Centre for Research in Nano-Technology and Science
JEOL JEM-2100F TEM

Alignment and operation notes:

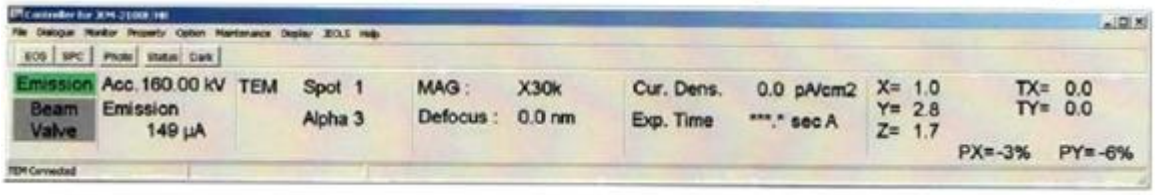
I. Initial startup:

1. Fill out instrument log book and verify session is reserved on appointment log-book.
2. Verify column vacuum (CVG-1 & CVG-4) is in 10^{-5}Pa range and both gun vacuum gauges (above column vacuum gauge) are $<1x10^{-6}$ Pa. If not, proceed no further and notify CMI instrument manager.
3. Verify that column, camera, RT, and pipe all display Evac Ready in the Vacuum status window of the TEM Controller before proceeding to section II. If the vacuum status window is not, select menu Monitor → Vacuum System to open the Vacuum Status Window.
4. Remove anti-contamination device (ACD) heater (if inserted). Fill ACD Dewar with liquid nitrogen. During operation, the ACD Dewar must be refilled every 4-5hrs. Also, refill ACD 5minutes after first fill of the morning.

II. High voltage ramp:

1. Nominally, the field emitter is on (display shows emission in green box).

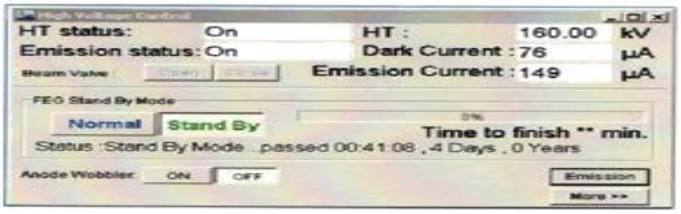
If the emission is not on, proceed no further and notify CMI instrument manager.



2. In the high voltage control window, FEG STAND BY Mode should be either "NORMINAL" or "STAND BY".

If the high voltage control window is not open, select menu DIALO→HIGH VOLTAGE CONTROL to open the HIGH VOLTAGE CONTROL WINDOW.

If you are the first user of the day the instrument will be in "STAND BY" mode and high voltage HT (or Acc.) will be 160 KV. If in "STAND BY" mode, select "NORMAL" to ramp HT from 160KV to 200KV. The ramp will take approx. 13 minutes to complete.



III Specimen holder loading and insertion

Gloves must be worn when handling specimen holder

Procedure for loading specimen holder

See the specific instructions for loading and handling the particular sample holder to be used.

1. Make certain sample is securely mounted.
2. Inspect O-rings on sample holder and gently remove any dirt or lint.

Procedure for holder insertion into column

(Inserting / removing holder while beam valve is opened will damage electron emitter).

1. Before proceeding to step 2 ALL of the following must be true.
   - **Beam air lock valve (v1) is closed** (inspect the vacuum status window for status).
   - Column vacuum (CVG-1 & CVG-4) is $\leq$ 2**.0x10^{-5} Pa.**
   - X, Y translators, z-height, tilts and piezo stage or zeroed (if not see section VIII, step 6).

2. Open shroud on goniometer and remove dummy holder (if inserted).
   a. Retract "black tab" by sliding shiny metal slider on dummy holder back towards you.
   b. While metal slider is held back, pull dummy holder out slightly (=1 mm and no more), and turn holder clock wise until it stop (metal slider at 1:00 position).
   c. When the yellow light blinks, toggle the prepump switch from **pump** to **air**, listen for 3 valves (V21, v34 and v36) to cycle, and then wait 10 sec. before removing holder.

3. Carefully insert holder with its guide peg (located on aluminum rod) aligned with notch in stage assembly (LEDs will **not** flash, but a solenoid valve will be heard when holder is seated).

   DONOT rotate holder clockwise

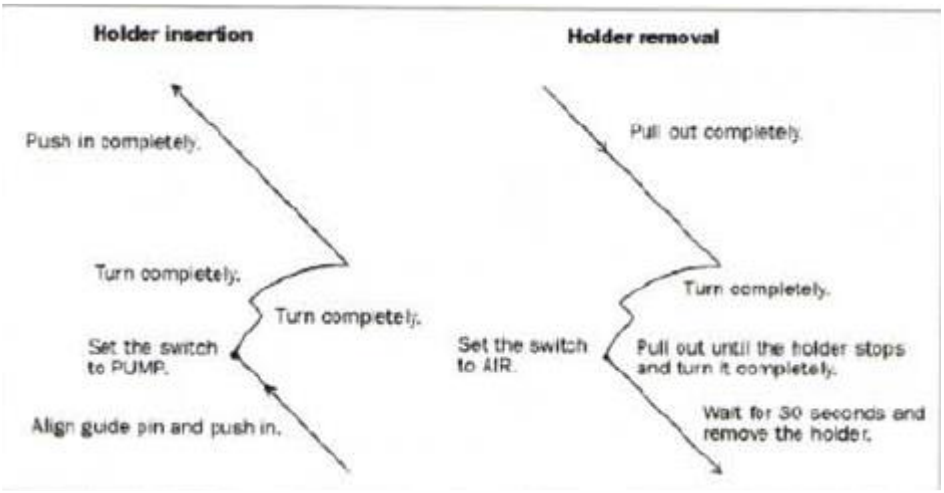
4. Toggle prepump switch from **air** to **pump**.

   Yellow led should flash when toggle is flipped to **pump**. If not, align black tab to 12:00 position (by rotating holder **counter**- clockwise) & verify holder is fully seated.

5. Only after green LED turns **ON** (specimen displays "Evac ready" in vacuum status window)

Insert holder:

a. Turn holder clockwise until it stops (black tab at 1:00 position). Do not allow holder to be rapidly pulled in by vacuum. Slowly insert holder (=0.5 cm travel).
b. Turn holder clockwise until it stops (black tab at 3:00 position) and slowly insert holder into column.
c. Immediately check column vacuum, remove holder if above 5 x10^{-5} Pa.



6. On TEM computer in TEM controller main menu, select menu property → stage to open specimen property window. Select appropriate holder from list, click applies.

IV. Specimen illumination by electron beam

1. Verify the instrument in TEM mode, the FEG is in the NORMAAL MODE (i.e. HV ramp completed), and the view screen is in the lowered position.
2. When the column vacuum (CVG-1 & CVG-4) is ≤ **1.6 x 10-5 Pa**, the beam air lock valve (L1-1) can be opened to illuminate the specimen with the electron beam.

While beam airlock valve is open, do not allow the liquid nitrogen in the ACD Dewar to completely boil away. Liquid nitrogen will boil away in ~ 5 hours.

V. Gun and column alignment

Condenser aperture alignment

1. Select and insert a **condenser aperture.**
2. Select TEM mode, **spot size = 1** and **α = 3** (L1-3)
3. Focus beam to a small spot ("crossover") using **brightness** (L1-6)
4. Center illumination using shift X,Y(L1-8, R1-3)
5. Spread the beam with brightness knob, center the condenser aperture.
6. Repeat steps 3-5 until beam converges to center when adjusting brightness.

Condenser astigmatism correction

1. Select spot size 1 and condense beam to crossover using brightness.
2. Engage condenser lens stigmator (cond stig) (L1-5).
3. Adjust the def. stig X, Y so that the shape of crossover is as small as possible. Expand and contract the beam through crossover using the brightness knob and confirm the illumination is circular.
4. Disengage cond stig.

Gun and condenser lens alignment

1. Set magnification ≥ 50kx using mag/cam L (R1-5) and condense beam to crossover using brightness.
2. Click on the wobbler-anode in alignment window. If alignment window is not open, on TEM computer in the TEM controller main menu, select menu maintainence→alignment.
3. Select spot size 1 and click on def select gun in the alignment window.
4. Adjust def/stig X, Y so that the beam contracts and expands concentrically.
5. Center the condensed beam using shift X, Y (L1-8, R1-3).
6. Select spot size 5 and press the bright tilt switch (L1-5).
7. Center the electron beam using shift X, Y.
8. Adjust def/stig X, Y so that the beam contracts and expands concentrically.
9. Repeat steps 3 to 8 until the electron beam remains at the center of the screen when the spot size is changed.
10. Disengage wobbler- anode and select spot size 1.

Z-height adjustment

This adjustment must be redone whenever the specimen stage is tilted or translated. The TEM loses image resolution if the objective kens are operated far away from the optimum value.

1. Set magnification ≥ 100kx.
2. Set objective Lens to optimum "Standard Focus" value using STD FOCUS (R1-9).
3. Locate a feature on the specimen.
4. Turn on Image X or Y Wobbler (R1-1) and move specimen stage to proper z-height using up or down buttons (R1-11). Correct z-height is achieved when the image is no longer doubled and minimum image contrast is achieved. (Speed of the z-height up/down control can be set in the specimen property window).

Beam Tilt-Shift Purity Adjustment

A: Tilt Adjustment

This adjusts the ratio of currents in the upper and lower CL deflection coils so that the electron beam spot remains stationary when the electron beam is tilted.

1. Set the Spot Size to the value you will primarily use. Set Magnifications =100kx
2. Condense beam to crossover using BRIGHTNESS and center using Shift X, Y.
3. Click on Wobbler Tilt X and Compensator –Tilt in the Alignment Window.
4. Adjust DEF/STIG X until the crossover spot non longer moves.
5. Center the beam using Shift X, Y.
6. Click on Wobbler Tilt Y in Alignment window.

7. Adjust DEF/STIG Y until the crossover spot no longer moves.
8. Disengage Compensator-Tilt and Wobbler Tilt Y in Alignment window.
9. Center the beam using Shift X, Y.

B: Shift adjustment
This adjusts the ratio in currents in the upper and lower CL deflection coils so that the electron beam tilt remains unchanged when the electron beam is shifted.

1. Select diffraction mode (SA DIFF) (R1-2) and set camera length (R1-5) =100cm.
2. Turn the BRIGHTNESS knob fully counterclockwise (it may take a while).
3. Adjust DIFF FOCUS (R1-7) by approaching crossover clockwise to form a structured caustic spot.
4. Engage PLA (L1-5) and center caustic using DEF/STIG.
5. Engage IL STIG in Alignment window and use DEF/STIG to make the spot (see figure to right) circular and as small as possible.
6. Adjust DIFF FOCUS (R1-7) by approaching crossover counterclockwise to obtain a sharp caustic spot.
7. Click on Compensator – Shift and Wobbler – Shift X in Alignment window.
8. Adjust DEF/STIG X until the caustic spot does not move.
9. Disengage Wobbler – Shift X and engage Wobbler – Shift Y in Alignment window.
10. Adjust DEF/STIG Y until the caustic spot does not move.
11. Disengage Compensator - Shift and Wobbler – Shift Y in Alignment window.
12. Select imaging mode (MAG1) and use BRIGHTNESS knob to condense beam so until the view screen is visibly illuminated.

Objective Current Centering (Skip this step)

1. Center region of interest on specimen (Mag ≥100kx) and focus image using OBJ FOCUS (R1-6).
2. Spread out the beam with BRIGHTNESS to illuminate the entire screen.
3. Engage Wobbler –OBJ in Alignment window.
4. Engage BRIGHT TILT (L1-5).
5. Adjust DEF/STIG X, Y so that the image expands and contracts around the center of the screen.
6. Disengage Wobbler – OBJ in Alignment window.

High Voltage Centering

1. Center point of interest on specimen (Mag at least 200kx) and focus image using OBJ FOCUS.
2. Spread out the beam with BRIGHTNESS to illuminate the entire screen.
3. Engage HT WOBB (R1-1).
4. Engage BRIGHT TILT (L1-5).
5. Adjust DEF/STIG X, Y so that the image expands and contracts around the center of the screen without any lateral motion in any particular direction.

6. Disengage HT WOBB.

Correct Objective Astigmatism (necessary only for lattice resolution imaging)

1. Select a thin amorphous region of your specimen.
2. Adjust z-height.
3. Increase Mag >=500kx.
4. Optional step: Fine –tune z-height.
5. Focus image with OBJ FOCUS (R1-6) if necessary.
6. Engage objective lens stigmators (OBJ STIG) (L1-5).
7. Adjust DEF/STIG X,Y to remove astigmatism in the image.
8. Disengage OBJ STIG button.

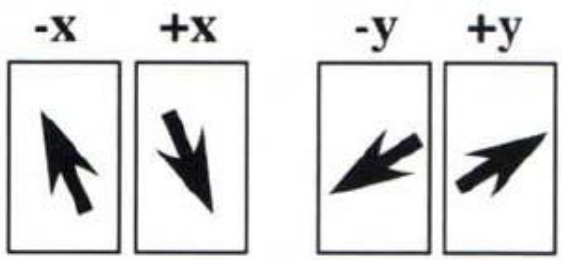
VI. Basic Instrument Operation

- Specimen Tilting and Translation

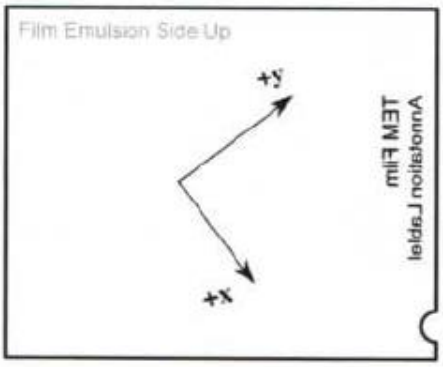
When you have reached the limit of the specimen Tilt (X+- 25, Y+- 30) or Shift an alarm will sound. In the event that the limit alarm sounds, immediately stop your adjustments. Slowly reduce the Shift and Tilt values towards zero until the alarm silences.

If you proceed with increases fro zero in Shift or Tilt when the limit alarm sounds, damage may occur to the holder, apertures, or the pole piece.

Specimen Tilting
The orientation of the TEM micrograph as viewed from looking down th viewing screen is shown below right and a schematic of the tilt foot pedals are shown below left.



Tilt Foot Pedals



Tilting the specimen in the +(x/y) direction will result in the movement of CBED Kikuchi bands in the direction of the arrows, i.e. increasing (x/y) angles are in the opposite direction to the arrows. To adjust the speed of the X, Y tilt, in TEM Controller menu bar, select menu Property -> Stage to open the Specimen Property window.
Note: The single tilt holder allows tilting only in the x-direction.

Specimen Translation
Specimen translation is controlled by the track ball or arrow buttons on the Spec Control pad.

- CRS switch toggles between fine and course control of X, Y, Z Translators and X, Y Tilts.
- PIEZO switch (SC-4) toggles between motor driven translators and the ultra fine piezoelectric drive. The piezo drive has a full range movement of +- 1.2um and is best suited for magnifications >100kx.
- Image Shift (L1-5) when engaged is controlled by the DEF/STIG X, Y and translated the image by +- 2um on the view screen.

- Electron Diffraction

Selected Area – Diffracting Area Defined by Aperture
While in TEM (L1-3) illumination mode.

Select SA MAG (R1-2) and set magnification using MAG/CAM L.

1. Neutralize Image Shift (Select Image Shift and push NTRL button) (L1-5).
2. Insert field – limiting (selected area) aperture and center area of interest in aperture.
3. Adjust BRIGHTNESS so that region of interest is completely illuminated.
4. Remove any objective aperture that is inserted.
5. Press SA DIFF (R1-2), set camera length using MAG/CAML, and focus diffraction spots using DIFF FOCUS (R1-7).

Nano beam – Diffraction Area Defined by Probe

1. Select SA MAG (R1-2) and using MAG/CAML.
2. Neutralize Image Shift (Select Image Shift and push NTRL button) (L1-5).
3. Select NBD (L1-3) illumination mode and focus beam to crossover using BRIGHTNESS.
4. Adjust SPOT SIZE.
5. Press SA DIFF and set camera length using MAG/CAM L.
6. Adjust size of diffraction spots by using the α- Selector and changing the condenser aperture size.

Table II: Diffraction Pattern Measurement
d-spacing[Å] = **wavelength*Camera Length / R**
R = distance (cm) on film

Voltage V (kV)	Wavelength λ (Å)	Wavelength*Camera Length		
		80 cm	100 cm	120 cm
200	0.025081	2.006	2.508	3.010
160	0.028551	2.284	2.855	3.426
100	0.037017	2.961	3.702	4.442

$\lambda \approx 12.3$ Å / sqrt ($V + 10^{-6} V^2$)

VII. Specimen Exchange during Operation of TEM

1. Zero X, Y Translators: X, Y Tilts; and z-height.

a. On Stage Control track ball unit verify that the Piezo driver is off (SC-4).
b. In TEM Controller menu bar, select menu Property -> Stage to open the Specimen Property window.
c. In the Specimen Property window click Holder Exchange to zero stage parameters.
d. In the Main Controller Window right mouse click anywhere with in the stage parameters field at the far right of the window and select NTRL under the Super Fine menu to zero the Piezo stage.

Specimen holder cannot be removed while there is electron emission through the column.

2. Close Beam Airlock valve (L1-1). Verify that Beam Airlock valve (V1) is closed either by watching electron illumination cease or inspecting the status of valve V1 in the Vacuum status schematic (Monitor-> Vacuum System).
3. Follow step 7 of Section VIII. Shutting Down TEM
4. Follow Section II. Specimen Holder Loading and Insertion
5. Follow Section III Electron Emission.

VIII. Shutting Down TEM

1. Select MAG 1 imaging mode and set Magnification to 100kx.
2. Expand the beam using the BRIGHTNESS control to fill the view screen.
3. Remove all apertures from beam path.
4. Close Beam Airlock (L1-1). Verify that Beam Airlock valve (V1) is closed either by watching electron illumination cease or inspecting the status of valve V1 in the Vacuum status schematic (Monitor-> Vacuum System).
5. Consult the web-based on-line sign-up calendar for the instrument. If you are the final user of the instrument for the day, set the FEG Stand By Mode to “Stand

By" (select Dialog ->High Voltage Control to open the High Voltage Control Window).

Only leave the FEG in "Normal" mode if the instrument will be used after your session.

6. Zero X,Y Translators: X,Y Tilts ; and z-height.

    a. On Stage Control track ball unit verify that the Piezo driver is off (SC-4).
    b. In TEM Controller menu bar, select menu Property->Stage to open the Specimen Property Window.
    c. In the Specimen Property Window click Holder Exchange to zero stage parameters.
    d. Repeat c.
    e. In the Main Controller Window right mouse click any where within the stage parameters field at the right of the window and select NTRL under the Super Fine menu to zero the Piezo stage.

7. Remove the sample holder (consult specific instructions for the holder if available).

    a. Verify that Beam Airlock valve (V1) is closed by inspecting the status of valve V1 in the Vacuum Status schematic (Monitor -> Vacuum system) before proceeding to b).
    b. Verify X,Y Translators ; X,Y Tilts; and z-height are zero in the Specimen Property Window before proceeding to c).
    c. Pull holder out until it sops (tab is at 3:00 position).
    d. Turn holder counterclockwise until it stops (tab at 1:00 position).
    e. Pull holder slightly out (0.5 cm) and turn counterclockwise until it stops (tab at 12:00 position).
    f. When the yellow light blinks, toggle pre-pump switch to Air ,listen for valves (V21,V34 & V36) to open , and then wait 10 seconds before removing the holder.

8. Remove your specimen from the holder.
9. Proceed to steps 10, 11, and 12.
10. If you are the final user of the instrument for the day , perform the following:

a. Set FEG Stand by Mode to "Stand By" (select Dialog ->High Voltage Control to open the High Voltage Control Window).

b. Insert the ACD Heater in the ACD Dewar with the hose for the nitrogen to boil off directed away from you .Insert the heater until the banana jacks are seated in their sockets.

c. In the Bake Out /ACD Heat Window, select the ACD Heat tab.

NOT the Bake Out tab!
And press ACD Heat On.

11. Complete Instrument Log Book entry (also comments on instrument problems).

IX. Emergency Procedures

Microscope Alarm Dialog Window Appears

In the event of a hardware failure, an Alarm Dialog Window will appear.

1. Close Beam Airlock valve (L1-1). Verify that Beam Airlock valve (V1) is closed either by watching electron illumination cease or inspecting the status of valve V1 in the Vacuum status schematic (Monitor-> Vacuum System).
2. Set the FEG Standby Mode to "Stand By "(select Dialog -> High Voltage Control to window).
3. Immediately contact C.R.N.T.S Technical Staff.

Power Outrage during Operation

The microscope is protected from short duration brownouts by a UPS battery back-up system. If a power outage lasts for longer than 5-6 Minutes the instrument must be shut down.

1. Close Beam Airlock valve (L1-1). Verify that Beam Airlock valve (V1) is closed either by watching electron illumination cease or inspecting the status of valve V1 in the Vacuum status schematic (Monitor-> Vacuum System).
2. Set the FEG Stand by Mode to "Stand By" (select Dialog -> High Voltage Control window).
3. Immediately contact C.R.N.T.S staff. If C.R.N.T.S Staff are unavailable proceed to steps 4-5.
4. In High Voltage Control under More click the Auto HT & Emission OFF button and wait until HT & Emission is OFF before proceeding,
5. On the control panel behind the door on the left pedestal, turn power off (L2-2).

Emergency Evacuation

⚠ This procedure will harm the instrument so use it for only for emergencies that pose immediate and serious threat to the instrument (e.g., fire, sprinkler system activation, flood, and etc.) ⚠

This procedure will harm the instrument so use it only for emergencies that pose immediate and serious threat to the instrument (e.g. Fire, Sprinkler system activation, flood etc.)

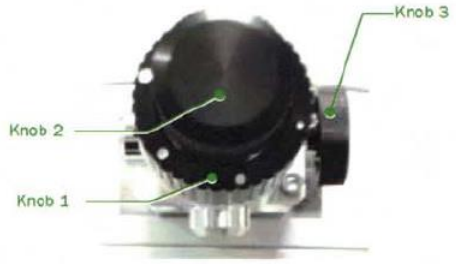
1. Close Beam Airlock valve (L1-1).
2. Push the EM STOP switch (L2-1).
3. Turn off main power breaker throw in back of FEG-TEM room.
4. Notify Emergency responders of the emergency, then C.R.N.T.S Staff, as soon as possible.

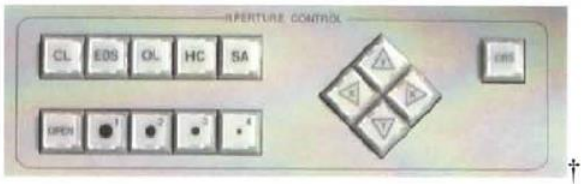
Appendices

- **I. Aperture Assemblies**
- **II. Control Panels**
- **III. Software Controls**

REFER TO JEOL JEM-2100F TEM MANUAL FOR EXPANDED DETAILS OF SPECIFIC PROCEDURES.

I. Aperture Assemblies

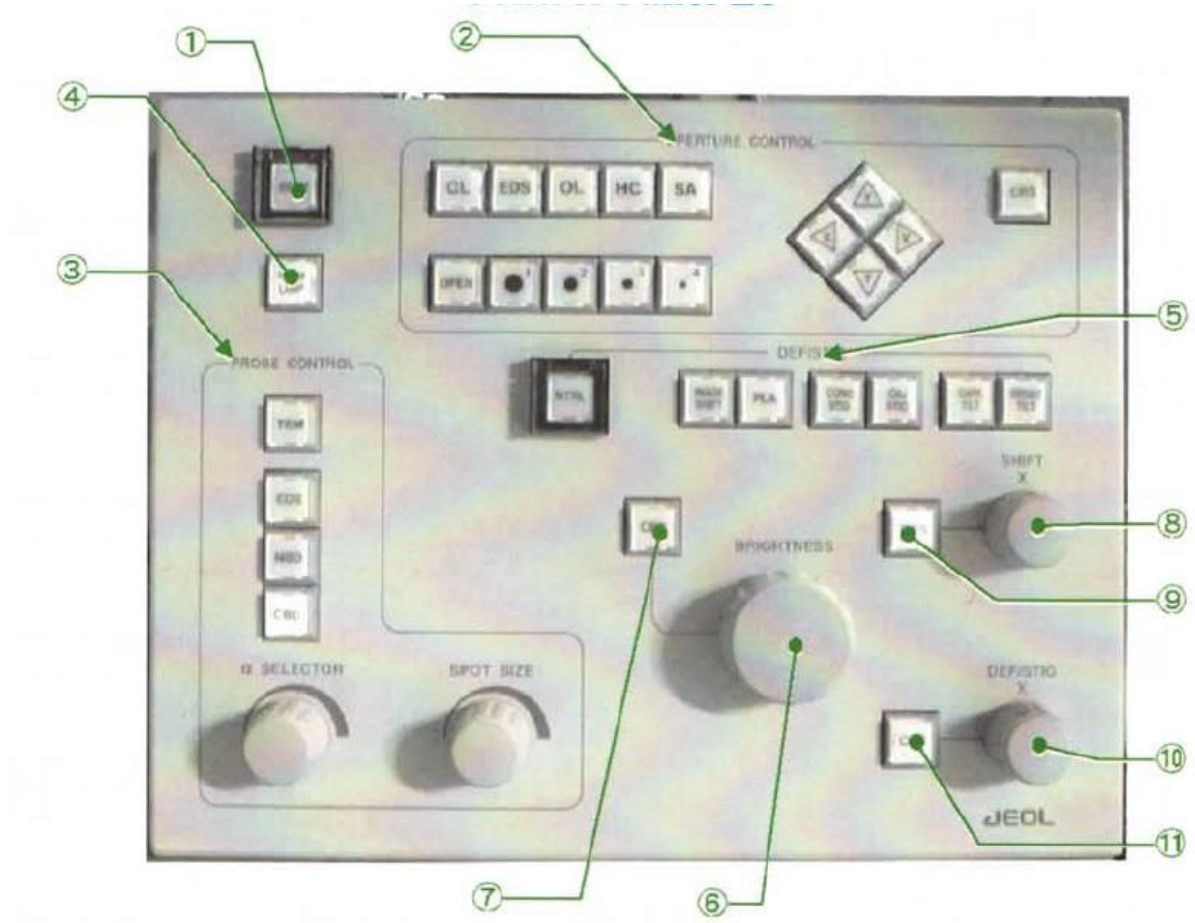




†

Manual Knob 1 Position					
Aperture Size Indicator	●	○	○	○	○
Condensor	none	200 μm	100 μm	40 μm	10 μm
Selected Area	none	120 μm	50 μm	20 μm	10 μm
Motor Driven†	OPEN	●1	●2	●3	●4
Condensor (CL)	none	none	none	none	none
Hard X-ray Aperture (EDS)	none	none	none	none	none
Objective (OL)	none	60 μm	40 μm	30 μm	5 μm
High Contrast (HC)	none	120 μm	60 μm	20 μm	5 μm
Selected Area (SA)	none	none	none	none	none

Control Panel L1



L1-1 BEAM VALVE

Pressing the switch opens valve V1 (the isolation valve between the microscope column and the electron gun chamber).

L1-2 APERTURE CONTROL (In case of built-in the motor drive aperture)

Pressing one of the apertures switches (CL,EDS,OL,HC or SA) lights the built-in lamp; the aperture –selector switches (OPEN,1,2,3 and 4) and X and Y arrow switches then control the selected aperture, provided that the corresponding aperture is installed in the microscope.

- Aperture Selection Switches –selects and inserts the aperture assembly.

OL – Selects the objective aperture.
HC - Selects the high-contrast objective aperture.

- Aperture Size Switches –selects the aperture number (size) of the inserted aperture assembly. See Appendix I

OPEN – The aperture is open.
1 to **4** - Selects aperture number 1 through 4.

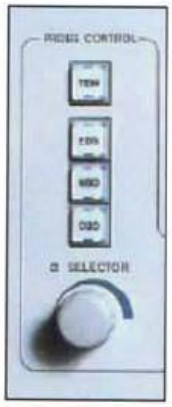
- X and Y arrow switches – Move the aperture in the X and Y directions.
- **CRS** (Coarse) switch –When On, the distance the aperture moves when the X or Y switch is pressed increases by a factor of 16.

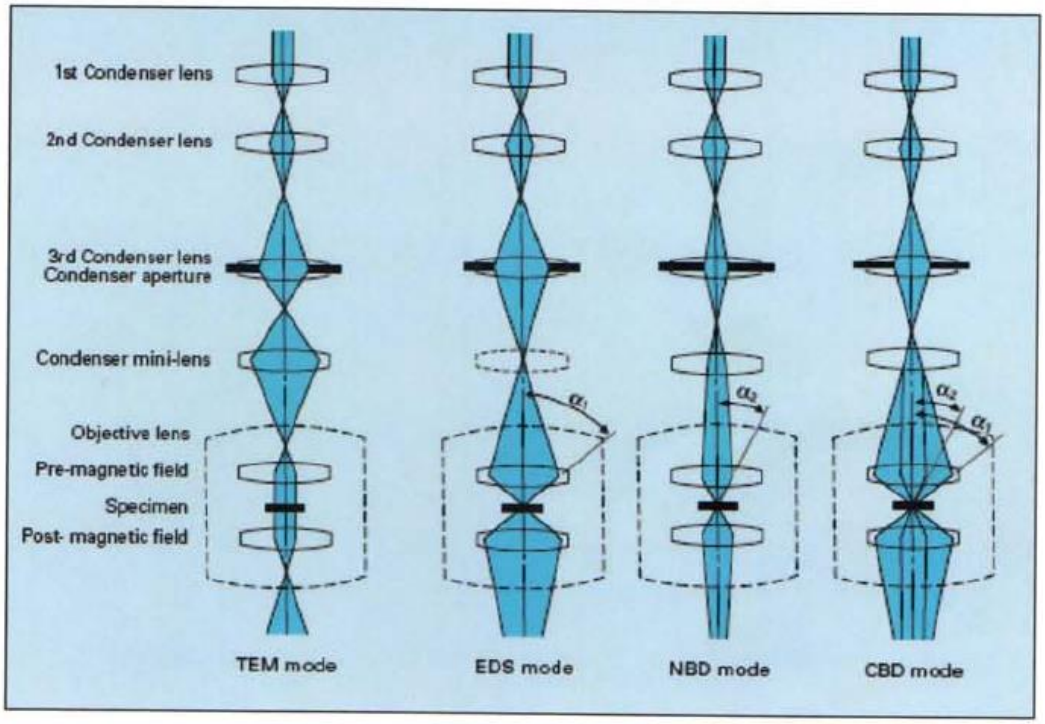
L1-3 PROBE CONTROL

- Illumination mode selector switches (TEM, EDS, NBD and CBD). When selected button is backlit.

TEM – Sets the illumination mode to the TEM (wide-area illumination) mode.
EDS - Sets the illumination mode to the EDS (high –current density micro-area illumination) mode.
NBD - Sets the illumination mode to the NBD (small convergence angle micro-area illumination) mode.
CBD - Sets the illumination mode to the CBD (wide range changeable convergence angle micro-area illumination) mode.

- R-SELECTOR knob – Varies the convergence angle while the illumination spot size remains constant. Turning this knob clockwise decreases the CM lens current to zero.
- SPOT SIZE knob - Turning this knob increases or decreases the spot size (the size of the electron beam when converged to minimum size using the BRRIGHTNESS knob). The spot size decreases as the SPOT SIZE number increases and the spot size is increased as the SPOT SIZE number decreases.





L1-4 ROOM LAMP SWITCH: Turns on and off the room lamp when a lamp is provided.

L1-5 DEF/STIG switches :Pressing one of these switches lights up the built-in lamp and sets the **SHIFT** knobs (L1-8, R1-3) or **DEF/STIG** knobs (L1-10, R1-4) to control the selected coil current. Pressing the switch again turns off the built-in lamp and holds the selected coil current to the value it has when this switch is pressed (the built-in lamp dims).

IMAGE SHIFT switch – Shifts the image. **DEF/STIG** knobs (L1-10, R1-4)
PLA switch - Adjusts the projector lens deflector coil current during shifting of the diffraction spot or the specimen image .**DEF/STIG** knobs (L1-10, R1-4)
COND STIG switch -Adjusts the condenser lens stigmator coil current during condenser lens astigmatism correction.
OBJ STIG switch -Pressing this switch sets the objective lens stigmator coil to the current stored in the selected memory and sets the **DEF/STIG** (L1-10, R1-4) knobs to adjust the current. Used for objective-lens astigmatism correction.
DARK TILT switch - Pressing this switch sets the condenser lens beam deflector coil to the current stored in the selected memory and sets the **SHIFT** and **DEF/STIG** knobs to adjust the current .Used to tilt the electron beam when observing dark-field images.
BRIGHT TILT switch - Pressing this switch sets the condenser lens beam deflector coil to the current stored in the selected memory and sets the **SHIFT** and **DEF/STIG** knobs to adjust the current .Used to tilt the electron beam when observing bright-field images.
NTRL switch - Pressing this switch brightens the built-in lamp and clears the current data from the memory corresponding to the selected switch.

L1-6 BRIGHTNESS knob
Converges and spreads the electron beam.

L1-6 BRIGHTNESS CRS switch
When engaged, the change in current per notch of the **BRIGHTNESS** knob (L1-6) is increased 16 times.

L1-8 SHIFT X knob
Shifts the electron beam in the X direction by varying the condenser lens beam deflector coil current .The electron gun 1st beam deflector coil current is adjustable when Align-Gun is selected from the Alignment Panel for maintenance window.

L1-8 SHIFT CRS switch

When engaged, the change in current per notch of the **SHIFT** knobs (L1-8, R1-3) is increased by 16 times.

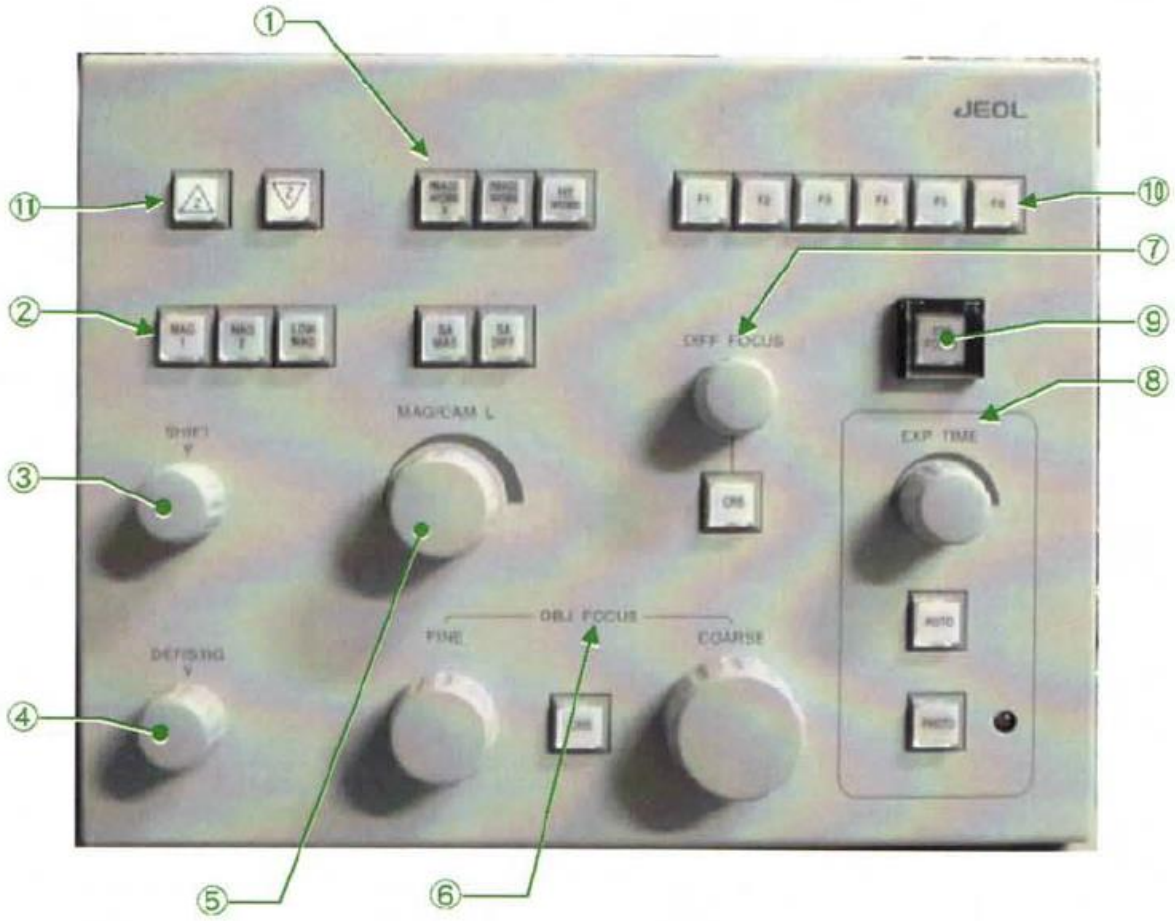
L1-10 DEF/STIG X knob

Varies the X current in the coil selected by the **DEF/STIG** switch or from the Alignment Panel for Maintenance window.

L1-11 DEF/STIG CRS switch

When engaged, the change in current per notch of the **DEF/STIG** knobs (L1-10, R1-4) is increased by 16 times.

Control Panel R1



R1-1 Wobble switches

IMAGE WOBB X –Used for focusing. The 1st and 2nd beam deflector coil currents vary periodically while this switch is on. If the image is out of focus, it wobbles in the X direction.

IMAGE WOBB Y - Used for focusing. The 1st and 2nd beam deflector coil currents vary periodically while this switch is on. If the image is out of focus, it wobbles in the Direction.

HT WOBB -While this switch is on, the high voltage varies periodically, facilitating alignment of the voltage axis.

R1-2 Function switches

Used to choose a projector lens image-forming mode. The magnification Or the camera length in the selected mode can be varied with the **MAG-CAM L** knob (R1-5) and is displayed on the monitor. The magnification or camera length set by the **MAG-CAM L** knob is stored so that even if another mode (except for MAG 2 mode) is once selected, the magnification or camera length can be reset to the stored value by selecting the original mode again.

MAG 1 switch -	Image Magnification (MAG)	2kx-1.5Mx
MAG 2 switch -	Image Auxiliary Magnification (MAG2)	2kx-1.5Mx
LOW MAG switch –	Image low magnification (LMAG)	50x-6kx
SA MAG switch -	Image Selected Area Magnification (SAM)	8kx-800kx
SA DIFF switch -	Diffraction (DIFF)	10-250cm

R1-3 SHIFT Y knob

Shifts the electron beam in the Y direction by varying the condenser lens beam deflector coil current. The electron gun 1st beam deflector coil current is varied when Align-Gun is selected from the Alignment Panel for Maintenance Window.

R1-4 DEF/STIG Y knob

Varies the Y current in the coil selected by DEF/STIG switch or selected from the Alignment Panel for Maintenance Window.

R1-5 MAG/CAM L knob

Varies the normal magnification when the MAG1 OR MAG2 switch (R1-2) is pressed, the low magnification when the LOW MAG switch is pressed .Varies the selected area magnification when SA MAG is selected and the camera length when SA DIFF is selected .Turning this knob clockwise increases the magnification or camera length and turning it counterclockwise decreases the magnification or camera length.

R1-6 OBJ FOCUS knob

Focuses the image by varying the objective lens current (objective minilens current in LOW MAG mode).

FINE knob -The change in current resulting from turning the knob by one notch is the smallest.

COARSE knob –The change in current resulting from turning the knob by one notch is the same as when the FINE and COARSE knobs by one notch by a factor of 16.

CRS Switch -Turning this switch on by pressing it increases the current change resulting from turning the FINE and COARSE knobs by one notch by a factor of 16.

R1-7 DIFF FOCUS

Knob - Focuses the field-limiting aperture while the SA MAG switch (R1-2) is on and focuses the diffraction pattern while the SA DIFF switch (R1-2) is on.

CRS switch - Turning this switch on multiplies the change in current resulting from turning the FOCUS knobs by one notch by a factor of 16.

R1-8 EXP TIME/PHOTO

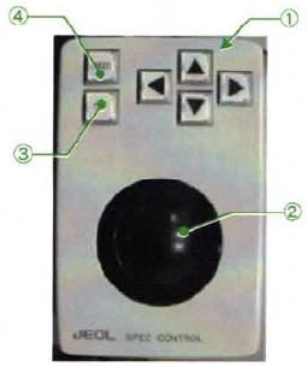
EXP TIME knob – Varies the exposure time. Turning this knob clockwise increase the exposure time and turning it counter clockwise decreases the exposure time.
AUTO switch – Pressing this switch selects the automatic exposure mode and lights up the built-in lamp. Pressing switch again selects the manual exposure mode (the built-in lamp goes out).

R1-9 STD FOCUS switch
Pressing this switch sets the objective lens current to the optimal value.
R1-10 F switches
Allocate the functions selected by the operator to the F1 to F6 switches.

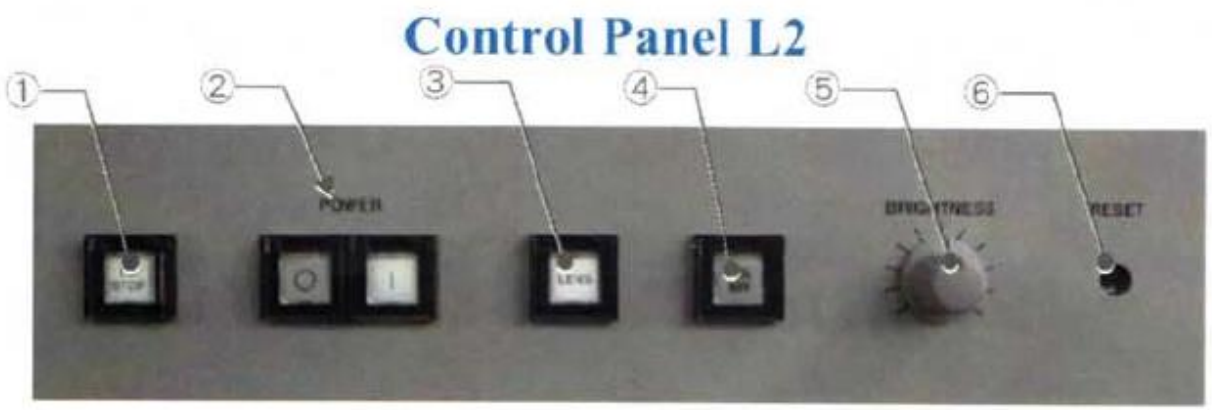
R1-11 Z switches
Shifts the specimen in the vertical direction.

Control Panel (Stage Control) SC

SC-1 Move the specimen by one increment in the X or Y direction.
SC-2 Trackball – moves the specimen in the direction the ball is rotated.
SC-3 CRS switch –Toggles between fine and coarse specimen translation for SC-1 and SC-2. When switch is lighted the course mode is selected.
SC-4 PIEZO switch –Toggles between the standard motor driven translators and the ultra fine piezoelectric drive. When switch is lighted the Piezo drive is controlled by SC-1 and SC-2.



Control PanelL2

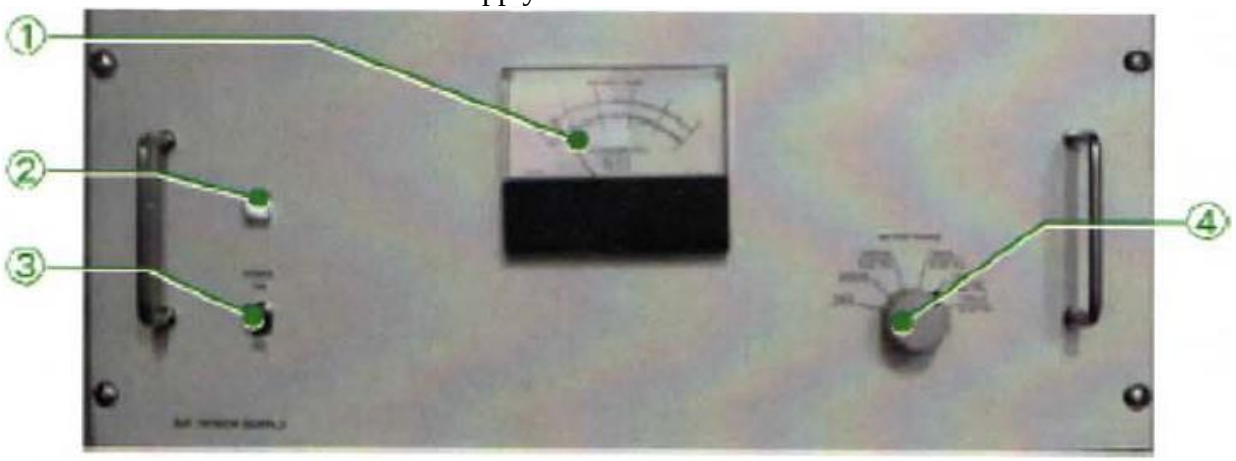


L2-1 for emergency use only. EM STOP abruptly shuts down the entire instrument.

Do not touch L2-2 through L2-6

Column Vacuum Gauge (CVG)

Located on Power Supply Console in back of TEM room.

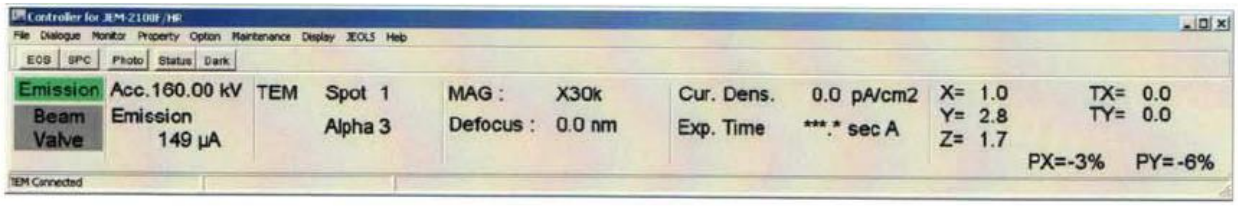


CVG-1 Meter-Read vacuum pressure from BLUE scales (150L/s pump).
CVG-4 Meter-Range –Should be set on 10 -5 Pa or 10 -5 Pa scale.

Do not switch off CVG-3

III. **Control Software**

Main Controller Window



Illumination Parameters

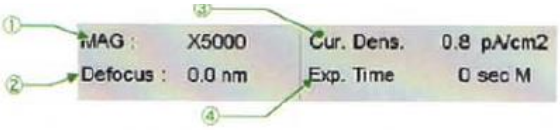
1) HT or Emission
   When HT is off, HT has gray background.
   When HV is on, HT has green background.

2) Beam Valve

When it is possible to open the valve, Beam Valve has a green background.
When it is not possible to open the valve, Beam Valve has a gray background.

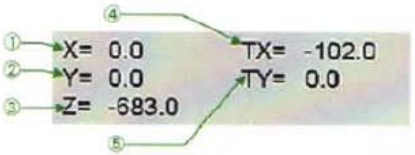
3) Acc. - Accelerating voltages in kV.
4) Emiss. –Electron beam current in µA.
5) Mode –TEM, EDS, NBD and CBD.
6) Spot size.
7) Alpha –Convergent angle.

Imaging Parameters



1) Mag – Image Magnification.
2) Defocus – Difference between reference focus and present focus.
3) Cur. Dens. - Current density inpA/cm2 as measured on fluorescent screen.
4) Exp. Time- Film exposure time and exposure mode M (manual) or A (auto).

Specimen Stage and Goniometer Status



1) X – Position of x-direction specimen translator.
2) Y –Position of y-direction specimen translator.
3) Z - Position of z-direction specimen translator.
4) TX – Tilt in x- direction (degrees)
5) TY - Tilt in y- direction (degrees)

High Voltage Control Window

1) HT Status
   "Not ready" will be displayed when HT cannot be turned on.
   "Ready" will be displayed when HT can be turned on.
   "On" is displayed when HT is on.

2) Emission Status
   "Not ready" will be displayed when Emission cannot be turned on.
   "Ready" will be displayed when Emission can be turned on.
   "On" is displayed when Emission is on.

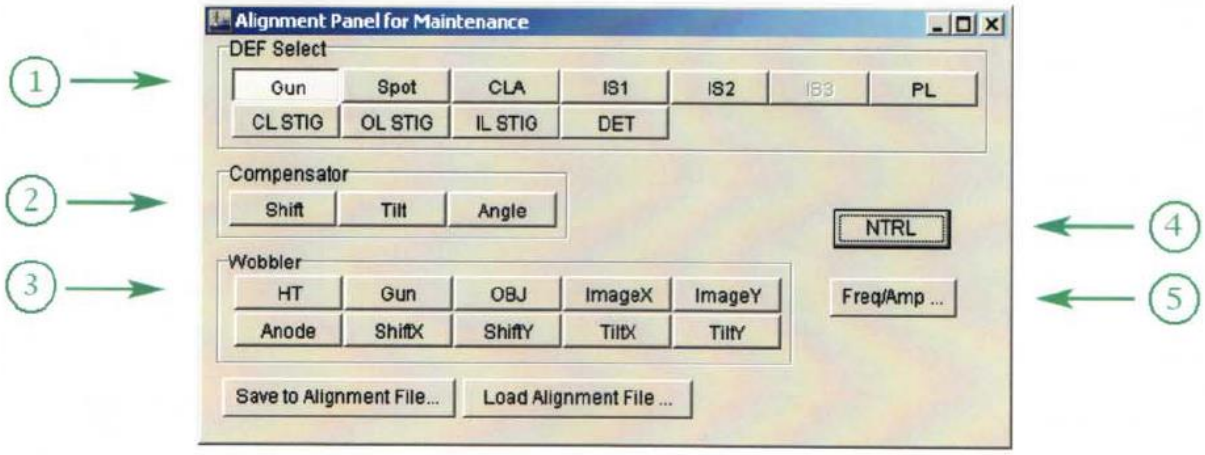
3) Displays HT.
4) Displays Dark current (µA).
5) Displays Emission current (µA).

6) Opens and closes the beam valve.

7) Nominally buttons are displayed that allow the user to select "Normal" or "stand by" mode
   Normal mode-emission on, HT at 200kv.
   Standby mode-emission on, HT at 160kv

8) Used for aligning the electron gun.
   Do not adjust (9) and (10)

Alignment window



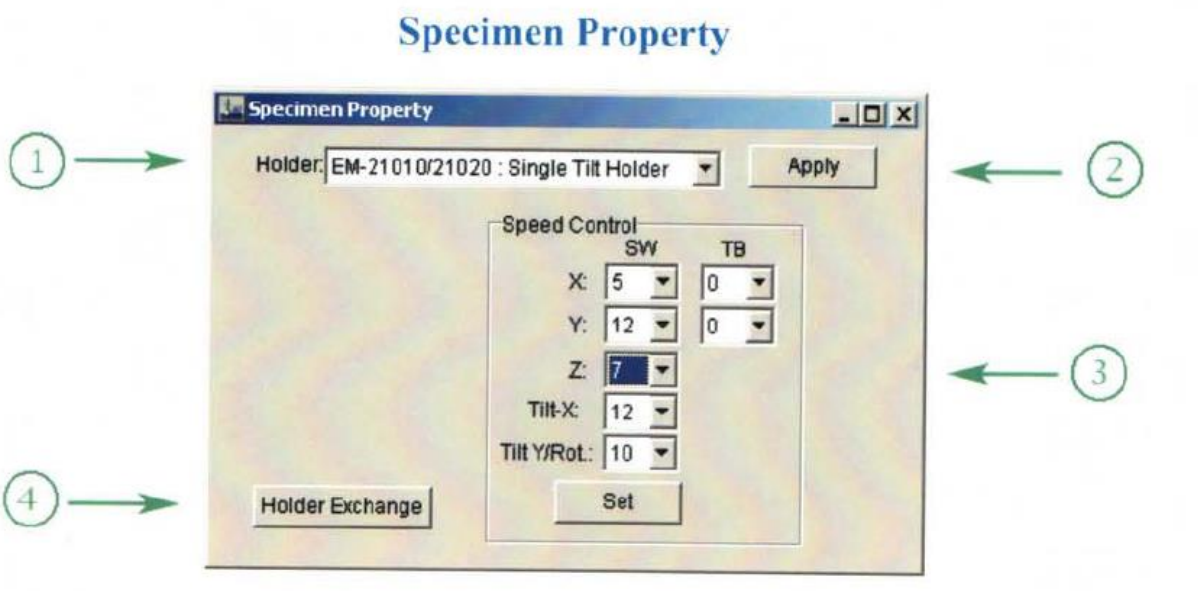
1) DEF Select- set which alignment coil is controlled by the L1-10 and R1-4 DEF/STIG knobs.
   Gun gun deflector
   Spot Ppot deflector
   CLA condenser lens alignment deflector also known as **bright tilt**
   IS1 Intermediate stigmator 1
   IS2 Intermediate stigmator 2
   PL Projector Lens Deflector (also known as PLA)
   CL STIG Condenser Lens Stigmator
   OL STIG Objective Lens Stigmator

2) Compensator – Sets which compensator coil is controlled by the L1-10 and R1-4 DEF/STIG knobs.
3) Wobbler - Turns on the selected wobbler:

   HT High Tension
   Gun Gun
   OBJ Objective Lens
   Image X Image X
   Image Y Image Y
   Anode Anode
   Shift X Gun Shift X
   Shift Y Gun Shift Y
   Tilt X Gun Tilt X
   Tilt Y Gun Tilt Y
4) NTRL- Resets the selected DEF select or compensator to the fractory alignment setting. This value is not always correct.
5) Freq/Amps- sets the frequency and amplitude of the wobblers.

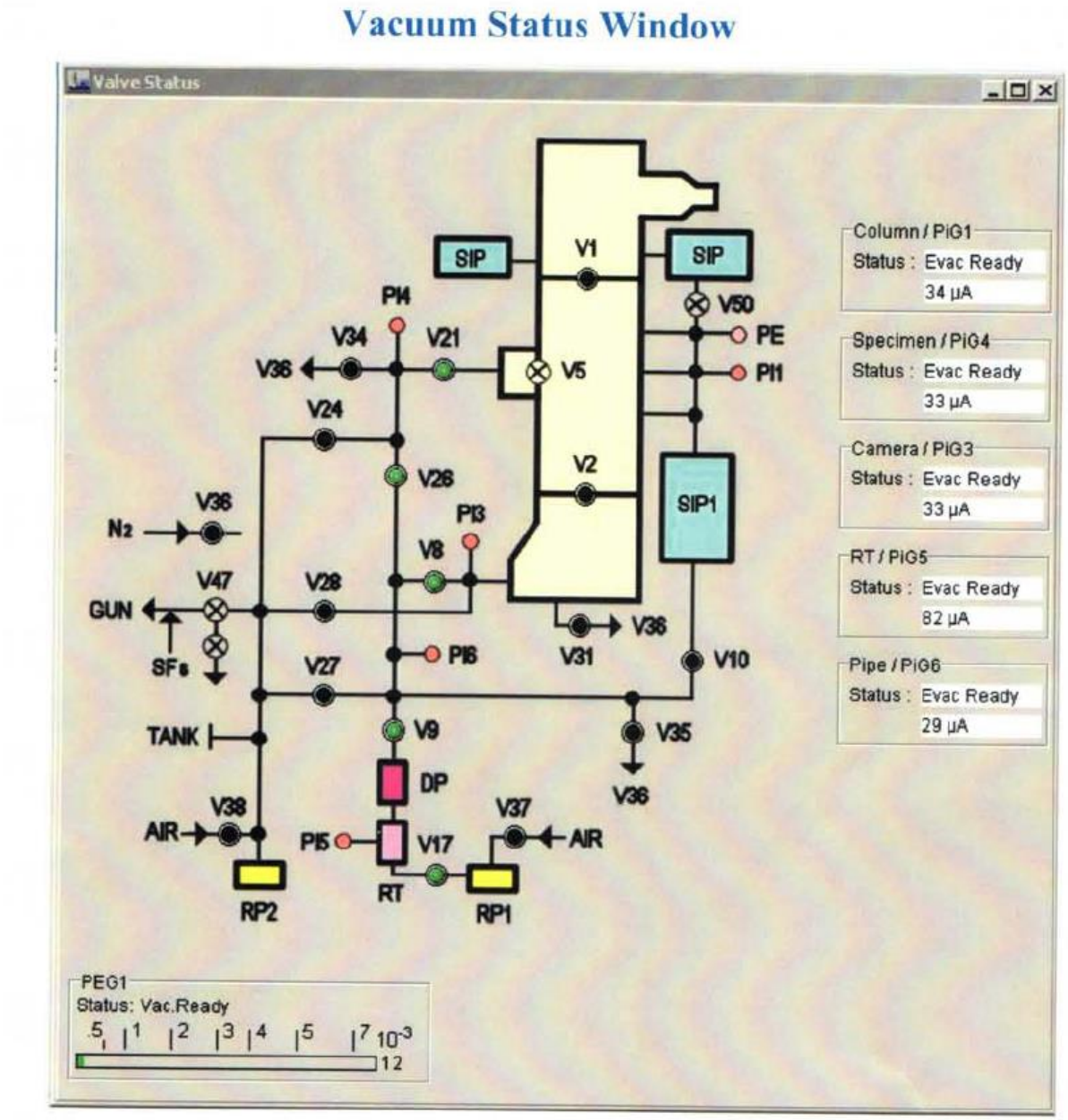
Do not adjust (5)

Specimen property



1) Holder – select specimen holder
2) Apply file containing parameter inform on selected specimen holder.
3) Select speed of X, Y, Z Translators and X, Y Tilt values.
   Note: Holder exchange does not zero the
   Piezo X, Y translator stage and will not function if piezo stage is turned on.

Vacuum status window



- Valve Open.
- Valve Closed.
- Vacuum lines connected together.

Specimen and Camera toggle from Evac to Evac Ready at 36 µA.
RT toggles from Evac to Evac Ready at 150 µA.