Making Electron Lifetime Measurements with the CRT with Data

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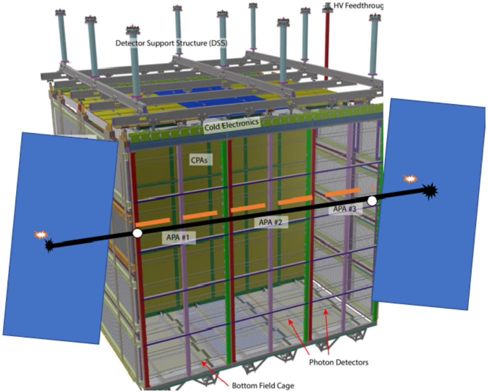
Advantages to using a CRT

- Get a T0 and a track. We can do SCE tracking calibrations on-the-fly with the CRT track.
- Tracks parallel to the z; therefore, not moving significantly towards the wire plane.
- Another method to measuring the electron lifetime along with the purity monitors and crossing tracks.

Matching Methodology

- Match using US AND DS (two CRT).
- Minimize Δx and Δy between TPC's predicted CRT hit and the reco CRT hit.



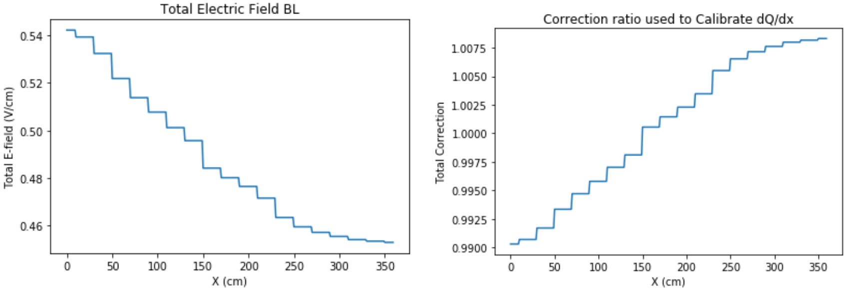
Example of CRT (black) and TPC (orange) track analysis. The white "hits" represent predictions we could make comparing the two tracks.

Measuring lifetime using the CRT

1. Match a track between TPC and CRT. Check to see how parallel to the wire plan it is in z and t0-correct the track hit time.
2. We need areas well-known in z to do the CRT tracking calibration; therefore, we select areas, stolen from Ajib, Lisa, and Tianle, of 230<z<460 cm and 200<y<400 cm. We then use the straight line from the CRT as a truth track for positions in x and y as a function of z.
3. Calculate Q from the integral of a hit on the collection plane. dQ/dx is calculated from the wire pitch and track direction:
   - $dQ/dx = \frac{Q}{\frac{4.867\ mm}{dir_z}}$
4. Calibrate dQ/dx based on electric field by multiplying a correction coefficient of nom/meas dQ/dx using recombination. Find the electric field using CRT trackpoints.
5. Fit slices in 100 us to a Landau-Gauss and then make a MPV vs. track time plot to measure the lifetime.

Calibration Calculations

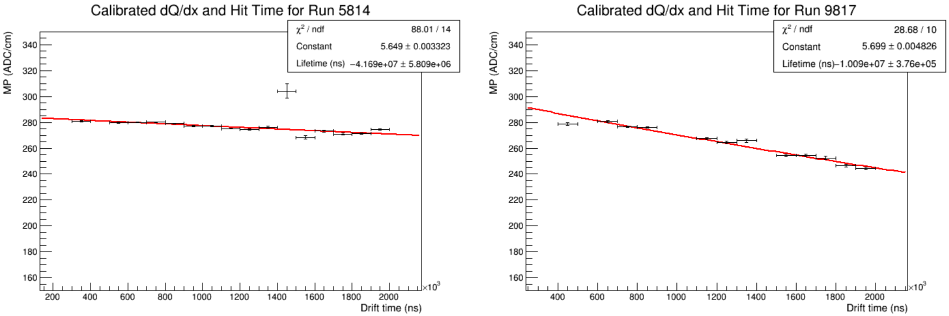
Plotting at (y,z)=(200 cm, 350 cm)



Electric field BL (left) and dQ/dx calibration (right) as a function of distance.

Electron lifetime with two different purities

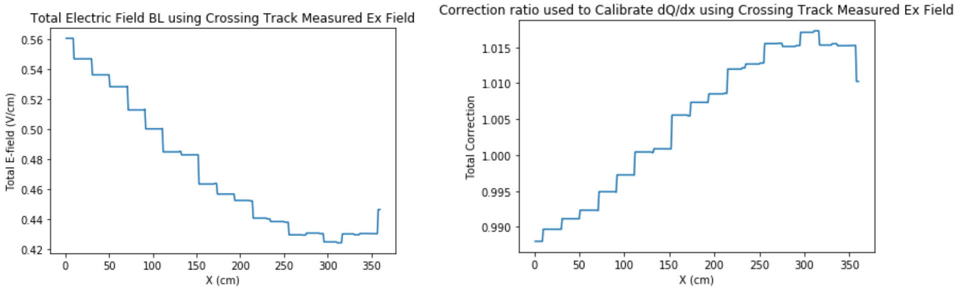
Run 5814 the purity monitors read high and run 9817 the purity monitors read low.



Run 5814 (left) and run 9817 (right)

More Calibration Calculations

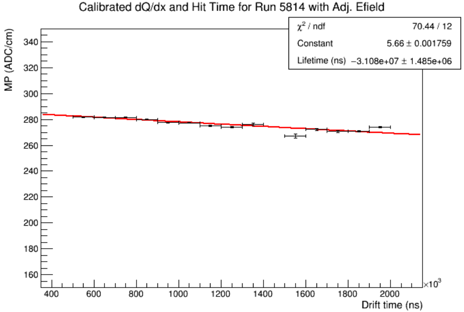
Tinale Liu and Ajib made a histogram using crossing-tracks to measure Ex directly. How does that impact measurements if we use their Ex and Mike's Ey and Ez?

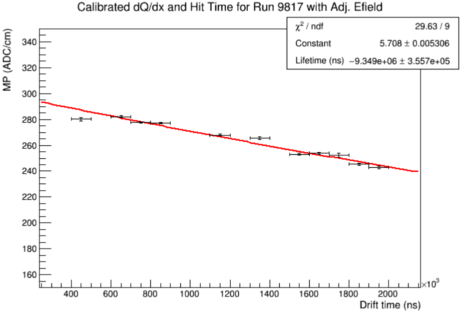


Electric field BL (left) and dQ/dx calibration (right) as a function of distance using an adjusted electric field.

Electron lifetime with adjusted electric field calibrations

Run 5814 the purity monitors read high and run 9817 the purity monitors read low.

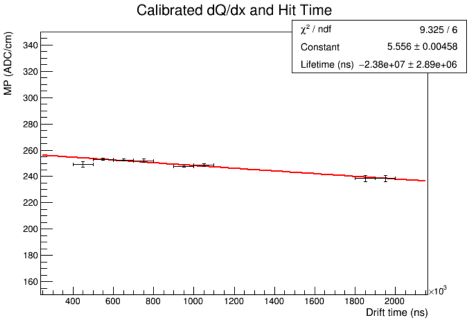


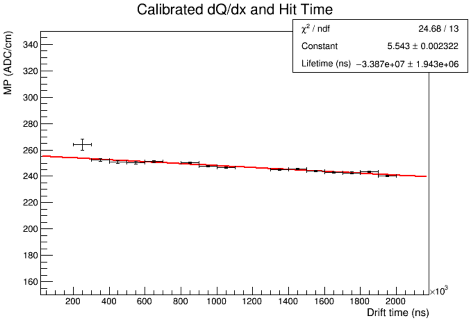


Run 5814 (left) and run 9817 (right)

MCC Electron Lifetime Measurements

Fit: dQ/dx=exp([0]+t/[1])
MCC samples has 35 ms as the input lifetime.

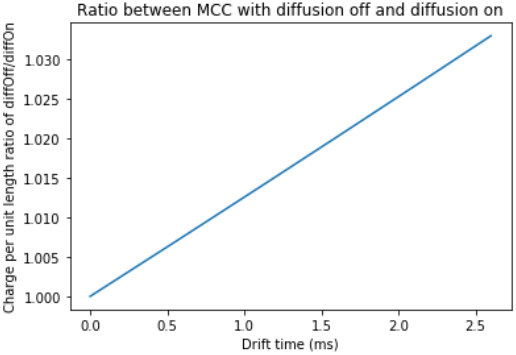




Lifetime in MCC with SCE simulated and calibrated (right) and MCC with no SCE and no diffusion simulated.

MCC Diffusion Measurements

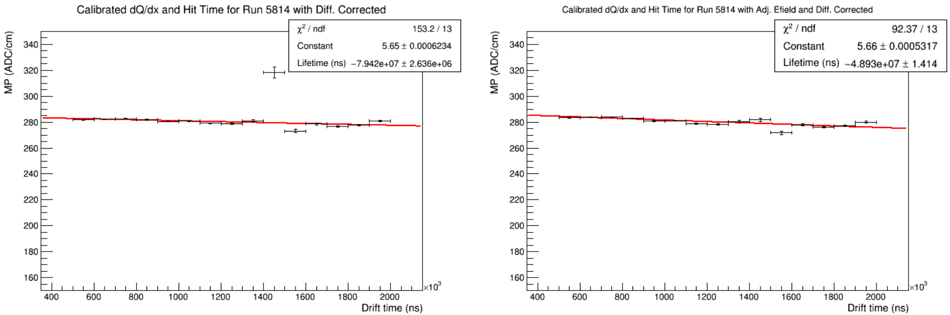
Can measure the impact of diffusion by looking at the ratio between the two MCC samples. (Note: MCC with SCE calibrated gives the same lifetime as MCC with no SCE and diffusion simulated)



Ratio of diffusion on and diffusion off fits in MCC used to estimate the impact of diffusion.

Electron lifetime with “diffusion corrected”

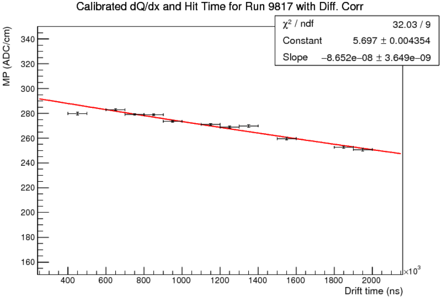
Fit: dQ/dx=exp([0]+t/[1])

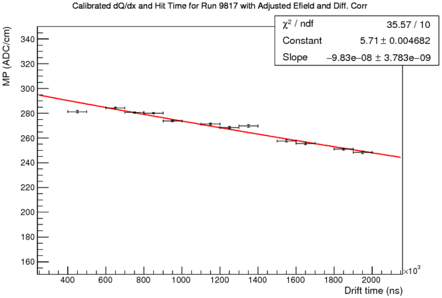


Run 5814 with diffusion “corrected” using base SCE electric field correction (left) and the adjusted electric field correction (right).

Electron lifetime with "diffusion corrected"

Note: For this run and setting, I had to use a different fit (the conversion to ms is in the next slide).
For this, I used y=exp([0]+[1]*x)





Run 9817 with diffusion "corrected" using base SCE electric field correction (left) and the adjusted electric field correction (right).

Table of Lifetimes

Lifetime (ms)	Run 5814	Run 9817
Default Efield Map	41.6	10.1
Default Map with Diff "Corr"	79.4	11.22
Adj. Efield Map	31.1	9.35
Ajd. Map with Diff "Corr"	48.9	10.2

Moving Forward

- Currently working on processing HV runs to see the lifetime as a function of electric field.
- Moving towards validating all elements of the analysis chain and coming up with summary results from these fits.
- Open to suggestions (I did not forget about yours from last time Stephen :)).
- The overall goal is to give each possible beam run with a CRT-measured lifetime.