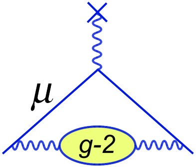

Muon losses in the Muon g-2 experiment at Fermilab

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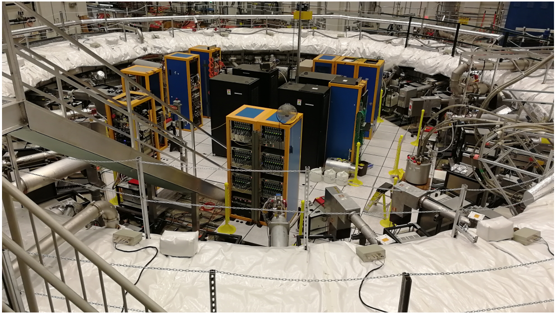
The Muon g-2 experiment

The Muon g-2 experiment examines the precession of muons that are subjected to a magnetic field.
The main goal is to measure the muon anomalous magnetic moment, $a_\mu = (g-2)/2$, to the unprecedented precision of 0.14 ppm.



Experimental Technique

Inside the ring the muons are subject to both the spin precession frequency ω_s and the cyclotron frequency ω_c: the difference between them is called anomalous precession frequency ω_a.

These approximations are used:

- the muon velocity is perpendicular to the magnetic field ($\vec{\beta} \cdot \vec{B} = 0$)
- the magnetic field is perfectly uniform
- betatron oscillations of the beam are neglected

$$\vec{\omega}_a = \vec{\omega}_s - \vec{\omega}_c = \frac{e}{m_\mu}\left[a_\mu \vec{B} - \left(a_\mu - \frac{1}{\gamma^2 - 1}\right)\frac{\vec{\beta} \times \vec{E}}{c}\right] \quad (1)$$

The muon beam enters the storage ring with a forward momentum of $\simeq 3.094$ GeV/c ($\gamma \simeq 29.3$), hence $a_\mu - 1/(\gamma^2 - 1) \simeq 0$ and Eq. 1 simplifies to:

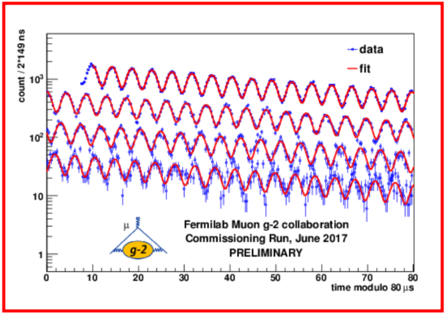
$$\omega_a = \frac{e}{m_\mu} a_\mu B \quad (2)$$

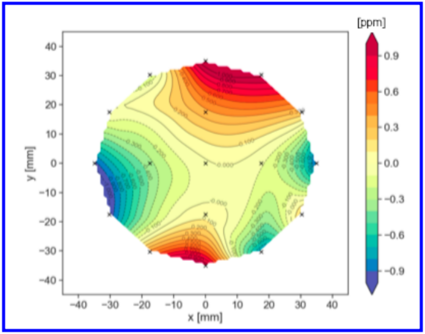
ω_a can be measured fitting the rate of the more energetic positrons with the following 5 parameters formula:

$$N(t) = N_0 e^{-t/\tau} \left[1 - A\cos(\omega_a t + \varphi)\right] \tag{3}$$

Finally, to have a measurement of a_μ, it is necessary to precisely measure $\boxed{\omega_a}$ and

the magnetic field inside the ring.





Lost Muons

Some of the muons are lost mainly because they hit the collimators or other materials after injection, curving inward and eventually being lost from the ring.

The effect can be taken into account in the final ω_a fit with by including an additional factor $\Lambda(t)$:

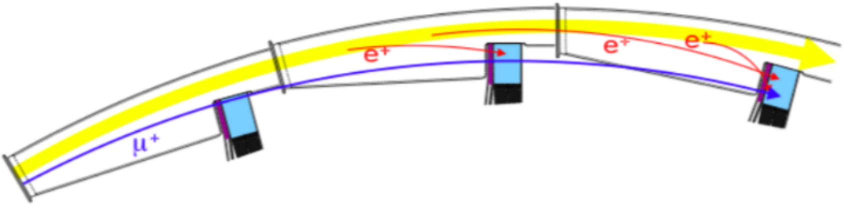
$$N(t) = N_0 e^{-t/\tau} \Lambda(t) \left[1 - A \cos(\omega_a t + \varphi)\right] \quad (4)$$

where:

$$\Lambda(t) = 1 - K_{LM} \int_0^t L(t')\, e^{t'/\tau} dt' \quad (5)$$

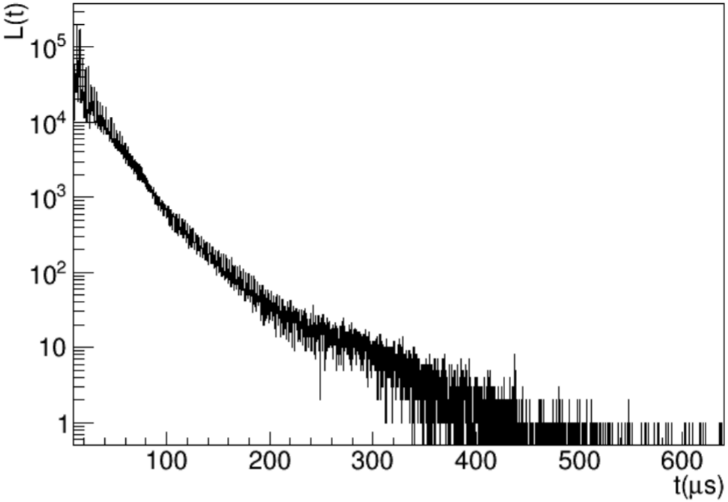
Lost muons preselection

To identify lost muons, multiple coincidences between adjacent calorimeters are used.



- Number of cluster hits: $nHits = 1$ (Isolation cut)
- Cluster time difference: $\Delta t = (6.25 \pm 1.25)$ ns
- Energy cut based on the energy PDF of the Lost Muons

$L(t)$



Courtesy of M. Sorbara

Thanks for your attention!