

2D Vertexing in ArgoNeuT

Preliminary work (Proposal)

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Vertexing

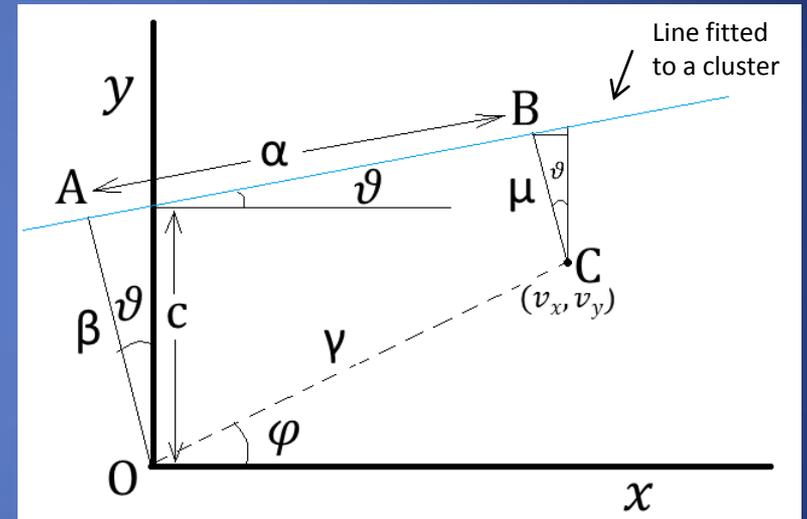
- Sort the clusters in each view
 - Matched cluster (if any) is the first one in the sorted clusters
 - Then length wise
 - Length of a cluster(ticks) = $\left[\left(\frac{(wire\#)(0.4cm)}{(v_d cm/\mu s) \left(\frac{0.198\mu s}{tick} \right)} \right)^2 + (time\ in\ ticks)^2 \right]^{1/2}$
- Fit a 'pol1' on first 20 hits of each cluster (if cluster has ≥ 10 hits)
 - Hit errors: 0.005 in wire #, 4 ticks (need to put actual hit errors)
- Start with the first Cluster's start point as the 'guessed vertex'
- Calculate the χ_i^2 contribution of each cluster to the vertex, where

$$\chi_i^2 = dca_i^2 / (err\ on\ dca)_i^2$$

where dca is the distance of closest approach between the guessed vertex and the fitted line on the i^{th} cluster

Calculating the χ_i^2 contribution of each cluster to the vertex

$$dca = \mu = cc\cos\vartheta - v_y\cos\vartheta + v_x\sin\vartheta$$



Wire-Time View: $x = \text{wire \#}$, $y = \text{\# ticks}$
 (v_x, v_y) is the 'guessed vertex'
 $\mu = dca$
 (need to use one unit for x and y)

Calculating the Error on μ

$$dca = \mu = c \cos \vartheta - v_y \cos \vartheta + v_x \sin \vartheta$$

Here, $\vartheta = \tan^{-1} m$, where $m = \text{slope}$

$$\mu = c \cos(\tan^{-1} m) - v_y \cos(\tan^{-1} m) + v_x \sin(\tan^{-1} m)$$

$$\Delta \mu = \sqrt{\left(\frac{\partial \mu}{\partial c}\right)^2 \sigma_c^2 + \left(\frac{\partial \mu}{\partial m}\right)^2 \sigma_m^2}$$

$$\left(\frac{\partial \mu}{\partial c}\right) = \cos \vartheta,$$

$$\begin{aligned} \left(\frac{\partial \mu}{\partial m}\right) &= \frac{1}{1+m^2} [-c \sin(\tan^{-1} m) + v_y \sin(\tan^{-1} m) + v_x \cos(\tan^{-1} m)] \\ &= \frac{1}{1+m^2} [-c \sin \vartheta + v_y \sin \vartheta + v_x \cos \vartheta] \end{aligned}$$

$$\Delta \mu = \sqrt{(\cos \vartheta)^2 \sigma_c^2 + \left(\frac{1}{1+m^2} [-c \sin \vartheta + v_y \sin \vartheta + v_x \cos \vartheta]\right)^2 \sigma_m^2}$$

χ_i^2 of Cluster i

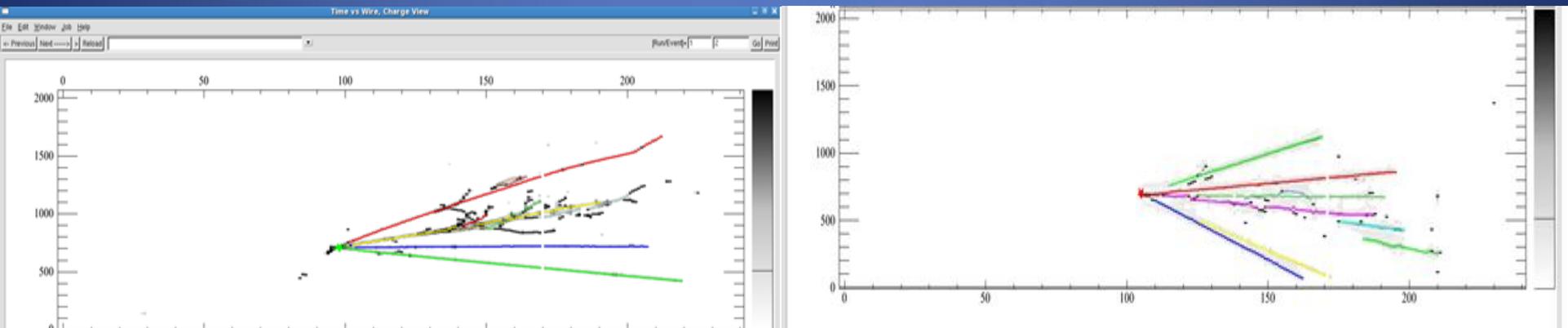
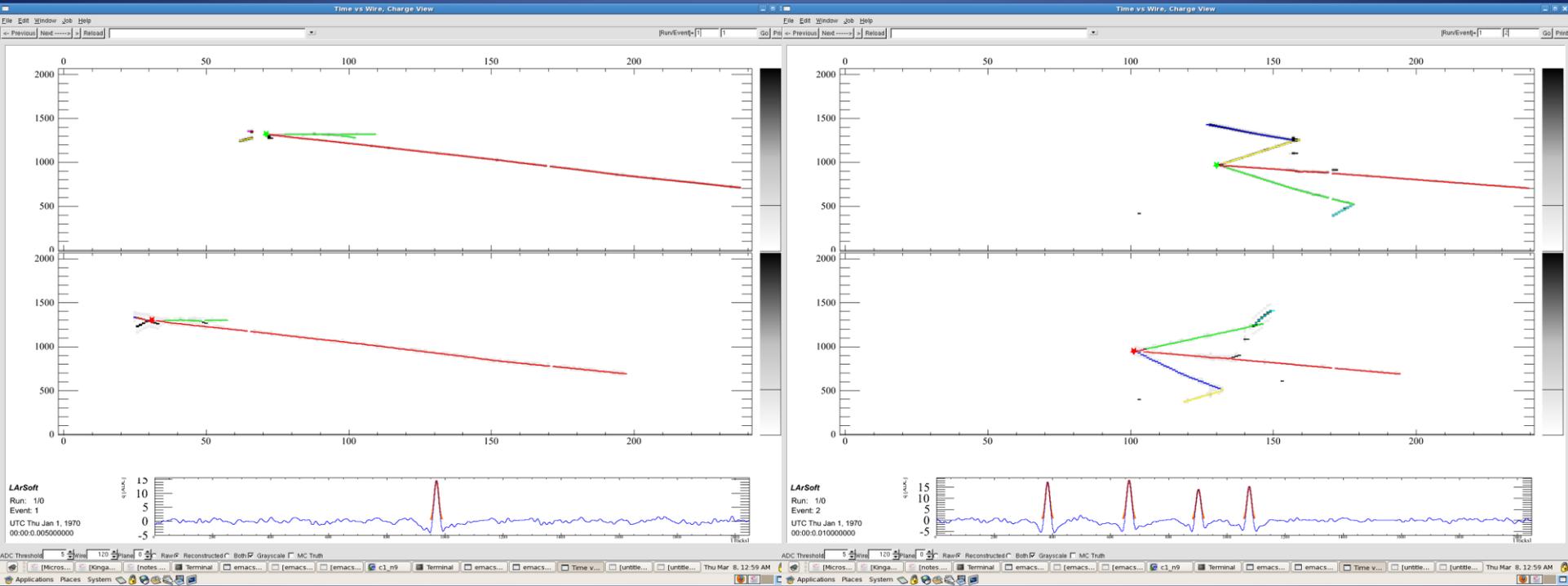
- $\chi_i^2 = \frac{\mu_i^2}{\Delta\mu_i^2} =$

$$\chi_i^2 = \frac{(c_i \cos\vartheta_i - v_y \cos\vartheta_i + v_x \sin\vartheta_i)^2}{(\cos\vartheta_i)^2 \sigma_{ic}^2 + \left(\frac{1}{1+m_i^2} [-c_i \sin\vartheta_i + v_y \sin\vartheta_i + v_x \cos\vartheta_i]\right)^2 \sigma_{im}^2}$$

- If $\chi_i^2 < 16$, use the track for vertex fitting, otherwise do not add it to the vertex
- Now sum the individual χ_i^2 (of each cluster that passed the cut and add it to the vertex) to get total χ^2 of the vertex
- $\chi^2 = \sum_i \chi_i^2$
- Minimize the χ^2 function to obtain the v_x and v_y (vertex position)

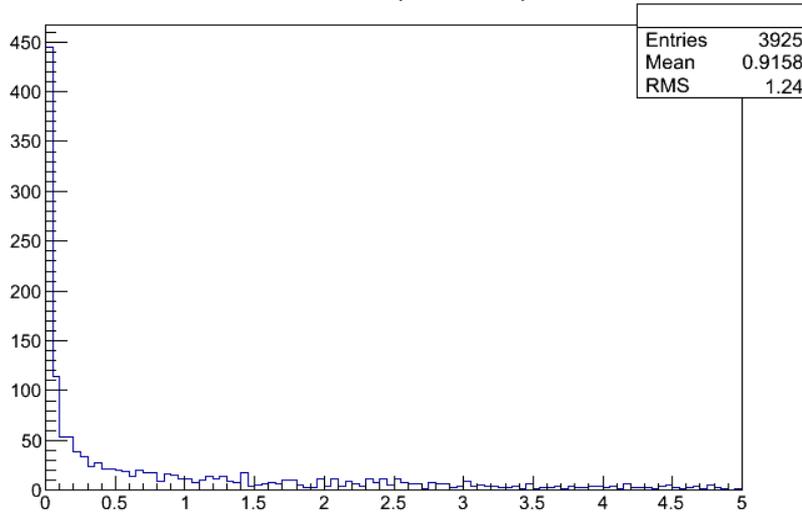
- Generated 4500 default GENIE events with Simple NUMI Neutrino Flux

Vertex Reconstruction

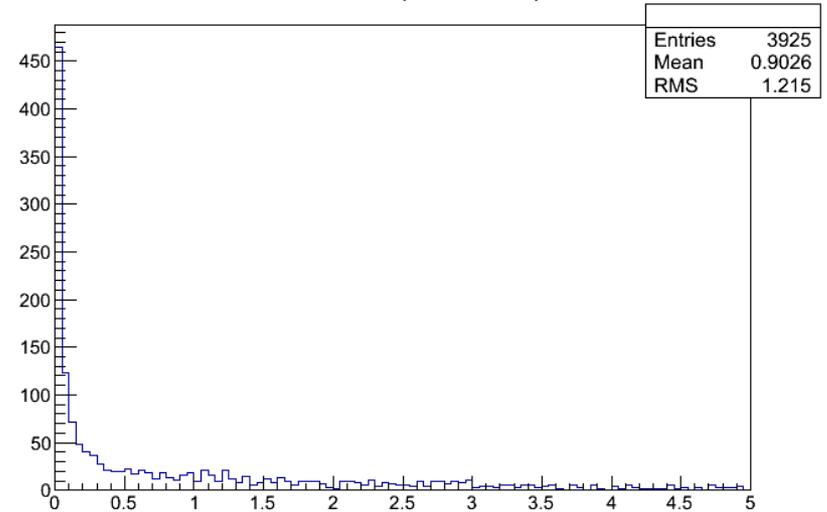


χ^2_{\min}/DOF (for more than 2 vertex clusters)

Chi2/DOF (Induction)



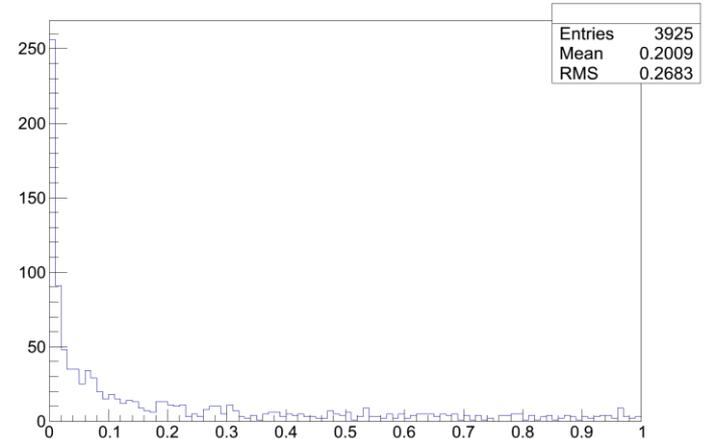
Chi2/DOF (Collection)



Chi2/DOF (Induction)

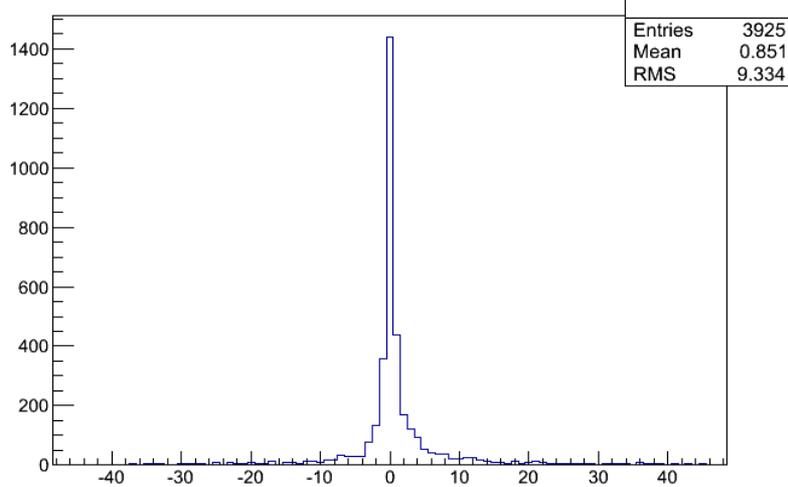


Chi2/DOF (Collection)

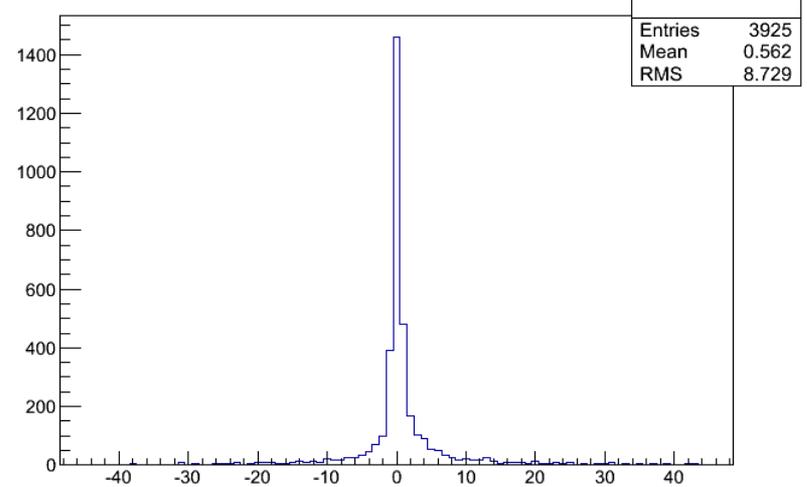


Wire Reco vtx – Wire True vtx

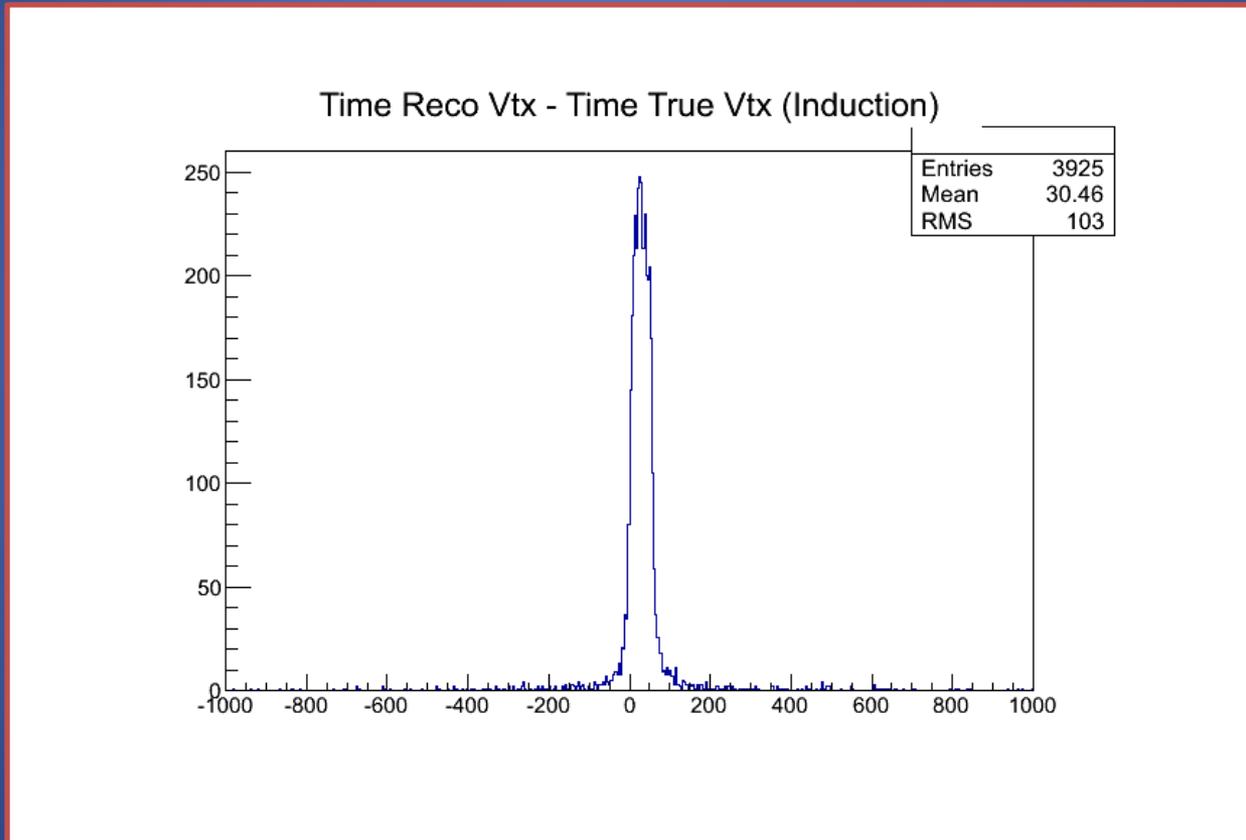
Wire Reco Vtx - Wire True Vtx (Induction)



Wire Reco Vtx - Wire True Vtx (Collection)

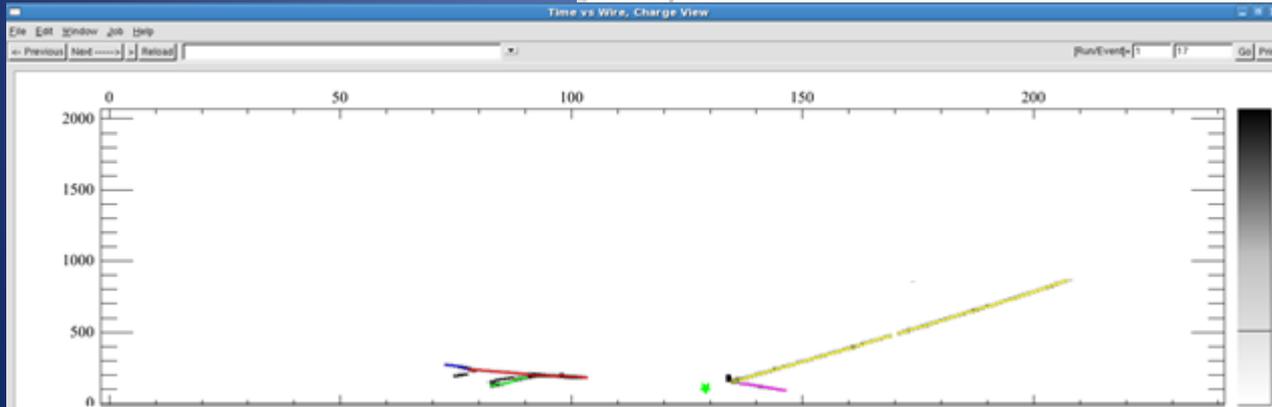
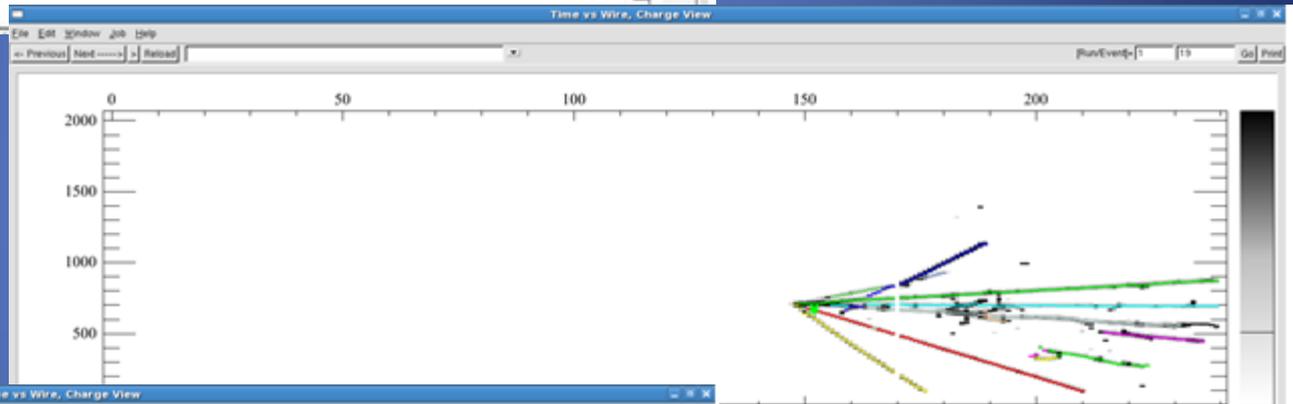
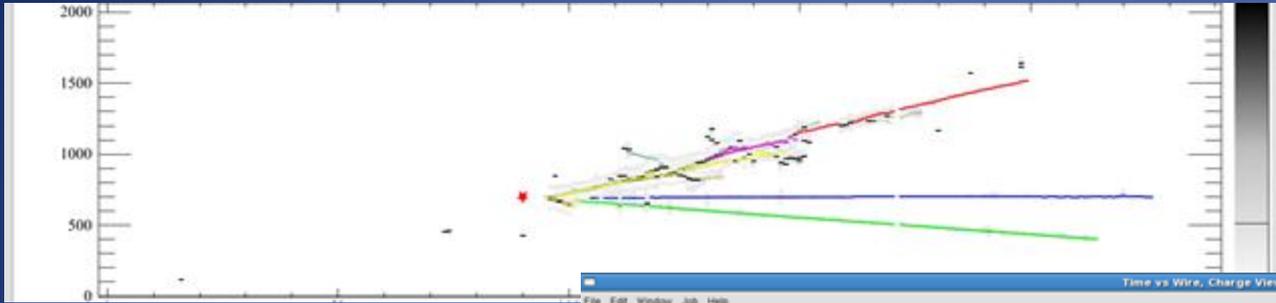


Time Reco vtx – Time True vtx



Large Mean Value!!

Things to Fix



To Do..

- Put Actual Hit Errors
- Use same unit in the calculations (cm or ticks) so that dca and other cuts be quantified in cm or in ticks
- Check the big difference between the Time Reco vtx and Time True vtx
- Deal with the parallel tracks and detached tracks

THANK YOU