

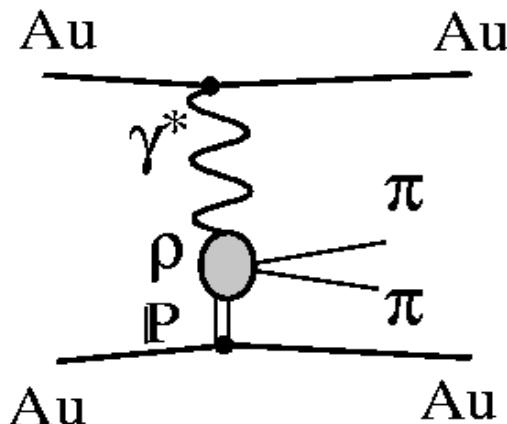
Understanding the Cosmic Ray Background

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

Algorithm for Eliminating Background

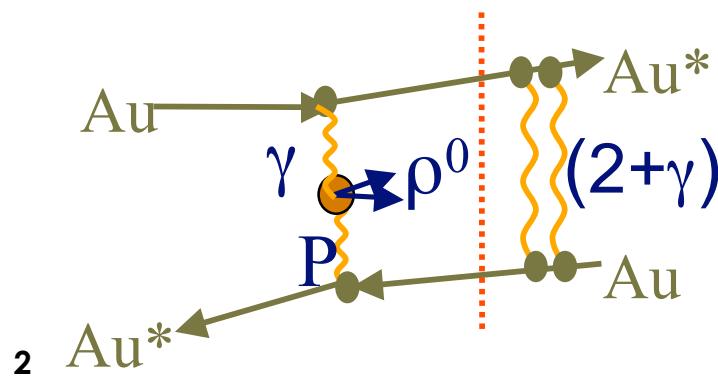
- Apply cuts to maximize cosmic ray background, minimize ρ signal
- Estimate cosmic ray spectrum
- Apply cuts to maximize ρ signal, minimize cosmic ray background
- Estimate proportion of cosmic rays that escape cuts

Production Mechanisms



Exclusive ρ^0 Production -
UPC Topology trigger

Courtesy of F. Meissner



ρ^0 Production With Coulomb Excitation
- UPC Minbias trigger

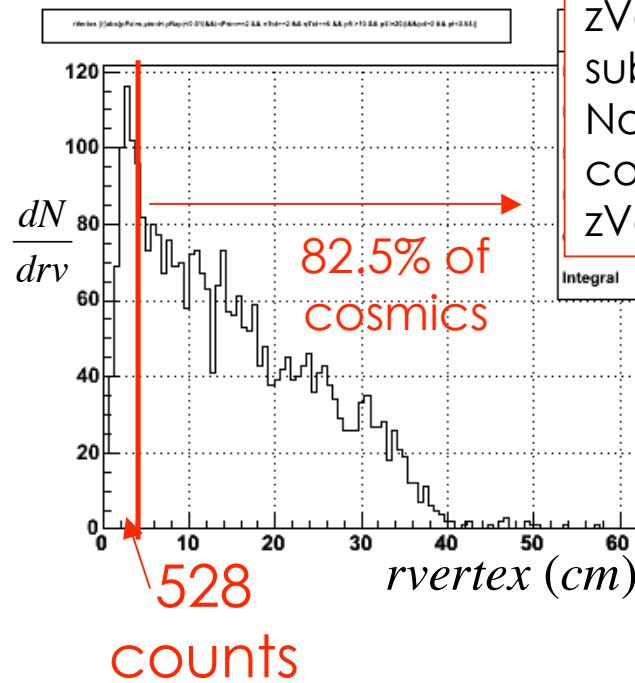
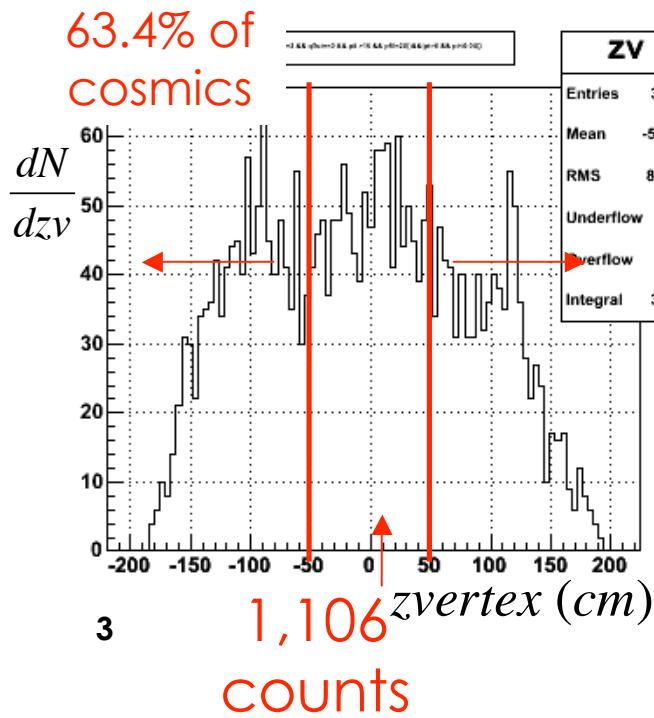
Isolating the Cosmic Ray Candidates

Topology

Cuts applied:

of primary tracks = 2, total tracks =2, total charge = 0,
 $p_T > 10$ and $p_T \neq 20$ (here is where I explain what p_T 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.

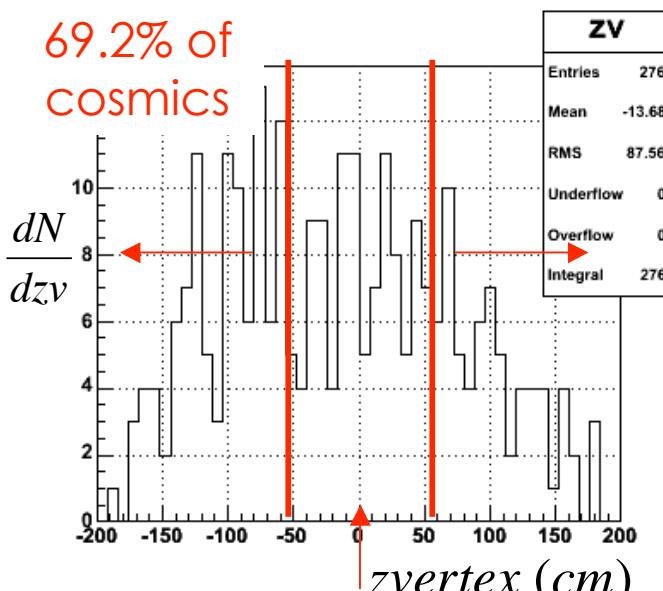
The right panel shows the rVertex distribution subsequent to the cuts. Note that 83% of the cosmics fall beyond an rVertex of 4 cm.

Isolating the Cosmic Ray Candidates

Minbias

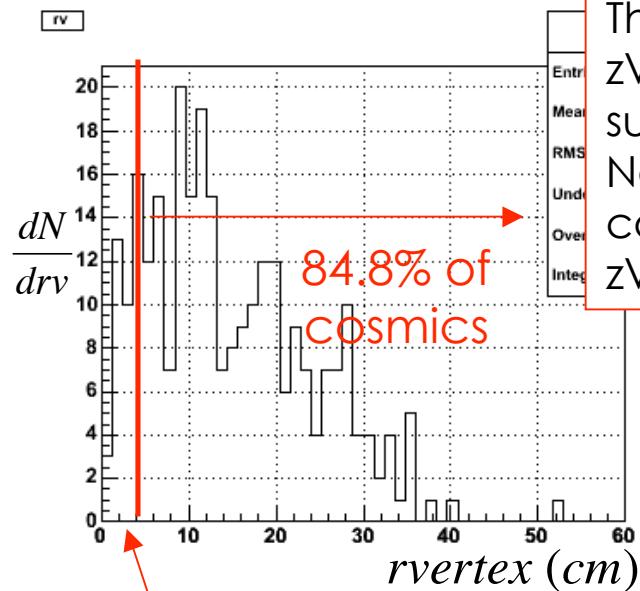
Cuts applied:

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 z_{Vertex} distribution subsequent to the cuts. Note that 69% of the cosmics fall outside of the z_{Vertex} window ± 50 cm.

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

Isolating the Cosmic Ray Candidates

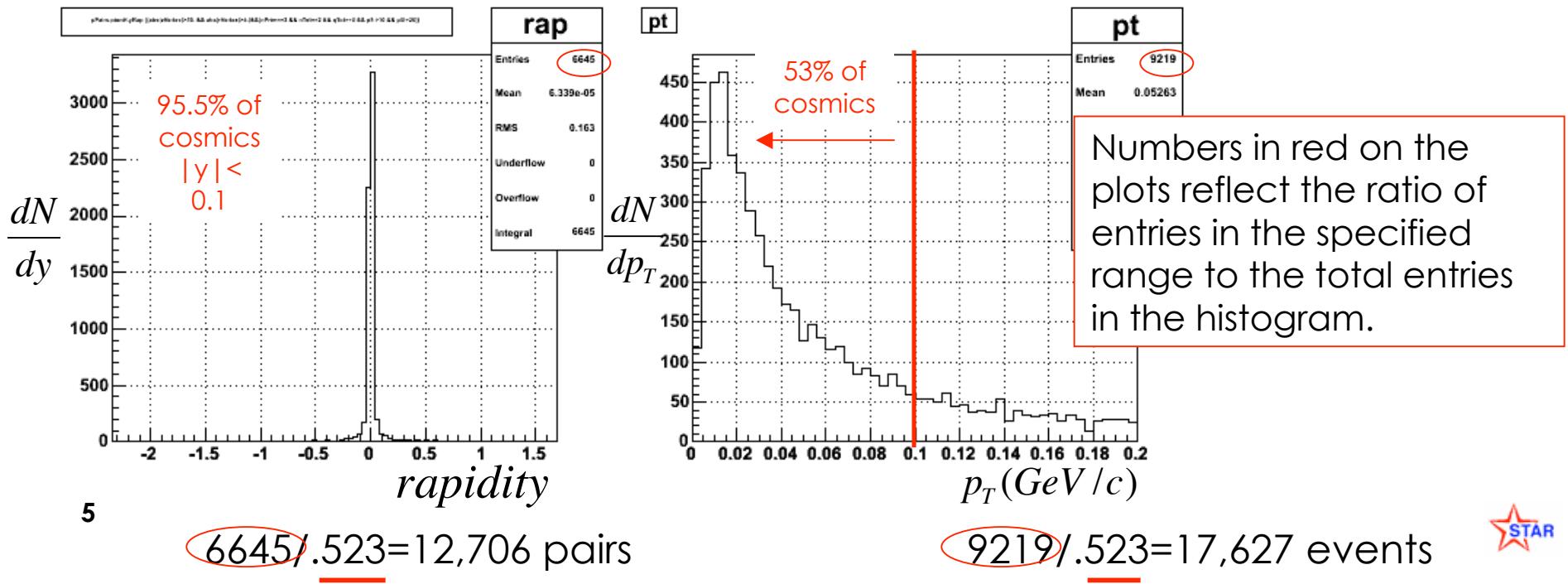
Topology

Cuts applied:

of primary tracks = 2, total tracks =2, total charge = 0, $p_T > 10$ and $p_T \neq 20$, $|z_{\text{Vertex}}| > 50 \text{ cm}$, $|r_{\text{Vertex}}| > 4 \text{ cm}$

Here we assume that cosmic rays will mainly fall outside of a z_{Vertex} of 50 cm and an r_{Vertex} of 4 cm.

Referring back to our r_{Vertex} and z_{Vertex} distributions on slide 3, we can see that the vertex cuts select $(82.5\%)(63.4\%) = \underline{52.3\%}$ of cosmics.



Isolating the Cosmic Ray Candidates

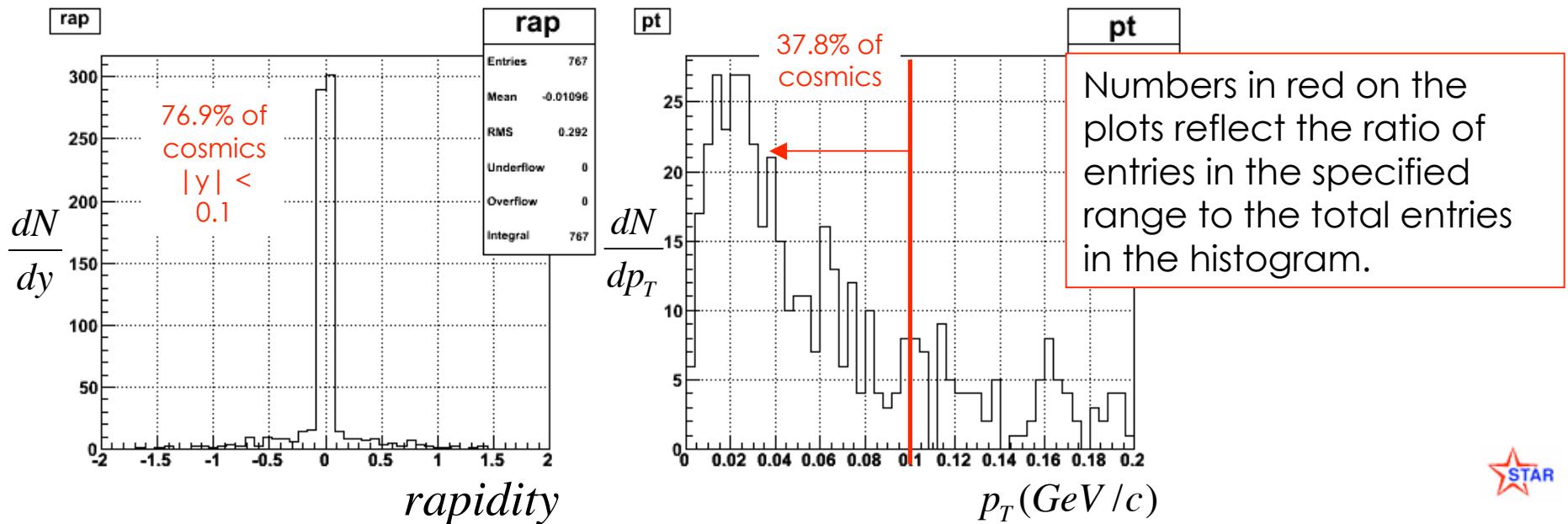
Minbias

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
 $|z\text{Vertex}| > 50 \text{ cm}$, $|\text{rVertex}| > 4 \text{ cm}$

Here we assume that cosmic rays will mainly fall outside of a $z\text{Vertex}$ of 50 cm and an rVertex of 4 cm.

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

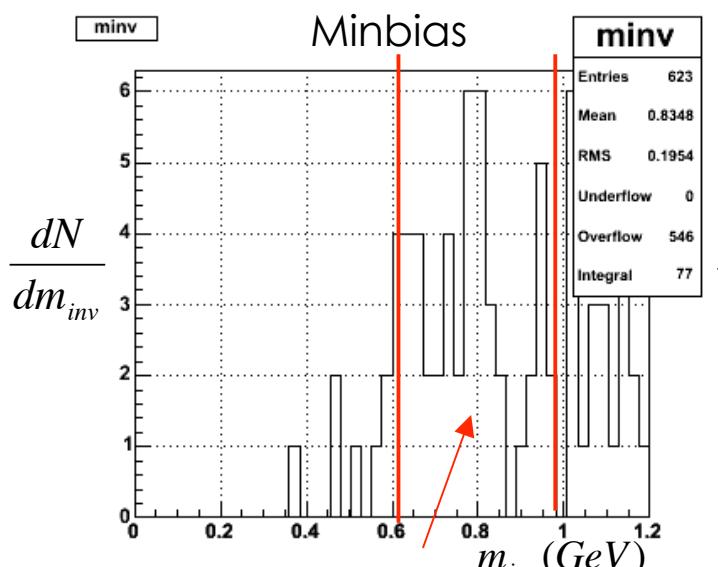


Isolating the Cosmic Ray Candidates

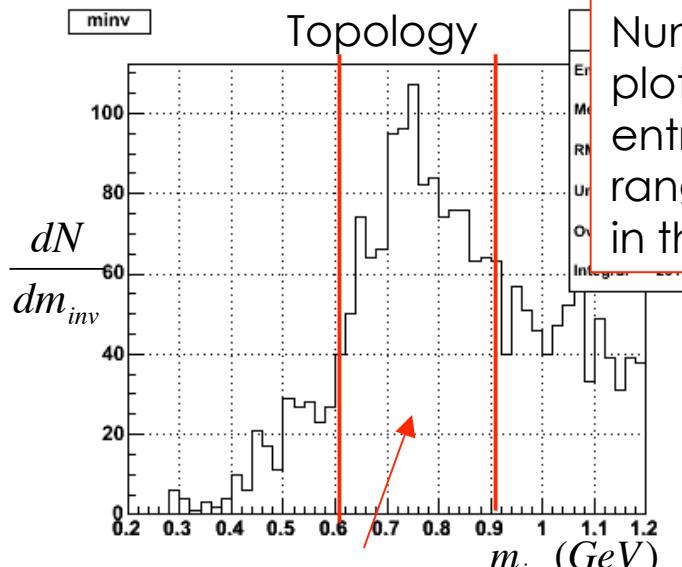
Cuts applied:

of primary tracks = 2, total tracks =2, total charge = 0,
 $|r_{\text{Vertex}}| > 4 \text{ cm}$, rapidity < 0.01 (topology - $p_T > 10$ and $p_T \neq 20$)

Since the mass of the ρ is $\sim 0.770 \text{ GeV}$, 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.



7 5.3% of cosmics
between $0.9 < m_{\text{inv}} < 0.6$



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

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

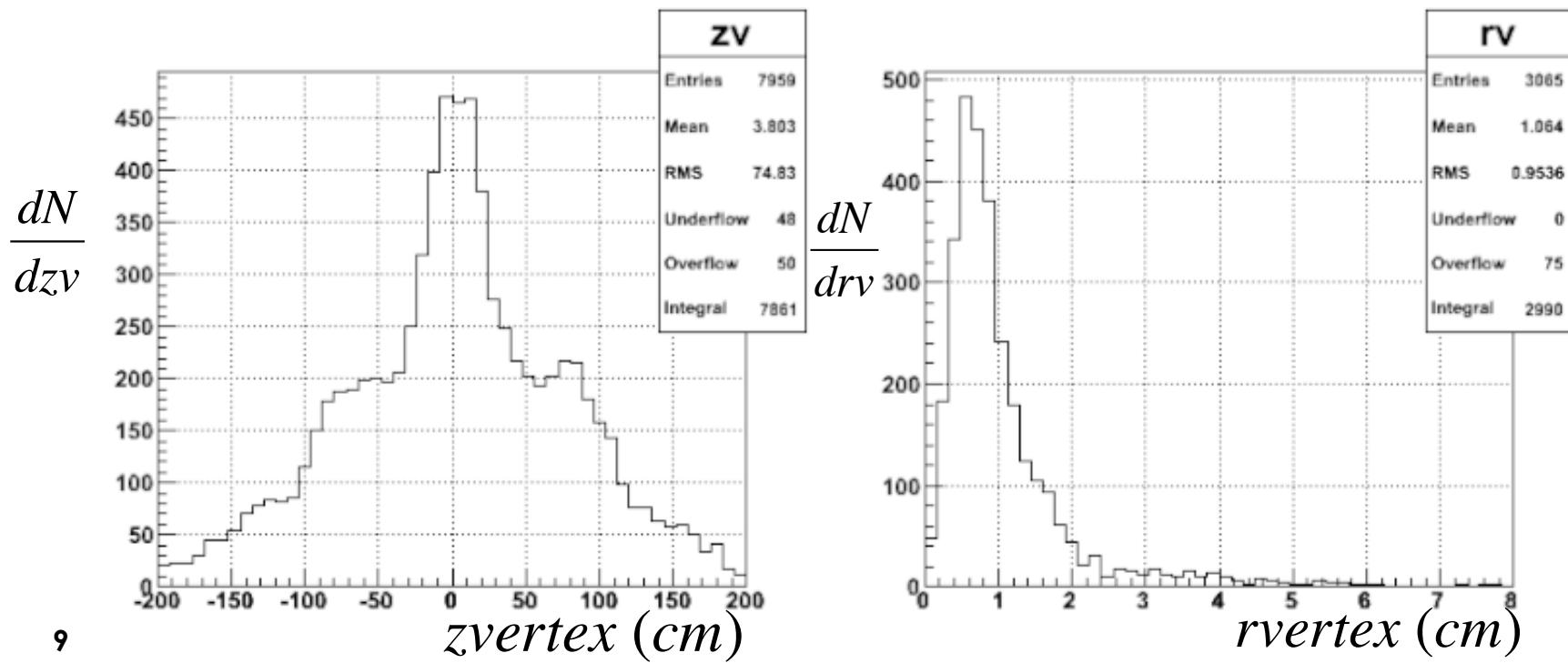
→ Estimate proportion of cosmic rays that escape cuts

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, $p_T > 10$ and $p_T \neq 20$, (in addition for zVertex distribution $|z_{\text{Vertex}}| < 4$ cm and for rVertex distribution $|r_{\text{Vertex}}| < 30$)

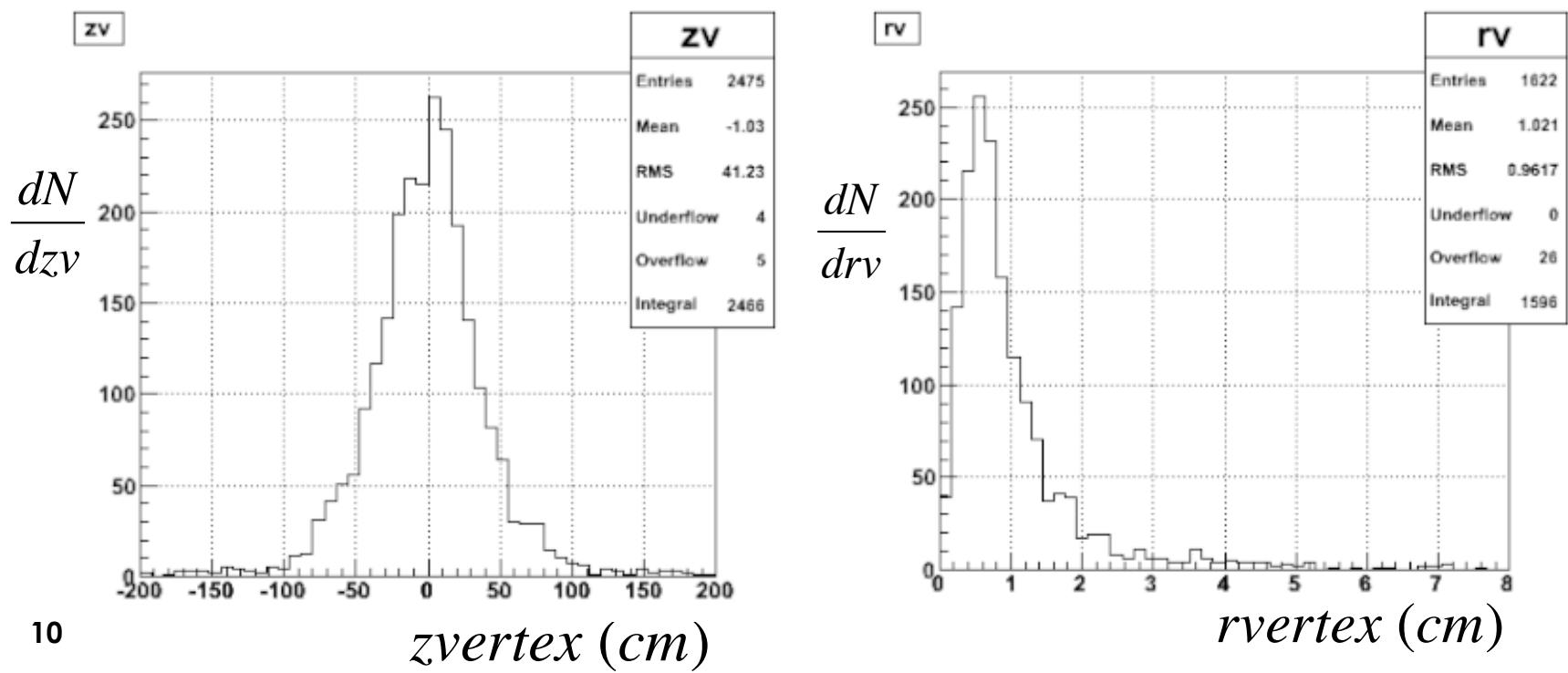


Isolating ρ Candidates - vertex distributions

Minbias

Cuts applied:

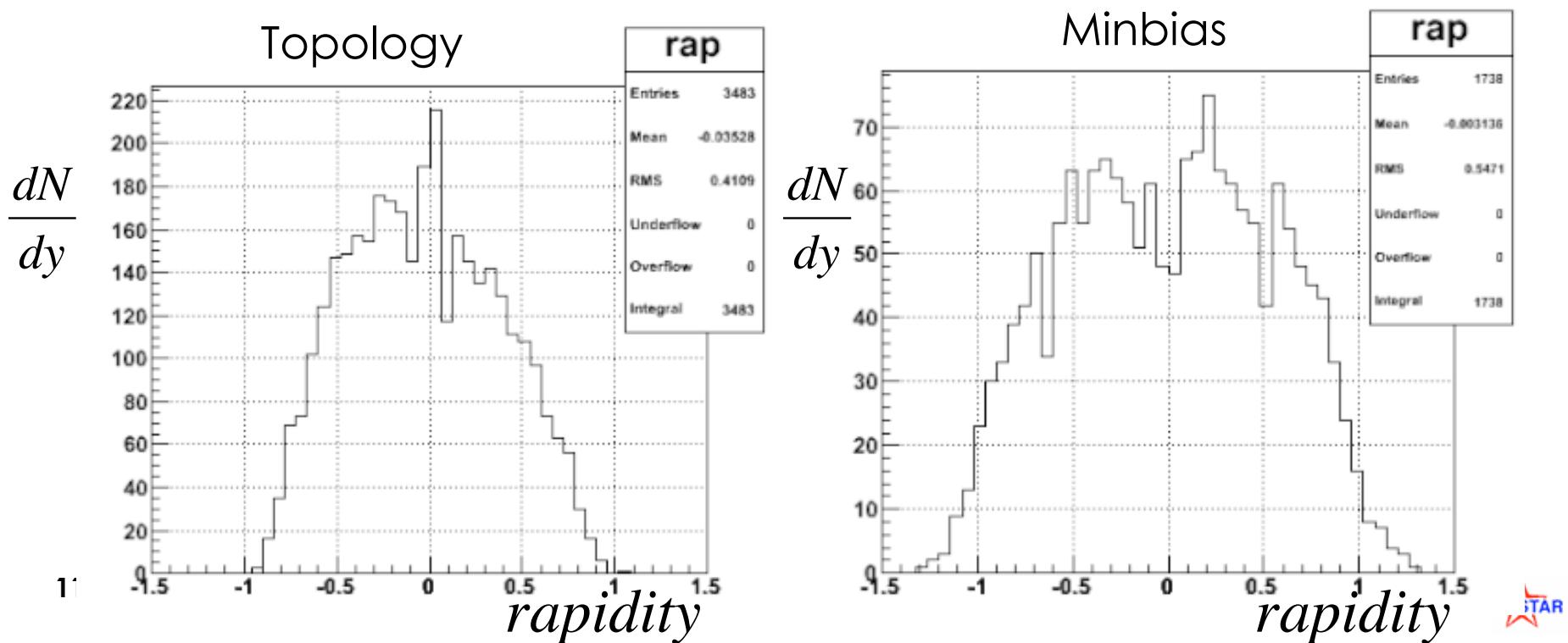
of primary tracks = 2, total tracks = 2, total charge = 0,
rapidity > 0.1, transverse momentum > 0.1 GeV,
(in addition for zVertex distribution $|r_{\text{Vertex}}| < 4$ cm and for
 r_{Vertex} distribution $|z_{\text{Vertex}}| < 30$)



Isolating ρ Candidates - rapidity distributions

Cuts applied:

of primary tracks = 2, total tracks = 2, total charge = 0,
transverse momentum > 0.0 & < 0.1 GeV,
 $|r_{\text{Vertex}}| < 4$ cm, $|z_{\text{Vertex}}| < 30$,
(topology - $p_T > 10$ and $p_T \neq 20$)

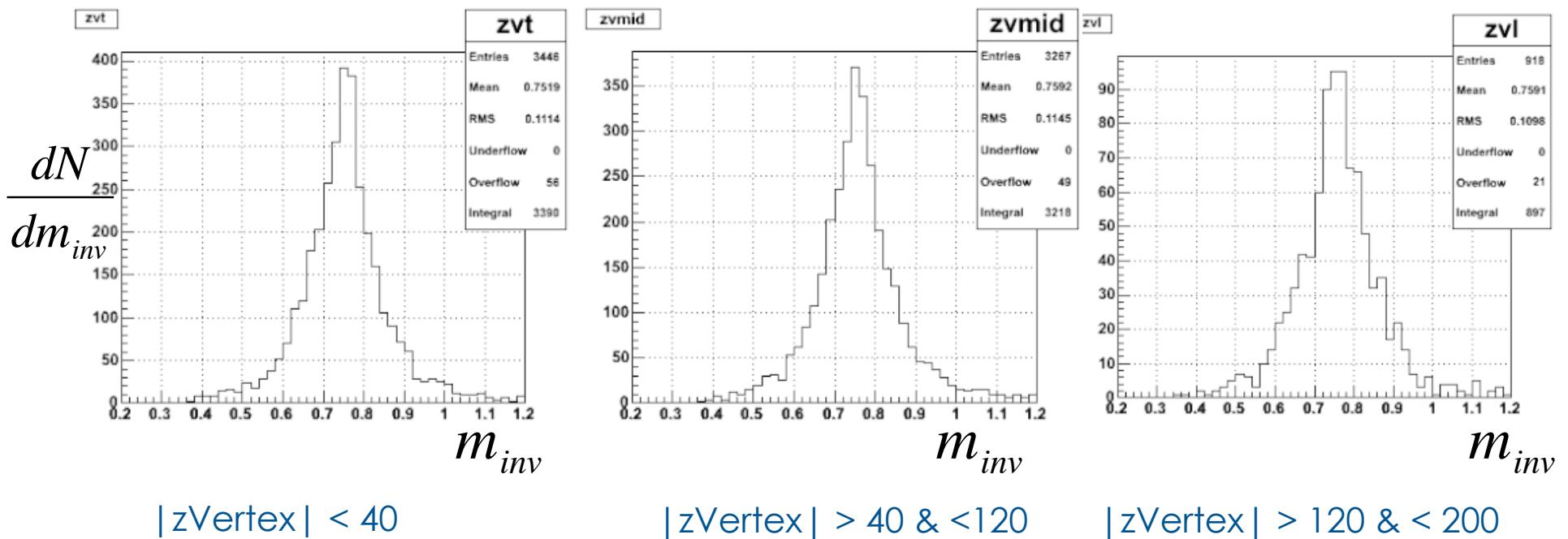


Isolating ρ Candidates - investigating zVertex dependence

Topology

Cuts applied:

of primary tracks = 2, total tracks =2, total charge = 0,
 $p_T > 10$ and $p_T \neq 20$, transverse momentum > 0.0 & < 0.1
 GeV, rapidity > 0.025 , $|r_{\text{Vertex}}| < 2$ cm

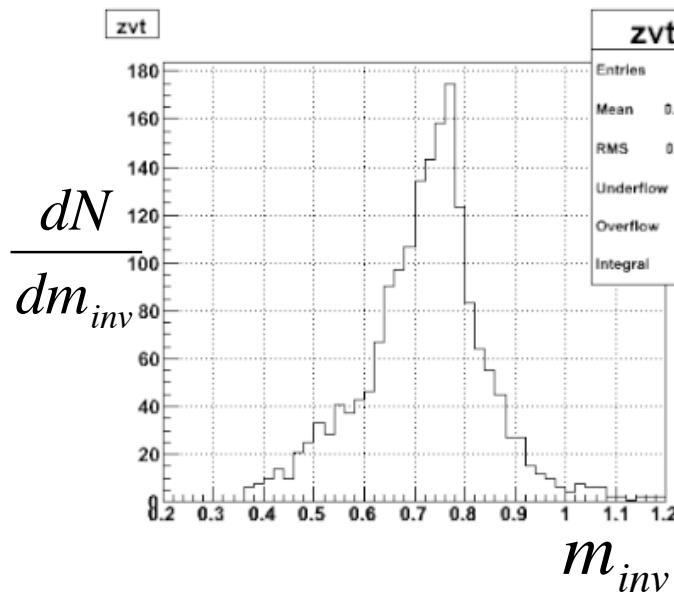


Isolating ρ Candidates - investigating zVertex dependence

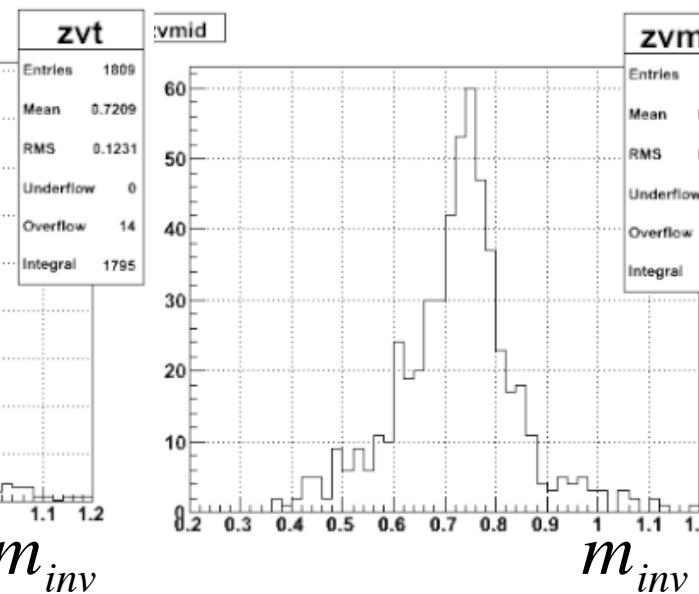
Minbias

Cuts applied:

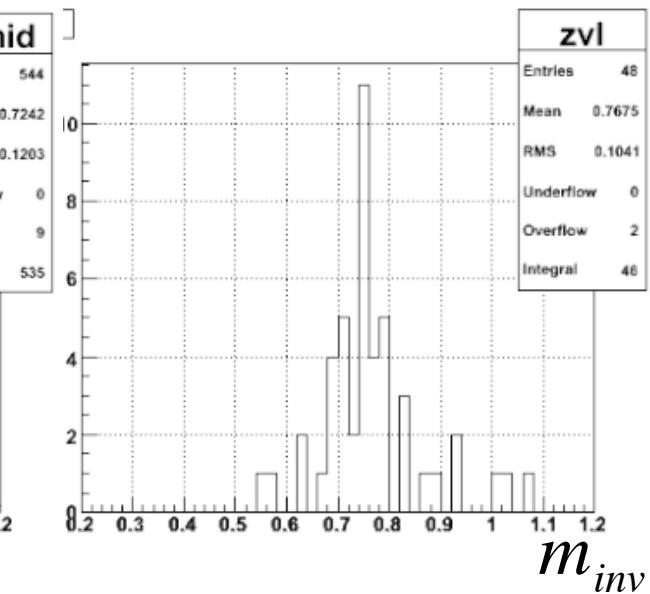
of primary tracks = 2, total tracks = 2, total charge = 0,
transverse momentum > 0.0 & < 0.1 GeV,
rapidity > 0.025, $|r\text{Vertex}| < 2$ cm



$|z\text{Vertex}| < 40$



$|z\text{Vertex}| > 40 \& < 120$



$|z\text{Vertex}| > 120 \& < 200$

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