(4) For the linearized data I found the best fit line gave a lifetime of :

$\tau = 3.47 * 10^{-8}$ s

Which compared to the theoretical value of

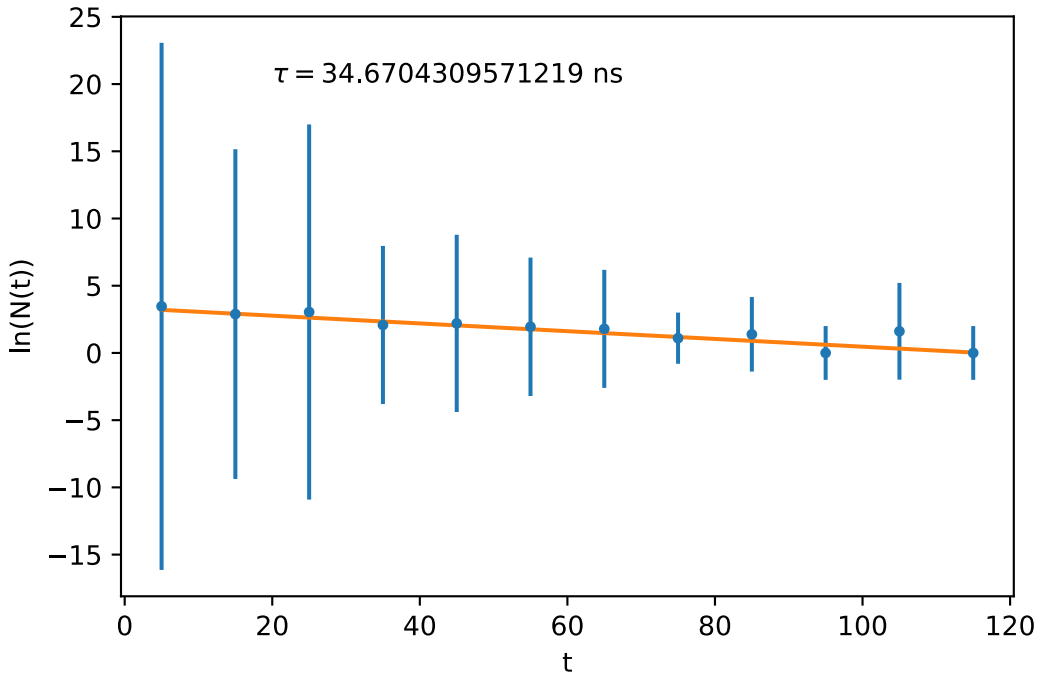
$\tau = 2.6x10^{-8}\ s$

Has a percent different of 86.6%, so it's not great.

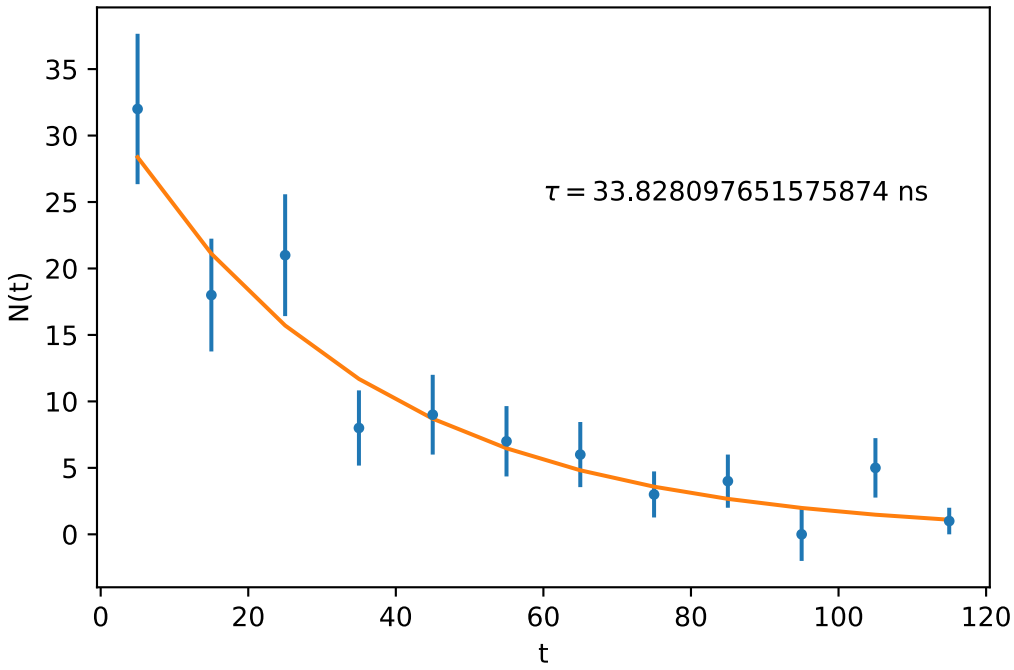
(5) For the non-linearized data, I found a lifetime of:

$\tau = (3.28 \pm 1.32)^{-8}\ s$ [uncertainty from covariance matrix]

Which compared to the theoretical value gives a percent difference of 23%, so better than the linearized equation, but still not great.



The uncertainties in the linear regression seem a bit too large to make a good fit. Also, as a side note, the error bars on the t = 95 ns is large because I assigned it to be large before fitting. I did this because there were 0 counts at this point and the natural log of 0 in -inf. By assigning the error bars to be substantially larger than the other points, I reduce the significance of the fit to this point. There are many lines which could be plotted through these error bars. However, the line does run through all of the error bars, which doesn't occur for the exponential fit.



Compared to the linear fit, the exponential looks worse, by eye to me, but it's determined lifetime value is closer to the theoretical value.

(9) Improving the quality of the fit:

So, per a certain suggestion, I tried artificially increasing the uncertainties in the data by a factor of 2. This increases the quality of the fit for the exponential and brought the percent difference down from 23% before increasing the uncertainties to 19% after increasing the uncertainty. Also the uncertainty in the best fit half-life decreased from $1.32 * 10^{-8}$ to $1.28 * 10^{-8}$ Then when I increased the uncertainties by a factor of 4, I decreased the percent difference to 1.5% and the error to $1.17 * 10^{-8}$ s. It seems curious to me that increasing the experimental uncertainties *decreases* the uncertainty in the fit. While curve_fit chooses the optimal fit, I expect there are other fits which have no statistical difference in the goodness of fit.