Simulation Update

V. Galymov (IP2I)

27.03.2024

Overview

- First check of signal simulation / signal processing for ProtoDUNE-DP with point-like (low-energy) mono-energetic electron source

- Several issues:
  - Signal simulation of the TDE needed some fixes
  - Signal processing required some tuning of the deconvolution filter
  - Overall cleanup of unused / obsolete services

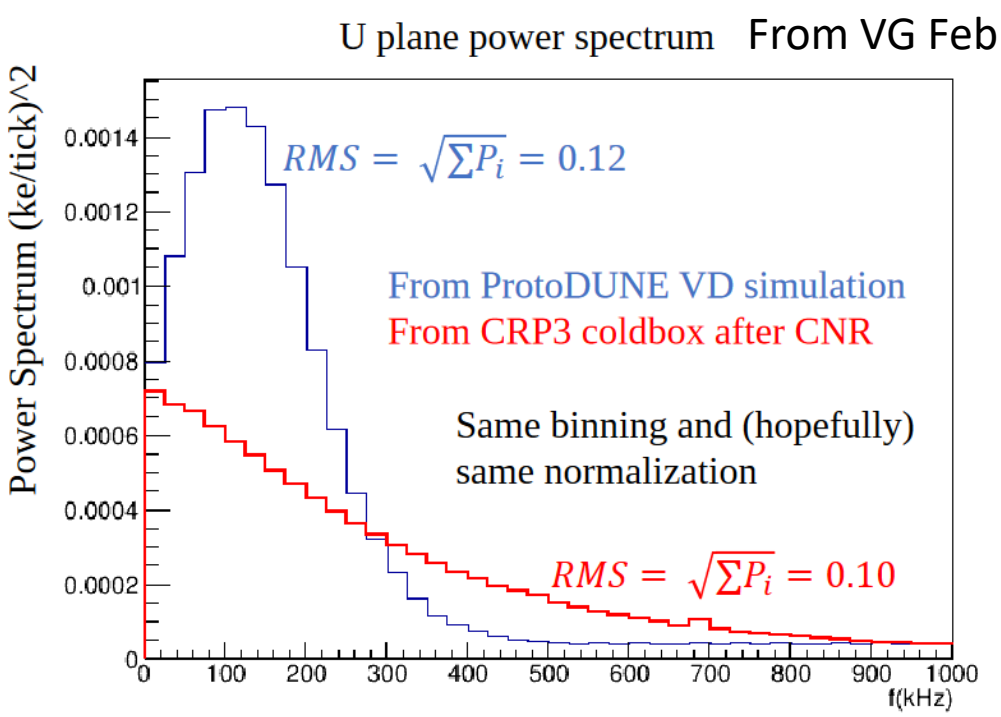
Perhaps not within the purview of simulation, but more in reco domain

TDE Response Simulation

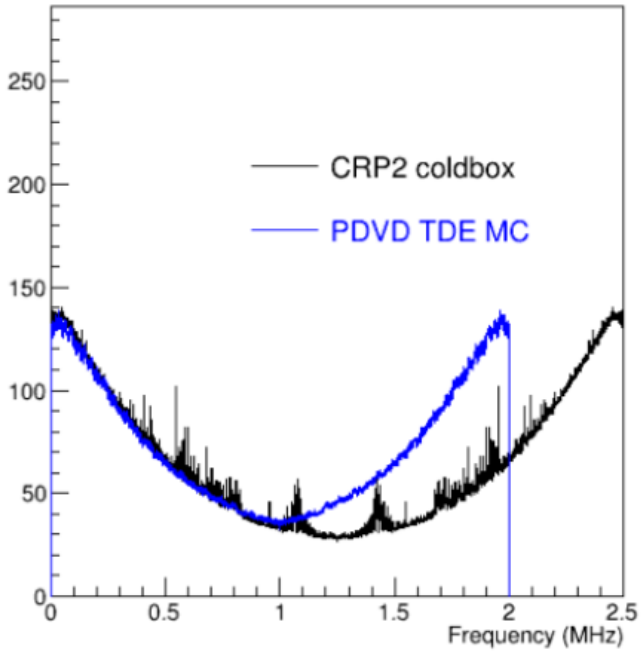
- ADC resolution → 14 bits
- Noise spectrum match better that of TDE
- Pulse simulation normalization

Addressed by W. Gu and J. Jo

From VG Feb 23 talk



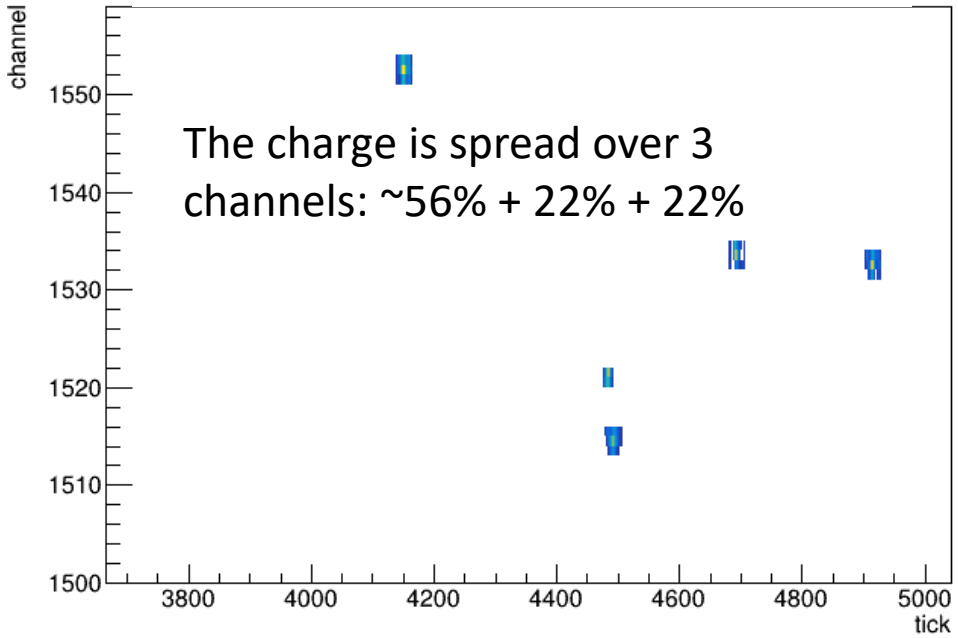
From W. Gu March 15 talk

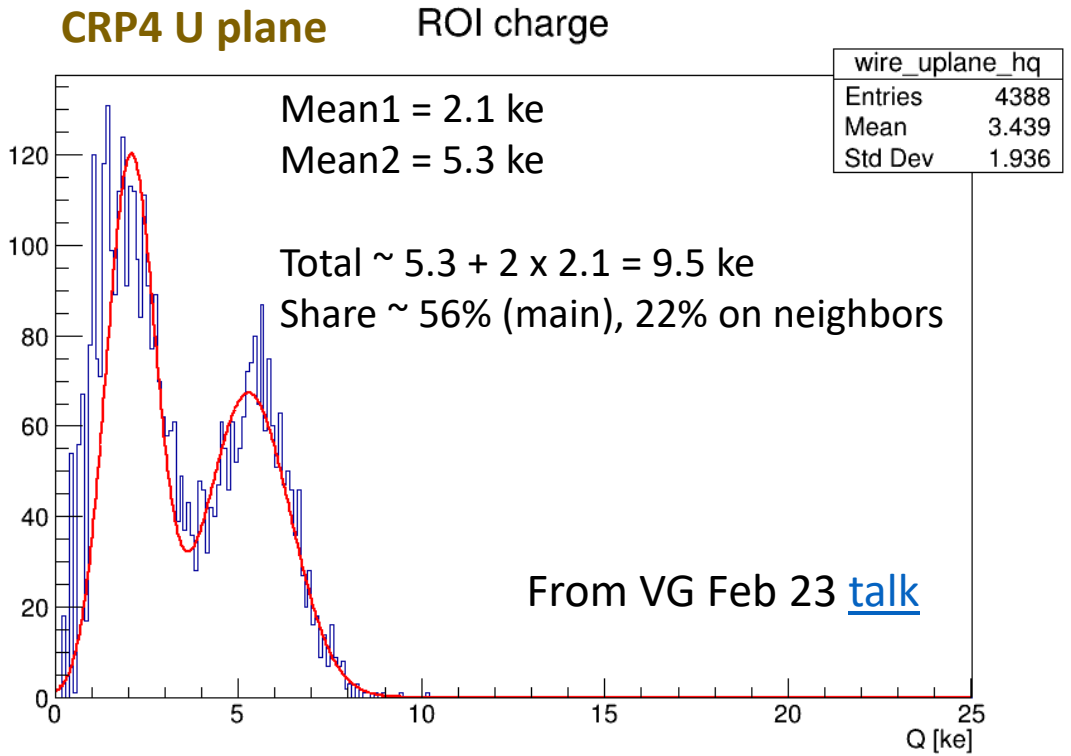


Signal processing

- Smearing of point source in the induction planes after signal processing

Example: point source in U plane after signal processing

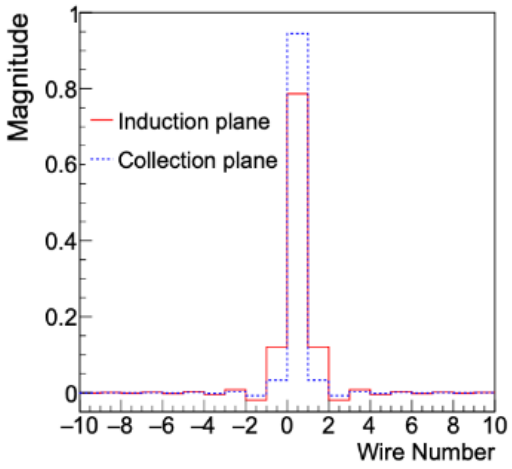




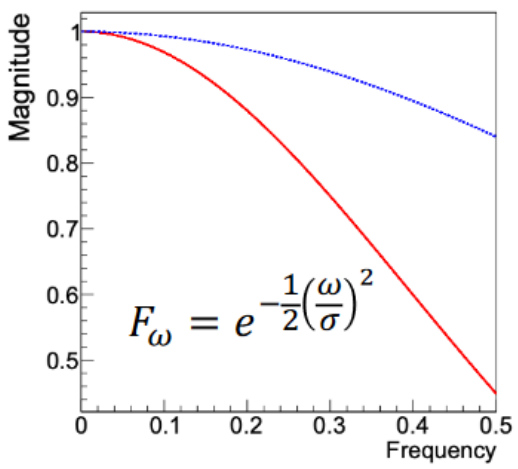
For this simulation the diffusion was disabled, so a 2 mm blip in the detector is “seen” as a 23 (3 x 7.65) mm blob in induction

Signal processing

- The charge smearing is controlled by “wire” filter



(a) Wire filters in the wire number domain.



(b) Wire filters in the “frequency” domain.

Plots from:
Ionization Electron Signal Processing in Single Phase LArTPCs I. Algorithm Description and Quantitative Evaluation with MicroBooNE Simulation

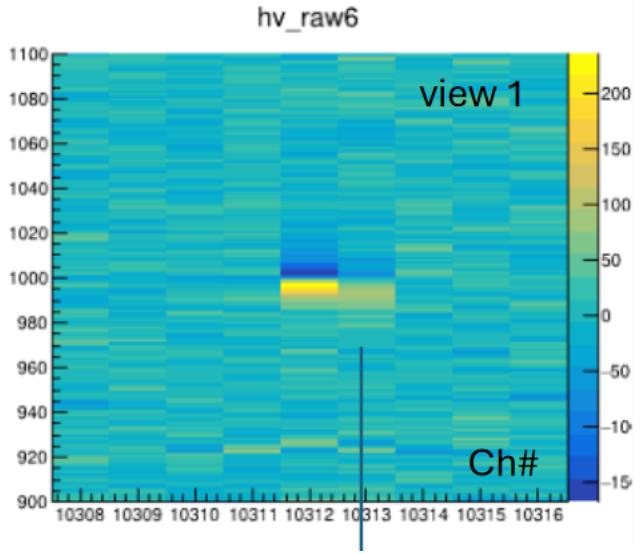
The values of the filter parameters used for ProtoDUNE-VD were tuned (?) in ProtoDUNE-SP

	induction	collection
σ	0.75	10.0

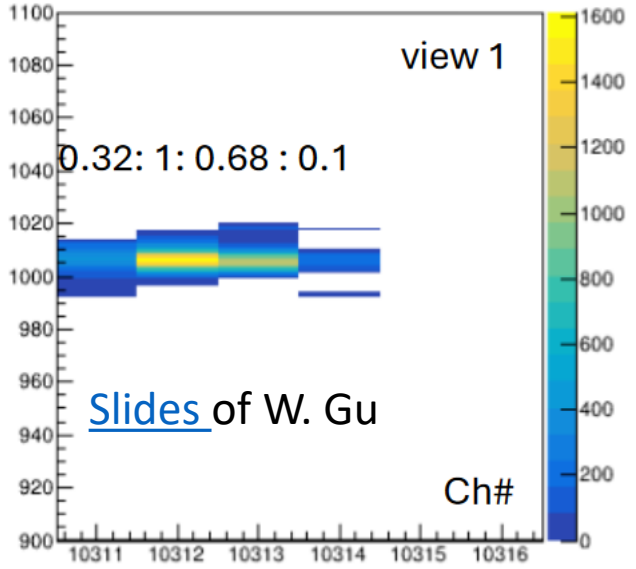
Slides of W. Gu

Signal processing

	induction	collection
σ	0.75 → 5	10.0

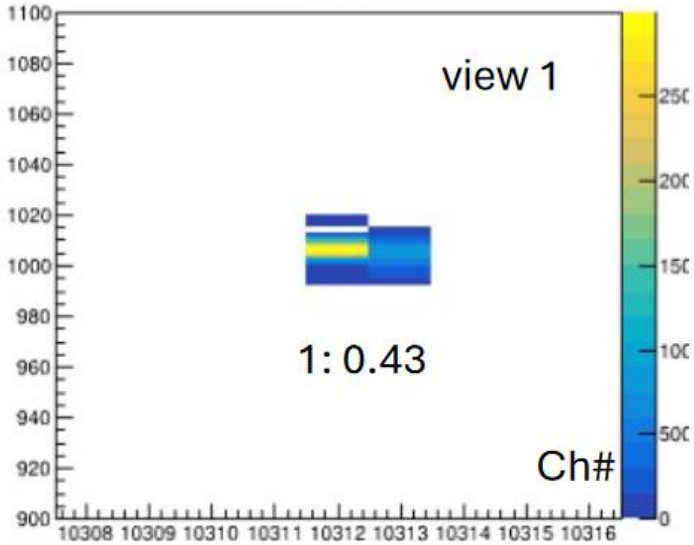


Original filter config (after signal proc)



[Slides](#) of W. Gu

New filter config (after signal proc)



The charge sharing between nearby channels is more consistent with sim raw data

Probably not critical for track reco.
But what are the handles to tune this parameter with ProtoDUNE-VD data?

Overall cleanup of unused / obsolete services

- Unused services and (incorrectly configured) dataprep tools were causing warning / errors in simulation
- New processing chain now removes altogether dataprep stage:
  - WCL runs on *RawDigit* products directly (not *recob::Wire* from dataprep as before)
  - Dataprep noise filtering etc outsourced to WCL (guess dataprep is no longer in active maintance)
- Pull requests from W. Gu (already merged):
  - https://github.com/DUNE/dunecore/pull/106
  - https://github.com/DUNE/dunesw/pull/110

Summary

- Updated signal sim for TDE
- Updated signal processing with tuned “wire” filter parameters
  - Should provide better localization of point sources in U/V planes
- General cleanup of services / unused tools

- A very short wish list:
  - Redo point source sim and analysis with updated dunesw release
  - Check consistency of signal processing for both top and bottom CRPs with point sources: deconvoluted signals should be identical between two halves of the detector provided simulation → signal processing is self consistent