



FZT4000HVIIVPOPC\_Manual Kazan Univ\_EG

## **FOUR MIRROR INFRARED FURNACE**

OPTICAL FLOATING ZONE SYSTEM  
FOR GROWTH OF SINGLE CRYSTALS

***MODEL FZ-T-4000-H-VII-VPO-PC***

# **Operation Manual for California Institute Of Technology**



***CRYSTAL SYSTEMS CORP.***

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## 1. Introduction

Optical floating zone systems having single or double mirror systems have been used for single crystal growth and phase equilibrium researches, and recently remarkable results are achieved in the researches of single crystal growth for oxide-superconductivity. however, it was difficult to make uniform the temperature variation around the circumference of the sample as they are being solidified, which means there was a barrier against the high quality single crystals growth. Crystal Systems Inc. had succeeded to develop the four-mirror type image furnace, which improves the temperature and enables the growth of high quality single crystals.(US patent No.5762707, EC patent No.0768391).

This system is showing extraordinary ability especially for single crystal growth of oxide-superconductivity.

LabVIEW control makes data collection and management easier, and you can confirm the growth condition remotely with your PC through LAN or INTERNET.

## 2. Specifications and Capabilities :

◆ Maximum Operating Temperature	2200° C
◆ Normal Operating Temperature	1850° C
◆ Maximum Crystal Growth Length	150 mm
◆ Maximum Gap Length	50 mm
◆ Maximum Feed Length (=upper shaft adjusting length)	150 mm
◆ Mirror slow movement (for growing crystal)	0.01 ~ 300 mm/hr
◆ Mirror fast movement (for positioning)	6 ~ 150 mm/min
◆ Upper shaft slow movement(for growing crystal)	0.01 ~ 300 mm/hr
◆ Upper shaft fast movement(for positioning)	6 ~ 150 mm/min
◆ Shaft rotation speed	5~100rpm
◆ Halogen lamp max power	1.0 KW x 4
◆ Fluctuation of out put Voltage (Against the $\pm 10\%$ Fluctuation of Input Voltage)	< $\pm 0.4\%$
◆ Number of Mirrors/Lamps	4 sets
◆ Outer diameter of Quartz Tube	50 mm
◆ Maximum Pressure in Quartz tube	0.95 MPa

- ◆ CCD Camera and LCD monitor system 1 set
- ◆ Atmosphere gas flow control system(Float method: GF-2-T) 1 set

3. Structure :

- ◆ Main Body 1 set
- ◆ Operation box 1 set

4. Function and Specification :

1) Reflecting Mirror

Four ellipsoidal mirrors which share one of two focuses each are used.

High quality glass mirrors are used to achieve high reflectivity of infrared light and longer operating life.

2) Halogen Lamps

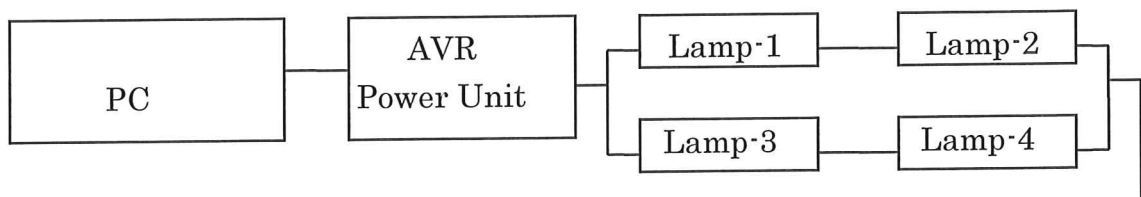
The lamps are air cooled to maintain stable and safety use.

The life of the halogen lamp should be more than 500 hours in power ratio of 80%, however, it may be reduced at the maximum ratio.

3) Cooling

Halogen Lamp	Air cooled
Ellipsoidal Mirror	Air cooled
Upper and Lower Flange Housing	Water cooled

4) Lamp power control



Four lamps are connected as above and PC controls power unit and Halogen lamps. Digital in-put is done through PC and it can be changed during program operation.

5) Observation unit

The molten zone can be monitored using the CCD camera and LCD monitor( color ).

Color CCD Camera - - - - - WAT231S2

Lens - - - - - LCV50

6) Sample Housing (Quartz tube)

The sample housing is made of the specially designed transparent quartz tube. Normal pressure type(straight tube) and High pressure tube(straight tube) are available.

① For Normal Pressure --- 2 t x 50Φ(outer dia) x 305 long

② For High Pressure ----- 5 t x 50Φ(outer dia) x 305 long

7) Atmospheric Gas Flow Control

Atmospheric gases are controlled by 2 kinds of Mass Flow Controllers.

- Ar Flow Meter ----- PF-8 5L/min

- O2 Flow Meter ---- PF-8 500cc/min

- Air Flow Meter --- RK1150 10L/min

- Stop Valve ----- SS-1RS4 Needle valve

- Mist Separator ----- AFM30-02B

8)Single Crystal Growth

The single crystal growth and phase-equilibrium researches are operated by adjusting the positions of Mirror stage and upper shaft.

- Mirror movement

Fast movement ----- 6~150 mm/min

Slow movement ----- 0.01~300 mm/hr

- Upper shaft movement

Fast movement ----- 6~150 mm/min

Slow movement ----- 0.01~300 mm/hr

- Shaft rotation

Both of upper and lower shafts can be rotated at your option.

Rotation speed ----- 5~100 rpm

9) LabVIEW

In configuration display, operation display, and monitoring display etc contain many information, and you can confirm various switch operation, positions, out-puts, accumulation time, abnormality

10) Handy operation box

Handy operation box is used at time of setting and for jogging at time of abnormality.

Handy operation box can control “upper and lower shafts movements”, “upper/lower shaft rotation”, “speed adjusting volume”, “mirror angle adjustment”, “mirror back-and-forward adjustment”, “mirror up-and-down” and “returning to original position”.

5. Safety:

- When cooling water stopped, all operation is stopped automatically and even after the reasons are removed, the system would not recover automatically.
- When power source is disconnected due to some reason, it will not recover automatically.
- Mirror stage and upper shaft stop at the position of the respective limit switch.

6. Accessories

1) Halogen lamps	-----	300 W	8 pcs	
		1000W	8 pcs	
2) Quartz Tube (High pressure type)	----		2 pcs	
		(Normal pressure type)	----	2 pcs
3) Tool Box	-----		1 box	

7. Size, Weight, Power

Furnace main body ----- 700W x 820D x 1950H  
About 350 kgs

Control box ----- 605W x 800D x 1650H  
About 120 kgs

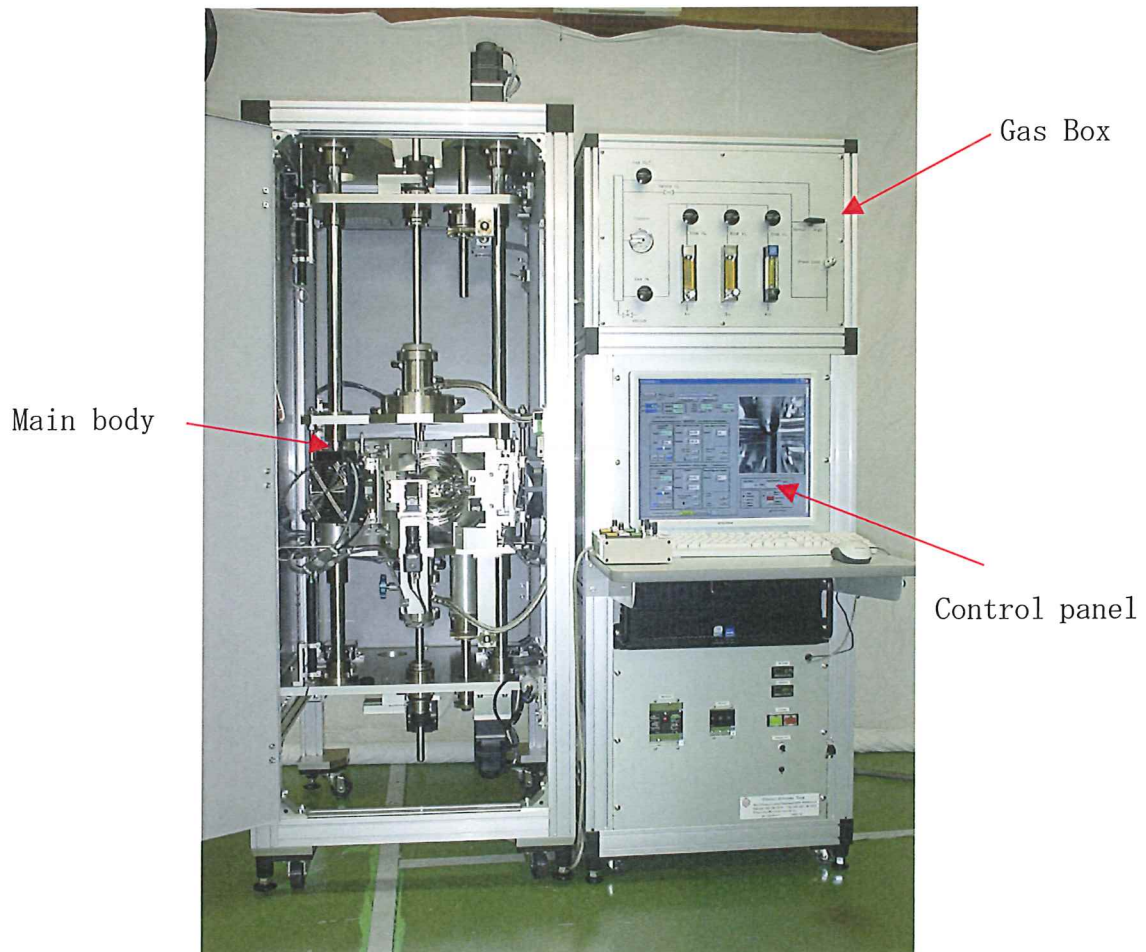
Electric power ----- 3Φ x 200V, 30A (Furnace main body)

## 8. Warranty

The warranty of this system is one year after the installation.  
The glass products such as mirrors, lamps and quartz tubes are  
Out of warranty.

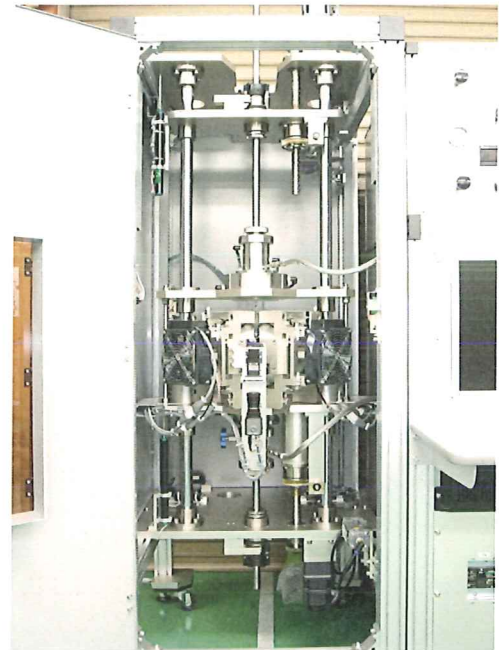
## 9. Name of parts

9-1 Structure



### 9-2 Main body

comprises ellipsoidal mirrors, driving system and observation system. To shut-out heat and light, and to protect high pressure operation, the safety-coverings are equipped at three directions (except control panel side).



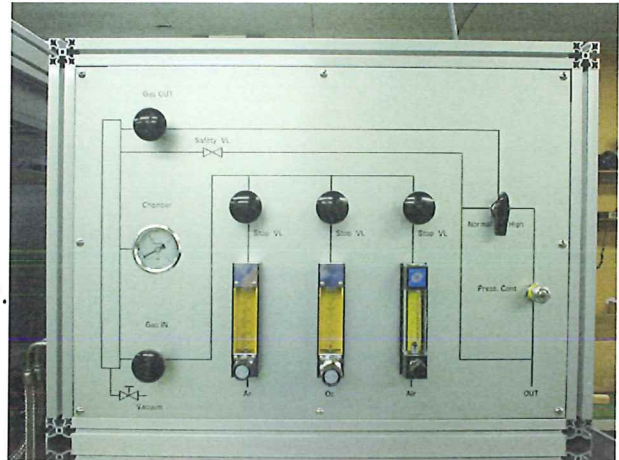
### 9-3 Control system

comprised PC, PC control monitor, Power source for lamp control etc.



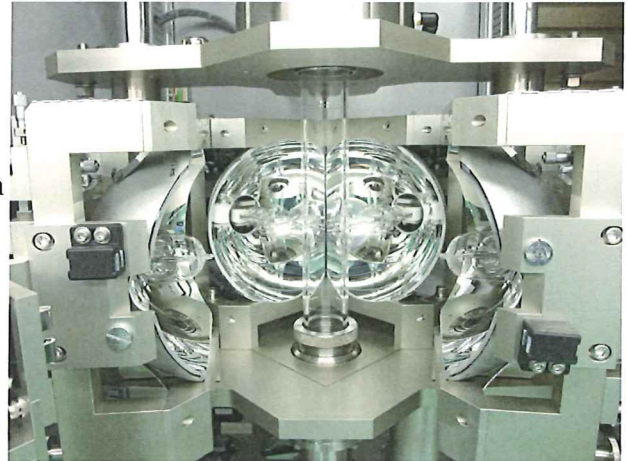
#### 9-4 Gas Box

You can use two kinds of gases, or you can mix them. With mass flow controller, you can control the flow precisely. If you do not need such preciseness, air-atmosphere is possible with attached compressor. (Details are described in separate Clause).



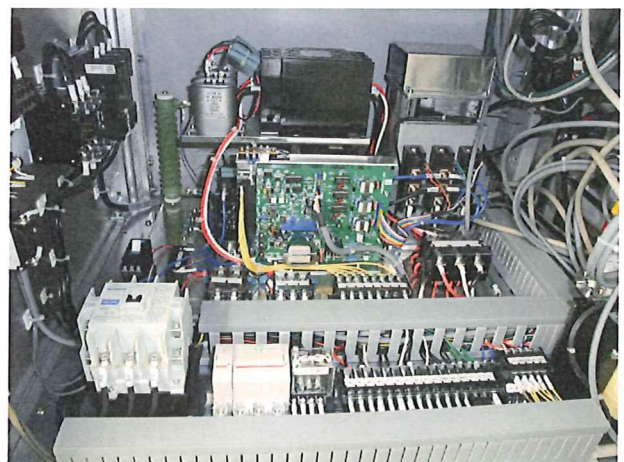
#### 9-5 Mirrors

Focus distance is fixed to get the best temperature condition. The clear quartz tube without strain is used, so you can perform the more stable experiments.



#### 9-6 AVR electric source

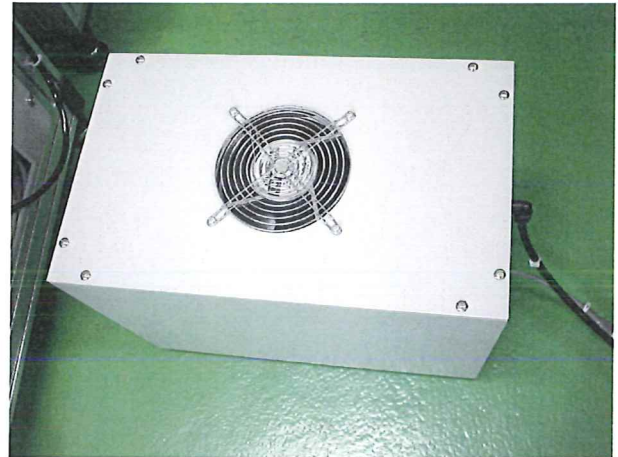
The AVR source in our system is developed especially for FZ furnace. With very stable out-put, it is suitable for Crystal growth.





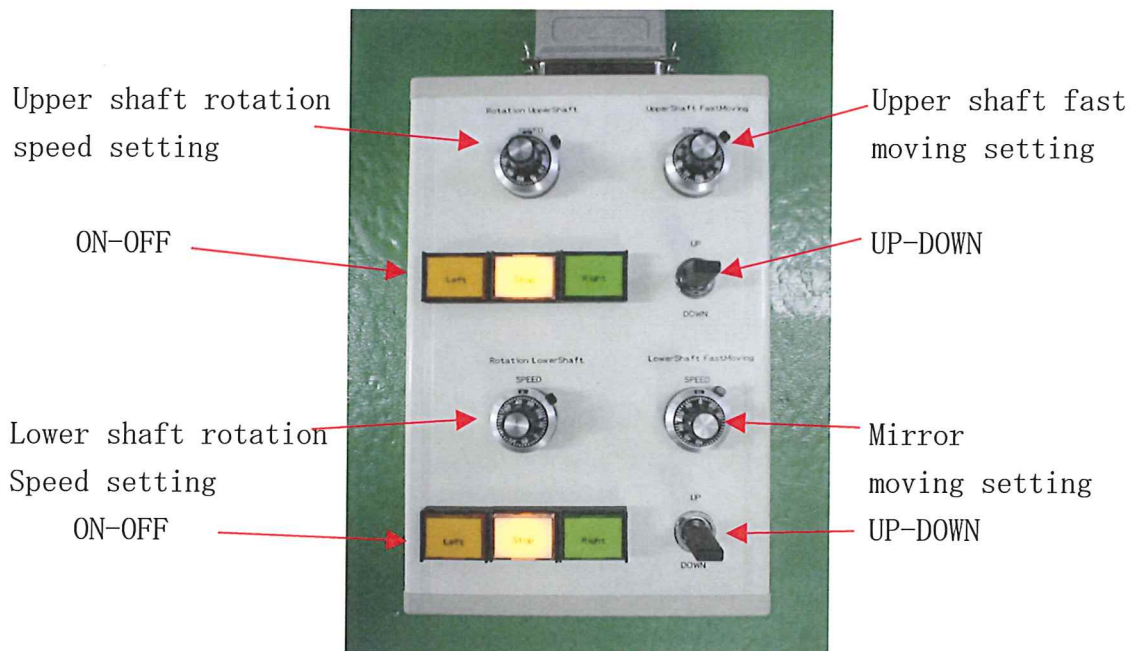
9-7 Air Atmosphere Compressor Box

The compressor DAP-15 (ULVAC) is installed. Flow of Max 10L/min is available.



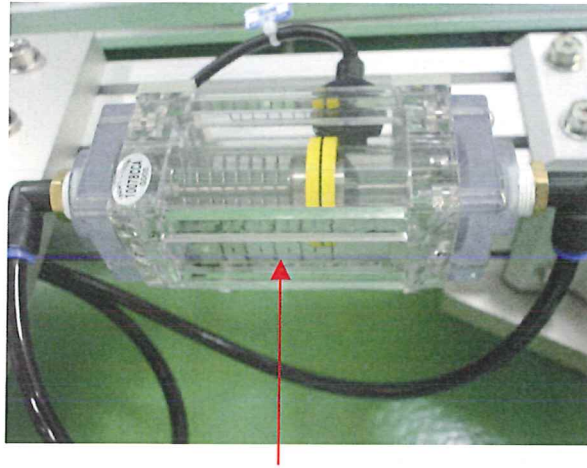
9-8 Handy Control Box

You can adjust the position of Sample, Heater, Mirror by the Handy Control Box.



### 9-9 Flow Switch

This locates at the bottom right side of Main Body.  
The flow switch can confirm the water volume. If the water volume is 3L/min or more, there exists no problem.,



Flow Switch FAT-CC-5-C (flowcell)

### 9-10 CCD Camera

WAT-231S2 (WATEC) is installed.

Initial setting

- 1-OFF
- 2-ON
- 3-ON
- 4-ON



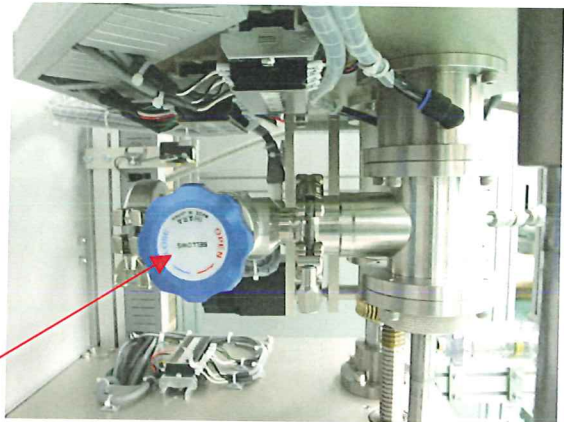
### 9-11 Filter

Color filter is used for observation of single crystal growth conditions.  
Two kinds of filters are available.  
#10 (dark) 、 #8 (pale)



9-12 High pressure valve  
 By connecting with vacuum exhaust equipment, the atmosphere in the chamber can be replaced quickly. This is the valve for high pressure, so please close it when you make the chamber high pressure.

G-351332



9-13 Driving system

Driving system comprises ①slow movement, ②fast movement and ③Upper/lower rotation

Following motors are used.

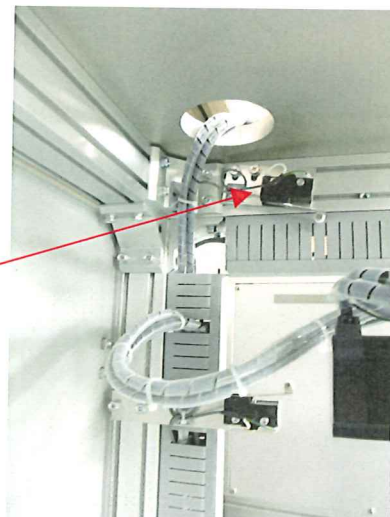
Slow movement	RK564AC-T7.2
Fast movement	BX460CM-50
Rotation	BLH450K-15



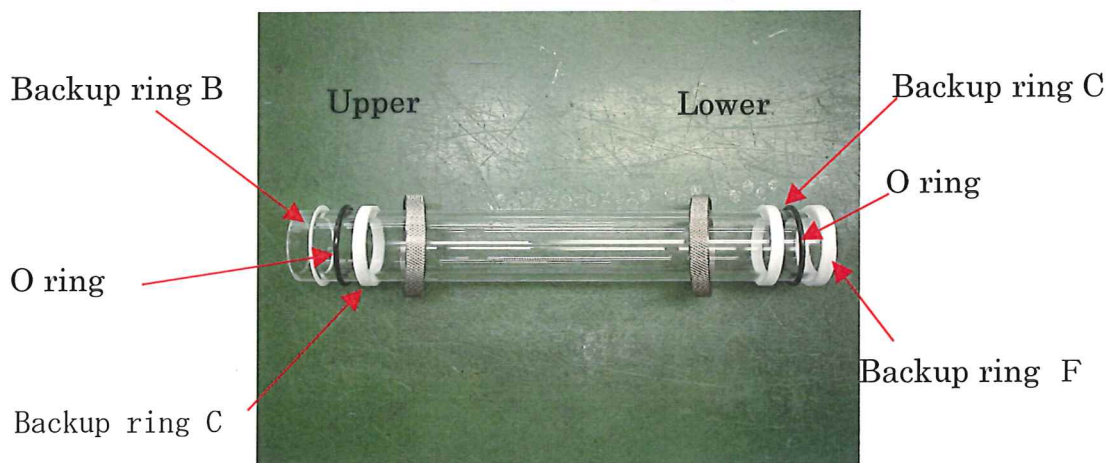
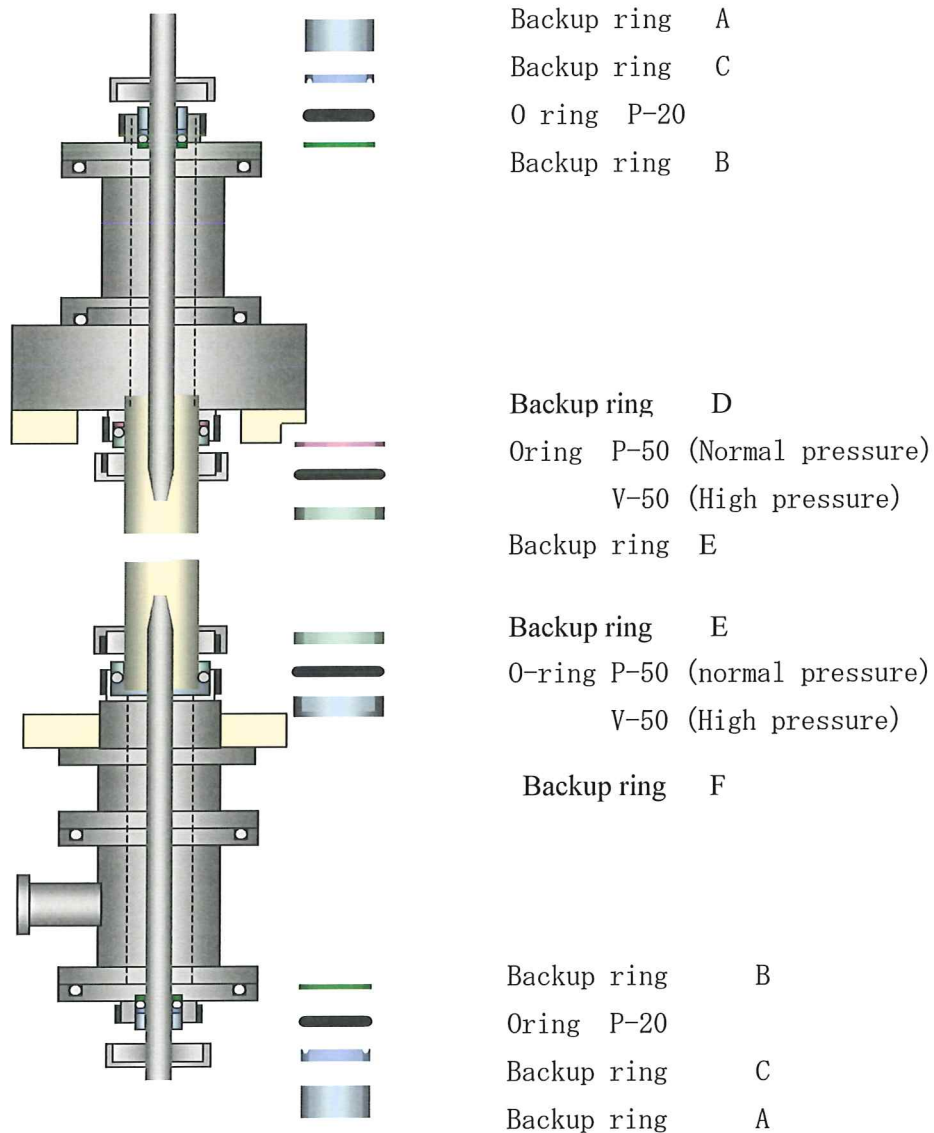
9-14 Limit switch

Mirror stage and upper shaft stage are designed to stop at respective limit Switch.

Z-15GW2-B



9-15 Sealing structure of shafts and quartz tube



## 10.Operation Procedures

### 10-1.Checking before operation

Check the appearance of main body, control box etc, and confirm that nothing is abnormal.

### 10-2. To flow cooling water

Before turning on the electricity, start the water supply.

This system is designed to stop all system unless proper quantity of cooling water is being supplied.

In case interlock happened, to release the interlock, ①press error-reset of control panel or ②turn off the power of control panel once, then turn on again.

### 10-3.To Turn ON Power source switch

- Turn ON control panel switch (Main breaker) .
- Turn ON SCR breaker
- Turn ON control panel switch
- Turn ON PC power switch

### 10-4.To set lamps (Not everytime)

Two kinds of lamps,300W and 1000W are prepared.

Pick up and use the lamp which meets your purpose.

When the system is shipped from Manufacturer, 1000 W lamps are equipped. If you change the lamps, please follow procedures below.

※ Detailed method of exchanging lamps is described in latter part.

The summary is as follows;

- ① Dismount the lamps from the holders.  
Lamps are just inserted to the holder.  
Use gloves or tissue paper not to make it dirty.
- ② Remove the fan (for mirror cooling), and take off lamp holder.
- ③ Reset lamp-socket to the position meeting lamp power,  
Then insert the lamp and set to lamp-positioning-jig attached.
- ④ By eye, adjust lamp-filament to the appointed position.
- ⑤ Return the holder to the appointed position.

Proceed to next step to operate control box and main body.

#### 10-5. Setting of feed rod

- ① Open two front mirrors to the right and to the left.  
They are stuck by magnets, so you can open them with hand easily.
- ② Attach feed rod and seed to upper shaft and lower shaft respectively.
- ③ Turn on main power switch(ELB1) and lamp power switch(CP1).
- ④ Rotate upper shaft and lower shaft, and confirm the centering of both shafts.
- ⑤ Loosen the collet chucks of upper/lower shafts, and move up the upper shaft and down the lower shaft, then move the feed rod and seed out of the chamber.

#### 10-6 Setting of Quartz tube

- ① Attach O-rings, back-up rings and SUS metal jig to the quartz tube, and install it at appointed position.

At this timing, be careful not to hit the tube holder(cooling jacket) by quartz tube.

It is enough to tighten the SUS metal jig to the quartz tube with one hand only.

- ② After setting the quartz tube, then set feed rod and seed to appointed position.

At this timing, please check/confirm the growth starting position and ending position of each stage (i.e. mirror stage and upper shaft stage).

Though collet chuck can clamp the shaft at position you want, But it might reach the limit switch during the growth and you might not be able to keep on growing the crystal.

Especially for high pressure use, please tighten collet chuck firmly by using specific tool.

- ③ Rotate upper and lower shafts at suitable speed, and confirm feed rod and seed rotate properly. Also please confirm that lamps are not abnormal.
- ④ Please check/confirm that lamp cooling fans and mirror cooling fans are working in normal condition.
- ⑤ Return the mirror stage to appointed position.
- ⑥ Close the front door tightly.

Setting completed

### 10-7 Heating up

- Please refer to Software manual attached.
- Confirm that feed rod and seed locates at correct position, then start heating-up.
- Total voltage and currency supplied to four lamps are indicated digitally.

### 10-8 Touch-down and Crystal growth

① When the tips of feed rod and seed become melting, let both of them approach, and touch-down, and start crystal growth.

② By moving mirror stage, the crystal is grown.

Meanwhile the upper shaft can be moved up-and-down during growth as you like.

- Distance(crystal growth length) indication

The crystal growth is made by mirror stage migration.

The upper shaft can be moved independently 150 mm in order to adjust the width between upper and lower shafts, and these figures are shown by digital indicator.

Mirror stage moving length(Crystal growth length) Max 150mm

Upper shaft moving length is Max 150 mm

- Distance meter

By pressing “reset” at any position, “ZERO” is indicated and start distance indication from there.

- Lamp usage accumulation time

Lamp usage time is accumulated and digitally indicated.

Please refer it for the lamp exchange.

- Transfer Limit

Upper/Lower shafts have transfer/moving limit by limit switch.

Crystal growth operation must be considered to complete within the range of stage transfer/movement by adjusting starting position.

### 10-9 Observation

CCD Camera takes photo of melting zone which can be monitored with LCD.

Adjust the photo depending on melting zone temperature, filter and

brightness.

The photo on LCD is erect image, so you can see it as it is.

#### 10-10 Stage transfer

With this system, crystal growth is done by transferring the stage upper side. You can adjust the transfer of slow and fast movements as you like independently.

You can select suitable speed of transferring by rotating the volume switch. Stage transferring distance is indicated digitally, so if you need the distance of crystal growth from the starting, please press reset button, and start from the ZERO. You can push reset button At any place.

#### 10-11 Upper shaft transferring

Like the stage, you can adjust direction/time/speed of slow moving and fast moving of upper shaft.

#### 10-12 Stoppage

When the growth is completed, separate the feed rod and crystal, Decrease down the electricity supply gradually, and turn off the lamps. At this moment, we recommend you to cool down the lamp slowly by using the program controller.

#### 10-13 Take out the sample from the chamber

Please take out the feed rod and crystal with reverse procedures of sample setting.

Please stop the cooling water, turn off the power switch.

The operation procedure is completed.

#### 10-14 Others

##### ① Interlock functioning and release

When abnormality happens such as lack of cooling water etc, Interlock happens and there is possibility that power supply may be turned off.

Remove the reason and press error-reset switch, then the system is restored. In case it is not restored even by pressing the error-reset



switch, please turn off all power supply, and then turn on the power again.

② Lamp usage time indication

The accumulated lamp usage time is indicated by digital indicator.

③ Transfer limit

When stage and upper shaft reach the transfer limit, the limit switch functions and stop the movement.

④ Dew generation by water cooling

The upper/lower quartz tube holders are water cooled.

Please be careful about the dew generation at these spots, especially Summer time.

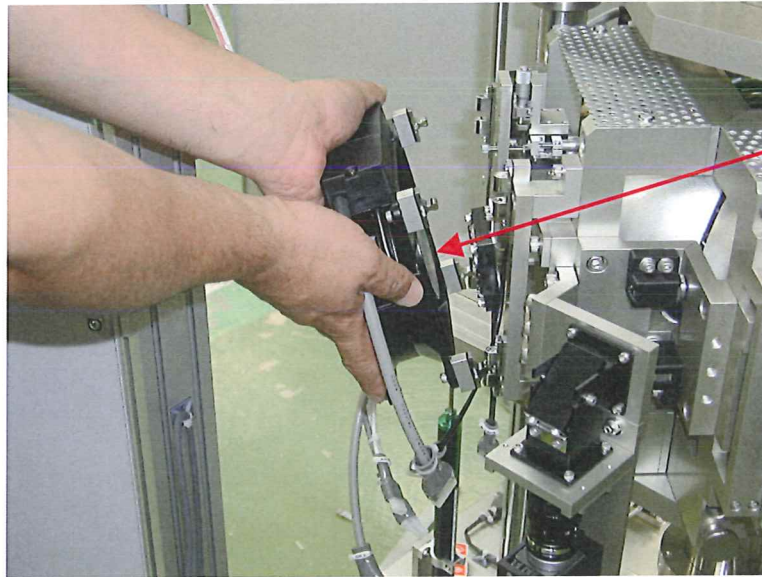
⑤ Reset

During the operation, because of happening of abnormality, buzz sounds and in some cases, power becomes off.

If abnormality happened, please remove the reason, and press the error-reset button, then the system is restored.

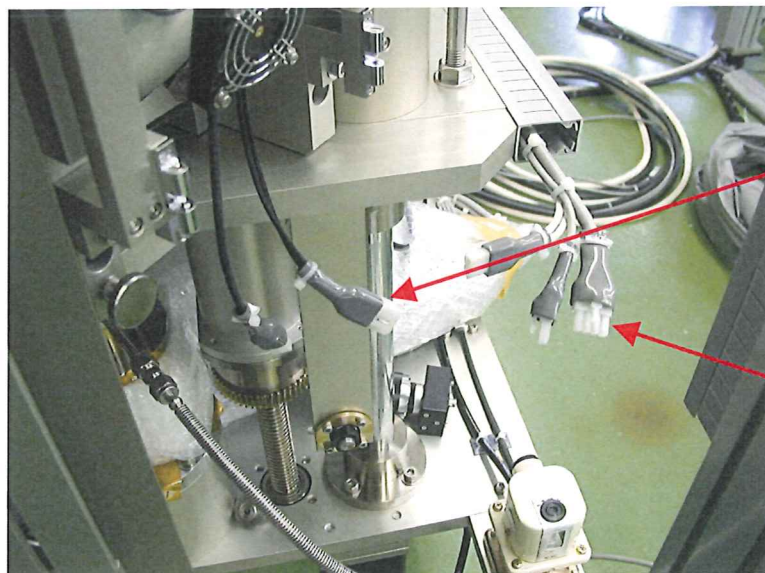
## How to replace the lamp and its adjusting method

- (1) Detach the mirror cooling fan



Mirror Cooling fan

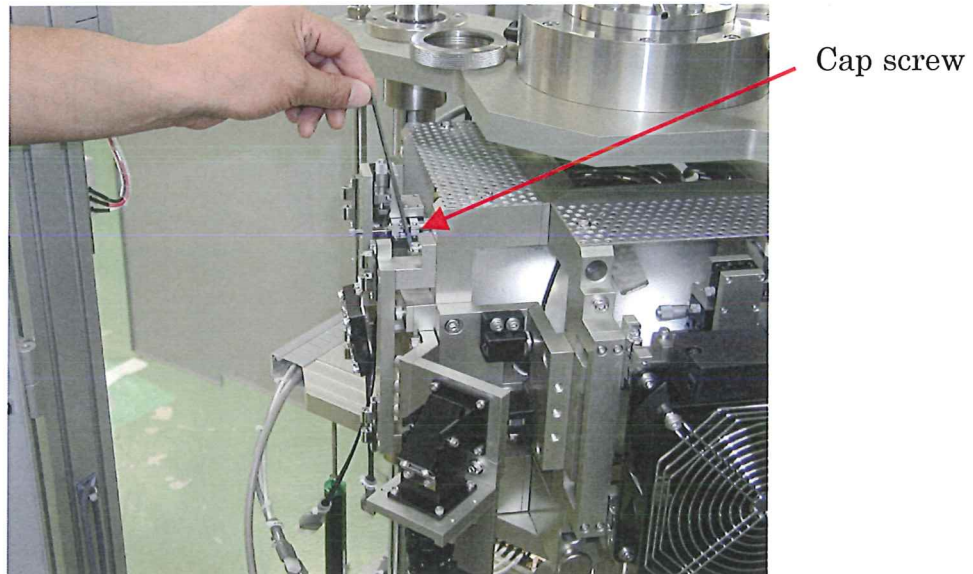
- (2) Remove power cable, and the connector for mirror cooling fan..



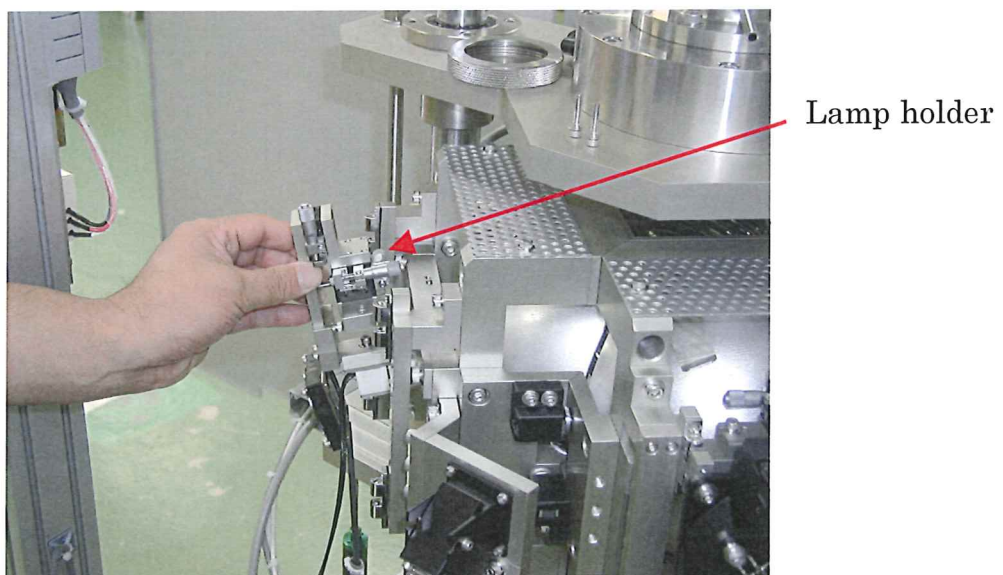
Power cable

Mirror cooling  
Fan cable

(3) Release the screw which fasten the lamp holder.

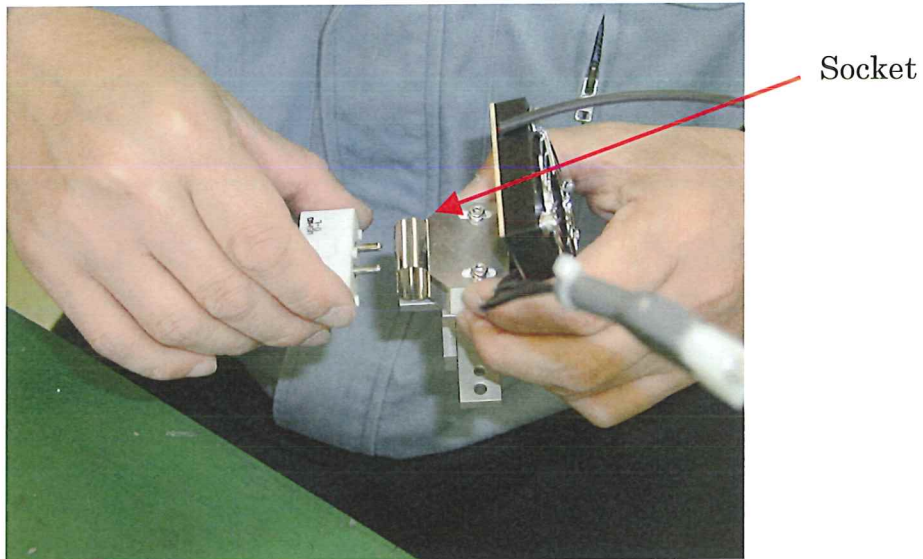


(4) Pull out the lamp holder..



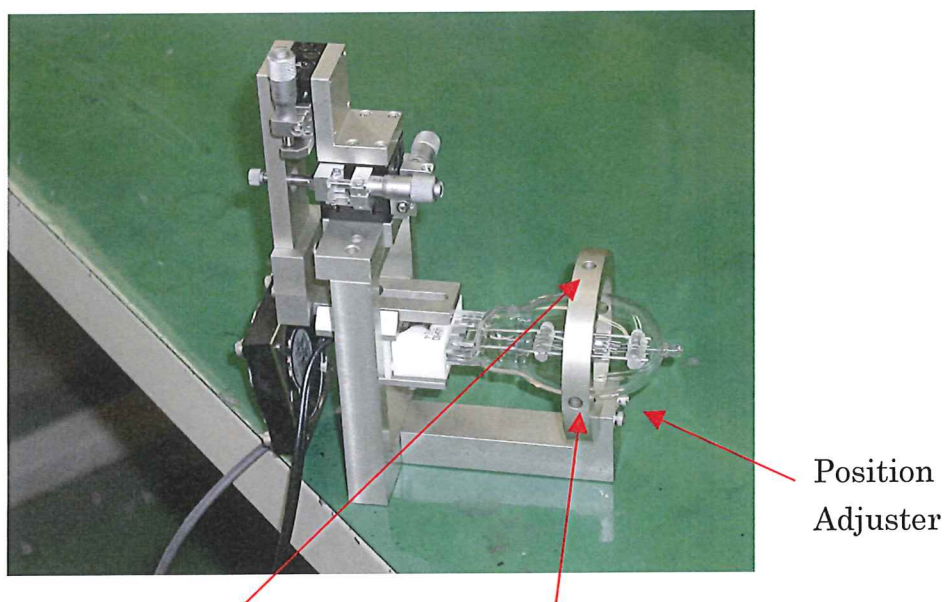
(Be careful not to hit the mirror)

- (5) Release the used lamp.
- (6) Set the new lamp



The photo shows how to release the used lamp.  
 When install a new lamp, use cotton gloves and do not touch with bare hands.

- (7) Set the lamp holder to the focus adjuster.

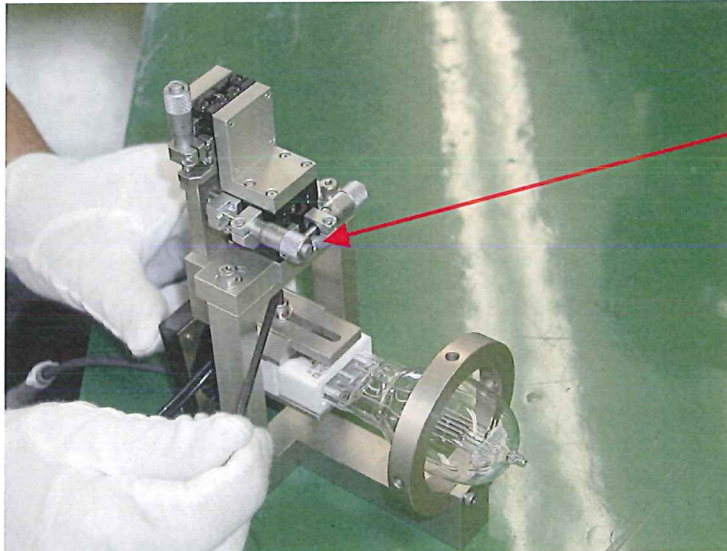


Front-back and right-left  
 Adjusting hole

Up-down adjusting hole

Position  
 Adjuster

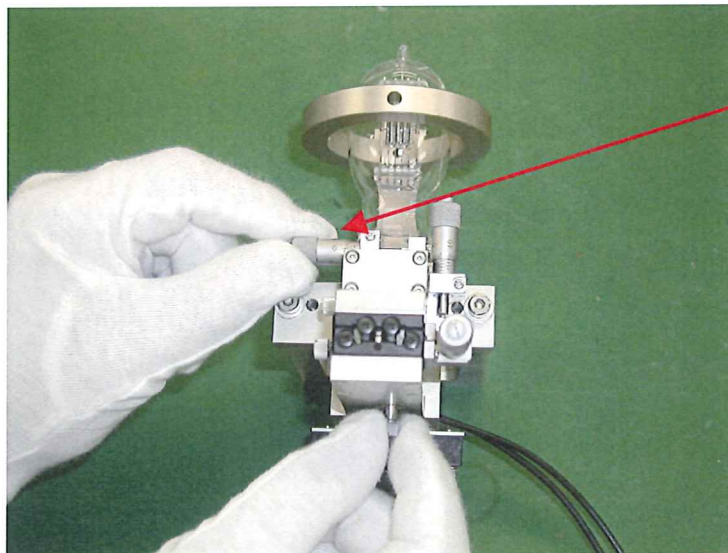
(8) Front and back adjusting



Micrometer

Loosen M4 screw, and adjust so that filament comes to the center.  
With micrometer for fine tuning, adjust it to come to the center using position adjustor and jig crate.

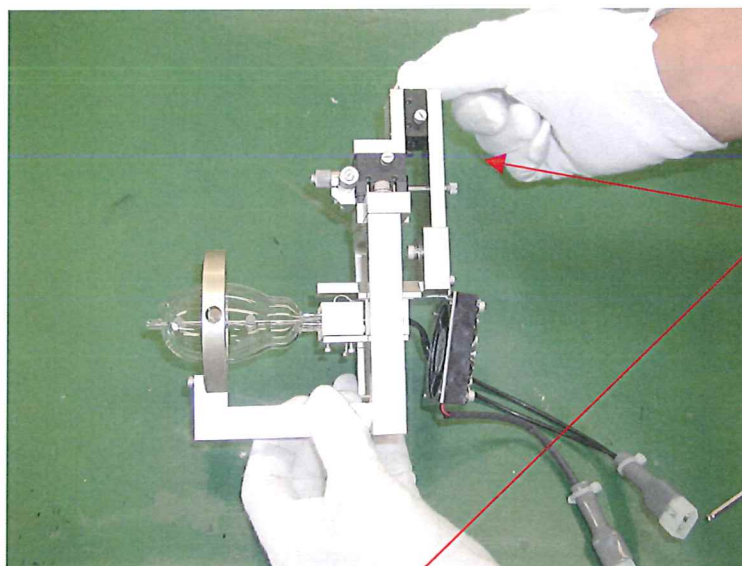
(9) Left and right adjusting



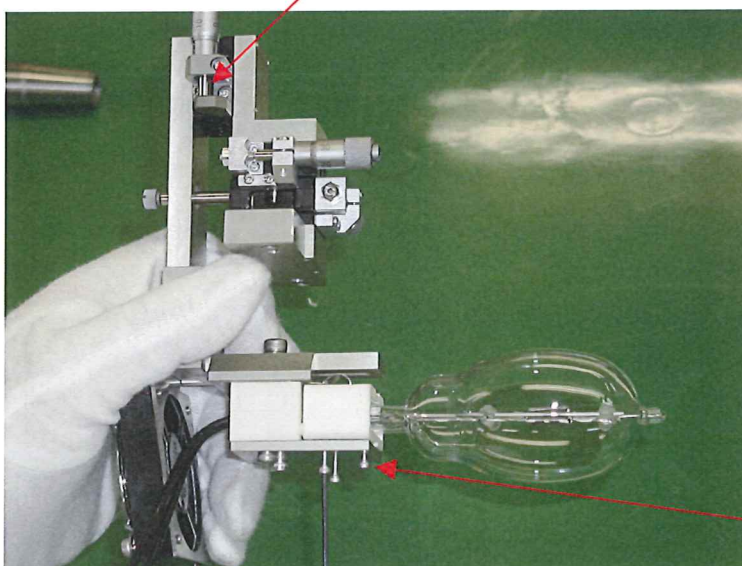
Micrometer

Looking from above, adjust filament center to come to the center of the peeping hole. At this moment, be careful not to fix the filament as tilted.

(10 Upper and lower adjusting



Up-down  
adjusting  
micrometer



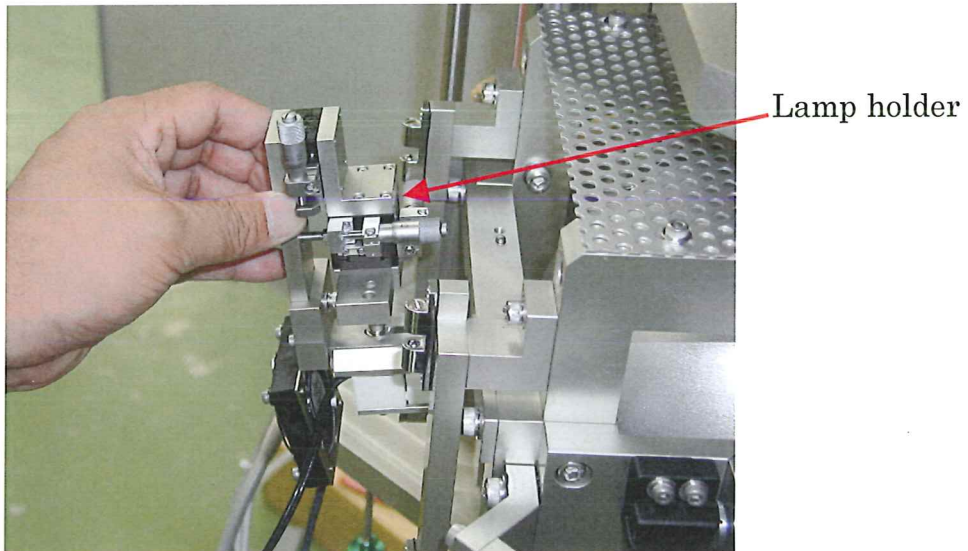
M3 screw

Adjust the height by the micrometer in the photo.

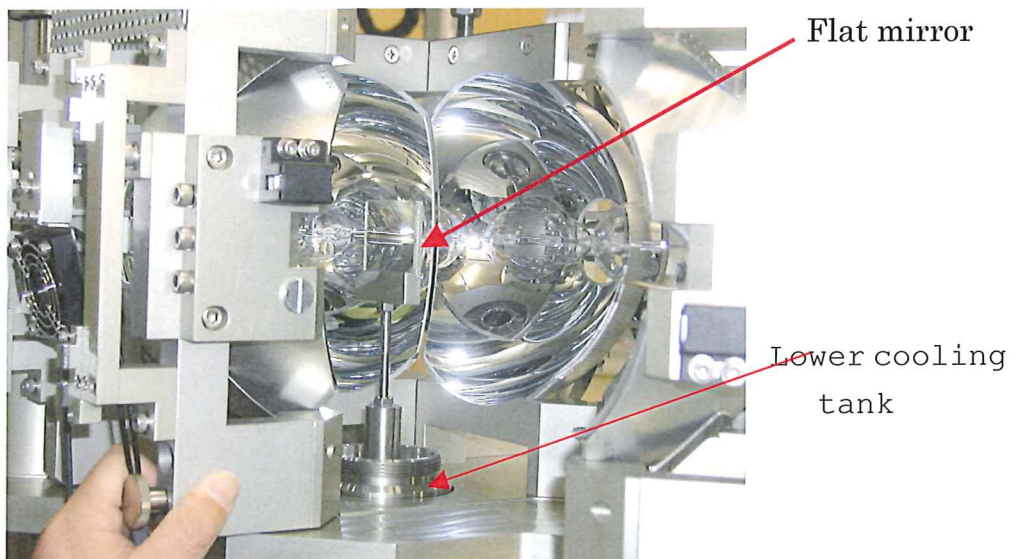
Adjust the filament center to come to the center of peeping hole.

At this moment, be careful the filament becomes tilted. Use M3 screw and adjust it to be parallel.

(11) Set the holder to the mirror stage.

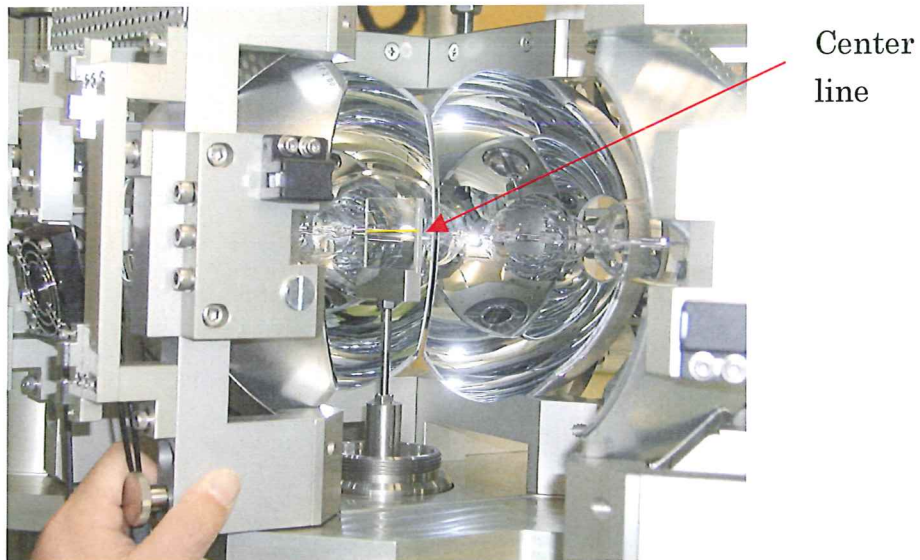


(12) Set the Flat mirror to adjust the focusing at lower cooling tank..



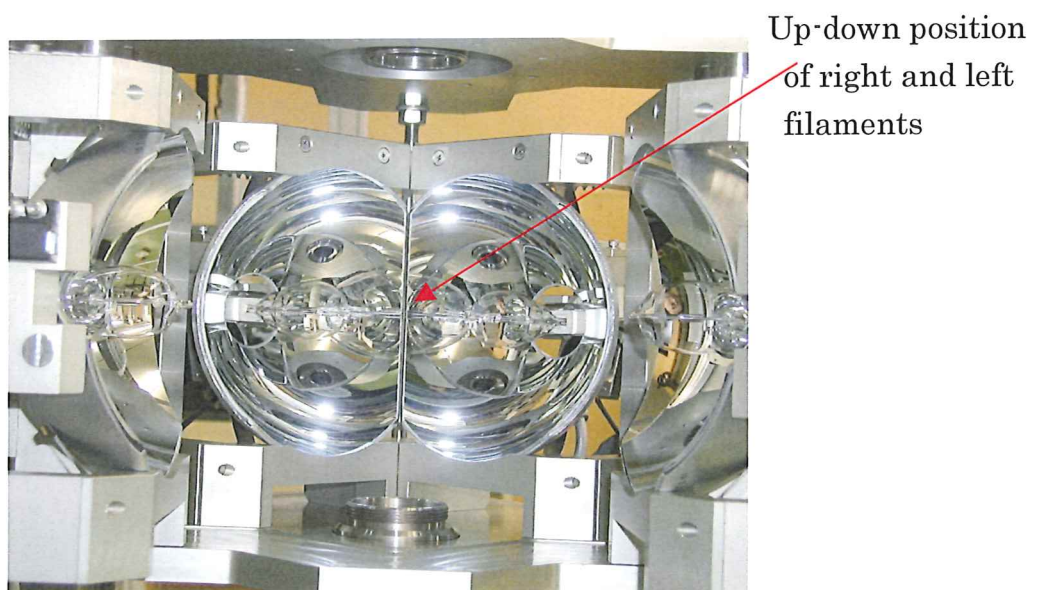
(13) Adjust left near mirror at appointed position.

Reflect the boundary of left-near-mirror and left-far-mirror in Flat mirror, and confirm that filament centers of each lamps are positioned on the center line of Flat mirror.



If diverted, adjust with up-down adjusting screw.

(14) Remove Flat mirror from the cooling tank once, and confirm the filament positions of right-far-mirror and left-far-mirror .





- (15) Set again Flat mirror, adjust right-near-mirror at appointed position, and adjust right-near-mirror and right-far-mirror by the same manner of (14).



- (16) Now, focus adjustment is completed. Insert the connector which was released before, and fasten mirror cooling fan.



## 12 Others

### 12-1 How to exchange rubber belt.

The rubber belt should be exchanged when became slippery or cracks were generated.

To exchange it, at first, loosen the M8screw. (not necessary to remove all)



With motor pulled this side, the belt becomes to be easy to be removed.  
Please remove from the pulley as shown in the photo.



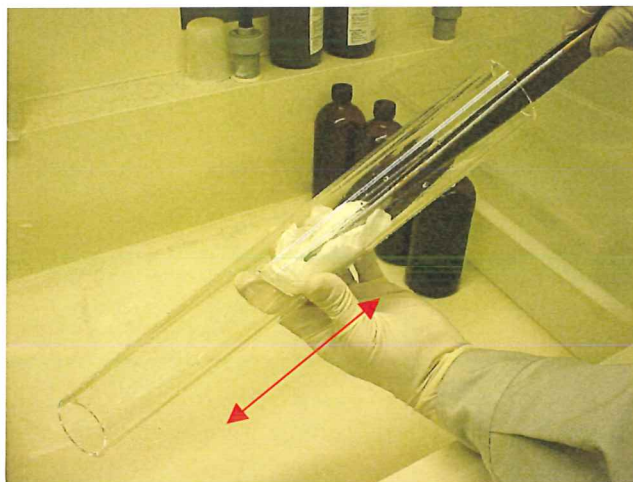
Exchange to a new belt, and fasten the motor. At this moment, it is necessary to give tension to the belt, so please fasten M8 screw pushing backward. Without some tension, it becomes slippery.



## 12-2 How to rinse quartz tube

When dirtiness is not so heavy, as shown in the photo please wash inside with tissue containing organic solvent such as alcohol.

After washing, please dry it



If dirtiness cannot be removed even with organic solvent, please use neutral detergent together with brush. Clean it with foams.



At the end, rinse with organic solvent, and then dry it.

※ When use acids, please do the cleaning in the exhaust facility such as draft etc.

When deposits generated inside quartz tube, use acids(hydrochloric, nitric, fluoric acid etc).

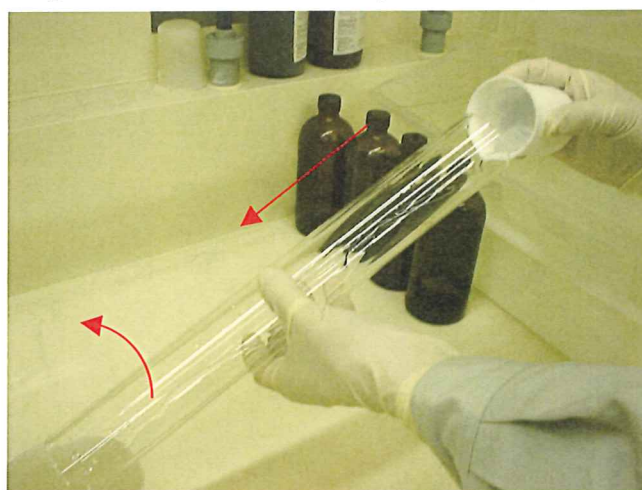
Select the acid depending on the deposit.

As shown in the photo, rotating the quartz tube, flow in the acid.

Repeat it and clear off the deposits.

Rinse off the acids, and finally wipe off with organic solvent

And dry it.



## 13 HOW TO USE GAS BOX

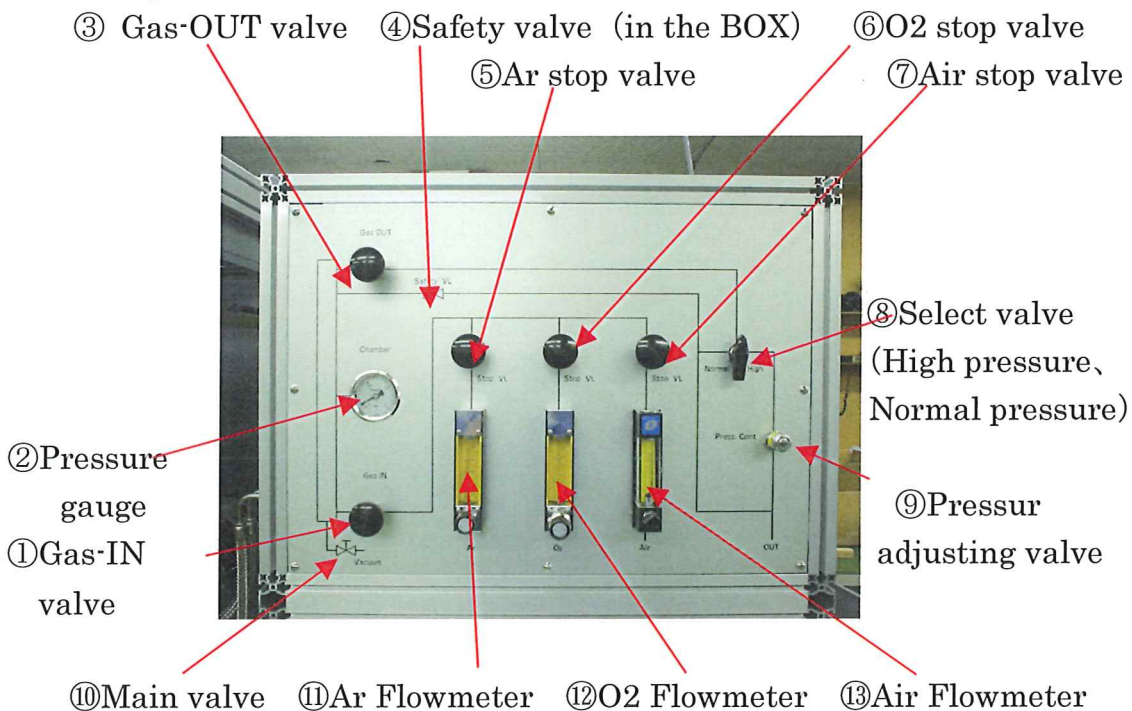
13)-1. Summery

This system can perform the FLOW CONTROL of two kinds of gases(Ar, O<sub>2</sub>) and Air.

The flowmeter (Ar, O<sub>2</sub>) has a structure enduring high pressure of 0.95Mpa and can mix the two kinds as well. With the air flowmeter, you can perform the experiments with air even without gases by utilizing the accessory compressor.

13)- 2.Explanation of each part

Front panel

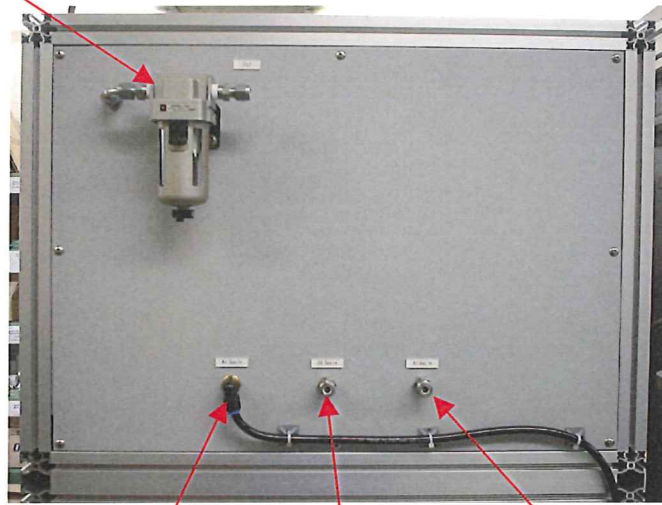


- ①Gas-In valve . . . . . Valve to supply for the chamber
- ②Pressure valve . . . . . To indicate the pressure in the chamber
- ③Gas-OUT valve . . . . . Valve to exhaust from the chamber
- ④Safety valve . . . . . To exhaust at 0.95Mpa It is located in the BOX
- ⑤Ar stop valve . . . . . Stop valve of Ar gas
- ⑥O<sub>2</sub> stop valve . . . . . Stop valve of O<sub>2</sub> gas
- ⑦Air stop valve . . . . . Stop valve of Air
- ⑧Select valve . . . . . To select high pressure or normal pressure
- ⑨Pressure adjusting valve . . . . . To adjust the high pressure at your discretion

- ⑩Main valve . . . . . To disconnect from the vacuum system. It is located in the FZ system main body.
- ⑪Ar Flowmeter . . . . . Max flow rate 2L/min
- ⑫O<sub>2</sub> Flowmeter . . . . . Max flow rate 200cc/min
- ⑬Air Flowmeter . . . . . Max flow rate 10L/min

Back side panel

⑭Filter



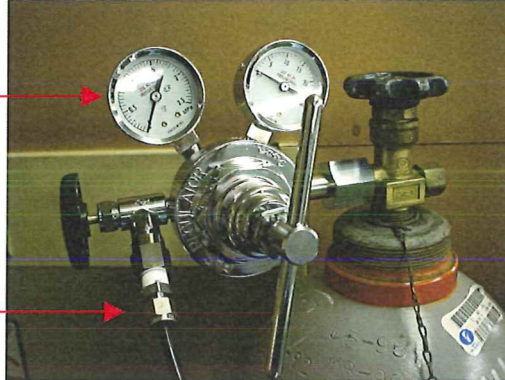
⑮Air Gas-IN      ⑯O<sub>2</sub> Gas-IN      ⑰Ar Gas-IN

- ⑭Filter . . . . . Exhaust gas filter AFM30-02B (SMC)
- ⑮Air Gas-IN . . . . . Inlet port for Air (No need to connect because it is connected with compressor)
- ⑯O<sub>2</sub> Gas-IN . . . . . Inlet port for O<sub>2</sub> (Please connect with 1/4 swagelock)
- ⑰Ar Gas-IN . . . . . Inlet port for Ar (Please connect with 1/4swagelock)

### 1.3) -3. CONNECTION

more than  
2MPa

1/4 swagelock



In case of direct connection from the cylinder, please use the regulator for high-pressure application. With the pressure meter of 2<sup>nd</sup> side which can cover up to more than 2M Pa, you can perform the experiment of Max. 1 M Pa., therefore we recommend to use the regulator of high-pressure application.

Also as shown above photo, please use 1/4swagelock at supply-side.

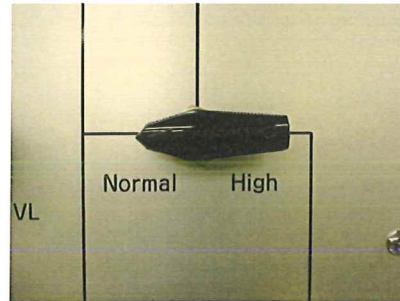


1/4 inch tube made with Metal

The supply should be connected with 1/4swagelock at back side of GAS BOX. At this time, The metal tube is the best. In case the metal is not available, and when you use plastic tube, please make sure that the tube can endure up to 2M Pa.

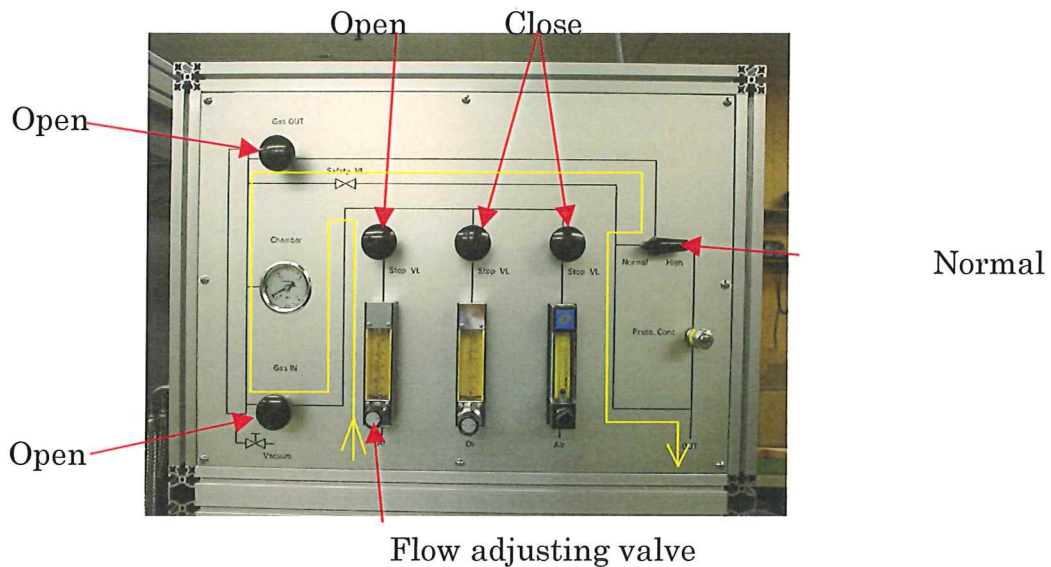
13)-4. How to operate

13)-4-1 Experiment under normal pressure(flow)



Set the select valve to Normal position on the front panel.

( FYR)In case Ar is connected, yellow line shows the gas flow route



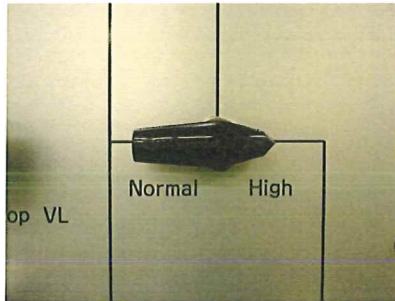
Please adjust "Flow adjusting valve" of each Flowmeter.

In case to mix Ar with O<sub>2</sub>, please blend together adjusting the flow rate of O<sub>2</sub> with opening the O<sub>2</sub> stop-valve.

※ It is not possible to mix Ar or O<sub>2</sub> with Air

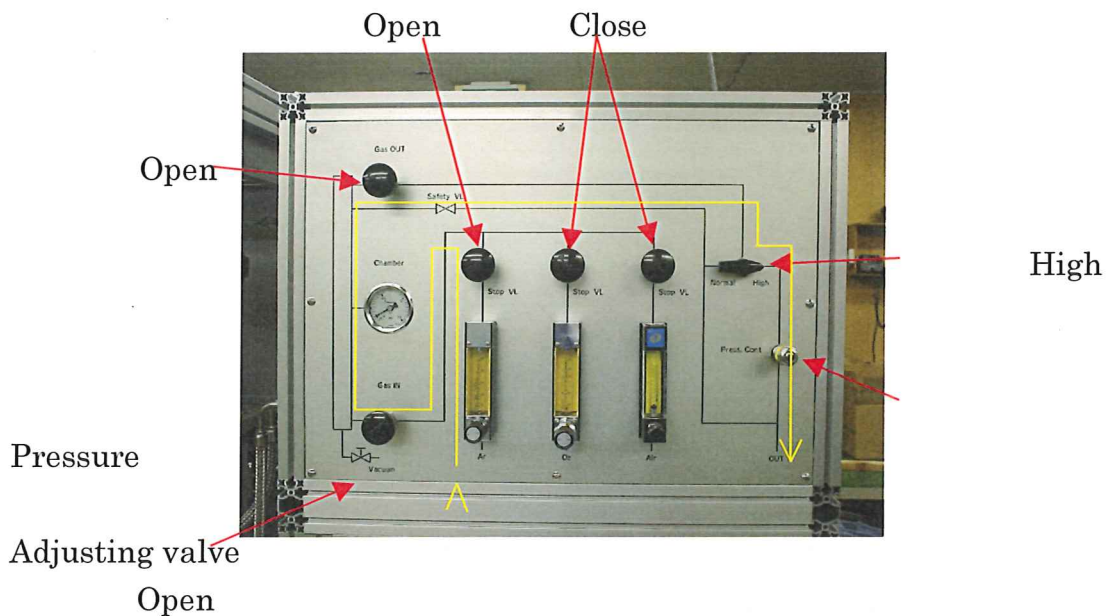
13)-4-2 Experiment under high pressure

※ Please make sure to use **QUARTZ TUBE of HIGH PRESSURE USE**  
(thickness 5mm)



Set Select-valve on front panel to “High” position as shown on the above photo.

In case Ar gas is connected, yellow line shows the gas flow route



Please adjust the pressure by tuning the pressure adjusting valve (“Press.Cont”.)

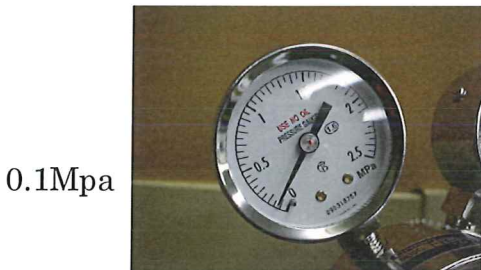
By turning it to the right, the pressure will increase, and by turning to the left, the pressure will decrease.





On actual operation, the pressure adjusting valve (“Press.Cont.”) is tuned balancing with the cylinder regulator. However, at the very beginning, please make sure to turn it to the right completely.

① Increase the pressure of the regulator



② Make sure the pressure gauge of GAS BOX shows the same pressure as the regulator.



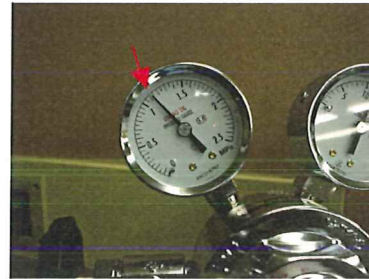
③ Chamber pressure reaches a constant level when the flow of Flowmeter becomes “0”.



④ Increase the pressure gradually



0..95Mpa



1.2Mpa

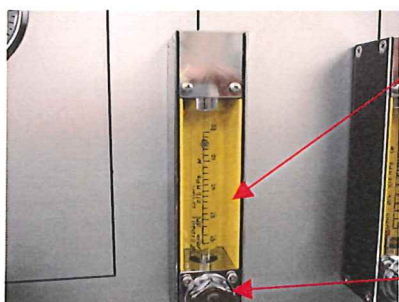
It is dangerous to increase the cylinder regulator instantly, so please increase the pressure gradually by 0.2~0.3Mpa. The last photo shows the regulator pressure of 1.2Mpa. When you experiment under the MAX pressure, there exists no flow if the pressure inside the chamber (2<sup>nd</sup> side) and the pressure of cylinder regulator (1<sup>st</sup> side) become exactly the same. Therefore please make the gas flow by adjusting the pressure of cylinder regulator slightly higher.



In case of the experiment under 0.95Mpa



Turn to the left gradually



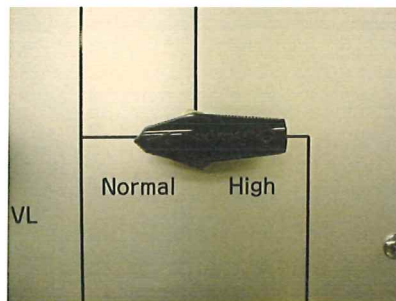
Turn till the flow becomes generated. After you recognize the flow, please adjust the flow by tuning the Flow adjusting valve

the Flow adjusting valve

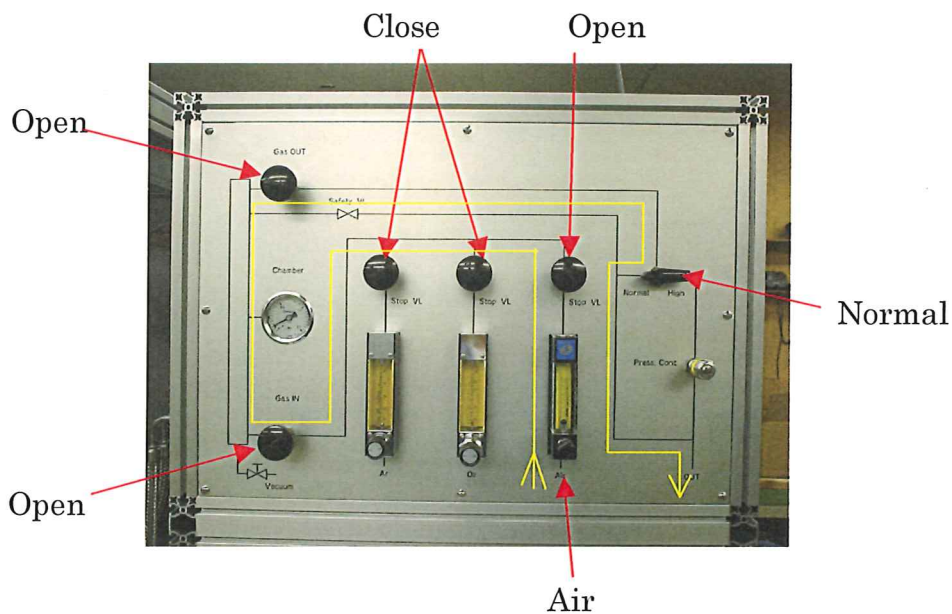
※ Please make sure to make the flow.

Without making the flow, it might be possible that small particles get adhered on the surface of quartz tube. Then the efficiency becomes lower, or in case the adherence is severe, the portion might absorb the infrared rays, and eventually it might cause the deformation or bursting of the quartz tube.

13) 4-3 Experiment with Air



Set the select-valve on the front panel to "Normal".





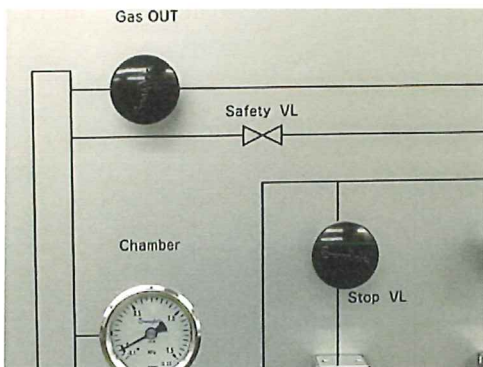
Please turn on the switch of “Atmospheric Air” located at down-right of GAS BOX.

Then Air will be started to supply.

### 13)-5 OTHERS

#### 13)-5-1 Safety-valve

Just in case the pressure of inside the chamber increased, the system equipped with safety-valve in the GAS BOX in order to avoid bursting. The safety-valve is designed to exhaust at 0.95Mpa.

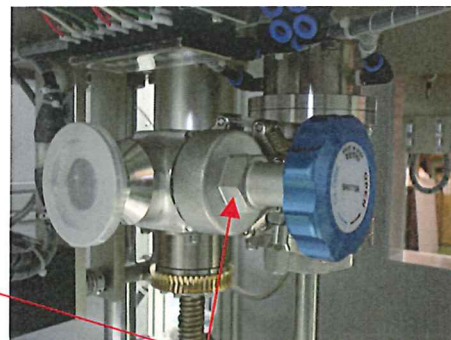
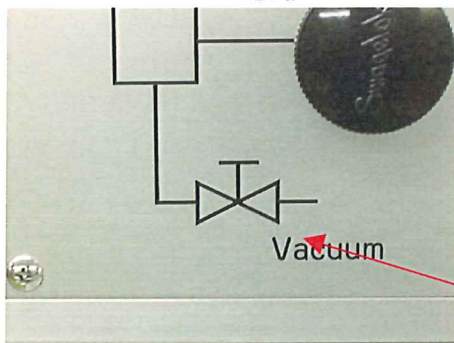


Safety-valve inside the BOX

#### 13) 5-2 Vacuum

You can vacuum the chamber from the Main valve fitted to the main body.

In case of vacuuming, please connect to the port of KF40.



Vacuum valve

When vacuuming,, please make sure to close Gas-IN and Gas-OUT valves.

At the time the pressure becomes to required level, please close the main valve, and

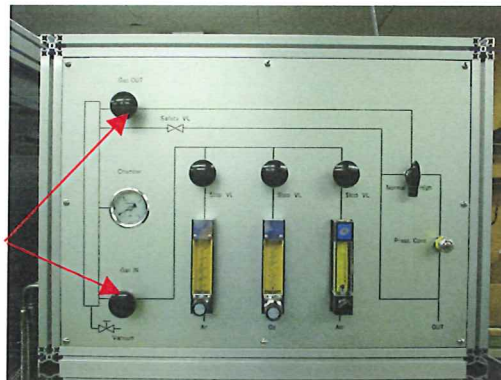
then open the Gas-In valve in order to fill-in the gas.

When the pressure inside the chamber becomes over 1 atm, then please flow the gas by opening the Gas-OUT valve.

Please use the select-valve to change the experiment under “pressure mode” or ”flow mode”.

**Vacuuming**

Close

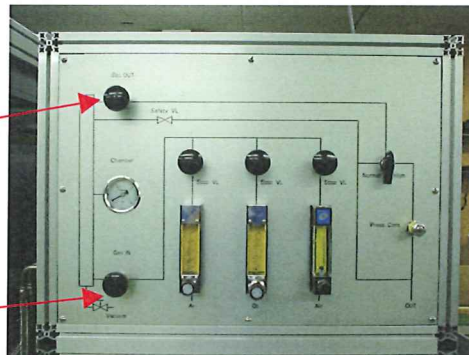


※Please confirm vacuum condition

**Gas introduction**

Close

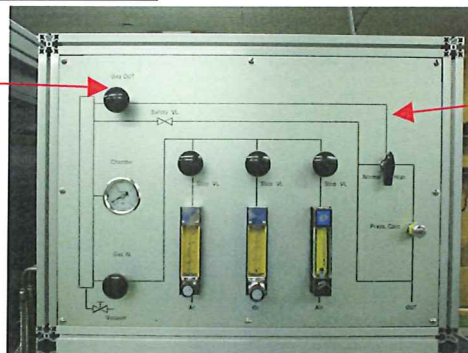
Open



Pay attention to Pressure meter

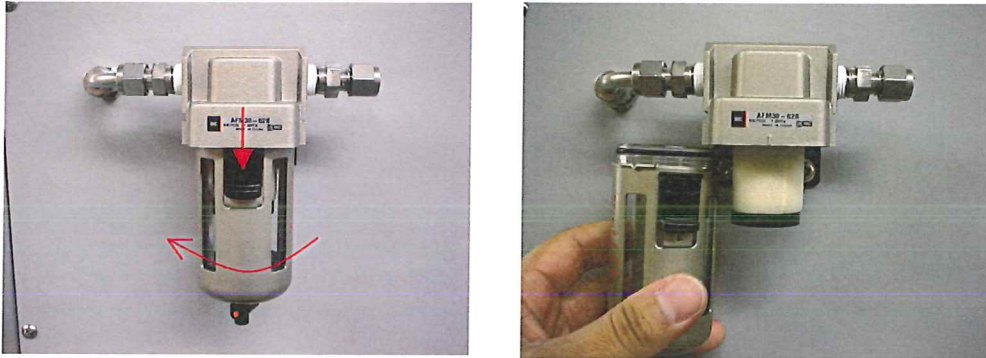
**After the pressure becomes plus**

Open



Select ”high pressure” or ”under flowing” with the select valve.

### 13) 5-3 Filter



The filter for exhaust gas is equipped at back side of GAS BOX.

We recommend you to change it when the color of the filter becomes black with dirt.

Depending on how many you used, but normally we recommend you to change the filter once a year.

As shown on the left photo, press down the black lever at first, then turn to the right, and the filter appears (Shown on the right photo). You can remove the filter by screw

out it.

The part number is AFM30P-060AS (SMC)

#### 1) Please pay attention:

- In case of pressured experiments, please do not stand in front of the pressure gauge of GASBOX and the regulators in order to avoid the dangers in case of the bursting.
- For the experiments under high pressure, please use the quartz tubes and O-rings designated by Crystal Systems Corporation.
- Please do not use quartz tubes stained, or cracked, or chopped. Such tubes might cause bursting.

### 14) **Maintenance and attentions**

- Please turn off the main power when no use for long time.
- Please check quartz tubes every time before use by eye, and NEVER use quartz tubes when stained, or cracked, or chopped. Such tubes might cause bursting
- Even when the system is not used, please keep it under atmosphere pressure since it will take too long time to reach aimed vacuum level next time.

- The covering panels around the main body may become very hot depending on the usage conditions. Therefore please do not touch them during the operation.
- Even you need to touch the parts which are posted with ELECTRIC SHOCK Label, DO NOT TOUCH before you turn off the main power.
- In case of pressured experiments, please do not stand in front of the pressure gauge of GASBOX and the Regulators in order to avoid the dangers of the bursting.
- For the experiments under high pressure, please use the quartz tubes and O-rings designated by Crystal Systems Corporation.

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<http://www.crystalsys.co.jp>

# Four-mirror Optical Floating Zone Furnace

Model : FZ-T-10000 (4000) -H-VII-VPO-PC

Users Manual  
(Software)

*Crystal Systems Corp.*

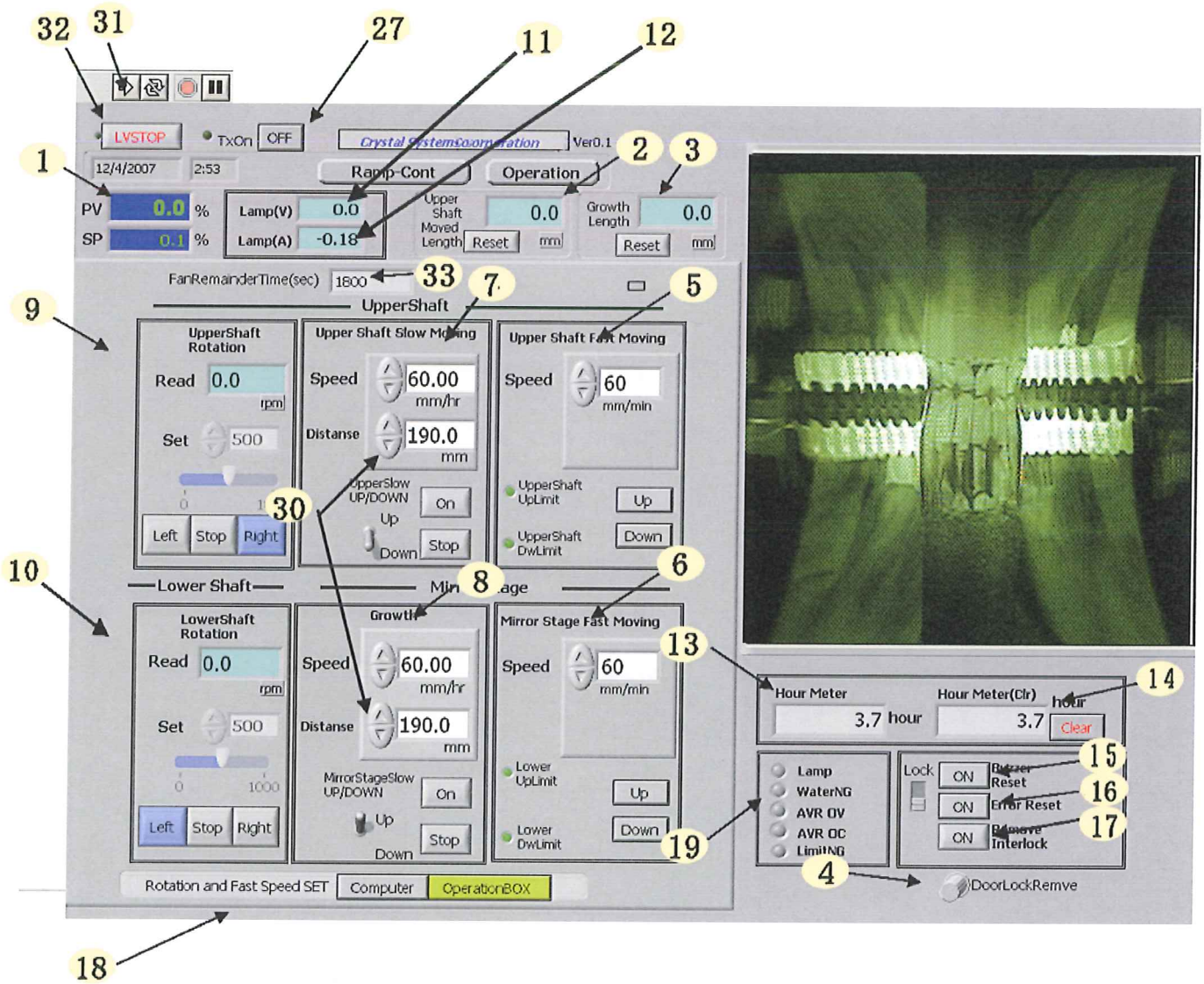
9633 Kobuchisawa, Yamanashi 〒408-0044 Japan

TEL : +81-551-36-5271 FAX : +81-551-36-5273



# 1) Operation Procedure

-1 Explanation on Lab VIEW screen



Operation Screen

1. To AVR POWER (%)  
    PV: Process Value  
    SP: Set point
2. Upper Shaft Moved Length  
    Upper shaft position. Push Reset to return to zero.
3. Growth Length  
    Crystal grown length. Push Reset to return zero.
4. Door lock Remove  
    Push this ON to door lock remove.
5. Upper Shaft Fast Moving  
    Switch to start Upper Shaft movement and select speed.
6. Mirror Stage Fast Moving  
    Switch to start Mirror Stage movement and select speed.
7. Upper Shaft Slow Moving  
    Switch to start Upper Shaft movement and select speed.
8. Mirror Stage Slow Moving  
    Switch to start Mirror Stage movement and select speed.
9. Rotation Upper Shaft  
    Switch to start rotation of Upper Shaft, and select speed and direction.
10. Rotation Lower Shaft  
    Switch to start rotation of Lower Shaft, and select speed and direction.
11. Lamp Voltage  
    AVR voltage
12. Lamp Current  
    AVR current
13. Hour Meter  
    Accumulated usage time of lamps
14. Hour Meter(Clr)  
    Usage time of new lamps
15. Buzzer Reset  
    Buzzer alarms for such cases as cooling water supply stops and Lamp supply power is errors. Push this ON to stop buzzer alarm.
16. Error Reset

After remove reason of buzzer alarm, push this ON to resume driving system. (for Water NG and Motor Limit NG)

17. Remove Interlock

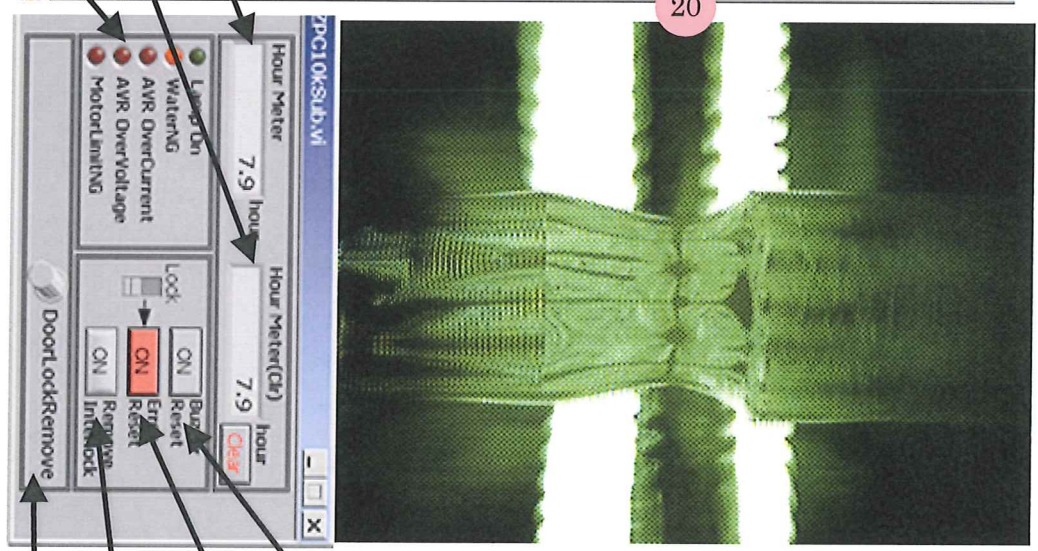
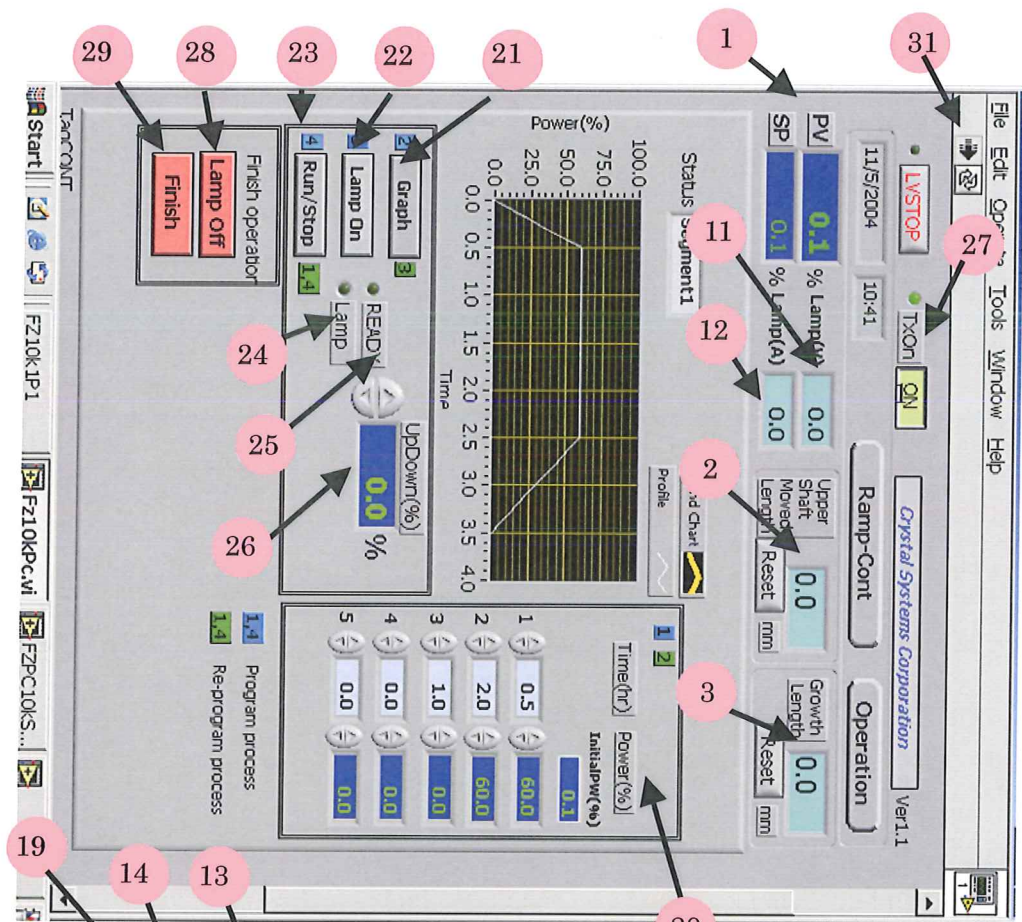
In case to use driving system before removing reason of buzzer alarm, push this ON.

18. Speed setting VR of rotation and fast motor is chosen

In-hand Speed Control Box or PC Speed Control can be chosen.

19. Indicator

Lamp LED	: Illuminated when Lamp supply power is on.
Water NG	: If the cooling water circulation is stopped, the electric power supply for the lamps is automatically cut off and all shaft movement will cease,
AVR Over Current	: Illuminated when Lamp supply power is over current.
AVR Over Voltage	: Illuminated when Lamp supply power is over voltage.
Motor Limit NG	: End of travel position.



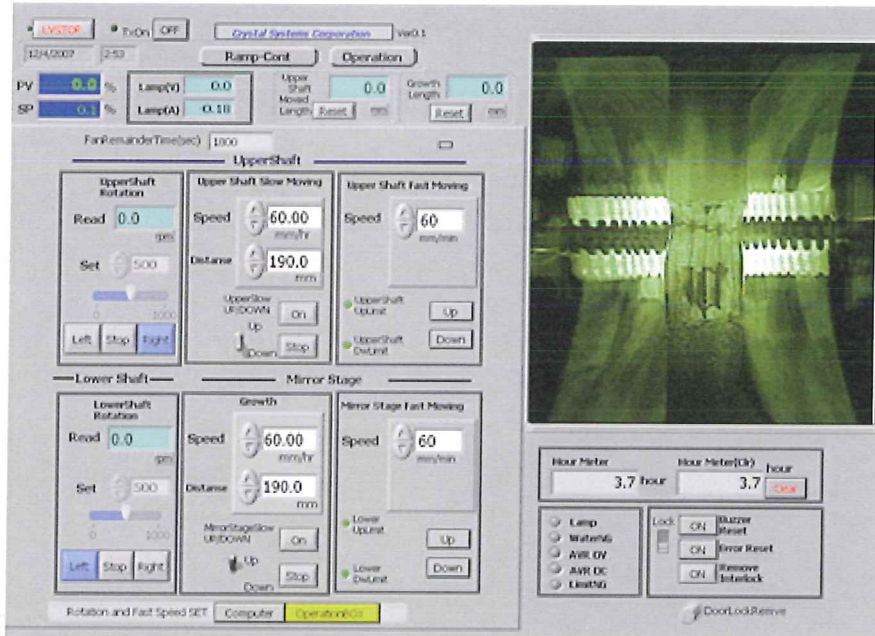
Lamp Control Screen

20. Programming  
Input temperature increase rate, plateau and decrease rate by time(hour) and rate(%).
21. Graph  
Illustration of above 20 program.
22. Lamp ON  
Stand-by to supply power from AVR.
23. Run/Stop  
Push this ON to start program by supplying power Form AVR. One more push this "STOP" to stop Program and Change to manual mode.  
For such case as crystal happens to melt down, and need to stop Program and change to manual mode.
24. LampOn : ON when Lamp on.
25. Ready : ON when Interlock is off.
26. UpDown(%)  
Power output adjustment at manual mode. (by 0.1%)
27. TxOn :  
It is a serial transmitting On Off switch to a controller D/AC. Usually, it is automatic and operate. When you want to stop transmission compulsorily It is mode off.
28. Lamp Off  
To stop power supply to lamps. After switched off.
29. Finish  
To delete Program completely and to stop the Virtual Instruments
- 30.Distance  
destination or target position for motion specified with respect to the current location regardless of its value
- 31.Run button  
Click the Run button on the toolbar to run the Virtual Instruments.

## 2) How to use LabVIEW

Driving system of Main Body

Open Lab VIEW on Operation Screen.

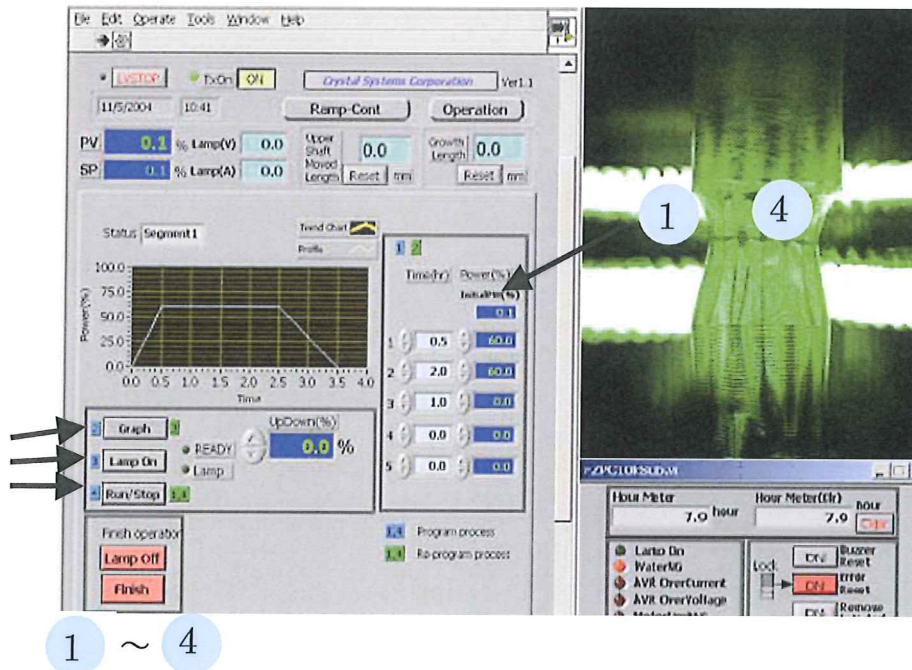


Switches can be operated by mouse.

Fast movement of Upper Shaft and Lower Shaft are normally set at 1mm/min.

Keep record of rotation speed of Upper and Lower Shafts.

Temperature increase of halogen lamps



Example) Increase to 50% in 30 min. then increase to 80% in 1 hour, and keep for 1 hour, then decrease to zero in 90 min.

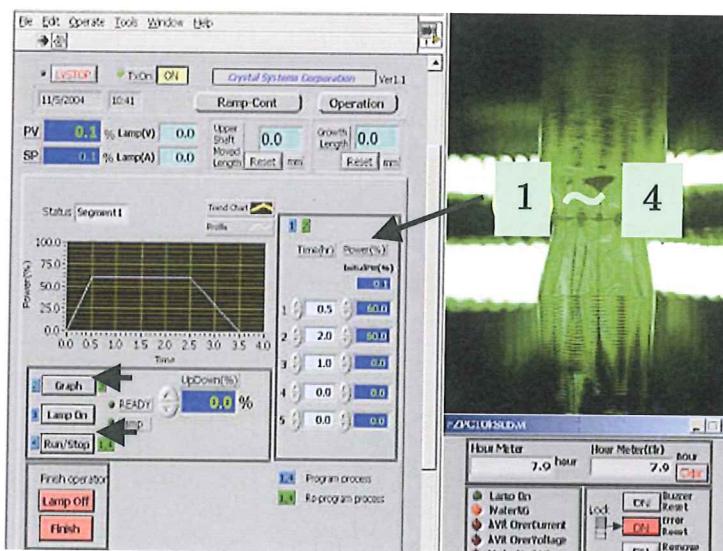
1 ↓	1	0.5 (hr)	50 (%)
	2	1 (hr)	80 (%)
	3	1 (hr)	80 (%)
	4	1.5 (hr)	0 (%)

- 2 **Graph**  
Switch ON.  
Graph appears to confirm Program.
- 3 **Lamp On**  
AVR power ON, Cooling fans start to run.
- 4 **Run**  
Switch ON.  
Program runs and graph is filled according to progress. AVR value changes accordingly.

※ Firstly make trapezoid shape and **Run**.  
At melting, **Stop**, and change to manual mode.  
At manual mode **UpDown**(%) Up-Down key is used.

### 3) Temperature decrease procedure

- How to input Lab VIEW



Input in **1** ~ **4** order.

Example) Decrease to zero in 2 hours.

- 1      **Stop**  
          Confirm this switch Stop.
  
- 2      **1**    2 (hr)    0(%)  
          **2** onwards, input 0(%) to power.  
          (A time remains as it is.)
- 3      **Graph**  
          Make out graph to confirm.
  
- 4      **Run**        Switch ON.  
          ( then new Program start to decrease  
          power.)

※ Mirror Fans to continue for  
power 20% more, and thereafter automatically stop.

#### 4) **Takeout of sample crystal**

Take out sample crystal 30 minutes or 1 hour after lamps turned off because temperature of shafts are too hot to handle just after lamp turnoff. In case of high-pressure application, firstly decrease inside pressure.

#### 5) **Power off**

If it is not scheduled to use for a long time, turn off power because Monitor may be damaged. PC is turned off in normal way.

#### 6) **Growth and operation procedures**



### 6-1. Preparation

-1 Check the electricity and turn on the corresponding switch in power supply boxes

-2 Check the cooling water

a) Turn on the water supply

Note; The temperature of the cooling water must be kept higher than their dew temperature, and also lower than 40°C.

-3 Turn on power switch of operation board.

Note; Confirm the cooling air supply(electric fan) is in action

-4 Turn on the SCR power supply switch.

-5 Push the Power on switch.

-6 Push the Computer switch.

### 6-2 Starting the crystal growth

After the molten zone become stable

-1 Push the reset bottom of the growth length display and confirm 00 is shown.

-2 Set the mirror stage by the speed controller.

-3 Push the mirror stage slow movement switch of up. The crystal growth is just started.

## 7) How to exchange the HD cartridge

- ① Two the same HD cartridge had been set in this system, then when the operating HD would be broken, the backup HD can be replaced with safety( These two HD are not RAID system, the data installed later are not the same)
- ② insert the key and turn to anti clockwise direction, then the HD can be drawn out.
- ③ insert the back up HD until it hit to backside, then pull the handle and insert furthermore, and turn the handle to lower side Lock using the key.



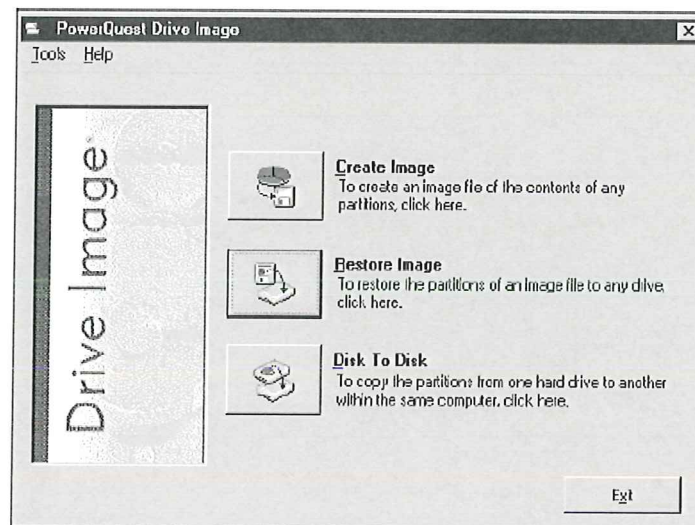
Back up HD

This is not connected to electric line.

Operating HD

## 8) Running Drive Image from the Rescue Diskettes

You will normally run the Windows version of Drive Image. If your computer will not boot, you can run the rescue diskette version of Drive Image. The DOS interface is different from the Windows interface, but the underlying features are the same as the



## Rescue Diskette Consideration

On Windows 95, Windows 98, and Windows Me systems, Drive Image uses the operating system's DOS files to build the first rescue diskette. On Windows NT/2000/XP systems,

Drive Image uses Caldera DOS.

When you boot from a rescue diskette with Caldera DOS, some drives (partitions) may not display with drive letters. Instead, they will use the following naming convention:  $\text{¥¥diskm.partn}$ . For example, the second partition on the first hard disk would display as

$\text{¥¥disk1.part2}$ . The volume label (if there is one) will also display to help you identify the

drive. You can still include these drives in images or save images to drives with the unconventional designation.

If you use a Windows 95/98 startup disk in place of the Drive Image bootable diskette

(diskette 1 of the 2-diskette set), drive letters will display for all your drives, except hidden, NTFS, and Linux partitions.

Drive letters do not display for CD drives from the rescue diskette version. Instead, they

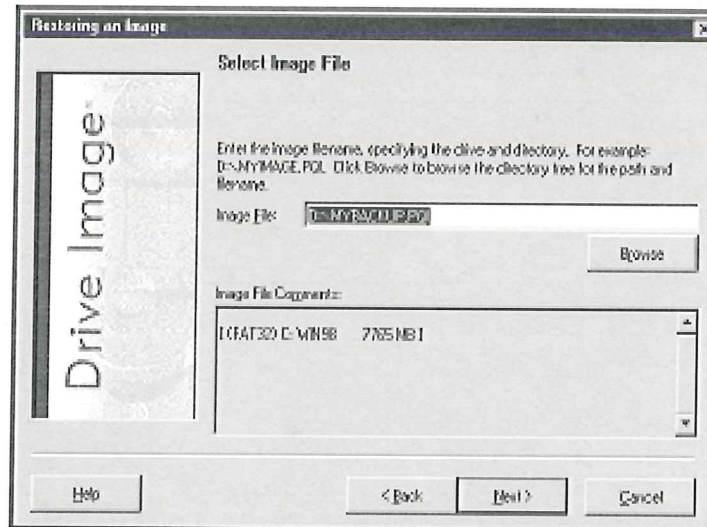
display as  $\text{¥¥¥¥pqcdx}$ , where x is the number of the CD drive.

## Restoring Images

You can restore an image from the rescue diskette version of Drive Image. At any screen, you can click Help to display more detailed information than is included in this quick start guide.

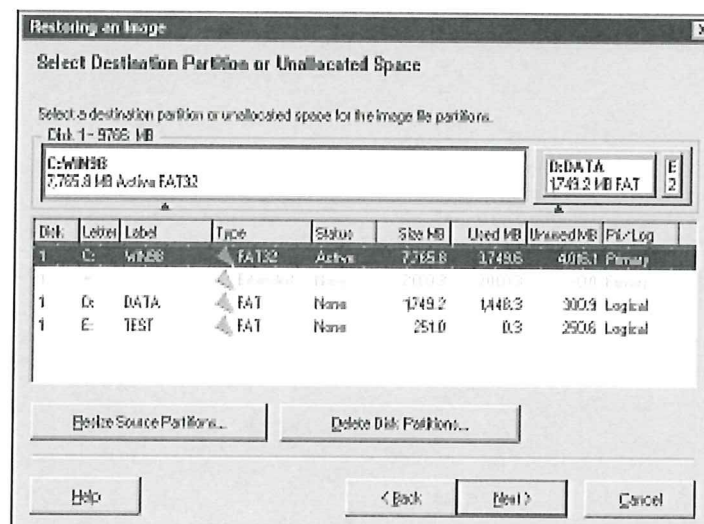
1 Click Restore Image at the main screen.

2 Select the image to restore, then click Next. You may want to click Browse to identify the drive where the image is located, since drive letter designations are likely to be different from running under Windows.



3 If you have more than one hard disk, select the destination drive, then click Next. (The screen does not appear if you only have one hard disk.)

4 Select the space where you want to restore the image, then click Next. This space may be an existing partition or unallocated space.



5 Select the disk write mode, then click Next.

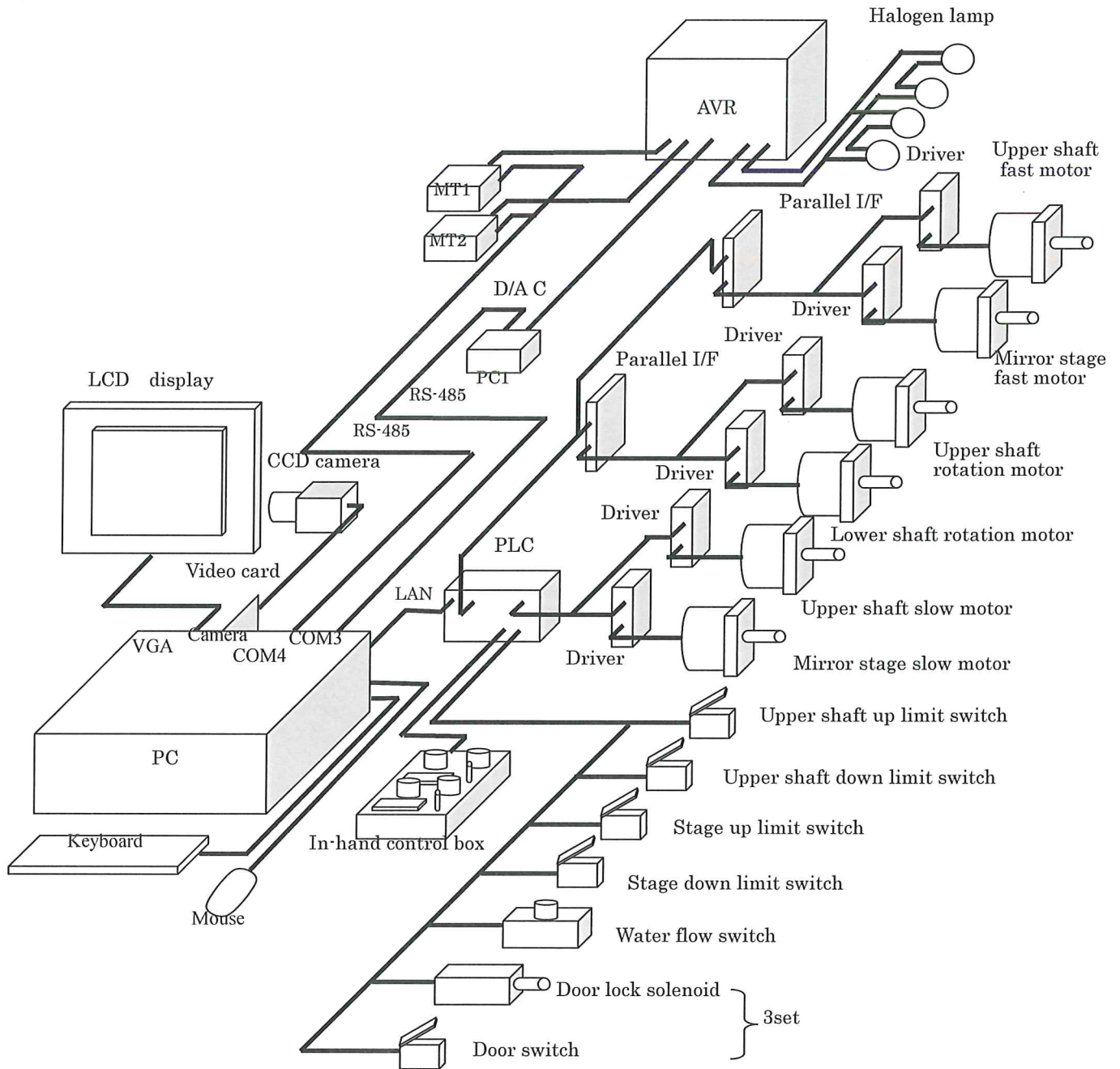
6 (Optional) Click Advanced Options to change settings that affect the restore process.

7 Click Finish.

### 9) Appended software

- 1、 Windows OS
- 2、 PcAnywhere (RemoteControl)
- 3、 VISION ACQUISITION CD
- 4、 Recovery Software

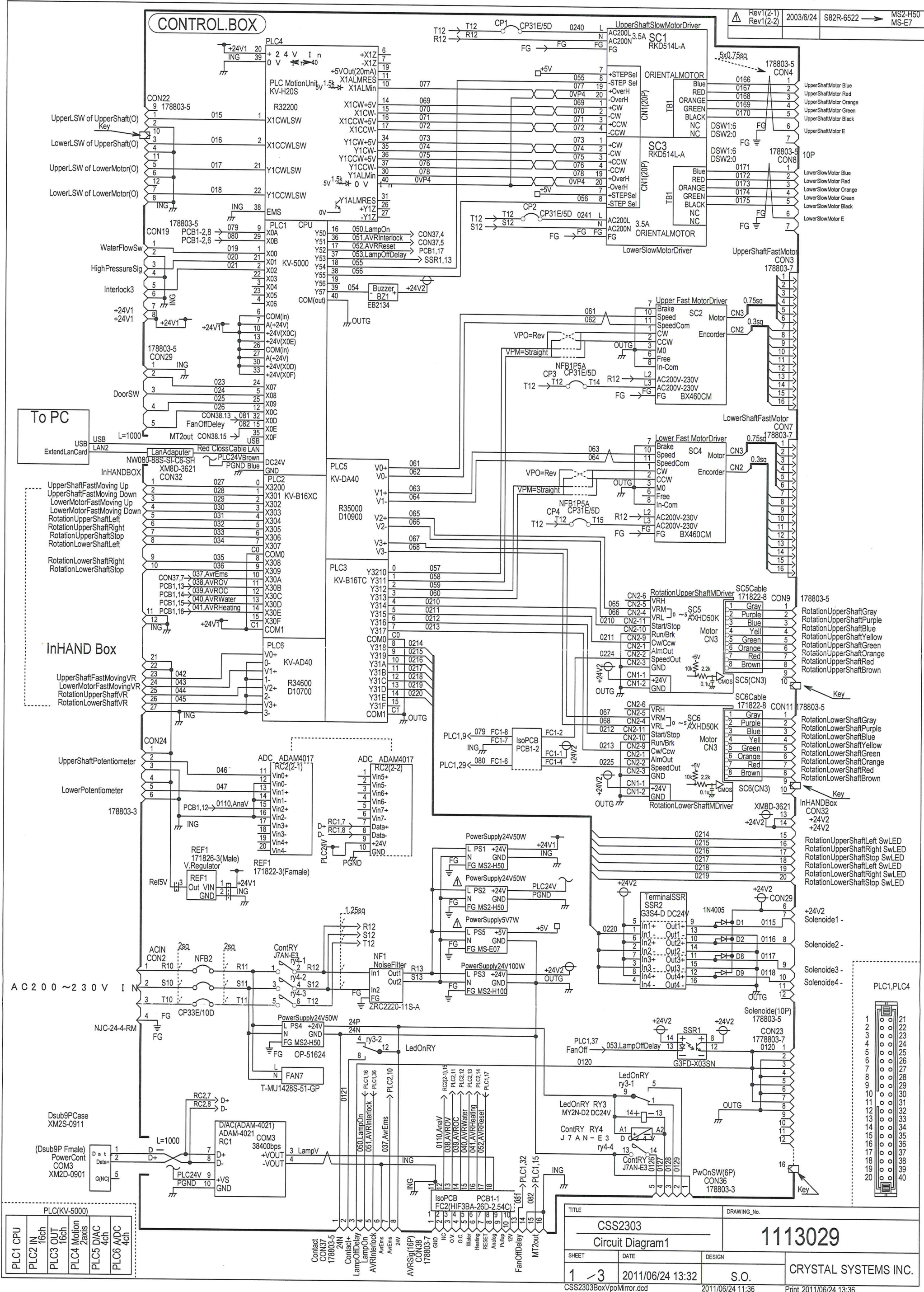
## 10) Electric structure diagram



Drawing table

June.11.2011

Number	Drawing No	Name	Note	
1	CIT125-000	Optical Floating Zone Furnace		
2	CIT125-001	UPPER SHAFT DRIVING MECHANISM		
3	CIT125-002	MIRROR STAGE		
4	CIT125-003	LOWER SHAFT DRIVING MECHANISM		
5	CIT125-004	MOTOR DRIVING MECHANISM		
6	CIT125-005	STEPPING MOTOR		
7	CIT125-006	LAMP POSITION ADJUSTER		
8	CIT125-007	CCD CAMERA		
9	CIT125-008	INTERLOCK (DOOR)		
10	CIT125-009	GAS CONTROL SYSTEM		
11	CIT125-010	CONTROL BOX		
12				
13				
14				
		California Institute of Technology		
		Production number	CSS2403-1	
		Approved by	Date Signature Title	
		2012/6/11	I.Shindo	Optical Floating Zone Furnace
		Checked by	2012/6/11 S.Ozawa	
		Drawing by	2012/6/11 S.Kimura	
No	Date	Crystal systems corp. FZ-T-4000-H-VII-VPO-PC		



PLC1 CPU	PLC2 IN	PLC3 OUT	PLC4 Motion	PLC5 DIAC	PLC6 A/D
16ch	16ch	16ch	2axis	4ch	4ch

TITLE		DRAWING No.	
CSS2303		1113029	
Circuit Diagram1			
SHEET	DATE	DESIGN	
1-3	2011/06/24 13:32	S.O.	CRYSTAL SYSTEMS INC.