Energy reconstruction of supernova events

DUNE Photon Detector taskforce meeting

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Introduction

- Long term goal – what PD performance do we need to ensure best reconstruction of SN neutrino position and thus energy?
- Short term (today) – do the best energy reconstruction with the parameters we have

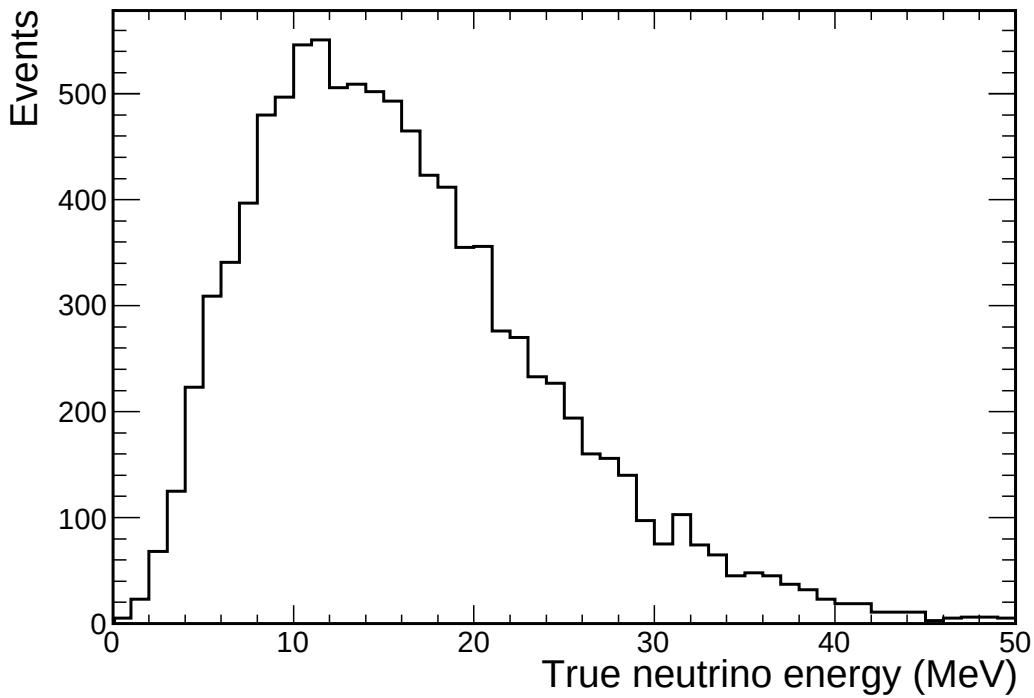
SNB workshop recap

- Used 9000 20MeV e^- single-particle events in workspace geom
- Ar^{39} ommitted for complexity and runtime

Resolution	Fit	RMS
Raw	26%	29%
"Realistic" corr	8.3%	13.4%

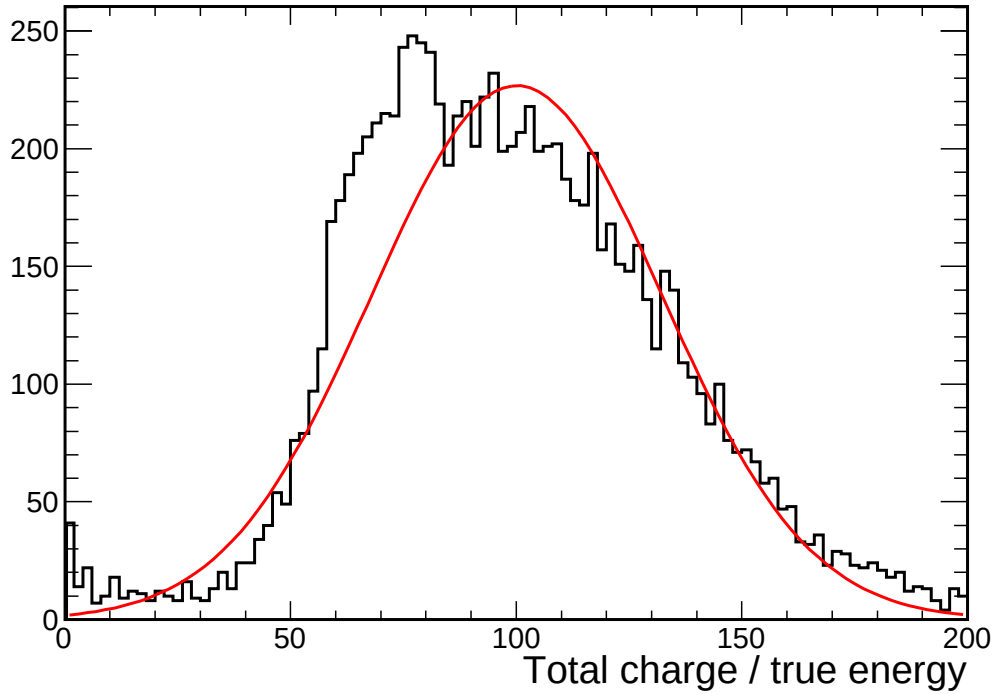
Files

- Use MCC7's `prodmarley_nue_spectrum_ar39_dune10kt_1x2x6_mcc7.1`



- Supernova energy distribution
- Full MARLEY sim rather than single particles
- Includes Ar^{39} noise

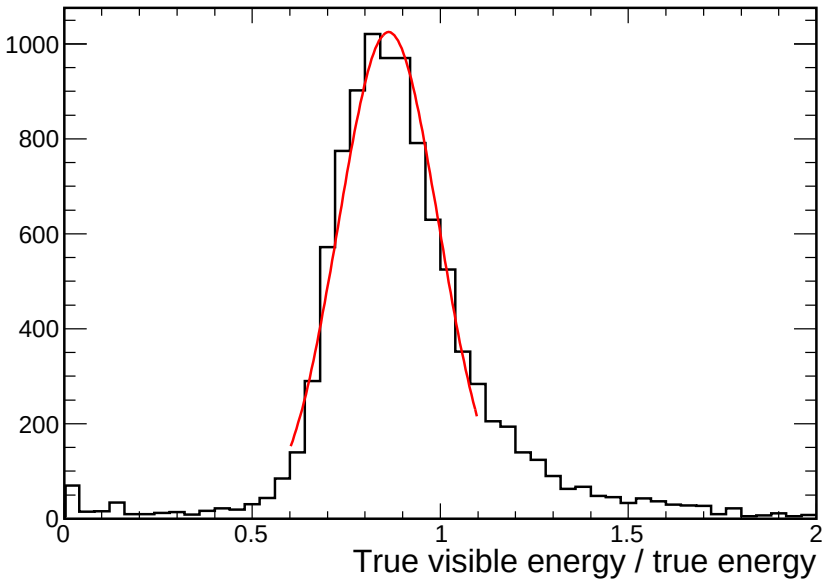
Reconstruct event energy

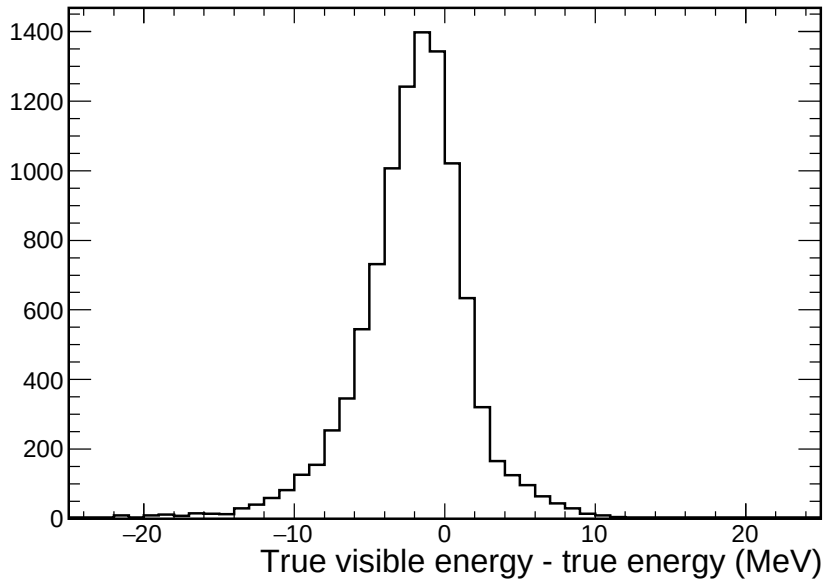


- totq is sum of `clust.Charge(cmFit)` if `clust.View() == geo::kZ`
- Width = 32% (fit), 34% (RMS)
- Invisible energy from full MARLEY sim?
- Picking up noise clusters? Have to cluster the clusters?

Truth information

- Compute "true visible energy fraction"
- Of all the hits in the event, sum the true energy deposits that led to them, so long as the responsible particle is a SN neutrino descendant

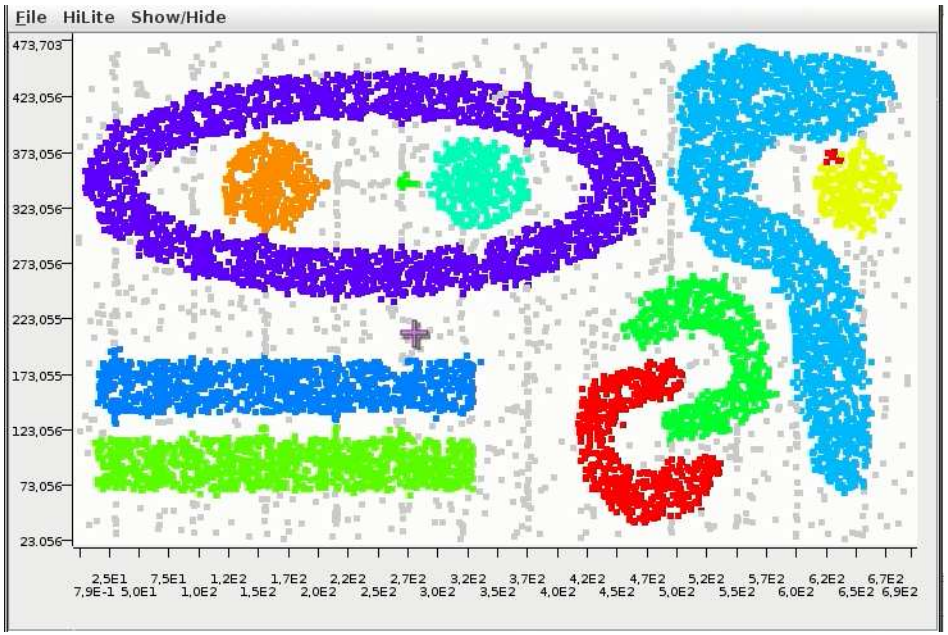




- Width 15% (fit), 26% (RMS)
- At face value, intrinsic width (invisible particles from MARLEY) twice as large as the resolution achievable from single particles
- Large tail above one suspicious. Map from hits to true deposits (IDEs). Nothing preventing double-counting there...

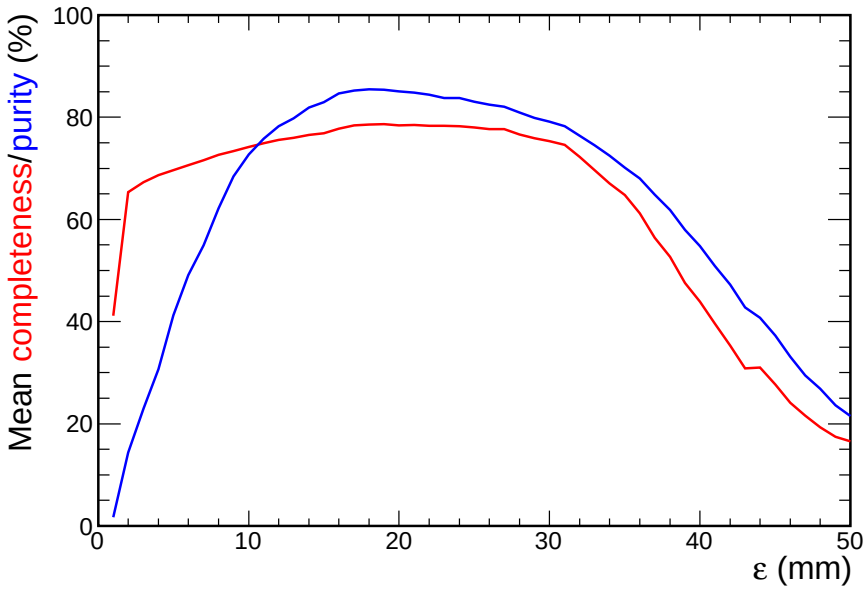
Slicer digression

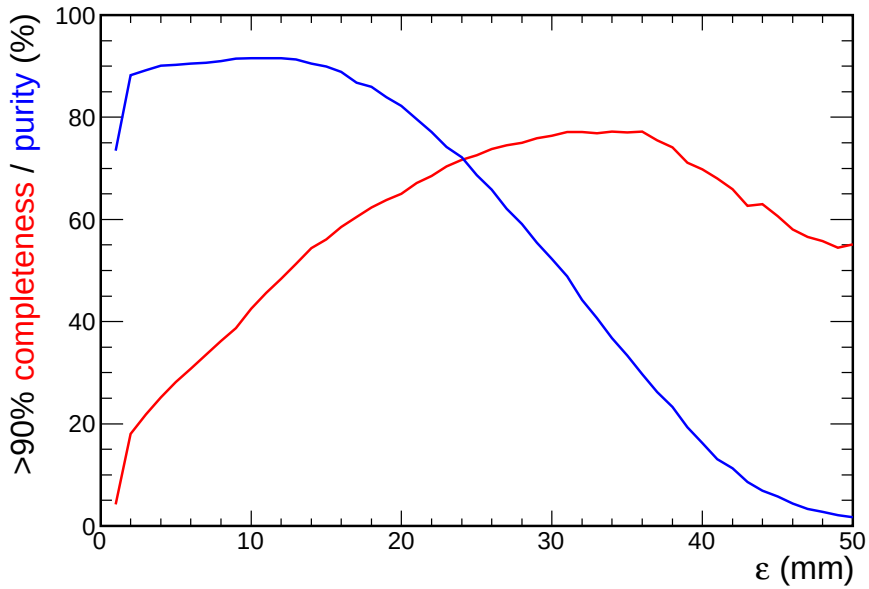
- DUNE reco seems to work "bottom up"
- Cluster hits into little segments, join those up into events
- Worried by lack of objective metrics
- MINOS and NOvA reco works "top down"
- First step is slicer – cluster all the hits from a single interaction
- Metrics are clear, completeness and purity of this cluster
- For my needs at least, the slice for the SN event is all I need



Slicer

- Hit is in slice if it has N neighbours within ε
- Fix $N = 4$, scan ε
- Calculate "completeness" (fraction of truly SN charge included in slice) and "purity" (fraction of charge in slice that is truly SN)





- Best parameters around $\varepsilon = 20$mm

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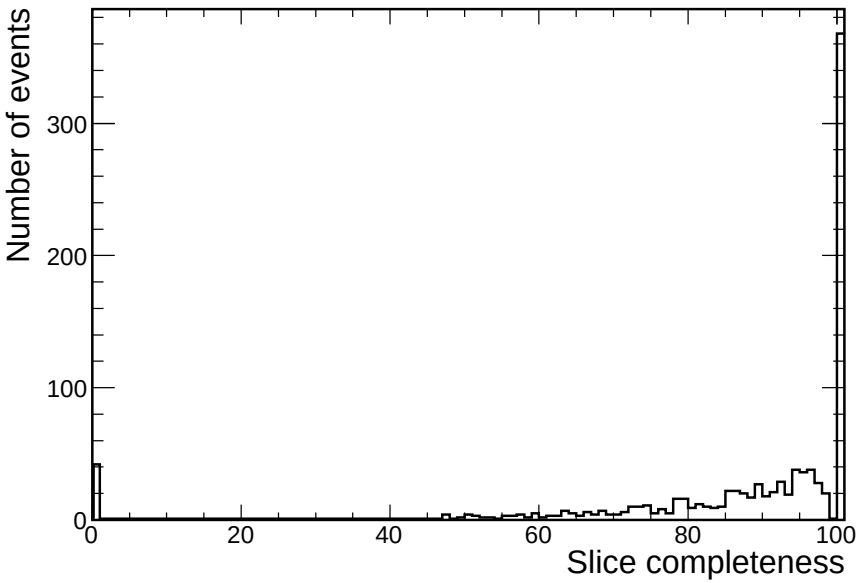

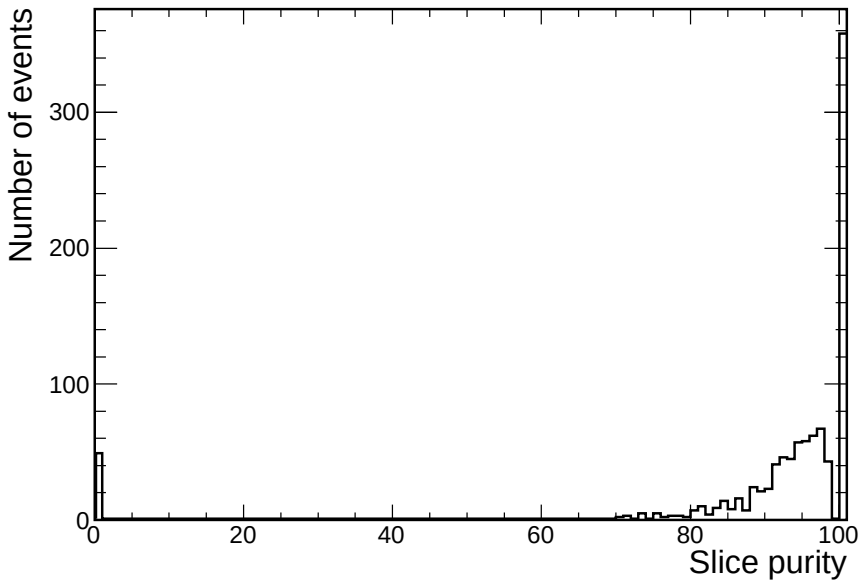

- Best parameters around $\varepsilon = 20$mm
- Stats skewed by zeros (SN slice is not the largest slice in window)

Conclusion

- Substantial intrinsic width introduced by MARLEY sim
- Still open questions, need to:
  - Check calculation
  - Look into particle of MARLEY output
- Slicer technique showing promise
  - Not yet compared to existing clustering algorithms
  - Possibly applicable to Flash-making
- Make contact with PD topics again soon...