Track reconstruction software and performance studies of the Fermilab Muon g-2 straw tracking detectors

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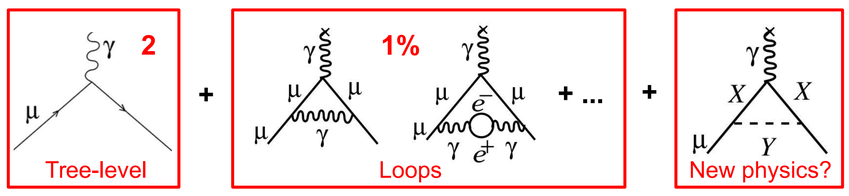
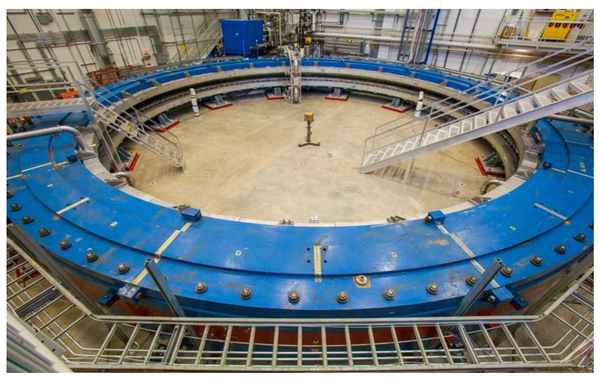
On behalf of the Muon g-2 Collaboration

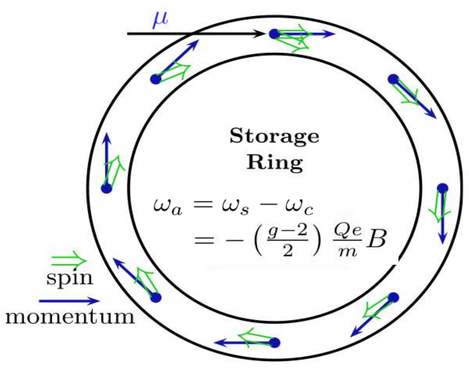
Muon g-2

$\vec{\mu} = g\frac{q}{2m}\vec{s}$ g =



- Particles with spin have intrinsic magnetic moment characterised by g-factor (~2 for spin ½)
- Contribution from above tree level diagrams → g-2 (anomalous magnetic moment)
- Lepton g-2 measurements are precision tests of SM (small QCD contribution)

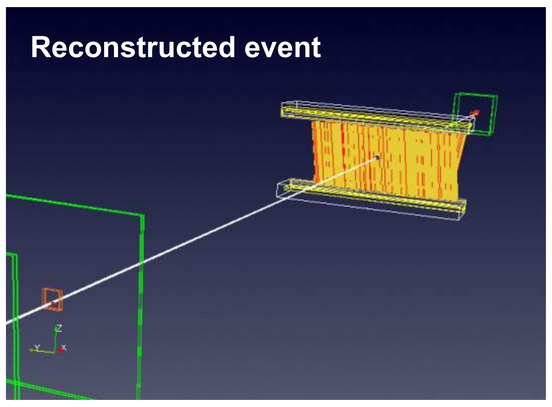


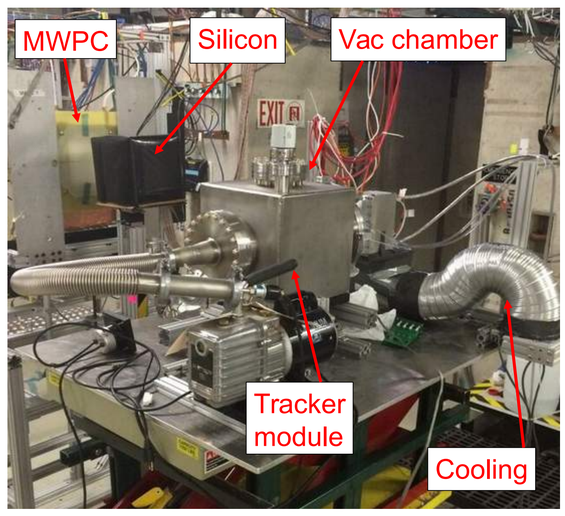


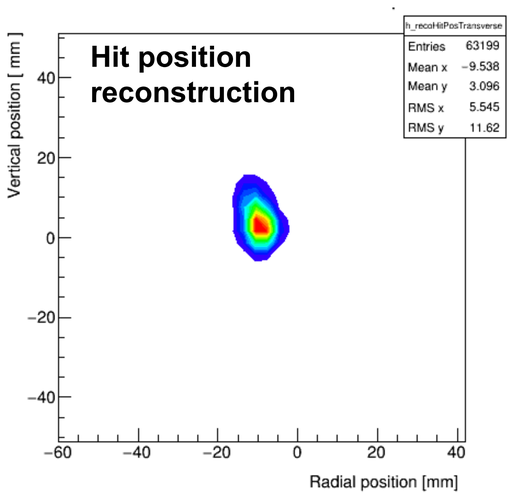
- Measure μ g-2 by observing spin precession in storage ring B field via decay e^+ E modulation
- BNL 540 ppb measurement of muon g-2 found **3.6σ** discrepancy w.r.t. SM → **new physics?**
- Seek to confirm/reject with 140 ppb storage ring measurement at Fermilab

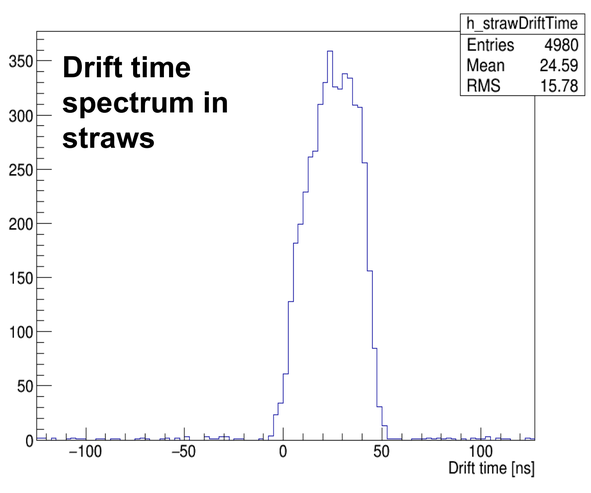
Test Beam At Fermilab

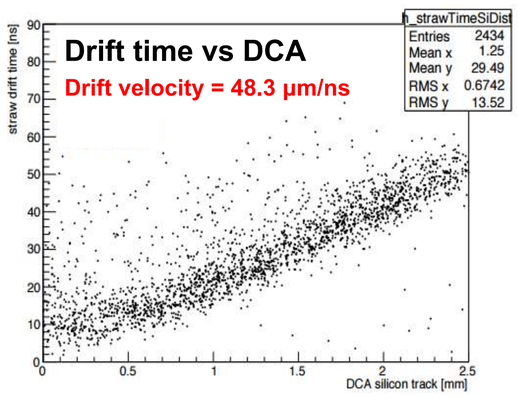
- Test beam for tracker module June 2015
- Fermilab MTest facility (120 GeV protons)

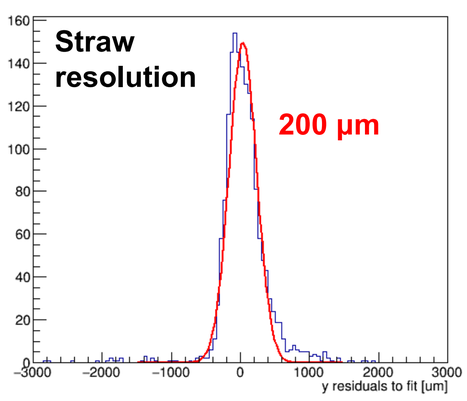










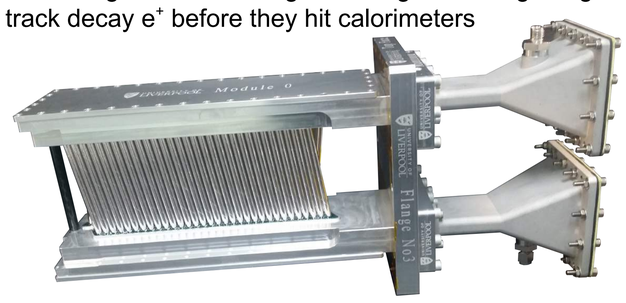


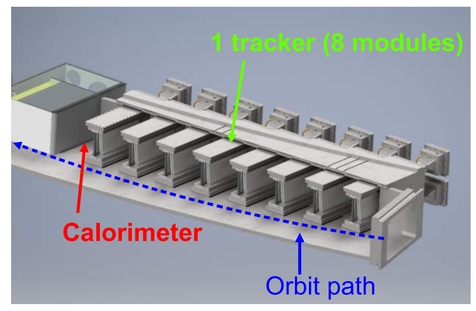
In collaboration with:

University of Liverpool · University of Oxford · Boston University · Fermilab · NIU

The Straw Tracker

- Tracking detectors along inner edge of storage ring track decay e^+ before they hit calorimeters

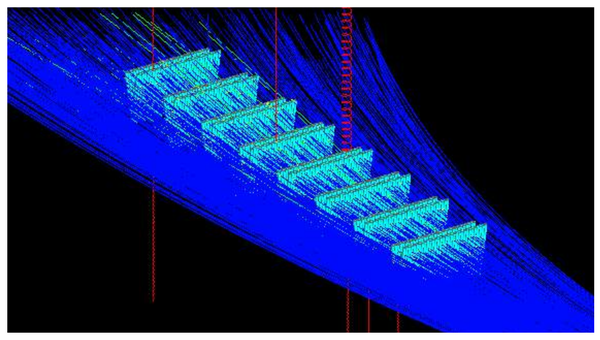


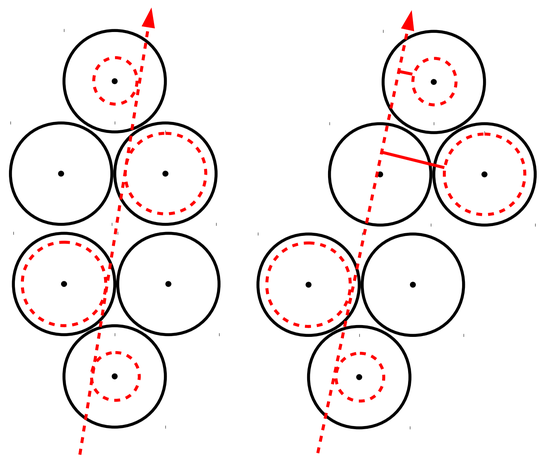


- At-Ethane filled straws at stereo angles
- Charged particles ionise gas, drifting charge is collected by sense wire and triggers electronics
- Measure stored μ profile, corrections due to E field and calorimeter pile-up
- Non-zero EDM → pitch angle oscillations

Track Reconstruction

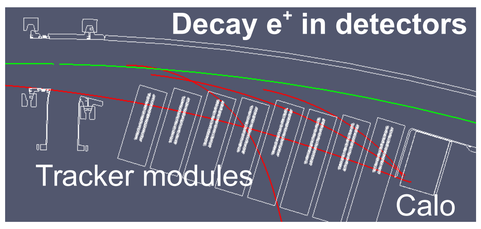
- Hits in straws grouped in time and clustered spatially
- t_0 finding algorithms and r-t calibration to determine charge drift distances from hit times
- Drift distance in each straw specifies cylindrical isochrone
- Combine with straw stereo angles to fit height and reconstruct track point in each module
- Join track points to make track candidates
- Fit track, rejecting points a required
- **GEANE** and **Kalman filter** fitters implemented

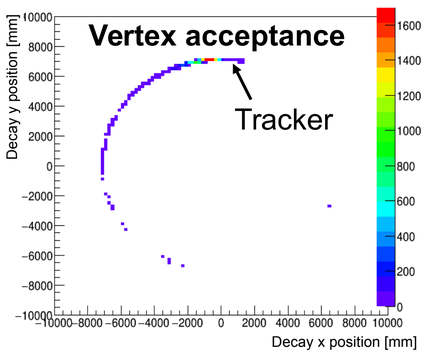


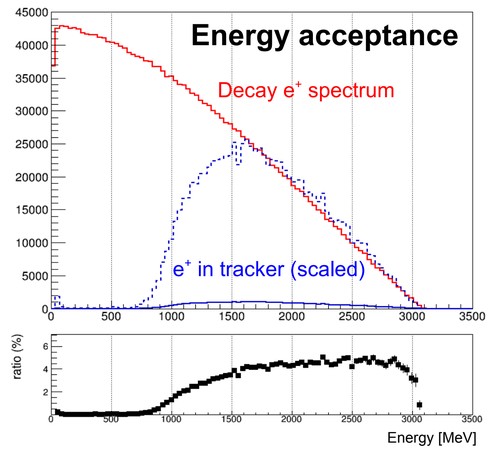


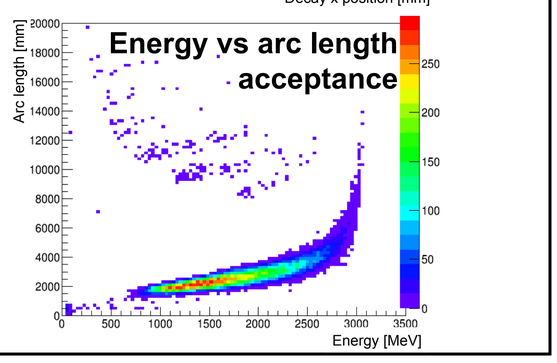
Tracker Acceptance

- Geant4 simulation of storage ring used to evaluate tracker acceptance of decay e^+









Next Steps...

- Detector installation begins November 2016
- First beam April 2017 → BNL statistics within a year of data taking