Adding support structures to the spherical CALO in HerdSoftware

N. Mori
INFN Florence

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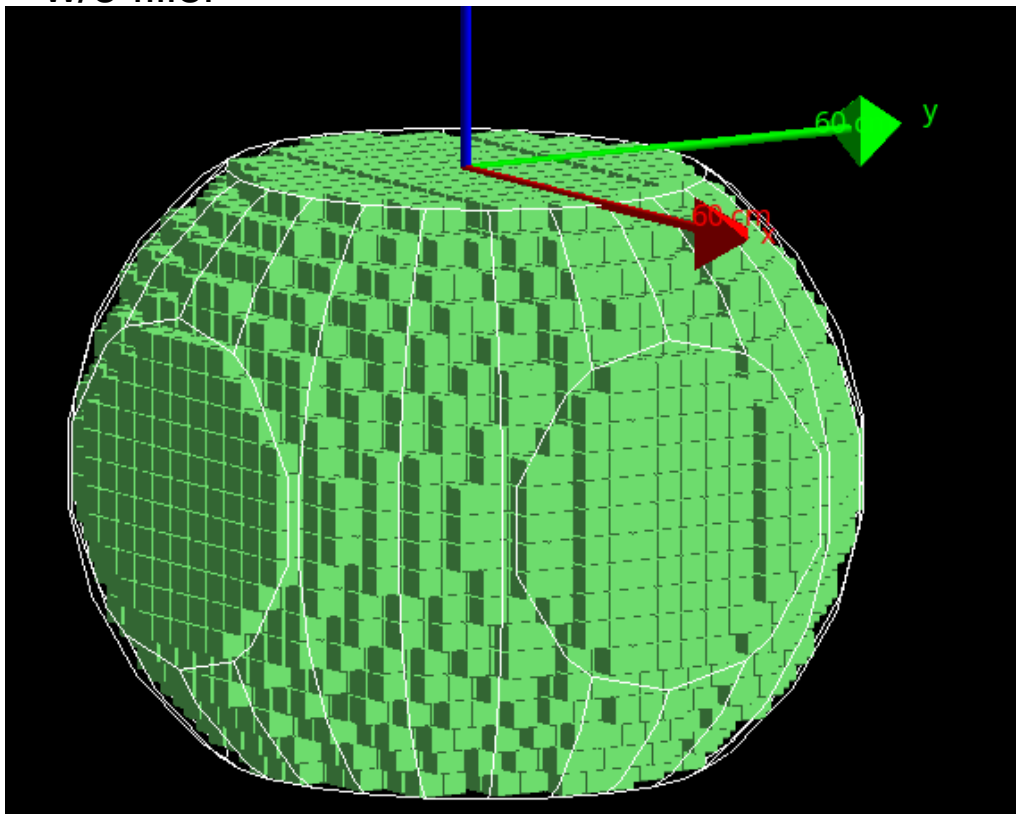
Introduction

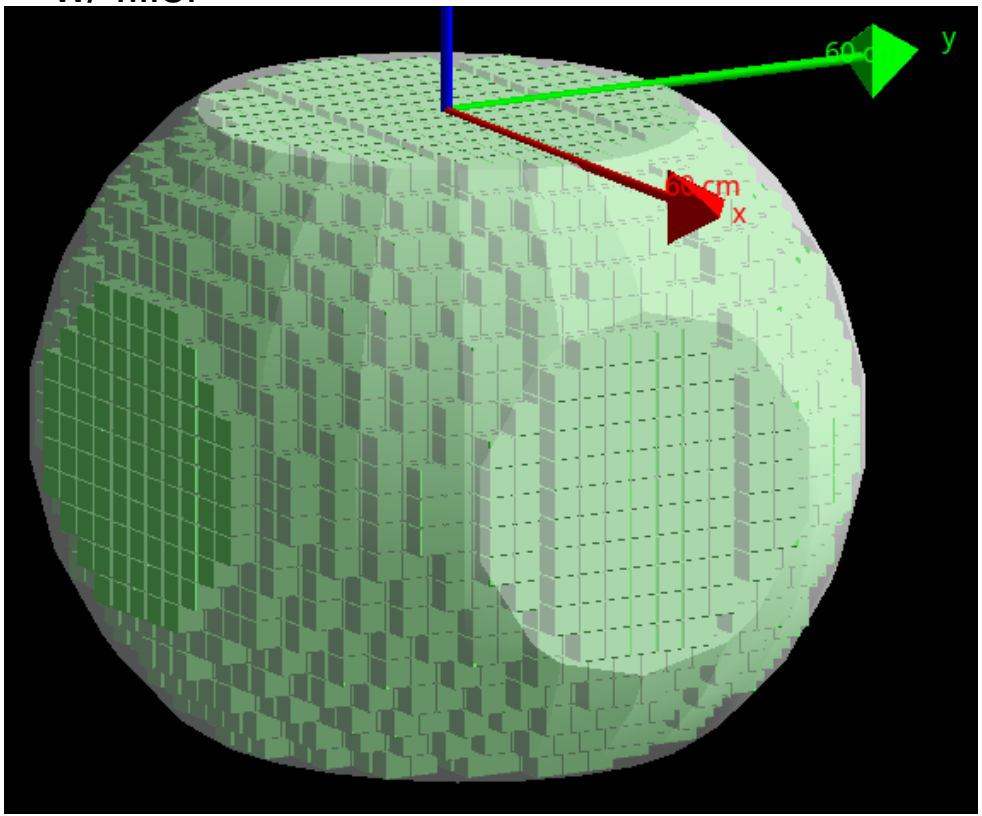
- Spherical CALO already available in HerdSoftware since ~ 1 y
- No support structure / passive materials
- Possibility to fill the CALO volume with e.g. carbon to roughly take into account the passive material

Introduction

w/o filler



w/ filler

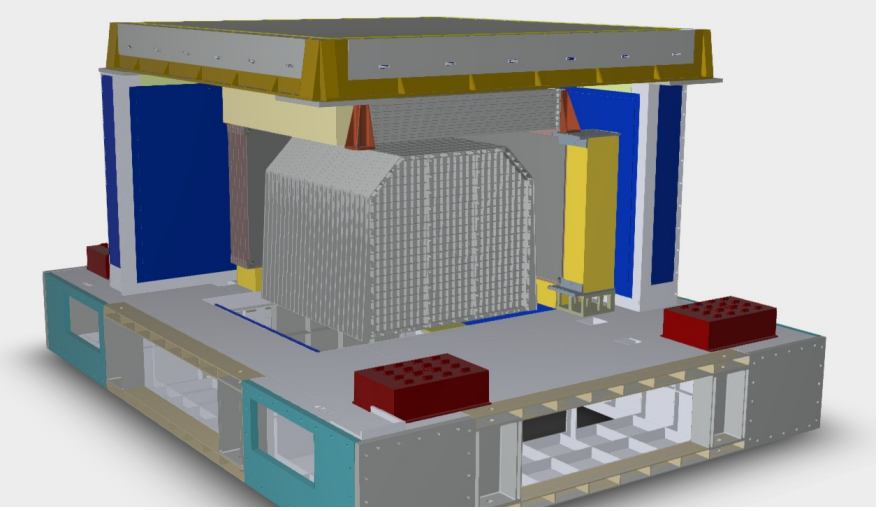


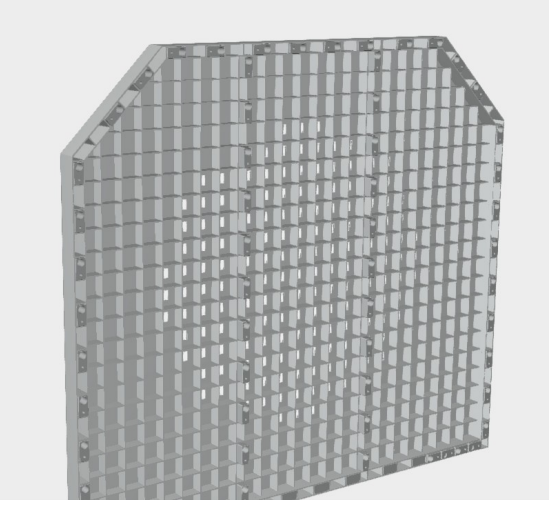
Introduction

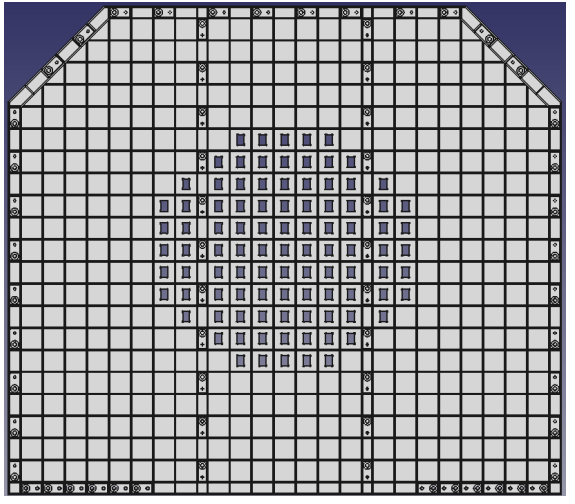
- Simple, but not accurate
- Real supports might play a relevant role for important physical quantities like energy resolution for electrons
- Need to implement a more realistic structure

Implementation strategy

- Extract the CALO tray from full CAD model of flight detector provided by R. Wang on 15th July 2022, and save to STEP file

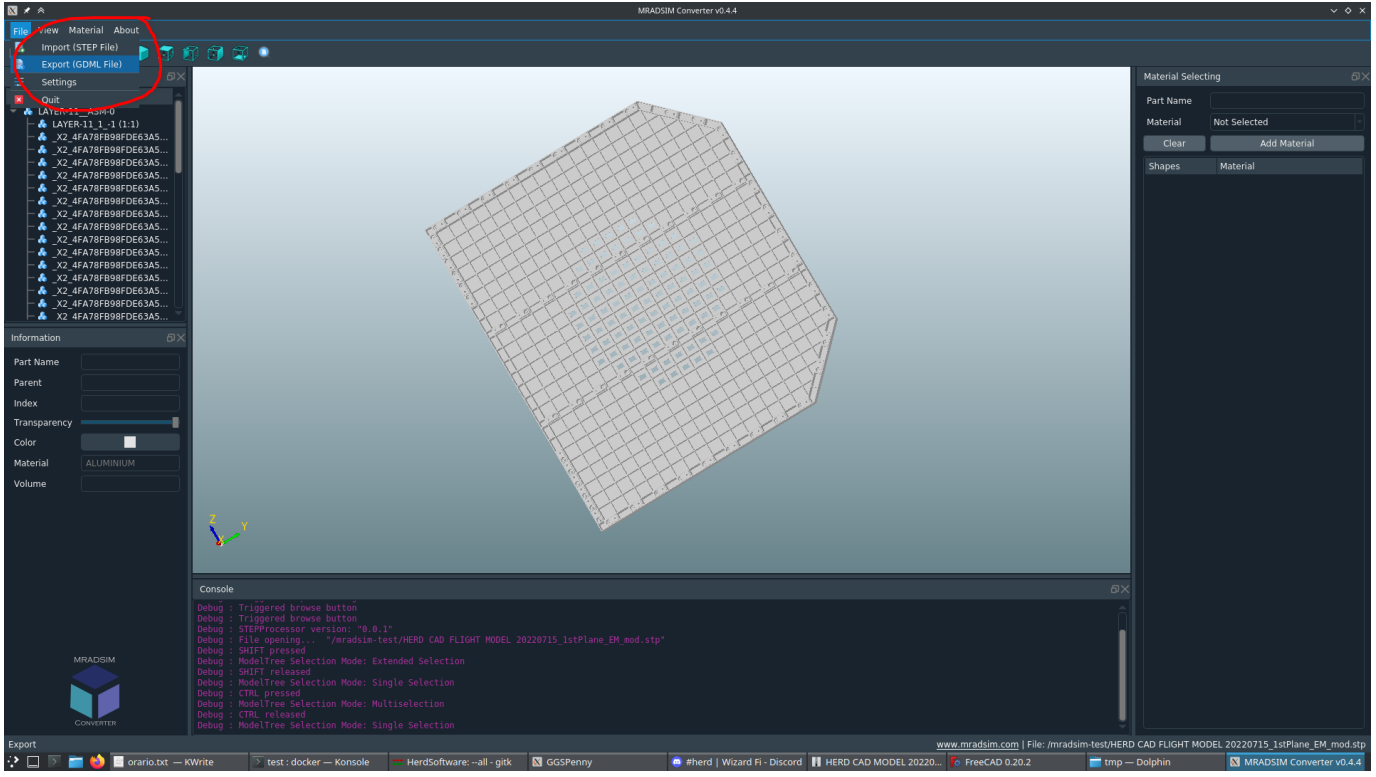






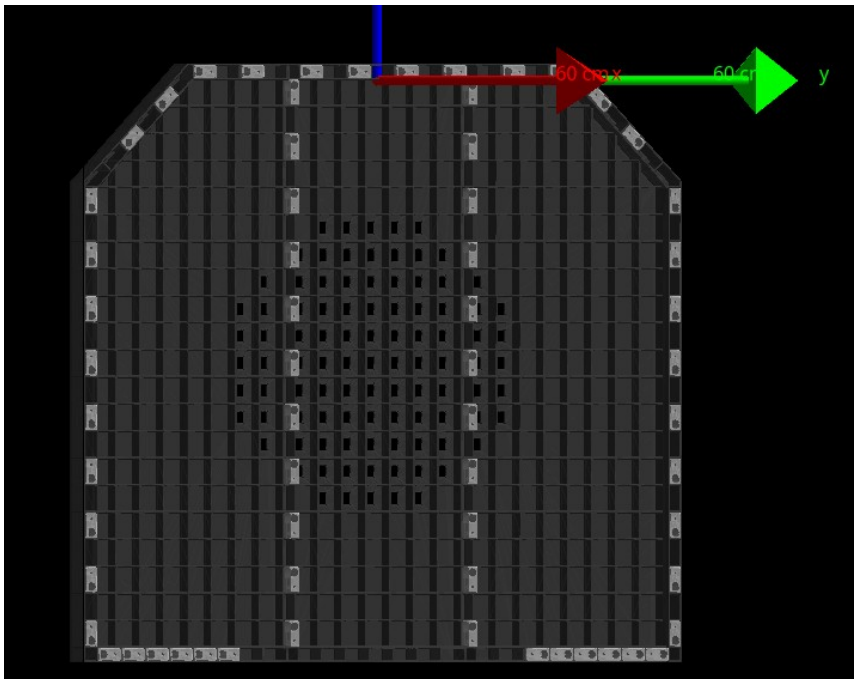
Implementation strategy

- Convert STEP file to GDML with MRADSIM



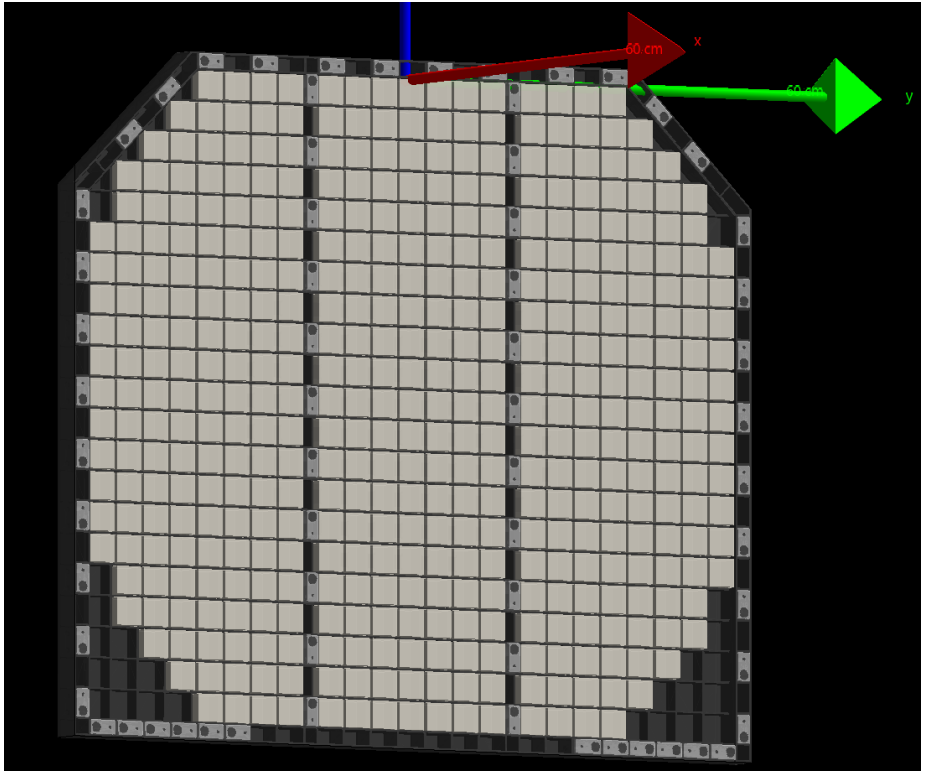
Implementation strategy

- Import the tray GDML in HERD simulation using the native Geant4 GDML interface



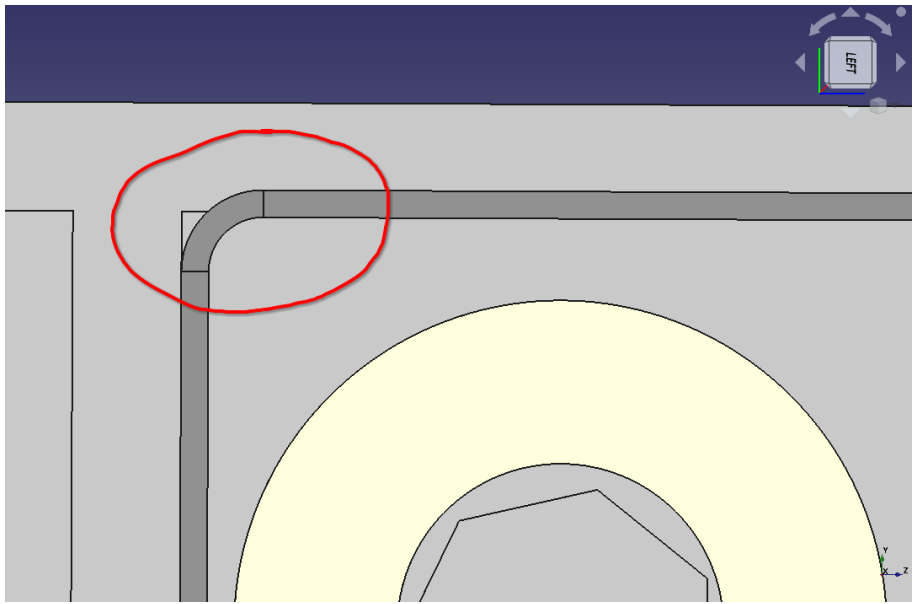
Implementation strategy

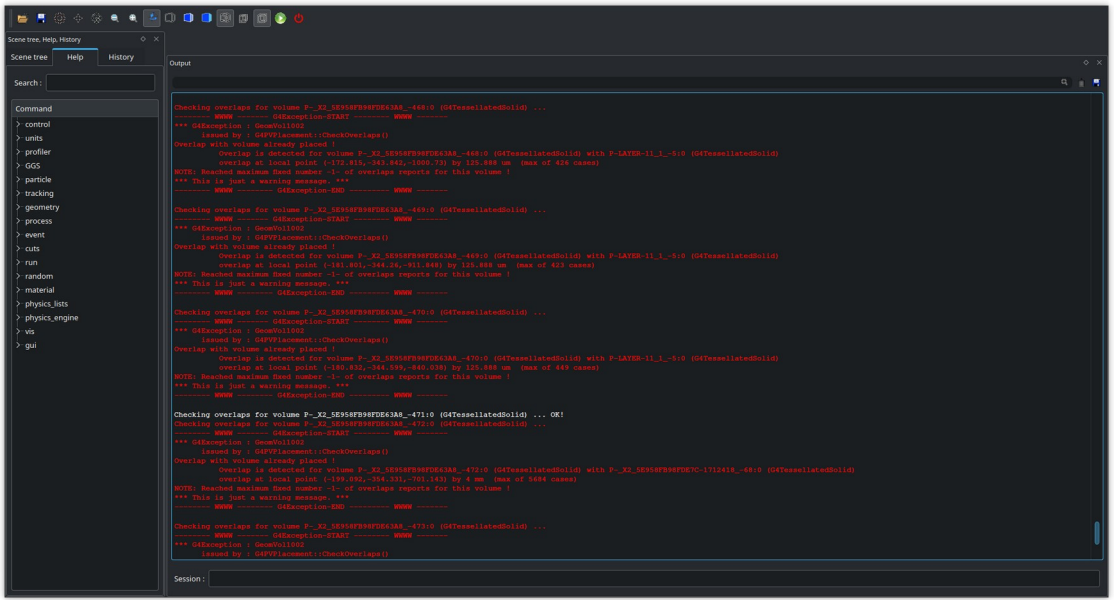
- Add LYSO cubes using the Geant4 C++ API



Problems

- The CAD model features several overlaps/collisions (misplaced aluminum blocks)





Problems

- Aluminum blocks are too big (i.e. same size of tray slots)
  - Dimensions are “too exact”, and overlaps/collisions arise due to rounding errors even with exact placement
- Direct import of full tray GDML takes time and consumes memory (one logical volume per aluminum block)

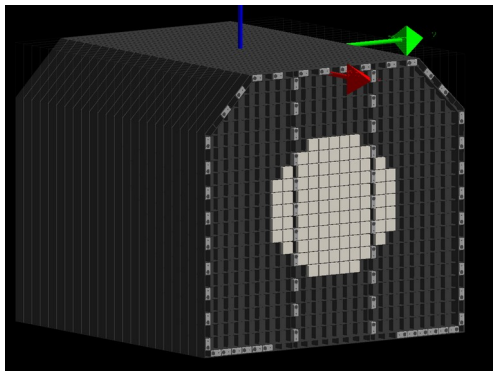
Solution

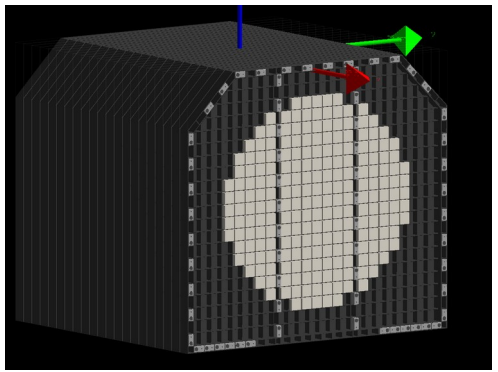
- Produce separate CAD files for tray without aluminum blocks, big block and small block
- Scale blocks dimensions by 0.99
- Fix some errors (e.g. remove conic surface for small blocks)
- Convert to GDML

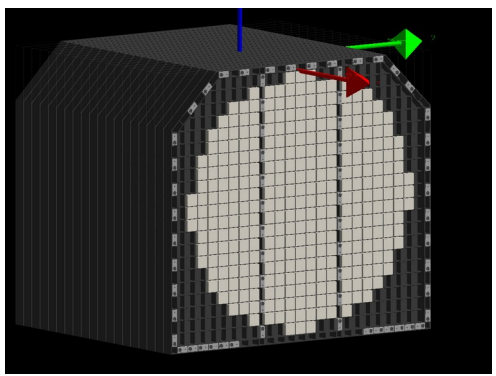
Solution

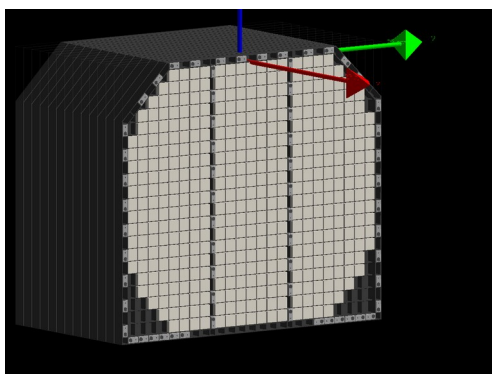
- Import tray and blocks separately in Geant4
- Place blocks in the tray
- Place cubes in the tray
  - Same placement algorithm provided by Z. Tang
  - Limited to a single tray
- Place trays

Results

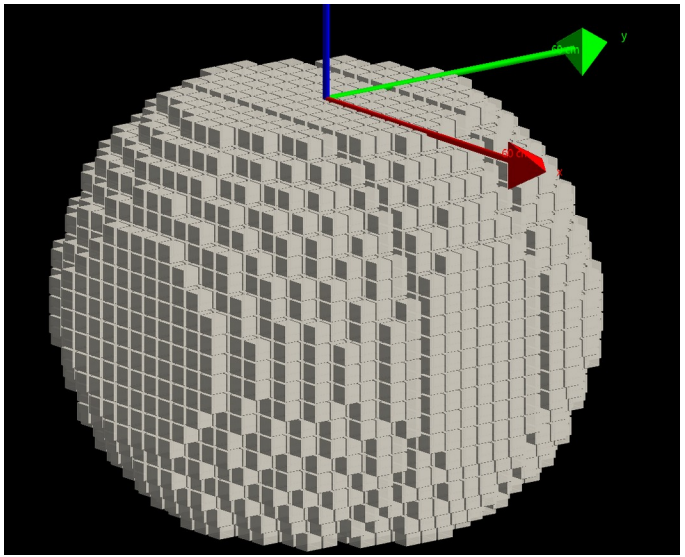


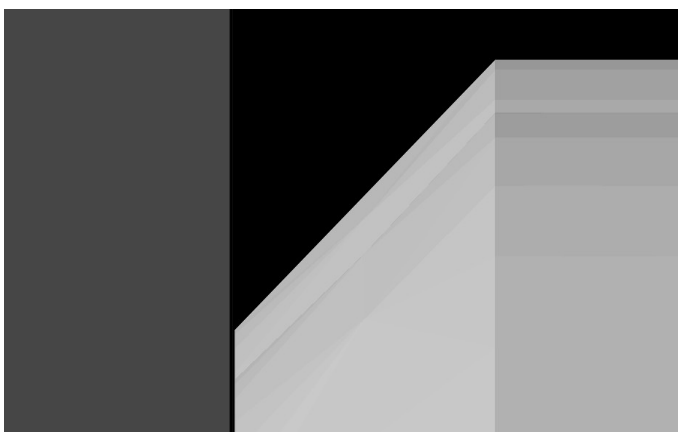






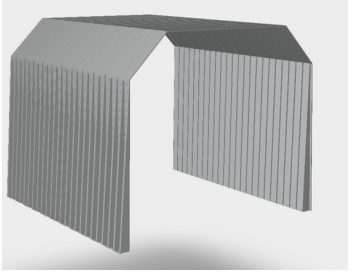
Face-to-face cube distances: (8mm, 4mm, 4mm)

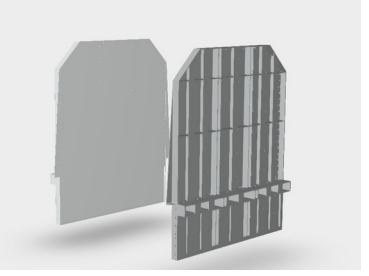




Status

- Full CALO implemented, no overlaps
- Still to be tested with a full simulation run
- Missing features:
  - Different trays (needed?)
  - Cover structures
  - Photodiodes
  - Distribution of GDML files
    - Big files (~ 20 MB), better avoid committing them to git repository





- Will be available as spherical_v3 in HerdSoftware 0.4.0

Lessons learnt

- Importing the geometry from CAD models can greatly speed up the development of a realistic model for MC simulations
- All the needed tools are available
- No “silver bullet”: work is needed to adapt CAD to simulation necessities
- Cooperation between simulation and engineering people is needed to produce CAD models that can be more easily ported to MC
  - Thanks to E. Mancini for help in fixing the CAD