HG-1 Mercury Argon Calibration Source

The **HG-1 MERCURY ARGON CALIBRATION SOURCE** is a wavelength calibration source for UV-VIS-Shortwave NIR spectrophotometric systems. The HG-1 produces Mercury and Argon lines from 253-922 nm, for use in performing fast, accurate spectrometer wavelength calibrations. The HG-1 has an SMA 905 termination for connecting to optical fibers.

Caution!

- The beam emerging from the HG-1 produces ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Never look directly into the light source.
- *Never* take apart the HG-1. The HG-1 contains mercury. Dangerous voltages present. No user-serviceable parts inside.
- The SMA connector may get **HOT** during operation.

Setting Up

To re-calibrate the wavelength of your spectrometer, you will need the following:

- The HG-1 Mercury-Argon lamp
- Your spectrometer
- An optical fiber (for spectrometers without a built-in slit, a 50-µm fiber works best)
- Either a spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions. If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisToolPak-VBA**

Operation

1. Plug the wall transformer end of the HG-1's power supply into a standard 110 V outlet. Plug the 12 V output end into the back of your HG-1. Or, insert a 9V battery (not included).
2. Attach a fiber from the spectrometer into the SMA connector on your HG-1. If your spectrometer does not have an entrance slit, use a 50-µm diameter (or smaller) optical fiber. Larger fibers and slits will have lesser optical resolution. Also, keep in mind that if the spectrometer has no slit and your experimentation involves using optical fibers of different diameters, wavelength calibration with each fiber you anticipate using will be necessary. Calibration is also recommended each time you unscrew the fiber from the spectrometer.
3. Find the on/off switch next to the SMA connector and turn the lamp on. The red indicator will light when the lamp is on.

Calibration

You are going to be solving the following equation, which shows that the relationship between pixel number and wavelength is a third-order polynomial:

$$\lambda_p = I + C_1 p + C_2 p^2 + C_2 p^3$$

where λ is the wavelength of pixel p, I is the wavelength of pixel 0, C_1 is the first coefficient (nm/pixel), C_2 is the second coefficient (nm/pixel^2), and C_3 is the third coefficient (nm/pixel^3). You will be calculating the value for I and the three Cs.

1. After placing OOIBase32 into Scope Mode, take a spectrum of your light source. Adjust the integration time until there are several peaks on the screen that are not off-scale.
2. Move the cursor to one of the peaks and carefully position it so that it is at the point of maximum intensity. Record the pixel number that is displayed in the status bar (located beneath the graph). Repeat this step for all of the peaks in your spectrum.
3. Using your spreadsheet, create a table like the one below. In the first column, place the exact or true wavelength of the spectral lines that you used. The spectral lines of the HG-1 are printed on the lamp's casing. In the second column of this worksheet, place the observed pixel number. In the third column, calculate the pixel number squared, and in the fourth column, calculate the pixel number cubed.

Independent Variable	Dependent Variables			Values computed from the regression output	
True Wavelength (nm)	**Pixel #**	**Pixel # ^{2}**	**Pixel # ^{3}**	**Predicted Wavelength**	**Difference**
253.65	175	30625	5359375	253.56	0.09
296.73	296	87616	25934336	296.72	0.01
302.15	312	97344	30371328	302.40	-0.25
313.16	342	116964	40001688	313.02	0.13
334.15	402	161604	64964808	334.19	-0.05
365.02	490	240100	117649000	365.05	-0.04
404.66	604	364816	220348864	404.67	-0.01
407.78	613	375769	230346397	407.78	0.00
435.84	694	481636	334255384	435.65	0.19
546.07	1022	1044484	1067462648	546.13	-0.06
576.96	1116	1245456	1389928896	577.05	-0.09
579.07	1122	1258884	1412467848	579.01	0.06
696.54	1491	2223081	3314613771	696.70	-0.15
706.72	1523	2319529	3532642667	706.62	0.10
727.29	1590	2528100	4019679000	727.24	0.06
738.40	1627	2647129	4306878883	738.53	-0.13
751.47	1669	2785561	4649101309	751.27	0.19

4. Now you are ready to calculate the wavelength calibration coefficients. In your spreadsheet program, find the functions to perform linear regressions. If you are using Quattro Pro, look under **Tools | Advanced Math**. If you are using Excel, look under **Tools | Data Analysis**.
5. Select the true wavelength as the dependent variable (Y). Select the pixel number, pixel number squared and the pixel number cubed as the independent variables (X). After you execute the regression, an output similar to the one shown below is obtained.

Regression Statistics	
Multiple R	0.999999831
R Square	0.999999663
Adjusted R Square	0.999999607
Standard Error	0.125540214
Observations	22

intercept

	Coefficents	Standard Error
Intercept	190.473993	0.369047536
X Variable 1	0.36263983	0.001684745
X Variable 2	-1.174416E-05	8.35279E-07
X Variable 3	-2.523787E-09	2.656608E-10

first coefficient

second coefficient

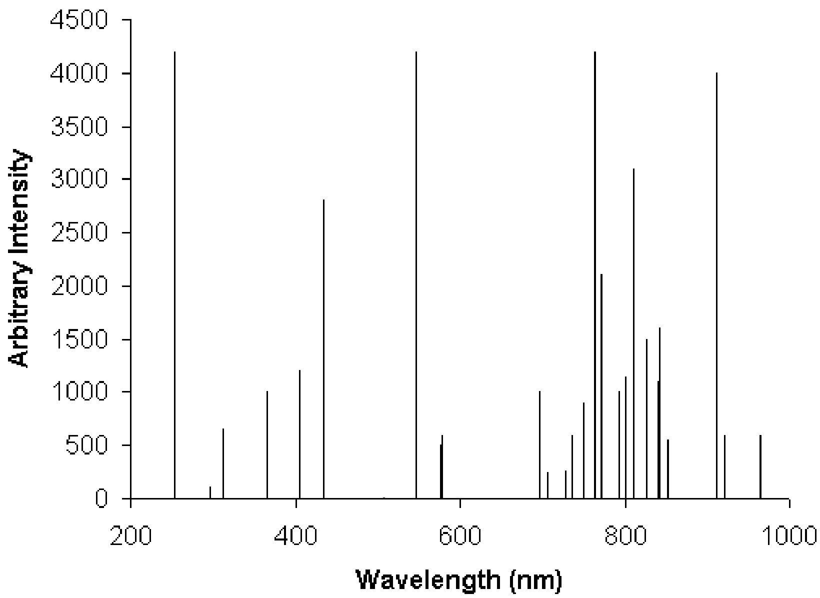
third coefficient

6. The numbers of importance are indicated in the above figure. You will need to record the Intercept as well as the First, Second, and Third Coefficients. Also, look at the value for R squared. It should be *very* close to 1. If it is not, you have probably assigned one of your wavelengths incorrectly.
7. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page to update the wavelength coefficients within OOIBase32.
8. Repeat this process for each channel in your setup.

Spectral Output

Mercury emission lines are <600 nm. Argon emission lines are >600 nm, and are shown here on the right on an exaggerated amplitude scale. Below is a list of the most prominent mercury and argon peaks.

Mercury Lines	Argon Lines
253.65	696.54
296.73	706.72
302.15	710.75
313.16	727.29
334.15	738.40
365.01	750.39
404.66	763.51
407.78	772.40
435.84	794.82
546.08	800.62
576.96	811.53
579.07	826.45
	842.46
	852.14
	866.79
	912.30
	922.45



Specifications

Output:	low-pressure gas discharge lines of Mercury and Argon
Spectral range:	253-922 nm
Dimensions:	11.4 cm x 6.98 cm x 2.54 cm (LWH), 4.5" x 6.98" x 1.0" (LWH)
Power requirements:	12 VDC wall transformer (comes with unit) **or** 9 VDC battery
Internal voltage:	600 volts at 30 kHz
Bulb life:	~3,500 hours
Amplitude stabilization:	~1 minute
Aperture:	3 mm
Connector:	SMA 905