DEEP UNDERGROUND
NEUTRINO EXPERIMENT

An ECAL/MuID design proposal

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ND-GAr meeting
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(revised as per suggestions in meeting)

Problem statement

- In order to keep the gdml file to a reasonable size, we decided to simplify the ECAL representation to single tiles, strips, absorbers, and FR4 for PC boards.
- Code to do various geometric calculations is then written for each particular ECAL design and placed in `garsoft/Geometry/ChannelMapAlgs/*Segmentation*Alg*.*`
- e.g. to run our recent dodecagonal geometry, you need to get the `nd_hall_mpd_only_ECal12sides_42l_SPY_v3_wMuID.gdml` file; then your job creates a `SegmentationAlg` object with methods like `getStripLength` and `GetCellID`. These methods are actually implemented in a class derived from `SegmentationAlg` by the name of …/`ChannelMapAlgs/SegmentationMultiGridStripXYAlg.*`
- When the geometry service is initialized it gets a pointer to this code.

Problem statement

- In the course of work on the ND-GAr detector, we've tried different ECAL geometries... octagonal, dodecagonal, 80 layers, 42 layers, etc.
- The geometry `fcl` files point to a new set of code for each geometry. The new set of code is copied from the old set of code and modified for the new geometry.
- Except it is usually not modified correctly, creating many bugs.

- On 27 Jun I suggested that our best solution for this dilemma is to develop a set of parameters which define ALL the geometries we will EVER want, write segmentation algorithms which only use those parameters for their calculations and thereby have only one segmentation code.
- I got volunteered to propose said set of parameters.

Problem statement

- Of course, we are very short of people to work on implementing said segmentation code.
- But here's the proposal. The key question for today:

Are all the ECAL and MuID geometries we anticipate studying/using/contemplating covered with this set of parameters?

Parameter Set Background

The MuID detector is a 2nd instance of the ECAL detector with different geometry and segmentation code. It isn't just the ECAL we have to think about.

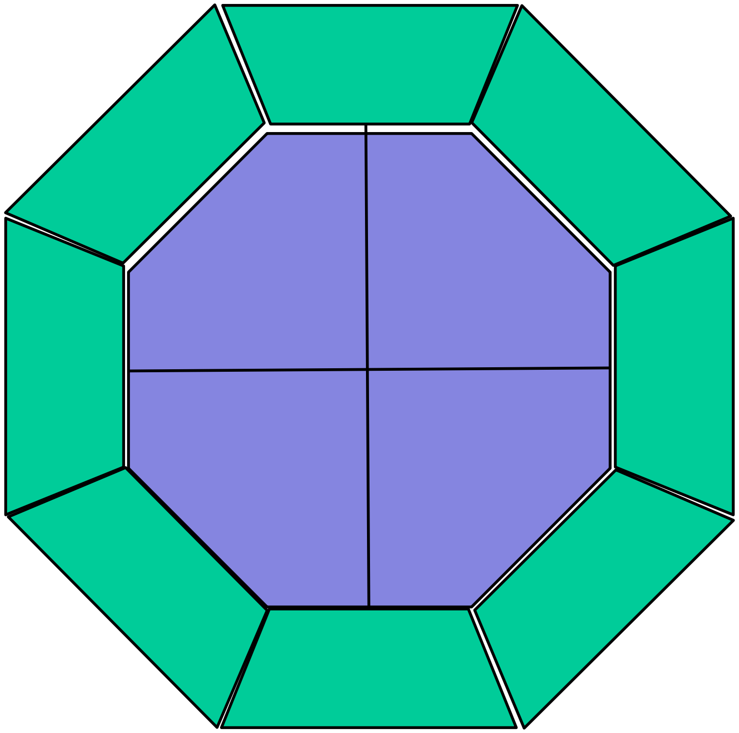
The pressure vessel is a separate piece of material and we don't have to think about that.

I will assume that the top half of the detector is the same as the bottom half, and that the two sides ($+x$, $-x$) also are the same.

I guess we'd want the same set of parameters, down to having the same name, in the `python` code which creates the `gdml` as well as in `GArSoft`.

Parameter Set Background

- In the barrel each "gon" is a stave, i.e. in an octogonal geometry, there are 8 staves.
- In the endcaps, 4 staves corresponding to 4 quadrants relative to the (z, y) axes.



Proposed Geometry Parameter Set

Global parameters

- **Flat or tilted: is the *z* axis of the geometry perpendicular to the force of gravity or parallel to the beamline? [Not the REAL *z* axis of course!]**

- **The gonality, i.e. 8 for an octagon, 12 for a dodecagon etc.**

- **First layer is absorber or scintillator?**

- **Barrel has 2 half-barrels or just 1 full length barrel?**

Proposed Geometry Parameter Set

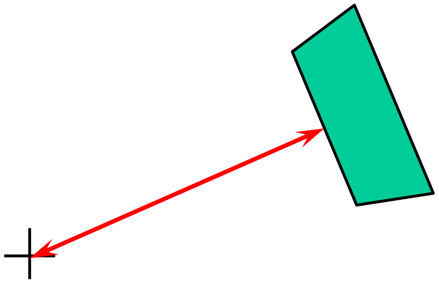
Per-stave parameters, both barrel & EC (different for each stave in top half, one side; bottom half, other side from symmetry)

- Number tile layers
- Number total layers
- Tile size
- Strip width
- Absorber material, for tiles & similar for strips
- Absorber thickness, for tiles & similar for strips
- Scintillator thickness, tiles & similar for strips
- FR4 thickness for tiles

- Derived: thicknesses

Proposed Geometry Parameter Set

Barrel only parameters



- Inner distance (in red)
- Half-length or full length (as the case may be)

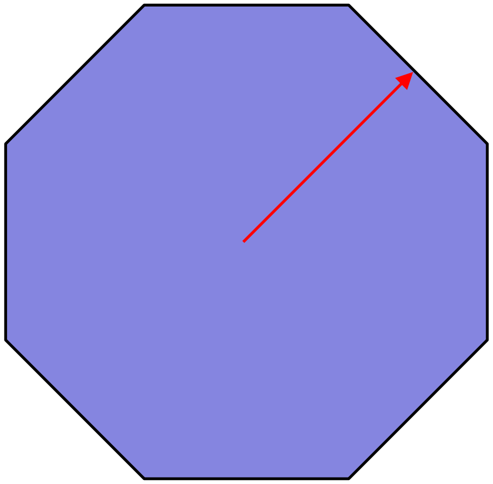
- Derived quantity: apothem, outer distance, corner distances from axis

Proposed Geometry Parameter Set

Endcap only parameters

- Start distance, i.e. distance from center of TPC to 1st layer of endcap in drift direction
- Inner distance (in red)

- Derived quantity: end distance in drift direction and corner distances from axis



Numbering convention

No little confusion has resulted from the fact that different `gdml` files & segmentation code number the different parts of the detector in different ways. Also, sometimes the numbers are hard-coded into the segmentation…

- In the barrel, the most downstream stave is 0; the one directly above it is 1, and the numbering increases as one goes around the barrel.
- In the endcap, the stave which is most downstream is 0; if two staves are equally downstream, the one on top is 0. The numbering then proceeds in an arc with the same sense as in the barrel.
- The endcap at negative *x* in the coordinate system centered at the middle of the TPC and having the same sense as the overall ND coordinate system is module 0; the half-barrel adjacent to that is module 1; the other half-barrel is module 2 and the other endcap is module 4. In the case where there is one module in the barrel, i.e. only 2 SiPMs instead of 4, that will be module 3.
- The ECAL is system 0 and the MuID is system 1

In A Single Slide

- Level 1
  - Level 2
    - Level 3