Neil Ghugare

Physics 3700

Lab 5 Report

The goal of this lab was to demonstrate the principle of propagation of errors and χ^2 analysis. This was done by measuring the resistance of 200 resistors across five PCB boards. Scatter plot histograms of the collected R_1, R_2, and R_{12} resistance of the resistors on the PCB boards are displayed on Figures 1, 2, and 3, respectively. A Gaussian distribution is superimposed on top of the histogram. Using this Gaussian distribution, we can extract the respective σ_1, σ_2, and σ_{12} standard deviations of the distributions. We extracted values of $\sigma_1 = 0.0044$, $\sigma_2 = 0.0053$, and $\sigma_{12} = 0.007$ from the expectation. Using our experimental data and Gaussian expectations, we can calculate the χ^2 values for each of the distributions. For the distributions of the R_1, R_2, and R_{12} resistances, we calculate χ^2 values of 7.72, 16.30, and 7.96, with degrees of freedom of 10, 10, and 9, respectively. Therefore, we can calculate the χ^2 / degrees of freedom values of about 0.77, 1.63, and 0.80. These values indicate that our distributions do, in fact, roughly approximate a Gaussian distribution, as they are around one. We can see from the figures that our scatter plot is consistent with the Gaussian expectation as well. Using the propagation of errors formula for uncorrelated variables, we wish to confirm that $\sigma_{12}^2 = \sigma_1^2 + \sigma_2^2$. Using our extracted values, we get $\sigma_{12}^2 = 4.9 \times 10^{-5}$, and we get $\sigma_1^2 + \sigma_2^2 = 4.7 \times 10^{-5}$. Therefore, the percent error between the expected and observed σ_{12} values was about 2% (we needed to square root the values we obtained earlier), so we can say that the measured σ_{12} is consistent with the propagation of errors formula we used.

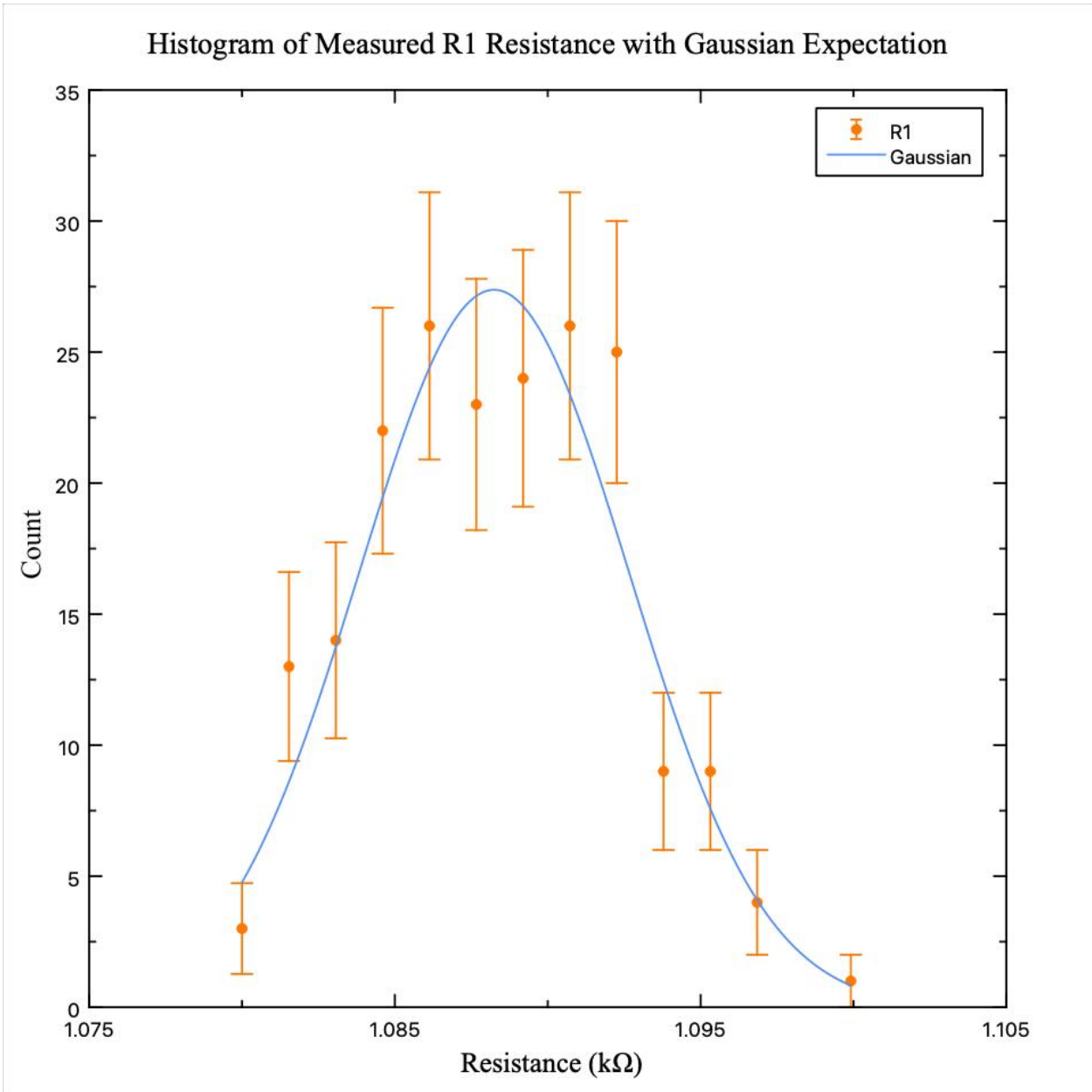

Figure 1: Measured R1 Resistance with Gaussian Expectation

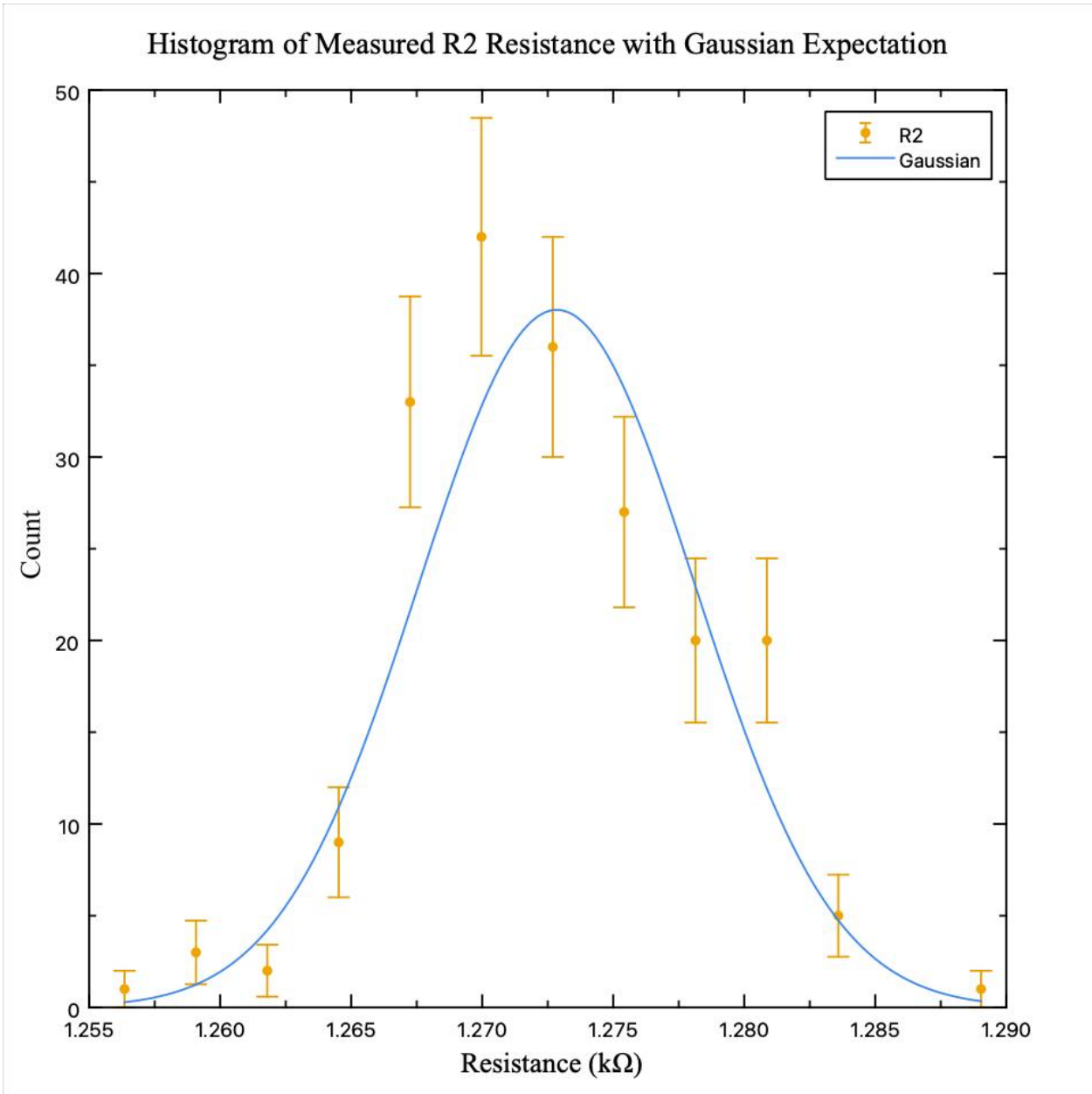

Figure 2: Measured R2 Resistance with Gaussian Expectation

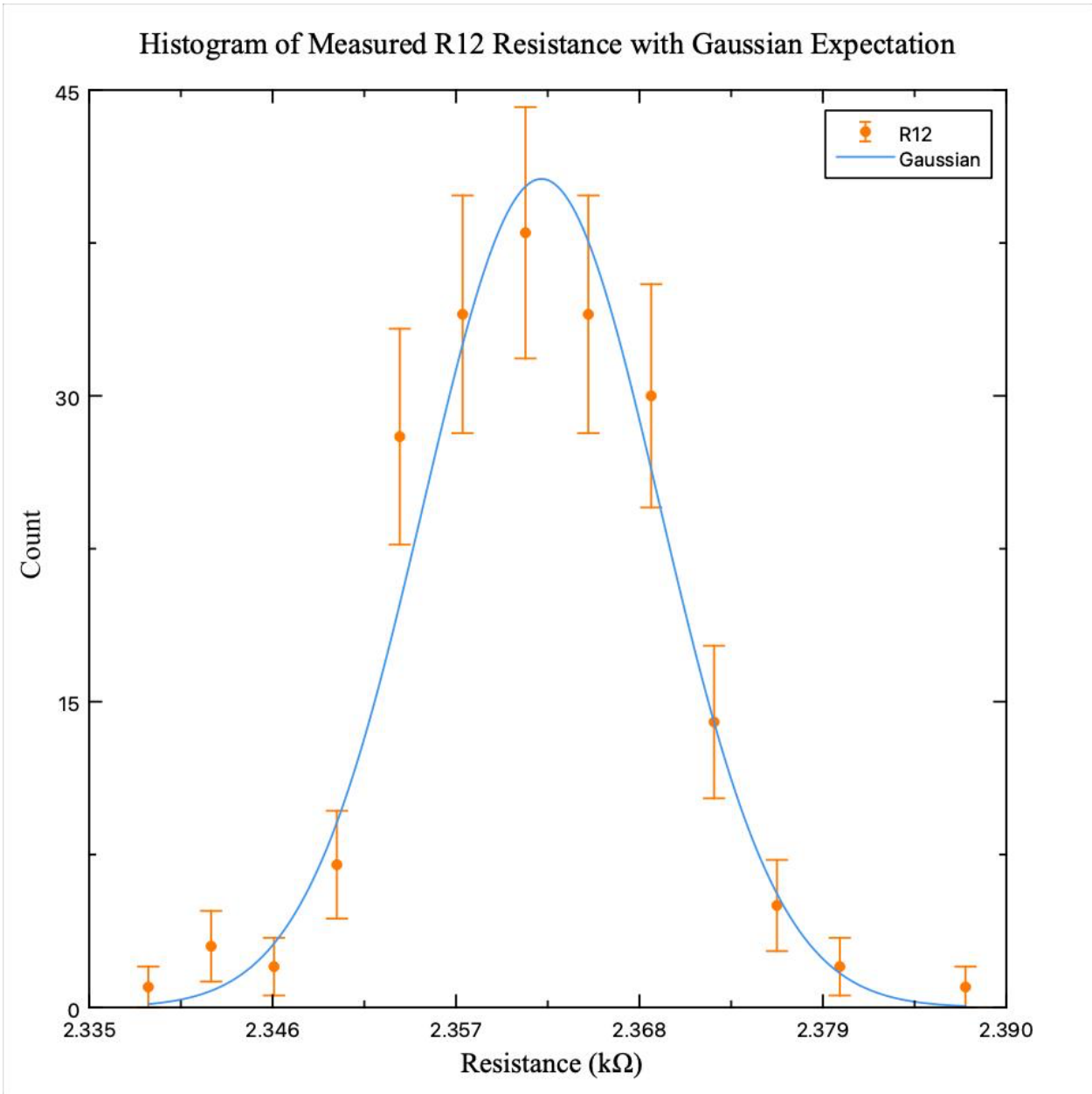

Figure 3: Measured R12 Resistance with Gaussian Expectation