Update on Trigger inputs

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11/09/2024

Introduction

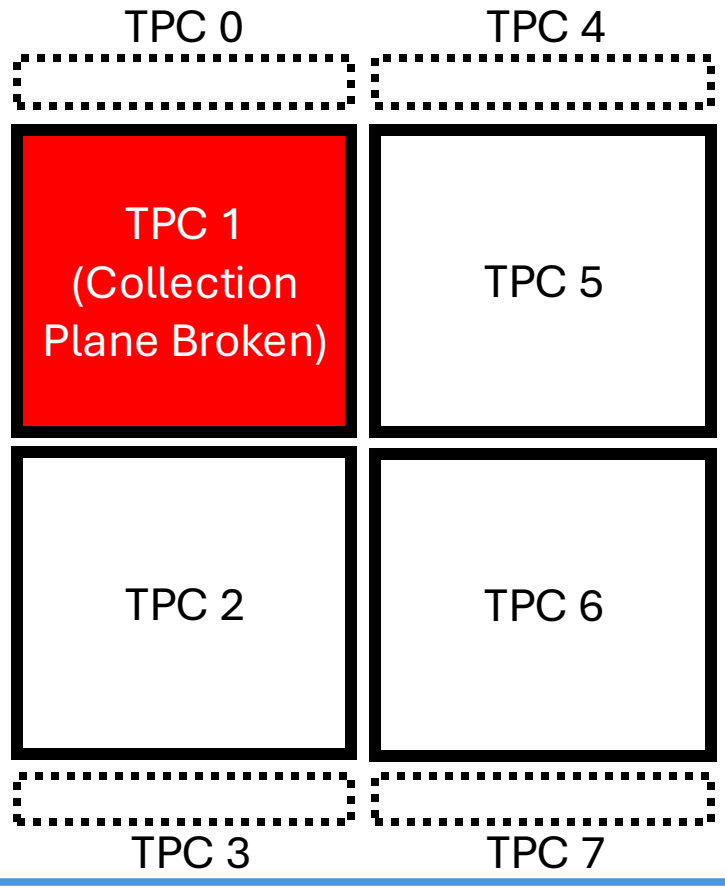
Points to address in simulation inputs to trigger

- Calculate ADC Integral Sum over each TPC individually
- Differences in TP multiplicity between neutrino/cosmic events – very closely connected to ADC Integral Sum
- Look at CC/NC interaction differences
- Look at event displays of events passing/failing chosen trigger ADC Integral Sum threshold

Introduction

Beam axis

- MC Samples:
  - 400 cosmic events
  - 600 $\boldsymbol{\nu_\mu}$ events
  - 600 $\boldsymbol{\nu_e}$ events



- Simulate TPs for cosmics and neutrinos
- Only relevant TPs are those on collection plane of TPCs 2, 5 and 6
- Threshold to generate TP set to 100 ADC
- **When I say TPC I am referring to a specific TPC 2, 5 or 6**

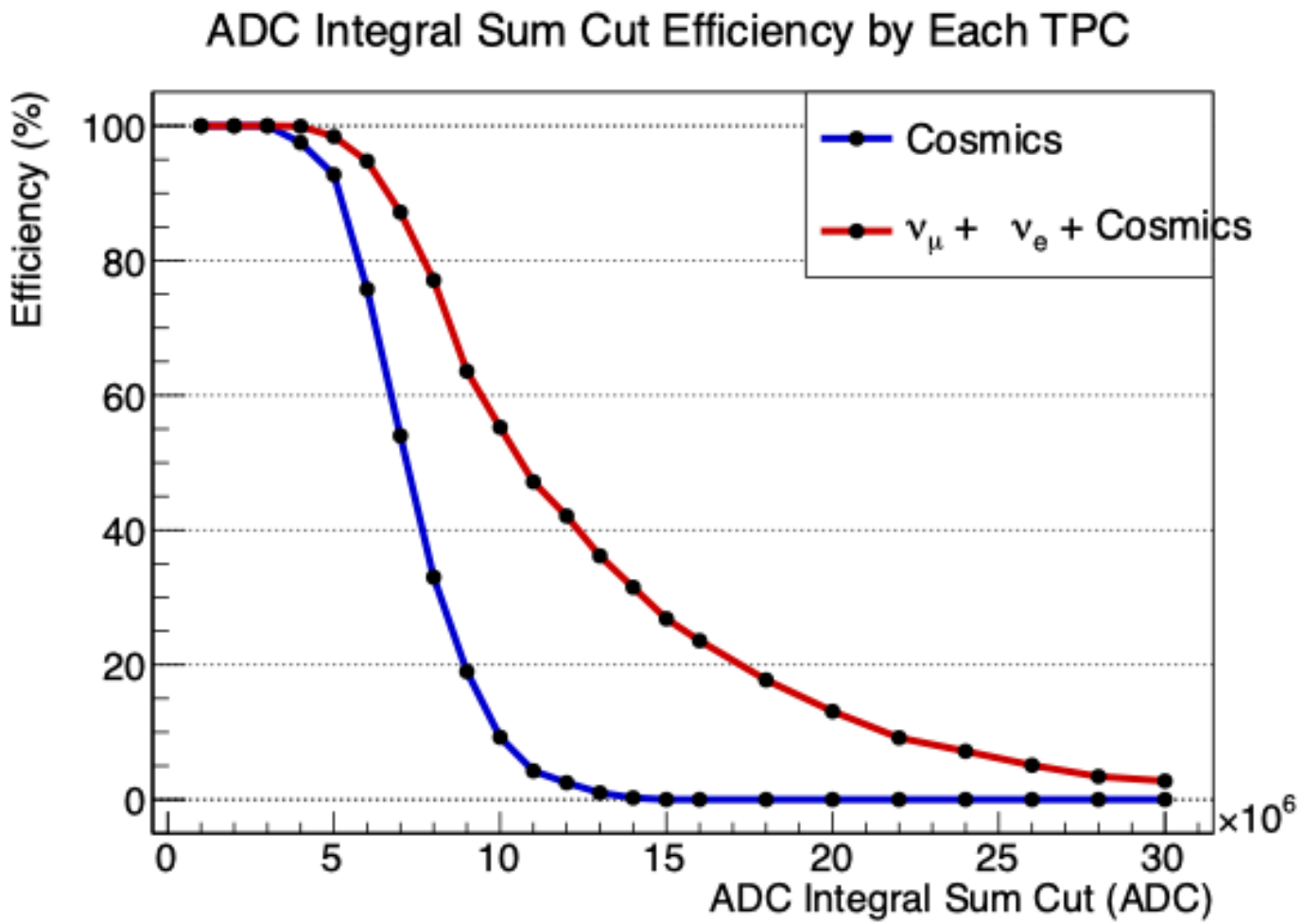
Trigger Algorithm (as I understand it)

Previously summed the ADC Integrals across the 3 active TPC volumes. I hope the procedure below better reflects how the trigger we have now works:

1. Considering TPs from TPCs 2, 5 and 6
2. Consider the TPs in each TPC one at a time
3. Sum the ADC Integrals from all the TPs in that specific TPC
4. If the sum of the ADC Integrals in the current TPC crosses the threshold readout the data from NP04
5. If the sum of the ADC Integrals does not pass the threshold move on to the next TPC and start again from step 3
6. If threshold not passed in any of the TPCs then no data readout – on to the next readout window

ADC Integral Sum Threshold Choice

- Efficiency of ADC Integral Sum cut for cosmic-only events and neutrino events
- Uses algorithm described above – **threshold is for a single TPC** (i.e. TPC 2, 5 or 6)
- So, the ADC Integral Sum cut for each APA collection plane in the region 10E6-15E6 looks about right



ADC Integral Sum Threshold Choice

Cut at **12E6**:

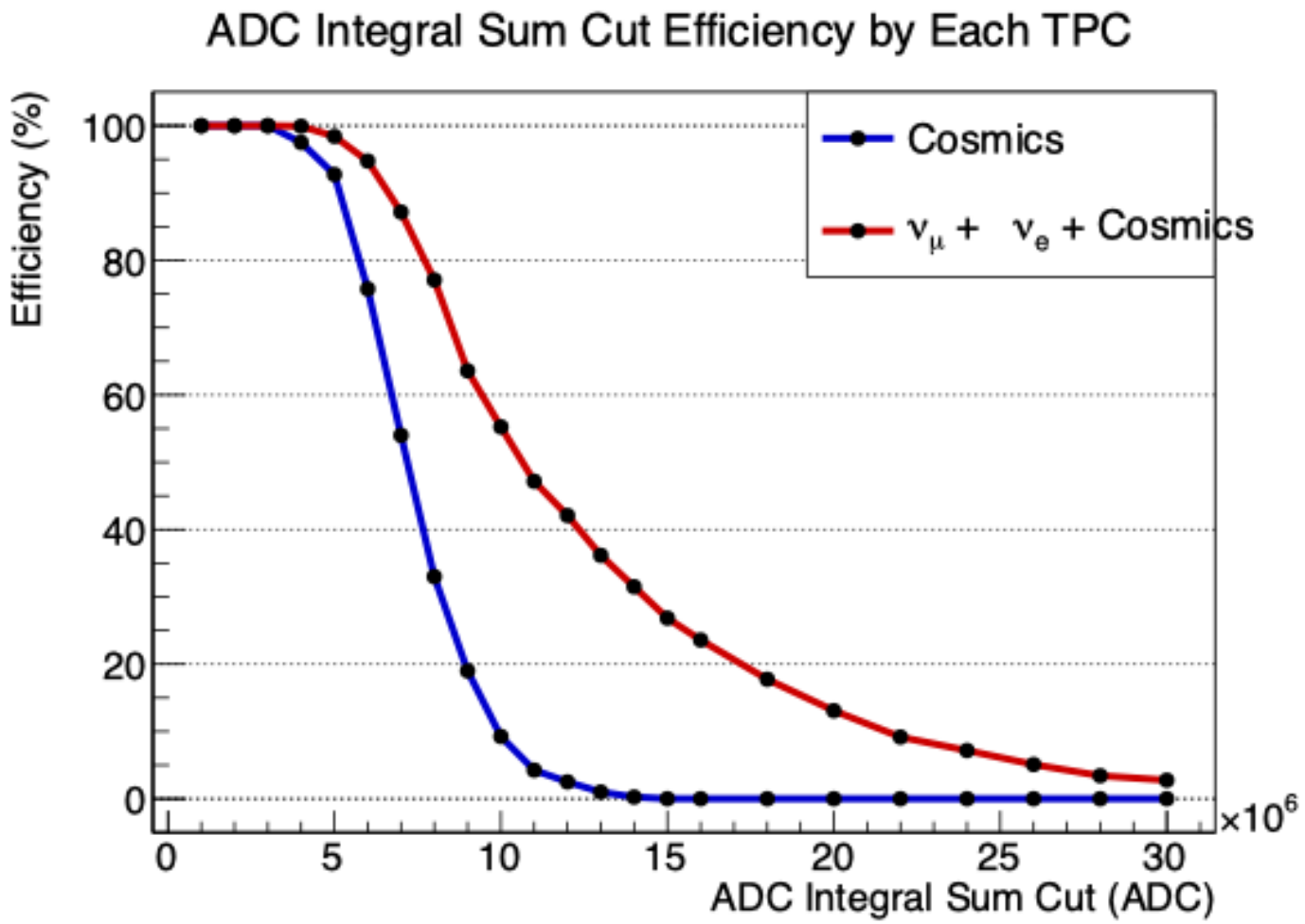
- 2.5% of cosmic events left
- 42% of neutrino events left

Cut at **13E6**:

- 1% of cosmic events left
- 35% of neutrino events left

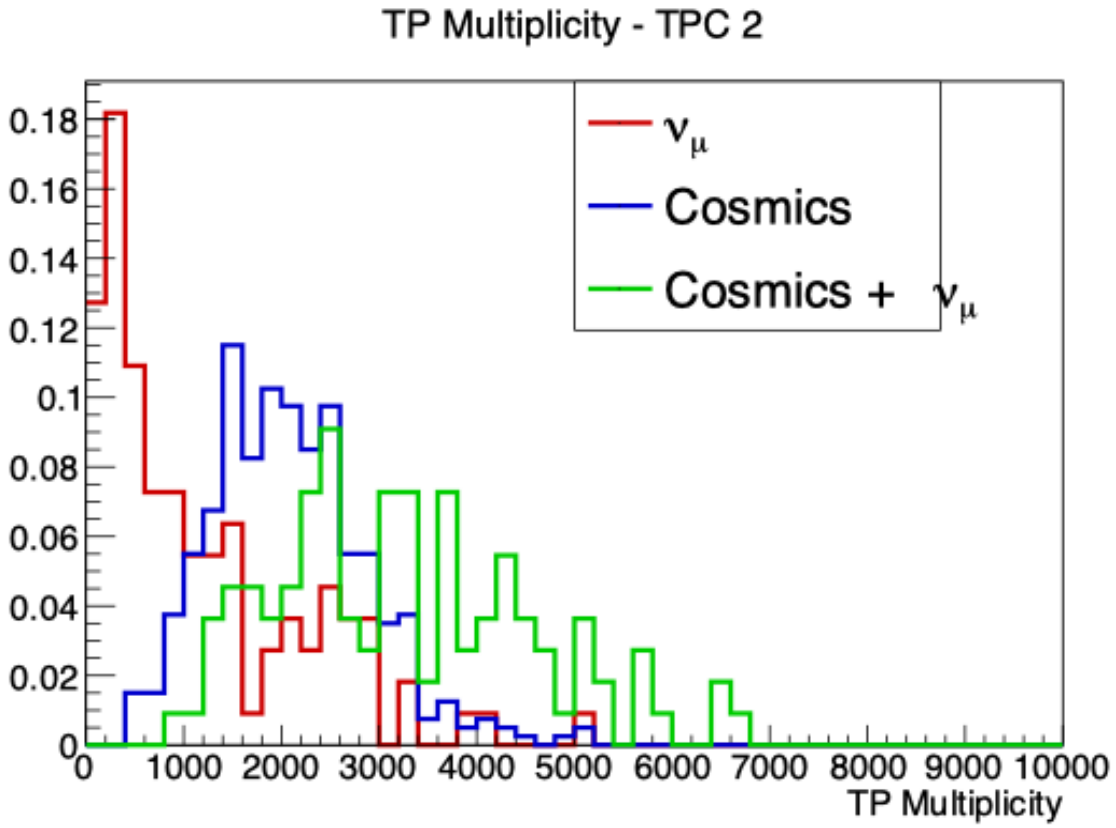
Cut at **14E6**:

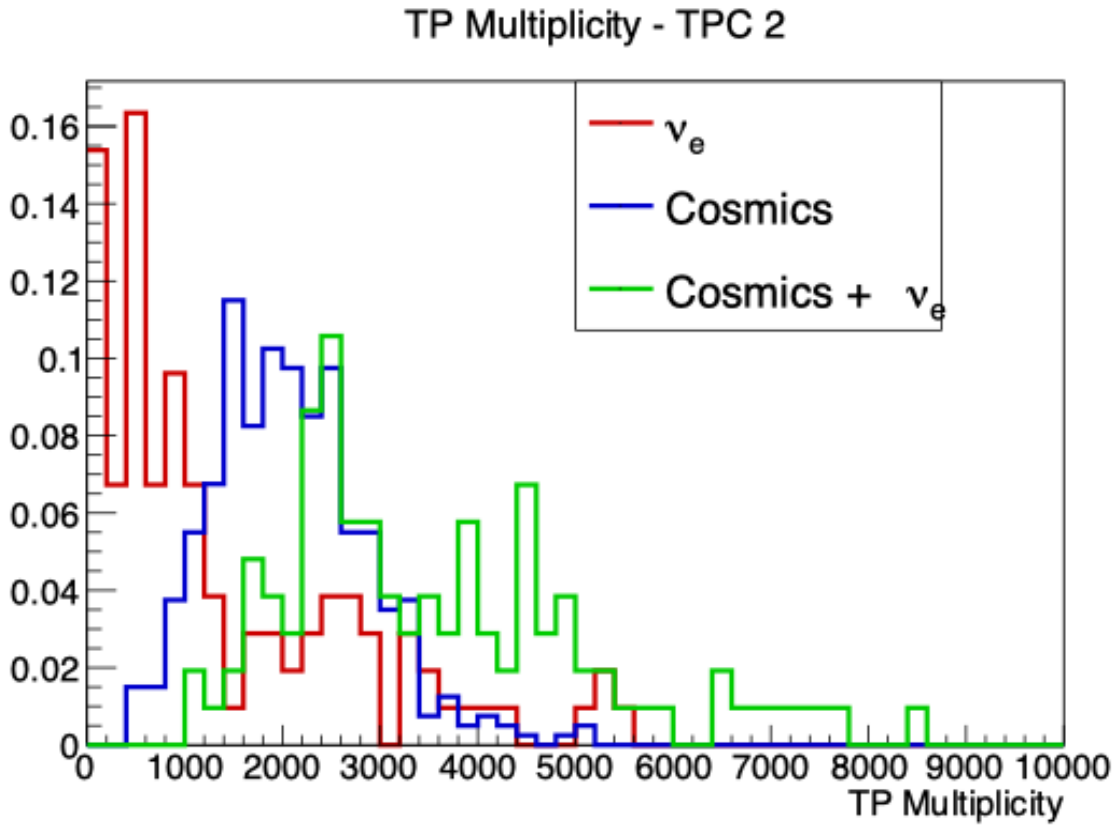
- 0.25% of cosmics left
- 32% of neutrinos left



TP Multiplicity

- Thought counting the number of TPs in an event in each TPC would give extra power to the trigger
- If a neutrino or BSM event occurs more TPs will be generated – count number of TPs in a TPC





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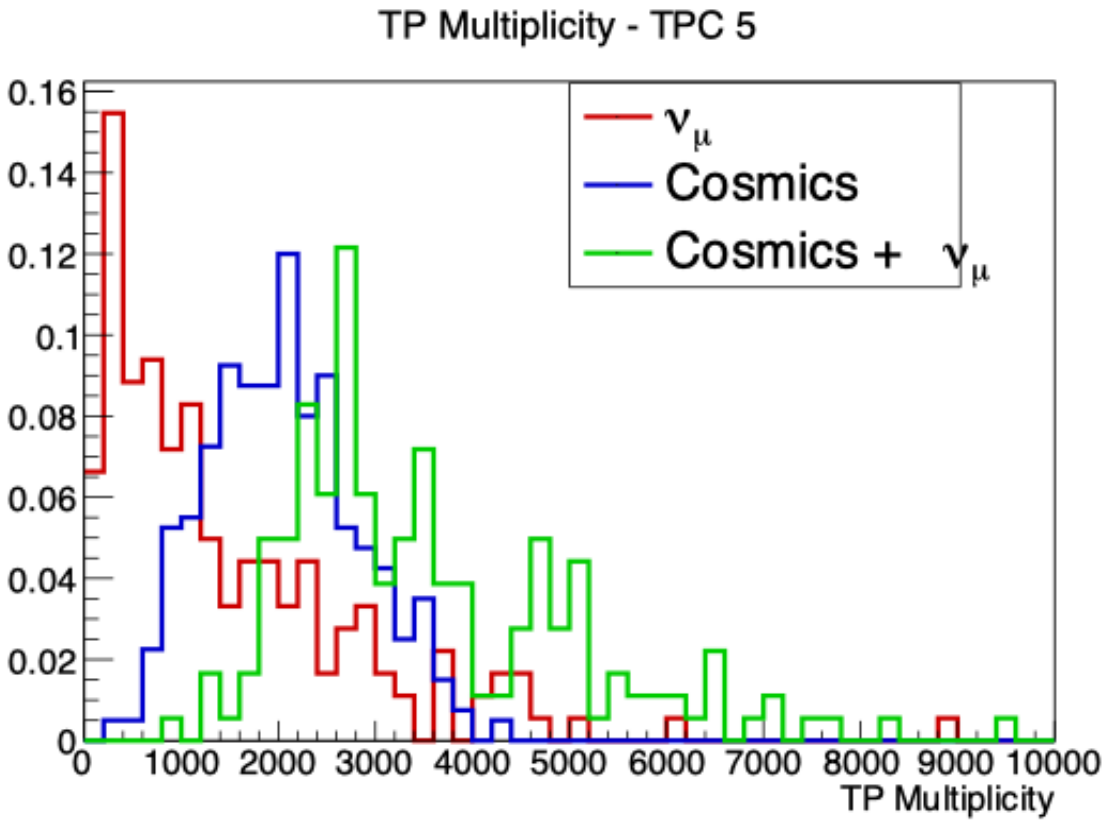

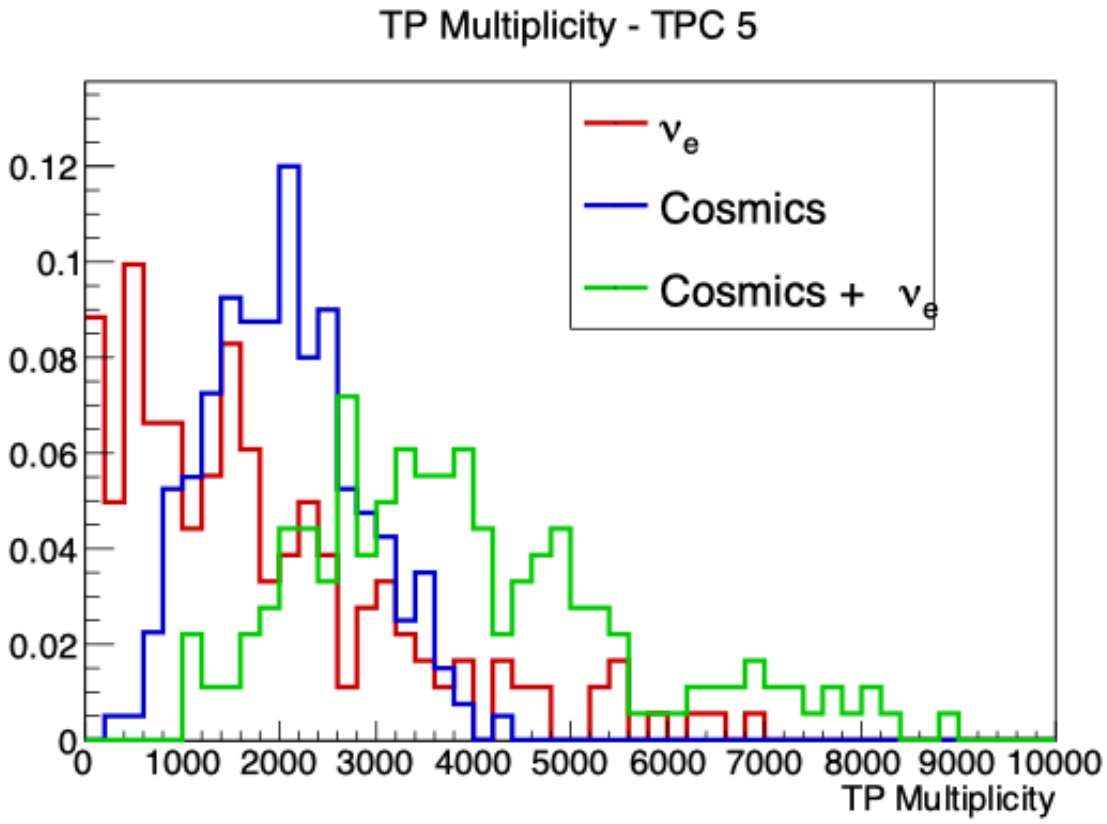

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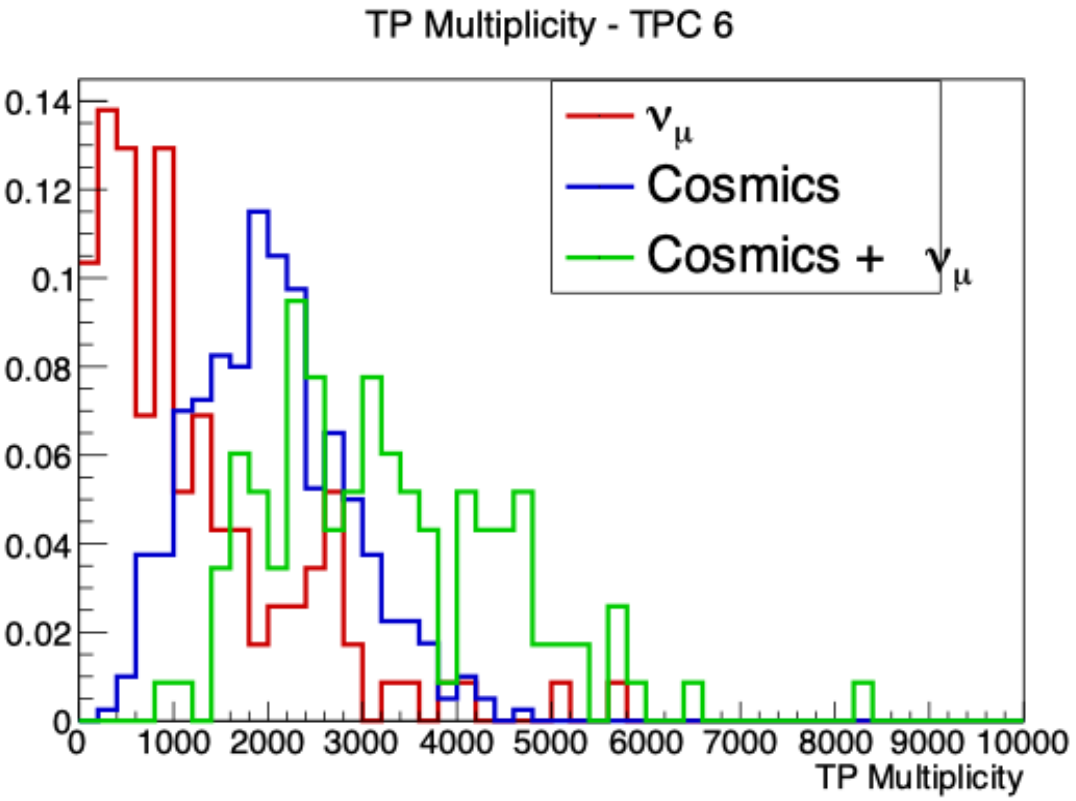
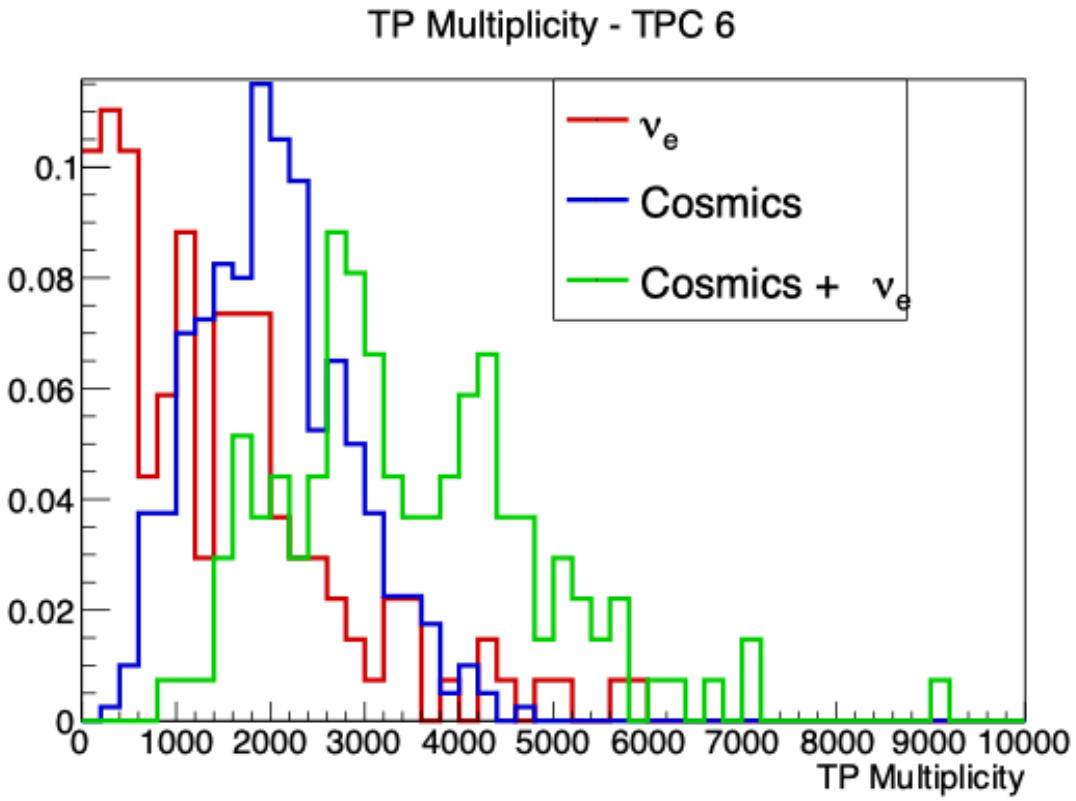
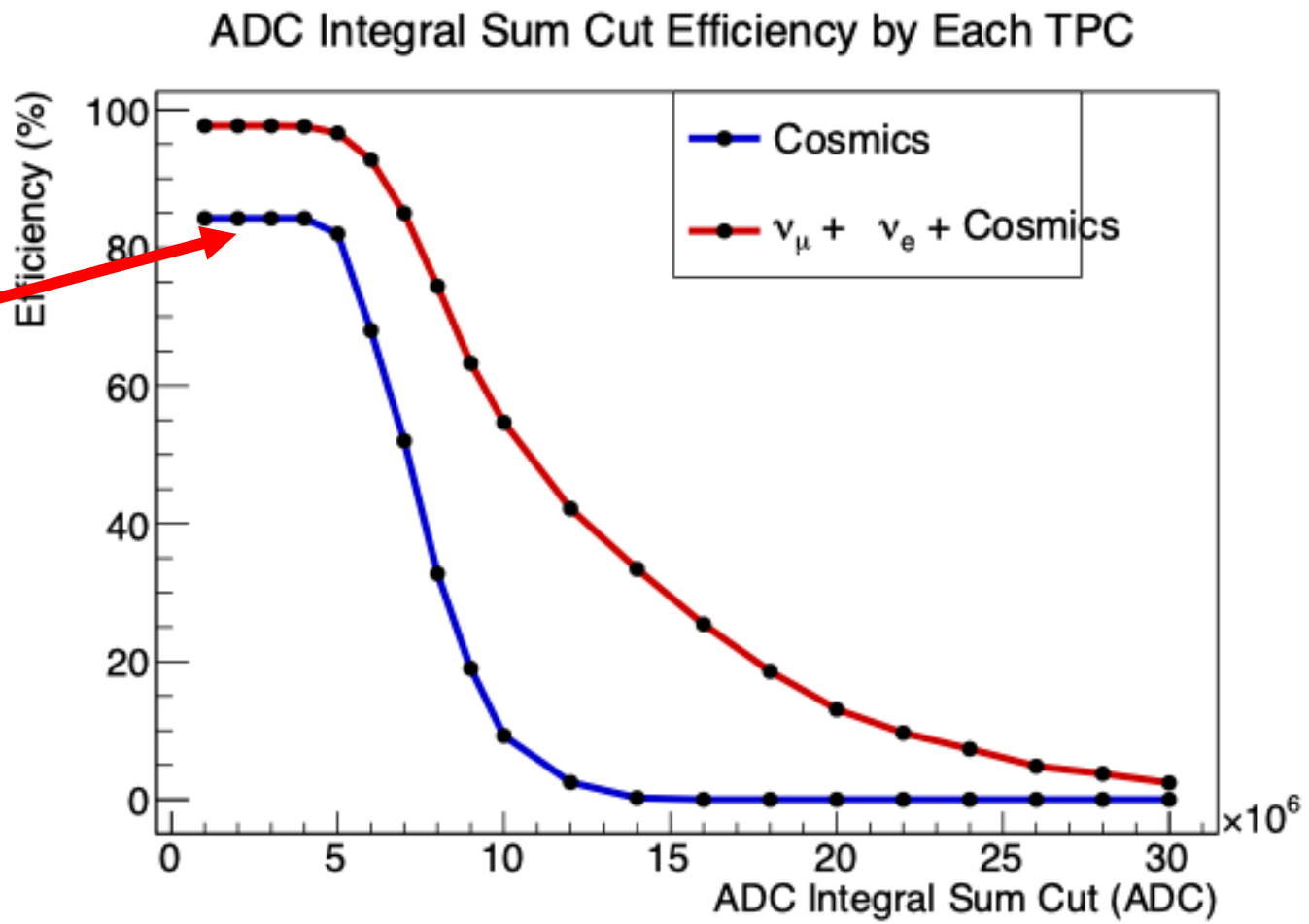




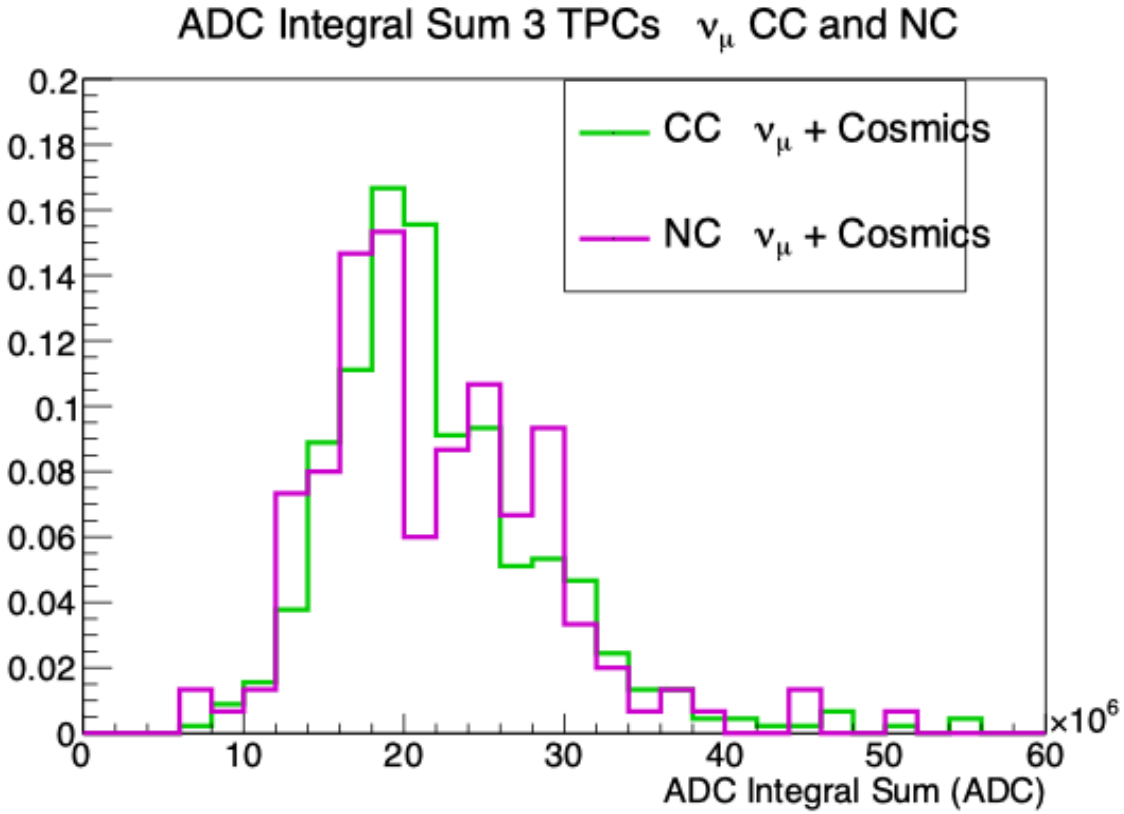
TP Multiplicity Threshold Requirement

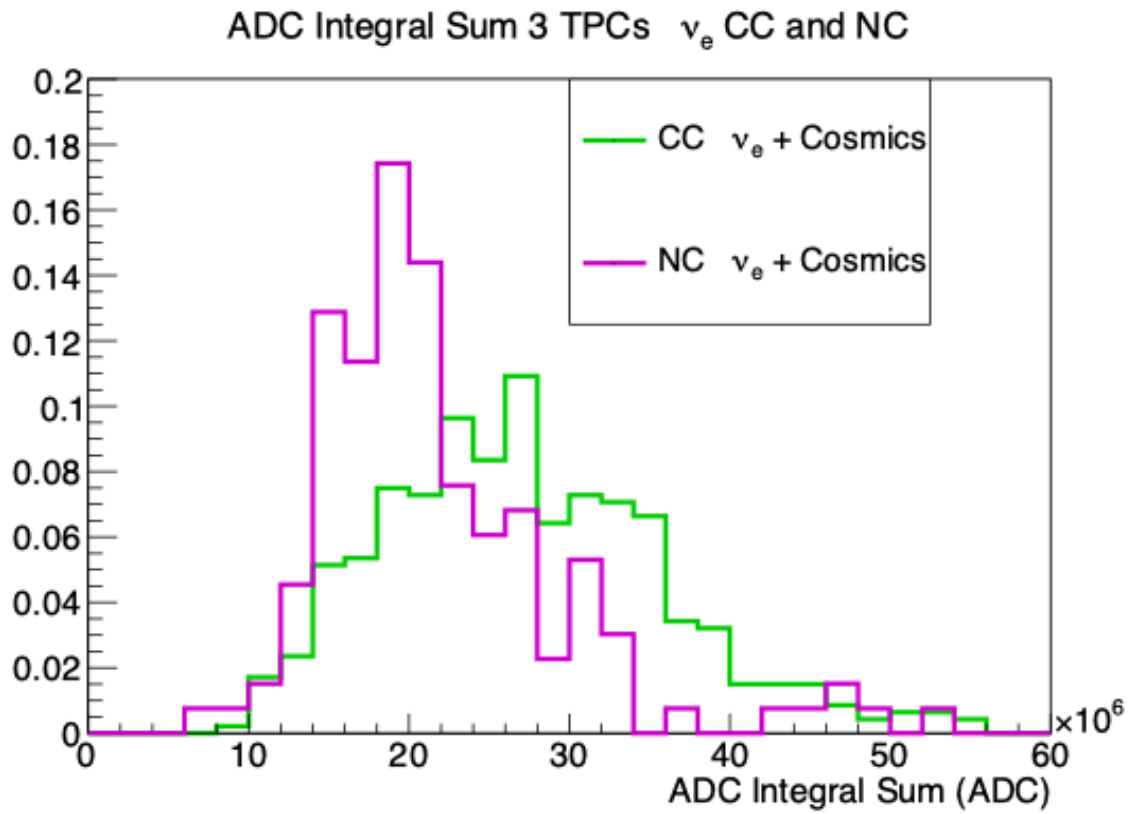
- Try adding a cut on the TP multiplicity per TPC drift volume
- TP multiplicity per **TPC > 2000 TPs**
- Main affect is to **reduce the low energy cosmics**
- Little/no effect at high ADC Integral Sum – expected since ADC Integral Sum typically means high TP multiplicity
- Probably not much value in having TP multiplicity as an additional threshold requirement



Neutrino CC/NC Differences

- Look at ADC Integral Sums (across all 3 active TPCs) for nue/numu and CC/NC
- With nue we get some separation between CC/NC
- This is why we get higher energy deposits for nue – EM shower from the electron in a nue **CC** event

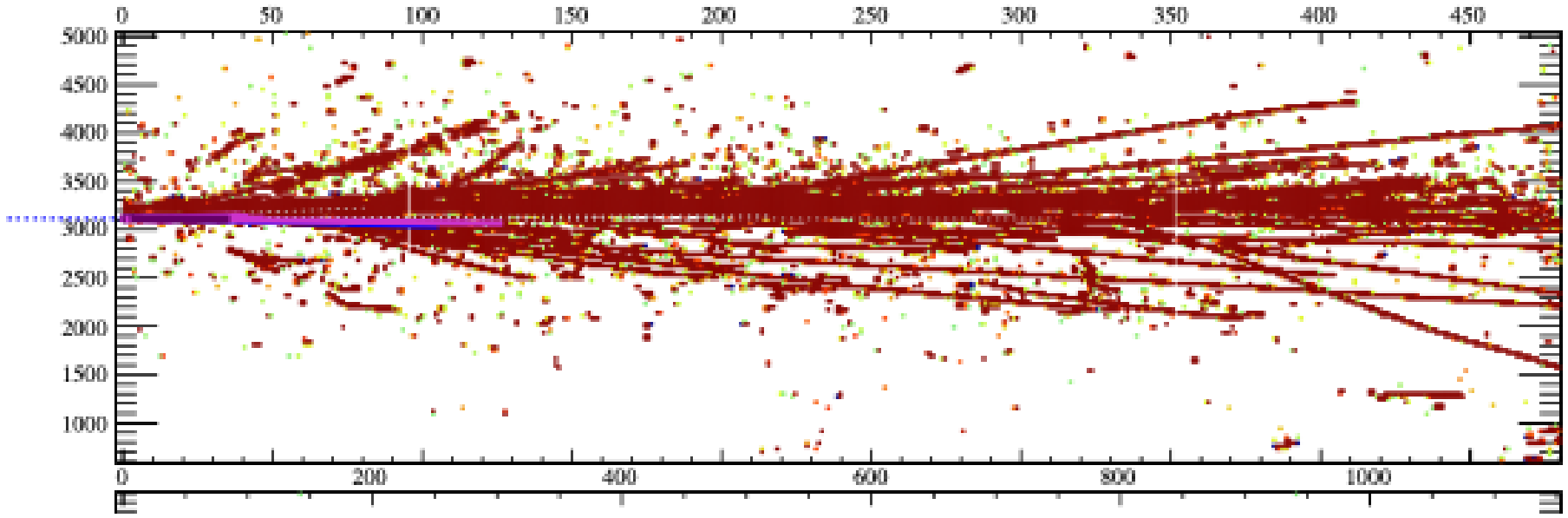




Events Displays for Events Passing ADC Integral Threshold

- This 59 GeV numu CC event **passes** the ADC Integral Sum threshold
- Fairly clear how that happened looking at the collection plane

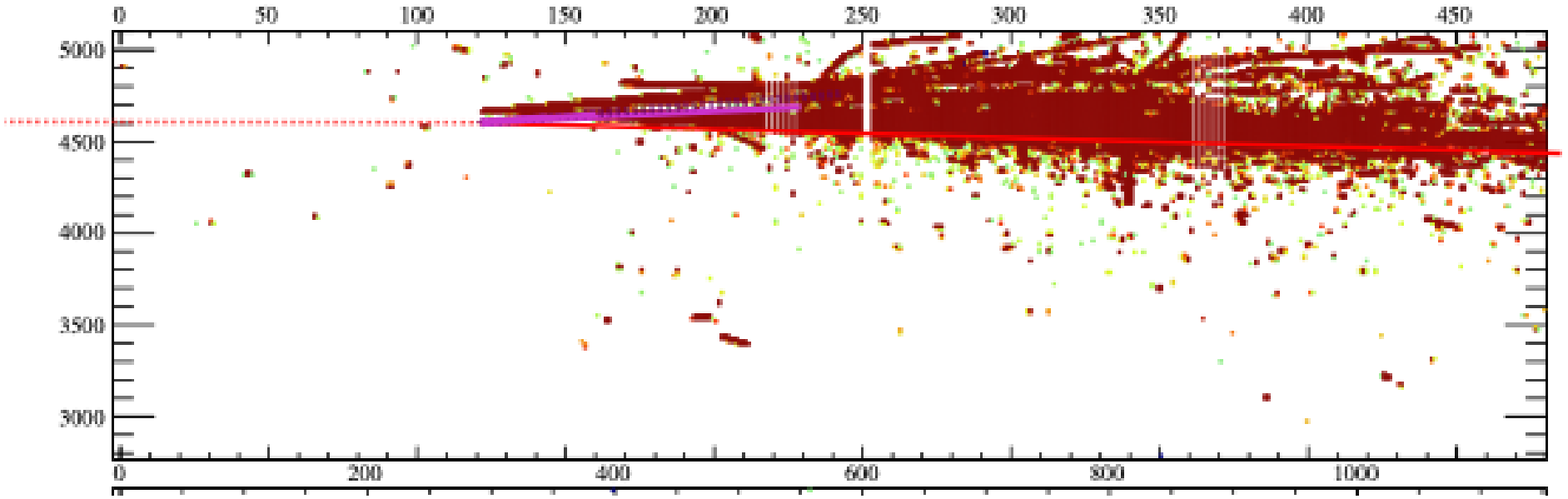
Collection plane tpc 5



Events Displays for Events Passing ADC Integral Threshold

- This 49 GeV nue CC event **passes** the ADC Integral Sum threshold
- Big forward-going shower

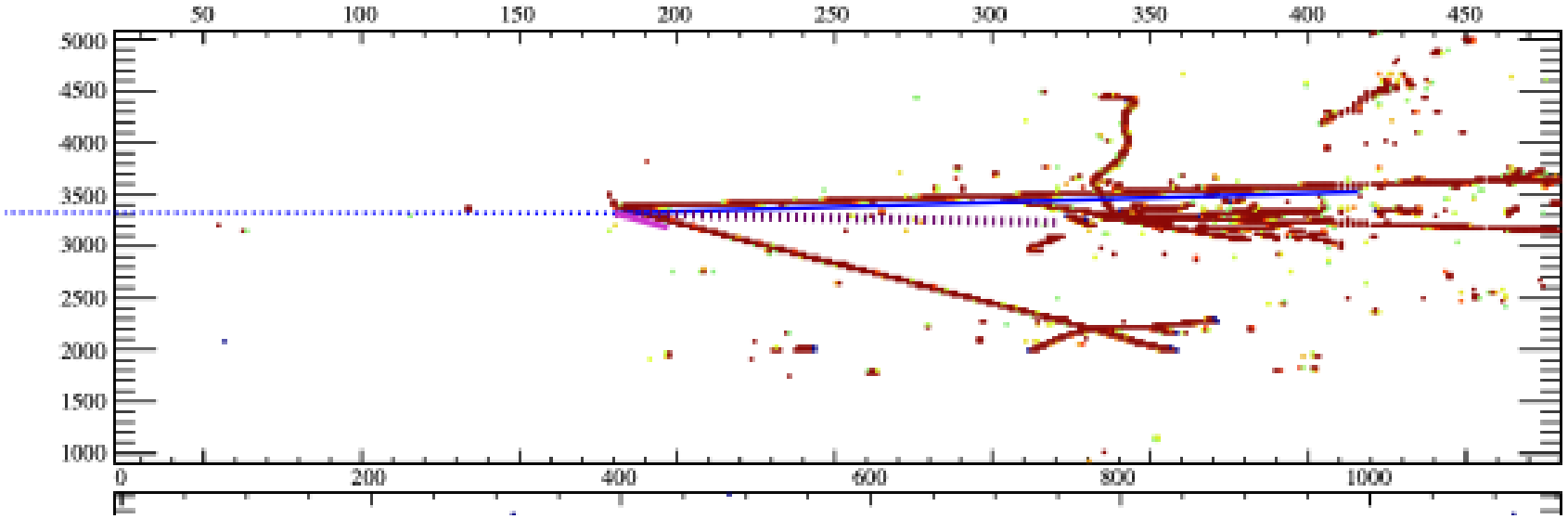
Collection plane tpc 2



Events Displays for Events Failing ADC Integral Threshold

- This 18 GeV numu CC event **fails** the ADC Integral Sum threshold
- Can see the contrast with the previous event display – not enough hadronic activity

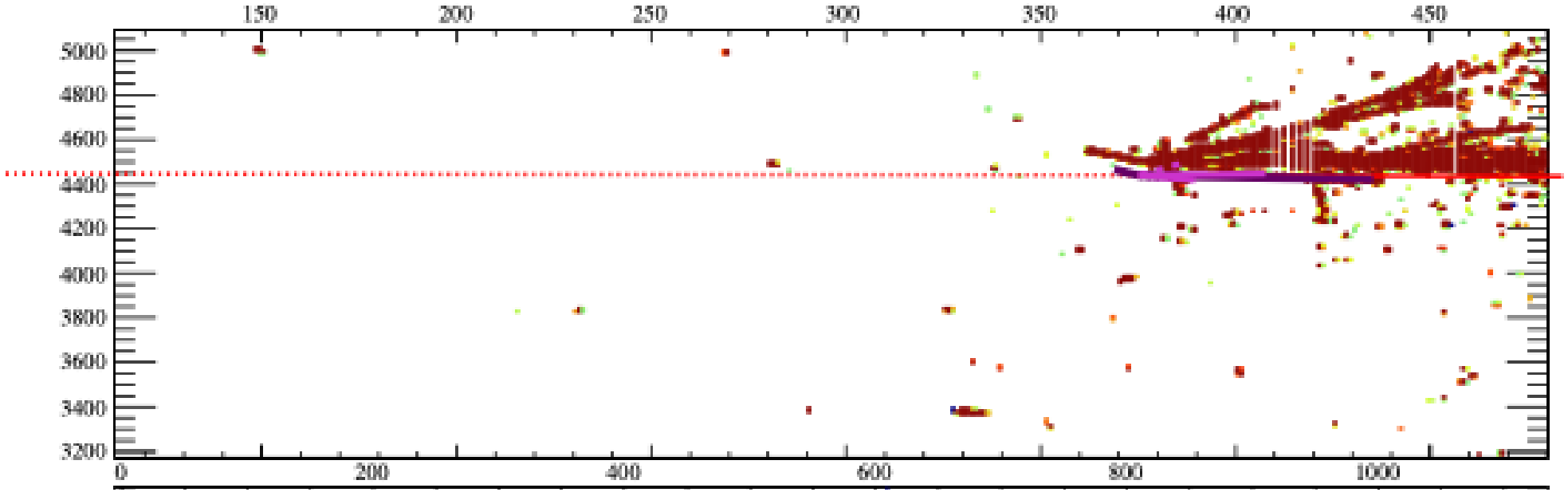
Collection plane tpc 6



Events Displays for Events Failing ADC Integral Threshold

- This 36 GeV nue CC event **fails** the ADC Integral Sum threshold
- High energy nue interaction – but it happens close to the end of the detector so not enough energy deposited in the active volume

Collection plane tpc 6



Next Steps

- Slide 6 provides some suggestions for suitable ADC Integral Sum thresholds
- The suggested thresholds are for each individual APA collection plane
- Keeping somewhere between 30-40% of neutrinos that interact whilst suppressing the cosmic background seems feasible
- An additional requirement in the threshold on TP multiplicity does not give much more power – very similar to the ADC Integral Sum
- The nue CC events deposit the most energy on average
- Wes has provided a description of an algorithm to place a cut on the drift time – I will have a go at implementing this