

# Raw and deconvoluted signal shapes

DUNE 35 ton sim/reco

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# Introduction

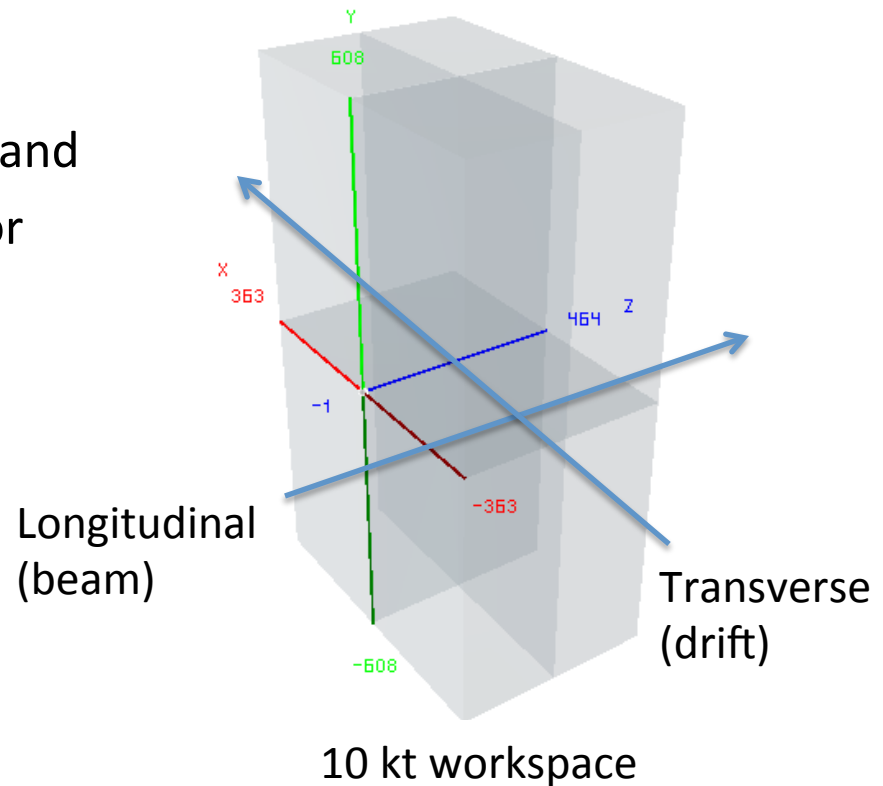
I have been looking at LAr TPC signal spectra

Inspired by talk by Michelle at last week's FD physics meeting

- <https://indico.fnal.gov/conferenceDisplay.py?confId=10567>

Looked at signals

- as function or tick with longitudinal (z dir) muons and
- as a function of channel for transverse (x dir) muons



# TDC signal shapes for 35 ton

## Samples

- Three muons, horizontal and parallel to the wire planes
- Geometry: dune35t4apa\_v5

## Figures

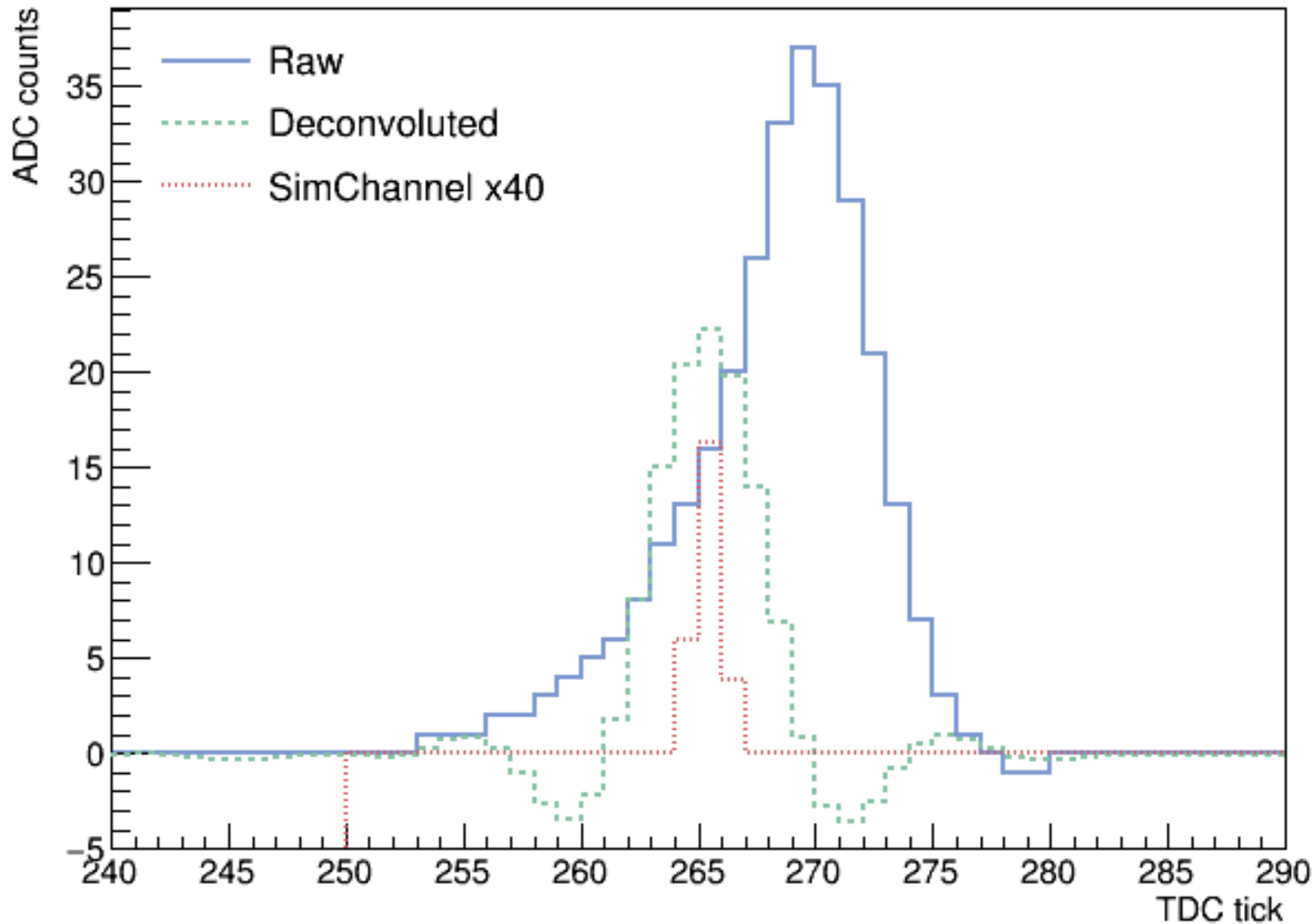
- Select channel where muons have little delta ray activity
- Show signals as function of TDC tick for that channel
  - SimChannel, raw and deconvoluted
  - First is MeV, latter are ADC counts

## Results

- All spectra get wider with increasing drift (longitudinal diffusion)
- Deconvoluted significantly narrower than raw
  - Good—signal shaping is removed
- But deconvoluted have undershoot tails especially for short drift
- Deconvoluted area is much less than raw
- Deconvoluted width does not decrease as much for short drift

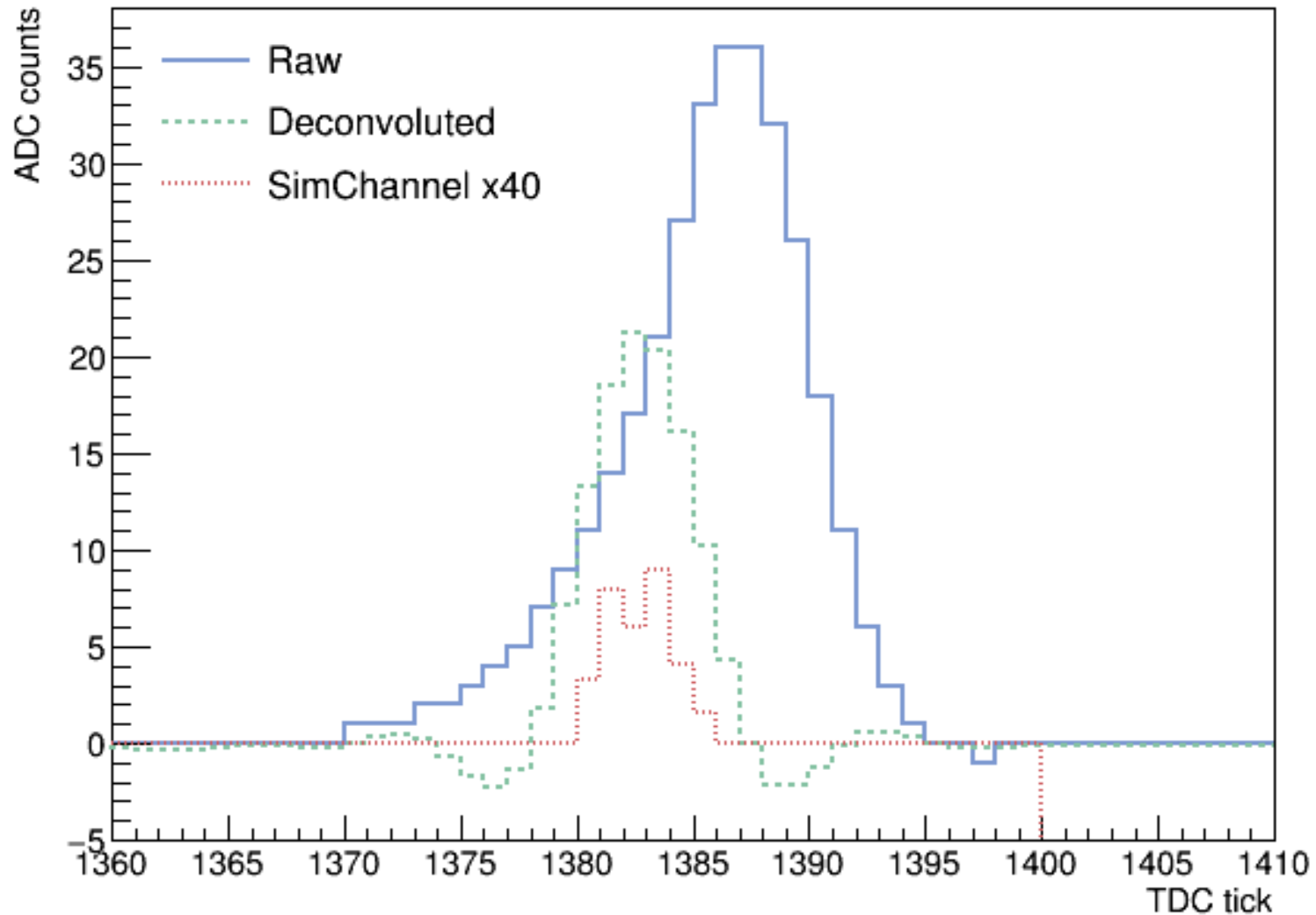
# TDC signal shapes for 35 ton: short drift

## Raw signals for apa0z2 event 1 channel 70



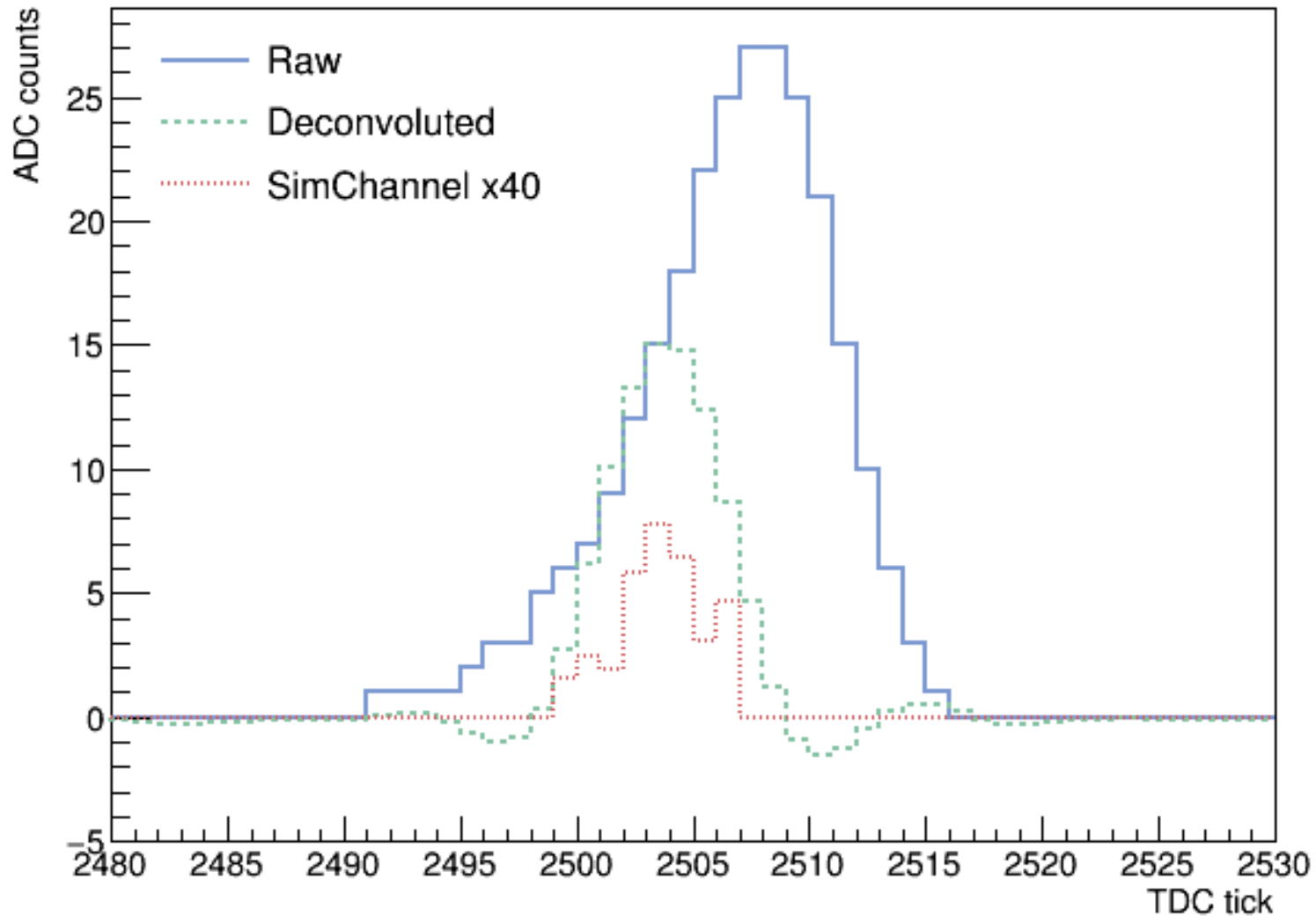
# TDC signal shapes for 35 ton: mid drift

## Raw signals for apa0z2 event 1 channel 70



# TDC signal shapes for 35 ton: long drift

Raw signals for apa0z2 event 1 channel 70



# TDC signal shapes for 10 kt

## Samples

- Three muons, horizontal and parallel to the wire planes
- Geometry: dune10kt\_v1\_workspace

## Figures

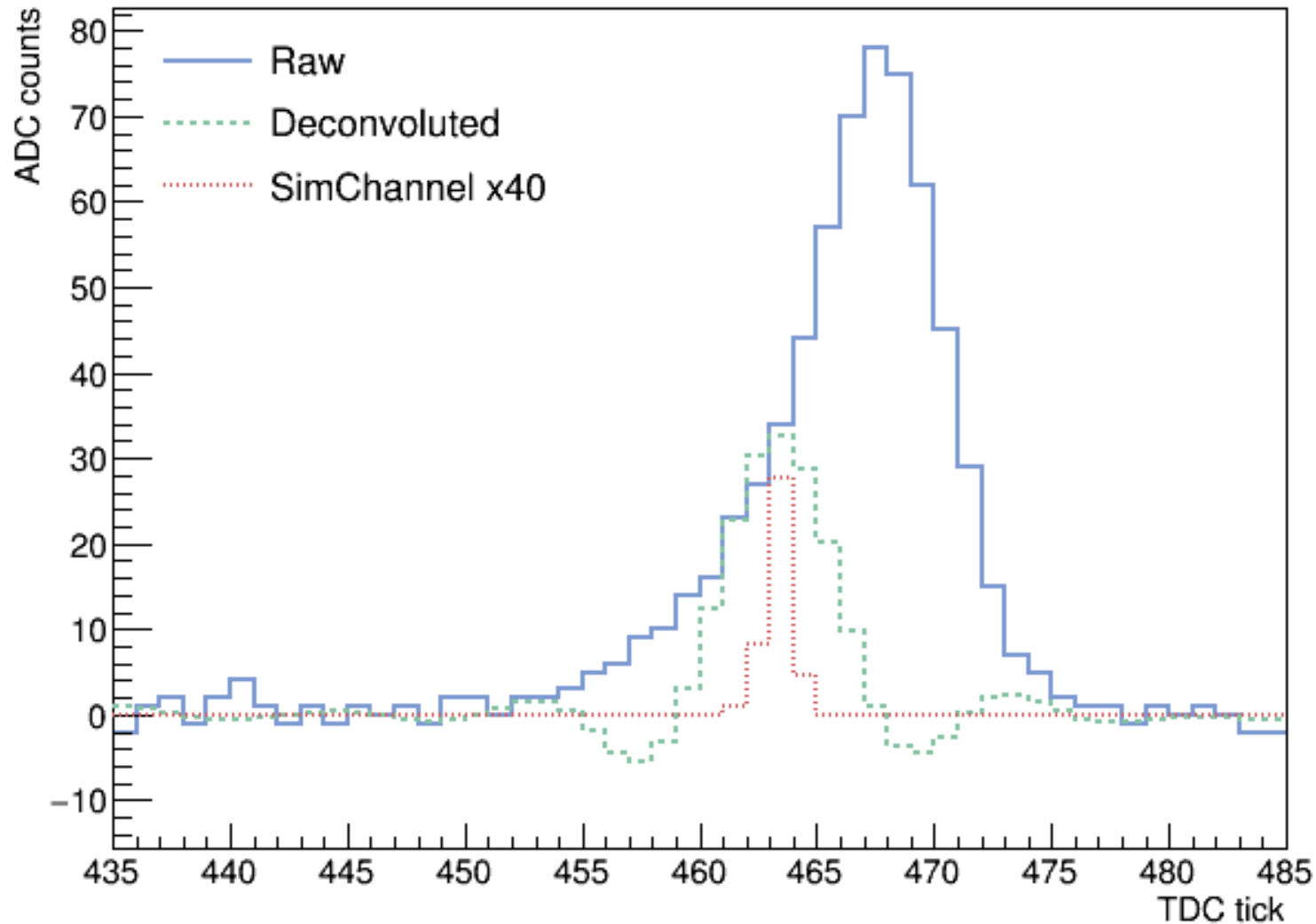
- Select channel where muons have little delta ray activity
- Show signals as function of TDC tick for that channel
  - SimChannel, raw and deconvoluted
  - First is MeV, latter are ADC counts

## Results

- Same observations as for 35 ton
- Deconvoluted/Raw is even less

# TDC signal shapes for 10 ktw: short drift

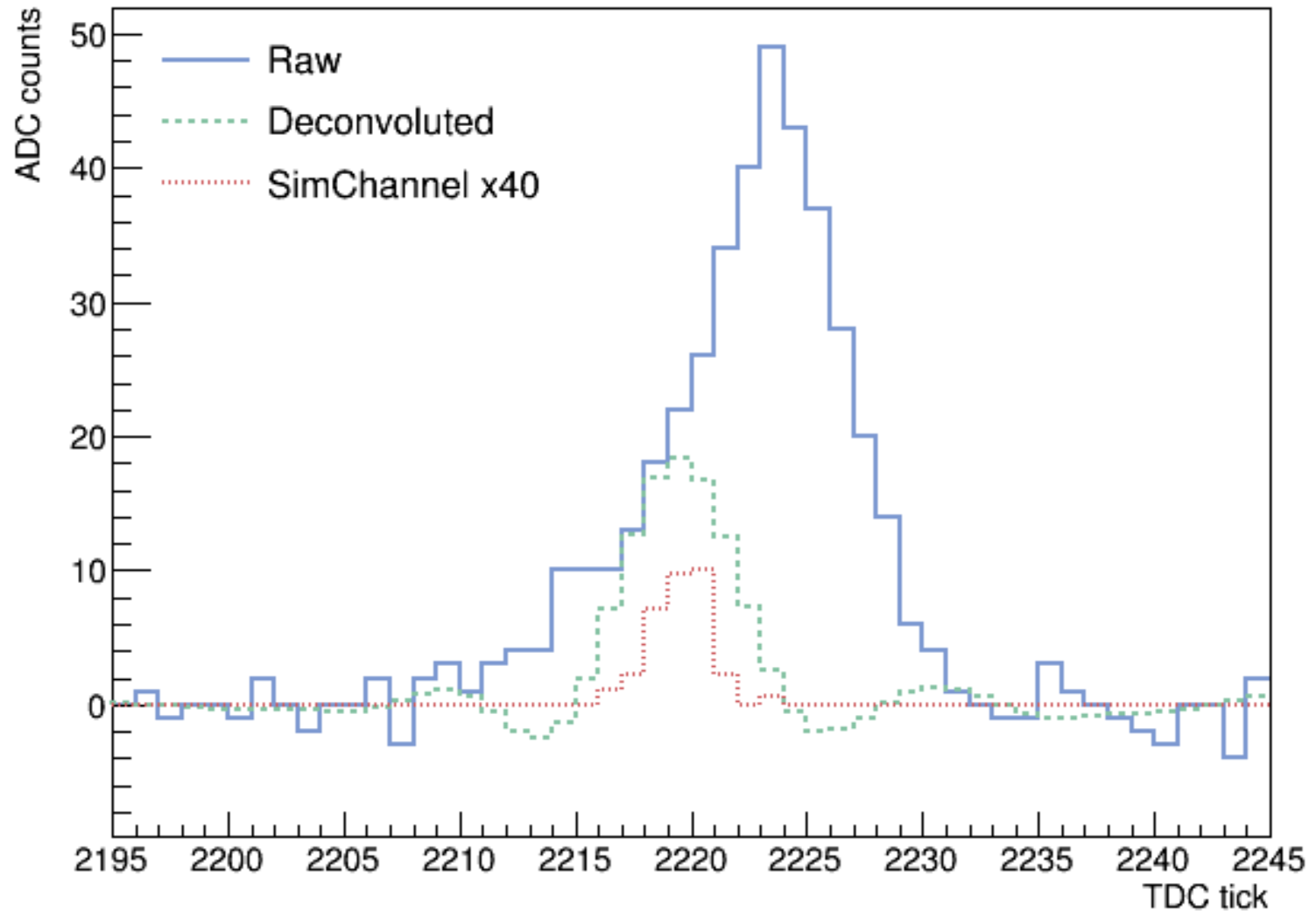
## Raw signals for apa1z2 event 1 channel 350





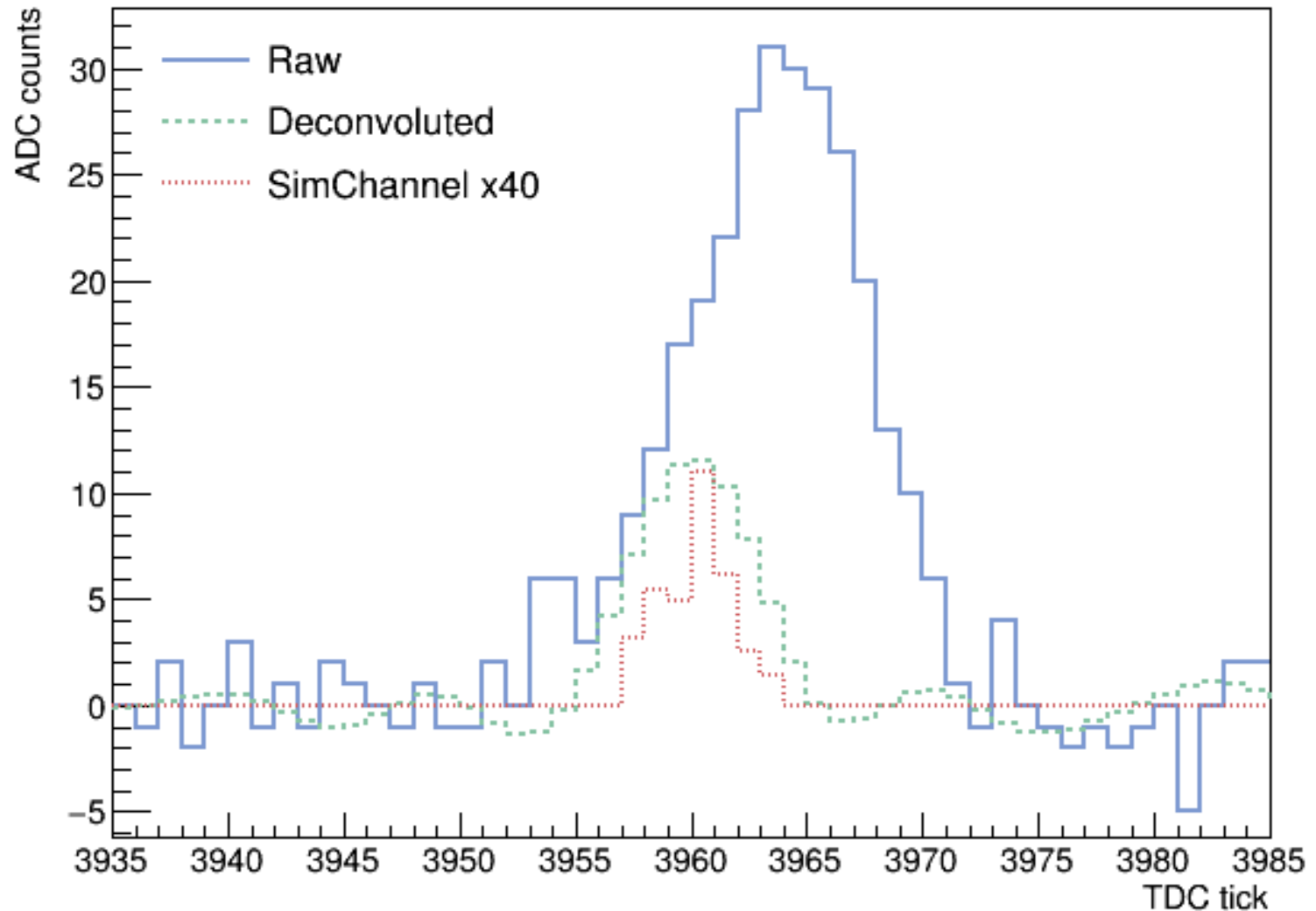
# TDC signal shapes for 10 ktw: mid drift

Raw signals for apa1z2 event 1 channel 350



# TDC signal shapes for 10 ktw: long drift

Raw signals for apa1z2 event 1 channel 350



# Comments on tick spectra

## From the 35t and 10kt studies

- Increasing width with increasing drift is evident
  - Longitudinal diffusion of drift electrons
- Deconvoluted signal
  - Has undershoot tails
  - Has much less area than raw
  - Show relatively little change in width with drift

## Speculation

- Might be able to improve deconvolution to reduce these effects
  - Maybe deconvolute as a function of drift?
- Better time resolution for short drifts
- Better energy (area) resolution without undershoots

# Channel signal shapes

## Samples

- Two muons, horizontal and transverse to the wire planes
- Geometry: dune10kt\_v1\_workspace

## Figures

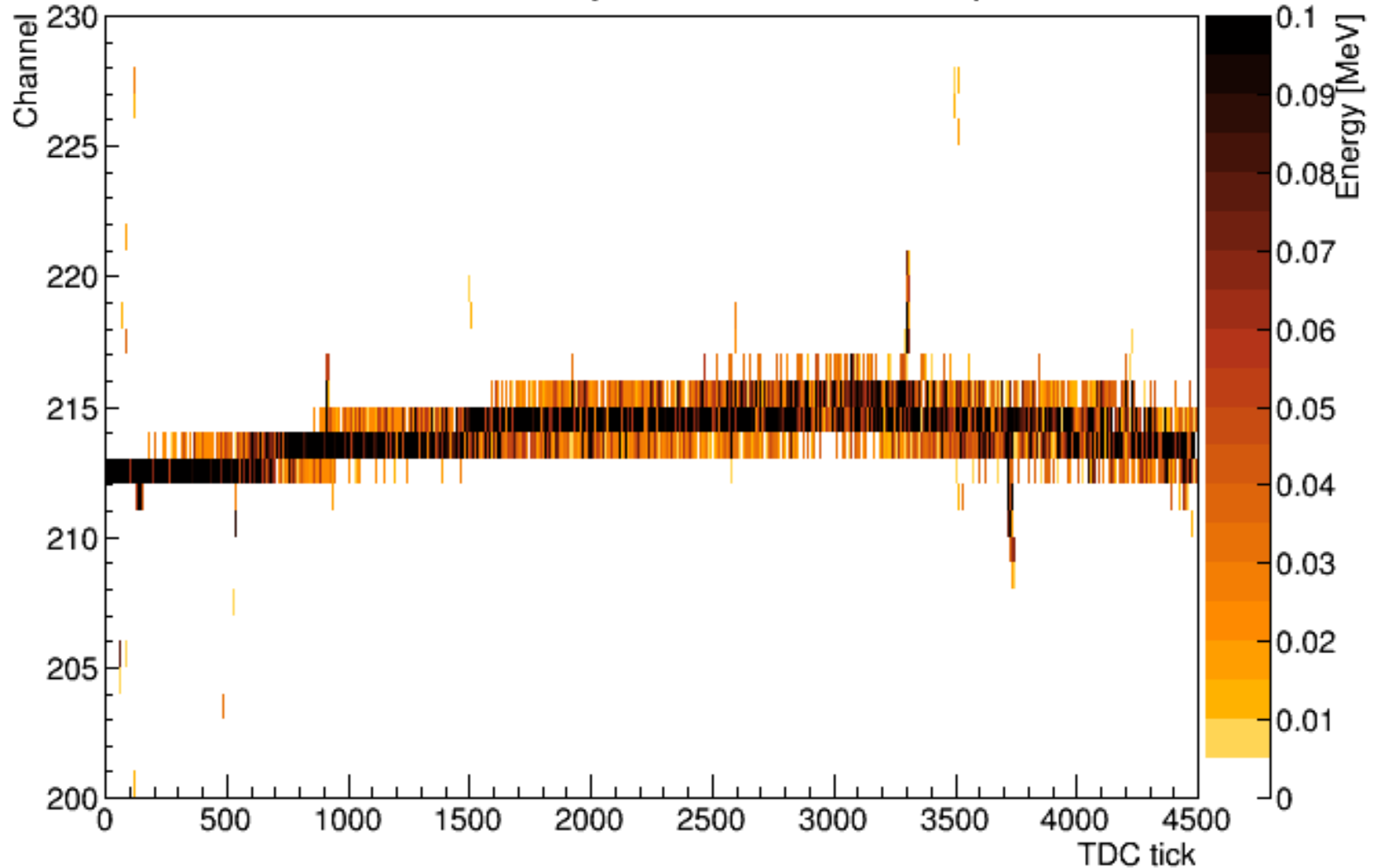
- Select TDC tick range where muons have little delta ray activity
- Show signals as function of channel for that tick range
  - SimChannel, raw and deconvoluted
  - First is MeV, latter are ADC counts

## Results

- SimChannel gets wider with increasing drift (transverse diffusion)
  - Effect is fairly small for this 5 mm wire spacing
- Raw signal is narrower than SimChannel for long drift
- Deconvoluted signal disappears at long drift

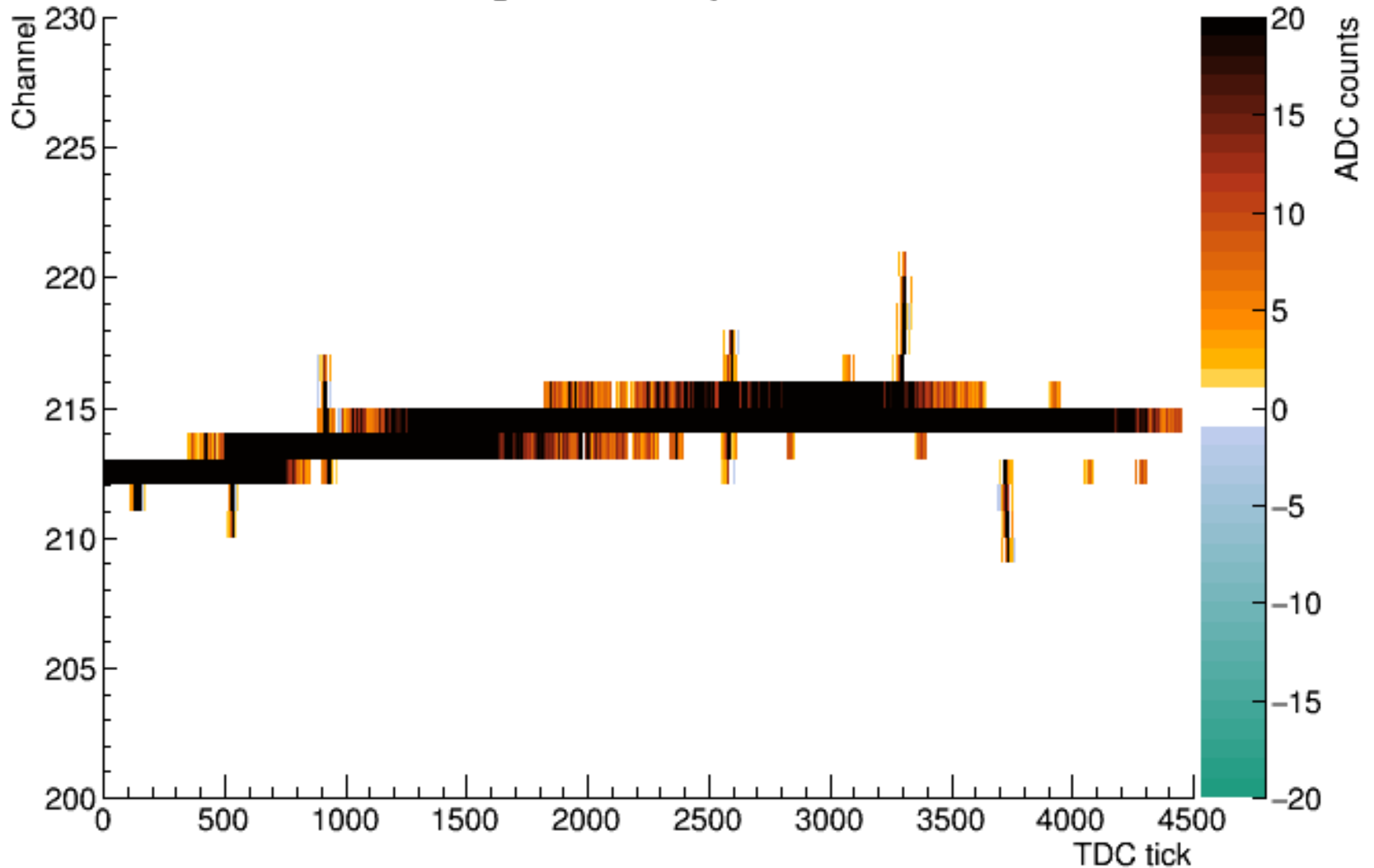
# SimChannel channel vs. tick

Sim channels for apa1z2 event 4 MC particle 1



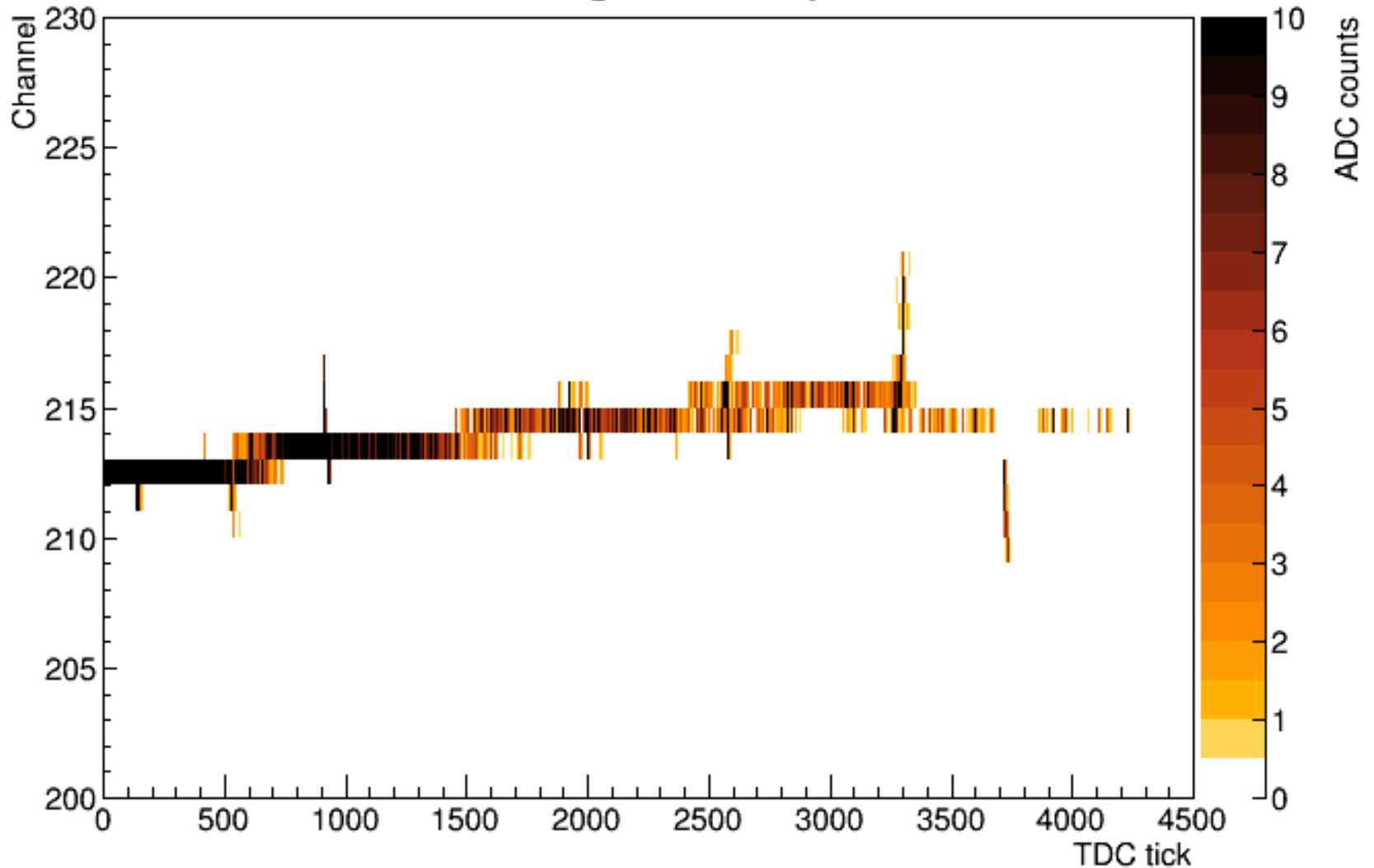
# Raw channel vs. tick

Raw signals for apa1z2 event 4



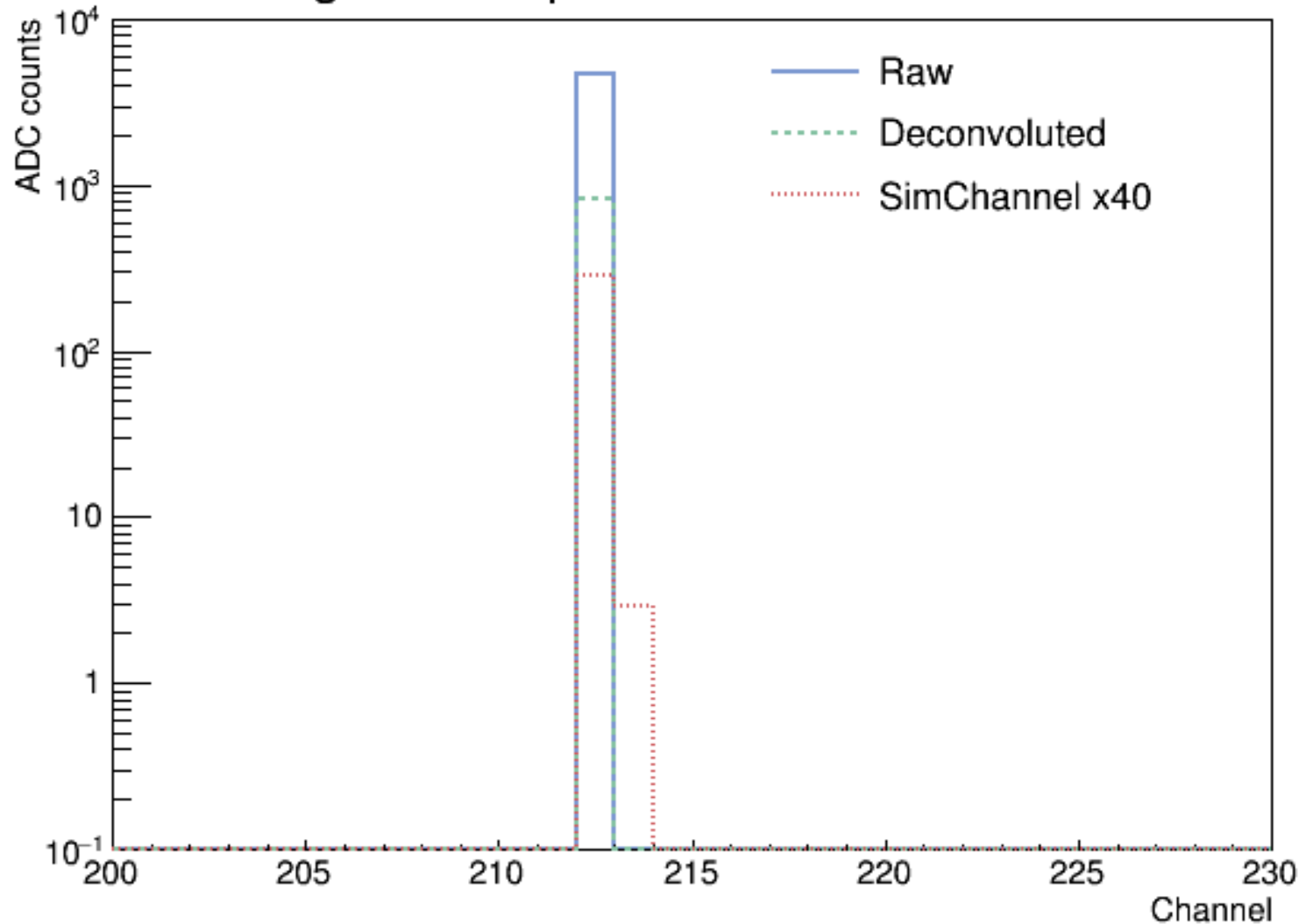
# Deconvoluted channel vs. tick

Deconvoluted signals for apa1z2 event 4



# Channel signal shapes: short drift

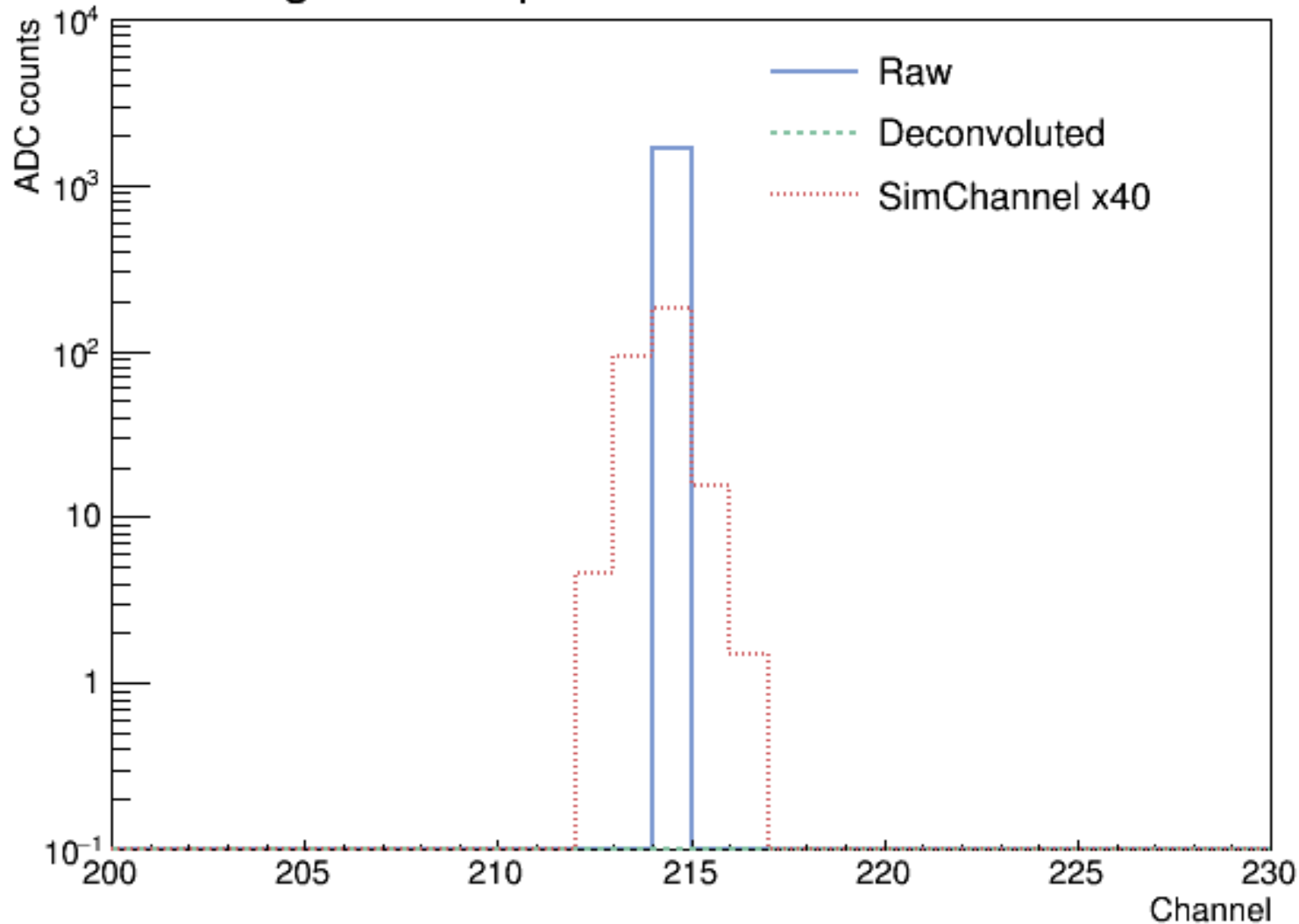
Signals for apa1z2 event 4 ticks 200-249





# Channel signal shapes: long drift

Signals for apa1z2 event 4 ticks 3800-3849



# Comments on channel spectra

## Raw spectrum

- For long drift, narrower than SimChannel (from which it is derived)
- Are small signal rejected by threshold on raw signals?
  - Zero suppression keeps adjacent channels and so can't be blamed
  - Single-channel threshold (integerization) doesn't explain observation
- Software problem??

## Deconvoluted signals

- Disappear for long drift
- Artifact of very many ticks on a wire or
- Problem with deconvolution algorithm?

# Conclusions

I looked at simulated, raw and deconvoluted signals

Longitudinal muon signals as function of TDC tick

- Suggest deconvolution might be improved
- E.g. add dependence on drift (need  $t_0$ )

Transverse muon signals as function of channel

- Suggest problem with detector simulation
- And maybe also issues with deconvolution

# Extras

Other issues

dune\_extensions

Detector displays

- Made with draw\_detector

# Other issues

## How to subtract pedestals from 35 ton data

- Tingjun pointed me to DetPedestalRetrievalAlg
- But I need to know how to configure this service in my fcl
- And how to use it in my code
  - Should I retrieve and subtract the pedestal for each channel individually?

## End process for muons

- I see muons that stop in LAr have an end process of
  - "FastScintillation" for the DUNE 35t detector and
  - "LArVoxelReadoutScoringProcess" for 10 ktw
- But the “real” end process is "muMinusCaptureAtRest" or “Decay”
- It would be convenient for me to see this changed

## ServiceHelper

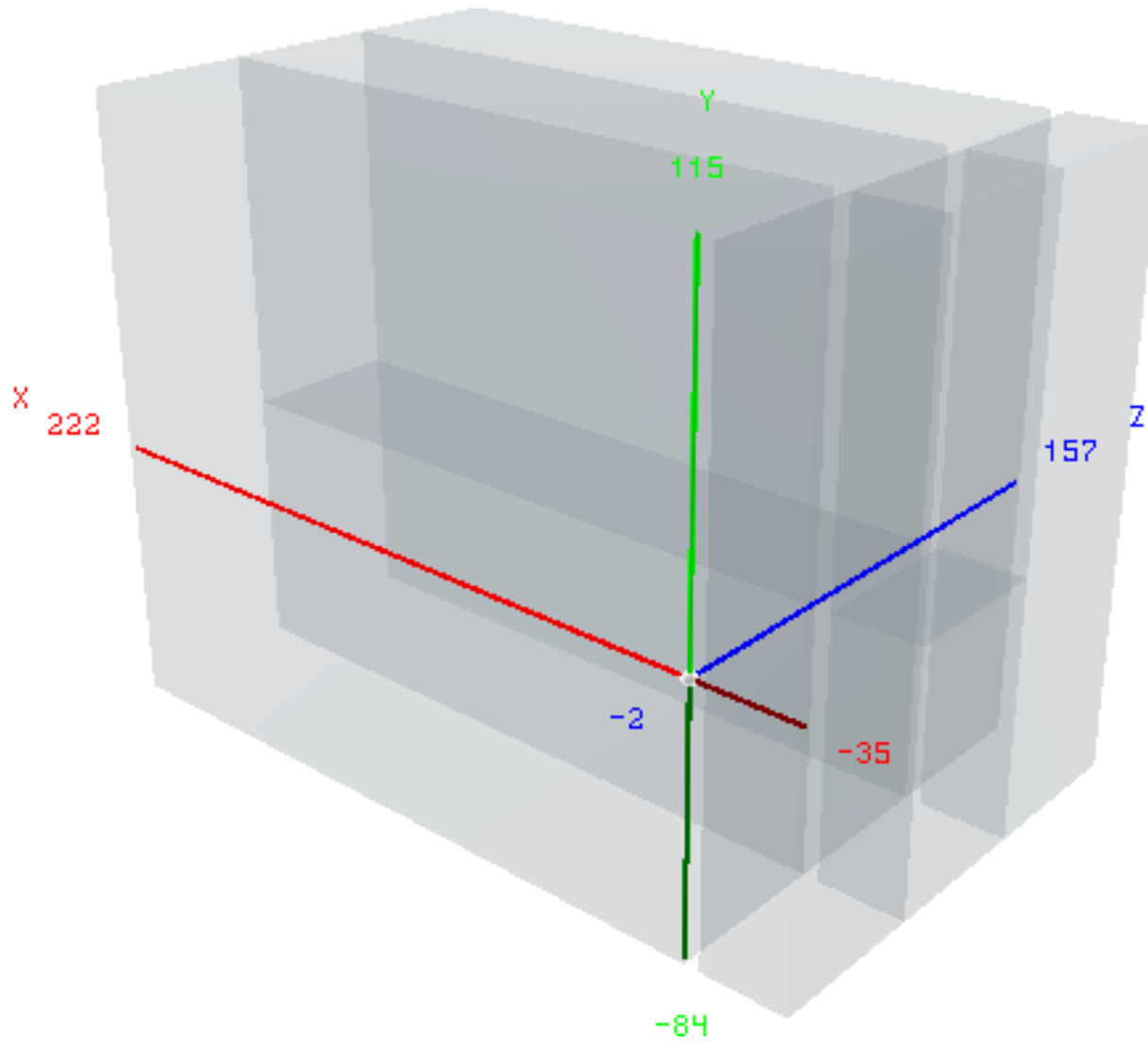
- I created this class that allows use of services outside the art framework
- Little progress in moving this to art, larsoft or DUNE

# dune\_extensions

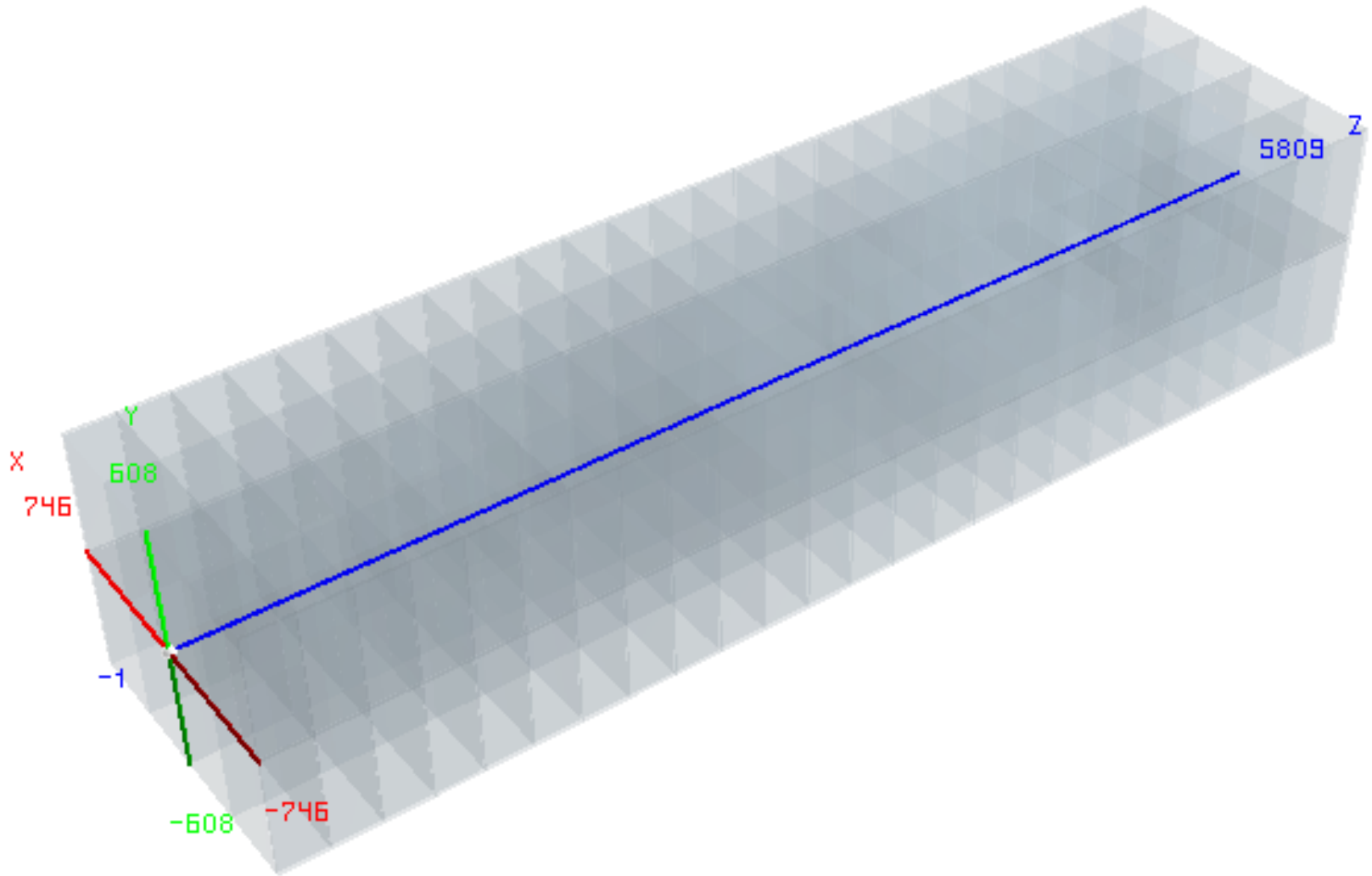
## Code used for the study here

- Code is in github
  - [https://github.com/dladams/dune\\_extensions](https://github.com/dladams/dune_extensions)
- Directories
  - ups: Usual ups stuff (including dependencies)
  - run: Directory for running the SW; includes run script
  - root: Root scripts to help use trees and histograms
  - DXUtil: C++ utilities
  - DXGeometry: Geometry helper classes
  - DXPerf: Classes to asses performance
  - DXModule: DXDisplay module to create histos, trees and performance results
  - exe: Binaries:
    - draw\_detector is a quick and simple detector display
    - dxroot: configures local directory to use Root scripts

# dune35t4apa\_v5



# dune10kt\_v1





# dune10kt\_v1\_workspace

