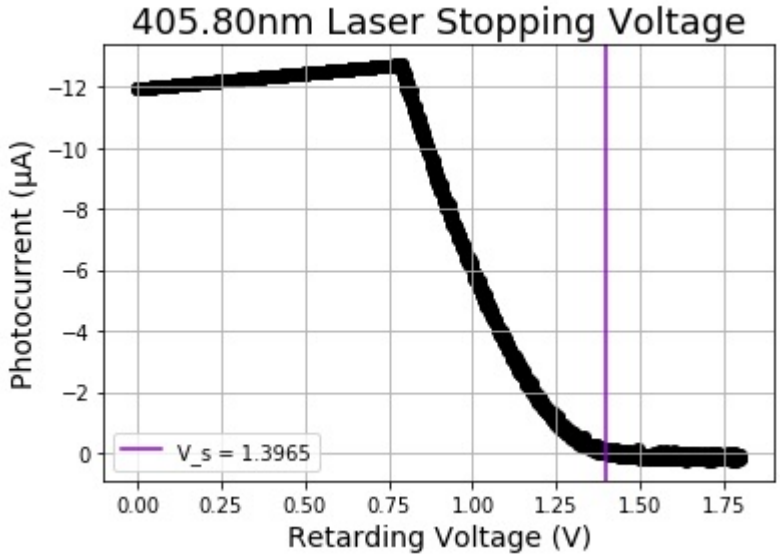
```
Python 3.7.3 (default, Apr  3 2019, 05:39:12)
Type "copyright", "credits" or "license" for more information.

IPython 5.8.0 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for extra details.

Restarting kernel...
```

```
 /usr/lib/python3/dist-packages/traitlets/config/configurable.py:84: UserWarning:
Config option `use_jedi` not recognized by `IPCompleter`.
  self.config = config

In [1]: runfile('/home/pi/Photoelectric_Effect/final-lab/PEF_Lab.py', wdir='/home/pi/
Photoelectric_Effect/final-lab')
Welcome! Perform your own Photoelectric Effect experiment.
You will be asked to provide information about various light sources.
From this information, you will be able to approximate Plank's constant.
Select the 'Quit' option for the experiment when you are done.


Enter the experiment name: Final Lab
Beginning experiment 'final-lab'

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: laser

Enter the Laser wavelength in nm: 405.8

Load data from csv file (y/n)?: y

Enter csv file path: final-data/laser_406nm.csv
[+]Added entry:
-> Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V
```




```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
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   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: laser

Enter the Laser wavelength in nm: 530.3

Load data from csv file (y/n)?: y

Enter csv file path: final-data/laser_530nm.csv
[+]Added entry:
-> Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
```

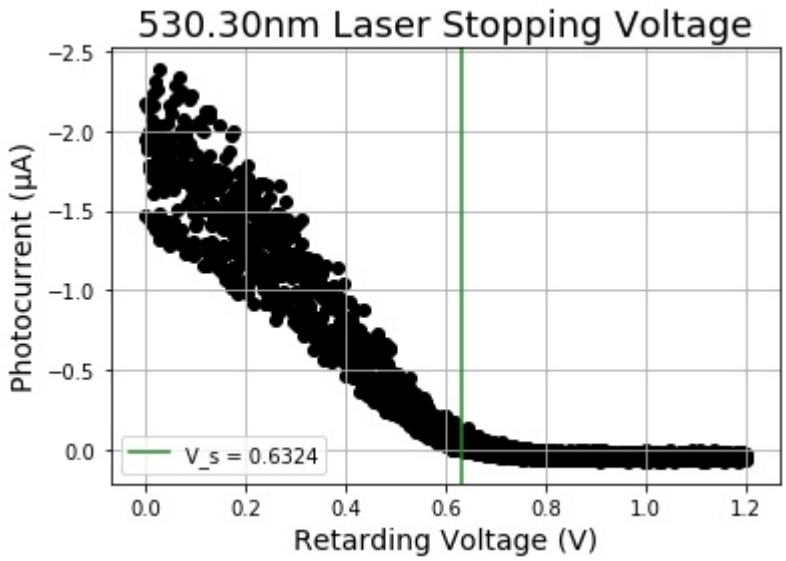


```
------------------------- EXPERIMENT OPTIONS -------------------------
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   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 12
ERROR: invalid option: valid options are 0-9

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: laser

Enter the Laser wavelength in nm: 654.9

Load data from csv file (y/n)?: y

Enter csv file path: final-data/laser_655nm.csv
[+]Added entry:
-> Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
```

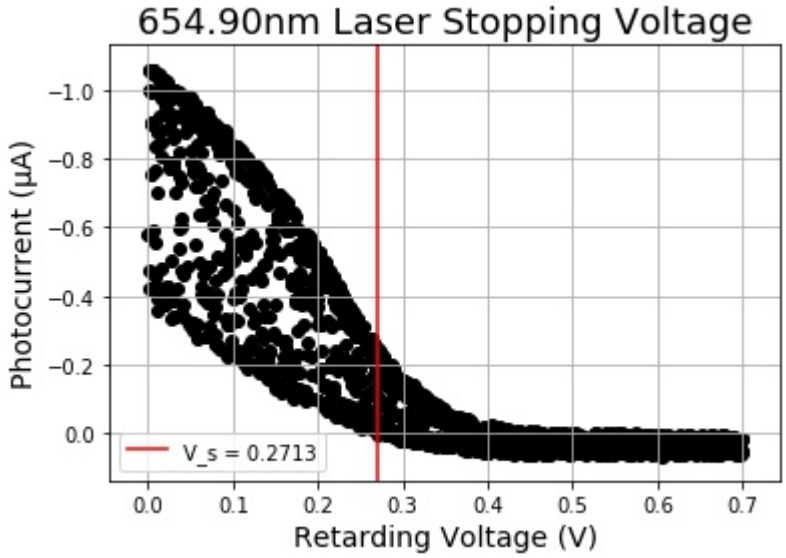


```
------------------------- EXPERIMENT OPTIONS -------------------------
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   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
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   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
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   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: led

Enter the LED wavelength in nm: 404

Load data from csv file (y/n)?: y

Enter csv file path: final-data/led_404nm.csv
[+]Added entry:
-> Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
```

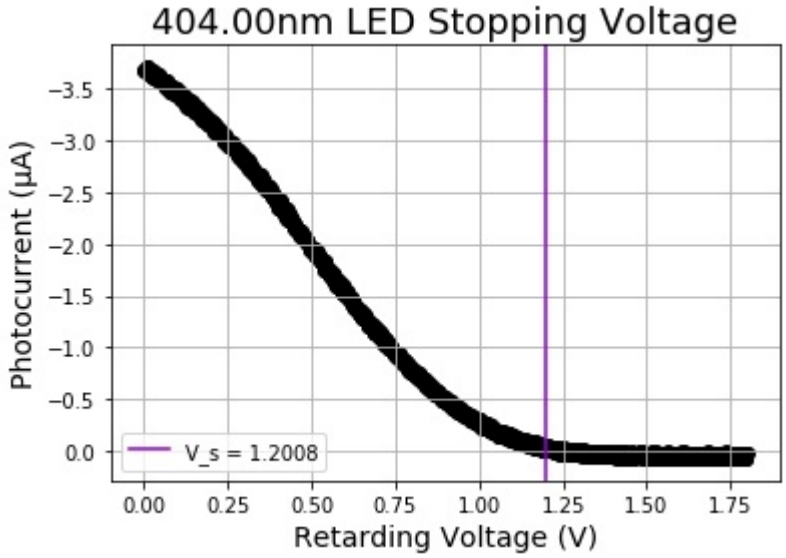


```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
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   3. Update datalog entry
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   5. View datalog entry
   6. Save datalog entries to files
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   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: led

Enter the LED wavelength in nm: 458.5

Load data from csv file (y/n)?: y

Enter csv file path: final-data/led_458nm.csv
[+]Added entry:
-> Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
```

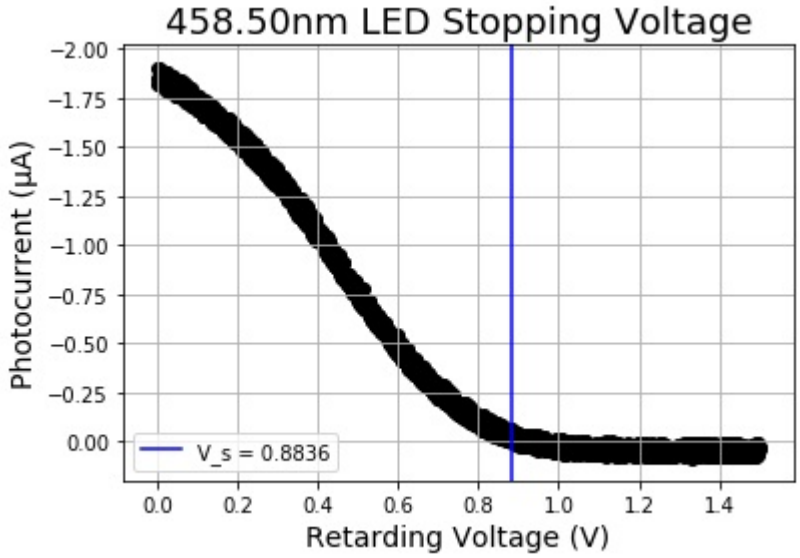


```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
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   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: led

Enter the LED wavelength in nm: 509.3

Load data from csv file (y/n)?: y

Enter csv file path: final-data/led_509nm.csv
[+]Added entry:
-> Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
```
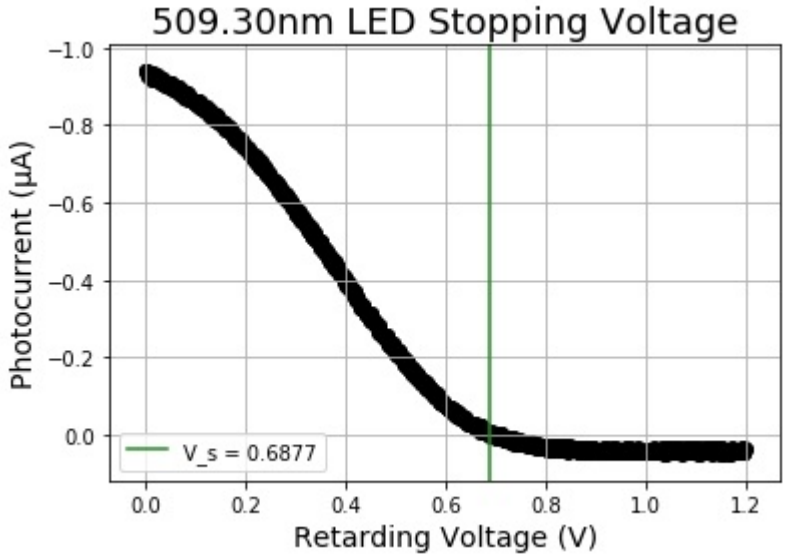
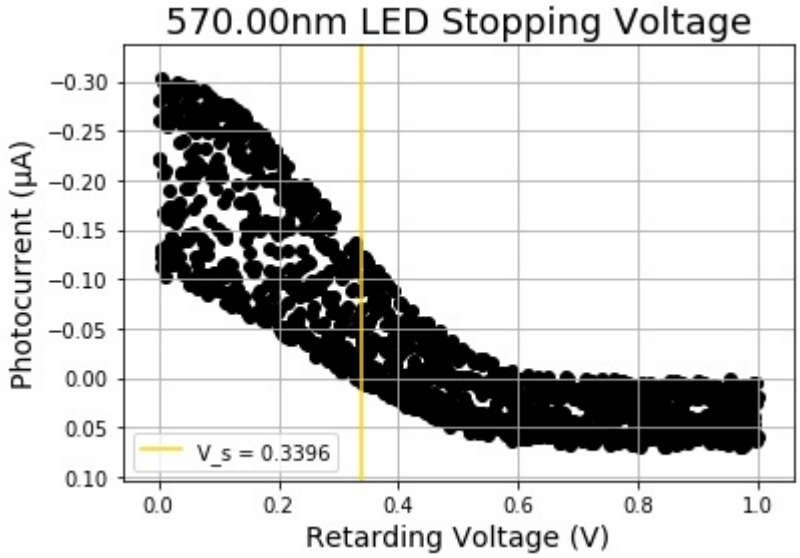
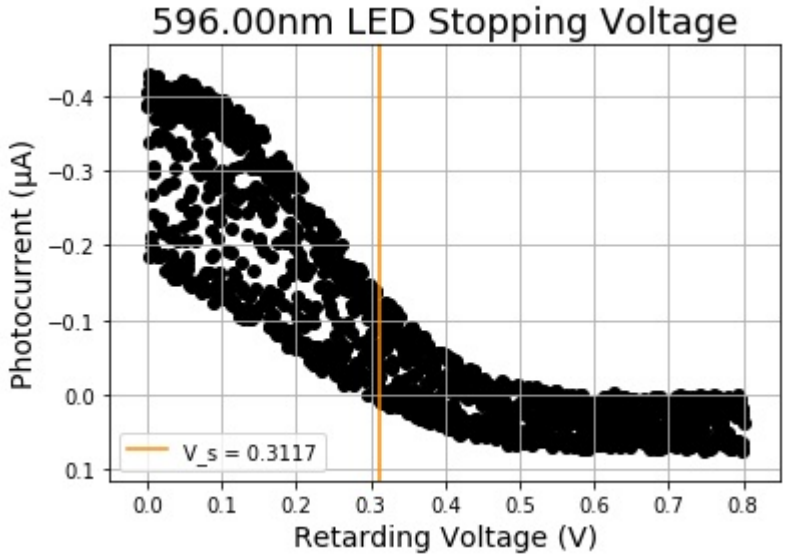




```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: led

Enter the LED wavelength in nm: 570

Load data from csv file (y/n)?: y

Enter csv file path: final-data/led_570nm.csv
[+]Added entry:
-> Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
```




```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 1

OPTION 1: Add entry to datalog

Is this an LED or a Laser?: led

Enter the LED wavelength in nm: 596

Load data from csv file (y/n)?: y

Enter csv file path: final-data/led_596nm.csv
[+]Added entry:
-> Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
```

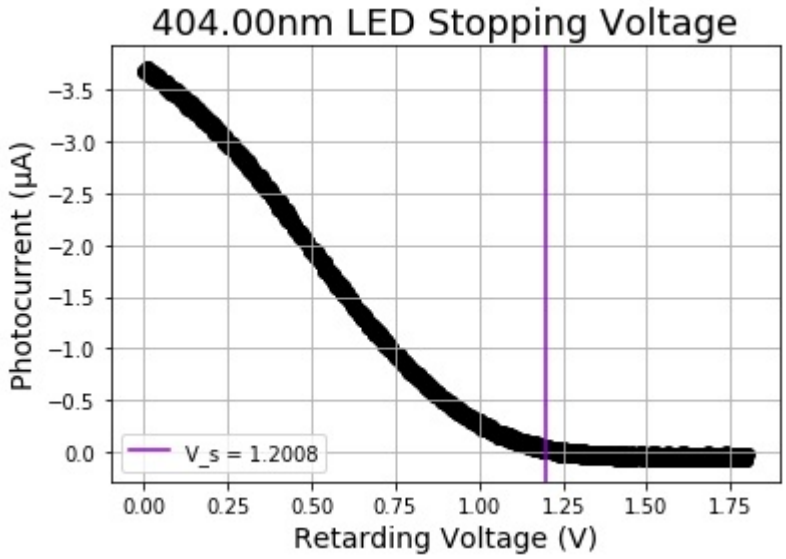



```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 4

OPTION 4: Display current datalog
--------------- Datalog for final-lab ---------------
 0.  Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V
 1.  Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
 2.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
 3.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 4.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 5.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 6.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 7.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 5

OPTION 5: View datalog entry
--------------- Datalog for final-lab ---------------
 0.  Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V
 1.  Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
 2.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
```

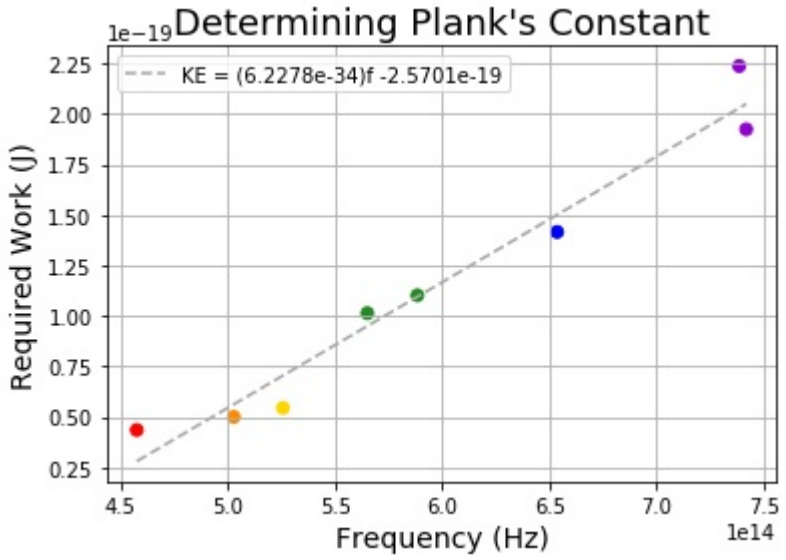
```
 3.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 4.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 5.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 6.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 7.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V

Select the entry to view: 3
 3.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
```

	V_r	I_ub	I_b	I_φ
0	0.000000	-3.680	0.003	-3.677
1	0.001201	-3.681	0.003	-3.678
2	0.002402	-3.714	0.003	-3.711
3	0.003602	-3.679	0.003	-3.676
4	0.004803	-3.684	0.003	-3.681
5	0.006004	-3.691	0.003	-3.688
6	0.007205	-3.673	0.003	-3.670
7	0.008406	-3.687	0.003	-3.684
8	0.009606	-3.725	0.003	-3.722
9	0.010807	-3.669	0.003	-3.666
10	0.012008	-3.721	0.003	-3.718
11	0.013209	-3.696	0.003	-3.693
12	0.014410	-3.676	0.003	-3.673
13	0.015610	-3.691	0.003	-3.688
14	0.016811	-3.648	0.003	-3.645
15	0.018012	-3.649	0.003	-3.646
16	0.019213	-3.629	0.003	-3.626
17	0.020414	-3.621	0.003	-3.618
18	0.021614	-3.638	0.003	-3.635
19	0.022815	-3.629	0.003	-3.626
20	0.024016	-3.642	0.003	-3.639
21	0.025217	-3.612	0.003	-3.609
22	0.026418	-3.665	0.003	-3.662
23	0.027618	-3.628	0.003	-3.625
24	0.028819	-3.684	0.003	-3.681
25	0.030020	-3.604	0.003	-3.601
26	0.031221	-3.622	0.003	-3.619
27	0.032422	-3.618	0.003	-3.615
28	0.033622	-3.663	0.003	-3.660
29	0.034823	-3.599	0.003	-3.596
...	...	...	...	...
1470	1.765177	0.045	0.003	0.048
1471	1.766378	0.071	0.003	0.074
1472	1.767578	0.070	0.003	0.073
1473	1.768779	0.009	0.003	0.012
1474	1.769980	0.052	0.003	0.055
1475	1.771181	0.063	0.003	0.066
1476	1.772382	0.066	0.003	0.069
1477	1.773582	0.065	0.003	0.068
1478	1.774783	0.015	0.003	0.018
1479	1.775984	0.067	0.003	0.070
1480	1.777185	0.016	0.003	0.019
1481	1.778386	0.028	0.003	0.031
1482	1.779586	0.069	0.003	0.072
1483	1.780787	0.046	0.003	0.049
1484	1.781988	0.058	0.003	0.061
1485	1.783189	0.019	0.003	0.022
1486	1.784390	0.038	0.003	0.041
1487	1.785590	0.040	0.003	0.043
1488	1.786791	0.042	0.003	0.045
1489	1.787992	0.020	0.003	0.023
1490	1.789193	0.062	0.003	0.065
1491	1.790394	0.069	0.003	0.072
1492	1.791594	0.052	0.003	0.055
1493	1.792795	0.045	0.003	0.048
1494	1.793996	0.074	0.003	0.077
1495	1.795197	0.039	0.003	0.042

```
1496  1.796398  0.033  0.003  0.036
1497  1.797598  0.008  0.003  0.011
1498  1.798799  0.065  0.003  0.068
1499  1.800000  0.009  0.003  0.012

[1500 rows x 4 columns]
```




```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 7

OPTION 7: Display estimate results
```




```
--------------- Datalog for final-lab ---------------
```

```
 0.  Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V
 1.  Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
 2.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
 3.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 4.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 5.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 6.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 7.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V

-------------------- Report --------------------
Cesium-Antimony Work Function (Φ):
  actual   = 1.43-1.59 eV
  estimate = 1.60415 eV
Plank's Constant (h):
  actual   = 6.62607015e-34 J·s
  estimate = 6.22777045e-34 J·s
  % error  = 6.0111%

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 2

OPTION 2: Remove entry from datalog
--------------- Datalog for final-lab ---------------
 0.  Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V
 1.  Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
 2.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
 3.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 4.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 5.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 6.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 7.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
Warning - This action cannot be undone

Select the entry to remove: 0
[+]Removed entry:
-> Type: Laser,   λ: 405.80 nm,   V_s: 1.397 V

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 2

OPTION 2: Remove entry from datalog
--------------- Datalog for final-lab ---------------
 0.  Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V
```

```
 1.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
 2.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 3.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 4.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 5.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 6.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
Warning - This action cannot be undone

Select the entry to remove: 0
[+]Removed entry:
-> Type: Laser,   λ: 530.30 nm,   V_s: 0.632 V

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
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Select an option: 2

OPTION 2: Remove entry from datalog
--------------- Datalog for final-lab ---------------
 0.  Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V
 1.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 2.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 3.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 4.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 5.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
Warning - This action cannot be undone

Select the entry to remove: 0
[+]Removed entry:
-> Type: Laser,   λ: 654.90 nm,   V_s: 0.271 V

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
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----------------------------------------------------------------------

Select an option: 7

OPTION 7: Display estimate results
```

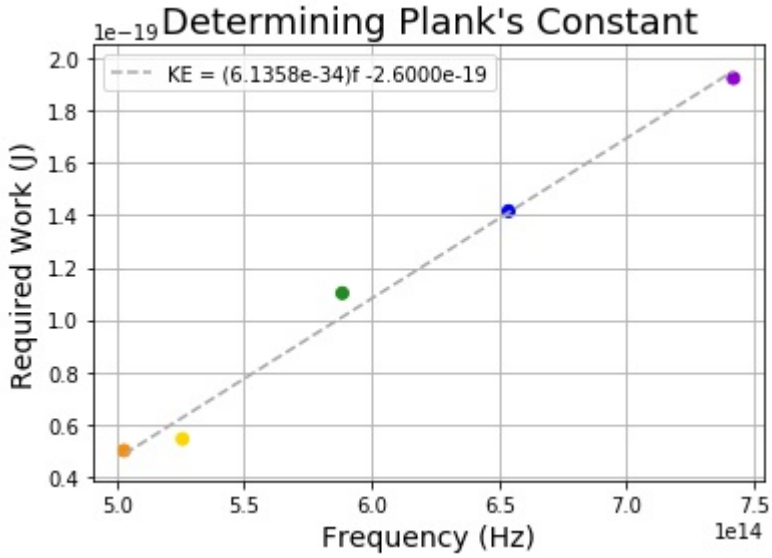


```
--------------- Datalog for final-lab ---------------
 0.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 1.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 2.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 3.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 4.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V

-------------------- Report --------------------
Cesium-Antimony Work Function (Φ):
  actual   = 1.43-1.59 eV
  estimate = 1.62282 eV
Plank's Constant (h):
  actual   = 6.62607015e-34 J·s
  estimate = 6.13581549e-34 J·s
  % error  = 7.3989%

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
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   3. Update datalog entry
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   6. Save datalog entries to files
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   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 3

OPTION 3: Update datalog entry
--------------- Datalog for final-lab ---------------
 0.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V
 1.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 2.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 3.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 4.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
Warning - This operation will overwrite existing data

Select the entry to update: 0
 0.  Type:   LED,   λ: 404.00 nm,   V_s: 1.201 V

Load data from csv file (y/n)?: y

Enter csv file path: final-data/laser_406nm.csv
```
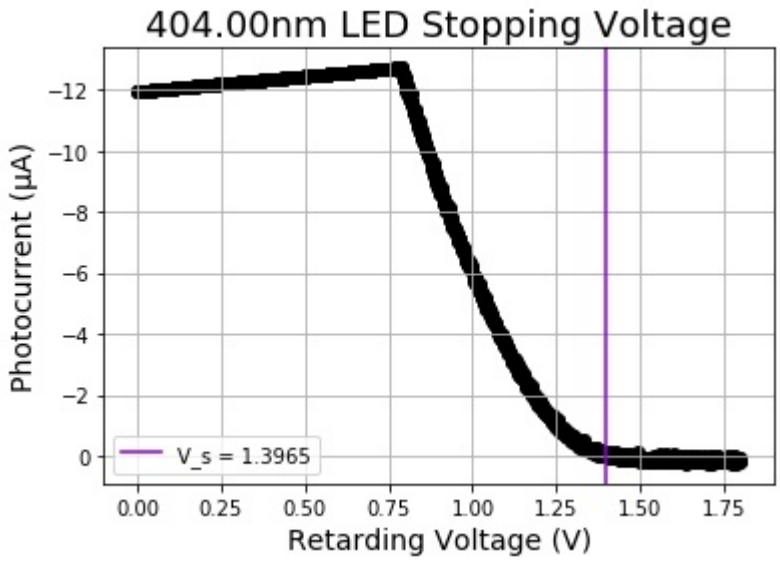
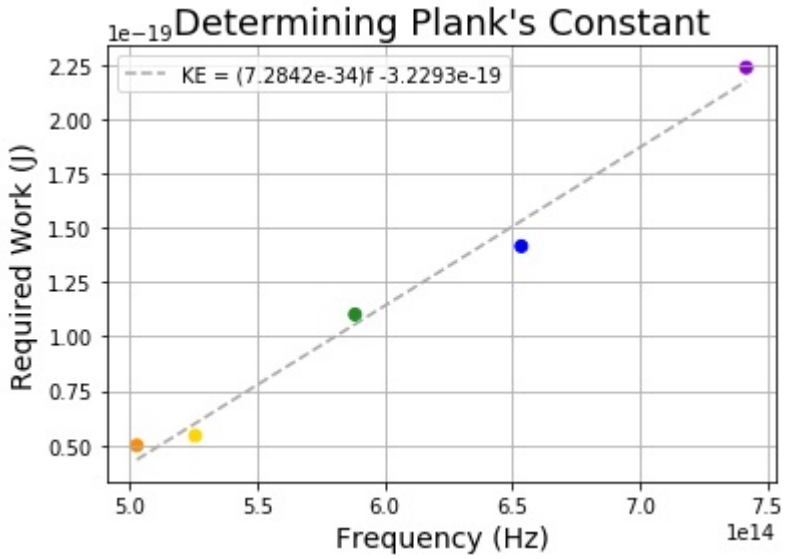

```
[+]Updated entry:
-> Type:   LED,   λ: 404.00 nm,   V_s: 1.397 V
```




```
------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 7

OPTION 7: Display estimate results
```




```
--------------- Datalog for final-lab ---------------
 0.  Type:   LED,   λ: 458.50 nm,   V_s: 0.884 V
 1.  Type:   LED,   λ: 509.30 nm,   V_s: 0.688 V
 2.  Type:   LED,   λ: 570.00 nm,   V_s: 0.340 V
 3.  Type:   LED,   λ: 596.00 nm,   V_s: 0.312 V
```

```
 4.  Type:   LED,   λ: 404.00 nm,   V_s: 1.397 V

-------------------- Report --------------------
Cesium-Antimony Work Function (Φ):
  actual   = 1.43-1.59 eV
  estimate = 2.01556 eV
Plank's Constant (h):
  actual   = 6.62607015e-34 J·s
  estimate = 7.28424616e-34 J·s
  % error  = 9.9331%

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 9

OPTION 9: Clear datalog
Warning - This action cannot be undone

Would you like to proceed (y/n)?: y
[+]The datalog has been cleared

------------------------- EXPERIMENT OPTIONS -------------------------
   0. Quit experiment
   1. Add entry to datalog
   2. Remove entry from datalog
   3. Update datalog entry
   4. Display current datalog
   5. View datalog entry
   6. Save datalog entries to files
   7. Display estimate results
   8. Save results
   9. Clear datalog
----------------------------------------------------------------------

Select an option: 0

OPTION 0: Quit experiment
Warning - Unsaved data will be lost.

Would you like to proceed (y/n)?: y

In [2]:
```