# TPC Reconstruction Update

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- Reconstruction is based on E910 reconstruction algorithm, described in Xihong Yang's thesis.

- General overview:

  - Begin with raw data: TPCDigit class has the following data members: (padColumn, padRow, bucket, ADC).

  - TPCR2DClusters are formed in the x-y (column,bucket) plane from connected digits. 2DClusters are formed in each padRow.

  - TPCRHits are formed from the 2D clusters using the center-of-gravity (weighted by ADC value) of each cluster.

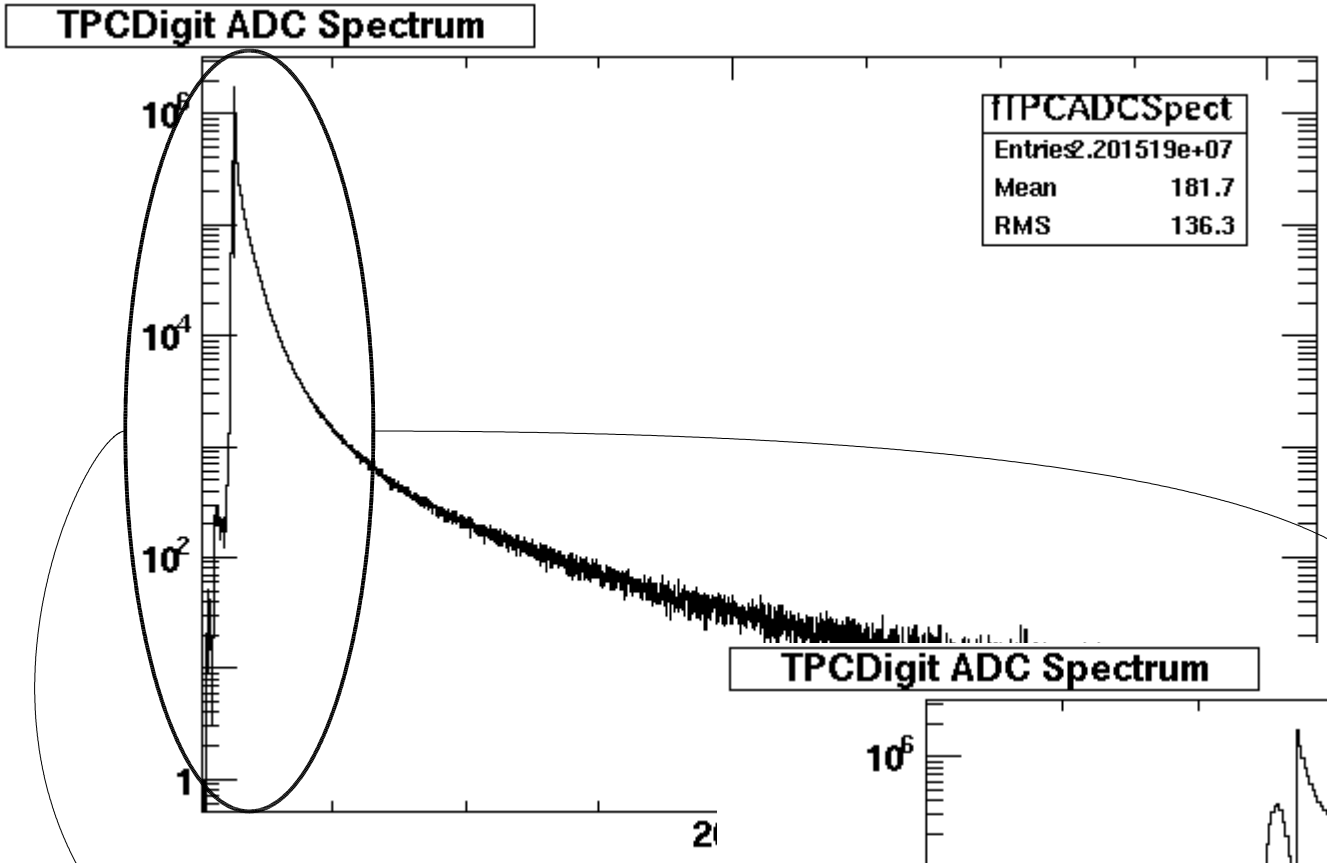
  - TPCRTracks are formed from TPCRHits.

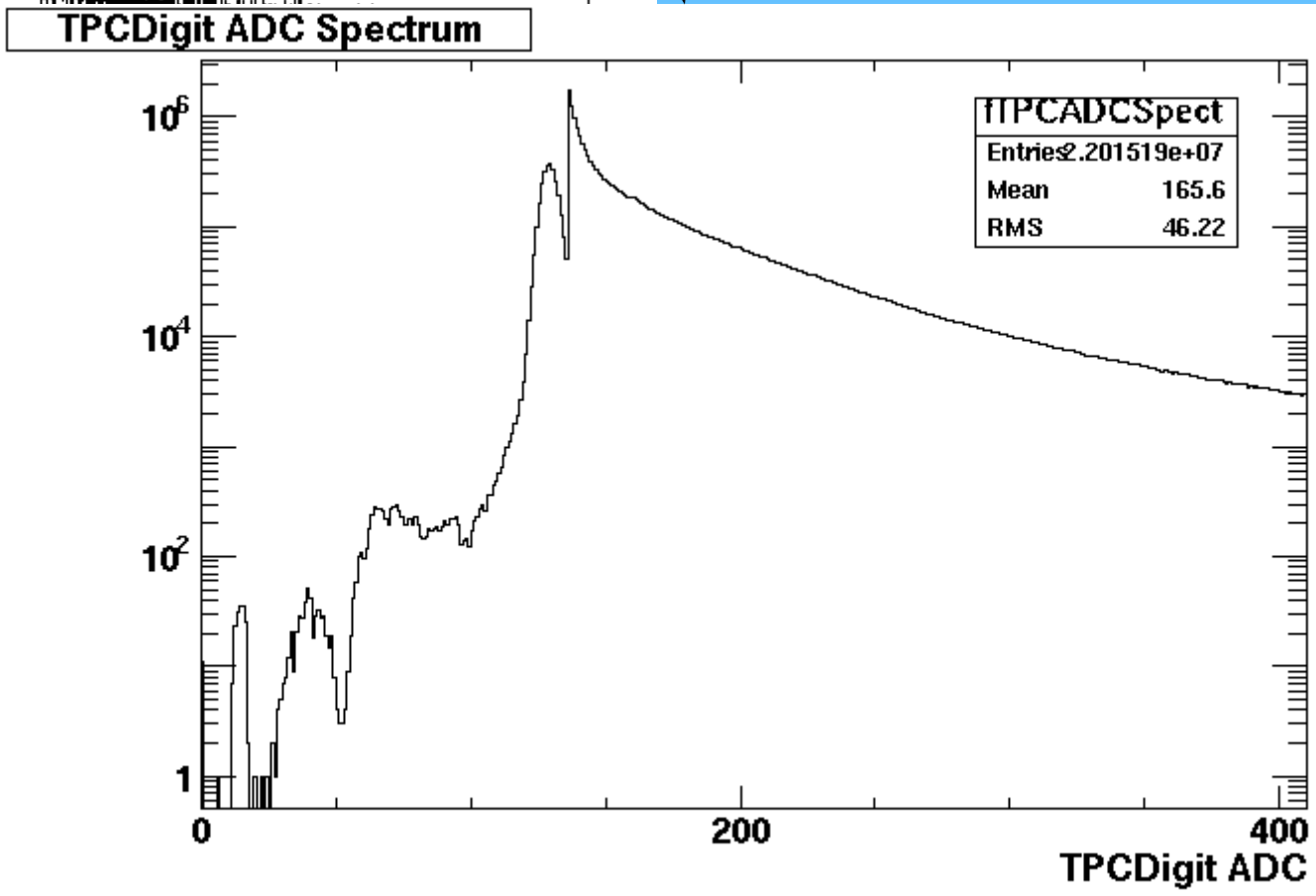
  - TPCRVertices are formed from TPCRTracks.

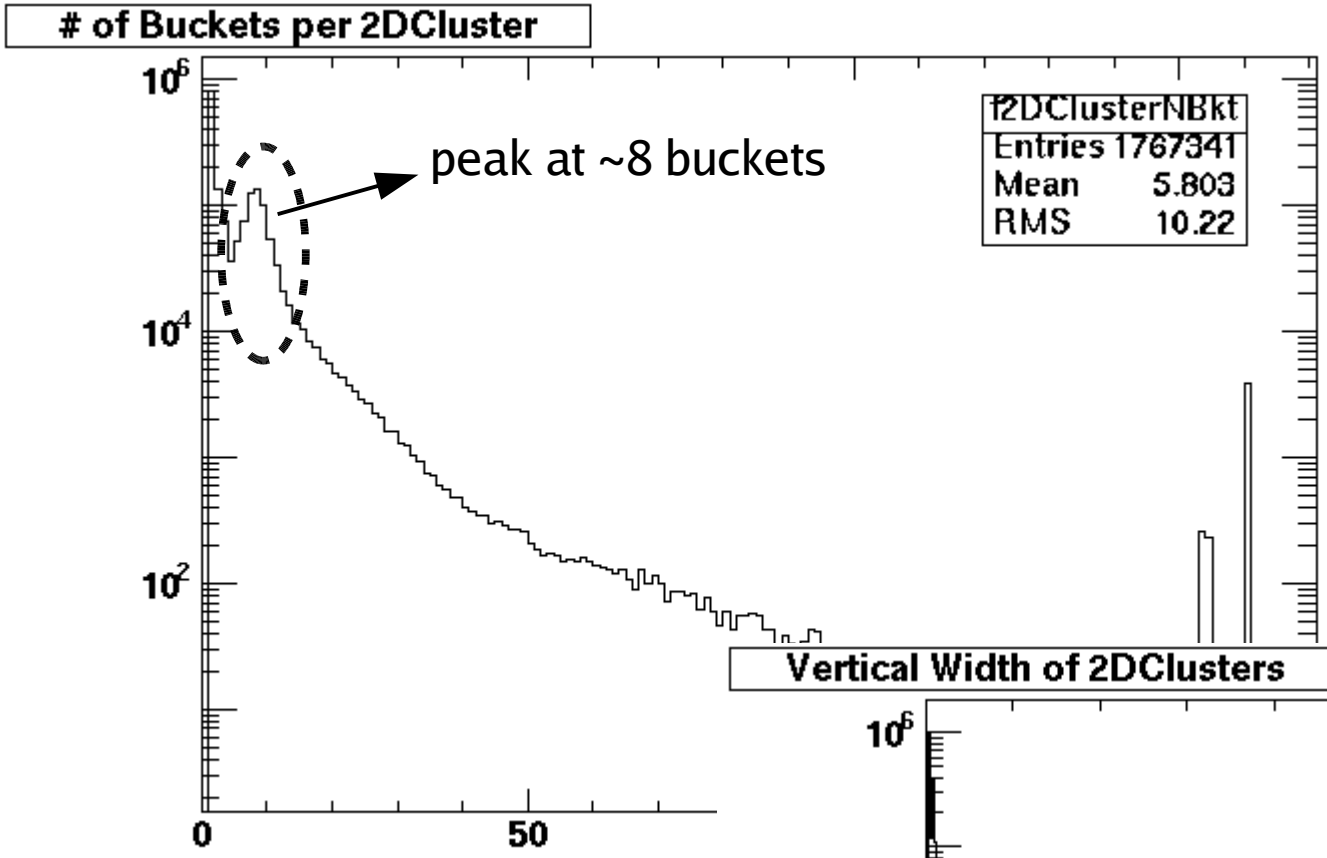
# TPCR2DCluster and TPCR2DClusterFind

- TPCR2DCluster: class that holds list of TPCDigits, as well as some other useful info:
  - max., min. bucket
  - max., min. pad column
  - sum of ADC values
  - avg. (x,y)
  - rms (x,y).

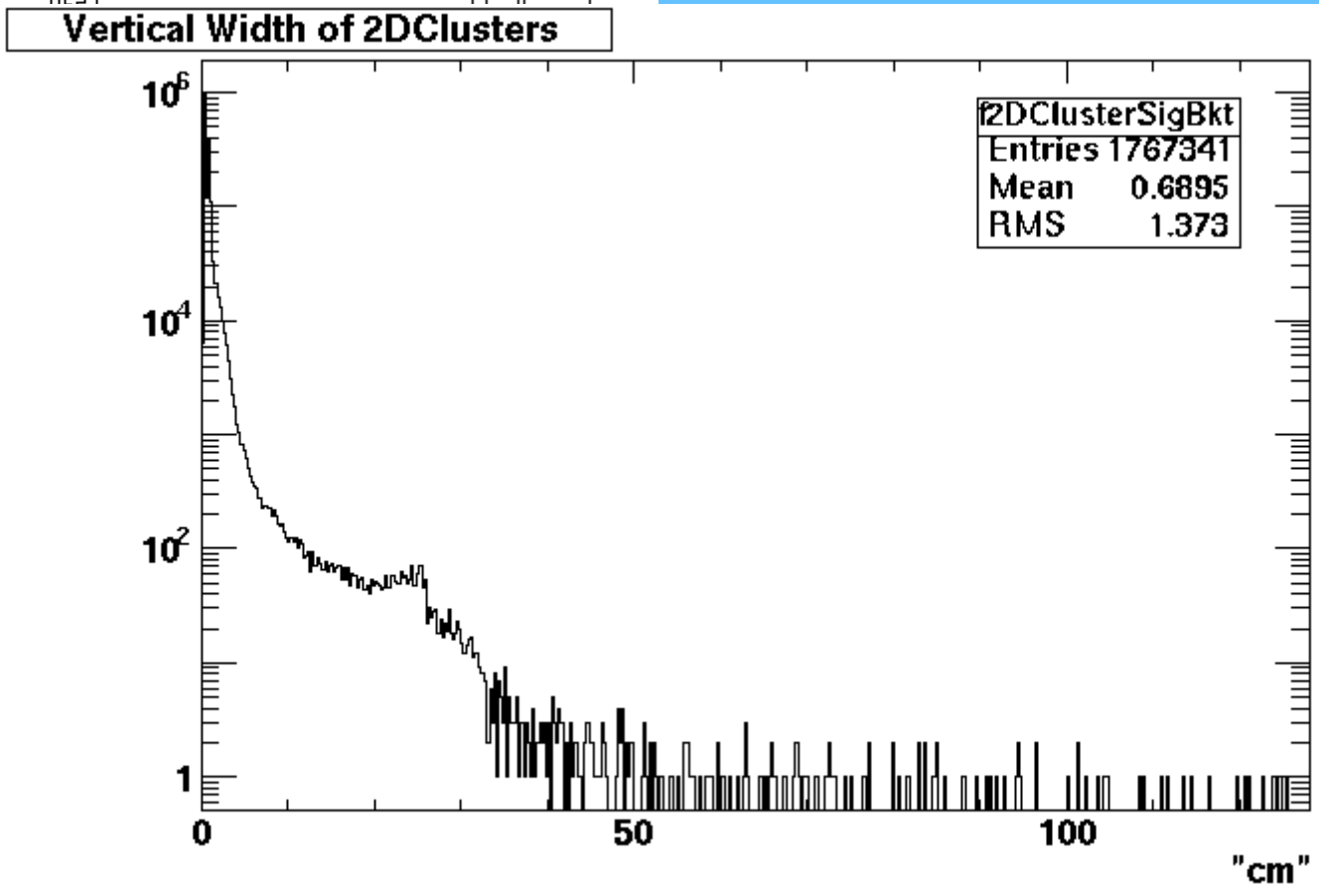
- TPCR2DClusterFind: JobCModule class whose job it is to find 2DClusters from raw TPCDigits:
  - sorts raw TPCDigits by pad row
  - forms 2DClusters from digits that are connected either vertically or horizontally (but not diagonally)
  - calculates all of the member variables of each 2DCluster


TPCDigit ADC Spectrum
fTPCADCSpect
Entries 2.201519e+07
Mean 181.7
RMS 136.3
10^6
10^4
10^2
1

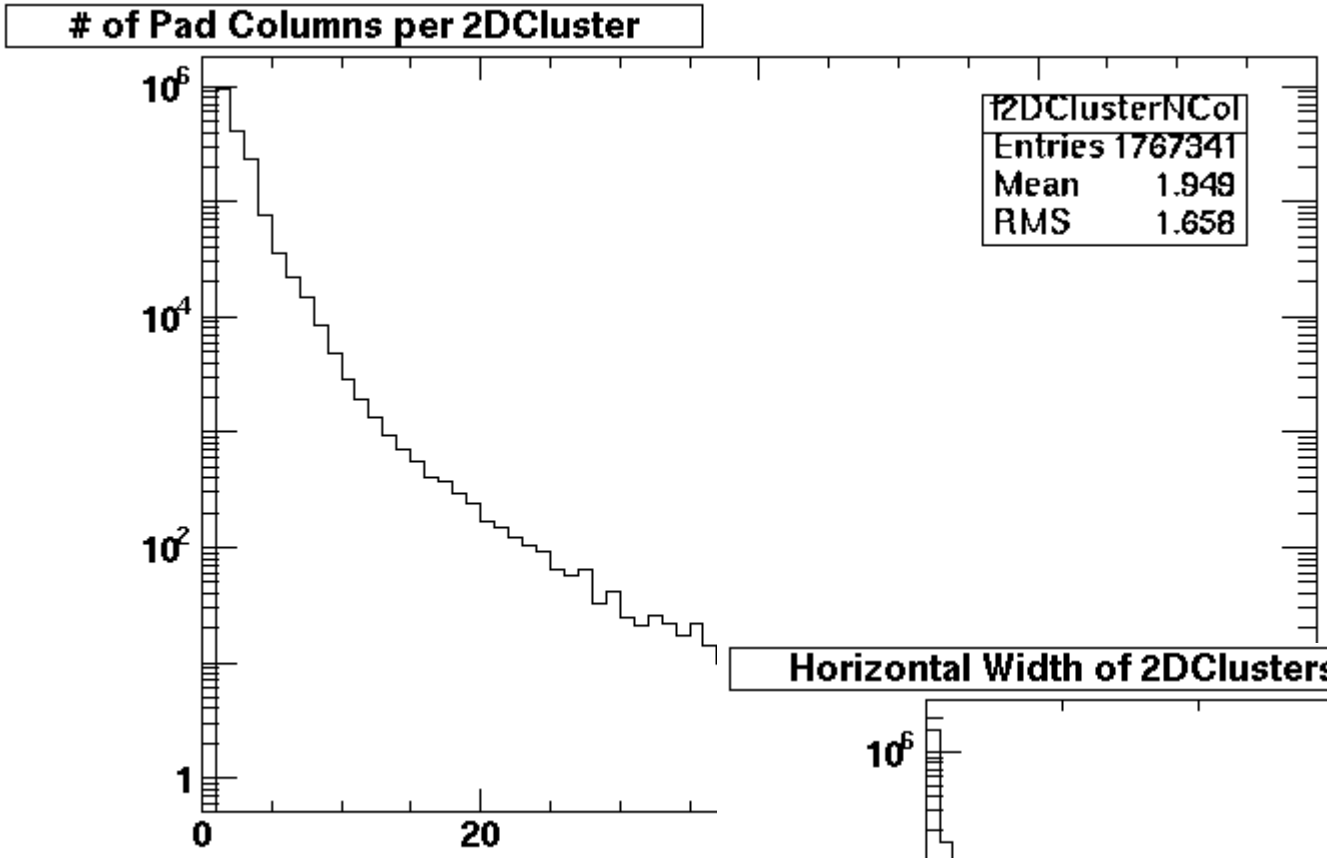

TPCDigit ADC Spectrum
fTPCADCSpect
Entries 2.201519e+07
Mean 165.6
RMS 46.22
10^6
10^4
10^2
1
0
200
400
TPCDigit ADC



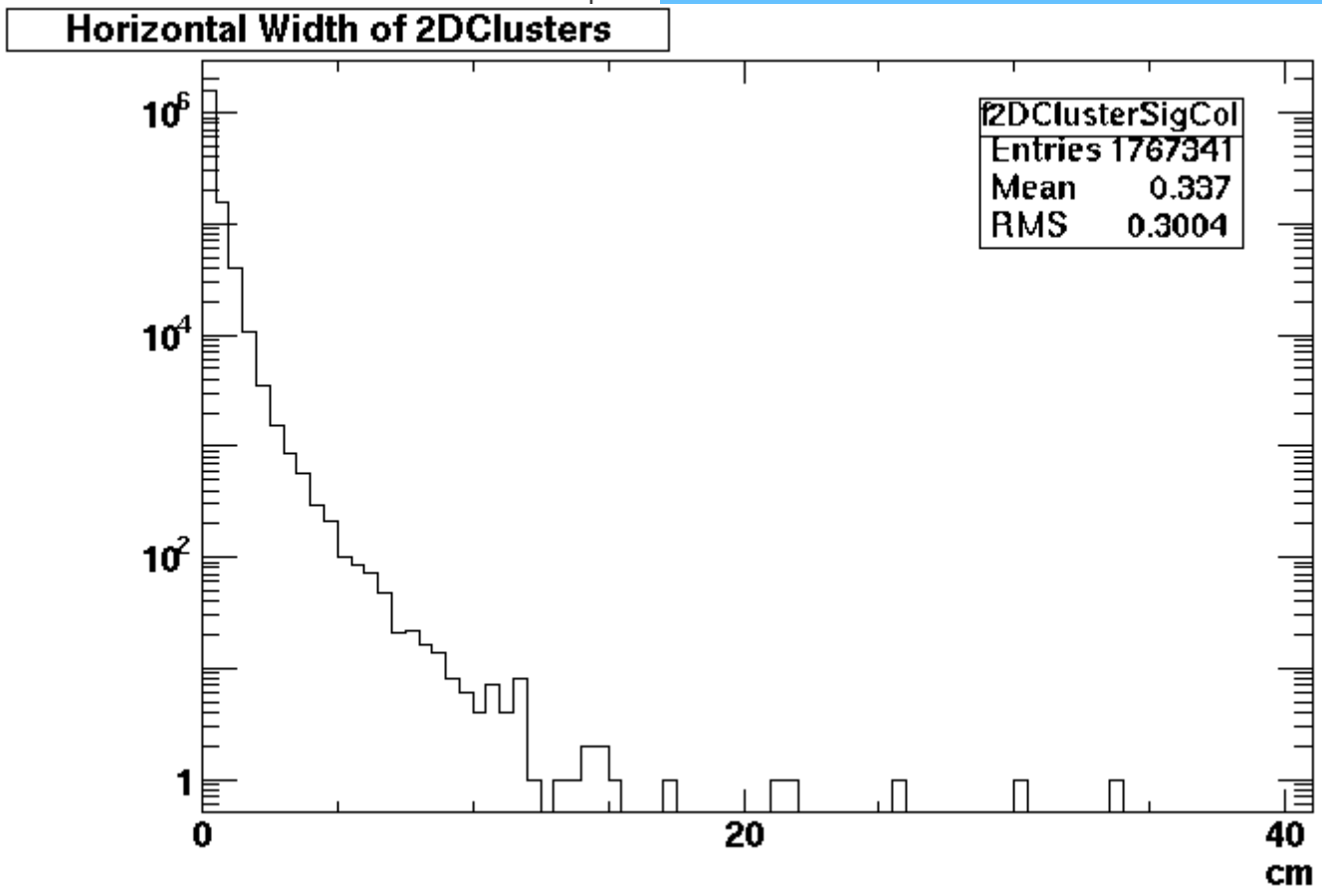

On average, there are about 8 buckets in each 2DCluster.



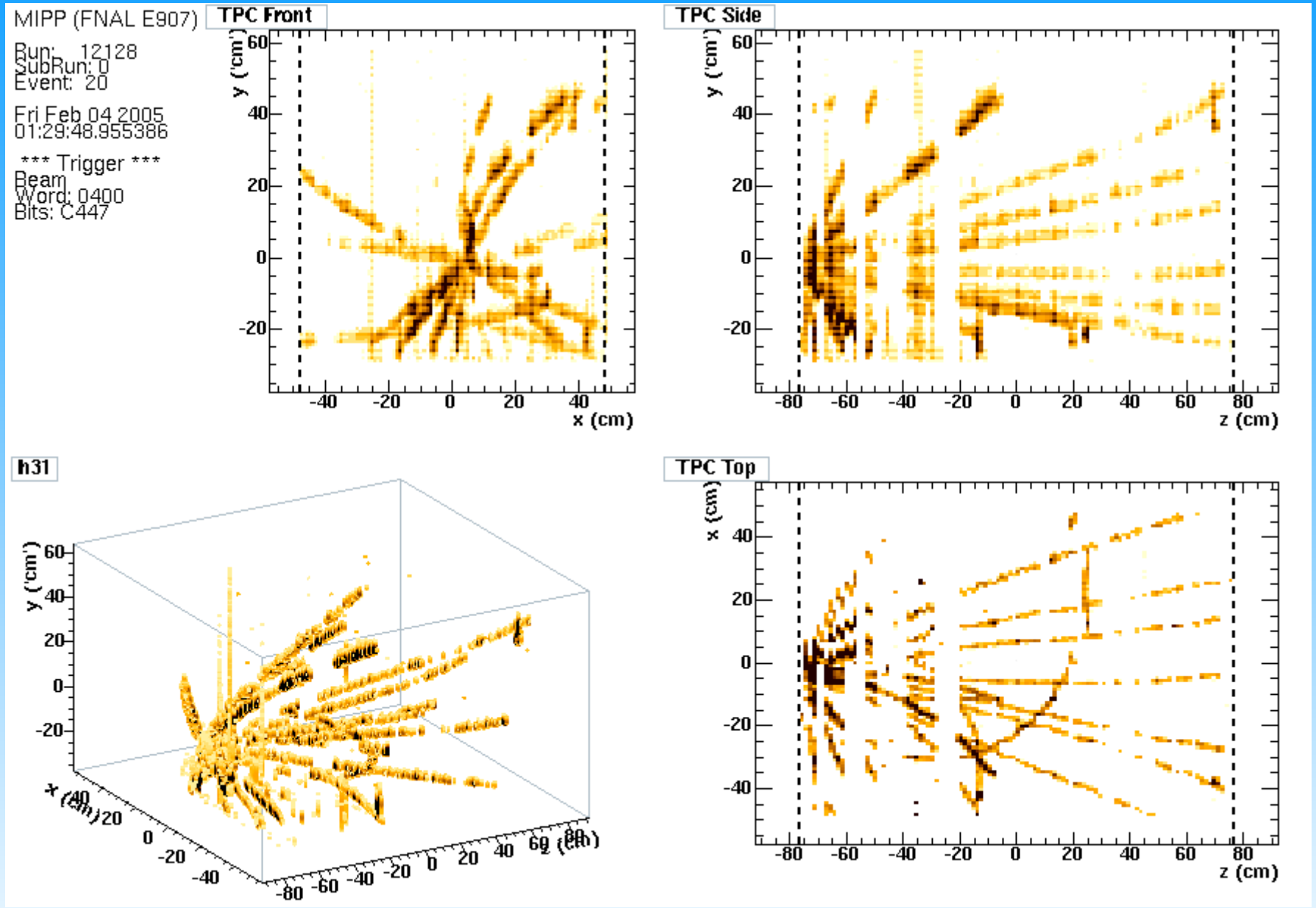

The vertical width of a 2DCluster is about 0.7 “cm” (bucket-to-distance conversion assumes $v_D$ = 5.45 cm/us

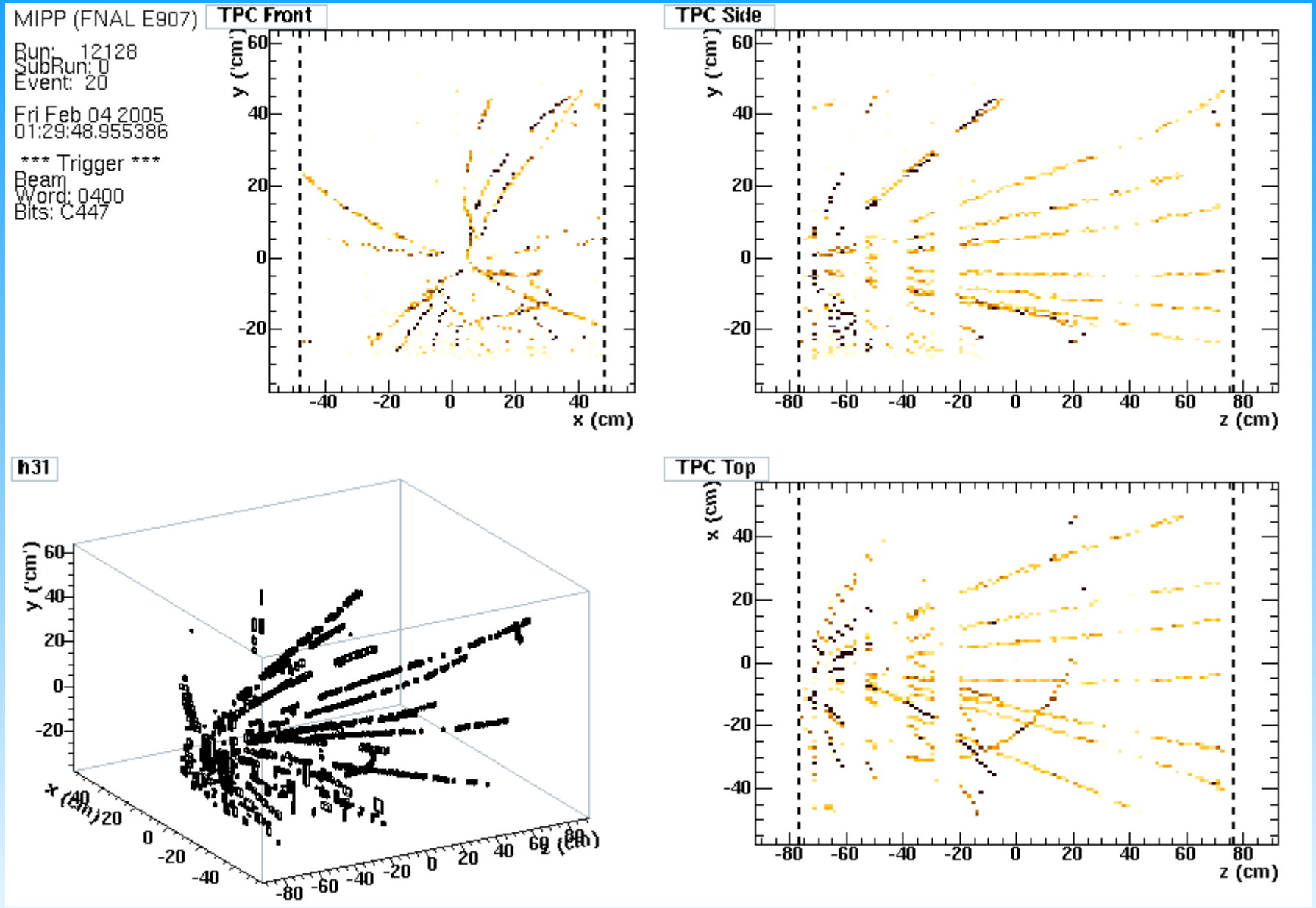



On average, there are about 2 pads in each 2DCluster.




The horizontal width of a 2DCluster is about 0.3 cm.


MIPP (FNAL E907)
Run: 12128
SubRun: 0
Event: 20
Fri Feb 04 2005
01:29:48.955386
*** Trigger ***
Beam
Word: 0400
Bits: C447
TPC Front
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
h31
y ('cm')
x (cm)
z (cm)
TPC Top
x (cm)
z (cm)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Fri Feb 04 2005
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*** Trigger ***
Beam
Word: 0400
Bits: C447
TPC Front
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
h31
y ('cm')
x (cm)
z (cm)
TPC Top
x (cm)
z (cm)

# TPCRHit and TPCRHitFind

- TPCRHit: placeholder class for final hit(s) that will be formed from 2DClusters. Currently only takes the avg. x and y positions of each 2DCluster.

- TPCRHitFind: JobCModule class whose job *will be* to find individual hits from the 2DClusters.

# TPCRTrack and TPCRTrackFind

- TPCRTrack: class that holds list of TPCRHits, as well as:
  - track fit parameters (rho, d, phi, dy/ds, y0), their uncertainties and their correlations
  - ID (unique number, used mostly for debugging)
  - fit status (success or fail), goodness-of-fit (g.o.f.) ~ $chi^2$
  - helicity (charge)
  - two matrices, used for fitting

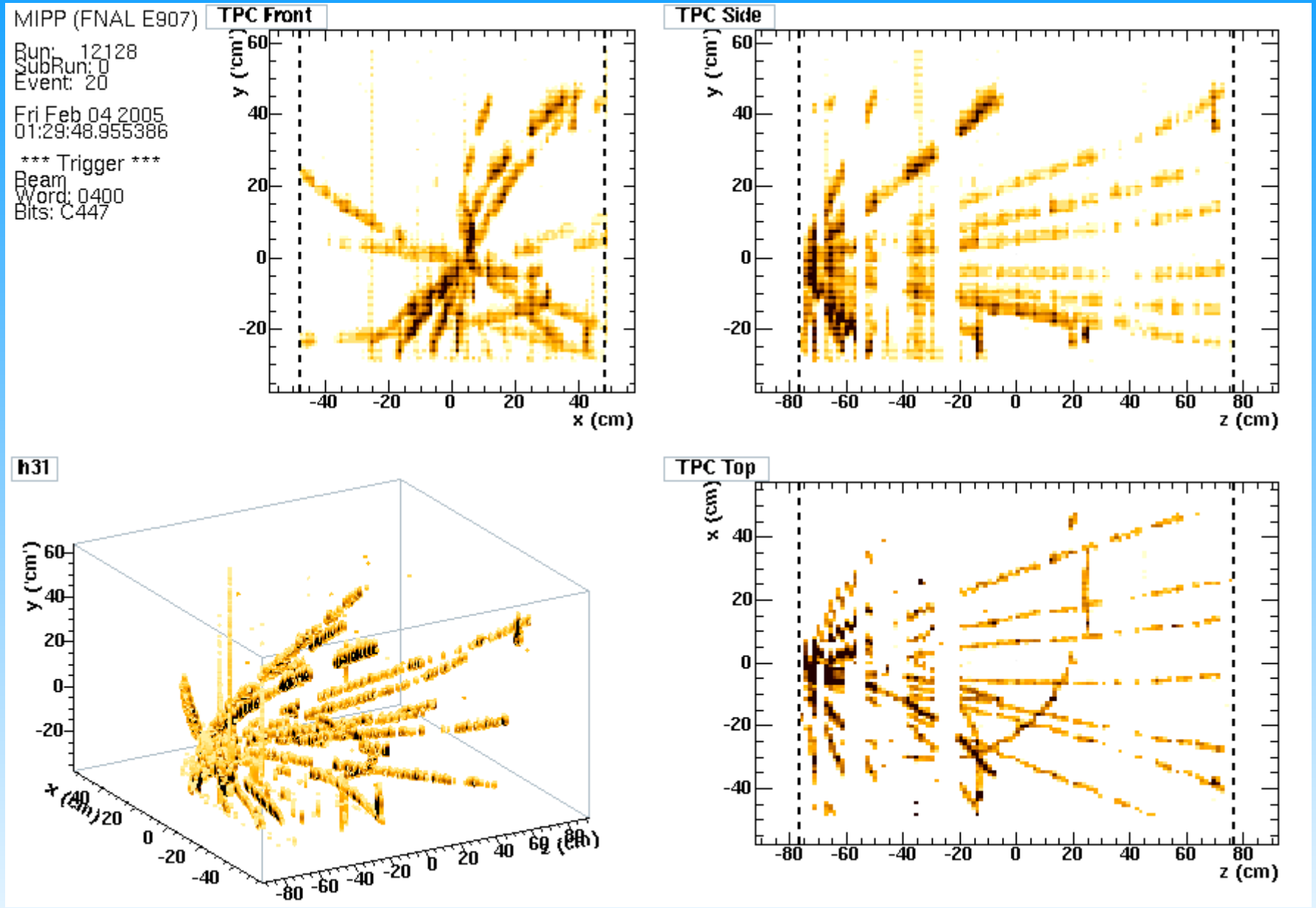
- TPCRTrackFind: JobCModule class whose job it is to find tracks from TPCRHits:
  - track seeds are formed using a "follow-your-nose" approach, where a collection of hits is formed by searching only in the z-direction and picking up nearest-neighbor hits
  - looping until we find no more tracks:
    - take the longest list of *unused* hits, fit them to a helix
    - go back to look for bad hits (and remove them)
    - look for any "acceptable" unused hits, add them to the track
    - check again for bad hits (and remove them)

# TPCRTrack and TPCRTrackFind (cont.)

- “Bad” hit fails cut on residual.
- “Acceptable” hit passes cuts on:
  - distance away from nearest track hit (cuts on both longitudinal and transverse distance)
  - change in g.o.f. parameter is less than max. allowed residual

- Next, we look for tracks to merge
  - merge two tracks if they intersect inside the TPC volume, and if the g.o.f. of the merged track is less than the sum of the g.o.f.'s of the two single tracks.

- Finally, we look for any remaining “acceptable” unused hits that could be added to any of our tracks.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Bits: C447
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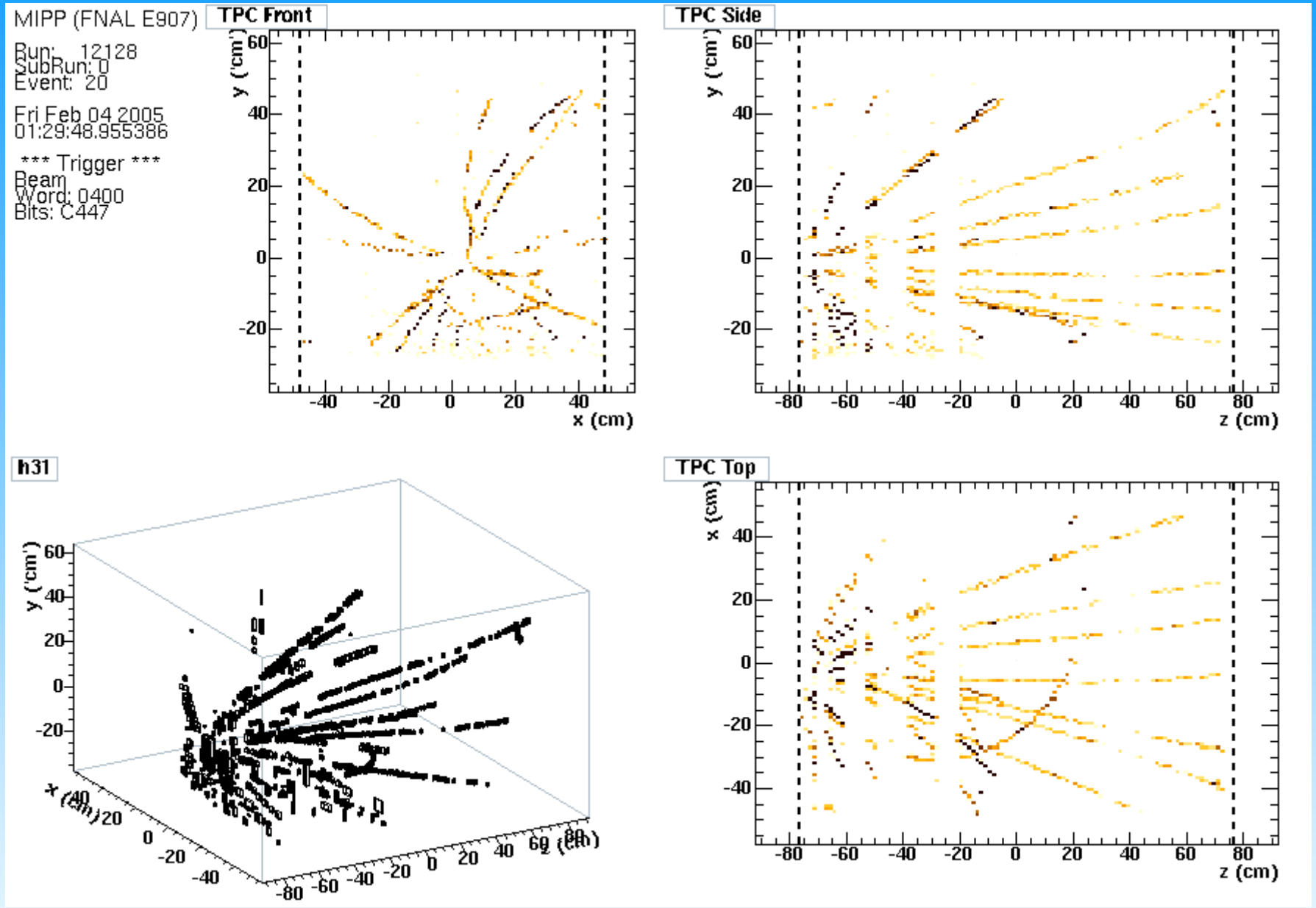
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
h31
y ('cm')
x (cm)
z (cm)
TPC Top
x (cm)
z (cm)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TPC Top
x (cm)
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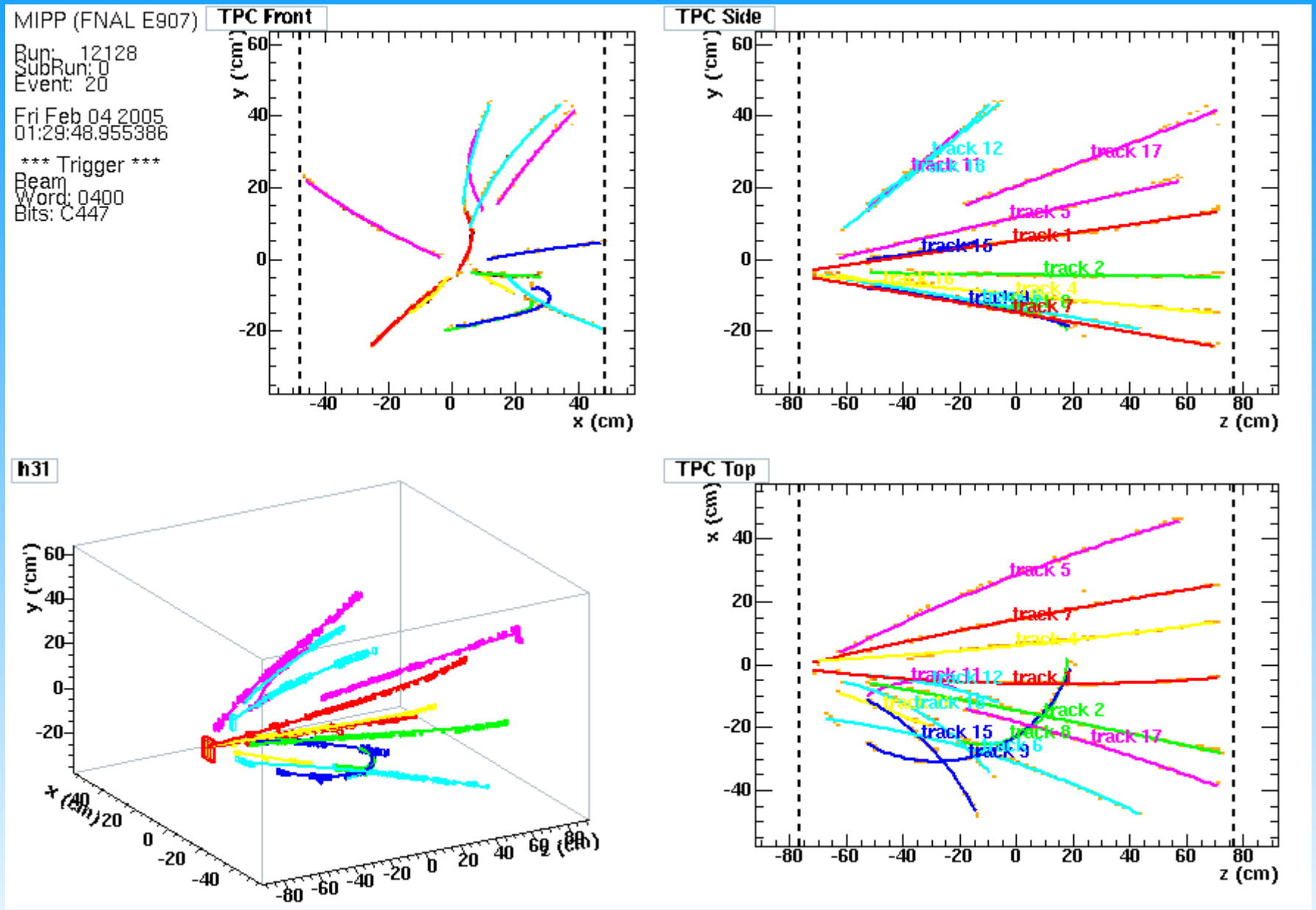
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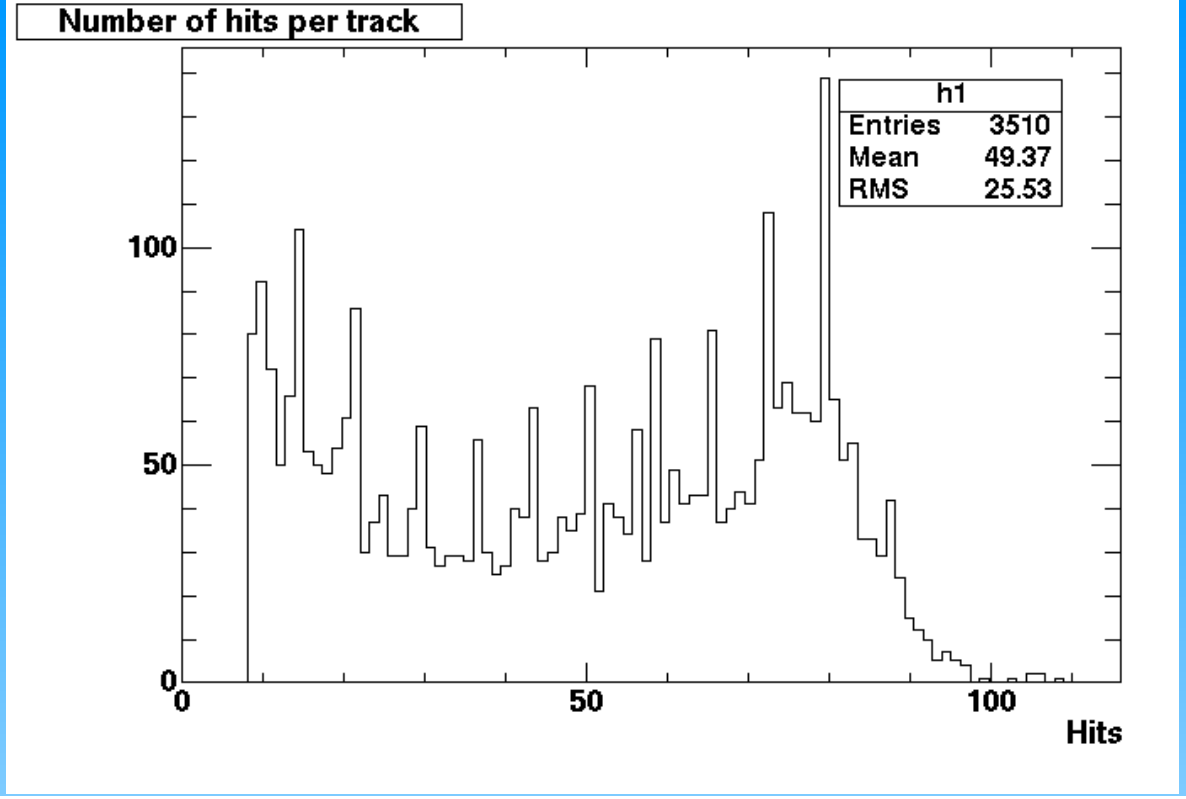
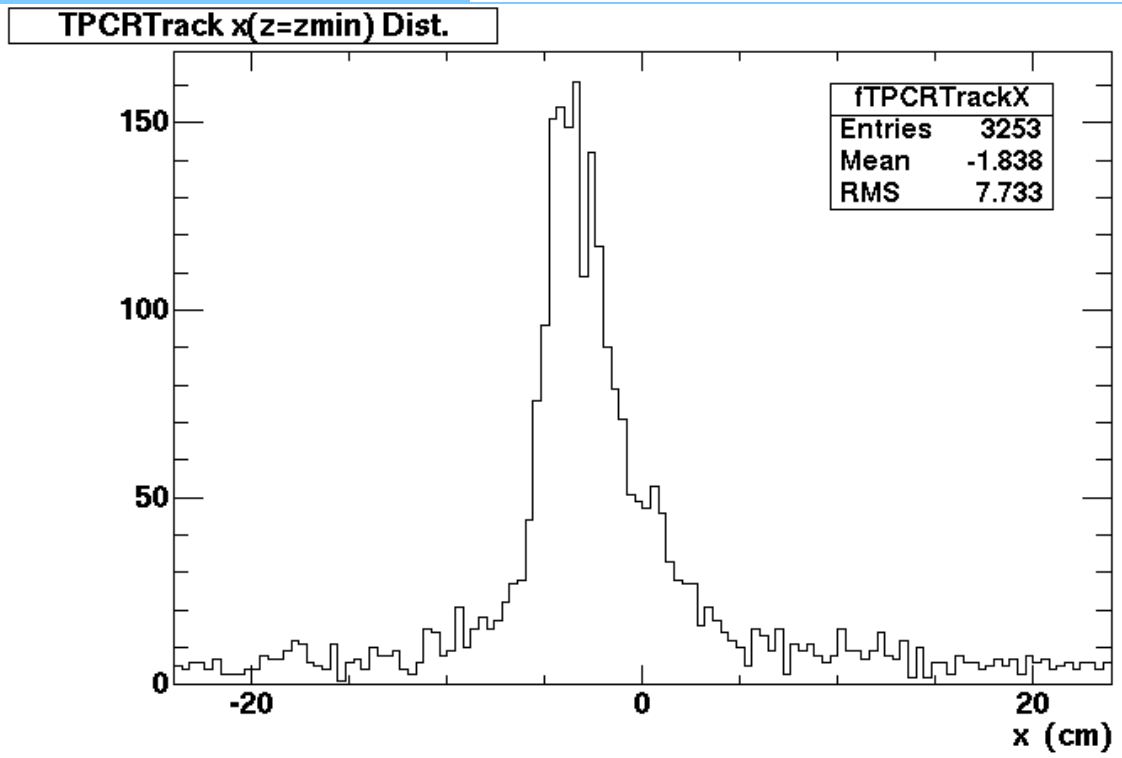
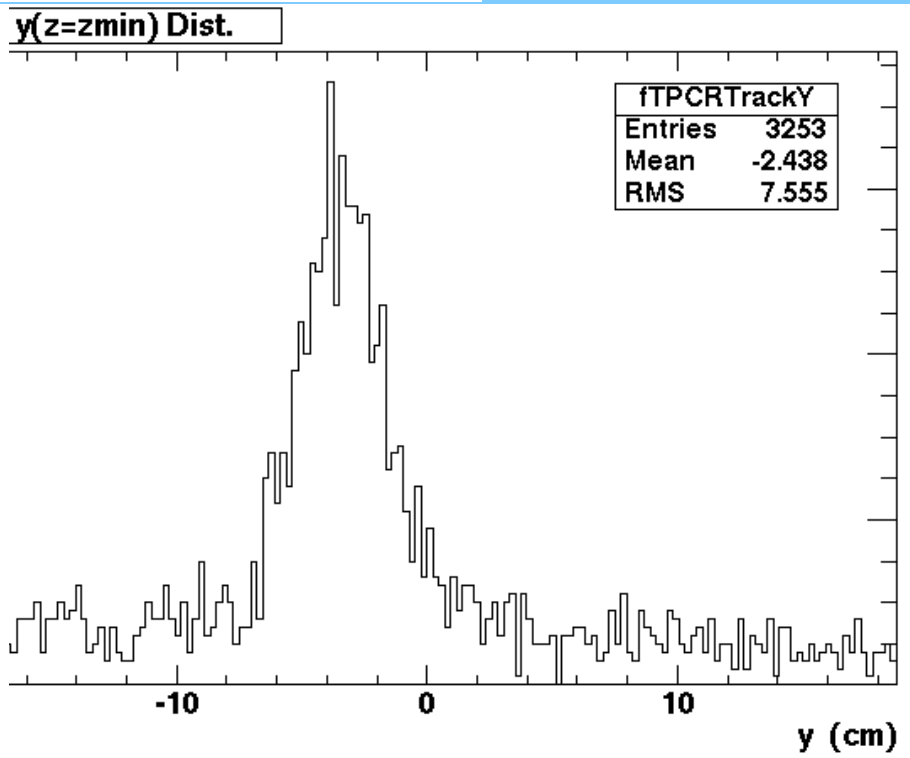
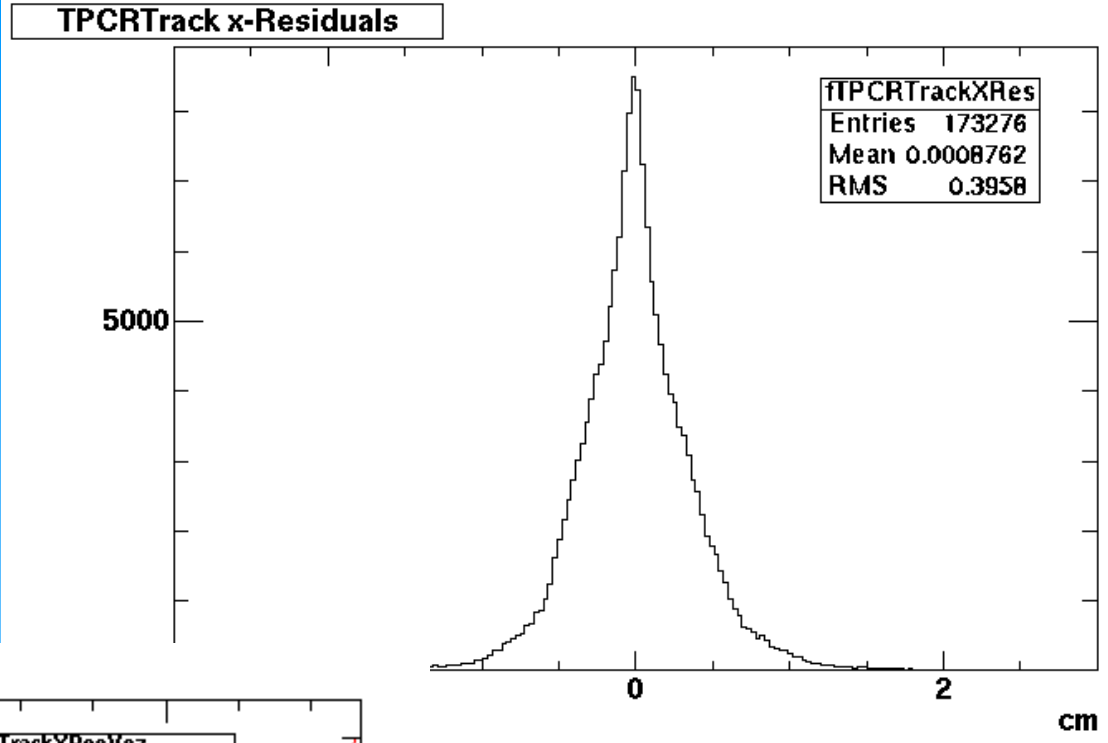
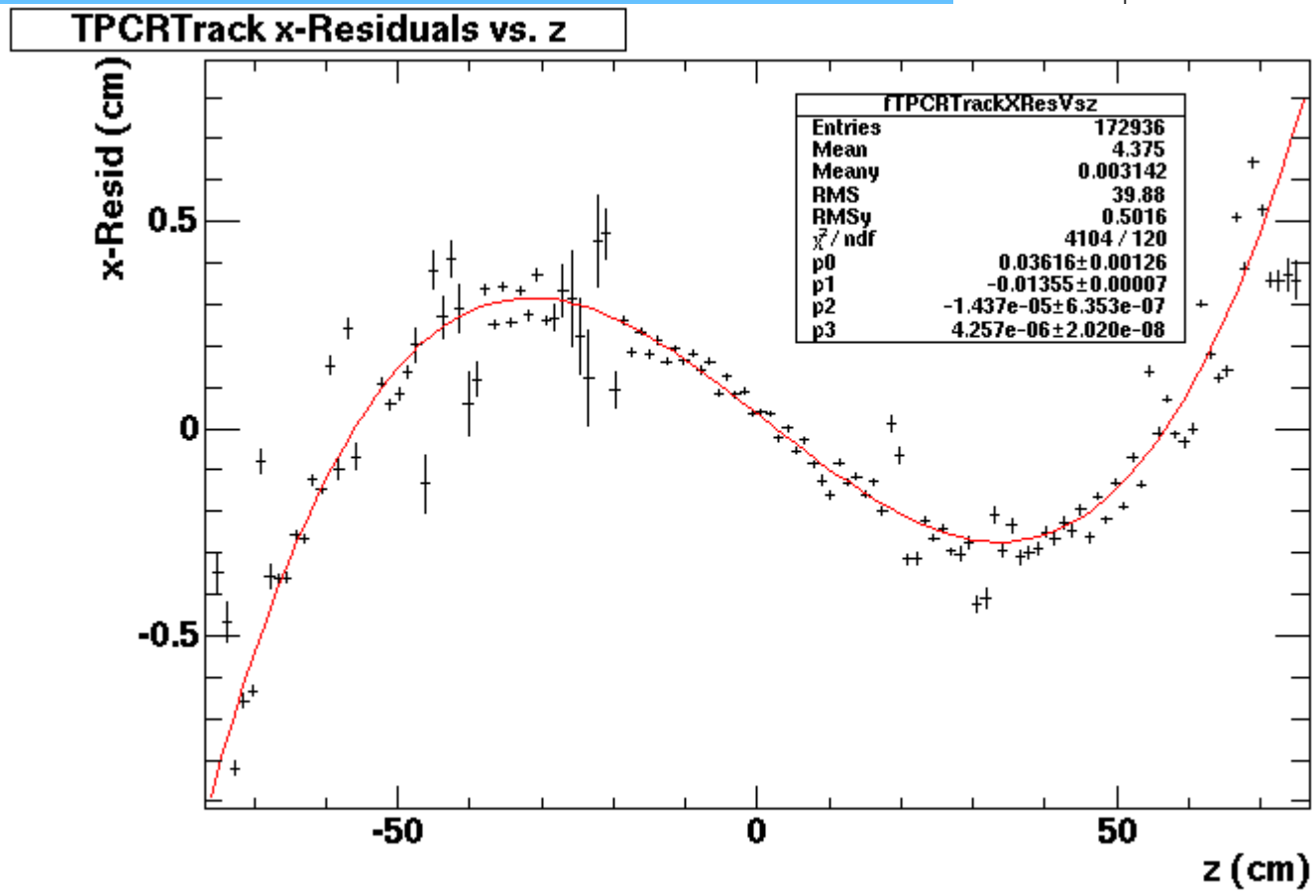
Word: 0400
Bits: C447
TPC Front
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
track 12
track 18
track 17
track 5
track 1
track 15
track 2
track 4
track 9
track 7
h31
y ('cm')
x ('cm')
z ('cm')
TPC Top
x ('cm')
z (cm)
track 5
track 7
track 4
track 11
track 12
track 1
track 2
track 15
track 8
track 17
track 9

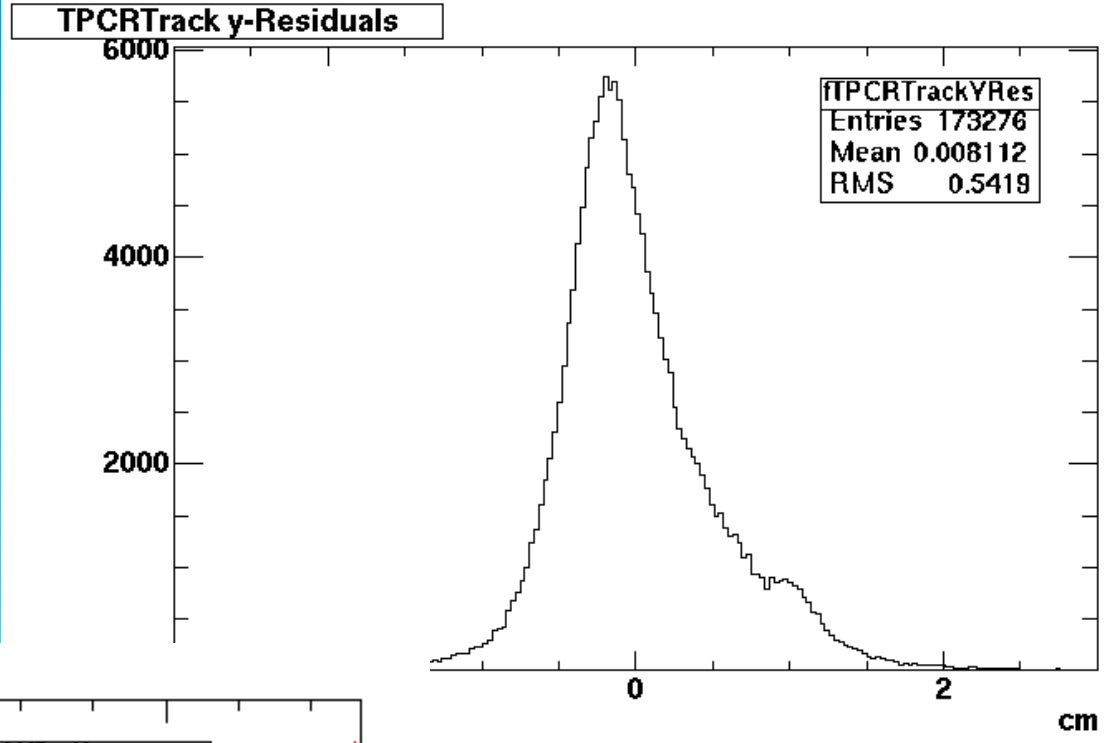

Number of hits per track
h1
Entries 3510
Mean 49.37
RMS 25.53
100
50
0
0
50
100
Hits

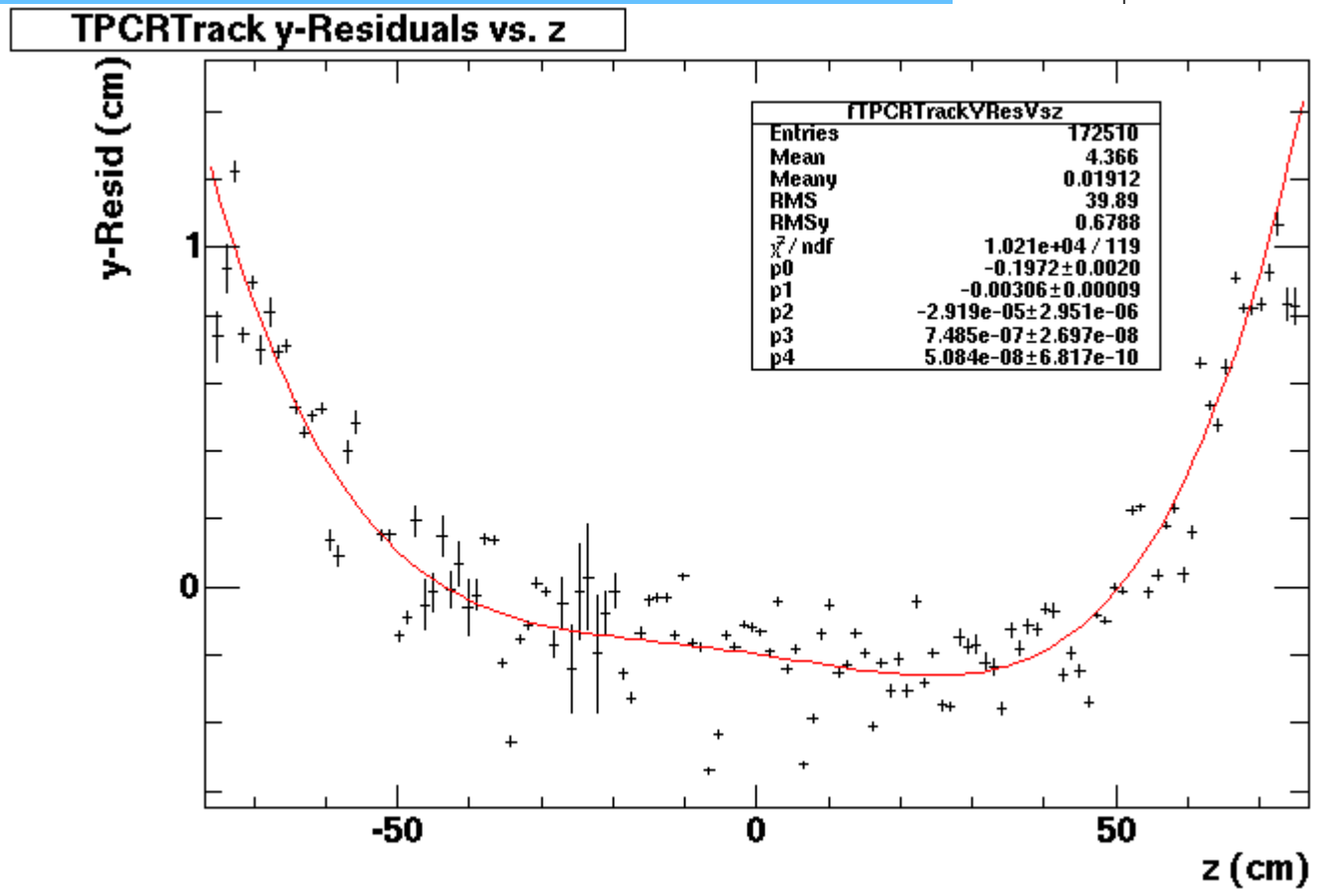

TPCRTrack x(z=zmin) Dist.
fTPCRTrackX
Entries 3253
Mean -1.838
RMS 7.733
150
100
50
0
-20
0
20
x (cm)


y(z=zmin) Dist.
fTPCRTrackY
Entries 3253
Mean -2.438
RMS 7.555
-10
0
10
y (cm)


TPCRTrack x-Residuals
fTPCRTrackXRes
Entries 173276
Mean 0.0008762
RMS 0.3958
5000
0
2
cm


TPCRTrack x-Residuals vs. z
fTPCRTrackXResVsz
Entries 172936
Mean 4.375
Meany 0.003142
RMS 39.88
RMSy 0.5016
χ² / ndf 4104 / 120
p0 0.03616±0.00126
p1 -0.01355±0.00007
p2 -1.437e-05±6.353e-07
p3 4.257e-06±2.020e-08
x-Resid (cm)
0.5
0
-0.5
-50
0
50
z (cm)


TPCRTrack y-Residuals
6000
4000
2000
fTPCRTrackYRes
Entries 173276
Mean 0.008112
RMS 0.5419
0
2
cm


TPCRTrack y-Residuals vs. z
y-Resid (cm)
1
0
fTPCRTrackYResVsz
Entries 172510
Mean 4.366
Meany 0.01912
RMS 39.89
RMSy 0.6788
χ²/ndf 1.021e+04 / 119
p0 -0.1972±0.0020
p1 -0.00306±0.00009
p2 -2.919e-05±2.951e-06
p3 7.485e-07±2.697e-08
p4 5.084e-08±6.817e-10
-50
0
50
z (cm)

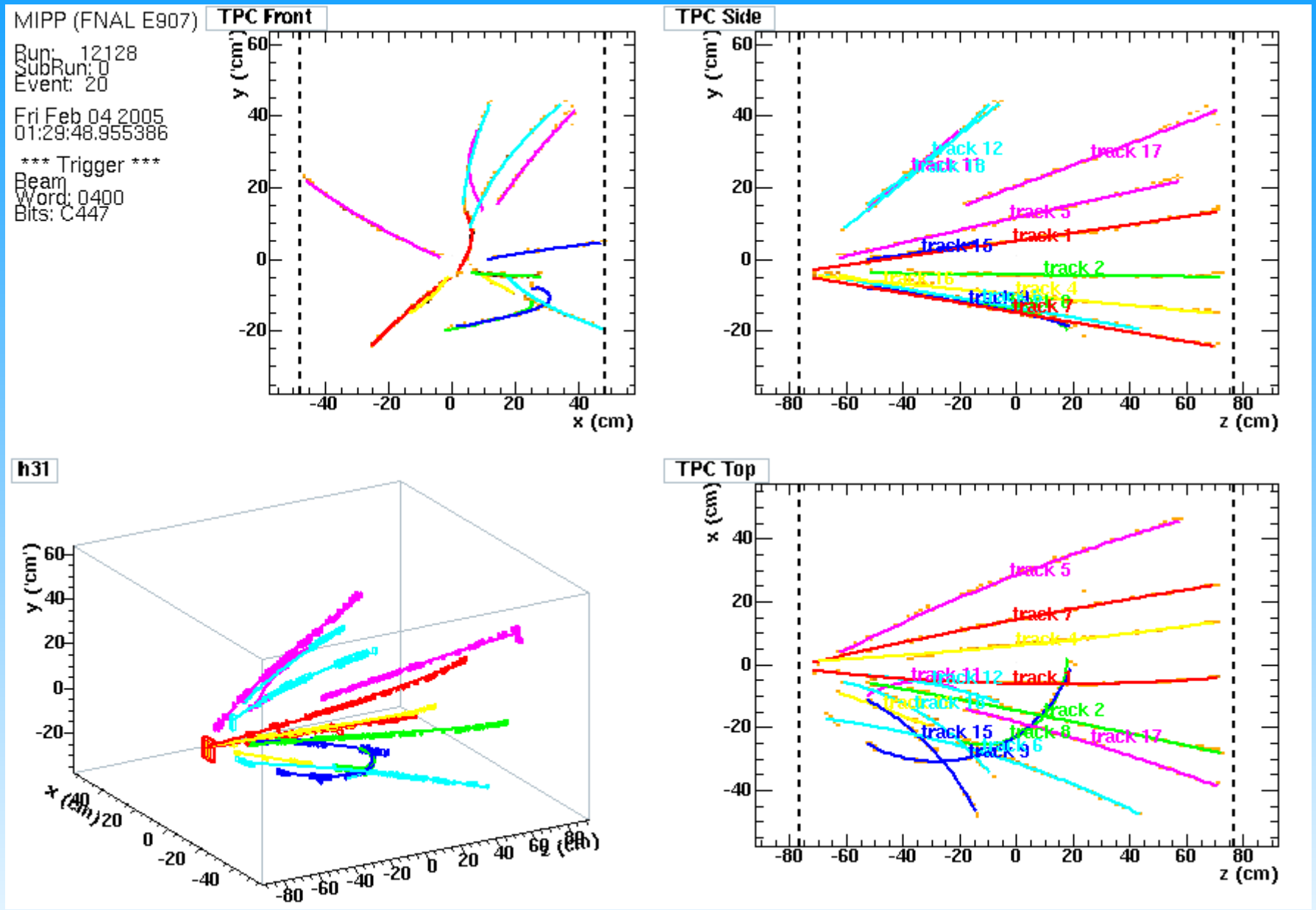
# TPCRVertex and TPCRVertexFind

- TPCRVertex: class that holds list of TPCRTracks associated with the vertex, as well as the position of the vertex.

- TPCRVertexFind: JobCModule class whose job it is to find a vertex from TPCRTracks:

  - algorithm for calculating vertex position assumes the vertex is *outside* the TPC volume. This is because with no magnetfic field, the calculation is linear, and all we have to do is matrix inversion.

  - the collection of tracks that form a vertex is initally formed from a list of two-track intersections that fall within a variable sized “box”.


MIPP (FNAL E907)
Run: 12128
SubRun: 0
Event: 20
Fri Feb 04 2005
01:29:48.955386
*** Trigger ***
Beam
Word: 0400
Bits: C447
TPC Front
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
track 12
track 18
track 17
track 5
track 1
track 15
track 2
track 4
track 9
track 7
h31
y ('cm')
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z ('cm')
TPC Top
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track 5
track 7
track 4
track 11
track 12
track 1
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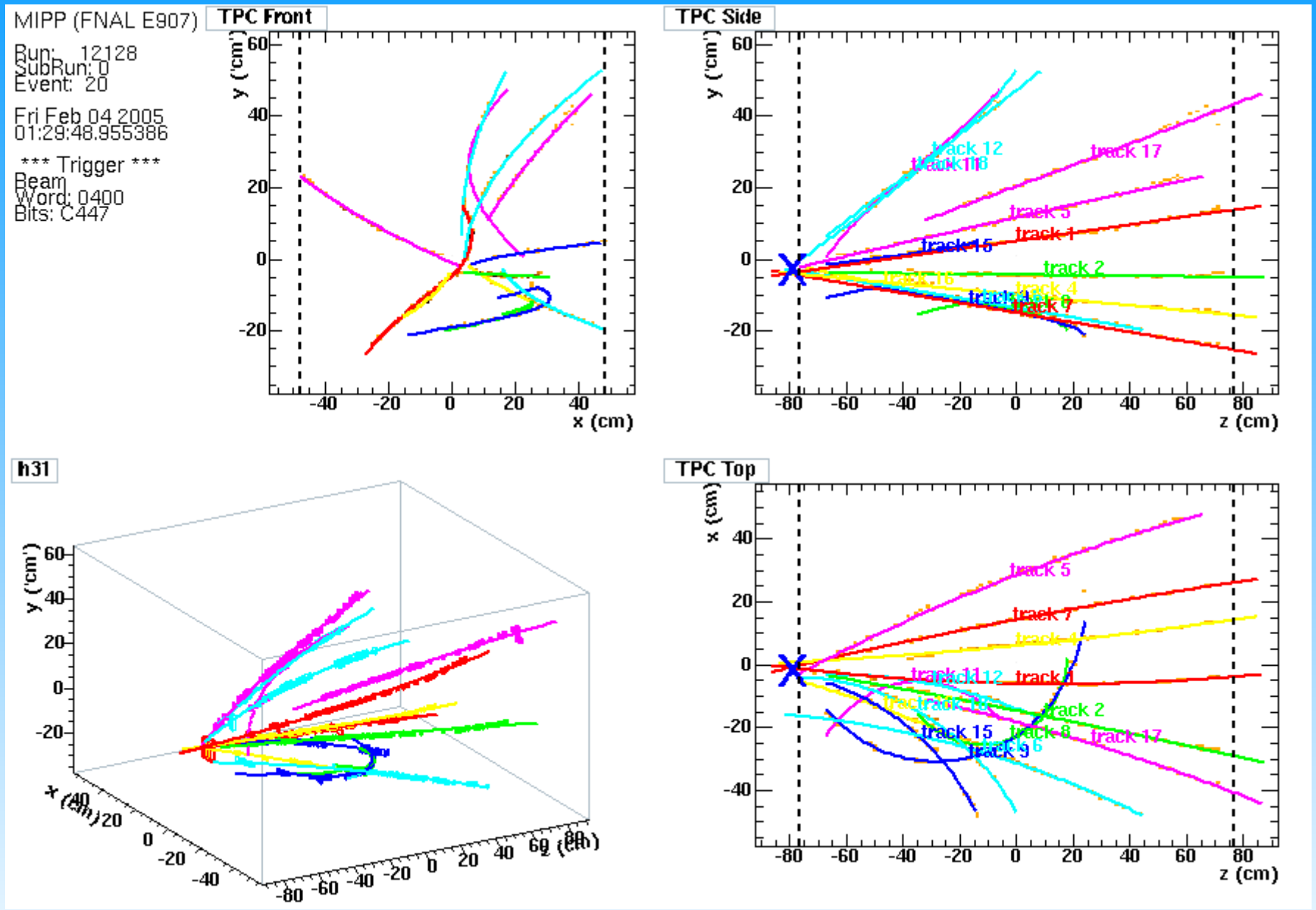
track 15
track 8
track 17
track 9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TPC Top
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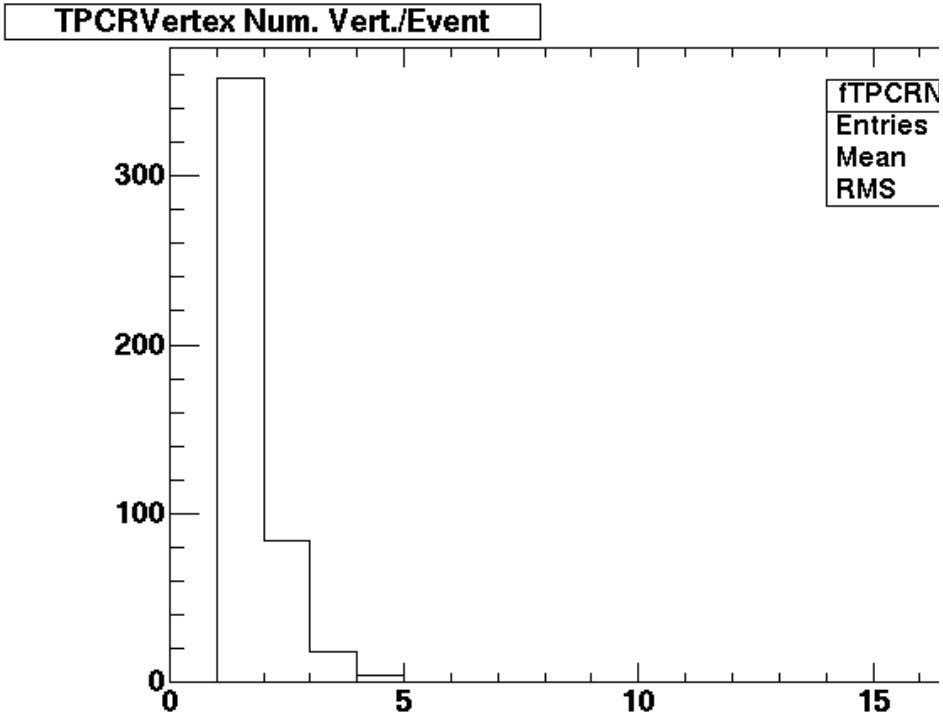
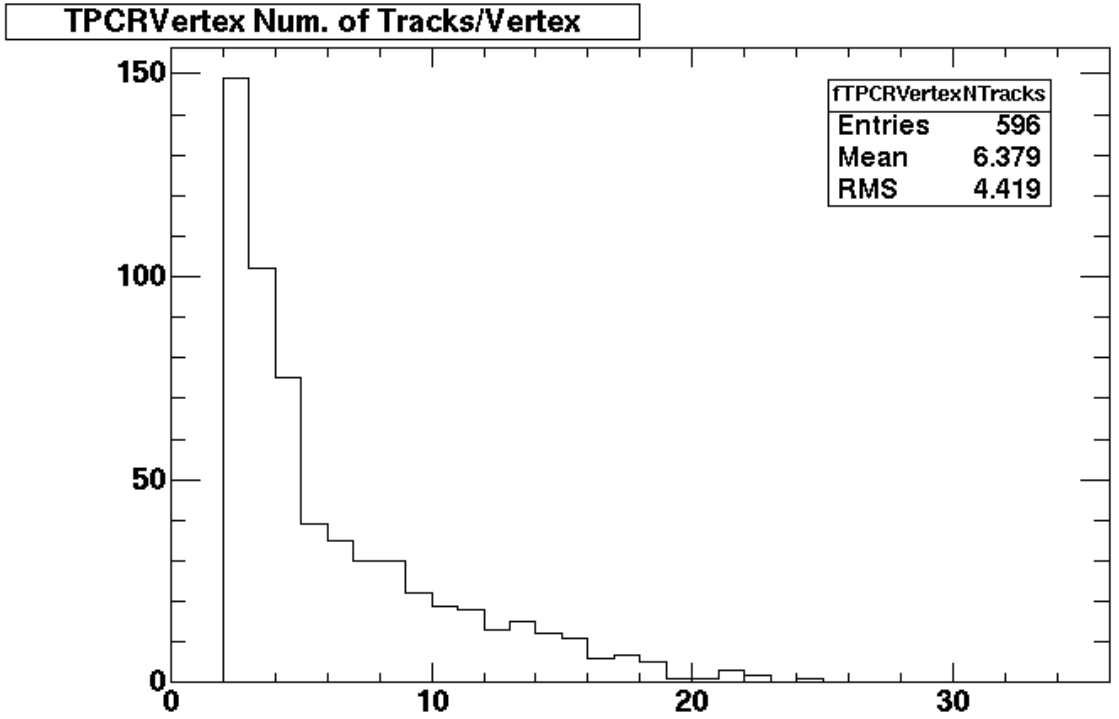
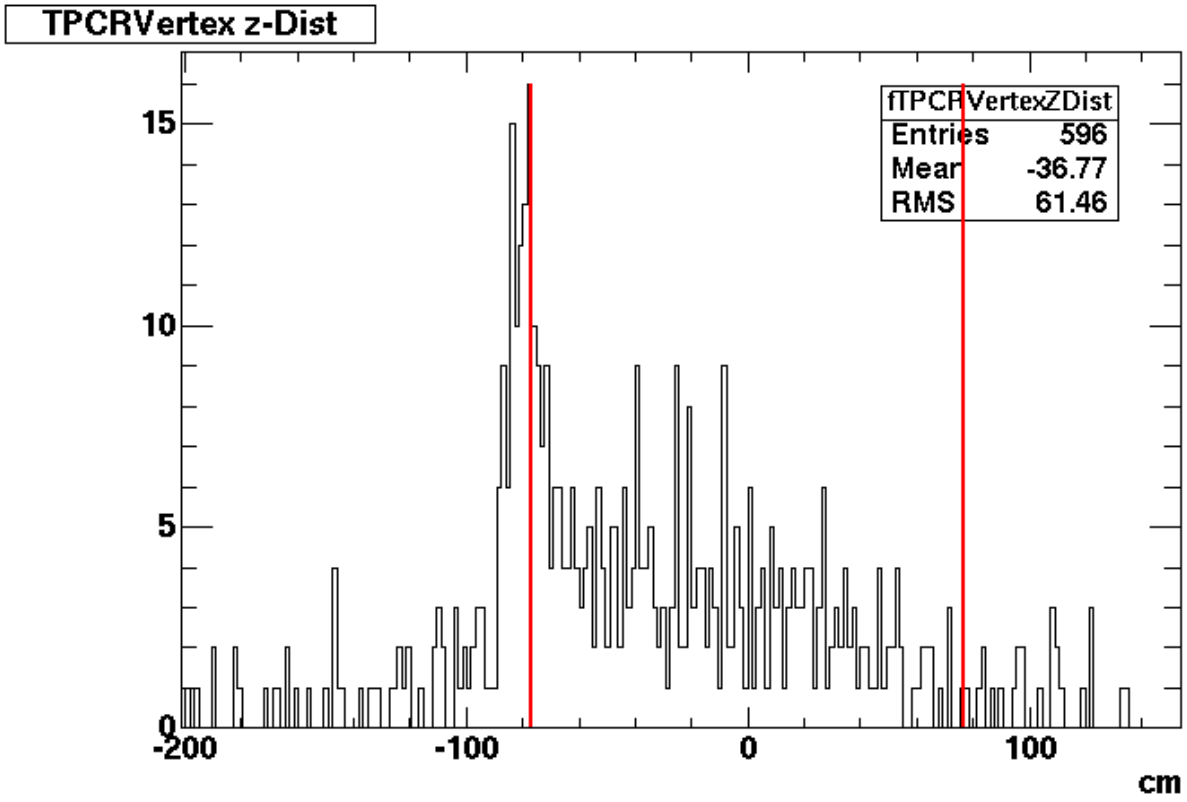
track 17
track 9


TPCRVertex Num. Vert./Event
fTPCRN
Entries
Mean
RMS
300
200
100
0
0
5
10
15


TPCRVertex Num. of Tracks/Vertex
fTPCRVertexNTracks
Entries 596
Mean 6.379
RMS 4.419
150
100
50
0
0
10
20
30


TPCRVertex z-Dist
fTPCRVertexZDist
Entries 596
Mean -36.77
RMS 61.46
15
10
5
0
-200
-100
0
100
cm