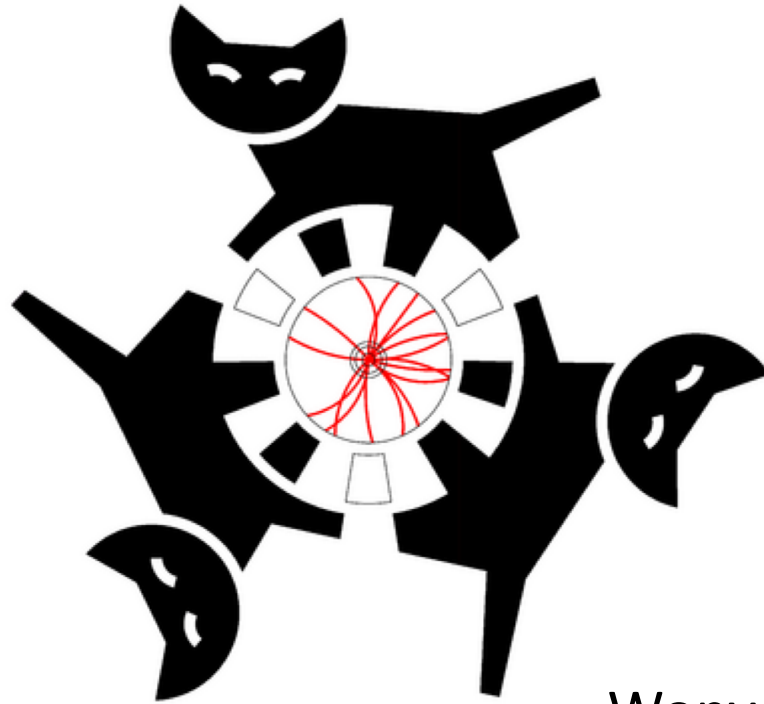


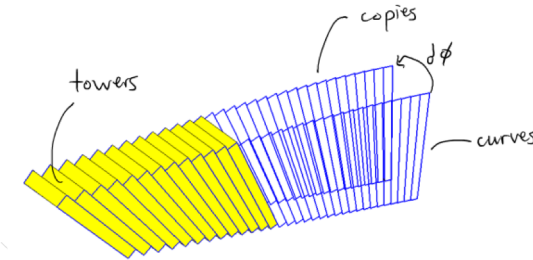
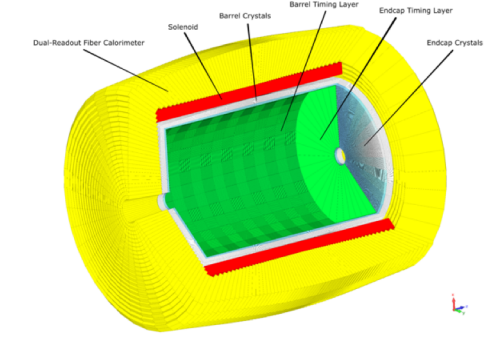
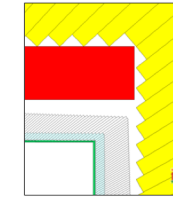
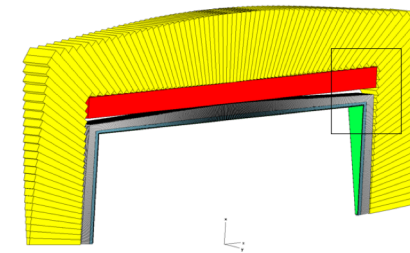
# CALVISION Simulation Updates with dd4hep, CaTS, and Muon/ILCSoft



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# Summary

- Testing full geometry performance/usability in dd4hep, CaTS, and Muon/ILCSoft
- Have a “cookbook” for the geometry, so mainly a matter of fitting it into these new programs (WIP)
- All still based on geant4 but easier to use
- (Initial) setup effort is still about the same as a pure geant4 sim
- High-level XML configs should make collab. easier after initial time investment
- Aiming for new benchmarks to test Higgs self-coupling



Points 3 & 4:

Extensions of similar triangles from points 1 & 2.

$$r_1 = \sqrt{z_1^2 + x_1^2}$$

$$r_2 = \sqrt{z_2^2 + x_2^2} = r_1$$

$$z_3 = z_2 \cdot \left( \frac{r_2 + t_{\text{length}}}{r_2} \right)$$

$$x_3 = x_2 \cdot \left( \frac{r_2 + t_{\text{length}}}{r_2} \right)$$

$$z_4 = z_1 \cdot \left( \frac{r_1 + t_{\text{length}}}{r_1} \right)$$

$$x_4 = x_1 \cdot \left( \frac{r_1 + t_{\text{length}}}{r_1} \right)$$

Start with point 1.

$s = -1$  here because we are in the negative z side

$$z1 = s * r_{\text{inner}} * \tan(\theta + d\theta * (i-1))$$

$$x1 = r_{\text{inner}}$$

$$z1_{\text{next}} = s * r_{\text{inner}} * \tan(\theta + d\theta * (i))$$

$$x1_{\text{next}} = x1$$

We need to use  $z1_{\text{next}}$  to calculate point 2.

$z1, x1, d\theta$  known

$$\Rightarrow r1 = \sqrt{z1^2 + x1^2}$$

Calculate point 2 using angle alpha and tower face width (face\_width)

$$\Rightarrow \frac{\text{face\_width}}{2} = r1 \cdot \sin(\frac{d\theta}{2})$$

Law of Cosines to find  $\alpha$ :

$$a = \text{face\_width}$$

$$b = |z1 - z2_{\text{next}}|$$

$$c = r1 = \sqrt{z1^2 + x1^2}$$

$$c^2 = a^2 + b^2 - 2ab \cos \alpha$$

$$\Rightarrow \alpha = \arccos \left( \frac{c^2 - a^2 - b^2}{-2ab} \right)$$

Result:

$$z2 = z1 - s * a * \cos(\alpha)$$

$$x2 = x1 + a * \sin(\alpha)$$

$s = -1$  here because we are in the negative z side

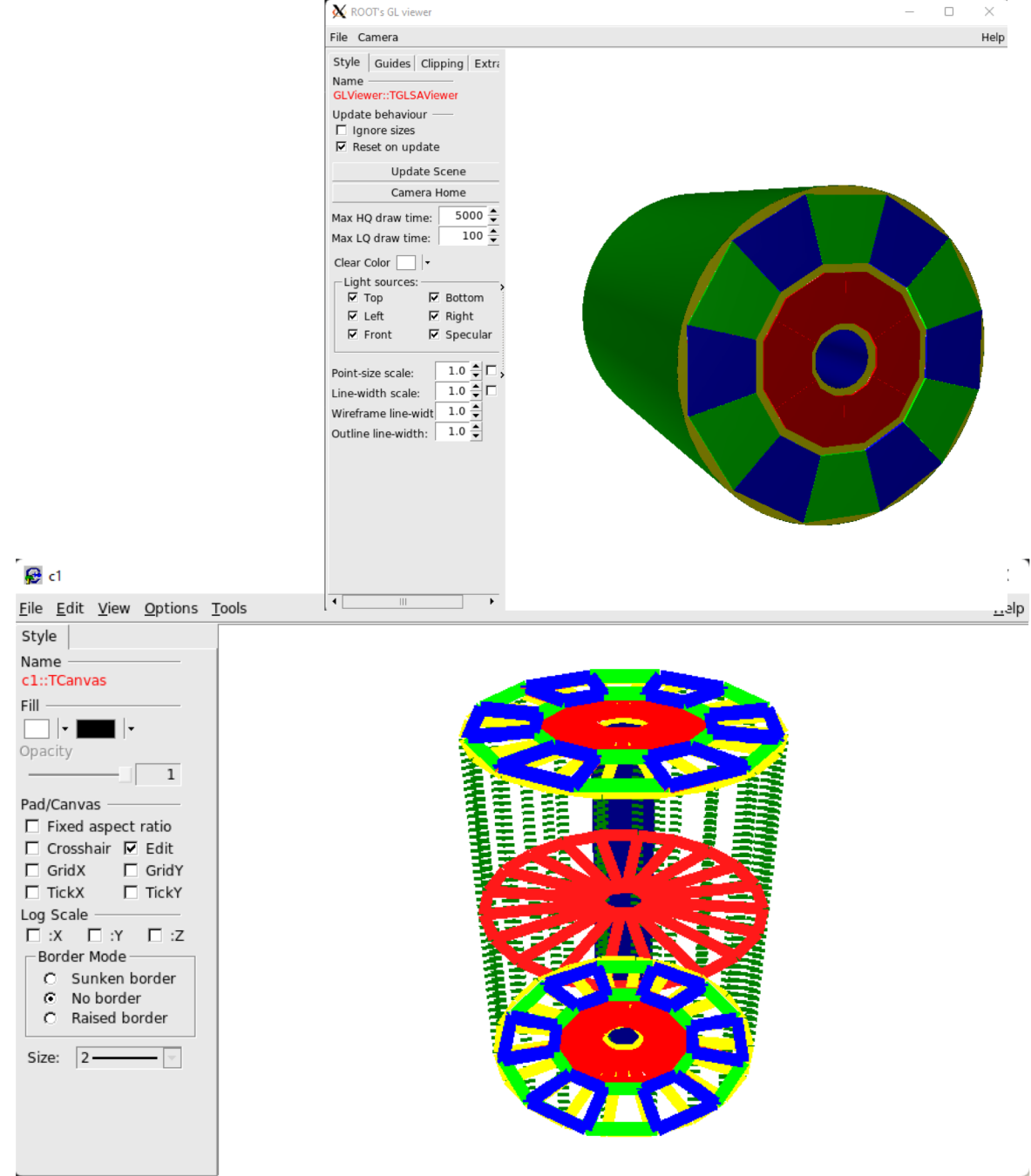
# Setup

- WSL2 (Windows Subsystem for Linux) on Windows 11
  - Debian
  - NVIDIA graphics drivers, X11 forwarding may cause hiccups
- Tried first on macOS with a range of old and new package managers (homebrew, macports, spack, conda, ...)
  - All advertised themselves to be slick solutions, all eventually broke as dependency chains got longer/had stricter requirements
- Compiling from source gives peace of mind



# dd4hep

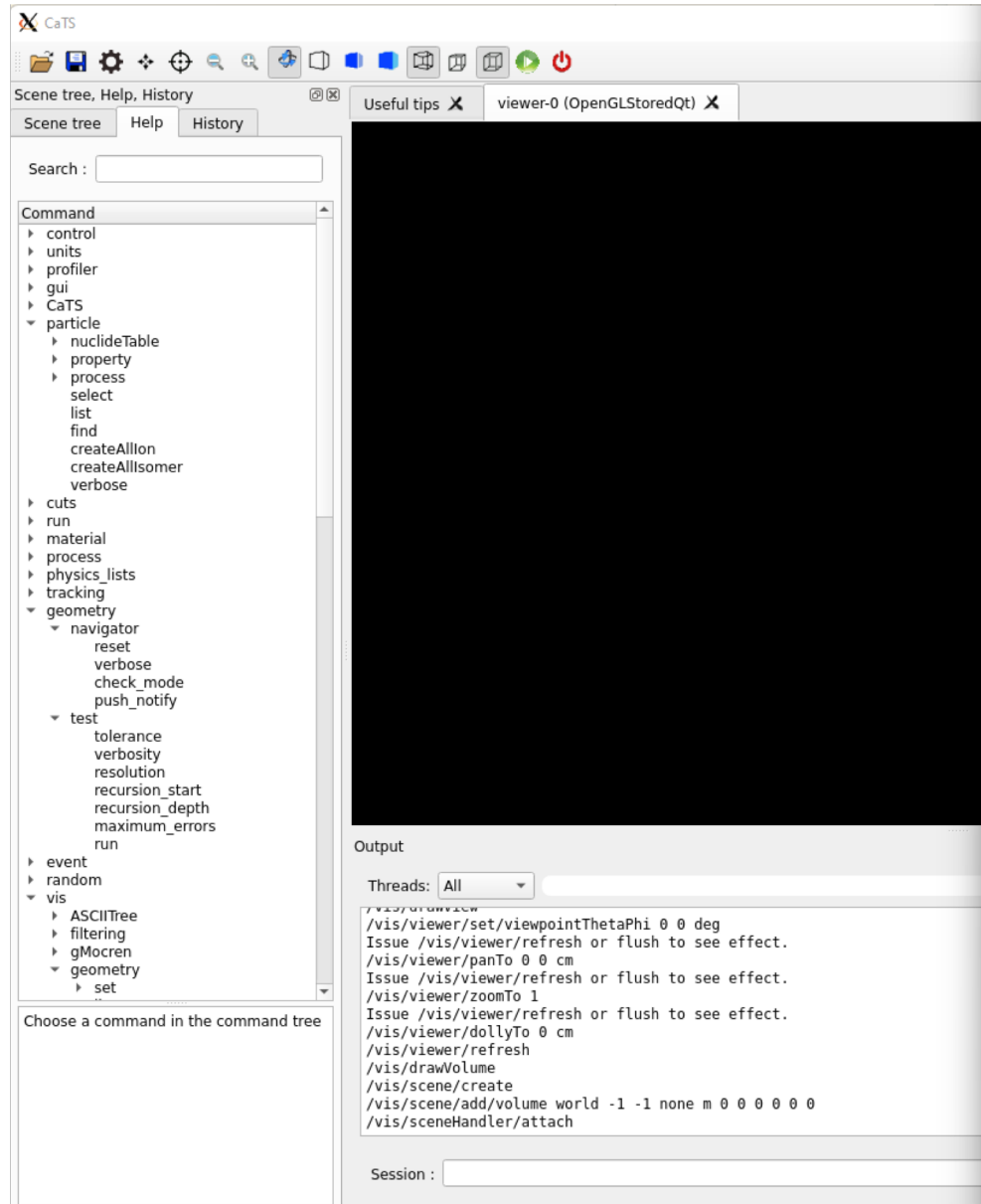
- Works
- Mix of XML configs and C++
  - Define custom detector components/shapes in C++
  - Use them as XML elements in high-level config
- Better separation/abstraction, shorter config files, reduced code duplication
- But still about the same initial effort as pure geant4
- Rest of dd framework on alignment, timing, reco, evt display, should be promising



dd4hep AlephTPC example

# CaTS

- Built on top of Geant4
- Simulation works, but graphics may be buggy thru X11
- Uses ray-tracing capabilities of newer GPUs for photons (Optick)
- Uses geant4 gdml XML configs for geometry, G4 macros for sim
- GUI performance is good



```
/vis/initialize
WARNING: G4VisManager::Initialise: already initialised.
/vis/enable
There are 0 kept events.
"/vis/reviewKeptEvents" to review them one by one.
"/vis/viewer/flush" or "/vis/viewer/rebuild" to see the
/vis/geometry/list

Logical Volume "lvCoating":
G4VisAttributes: visible, daughters visible, colour: (1,0,0)
linestyle: solid, line width: 1, min line segments per circle: not forced, auxiliary edge visibility: not forced.
time range: (-1e+100,1e+100)
G4AttValue pointer is zero, G4AttDef pointer is zero

Logical Volume "lvPhotoDetector":
G4VisAttributes: visible, daughters visible, colour: (0,0,0)
linestyle: solid, line width: 1, min line segments per circle: not forced, auxiliary edge visibility: not forced.
time range: (-1e+100,1e+100)
G4AttValue pointer is zero, G4AttDef pointer is zero

Logical Volume "lvHousingRing":
G4VisAttributes: visible, daughters visible, colour: (0,1,0)
linestyle: solid, line width: 1, min line segments per circle: not forced, auxiliary edge visibility: not forced.
time range: (-1e+100,1e+100)
G4AttValue pointer is zero, G4AttDef pointer is zero

Logical Volume "lvHousingBase":
G4VisAttributes: visible, daughters visible, colour: (0,1,0)
linestyle: solid, line width: 1, min line segments per circle: not forced, auxiliary edge visibility: not forced.
time range: (-1e+100,1e+100)
G4AttValue pointer is zero, G4AttDef pointer is zero

Logical Volume "lvHousingEnv": no vis attributes

Logical Volume "TOP":
G4VisAttributes: invisible, daughters visible, colour: (1,0,0)
linestyle: solid, line width: 1, min line segments per circle: not forced, auxiliary edge visibility: not forced.
time range: (-1e+100,1e+100)
G4AttValue pointer is zero, G4AttDef pointer is zero

/vis/viewer/clearVisAttributesModifiers
/vis/viewer/refresh
/vis/ogl/set/displayListLimit
/vis/drawView
/vis/viewer/set/viewpointThetaPhi 0 0 deg
Issue /vis/viewer/refresh or flush to see effect.
/vis/viewer/panTo 0 0 cm
Issue /vis/viewer/refresh or flush to see effect.
/vis/viewer/zoomTo 1
Issue /vis/viewer/refresh or flush to see effect.
/vis/viewer/dollyTo 0 cm
/vis/viewer/refresh
/vis/drawVolume
/vis/scene/create
/vis/scene/add/volume world -1 -1 none m 0 0 0 0 0
/vis/sceneHandler/attach

Session :
```

# Muon/ILCSoft

- Next up to try