UNIVERSITY OF TORONTO

# Characterizing the Fibre Optics

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# The Project

- Create an experimental setup to measure the attenuation property of the **Kuraray Y-11(200)J (1.5mm)** WLS fibre
- Attenuation is assumed to be due to photon absorptions in the fibre:

$$I(x) = I_0 e^{-x/b}$$

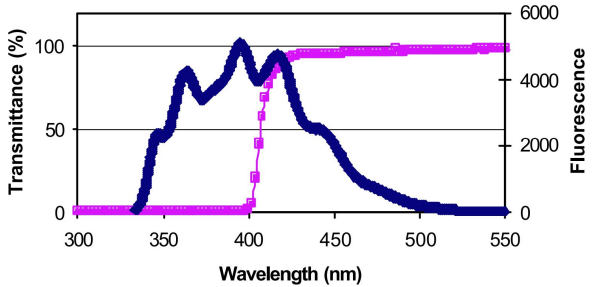
- The attenuation length (mean free path of a photon) is simply λ = 1/b
- An LED was used to mimic scintillation light

# Experimental Setup

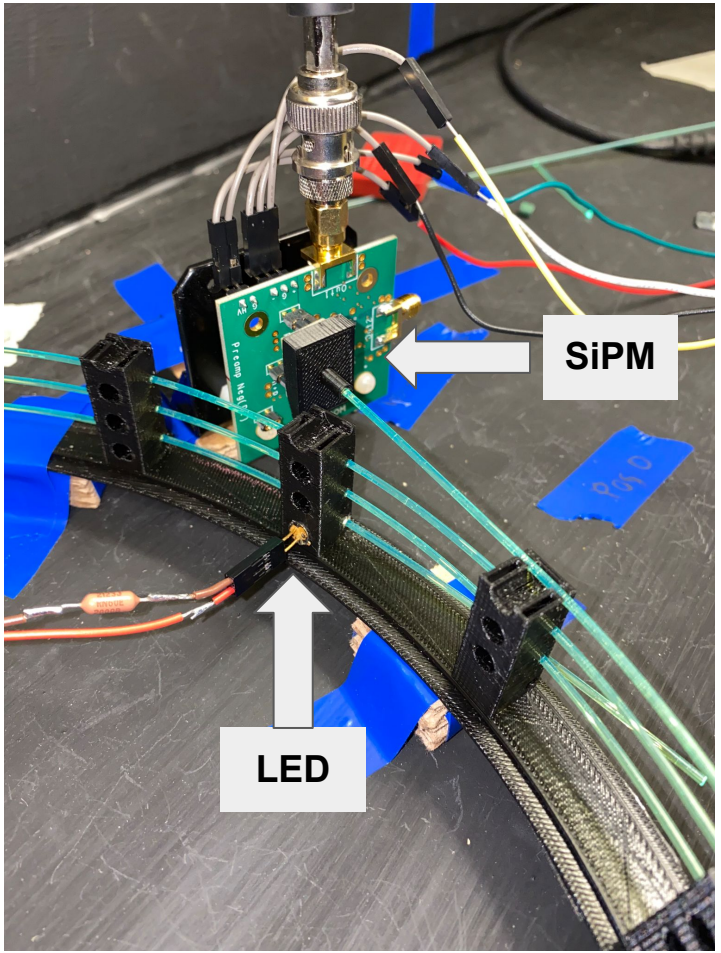
- 300 cm helical track housed the fibre
- Holes located every 5 cm for LED
- SiPM must be off course of the track

LED pulser:

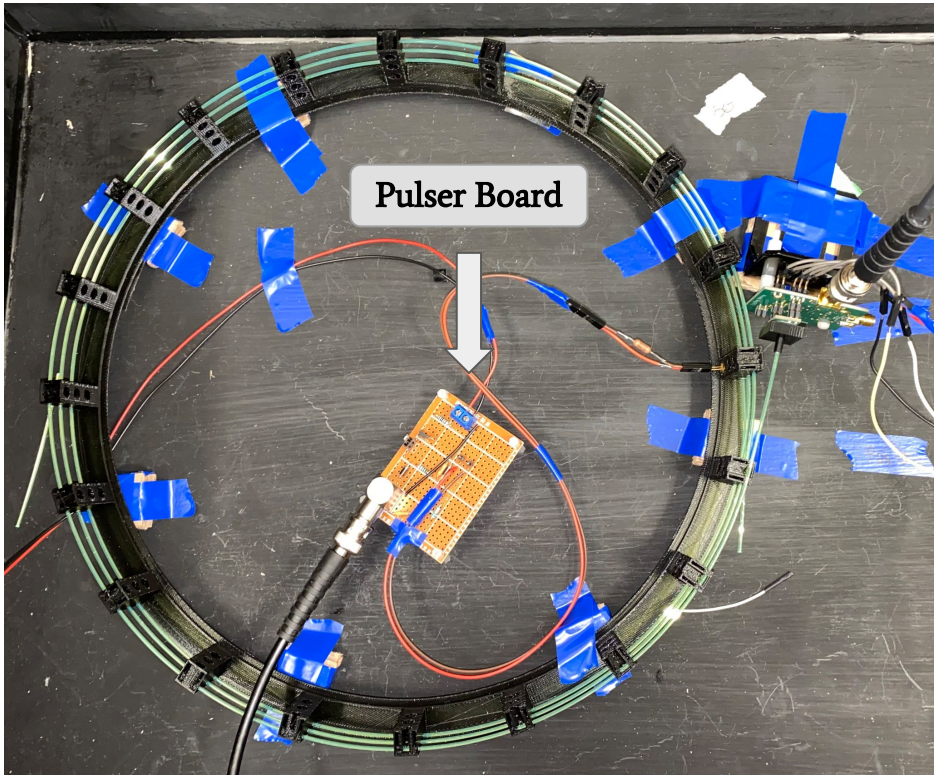
- 405 nm ± 5 nm LED
- LED pulse width: <10 ns
- 50 kHz pulse repetition

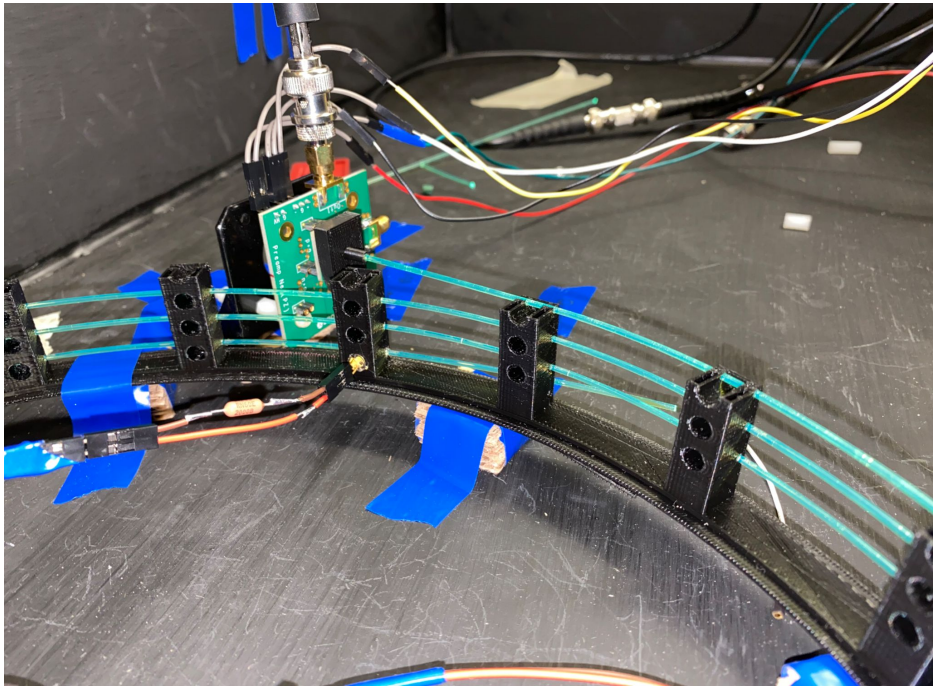



FNAL Scintillator (1% PPO + 0.03% POPOP)
https://lss.fnal.gov/archive/2003/conf/fermilab-conf-03-318-e.pdf



# Experimental Setup



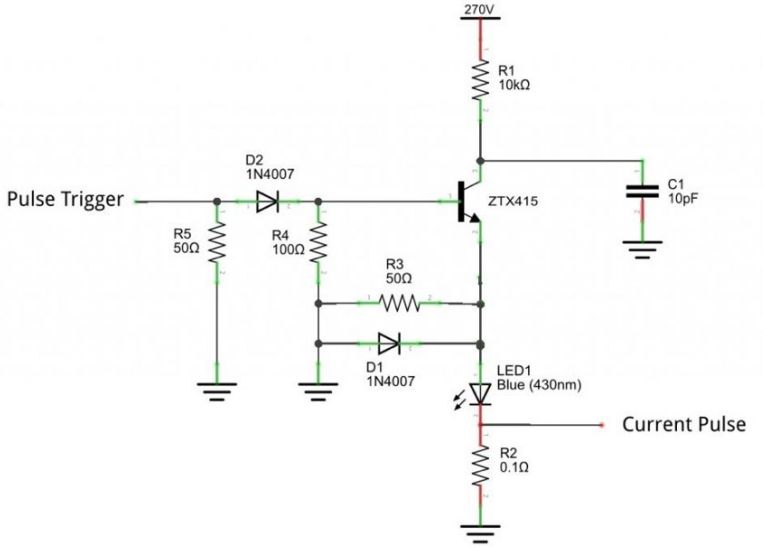



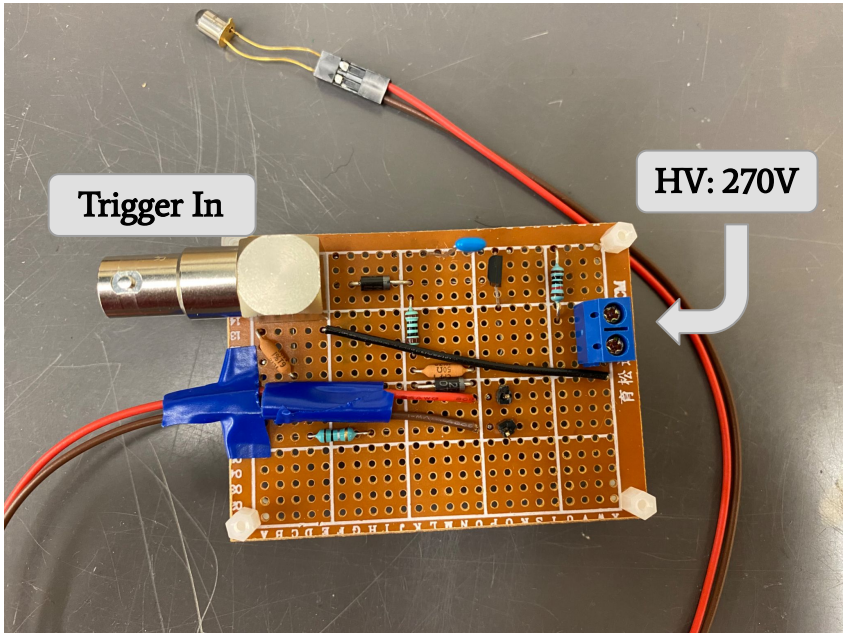
# Experimental Setup (finer details)

- SiPM type: AFBR-S4N44C013
- SiPM board: AFBR-S4E001
- SiPM HV: 30.5 V
- SiPM amplification: no external amplification
    - We could not conveniently acquire a working amplifier for the SiPM

- Due to no external amplification, SiPM dark noise bands were not resolvable
    - Therefor, the exact photon count was unknown

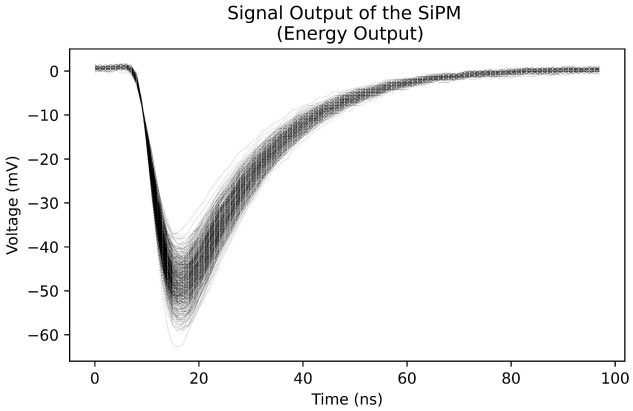
# LED Pulser



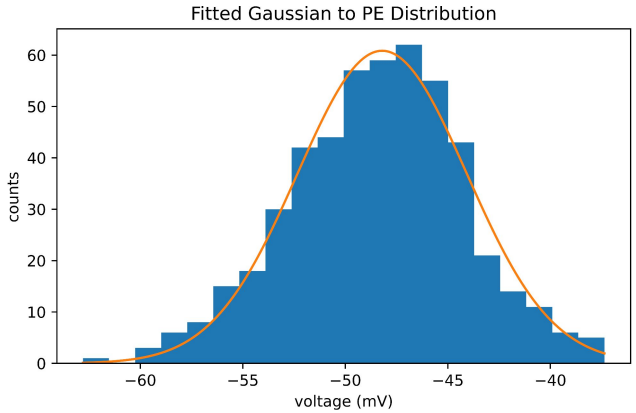




Circuit schematic: https://physicsopenlab.org/2018/12/02/fast-led-light-pulser-sipm/

# Interpreting SiPM Signal

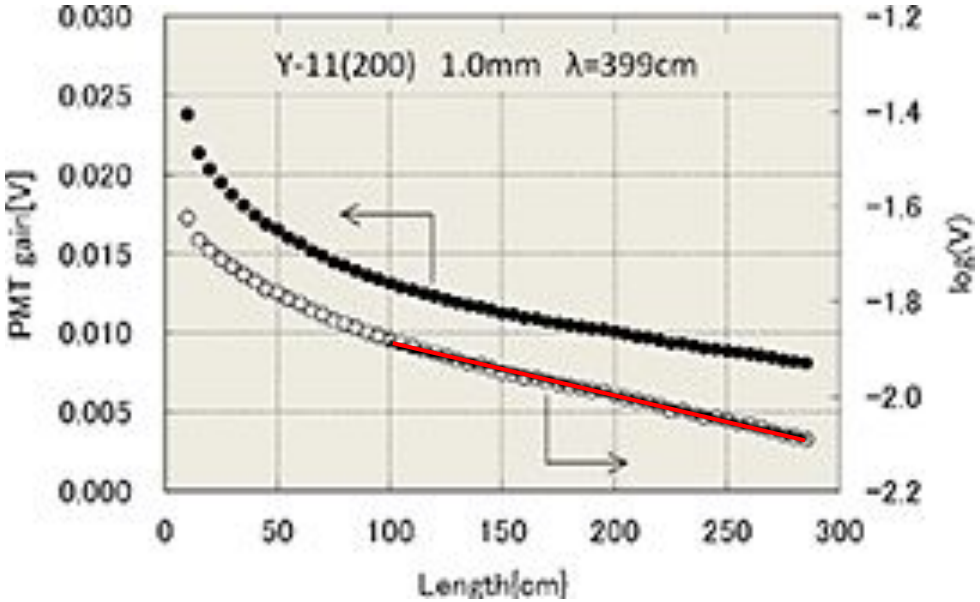



Minimum voltages




- Mean position and sigma of the Gaussian is tracked for every LED position
- Bench Vue application used to operate oscilloscope and acquire data

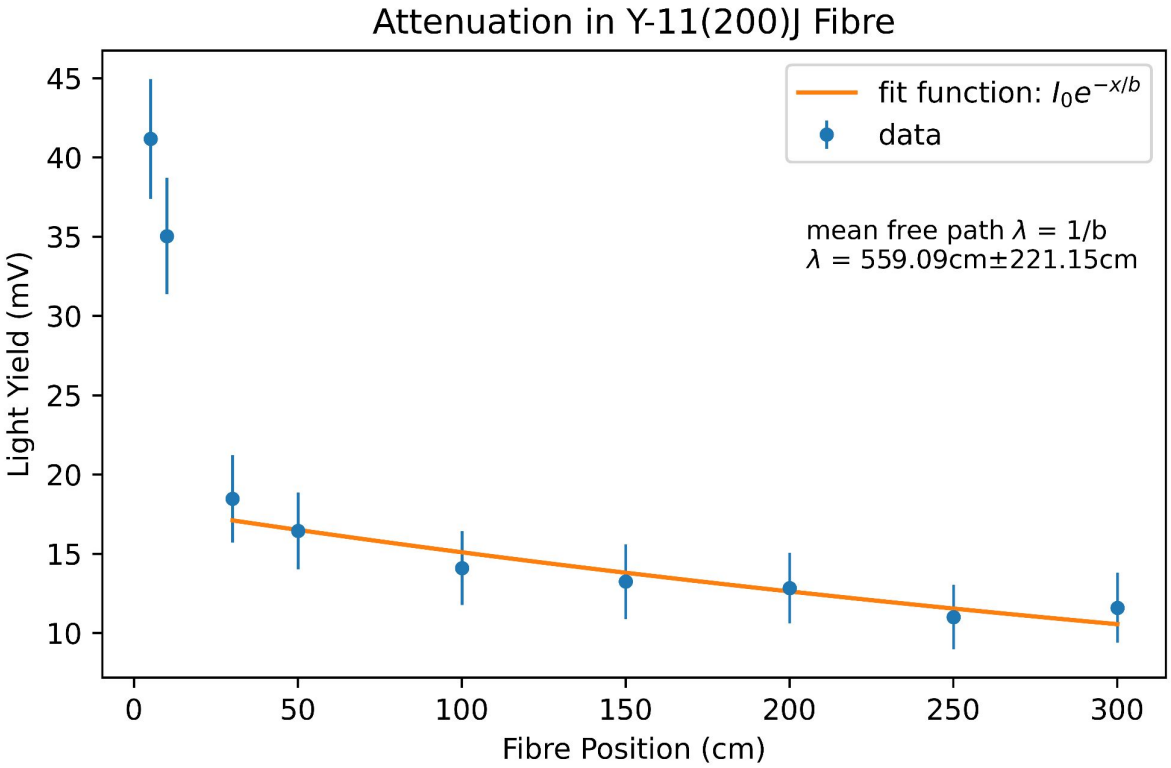
# Expectation of Attenuation Parameter




- Kuraray expects mean free path λ = 399 cm for a 1.0 mm fibre
- Mean free path λ = 1/b

See http://kuraraypsf.jp/psf/ws.html

# Results

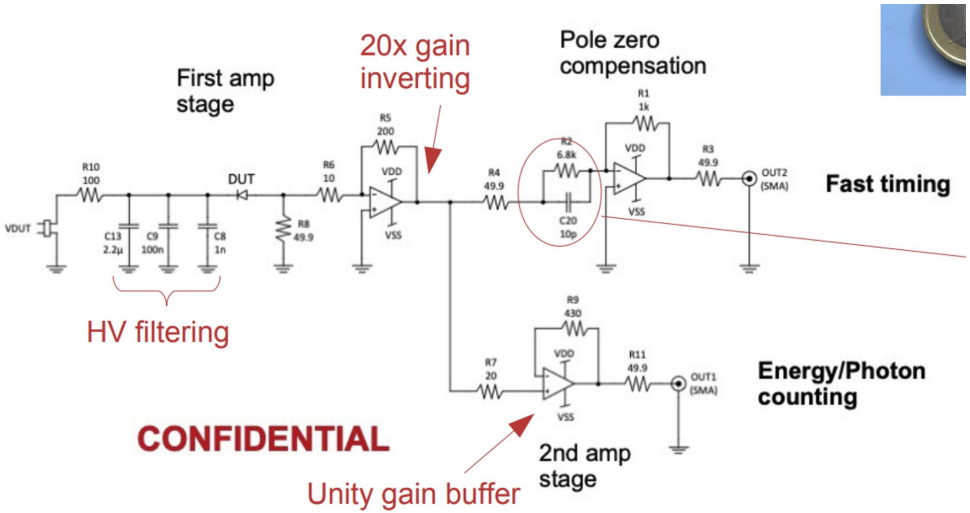


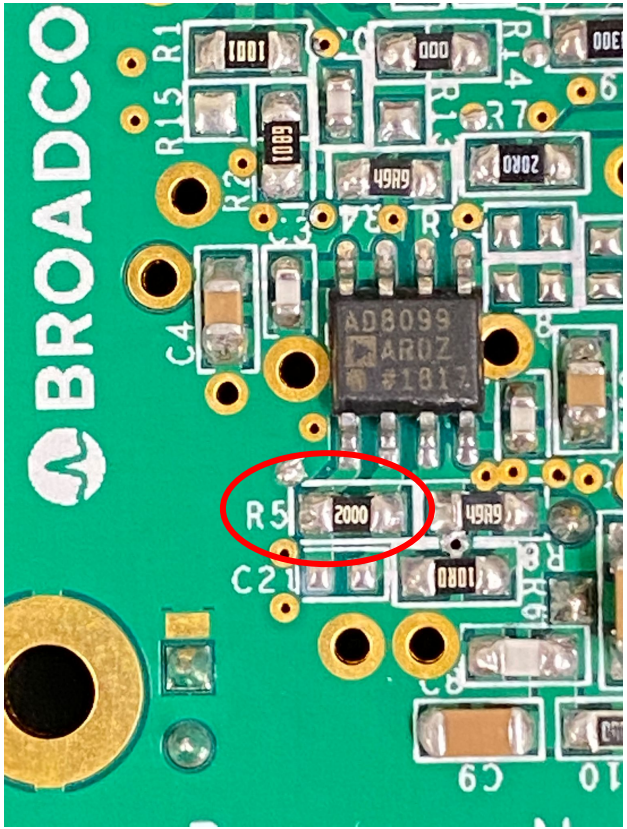

- λ = 559.09 cm ± 221.15 cm
- Two attenuation modes (near and far)
- Note the difference in λ between the 1.0 mm and 1.5 mm fibre

- To decrease uncertainty on λ, take more position data and decrease LED PE spread

# Next Steps

- Increasing SiPM gain 10x more
- Inverting Gain = R5 / R6
  - => For 10x more gain, R5 = 2k



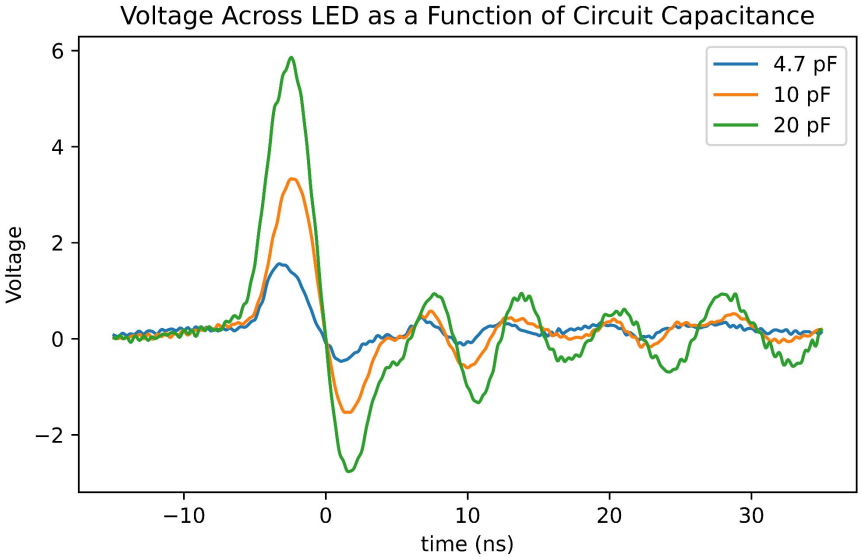



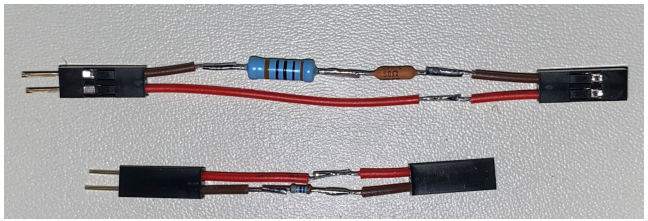

Schematic found on Steven Robertson's presentation (April 6 2021)

# Extras

RE: Led Pulser

- Circuit capacitor heavily influences pulse width and amplitude of the LED
- Note that the after pulses for 20 pF may be large enough to trigger the LED
- Adding a 100 - 330 Ohm resistor to the LED can precisely adjust the pulse amplitude as well



These resistors were added between the LED and pulser board to adjust LED intensity