Muon Detection Testing at Nevis Labs

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Outline

- Experimental Setup
  - Spacers and 5-fold coincidences
- Expected number of Muon events
- Troubles
  - Not enough events or pe's
- Improvements: Remove spacer and use optical grease
  - Trigger modes 0 and 2
- Possible reasons for continued photoelectron deficit

Setup

- four long Scintillator strips in light-tight box.
  - Each of the strips has a wavelength-shifting fiber running through it and into a channel of the PMT.
- 4 pairs of 'trigger counters,' which are 5 by 4.5 cm pieces of Scintillator.
  - T1 is farthest from PMT, T4 is closest.
- We define a Muon event as one where both top and bottom triggers detect a Muon.
  - We consider the trigger to have 'detected a muon' if the pixel sees ADC counts > 1 photoelectron
    - 35 ADC counts.

Improvements

- After the first run with this experimental setup we had some minor problems
  - Broken PMT
    - Introduce spacers
  - Triggering on crosstalk
    - The trigger pairs were PMT neighbors, which induced false triggers and skewed our data
    - We then took all data with 5-fold coincidences
      - We trigger only if both triggers, as well as 3 other strips, have ADC counts > 1 pe

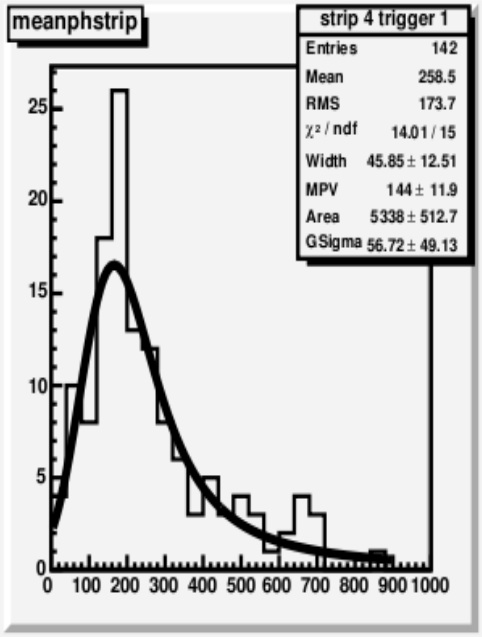
Expected Muon Events

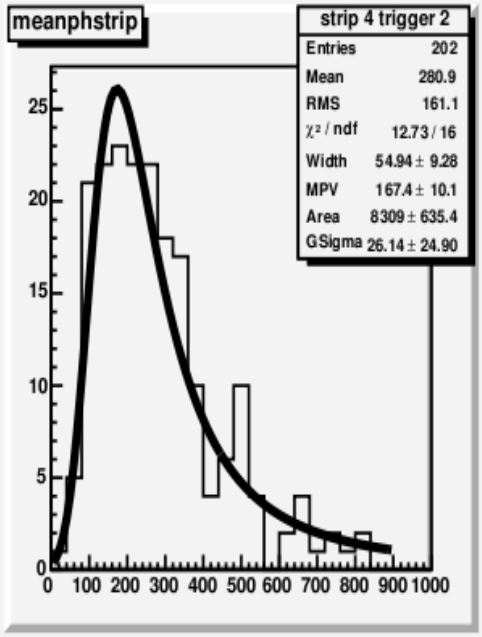
- According PDG, we should expect a Muon rate of $70 m^{-2} s^{-1} str^{-1}$ at sea level.
- for each of our triggers we should expect a Muon rate of .413 Hz
  - 99.12 Muons each minute for total setup
- expect to detect about 12000 events that would peak at 350 ADC counts, or 10 pe's.
  - 2,973.6 Muons per trigger counter

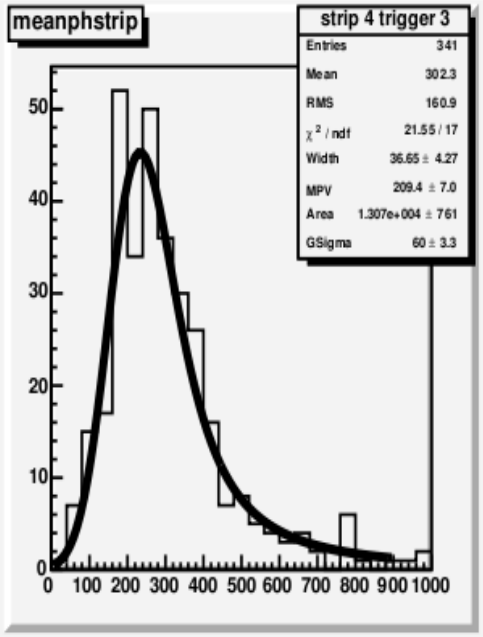
…After More Improvements

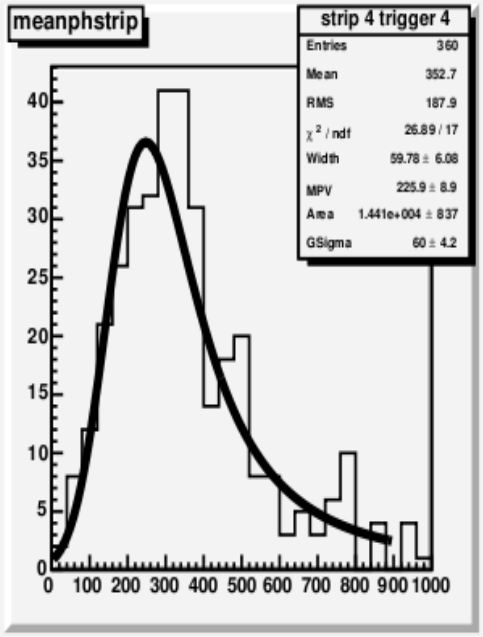
- The first data we took
  - ~1 or 2 photoelectrons
  - Only ~ 100 events over two hours (expect 12000)
- Adjustments
  - Remove spacer
  - Use optical grease
  - Add crosstalk counts from neighboring chanels back in to the main pixel while (offline)

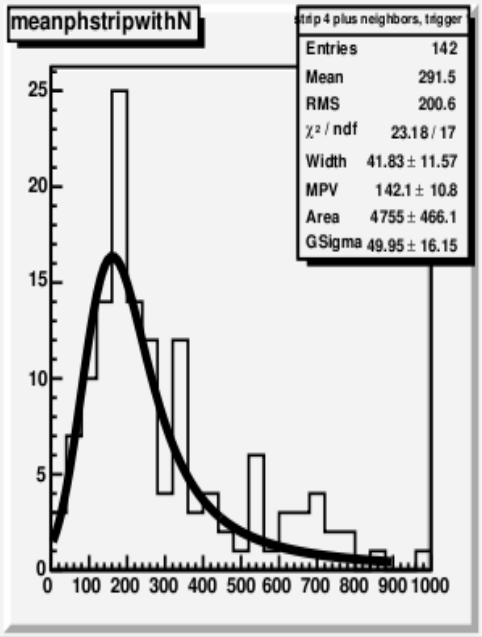
No Spacer with Grease

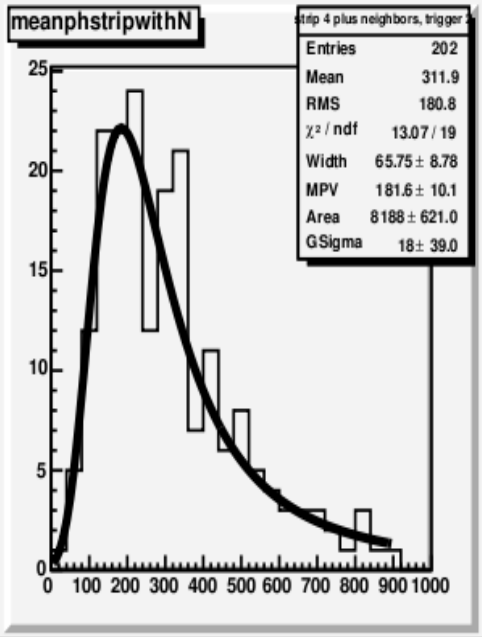


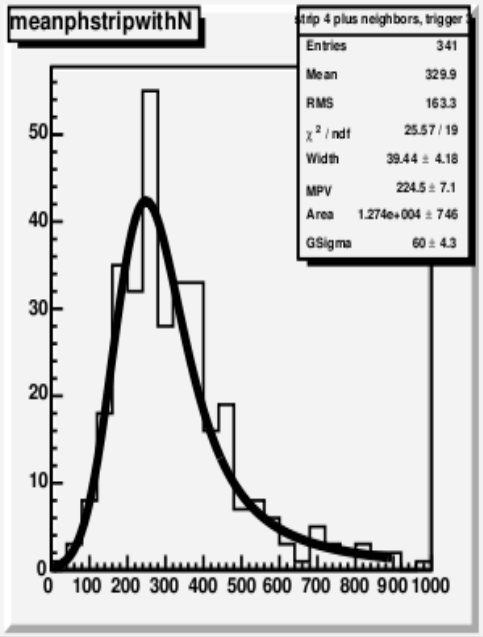


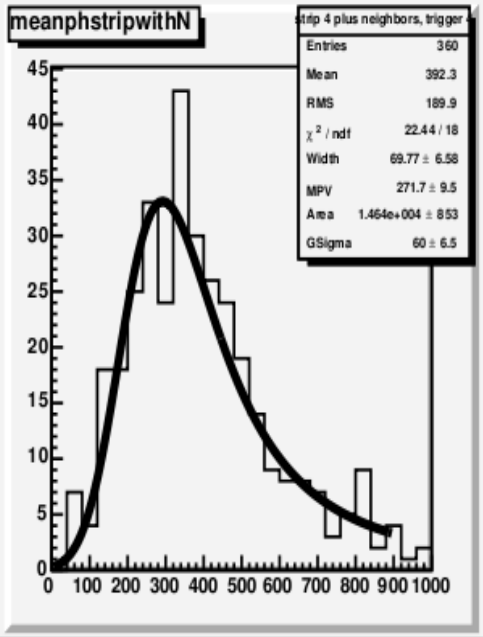




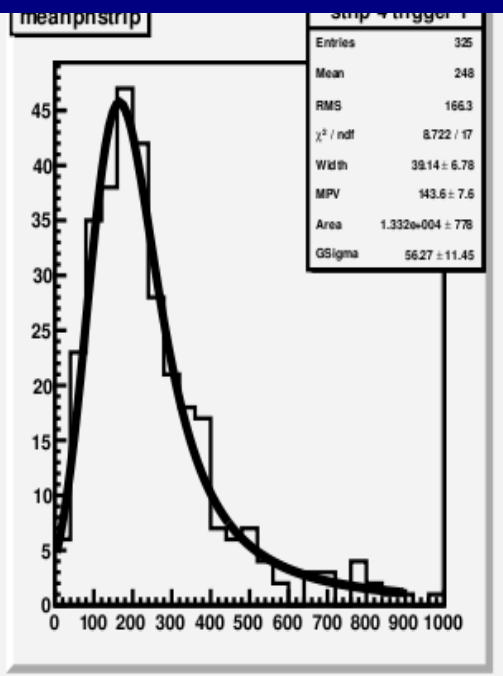


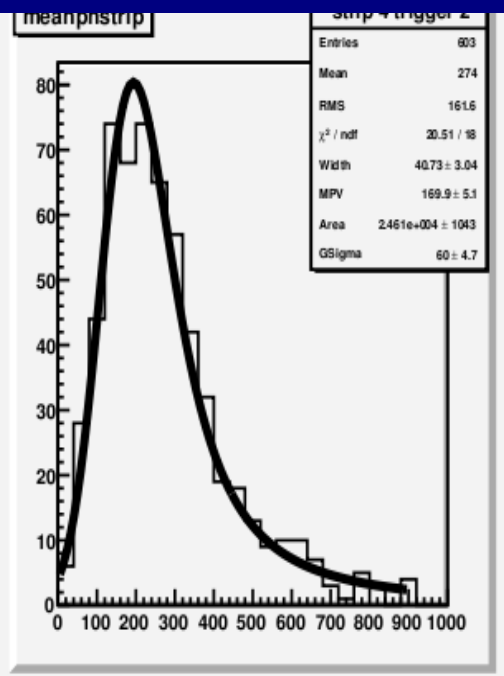


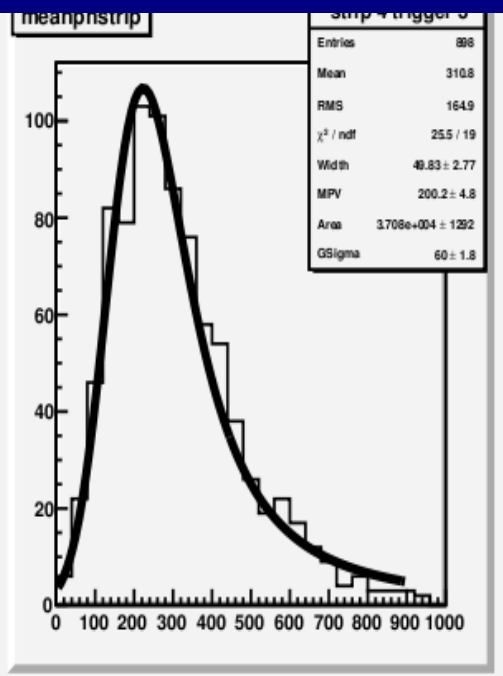


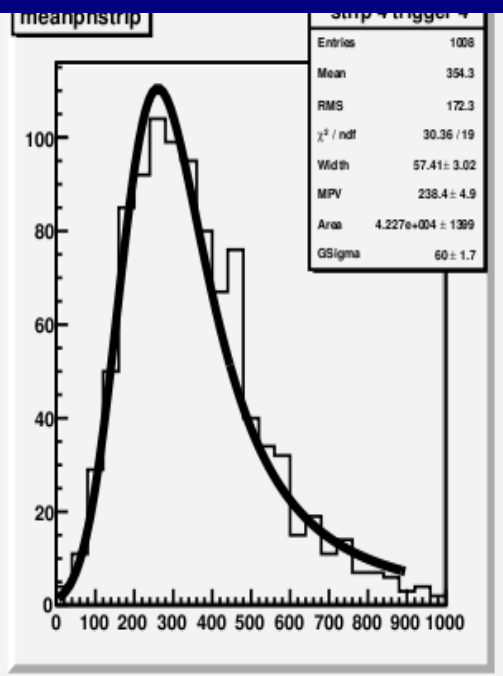


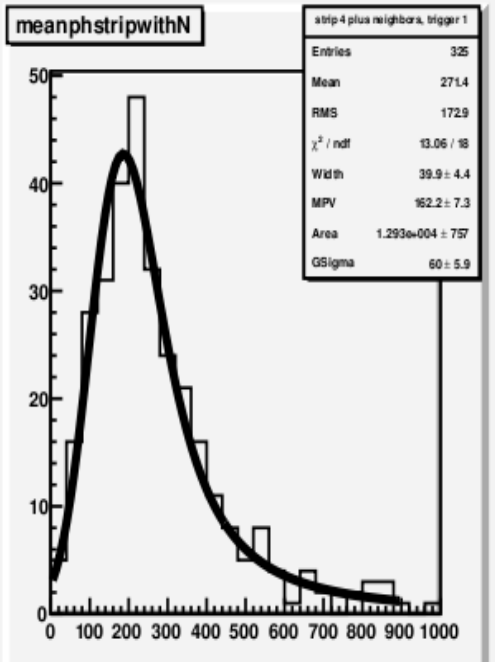
Trigger Mode 2: Grease

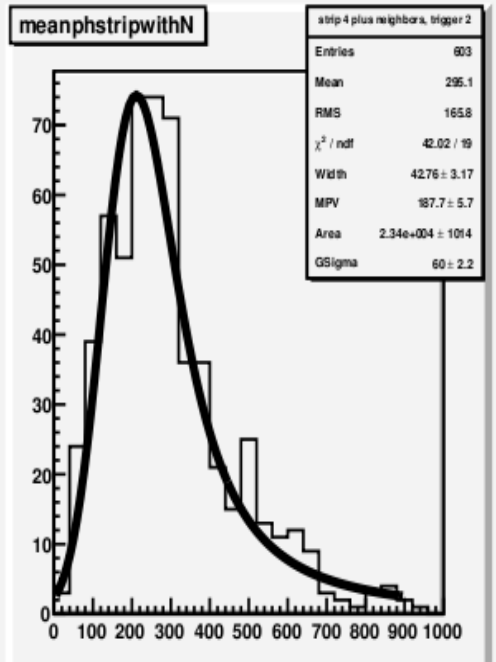


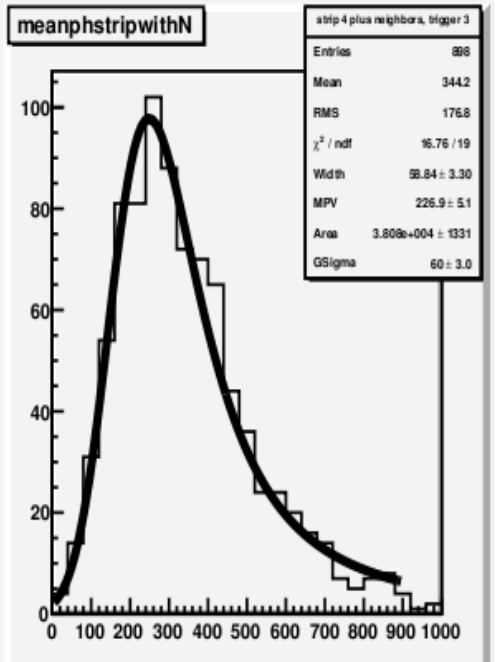


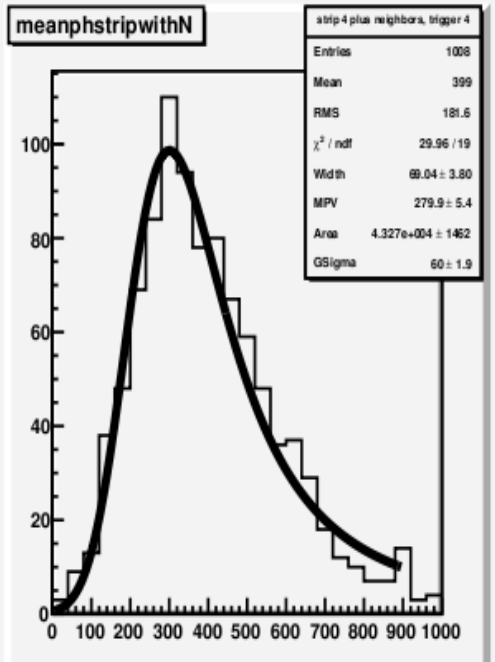












Attenuation lengths

Attenuation length (cm):

Strip no	T0 small spacer	T0 no spacer	T0 grease	T2 grease	T2 grease (gain online)	*average per strip*
1	260.11	127.66	162.52	177.54	160.55	*177.67*
2	204.9	174.82	220.29	229.37	336.92	*233.26*
3	281.66	236.95	212.73	209.66	280.37	*244.27*
4	364.54	302.58	296.6	268.95	255.62	*297.66*

- We expect about 271 cm
- error ~ 10-15%

Conclusions (so far)

- The most Muons detected over the course of 2 hours was only 1008 for a near Trigger counter, and the max pe count was 7.996
  - Expected 3,000 Muons, 10 pe's (without grease)
- While this is a vast improvement from initial data, we still have a long way to go
  - MPV vs Mean to calculate number of pe's?
- The installation of fibers could've damaged the edges of the fibers, which would reduce the amount of light we get