T-1005 Report
(g-2 Detector Team)
April 23rd, 2012

Groups Involved (on site for all or part of the run)
Washington
Kentucky
Virginia
Fermilab
Shanghai
Cornell
Overview

• BNL E821 measured muon g-2 to 0.54 ppm

• Measurement was statistics limited
  – Increase statistics by moving to Fermilab
    • Goal > 21x increase

  – Reduce systematics with new detectors (among other things)
    • Goal ~ factor of 3 reduction

• Overall goal is factor of 4 improvement in measured value of muon g-2
Questions for this beam test

Calorimeter: Tungsten SciFi or PbF2?

Photodetector: Very fast PMT or SiPM?

Digitizer: 500 MHz or 1 GHz?
Equipment Deployed & Tested

• **EM Calorimeters:**
  – PbF2 array of 7 crystals in 2 x 3 x 2 stack (various wrapping, couplings)
  – PbW04 crystal (as alternative in stack above)
  – W/SciFi calorimeter
  – PbGlass (Fermilab device as reference)

• **Readout devices**
  – Very fast Hamamatsu 8-Stage, R9800 PMT
  – 16-Channel Hamamatsu SiPM 12 x 12 mm², 50 mm pitch, 56000 pixels, custom summed amplifier card
  – Various Photonis and EMI 22 mm PMTs for side crystals

• **Beam defining equipment & trigger counters**
  – Fast MWPC with 3% Dimethoxy Methan 15% Isobutane, rest Argon
  – 1.5 cm wide scintillator “finger counters”; larger paddle
  – Cherenkov

• **Electronics / DAQ test equipment**
  – 8-channels of 12-bit, 500 MHz digitizers
  – 2-channels of 8-bit 1 GHz digitizers
  – MIDAS full system in test mode related to g-2 designed architecture
g-2 Program Goals and Highlights

• Short pulses
• Segmentation: 24 arrays of 5x7 channels
• Good resolution
• Dense (short radiation length)

**1. PbF2 Cherenkov**; Typically 3-4%/sqrt(E);
Pulse-optimized **SiPM array**, can be used in storage ring magnetic field
Fast PMTs as backup; requires complex lightguides

Similar readout options
Setup

Crystal preparation

Fast PMT

SiPM

Pb Glass

PbF2 array

W/SciFi

MIDAS DAQ

Setup

Crystal preparation

Fast PMT

SiPM

Pb Glass

PbF2 array

W/SciFi

MIDAS DAQ
Preliminary Findings – PbF2

- Wrapping: Millipore paper; Black end; Optical grease
  - Variants: all white → longer pulse; all black → short pulse but low light; silicon interface → much lower light

- Pulse shape
  - FWHM ~8 ns; FWTM ~20 ns

- Resolution @ 4 GeV
  - 2.4% (includes ΔP/P of beam)

![Energy sum of PbF2 Sum of 7 Crystals](image-url)
Typical Program

• Calibrate all tubes at 4 GeV
• Sweep energies with open trigger
  – 1, 2, 3, 4, 5, 8 GeV
• Vary wrapping, couplings, detectors, readout devices, angles of impact, rate of beam
• Record pulse shapes, scope shots, long acquisition periods of digitized islands for pulse finding and energy reconstruction
16-channel SiPM – first tests
Analysis of array in progress

12 x 12 mm²
W/SciFi – followup to our 2010 run
(simple analysis)

\[ \chi^2 / \text{ndf} = 1.657 \times 10^4 / 5 \]

- \( p_0 = 0 \pm 1 \)
- \( p_1 = 3756 \pm 1.233 \)

15 cm

W/SciFi Calorimeter

The end ...

Thanks Fermilab for fantastic SUPPORT and excellent BEAM !!!

The g-2 Detector Team