# Update on $\nu_e$ Selection

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19/12/16

# Reminders

- Working on the $\nu_e$ CC selection which has been started by Tingjun and Tyler.

- So far, I've only been working on reconstruction.

- Updates today include changes to the reconstruction, an initial look at the reconstruction performance and an even-more-initial look at the selection!

- Note: I don't consider the reconstruction to be in a working state yet — need a couple of days (later this week it'll be ready). Results are so preliminary they're not even results!

# Reconstruction

- Tingjun and I discussed the $\nu_e$ selection and decided changes to the reconstruction are necessary in order to make improvements.

- MCC 7 performance (run over $\nu_e$CC events):
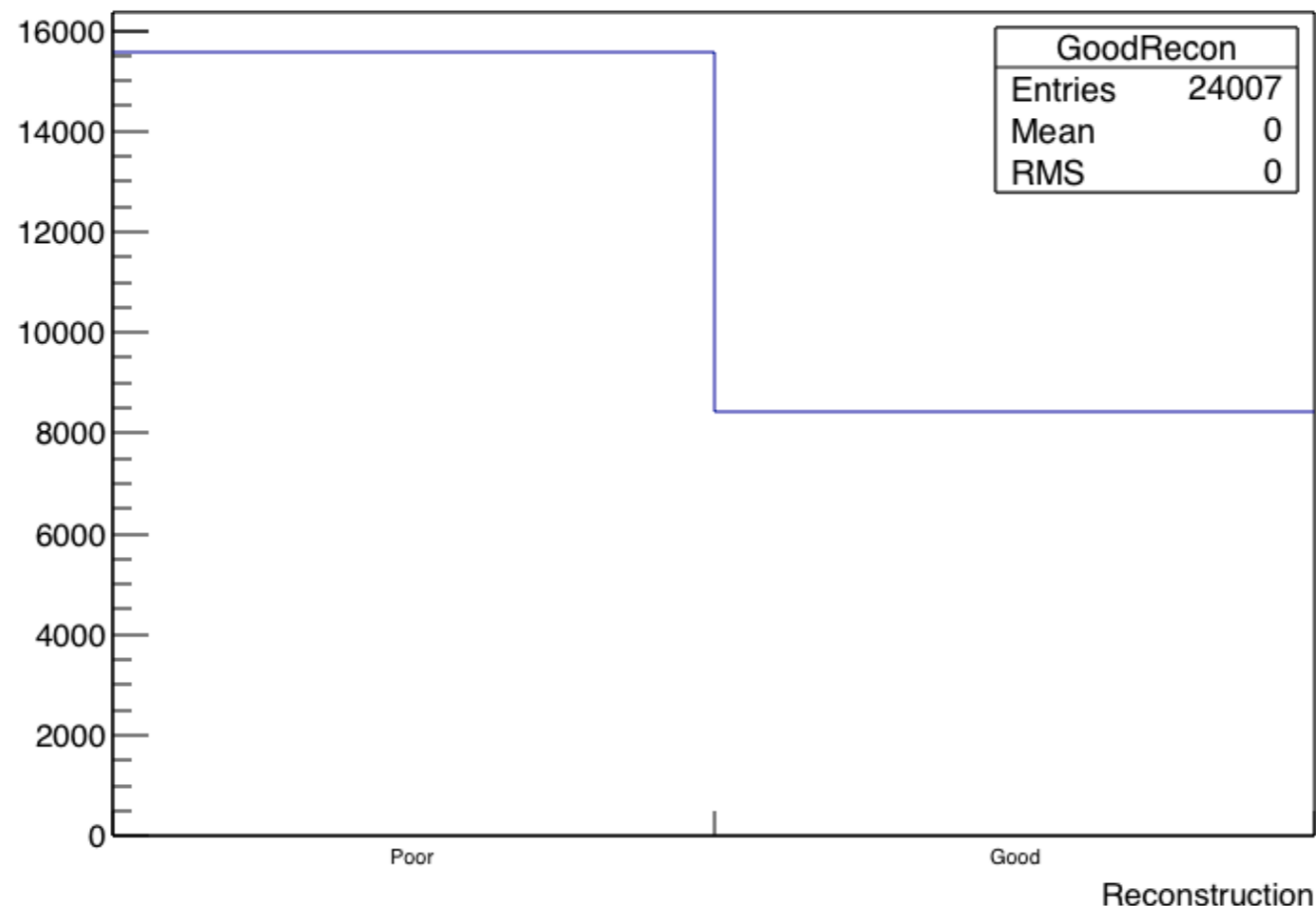


- Good reconstruction: at least one reconstructed electron shower, no showers associated with hadron tracks from vertex, reconstructed electron shower start < 10 cm, direction < 10°.

# Track/Shower Separation

- Main problem is correctly reconstructing track and showers. Tracking works very well and shower reconstruction works when applied to shower-like hits!

- I've been working on an algorithm to try to separate shower-like tracks from track-like tracks.

  - Runs over the output of tracking so we have as much information as possible (2D hits, clusters, 3D tracks, space points etc).

- Written in larreco/RecoAlg/TrackShowerSepAlg (most recent developments are on feature/wallbank_TrackShower).

- Also added a producer module in larreco/TrackFinder/TrackIdentifier_module.cc which produces:

  - Tracks which are determined to be tracks, along with all their previous associations;

  - Hits and vertices determined to be from showers, passed on to showering algorithms.

- Can also run track shower separation as an option in BlurredCluster without producing tracks.

# Track/Shower Separation
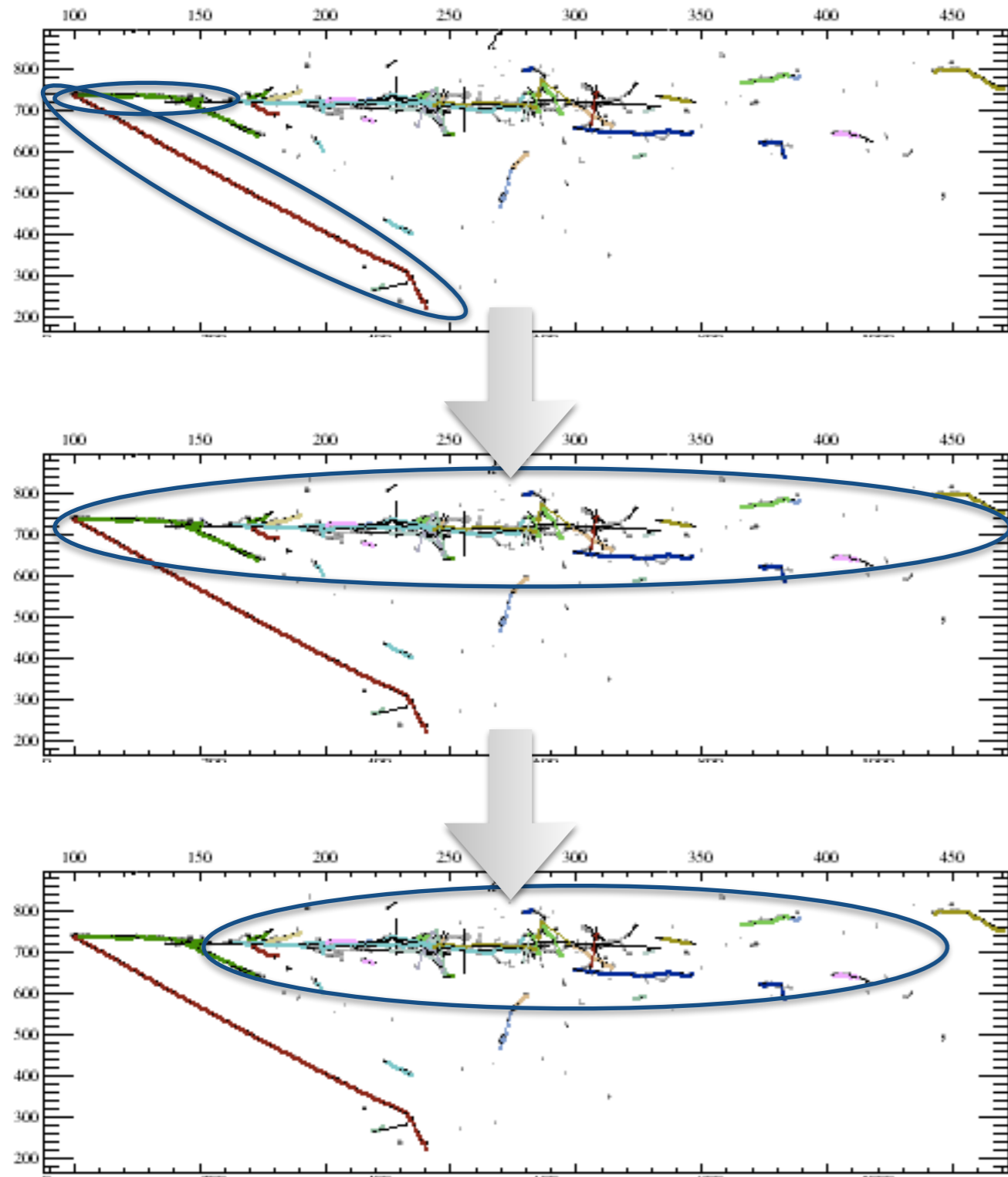


Tag tracks and shower tracks (consider activity in the cylinder (3D) and rectangle (2D) a certain radius around object

'Shower cone'
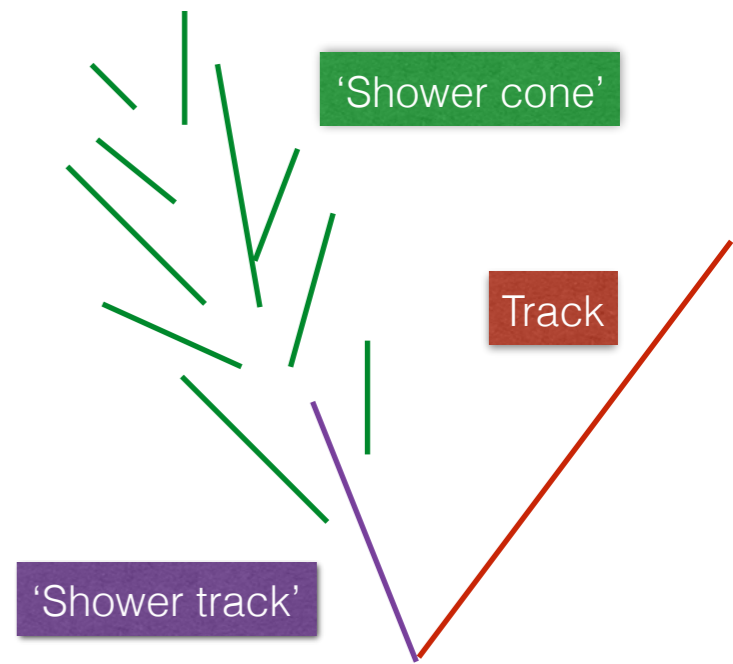
Track

'Shower track'

Determine if any tracks are actually 'shower tracks' (consider activity downstream of the track)
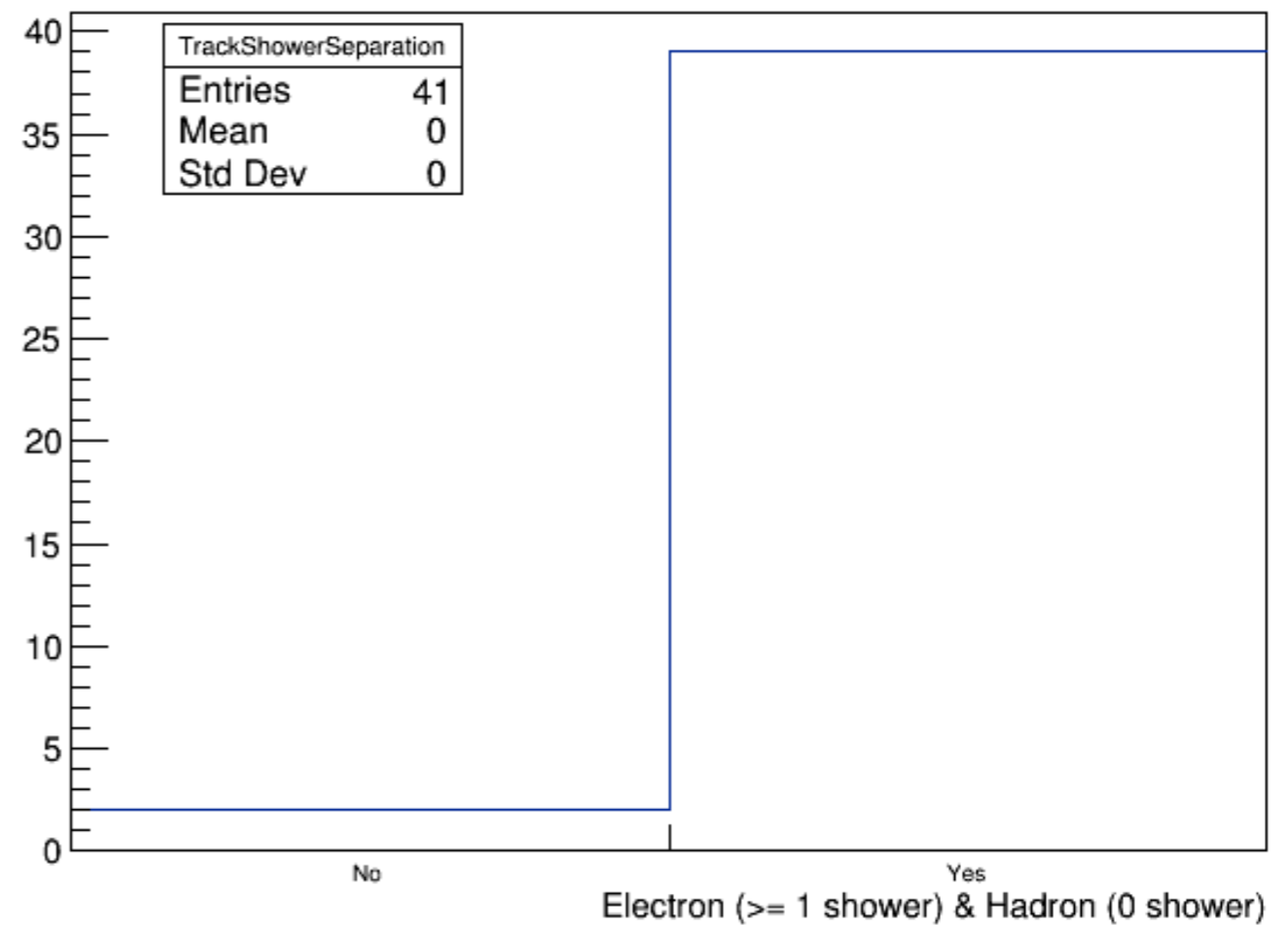
Find all downstream 'shower cone' tracks

All cuts are made as ratios of event averages — deal with neutrinos with a range of energies effectively.

# The Good News!

- 'Basic track/shower separation': zero reconstructed showers associated with longest hadron track from vertex, at least one reconstructed shower associated with the electron.
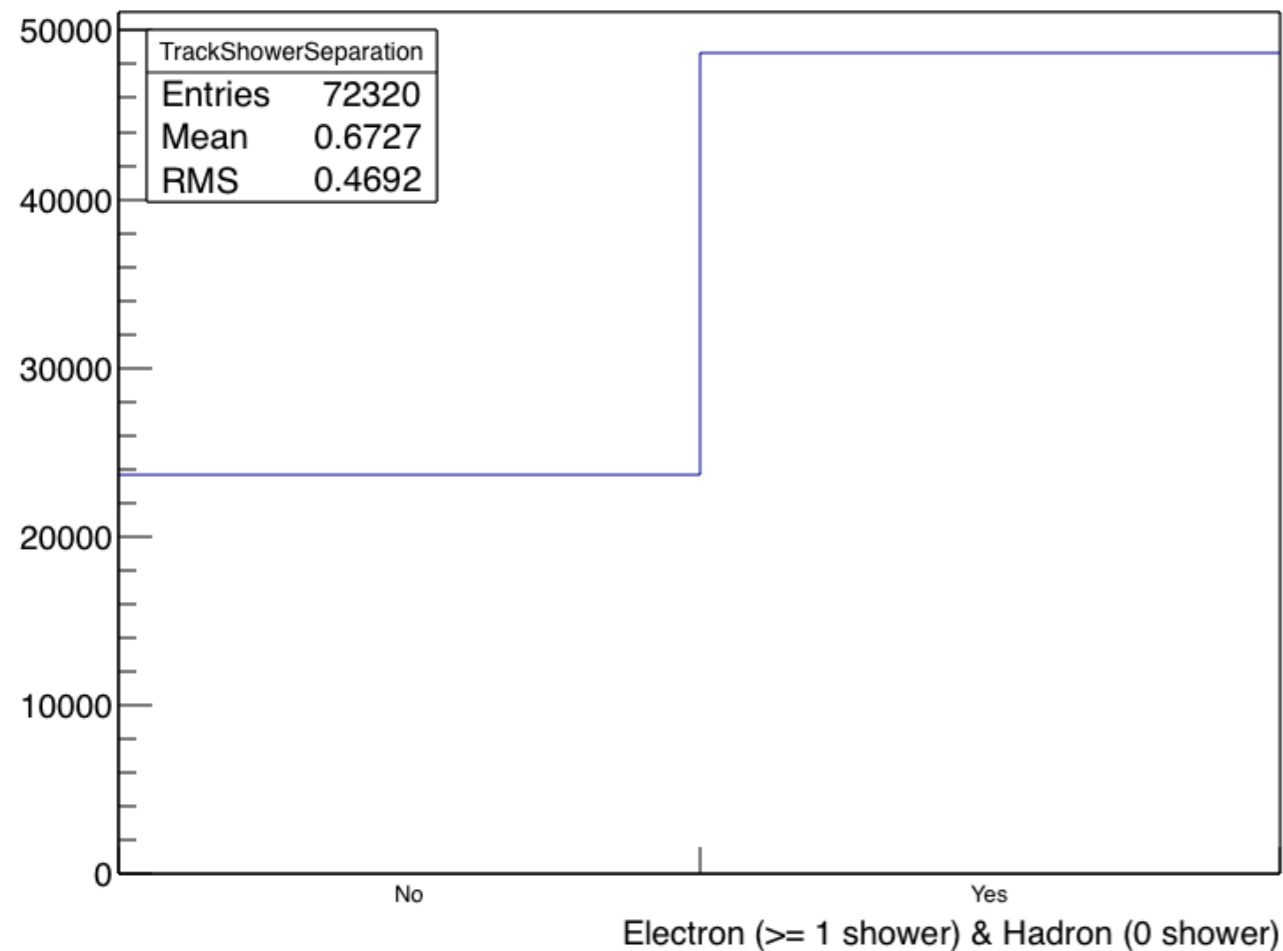


Reconstruction from MCC7



After these improvements

# The Bad News!

- 'Good shower': reconstructed shower start < 10cm from true start, reconstructed shower direction < 10° from true direction.
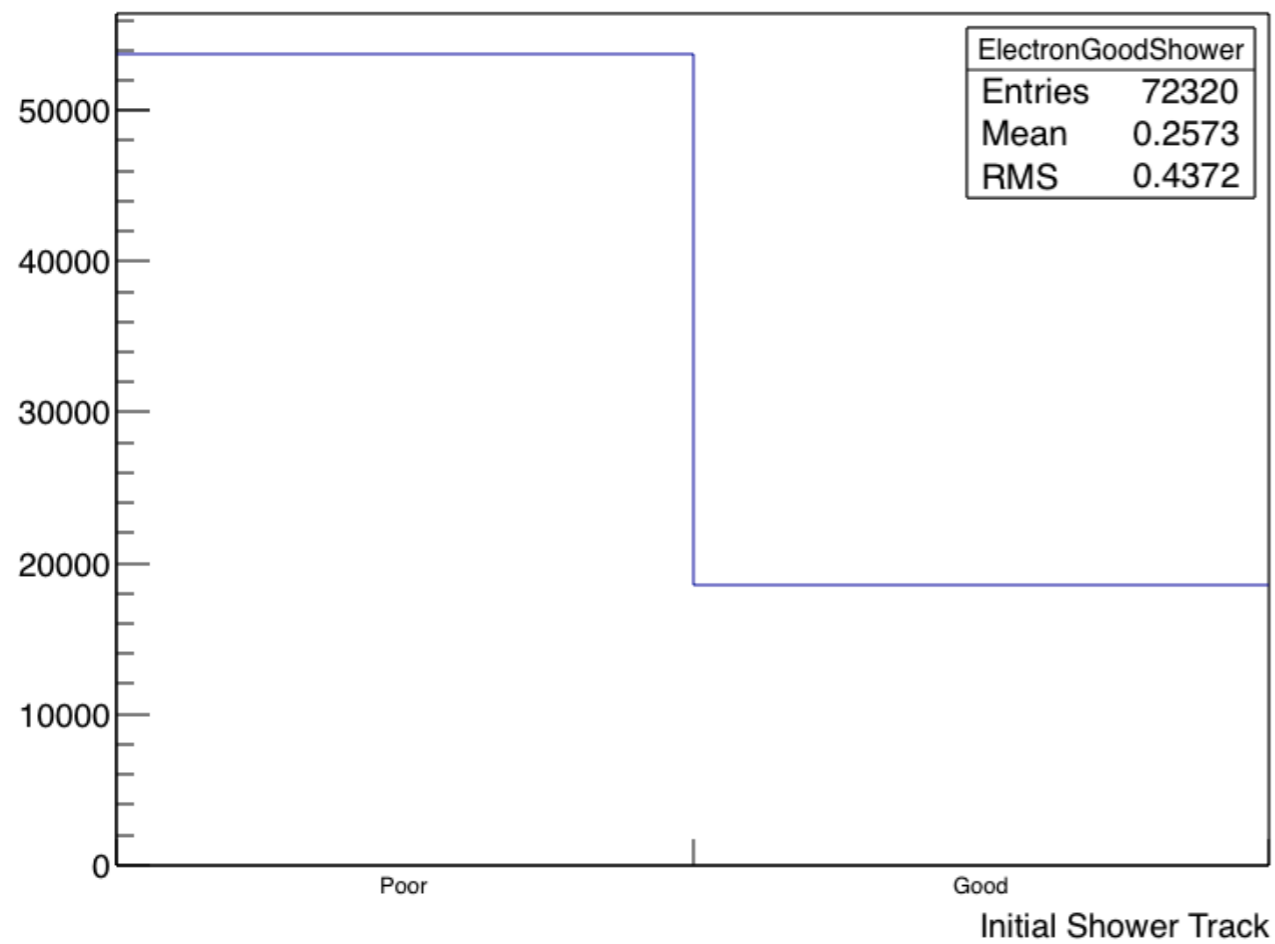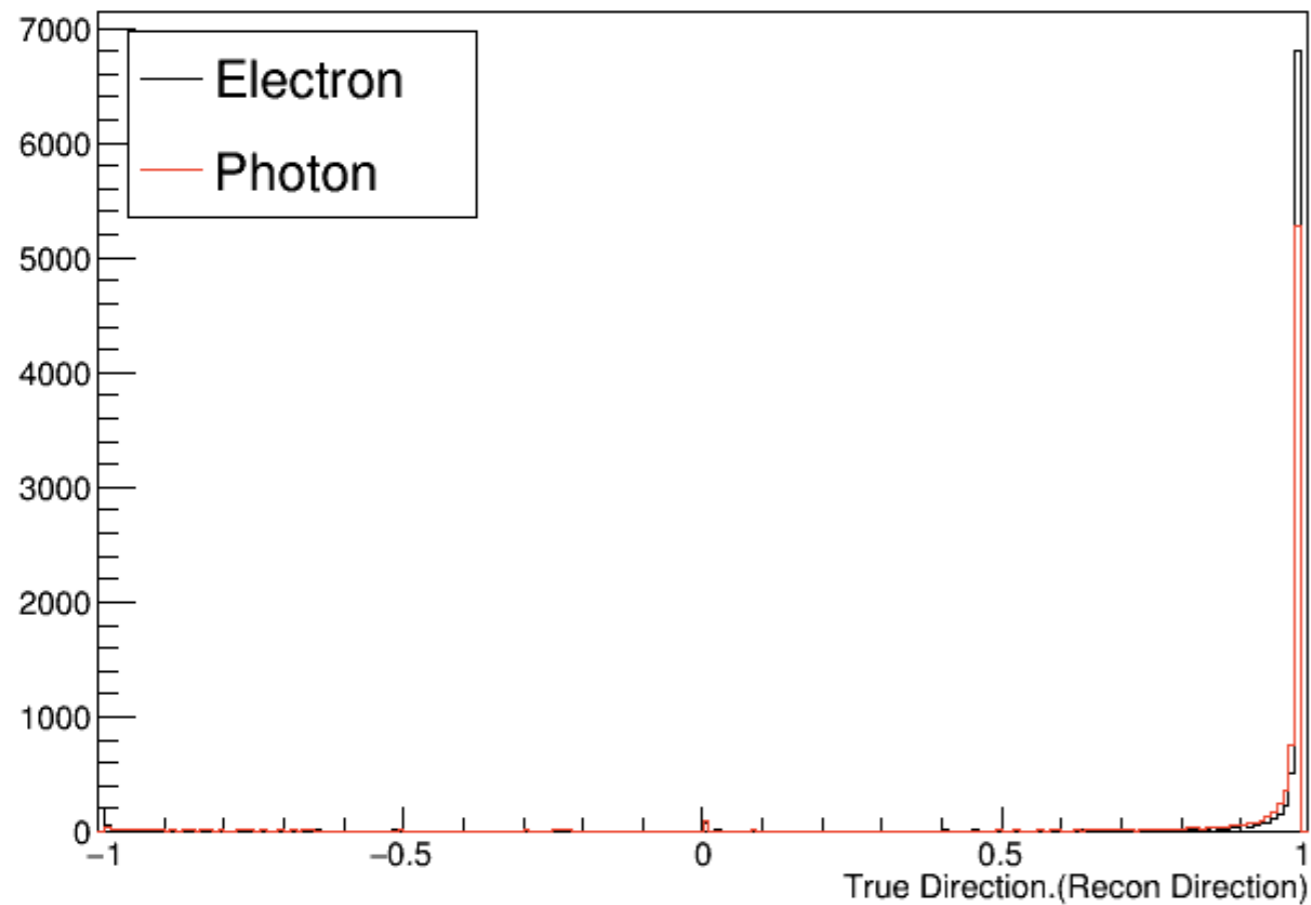


Reconstruction from MCC7
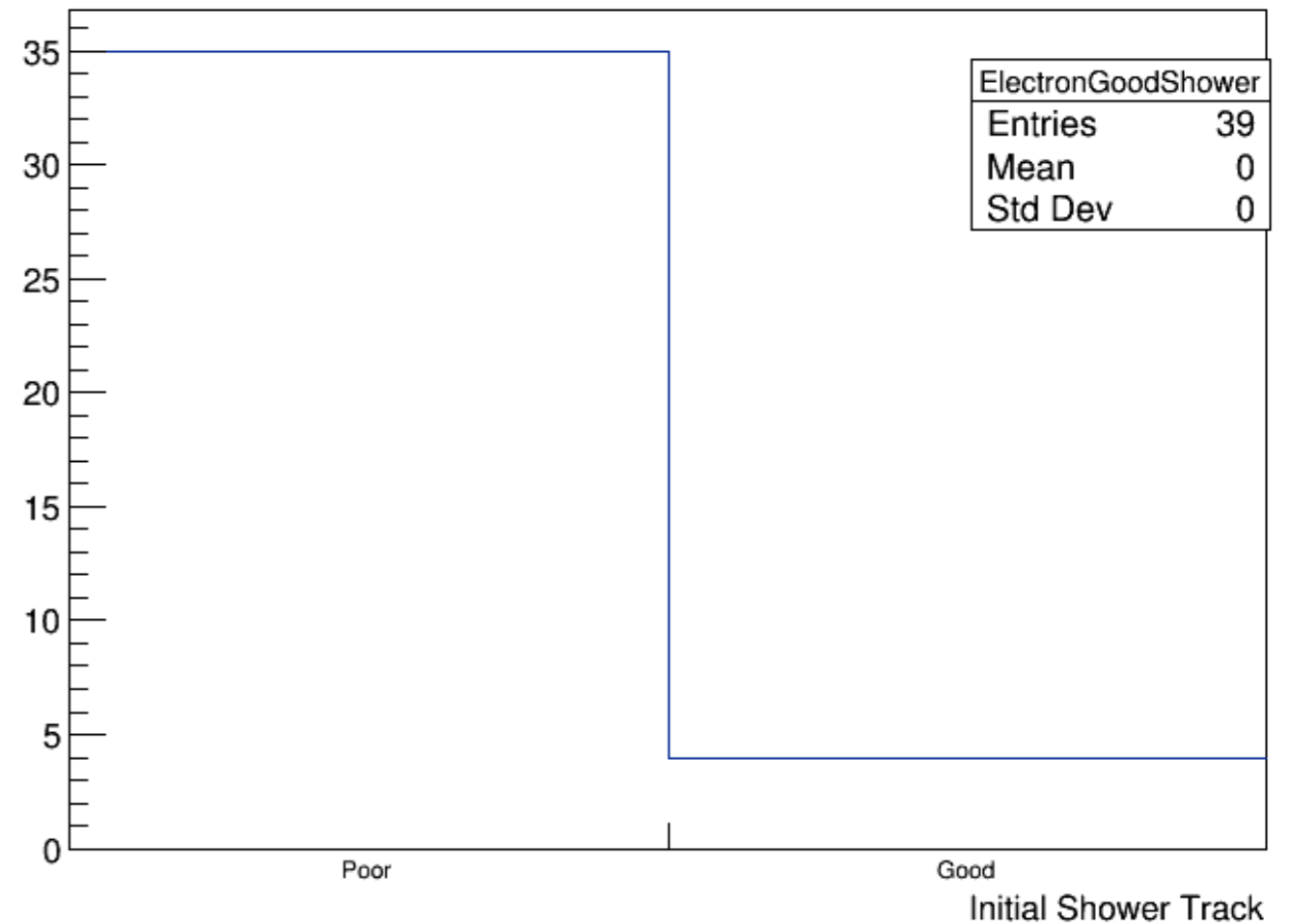
After these improvements

# Current Reconstruction Status

- Huge improvements in track shower separation is very encouraging — this is, after all, what I've been working on!

- These improvements also make huge improvements in multiple reconstructed showers; in MCC7 there was nearly always only one shower per event.

  - Essential to all analyses!

- Somehow, I've managed to adversely affect the shower reconstruction.  I haven't had chance to look at this yet…  I will over the next couple of days.

  - By the end of the week the reconstruction will be ready for processing — Tingjun is in charge of this and we are coordinating.

  - Because of the holidays, I don't think it'll be included in develop until the New Year.

# Reminder (And Reason for Optimism!)

- Properties of showers when applied to single particles:

- Just need to figure out what's changed!
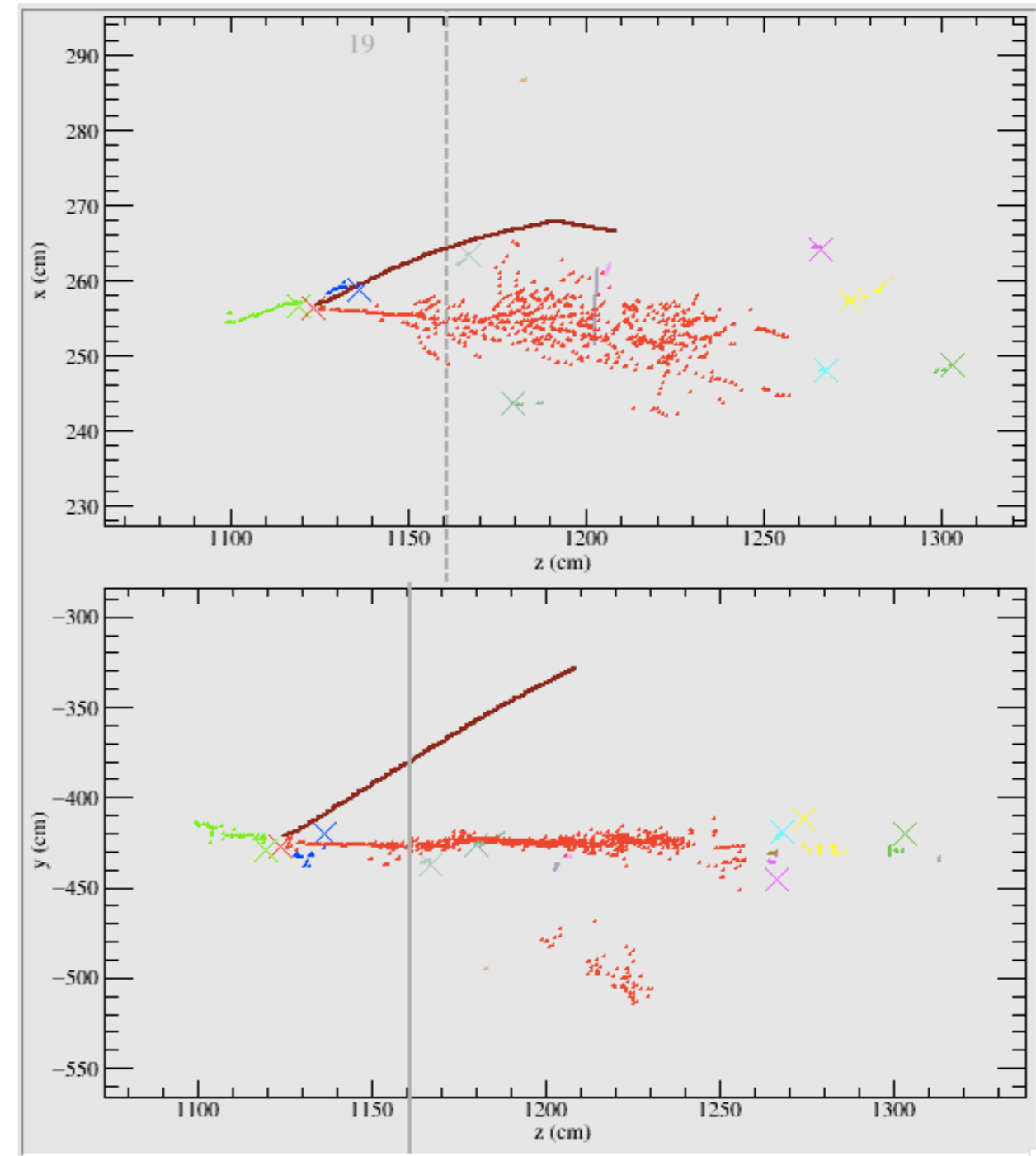


Shower direction
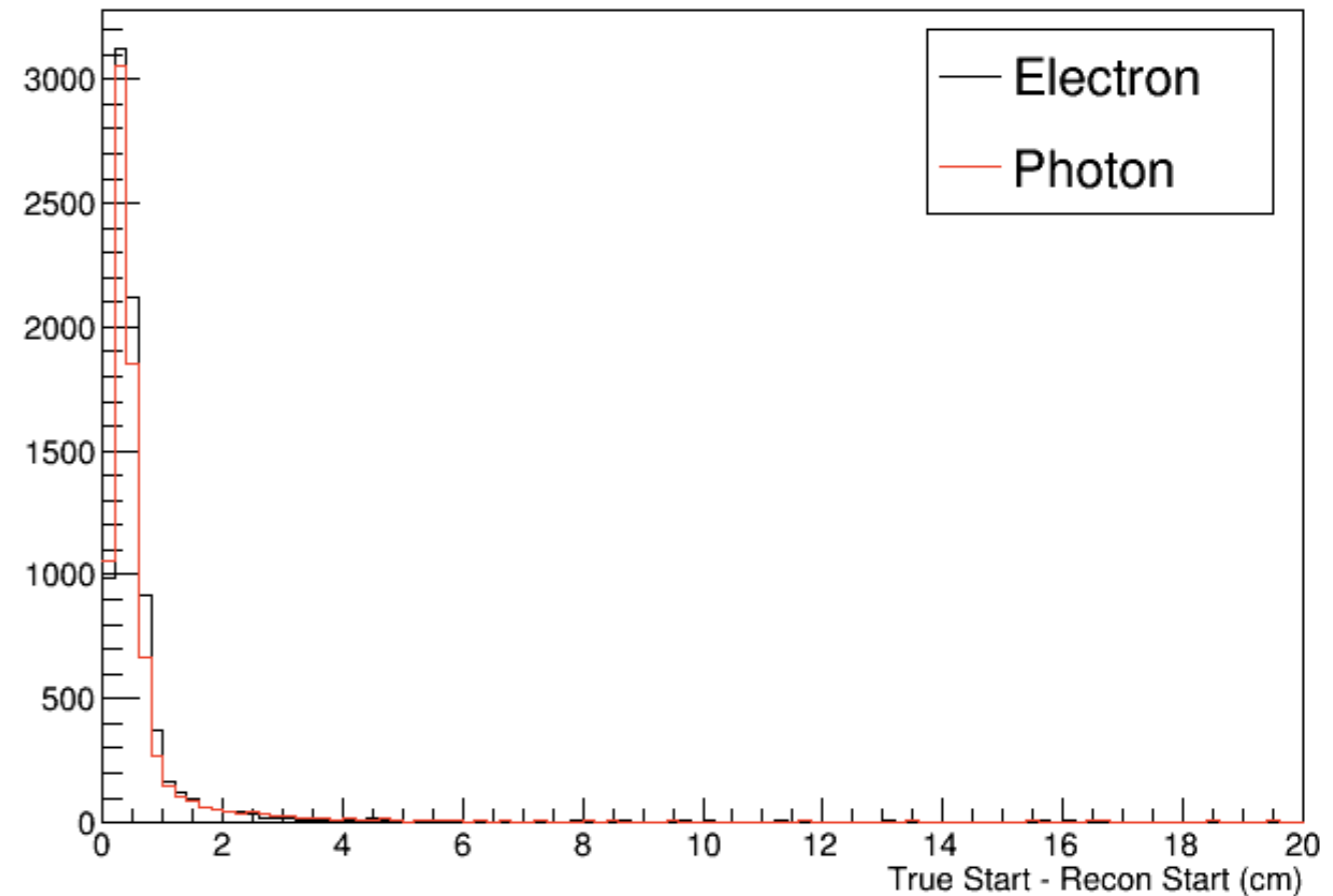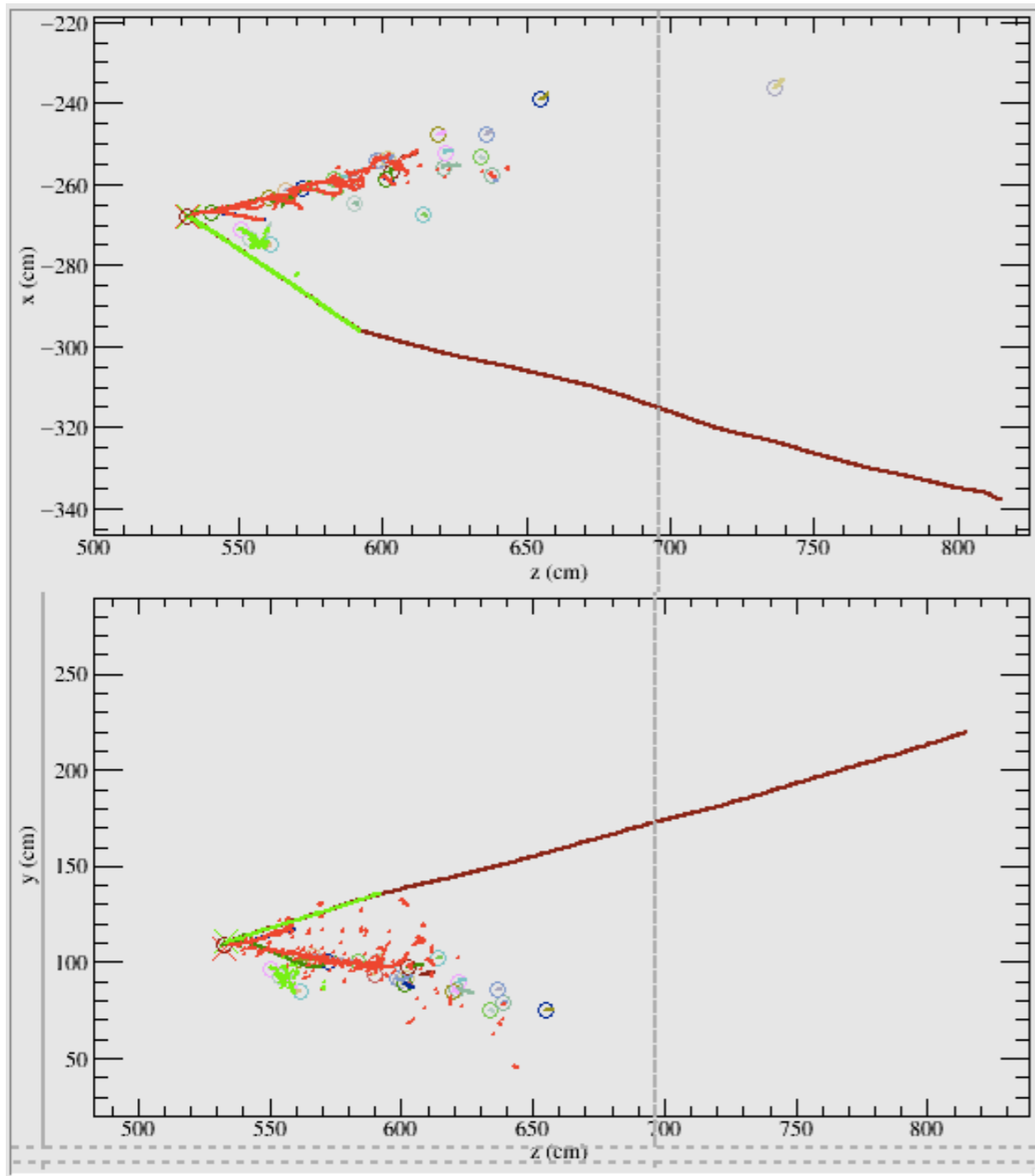
Shower start

# Some Example Events
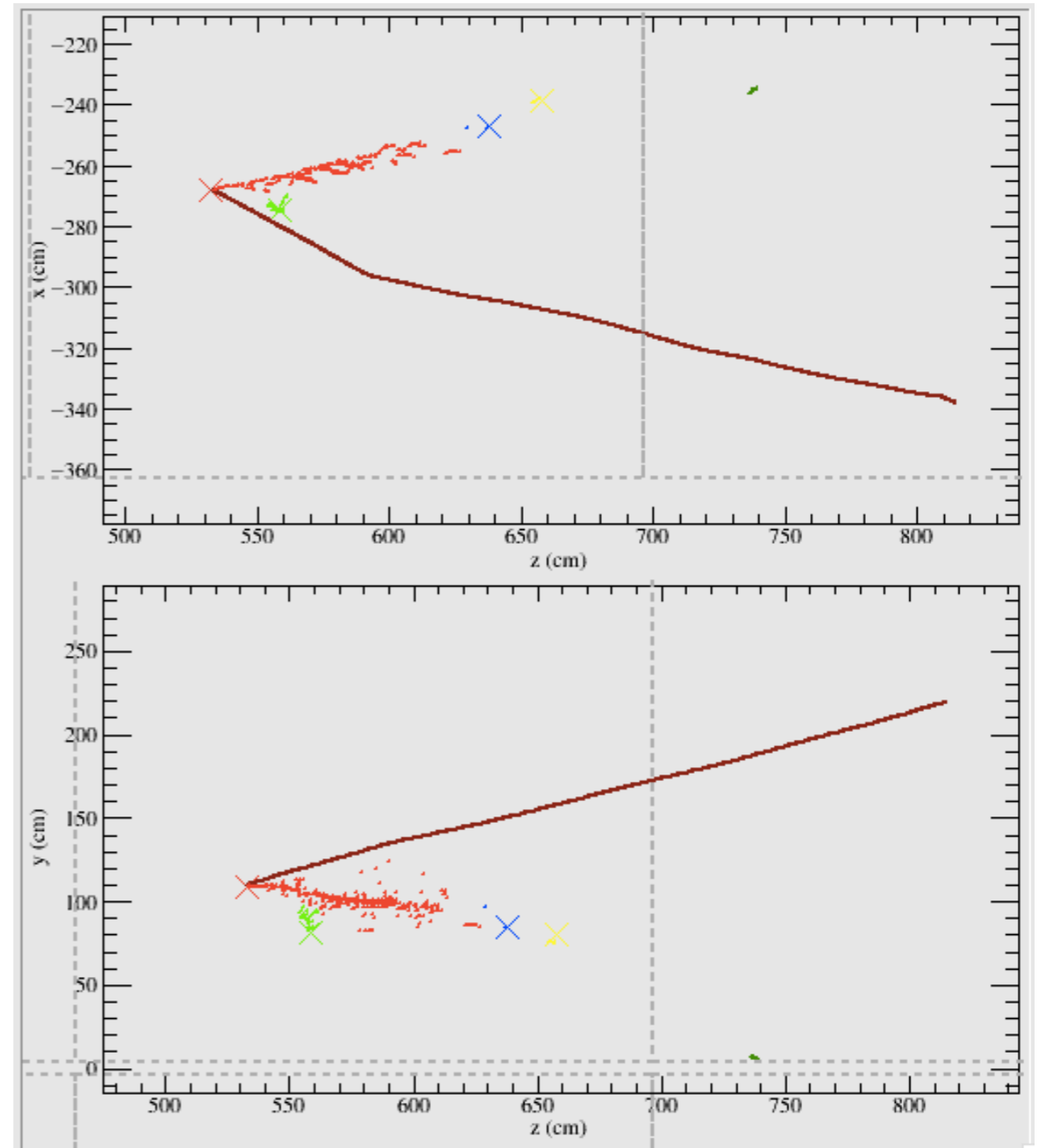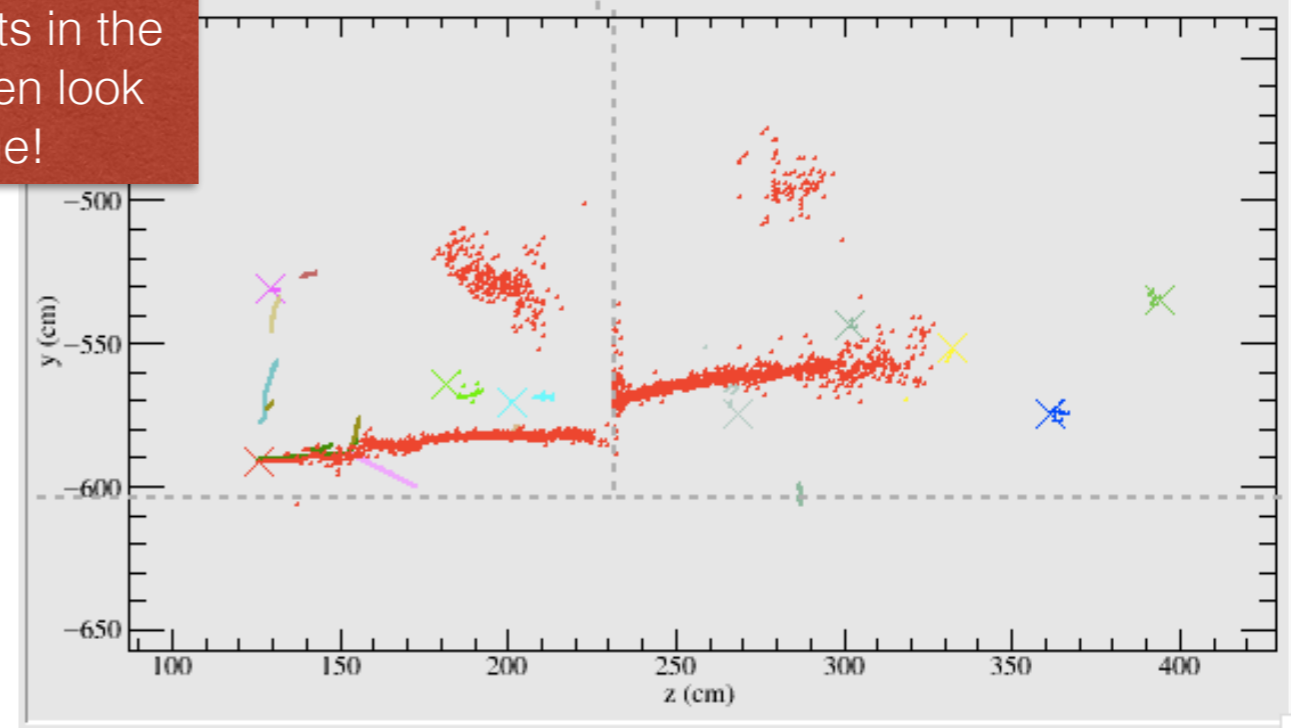


Actually a photon shower

Shower start wrong
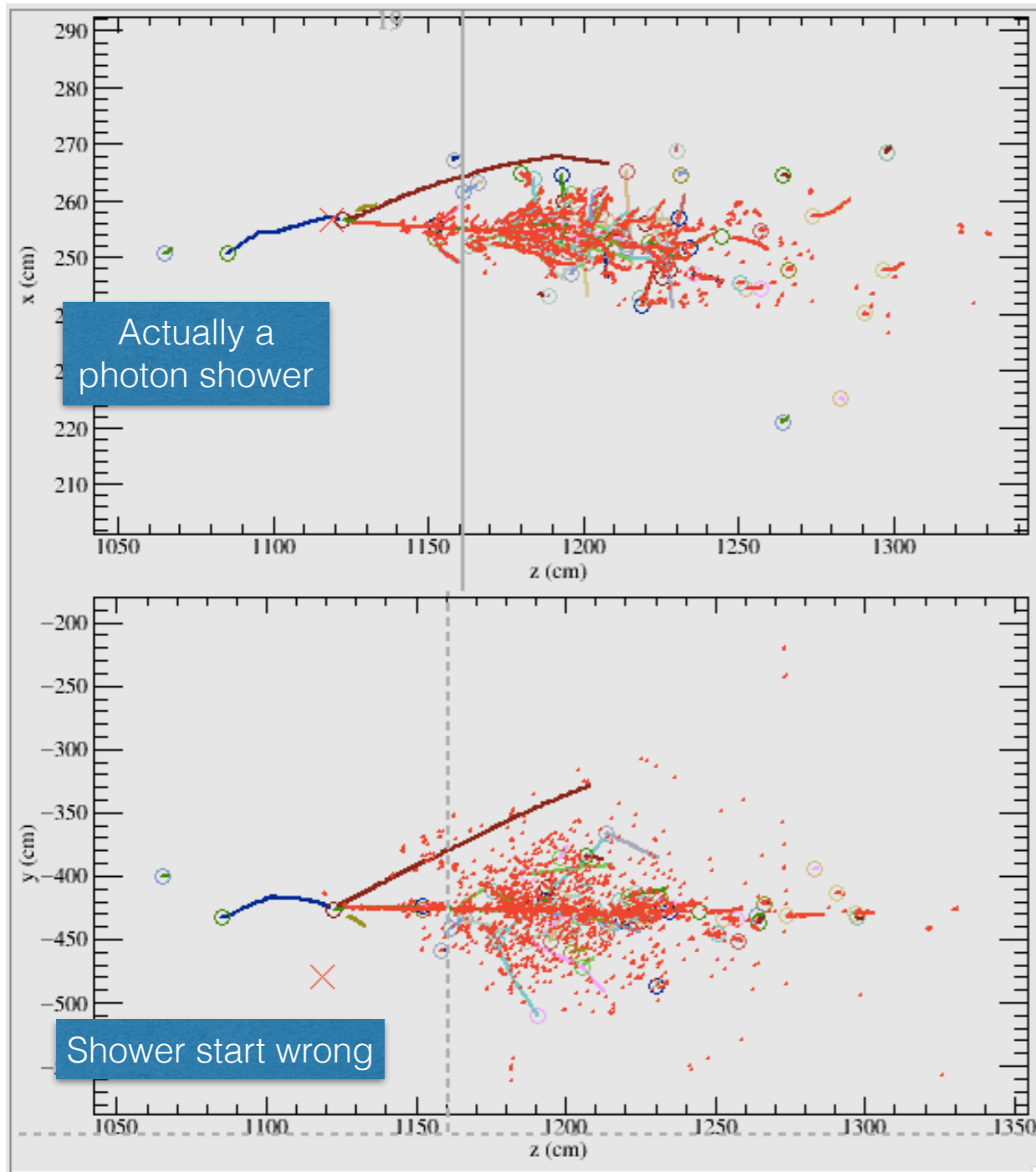
Reconstruction from MCC7

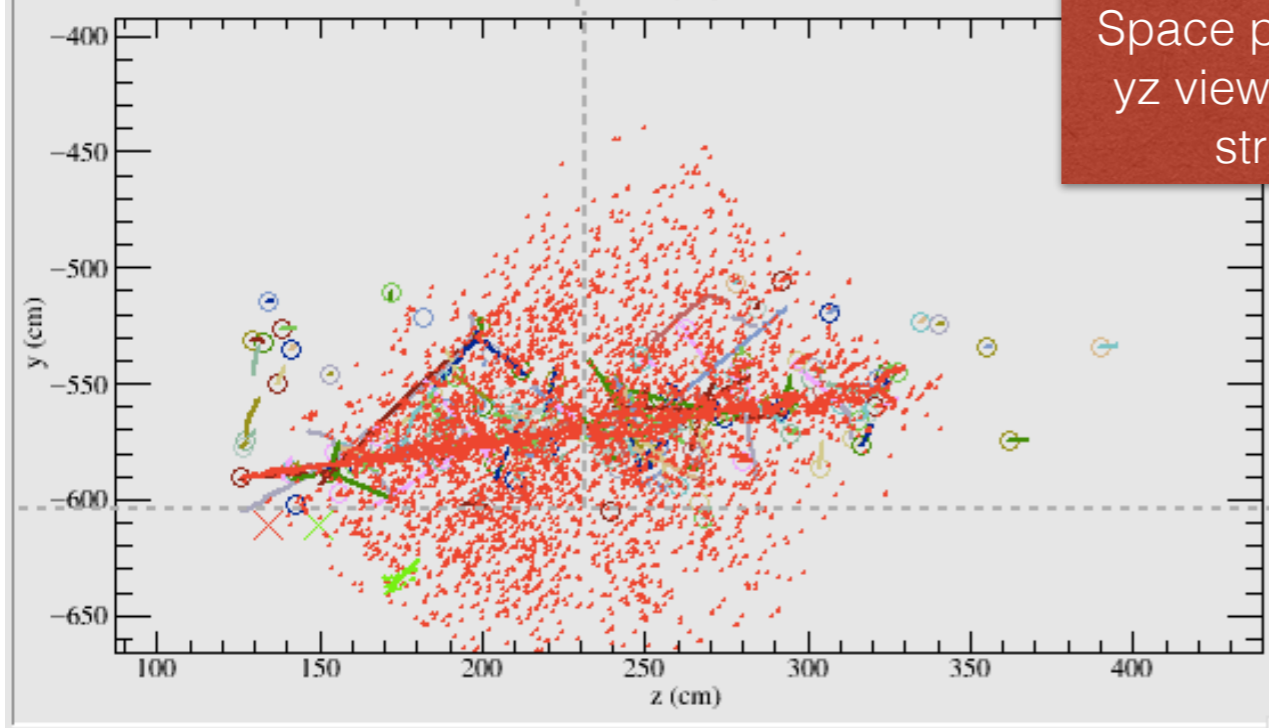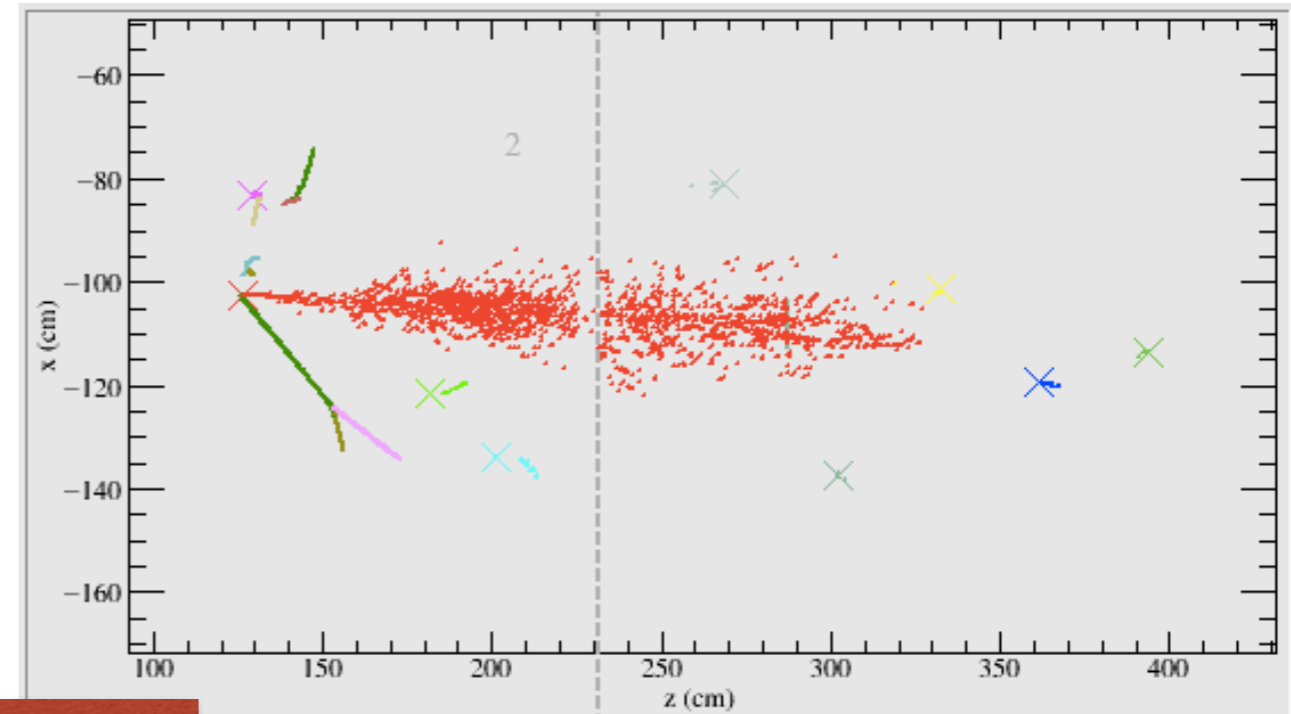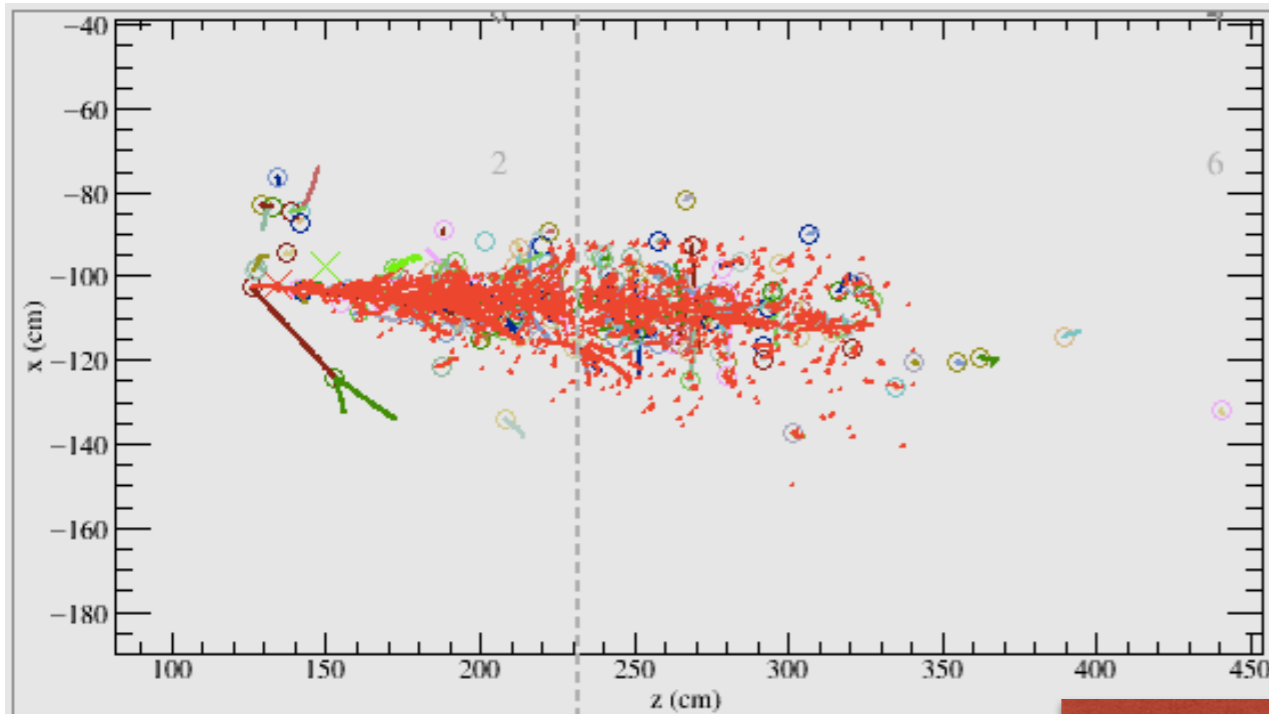After these improvements

# Some Example Events



Reconstruction from MCC7

After these improvements

# Some Example Events



Space points in the yz view often look strange!

Reconstruction from MCC7

After these improvements

# The Selection

- I've rerun the selection using the new reconstruction, without changing anything.

  - Just instructive to see how it looks!

- Basically no difference at all between this and the previous attempts.  (At least I haven't made it worse!)

- With the new track shower separation looking very promising, once I fix the shower reconstruction and get some separation from the shower dE/dx things will hopefully start looking better…

- Timescale: before Christmas.

# The Selection
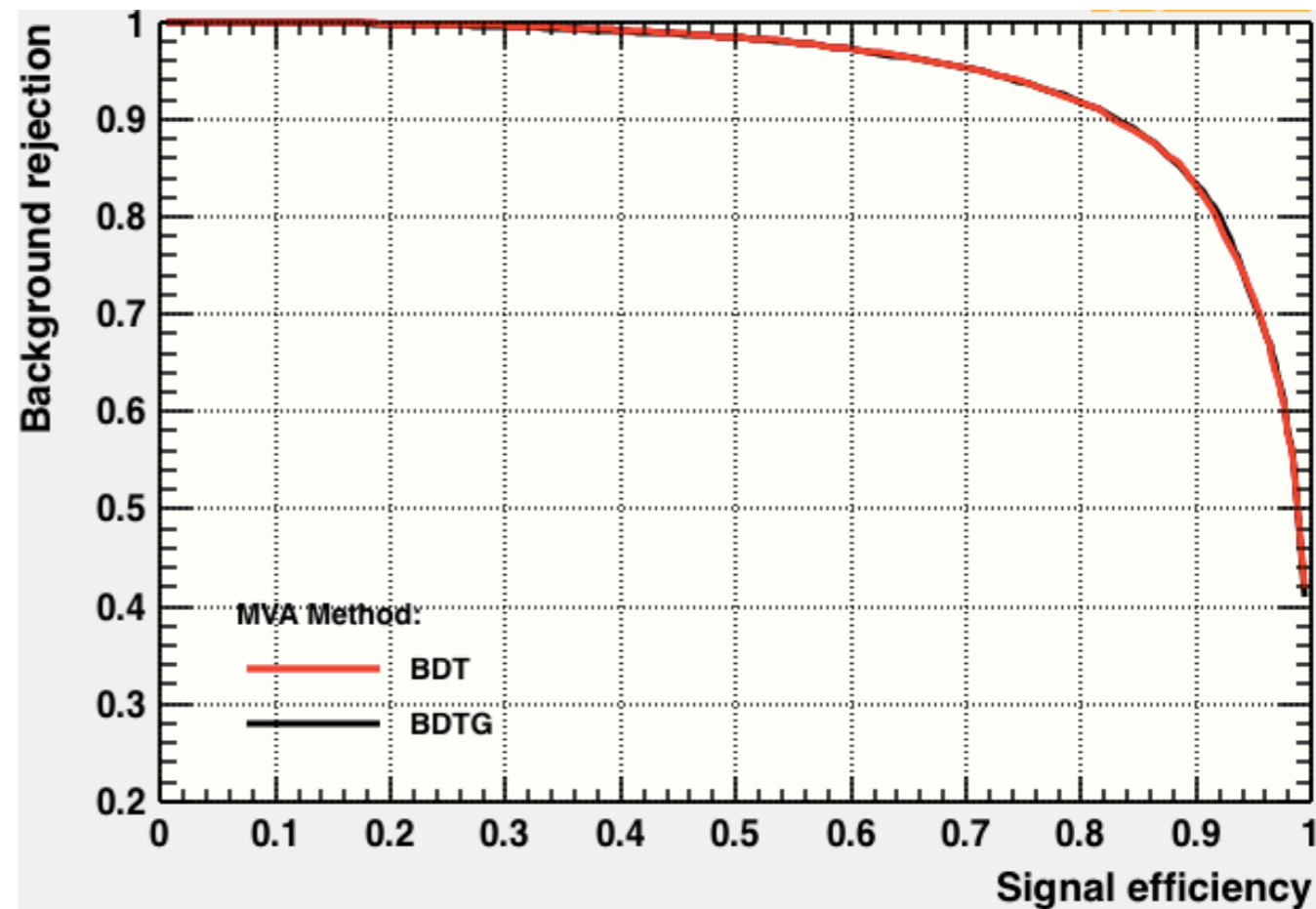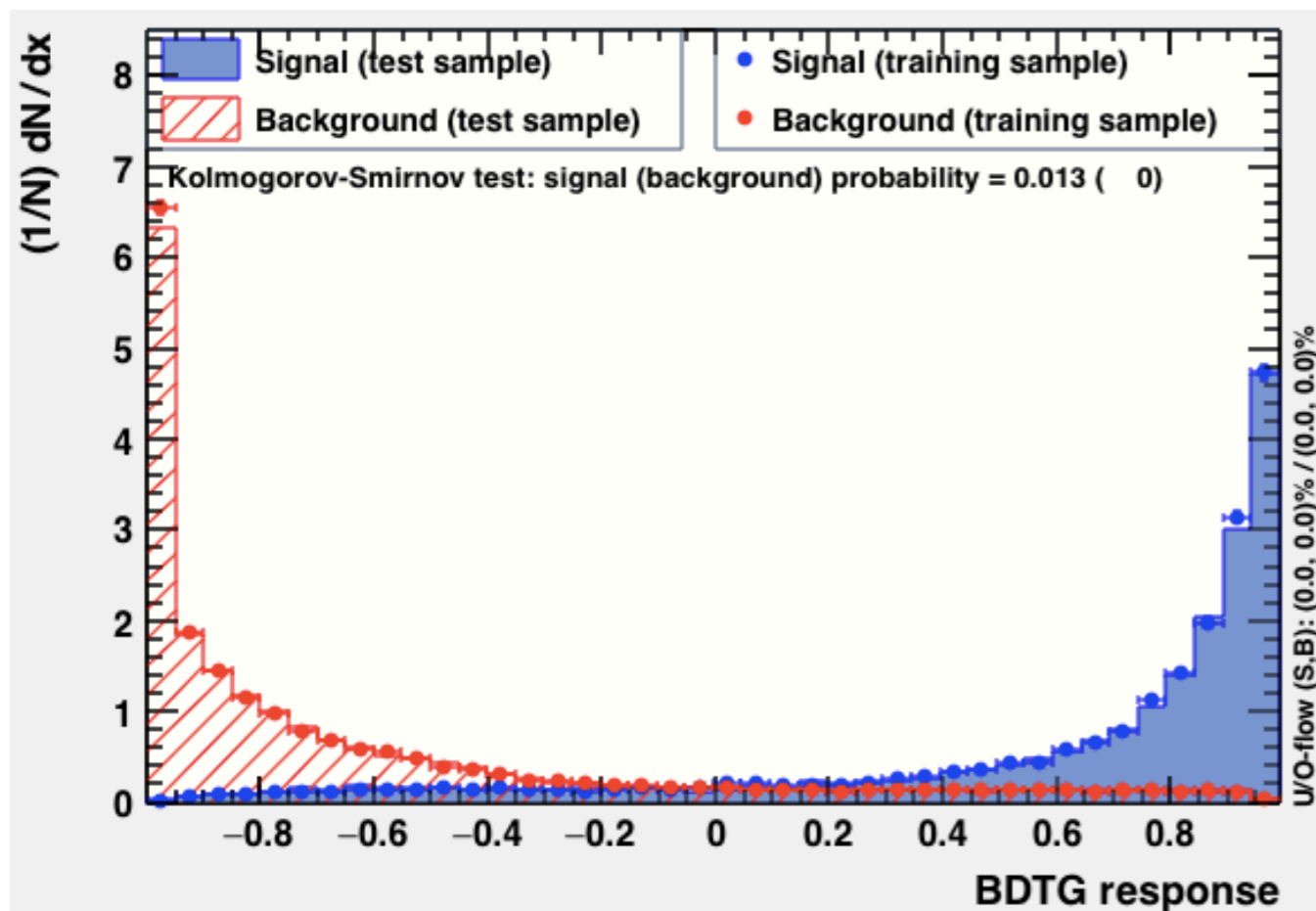


- Very little difference from Tyler's selection using MCC6 (May CM, <u>link</u>).

- At least things aren't worse (given how much I've changed, this is a positive!)... and if I can improve the shower dE/dx variable by fixing the showering then hopefully we'll start to see some improvements!
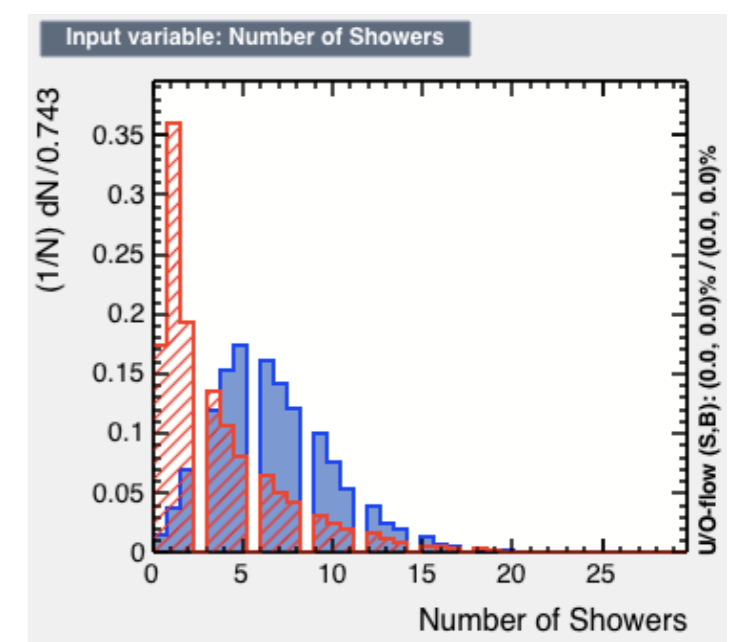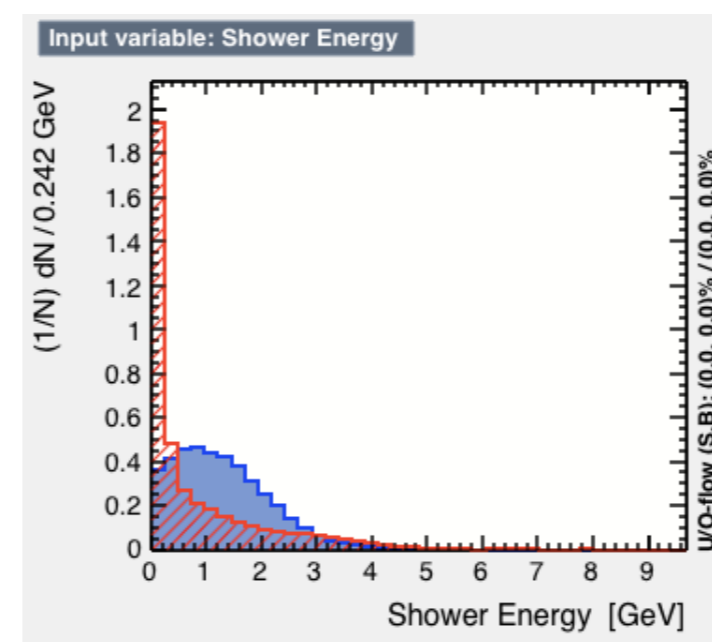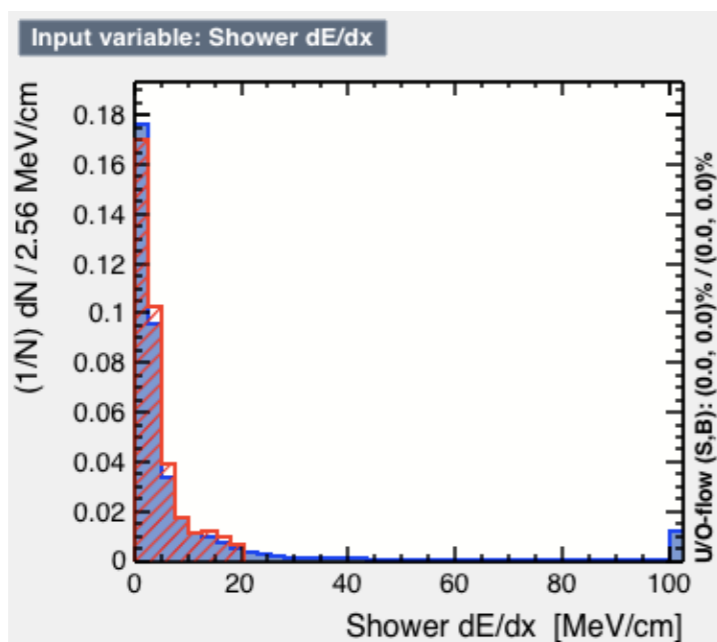
# The Selection: Improvements and Other

- See last few slides for full list of MVA input variables.
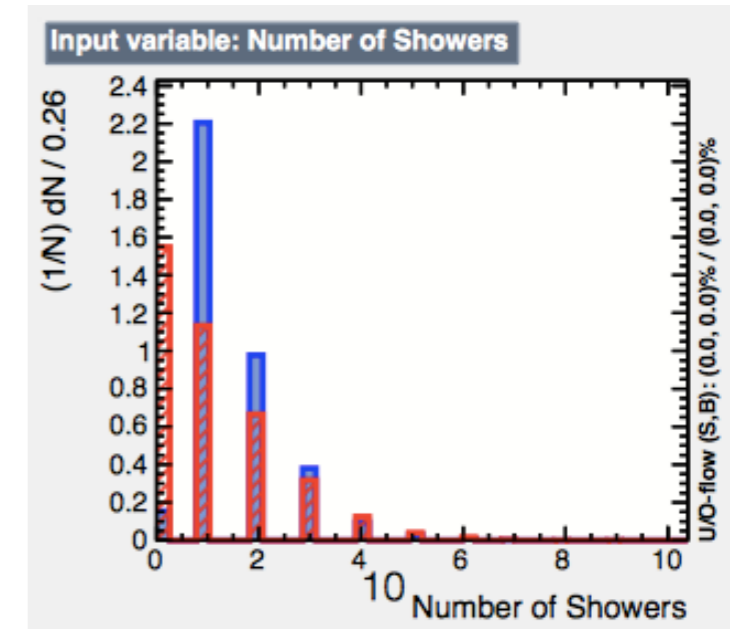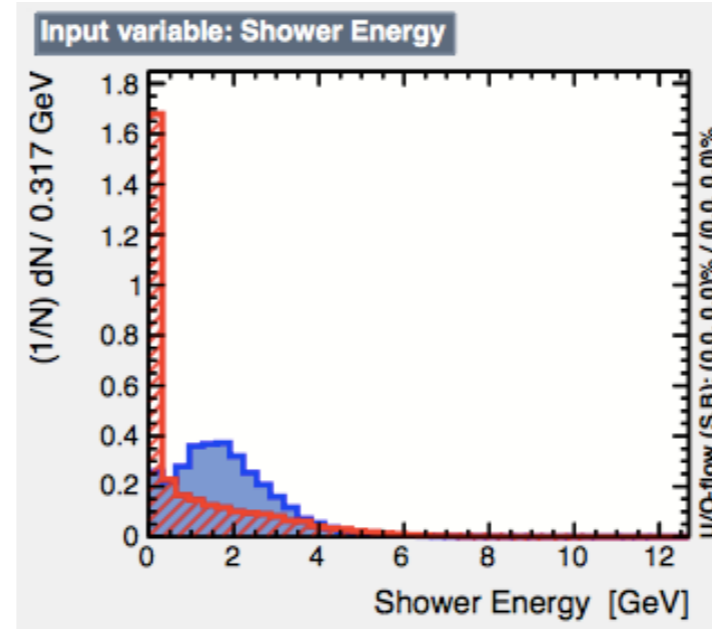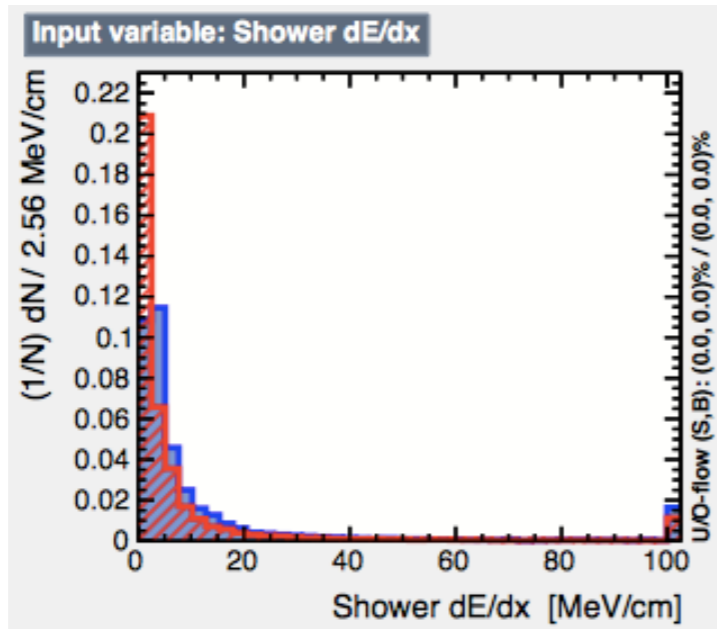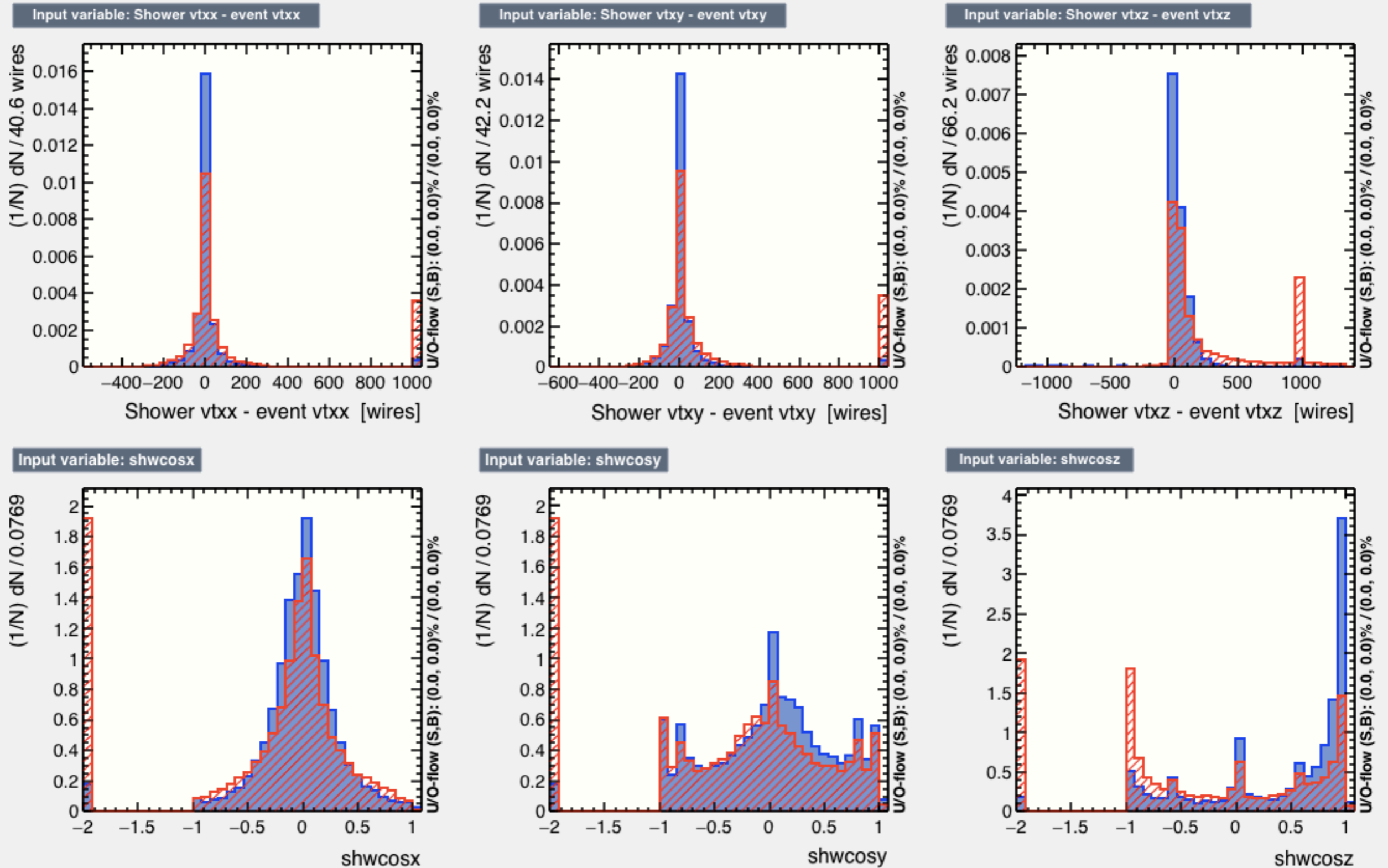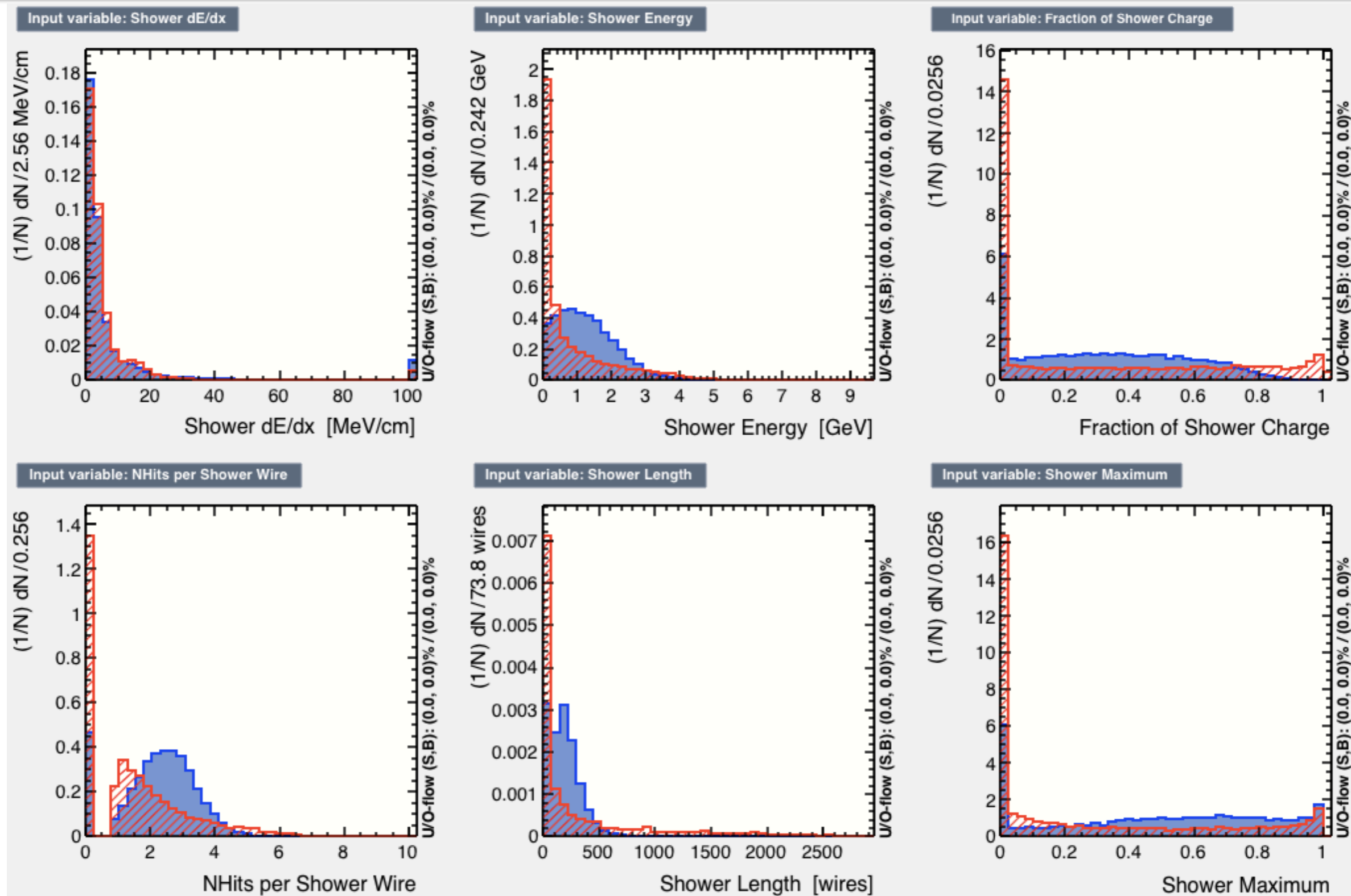
# Conclusions

- I believe we're making progress… slowly!

- Plan to have the reconstruction ready by the end of the week.

  - This will hopefully lead to improvements in the shower start reconstruction and therefore an improvement in the selection.

  - Will rerun the selection with full reconstruction later this week!

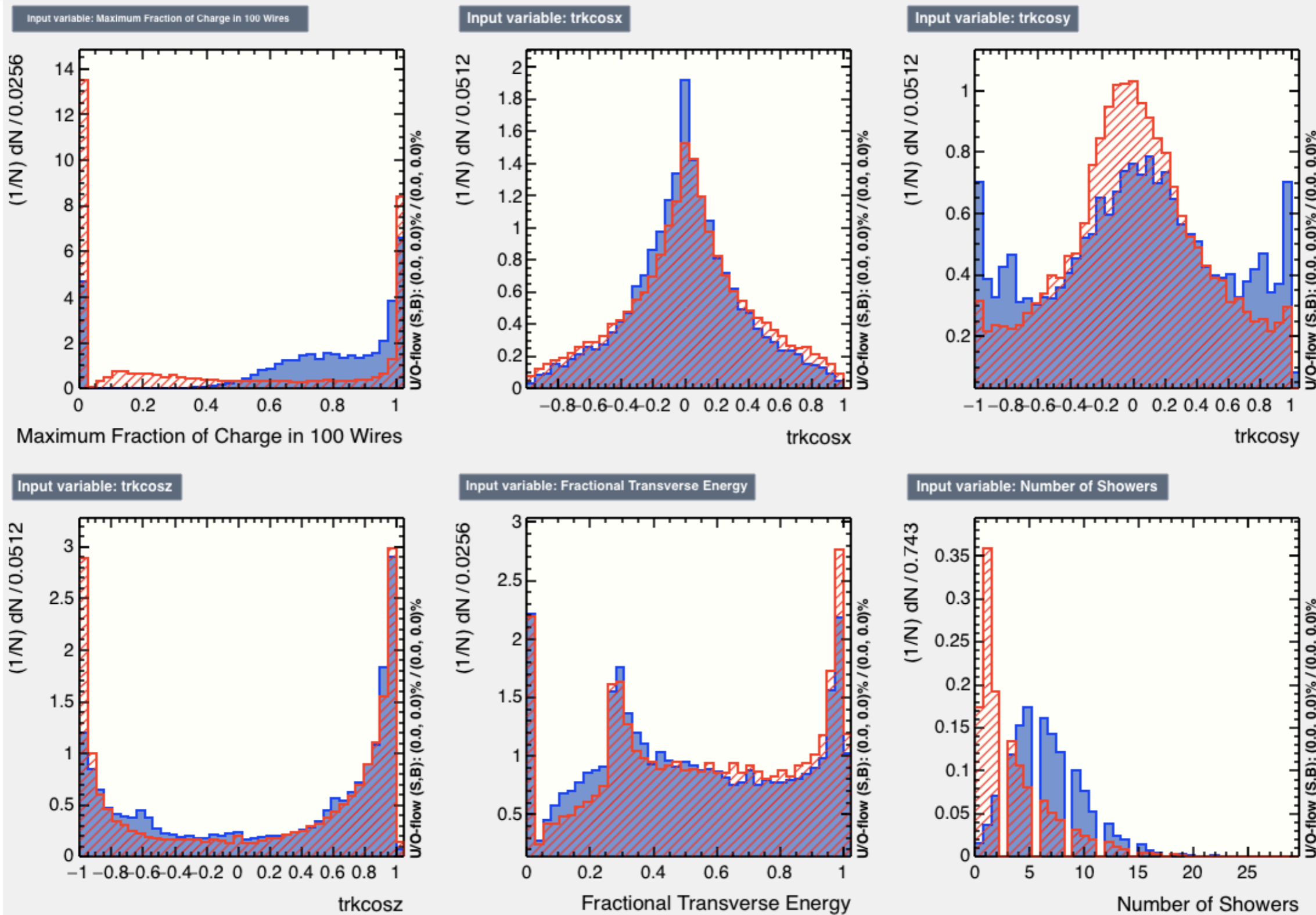- Still plenty of time until the CM (my main deadline!) to make improvements.
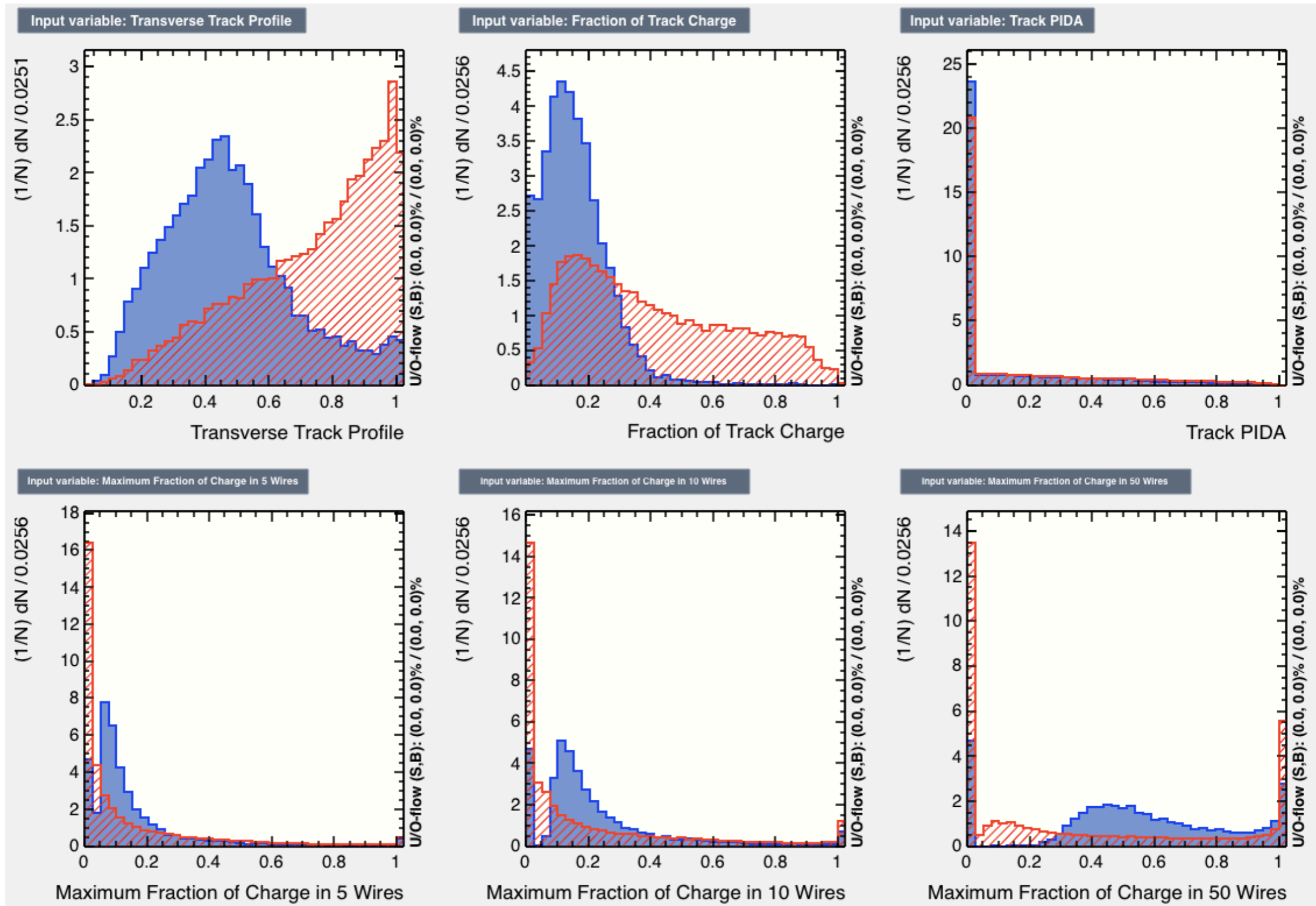
# MVA Input Variables

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