Data-Driven Light Model for the MicroBooNE Experiment
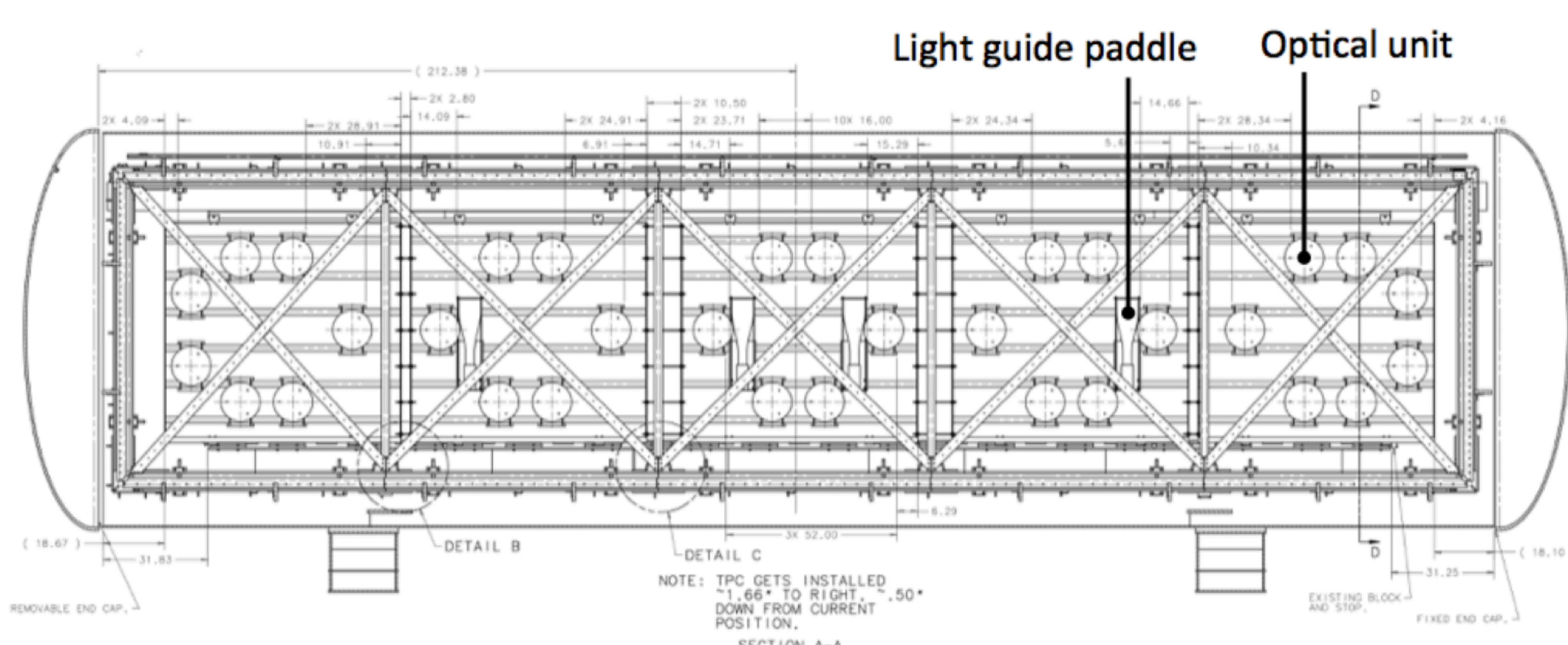
Polina Abratenko on behalf of the MicroBooNE Collaboration

μBooNE

Tufts UNIVERSITY

- 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 guide paddle   Optical unit

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
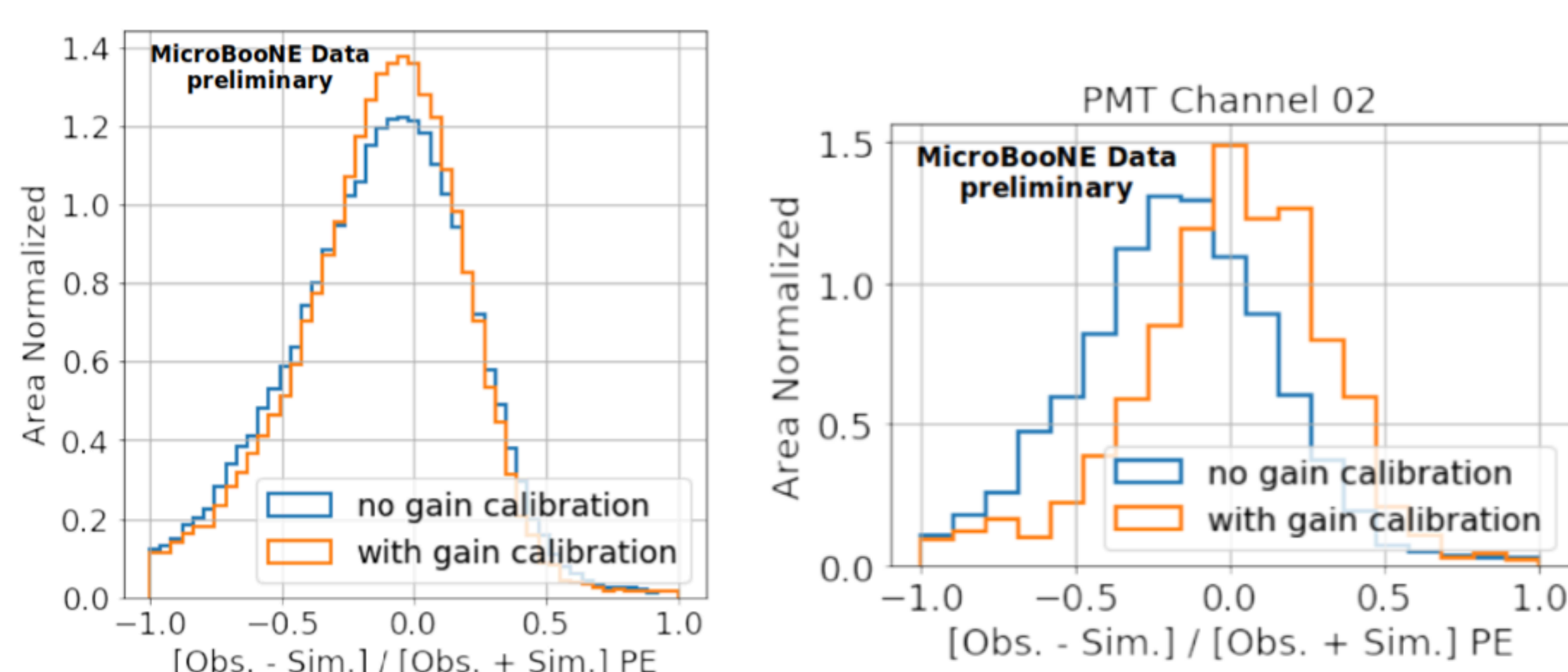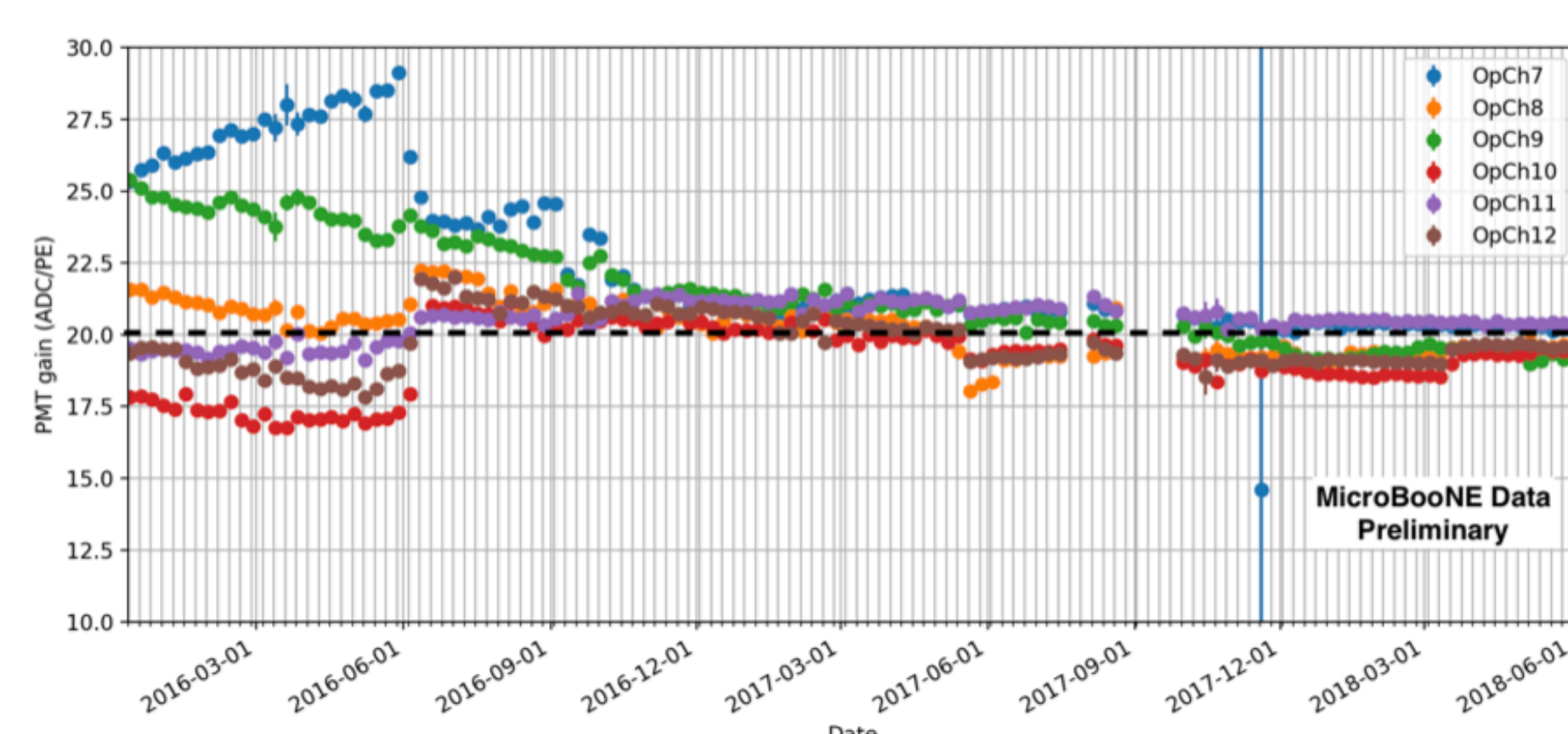

Data-Driven Light Yield Calibration
- Cathode and anode piercing cosmic muon tracks used to study light yield over 5 years of detector runs [2]
- Calibration of light yield applied and incorporated into contribution to systematic uncertainties
- Has allowed MicroBooNE's neutrino selection to not be impacted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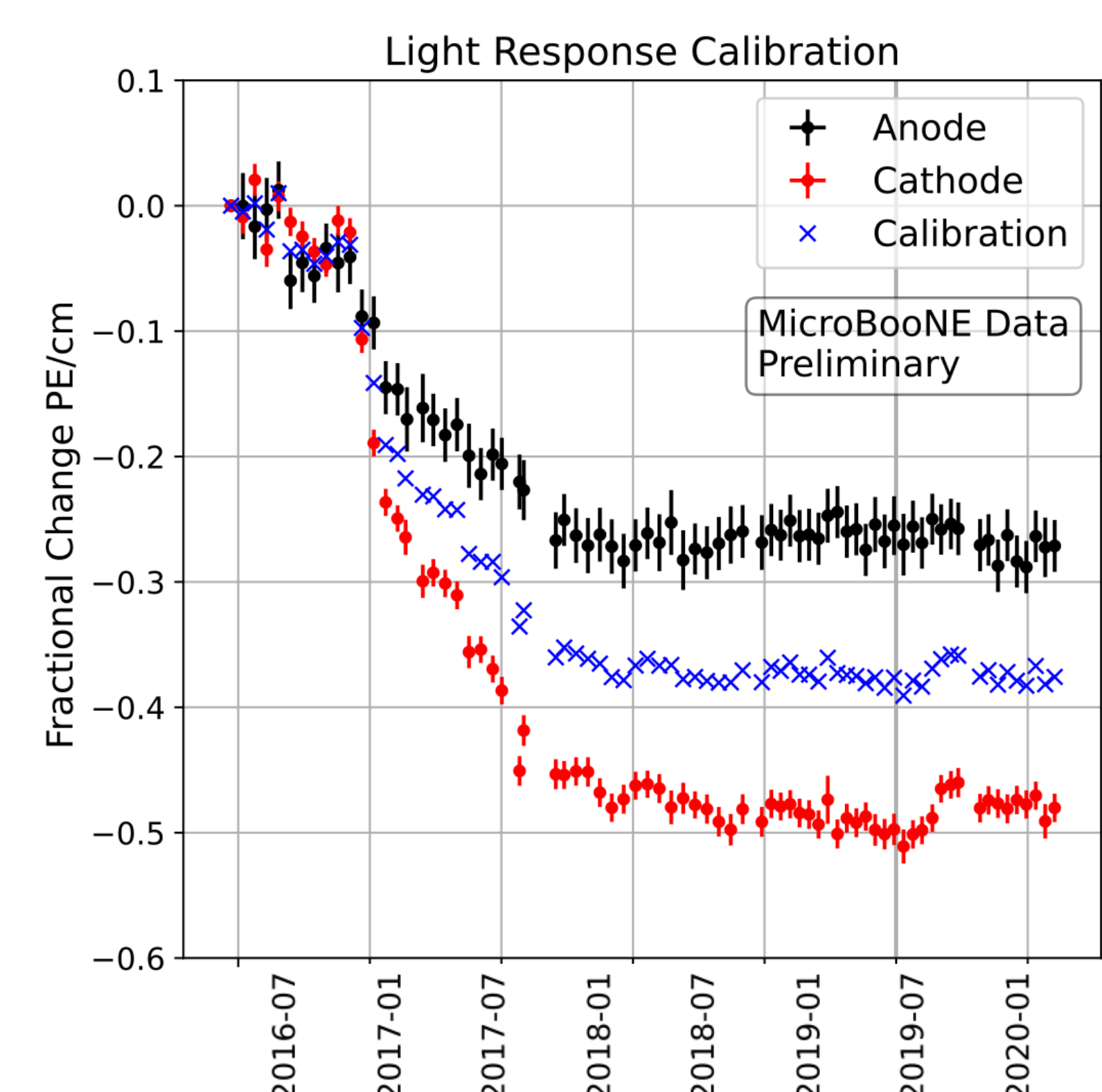

### Measuring Light Yield with Isolated Protons
- Large sample of isolated cosmic protons in off-beam data has allowed measurement of position-dependent total LY within the detector [3]
- Use semi-analytical light model to simulate visibility map [4]
- Confirms LY decline seen in calibration studies, and that it is position independent
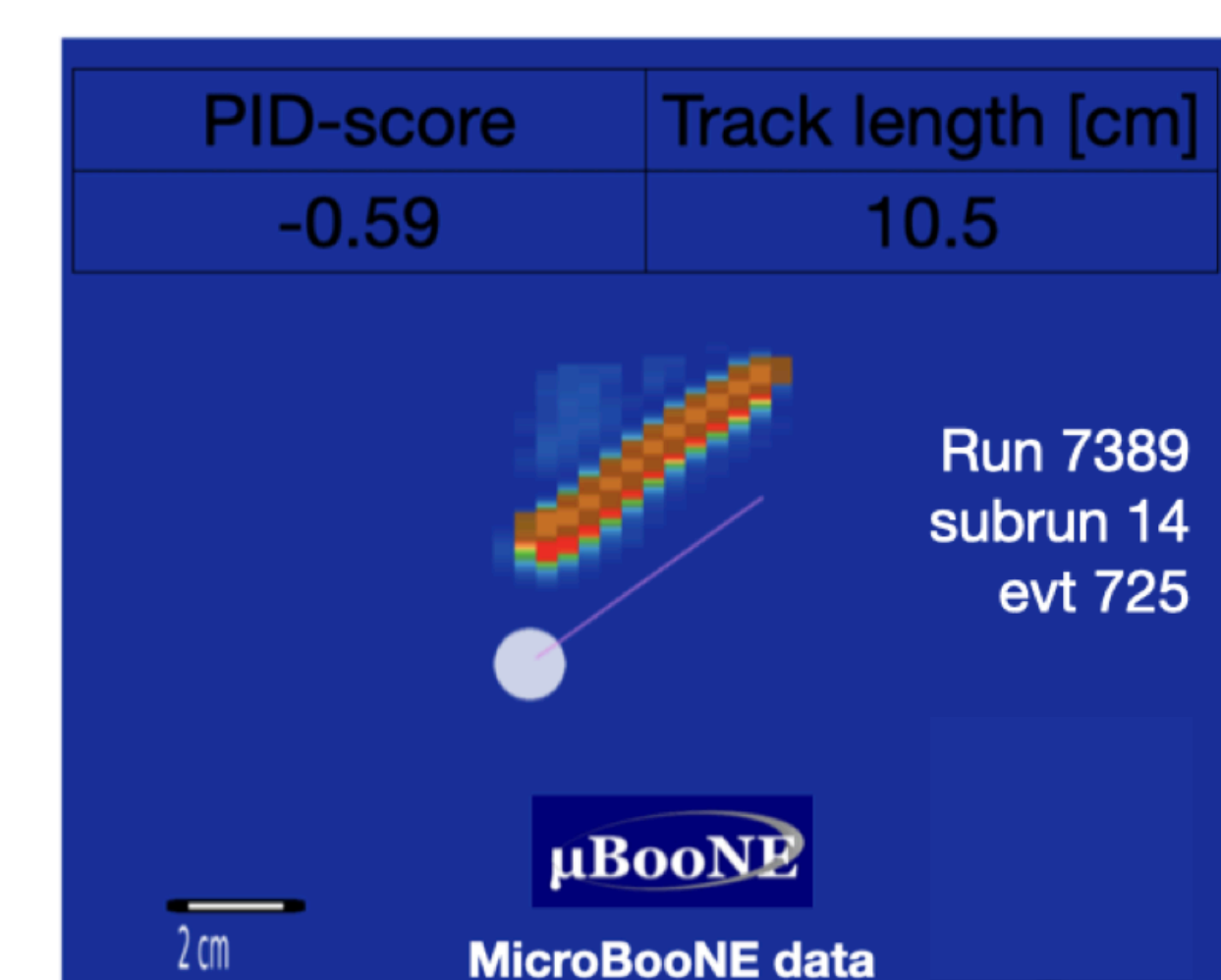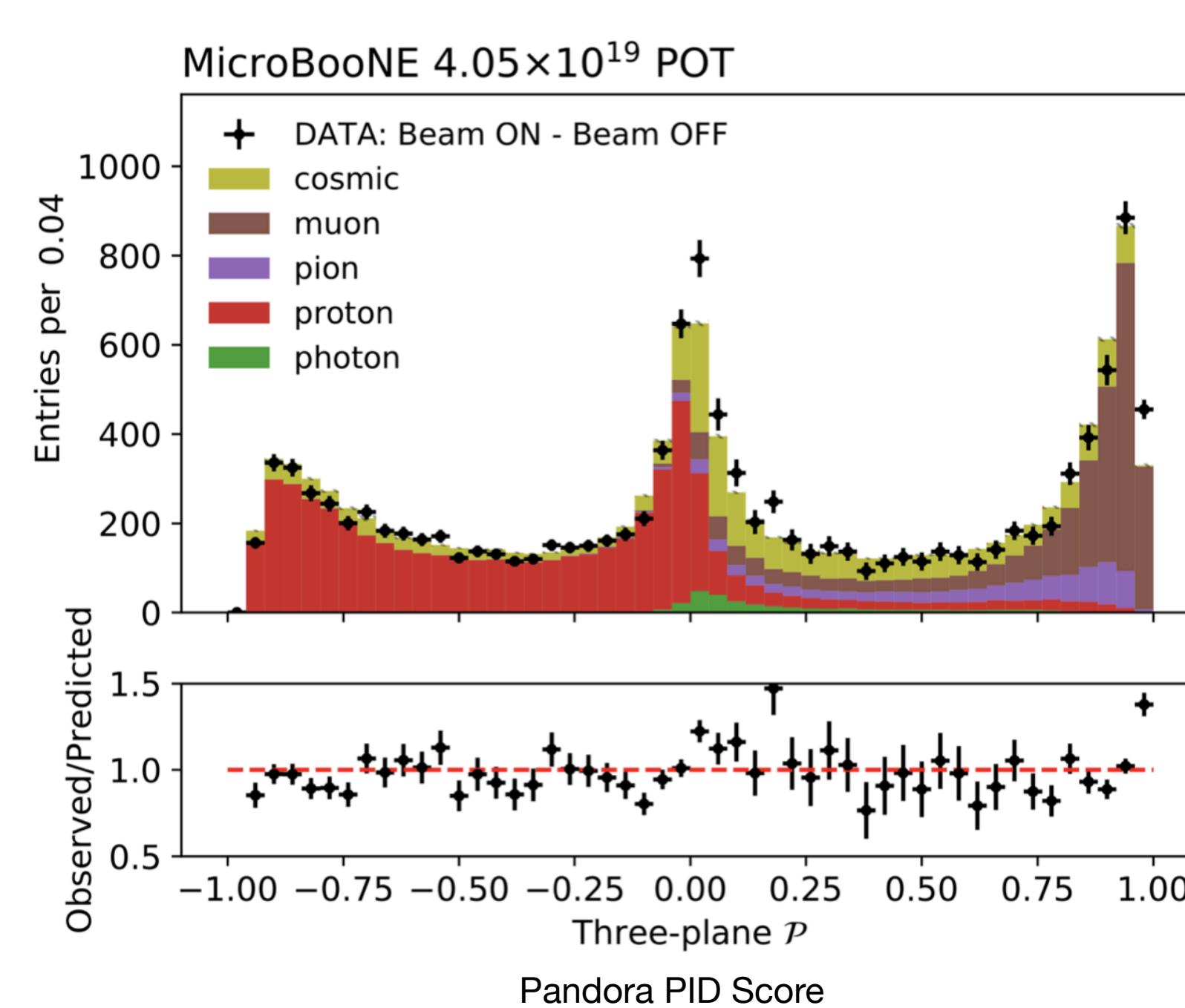
PID-score	Track length [cm]
-0.59	10.5

Run 7389 subrun 14 evt 725
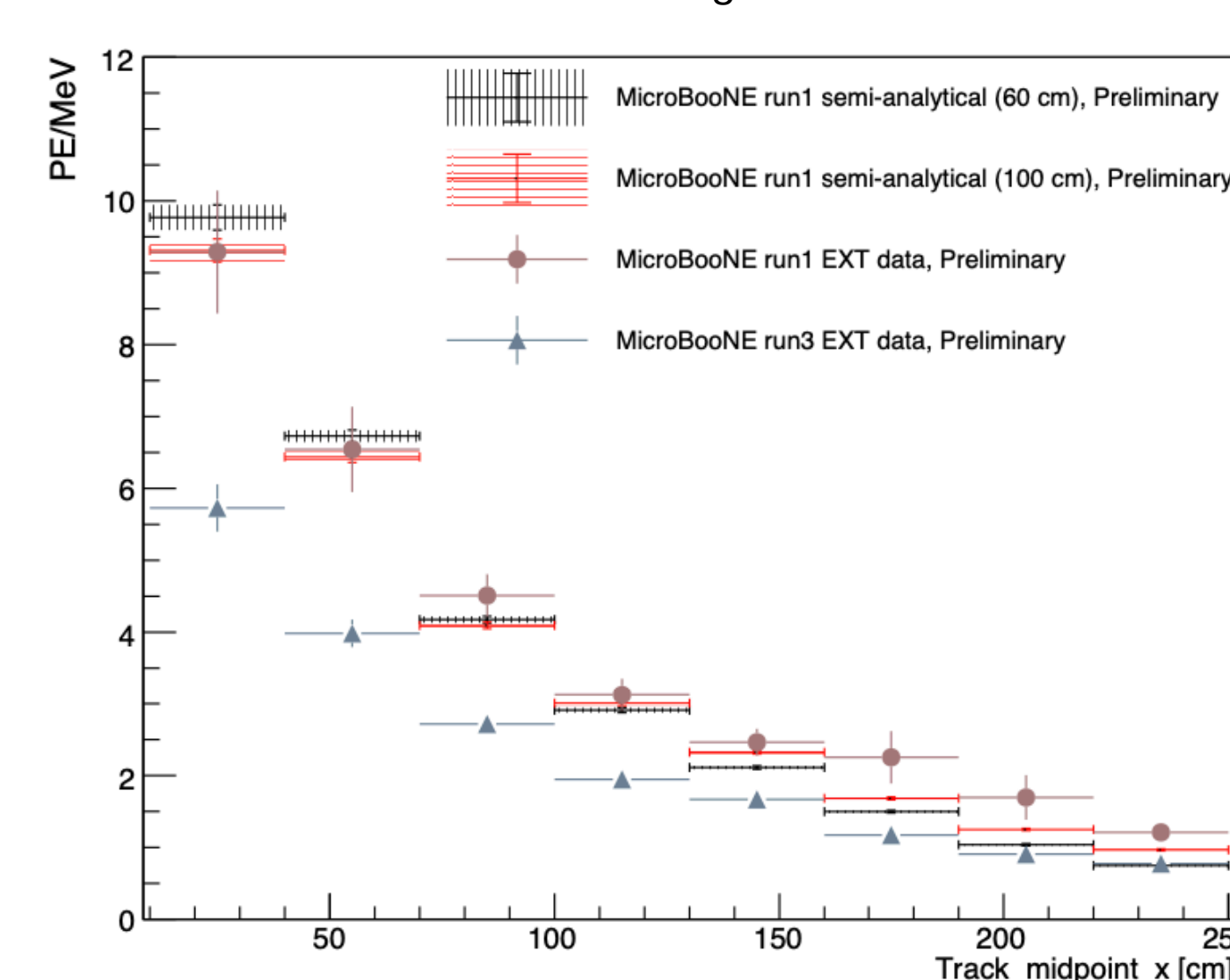
μBooNE MicroBooNE data
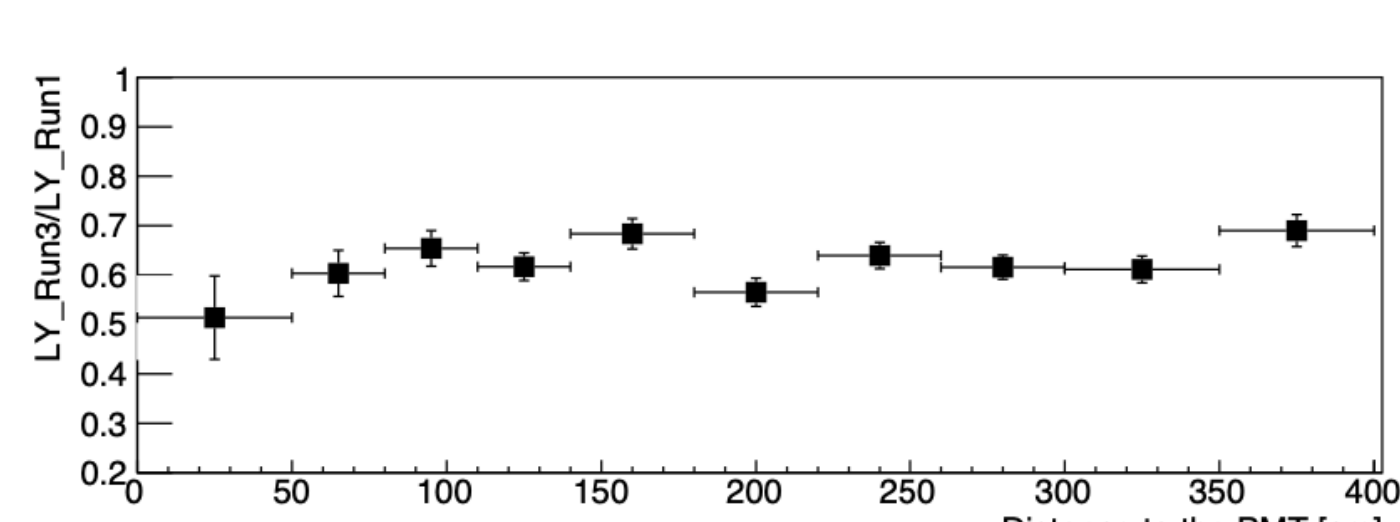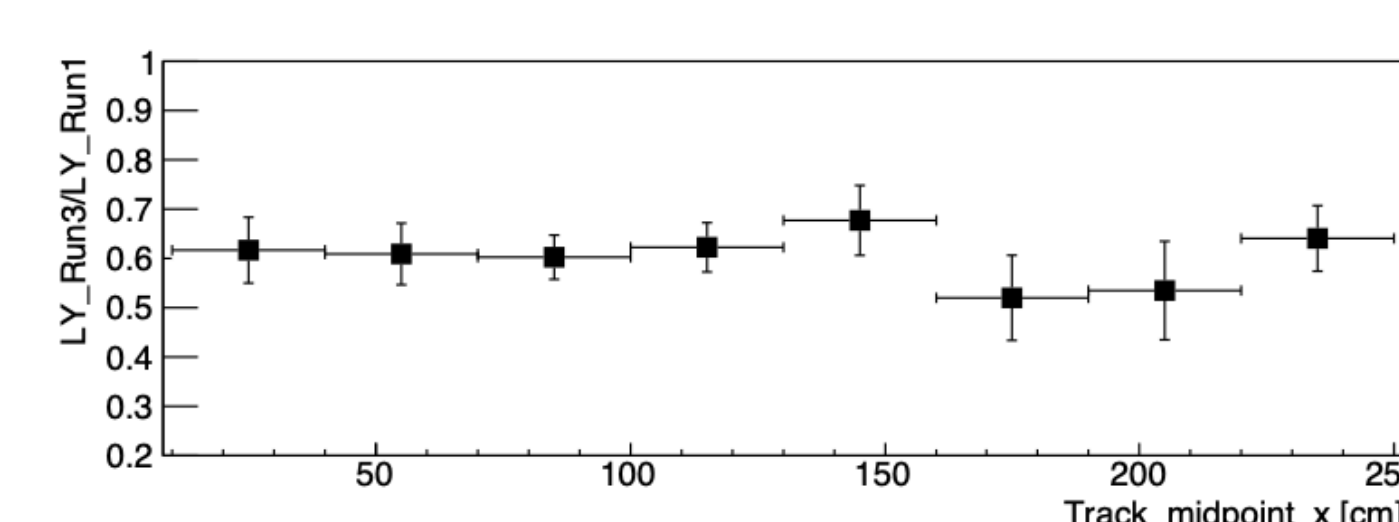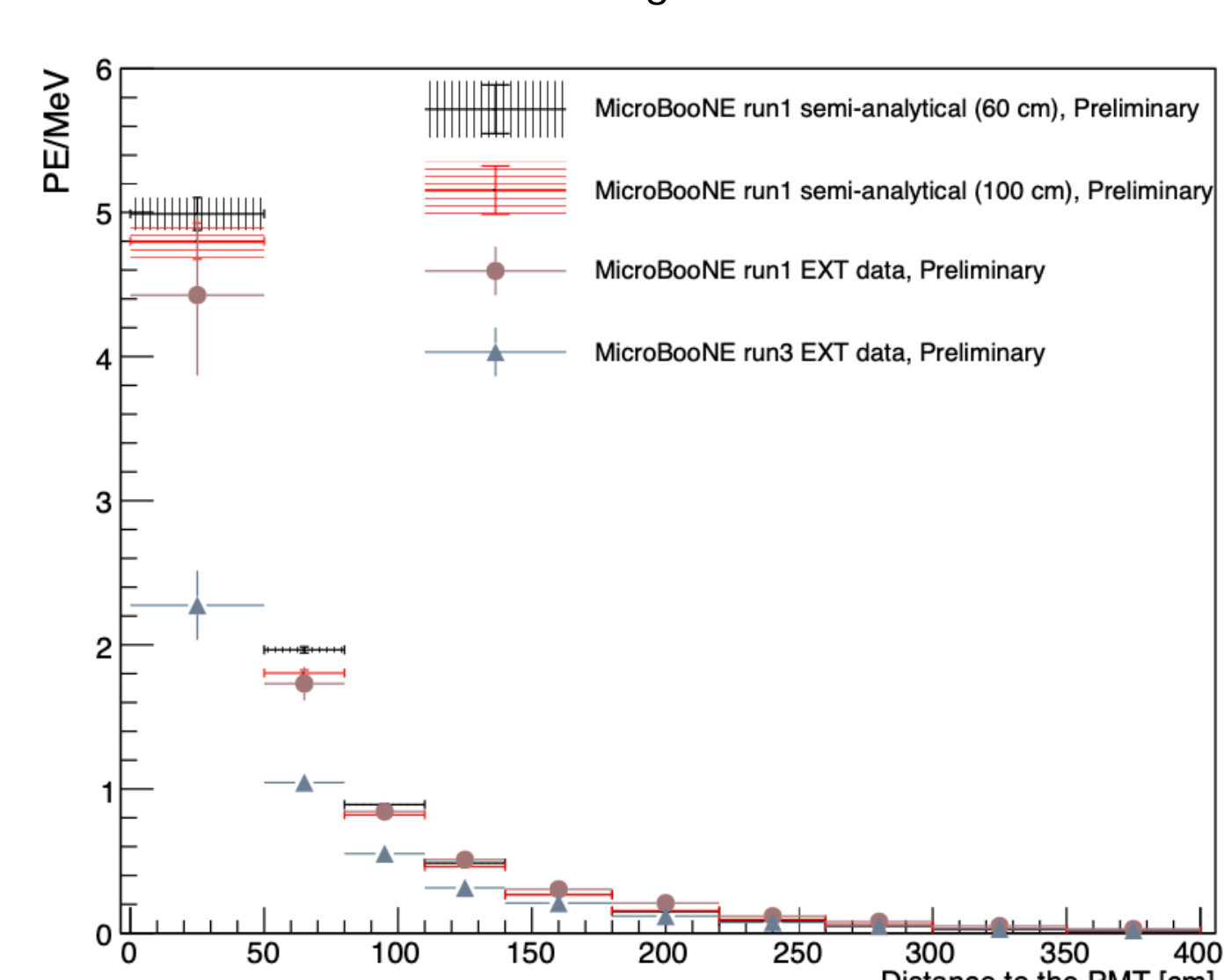
- MicroBooNE has several data-informed studies of light behavior over time
- Calibrations implemented to account for observed behavior
- Future plans include using MicroBooNE data to inform a visibility map and study out-of-detector light behavior

[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