

# **Philips CM12 (S)TEM Alignment & Setup Manual**

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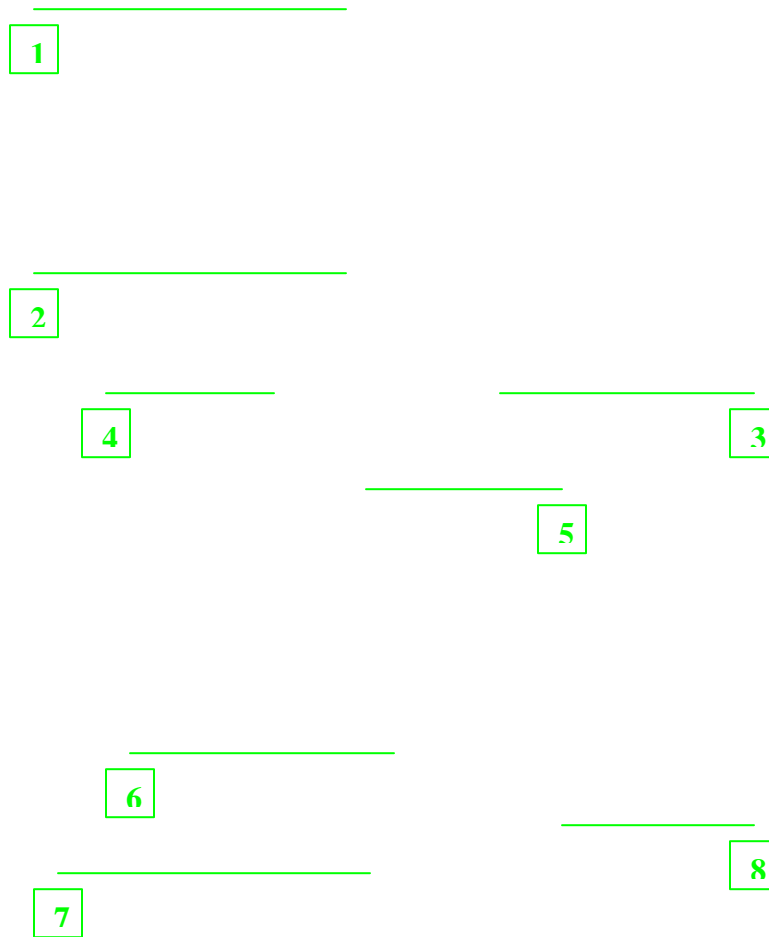
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## Parts of the CM12

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### *The Microscope*

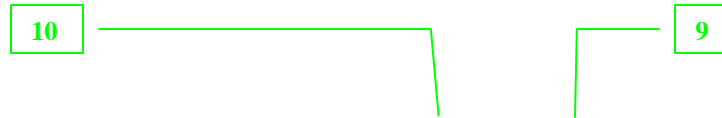


**Figure 1** The Philips CM12 (S)TEM Microscope

1	Electron Gun	A filament tip (LaB <sub>6</sub> in this case) that emits electrons upon application of electrical current.
2	Condenser Aperture Assembly	An area that houses the condenser aperture, control knobs, and related circuitry.
3	Specimen Chamber/Holder	High vacuum tunnel where the specimen is inserted.
4	Objective Aperture Assembly	An area that houses the objective aperture, control knobs, and related circuitry.
5	Field Limiting Aperture Assembly	An area that houses the intermediate lens aperture, control knobs, and related circuitry.
6	Binoculars	Eyepieces used to view the projected image up close.
7	Viewing Window	Glass windows (another on the left side) where the large phosphor screen can be viewed.
8	Mechanical Stage Controls	Two knobs that control the translational coordinates of the sample image.

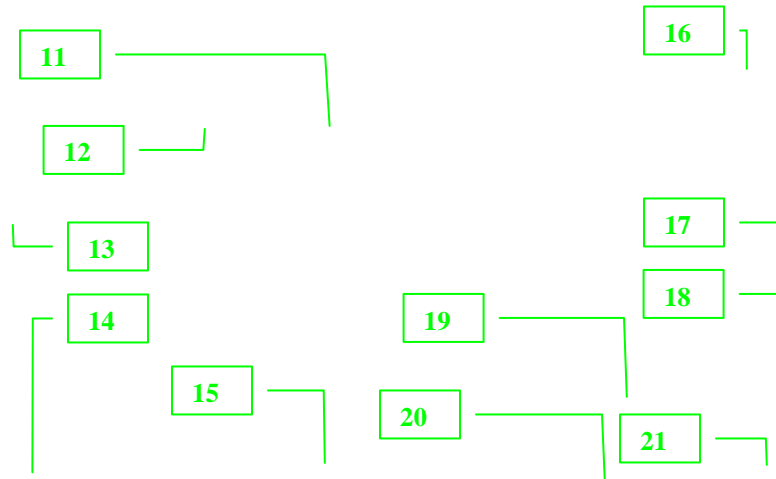
## The Control Panels

### Left Control Panel



**Figure 2** The Control Panel located to the left of the microscope column.

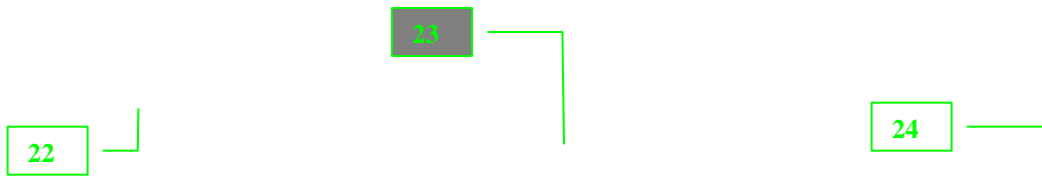
### Right Control Panel



**Figure 3** The main control panel on the right hand side of the microscope.

- |    |                        |    |                            |
|----|------------------------|----|----------------------------|
| 9  | Intensity Knob         | 16 | Emission Meter             |
| 10 | Fine Adjustment Knob   | 17 | High Tension Button        |
| 11 | Screen                 | 18 | Filament Control Knob      |
| 12 | Screen Control Buttons | 19 | Ready Button               |
| 13 | Power Switch           | 20 | Focus/Focus Step Knob      |
| 14 | Magnification Knob     | 21 | Multifunction Control Knob |
| 15 | Beam Shift Knobs       |    |                            |

## The Specimen Holder

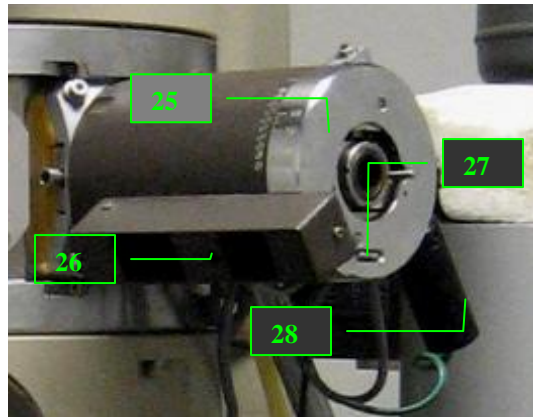


**Figure 4** The CM12 Specimen Holder

22 Black Cap  
23 O-ring

24 Specimen Cavity & Clamp

## The Side Entry Specimen Chamber



**Figure 5** The Side Entry Chamber

25 Tilt Knob  
26 Indicator Light

27 Z-Adjustment Knob  
28 Tilt Lock Lever

## Startup Procedure

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## Powering Up the Microscope

1. Start by logging in to the computer connected to the TEM. Login is a necessary step to prevent unauthorized users from accessing the microscope. Without login, the control panel is not accessible.
2. Turn on the control panel by pushing the Power Switch [13] on the left hand side of the screen.
3. At this point, the main menu will appear on the computer screen. (Note: pressing the READY [19] button at any time will revert the screen back to this menu)



**Figure 6** The main menu screen of the CM12 TEM

4. Select VACUUM from the main menu to check for the vacuum settings. P3 must be less than 50 while IGP must be less than 35.
5. Before powering the gun, go to MODE > TEM > PARAMETER from the main screen to check the current and voltage setting that will be applied to the gun. Ideally the current should be around 3 and the voltage at 100keV and should be kept at these levels.
6. Finally, push the HIGH TENSION [17] button to turn on the current on the electron gun. Wait for the needle in the emission meter [16] to kick twice to full deflection then return to the zero position, after which the microscope is fully powered up for operation.



**Figure 7** The needle will kick twice to the right after the High Tension button is turned on.

## Saturating the Filament

1. Once the microscope is powered up, the filament must be heated to adjust the intensity of the electron beam.
2. Go to MODE > CONFIGURATION to view the filament saturation window. The screen will show a FIL LIMIT of 24 indicating maximum saturation.

3. Start saturating the filament by slowly turning the Filament Knob [18] clockwise. Each click raises the level by one with a wait time of 5 seconds between each step.
4. As the filament saturation is being adjusted, check the green beam on the large screen inside the viewing chamber [7]. The brightness of this beam indicates the relative intensity of the actual electron beam. Turn the filament knob to reach just enough brightness of the beam. Turning the knob above the FIL LIMIT will not increase the brightness of the beam.

**Figure 8** The green beam seen at the viewing screen represents visually the beam of electrons.



## Column Alignment

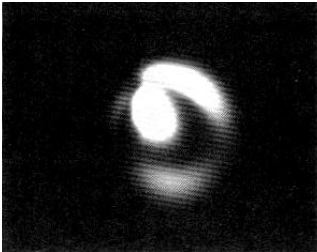
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### Centering the Beam

1. To center the beam more easily, adjust the intensity knob [9] to find the cross over i.e. the brightest and more focused beam setting. (Note: if the intensity knob is a little hard to control, press the FINE button [10] to spread or concentrate the beam more slowly.)
2. Check to see if the center of the beam coincides with the black dot on the screen.
3. Use the X & Y shift knobs [15] to center the beam.

### Alignment of the Thermionic Gun

1. Adjusting the tilt of the gun ensures that the beam of electrons is directed to the center of the sample area. Start by centering the cross-over beam as described earlier.
2. Undersaturate the gun by going to MODE > CONFIGURATION and turning the Filament Knob [18] counter-clockwise until the shadow of the filament becomes visible in the beam as in Figure 9.



**Figure 9** The shadow of the filament becomes visible at low saturation.

3. Press the ALGN button to the right of the multifunction knobs [21] then select GUN > TILT from the menu that appears onscreen. At this point the multifunction X/Y knobs become active and now be used to adjust the tilt of the gun.

**Figure 10** The STIG, DF, and ALGN buttons activate the multi-function knobs.

4. Adjust the multifunction X/Y knobs until the shadow of the gun in the beam becomes centered and as symmetric as possible.
5. Once the gun has been tilted correctly, press the ALGN button again to exit the gun alignment mode.

## **Condenser Aperture Adjustment**

1. The condenser aperture controls the beam that passes through the condenser lens. If the aperture is not aligned, the beam will not spread concentrically on either side of the cross-over when the intensity knob is turned. Start aligning by spreading the beam on one direction past the crossover.

**Figure 11** A non-concentric beam is seen when the condenser aperture is not aligned.

2. Adjust the knobs found on the condenser aperture assembly [2] until the beam becomes centered.
3. Spread the beam toward the other direction and adjust the condenser aperture knobs once more.
4. Repeat the above steps until the beam spreads concentrically on either direction past the cross-over.

## **Condenser Astigmatism Correction**

1. Asymmetric magnetic fields around the condenser lens results in an unbalanced focus of the beam. This phenomenon is called astigmatism. When this happens, the beam spreads as asymmetric ellipses on either direction past the cross-over when the intensity knob is turned. Start correcting astigmatism by spreading the beam on one direction past the crossover.

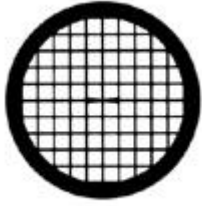
**Figure 12** Schematic of the symptom of condenser astigmatism

2. Press the STIG button found near the ALGN button shown in Figure 10 then select condenser from the menu that appears onscreen.
3. The STIG button once again activates the multifunction X/Y knobs. Use these to adjust the beam so that it becomes circular.
3. Spread the beam toward the other direction and adjust the multifunction X/Y knobs once more.
4. Press the STIG button once the astigmatism has been corrected to exit stigmatism mode.

## Sample Loading & Unloading

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### Mounting the Sample



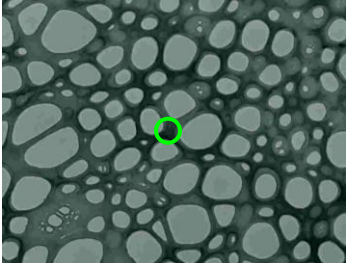
**Figure 13** An example of a TEM grid used to hold thin film samples

1. Samples for the CM12 are deposited as thin films on a copper mesh grid such as in Figure 13. This grid is the one loaded into the specimen holder (Figure 4) by first lifting the specimen clamp [24] using a pin-locking tool. (Note: Care must be taken to lift the clamp very gently so as not to break the fragile contraption. In addition, never touch the rod between the o-ring [23] and the specimen cavity at any point during sample mounting.)
2. Using a pair of tweezers, carefully grab one side of the sample grid and lower it into the specimen cavity. (Note: Never grab the mesh in any other way so as not to distort the mesh or scrape away the sample.)
3. Gently lower the clamp in place using the pin tool to ensure the sample is locked in place.

### Inserting the Specimen Holder

1. Before inserting the specimen holder into the side entry chamber [3] (also called goniometer), check to make sure the tilt [25] is at 0 degrees and the lever [28] is in lock position.
2. Grab the end of the specimen holder nearest the black cap [22] and ensure that the slit on the cap is at the 8:00 position when inserted to the chamber. Push the holder further until a click is heard.
3. The red indicator light [26] will turn on as the chamber begins to be evacuated. Wait for this light to turn off before proceeding to the next step.
4. When the light goes off, turn the specimen holder counter clockwise until the slit is at the 3:00 position.
5. Gently support the rod as it gets sucked further into the chamber to prevent damage to the tip with the sample.
6. To “see” the sample on the large screen, spread the beam then adjust the stage controls [8] so that the viewing area is at the center of the opaque grid.

### **Sample Image Adjustment-Optimizing Eucentric (Z) Height**



**Figure 14** The center of the four holes in this sample can be chosen as a reference point for z-height adjustment.

1. Adjust the beam intensity on the sample or increase the magnification by turning the magnification knob [14] to see certain structures of the sample. Then pick a feature on the center of the sample as a reference point for adjusting the Z-height.
2. Unlock the tilt lever and tilt the sample from +10 degrees to -10 degrees to see how far the reference point moves. Return the sample to 0 tilt.
3. Turn the z-height knob [27] to one direction then tilt the sample +/-10 degrees again to check the movement of the reference point. If the movement becomes smaller, continue turning the knob in that direction. Otherwise, turn the other way.
4. Continue alternating between turning the z-knob and tilting the device until the movement of the reference point reaches a minimum. At this point, the optimal z-height has been reached.
5. Return the tilt to 0 degree then put the lever in lock position.

### **Sample Image Adjustment-Adjusting Rotation Center**

1. As in z-height adjustment, begin by choosing a central feature or the sample as a reference point.
2. Press the ALGN button on the control panel and select ROT CENTER from the onscreen menu.
3. The image should wobble in and out i.e. symmetrically around the center when the objective rotation center is aligned. If the reference point moves in addition to the wobbling, adjust the multifunction X/Y knobs until the reference point stays put.
4. Another way to check if the rotation center is aligned is to go to different focus steps by turning the outer knob of the focus-focus step knob [20]. The wobbling of the sample should appear relatively the same at different focus steps.

5. Once rotation center has been aligned, press ALGN to exit the current mode.

### ***Sample Image Adjustment-Centering the Pivot Point***

1. Adjusting the pivot point ensures that the beam of electrons coincide in one spot. To start, go to the crossover of the beam.
2. Press the ALGN button then select PIVOT PT X from the onscreen menu. If the beam splits into two, then the pivot point needs to be aligned. Use the multifunction knobs to coincide the beams.



**Figure 15** If the beam splits into two when entering the pivot point alignment menu, the pivot point must be adjusted.

3. Next, select PIVOT PT Y and again coincide the beams if necessary using the multifunction knobs.
4. Press the ALGN button again to exit the align mode.

### ***Removing the Sample***

1. Ensure once again that the tilt of the sample is at 0 and the level is in lock position.
2. Pull the black cap of the sample holder until a natural stop is felt.
3. Rotate the specimen holder clockwise until the slit returns to the 8:00 position.
4. Gently pull the specimen holder until it fully comes out of the specimen chamber.
5. Remove the sample grid from the holder following the steps for mounting in reverse order.

## Obtaining the Image

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### *Fine Tuning the Microscope*

1. Use the mechanical stage controls to select certain areas of the sample to be captured.
2. Increase the magnification and adjust the focus knobs as necessary to see textures and fine features of the sample.
3. Use the binoculars [6] and small viewing screen as necessary to look at desired areas of the sample.

### *Capturing the Image*

1. Spread the beam to illuminate a wide area and take out the viewing screen out of the way of the camera by pulling a lever on the left side of the viewing chamber.
2. Switch to the computer and access the iTEM imaging software. Click on the ACQUIRE button to see a live image of the sample on the computer screen.
3. If ready, click on SNAPSHOT to capture a still image of the sample.
4. Click on STOP ACQUISITION right away to prevent the camera from being exposed to the electron beams for a long period of time.
5. Click on CAMERA CONTROL to lower exposure times when necessary.

**Figure 16** The image captured from a sample during an EMS230 lab session

## **Power Down Sequence**

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1. Return the viewing screen back to its original position and spread the beam.
2. If high magnification was used, lower the magnification to about 7100x by moving the magnification knob counter-clockwise.
3. Go to MODE > CONFIGURATION then turn the filament knob counter-clockwise until the filament level goes back to zero. (Note: There is no wait time when decreasing the filament saturation.
4. Turn off the HIGH TENSION switch and turn off the control panel. If another user will use the microscope soon after, just press VACUUM from the main menu to see the vacuum status then leave it at that.
5. Cover the viewing windows with their lids.
6. Logoff from the computer to lock the control panel.
7. Sign the microscope user logsheet and indicate if the microscope has been in good working condition.

## Photo Credits

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<b>Figure #</b>	<b>Source</b>
1	Mehraeen S. (2007, January 19). <i>230L, first report</i> . Email attachment.
2	Browning, Nigel (2006). <i>1Experiment</i> . p. 4, EMS 230L Internal Presentation.
3	Ibid.
4	Ibid.
5	Mehraeen S. (2007, January 19). <i>230L, first report</i> . Email attachment.
6	Author's photo
7	Ibid.
8	Ibid.
9	Williams, David B. and Carter, C. Barry (1996). <i>Transmission Electron Microscopy</i> . (Volume I, p. 74). New York: Plenum Press.
10	Author's photo
11	Williams, p. 137.
12	Ibid.
13	<i>Gilder Grids</i> . Retrieved 2007, January 17 from <a href="http://www.gildergrids.co.uk/">http://www.gildergrids.co.uk/</a>
14	<i>Untitled</i> . Retrieved 2007, January 22 from <a href="http://www.kwc.edu/academic/biology/TEMPics/teminstallation.htm">http://www.kwc.edu/academic/biology/TEMPics/teminstallation.htm</a>
15	Author's photo
16	Ibid.