ν_e tagging update

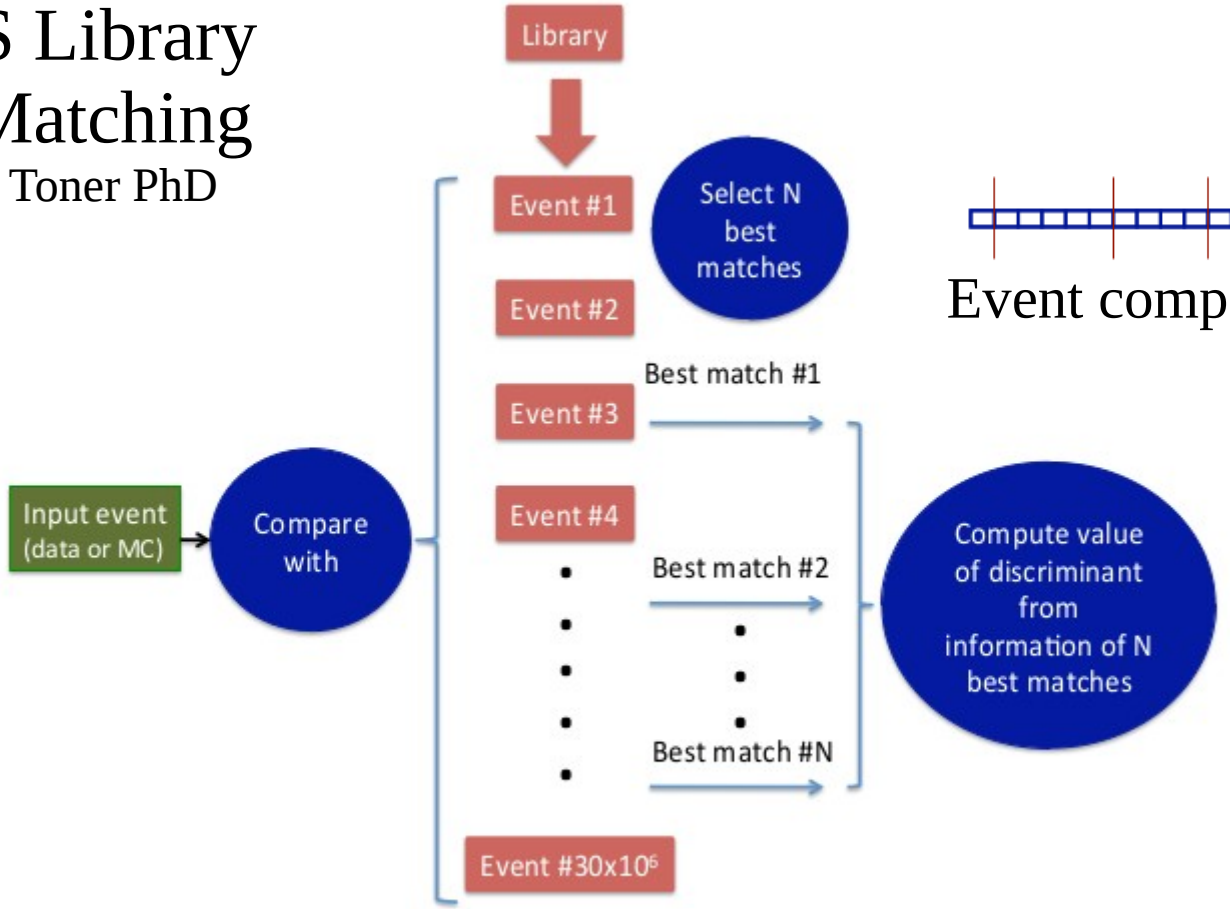
D Adey

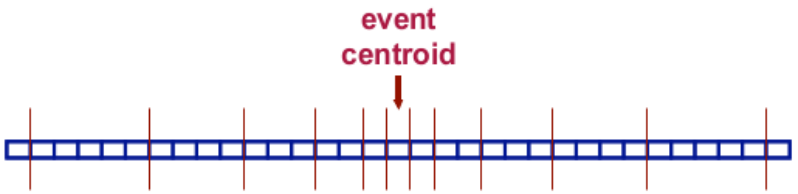
nuSTORM workshop
Fermilab 21st November 2013

- SuperBIND designed for muon appearance – there will also be nu_e in the beam
- Appearance is very tricky, but disappearance plausible
- Either way tagging the electron is required
- Main issue is distinguishing from NC – can't range out like muon
- MINOS uses Multi-Variate Analysis based on selected variables and separate Library Event Matching

MINOS Library Event Matching

(Ochoa and Toner PhD theses)





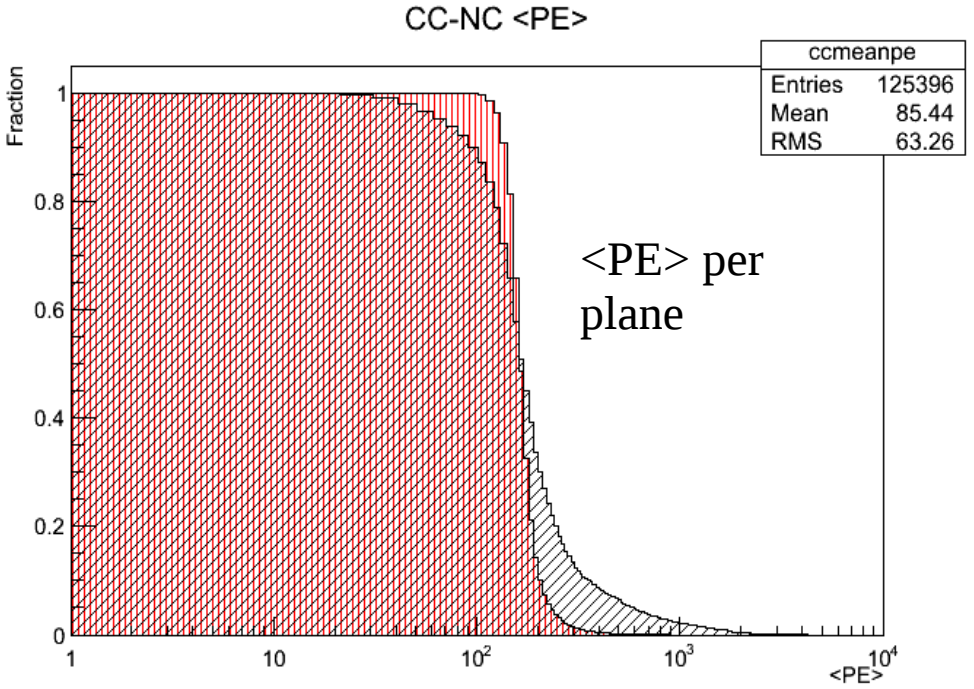
Event compaction

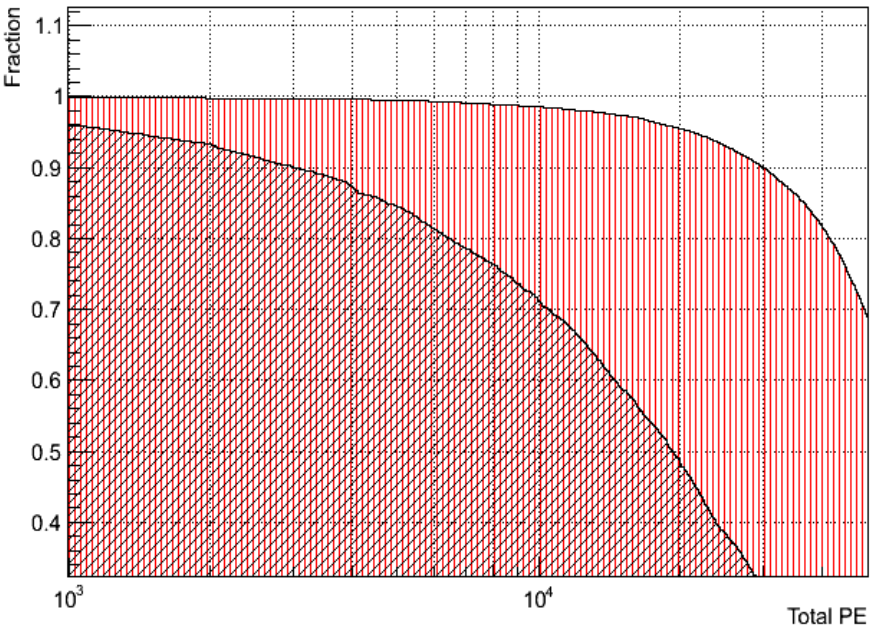
Strip by strip light yield comparison

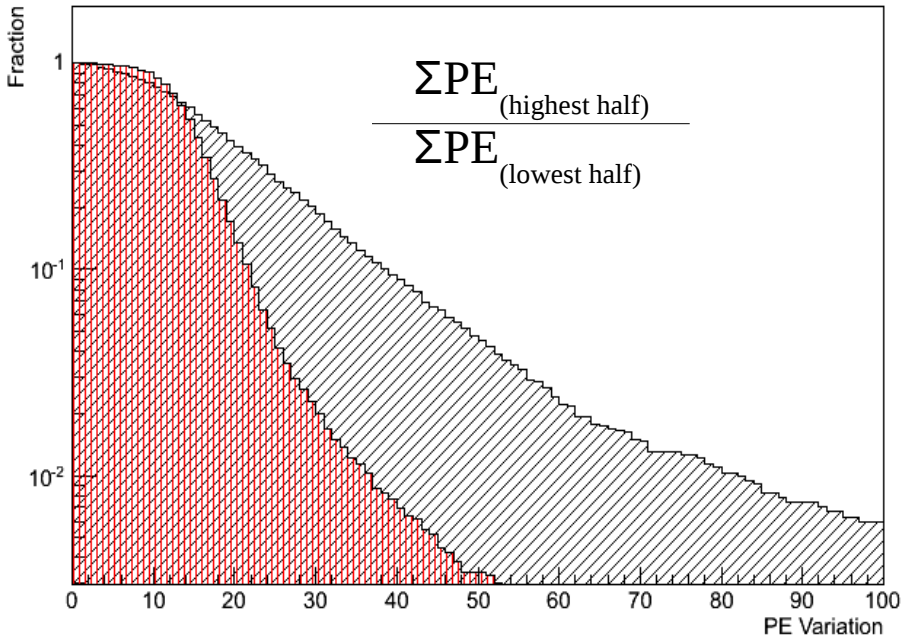
$$\mathcal{L} = \sum_{i=1}^{\mathrm{N^{strips}}} \ln\left(S^i\right) = \sum_{i=1}^{\mathrm{N^{strips}}} \ln\left(\int_0^\infty P(n_A^i;\lambda)P(n_B^i;\lambda)d\lambda\right)$$

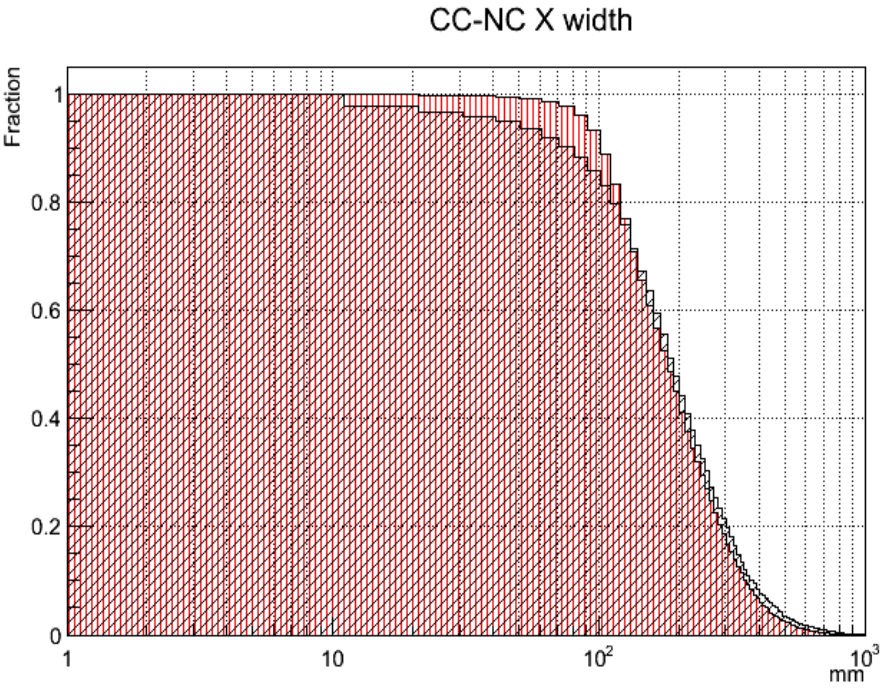
MVA discriminator variables

CC
NC

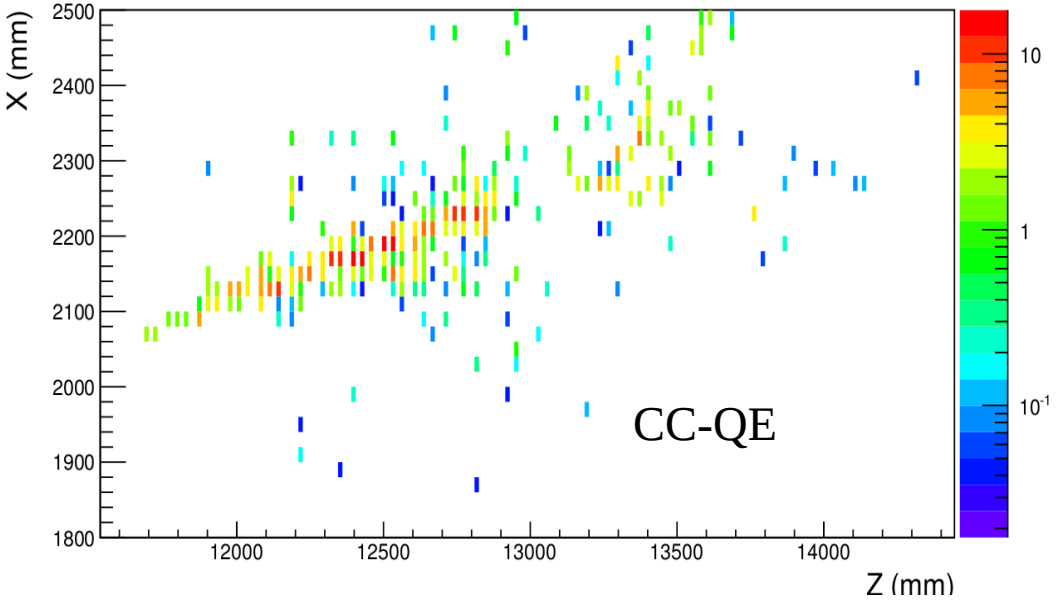


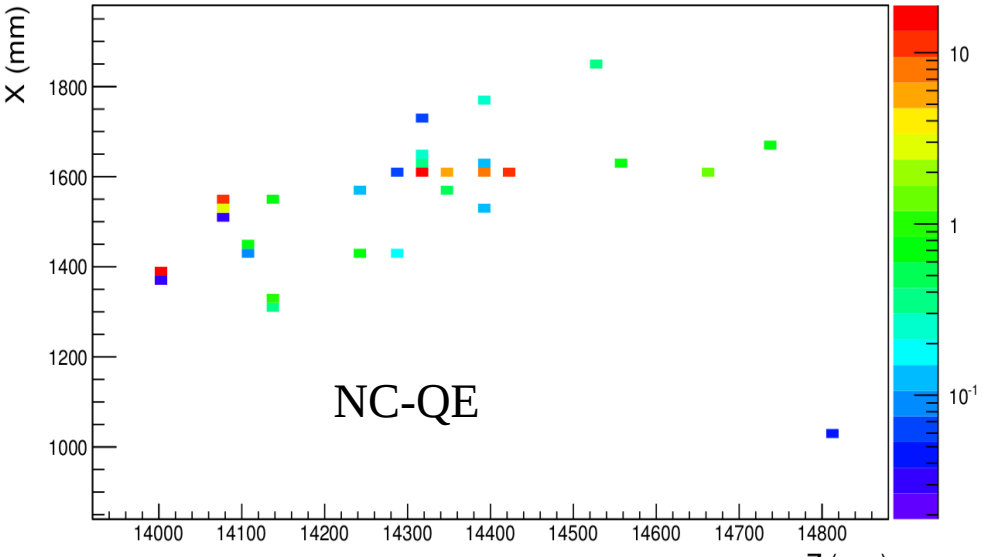


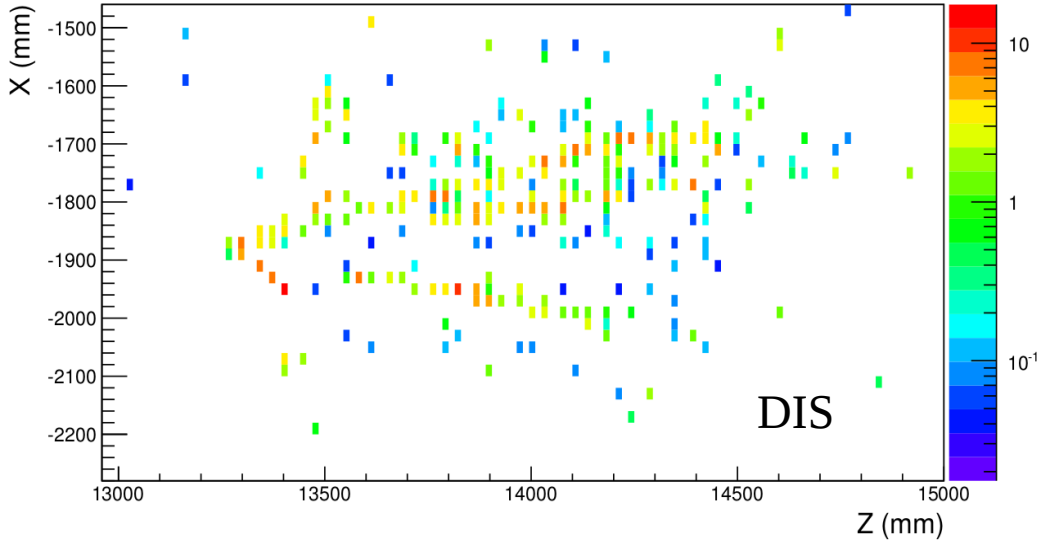


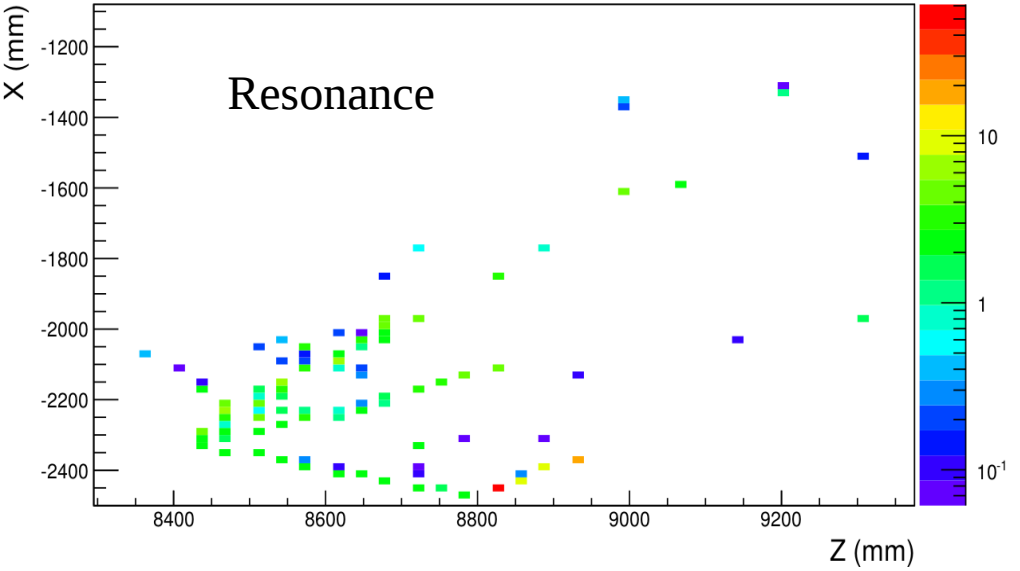


ν_e Event types in SuperBIND

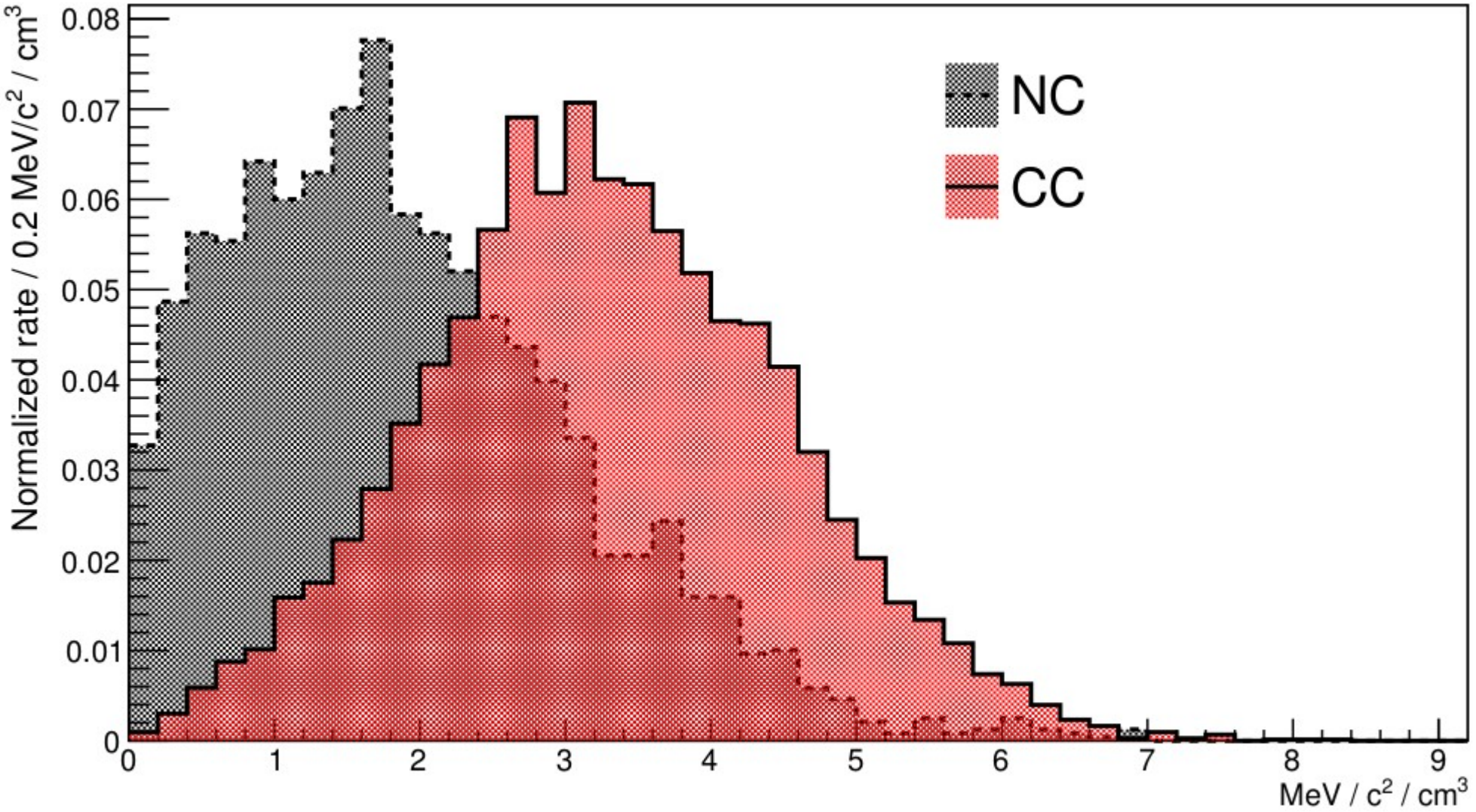




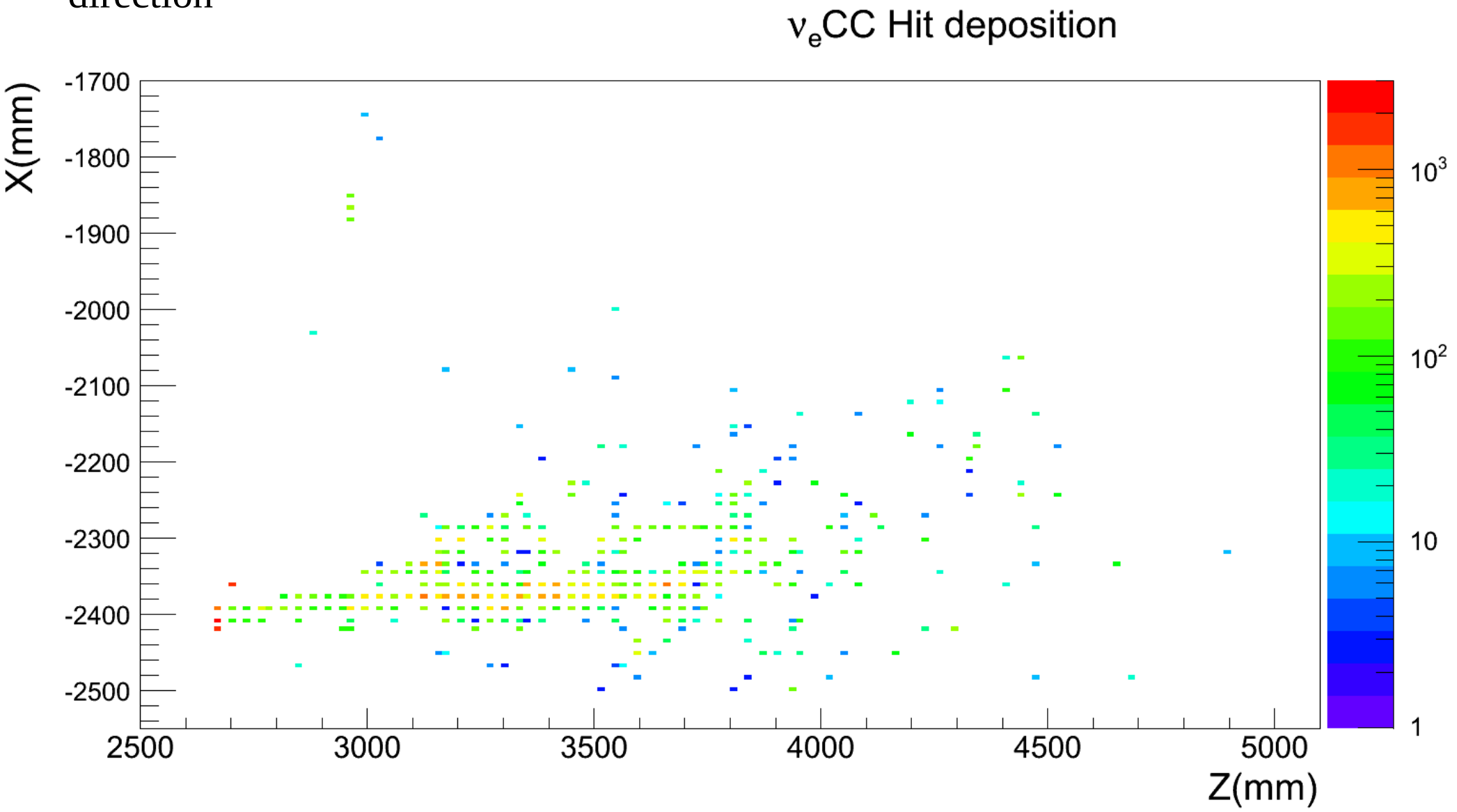




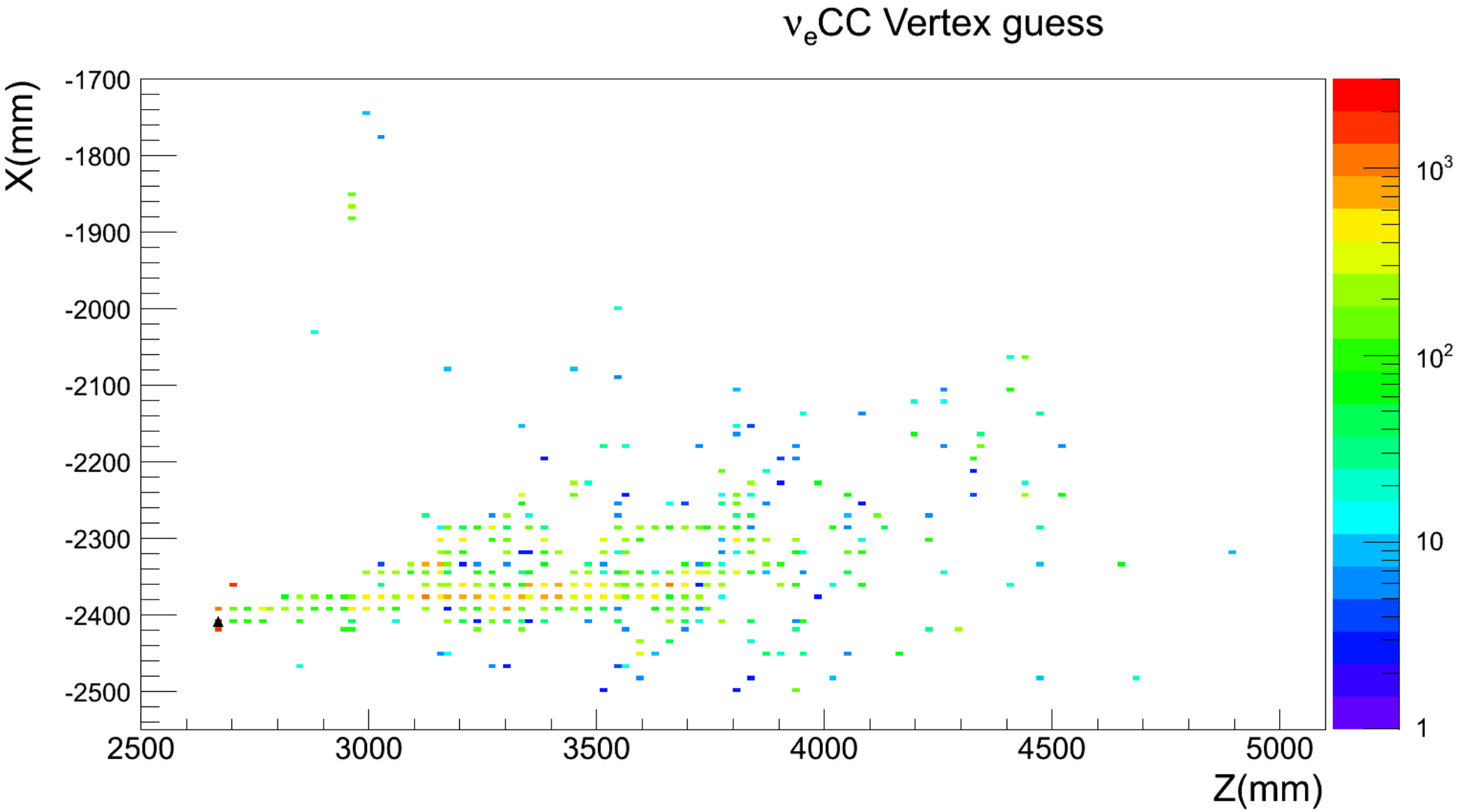
For electromagnetic shower, 90% of energy deposition should be within one Moliere radius ~ 14cm



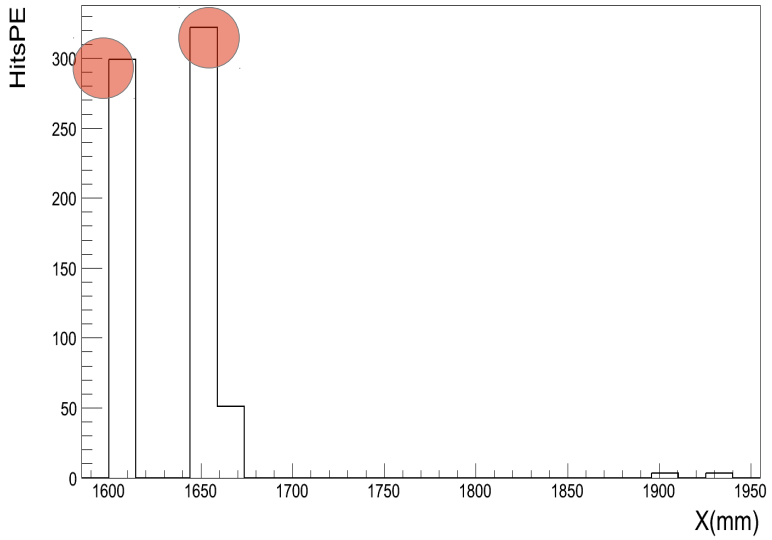
Finding the region encompassing the energy deposition – shower direction

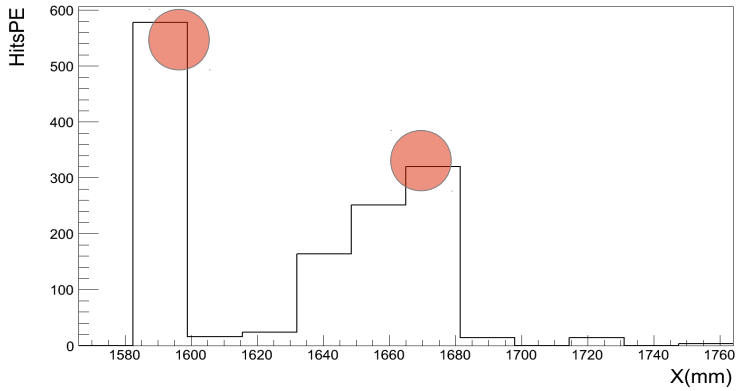


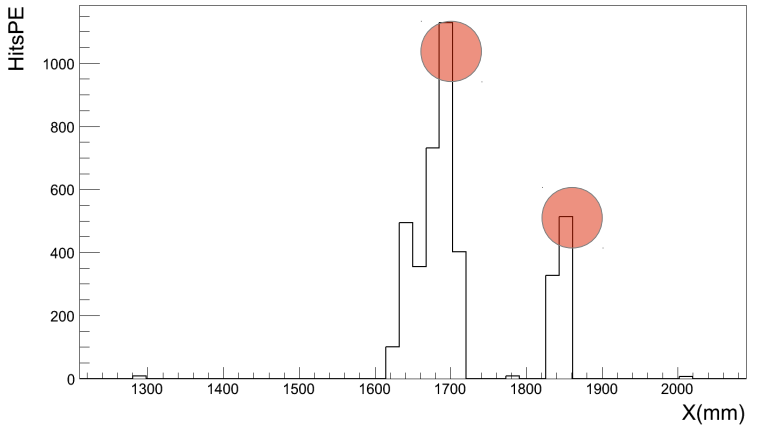
Attempt to find beginning of shower



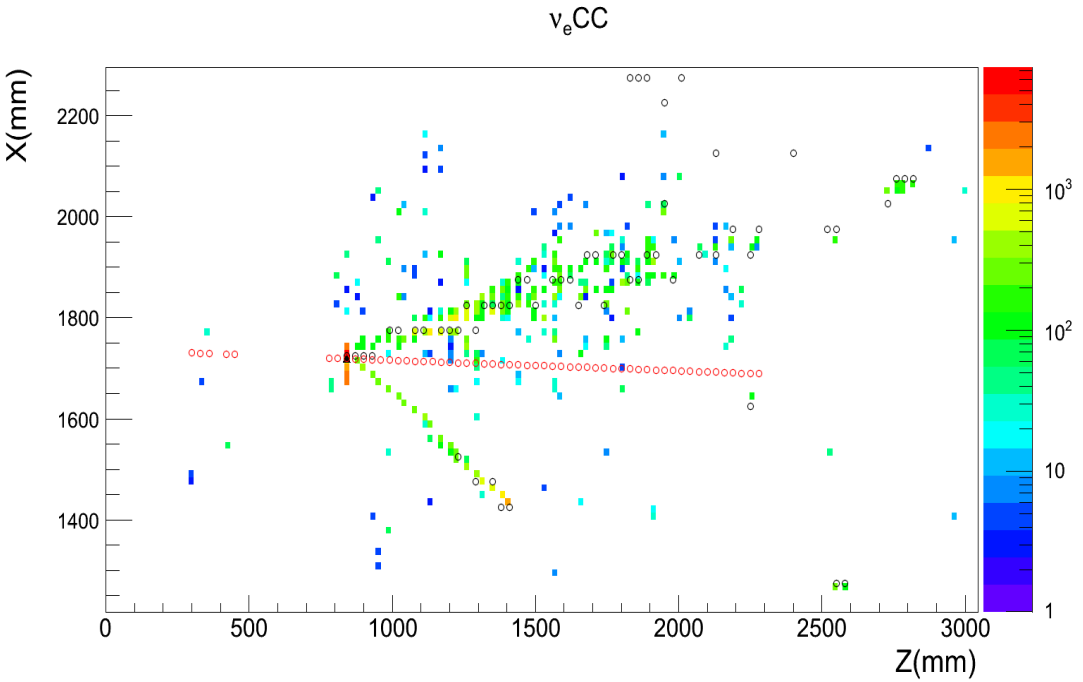
Vertex guess







Z

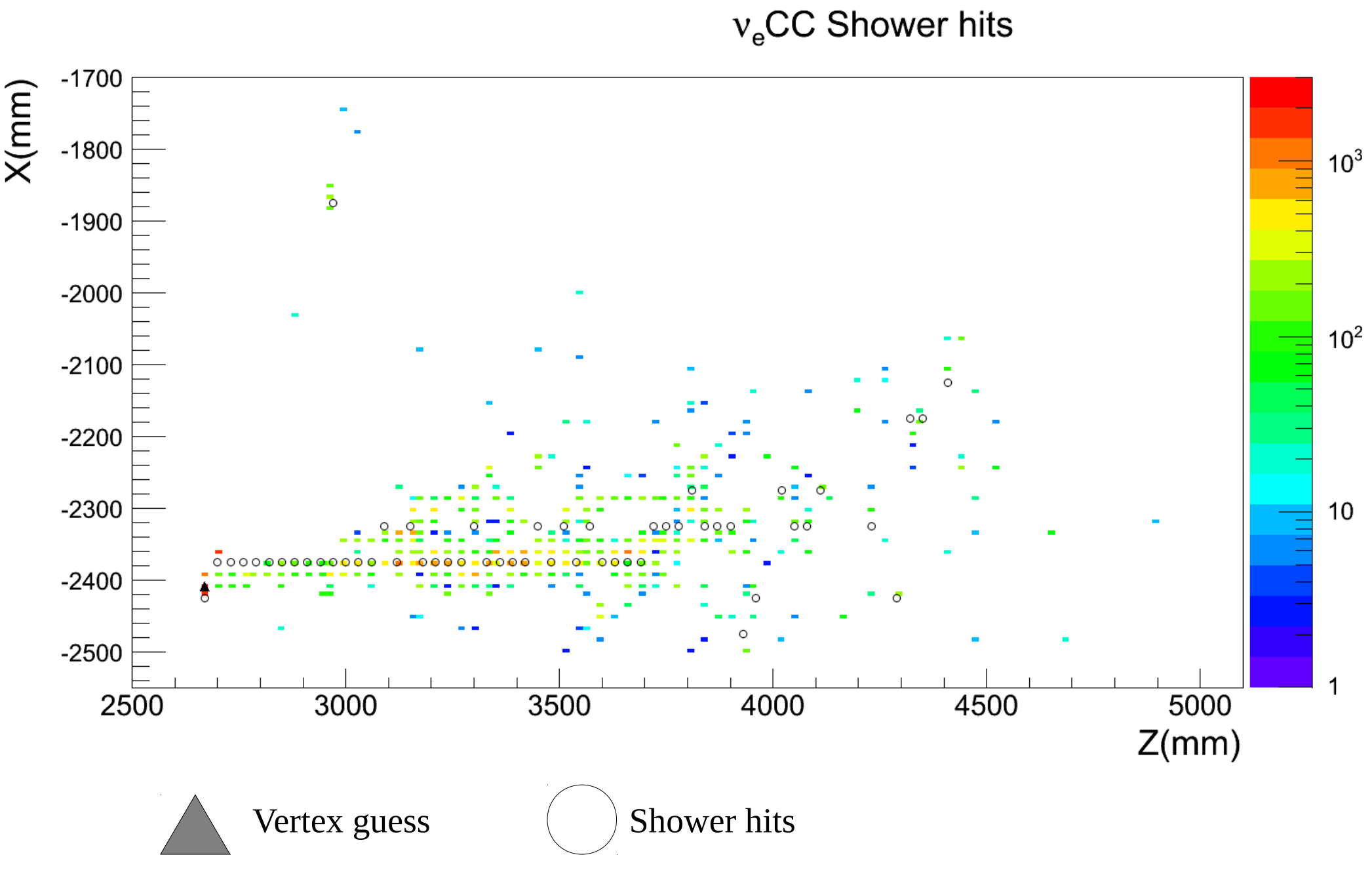


Look for some kind of structure in the shower(s).

Taking the charge-weighted mean from each x-plane doesn't work if there are multiple showers/tracks.

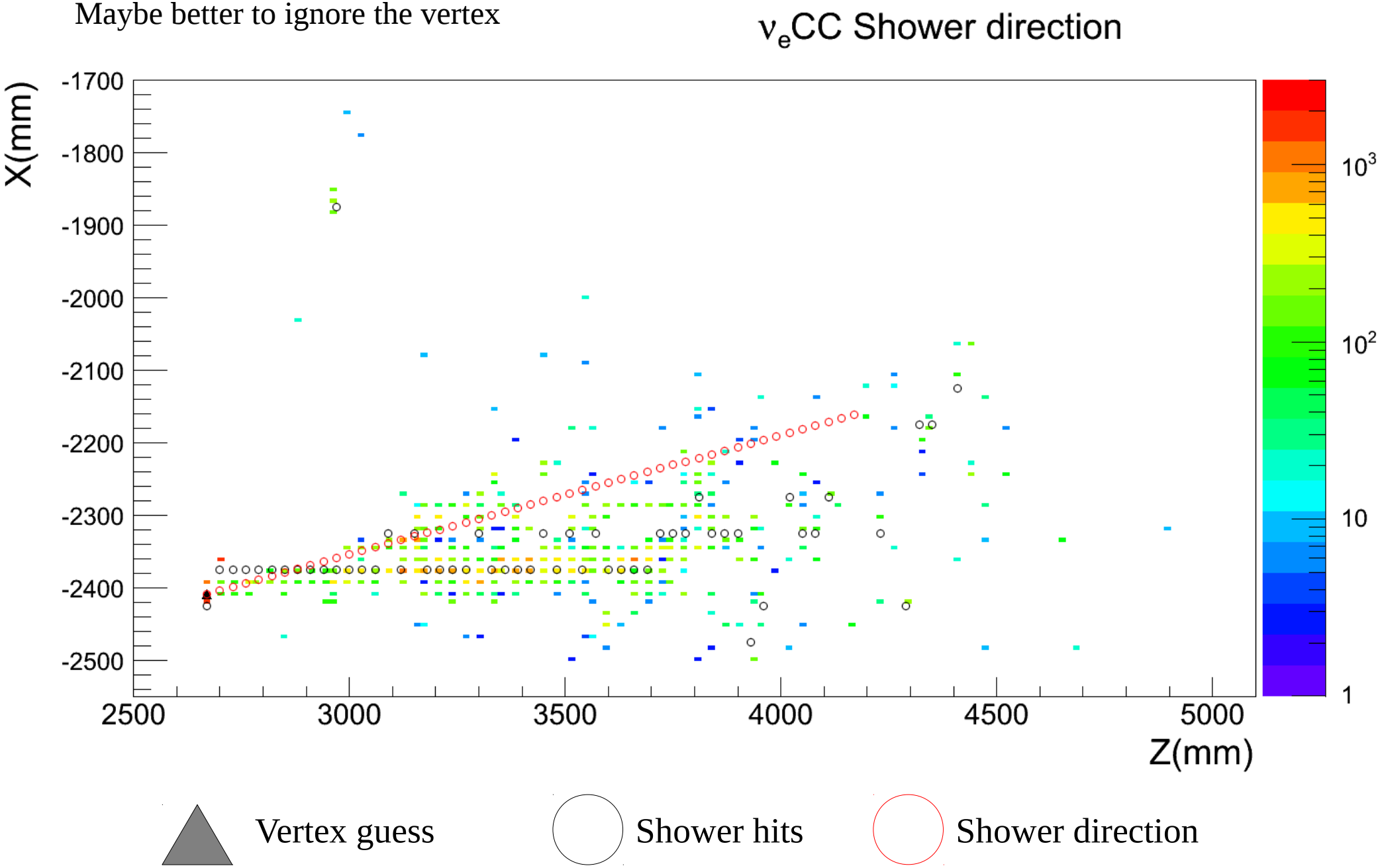
Use a peak finder in each x/y plane.

Requires creative binning distinct from detector geometry.

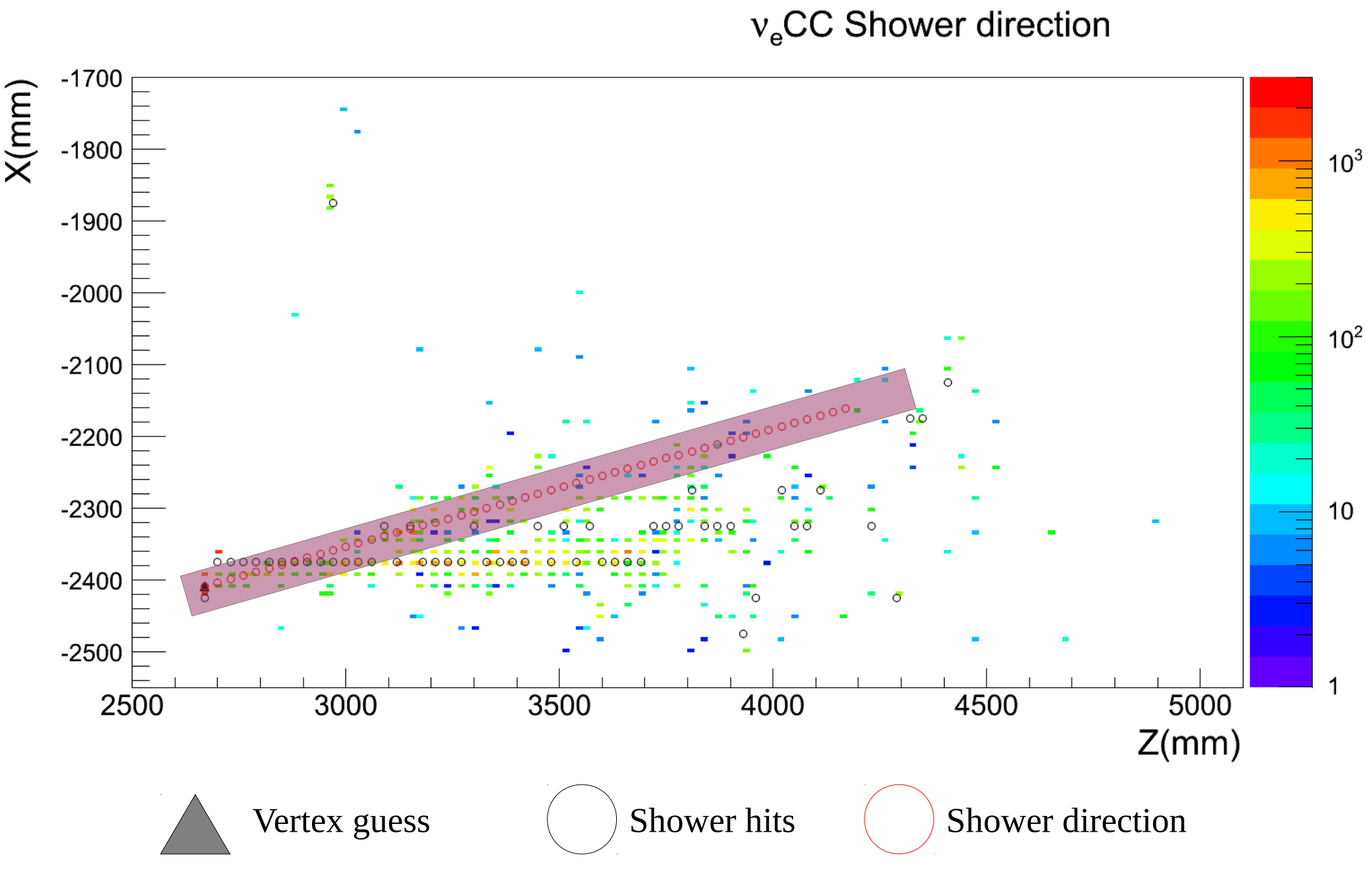

ν_eCC Shower hits
X(mm)
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
2500
3000
3500
4000
4500
5000
Z(mm)
10^3
10^2
10
1
Vertex guess
Shower hits

Fit the “shower hits” and peg at the vertex

Maybe better to ignore the vertex



Expand region around shower direction until
75% of charge encased.



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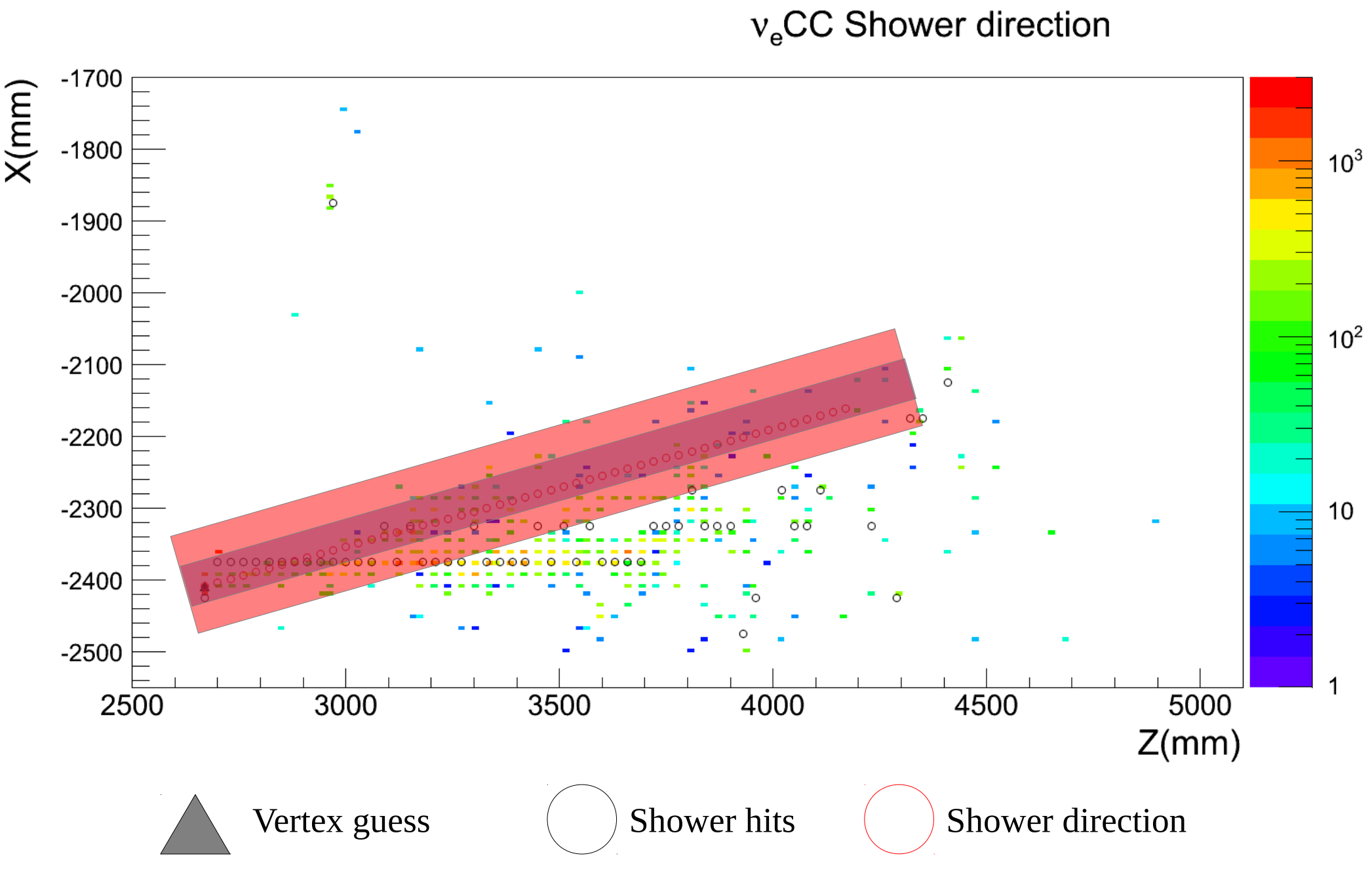
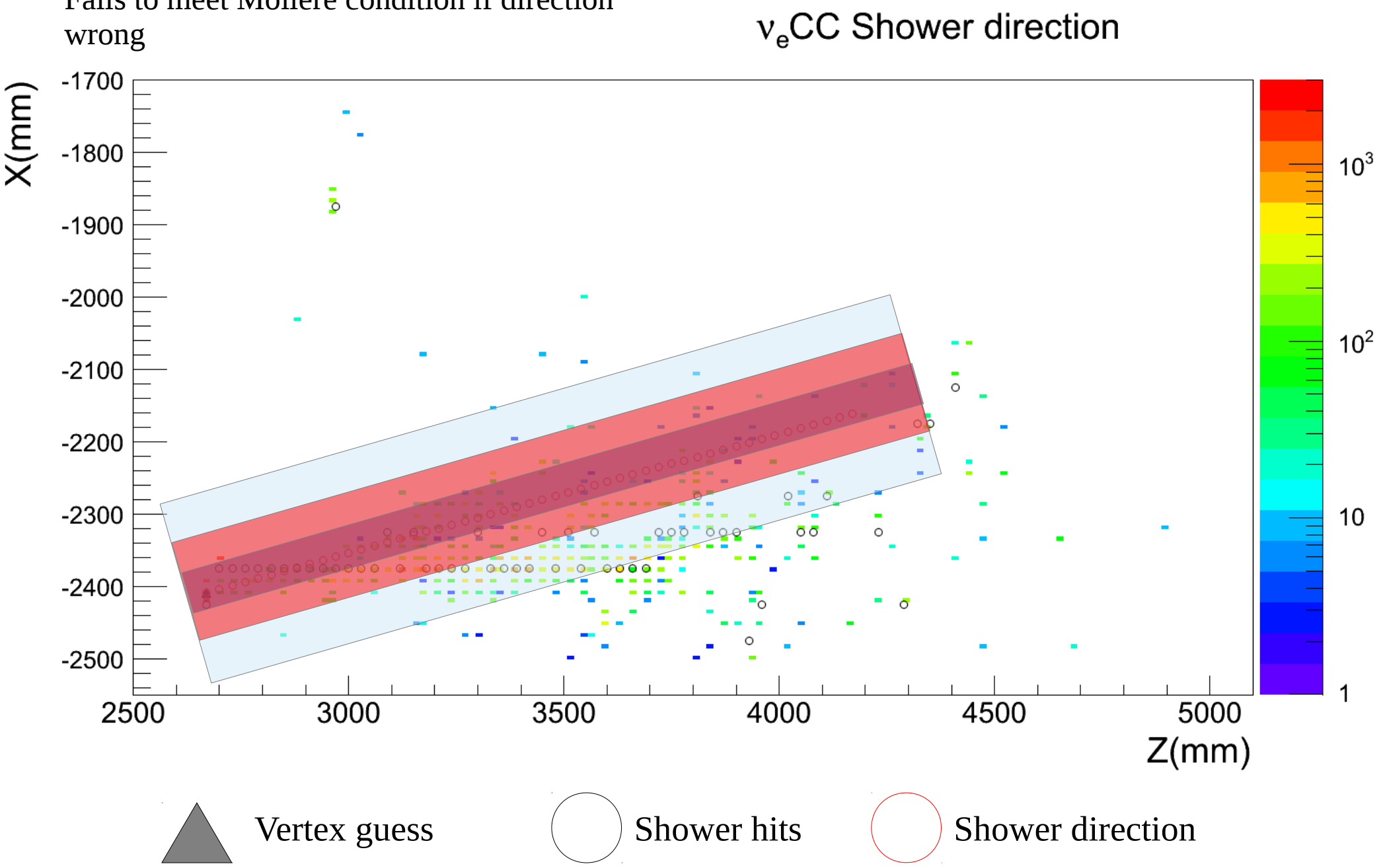


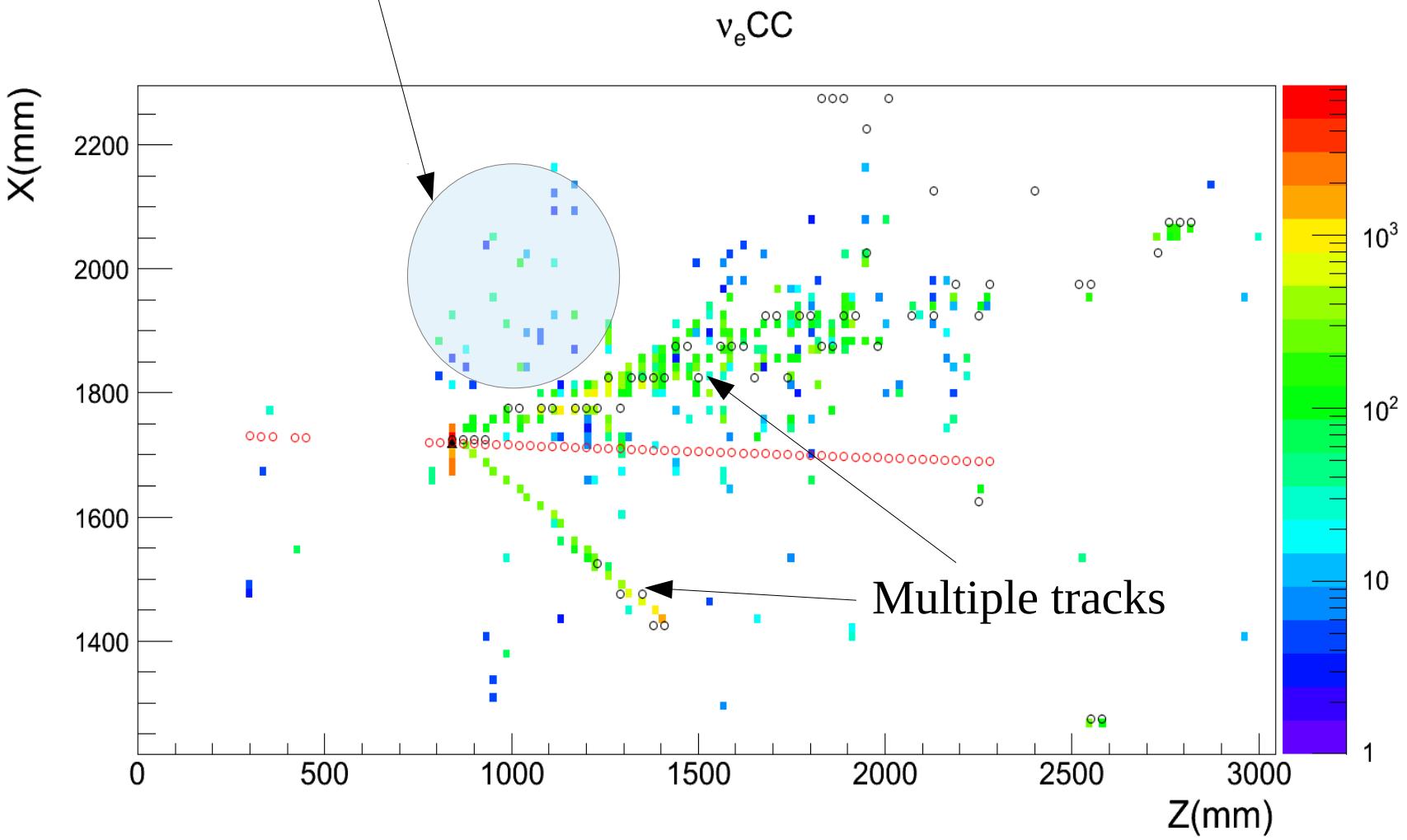
Expand region around shower direction until 75% of charge encased.

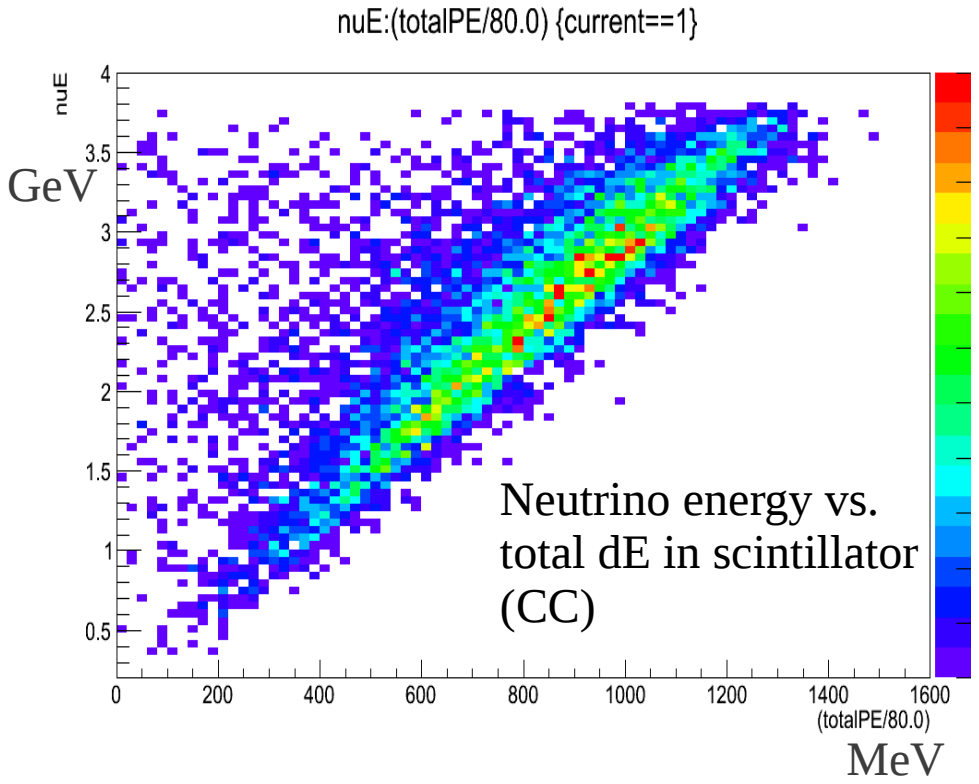
Fails to meet Moliere condition if direction wrong

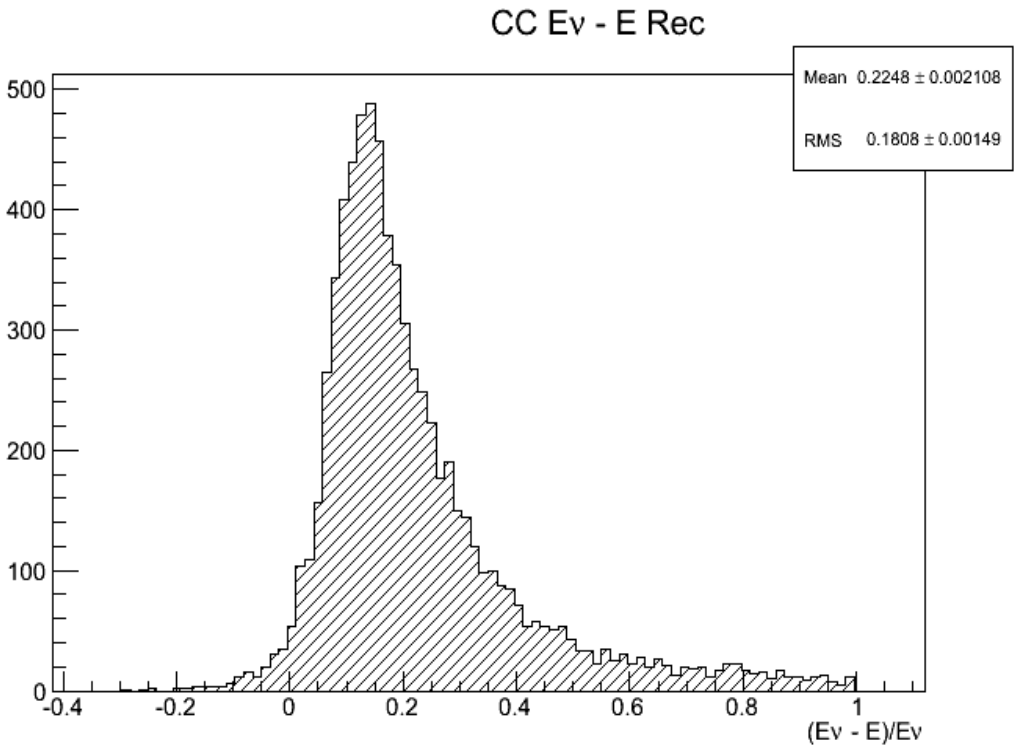


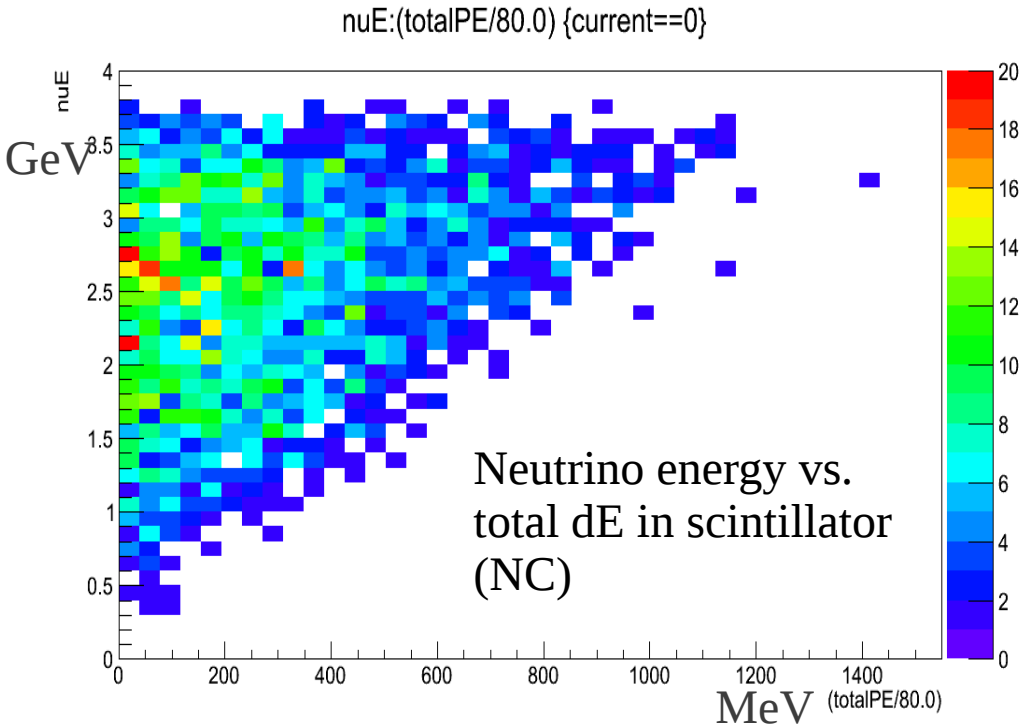
Clear up isolated hits

It would help if the cone or cylinder used as a discriminator actually encompassed the shower









$(E_{true} - E_{rec})/E_{true}$

Total dE (from PE) scaled to steel/scintillator

Birk's law correction in simulation

Left to do

- Get the shower direction working
- Characterise performance
- Add new variables into MVA analysis (currently just likelihood on these variables)
- Make statement about SuperBIND shower tagging efficiency
- Think more about energy reconstruction
- Library Event Matching
- Merging of code bases