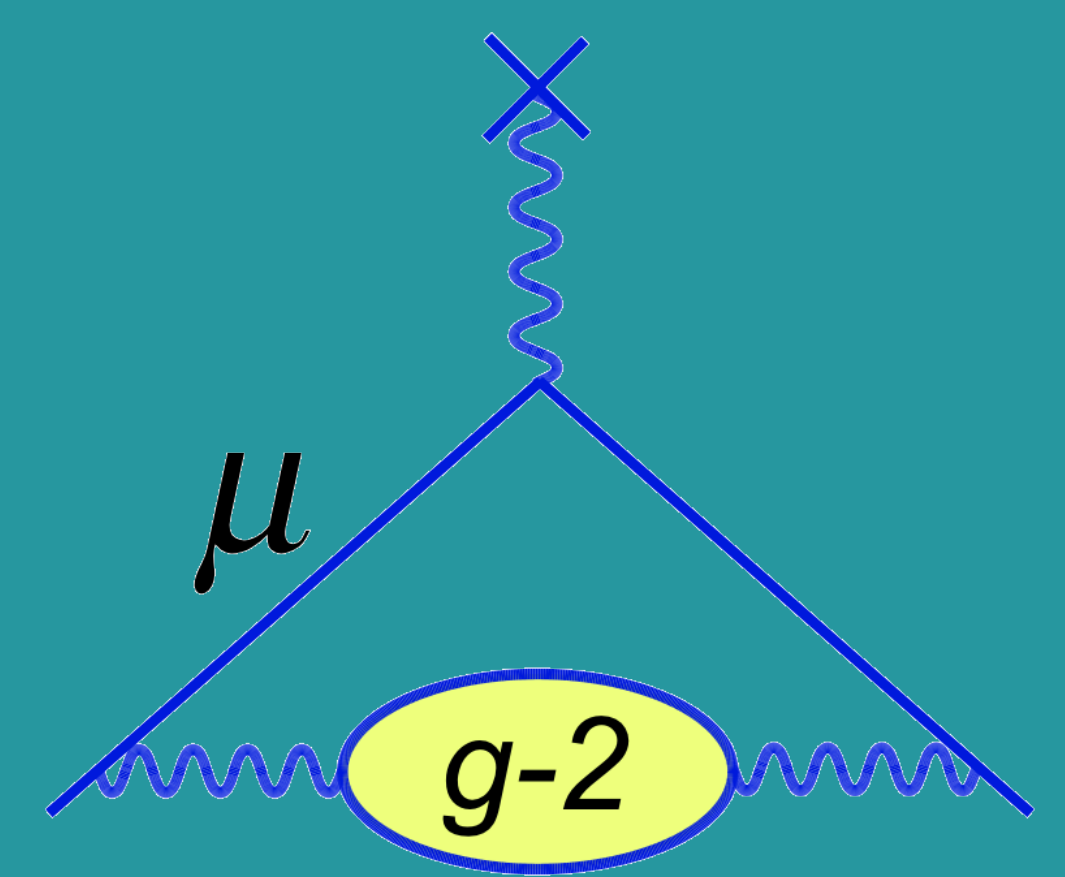# Using 3D CAD Models in Geant4

Leah Welty-Rieger, Muon g-2, Fermilab

Muon g-2 Detector Design

There are 12 custom vacuum chambers in the Muon g-2 experiment which connect in a ring shape and interface with tracking and calorimeter detectors. It is essential that the composition and alignment of the material in front of the calorimeters is correct. Mocking up the detector designs to the necessary precision was proving to be nearly impossible. We asked ourselves - is there a solution that utilizes existing 3D engineering models?

All these images are taken from visualization of our Geant4 Simulation. Not from a CAD program
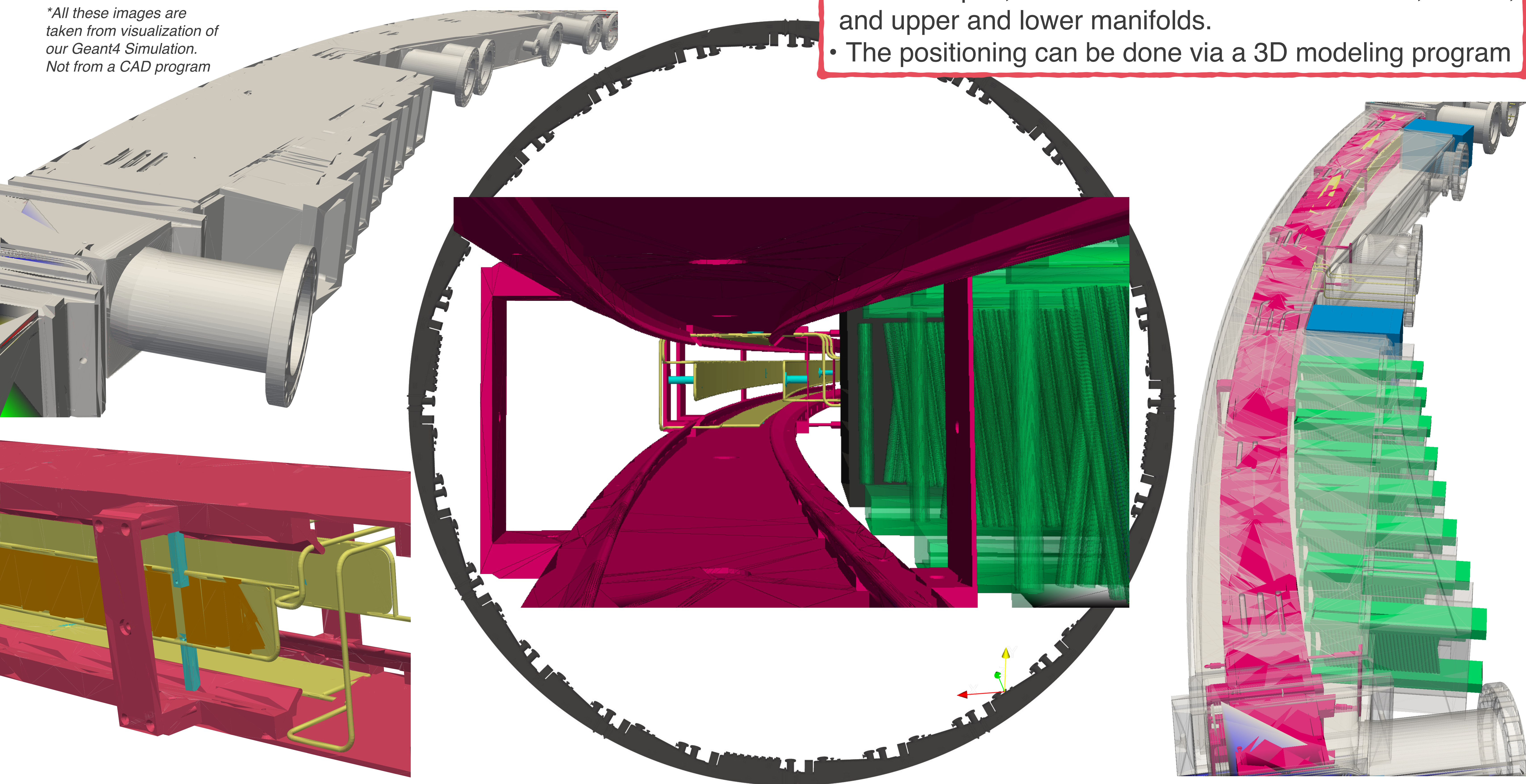
Turns out we could use the **CADMesh** libraries (https://github.com/christopherpoole/CADMesh) to convert STL files from 3D models into tessellated solids. This method reduces design time, improves accuracy and allows for quick updates to the experimental geometry.

Mix Native & 3D Models

- Not every component in the simulation has to be formed from a 3D model, mixed and matched for what is best.
- Ex: The straw trackers are constructed completely using native shapes, different materials within modules, straws, and upper and lower manifolds.
- The positioning can be done via a 3D modeling program

Helpful hints

- When you get the file from the engineers, it could be composed of several different solid bodies; unite these so the entire piece is made of one solid body.
  - When you do this you might have to extend pieces a little bit to get them to touch. If you don't unify the pieces, Geant4 has trouble tracking across the boundaries and will issue "stuck track" warnings.
- Use a 3D modeling program (NX, e.g.) to point to where you have an overlap.
  - The 3D model is in the same frame of reference as the simulation. When Geant4 outputs a coordinate in space of the overlap, you can go directly to the model and go to that point to find it and fix it.

Additional Information

- It doesn't matter what CAD software you use, as long as it can export an ".stl" file.
- The output files are larger than with native volumes and take longer to open in visualization programs like ParaView (*http://www.paraview.org*)
- It's slower to build the geometries, but once built for one event there is no significant slow down on subsequent events.