FEI Helios NanoLab 460F1
FIB operational guide
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- TEM lift-out grid
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- Finishing the secession

Beginning your session

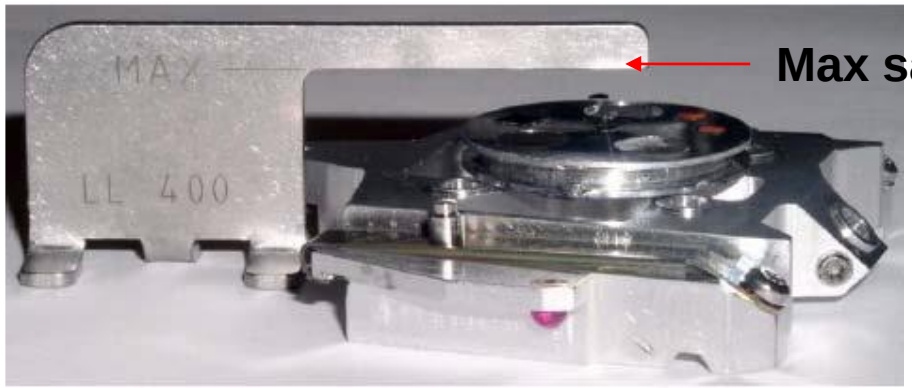
Note:
- Always check the stage in quad 4 on the screen when loading/unloading your samples.
- Please contact staff for ferromagnetic powers/particles or small samples.
- For ferromagnetic samples, place your sample securely on the stub so that samples will not hit the objective lens.

Starting your session

1. Start iLab.
2. Log in to the user software
3. Load your sample
    1. Check the height of your sample (pictures on next slide)
    2. Load samples (next slide)
    3. Wait until the stage transfers to the loading/unloading chamber
    4. Pick up the stage, load your sample, and place the stage back on the stage holder
    5. Click load/unload button
    6. Wait until the stage transfer is completed
4. Take a Navigation picture
    1. In the menu, 'stage' – '**take nav-Cam Photo**'
    2. Explore the sample locations by clicking the specific locations in the picture at 3rd quad

Sample mount and loading/unloading

Sample stage



Max sample height

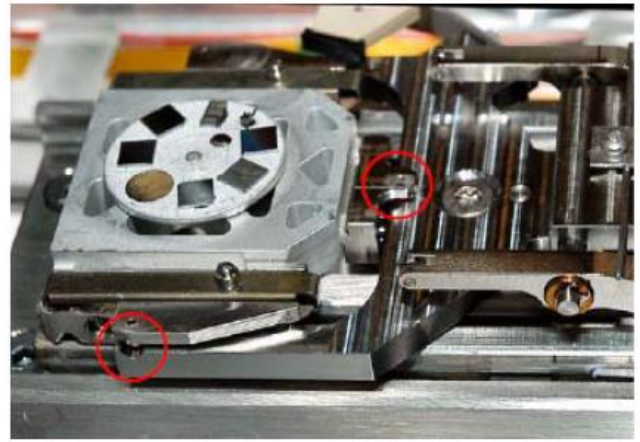
Unloading Sequence

1. Push the **Unload / Release** button to start the unloading sequence (lit is blinking). After finishing, the Loadlock is vented and the lid can be opened. Both buttons are enabled.
2. Open the lid, the **Clamp / Load** button becomes disabled. Push the **Unload / Release** button to release the carrier from the Loadlock arm.
3. Take the carrier out from the Loadlock arm.

Loading Sequence

1. Place the carrier on the Loadlock arm, making sure that all three alignment rubies are positioned properly. The **Clamp / Load** button becomes enabled (lit is on).

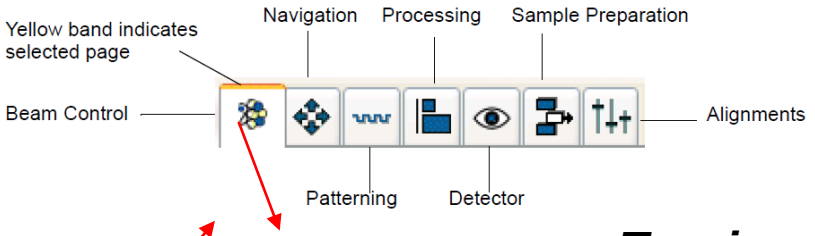
Figure 5-7 Alignment Rubies with Only Two Shown



2. Close the lid and push the **Clamp / Load** button. The loading sequence starts (lit is blinking).

Start E-beam & I-beam

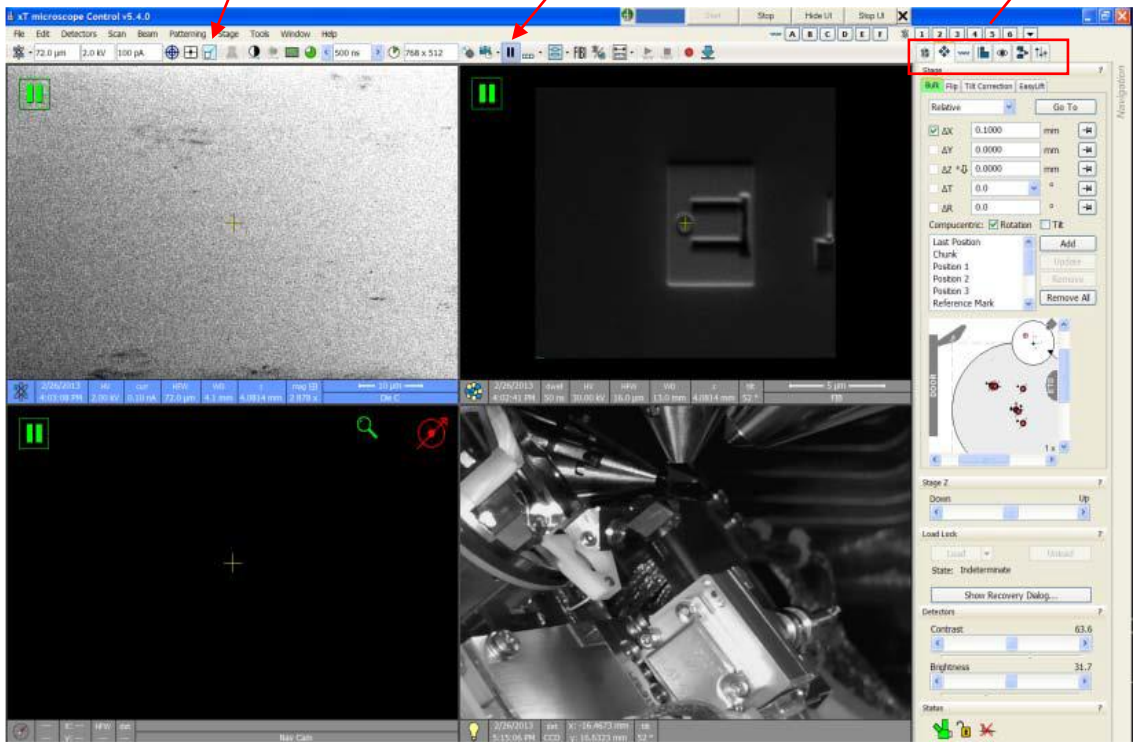
Pages Toolbar

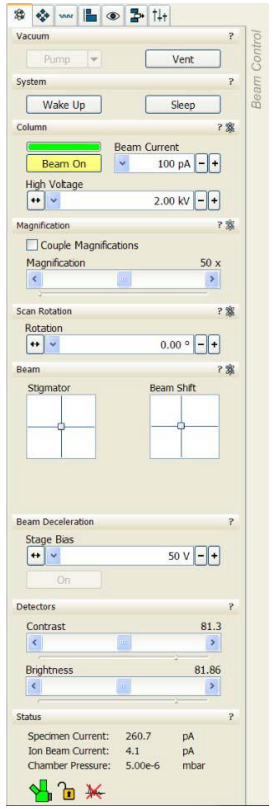


'**Reduced Area**' icon

'**Pause**' icon

Beam control page





Turning e-beam

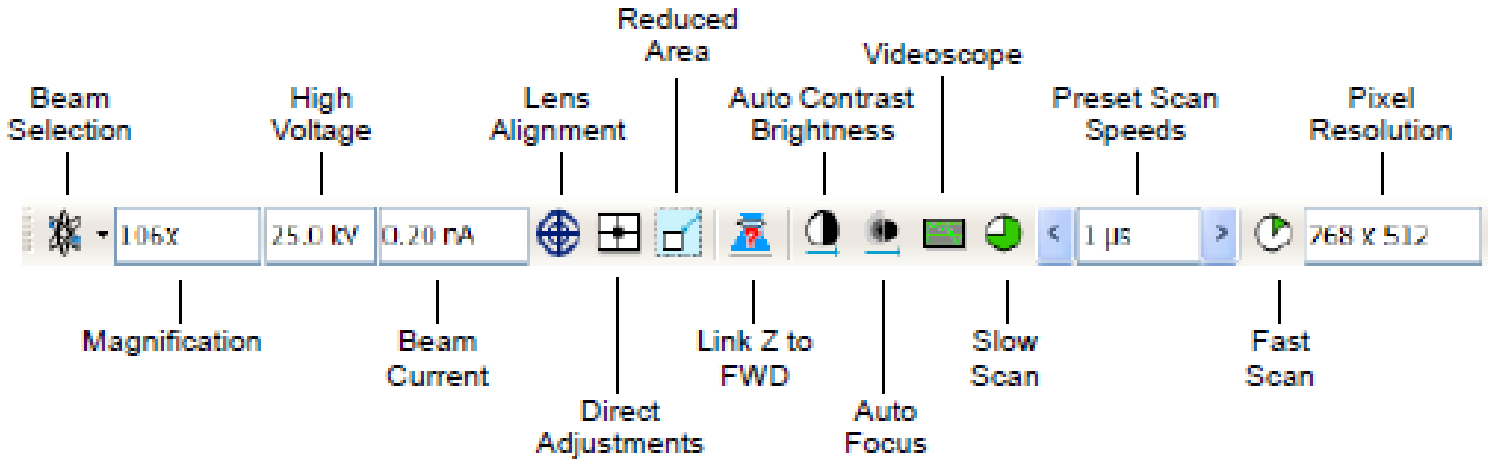
1. Click 'Beam control' in the **Pages Toolbar**
2. Click 1st quad on the monitor screen
3. Select the voltage and current
   - Menu bar or
   - **'Beam Control page'**
4. Click the **Beam on** button under the **'Beam Control page'** tab
5. Unpause the screen using the '**Pause**' icon

Turning I-beam

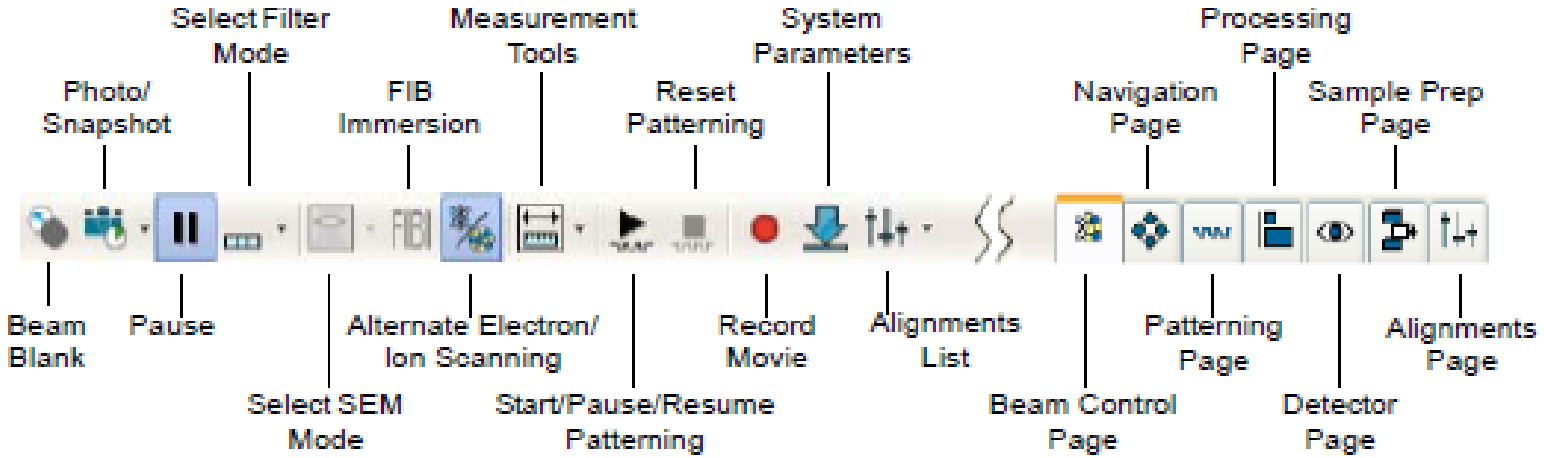
1. *Click the 2nd quad on the screen*
2. *click the 'Wake Up' button*
3. *Leave the i-beam as paused*
   - *The green pause symbol is shown left top screen*

Toolbar icons/menus

Toolbar Left Half



Toolbar Right Half



Eucentric height

1. **Link Z to working distance**
   - Focus on the sample surface with SEM
   - Click ‘Z to WD’ icon: the icon changes its shape with green arrow.

2. **Set the working distance to 4 mm.**
   - Input 4 in the Z (Navigate page)
   - Click ‘go to’ button

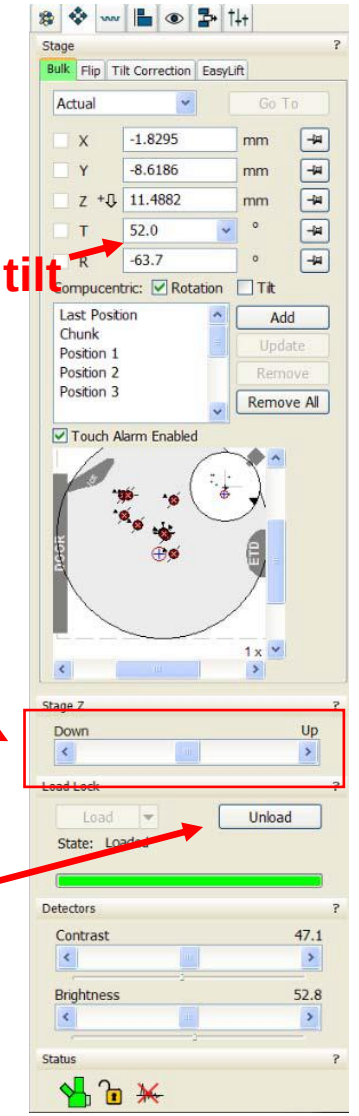
3. **Find Eucentric height/point: the height of the stage where the specific point remains the same at tilt = 0 and 52**
   - Set magnification X1000
   - Find a recognizable feature, and center it under the yellow cross by moving the stage
   - Watching the feature, change the stage tilt to 10°. Using the Z control, bring the feature back under the cross
   - Repeat the previous step at 20° or 30°
   - Repeat at tilt = 52°

‘Z to WD icon’



- **Red question mark**: The function is enabled and the link between Z and FWD is unknown. Use the function as soon as possible, after properly focusing the image.
- **Red circle**: The function is enabled. Z is roughly linked to FWD, but it needs correction. This could happen after changing the sample, focusing and linking Z to FWD at a long working distance (WD), and then moving the stage to a short WD. Focus the image carefully at a WD around 4 mm and use this function again.
- **Green double-ended arrow**: The function is still enabled and Z is properly linked to FWD. It is now safe to change the WD by setting a Z coordinate on the Stage page.

‘Nevigate’



tilt

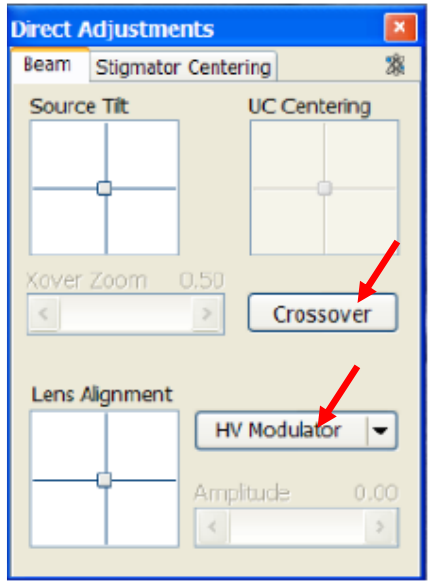
Stage move up/down

Load/Unload button

E-beam alignment

1. Focus on the surface with the magnification you will be doing operation.
2. Adjust stigma
3. Do the lens modulation
    1. Click ‘Direct Adjustments’ icon
    2. Click ‘Crossover’ button and center the beam
    3. Click ‘HV Modulator’ and make the image static by adjusting the horizontal and vertical lines. Click and drag the lines one by one.
4. Adjust focus and stigma again.

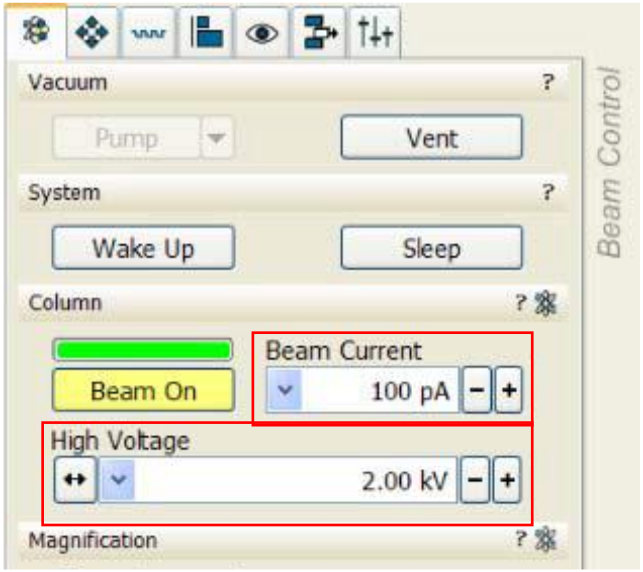
‘Direct Adjustments’



FIB operation

Starting Ion-beam, tilt = 52°

1. Click 2nd quad on the screen
2. The Ga ion source was activated previously by clicking the ‘Wake Up’ button.
3. Select the ‘Beam Current’ and ‘High Voltage’: those can be selected in the ‘Beam control page’ or in the menu bar.
4. Before scanning I-beam, adjust the magnification.
5. Once the 2nd quad is unpaused, the ion beam scans the sample area.
6. ‘Shift’ key + ‘mouse left drag’ is used to shift the I-beam image to align it with the SEM image.
7. Adjust focus and stigma



Aperture		use
1.1	pA	High resolution imaging
7.7	pA	High resolution imaging
24	pA	High resolution imaging, small cross section cleaning
40	pA	General resolution imaging, cross section cleaning
80	pA	General resolution imaging, cross section cleaning
230	pA	Imaging, cross-section cleaning
430	pA	Cross-section cleaning
790	pA	Medium bulk milling or large cross-section cleaning
2.5	nA	Large cross-section cleaning
9.3	nA	Rough bulk milling for large cross-sections
21	nA	Extremely rough bulk milling for large cross-sections
47	nA	Extremely rough bulk milling for large cross-sections
65	nA	Extremely rough bulk milling for large cross-sections

Patterning tap (1/2)

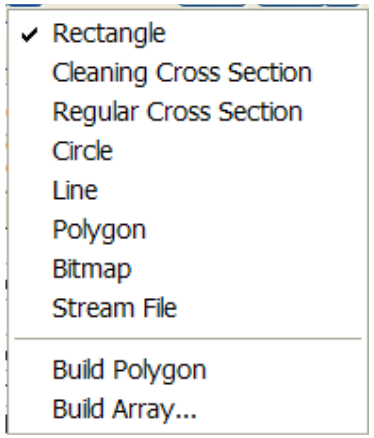
1. Select a pattern from the Pattern Selector and draw a pattern in the active quad (1st quad: electrons, 2nd quad: ions).

2. Select a beam for patterning from the toolbar.
3. Enter a value in µm as the depth in the Property Editor.
4. Select the milling aperture.
5. Focus and stigmate the beam on the area adjacent to the pattern.
6. Snapshot a single frame to confirm the pattern position.
8. Select **Patterning > Start Patterning** or click **Start Patterning** on the toolbar to begin milling.
9. **Pause, resume,** and **stop** patterning by clicking the corresponding buttons in the menu bar

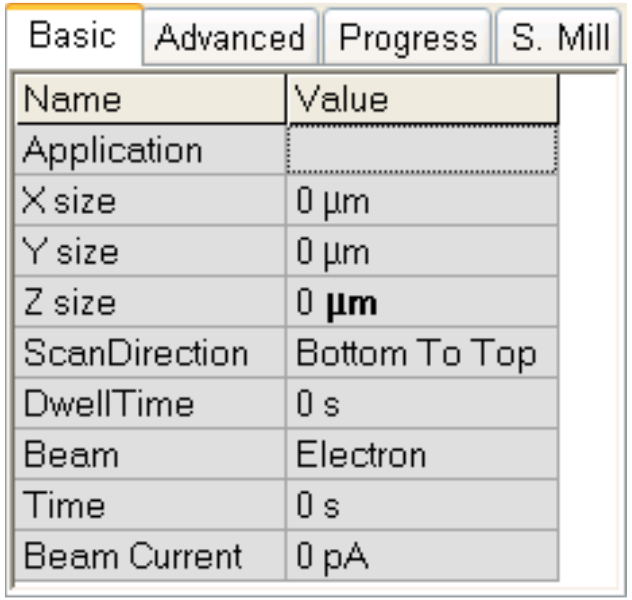
Patterning tap (2/2)

Pages Toolbar

Click drop down menu



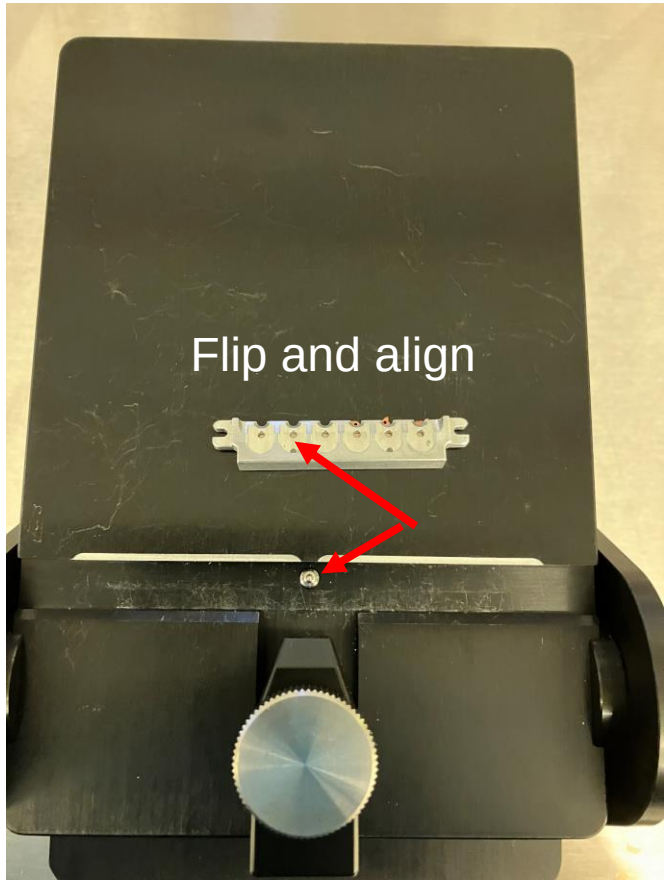
Patterning Properties



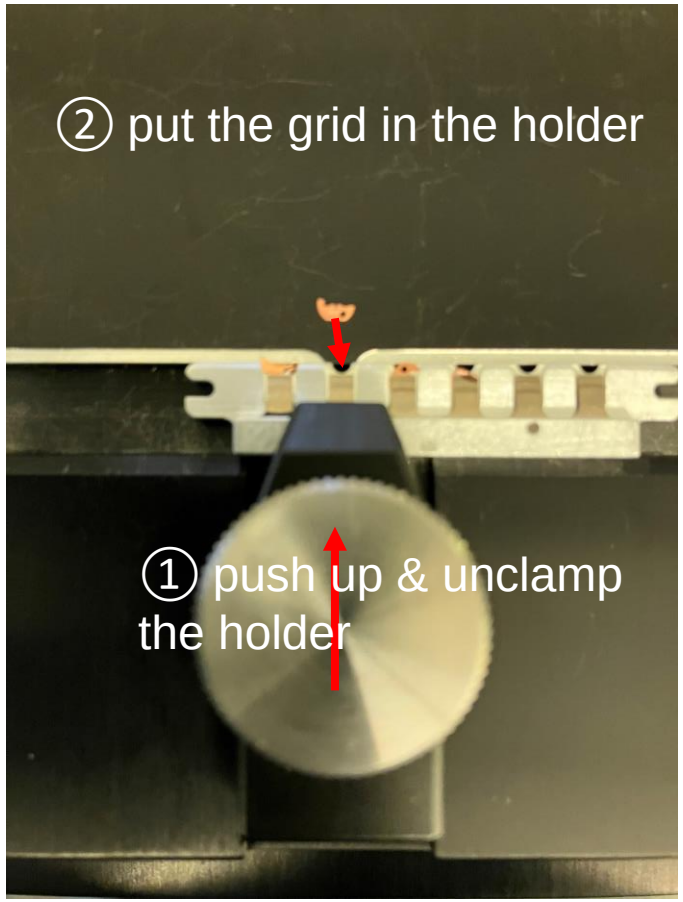
Application: Name of the application. Clicking the value field produces a dropdown arrow and list of applications. The parameters for the selected application are automatically set for the subsequent properties.
Scan Direction: Bottom to Top or Top to Bottom, etc.
Beam: The beam used for patterning
Beam Current: The amount of current striking the sample.

TEM lift out grid

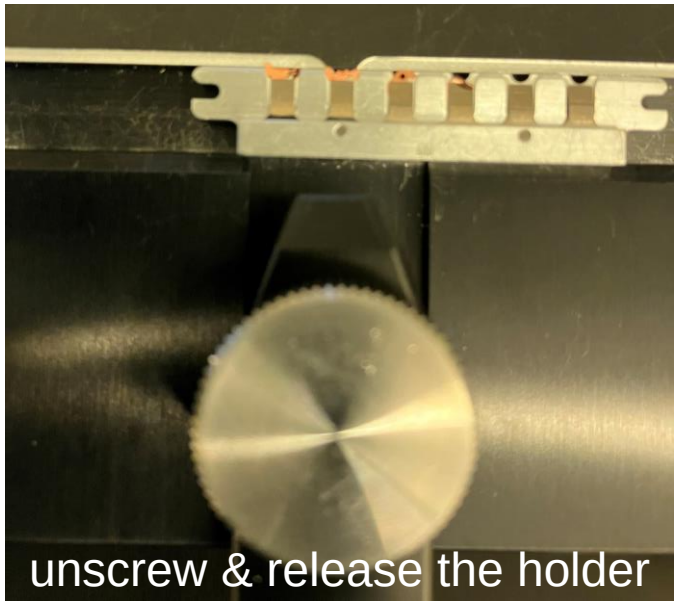
Placing TEM grid holder on the base



Clamping the grid

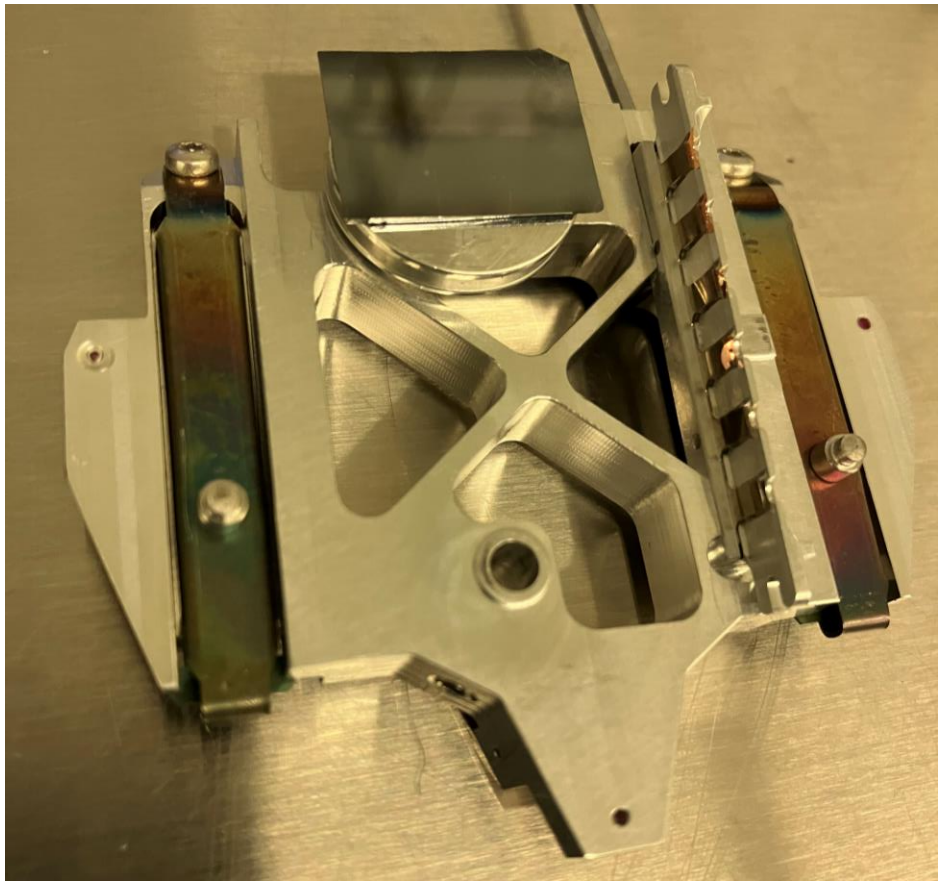


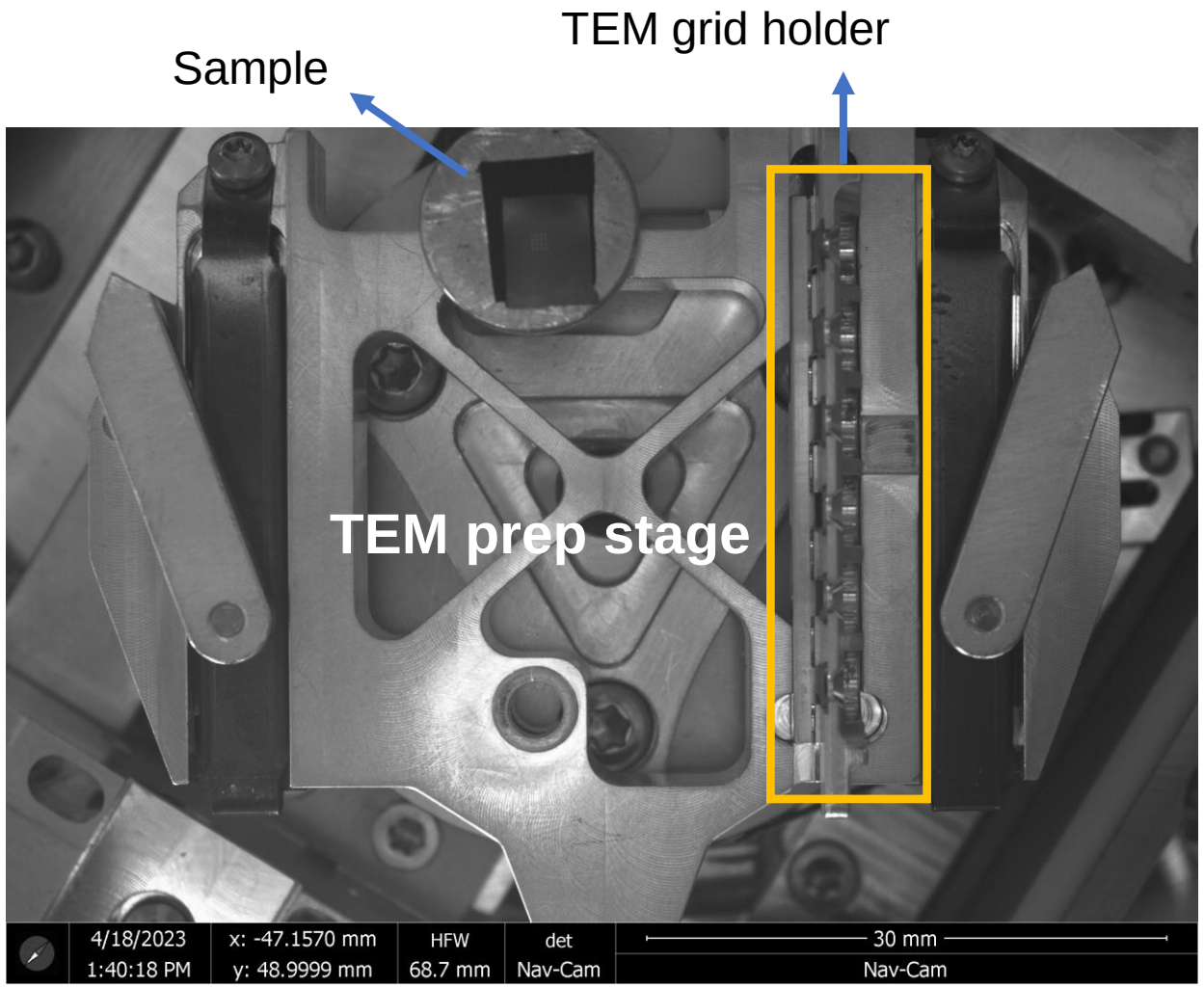
Releasing the holder



TEM sample holder

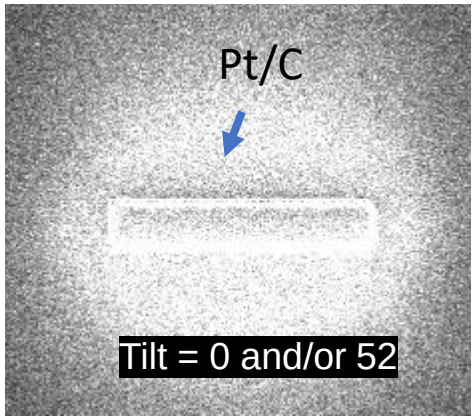
Dedicated stage for theTEM grid holder



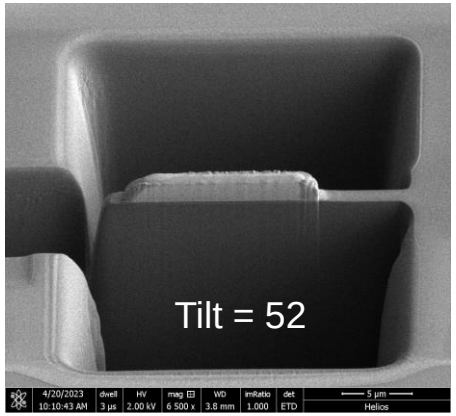


TEM sample lift out flow

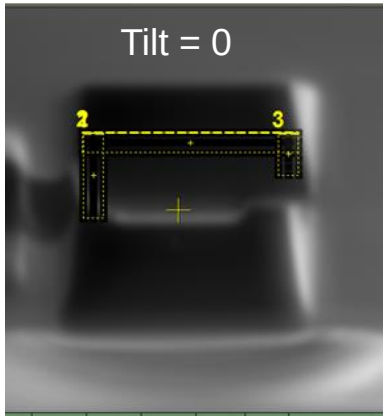
1. Cap deposition



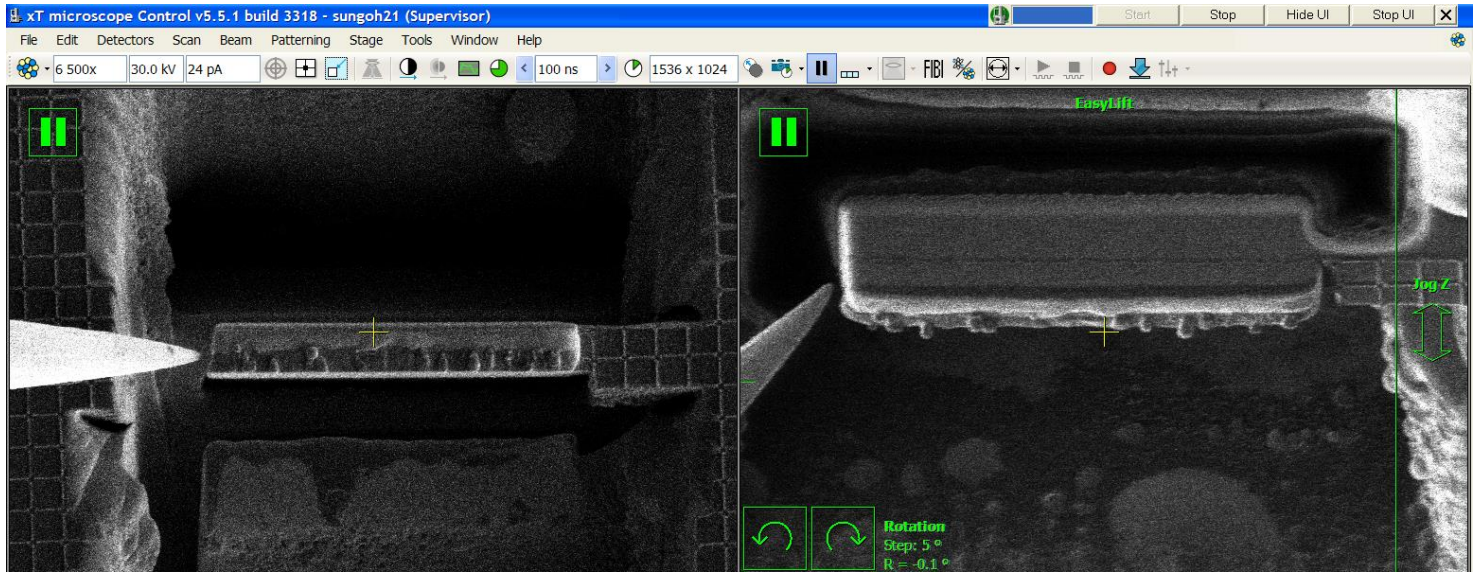
2. trenches

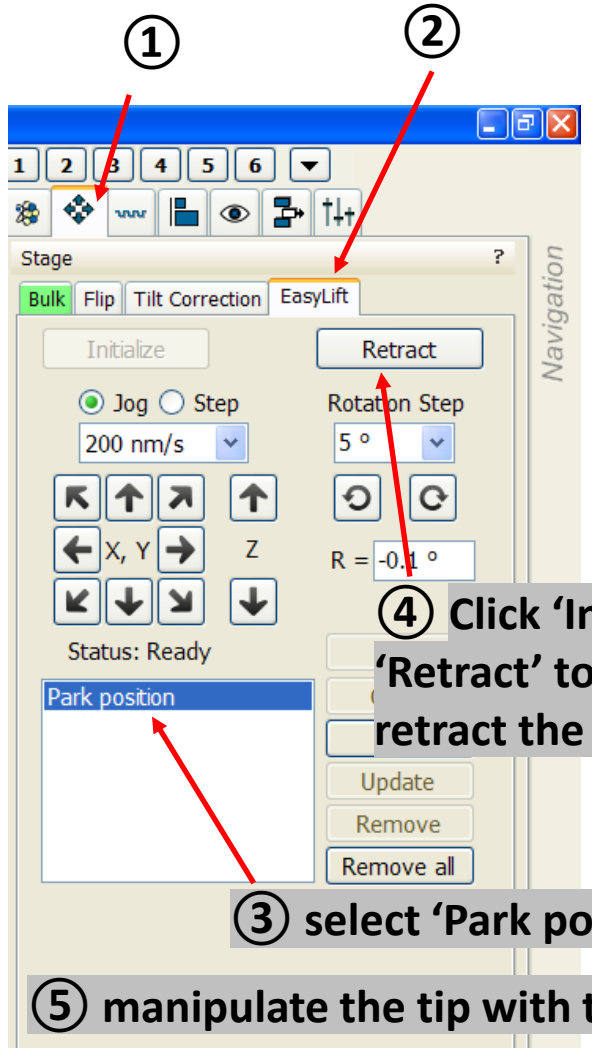


3. J cut

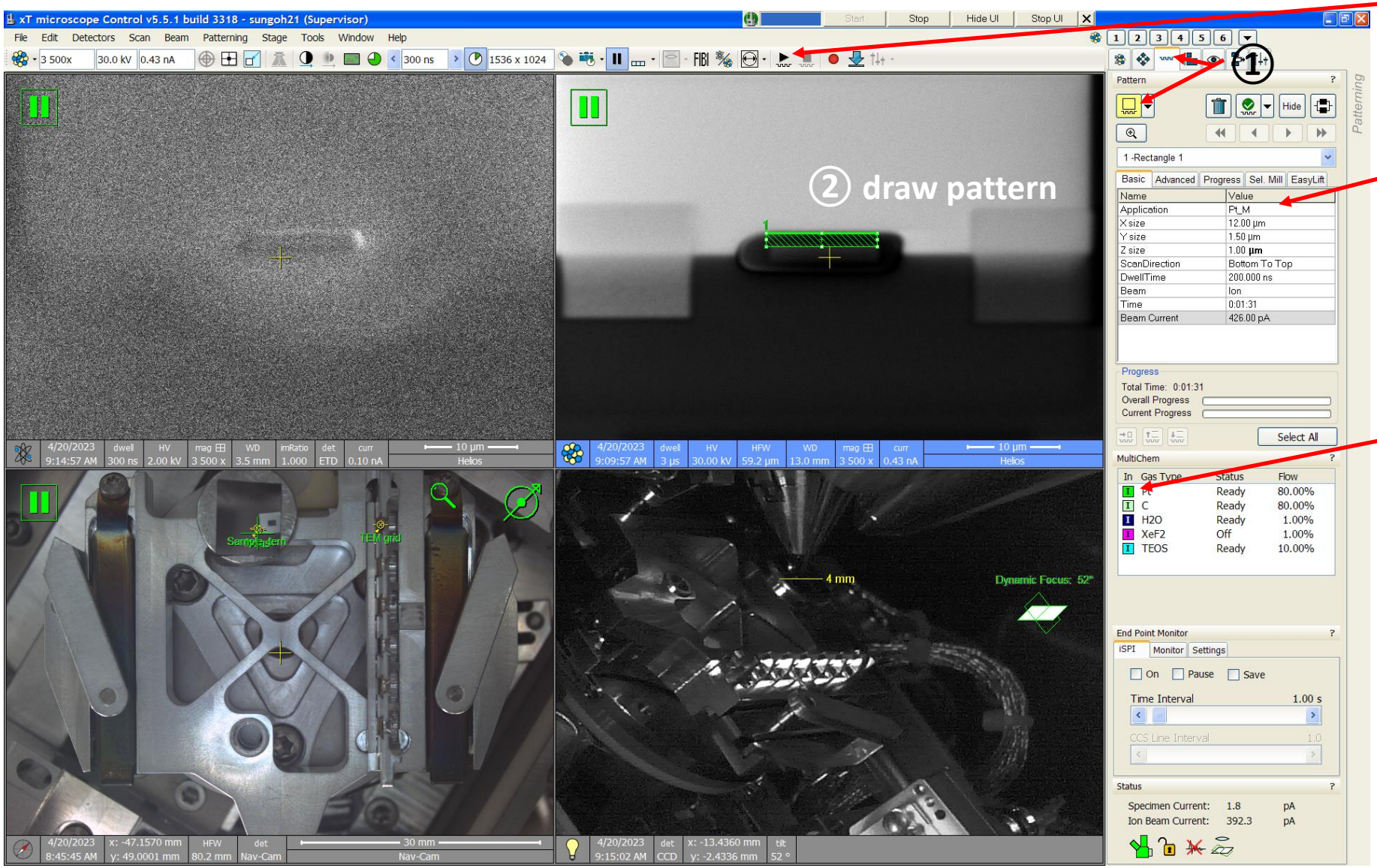


4. EasyLift: micromanipulator for sample handling





Cap deposition



⑤ Click ‘start’ - triangle

③ Application: Pt_M

④ Insert the nozzle by click the green square for Pt

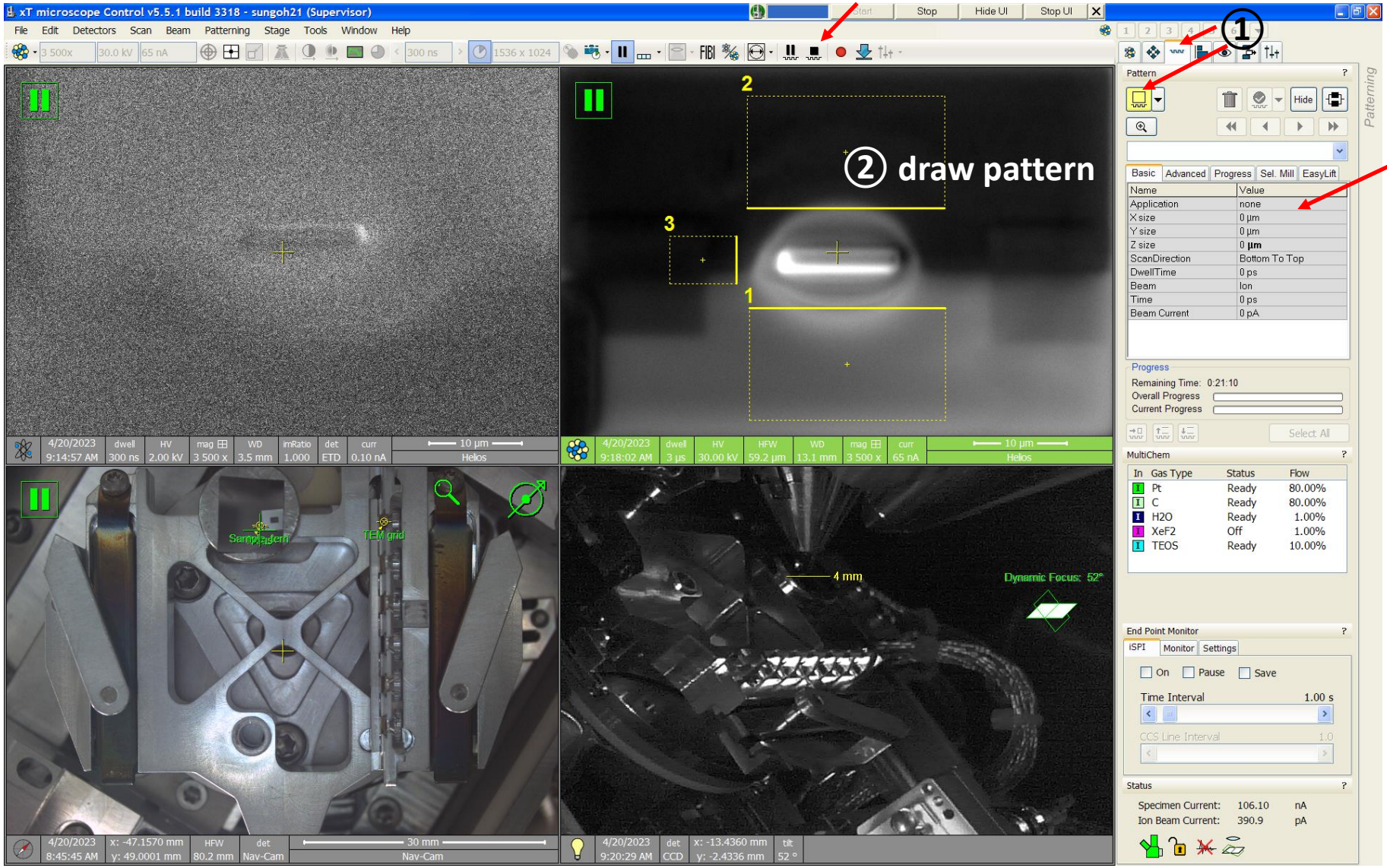
Cap deposition

1. Deposition for protecting the sample. Example: carbon and Pt deposition
    1. E-beam induced deposition, stage tilt = 0°
        1. In the ‘Pattern’ tab, draw a rectangle pattern in the 1st squd (SEM)
        2. In the ‘*Application*’, select ‘C e-dep surface’
        3. Insert gas injector needle: click the square for the gas you want to use
        4. Hit the start icon, triangle in the menu
        5. Low HV (<5kV) and high current (~26nA)
        6. Retract the gas nozzle

    2. I-beam induced deposition, stage tile = 52°
        1. Align the SEM and the FIB images using ‘*beam shift*’
        2. Click the 2nd sqad, and draw the pattern on the pattern
        3. Ex) carbon & Pt deposition, carbon deposition ‘*C_M*’ and followed by Pt, ‘*Pt_dep*’
            1. Ion beam current depends on the size of patterns.
            2. Check focus, stigma, and shift when the beam current changes

Trenches

④ Click ‘start’ - triangle

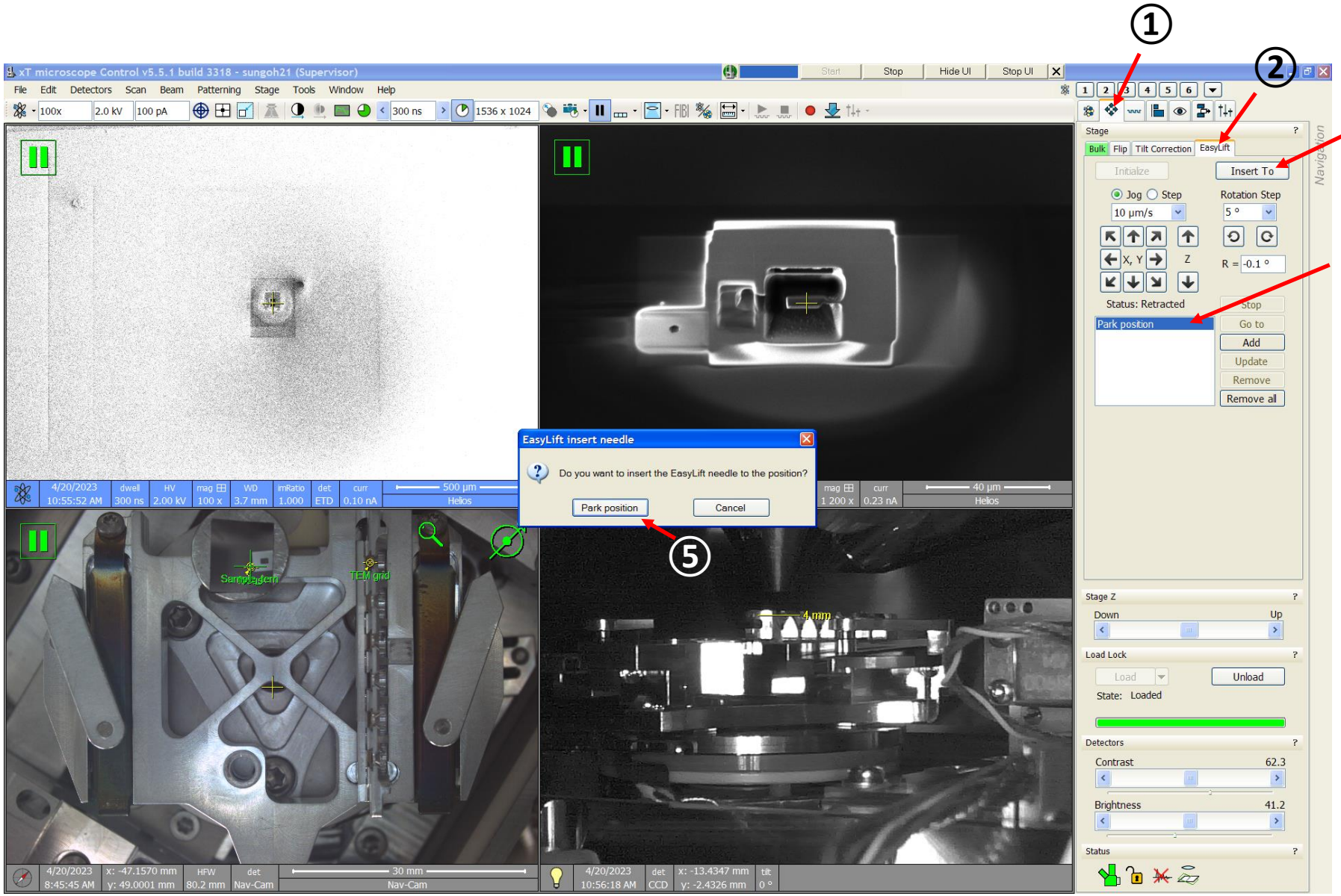


③ Application: Si or other materials

Trenches

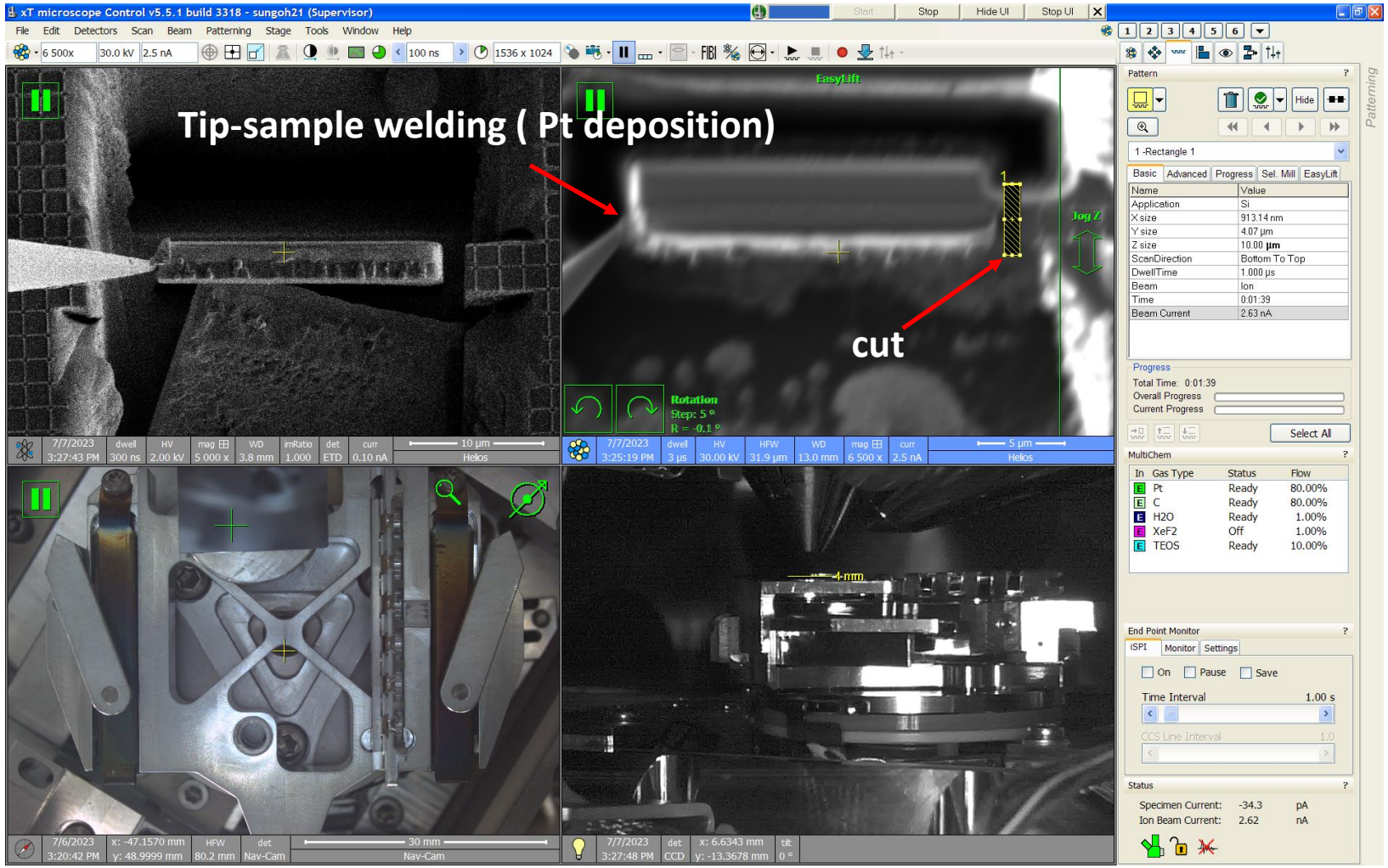
1. Cross-section cuts – ‘Regular Cross Section 1’ top and bottom of the protection pattern
    1. Draw the cut patterns that are a couple microns wider than the protection pattern
    2. For bulk cuts, high current might be chosen. Adjust focus and stigma.
        1. Turn off the beam blaker, full screen, and then check the beam using the snapshot
            1. *‘Scan’ – ‘Spot’* mode. Select the point where the beam is pointing at.
            2. *‘Scan’ – ‘Beam Blank’.* I-beam exposure immediately.
            3. *‘Scan’ – ‘Full Frame’.*
        2. Put the gaps between the cut and the protection pattern according to the beam size
2. Cleaning cross section cut with two or three lower aperture (~20nA or less if needed)
    1. Application - ‘Si New’`

Easy-Lift: micromanipulator

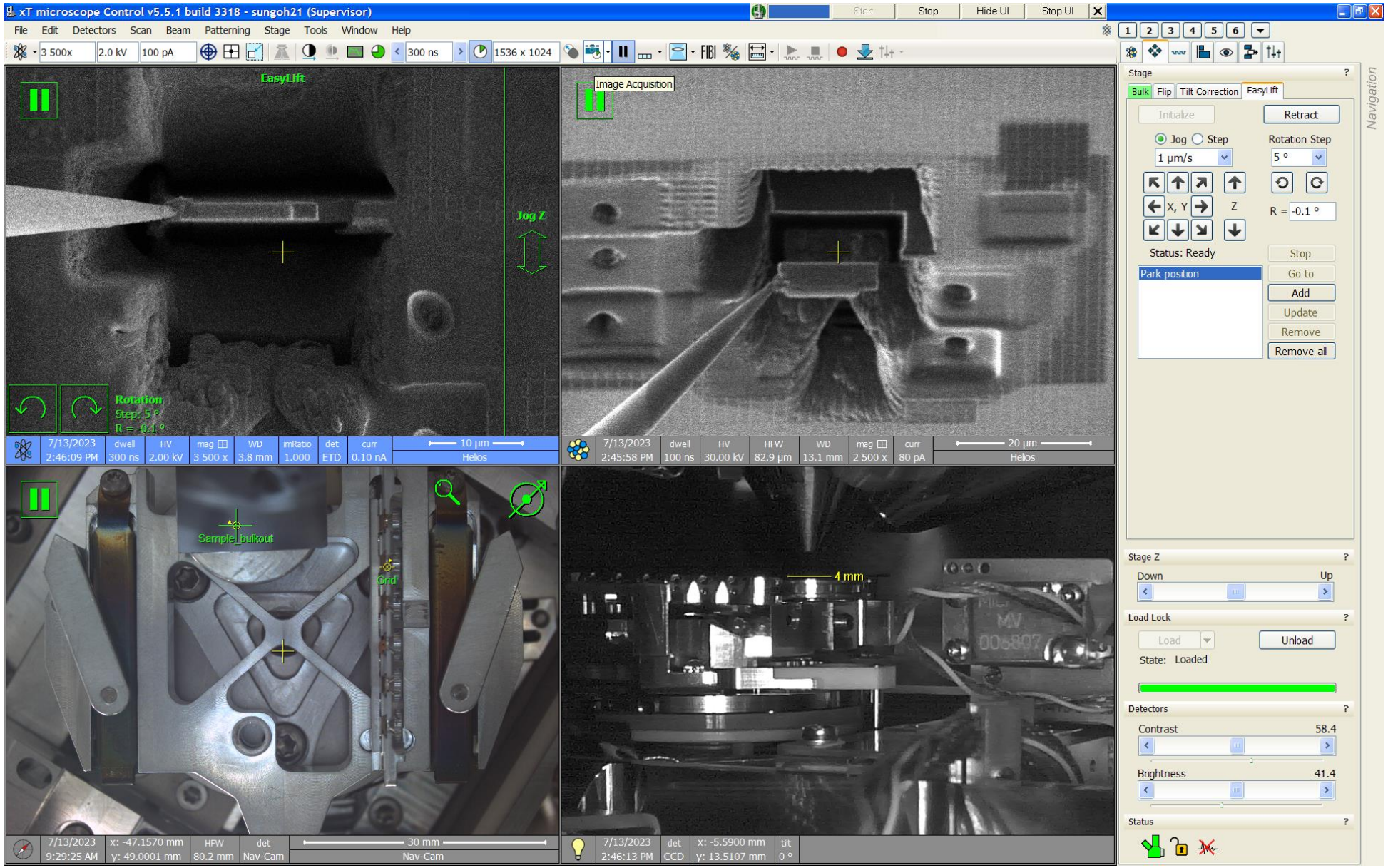


TEM sample lift out

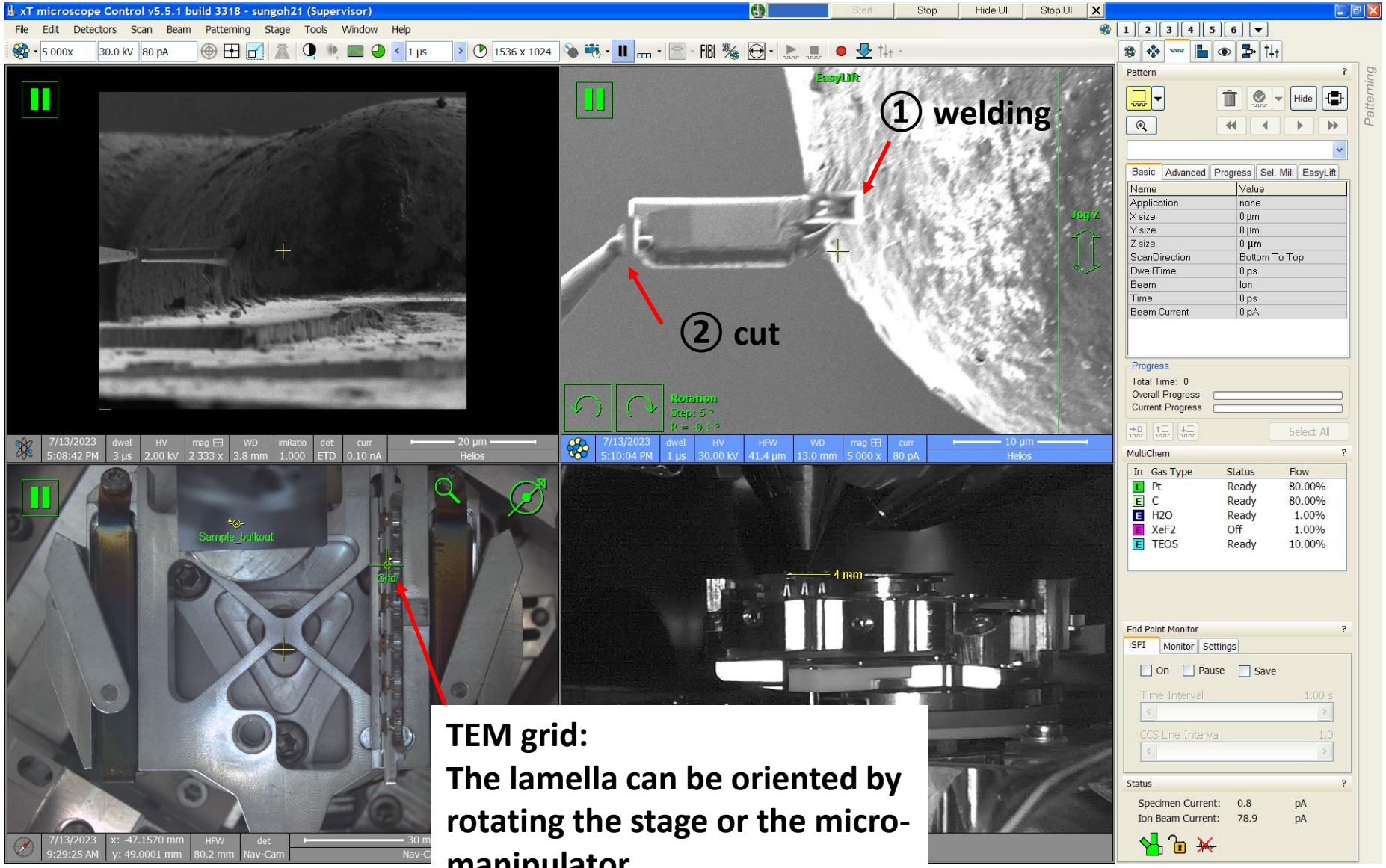
5. Lift out the sample



TEM sample lift out - continued



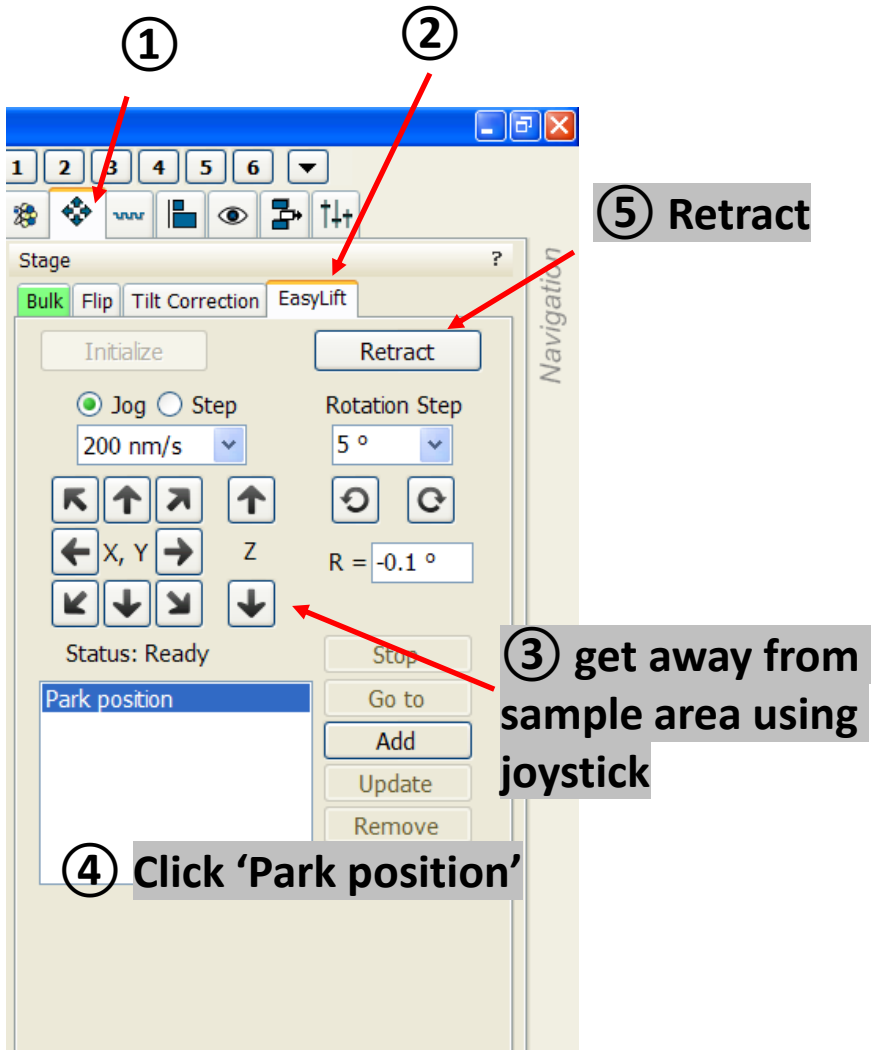
Place the sample on the grid



TEM grid:
The lamella can be oriented by rotating the stage or the micro-manipulator

Finishing your session

If you used the micromanipulator,
Retract the micromanipulator



Finish the secession

1. Click the 'Pause' button to stop beams
2. Tun off the e-beam: click the '**Beam On**' buttons on the beam control page
3. Click the '**Sleep**' button
4. Set tilt = 0
5. Unload your samples
6. Transfer the stage back to the main chamber:
    1. wait until the stage comes back to the main chamber
    2. Check visually through the CCD CAM at quad 4.
7. Log off the SEM/FIB software
    1. File – log off
8. Log off iLab