

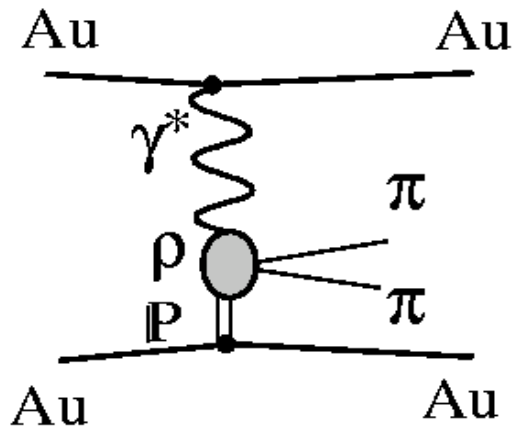
Understanding the Cosmic Ray Background

- Motivation - maximize signal (p^0 candidates) and minimize cosmic ray background
- Method - systematic study of cuts to determine significant dependencies

Algorithm for Eliminating Background

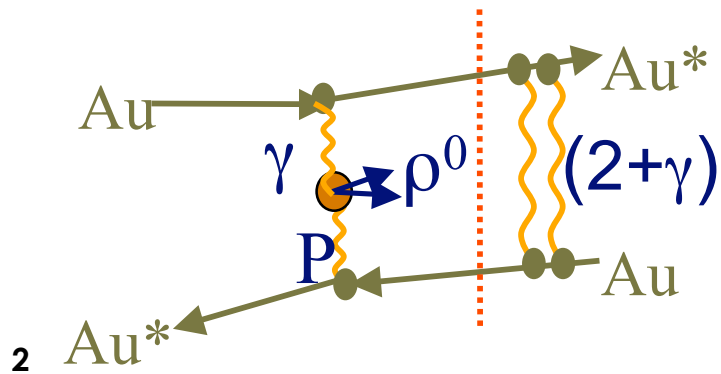
- Apply cuts to maximize cosmic ray background, minimize p signal
- Estimate cosmic ray spectrum
- Apply cuts to maximize p signal, minimize cosmic ray background
- Estimate proportion of cosmic rays that escape cuts

Production Mechanisms



Exclusive ρ^0 Production -
UPC Topology trigger

Courtesy of F. Meissner



ρ^0 Production With Coulomb Excitation
- UPC Minbias trigger

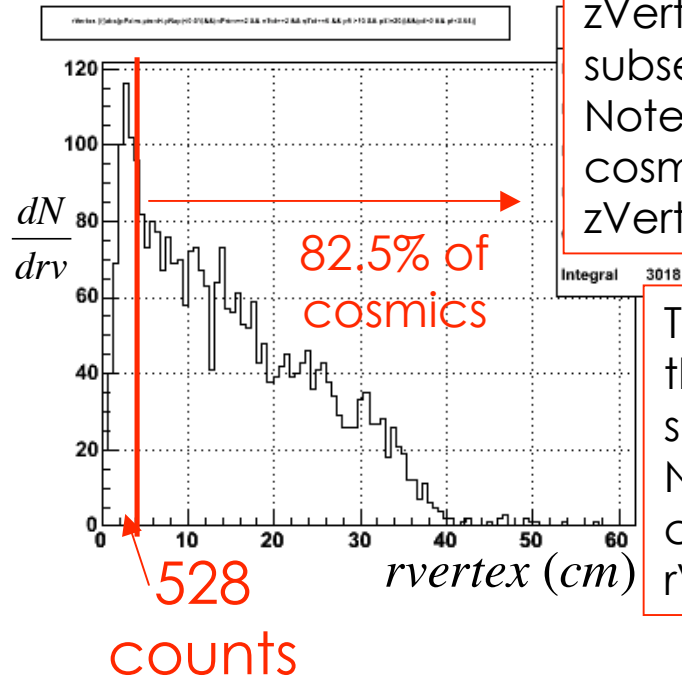
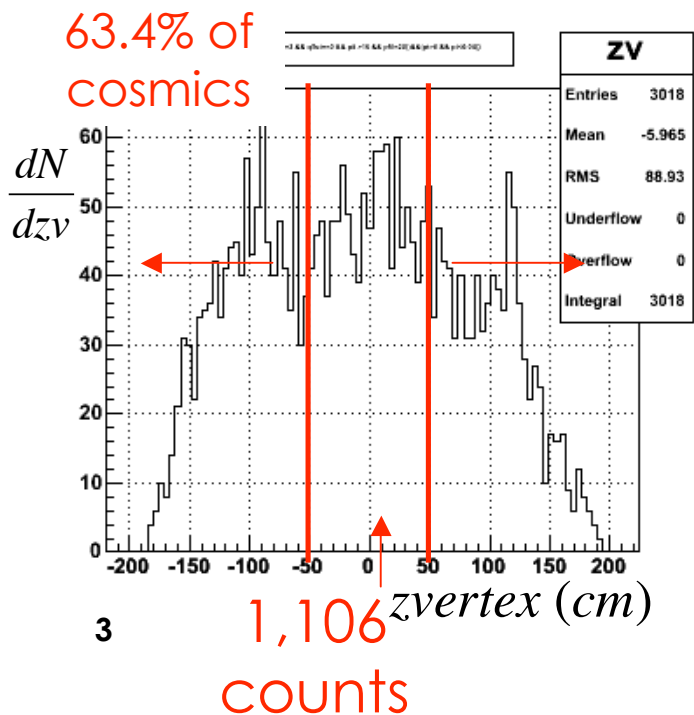
Isolating the Cosmic Ray Candidates

Topology

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
 $p_5 > 10$ and $p_5 \neq 20$ (here is where I explain what p_5 is),
 rapidity < 0.01 , transverse momentum > 0 GeV & < 0.04 GeV

The main cuts selecting the cosmic candidates are the rapidity and p_T cuts. The cosmic rays are reconstructed with a rapidity of 0 and a low transverse momentum.



The left panel shows the zVertex distribution subsequent to the cuts. Note that 63% of the cosmics fall outside of the zVertex window ± 50 cm.

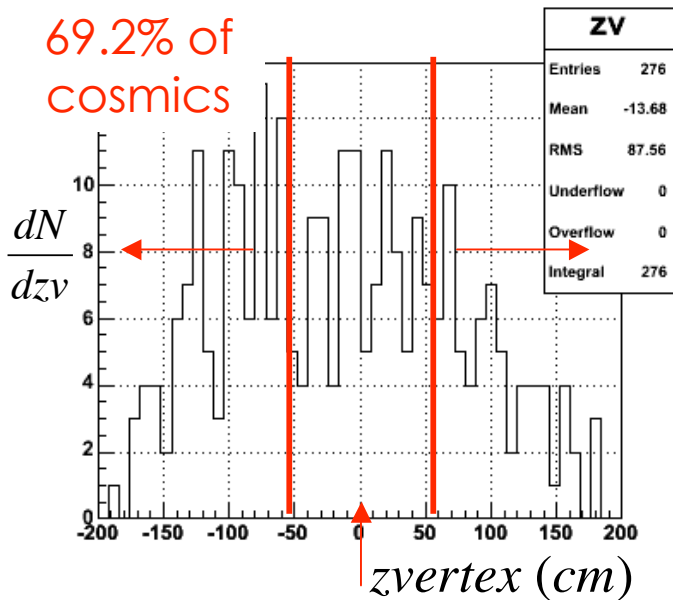
The right panel shows the rVertex distribution subsequent to the cuts. Note that 83% of the cosmics fall beyond an rVertex of 4 cm.

Isolating the Cosmic Ray Candidates

Minbias

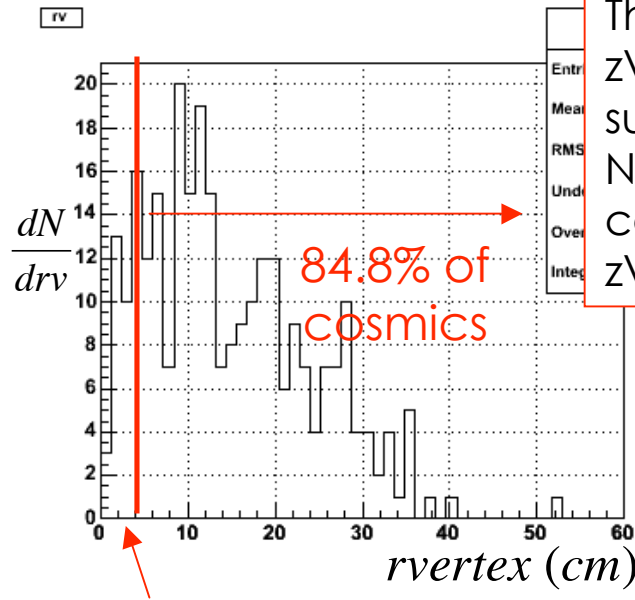
Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
rapidity < 0.01, transverse momentum > 0 GeV & < 0.04 GeV



4

85
counts



42
counts

The left panel shows the zVertex distribution subsequent to the cuts. Note that 69% of the cosmic fall outside of the zVertex window ± 50 cm.

The right panel shows the rVertex distribution subsequent to the cuts. Note that 85% of the cosmic fall beyond an rVertex of 4 cm.

Isolating the Cosmic Ray Candidates

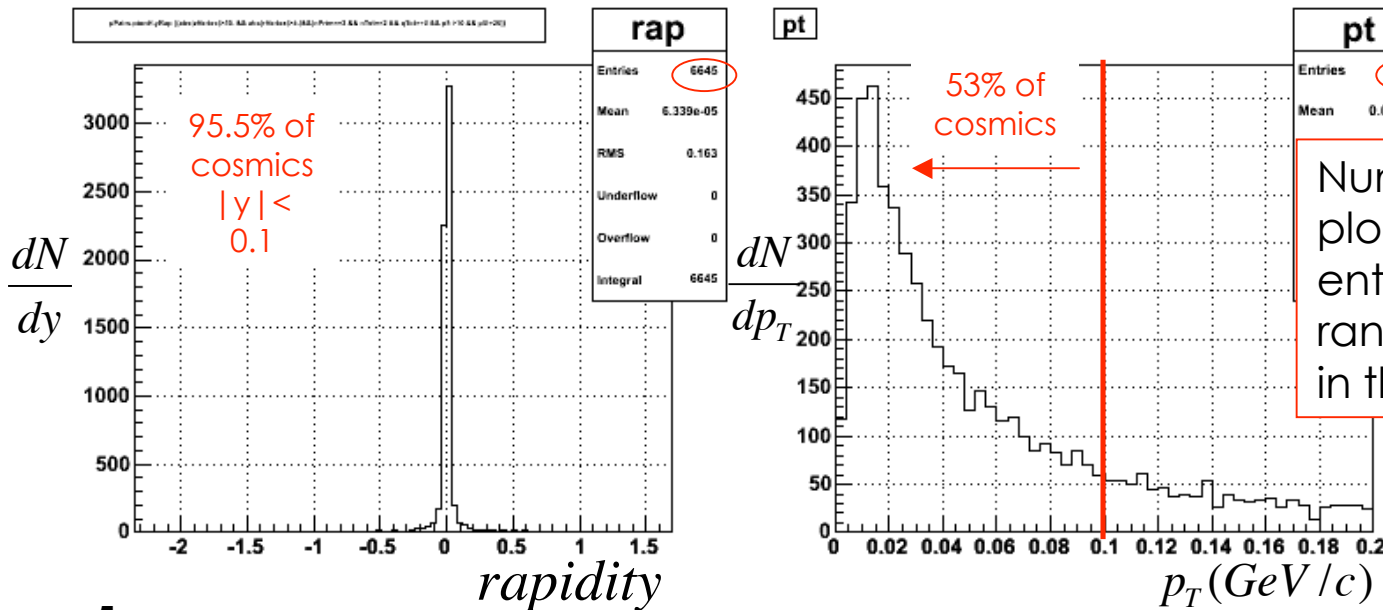
Topology

Cuts applied:

of primary tracks = 2, total tracks =2, total charge = 0, p5 >10 and p5 !=20, |zVertex| > 50 cm, |rVertex| > 4 cm

Here we assume that cosmic rays will mainly fall outside of a zVertex of 50 cm and an rVertex of 4 cm.

Referring back to our rVertex and zVertex distributions on slide 3, we can see that the vertex cuts select (82.5%)(63.4%)=52.3% of cosmic.



Numbers in red on the plots reflect the ratio of entries in the specified range to the total entries in the histogram.

5

$\frac{6645}{.523} = 12,706$ pairs

$\frac{9219}{.523} = 17,627$ events



Isolating the Cosmic Ray Candidates

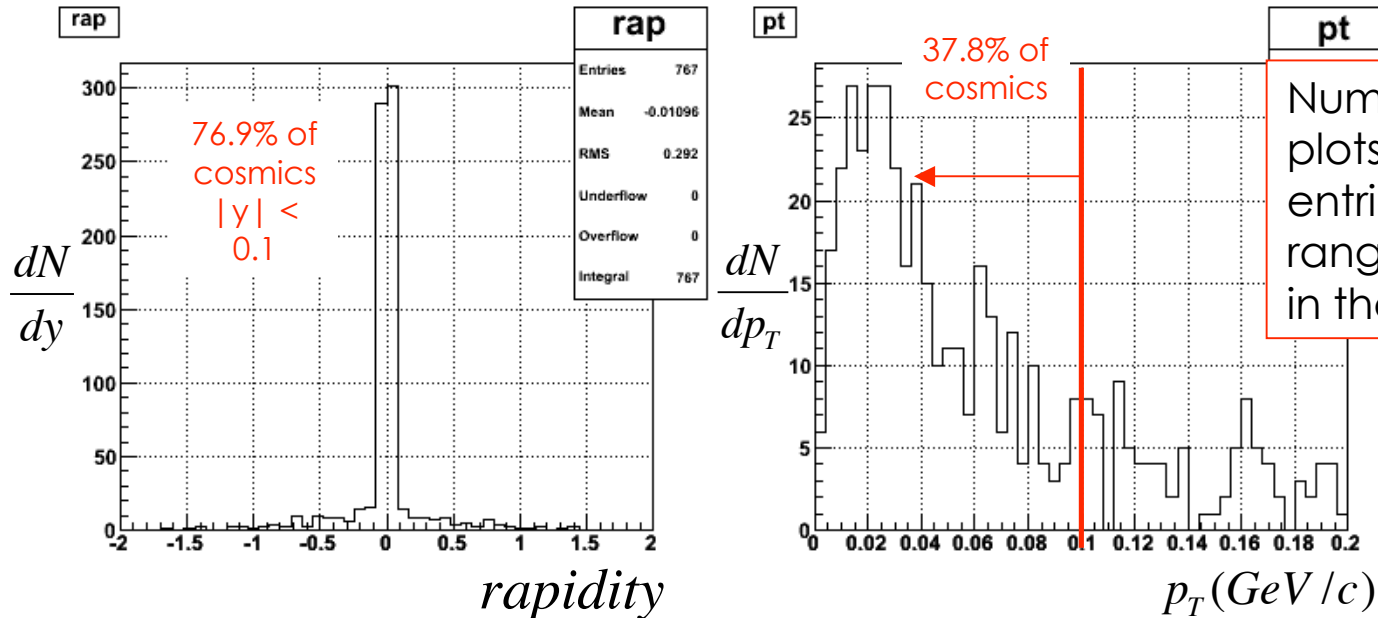
Minbias

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
 $|zVertex| > 50$ cm, $|rVertex| > 4$ cm

Here we assume that cosmic rays will mainly fall outside of a zVertex of 50 cm and an rVertex of 4 cm.

Referring back to our rVertex and zVertex distributions on slide 4, we can see that the cuts vertex cuts select $(69.2\%)(84.8\%) = \underline{58.7\%}$ of cosmic.



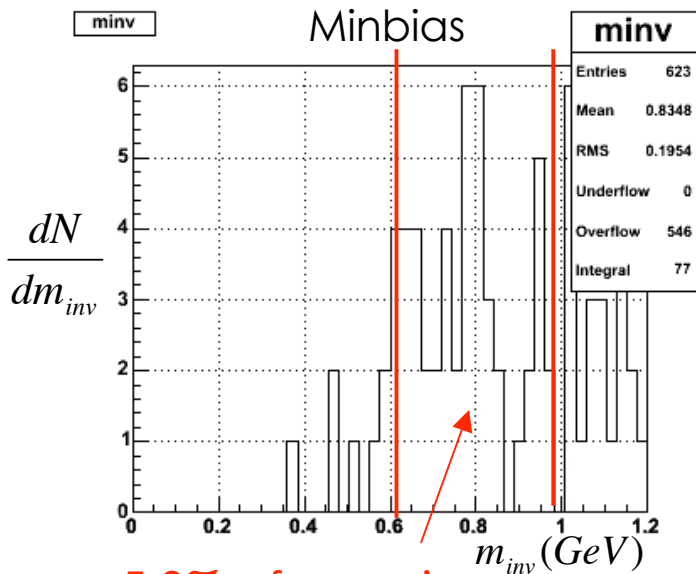
Numbers in red on the plots reflect the ratio of entries in the specified range to the total entries in the histogram.

Isolating the Cosmic Ray Candidates

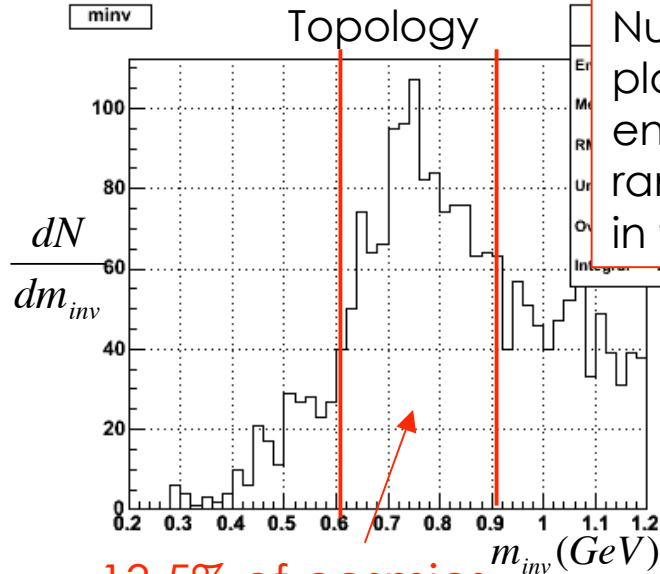
Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
 $|rVertex| > 4$ cm, rapidity < 0.01 (topology - $p_5 > 10$ and $p_5 \neq 20$)

Since the mass of the ρ is ~ 0.770 GeV, the invariant mass cut used in the analysis is from 0.6 GeV to 0.9 GeV. This is the range indicated between the red lines in the histograms.



5.3% of cosmics
 between $0.9 < m_{inv} < 0.6$



13.5% of cosmics
 between $0.9 < m_{inv} < 0.6$

Numbers in red on the plots reflect the ratio of entries in the specified range to the total entries in the histogram.

Isolating ρ Candidates

Recall:

- Motivation - maximize signal (ρ^0 candidates) and minimize cosmic ray background
- Method - systematic study of cuts to determine significant dependencies

Algorithm for Eliminating Background

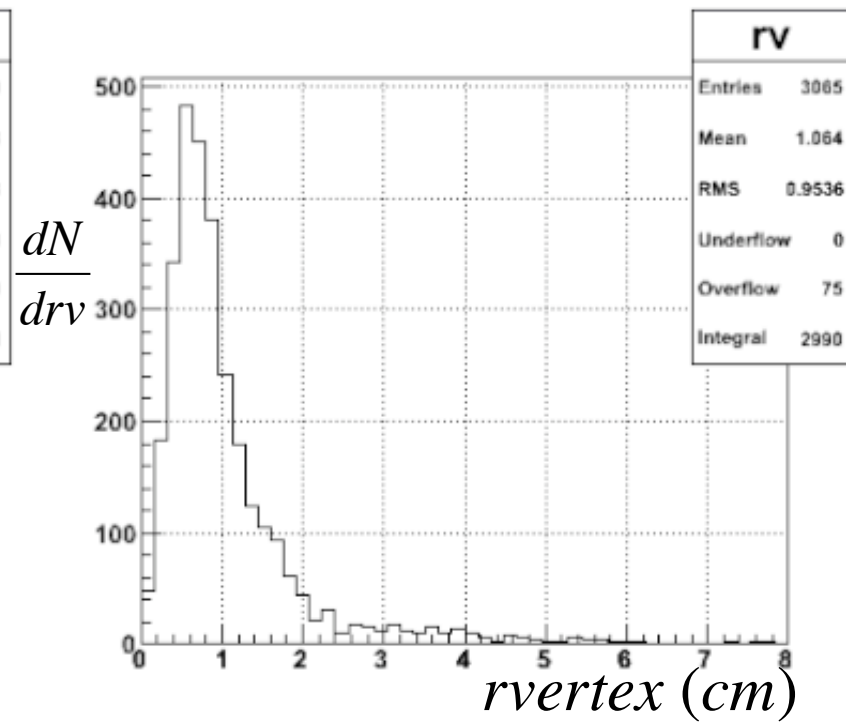
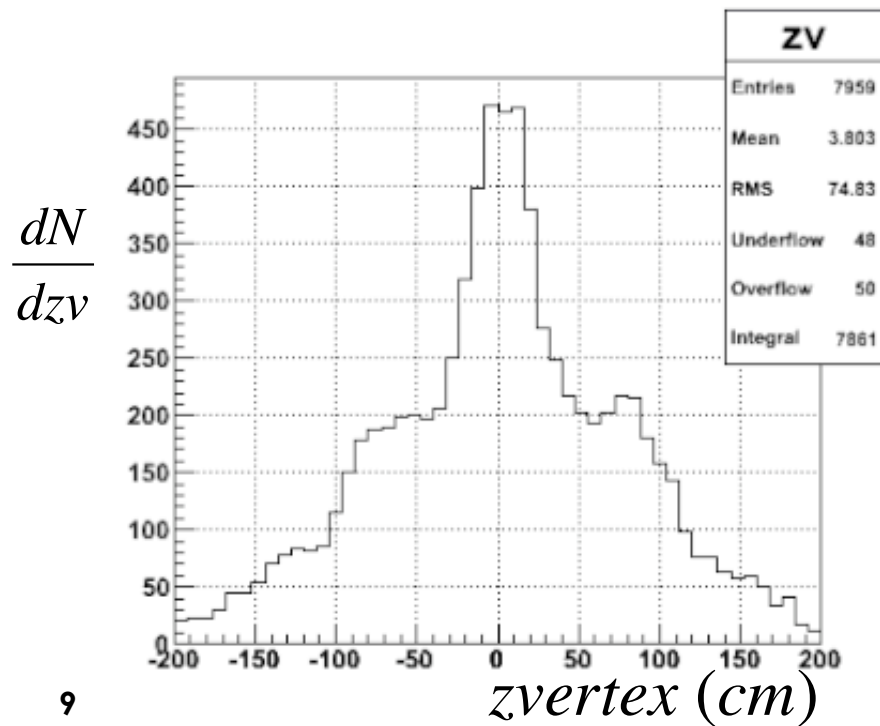
- ✓ Apply cuts to maximize cosmic ray background, minimize ρ signal
- ✓ Estimate cosmic ray spectrum
- Apply cuts to maximize ρ signal, minimize cosmic ray background
- Estimate proportion of cosmic rays that escape cuts

Isolating ρ Candidates - vertex distributions

Topology

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0, rapidity > 0.1, transverse momentum > 0.1 GeV, $p_5 > 10$ and $p_5 \neq 20$, (in addition for zVertex distribution $|rVertex| < 4$ cm and for rVertex distribution $|zVertex| < 30$)

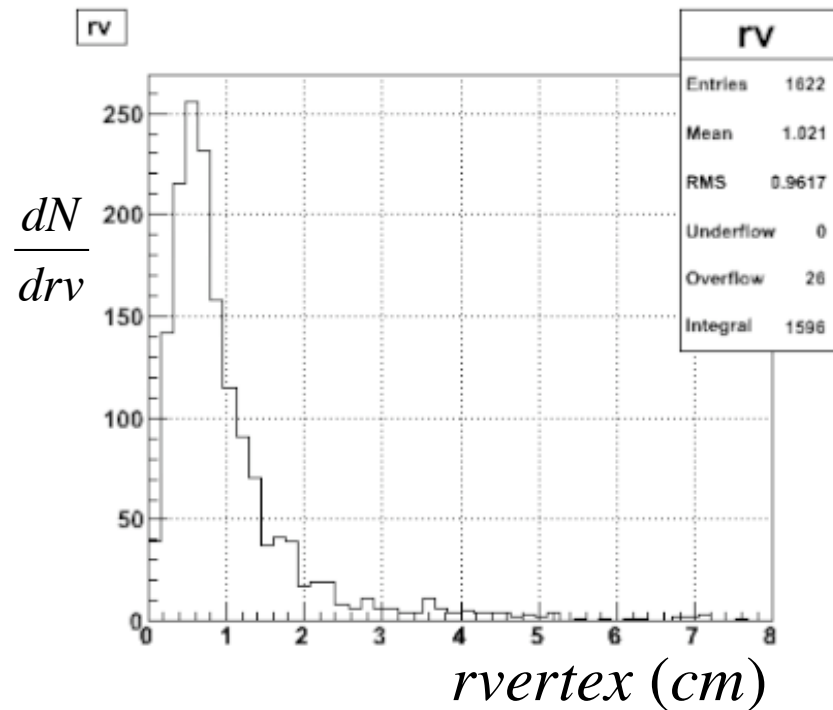
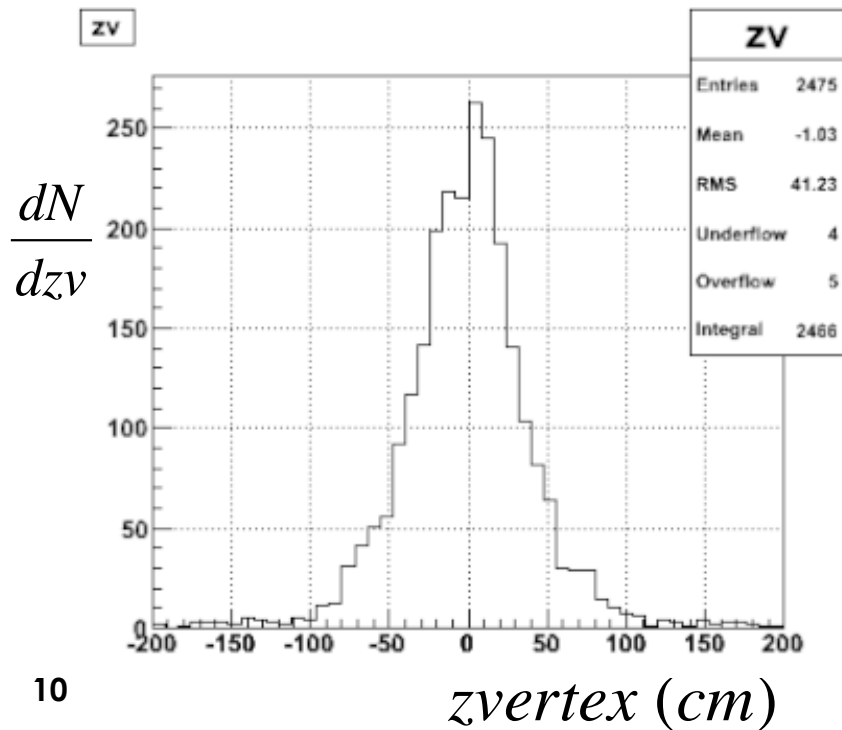


Isolating ρ Candidates - vertex distributions

Minbias

Cuts applied:

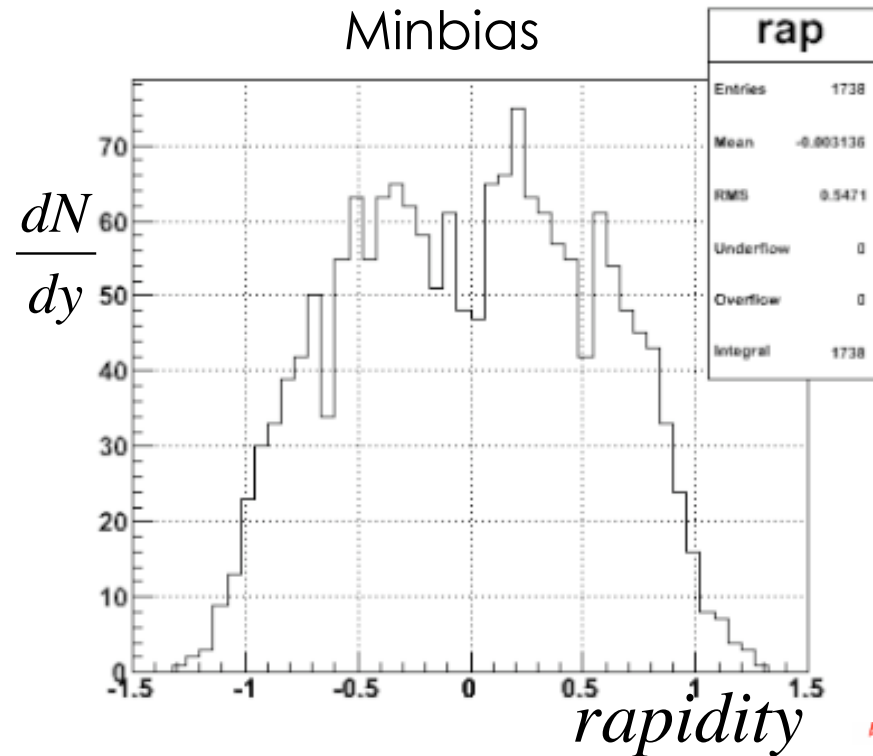
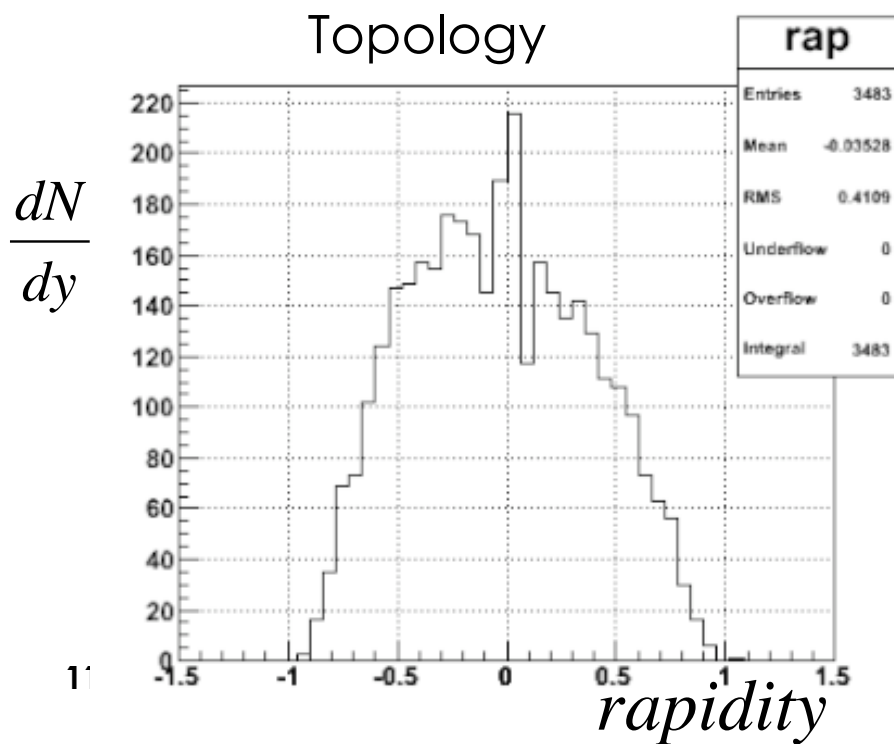
of primary tracks = 2, total tracks = 2, total charge = 0,
rapidity > 0.1, transverse momentum > 0.1 GeV,
(in addition for zVertex distribution $|rVertex| < 4$ cm and for
rVertex distribution $|zVertex| < 30$)



Isolating ρ Candidates - rapidity distributions

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
transverse momentum > 0.0 & < 0.1 GeV,
|rVertex| < 4 cm, |zVertex| < 30,
(topology - p5 > 10 and p5 != 20)

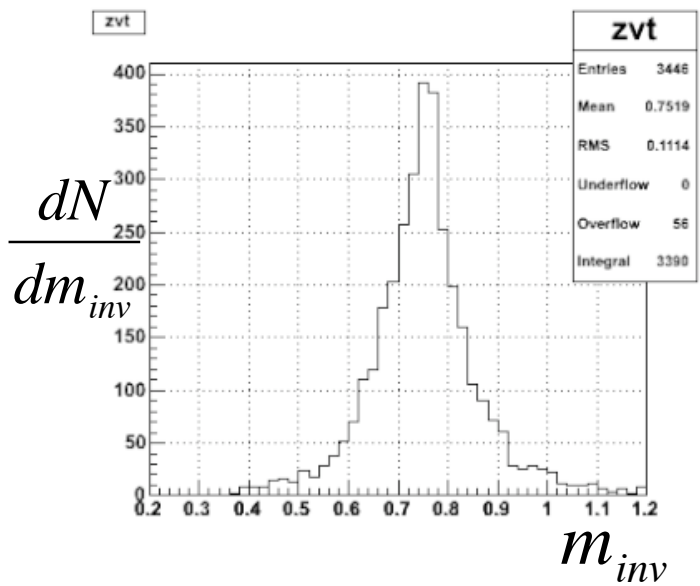


Isolating ρ Candidates - investigating zVertex dependence

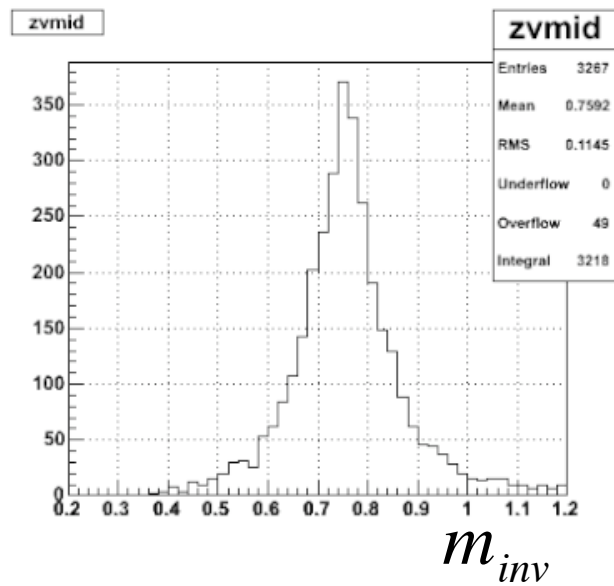
Topology

Cuts applied:

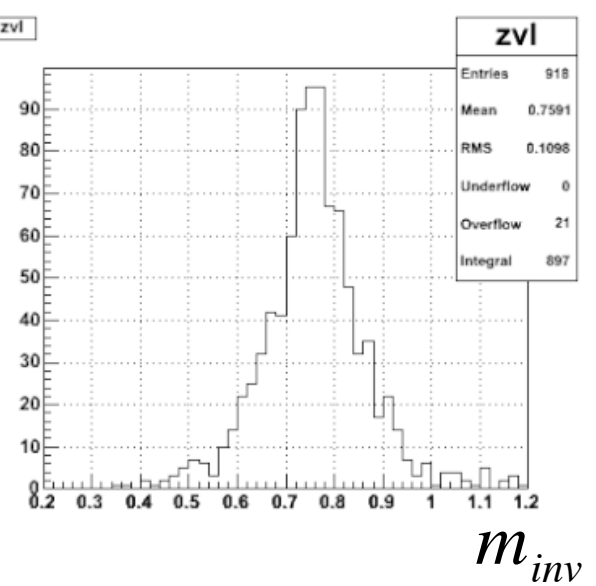
of primary tracks = 2, total tracks = 2, total charge = 0,
 $p_5 > 10$ and $p_5 \neq 20$, transverse momentum > 0.0 & < 0.1
 GeV, rapidity > 0.025 , $|rVertex| < 2$ cm



$|zVertex| < 40$



$|zVertex| > 40$ & < 120



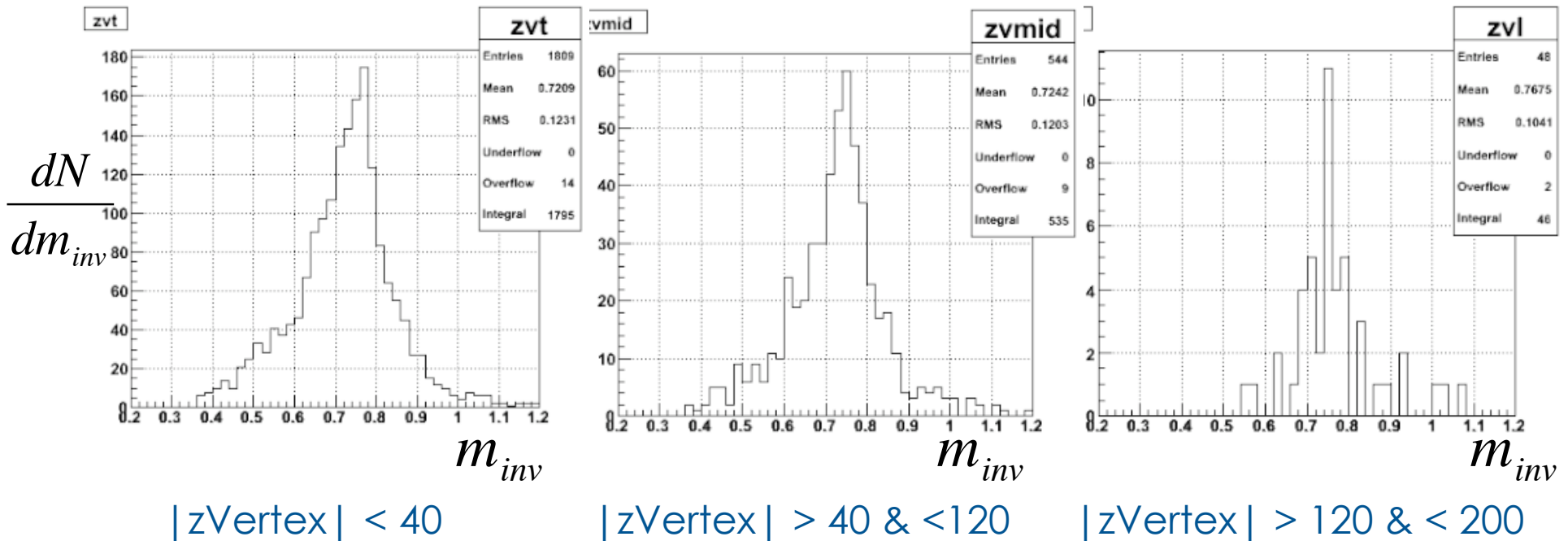
$|zVertex| > 120$ & < 200

Isolating ρ Candidates - investigating zVertex dependence

Minbias

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
 transverse momentum > 0.0 & < 0.1 GeV,
 rapidity > 0.025, |rVertex| < 2 cm



Topology Summary

Cuts	Cosmics	Reals
Total in Data Set	12,706	9,035
$z_{\text{Vertex}} < 30$	22%	34%
$ y > 0.1$	4.5%	91.4%
$r_{\text{Vertex}} < 8$	30%	98%
$p_T < 0.1$	54%	95%
m_{inv} in range	13.5%	100%
Candidates in Mass Peak	2.7	2614