ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

Transmission Electron Microscopy

Normal-TEM self-user operation training course

Jong Hoon Lee

Overview of TEM operation class

❖ **TEM self-user training**

1. **Theory class (Prof. HY Jeong)**
2. **Operation class (TEM manager, Jong Hoon Lee, 4171)**
   - A.M : Explanation of overall TEM analysis
   - P.M : Each person practices with manager

❖ **TEM test**

1. **During 40 min**
2. **You can apply a test on UCRF homepage every month**

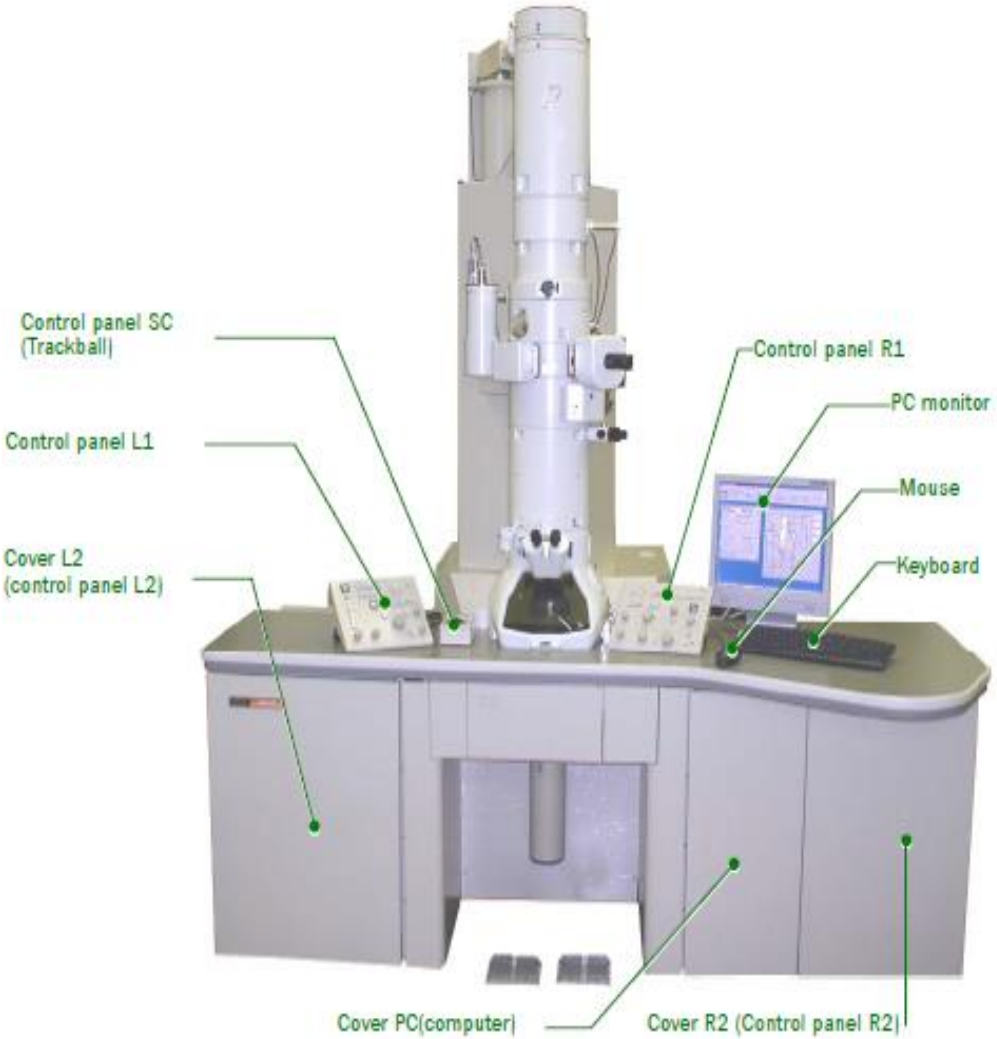
❖ **Process of TEM analysis for self-use**

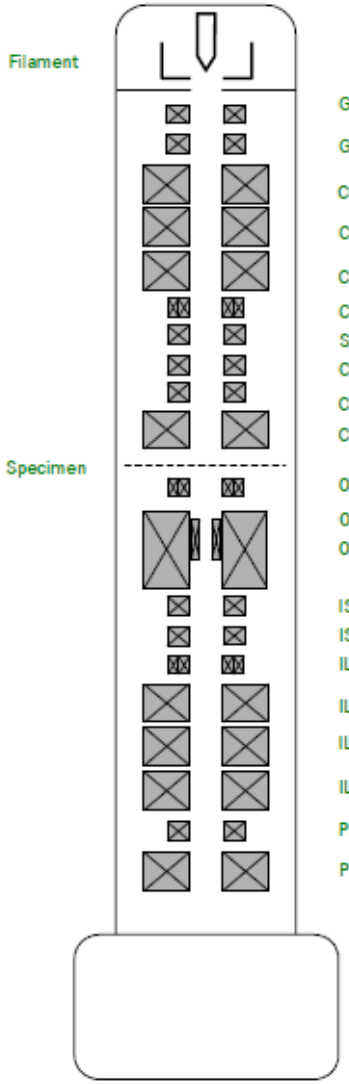
1. **Request for self-user on UCRF homepage**
2. **Normal-TEM equipment reservation on UCRF homepage**
3. **Write of reservation time on the board of normal TEM room before 6hours (after online reservation)**

❖ **Self user qualifications are given to the person who complete the whole training courses and pass the test by the rules of UCRF equipment use**

❖ **If you don't use Normal TEM at least once a month, your self user qualification will be expired. You have to reapply a test and pass**

Instrument Overview





Gun1	Electron gun 1st beam deflector
Gun2	Electron gun 2nd beam deflector
CL1	1st condenser lens
CL2	2nd condenser lens
CL3	3rd condenser lens
CLS	Condenser lens stigmator
Spot	Spot alignment
CLA1	Condenser lens 1st deflector
CLA2	Condenser lens 2nd deflector
CM	Condenser mini lens
OLS	Objective lens stigmator
OL	Objective lens
OM	Objective mini lens
IS1	Image shift 1st deflector
IS2	Image shift 2nd deflector
ILS	Intermediate lens stigmator
IL1	1st intermediate lens
IL2	2nd intermediate lens
IL3	3rd intermediate lens
PLA	Projector lens deflector
PL	Projector lens

Guideline of Normal TEM operation

❖ **Check the equipment before and after use**
- Column vacuum
- Any error message
- Check LN_2 tank(portable) and equipment chamber (Refill LN_2 for 4 h)
- On the board

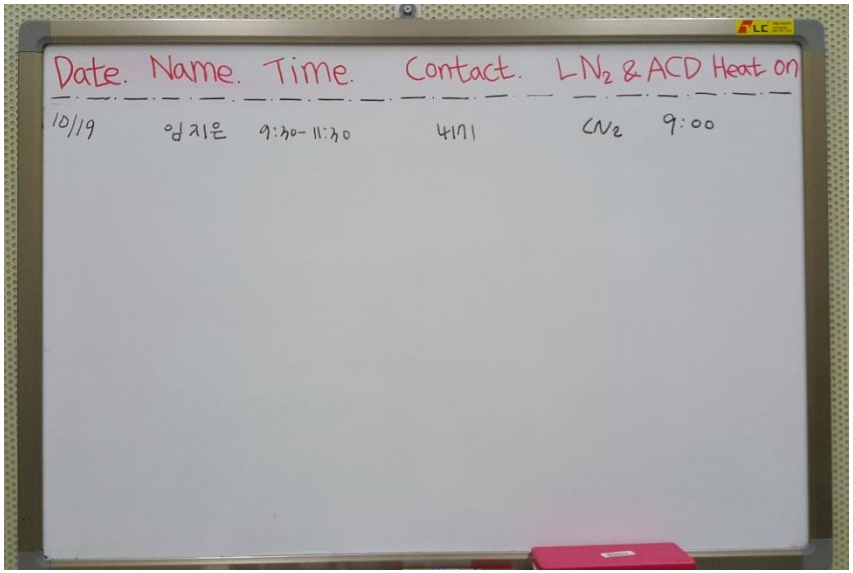
❖ **Increase and decrease of HT voltage**
- HT : 160 kV -> 200 kV

❖ **Loading the specimen**
- Sample loading on the specimen holder
- Dry pumping station
- Inserting and removing the specimen holder

❖ **Beam alignment**
- CL aperture centering
- CL astigmatism correction
- High voltage centering
- OL astigmatism correction

Check the equipment before use

❖ **Check the white board**

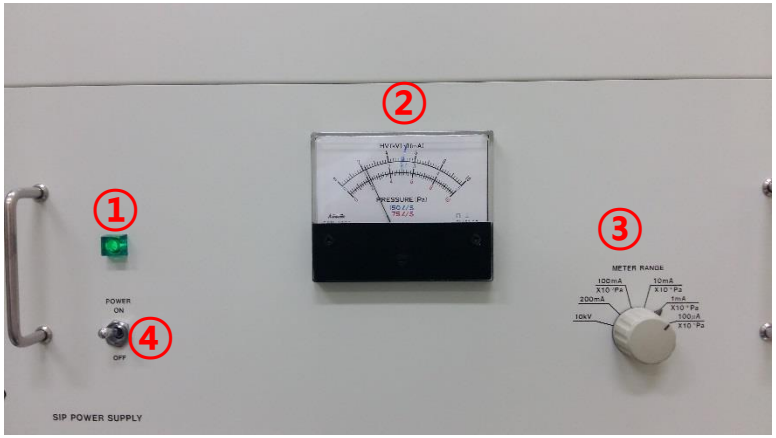


1. **Check notice and the message on the board (If there are something wrong, you can't use the equipment)**

2. **LN_2 should be filled below 4 h on the board**
   - **200 kV as it is**
   - **Refill LN_2**
   - **Write the refill time on the board**

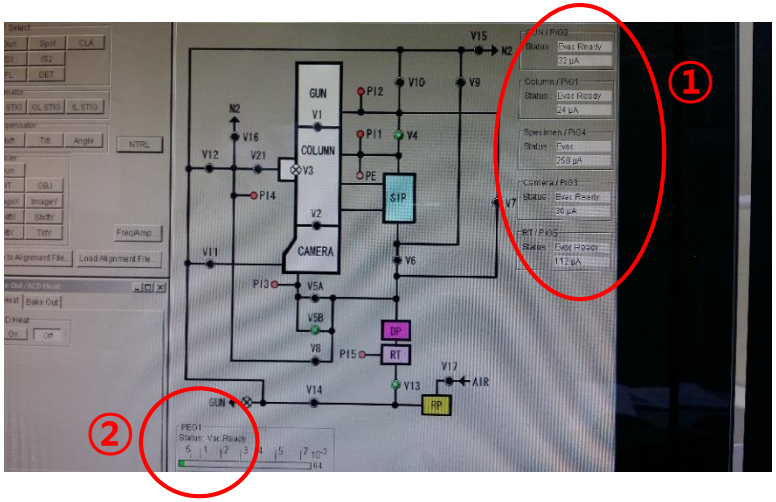
Check the equipment before use

❖ SIP power supply



1. Check that the power lamp is green ①
2. SIP vacuum gauge should be 1~2(blue) ②
   (When it exceed 3×10^{-5} Pa, you can't use the equipment)
3. Meter range knob ③-> 1mA × 10^{-5} Pa
4. ④ is always up.

❖Vacuum program on the screen

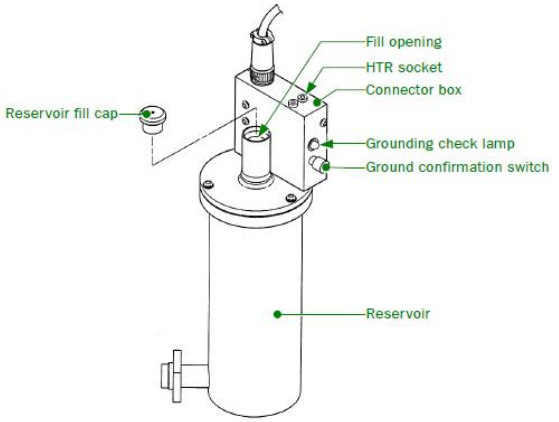


1. Check the vacuum of Gun, Column ①
   - Status : Evac Ready
   - Both values should be less than 30 uA
2. Check PEG1 ②
   - Status : Vac. Ready
   - bar : green
3. Check the error message on a computer screen.
   - If there are error messages on a screen, you have to take a picture and send to the manager.

Fill LN_2

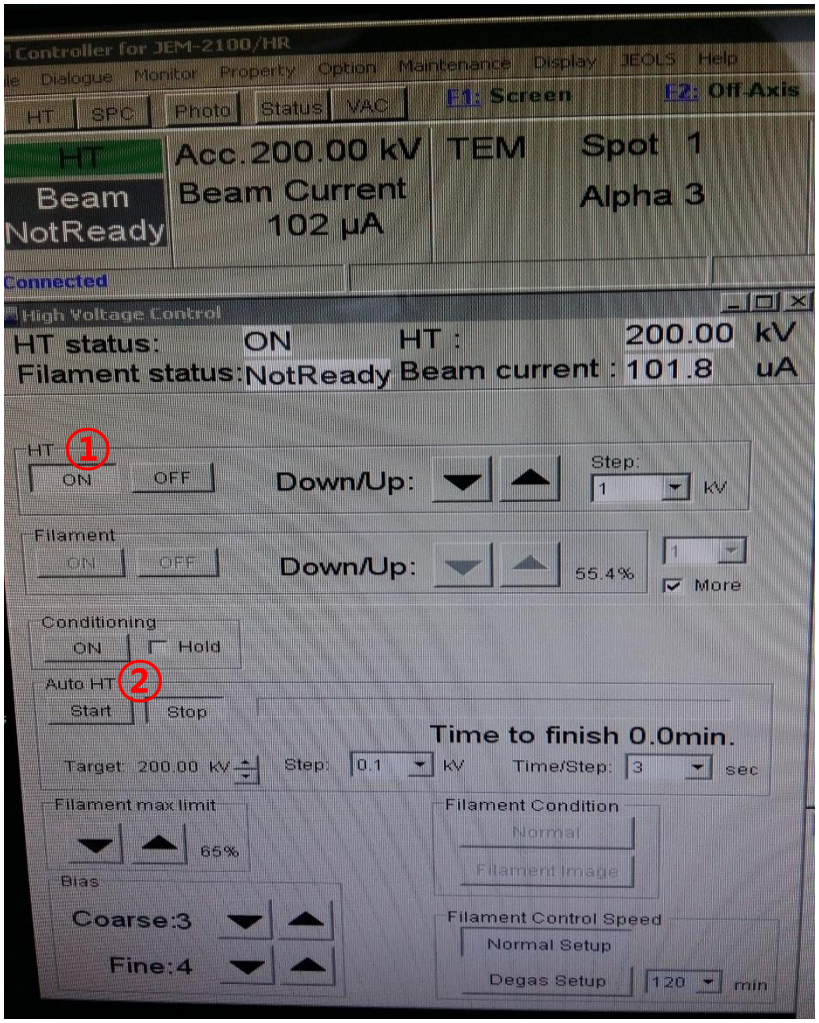
1. Position the plastic beaker to the tube entrance
2. Raise up the green valve
3. Fill LN2 to about 1/3 of the beaker
4. Put the funnel into ACD liquid nitrogen tank, fill LN_2 fully
5. After filling LN_2, close the cap

- The face and body away with LN_2 as possible
- When you fill LN_2, you should climb a ladder positioned to the center of Normal-TEM table.



Increase the HT voltage

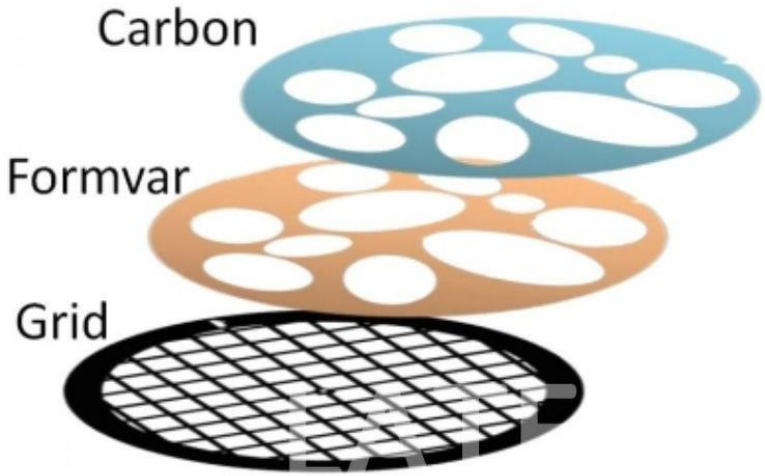
❖ **If you are seeing that message 'ACD heat on' you are first user at today. So, You have to do Increase the HT voltage step.**

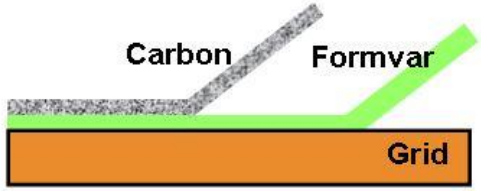


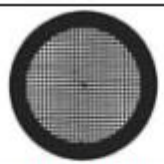
1. **Turn on the HT ①**
   1) Click HT ON
   - HT status : Ready -> ON
   - HT : 160 kV
   - Beam current : 0 uA -> 80 uA

2. **Increase the HT ②**
   1) Target : 200kV, Step : 0.1 kV, Time/Step : 3 sec
   2) Click start button of auto HT
   - HT : 160 kV -> 200 kV
   - Beam current : 80 uA -> 102 uA

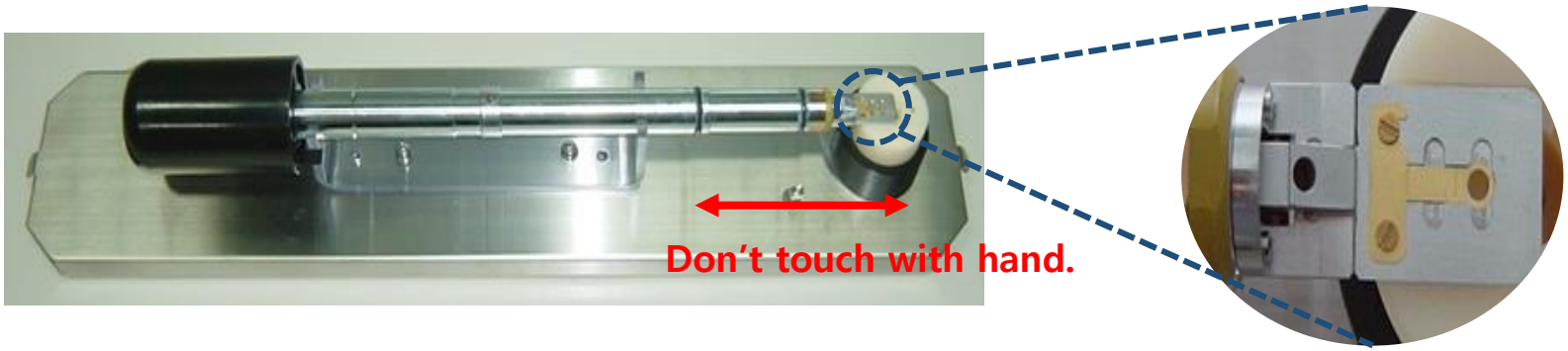
Grid

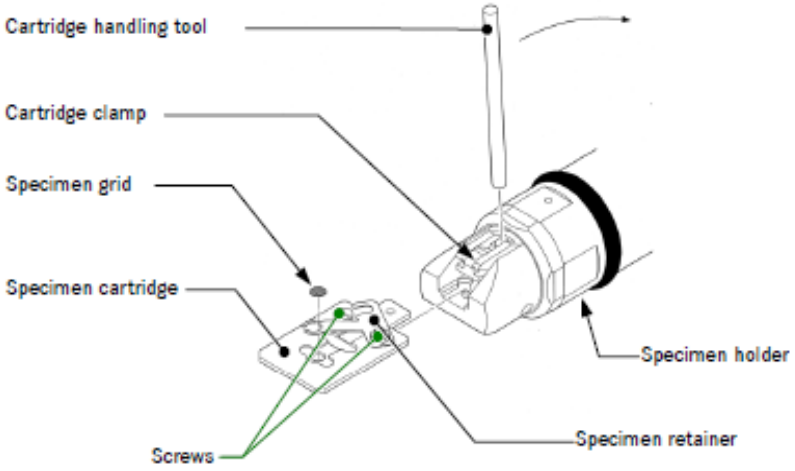




								
600 mesh	500 mesh	400 mesh	300 mesh	200 mesh	100 mesh	50 mesh	single hole	slot hole

Load a sample





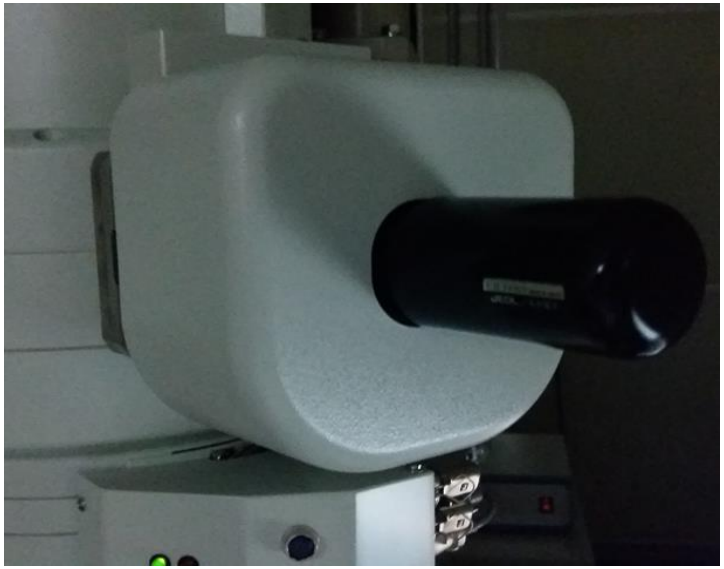
1. Load the specimen where the upside of target face is located on upside
2. Put the spacer on the sample
3. Put the plate on the spacer and screw on the plate

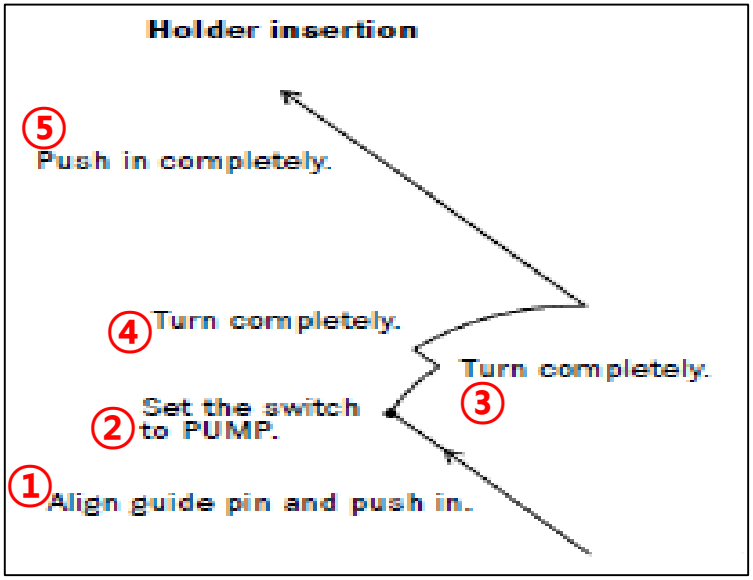
❖ Caution! If you tighten too much the screw, the screw line will be break .

Dry pumping station

1. Insert the holder
2. Check power on status
3. Click Evac button
4. After 5 minutes, click the Vent button
5. The Vent light will be stop, you can pull out the holder straightly

Inserting the specimen holder



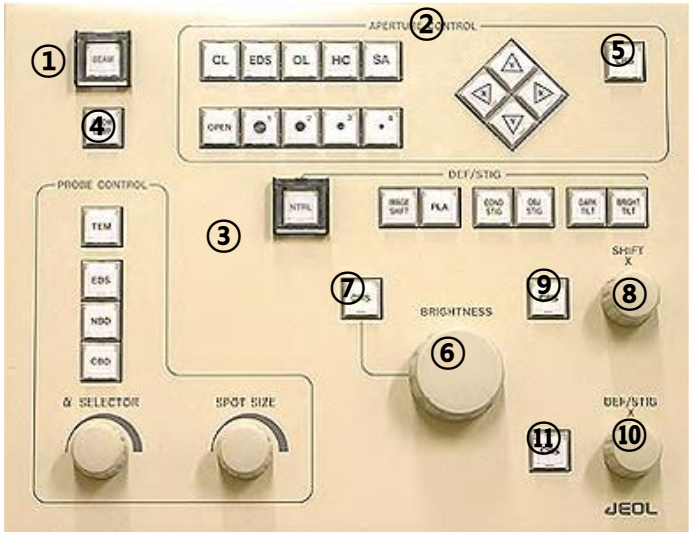


1. Insert the specimen holder straightly ① (You can hear the two sound of valve)
2. Position up the switch ② from air to pump
   specimen pump check (240->100->40)
3. You have to wait until the light to be green
4. Step 1.Turn the holder clockwise(15°) and insert(5cm) ③
   step 2. Turn the holder clockwise(75°) and insert(fully) 1min wait ④⑤
5. You can turn on the filament

❖ If you break the vacuum of TEM because of inappropriate manner,
You can't attend the training anymore

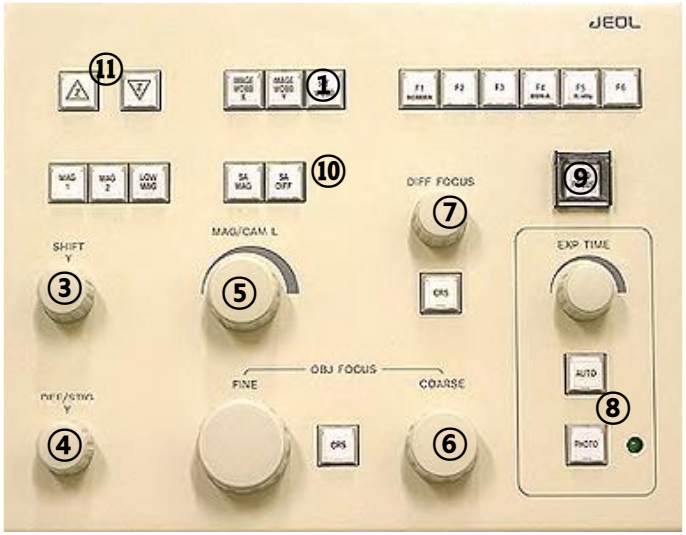
Panel

Left panel



① BEAM switch
② APERTURE CONTROL
③ PROBE CONTROL
④ ROOM LAMP switch
⑤ DEF/STIG switches
⑥ BRIGHTNESS knob
⑦ BRIGHTNESS CRS switch
⑧ SHIFT X knob
⑨ SHIFT CRS switch
⑩ DEF/STIG X knob
⑪ DEF-STIG CRS switch

Right panel

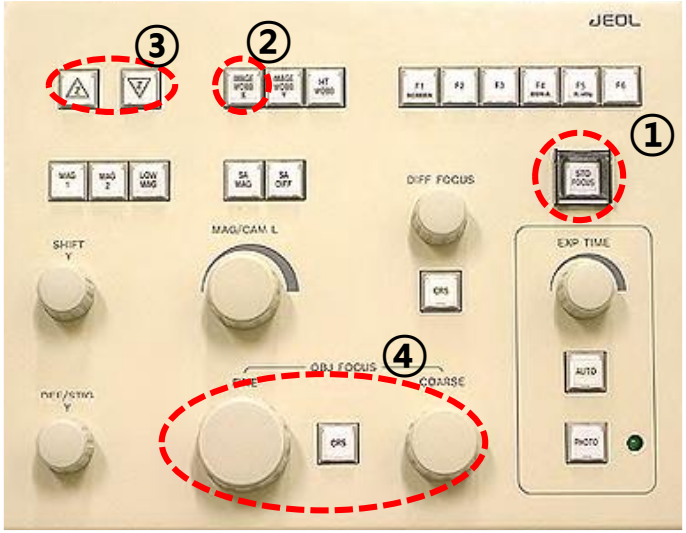


① Wobbler switches
② Function switches
③ SHIFT Y knob
④ DEF-STIG Y knob
⑤ MAG/CAM L knob
⑥ OBJ FOCUS knob
⑦ DIFF FOCUS
⑧ EXP TIME/PHOTO
⑨ STD FOCUS switch
⑩ F switches
⑪ Z switches

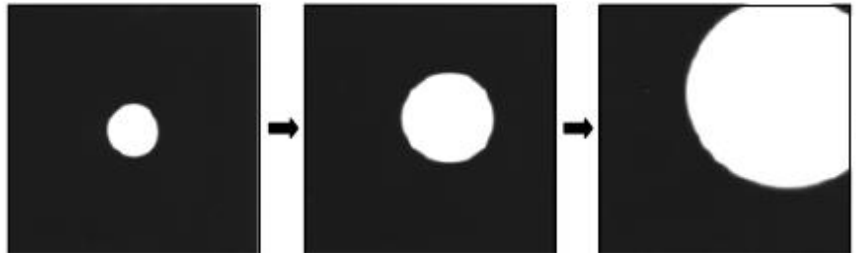
Focus

1. Adjust the magnification to over x40k
2. Beam centering
3. The beam should be center of the large screen
4. Push STD FOCUS switch (①)
5. Push Image Wobb X (②)
6. Adjust Z Height for minimum movement (③)
7. Deselect Image Wobb X (②)
8. Adjust with OBJ Focus (④)

Right panel



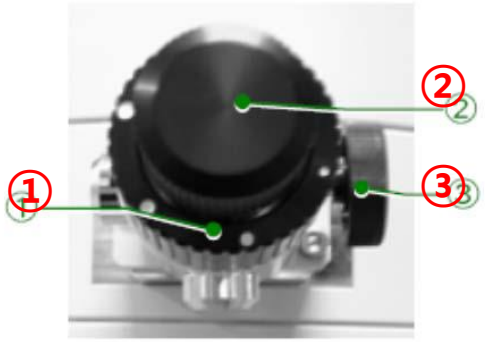
Condenser Lens aperture centering



NO GOOD

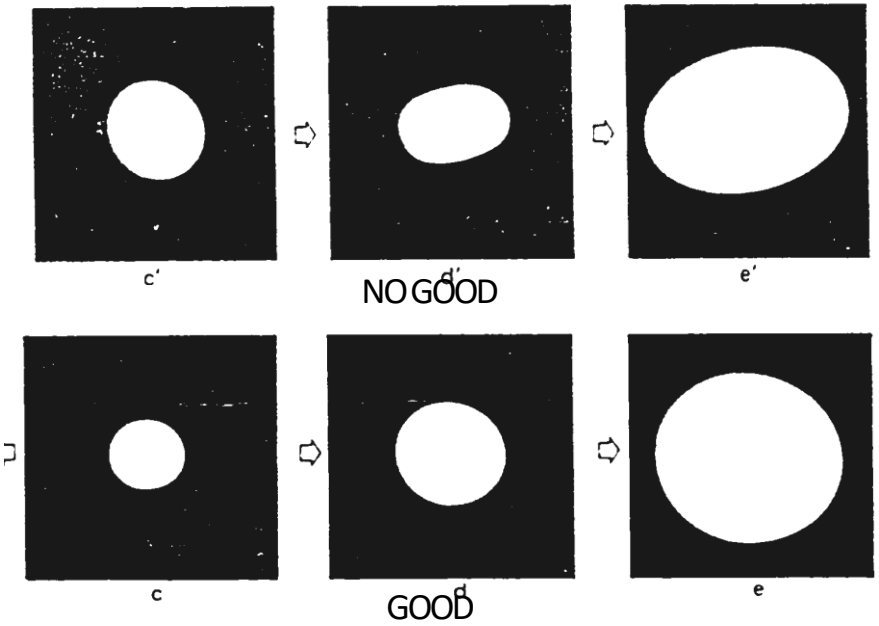
GOOD

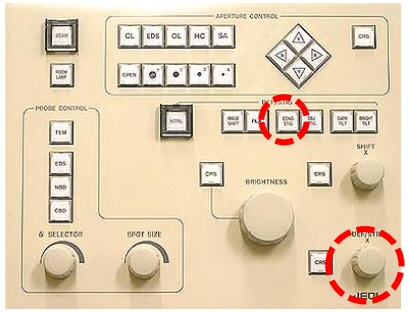
1. Adjust the magnification to over x40 k
2. Beam centering
3. Open the electron beam
4. The beam should be center of the large screen



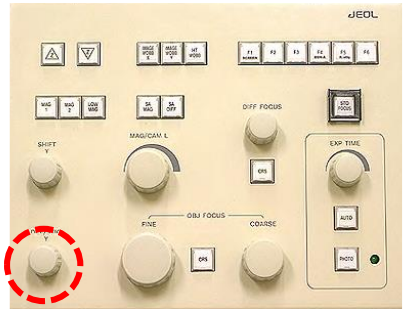
- ❖ Do not touch ①
- ❖ you can adjust by ② or ③ , do not turn too much

Condenser Lens astigmatism correction





Left panel



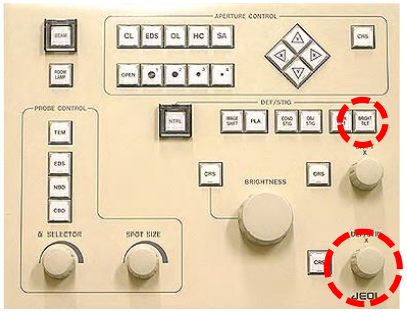
Right panel

1. Adjust the magnification to over x60k
2. Beam centering
3. Make a shape of the electron beam to be circular triangle.

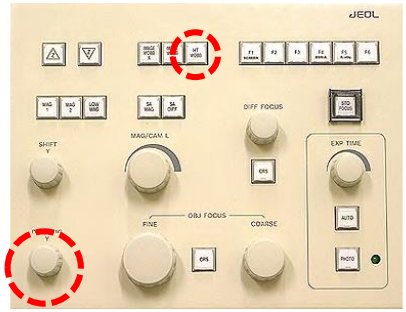
❖ CL Stig button + DEF/STIG X/Y knobs

High voltage centering

1. Adjust the magnification to over x100k
2. Beam centering
3. Find the sharp edge of sample and than be located on the large screen center.
4. Down the small screen
5. Let's make the edge point of the sample do wobbling at the small screen center



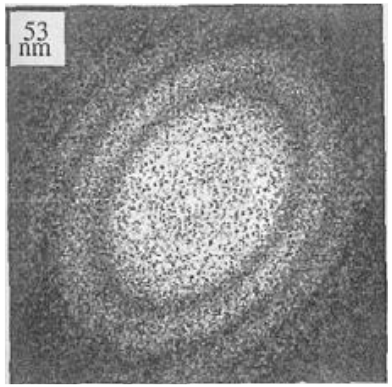
Left panel



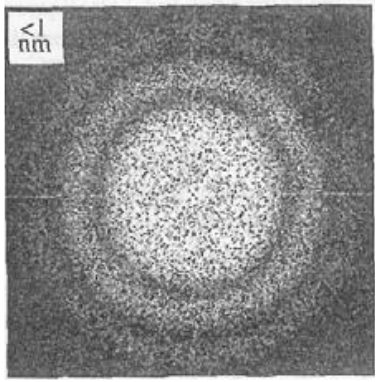
Right panel

❖ HT wobbler button + Bright button + DEF/STIG X/Y knobs

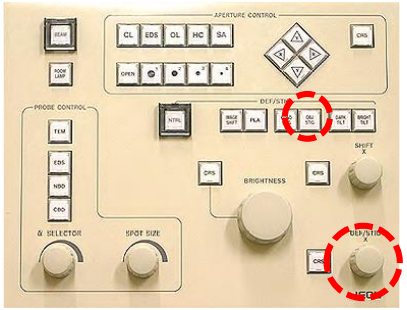
Objective Lens astigmatism correction



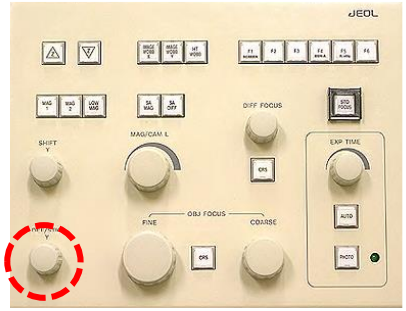
NO GOOD



GOOD



Left panel



Right panel

1. Adjust the magnification to over x200k
2. Beam centering
3. You must be use the amorphous phase of the sample
4. Make Cur. dens to under 40 pA/mm^2 - Spread the beam with brightness knob
5. Up the large screen with F1 button
6. Start view and Process-Live-FFT click
7. Make FFT image to be perfect circle

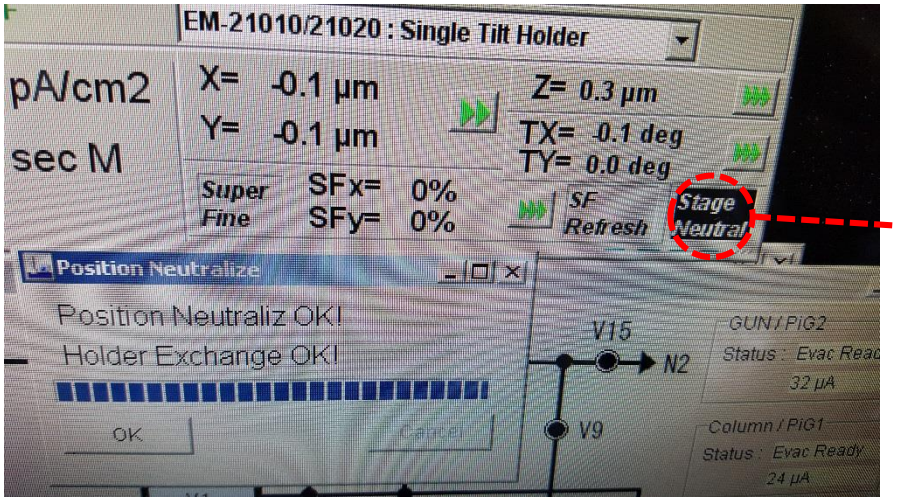
❖ OL Stig button + wobbler + DEF/STIG X/Y knobs

Focusing & imaging

a: Underfocus　　b: Just-focus　　c: Overfocus

1. Select the image you went
2. Adjust the magnification to x300k
3. Beam centering
4. Make Cur. dens to under 40 pA/mm^2 - Spread the beam with brightness knob
5. Up the large screen with F1 button
6. Focusing and take the image

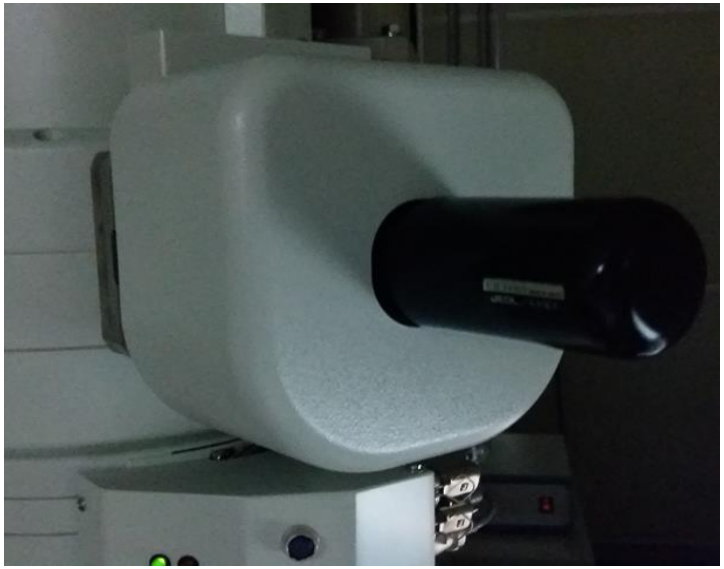
Before turn off the filament

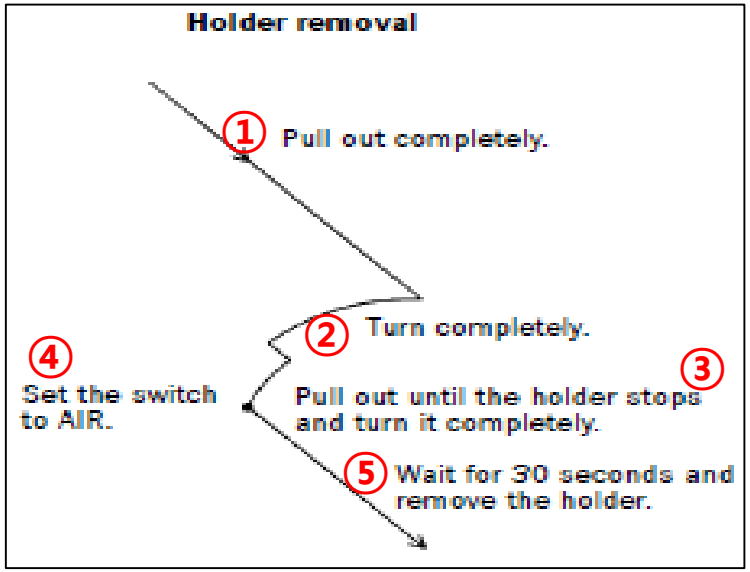


1. Mag : 40K
2. Beam centering
3. Increase the beam size
4. Stage Neural (twice)

You can turn off the filament.

Removing Specimen Holder





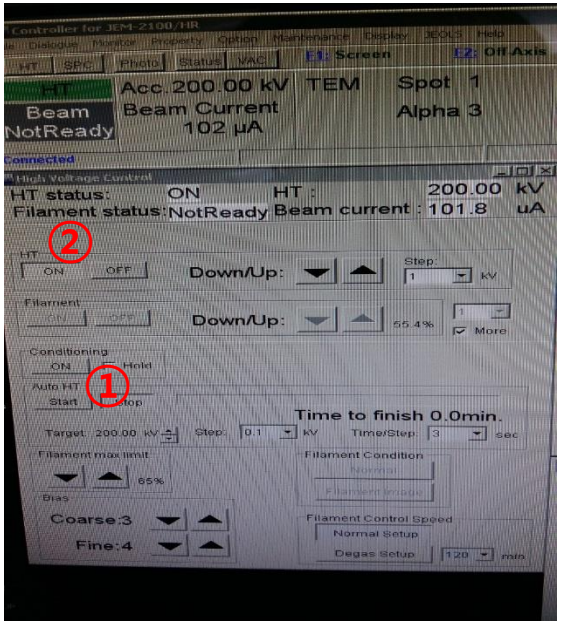
1. Pull the specimen holder straightly ①
2. Turn the holder anti-clockwise (75°) and pull and turn the holder anti-clockwise (15°) ②③
3. Down the switch of the pump to air ④
4. You have to wait until the value of specimen is over 230 μA ⑤
5. Pull the specimen holder completely.

❖ If you break the vacuum of TEM because of inappropriate manner, You can't attend the training anymore

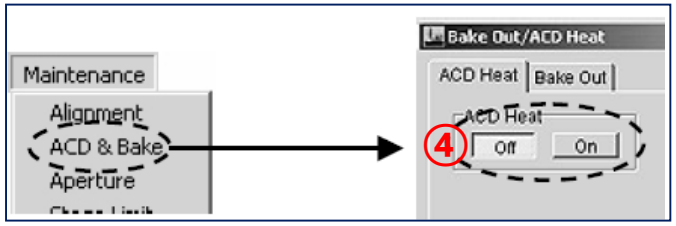
Decrease the HT voltage & ACD Heat on

❖ When the blank time is over 5 h on the board or you are last user at today.

❖ You have to do decrease the HT voltage & ACD heat on step.

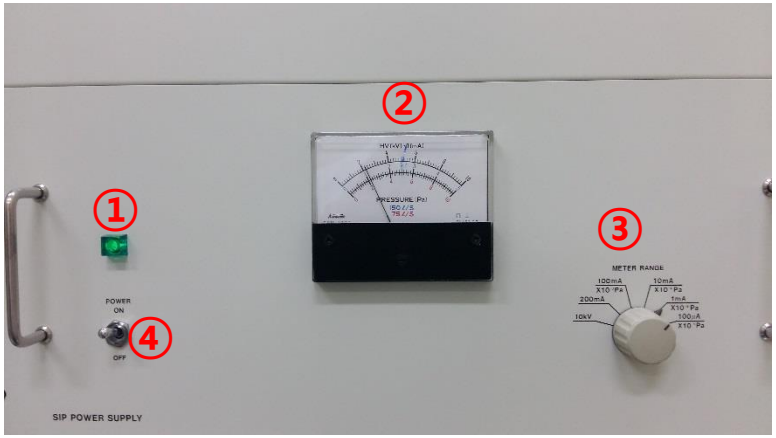


1. **Decrease the HT**
   1) Target : 160 kV, Step : 1 kV, Time/Step : 1 sec
   2) Click start button of auto HT ①
      - HT : 200 kV -> 160 kV
      - Beam current : 102 uA -> 80 uA
2. **Turn off the HT**
   1) Click HT OFF ②
   - Beam current : 80 uA -> 0 uA
3. **Plug ACD heater ③**
4. **ACD Heat On ④**



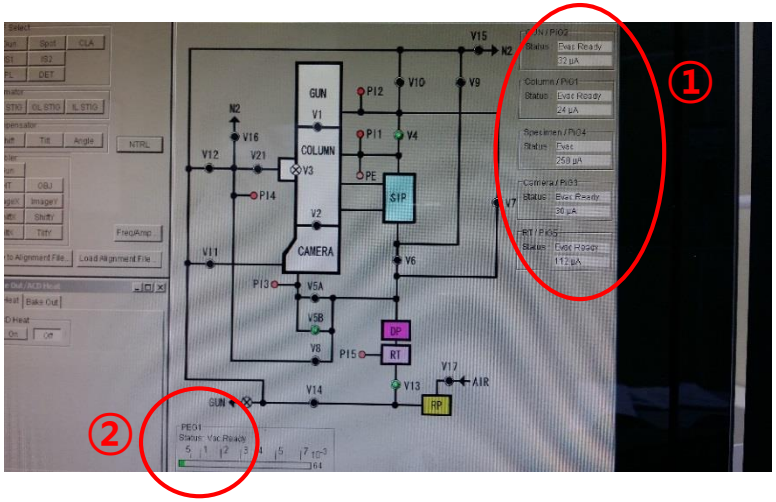
Check the equipment after use

❖ SIP power supply



1. Check that the power lamp ① is green.
2. SIP vacuum gauge should be 1~2(blue)
   Meter range knob ③-> 1 mA × 10^{-5} Pa
3. When it ② exceed 3 × 10^{-5} Pa, you can't use the equipment.
4. ④ is always up.

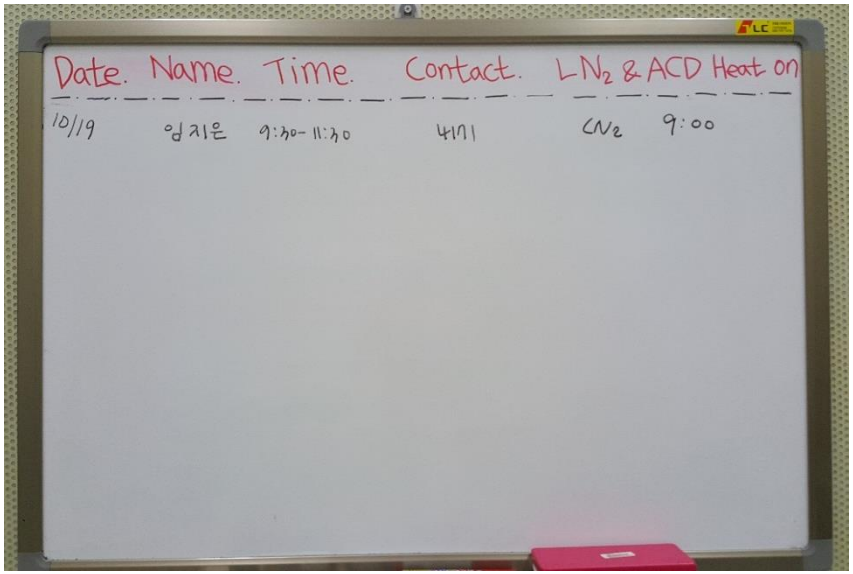
❖ Vacuum program on the screen



1. Check the vacuum of Gun, Column ①
   - Status : Evac Ready
   - Both values should be less than 30 uA
2. Check PEG1 ②
   - Status : Vac. Ready
   - bar : green

Check the equipment after use

❖ **Check the white board**



1. **LN2 should be filled below 4 h on the board**
   - **200 kV as it is**
   - **Refill LN2**
   - **Write the refill time on the board**

2. **When the blank time is over 5 h on the board**
   - **Decrease HT voltage & ACD heat on (22page)**
   - **Write the ACD heat on time on the board**

Equipment Information

장비명	투과전자현미경 (Normal-TEM)		
장비위치	B104	자산번호	14000483
모델명	JEM-2100	제조사	JEOL
장비사양	1. Resolution - Point in TEM mode : 0.23 nm or better - Lattice in TEM mode : 0.14 nm or better 2. Electron Gun : Lab6 (200 kV) 3. Specimen tilting : X=+-35’ , Y=+-30’ 4. Imaging recording system : CCD 5. Spot Size - TEM mode : 2~5 nm dia or more - EDS, NBD, CBD mode : 0.5~2.4 nm dia or more 6. EDS Resolution : 132 eV		
업체 엔지니어	김홍중 책임	업체 엔지니어 연락처	010-9090-6818
장비 담당자	이종훈	장비 담당자 연락처	052-217-4171