

FC 1800 #1 Operation Manual

University of Notre Dame



For Training Please contact: Dave Heemstra

General Precautions

Contacts

For problems, clarification of procedures, or general information pertaining to this machine please contact one of the following personnel.

Mark Richmond	631-6478	<u>mrichmon@nd.edu</u>
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In Case of Emergency, Please Contact Notre Dame Security at

911

Metal Verification is MANDATORY – Failure to verify >50% metal in the crucible can result in serious equipment damage.

Alignment and Sweeping of the Electron beam is MANDATORY. Failure to sweep the beam can cause damage to the machine and cause you to lose your privileges to use this machine.

Do Not Exceed 3 A/sec. 1 to 2 A/sec is normal, deposition Rates > 2 A/sec can result in damage quickly

Users must constantly be watching the metal source, deposition controller and emission current when the e-beam is on.

If any step does not respond as it should, stop and put the machine into standby if you can and contact help. If unsure on how to get to standby mode safely, leave the machine as it is and contact above personnel.

YOU MUST VERIFY THERE IS ENOUGH METAL EVERYTIME YOU PERFORM A DEPOSITION. DO NOT PROCEED UNLESS THE CRUCIBLE IS FILLED MORE THAN 50%

Metal Verification:

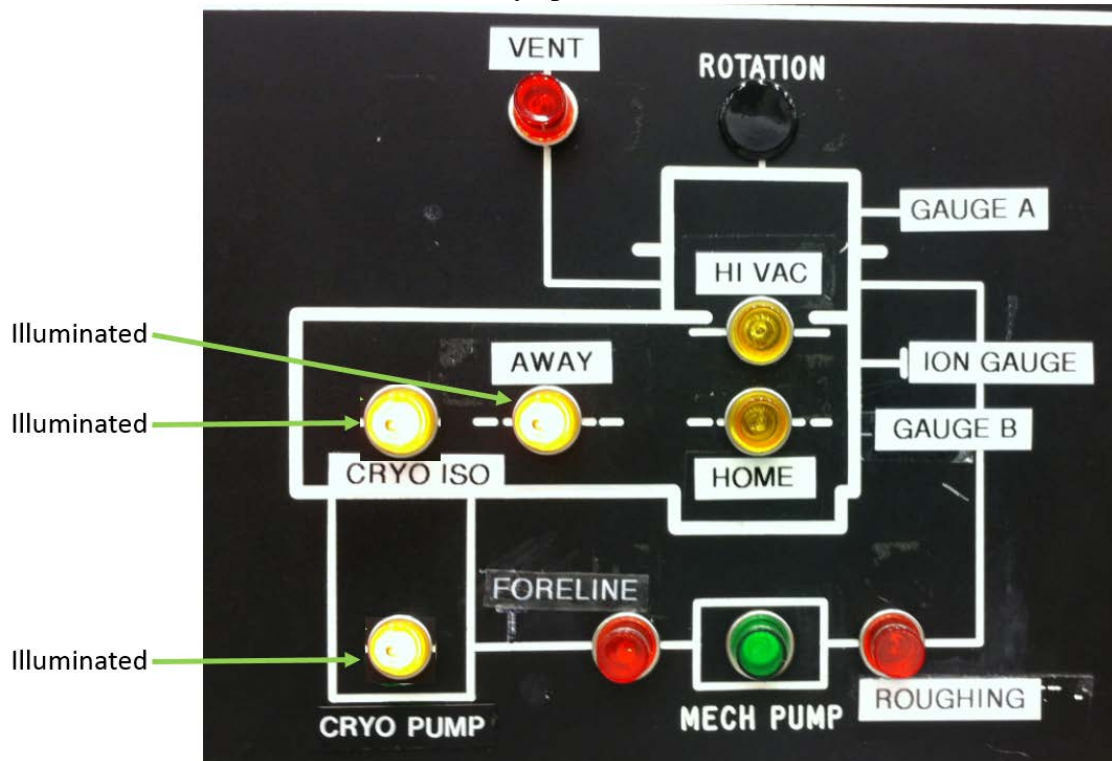
- 1 – Turn “ON” the chamber light
- 2 – Open the shutter in the lower portion of the chamber
- 3 – Advance tape (1/4 turn) if necessary
- 4 – Change Pocket or Turret Selector to appropriate metal
- 5 – Turn “OFF” the chamber light
- 6 – Close the lower shutter

!!!!!!!YOU MUST VERIFY ALL METALS – EVERY TIME!!!!!!!

Standby Conditions:

(These conditions allow for the safest and best conditions for the machine, your safety, and the best results for your research)

1. Main Chamber lid should be closed and under High Vacuum.
2. Valves that should be illuminated, open, or on in Standby conditions on the automatic pump down controller.
 - a. "Cryo Iso."
 - b. "Cryo pump"
 - c. Gate should be in the "Away" position.



3. Valves that should closed or not be illuminated in Standby Mode.
 - a. "Roughing" Valve
 - b. "Fore Line" Valve
 - c. "Mechanical Pump"
 - d. "Vent" Valve
 - e. "Hi Vac" Position
 - f. "Home" Position
4. Shutter should be on "Closed".
5. Chilled water Valves should be ON.
6. High Voltage & Emission (e-beam gun) Controllers should be off
7. CV14 Main Breaker OFF.
8. Chamber light should be turned off.

Depositing a Metal:

Refer to Figure 1 for all indicator light locations.

From Standby Conditions:

1. Enable FC 1800 #1 in Coral. Machine will not operate unless enabled.
2. Follow the procedure to “Change a sample” on Page #7.
3. Follow the procedure “Programming the SQM-160” to setup the film thickness monitor on Page #8.
4. Switch the pocket to the position of your desired source by rotating (clockwise) the knob on the Turret (a.k.a Pocket) Selector to the desired number. When the light turns on the system has found the selected metal.
5. Wait for the system vacuum to be below 2×10^{-6} to continue.
6. Pull up on the High Voltage Power Supply Breaker to turn it on (CV-14). Located on the front of the High Voltage Power Supply.
7. Verify interlock light stacks on CV-14 HVPS Controllers:
 - a. On the Gun Controller:
 - i. “Vac Tank” is illuminated.
 - ii. “Vac Gauge” is illuminated.
 - iii. “Gun Water” is illuminated.
 - iv. “Aux” is illuminated.
 - v. “Focus” is illuminated.
 - vi. “Gun 1 Tank 1” is illuminated.
 - b. On the HVPS Controller:
 - i. “Power ON” is illuminated.
 - ii. “Triode Water” is illuminated.
 - iii. “Doors” is illuminated.
 - iv. “Air” is illuminated.
 - v. “PC Cards and key lock” is illuminated.
8. Verify “Emission Current” knob is fully counter clockwise.
9. Turn High Voltage on by depressing the “HV ON” button on the High Voltage Controller.
10. Switch on the Filament on by depressing the “GUN 1 Fil ON” button on the gun controller.
11. Open the shutter by pushing the shutter switch up on the shutter controller.
12. Verify filament is on by looking thru the view ports and making sure a white light is coming from the filament area. NOTE: May need to look thru bottom viewport due to Cryo Restriction Plate.
13. Slowly advance “Emission Current” on the gun controller until you are just able to see the blue beam spot on the crucible when looking into the top view port.
14. Position the beam on the metal inside the crucible by adjusting the lat and long beam position on the XY controller for the settings you are wanting.
15. Verify sweeping of beam by increasing the Long and Lat Freq. switches on the XY controller if necessary. **Warning:** Failure to sweep the beam can cause damage to the source crucible, turret, FC 1800 system, your wafers, and/or your privileges to use this machine. The beam spot should never come into contact with the crucible walls or turret at any time or location.
16. Close the shutter by pushing down on “shutter” switch on the shutter controller.
17. Slowly ramp current over a couple of minutes until a deposition rate of 0.5 to 1 Angstroms per second on the film thickness monitor is achieved. Allow the crucible to heat for approximately 1 additional minutes.

18. Slowly increase emission current by turning the “emission current” control pot on the gun controller until you have reached your desired deposition rate.
 - a. DO NOT EXCEED 2 A/Sec – Bad Things happen quickly!!!!
19. Zero Film thickness meter by pressing “zero” and open shutter by pressing up on the “shutter” toggle switch on the shutter controller. Wait until desired thickness is almost achieved.
20. Close shutter by pressing down on the “shutter” toggle switch on the shutter controller and log your results.
21. Set emission current to ZERO by rotating the “emission current” control pot fully CCW on the gun controller slowly but continuously.
22. Switch off Filament by pressing the “GUN 1 FIL OFF” button on the gun controller.
23. Switch off HV by pressing “HV OFF”, located on the High Voltage controller.
24. Wait 10 minutes for turret and source to cool down from last deposition before continuing to the next step.
25. Repeat step #3 thru step #26 for as many layers as you need.
26. Push down on the High Voltage Circuit Breaker on the CV-14 High Voltage Power Supply.
27. To remove your samples, follow the procedure “Changing a Sample from standby” on page #7.
28. Verify the machine is in Standby.
 - a. Main Chamber lid should be closed and under High Vacuum.
 - b. Valves that should be illuminated, open, or on in Standby conditions on the automatic pump down controller.
 - i. “Cryo Iso”
 - ii. “Cryo Pump”
 - iii. Gate should be in the “Away” position.
 - c. Valves that should not be illuminated or open in Standby Mode.
 - i. “Roughing” Valve
 - ii. “Fore Line” Valve
 - iii. “Mechanical Pump”
 - iv. “Vent” Valve
 - v. “Hi Vac” Position
 - vi. “Home” Position
 - d. Shutter should be on “Closed” and the indicator should not be illuminated.
 - e. All Chilled water Valves should be ON.
 - f. HV & Gun Controllers should be off.
 - g. Ion Vacuum Gauge should be heading into the 10^{-6} range or better.
29. Disable the machine in coral filling in all log entries and take trash with you when you leave the machine.

Changing a Sample:

Refer to Figure #1 for all indicator light locations.

1. Move the Gate Valve to the "Home" position.
2. Verify the indicator light switches from "Away" to "Home".
3. Close the "High Vac" valve by pressing down on the switch labeled "High Vac" on the Automatic Pump Down Controller.
4. Verify the "High Vac" light comes on and the "Home" light goes out.
5. Open the N2 "Vent" valve by pressing up on the switch labeled "Vent" on the Automatic Pump Down Controller.
6. Verify the "Vent" light illuminates.
7. Allow a couple of minutes for the lid to come up to atmosphere pressure.
8. After the lid has been released from vacuum, the lid will pop up slightly. Pull up and open the lid.
9. Close N2 "Vent" Valve by pressing down on the switch labeled "Vent" on the Automatic Pump Down Controller.
10. Verify the "Vent" indicator goes out.
11. Make sure a new and clean plastic shield is in place for your deposition. As a rule, Always verify there is a new shield installed when you put your sample in and always change the shield after your deposition.
12. Install or remove samples on the FC1800 #1 sample holder.
13. Verify the Lid O-ring has not popped out of the groove.
14. Pull down the lid and set it gently down on the O-ring.
15. Start mechanical pump by depressing the "ON" button on the M.P. Control.
16. Wait for 10-15 seconds for the mechanical pump to start.
17. Open the "roughing" valve by pressing up on the switch labeled "roughing" on the Automatic Pump Down Controller.
18. Verify the "roughing" indicator illuminates.
19. Allow system to pump down to 9.9E-2 or lower on Gauge A
20. Close "roughing" Valve when the Thermocouple gauge reads less than 9.9E-2 Torr by pushing down on the switch labeled "Roughing" on the Automatic Pump Down Controller.
21. Quickly Verify the "Roughing" indicator goes out.
22. Quickly Open "High Vac" by pressing up on the switch labeled "High Vac" on the Automatic Pump Down Controller.
23. Verify "High Vac" indicator goes out and the "Home" indicator illuminates.
24. Verify the "Cryo Iso" light is illuminated and if not press up on the switch labeled "Cryo Iso".
25. Move the gate valve to the "Away" position by pressing up on the switch.
26. Verify the "Home" indicator goes out and the "Away" indicator illuminates.
27. Shut off the mechanical pump.
28. If installing a sample, return to page #5 and step #3. If removing a sample, return to page #6 and step #30.

Programming the Film Thickness Monitor (SQM 160):

This monitor is capable of retaining the characteristics of 9 different films. However due to the many different films we use here at ND, the number of users this machine has, and the amount of use it sees I suggest that you verify your information every time you use this machine.

1. If you start using this monitor and it is displaying CRYSTAL 1, press “Xtal life” button to bring it back to its normal view. This reading shows the amount of life the Crystal has left. Change if < 60%
2. Press “Zero” button to zero the monitor readings (Thickness and Time)
3. On the film thickness monitor. Press the “program” button.
4. Pick your film by rotating the knob to “Film X”. X can be any number between 1 and 9
5. Press “Next” button. “Density” should be displayed. Density and Z-Factor charts will be available in Appendix B and posted on side of the control rack as well.
6. Rotate the knob until the density you want is displayed.
7. Press “Next” button. “Tooling” should be displayed.
8. Rotate the knob until the tooling for your sample holder is displayed. Appendix A contains a list of tooling factors for the different sample holders and will be posted on side of control cabinet as well. **NOTE:** There will be specific sample holders for this machine and will be labeled FC 1800 #1”. **WARNING:** Do not use the numbers from FC 1800 #2 or #3, these numbers will be wrong for the setup in the FC1800 #1.
9. Press “Next” button. “Z-Factor” should be displayed.
10. Rotate knob until the Z-Factor you desire is displayed. Density and Z-Factor charts will be available in Appendix B and posted on side of control rack as well.
11. Press “Next” button. “Finl Thk” should be displayed. This step saves the last setting of “Z-factor” into the program.
12. Press “Program” button to exit program mode. It is now ready for the deposition.
13. Go to step 4 on page #5.

NOTE: The Film thickness monitor does not stop sampling of the deposition when you close the shutter. You will need to watch the monitor and log the thickness when you close the shutter.

NOTE1: The Film Thickness Monitor should be on at all times.



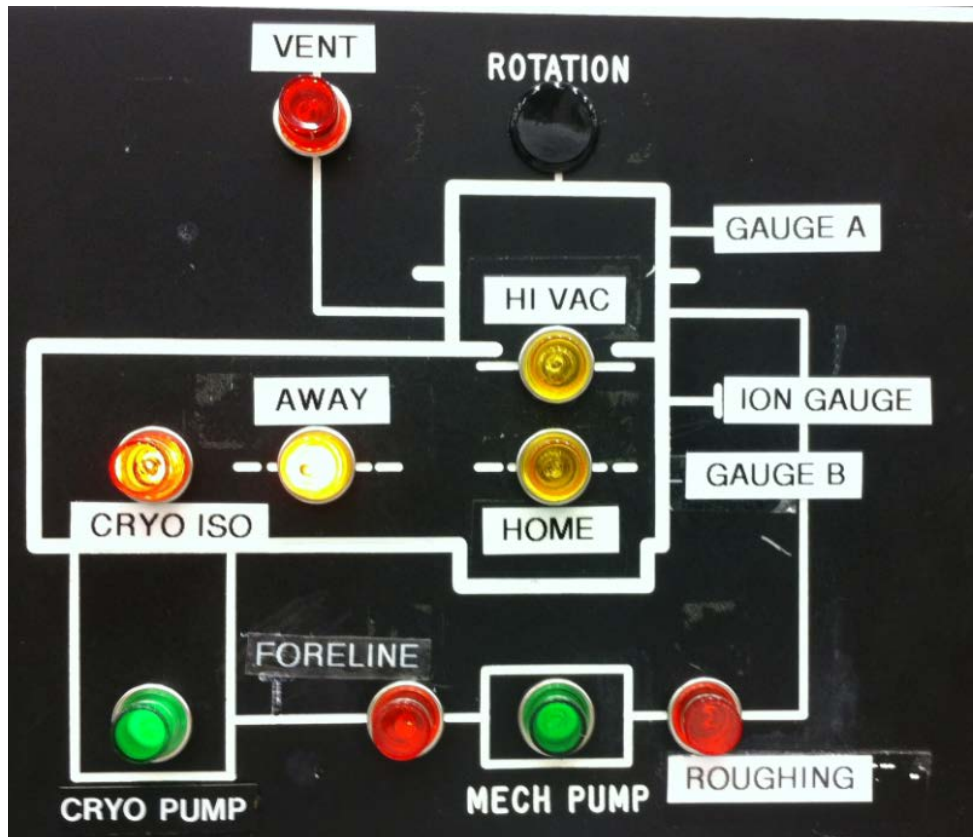


Figure 1: Indicator Panel of Automatic Pump Down Controller



Figure 2: HVPS Controls

Emission current and High Voltage on left. Beam Position controls on Right.

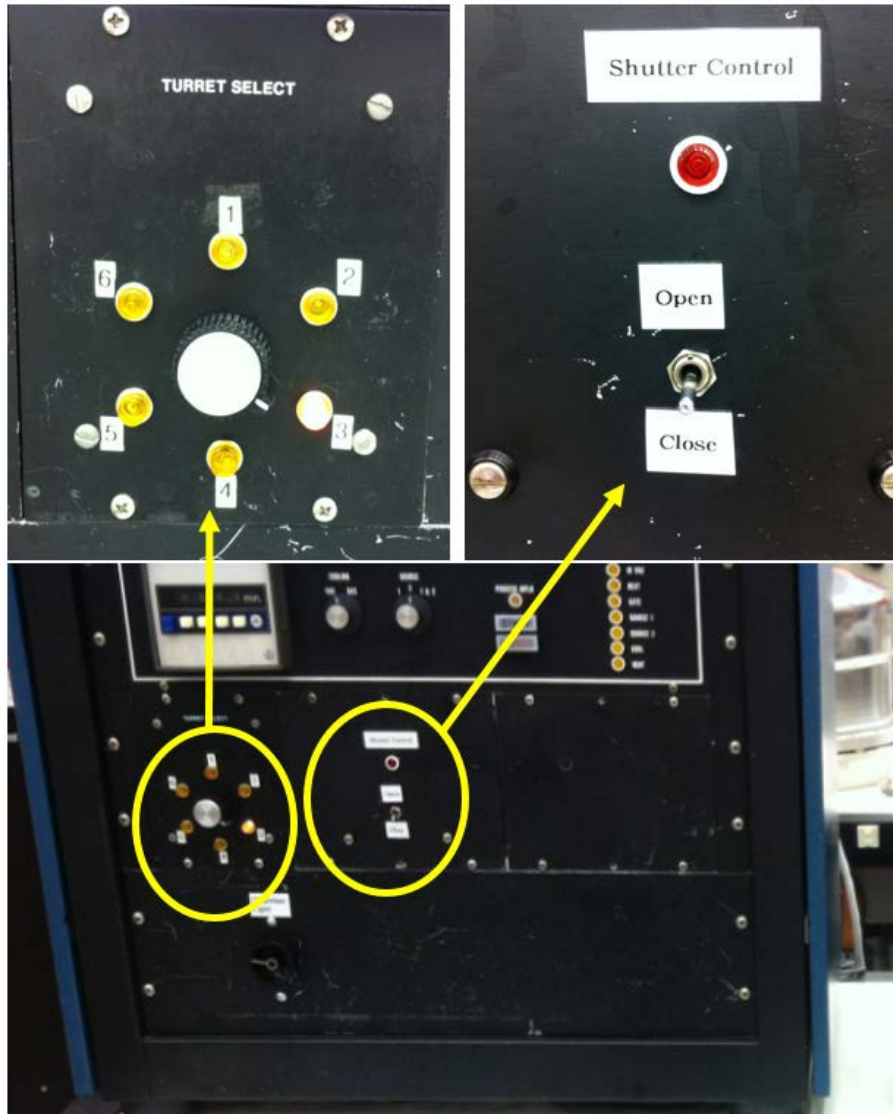


Figure 3: Turret or Pocket Selector (Left), Shutter Control (Right).

Appendix A: Tooling Information

Flat Bar: 347

U-Bar: 169

Appendix B: Density and Z-Ratio Chart

Material	Formula	Ratios	Density	Z-Ratio	Notes
Aluminum	Al		2.700	1.080	Slowly heat – crucibles crack easily
Aluminum Oxide	Al ₂ O ₃		3.97	0.336	
Aluminum Boron Silicon	Al/B/Si	98-1-1	2.693	1.169	
Aluminum Silicon	AlSi	98-2	2.692	1.073	
Chromium	Cr		7.200	0.305	Sublimes
Cobalt	Co		8.710	0.343	
Copper	Cu		8.930	0.437	
Germanium	Ge		5.35	0.516	Permission Required
Gold	Au		19.300	0.381	
Gold Germanium	AuGe	88/12	17.626	0.397	
Gold Palladium	AuPd	60/40	16.380	0.371	
Hafnium	Hf		13.09	0.34	
Molybedum	Mo		10.200	0.257	
Nickel	Ni		8.910	0.331	
Palladium	Pd		12.038	0.357	
Platinum	Pt		21.400	0.245	
Platinum Iridium	PtIr				Permission Required
Silicon	Si		2.320	0.712	Permission Required
Silicon – p-doped	Si (boron)		2.320	0.712	Permission Required
Silicon Dioxide	SiO ₂		2.200	1.070	Permission Required
Tantalum	Ta		16.6	0.262	
Titanium	Ti		4.500	0.628	
Tungsten	W		19.300	0.163	
Vanadium	V		5.96	0.53	