Barrel SciGlass ECal Description Using DD4hep

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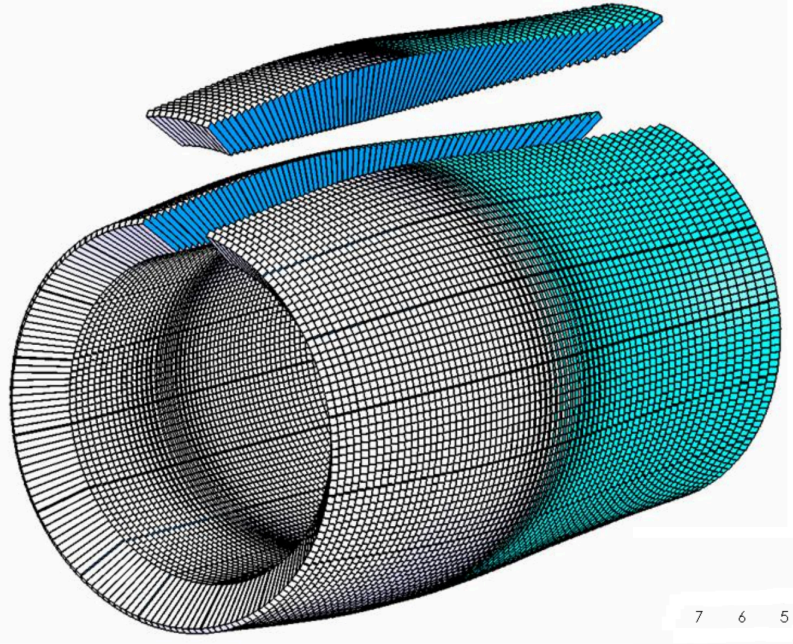
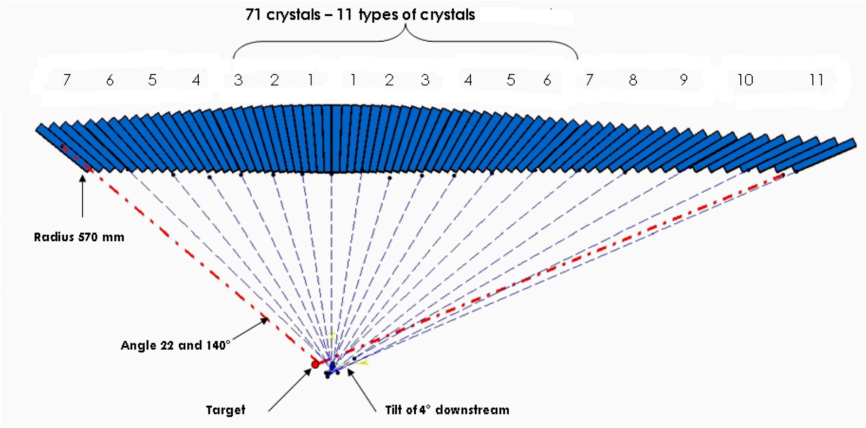
THE PANDA DESIGN

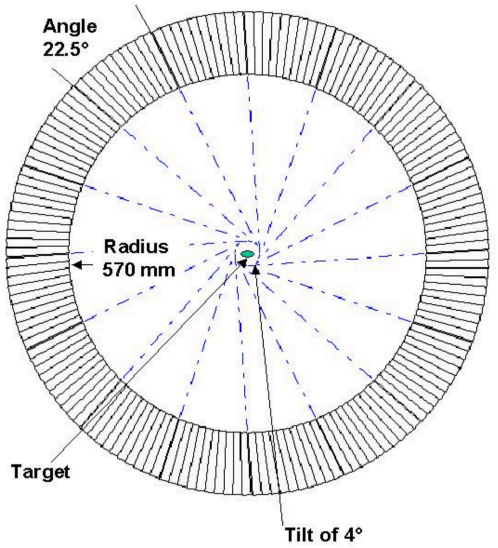


Based on PANDA design, see:

https://panda.gsi.de/system/files/user_uploads/heinsius%40ep1.rub.de/RE-TDR-2020-007.pdf

Tilted in phi



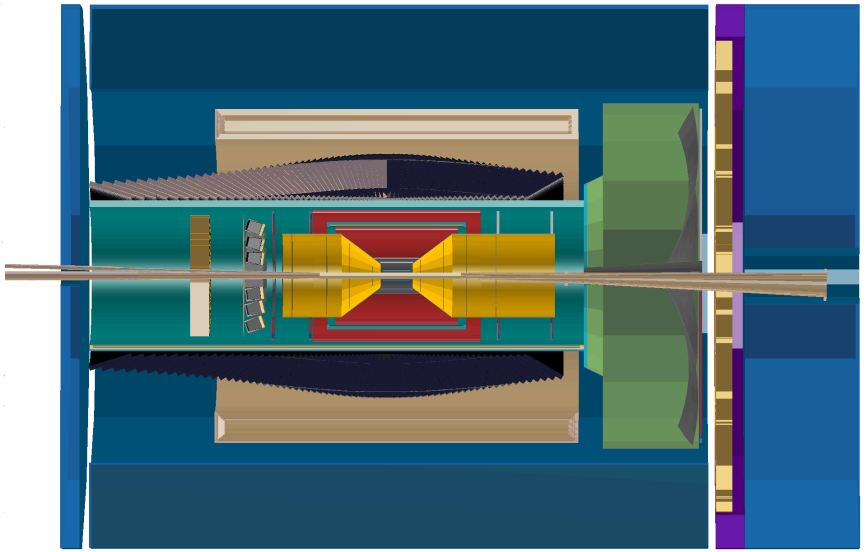


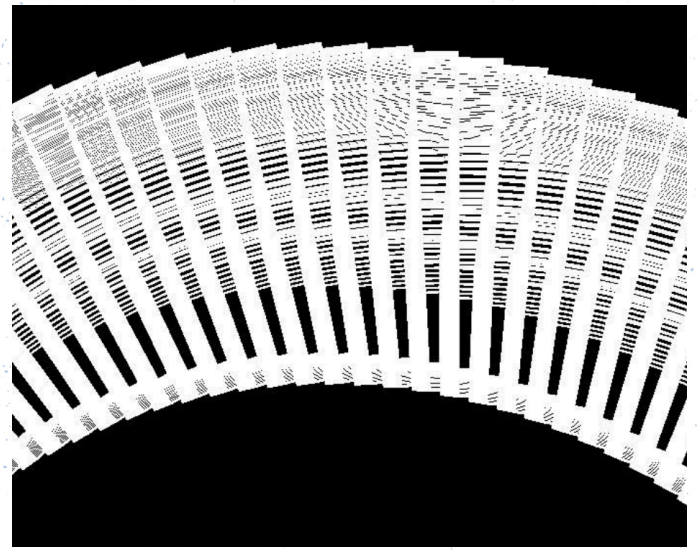
University of Kentucky

PANDA-LIKE ECAL IMPLEMENTED IN DD4HEP

By Wouter Deconinck https://github.com/eic/epic/blob/691f7a8755bfdd89fb4ff4cd22b7599b78860926/src/SciGlassCalorimeter_geo.cpp

geoDisplay -compact $DETECTOR_PATH/ecce_sciglass.xml



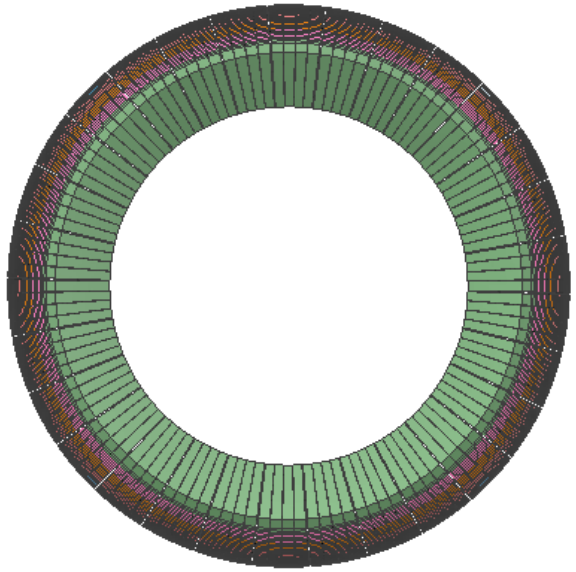


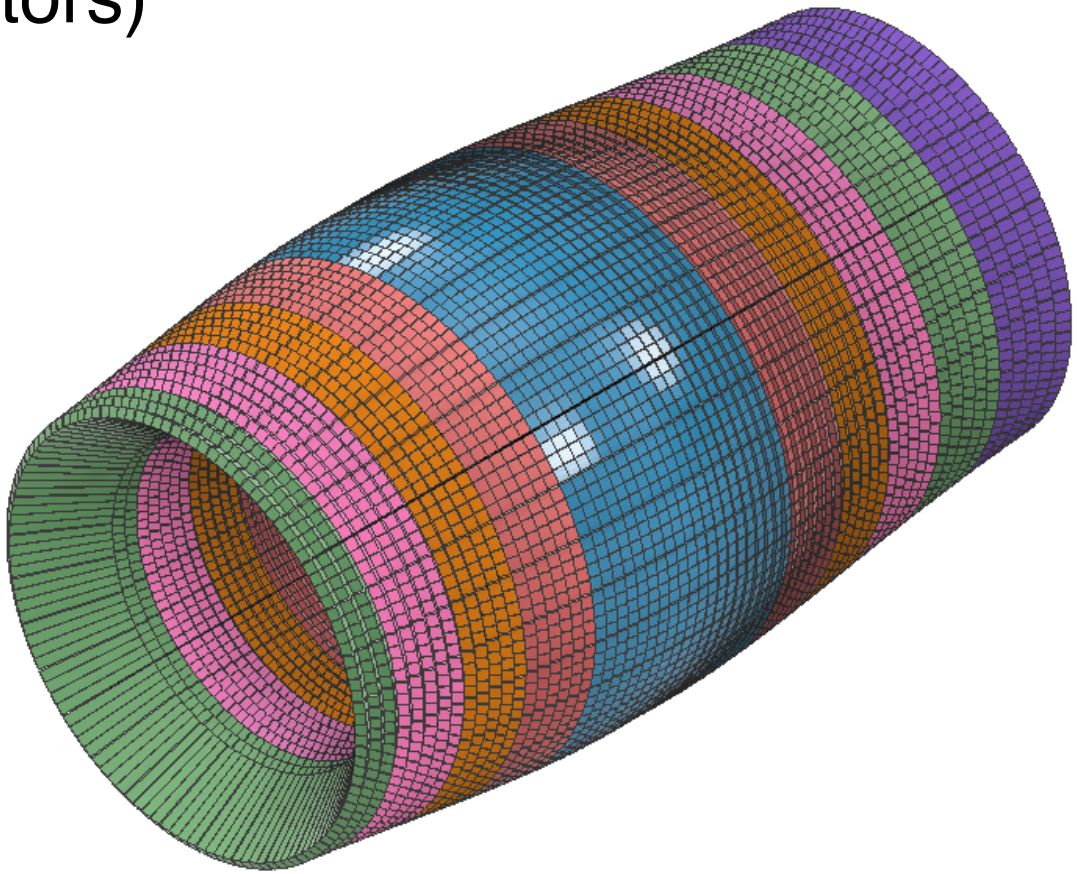
THE NEW DESIGN

No tilt, uneven gaps in phi (sectors)

CAD drawings provided

by Joshua Crafts (CUA)





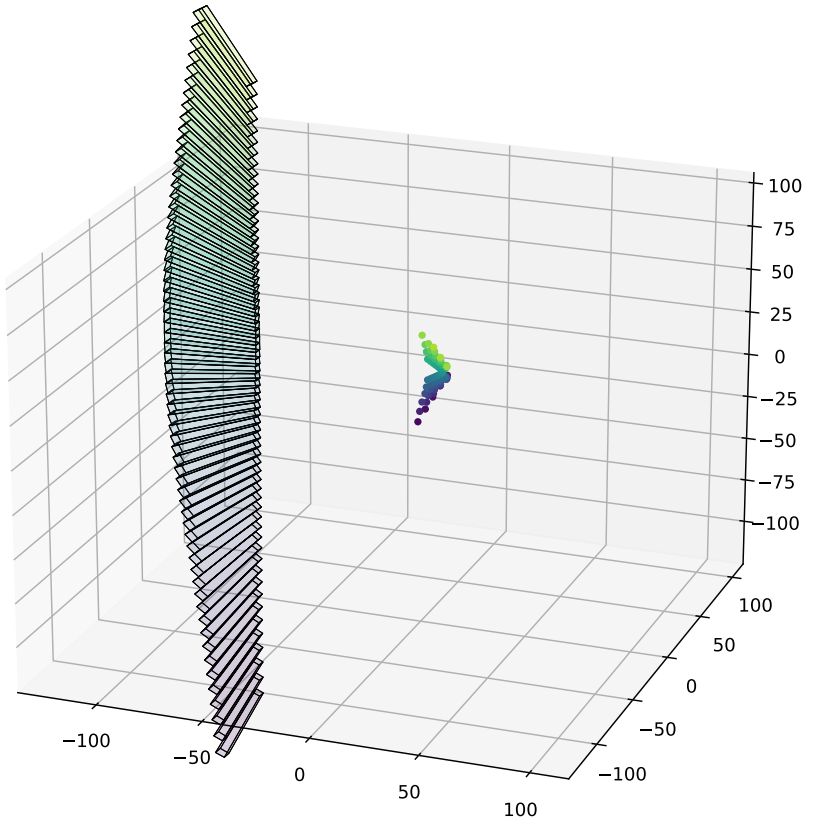
REVERSE-ENGINEERING

Goal: Parametrized design for ML detector optimization

Strategy: Analyze CAD design exported to STL format

- Allows to measure angles & lengths to ensure correct understanding
- Helps inputting further design iterations

On the right: one row of the detector along with focal point for each cell.



RAPID PROTOTYPING

Implement in terms of G4Traps / TGeo-Trap for maximal performance and clarity.

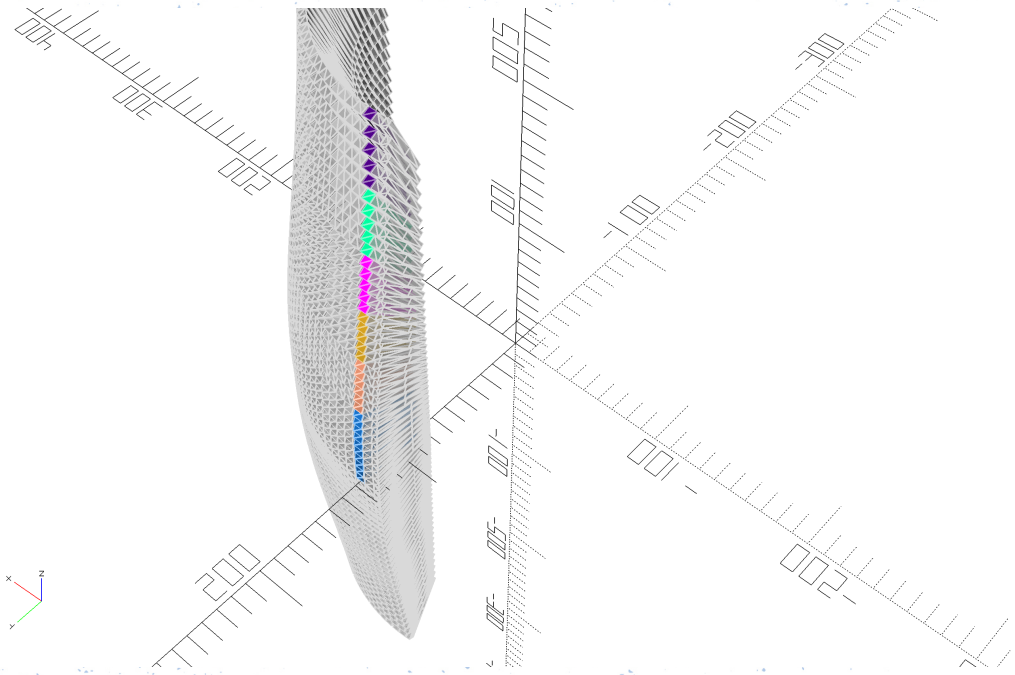
Trap implemented in OpenSCAD:

```
// https://apc.u-paris.fr/~franco/g4doxy/html/classG4Trap.html
module trapezoid(pDz, pTheta, pPhi, pDy1, pDx1, pDx2, pAlp1, pDy2, pDx3, pDx4, pAlp2) {
pTthetaCphi = 0;
pTthetaSphi = 0;
pTalpha1 = 0;
pTalpha2 = 0;

points = [
  [ -pDz * pTthetaCphi - pDy1 * pTalpha1 - pDx1, -pDz * pTthetaSphi - pDy1, -pDz ],
  [ -pDz * pTthetaCphi - pDy1 * pTalpha1 + pDx1, -pDz * pTthetaSphi - pDy1, -pDz ],
  [ -pDz * pTthetaCphi + pDy1 * pTalpha1 - pDx2, -pDz * pTthetaSphi + pDy1, -pDz ],
  [ -pDz * pTthetaCphi + pDy1 * pTalpha1 + pDx2, -pDz * pTthetaSphi + pDy1, -pDz ],
  [ +pDz * pTthetaCphi - pDy2 * pTalpha2 - pDx3, +pDz * pTthetaSphi - pDy2, +pDz ],
  [ +pDz * pTthetaCphi - pDy2 * pTalpha2 + pDx3, +pDz * pTthetaSphi - pDy2, +pDz ],
  [ +pDz * pTthetaCphi + pDy2 * pTalpha2 - pDx4, +pDz * pTthetaSphi + pDy2, +pDz ],
  [ +pDz * pTthetaCphi + pDy2 * pTalpha2 + pDx4, +pDz * pTthetaSphi + pDy2, +pDz ]
  ];

faces = [
  [0,4,5,1], // -y
  [2,3,7,6], // +y
  [0,2,6,4], // -x
  [1,5,7,3], // +x
  [0,2,3,1], // -z
  [7,6,4,5] // +z
  ];

polyhedron( points, faces );
}
```

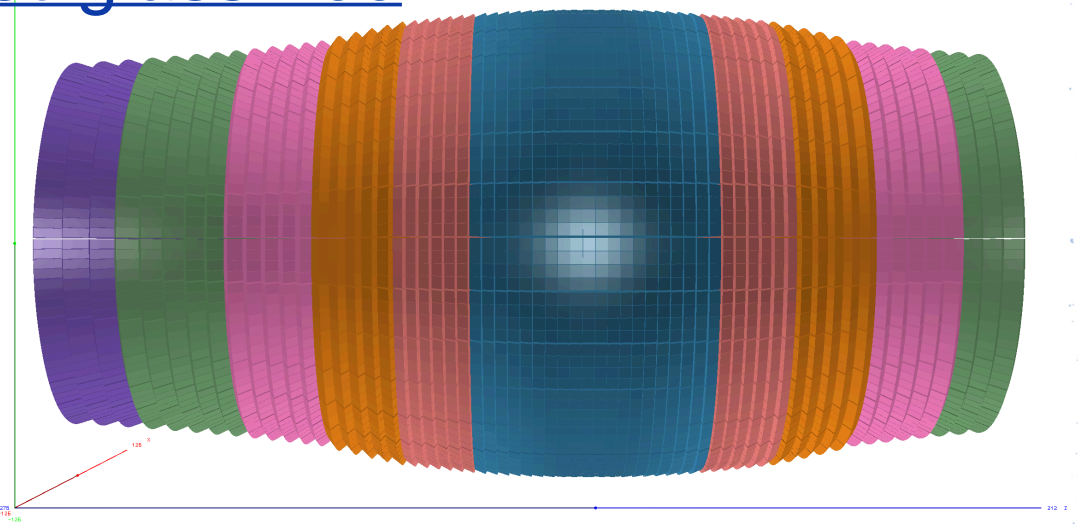


STL file (in transparent grey)

The geometry coded in the OpenSCAD programming language (colored) can be rapidly iterated.

DRAFT DD4HEP IMPLEMENTATION

https://git.sr.ht/~veprbl/epic-ecal-sciglass/tree



TODO:

- Touchables:

system - sector - row? - tower

- Accurate flaring angles
- Validate to STL
- Validate in simulation!
- Light collection?

```
<detector id="4" name="ecce_becal" type="ecce_becal_type" readout="becal_hits" vis="det_vis" calorimeterType="EM_BARREL">
  <sectors number="30" phi0="0." deltaphi="pi / 15">
    <rows number="4" deltaphi="0.05096349">
      <dimensions inner_r="80 * cm" outer_r="125 * cm" inner_z="300 * cm" gap="1*mm" />
      <family dir_sign="+1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="10" flare_angle_polar="1.16 * degree"  vis="family1" />
      <family dir_sign="+1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="6"  flare_angle_polar="1.045 * degree" vis="family2" />
      <family dir_sign="+1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="5"  flare_angle_polar="1.929 * degree" vis="family3" />
      <family dir_sign="+1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="5"  flare_angle_polar="0.82 * degree"  vis="family4" />
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      <family dir_sign="-1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="5"  flare_angle_polar="0.70 * degree"  vis="family5" />
      <family dir_sign="-1" x1="4 * cm" y1="4 * cm" z_length="45.5 * cm" number="3"  flare_angle_polar="0.586 * degree" vis="family6" />
    </rows>
  </sectors>
</detector>
```

CONCLUSIONS

- Exercise in shape-building is near its completion
- DD4hep is friendly towards developers and users
- Further look into actual simulation is needed