



Phase II Optical Sims

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Optical Simulations

Goal:

Test our ability to resolve positions in Phase II using weighted averages and PMT detection data.

- **Current Work**

- Using just photon point sources
- Developing the methods/tools to analyze optical sims



Current Work

Spent the past few weeks playing around with some data, found an approach that should work:

- Photons don't keep tracks, or their PMT interaction position :-{
- The only useful info they record is their volumeID (corresponds to photocathode)
 - Cross reference this with the BACCARATExecutable printout to find the PMT ID's
 - $ID_{PMT} = (ID_{pcathode} - 9) / 5$
 - I need to make a script to output a list of these PMT ID's and



From there, I could use the PMT locations array to make:

- Raw PMT detection map vs source position
- Calculate signal weighted average of PMT positions
 - Compare weighted average position to the source position

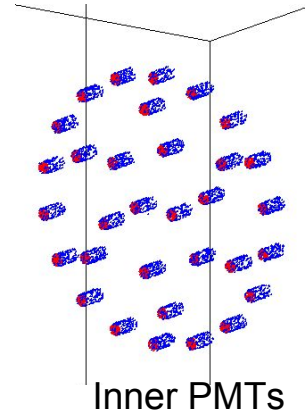
Backup Slides

- Test position resolution as a function of position in the phase 2 detector
 - Test different positions between the grids
 - Test positions in the outer ring section
 - Test with different amounts of light
- Miscellaneous
 - Fix condor submissions/output
 - Develop analysis techniques(jupyter notebooks)
 - Read some papers within the DDM field

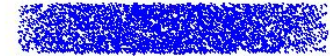


Current State of Phase II Geometry

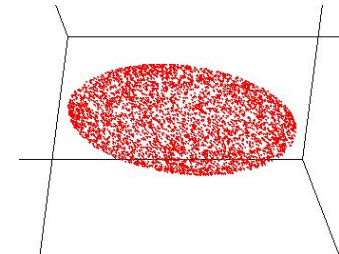
- Components implemented
 - Inner steel cryostat
 - Reflective AlMgF2 wall, bottom, & top
 - Reflectivity = .88
 - Specular lobe constant = 0
 - Specular spike constant = 0
 - Backscatter constant = 0
 - Efficiency = 1
 - Inner Gaseous Xenon Space
 - LZ Grid
 - LUX R8778 PMTs (inner array)



Crude visualizations using
Baccarat e- particle source



GXe space



LZ Grid

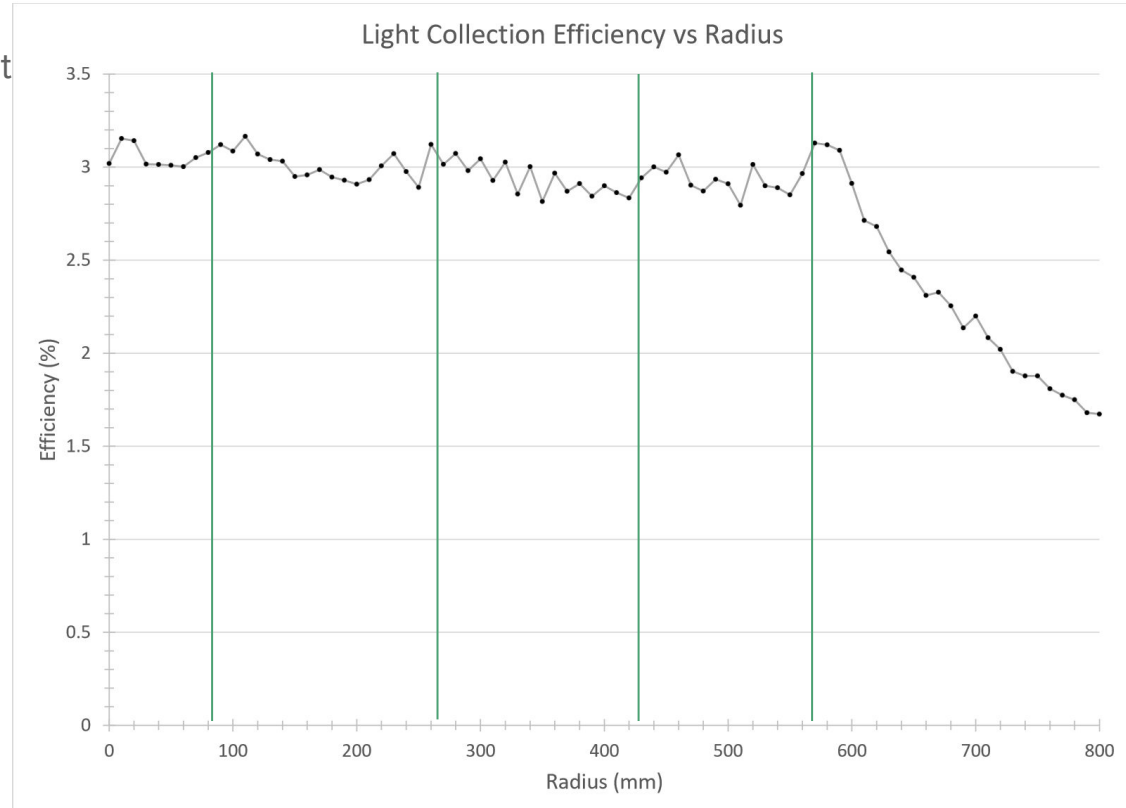


Light Collection Efficiency

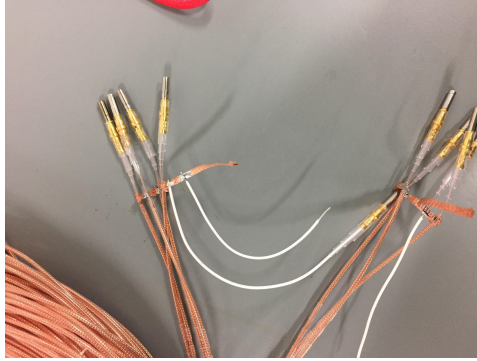
- 100,000 - 7ev photons @ each point
- 88% reflective AlMgF2 everywhere
- 20% reflective Grid
- 20cm Grid-PMT separation

Future: Quantum Efficiency

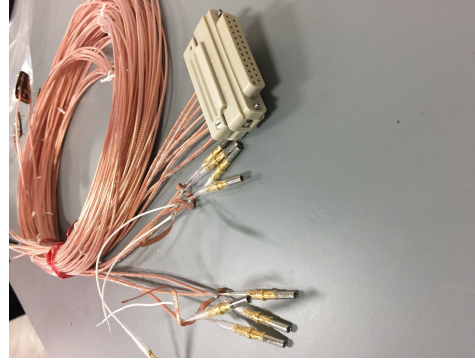
“LUX R8778 PMTs feature a measured average 33% quantum efficiency and 90% collection efficiency “ - arXiv:1205.2272



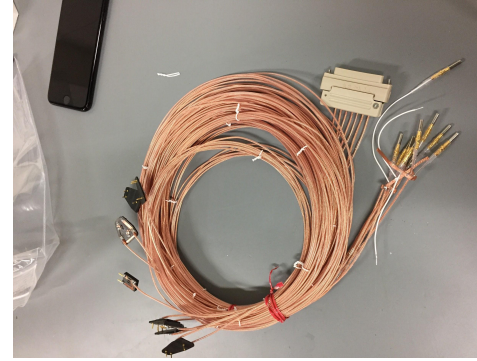
Cable Making



HV Ends



HV and DB25



Cable 301/302



All 8 cables finished and packaged



Summer Review:

- Created a working, simplified phase 2 geometry
- Performed initial optical simulations of light collection efficiency
- Phase I Internal Cable Making
- Began playing around with HTCondor



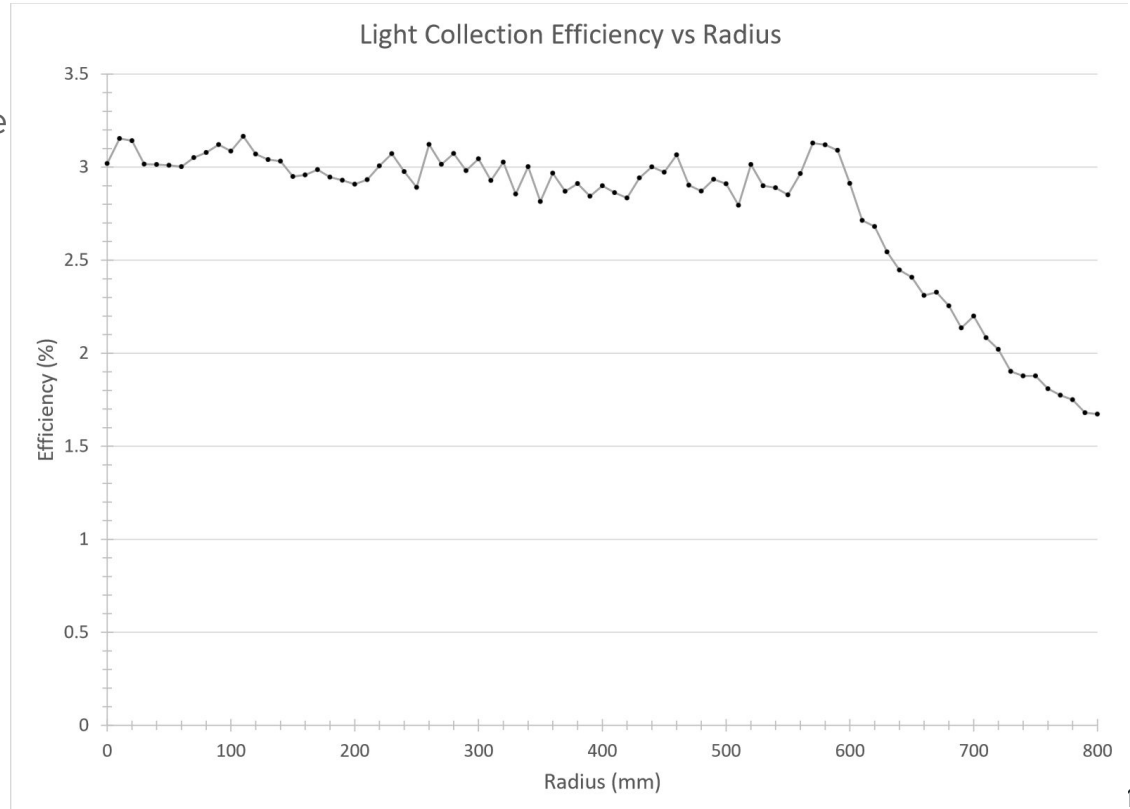
Semester Goals

- More Optical Simulations with BACCARAT
 - Change specular coefficients
 - Take into account quantum efficiency
 - Signal reconstruction sims
- Fix issues with HTCondor
 - Can't get an output
- Increase Complexity of Phase II geometry
 - More Components
 - More Macro level commands
- Get better at
 - C++
 - ROOT
 - Python



Light Collection Efficiency

- 100,000 - 7ev photons
- 88% reflective AlMgF2 everywhere
- 20% reflective Grid
- 20cm Grid-PMT separation





Done Last Week:

- Changed optical properties of AIMgF2
 - Modified to be more like a metal than a diffuse reflector
- Finished geometry for optical sim usage
 - Updated dimensions
 - AIMgF2 reflective surfaces
 - Inner PMT array in place
 - Bottom Grid in place (Hijacked from LZGrid.cc)
- Made a new macro lightCollection.mac
 - 10,000 7 eV optical photons
 - Isotropic point source



Next Steps

- Finalize macro
 - More photons
 - Modify photon source position to .5 cm above floor
 - Potentially switch value for recordLevelOptPhot
- Write analysis code
- Start optical simulations
 - Simulate same situations as Rachel's sims
 - Try to recreate format of Rachel's plots for easy comparison
- Other Suggestions?

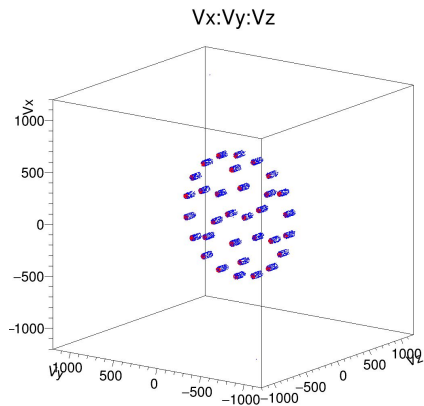


Goal

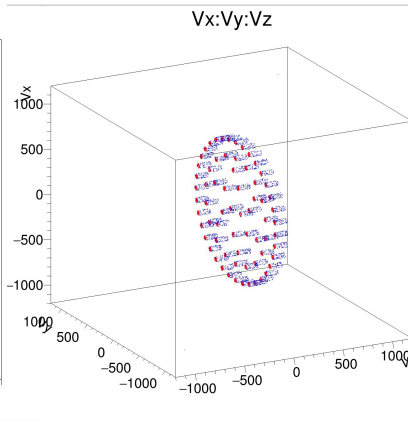
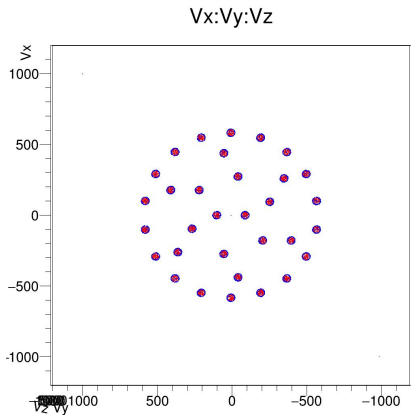
Design Phase II System Test detector geometries for use in simulations.

R8778 PMT Arrays

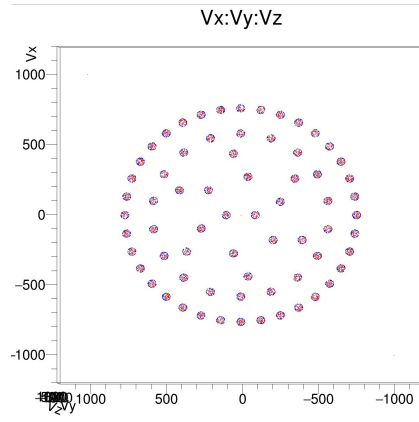
Blue is steel PMT body, red is PMT window



Inner array



Inner + Outer array





Plan



1. Study Phase I and LZ geometries
2. Design simplified geometry
3. Increase complexity of geometry
 - a. Add optical surfaces
 - b. Add PMT's
 - c. Other features
4. Work towards final Phase II geometry
 - a. More components, most realistic
5. Work on macros for Phase II

AlMgF2

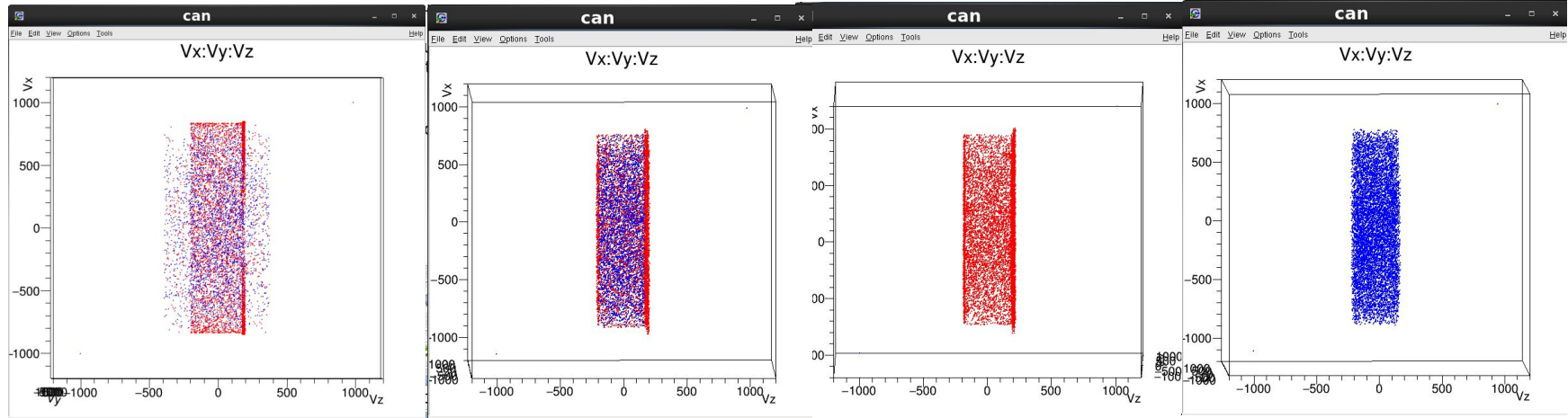
Accessed with: `CoatingAlMgF2()`, `GXeAlMgF2Surface()`

- Defines a new material with many of the same properties of Aluminum but with reflectivity of AlMgF2 (approximation)
- Defines AlMgF2 MaterialPropertiesTable (followed format of Teflon)
 - **Reflectivity = .88**
 - **Specular lobe constant = 0**
 - **Specular spike constant = 0**
 - **Backscatter constant = 0**
 - **Efficiency = 1**
- Creates a boundary surface for the gas Xe - AlMgF2 interface with above properties

Any other suggestions for improvement?



2 Component Visualization



Both (before)

Both (after)

GXe space (after)

IV (after)

- All particles accounted for and within defined geometry

- Error caused by overlap in geometry dimensions