

PHYS 3989 Physics Undergraduate Research Progress Summary

John Bartolotta, with Richard Jones September 12, 2014

In the Spring semester of 2014, I enrolled in a 2-credit undergraduate physics research section (PHYS 3989) with University of Connecticut professor, Dr. Richard Jones. My project, originally planned to be an Senior Honors Thesis for my undergraduate degree, was to analyze electronic data taken from an active collimator, which is currently installed in Experimental Hall D of Jefferson National Accelerator Facility in Newport News, Virginia for initial beam testing. Prior to the Spring 2014 semester, I attained 3-credits for acquiring electronic data from the collimator in the Fall semester of 2013 and traveled to JLab in January of 2014 to transport the collimator, as well as to acquire more electronic waveforms. See my UConn wiki page, http://zeus.phys.uconn.edu/wiki/index.php/JB_Undergraduate_Research_Progress, for details on my trip, the equipment I used, and the data I acquired.

I collected three types of data, which I called “quiescence,” “hold,” and “tap.” They were all taken from the four tungsten pin cushions that were installed in the collimator when I had been working with it. I used a LabVIEW data acquisition program, designed by Igor Senderovich, that was installed on a computer, named the “act-col-station,” that Alex Barnes and I built. (The act-col-station is currently at JLab.) Quiescent waveforms were background signals (no physical contact with the collimator other than the apparatus holding it and the wires connecting it to the act-col-station). “Hold” waveforms were acquired by holding a piece of metal to an external metal screw connected to one of the pin cushions located inside the collimator. “Tap” waveforms were acquired by quickly tapping one of the metal screws to generate transient waveforms. My goal for the Spring 2014 semester was to fit this data to various linear combinations of decaying and normal 1-D trigonometric functions. These functions were as follows:

$$f_q(x) = A_q \sin(k_{1q}x + \phi_{1q}) + \alpha_q; \quad (1)$$

$$f_h(x) = A_h \sin(k_{1h}x + \phi_{1h}) + B_h \sin(k_{2h}x + \phi_{2h}) + \alpha_h; \quad (2)$$

$$f_t(x) = A_t e^{-x/\tau} \sin(k_{1t}x + \phi_{1t}) + B_t \sin(k_{2t}x + \phi_{2t}) + C_t \sin(k_{3t}x + \phi_{3t}) + \alpha_t. \quad (3)$$

I became very busy with my full course load and two jobs in the Spring 2014 semester. Consequently, I was unable to dedicate enough of my brain power to generate substantial results for my research project. Dr. Jones allowed me to work on this project more during the summer, but other commitments withheld me once again from attaining solid results. I was, however, able to fit various data files to trig functions using a macro called “fit.C” that was written by me and Fridah Mokaya. Further information is located later in this document.

Although I was unable to make much progress in data analysis, I did have the pleasure to work with Dr. Jones for a few coding sessions. Our goal was to write a macro that would generate trees in ROOT capable of creating quick 1-D histograms from data files containing voltage values for each pin cushion as a function of time. We named these files “colviewer.h” and “colviewer.C;” they are available on my gluey account under “/home/bartolotta/Collimator/collimator_data.” These macros work quite well (with almost all the credit going to Dr. Jones), and there is an example tutorial for the functioning of the macro in the header of the colviewer.C macro.

While working on this macro, we reorganized all the collimator data (all contained in the last mentioned directory) according to the following scheme: “{type}/{type}-{pin}/{type}-{gain}-{rep},” where “type” refers to the data type, “pin” refers to the pin cushion that was in contact with the piece of metal (only useful for hold and tap waveforms), “gain” refers to the amplifier gain setting (ranging from 10^6 to 10^{12}), and “rep” presents a chronological denotation for waveforms of the same type, pin cushion, and gain setting (1 for all my data), which would be useful if similar data acquisition occurs in the future. Throughout my time working in Dr. Jones’s lab, I kept a detailed log of my efforts, which is available on my aforementioned UConn wiki page; this log goes into more detail about these coding sessions (among other things), if one is interested.

For the sake of demonstrating the application of the fit.C macro to the hitherto allusive active collimator data files, I have compiled a table with supplemental graphs on the succeeding page. These data are from tap, hold, and quiescent waveforms; see the captions for more details. The specific fit.C macro used for the three fits are contained in the same folder as the data they represent.

Table 1: Calculated quantities for “quiesc_3.12.1,” “tap_3.12.1,” and “hold_2.6.1” (type, pin, gain, rep) data files via fit.C macro ROOT analysis for functions (1), (2), and (3). See Figures 1-3 for more details.

variable	quiescent	tap	hold
A	0.03672 ± 0.00003	268000 ± 4000	0.000 ± 0.003
B		-20.2 ± 0.3	-0.335 ± 0.003
C		-20.2 ± 0.3	
τ		23.21 ± 0.03	
k_1	377.042 ± 0.007	375.70 ± 0.01	194.1 ± 0.6
k_2		385.87 ± 0.01	377.10 ± 0.08
k_3		385.88 ± 0.01	
ϕ_1	29.610 ± 0.005	43.698 ± 0.007	-73.2 ± 0.3
ϕ_2		49.62 ± 0.1	62.00 ± 0.07
ϕ_3		52.76 ± 0.01	
α	$-.32378 \pm 0.00002$	$-.45954 \pm 0.00009$	$-.383 \pm 0.002$

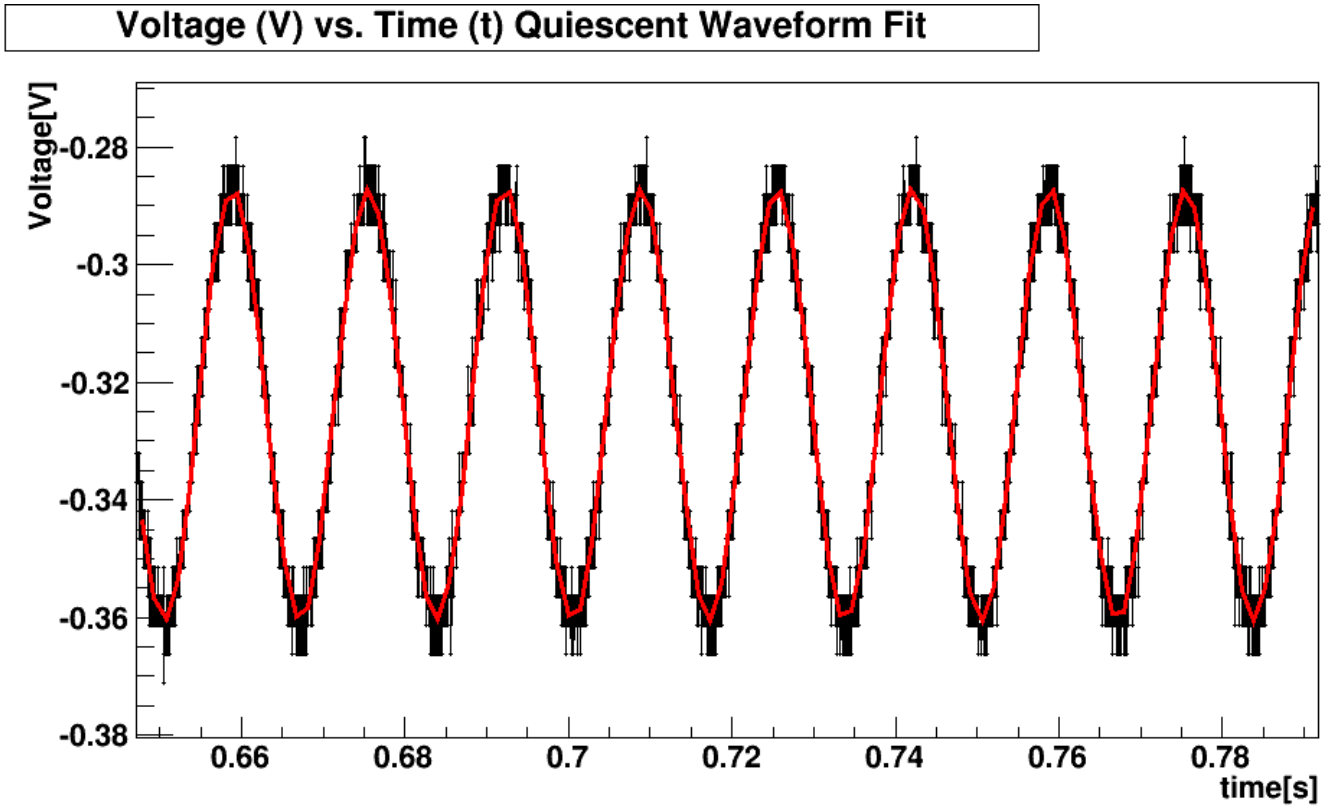


Figure 1: quiesc_3.12.1 fit.

Voltage (V) vs. Time (s) Tap Transient Waveform

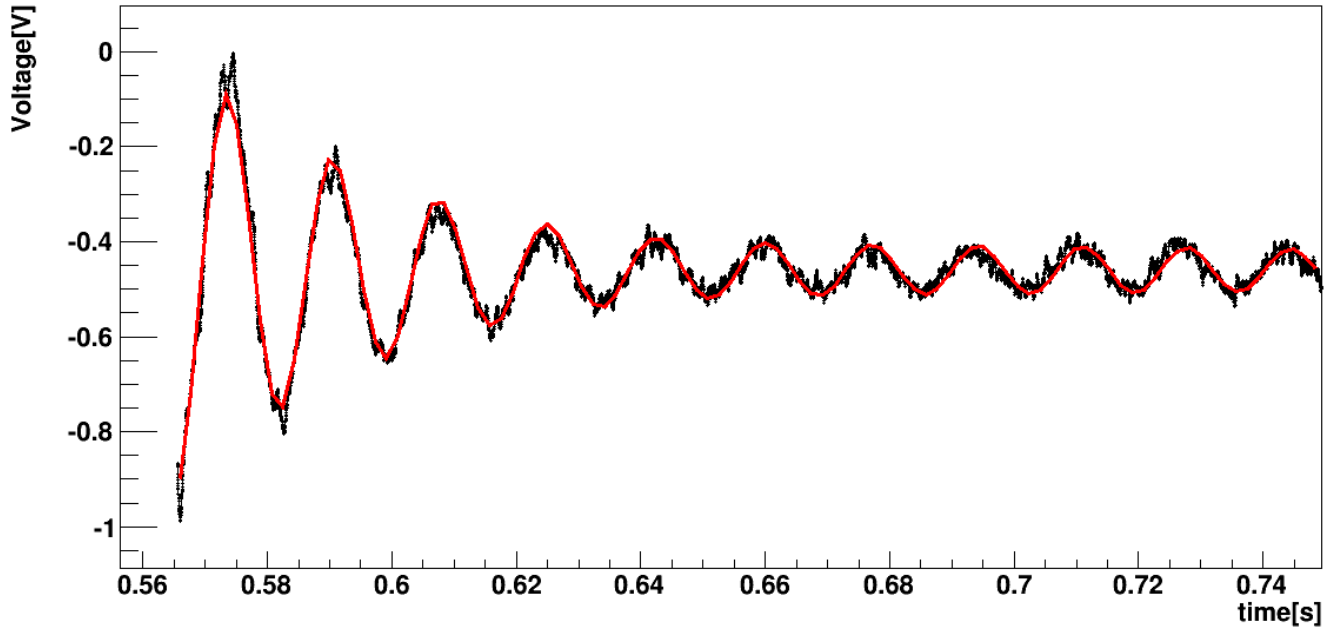


Figure 2: tap_3-12_1 fit.

Voltage (V) vs. Time (s) Hold Fit

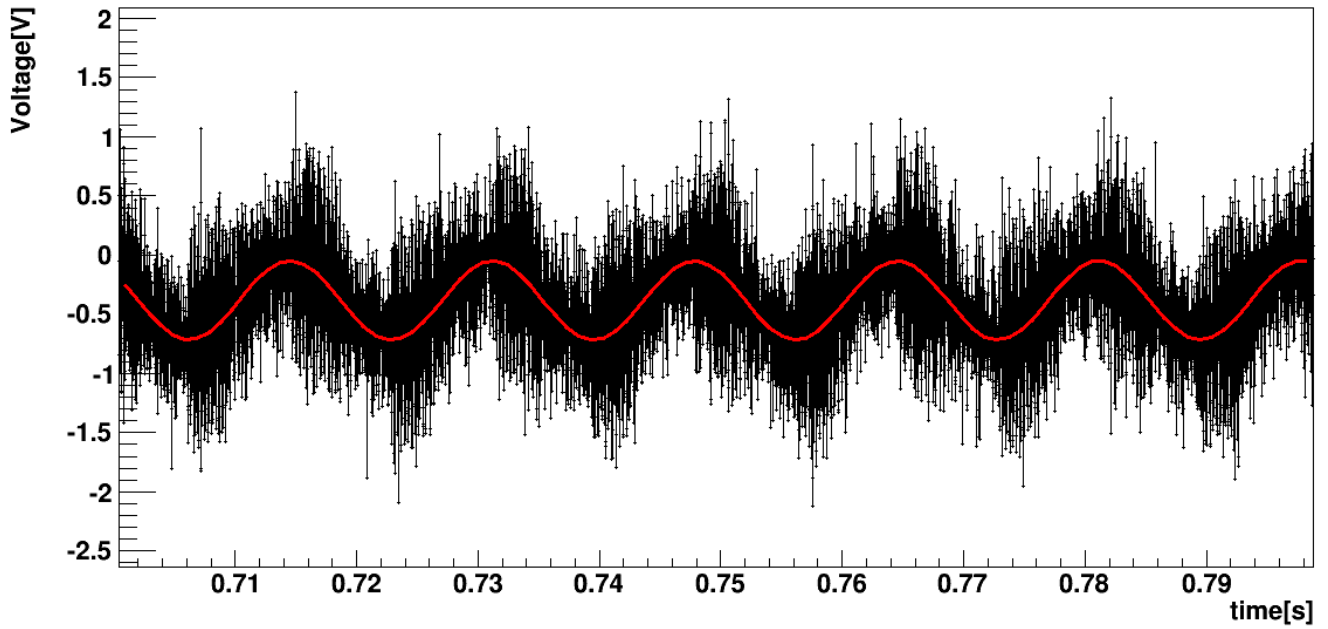


Figure 3: "hold_2_6_1" fit.

I had a hard time calculating the “ χ^2 ” values for these fits in ROOT. Specifically, I was encountering an “abnormal termination of minimization” warning for the “tap” transient waveform fit. These problems would have been taken care of if I were to persevere with this project.

In conclusion, I would like to thank Dr. Richard Jones for his large contribution to my physics career. Also having taken an advanced lab and graduate quantum mechanics course under his direction, I owe much of my physics knowledge to his diligent teaching methods and patience. I have never had a teacher that welcomed me into his home, spent hours specifically to help me reach personal and professional goals, and held me to such high standards. Although I am planning to enter the secondary education field, Dr. Jones has instilled life skills in me that will help me succeed in whichever path I may take.