Initial Electron Lifetime and dE/dx Studies at Bern SingleCube Run

Alex Flesher, Lane Kashur, Michael Mooney

Colorado State University

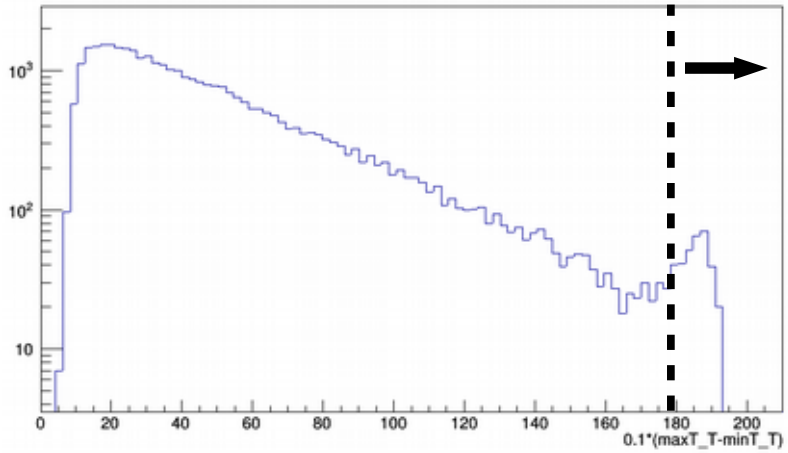
ND-LAr Consortium Meeting

October 29th, 2020

Introduction

- Goals of these studies:
  - Give a preliminary understanding of energy (charge) scale and purity level in Bern SingleCube Run → data quality
  - Inform data-taking modality for SingleCube running – do we need to change the way we take data (e.g. length of runs, ASIC settings)?
  - Develop calibration tools that can be used by others throughout Bern SingleCube run and at other SingleCube tests (e.g. CSU, UTA)
- Very pressing to understand electron lifetime in detector
  - If this is poor, would substantially impact ability to fully characterize charge readout (and possibly light readout)
  - May need to take quick action (spoiler: things look **great** so far)
- Brief overview of tools and preliminary results in these slides
  - Tools will be exercised by Lane and Alex during their shifts for the Bern SingleCube run

Methodology



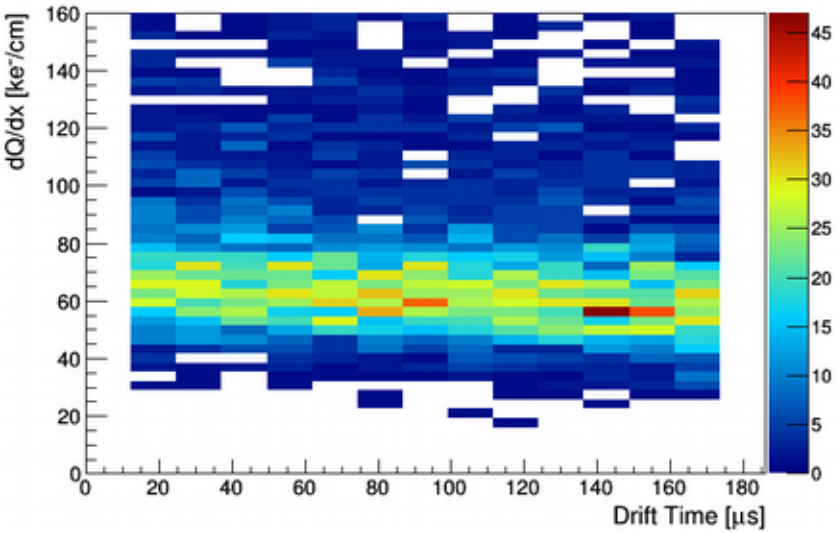
~10 A-C-crossing tracks/minute

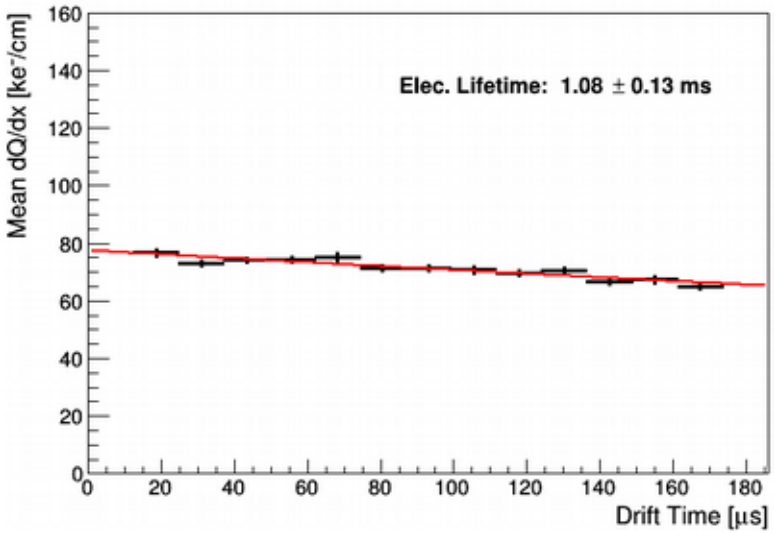
Ideal run:
30 min.
(~300 tracks)

- Basic steps of workflow:
  - Download h5 file from Bern to laptop (by hand for now)
  - Convert h5 file to ROOT file using python script
  - Run "TrackMaker" C++/ROOT program to produce clustered tracks, clustered in 3D using DBSCAN, with hit x/y/z/charge info
  - Run "PurityStudy" C++/ROOT program to select **anode-cathode-crossing tracks** via maximum drift time cut (~180 μs), measure electron lifetime by fitting to dQ/dx vs. drift time, and measure dE/dx via electronics gain, recombination correction, and electron lifetime corrections

First Electron Lifetime Results

File: datalog_2020_10_28_22_41_18_CET_.h5

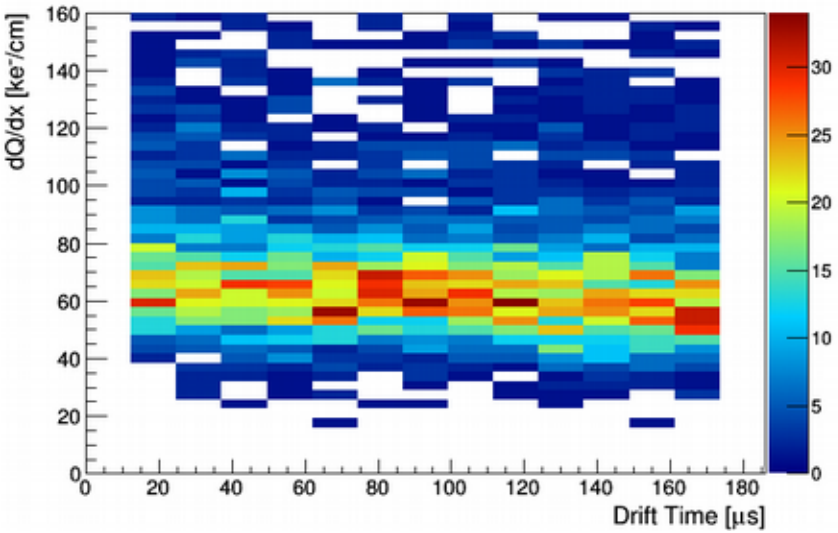


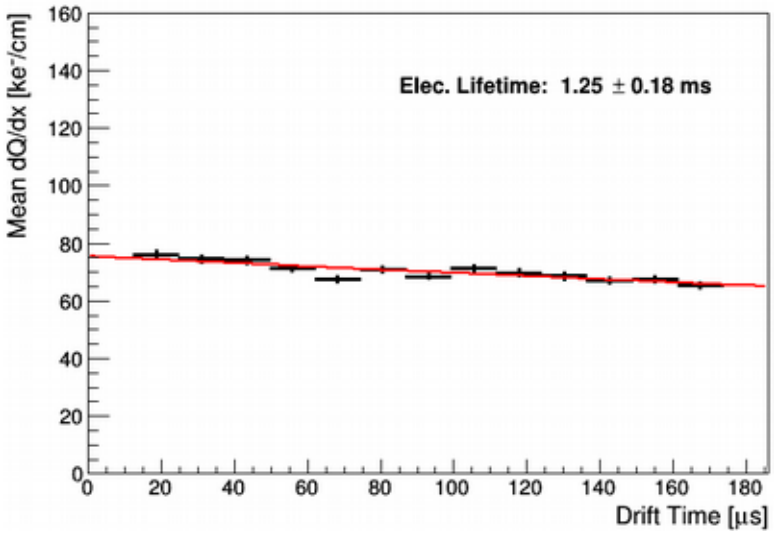


- First find pedestal using dedicated run: ~78 ADCs
  - Taking as uniform across detector for now
- Assume constant electronics gain for now
  - Should obtain per-channel measurements using pulser?
- dQ/dx = 0.250 ke⁻/mV × 3.9 mV/ADC × (Q [ADCs] – 78) / (Δx [cm])
- First electron lifetime results close to **1 ms** – looking good!

First Electron Lifetime Results

File: datalog_2020_10_28_23_41_19_CET_.h5

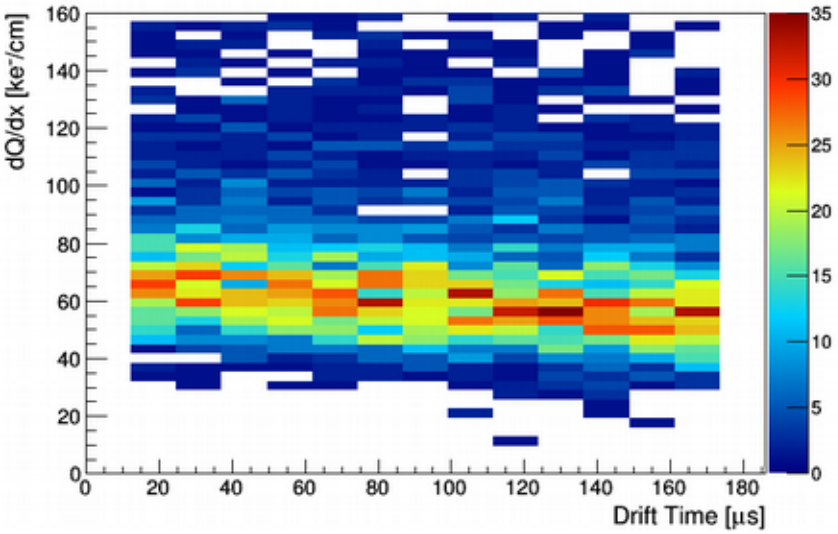


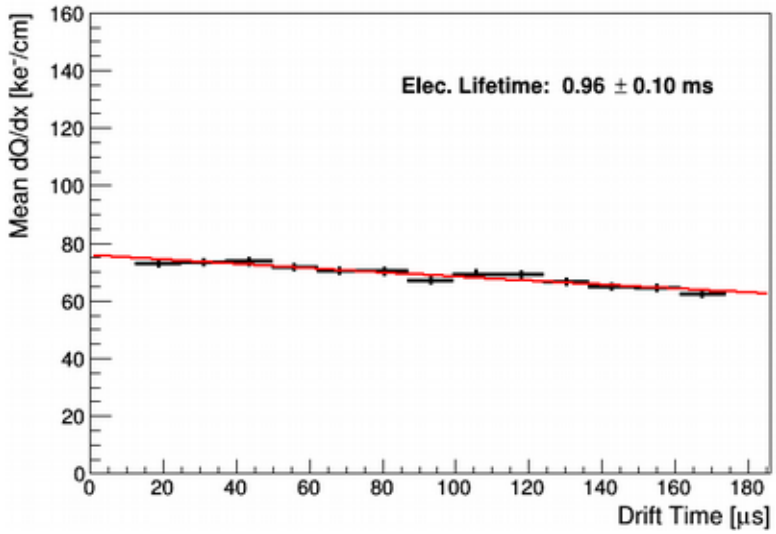


- First find pedestal using dedicated run: ~78 ADCs
  - Taking as uniform across detector for now
- Assume constant electronics gain for now
  - Should obtain per-channel measurements using pulser?
- $dQ/dx = 0.250\ ke^-/mV \times 3.9\ mV/ADC \times (Q\ [ADCs] - 78) / (\Delta x\ [cm])$
- First electron lifetime results close to **1 ms** – looking good!

First Electron Lifetime Results

File: datalog_2020_10_29_08_17_11_CET_.h5

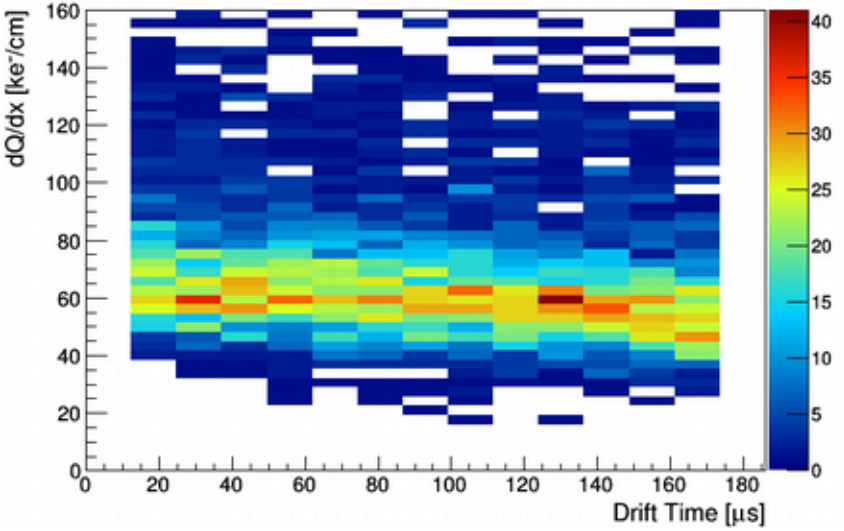


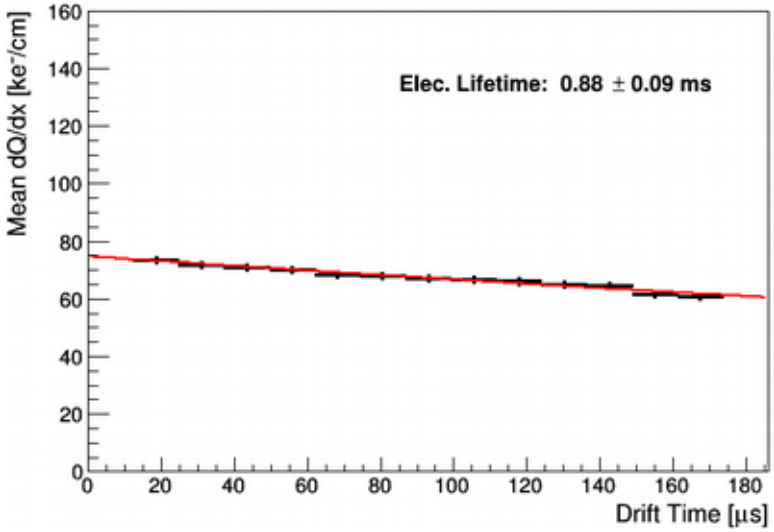


- First find pedestal using dedicated run: ~78 ADCs
  - Taking as uniform across detector for now
- Assume constant electronics gain for now
  - Should obtain per-channel measurements using pulser?
- $dQ/dx = 0.250\ ke^-/mV \times 3.9\ mV/ADC \times (Q\ [ADCs] - 78) / (\Delta x\ [cm])$
- First electron lifetime results close to **1 ms** – looking good!

First Electron Lifetime Results

File: datalog_2020_10_29_10_38_24_CET_.h5

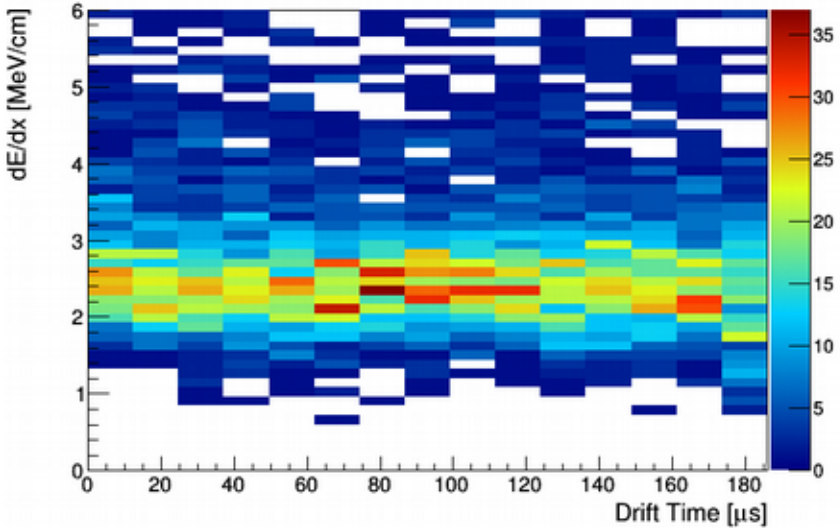


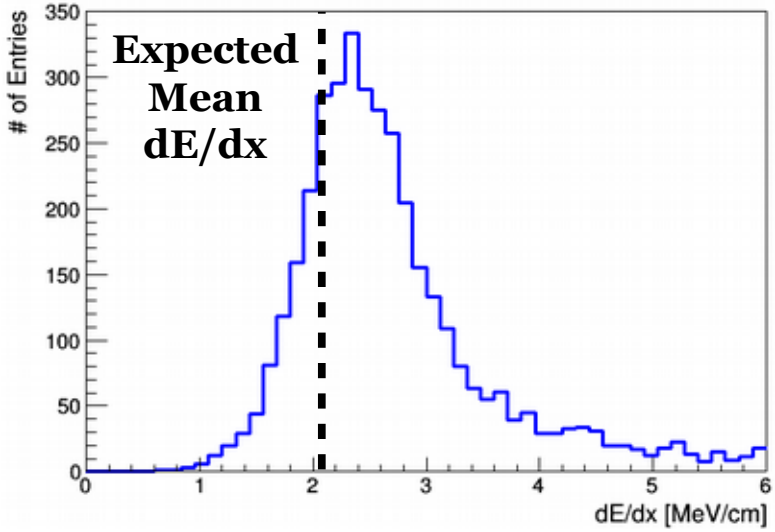


- First find pedestal using dedicated run: ~78 ADCs
  - Taking as uniform across detector for now
- Assume constant electronics gain for now
  - Should obtain per-channel measurements using pulser?
- $dQ/dx = 0.250\ ke^-/mV \times 3.9\ mV/ADC \times (Q\ [ADCs] - 78) / (\Delta x\ [cm])$
- First electron lifetime results close to **1 ms** – looking good!

First dE/dx Results

File: datalog_2020_10_28_23_41_19_CET_.h5

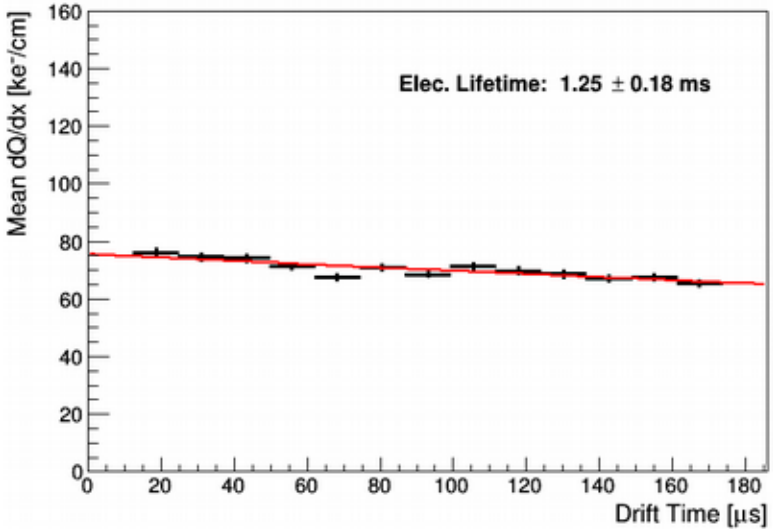


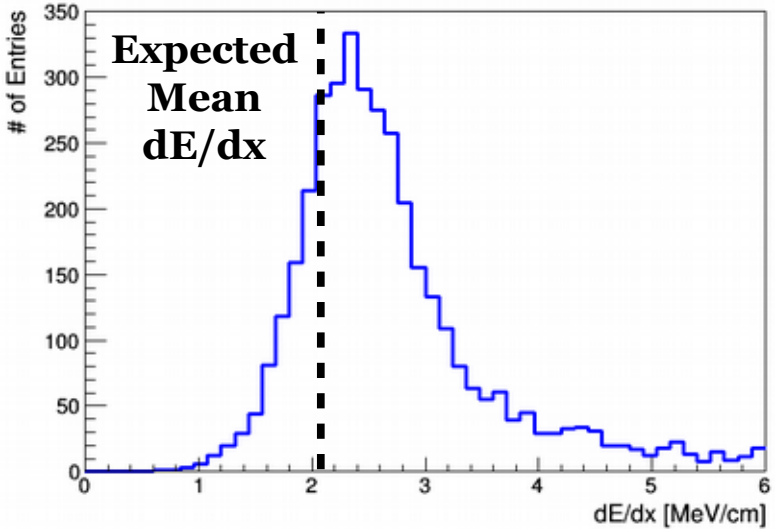


- $dE/dx = (23.6\times10^{-3}\ \text{MeV/ke}^- \times e^{\Delta t/\tau} / 0.66) \times dQ/dx\ [\text{ke}^-/\text{cm}]$
- Ignore first and last bins in Δt for 1D histogram of dE/dx
  - Track selection effects, or something like E field distortions?
- First dE/dx distribution looks close! However, seems to be **20-30% too high** in scale – electronics gain off?
  - Also can measure dE/dx resolution → do this next

Summary

File: datalog_2020_10_28_23_41_19_CET_.h5





- First results shown on electron lifetime and dE/dx at SingleCube run at Bern
  - Electron lifetime is great! Roughly **1 ms** (need > 300 μs)
  - dE/dx looks good, but scale is **20-30% too high** → electronics gain likely needs tuning using pulser data
  - Request: **30-minute runs** best for this analysis
- Will work today to publish tools for use by all (via GitHub)

BACKUP SLIDES

Pedestal Distribution