VDC Multi-Track Analysis

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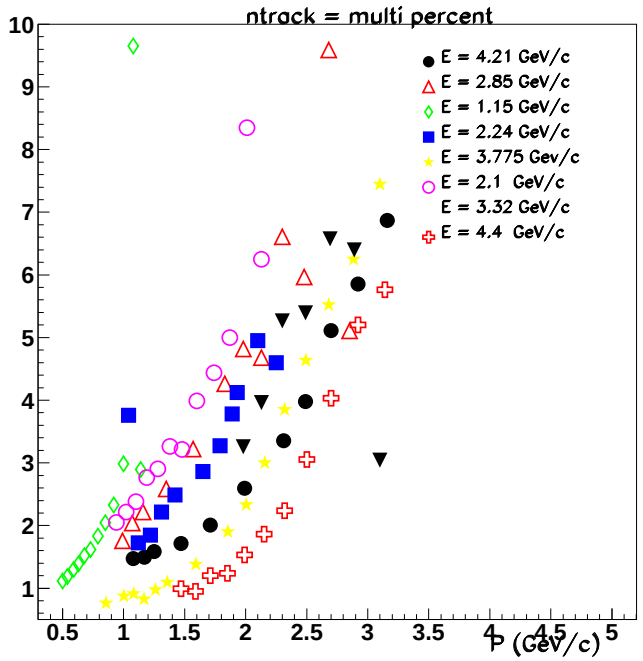
- Introduction
- Projecting VDC tracks to shower
- Use distance between two-tracks for analysis
- Conclusions

Hall A Workshop

12 June 2008

Introduction

- In E97-110, Multi-Tracks events can be $> 10\%$ of events, especially in elastic and QE kinematics - so up to $\approx 10\%$ uncertainty in σ
- We want to identify if there are 0, 1, or more good tracks in Multi-tracks events.
- Before, there was no code in Hall A analyzer to project the VDC track to the Shower and associate energy in the shower with the tracks. We wrote new code to address this problem.

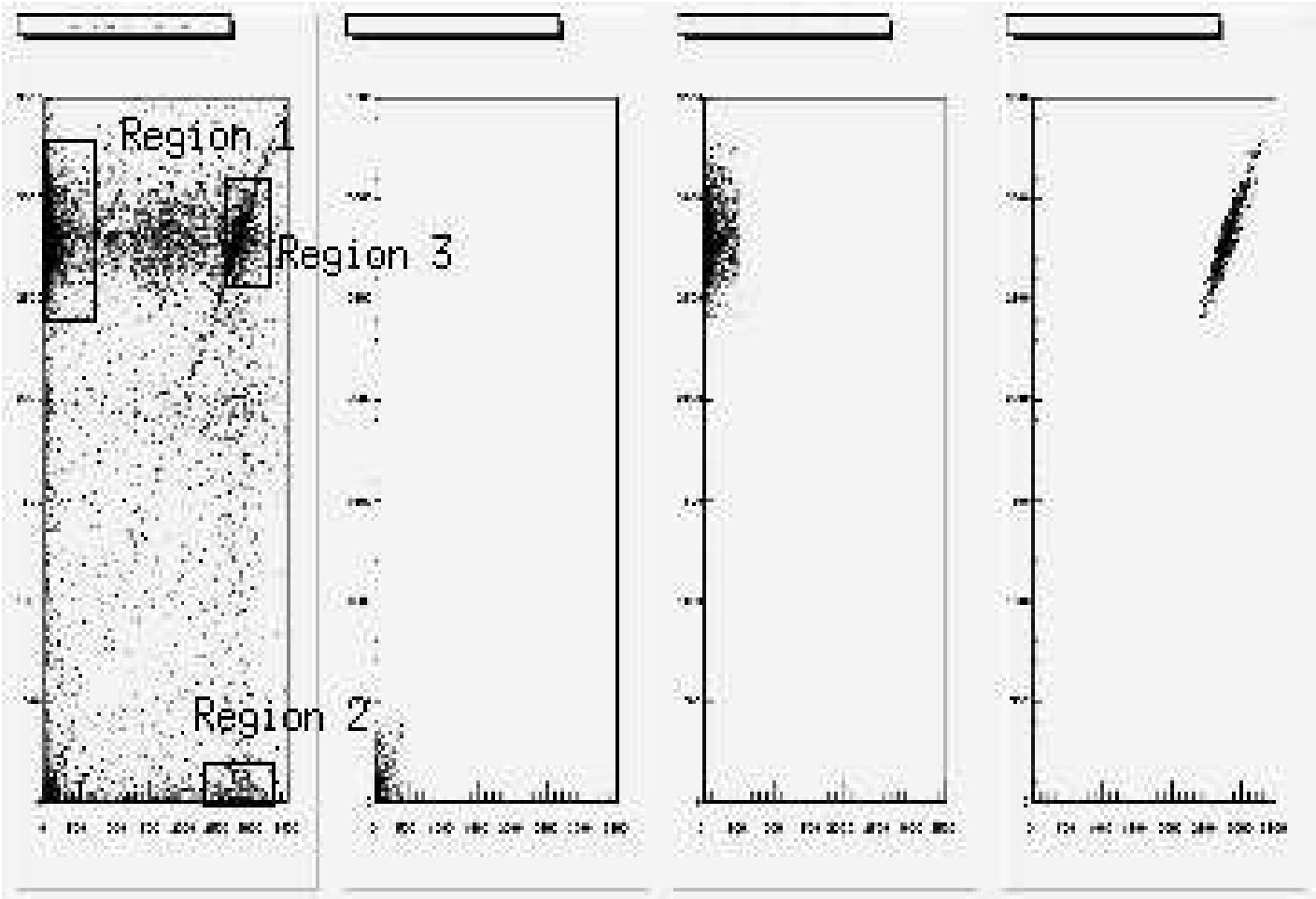


Reconstruct each track from VDC to Shower

- Uses VDC coordinates, x, y, θ, ϕ, and VDC-to-Shower distance.
- Calculate the position of each track at Prehower and Shower.
- Look at energy near this position to construct a cluster of blocks.
- Before: maximum energy cluster found in shower, paying no attention to where track pointed
- VDC identifies multiple tracks: 1st, 2nd, ...: 1st is best χ^2, etc.

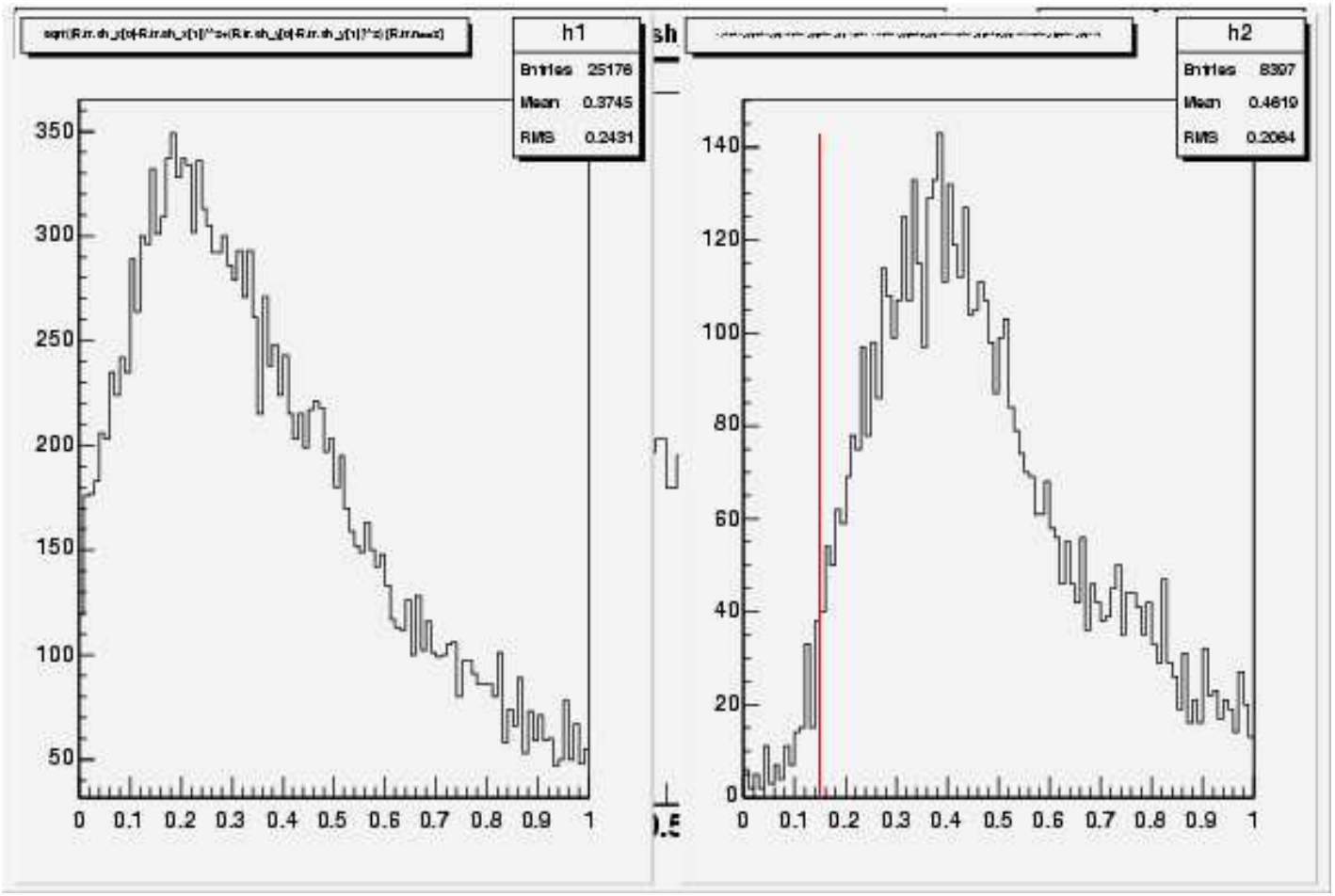
E_{1st} vs. E_{2nd}

- Plot shows two-track calorimeter energies, E_{1st} vs. E_{2nd}, with order $1st$ and $2nd$ chosen by VDCs



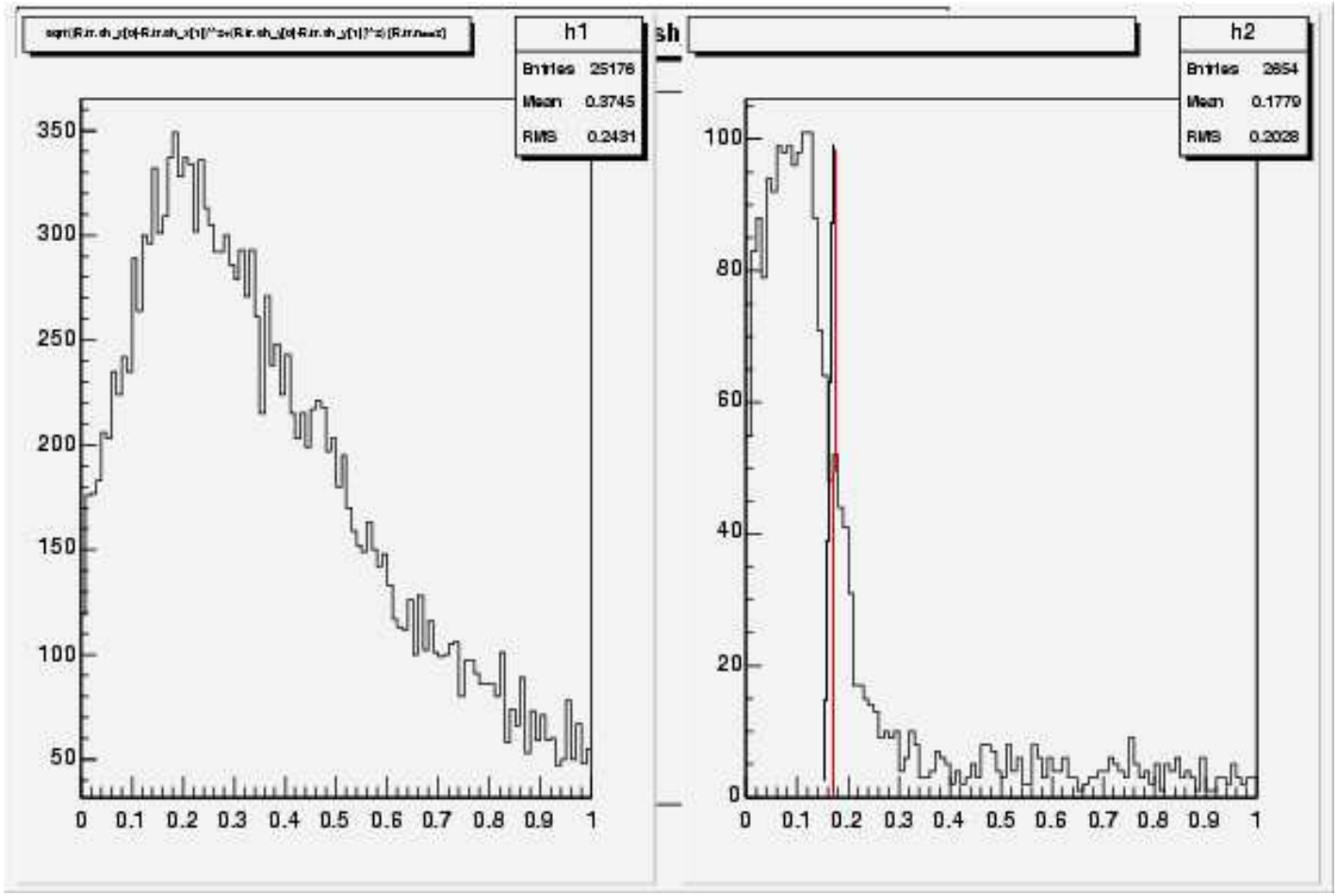
Analysis: Distance between Two Tracks in Shower

- Left: distance distribution for all two-track events
- Right: distance distribution for $E_{1st} \approx p_{spec}$ and $E_{2nd} \ll p_{spec}$.
- Results consistent with knockout of low-energy δ electron



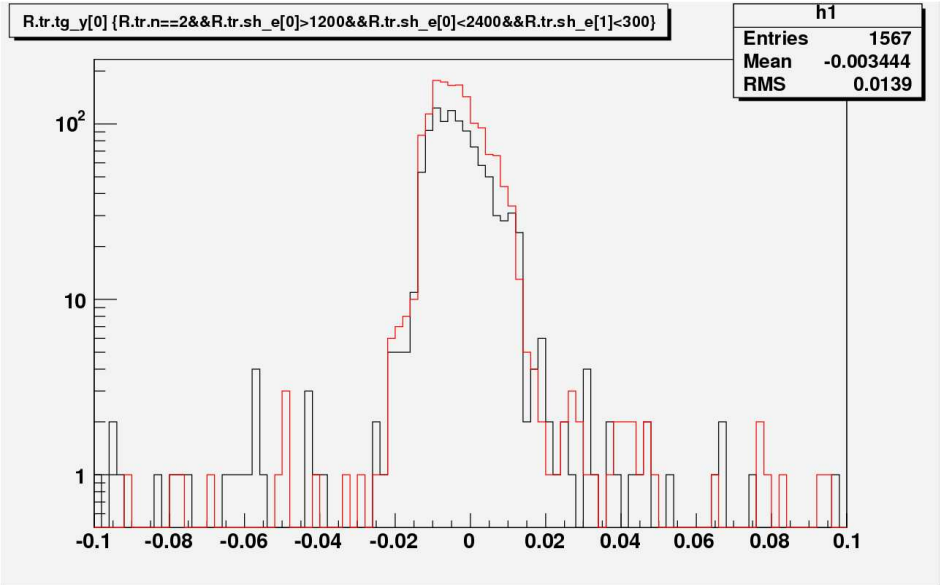
Analysis: Distance between Two Tracks in Shower

- Left: distance distribution for all two-track events (repeat)
- Right: distance distribution for $E_{1st} \approx p_{spec}$ and $E_{2nd} \approx p_{spec}$. .
- Note: $E_{showertotal}$ usually $\approx p_{spec}$, not $2p_{spec}$, tracks unresolved
- Consistent with mostly forward δ knockout, unresolved in calorimeter



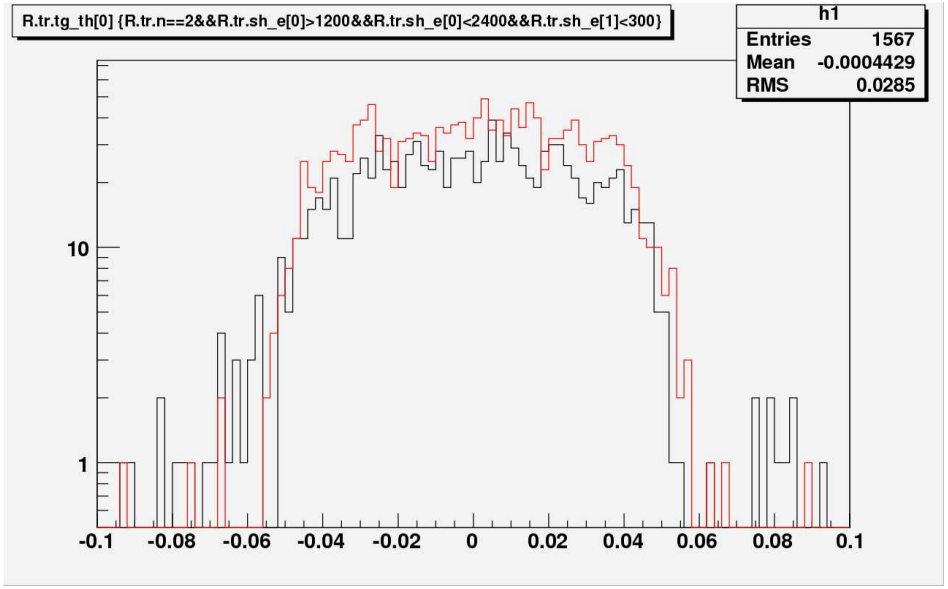
Analysis: y_{target} distribution

- red line: distribution of one-track events
- black line: distribution of the 1st track ($E_{1st} \approx p,\ E_{2nd} \ll p$) of two-tracks events.
- Distributions $\approx$ same, indicating 1st track is a good track



Analysis: θ_{target} and ϕ_{target} distributions

- red line: distribution of one-track events
- black line: distribution of the 1st track of two-tracks events.
- Distributions $\approx$ same, indicating 1st track is a good track



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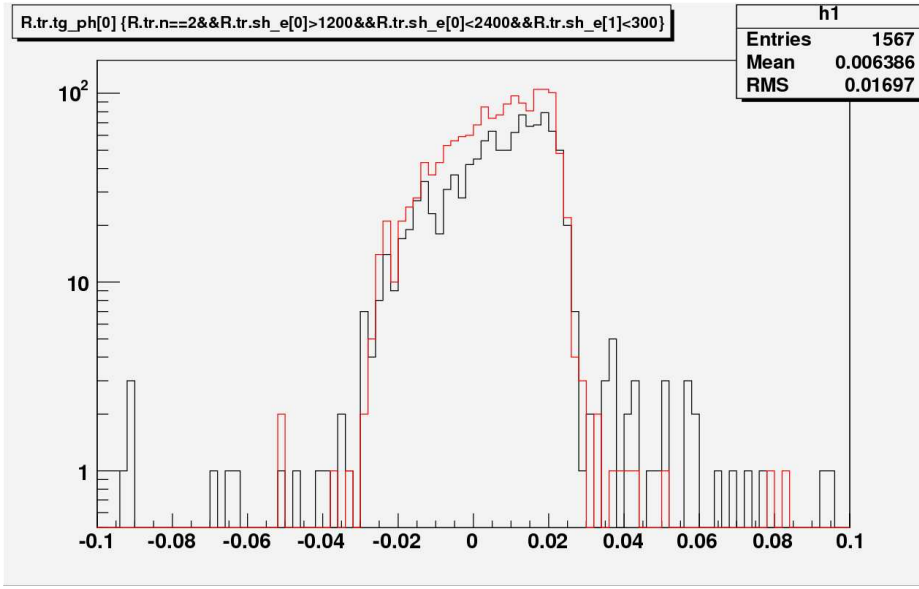

Conclusions

- For $0.8 < \frac{E_{1st}}{p} < 1.1$ and $\frac{E_{2nd}}{p} < 0.9$, 40% - 50% of events are good
- For $0.8 < \frac{E_{2nd}}{p} < 1.1$ and $\frac{E_{1st}}{p} < 0.9$, 10% - 20% of events are good
- For $0.95 < \frac{E_{1st}}{E_{2nd}} < 1.05$ and $0.9 < \frac{E1}{p} < 1.1$, 10% of events are good
- For the standard low Q^2 GDH cut, $0.8 < \frac{E}{p} < 1.1$ cut on two-tracks events, nearly 70% of two-tracks events can be added into good events when we calculate the cross section - not very sensitive to kinematics

Backup: How Can Tracks Close Together Have Different Energies?

- We have events where $E_{1st} \approx p$, but $E_{2nd} \ll p$, which are only separated by a few cm at the calorimeter. How can this be?
- tracks just enter edge region between blocks, then little X,Y 's difference let track accounted into different blocks .So though distance of two tracks show few cm separated, two tracks accounted the cluster of blocks are really separated much.

Backup: Calorimeter Total Energy vs. Distance

- For events with $E_{1st} \approx E_{2nd} \approx p$, do we have 1 or two high energy electrons?
- Plots shows total calorimeter energy as a function of distance between tracks at calorimeter, when $E_{1st} \approx E_{2nd} \approx p$