# What I Am Doing

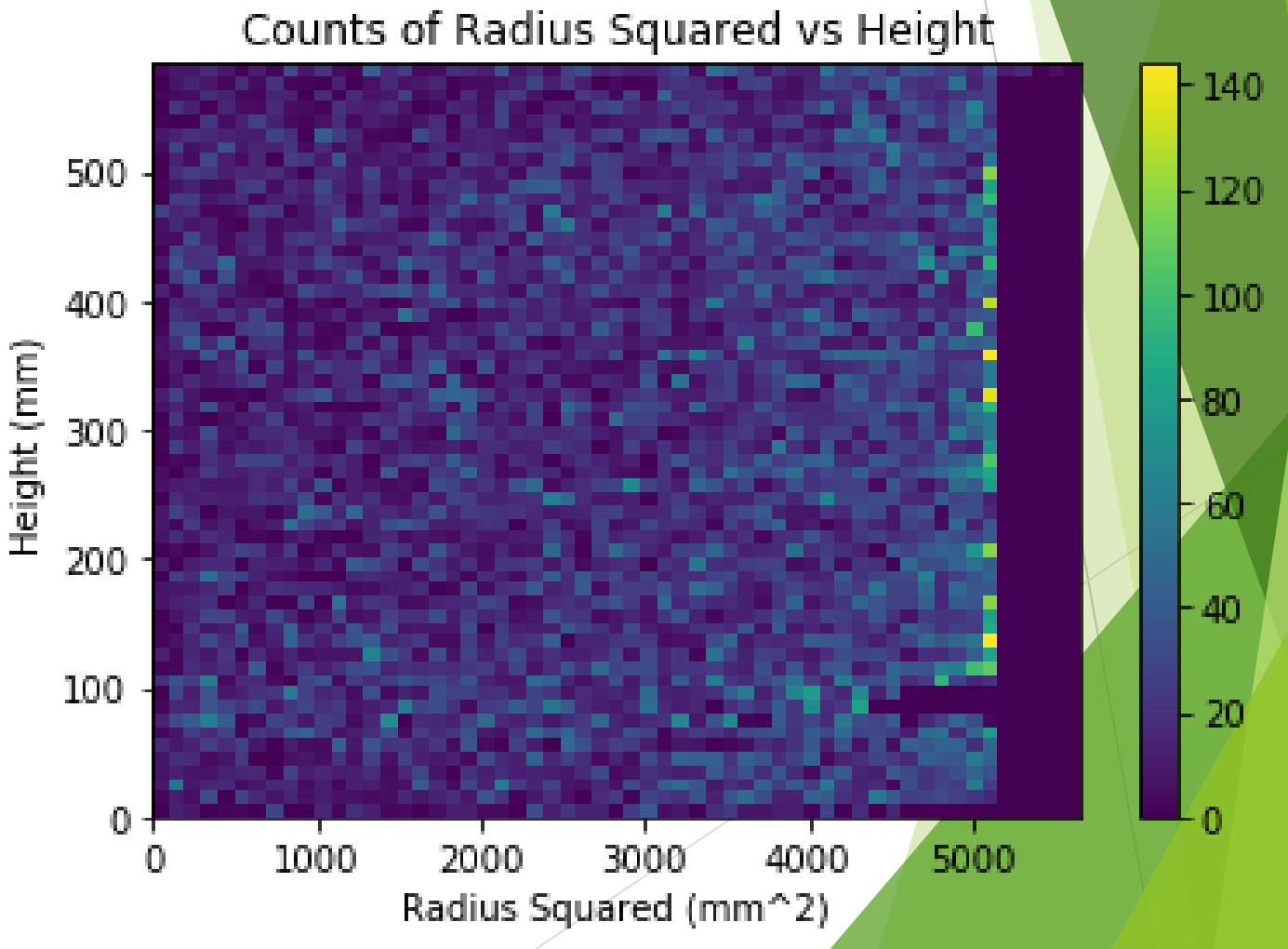
Various Topics for My Thesis

Today's Slide is Here

# Plots!

Concerns

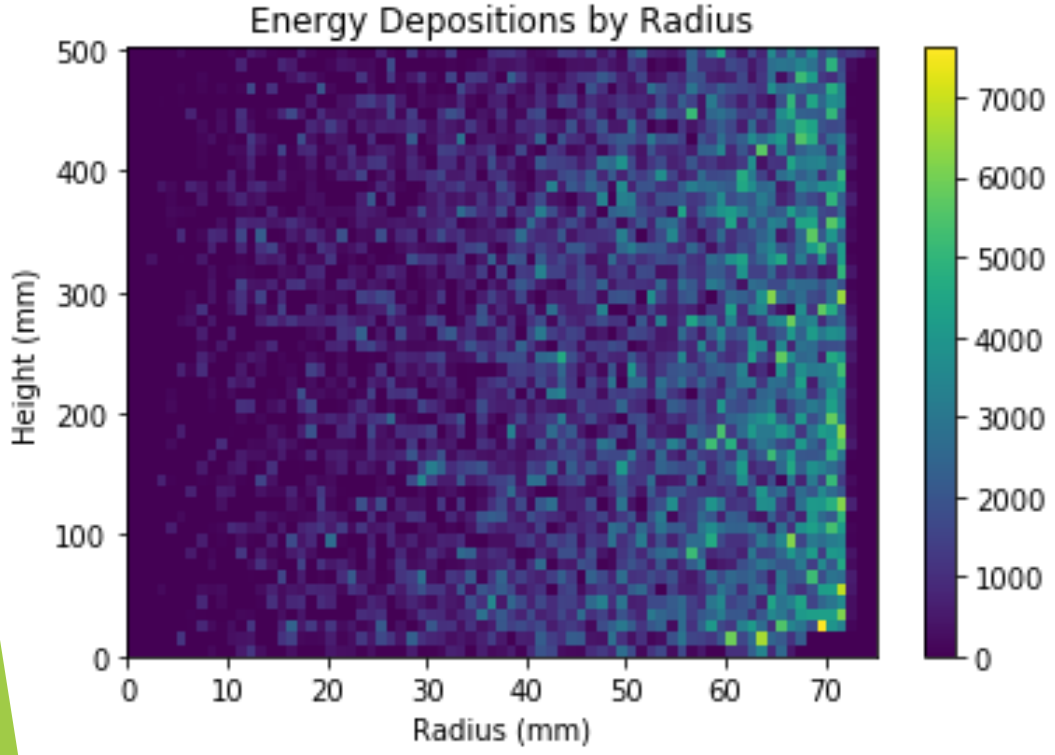
- Time threshold?
- Does not line up exactly with parameters (especially height)
- Gap at 100mm height

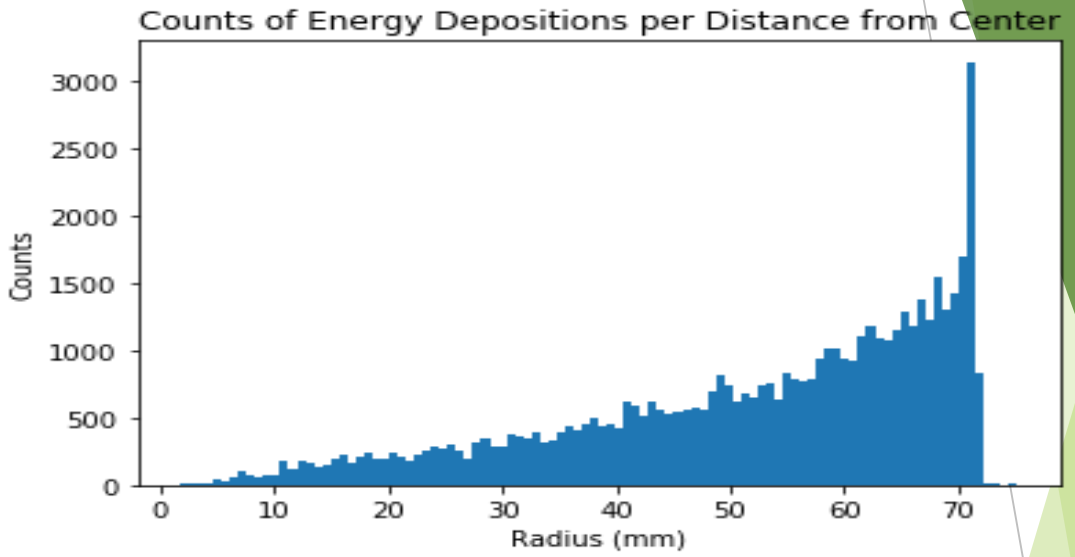


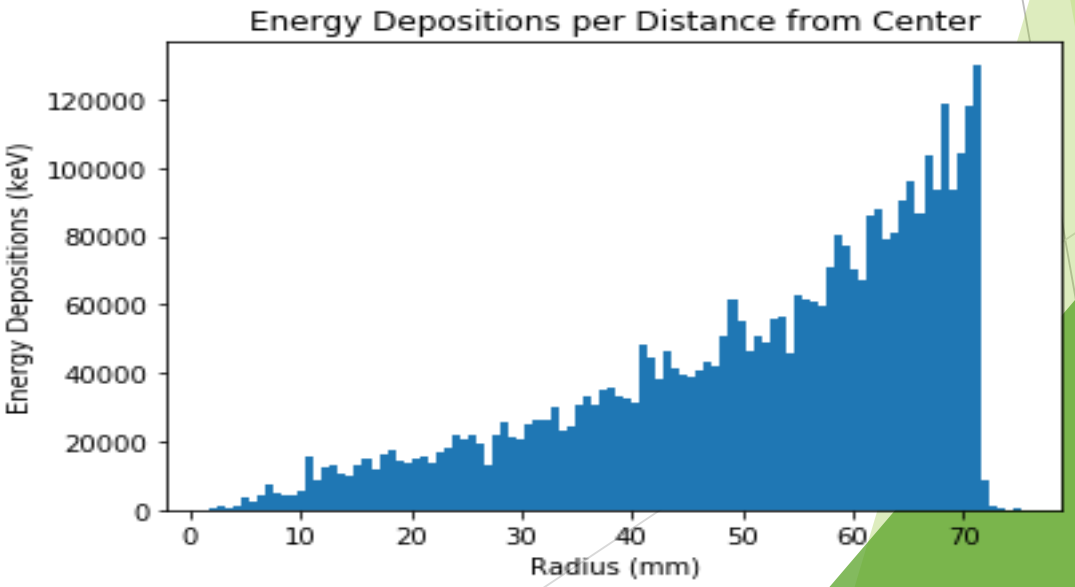
# Still To Do

- Fix Current Issues
- Use Energy Values Instead of Counts
- Try Simulating Decays from Bottom
- Possibly other Materials?

# Energy Depositions and Correct Dimensions



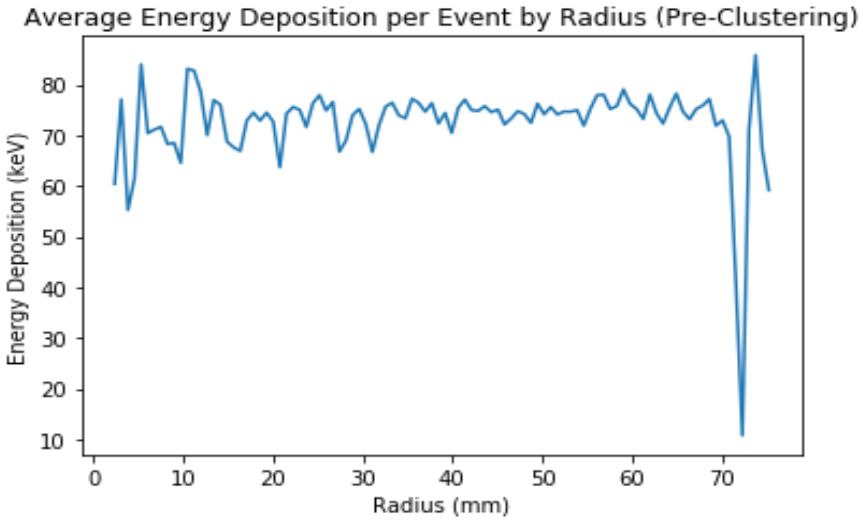
# Still To Do

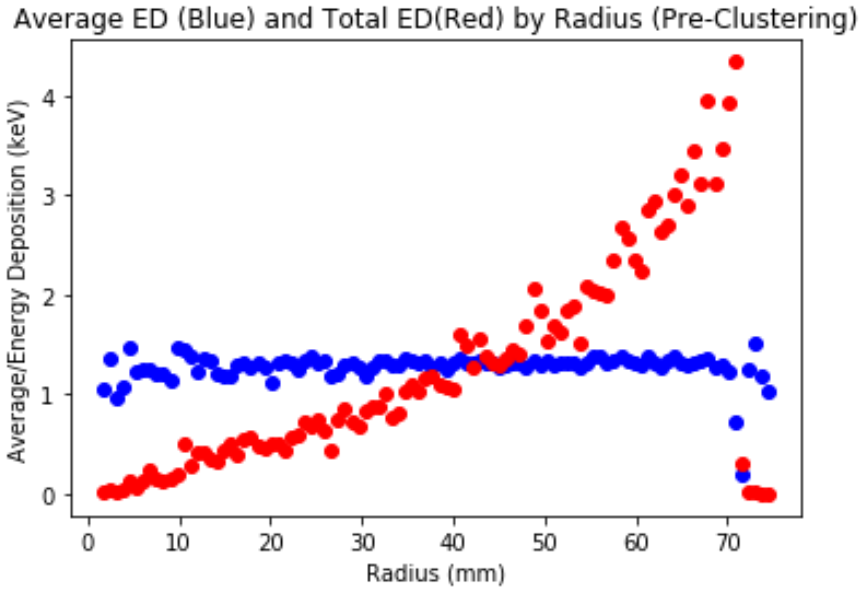
- Find decay rates in area
- Fix geometry problems
- Other materials?

# Thermal Neutron Scattering

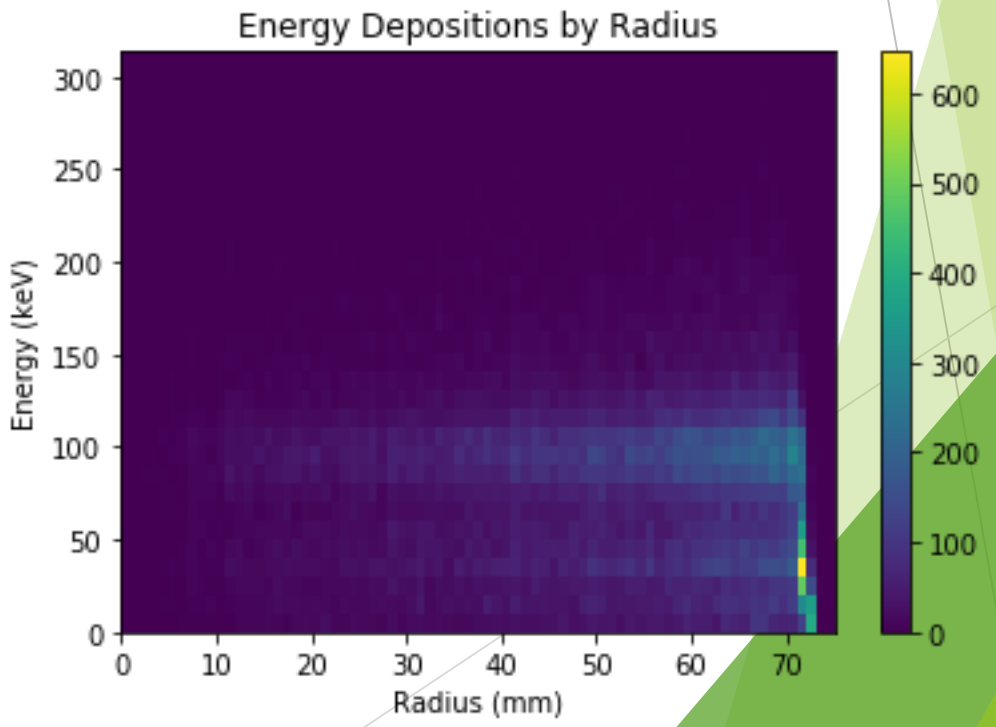
- https://indico.cern.ch/event/245281/contributions/1564676/attachments/420136/583408/thermal_physics_validation_argarcia.pdf
- http://pubs.cnl.ca/doi/pdf/10.12943/CNR.2017.00002

# Average Energy Deposition



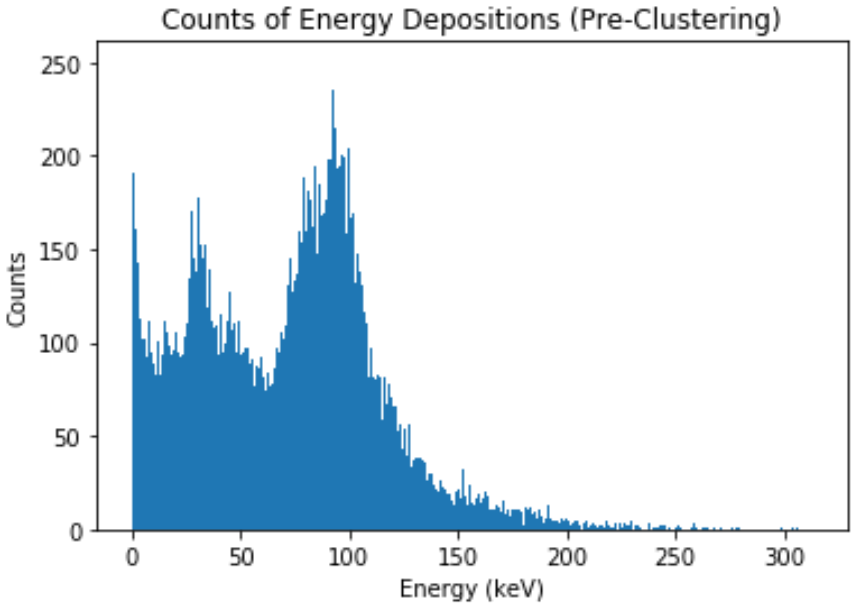




- Why is there so little energy degradation until it is close to the center?
- Why is there a sudden drop at the edge, but regular events past it?
- Why are there so many small-energy events at the edge, but fewer later on?

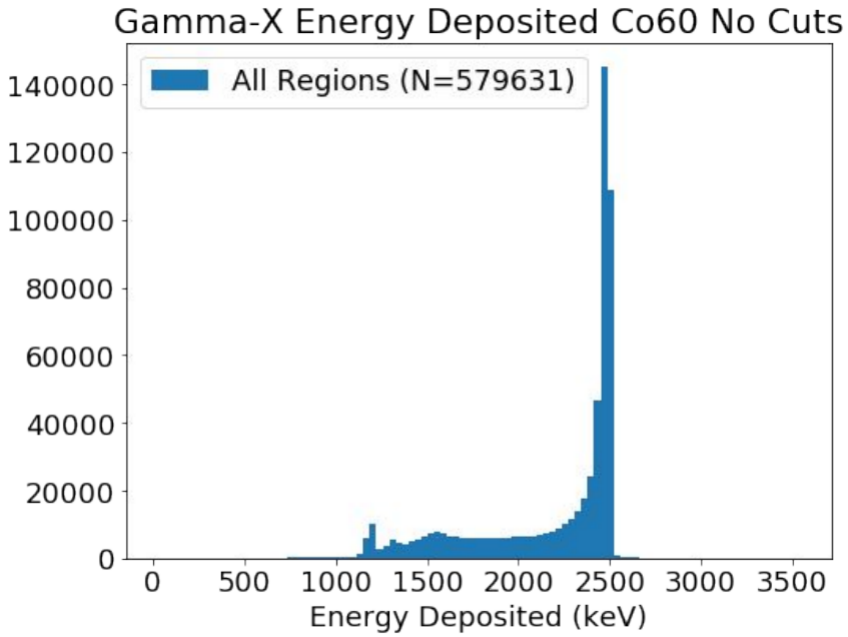


# Energy Histogram Very Far Off

## Mine

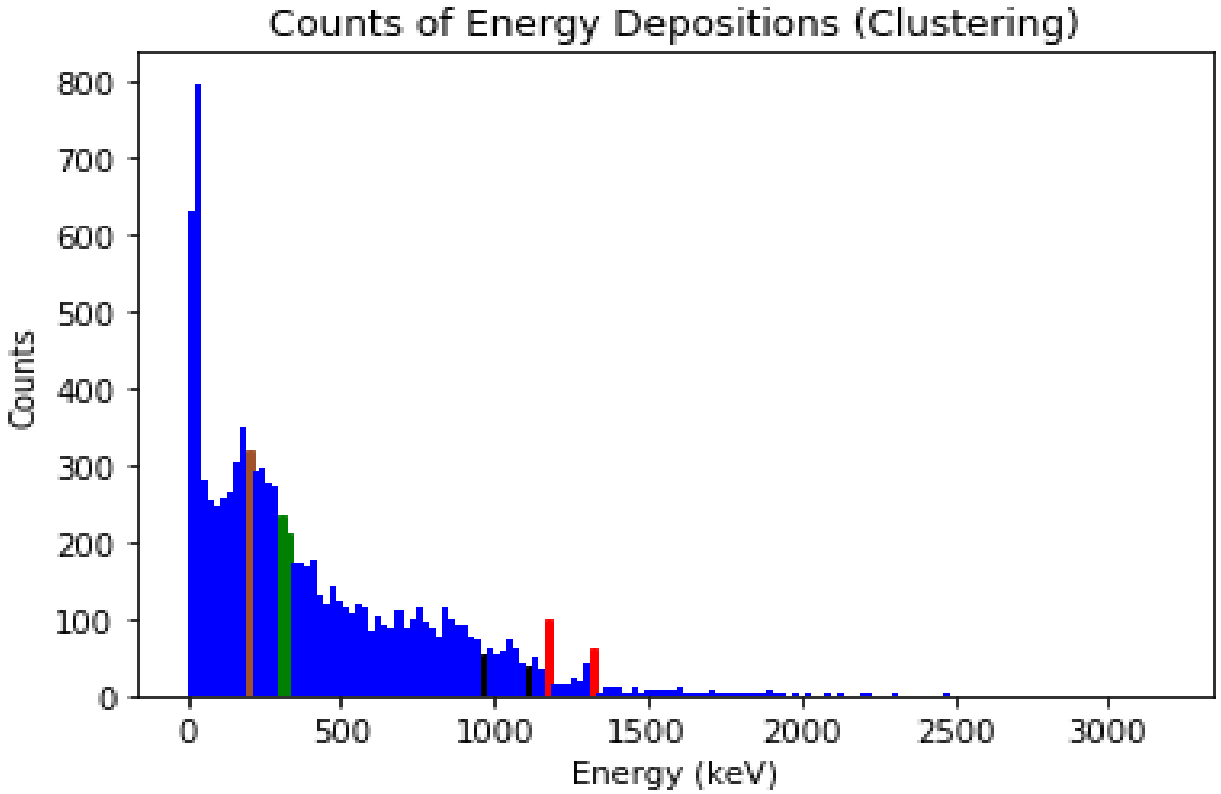



## Jonathan's



# Now With Clustering

## Post-Clustering




## Expected Values (keV)

- Brown=E' (204, 208)
- Green=$\beta^{-}$ max (316)
- Black=$E_e$ (966,1112)
- Red=Photopeak (1173,1333)

| | | | | | | |
|---|---|---|---|---|---|---|
| $^{60}_{27}Co$ | 5.271 y | $\beta^-$ | 0.316 | 100% | 1.173 | 100% |
| | | | | | 1.333 | 100% |

# Still to Do/Answer

## Read

- *Why I am getting so many events well above 1333 keV?
- *What types of events are causing the very small, but numerous energy deposits?
- Why are there relatively few events at photopeak (compared to other measurements)?
- What other energy values do I want to look at?
- Understand equations that I am using

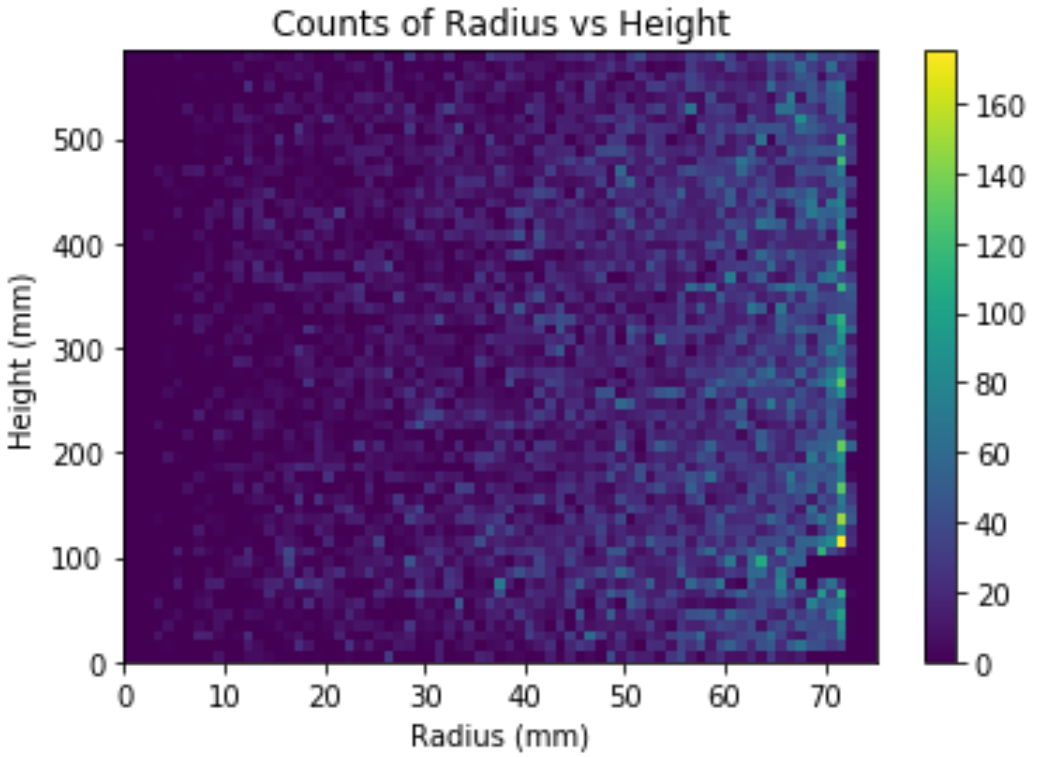
## Do

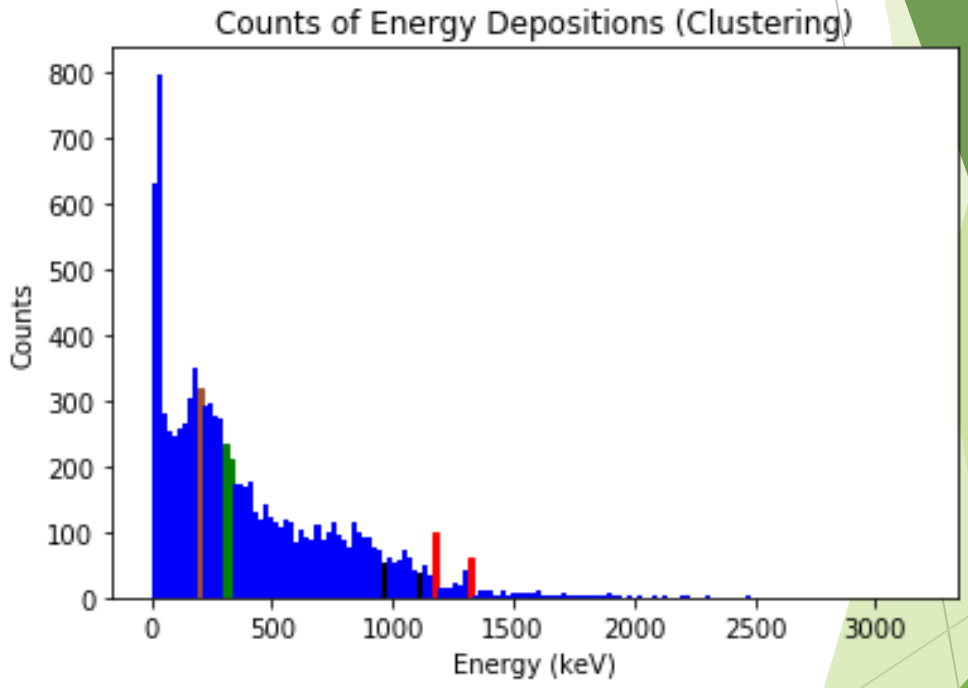
- Find values of other energy factors (escape peaks, detector efficiency, etc.)
- Create rough model of what I should be seeing (ideally)
- Keep reading

# Summer Overview

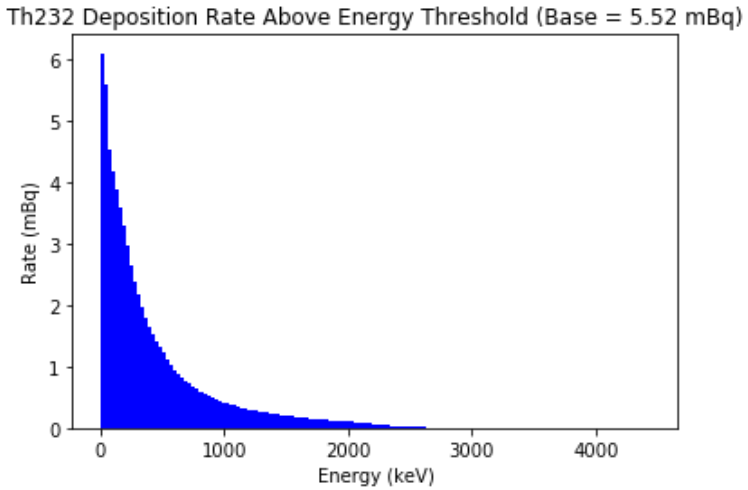
- Got Submission Script/Macro running
- Plotted by position
- Plotted by energy/histograms of energy
- Included Clustering
- Included Accurate Values
- Other elements
- Measured rate above energy threshold
- Cable Making (Minor)
- More components w/ More Decays (In Progress)

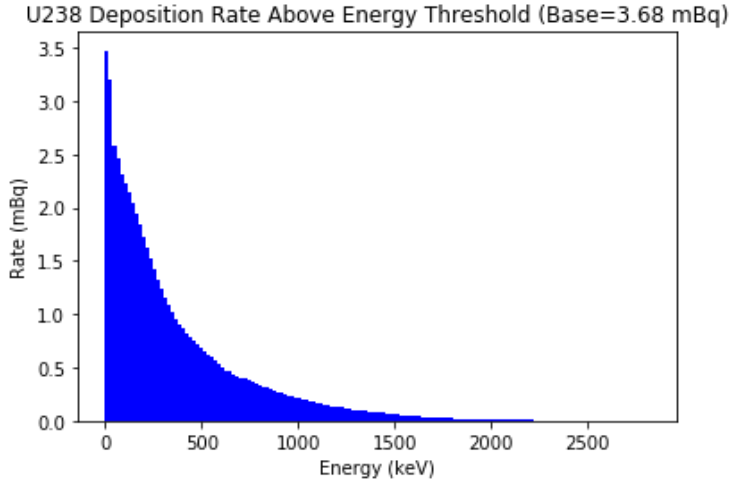
# Plotting By Position/Energy/Clustering

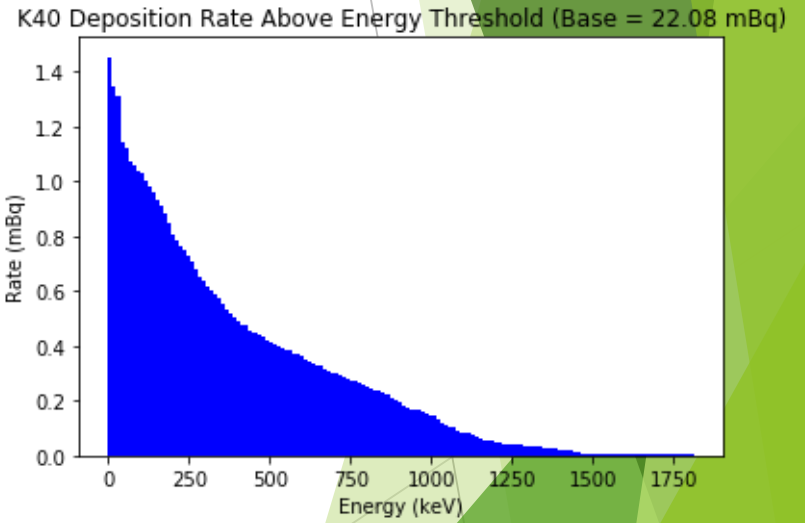


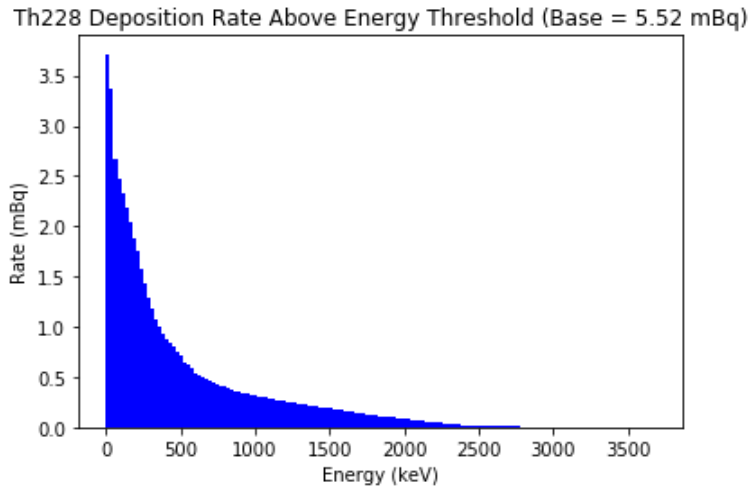



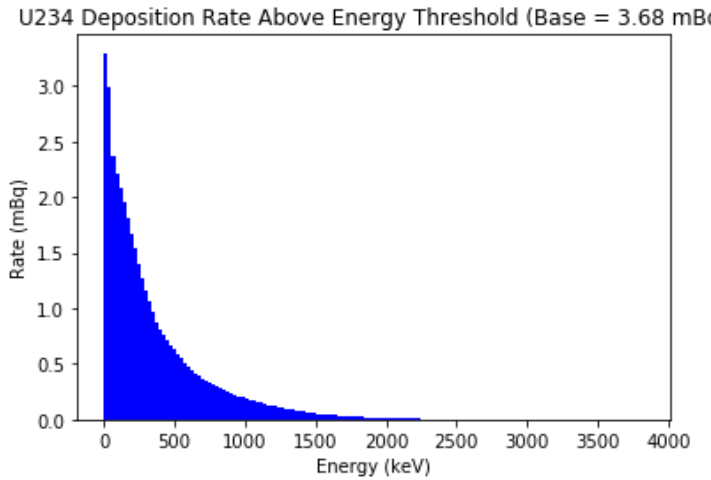
# Accurate Values/Rate/More Elements



# Goals For Fall 2017 Semester

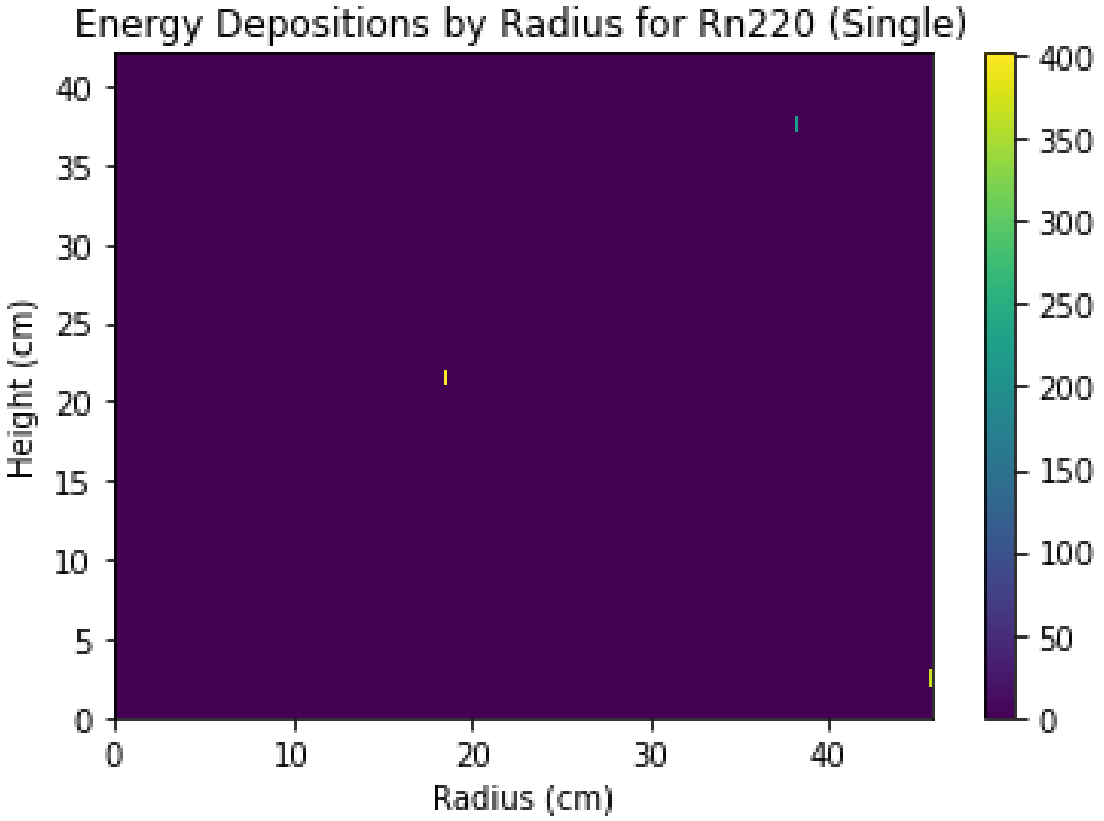
- Research Tasks
  - More Components
  - Give LZ-value estimate range
  - Errors (And More Events)
  - Thorium Alpha Energies
- Conceptual Knowledge
  - What Specific Impact Do Decays Have on Experiment
- Technical Knowledge
  - Learn More C++; be able to write code in C++ instead of Python
  - Getting Better at ROOT

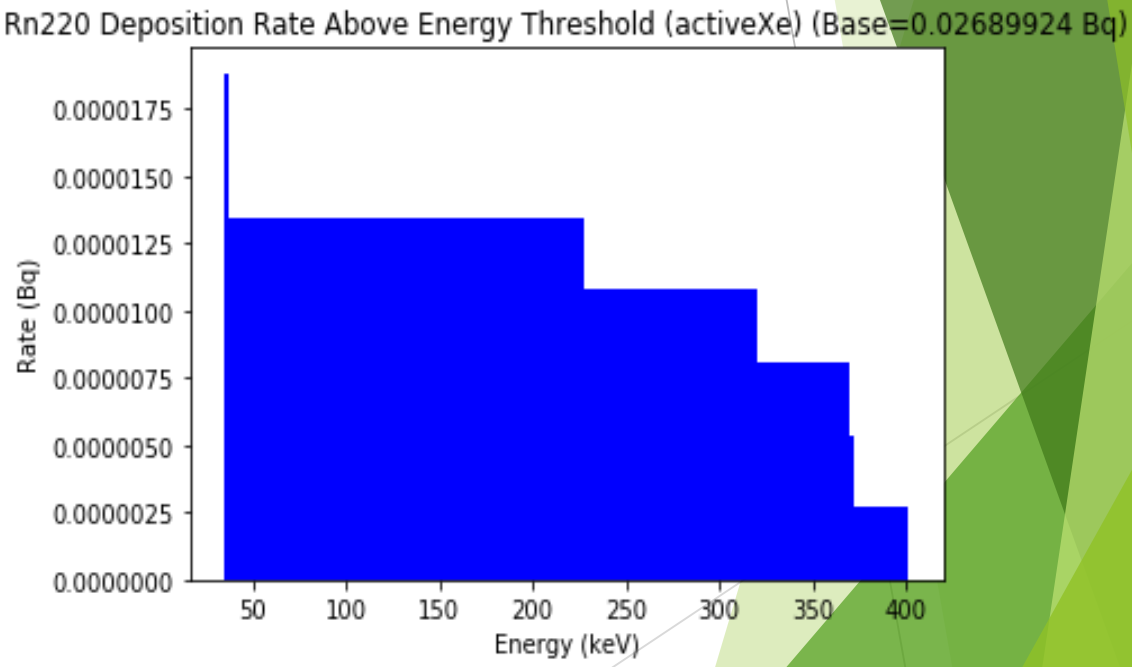
# K40 Background Sources

- Each source @ 1mBq/kg
- Rate is for > 0 keV
- Issues

| Volume Name | Mass (g) | Other masses | K | % |
|---|---|---|---|---|
| VacuumSpaceOuterCryoVessel | 1.22E-20 | | 8.52E-29 | 0.7 |
| InnerCryoVessel | 78576.8 | | 2.81E-03 | 3.572002652 |
| LiquidXenonInnerCryoVessel | 48918.7 | 96588.6 | 1.29E-03 | 2.64 |
| GasXeInnerCryoVessel | 243.699 | 257.436 | 2.39E-06 | 0.98 |
| TPCptfeInLiquid | 13548.2 | | 8.91E-04 | 6.58 |
| TPCptfeConeInLiquid | 1531.61 | | 5.05E-06 | 0.33 |
| gridRingInLiquid | 108.655 | | 4.93E-06 | 4.54 |
| PeekSpacerArc1 | 7.09061 | 7.09144 | 2.67E-07 | 3.77 |
| PeekSpacerArc2 | 2.57045 | 2.56987 | 9.77E-08 | 3.8 |
| PeekSpacerArc3 | 2.57033 | 2.57025 | 1.00E-07 | 3.89 |
| PeekSpacerArc4 | 2.57021 | | 6.84E-07 | 26.63056824 |
| PeekSpacerArc5 | 2.57049 | 2.57035 | 6.84E-07 | 26.62766741 |
| peekSpacersInGas | 47.5447 | | 1.73E-06 | 3.64 |
| gridRingInGas | 108.664 | | 4.93E-06 | 4.54 |
| activeLXeRFRegion | 3643.83 | | 9.66E-05 | 2.65 |
| activeLXeFFRegion | 23253.3 | | 1.52E-02 | 65.23999991 |
| activeGXeFFRegion | 2.10509 | | 2.33E-07 | 11.09 |
| AnodeGridHolder | 0.05311 | | 5.53E-09 | 10.42 |
| CathodeGridHolder | 7.8301 | | 9.22E-07 | 11.77 |
| GateGridHolder | 7.86043 | | 1.04E-06 | 13.19000004 |
| BottomGridHolder | 8.14317 | | 7.08E-08 | 0.87 |
| anodeGridRingSupportInGas | 1114.76 | | 2.93E-05 | 2.63 |
| TPCptfeConeInGas | 871.769 | | 2.62E-05 | 3 |
| top_pmtR9288_adapter | 162.704 | | 3.11E-06 | 1.91 |
| top_pmtR9288_quartzWindow | 10.6158 | 10.6159 (ad) | 3.07E-07 | 2.89 |
| top_pmtR9288_realVacuum | 5.76E-24 | 5.76301e-24 (ad) | 1.23E-31 | 2.128739756 |
| topR9288_PMT_Photocathode_1 | 4.21468 | | 1.11E-07 | 2.63 |
| top_pmtR9288_flashing | 1.11387 | 1.11377 (ad) | 2.97E-08 | 2.67 |
| top_pmtR9288_aluminumBody | 51.4667 | 51.4608( ad) | 1.03E-06 | 2.01 |
| TopPMT | 0.33035 | | 1.48E-08 | 4.49 |
| bottom_pmtR9288_adapter | 162.726 | | 3.25E-07 | 0.2 |
| bottom_pmtR9288_quartzWindow | 10.6158 | | 2.34E-08 | 0.22 |
| bottom_pmtR9288_realVacuum | 5.76E-24 | | 1.09E-32 | 0.189900764 |
| bottomR9288_PMT_Photocathode_1 | 4.21483 | | 7.17E-09 | 0.17 |
| bottom_pmtR9288_flashing | 1.11391 | | 1.89E-09 | 0.17 |
| bottom_pmtR9288_aluminumBody | 51.463 | | 2.11E-07 | 0.41 |
| BottomPMT | 63.5921 | | 3.12E-07 | 0.49 |
| Total | 1.73E+05 | | 2.03E-02 | 11.78823734 |

# Thoron Calibration



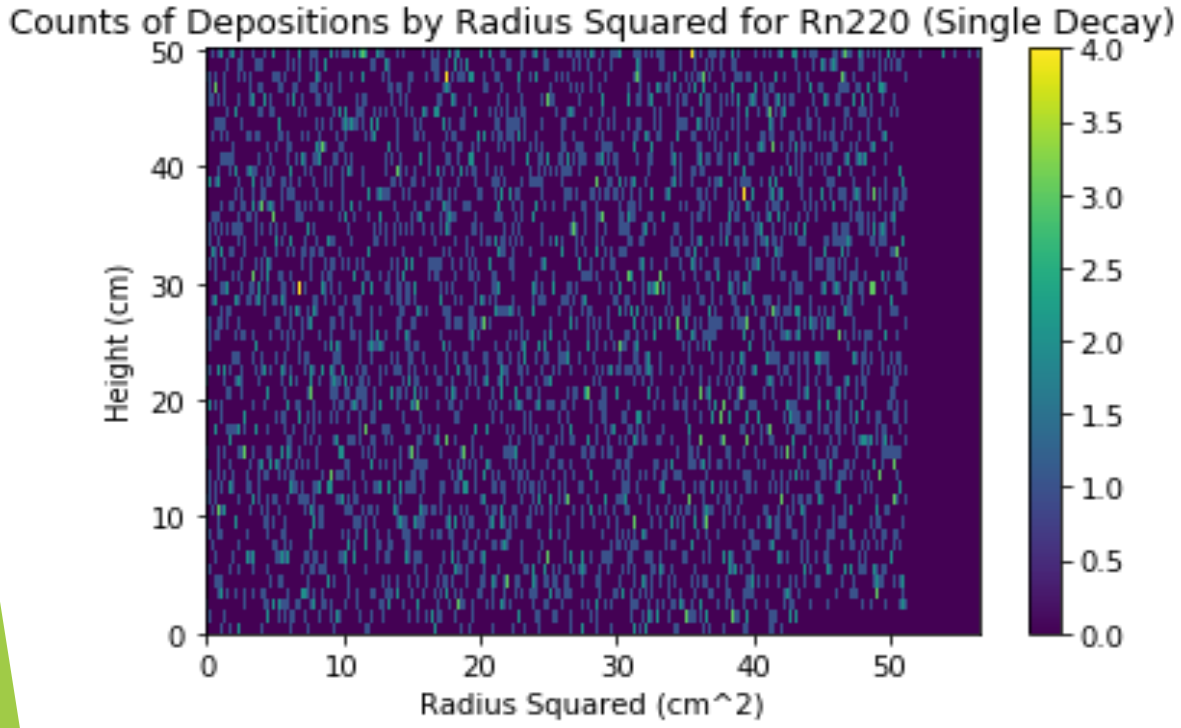
# To Work On

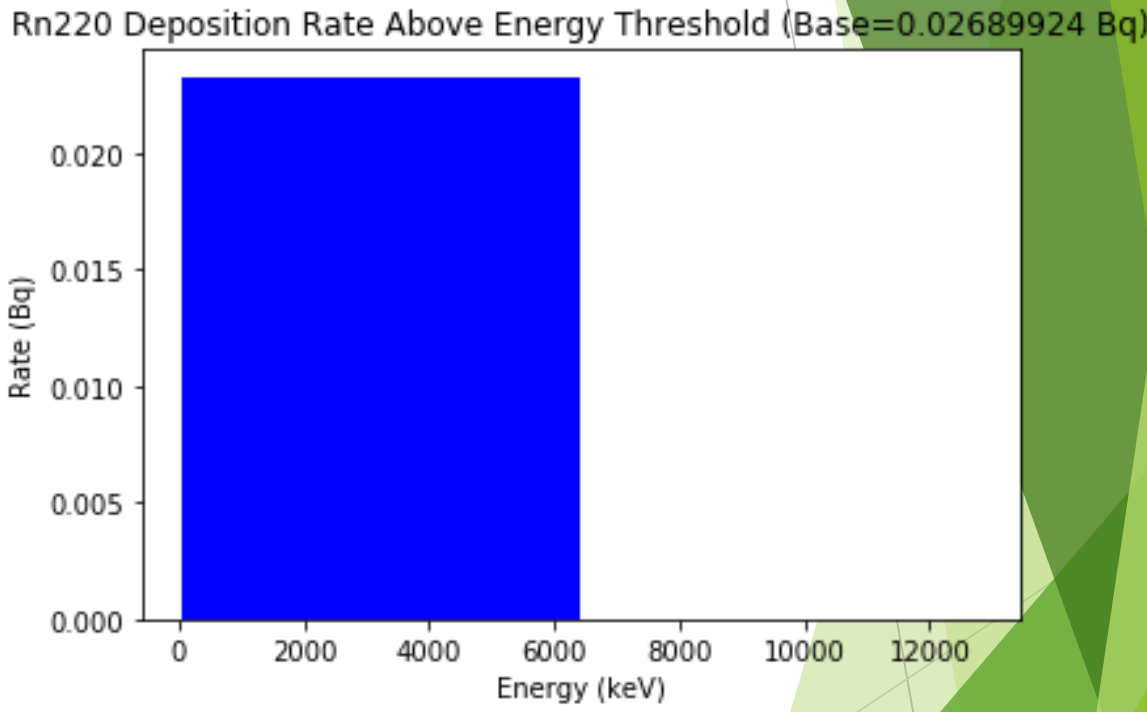
- Backgrounds for other elements
- Give energy threshold histograms
- Better statistics for Thoron calibration source

# Tasks/Issues From Last Week

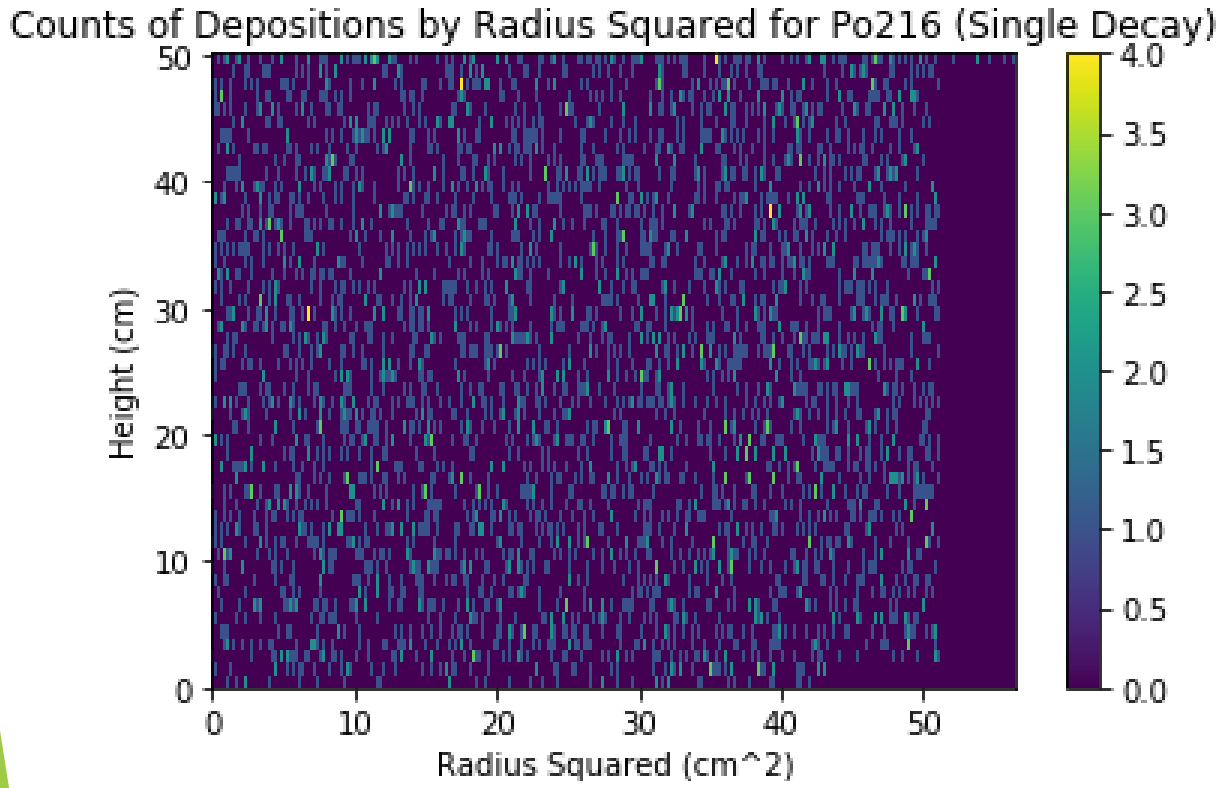
- Data For Other Elements-
  - I looked at single decays of Radon 220 and Polonium 216, as I though that they would be the most important for calibration
- So Few Events/Bad Energies-
  - Combination of coding error and old BACCARAT
- Bad Geometry-
  - Was looking at r^2, so units check out

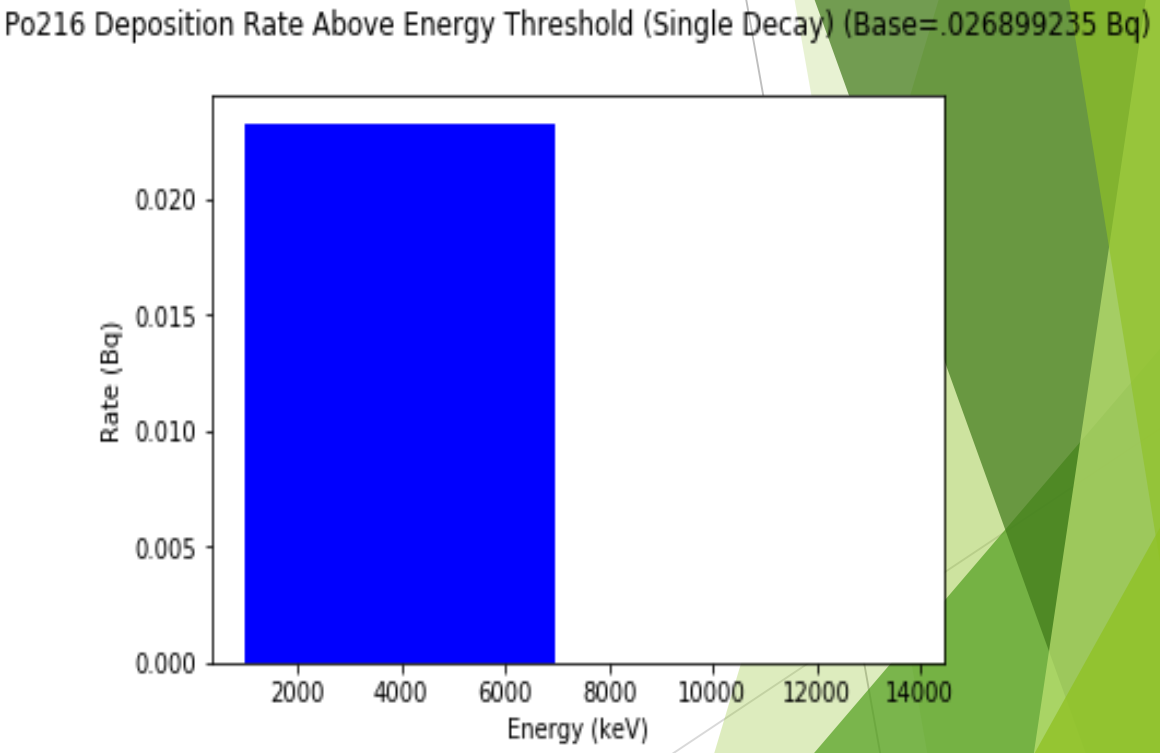
# Thoron Single Decay



# Polonium Single Decay

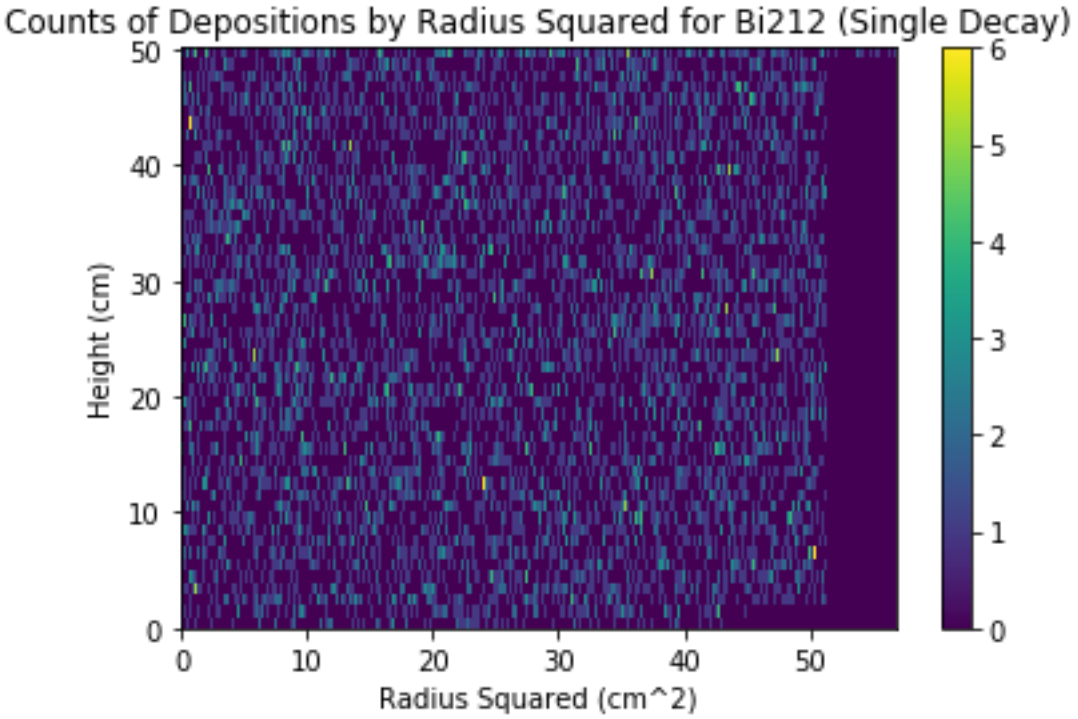


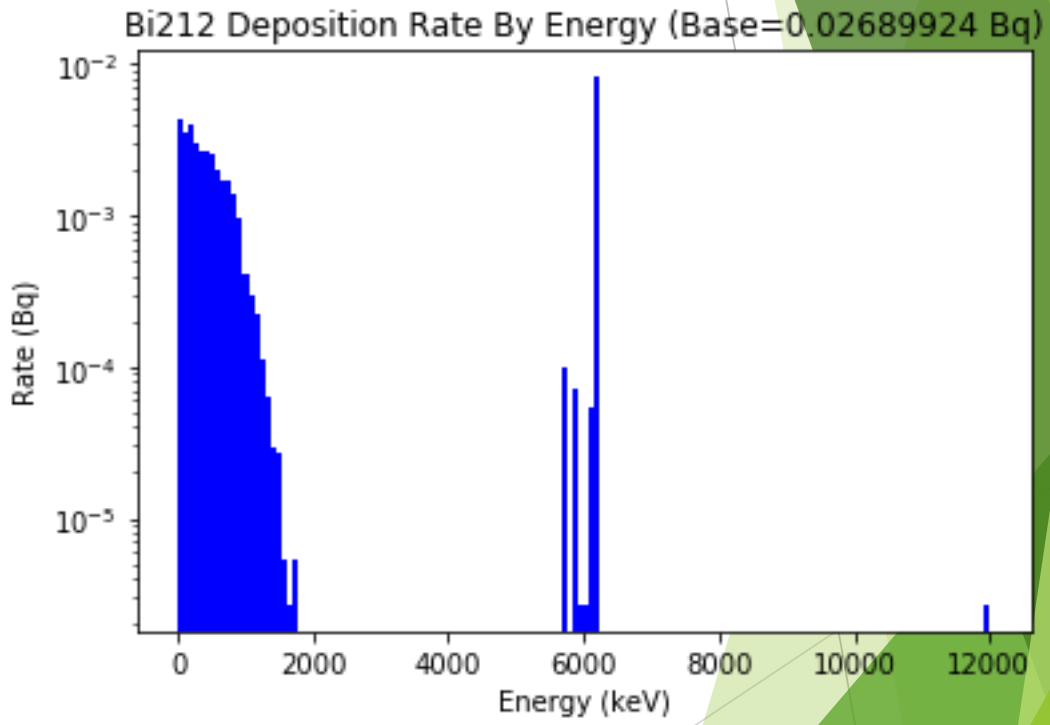



# For Next Week

- Use Updated Geometry
- Look into using DER to produce “fake data”

# 10/25/17
# New Geometry + Full Chain



# DER and Lzap (Moving Forward)

- Get Phase 1 DER config file from systemtestanalysis channel
- Get LZAP?

- Finish DER User Manual
- Try to understand physics behind S1 and S2 events

# 11/8/17

- Simulated decays w/ optical photons
  - Only about 20 events
- Talked to Theresa about using DER with Phase 1
  - Says to use her branch
- Read some more about physics about S1 and S2

# 2/6/18

Get Phase 1 Simulations to Run on Various Analysis Code

- Worked with Theresa and TJ
  - Weird time zones -> slow responses
  - Vague errors
- Try to get code working locally instead
- I (apparently) be able to make it work the whole chain
- BaccMCTruth errors (Permission denied?)

# 2/20/18

Get Phase 1 Simulations to Run on Various Analysis Code

- Running into “make” issue with ElectronicsSimulation
  - Made post on systemtestanalysis to help resolve
- Made pdsf account
  - Errors making both BACCARAT and ElectronicsSimulation

# 3/6/18

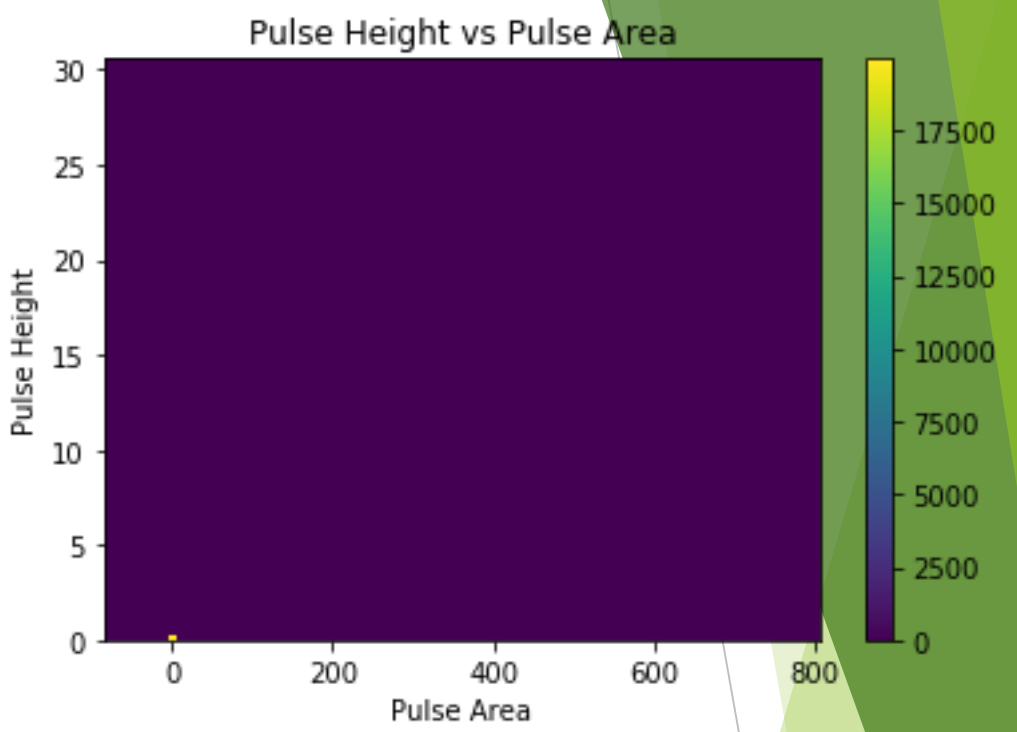
- Got DER to compile on lz login
  - Still trying to find exact problem with Theresa's setup.sh file
  - Got valid output
- Got LZap on lz login and pdsf
  - Getting different errors on pdsf and lz login

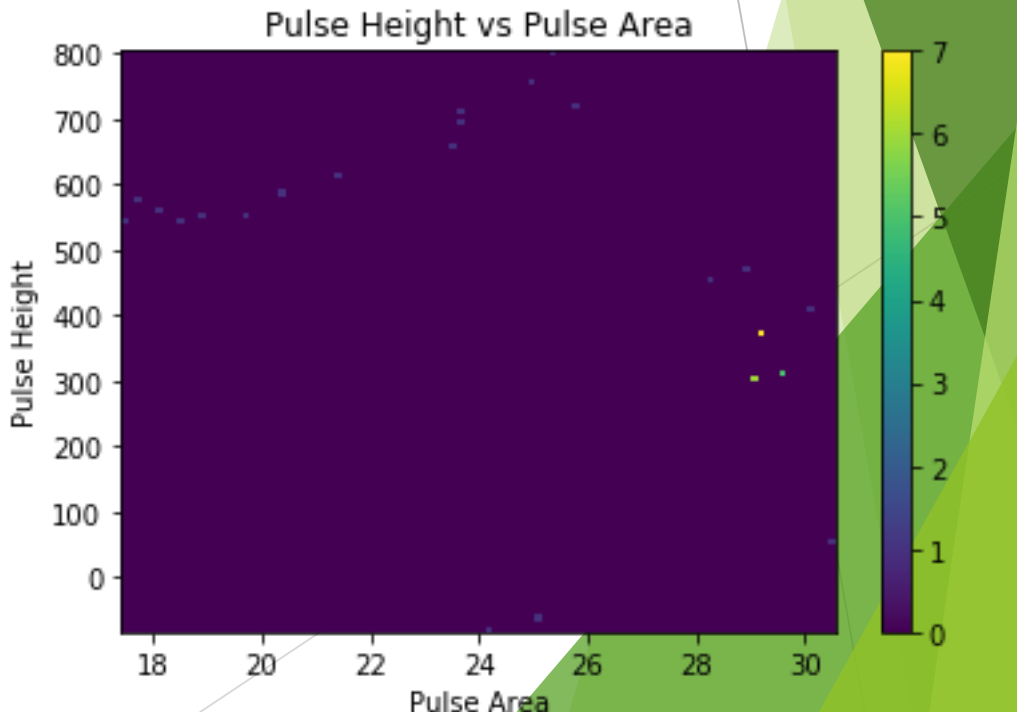
- To Do:
  - Narrow down error/solution for setup.sh file
  - Fix Lzap errors on either server

# 4/3/18

- Pulse Area vs. Pulse Height Graphs
- Don’t know units, so not very useful
- Don’t know how to interpret data
- Getting a lot of 0’s?
  - Only 38 are not [0,0]

- To Do:
- Other useful graphs
- Make sense of data



# 4/24/18

- Trying to update branches to get better simulation
- BACCARAT will update, but won't compile
  - TJ had branch that wouldn't, but I can't even after he fixed it
- DER will update/compile, but won't run correctly
  - Other two are more important, so I didn't spend much time on this
- Lzap will run, but possible errors (I think)
  - Pulse areas/heights are 0,0 (but the branches exist)

# 9/20/18

- Main Tasks:
  - Be able to get sims all the way through Lzap
  - Until I have a topic for my thesis, do thoron calibration simulations?
- Progress:
  - BACCARAT, ElectronicsSimulation, and Lzap all up-to-date and compiled on lzlogin
    - Unable to compile on pdsf
  - Am able to run BACCARAT sims fine, but issues with BaccMCTruth
- To Do:
  - Fix BaccMCTruth so sims go through
  - Prepare for thesis topic?

# 11/1/18

New Topics to Research!

1) Effects of Variables on S2 traits (mostly width)
    1) Tilting of Anode/Cathode
        1) Difference in Electric Field
    2) Flow Rate of Liquid Through Detector
        1) Start with Width vs Time, later Incorporate Flow Rate Data
2) Look at XY Reconstructions
    1) Possibly do Mercury Reconstruction?
        1) Generate LRFs for Phase 1