Analysis & Dark Matter Physics Simulation for the Dark Photon Milestone 2

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Recap

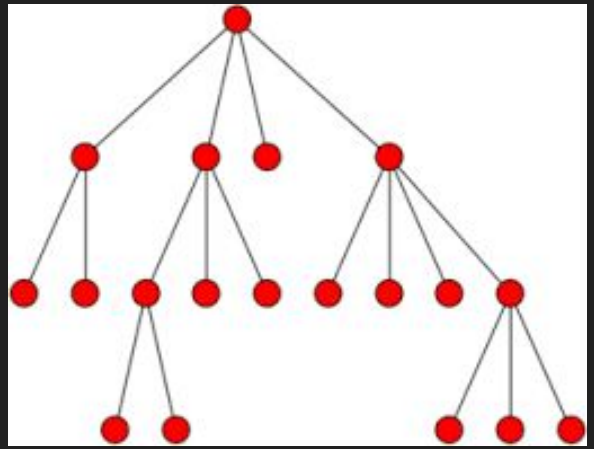
Softwares/file formats:

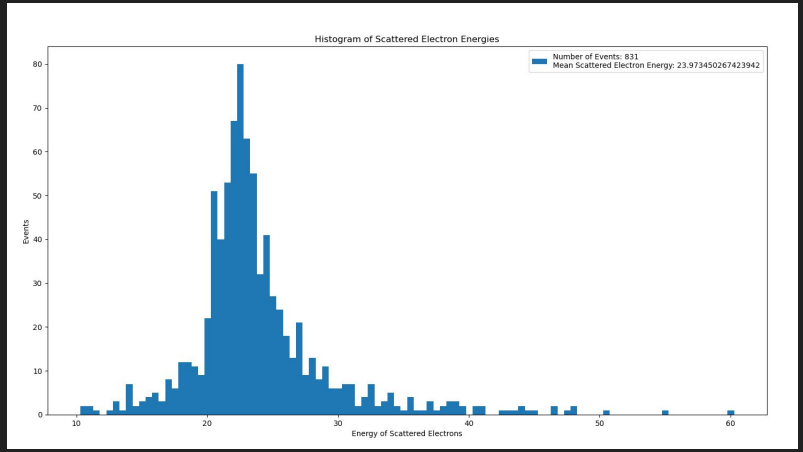
- MadGraph
- EIC shell
- ROOT
- NPSIM
- HepMC files
- .root files

The Pipeline

Root files

HEPmc files

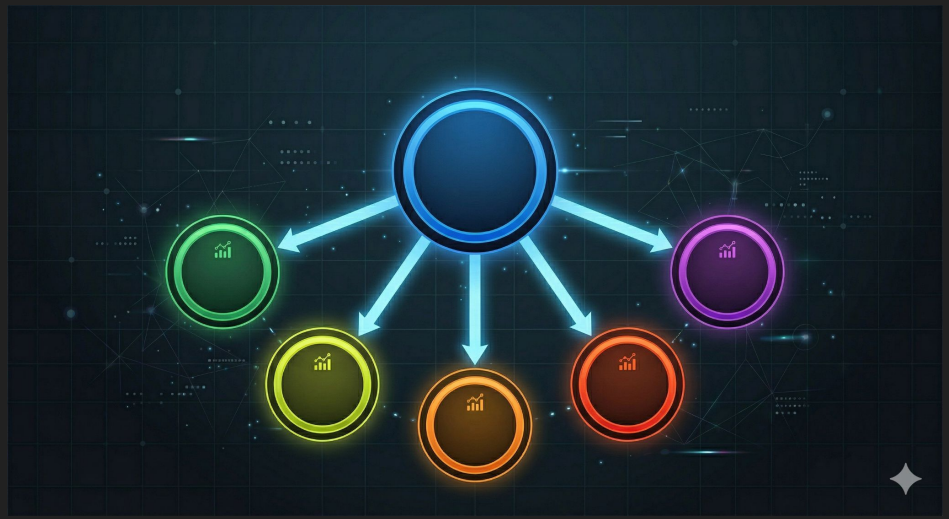




Exploring Different Masses

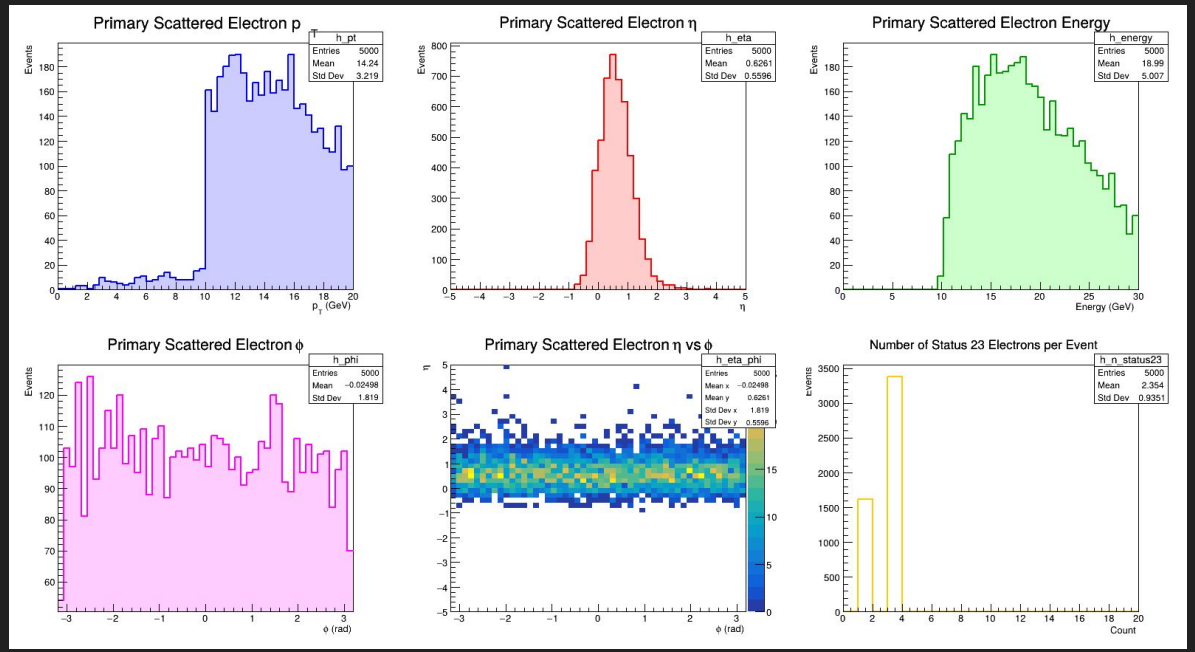
We understand how to use mad graph, now we need to automate that process.

Naming scheme is mz_1.0e-1_e_1.0e-2



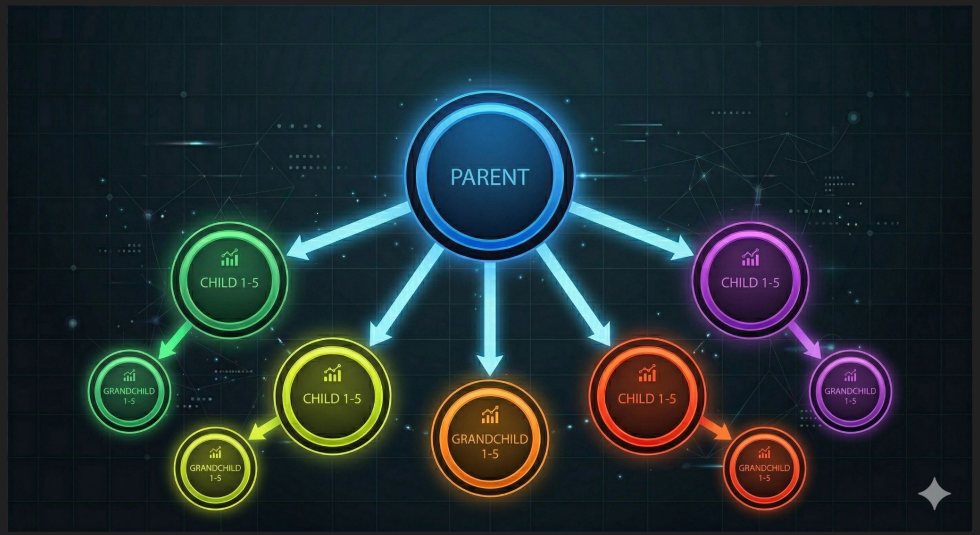
Gathering the Information

Similar to our first milestone we corrected a script that runs through the created simulation data to produce analysis root files



Automated Gathering

With the automation of the creation of the simulations, we then automated the information gathering process to match the production



Extracting Decay Values

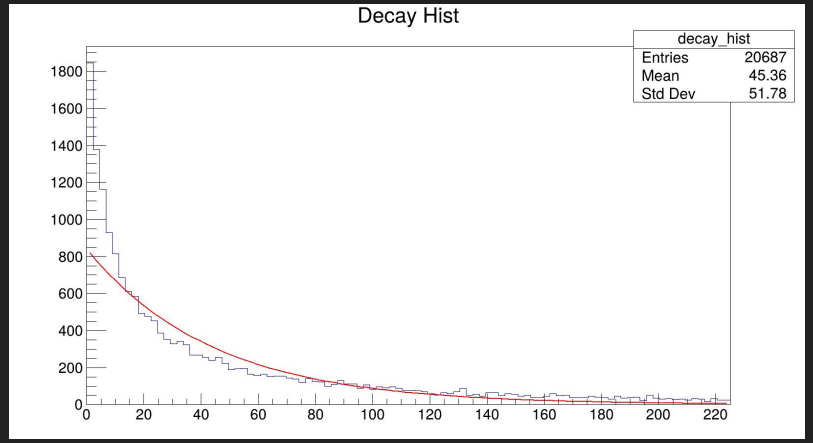
Decay Value for 1023, Dark Particle

```
File: scan_results/mz_1.0_e_1e-3//Events/run_01/run_01_tag_1_banner.txt
DECAY 1023: 1.046236e-08

File: scan_results/mz_1.0_e_1e-4//Events/run_01/run_01_tag_1_banner.txt
DECAY 1023: 1.046234e-10

File: scan_results/mz_2.0_e_1e-3//Events/run_01/run_01_tag_1_banner.txt
DECAY 1023: 2.092768e-08

File: scan_results/mz_2.0_e_1e-4//Events/run_01/run_01_tag_1_banner.txt
DECAY 1023: 2.092766e-10
```

Running c_tau and output.root on Different HepMC Files

Quickly extract needed information from multiple directories, such as:

```
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
****************************************
Minimizer is Minuit2 / Migrad
Chi2                      =      2110.76
NDf                       =           98
Edm                       =  1.28211e-07
NCalls                    =          174
p0                        =      840.826   +/-   13.2941
p1                        =    0.0225604   +/-   0.000320547
44.3254
```



Mass smaller than 1.0e-2

Mad Graph had problem generating enough events when the mass of the targeted particle was less than 1.0e-2 so we researched how to fix this


```
sed -i '/DECAY\s*32/s/DECAY\s*32\s*.*/DECAY   32   1.0e-6/' ${RUNAME}/Cards/param_card.dat
set ptj 0.0
set ptl 0.1
set mmll 0.001
set etal -1.0
set drll 0.0
set sde_strategy 2
```

Visualization

Yellow = Kaons

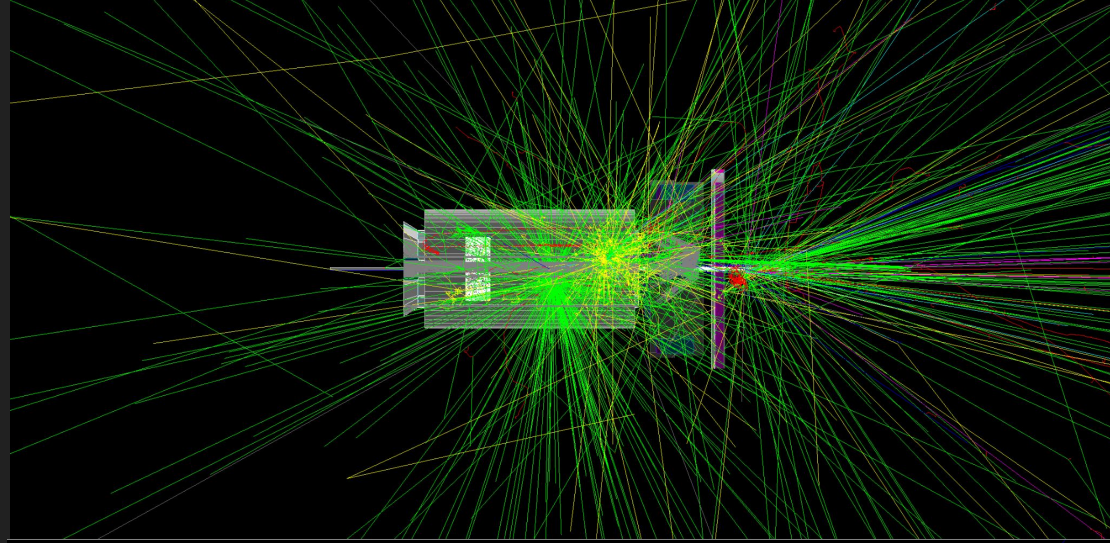
Cyan = Protons

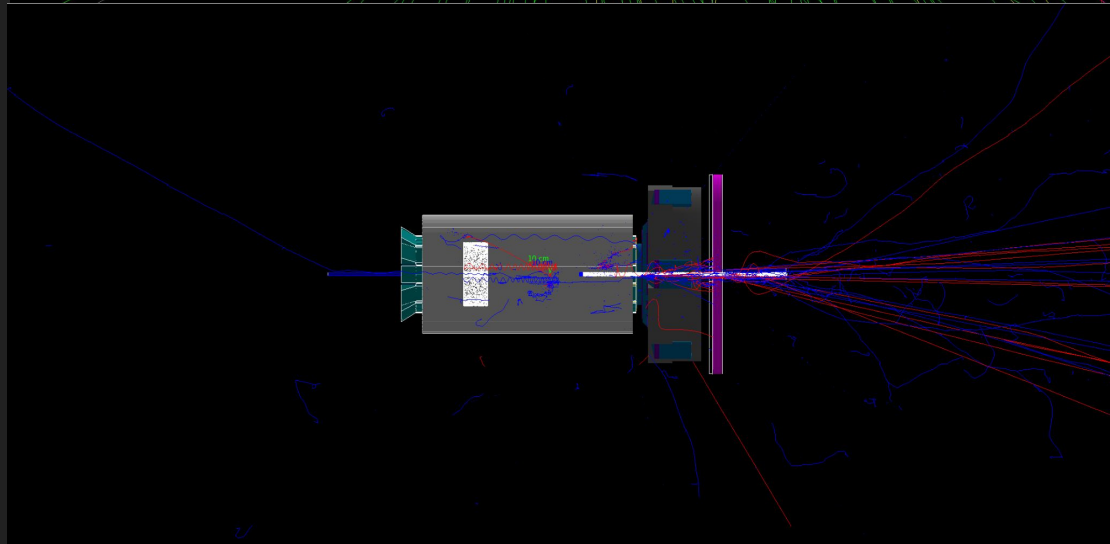
Grey = Neutrons

Red = Positrons (negatively charged electrons)

Blue = Electrons

Pink = Muons





```
/vis/open OGLSQt
/vis/verbose warnings

# Camera/style
/vis/viewer/set/viewpointThetaPhi 90 180
/vis/viewer/set/lineSegmentsPerCircle 24

# Geometry
/vis/drawVolume
/vis/scene/add/axes 0 0 0 100 mm
/vis/scene/add/hits

# Store trajectories
/tracking/storeTrajectory 1

# Filter to e- and e+ only
/vis/filtering/trajectories/create/particleFilter
/vis/filtering/trajectories/particleFilter-0/add e-
/vis/filtering/trajectories/particleFilter-0/add e+

# Color trajectories by particle ID
/vis/modeling/trajectories/create/drawByParticleID
/vis/modeling/trajectories/drawByParticleID-0/set e- blue
/vis/modeling/trajectories/drawByParticleID-0/set e+ red
/vis/modeling/trajectories/select drawByParticleID-0

# Add trajectories to scene
/vis/scene/add/trajectories smooth

# Event/run display behavior
/vis/scene/endOfEventAction refresh
/vis/scene/endOfRunAction accumulate

/vis/enable
/run/beamOn 1
```

C:\Program Files\WSL\wsl.exe

```
jug_dev> root@NK-ASUS-LP2:/mnt/h/Senior Design/workspace/eic-shell2$ npsim   --compactFile "$DETECTOR_PATH/epic_inner_detector.xml"   --inputFiles "tag_1_pythia8_events_clean.hepmc"   --hepmc3.useHepMC3 false   --numberOfEvents 1   --runType qt   --macroFile vis.mac
```

Milestone 2 Task Matrix

Task	Completion %	Nikhil	Sam	Jacob
Complete pseudorapidity, momentum, azimuthal, energy, and past related graphs with updated background subtracted signal of dark matter at the end of EIC pipeline	0%	-	50%	50%
Explore 10-20 different invariant masses and have them get run through the simulation pipeline	100%	-	50%	50%
Visualize the invariant masses to identify most probable dark matter invariant mass, and incorporate the background subtracted	50%	100%	-	-
Created Bash scripts to run MadGraph, extract decay values, and run c_tau and output.root across different HepMC files/directories	100%	-	50%	50%
MadGraph low mass fix	75%	-	-	75%

Milestone 3

- From Milestone 2, Complete pseudorapidity, momentum, azimuthal, energy, and past related graphs with updated background subtracted signal of dark matter at the end of EIC pipeline
- Streamline the process
- Get cross section comparison at generator level, at reconstruction level, Pseudorapidity (Eta), momentum transfer for each invariant mass that is put in pipeline
- Visualization of tracks

Milestone 3 Task Matrix

Task	Nikhil	Sam	Jacob
Complete pseudorapidity, momentum, azimuthal, energy, and past related graphs with updated background subtracted signal of dark matter at the end of EIC pipeline	-	50%	50%
Streamline the process	1/3	1/3	1/3
Get cross section comparison at generator level, at reconstruction level, Pseudorapidity (Eta), momentum transfer for each invariant mass that is put in pipeline	1/3	1/3	1/3
Visualization of Tracks	100%	-	-

Thank you, Questions?