Muon Veto Studies

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This Week

- Set up macros to search through simulation output to find events tagged by the particle particle. I'm not yet sure how to plot these as in the post-simulation output we pick up daughter particles from various parents.
- We require a study of how many events are removed as a function of shielding thickness, parent particle and energy, for which we need to run more simulations.
- Studied muon rates into a cuboidal veto as a function of height, ranging from 1-3m

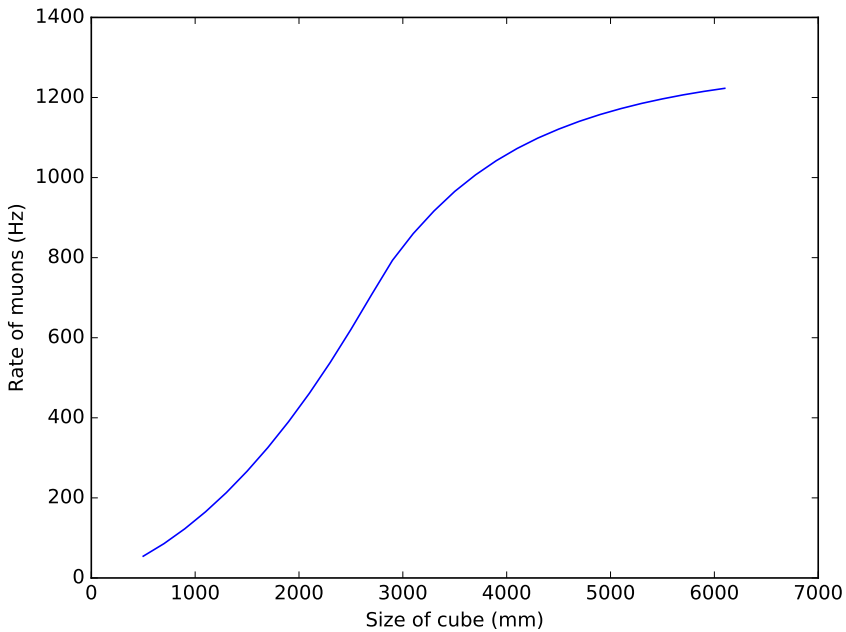


Figure 1: Veto Rate as a function of cube edge for a height of 1m

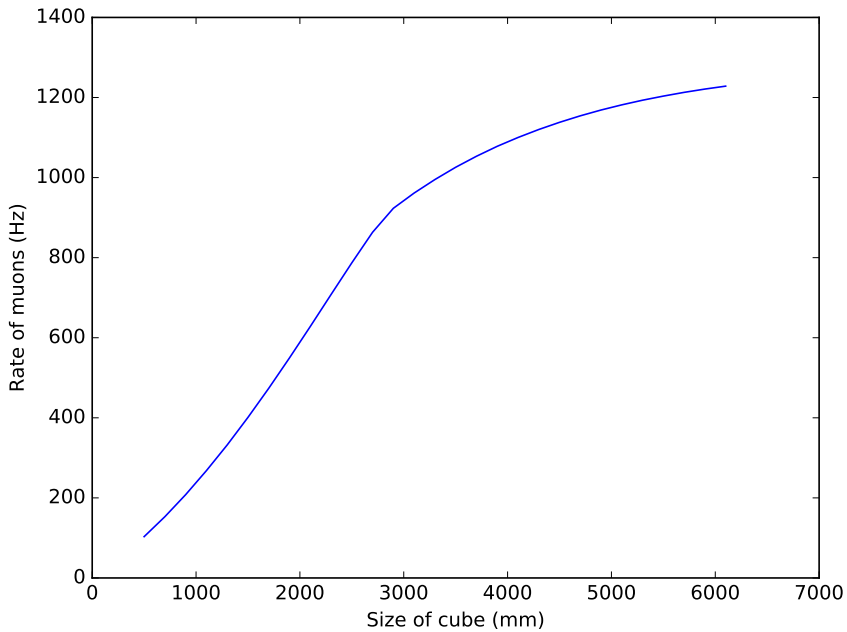


Figure 2: Veto Rate as a function of cube edge for a height of 2.6m

Last Week

- Worked out the geometrical distribution of the inputs
- Worked out the Muon Veto rate

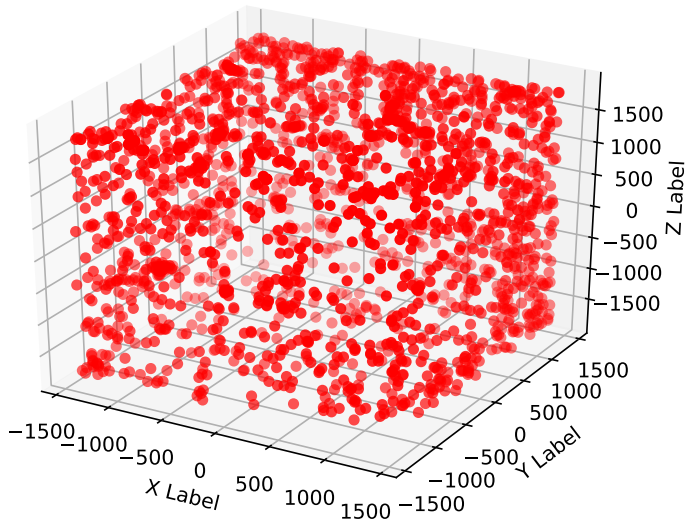


Figure 3: Input Spatial distribution

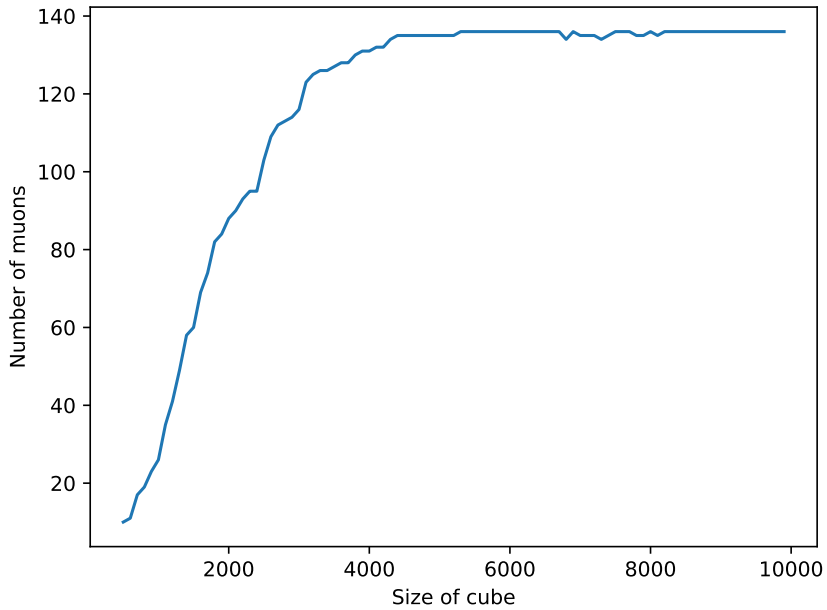


Figure 4: Rate of Muons from a sample of 1000 events

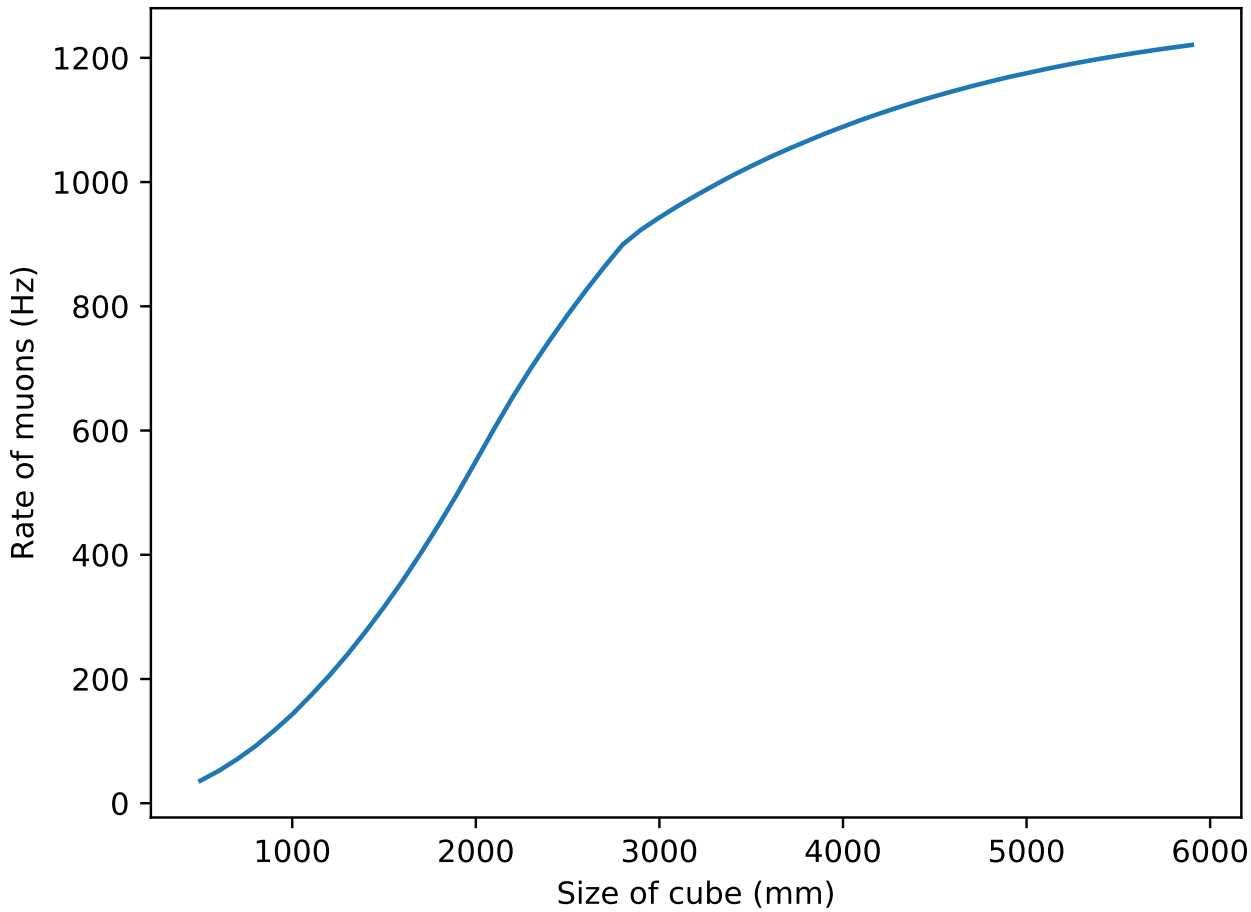
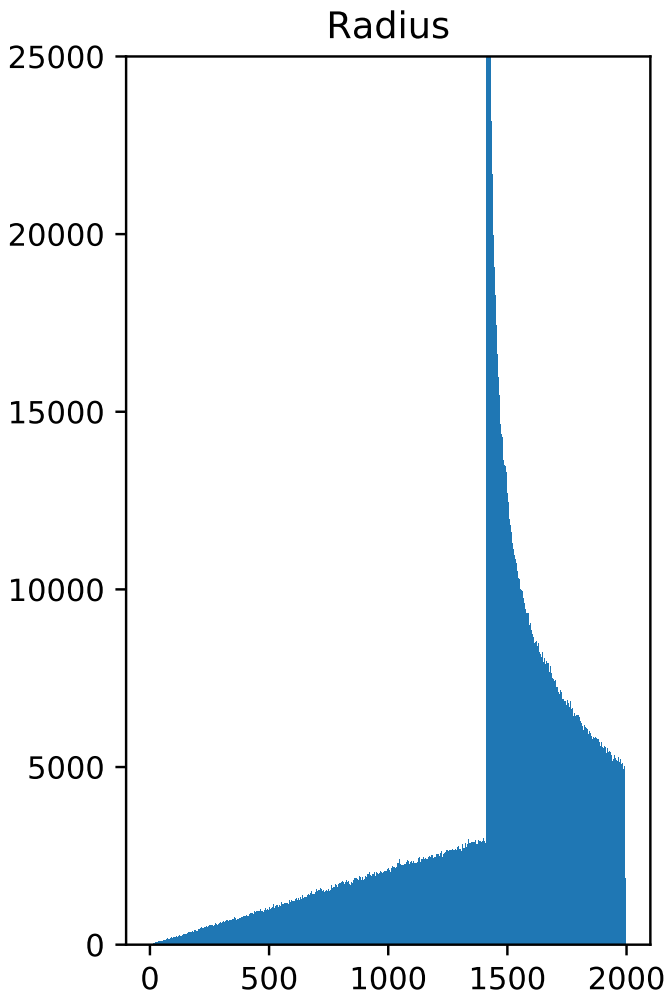
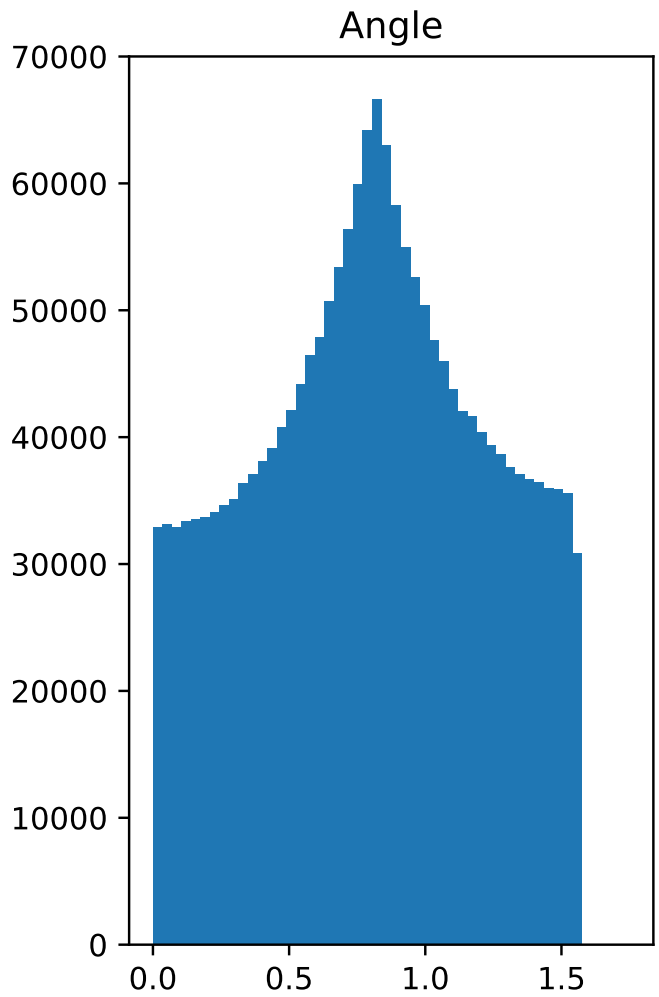


Figure 5: Rate of Muons from CosmicILL1 sample

Week before last

- Valerian wanted to study muon veto rate from the cosmic ILL files. The idea is to know how compact the shielding must be, so that it fits into a reasonable veto.
- The final result is to be veto muon rate vs cube edge length.





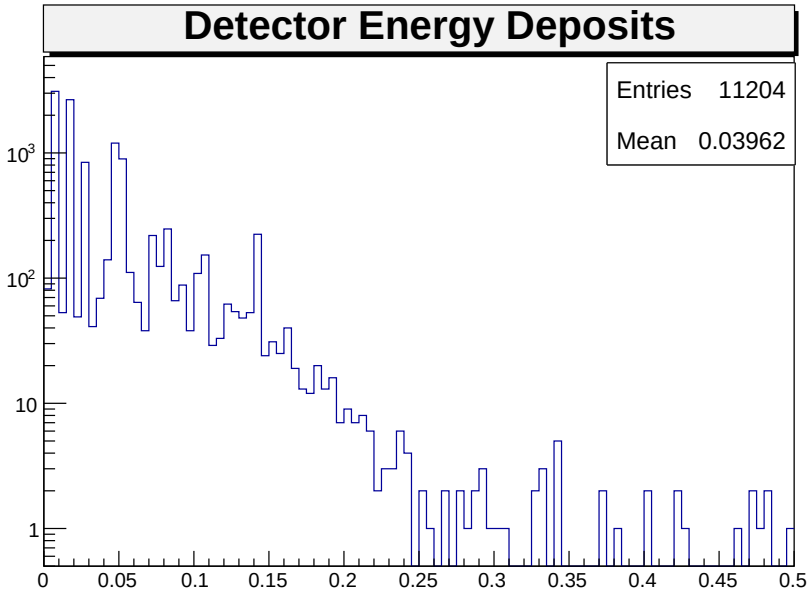


Figure 7: Energy Deposits without removing Muon tagged events

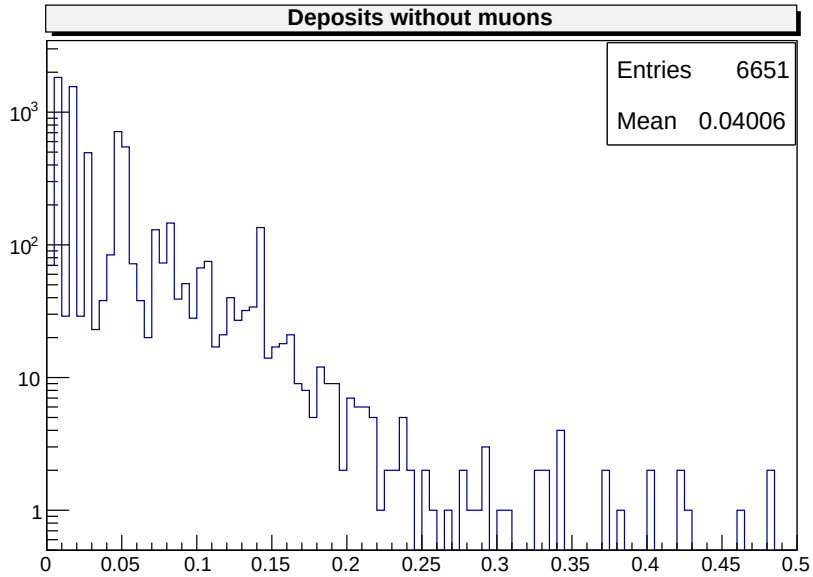


Figure 8: Energy Deposits after removing muons

Last Week

- Clarified issues with input data, such as energy scaling and input particle distributions
- Set up a test macro to find energy deposits of all events with and without muons

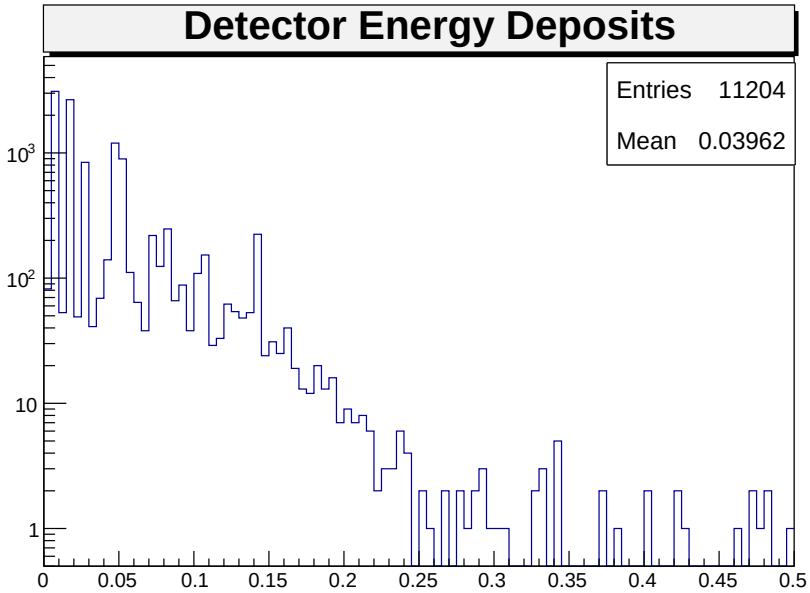


Figure 9: Energy Deposits without removing Muon tagged events

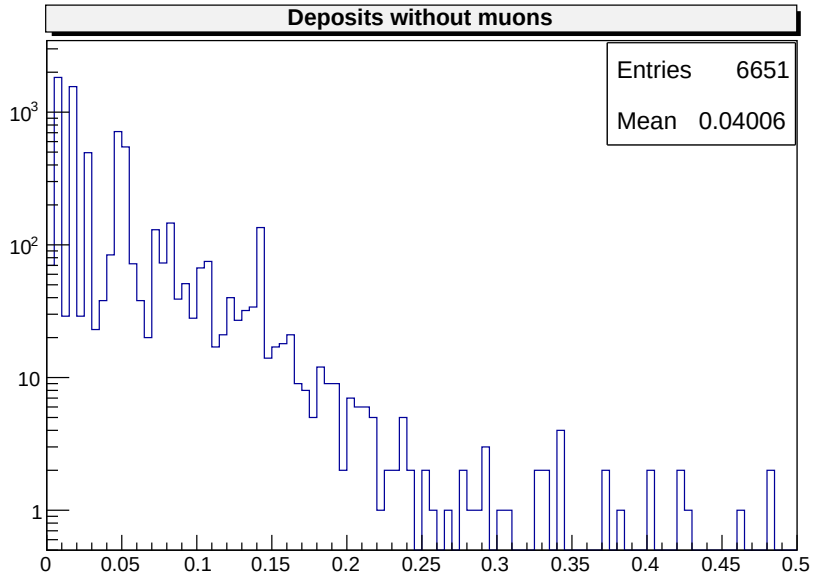
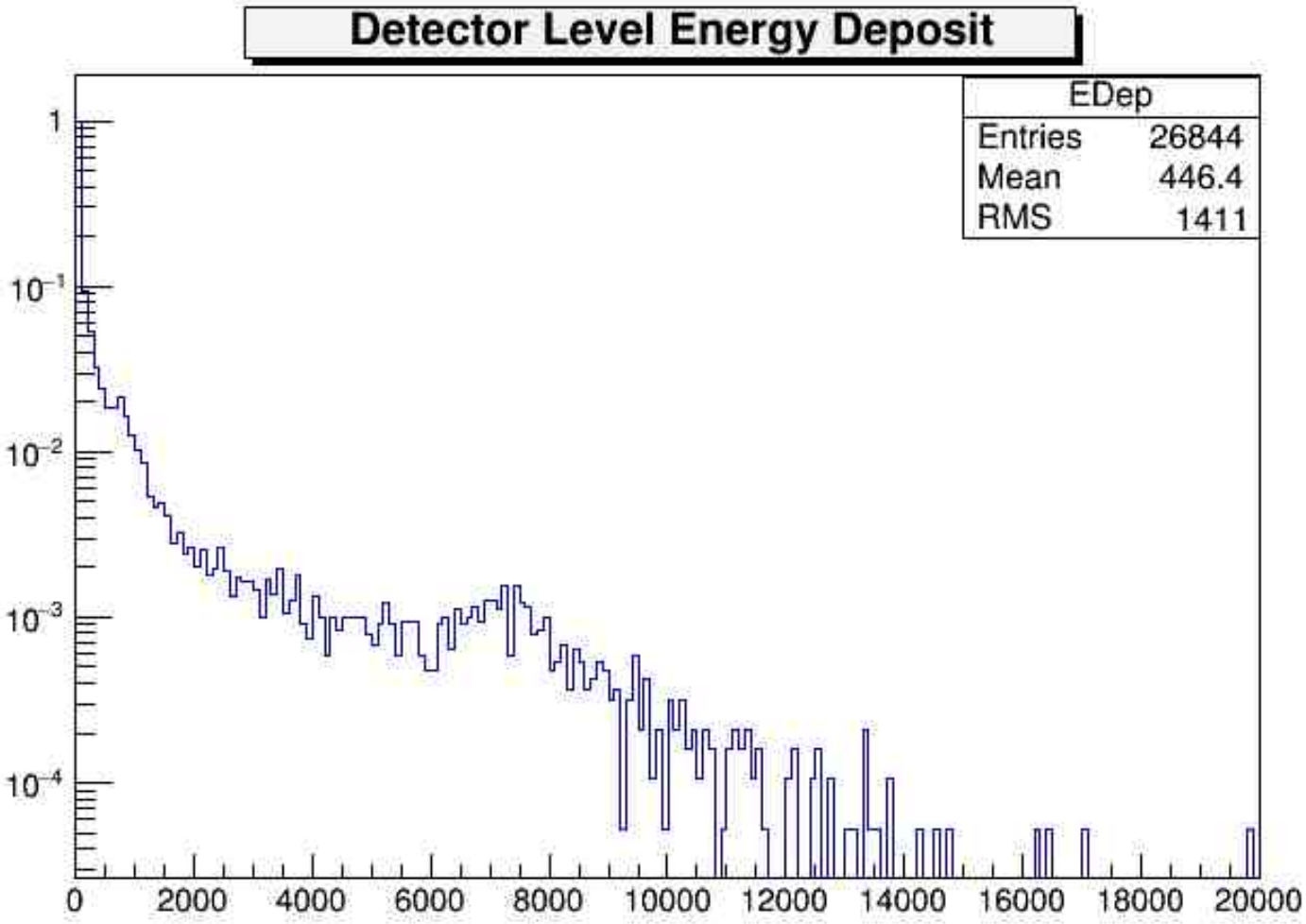


Figure 10: Energy Deposits after removing muons

Last Week

- Installed Shielding modules for Ricochet Simulation
- Examined output of Cosmic ILL simulation



Incident Energy

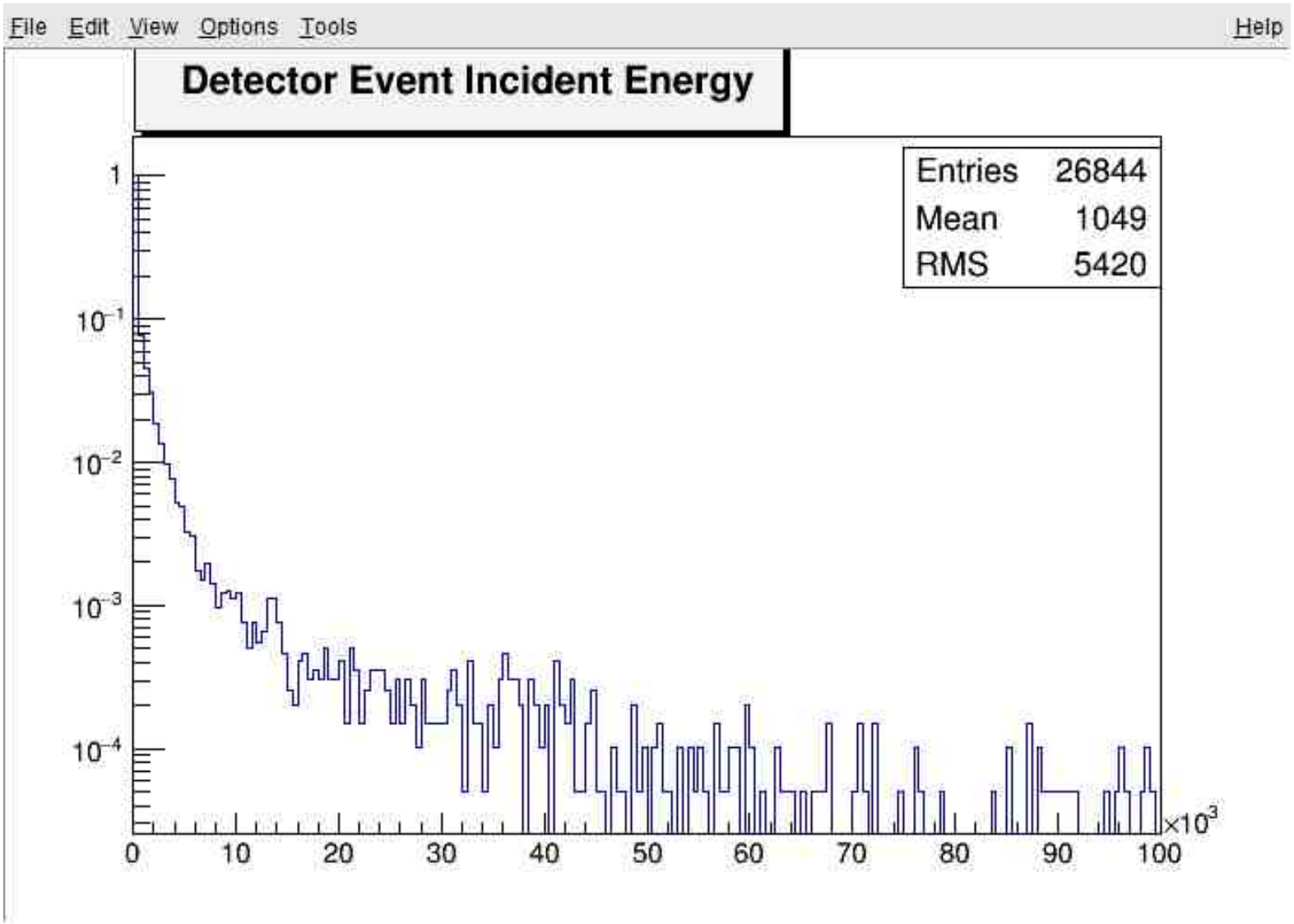


Figure 12

Particle ID

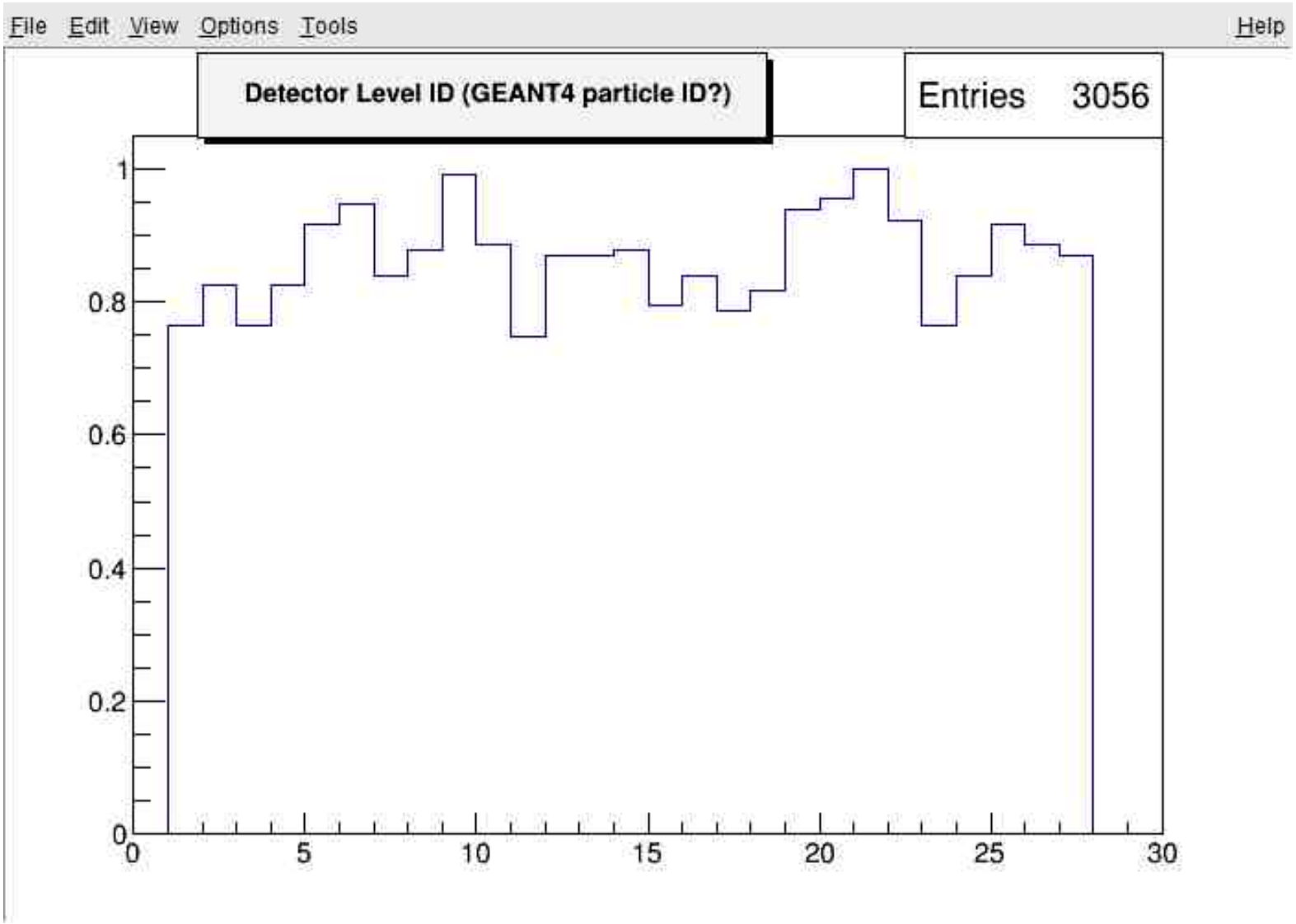


Figure 13

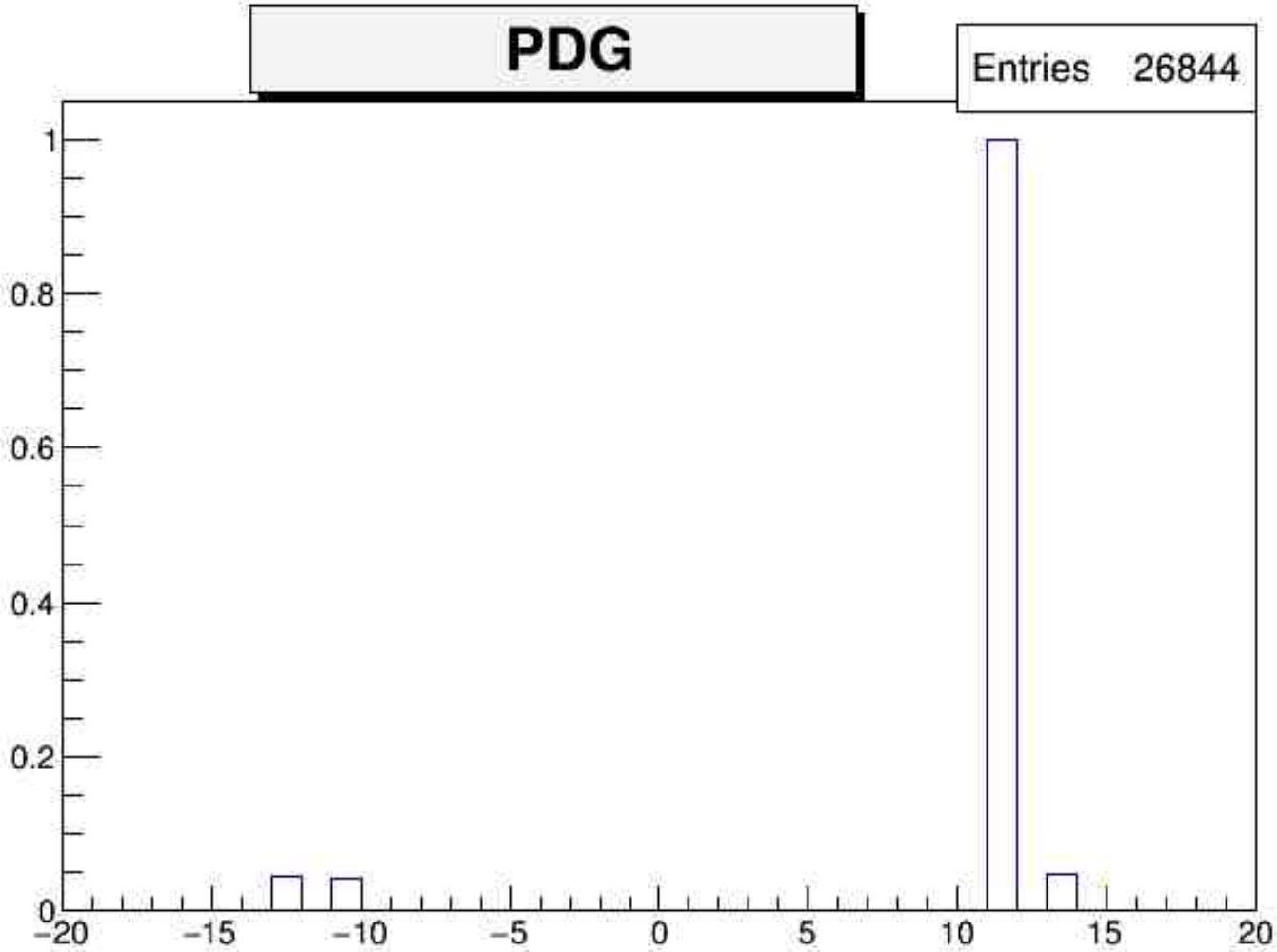


Figure 14

Last Week

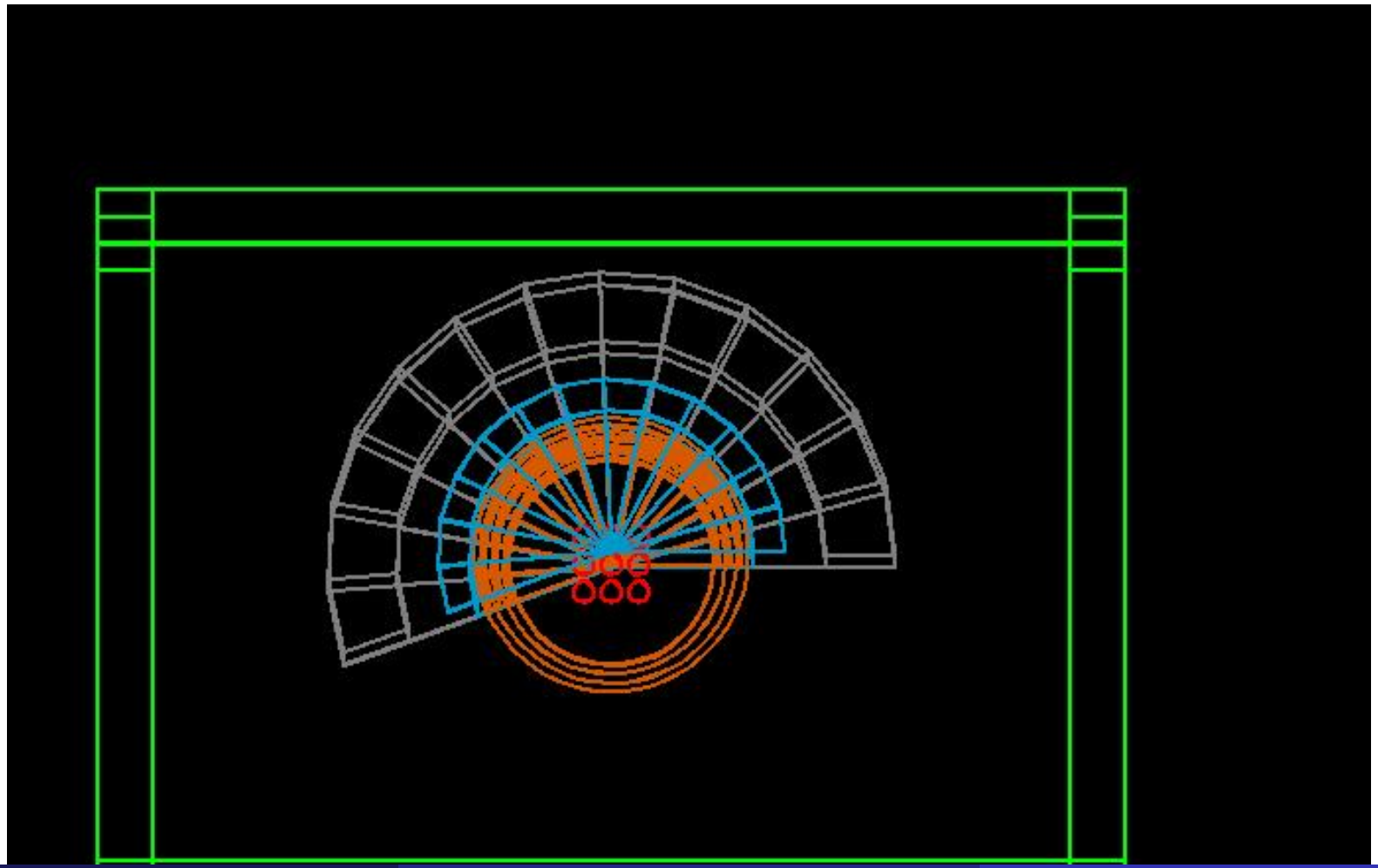
- Studying inputs to CosmicILL test macro using cosmic_ILL1.root.
- Effects of muon veto given to be 80 % rate reduction with 20 cm lead.
- Attempting to replicate setup to verify these results, using the vetoShield branch of the repo

TODO

- run all three cosmic input files to completion multiple times on cluster to obtain reasonable statistics
- During analysis of simulation output, remove events with a muon tag and study remaining events
- Work out a method to generate cosmogenic muon distribution, to study effects of veto

Last Week

- Reading up on GEANT4, tinkering with existing macros. Setup detector visualisation with HepRep
- Working on visualising the detector geometry, from presentations and simulation output.



Diagrams

CryoCube baseline design

An array of 27 x 30 g cryogenic detectors (20 mK)

- 50 % of Ge semiconductors
- 50 % of Zn superconductors

Total: 1 kg with a minimum level of complexity

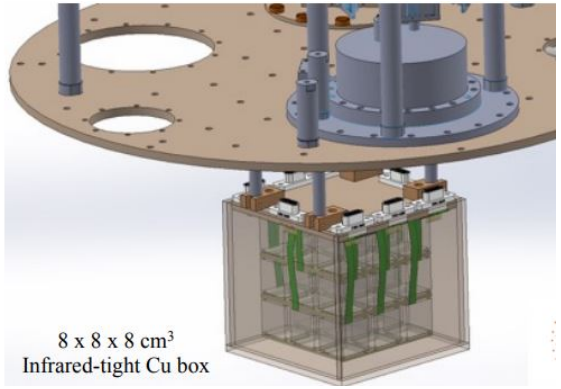
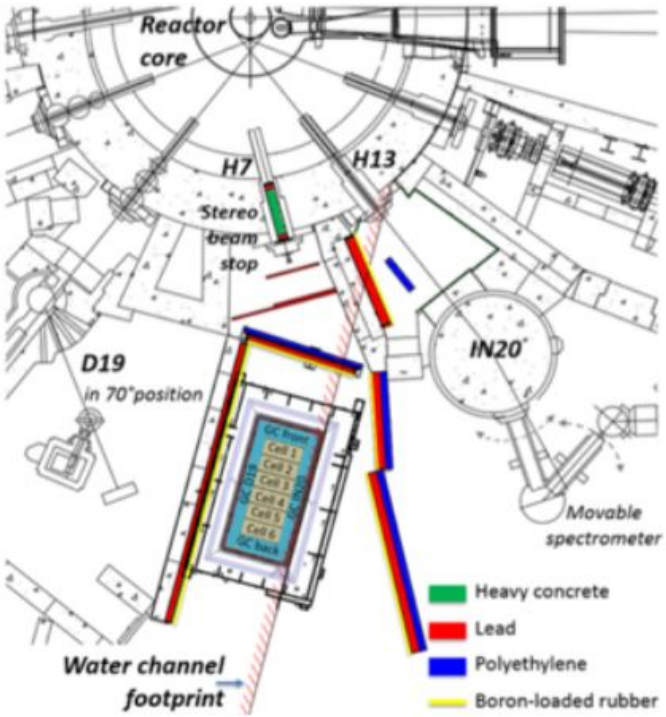


Figure 16: CryoCube setup[2]



Last Week

- Finally setup Ricochet Simulations! Still haven't quite figured out how to make my own macros, will speak to Valerian regarding this
- Reading up on Ricochet

Ricochet

- Process under study: Coherent Neutrino Nucleus scattering, following confirmation of COHERENT
- Why we study this: Test of standard model parameters, possible probe of exotics like sterile neutrinos, characterisation of neutrino floor for DDM. May also have practical applications in reactor monitoring.

- Experimental signature: low energy nuclear recoil, $\sim$0.1-10 keV,[1] which is why low-threshold detector development was necessary.
- Detection mechanism: Phonon readout using cryogenic Zn bolometers. Energy deposits break Cooper pairs, which thermalise into phonons or form quasi-particles.
- Differential recombination times used as discriminant

TODO

- Obtain access to deapclean twiki for RAT manual
- run background simulations with different geometries

References

[1] J Billard, Rachel Carr, J Dawson, Enectali Figueroa-Feliciano, Joseph A Formaggio, J Gascon, ST Heine, M De Jesus, J Johnston, T Lasserre, et al. Coherent neutrino scattering with low temperature bolometers at chooz reactor complex. *Journal of Physics G: Nuclear and Particle Physics*, 44(10):105101, 2017.

[2] Institut de Physique Nucléaire de Lyon / CNRS / Université Lyon 1. *Probing new physics with Coherent Elastic Neutrino-Nucleus Scattering and the future Ricochet experiment*, Milan, 2019.