# AR2D2 DETECTOR SIMULATION

MEGAN FOSTER

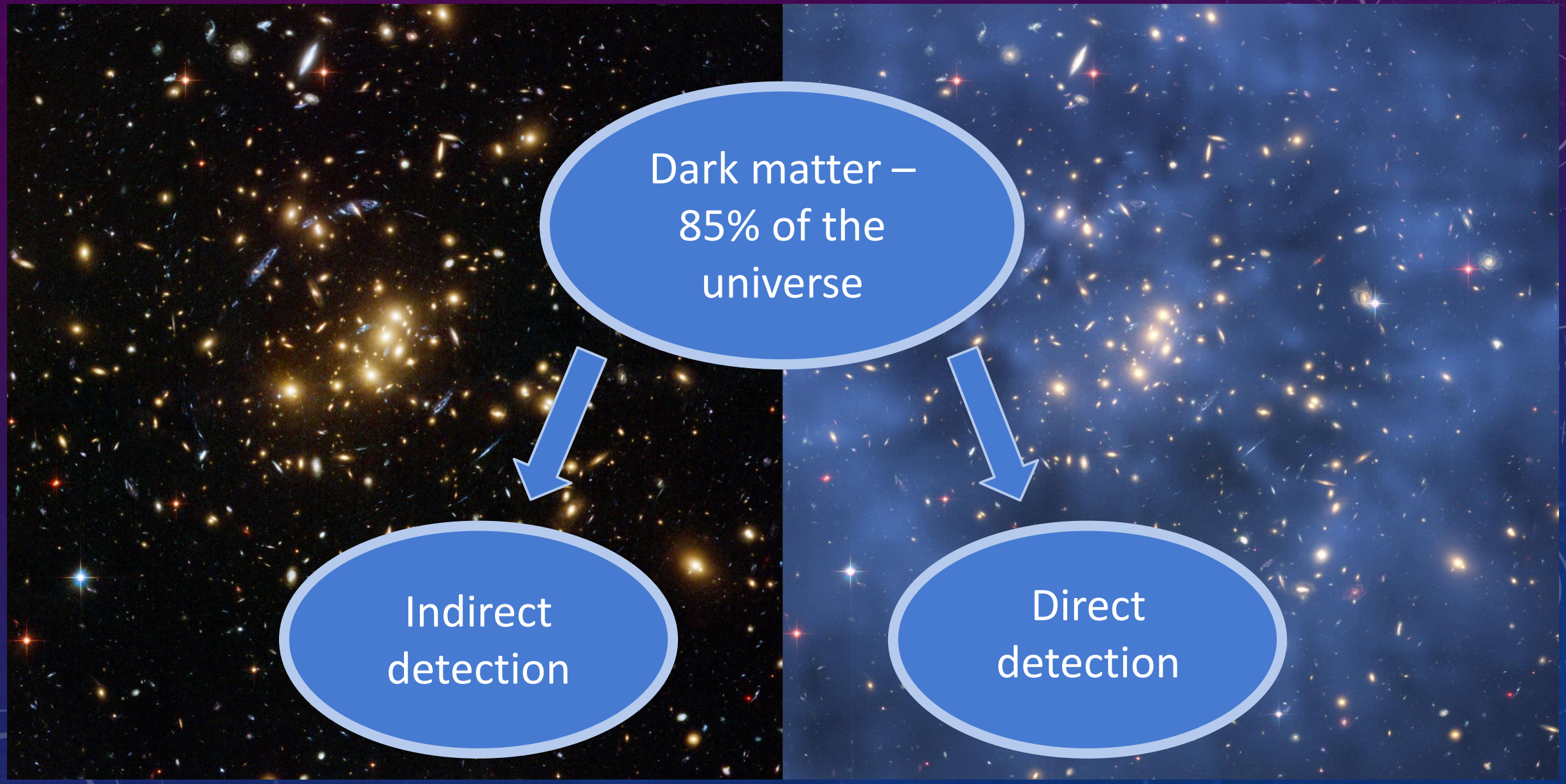
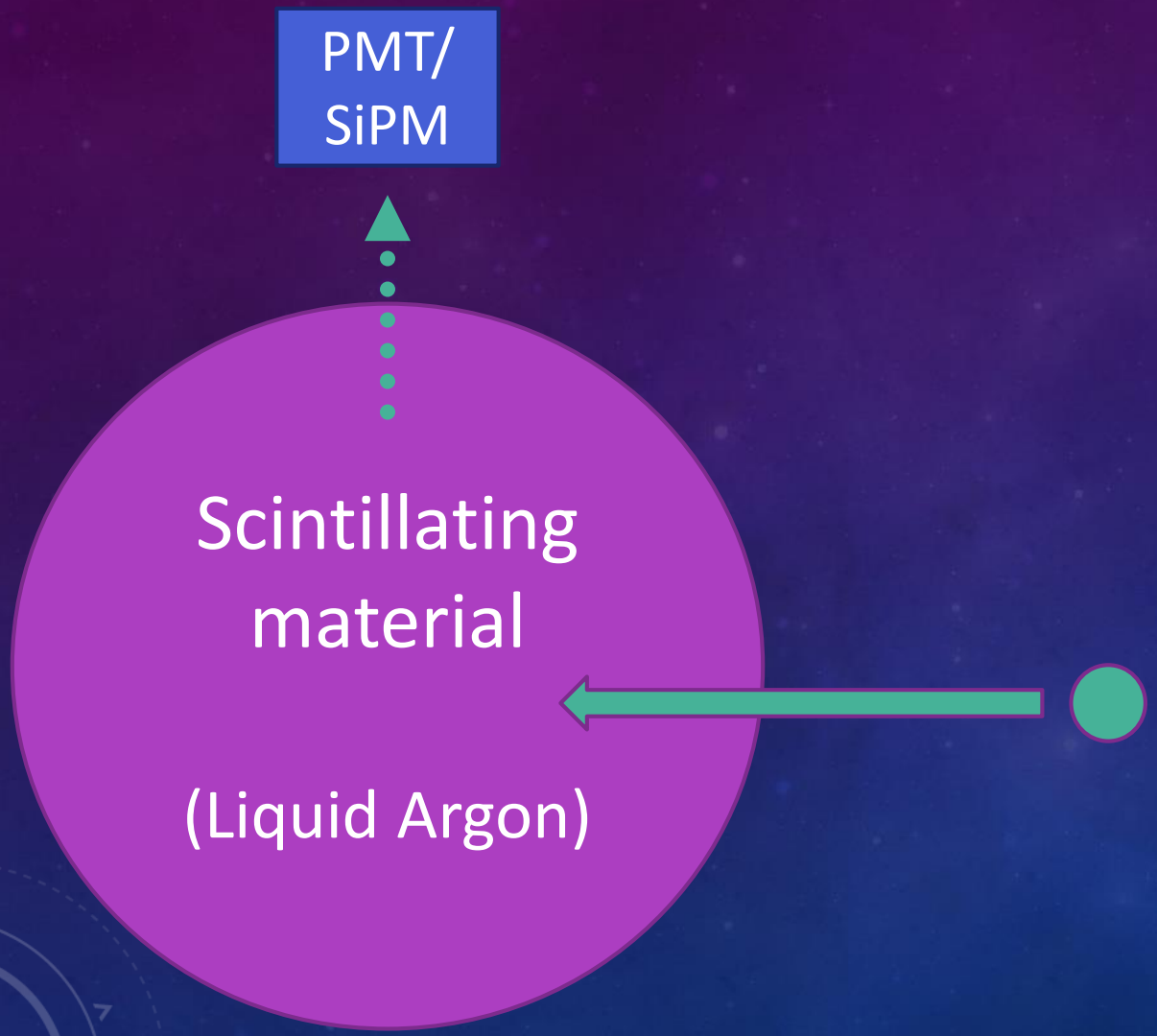



Image credit: NASA (Hubble Telescope), ESA, M.J. Jee and H. Ford (Johns Hopkin's University)

# SCINTILLATING DETECTORS

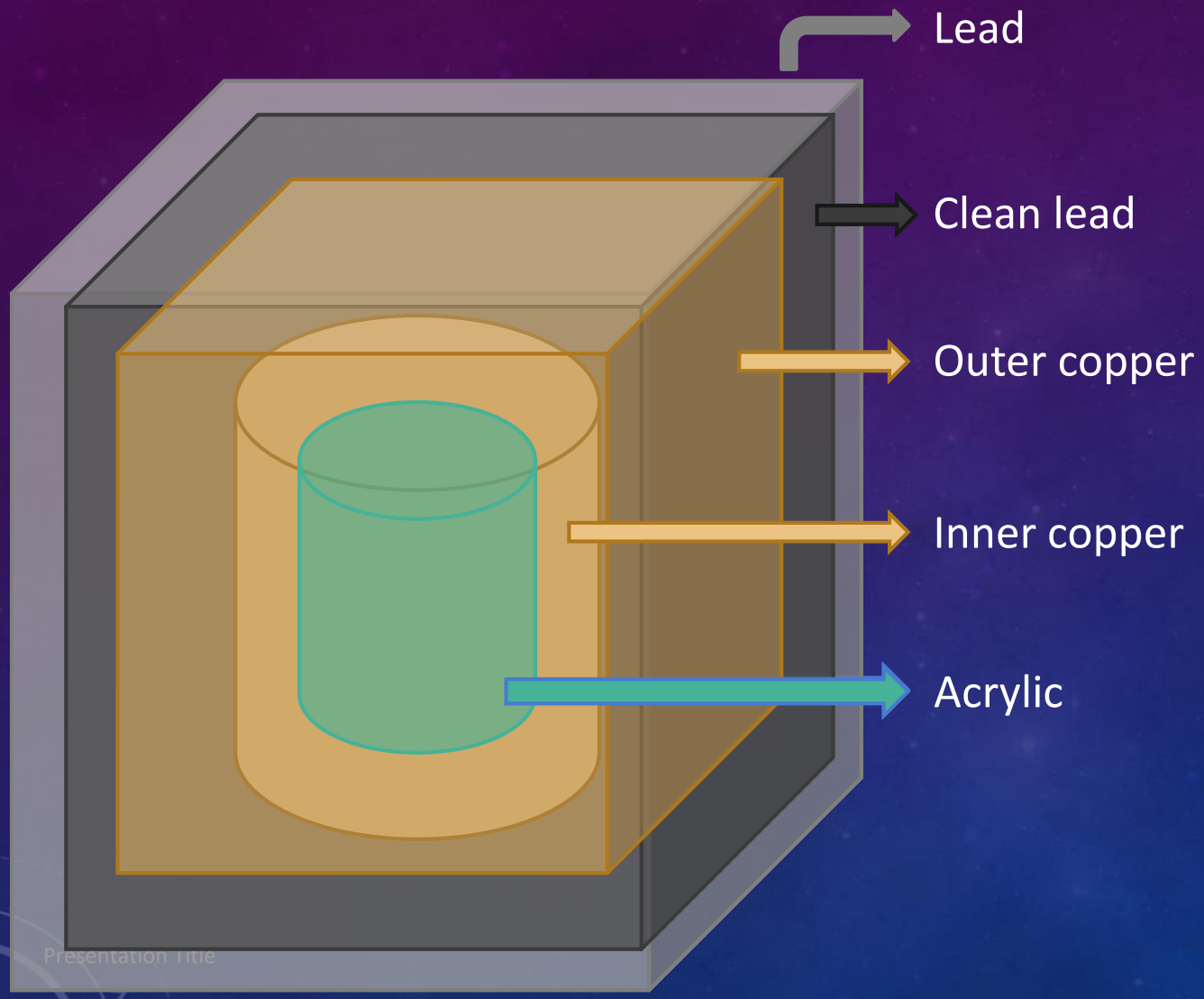



**Backgrounds**

- Atmospheric/external radiation
- Radiation from detector materials
- Ar39

# THE AR2D2 DETECTOR

# DESIGN




**Backgrounds**

- ~~Atmospheric/external radiation~~
- Radiation from detector materials
- Ar39

# MATERIALS

- Activity of each layer taken from SNOLAB gamma assays website
- Relative abundancies taken from SNOLAB branching percentages website
- Simulation used to determine usable geometry and materials

**Backgrounds**

- ~~Atmospheric/external radiation~~
- ~~Radiation from detector materials~~
- Ar39



Gamma assays: https://www.snolab.ca/users/services/gamma-assay/HPGe_samples_pub.html
Branching percentages: http://snolab.ca/~tjsonley/HPGE_Test/COAX/180427/

# THE SIMULATION

# PREVIOUS WORK

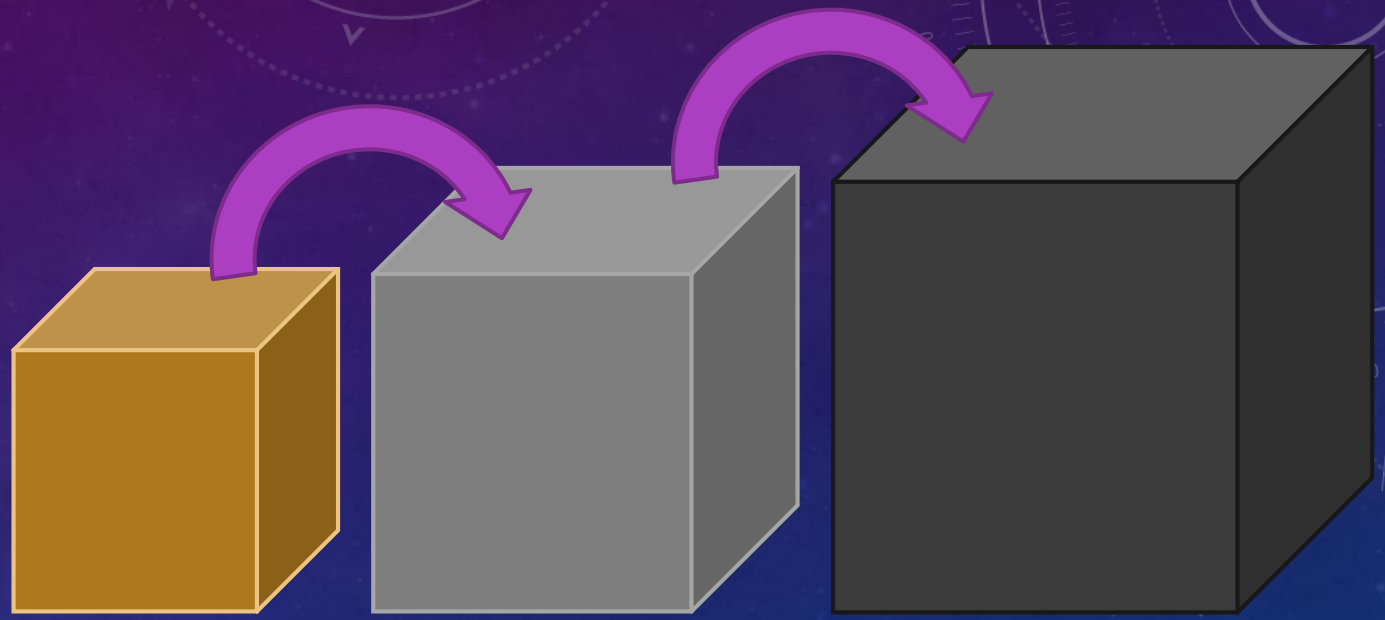
Separate simulations for each layer of the detector, SiPMs, and external

Detector partially defined in geometry file

Visualizations complete

Actual geometry

Simulated geometry (nested solid volumes)



# STEP 1 - GEOMETRY

CREATE A .GEO FILE CONTAINING ALL COMPONENTS OF THE DETECTOR

# STEP 2 – GENERATE MACROS

Calculate event counts (N) for each element in decay chain

Specify energy of decay

Specify location of origin (fillshell)

Specify how many times to run simulation (N)

```
/generator/add combo gun:fillshell
/generator/vtx/set gamma  0 0 0 0.29521
/generator/pos/set 294.0 0.0 0.0 0.0 0.0 0.0 50.0 5000.0
/run/beamOn 75232
```

N

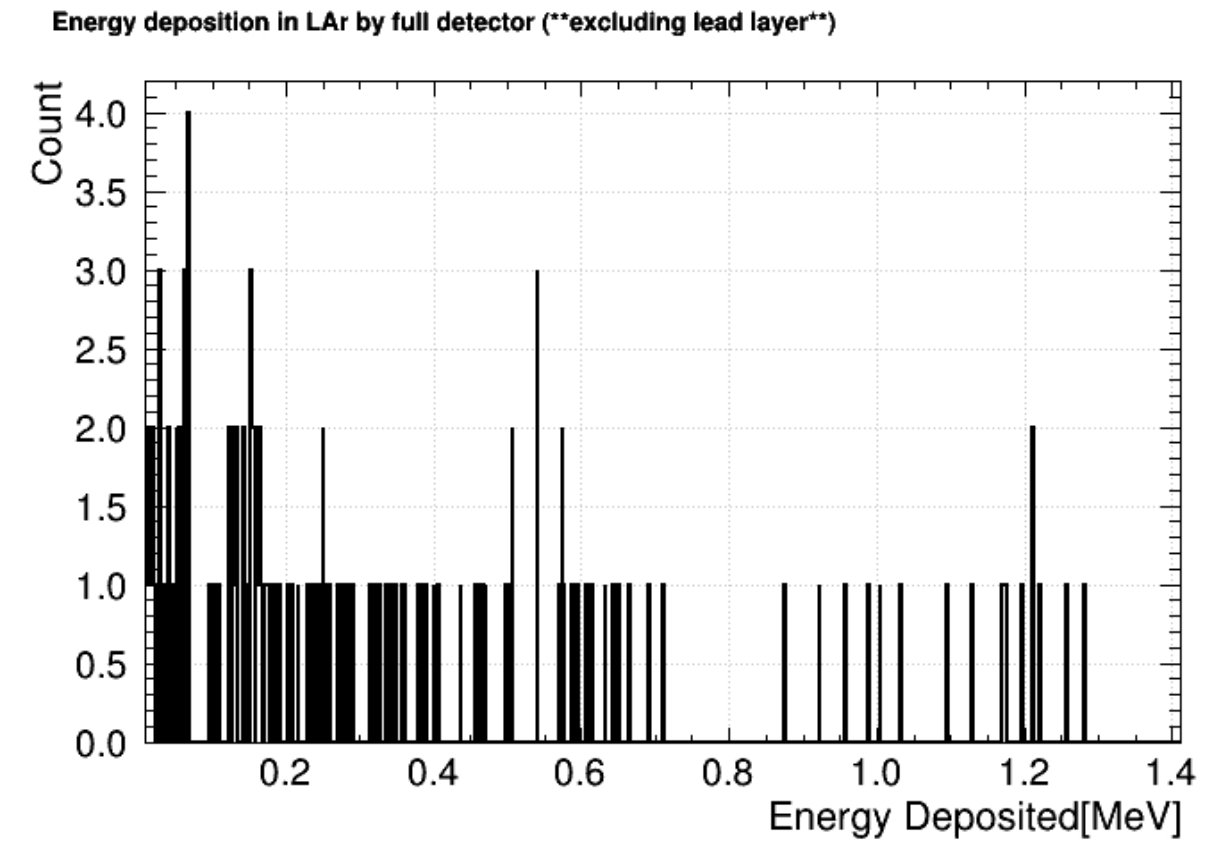
# STEP 3 – RUN SIMULATION

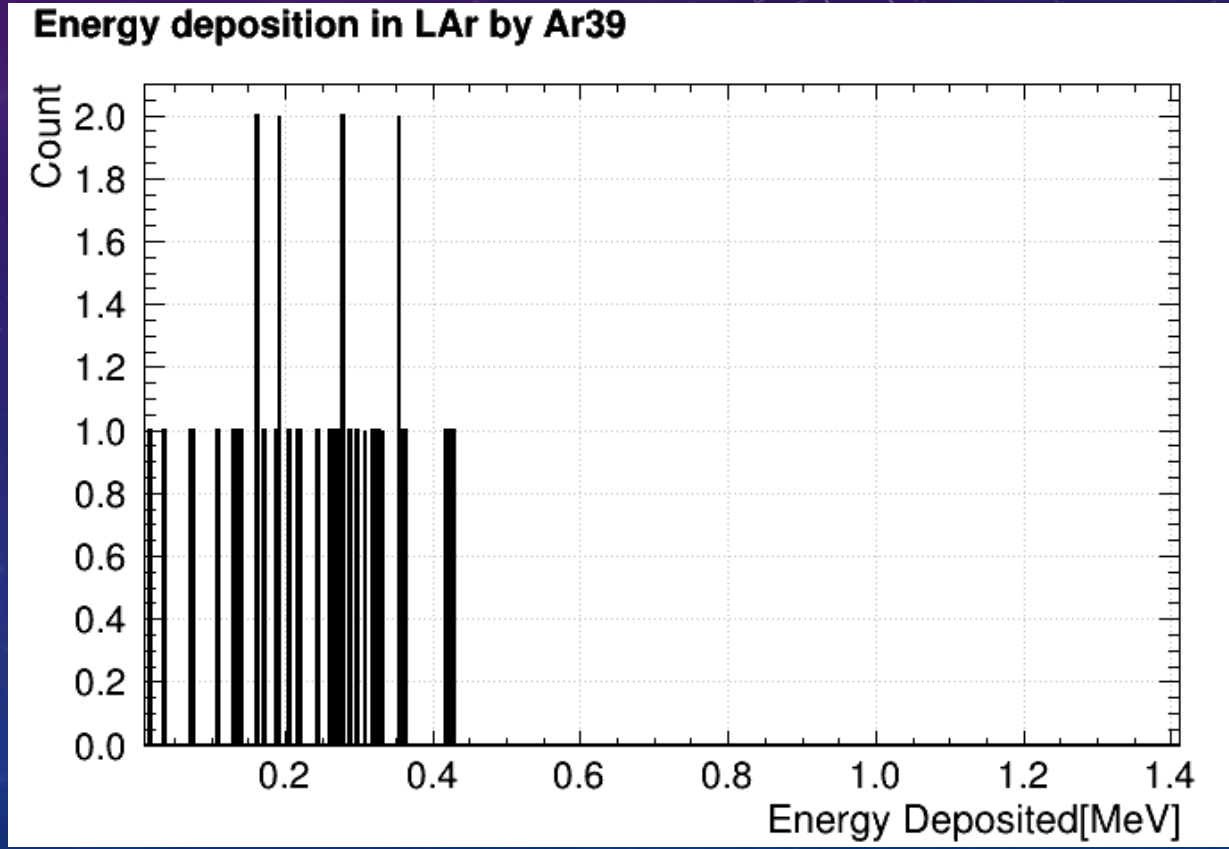
- Submit to nearline
- Results are stored in .root files
- Position information is stored in RAT logs and ROOT Tree

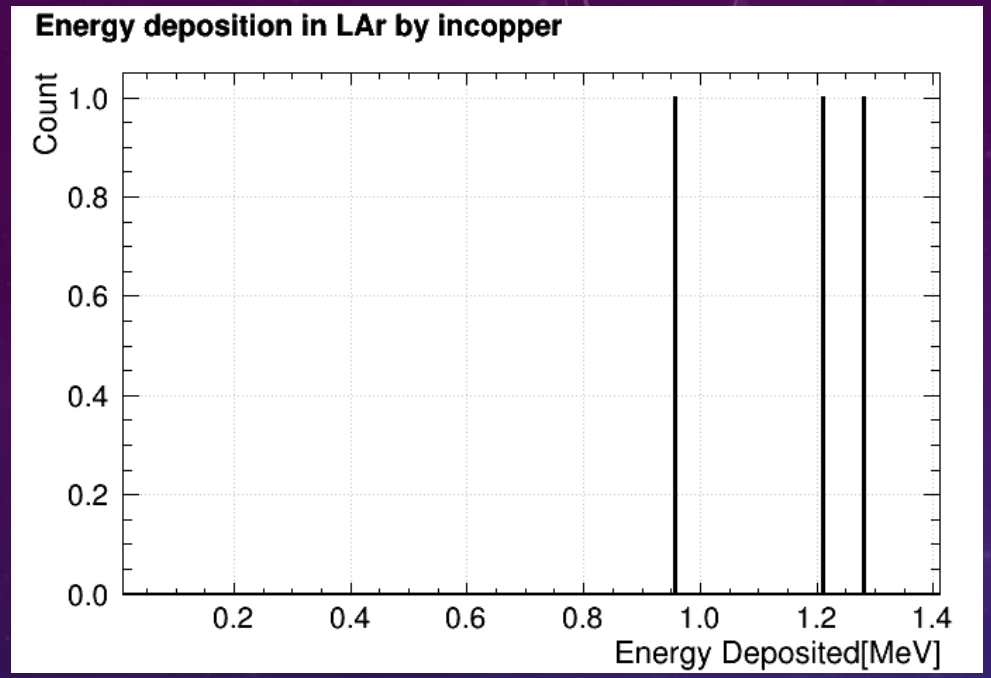
```
*********************************************************************************************************
* G4Track Information:   Particle = e-,   Track ID = 3,   Parent ID = 1
*********************************************************************************************************

Step#    X(mm)    Y(mm)    Z(mm) KinE(MeV)  dE(MeV) StepLeng TrackLeng  NextVolume ProcName
    0      137    -18.7    -49.9     0.115        0        0         0 copperOuter initStep
    1      137    -18.7    -49.9    0.0619    0.053   0.0197    0.0197 copperOuter eIoni
    2      137    -18.7    -49.9   0.00468   0.0572   0.0111    0.0308 copperOuter eIoni
    3      137    -18.7    -49.9         0  0.00468 0.000156     0.031 copperOuter eIoni
    4      137    -18.7    -49.9         0        0        0     0.031 copperOuter Scintillation
```

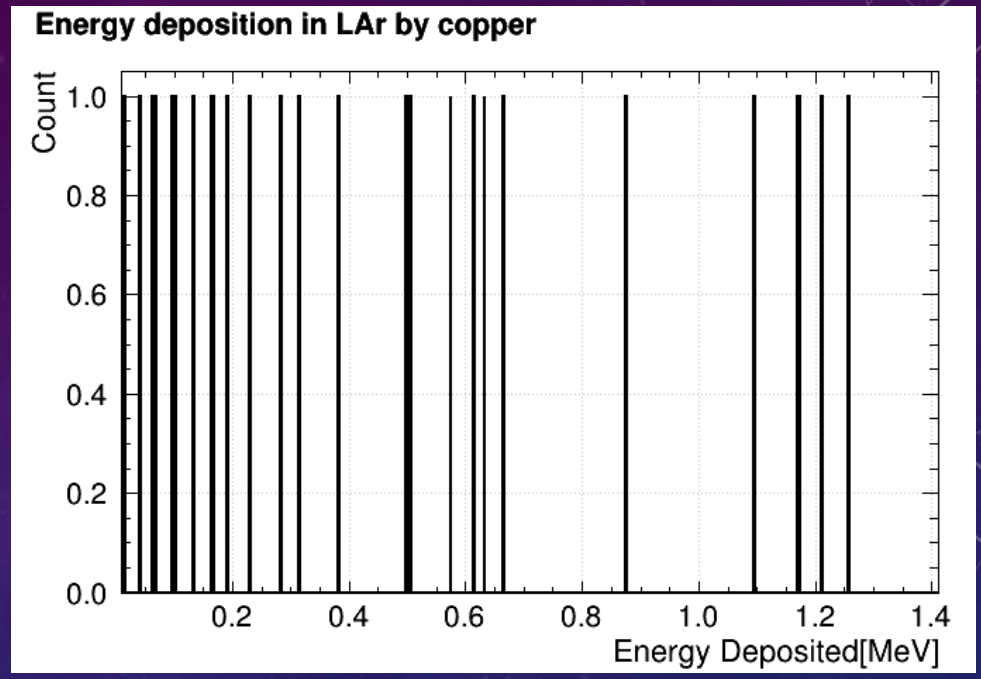
# RESULTS

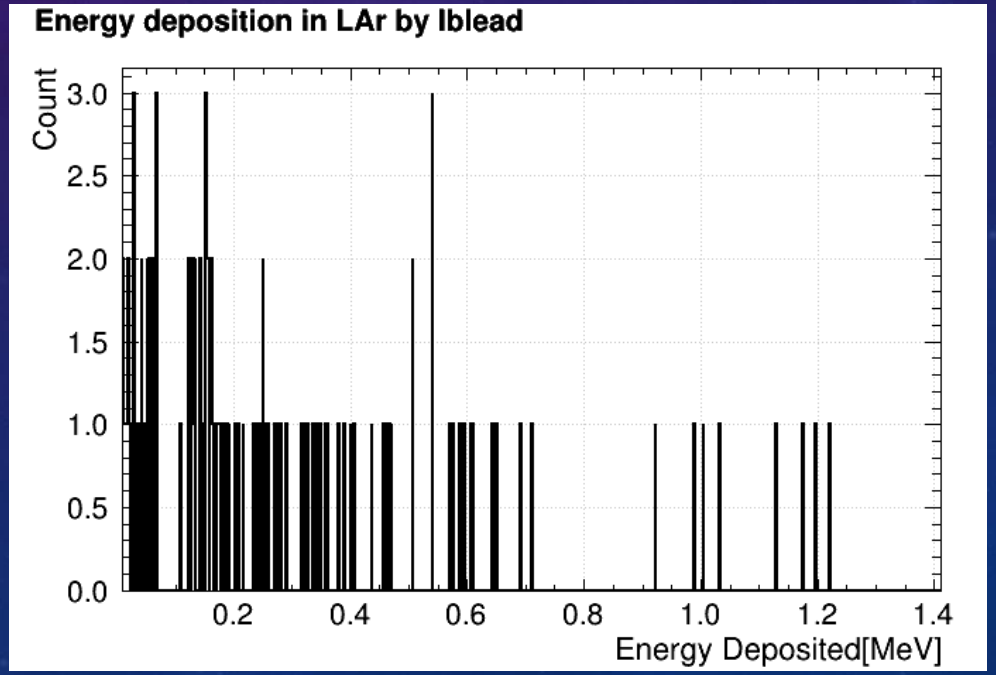
# FULL DETECTOR SIMULATION (EXCLUDING LEAD LAYER)




Energy deposition in LAr by incopper
Count
1.0
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Energy Deposited[MeV]


Energy deposition in LAr by copper
Count
1.0
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Energy Deposited[MeV]


Energy deposition in LAr by Iblead
Count
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Energy Deposited[MeV]

# CONCLUSIONS & FUTURE WORK

- Layer that contributes most to background in range of interest: clean lead
- Future work:
  - Run entire simulation with SiPMs and external backgrounds
  - Edit detector composition and geometry to mitigate backgrounds from clean lead

# THANK YOU!

# QUESTIONS?