Proposed changes to recob::Hit

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The methods in question

- recob::Hit
  - Contains two members that (in principle) estimate total charge in the hit

$$\sum_i (ADC)_i$$

```
143
144        /// The sum of calibrated ADC counts of the hit (0. by default)
145        float SummedADC() const;
146
147        /// Integral under the calibrated signal waveform of the hit, in tick x ADC units
148        float Integral() const;
149
```

$$\int_t \text{Fit\_to\_pulse\_shape}(t)dt$$

  - Seems reasonable to expect these to track each other fairly closely
  - All experiments use GausHitFinder to find hits, fill recob::Hit

DUNE energy reconstruction studies

Anselmo Meregaglia, et al.

- ## In course of energy reco studies, looked at SummedADC and Integral

  - ### Not all hits have good values for Integral
    - Gaussian fit sometimes fails

  - ### Generally, found that SummedADC as good as Integral in energy reco
    - In principle still works when Gaussian fit fails

$$\int_t \text{Fit\_to\_pulse\_shape}(t)dt$$

$$\sum_i (ADC)_i$$
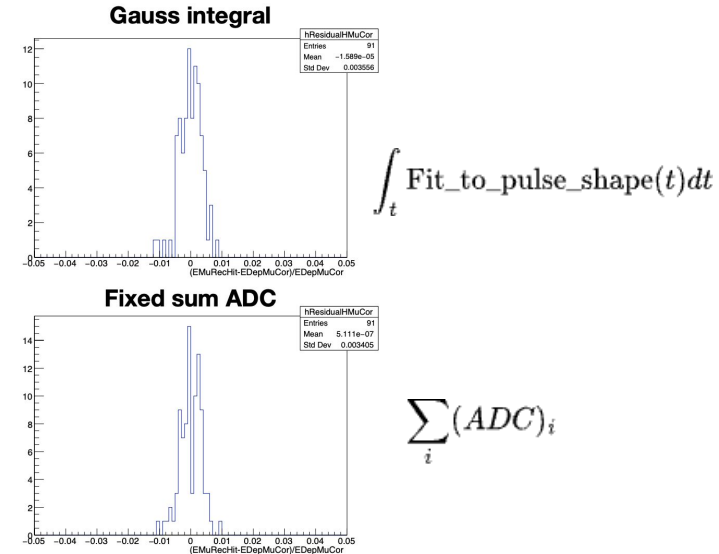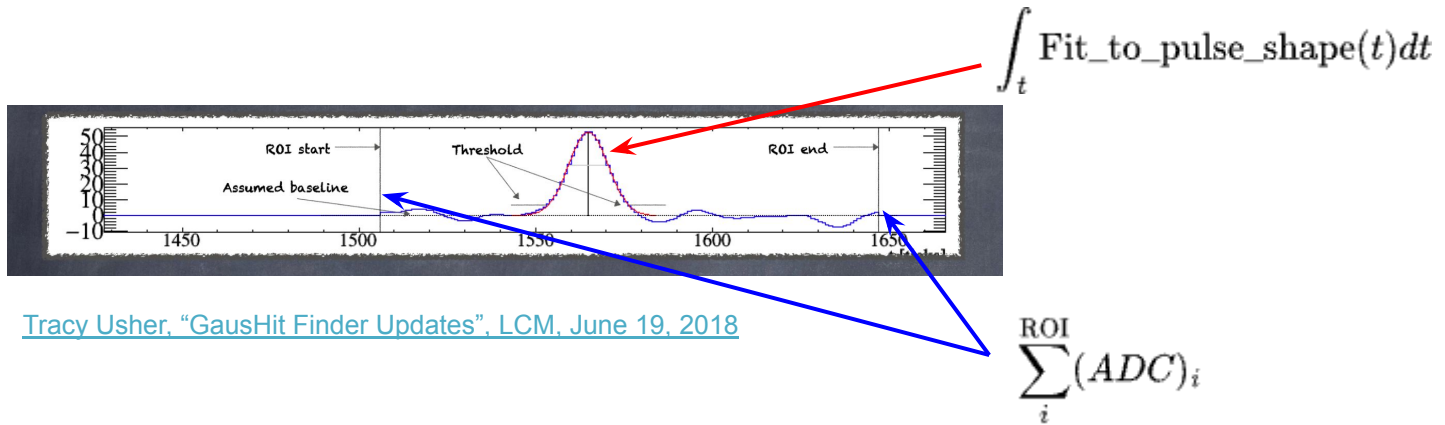
DUNE energy reconstruction studies

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- ## In course of energy reco studies, looked at SummedADC and Integral

  - Not all hits have good values for Integral
    - Gaussian fit sometimes fails

  - Generally, found that SummedADC
    as good as Integral in energy reco
    - In principle still works when Gaussian fit fails

  - Also noted that SummedADC does not
    always track Integral

Line: y=x
Blue: chi2=-1 (1.0%)
Red: chi2>10 (3.8%)
Green: 0<chi2<10 (95.2%)
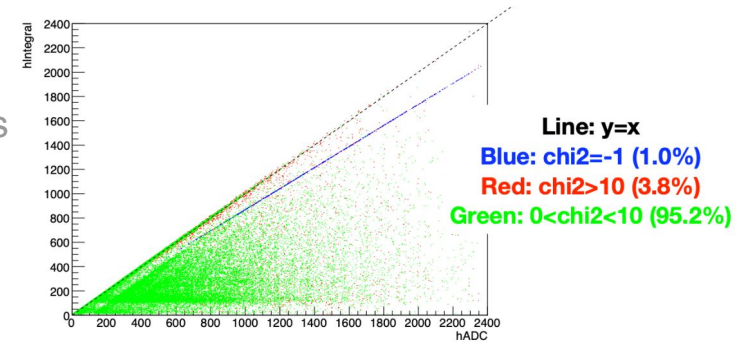
Hits from GausHitFinder

- Hits reconstructed within "region of interest" (ROI)

  - Isolated hits:

$$\int_t \text{Fit\_to\_pulse\_shape}(t)\,dt$$

Tracy Usher, "GausHit Finder Updates", LCM, June 19, 2018
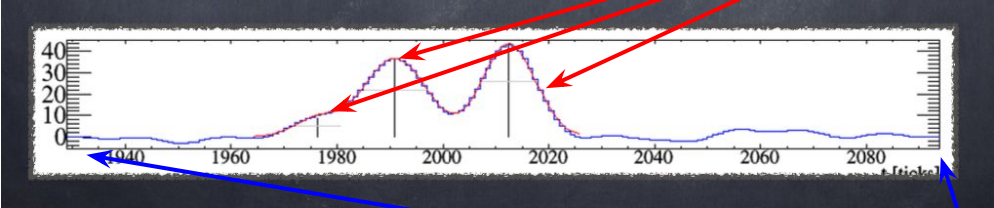
$$\sum_i^{\text{ROI}} (ADC)_i$$

  - Approximately same value of SummedADC and Integral

Hits from GausHitFinder

- Hits reconstructed within "region of interest" (ROI)

    - For overlapping hits:

$$\int_t \text{Fit\_to\_pulse\_shape}(t)dt$$

Each hit has distinct value of Integral

All hits in ROI get same value of SummedADC

$$\sum_i^{\text{ROI}} (ADC)_i$$

    - This is a known "feature" of GausHitFinder
        - Unclear from header comments that this is possible

What to do?

- ● DUNE proposes a "fix"
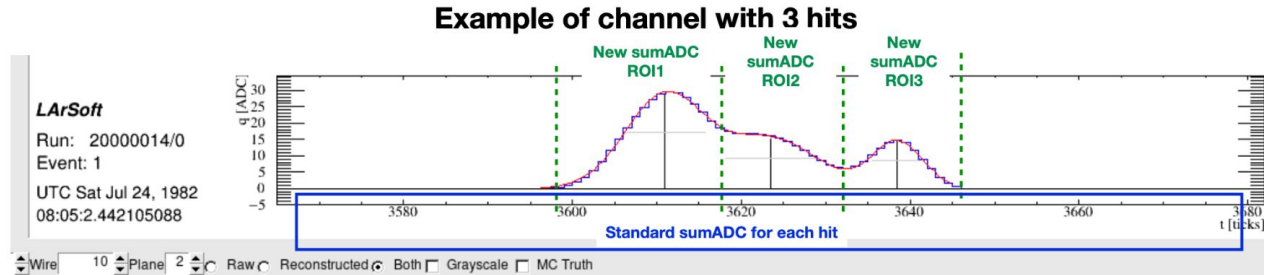
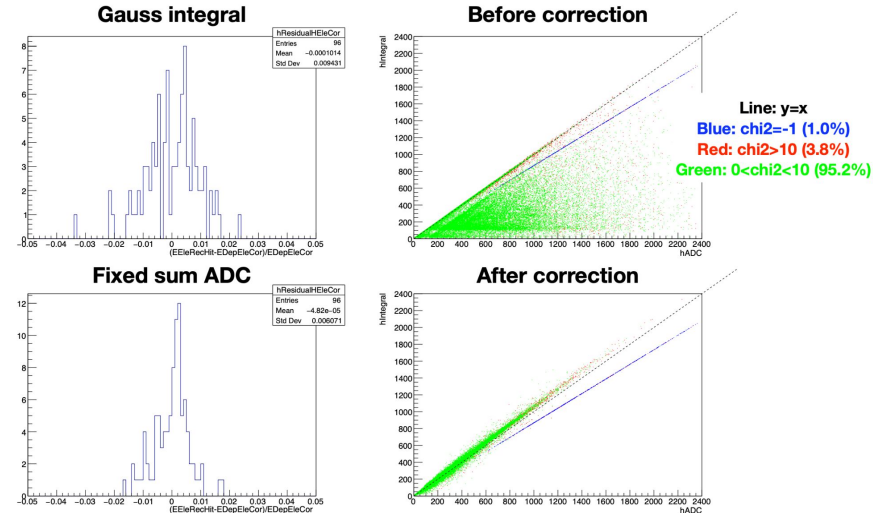Anselmo Meregaglia, et al.

- ○ Uses fitted sigmas to define region for ADC sum, sharing between overlaps

What to do?

- ## After the fix

  - ### SummedADC tracks Integral

  - ### Resolution in some cases improves

Hits study

Custom electron files (All events : each event has 1-2% of badly fitted hits)

Gauss integral   Before correction

Line: y=x
Blue: chi2=-1 (1.0%)
Red: chi2>10 (3.8%)
Green: 0<chi2<10 (95.2%)

Fixed sum ADC   After correction

Resolution improvement (from 0.9% to 0.6%) and correct agreement between integral and sumADC

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Proposed changes to recob::Hit

SummedADC is in use, so cannot just change the behavior

- Proposal
    - Change name of "SummedADC" to "ROISummedADC"
        - Describe as algorithm-dependent value that may sum over full range for overlapping hits (the "ROI")
    - Add following methods / data members
        - HitSummedADC()
            - Algorithm-dependent value equal to sum of ADC for time ticks assigned to the hit.
            - Intended to be "simple" analog of Integral
        - HitSumStartTick(), hitSummedEndTick()
            - First and last time ticks used to calculate HitSummedADC()
            - In same units as StartTick() and EndTick()

Comments, discussion?

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The end