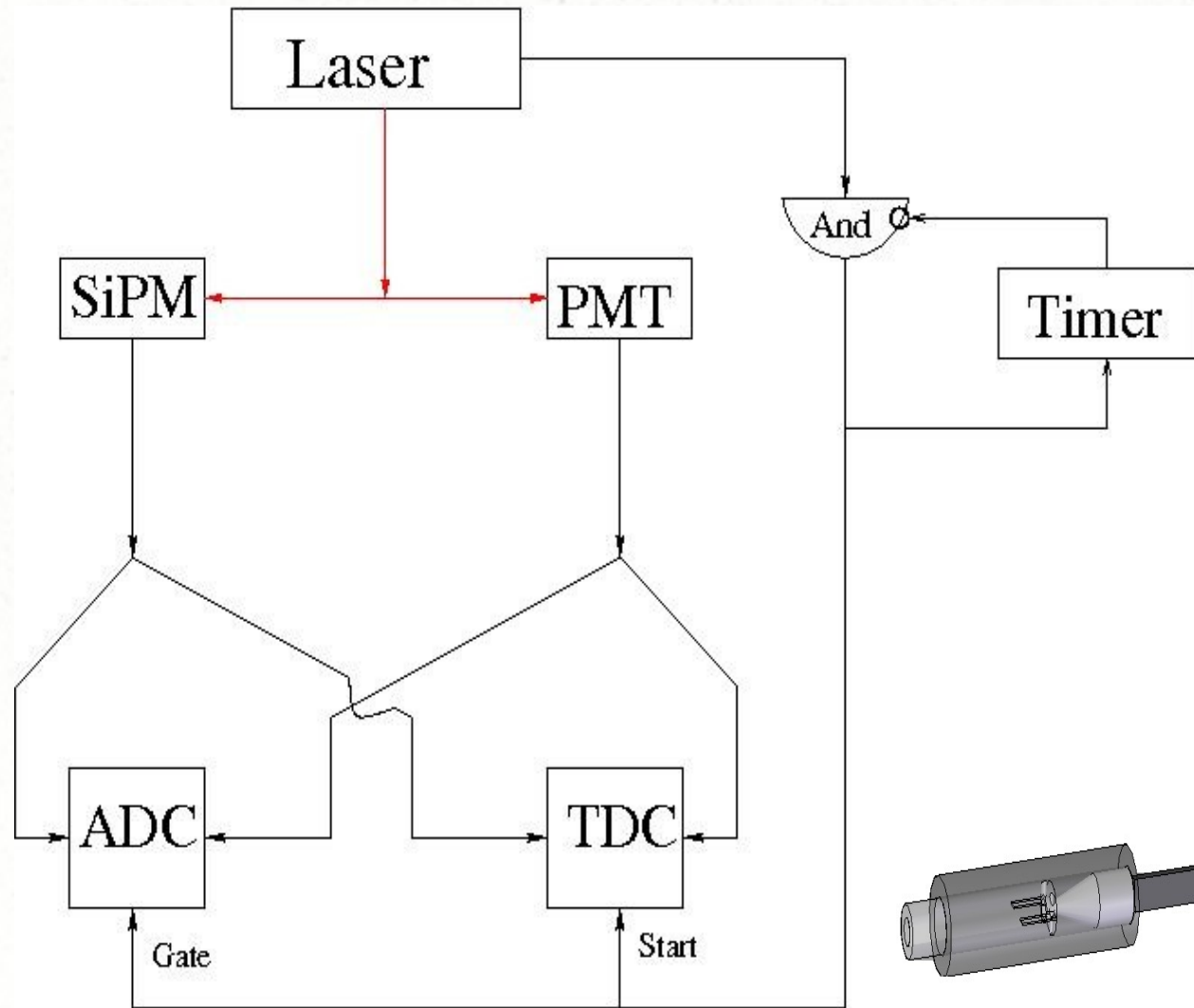# *SiPM Bias Analysis*

Shaun Krueger, Tegan Beattie
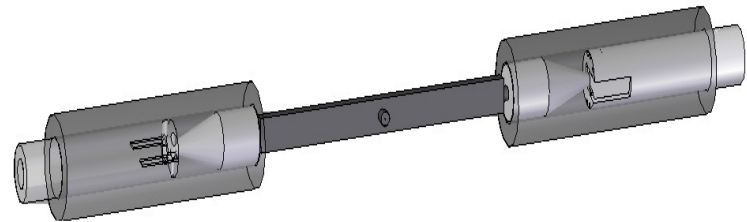On behalf of UofR group
September 11, 2012

Motivation

- In response to the theoretical results achieved by Yi Qiang on July 24, 2012

- To perform a direct check of the response of the 2010 SiPMs to varying voltage biases

- To provide a physical analysis of the normalized resolution and dark current of the 2010 SiPMs

Experimental Setup

- PicoQuant PDL 800-B laser

- 2.5 MHz frequency pulses

- 2 ms timer to slow count rate

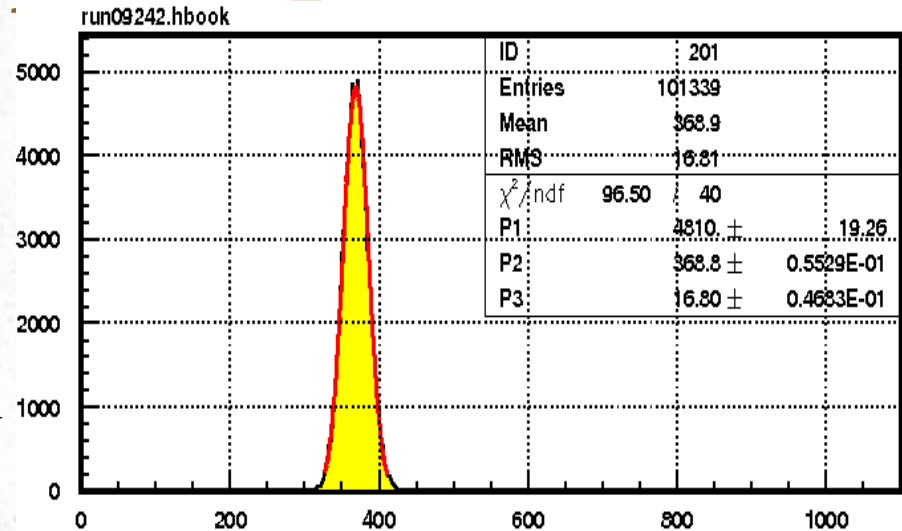- Bias supplied by Keithley 6487 Voltage Source

3

Data Sets

- Signal Data:

  - Taken at laser intensity 2.2, 2.4, and 2.6 (a.u.)
  - Using amplifier, bias, and laser light

- Noise:

  - Using amplifier and bias. No laser light.

- 50 Ω pedestal

  - Taken with 50 Ω terminators in ADC inputs
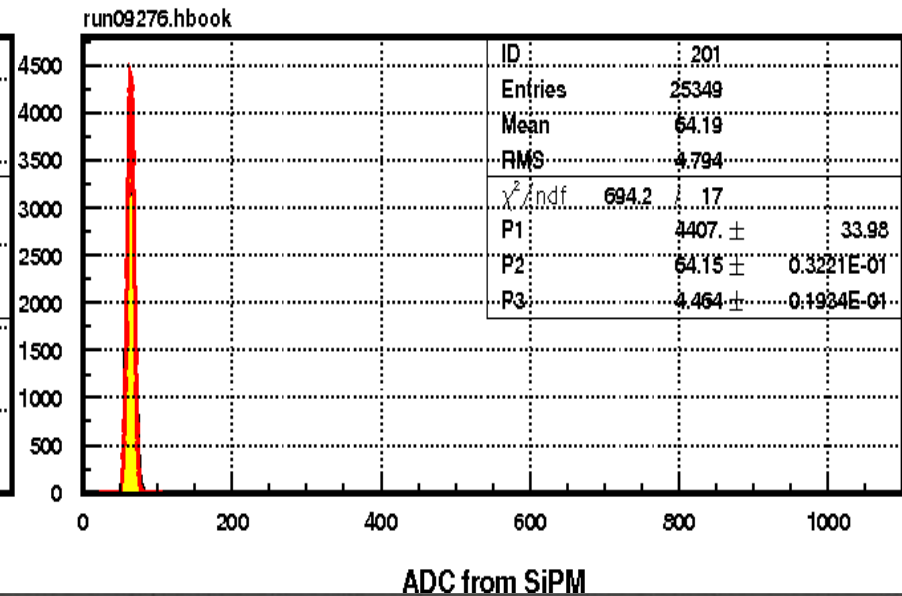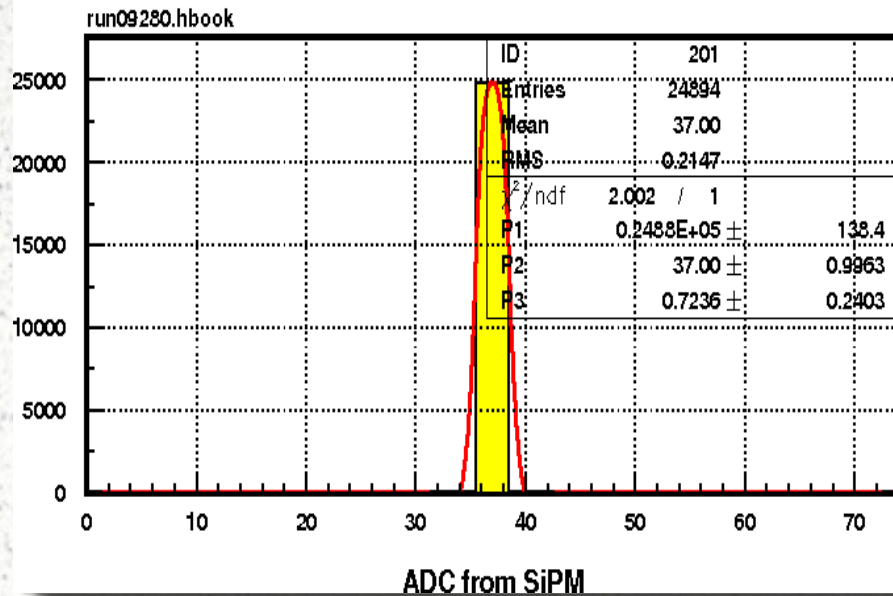
Spectra Examples

- Top Right: Signal Spectrum

- Bottom Left: 50 Ω pedestal

- Bottom Right: Noise Spectrum

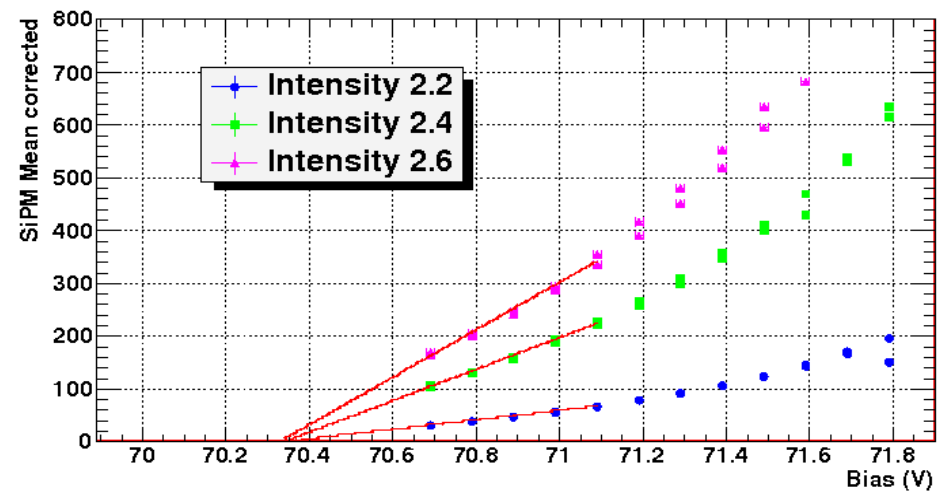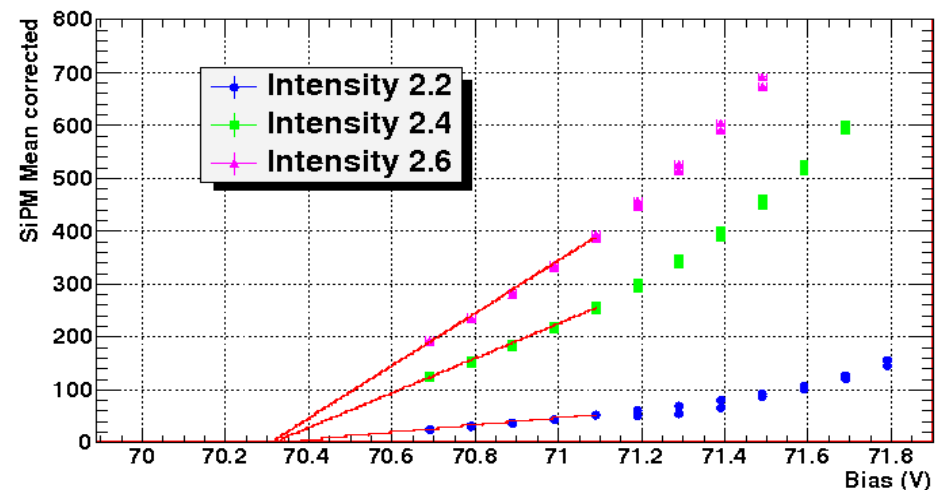# *Breakdown Voltage*

- Determined the breakdown voltage of the 2010 pre-production SiPMs was 0.4 V higher than stated from Jlab.

- New breakdown voltage found to be 70.34 ±0.02 V

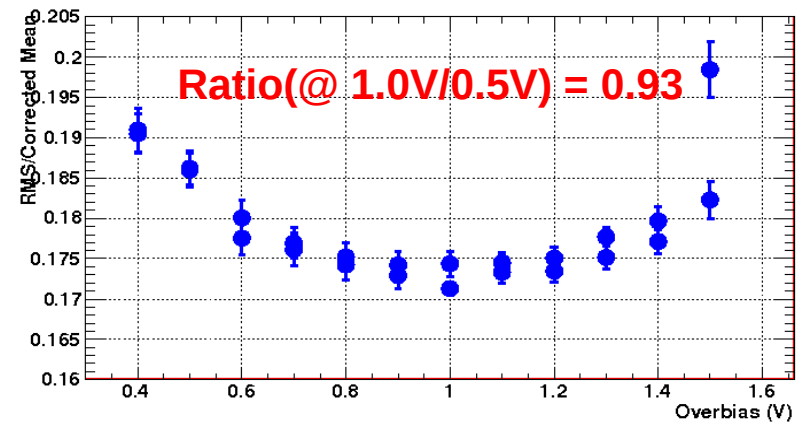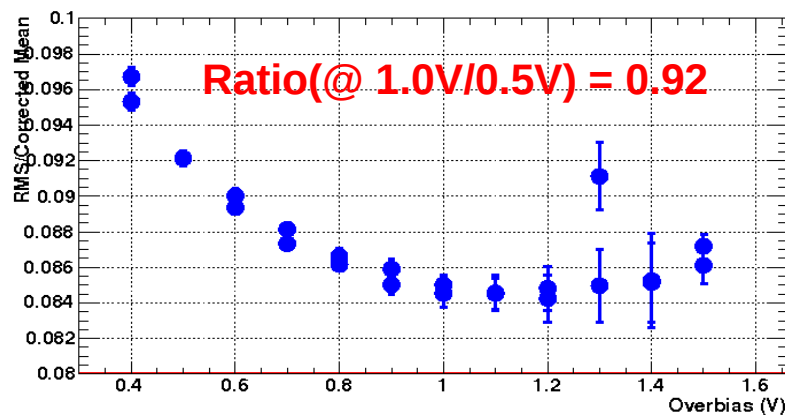- Adjusted all further graphs to account for adjusted breakdown voltage.

Normalized Resolution: SiPM 10

- Plot of RMS/Corrected Mean vs bias

- Top Right: Laser Intensity 2.2

- Bottom Left: Laser Intensity 2.4
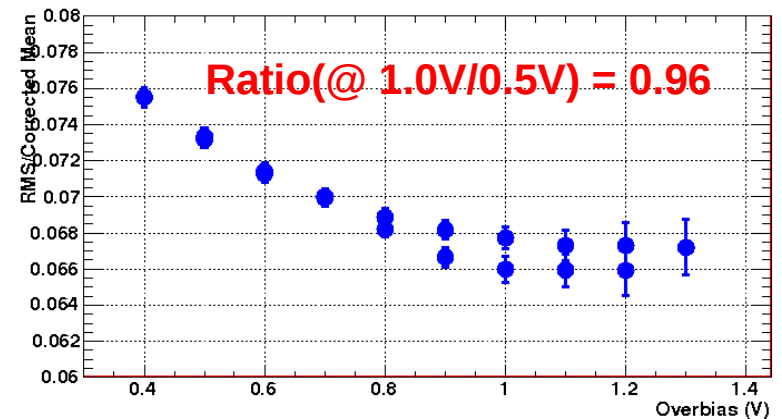
- Bottom Right: Laser Intensity 2.6

Normalized Resolution SiPM 10: Laser Intensity 2.2

Ratio(@ 1.0V/0.5V) = 0.93

Normalized Resolution SiPM 10: Laser Intensity 2.4

Ratio(@ 1.0V/0.5V) = 0.92

Normalized Resolution SiPM 10: Laser Intensity 2.6

Ratio(@ 1.0V/0.5V) = 0.96

Normalized Resolution: SiPM 2

- Plot of RMS/Corrected Mean vs bias

- Top Right: Laser Intensity 2.2

- Bottom Left: Laser Intensity 2.4

- Bottom Right: Laser Intensity 2.6
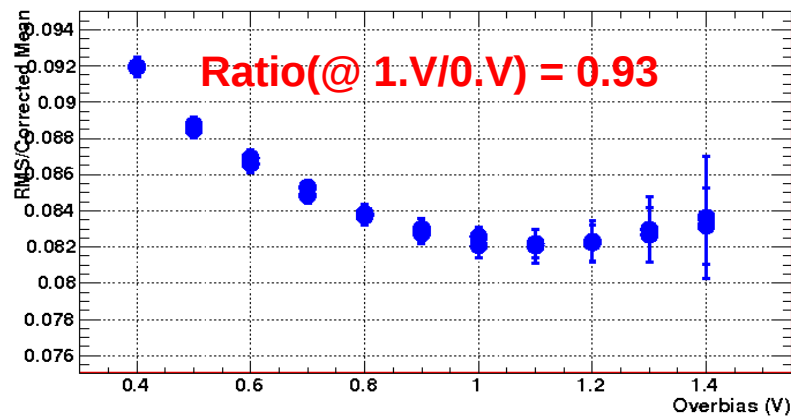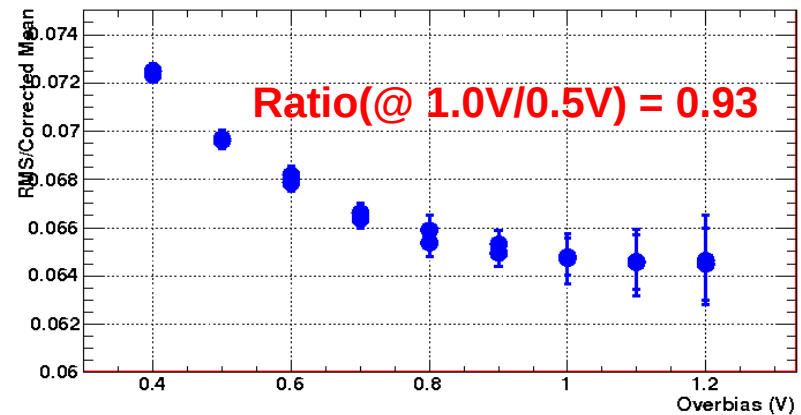

Normalized Resolution SiPM 10: Laser Intensity 2.2

Ratio(@ 1.0V/0.5V) = 1.05

Normalized Resolution SiPM 10: Laser Intensity 2.4

Ratio(@ 1.V/0.V) = 0.93

Normalized Resolution SiPM 10: Laser Intensity 2.6

Ratio(@ 1.0V/0.5V) = 0.93

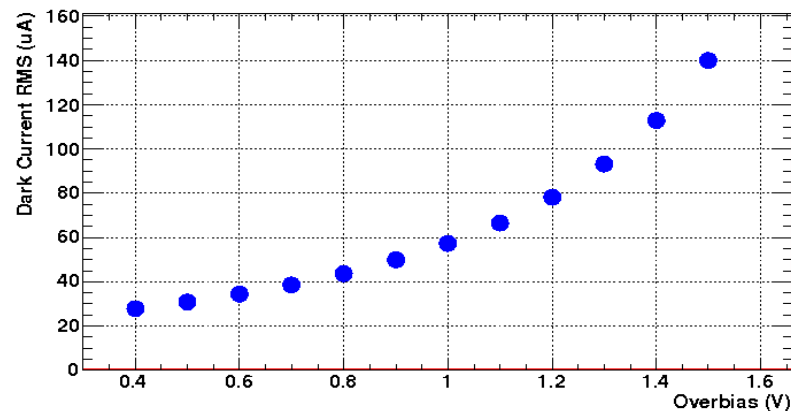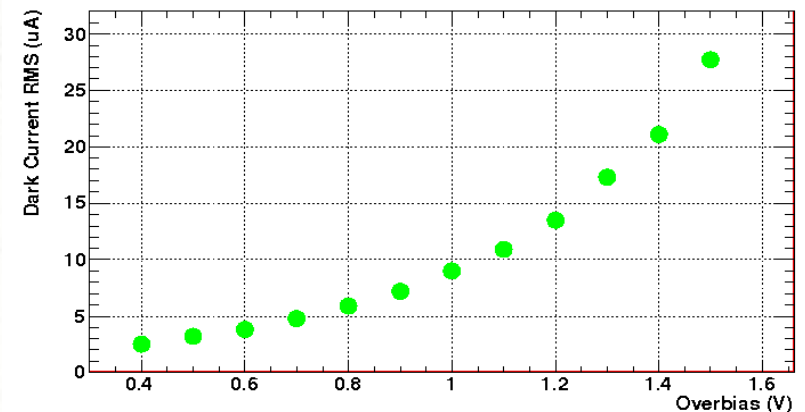# SiPM 10: Mean Noise and RMS

- Top: Average noise and RMS in ADC channels

- Bottom: Average noise and RMS expressed as dark current
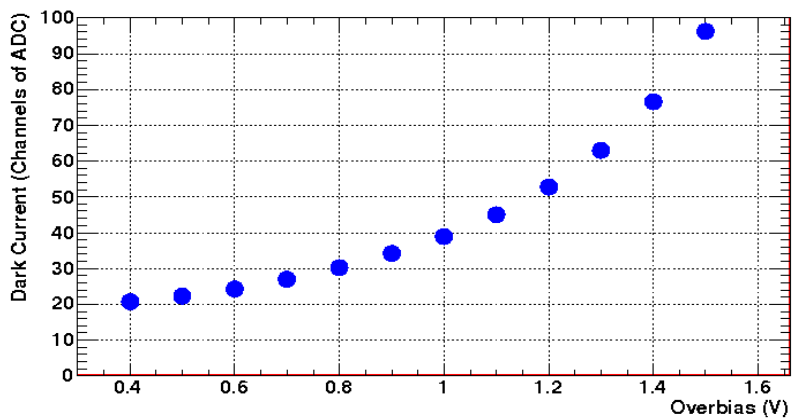
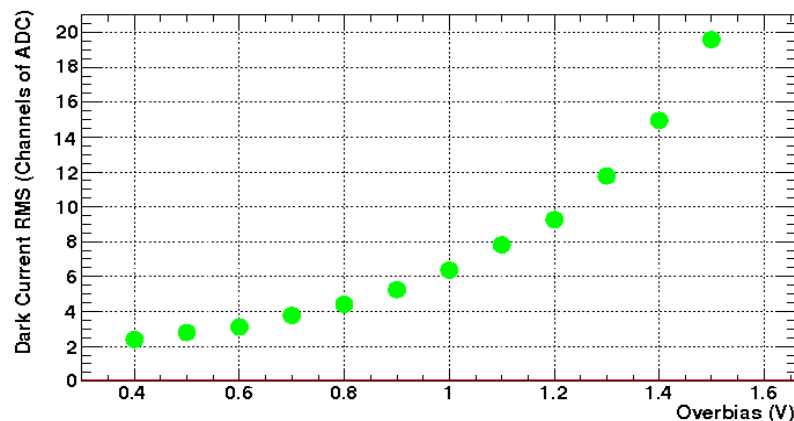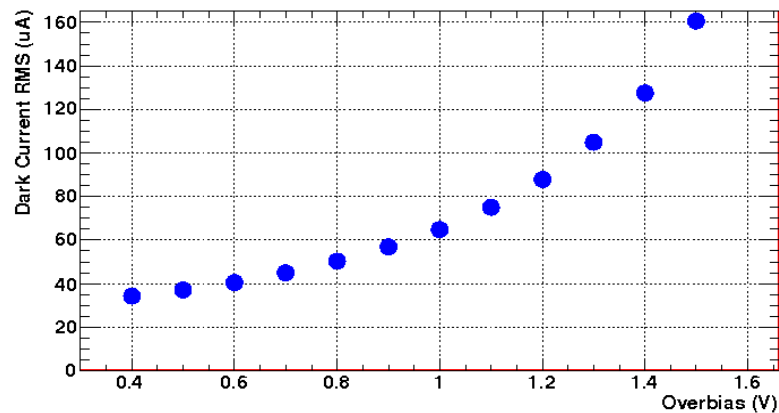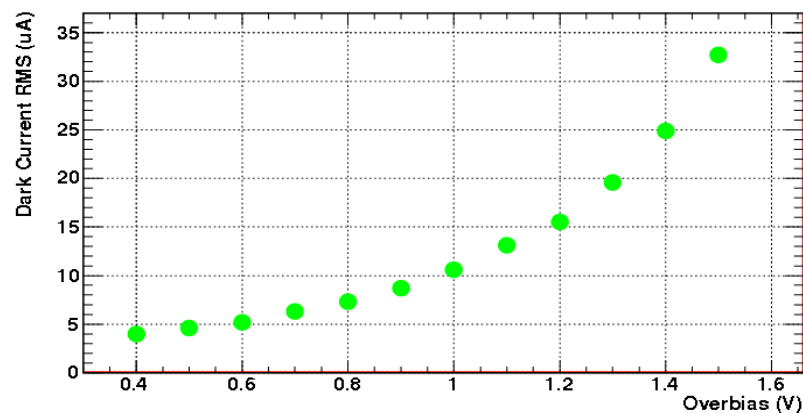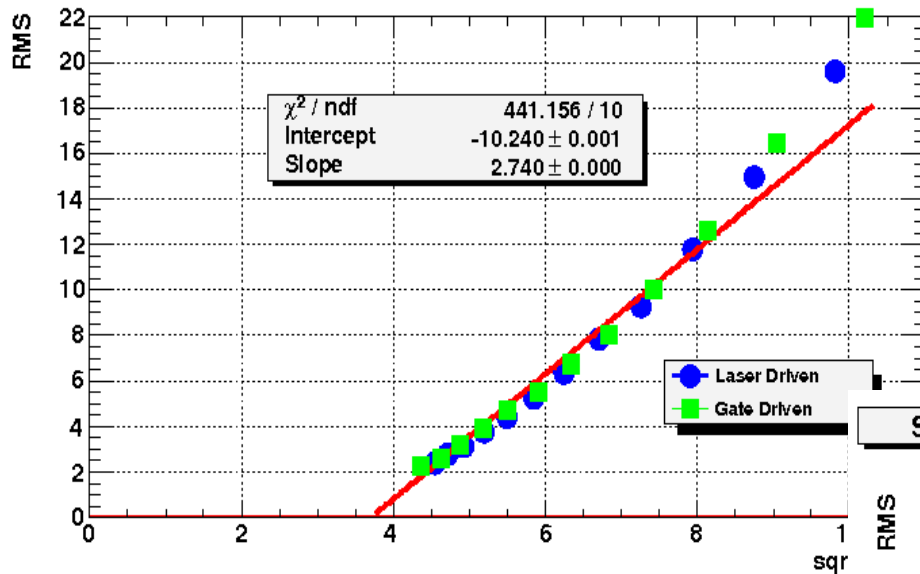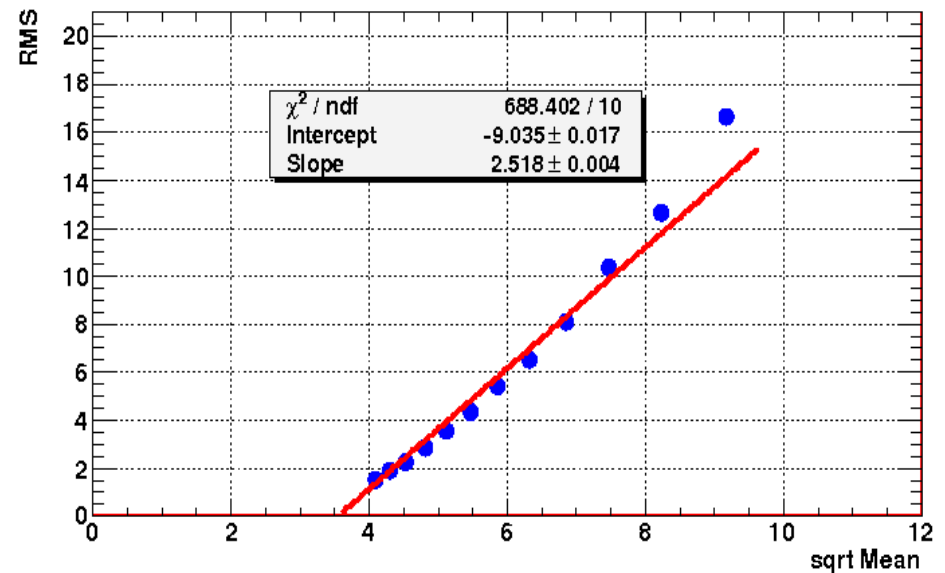# *SiPM 2: Mean Noise and RMS*

- Top: Average noise and RMS in ADC channels

- Bottom: Average noise and RMS expressed as dark current

Check for Poisson Characteristics

SiPM 2: Poissonian characteristics - Linear

χ^2 / ndf	441.156 / 10
Intercept	-10.240 ± 0.001
Slope	2.740 ± 0.000

- Laser Driven
- Gate Driven

SiPM 10: Poissonian characteristics - Linear

χ^2 / ndf	688.402 / 10
Intercept	-9.035 ± 0.017
Slope	2.518 ± 0.004

- RMS vs sqrt Mean of noise

- Fitted with linear line to check on Poisson characteristics

- Does not go through 0,0 or follow data closely.

Conclusions

- Resolution is minimized around 0.9V – 1.1V

  => 1.2 V may be too high

- 15% increase in noise going from 1.0V to 1.1V

- 35% increase in noise going from 1.0V to 1.2V

- Noise does not follow Poissonian trend

  => Rises faster than expected

- Future Measurements:

  - Recheck outliers

  - Check 2011 Units