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# Habanero™ Spectroscopy Reference Cell Furnace

(P1012726)

## USER MANUAL



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# SAFETY

## IMPORTANT SAFETY INFORMATION

Thank you for purchasing this equipment from Ideal Vacuum Products. We want you to operate it safely.



- Read this manual and all associated equipment manuals before installing or operating this equipment. Failure to follow the warnings and instructions may result in serious injury or equipment damage.
- Keep this manual in a safe location for future reference.
- This equipment should only be installed and operated by trained, qualified personnel, wearing appropriate protective equipment.
- Follow all codes that regulate the installation and operation of this equipment.

## WARNING SYMBOLS AND DEFINITIONS



This is the universal safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



Indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.



Indicates an imminently hazardous situation that, if not avoided, could result in death or severe injury.



Indicates a potentially hazardous situation that, if not avoided, could result in moderate or minor injury. It may also be used to alert against unsafe practices.



Indicates a potentially hazardous situation that, if not avoided, could result in equipment or property damage.



Indicates helpful tips and recommendations, as well as information for efficient, trouble-free operation.

Internationally recognized safety symbols may be used with safety warnings to specify the type of hazard or a safety protocol to follow. For example:



Indicates an electric shock hazard



Indicates safety glasses are required

# 1. OVERVIEW

## 1.1 INTRODUCTION

Ideal Vacuum's Habanero™ is a benchtop sized reference absorption cell heating furnace for spectroscopy, and can be used with all of our sealed wavelength reference cells. The Habanero furnace provides a stable temperature and convenient package for many reference cell applications. It provides an even, elevated temperature to maintain a constant absorption spectrum of tellurium for laser locking and spectrum calibration. For applications where greater resolution is required, it can be used in a saturated absorption system for doppler-free absorption spectroscopy. As configured, the Habanero is ready for use in transmission spectroscopy.

With a maximum operating temperature of 900°C, the Habanero furnace is especially useful for high temperature references such as tellurium and the excited states of iodine. With its wide operating range from maximum to ambient, the Habanero can be used with all of Ideal Vacuum's sealed wavelength reference cells. Note that care must be taken not to exceed the damage threshold temperature of alkali and organic reference cells.

Raising the temperature of a reference material that is solid under normal conditions increases the number density of atoms or molecules in the gas phase. This increases the optical density of the reference, increasing signal-to-noise ratios and the number of lines that can be confidently used to calibrate a spectrum. Raising the temperature also changes the distribution of populated states, allowing access to calibration-quality absorption lines beginning from higher rotational, vibrational, and even electronic states in wavelength ranges inaccessible at normal room temperature. Some reference materials have absorption lines or peaks that move as a function of temperature. For these materials, the Habanero furnace can provide the precise long-term temperature control necessary to maintain laser calibration for the full duration of an experiment.

## 1.2 PHYSICAL SPECIFICATIONS

Parameter	Value
Maximum Heater Temperature	900°C (1652°F)
Minimum Heater Temperature	Ambient
Window Diameter/Type	Ø1" Uncoated UV Fused Silica, 5 mm Thick, 0.5° Wedge, Wavelength Range: 185-2100 nm
Maximum Window Thickness	8 mm (0.315 in.)
Heater Type	Ceramic Fiber
Heater Bore Diameter	50.8 mm (2.0 in.)
Cell Holder Material	Macor Ceramic
Maximum Cell Holder Sample Diameter	26 mm (1.024 in.)
Maximum Cell Length (in Holder)	139.7 mm (5.5 in.)
Maximum Mounting Rod Sample Diameter	41.3 mm (1.625 in.)
Maximum Cell Length (on Mounting Rods)	155 mm (6.1 in.)
Heater Sheath Material	304 Stainless Steel
Case Material	10 ga. 5052 H32 Aluminum
Maximum Case Temperature	130°C (266°F)
Cooling	Passive Convection
Power Input	100-120 VAC, 50/60 Hz
Maximum Current	3.6 A
Heating Power	425 W
Power Cable	118 cm (3.9 ft.) long with NEMA 15-5 plug
Thermocouple Cable	118 cm (3.9 ft.), Type K Mini Male Connector
Recommended Controller	IVP PID Heater Controller (P107361)
Physical Dimensions	212 x 129 x 142 mm (8.34 x 5.08 x 5.60 in.)
Minimum Top Clearance	305 mm (12 in.)
Minimum Side Clearance	76 mm (3 in.)
Recommended Underneath Clearance	76 mm (3 in.)
Weight	5.33 kg. (11.75 lb.)

*Table 1 - Furnace specifications*



### 1.3 AVAILABLE WAVELENGTH REFERENCE CELLS

Part #	Material	Chemical Formula	Typical Temp. Range	Wavelength Range	Dimensions (OD. x Length)
P1011696	Sodium	Na	20-200°C	232-2338 nm	19 mm x 75 mm
P1011695	Potassium	K	20-200°C	219-4016 nm	19 mm x 75 mm
P1011689	Rubidium	Rb	20-80°C	207-1529 nm	19 mm x 75 mm
P1011692	Isotopic Rubidium	<sup>85</sup> Rb	20-80°C	207-1529 nm	19 mm x 75 mm
P1011693	Isotopic Rubidium	<sup>87</sup> Rb	20-80°C	207-1529 nm	19 mm x 75 mm
P1011694	Cesium	Cs	20-120°C	227-3613 nm	19 mm x 75 mm
P1012466	Methane	CH <sub>4</sub>	Ambient	430-1050 nm 3050-3650 nm 7275-8300 nm	10 mm x 75 mm
P1012478	Ethane	C <sub>2</sub> H <sub>6</sub>	Ambient	3050-3650 nm	10 mm x 75 mm
P1012479	Propane	C <sub>2</sub> H <sub>8</sub>	Ambient	2950-4000 nm	10 mm x 75 mm
P1012480	Ethylene	C <sub>2</sub> H <sub>4</sub>	Ambient	3075-3650 nm	10 mm x 50 mm
P1012481	Isotopic Acetylene	<sup>12</sup> C <sub>2</sub> H <sub>2</sub>	Ambient	2985-3125 nm	10 mm x 50 mm
P1012482	Isotopic Acetylene	<sup>13</sup> C <sub>2</sub> H <sub>2</sub>	Ambient	2985-3125 nm	10 mm x 50 mm
P1012483	Isotopic Carbon Monoxide	<sup>12</sup> C <sup>16</sup> O	Ambient	2300-2410 nm (NIST Telecom SRM 2515)	10 mm x 150 mm
P1012484	Isotopic Carbon Monoxide	<sup>13</sup> C <sup>16</sup> O	Ambient	1595-1635 nm 2300-2410 nm (NIST Telecom SRM 2515)	10 mm x 150 mm
P1012485	Carbon Dioxide	CO <sub>2</sub>	Ambient	2665-2855 nm	10 mm x 50 mm
P1011697	Water	H <sub>2</sub> O	-10-100°C	2500-2900 nm	19 mm x 75 mm
P1011698	Isotopic Tellurium	<sup>130</sup> Te <sub>2</sub>	550-800°C	420-540 nm	25 mm x 100 mm
P1010959	Iodine	I <sub>2</sub>	20-70°C	500-910 nm	20 mm x 100 mm

Table 2 - Specifications of available reference cells



## 2. BASIC INSTALLATION

### 2.1 POWER AND CONTROL

The Habanero's resistive heating elements are designed to be powered by 100-120 VAC, 50/60 Hz, 3.6 A and have a heating power of 425 W under these conditions. Reducing the voltage results in a slower heating rate and reduced maximum temperature.

Power is supplied to the furnace via a permanently attached power cord with a standard NEMA 5-15 plug. The power plug must be connected to a power regulating device, such as our PID heater controller (p. 16), a variable transformer (Variac), or another user supplied controller. Direct connection to an unregulated power source (such as the wall or a power strip) will result in overheating and permanent damage to the furnace.

For temperature monitoring, the Habanero is equipped with a type K thermocouple with a miniature male straight blade connector.

### 2.2 MOUNTING

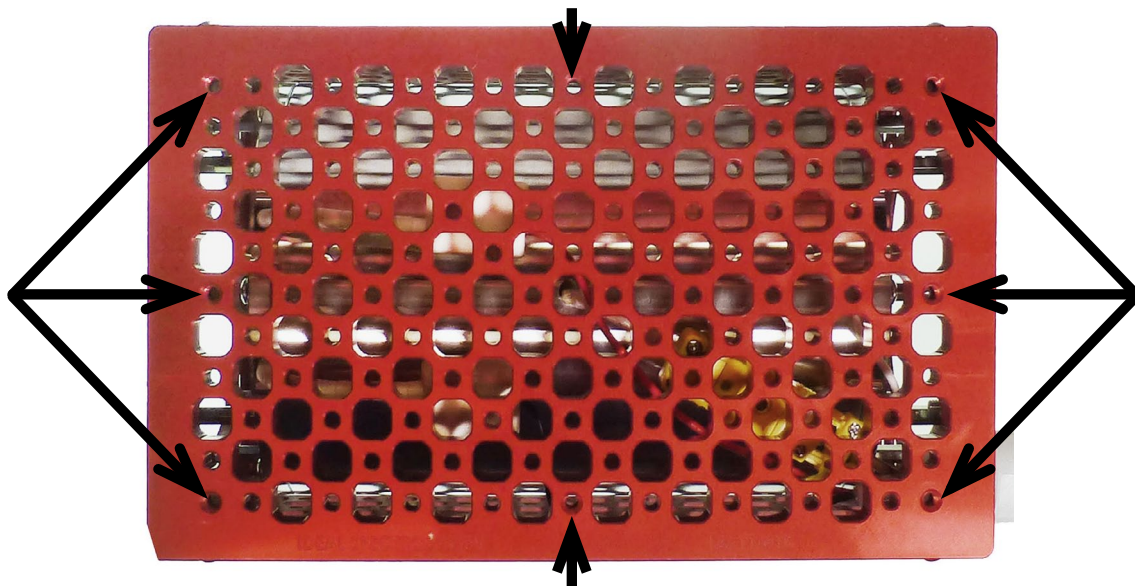
#### CAUTION



When the furnace's internal temperature is high, the furnace's exterior surface temperature can reach as much as 130°C (266°F). Do not touch the furnace when it is heating. Do not put anything on top of the furnace. Remove all combustibles from the furnace vicinity (i.e., paper). Do not operate in a fully enclosed space.

For adequate ventilation, at least 3" of clearance on each side and 12" above the furnace is required. It must be placed on or mounted to a non-combustible working surface. We recommend elevating it at least 3" above the surface to improve air flow.

The base of the Habanero has eight 8-32 tapped holes for mounting legs or posts.



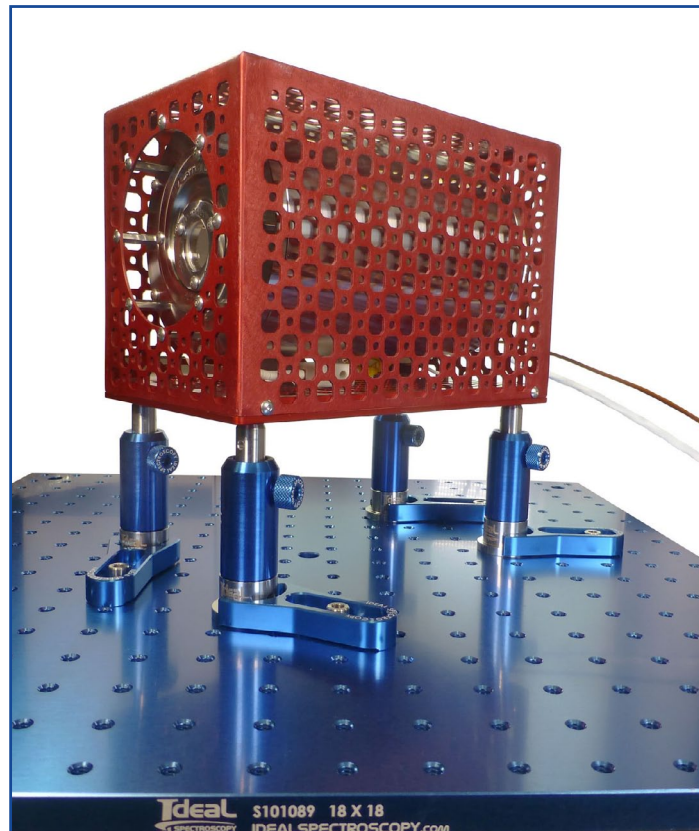
*Figure 1 - Tapped mounting holes in base*

For benchtop use, we recommend using four 3 inch long optical posts for legs screwed in at each corner of the furnace base (P1012739).



*Figure 2 - Optical post legs for benchtop placement (P1012739)*

For easiest mounting to an optical table with standard 1" x 1" breadboard tapped holes, we recommend our optical table furnace mounting kit (P1012736) (shown below), which includes everything needed for a vibration-free, secure installation. Other optical table accessories are available, including optical posts and holders in varied lengths, optic mounts, and breadboards.



*Figure 3 - Optical table furnace mounting kit (P1012736)*

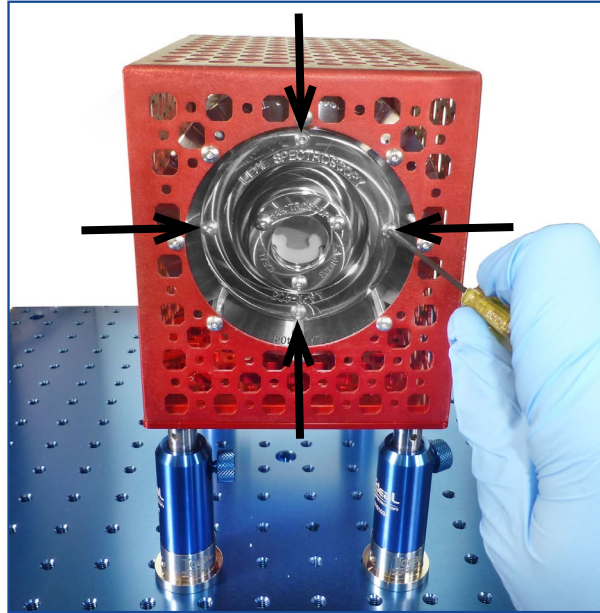
### 3. REFERENCE CELL INSTALLATION

#### NOTE

It is not necessary to remove the furnace windows when installing or replacing a reference cell.

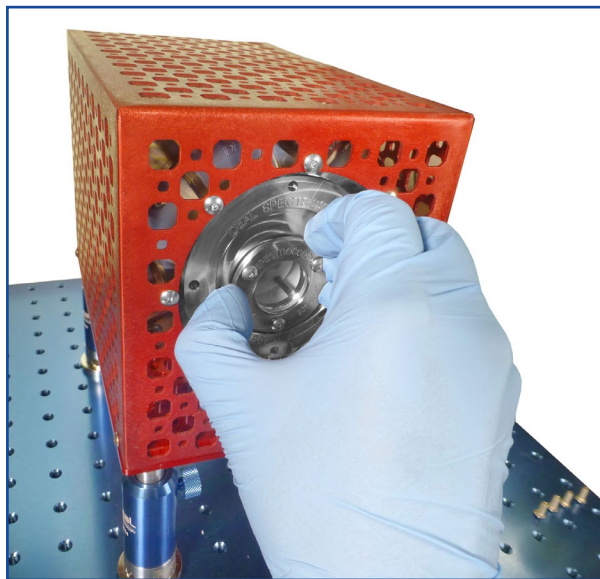
Initial installation or replacement of the reference cell is done when the heater is cold (at ambient temperature), and requires a 5/64" hex wrench. Wear gloves when performing this procedure.

1. On the side of the furnace opposite the power cable, unscrew the four 6-32 x 3/8" button head screws on the end cap (LA-11-405) just inside the furnace case.



*Figure 4 - Remove four end cap screws (LA-11-405)*

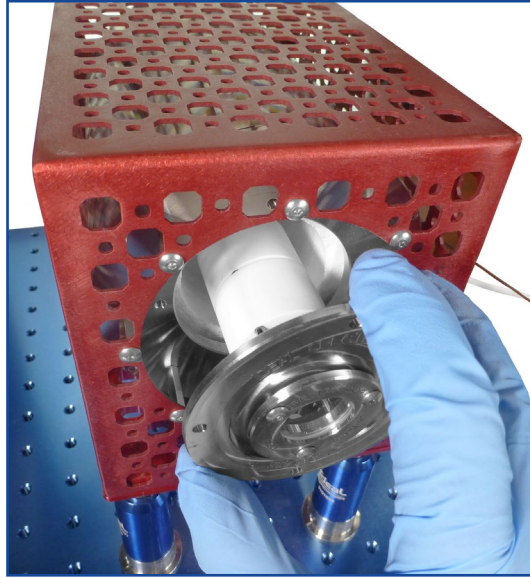
2. Grasp the window retaining ring and carefully pull the cell holder assembly out of the furnace.



*Figure 5 - Grasp and pull on window retaining ring*

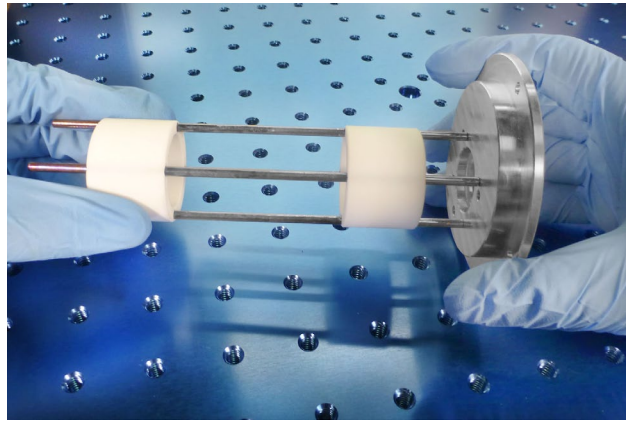


3. When the end cap is past the furnace case, grab the end cap and continue gently pulling the cell holder assembly out.



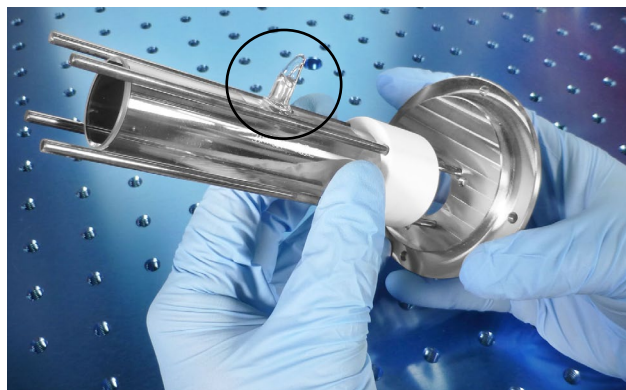
*Figure 6 - Pull out from end cap*

4. Once the cell holder assembly is out of the furnace, slide off the first ceramic holder.



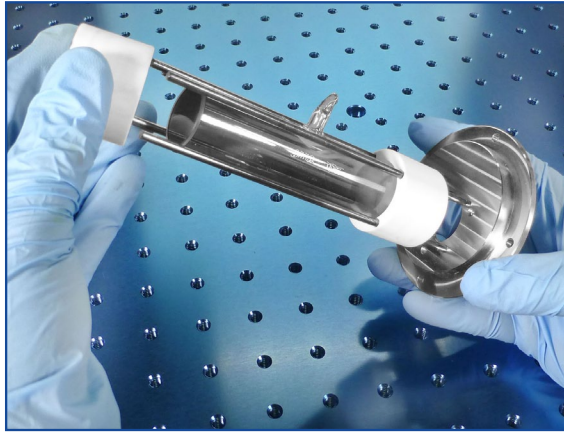
*Figure 7 - Slide off ceramic holder*

5. Notice that the end cap optic hole is off-center. Slide the reference cell in between the rods, cell stem pointing towards the larger side of the end cap. Seat the cell into the holder.



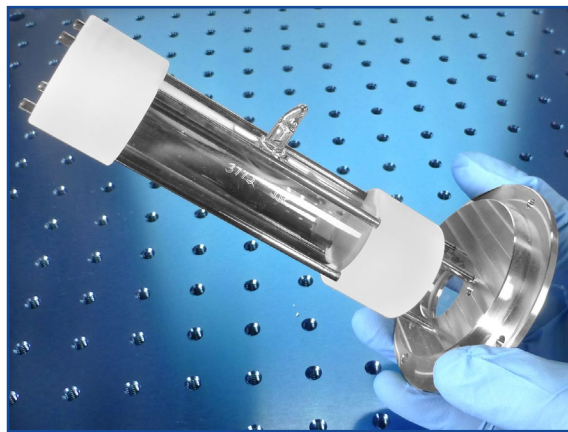
*Figure 8 - Seat the reference cell into the ceramic holder*

6. Take the previously removed ceramic cell holder and slide it, circular end first, back onto the mounting rods.



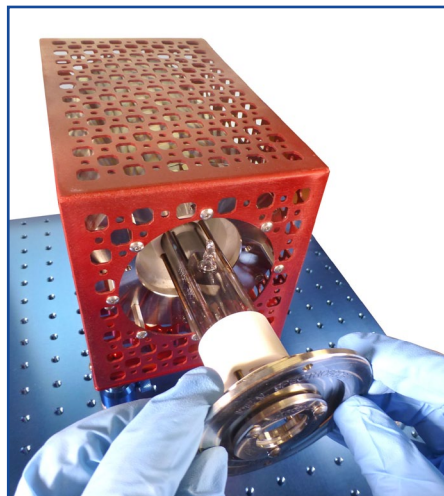
*Figure 9 - Slide the ceramic holder back onto the mounting rods*

7. Carefully slide the ceramic holder over, and seat it on, the reference cell.



*Figure 10 - Seat the ceramic holder onto the reference cell*

8. Carefully slide the cell holder assembly back into the furnace, cell stem up.



*Figure 11- Insert the cell holder assembly into the furnace*

9. Secure the assembly to the furnace with the four 6-32 x 3/8" screws. Use a 5/64" hex wrench.

## 4. WINDOW REPLACEMENT

### 4.1 AVAILABLE REPLACEMENT WINDOWS

Two 1" diameter, uncoated, wedged fused silica windows are included standard with the Habanero furnace. Window replacements may be required if the optics become degraded over time due to elevated temperatures. If focusing or other special considerations are required for an application, the researcher can substitute windows with their own optics. The furnace uses 1 inch diameter windows up to a maximum thickness of 8 mm. The windows may be removed entirely, which results in reduced heating performance and temperature uniformity. Below, Table 4 lists our available replacement windows. All are 1" diameter (25.4 mm), 5 mm (.197 in.) thick, 0.5° wedge, and have high surface flatness to prevent beam distortion.

Part #	Material	Maximum Temperature	Transmission Range	Reflection Loss
P1012275	N-BK7	619°C	350-2000 nm	8.1% @ 587.5618 nm
P1012276	Fused Silica*	1600°C	185-2100 nm	6.8% @ 588 nm
P1012277	Sapphire	1134°C	150-5000 nm	14% @ 1060 nm
P1012278	Calcium Fluoride	600°C (Humid) 1000°C (Humid)	130-10000 nm	5.4% @ 5000 nm

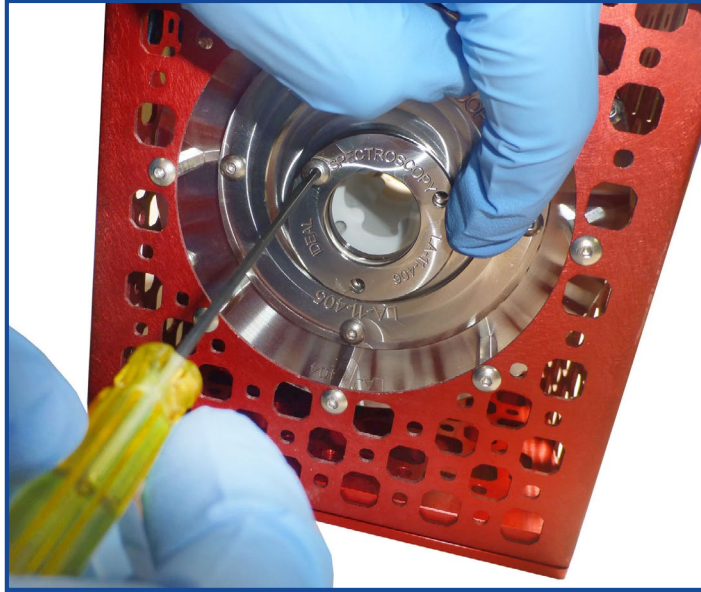
\* Included standard with furnace.

*Table 3 - Available replacement windows*

## 4.2 WINDOW REPLACEMENT PROCEDURE

Removal or replacement of the windows is done when the heater is cold (at ambient temperature), and requires a 5/64" hex wrench. Wear gloves when performing this procedure.

1. Unscrew the three 6-32 x 3/8" button head screws which secure the window retaining ring (LA-11-406). Be careful not to drop the screws or retaining ring into the furnace case.



*Figure 12 - Remove screws in window retaining ring*

2. Carefully remove the window. Do not let it fall into the furnace case.



*Figure 13 - Carefully remove and replace window*

3. Install the replacement window in reverse order.



## 5. FURNACE CONTROL

### 5.1 WITH IVP PID HEATER CONTROL

Follow the instructions below if you have the IVP Furnace and PID Heater Controller Kit with mounting hardware (P1012730), or if you are using the PID heater controller separately (P107361).

1. The controller has four navigation buttons, shown in Figure 14. They are used to select and change all controller parameters including setting the thermocouple type, starting and stopping furnace heating, and changing the furnace target temperature.



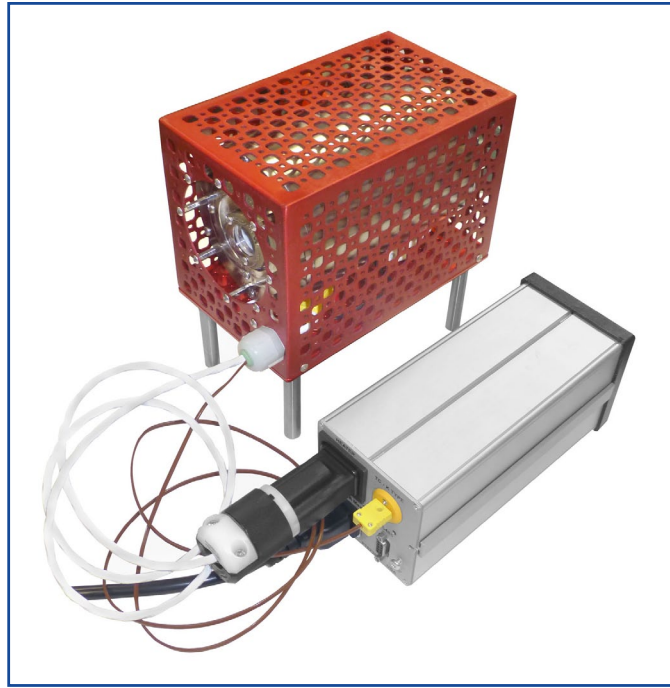
*Figure 14 - Controller navigation buttons*

2. Before using the PID heater controller for the first time, verify that the thermocouple setting is set to Type K on the controller.
3. Plug the controller into to a 100-120 VAC source (wall outlet or outlet strip) and switch power on from underneath the display.
4. Since a thermocouple is not yet plugged in, the display will read “no Cont”.
5. Press and hold down the **SET** button for 5 seconds.
6. The display should show “CnPt **v**”, the correct setting for a Type K thermocouple. If it does, then press the **SET** button.



*Figure 15 - Verify the Type K thermocouple setting*

7. If the controller shows a **CnPt** value other than that shown in Figure 15, press the **UP** or **DOWN ARROW** until it does. Then press the **SET** button to save the setting.
8. Once the thermocouple setting is verified, turn off the controller.
9. Plug the furnace’s power cord into the controller. Use a NEMA 5-20R to IEC C20 adapter (P1012728) to connect the furnace power plug to the PID heater connector.
10. Plug the furnace’s thermocouple into the controller (Figure 16, next page).



*Figure 16 - Plug furnace power and thermocouple cables into controller*

11. Press the power switch to turn on the controller.
12. The first time the controller is powered and connected to the furnace, the current temperature (PV) will be ambient. The target temperature (SV) will be 0.0 (Figure 17).
13. The PV (process value) is the furnace's current temperature, shown in red digits. The SV is the furnace target temperature, shown in green digits.



*Figure 17 - Initial current and target temperatures*

14. The controller is factory programmed to turn the furnace on immediately upon power up.
15. To turn off furnace heating and enter a new furnace target temperature, press the **ROTATE** button. The display will show "**r-S**" and **RUN** (Figure 18, next page).
16. Press the **UP ARROW**. The display changes to **STOP** (Figure 19, next page).
17. Press the **SET** Button to save the selection and go back to the temperature display.
18. Similarly, if **r-S** is set to **STOP**, press the **ROTATE** button. Press the **UP ARROW** to change to **RUN**. Press the **SET** Button to save the selection and go back to the temperature display.



*Figure 18 - Furnace runs on powerup      Figure 19 - Furnace does not run on powerup*

19. To change the furnace target temperature, press the **UP ARROW**. The green SV digits will flicker.
20. Hold down the **UP ARROW** to increase the target temperature. The value will increase slowly at first, then more quickly the longer the **UP ARROW** is depressed.
21. In Figure 20, our reference cell is Tellurium 130 and our target temperature is 650°C. When the target is reached, press the **SET** button to save.



*Figure 20 - Set the furnace target temperature*

22. When an experiment is completed and you want to turn off the furnace but leave the controller on, set the **r-S** value to **STOP**.
23. Alternatively, at the end of an experiment, turn the controller's power switch off. The SV value is retained and as soon as the power switch is turned back on, the furnace will immediately begin heating if the **r-S** value is set to **RUN**.

**For more information about setting controller parameters, refer to the SOLO 4848 manual, included with the controller or download the manual and RS485 serial configuration software at [idealvac.com](http://idealvac.com).**

## 5.2 WITH VARIABLE TRANSFORMER

If you are controlling the furnace with a variable transformer (Variac), make sure to use a readily available digital temperature gauge that accepts a Type K thermocouple mini connector. Do not run full voltage. The furnace will be damaged. Instead, increase the transformer's voltage slowly from zero to achieve the desired temperature.



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