Michel Analysis: comparison of MCC11 and Prod 2

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DRA group meeting

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Argonne NATIONAL LABORATORY

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

Updates

- Some updates were made to increase the purity of the sample
  - Broken tracks removal update:
    - Calculated the opening angle, $\Omega = \cos\theta_1 \cos\theta_2 + \sin\theta_1 \sin\theta_2 \cos(\phi_2 - \phi_1)$
    - Calculated the 2D distance (in Y and Z) "d" between the two tracks
    - Counted the tracks as broken and removed from further selection if (abs(d)<30 and abs(Ω) > 0.97) or (abs(d)<50 and abs(Ω) > 0.998)
  - Closest shower distance from the track 15→30 cm
  - Changed the minimum hit peak time cut 200 → 500 ticks
  - Included the maximum hit peak time cut (maxhitpt<5500 ticks)
- Changed hit module from "linecluster" to "hitpdune" in new production "prod2"

Samples

- MCC11:
  - MC: jhugon_mcc11_pd_sp_reco_sce_1.0GeV (1000 events)
  - Data: Run 5809: (2000 events)
- Production 2:
  - MC: MC_PDSPProd2_reco_sce_1GeV (1000 events)
  - Data: Run 5809: (2000 events)

Efficiency and purity comparisons for MC

Cuts	Efficiency MCC11; wrt previous step (wrt T_0 tagged trks)%	Purity MCC11 %	Efficiency prod 2; wrt previous step (wrt T_0 tagged trks)%	Purity prod 2 %
T_0 tagged tracks	6.5		12	
Tracks starting form edges of detector	73 (73)		61 (61)	
Tracks ending in FV	39 (29)		18 (11)	
Removing APA bounds	90 (26)	29	90 (9.8)	21
Unbroken tracks	94 (24)	30	92 (9.1)	22
Tracks length > 75 cm	98 (24)	30	99 (9.0)	22
Min hit peak time > 500	37 (8.7)	67	46 (4.1)	40
Max hit peak time < 5500	84 (7.3)	69	59 (2.5)	56
Nearby hits > 5	13 (1.1)	85	47 (1.2)	75
Closest reco shower distance < 30 cm	73 (0.8)	92	79 (0.9)	79

We have anode-piercing tracks as well

Different hit reco algorithm

Efficiency comparisons for Data

Cuts	Efficiency MCC11; wrt previous step (wrt T_0 tagged trks)%	Efficiency prod 2; wrt previous step (wrt T_0 tagged trks)%
T0 tagged tracks	1.8	1.8
Tracks starting form edges of detector	65 (65)	66 (66)
Tracks ending in FV	46 (30)	38 (25)
Removing APA bounds	73 (22)	75 (18)
Unbroken tracks	91 (20)	91 (17)
Tracks length > 75 cm	99 (20)	99 (17)
Min hit peak time > 500	41 (8.3)	39 (6.5)
Max hit peak time < 5500	83 (6.9)	81 (5.3)
Nearby hits > 5	17 (1.2)	51 (2.7)
Closest reco shower distance < 30 cm	60 (0.7)	74 (2.0)

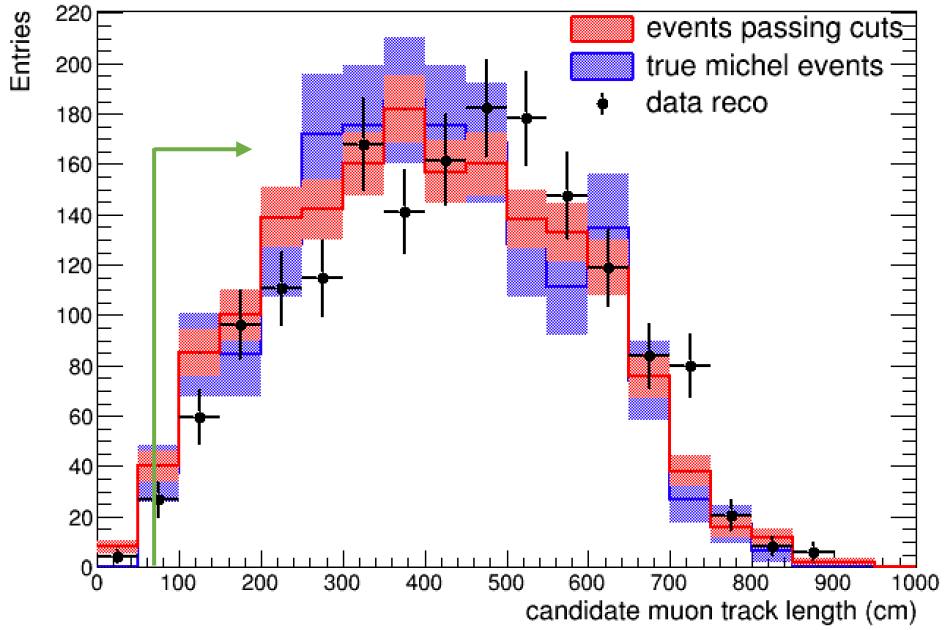
In data, the number of T_0 tagged tracks are same in MCC11 and Prod2

Different hit reco algorithm

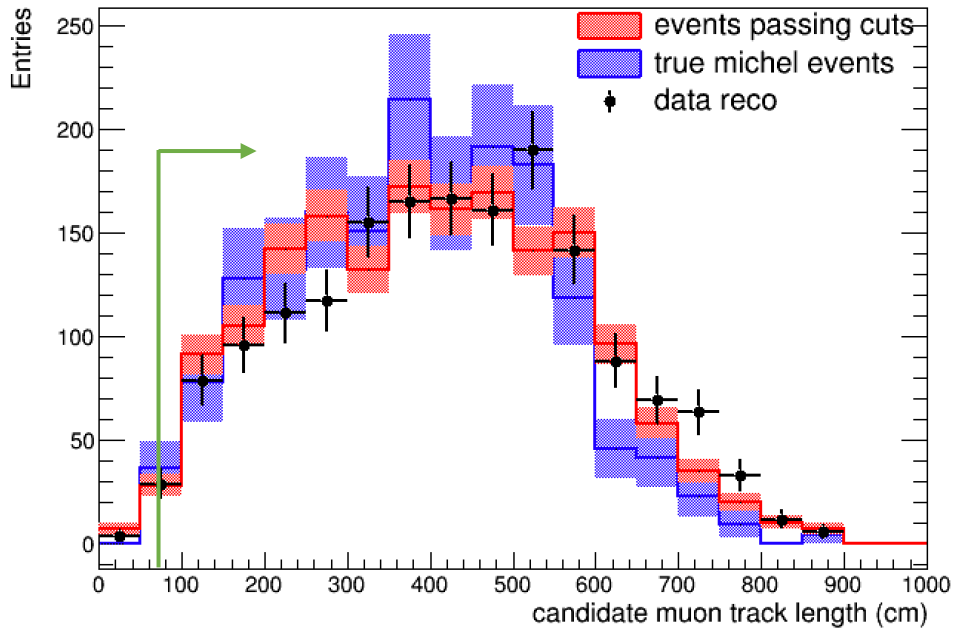
Comparison of MC distributions

Candidate muon track length

MCC11

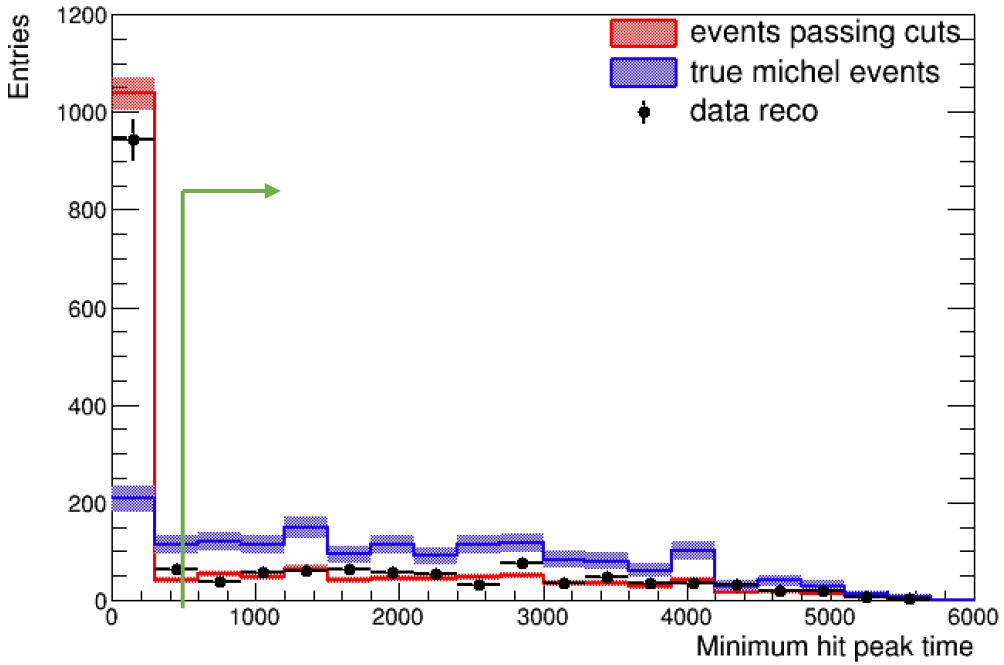


Prod 2

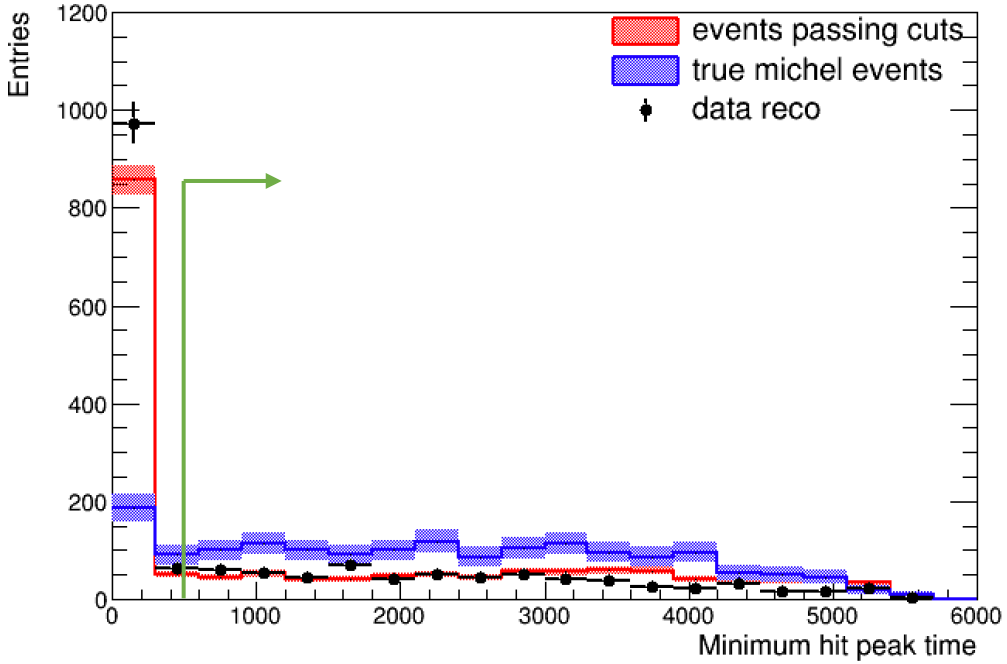


Candidate muon minimum hit peak time

MCC11

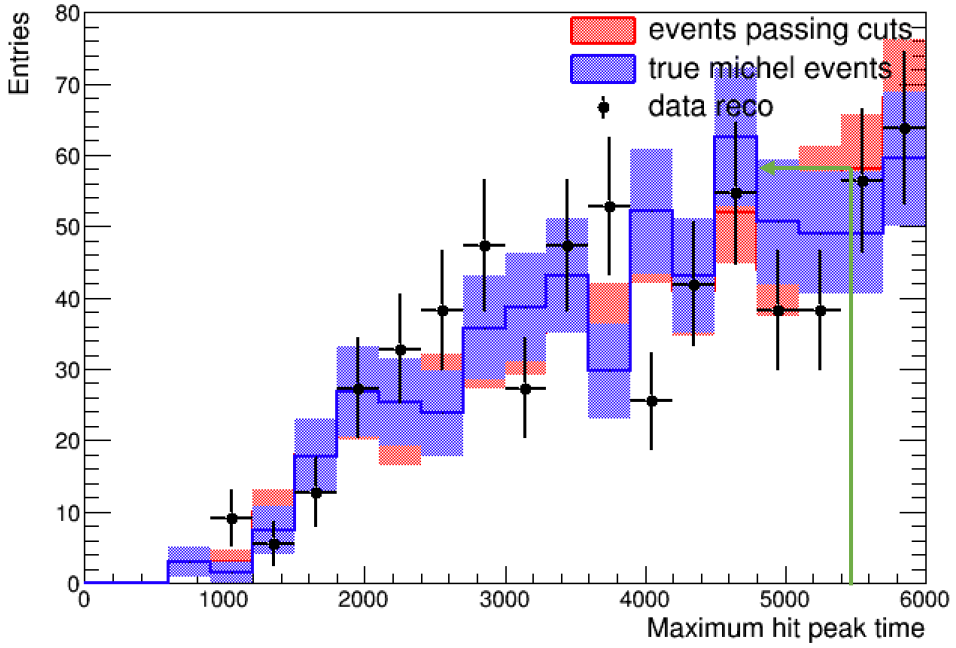


Prod 2

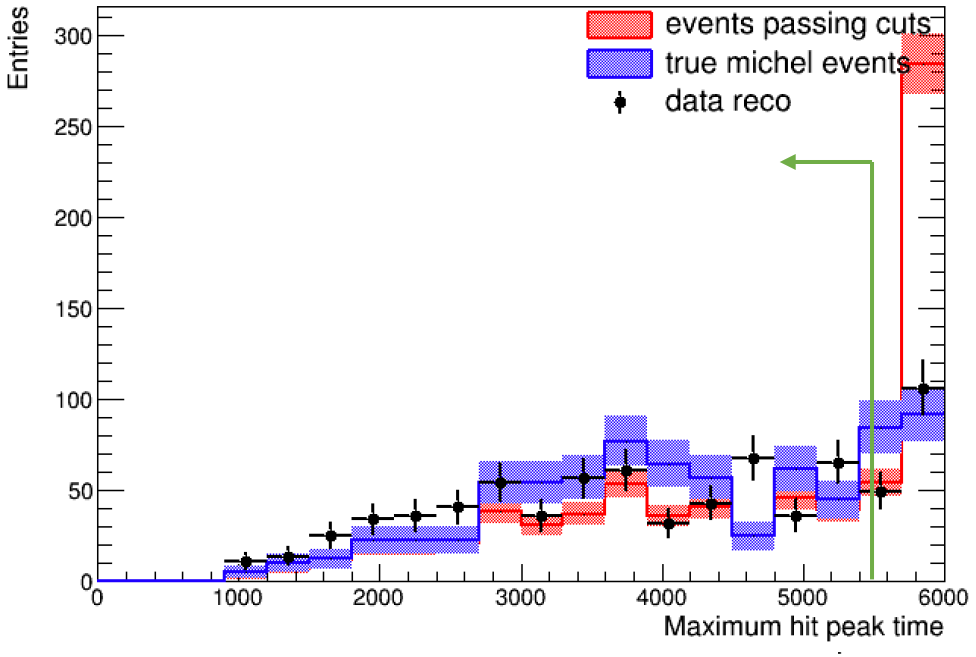


Candidate muon maximum hit peak time

MCC11

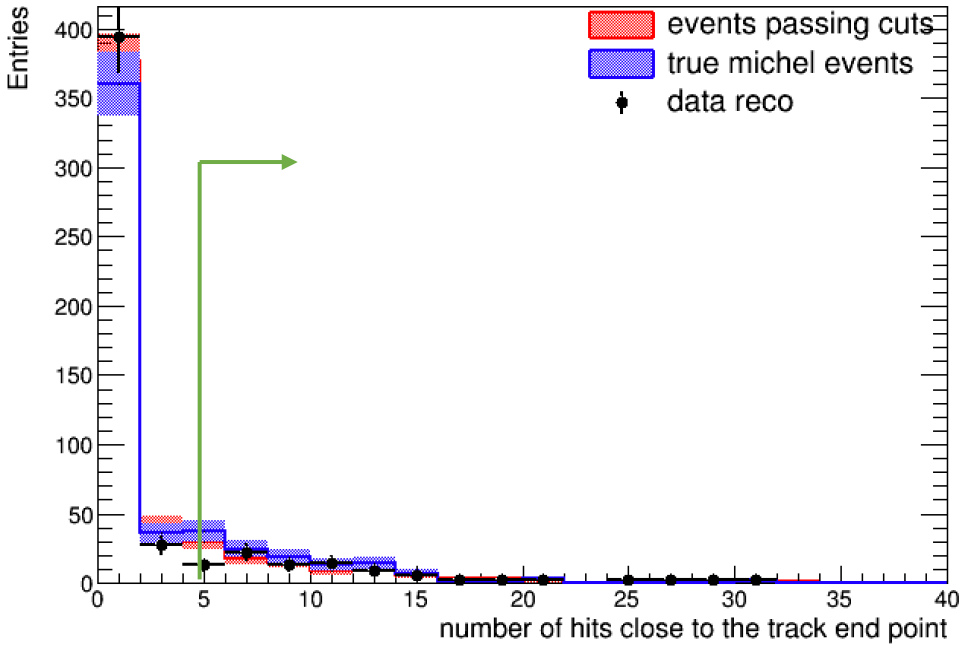


Prod 2

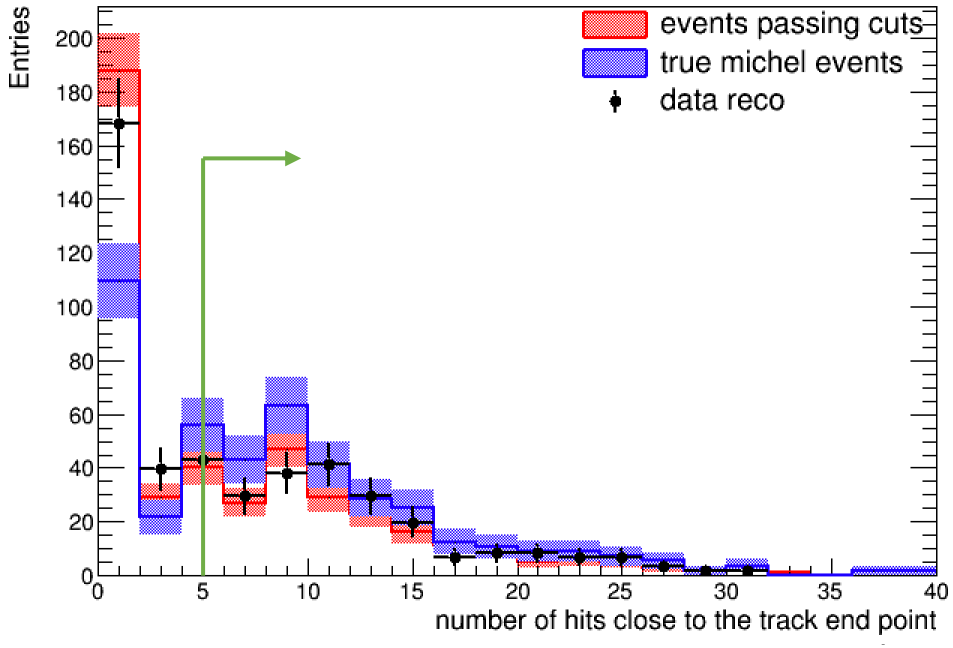


Hit count close to muon end point

MCC11

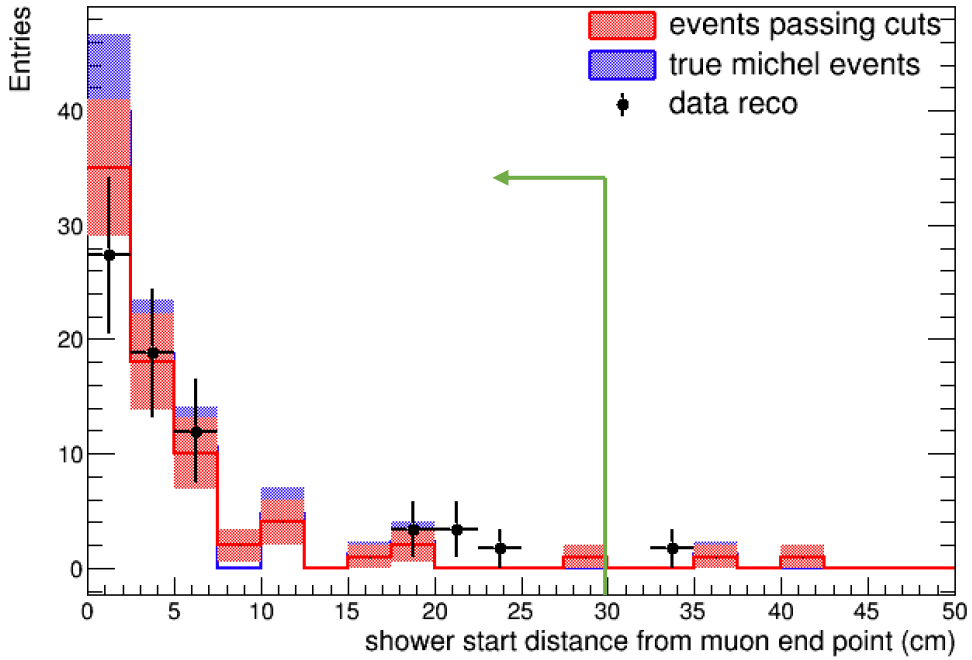


Prod 2

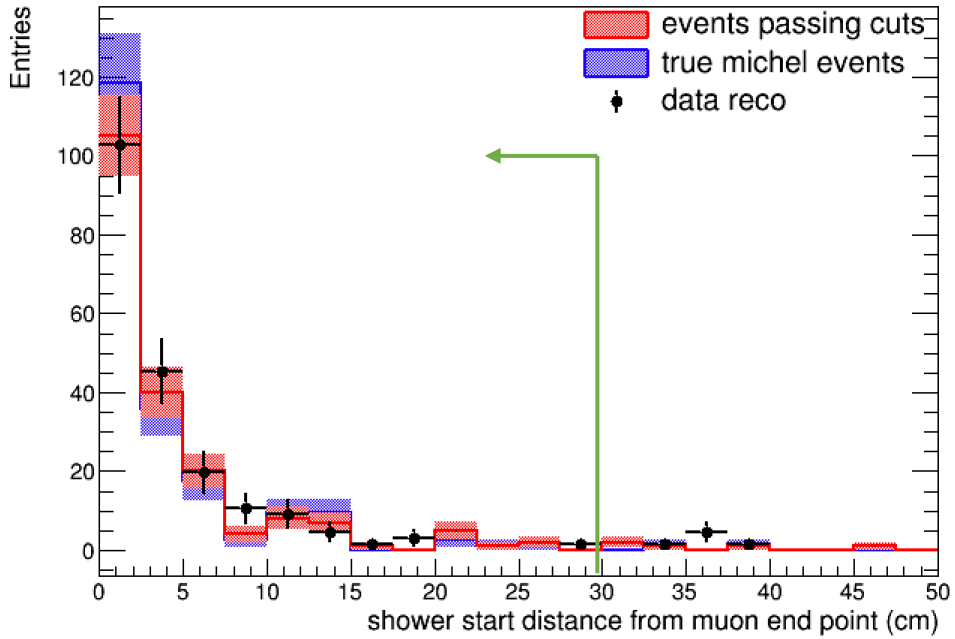


Closest reco shower distance

MCC11



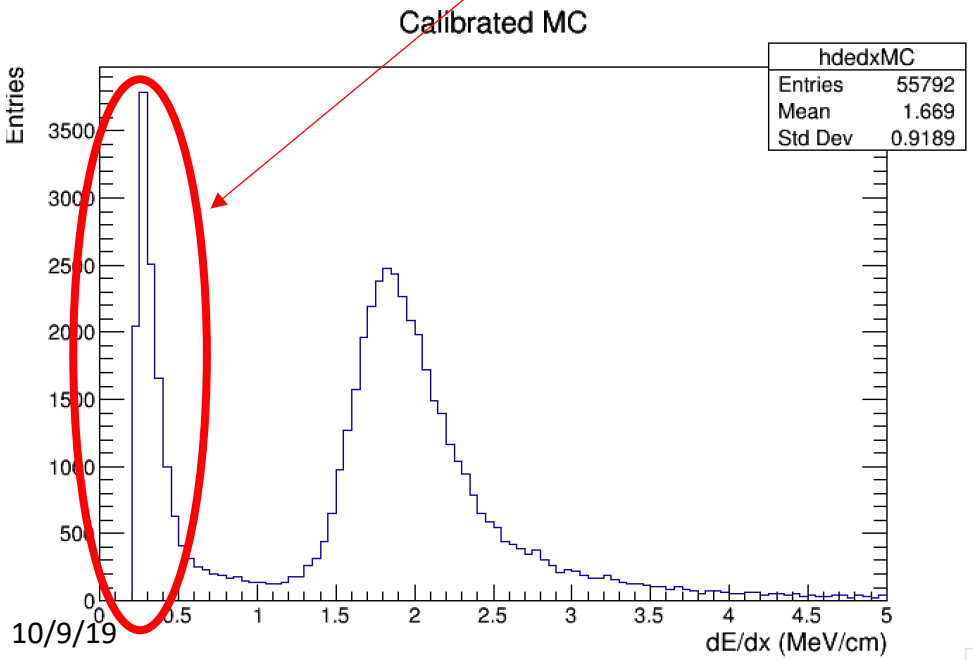
Prod 2

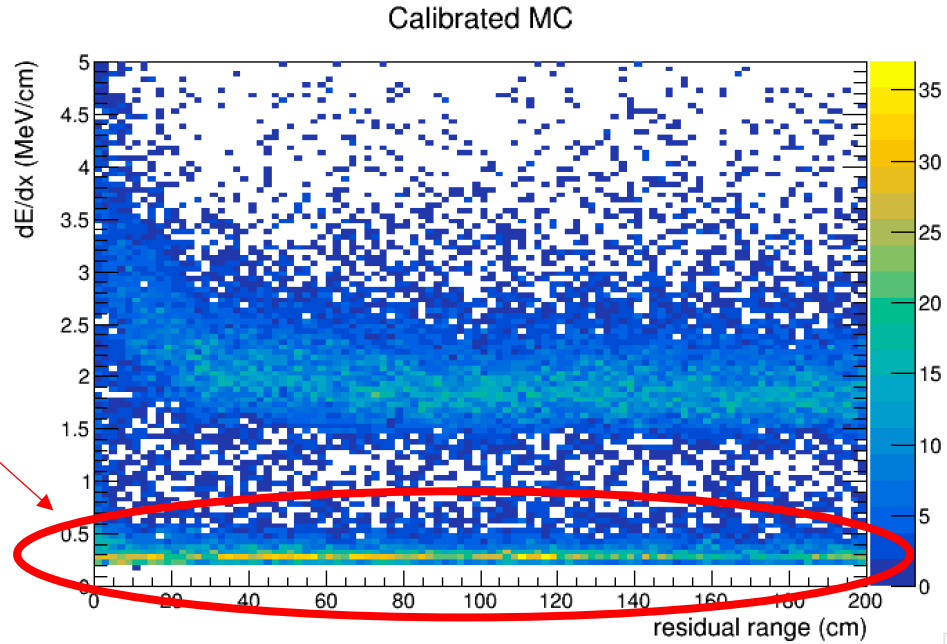


dEdx vs residual range for candidate muons

dEdx vs residual range of candidate muons using updated calibration in Prod2

- Trying to investigate < 0.5 MeV entries in here
- Trying to see if they are miss reco tracks





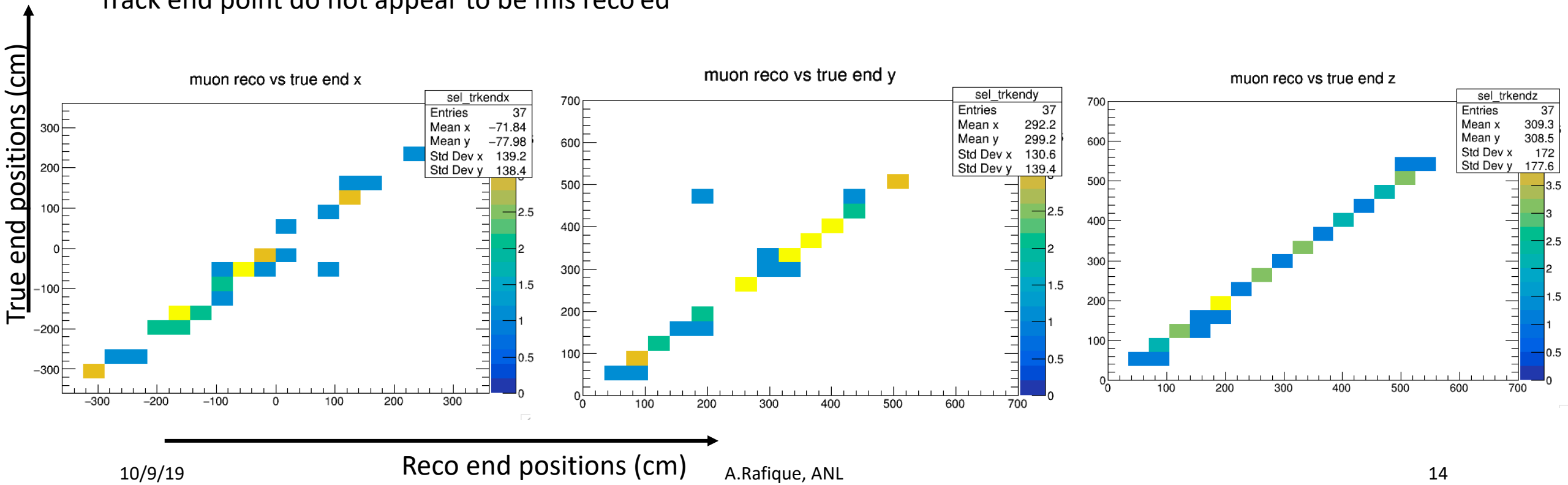
https://indico.fnal.gov/event/21203/contribution/1/material/slides/0.pdf

Ajib's calibration document: https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=15974&filename=prod2_calibration_constants_for_selected_runs.pdf&version=1

“Unusual” muon candidate track end positions

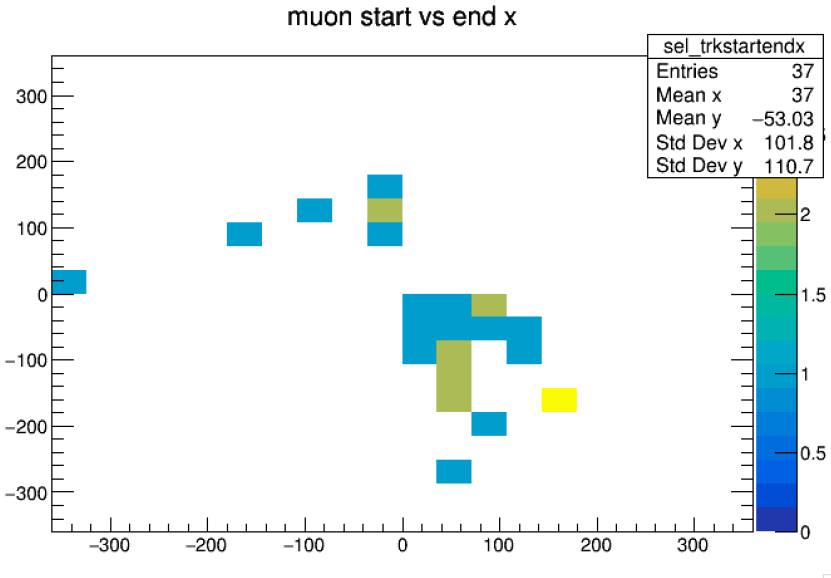
To investigate them, if a track has more than half collection plane hits having < 0.5 MeV/cm dEdx, I plot the start/end positions for that track

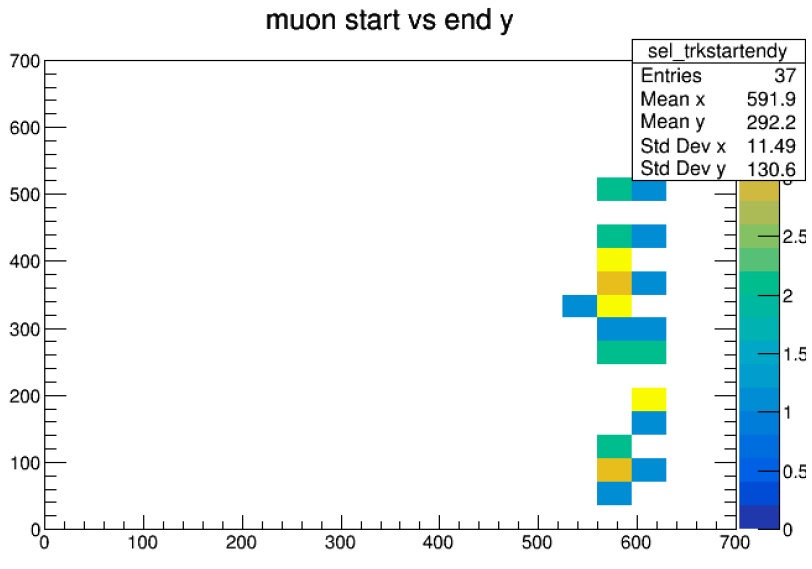
Track end point do not appear to be mis reco’ed

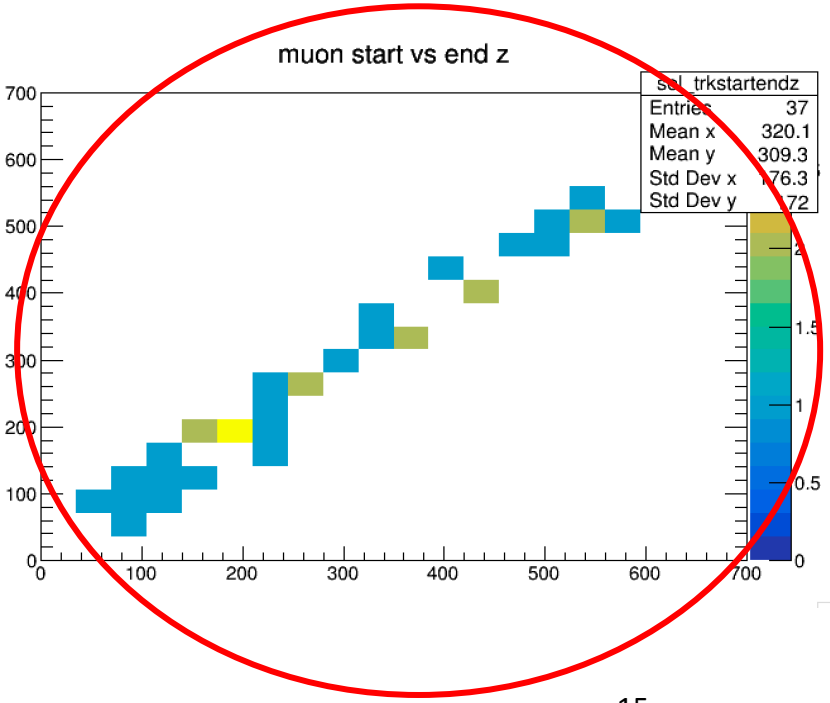


Start vs stop positions of unusual tracks

Could be vertical tracks that can produce ambiguity in the charge deposition on the same wire

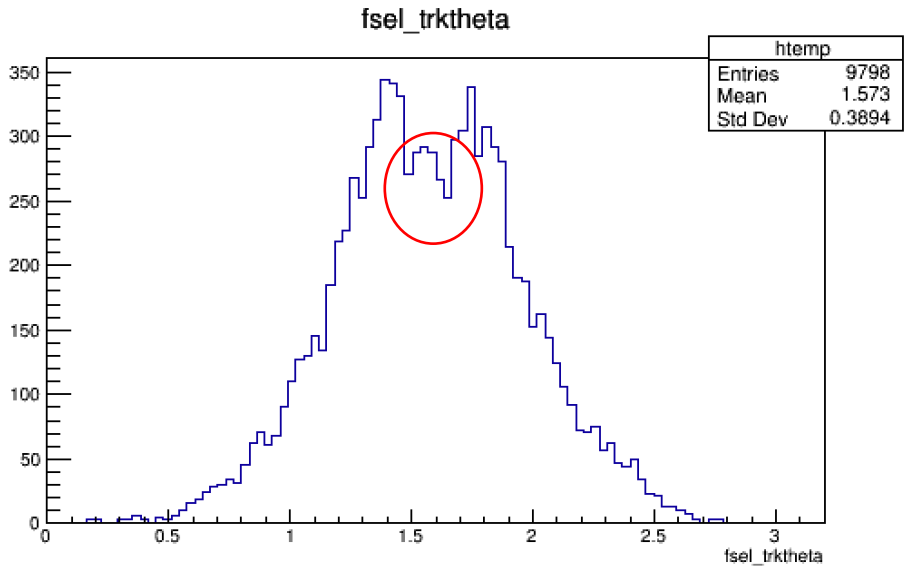




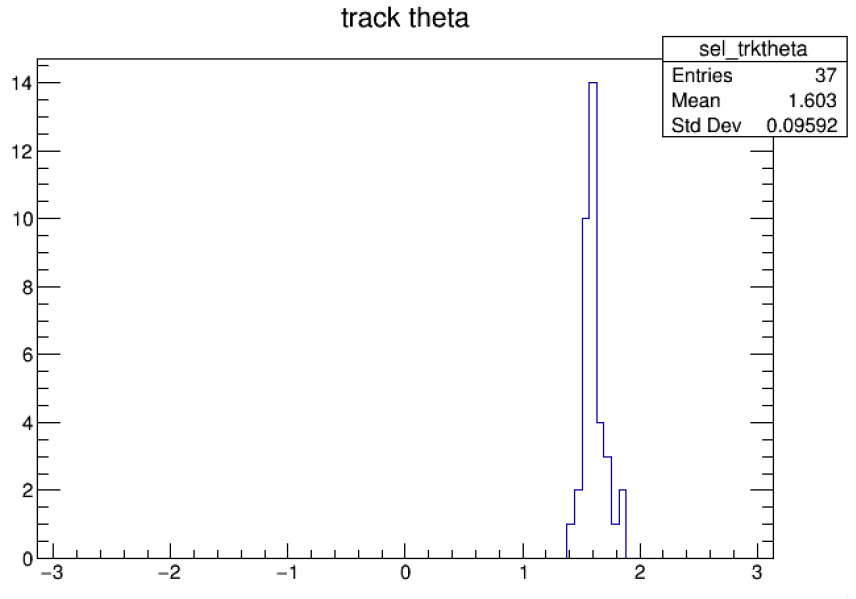


Track theta distribution comparison

All selected tracks theta distribution from MCC11



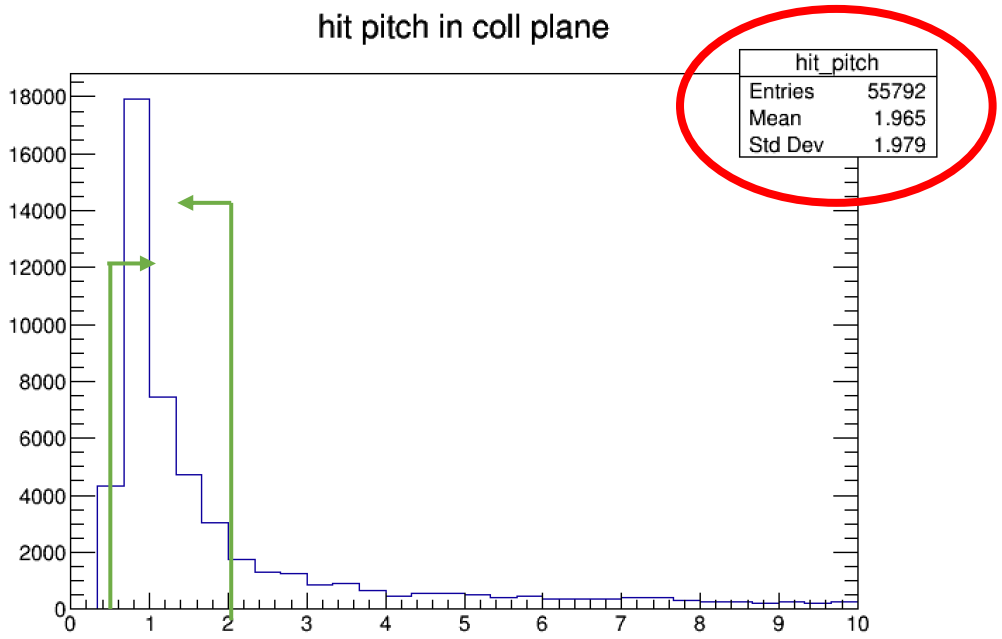
Unusual tracks theta distribution in prod2



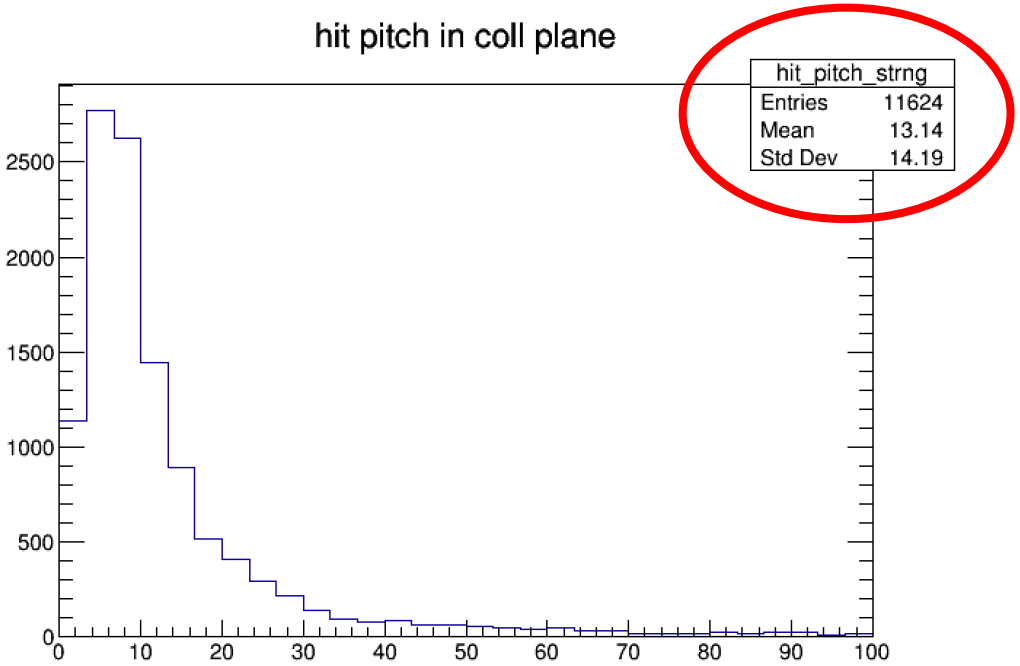
Mostly vertical tracks

Hit pitch distribution comparison

All selected hit pitch distribution in prod2

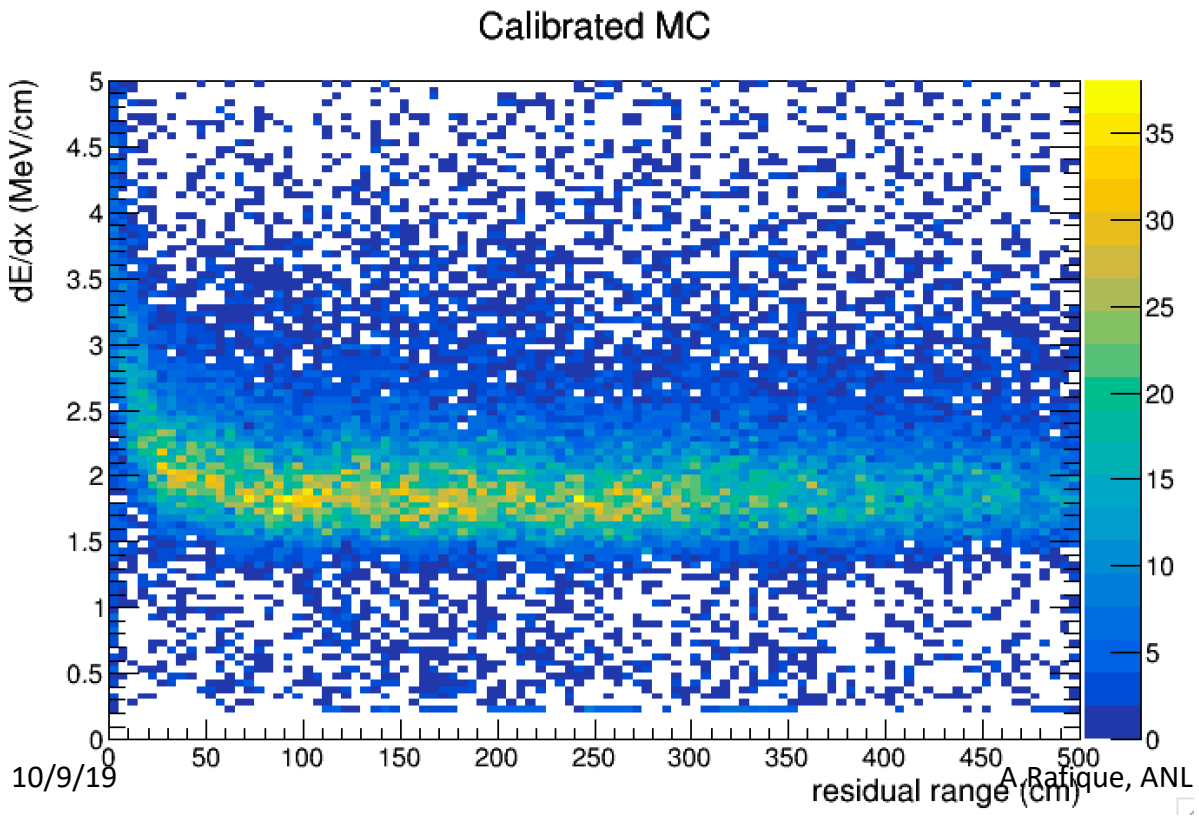


Unusual tracks hit pitch distribution in prod2

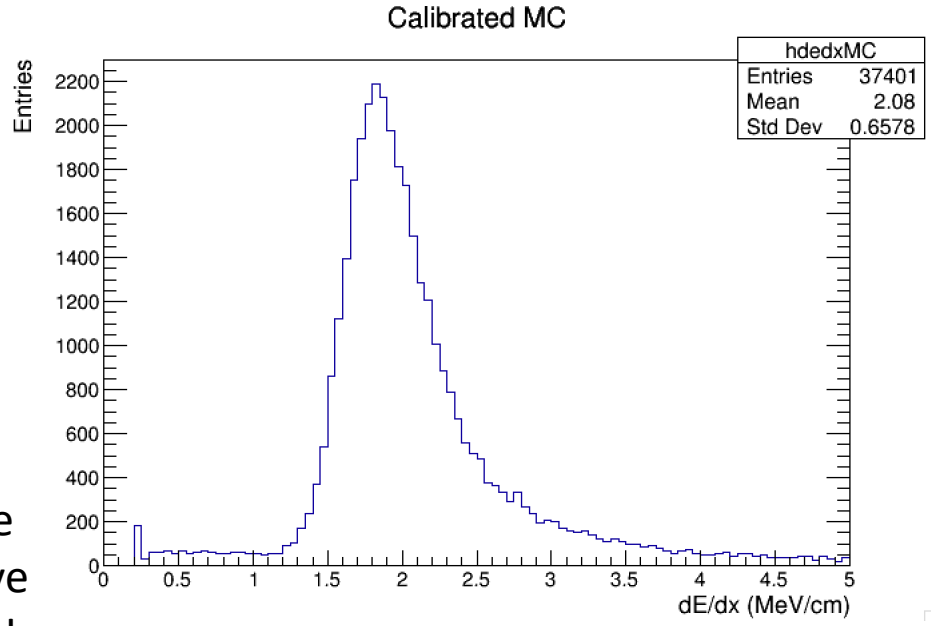


dEdx vs residual distribution for candidate muons in prod 2 MC

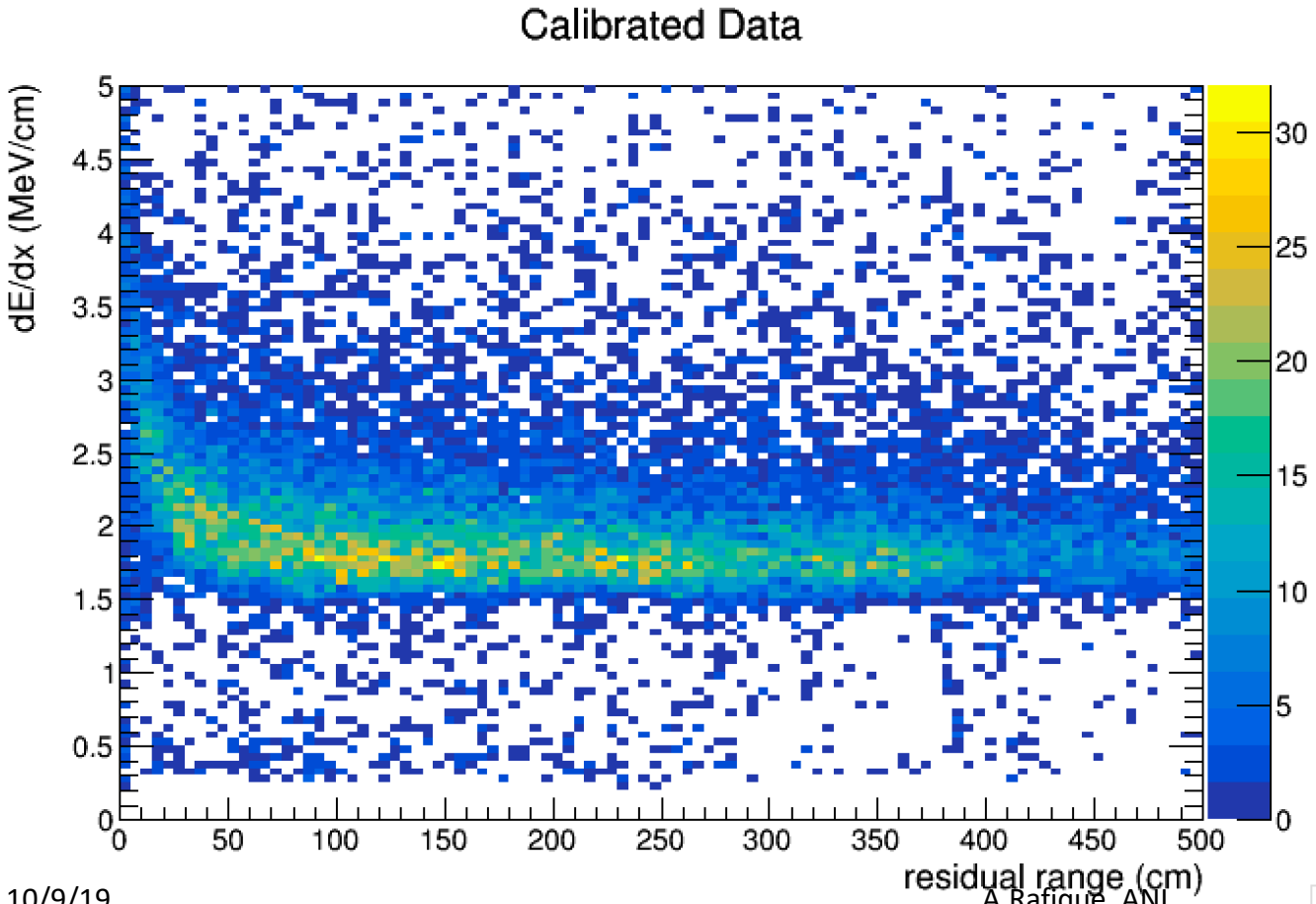
In addition, we could also add an additional cut:
Select only those tracks that have at least half collection plane hits on distinct wires

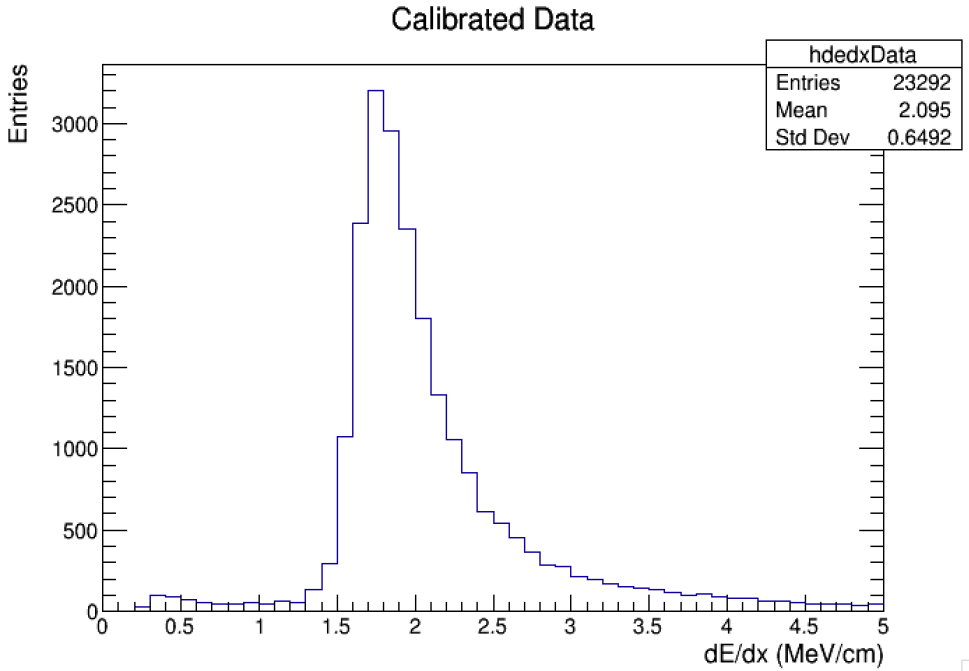


For now we only remove the unusual hits



dEdx vs residual distribution for candidate muons in Prod 2 Data





Next steps

- Optimize the selection based on Prod 2 reco
- Plan to run over high statistics data and MC samples
- Will work on michel energy reconstruction