# Contents

1 How to Read this Document 2

2 Special Considerations 2

3 Timing 3
   3.a ADC Time Offsets .................................................. 3
   3.b TDC Offsets .......................................................... 5
   3.c ADC Time Aggregate Comparison .................................. 8

4 Time vs Run 9
   4.a ADC\(t\) vs Run ......................................................... 9
   4.b TDC vs Run ............................................................ 10

5 Supplemental Timing 12
   5.a TDC Timewalk, Fits to Data ....................................... 12
   5.b ADC\(t\) Timewalk, Fit to Data ..................................... 14

6 SBS-offline check, ADC\(t\) set 1 15
   6.a ADC Time All Channels .............................................. 15
   6.b TDC All Channels .................................................... 16

7 SBS-offline check, ADC\(t\) set 2 16
   7.a ADC Time All Channels .............................................. 16
   7.b TDC All Channels .................................................... 17

8 Supplemental 17

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

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
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
5 Supplemental Timing

5.a TDC Timewalk, Fits to Data

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

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.
5.5 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 16: HCal TDC vs E

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

The following is over run 13314.

7 SBS-offline check, ADCt set 2

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

Figure 22: SBS14 adct timing cuts and experimental parameters, set 1.
Figure 23: SBS14 adct timing cuts and experimental parameters, set 2.

Figure 24: SBS14 tdc timing cuts and experimental parameters.