Dark Matter Physics Simulation & Analysis for the Dark Photon Milestone 3

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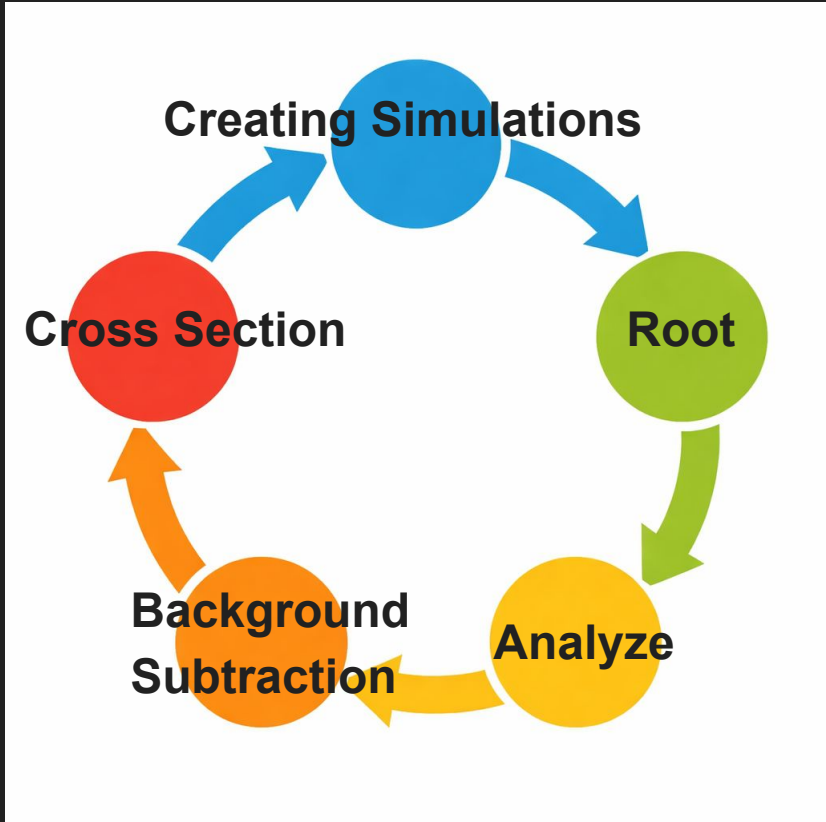
Using Our Automated System



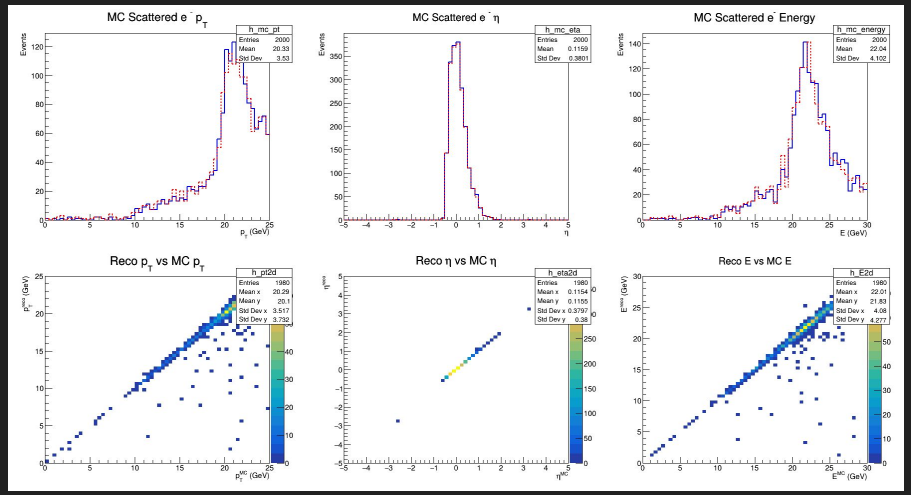
Optimal MadGraph Values

ΔR_{max} = 0.1 Energy Difference$_{max}$ = .1		
Mass (GeV)	Epsilon	Reconstruction Efficiency (%)
1×10^{-1}	1×10^{-4}	52
5×10^{-2}	1×10^{-4}	47
1×10^{-2}	1×10^{-4}	39
1×10^{-1}	5×10^{-5}	47
5×10^{-2}	5×10^{-5}	50
1×10^{-2}	5×10^{-5}	33
1×10^{-1}	1×10^{-5}	56
5×10^{-2}	1×10^{-5}	50
1×10^{-2}	1×10^{-5}	37

Background Subtraction

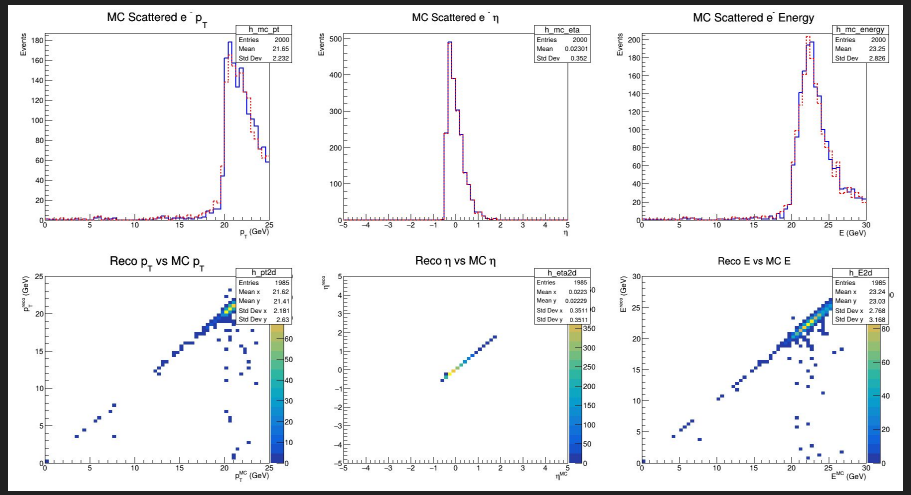
Dark Matter run

p e- > p e- zp, zp > e+ e-



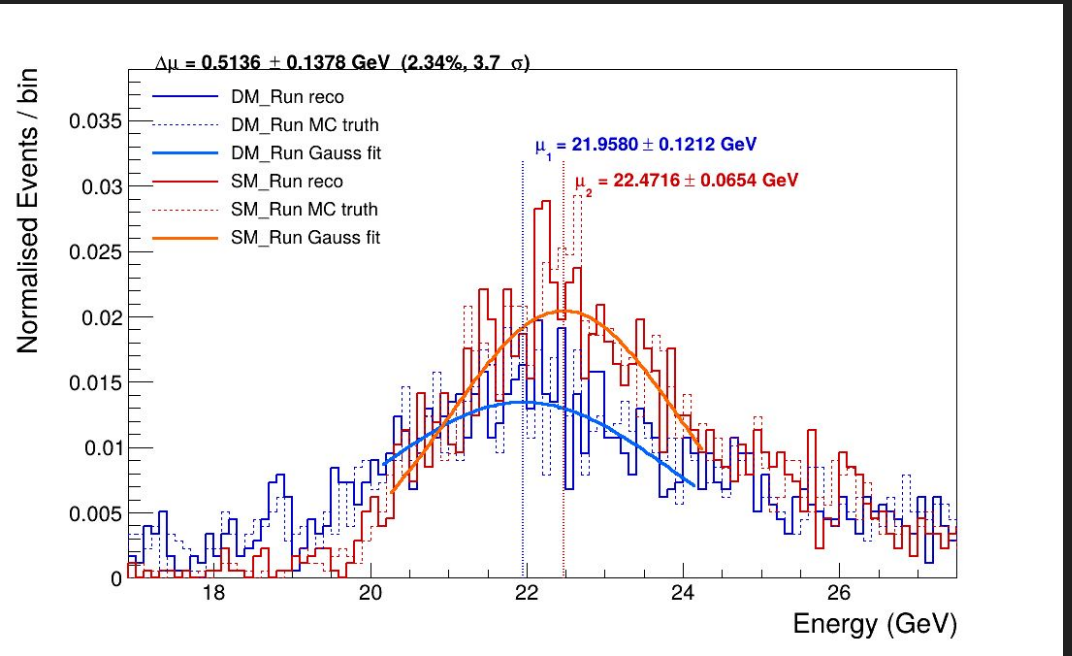
Normal Run

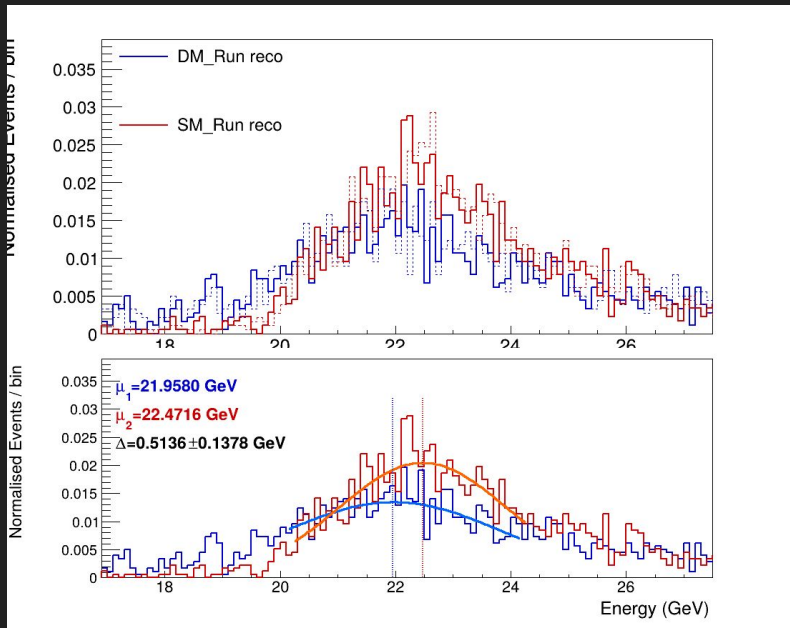
p e- > p e-



Data for Background Subtraction

Values: mzd = 1e-1 epsilon = 1e-5





Generator Level Cross-section

- Total probability that a specific process will take place in a collision of two particles
- Known as: Sigma (σ)
- In unit: picobarns (pb)

Dark Matter Run: p e- > p e- zp, zp > e+ e-

“An electron scatters off of a proton, produces a new particle, which then decays into e+ e-”

```
File: scan_results/DM_run/Events/run_01/DM_run_01_tag_1_banner.txt
Number of events: 100
Cross Section (σ): 2.5430879000670 63e-10
```

Normal (Background) Run: p e- > p e-

“A proton and an electron collide, and you get a proton and electron out”

```
File: scan_results/normal_run/Events/run_01/Normal_run_01_tag_1_banner.txt
Number of events: 100
Cross Section (σ): 63.6814600020646 04
```

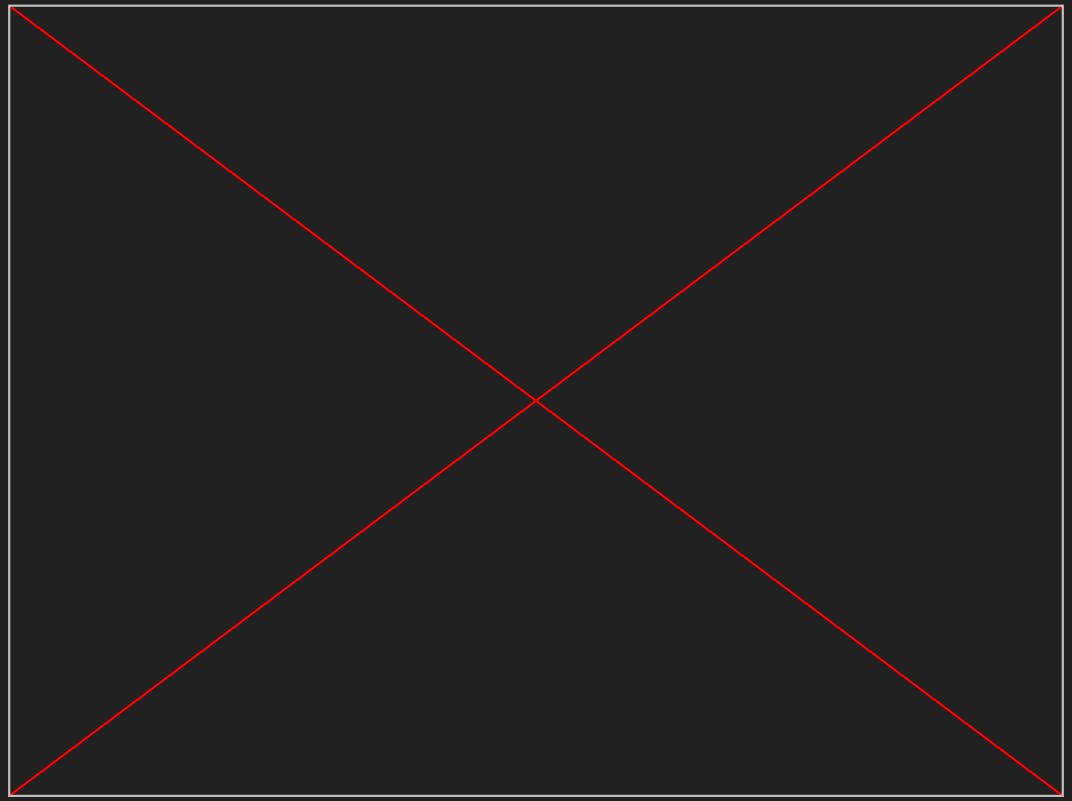
Can improve by:

- Run on more files to ensure its the correct data
- Run on files that have more events

Visualization Demo

- Commands needed for visualization:
  - ./eic_shell/eic-shell
  - source /opt/detector/epic-main/setup.sh
  - source /opt/detector/epic-main/bin/thisepic.sh
  - 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
- Geant4 visualization commands:
  - /vis/viewer/zoom 0.5 (changes the zoom by a scale factor).

Visualization Demo



Milestone 3 Task Matrix

Task	Completion:	Nikhil	Sam	Jacob	To do:
Complete pseudorapidity, momentum, azimuthal, energy, and past related graphs with updated background subtracted signal of dark matter at the end of EIC pipeline	100%	-	50%	50%	-
Streamline the process	-	33%	33%	33%	Can always improve
Get cross-section comparison at generator level and at the reconstruction level	50%	-	50%	50%	Get cross section value(s) at reco level and compare
Visualization of Tracks	50%	100%	-	-	Produce visualizations off of the data we are finding now, and find/show collision sites

Milestone 4 Task Matrix

Task	Nikhil	Sam	Jacob
Optimize background subtraction and path flow	-	50%	50%
Find a location where physicists should put another detector, aka a vertex	100%	-	-
Continue streamlining and cross section validation	-	50%	50%

Thank you, Questions?