UNIVERSITY OF SUSSEX

DEEP UNDERGROUND NEUTRINO EXPERIMENT

DUNE Far Detector Full Geometry Update

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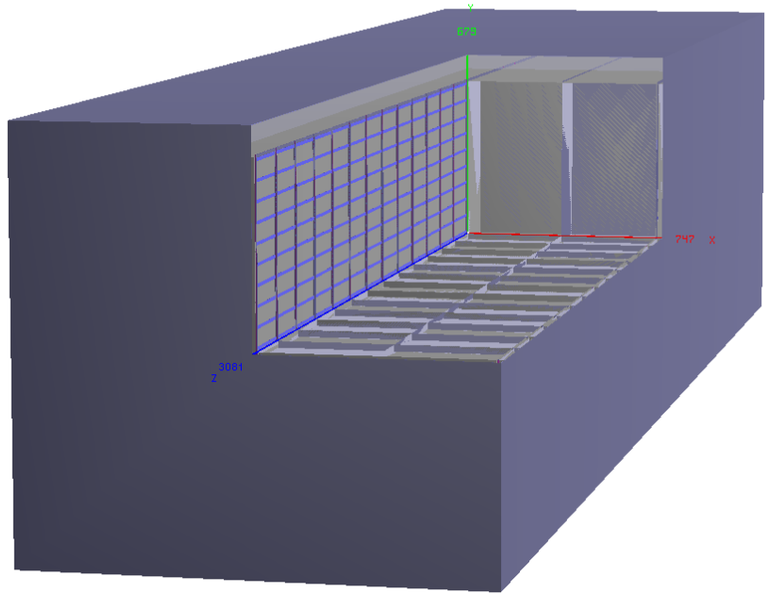
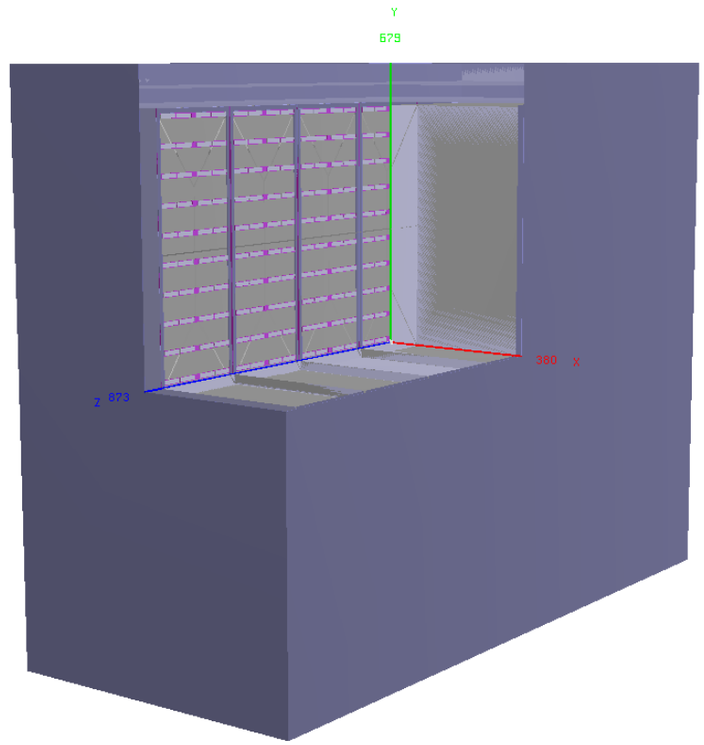
Current Geometries in LArSoft

- **Issue with the geometry**
  - Most simulation fhicl files (and subsequently most of the MCC11 files) are based on the 1x2x6 workspace geometry
  - This is fine for most applications but not for radiological simulations
  - The production regions are very strange and any capture result is not trivially scalable



- **Full 10kt geometry in LArSoft**
  - The full 10kt geometry exists in LArSoft but is very basic
  - There are some very suspicious material definitions, eg the steel support structure is defined as a uniform layer of an air steel mixture



- **Two solutions**
  - Break down the 1x2x6 simulation into separate parts and try and stitch them together to get a more accurate simulation
  - Build a new geometry that is more physically accurate and integrate that into LArSoft

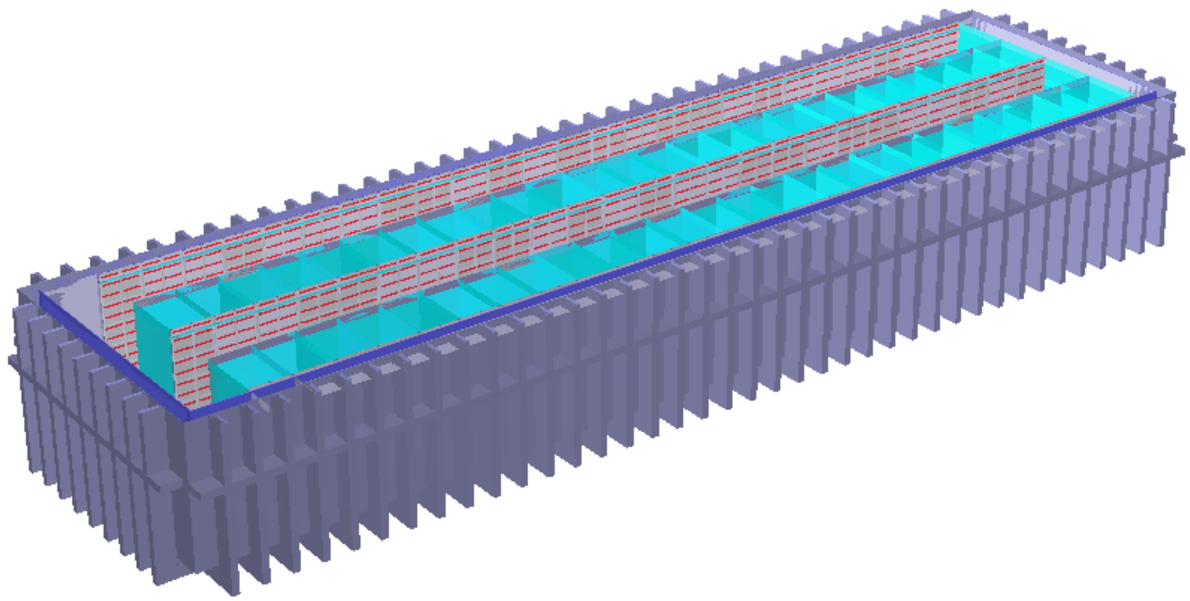
New DUNE FD Geometry

- **Development in GEGEDE**
  - Python module (way more friendly than the previous Perl scripts)
  - Build is parameterised and adjustable with config file
  - Hierarchal structure so outer elements have to fit around inner elements

```
[Cryostat]
subbuilders          = ['TPC']
class                = duneggd.larfd.Cryostat.CryostatBuilder
membraneThickness    = Q('0.5in')
cathodeThickness     = Q('0.016cm')
nAPAs                = [1, 2, 6]
# nAPAs                = [3, 2, 25]
outerAPAs            = False
#outerAPAs            = True
sideLAr              = Q('15cm')
APAToFloor           = Q('49.2cm')
APAToGAr             = Q('40.7cm')
APAToUpstreamWall    = Q('301.2cm')
APAToDownstreamWall  = Q('49.2cm')
```

- **Possibility for exotic geometries**
  - As mentioned 1x2x6 results aren't trivially scalable
  - You could define specific active regions and ignore as much or as little of the detector as you'd like

- **Addition of new volumes**
  - Theoretical shielding could be applied to the detector
  - Basic water shielding has already been explored

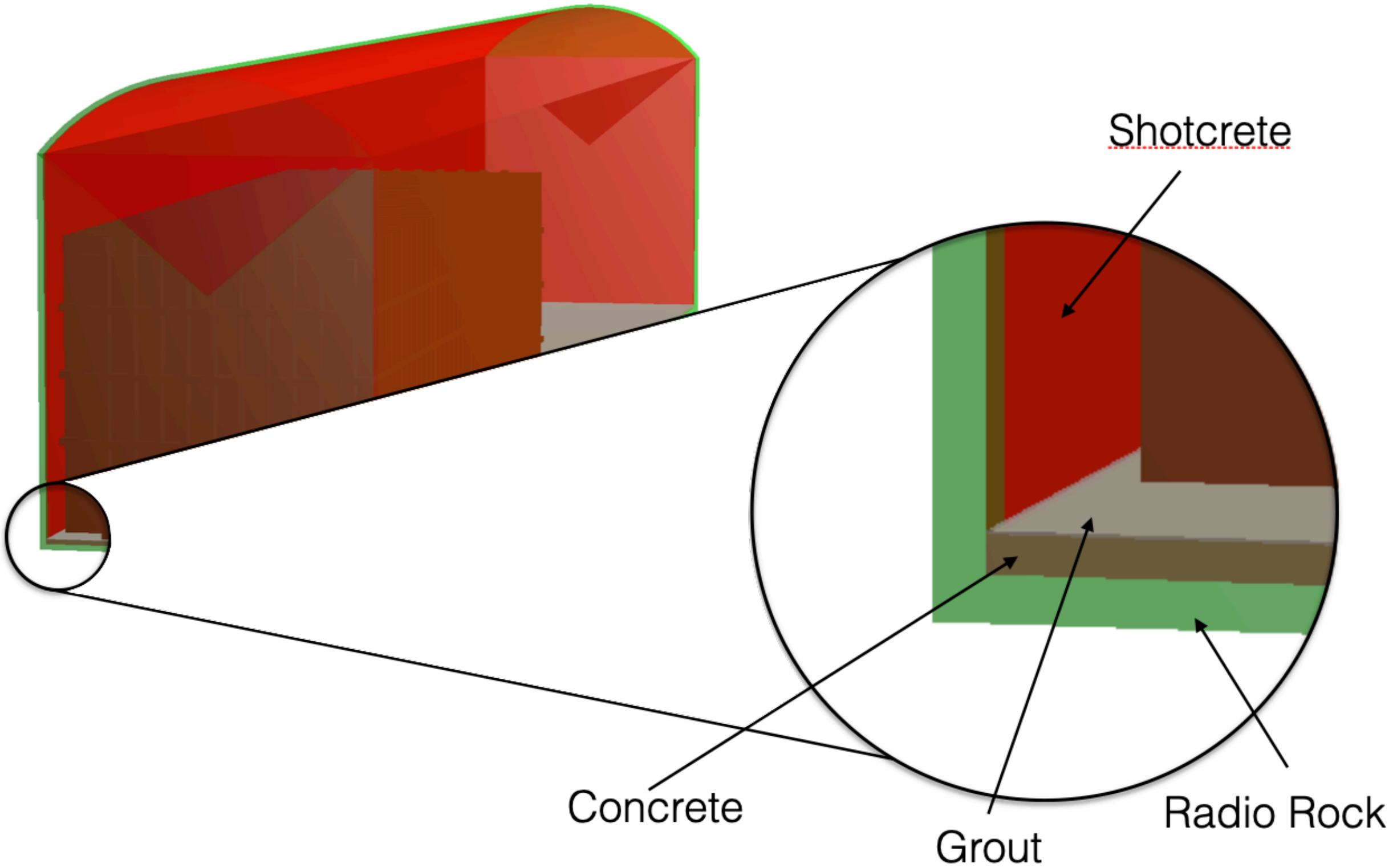


New volumes in the FD Geometry

- **Rock-ey volumes in the detector cavern**
  - The floor of the cavern as 11” of concrete and 1” on grout
  - The walls and ceiling have a 6” layer of shotcrete
  - Based on specifications from the TDR
  - Very important for radiological studies in background TF

- **Material definitions**
  - Spectroscopic analyses undertaken at SDSMT
  - Rock compositions from 4 samples averaged to approximate cavern material
  - Concrete compositions from various suppliers included
  - Radiological analysis done on many materials to provide accurate simulations

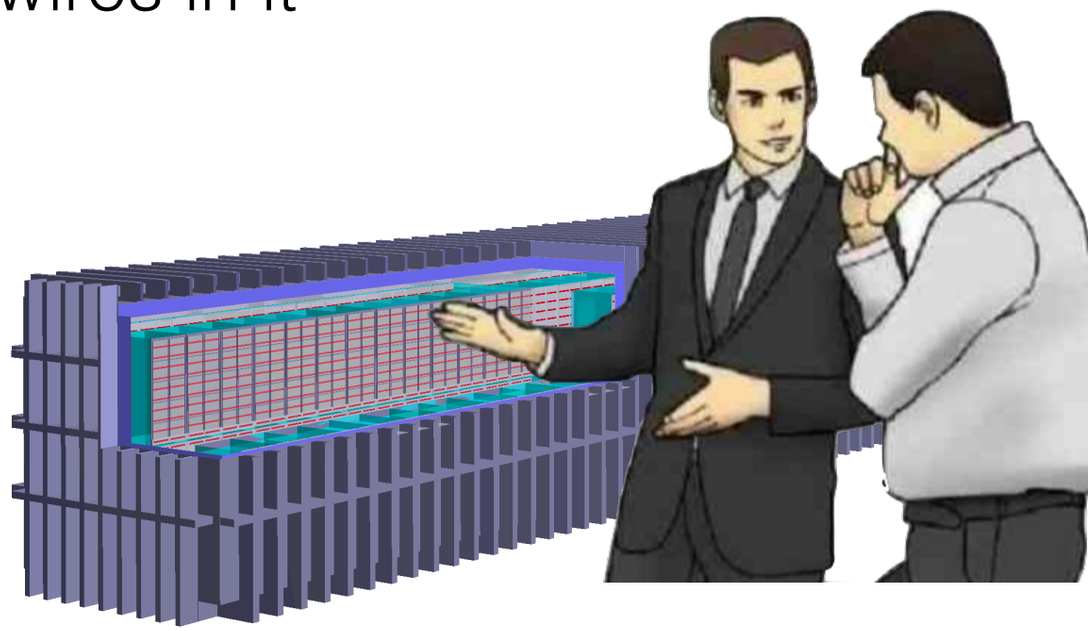
New volumes in the FD Geometry



Consistency checks

- **TPC plane wire placement**
  - Wire segment positions calculated externally to GGD code
  - Positions read in from .CSV when running GGD
  - Not the most efficient way but it works reliably

Scientist: *slaps roof of detector*
This bad boy can fit so many wires in it



- **Verification of wire positions**
  - Channel Map run in LArSoft processes displays the necessary values for
    - U, V, Z channels
    - Wire pitches
    - Number of APAs

```
Initializing channel map...
%MSG
Cryostat 0:
  384000 total channels
  150 APAs
  For all identical APA:
    Number of channels per APA = 2560
    U channels per APA = 800
    V channels per APA = 800
    Z channels per APA = 960
    Pitch in U Plane = 0.4667
    Pitch in V Plane = 0.4667
    Pitch in Z Plane = 0.479
```

Spacial checks in the new geometry

- **Various macros for spacial checks**
  - **DrawGeometry.C**: Locating the proper (0, 0, 0) point
  - **CheckOverlaps.C**: Ensures no extrusions or overlaps - vital for G4 material properties
  - **PointWalk.C**: Shows materials over a given trajectory - used to find erroneous air gaps

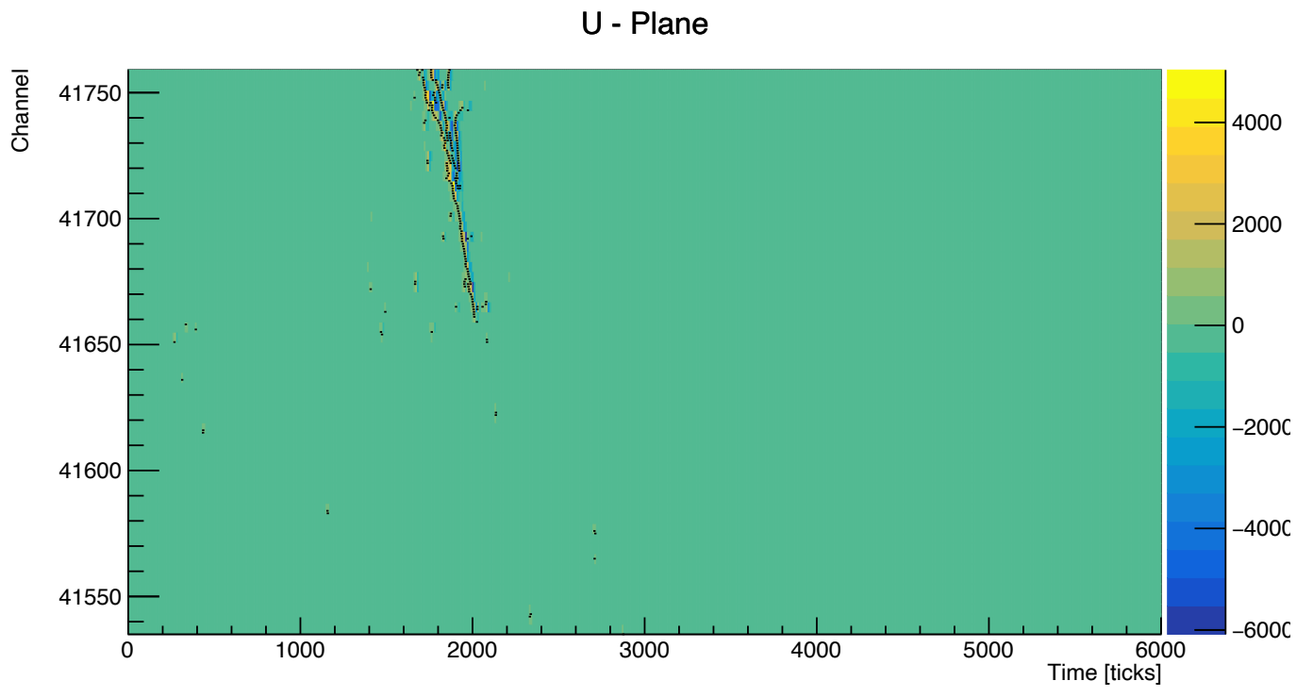
What else is needed

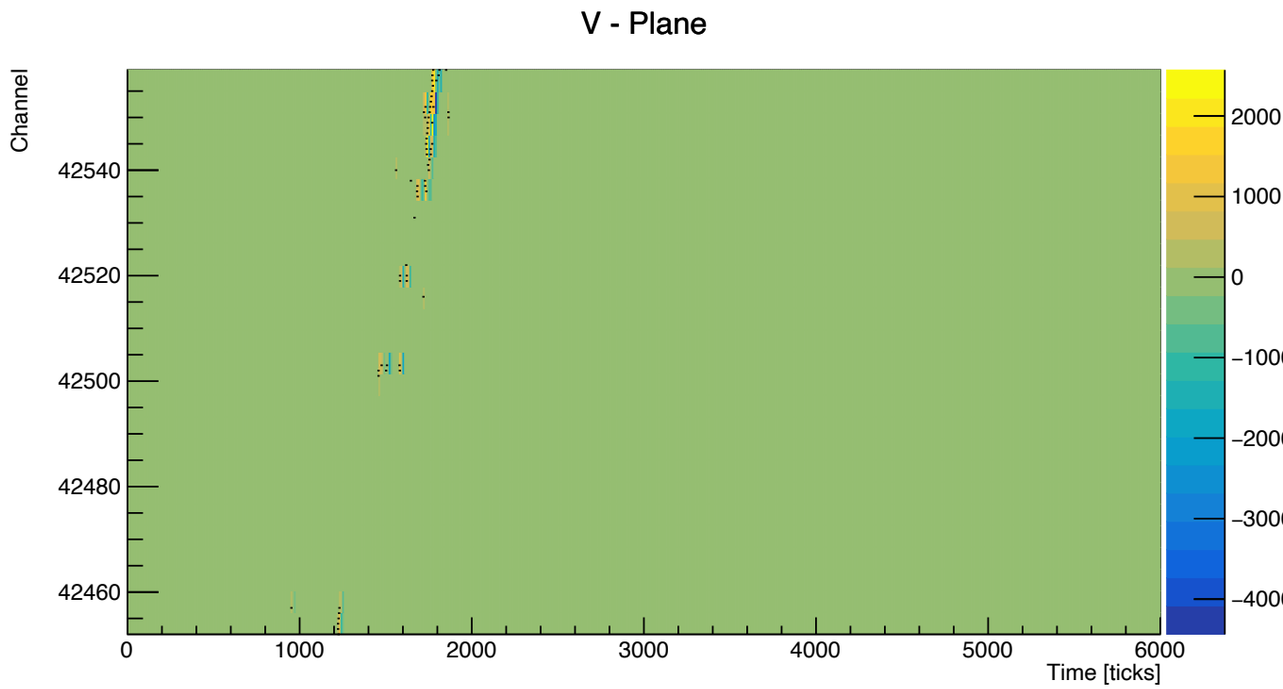
- **APA spacing**
  - APAs in the FD are grouped in triplets
  - There is a slightly larger gap between every third APA
  - This is not yet implemented in the FullGeo

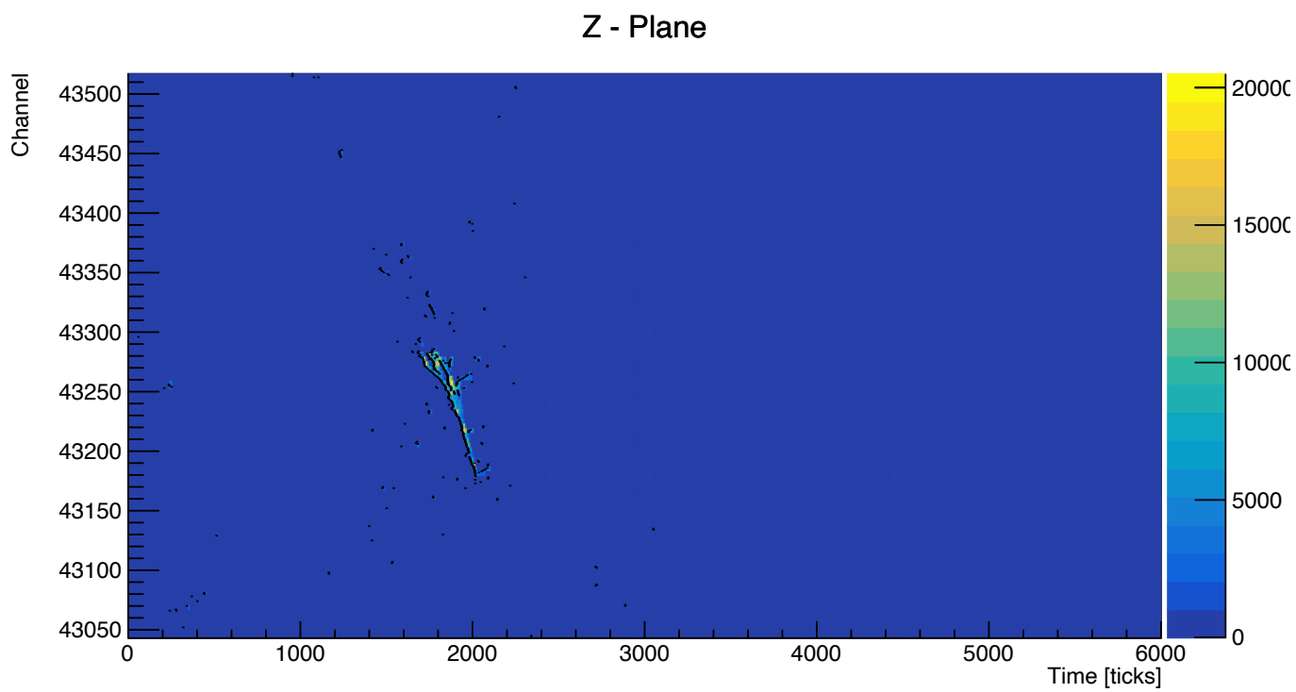
- **Non-zero suppressed no noise deism**
  - Specific FHiCL: nonoise_nozs_detsim_supernova_dune10kt_1x2x6.fcl
  - Saves a huge amount of information
  - Requires a lot of memory
  - Fortunately, other detsim processes run

- **Photon detector system**
  - It now works!
  - Again, requires a lot of memory which can be a limiting factor

Electron neutrino event in the full detector

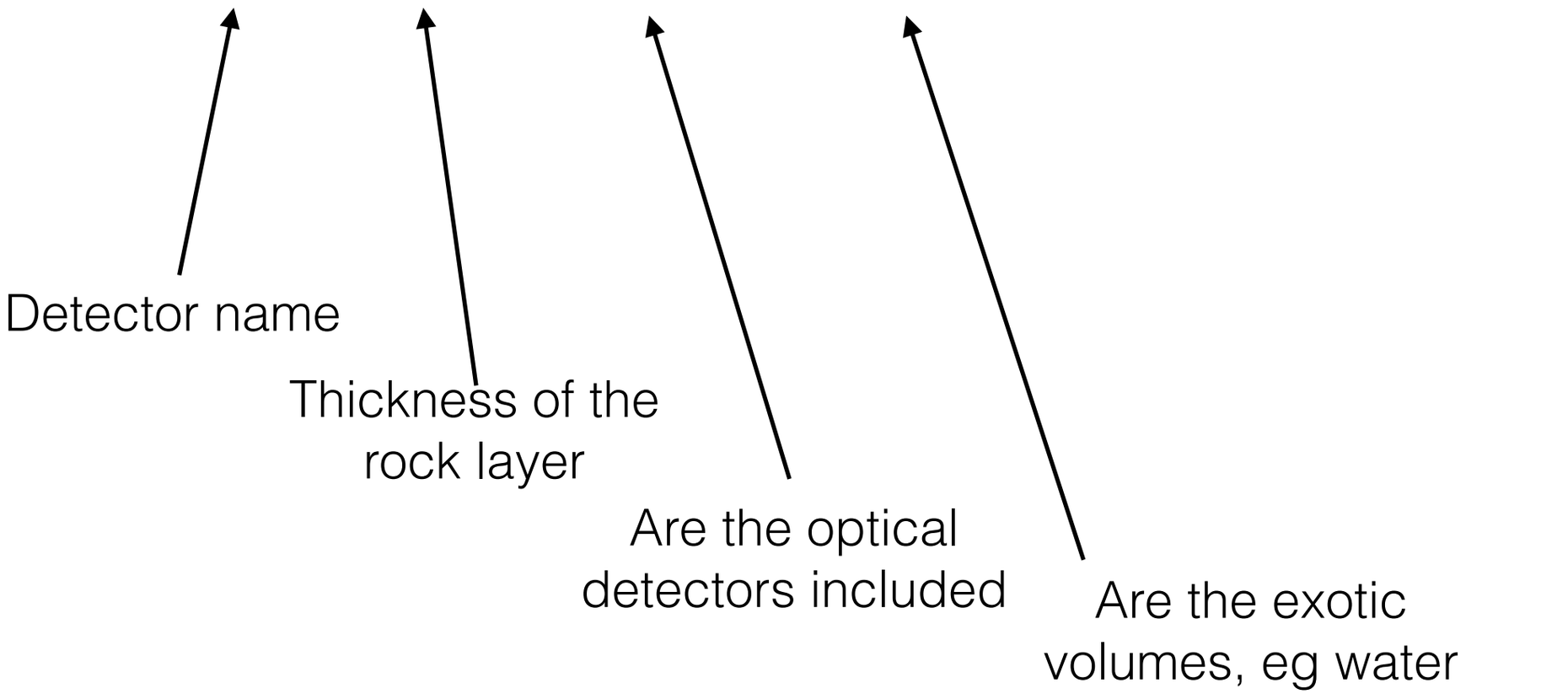






Availability and version control

- **All code is on DUNE GitHub**
  - You can get the python scripts here: https://github.com/DUNE/duneggd
- **Versioning the GDMLs**
  - Currently my naming convention is larfd_rn200cm_noOpDet_<exotic>_v1.gdml



  - Not married to this naming convention, just convenient for our uses

Future plans and prospects

- **Distribution**
  - Currently anyone who wants to use this FullGeo is cp-ing it from my **/Geometry/gdml/** directory
  - Making this a UPS product could be done if people are interested

- **Updates**
  - Geometry now at a complete working order for the purposes of the BKG group
  - Only major updates foreseeable from that end are to material compositions
  - APA spacing is a potential project for anyone interested
  - Memory management issues probably an issue for the LArSoft Gurus

- **Other information**
  - Currently one open pull request which updates the materials and includes the PDS

- **Thank you for listening**