A Compilation of Results for Solid State Photo-detectors

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SLAC-LCWG

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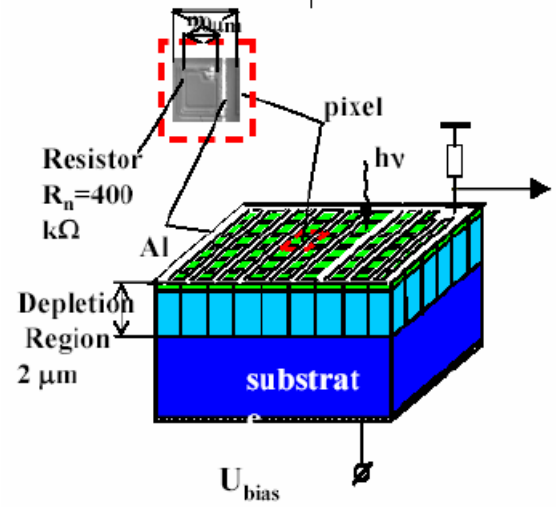
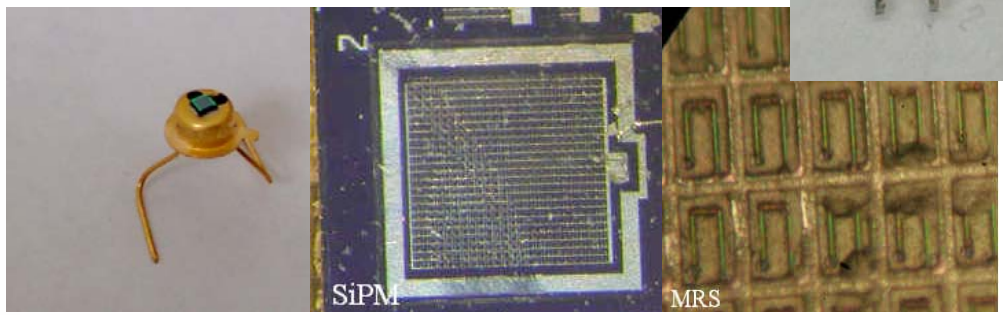
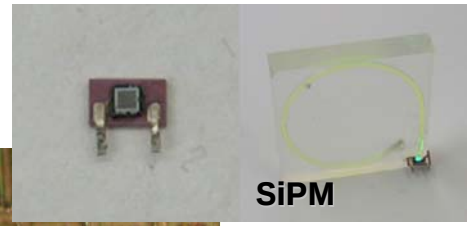
References

- Towards a Scintillator-based Digital Hadron Calorimeter for the Linear Collider Detector", A. Dyshkant et al, IEEE TNS vol. 51, N4(2004).
- ``Small Scintillating Cells as the Active Elements in a Digital Hadron Calorimeter for the e^+e^- Linear Collider Detector", A. Dyshkant et al, J. Phys. G30:N1 (2004).
- ``Investigation of a Solid-State Photodetector", D. Beznosko et al, submitted to NIM A.
- ``The MRS Photodiode in a Strong Magnetic Field", D. Beznosko et al, FERMILAB-TM-2284.

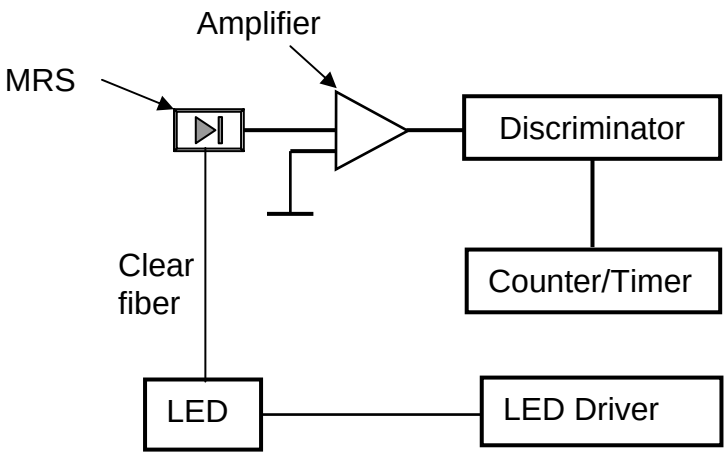
SiPM / MRS

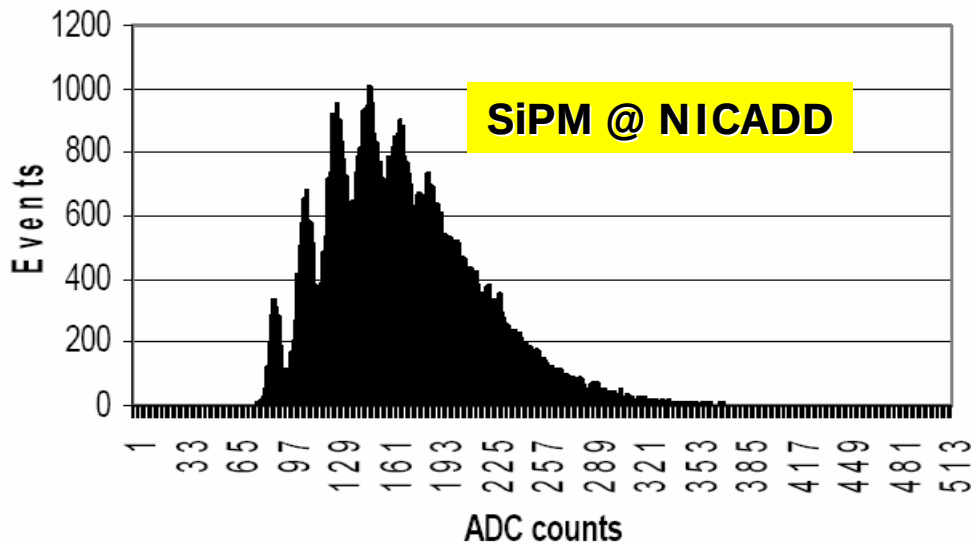






~1000 pixels on 1mm x 1mm; Limited Gieger multiplication mode; Bias voltage ~ 50-60V; Gain ~ 10^6; Quantum ε x geom ~ 12-15%





*SiPM --> MEPhI / Pulsar
MRS---> CPTA

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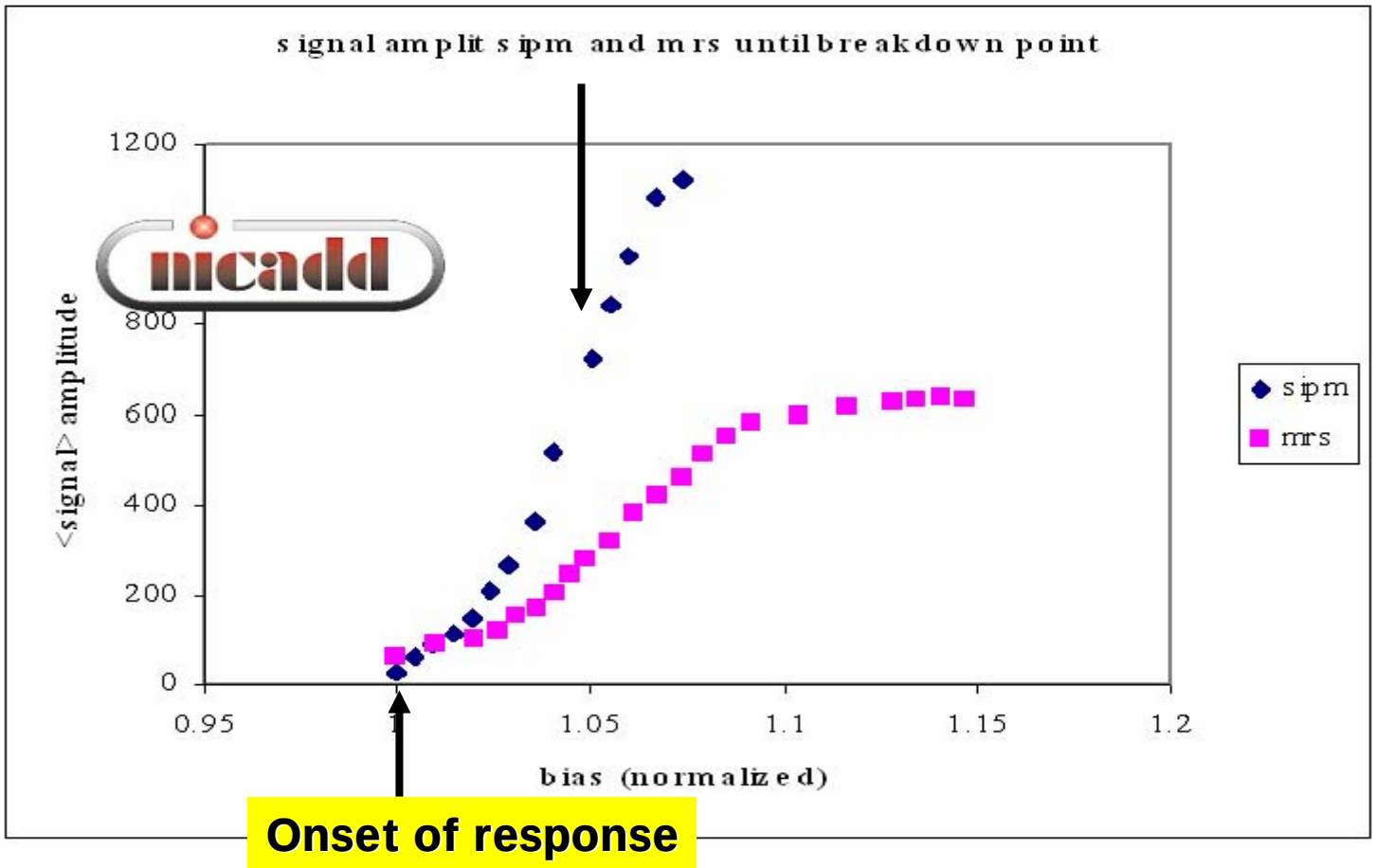
Signal Amplitude vs. Bias



Green LED(~130Hz) with clear fiber used
Representative, wafer behavior uniform

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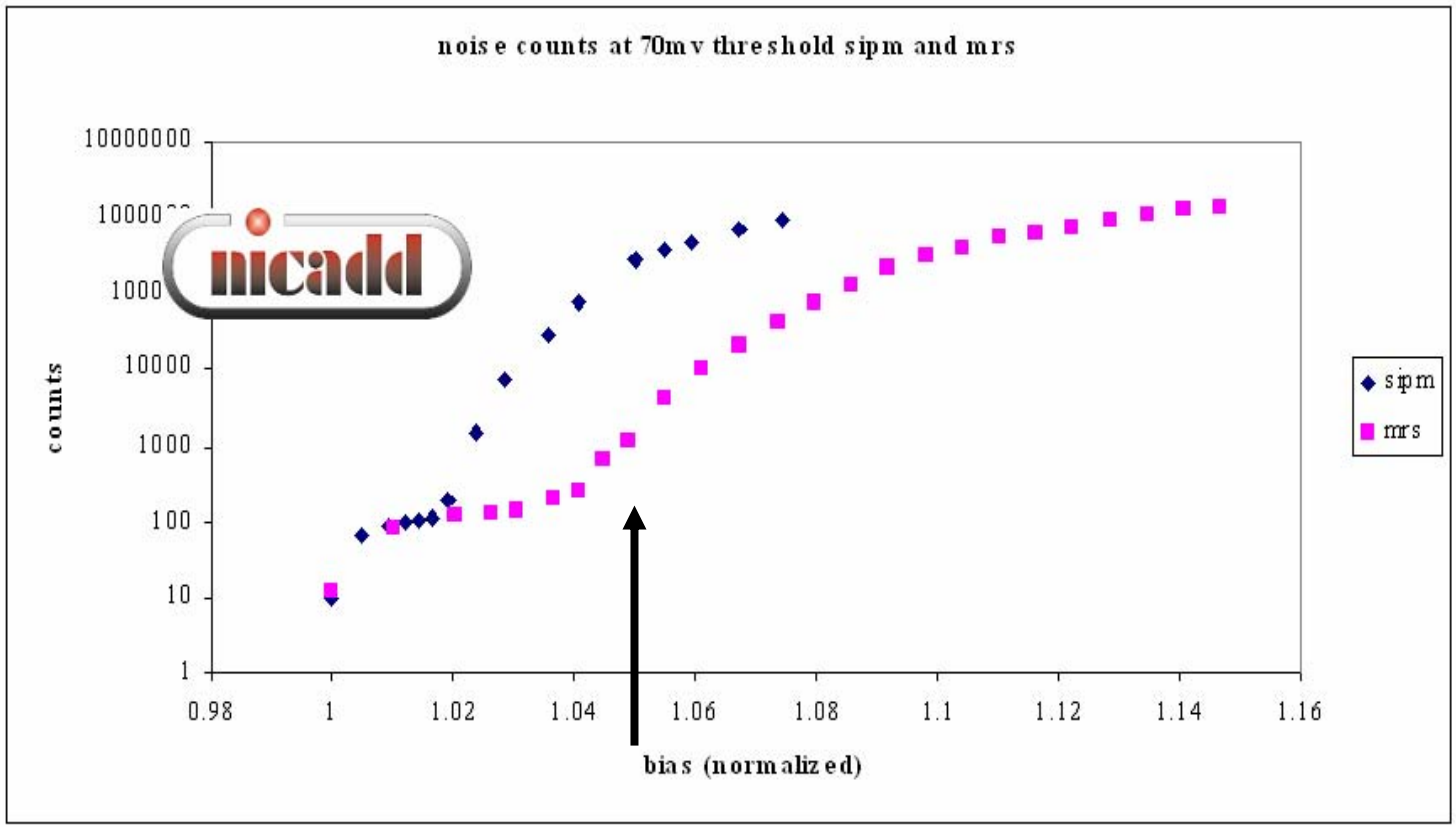
Count Rate vs. Bias



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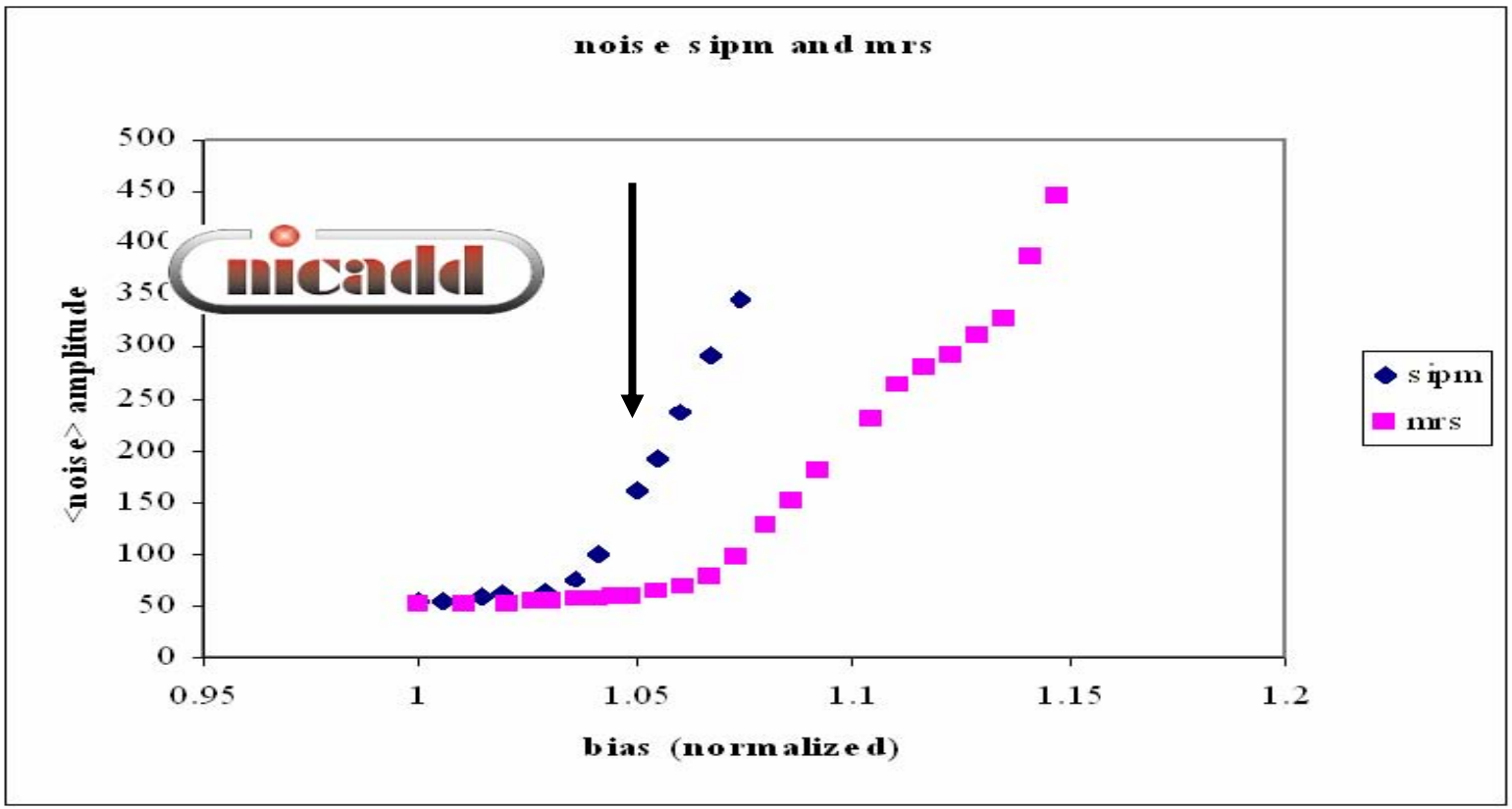
Noise Amplitude(LED off) vs. Bias



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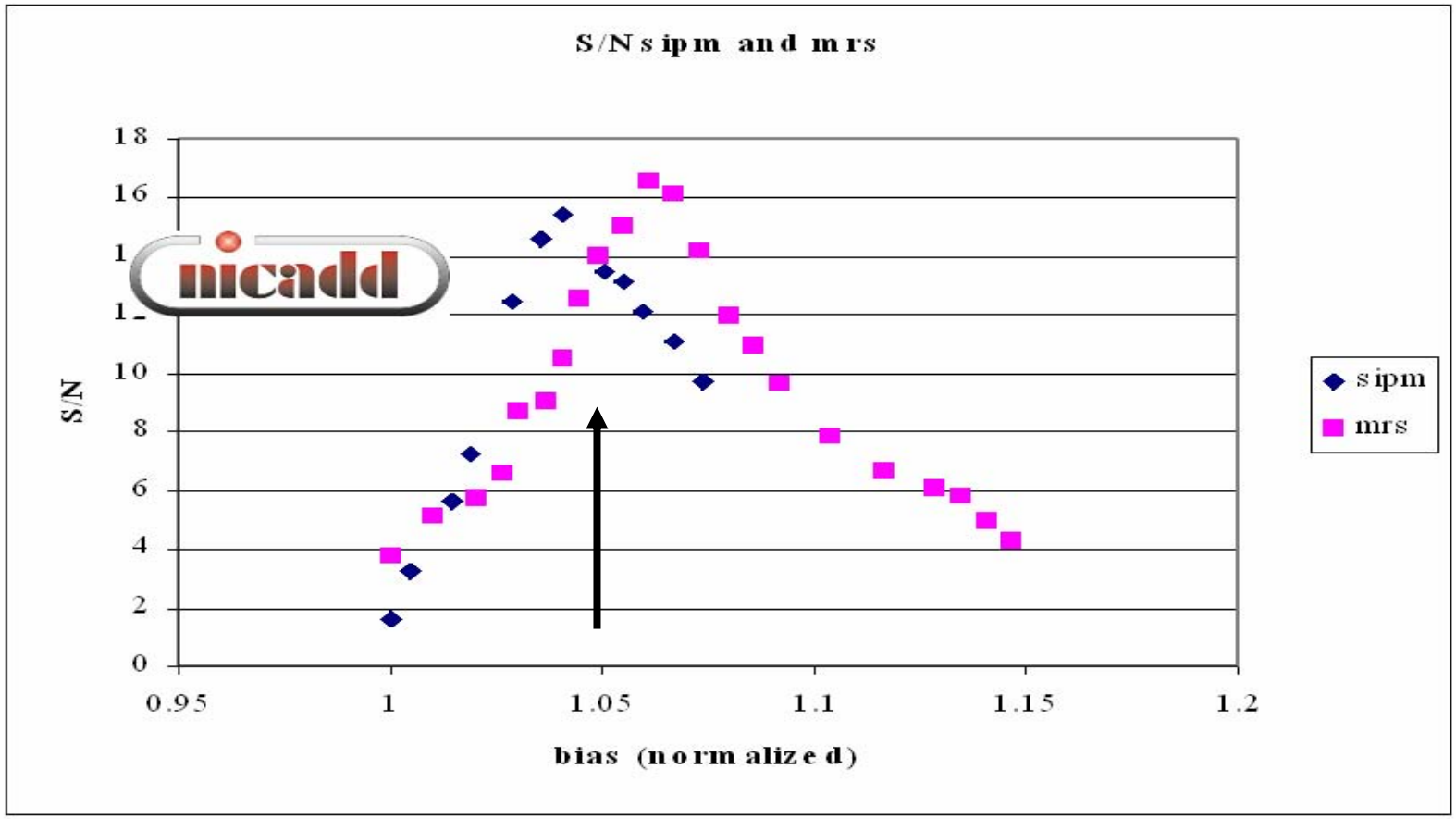
S/N vs. Bias Voltage

Slide 7 Divided by Slide 5



Maximum offers operating point with high amplitude and controllable rate, can be adjusted to ensure linearity if needed.

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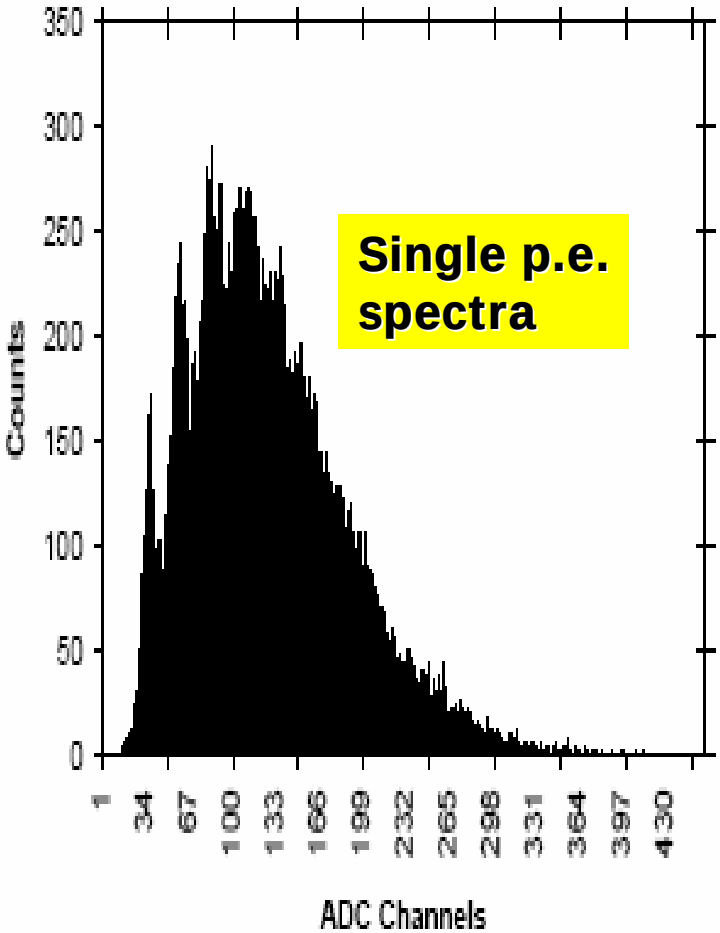
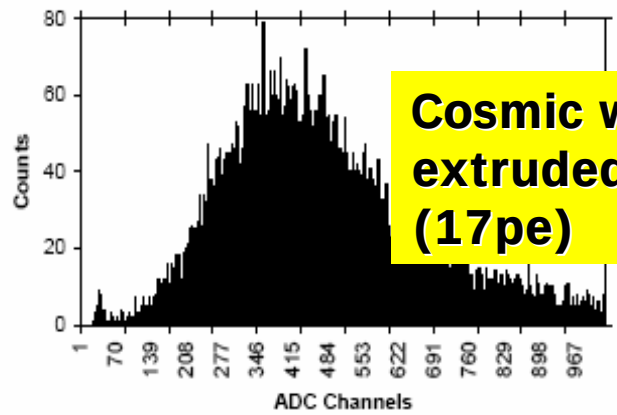
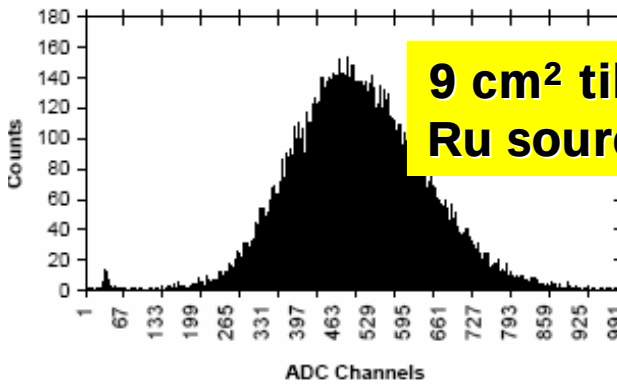
MRS Light Yield







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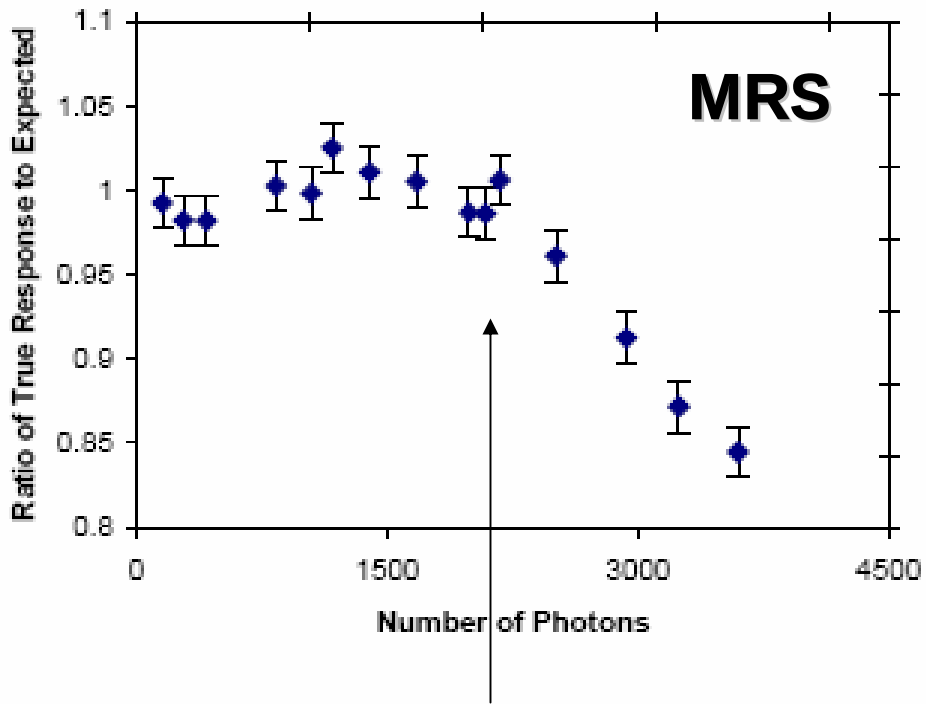
Linearity



~ 30 MIPS

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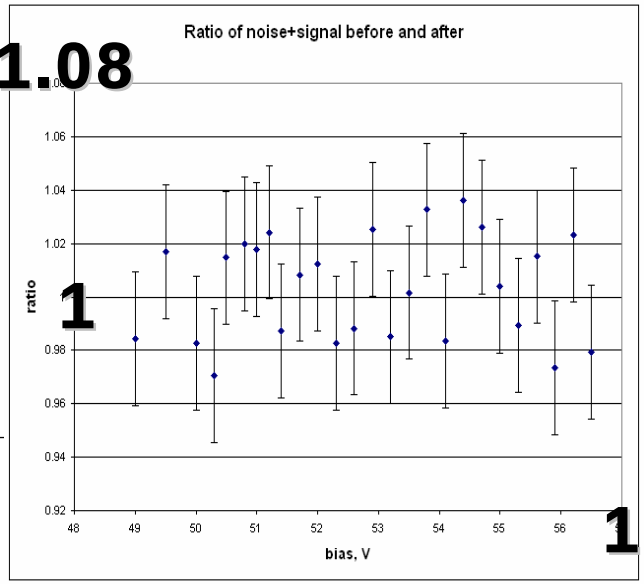
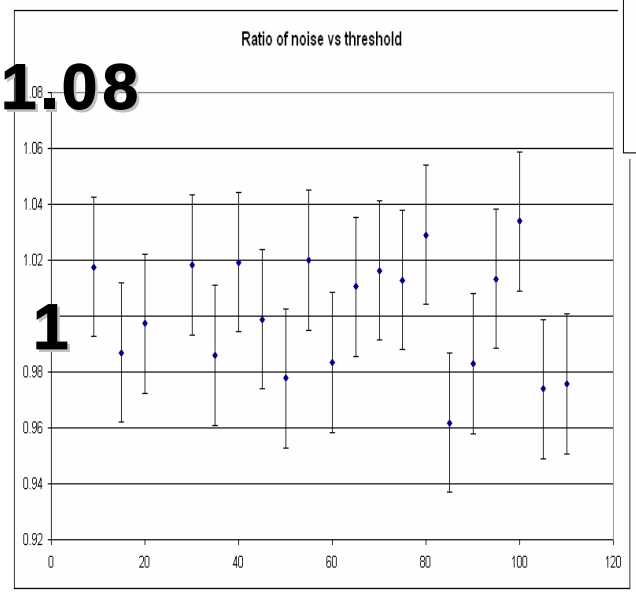
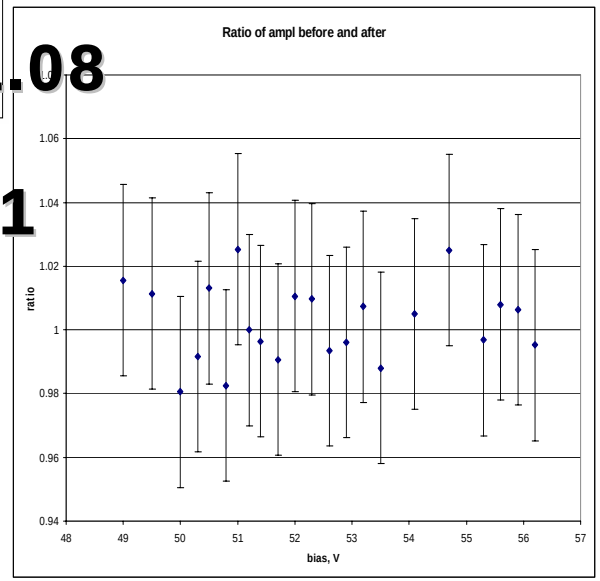
Other studies…. response of photodetector to irradiation

- Sent sensors to Michigan γ irradiation facility
- Dosage ~ 1MRad
- Comparison of noise & signal before & after irradiation
- Plan to irradiate with protons

MRS Rate, Noise, and Amplitude Before & After







No measurable change in response

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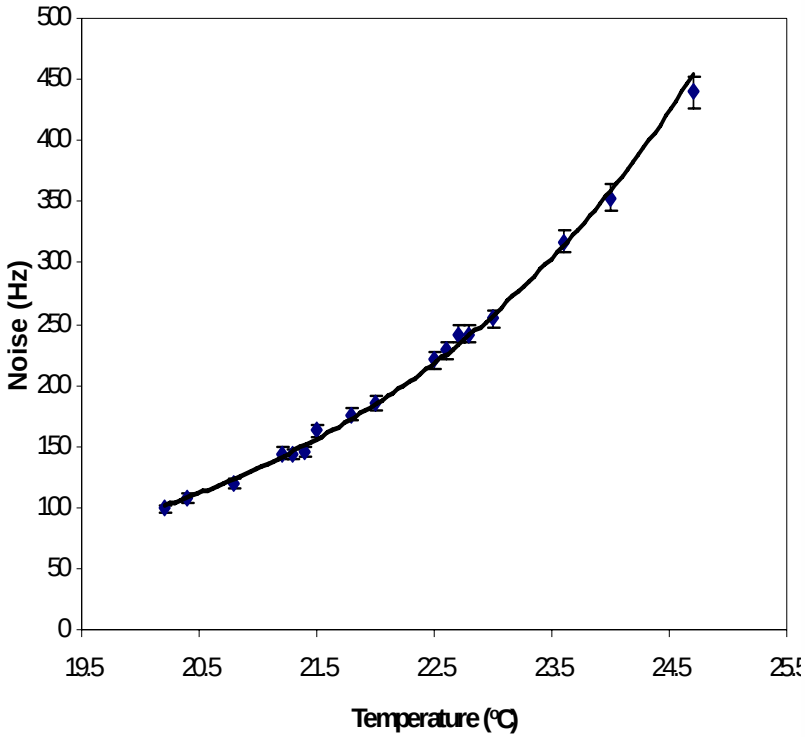
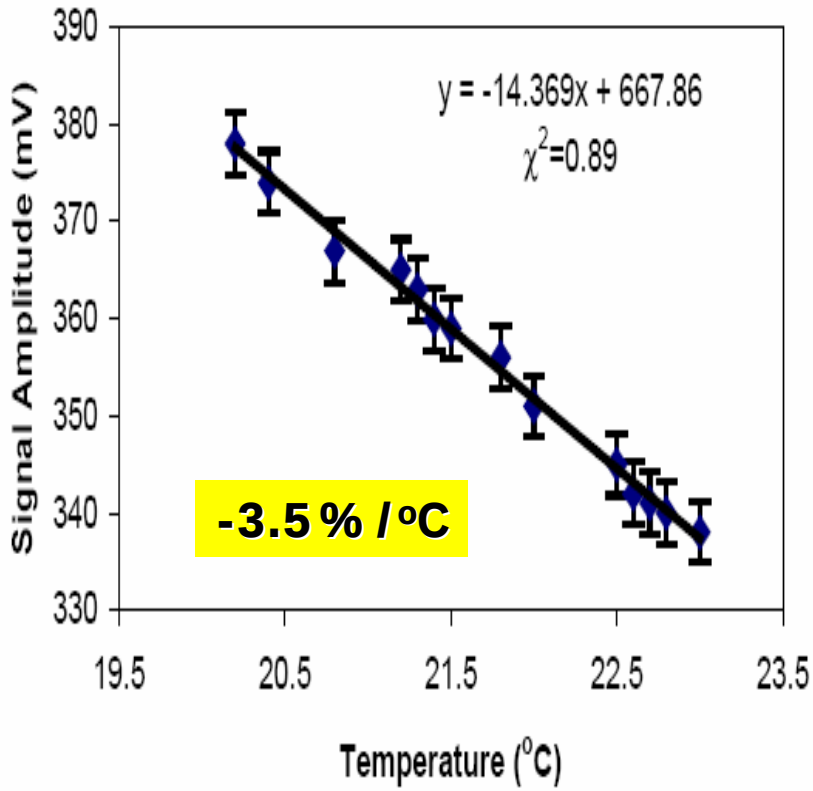
MRS Temperature dependence of Noise and Amplitude





Will require control, monitoring…

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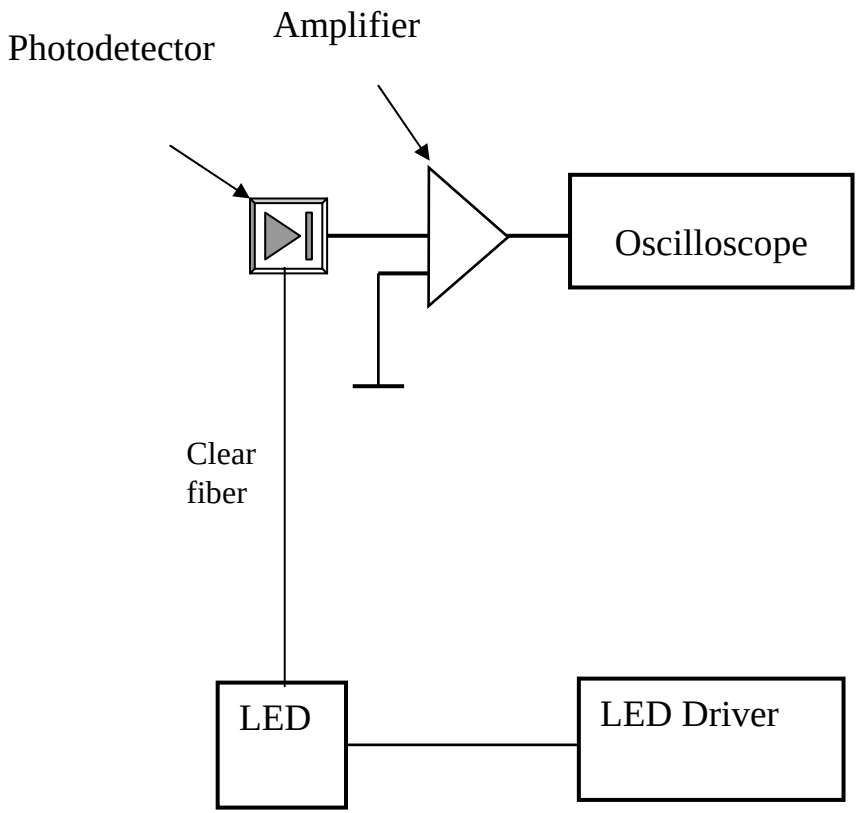
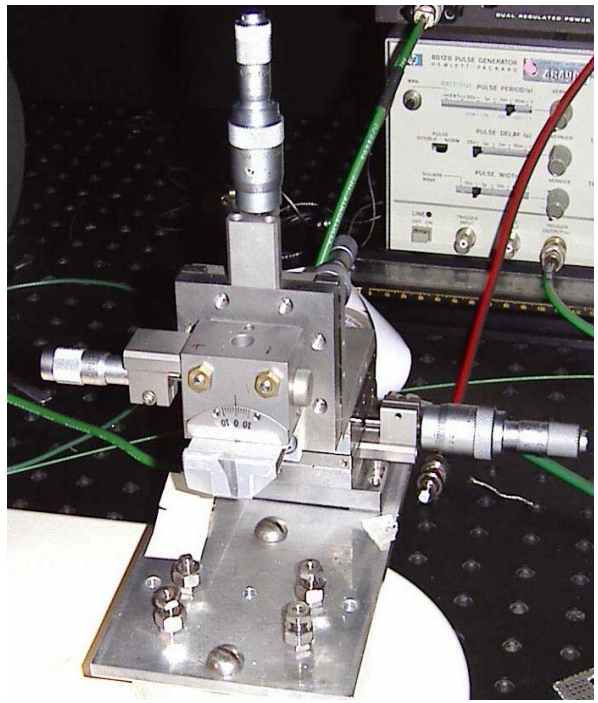
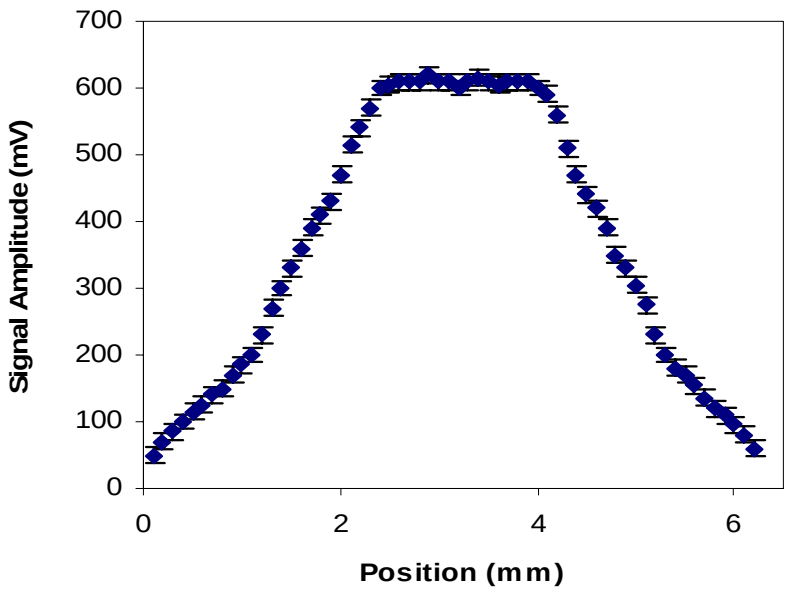
Studies of fiber position and response…

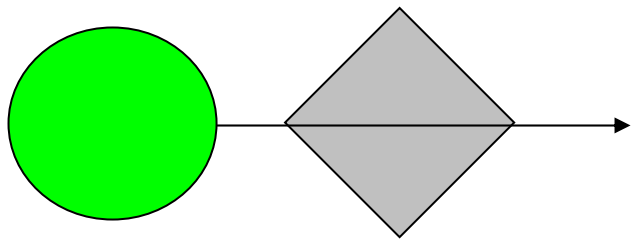




In collaboration with P. Polozov(ITEP) & G. Sellberg(Fermilab)

Uniformity across MRS Photodetector





Some leeway in positioning…

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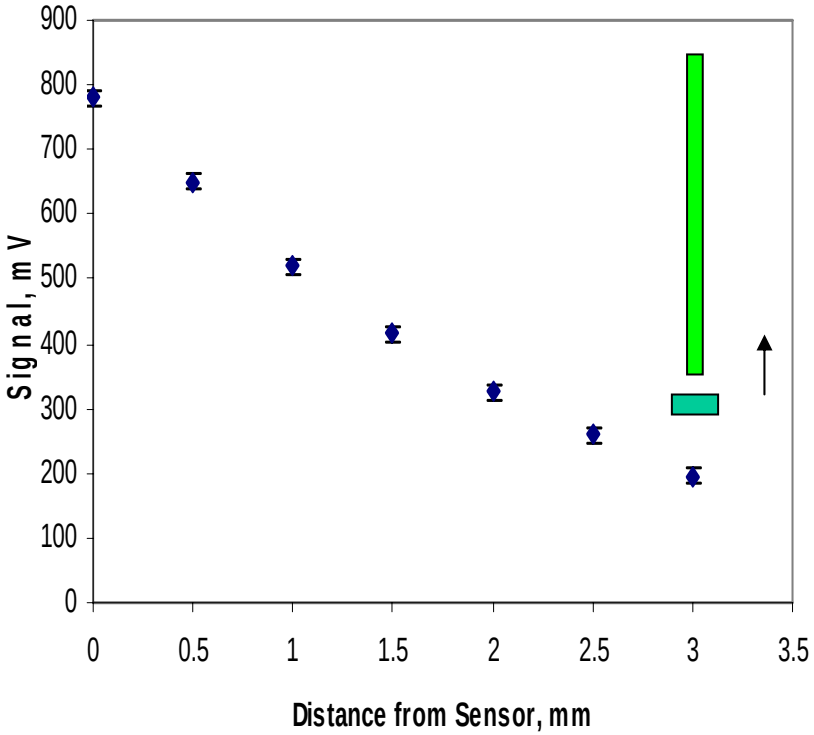
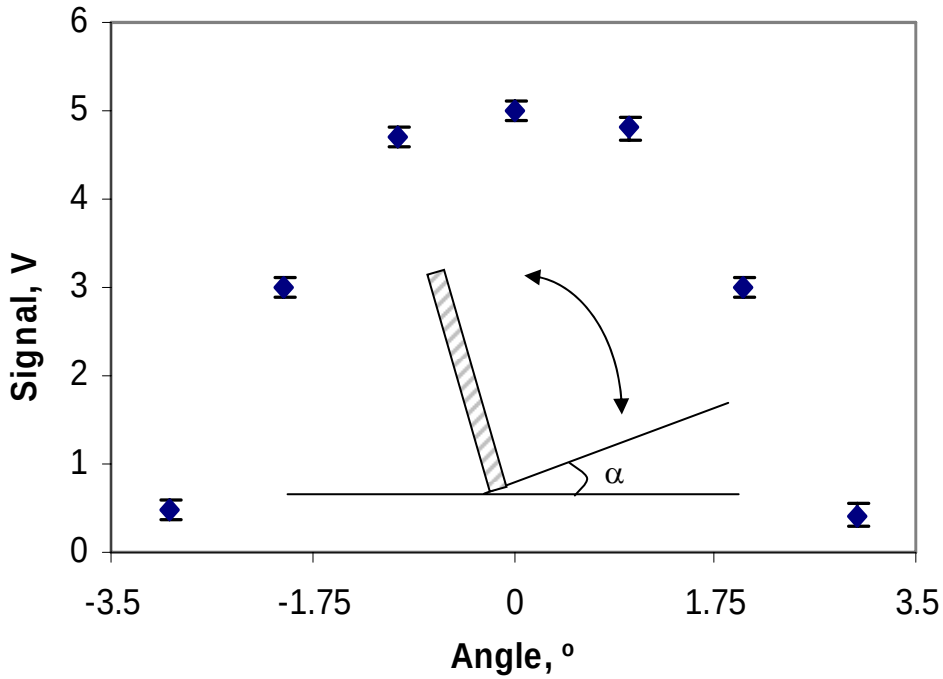
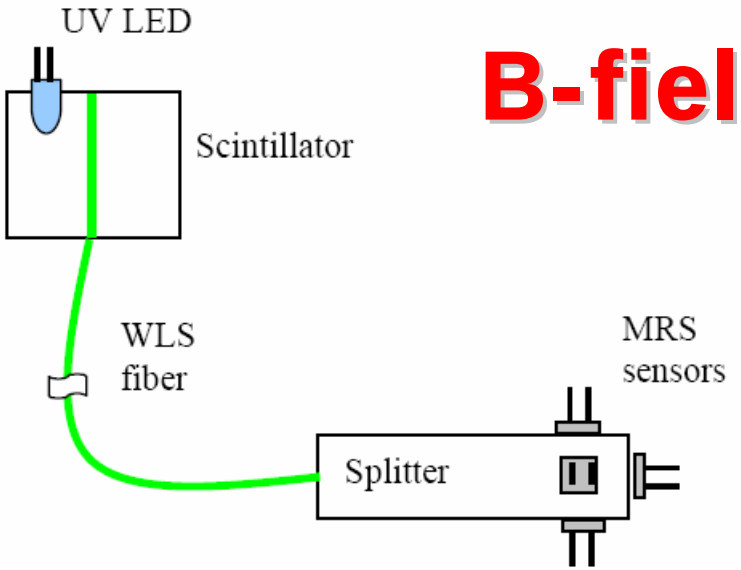
SiPM Response & Fiber Position / Angle

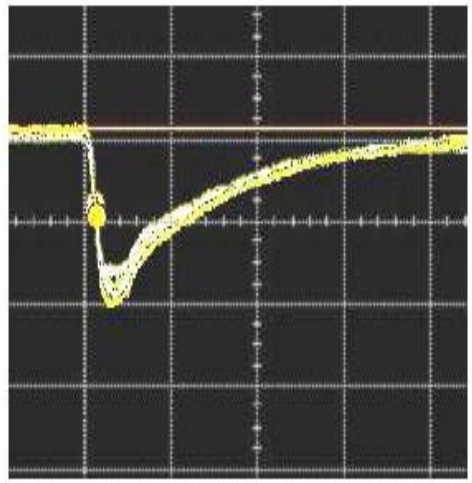


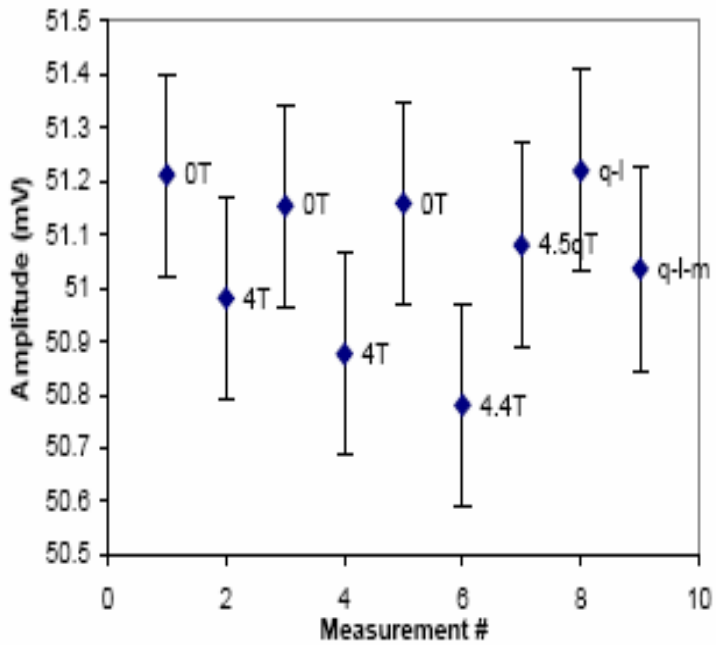
Response very sensitive to proximity & mildly to normality, need to be minimized.



B-field Sensitivity







Signal shapes at 0, 4, 4.4 & after quench at 4.5T

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Conclusions/Closing Comments

- MRS/SiPM excellent photodetector candidates.
- Ample MIP signal & linear
- Operating point easily selected for reasonable noise rates and amplitude
- Fiber positioning tolerance can be controlled
- Robust to irradiation
- Impervious to magnetic field
- See related talks
  - Today 2PM, CALICE TCMT, D. Chakraborty
  - Sunday 3:15PM, Studies of NICADD Extruded Scintillator Strips, S.Dychkant