

Purity Monitor Systematics

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October 9, 2013

Updated Oct 23, 2013

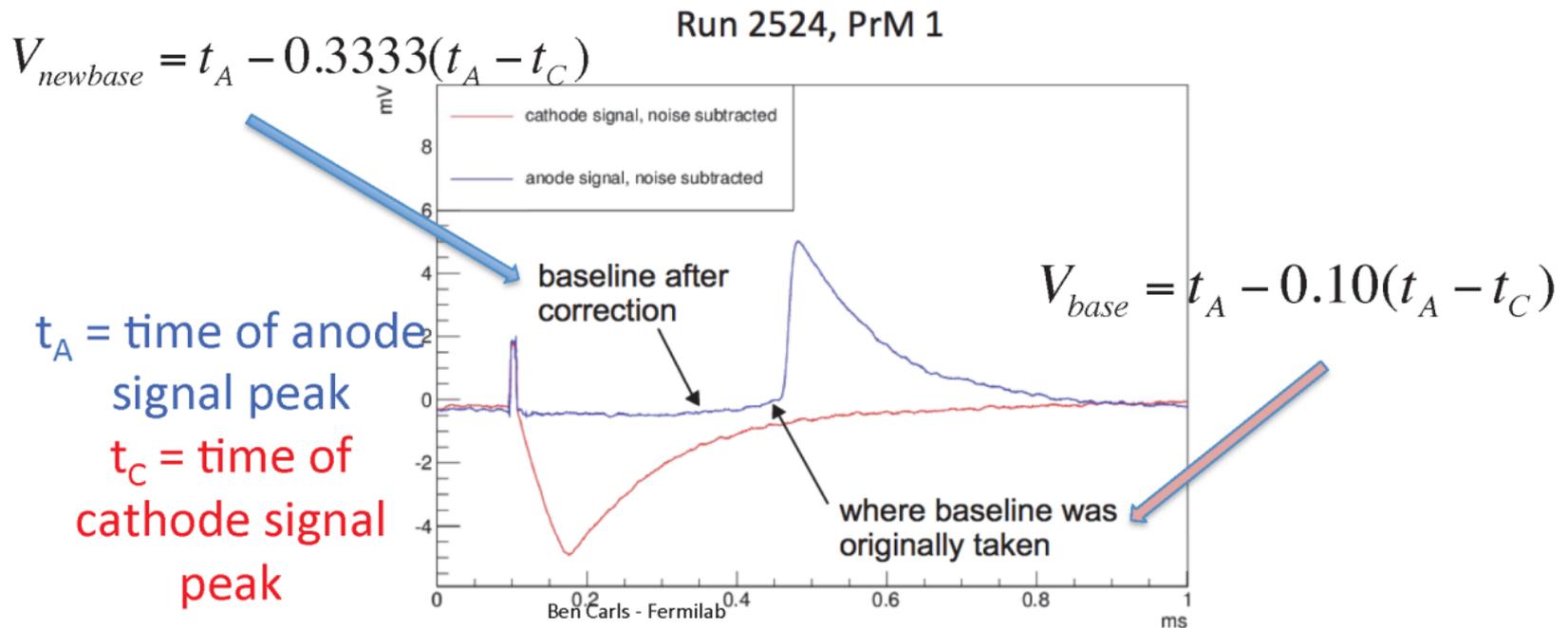
Bug fixes

- Remove factor of 1.05 in anode signal calculation.
 $f_{\text{AnoTrue}} = (f_{\text{AnoPeak}} - f_{\text{AnoBase}}) * 1.05 * f_{\text{AnoF}}$
 - Replaced by Emily's fix (next slide).
- Add factor of 1.028 ± 0.007 to Q_a/Q_c plots for amplifier gain calibration
 - was in lifetime calculation but not in Q_a/Q_c plots
 - Measured by Ben Carls, uncertainty is my guess from the difference between versions
- Runs 2311-2364 have unknown full scale range on the digitizer. Guess $\pm 2V$ from nearby data at ± 50 mV.
 - Affects only Q_a and Q_c separately, not the ratio Q_a/Q_c except its uncertainty
 - Investigating possible calibration measurement

Reminder about Emily's fix (from her LBNE presentation)

Change of Analysis - Baseline

- Determining the baselines in the signal are critical in determining the lifetime
- Reduced the amount of discrepancies in lifetime by changing the location of the baseline and averaging around that point
 - The change from 10% to 33.33% in the baseline equation was done empirically by myself and Ben Carls



Data Quality Cuts

- Remove random measurements of Q_a/Q_c where the anode trace was flat: $t_a = \text{Anode time}$ and $t_c = \text{cathode time}$ (**note that these cuts are specific to LAPD run2)
 - Vanode=2 kV: $0.36 < t_a < 0.40$ ms; $0.065 < t_c < 0.08$ ms
 - Vanode=3kV: $0.26 < t_a < 0.30$ ms; $0.05 < t_c < 0.08$ ms
 - Vanode=4kV: $0.23 < t_a < 0.25$ ms ; $0.05 < t_c < 0.08$ ms
 - Vanode=5kV: $0.21 < t_a < 0.23$ ms ; $0.05 < t_c < 0.08$ ms
- Runs with bad traces were removed by hand

One flat trace
averaged
with 9 good
ones.

Runs are
discarded.

| Tab | View | | | | | | | |
|------|--------|-------|--------|-------|--------|--------|--------|--|
| 2647 | 23.906 | 0.223 | 25.715 | 0.274 | 0.3806 | 0.0734 | 7.294 | |
| 2648 | 21.215 | 0.223 | 24.951 | 0.274 | 0.3824 | 0.0738 | 2.704 | |
| 2649 | 23.533 | 0.223 | 25.233 | 0.274 | 0.3810 | 0.0738 | 7.775 | |
| 2650 | 23.192 | 0.223 | 24.401 | 0.274 | 0.3804 | 0.0746 | 12.659 | |
| 2651 | 23.315 | 0.223 | 25.191 | 0.274 | 0.3800 | 0.0734 | 6.709 | |
| 2652 | 23.334 | 0.223 | 25.387 | 0.274 | 0.3812 | 0.0742 | 5.997 | |
| 2653 | 23.396 | 0.223 | 25.152 | 0.274 | 0.3806 | 0.0730 | 7.373 | |
| 2654 | 23.670 | 0.223 | 25.614 | 0.274 | 0.3806 | 0.0744 | 6.542 | |
| 2655 | 23.771 | 0.223 | 25.817 | 0.274 | 0.3804 | 0.0748 | 6.154 | |
| 2656 | 23.159 | 0.223 | 24.984 | 0.274 | 0.3808 | 0.0748 | 6.912 | |
| 2657 | 23.215 | 0.223 | 25.184 | 0.274 | 0.3806 | 0.0738 | 6.275 | |
| 2658 | 23.488 | 0.223 | 25.035 | 0.274 | 0.3808 | 0.0744 | 8.853 | |
| 2659 | 23.377 | 0.223 | 24.962 | 0.274 | 0.3802 | 0.0732 | 8.483 | |
| 2660 | 23.227 | 0.223 | 25.102 | 0.274 | 0.3800 | 0.0738 | 6.681 | |
| 2661 | 23.309 | 0.223 | 25.014 | 0.274 | 0.3808 | 0.0744 | 7.641 | |
| 2662 | 23.299 | 0.223 | 25.294 | 0.274 | 0.3812 | 0.0756 | 6.208 | |
| 2663 | 23.566 | 0.223 | 25.197 | 0.274 | 0.3810 | 0.0744 | 8.254 | |
| 2664 | 21.200 | 0.223 | 24.938 | 0.274 | 0.3810 | 0.0738 | 2.690 | |
| 2665 | 23.268 | 0.223 | 25.373 | 0.274 | 0.3810 | 0.0740 | 5.785 | |
| 2666 | 23.421 | 0.223 | 25.267 | 0.274 | 0.3810 | 0.0742 | 6.913 | |
| 2667 | 23.147 | 0.223 | 25.370 | 0.274 | 0.3806 | 0.0738 | 5.365 | |
| 2668 | 23.183 | 0.223 | 24.955 | 0.274 | 0.3806 | 0.0746 | 7.199 | |
| 2669 | 23.454 | 0.223 | 25.218 | 0.274 | 0.3812 | 0.0748 | 7.367 | |
| 2670 | 23.286 | 0.223 | 25.238 | 0.274 | 0.3800 | 0.0746 | 6.363 | |
| 2671 | 23.441 | 0.223 | 25.338 | 0.274 | 0.3804 | 0.0742 | 6.667 | |
| 2672 | 23.398 | 0.223 | 25.152 | 0.274 | 0.3800 | 0.0738 | 7.372 | |
| 2673 | 23.319 | 0.223 | 25.078 | 0.274 | 0.3810 | 0.0738 | 7.334 | |
| 2674 | 23.273 | 0.223 | 25.187 | 0.274 | 0.3808 | 0.0748 | 6.536 | |
| 2675 | 23.358 | 0.223 | 25.153 | 0.274 | 0.3810 | 0.0742 | 7.151 | |
| 2676 | 23.385 | 0.223 | 25.149 | 0.274 | 0.3808 | 0.0734 | 7.329 | |
| 2677 | 23.596 | 0.223 | 24.992 | 0.274 | 0.3816 | 0.0742 | 10.386 | |
| 2678 | 21.337 | 0.223 | 24.959 | 0.274 | 0.3812 | 0.0742 | 2.803 | |
| 2679 | 23.243 | 0.223 | 25.004 | 0.274 | 0.3814 | 0.0740 | 7.299 | |

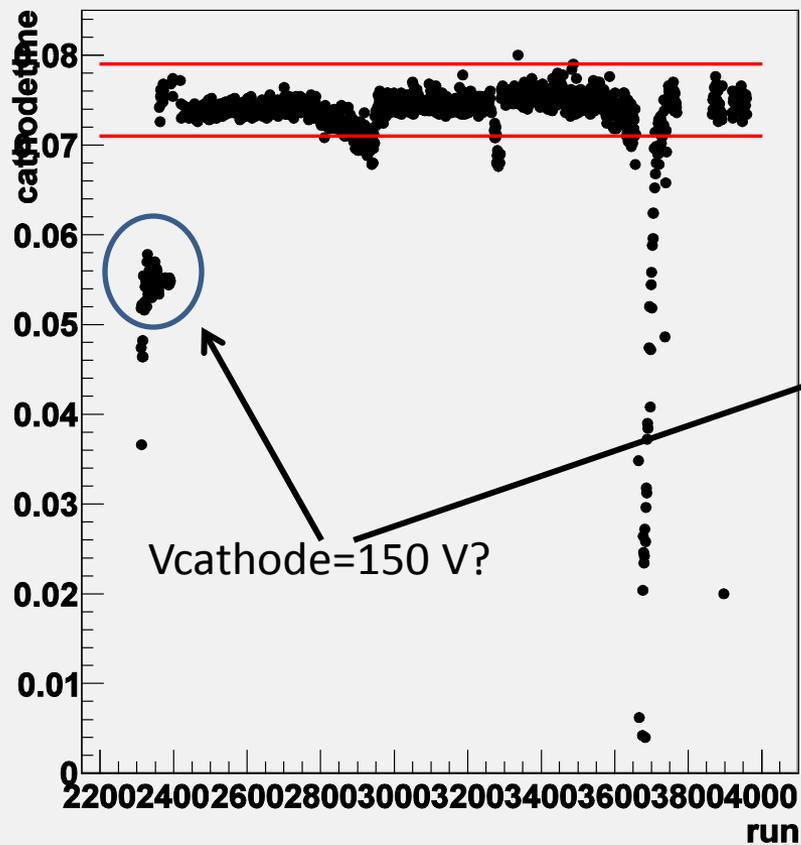
--More-- (22%)

tcsh

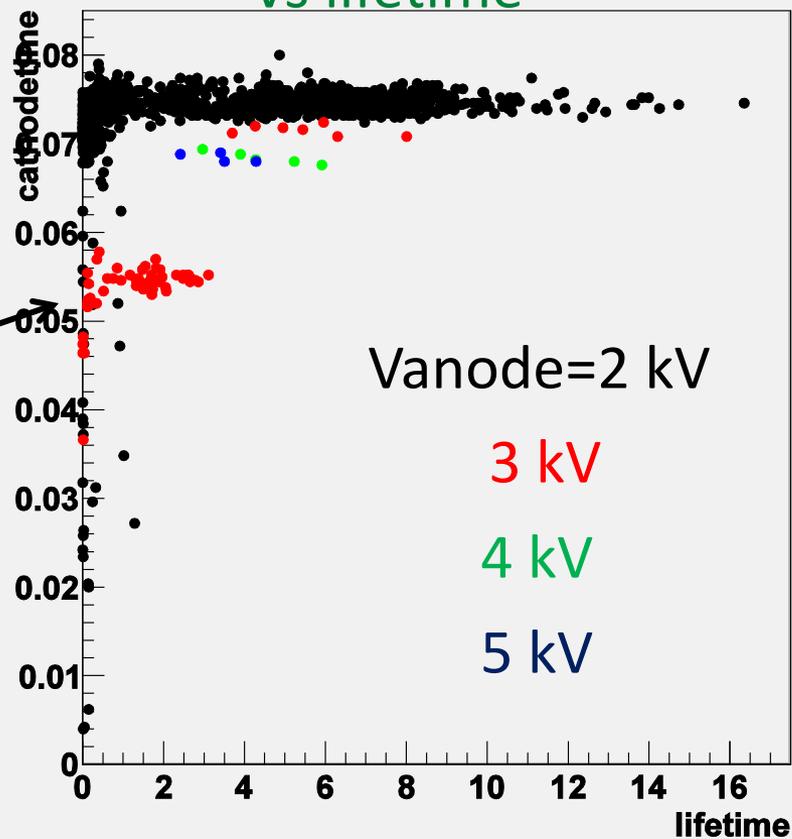
Qa Qc

Cathode time

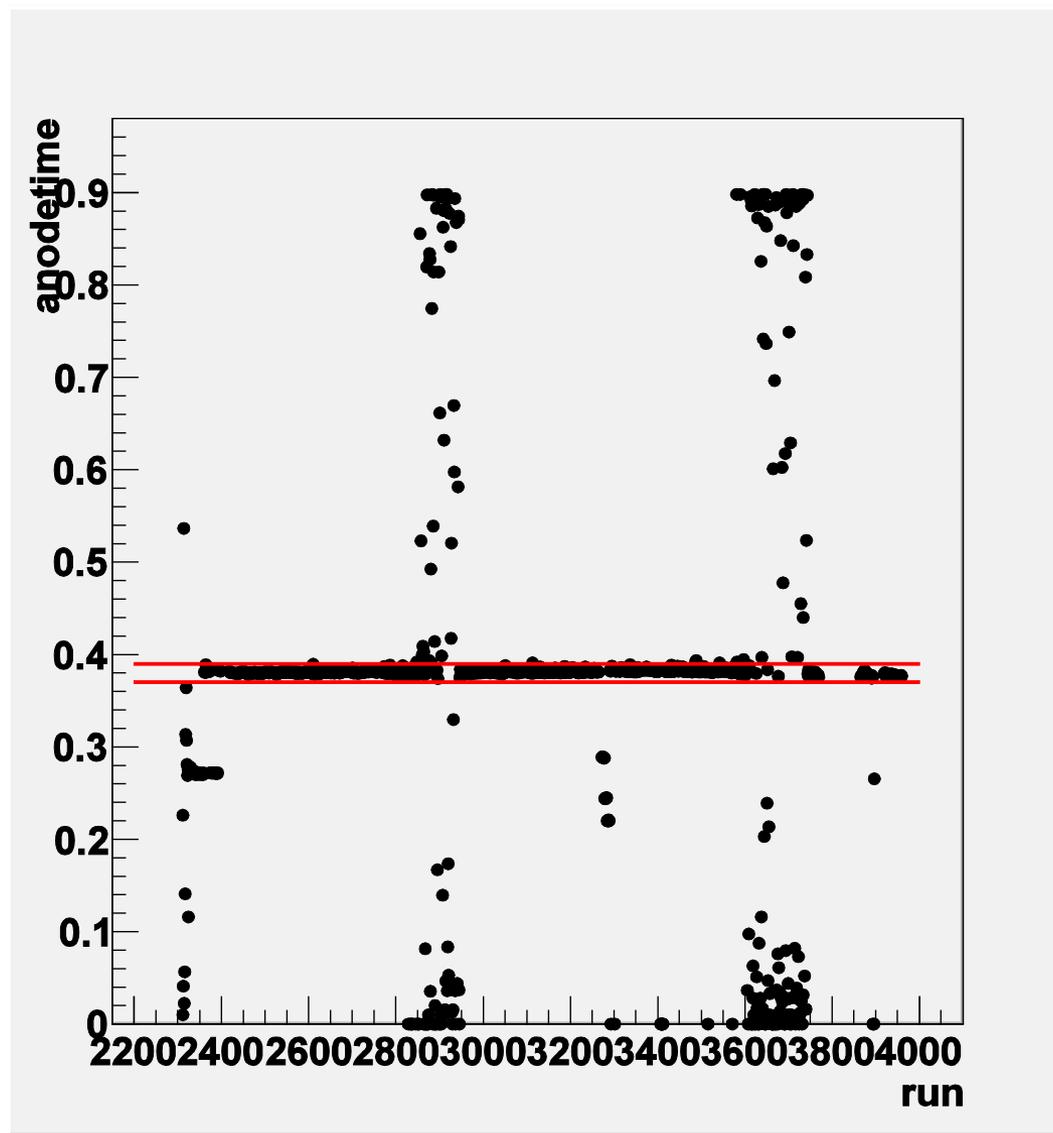
Vs run



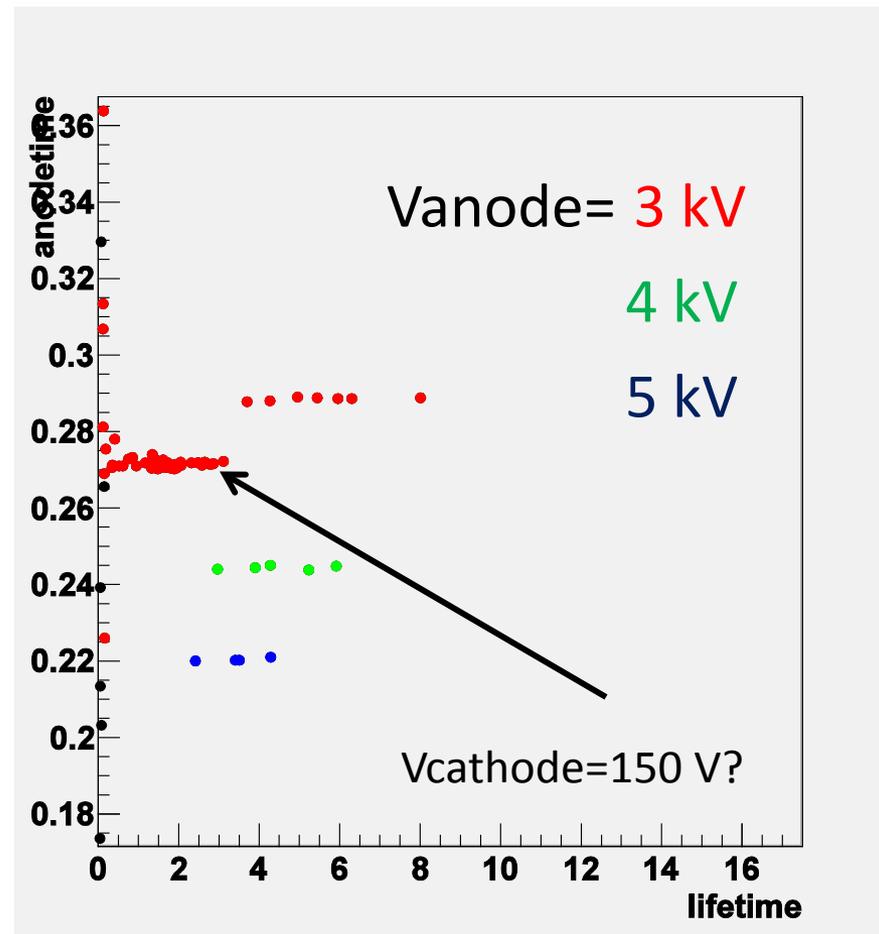
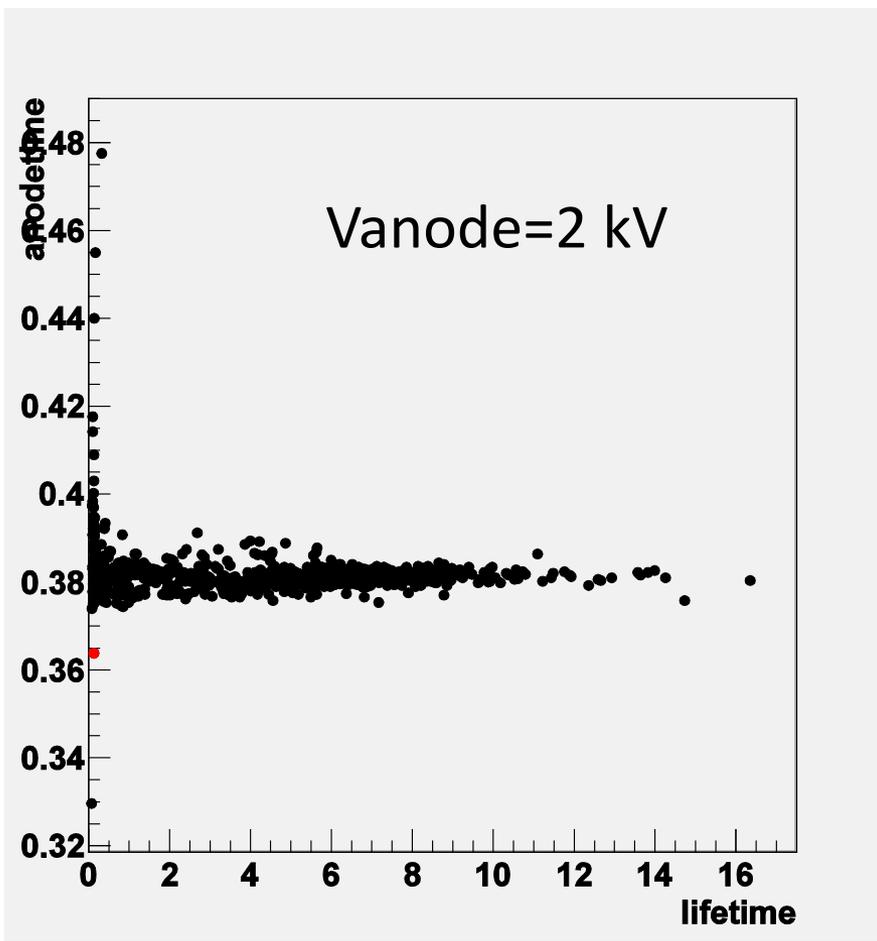
Vs lifetime



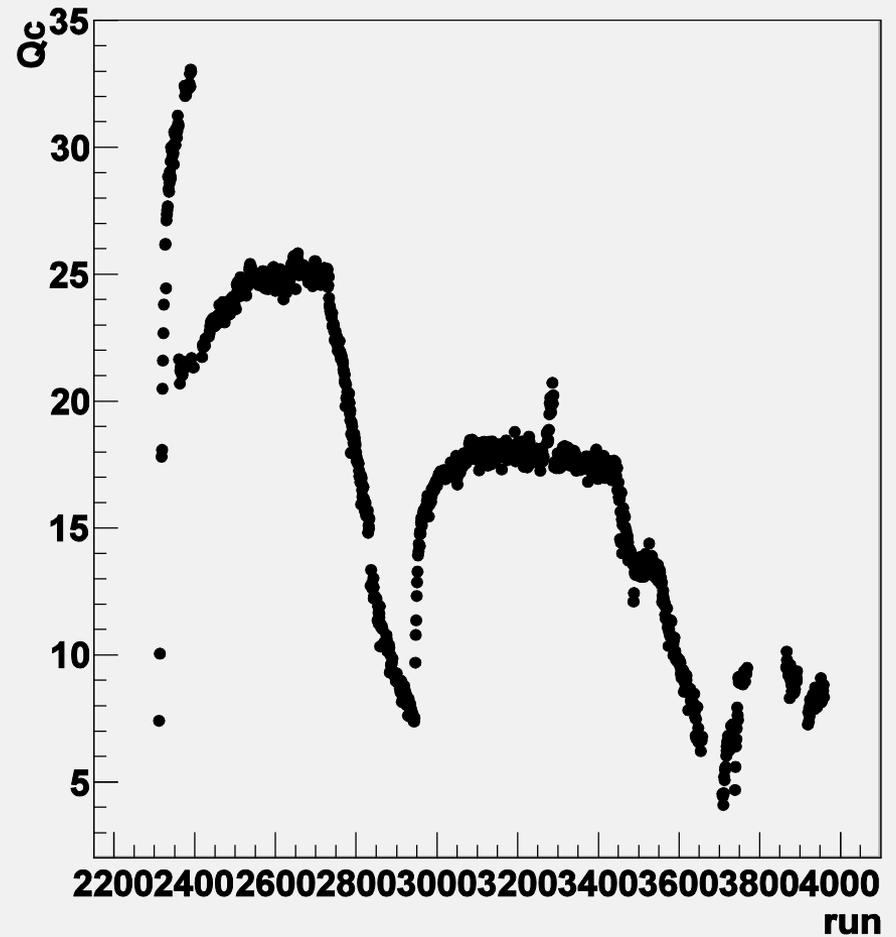
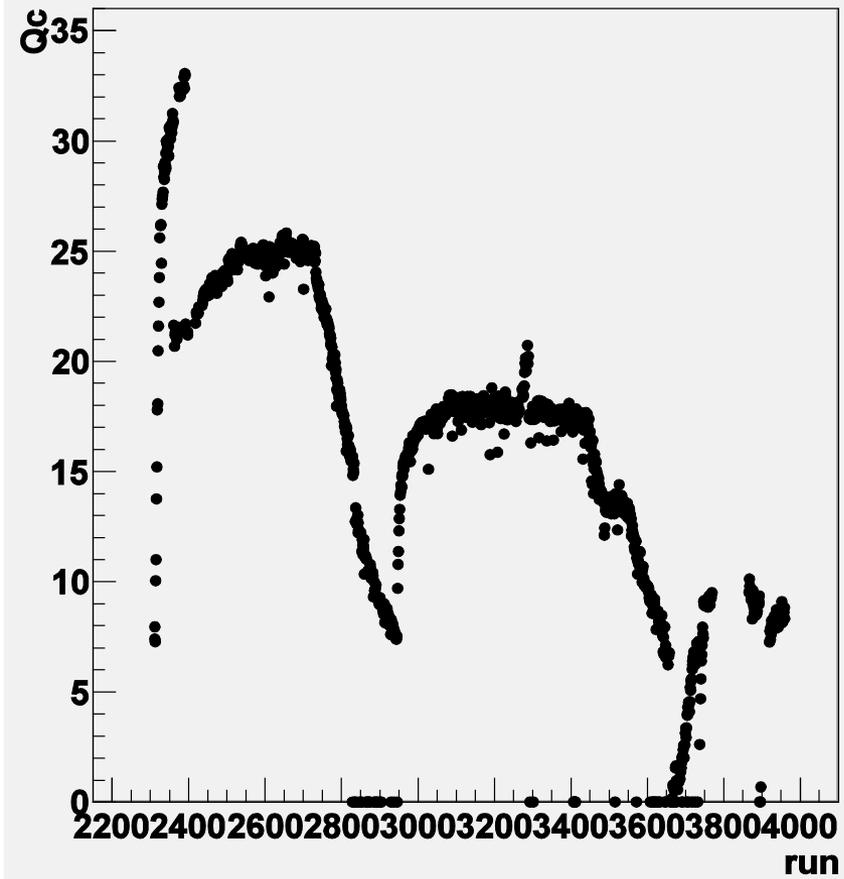
Anode time (ms) vs run



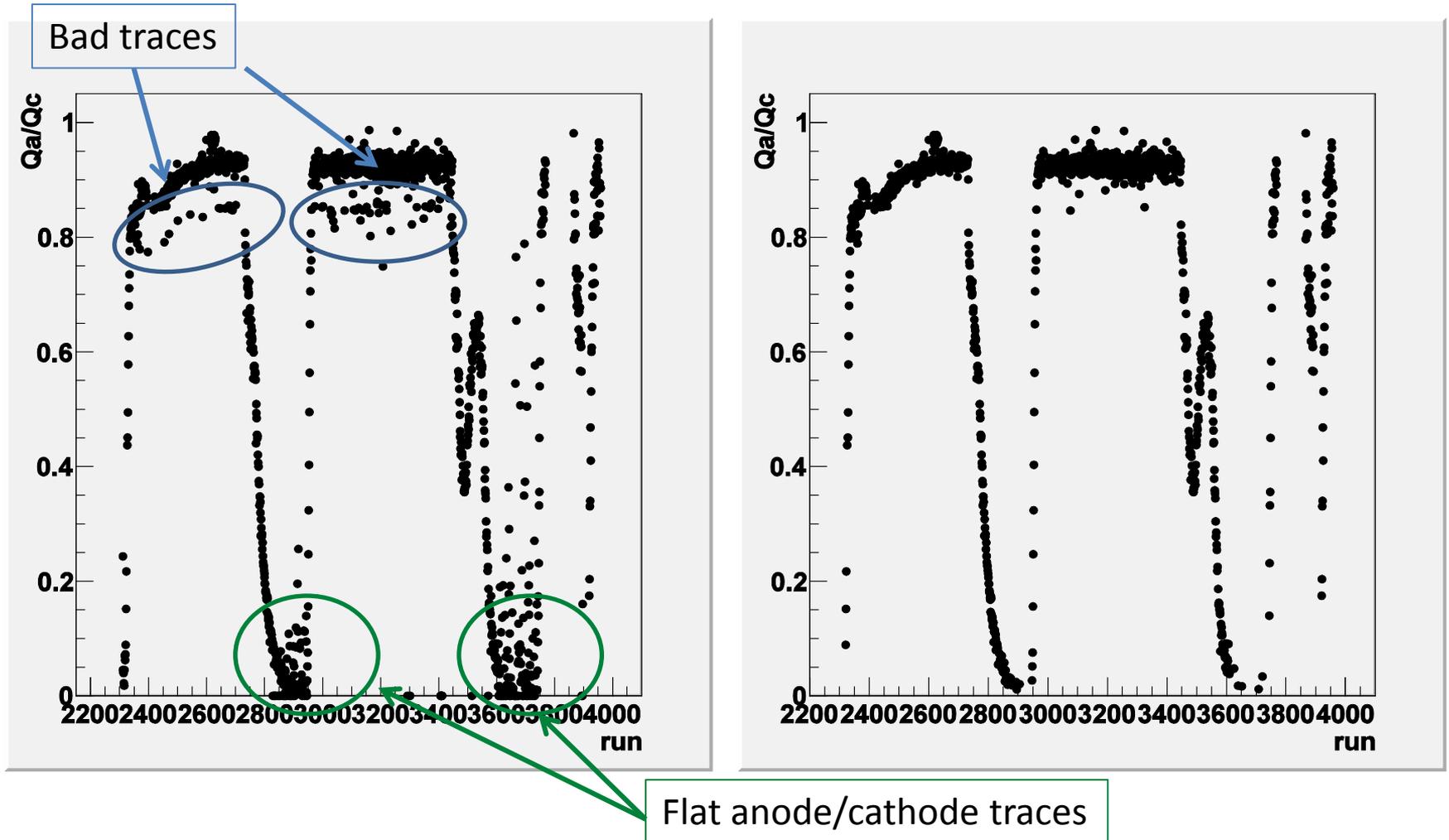
Anode time (ms) vs lifetime



Cathode signal Before/After cuts



Qa/Qc before/After cuts

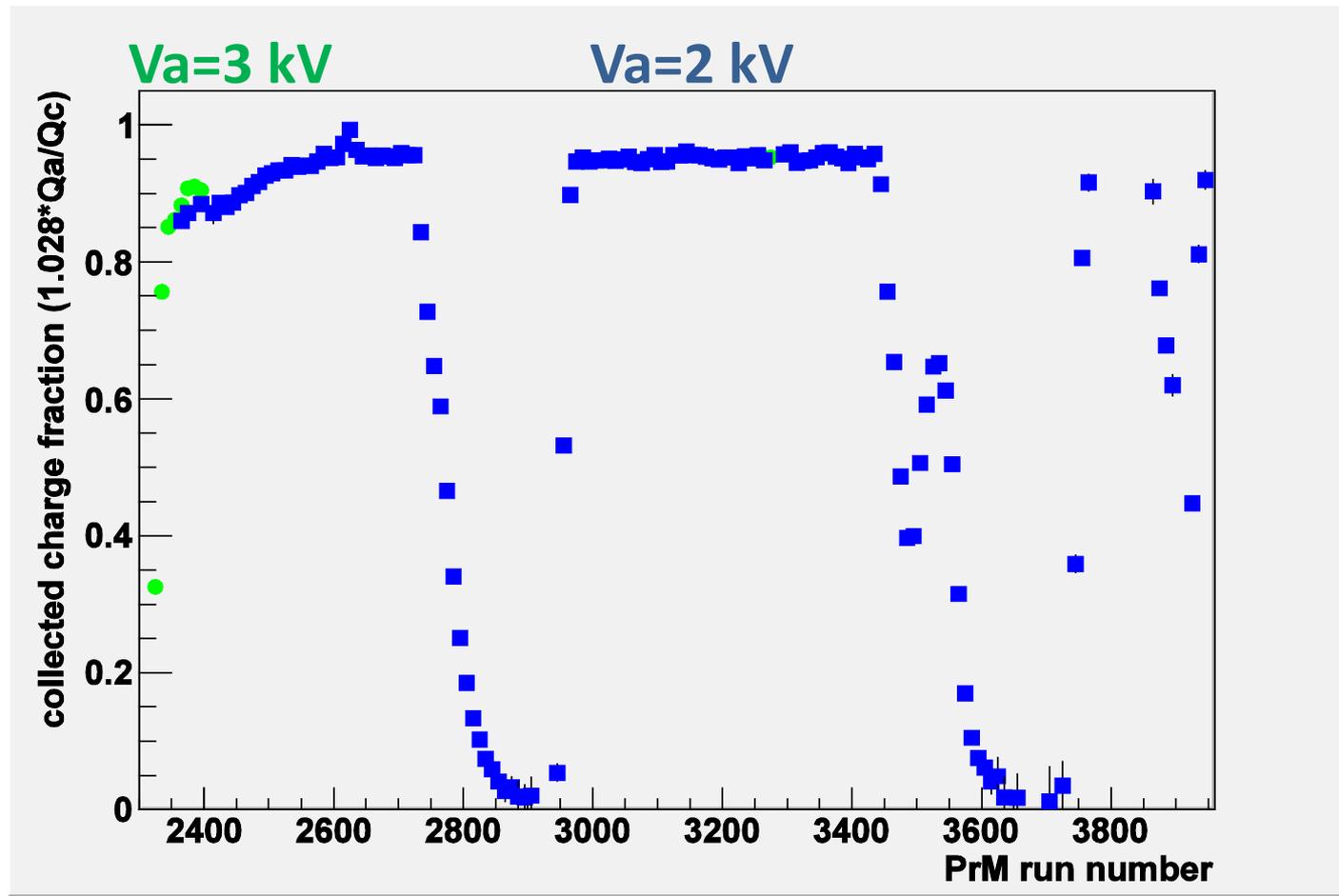


**No 1.028 correction on Qa/Qc by mistake

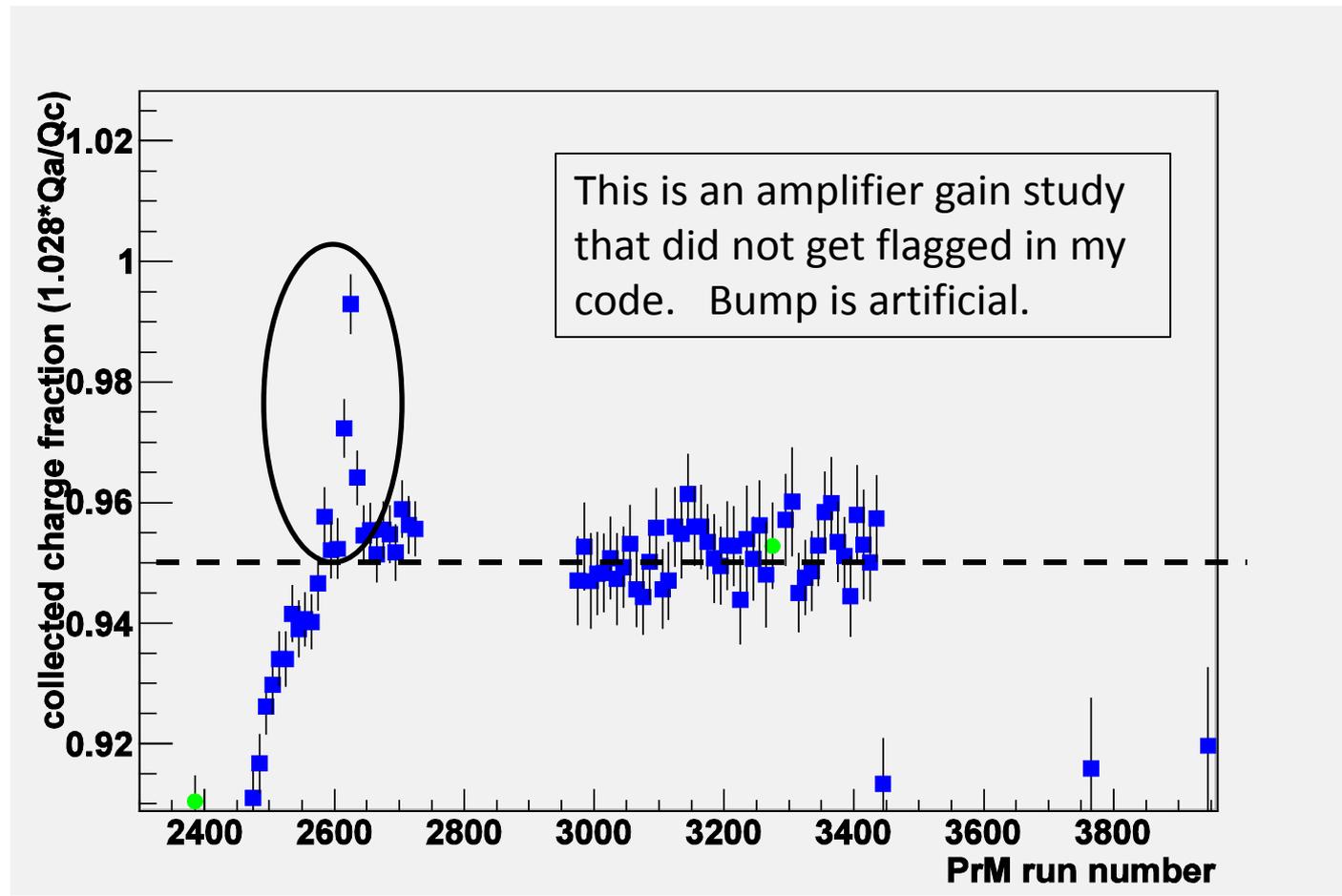
Statistical Uncertainties

- Using Emily's preliminary numbers for Q_a and Q_c extracted from the average of 10 traces not smoothed. She is re-calculating them (before Oct 15)
- Uncertainty on Q_a : 0.22325 mV
- Uncertainty on Q_c : 0.273771 mV
- The fluctuations on Q_a and Q_c are (partially?) correlated by the fluctuating intensity of the flashlamp.

1.028*Qa/Qc Coarse Bins with errors



1.028*Qa/Qc Coarse Bins with errors



Corrections to Q_a/Q_c

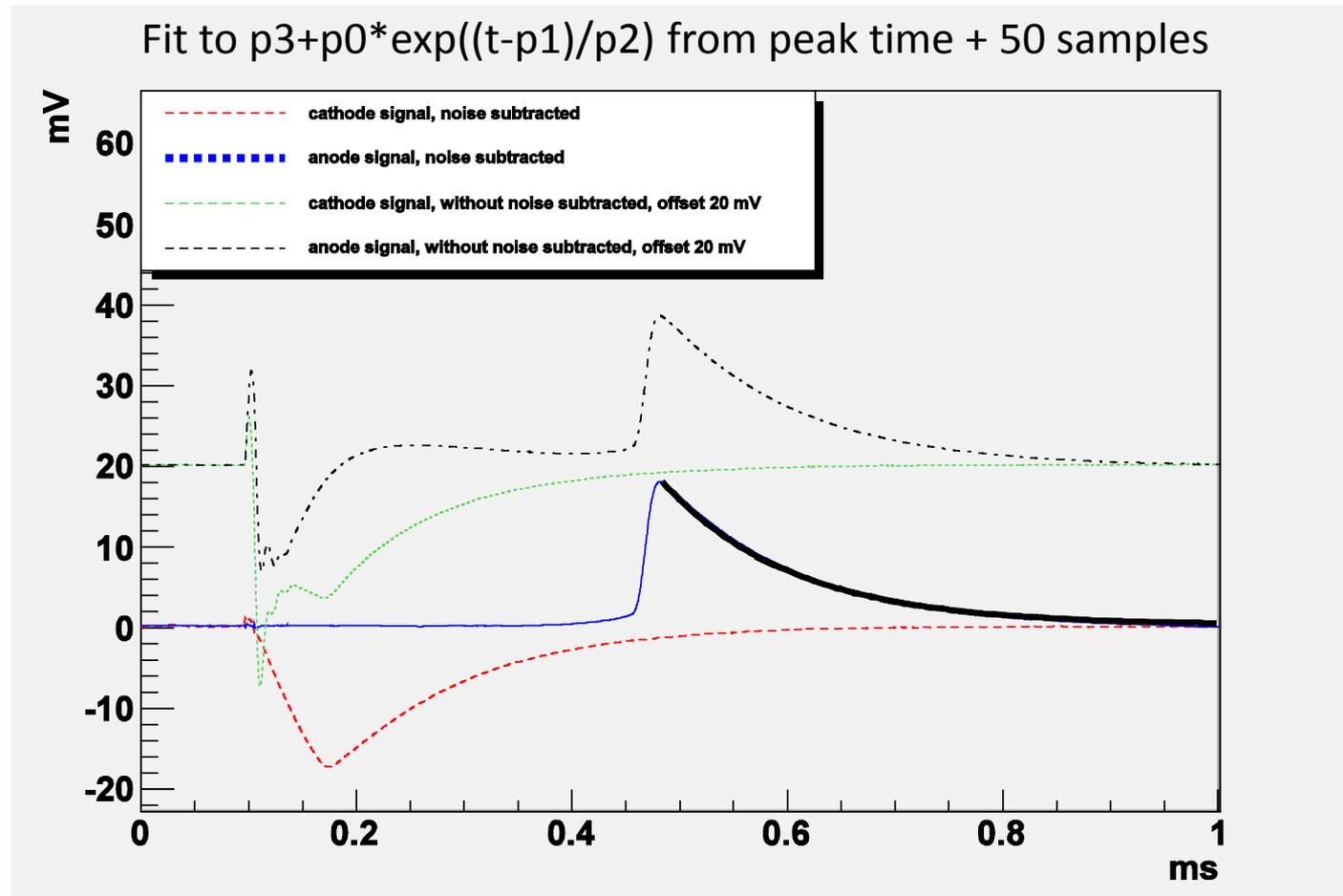
$$\frac{Q_a}{Q_c} = C \frac{\frac{1}{\alpha} Q_{a,\text{meas}}}{\beta \delta Q_{c,\text{meas}}}$$

Why does measured Q_a/Q_c plateau at a value different than 1??

- Amplifier gain calibration $C=1.028\pm 0.007$ (included in Benton's plots starting 10/23)
- Anode ring acceptance – what fraction of electrons counted by the cathode are not seen at the anode because they drift too far from the PrM axis?
- Cathode signal correction – what fraction of electrons counted by the cathode do not make it to the cathode grid?
- Uncertainty on cathode signal RC correction – 2% uncertainty on Q_c from RC uncertainty. Current RC value looks 5-10% too small.

Note that all these systematics reduce the measured Q_a/Q_c !
One or some combination can explain the plateau lower than 1.

RC fits - Anode

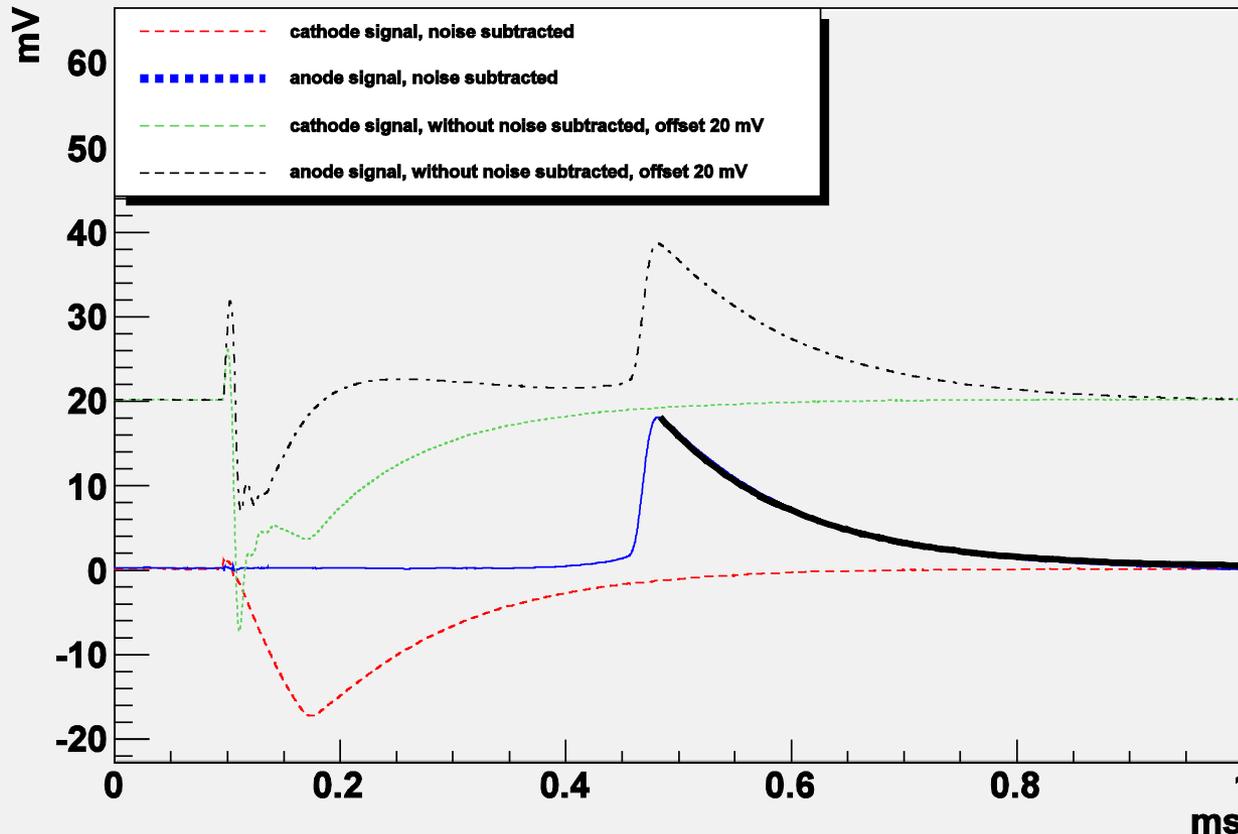


RC=119.2 +/-0.5 us

Fix p_3, p_0 and p_1 to values from code for baseline, peak height and peak time

RC fits - Anode

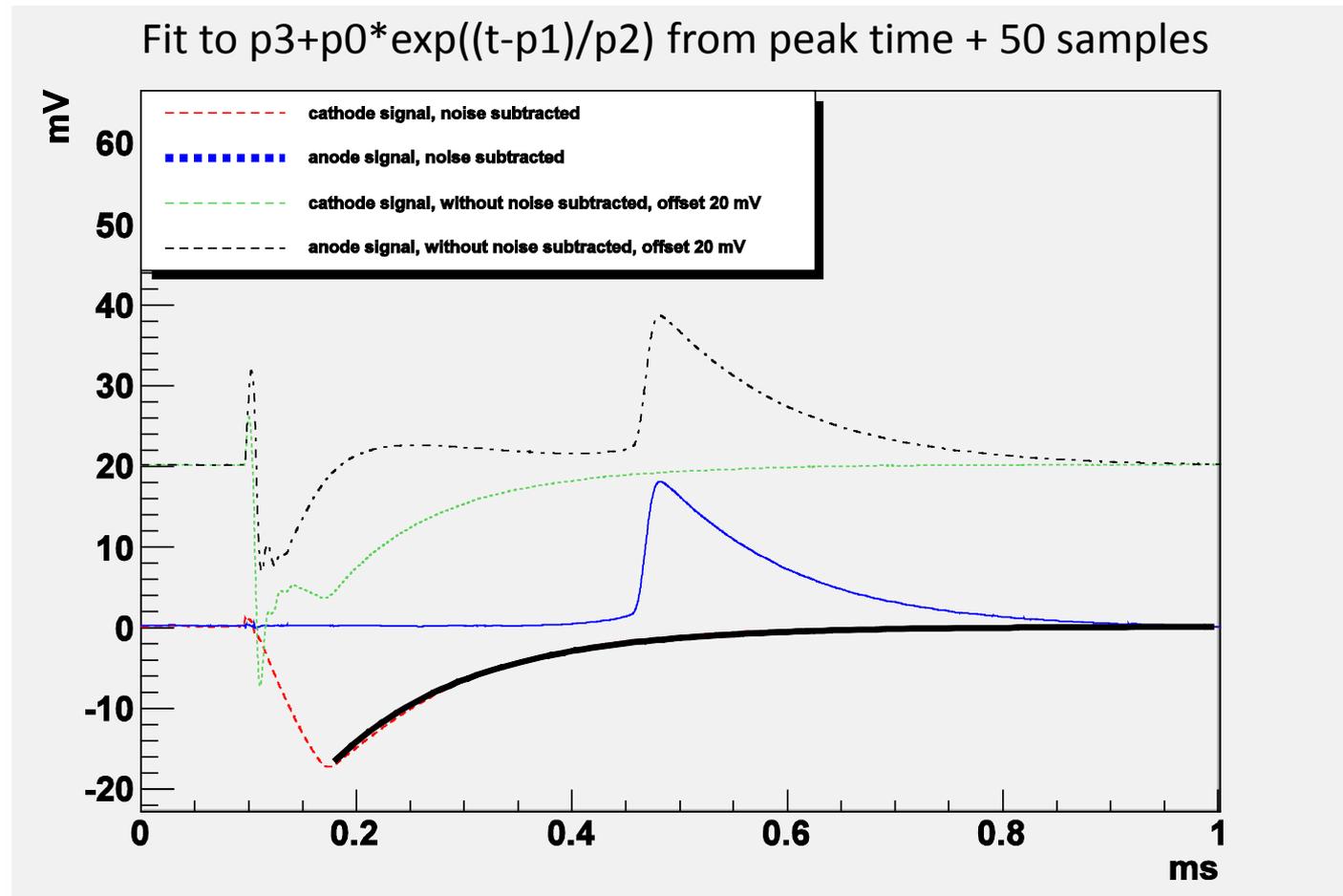
Fit to $p3+p0*\exp((t-p1)/p2)$ from peak time + 50 samples



RC=126.0 +/-1.3 us

All 4 parameter free in the fit

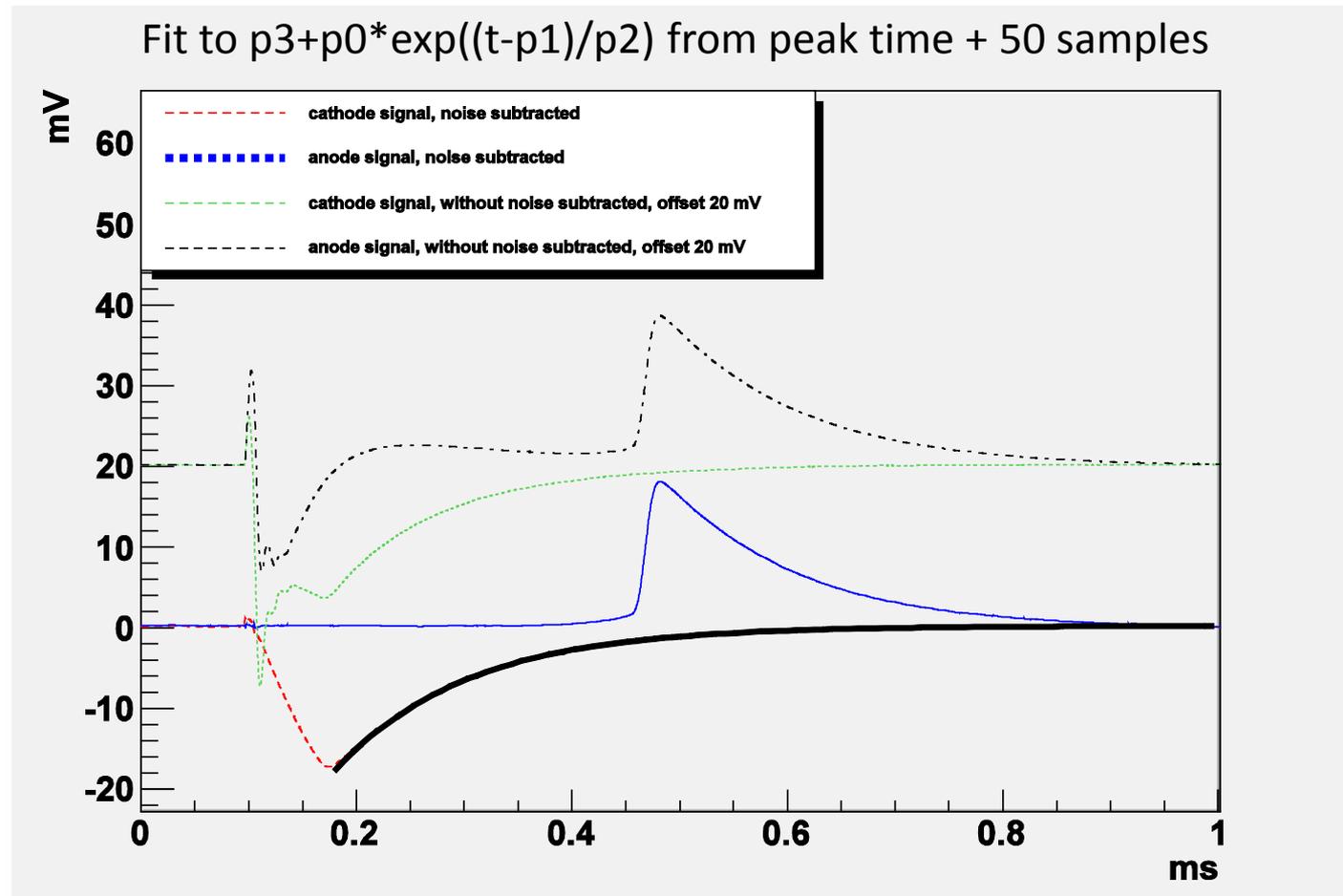
RC fits - Cathode



RC=130 +/- 0.5 us

Fix p_3, p_0 and p_1 to values from code for baseline, peak height and peak time

RC fits - Cathode



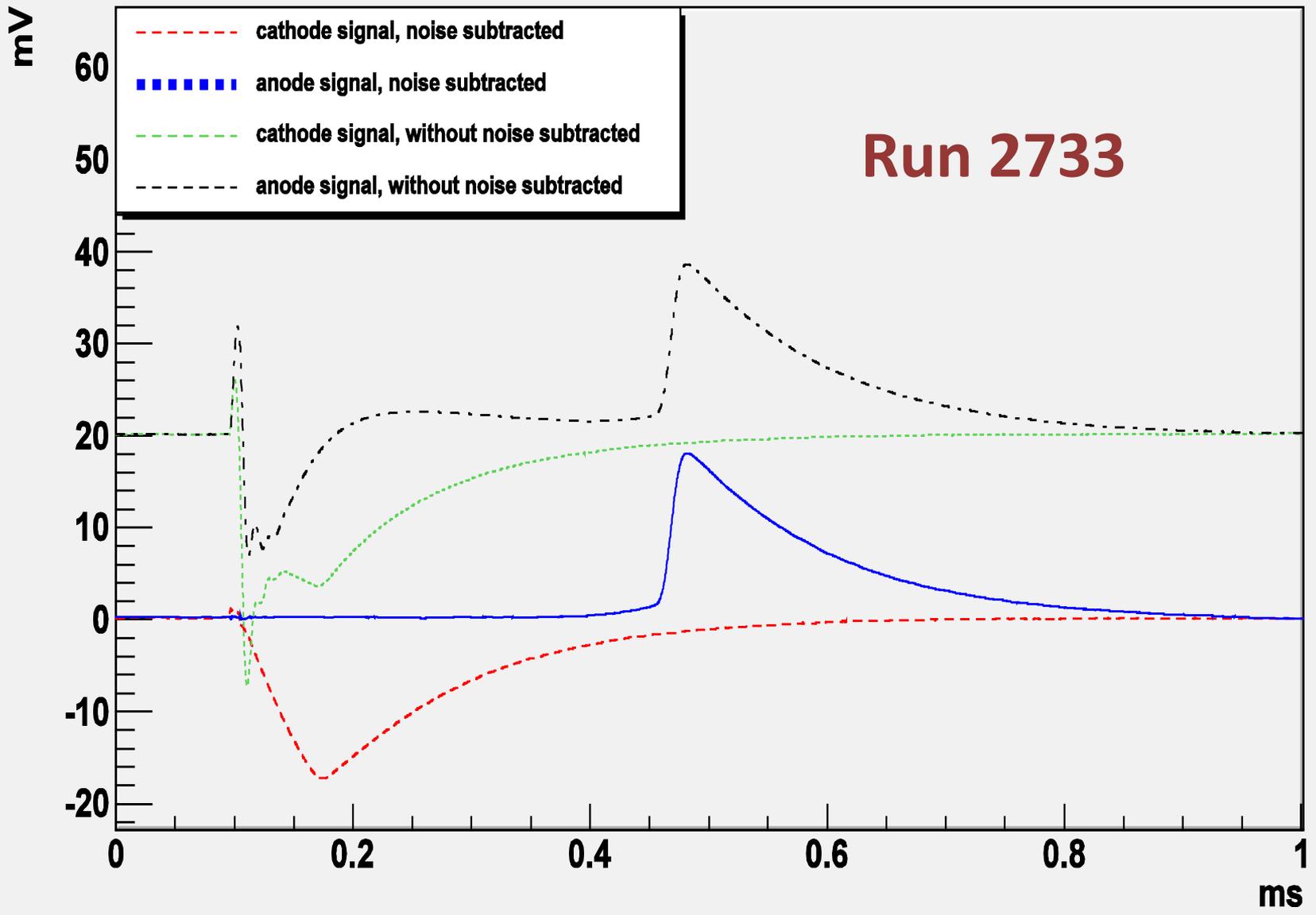
RC=124+/-1 us

All 4 parameters free in the fit, biggest change is shift in baseline

Lifetime

$$\frac{Q_a}{Q_c} = e^{-t/\tau}$$

- Drift time (=anodetime) uncertainties
 - changes 5% with cathode voltage
 - Anodetime vs (anodetime-cathodetime). Latter is 20% smaller, but more stable w.r.t. cathode voltage
- $Q_a/Q_c > 0.95$ means $\tau > 5.4\text{ms}$
 - Taking lower limit for drift time



Status

- List of runs removed with DQ cuts provided to Benton
- Waiting for final errors from Emily