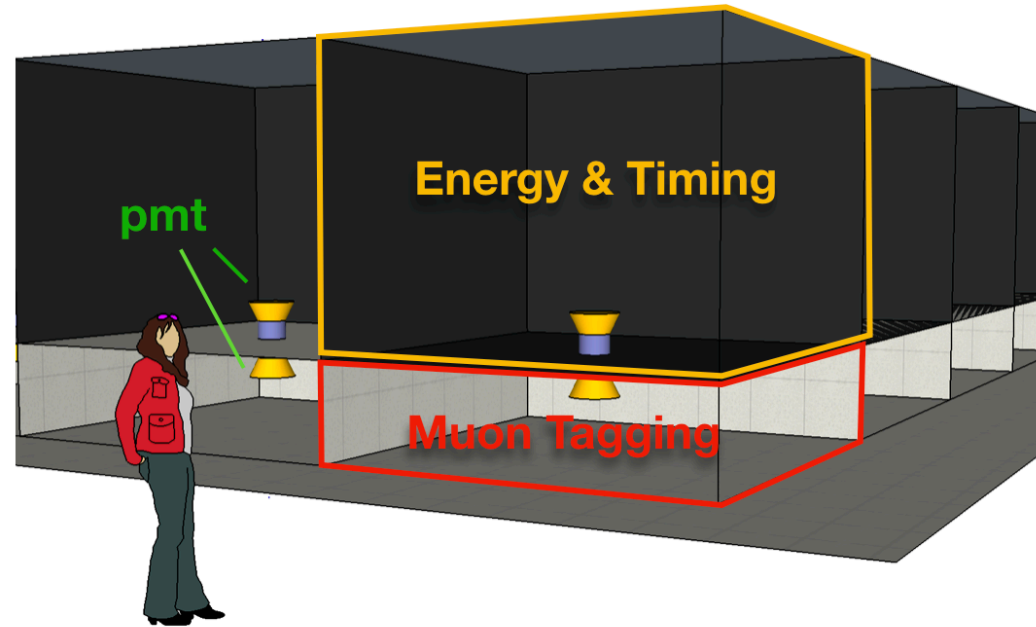


Optimization of a Double Layered WCD

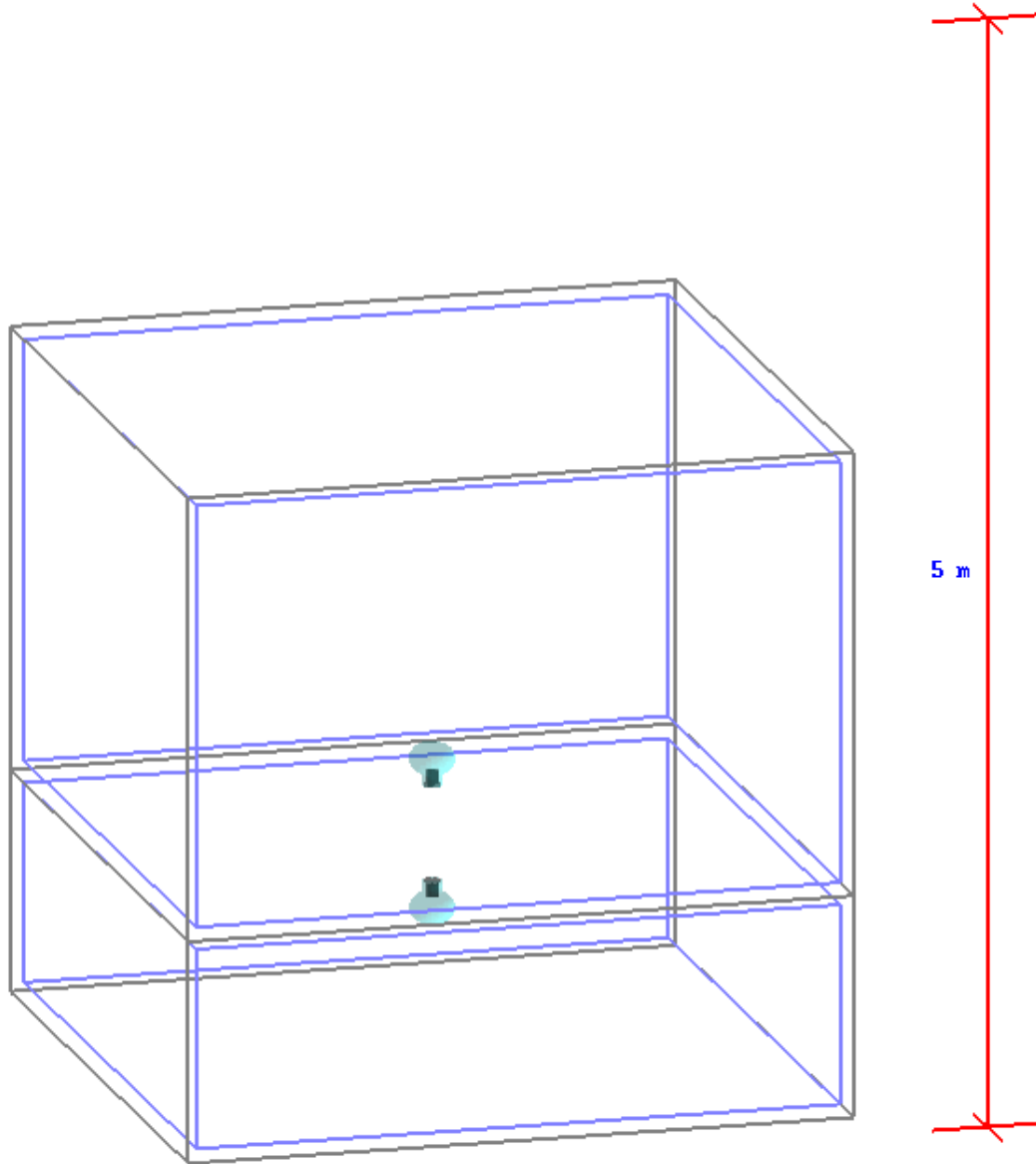


Samridha Kunwar, Harm Schoorlemmer & Jim Hinton
MPIK

SGSO Meeting
Lisbon, Portugal
May 20th - 22nd, 2019



Double Layered WCD **Integrated** into the HAWC framework



Abstract layer added to hawcsim to be able to select different units!

Now only need individual detector construction code!!

Abstract Layer

The screenshot shows a GitLab repository page for the 'aerie' project. The left sidebar contains navigation options: Repository, Files, Commits, Branches, Tags, Contributors, Graph, Compare, Charts, Issues (1), and Collapse sidebar. The main content area displays a list of files with their commit messages and dates. A red arrow points from the 'Abstract Layer' text to the 'Tank.hh' file. A blue arrow points from the 'Tank Implementations' text to a group of files including TankDLWCD.hh, TankHAWC300.hh, and TankHAWCOR.hh.

| File Name | Commit Message | Time Ago |
|----------------------------|--|-------------|
| ParticleGeneratorAction.hh | Removed all tabs. | 4 years ago |
| ParticleIDManager.hh | Make sure svn Id keyword is set. | 3 years ago |
| PhysicsList.hh | Make sure svn Id keyword is set. | 3 years ago |
| PrimaryGeneratorAction.hh | Make sure svn Id keyword is set. | 3 years ago |
| Tank.hh | Merge branch 'addDLWCD' into HEAD | 1 week ago |
| TankArray.hh | PMTs can only be declared once (don't exactly und... | 1 week ago |
| TankDLWCD.hh | small changes to facilitate the merge request | 1 week ago |
| TankHAWC300.hh | PMTs can only be declared once (don't exactly und... | 1 week ago |
| TankHAWCOR.hh | PMTs can only be declared once (don't exactly und... | 1 week ago |
| TestFlatPMT.hh | Add headers for CylindricalPMT and modify others ... | 3 years ago |
| TrackInformation.hh | Removed all tabs. | 4 years ago |
| TrackingAction.hh | Removed all tabs. | 4 years ago |
| UnitConversions.hh | Removed all tabs. | 4 years ago |

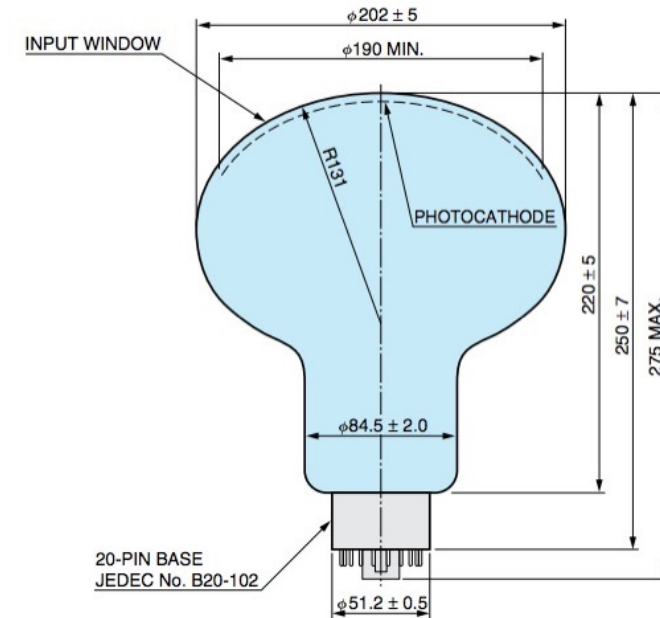
Tank Implementations

Hamamatsu R5912 – 8" Hemispherical PMT



Pyrex Glass with RI of typical Borosilicate glass (3mm)

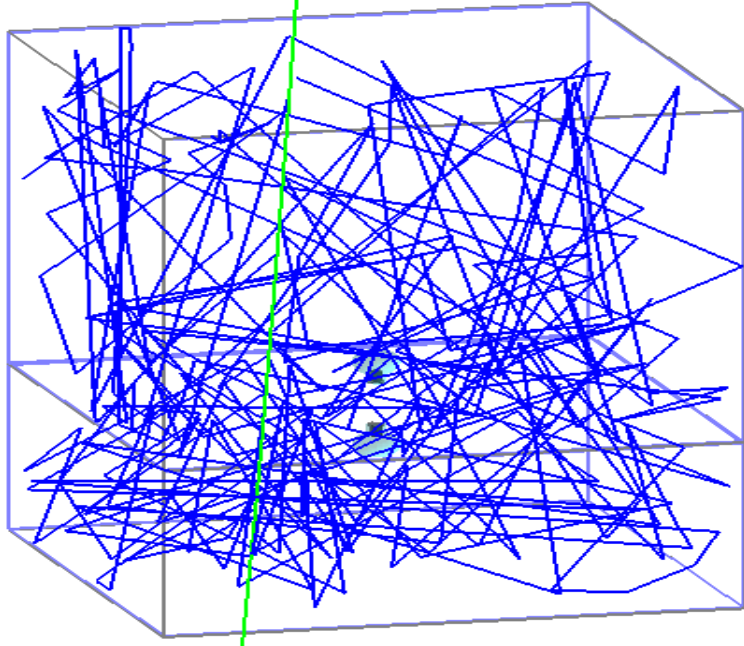
●R5912/-20/-100



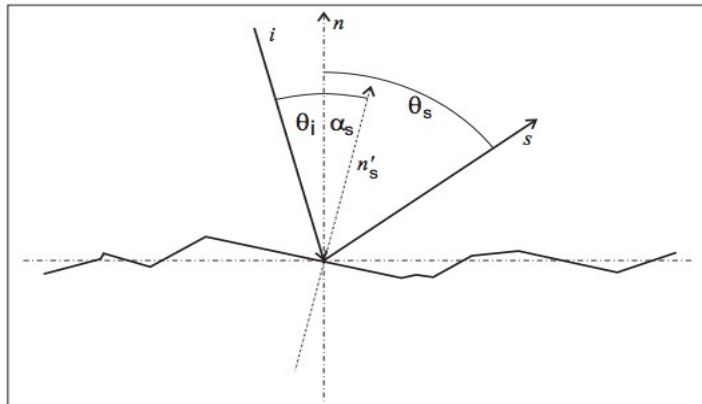
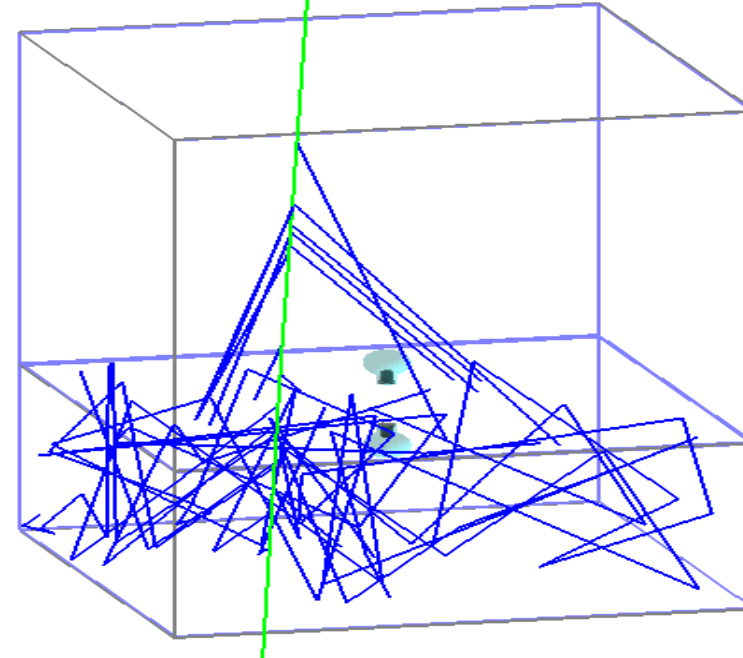
Bi-alkali Photocathode

Muon Events (Example with photons limited for illustration)

Tyvek Upper



Polypropylene Upper



rough surface with top layer paint

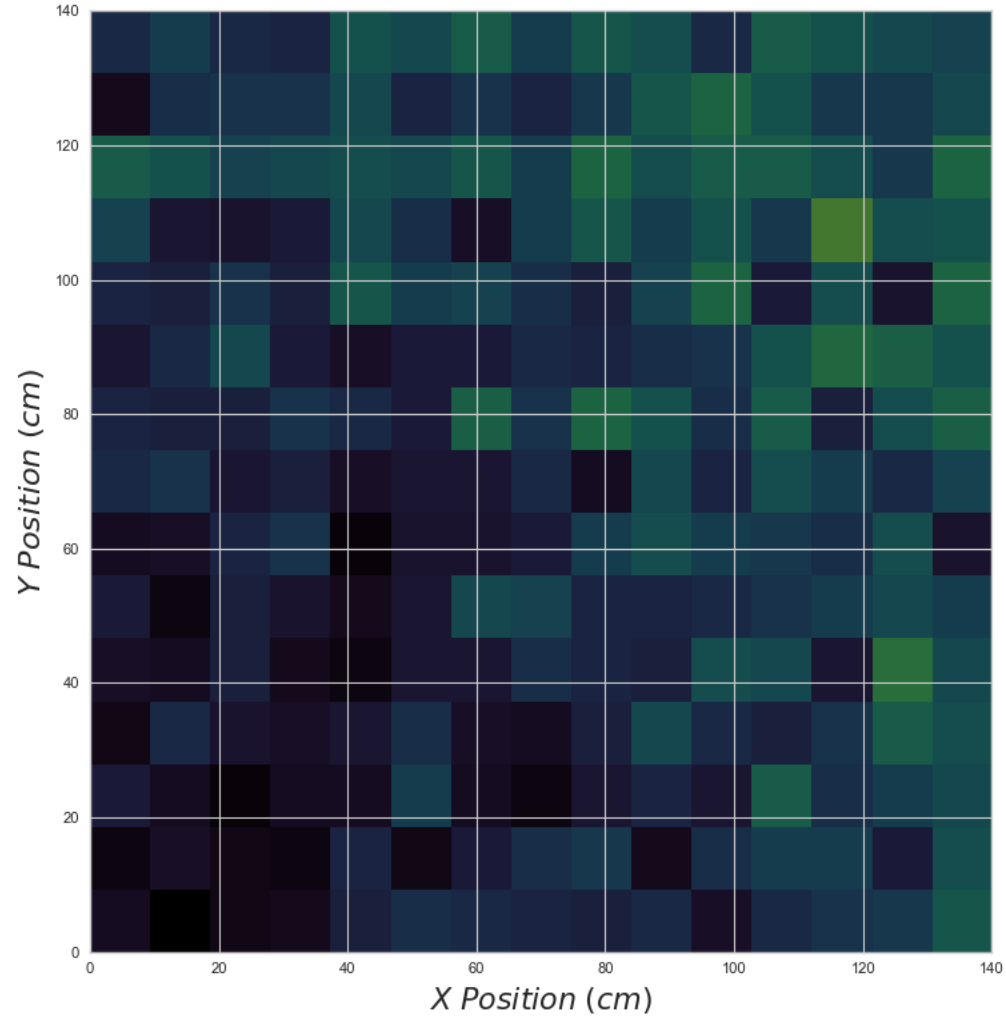
Aspect ratio ? (presentation from October 2018 in Heidelberg for Upper Cell)

Black or White (Tyvek / Polypropylene) upper chamber ?

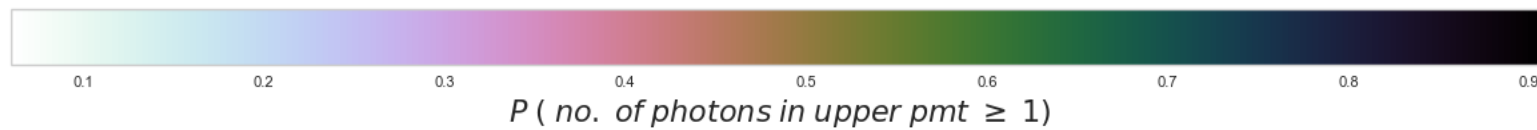
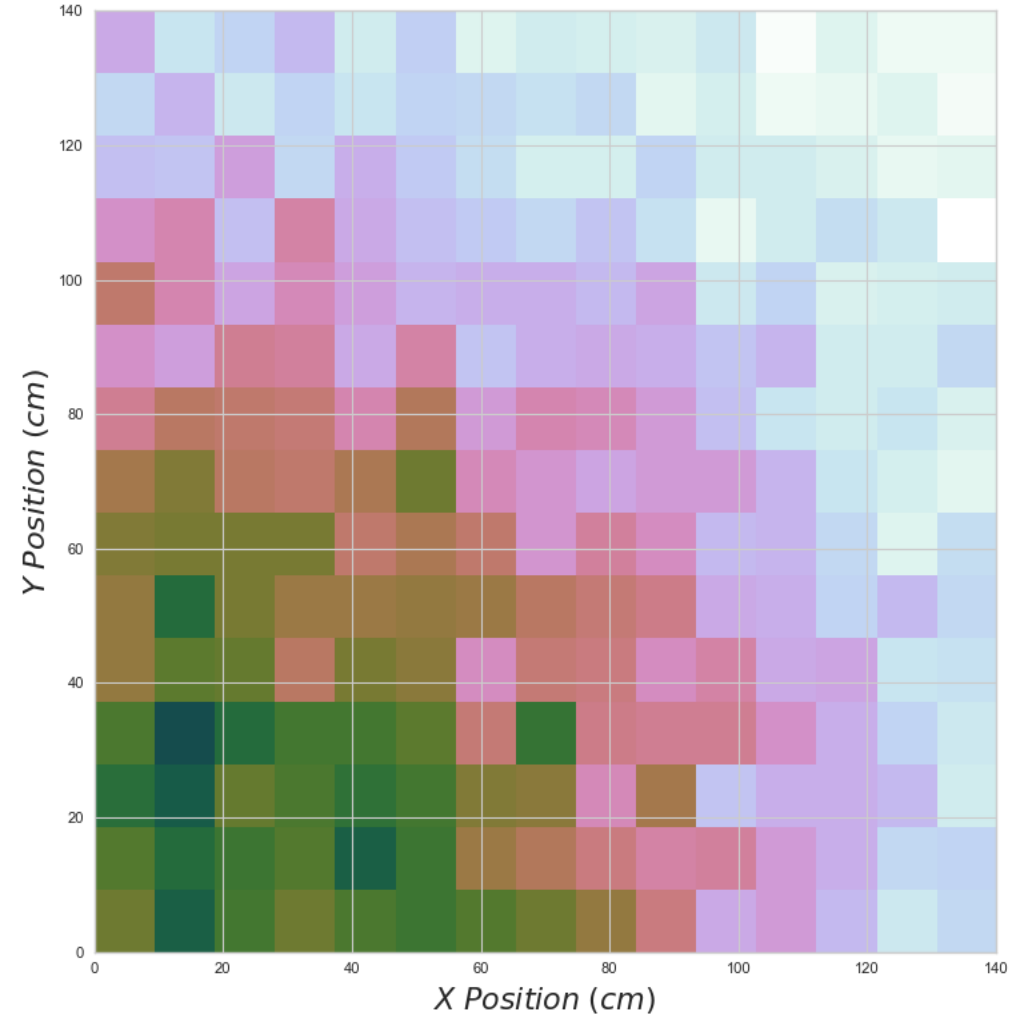
PMT? (To do)

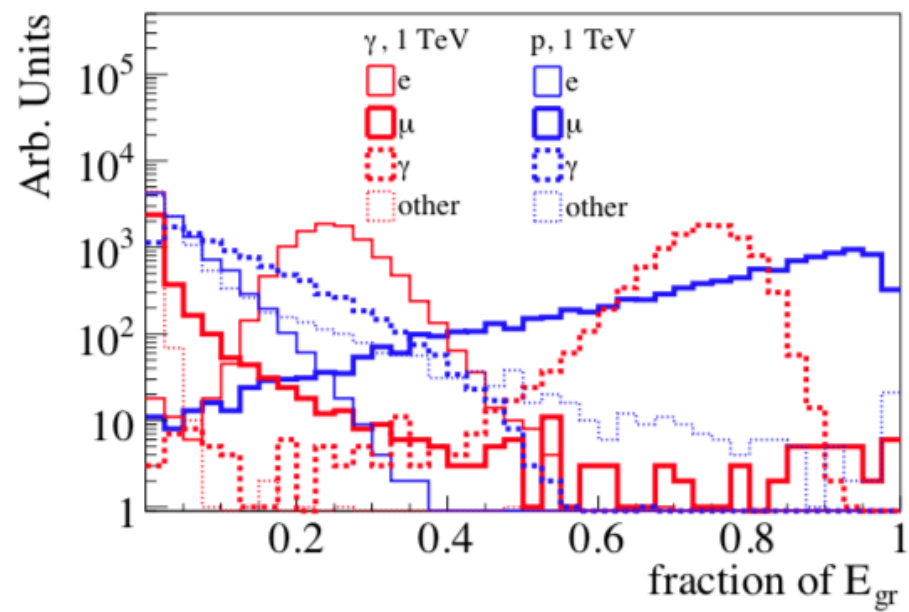
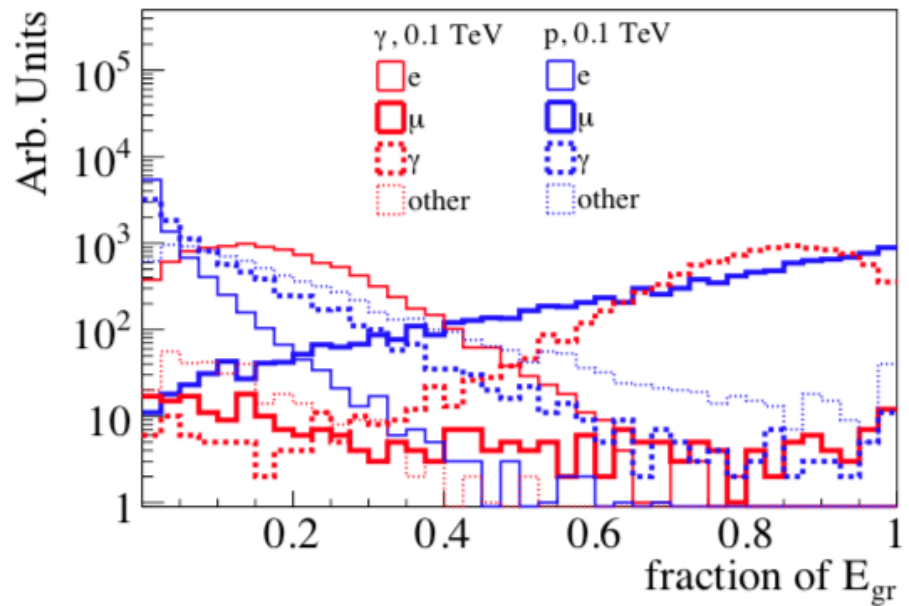
10 MeV γ , 3x3x2 m Upper Cell

White Walls



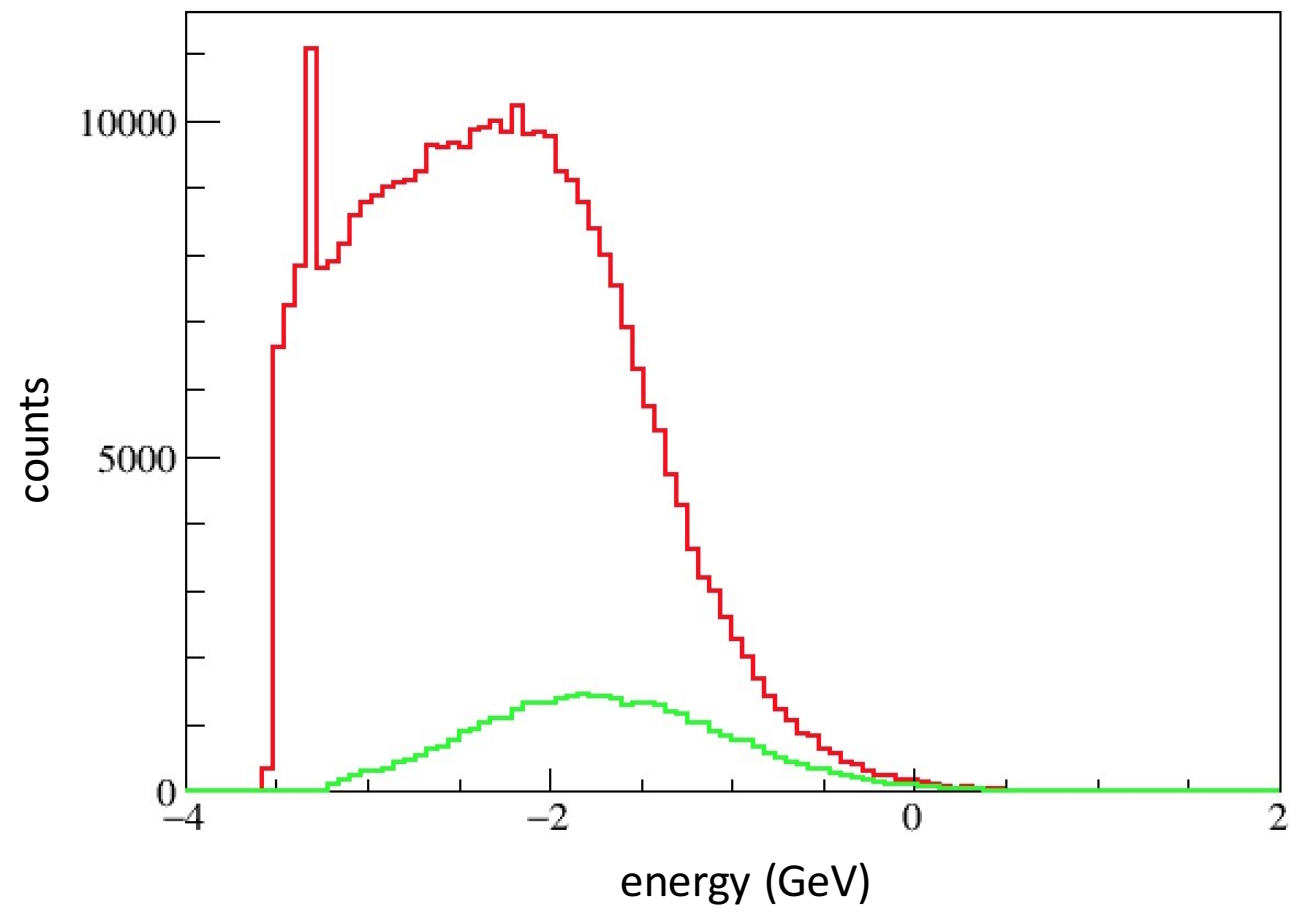
Black Walls





What do we optimize for?

Gamma , Electron /positron



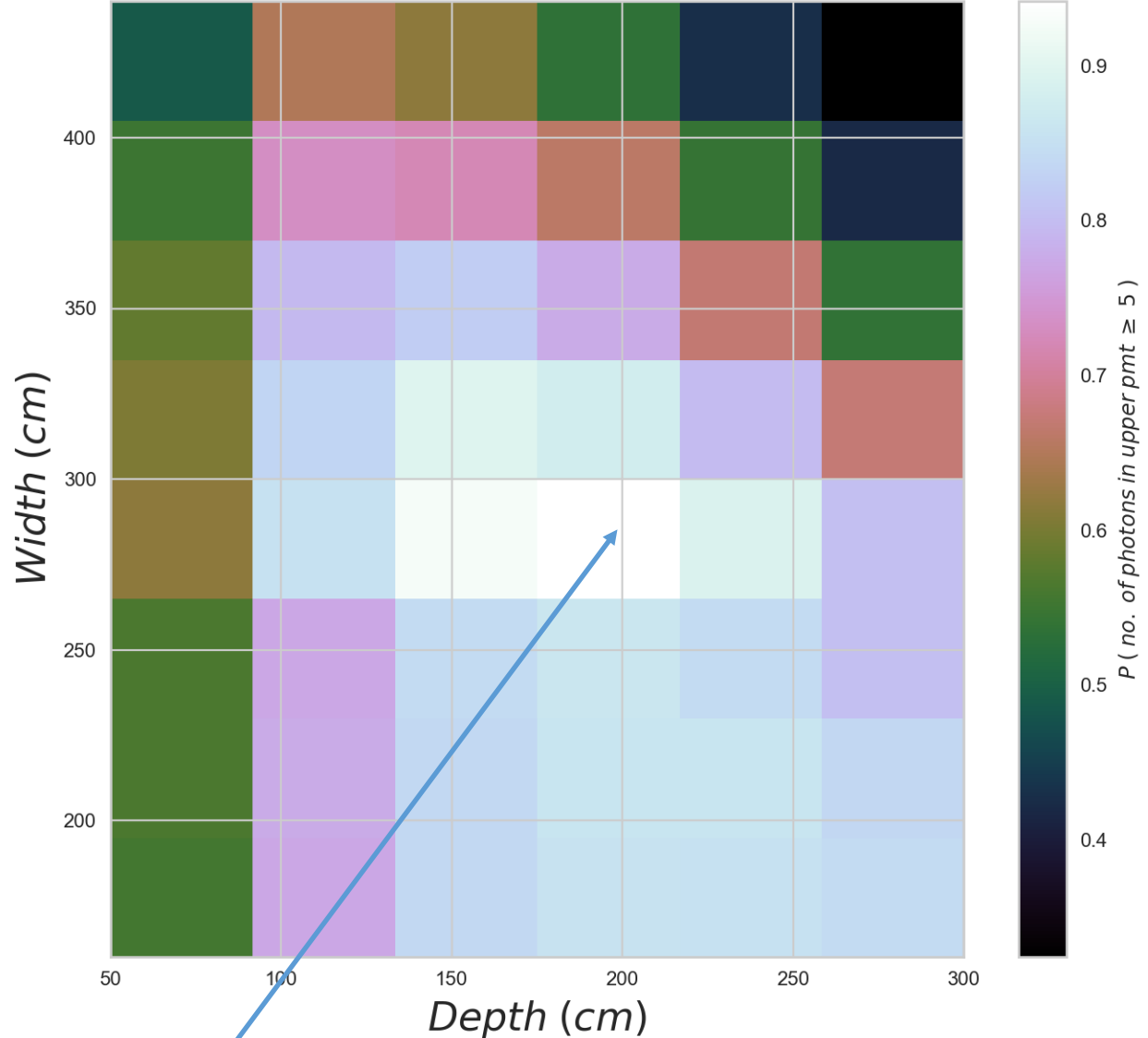
1 TeV , 5 KM, $\phi = 0$

At 5 KM

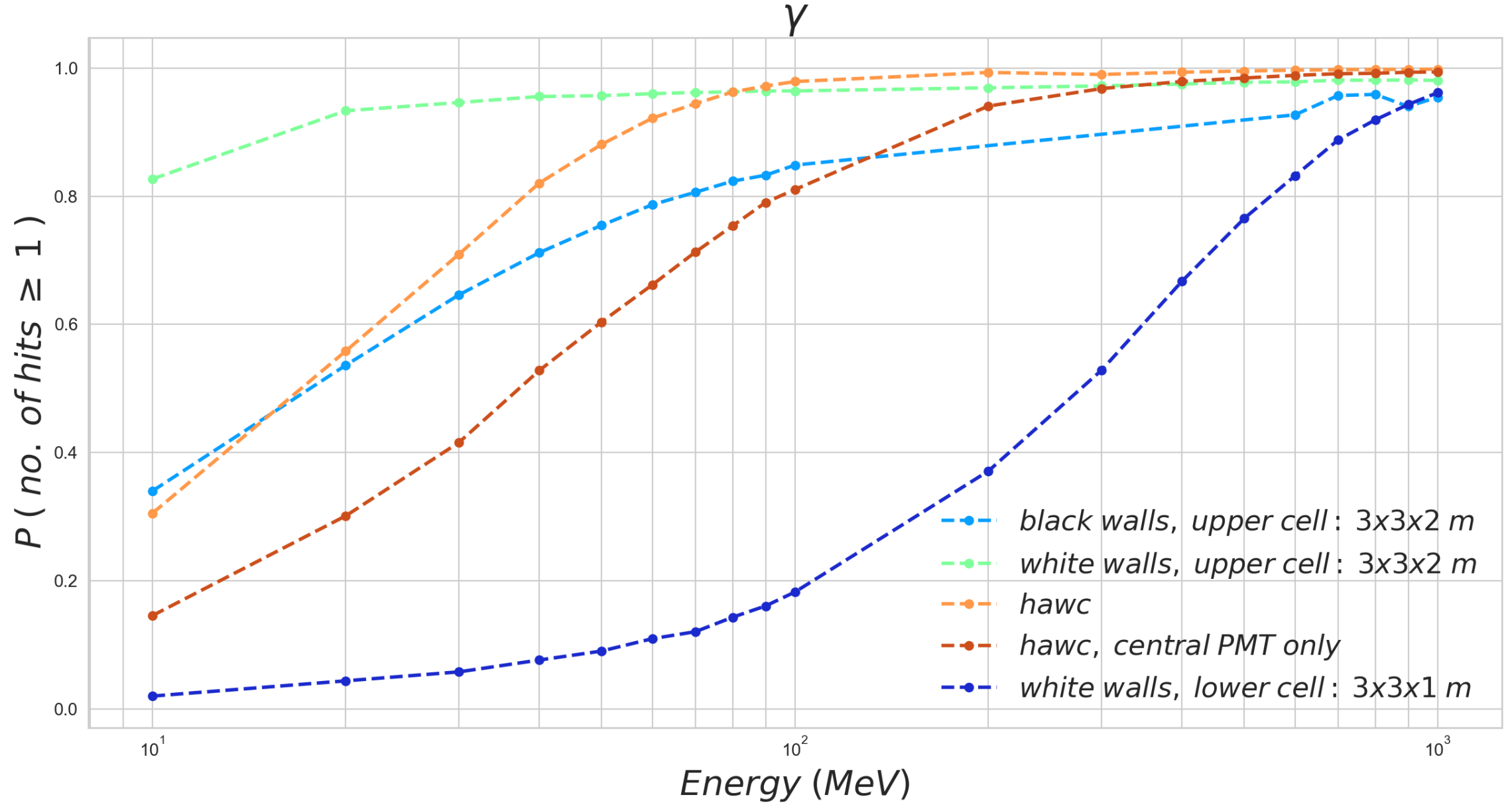
What is the best case for a **white walled** upper unit?

From October 2018

10 MeV γ , white walls



Best Case for 10 MeV Gamma Detection?



How do the different designs compare?

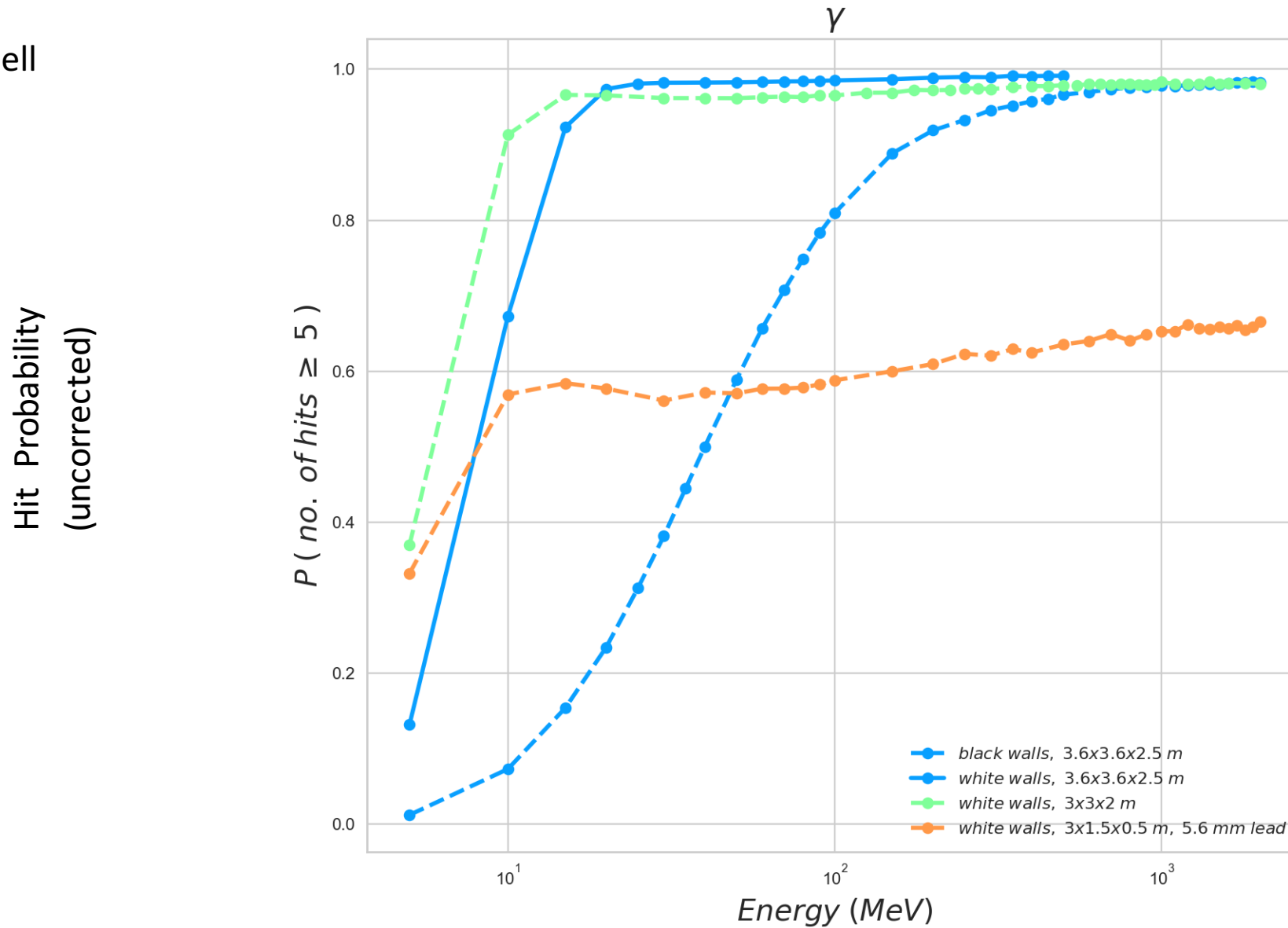
From October 2018

Upper Cell

All positions, All photons

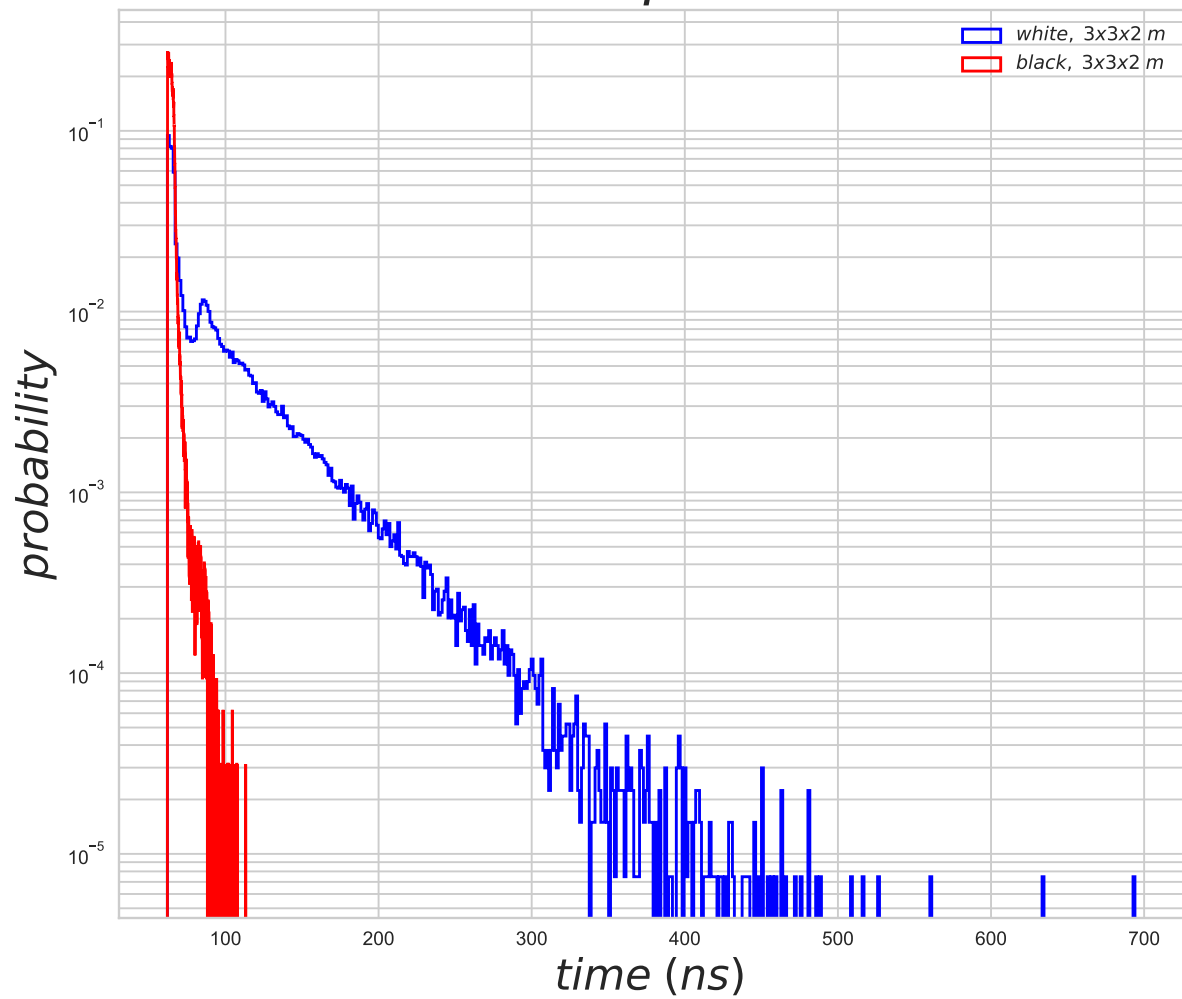
Gamma

Momentum (0, 0, 1)



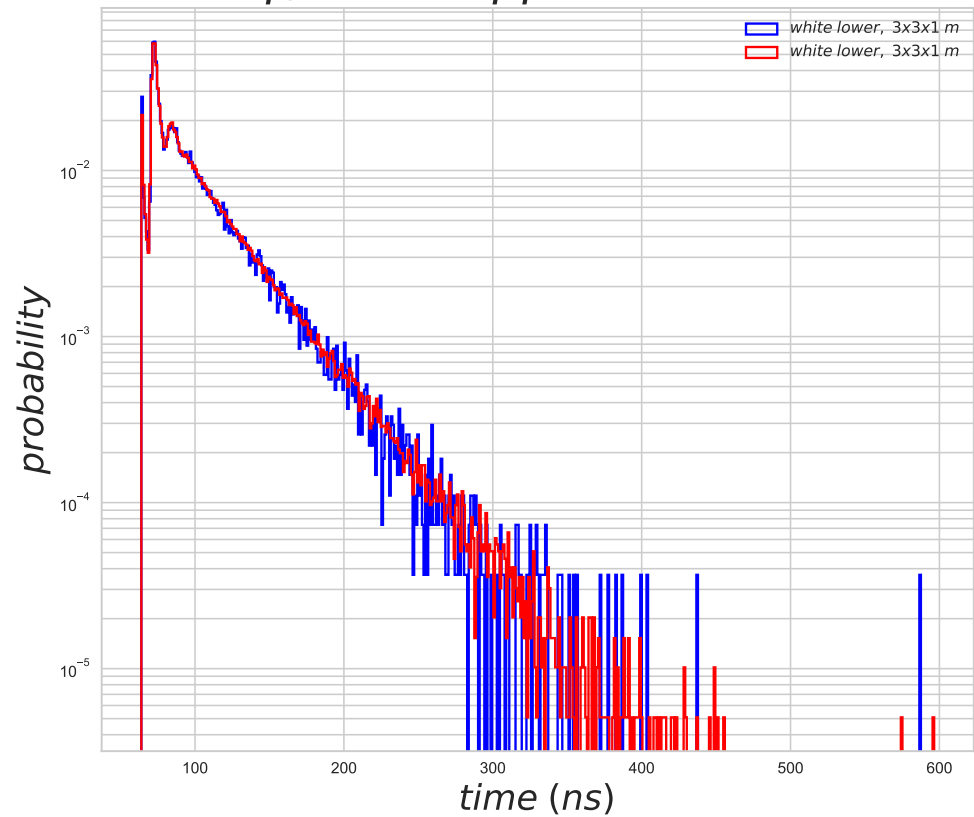
hit time distribution

γ

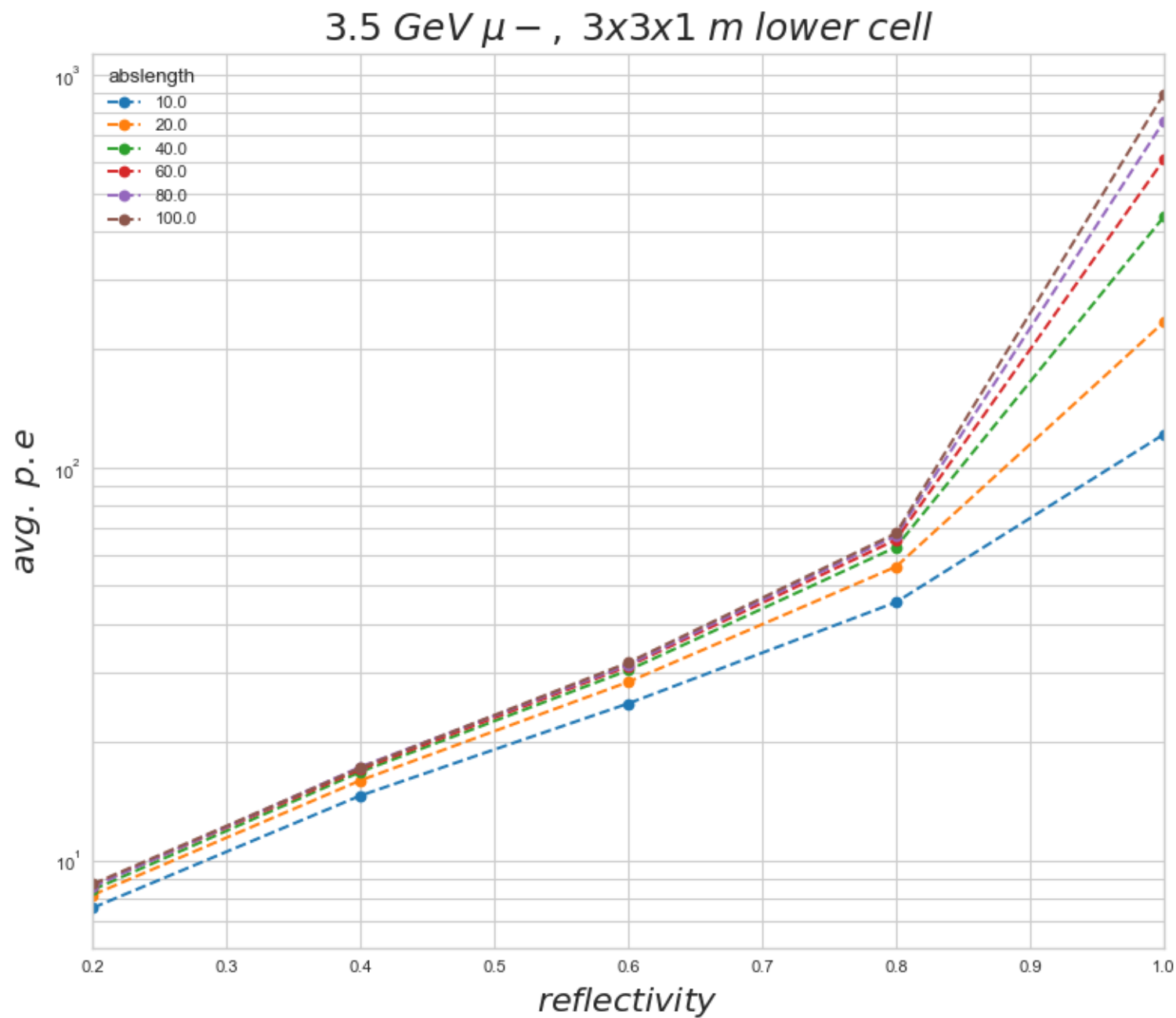
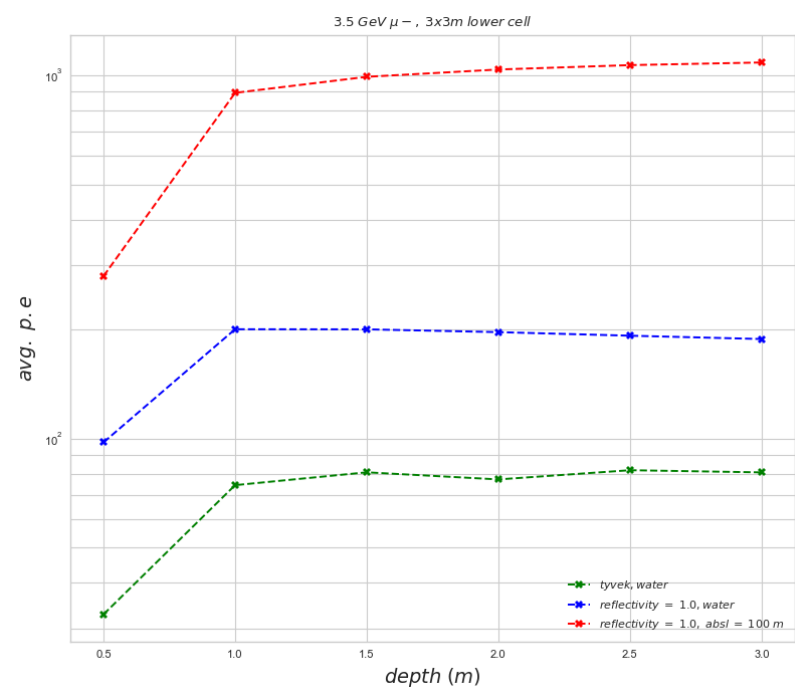
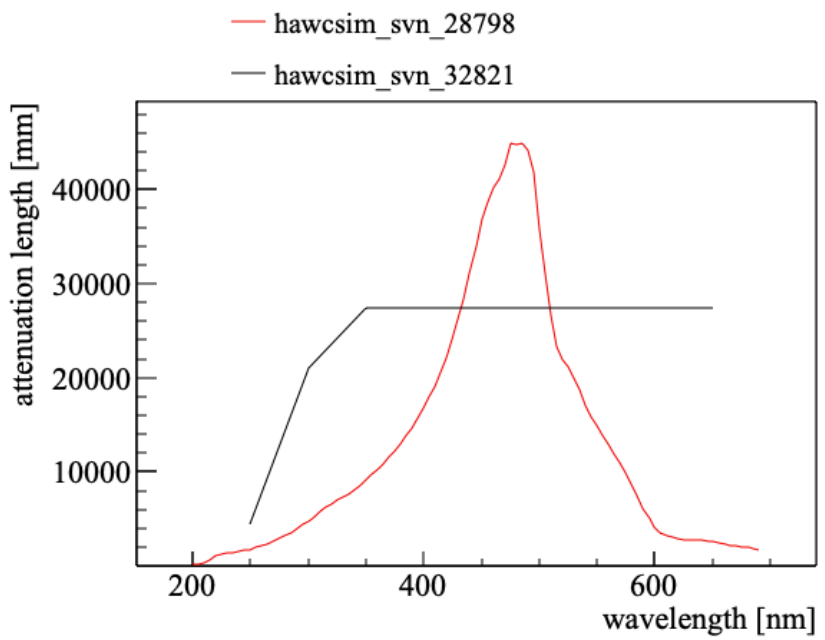


Upper Cell

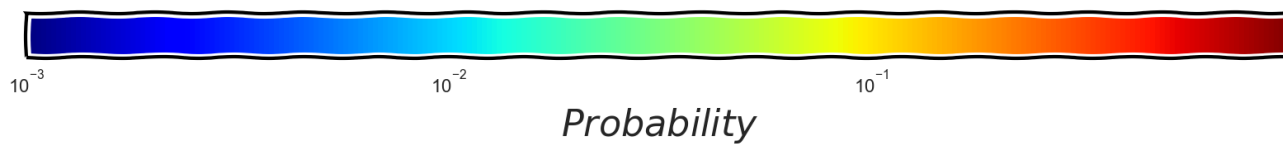
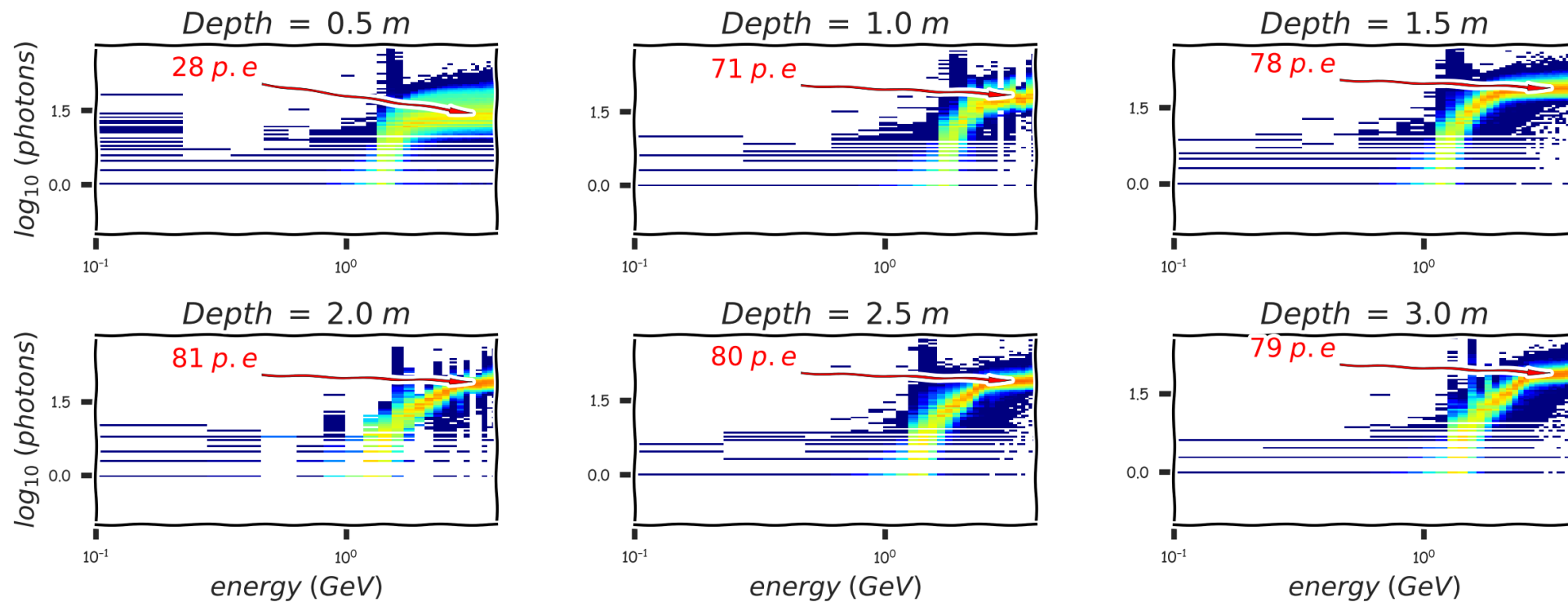
γ , white upper 3x3x2 m



Lower Cell



3x3 m, White Walled Lower Cell, muons

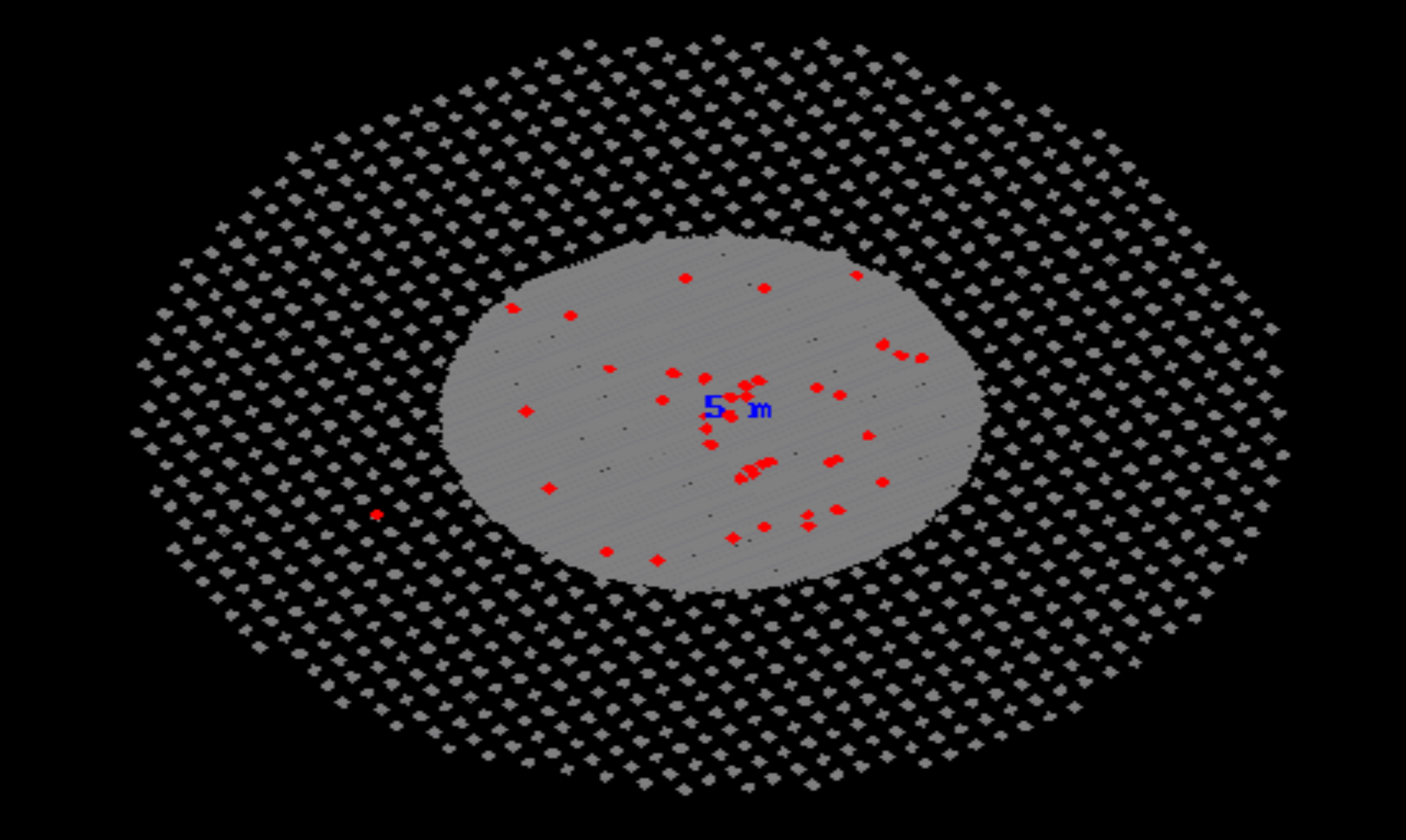


3x3x2 m, White Walled Upper Cell

High Fill Factor Inner Array ~ 80%

500 GeV gamma, Zenith 20

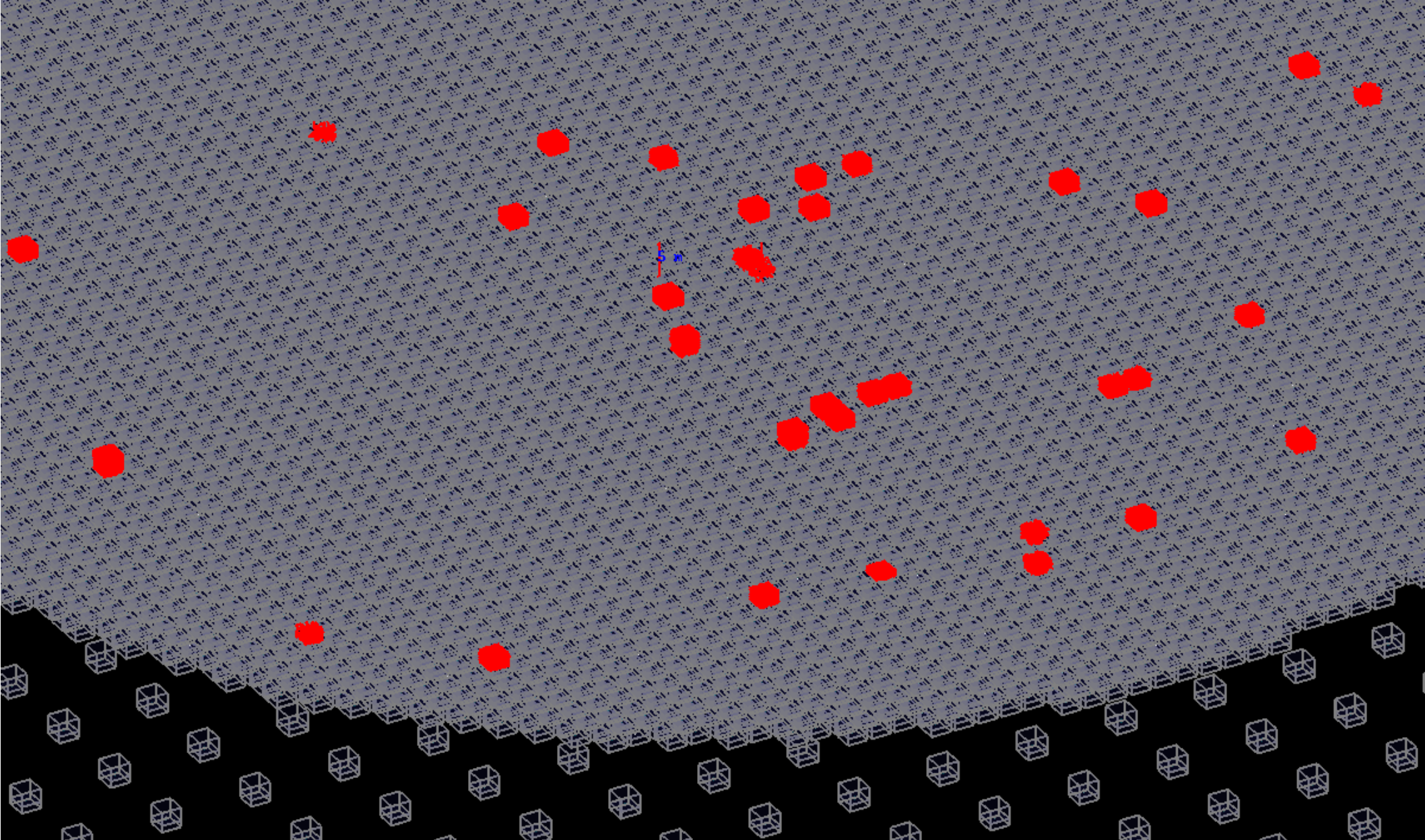
Outer Array with ~8 % Fill Factor



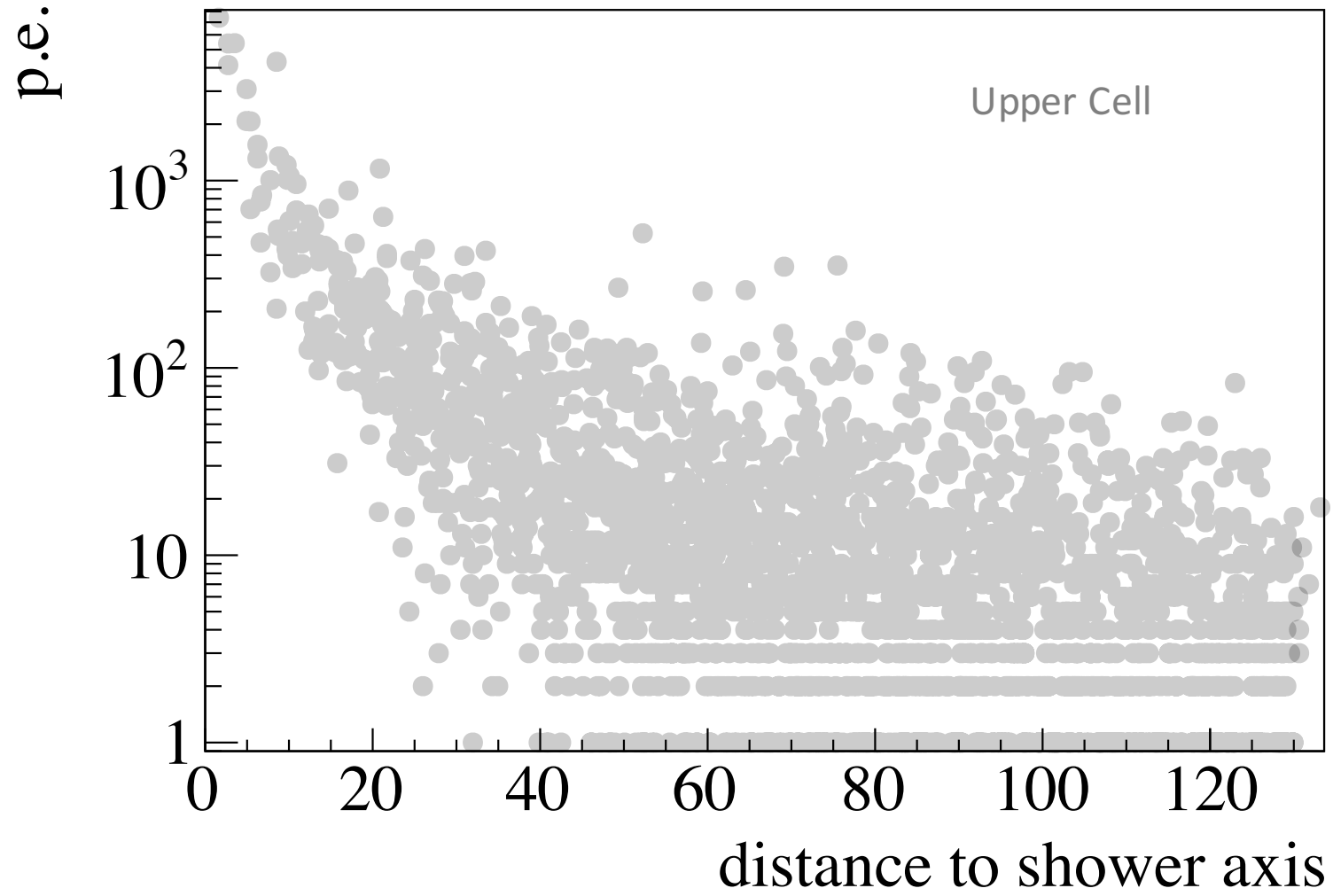
High Fill Factor Inner Array ~ 80%

Outer Array with ~8 % Fill Factor

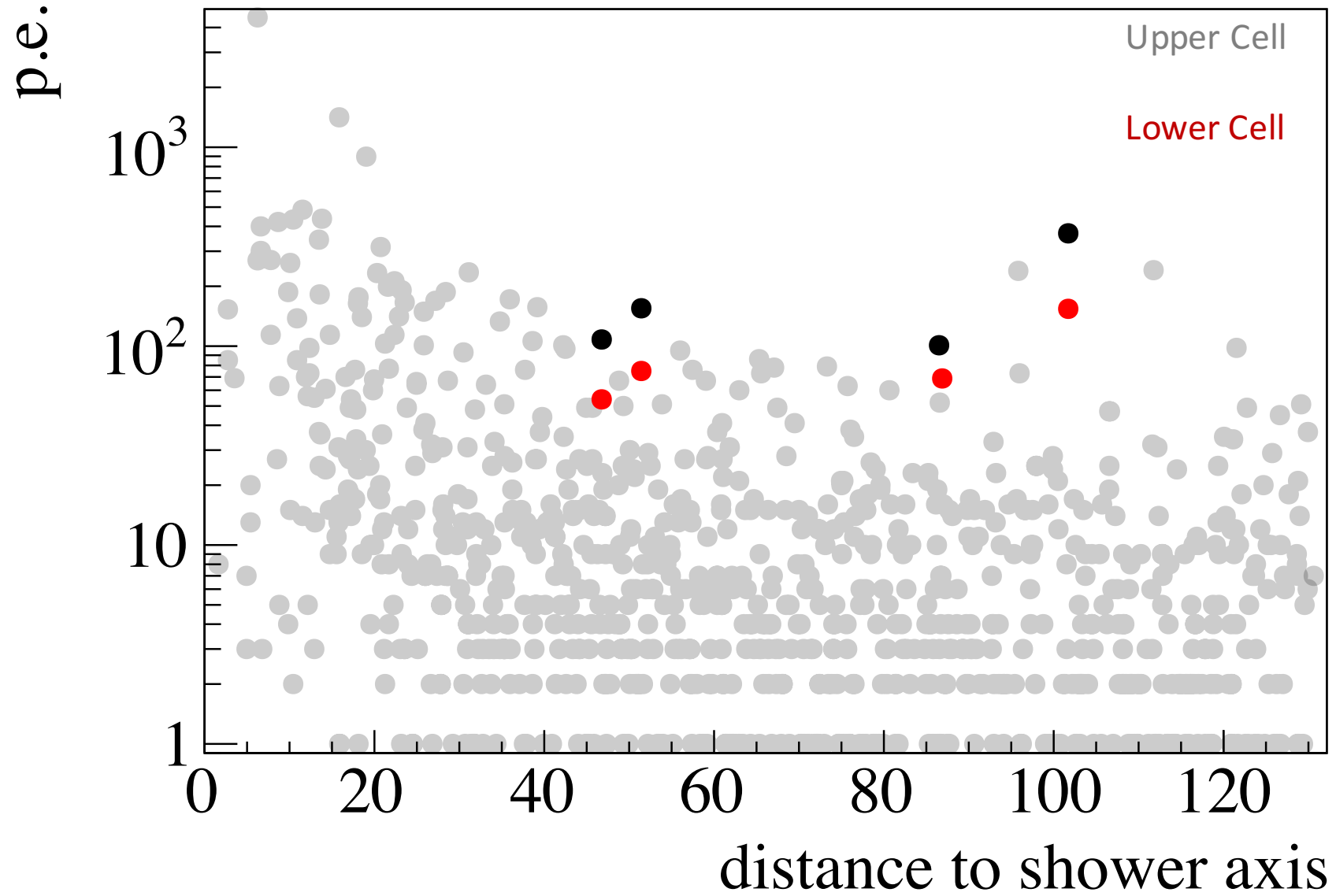
500 GeV gamma, Zenith 20



5TeV Gamma, Vertical shower

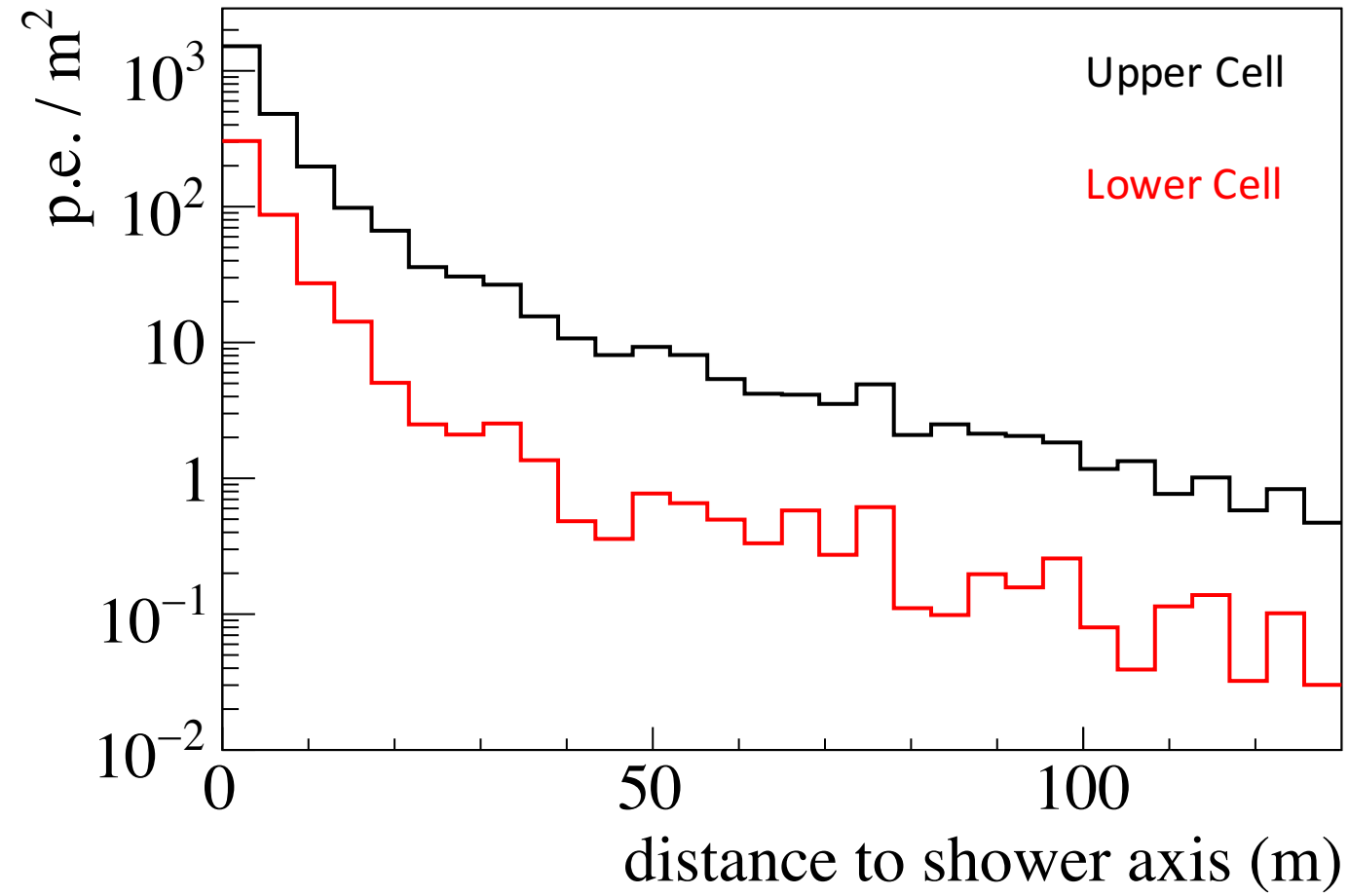


10TeV Proton, Vertical shower



Mu+ with upper and lower cell counterpart

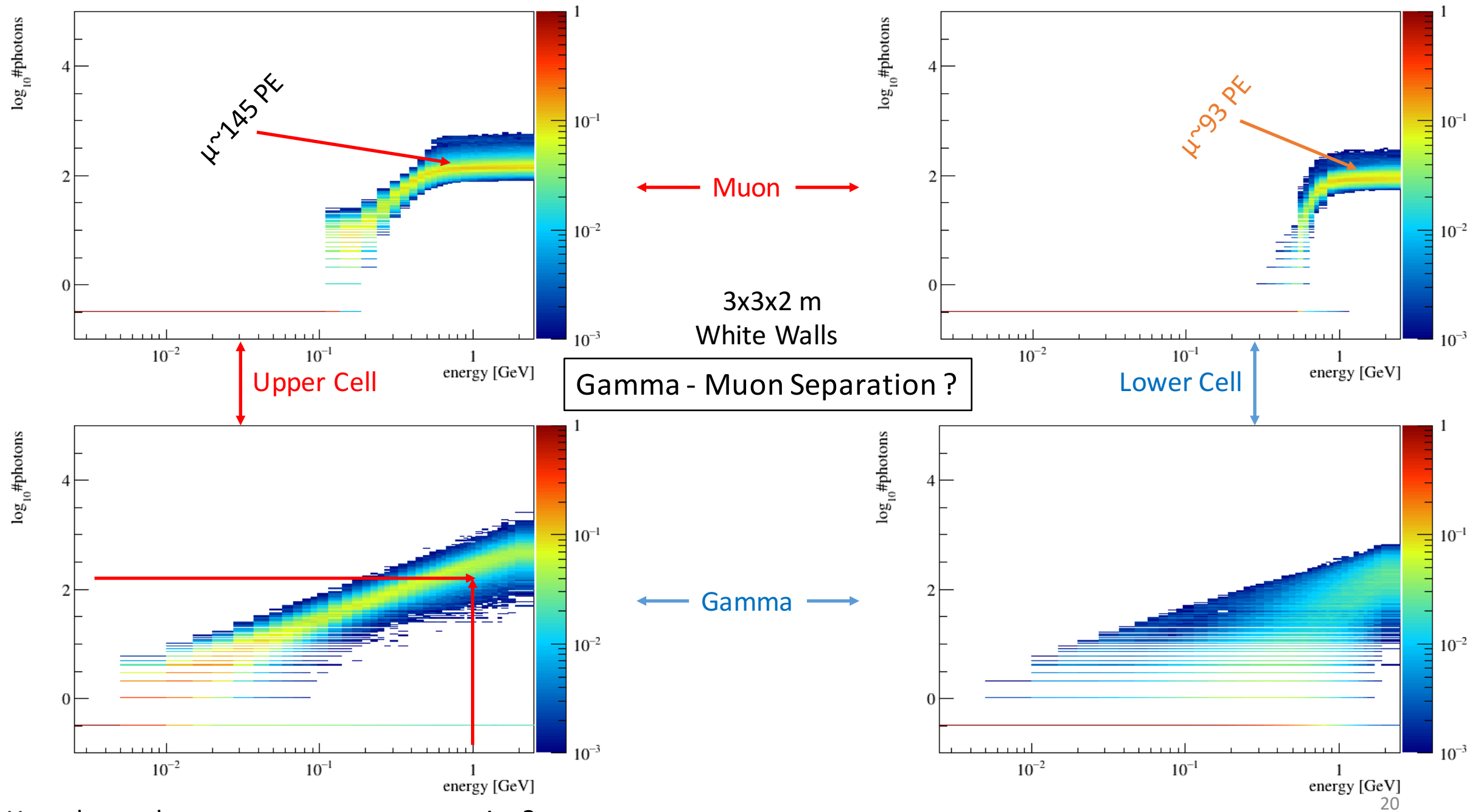
5 TeV Gamma, Vertical shower



Summary

- G4 interface in hawcsim verified
- Implemented double layered WCD unit in the SW with steering cards
- 3x3x2 upper chamber with white walls
- 3x3x1 lower chamber with white walls

From October 2018



How do we do a muon – gamma separation?