Sine Wave INL and DNL

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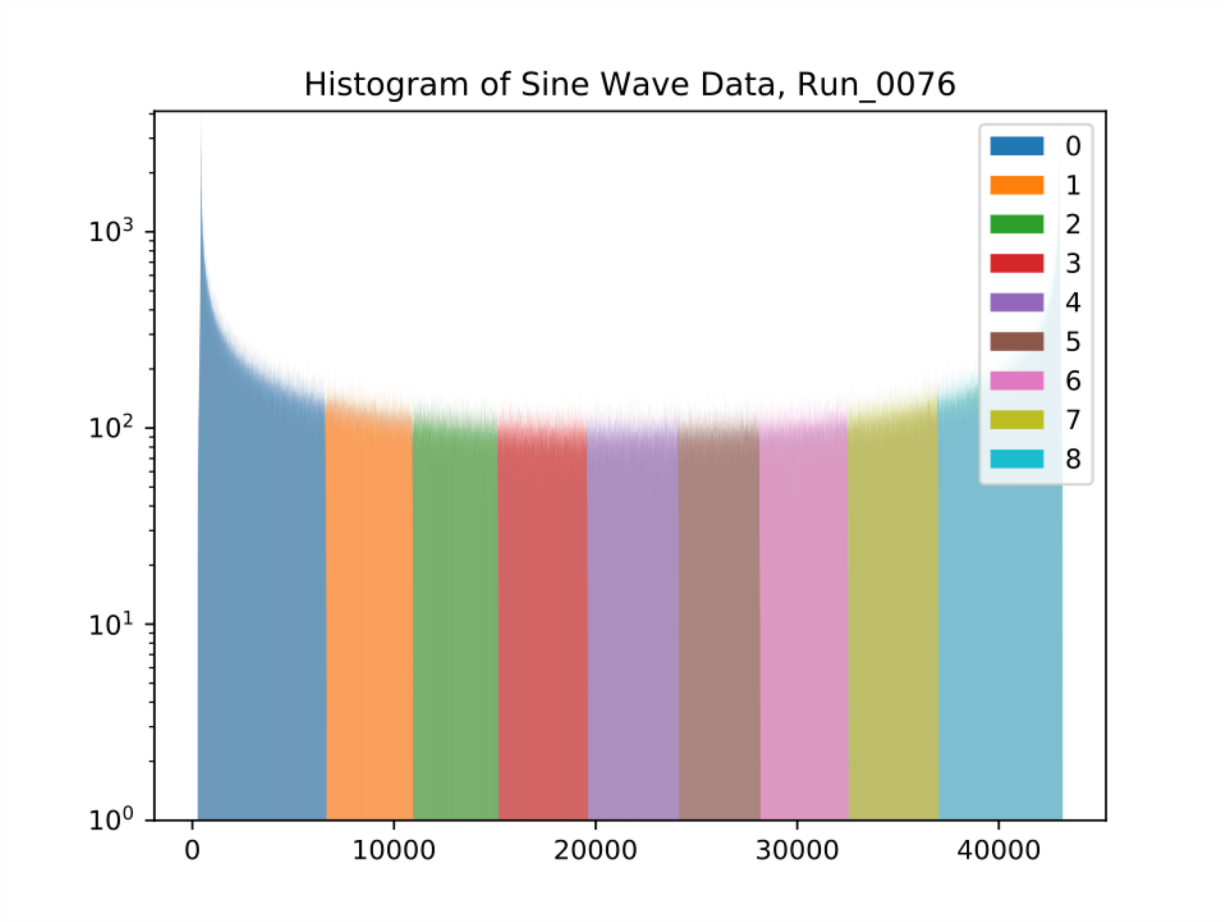
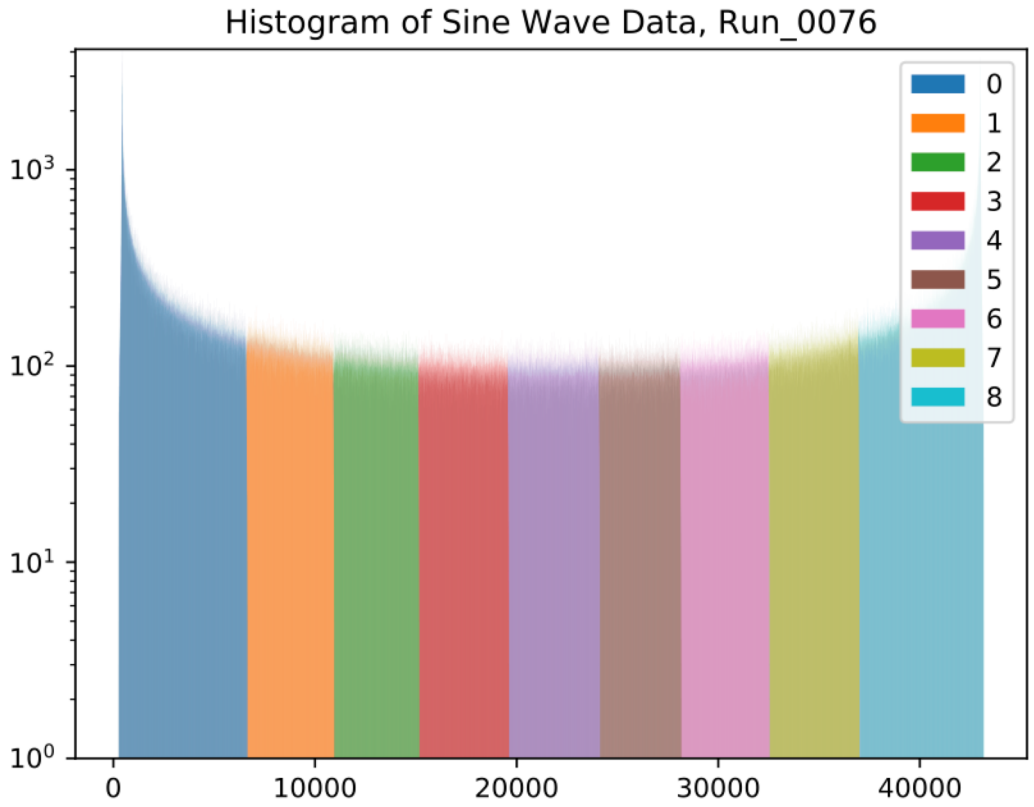
Histogram of Counts

- Looked at data from 12 V sine wave, applied MDAC MDAC constants from Brian (calculated using sine wave data) and SAR constants from Chen-Kai
- Will use this to calculate INL and DNL



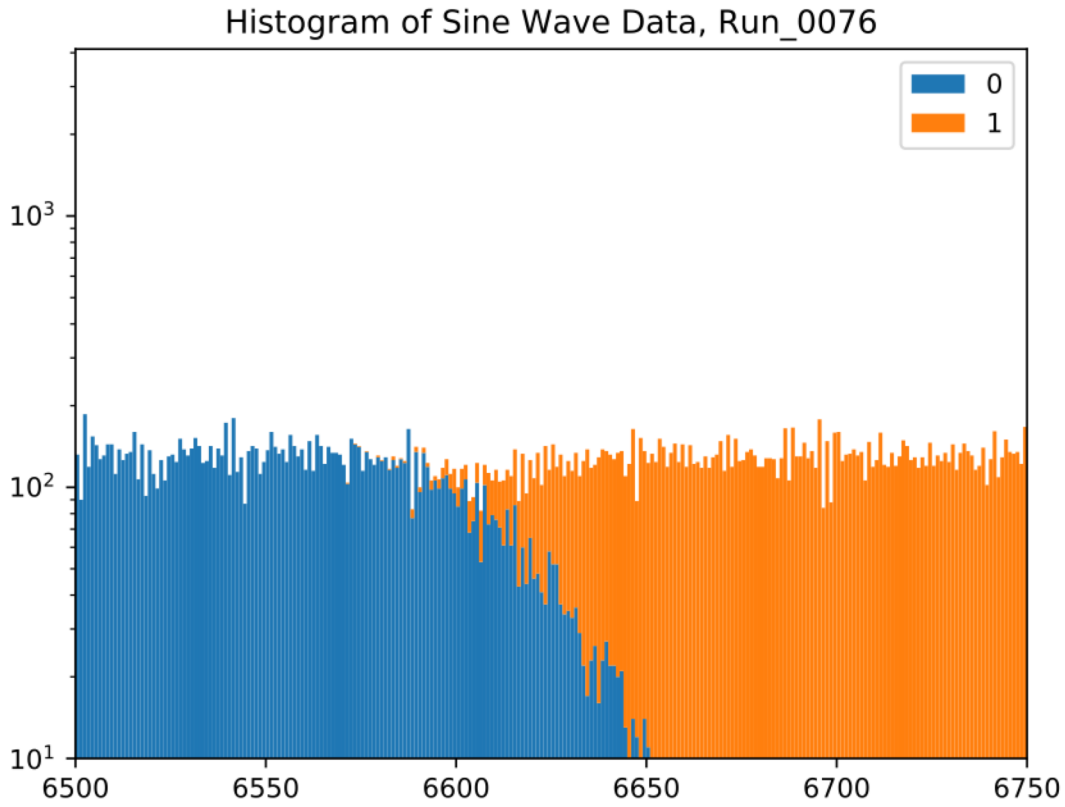
Zoom in on Transition Regions

- As a qualitive check for nonlinearity, zoom in on the regions surrounding each MDAC transition
  - If MDAC and SAR constants are correct, there should be no obvious dips/bumps in the histogram



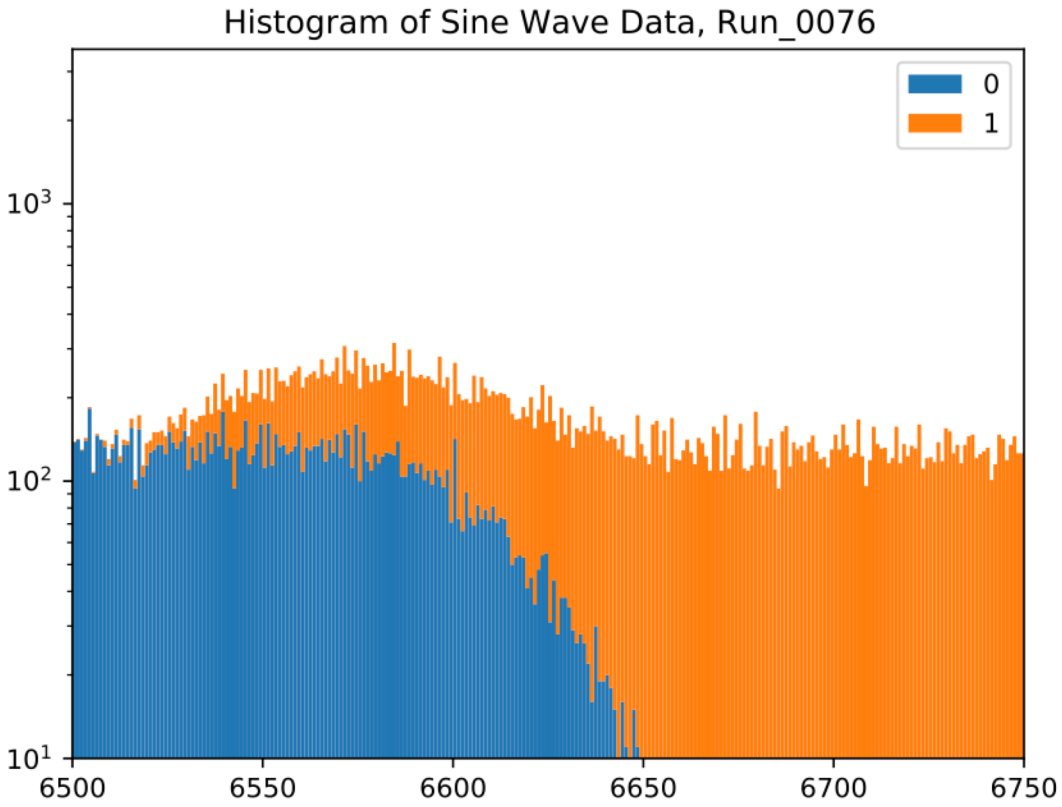
Example Transition Region

- There is no noticeable bump at the MDAC transition region, suggesting the MDAC constants are correct
  - If we used “wrong” MDAC constants, what happens?



Transition Region with Wrong Constants

- We see a noticeable bump
  - Here is a zoomed in transition region with the default MDAC constants applied, i.e. constants are the default 4280 instead of the calibrated ~4340



Calculation of INL and DNL

- Used quantitative method outlined in ADC testing document

Second, the transition voltages are found from

$$V_j = -A\cos\left(\frac{\pi}{M}\sum_{k=0}^{j} H_k\right)$$

Once the transition voltages are known, the INL and DNL follow

$$\mathrm{INL}_j = \frac{V_j - V_1}{1\ \mathrm{LSB}} \qquad \mathrm{DNL}_j = \frac{V_{j+1} - V_j}{1\ \mathrm{LSB}}$$

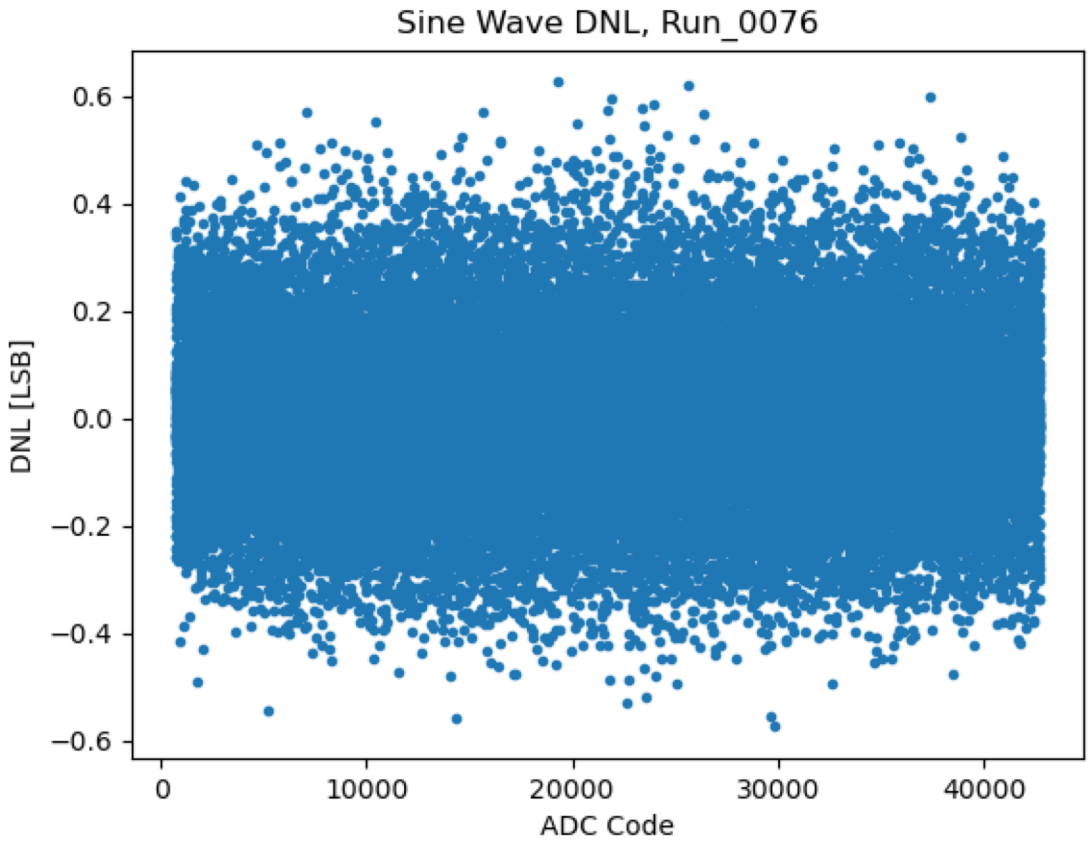
-1

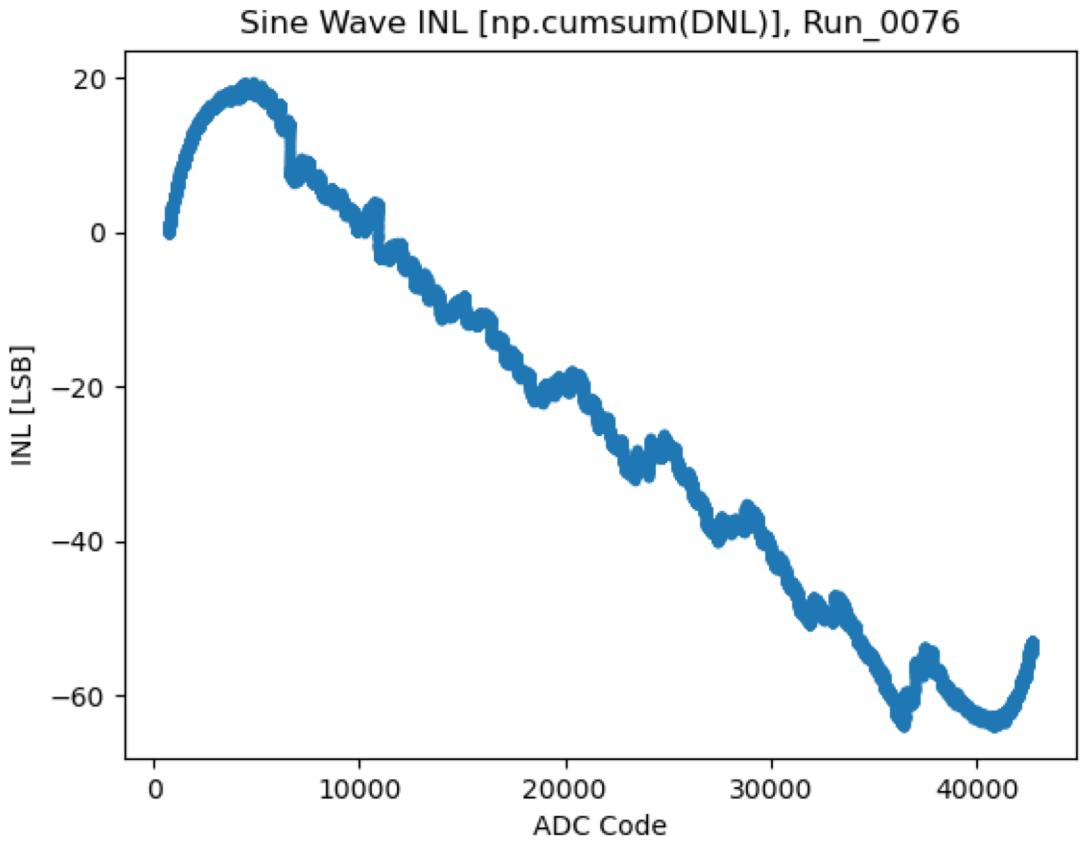
= np.cumsum(DNL)

A = amplitude in ADC counts
M = total number of samples
H_k = contents of hist bin k

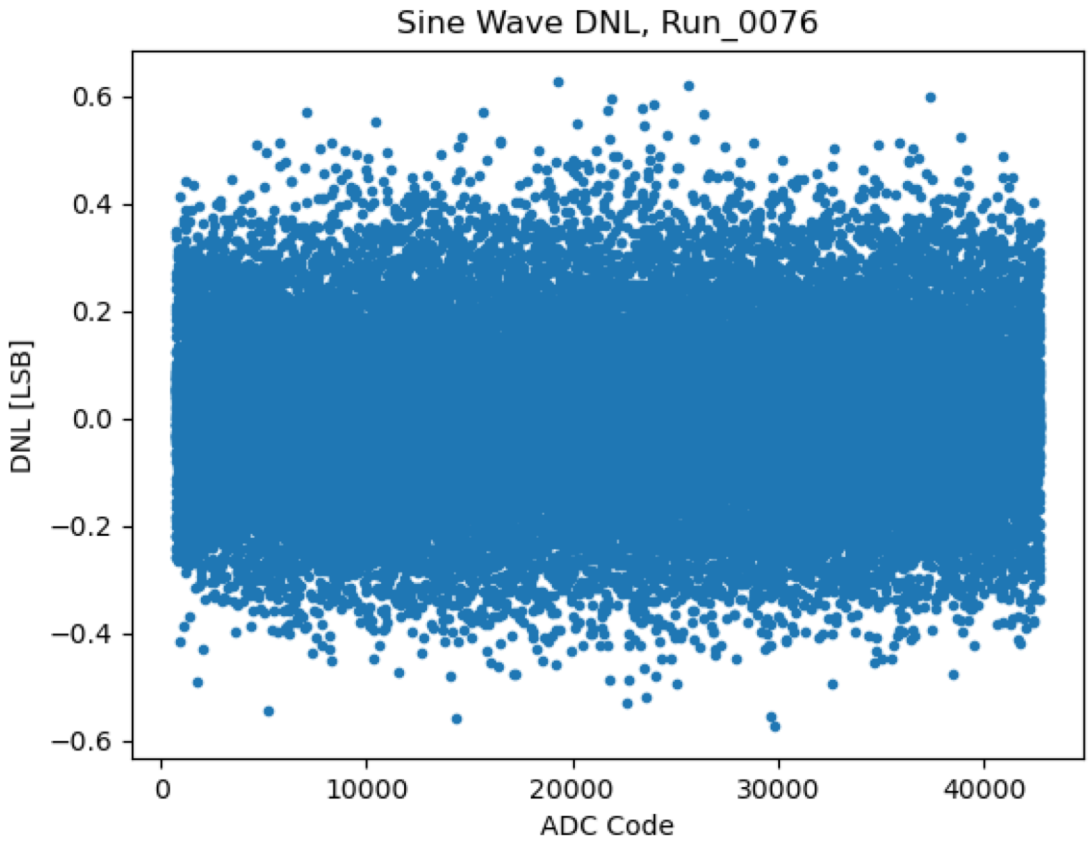
MDAC_weights = [4280, 4344.26, 4342.07, 4340.94, 4344.62, 4345.64, 4350.17, 4359.58]
SAR_weights = [3584, 2048.23, 1025.45, 641.601, 385.307, 257.055, 127.963, 220.947, 126.739, 62.9949, 31.8938, 23.623, 15.7468, 9.87716, 5.92556, 3.93465, 1.93457, 1.02868, 0.519091, 0.332857]

DNL and INL (first method)

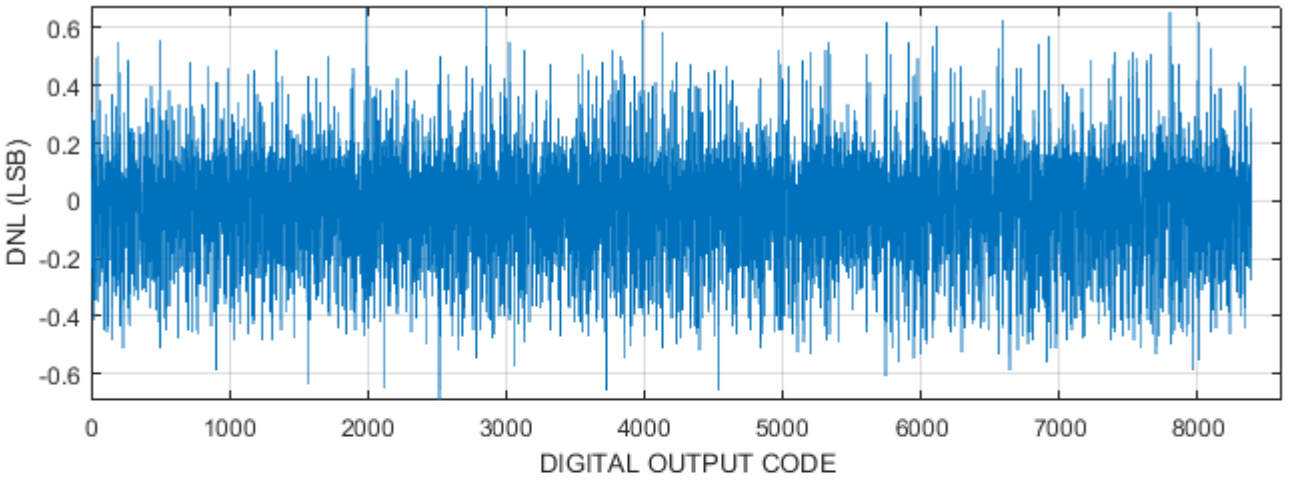




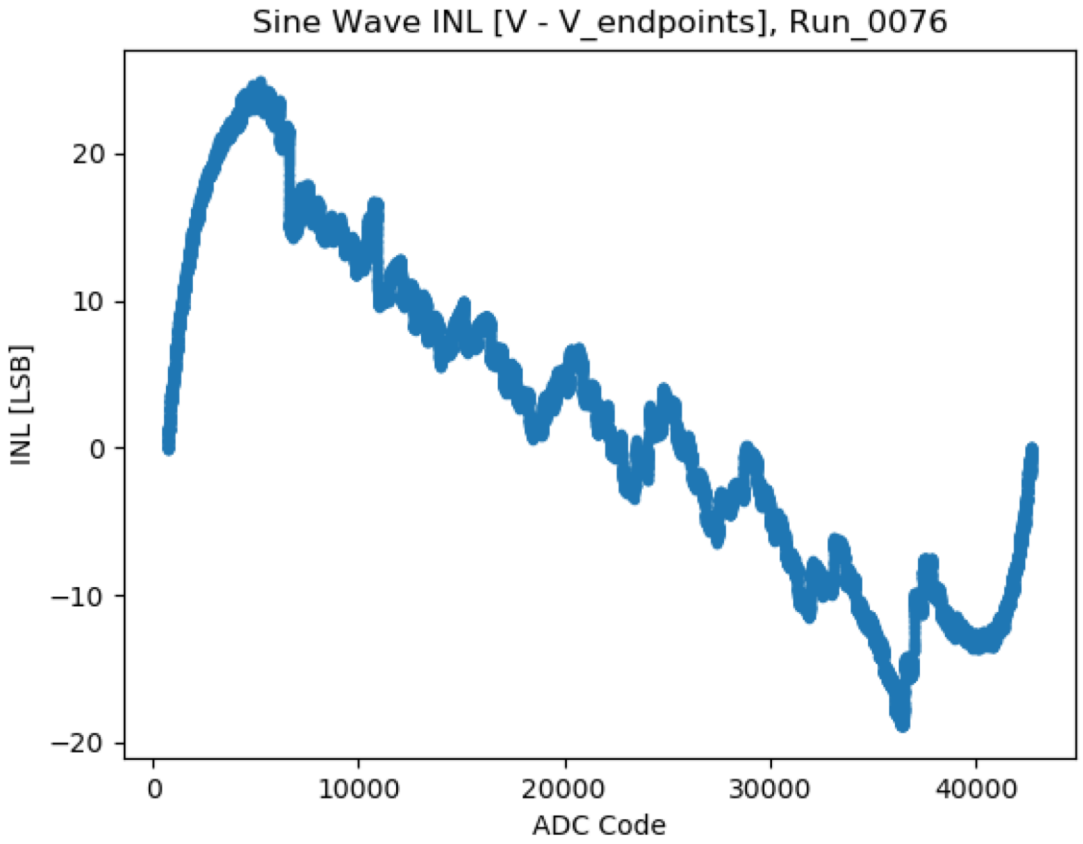
DNL Comparison

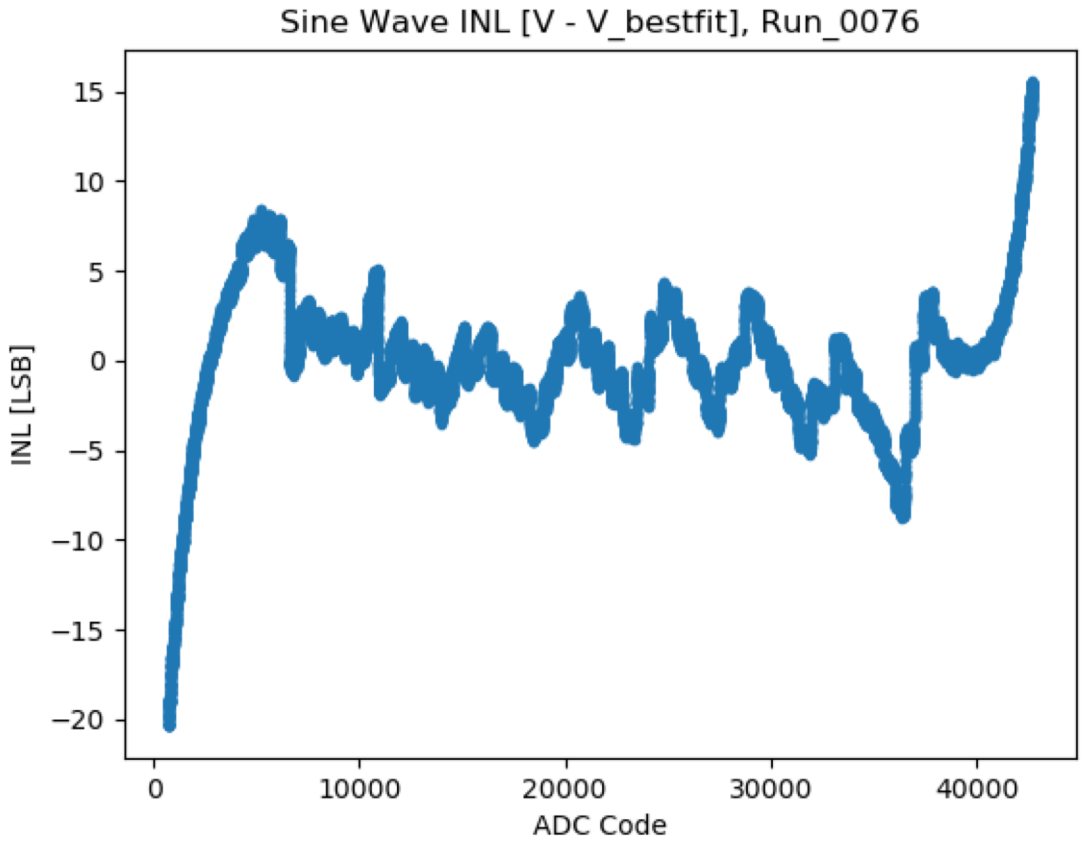


- DNL appears similar to Chen-Kai's results for the calibrated SAR

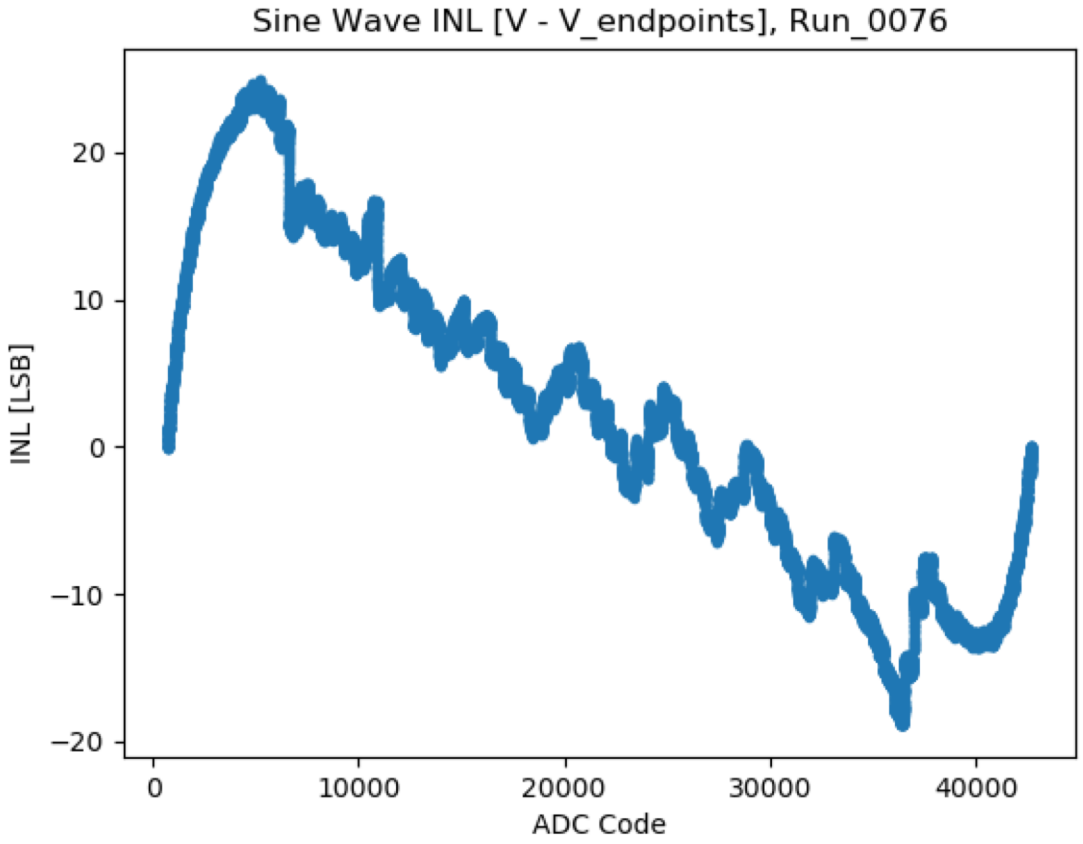


INL (Endpoint and Best-fit methods)



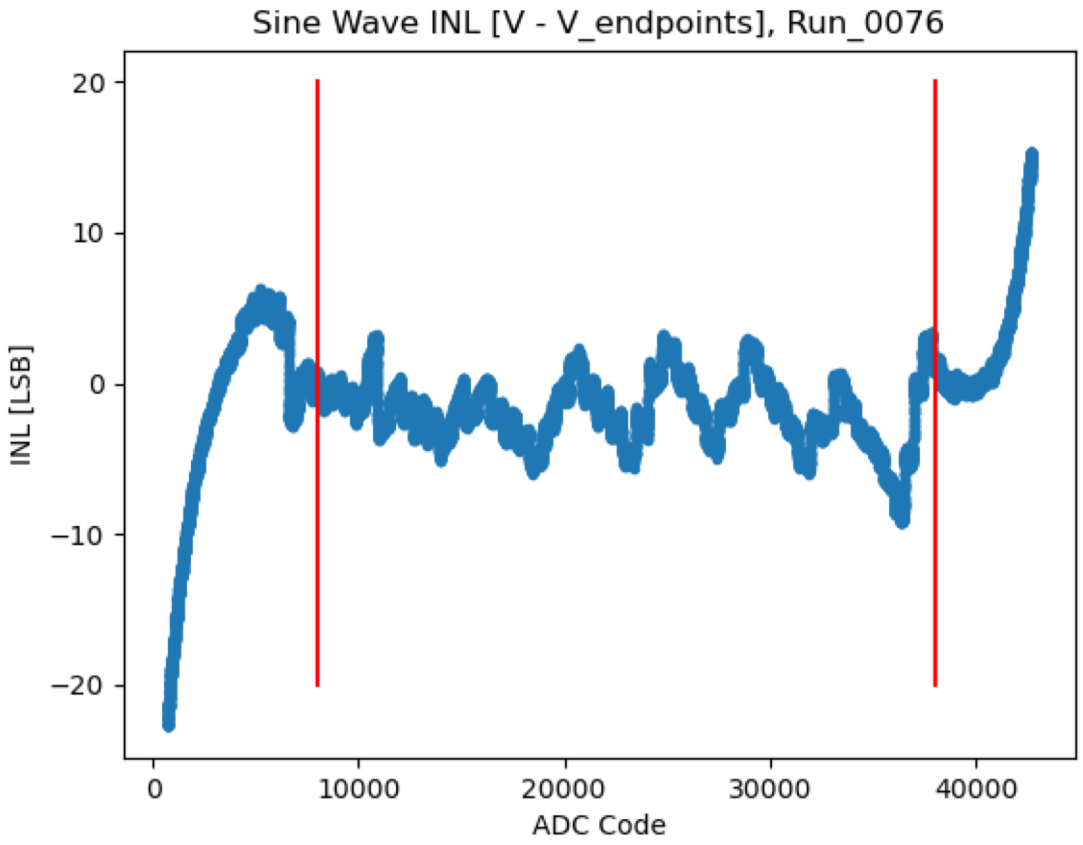


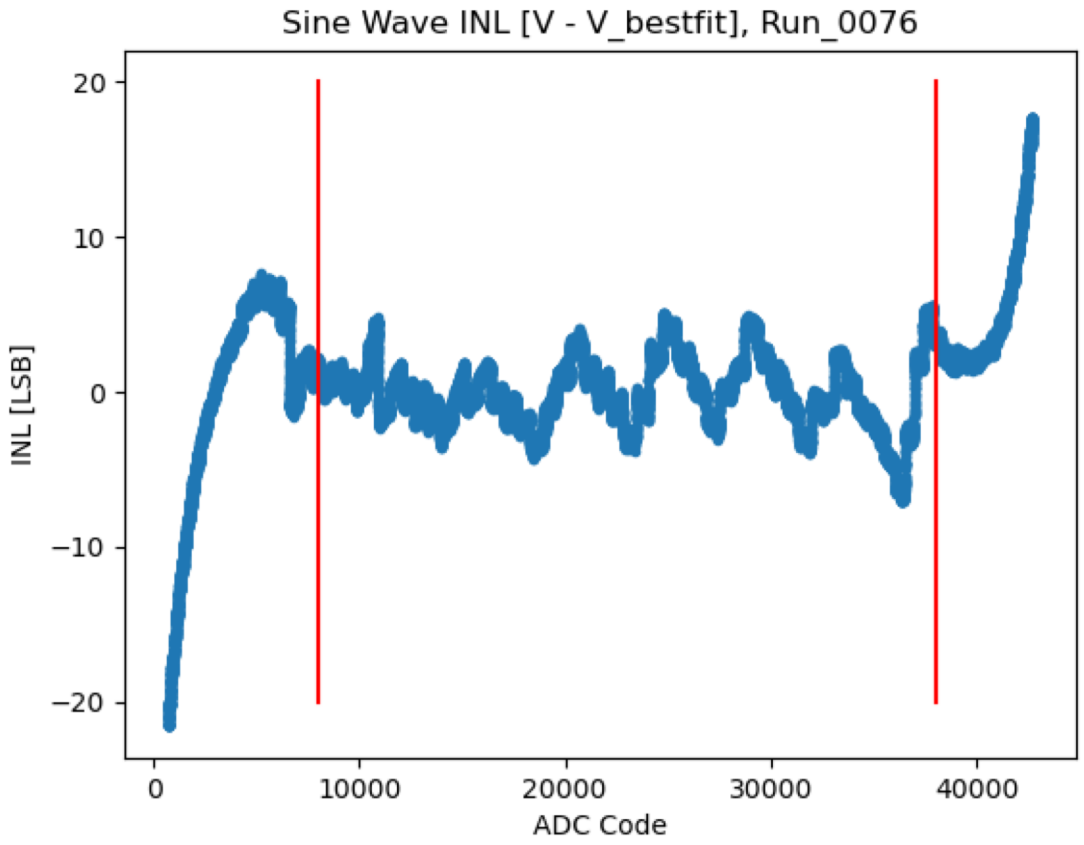
INL End Behavior



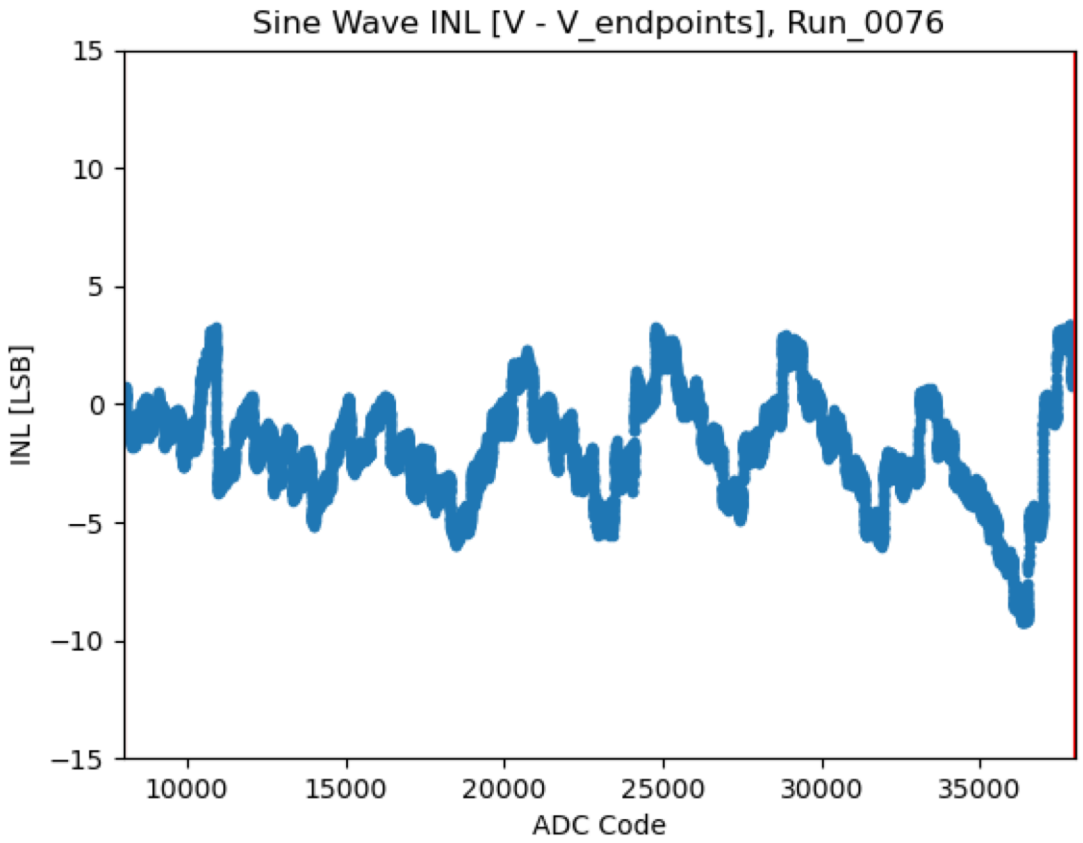
- 12 V from AWG appears to exceed the good operating range, causing the large INL values seen at either end of the distribution
  - Restricting the fit to the good operating range should get rid of this negative slope and better give us and idea of INL

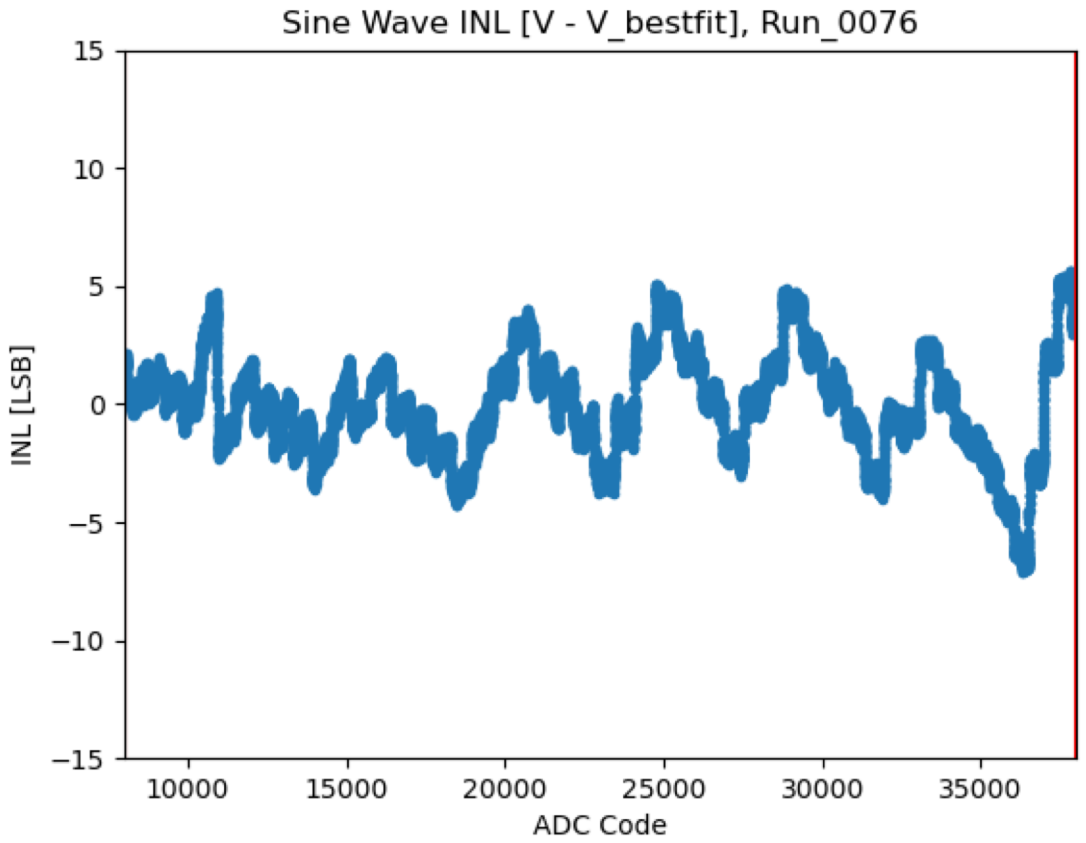
INL (restricting fit range)



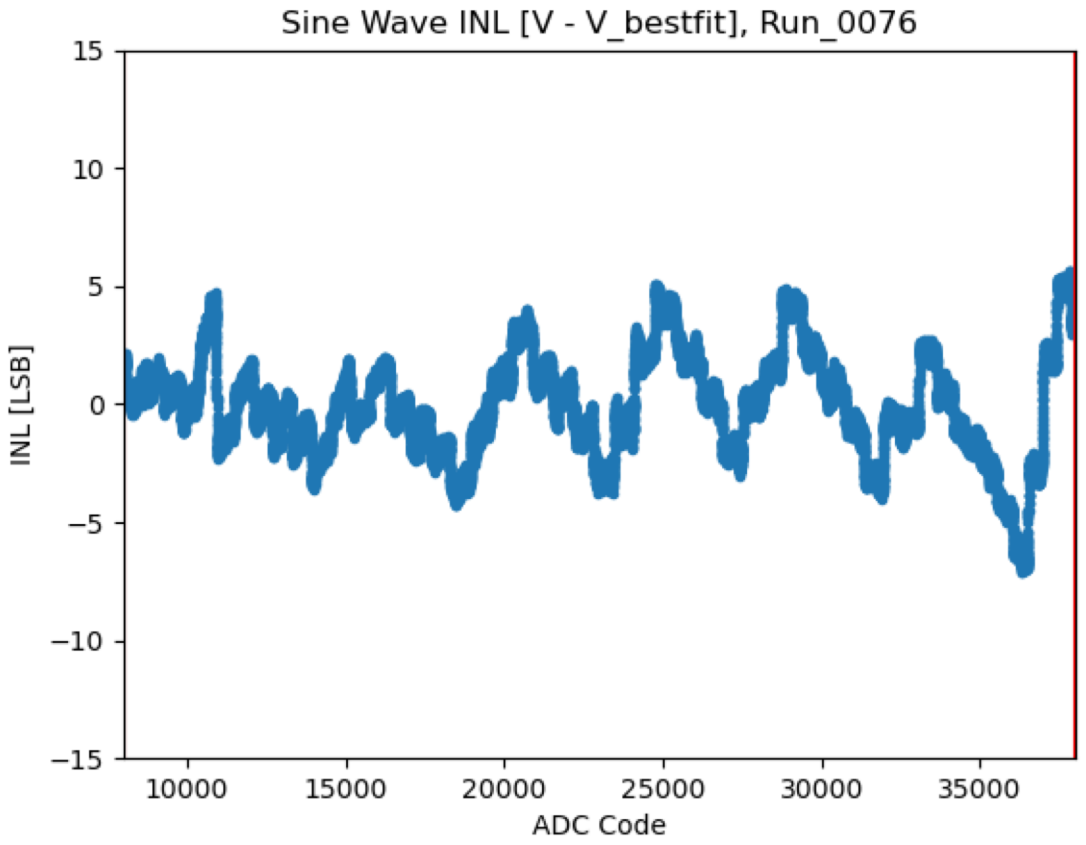


INL (restricting fit range, zoomed)

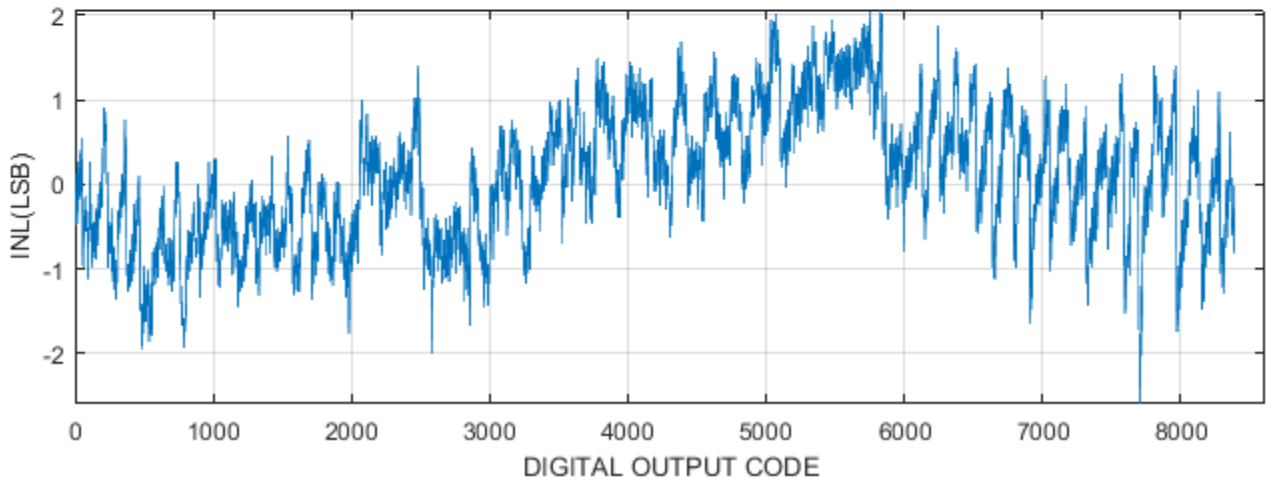




INL Comparison

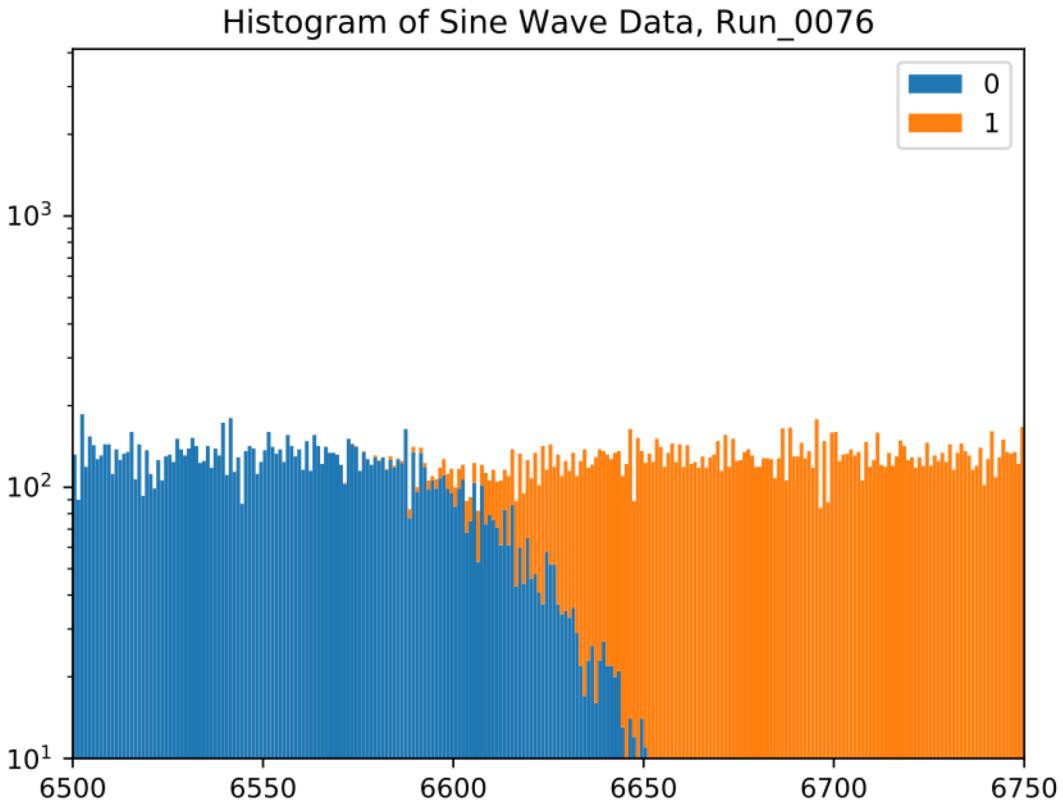


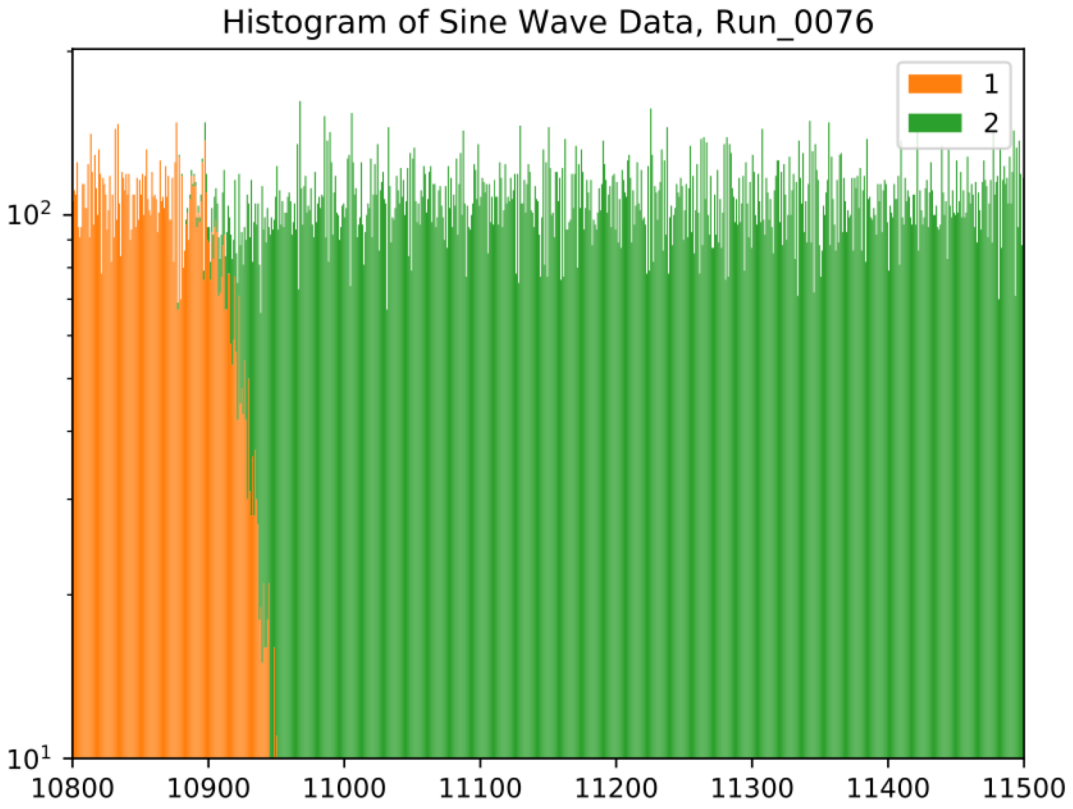
- INL appears worse than Chen-Kai's results for the calibrated SAR
  - MDAC adds ~4 counts to INL



Backup

Zoom in on Transition Regions





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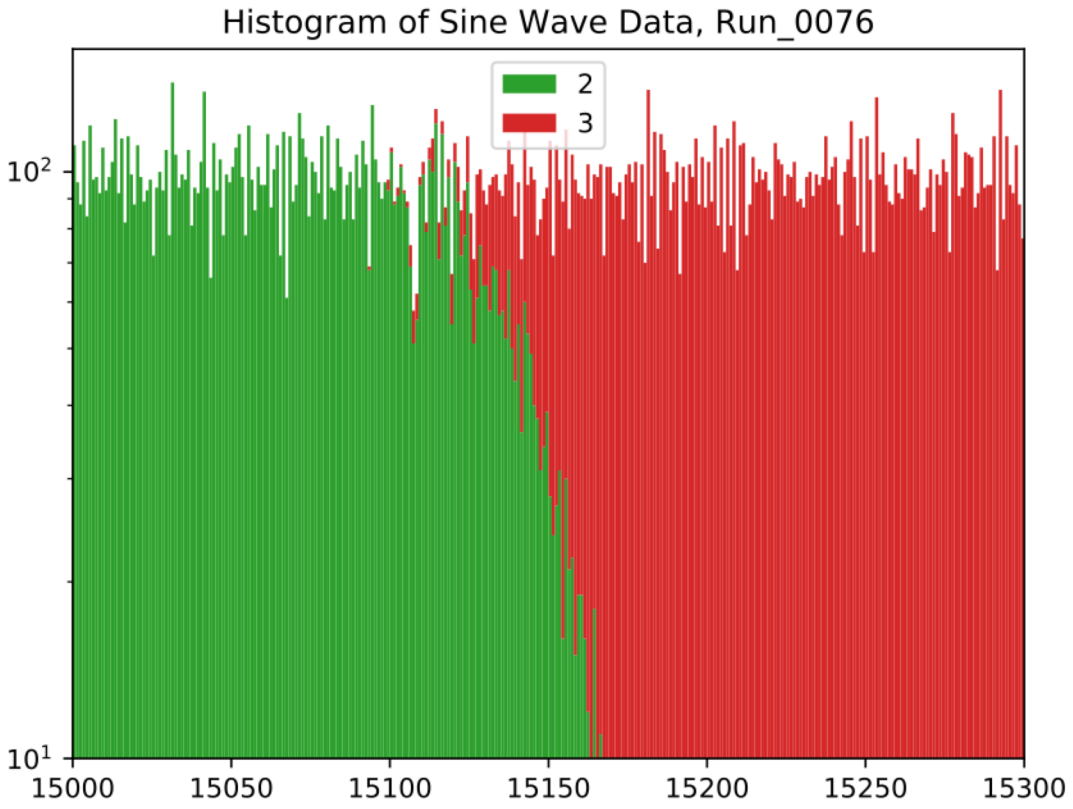

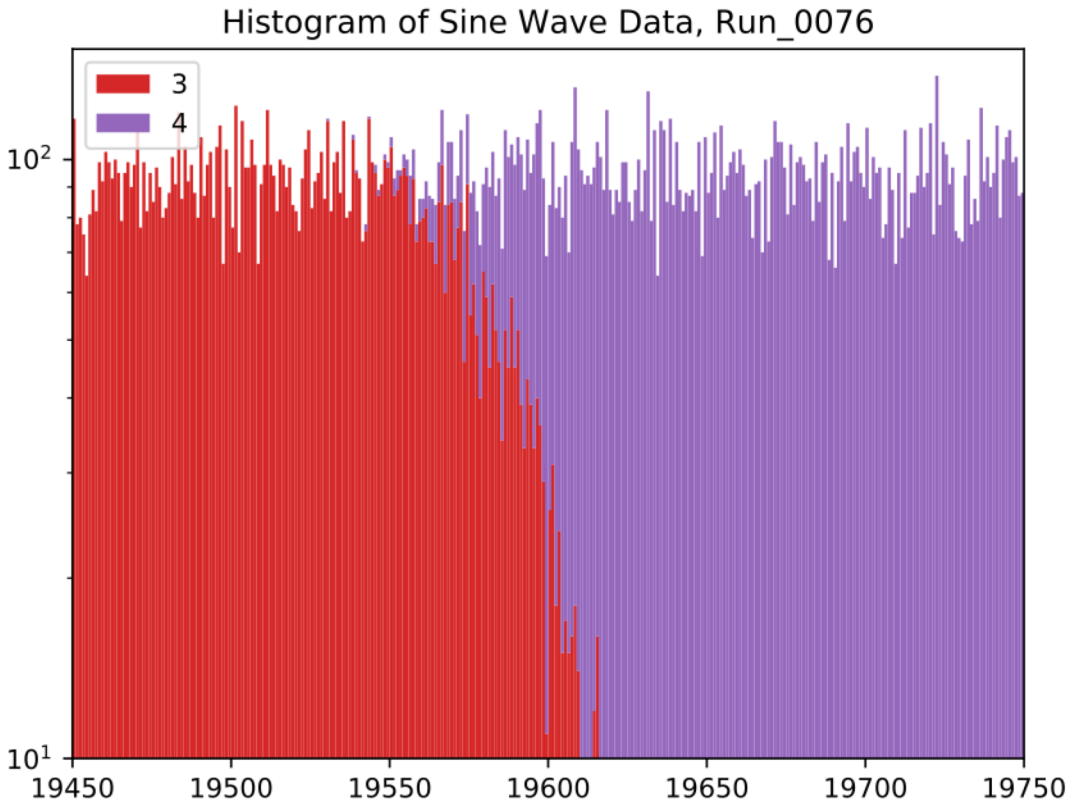

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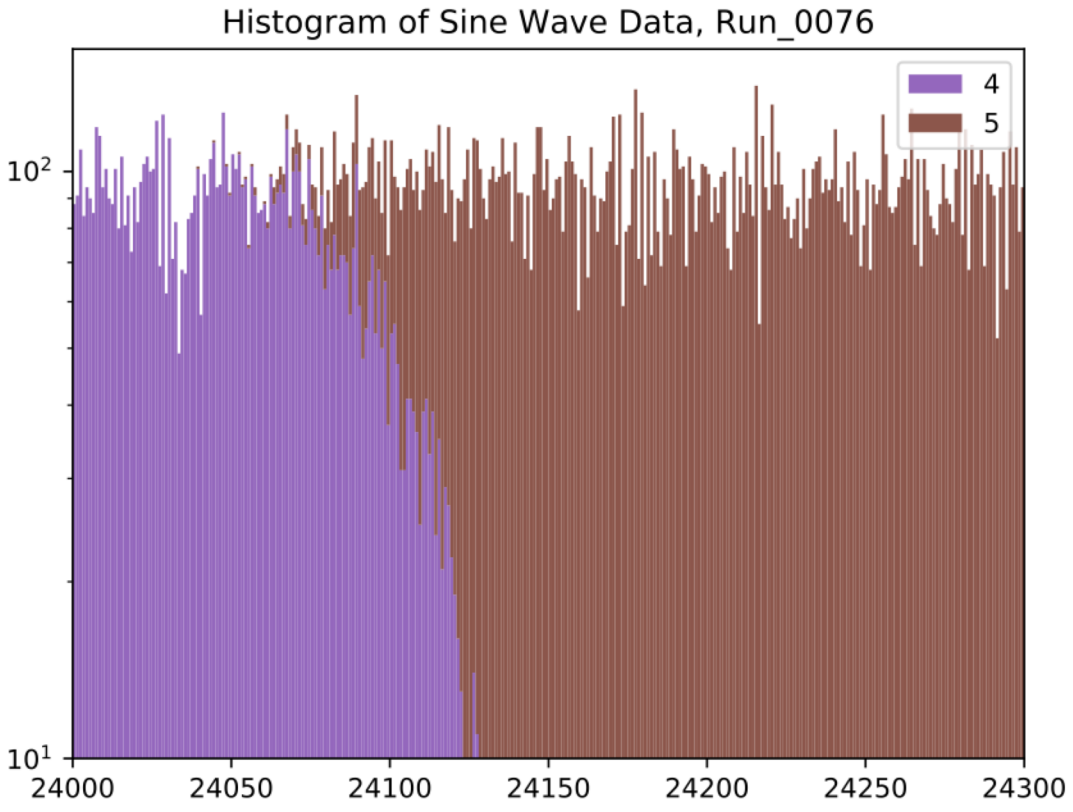

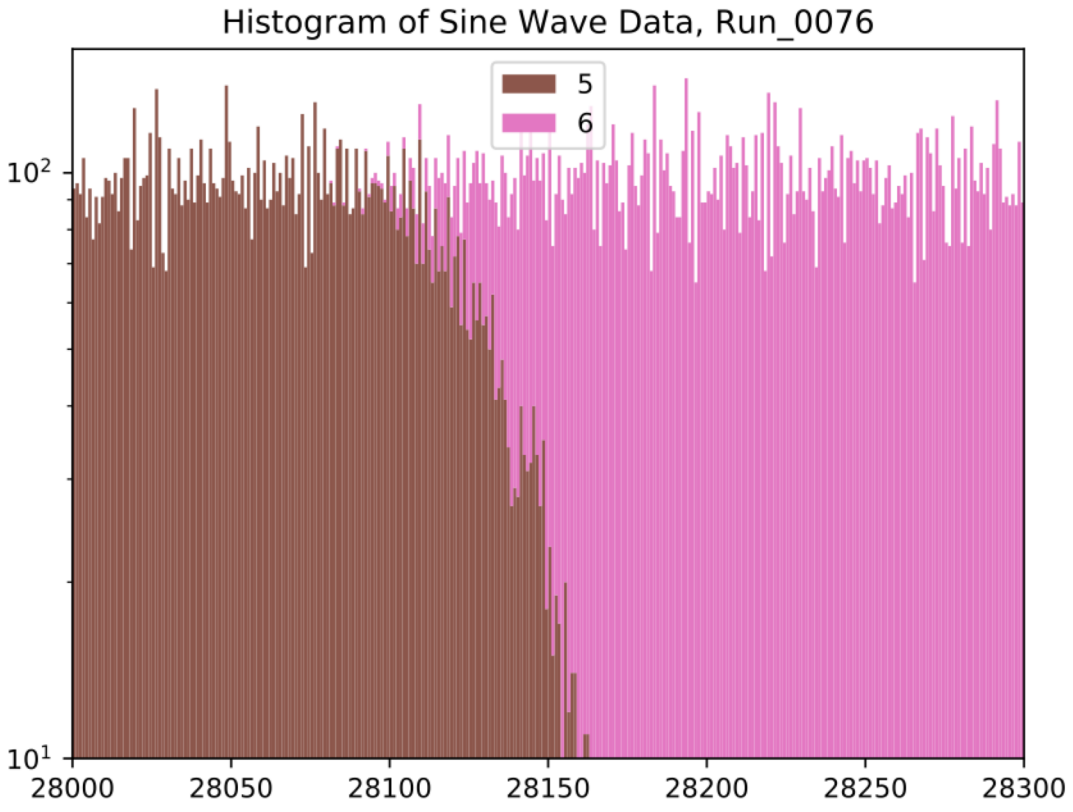

Zoom in on Transition Regions