Phase II Optical Sims

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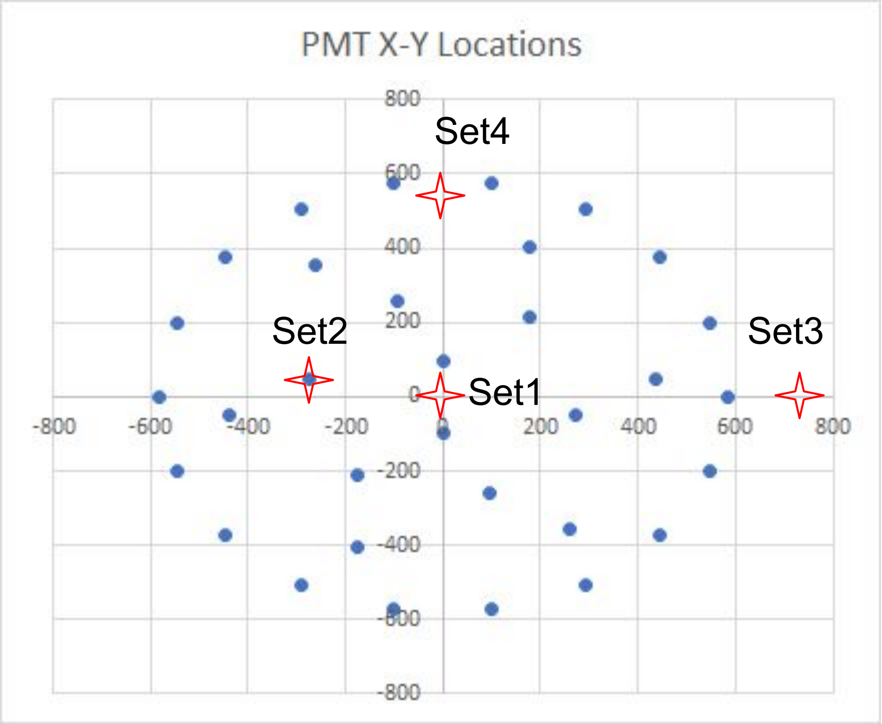
Fall Work

Phase 2 Sim data

- Have *.bin files of 10k events for 4 data sets
- Persistent issues submitting jobs to condor (environment sourcing issues)
- But...seems that Ryan may no longer need this (Phase2 XY slides)

Access and play with Phase 2 data on pdsf

- Currently searching for location of the data
- Suggestion for intro analyses I can do?



Backup Slides

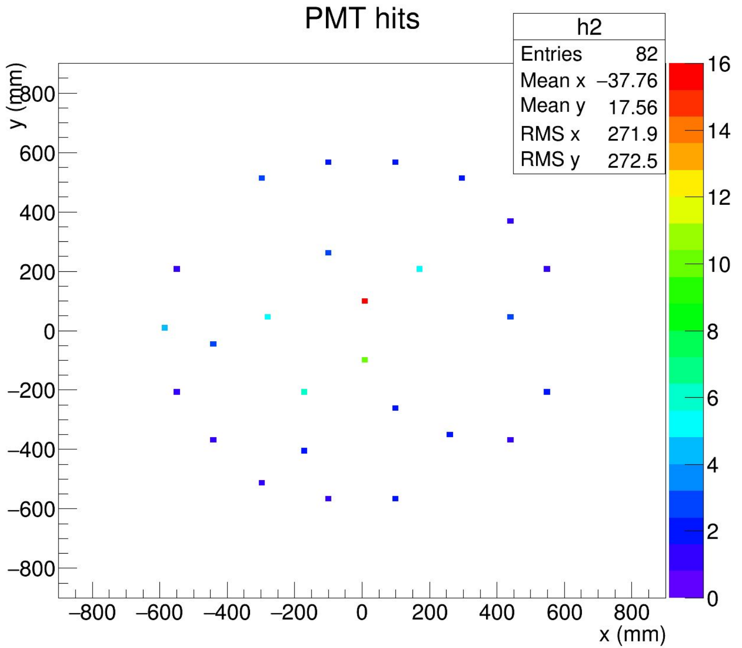
Optical Simulations

Goals:

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

Test light collection differences with different configurations of the outer PMT array using 32/36 locations

- Recently Completed
  - Switched back to Inner PMT Array
  - Modified Analysis to compute x-y average position
- Current Work
  - Testing Position Reconstruction



10,000 photons,

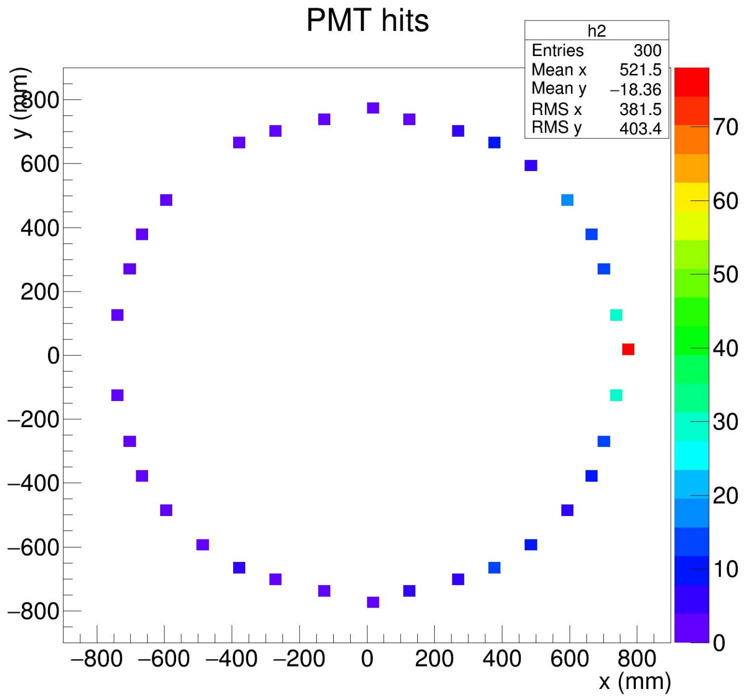
Source: (0, 0) mm

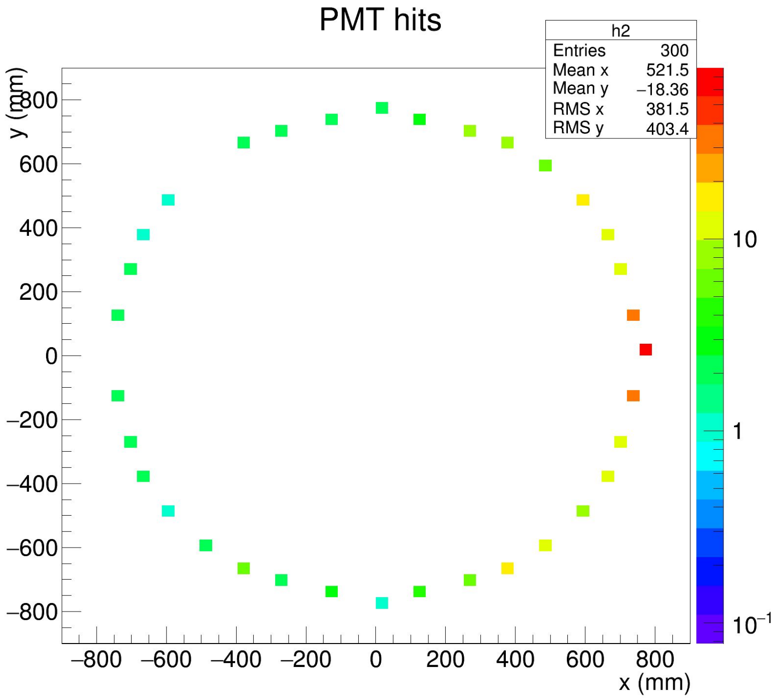
Reconstructed Position: (-39.6, 16.3) mm

Simulation Parameters

- No grid
- Inner PMT Array configuration
- 10,000 photons (point source)
    - At half height in the GXe
    - Source at xy - (0mm, 0mm)
    - Quantum efficiency not taken into account

Full Array

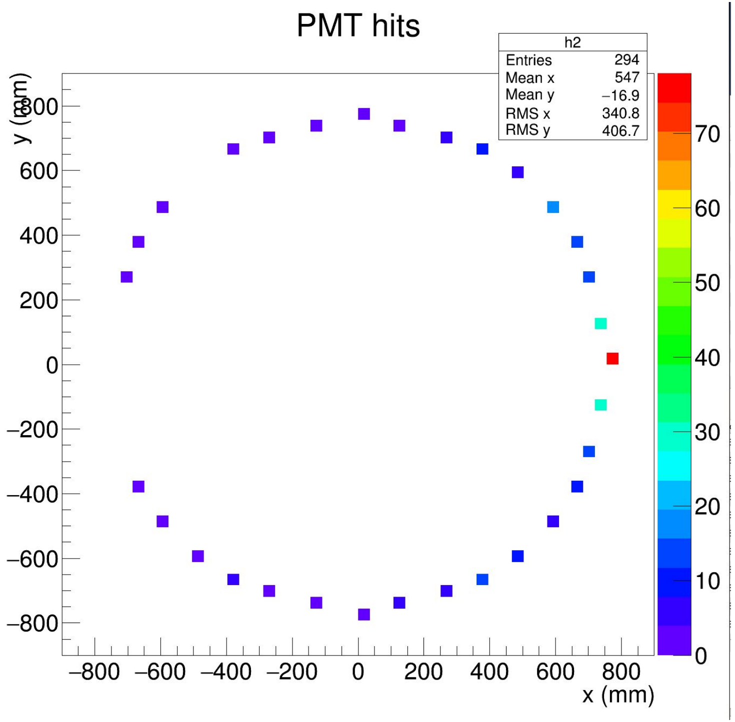

PMT hits
h2
Entries 300
Mean x 521.5
Mean y −18.36
RMS x 381.5
RMS y 403.4
y (mm)
x (mm)

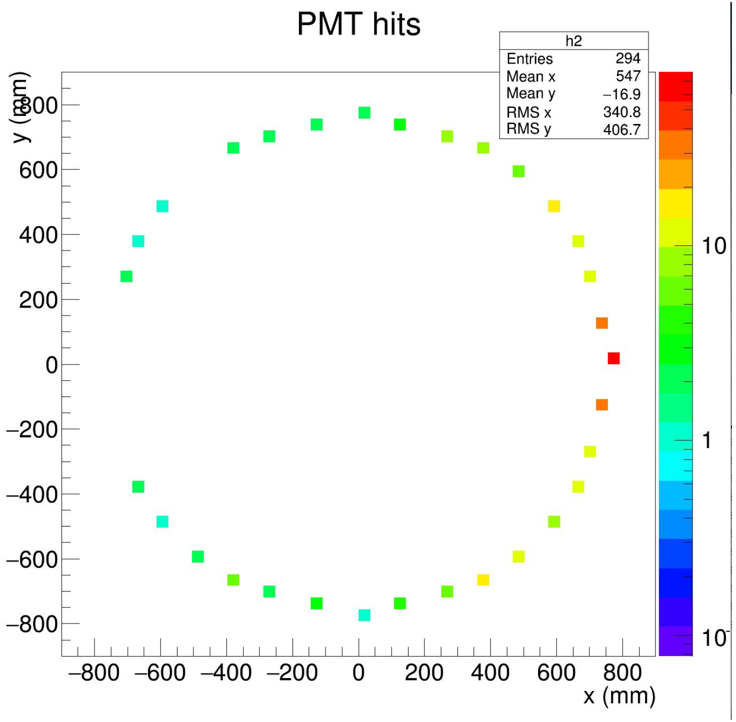

PMT hits
h2
Entries 300
Mean x 521.5
Mean y −18.36
RMS x 381.5
RMS y 403.4
y (mm)
x (mm)

Simulation Parameters

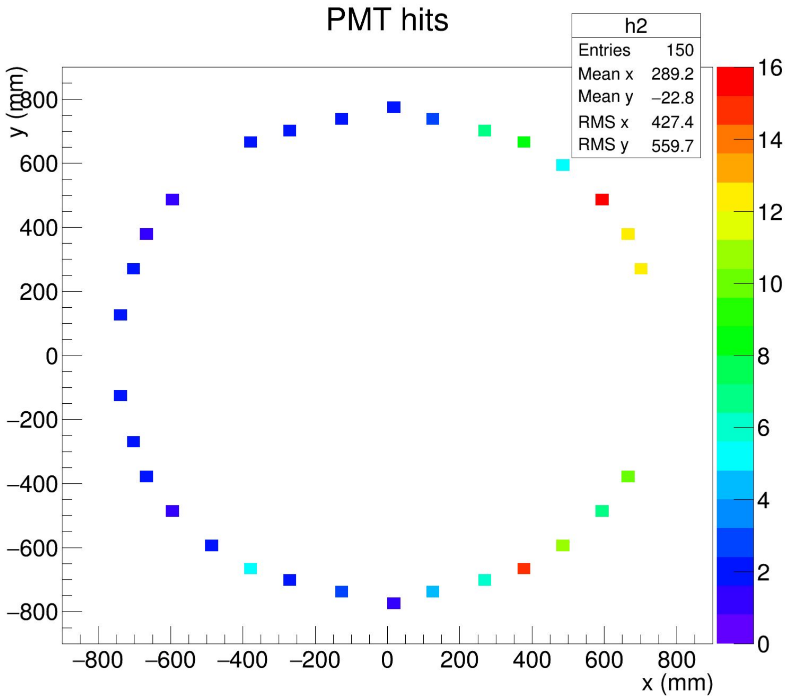
- No grid
- Inner PMT Array configuration
- 10,000 photons (point source)
    - At half height in the GXe
    - Generated between grid ring and field hoop at xy - (755mm, 0mm)
        - Directly below a PMT
    - Quantum efficiency cut of 1/3 used

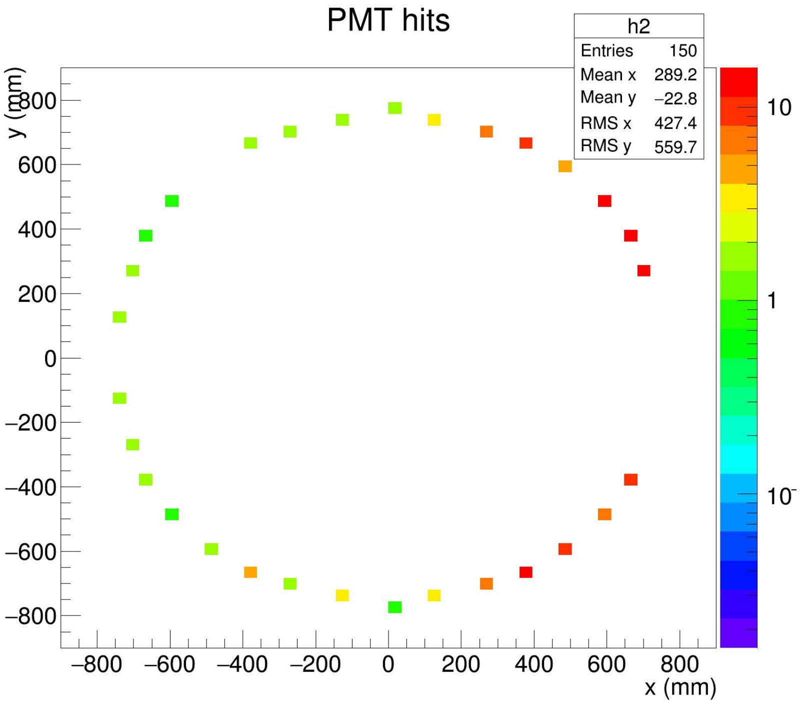
4 Grouped PMTs Removed Opposite of Event



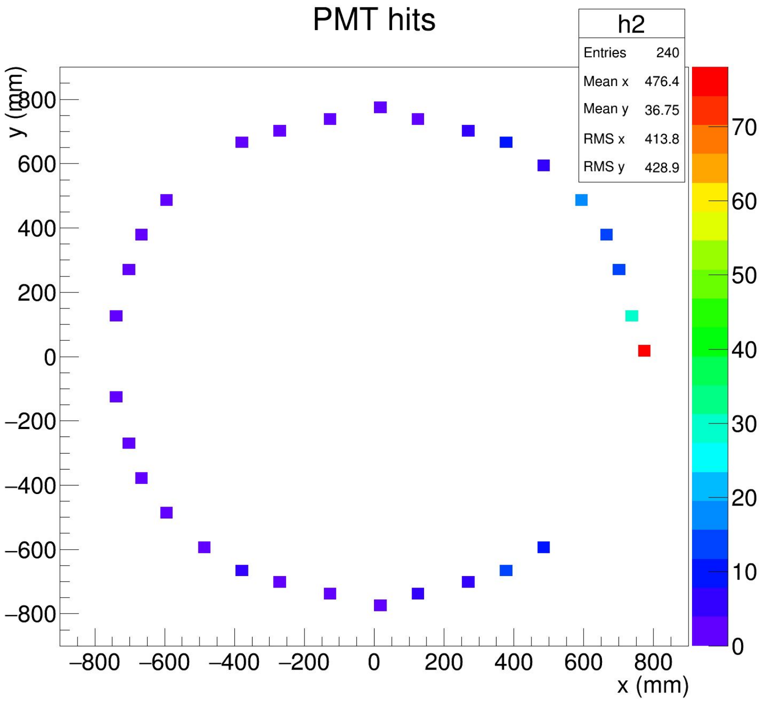


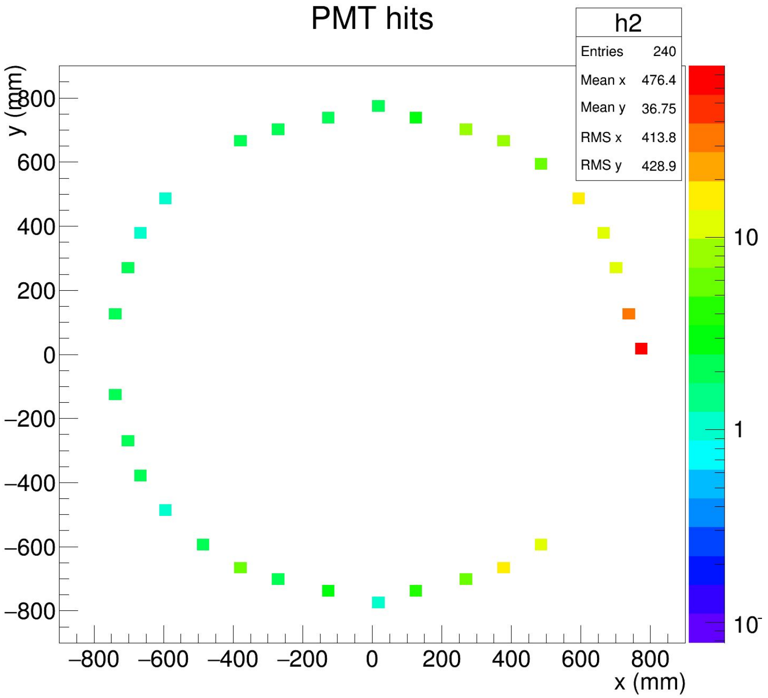
4 Grouped PMTs Removed Directly Over Event



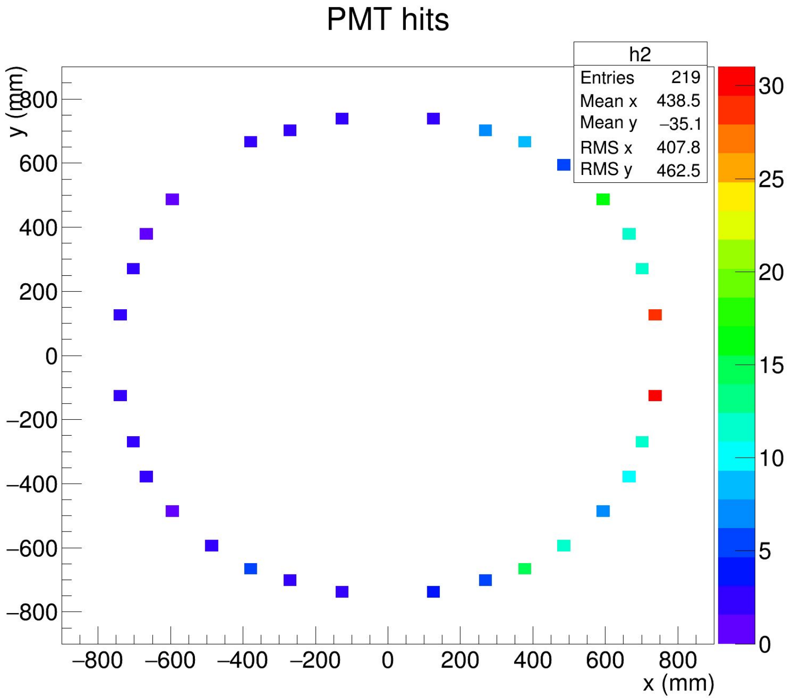


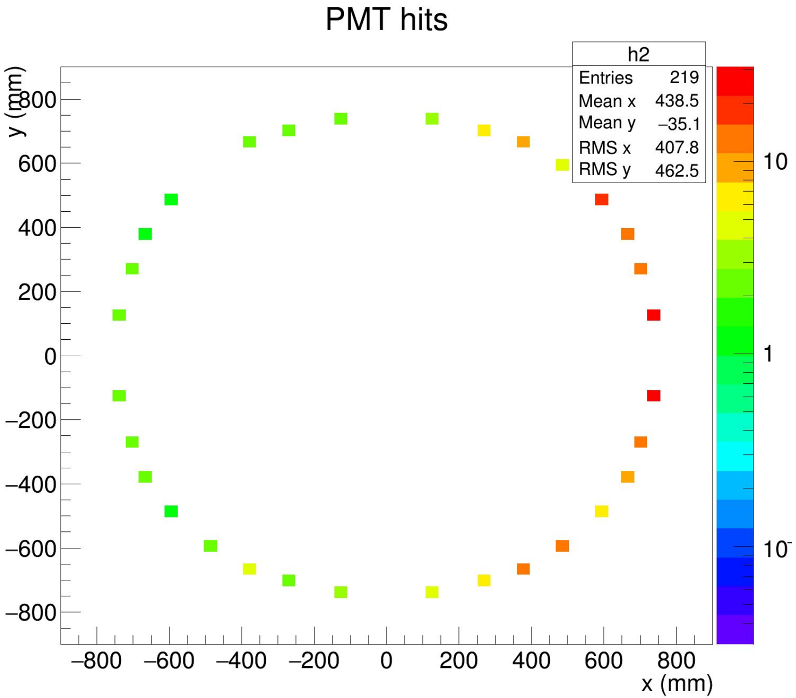
4 Grouped PMTs Removed Opposite Offset of Event





4 Corner PMTs Removed (1 Removed Directly Over)

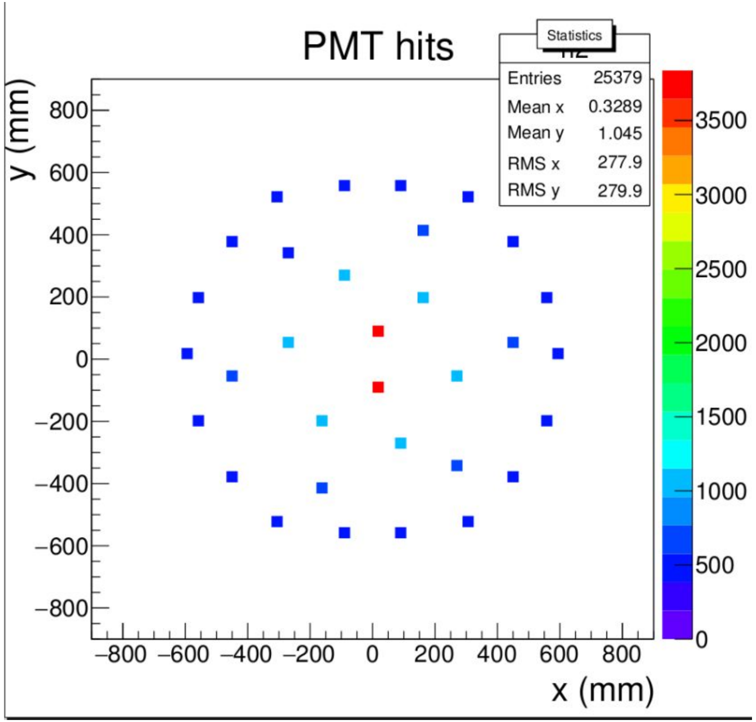




Current Work

Using my idea from last time...

- Reconstruct PMT Volume ID from triggered photocathode volume ID
- Use this PMT ID to reference the PMT location array to determine x, y coords of the hit PMT
- Plotted this in 2D histogram
    - Plot at right: proof of concept
        - 1e6 photons generated at (0,0,0) mm



Next Steps:

- Update Geometry to model initial Phase 2 Tests
  - Add field hoop
  - Remove grid wires
    - Command for turning off wires?
    - Comment out temporarily?
  - Implement Outer PMT Array
    - Few different configurations

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:

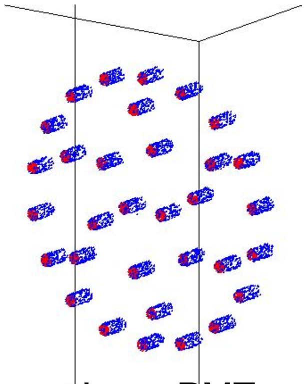
- Raw PMT detection map vs source position
- Calculate signal weighted average of PMT positions
  - Compare weighted average position to the source position

- 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

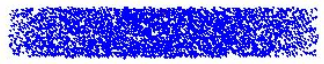
Current State of Phase II Geometry

- 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)

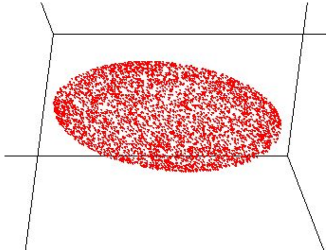
Crude visualizations using Baccarat e- particle source



Inner PMTs



GXe space



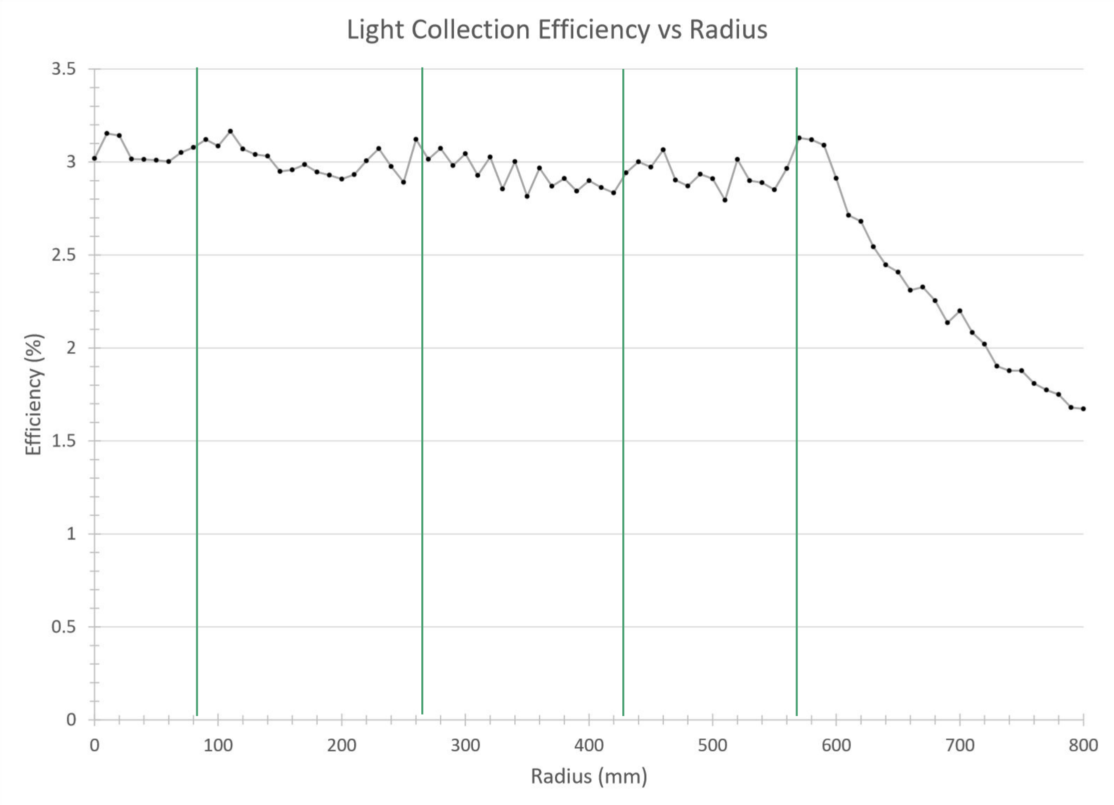
LZ Grid

Light Collection Efficiency

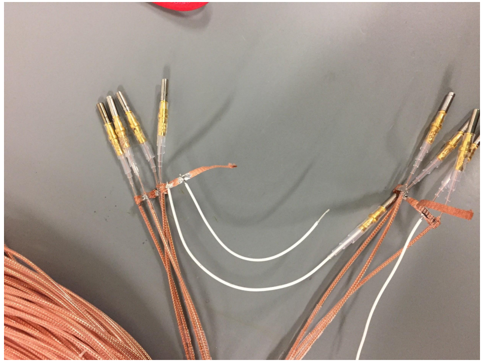
- 100,000 - 7ev photons @ each point
- 88% reflective AlMgF2 everywhere
- 20% reflective Grid
- 20cm Grid-PMT separation

Future: Quantum Efficiency

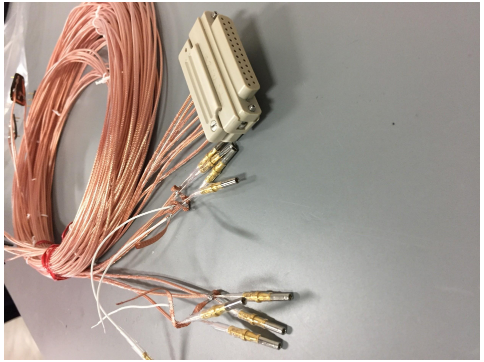
“LUX R8778 PMTs feature a measured average 33% quantum efficiency and 90% collection efficiency “ - arXiv:1205.2272



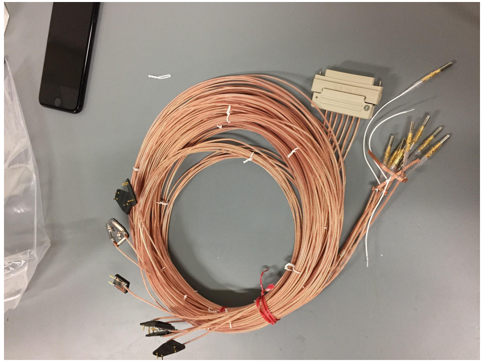
Cable Making



HV Ends



HV and DB25



Cable 301/302

All 8 cables finished and packaged

Summer Review:

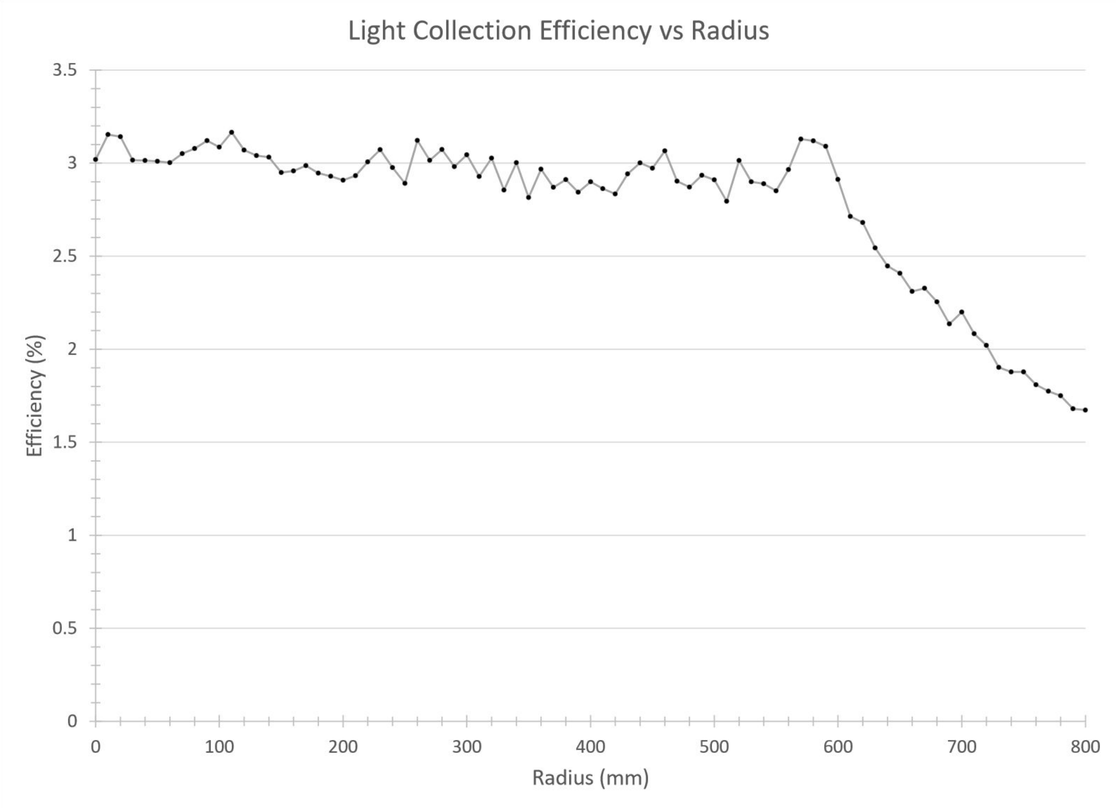
- Created a working, simplified phase 2 geometry
- Performed initial optical simulations of light collection efficiency
- Phase I Internal Cable Making
- Began playing around with HTCondor

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 (per point)
- 88% reflective AlMgF2 everywhere
- 20% reflective (GXe-Streel) Grid
- 20cm Grid-PMT separation



Done Last Week:

- Changed optical properties of AlMgF2
  - Modified to be more like a metal than a diffuse reflector
- Finished geometry for optical sim usage
  - Updated dimensions
  - AlMgF2 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

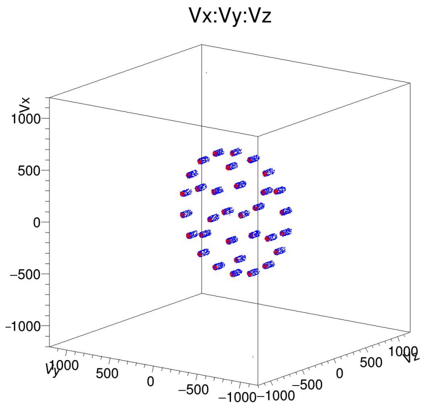
- Finalize macro
  - More photons
  - Modify photon source position to .5 cm above floor
  - Potentially switch value for recordLevelOptPhot
- Write analysis code
- Start optical simulations
  - Simulate same situations as Rachel's sims
  - Try to recreate format of Rachel's plots for easy comparison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

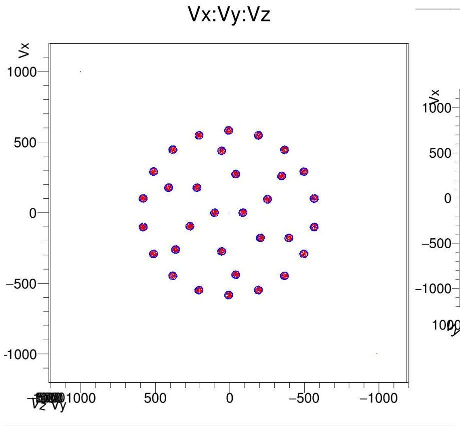
Goal

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

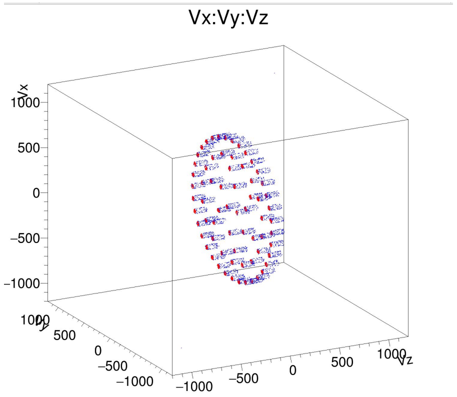
R8778 PMT Arrays

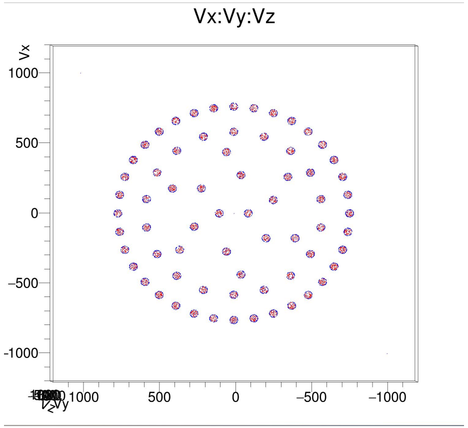
Blue is steel PMT body, red is PMT window





Inner array





Inner + Outer array

Plan

--------Done----------
--------In Progress--

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

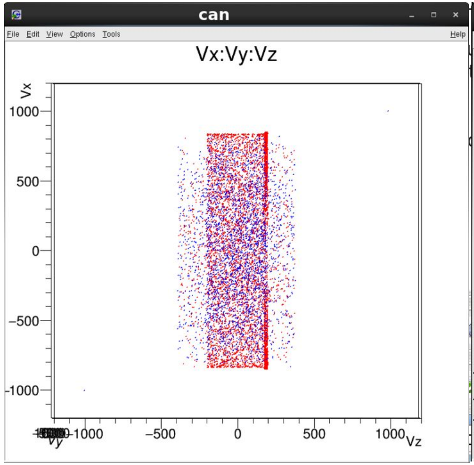
AlMgF2

Accessed with: CoatingAlMgF2(), GXeAlMgF2Surface()

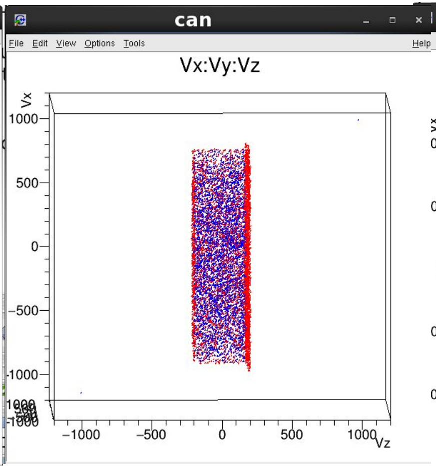
- Defines a new material with many of the same properties of Aluminum but with reflectivity of AlMgF2 (approximation)
- Defines AlMgF2 MaterialPropertiesTable (followed format of Teflon)
  - **Reflectivity = .88**
  - **Specular lobe constant = 0**
  - **Specular spike constant = 0**
  - **Backscatter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

Any other suggestions for improvement?

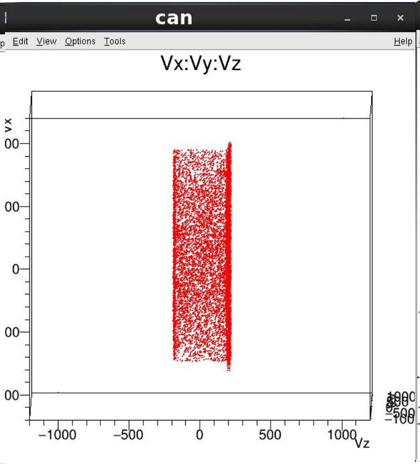
2 Component Visualization



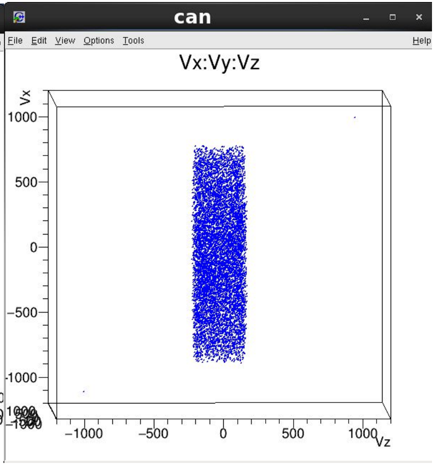
Both (before)



Both (after)



GXe space (after)



IV (after)

- All particles accounted for and within defined geometry
- Error caused by overlap in geometry dimensions