Project:

Analysis & Dark Matter Physics Simulation for the Dark Photon

Team Members:

- Nikhil Chaba, nchaba2021@my.fit.edu
- Samuel Rock, srock2023@my.fit.edu
- Jacob Woods, jwoods2022@my.fit.edu

Faculty Advisor:

- Pietro Iapozzuto, piapozzuto2015@my.fit.edu

Clients:

- Dr. Marcus Hohlman - Physics Professor
- Pietro Iapozzuto - Graduate Student with Dr. Hohlman
- Other Graduate Students

Progress of Current Milestone (Matrix):

Task	Completion %	Nikhil	Sam	Jacob	To do
Learn and understand how to use MadGraph, HEPMC, and ROOT	100%	1/3	1/3	1/3	-
Read HEPMC Files	100%	1/3	1/3	1/3	-
Use ROOT to identify particle id numbers ie 1023 is dark photon candidate as a parent particle and its decays (children) and graph physics related quantities ie Momentum of scattered particle	100%	-	-	100%	-
Use ROOT to graph signals of initial proton and electron, the scattered electron and decay products at the madgraph generator level, and compare it to the EIC reconstruction level	50%	-	-	50%	Create more unique HepMC and ROOT files, get more examples of quantities at both levels, and then start comparing
Install EiC RECO and Use EIC Geometry, NPSIM to output reconstruction root file	100%	100%	-	-	-
Produce EIC visualization using inner detector obtaining dark matter decay product e- e+ tracks	100%	100%	-	-	-

Using HepMC file data, produce a Python script that works along with ROOT to produce histograms of scattered electron energy	100%	-	75%	25%	-
Requirement Document	100%	100%	-	-	-
Design Document	100%	-	100%	-	-
Test Plan	100%	-	-	100%	-

Discussion of each accomplished task for the current Milestone:

- Task 1: Learned the numerous tools that are used in the simulation pipeline, which were all new to us, and had trouble producing visualizations, but now the frames per second of the models are too slow to be operable.
- Task 2: Learned how to read the HepMC files line by line in text readers/editors, and what certain numbers and characters are, and importantly, which ones we will be comparing at the end of the pipeline.
- Task 3: Wrote a script to properly identify specific particles and retrieve the wanted quantities, and graph them.
- Task 4: Wrote a script to retrieve signals, but still need to create more unique HepMC and ROOT files, get more examples of quantities at both levels, and then start comparing them
- Task 5: Got a reconstructed ROOT file through ddsim
- Task 6: Produced visualizations of the detector and dark matter materials, such as gamma rays and traces of positrons and electrons
- Task 7: Wrote a Python script that reads specific scattered electron particles and retrieves their energies, gets the mean scattered electron energy, and puts the data on a histogram.
- Task 8: Goes over the functional and non-functional requirements of our pipeline.
- Task 9: Includes the overview, design, and architecture of our pipeline and how each component goes together.
- Task 10: Goes over the testing, validating, and core features of our pipeline.

Discussion of the contribution of each team member to the current Milestone:

- Nikhil Chaba: Learned and understood the tools we will be using, looked into the HEPMC file data, created a ROOT file, produced visualizations of detector and gamma, positive, and negative rays, and wrote the Requirements Document
- Samuel Rock: Learned and understood the tools we will be using, understands how to read HEPMC file data, produced a Python script that would read a

HEPMC file, produce a histogram of scattered electron energies, and produce the number of total events and the mean of electron energy, wrote the Design Document, and worked on the Milestone 1 Evaluation and Presentation
- Jacob Woods: Learned and understood the tools we will be using, knows how to read HEPMC file data lines, produced part of a Python script that would read a HEPMC file, used ROOT to produce a C++ script to graph HepMC and ROOT files, wrote the Test Plan Document, and worked on the Milestone 1 Presentation

Plan for the next Milestone (Matrix)

Task	Nikhil	Sam	Jacob
Create and complete graph of background subtracted signal of dark matter at the end of the EIC pipeline	-	50%	50%
Explore 10-20 different invariant masses and have them get run through the simulation pipeline	-	50%	50%
Visualize the invariant masses to identify most probable dark matter invariant mass, and incorporating the background subtracted	100%	-	-

Discussion of each planned task for the next Milestone:

- Task 1: Make and complete the graphing of background subtracted signals of dark matter materials at the end of the simulation pipeline
- Task 2: Get various invariant masses and put them through the entirety of the simulation pipeline and check that all aspects of the pipeline function as intended while producing the correct data and their differences
- Task 3: Produce visualizations of the variant masses at the end of the pipeline showing the dark matter materials and be able to see the background subtraction

Date(s) of meeting(s) with Client during the current milestone:

x

Client Feedback

- **See Faculty Advisor Feedback below**

Date(s) of meeting(s) with Faculty Advisor during the current milestone:

1/27, 1/29, 2/2, 2/9, 2/16

Faculty Advisor feedback for the current Milestone

- The group had done an excellent job meeting milestone 1 , Milestone 1 was focused on the group being able to learn and replicate the past work on the pipeline we have done. Each student has surpassed my expectation , this was a great amount work and each been successful in replicating a madgraph process, getting EIC repo to work , and visualization. This puts them in very good standing for milestone 2.