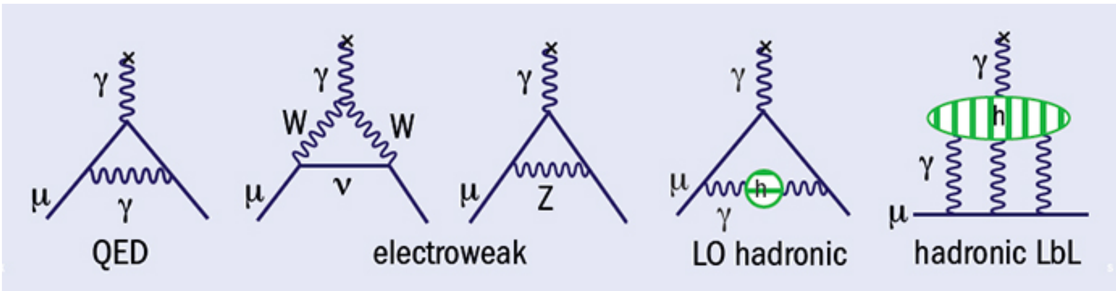
Muon anomalous precession frequency measurement using lead fluoride calorimeters in the Muon g-2 experiment

Kim Siang Khaw on behalf of the Fermilab Muon g-2 collaboration
University of Washington

Muon g-2: Precision test of Standard Model, Search for Beyond Standard Model Physics

Precise calculation using Standard Model

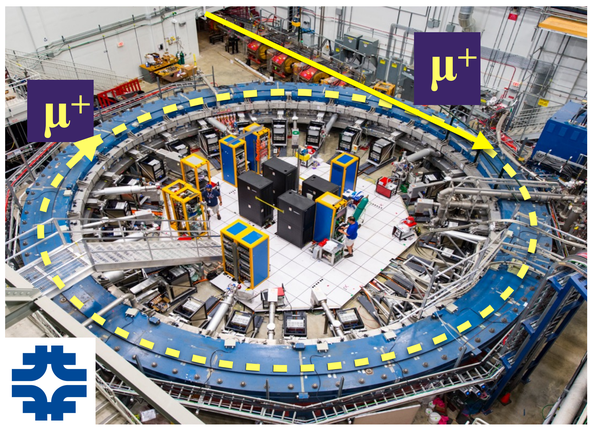
$$\vec{\mu} = g\frac{e}{2m}\vec{S} \longrightarrow a = \frac{g-2}{2}$$



a_μ (SM) = (116 591 821 ± 36) x 10^{-11}

3.7σ

Precise measurement using storage magnet



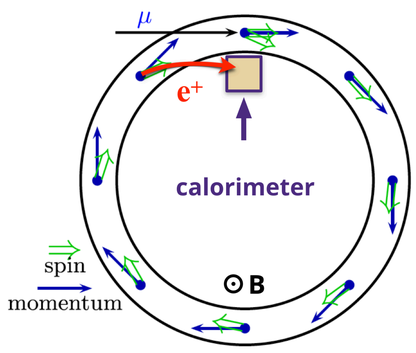
BNL (540 ppb)

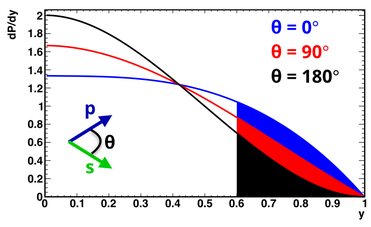
FNAL (140 ppb)

a_μ (BNL) = (116 592 089 ± 46) x 10^{-11}

Measuring muon anomalous precession frequency using calorimeter system

Principle of the measurement





Larmor Thomas Cyclotron

$$\omega_s = \frac{geB}{2m} + (1-\gamma)\frac{eB}{\gamma m} \qquad \omega_c = \frac{eB}{\gamma m}$$

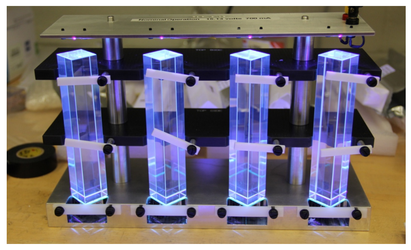
$$\omega_a = \omega_s - \omega_c = \left(\frac{g-2}{2}\right)\frac{eB}{m}$$

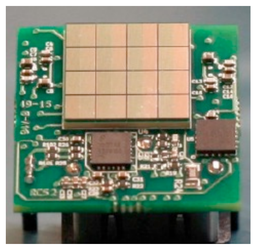
measure difference in frequency precisely

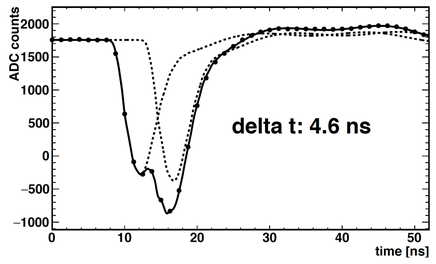
$$\omega_a = a_\mu \frac{eB}{m}$$

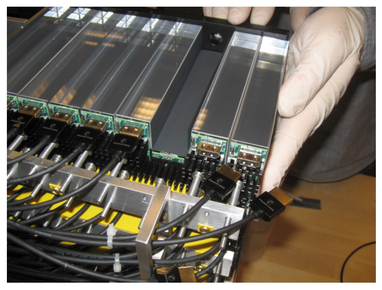
homogenous field and precise field measurement

Lead fluoride calorimeters with SiPMs



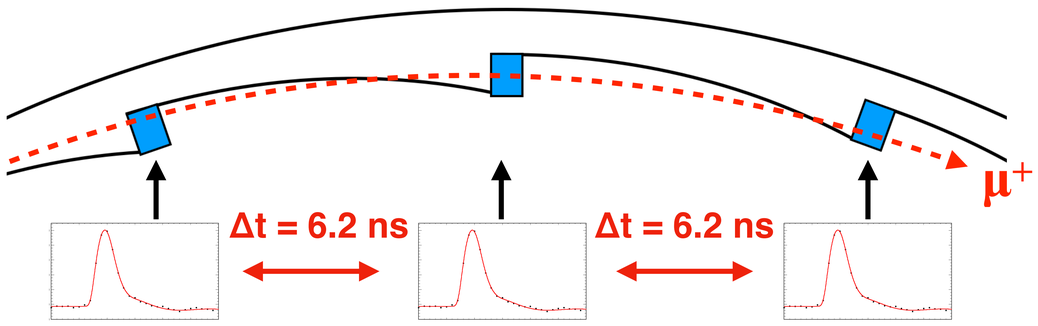






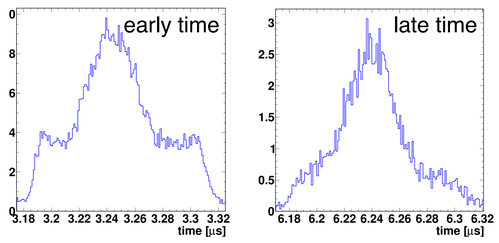
Energy scale calibration, timing alignment and preliminary results

Triple coincidence muon events

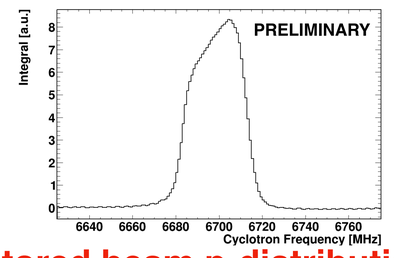


- systematically scatter the muon beam out of the ring
- "lost muons" always leave the same energy signature
- time-of-flight is utilized for timing alignment
- ~ 5 ps alignment precision, ~ 1% energy scale precision

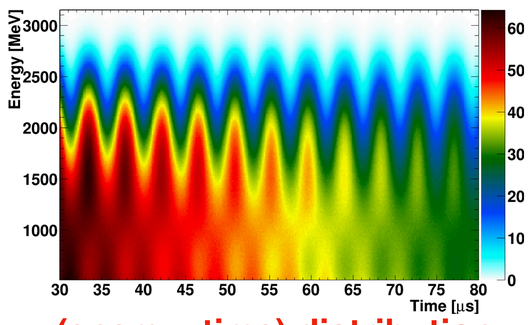
Preliminary results



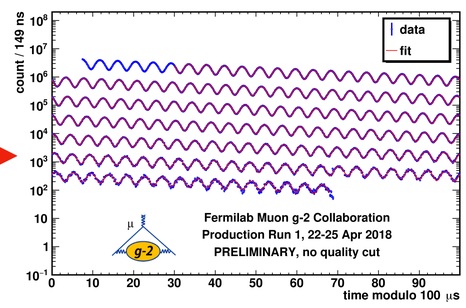
beam de-bunching analysis



stored beam p-distribution



(energy, time) distribution



precession frequency fit