260L LAr System Purity Demonstration Run Preliminary Results

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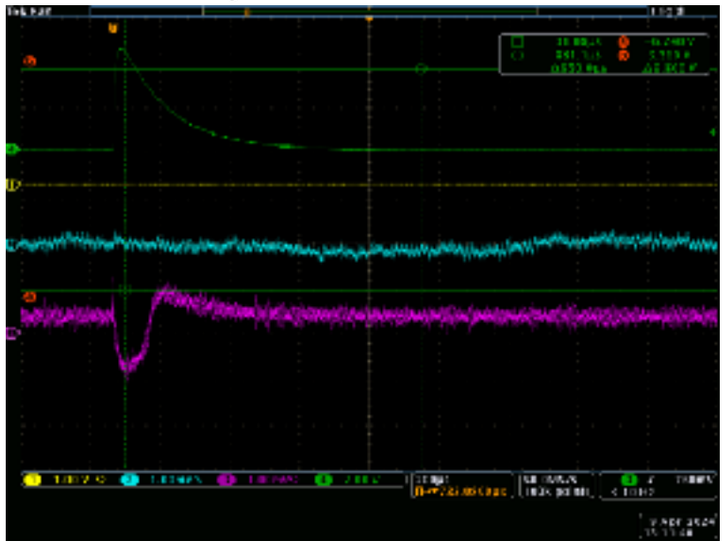
4/16/24

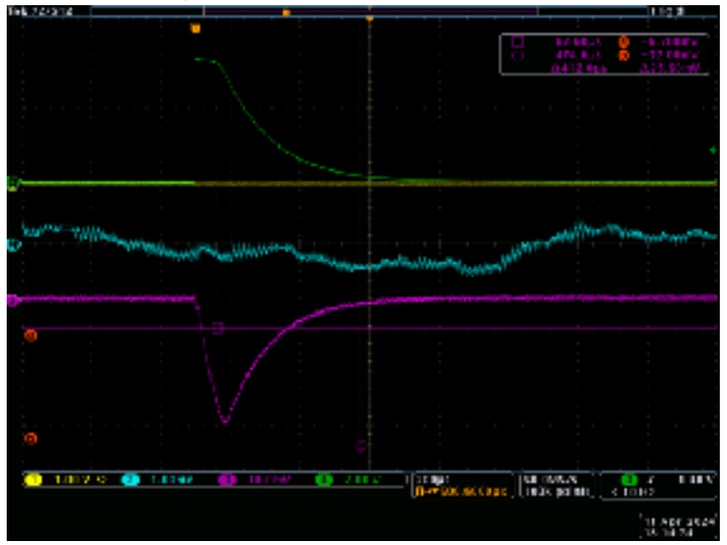
Lab Safety and Space Management

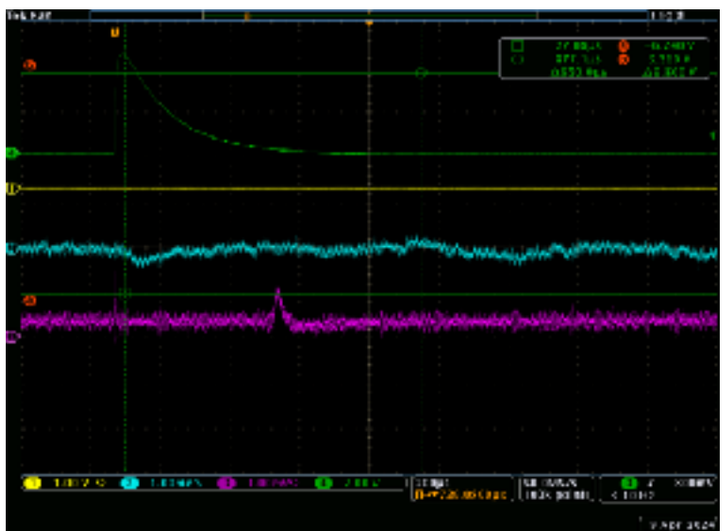
- HighBay roof leak
  - No leaks las week
  - Tent overhead protected the setup
- ECP monthly meeting last Friday
  - Missed the meeting due to Wire-Cell Workshop

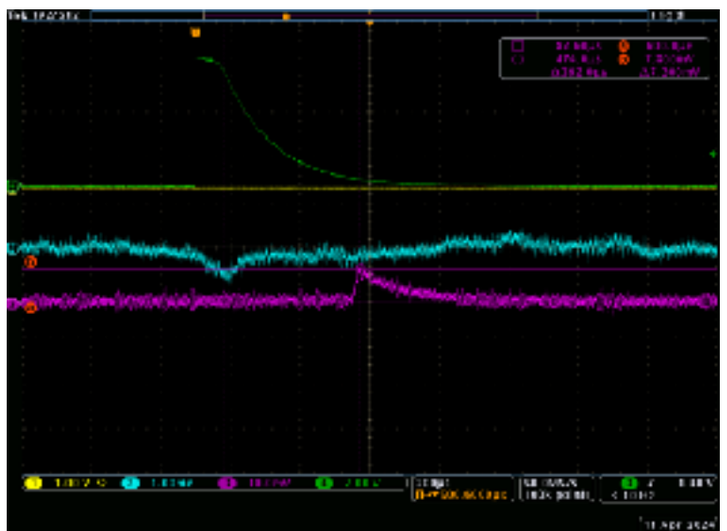
PrM Readings

- **PrM performance in LAr**
  - No signal observed right after fill and the day after fill
  - Started to observe anode signal on day 5
  - The strange shape problem was resolved with Wenjie's help
  - The noisy CH1 problem was not resolved
  - Currently taken data on the same CH2 separately





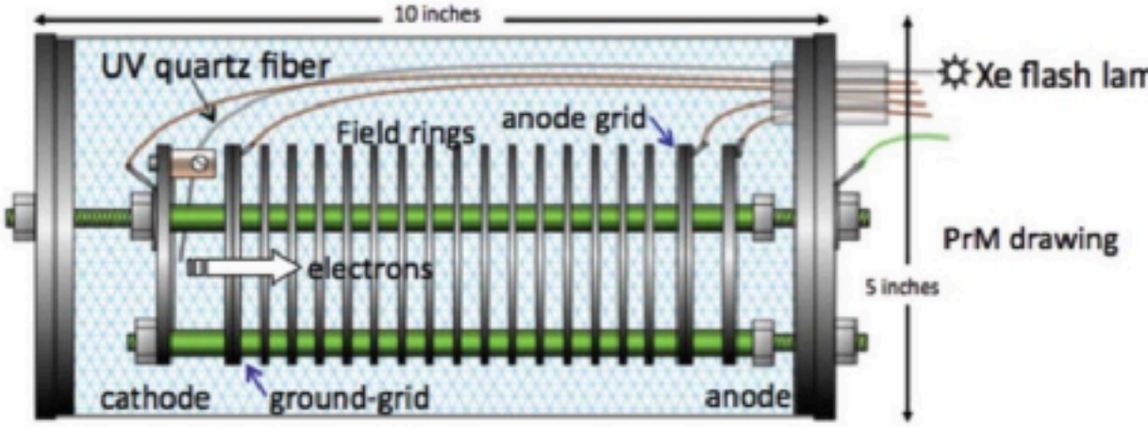




Purity Monitor

- Purity monitor (PrM): Miniature TPC measuring drifting electron lifetime with photoelectrons.
- UV from Xenon flash lamp to generate photoelectrons on PrM gold photocathode
- Use anode-to-cathode charge ratio to measure drift electron lifetime:

$$Q_{anode}/Q_{cathode} = e^{-t_{drift}/\tau}$$



M. Adamowski et al., JINST 9, P07005 (2014).

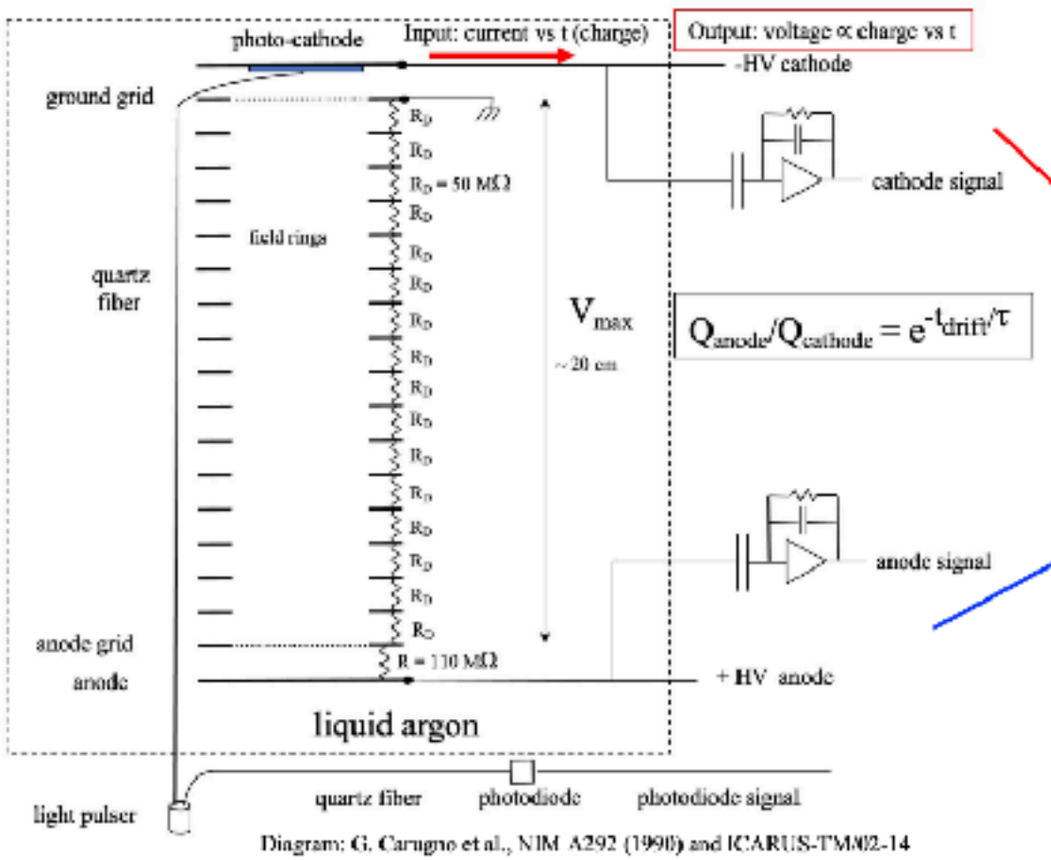
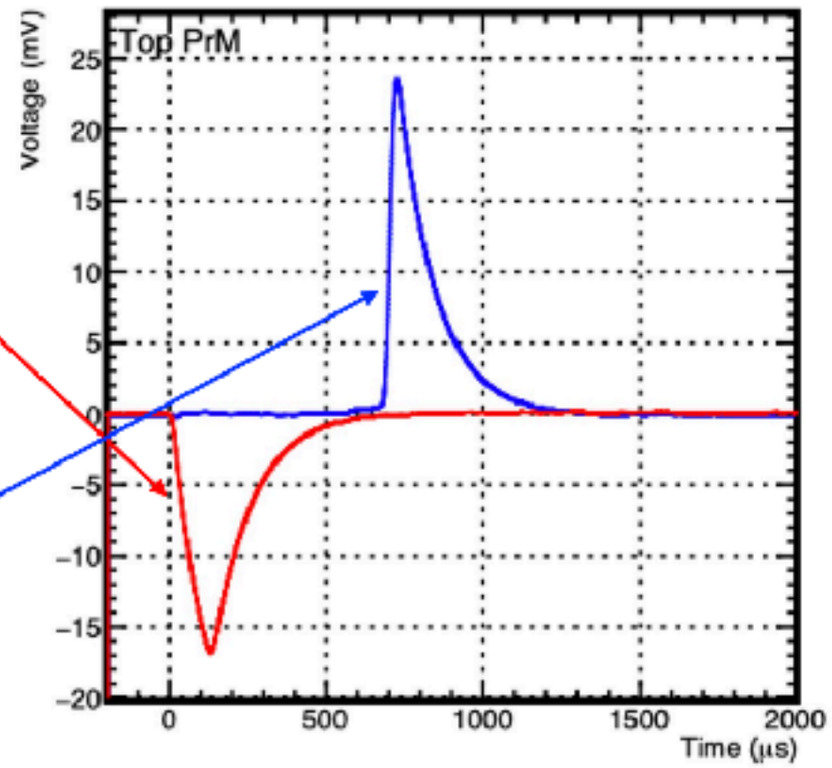


Diagram: G. Carugno et al., NIM A292 (1990) and ICARUS-TM#2-14

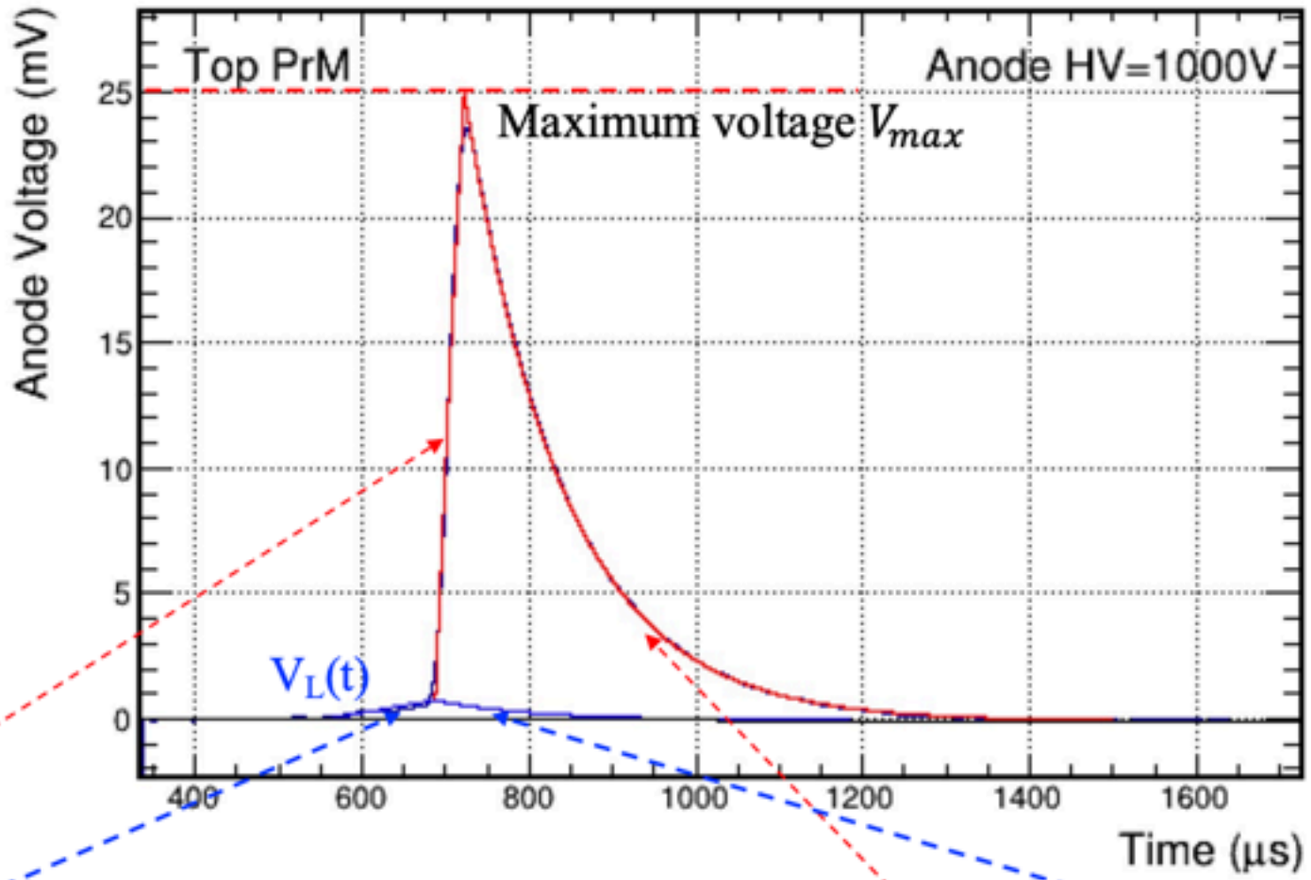


Purity monitor Cathode and anode signals in ProtoDUNE-SP

From Jianming Bian

Fit to precisely measure V_0 and charge

- Fit to baseline subtracted waveform with the signal waveform equation
- Parameterize induced current on anode due to inefficiency of anode-grid
- Fit for t_{rise}, t_{start},V_0
- Fix RC to average values measured at different HVs
- Free linear baseline function
- Fit very well to waveform data



Rising Edge: t<=trise

$$V_{rise}(t) = V_0 \frac{1-\exp(-t/RC)}{t/RC} + V_L(t)$$

Falling edge: t>trise

$$V_{fall}(t) = V_{max} \exp(-\frac{t-t_{rise}}{RC}) + V_L(t)$$

$$V_{max} = V_{rise}(t_{rise})$$

t = Time - t_{start}

$V_L(t)$ - Extra voltage caused by induced current:

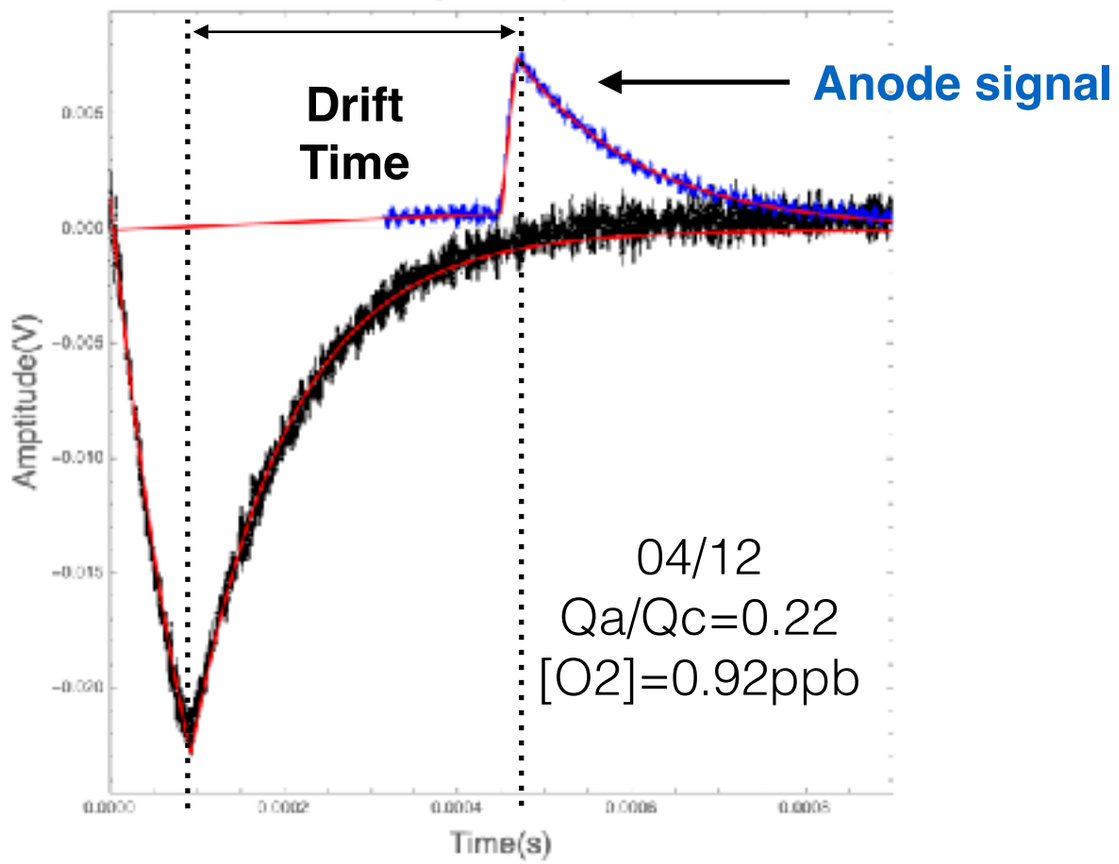
Anode t<0: $V_L(t) = a \cdot t$, t>0: $V_L(t) = V_{L0} \exp(-\frac{t-t_{rise}}{RC})$

Cathode $V_L(t)$=0

From Jianming Bian

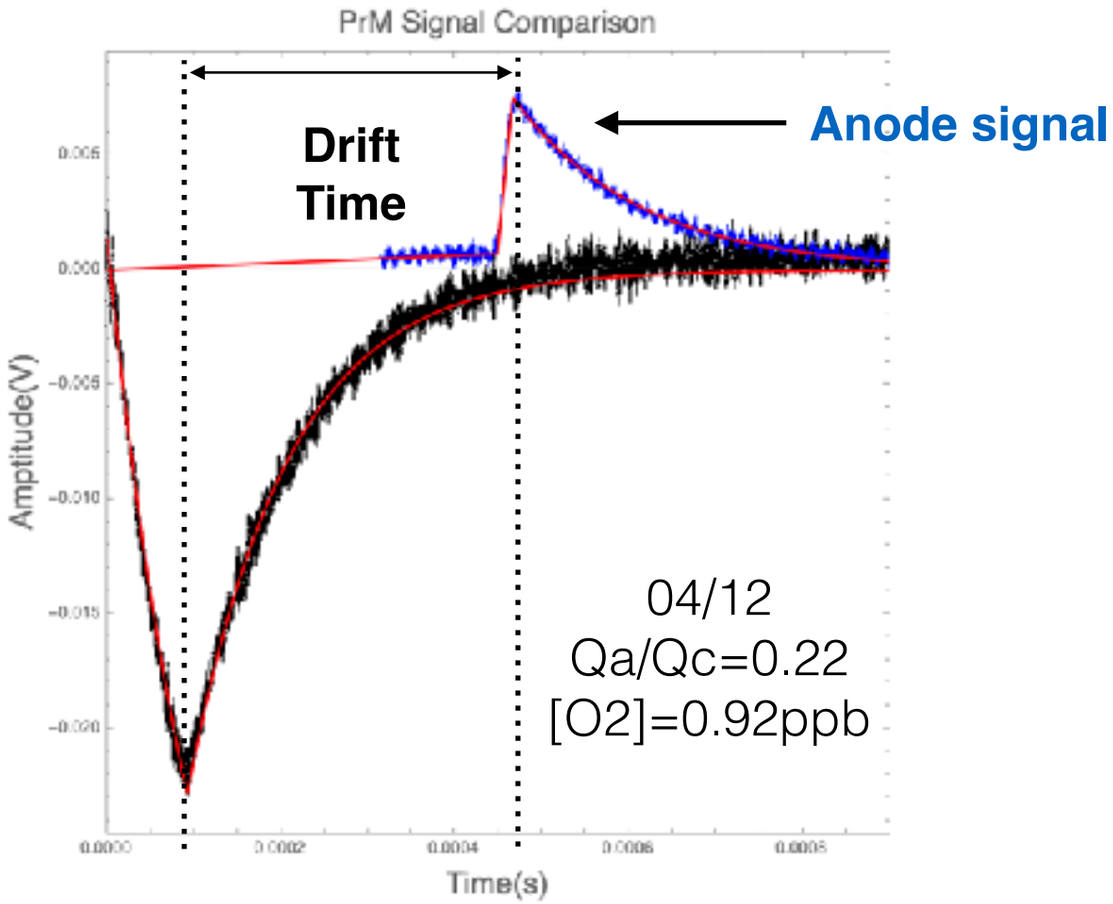
260L LAr System Purity Performance Preliminary Results

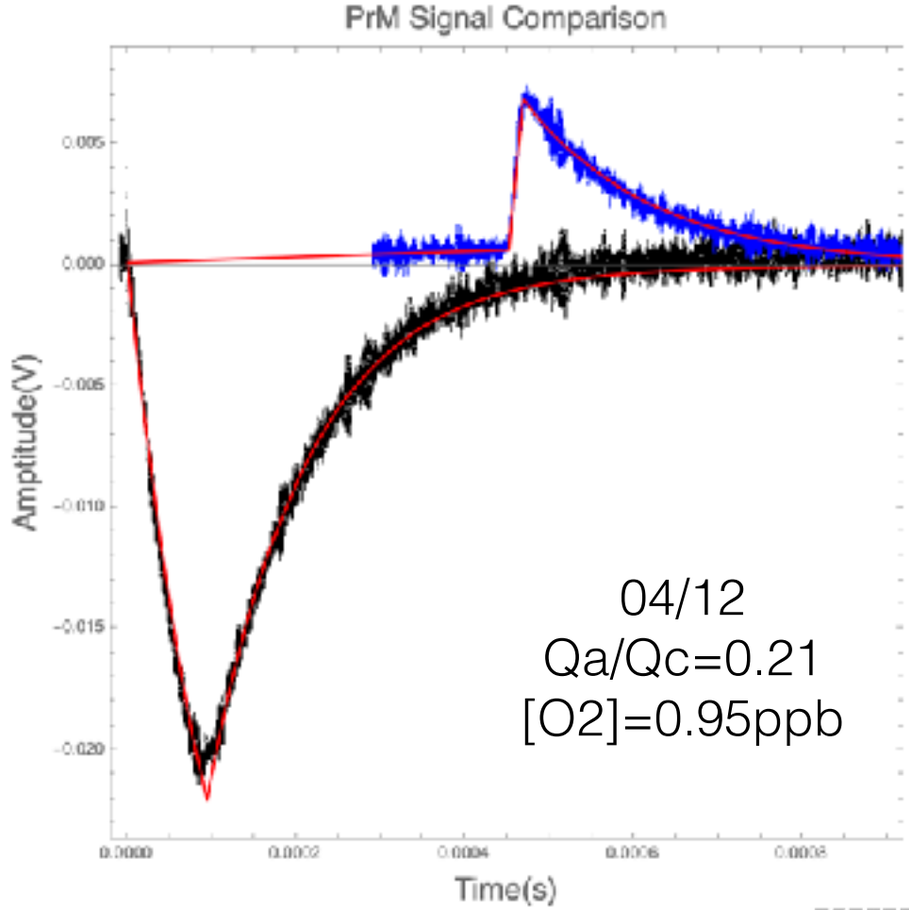
- **Purity Performance**
  - The data was fit to extract the V_0
  - Fit well with data
  - The estimated purity is ~0.90 ppb with electron lifetime ~ 0.3 ms at 500V/cm, ~0.5 meter drift distance, sufficient for physics measurement



260L LAr System Purity Performance Preliminary Results

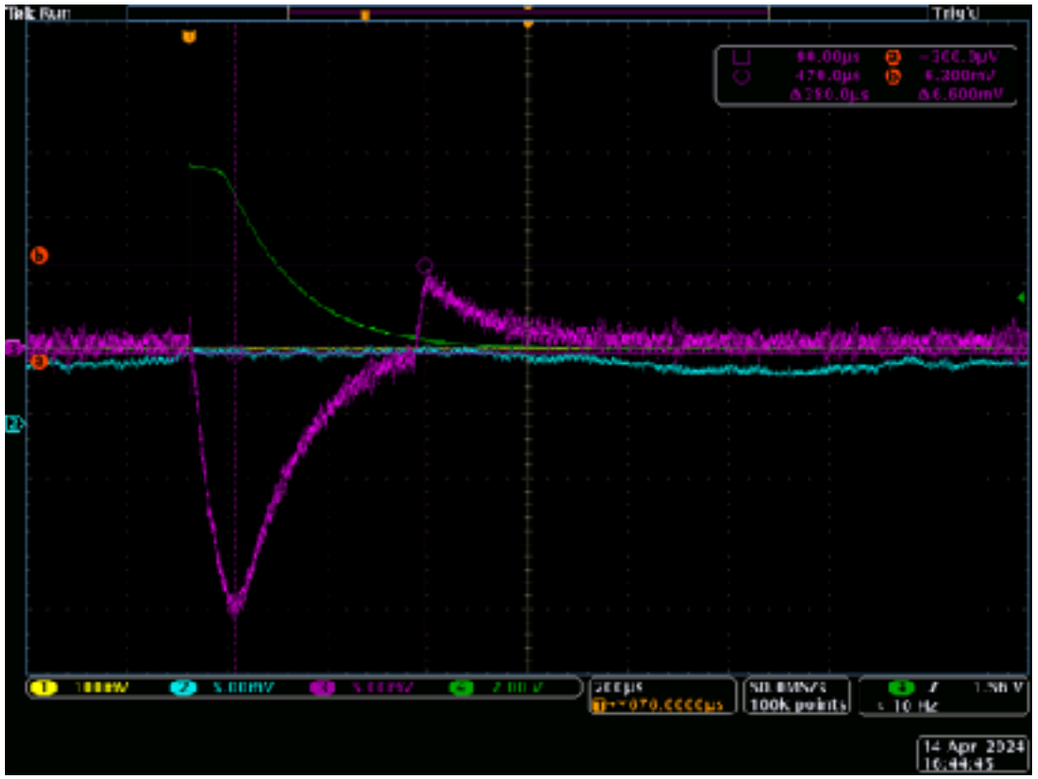
- **Problems with data taken separately**
  - The signal amplitude of the Xenon lamp has fluctuations
  - Data were taken separately, contains large errors
  - Need to take anode and cathode data on the same trigger to extract accurate lifetime

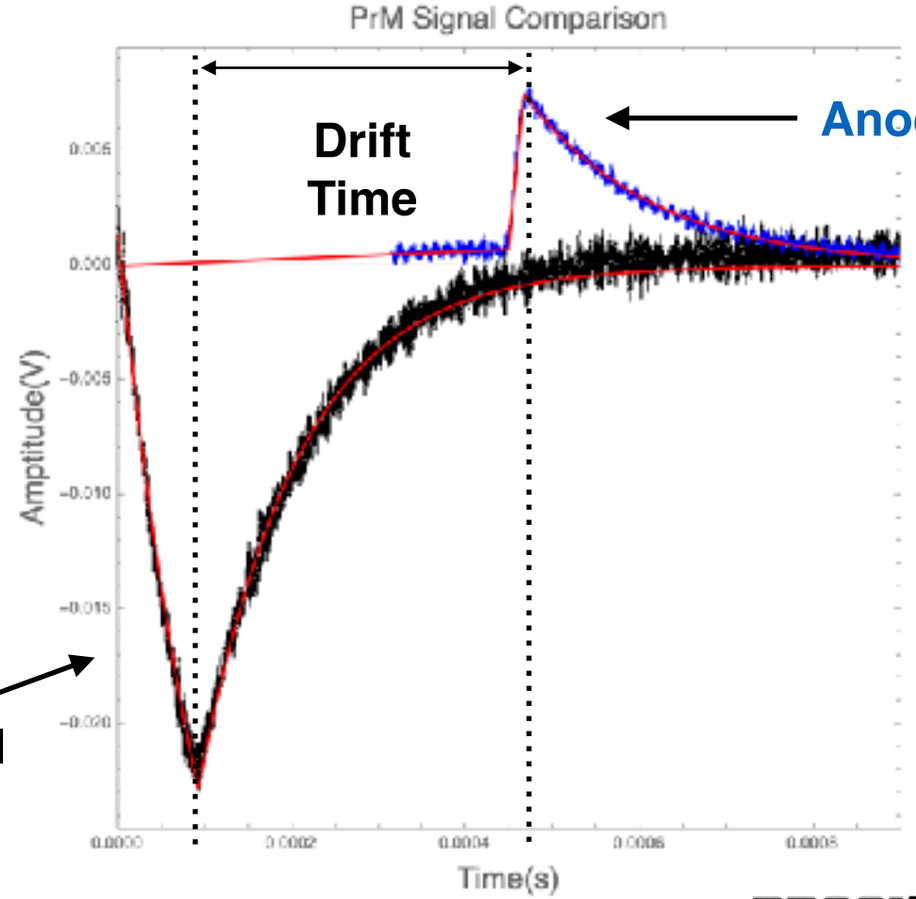




260L LAr System Purity Performance Preliminary Results

- **Possible approaches**
  - Feed both anode and cathode signal into the same CH2
  - The tail of cathode signal overlap with anode signal
  - The direct peak value can be a direct observation of lifetime
  - Trying to make a fit function
  - Contacting Jianming for swapping for another electronics box





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260L LAr System Plan

- Continue the running for several months
  - Currently need LN2 change for every 24 hours
- Keep PrM data taking twice a day
- Plan for technical meeting in the future for lab details
- Prepare a short paper on the system
- I will be on vacation 04/25-04/30, Lingyun agrees to change LN2 supply during the period of time