Photon Counting: Interim Lab Report

Diana Kossakowski
Lab Group: foxy

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Key Step 1

We collected our data from the photomultiplier and then we plotted the intervals between the events as shown in Figure 1 and Figure 2. Figure 1 and Figure 2 represent the same data, though, Figure 2 presents the data more clearly by showing how the integers go from 2^31 to -2^31 with a gap in between (not evidently clear in Figure 1). When the "dtype='int32'" argument is left out, the data will load in as floats which will end up using a little bit more memory which becomes a problem when reading in a large amount of data.

Key Step 2

After exploring the statistical properties of the mean interval between events, recorded by the photomultiplier, we see that the precision of the mean is quantified by the standard deviation of the mean, given by $\frac{s}{\sqrt{N}}$, where s is the standard deviation for the data set and N is the number of event intervals. Figures 6, 8, and 9 show this precision.

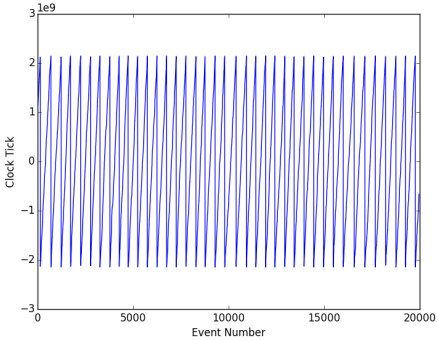

Figure 1: Time Series. This graph shows how integers are represented between -2^{31} and 2^{31} since the CoinPro counter uses 32 bits. This means that when the ticks reach 2,147,483,647, the next tick "rolls over" to -2,147,483,648. Python formats the plot such that points are connected together. A better representation of the "rolling over" would be if the plot were plotted by individual points (as in Figure 2).

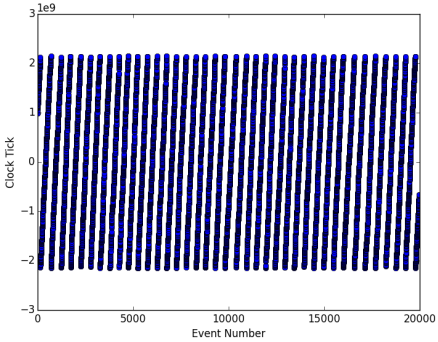

Figure 2: Time Series. Scattered

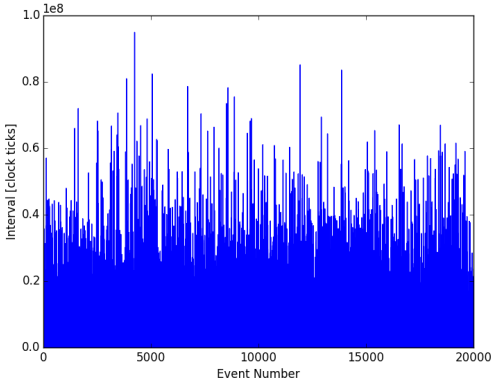

Figure 3: Clock Interval: Interval subsequent events (in clock ticks) as a function of event number. Here, the points are joined by lines making it harder and less clear to understand the data

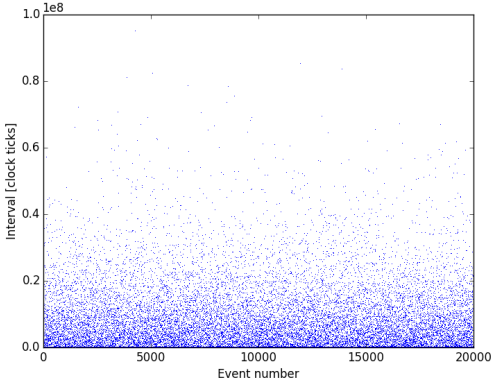

Figure 4: Clock Interval: Scattered. Here, the points are just points, making it much more evident and precise as to what the data is.

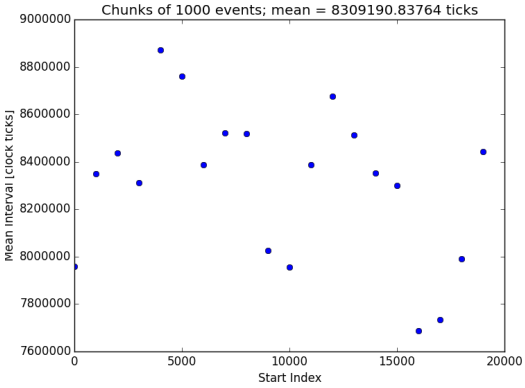

Figure 5: The mean interval form Figure 3/Figure 4 computed for twenty chunks of 1000 events. One can see how the means of chunks are close to the mean interval.

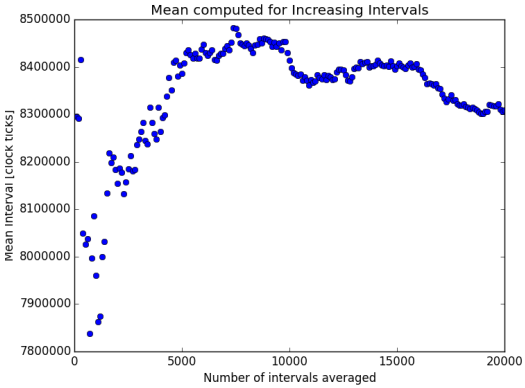

Figure 6: The mean for fractions of data are computed for increasing intervals. The points on the left represent the means of smaller chunks of data and the points on the right represent the means of increasingly larger chunks of data (the last point is the mean for all 20,000 events)

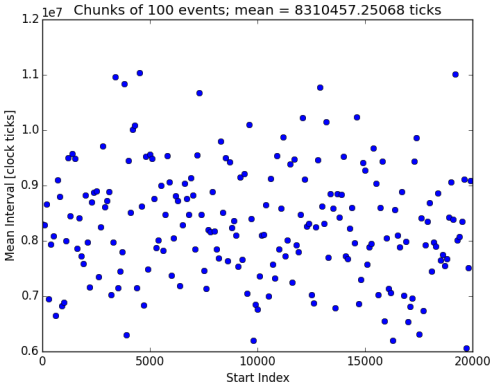

Figure 7: The mean interval form Figure 3/ Figure 4 computed for chunks of 100 events. One can see how the means of chunks are close to the mean interval.

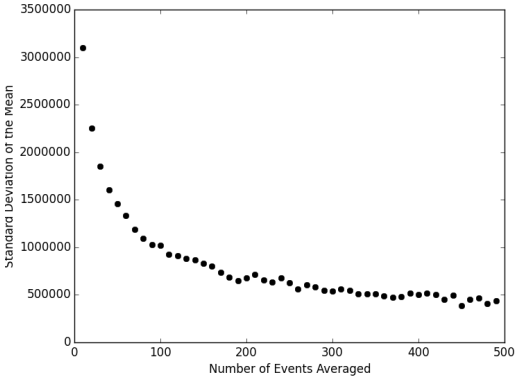

Figure 8: Variation of the standard deviation of the mean with the size of the data chunk averaged

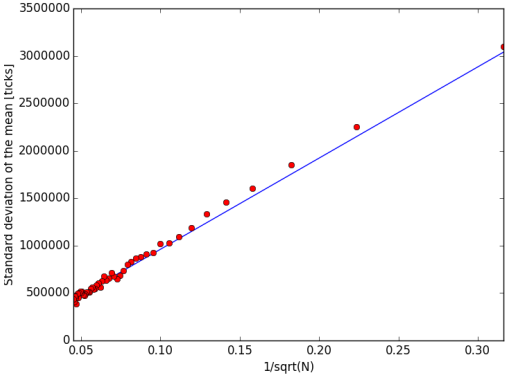

Figure 9: Figure 8: Standard deviation of the mean vs. $\frac{1}{\sqrt{(N)}}$ showing linear behavior. The green line is the theoretical expectation with SDOM = $\frac{s}{\sqrt{(N)}}$, where s is the sample standard deviation