# *SiPM Bias Analysis*

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On behalf of UofR group
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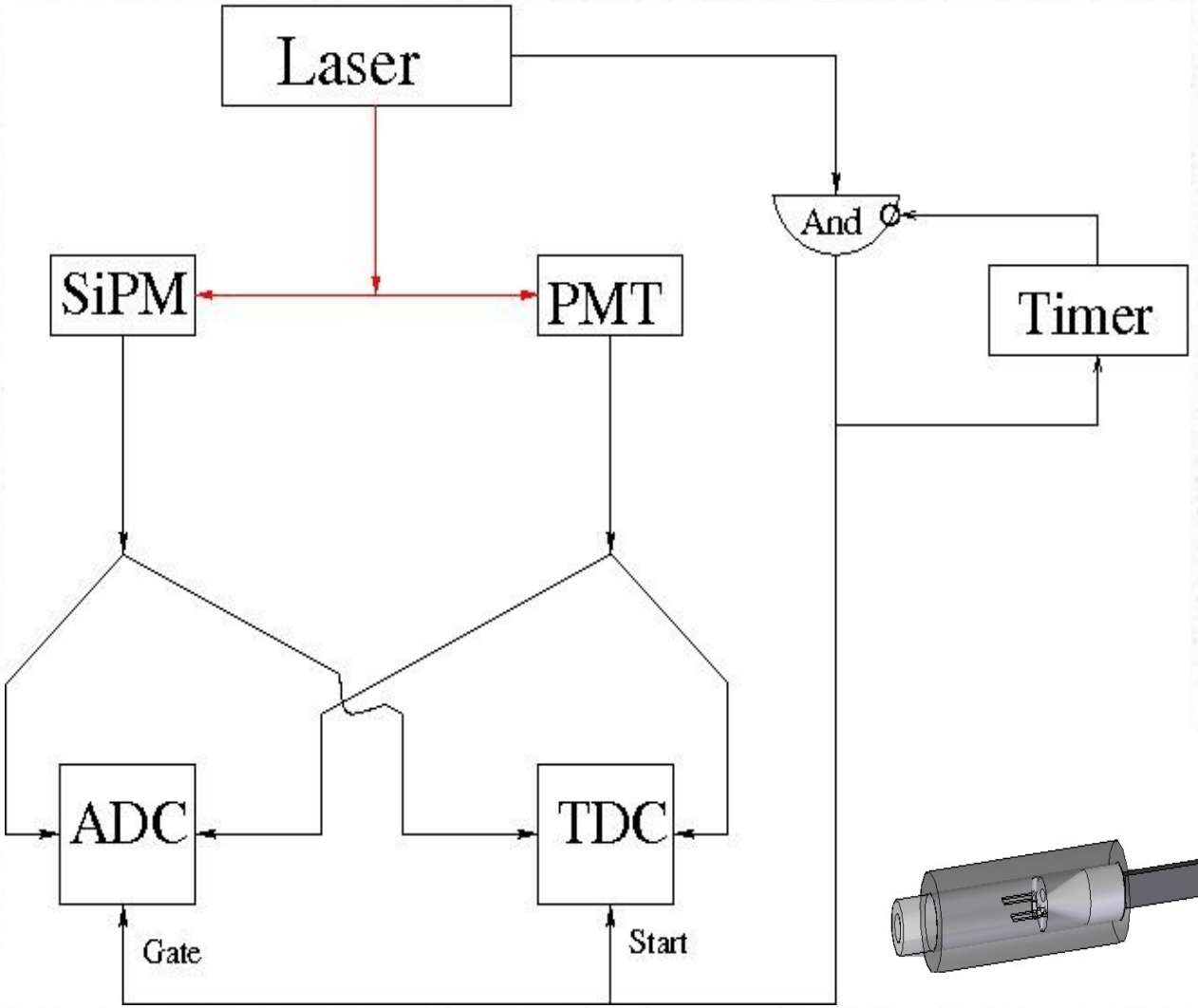
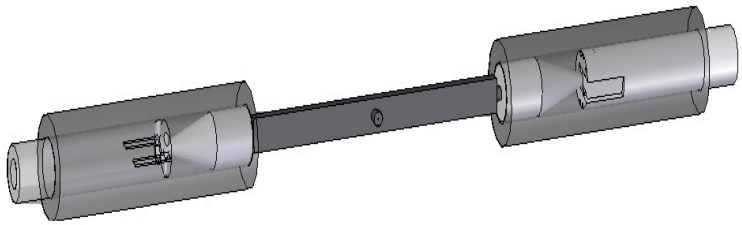
# *Motivation*

- 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

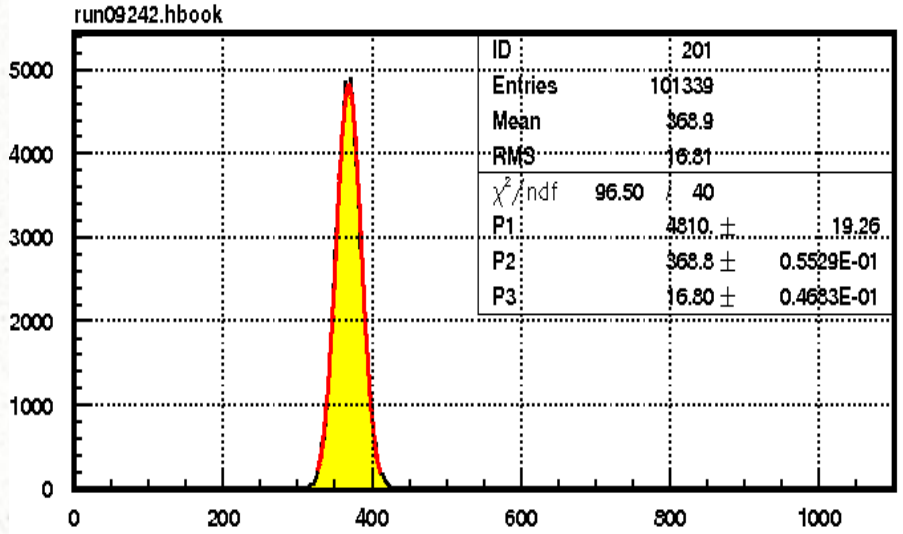


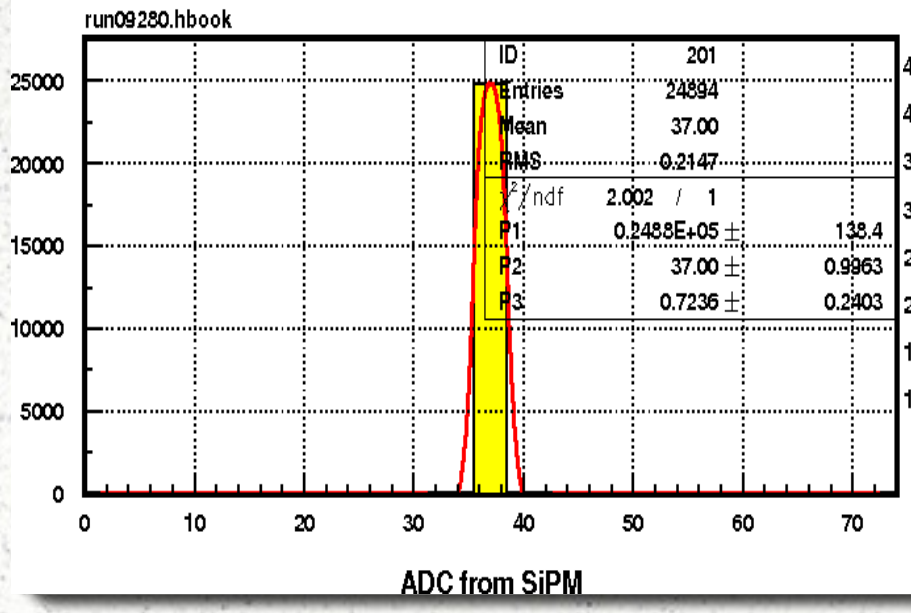
# *Data Sets*

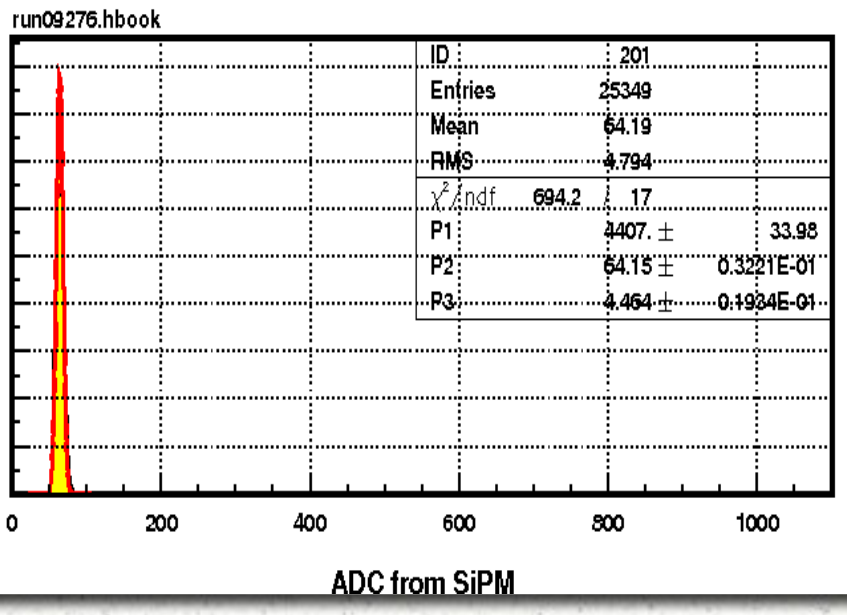
- Signal Data:
  - Taken at laser intensity 2.2, 2.4, and 2.6 (a.u.)
  - Using amplifier, bias, and laser light
- Noise:
  - Using amplifier and bias. No laser light.
- 50 Ω pedestal
  - Taken with 50 Ω terminators in ADC inputs

# *Spectra Examples*

- Top Right: Signal Spectrum
- Bottom Left: 50 Ω pedestal
- Bottom Right: Noise Spectrum

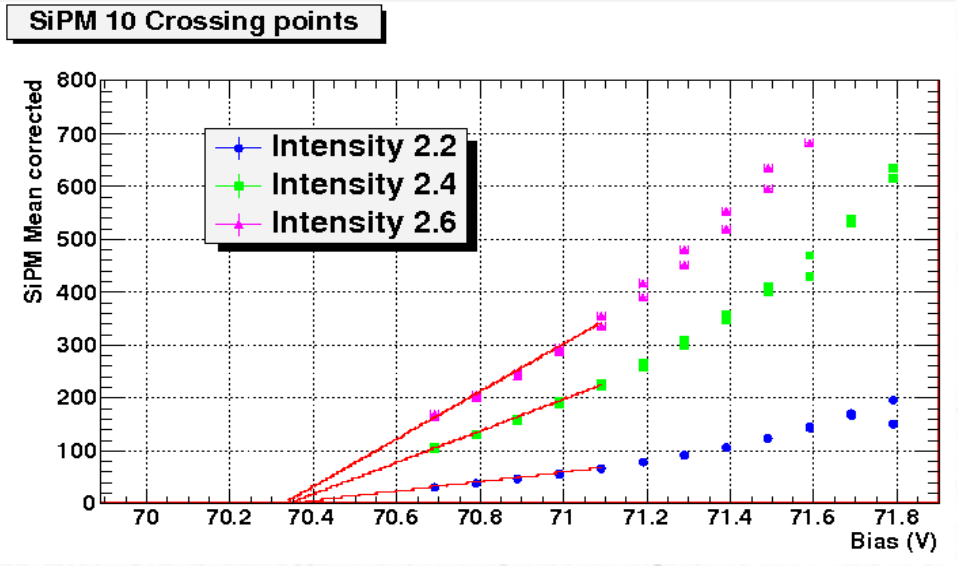


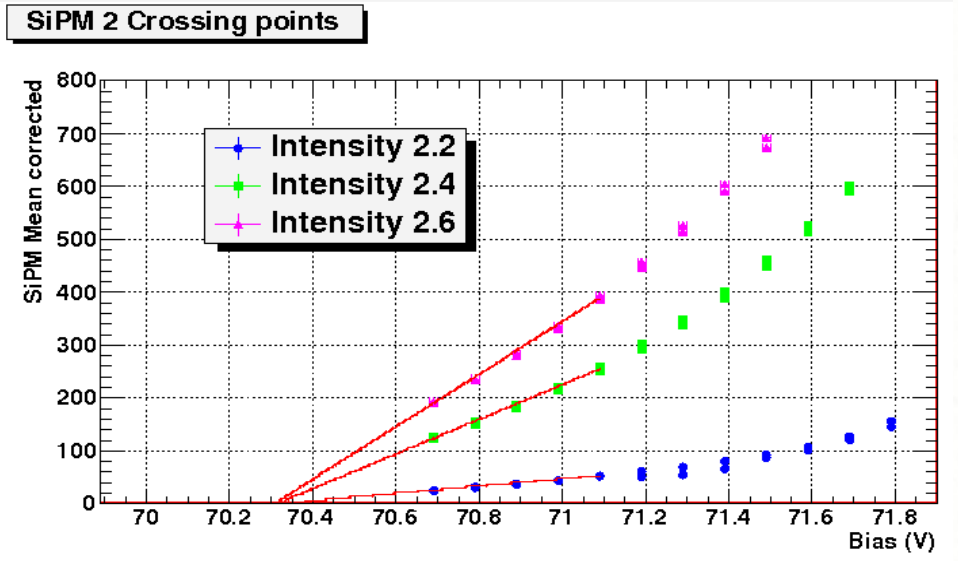



# *Breakdown Voltage*

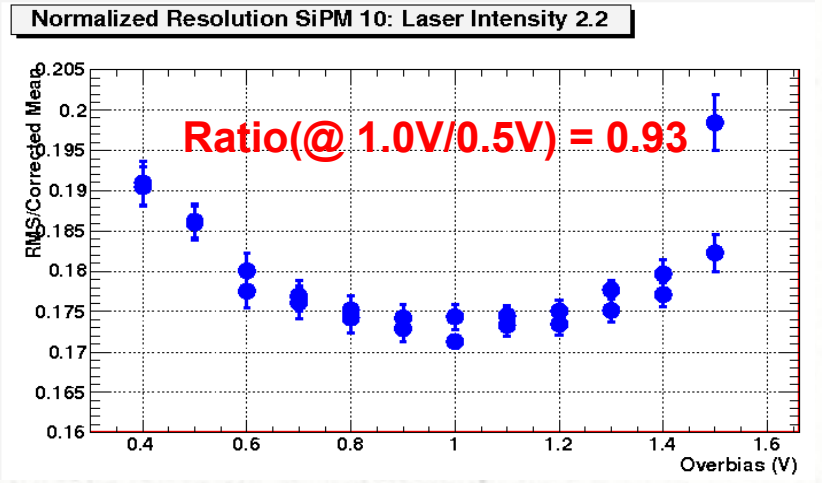
- Determined the breakdown voltage of the 2010 pre-production SiPMs was 0.4 V higher than stated from Jlab.
- New breakdown voltage found to be 70.34 ±0.02 V
- Adjusted all further graphs to account for adjusted breakdown voltage.

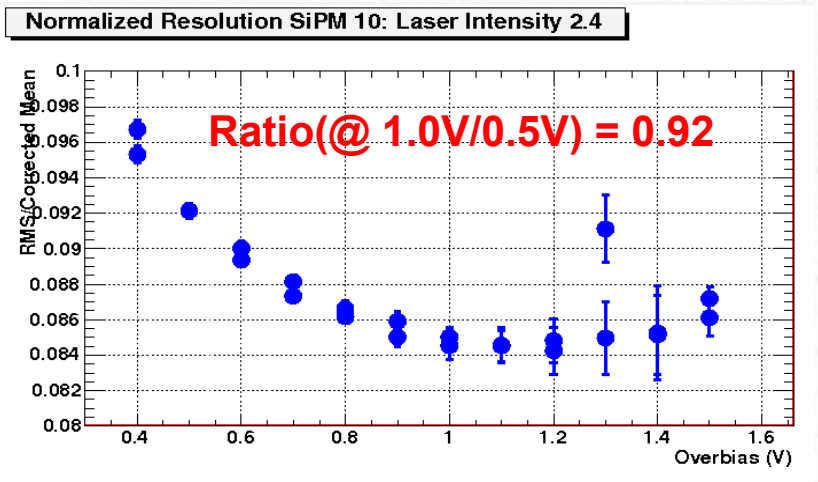


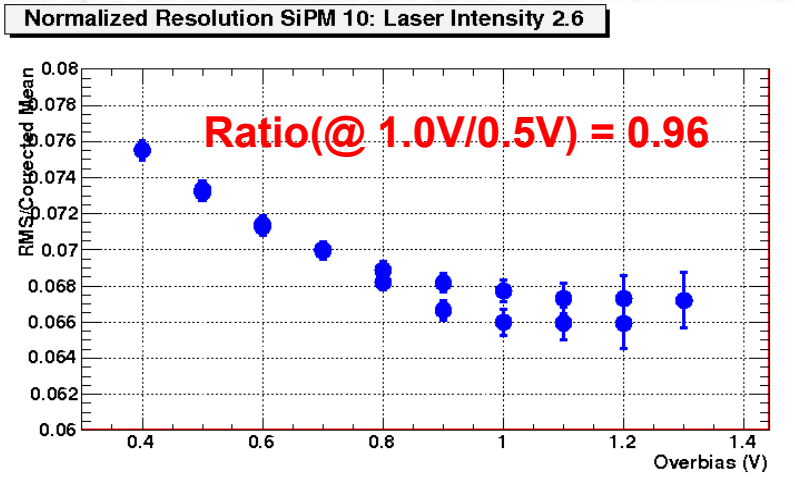



# *Normalized Resolution: SiPM 10*

- 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

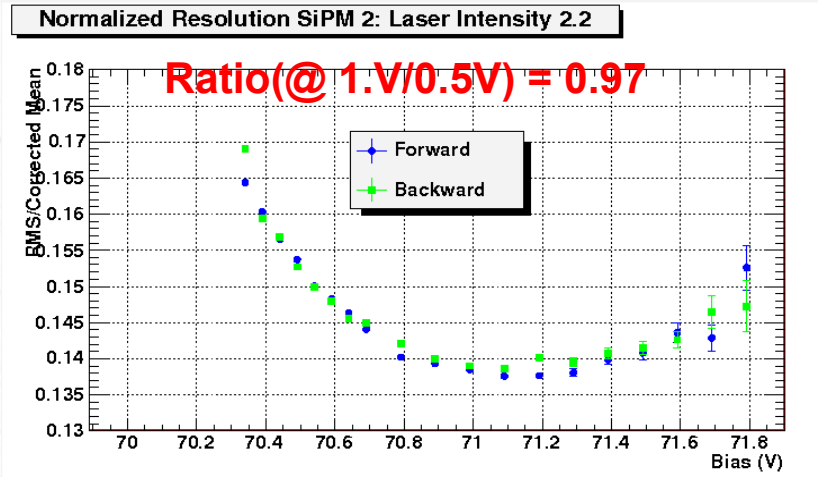


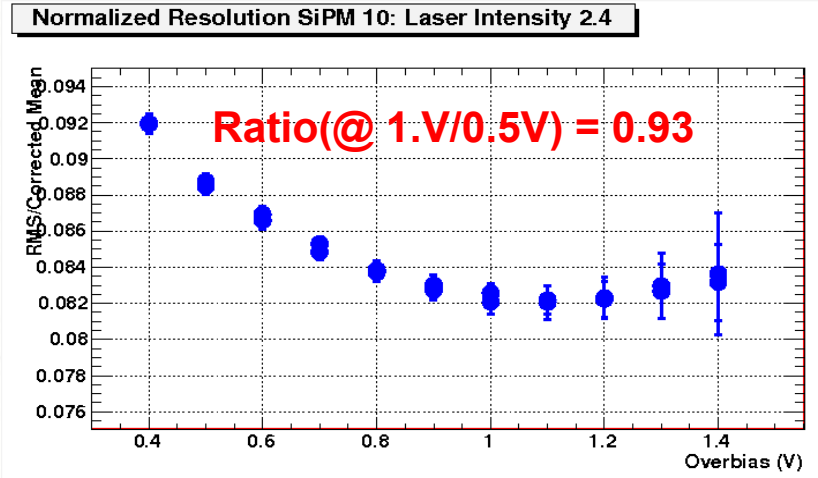



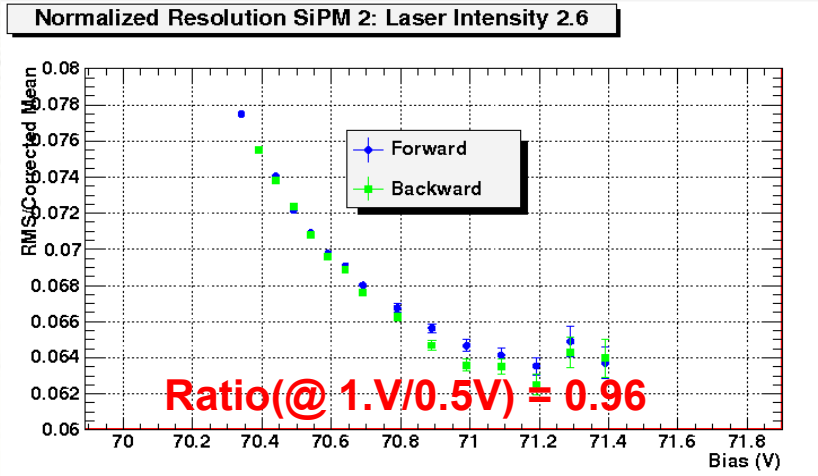



# *Normalized Resolution: SiPM 2*

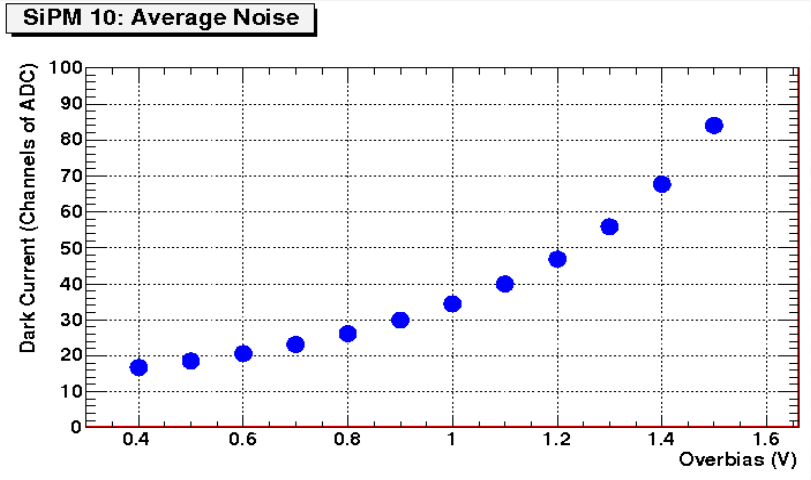
- Plot of RMS/Corrected Mean vs bias
- Updated Top Right: Laser Intensity 2.2
- Bottom Left: Laser Intensity 2.4
- Updated Bottom Right: Laser Intensity 2.6

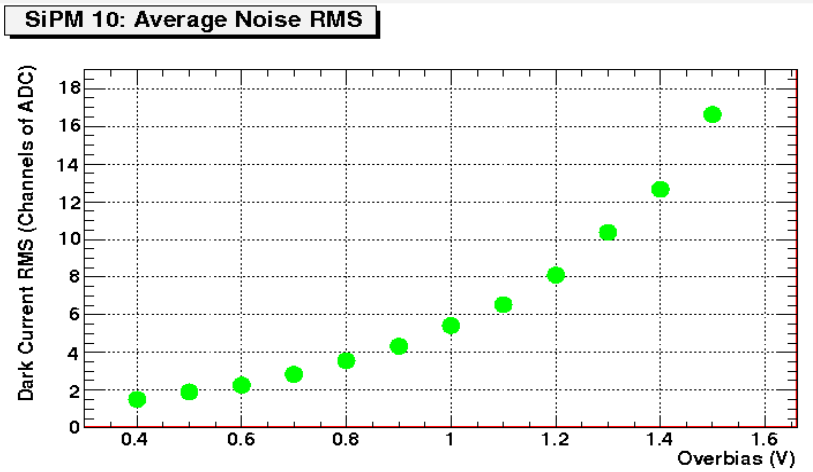


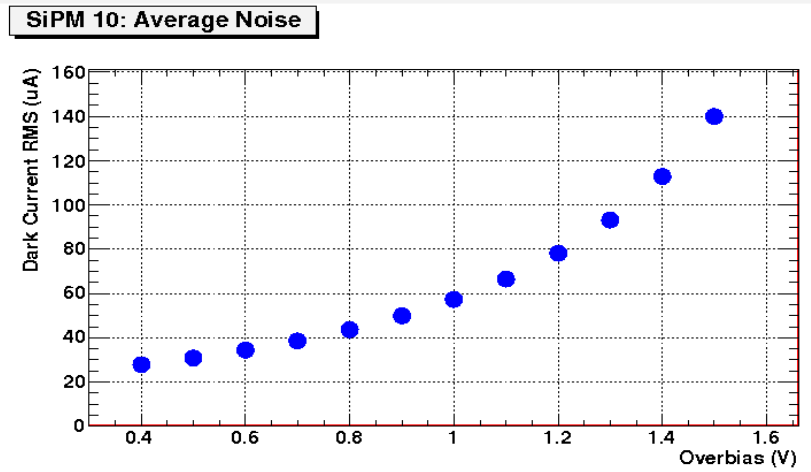



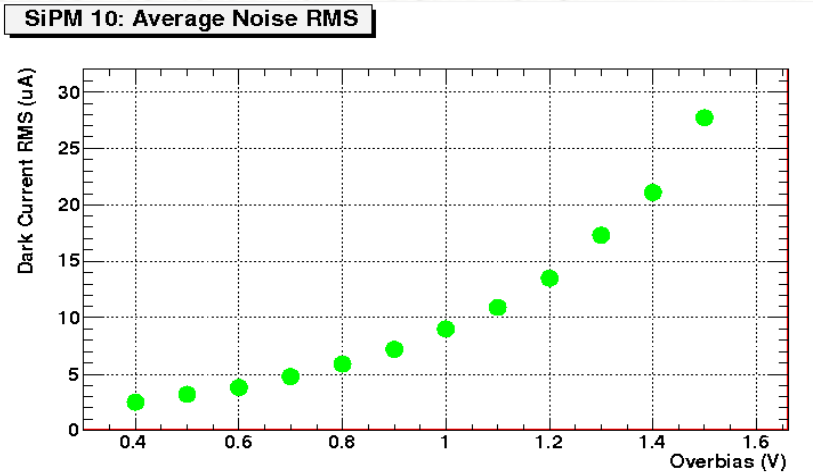
# SiPM 10: Mean Noise and RMS



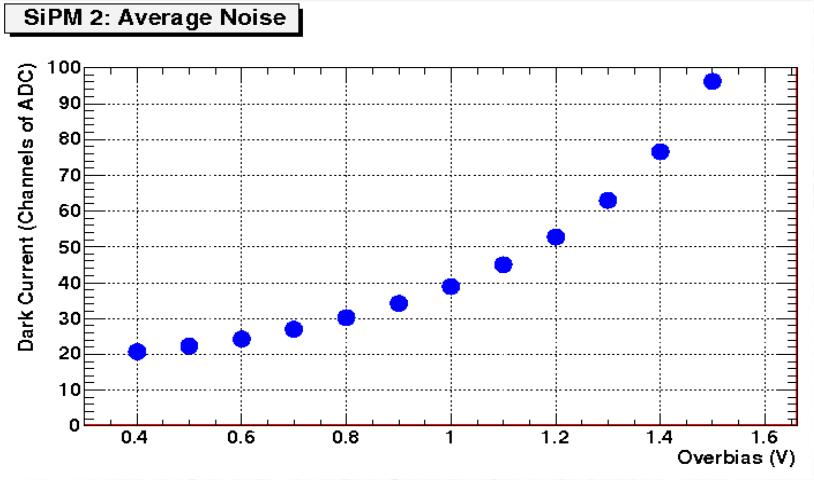



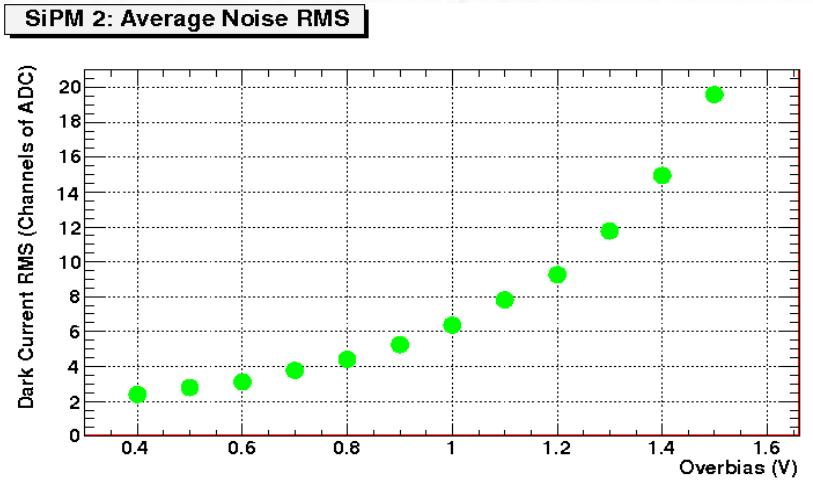

- Top: Average noise and RMS in ADC channels
- Bottom: Average noise and RMS expressed as dark current



# SiPM 2: Mean Noise and RMS

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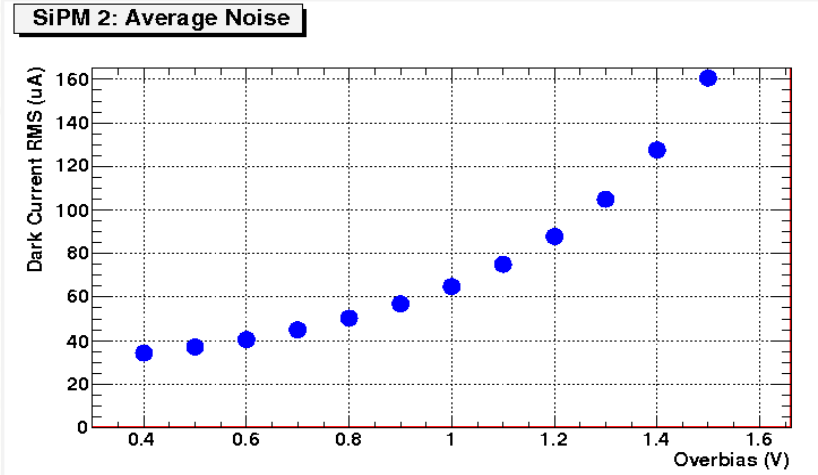
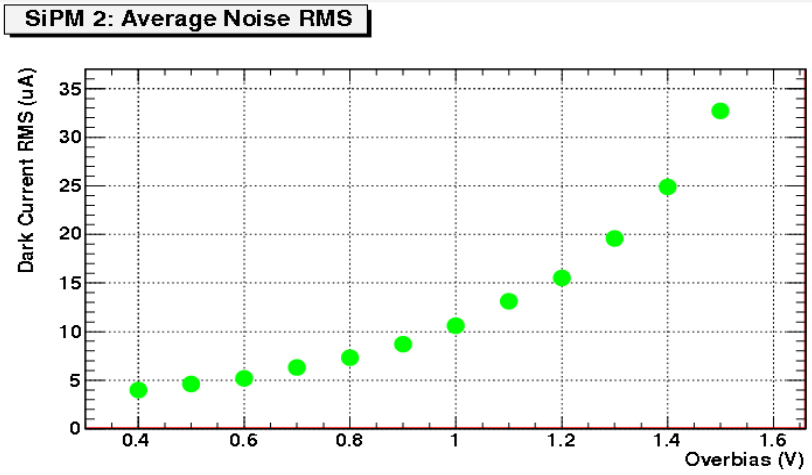
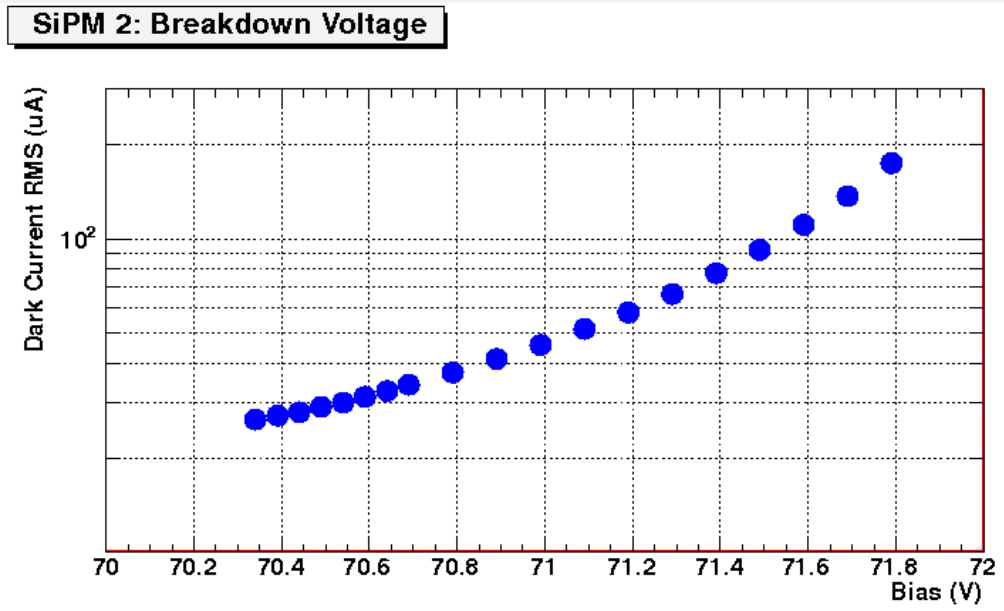


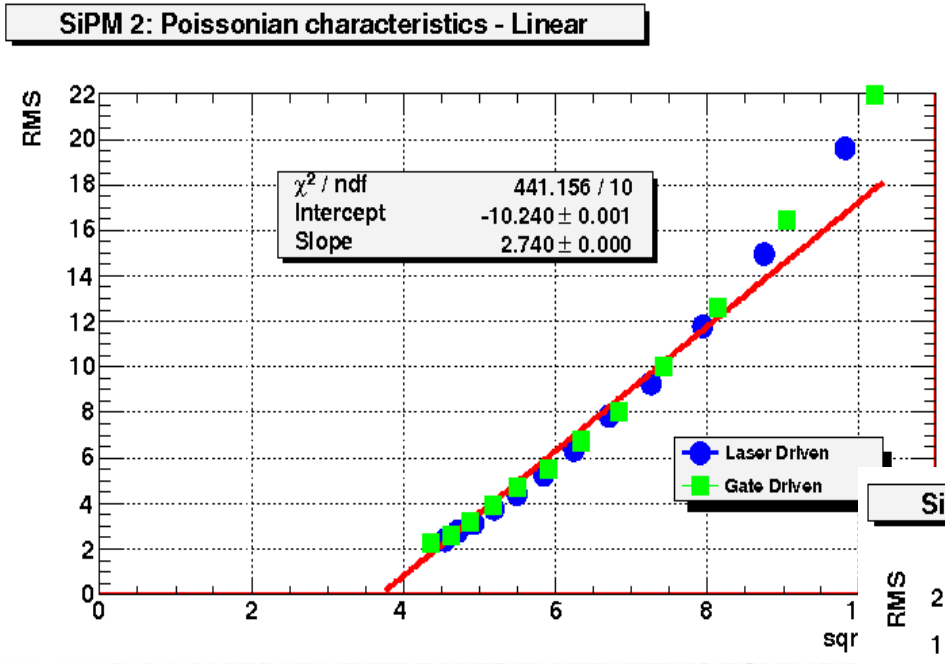



# *Breakdown Voltage via Dark Current*

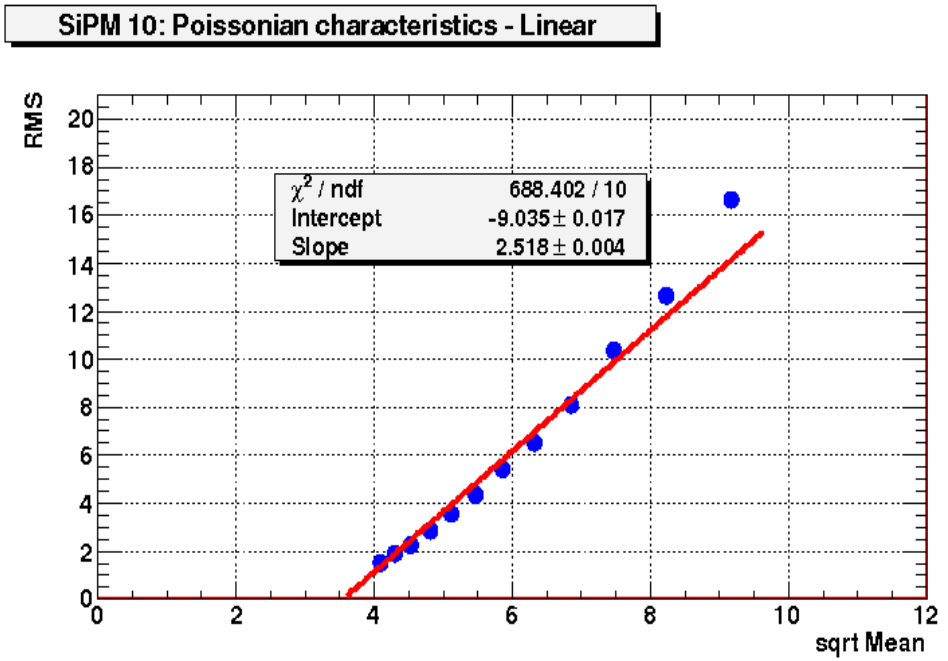
- Plotted Dark Current (uA) on log scale vs bias as suggested by Carl Zorn
- Point of rapid growth indicates breakdown point



# *Check for Poisson Characteristics*




- 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