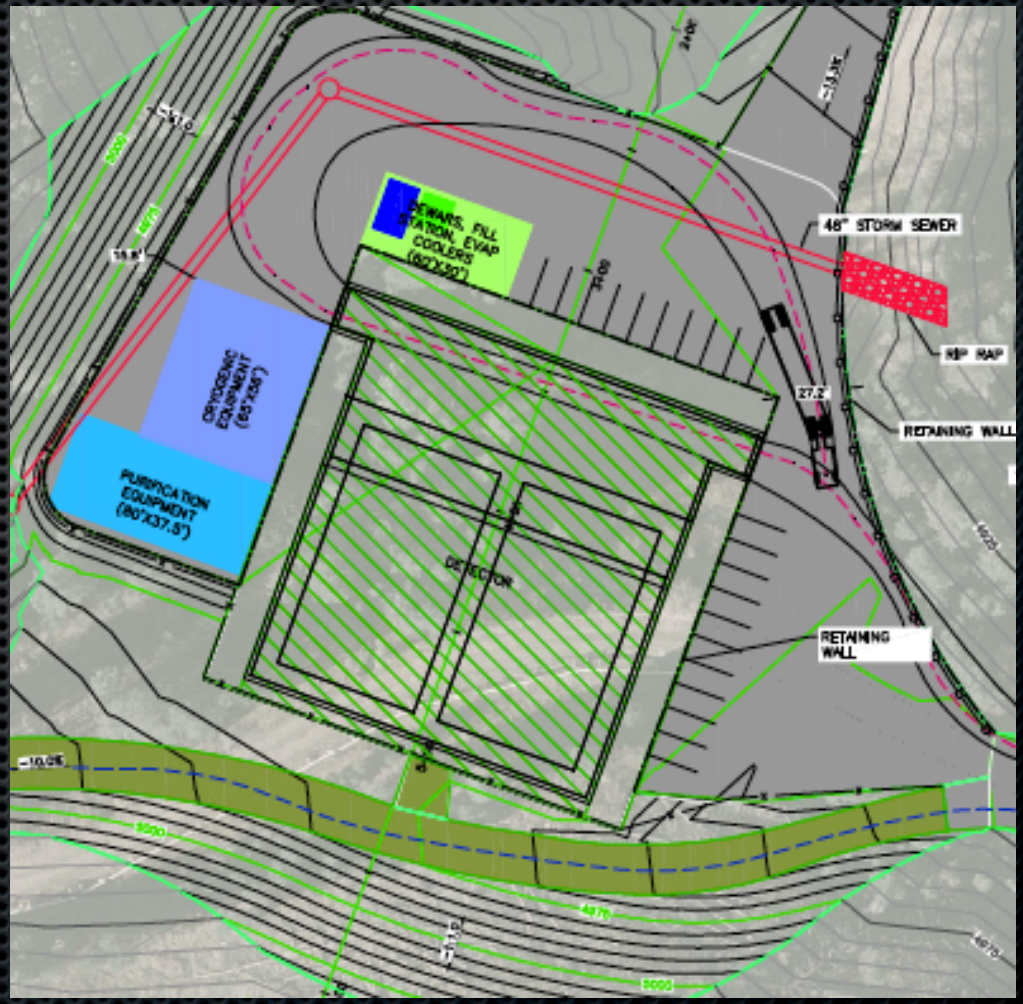
Simulation of LArTPC detectors

Mike Kirby
for LArSoft Simulation Working Group

Outline

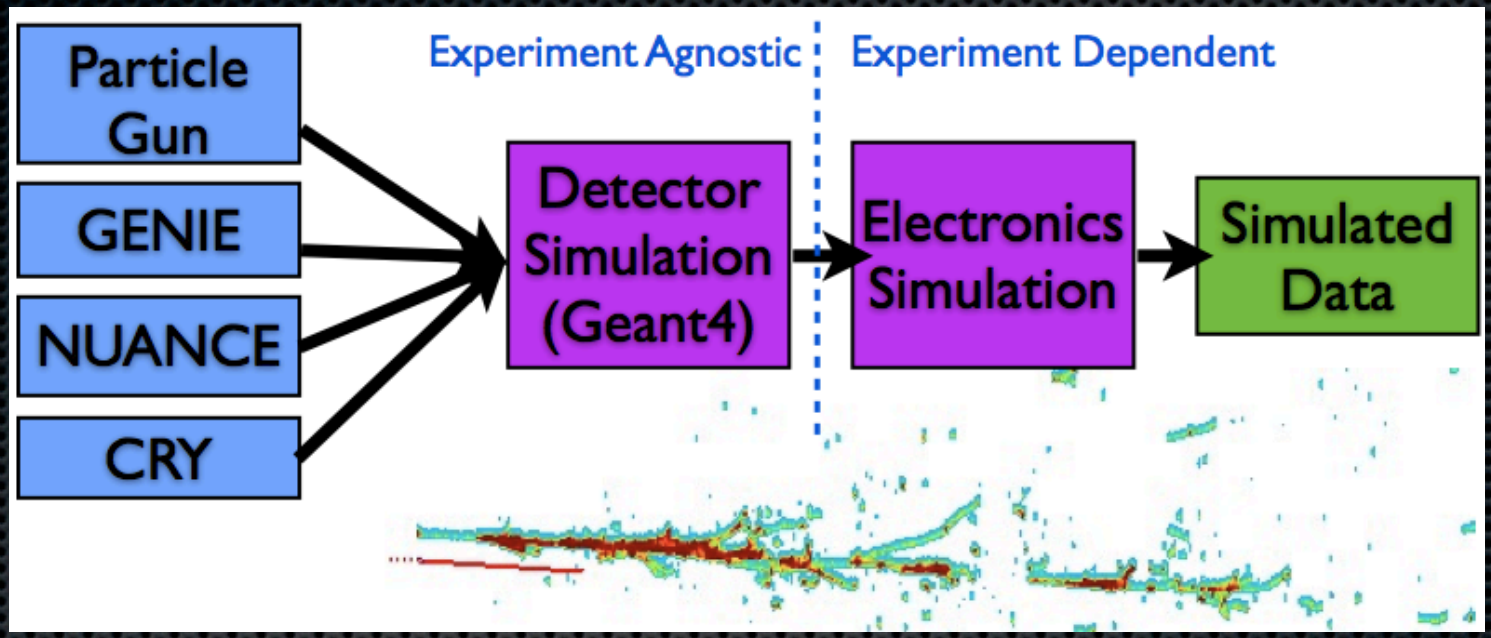
- motivation
- geometry updates
- noise simulation & filtering
- electronic response
- event display
- future projects



Motivation

- move beyond parameterized studies of detector to detailed studies of competing designs
- understand what parameters will affect physics sensitivity
  - event acceptance, reconstruction efficiency, and background estimates
  - non-trivial task of developing simulation
- important for studies of reconstruction algorithms for developed specifically for large mutli-TPC detectors

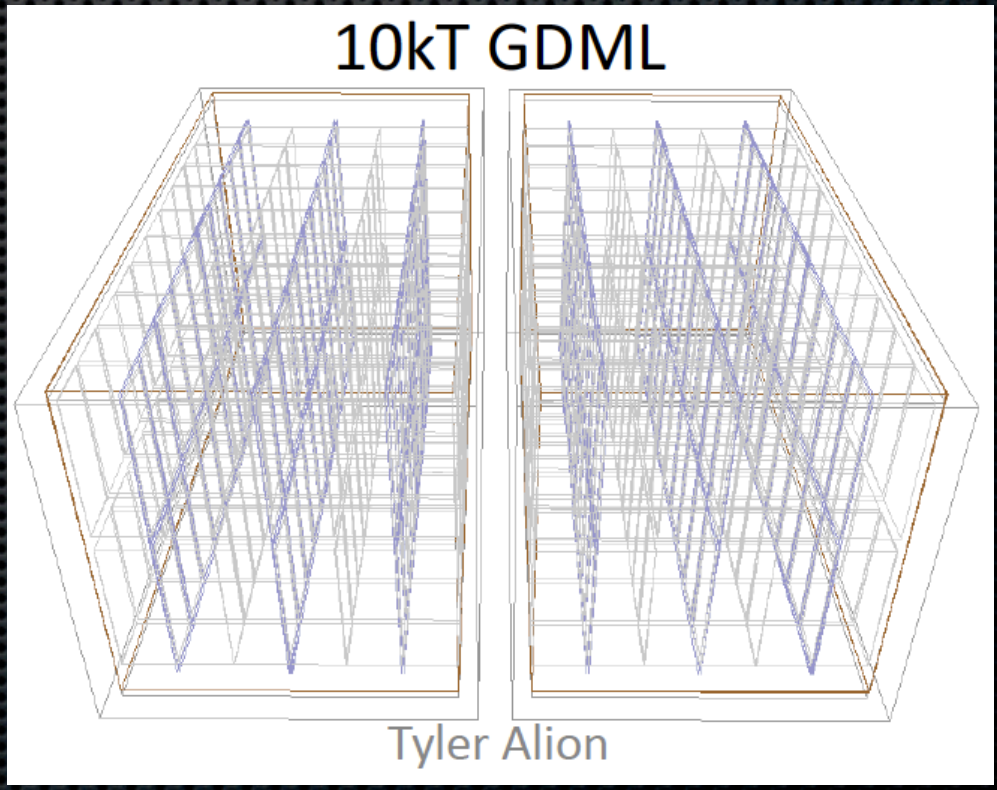
How simulation fits into LArSoft



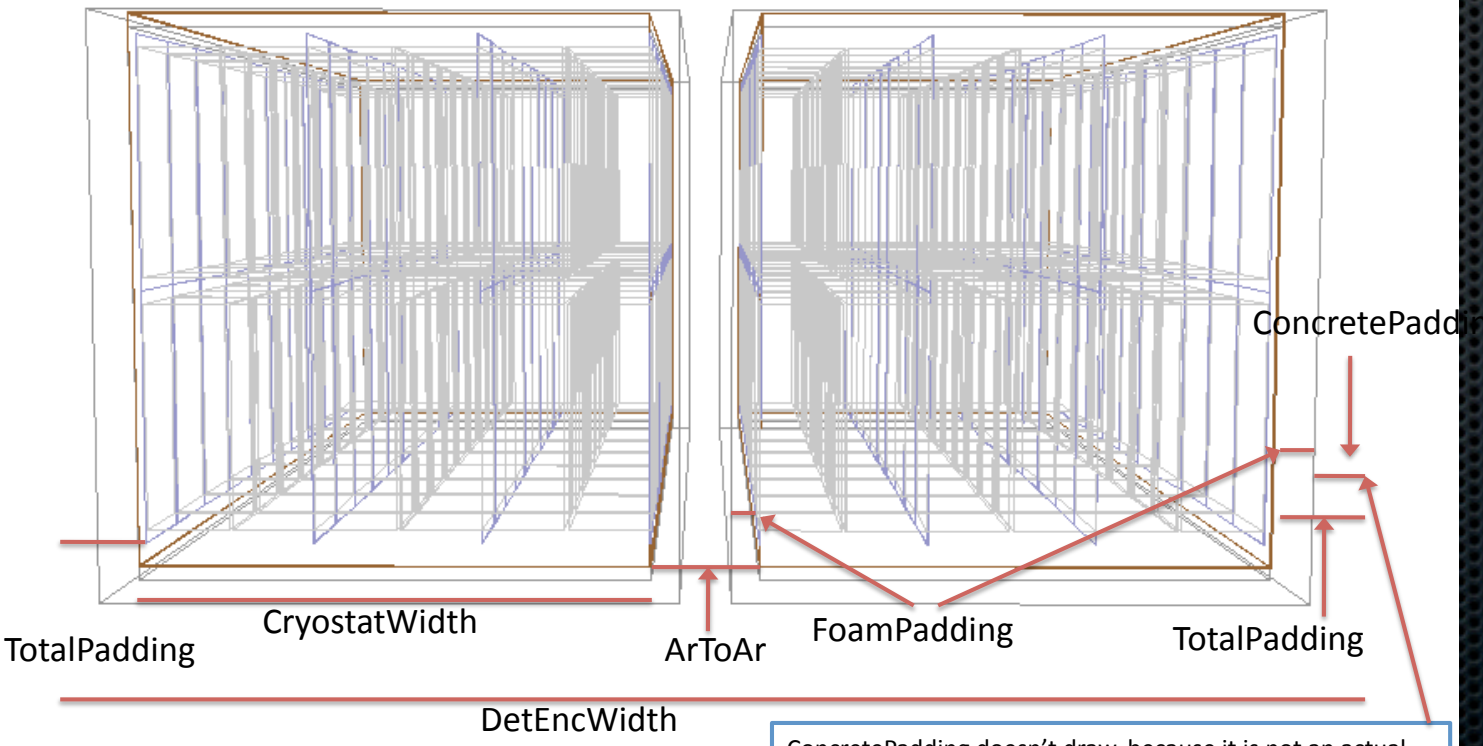
- event generation (GENIE, NuANCE, etc)
- detector geometry (GDML files)
- particle transport, material simulation, and detector response (GEANT4, photon propagation/response, etc)
- digitization of detector response and data generation
- reconstruction (numerous modules)

building up the detector

- South Carolina group has written perl scripts for LBNE and 35 T to generate GDML
- can easily build GDML files for different cryostat configurations
- the APA designs appears to be stable (2.5m x 7m)
- allows the input of the number of cryostats and APA configuration and so much more



double cryostat



ConcretePadding doesn't draw, because it is not an actual volume. volDetEnclosure's material reference is concrete, so the concrete is there implicitly. The volumes within are placed so that the ConcretePadding dimensions are correct.

FiducialWidth = nAPAWide*APAWidth

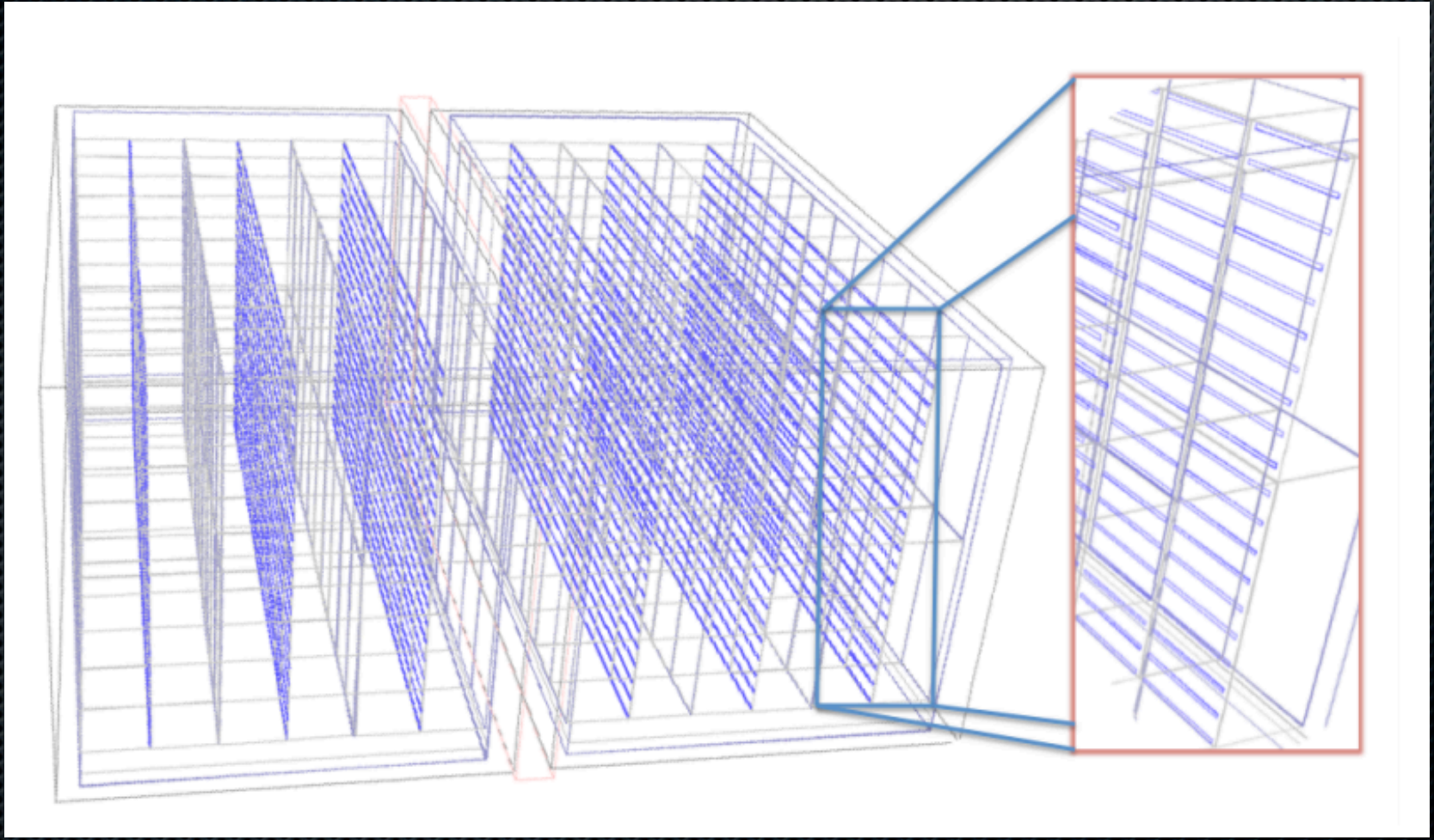
ArgonWidth = FiducialWidth + 2*SpaceCPAToCryoWall ← Remember, extra space doesn't draw

CryostatWidth = ArgonWidth + 2*SteelThickness

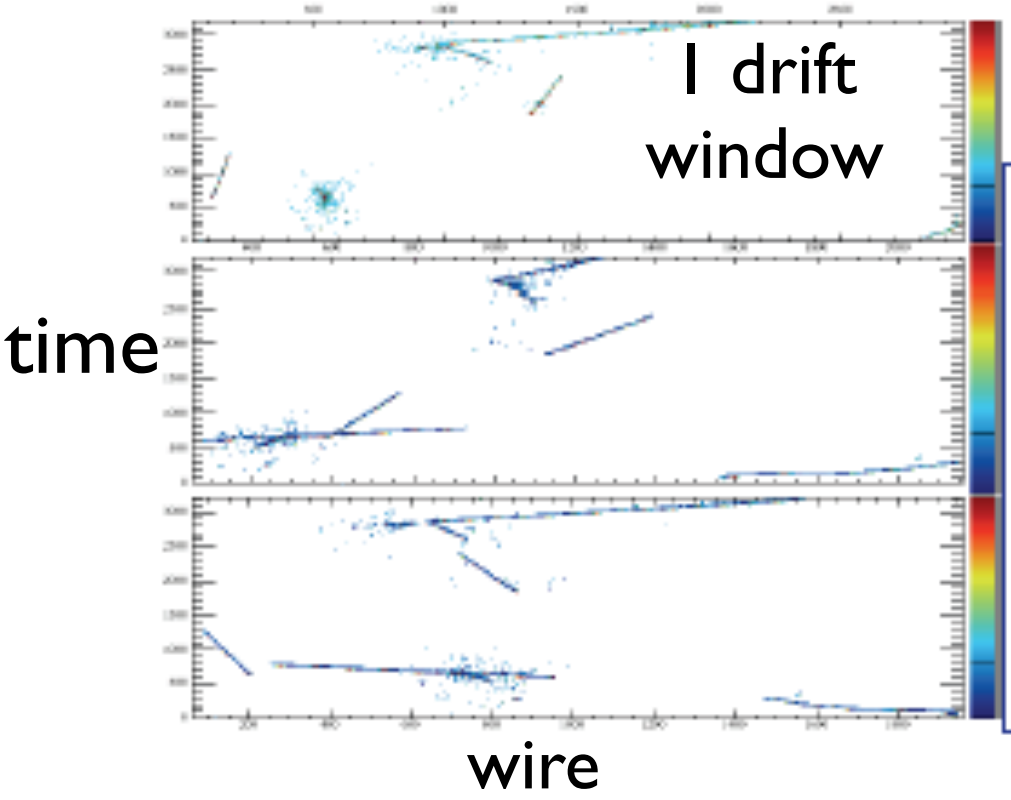
DetEncWidth = 2*CryostatWidth + 2*TotalPadding + ArToAr

The part of ArToAr that isnt FoamPadidng is concrete.

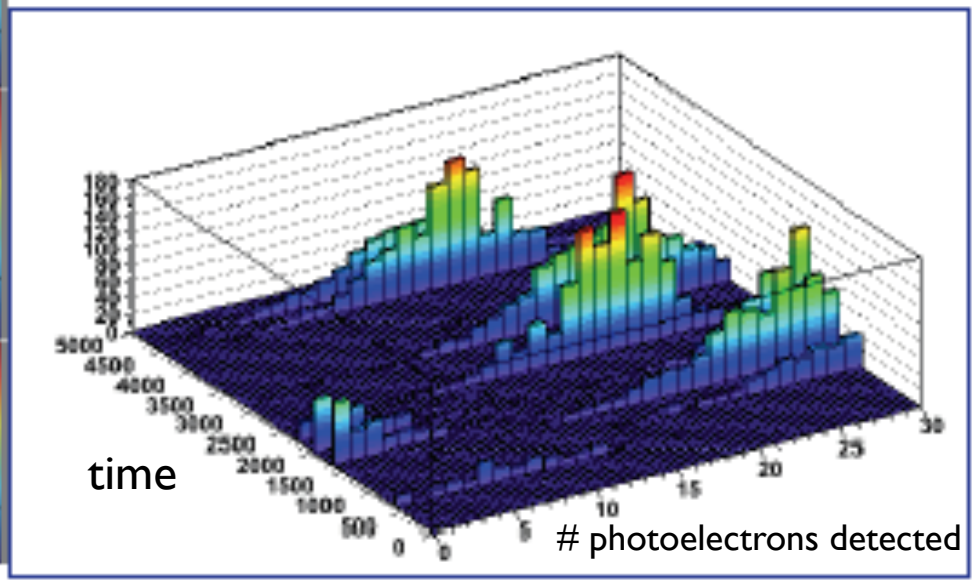
photon detectors in APAs



Charge + Light!



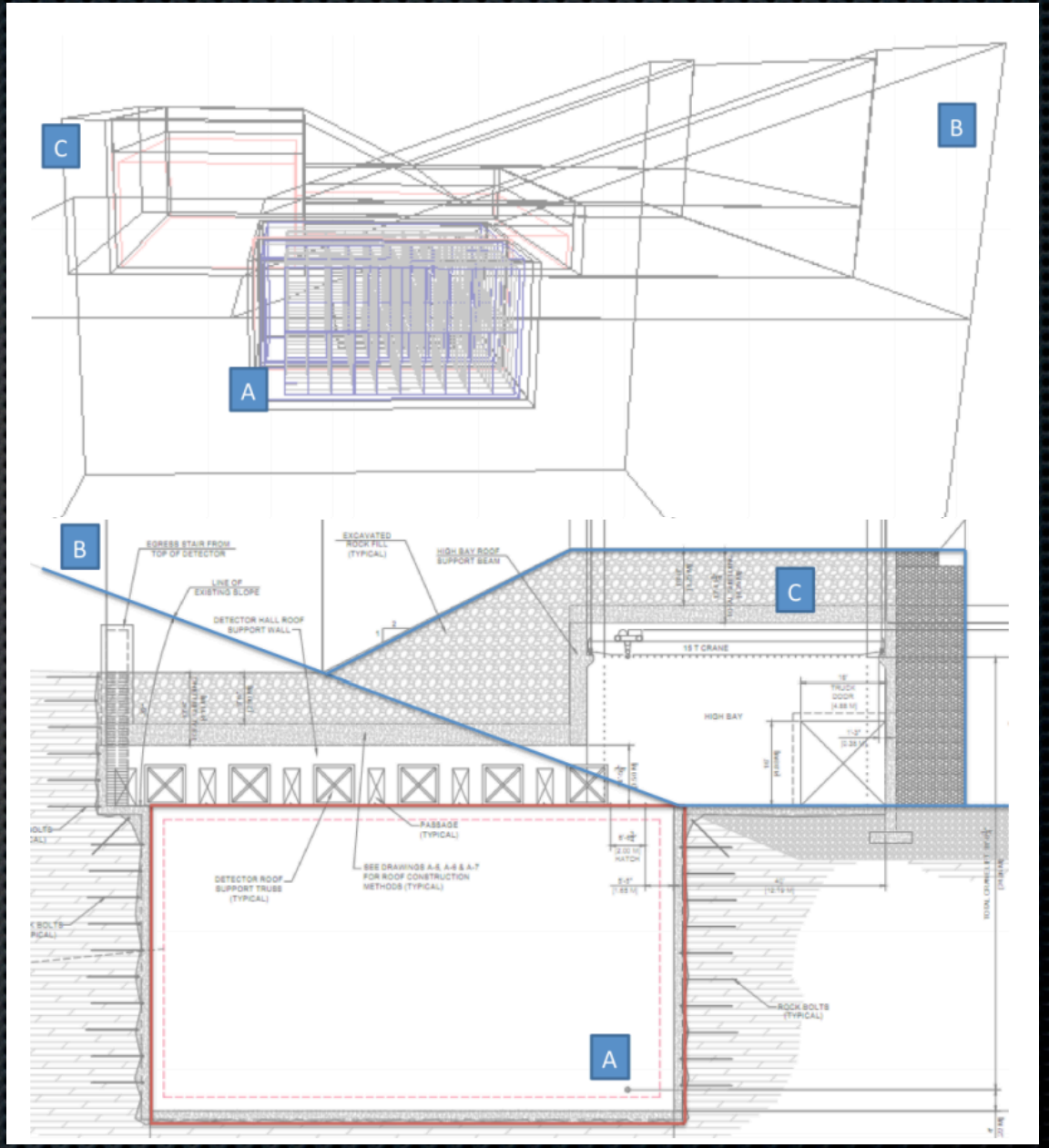
3 drift windows



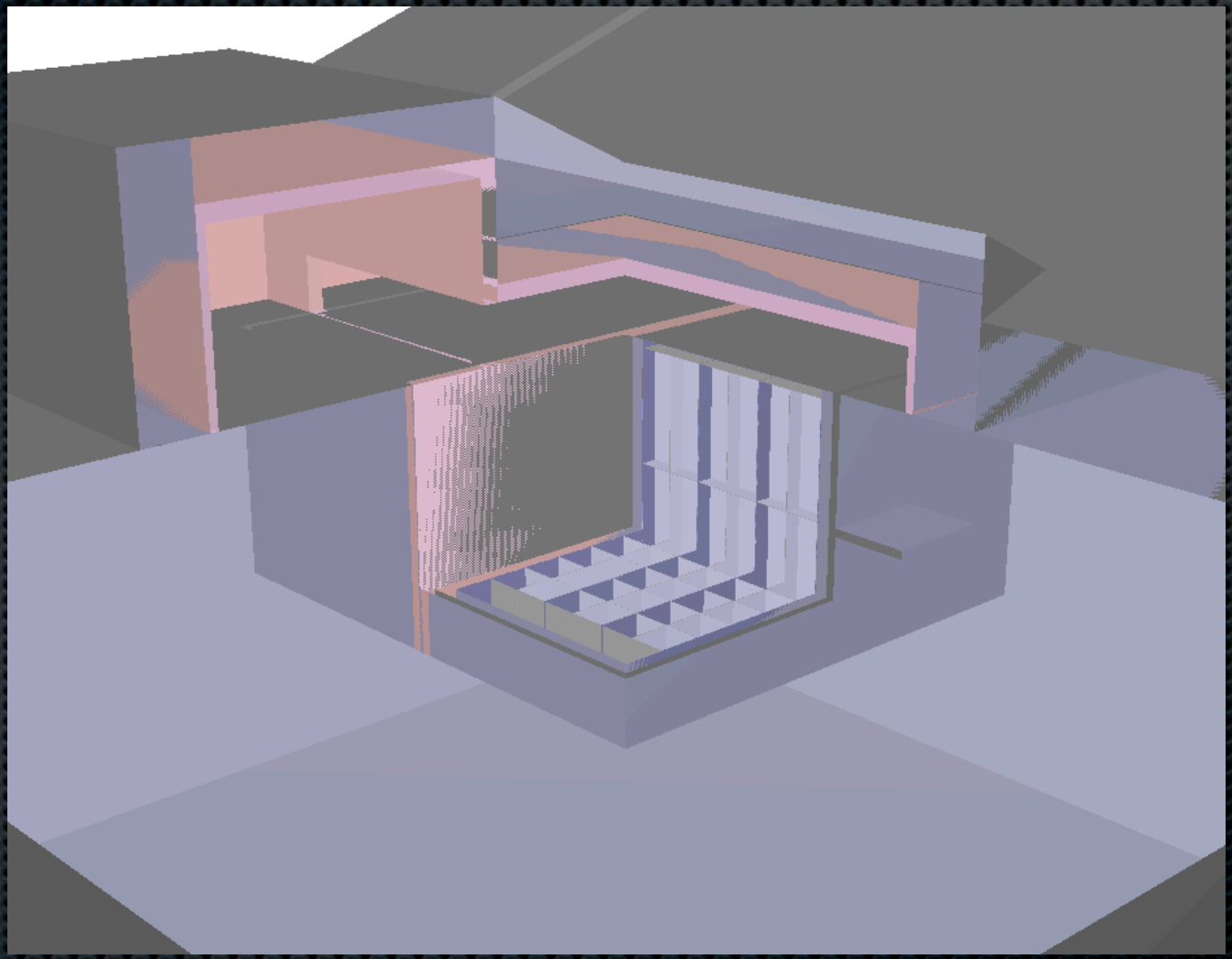
CRY Cosmics overlaid on a GENIE evt

building and overburden

- incorporated the previous surface design utilizing the hill for shielding
- include the building high and low bays
- getting the correct overburden important for physics backgrounds and capabilities, using default DUSEL rock composition
- now looking to modify for the new flat-spot design

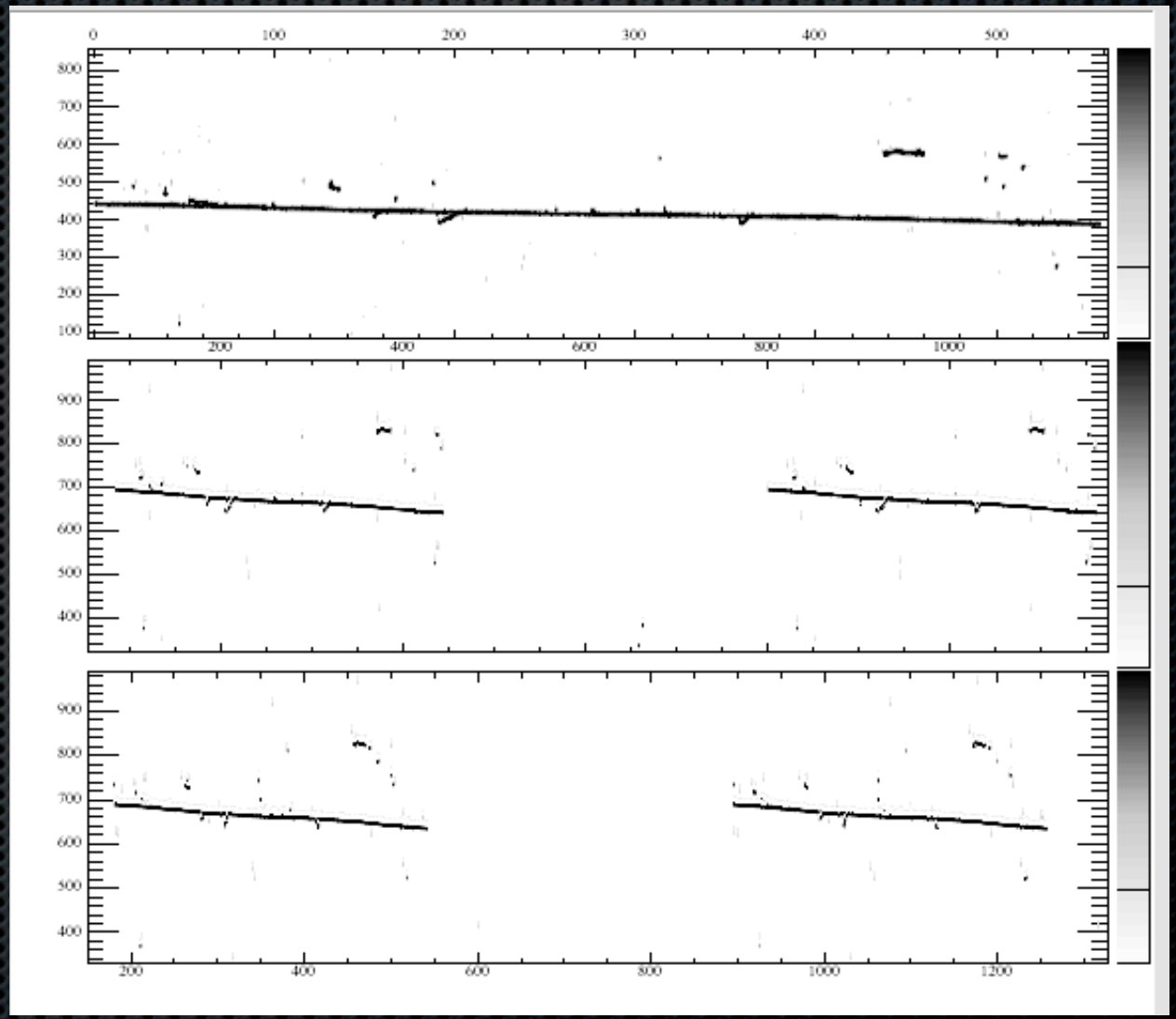


clipped view of the detector



first event display

- shows a single TPC of the full LBNE far detector
- wrapped wires apparent in the U and V views
- need to develop new event display for multi-TPC detectors



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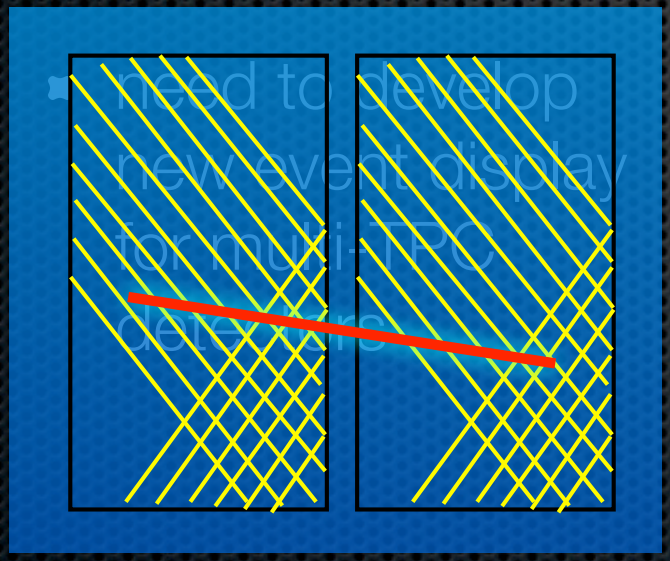

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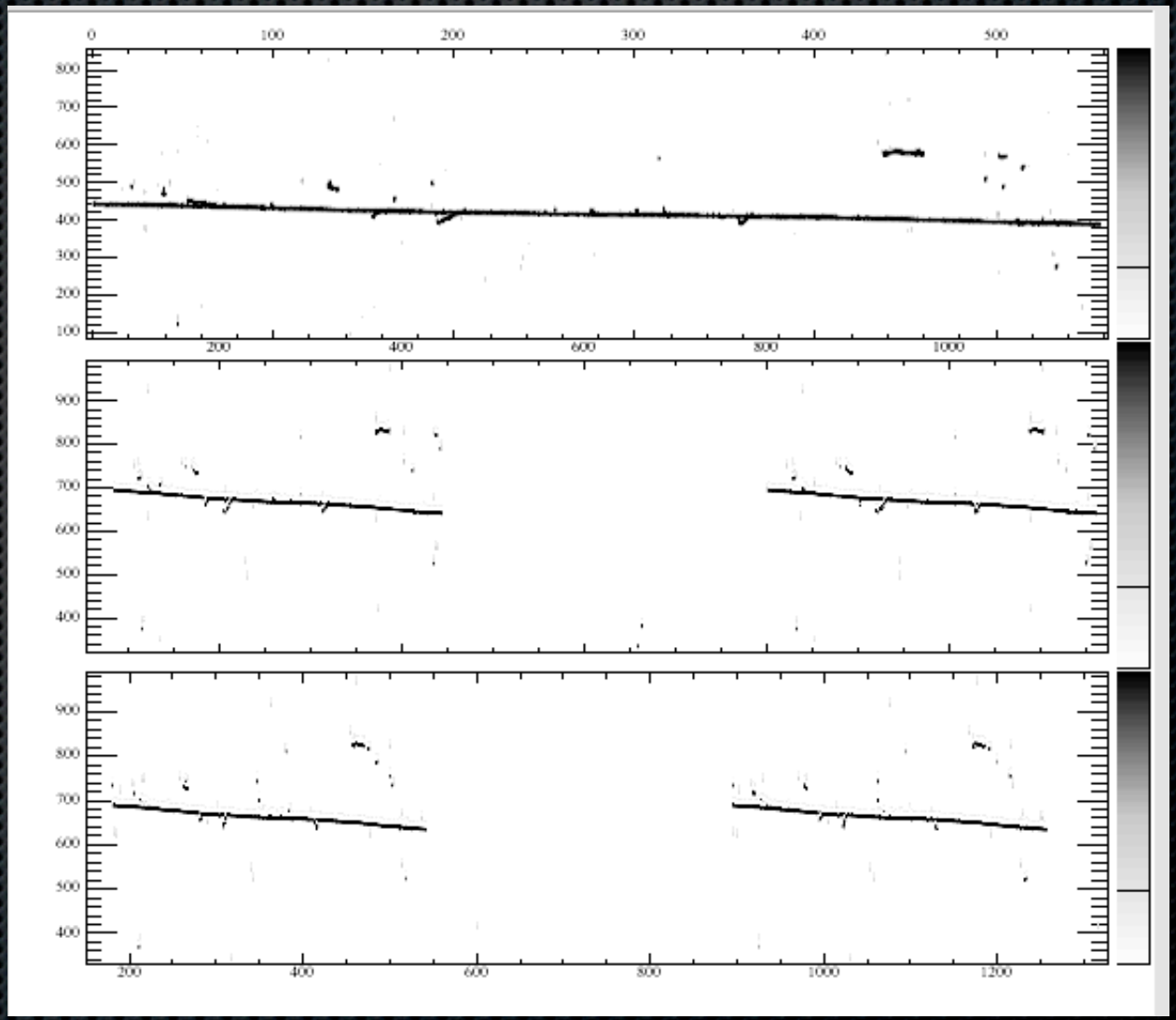

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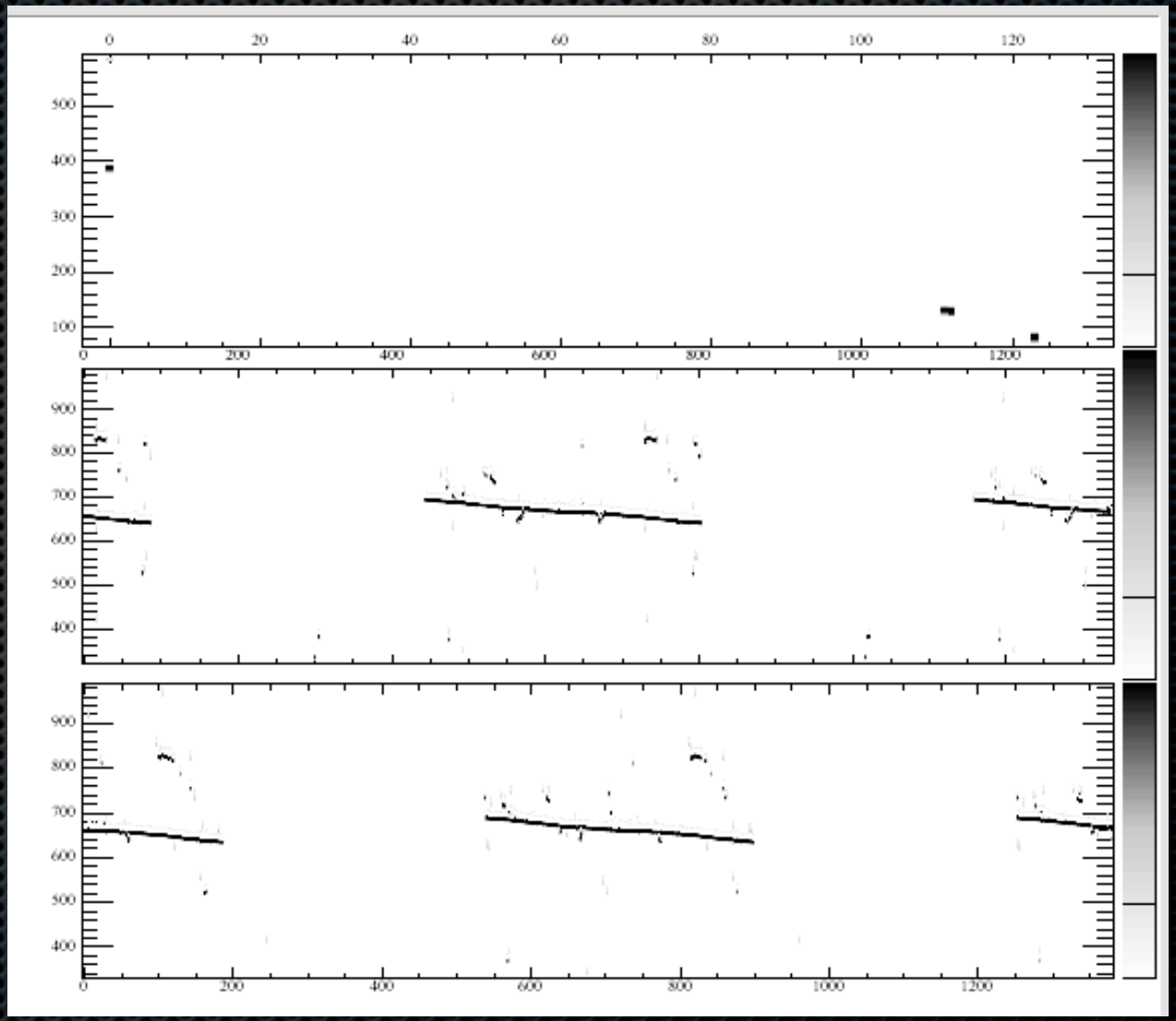
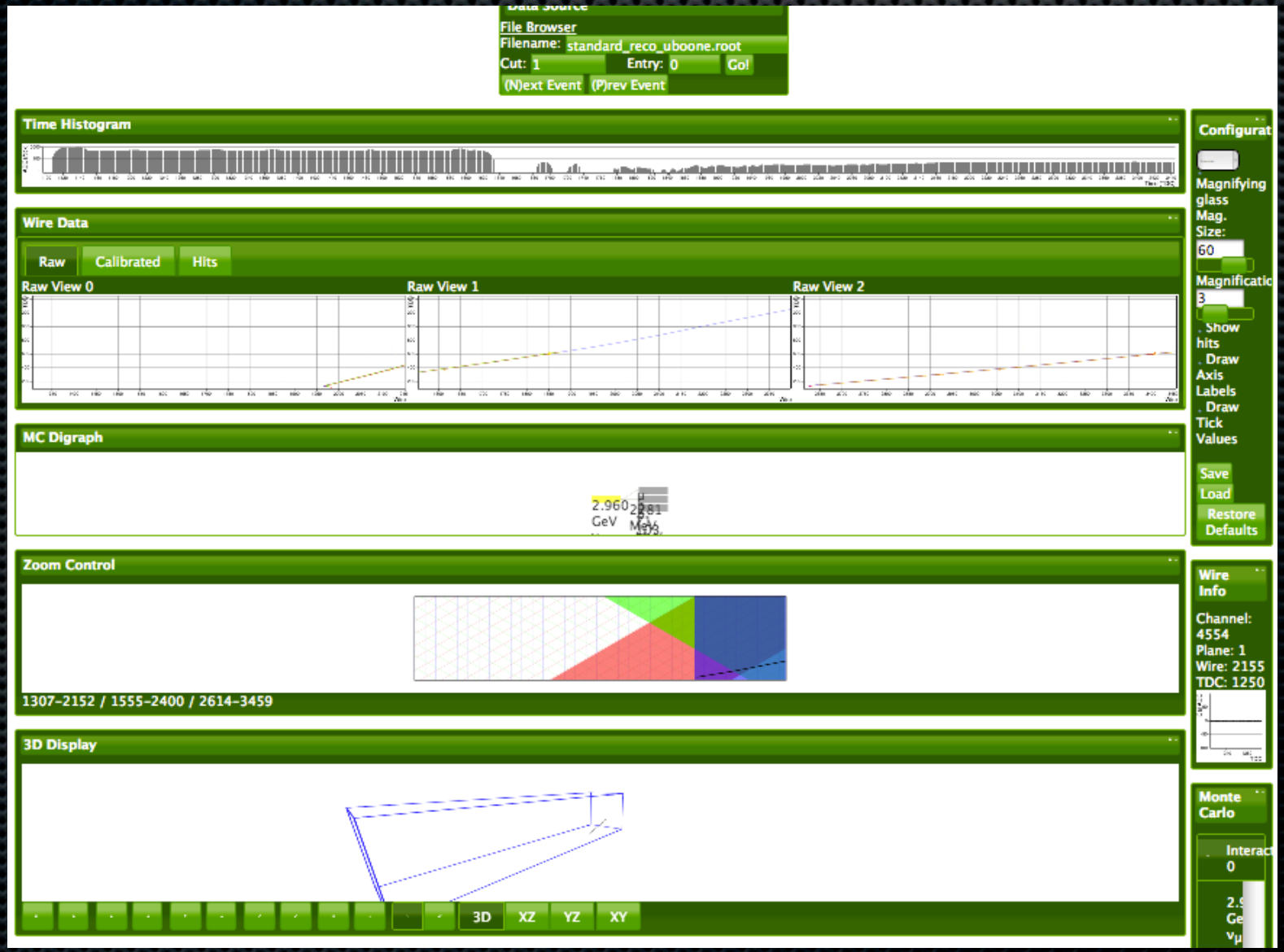
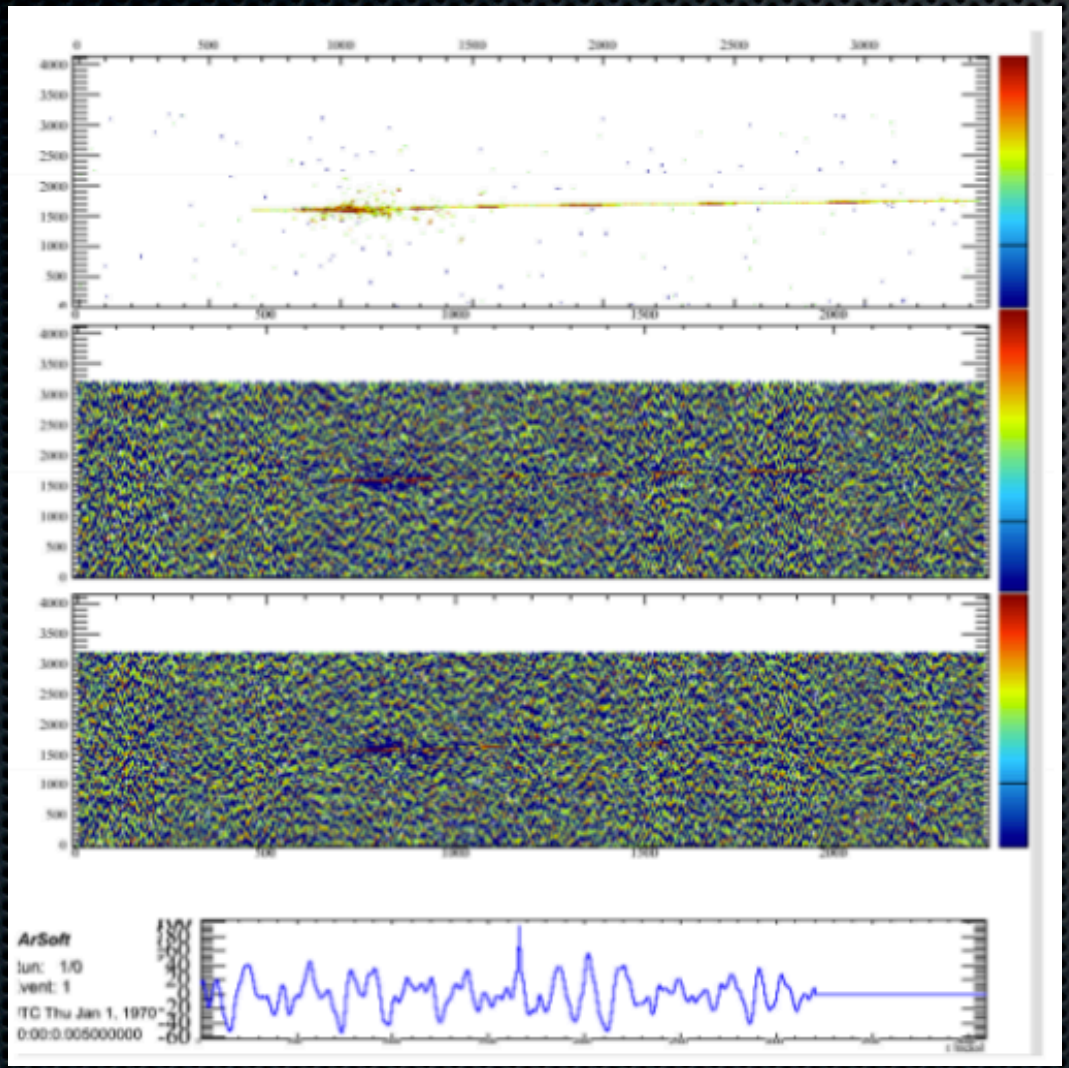


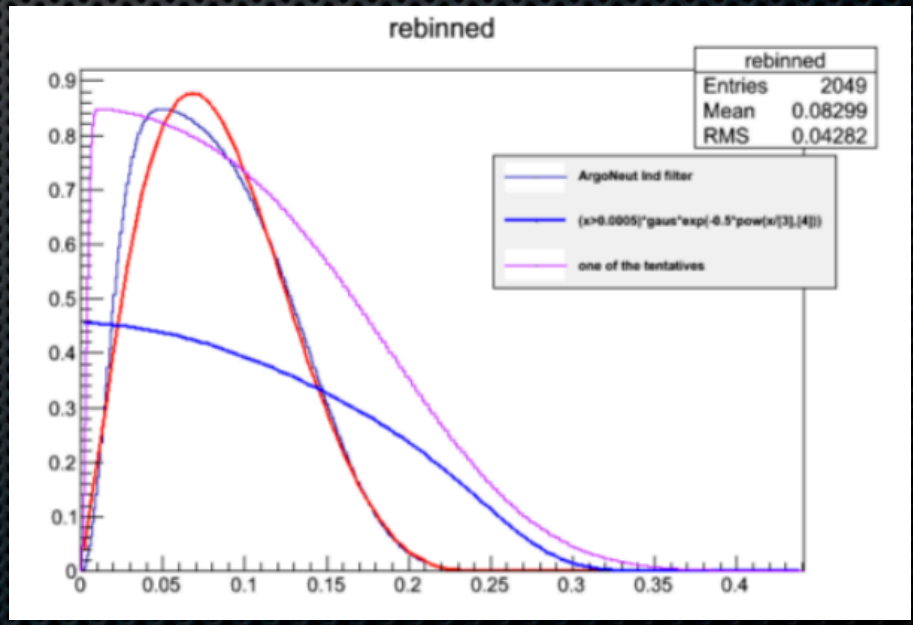
improved event display - Nathaniel Tagg



detector noise



- original noise filter done using function based filter
- one problem non-zero value of filter at *f*=0
- return to basics



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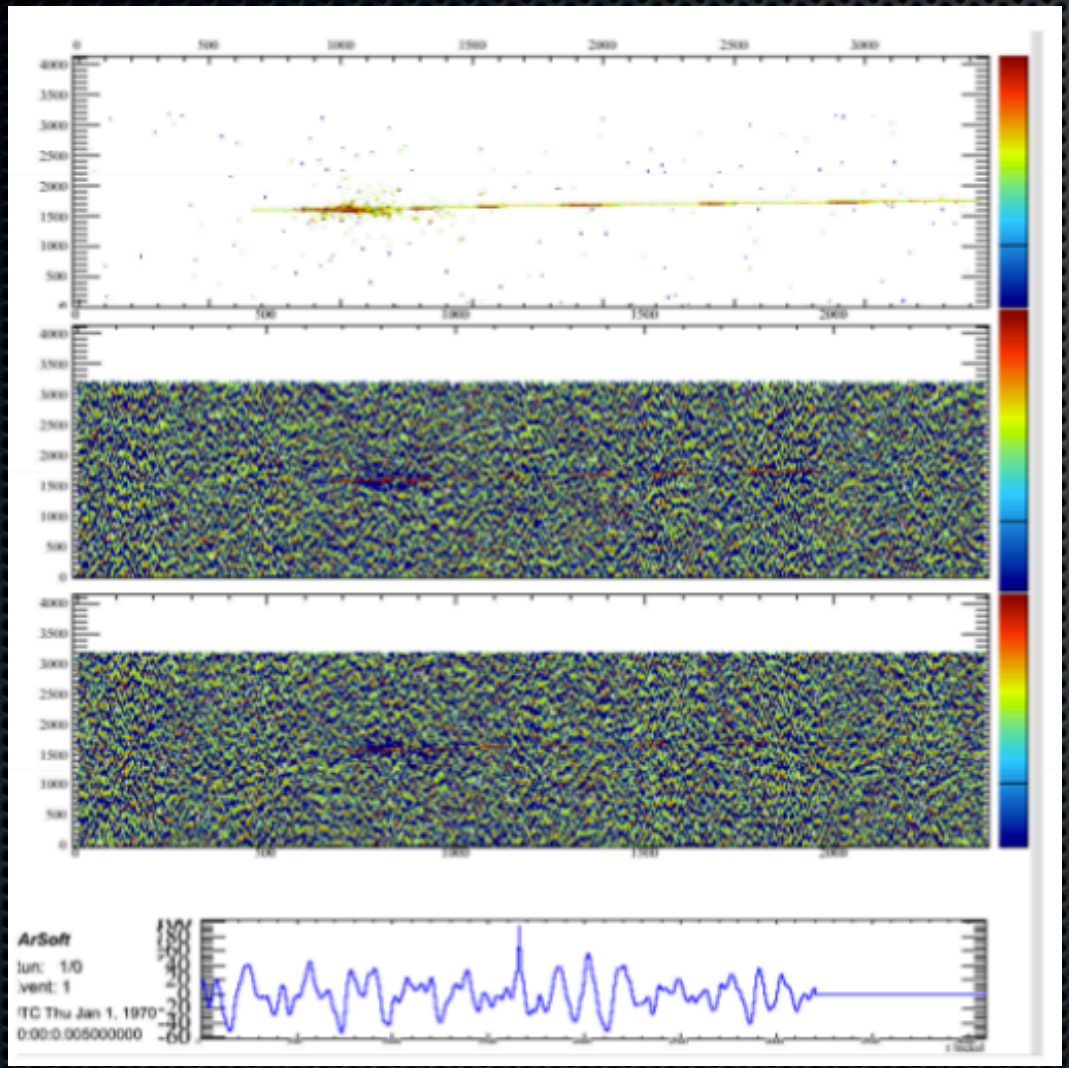

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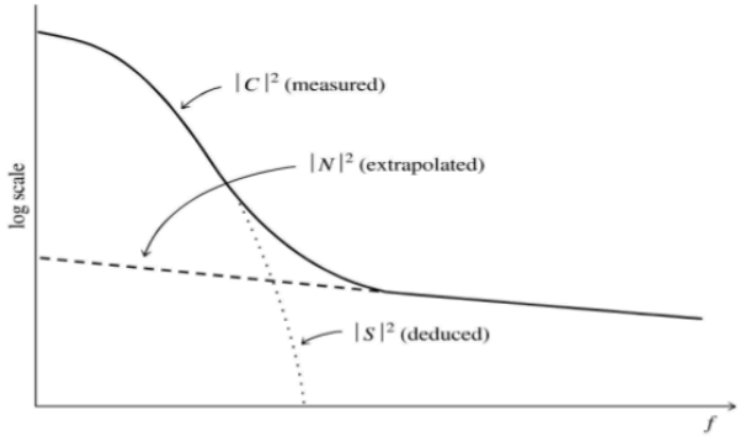
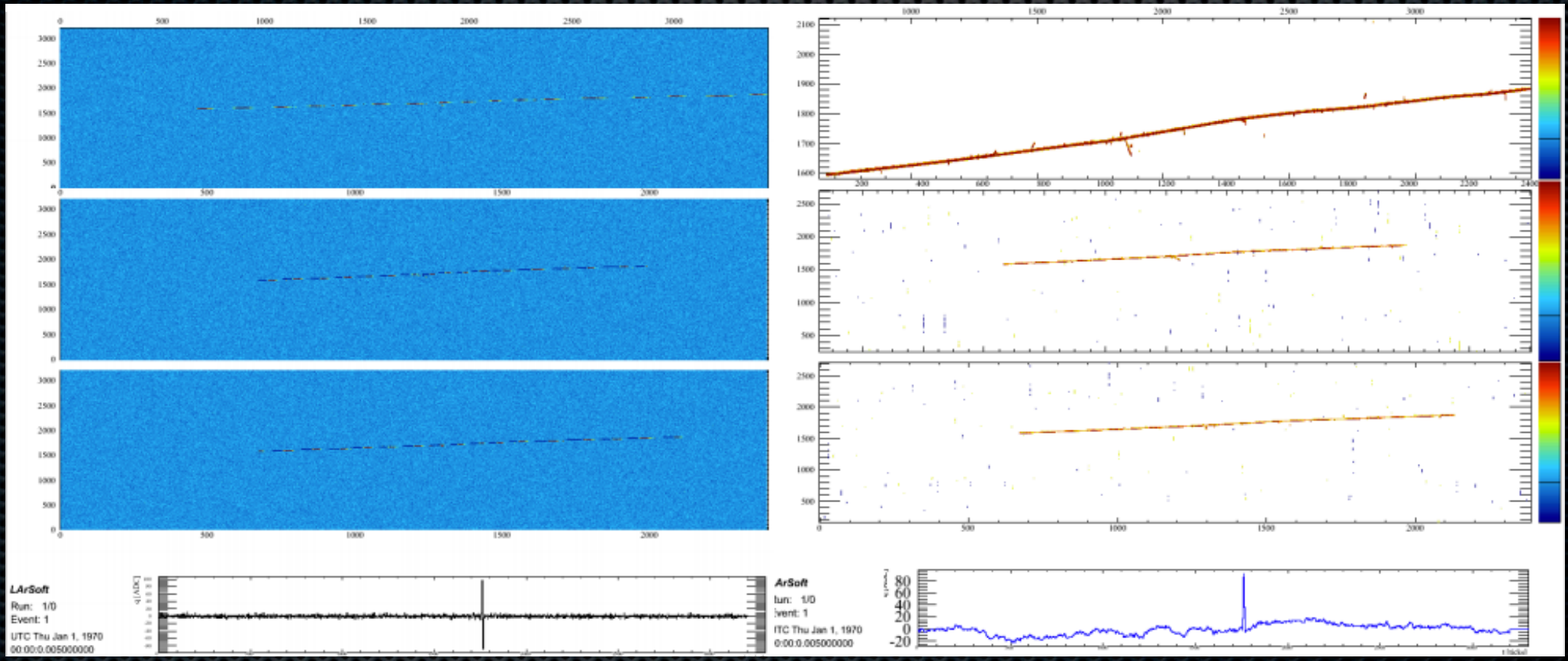
- The formula is: $\Phi(f) = \frac{|S(f)|^2}{|S(f)|^2+|N(f)|^2}$
- the trick is: $|S(f)|^2 + |N(f)|^2 \simeq |C(f)|^2$

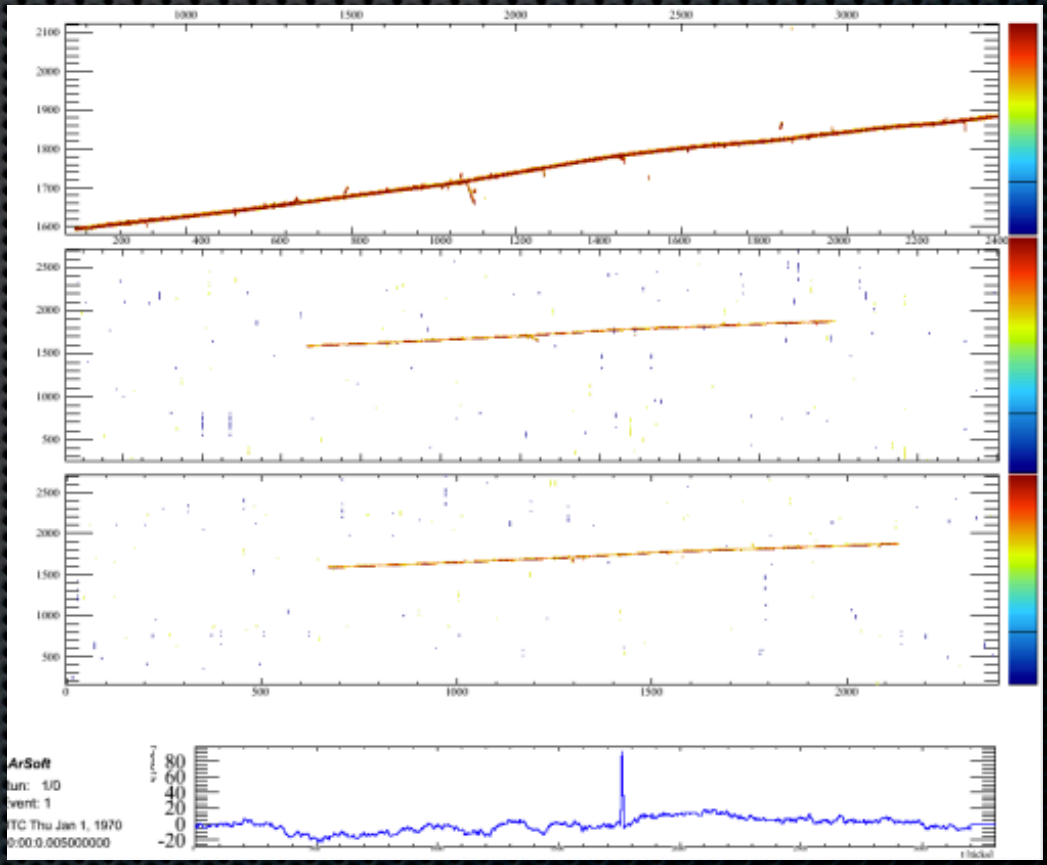


improved noise filter for μBooNE in LArSoft

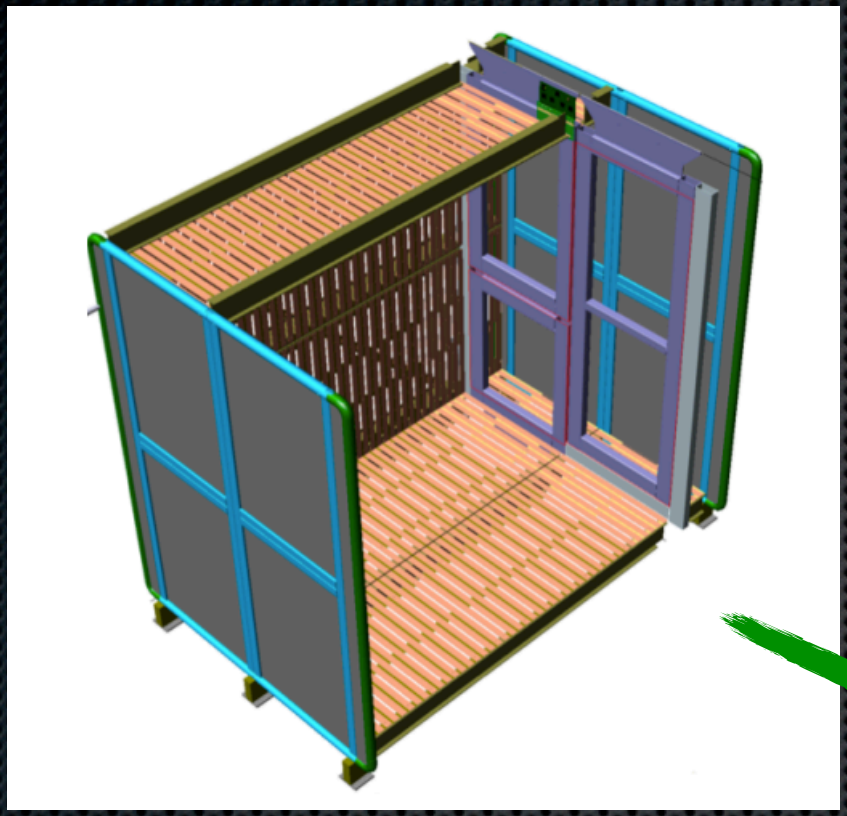


LBNE signal simulation in LArSoft

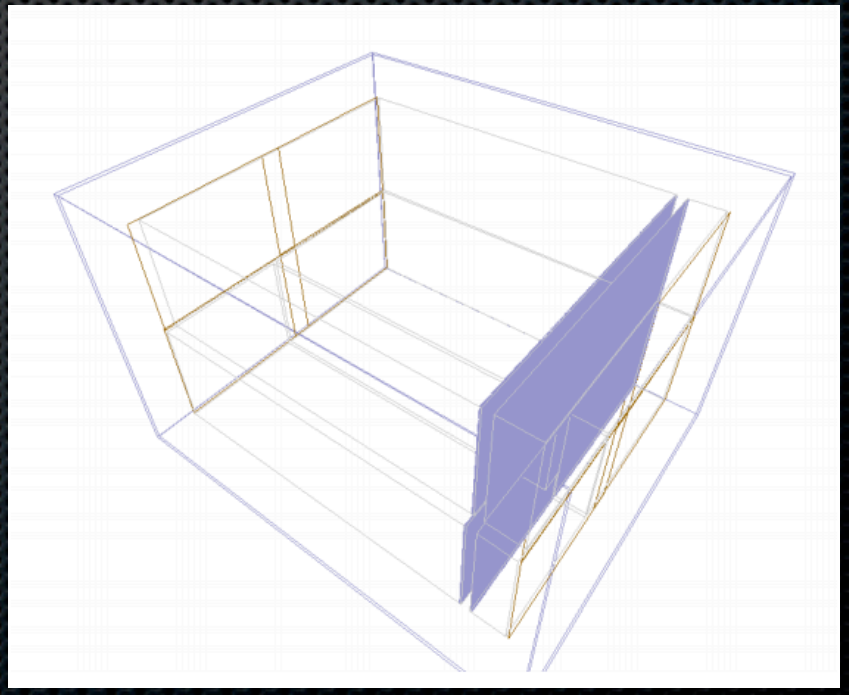
- work is ongoing to develop wire response simulation for both 10 kT and 35 T configuration
- modules and parameters have been developed
- signal shaping incorporated
- studies of zero suppression algorithms incorporated within modules



35T detector geometry



- three different drift volumes
- modified the APA design from 10kT design
- preliminary GDML available



conclusions

- the geometry is 99.44% complete for the two cryostat 10kT far detector
  - generation of events has been successful and within the month should be available for large scale generation
- considerable amount of work needed to fill in the details of the material in the detector - electronics, g10, CPS details
- basic design of the overburden available, but is now a moving tager
- software for mapping the wrapped APA needs integration and validation finished today
- considerable success for the noise and signal simulation
- event display progressing nicely but considerable effort needed