FERMILAB-POSTER-21-104-STUDENT

NEGATIVE MUON COUNT FOR THE MUON g-2 EXPERIMENT

Elettra Preosti, University of California, Berkeley, CA

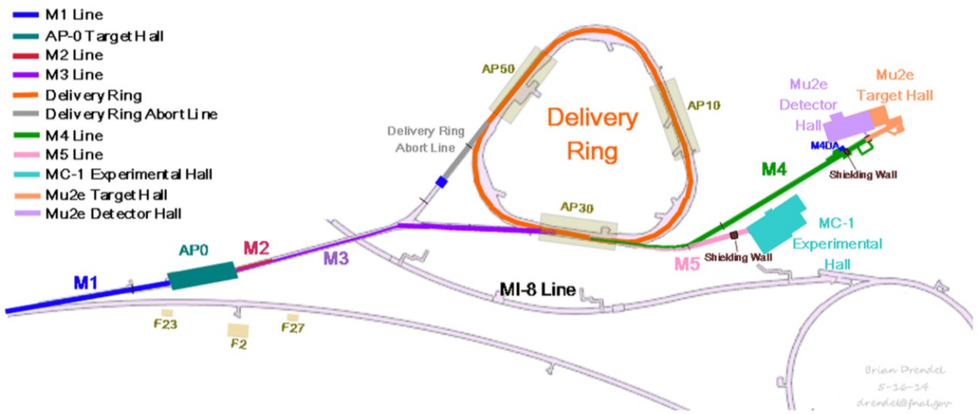
INTRODUCTION

The Fermi National Accelerator Laboratory (FNAL) Muon g-2 experiment, located in Batavia, IL, USA seeks to measure the anomalous magnetic moment (a_μ=(g-2)/2) of muons to a .14 ppm uncertainty.

Muons are prepared in the Muon Campus Accelerator before they are delivered to the FNAL Muon g-2 experiment, which only accepts muons with momentums within ~.2% of 3.094 GeV/c dubbed the 'magic momentum' (MM).

The Muon Campus Accelerator used to deliver muons to the FNAL Muon g-2 experiment consists of the following components:

- **M1 Line**: Delivers 8GeV/c protons to the AP-0 Target Hall
- **AP-0 Target Hall**: Produces a secondary beam containing pions, kaons, and muons
- **M2 and M3 Lines**: Transports secondary beam to the Delivery Ring
- **Delivery Ring** (4 turns): Allows for pions and kaons to decay to muons; separates muons from protons
- **M4 and M5 Lines**: Delivers muons to FNAL Muon g-2 experiment Storage Ring



A schematic of the FNAL Muon Campus Accelerator.

MOTIVATION

So far, all experiments to measure a_μ have only used positive muons. However, the FNAL Muon g-2 experiment is planning to run with negative muons beginning in 2022 for the following reasons:

- To confirm that the same value of a_μ is obtained as for positive muons.
- To test Charge Parity Theory and Lorentz Invariants

The goal of this work is to estimate the rates of negative muons arriving at the FNAL Muon g-2 experiment

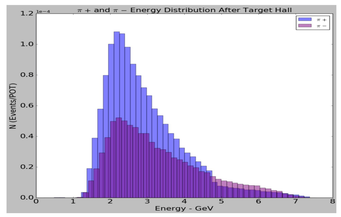
METHODLOGY

This work was conducted using the Geant4beamline program in the National Energy Research Scientific Computing Center (NERSC). Muons were tracked through separate simulations for separate sections of the Muon Campus Accelerator, with the output of the prior section becoming the input of the next (ex. the output after four turns in the Delivery Ring becomes the input of the M4 and M5 lines).

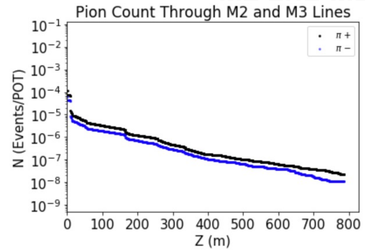
RESULTS

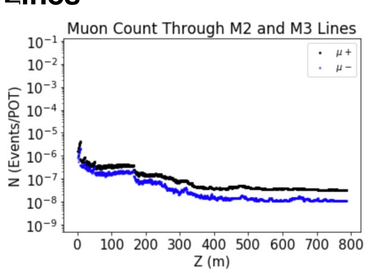
The rate of negative muons arriving at the FNAL Muon g-2 experiment was estimated to be approximately 0.549 the rate of positive muons arriving at the FNAL Muon g-2 experiment. However, this simulation considered only 10^9 protons on target (POT), which resulted in approximately 1000 particles at the end of the M5 line. For future studies, we suggest increasing the number of POT by at least an order of magnitude.

AP-0 Target Hall

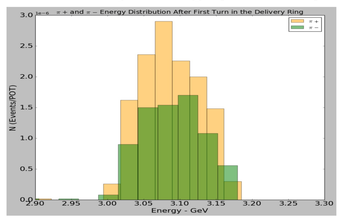


M2 and M3 Lines

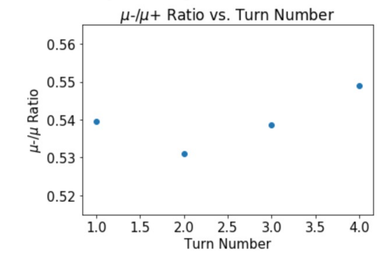




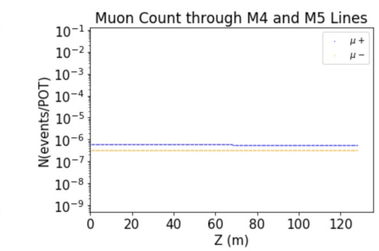
Delivery Ring (Turn 1)



Delivery Ring (4 Turns)



M4 and M5 Lines



The table to the right indicates the ratio of positive and negative pions that have momentum within ~.2% of 3.094 GeV/c as well as positive and negative muons that have momentum ~.2% of 3.094 GeV/c at different stages of the Muon Campus Accelerator.

	π-/π+	μ-/μ+
Target (Before Magnet)	0.614	0.375
Target (End)	0.570	0.400
M3 Line (End)	0.532	0.507
DR (Turn 1)	0.545	0.540
DR (Turn 2)	0.529	0.531
DR (Turn 3)		0.539
DR (Turn 4)		0.549
M5 Line (End)		0.549