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Plots:

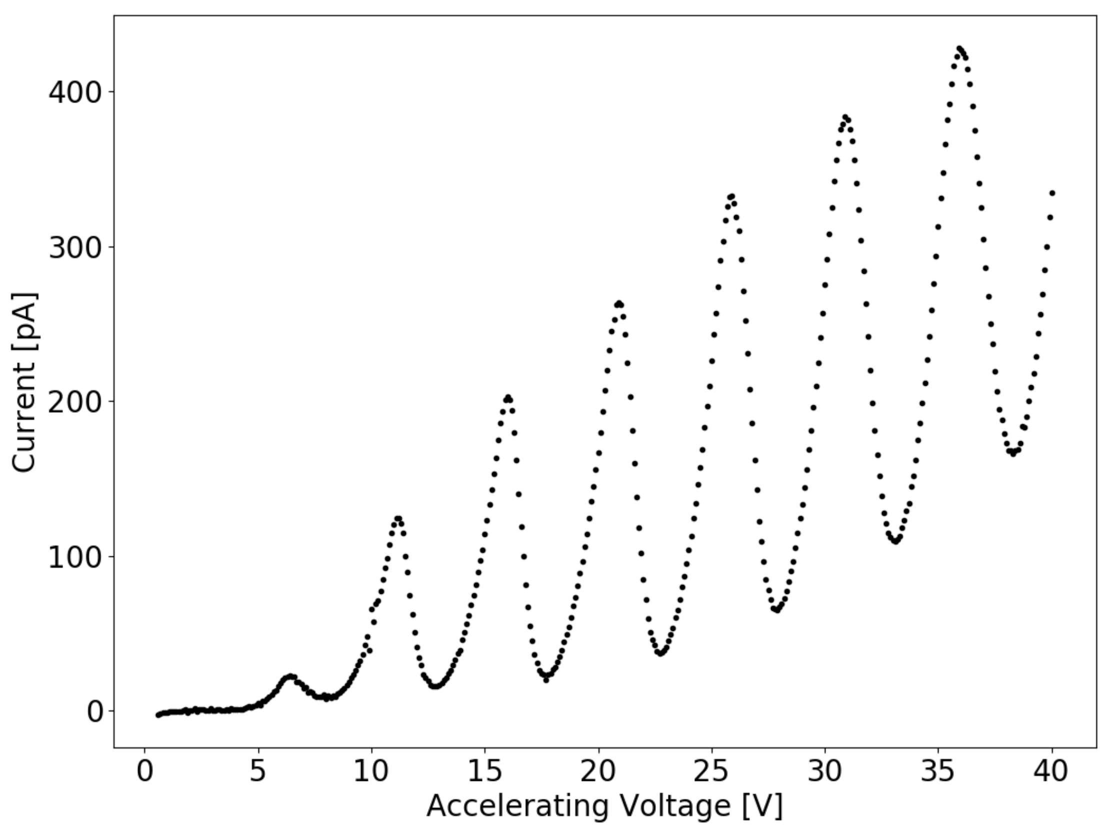

Figure 1: Current vs Accelerating Voltage Overall Scan

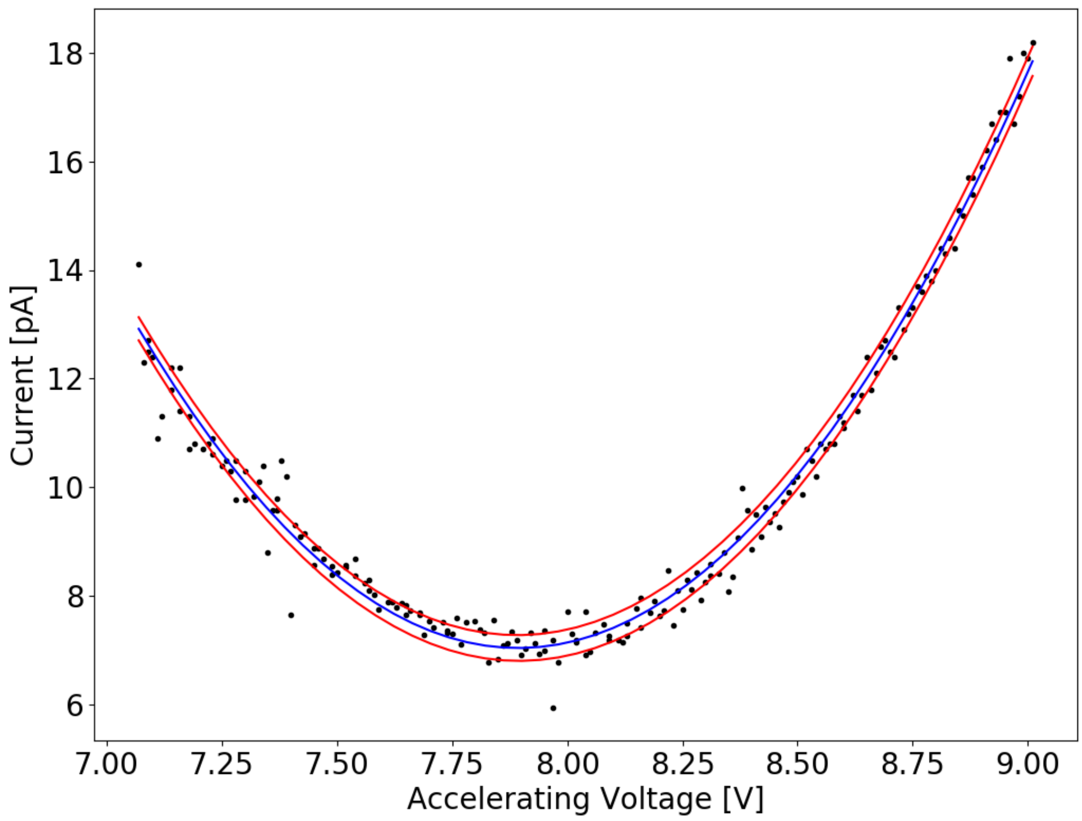

Figure 2: Current vs Accelerating Voltage for minima 1: 7.28

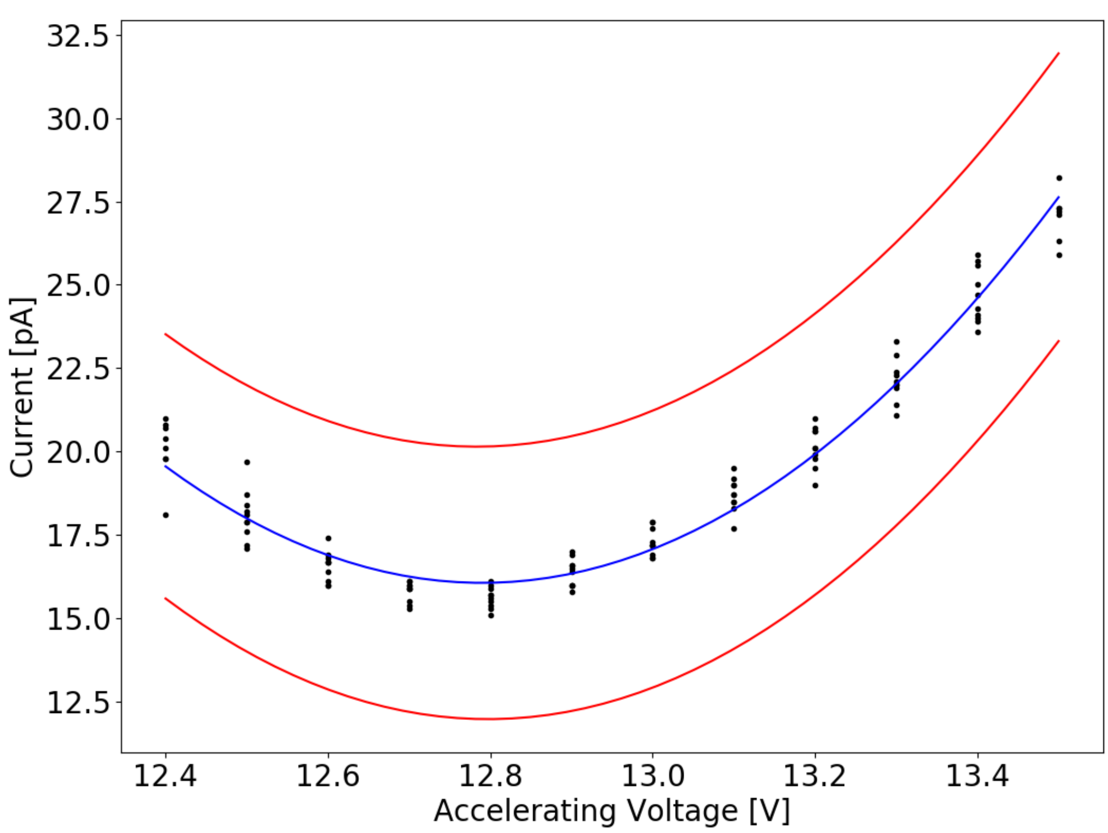

Figure 3: Current vs Accelerating Voltage for minima 2: 12.5

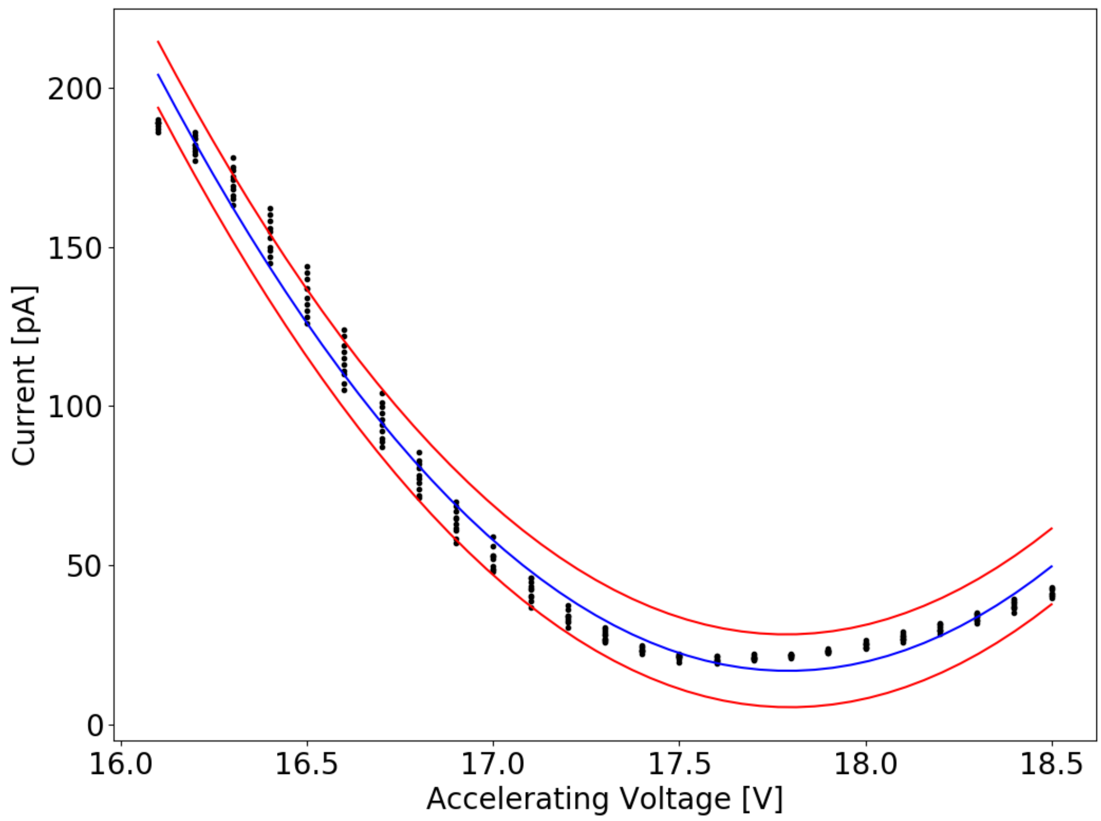

Figure 4: Current vs Accelerating Voltage for minima 3: 16.4

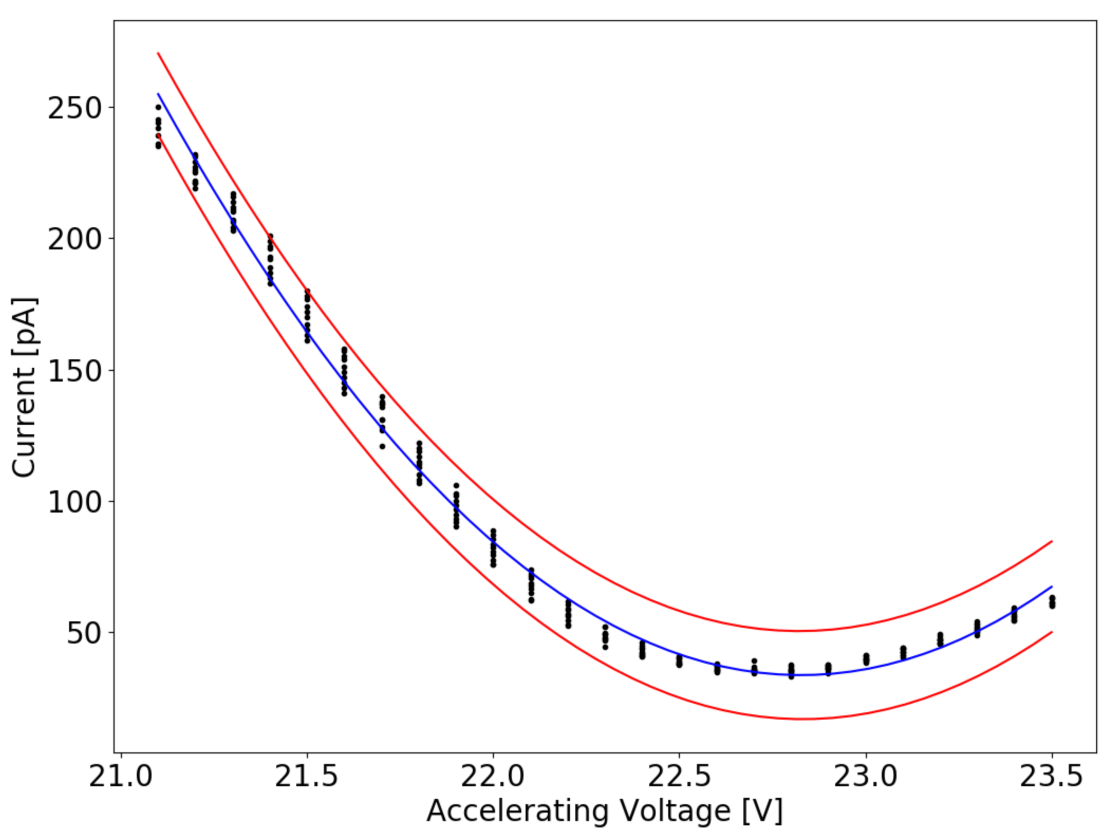

Figure 5: Current vs Accelerating Voltage for minima 4: 21.4

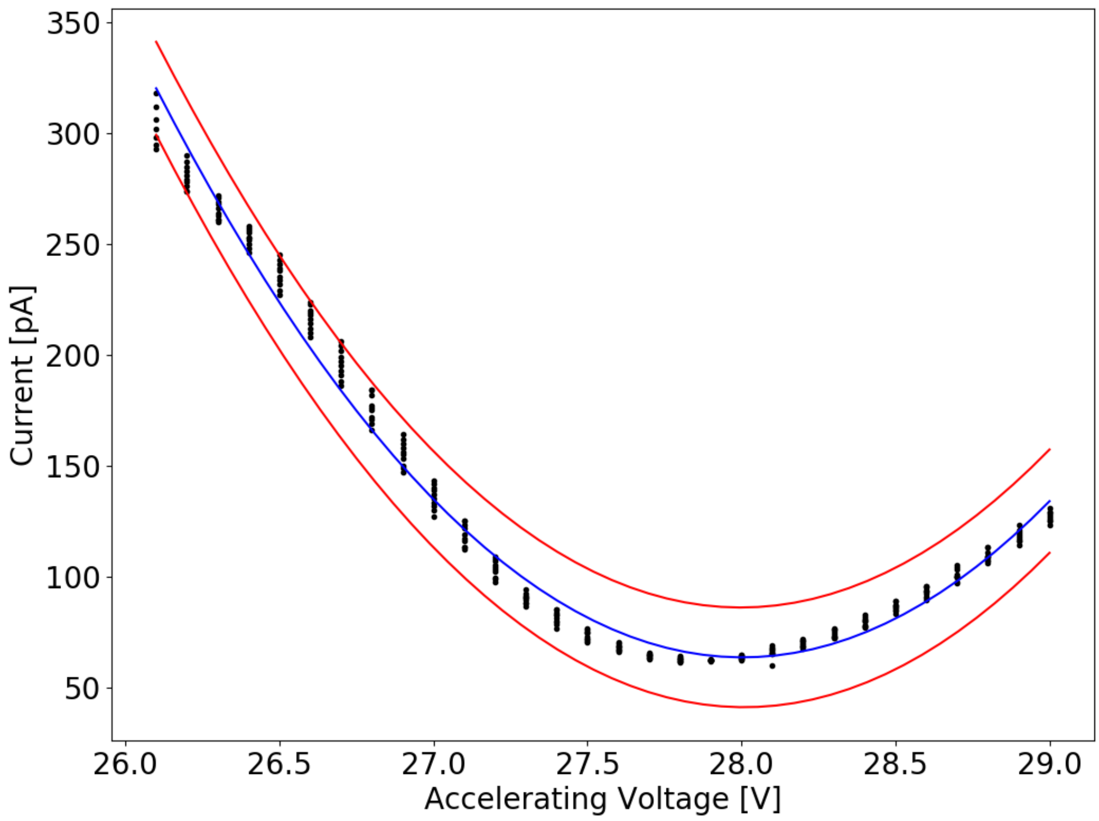

Figure 6: Current vs Accelerating Voltage for minima 5: 26.4

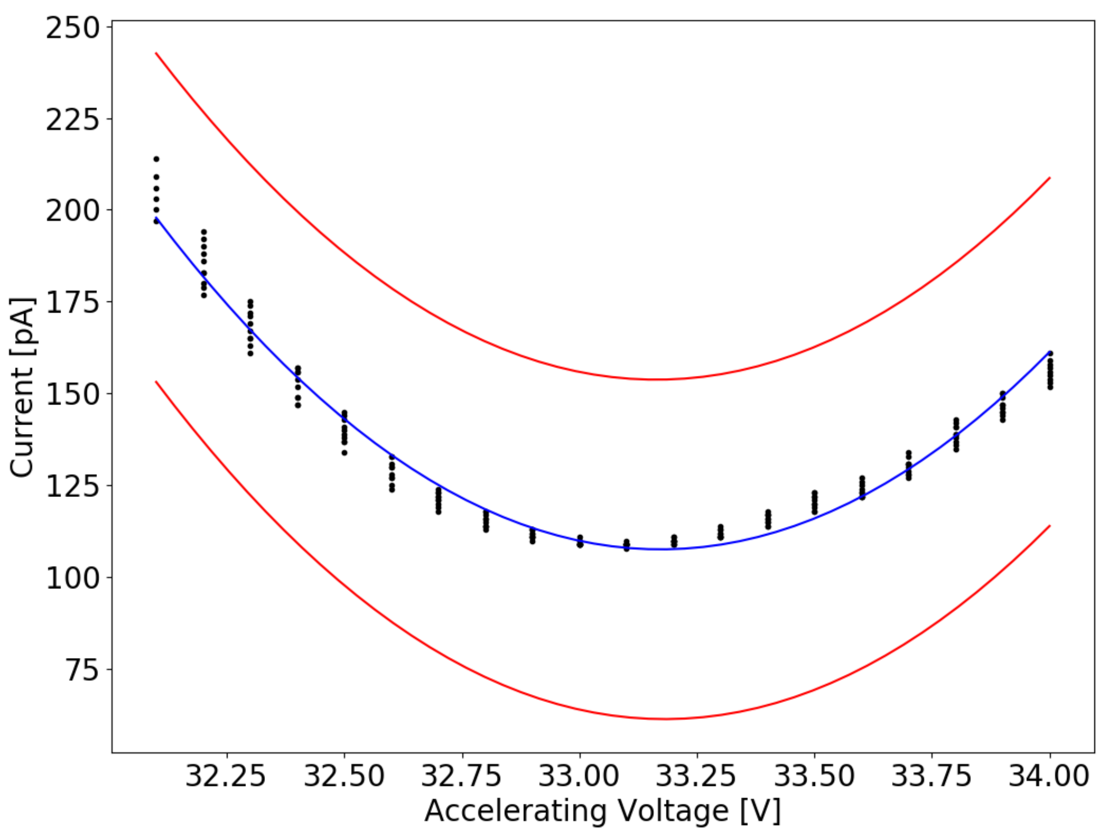

Figure 7: Current vs Accelerating Voltage for minima 6: 32.4

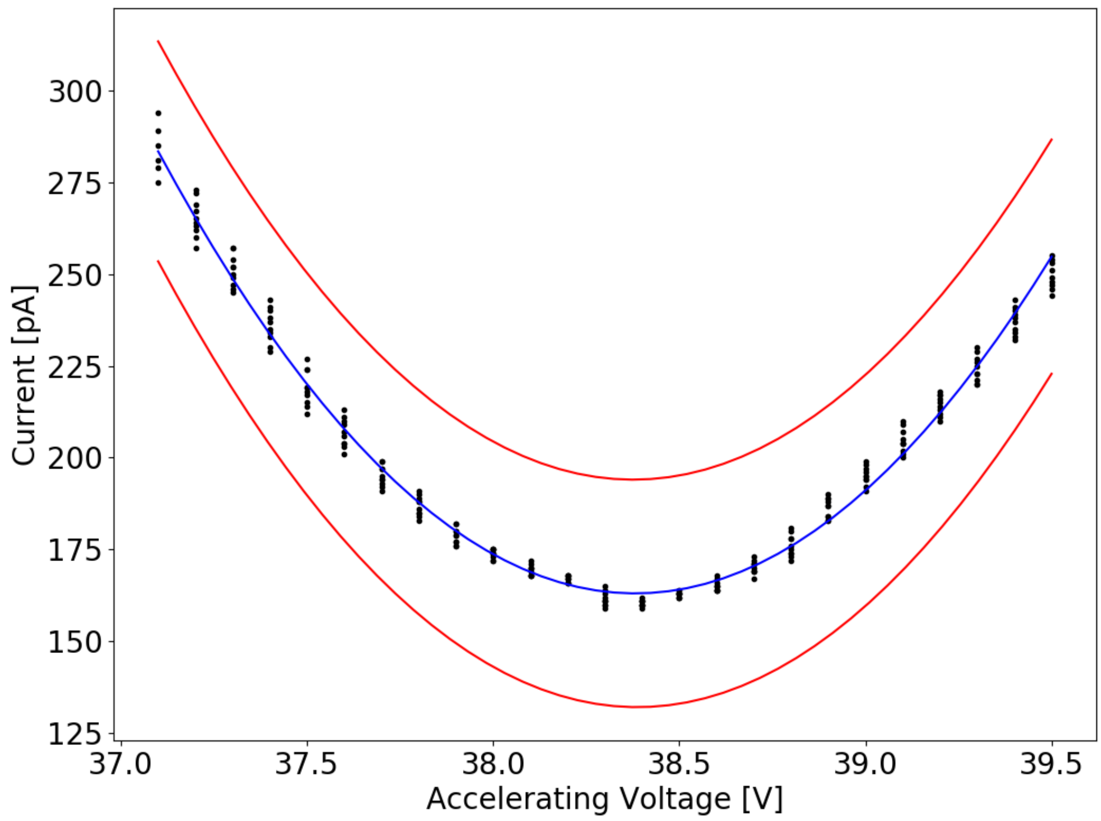

Figure 8: Current vs Accelerating Voltage for minima 7: 37.4

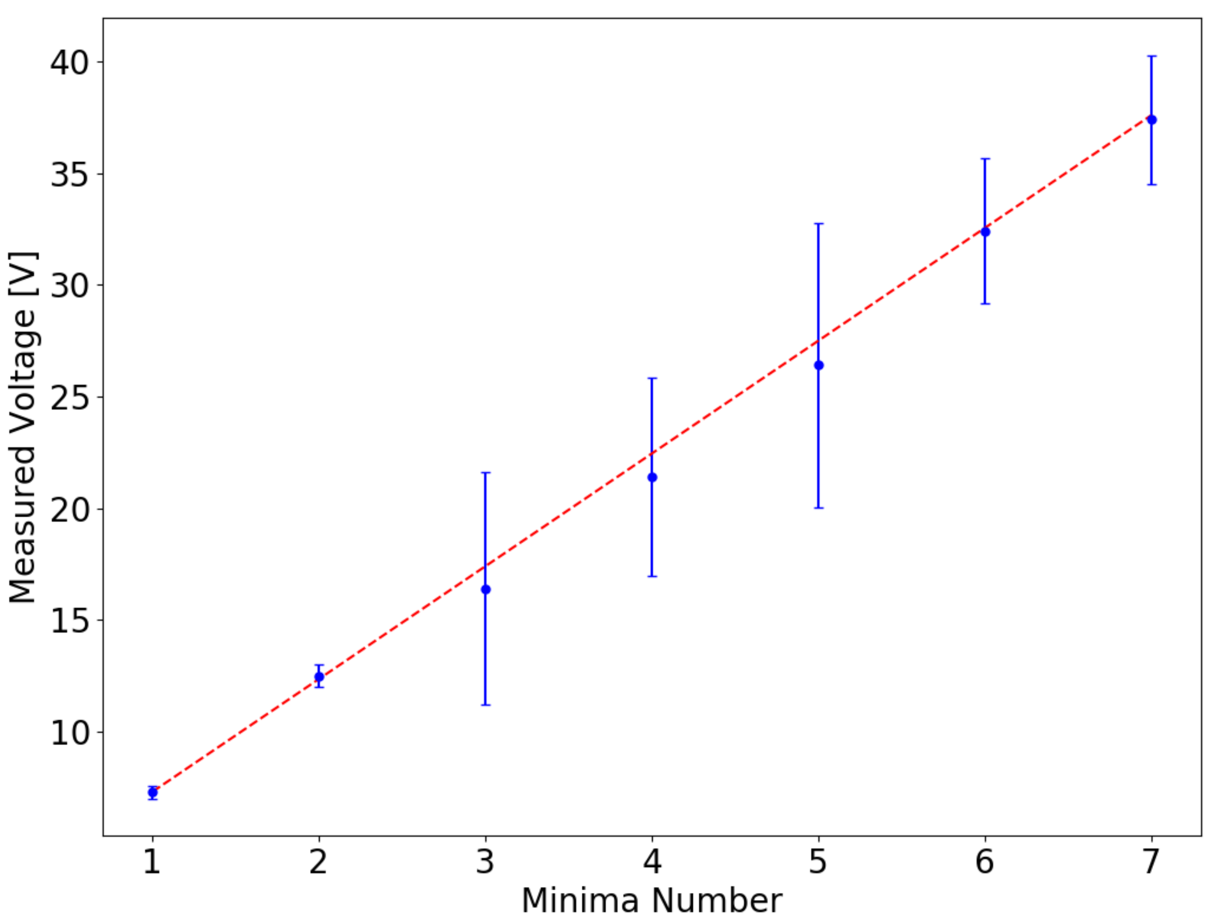

Figure 9: Measured Voltage vs Minima Number to extract Excitation Energy and Contact Potential Voltage

Part I:

n	Energy gains K_n [eV]
1	7.28 ± 0.3
2	12.5 ± 0.5
3	$(1.64 \pm 0.5) \times 10^1$
4	$(2.14 \pm 0.4) \times 10^1$
5	$(2.64 \pm 0.6) \times 10^1$
6	$(3.24 \pm 0.3) \times 10^1$
7	$(3.74 \pm 0.3) \times 10^1$

Table 1: Kinetic energy gain at each minima

To measure the excitation energy of mercury and the contact potential difference, we combine

$$eV_{accel} = n\Delta E_{exc}, \tag{1}$$

and

$$V_{actual} = V_{accel} - V_{cpd}, \tag{2}$$

and obtain

$$V_{actual} = \frac{n\Delta E_{exc}}{e} - V_{cpd}, \tag{3}$$

a linear relationship in the form of $y = mx + b$, allowing us to extract the excitation energy from the slope (times a factor of e and the contact potential difference from the intercept. Our fit gave us 5.05 ± 0.07 eV, which is within 2σ agreement with accepted value of 4.89 eV. Our fit also gave us a contact potential difference of 2.26 ± 0.10 While we were not able to take data for higher temperature, we do not expect the results to change with temperature because Mercury should have the same excitation energy at different temperatures and the contact potential difference was not temperature dependent.

Part II:

1. Note that the mean free path at room temperature is on the same order as the cathode-grid distance, but for the other temperatures, the mean free path is much smaller, and

Temp [K]	Vapor Pressure [Pa]	Number Density [m^{-3}]	Mean Free Path [m]
293	0.21	5.23×10^{19}	0.13
427	453.05	7.69×10^{22}	9.04×10^{-5}
458	1409.70	2.23×10^{23}	3.11×10^{-5}

Table 2: Mercury Vapor pressure at different temperatures

so the accelerating voltage to impart enough kinetic energy for the electrons to reach the other side would be much larger.

2. In the current vs accelerating voltage plots, we expect a higher accelerating voltage necessary to allow the electrons to reach the other side at higher temperatures due to the number of collisions increasing via an decrease in the mean free path. The spacing between the minima will stay the same, since Mercury's excitation energy is not temperature dependent.

3. The evenly spaced minima show the necessity for an integer multiple of energy required to excite the Mercury between states. If atoms did not have quantized energy levels, we would not see the spacing in between the minima that we do in Figure 1, but rather a continuous increase.

Part III:

The fit returned 4.78 ± 0.07 eV, which is within 2σ agreement with accepted value of 4.89 eV. In general, the results should not change with temperature because Mercury should have the same excitation energy at different temperatures.

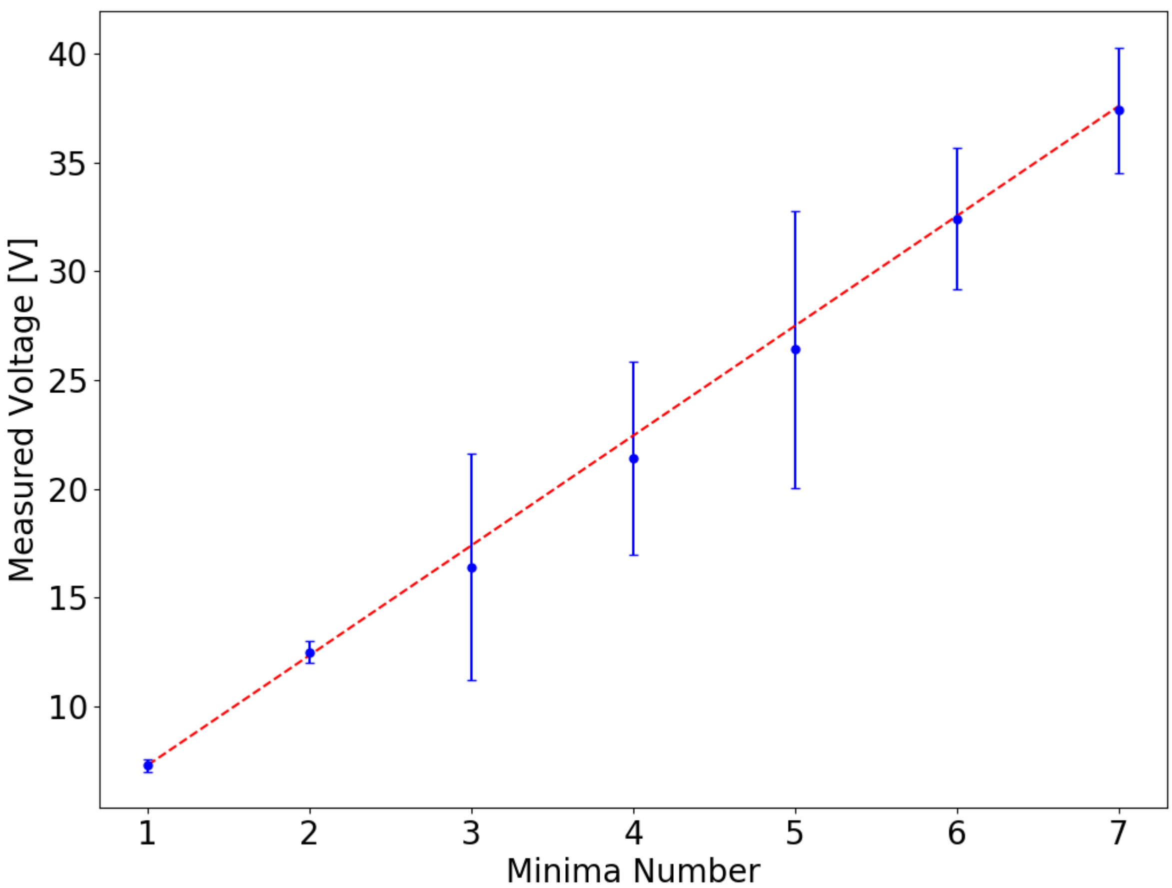

Figure 10: Measured Voltage vs Minima Number for New Function