

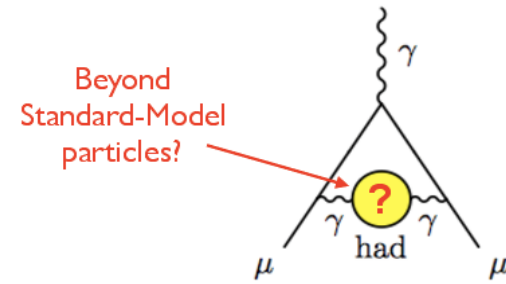


E989

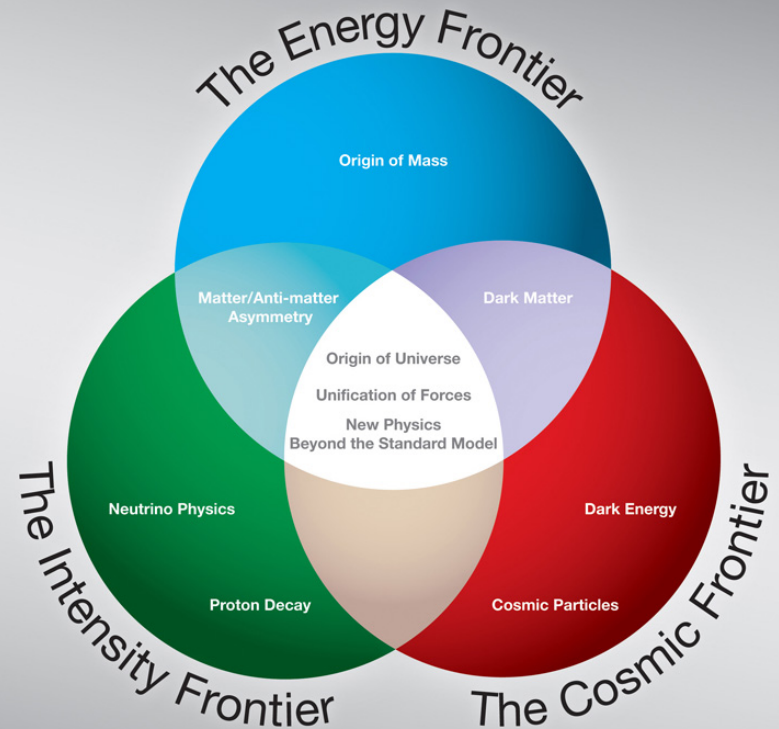
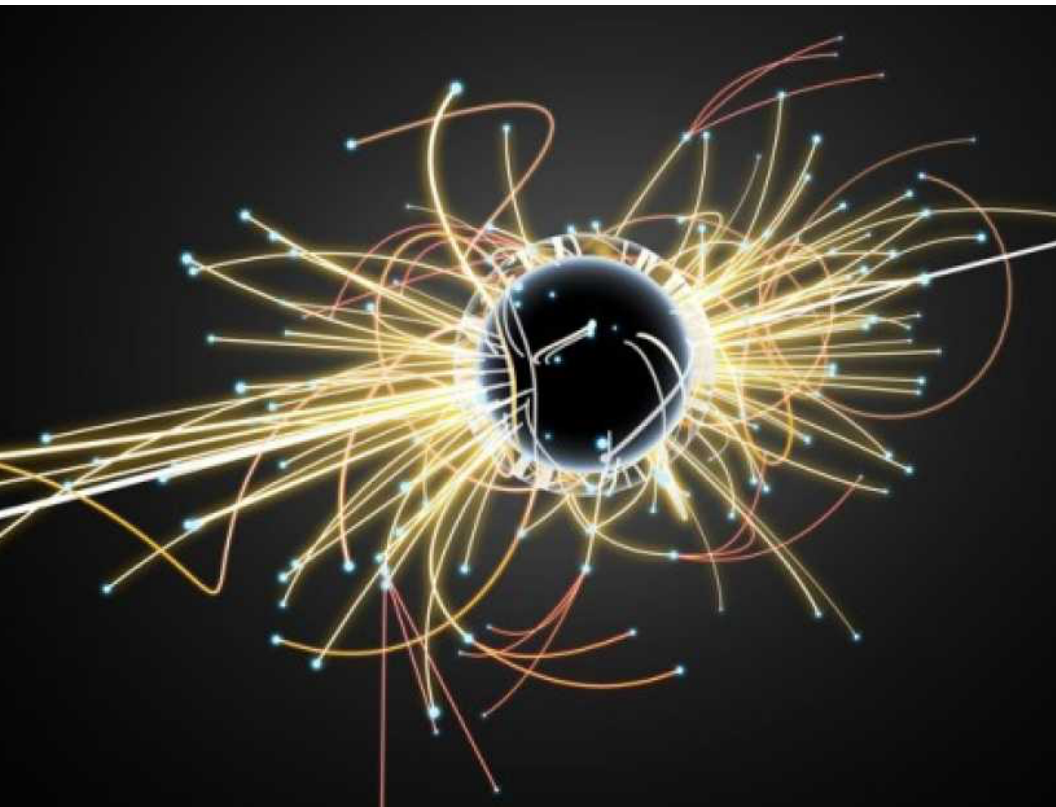
Muon $g-2$ Collaboration

8 Countries, 33 Institutions

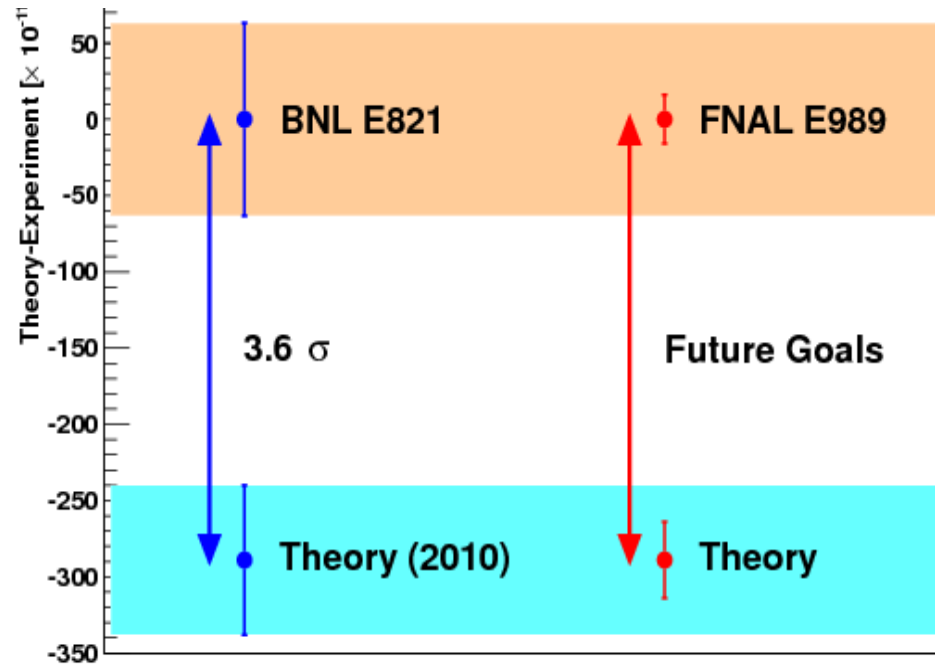
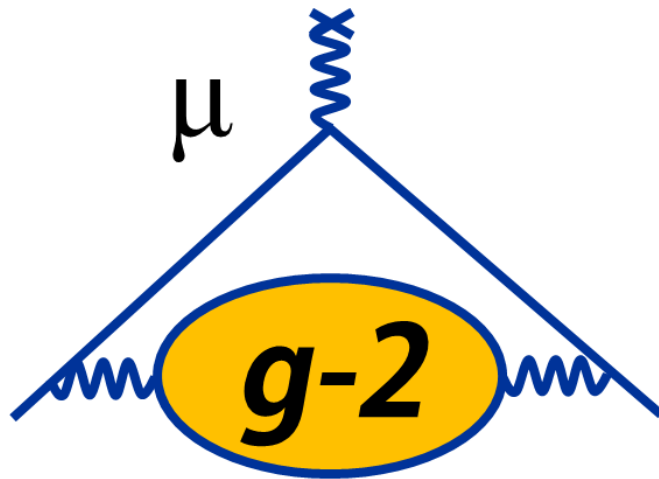
Solving a Mystery



- *By studying the properties of muons, scientists at Fermilab hope to learn whether there are elementary particles beyond the ones we know*

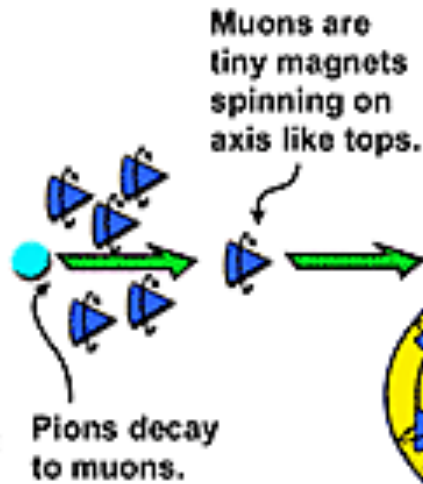
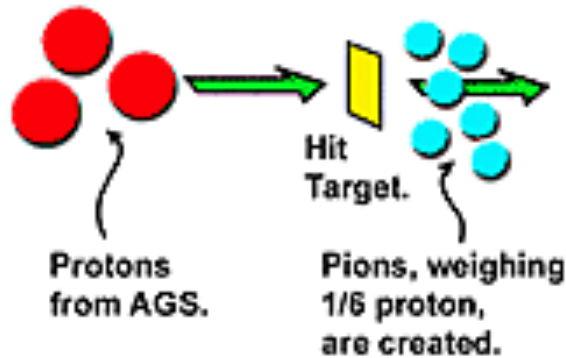
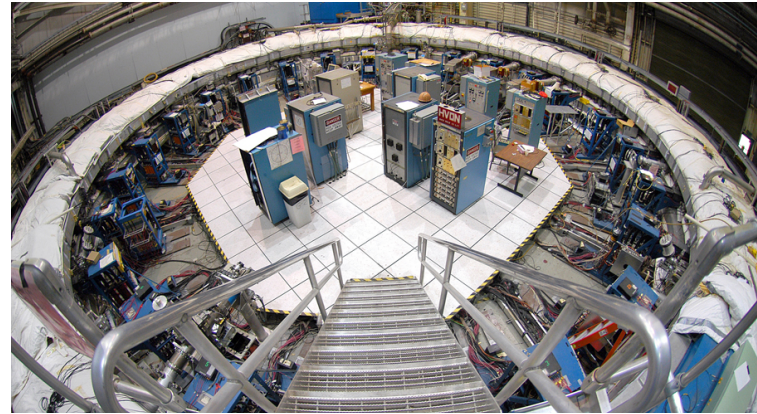


The Physics of $g-2$



Leptons	0.511 MeV	105.7 MeV	1.777 GeV
	-1	-1	-1
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
	e electron	μ muon	τ tau

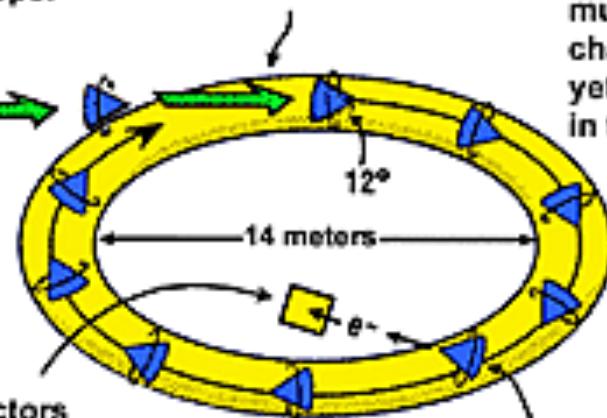
How Does Muon g-2 Work?



Muons are fed into a uniform, doughnut-shaped magnetic field and travel in a circle.

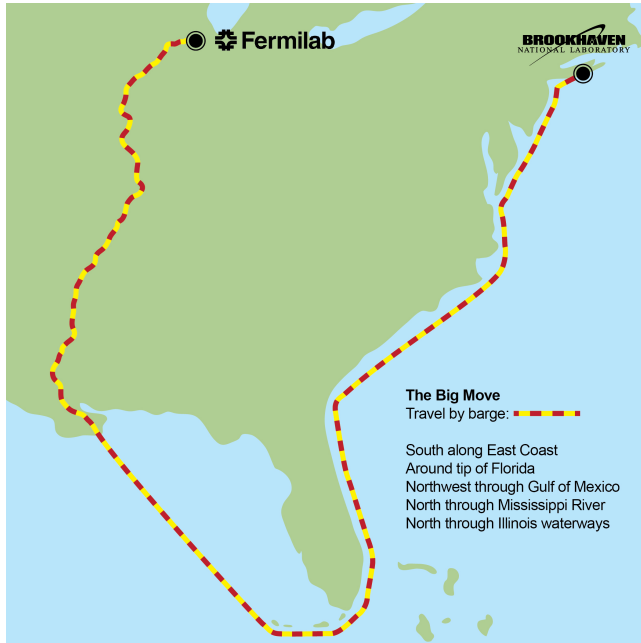
After each circle, muon's spin axis changes by 12', yet it keeps on traveling in the same direction.

One of 24 detectors see an electron, giving the muon spin direction; g-2 is this angle, divided by the magnetic field the muon is traveling through in the ring.

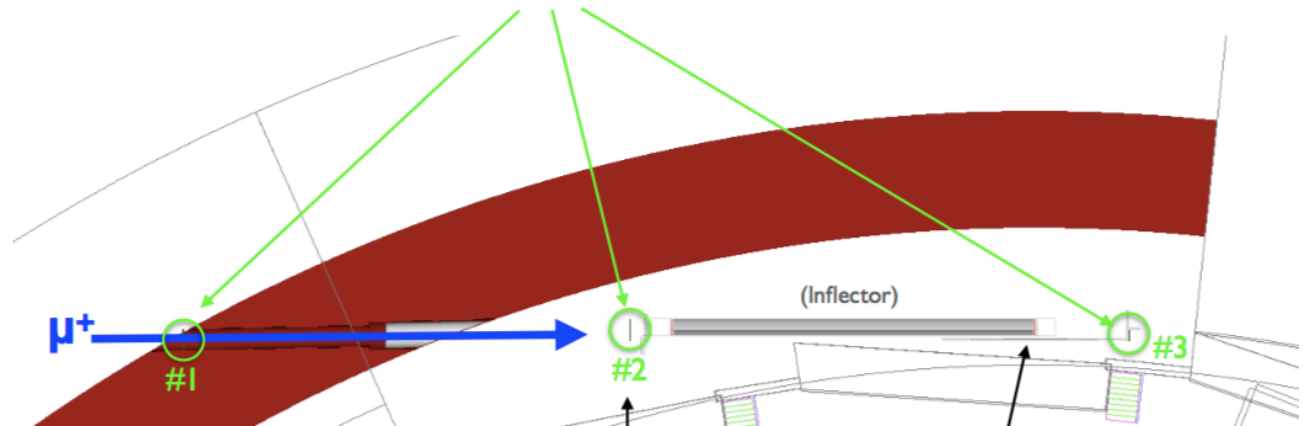
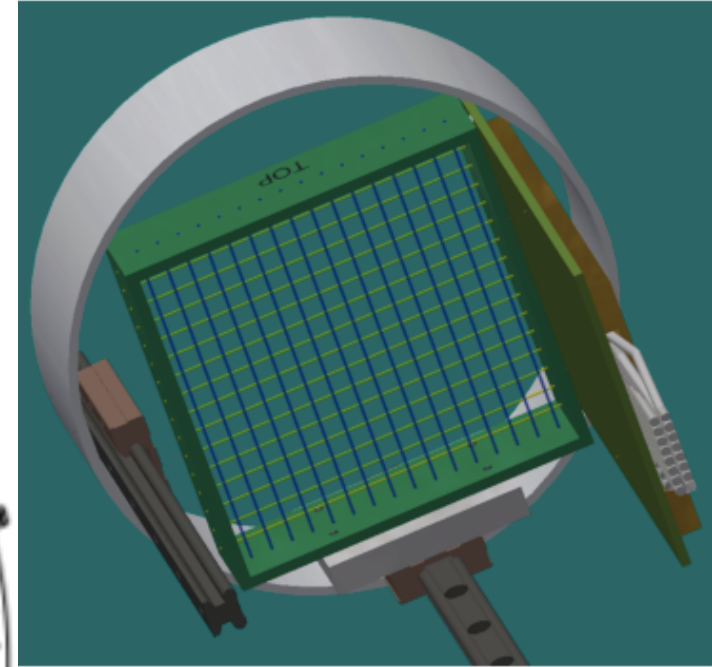
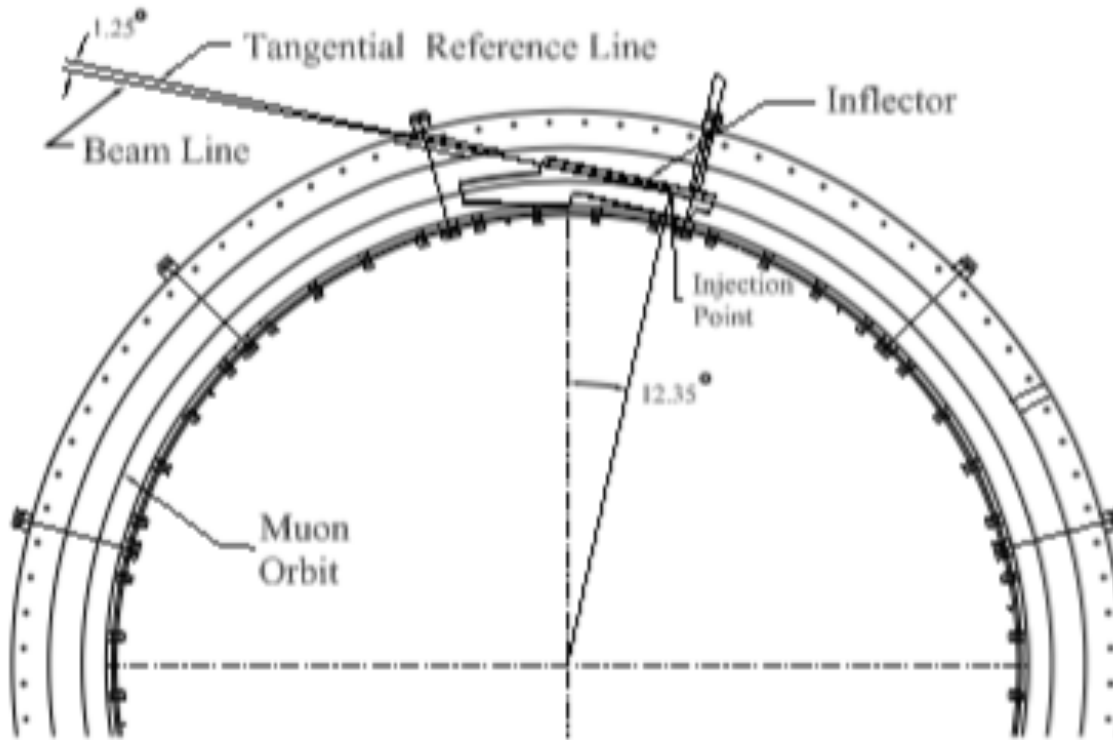


After circling the ring many times, muons spontaneously decay to electron, (plus neutrinos,) in the direction of the muon spin.

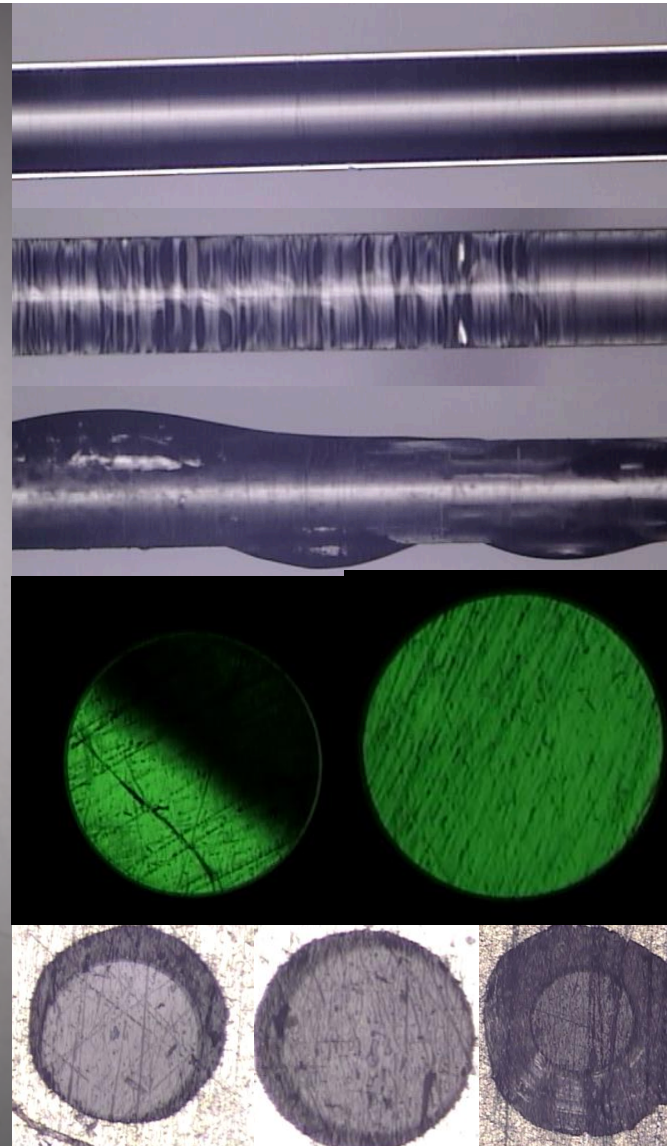
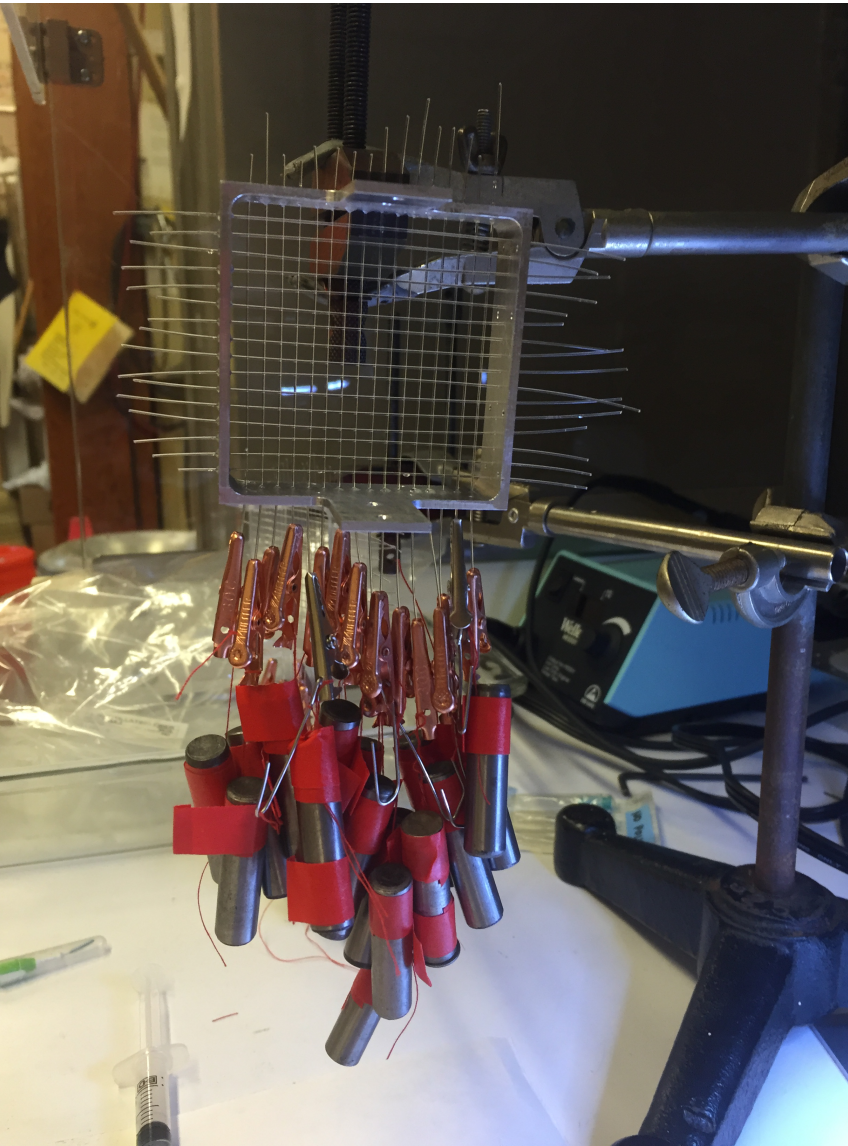
Brookhaven (E821) --> Fermilab (E989)



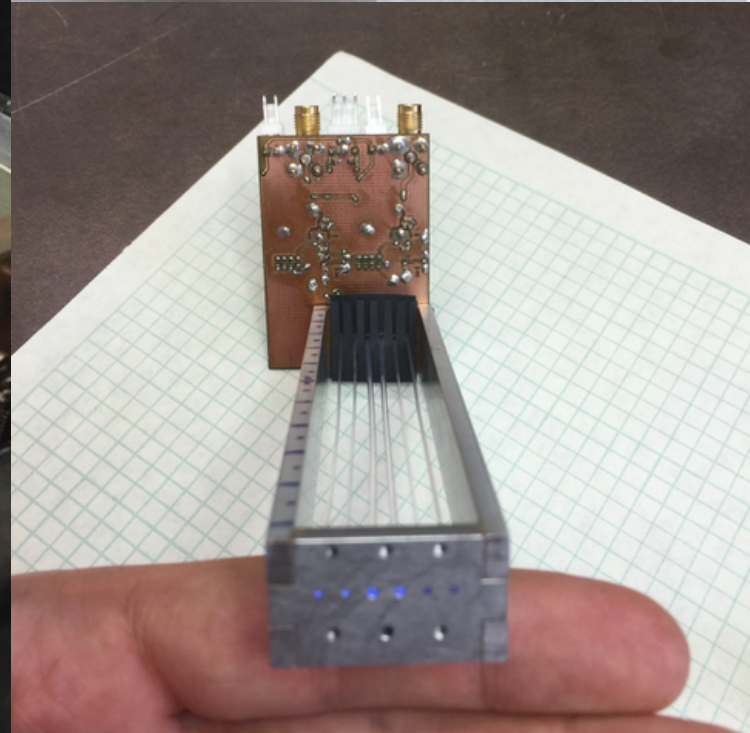
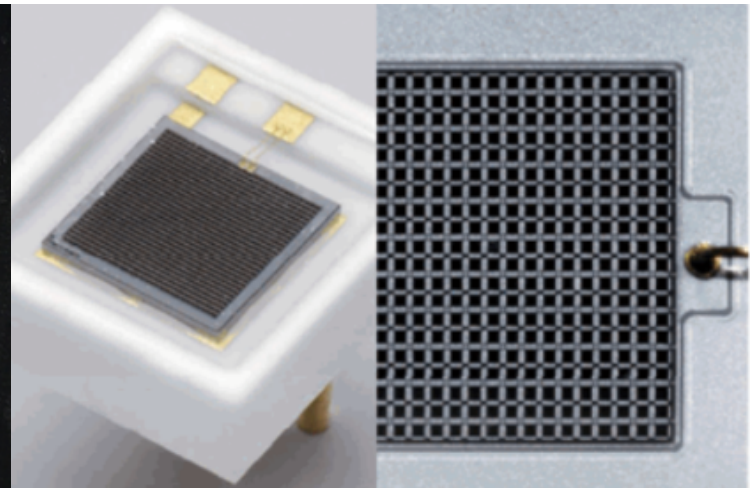
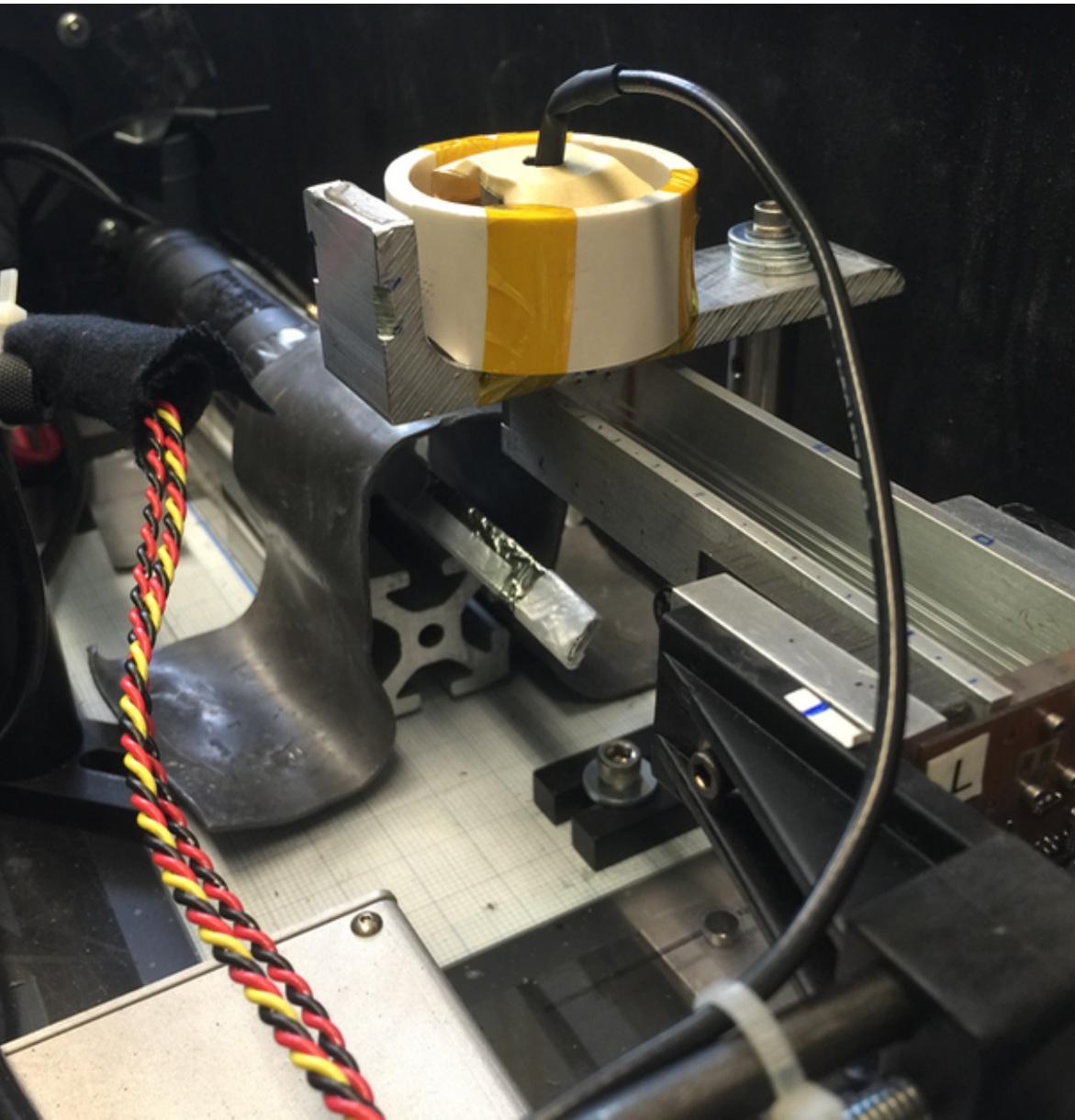
Inflector Beam Monitoring System (IBMS)



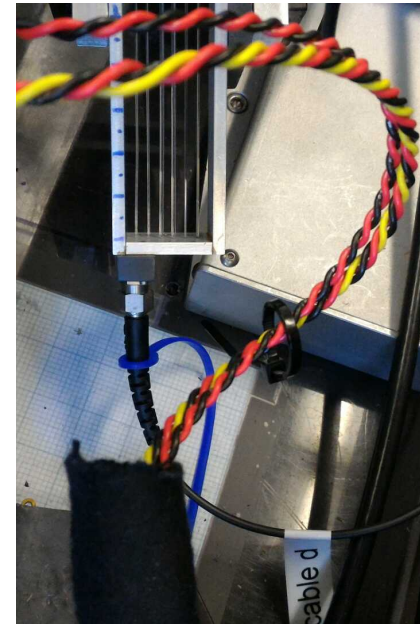
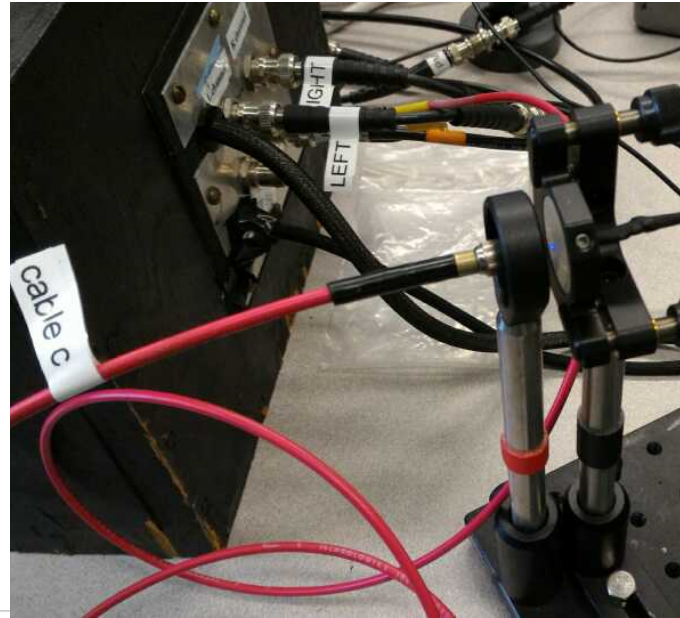
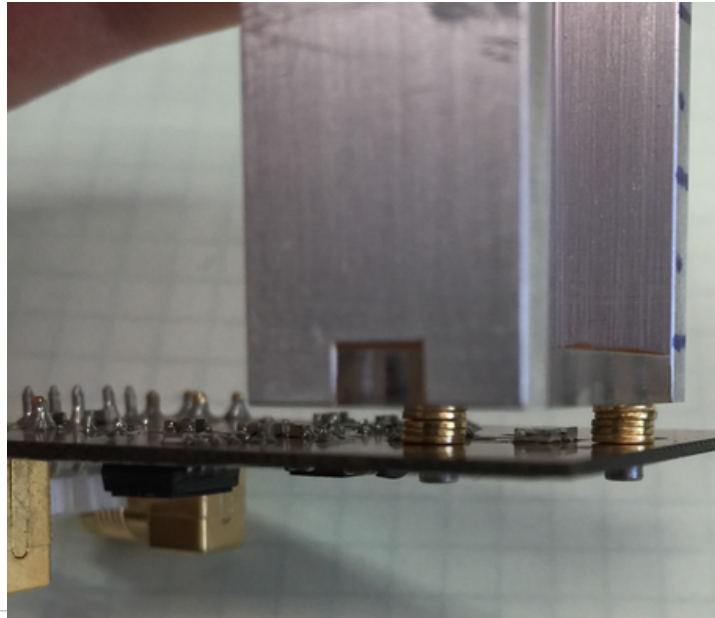
How to Build an IBMS Detector



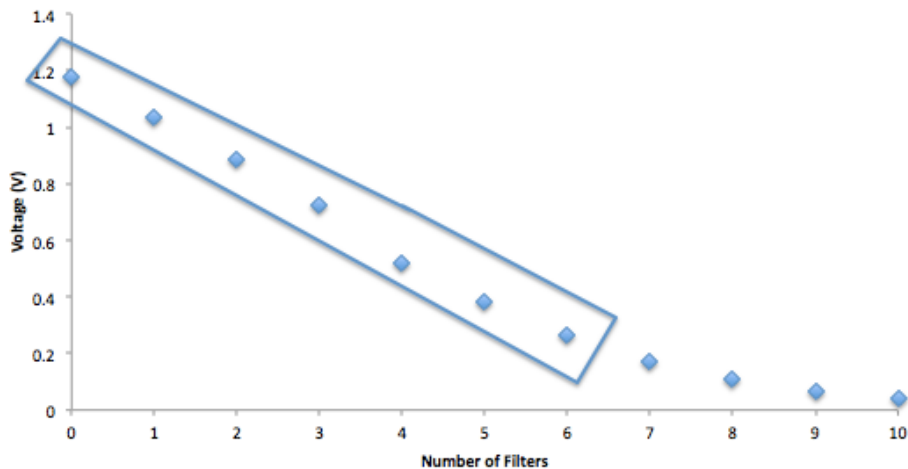
How to Test an IBMS Detector



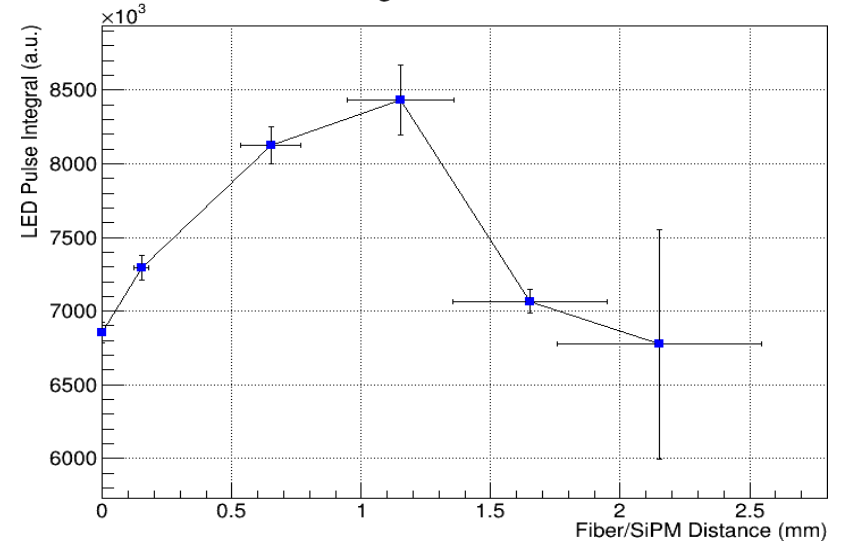
Optimizing SiPM Signal



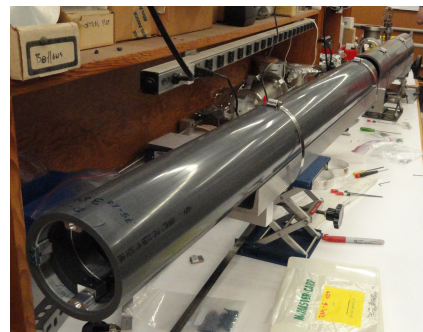
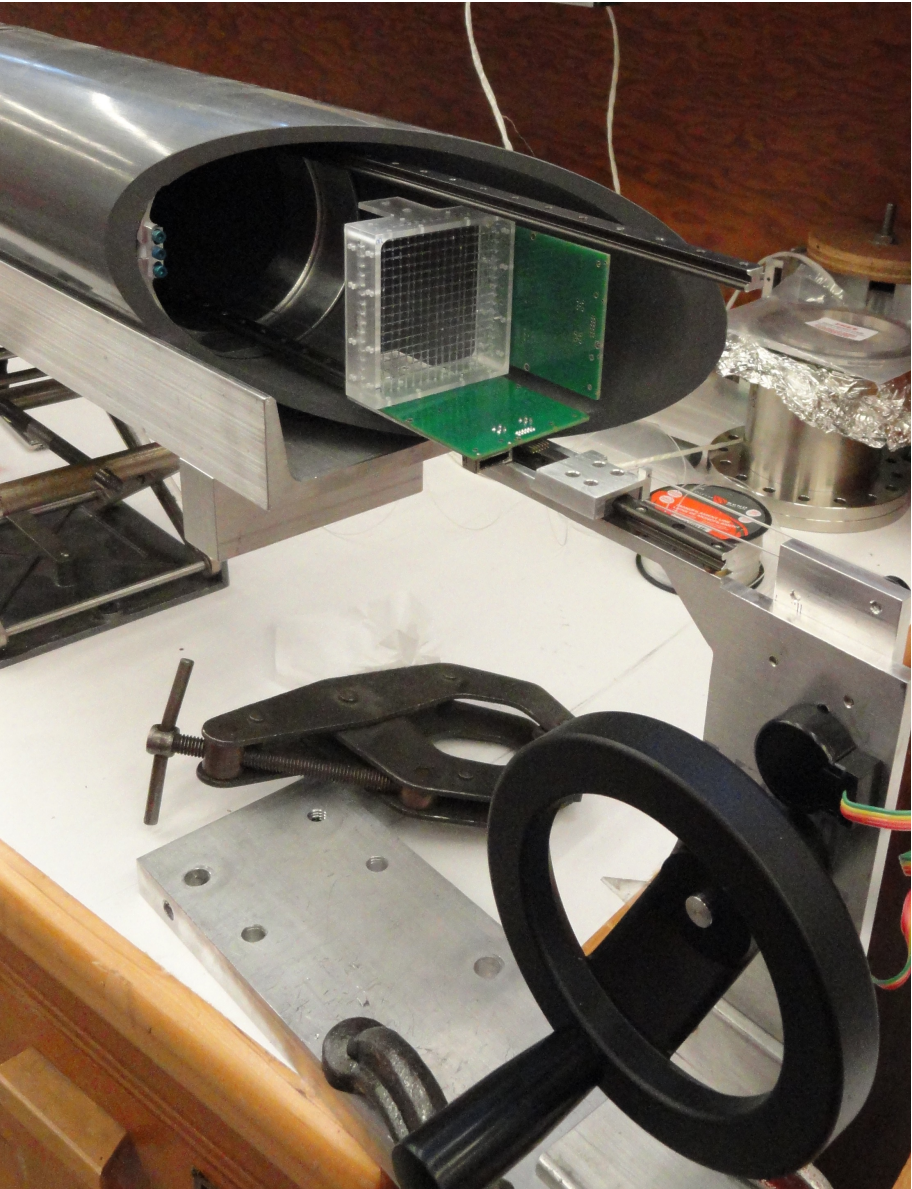
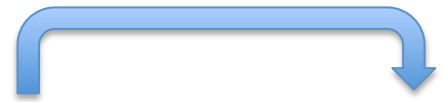
4 washers, LED outside of box directly coupled to frame with 1 mm fiber cable



LED Pulse Integral vs. Fiber/SiPM Distance



How to Install an IBMS Detector



Project Going Forward

- Move onsite to Fermilab --> September 2016
- Calorimeters installed in ring --> October 2016
- IBMS detectors installed in ring --> Early 2017
- First beam --> Spring 2017



Questions!

- Further questions about this project, please contact: Fermilab Office of Communication, 630-840-3351.
Or send email to Fermilab@fnal.gov
- Or go to our Facebook page! <https://www.facebook.com/The-new-g-2-experiment-at-Fermilab-76812692423/>



References

- http://www.fnal.gov/pub/today/archive/archive_2011/today11-08-19_muong-2ReadMore.html
- http://www.fnal.gov/pub/today/archive/archive_2012/today12-05-02_Muong-2ReadMore.html
- J. Grange *et al*,
[Muon \(g-2\) Technical Design Report \(2015\)](#)

- Why use muons over electrons?
- Why tau can't be used?

	Electron	Muon	Tau
Mass (MeV)	0.511	106	1,777
Lifetime (s)	—	2.2×10^{-6}	2.9×10^{-13}

- Sensitivity to a mass scale Λ much greater than the lepton mass m_l behaves generally as

$$\delta a_\ell \propto \frac{m_\ell^2}{\Lambda^2}$$

- Using the above measure, the muon is $(m_\mu/m_e)^2 \approx 43,000$ times a more sensitive probe