# HG-1 Mercury Argon Calibration Light 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 253-1700 nm, and is an ideal lamp to use when performing fast, accurate spectrometer wavelength calibrations.

The HG-1 features an SMA 905 Connector for interfacing with our optical fibers. It operates with a 12 VDC power supply (included with the unit) or 9V battery (not included).

The following sections detail the features of the HG-1 Mercury Argon Calibration Light Sources.

**Note**: The HG-1 is NOT designed to operate as an excitation source in your experiments.

Spectral lines above 922 nm are not easily detectable by the S2000, USB2000, or HR2000 Spectrometers.

*HG-1 Mercury Argon Calibration Light Source*

### Parts Included

The HG-1 ships with the following items:

- HG-1 Mercury Argon Calibration Light Source
- 12 VDC power supply

**Warnings**

- The beam emerging from the light source contains UV radiation that can cause serious eye injury upon direct contact with the eye. Never look directly into the light source.
- The SMA 905 Connector may get extremely hot during operation. After lamp use, allow sufficient time to cool before handling.
- Dangerous voltages are present, and there are no user-serviceable parts inside. Additionally, the HG-1 contains mercury. You should never open the HG-1.

## Using the HG-1

The following sections provide instructions on setting up the HG-1 light source and performing a wavelength calibration using the HG-1:

### Configuring the HG-1

Follow the steps below to configure the HG-1:

1. Plug the 12 VDC power supply into a power outlet, then connect the barrel connector of the power supply to the power input on the rear of the HG-1.

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2. Alternately, you can use a 9-volt battery (not included) to power the HG-1. Open the battery hatch of the HG-1 and install the 9-volt battery, then proceed to Step 2.
3. Connect a fiber to the SMA 905 Connector on the HG-1. If your spectrometer does not have an entrance slit, use a 50 µm diameter (or smaller) fiber. Larger fibers and slits result in reduced optical resolution.

   Please note that if the spectrometer does not have a slit and your experiment requires you to use fibers of varying diameters, you will need to perform a wavelength calibration. You should also perform a wavelength calibration each time you unscrew the fiber from the spectrometer.
4. Move the On/Off switch on the HG-1 (next to the SMA 905 Connector) to the On position. The red LED will illuminate to indicate that the HG-1 is powered on.

You have now configured the HG-1 for use. Proceed to the next section for wavelength calibration instructions.

## Performing a Wavelength Calibration

Follow the instructions below to perform a wavelength calibration on your spectrometer using the HG-1:

### About the Wavelength Calibration

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

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

...where $\lambda$ 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$^2$). You will be calculating the value for $I$ and the two $C$s.

### Calibration Requirements

To re-calibrate the wavelength of your spectrometer using the HG-1, you will need the following items:

- An HG-1 Mercury Argon Calibration Light Source
- A spectrometer
- An optical fiber (for spectrometers without a built-in slit, a 50-µm fiber works best)
- A spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions

**Note**: If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisTookPak-VBA**

### Calibrating the Wavelength of the Spectrometer

Perform the steps below to calibrate the wavelength of the spectrometer:

1. Place OOIBase32 into **Scope Mode** and take a spectrum of the HG-1. Adjust the integration time (or the A/D conversion frequency) until there are several peaks on the screen that are not off-scale.
2. Move the cursor to one of the peaks and position the cursor so that it is at the point of maximum intensity.
3. Record the pixel number that is displayed in the status bar or legend (located beneath the graph). Repeat this step for all of the peaks in your spectrum.

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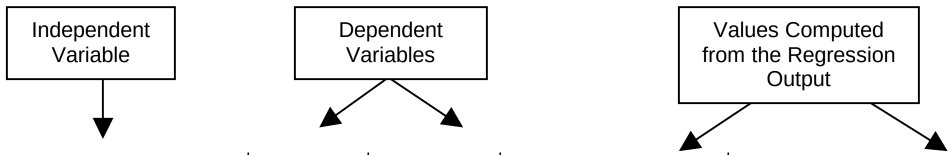
4. Use the spreadsheet program or calculator to create a table like the one shown below.

   In the first column, place the exact or true wavelength of the spectral lines that you used. In the second column, place the observed pixel number. In the third column, calculate the pixel number squared. In the fourth column, calculate the pixel number cubed.




| True Wavelength (nm) | Pixel # | Pixel # $^2$ | Predicted Wavelength | Difference |
|---|---|---|---|---|
| 253.65 | 105 | 11025 | 253.516577 | 0.133422619 |
| 296.73 | 179 | 32041 | 296.979662 | -0.249662049 |
| 302.15 | 188 | 35344 | 302.220703 | -0.070702657 |
| 313.16 | 206 | 42436 | 312.6735 | 0.486499891 |
| 334.15 | 243 | 59049 | 334.037188 | 0.112812248 |
| 365.01 | 298 | 88804 | 365.489132 | -0.479132164 |
| 404.66 | 368 | 135424 | 404.991651 | -0.331651335 |
| 435.84 | 423 | 178929 | 435.615094 | 0.224905808 |
| 546.08 | 626 | 391876 | 545.48766 | 0.592339659 |
| 696.54 | 921 | 848241 | 696.302678 | 0.237321917 |
| 706.72 | 942 | 887364 | 706.638812 | 0.081187518 |
| 727.29 | 984 | 968256 | 727.151647 | 0.138352544 |
| 738.40 | 1007 | 1014049 | 738.294786 | 0.105214107 |
| 750.39 | 1033 | 1067089 | 750.814613 | -0.424612735 |

5. Use the spreadsheet or calculator to calculate the wavelength calibration coefficients. In the spreadsheet program, find the functions to perform linear regressions.
   - If using Quattro Pro, look under **Tools | Advanced Math**
   - If using Excel, look under **Analysis ToolPak**
6. Select the true wavelength as the dependent variable (Y). Select the pixel number and the pixel number squared as the independent variables (X). After executing the regression, you will obtain an output similar to the one shown below.

**Regression Statistics**

| | |
|---|---|
| Multiple R | 0.999999831 |
| R Square | 0.999999663 |
| Adjusted R Square | 0.999999607 |
| Standard Error | 0.125540214 |
| Observations | 22 |

(Continued)

Intercept

| | Coefficients | Standard Error |
|---|---|---|
| Intercept | 190.473993 | 0.369047536 |
| X Variable 1 | 0.36263983 | 0.001684745 |
| X Variable 2 | -1.174416E-05 | 8.35279E-07 |

First coefficient

Second Coefficient

The figure above notes the numbers of importance.

7. Record the Intercept, as well as the First and Second coefficients. Additionally, look at the value for R squared. It should be very close to 1. If not, you have most likely assigned one of your wavelengths incorrectly.
8. Repeat this process for each channel in your spectrometer system.

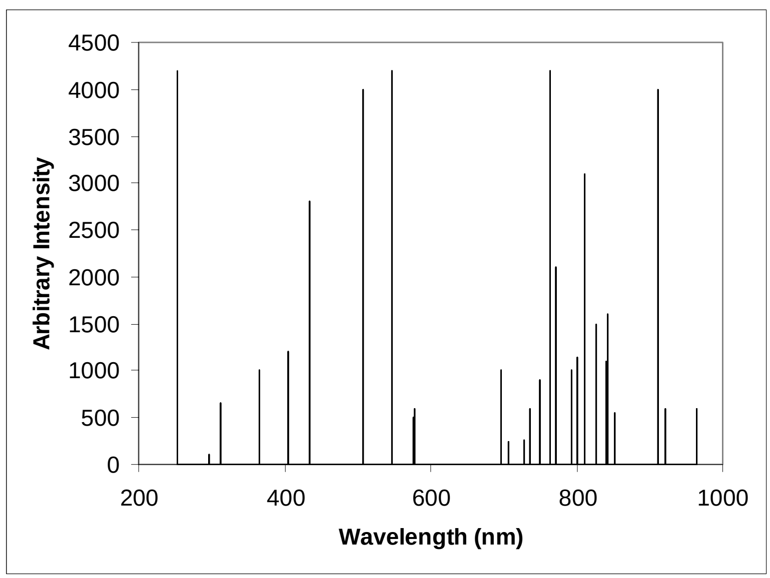
# HG-1 Specifications

The following sections detail the specifications of the HG-1:

## Spectral Output of the HG-1

The list on the left identifies the most prominent mercury and argon peaks. Mercury emission lines are <600 nm, and Argon emission lines are >600 nm. These lines are shown in the graphic to the right (on an exaggerated amplitude scale):

| Mercury Peaks | Argon Peaks |
|---|---|
| 253.65 | 696.54 |
| 296.73 | 738.40 |
| 302.15 | 750.39 |
| 313.16 | 763.51 |
| 334.15 | 772.40 |
| 365.01 | 794.82 |
| 404.66 | 800.62 |
| 435.84 | 811.53 |
| 546.08 | 826.45 |
| 576.96 | 842.46 |
| 579.07 | 912.30 |



## HG-1 Specifications

| | |
|---|---|
| Output | Low-pressure gas discharge lines of Mercury and Argon |
| Dimensions (in mm): | 125.7 x 70 x 25.8 |
| Power consumption: | 250 mA at 12 VDC |
| Power requirements: | 12 VDC wall transformer (included) or 9 VDC battery (optional) |
| Bulb life: | Approx. 3500 hours (at 20 mA) |
| Internal voltage: | 600 volts at 30 kHz |
| Aperture: | 3 mm |
| Amplitude stabilization: | ~ 1 minute |
| Connector: | SMA 905 |