

# Remote EPU operation guide for eBIC microscopes

Revision:	2.1.4
EPU version:	3.4.0.5
Revision date:	28 June 2023
Revision summary:	<ol style="list-style-type: none"><li>1) Added notes to 'Quick start section'</li><li>2) Order of Atlas and Image Shift Calibrations swapped around</li><li>3) Bug work arounds for EPU 3.4.0.5<ul style="list-style-type: none"><li>- Adjustments for scaling on ice filter</li><li>- Removal of I0 calibrations</li></ul></li></ol>
Comments to:	Kyle Morris Lorna Malone
Acknowledgements:	We would like to acknowledge all eBIC staff for their invaluable efforts and contributions towards the writing of this documentation, in particular Davide Zabeo, David Owen, Andy Howe and Yun Song.

## Introduction

This document is intended as a guide for trained eBIC users to assist them in setting up their data collection session at eBIC on a Krios, K3 and GIF. The guide is principally aimed at the remote user but is applicable to on-site operation. The level of detail is targeted at a standard eBIC operator. The user is ultimately responsible for their use of eBIC and Diamond systems. If you are in doubt about an action you need to perform or are unable to progress, then please reach out to the eBIC Local Contact assigned to your session for assistance. Finally, please report any errors in this guide to your Local Contact or [kyle.morris@diamond.ac.uk](mailto:kyle.morris@diamond.ac.uk).

**Please consult the following documentation for guidance on remote microscope access, data analysis and transfer: '[Remote access and analysis](#)'**

## Information box colour key

Information boxes are presented in green

Optional actions are presented in yellow

## User and local contact expectations

**Please consolidate your grids into the minimum number of autogrid boxes.** We standardly load grids from autogrid boxes in the number order they are present and follow the numbering written on the boxes. The local contact (LC) will load the microscope and take an inventory of the grids in the autoloader before handover.

**Ahead of your session, please inform your local contact (LC) of your:**

- ☐ Target pixel size and target total dose
- ☐ Grid type (UAu, QF, Cflat or Lacey) and number of grids

Your LC requires this information to complete energy filter tuning, camera gain preparation and grid loading. The gain will be found in your visit processing directory. **Your LC will complete essential alignments (beam shift, pivot points, aperture centring) prior to your session, but the user will complete Image Shift Calibrations and Auto Function alignments prior to starting collection.**

**Please consult with your LC to decide on a plan if you wish to recover grids from your session. Grids can be recovered from the cassette, but not the microscope column.**

## Getting prepared

- ☐ Establish contact with the Local Contact for your session via yours and your LC's preferred choice of communication i.e. Teams, email, notepad, etc.
- ☐ Refer to the '[Remote access and analysis](#)' guide to access the microscope via NoMachine

**Note:** *If you try to connect via NoMachine and appear to be stuck waiting with a message saying 'waiting for the desktop user to authorise your connection' then contact your LC. For security reasons only one connection can be made to nx-cloud at a time – if the previous user has not properly closed their nx cloud connection then your LC will have to manually close this connection before you can connect.*

- ☐ Refer to the '[Remote access and analysis](#)' guide to familiarise yourself with our on-the-fly analysis pipeline

## Contents

<b>Contents .....</b>	<b>3</b>
<b>Quick start guide .....</b>	<b>5</b>
<b>1 Preparation.....</b>	<b>6</b>
1.1 Communication.....	6
1.2 Remote connection .....	6
1.3 Reasonable session timings .....	6
<b>2 User interface summaries.....</b>	<b>7</b>
<b>3 Microscope setup and grid screening .....</b>	<b>10</b>
3.1 Initial checks and start up .....	10
3.2 Check and adjust your imaging condition Presets .....	11
3.2.1 Check and adjust Low Magnification Presets (Atlas, Gridsquare, Hole/Eucentric).....	11
3.2.2 Check and adjust High Magnification Presets (Data Acquisition) .....	13
3.2.3 Other High Magnification Presets (Autofocus, Drift Measurement, Zero Loss, Thon Ring).....	15
3.3 Image shift calibrations .....	16
3.3.1 Prepare for image shift calibrations .....	16
3.3.2 Find eucentric height.....	16
3.3.3 Target a feature for Image Shift calibrations and track it through the magnifications .....	17
3.3.4 Calibrate the Image Shifts.....	18
<b>4 Screening.....</b>	<b>21</b>
4.1 Atlas session setup and collection .....	21
4.1.1 Inspect your Atlas.....	22
4.2 Navigation and targeting .....	23
4.2.1 Inspect your atlas and navigate to a square you want to screen using the Atlas .....	23
4.2.2 Ensure you are at eucentric height .....	25
4.3 Manual image acquisition using Presets.....	26
4.3.1 Grid Square image and positioning .....	26
4.3.2 Autofocus .....	26
4.3.3 Acquire a screening image at Data Acquisition .....	27
4.3.4 Document your findings .....	28
<b>5 SPA single grid setup .....</b>	<b>30</b>
5.1 Setup .....	30
5.1.1 Remove the I0 calibrations .....	30
5.1.2 Session setup.....	30
5.2 Target setup .....	31
5.2.1 Initial square selection and hole targeting .....	31
5.2.1.1 Square selection.....	31
5.2.1.2 Hole selection (for holey carbon grids) .....	32
5.2.1.3 Filter the hole selection .....	33
5.2.2 Additional square selection and hole targetting setup (Automatic/Manual) .....	34
5.2.2.1 Square selection.....	34
5.2.2.2 Automatic hole target setup .....	35
5.2.2.3 Manual hole target setup.....	36
5.2.3 Template definition.....	36
5.2.3.1 Hole targetting .....	36
5.2.3.2 Setting a template for acquisition areas and defocus series .....	37

5.2.3.3	Defocus area and dwell times .....	37
5.2.4	Template execution .....	38
<b>6</b>	<b>SPA multigrid set up .....</b>	<b>40</b>
6.1	Current considerations .....	40
6.2	Prerequisite steps.....	40
6.3	Manual queuing of grids .....	41
6.3.1	Set up the first grid .....	41
6.3.1.1	Grid loading .....	41
6.3.1.2	Square targeting .....	41
6.3.1.3	Hole targeting .....	43
6.3.1.4	Hole filtering.....	44
6.3.1.5	Template.....	44
6.3.1.6	Finalise .....	44
6.3.2	Load a subsequent grid .....	45
6.3.3	Set up targeting and other custom Session parameters .....	45
6.3.4	Repeat for all grids .....	45
6.4	Automatic queuing of grids.....	45
6.4.1	Set up a master grid.....	45
6.4.2	Auto create additional Sessions for subsequent grids.....	46
<b>7</b>	<b>Final checks and data collection .....</b>	<b>48</b>
7.1	Auto Functions and alignment.....	48
7.1.1	Alignments via Autofunctions .....	48
7.1.2	Beam centring .....	49
7.1.3	Objective aperture.....	49
7.1.4	Zero-loss peak .....	50
7.2	Start automated acquisition .....	51
7.2.1	Double check your data acquisition parameters.....	51
7.2.2	Record keeping .....	51
7.2.3	Data collection.....	52
7.2.4	Communication with you local contact during your session .....	53
7.2.5	Set up on-the-fly processing .....	54
7.2.6	Plan to request your dewar return in ISPyB.....	54
7.2.7	Monitor your data collection .....	55
7.2.8	Closing Teamviewer and disconnecting NoMachine .....	56

## Quick start guide

- 1) Check your magnification presets and adjust as required
- 2) Check image shift calibrations
- 3) Atlas your grids and screen as required

**Naming:** Supervisor\_YYYYMMDD\_XXXXXX\_visit-ID\_ATLAS  
**Output folder:** Z:\your session ID, i.e., biXXXXXX\atlas

- 4) Remove the I0 calibrations

*EPU: Preparation > Tasks > Calibrate I0 > 'Remove I0 Measurements'*

- 5) Create your EPU session

**Naming:** Supervisor\_YYYYMMDD\_XXXXXX\_visit-ID\_positionX\_EPU  
**Grid type:** Holey/Lacey  
**Session type:** Manual  
**Acquisition Mode:** Faster (AFIS on all Krioses)  
**Image format:** MRC  
**Dose Fraction output:** Tiff LZW non-gain normalised  
**Output folder:** Z:\your session ID, i.e., biXXXXXX\

- 6) Select a square, set up hole finding/targeting and ice filter

**Note:** You may need to rescale the ice filter histogram

- 7) Add additional squares, aiming to start data collection by 4 pm
- 8) Define template: acquisition areas, defocus series, autofocus area
- 9) Perform AutoFunction alignments in EPU
- 10) Start data collection
- 11) Inform your local contact you have started data collection
- 12) Start the on-the-fly analysis pipeline in SynchWeb
- 13) Return to add more squares as necessary

# 1 Preparation

## 1.1 Communication

Prior to your session, you should have informed your local contact information about your session and the grids you have shipped, including at least:

- How many grids have you sent? (Max. 4 grids per 48 hr session, these should be condensed into as fewer grid boxes as possible)
- What type of grid do you have (e.g., Quantifoil, UltrAuFoil, Cflat, Lacey etc.)
- Are all the grids clipped?
- What pixel size or magnification do you want to collect at? (see [Instrument calibrated pixel sizes](#))
- What is your target total dose per micrograph ( $\dots e^-/\text{\AA}^2$ ) ?
- What is your experience with remote EPU sessions?
- If you require guidance in use of EPU, is there someone in your BAG who will be assisting you with your set up or will you require assistance from your Local Contact?

## 1.2 Remote connection

Prior to your session, please check you can log in on NoMachine as described in the [Remote access and analysis](#) guide. You will not be able to access the instrument until your session is scheduled but you should check you can successfully log in to nx-cloud.diamond.ac.uk via NoMachine. From NoMachine you will access your visits instrument via TeamViewer, passwords can be found in the [Remote access and analysis](#) guide.

## 1.3 Reasonable session timings

### Day 1

Atlas your grids	by midday
Decide on a grid for collection	after midday
Have squares selected	by 2 pm
Have hole targets setup	by 3 pm
Start data collection	by 4pm

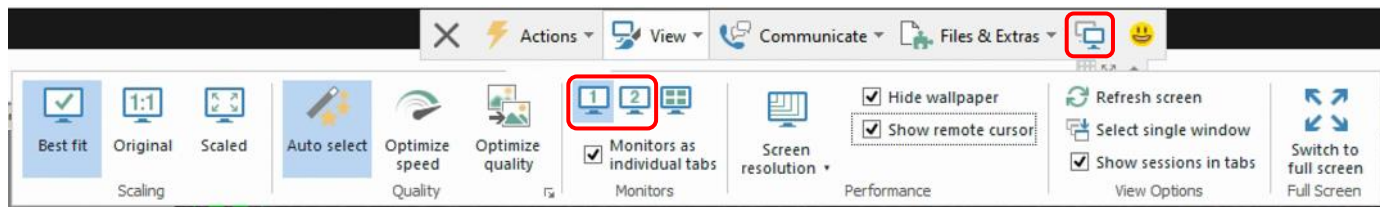
### Day 2

Add further acquisition targets  
(as required for session length)

## 2 User interface summaries

### Team Viewer

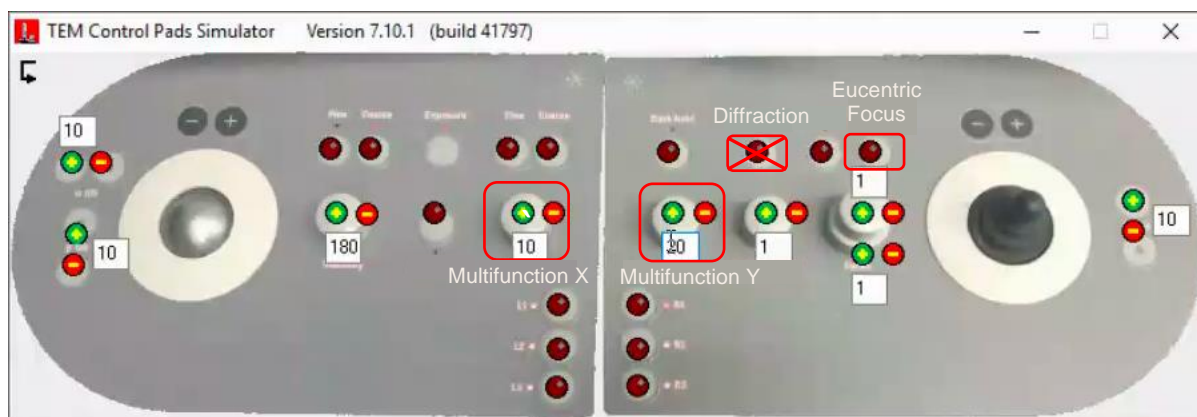
To switch between the virtual monitor hosting the TEM user interface and EPU, use the Team Viewer Monitor buttons.



### TEM Control Pads Simulator

The Control Pads Simulator provides access to the microscope controls you would find at the instrument itself. It is in general becoming less necessary to use these controls but for some operations later in the guide it is useful to be aware of where to find them.

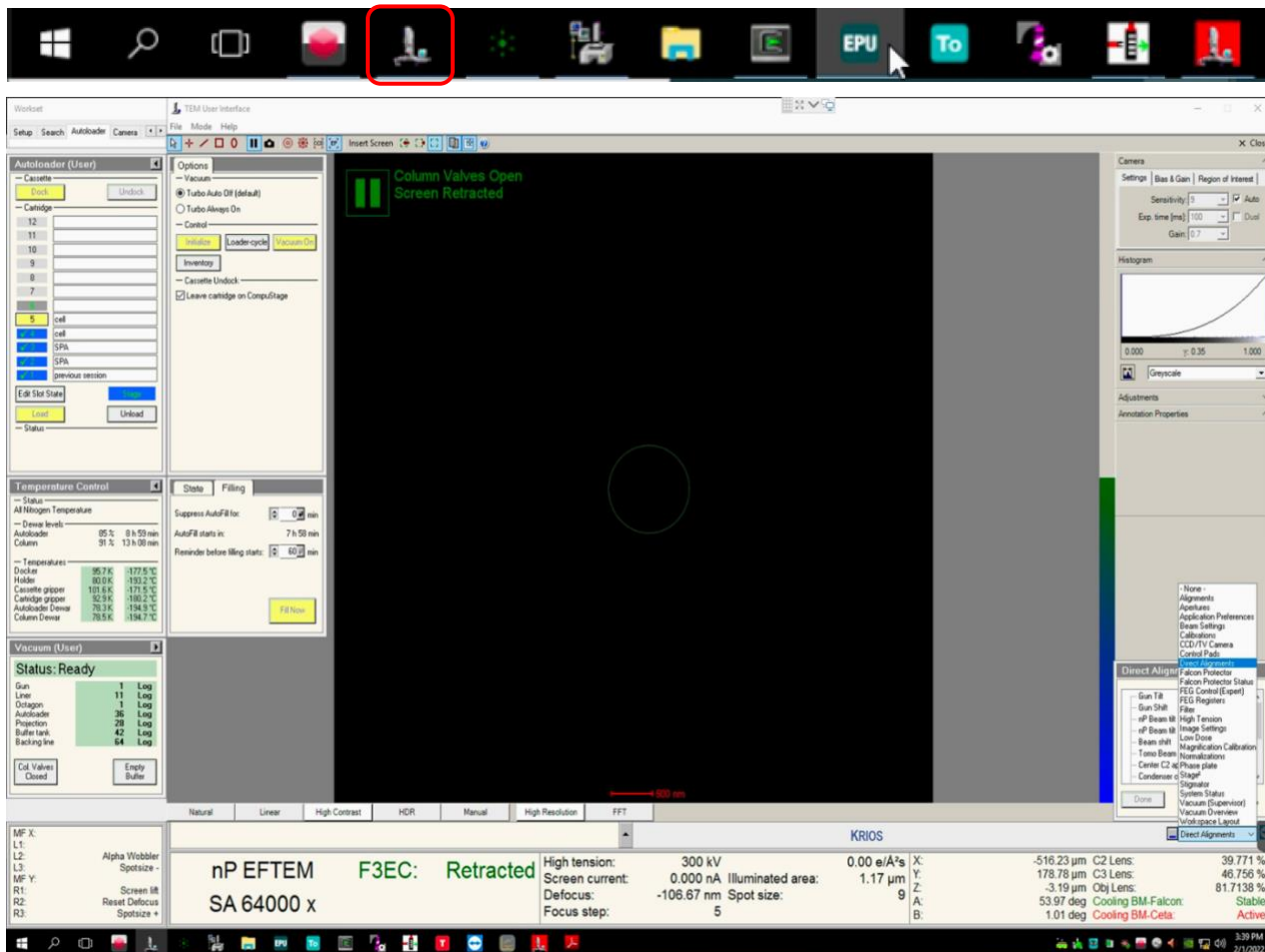
**! WARNING: Take care not to accidentally press the 'Diffraction' button !**





## TEM User Interface (TUI)

It is in general becoming less necessary to use TUI but for some operations later in the guide you will need to access this interface.





## Thermo Fisher Scientific EPU software

You can generally navigate through the single particle workflow by working left to right through the 'Workflow tabs', and top to bottom through the various 'Workflow tasks'.

E.g., Imaging conditions (Presets) are first configured under the 'Acquisition and Optics Settings'.

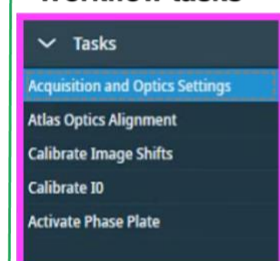
This guide presents a suggested sequence through the EPU workflow.



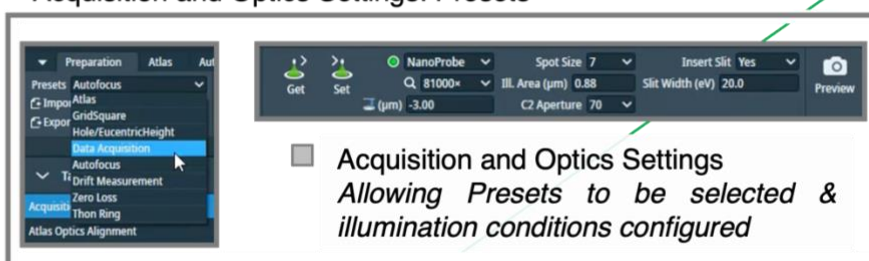
### Workflow tabs: Preparation, Atlas, Auto Functions, EPU



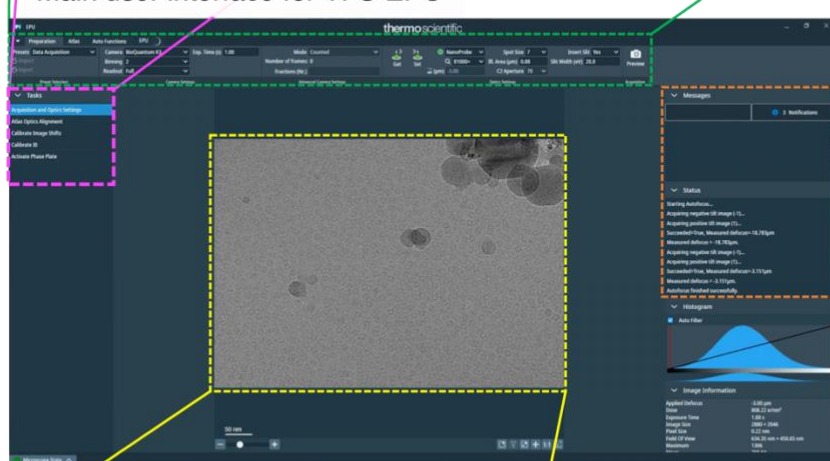
#### Workflow tasks



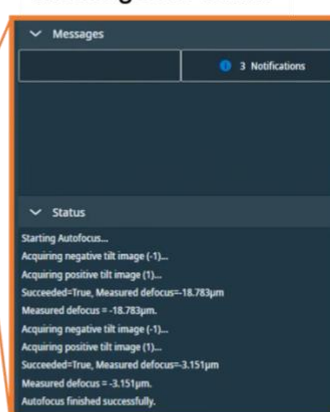
#### Acquisition and Optics Settings: Presets



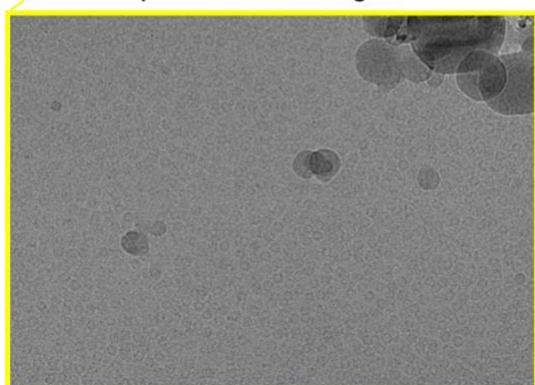
#### Main user interface for TFS EPU



#### Messages & status



#### Last acquired Preset Image



- **Workflow tabs**  
Preparation, Auto Functions, Atlas, EPU
- **Workflow tasks**  
Specific to each workflow section tab
- **Acquisition and Optics Settings**  
To configure Preset illumination conditions
- **Messages and status**
- Last image acquired under Preparation Preset

## 3 Microscope setup and grid screening

### 3.1 Initial checks and start up

During setup at the start of your session, your Local Contact (LC) will have loaded and inventoried the autoloader cassette.

**Note:** You may find that a grid from the previous session is still on the column or present in 'position 1' of the cassette.

- ☐ If an EPU window is not open, begin by starting this software



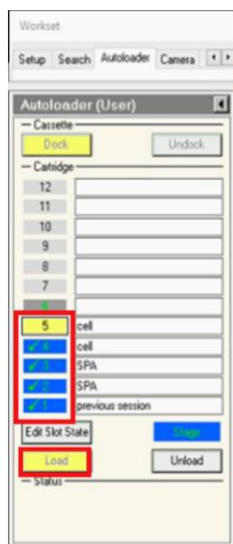
Session set-up can be controlled by users directly through the EPU interface. Changes to beam settings should all be controlled directly through the EPU imaging presets (EPU: Preparation > Presets) and navigation around the grid can be done via right-click options over the images in Preparation, Atlas and EPU image windows.

- ☐ Check if one of your grids is on the stage

*(TUI: Workset > Autoloader > Autoloader (User) > check if a grid is on the stage (blue when in cassette, yellow when on stage)*

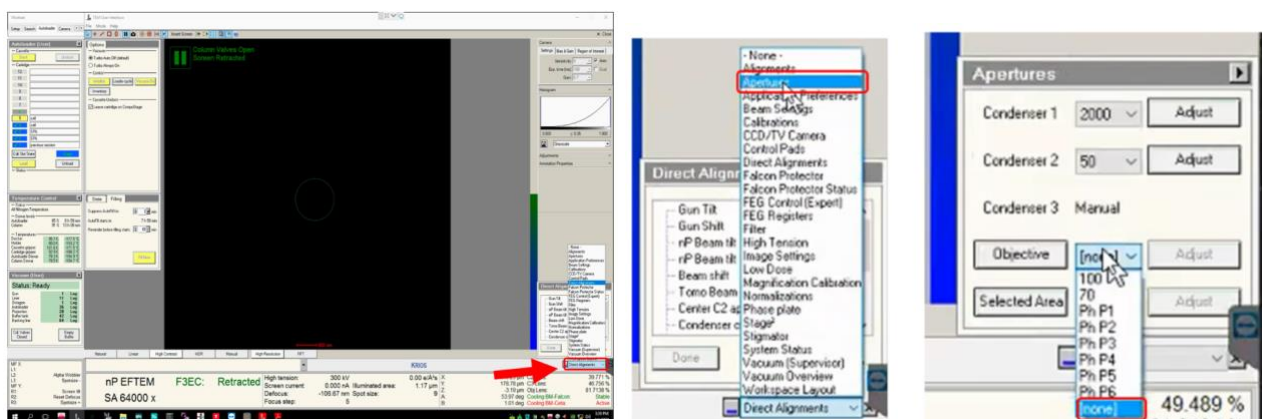
If no grid is loaded then select one of the slots and press 'Load'

**Note:** keep an eye on the 'Status window'



- ☐ Make sure the Objective aperture is not inserted

*(TUI: drop down menu (bottom right) > Apertures > Objective – check 'Objective' button is grey and 'none' is selected)*



## 3.2 Check and adjust your imaging condition Presets

Illumination conditions may differ between microscopes. The specimen will also affect how you need to configure your presets. You will need to adjust the magnification of each preset to suit your experiment. Begin with the low magnification presets (Atlas, Grid square, Hole/eucentric) before moving on to your high magnification presets (Data Acquisition, Autofocus, Drift, Zero-Loss).

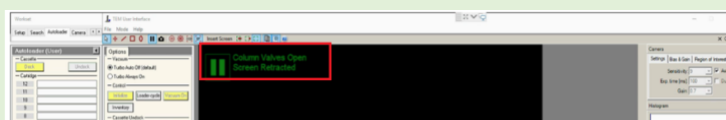
### 3.2.1 Check and adjust Low Magnification Presets (Atlas, Gridsquare, Hole/Eucentric)

- ☐ Take an image using the 'Atlas' preset

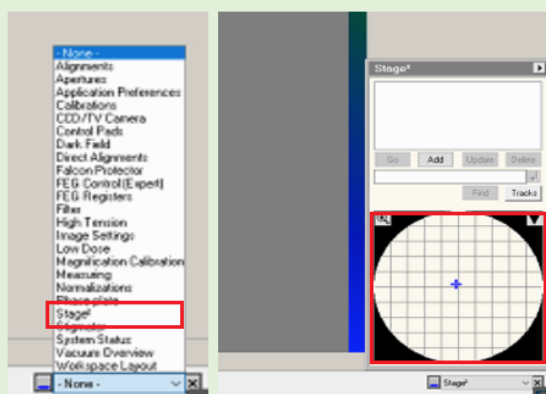
*(EPU: Preparation > Acquisition and Optics Settings > Presets > select the 'Atlas' preset > press 'Preview')*

**If you don't see anything or the image is black**

- 1) Check the screen is retracted and column valves are open



- 2) You may be over a grid bar or thick ice.  
Try moving to the other side of the grid using the 'Stage' in TUI  
*(TUI: dropdown in bottom right > select 'Stage' > double click on an area of the stage to move to)*  
Then 'Preview' again in EPU to image the new position



- ☐ Use the atlas image to navigate to the centre of a grid square (choose one with reasonably thin ice)  
*(EPU: right-click on grid square on image > 'Move stage here')*

☐ Go to the 'Preparation' tab and check each low magnification presets (Atlas, Grid Square, Hole/ Eucentric Focus) **in turn**:

- 1) Select the 'preset'  
(EPU: Preparation > Acquisition and Optics Settings > Presets > select 'Atlas/Grid Square/Hole Eucentric')
- 2) 'Set' the Preset to the microscope  
(EPU: Preparation > Acquisition and Optics Settings > Presets > select 'Atlas/Grid Square/Hole Eucentric' > 'Set')
- 3) Press 'Eucentric Focus' on the control panels
- 4) Switch to the TUI screen and insert the flu screen (Control pads: R1). Check the size of beam is larger than the sensor green circle on the flu screen
- 5) Switch back to the EPU screen and collect a preview image  
(EPU: Preparation > Acquisition > 'Preview')
- 6) Adjust magnification in EPU so that:

#### **Atlas**

Image encompasses the whole screen

#### **Grid square**

Image encompasses one grid square

#### **Hole / Eucentric Focus**

Image encompasses one hole and sufficient surrounding carbon for placing an autofocus

For the low magnification presets, some parameters that are predictable that you might reasonably expect are:

Preset	Magnification	Exposure (s)	Probe Mode	C2	Defocus (µm)
Atlas	135X	~ 1.0	Micro	150	- 500 to - 1000
GridSquare	360–940X (Square size dependent)	~ 1.0	Micro	50	- 100 to - 500 (Grid dependent)
Hole/Eucentric	6500–11500X (Hole size dependent)	~ 1.0	Micro	50	- 20.0 (Grid dependent)

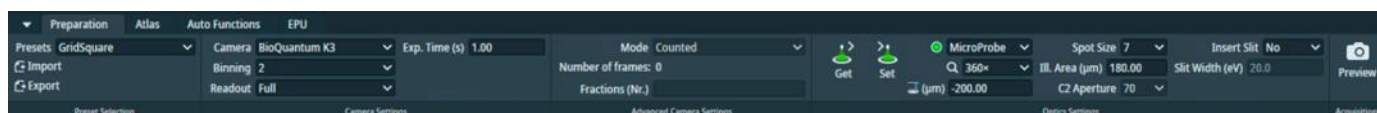
The following screenshots further indicate how you may expect to set your low magnification presets:

**Note:** the sections 'Preset Selection', 'Camera Settings', 'Advanced Camera Settings' and 'Optics Settings' sections. Optics Settings, in particular, will be microscope and session dependent.

### **Atlas**



### **GridSquare**





## Hole/Eucentric Height



### 3.2.2 Check and adjust High Magnification Presets (Data Acquisition)

The **magnification** for the data acquisition preset will have been set by your Local Contact based on communication before your session. Calibrations made by your Local Contact will be dependent on this magnification, **do not** adjust the 'Data Acquisition' **magnification** without discussing with your Local Contact. You should double check that the **exposure time** and other parameters are appropriate for your experiment. There is a [Dose rate calculation](#) tool on our website if required.

- ☐ Calculate the exposure time based on the **physical pixel dose rate (e<sup>-</sup>/px/sec)** and **pixel size** (these values will have been provided to you by your local contact during handover).

There is a '[Dose rate calculation](#)' on our website if required.

Your LC will have told you the **physical pixel dose rate** over vacuum. Follow the example calculation below to calculate and enter your target exposure time based on your desired target dose per tilt or in total (e<sup>-</sup>/Å<sup>2</sup>). You may find these [online dose calculators](#) helpful.

Example exposure time calculation:	Visual representation of calculation principle:
<p><b>Physical pixel dose rate:</b> 15.076 e<sup>-</sup>/px/sec</p> <p>Pixel size (magnified): 1.072 Å/px</p> <p>Pixel area (magnified): 1.149 Å<sup>2</sup>/px</p> $\frac{e^- / \text{px} / \text{sec}}{\text{Å}^2 / \text{px}} = e^- / \text{Å}^2 / \text{sec}$ <p>Dose rate: 13.121 e<sup>-</sup>/Å<sup>2</sup>/sec</p> <p>Target total dose: 50 e<sup>-</sup>/Å<sup>2</sup></p> $\frac{e^- / \text{Å}^2}{e^- / \text{Å}^2 / \text{sec}} = \text{sec}$ <p>Exposure time per tilted image (sec): 3.81</p>	<p><b>Physical pixel dose rate</b></p> <p><b>Magnified pixel area</b></p> <p><b>Dose rate:</b></p> <p>2.00 e<sup>-</sup>/Å<sup>2</sup>/sec = 2.0 / 1.0</p> <p>2.00 = e<sup>-</sup>/px/sec / Å<sup>2</sup>/px</p> <p>e<sup>-</sup>/Å<sup>2</sup>/sec = e<sup>-</sup>/px/sec / Å<sup>2</sup>/px</p> <p>0.50 e<sup>-</sup>/Å<sup>2</sup>/sec = 2.0 / 4.0</p> <p>0.50 = e<sup>-</sup>/px/sec / Å<sup>2</sup>/px</p> <p>e<sup>-</sup>/Å<sup>2</sup>/sec = e<sup>-</sup>/px/sec / Å<sup>2</sup>/px</p>



In this example the target total dose is 50 e<sup>-</sup>/Å<sup>2</sup>, and so the **number of fractions** is set to 50 to achieve a final total dose of 1 e<sup>-</sup>/Å<sup>2</sup> per frame of the movie.

- ☐ Under the 'Data acquisition' preset tab enter the calculated exposure time and frame number (EPU: Preparation > Preset Selection > Presets > 'Data Acquisition' > enter 'Exp. Time' and 'Fractions (Nr.)')
- ☐ Check that the correct imaging mode and binning value is selected (we recommend using 'counted super resolution mode' with '2' times binning)

(EPU: Preparation > Advanced Camera Settings > Mode > select 'mode')

(EPU: Preparation > Camera Settings > Binning > select value)

**'Mode'** controls the binning behaviour of EPU

**'Binning'** controls the binning behaviour of the camera

**Example 1 :** 'Counted Super Resolution' mode **with** '2' times binning

*The camera will collect in its default super resolution format, the binning of 2 will tell the **camera** to bin the movies 2-fold before transferring standard resolution movies to EPU.*

**Example 2:** 'Counted Super Resolution' mode **with** '1' times binning

*The K3 will collect in its default super resolution format, the Binning of 1 will mean super resolution movies are transferred to EPU.*

**Example 3:** 'Counted' mode **with** '1' times binning

*The K3 will collect in its default super resolution format and transfer super resolution movies to EPU, but 2-fold binning will be performed by EPU to obtain standard resolution movies.*

*As in example 1 the outcome is standard resolution movies however binning in EPU is slower than binning on the camera).*

☐ Check all other parameters are correct

### 3.2.3 Other High Magnification Presets (Autofocus, Drift Measurement, Zero Loss, Thon Ring)

The **data acquisition** magnification settings should have been copied to your other high magnification presets (**autofocus**, **drift measurement**, **zero loss** and **thon ring**) by your local contact but you should double check the settings for these presets are appropriate for your experiment.

For the high magnification presets, some parameters that are predictable that you might reasonably expect are:

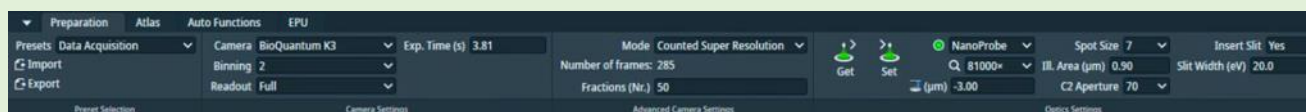
Preset	Magnification	Exposure (s)	Probe Mode	C2	Defocus (µm)
Data Acquisition	Set by Local Contact as per request	Dose dependent	Nano	50	- 3.0 (Sample dependent)
Autofocus	Copy of Data Acquisition	~ 1.0	Nano	50	- 3.0
Zero Loss	Copy of Data Acquisition	~ 1.0	Nano	50	- 3.0
Thon Ring	Copy of Data Acquisition	~ 2.0	Nano	50	- 1.0 to - 2.0

The following screenshots further indicate how you may expect to set your high magnification presets:

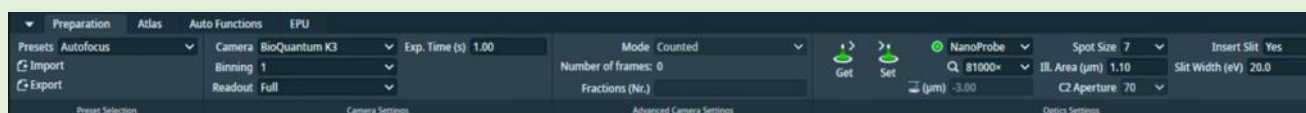
**Note:** the sections 'Preset Selection', 'Camera Settings', 'Advanced Camera Settings' and 'Optics Settings' sections. Optics Settings, in particular, will be microscope and session dependent.

**Note:** Do not change the Optics Settings for the high magnification presets except when indicated in this guide. The high magnification Optics Settings will have been optimised by your local contact to match your target magnification and the camera optimal dose rate.

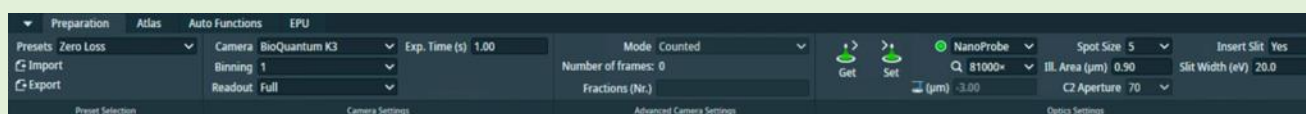
#### Data Acquisition



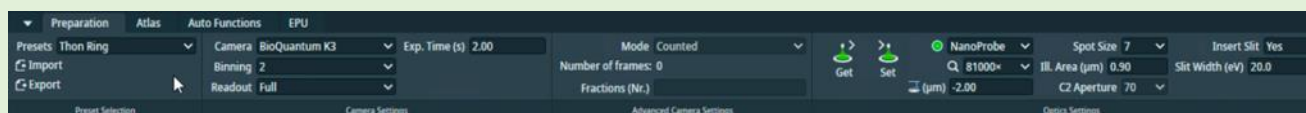
#### Autofocus



#### Zero Loss



#### Thon Ring





### 3.3 Image shift calibrations

#### 3.3.1 Prepare for image shift calibrations

☐ Take an image of your inserted grid at 'Atlas' magnification and use it to find an identifiable feature which will be recognisable at all magnification presets. Try to choose something which is fairly central on a grid square.

*E.g., a large non-symmetrical ice crystal*

☐ Move to that square

*(EPU: Atlas > Screening > select Atlas on the left > right-click on grid square on Atlas > 'Move stage here')*

#### 3.3.2 Find eucentric height

The stage must be at eucentric height to correctly calibrate the Image Shift Calibrations.

☐ Navigate to centre of your selected grid square

☐ Take an image of the area using the 'GridSquare' magnification preset

*(EPU: Preparation > Acquisition and Optics Settings > select the 'GridSquare' preset > press 'Preview')*

☐ Recentre the square as necessary and 'Preview' again.

☐ Set the stage to Eucentric height

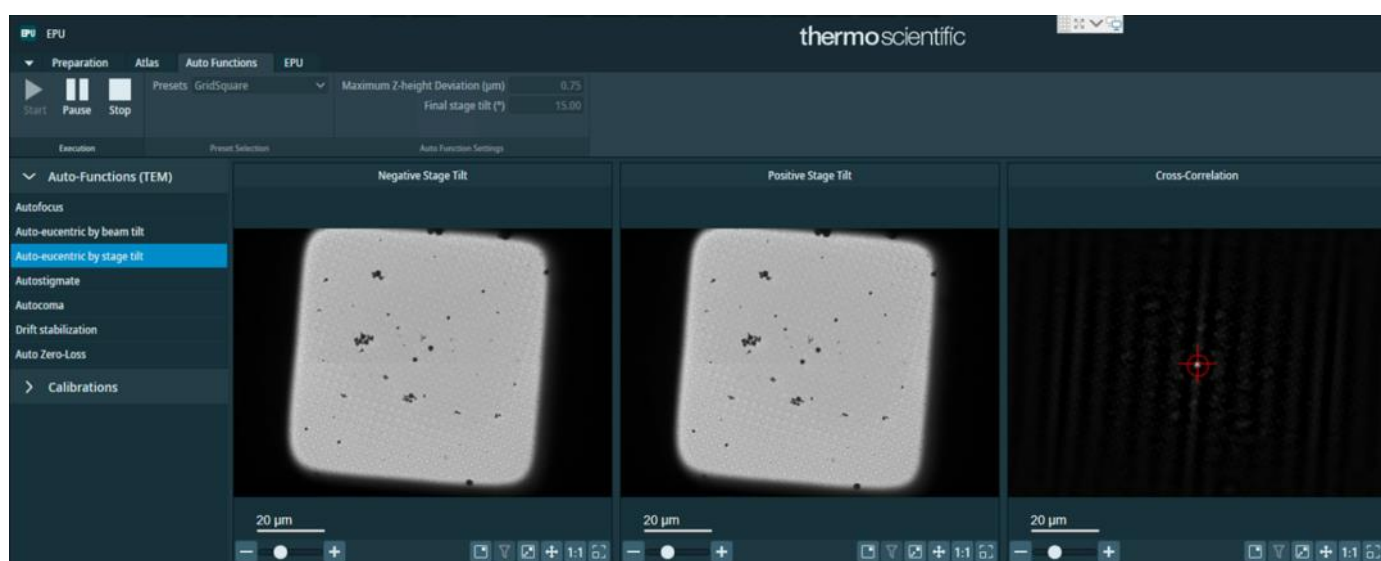
1) Select Auto Eucentric by stage tilt in the autofunctions tab

*(EPU: Autofunctions > Auto Eucentric by stage tilt)*

2) Set to 'Gridsquare' magnification preset in autofunctions

*(EPU: Autofunctions > Preset 'Grid square')*

3) Press 'Start'



Keep an eye on the Status window in EPU (right hand side) and look for decreasing Z values. On the EPU view you should see matching images on the left and a sharp 'peak' on the right.

If the 'Auto eucentric by stage tilt' routine fails then try the following options:

- 1) Try again with a smaller stage tilt of 5°, then if this succeeds try again with 15°
- 2) Try changing the 'GridSquare' preset to a smaller defocus offset and/or a shorter exposure time
- 3) Try Auto Eucentric by beam tilt at hole/eucentric magnification instead

*(EPU: Auto Functions > Auto-eucentric by beam tilt > Presets: Hole Eucentric > press 'Start')*

**Note:** Sometimes the repeating pattern of holes can prevent detection of a single cross-correlation peak at GridSquare magnification

If EPU **still** fails to find eucentric height automatically, speak to your LC.

### 3.3.3 Target a feature for Image Shift calibrations and track it through the magnifications

Prior to performing Image Shift Calibrations we systematically target a feature at low and up to high magnification. This will ensure that your feature is identifiable at all magnifications, provide indication of whether the Image Shift Calibrations need to be performed and importantly, centre a target feature at high magnification ready for Image Shift Calibrations.

☐ Centre the stage on your feature of choice (i.e., a large asymmetric ice crystal) which will be easily recognisable at both high and low magnifications

- 1) Collect a 'Preview' using the 'Atlas' Preset

*(EPU: Preparation > Acquisition and Optics Settings > select the 'Atlas' preset > press 'Preview')*

- 2) Centre on the feature

*(EPU: Right click on feature > Move stage here)*

☐ Check the feature remains aligned at higher magnification Presets

- 1) Collect a preview using the 'GridSquare' Preset

*(EPU: Preparation > Acquisition and Optics Settings > select the 'Gridsquare' preset > press 'Preview')*

- 2) Check the feature remains centred, right-click > Move stage here, if necessary

- 3) Collect a preview using the 'Hole/Eucentric Height' Preset

*(EPU: Preparation > Acquisition and Optics Settings > select the 'Hole Eucentric' preset > press 'Preview')*

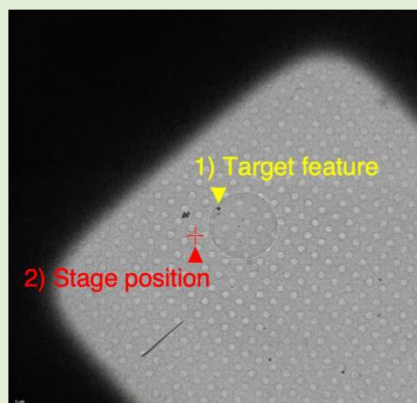
- 4) Check the feature remains centred, right-click > Move stage here, if necessary

- 5) Collect a preview using the 'Data Acquisition' Preset

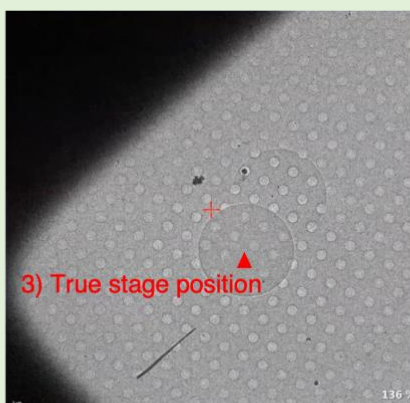
*(EPU: Preparation > Acquisition and Optics Settings > select the 'Data Acquisition' preset > press 'Preview')*

- 6) Check the feature remains centred, right-click > Move stage here, if necessary

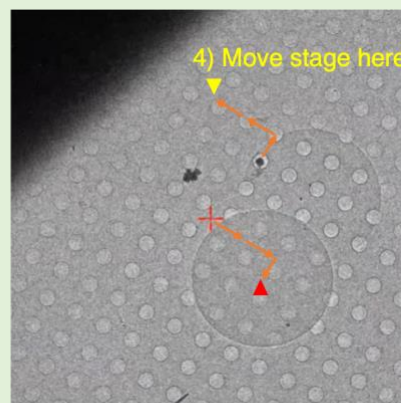
If you struggle to recentre the feature because it is out of a current field of view, one strategy is to take an image using your current Preset, and then subsequently take a new image using the GridSquare Preset as in (1). The charging mark introduced will be evident in the GridSquare image and indicate what the true stage position is versus where the stage thinks it is. You can then appropriately reposition the stage on the GridSquare image.



Grid Square image



After Hole/Eucentric Height image



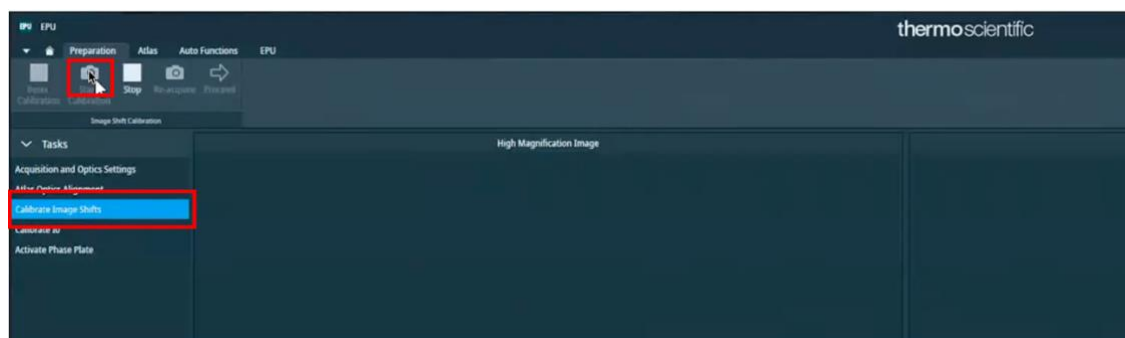
Recentre feature

### 3.3.4 Calibrate the Image Shifts

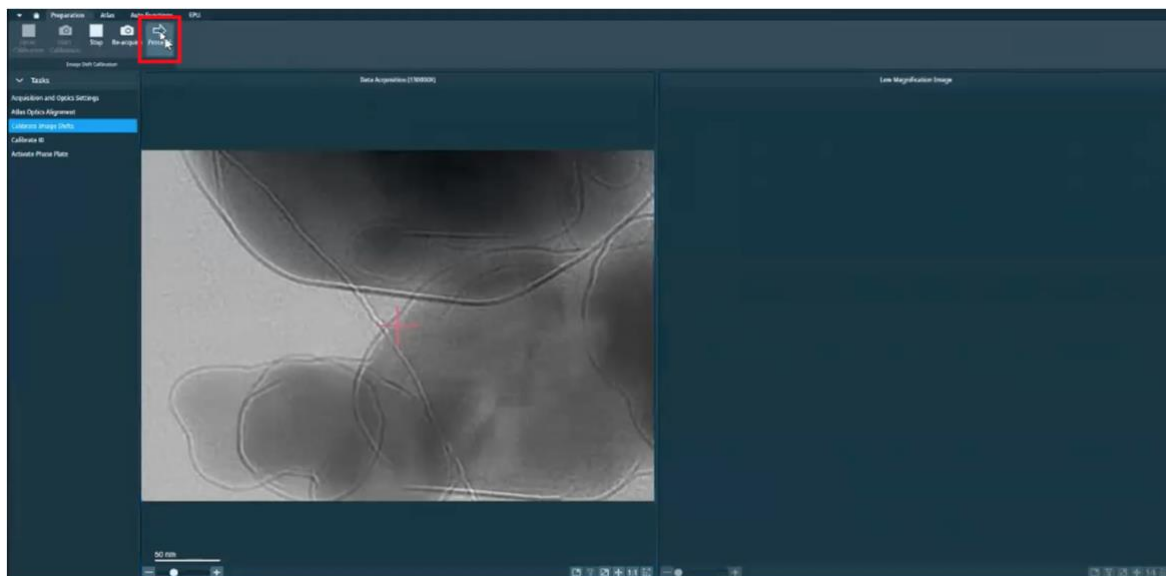
During image shift calibrations you will iteratively progress through the various magnification presets, realigning your target feature at each one to calibrate the stage to the same point in each.

#### ☐ Start image shift calibration

(EPU: Preparation > Tasks > Calibrate Image Shifts > press 'Start Calibration')



☐ We strongly suggest not to apply an image shift at the initial 'Data Acquisition' Preset. Click 'Proceed' to begin the calibration



☐ For each magnification in turn:

- 1) Move the stage (cross) to a particular point on your target feature that you can keep track of (e.g., the point where an ice crystal meets a hole).

(EPU: Double left click on the right-hand image where you want to move to)

**Note:** The original cross will turn blue and a new red cross will appear at the position you have clicked.

- 2) Press 're-acquire' to take a new image



- 3) Observe whether the position of the stage (red cross) in the right-hand image matches the position in the left hand image.
- 4) Repeat steps 1 - 3 until satisfied that the position of the stage is well calibrated between the magnifications shown in the left and right images.
- 5) Press 'Proceed' to move to the next pair of Presets

There is a 180° rotation between the 'Gridsquare' and 'Hole/Eucentric' magnification presets. You may find it helpful to take a photo on your phone and manually rotate this to orientate yourself

## 4 Screening

It is expected that eBIC users will be working on pre-screened grids during their sessions, however if you need to inspect and document areas to confirm ice characteristics, particle densities etc., now is an appropriate time to perform some quick screening.

There are several strategies here. It is possible to proceed through this guide and use the Template Definition routine to screen areas having set up a session in the EPU tab. It is also possible to collect manual acquisitions and use these as your screening images. These images can be saved for your own record keeping, as will be described in this section.

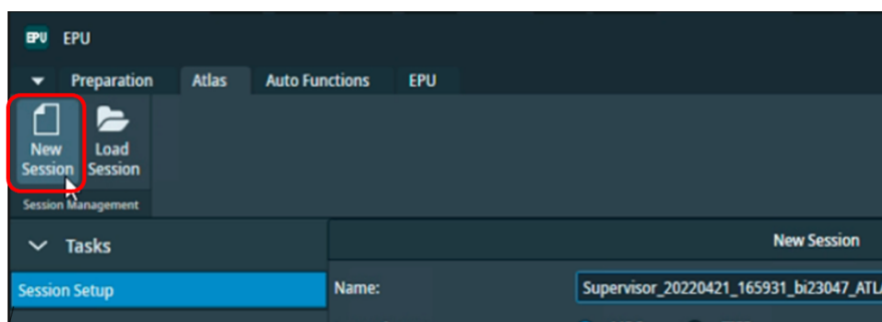
You will need to later manually configure your data collection if you wish to avoid re-exposing screened areas.

### 4.1 Atlas session setup and collection

#### Atlas Session setup:

- ☐ Start a new session for taking an Atlas

(EPU: Atlas > Session Setup > press 'New session')



- ☐ Setup the new session

- **Naming convention:** Supervisor\_YYYYMMDD\_XXXXXX\_visit-ID\_Atlas

**Note:** DO NOT edit the **prefix** created by EPU, this is required by our scripts for data transfer.

(i.e., **Supervisor\_YYYYMMDD\_XXXXXX**),

**Note:** We strongly suggest adding a **suffix** including your visit ID and 'ATLAS'

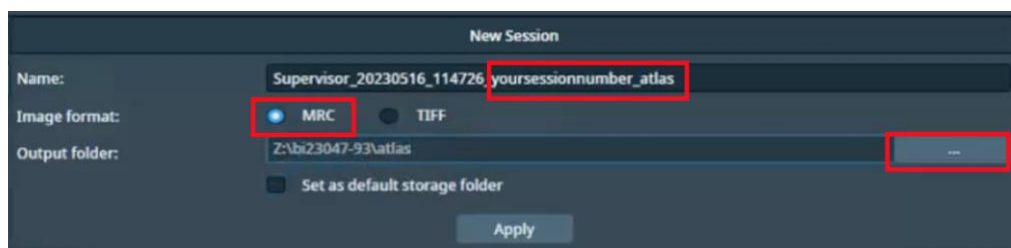
(i.e., **Supervisor\_YYYYMMDD\_XXXXXX\_biXXXXXXXX\_ATLAS**)

- **Image format:** MRC

**Note:** These are the Atlas and Atlas tile image formats. Using MRC is recommended to retain the extended MRC header information

- **Output folder:** Select the SSD storage folder path: Z:\[your session ID, i.e., biXXXXXXXX]/atlas

**Note:** If you do not see a folder with your session ID and atlas in the Z:\ drive (i.e. :Z\biXXXXXXXX/atlas), ask your LC to initiate 'murfey' before you set up your Atlas session



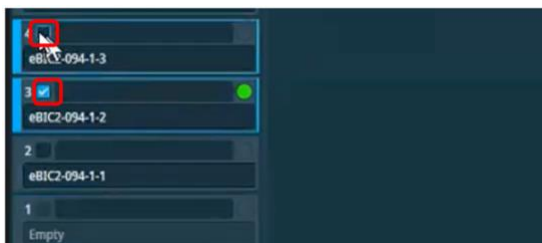


☐ Press 'Apply'

#### Atlas collection:

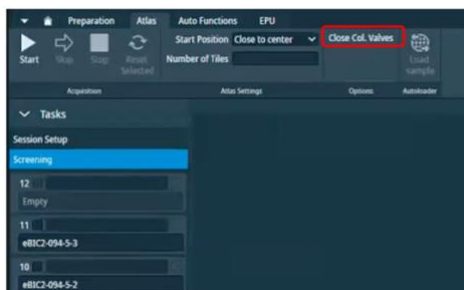
☐ Select which grids you'd like to acquire an atlas of

*(EPU: Atlas > Screening > Select the checkbox of each grid you want to acquire an Atlas of)*



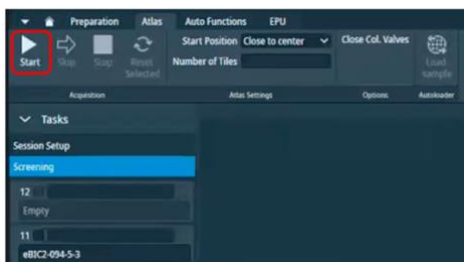
☐ Select 'close the column valves' to ensure EPU closes column valves when the Atlas is complete

*(EPU: Atlas > Screening > Close Col. Valves)*



☐ Press 'Start' to start acquiring atlases of your selected grids.

*(EPU: Atlas > Screening > Start)*

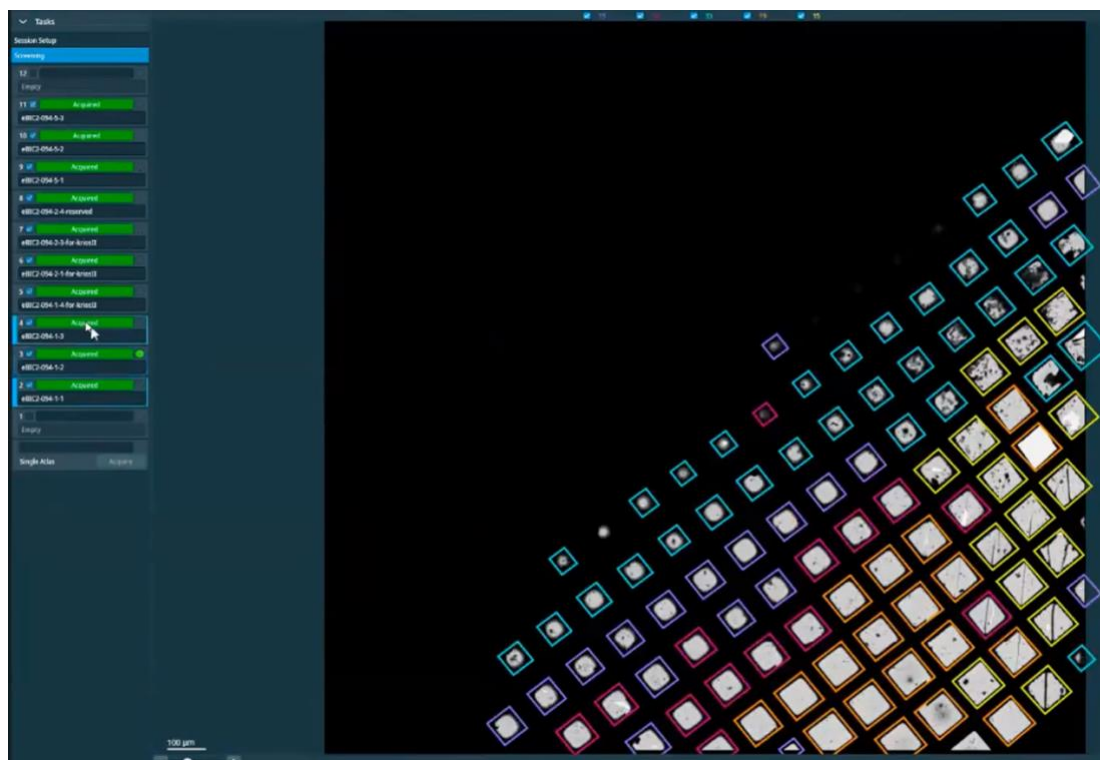


#### 4.1.1 Inspect your Atlas

☐ When atlas acquisition is complete, inspect the acquired atlas of each grid by clicking on the grid position in the left panel

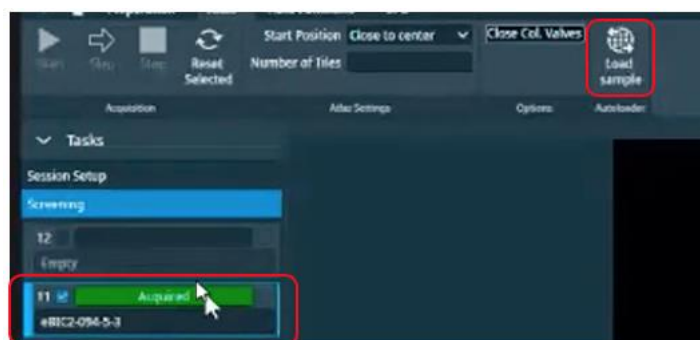
*Left-click on the atlas and drag to move around, middle scroll wheel to zoom in and out*





- ☐ When you have chosen your grid for target setup, select it and click 'Load Sample' from inside EPU  
(EPU: Atlas > Autoloader > 'Load sample')

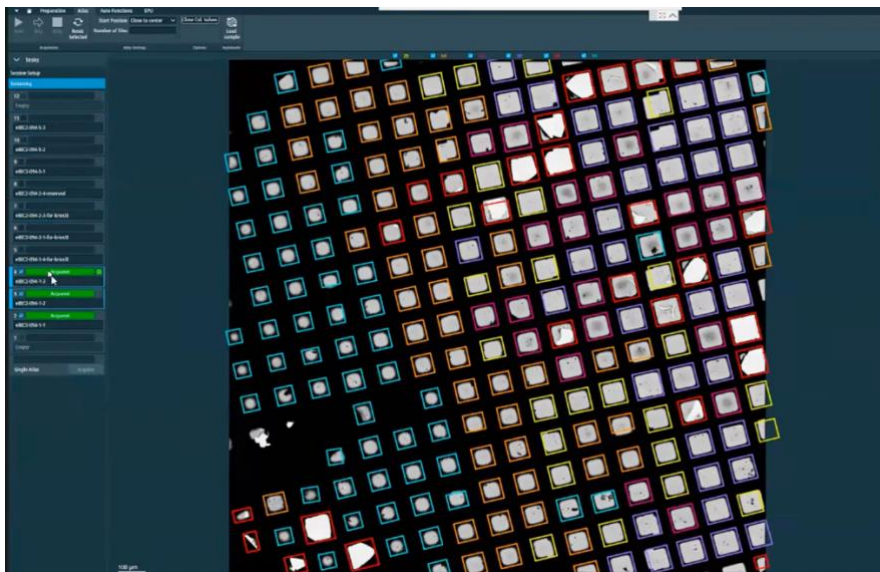
**Important:** Only load grids from inside EPU, any shifts and rotations that occur to the grid during loading and unloading will be measured and accounted for automatically.



## 4.2 Navigation and targeting

### 4.2.1 Inspect your atlas and navigate to a square you want to screen using the Atlas

- ☐ Click on each atlas in turn to view the overall ice distribution on each grid  
(EPU: Atlas > Screening > select grid to view acquired atlas)



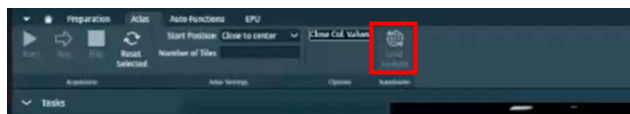
**A note on atlas montage ‘stitching’:** On each Atlas, EPU will have collected a montage of images taken at Atlas magnification and stitched them together to provide a view of the entire grid. Sometimes this ‘stitching’ is a bit off but this will not affect navigation or data collection.

**A note on square colouring:** EPU will colour squares according to ice thickness (*i.e.*, it will colour ‘similar’ squares purple or yellow, or orange etc.). You may find this helpful or you may not. If you do find this helpful it is important to note that the colourings between grids from different atlas sessions may not be the same (*i.e.*, purple may correspond to thin ice in one session and thick ice on another). If you don’t find this helpful you can turn the square colouring off using the tick boxes at the top of the atlas image.

☐ Chose a grid to screen

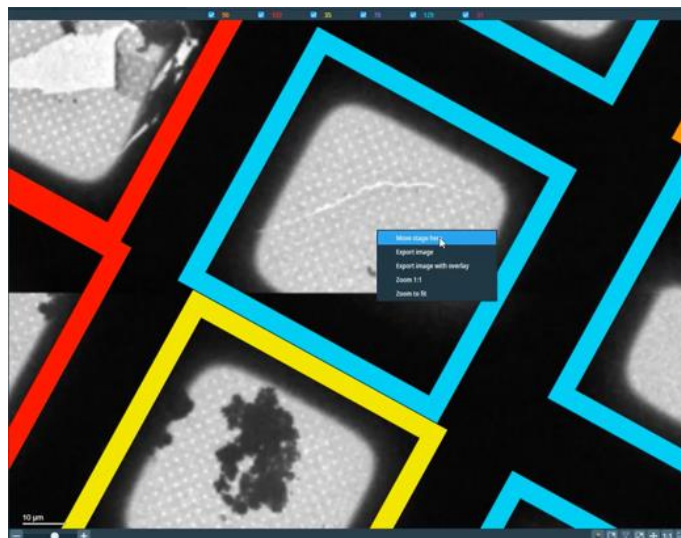
(EPU: Atlas > Screening > select grid to view acquired atlas)

**Note:** if this is different to the grid you have currently loaded then go to ‘Load sample’ (EPU: Atlas > Autoloader > press ‘Load sample’). This may take a few minutes.



☐ Navigate to a square in your Atlas

(EPU: Atlas > Right-click > Move stage here)

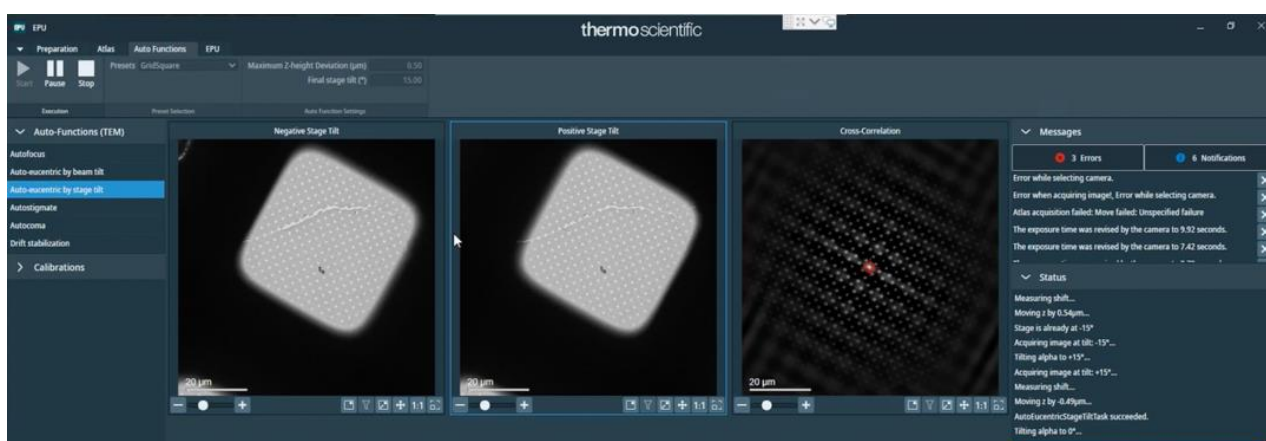


#### 4.2.2 Ensure you are at eucentric height

Each time you go to a new position on a grid you should ensure the stage is at eucentric height.

##### ☐ Set the stage to Eucentric height

- 1) Select Auto Eucentric by stage tilt in the autofunctions tab  
(EPU: Autofunctions > Auto Eucentric by stage tilt)
- 2) Set to 'Gridsquare' magnification preset **in autofunctions**  
(EPU: Autofunctions > Preset 'Grid square')
- 3) Press 'Start'



Keep an eye on the Status window in EPU (right hand side) and look for decreasing Z values. On the EPU view you should see matching images on the left and a sharp 'peak' on the right.

If the 'Auto eucentric by stage tilt' routine fails then try the following options:

- 1) Try again with a smaller stage tilt of 5°, then if this succeeds try again with 15°
- 2) Try changing the 'GridSquare' preset to a smaller defocus offset and/or a shorter exposure time
- 3) Try Auto Eucentric by beam tilt at hole/eucentric magnification instead

*(EPU: Auto Functions > Auto-eucentric by beam tilt > Presets: Hole Eucentric > press 'Start')*

**Note:** Sometimes the repeating pattern of holes can prevent detection of a single cross-correlation peak at GridSquare magnification

If EPU **still** fails to find eucentric height automatically, speak to your LC.

## 4.3 Manual image acquisition using Presets

### 4.3.1 Grid Square image and positioning

- ☐ Select the GridSquare preset and acquire a Preview

*(EPU: Preparation > Acquisition and Optics Settings > select the 'GridSquare' preset > press 'Preview')*

- ☐ Move to an area of carbon

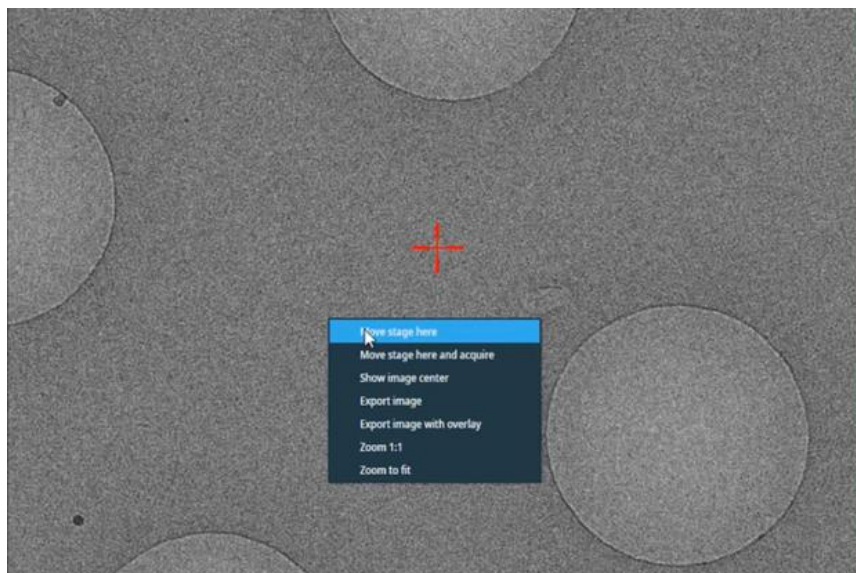
*(EPU: Right click > 'move stage here')*

- ☐ Select the Hole/Eucentric Height preset and acquire a Preview

*(EPU: Preparation > Acquisition and Optics Settings > select the 'Hole/EucentricHeight' preset > press 'Preview')*

- ☐ Recentre on an area of carbon

*(EPU: Right click > 'move stage here')*



### 4.3.2 Autofocus

- ☐ Run the autofocus routine on carbon

- 1) Select AutoFocus in the autofunctions tab

*(EPU: Autofunctions > AutoFocus)*

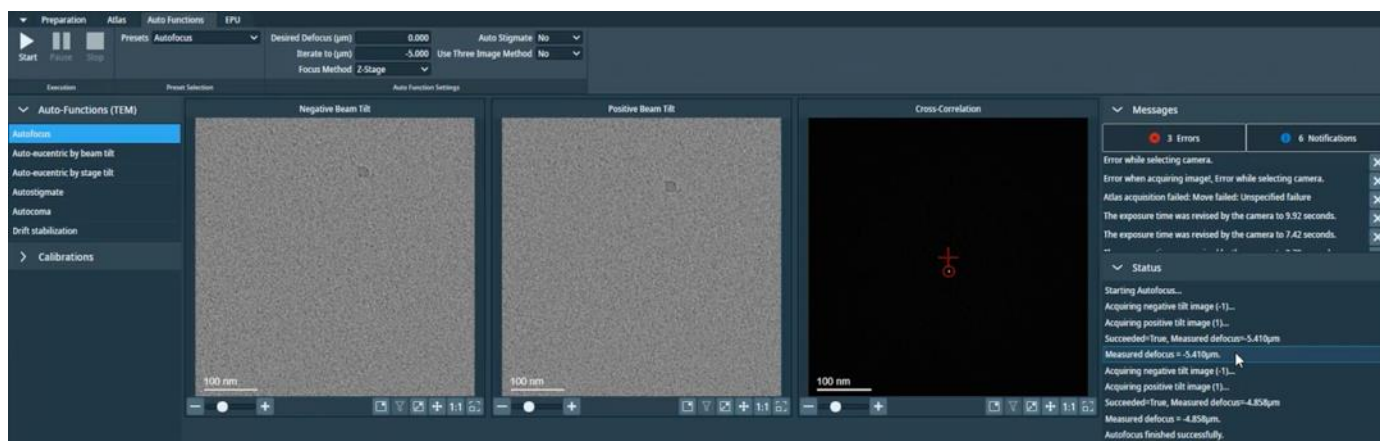
- 2) Set to 'AutoFocus' magnification preset **in autofunctions**



(EPU: Autofunctions > Preset 'AutoFocus')

3) Press 'Start'

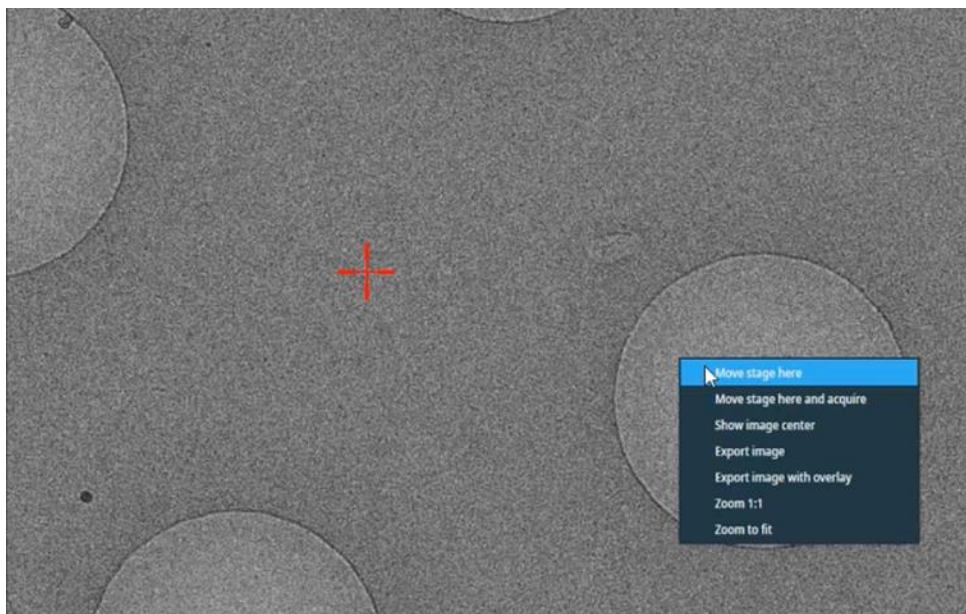
**Note:** Keep an eye on the Status window in EPU (right hand side) and look for a sharp 'peak' on the right



#### 4.3.3 Acquire a screening image at Data Acquisition

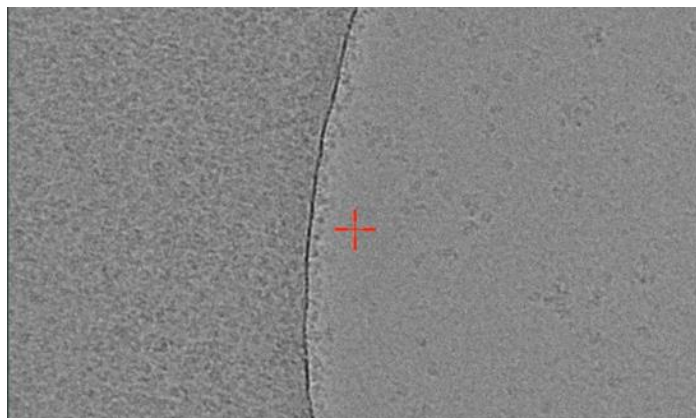
- ☐ Return to the Hole/Eucentric Height preset and reposition the stage on a target area in a hole

(EPU: Preparation > Acquisition and Optics Settings > select the 'Hole/EucentricHeight' preset > press 'Preview')



- ☐ Take an image at Data Acquisition preset

(EPU: Preparation > Acquisition and Optics Settings > select the 'Data Acquisition' preset > press 'Preview')



#### 4.3.4 Document your findings

Images are **not** automatically saved from this procedure so you may wish to save your images manually.

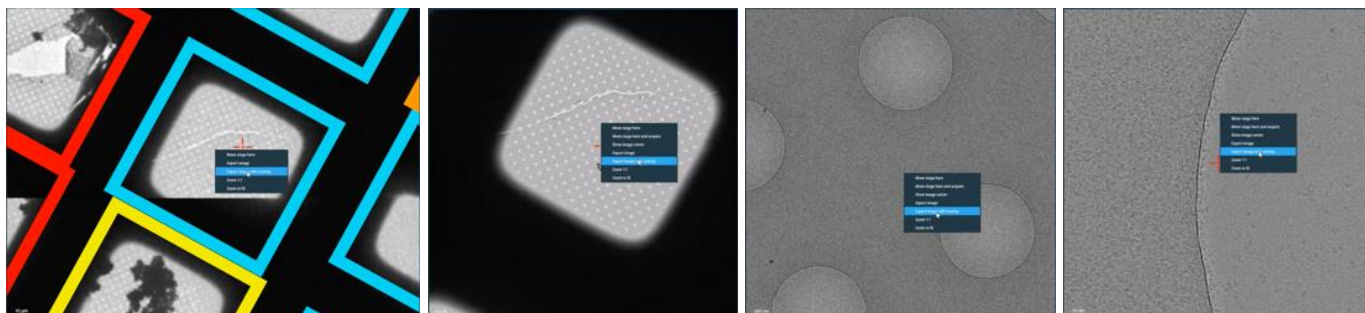
- ☐ Select one of the preset magnifications

(EPU: Preparation > Acquisition and Optics Settings > select a preset)

**Note:** Unless you press 'Preview' again, EPU will display the last image that was acquired using the selected magnification preset

- ☐ Export the image with overlay

(EPU: Right click on image > press 'Export image with overlay')

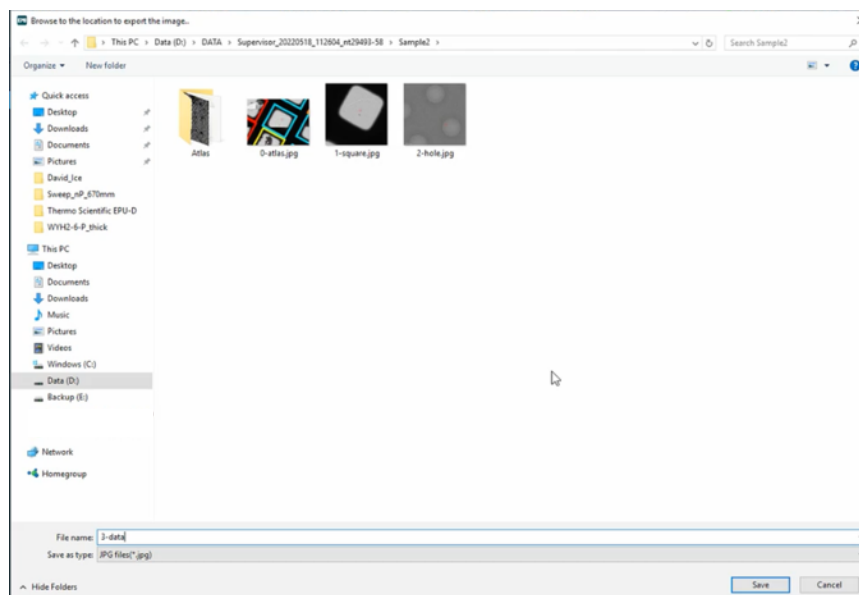


- ☐ Save the image to an appropriate area in your session directory

**Note:** Ensure you are definitely in the right directory!

**Note:** ensure your naming convention makes sense to you and provides detail about the location of the image on the grid

E.g.,   Grid1\_Square1\_Hole1\_DA  
          Grid1\_Square1\_Hole1\_HE  
          Grid1\_Square1\_Hole1\_GS  
          Grid1\_Square1\_Atlas





## 5 SPA single grid setup

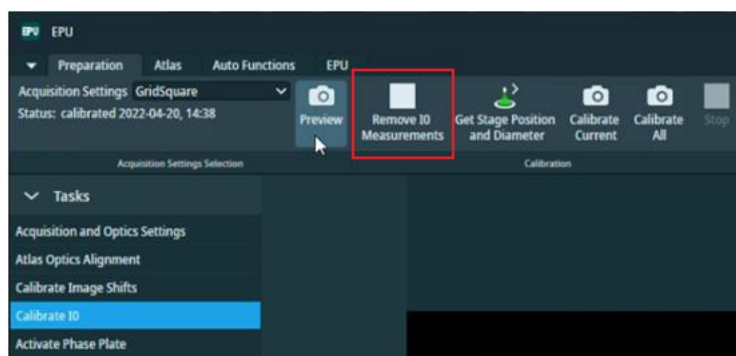
### 5.1 Setup

#### 5.1.1 Remove the I0 calibrations

This is a work-around for a bug in EPU 3.4.0.5 which causes issues with the ice filter.

- ☐ Remove the I0 calibrations

(EPU: Preparation > Calibrate I0 > press 'Remove the I0 Measurements')



#### 5.1.2 Session setup

- ☐ Set up a new EPU Session

(EPU: EPU > New session > Session Setup)

**Note:** When you set up a new session, EPU will ask you if you want to use parameters from the last EPU session (this includes hole sizes, ice filters, image formats etc. as well as any **mistakes** made by the last user during setup).

**DO NOT** use settings from a previous session unless you are 100 % sure that the parameters used were correct and also apply to your own experiment (i.e., if the previous session was your own).

- ☐ Setup the new session

- **Naming convention:** Supervisor\_YYYYMMDD\_XXXXXX\_visit-ID\_autoloader-position\_EPU

**Note:** DO NOT edit the prefix created by EPU

(i.e., **Supervisor\_YYYYMMDD\_XXXXXX**).

We also strongly suggest adding a suffix including your visit ID, autoloader position and EPU as a suffix

(i.e., **Supervisor\_YYYYMMDD\_XXXXXX\_biXXXXXXXX\_positionX\_EPU**)

- **Grid Type:** Holey carbon (Quantifoil: Hole finding enabled)  
Lacey carbon (Lacey: Hole finding disabled, targets added via pattern)
- **Session Type:** Manual (allows hole selection brush to be used)
- **Acquisition Mode:** Faster (AFIS, Krios) / Accurate (Talos only)  
AFIS – beam-image shifting, Accurate – Stage movement
- **Image format:** MRC

**Note:** These are the Atlas, GridSquare, Hole and Data images stored in the EPU folder. Using MRC is recommended to retain the extended MRC header information

- **Dose fraction output format:** Tiff LZW Non-Gain normalized

**Note:** These are the raw movie stacks from the detector. Using Tiff LZW non-gain normalized is required by eBIC. Please note that if EPU crashes this will revert back to .mrc format so **always double check** 'Tiff LZW Non-Gain normalized' is selected.

- **Output folder:** Select the SSD storage folder path: Z:\[your session ID, i.e., biXXXXXX]

**Note:** If you do not see a folder with your session ID and atlas in the Z:\ drive (i.e., :Z\biXXXXX), ask your LC to initiate 'murphy' before you set up your Atlas session

☐ Click 'Apply'

## 5.2 Target setup

Automatic setup at this point can be utilised to dramatically speed up setup times; autoeucentric, hole finding and filtering are first tested on an initial grid square (5.2.1) and then applied to all subsequently selected squares (5.2.2). We recommend, after adding squares (5.2.2.1) you may tell EPU to process all selected squares, refining eucentricity, finding holes and applying the ice filter for each grid square (5.2.2.2).

You may still choose to manually add targets, selecting a square (5.2.2.3) refining the eucentric height and selecting the acquisition positions in holes on each square individually.

First set up one square to establish your hole finding and ice filter conditions.

### 5.2.1 Initial square selection and hole targeting

#### 5.2.1.1 Square selection

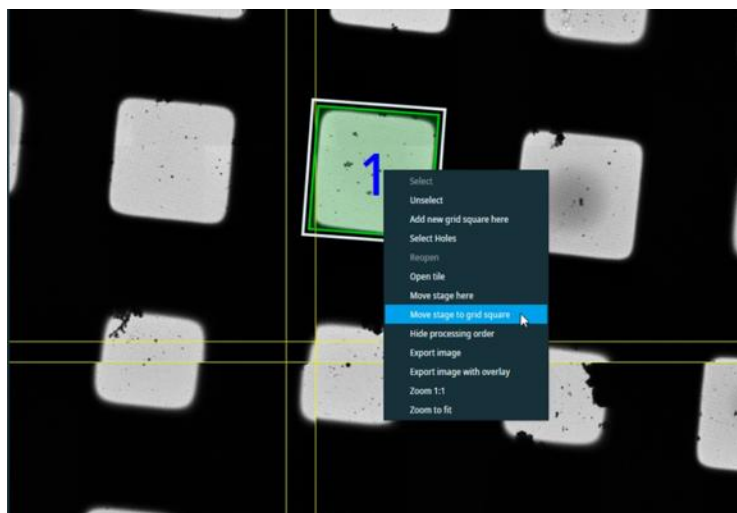
- ☐ Select a square in the Atlas for setting up acquisition targets

(EPU: EPU > Preparation > Square Selection > Right-click on square and press 'Select')

**Note:** If EPU struggles to add the square you may use 'Add new grid square here'

- ☐ Navigate to the selected gridsquare

(EPU: EPU > Preparation > Square Selection > Right-click on square and press 'Move stage to grid square')



#### 5.2.1.2 Hole selection (for holey carbon grids)

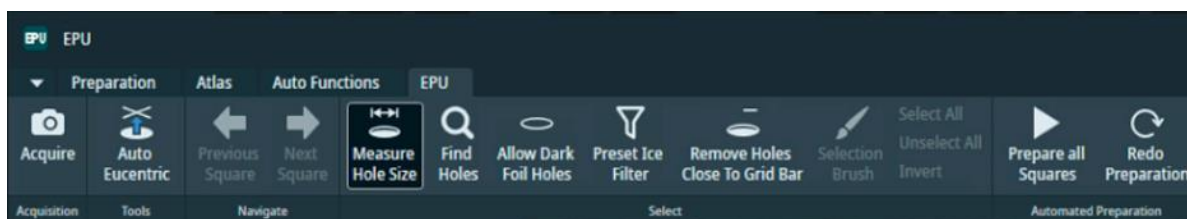
- ☐ Acquire an image of the gridsquare

(EPU: EPU > Preparation > Hole Selection > press 'Acquire')

- ☐ Set eucentric height for the selected gridsquare

(EPU: EPU > Preparation > Hole Selection > press 'Auto Eucentric')

*Note: skip if you have manually set eucentric height for this grid square using Auto Functions*

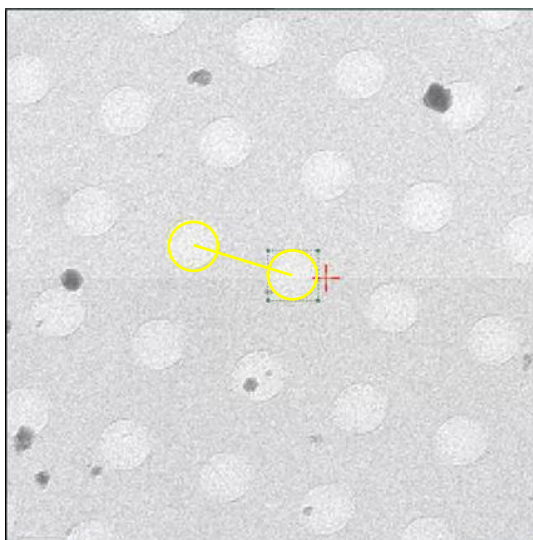


- ☐ Measure hole size

(EPU: EPU > Preparation > Hole Selection > press 'Measure Hole Size')

Left-click on the hole size outline to manipulate the yellow hole outline circles (resize the circles and drag them to two adjacent holes)

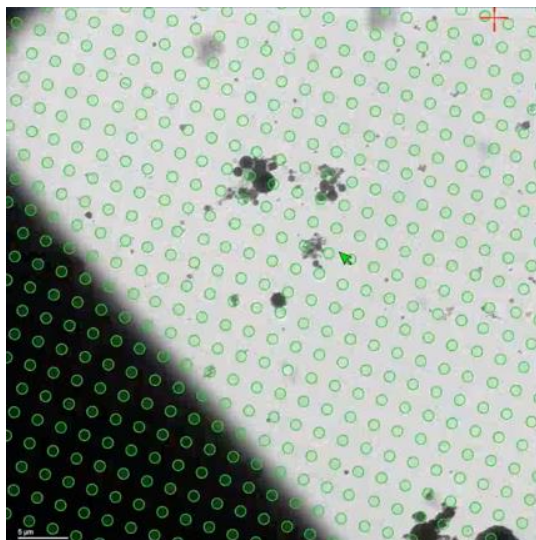
**Note:** You only need to do this on the first square



- ☐ Find holes

(EPU: EPU > Preparation > Hole Selection > press 'Find Holes')

Inspect quality of hole targeting using middle-scroll to zoom, left-click + drag to navigate

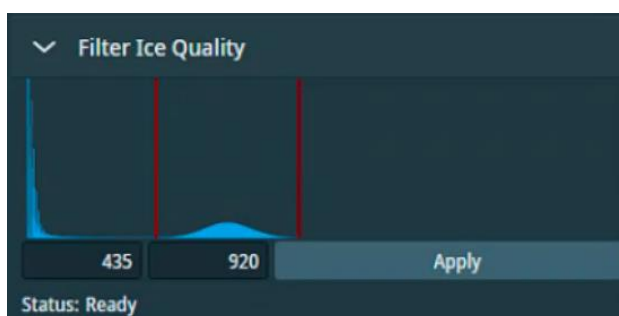


### 5.2.1.3 Filter the hole selection

- ☐ Adjust the ice filter to remove contaminated holes, dry holes and grid bars

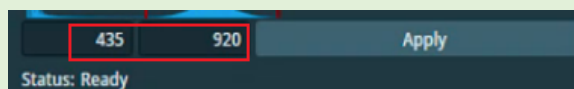
(EPU: EPU > Preparation > Hole selection > 'Filter Ice Quality' (right hand side of EPU window, bottom Histogram))

**Note:** the ice filter values correspond to grey scale values in the grid square image



#### Bugs in EPU 3.4.0.5:

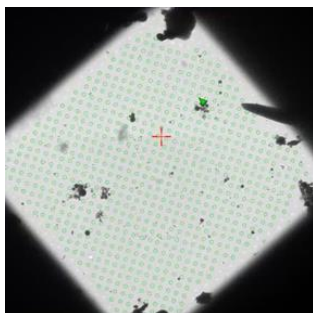
- 1) If you don't see any obvious peaks try adjusting the scaling on the histogram – this is a particular issue in EPU 3.4.0.5.



- 2) If the hole filtering is not working properly (e.g., **all** holes disappear when you adjust the filter) try removing the I0 calibrations as detailed in **section 5.1.1**

- ☐ Remove holes next to grid bar (optional)

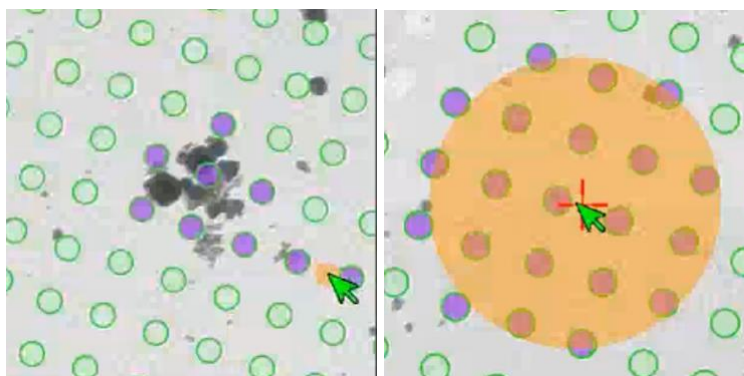
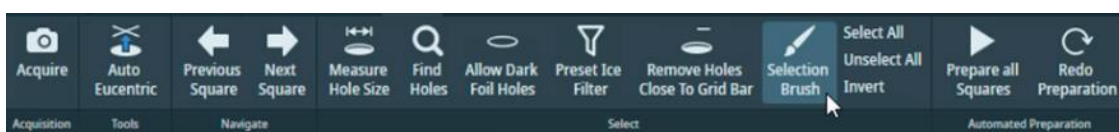
(EPU: EPU > Preparation > Hole Selection > select 'Remove Holes Close to Grid Bar' (optional))



- ☐ Use the Selection Brush to edit the hole targets on the square

**Left-click:** remove, **ctrl+left-click:** add, **shift+middle-scroll:** adjust brush size

**Note:** for MacOS, if scrolling fails, try using your trackpad to scroll.



## 5.2.2 Additional square selection and hole targetting setup (Automatic/Manual)

You may now either continue adding and setting up squares and hole acquisition targets manually or proceed automatically.

Under the session information box you may enter the expected number of 'Exposures per hour:' and the 'End of tool time:' to be given an indication of how many squares you need to add.

### 5.2.2.1 Square selection

We strongly recommend that users select and prepare a small subset of ~ 5 squares initially to ensure that automatic square preparation is functioning as expected (i.e., finding the correct z-height consistently etc.).

After ensuring that the 'prepare all squares' tool is functioning as expected on a subset of squares, you may continue adding additional squares> You should aim to get data collection started by 4pm. This is to ensure your Local Contact can get start data transfer during normal working hours (9am – 5pm).

Users may stop data collection to add more targets as required during their session. Please communicate with your Local Contact your plan.

- ☐ Navigate to a square



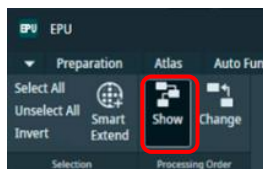
*(EPU: EPU > Preparation > Square Selection)*

*Right-click on a grid square in the image and press 'Move stage to grid square'*

- ☐ Check the 'Show' box to label selected squares

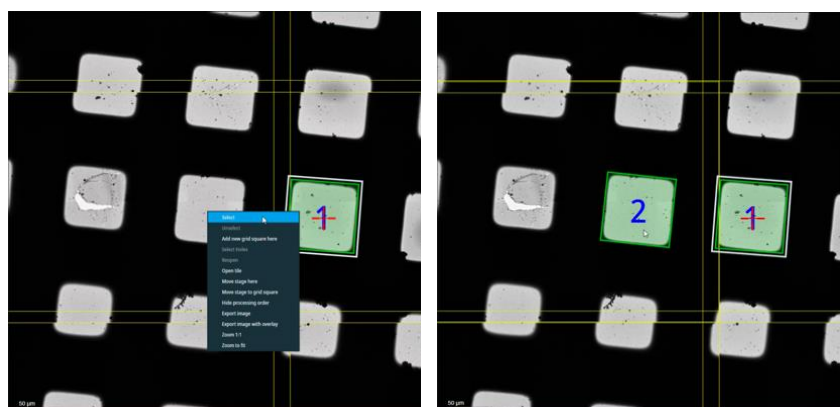
*(EPU: EPU > Preparation > Square Selection > Processing order > 'Show')*

**Note:** that if you activate the 'Change' button, clicking on a square will move that to the top of the collection order



- ☐ Add the square to your selected squares

*Right-click on the grid square and press 'Select'*



If you intend to use Automatic Hole Target Setup then proceed to 5.2.2.2

If you intend to use Manual Hole Target Setup then proceed to 5.2.2.3

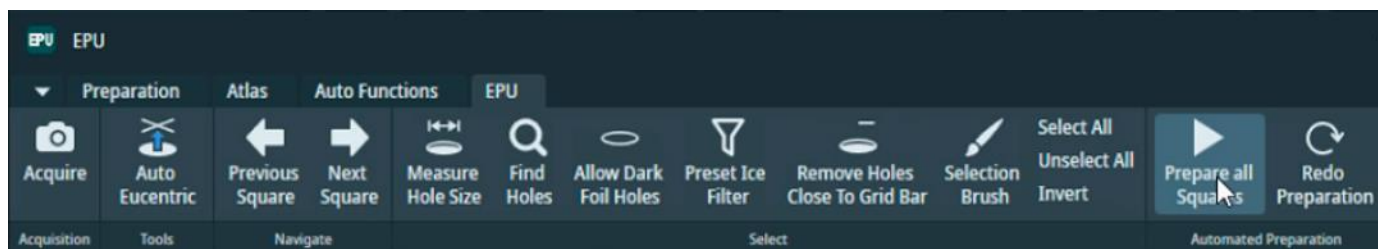
### 5.2.2.2 Automatic hole target setup

- ☐ Continue adding squares as in 5.2.2.1 until you reach an appropriate number of squares
- ☐ Prepare all Squares using the hole filtering you set up in section 5.2.1.2

*(EPU: EPU > Preparation > Hole Selection > Automated Preparation > 'Prepare all Squares')*

**Note:** EPU will attempt to find eucentric height, 'Find Holes' and apply the Ice Filter to automatically set up hole targets

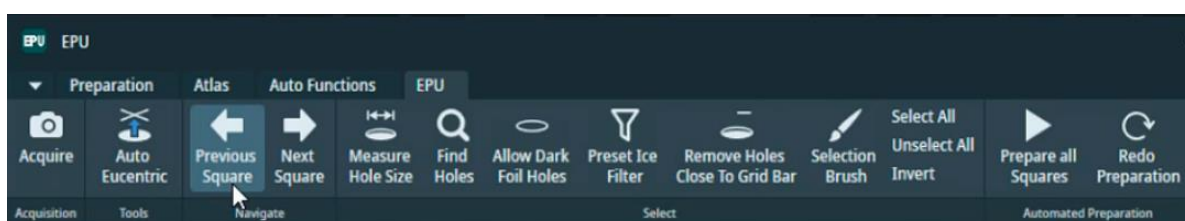
**Note:** You should keep an eye on the 'z-height' displayed in the bottom left corner for each square during square preparation and ensure this is consistent with what you would expect in different areas of the grid. If the eucentric height appears to vary significantly from square to square speak to your LC



- ☐ Inspect the quality of the automated square preparation

Switch between the squares to inspect the quality of the hole target setup and ensure that the z-height for each square is as expected (z-height displayed in bottom left of image)

(EPU: EPU > Preparation > Hole Selection > Automated Preparation > Navigate > 'Next Square')



- ☐ Refine hole target selection as required using the Selection Brush as described in section 5.2.1.2

### 5.2.2.3 Manual hole target setup

- ☐ Repeat the steps taken in section 5.2.1 for each square you wish to set up

## 5.2.3 Template definition

### 5.2.3.1 Hole targetting

- ☐ Move to a hole

(EPU: EPU > Hole Selection > Right-click on a hole > 'Move stage to location')

- ☐ Acquire an image of the hole

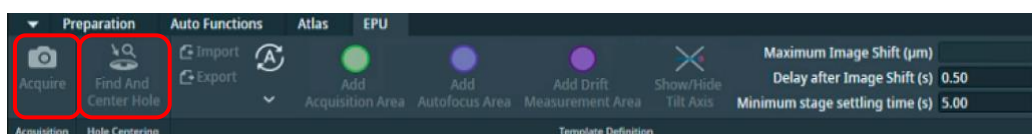
(EPU: EPU > Template Definition > Acquisition > press 'Acquire')

**Note:** You should examine the GridSquare to Hole accuracy. This is a good opportunity to confirm image shift calibrations are accurate. You may want to check on several holes to confirm consistent behaviour.

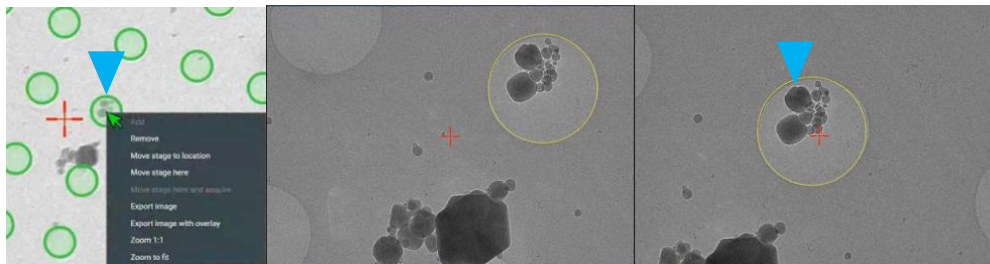
- ☐ Centre the hole in the field of view

(EPU: EPU > Template Definition > Hole Centring > Find and Center Hole)

**Note:** You should examine the Hole centring accuracy. The hole targeted for template definition is expected to be found after 'Find and Center Hole'. You may want to check on several holes to confirm consistent behaviour.







GridSquare

Hole

Hole  
(Find and Center Hole)

### 5.2.3.2 Setting a template for acquisition areas and defocus series

- ☐ Add Acquisition Area(s)

(EPU : EPU > Template Definition > Template Definition > press 'Add Acquisition Area')

- ☐ Position the acquisition area(s) in the desired location

(EPU: Left-click+drag to reposition)

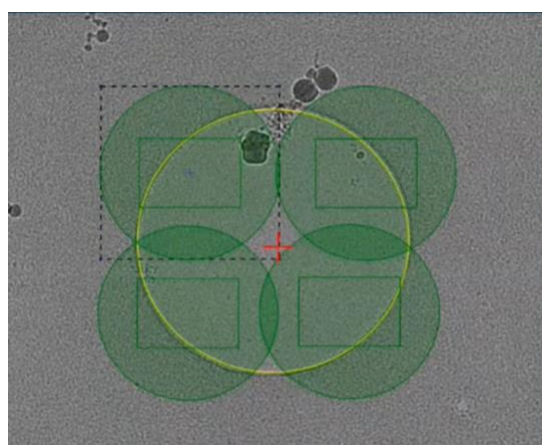
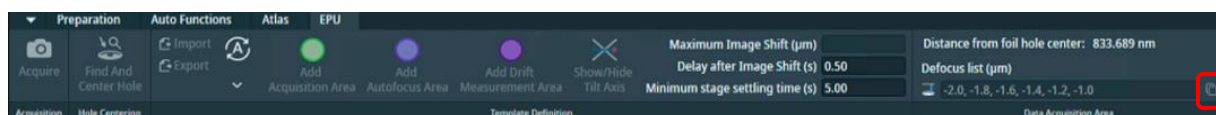
**Note:** For multishot strategies you may overlap the beam areas (circle) a little but **do not** overlap beam with the image acquisition area (rectangle)

- ☐ Select the Acquisition area and enter a defocus series you have determined to use for your session

(EPU: EPU > Template Definition > Data Acquisition Area > Defocus list ( $\mu\text{m}$ ) > enter a list)

**Note:** Ensure all values input are negative!

**Note:** For multi shot strategies use the copy button to copy defocus series to all acquisition areas



### 5.2.3.3 Defocus area and dwell times

- ☐ Add an AutoFocus area

(EPU : EPU > Template Definition > Template Definition > press 'Add AutoFocus Area')

- ☐ Position the autofocus area on carbon near the hole

(EPU: Left-click+drag to reposition)

- ☐ Select the AutoFocus area and enter a focussing regime

(EPU: *EPU > Template Definition > AutoFocus Area > select parameter for 'Recurrence'*)

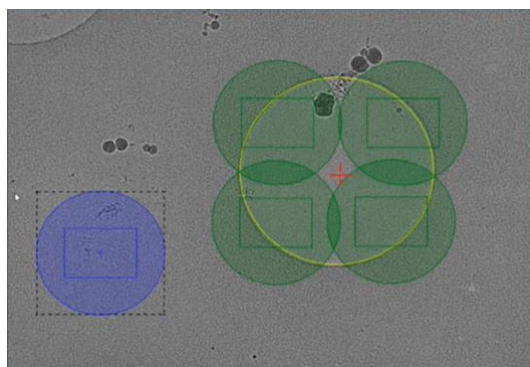
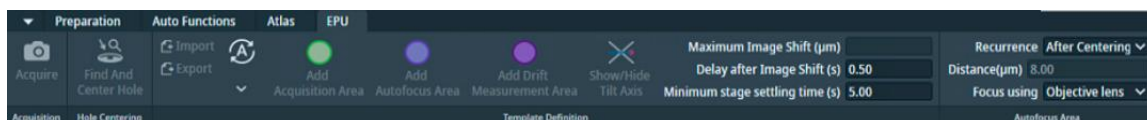
**Recurrence:** After Centering (suggested when using Faster Acquisition - see 5.1.1)  
After Distance (suggested when using Accurate Hole Centering - see 5.1.1)

- ☐ Select the AutoFocus area and setup settling times for stage and image shift (suggested)

(EPU: *EPU > Template Definition > Template Definition > add parameter for 'Delay after Image Shift' and 'Minimum stage settling time'*)

**Delay after Image shift (s):** 0.50 – 1.00

**Minimum stage settling time (s):** 3.00 – 5.00



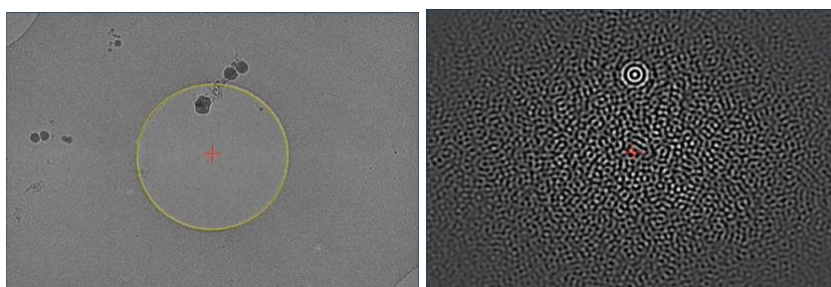
## 5.2.4 Template execution

This will run a trial automated acquisition on the hole that is currently centred on the stage, you can check for the success of hole centring, autofocus and acquisition areas. Note that the first defocus value in the defocus series setup in 5.2.3.3 will be used. This function can also be helpful if you need to test whether your template definition is targeting the best area of the hole for your particle distribution.

- ☐ Execute the template

(EPU: *EPU > Template Execution > Preview*)

- ☐ Inspect the image and status report to assess template execution





## 6 SPA multigrid set up

The multigrid functionality of EPU allows you to set up multiple grids for data collection, such that changing grid from one autoloader position to another is performed automatically as part of an EPU data collection. A Queue is created under the EPU tab and within this, each new grid to be collected on is added as a queued Session.

**These sections assume a familiarity with SPA single grid setup (section 5) for some specific operations but also troubleshooting. Please ask your Local Contact if you should require assistance.**

There are several ways to set up and utilise multigrid, so here we present two approaches that have been tested at eBIC:

- |                                       |   |
|---------------------------------------|---|
| <b>6.4 Automatic queuing of grids</b> | - For session parameters consistent across all grids      |
| <b>6.3 Manual queuing of grids</b>    | - For session parameters unique to all or groups of grids |

### 6.1 Current considerations

Please keep in mind that EPU multigrid is a new feature to the EPU software.

Further considerations on eBIC systems are that:

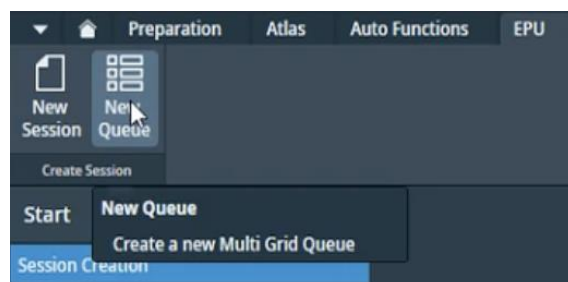
- 1) A single DataAcquisition magnification must be used for all grids in the Queue
  - a. As for all eBIC visits, the DataAcquisition magnification is set by your Local Contact
- 2) Different grid types may be used but it might help to group Sessions by their grid type
- 3) The I/O calibration must be removed
- 4) We strongly advise to monitor the data collection, particularly during grid changing
  - a. To check the grid translation and rotation calibration is successful on grid loading
  - b. To check automatic on-the-fly GridSquare set up is functioning correctly

### 6.2 Prerequisite steps

- ☐ Remove the I/O calibrations (**very important**)



- ☐ Atlas your grids as in section 4.1
- ☐ Load a representative grid onto the stage from inside the Atlas tab
- ☐ Adjust your Presets appropriately for the Grid Type as in section 3.2
- ☐ As necessary, calibrate the image shifts between any newly adjusted Presets as in section 3.3
- ☐ Create a new Queue under the EPU tab



- ☐ Proceed to Manual (section 6.3) or Automatic (section 6.4) queuing of data collection sessions

## 6.3 Manual queuing of grids

This approach follows the concept of loading a grid from inside EPU, adding the first grid to the Queue as a Session and establishing session parameters on it. Subsequent grids are also loaded onto the stage from inside EPU and added to the Queue as Sessions, and each may be set up individually, thus allowing a unique set of session parameters to be established per grid. Unique session parameters have been successfully tested at eBIC for the following:

- 1) Hole/Eucentric preset magnification and defocus
- 2) Template definition (shot number, pattern and defocus series)
- 3) Ice filter user defined boundaries
- 4) Data Acquisition energy filter slit width (eV) settings

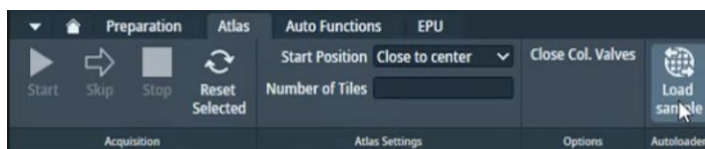
However, due to the requirement for Local Contact intervention for magnification dependent energy filter tuning, only a single DataAcquisition magnification may be used.

Each grid loaded onto the stage and added to the queue can have a custom set up. However, note that any subsequent grid left unmodified in the Queue will use the session parameters of the most recently collected grid. Therefore, you may choose to set up the first grid of each grid type manually on and automatically queuing (section 6.4) the rest of the same type, i.e. all 1.2/1.3 first and then all 2/2 grids.

### 6.3.1 Set up the first grid

#### 6.3.1.1 Grid loading

- ☐ Ensure the grid you want to set up has been loaded onto the microscope stage from within the Atlas tab



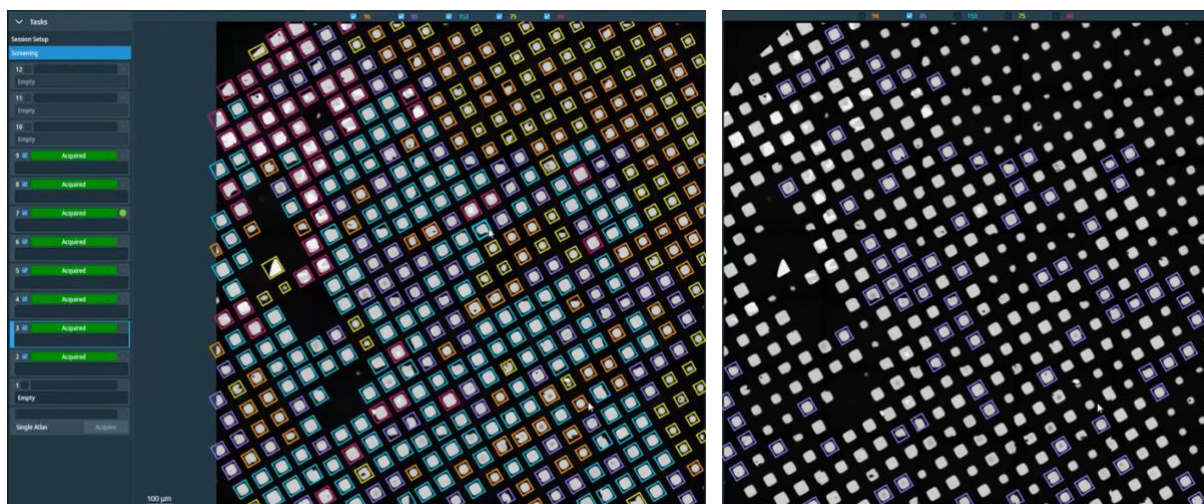
- ☐ Ensure that the Status window reports a sample displacement has been measured



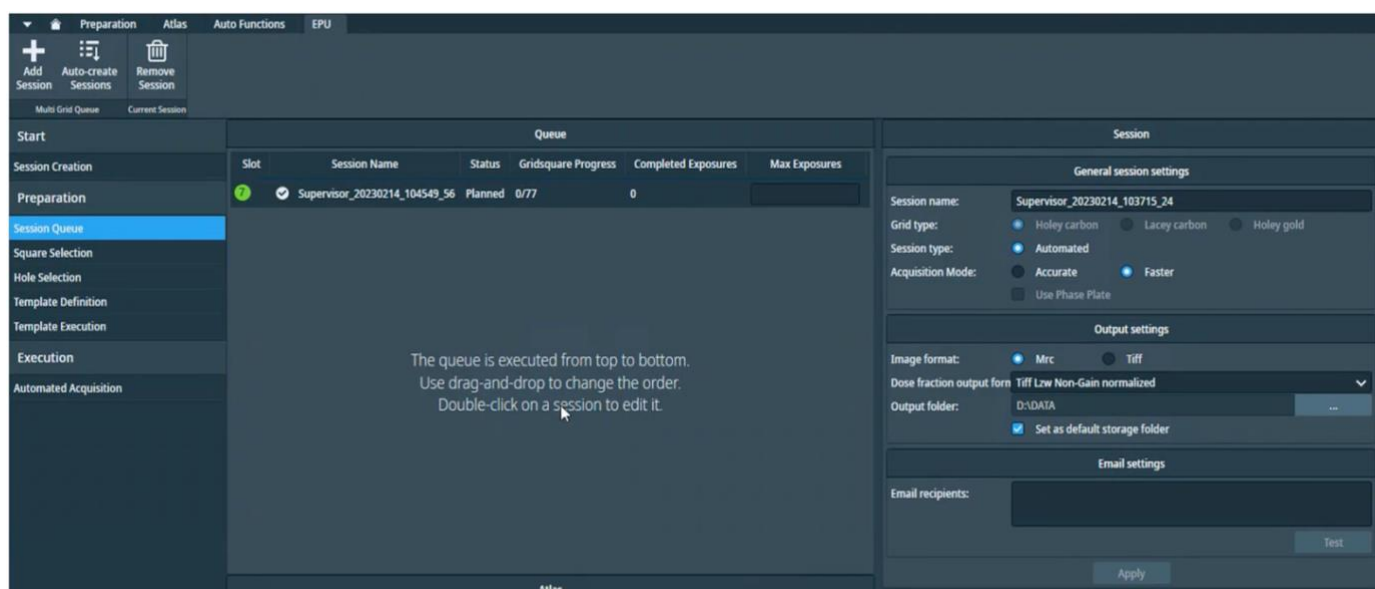
#### 6.3.1.2 Square targeting

- ☐ Adjust the square selection under the Atlas tab
- ☐ Leave only the Grid Squares you wish to collect on selected

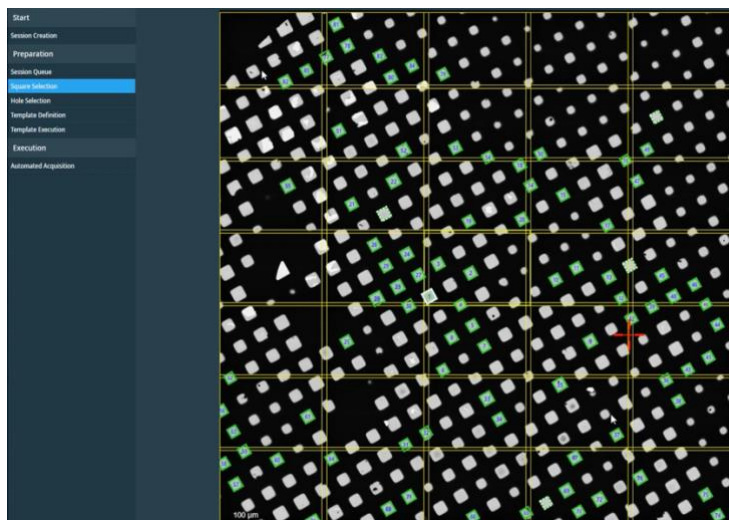




- ☐ Click Add Session under the EPU tab to queue a new Session for the grid currently on the stage
- ☐ Set up the Session parameters as in section 5.1.1 as press Apply

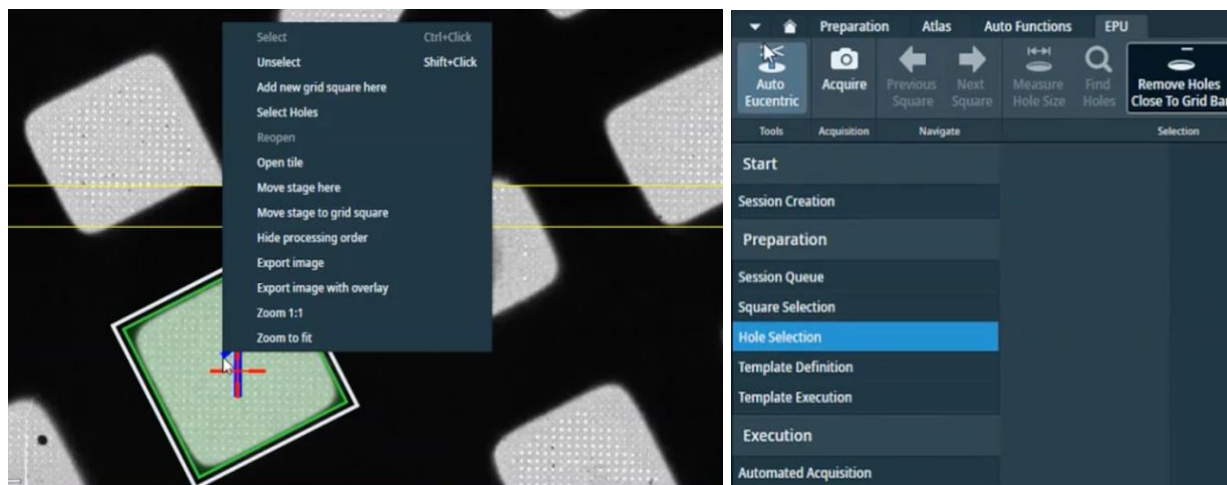


- ☐ Notice the square selection from the Atlas tab is carried over to the EPU tab Square Selection task  
You may choose to unselect all Squares and manually select those you want

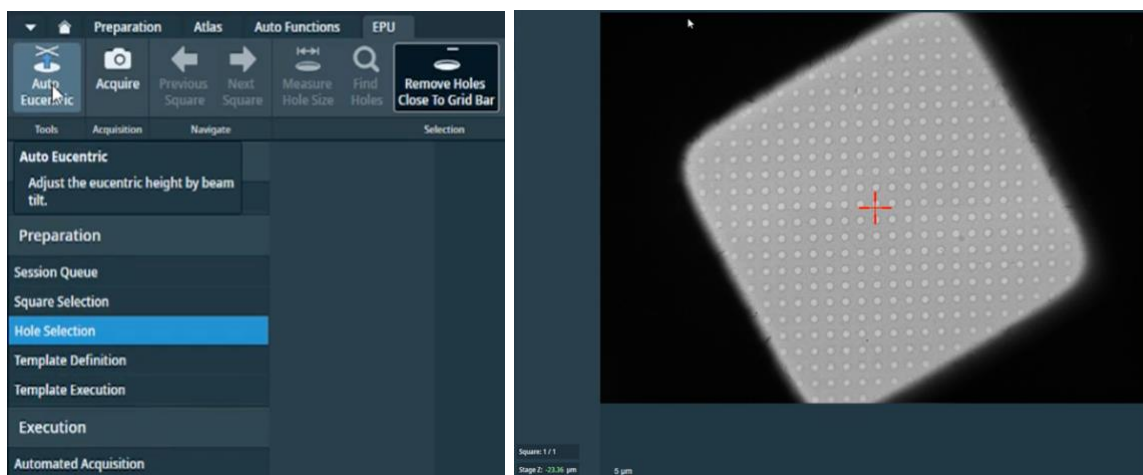


### 6.3.1.3 Hole targeting

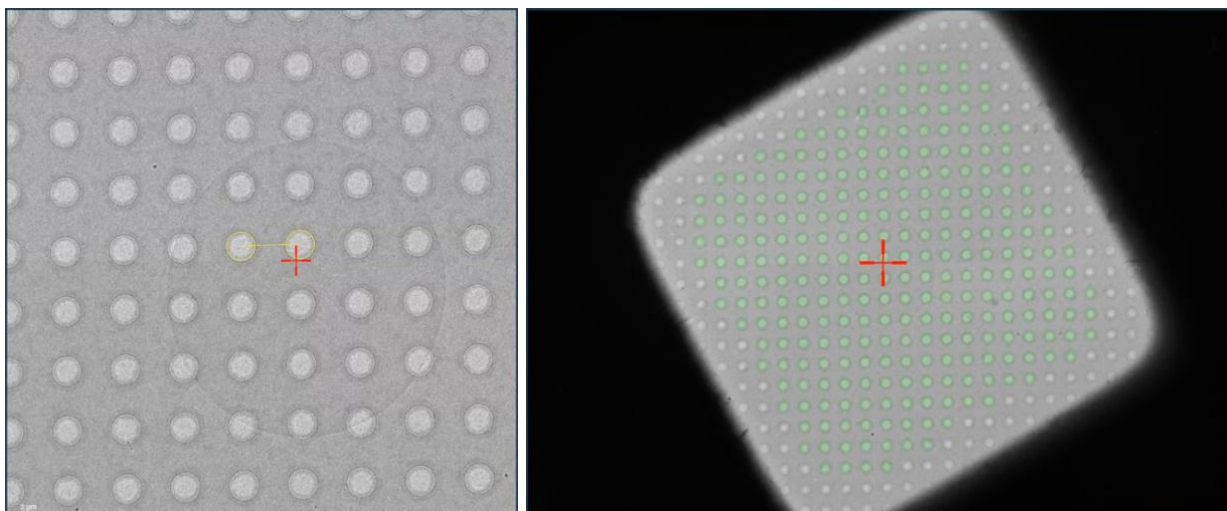
- ☐ Chose a representative square to set up on and right click to Select Holes



- ☐ Press the Auto Eucentric button to automatically move the stage to the selected Grid Square and perform auto eucentric by beam tilt



- ☐ Measure, Find Holes, and select Remove Holes Close to Grid Bar, as in section 5.2.1.2



#### 6.3.1.4 Hole filtering

- ☐ Adjust the ice filter as in section 5.2.1.3.

The ice filter boundaries will be remembered for this Session in the Queue and so can be set as stringently as required:

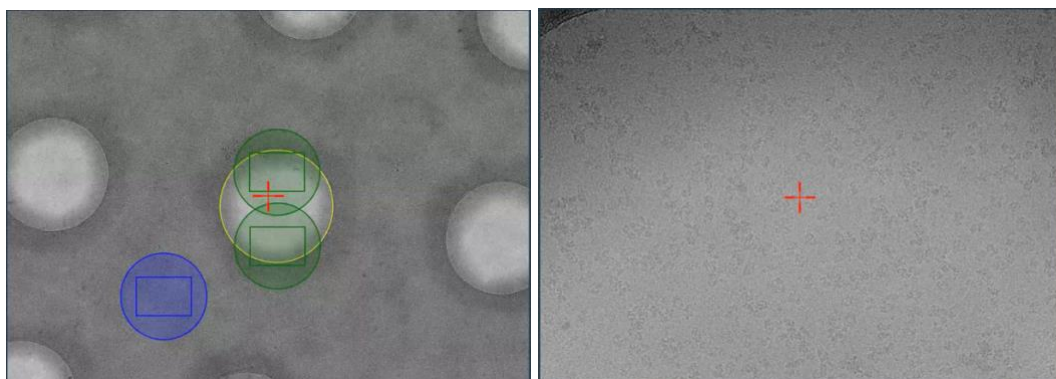


The following shows an example of the ice filter for a subsequently loaded grid Session in the Queue, and that the filter reads unique values from the GridSquare image and different user defined boundaries which will be recalled during data collection:



#### 6.3.1.5 Template

- ☐ Move the stage to a hole target
- ☐ Adjust your template, defocus strategy, and autofocus behaviour as in section 5.2.3
- ☐ Run a Template Execution as in section 5.2.4 to test your set up, remember this routine will run wherever the stage is currently positioned



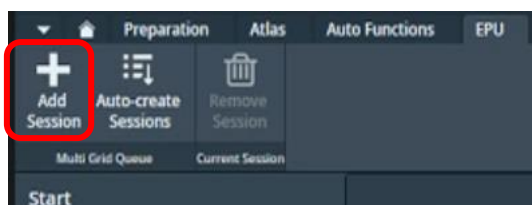
#### 6.3.1.6 Finalise

It is only necessary to set up Grid Squares to test the square targeting, hole finding and filtering and the template execution. You may set up additional squares if you wish to further test the sessions behaviour but note that every square (including any manually set up squares) will still be set up again on-the-fly (auto-eucentric by beam tilt and hole finding) during data collection.



### 6.3.2 Load a subsequent grid

- ☐ Load the next grid onto the stage
- ☐ Ensure that the Status window reports a sample displacement has been measured
- ☐ Once on the stage, add the grid to the Queue manually by pressing Add Session under the EPU tab



### 6.3.3 Set up targeting and other custom Session parameters

- ☐ You may check whether the Presets are appropriate for the newly loaded grid as in section 3.2  
Remember to check your image shift calibrations if you change any Presets, as in section 3.3
- ☐ Set up the rest of the Session as in sections 6.3.1.1 – 6.3.1.3
- ☐ You may adjust the ice filter (section 6.3.1.4) to be suitable to the currently loaded grid
- ☐ You may customise your template as in section 6.3.1.5

### 6.3.4 Repeat for all grids

- ☐ You may repeat these steps individually for each grid you want to collect on
- ☐ When all grids have been added, you may proceed to section 7 to perform final checks and begin data collection

Remember in this workflow, since each grid is loaded onto the stage and added manually to the Queue, there is opportunity to appropriately customise session and preset parameters. If you are collecting on groups of similar grid types, you may set up the first grid manually as in this section and subsequent similar grid types automatically without screening their Session settings. Then for the next grid type, load and set up the first of the set manually.

Note: EPU will use the session setup for all subsequent grids in the Queue until it reaches a grid with a different session setup. Remember, every square (including any manually set up squares) will still be set up on-the-fly (auto-eucentric by beam tilt and hole finding) during data collection.

## 6.4 Automatic queuing of grids

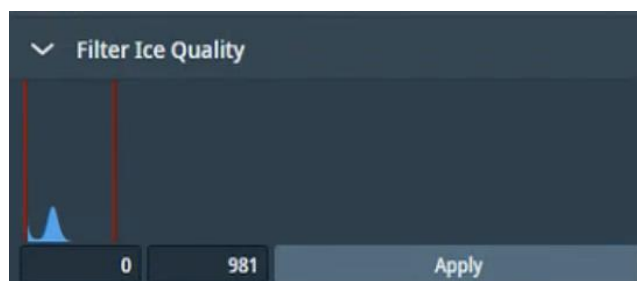
This approach follows the concept of loading the first grid from inside EPU, adding to the Queue as a Session, establishing session parameters that will be used for this master grid and then all subsequent grids. Subsequent grids are added as Sessions to the Queue automatically and are set up on-the-fly. Where each subsequent grid in the queue is left unmodified it will use the master defined presets and template.

### 6.4.1 Set up a master grid

- ☐ Set up the grid you wish to use as the master grid as in sections 6.3.1.1 – 6.3.1.3

These settings will be used by all subsequent grids in the Queue

- ☐ You may adjust the ice filter (section 6.3.1.4 **Error! Reference source not found.**) but we recommend leaving lots of room in the boundaries to accommodate intensity changes in subsequent grids

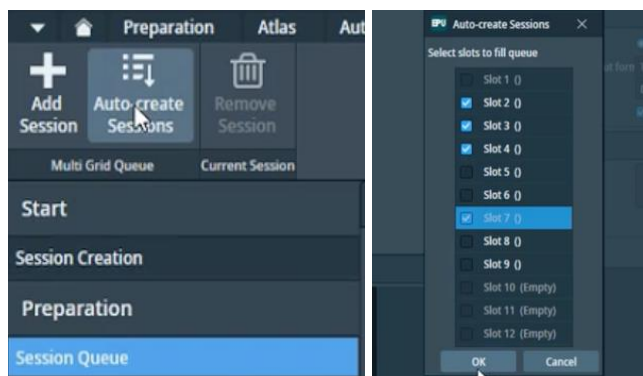


- ☐ Set up your template as in section 6.3.1.5

**Important: all parameters including the ice filter settings and hole template will be carried over onto subsequent grids. In particular, when using the automatic set up approach we recommend setting the ice filter boundaries conservatively since it may change from grid to grid.**

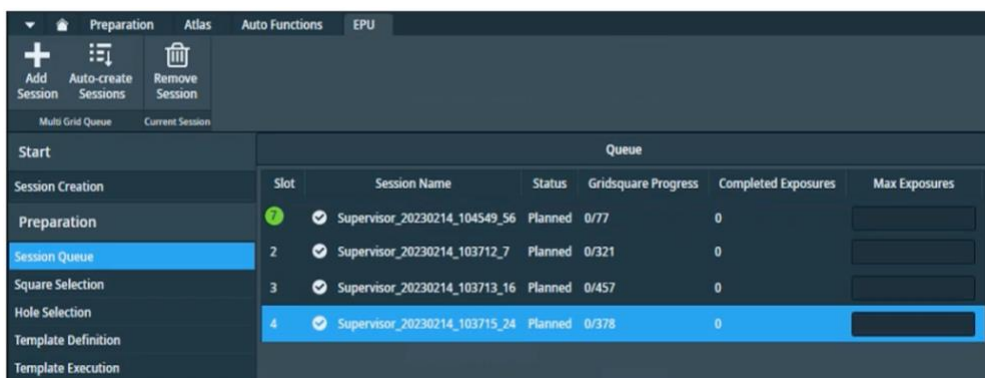
#### 6.4.2 Auto create additional Sessions for subsequent grids

- ☐ If you are satisfied with the set up and that it will apply to all subsequent grids you may select Auto-create Sessions
- ☐ Select the additional grids you wish to collect data on



- ☐ Note that if no square selection is made in the atlas, all available Grid Squares will be queued for collection
- ☐ You may modify the targeted squares under the Square Selection tab and/or enter Max Exposure values for each grid





The screenshot shows the EPU software interface with the 'Session Queue' table. The table has columns for Slot, Session Name, Status, Gridsquare Progress, Completed Exposures, and Max Exposures. The 'Session Queue' tab is selected in the left sidebar. The table contains four rows of session data, all with a status of 'Planned' and 0 completed exposures.

Slot	Session Name	Status	Gridsquare Progress	Completed Exposures	Max Exposures
1	Supervisor_20230214_104549_56	Planned	0/77	0	
2	Supervisor_20230214_103712_7	Planned	0/321	0	
3	Supervisor_20230214_103713_16	Planned	0/457	0	
4	Supervisor_20230214_103715_24	Planned	0/378	0	

☐ You may proceed to section 7 to perform final checks and begin data collection

Remember in this workflow, additional grids are not yet loaded onto the stage and so you will only be able to explore the grids from the available Atlas under the Square Selection task.

Note: EPU will use the entire session setup for all subsequent grids in the Queue. Remember, every square (including any manually set up squares) will still be set up on-the-fly (auto-eucentric by beam tilt and hole finding) during data collection.

## 7 Final checks and data collection

### 7.1 Auto Functions and alignment

☐ For alignments, use *EPU > Square Selection* to navigate to an area of carbon

**Note:** *If you do this on the most recently set up square and you will already be at eucentric height*

☐ Set eucentric height (if required)

#### 7.1.1 Alignments via Autofunctions

Alignments must be performed at eucentric focus which is achieved by bringing the sample to eucentric height, adjusting the objective lens to be at focus. The objective aperture should also initially be removed.

☐ Remove the objective aperture if inserted ☐ Perform Autofunctions in the following order:

**Note:** *If you are already at eucentric you can skip Step 1. If you moved to a new square, perform Step 1.*

**Note:** *Ensure that you select the corresponding Preset for each Auto Function alignment*

#### Step 1: Auto Eucentric

- 1) Select 'AutoEucentric by beam tilt' in the autofunctions tab  
(*EPU: Autofunctions > AutoEucentric by beam tilt*)
- 2) Set to 'Hole EucentricHeight' magnification preset **in autofunctions**  
(*EPU: Autofunctions > Preset 'Hole EucentricHeight'*)
- 3) Press 'Start'

#### Step 2: AutoFocus

- 1) Select 'AutoFocus' in the autofunctions tab  
(*EPU: Autofunctions > AutoFocus*)
- 2) Set to 'AutoFocus' magnification preset **in autofunctions**  
(*EPU: Autofunctions > Preset 'AutoFocus'*)
- 3) Press 'Start'

#### Step 3: Autostigmat

- 1) Select 'Autostigmat' in the autofunctions tab  
(*EPU: Autofunctions > Autostigmat*)
- 2) Set to 'Thon Ring' magnification preset **in autofunctions**  
(*EPU: Autofunctions > Preset 'Thon ring'*)
- 3) Press 'Start'

**Note:** *The astigmatism should ideally be less than 5 nm*

#### Step 4: Autocom

- 1) Select 'Autocom' in the autofunctions tab

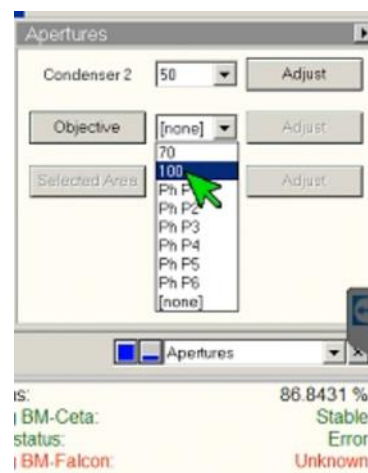
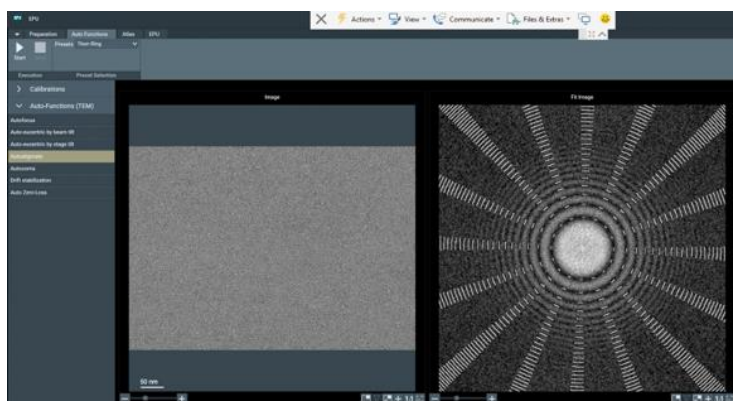
(EPU: Autofunctions > Autocomma)

- 2) Set to 'Thon Ring' magnification preset **in autofunctions**

(EPU: Autofunctions > Preset 'Thon ring')

- 3) Press 'Start'

**Note:** The coma would typically be less than 200 nm on eBIC Krioses



### 7.1.2 Beam centring

This assumes the objective lens is at eucentric focus from the previous alignments. If you are in doubt you may repeat Step 1 & 2 from 7.1.1.

- ☐ Switch to the TEM user interface (TUI)

- ☐ Insert the flu screen

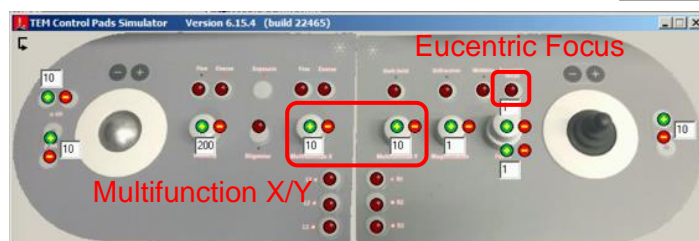
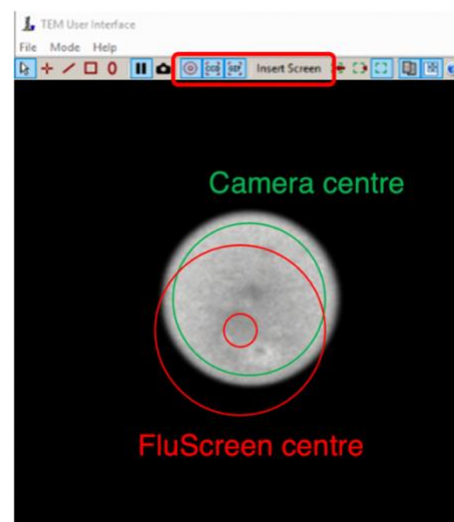
(TUI: Insert Screen)

- ☐ Load the TEM Control Pads Simulator

- ☐ Inspect if the beam is centred

- ☐ Recentre if necessary

- 1) Select 'Beam Shift' from the Direct Alignments  
(TUI: Direct alignments (bottom right drop down) > Beam Shift)
- 2) Use the **multifunction X/Y** on the simulator pads to centre the beam
- 3) Click 'Done' on the Direct Alignment panel



### 7.1.3 Objective aperture

- ☐ Insert the 100 µm objective aperture

(TUI: drop down menu (bottom right) > Apertures > Objective – yellow when in, grey when out)

☐ Inspect if the beam is centred

☐ Recentre if necessary

- 1) Select 'Beam Shift' from the Direct Alignments  
(TUI: Direct alignments (bottom right drop down) > Beam Shift)
- 2) Use the **multifunction X/Y** on the simulator pads to centre the beam
- 3) Click 'Done' on the Direct Alignment panel

☐ Repeat the Autostigmatize Auto Function on a carbon area

### Autostigmatize

- 1) Select 'Autostigmatize' in the autofunctions tab  
(EPU: Autofunctions > Autostigmatize)
- 2) Set to 'Thon Ring' magnification preset **in autofunctions**  
(EPU: Autofunctions > Preset 'Thon ring')
- 3) Press 'Start'

**Note:** The astigmatism should ideally be less than 5 nm

## 7.1.4 Zero-loss peak

The zero-loss peak centring routine can also be checked using the option in the Auto Functions tab. You may wish to run and check this routine before starting the data collection if you are using the energy selecting slit. This routine periodically runs during data collection using the Zero Loss preset and on the same area that you set up your autofocus area. Hence run the ZLP Auto Function on a carbon area representative of what would be encountered during data collection.

☐ Check your ZLP parameters

**e.g.,** Check the slit width is set to your desired width and that the width is the same for both the 'Zero Loss' preset and 'Exposure' preset)

Note whether the ZLP preset uses a larger spot size (lower number) than Exposure preset or the ZLP may fail.



☐ Perform Auto Zero-Loss Auto Function

### Auto Zero-Loss

- 1) Select 'Auto Zero-Loss' in the autofunctions tab  
(EPU: Autofunctions > Auto Zero-Loss)
- 2) Set to 'Zero Loss' magnification preset **in autofunctions**  
(EPU: Autofunctions > Preset 'Zero Loss')
- 3) Press 'Start'



☐ Inspect the Status window for reporting the operation was Successful

## 7.2 Start automated acquisition

### 7.2.1 Double check your data acquisition parameters

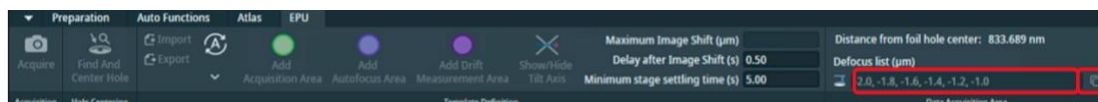
☐ Go to Data Acquisition preset and check your exposure time is consistent with your dose calculation (refer to 3.2.2)

*(EPU: Preparation > Preset Selection > Presets > 'Data Acquisition')*



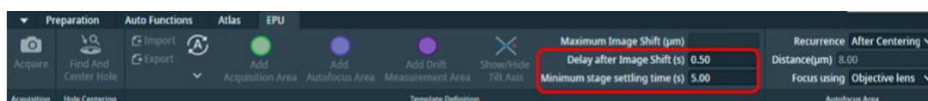
☐ Go to your template definition and check your defocus list (check numbers all negative and definitely copied to all acquisition areas) (refer to 5.2.3.2)

*(EPU: EPU > Template definition > Left-click on your acquisition area then check Defocus List)*



☐ Go to your template definition and check your stage and image shift wait/dwell times for autofocus are correct (refer to 5.2.3.3)

*(EPU: EPU > Template definition > Left-click on your autofocus area then check image shift wait/dwell times)*

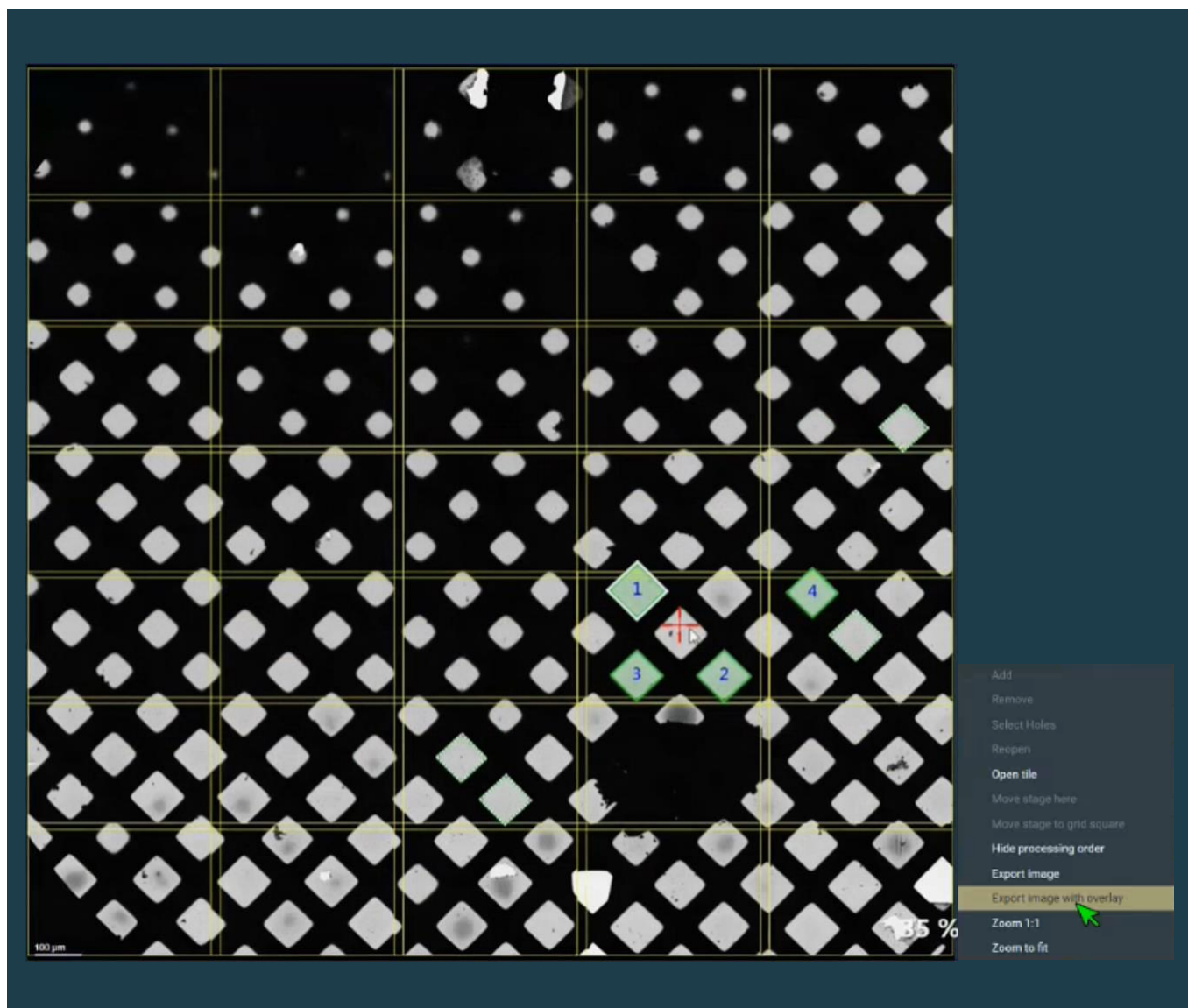


### 7.2.2 Record keeping

☐ Save an image of the Atlas with the squares you have set up

*(EPU: EPU > Preparation > Square Selection > Right-click > 'Export image with overlay')*

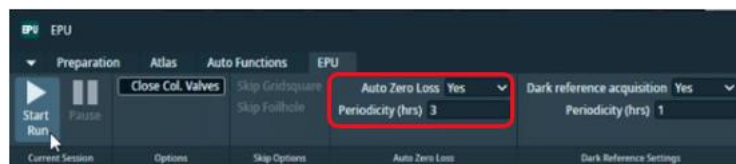




### 7.2.3 Data collection

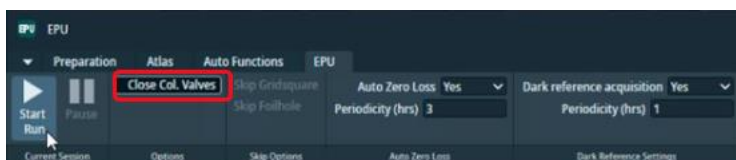
- ☐ Enable Auto Zero Loss refinement and input periodicity (suggested values between 3 - 8 hrs)

(EPU: EPU > Automated Acquisition > Auto Zero Loss > Auto Zero Loss > select 'yes' and add a value for 'periodicity')



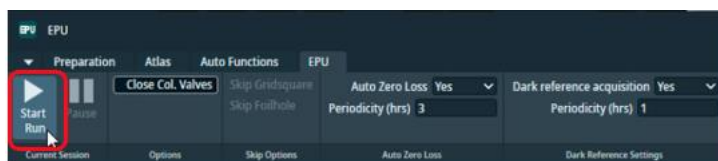
- ☐ Select Close Col. Valves to ensure column valves close once data collection is complete

(EPU: EPU > Automated Acquisition > Options > select 'Close column valves')

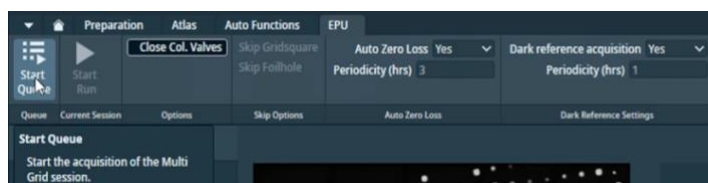


- ☐ Start the automated acquisition for SPA single grid

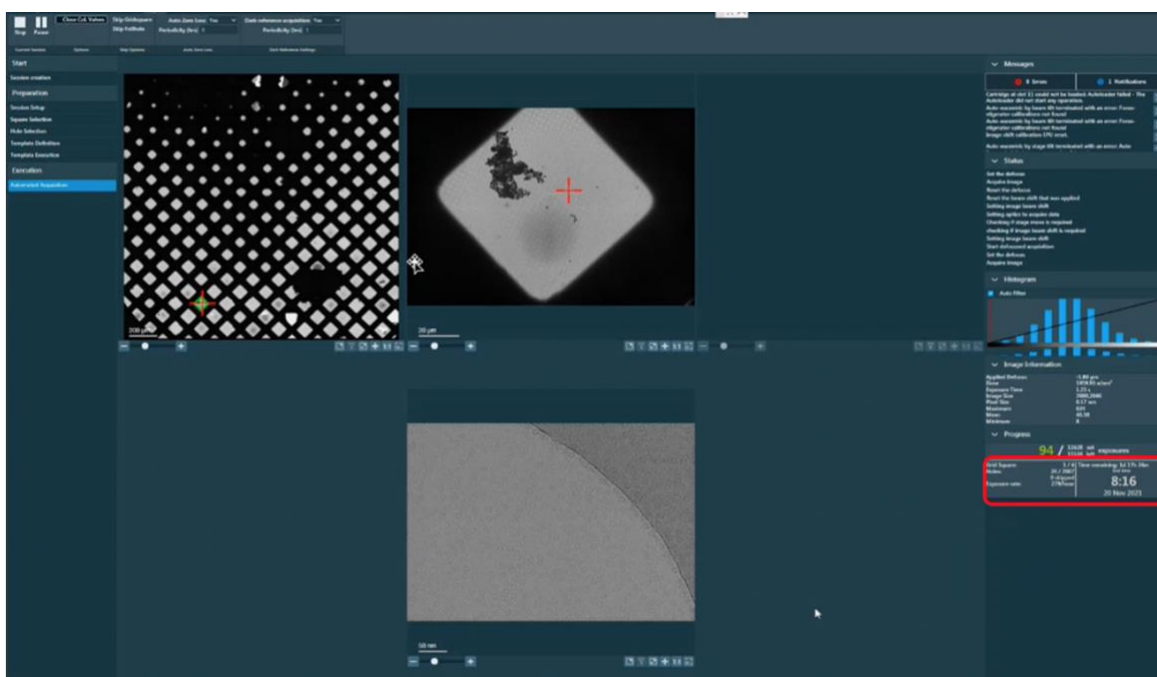
(EPU: EPU > Automated Acquisition > press 'Start')



- ☐ Star the automated acquisition Queue for SPA multi grid



- ☐ Monitor the beginning of data acquisition and frequently during your session
- ☐ **Inform your local contact that you have started your data acquisition.**
- ☐ Observe the estimated time remaining and plan to add more squares as required



## 7.2.4 Communication with you local contact during your session

Once collection is underway, you need to inform your Local Contact, who will commence the data transfer to your project directory.

If you wish to set up multiple data collections from different grids during your session, this is possible, provided that the same collection parameters are being used.

**You will need to inform your local contact in advance if you are planning to set up multiple collections so they can pause the automatic data monitoring system.** Please inform your local contact once you have set up a collection on a new grid, as they will have to run new data transfer scripts for each session that is run.

## 7.2.5 Set up on-the-fly processing

You may wish to start the auto-analysis pipeline by logging on to SynchWeb (<https://ispyb.diamond.ac.uk/>) and entering the session parameters in the 'Relion Processing' tab on your data collection page.

Please refer to the '[Remote access, analysis and data download:](#)' for further instructions.

## 7.2.6 Plan to request your dewar return in ISPyB

You should inform your local contact of your plans regarding the return of your dewar.

Please refer to the '[Shipping your dewar home](#)' section on our website for further instructions.

- ☐ Log in to ISPyB: <https://ispyb.diamond.ac.uk/>
- ☐ Select your visit/proposal
- ☐ Go to Proposal number > Shipments > Select shipment

Scroll to Shipment Contents

Click 'Dispatch dewar back to your lab'

### Shipment Contents

										+ Add Dewar	
Name	Barcode	Facility Code	Weight (Kg)	First Experiment	Tracking # to	Tracking # from	Status	Location	Containers	Click to dispatch de	
DLS-IN-0089	bi21404-17-m07-0050202	DLS-IN-0089	18	bi21404-17	9658845394	Click to edit	at facility	EBIC-IN-24	0	+	↔

## 7.2.7 Monitor your data collection



It is the user's responsibility to monitor their data collection and ensure that the quality is as expected. Please refer to the ['Remote access, analysis and data download'](#) for how to access and monitor your data.

If at any point you leave the microscope unattended, please ensure you close the NoMachine connection in case your LC requires access (only one NoMachine connection is permitted at a time for security reasons).

**For any issues:**

- During working hours (Mon-Fri, 9am-5pm) contact your **Local Contact** directly
- Outside working hours contact the **Diamond Experimental Hall Coordinators**

**phone:** 01235 77 8787

**email:** [experimentalhall@diamond.ac.uk](mailto:experimentalhall@diamond.ac.uk)

Tell them who your Local Contact is and the m0X number of the microscope you are on:

Microscope	m0X number
Krios I	m02
Krios II	m03
Krios III	m06
Krios IV	m07

**Anticipated pauses in data collection:**

Please note that EPU will pause collecting images when LN<sub>2</sub> is being refilled, or when GIF ZLP is being adjusted (for K3). These brief pauses in data collection should not last longer than 15-20 minutes. Additional time might be required for EPU to move to a new target and acquire an image.

If, after 30 minutes, no new files appear as described in the ['Remote access, analysis and data download'](#), please contact your Local Contact (LC) directly (during working hours ) or via the Diamond Experimental Hall Coordinators (outside normal working hours) as above.

## 7.2.8 Closing Teamviewer and disconnecting NoMachine

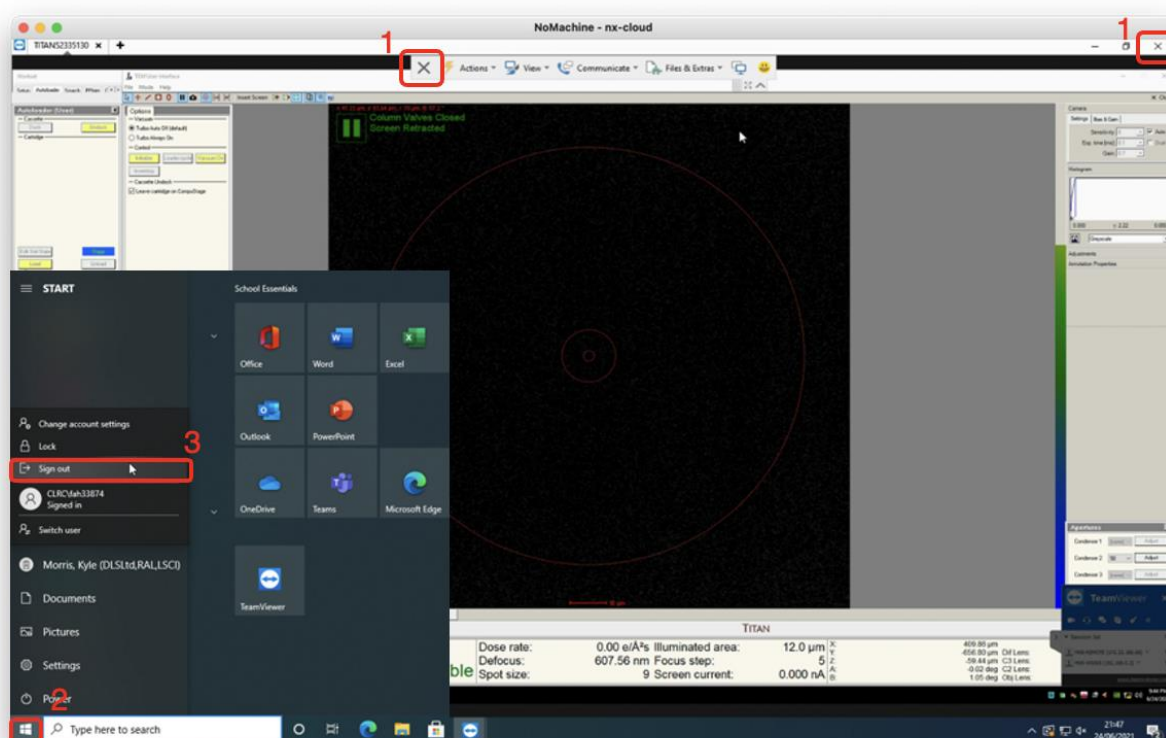
If at any point you leave the microscope unattended, please ensure you close the NoMachine connection in case your LC requires access (only one NoMachine connection is permitted at a time for security reasons).

- ☐ Click on (1) the highlighted cross to close TeamViewer

**(Take care that you do not accidentally close the 'TEM User Interface')**

- ☐ Click on (2 and 3) to sign out of the remote support PC

**(Take care that you do not accidentally log out the Microscope operating system)**



- ☐ Press Ctrl+Alt+0 (win) or Ctrl+Option+0 (apple) on your keyboard to access NX options
- ☐ Click on (4) 'Connection'
- ☐ Click on (5) 'Disconnect' to disconnect from the NoMachine nx-cloud session



