# DUNE full FD Geometry

Aran Borkum

# Overview



- **Motivation for doing the full geometry**
- **Construction of the full geometry**
- **Safety checks**
- **Initial things that are working**
- **Closing thoughts**

# Why do we want the full geometry

- **It all started with J. Beacom**
  - Backgrounds group want to better understand neutrons in the far detector
  - This was practically impossibly with the workspace geometry

- **Issues with using the 1x2x6**
  - Neutrons generally travel 30-100m in LAr before capturing
  - The radiological simulation for the 1x2x6 does not allow for trivial scaling to the full geo

- **Other motivating factors**
  - Good opportunity to revise the material definitions in the geometry
  - Good opportunity to include more complex, realistic volumes to the geometry
  - Even better opportunity to migrate away from using Perl and use Python instead

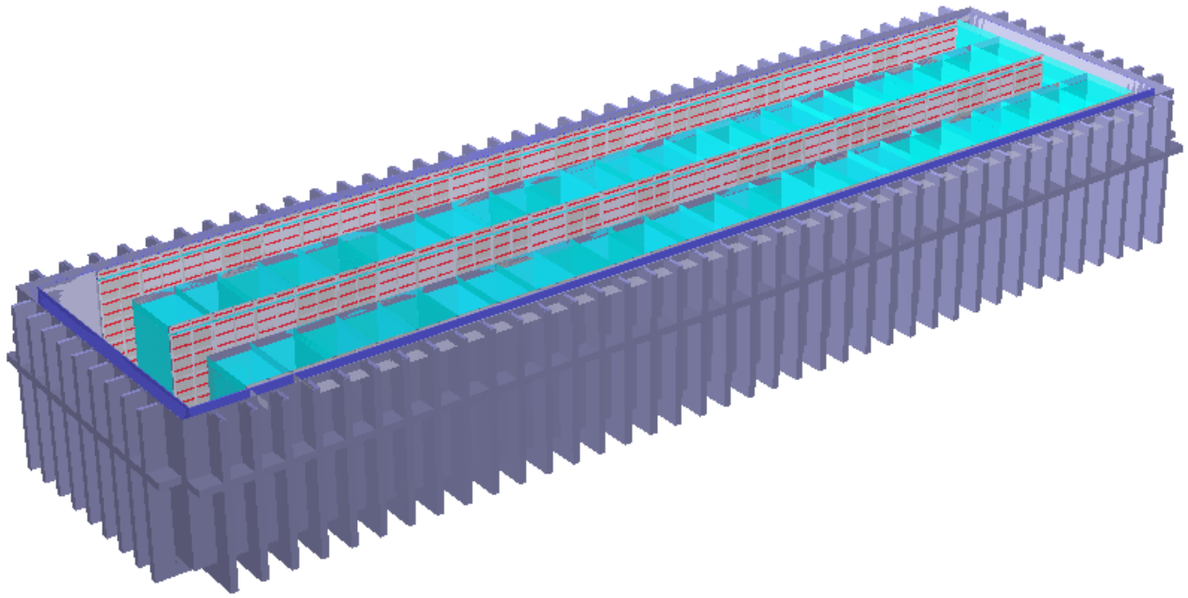
# New DUNE FD Geometry

- **Development in GEGEDE**
  - Python module
  - 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



# Validation new geometry

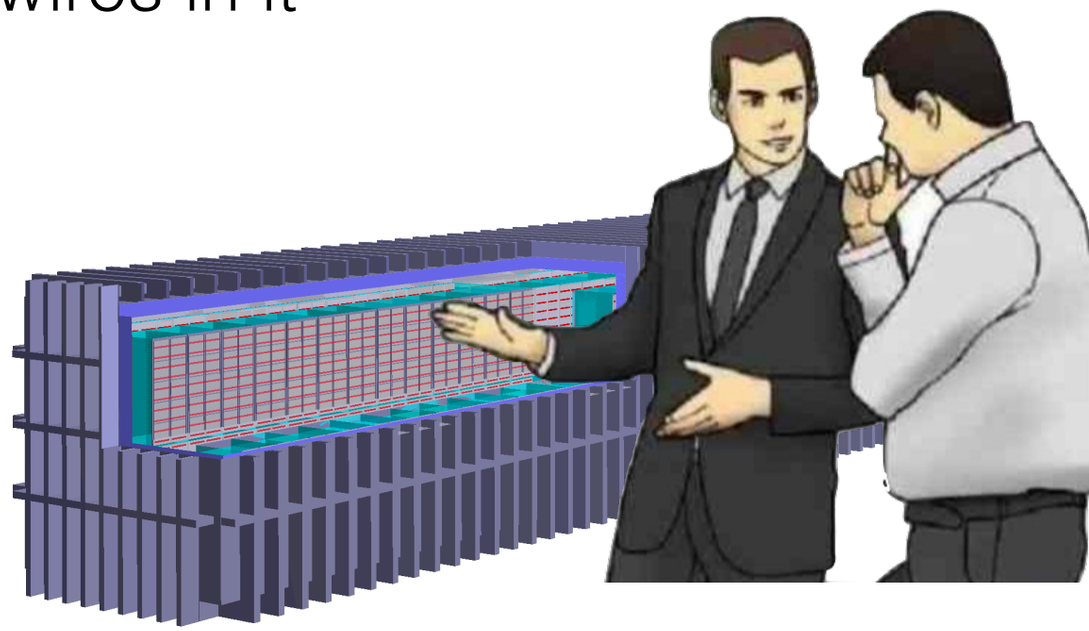
- **DuneGGD in-situ Tests**
  - Goal: incapable of creating a geometry that breaks LArSoft
  - Wires have consistent endpoints and pitches
  - Origin in intended place
  - ROOT macro
    - checks overlaps, default draw options

- **LArSoft Tests**
  - Existing GeoObjectSorter and ChannelMap works
  - LArG4 output looks reasonable
    - IDEs where there are TPCActive,  true dE/dx maps out APA Frames and other vol's
  - Check DetSim with EVD scans
  - Replaced GDML: Important standard FCLs still work
  - Go as far as checking Track/Vtx Reco?

# Sanity check in the new geometry: TPC wire planes

- **TPC plane wire placement**
  - The collection plane is very easy to build
  - Induction wire planes are very annoying to build
- **Generation of wire points**
  - Using an external module the position of the wires is calculated
  - These values are stored in a spreadsheet and read when constructing the geometry
- **Verifying correct wire placement**
  - LArSoft says so!

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



```
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
```

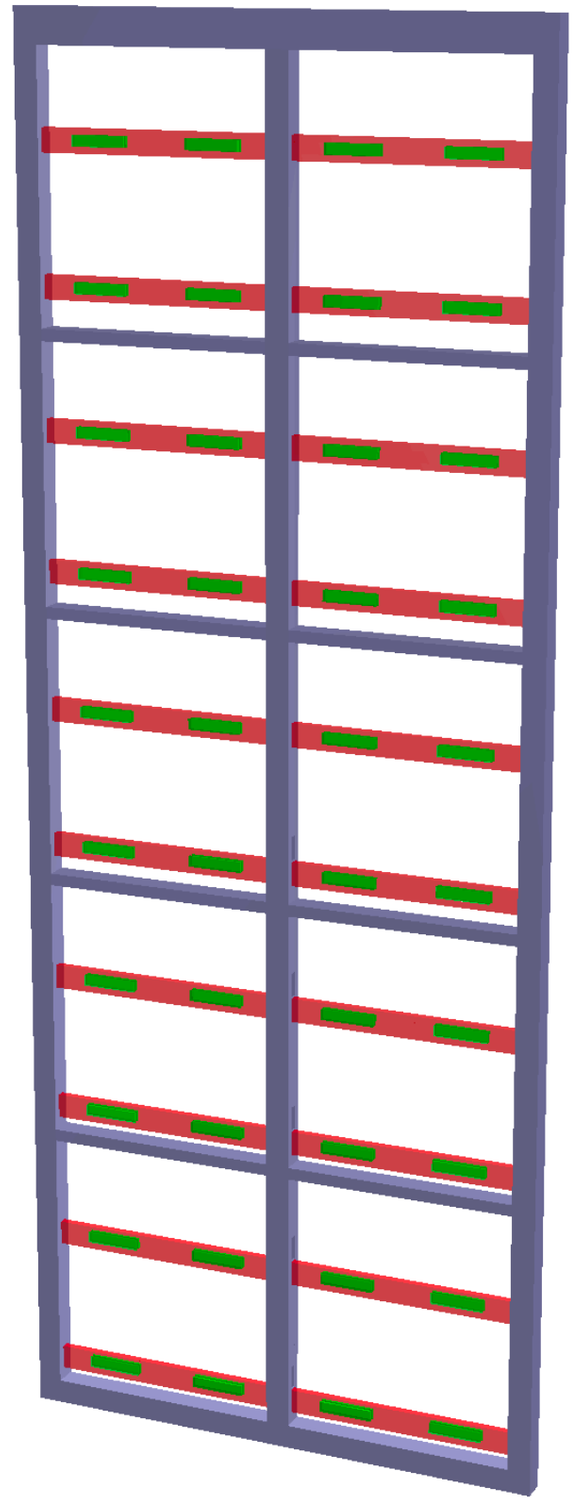
# Feature that requires revision: Photon detector



- **Photon Detector System**
  - The APA-Frame has 80 optical detectors (Green)
  - The light paddles (Red) are spaced properly so the distance stays constant when stacked vertically

- **Issues**
  - The optical detectors aren't the right size
  - More definitive measurements are needed
  - For some reason the g4 fhicl can't find OpFastScintillation.cxx, not clear why this is
  - This means the process seg-faults

- **Actions**
  - Need help from the simulation gurus on how to handle this
  - Write new fhicl's so things can be done now



# Versioning the geometry

- **Critical elements**
  - The bulk of the python script
  - “Databases” of materials -> elements, mixtures and molecules
  - Standard volume sizes

- **Python script**
  - Now that it’s done it remains fairly static
  - Changes will indefinitely need to be made

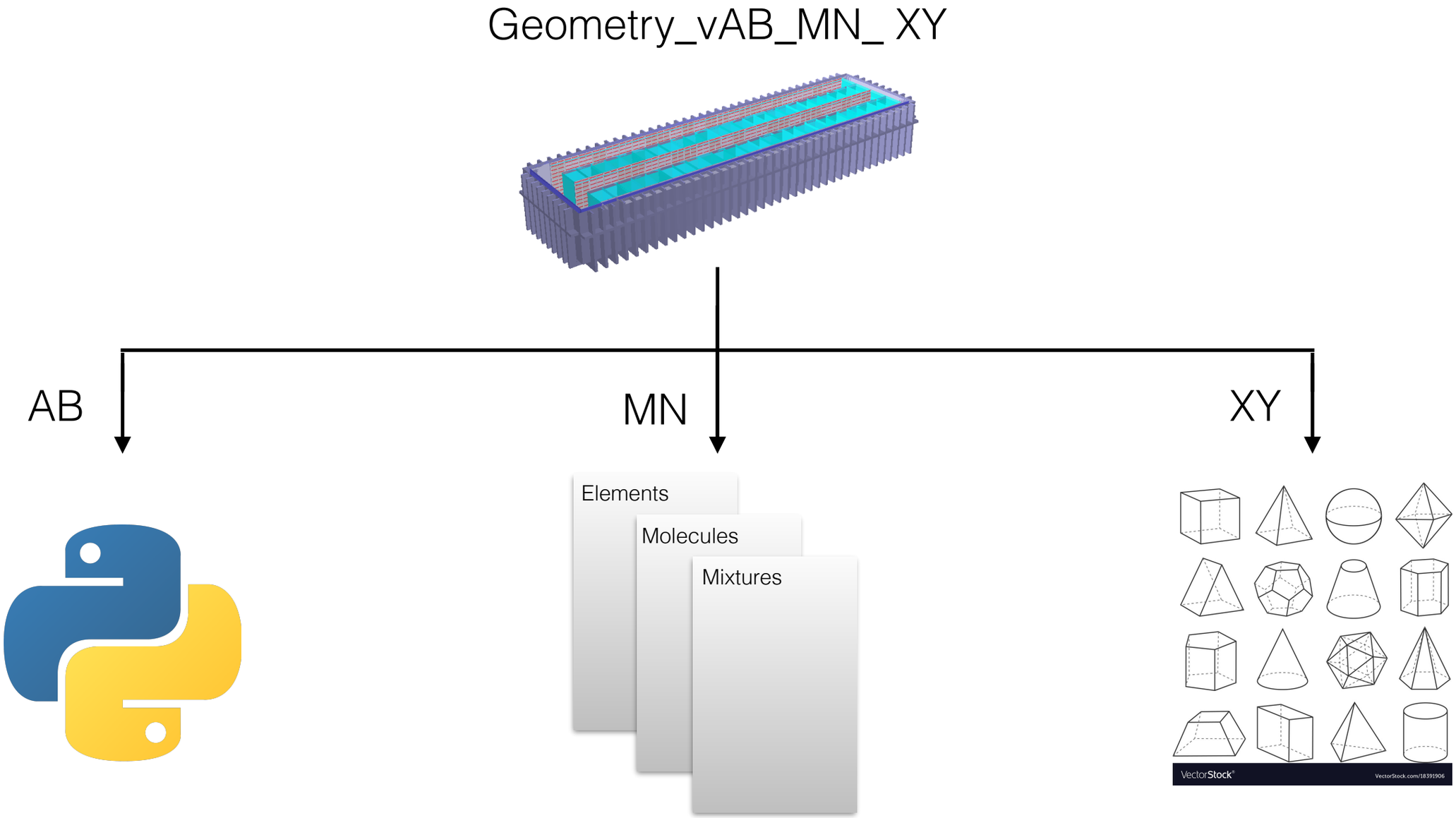
- **Materials**
  - I decided to have these in external CSVs for now so they can be changed on the fly
  - These are parsed into the python script

- **Standard Volumes**
  - This is not necessarily parsed into anything, more for reference
  - This will include things like wire diameter, cryostat dimension, ARAPUCA dimensions, etc

# Version control



- **What is there to version**
  - The python scripts that control the construction
  - The materials database
  - The standard volumes

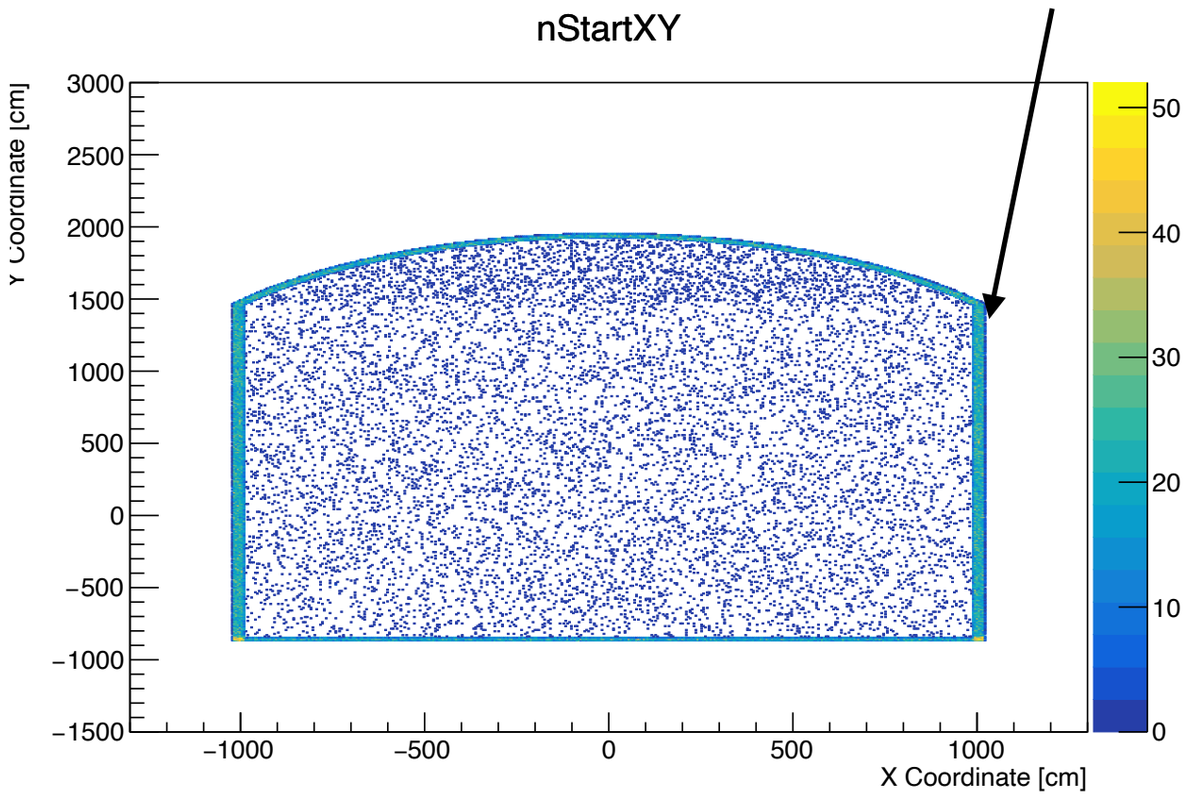


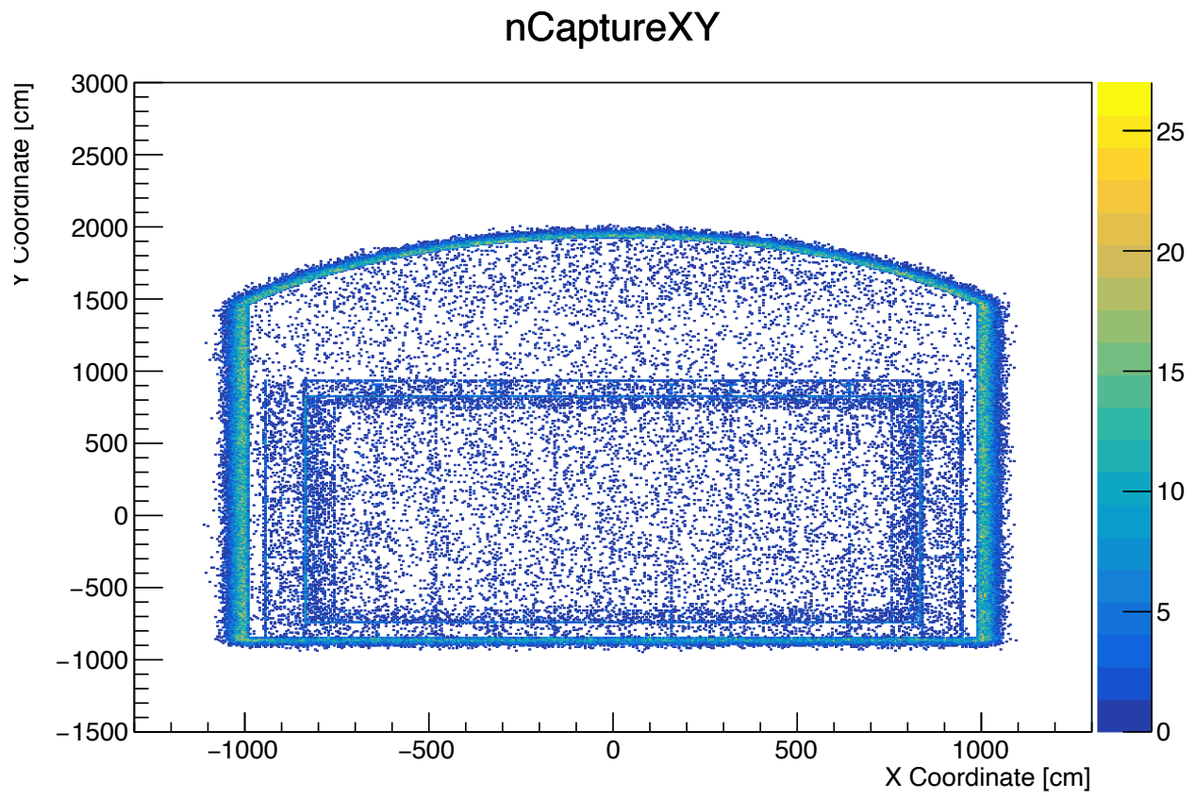
# Initial MC studies with the Full Geometry



- **Radiological neutron studies**
  - New geometry means we can get more realistic neutron capture rate estimations
  - Can exploit pre-existing generators and now produce particles from specified volumes
  - Theoretical volumes can be added (motivation to study water passive shielding)

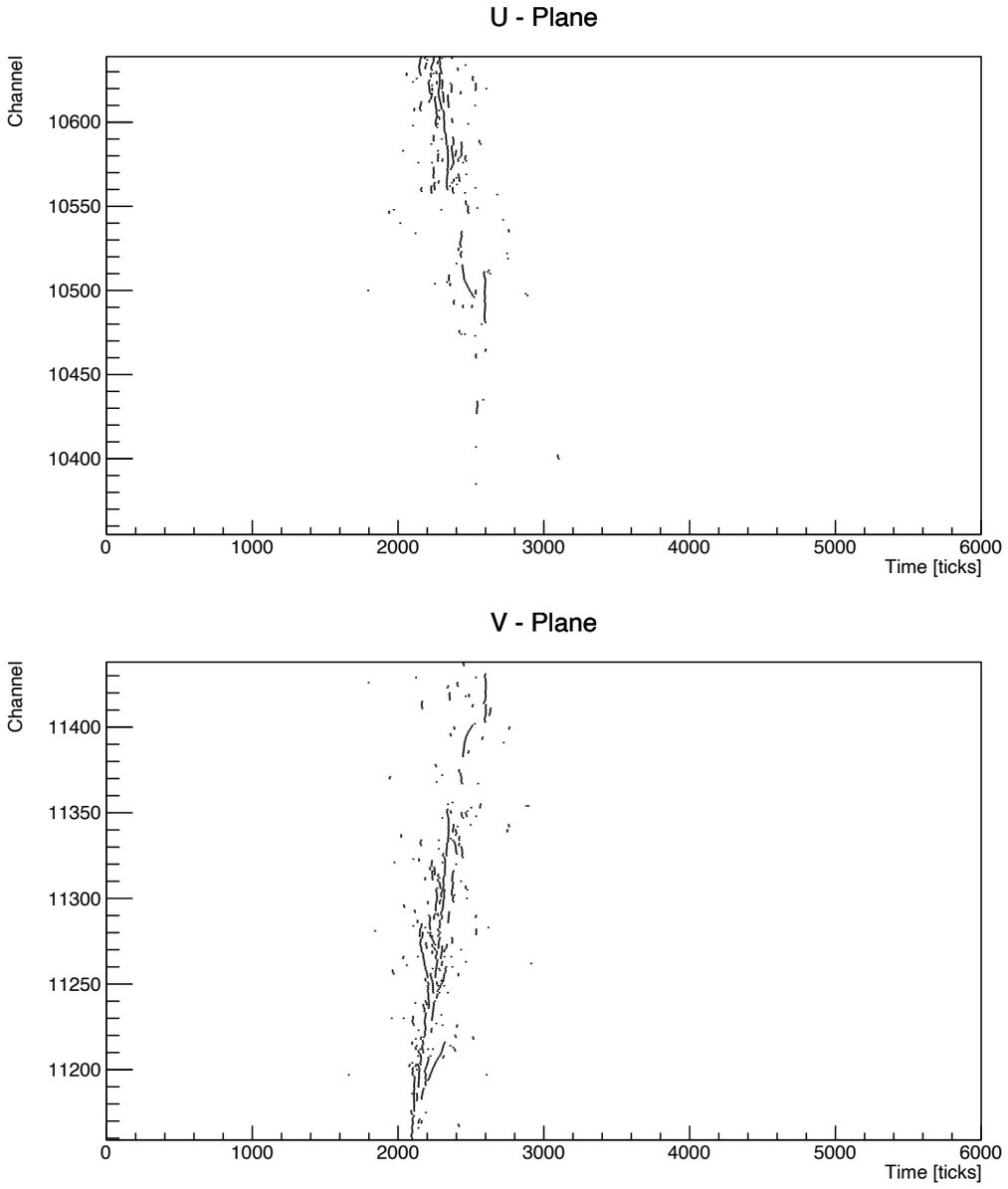
Neutrons produced from 30cm layer around the detector cavern

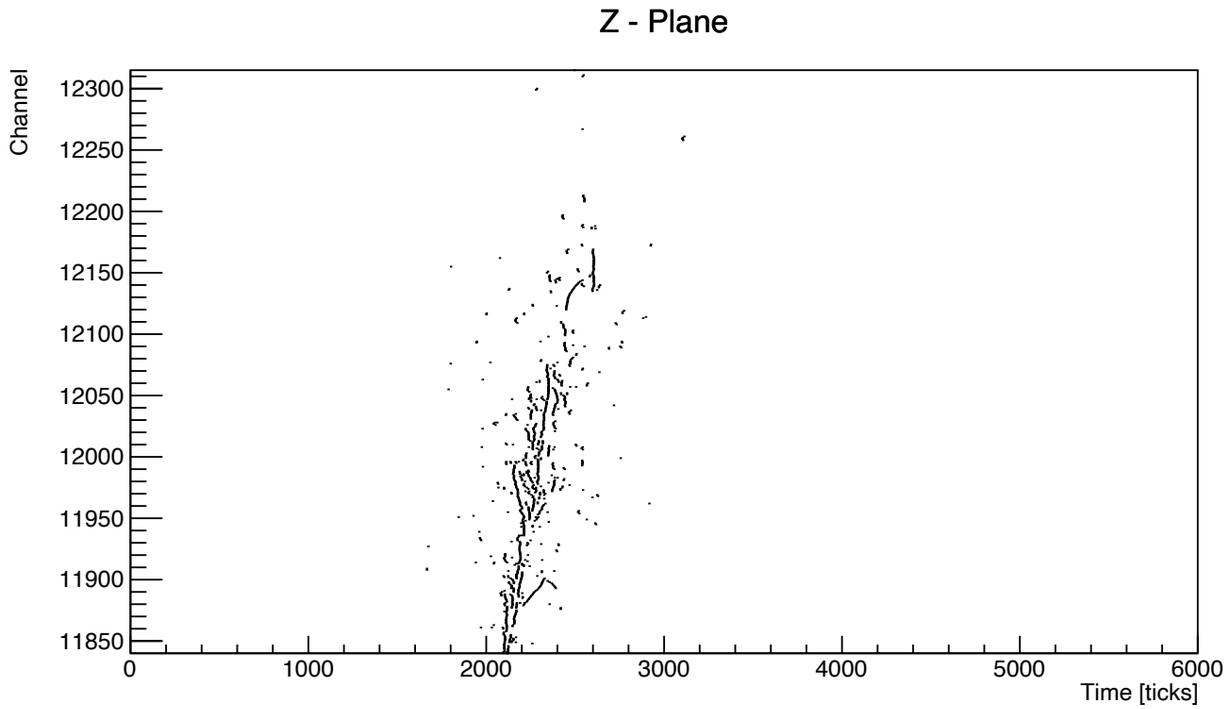


# Detector simulation

- **Ran an electron neutrino event through the whole MC chain**
- **Hit finding on all three planes: Trigger primitive finder on collection and running sum hit finder on induction planes**



# Conclusions and questions for collaborators

- **New DUNE-FD Geometry**
  - The geometry is now complete to a working order
  - Numerous versions do exist for different purposes
  - Material definitions and precise measurements will be required in the future
  - Work with relevant experts is required to improve the running efficiency so we can include PDS and non-compressed detector simulation and submit for a full scale productions

- **Other geometries?**
  - Are the geometries that have different values of the pitch wanted?
  - Are the geometries that have different values of the wire angle wanted?
  - Is there anything else people might want/need?

- **Anything else?**