The Calibration System of the new *g-2* experiment at Fermilab

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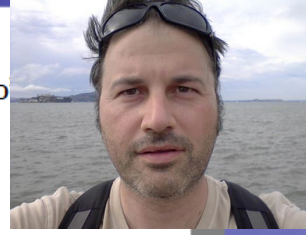
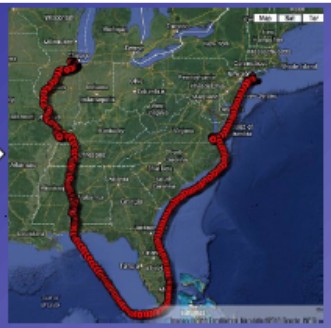


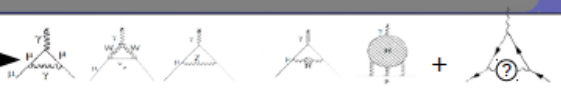
From BNL

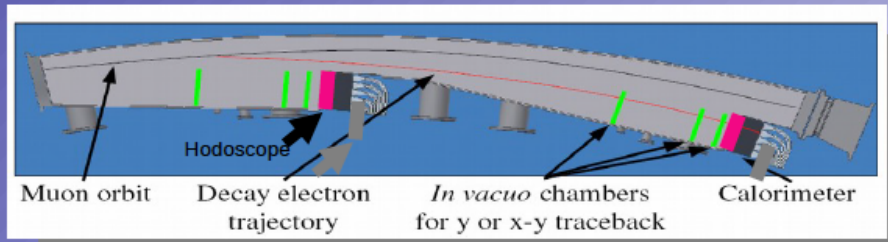


To FNAL

$$a_\mu^{SM} = a_\mu^{QED} + a_\mu^{Had} + a_\mu^{Weak}$$

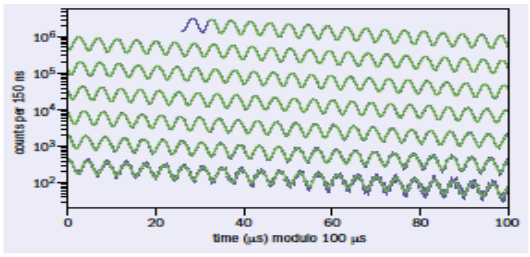
$$a_\mu^{Th} - a_\mu^{exp} \sim 3\,\sigma \rightarrow$$





- **E989 at Fermilab**

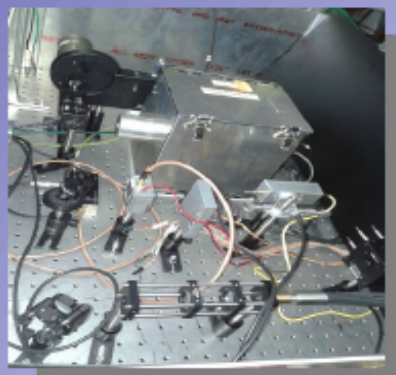
$$\left.\begin{aligned}\sigma_{stat} &= \pm 0.1 \text{ ppm} \\ \sigma_{syst} &= \pm 0.1 \text{ ppm}\end{aligned}\right\} \sigma = \pm 0.14 \text{ ppm}$$

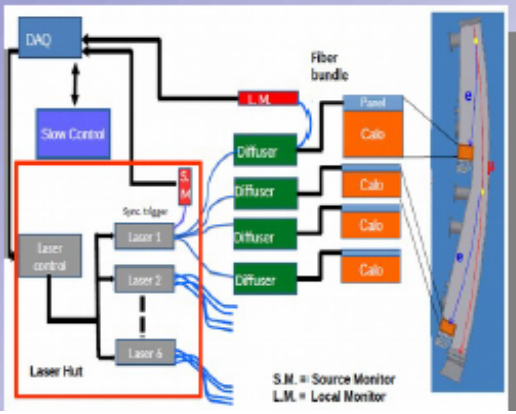


In E989 the Gain fluctuations must be monitored at the sub-per mil level during the fill [0-700μs]

E821 Error	Size [ppm]	Plan for the New $g-2$ Experiment — E989	Goal [ppm]
Gain changes	0.12	Better laser calibration and low-energy threshold	0.02
Lost muons	0.09	Long beamline eliminates non-standard muons	0.02
Pileup	0.08	Low-energy samples recorded; calorimeter segmentation	0.04
CBO	0.07	New scraping scheme; damping scheme implemented	0.04
E and pitch	0.05	Improved measurement with traceback	0.03
Total	0.18	Quadrature sum	0.07

Distribution System



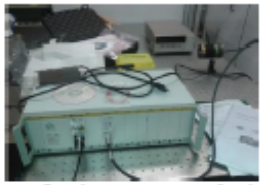


Laser Calibration System

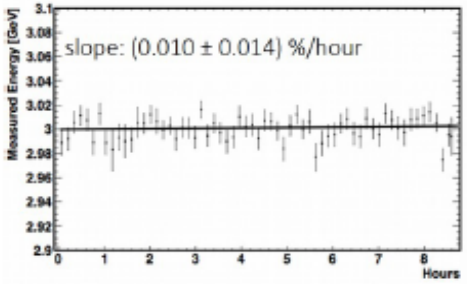
Laser
PicoQuant LDH-P-C 405M:
Pulse width[ps]:300
Energy/pulse[pJ]:500
Nominal Avg.Power[mW@kHz]:20@40000
Wavelength:405 nm
Photons/pulse:1,02·10⁹

Fiber Bundle:
Diameter per fiber[μm]:1000
Material: PMMA
NA: 0.49

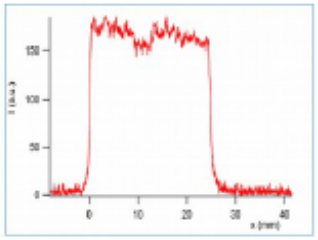
Engineered Diffuser
THORLABS:
Uniformity > 2-3%
Transmittance ~10%



Multi-Laser driver



Time stability~10^{-4}/h



Light output

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Test of candidate light distributors for the muon $(g-2)$ laser calibration system

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ABSTRACT

The new muon $(g-2)$ experiment E989 at Fermilab will be equipped with a laser calibration system for all the 1296 channels of the calorimeters. An integrating sphere and an alternative system based on an engineered diffuser have been considered as possible light distributors for the experiment. We present here a detailed comparison of the two based on temporal response, spatial uniformity, transmittance and time stability.