Optical properties of water and liquid scintillator for the Daya Bay Neutrino Oscillation Experiment

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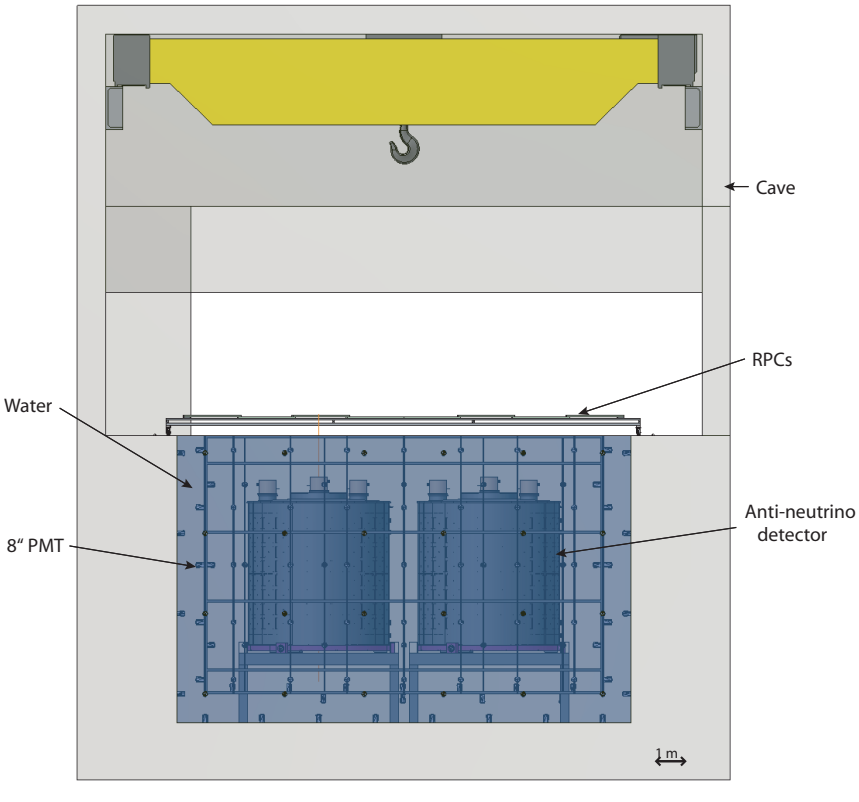
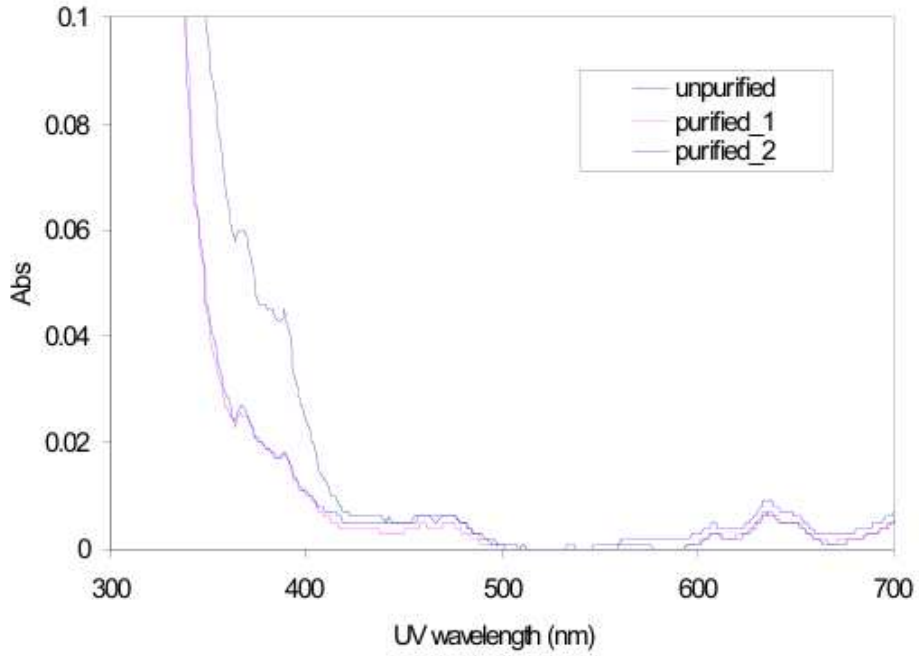
October 21, 2008

Overview

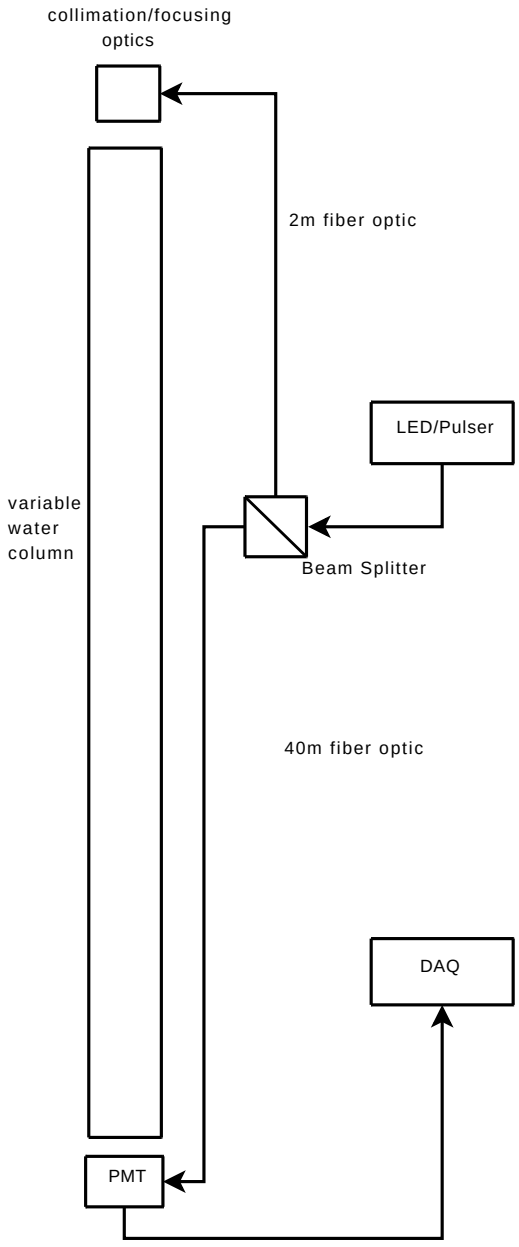


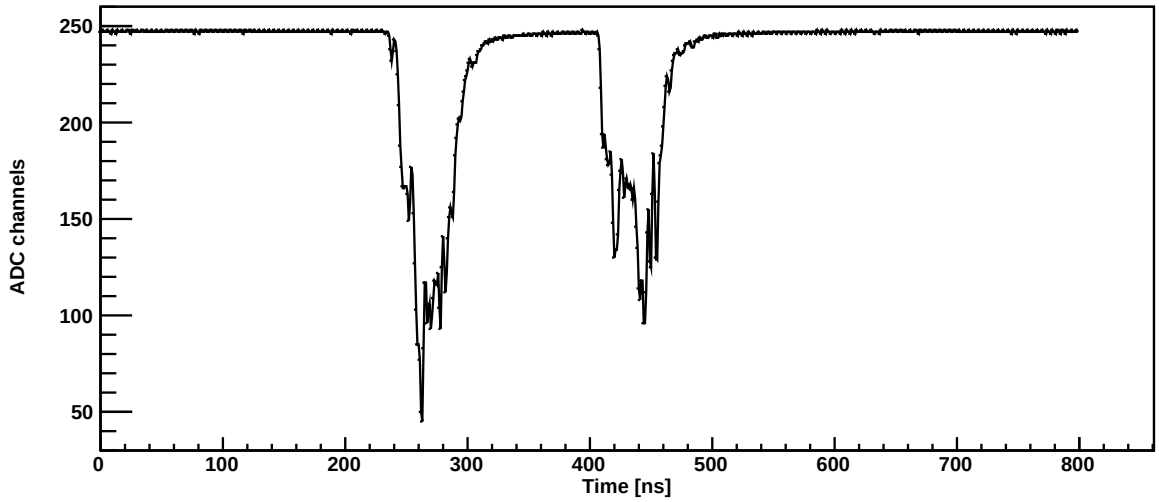
- Ultrapure water = Money
- Daya Bay simulations indicate $< 1\%$ effect between 20 - 30 m
- $18\text{M}\Omega cm\text{H}_2\text{O}$ has $l > 100$m in the near UV



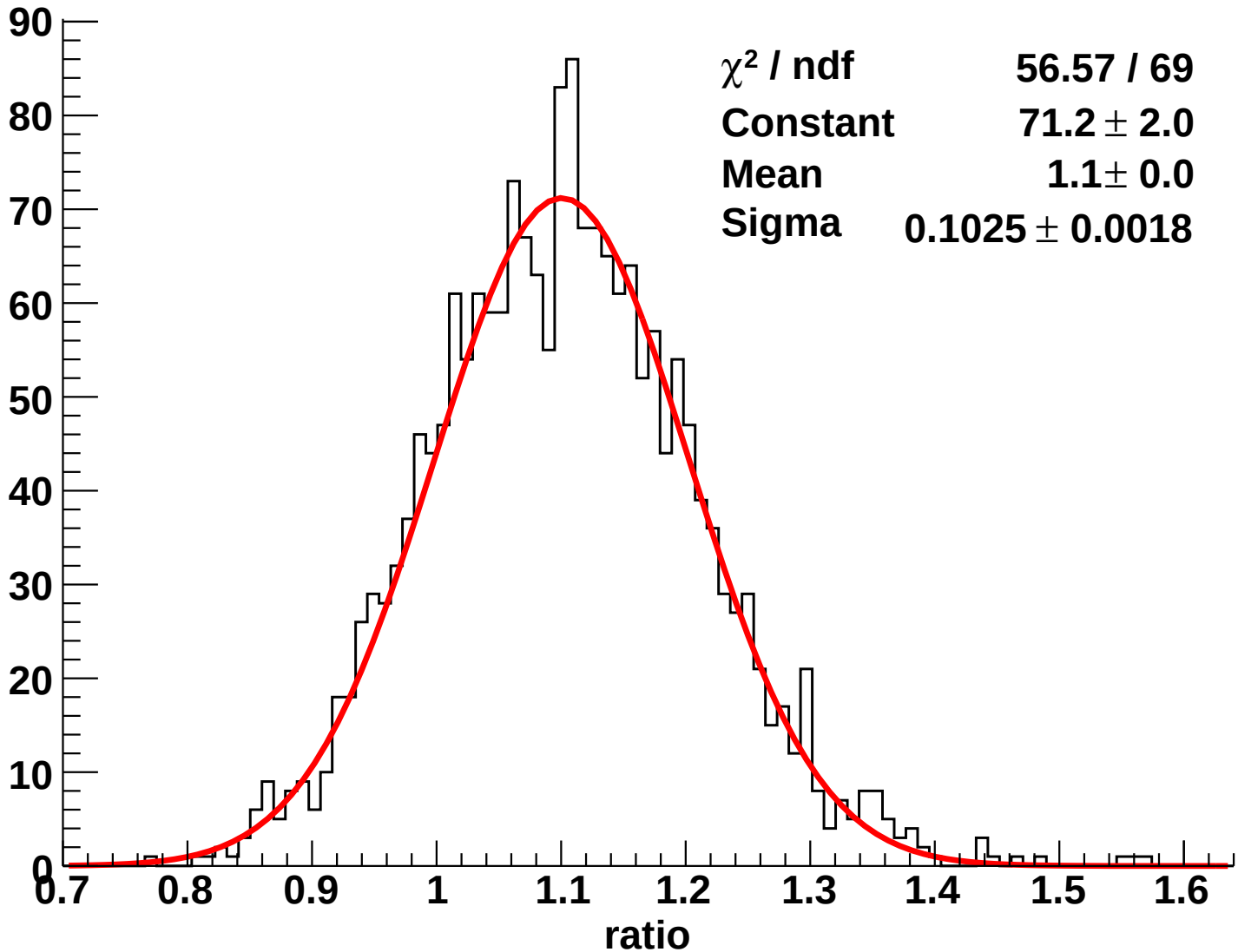
- Linear Alkyl Benzene (LAB) will be used as liquid scintillator (see Wei Wang's talk)
- Optical transparency should give $\lambda_{1/e} > 10$m
- Absorbance at 430 nm is very close to baseline requirements
- a long path-length attenuation system is needed for precision measurements

Apparatus

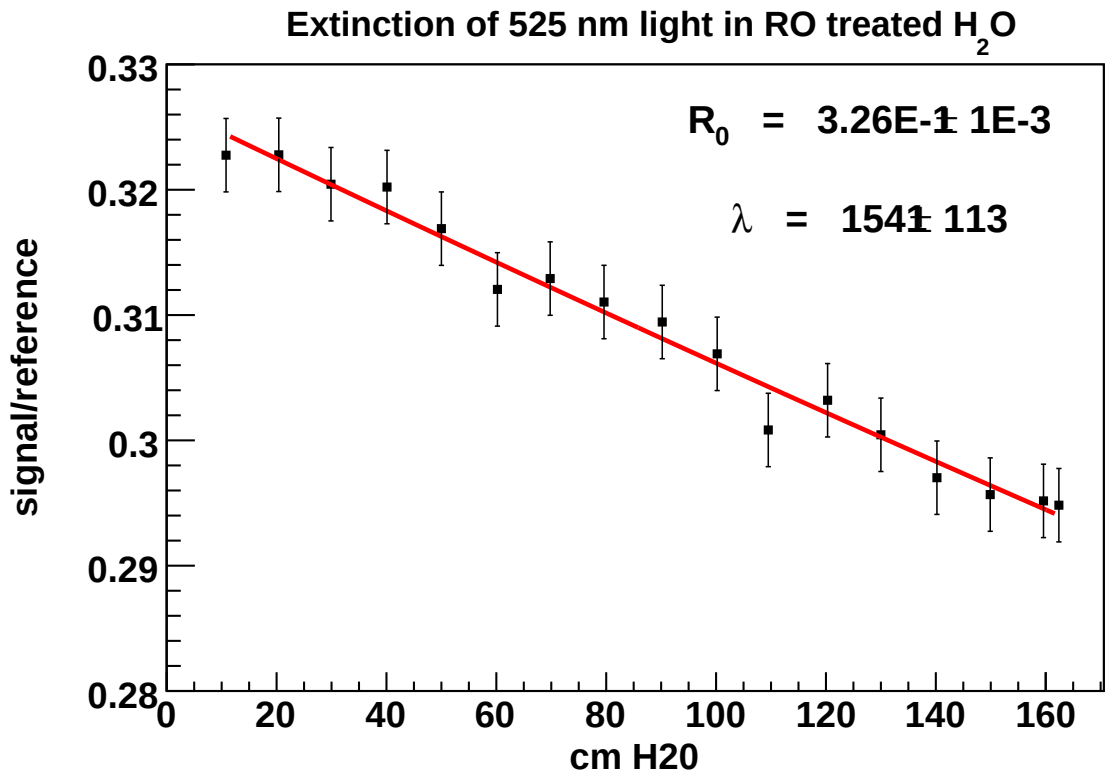

collimation/focusing
optics
2m fiber optic
LED/Pulser
variable
water
column
Beam Splitter
40m fiber optic
DAQ
PMT


ADC channels
250
200
150
100
50
0
100
200
300
400
500
600
700
800
Time [ns]

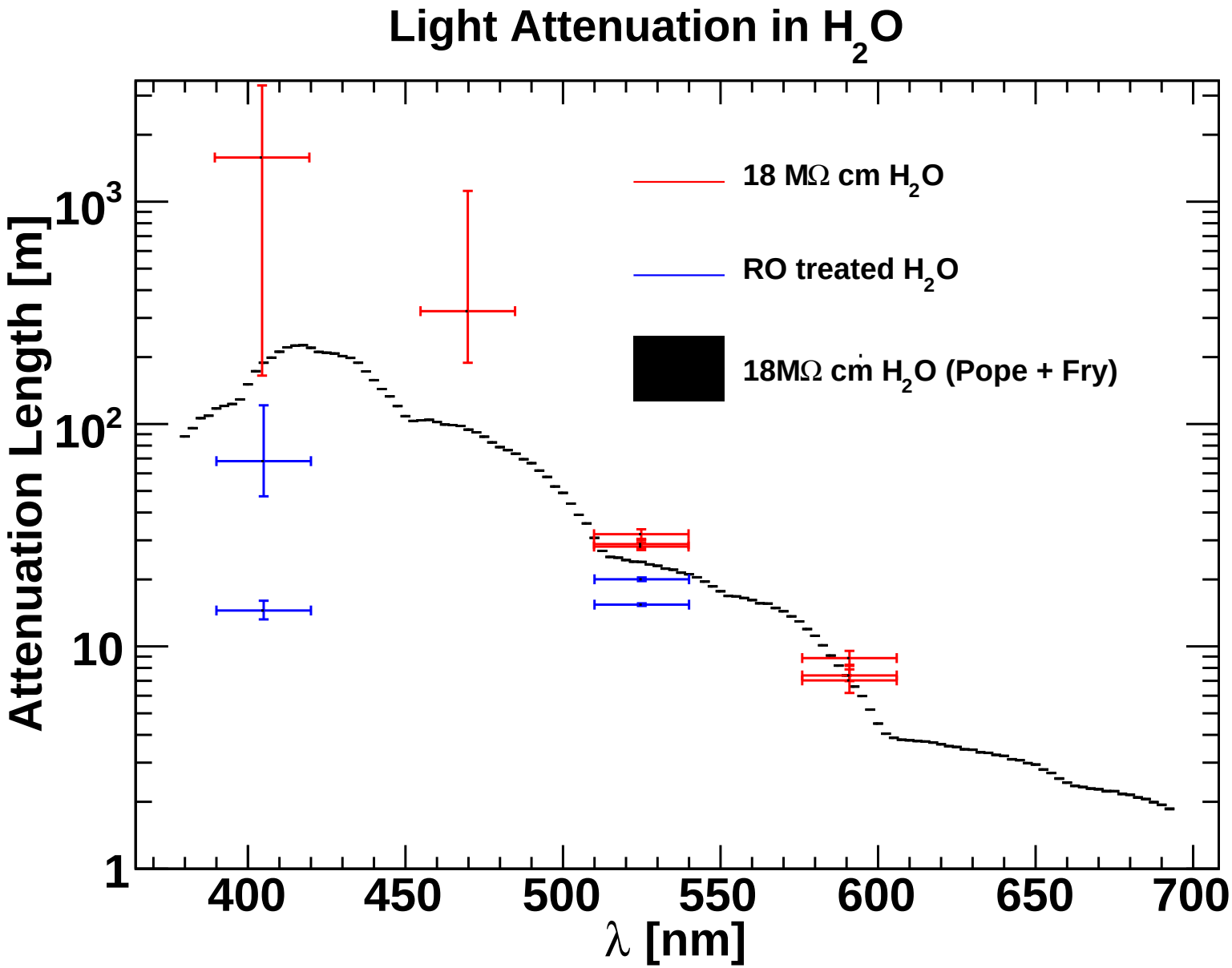
Fit ratios of integrated charge in prompt and delayed pulses:



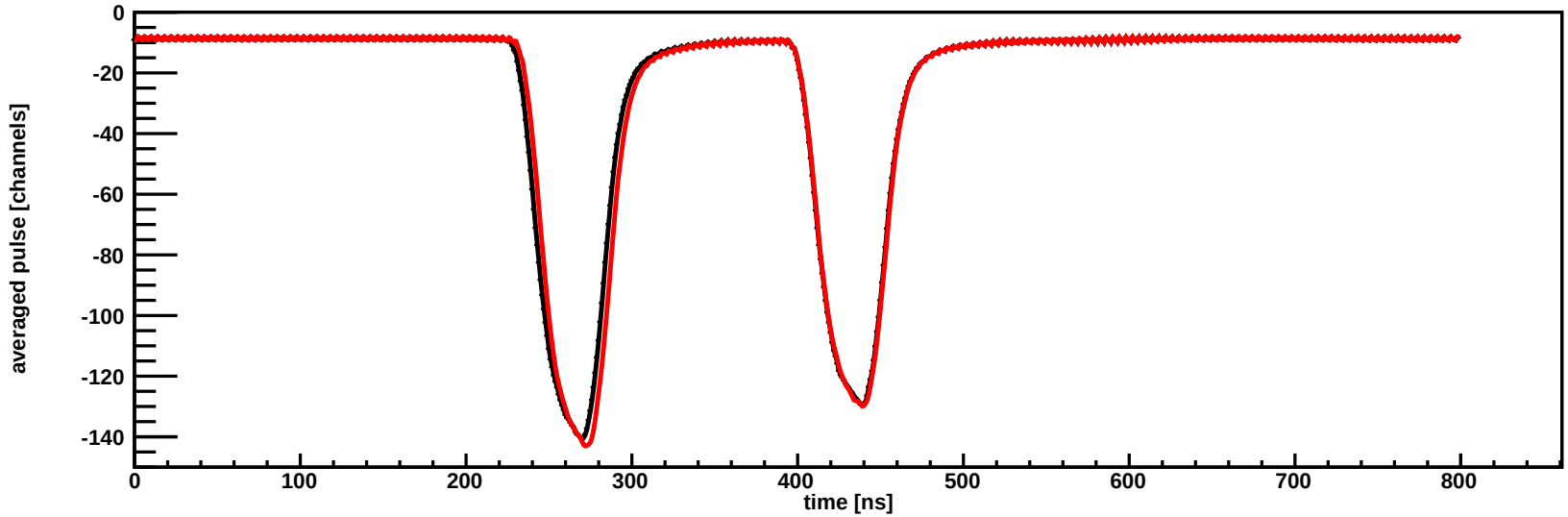
Plot as a function of path length through sample...



...and fit to convolution of exponentials.

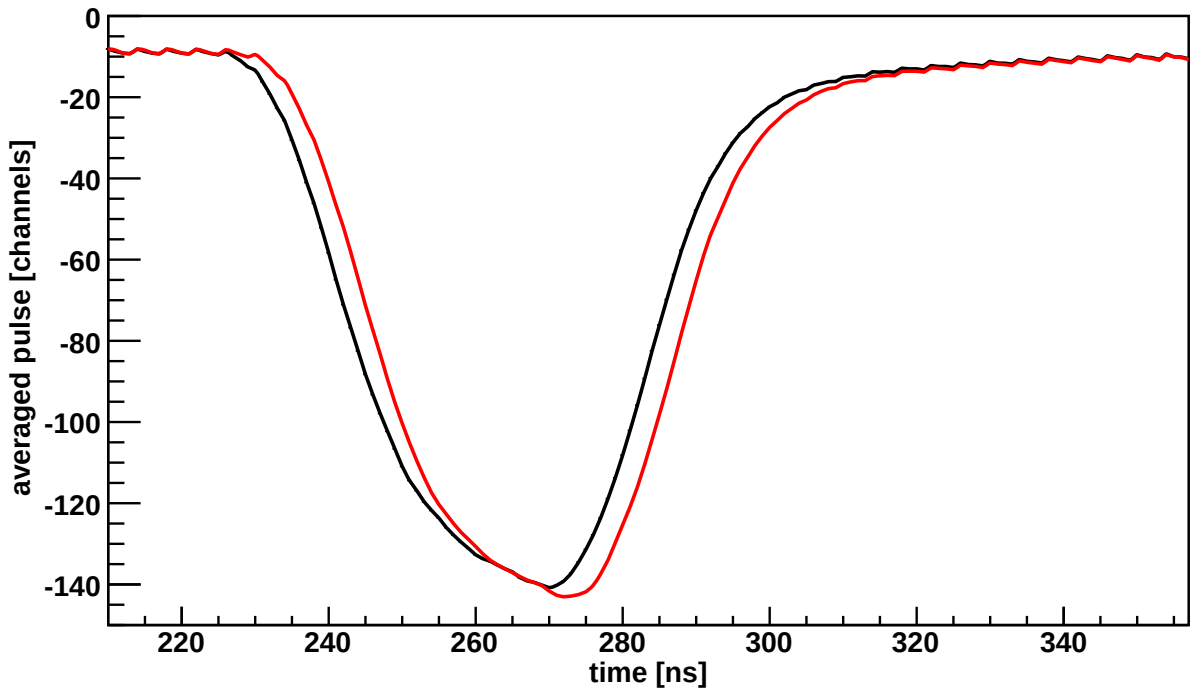

Light Attenuation in H_2O
18 MΩ cm H_2O
RO treated H_2O
18MΩ cm H_2O (Pope + Fry)
Attenuation Length [m]
10^3
10^2
10
1
400
450
500
550
600
650
700
λ [nm]

Travelling through a high index material, the attenuated light is delayed by a few ns.



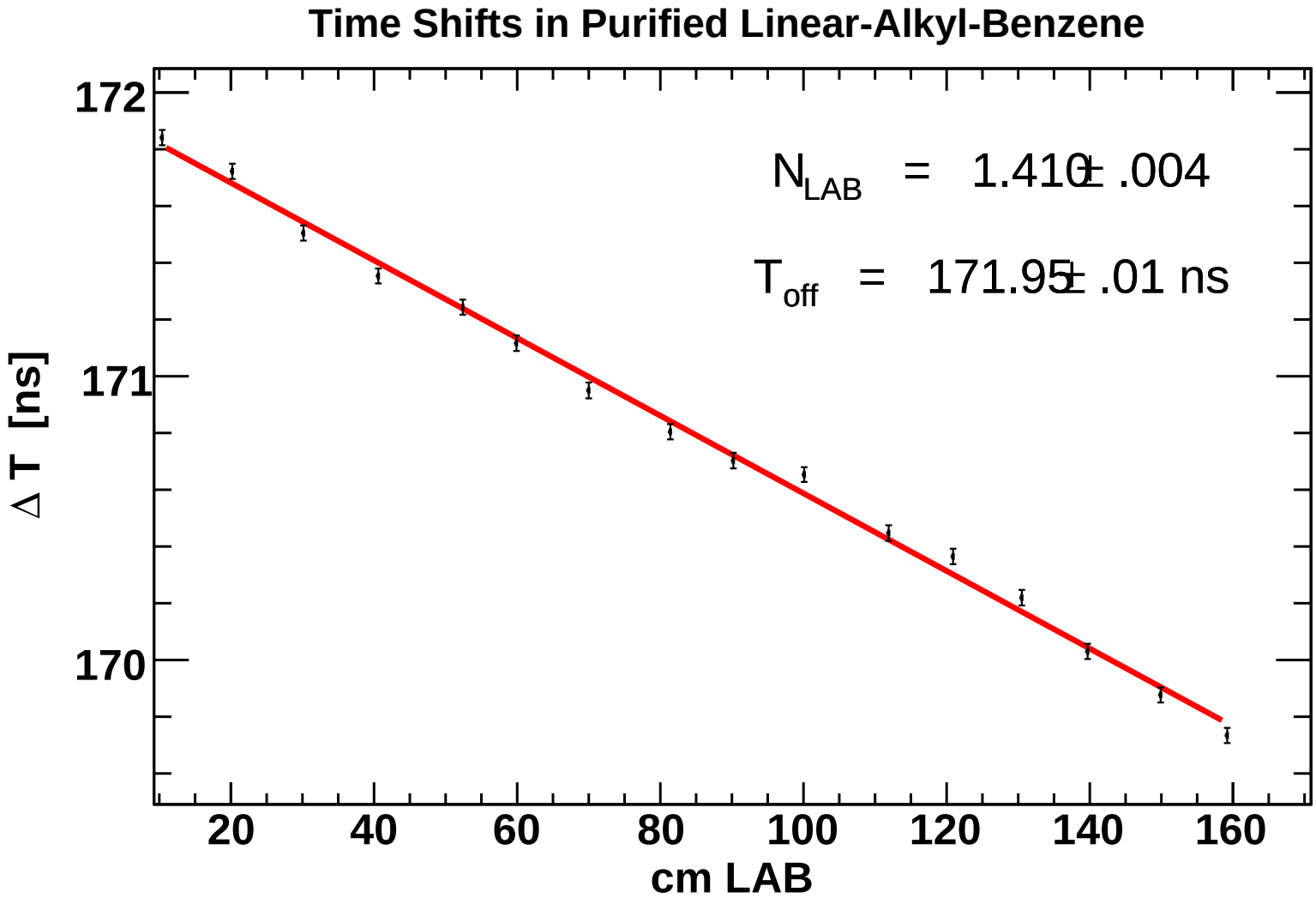
The red trace comes from light that has traversed a meter of LAB.

Find difference in time delay between centroids of prompt and delayed pulses for each path length through the liquid sample



The red trace comes from light that has traversed a meter of LAB.

Plot as a function of path length through sample... and fit.



- We have built a system to take precision measurements of attenuation length and index of refraction.
- We have demonstrated the benefit of RO water for small Water Cerenkov detectors
- optical characterization is useful for determining uniformity of scintillator batches and online monitoring of water quality in polishing loops.
- Characterization of LAB and Gd-LAB is in-progress
- Work on reducing systematics is in-progress