Precise calorimetric reconstruction of proton kinetic energy in ProtoDUNE to measure proton inclusive/exclusive cross section

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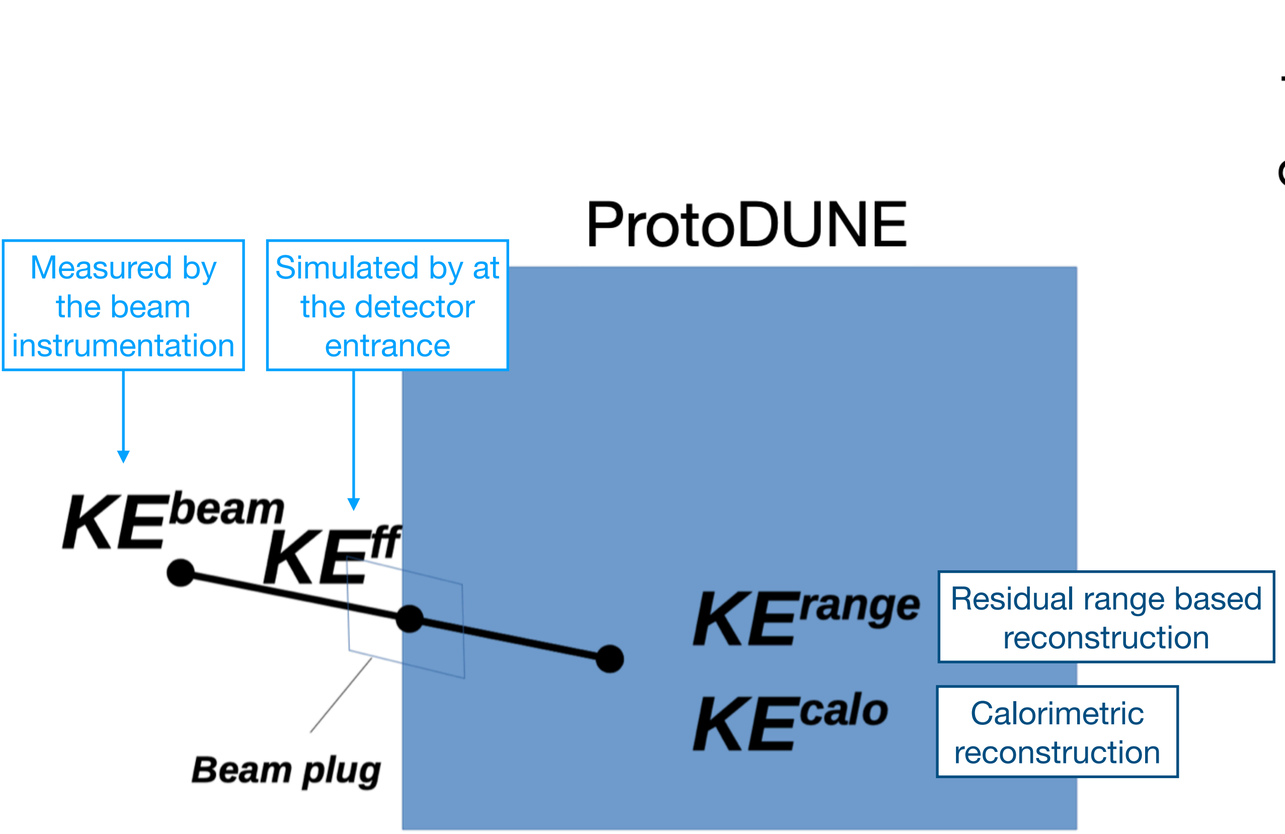
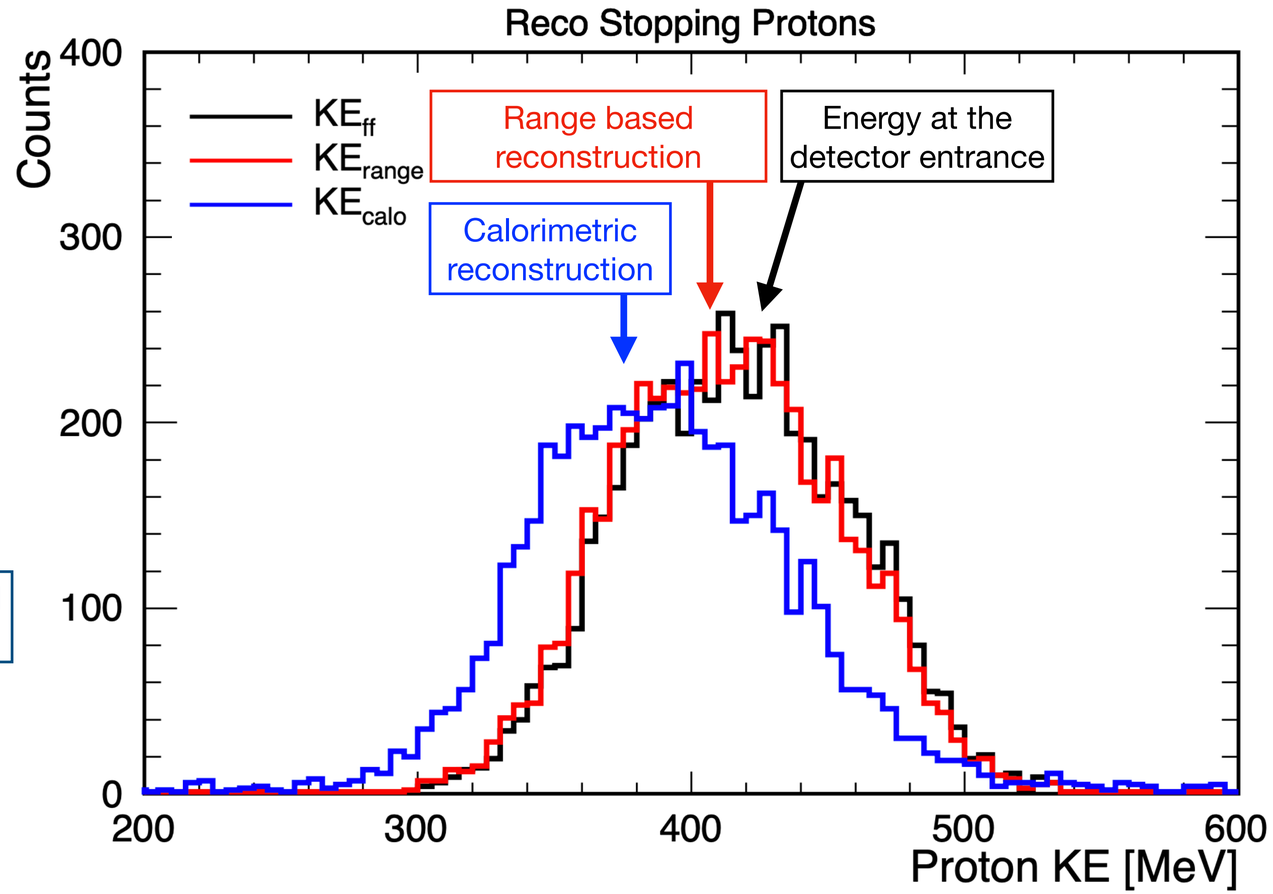
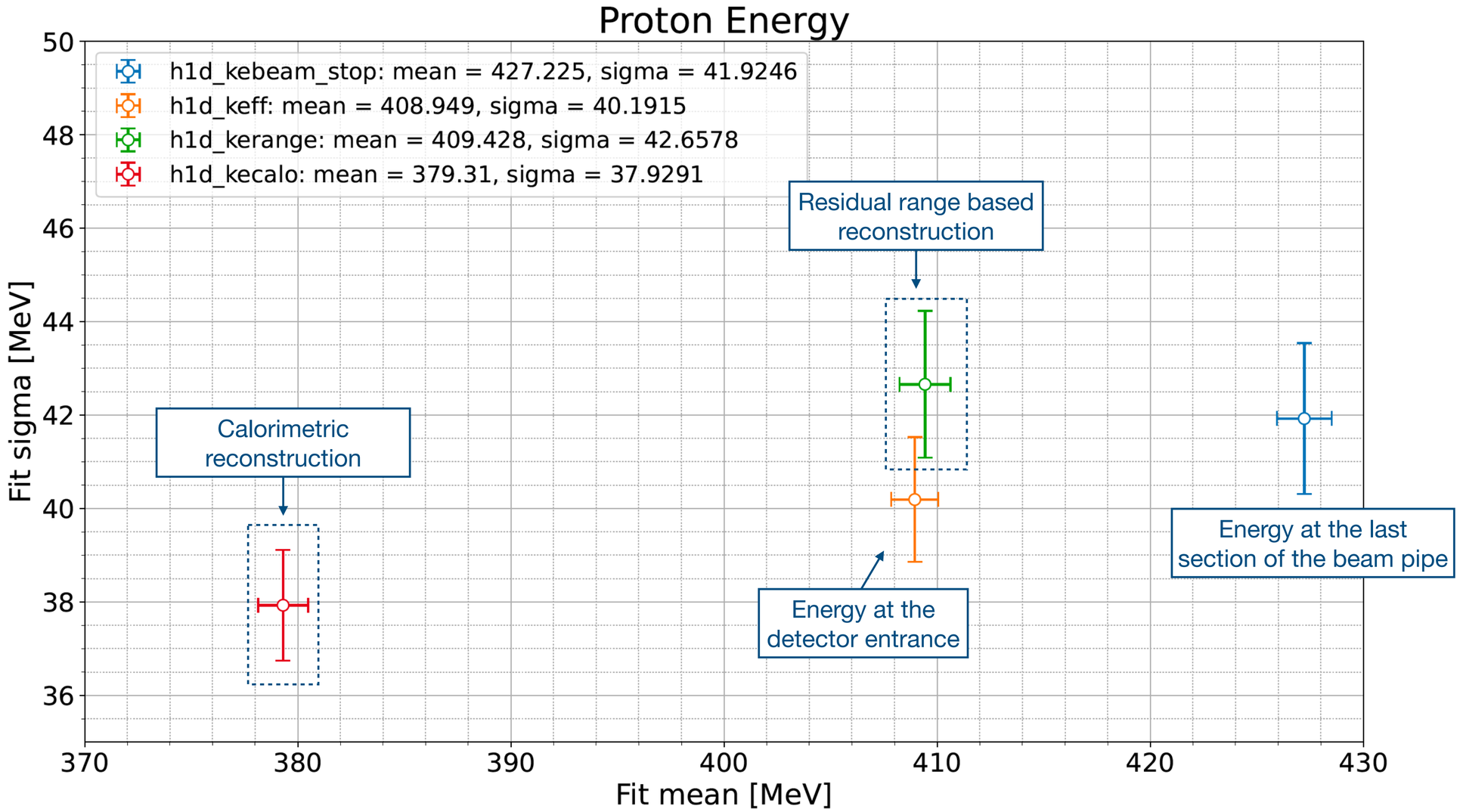




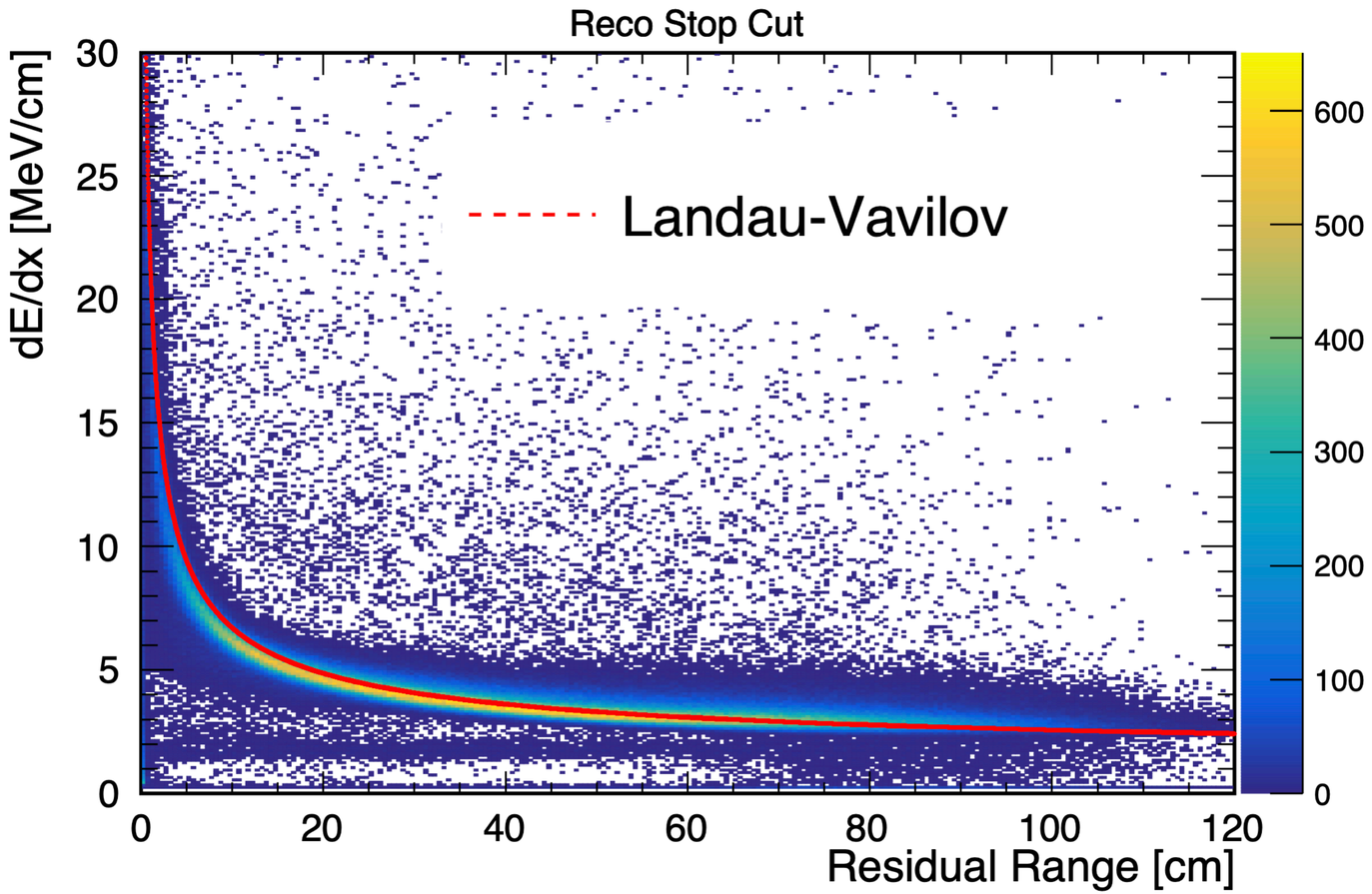
We only consider the particles that stop inside the detector. The deposited energy inside the detector is reconstructed with two different methods. Both of them should provide energy values close to the energy *simulated* at the detector entrance.

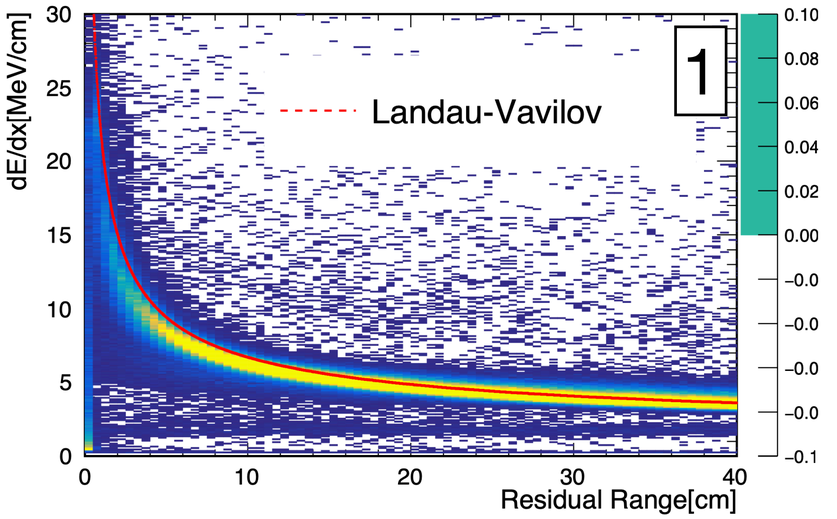


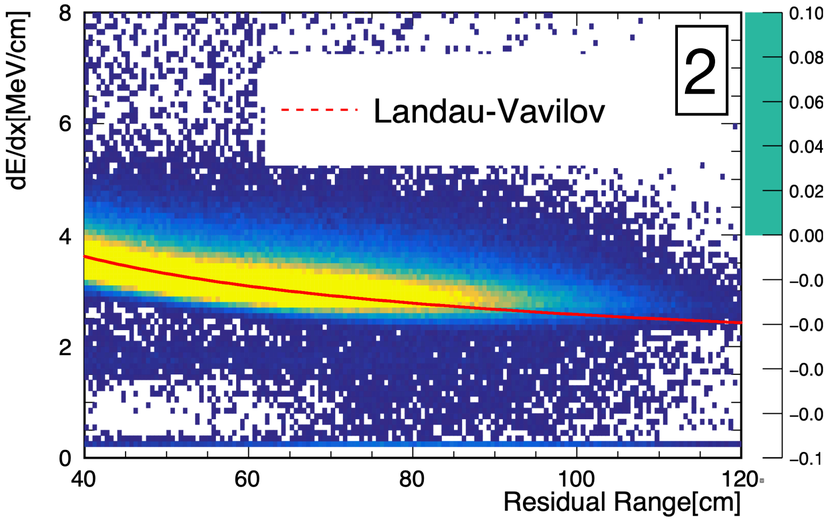
Residual range based reconstructed energy and calorimetric reconstructed energy differ by ~30 MeV

Energy reconstruction is relevant to the cross section study

Current status: we need to understand this loss in calorimetric reconstruction energy





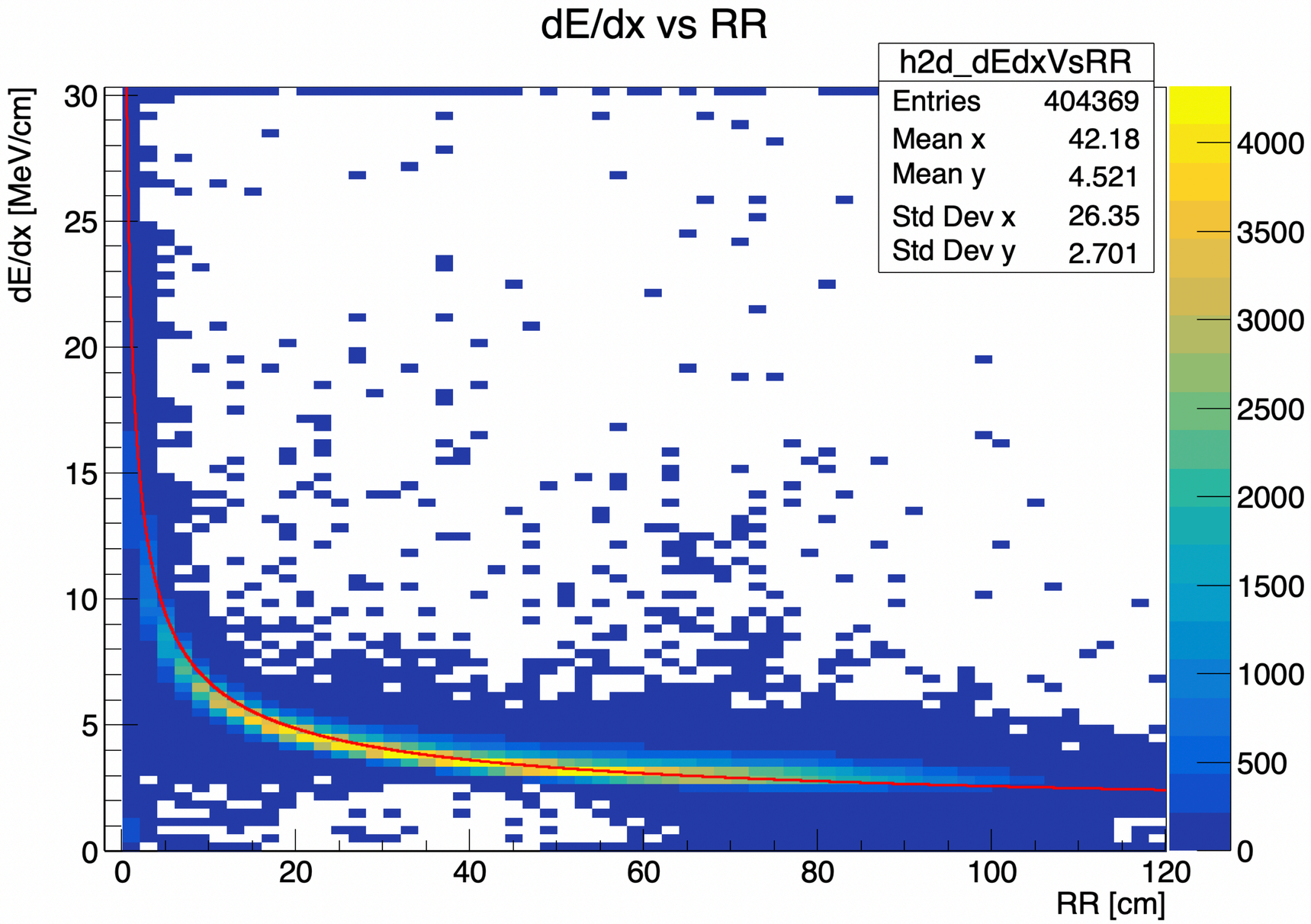


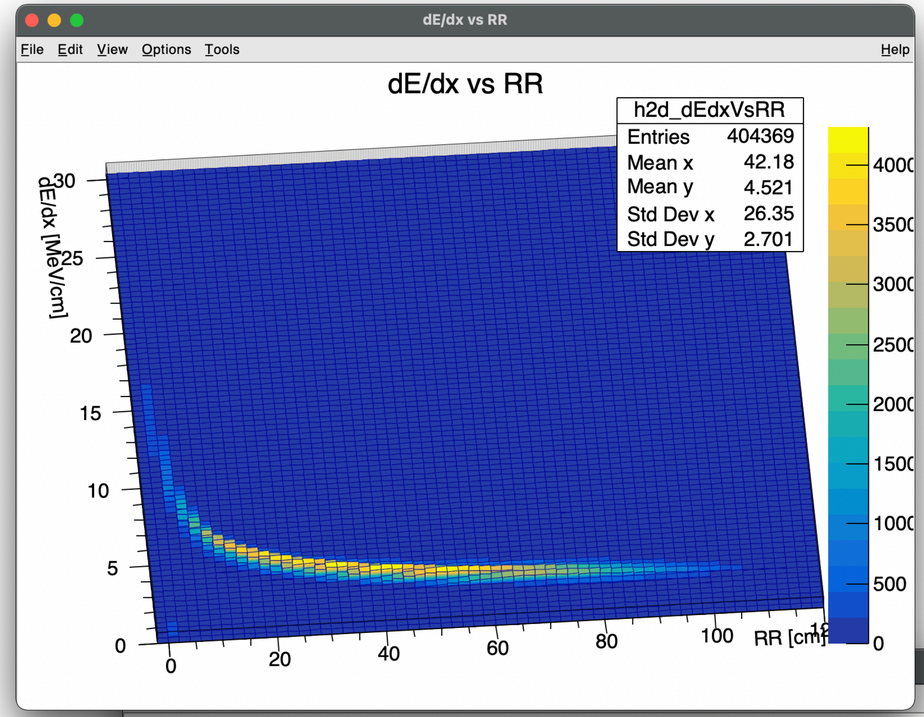
Two possible explanations, to be investigated:

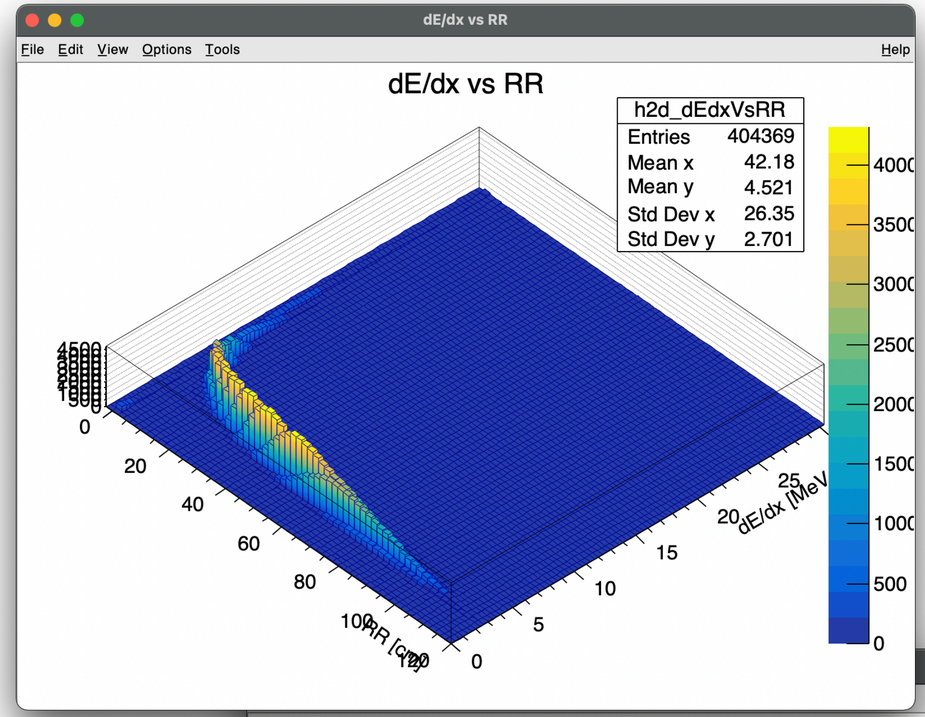
1.dE/dx might be over estimated at low RR

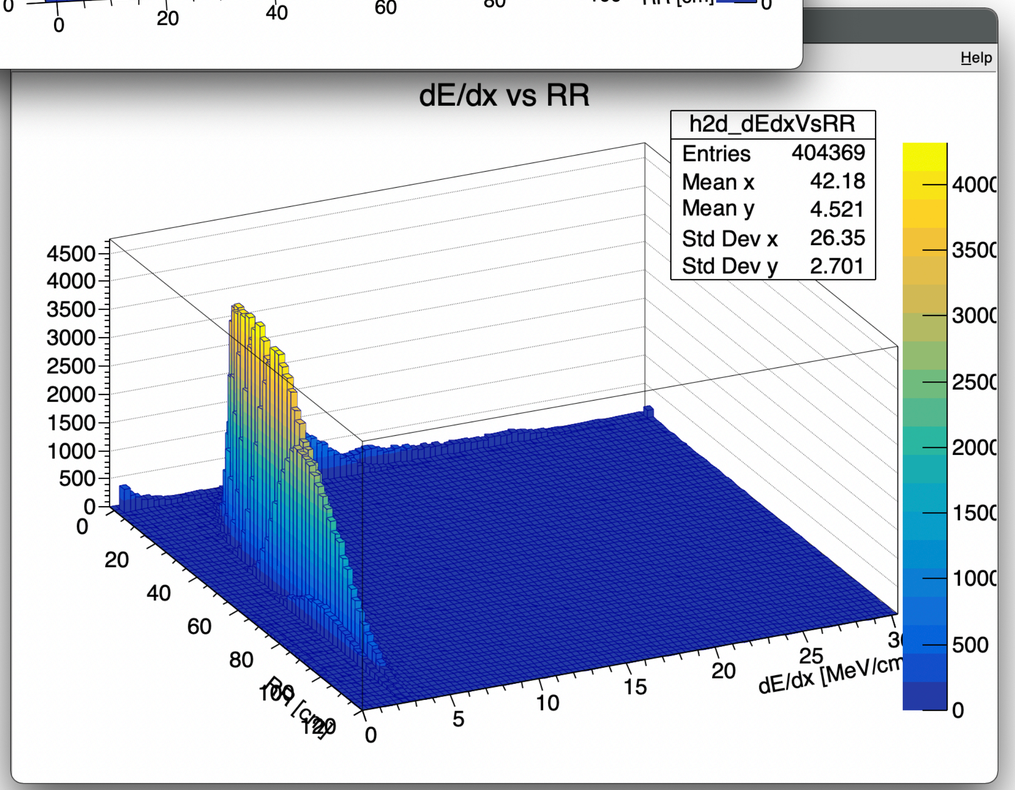
2.ProtoDUNE calibration may underestimate dE/dx in the high RR region

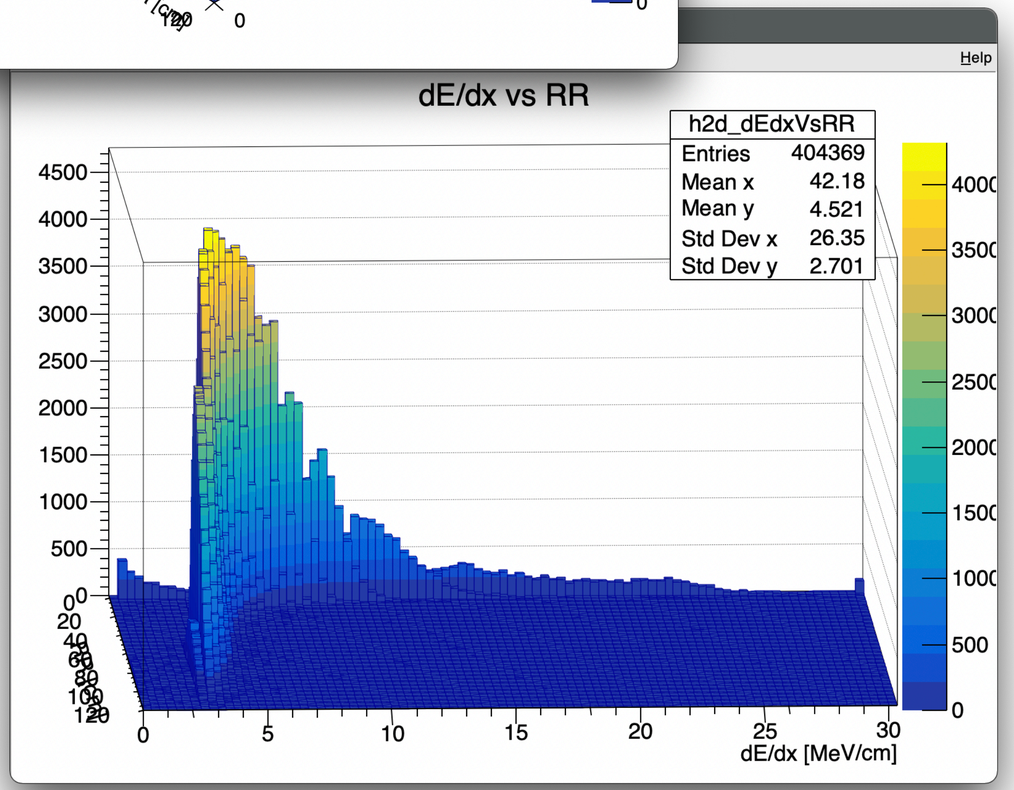
Data Prod. 3

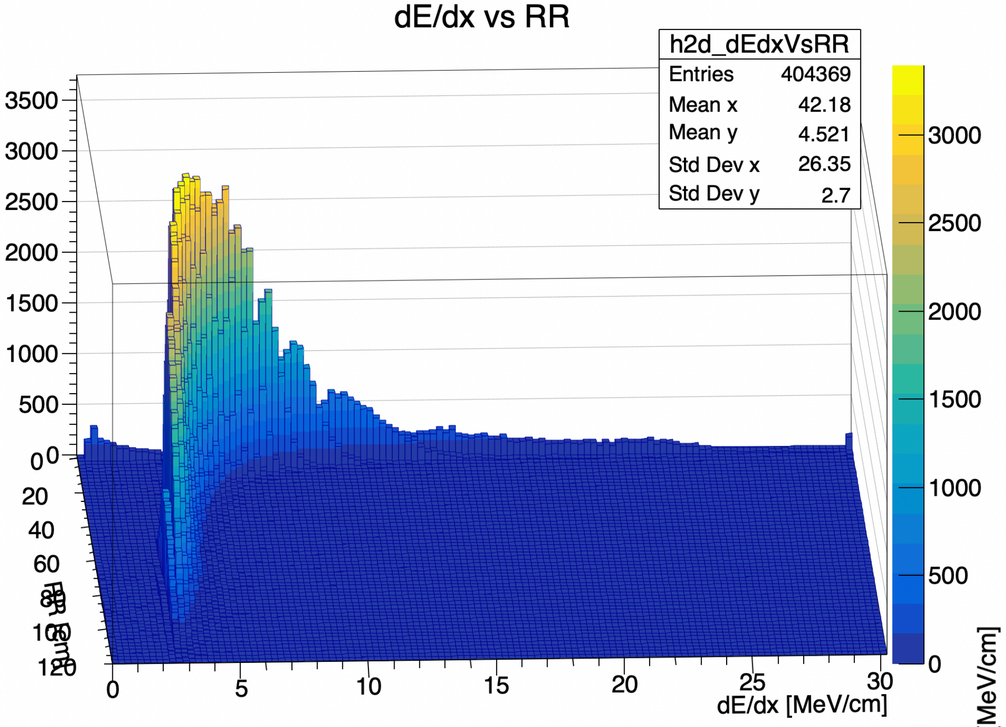

dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.701
dE/dx [MeV/cm]
RR [cm]
0
5
10
15
20
25
30
0
20
40
60
80
100
120
0
500
1000
1500
2000
2500
3000
3500
4000


dE/dx vs RR
File Edit View Options Tools Help
dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.701
dE/dx [MeV/cm]
RR [cm]


dE/dx vs RR
File Edit View Options Tools Help
dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.701
RR [cm]
dE/dx [MeV


Help
dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.701
RR [cm]
dE/dx [MeV/cm]


Help
dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.701
dE/dx [MeV/cm]


dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
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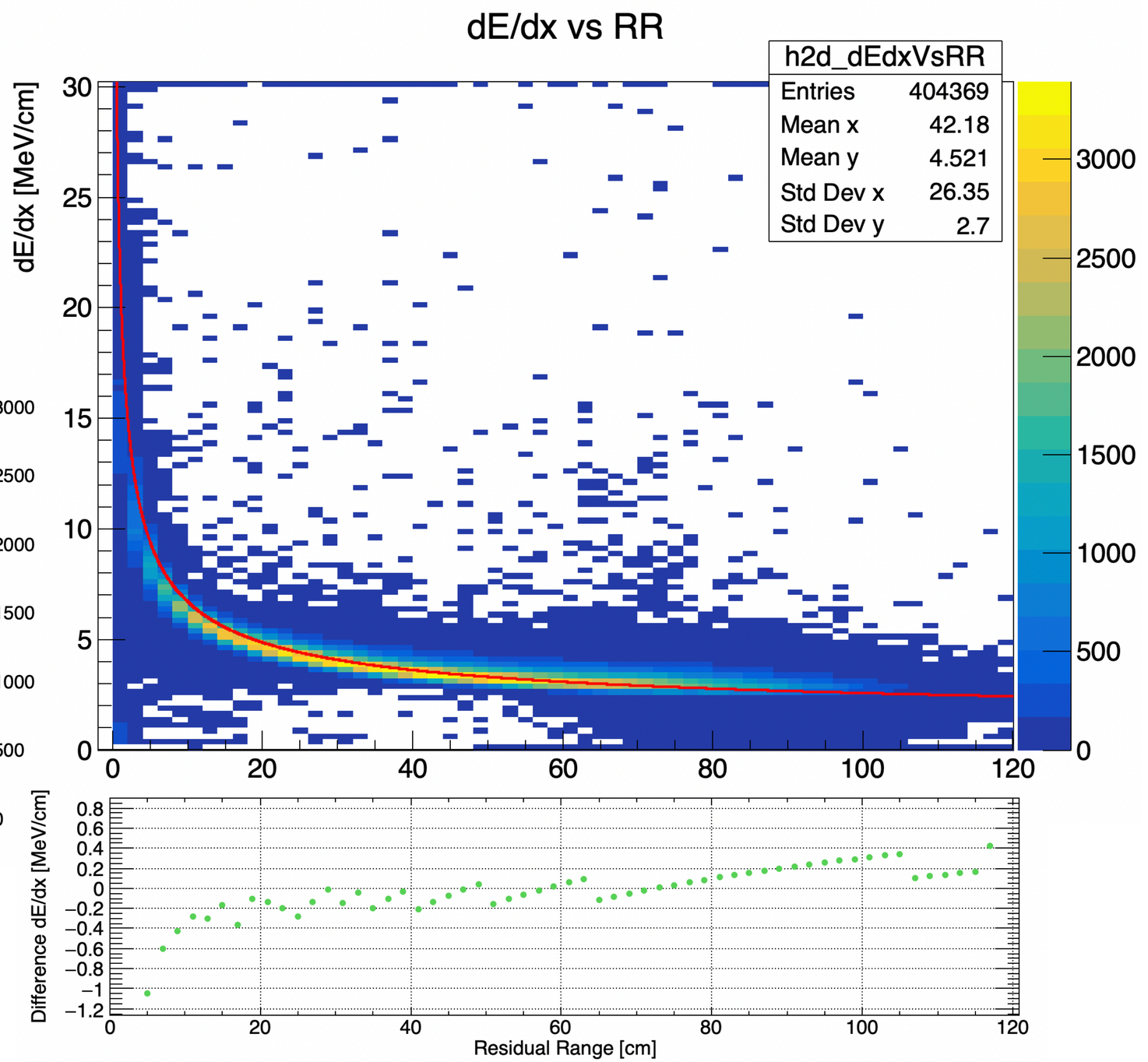
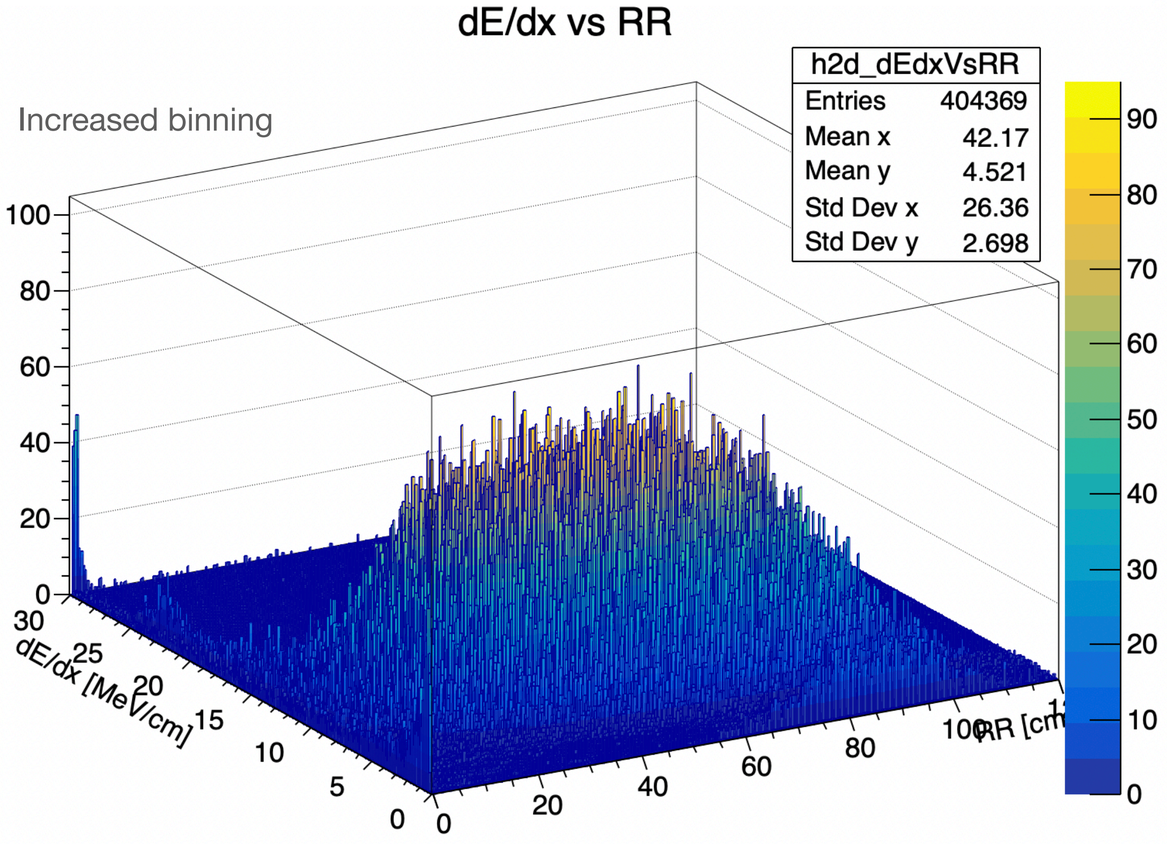
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.7
dE/dx [MeV/cm]
Residual Range [cm]


dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.18
Mean y 4.521
Std Dev x 26.35
Std Dev y 2.7
dE/dx [MeV/cm]
Difference dE/dx [MeV/cm]
Residual Range [cm]


dE/dx vs RR
Increased binning
h2d_dEdxVsRR
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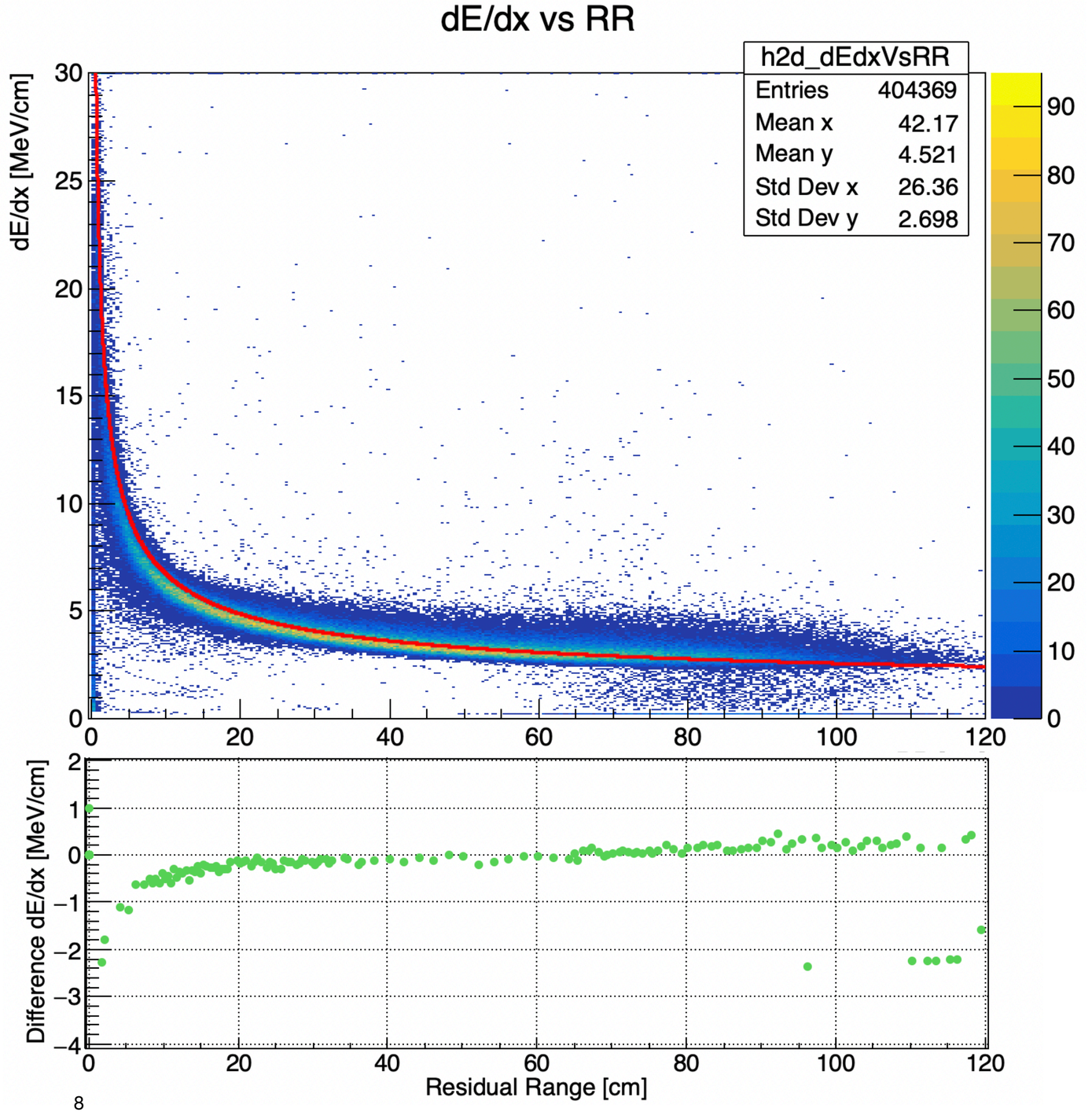
Mean y 4.521
Std Dev x 26.36
Std Dev y 2.698
dE/dx [MeV/cm]
RR [cm]


dE/dx vs RR
h2d_dEdxVsRR
Entries 404369
Mean x 42.17
Mean y 4.521
Std Dev x 26.36
Std Dev y 2.698
dE/dx [MeV/cm]
Difference dE/dx [MeV/cm]
Residual Range [cm]

Take-away points

- Range based reconstruction well reproduces the total deposited energy inside the detector while calorimetric based reconstructed energy show a significant loss.
- A preliminary study shows that the behaviour of the reconstructed dE/dx with respect to Residual Range differs from the theory at low Residual Ranges. Some differences are also shown at high ranges.
- Such a difference, if confirmed, can account for a large fraction of the above mentioned discrepancy.
- More studies are ongoing.