Measuring Light Guide Performance in Liquid Argon

Jarrett Moon
Massachusetts Institute of Technology
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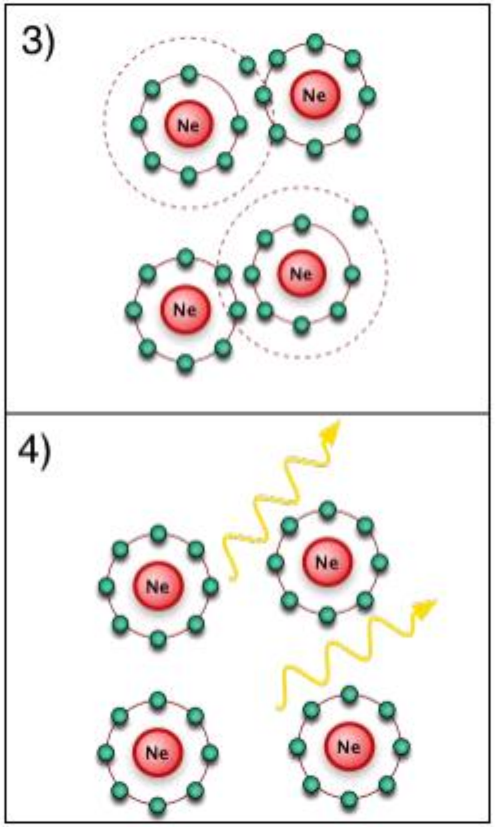
Outline

- Liquid argon scintillation
- Measuring attenuation
- Attenuation results
- Using air to predict argon behavior
- Adding Xenon
- Conclusions

Liquid Argon Scintillation

- Scintillation light is produced in LAr via the following reaction

$$Ar_2^* \rightarrow 2Ar + 128nm$$



- Ionized Argon atoms can form metastable molecules which then decay producing 128 nm light
  - There is a fast (7 ns) and slow (1.6μs) component

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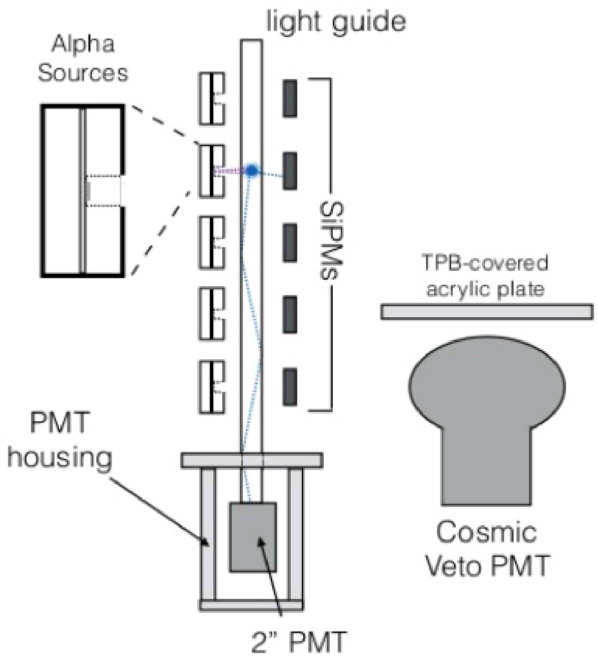
"Tall Bo" Dewar

- Measurements were done at the FNAL proton assembly building in a high purity dewar dubbed "Tall Bo"

- This setup allowed us to carefully measure and minimize contaminants

Measuring the Attenuation

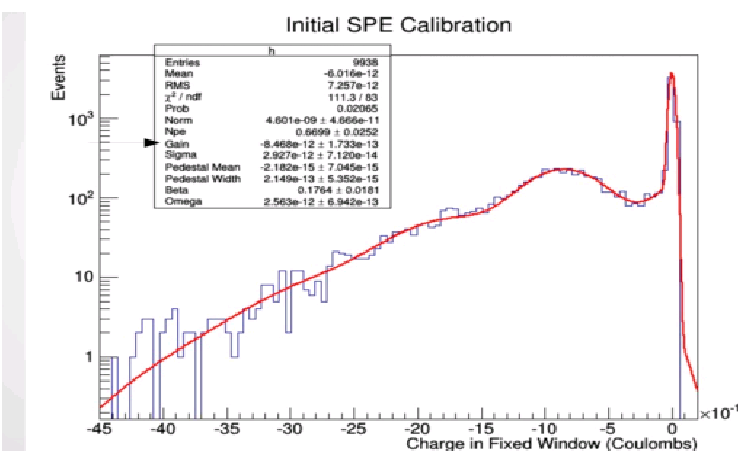
- We want to measure light output as a function of flash distance
- Flashes generated via scintillation produced by 5 Po-210 sources spaced along the bar
- 5 adjacent SiPMs act as triggers
- A PMT reads out the light output
- Another PMT is used for cosmic Veto

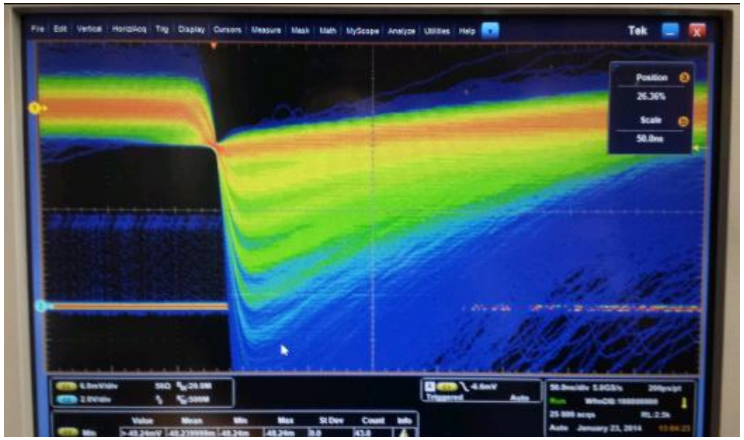


TallBo Schematic

SYSTEM CALIBRATION

- A UV LED was used to calibrate the PMT
  - The LED was pulsed at low voltage to primarily produce single photoelectron events
  - Fitting to this PMT data allows us to extract the calibration constants
- The SiPMs are easy to calibrate by eye





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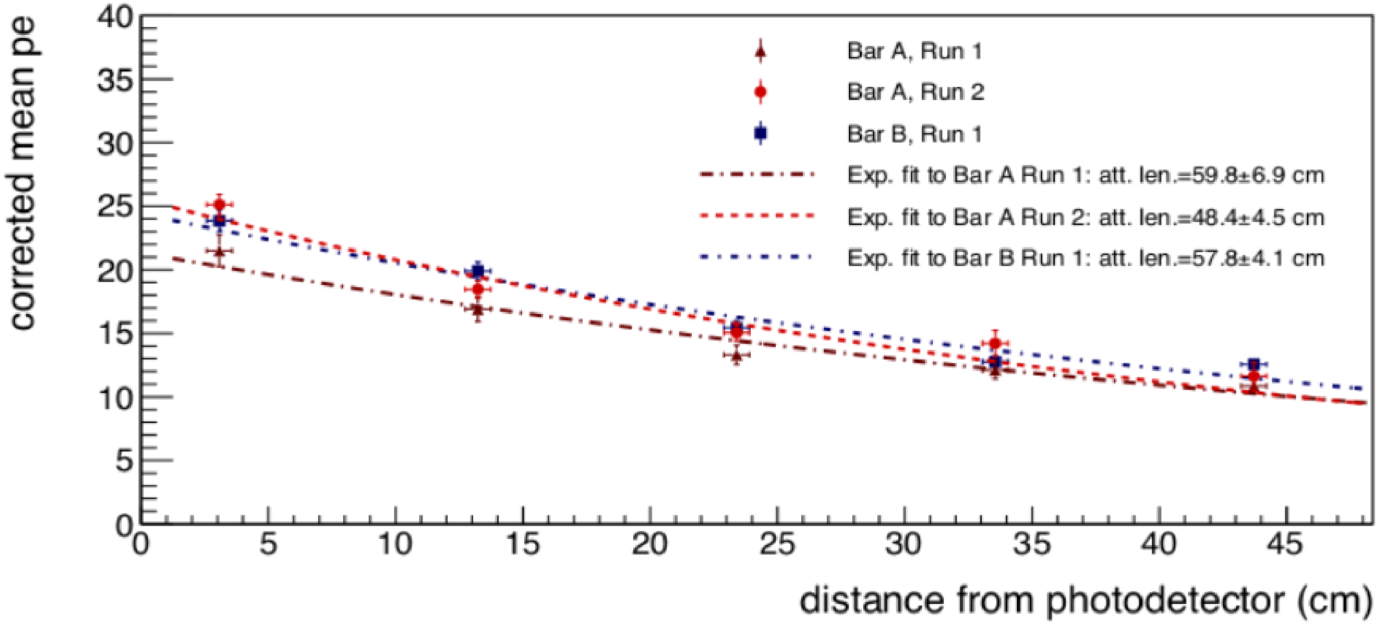
Attenuation Results

- We observed an attenuation length of ~50 cm which is a significant improvement over previous light guides



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Connecting Air and Argon Results

- Testing these bars in liquid argon is time consuming, expensive, and relatively problem prone

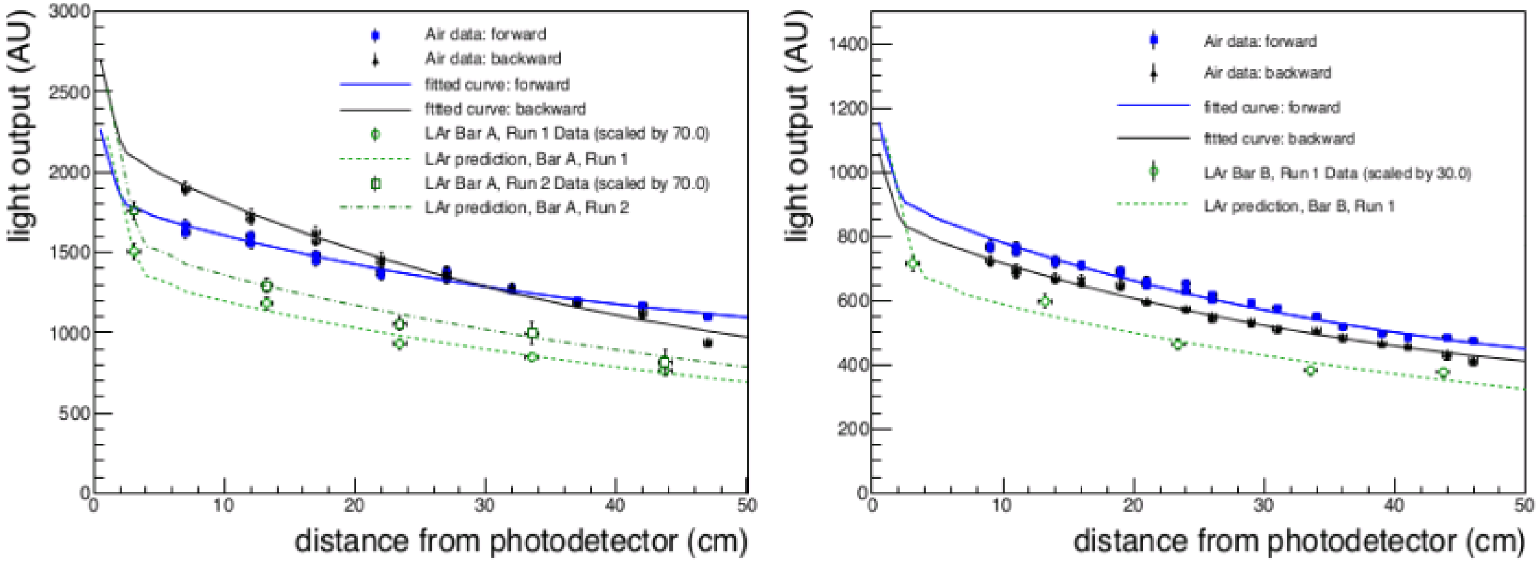
- Can we create a model which links performance in air to the performance in argon?

Connecting Air and Argon Results

- Try a 3 parameter model
  - Internal reflection which depends on the refractive index of the medium (air vs argon)
  - Photon loss per reflection
  - Coating thickness gradient
- Simultaneously fit the air data from a bar's forward and backward runs to extract parameters
- Use light loss per bounce to deduce an attenuation curve for liquid argon

Model Results

- The model correctly "post-dicts" the argon attenuation curve we already measured



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Adding Xenon

- One promising avenue for improvement we plan to pursue this summer is doping the argon with ppm Xenon

- Xenon has several key benefits
  - Its presence shifts the Argon late light to earlier times
  - It reemits the Argon light at a higher wavelength, which will improve the efficiency of our wavelength shifting coat

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Conclusions

- Our measurements in air and liquid argon are both great improvements over prior light guides
  - We can now reliably and consistently produce meter scale guides
- R&D is ongoing. We hope to push the attenuation of our guides higher, possibly to several meters

THANK YOU!
QUESTIONS?