Trigger Scintillator Progress

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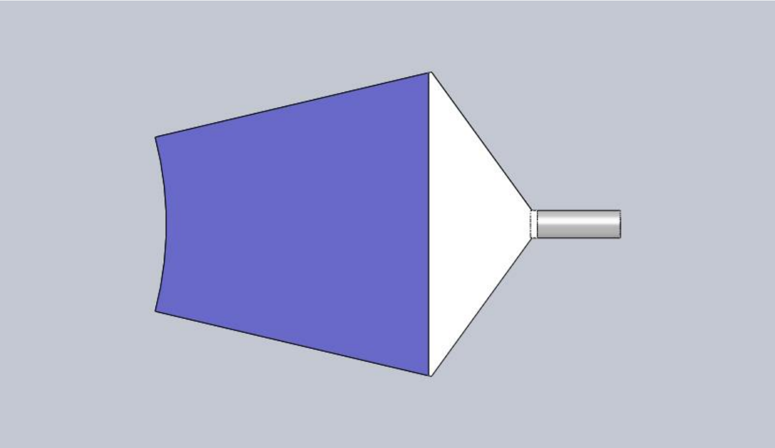
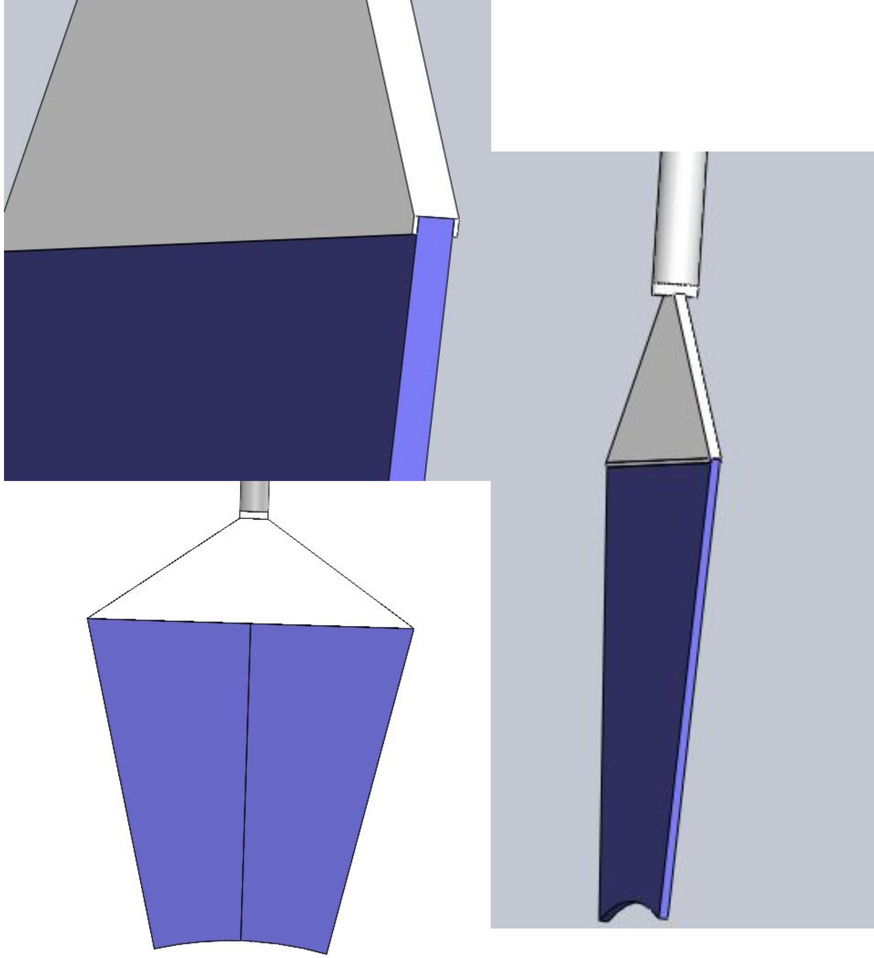
Previous Design

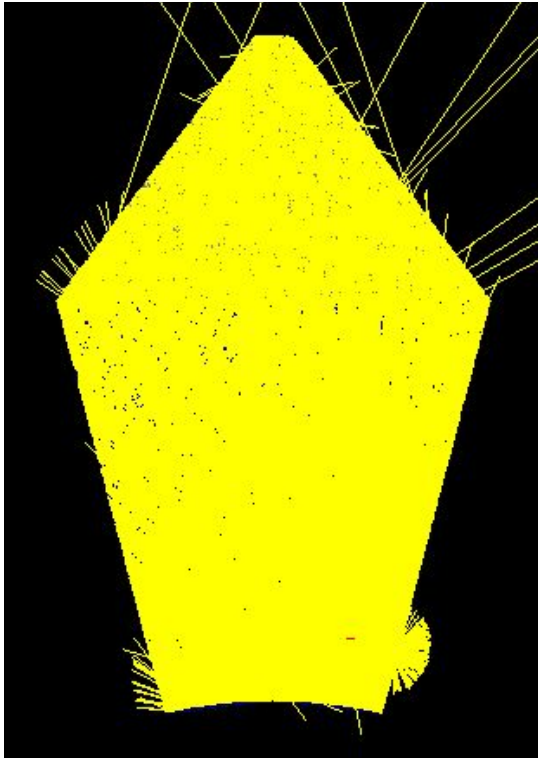
We first proposed to use a acrylic light-guide to interface one side of the scintillator to PMT

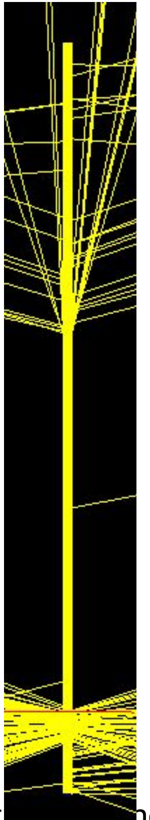


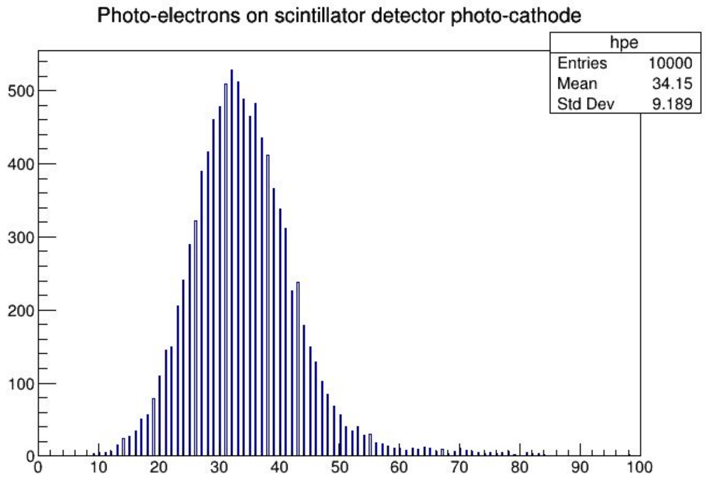


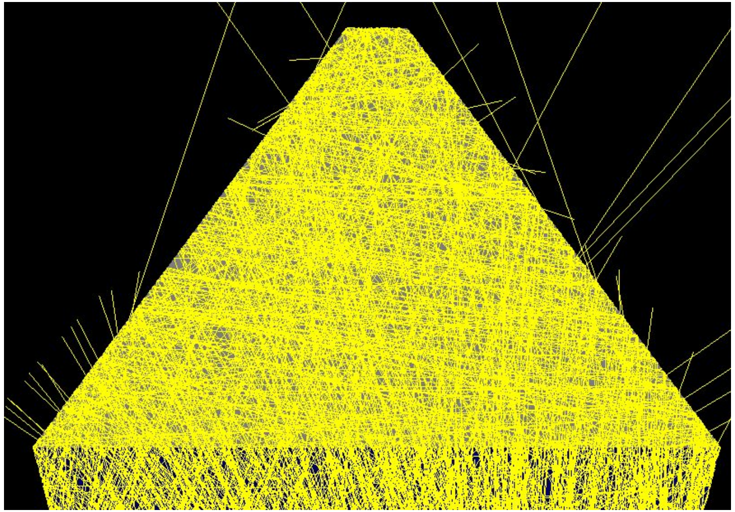
Previous Design

Moller Electron passing Through the Scintillator (no wrap)









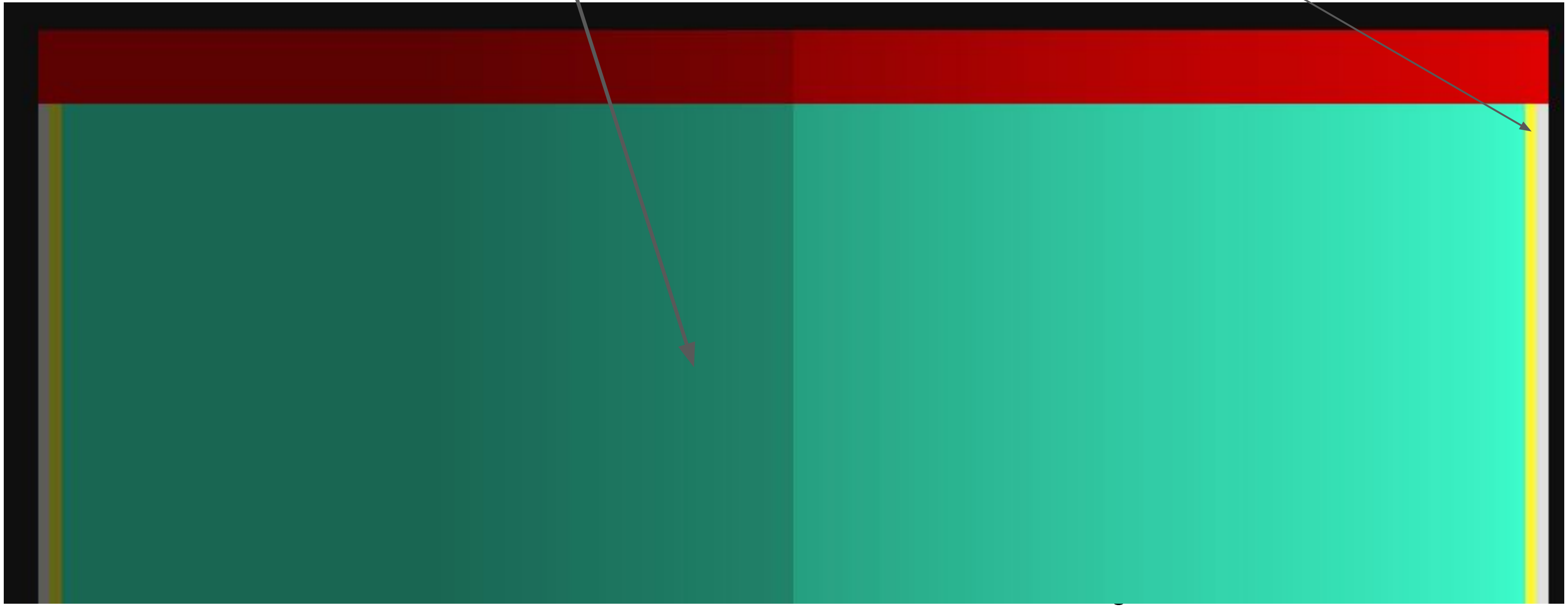
No Reflective wrap, therefore some light-leak and no optical glue

Changes to the Design

- We first proposed to use a acrylic light-guide to interface one side of the scintillator to PMT
- The optical simulation studies have shown low photo-electron (PE) yield and low efficiency using a simple light-guide
- After discussing pros and cons with senior collaborators we propose to replace the light-guide with wavelength shifting (WLS) fibers
    - Place WLS fibers in grooves cut in the scintillator
    - Interface WLS to a PMT

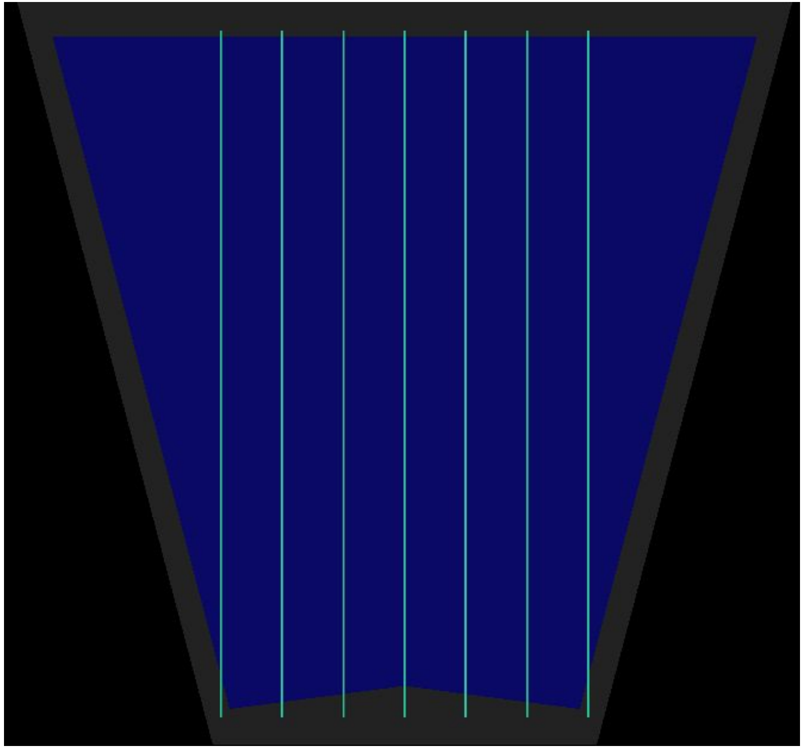
Two Cladding WLS Fiber Strand

- Each strand has 1 mm PMMA core and two cladding each 0.015 mm radially thin
- Claddings are Pethylene (C2H4)
- “PMT” sensitive detector at the ends is shown in Red



Embedded WLS Fiber Strands on the Scintillator: Test Case

- Seven fibers embedded in grooves cut in one large face of the scintillator
- No optical grease or glue interface, only air interface between fibers and scintillator
    - Scintillator surface is set to “ground”
- Each fiber is read using a PMT detector at both ends: 14 PMT detectors
- Summed 14 PMT detectors to get total photo-electrons



Efficiency Comparison*

*Events that missed or scraped the sides are also included under total events

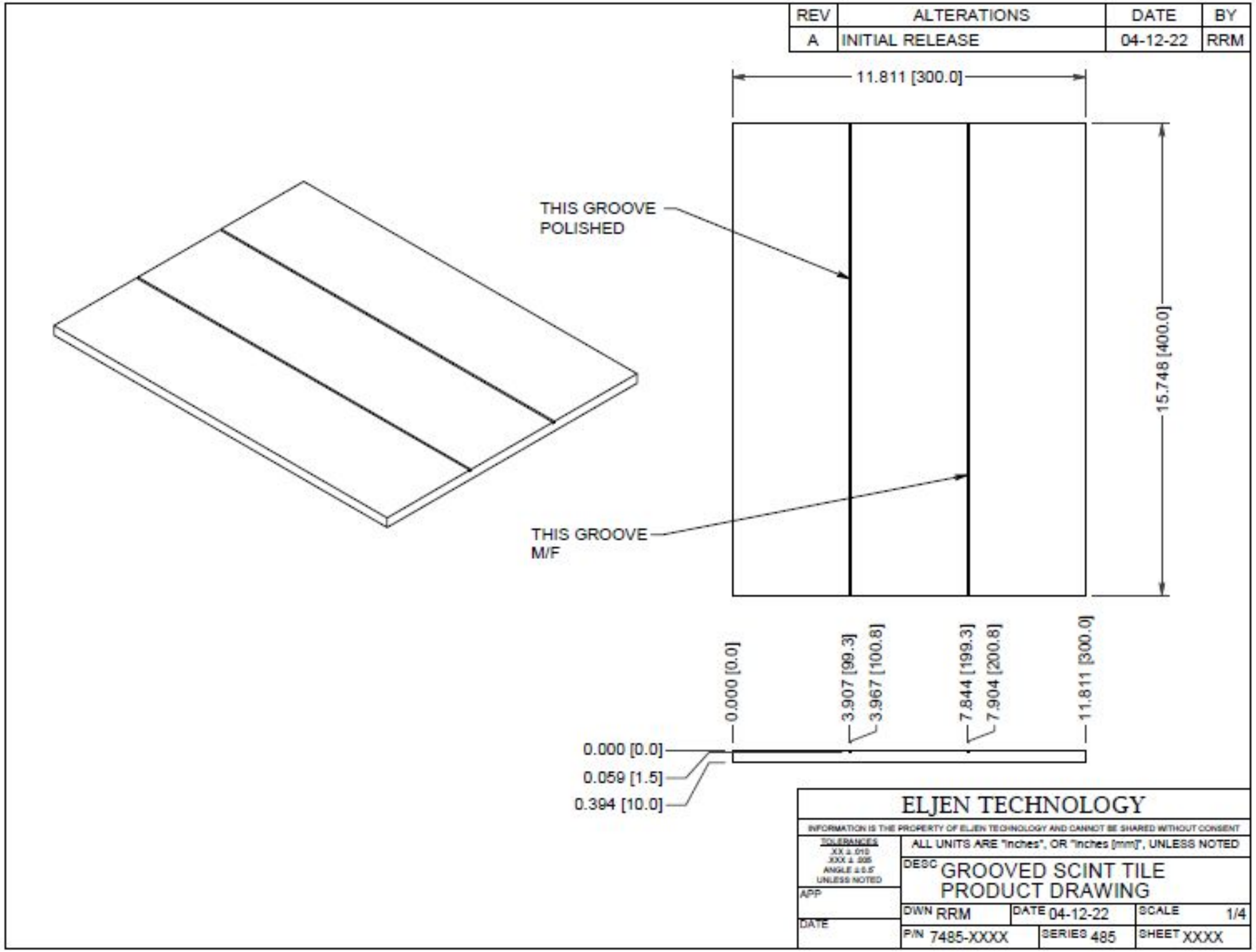
model,surface,wrap	Total Events	PE	Events with PE>0	Events with PE>5
unified polished and not wrapped	3000	142	2726 (91%)	2634 (88%)
unified ground and not wrapped	3000	328	2865 (96%)	2848 (95%)
unified polished and wrapped no air gap	10000	208	1769 (18%)	1673 (17%)

Efficiency Comparison*

*Events that missed or scraped the sides are also included under total events

model,surface,wrap	Total Events	PE	Events with PE>0	Events with PE>5
glisur polished and not wrapped	3000	140	2701 (90%)	2607 (87%)
glisur ground and not wrapped	3000	140	2701 (90%)	2596 (87%)
glisur polished and wrapped no air gap	3000	225	497 (16%)	466 (15%)

Prototype Ordered



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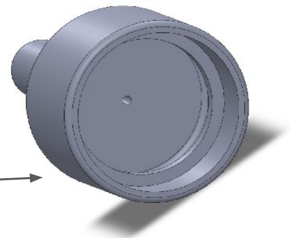
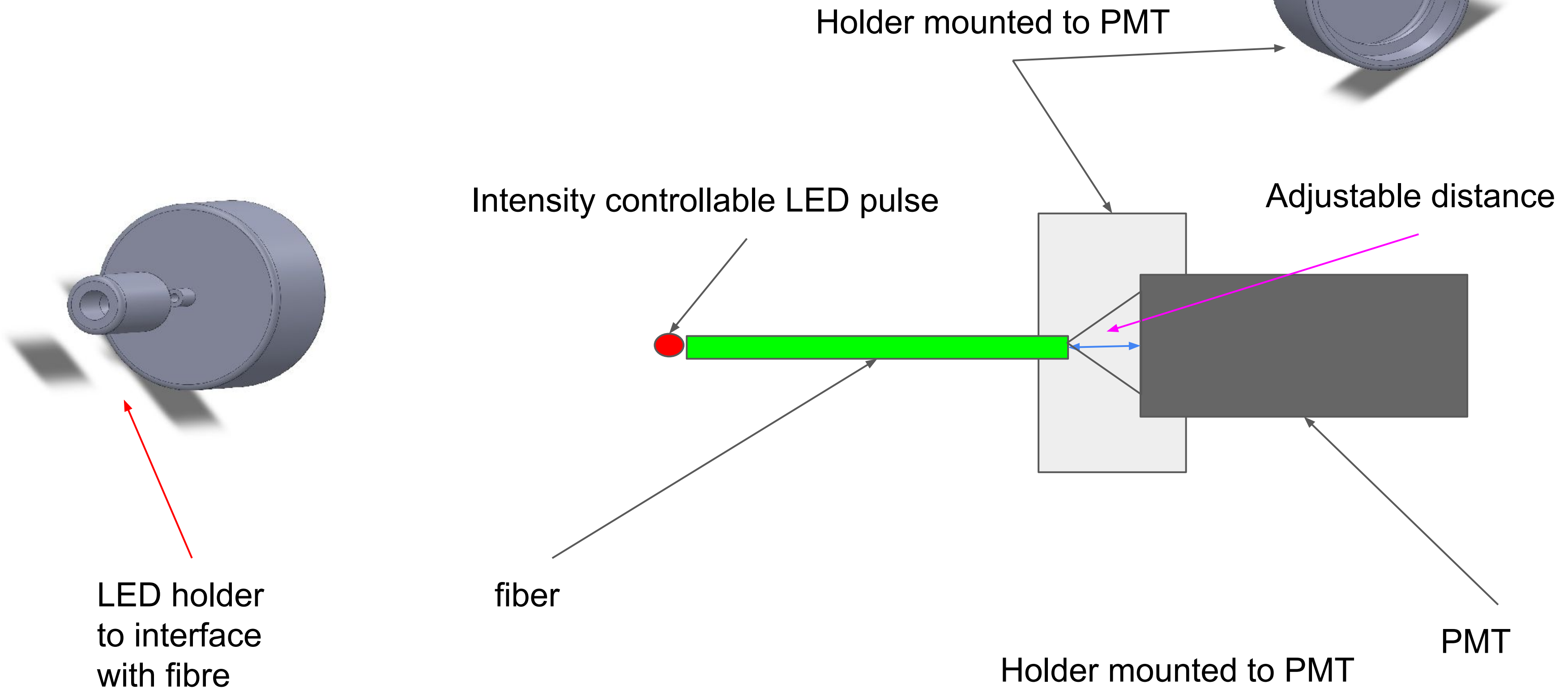
Test fiber PMT interface





PMT-Fiber Testing using LED

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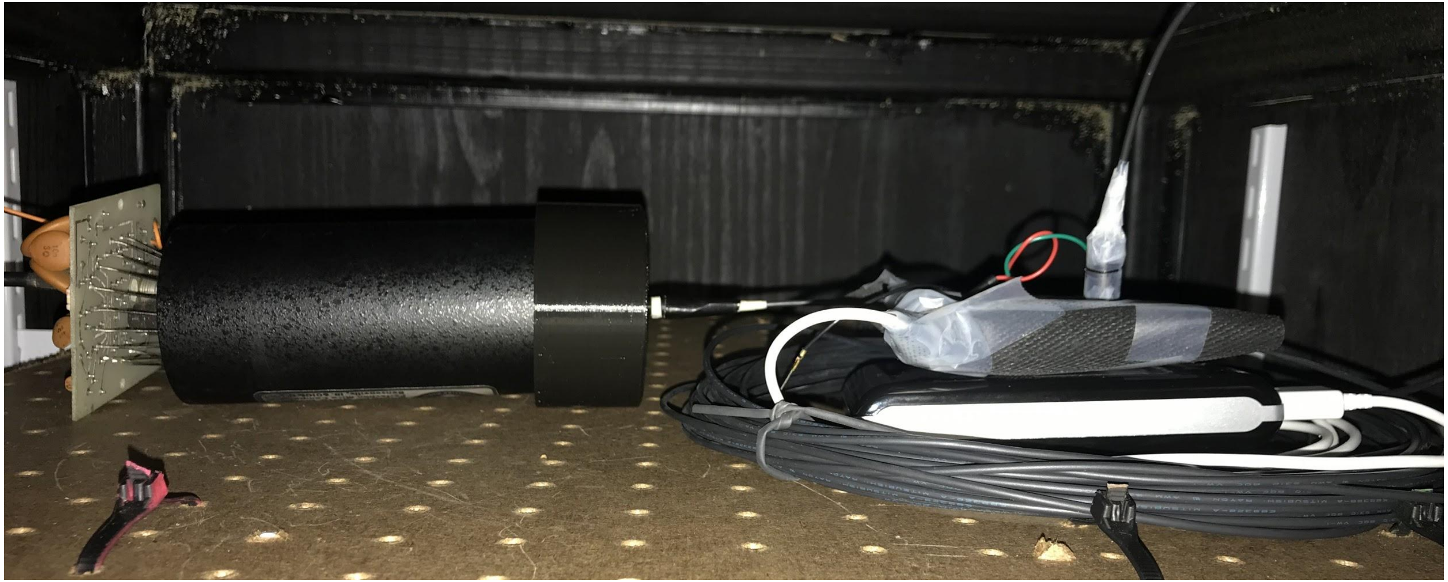


Progress

1. Testing PMT for prototype: Done
2. Configuring CAEN ADC to read PMT signal using simple trigger: Done
3. Building an apparatus to test fiber PMT interface: Done
4. Placed order to a scintillator panel with two grooves: Done
5. Purchased wrapping supplies for studying different options: Done

Current Work

1. Fine tuning LED intensity for Fiber testing
2. Testing PMT-fiber coupling
3. Testing WLS fiber using LED
4. Testing WLS fiber inside a reflective wrapped using LED

Summer Plans

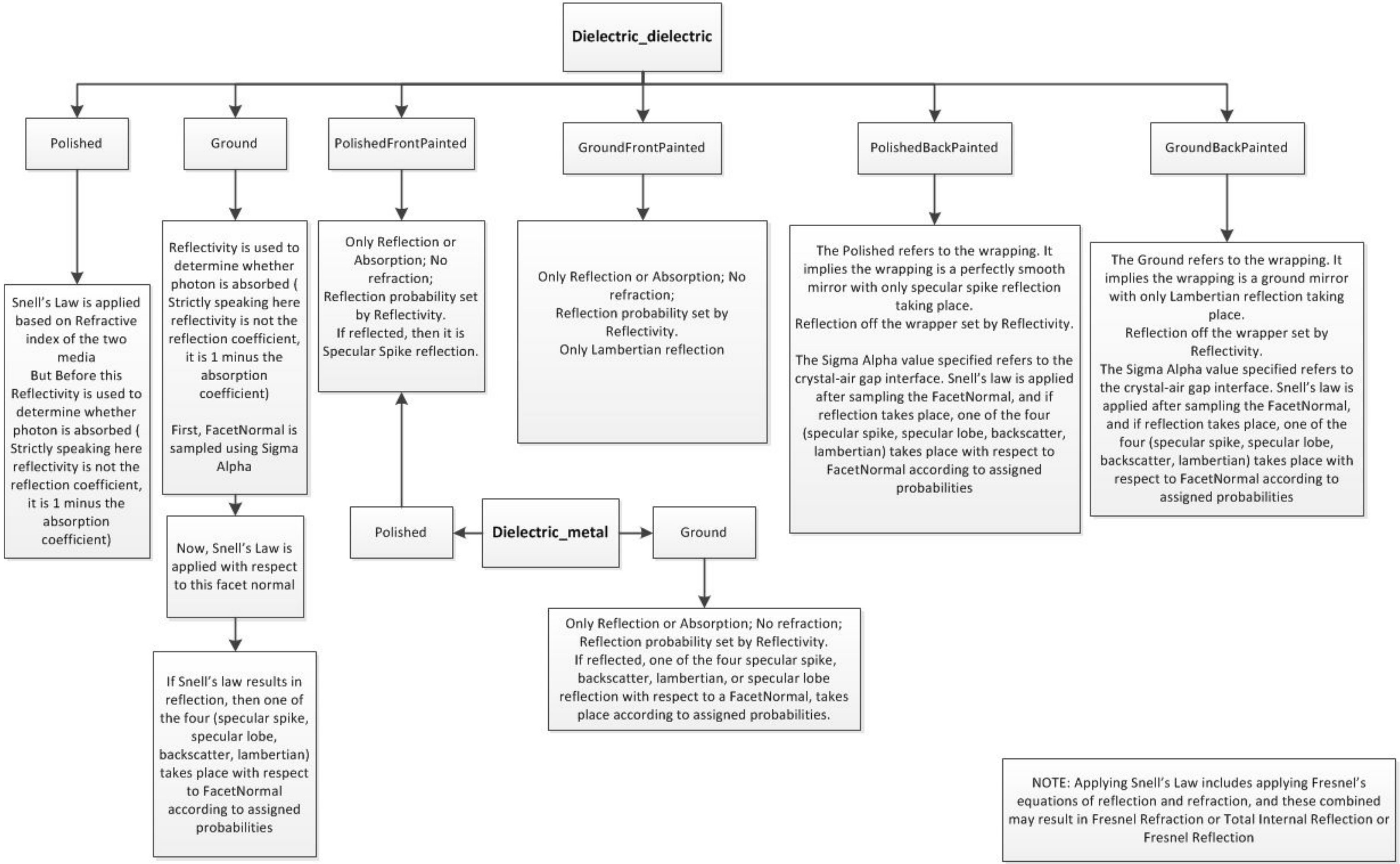
1. Build the prototype Scintillator
2. Test using cosmic rays
3. Benchmark simulation
    a. Optical properties of the surface
    b. Optical properties of the wrapping materials
    c. Wet vs air-gap between scintillator and wrapping materials
4. Select optimal wrapping material
5. Determine the optimal wrapping for best light collection

Supplementary

Scintillator Surface Optical Properties

- Unified or glisur model tested with both ground and polished surfaces.
- Mylar wrap surface is groundteflonair (preset model available) and there is an actual air gap between the wrap and scintillator

UNIFIED MODEL FOR OPTICAL SURFACES



Surface Optical Properties

The goal is to have a realistic Scintillator optical properties at the surface:

Geant4 optical physics:

It is possible to specify that a given fraction of photons are absorbed at the surface, or transmitted without change in direction or polarization. This is applicable for dielectric_dielectric interfaces that are not backpainted. The material properties `REFLECTIVITY` and `TRANSMISSION` are used. By default, `REFLECTIVITY` equals 1 and `TRANSMISSION` equals 0. At a surface interaction, a random number is chosen. If the random number is greater than the sum of the values of `REFLECTIVITY` and `TRANSMISSION` at the photon energy, the photon is absorbed. Otherwise, if the random number is greater than the `REFLECTIVITY` value, the photon is transmitted. Otherwise, the usual calculation of scattering takes place.

Light Yields at PMT for different Optical Surface Settings

Light loss at the surface by setting REFLECTIVITY (1- abs. coefficient) is a way to get more realistic scintillator surface

These changes needs more understanding to apply correctly

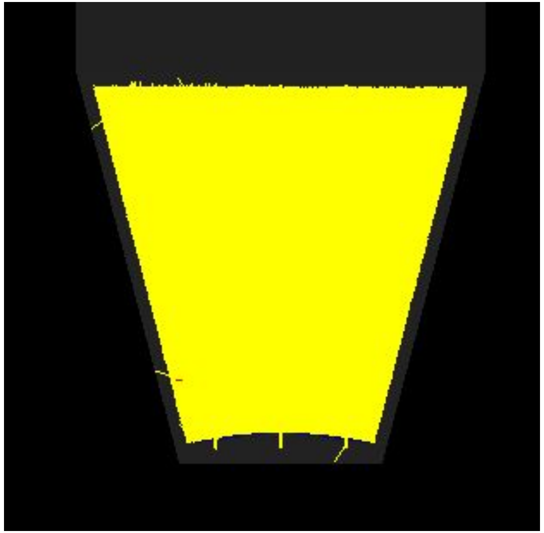
Blackening different sides of the scintillator needs more work in GDML once surface is properly understood

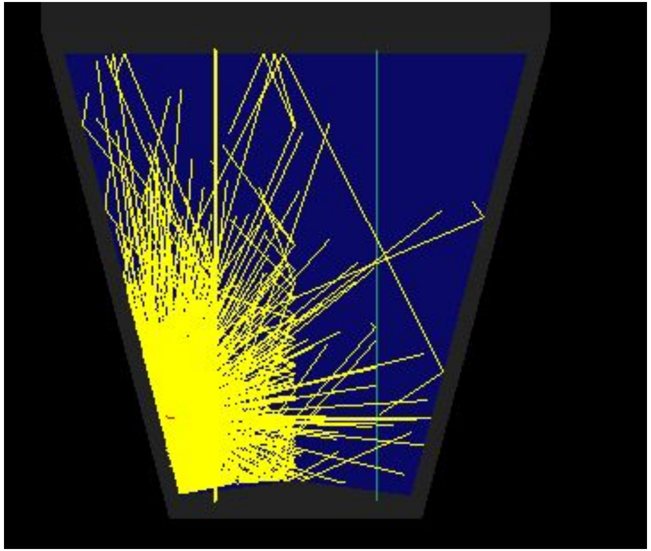
Light Yields at PMT for different Optical Surface Settings

With default settings: With a realistic surface (98% reflectivity) :

700 PE 190 PE

Single Track two surface configurations





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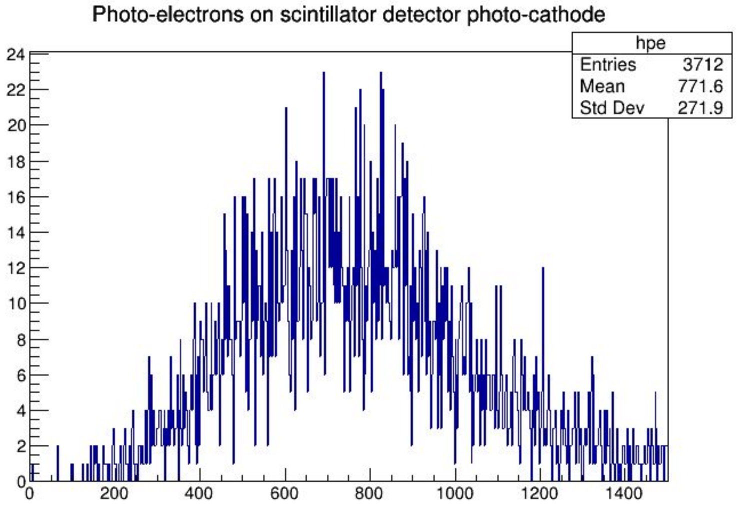

With a realistic surface (98% reflectivity) :
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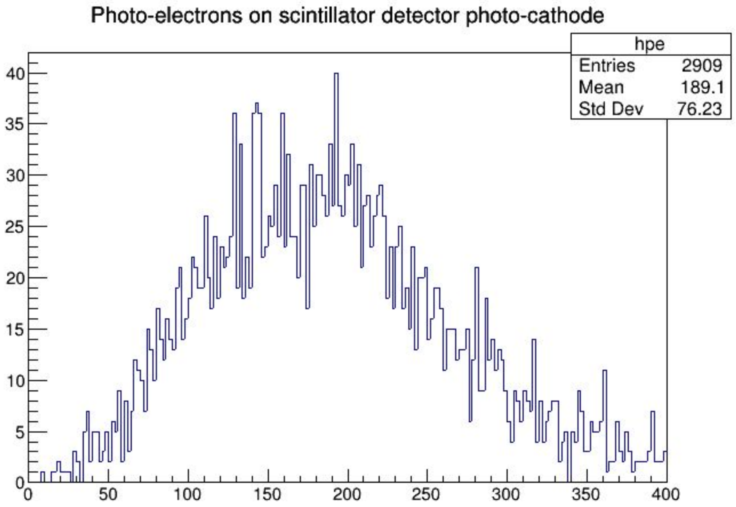

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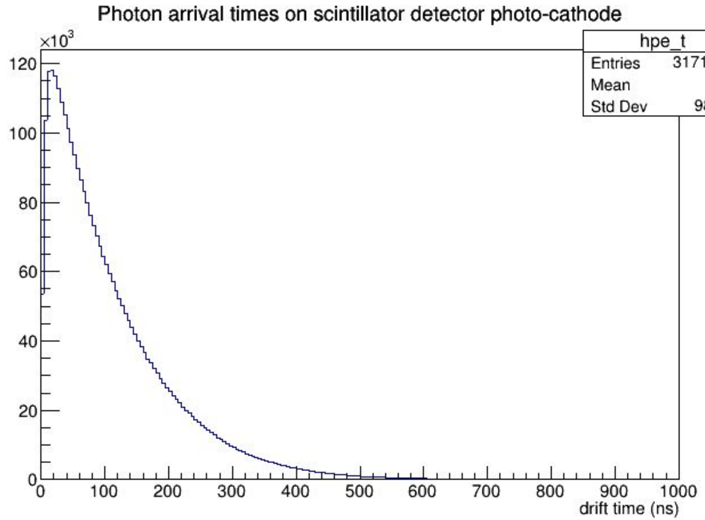

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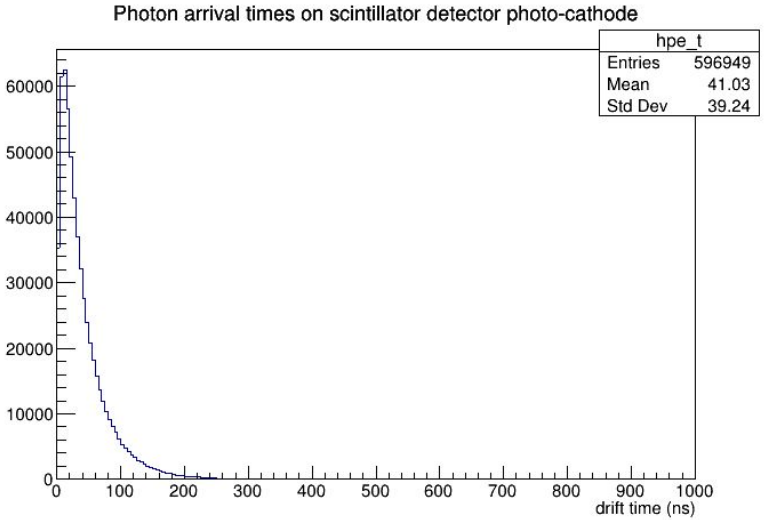
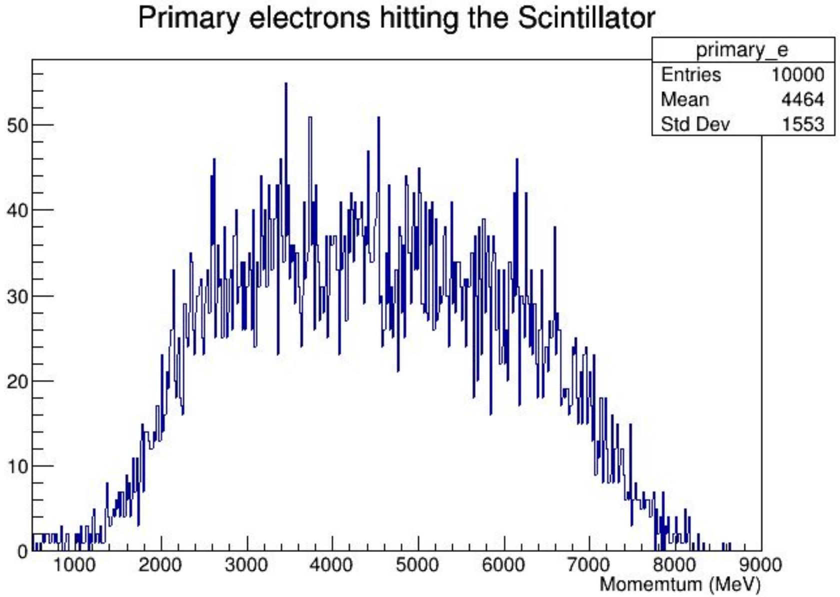
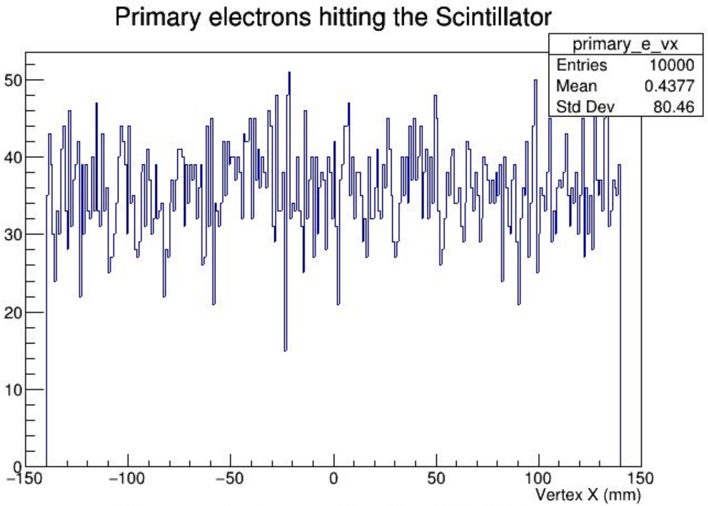
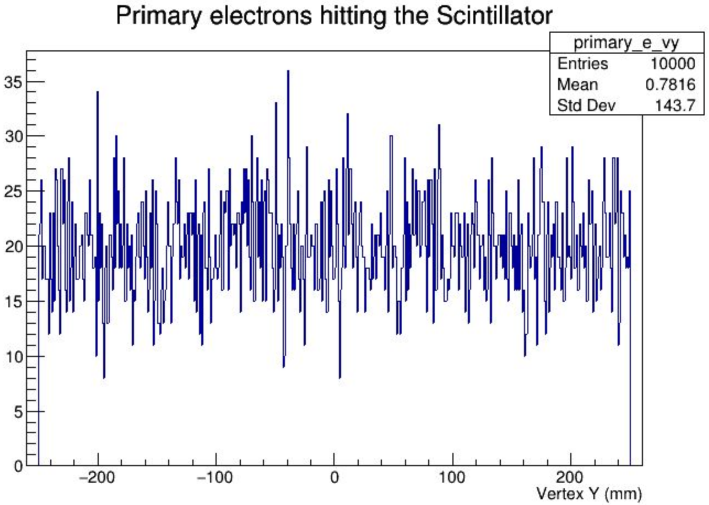


Primary Electrons







Primary Electrons Hit Map