



The Muon $g-2$ Experiment – Investigating how the spin of a muon is affected as it moves through a magnetic field

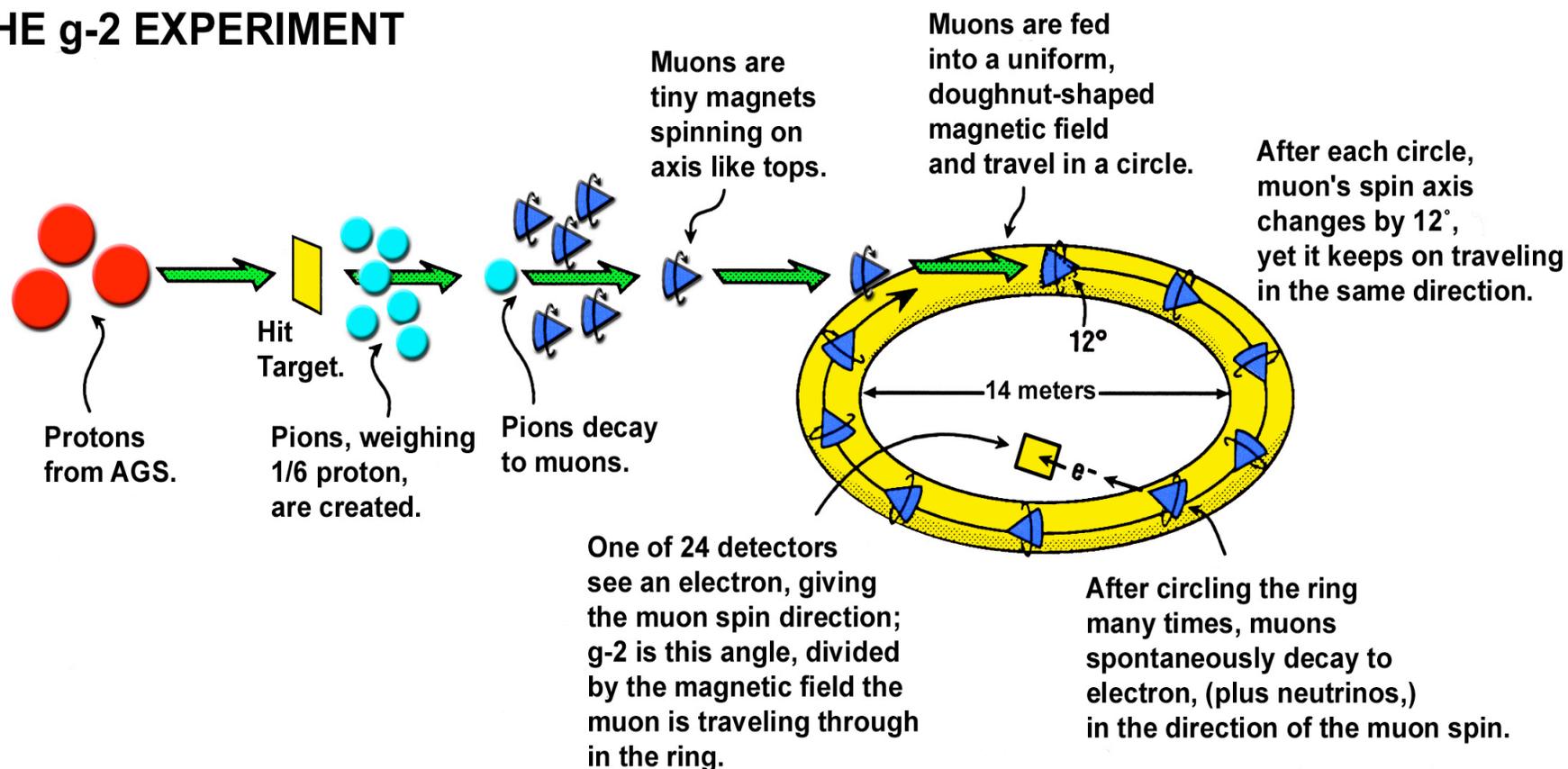
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The E821 Muon Experiment at BNL

- In 2004, the $(g-2)$ value of the negative muon was announced.
- The anomalous magnetic moment of the negative muon was measured to a precision of 0.7 ppm at BNL.
- Tested the Standard Model – but with a small discrepancy with the SM

Experiment Overview

LIFE OF A MUON: THE g-2 EXPERIMENT



Muon g-2 storage ring as installed at BNL

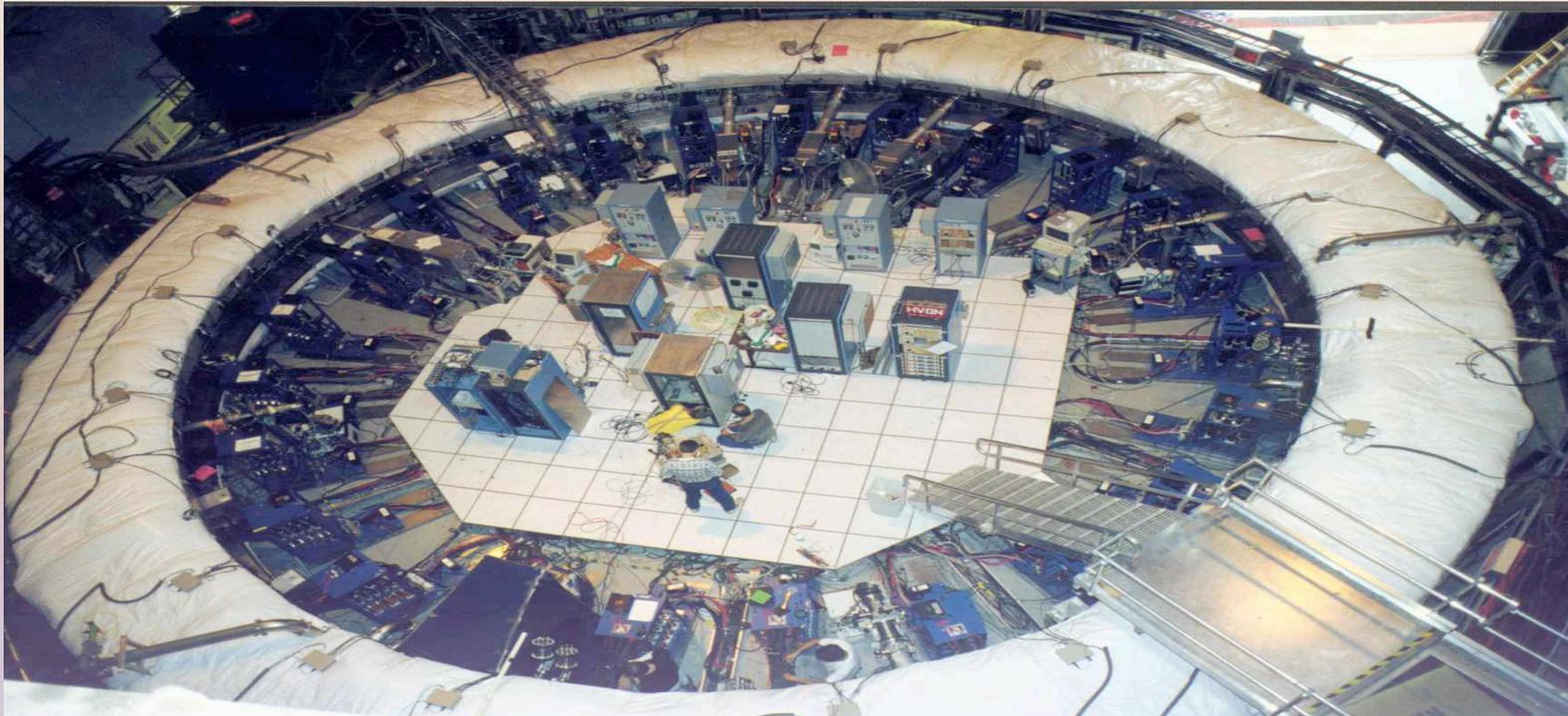


The new Muon g-2 Experiment at Fermilab

- Goal of the E-989 muon g-2 experiment is:
 - To measure the muon anomalous magnetic moment to 0.14 ppm.
 - Significant reduction in uncertainties and an increase in statistics by a factor of 20.
- New Physics beyond the Standard Model.
- Will use the fermilab beam complex to prepare a custom muon beam that will be injected into the relocated muon storage ring.

The Experiment at Fermilab

- Use existing E821 storage ring from BNL.....



Helicopters???



Modifications

1) Straw detector

- Measure EDM (Electric Dipole Moment) and find its 'limit'
- Aid in lowering the systematic error of the measurement.

2) Count positrons with new, segmented calorimeters.



The Straw detector

- At lab 3, making straws in the clean room



Material Analysis

- Guiding Question:
 - How will different materials in front of the straw tube affect the particles and their detection?
- Used GEANT 4 – a toolkit for the simulation of the passage of particles through matter
- Addition of a traceback detector (a 2-cm thick block)
- Changed materials in the traceback detector and plotted histograms for different materials and observed the energy loss.

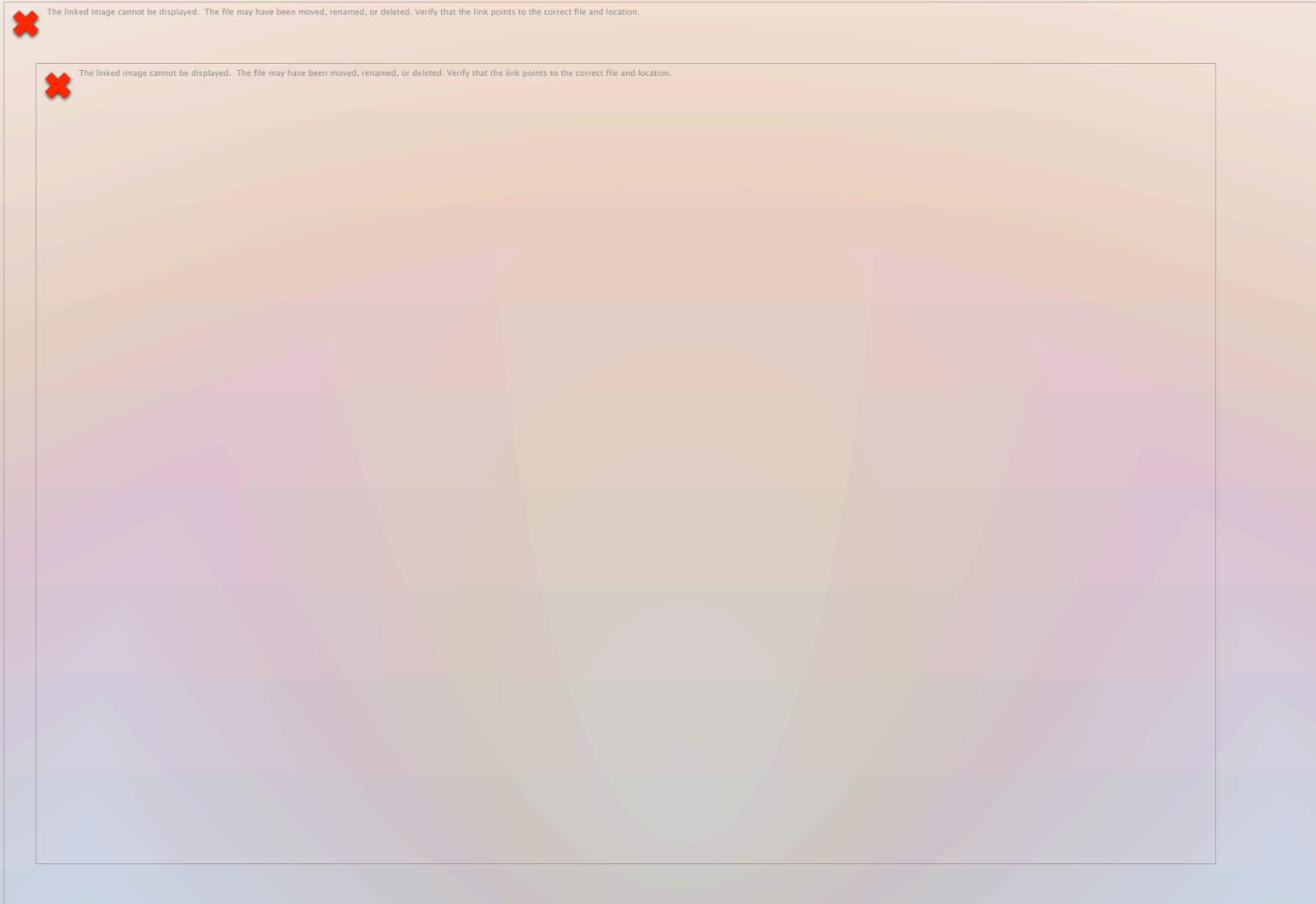
- For electrons, cut the turns on and draw histograms for turns > 4 and momentum < 2.8 .
- Needed more than 10k events per run.
- Run jobs on the grid.
- Ran 200,000 event jobs on the grid for each material and drew histograms for radiation length in cms vs. energy loss in GeV.

The materials used were W, Pb, Cu, Fe, Ti Al, Si,
H₂O.

Below is a plot of the energy loss (GeV) with the
material listed above vs. the radiation length of the
material (cm)



I also plotted the energy loss(GeV) for N, Air and Vacuum vs. the radiation length (cm) as shown below:

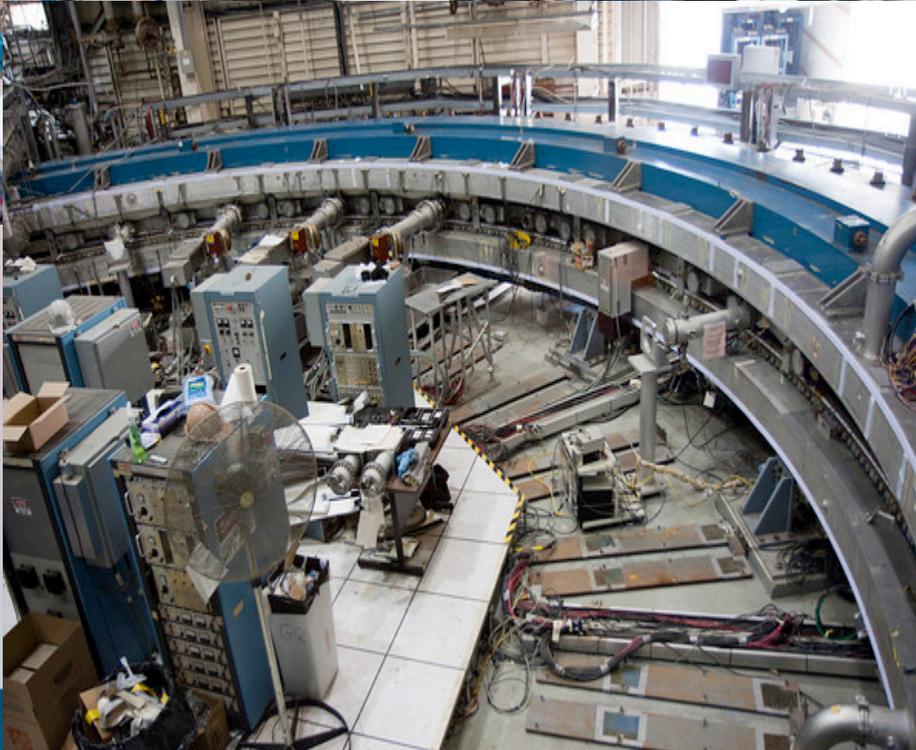


Next Steps

Try to plot the energy loss vs. radiation length for different shapes.



Pics of dis-assembly



Future of muon g-2 at fermilab

- In the next few years:
 - World class μ program at Fermilab with new g-2 and Mu2e.
- Next generation:
 - Continue and expand program using available intensity from Project X.

Thank You

Fermilab TRAC program - Harry Cheung & Bjoern Penning – for this amazing opportunity

Adam Lyon – excellent mentor – patiently taught me C++ and other required software

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