

Electron Shower Starts

James Pillow

14/11/2019

EM Task Force Meeting

What I'm trying to do



- Find the end of the MIP section of the electron showers

MC Sample

- Last update - Using the MC prod2 sce dataset
- Couldn't get processes for each trajectory point for the initial mc particle
 - `Simb::MCTrajectory::TrajectoryProcesses()` gives me an empty vector 99% of the time.
 - 1% of the time gives me a vector with each trajectory point having the same process.
 - Does anyone know why the `TrajectoryProcesses()` vector should be empty?

MC Sample

- Tried making my own dataset where I keep all the daughter mc particles of em showers.
- Tried using
 - protoDUNE_g4_35ms_sce_datadriven.fcl
 - protoDUNE_detsim_data_driven_noise.fcl
 - protoDUNE_reco_35ms_sce_datadriven.fcl
- But reconstruction seems to hang...

MC Sample

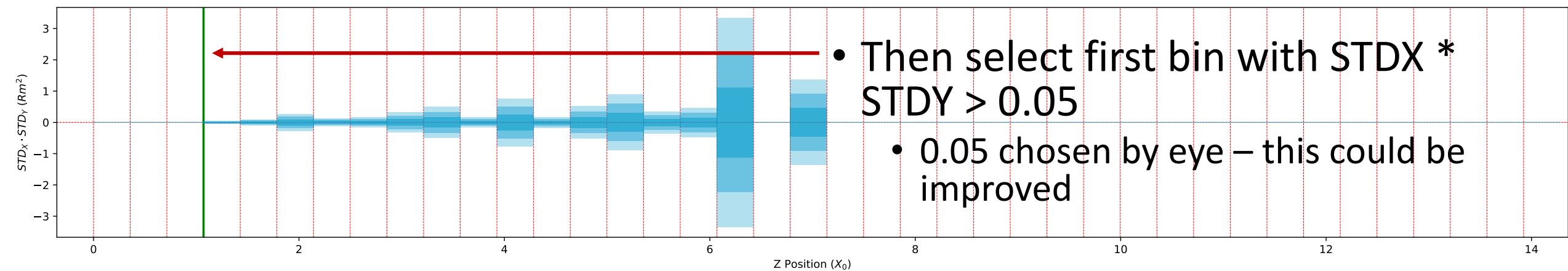
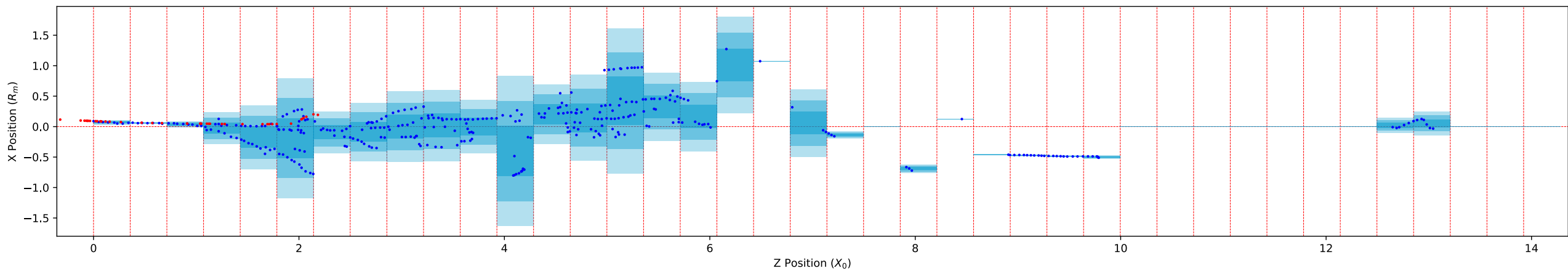
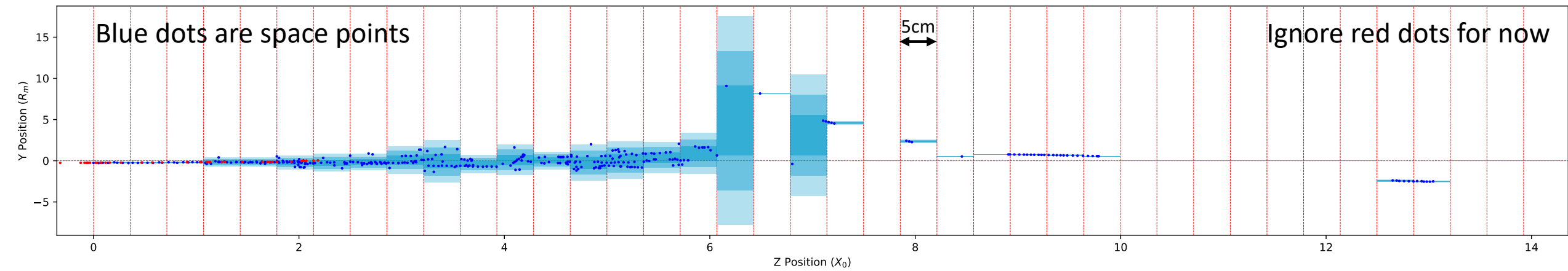
- So I made an mc sample without any sce for now.
 - Have about 7,500 events.
- Sample is 1 GeV
 - Energy has no spread (I forgot to turn that on).

Method

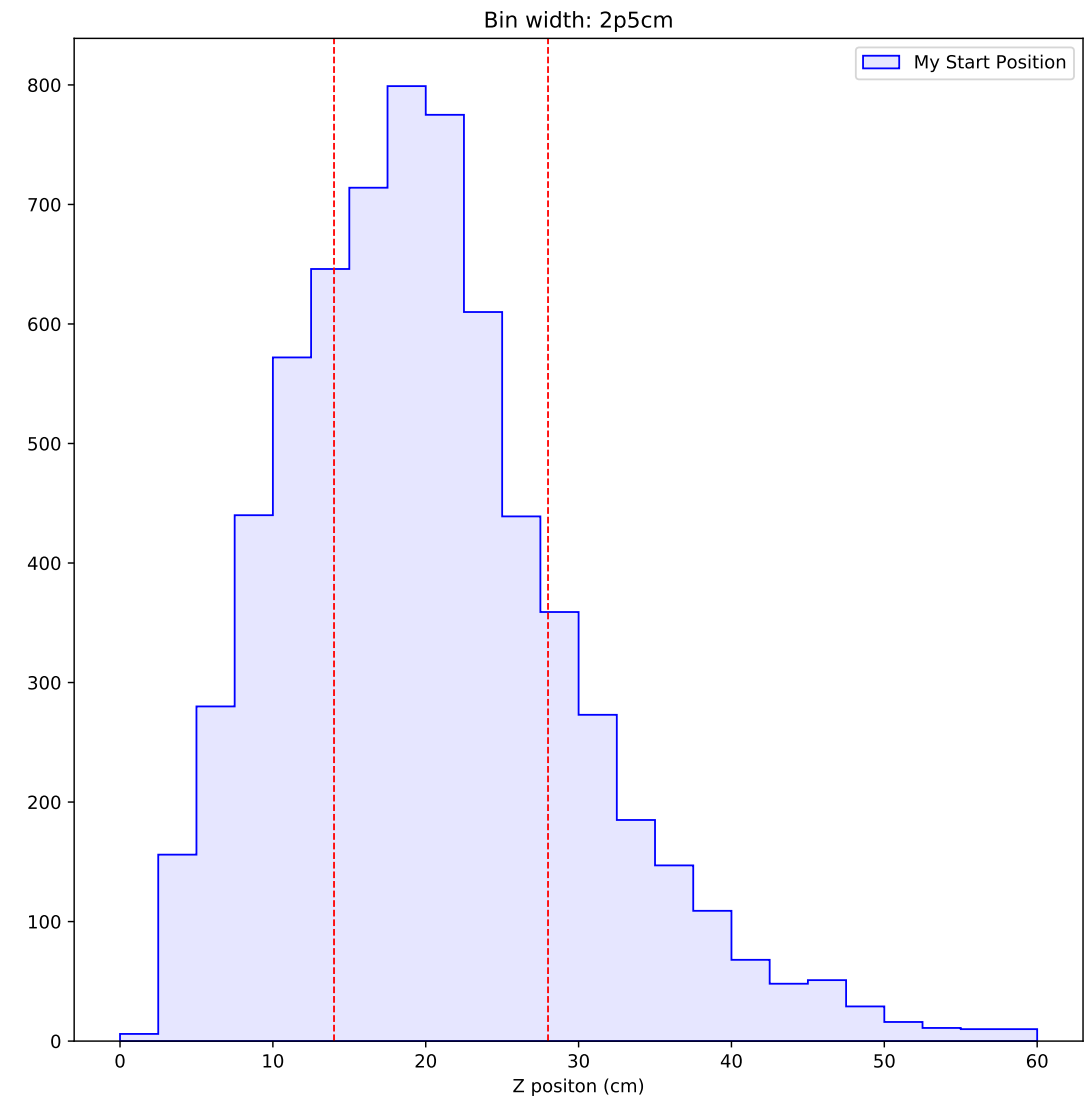
- Using a shower's `recob::SpacePoint`.
- Transform the space points to the PCA coordinates.
- Convert position along primary axis into terms of radiation length (X_0).
- Convert position along secondary/tertiary axis into terms of Moliere radius (R_m).
- Remove any small number of hits appearing far before rest of hits.
- Shift space points in primary axis so space point with smallest primary axis value is 0.

Method

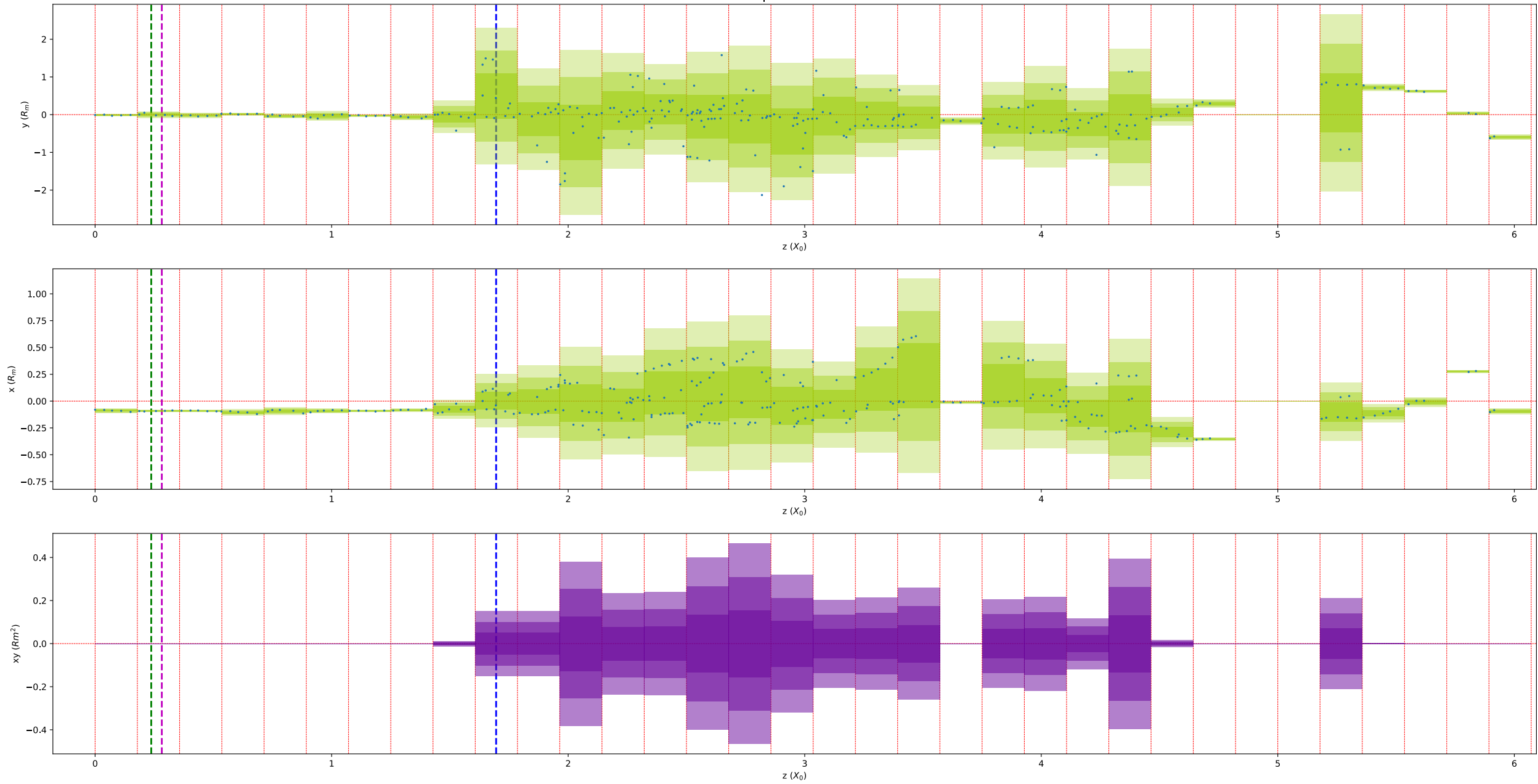
- Bin the space points along the primary axis
- Calculate the stds in each bin (for each axis).
- Multiply the stds for the secondary and tertiary axes, to form a cross-sectional area that the hits in that bin occupy.
- Find the bin for when the cross-sectional area goes above $0.05Rm^2$
- Find the mean position along the primary axis for this bin – set that as the end of the MIP section



- End of MIP section peaks around 20cm
- Red lines are 14cm and 28cm (1 and 2 radiation lengths)



1003 | bin width: 2.5cm



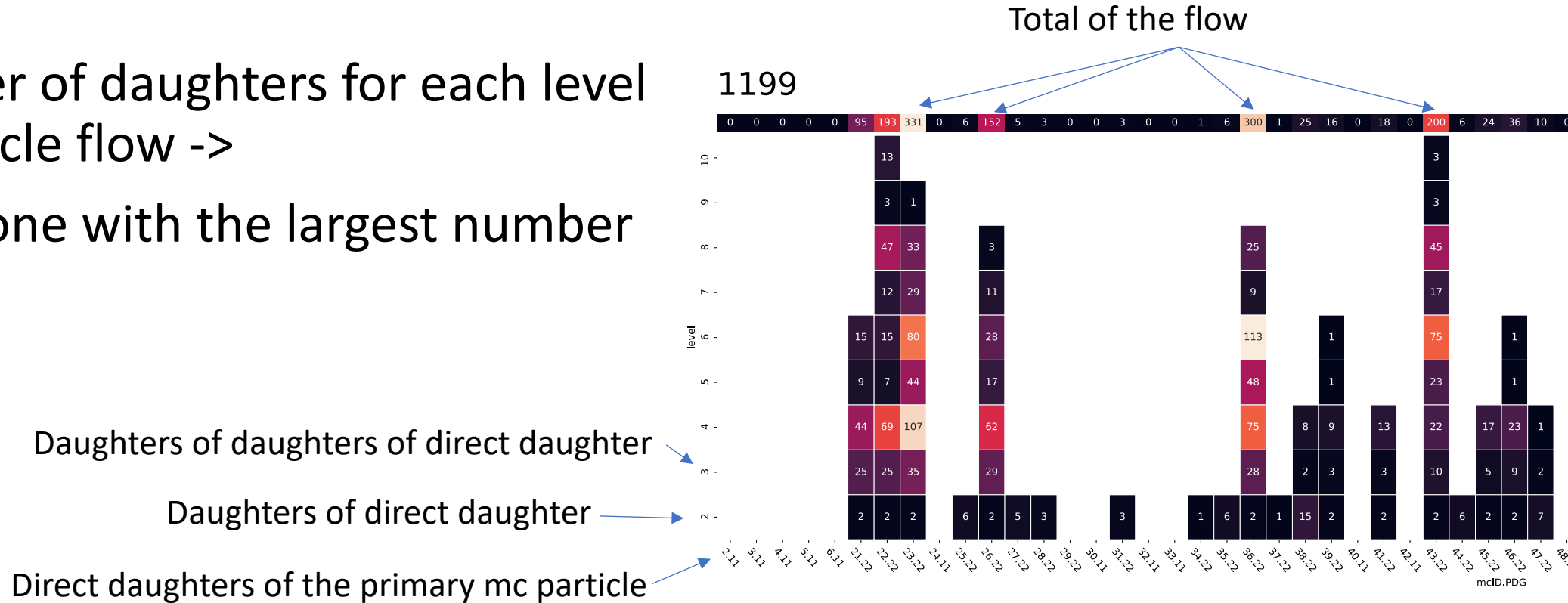
Estimating the true MIP end

- Dominant energy loss for electrons in proto-dune is brem.
- So electron should start showering when radiated photons convert to e^+/e^- pair.
- Select the radiated photon with the largest ‘flow’.
 - Define flow as the recursive sum of the number of daughters of the mc particle.
- Take the last trajectory position of that daughter photon.

Estimating the true MIP end

WARWICK

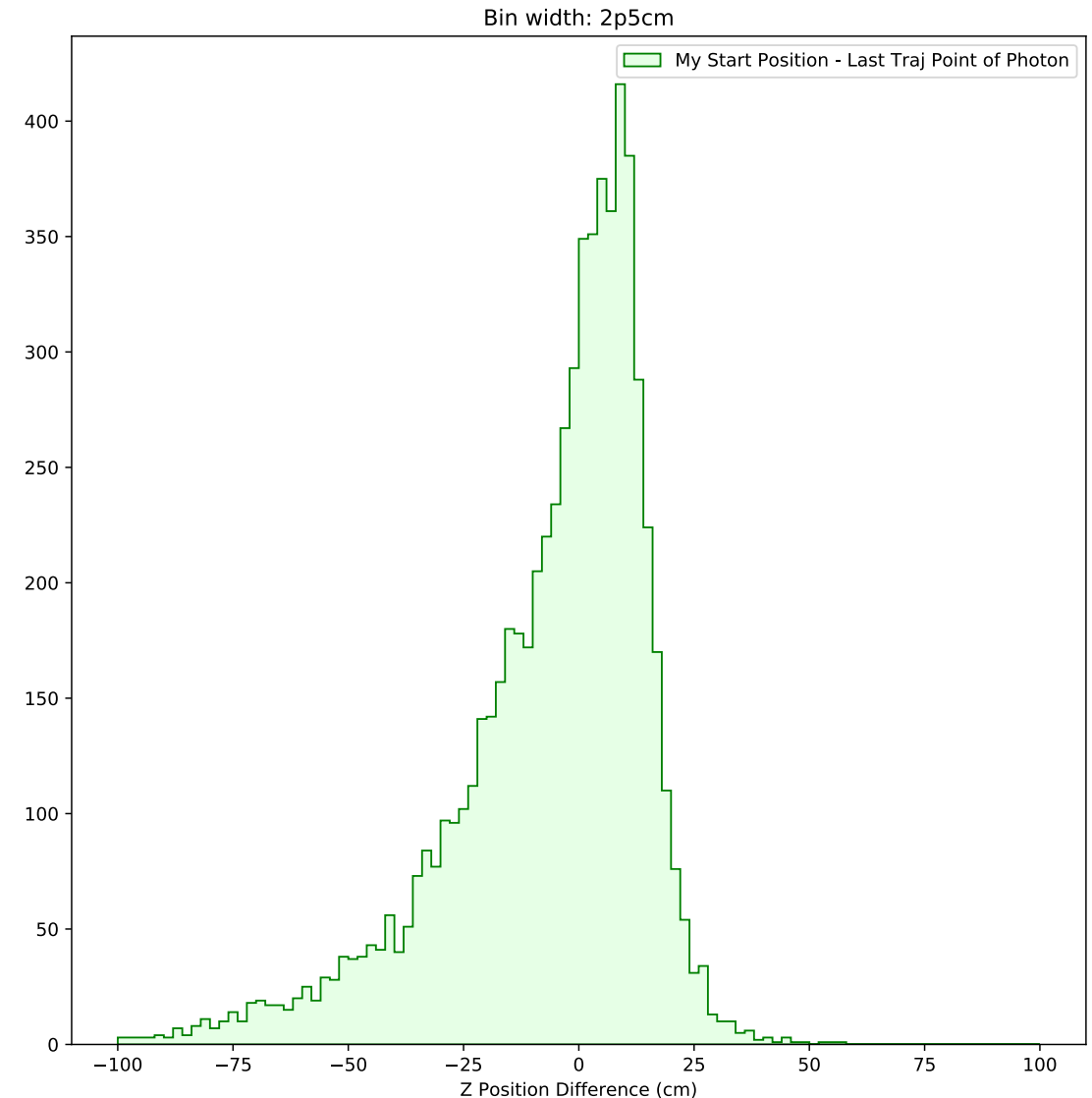
- Plot number of daughters for each level of the particle flow ->
- Select the one with the largest number



Comparison to my mip end

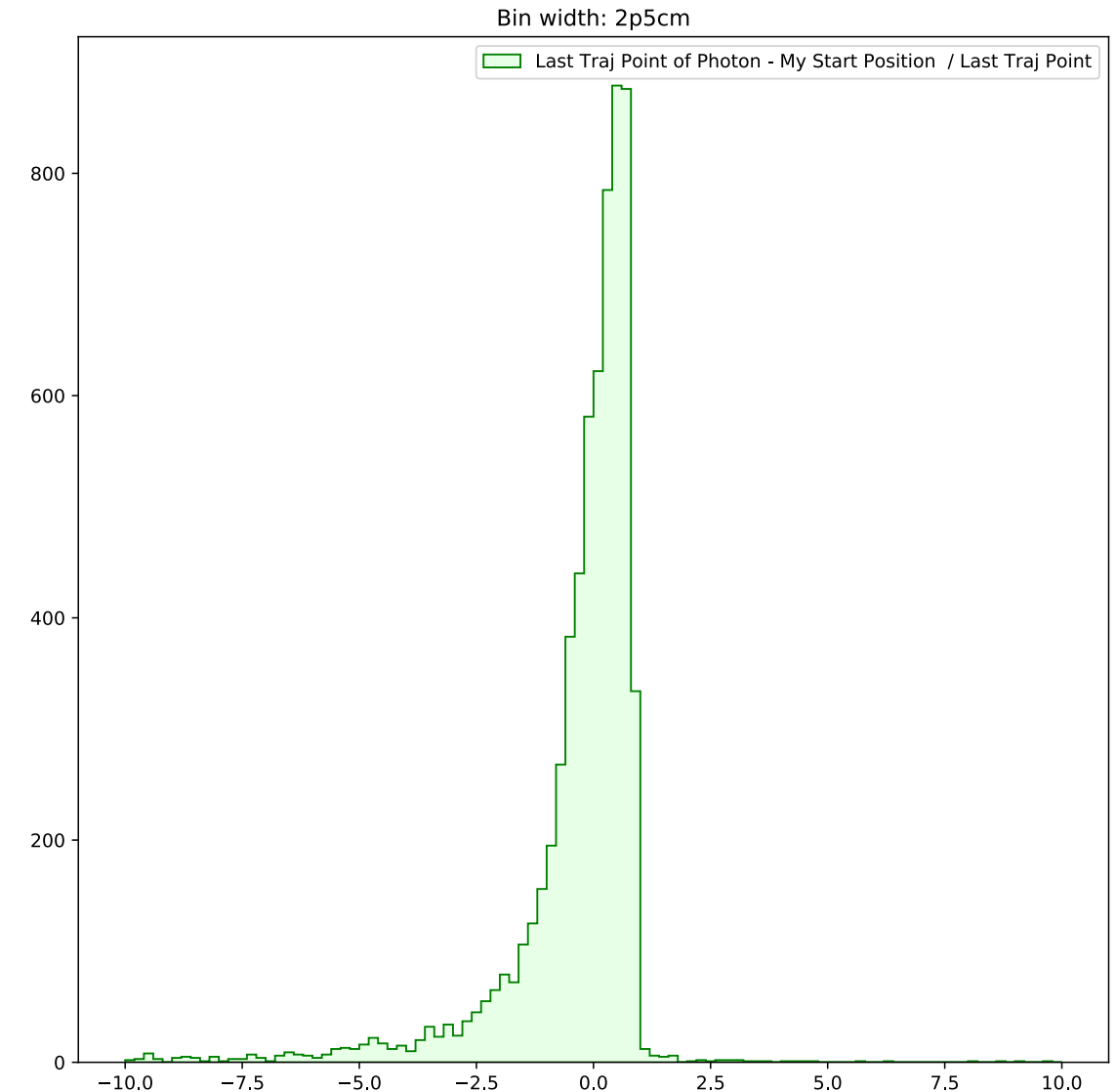
- Quite a wide distribution.
- Negative tail
 - My end of mip position is being set upstream of the final trajectory point of the largest daughter flow.

WARWICK



Comparison to my mip end

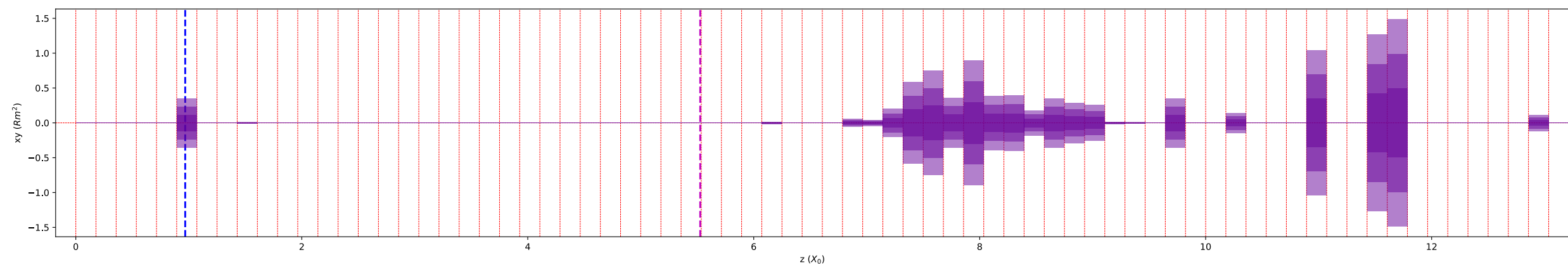
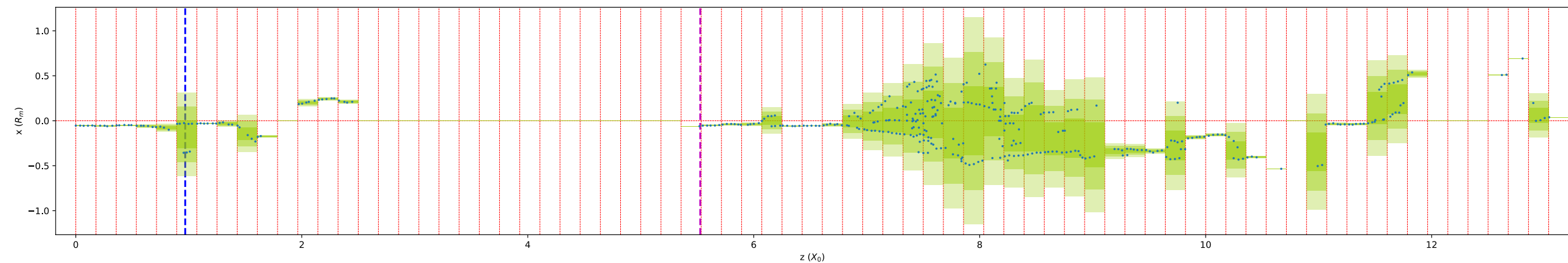
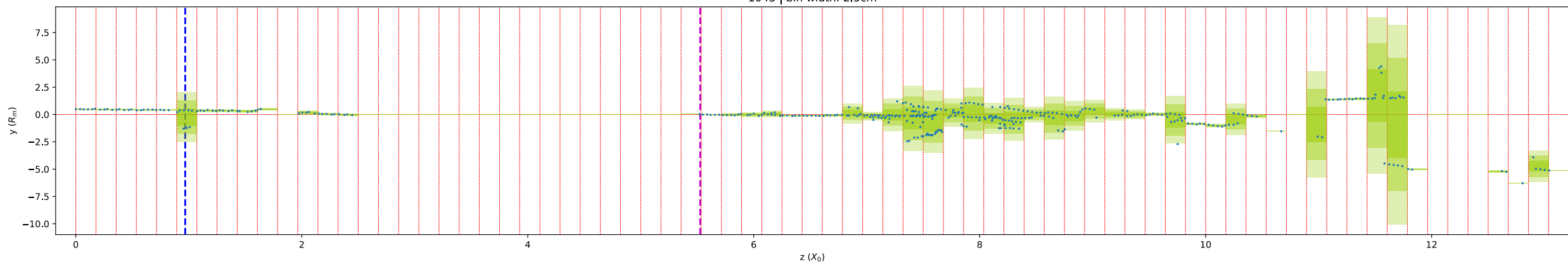
- Quite a wide distribution.
- Negative tail
 - My end of mip position is being set upstream of the final trajectory point of the largest daughter flow.



Blue dashed line: My mip end

Magenta dashed line: Last photon trajectory point

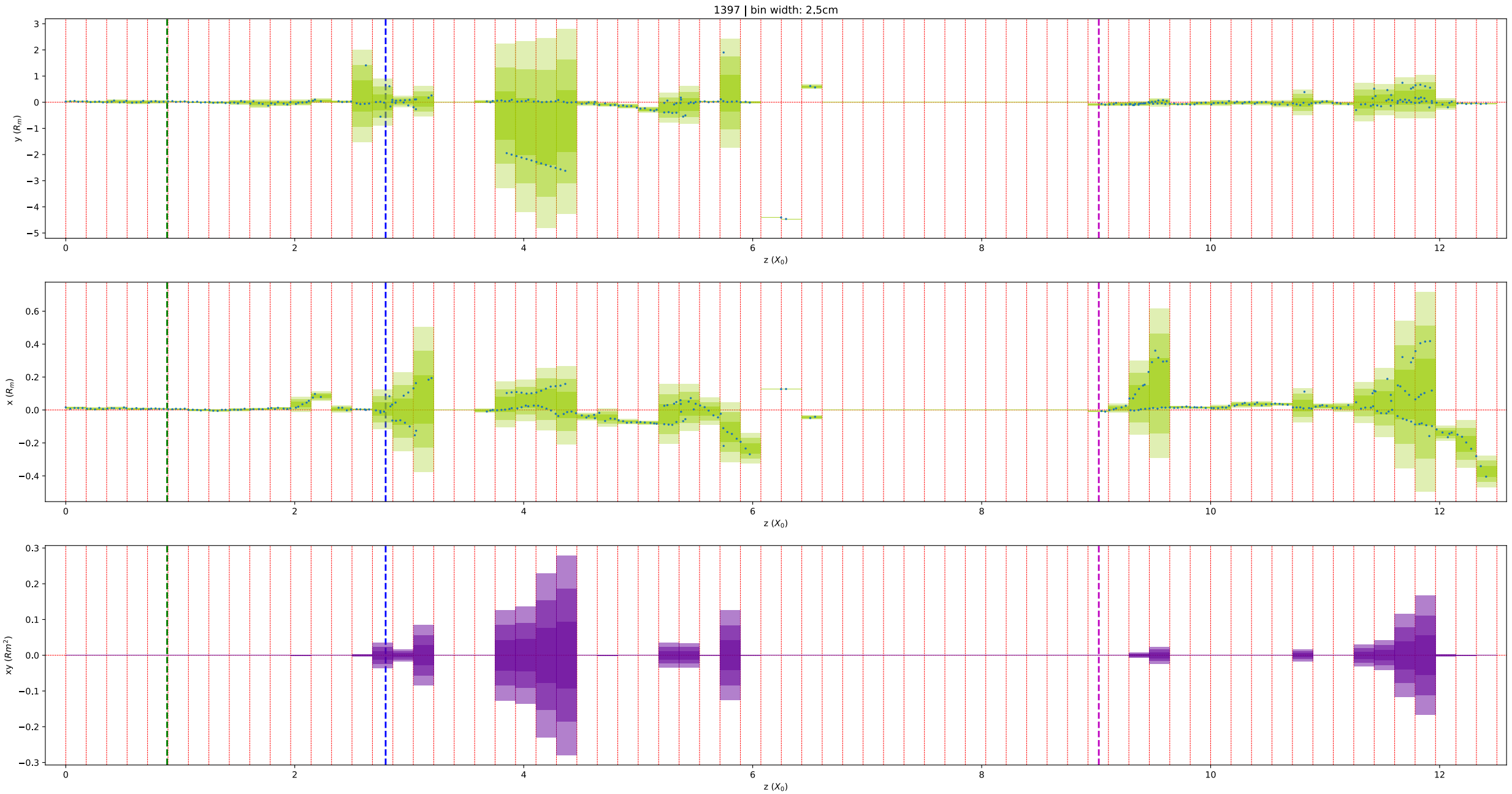
1043 | bin width: 2.5cm



Blue dashed line: My mip end

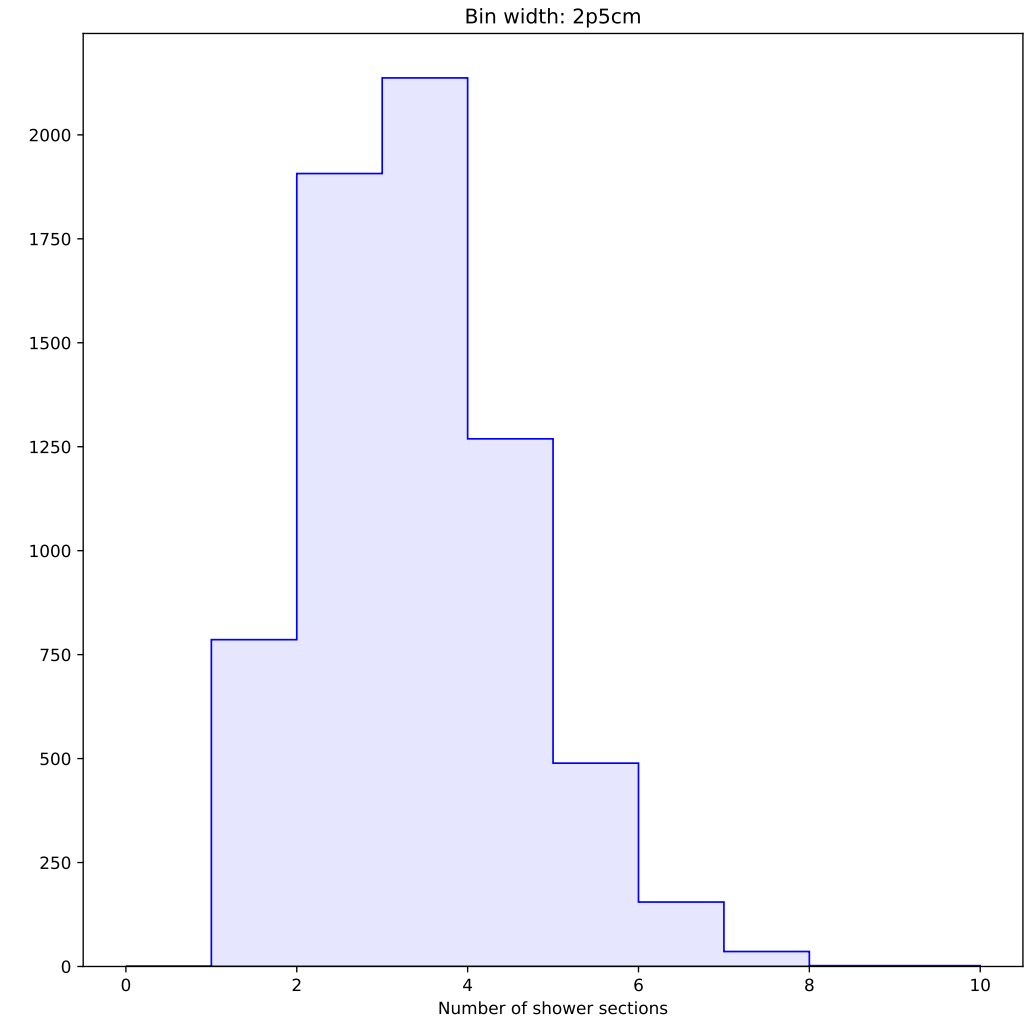
Magenta dashed line: Last photon trajectory point

Green line: First photon trajectory point

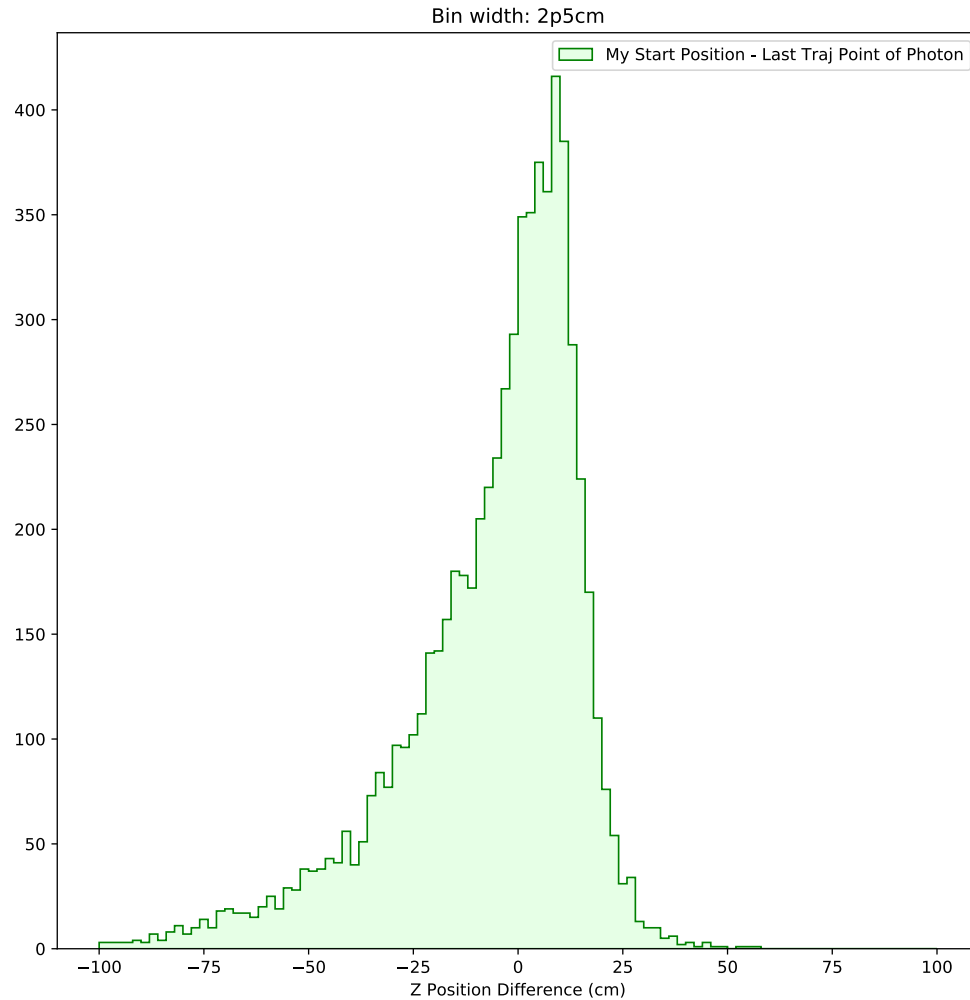


Shower sections

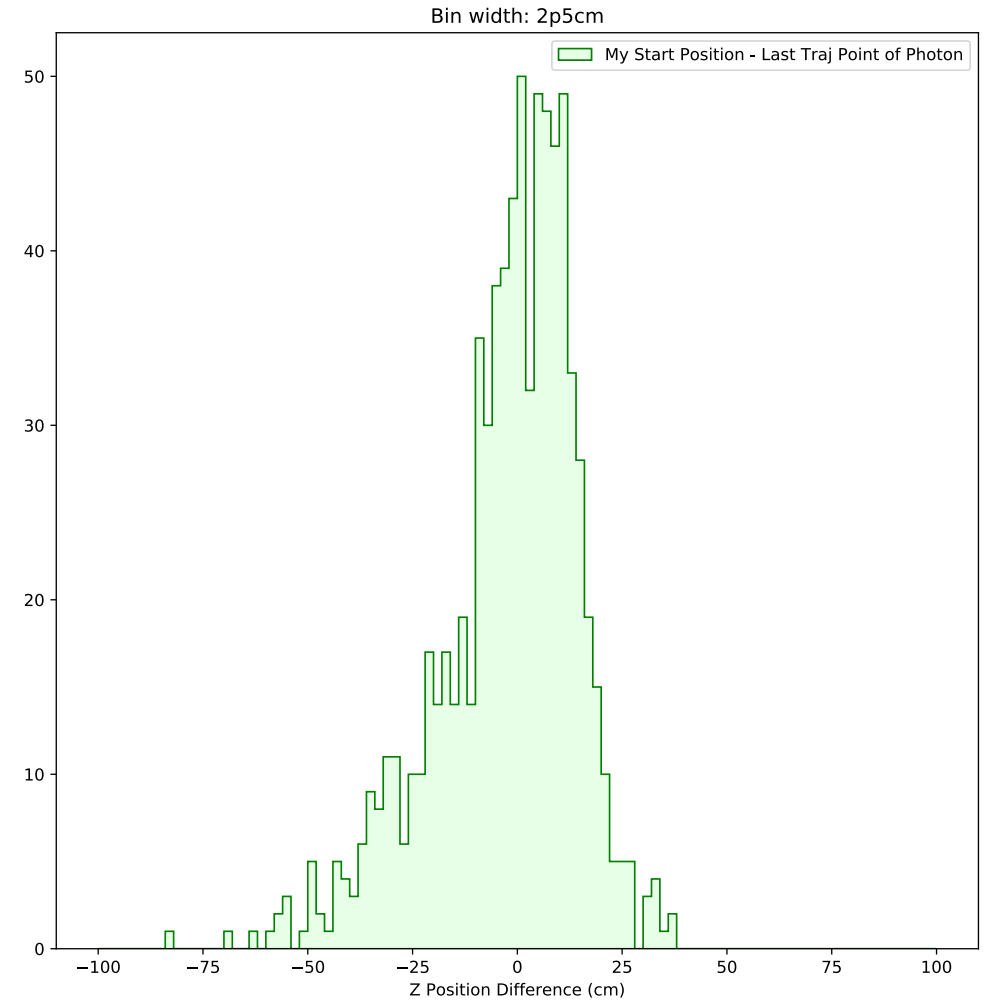
- Thought maybe I can remove these non-contiguous showers.
- Plot on right:
 - A section is defined as a continuous set of bins that have at least 1 hit in them
- Select the showers with only 1 section



Shower sections



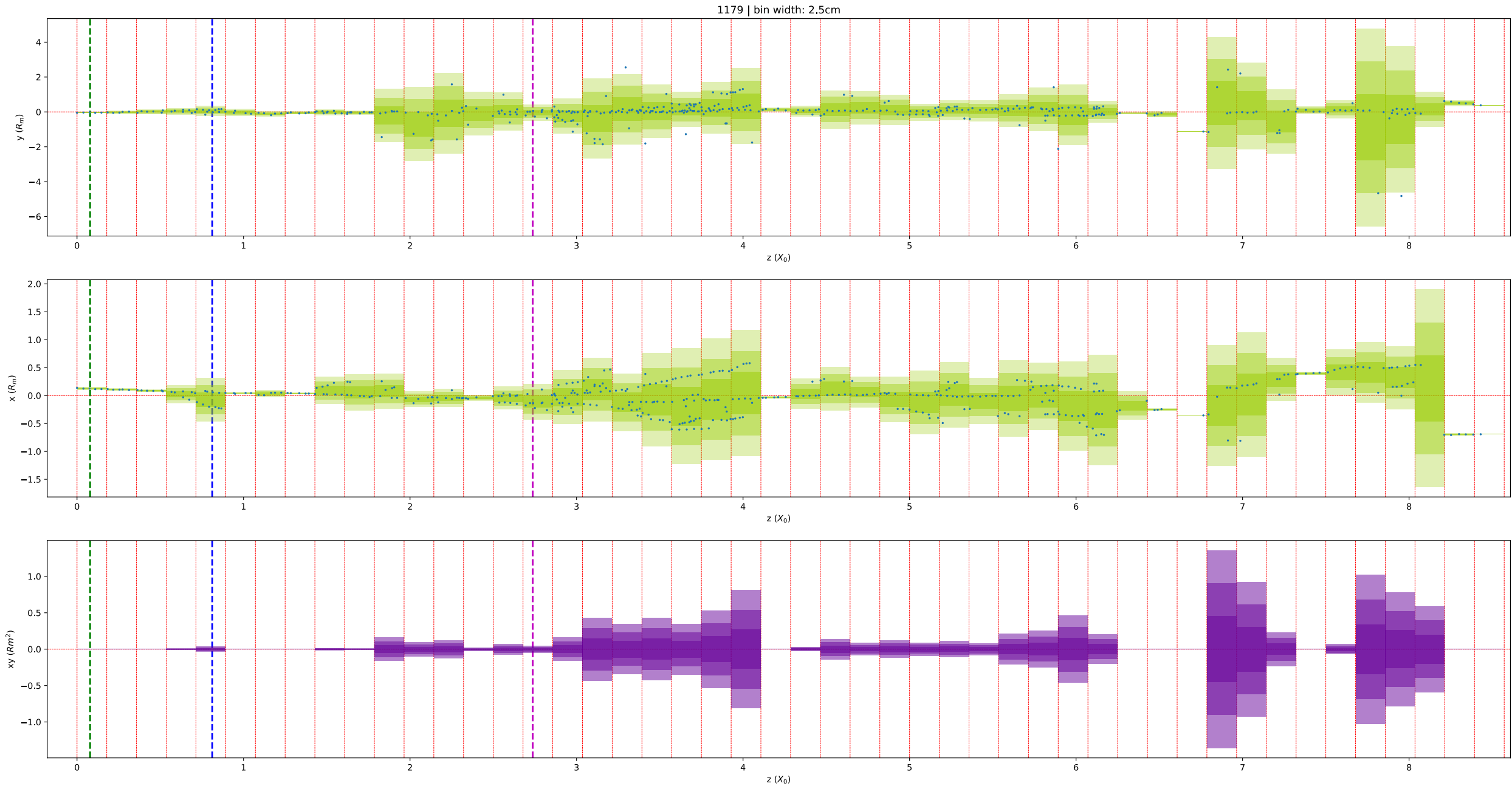
Select showers with only one section



Blue dashed line: My mip end

Magenta dashed line: Last photon trajectory point

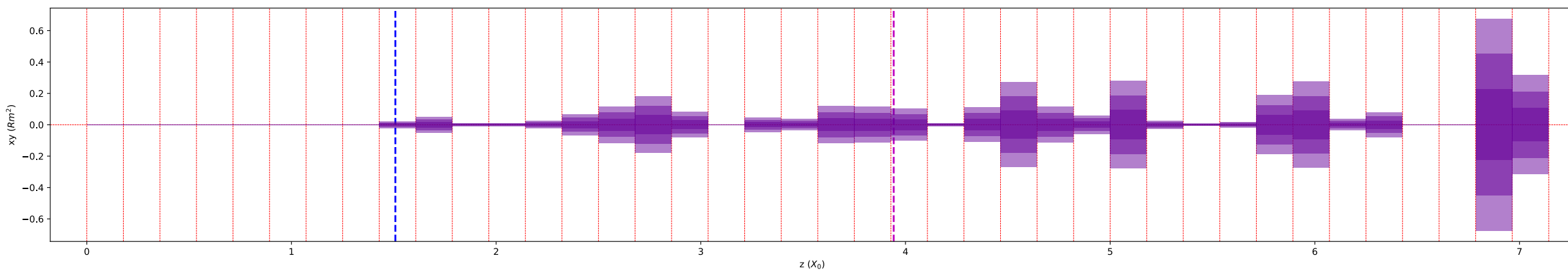
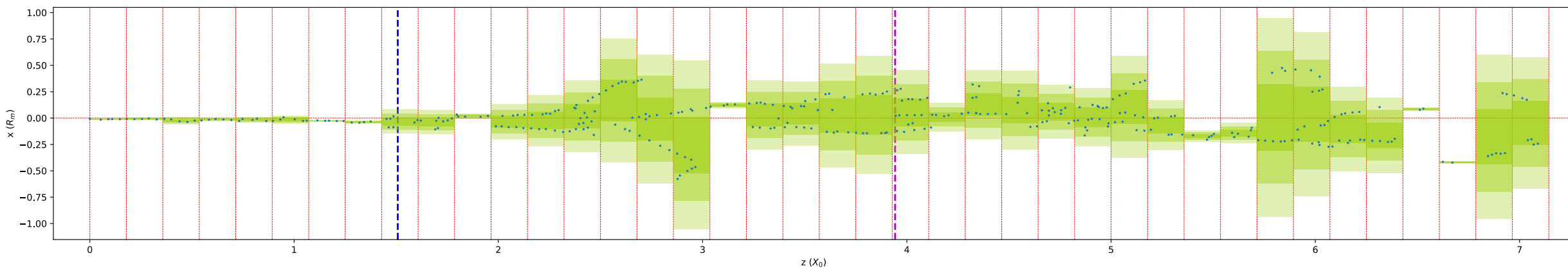
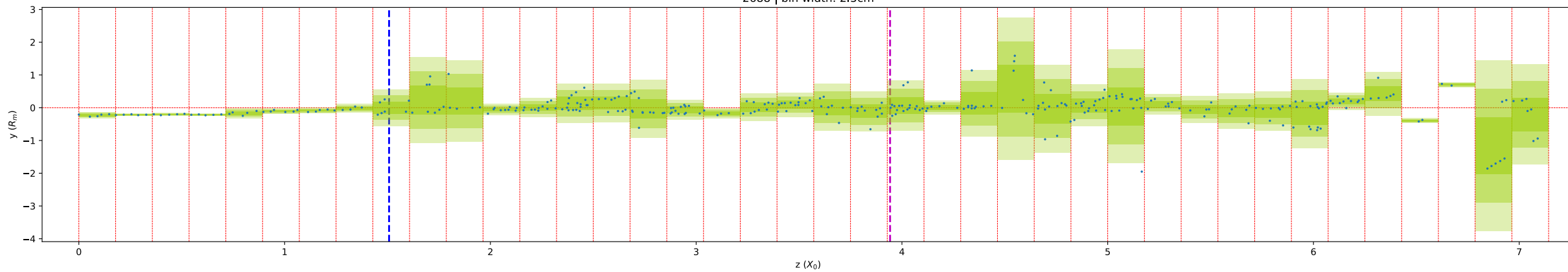
Green line: First photon trajectory point



Blue dashed line: My mip end

Magenta dashed line: Last photon trajectory point

2688 | bin width: 2.5cm



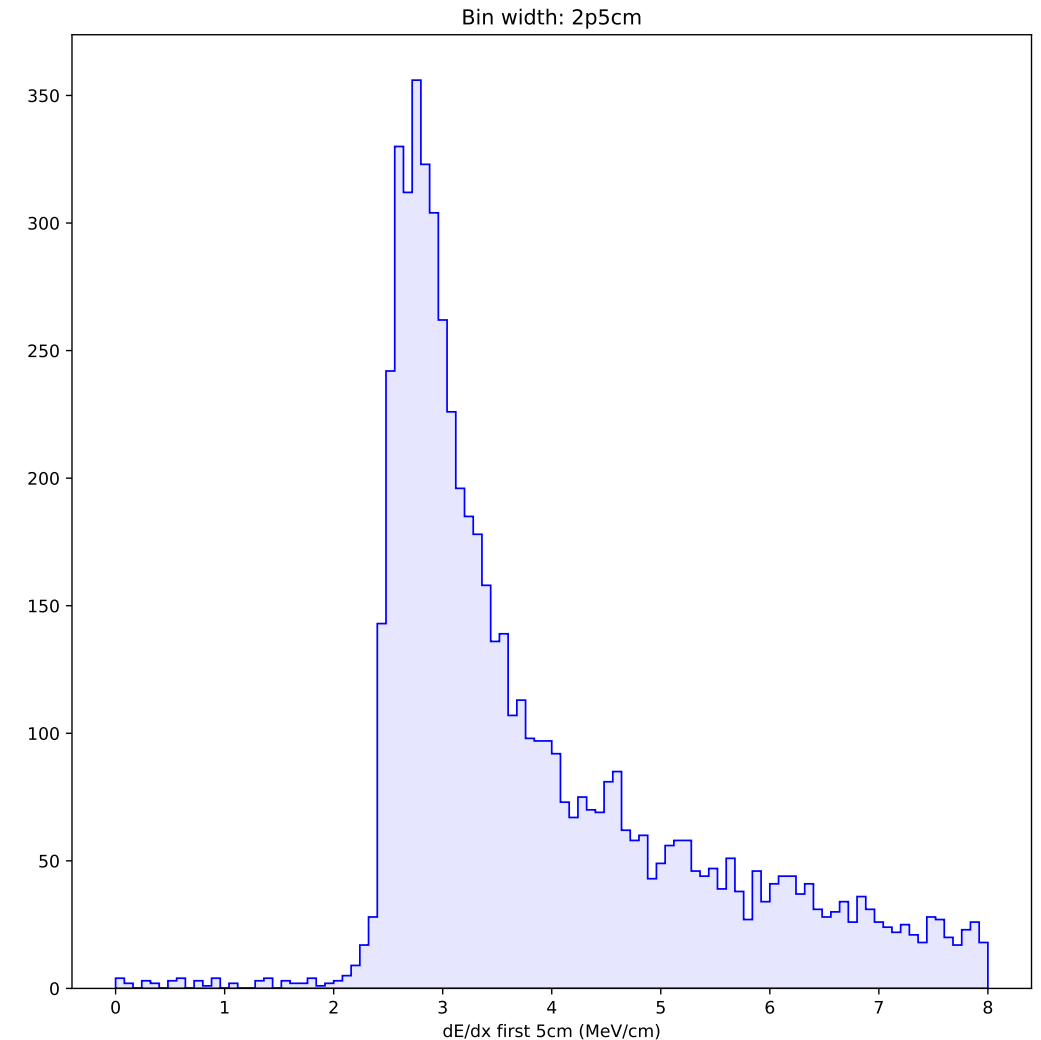
Any suggestions on how to improve?



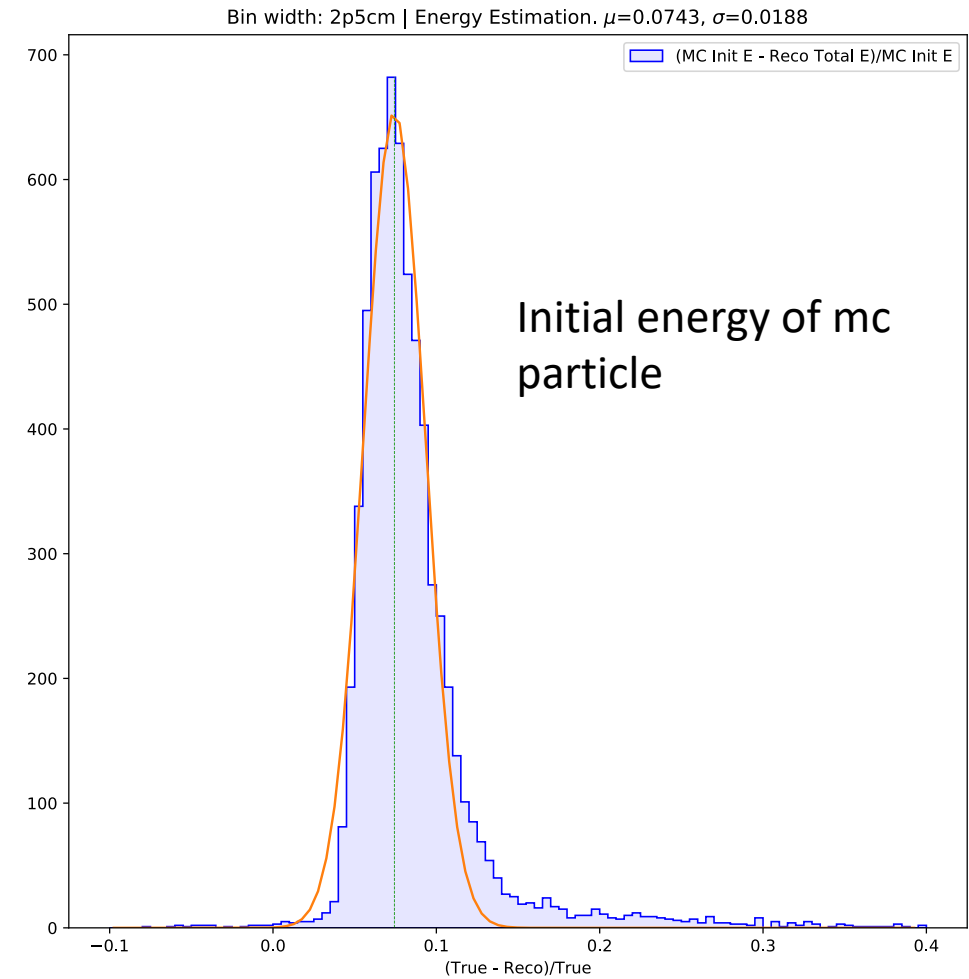
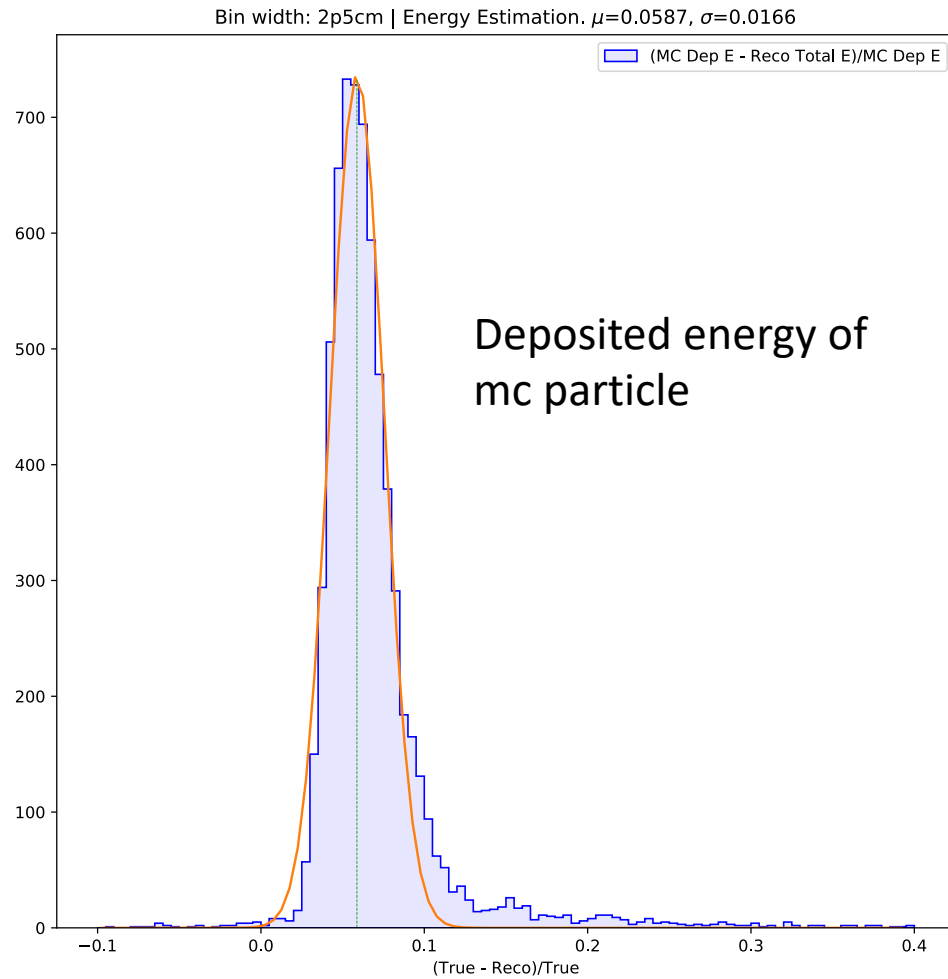
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dE/dx

- Calculate the dE/dx by summing the energy of the hits in a bin, and dividing by the bin width
- For first 5cm of shower, still getting a slightly too high value for dE/dx



Check Energy estimation



Back-up

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Shower Energy Estimation

- I estimate the energy of each hit using:

$(\text{caloAlg.ElectronsFromADCArea}(\text{hit} \rightarrow \text{Integral}(), \text{plane}) * \text{caloAlg.LifetimeCorrection}(\text{hit} \rightarrow \text{PeakTime}())) / \text{kGeVtoElectrons} * \text{recombination}$

CalorimetryAlg.cxx function to estimate number of electrons based on hit charge

Lifetime correction

Convert number of electrons to GeV (from physical constant)

Recombination correction (average value from modbox from Nick)

- I then total the energy estimation of each hit.
- I also then add together the total energy estimation for all particles in the PFParticle hierarchy.

Comparison of MC Initial Energy to MC Deposited Energy

