Understanding the Cosmic Ray Background

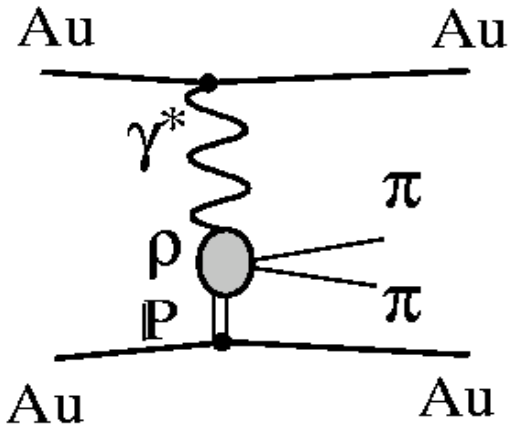
- Motivation - maximize signal (ρ^o candidates) and minimize cosmic ray background
- Method - systematic study of cuts to determine significant dependencies

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

Production Mechanisms

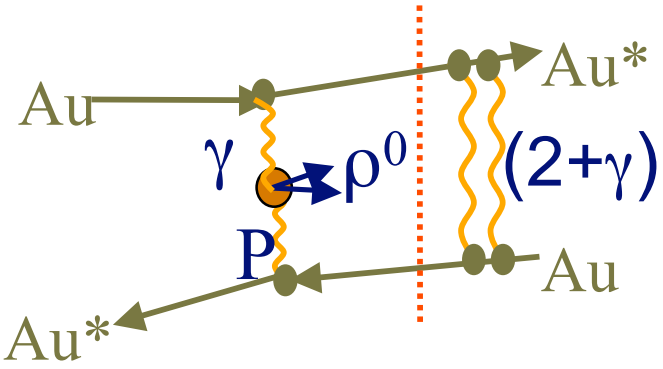
$Au+Au \rightarrow Au+Au+\rho^{o}$



Courtesy of F. Meissner

Exclusive ρ^{o} Production - UPC Topology trigger

$Au+Au \rightarrow Au^{*}+Au^{*}+\rho^{o}$



ρ^{o} Production With Coulomb Excitation (most probably accompanied by 1 neutron per excitation) - UPC Minbias trigger

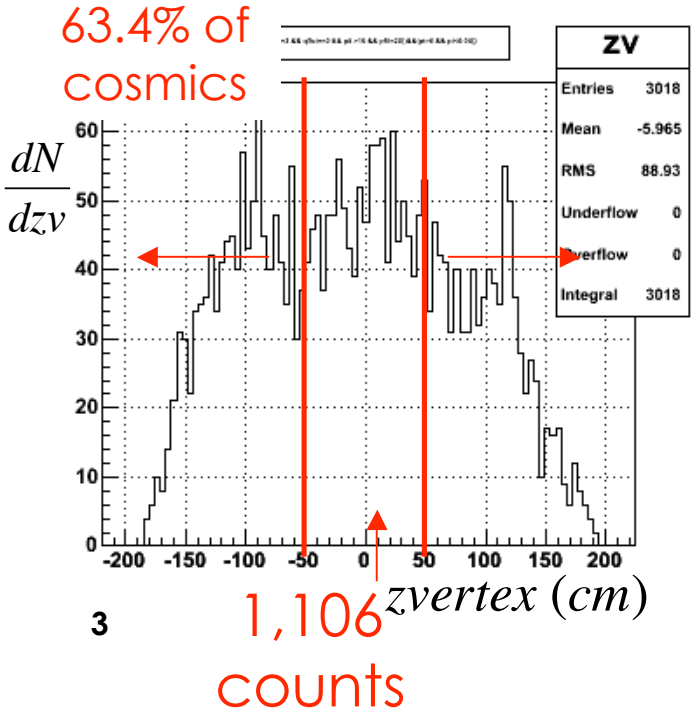
Isolating the Cosmic Ray Candidates

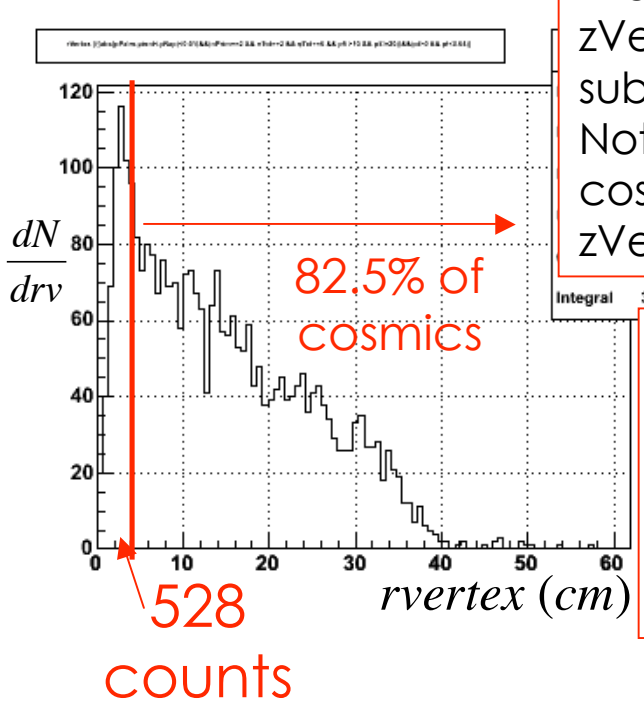
Topology

Cuts applied:

# of primary tracks = 2, total tracks =2, total charge = 0, p5 >10 and p5 !=20 (here is where I explain what p5 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.





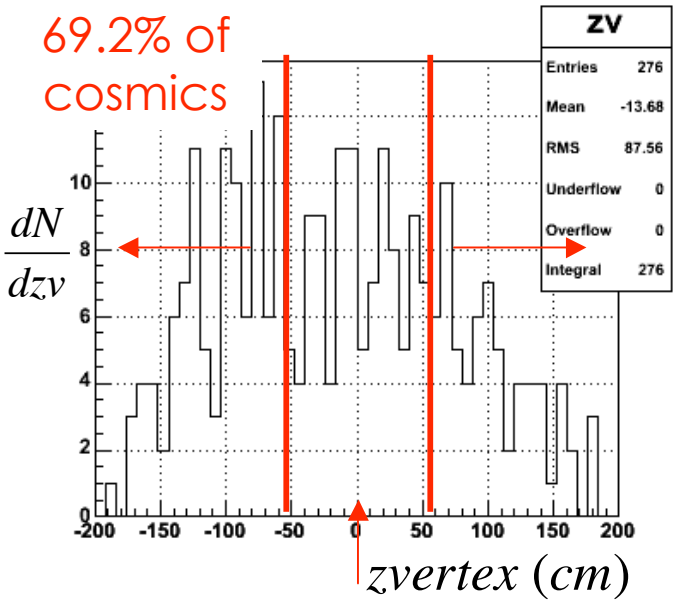
The left panel shows the zVertex distribution subsequent to the cuts. Note that 63% of the cosmics fall outside of the zVertex window ± 50 cm.

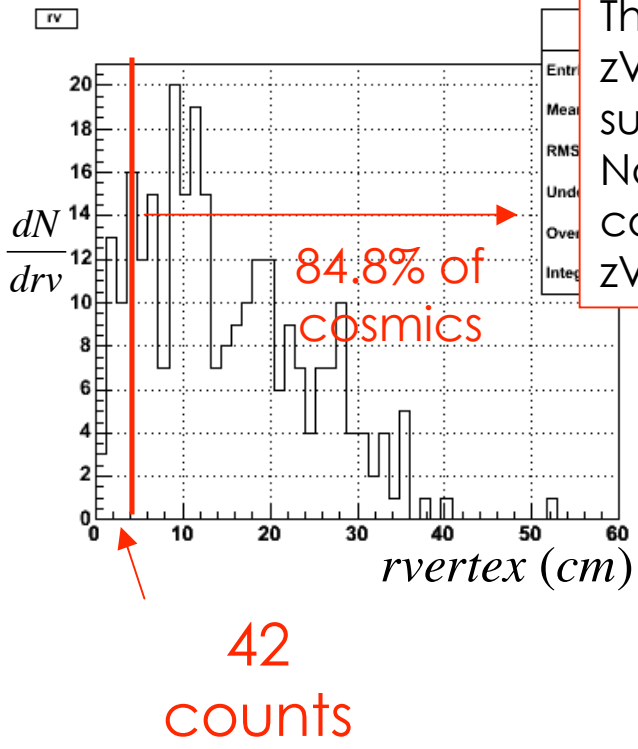
The right panel shows the rVertex distribution subsequent to the cuts. Note that 83% of the cosmics fall beyond an rVertex of 4 cm.

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





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

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

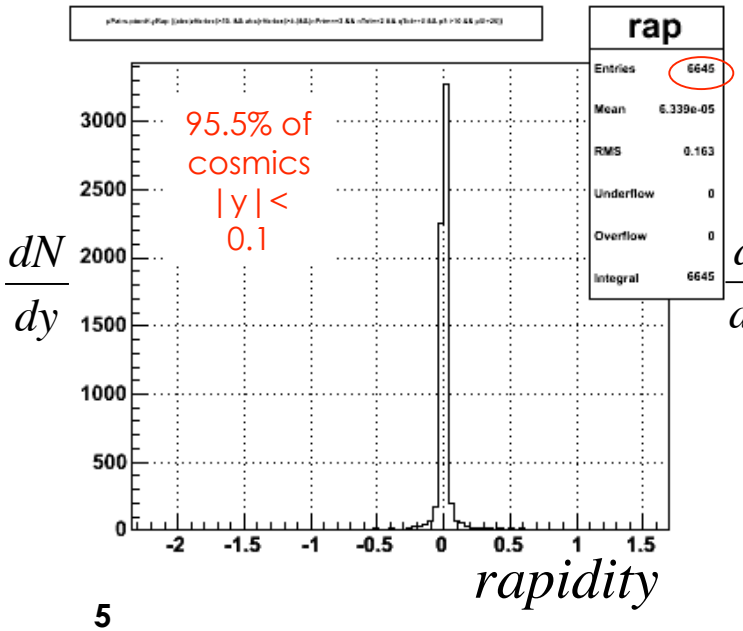
Isolating the Cosmic Ray Candidates

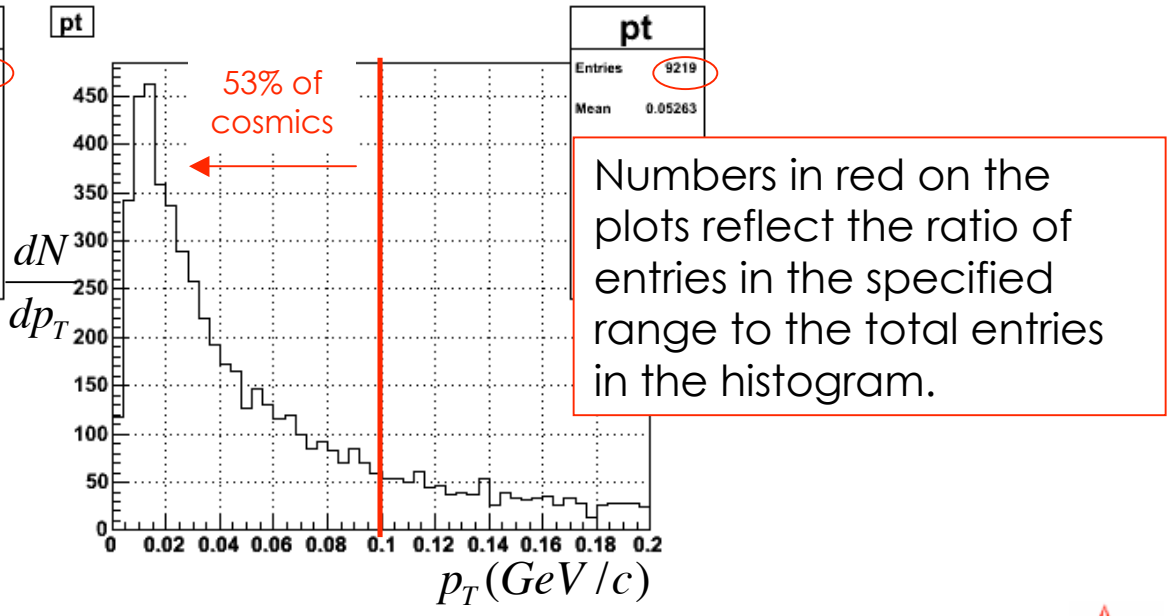
Topology

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 cosmics.





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

6645/.523=12,706 pairs

9219/.523=17,627 events

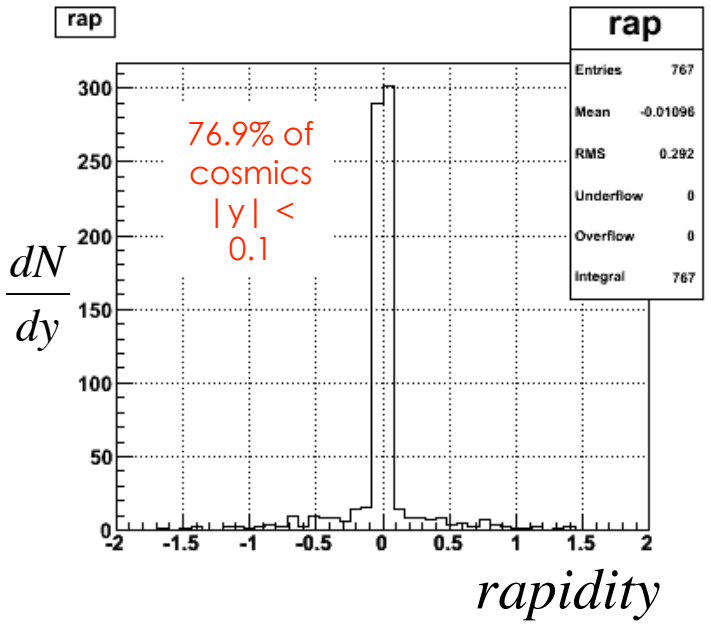
Isolating the Cosmic Ray Candidates

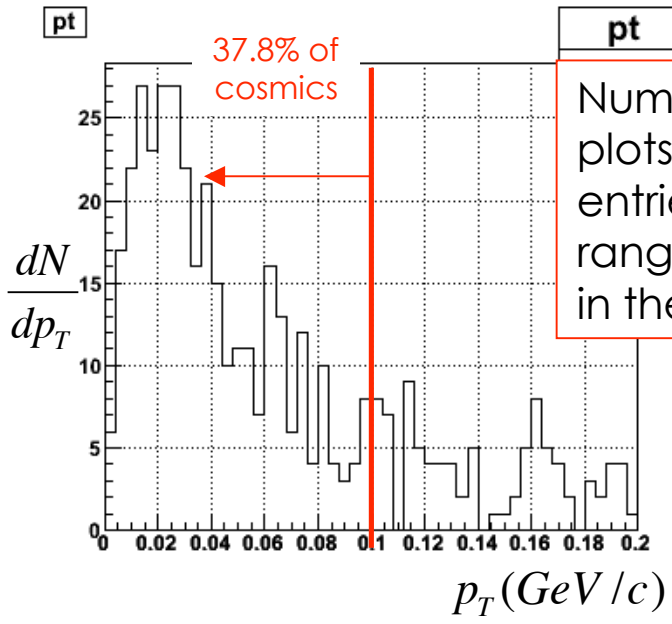
Minbias

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%) =58.7% of cosmics.





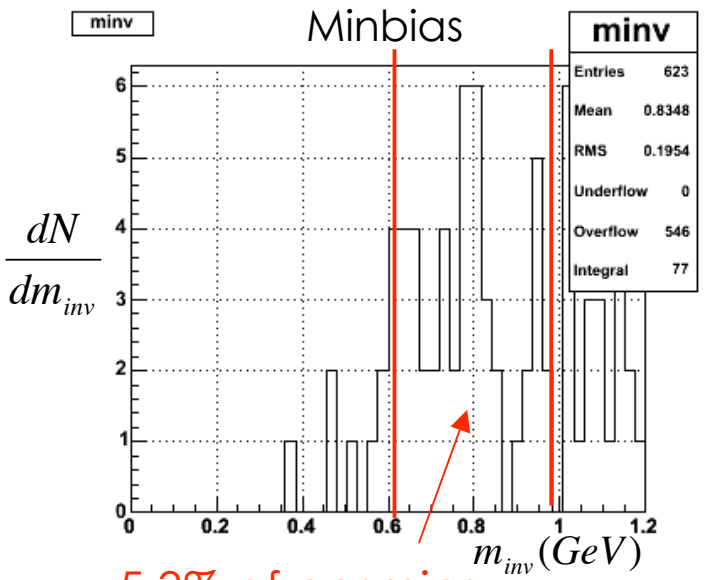
Numbers in red on the plots reflect the ratio of entries in the specified range to the total entries in the histogram.

Isolating the Cosmic Ray Candidates

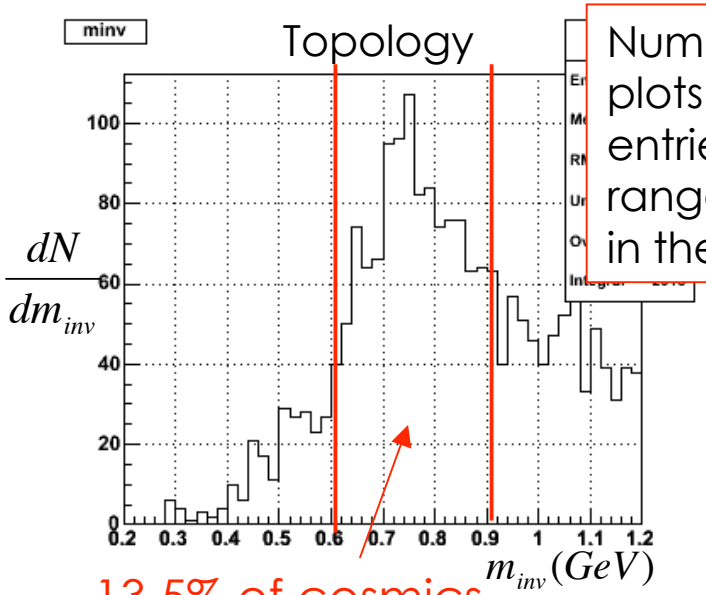
Cuts applied:

# of primary tracks = 2, total tracks =2, total charge = 0,
|rVertex| > 4 cm, rapidity < 0.01(topology - p5 >10 and p5 !=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^o 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

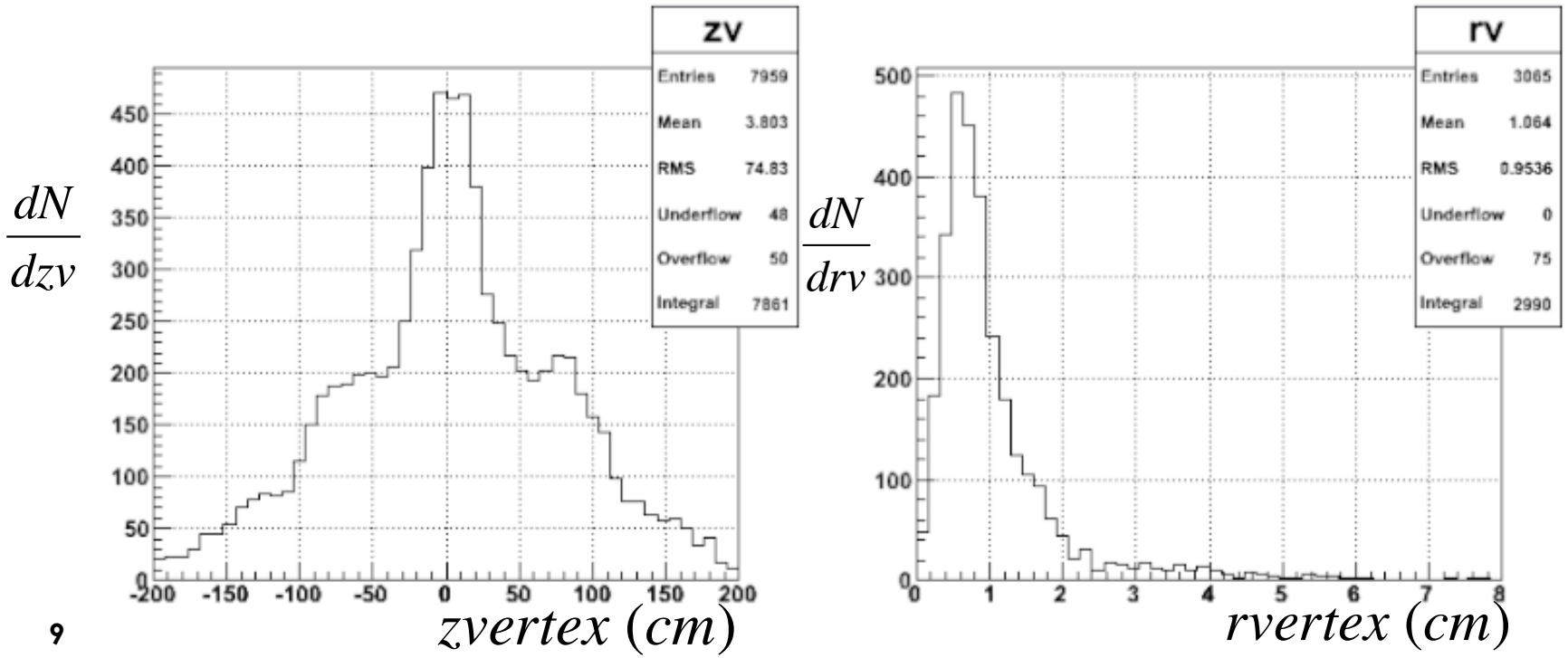
→ Estimate proportion of cosmic rays that escape cuts

Isolating ρ Candidates - vertex distributions

Topology

Cuts applied:

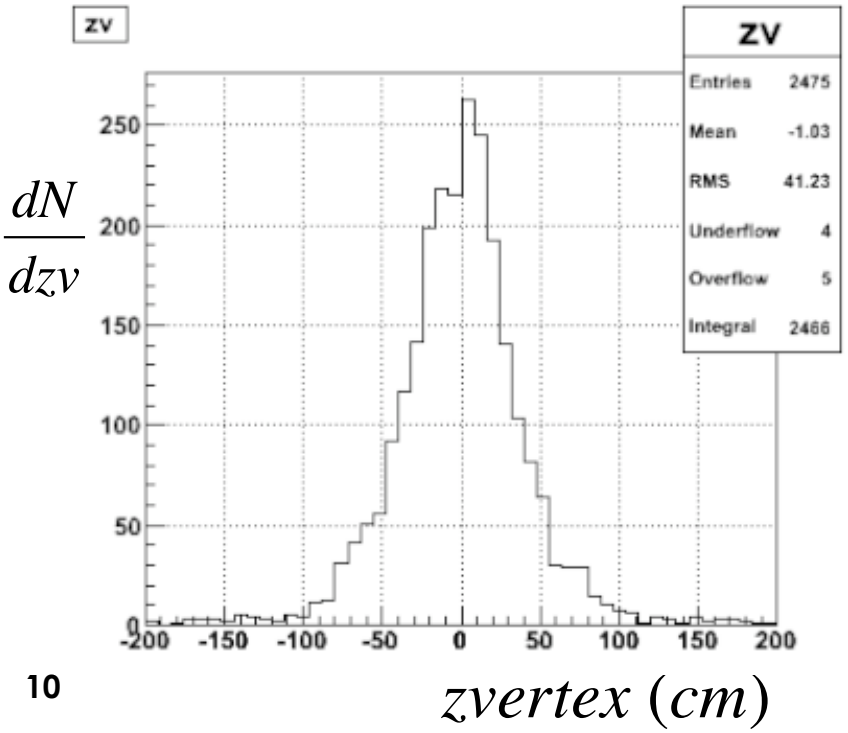
# of primary tracks = 2, total tracks =2, total charge = 0, rapidity > 0.1, transverse momentum > 0.1 GeV, p5 >10 and p5 !=20, (in addition for zVertex distribution |rVertex| < 4 cm and for rVertex distribution |zVertex| < 30)

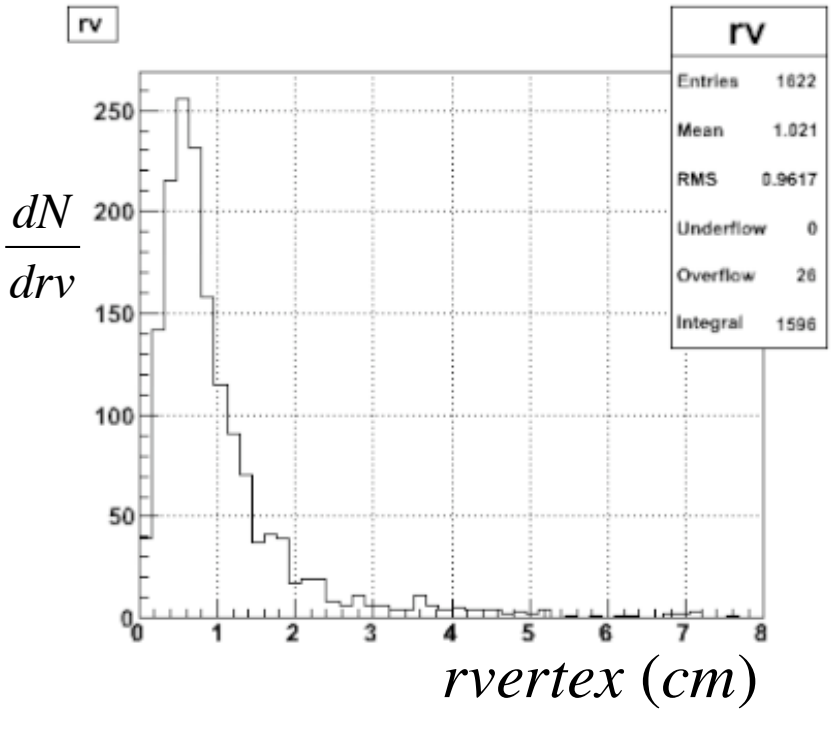


Isolating ρ Candidates - vertex distributions

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)



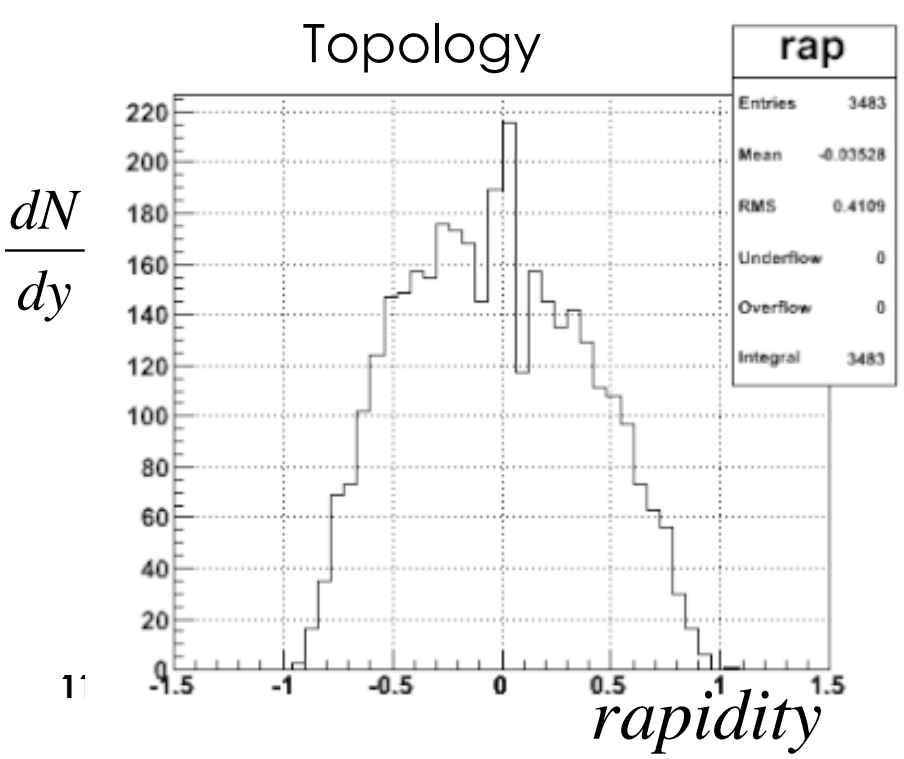


Isolating ρ Candidates - rapidity distributions

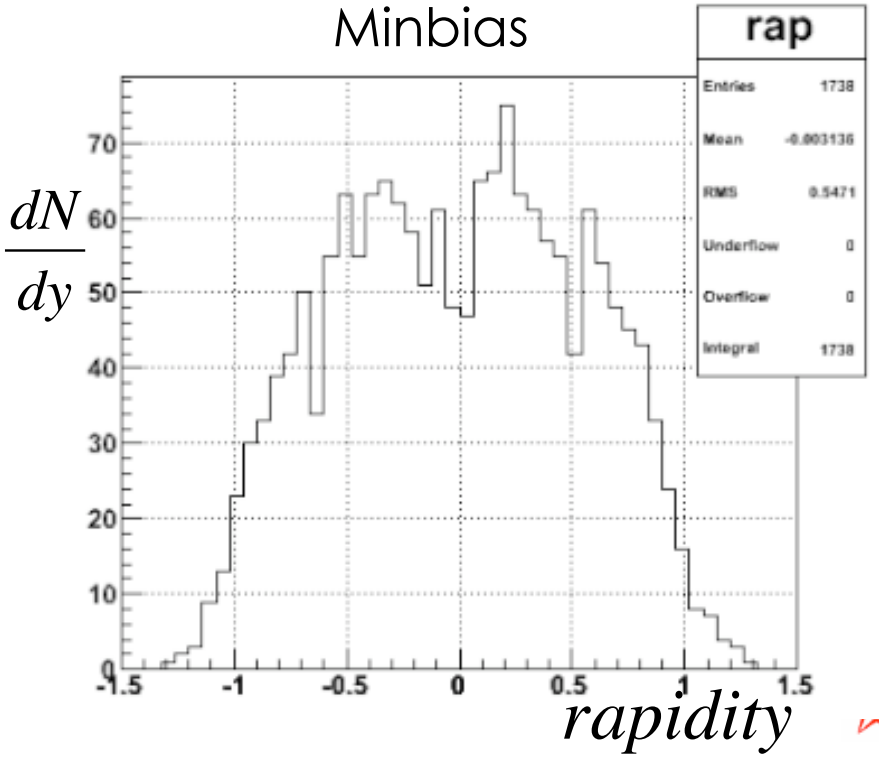
Cuts applied:

# 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)

Topology



Minbias

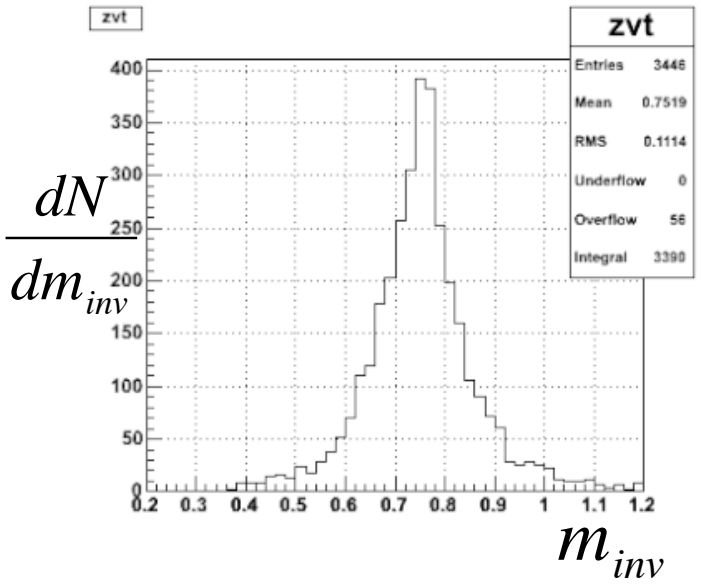


Isolating ρ Candidates - investigating zVertex dependence

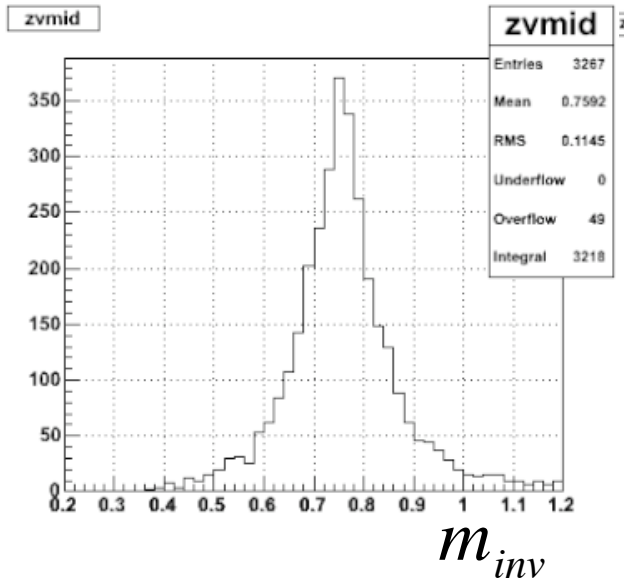
Topology

Cuts applied:

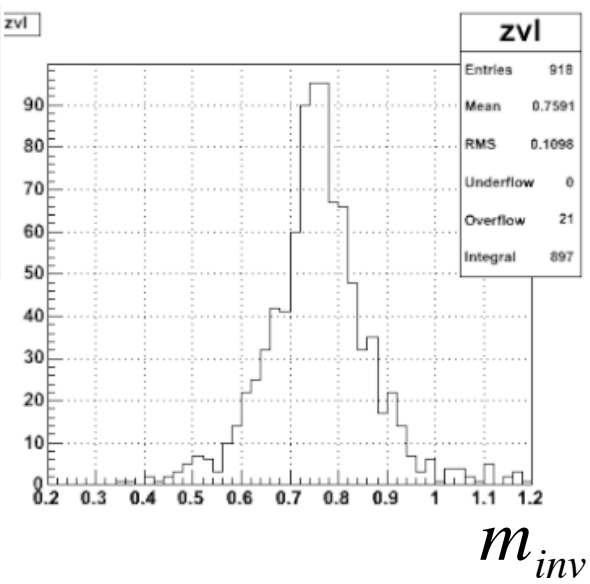
# of primary tracks = 2, total tracks =2, total charge = 0, p5 >10 and p5 !=20, transverse momentum > 0.0 & < 0.1 GeV, rapidity > 0.025, |rVertex| < 2 cm



|zVertex| < 40



|zVertex| > 40 & <120



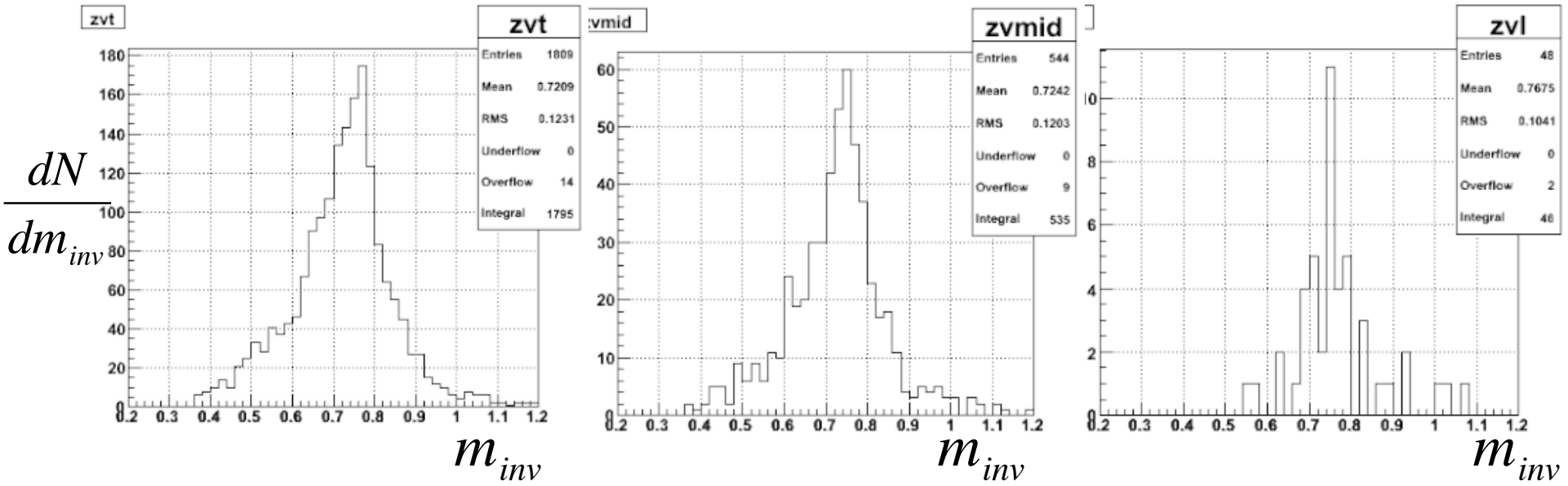
|zVertex| > 120 & < 200

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



|zVertex| < 40 |zVertex| > 40 & <120 |zVertex| > 120 & < 200

Topology Summary

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