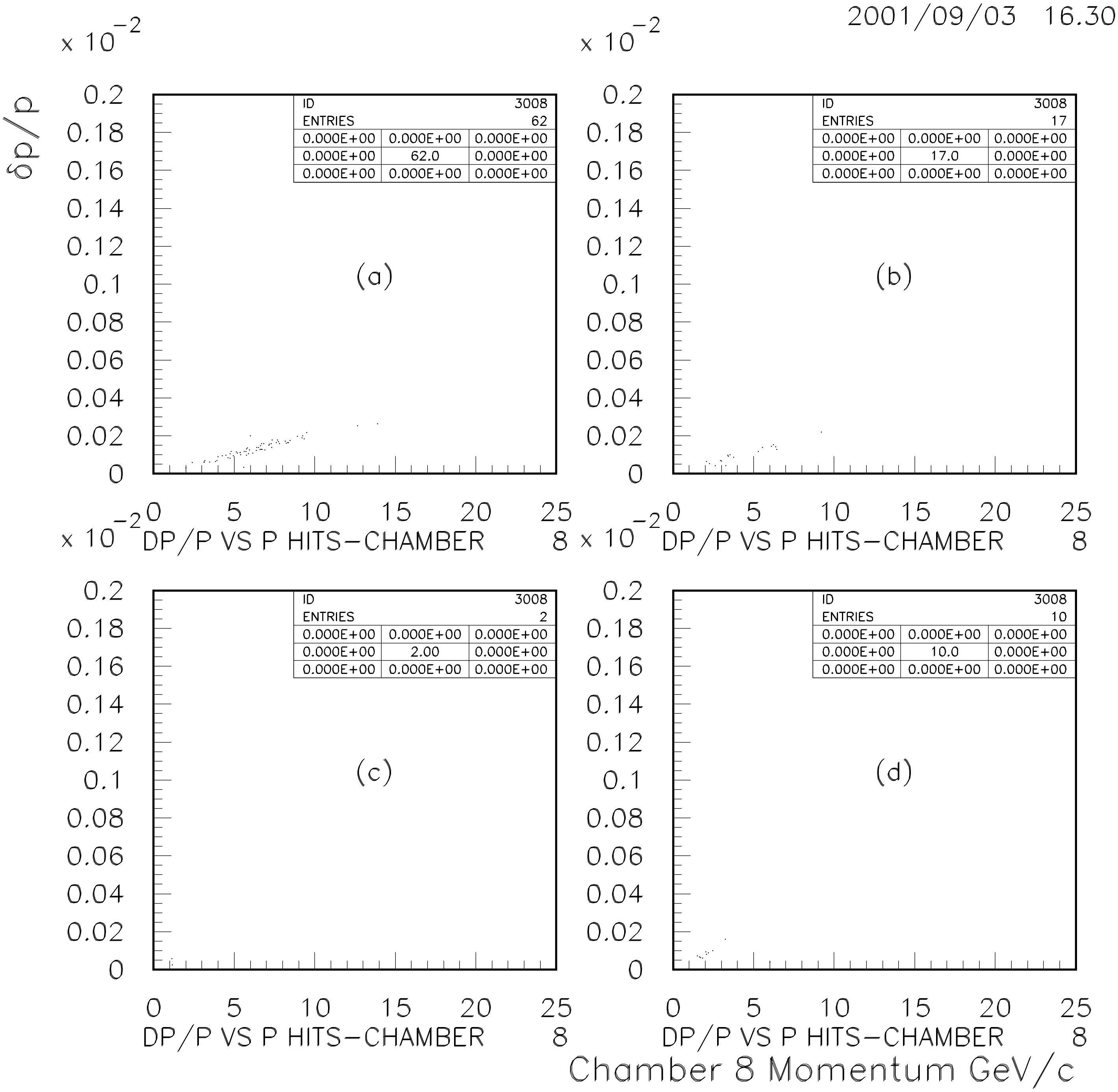

2001/09/03 16.30
x 10^-2
δp/p
ID 3004
ENTRIES 76
0.000E+00 1.00 0.000E+00
0.000E+00 74.0 1.00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 4
ID 3004
ENTRIES 76
0.000E+00 0.000E+00 0.000E+00
0.000E+00 76.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 4
ID 3004
ENTRIES 66
0.000E+00 0.000E+00 0.000E+00
0.000E+00 66.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 4
ID 3004
ENTRIES 68
0.000E+00 0.000E+00 0.000E+00
0.000E+00 68.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 4
Chamber 4 Momentum GeV/c

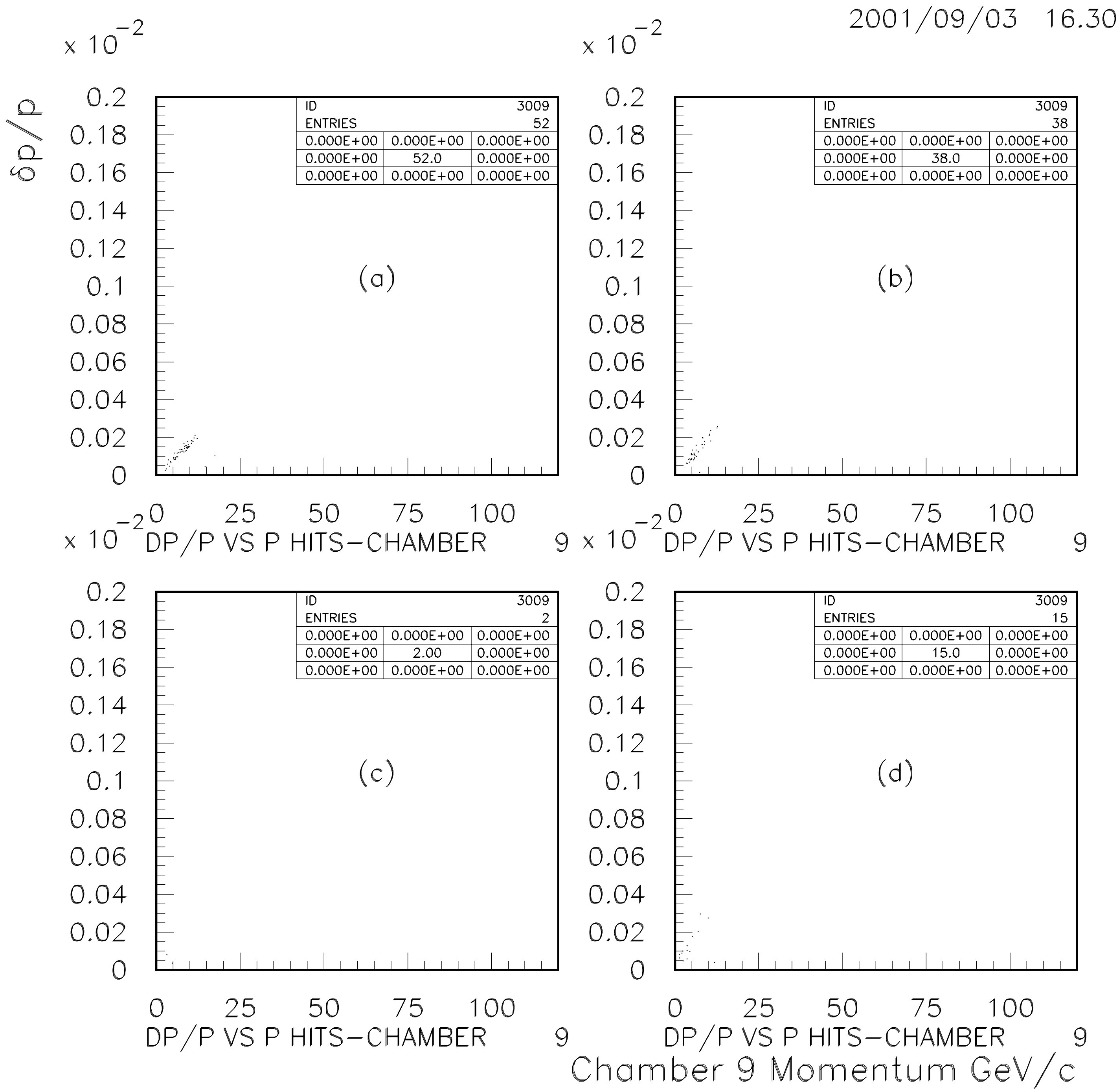

2001/09/03 16.30
δp/p
x 10^-2
(a)
ID 3005
ENTRIES 86
0.000E+00 0.000E+00 0.000E+00
0.000E+00 86.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 5
(b)
ID 3005
ENTRIES 83
0.000E+00 0.000E+00 0.000E+00
0.000E+00 83.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 5
(c)
ID 3005
ENTRIES 87
0.000E+00 0.000E+00 0.000E+00
0.000E+00 87.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 5
(d)
ID 3005
ENTRIES 95
0.000E+00 0.000E+00 0.000E+00
0.000E+00 95.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 5
Chamber 5 Momentum GeV/c

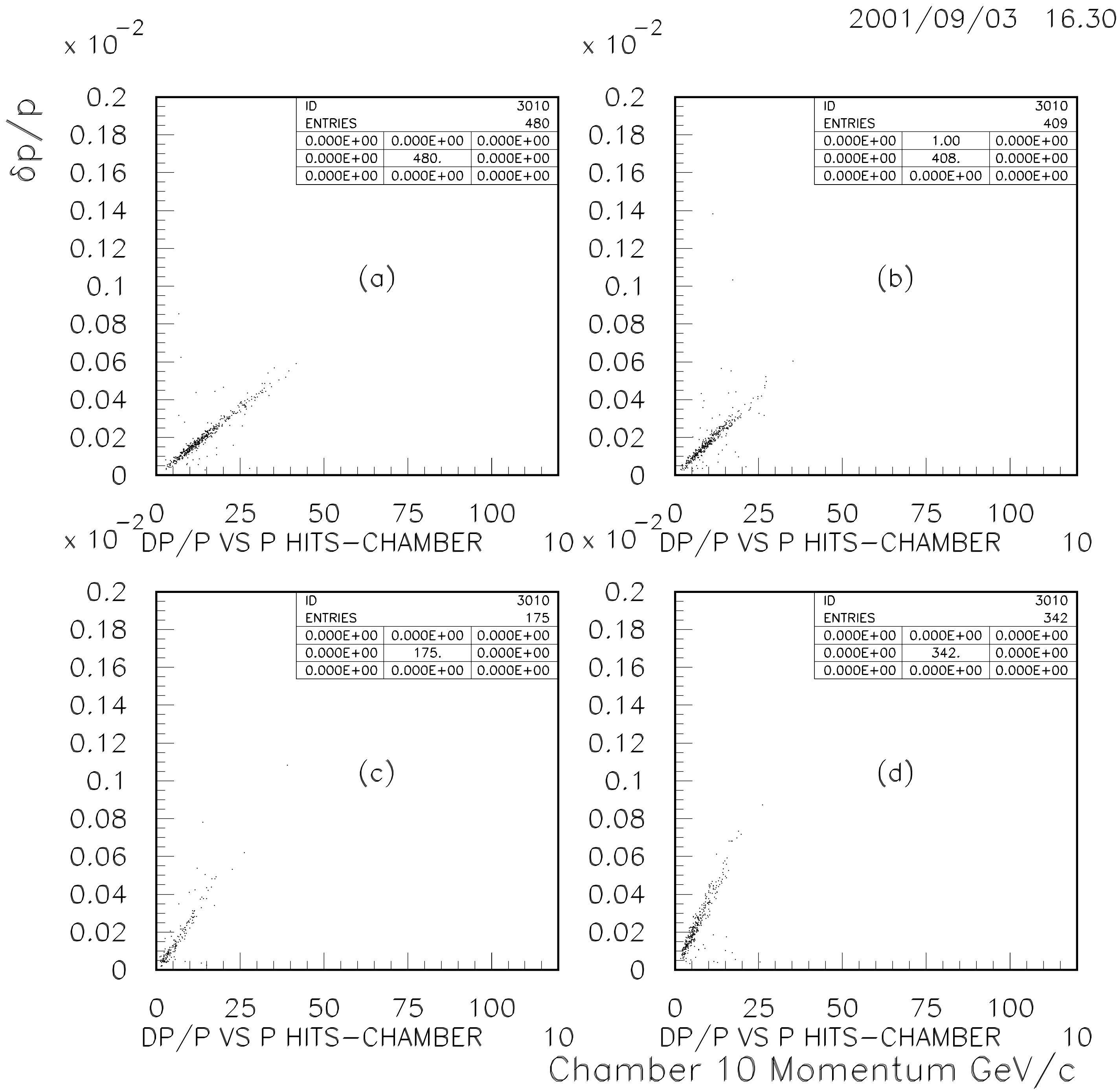

2001/09/03 16.30
δp/p
(a)
(b)
(c)
(d)
ID 3006
ENTRIES 786
ENTRIES 712
ENTRIES 546
ENTRIES 517
DP/P VS P HITS−CHAMBER 6
Chamber 6 Momentum GeV/c

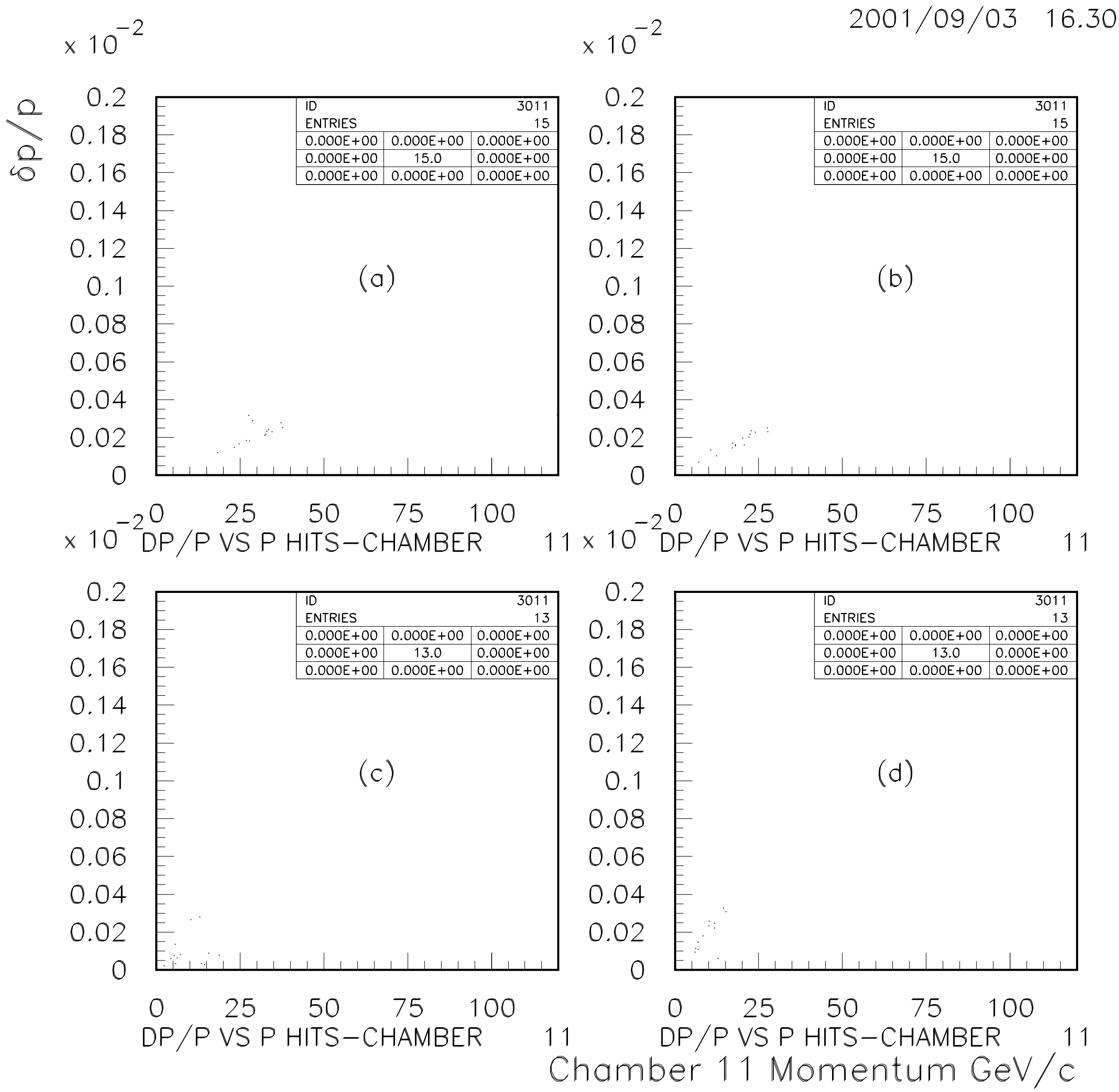
2001/09/03 16.30

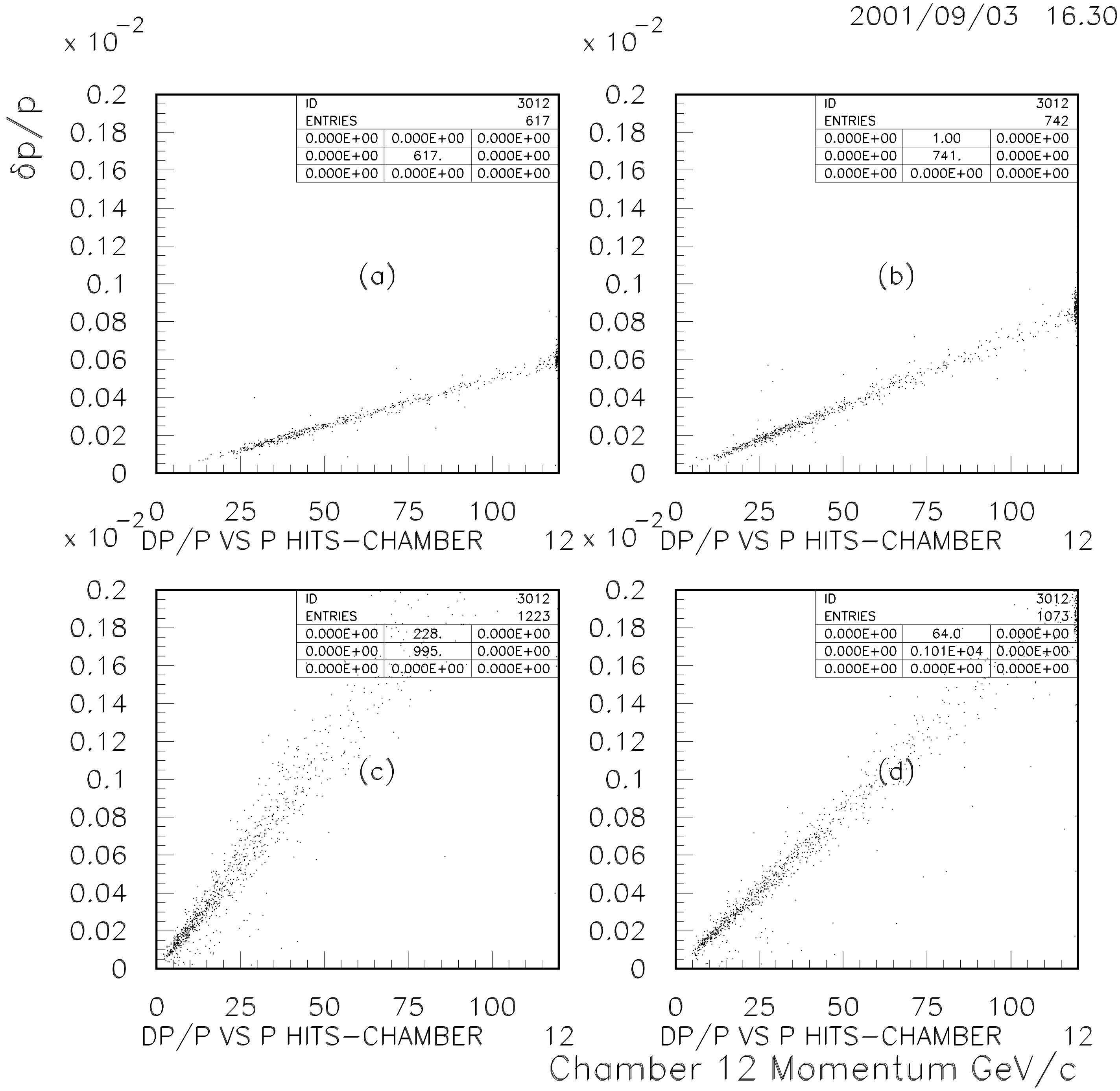



2001/09/03 16.30
x 10^-2
δp/p
ID 3008
ENTRIES 62
0.000E+00 0.000E+00 0.000E+00
0.000E+00 62.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 8
ID 3008
ENTRIES 17
0.000E+00 0.000E+00 0.000E+00
0.000E+00 17.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 8
ID 3008
ENTRIES 2
0.000E+00 0.000E+00 0.000E+00
0.000E+00 2.00 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 8
ID 3008
ENTRIES 10
0.000E+00 0.000E+00 0.000E+00
0.000E+00 10.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 8
Chamber 8 Momentum GeV/c


2001/09/03 16.30
δp/p
x 10^-2
ID 3009
ENTRIES 52
0.000E+00 0.000E+00 0.000E+00
0.000E+00 52.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS−CHAMBER 9
ID 3009
ENTRIES 38
0.000E+00 0.000E+00 0.000E+00
0.000E+00 38.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS−CHAMBER 9
ID 3009
ENTRIES 2
0.000E+00 0.000E+00 0.000E+00
0.000E+00 2.00 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS−CHAMBER 9
ID 3009
ENTRIES 15
0.000E+00 0.000E+00 0.000E+00
0.000E+00 15.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS−CHAMBER 9
Chamber 9 Momentum GeV/c


2001/09/03 16.30
δp/p
x 10^-2
(a)
ID 3010
ENTRIES 480
0.000E+00 0.000E+00 0.000E+00
0.000E+00 480. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 10
(b)
ID 3010
ENTRIES 409
0.000E+00 1.00 0.000E+00
0.000E+00 408. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 10
(c)
ID 3010
ENTRIES 175
0.000E+00 0.000E+00 0.000E+00
0.000E+00 175. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 10
(d)
ID 3010
ENTRIES 342
0.000E+00 0.000E+00 0.000E+00
0.000E+00 342. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
DP/P VS P HITS-CHAMBER 10
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2
0 25 50 75 100
Chamber 10 Momentum GeV/c


2001/09/03 16.30
x 10^-2
δp/p
ID 3011
ENTRIES 15
0.000E+00 0.000E+00 0.000E+00
0.000E+00 15.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
(b)
ID 3011
ENTRIES 13
0.000E+00 13.0 0.000E+00
(c)
(d)
0.2 0.18 0.16 0.14 0.12 0.1 0.08 0.06 0.04 0.02 0
0 25 50 75 100
DP/P VS P HITS-CHAMBER 11
Chamber 11 Momentum GeV/c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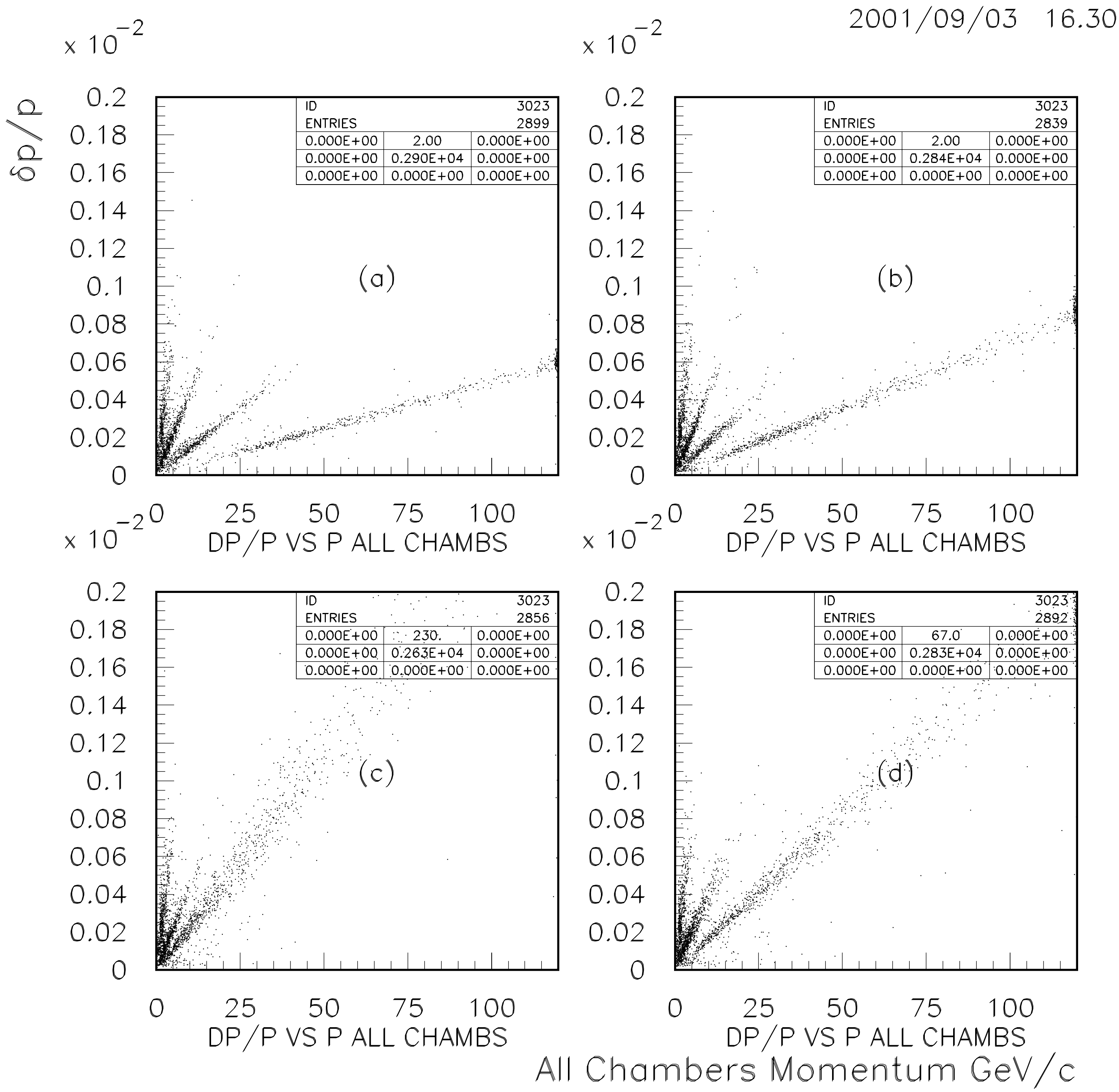
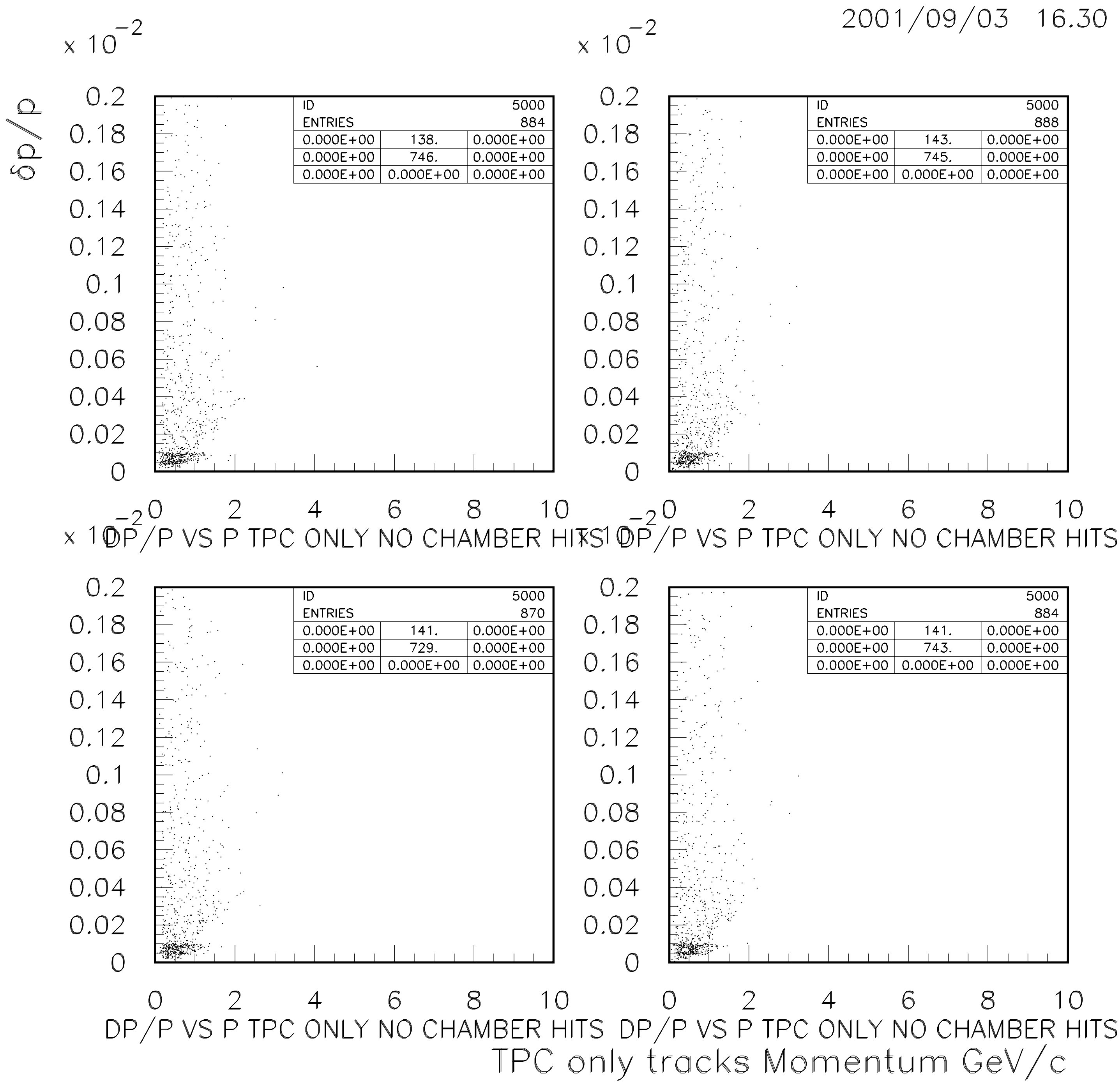
x 10^-2
δp/p
ID 3012
ENTRIES 617
0.000E+00 0.000E+00 0.000E+00
0.000E+00 617. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 742
0.000E+00 1.00 0.000E+00
0.000E+00 741. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 1223
0.000E+00 228. 0.000E+00
0.000E+00 995. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 1073
0.000E+00 64.0 0.000E+00
0.000E+00 0.101E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS−CHAMBER 12
Chamber 12 Momentum GeV/c


2001/09/03 16.30
x 10^-2
δp/p
ID 3023
ENTRIES 2899
0.000E+00 2.00 0.000E+00
0.000E+00 0.290E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
ID 3023
ENTRIES 2839
0.000E+00 2.00 0.000E+00
0.000E+00 0.284E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
ID 3023
ENTRIES 2856
0.000E+00 230. 0.000E+00
0.000E+00 0.263E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
ID 3023
ENTRIES 2892
0.000E+00 67.0 0.000E+00
0.000E+00 0.283E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P ALL CHAMBS
All Chambers Momentum GeV/c


2001/09/03 16.30
x 10^-2
δp/p
ID 5000
ENTRIES 884
0.000E+00 138. 0.000E+00
0.000E+00 746. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 888
0.000E+00 143. 0.000E+00
0.000E+00 745. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 870
0.000E+00 141. 0.000E+00
0.000E+00 729. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 884
0.000E+00 141. 0.000E+00
0.000E+00 743. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2
0 2 4 6 8 10
DP/P VS P TPC ONLY NO CHAMBER HITS
DP/P VS P TPC ONLY NO CHAMBER HITS
DP/P VS P TPC ONLY NO CHAMBER HITS
DP/P VS P TPC ONLY NO CHAMBER HITS
TPC only tracks Momentum GeV/c

Chamber	Rosy+1.2T	Rosy+0.6T	Rosy-0.6T	Rosy-1.2T
1	1.027E-04	1.065E-04	1.033E-04	1.033E-04
2	9.631E-05	9.537E-05	9.538E-05	9.448E-05
3	5.560E-05	6.071E-05	6.153E-05	6.060E-05
4	5.206E-05	5.346E-05	5.292E-05	5.100E-05
5	4.474E-05	4.610E-05	4.578E-05	4.539E-05
6	4.048E-05	3.994E-05	4.045E-05	3.969E-05
7	2.710E-05	0.000E+01	2.650E-05	3.764E-05
8	2.008E-05	2.337E-05	3.100E-05	3.460E-05
9	1.608E-05	1.907E-05	1.550E-05	2.863E-05
10	1.410E-05	1.721E-05	2.524E-05	3.384E-05
11	6.940E-06	9.260E-06	1.156E-05	1.899E-05
12	5.010E-06	7.241E-06	2.185E-05	1.593E-05

Cutting on Momentum resolution

In order to determine the aperture needed by chambers at particular positions, we employ the following technique. Let us say that a track passes through k chambers before exiting. Then for each chamber i, i=1,k, we associate a quantity called the fractional resolution f_i where f_i is defined as the resolution that would be obtained by all chambers preceding chamber i (including the TPC, but not including i) expressed as a fraction of the resolution obtained by all chambers including the last chamber k.

i.e.

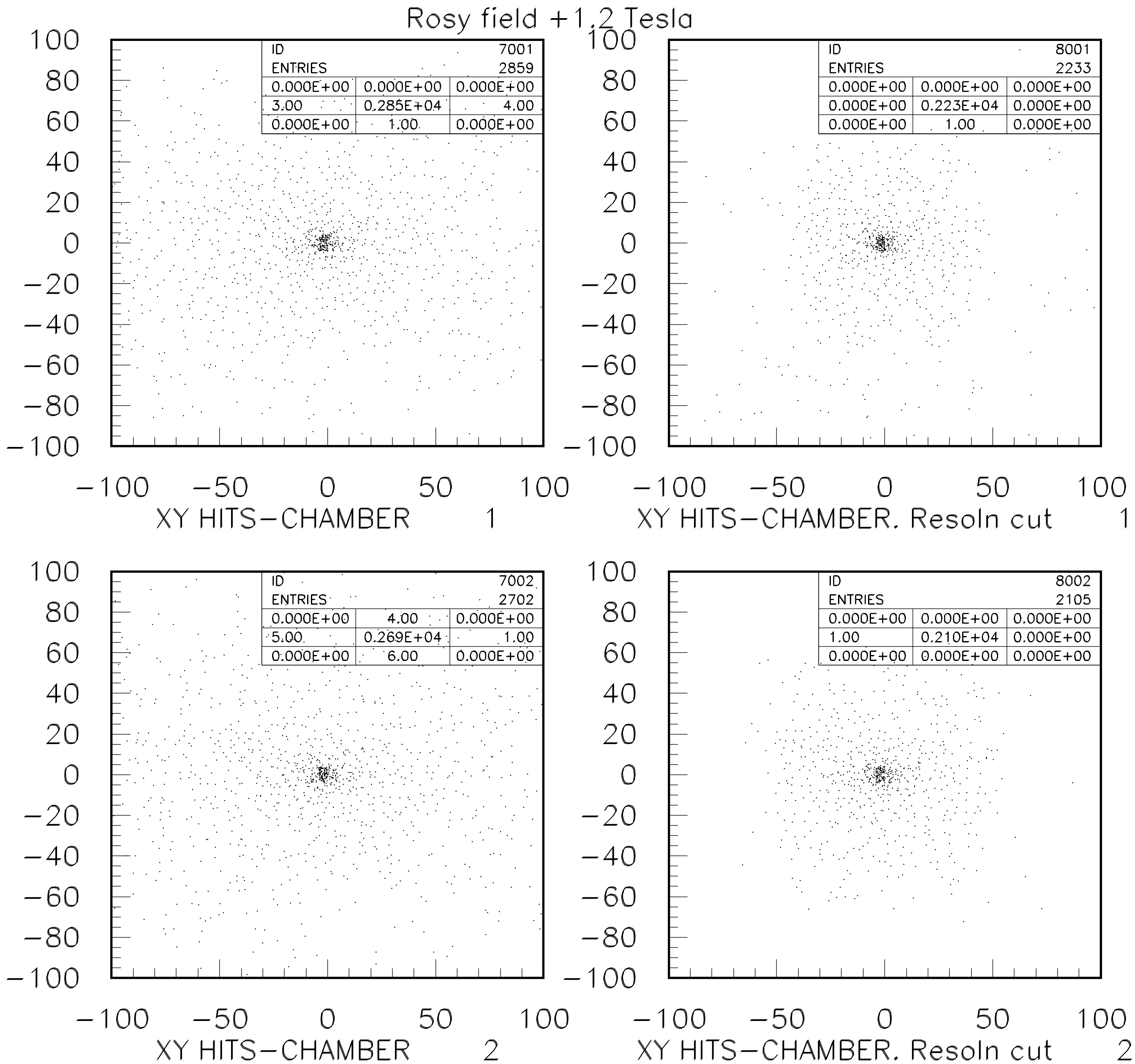
$f_{i} = ($resolution of track using all chambers 1-k)/(resolution of track using chambers TPC to chamber i-1)

We then plot the x and y position of hits in each chamber for all tracks and compare it with xy plots where the track is not plotted in chamber m if f_m is greater than a cut off (0.5). This means that the m^{th} chamber and the following chambers will add less than 50% more resolution for this track. 50% is a harsh cut and we will want to optimize this further and increase it to say 70% or so. So for each chamber we get two plots. The overall xy distribution and the truncated xy distribution. The truncated xy distribution gives the chamber size at that point.

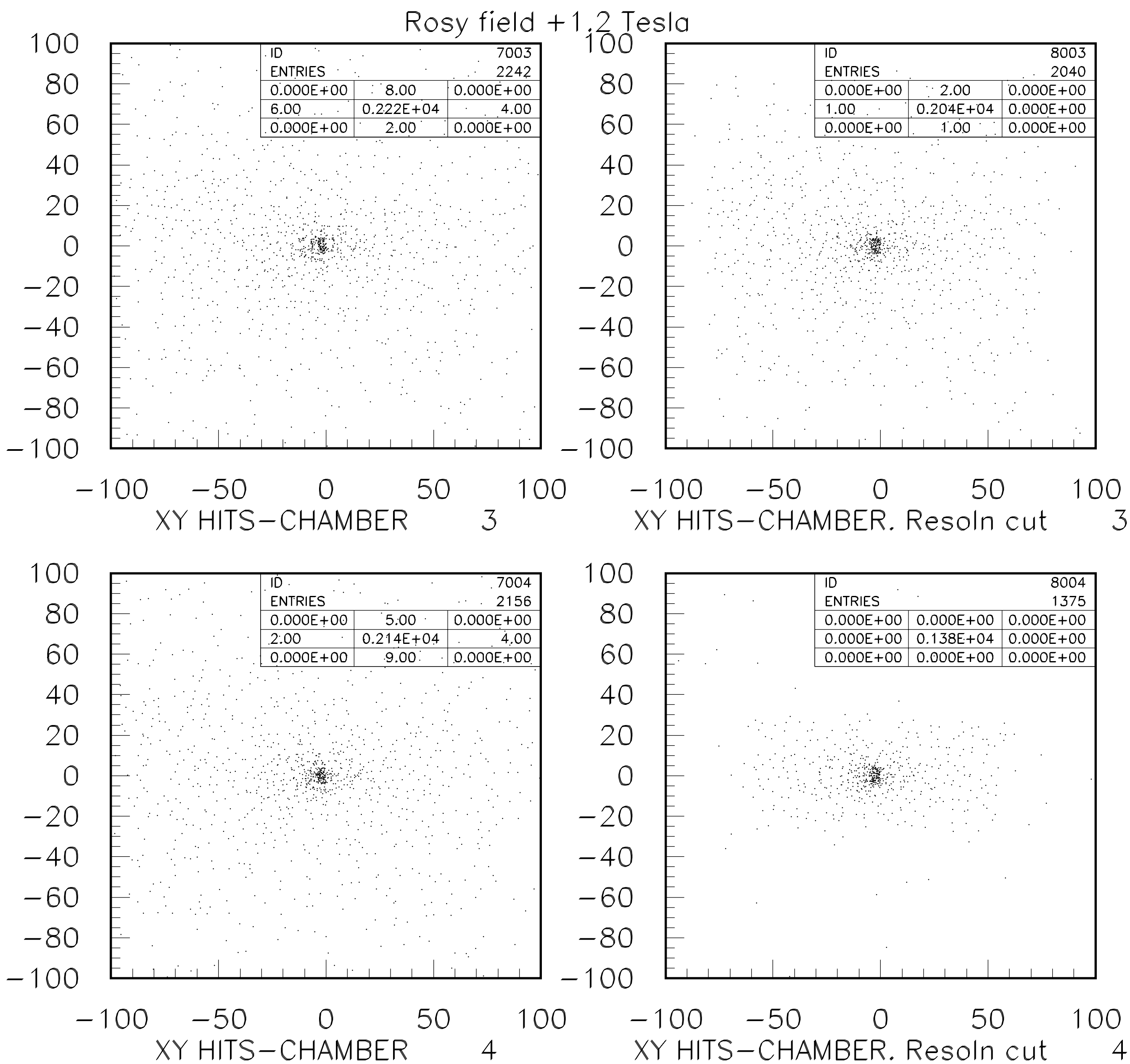
The following figures give such distributions for all chambers for Rosy fields +1.2T and for chambers 7-12 (downstream of ROSY) for ROSY fields +0.6T, -0.6T and –1.2T.

This is followed by a spreadsheet of available chambers.

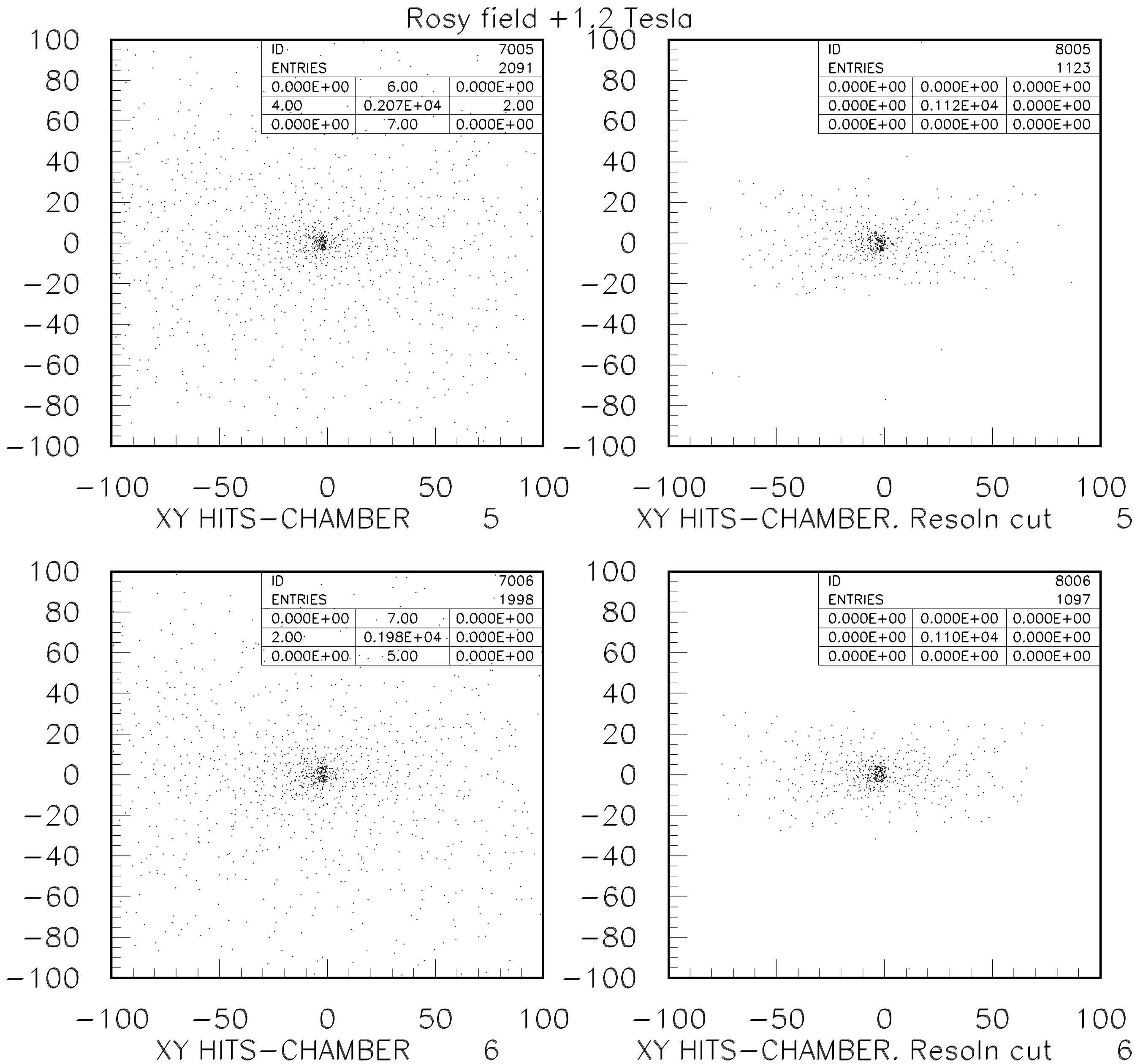
2001/09/03 17.11



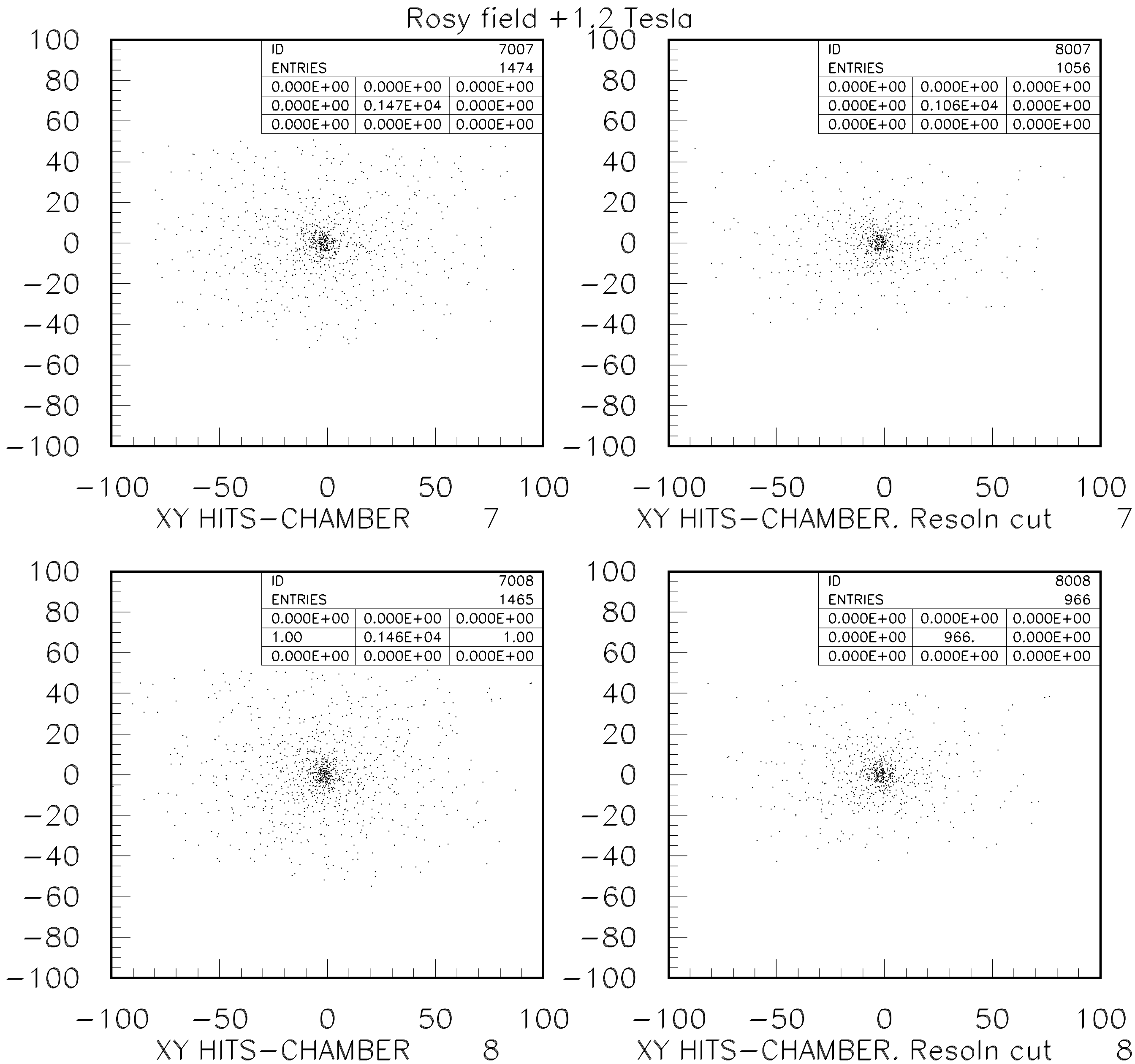
2001/09/03 17.11



2001/09/03 17.11

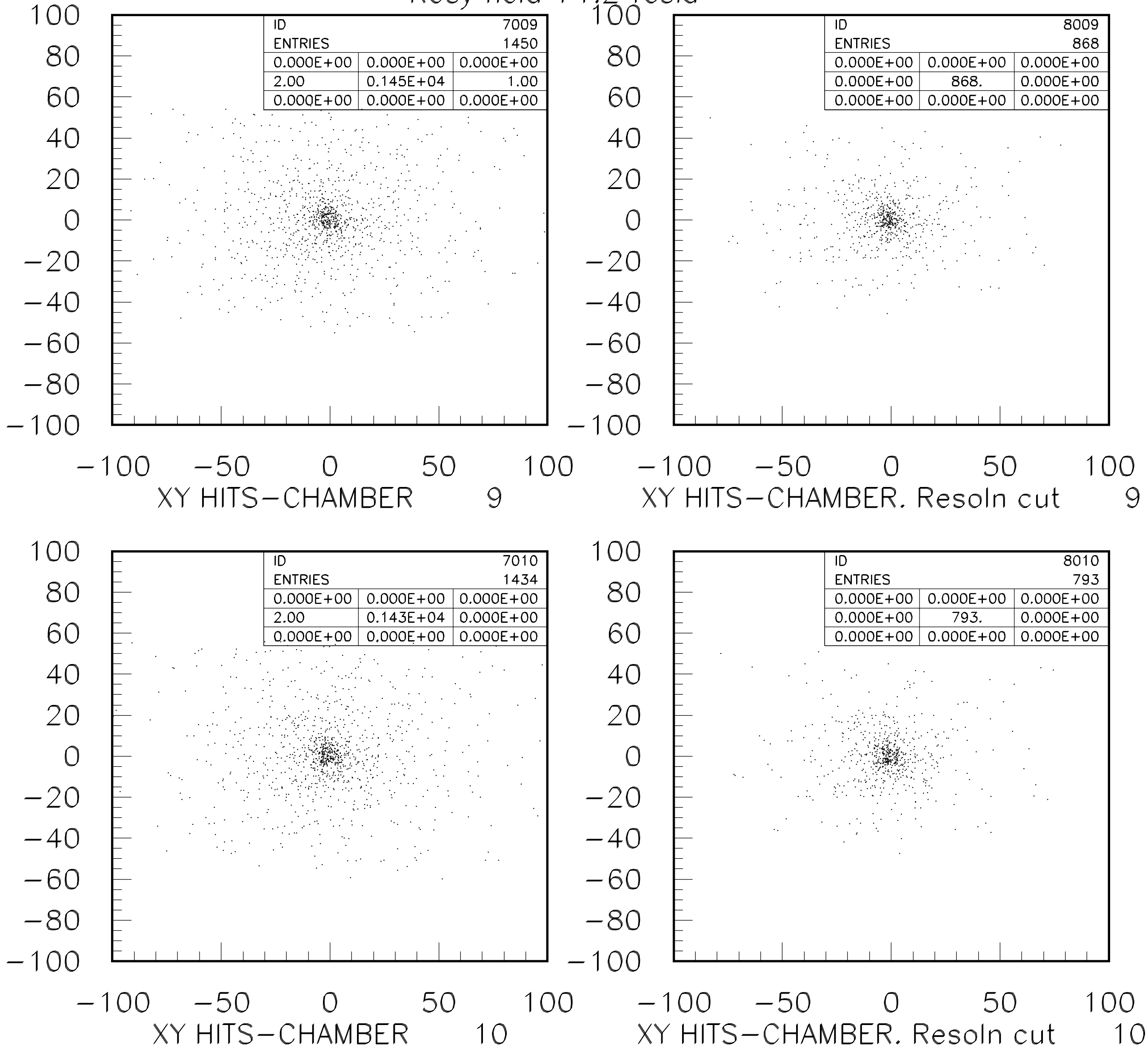


2001/09/03 17.11



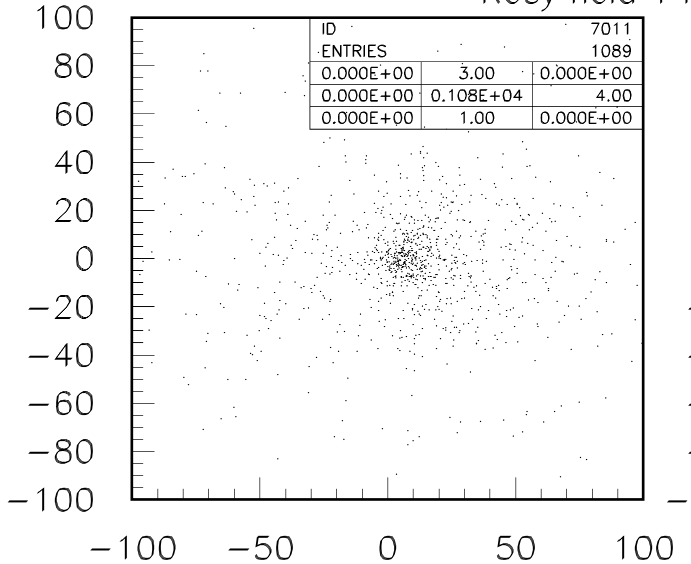
2001/09/03 17.11

Rosy field +1.2 Tesla

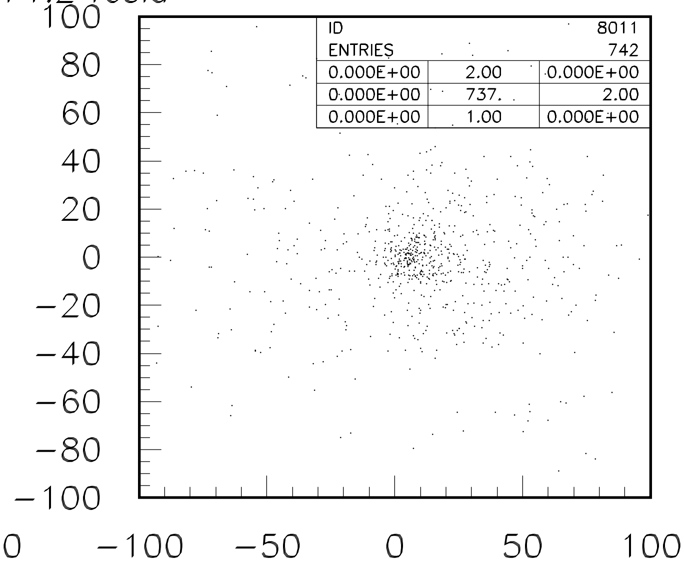


2001/09/03 17.11

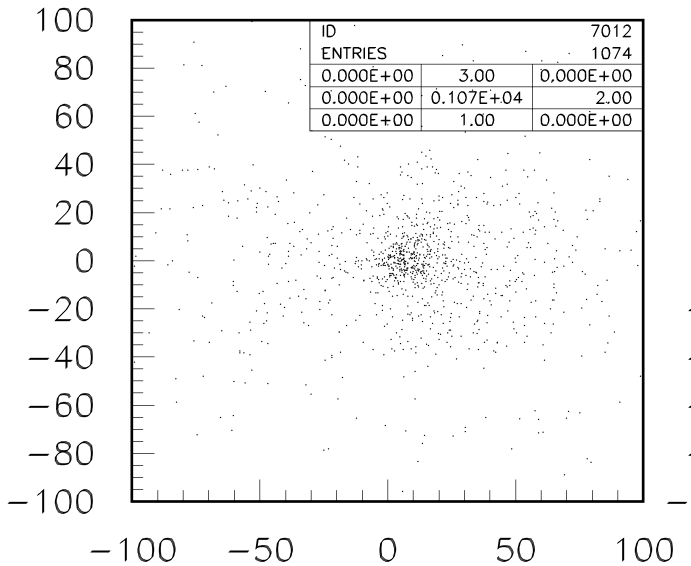
Rosy field +1.2 Tesla



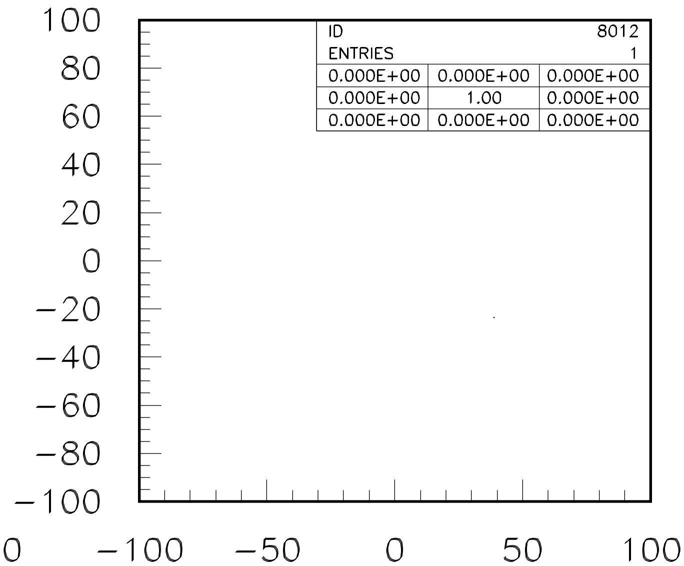
XY HITS−CHAMBER 11



XY HITS−CHAMBER, Resoln cut 11



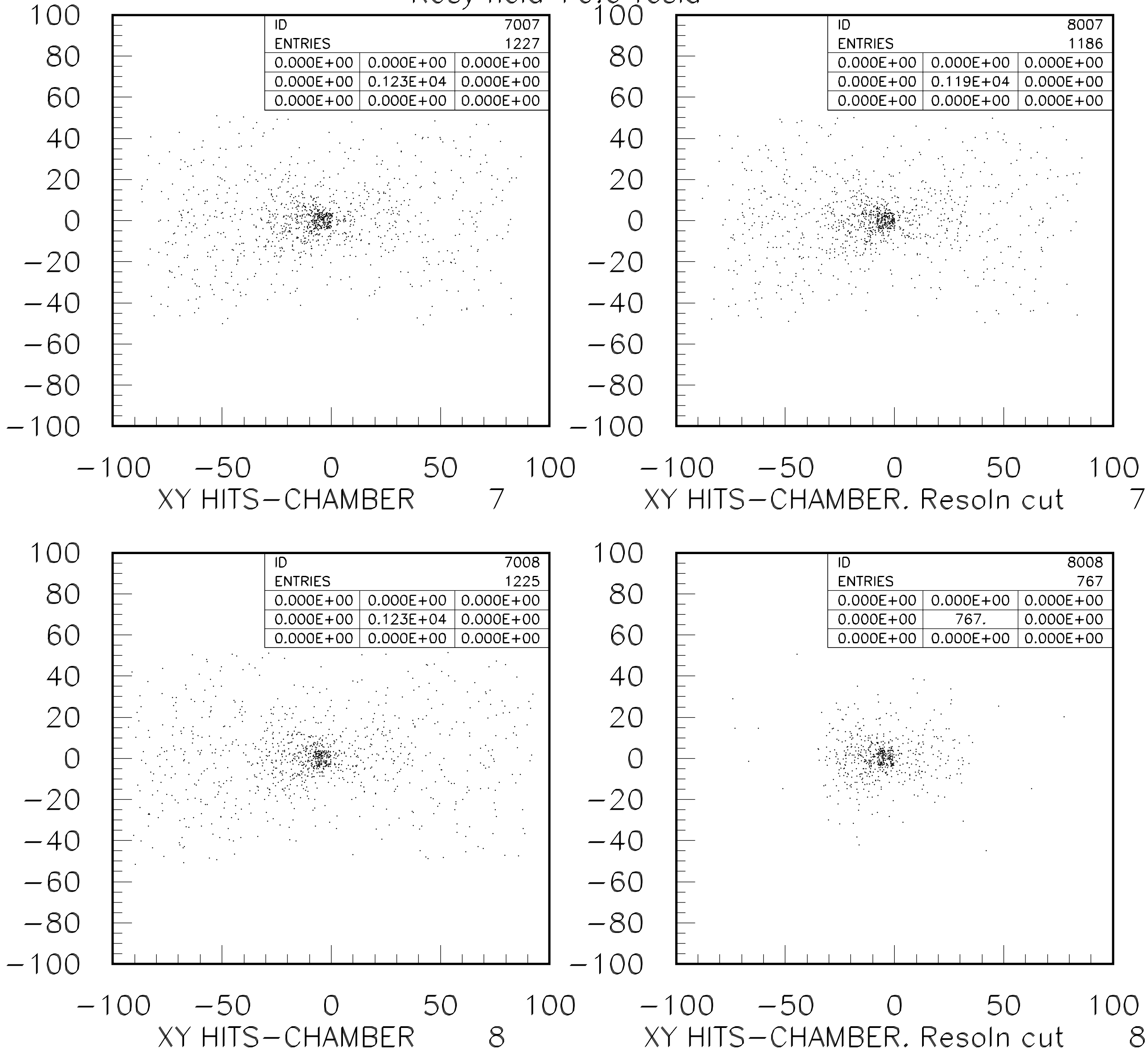
XY HITS−CHAMBER 12



XY HITS−CHAMBER, Resoln cut 12

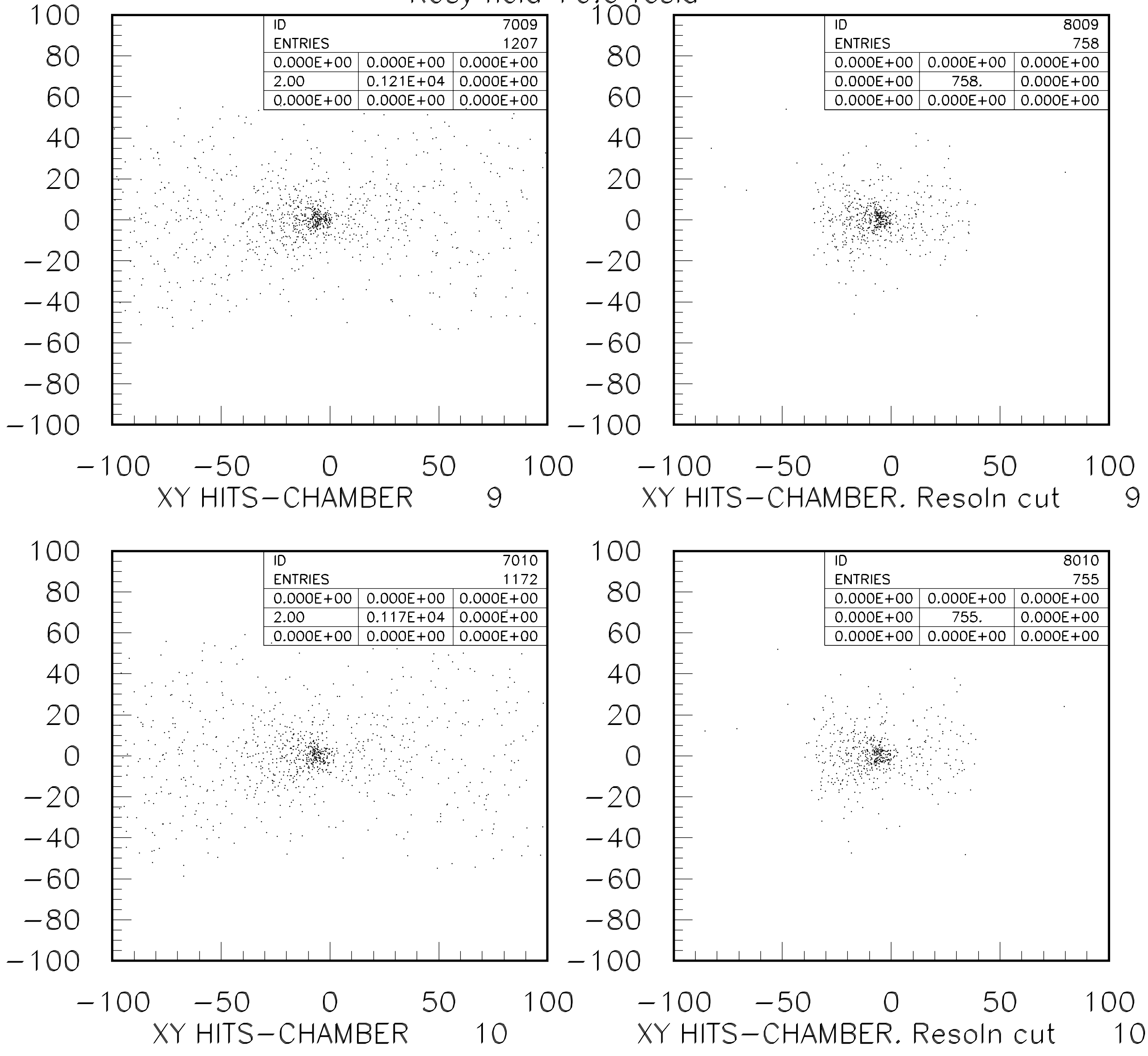
2001/09/03 17.12

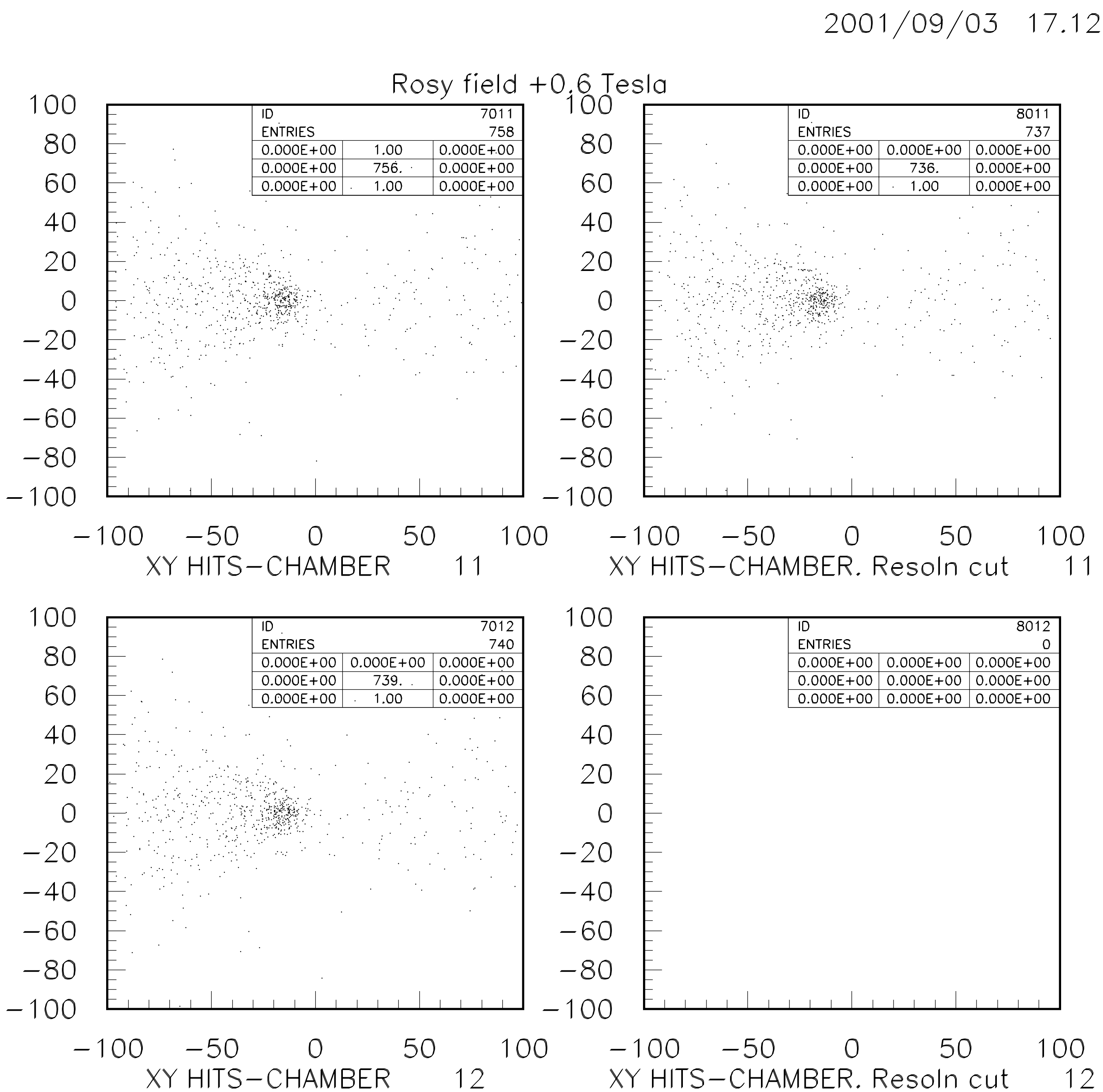
Rosy field +0.6 Tesla



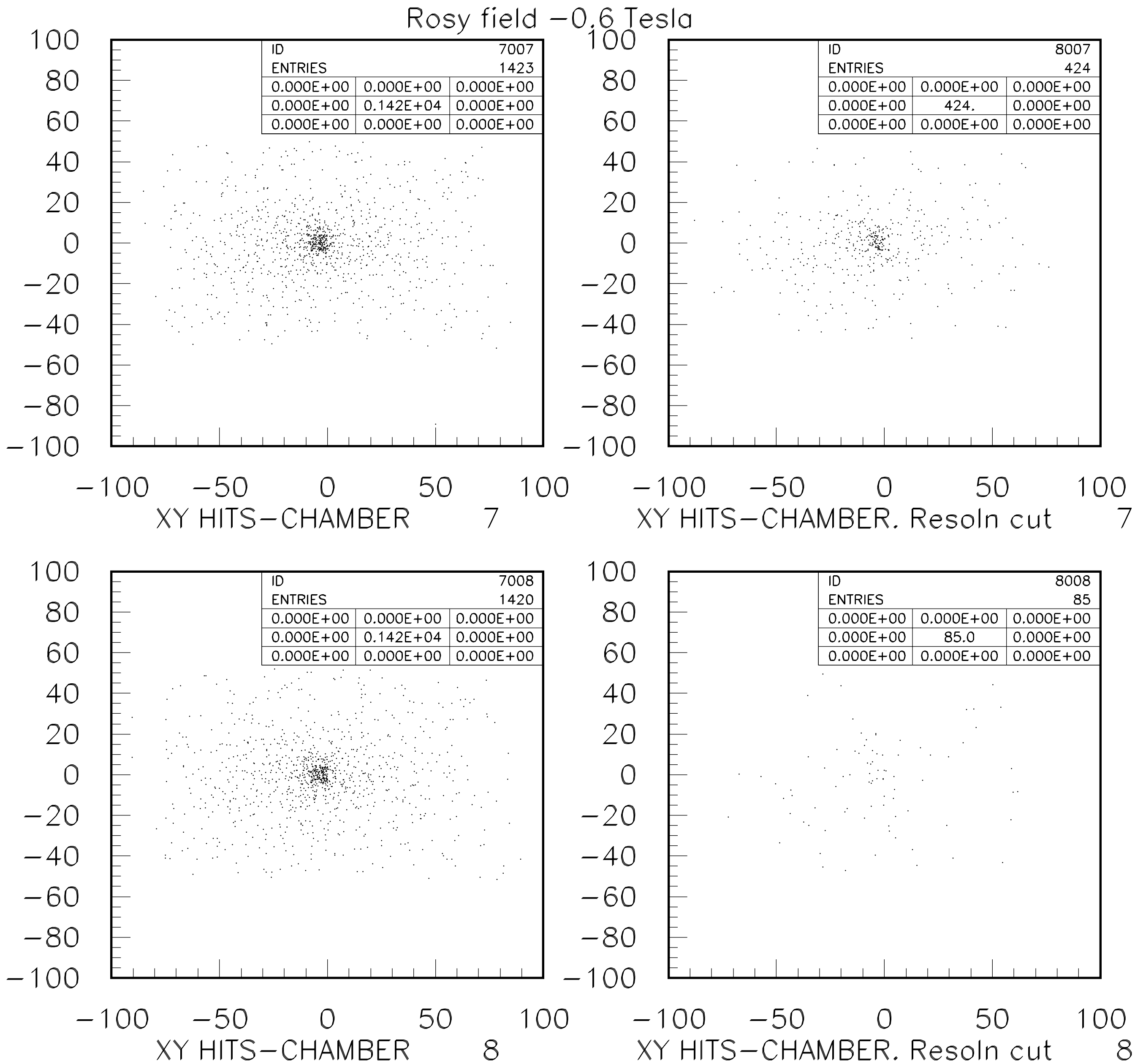
2001/09/03 17.12

Rosy field +0.6 Tesla

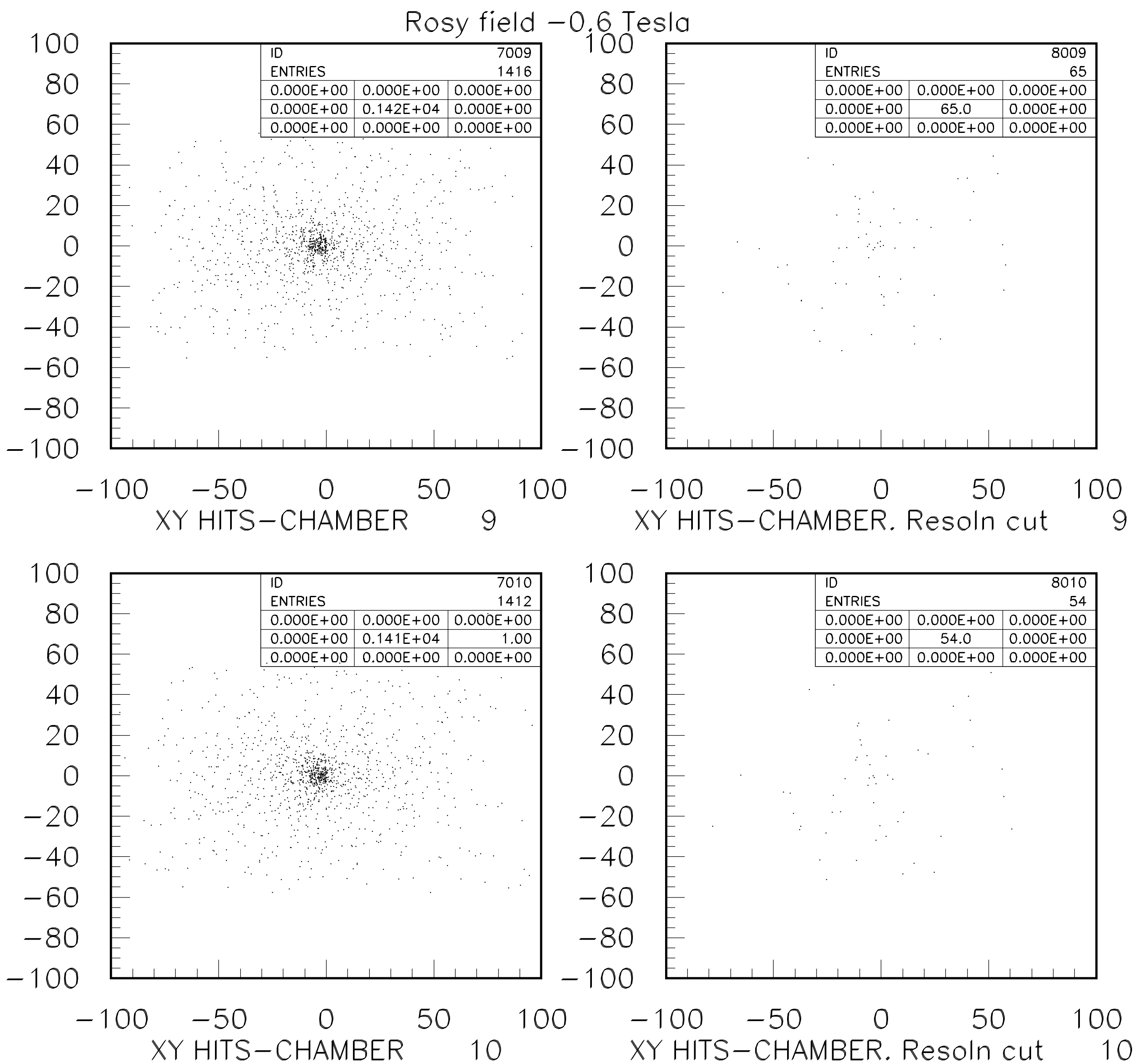



2001/09/03 17.12
Rosy field +0.6 Tesla
ID 7011
ENTRIES 758
0.000E+00 1.00 0.000E+00
0.000E+00 756. 0.000E+00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER 11
ID 8011
ENTRIES 737
0.000E+00 0.000E+00 0.000E+00
0.000E+00 736. 0.000E+00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER. Resoln cut 11
ID 7012
ENTRIES 740
0.000E+00 0.000E+00 0.000E+00
0.000E+00 739. 0.000E+00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER 12
ID 8012
ENTRIES 0
0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 12

2001/09/03 17.12

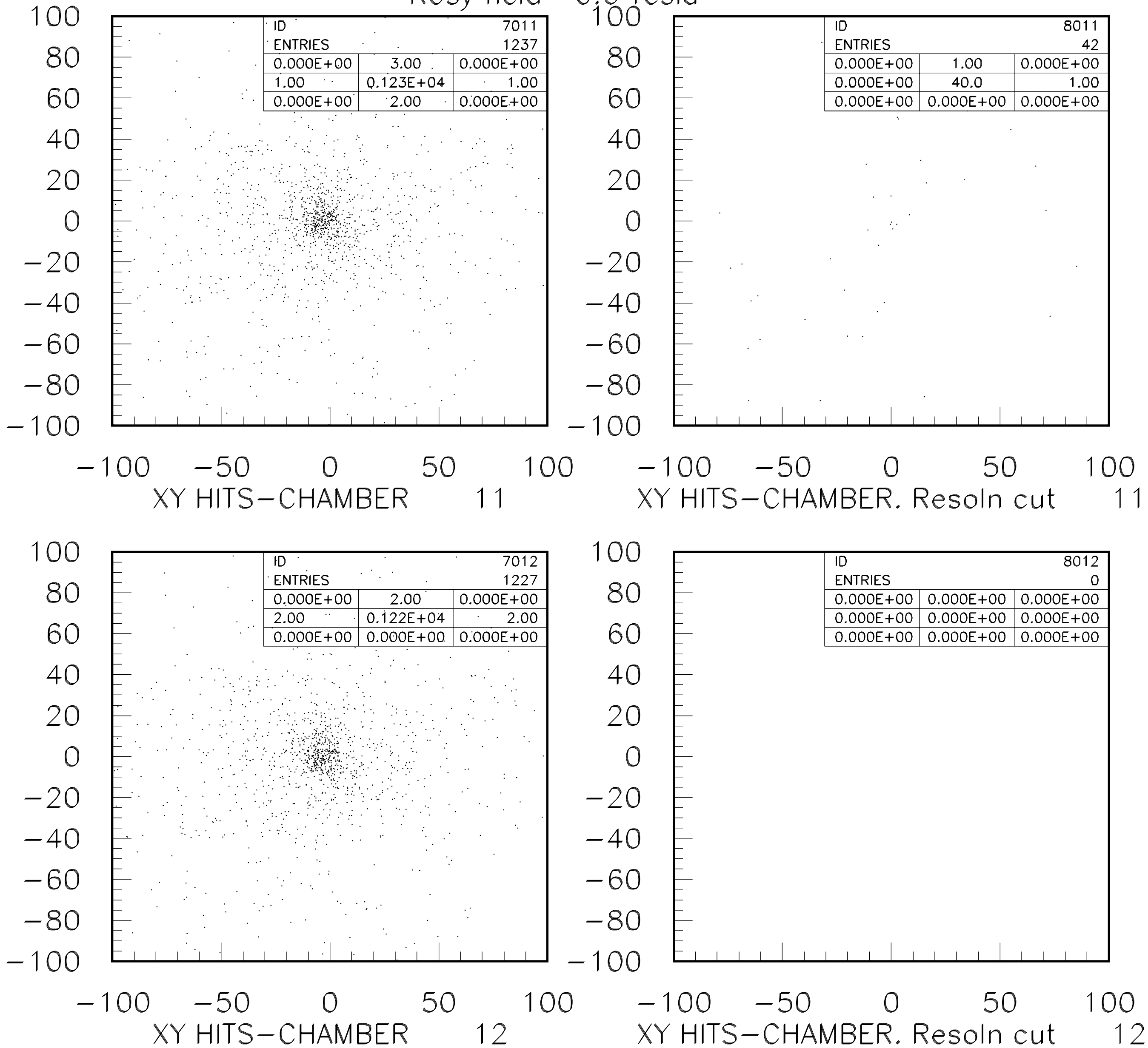


2001/09/03 17.12



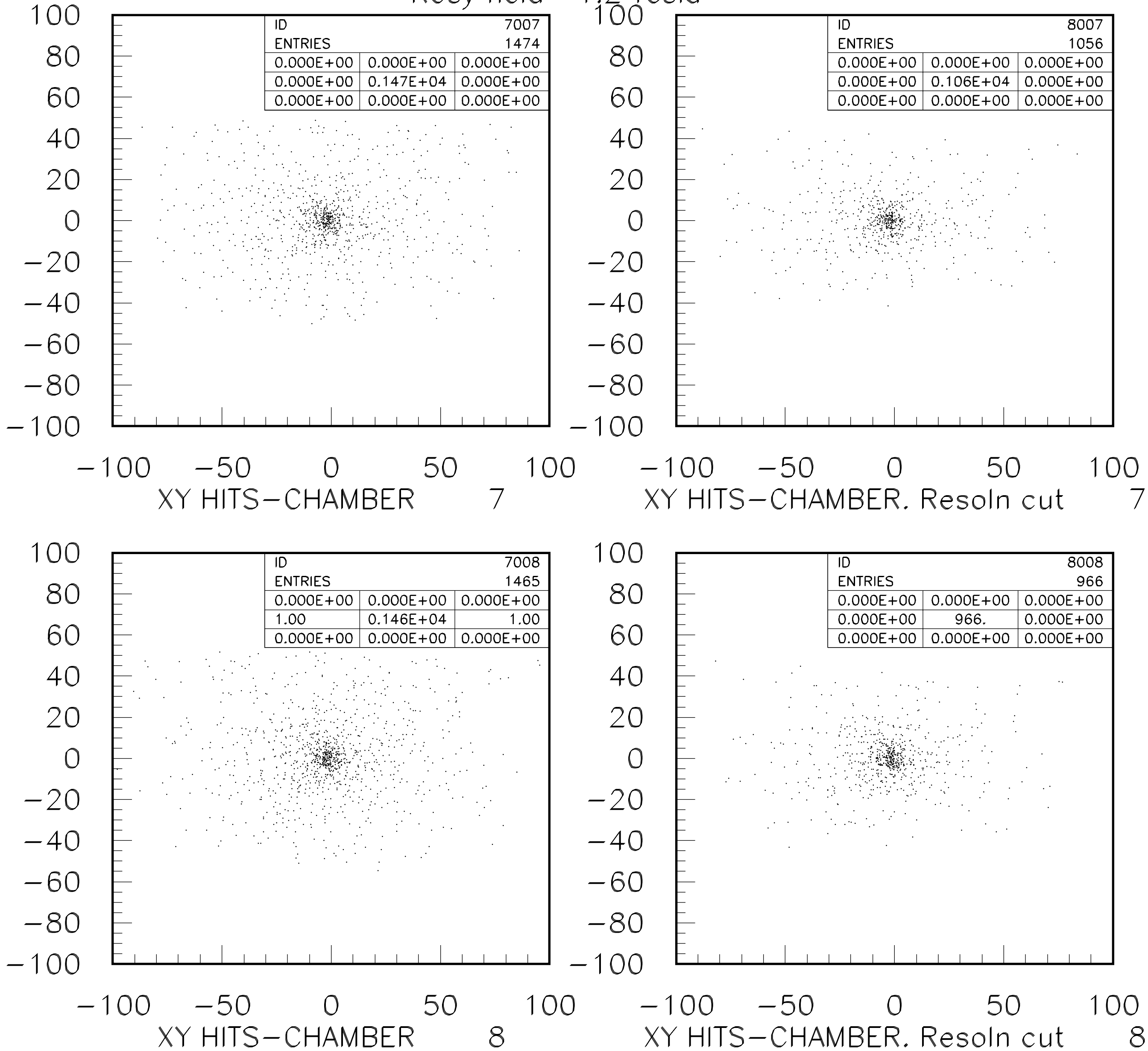
2001/09/03 17.12

Rosy field −0.6 Tesla

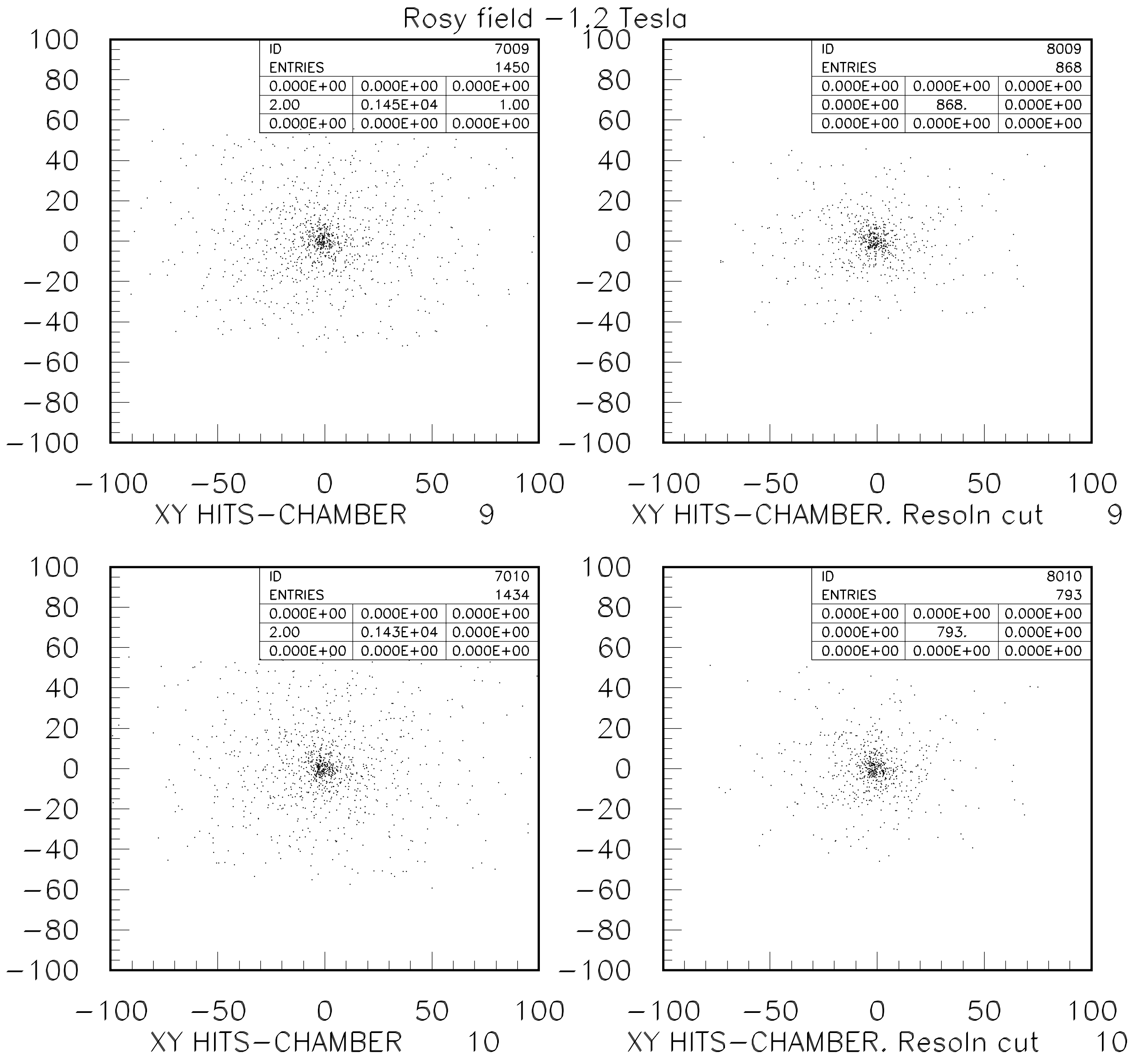


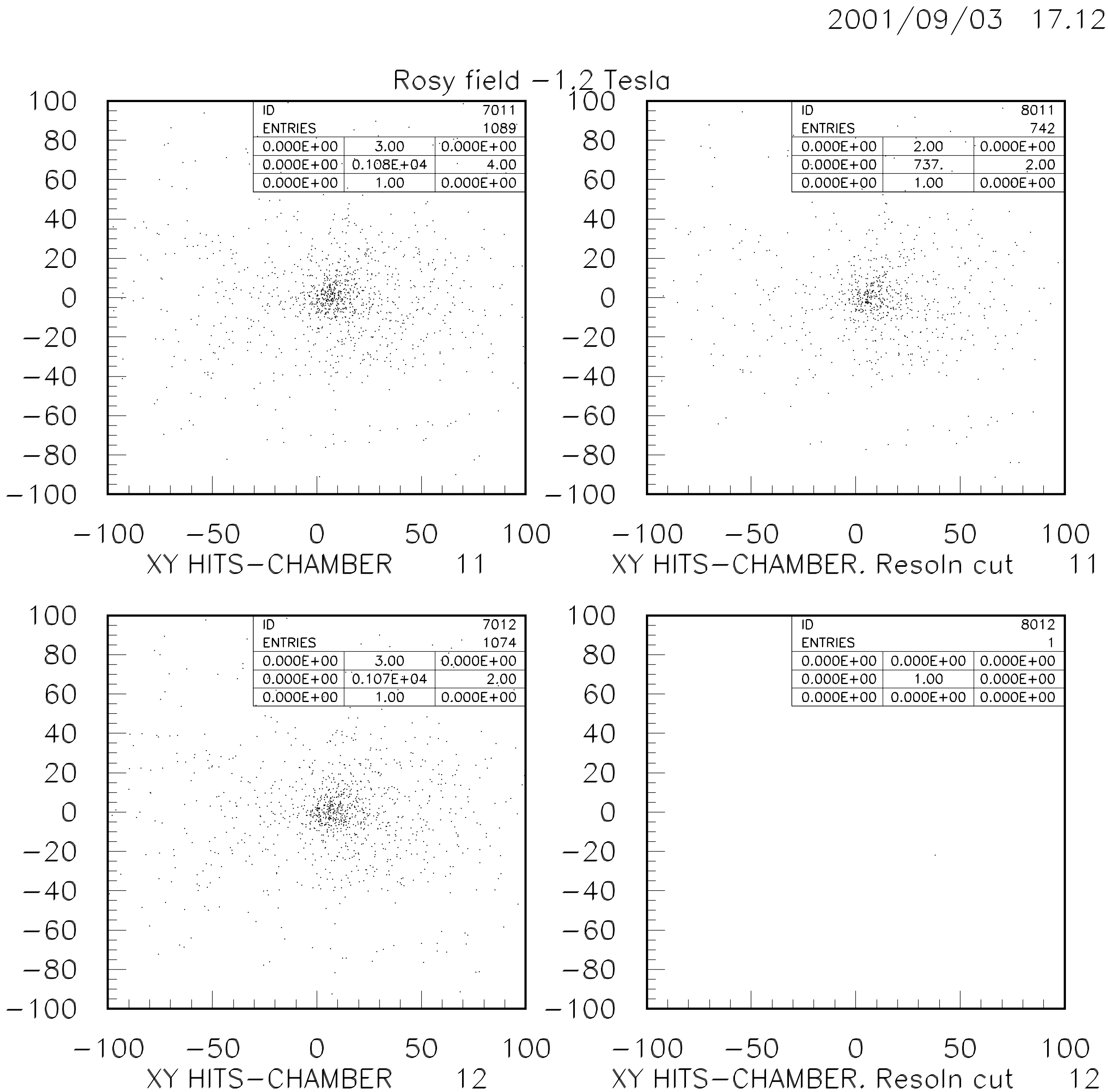
2001/09/03 17.12

Rosy field −1.2 Tesla



2001/09/03 17.12





2001/09/03 17.12
Rosy field −1.2 Tesla
ID 7011
ENTRIES 1089
0.000E+00 3.00 0.000E+00
0.000E+00 0.108E+04 4.00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER 11
ID 8011
ENTRIES 742
0.000E+00 2.00 0.000E+00
0.000E+00 737. 2.00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER, Resoln cut 11
ID 7012
ENTRIES 1074
0.000E+00 3.00 0.000E+00
0.000E+00 0.107E+04 2.00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER 12
ID 8012
ENTRIES 1
0.000E+00 0.000E+00 0.000E+00
0.000E+00 1.00 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER, Resoln cut 12

Fermilab Chamber Spread Sheet

experiment	chamber type	chamber name	x-aperture (cm)	y-aperture (cm)	anode spacing (mm)	anode-to-cathode spacing (mm)	#planes	#wires	plane orientation	angles (to local vertical)
E687 (Focus)	PWC	Type I (P0, P3)	76.2	127	2.032	5.969	4	2296	x-y-u-v	0,90,101.3,-88.7
		P4'	101.6	152.4			3	1372	x-u-v	0,101.3,-88.7
		Type II (P1,P2,P4)	152.4	228.6	3.048	6.096	4	2944	x-y-u-v	0,90,101.3,-88.7
E690	MWC	Chamber 1	76.2	45.72	1.984375	3.2512	4	1536	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 2	91.44	60.96	1.984375	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 3	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 4	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 5	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 6	182.88	121.92	3.4925	3.2512	4	2048	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Beam Chamber 1-(	15.24	10.16	1.016	1.397	4	640	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Beam Chamber 7-8	38.1	20.32	1.524	1.397	4	1024	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
E871(Selex)	MWC	m1_pwc_1	220	220	3				x-y-v-u	0,90,+28,-28
	DC	m1_dc1	200	150					x-x	0,0
	MWC	m1_pwc_2	220	220	3				x-y-v-u	0,90,+28,-28
	DC	m1_dc2	200	150					x-x	0,0
	MWC	m1_pwc_3	220	220	3				x-y-v-u	0,90,+28,-28
	MWC	m2_pwc_1	93	93	2				x-y	0,90
	MWC	m2_pwc_2	93	93	2				x-y	0,90
	MWC	m2_pwc_3	93	93	2				u-v	+28,-28
	MWC	m2_pwc_4	93	93	2				y-x	90,0
	MWC	m2_pwc_5	132	93	2				v-u	-28,+28
	MWC	m2_pwc_6	132	93	2				y-x	90,0
	MWC	m2_pwc_7	132	93	2				y-x	90,0
	MWC	m3_pwc_1	84.2	84.2					v-y-x-u	+28,90,0,-28
	MWC	m3_pwc_2	84.2	84.2					y-x	90,0
	MWC	m3_pwc_3	135	109.4					y-x-v	90,0,+28
HYPERCP	MWC	C1	45.72	25.4	1.0		4	1408	x-x'-u-v	
	MWC	C2	45.72	25.4	1.0		4	1408	x-x'-u-v	
	MWC	C3	55.88	30.48	1.25		4	1408	x-x'-u-v	
	MWC	C4	55.88	30.48	1.25		4	1408	x-x'-u-v	
	MWC	C5	152.4	40.64	1.5		4	3232	x-x'-u-v	
	MWC	C6	152.4	40.64	1.5		4	3232	x-x'-u-v	
	MWC	C7	203.2	55.88	2.0		4	4000	x-x'-u-v	
	MWC	C8	203.2	55.88	2.0		4	4000	x-x'-u-v	
	MWC	C9	203.2	55.88	2.0		4	4000	x-x'-u-v	