Update CYGNO simulation

Giulia D'Imperio
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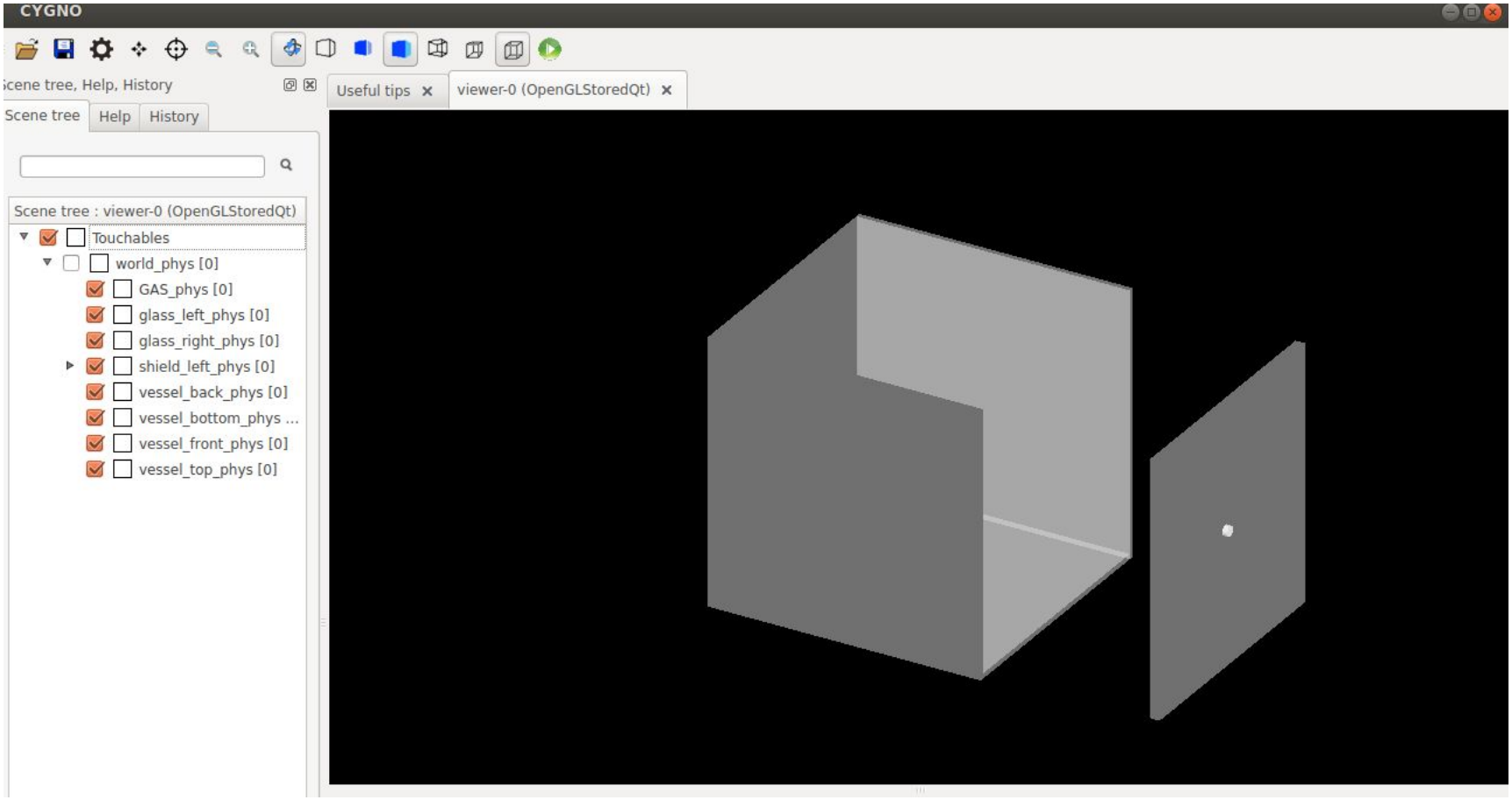
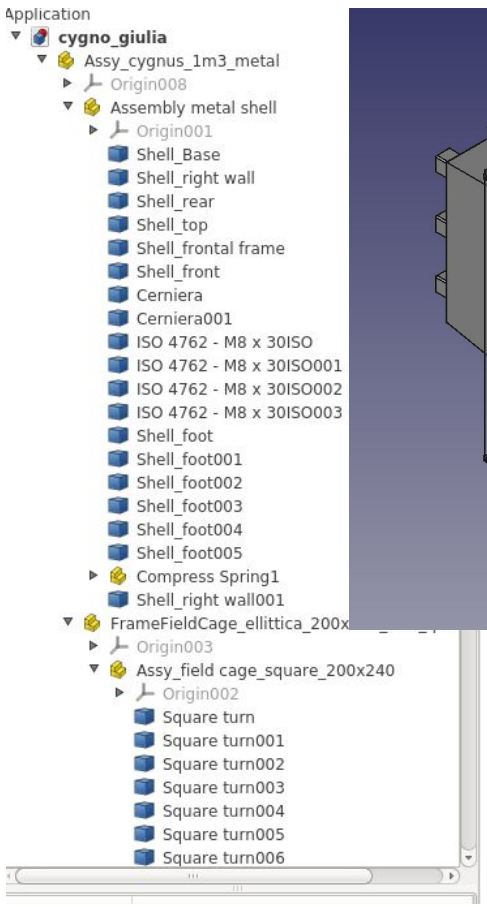
Existing simulation

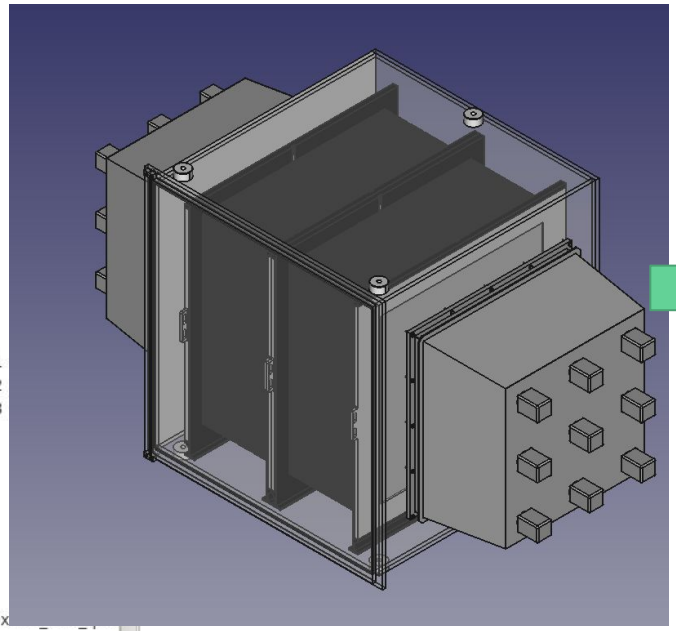
- Based on GEANT4 v9.6 (released in 2015)
  - latest version 10.5, introduced multithread and many improvements in low energy nuclear cross sections
- Geometry very simple

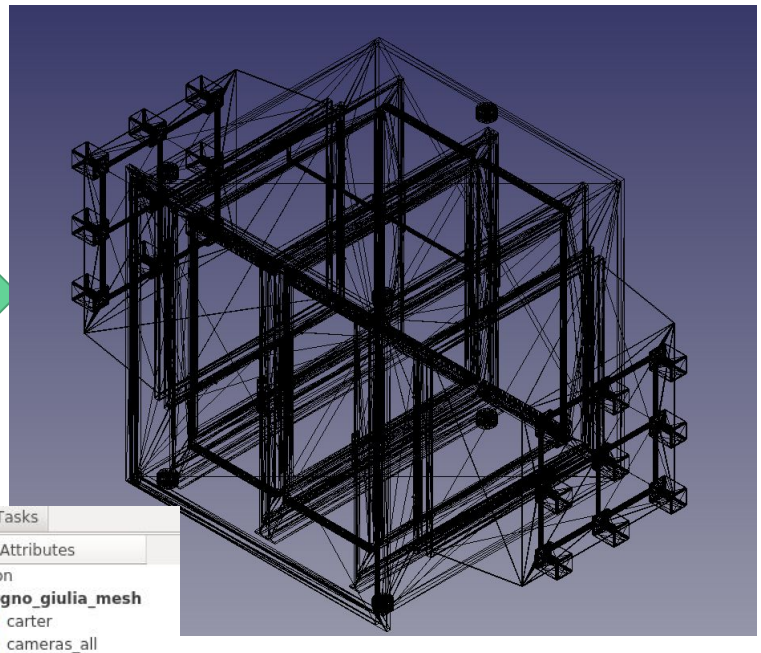


Geometry from CAD

- transform to tassellated solids (meshed .stl files)
- merge elements made of the same material

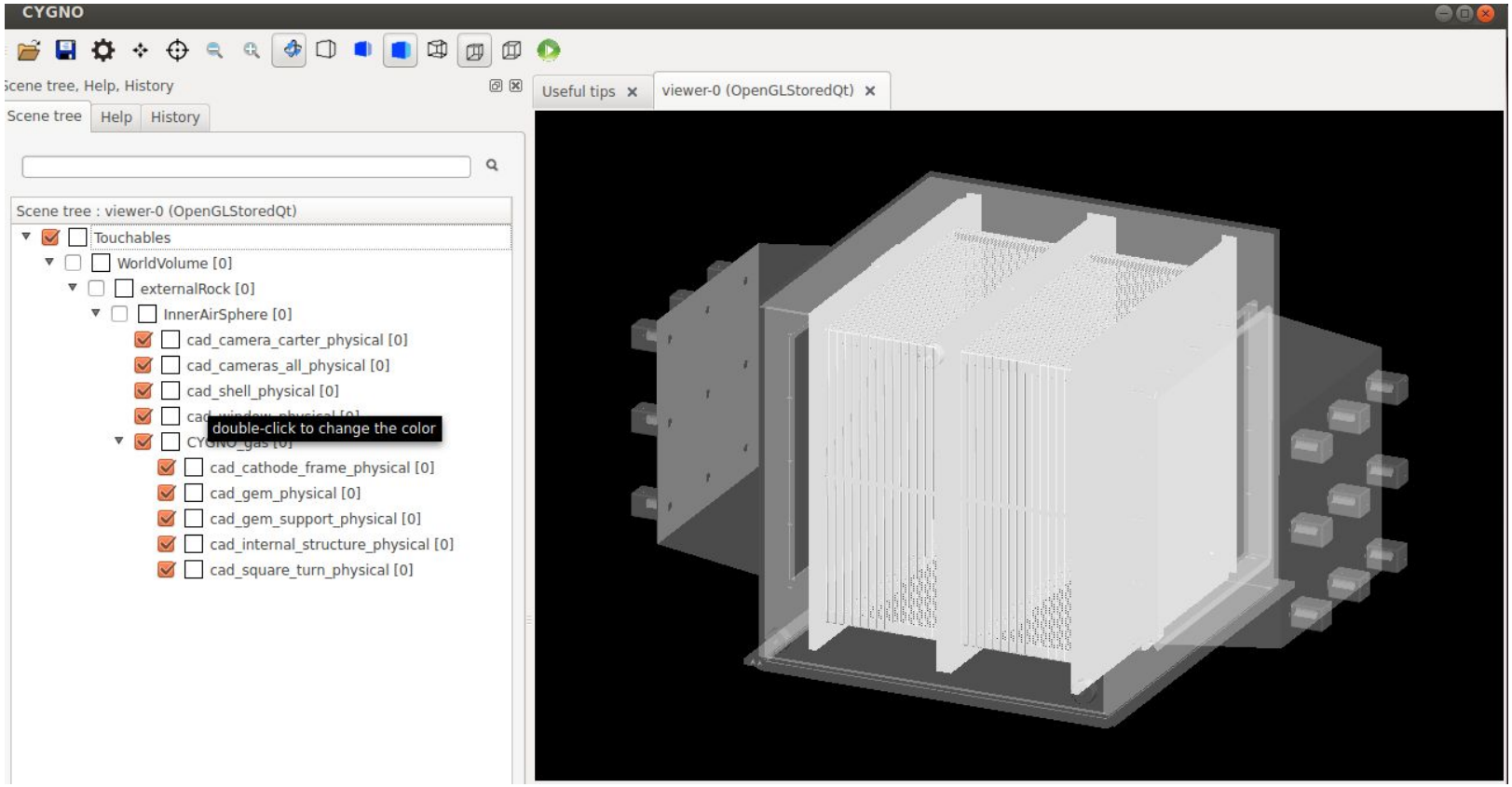






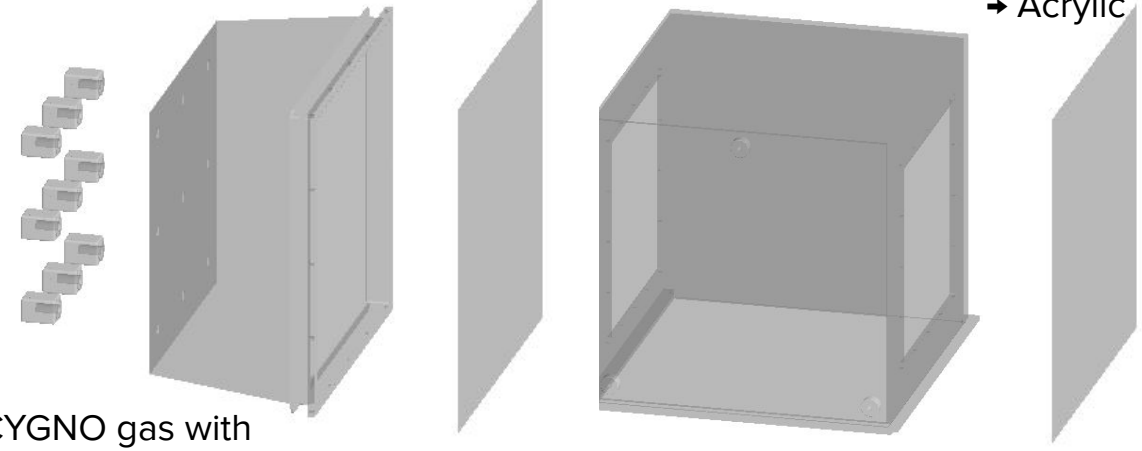
New simulation

- based on GEANT4 v10.5
- imported tassellated solids in GEANT4 using CADMesh: https://github.com/christopherpoole/CADMesh
- at the moment in my private repository but can be put on the common github of CYGNO



Materials

- Materials has to be assigned in GEANT4
- All is inside an air sphere ➔ air



shell ➔ Acrylic

windows ➔ Acrylic

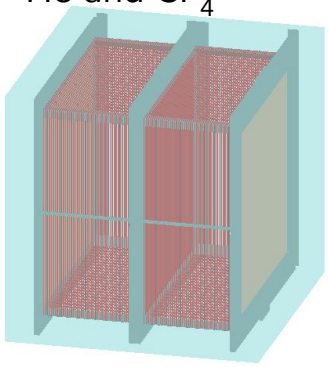
camera carter ➔ Acrylic

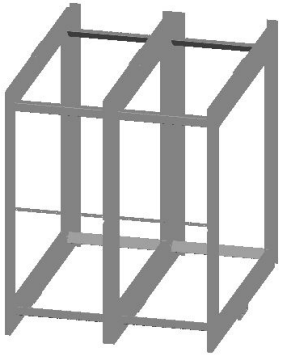
cameras ➔ effective material

CYGNO gas with configurable composition of He and CF_4

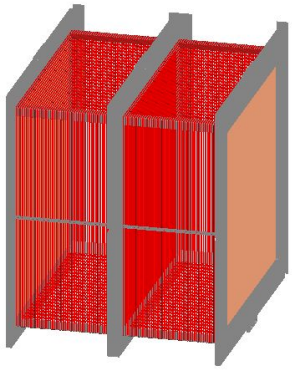
plate with camera holes ➔ copper?

separate volume for camera lens?





internal structure ➔Teflon/Peek?



cathode ➔ copper (red)
GEMs ➔ effective material (orange)

Geometry and materials: to do list

- Objects made of different material have to be separated in the CAD
- Useful to have a solid also for the gas volume in CAD:
  - difficult to handle a mixed geometry CAD + user defined in GEANT
- Add a configurable shielding
  - more than 1 layer? study different materials and hybrid (ex. PE+water, PE+Pb, ...)
- Update CAD to the last geometry
- Find tables with radioactivity of all materials

Output file

- Work in progress (will be in ROOT format)
- Informations to save:
  - Mass of all the setup volumes (needed to normalize the background in the analysis)
  - Event based:
    - tot energy in the sensitive volume
  - Hits (single interactions in the sensitive volume):
    - hit energy
    - hit position
    - particle ID
- ...other?

Hits information can increase the output size

➜ maybe option to switch off when not needed

Simulation process steps

1. Simulate radioactive decays in each volume
   a. Different volumes are simulated independently
   b. Each isotope is simulated independently
   c. For decay chains one has to simulate each isotope in the chain

2. Normalize everything to mass and activity

3. Sum the contributions
   ➜ Energy spectrum form radioactivity of the setup

External gammas and neutrons have to be generated with correct spectrum from an external surface, propagated inside the shielding, normalized to total flux

➜ Energy spectrum from external backgrounds