

# LOM Converter in CLSim

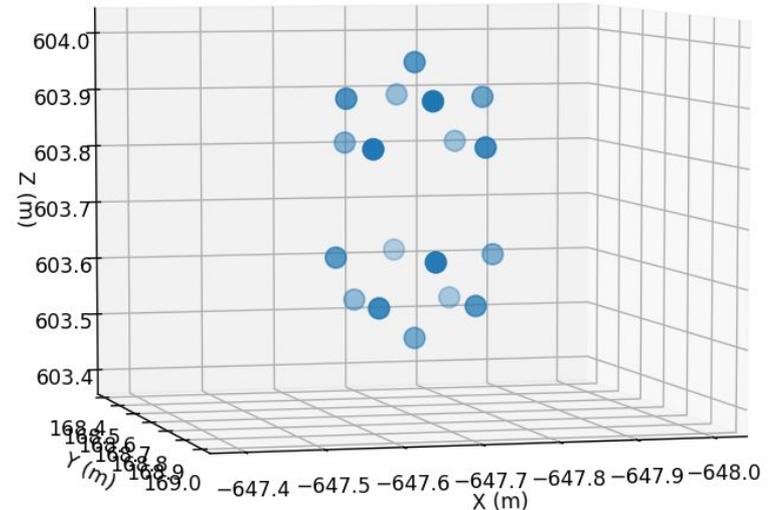
Samuel Benda --- UW Madison --- 10/19/2021



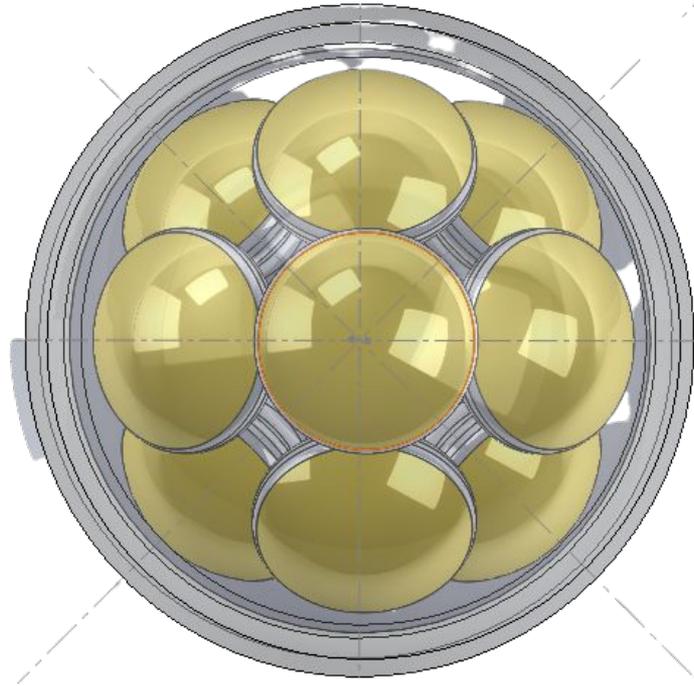
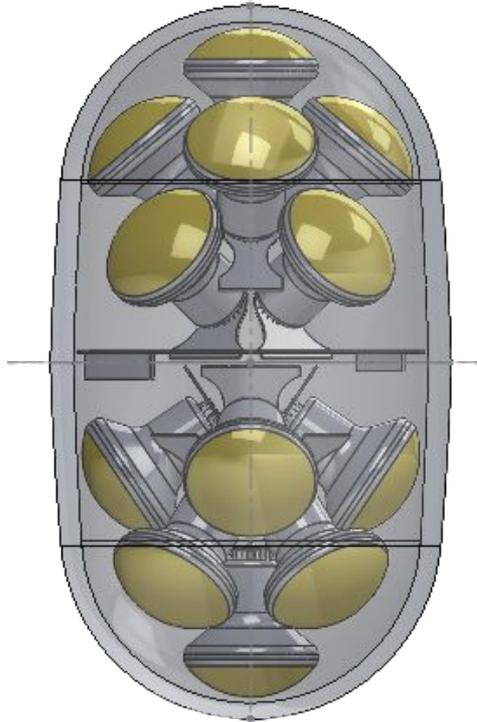
# Long Optical Module (LOM)

- ▷ Only have been working with 18 PMT LOM, with plans to branch to 16 PMT LOM.
- ▷ 18 LOM still in design process, measurements and placements **NOT** final.
- ▷ Generated two GCDs with this geometry:
  - IceCubeHEX\_Sunflower\_v3.1/2\_240m\_ExtendedDepthRange\_LOM.GCD.i3.bz2

LOM PMT Positions

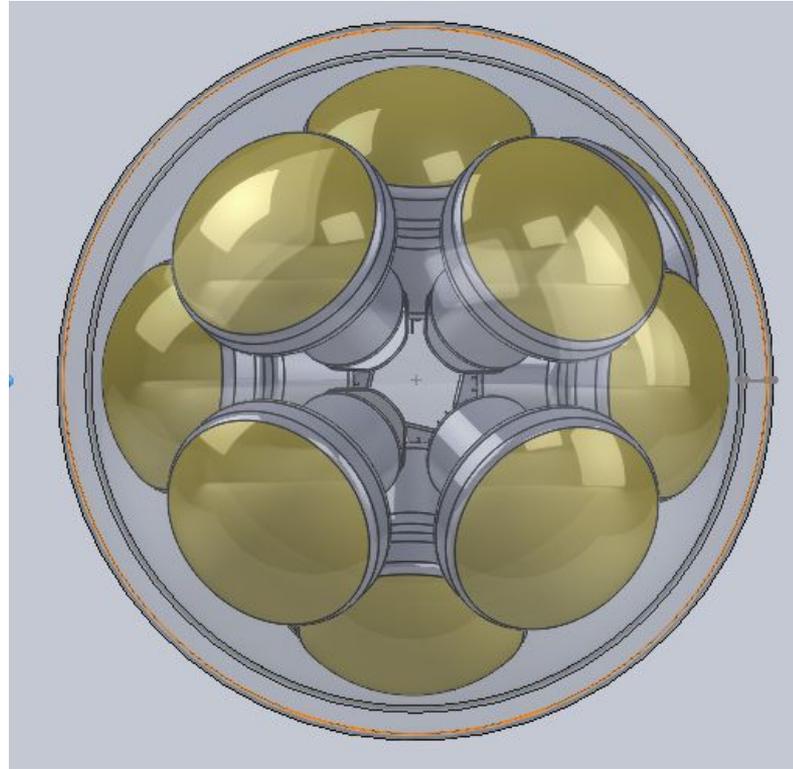
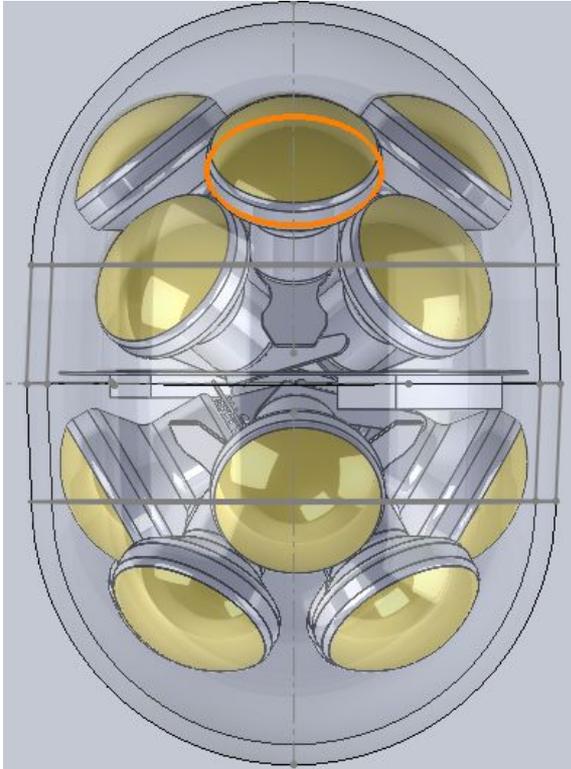


# LOM 18



Designs **NOT** final

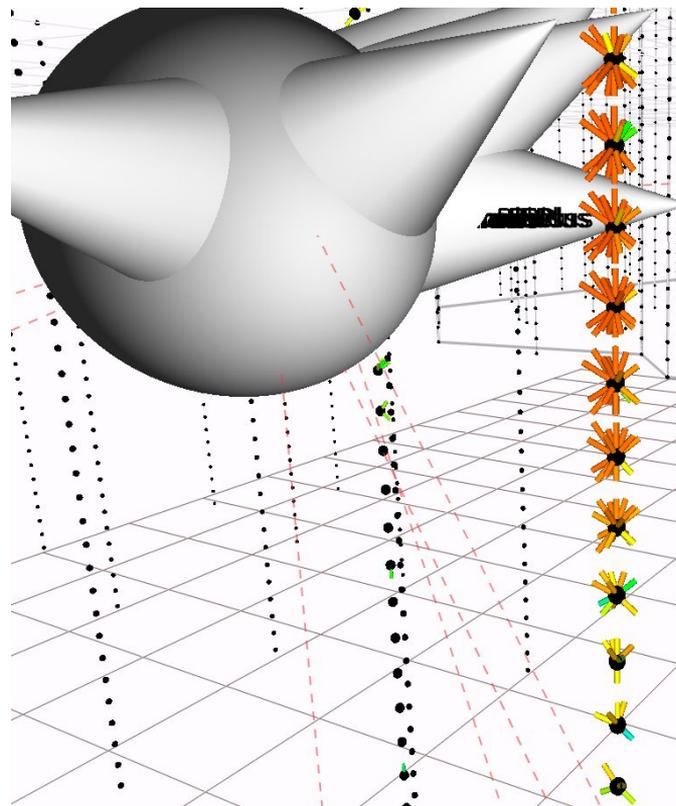
# LOM 16



Current design.  
No significant  
changes expected  
in future

# CLSim Converter

- ▷ Creates I3MCPESeriesMap from I3PhotonSeriesMap.
- ▷ Based off of mDOM converter with changes made for LOM.
- ▷ Three major changes made:
  - Exact PMT surface instead of flat discs.
  - Back Interpolation for larger module.
  - New weights for angular sensitivity for LOM/QE curves for new 4" Hamamatsu PMTs, (glass gel survival uses D-Egg glass)
- ▷ Still work to do to implement changes/clean up comments/write tests/troubleshoot/etc.



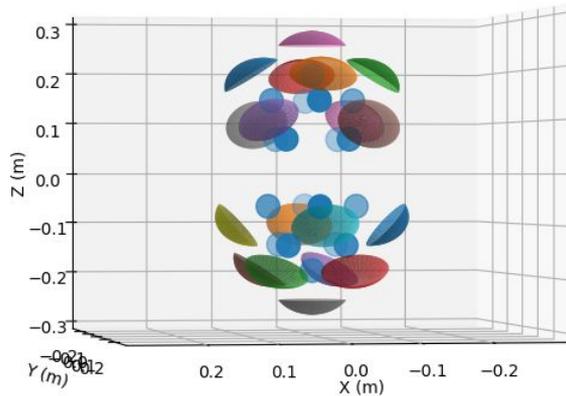
# Exact PMT Surface in CLSim

- ▷ Previous iterations of multi-PMT converters uses flat discs oriented in the direction of PMTs.
  - Good approximation, but not exact.
  - Simple design, able to perform easy photon veto. (Incoming/outgoing photon, approaching from PMT backplate, did it hit previous PMTs, etc).
- ▷ Closer approximation would be half-sphere PMTs.
  - Twice as much effective area
  - Introduces 3D element that can catch photons that would otherwise be undetected on disc.
  - Good approximation, but can be better as well.
- ▷ Exact shape of PMT used in CLSim
  - Cut half-sphere according to opening angle of PMT. Can exactly match PMT surface.
  - No approximation.
  - Easy to implement with current converter code
  - Need to implement another weighting scheme, i.e. higher chance for photons to hit on the center of surface than on the edges.

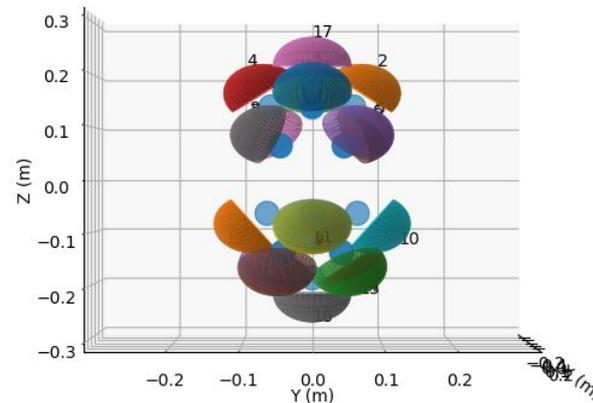
# Exact PMT Surface in CLSim

- ▷ Notice the side-on view shows the protruding PMTs; more active surface to catch photons.
- ▷ Need to compare effective area of disc>tight-sphere>half-sphere.

LOM Tight-Sphere PMTs

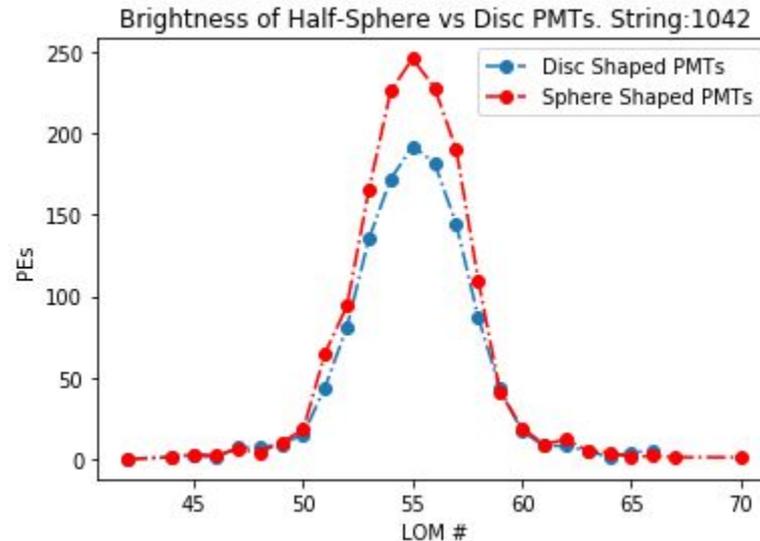


LOM Half-Sphere PMTs



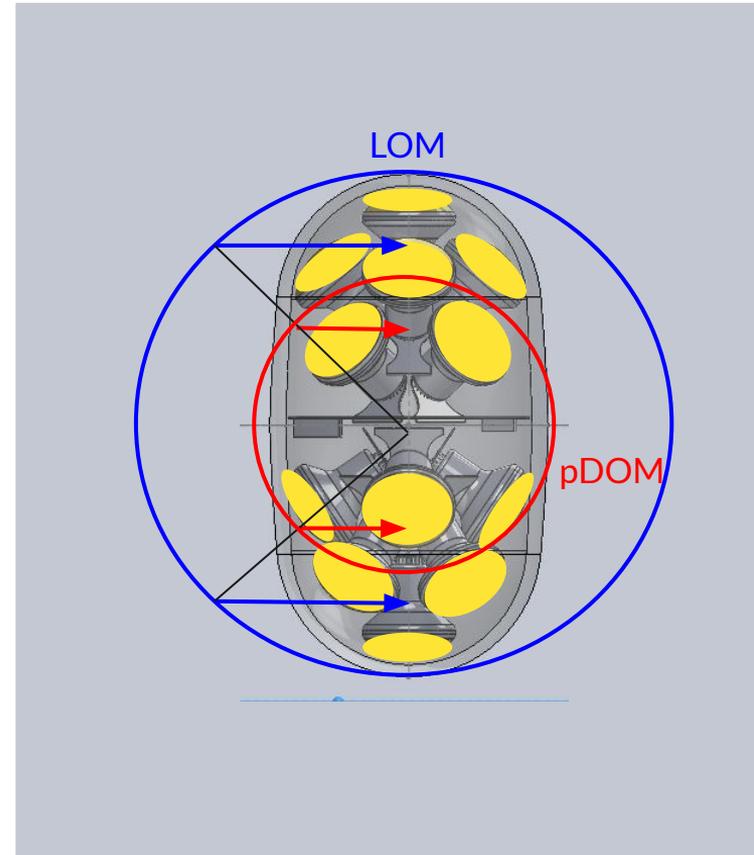
# Exact PMT Surface in CLSim

- Rudimentary distribution of brightness of disc and half-sphere PMTs.
- Definite increase in PEs detected using half-spheres.



# Back Interpolation

- ▶ LOM 18 module “radius” ~0.3m.  
Much larger than DOM 0.165m.
- ▶ CLSim can’t propagate to any sphere size other than DOM
  - One solution: Back Interpolation
  - Used in mDOM converter
- ▶ Scales position of photons from DOM sphere to LOM “sphere.”
- ▶ Not ideal, introduces multiple correction factors, does not account for scattering from bulk/hole ice.



# LOM Acceptance Curve

- ▷ Can we make or do we need LOM acceptance curve?
  - Currently using mDOM acceptance from CLSim.
  - I can provide GCDs, but otherwise I'll need some help.
- ▷ Chiba 4" Hamamatsu QE curve
- ▷ AE\*CE position dependence curve for 4" PMTs.
- ▷ Still using mDOM angular sensitivity, no longer valid.
  - mDOM ang sen zeroes out negative  $\cos(\theta)$ . No longer the case for my implementation of LOM PMTs.
- ▷ Please contact me at on slack if you can help, or if you have some input. Would much appreciate it!

# Future Scope

Unfortunate health situation, delayed a few weeks until now.

- ▷ Within the next 2-3 weeks
  - Finish LOM converter.
- ▷ Within the next 1-2 months
  - NuTau simulations with LOM.
  - Reco performance?.
- ▷ DNN would be cool to learn...