

Space Point Service and Time Calibration

LarSoft Meeting

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SpacePointService Updates

- In June after first commit of SpacePointService, I got a long list of suggestions from Brian and Eric. I believe these are now all addressed, as well as some other updates. Here are some updates.
 - Added analyzer module (SpacePointAna).
 - Updated MCCheater to support truth-based space point reconstruction.
 - Fix some more technical issues (all of the ones mentioned by Brian and Eric).
 - Absolute time calibration.

Absolute Time Calibration

- Goal of absolute time calibration is to find t_0 for each readout plane such that the absolute x -coordinate can be reconstructed using the following equation.
 - $x = (t-t_0)/v$.
- In words, t_0 is the readout time for ionization that starts at $x=0$.

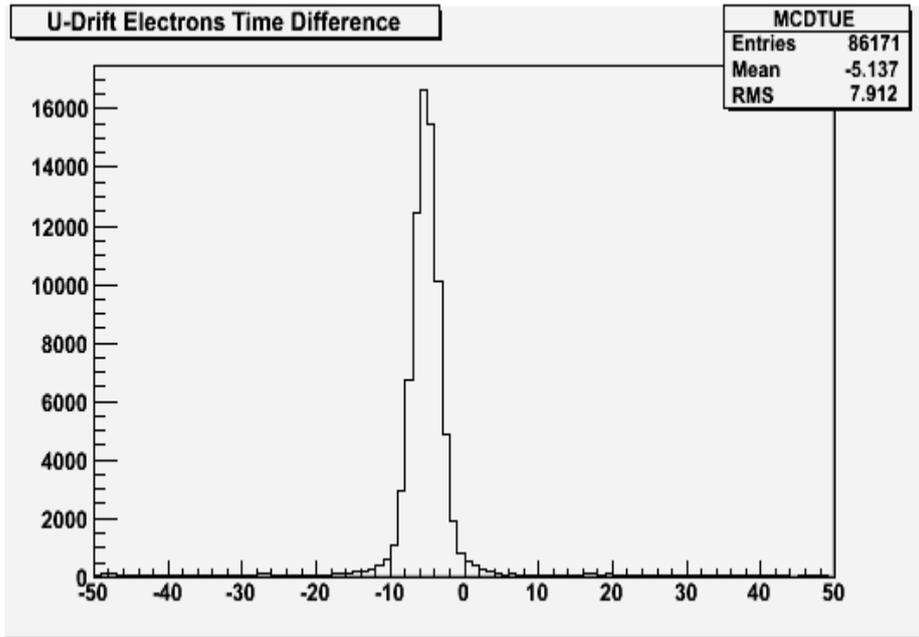
Absolute Readout Time in Sim + Reco

- Absolute readout time includes four contributions (plus noise).
 - $t = t_1 + t_2 + t_3 + t_4$
 - $t_1 = (x-x_0)/v$ (LArG4, drift time to plane 0).
 - $t_2 = (\text{plane-pitch})/v$ (LArG4, drift time from plane 0 to readout plane).
 - `plane-pitch = geo::TPCGeo::Plane0Pitch(plane)`.
 - $t_3 = \text{trigger-offset}$ (DetSim).
 - `trigger-offset = util::DetectorProperties::TriggerOffset()`.
 - $t_4 = \text{convolution} + \text{deconvolution} + \text{hit reconstruction}$.

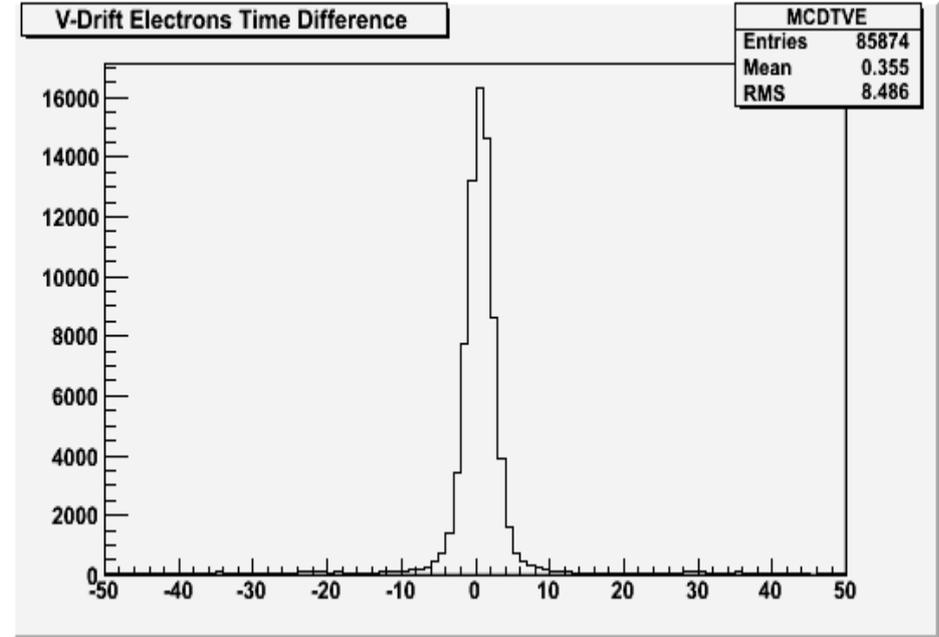
Absolute Time Offset

- Contribution from t_1 and t_2 to absolute time offset can be calculated from Geometry and LArProperties service.
 - $t_0 = (-x_0 + \text{plane-pitch})/v$.
- Contribution from t_3 to absolute time offset can be obtained directly from DetectorProperties service.
 - $t_0 = \text{trigger-offset}$.
- Contribution from t_4 to absolute time offset can not (easily) be calculated *a priori*. However t_4 can be measured (in mc) directly from Electrons-Hit time difference, independent of geometry and other detector features.

Argoneut Electrons-Hit Time Difference

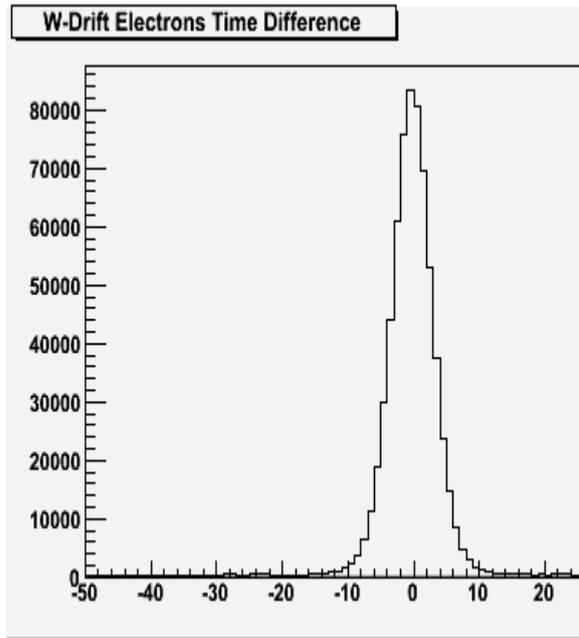


Plane 0
U view
Induction

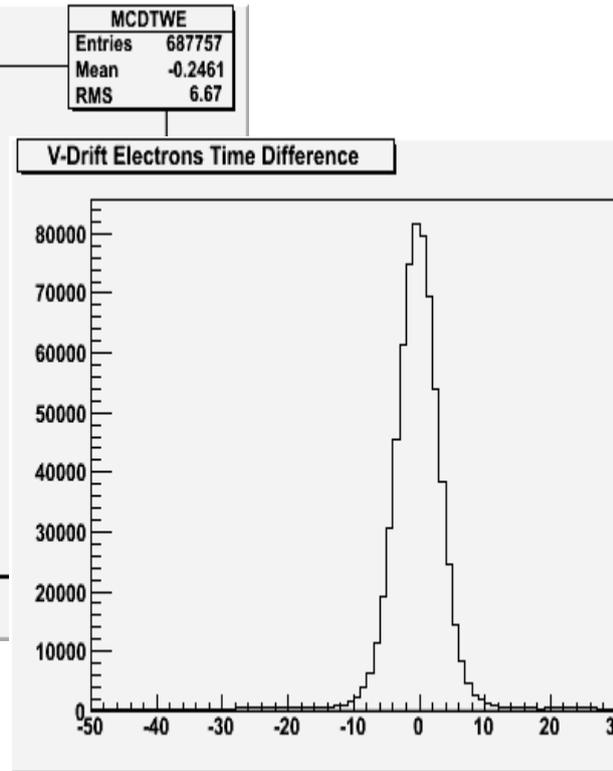


Plane 1
V view
Collection

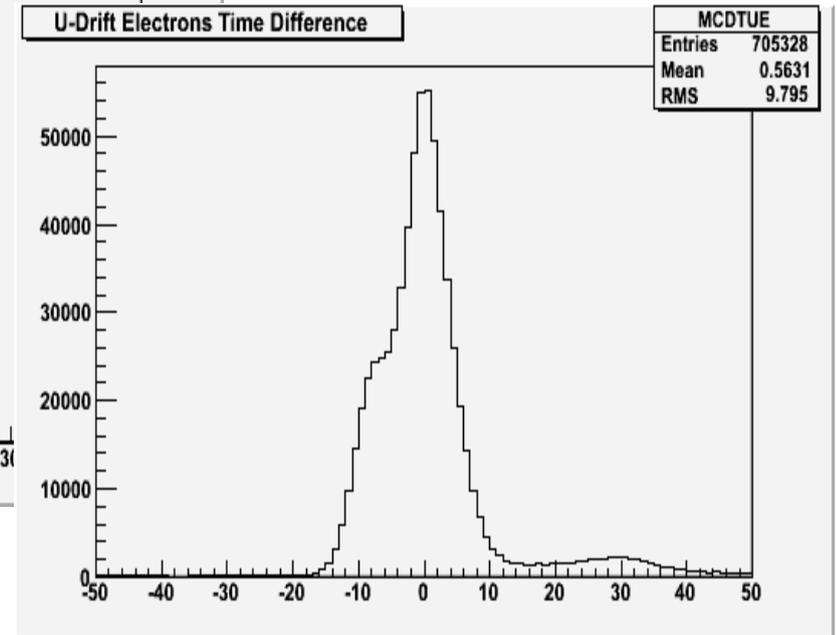
Mciroboone Electrons-Hit Time Difference



Plane 0
W view
Induction



Plane 1
V view
Induction



Plane 2
U view
Collection

Oddities and Bugs

- Argoneut plane 0 electron-hit time offset is unreasonably large.
- Microboone plane 2 electron-hit time offset is definitely screwed up.
- Plane pitch is negative for both argoneut and microboone geometry. This means that electrons arrive at later readout planes before plane 0 (this is a bug).
- Geometry bug (non-uniformly spaced wires).
- Track3Dreco uses a different timing model involving hard-coded constants and different drift velocities between wire planes than in the bulk. This timing model may better describe the data, but it is not reflected in argoneut simulation.

SpacePointService To Do List

- I have two more things on my personal short to do list.
 - Add a filtering mechanism to reduce the number of space points with shared hits. Goal is to have the number of space points not greatly exceed the number of hits, regardless of cuts.
 - Speed up SpacePointService by using wire information more efficiently and earlier (i.e. sort hits by wire in addition to, or instead of, by time).
- Longer term possibilities.
 - Integrate space point reconstruction with cluster merging, splitting, and matching.
 - Kalman filter development.