STUDIES OF CALORIMETRY IN DP

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protoDUNE reco meeting

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Introduction

- **<u>My aim</u>**: study photon and electrons showers in DP

- **<u>The topic of this talk</u>**: Preliminary studies on Energy reconstruction and Tracking on DP

- Dorota's module in $MRB_SOURCE/dunetpc/dune/ Protodune/singlephase/ECalibration_module.cc optimized for dual phase by myself

- Hit reconstruction "linecluster",
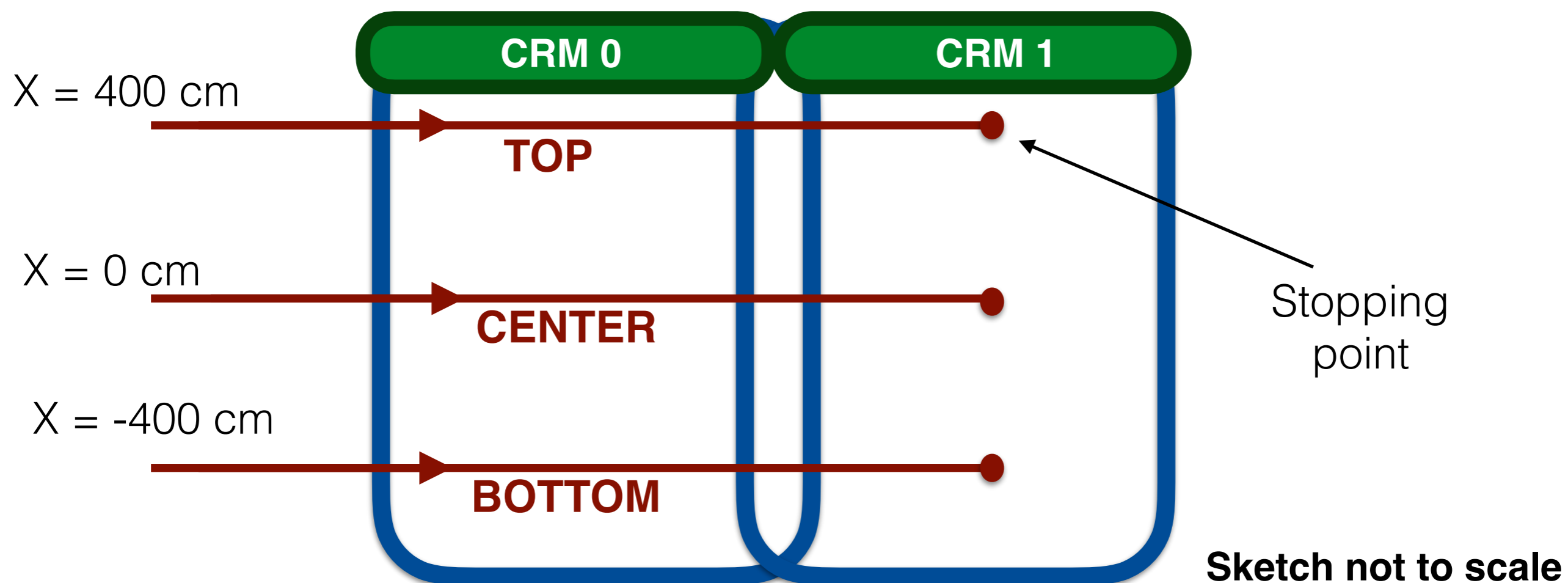
- Track reconstruction: "pmtrack"

DP geometry in LArSoft

- Use "**WorkSpace**" geometry
- Two Charge Readout Modules (**CRM**) of **3x3** meters each
- Total drift length: 12 m
- **Dead volume** between the CRMs
- More details about dune10kt dp geo can be found **here**
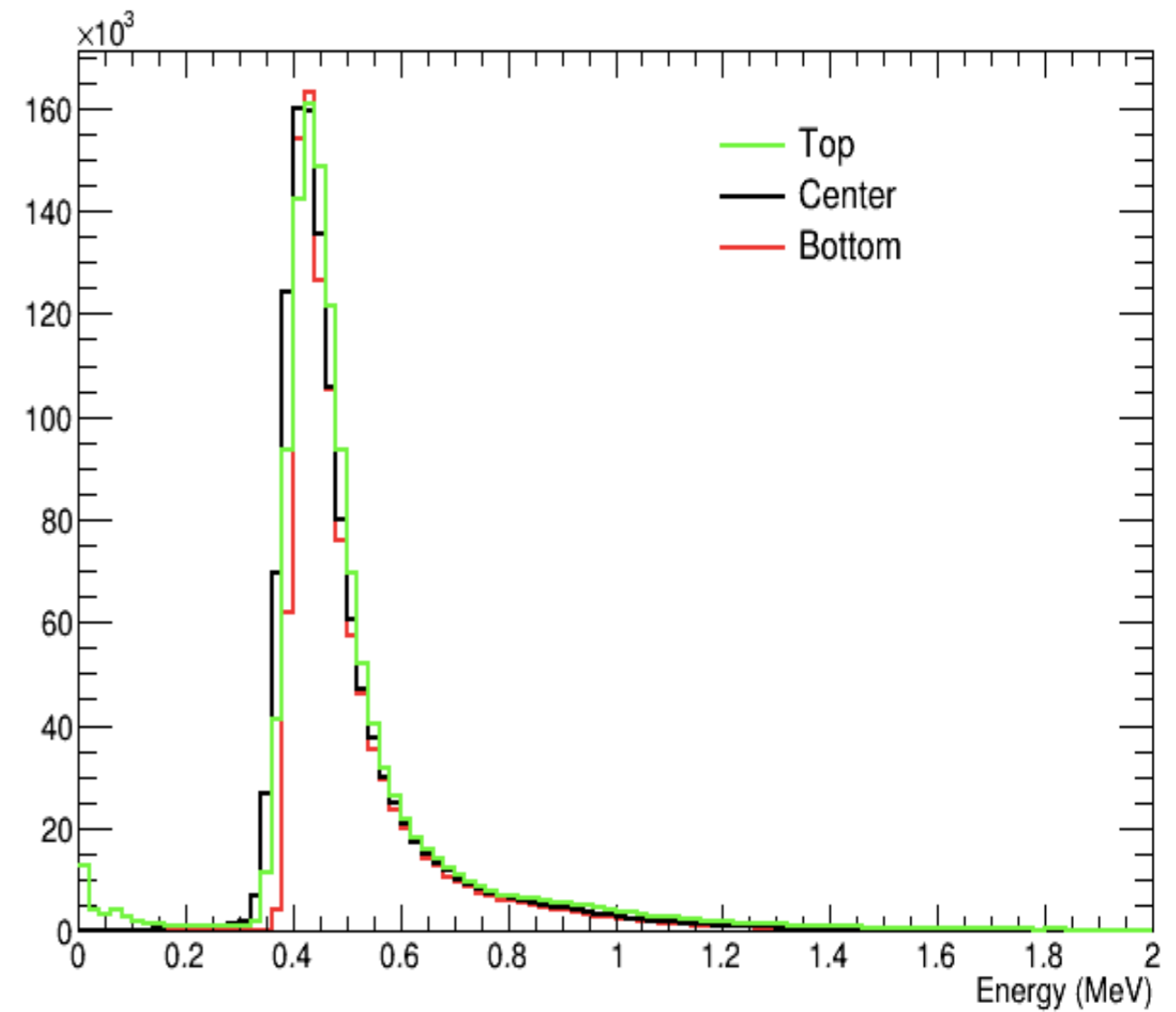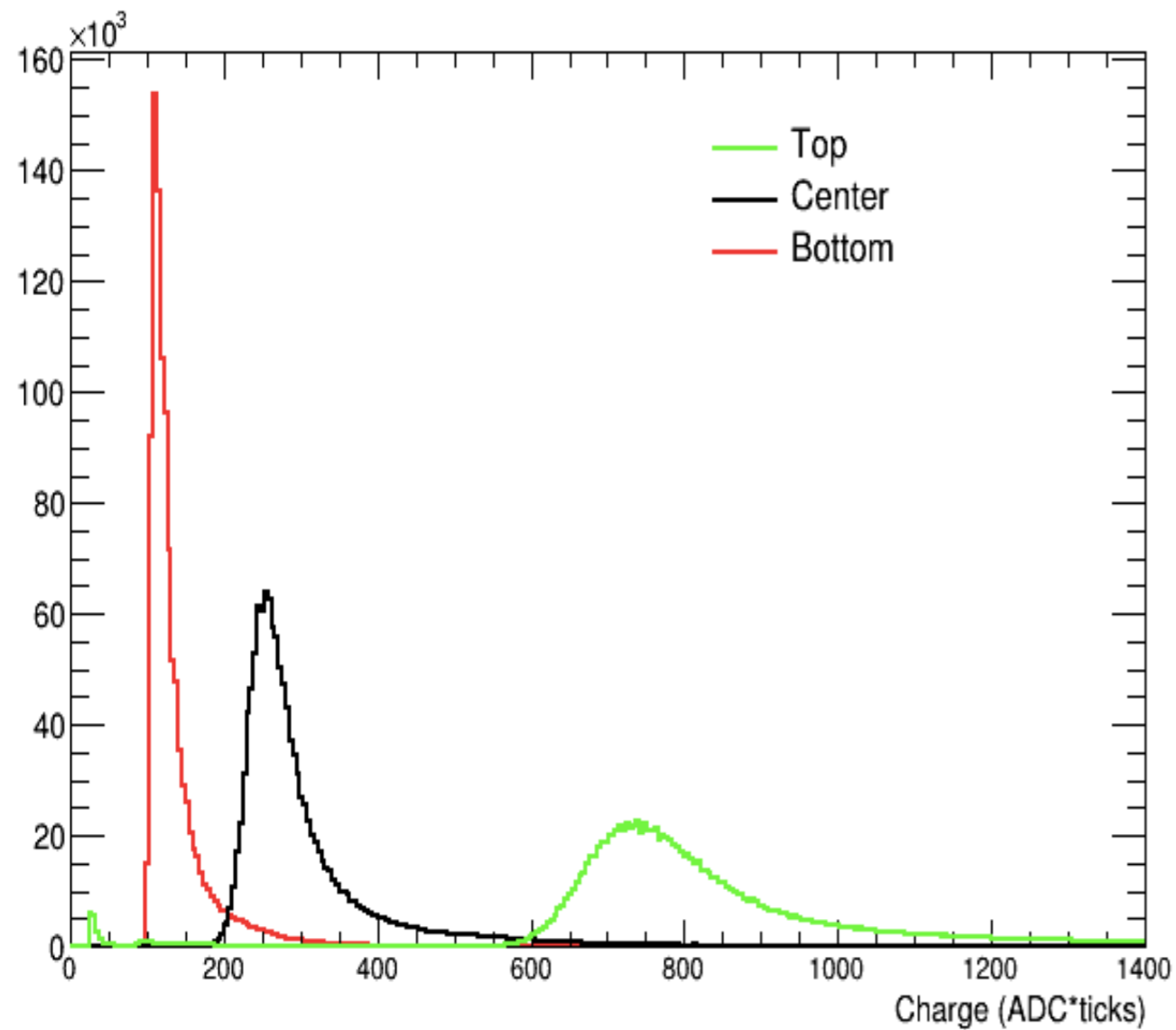

Sketch not to scale
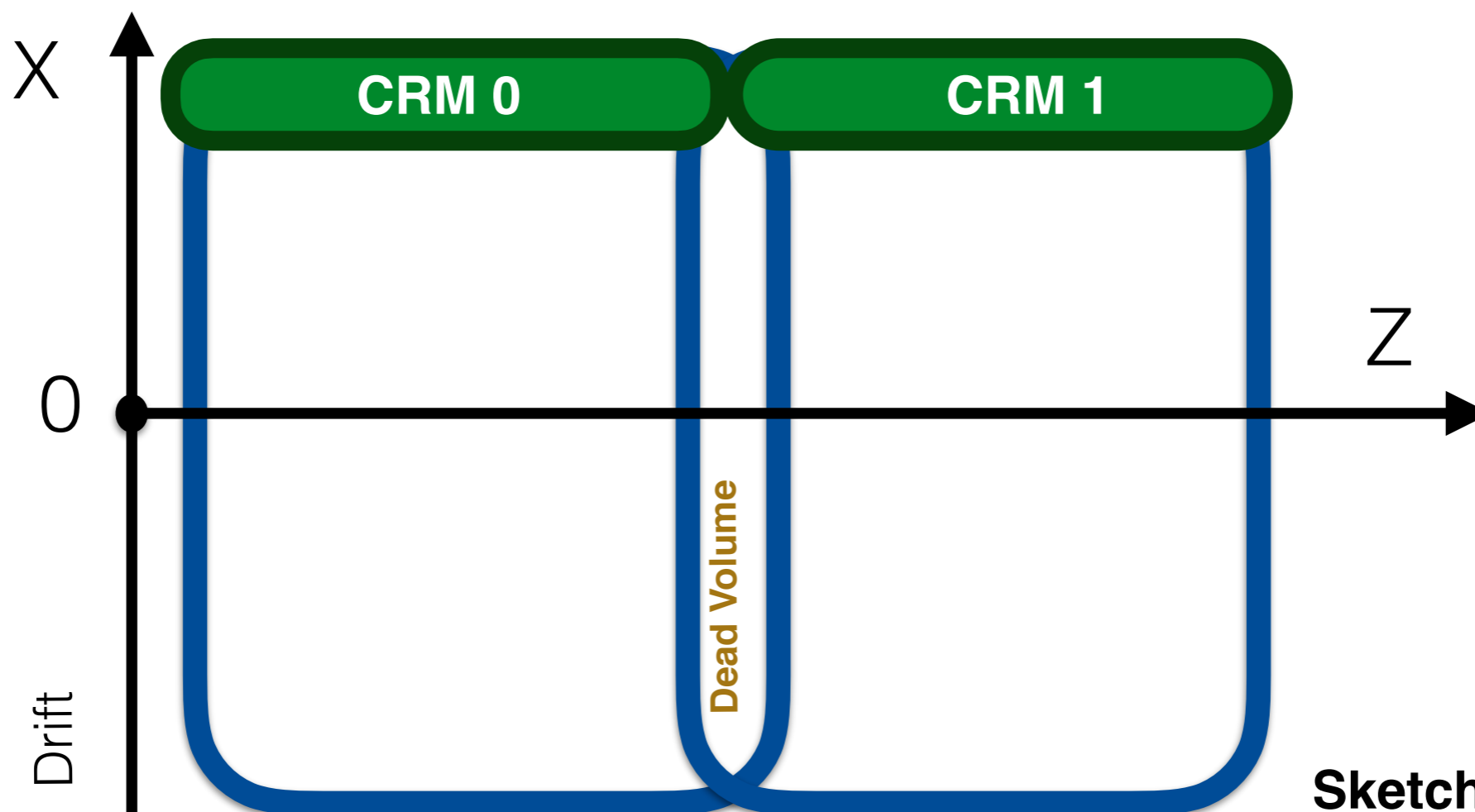
DP geometry in LArSoft

- **3 Samples 1K muons** each
- Initial **momentum 1 GeV** chosen to **stop the particle inside the detector**
- Three **X initial positions: +400, 0, -400 cm**
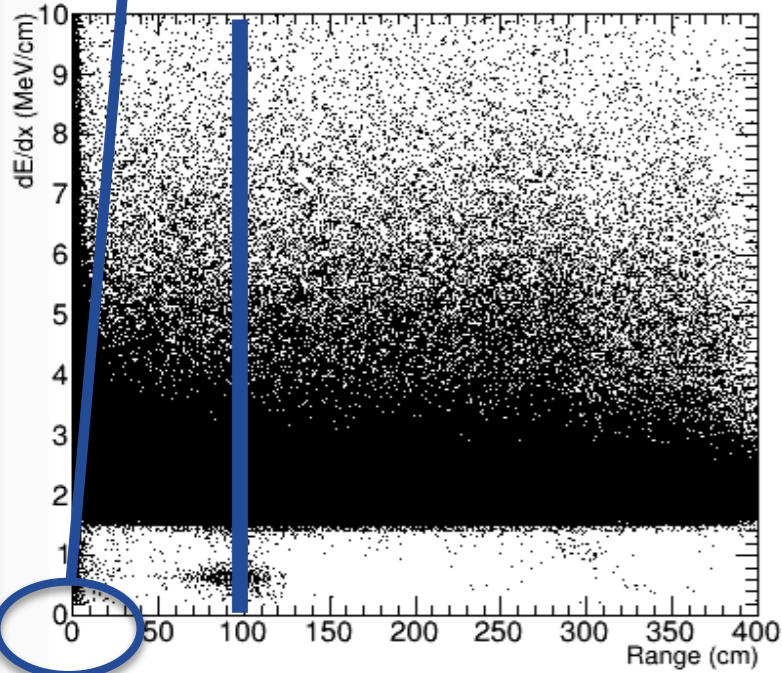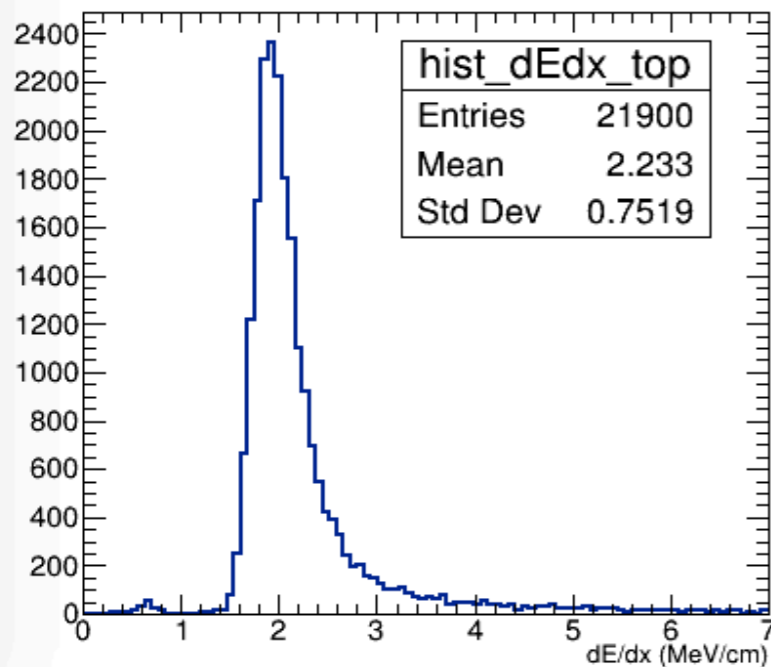- **Initial position along Z**, **no angles**

Sketch not to scale

Hit integrals and Energy

Stopping Power
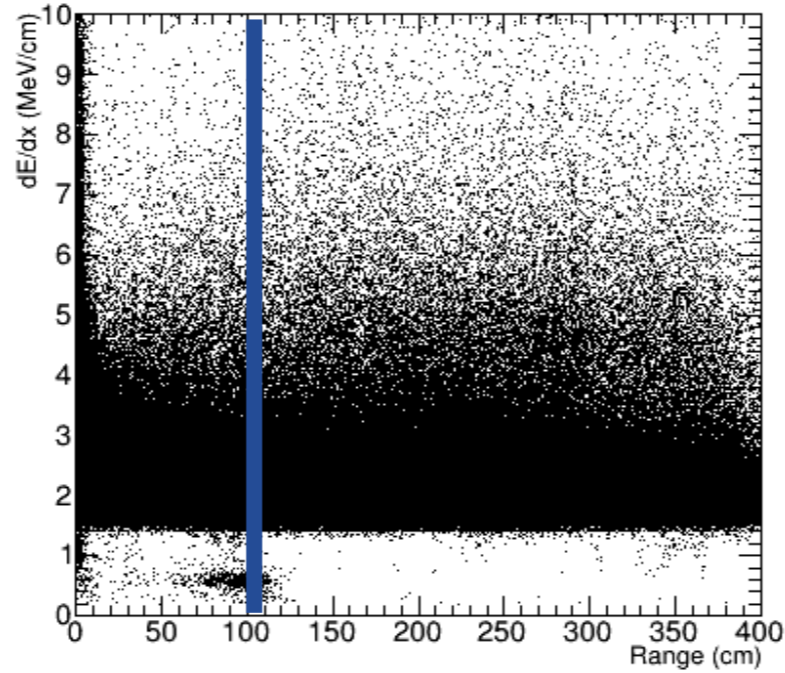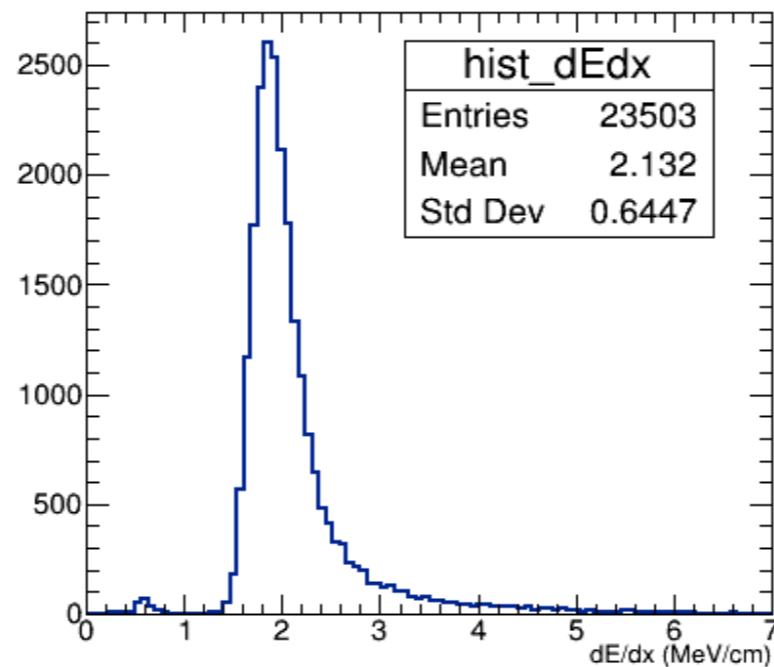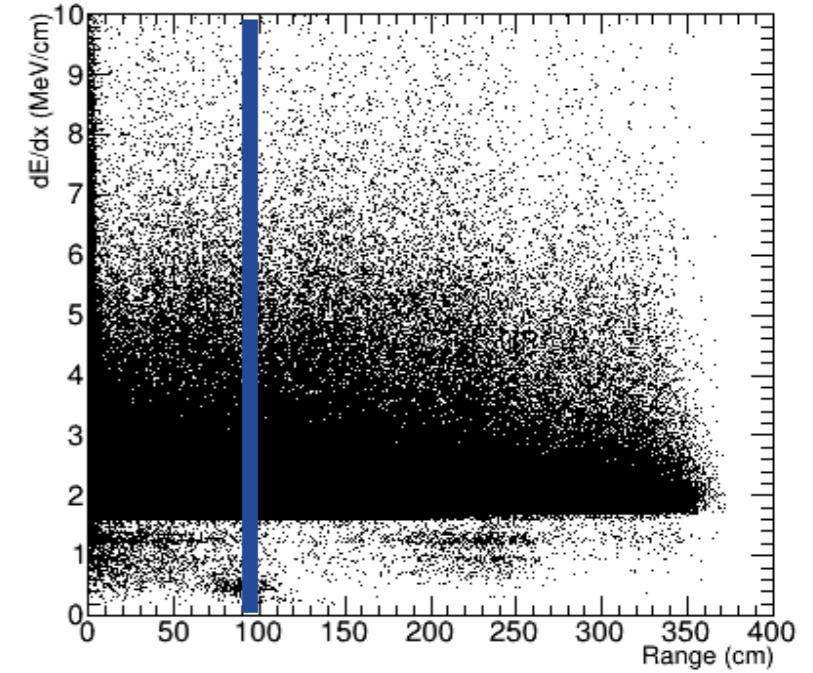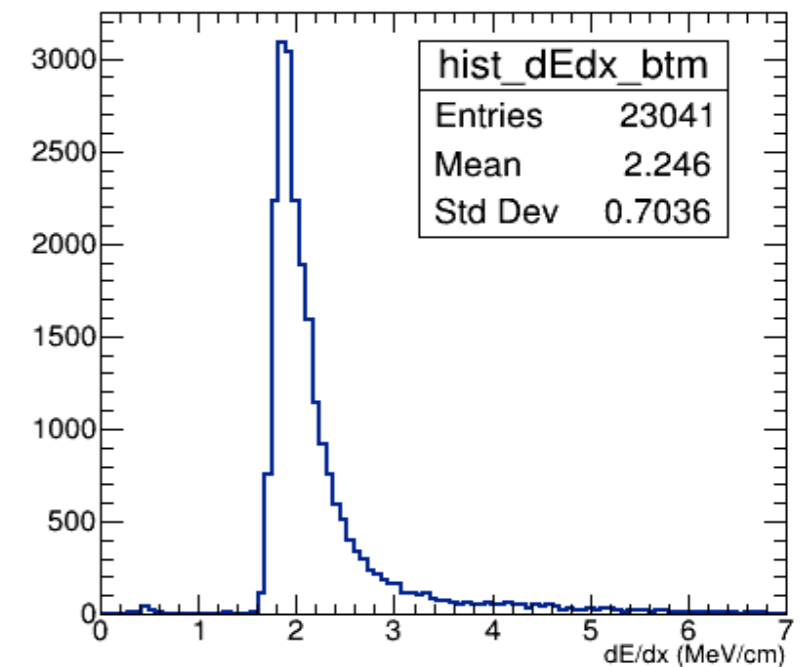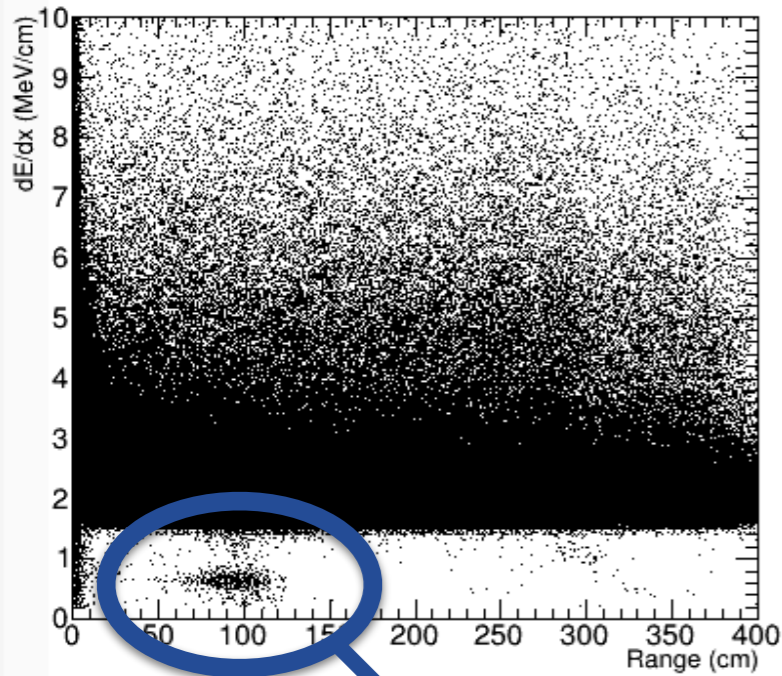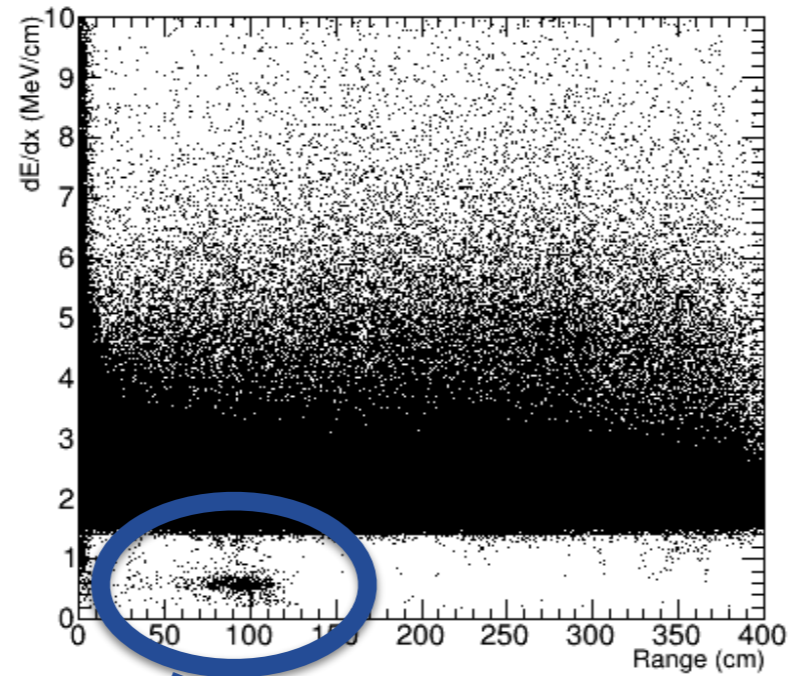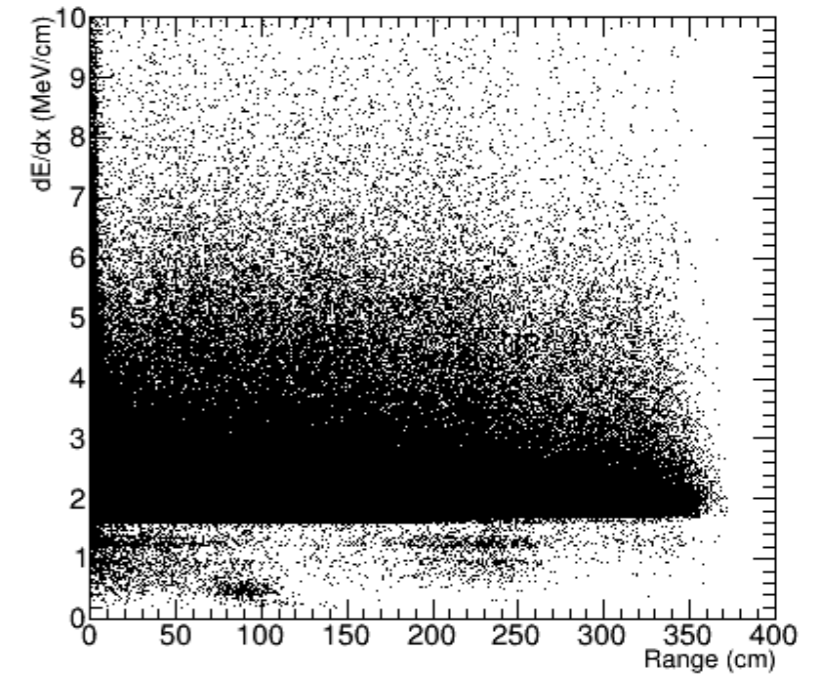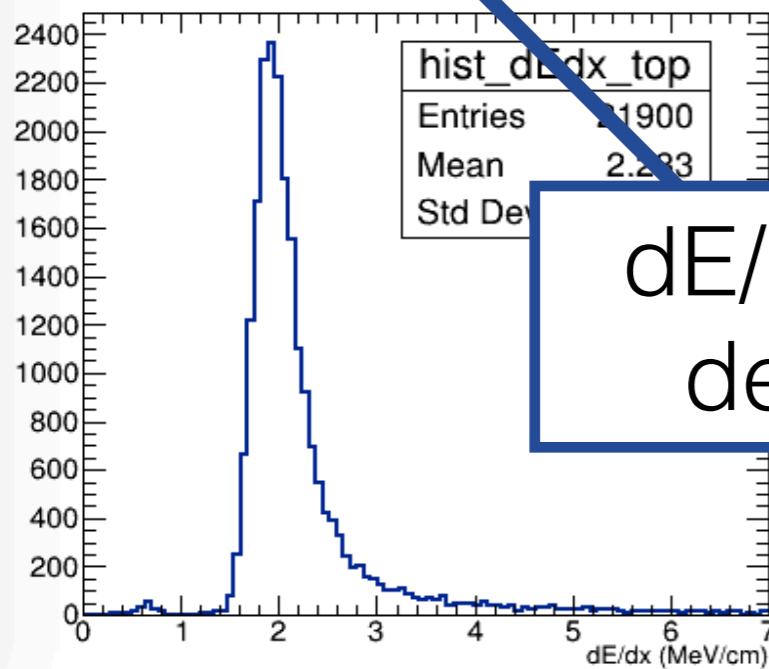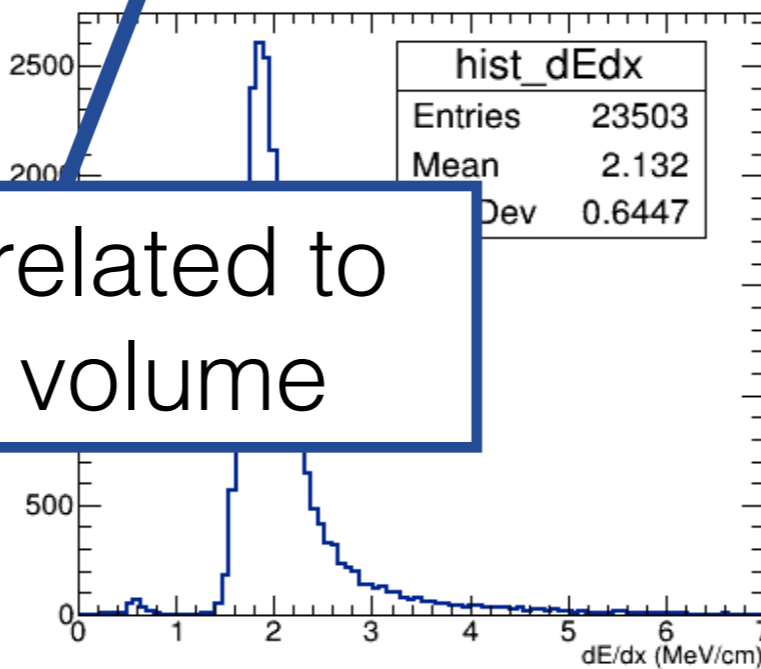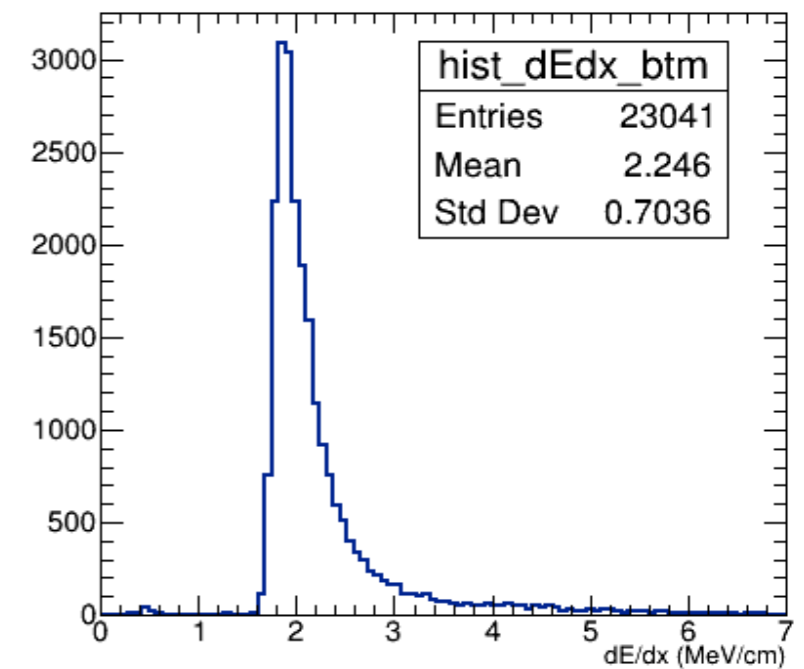
Stopping Power

dE/dx related to dead volume

Stopping Power (0-30 cm, Top)
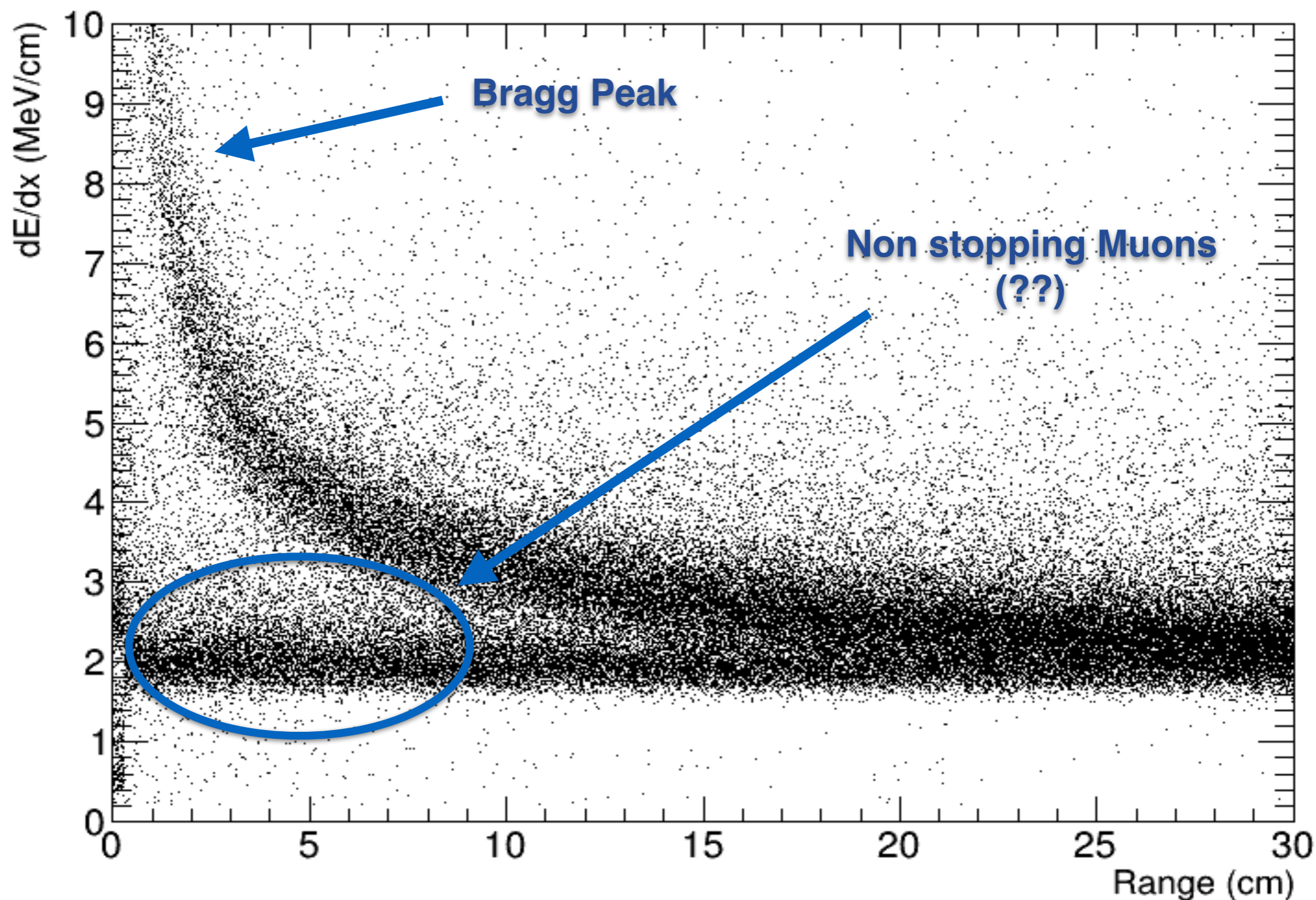
Kinetic Energy

- Ekin : energy associated to the track

- Expect highest deposit around 900 MeV

- Peaks around 300 and 700 MeV **(??)**

Stitching Problems

Top

Top
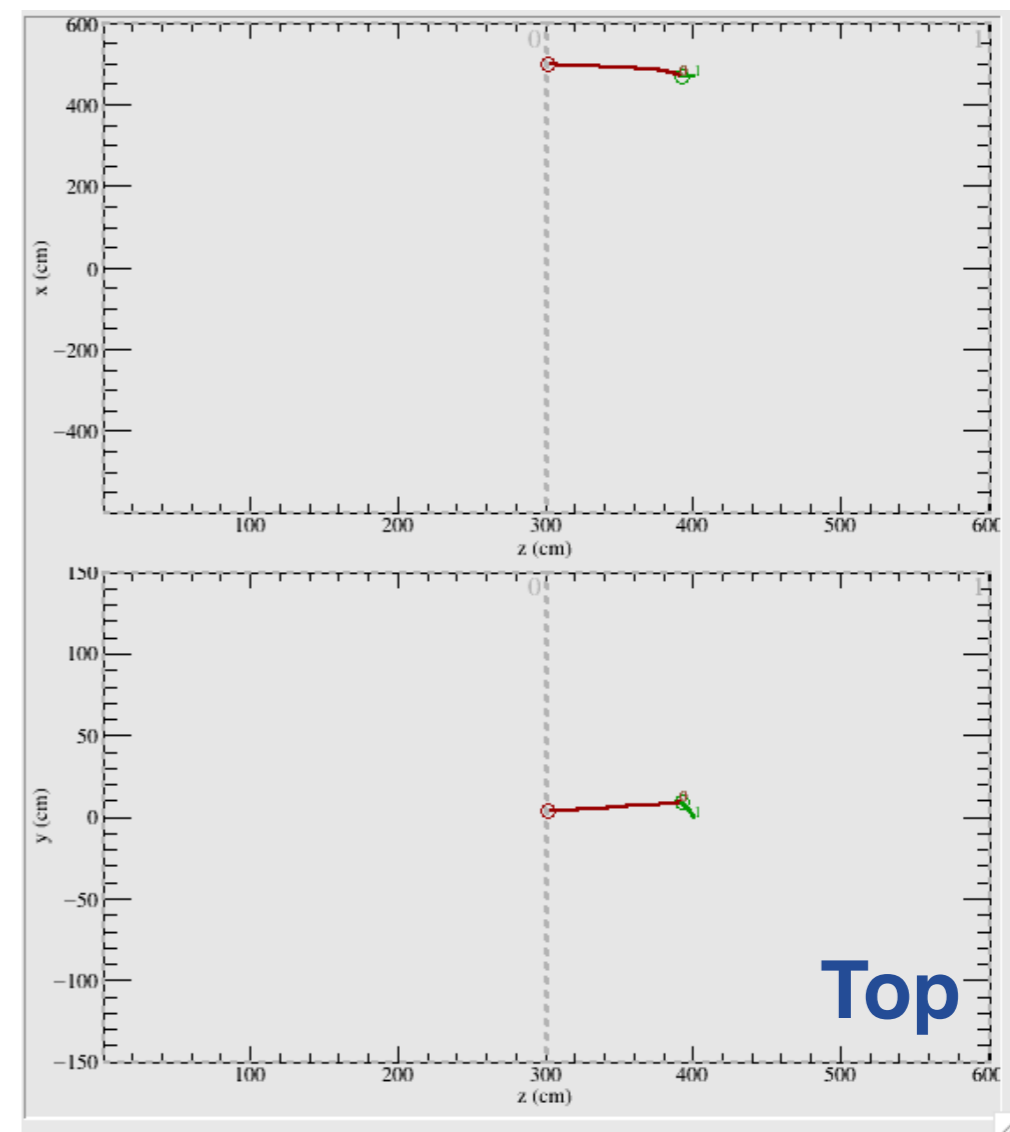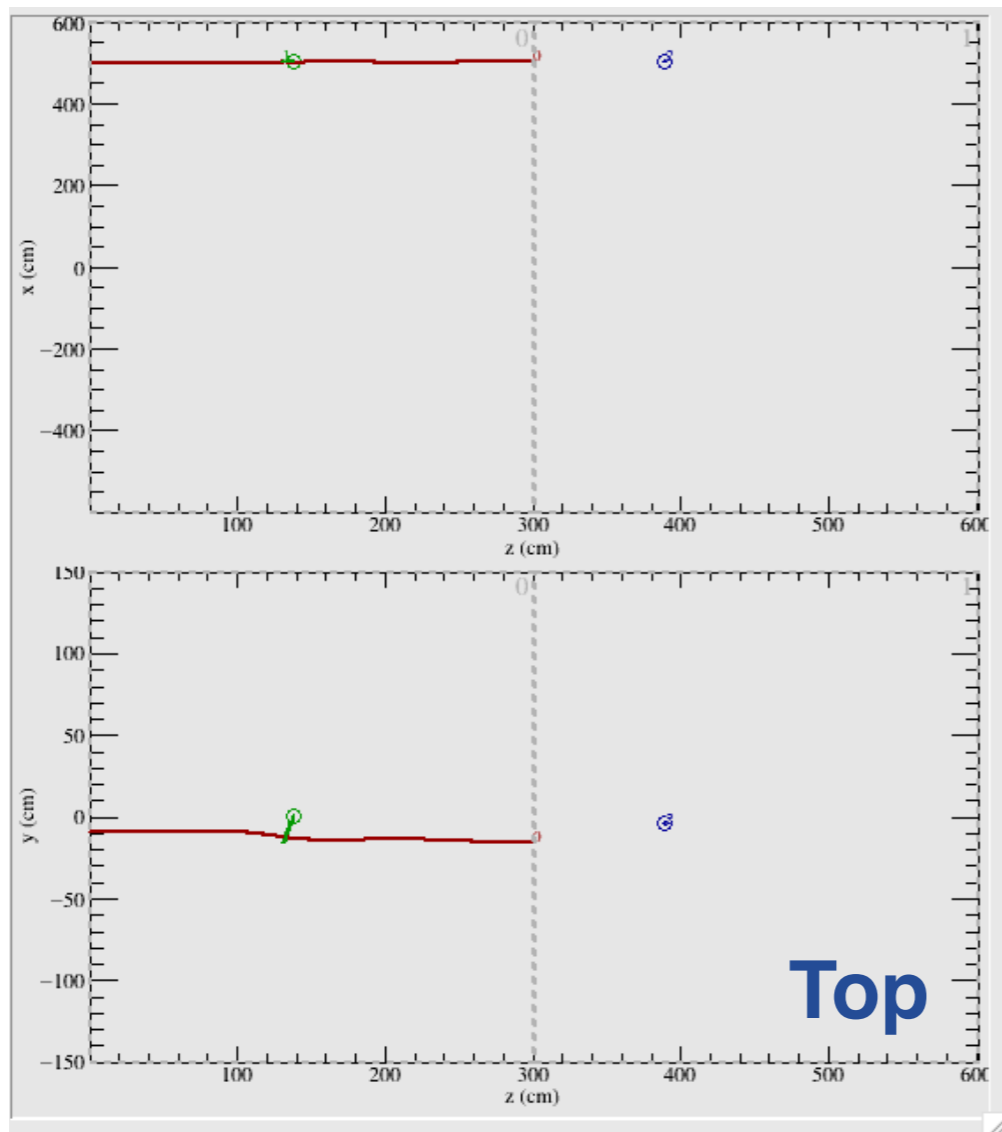
 Observed discrepancies in stopping power and Kinetic Energies
are compatible with split tracks between CRMs

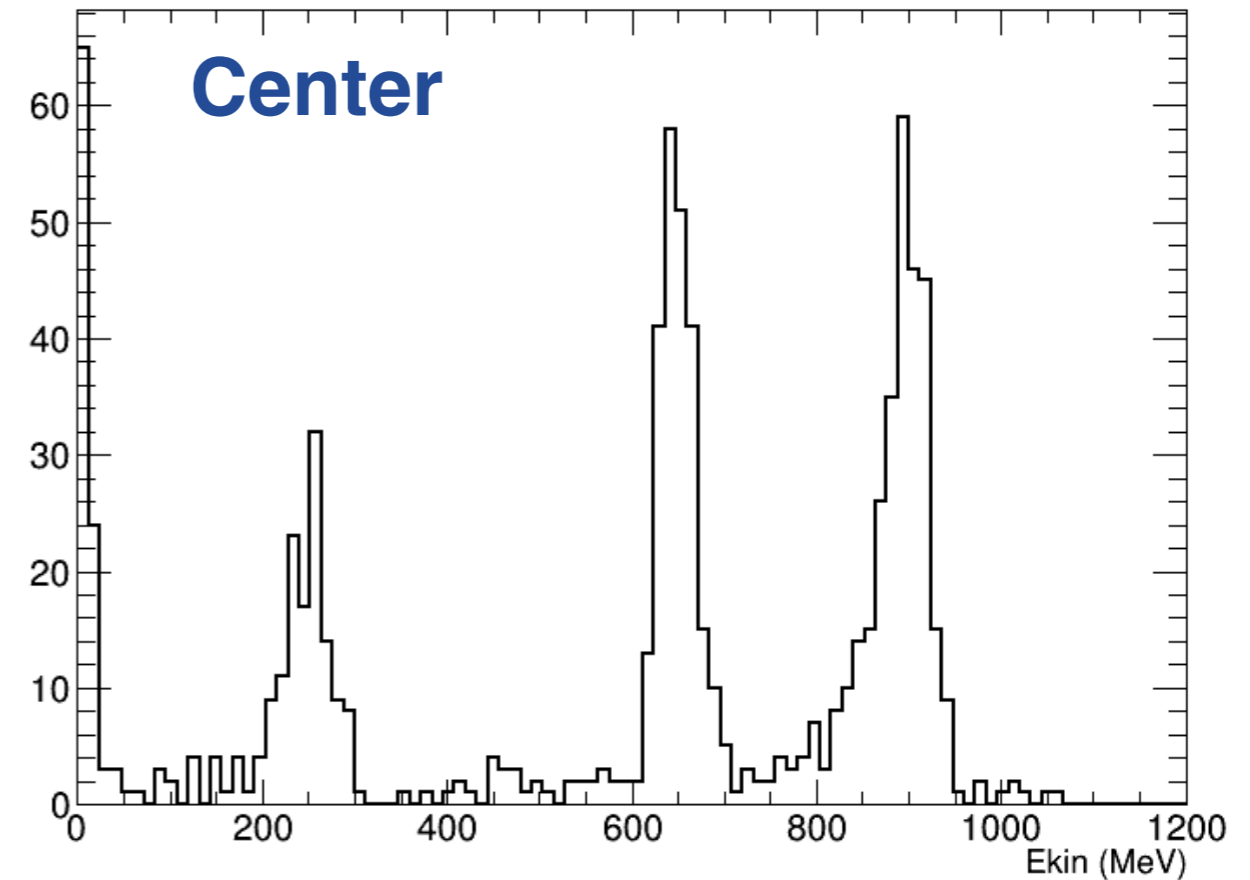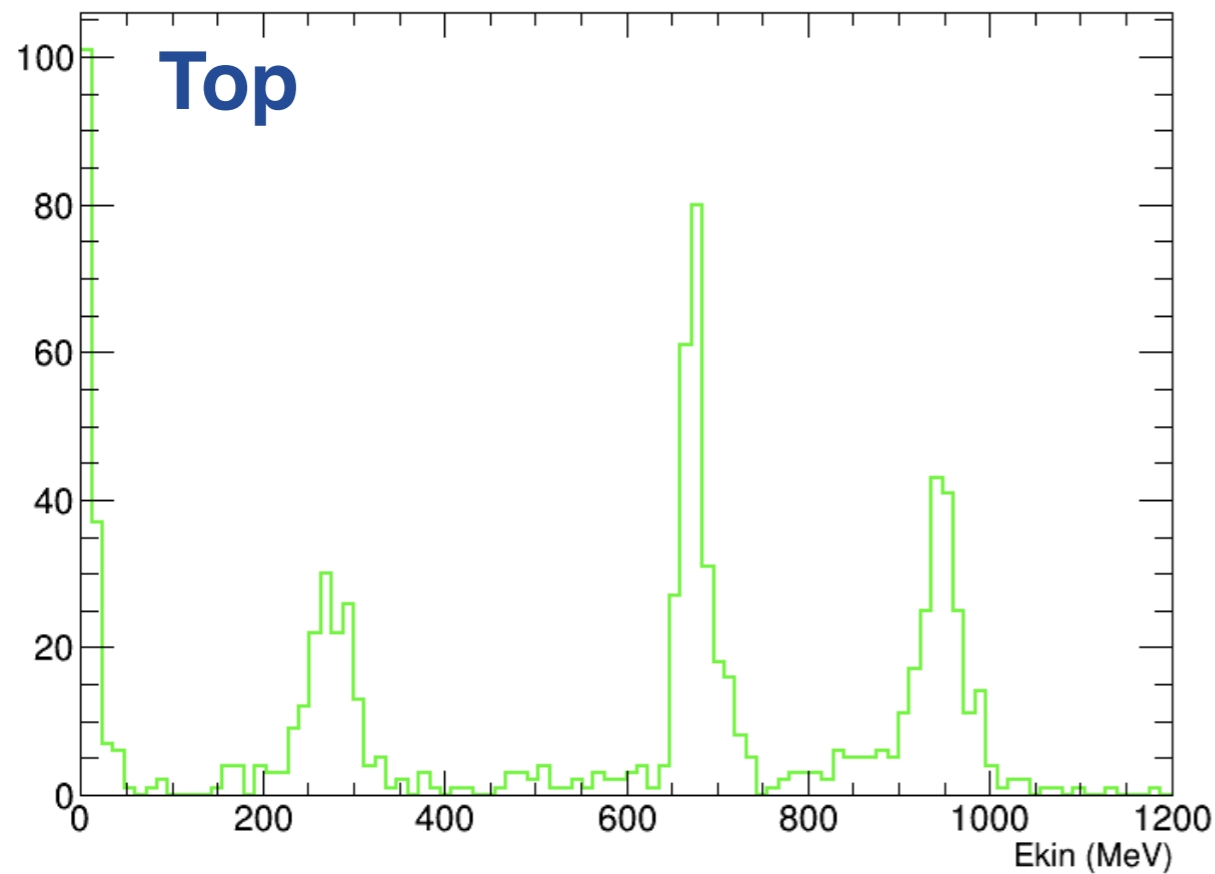# Energy and dE/dx on Planes

- So far I have always considered the plane with the largest number of hits;

- Check energy deposition on both planes

- In DP configuration: **two collection wire planes**

1st Vplane
(assigned geo::kU in larsoft)

2nd Zplane
(assigned geo::kV in larsoft)

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dE/dx

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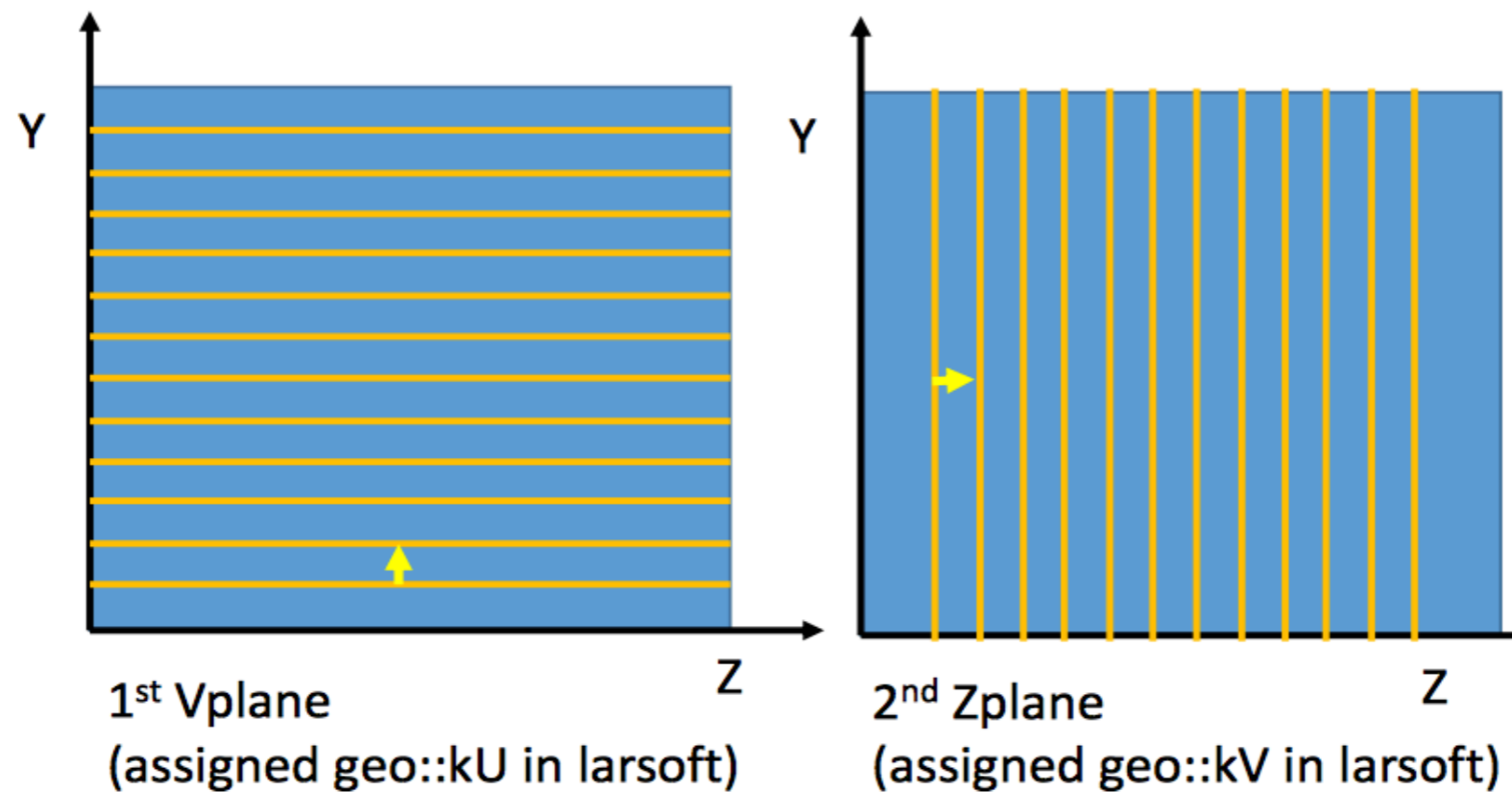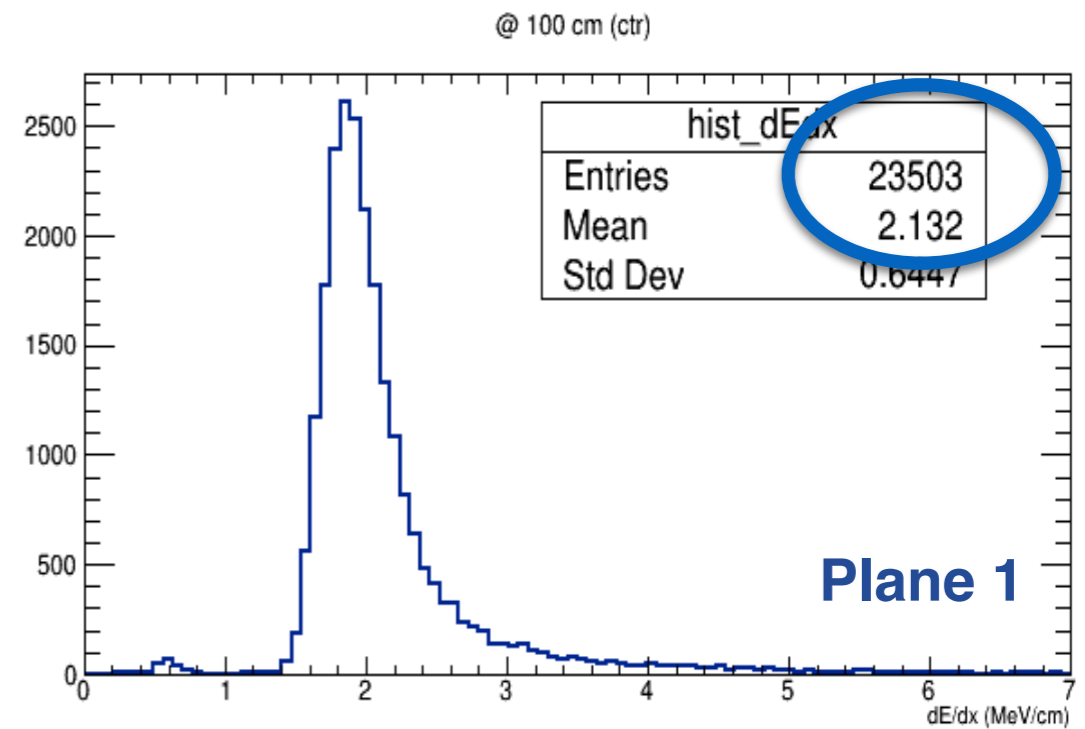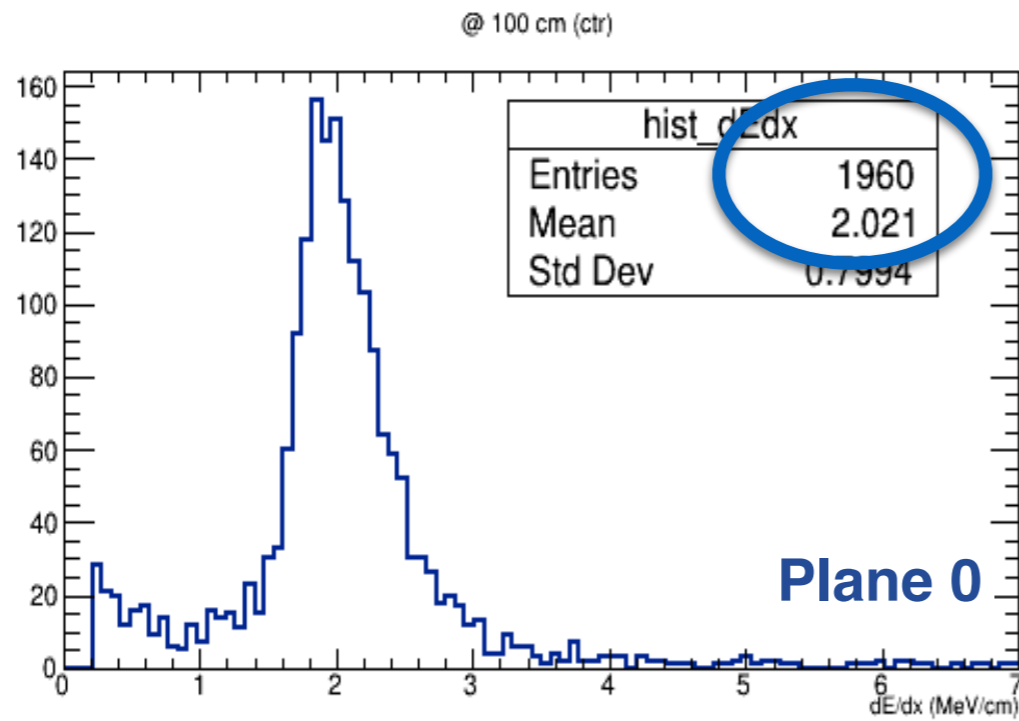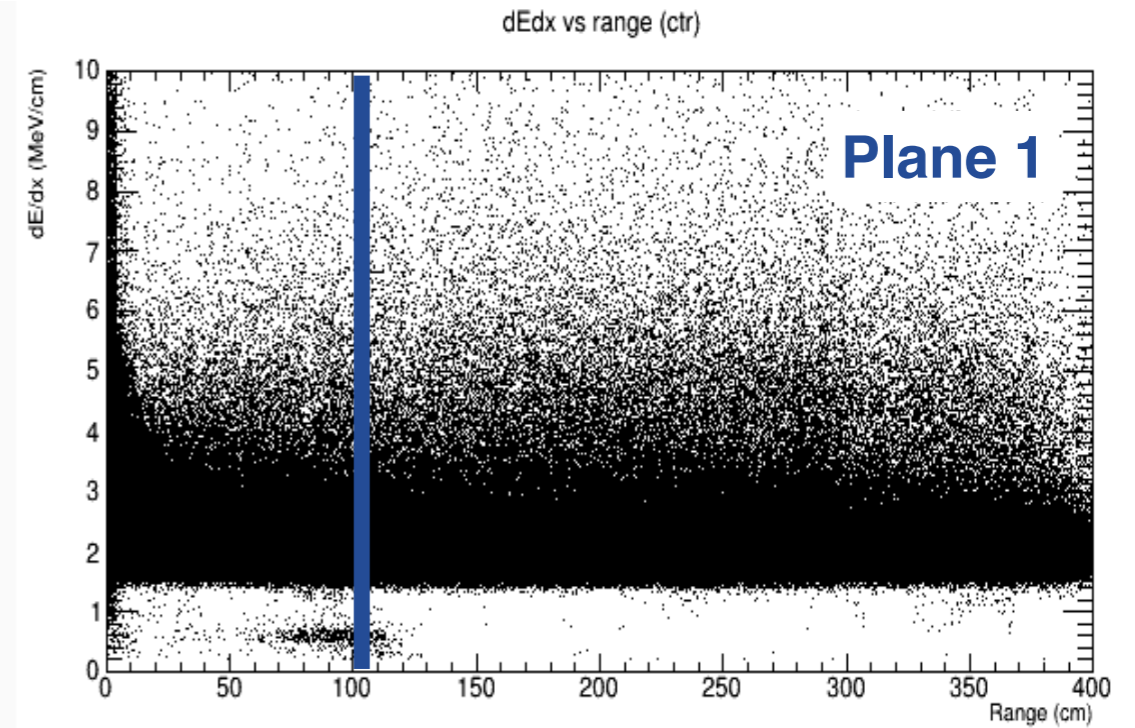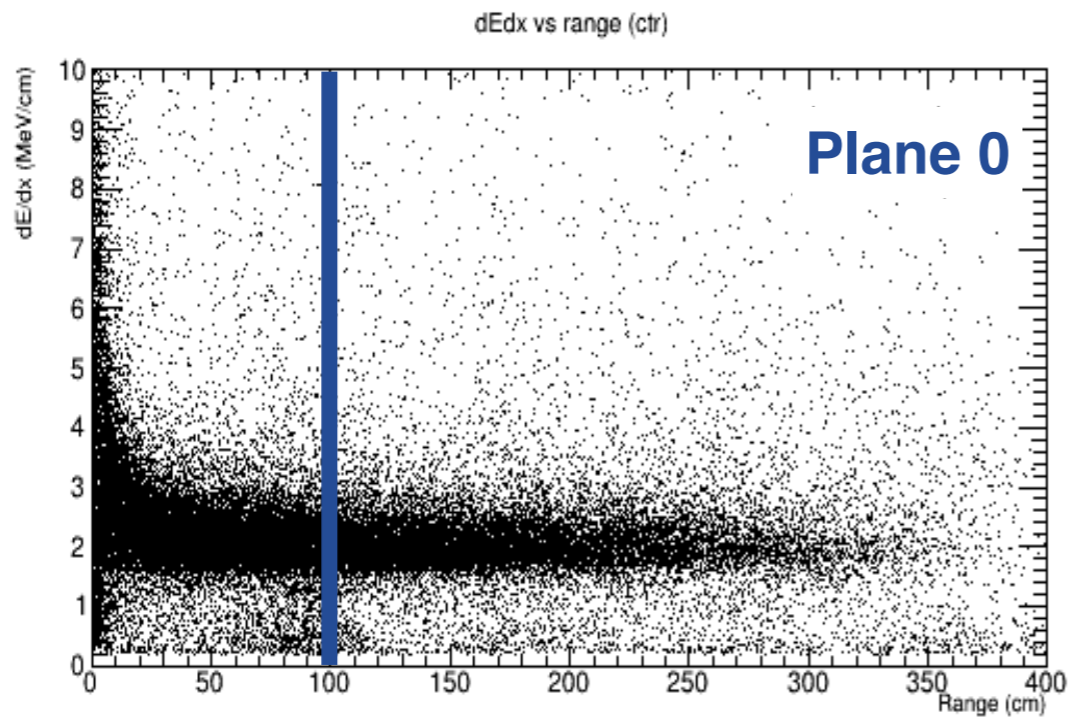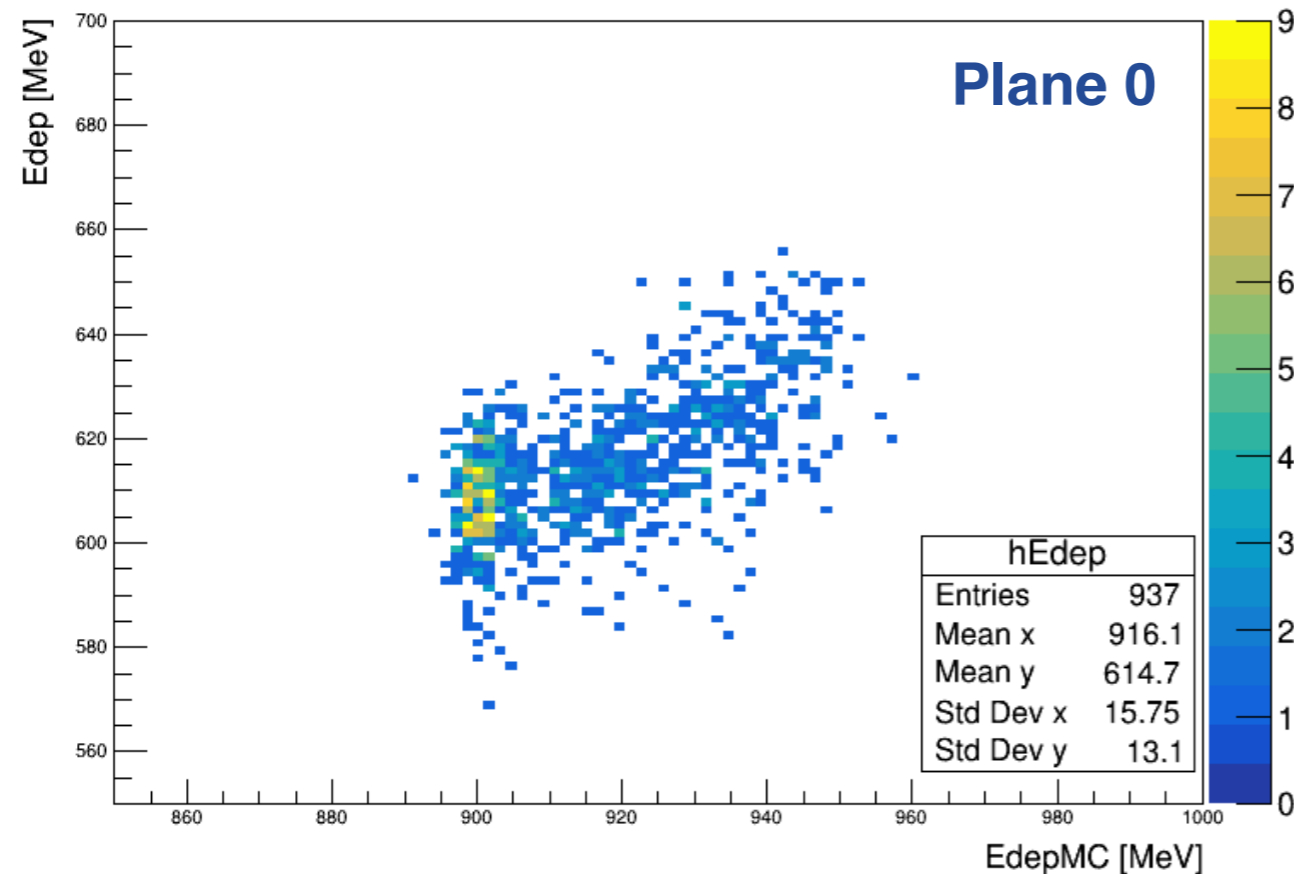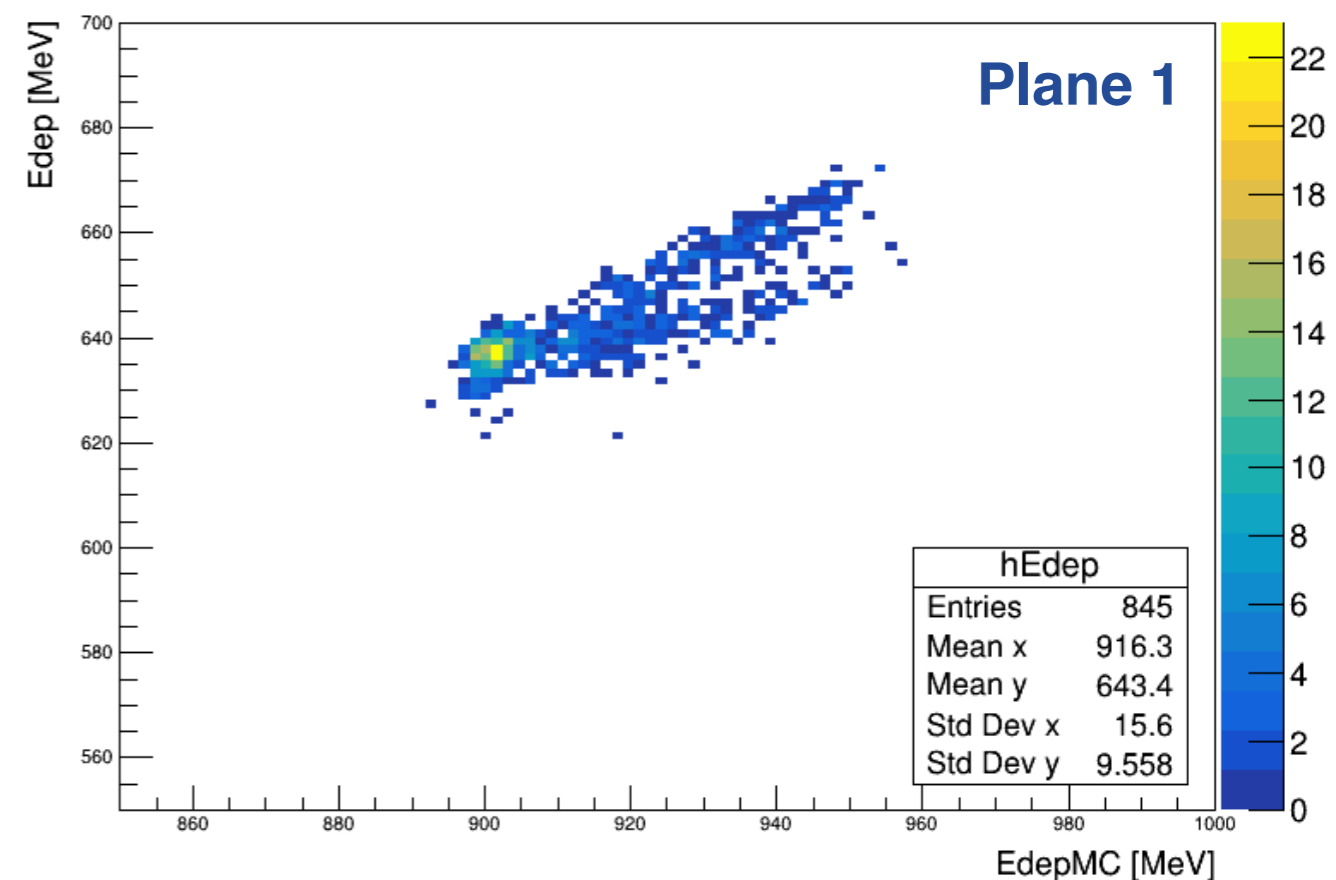
Energy deposit

- ‣ **Edep from hits**
- ‣ **EdepMC from sim::Channels**
- ▸ Ratio of ionization energy over total energy deposit is **~ 0.8** in LAr
- ‣ **Edep/EdepMC ~ 0.7**
- ▸ Both views show almost the same Edep. **Overall energy is doubled!**

A possible explanation for double energy

- When the electrons clusters (after the drift) are projected on the sim::Channels, the same number of electrons is assigned on each plane. This makes sense for single phase configuration, but not for dual phase

- However, the energy value returned by the Voxels results double as well

- Stopping power does not reproduce this behavior, because it is calculated starting from track metadata. The plots on each channel are in agreement with the geometry of the events

Conclusions

▸ **Overall DP geometry must be improved**;

▸ **Dead volume between the CRP + stitching issues** may alter physics;

▸ Calibration using **stopping power looks fine**

▸ Problems concerning **doubled energy deposit from MC truth must be better understood**

▸ Ratio between Edep and EdepMC is close to the expected ratio

Thanks for your Attention!

Backup slides

Hit integrals and Energy on Planes