Data-Driven Light Model for the MicroBooNE Experiment

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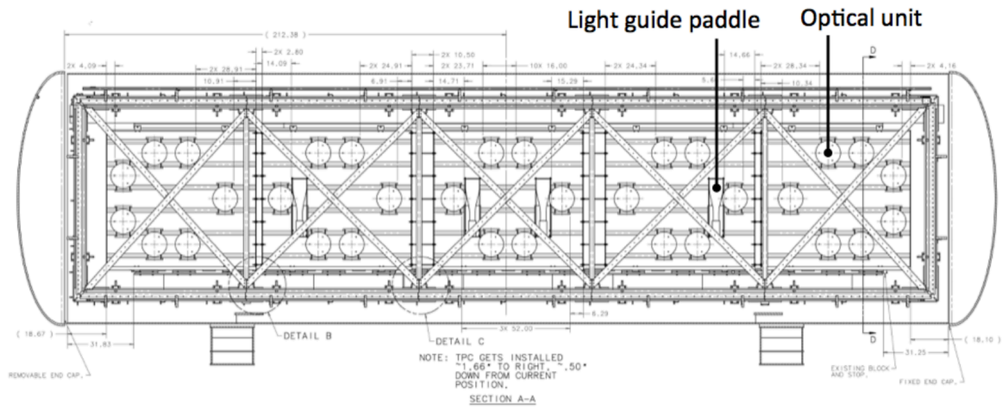
- **MicroBooNE ran from 2015-2021, collecting data from BNB and NuMI beamlines**
- **As a surface detector, has collected a large amount of cosmic data that has been used for light yield (LY) calibration and studies**



Light Detection System in MicroBooNE

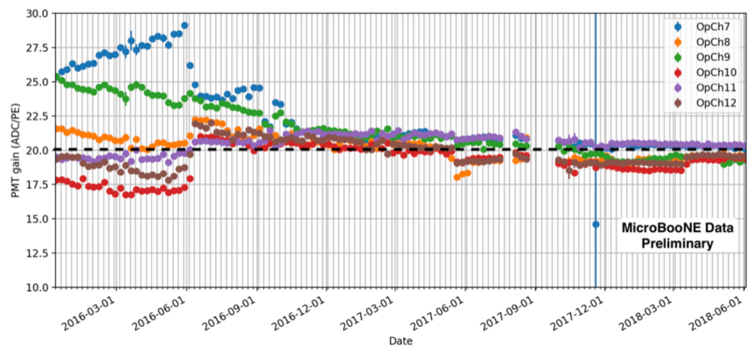
- 32 Hamamatsu 8” photomultiplier tubes along anode
- Plates covered in tetraphenyl butadiene (TPB) convert scintillation light from argon scintillation emission to visible spectrum
- Optical signals used in conjunction with reconstructed charge from TPC wires for flash-matching

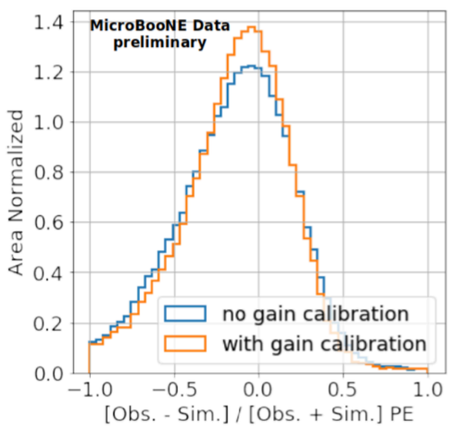
Potential Factors Contributing to LY Instability

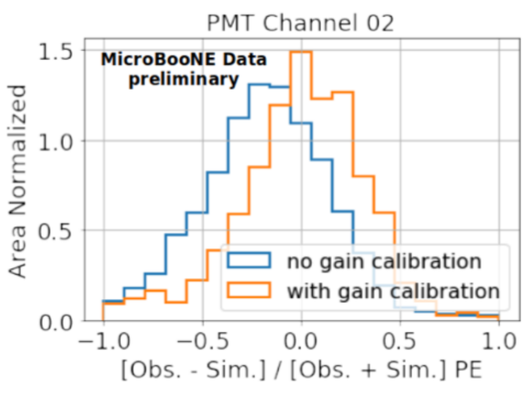
- Changing amounts of impurities in argon
- Aging of PMTs
- Degradation of TPB coating

Data-Driven PMT Gain Calibration

- PMT gain fluctuations over time can affect overall LY
- Studies of gain performed using intrinsic single- and few-PE light deposits in MicroBooNE off-beam data [1]
- Calibration implemented accounts for amplitude and distributions shifts

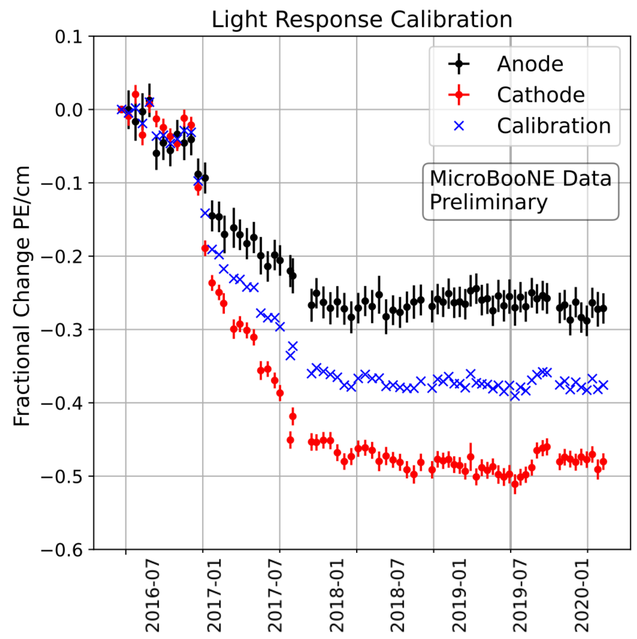






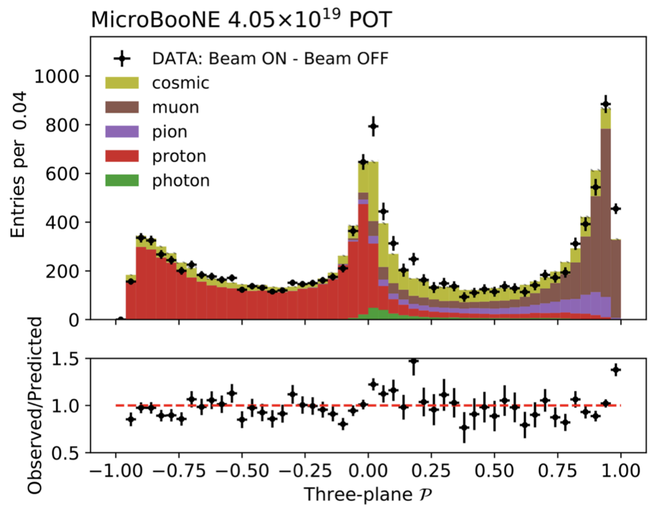
Data-Driven Light Yield Calibration

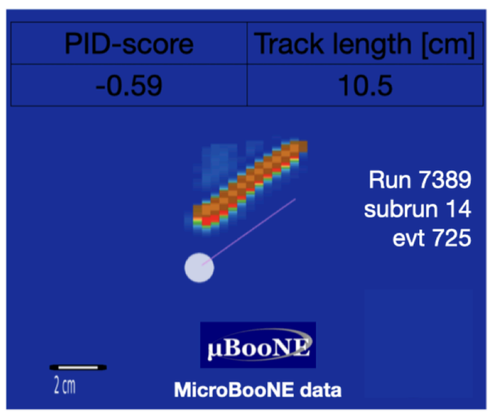
- Cathode and anode piercing cosmic muon tracks used to study light yield over 5 years of detector runs [2]
- Calibration of light yield applied and incorporated into contribution to systematic uncertainties
- Has allowed MicroBooNE’s neutrino selection to not be impacted by the LY decline seen in later runs

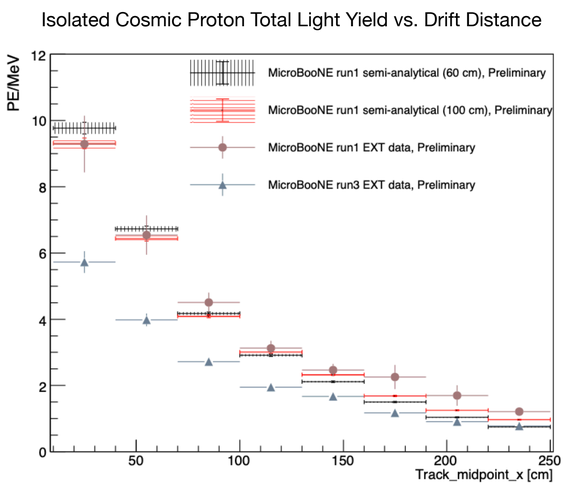


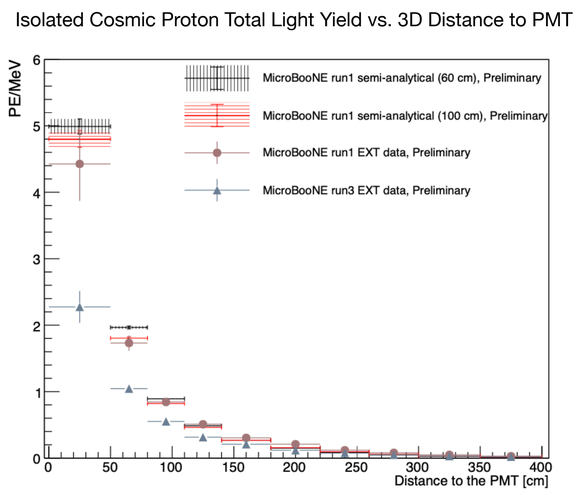
Measuring Light Yield with Isolated Protons

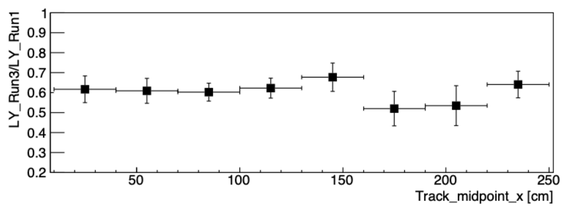
- Large sample of isolated cosmic protons in off-beam data has allowed measurement of position-dependent total LY within the detector [3]
- Use semi-analytical light model to simulate visibility map [4]
- Confirms LY decline seen in calibration studies, and that it is position independent

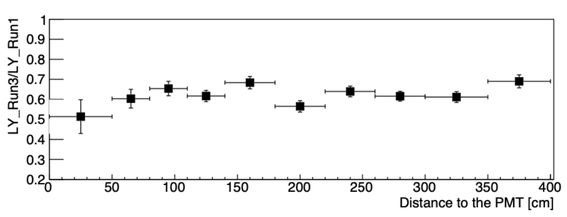












- **MicroBooNE has several data-informed studies of light behavior over time**
- **Calibrations implemented to account for observed behavior**
- **Future plans include using MicroBooNE data to inform a visibility map and study out-of-detector light behavior**

[1] https://microboone.fnal.gov/wp-content/uploads/MICROBOONE-NOTE-1064-TECH.pdf
[2] https://microboone.fnal.gov/wp-content/uploads/MICROBOONE-NOTE-1120-TECH.pdf
[3] https://microboone.fnal.gov/wp-content/uploads/MICROBOONE-NOTE-1119-PUB.pdf
[4] https://inspirehep.net/literature/1820607

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