

# NC/CC Separation in Far Detector

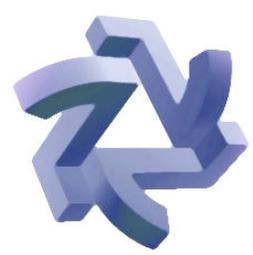
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11/12/04



# First Stab at NC/CC Separation



- Using gm\_geom\_far.reroot.root file, processed 25k events, 22k reconstructed
- Far detector so expect 1 event/snarl
- Fiducial cuts:
  - Tracks contained in either of the SM
    - $1\text{ m} < \text{Vertex } z \text{ pos} < 28\text{ m}$ , exclude tracks contained in region with  $14 < z < 16$
    - Vertex of the track is within 3.5 m of the coil hole
  - Showers have  $1\text{ m} < \text{vertex } z < 28\text{ m}$ , vertex is within 3.5 m of the coil hole
- 13k events pass fiducial cuts

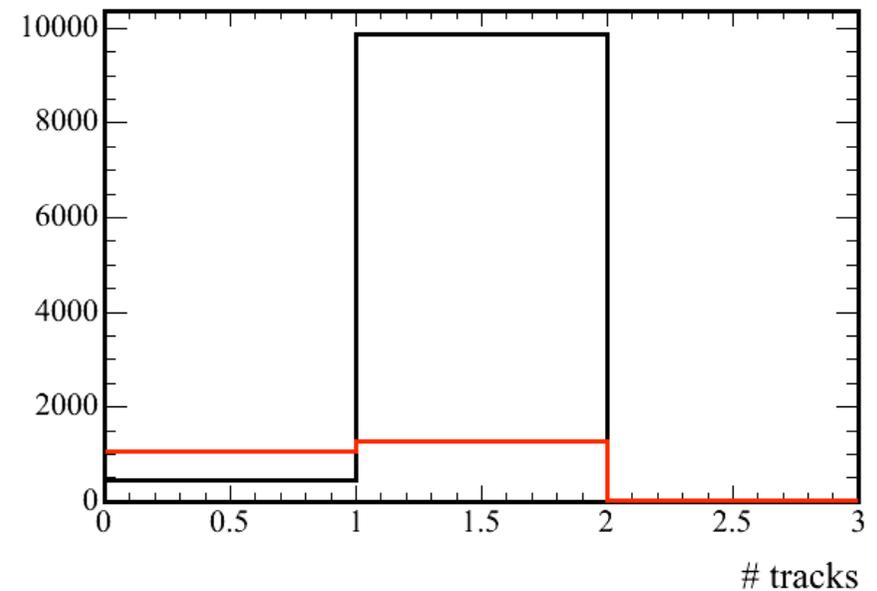


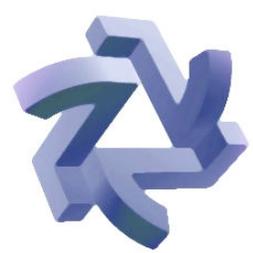
# Looking at the Obvious



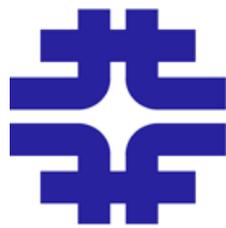
- Number of tracks in CC and NC events shown
- As many NC events with tracks in them as without
- Number of CC events without tracks is  $\sim 1/2$  the number of NC events without tracks
- In the following plots, **red** is for **NC**, black CC

CC Events

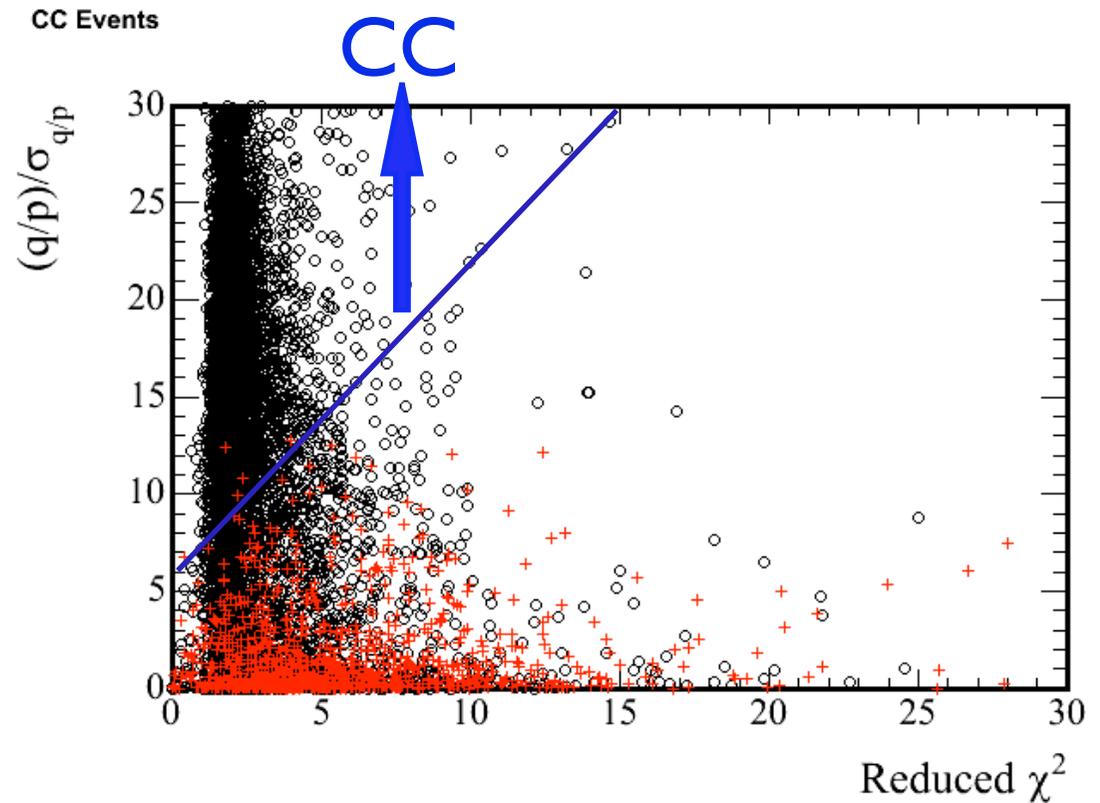


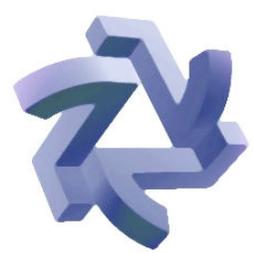


# Separating NC/CC events with a Reconstructed Track



- The track finder does its best to find tracks
- But track quality should give some clue as to whether the track is a real track or just a bunch of hits the track finder pulled out of a shower
- Tracks above the line are called CC events



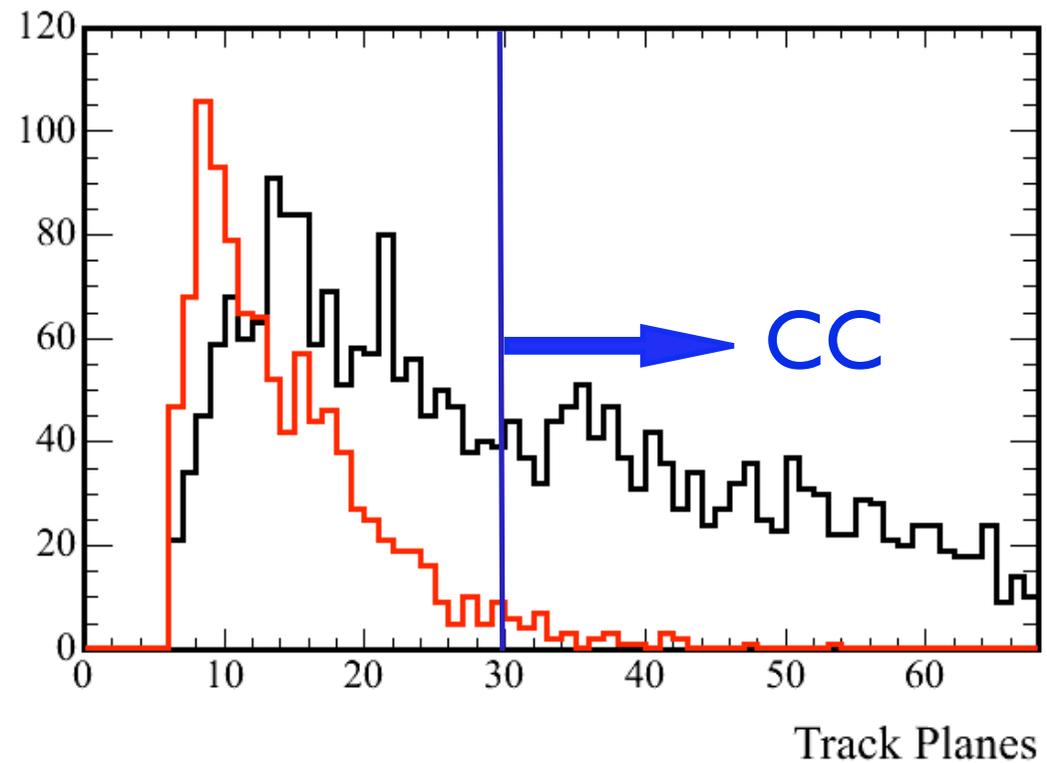


# Separating NC/CC events with a Reconstructed Track



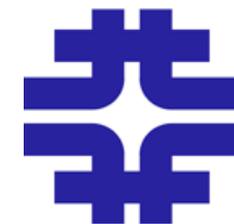
- Number of planes crossed may also be useful
- “Tracks” in NC events should be quite small
- Still a lot of events with tracks crossing 10-20 planes
- Looked at several NC and CC events in this range

CC Events

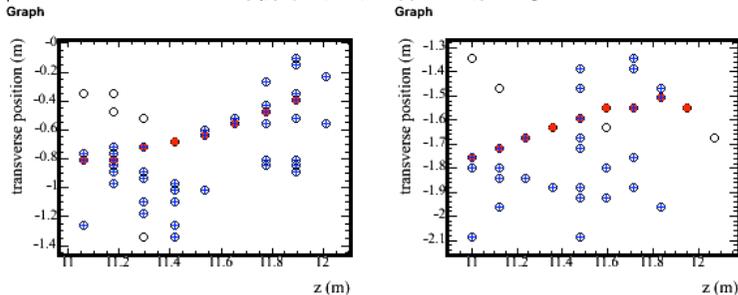




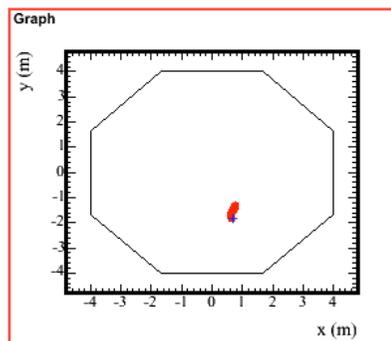
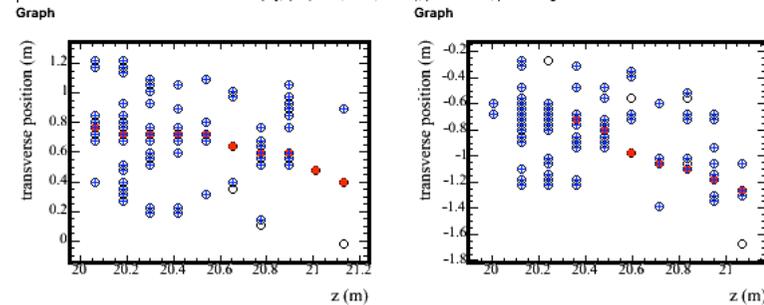
# Example NC Events with a Track



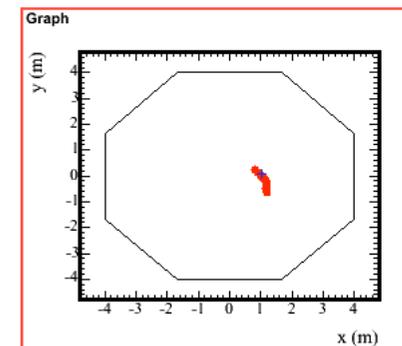
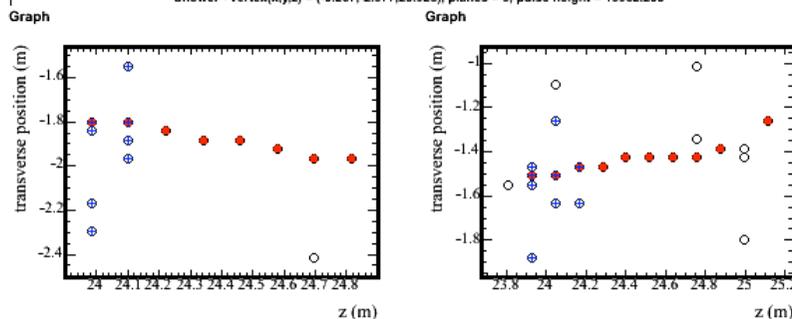
Run 2111 Subrun 1 Snarl 2252  
 $E_i = 23.203$ , NC interaction  
 $p_{fit} = 1.488$ ,  $p_{range} = 0.767$ ,  $\sigma_{tip} = 0.195$ ,  $p_{truth} = \text{nan}$   
Track - vertex(x,y,z) = (0.650,-1.843,11.000),  $b = 1.525$ , planes = 17, length = 1.148, dy/ds = -0.502  
Shower - vertex(x,y,z) = (0.674,-1.844,11.000), planes = 17, pulse height = 71645.914



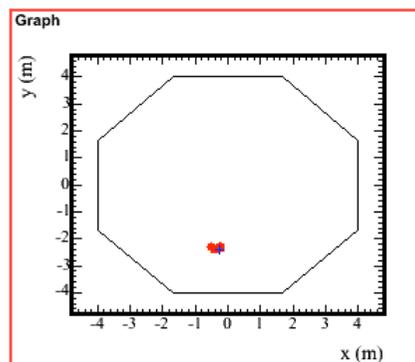
Run 2111 Subrun 1 Snarl 1255  
 $E_i = 27.492$ , NC interaction  
 $p_{fit} = 8.425$ ,  $p_{range} = 0.991$ ,  $\sigma_{tip} = 0.944$ ,  $p_{truth} = \text{nan}$   
Track - vertex(x,y,z) = (0.826,0.237,20.062),  $b = 0.860$ , planes = 17, length = 1.494, dy/ds = 0.556  
Shower - vertex(x,y,z) = (1.033,0.078,20.002), planes = 19, pulse height = 185625.672



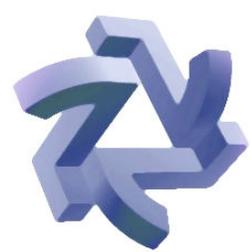
Run 2111 Subrun 1 Snarl 4528  
 $E_i = 4.267$ , NC interaction  
 $p_{fit} = -1.083$ ,  $p_{range} = 0.828$ ,  $\sigma_{tip} = 0.145$ ,  $p_{truth} = \text{nan}$   
Track - vertex(x,y,z) = (-0.208,-2.323,23.925),  $b = 2.325$ , planes = 18, length = 1.265, dy/ds = 0.099  
Shower - vertex(x,y,z) = (-0.267,-2.377,23.925), planes = 5, pulse height = 13962.208



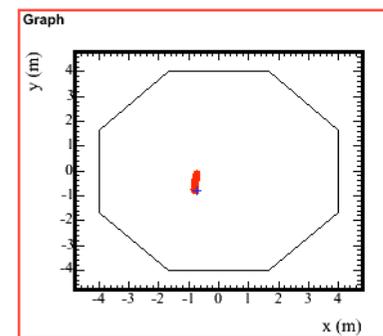
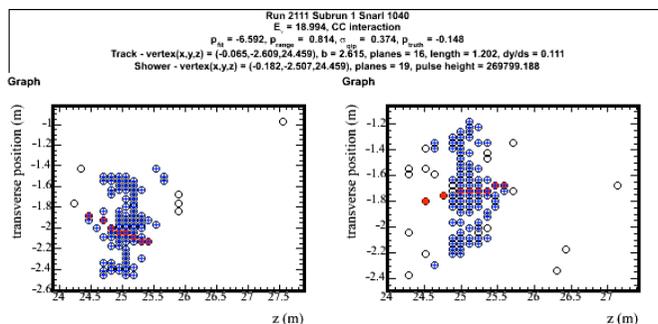
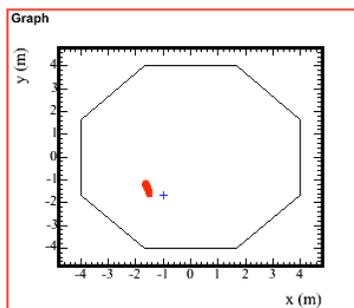
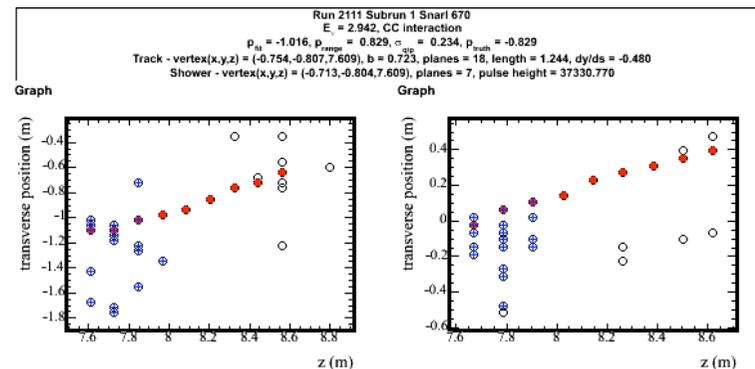
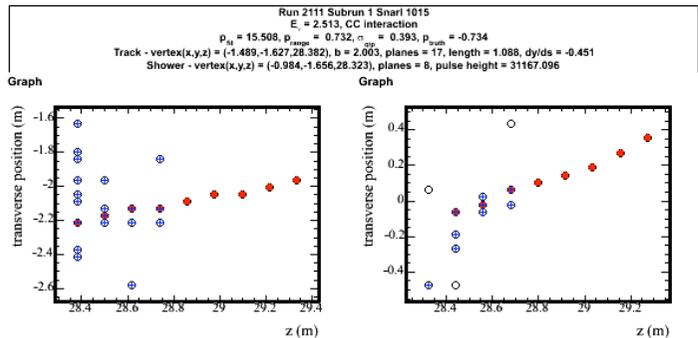
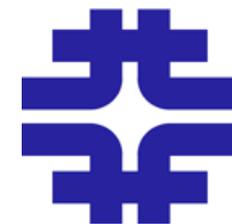
- Track Strip
- + Shower Strip
- Event Strip



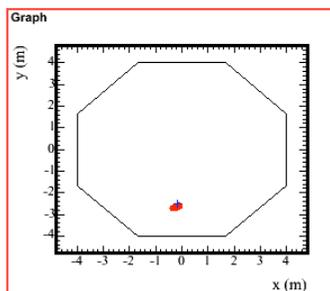
Really looks like a track



# Example CC Events with short Track



- Track Strip
- + Shower Strip
- Event Strip



19 GeV neutrino

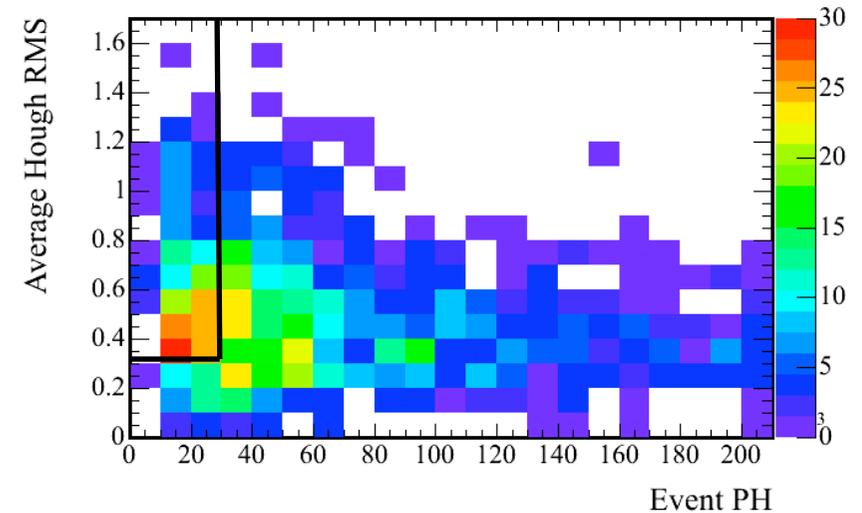


# Separation of Events with Short Tracks Using Hough Transforms

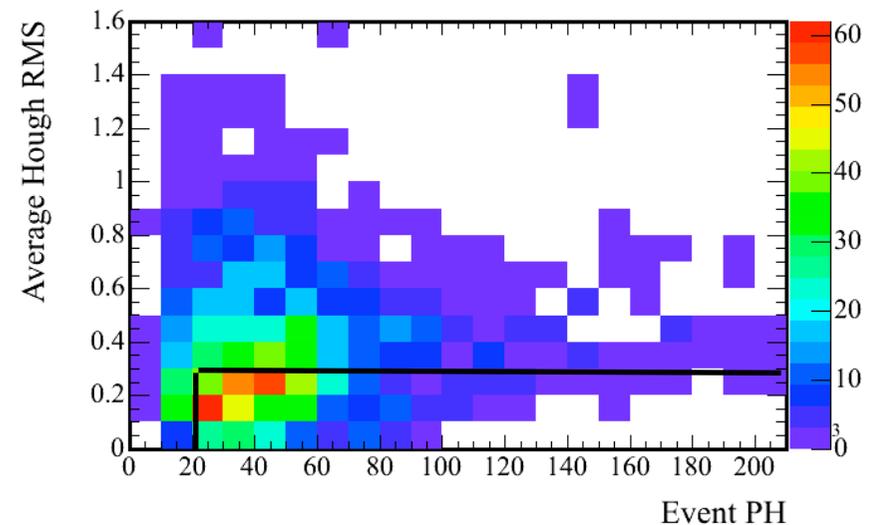


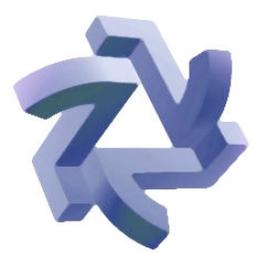
- The event topology should provide some NC/CC separation
- NC events should not have clear peaks in Hough space, CC events should
- RMS of points in Hough space having values at least 75% of the maximum is a measure of tracky-ness
- Average RMS for both views shown as a function of event pulse height
- Make initial cuts for NC and CC events indicated by the black lines

NC Events



CC Events



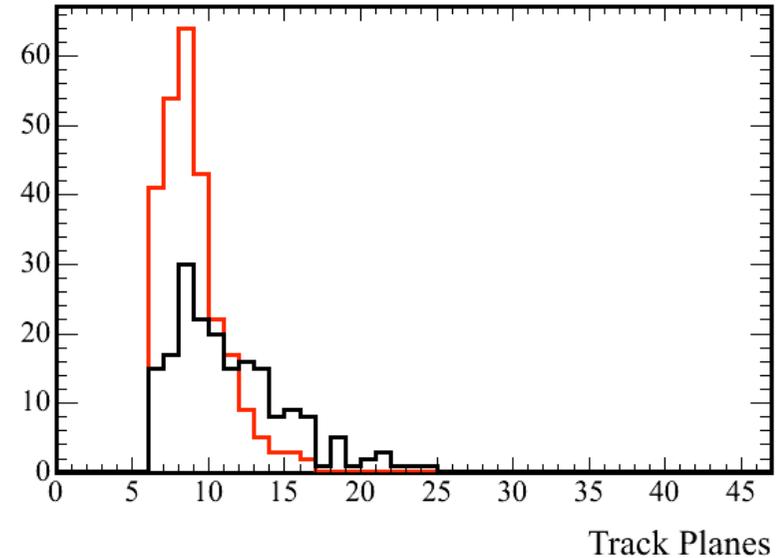


# Number of Planes after Hough Cuts

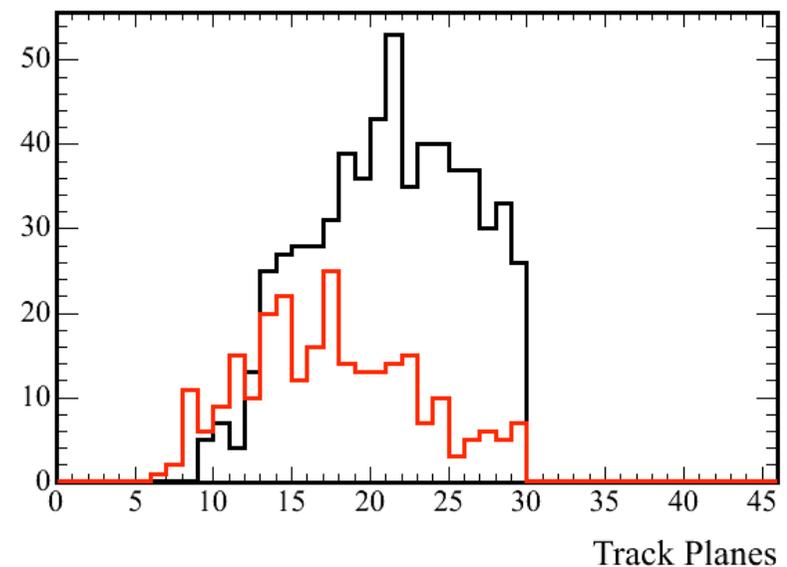


- Making the cuts indicated on the previous slide, gives the distributions of number of planes in the short tracks
- Top plot shows events passing the Hough cuts indicated by NC plot on previous slide, bottom shows the events passing the CC cuts
- Better separation between **NC** and CC events now as a function of planes crossed
- Still a lot of work to do

NC Events



CC Events





# Next Steps



- Look more closely at event topology to separate events with short tracks into NC and CC categories
  - Hough transform appears to provide good discrimination
  - Look at other parameters such as the degree of overlap between track and shower planes
  - Develop a figure of merit for the reconstructed tracks
- Need to understand the CC events where the reconstruction does not find a track