

Timing Studies

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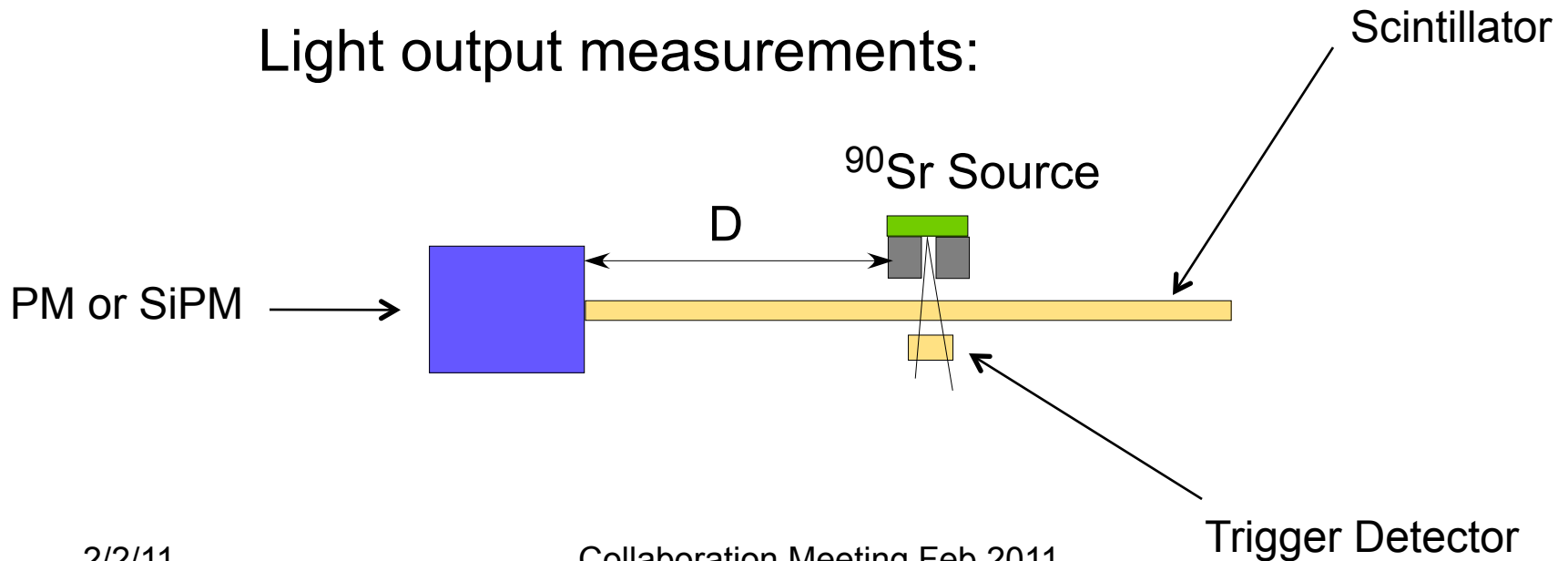
E. Pooser

- Measurements on EJ-212 scintillator bars
- Attenuation Lengths
- Propagation Time
- Comparison of PM and SiPM Detectors
 - Time Resolution measurements

EJ-212 Scintillator Bar

- Dimensions: 12,15 mm x 600 mm: thicknesses: 2, 3 mm
- With and without a VM2000 backing, mounted in dark box
- PMT and SiPM touches end of scintillator
- Used ^{90}Sr source

Light output measurements:

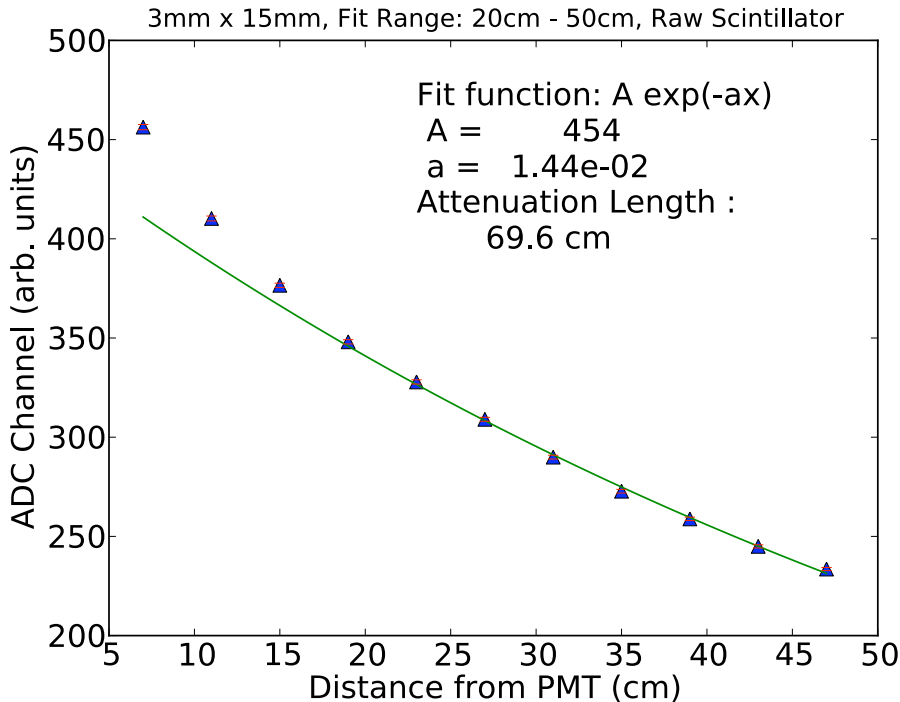


Attenuation Length

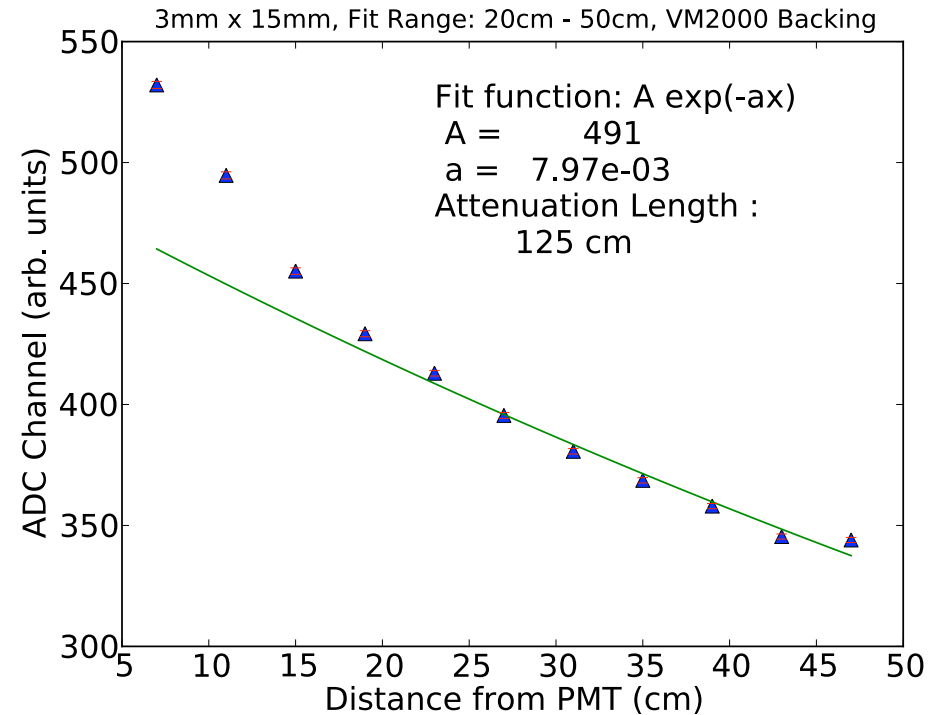
3 x 15 x 600 (mm)

Fit Range (20 – 50 cm)

No VM2000 Backing



VM2000 Backing



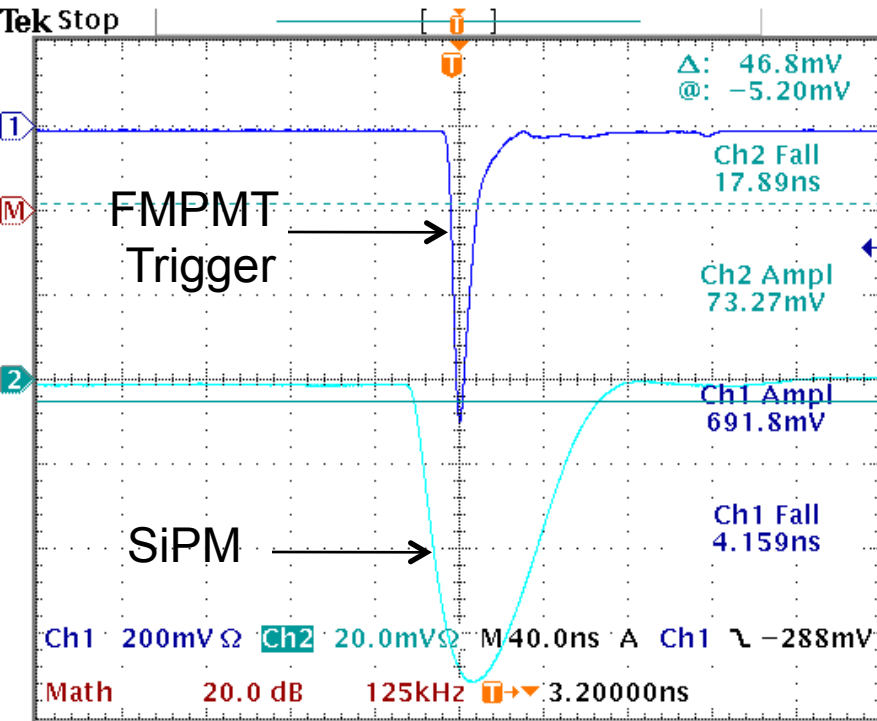
Attenuation Lengths Summary

- The attenuation lengths are much improved as compared to the EJ-200 bars
- Due to better manufacturing and diamond-milled edges
- On average, with VM2000 placed at the end of the scintillator, we see a factor 1.6 better attenuation length

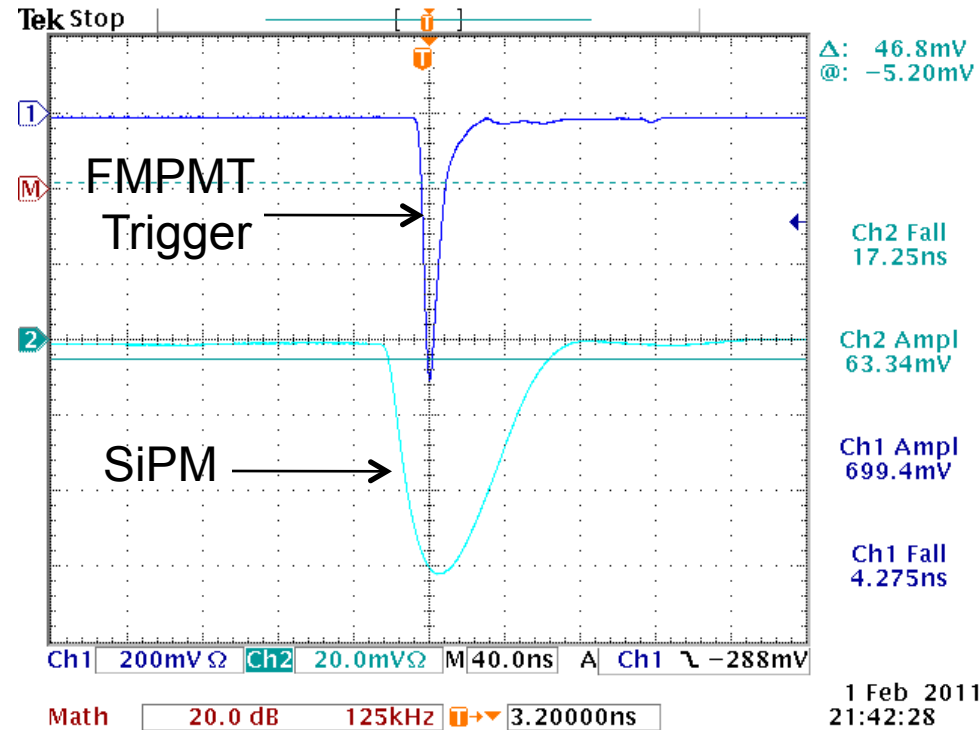
Scintillator Dim.	No VM Backing	VM Backing
2 x 15 x 600 (mm)	81.2 cm	135 cm
3 x 12 x 600 (mm)	50.8 cm	76.2 cm
3 x 15 x 600 (mm)	69.6 cm	125 cm

O' Scope Images (SiPM): Source Close to Detector

VM2000 Backing



No VM2000 Backing



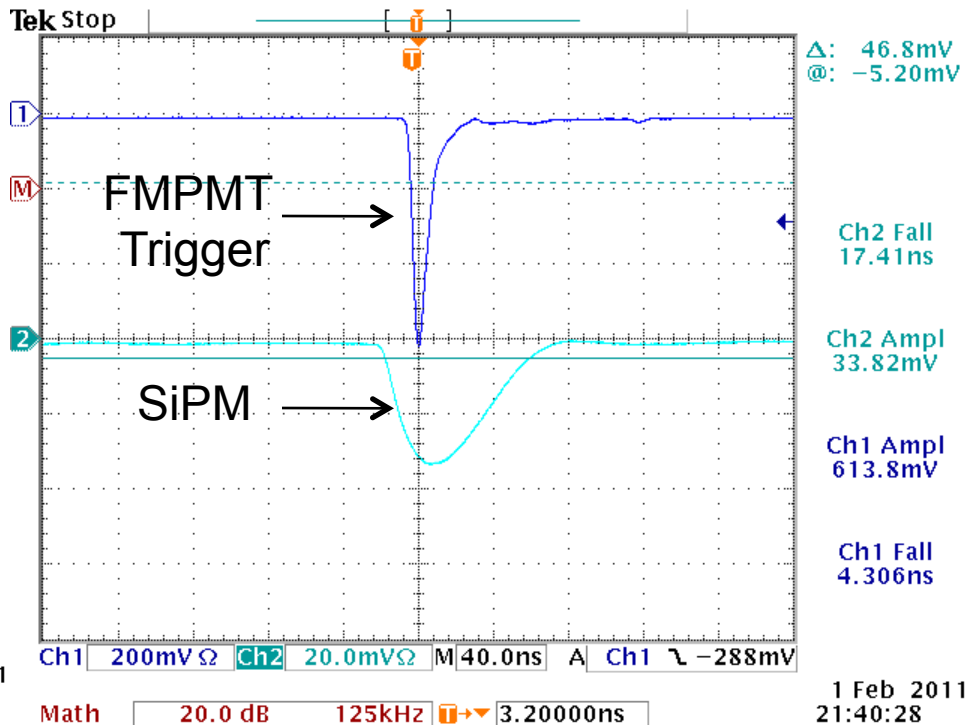
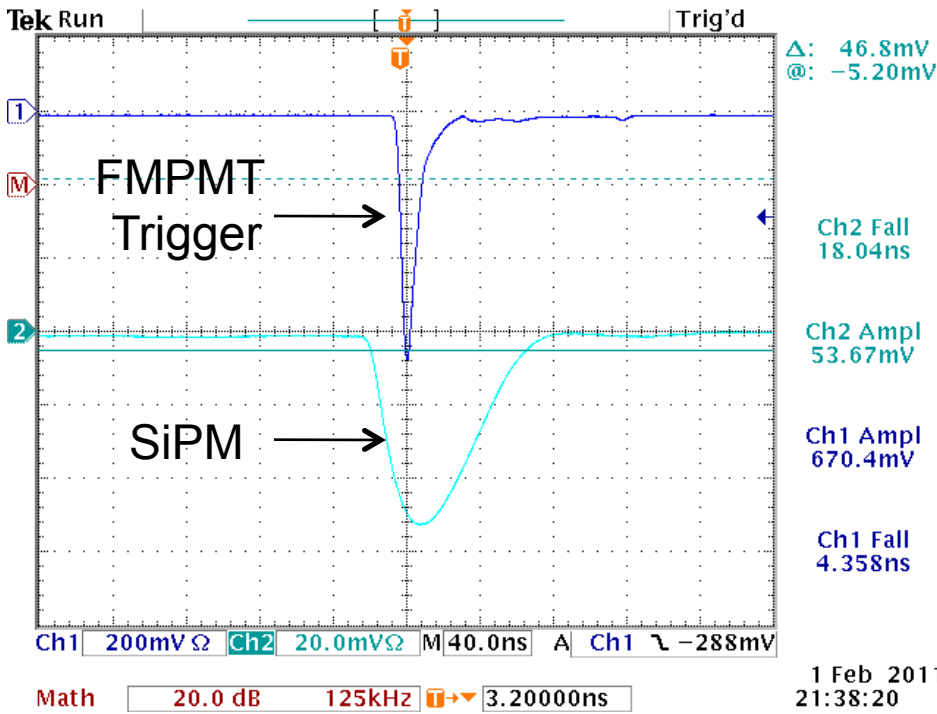
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- VM Backing has factor 1.2 Larger signal size
- Poor fall time for SiPM ~ 17 – 20 (ns)

O' Scope Images (SiPM): Source Far From Detector

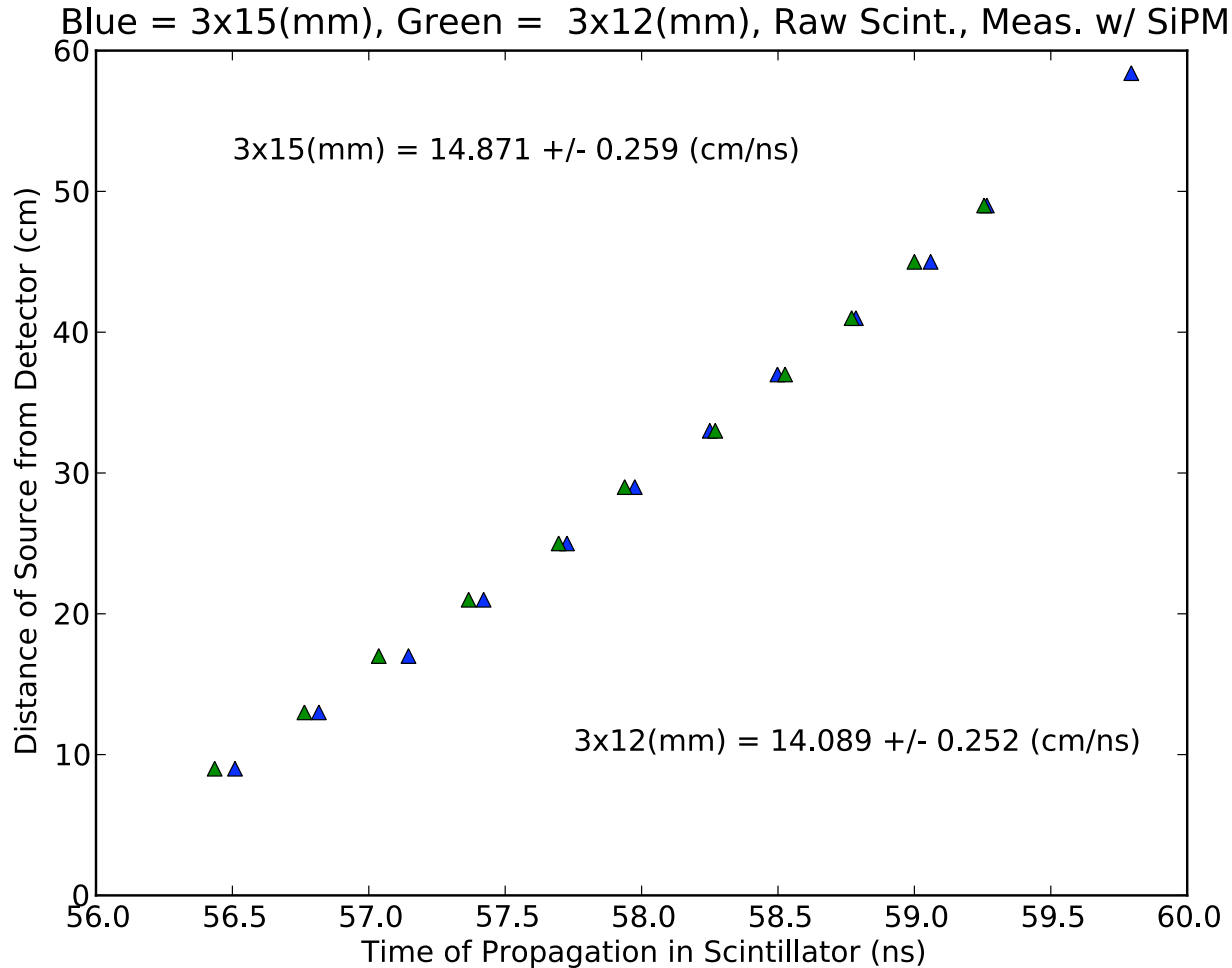
VM2000 Backing

No VM2000 Backing



- VM Backing has factor 1.6 Larger signal size
- No VM signal size when close is factor 1.9 larger than when far away
- VM signal size when close is factor 1.4 larger than when far away

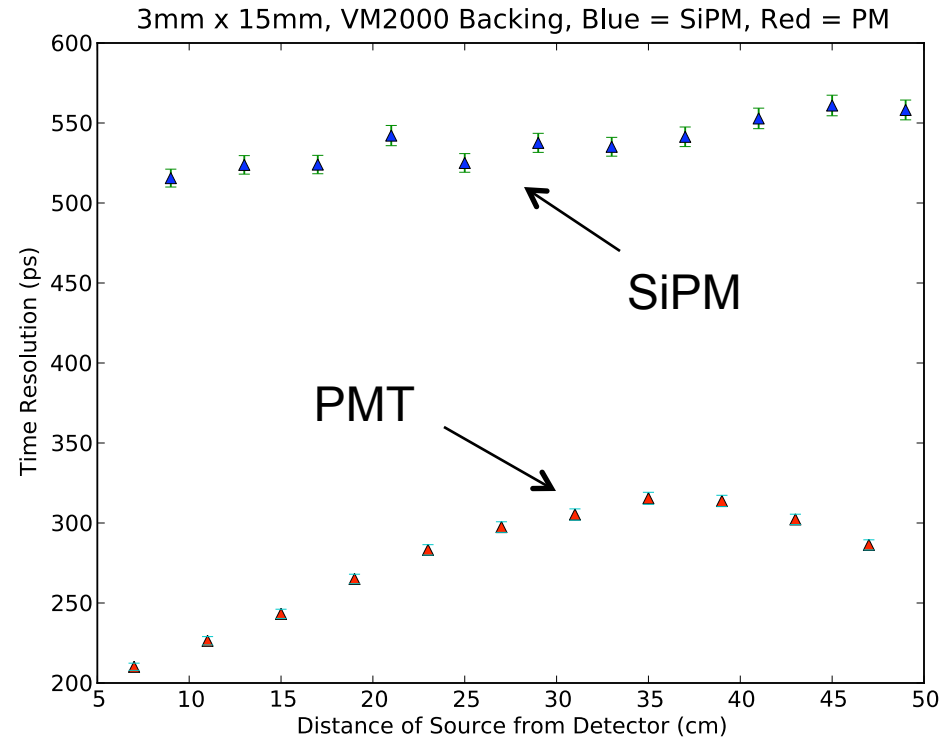
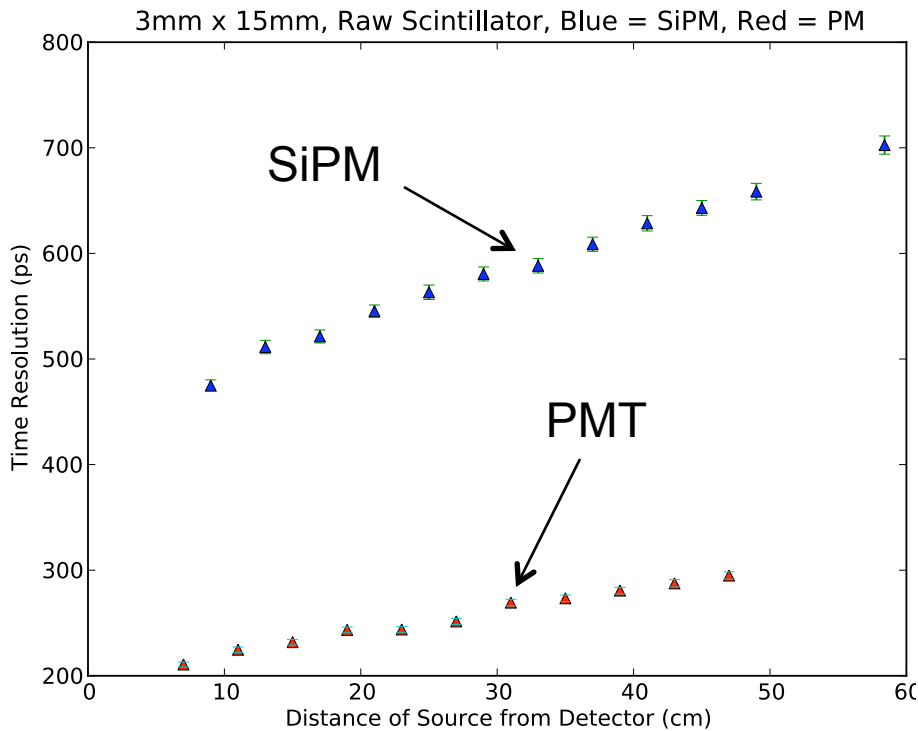
Propagation Time of Light in the scintillator bars



Comparison of Detector Time Resolutions (PM vs. SiPM) 3 x 15 x 600 (mm)

No VM2000 Backing

VM2000 Backing



Comparison of Detector Time Resolutions (PM vs. SiPM) Summary

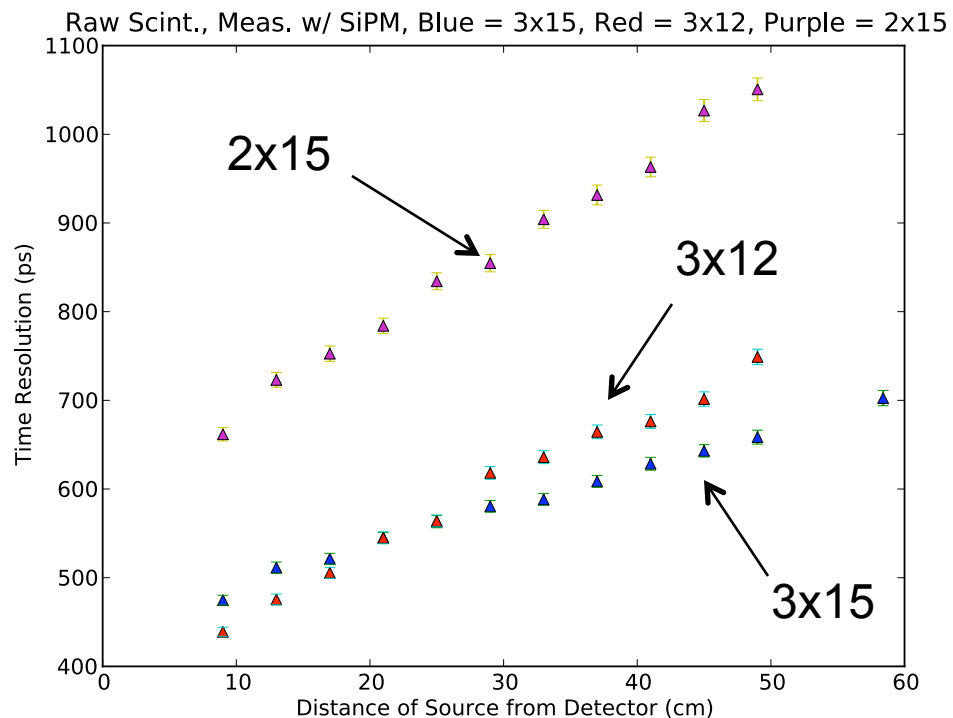
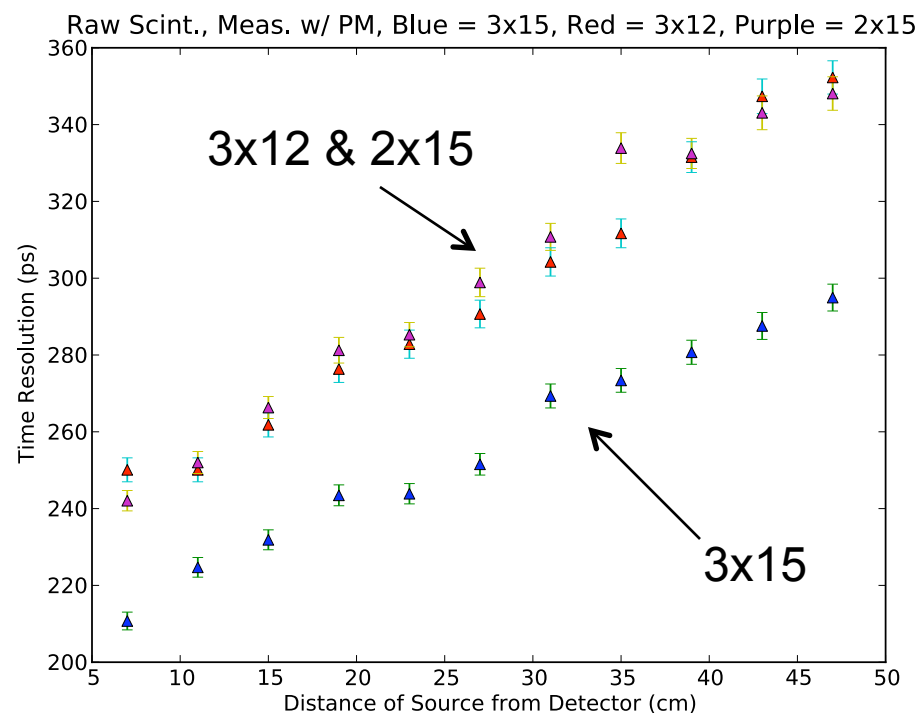
- Time Resolution gets worse in the 25 – 45 (cm) range when measured with the PM and bars have VM2000 backing
 - This is not the case when measured with the SiPM
- $\sigma(\text{SiPM}) \approx 2.3 * \sigma(\text{PMT})$

Scint. Dim. (mm)	SiPM (No VM) (ps)	PM (No VM) (ps)	SiPM (VM) (ps)	PM (VM) (ps)
2 x 15 x 600	800 < σ < 1000	300 < σ < 350	720 < σ < 820	300 < σ < 400
3 x 12 x 600	500 < σ < 700	300 < σ < 360	500 < σ < 600	300 < σ < 400
3 x 15 x 600	550 < σ < 650	220 < σ < 300	520 < σ < 550	270 < σ < 320

Time Resolution Comparison (No VM2000 Backing)

PMT

SiPM



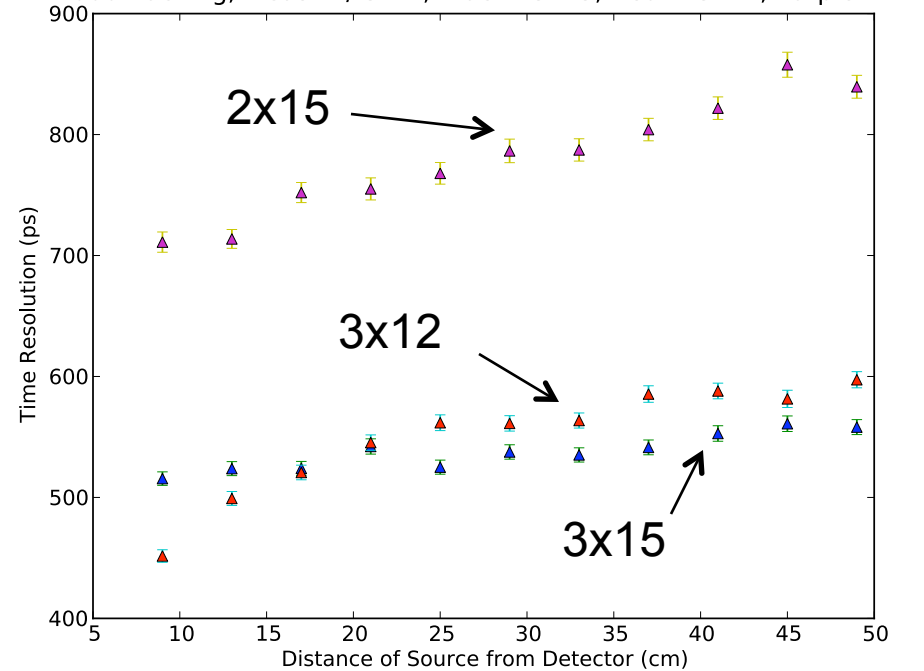
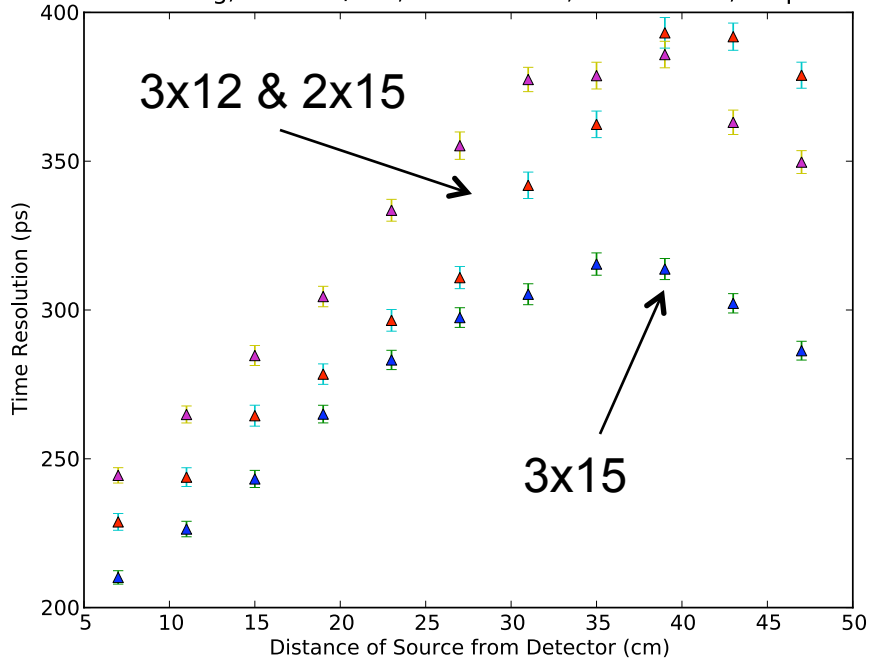
Time Resolution Comparison (With VM2000 Backing)

PMT

SiPM

VM2000 Backing, Meas. w/ PM, Blue = 3x15, Red = 3x12, Purple = 2x15

VM2000 Backing, Meas. w/ SiPM, Blue = 3x15, Red = 3x12, Purple = 2x15



Time Resolution Comparison Summary

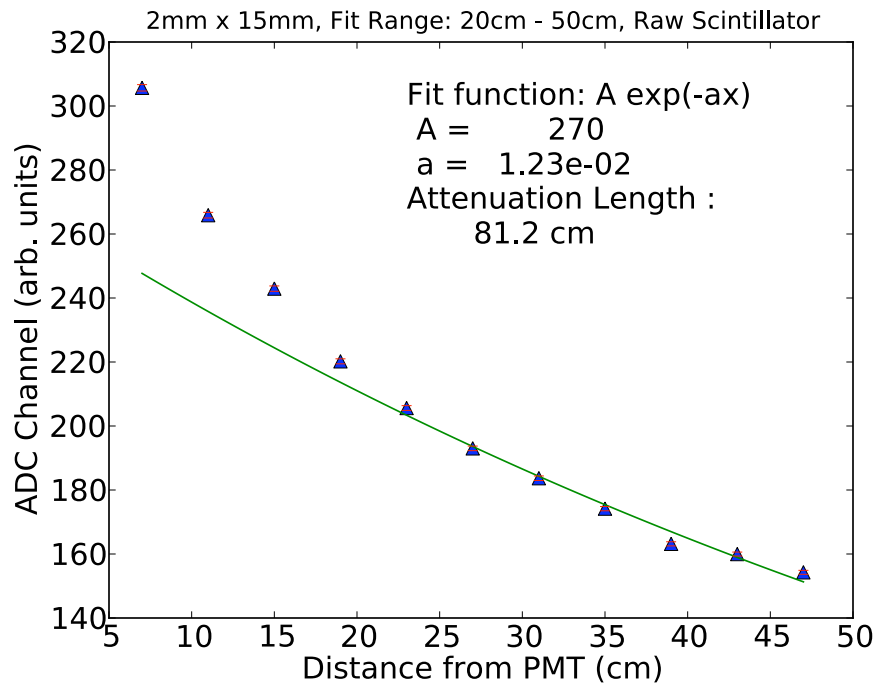
- The 2 x 15 (mm) bar has the worst time resolution with the SiPM
- The 3 x 12 (mm) and the 3 x 15 (mm) bars have approximately the same time resolutions with SiPM
- The 3 x 15 (mm) has the best time resolution

Summary

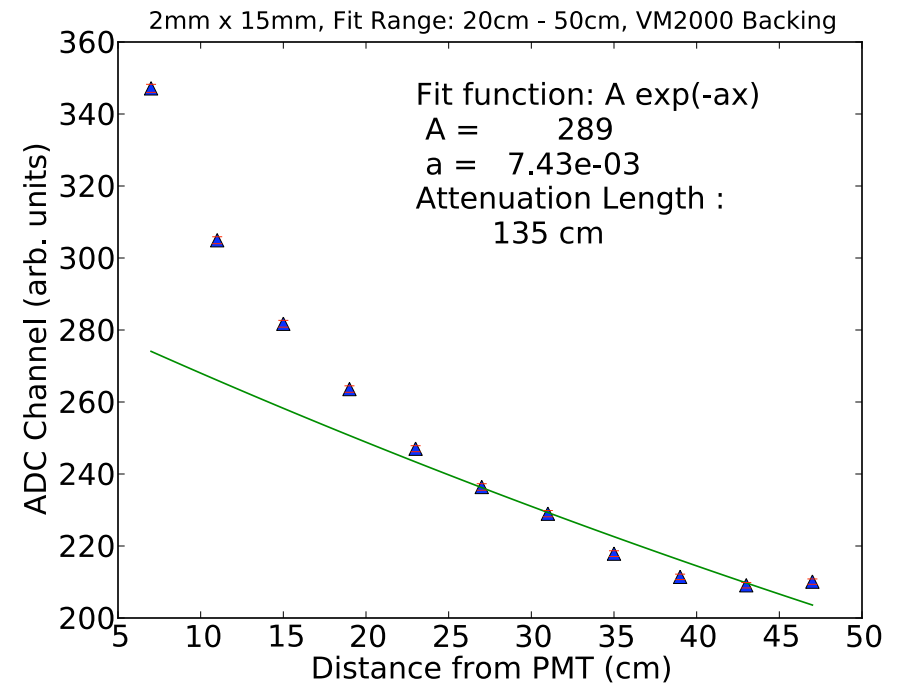
- Further measurements need to be made concerning the SiPM
- Cooling of SiPM so as to reduce noise and improve timing measurements
- Full wrapping of the 3mm bars with VM2000 (or similar highly reflective material)
- Begin testing of scintillator coupled to light guide

Attenuation Length 2 x 15 x 600 (mm) Fit Range (20 – 50 cm)

No VM2000 Backing

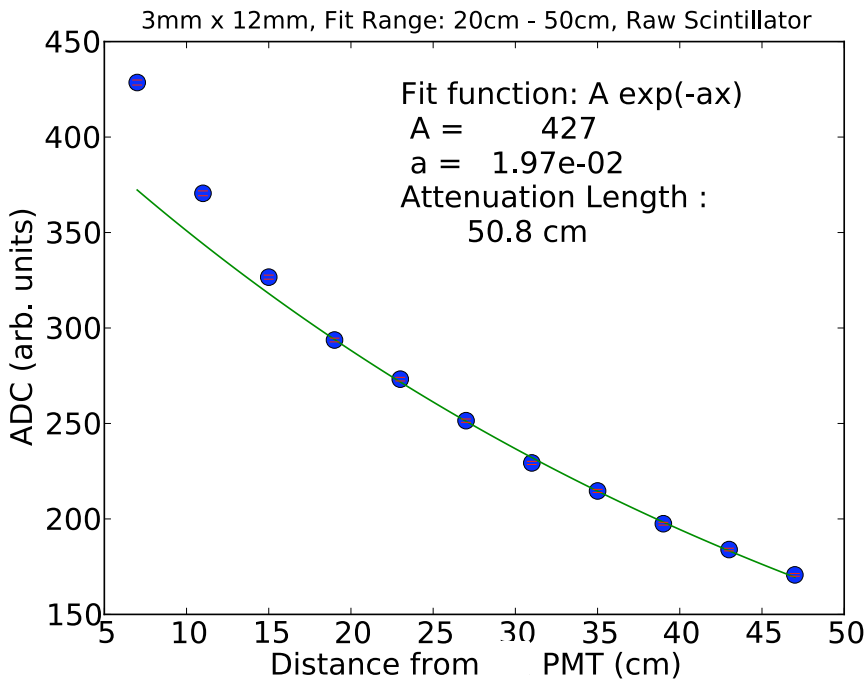


VM2000 Backing

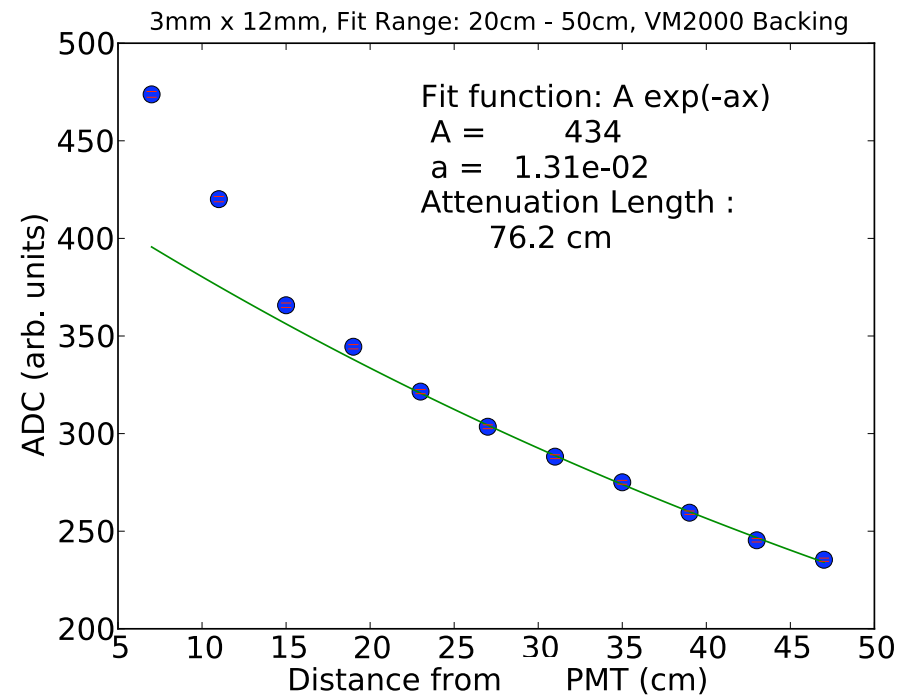


Attenuation Length 3 x 12 x 600 (mm) Fit Range (20 – 50 cm)

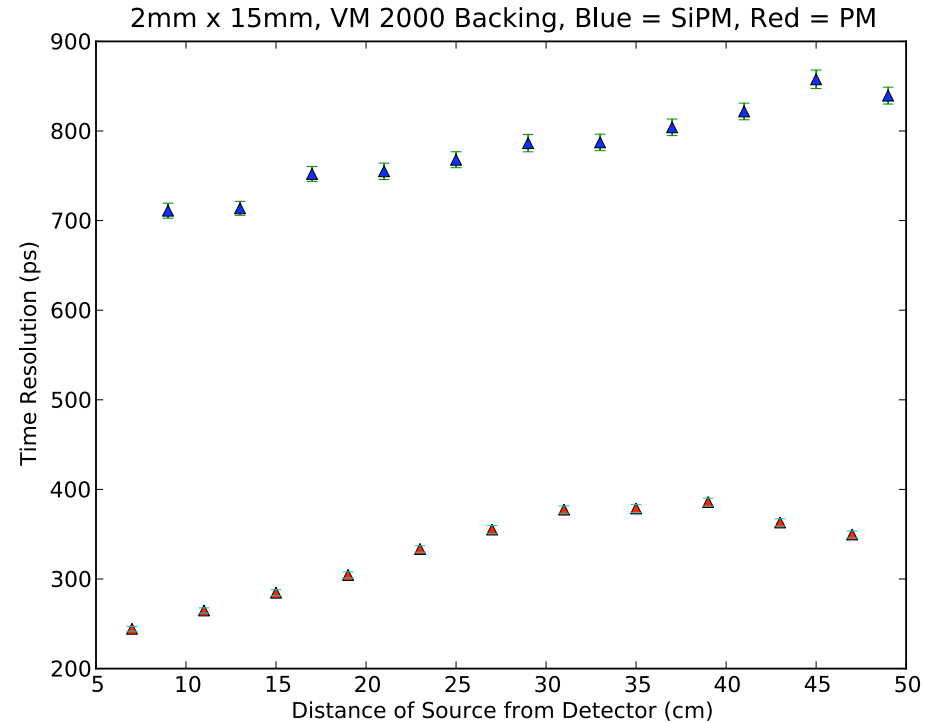
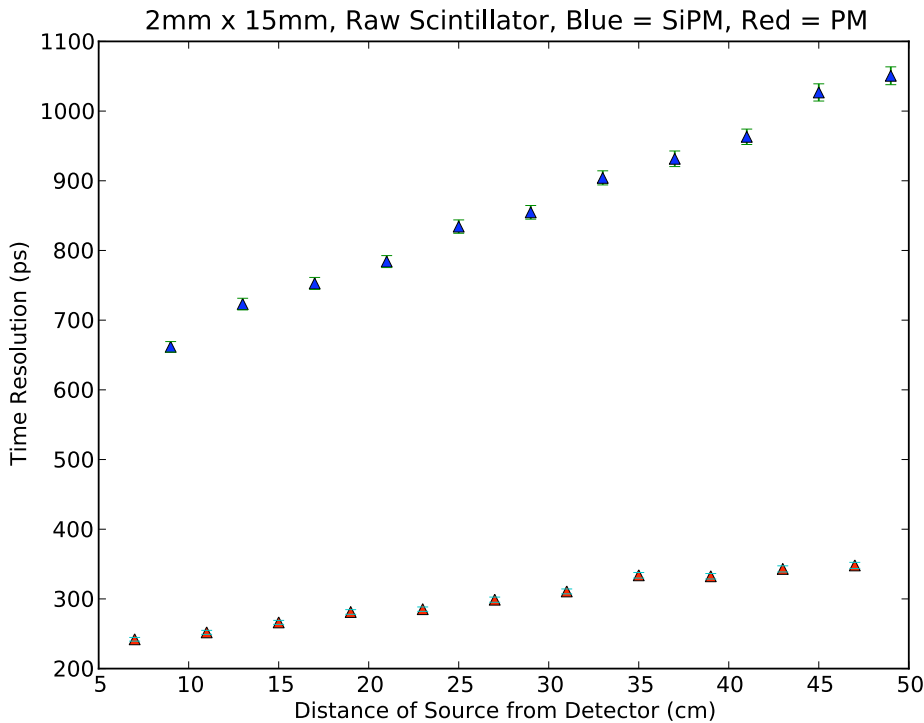
No VM2000 Backing



VM2000 Backing



Comparison of Detector Time Resolutions (PM vs. SiPM) 2 x 15 x 600 (mm)



Comparison of Detector Time Resolutions (PM vs. SiPM)

3 x 12 x 600 (mm)

