The importance of characterizing charged pions in neutrino interactions

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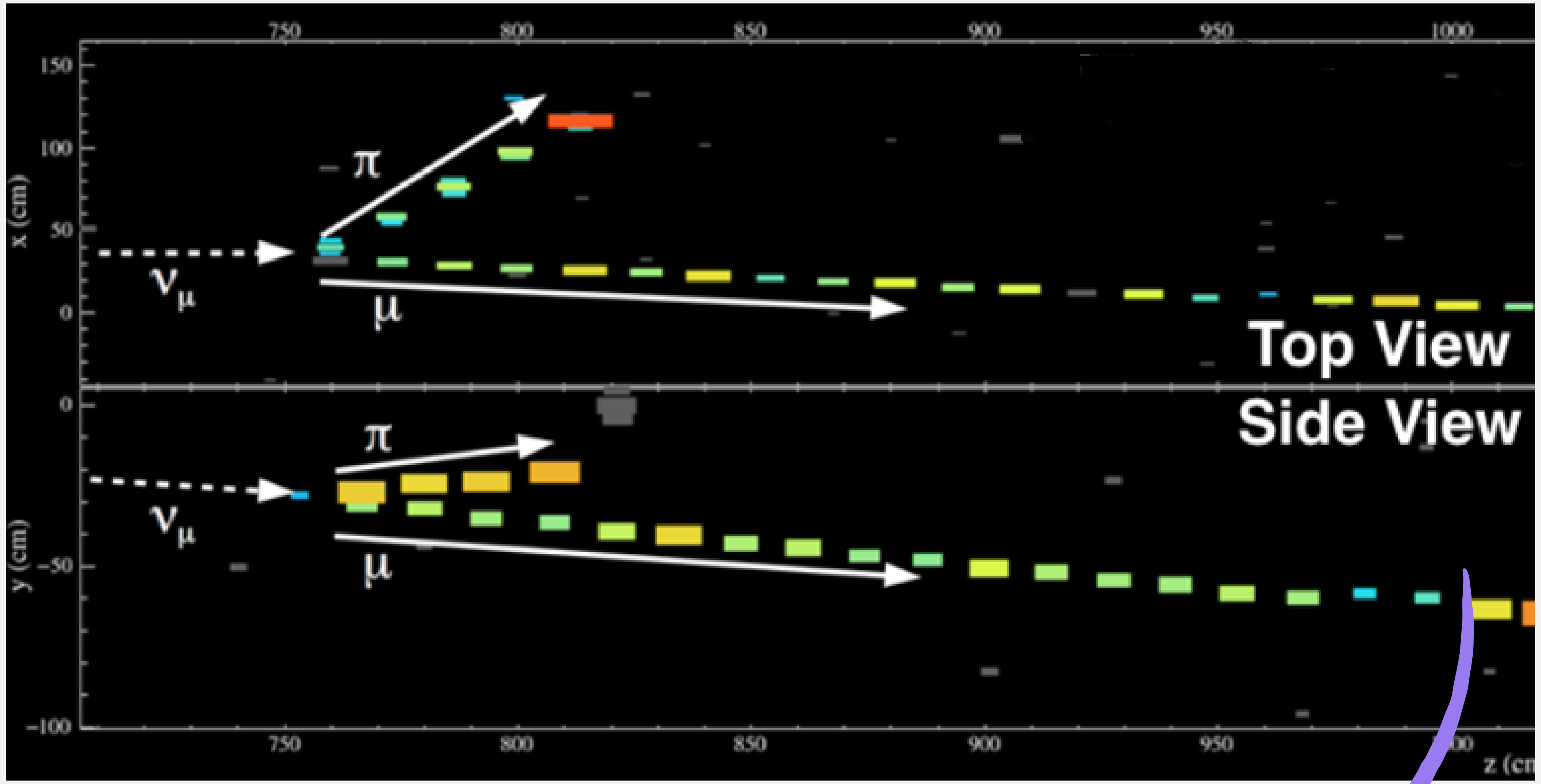
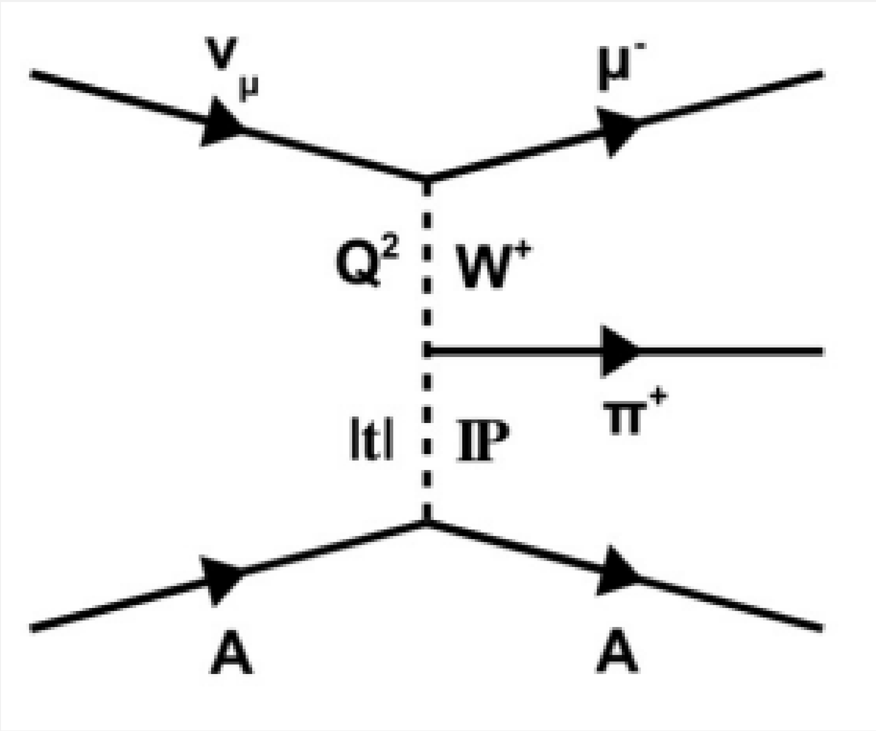
Charged Current (CC) Pion Process, Why is this relevant?



[1]: NOvA Event Display

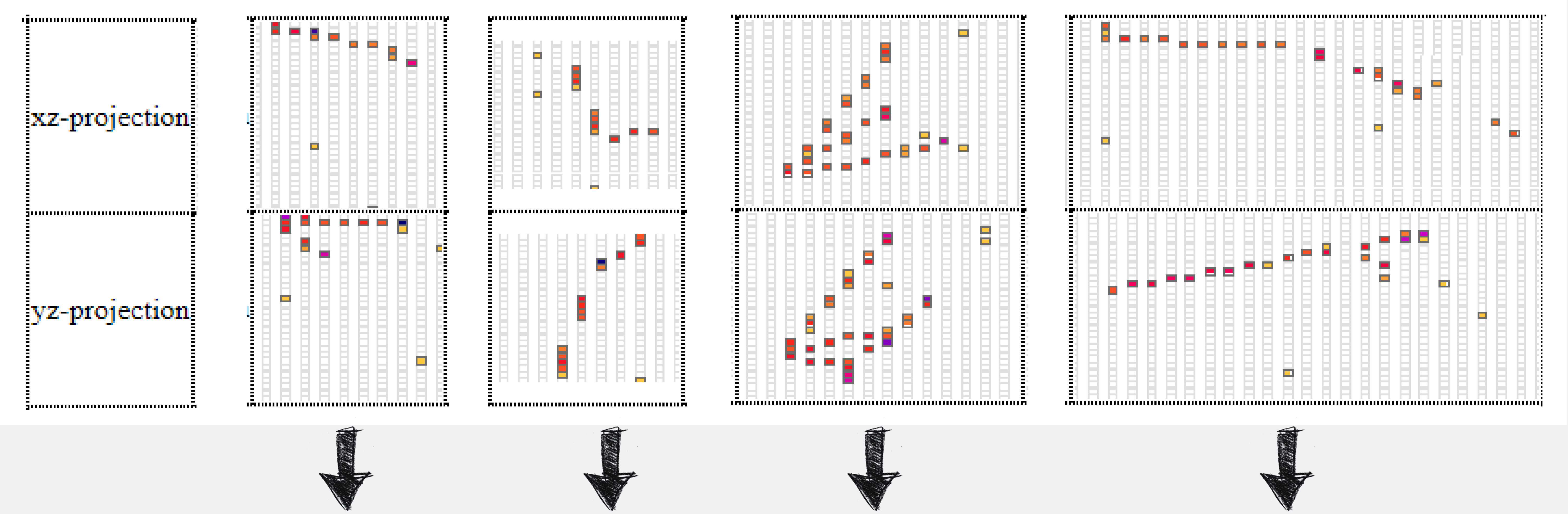
$$\nu_l + A \to l^- + \pi^+ + A$$

$$\bar{\nu_l} + A \to l^+ + \pi^- + A$$



Zoom In

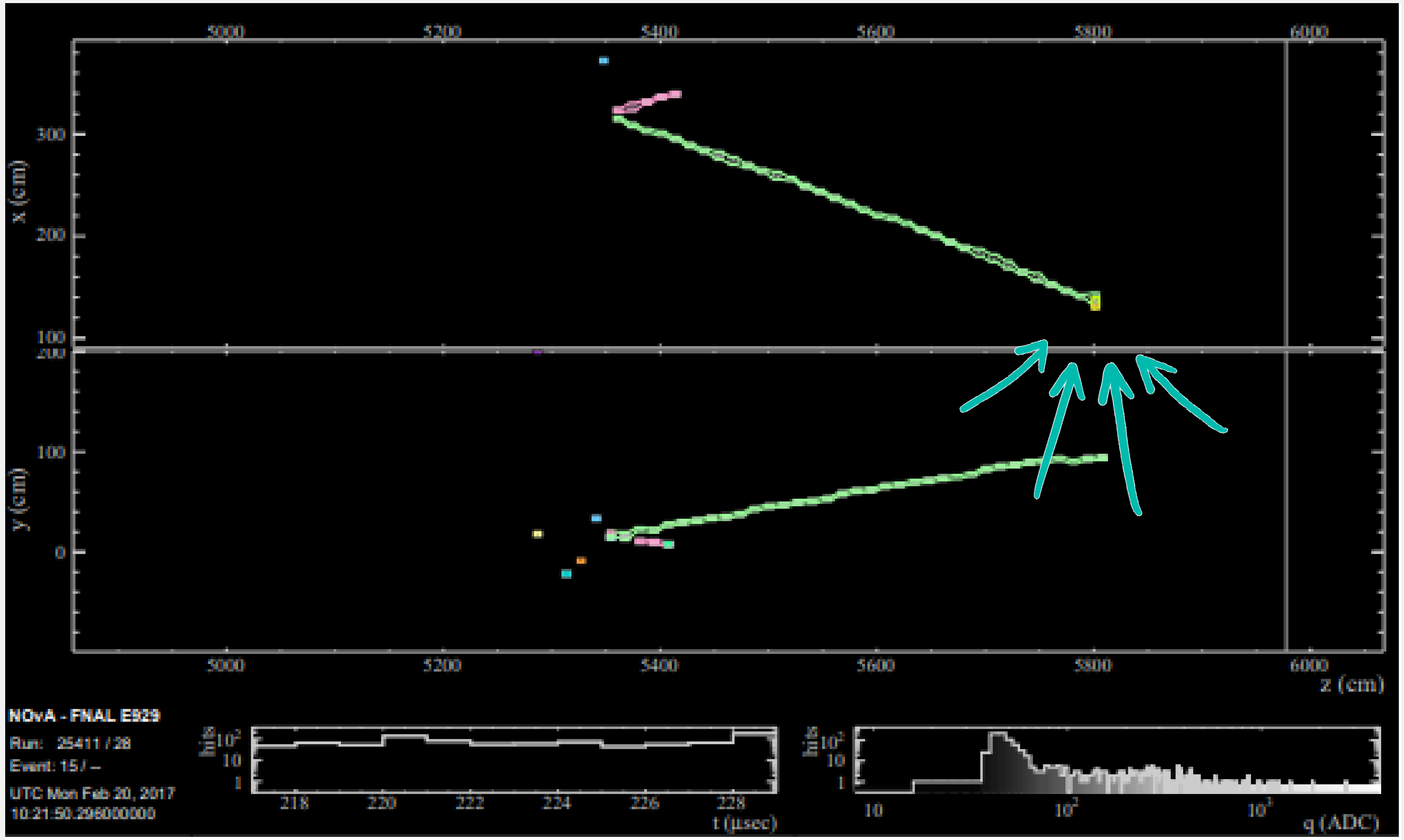
How to identify CC pion events?



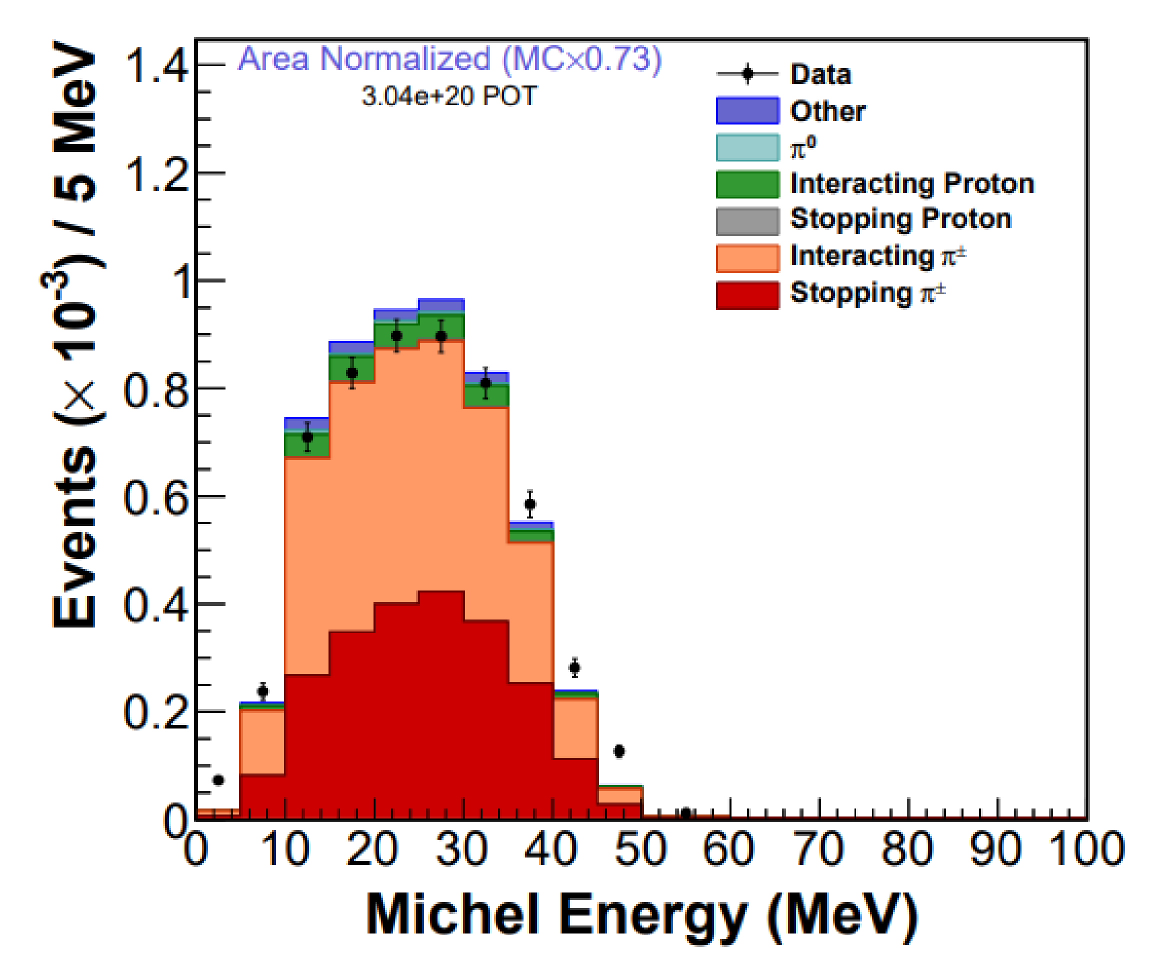
Two Pions Messy Track Three Pions Muon and electron track

How to identify CC pion events?

Zoom In



[3]: NOvA Event Display



[4]: MINERvA Collaboration

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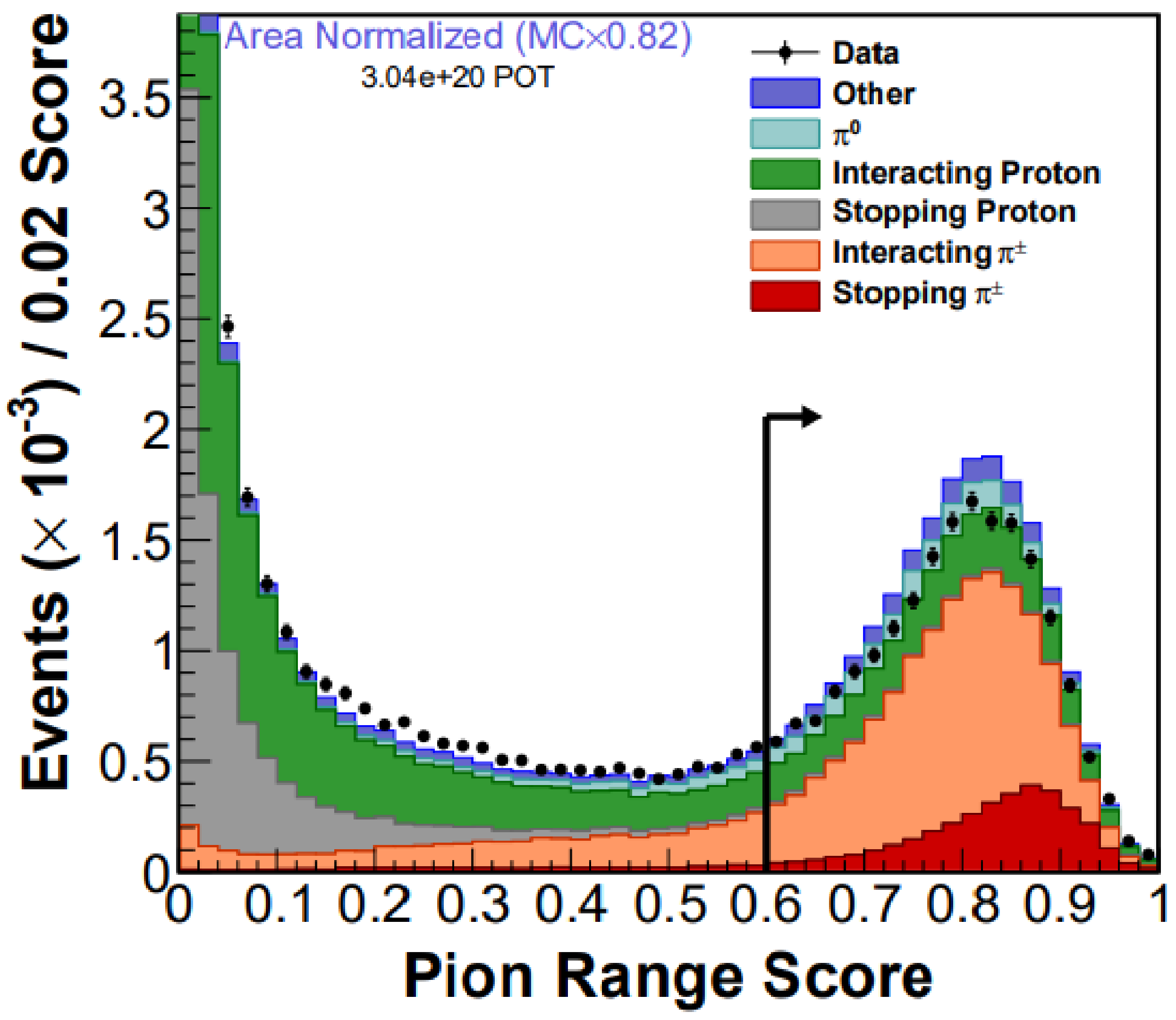
Current status



[4]: MINERvA Collaboration

Tests by MINERvA and MINOS report an average efficiency between models and experimental data arround 42% and 60%

Problems

- Discrepancies between models and data.
- Understanding the scattering.
- Need for more accurate models.

Conclusions

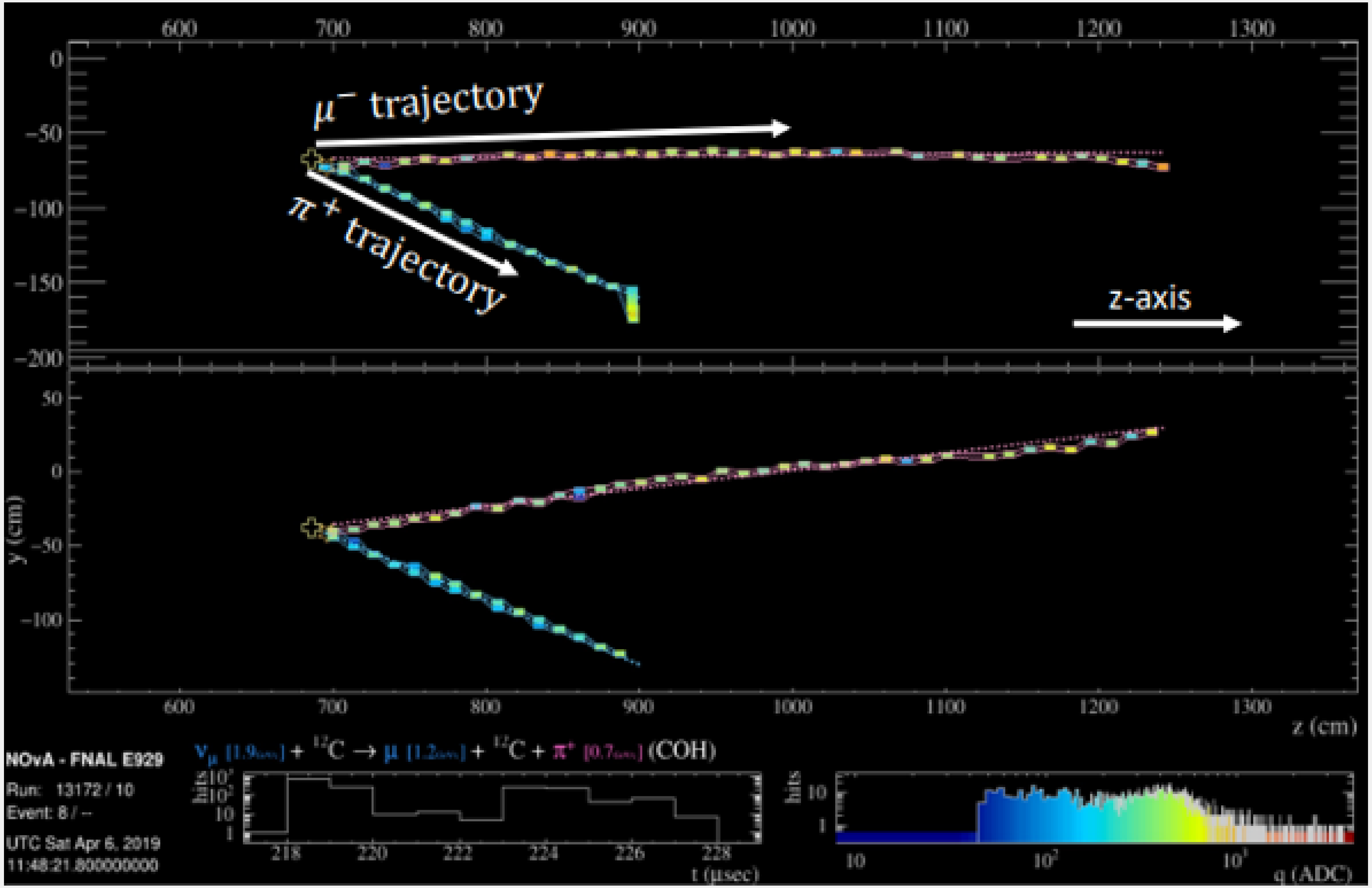
- Improvements on the identification algorithms.
- Enhanced theoretical models and simulations are required.
- Although it has been shown that CC pion problems have greater effect on large nucleus experiments, it is very useful to expand these analyses to experiments such as NOvA

Thanks

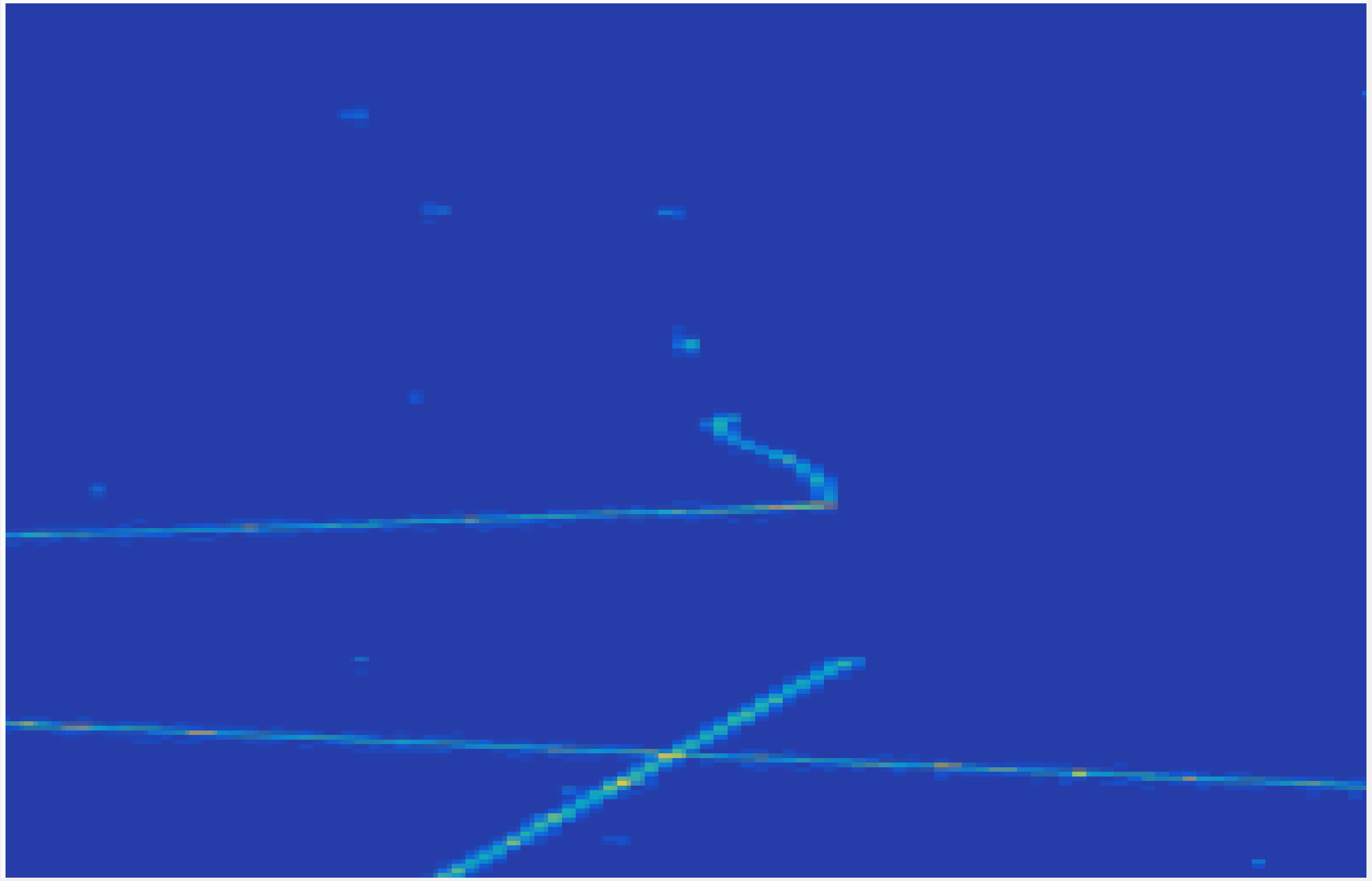
References

1. Progress of the Charged Pion Semi-Inclusive Neutrino Charged Current Cross Section in NOvA,, Aristeidis Tsaris. (Event Display Image Slide 1)
2. NOvA Event Identification Tutorial, Californian Institute of Technology. (Event Processes Slide 2)
3. CONSTRAINTS ON NEUTRINO OSCILLATION PARAMETERS FROM NEUTRINOS AND ANTINEUTRINOS WITH MACHINE LEARNING, Micah Groh. (Event Display Slide 3)
4. Charged pion production in νμ interactions on hydrocarbon at hEνi= 4.0 GeV. MINERvA Collaboration (Michel Electron Energy Distribution Slide 3, and Pion Range Score Slide 4)

Back-up Slides



μ⁻ trajectory
π⁺ trajectory
z-axis
y (cm)
z (cm)
NOvA - FNAL E929
Run: 13172 / 10
Event: 8 / --
UTC Sat Apr 6, 2019
11:48:21.800000000
ν_μ + ¹²C → μ + ¹²C + π⁺ (COH)
hits
t (μsec)
q (ADC)



$$\pi \rightarrow \mu \rightarrow e$$

$$\mu \rightarrow e + \nu_e + \nu_\mu$$