

HCal Timing Calibration Quality Checks

GMn, Config: 14, Prior to Pass 2

Sebastian SEEDS*

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*email: sseeds@jlab.org

1 How to Read this Document

This document details the timing calibration results for the above experiment, configuration, and replay pass. For information regarding the calibration process, see the [overleaf](#).

Each kinematic has been calibrated separately for timing and the database will reflect this moving forward. All time vs energy plots used for this calibration are generated using updated ADC gain parameters and timing offsets for accuracy.

Each of the sections contains a brief description of the calibration results that follow. Any and all questions/concerns regarding these plots should be directed to the author at the email provided.

2 Special Considerations

- A significant time shift in ADC time data is evident on this kinematic and as such ADC time offsets are divided into two sets. Runs 13239-13260 are **set 1** and runs 13621-13407 are **set 2**.
- Evaluation of various timewalk fits are presented here as a preliminary assessment of a new timewalk calibration added to SBS-offline. Changes to SBS-offline to add this timewalk calibration are commensurate with this calibration. It is recommended that future passes consider a $\Delta t = \alpha + \beta/E^N$ timewalk fit to the data where N is constrained to be very close to 0.5.
- Many of the fits to channels shown for set 1 demonstrate yellow or red coloring. If the histogram is red, there are not enough statistics in that channel to provide an offset. In this case, the offset implied by the aggregate of all channels is used. If the histogram is yellow, the fit is unreliable and the center of the bin in X corresponding to the maximum value is used. The second issue is generally caused by low statistics.

3 Timing

3.a ADC Time Offsets

- Fits to ADC time spectra, by HCal Channel.

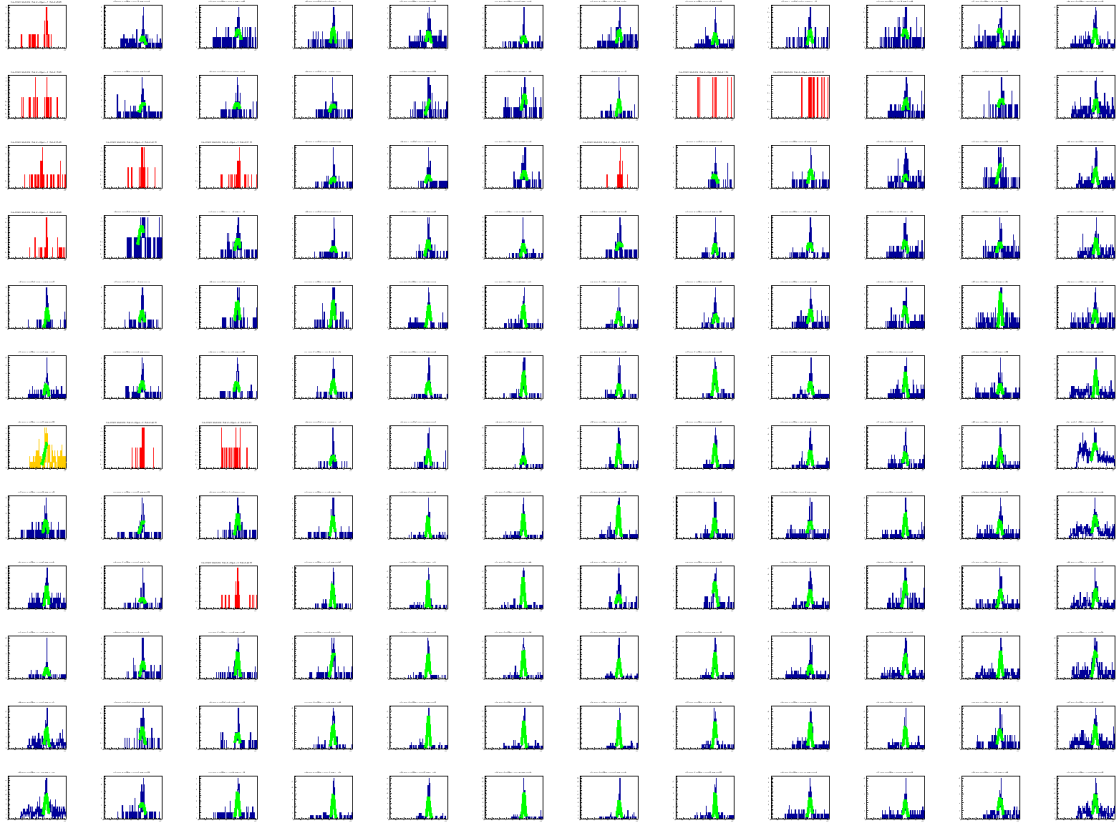


Figure 1: ADCt Spectra Fits vs. Channel, Top Half

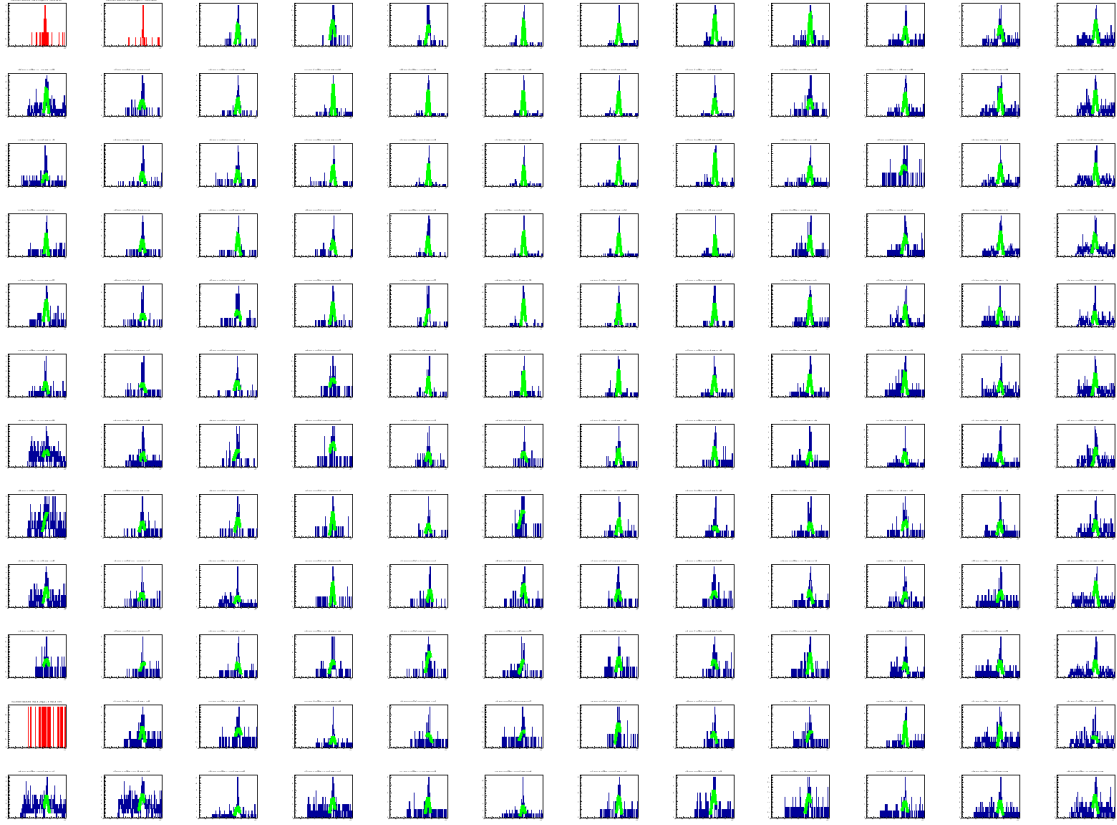


Figure 2: ADCt Spectra Fits vs. Channel, Bottom Half

- Mean/std. dev. comparisons before/after calibrations.

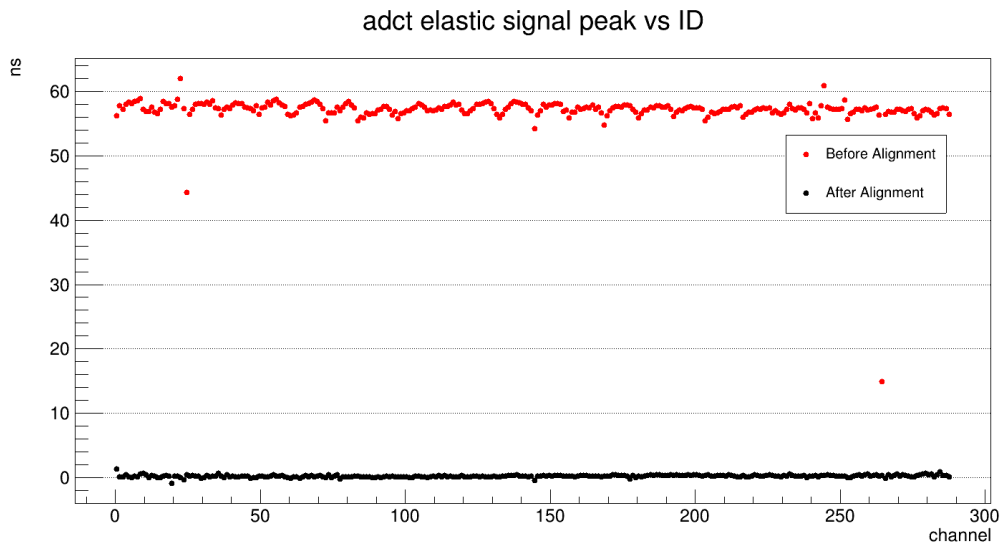


Figure 3: ADCt Fit Comparison, Post-Cal in Black

3.b TDC Offsets

- Fits to TDC spectra, by HCal Channel.

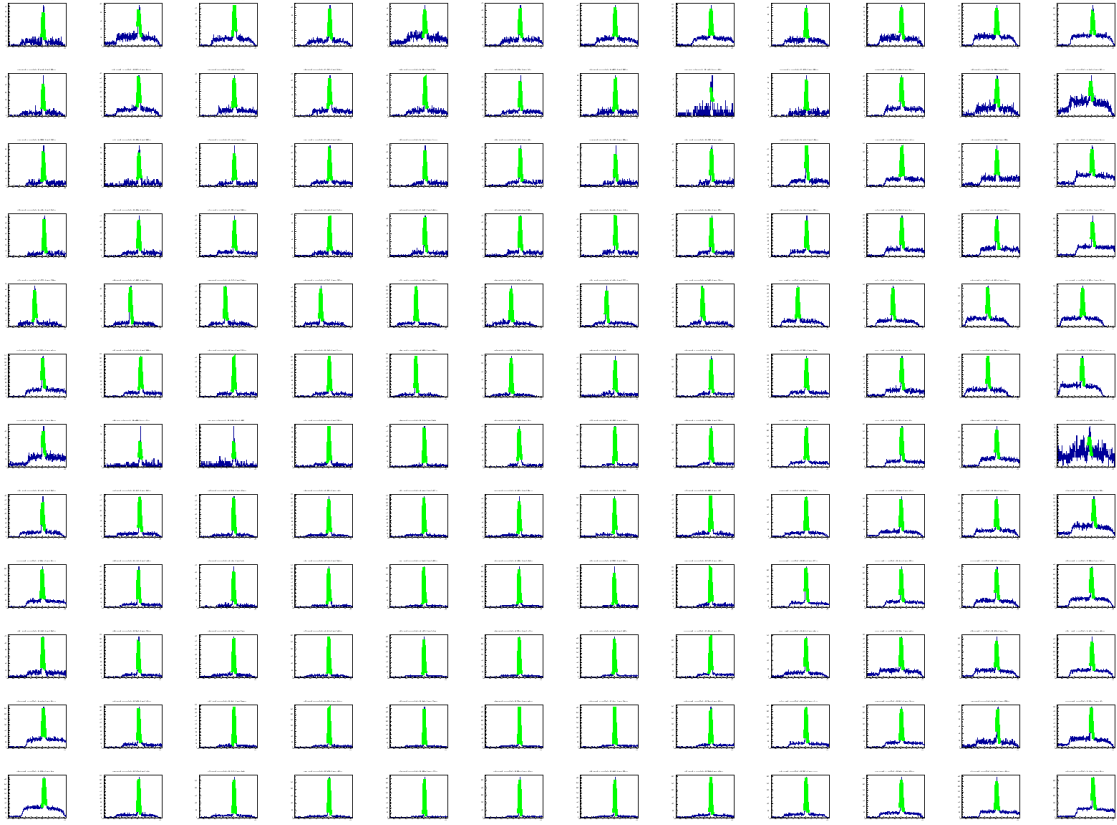


Figure 4: TDC Spectra Fits vs. Channel, Top Half

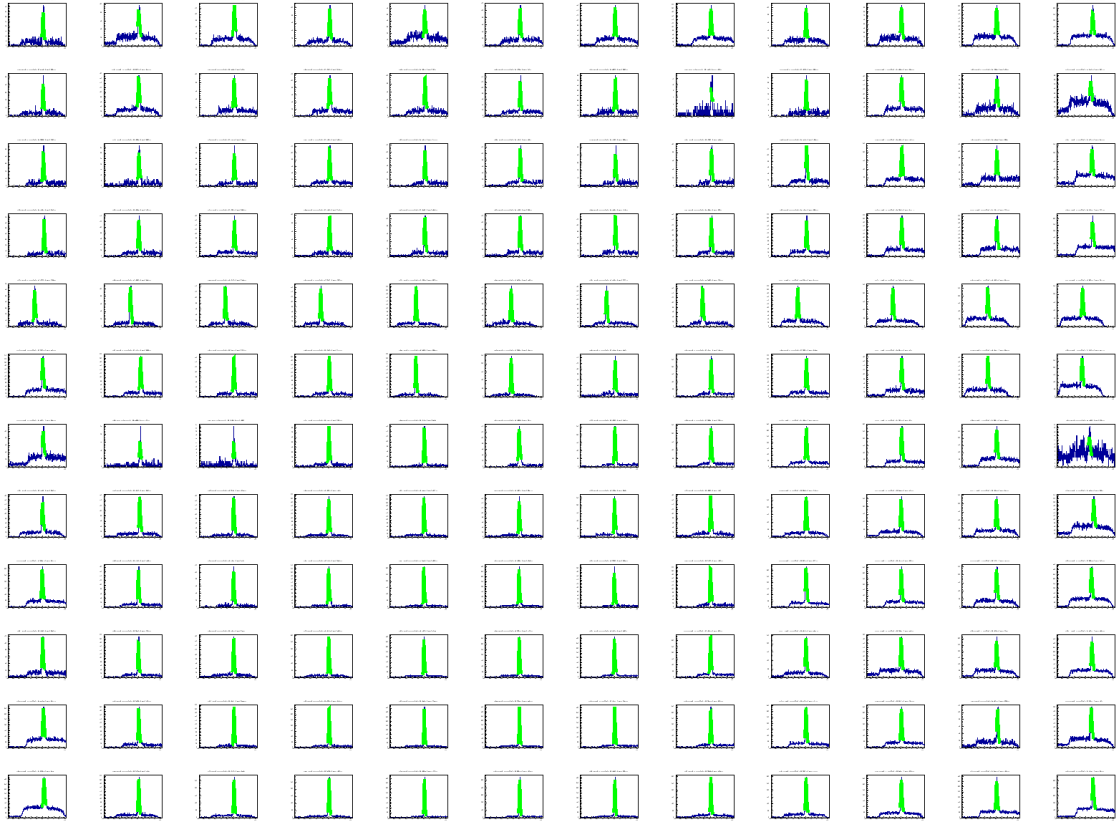


Figure 5: TDC Spectra Fits vs. Channel, Bottom Half

- Mean/std. dev. comparisons before/after calibrations.

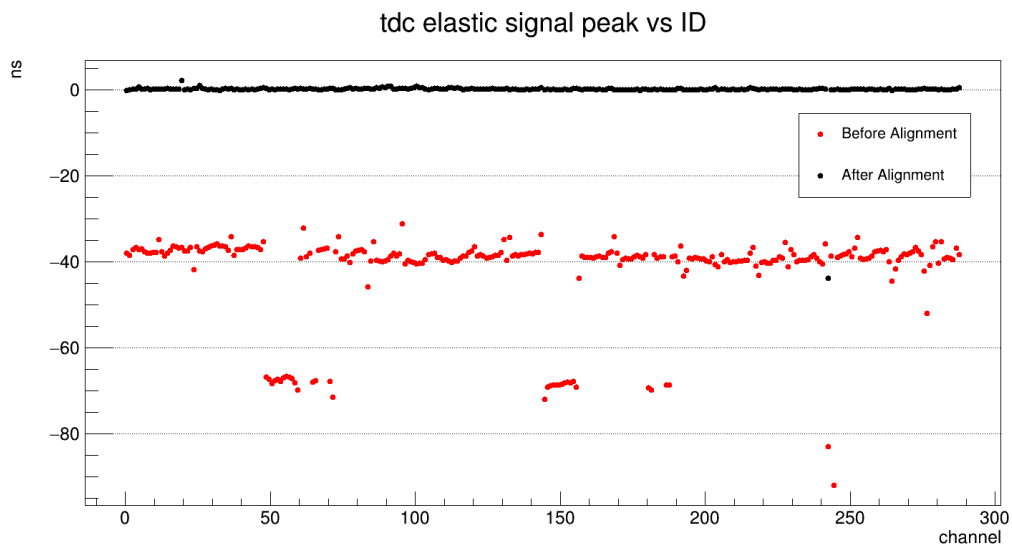


Figure 6: TDC Fit Comparison, Post-Cal in Black

3.c ADC Time Aggregate Comparison

All blocks post-alignment ADC time fit and comparison with ADC time from data before per-channel alignment.

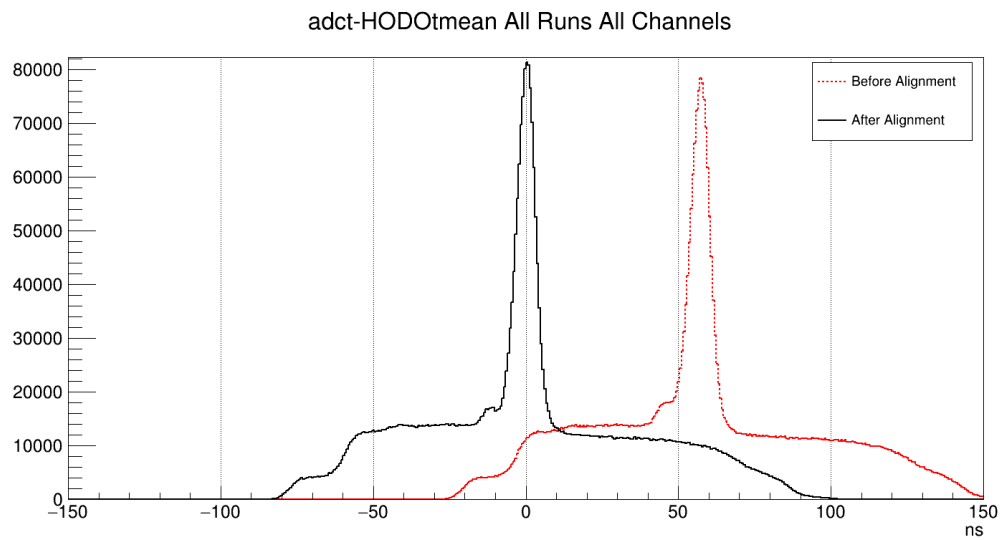


Figure 7: ADCt Comparison, All Channels. Post-alignment Mean: **0.15 ns**

4 Time vs Run

No significant deviations occur on either ADCt or TDC data as a function of run number.

4.a ADCt vs Run

HCal adc time (all blocks) vs run number, before and after. Includes direct comparison.



Figure 8: HCal ADCt vs Run Number All Channels, Before Alignment



Figure 9: HCal ADCT vs Run Number All Channels, After Alignment

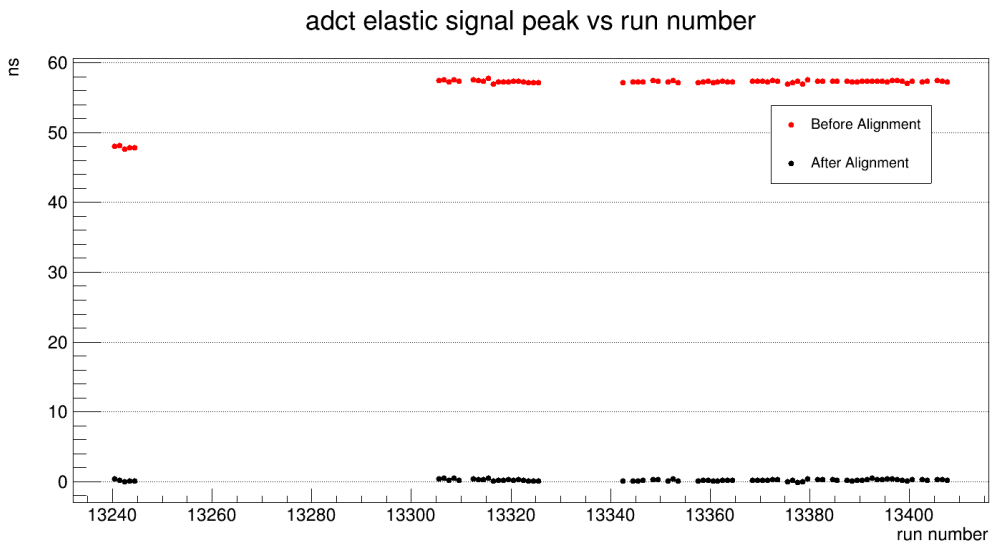


Figure 10: HCal ADCT vs Run Number All Channels, Comparison

4.b TDC vs Run

HCal tdc time (all blocks) vs run number, before and after. Includes direct comparison.

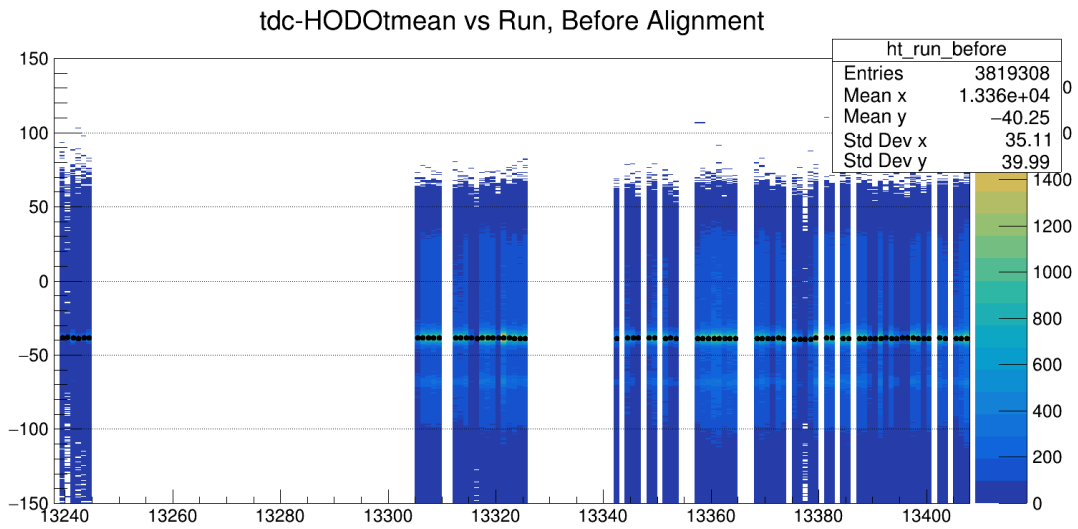


Figure 11: HCal TDC vs Run Number All Channels, Before Alignment

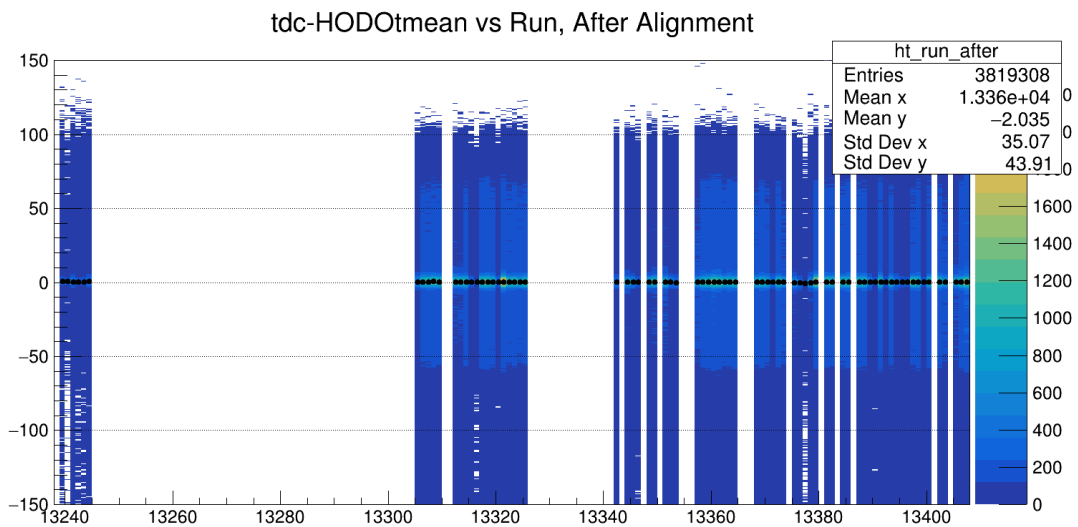


Figure 12: HCal TDC vs Run Number All Channels, After Alignment

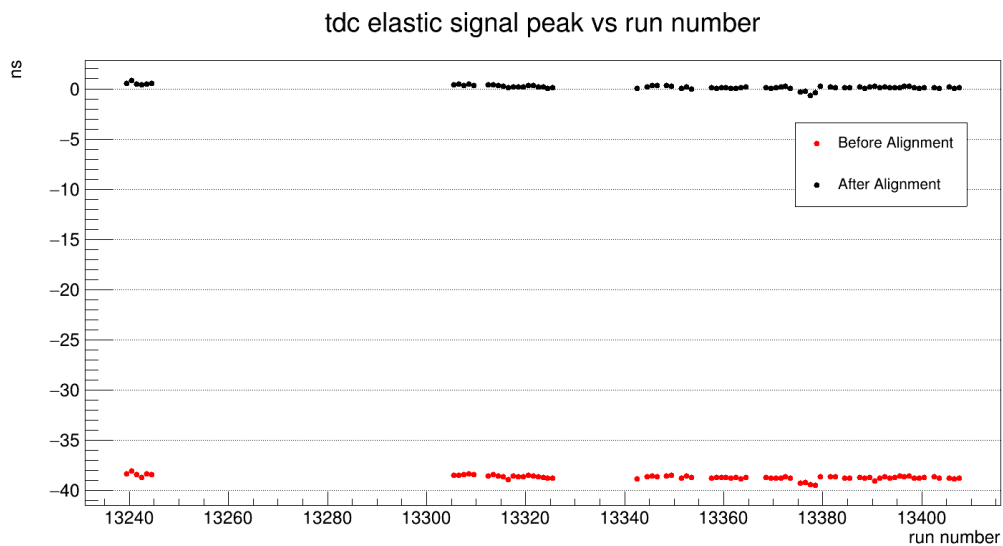


Figure 13: HCal TDC vs Run Number All Channels, Comparison

5 Supplemental Timing

5.a TDC Timewalk, Fits to Data

HCal tdc time (all blocks) vs energy, fit with $\Delta t = p_0 + p_1 \cdot E$. p_0 is normal to the data and not passed to the calibration.

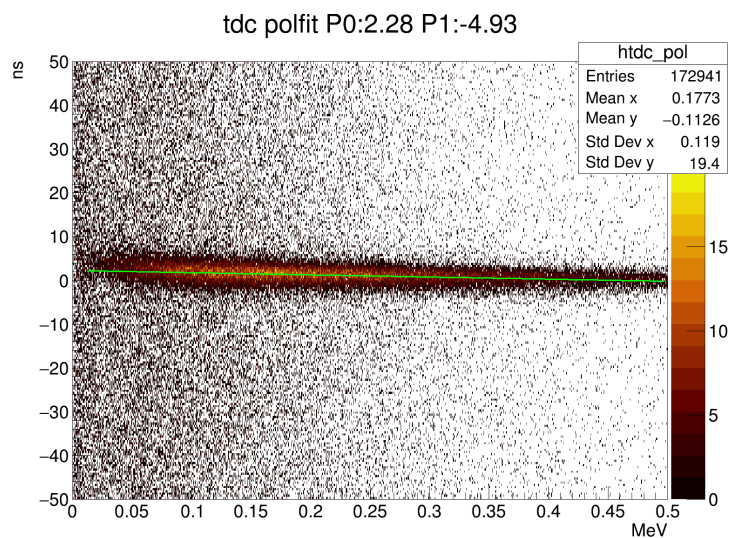


Figure 14: HCal TDC vs E

HCal tdc time (all blocks) vs energy, fit with $\Delta t = P0 \cdot \exp(-P1 \cdot E) + p2$. $p2$ is normal to the data and not passed to the calibration.

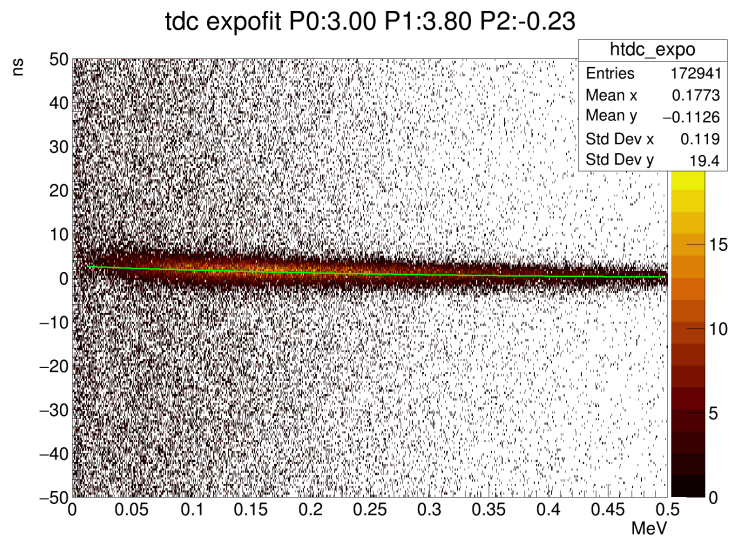


Figure 15: HCal TDC vs E

HCal tdc time (all blocks) vs energy, fit with $\Delta t = p0 + p1/E^{p2}$. $p0$ is normal to the data and not passed to the calibration.

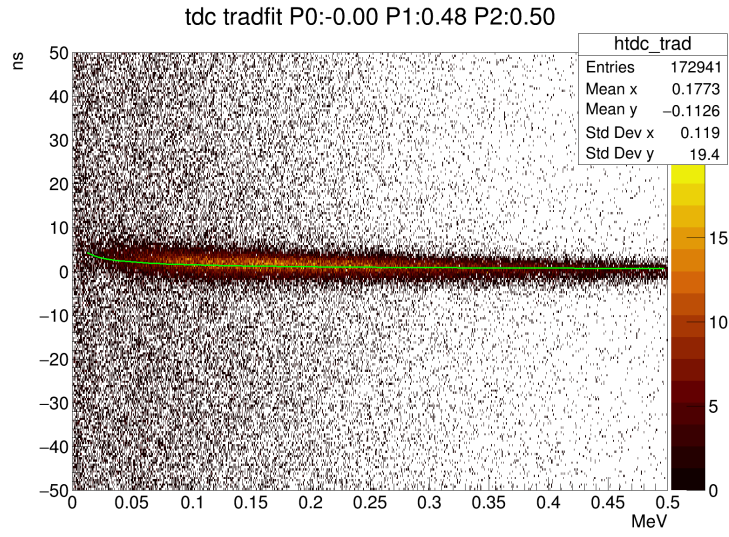


Figure 16: HCal TDC vs E,

5.b ADCt Timewalk, Fit to Data

HCal adct time (all blocks) vs energy, fit with $\Delta t = p_0 + p_1 \cdot E$. p_0 is normal to the data and not passed to the calibration.

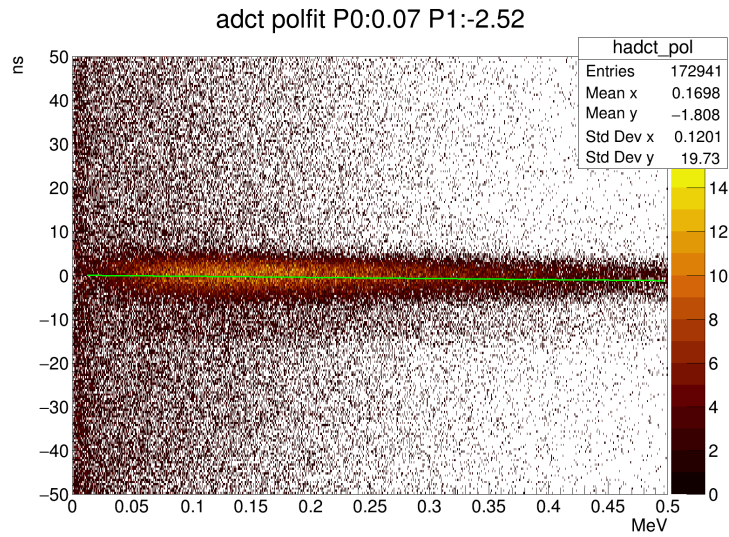


Figure 17: HCal ADCt vs E

6 SBS-offline check, ADCt set 1

The following plots repeat checks above, but with a small replay of run 13242 data using `replay_gmn.C` with SBS-offline associated libraries updated with timewalk and with new offsets included in the database.

6.a ADC Time All Channels

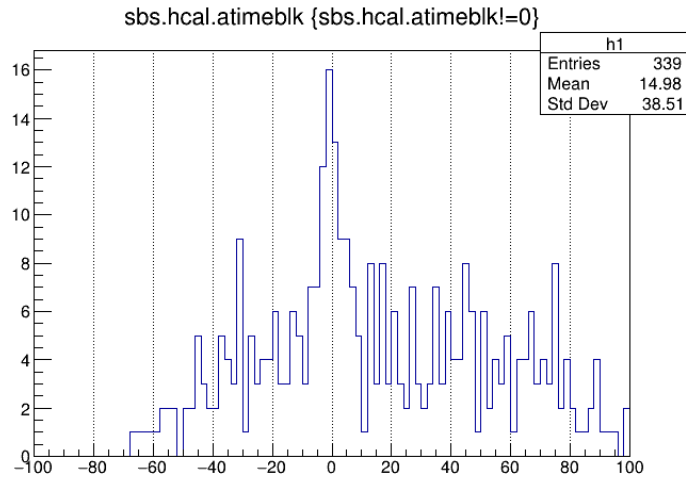


Figure 18: ADCt All Channels, Run 13242

6.b TDC All Channels

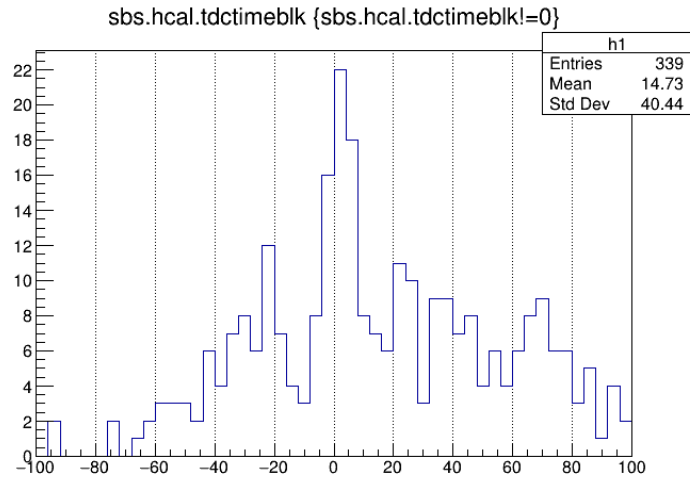


Figure 19: TDC All Channels, Run 13242

7 SBS-offline check, ADCt set 2

The following is over run 13314.

7.a ADC Time All Channels

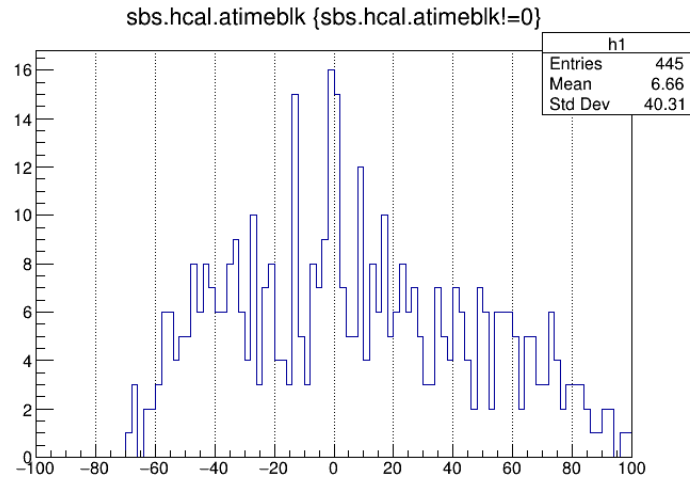


Figure 20: ADCt All Channels, Run 13314

7.b TDC All Channels

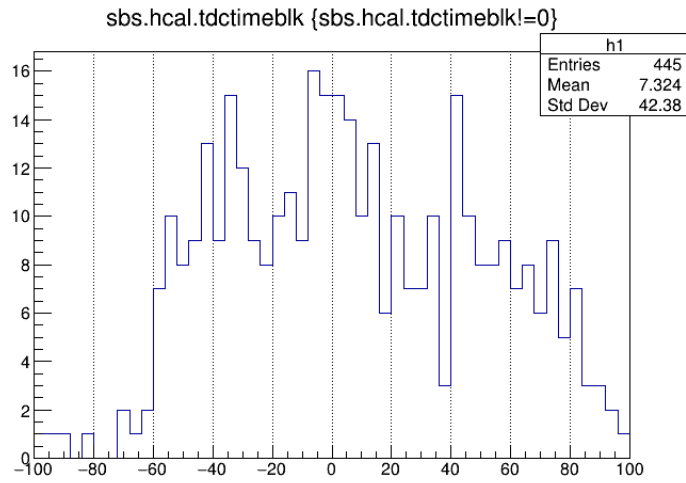


Figure 21: TDC All Channels, Run 13314

8 Supplemental

General Set ADCt Alignment Info
Experiment: gmn, Configuration: 14, Pass: 1
Creation Date: 9_14_2023
Run range 13239 - 13260
Exclusion range 0 - 0
Target(s) Used: All Available
Calibration Set: none

Elastic Cuts
Global Elastic Cuts: $bb.tr.n=0 \& \& abs(bb.tr.vz[0]) < 0.08 \& \& bb.gem.track.nhits > 2 \& \& bb.tr.p[0] > 1.6 \& \& sbs.hcal.e > 0.03 \& \& bb.ps.e > 0.2$

Other Cuts
Minimum Ev per Cell : 50
HCal Acceptance Match (Projected Nucleon Within HCal Acceptance)

Figure 22: SBS14 adct timing cuts and experimental parameters, set 1.

General Set ADC1 Alignment Info
Experiment: gmn, Configuration: 14, Pass: 1
Creation Date: 9_14_2023
Run range 13261 - 13407
Exclusion range 0 - 0
Target(s) Used: All Available
Calibration Set: none

Elastic Cuts
Global Elastic Cuts: `bb.tr.n>0&&sabs(bb.tr.vz[0])<0.08&&bb.gem.track.nhits>2&&bb.tr.p[0]>1.6&&sbs.hcal.e>0.03&&bb.ps.e>0.2`

Other Cuts
Minimum Ev per Cell : 50
HCal Acceptance Match (Projected Nucleon Within HCal Acceptance)

Figure 23: SBS14 adct timing cuts and experimental parameters, set 2.

General Set TDC Alignment Info
Experiment: gmn, Configuration: 14, Pass: 1
Creation Date: 9_14_2023
Run range 0 - 0
Exclusion range 0 - 0
Target(s) Used: All Available
Calibration Set: none

Elastic Cuts
Global Elastic Cuts: `bb.tr.n>0&&sabs(bb.tr.vz[0])<0.08&&bb.gem.track.nhits>2&&bb.tr.p[0]>1.6&&sbs.hcal.e>0.03&&bb.ps.e>0.2`

Other Cuts
Minimum Ev per Cell : 50
HCal Acceptance Match (Projected Nucleon Within HCal Acceptance)

Figure 24: SBS14 tdc timing cuts and experimental parameters.