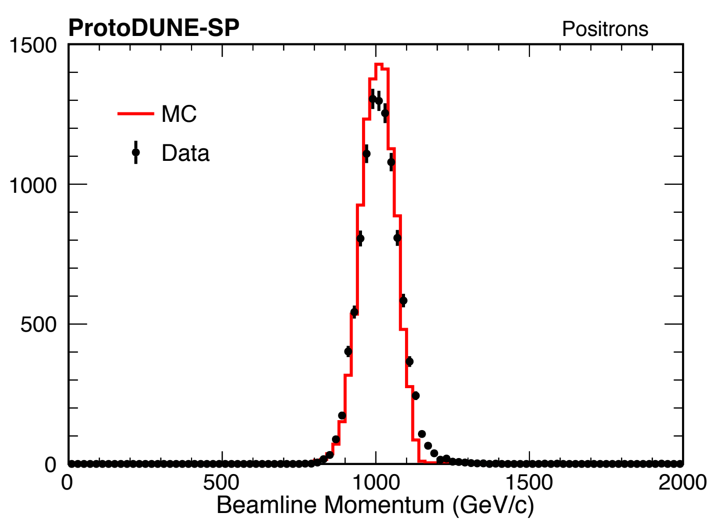
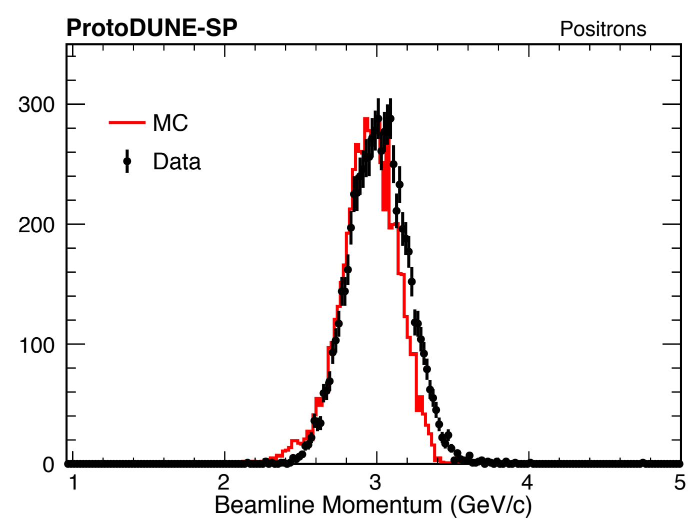
Electron Analysis Update

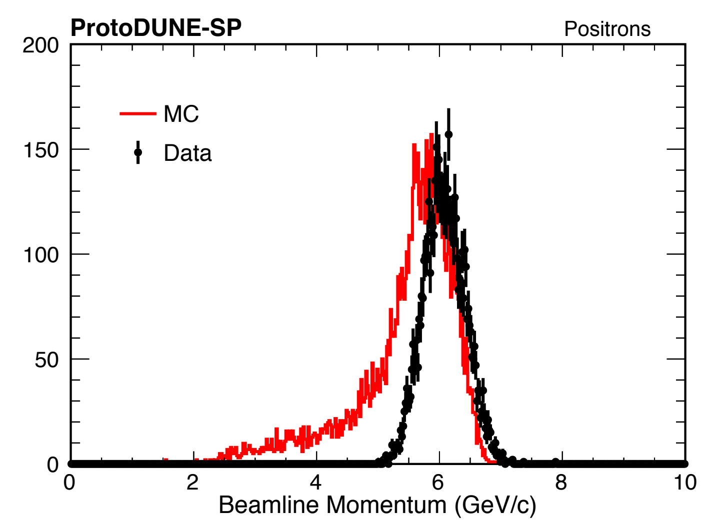
Aaron Higuera
University of Houston

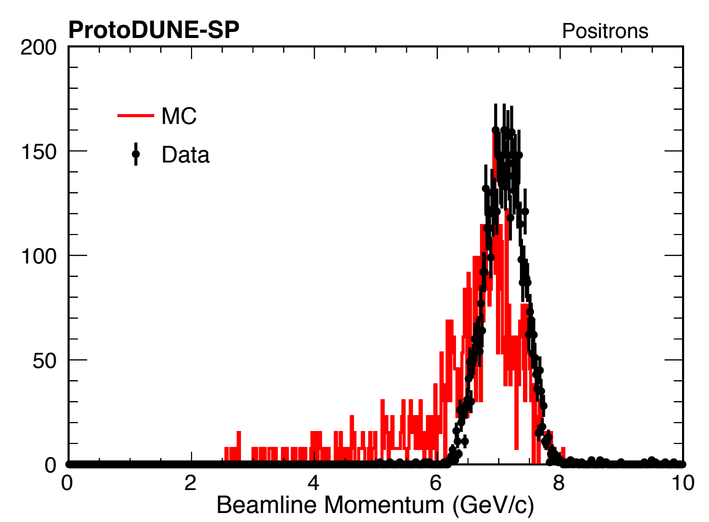
Beamline Simulation

As sanity check I looked at all the MC available to do a data/MC comparison
MC (1, 2, 3, 6 and 7 GeV)
2 GeV and 7 GeV very low statistics, today I will show only 1, 3, 6 and 7 GeV MC





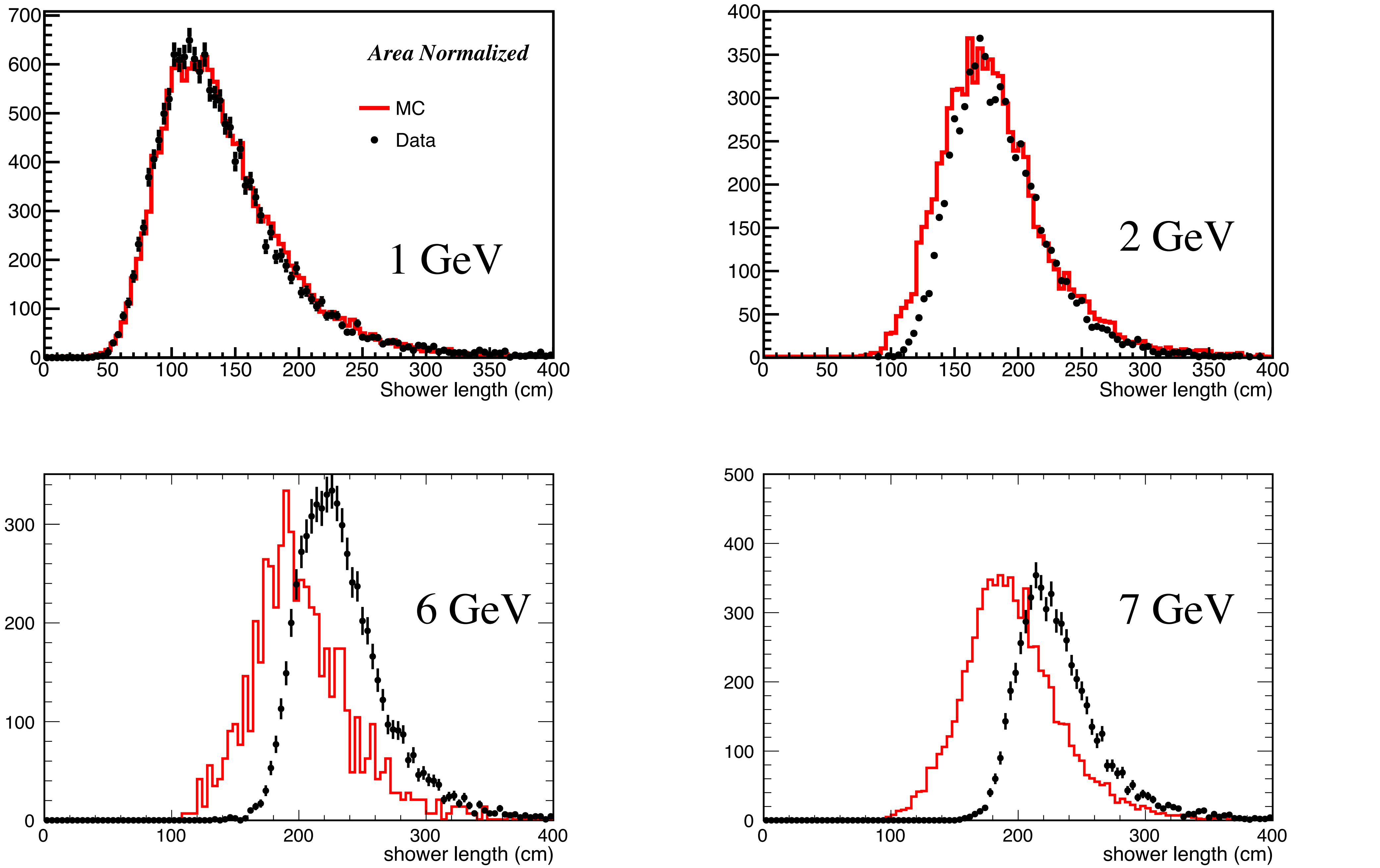




It is clear that the simulation of high momentum is quite different from data
MC is lower in momentum with a long tail
P_{peak} = 5.8 GeV (<P> = 4.9 GeV) Data <P>=6.07 GeV
P_{peak} = 6.8 GeV (<P>= 6.0 GeV) Data<P>=7.07 GeV

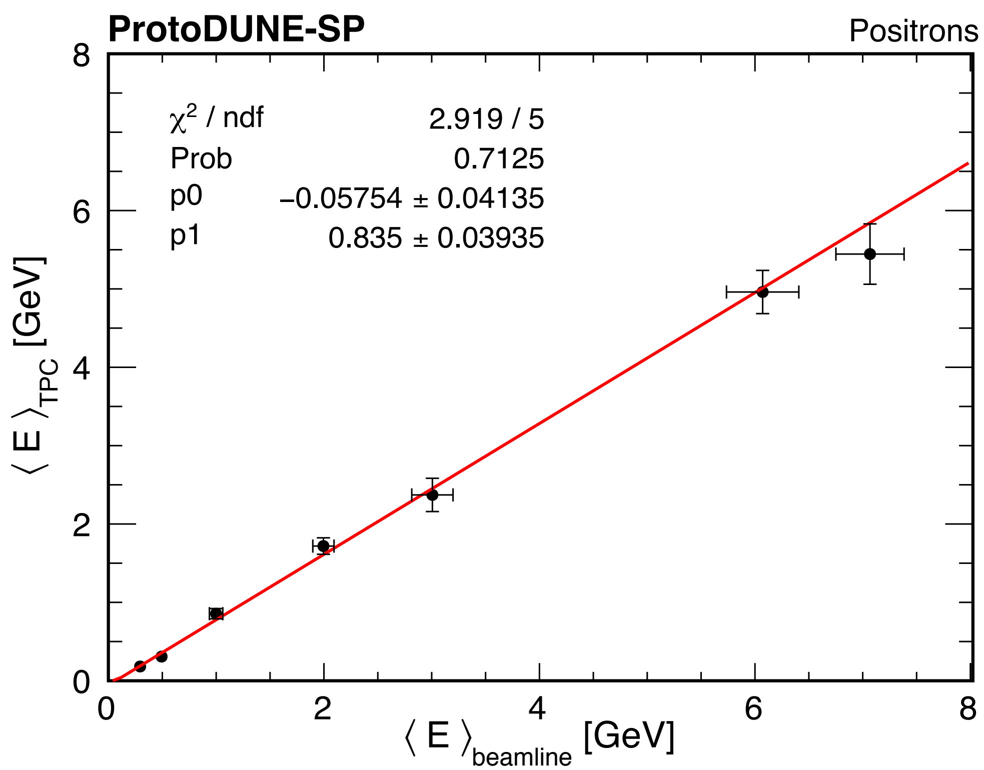
Beamline Simulation

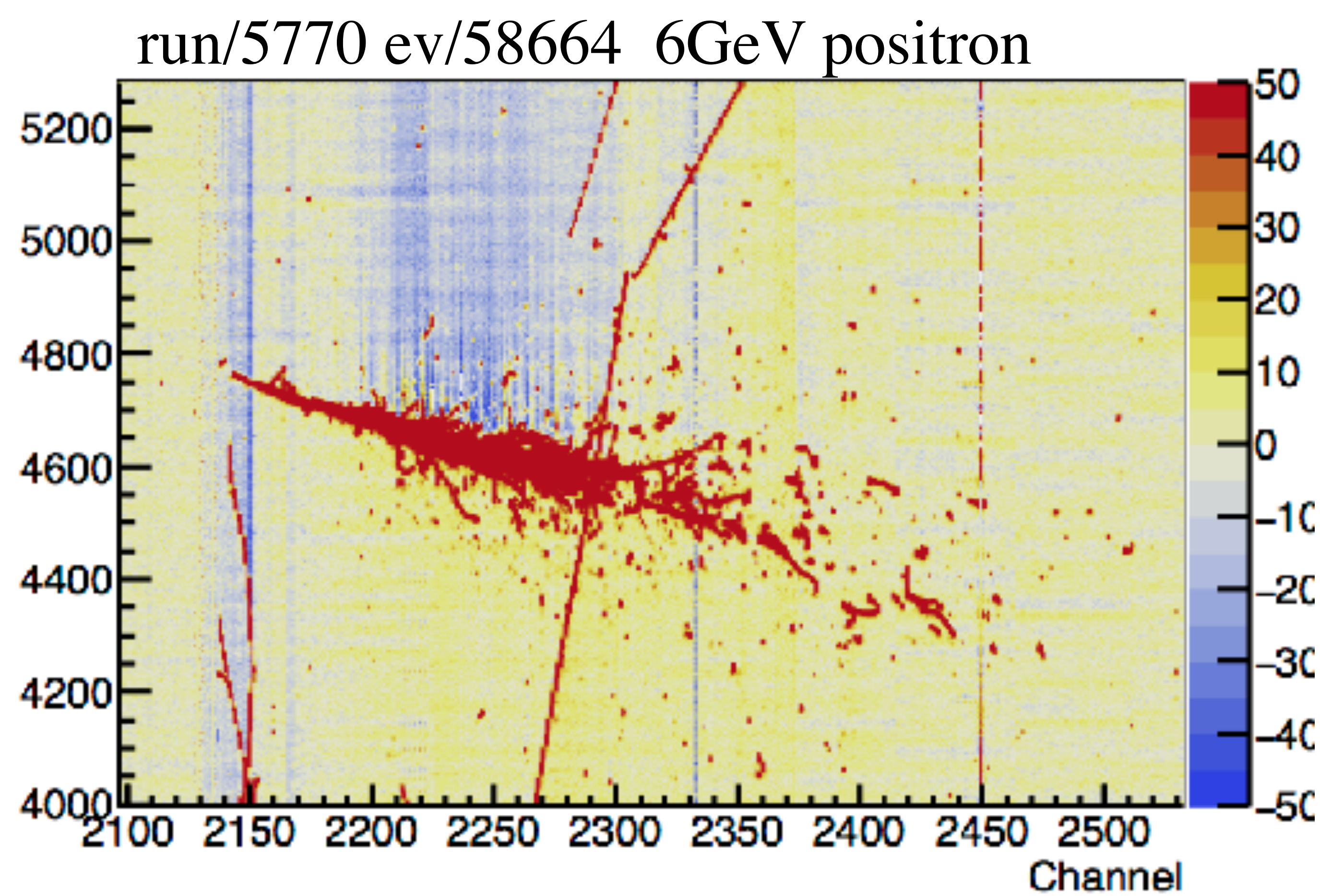
Difference in momentum has an impact on the analysis

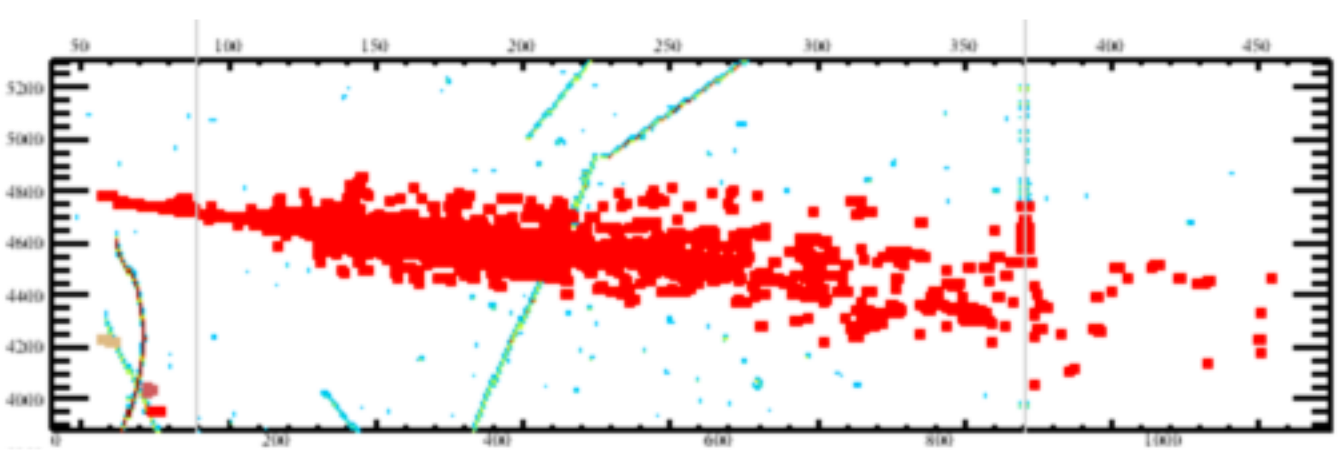


Energy Reconstruction

Energy Reconstruction







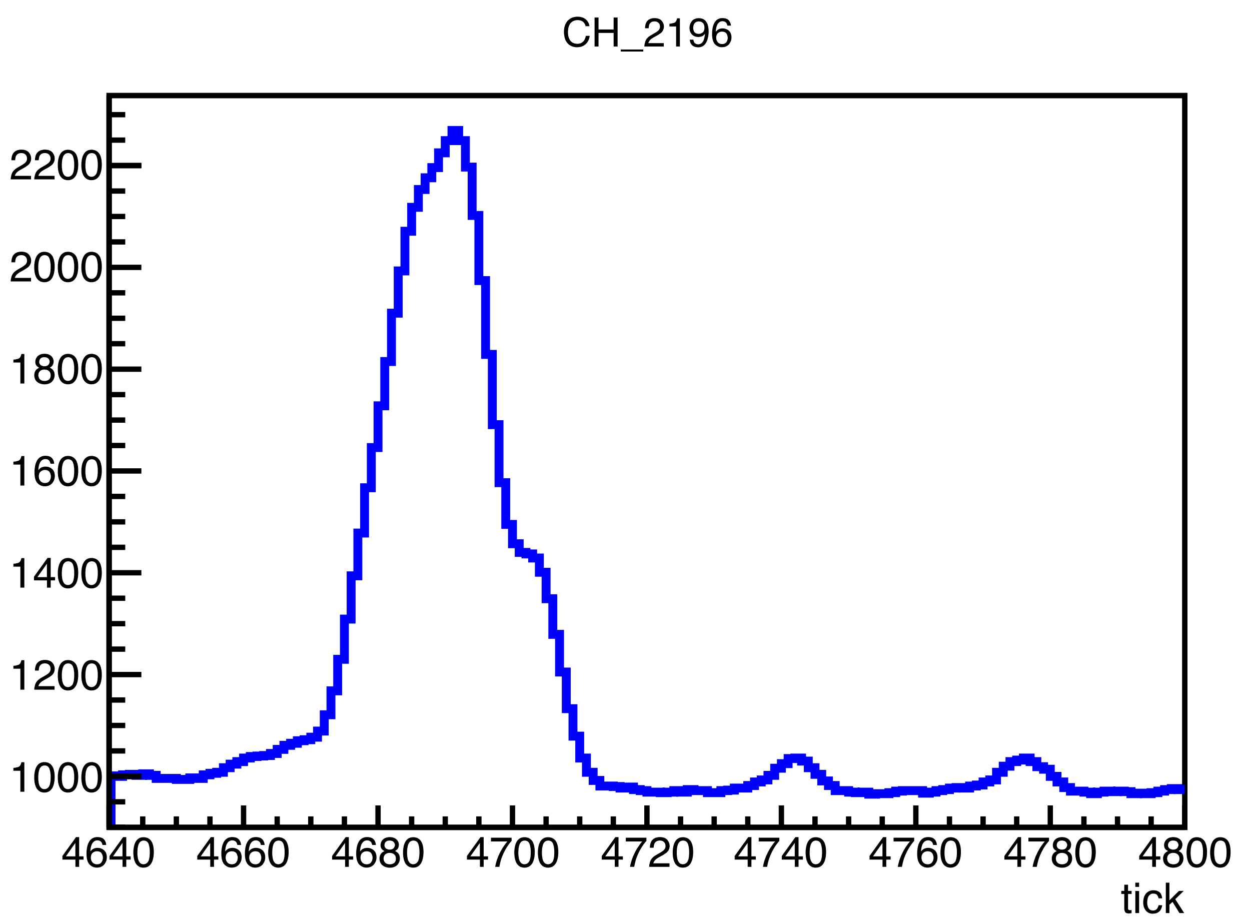
- No issues w/ reconstruction
- No issues w/ electronics, scanned several waveforms

Energy Reconstruction

$$E_{calo} = \sum_{i=1}^{i=N\ hits} \frac{\epsilon_i(X, YZ) dQ_i W_{ion}}{calorimetry\ factor \cdot Recombination\ factor}$$

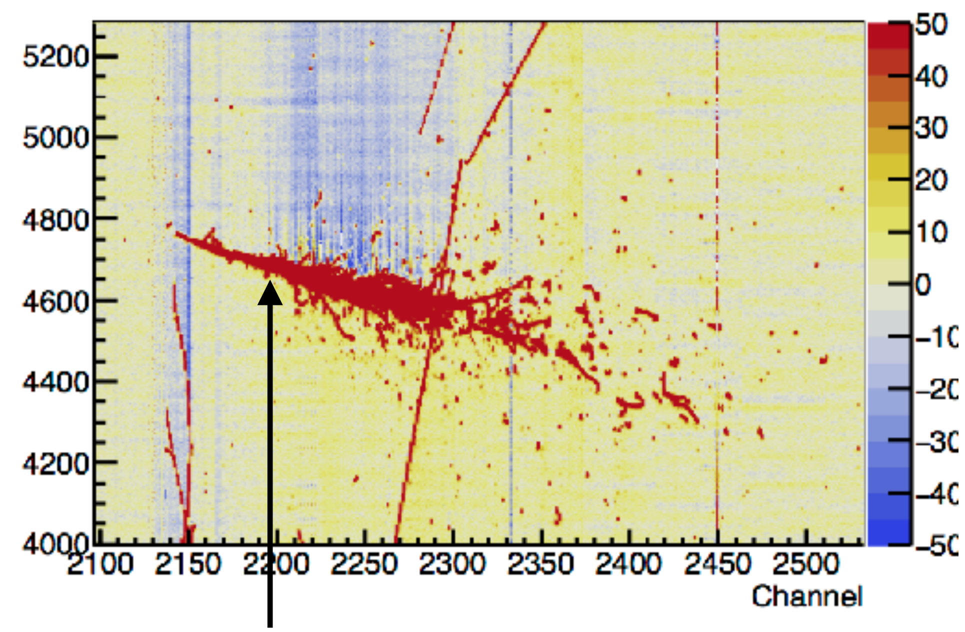
- epsilon_{i} = correction factor X(life time) and YZ(wire response, etc.)
- dQ_{i} = hit charge
- W_{ion} = 23.6e-6, from Argoneut
- calorimetry factor = convert ADC to electrons
- Recombination factor = 0.6417 (`larsim/LArG4/ISCalculationSeparate.cxx`)

Charge Integral



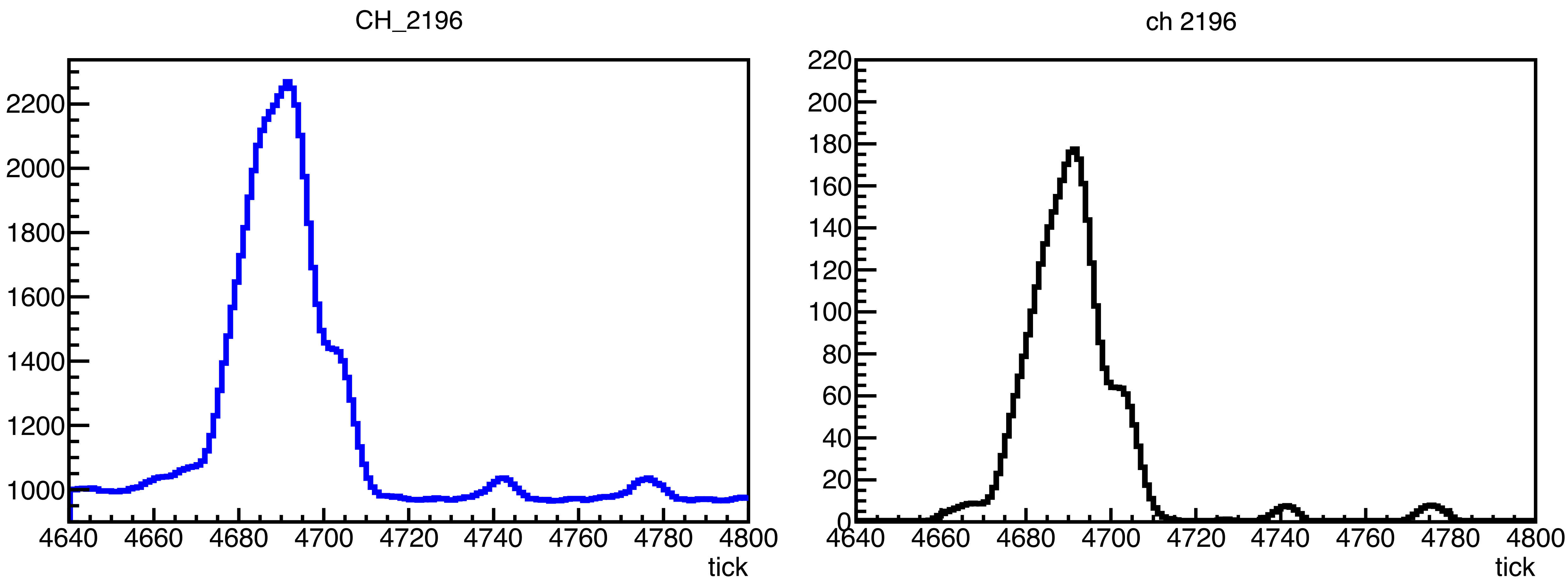
Raw wave form

- No issues w/ reconstruction
- No issues w/ electronics, scanned several waveforms



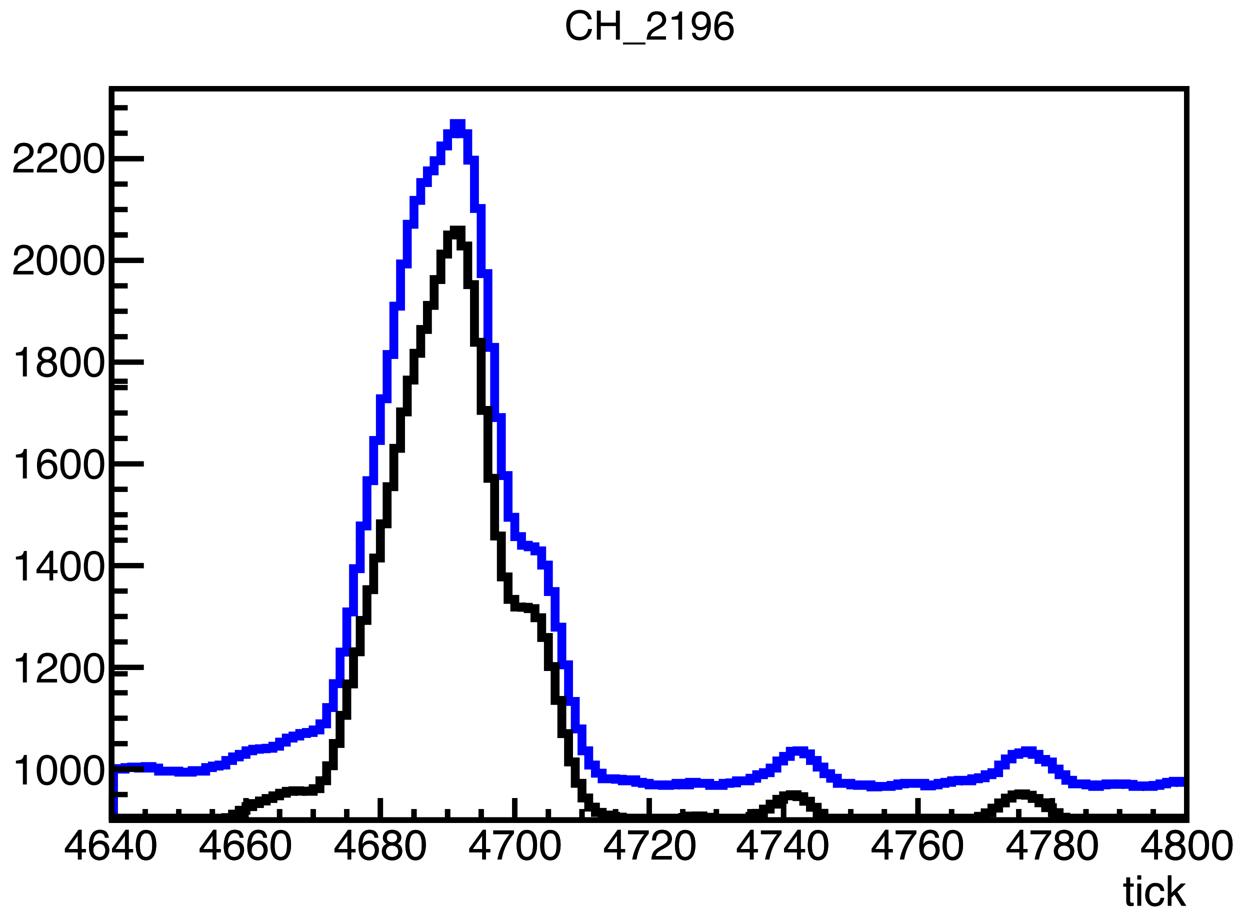
CH 2196

Charge Integral



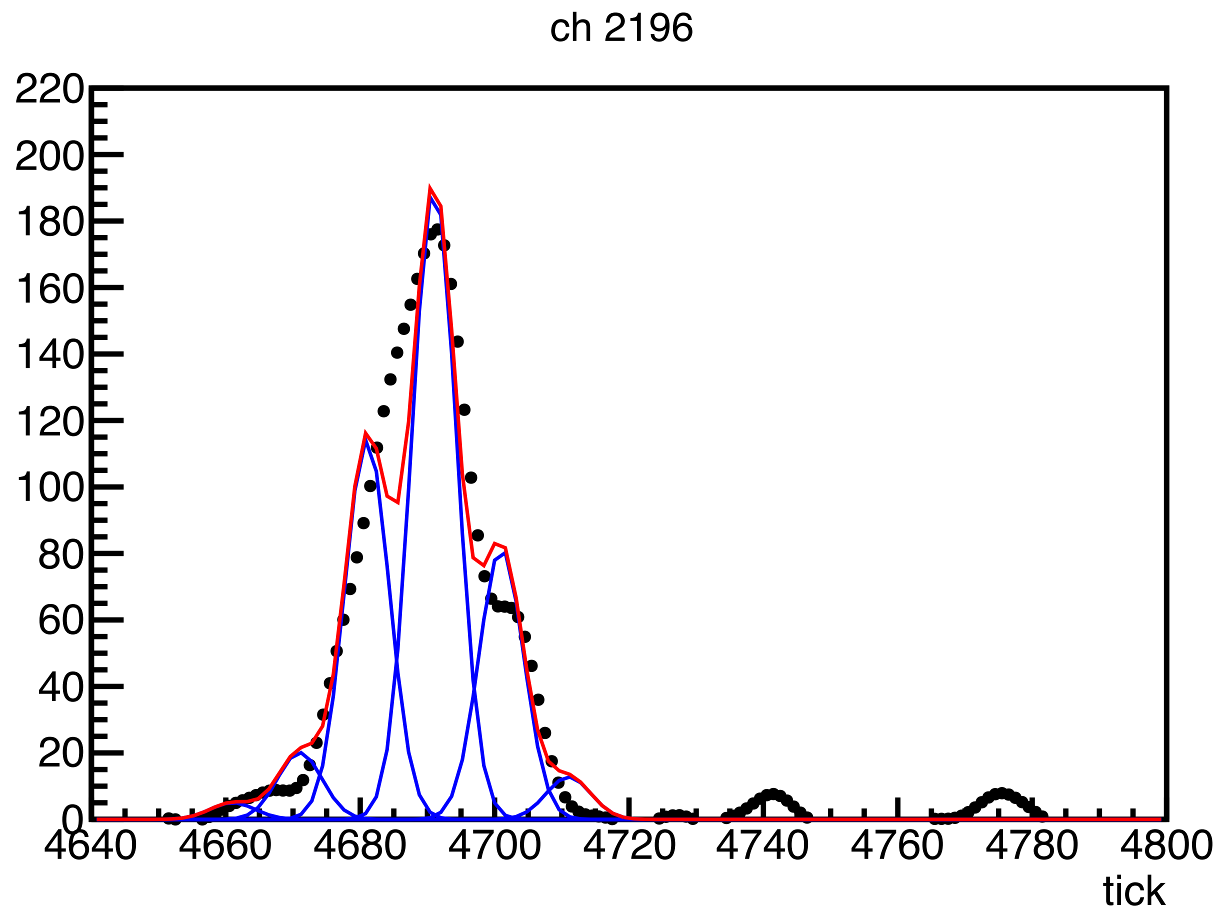
raw::RawDigit, raw waveform
recob::Wire wire, (after signal processing)

Charge Integral

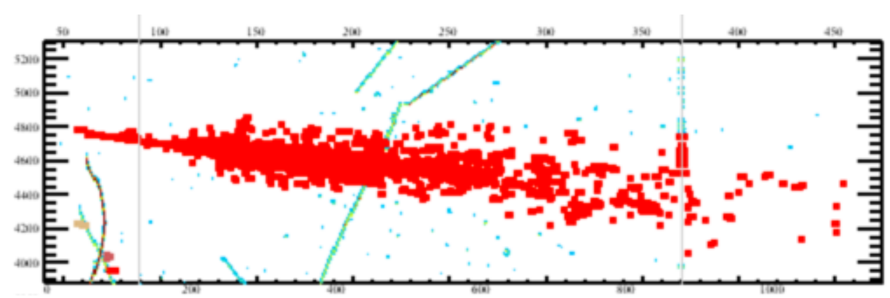


raw::RawDigit, raw waveform
recob::Wire wire, (after signal processing)
Signal processing “smear” the waveform (expected)

Charge Integral

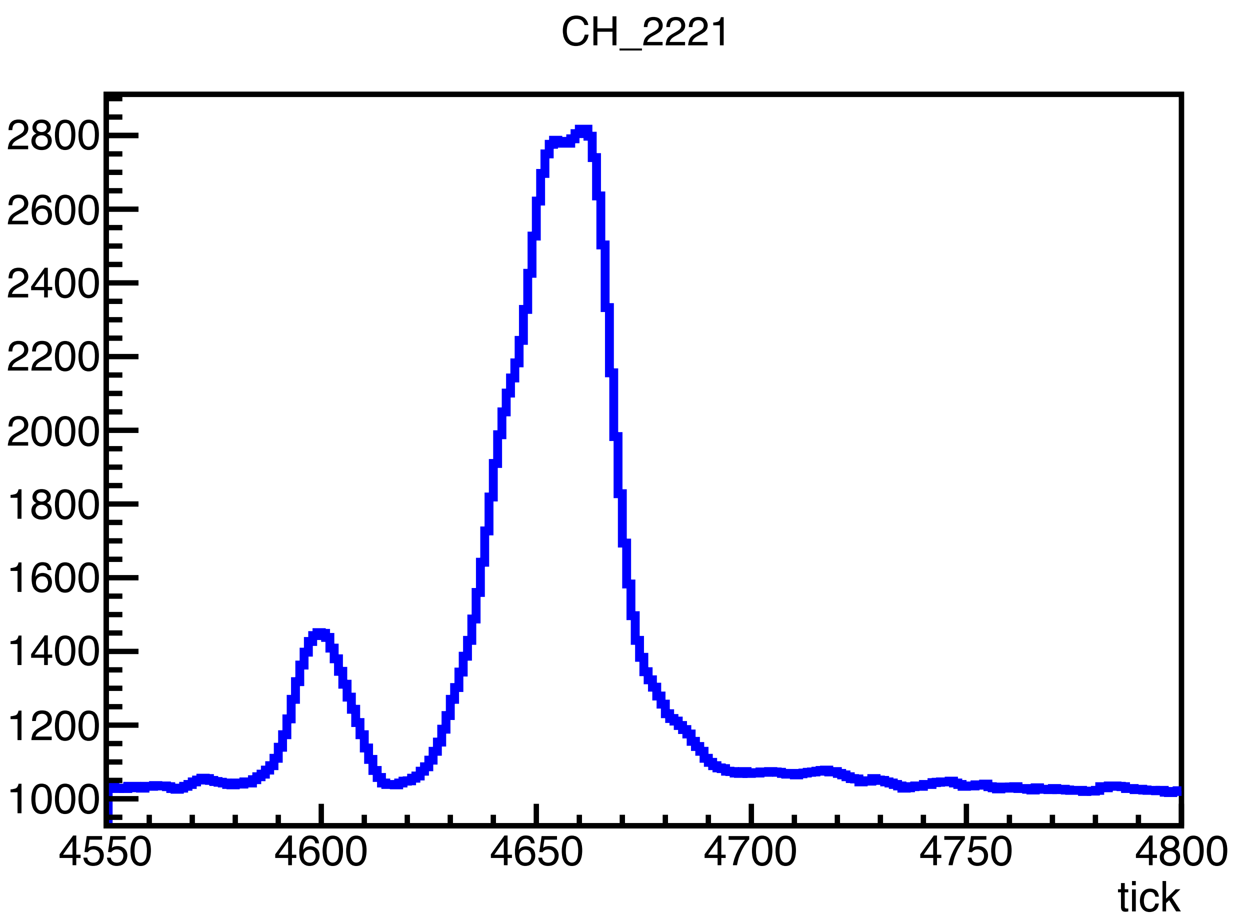


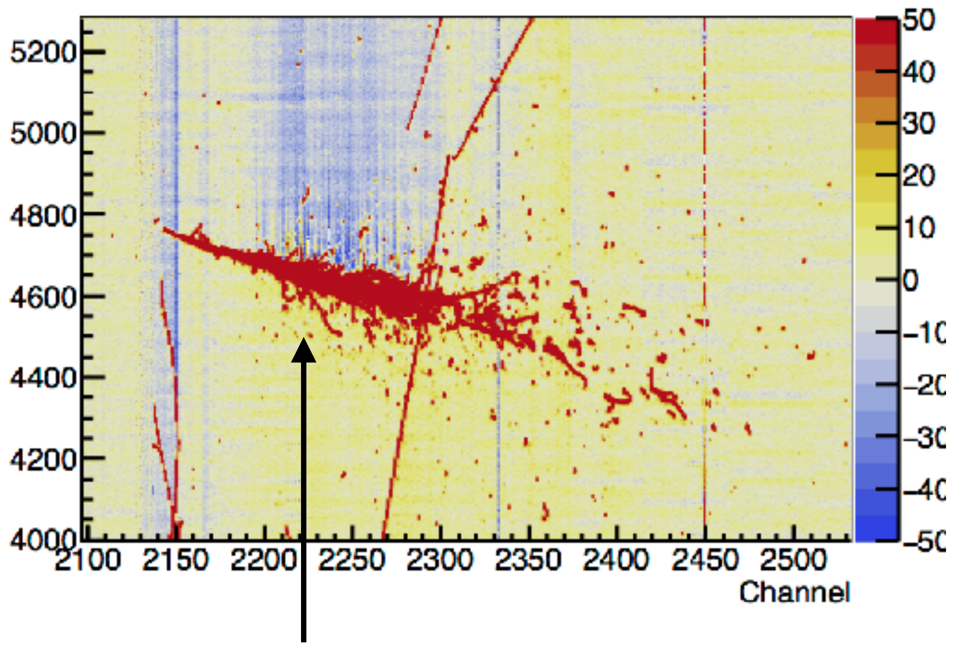
raw::RawDigit, raw waveform
recob::Wire wire, (after signal processing) Signal processing "smear" the waveform (expected)
recob::Hit hit (hitpdune), we use hit information to do patter recognition and to get charge from reco object (shower)



recob::Hit multiplicity 6
Integral of the gaussian hits (summedADC) = 3544.07
Integral of the waveform (recob::wire) = 4296.29
Deficit = 17.5%

Charge Integral



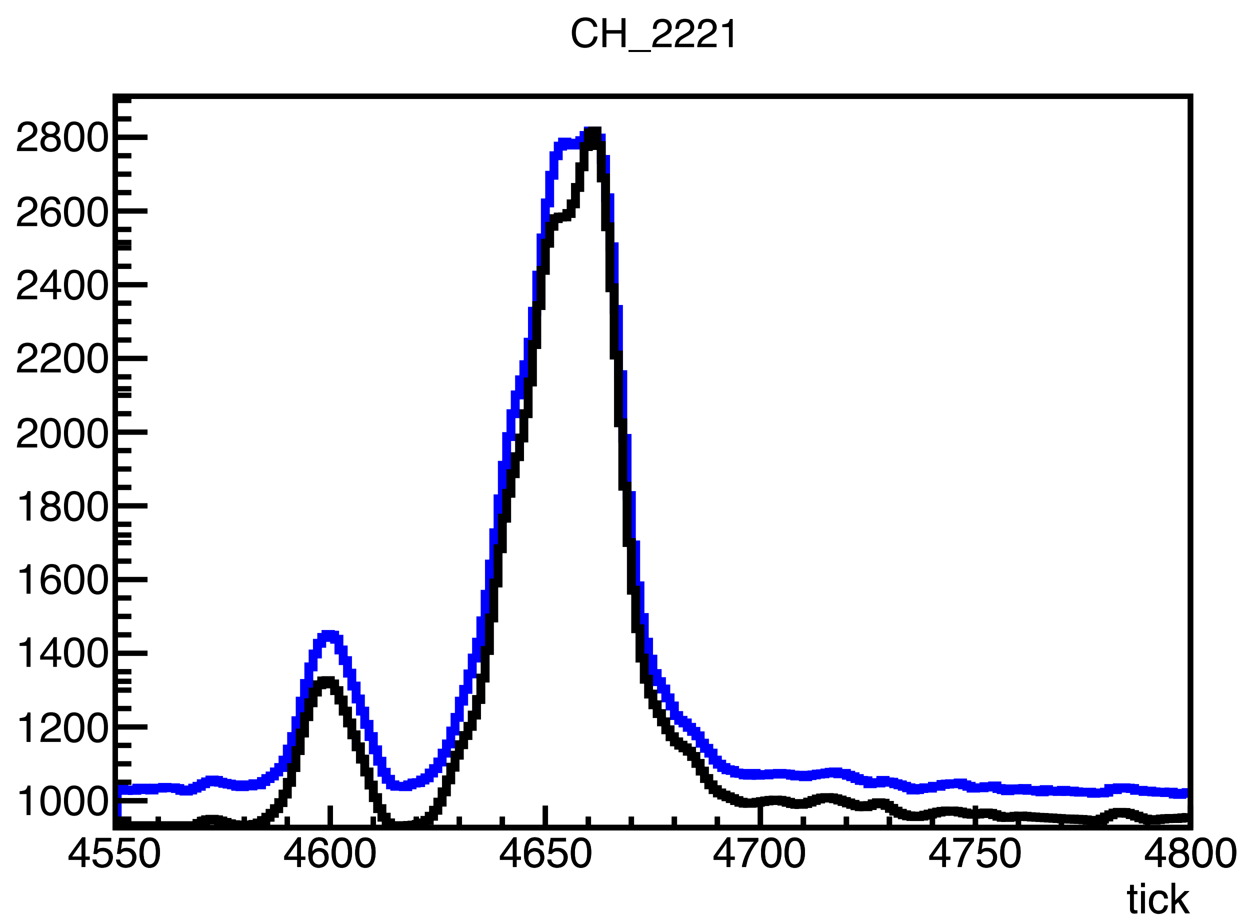


raw::RawDigit, raw waveform

recob::Wire wire, (after signal processing)

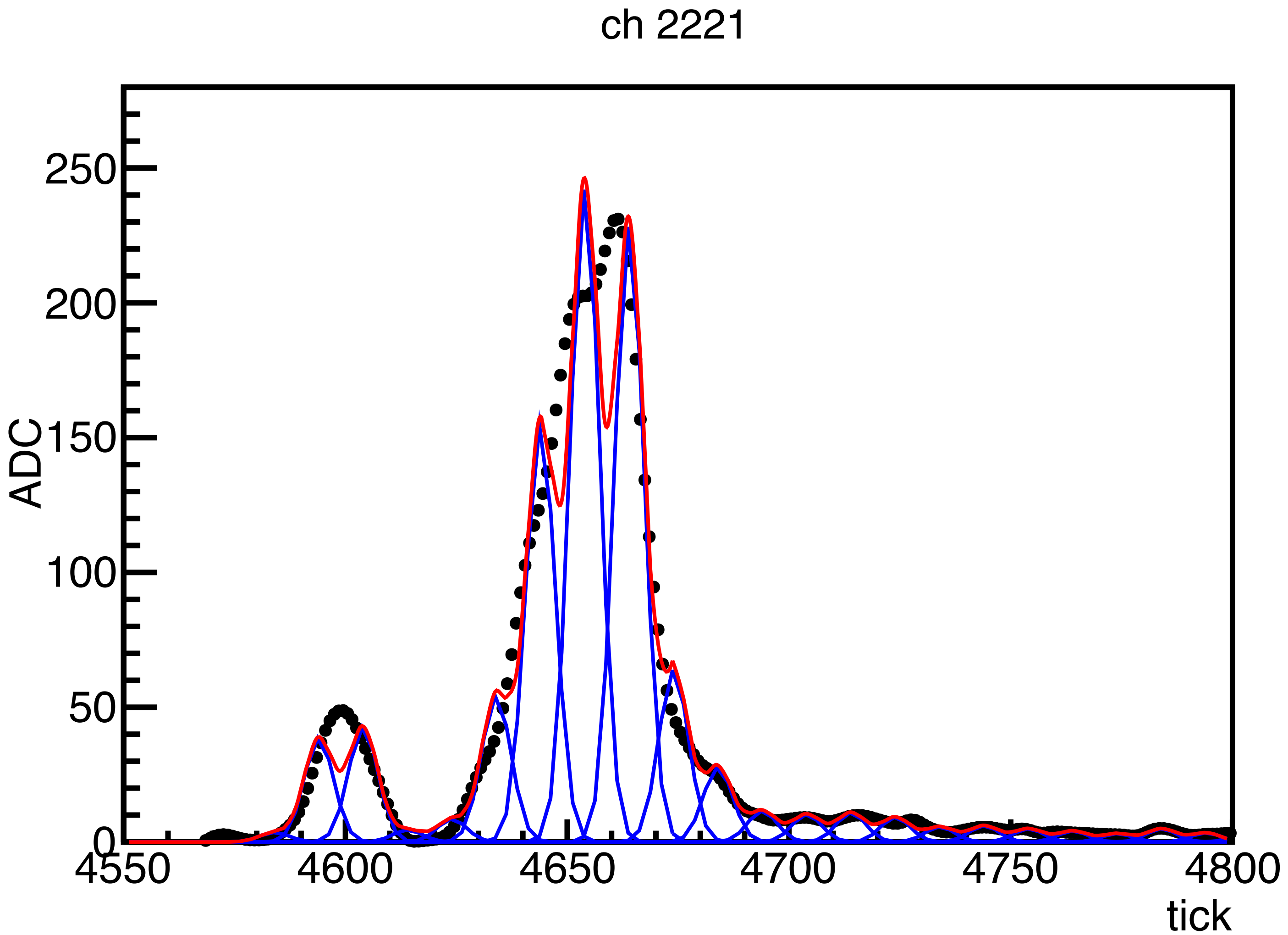
CH 2221

Charge Integral



raw::RawDigit, raw waveform
recob::Wire wire, (after signal processing)
Signal processing "smear" the waveform (expected)

Charge Integral



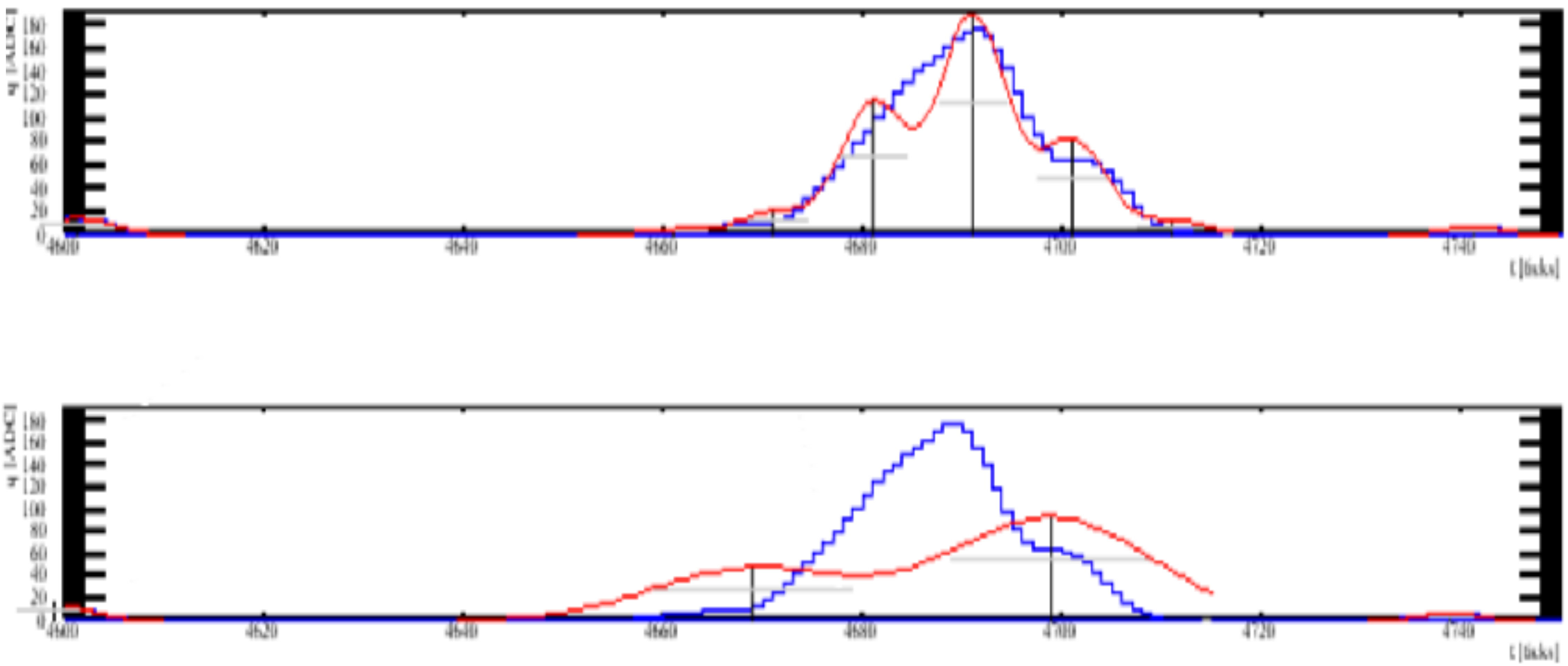
recob::Hit multiplicity 23

Integral of the gaussian hits (summedADC) = 7912.45

Integral of the waveform (recob::wire) = 9696.66

Deficit = 18.4%

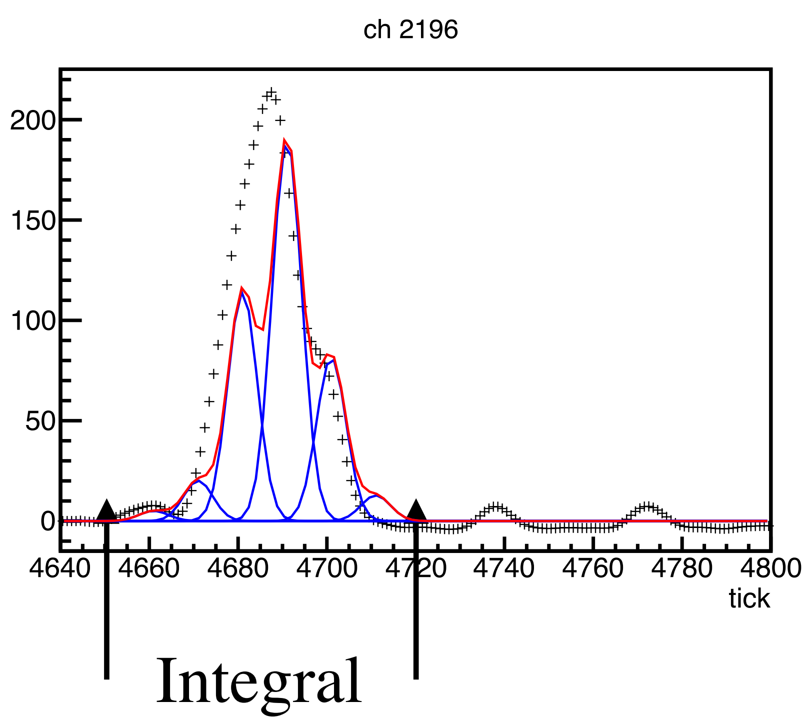
Tuning recbo::Hit



There is the option to tune `hitFinder` using `LongMaxHits` & `LongPulseWidth`
I'm not familiar with `hitFinder`, hard to find the right settings (energy dependence)

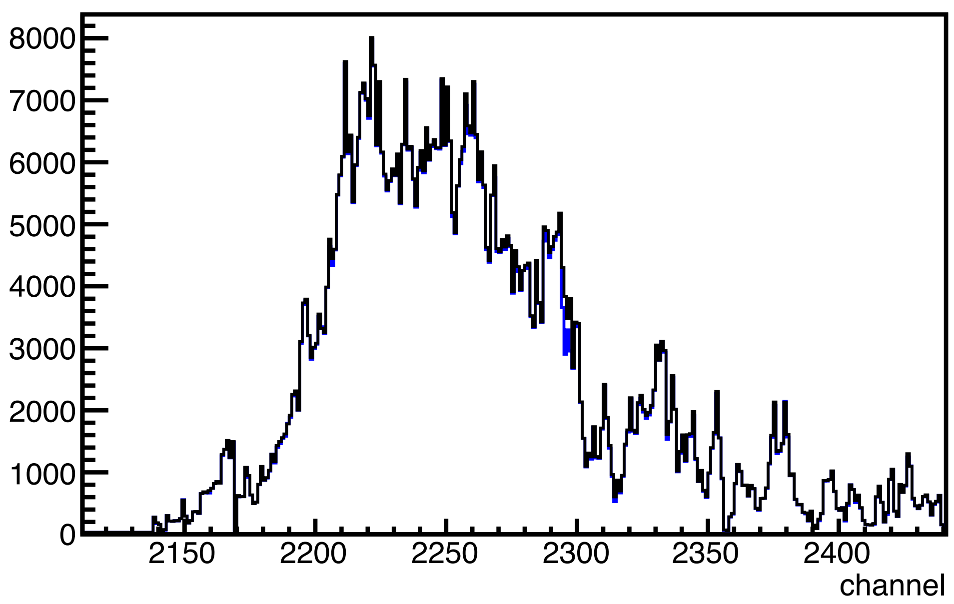
New Charge Integral

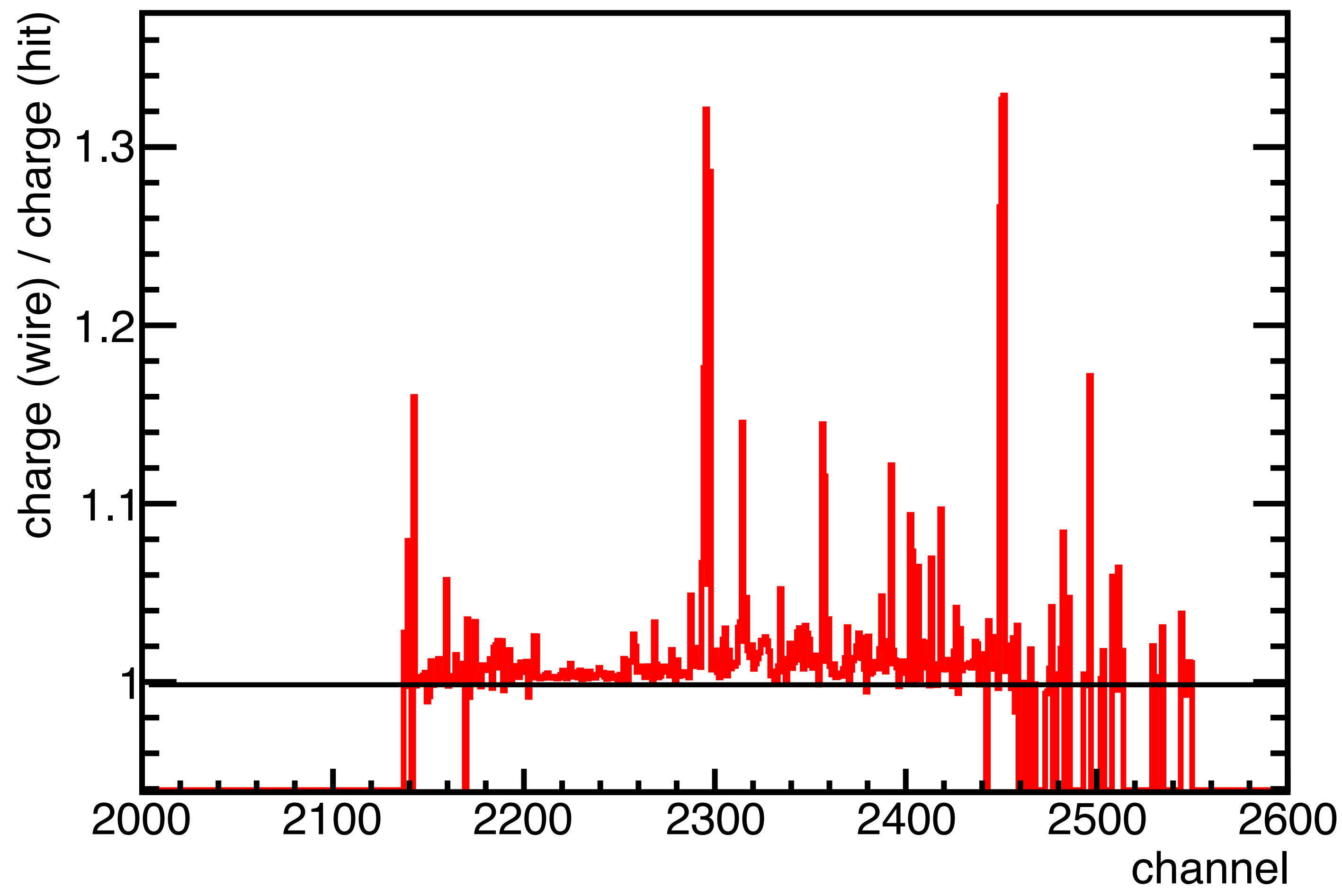
- Hit algorithm is doing great job for patter recognition (shower reconstruction)
- Hit integral misses some of the charge, this issue is evident at the core of the shower where charge density is higher due to high hit multiplicity
- A gaussian fit cannot account for the total integral
- We have recorded the charge already we just need to make sure we uses all the charge



- Look at recob::hit, get hit peaktime ± 5 sigmas
- from recob::hit get channel_ID and integral the charge on that recob::wire from peaktime ± 5 sigmas
- If hit multiplicity is greater than one, use min peaktime ± 5 and max peaktime ± 5 as integral range

New Charge Integral





- Overall I get ~20% more charge using the information from recob::wire

Electron Energy

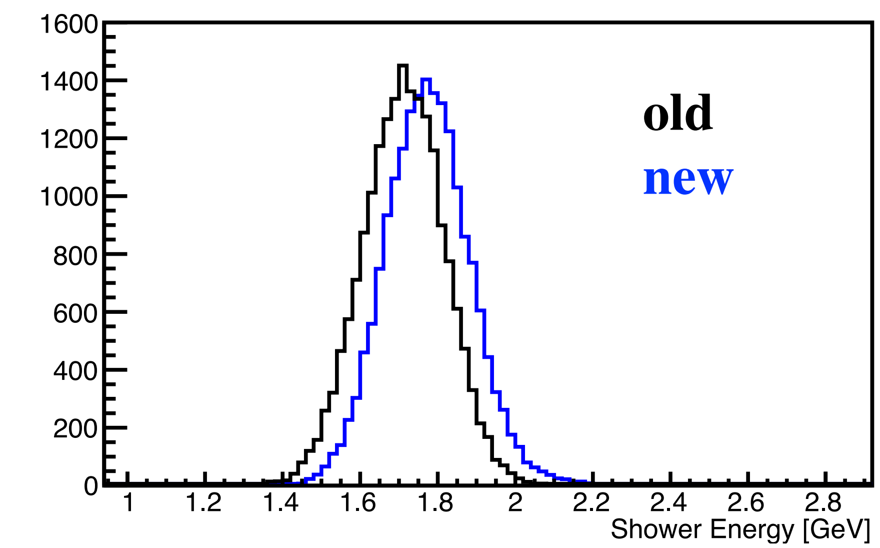
$$E_{calo} = \sum_{i=1}^{i=N\ hits} \frac{\epsilon_i(X, YZ)dQ_iW_{ion}}{calorimetry\ factor \cdot Recombination\ factor}$$

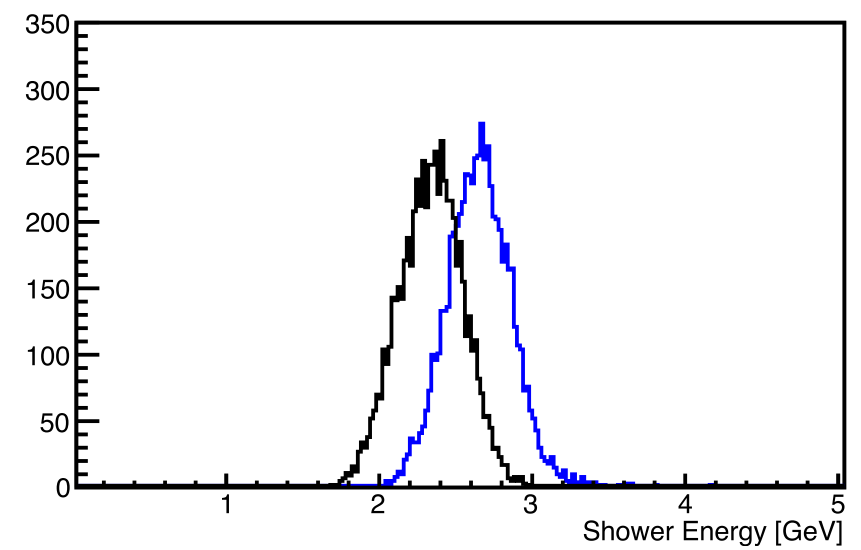
- epsilon_{i} = correction factor X(life time) and YZ(wire response, etc.)
- dQ_{i} = ~~hit charge~~ **wire charge**
- W_{ion} = 23.6e-6, from Argoneut
- calorimetry factor = convert ADC to electrons
- Recombination factor = 0.6417 (`larsim/LArG4/ISCalculationSeparate.cxx`)

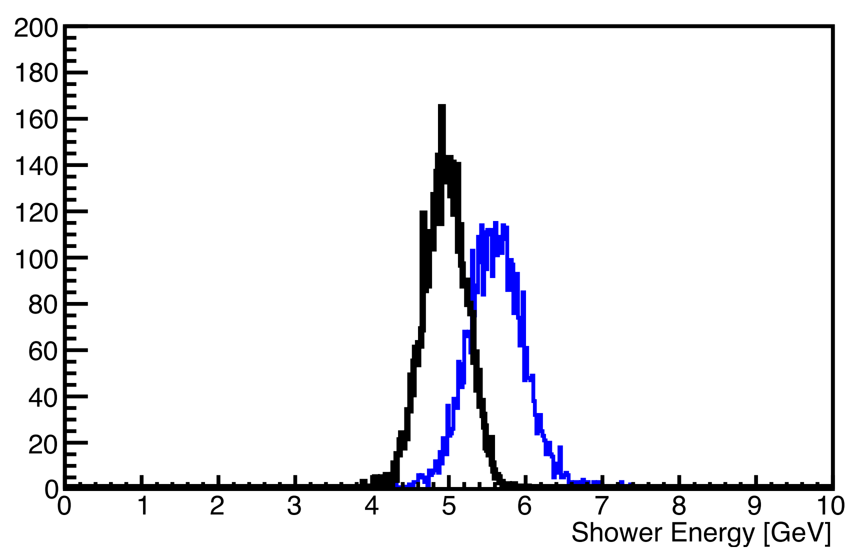
- Energy resolution bias?
- Previously I apply calorimetry correction for every hit. This will smear the energy distribution many-times as the hit multiplicity
- Now I apply calorimetry correction on a wire with average X and Y. This will smear the energy distribution once per wire

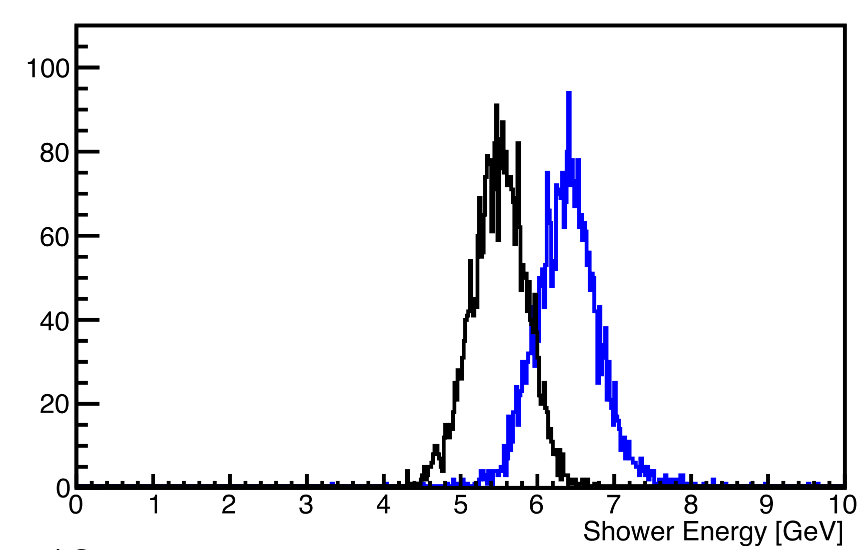
Electron Energy

- Re-calculate electron energy using integral over recob::wire (new method)
- Re-calculate 2, 3, 6, and 7 GeV data



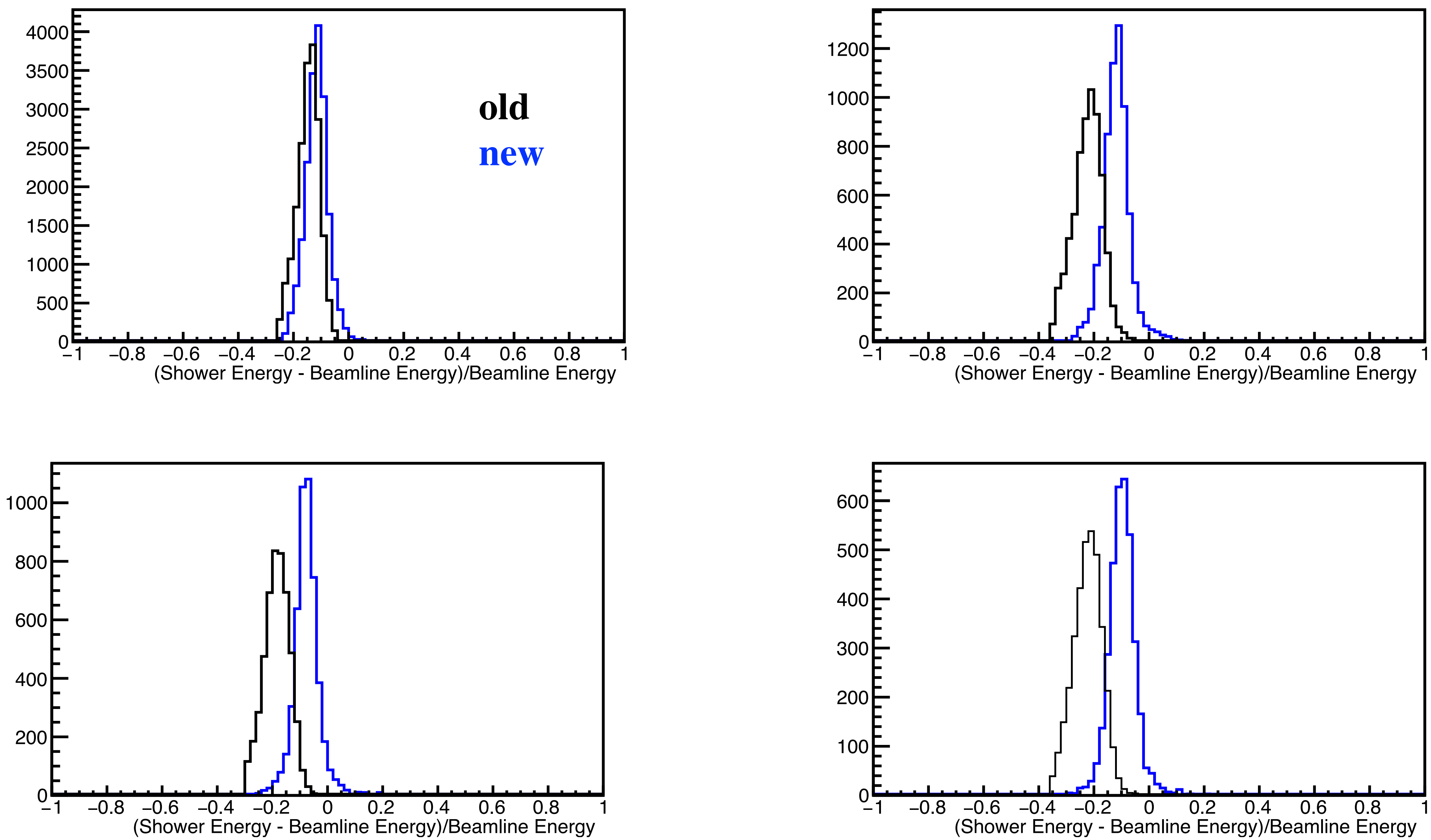




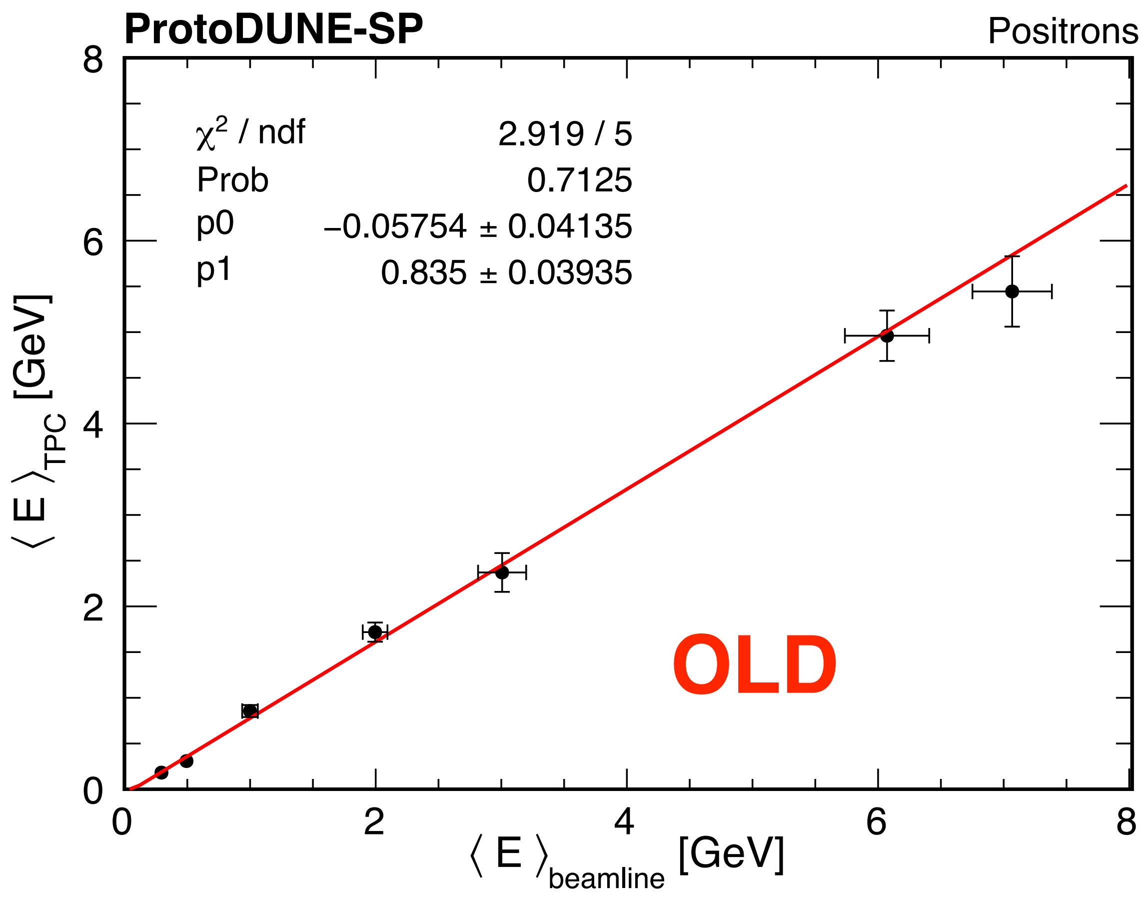


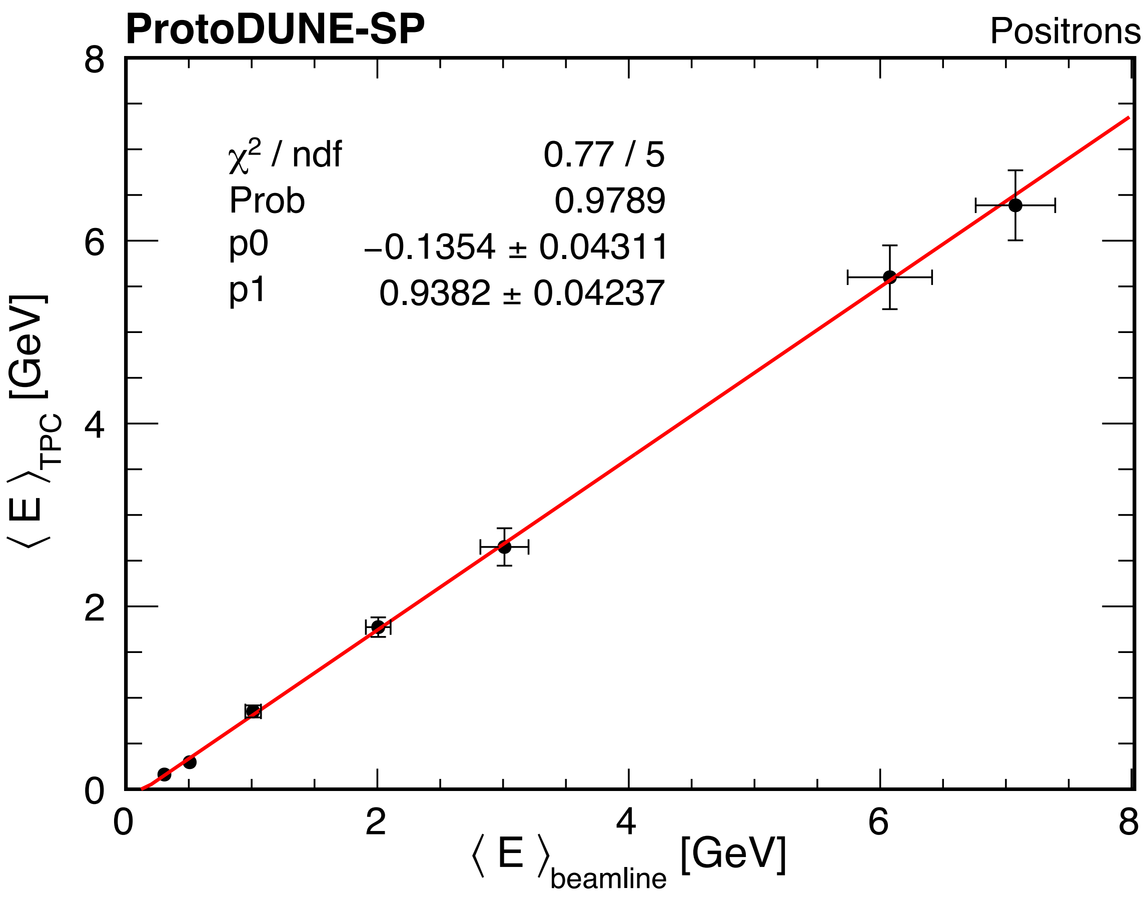
Electron Energy

- Re-calculate electron energy using integral over recob::wire (new method)
- Re-calculate 2, 3, 6, and 7 GeV data



Electron Energy





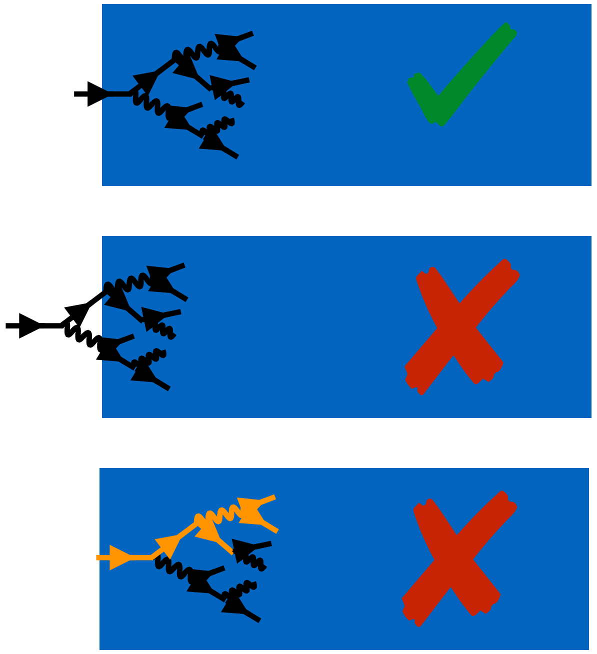
Summary

- New energy reconstruction gives better results
- Use MC to validate method, look at purity

The End

Electron Analysis

- Sample Production 2
- Selection
  - Beamline momentum reconstruction & quality cuts
  - Electron candidate (Cherenkov ID)
  - PFP beam particle most be a shower
  - Complete shower

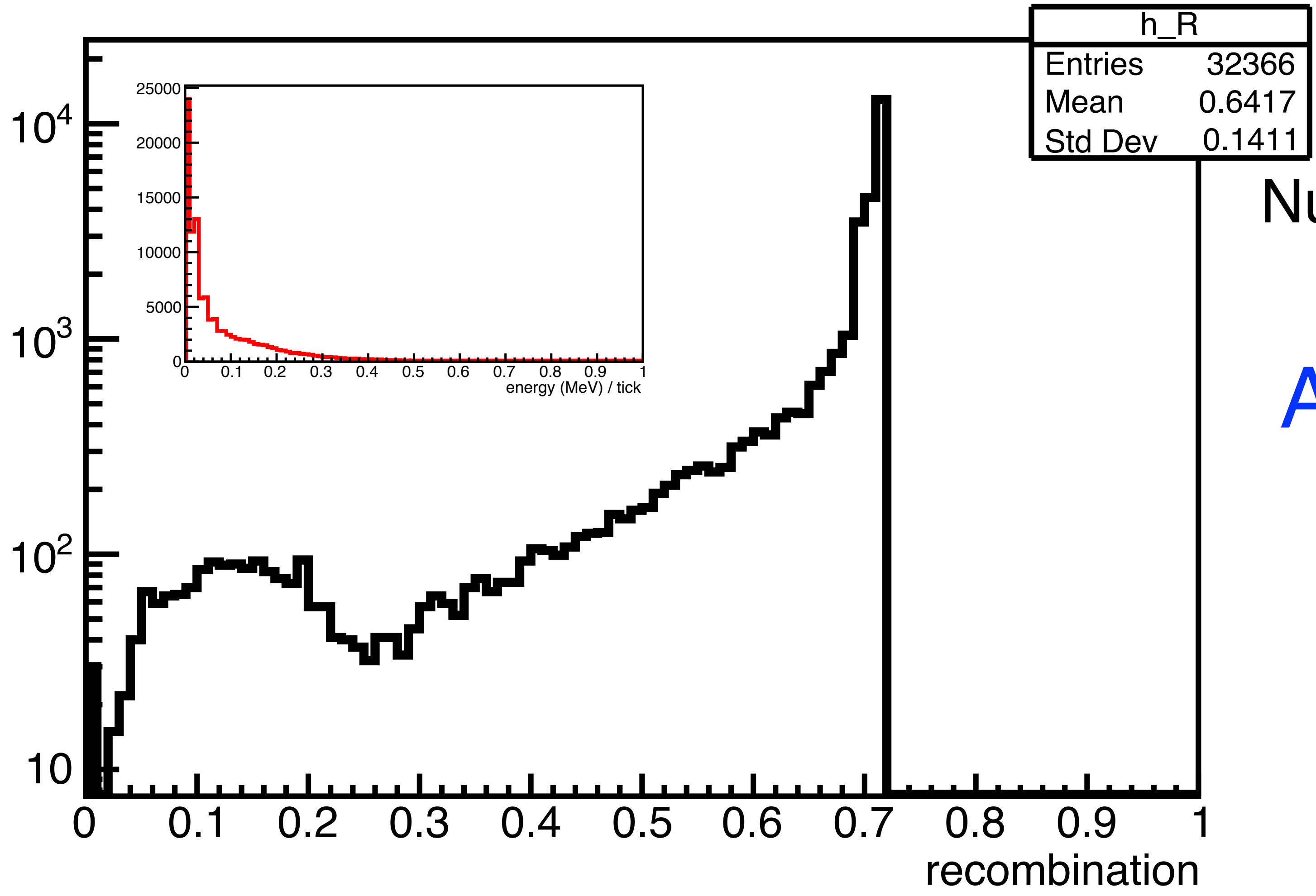


Recombination Factor

See, `larsim/LArG4/ISCalculationSeparate.cxx`

ModBoxA: 0.930

ModBoxB: 0.212



Nucl.Instrum.Meth.A523:275-286,2004

Average value R=0.6417

$$E_{calo} = \sum_{i=1}^{i=N\ hits} \frac{\epsilon_i(X, YZ) dQ_i W_{ion}}{calorimetry\ factor \cdot Recombination\ factor}$$