

MOTIVATION FOR MUSE



Conflicting proton radius measurements

- Since 2010, conflicting proton radius measurements found for different electron/muon-based methods \rightarrow proton radius puzzle¹
- Muon Scattering Experiment (MUSE) aims to shed more light on this puzzle
 - Comparing simultaneous electron-proton/muon-proton scattering¹

MUSE'S CALORIMETER



Rendering of MUSE's detector system¹

- MUSE calorimeter (CALO): 8x8 grid of lead-glass bars
- Gives beam energy info, helps with higher-order radiative corrections in cross-section data²
- MUSE taking data over 3 years \rightarrow monitoring stability/functionality of detectors over time is crucial
- · Here, examining stability of MUSE's calorimeter in particular

BH-CALO TIME ALIGNMENT

- · Beam hodoscope (BH) tracks beam particle identification and timing
- Electron time of flight (TOF) between BH and CALO is known to be ~6.6 ns
- Little variation between momenta
- Using previously calibrated TOF parameters from BH to calibrate and test CALO TOF alignment
- BH TOF calibrated for +160 and +210 MeV/c
- New BH-CALO TOF parameters calibrated with a +160 run; tested for several +160 and +210 runs from 2024 data

ENERGY DEPOSIT

- Energy deposit over different beam rates and two trigger types (standard and pulser)
- Looking for effects of events with second beam particles on CALO data
- For -115 MeV/c, energy deposit consistent across beam rates for each trigger type
- Central four CALO bars examined
- Pedestal peaks broader and shifted left at higher rates



Energy deposit curves for two CALO bars



Pedestal peak shifts

REFERENCES

- 1. E. Cline et al., "MUSE: The MUon Scattering Experiment," doi: 10.21468/SciPostPhysProc.5.023 (2021).
- 2. W. Lin et al., "The MUSE Beamline Calorimeter," arXiv:2408.13380 [physics.ins-det] (2024).



- Updating original analysis for 2024 data, after repairs to central CALO bars • Original Gaussian fits to data have resolution falloff at higher momenta
- Improvements: fit peaks with sum of Gaussian and Landau curves; rebinned histograms and widened ranges
 - Tested and working on 2023 data also
- To be implemented in MUSE's GEANT4 simulation



Gaussian + Landau fits



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Edep bar (3, 4), -115 MeV/c runs (BAW_ODC)



CALO bar

grid layout

48 49 50 51 52 53 54 55

56 57 58 59 60 61 62 63