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Numerical Study of a Passive Wedge Absorber System for Momentum Selection of Muon Beams

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Fermilab Muon g-2 Experiment:

Goal

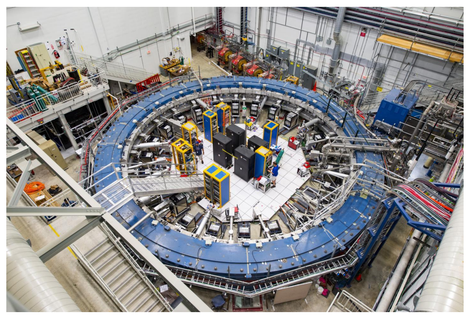
Measure the muon anomalous magnetic moment (g-2) with 0.14 ppm uncertainty - a fourfold improvement of the BNL measurement (0.54 ppm)

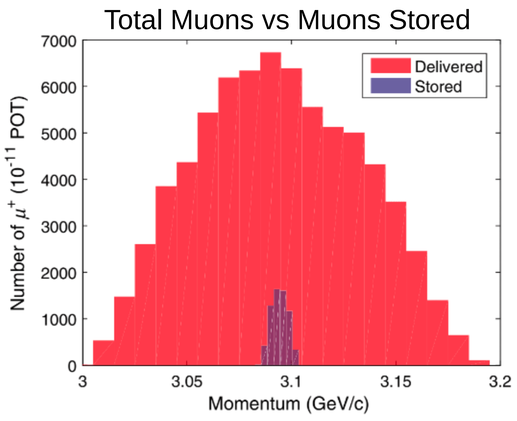
Approach

Circulate 3.1 GeV/c polarized muons in a uniform magnetic field and measure the precession frequency

Challenge

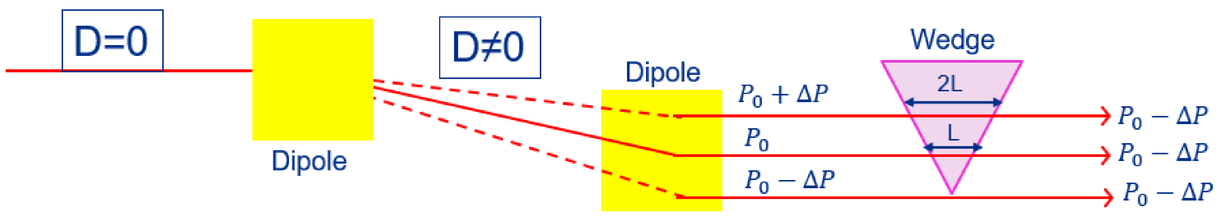
The beam delivered to the storage ring of the Muon g-2 Experiment has a rms momentum spread that is 10 times larger than the ring can accept resulting in 90% of the incoming beam being lost



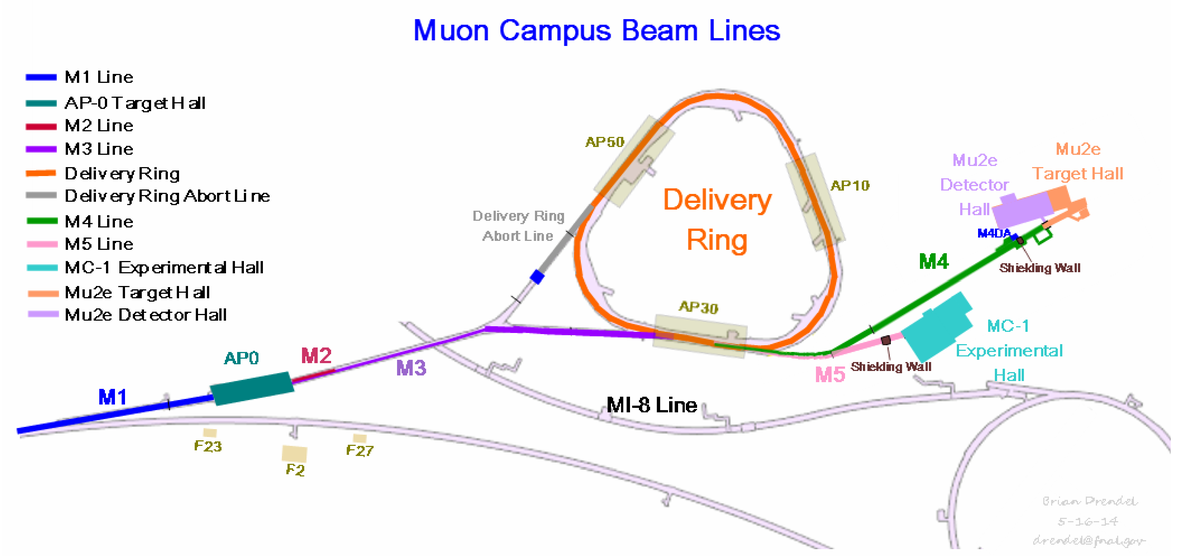


Proposed Solution:

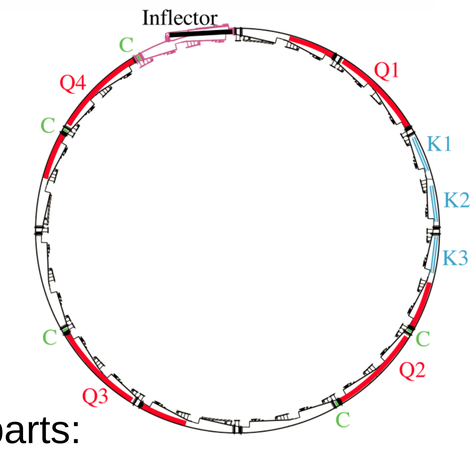
- Begin by separate particles by momentum, guiding them into a dispersive area
- Then, pass the beam through a wedge absorber
- With a properly designed wedge, high-energy muons will lose more energy than low-energy ones and as a result, the overall energy spread of the beam is reduced



Goal of this Study:



- In this study, a wedge system will be inserted along the M5 line and its performance will be studied with the code G4beamline
- We will examine the sensitivity in performance for different wedge offsets and compare our findings with recent experimental data

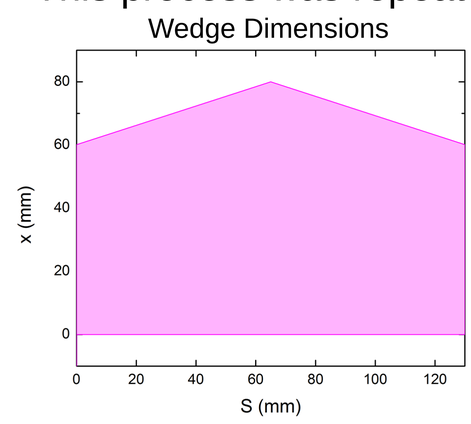


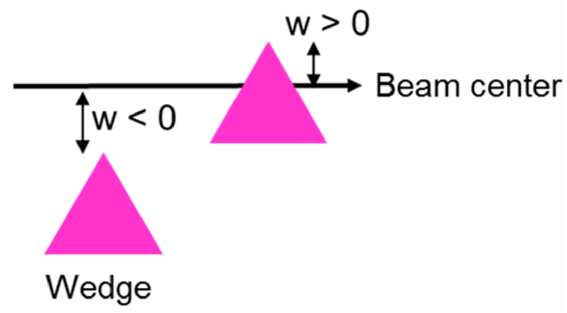
The simulation study is divided into two parts:

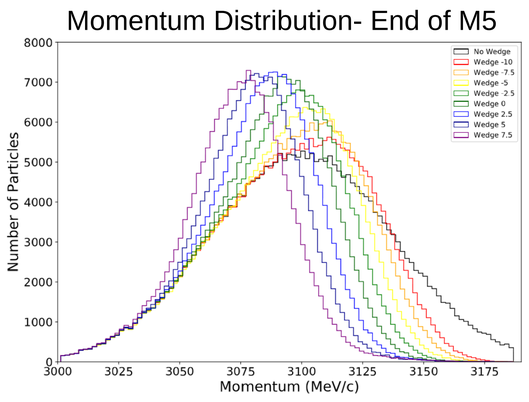
- Along the M4-M5 lines of the Fermilab Muon Campus and through the inflector
- Around the storage ring

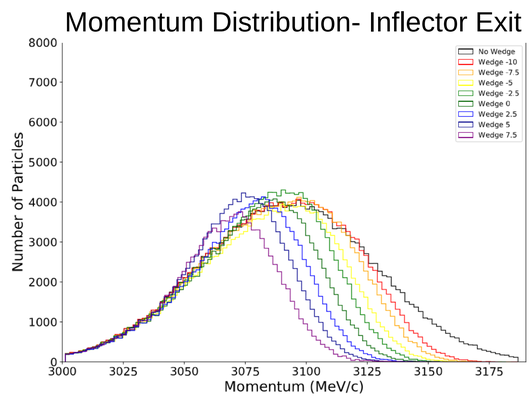
Results along the Muon Campus M4-M5 lines and Inflector:

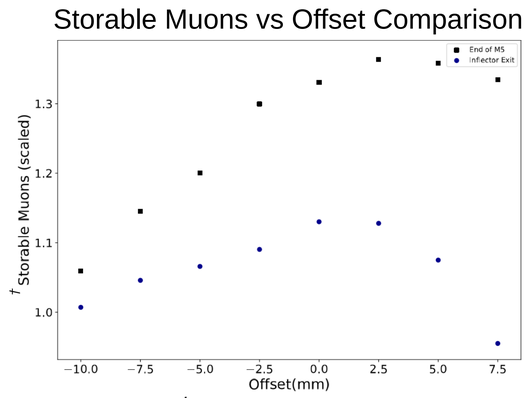
- An initial distribution of muons was created and tracked through the M4 and M5 lines with a wedge made of boron carbide placed at 8 different offsets
- The particles were then tracked through the inflector
- This process was repeated for a distribution of positrons

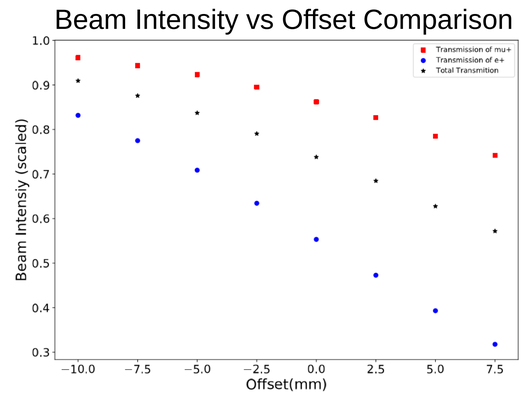








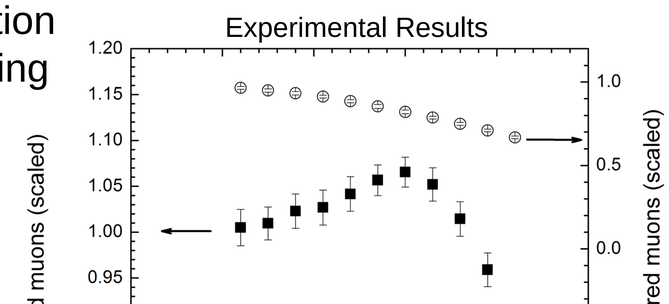


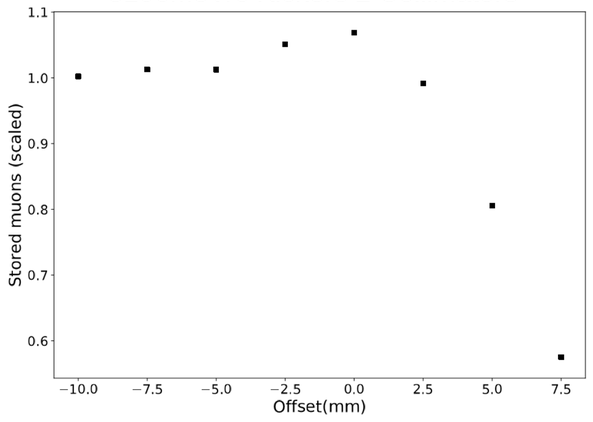


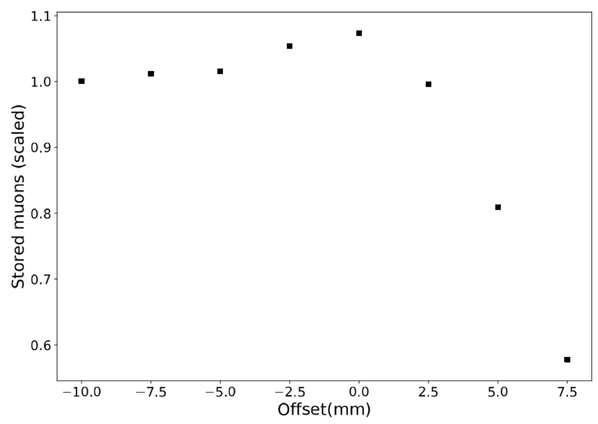
†Storable Muons are muons within 0.2% of 3094 MeV/c

Results along the Muon g-2 Storage ring:

- After the inflector, the distribution was passed into the storage ring for 30 turns
- The storage ring was run with different parameters including
  - With and without the kickers
  - With 5 collimators
  - With 2 collimators
  - With incoming energies of 3100, 3106, and 3110 MeV/c







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