adolphe merkle institute
excellence in pure and applied nanoscience

UNIVERSITY
OF FRIBOURG
SWITZERLAND

Focused ion beam

Introduction

Version 10 – May 2025

Universal rules

Rule 1: don't touch a control if you are not sure of the outcome of that action

Rule 2: never, ever force anything beyond finger strength

Rule 3: wear gloves when touching anything that goes into the chamber

Rule 4: if in doubt, ask for help

Demonstration: xT microscope server

Prerequisites:

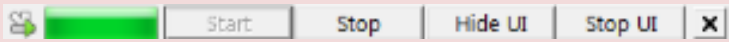
MPC (microscope PC) and SPC (support PC) switched on

Login: User (password: user)

Start the server

Experiment

Find the tiny view server bar at the top right of the central screen:



The xT server must run in order to use any FIB function. It runs when you arrive at the FIB.

YOU NEVER LOG OUT, YOU NEVER SWITCH OFF THE PC's

Start not enabled = server is running
Stop enables = server is running
Hide UI hides the user interface (will become start UI when switched off)
Stop UI closes the user interface

If the user interface is not active, start it by clicking "Start UI"

Notes:

Demonstration: Login onto the FIB software

Prerequisites:

Running xT server

Running UI

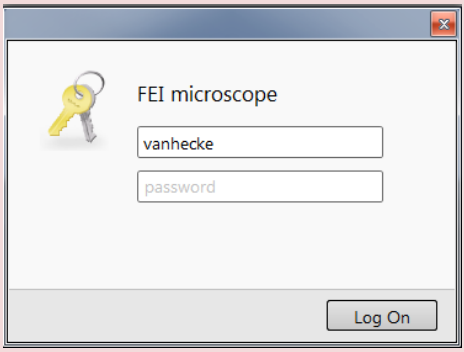
Action:

Login using your FIB account

Load the personal settings and history of the user

Experiment

After startup of the User interface (UI), a username and password are requested.



Username: your last name, with first letter capital, no accents, umlauts, etc.

Password: your first name (first letter capital but no accents, umlauts, etc.)

Click logon

Demonstration: System status

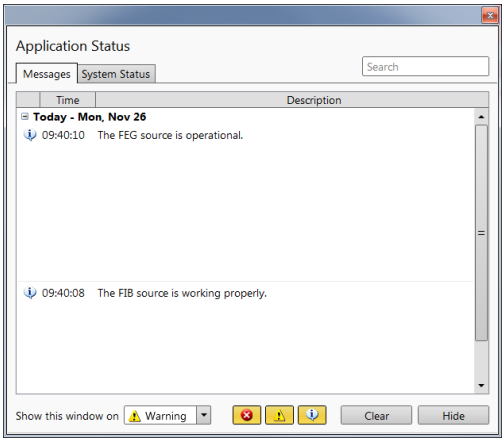
Prerequisites:

Running xT server

Running UI and successfully logged on

Notice the application status

A separate window will appear (usually on the rightmost screen): the application status, which will contain messages from the system. These will contain any errors that occurred.



You can close the application status window. You will see new messages in the bottom bar of the UI. Clicking the message button will reopen the application status window.

If the system behaves out of the ordinary, this is the first place to look for error messages.

Demonstration: Loading a sample

Prerequisites:

Running xT server

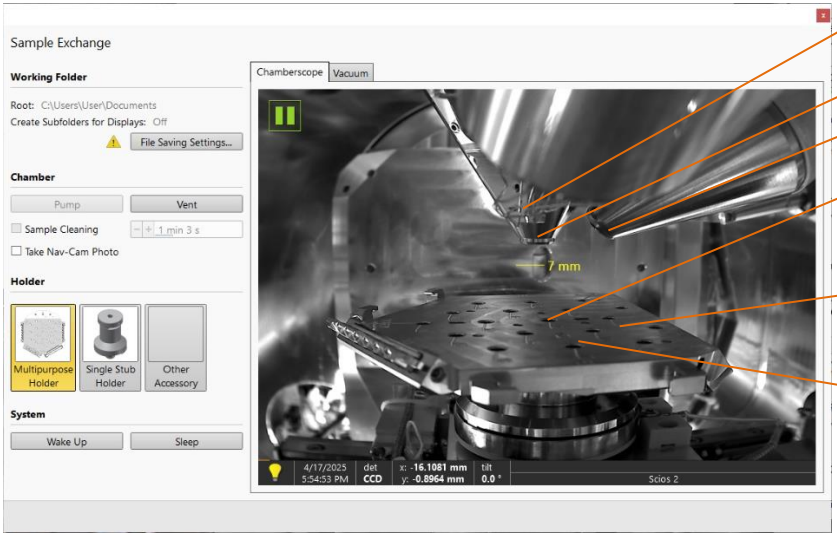
Running UI and successfully logged on

Action:

Load samples

Vent the chamber. Understand the height prerequisites of the load samples

Click the sample exchange button  on the top left of the central screen.



ETD

Electron gun

Ion gun

Samples

Multipurpose holder

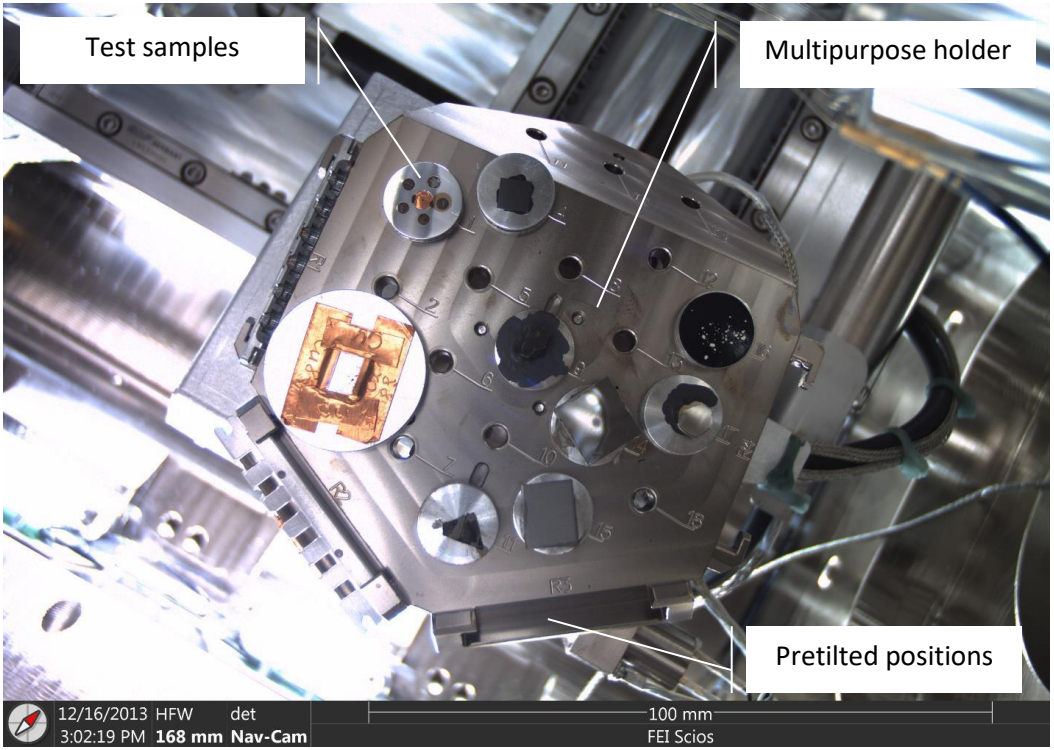
Pretilted positions

Experiment: Venting the chamber

Under Chamber, click vent. A venting confirmation will ask you to confirm the 3 minutes venting cycle. Click vent and wait 3 minutes (the green bar at the bottom shows the progress).

The multipurpose holder

In most slots, the stubs can be mounted without the need for a screwdriver.



Experiment: mounting the samples

- Gently open the stage
- Place the stubs in an empty slot on the multipurpose holder.
- Make sure that you place:
    - at least 1 stub / sample in the central position (#9)
    - the tallest samples on the left,
    - the lowest on the right (this avoids pole touches while tilting).
- Gently close the chamber. There is no lock.

The Vacuum system

Holder: Always have the Multipurpose holder selected. Never change this setting.

Chamber:

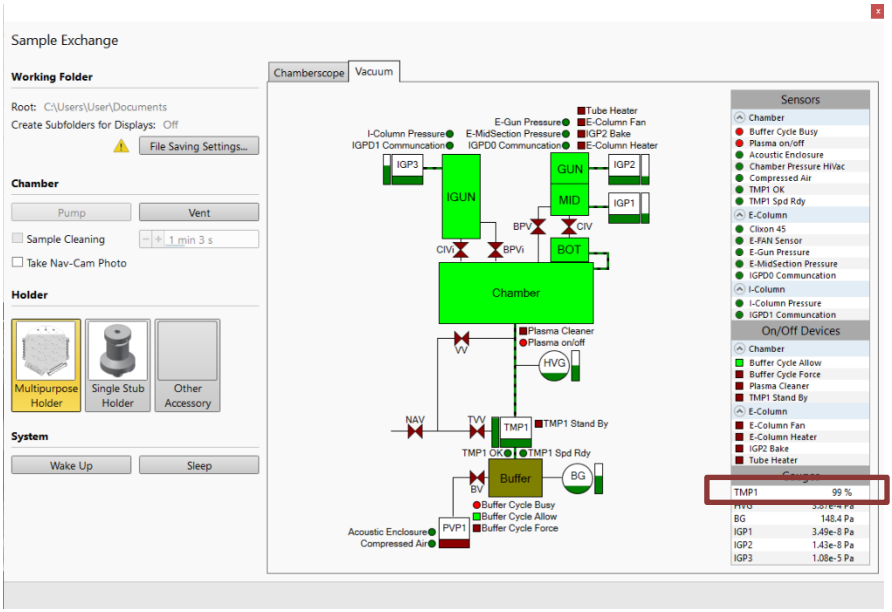
- Sample-cleaning: starts a in-chamber plasma cleaning of the stage/samples. Can help with the conductivity of notoriously badly conducting materials

Never use the chamber plasma cleaning with the EDS detector inserted!

- The take Nav-Ca Photos does not make sense because the eucentric height has not been set yet.

Tab Vacuum

The value mentioned under TMP1 is critical for the pumping of the chamber (see below)



Experiment: pump the chamber

- In the sample exchange window. In summary:
  - Sample cleaning (optional, not with an inserted EDS detector)
  - Do **not** select 'Take Nav-cam Photo',
  - Do not change the root folder settings.
  - Make sure multipurpose holder is selected
- Switch to the vacuum tab and locate the TMP1 reading (bottom right, under 'Gauges'). It should have the value 0%.

Keep the door firmly closed by leaning against the chamber door with your arm. This is extremely important![1]

- Click the Pump button in the exchange window.
- Keep leaning against the door / holding it tight until you see the TMP1 value increasing to at least 5% of the TMP1 (you stop hearing the rotation pump in the back). Now you can take back your seat.
- While waiting for the vacuum, home the stage: ***Stage*** **> home stage**.

After pumping, you should reach a chamber pressure of about $1 \cdot 10^{-2}$ Pa. This is not yet sufficient for a focused ion beam ($1 \cdot 10^{-4}$ Pa is needed), but it allows e-beam imaging. Pumping will go on in the back and by the time you have setup the e-beam, the necessary vacuum for the ion beam will be achieved.

[1] If the door is not properly sealed, an overheat safety will halt the pump. The pump (and the system) can only be reset by a technician. Hence, not sealing the door will mean the end of your session and about 1 week of downtime for all other users.

Demonstration: Beam control

Prerequisites:

Sample loaded

Pressure at $1 \cdot 10^{-2}$ Pa or lower

Starting the e-beam

On the right side of the central screen, an icon-based menu is available:

Beam control

Beam control ➔

Navigation

Detectors

Patterning

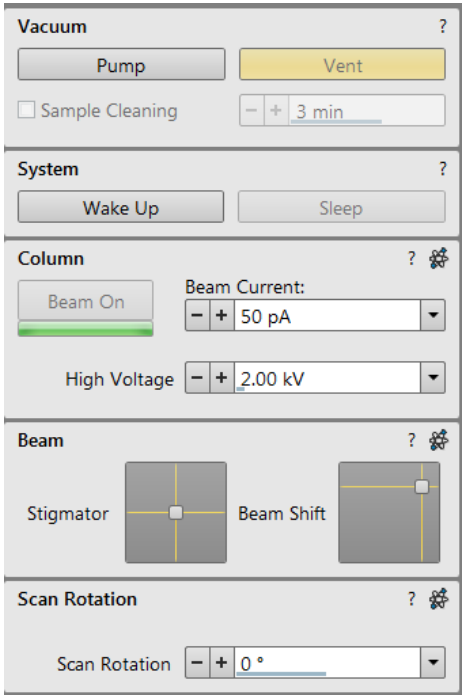
EasyLift

Direct adjustments

Sample preparation

Column presets

Alignements



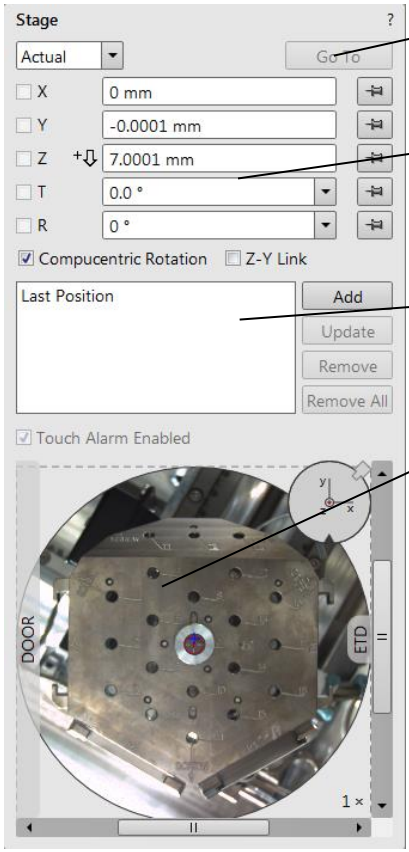
Experiment

Click in the top left quadrant (the SEM window). Then click the top icon (Beam control)
- Click Wake up
- Click beam on

Under the **column tab**, click **beam on.** You should hear a click from the back.

Stage navigation

➔



Goto / stop button stage movement

Stage position in X,Y, Z, tilt angle and rotation

Saved positions

Stage view from Nav Cam

Demonstration: The inside of the e-beam

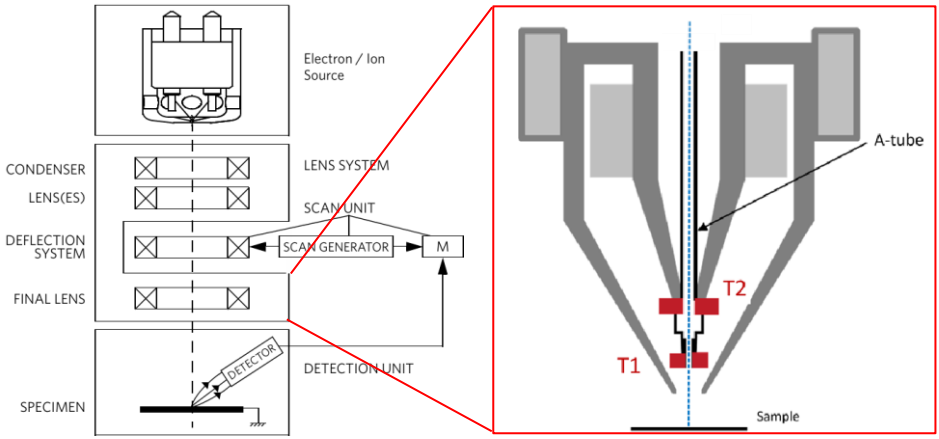
Prerequisites:

Sample loaded

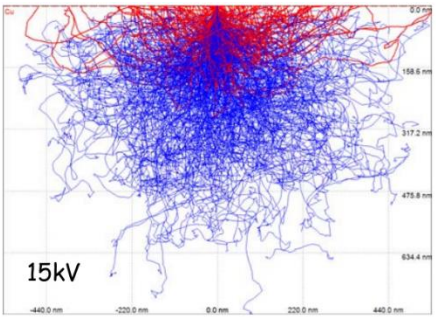
Electron beam on

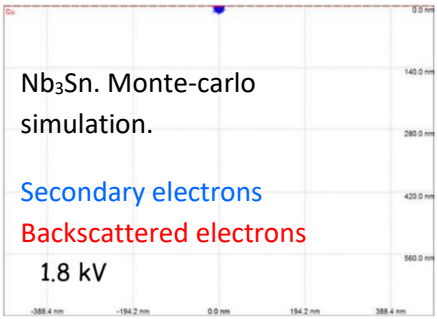
Learn about the SEM basics

Basic scheme of the SEM

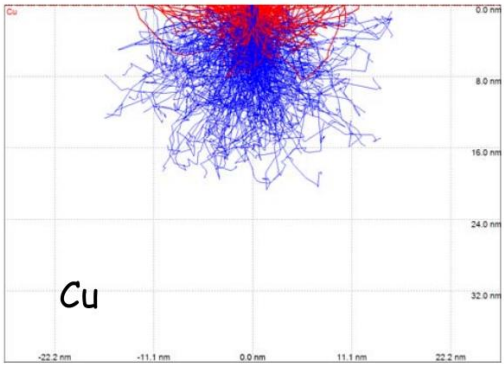


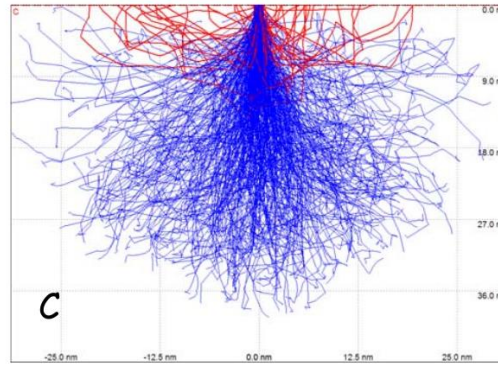
Interaction volume and the effect of the acceleration voltage (=HT, HV)



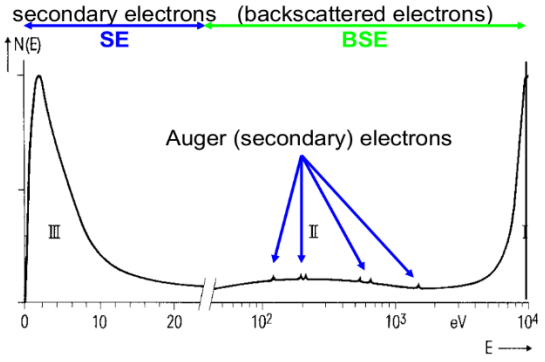


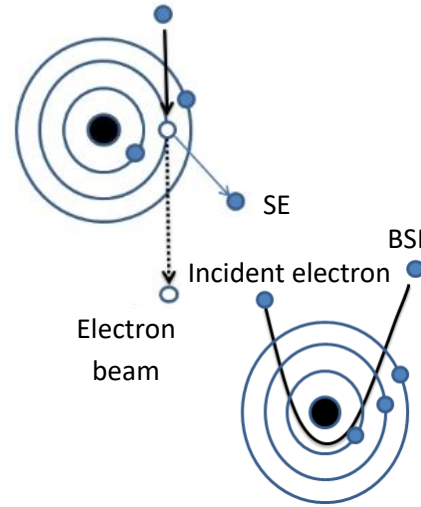
Interaction volume and the effect of elemental composition

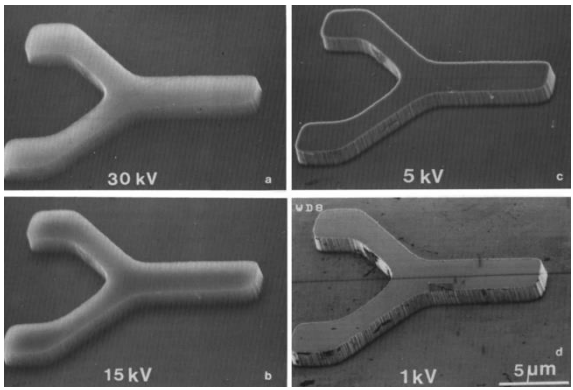




Secondary electrons vs backscattered electrons







Demonstration: First glimpse of your sample

Prerequisites:

Sample loaded

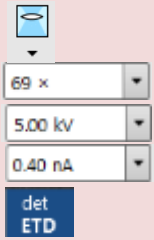
Electron beam on

Learn about the working distance

Experiment: Setup lens & detector

In the top menu:

1. Select the **Standard case**
2. Set magnification: low (< 100)
3. Acceleration voltage: 2-5 kV
4. Beam size: 100pA – 800pA
5. Select the ETD dectector in the topleft quadrant



These settings are generic and not perfect yet.

- Unpause the e-beam image (click the green pause button in the image or **F6**).
- Refresh contrast brightness (Click *Tools* > auto contrast / brightness or **F9**)

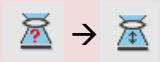
Focus an image

If this is the first image: use e.g. a sample in the central slot[2] or the multisample holder to find an edge to focus.

Experiment: Focus your image

You can focus the image using:

- The coarse / fine buttons on the right of the panel
- OR Click + hold RMB in the ebeam image and move the mouse right and left

Important: after focussing, click the **LINK button** in the top row.  →
This allows the system to estimate the distance between the pole piece and the stage. You will end up (after homing) with a working distance around 60 mm (Z value in Navigation  > stage).

[2] This is the reason why you always want to have at least one stub in the central slot.

Demonstration: Eucentric height

Prerequisites:

Focused imaged

Magnification: 20-5000X

Learn about the Eucentric height

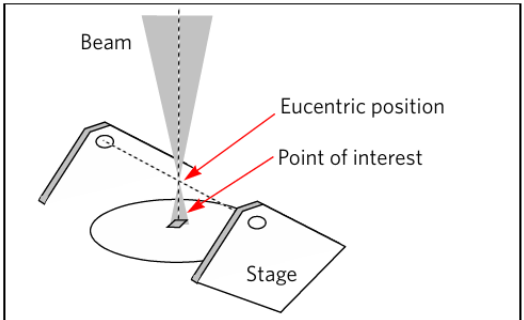
This is one of the two key alignments[3]. Every sample on every session on the FIB-SEM must be aligned to eucentric height. Failing to do so will damage the instrument.

The magic number is 7 mm

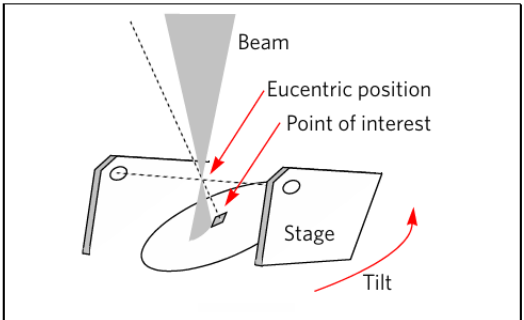
At the eucentric height position, the **stage tilt and the beam axes intersect**.

When the stage is tilted or rotated in any direction, this point remains focused and (almost) does not shift. At the eucentric position, one can use various system components in a safe and optimal way (e.g. GIS, Ion beam, EasyLift).

Eucentric position should be adjusted after loading any new sample, as the sample loading clears all position information.

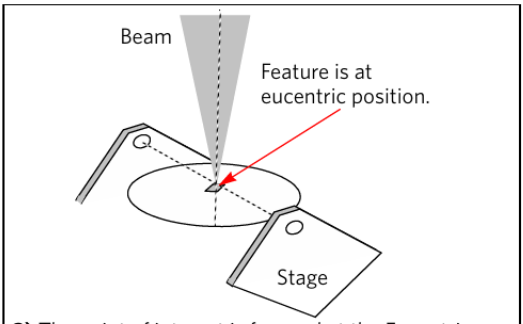


1) The point of interest is focused below the Eucentric point.

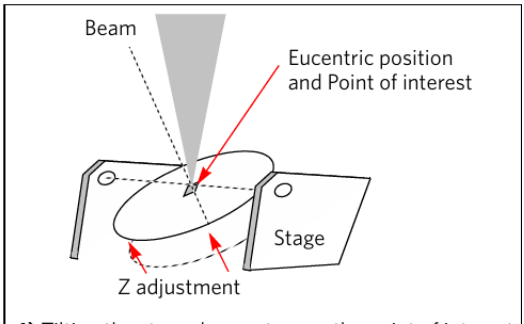


2) Tilting the stage moves the point of interest out of the beam.

[3] The other one being the beam coincidence point



3) The point of interest is focused at the Eucentric point.



4) Tilting the stage does not move the point of interest out of the beam.

Experiment: Eucentric heigth position

Presettings

1. Assuming you homed the stage during pumping
2. Assuming you focused the sample or stage and the stage is linked  (see p. 18)
3. Get a live Chamber View (bottom right): 5KV, Mag about 500-1000X, 0.4 nA
4. Click the navigation button on the right side of the screen 

Procedure: decrease Z → adjust focus → link stage

- Usually, initial Z will be somewhere 60-90 mm in a homed stage. Go in steps of 20-30 mm towards 20 mm
- E.g. Starting Z = 60mm → Focus image, click link stage.
  Set Z to 30 mm in  → Focus, link,
  Set Z to 20 mm → Focus, link,
  Set Z to 10 mm → Focus, link, 7 mm
  Eucentrich heigth (7 mm) reached!
- The exact starting height is dependent on the height of your sample. The values here are for a flat ½ inch stub.
- Be conservative! **Assure you are never going to touch the polepiece!!!**
- When moving, Keep the mouse pointer on the stop button ( > stage) and make sure the chamber view is live.
- Clicking the Link stage button updates the working distance.

- When the stage height is set to to 7.00 mm:  > Stage > Z=7.00 mm
- **Set the eucentric height: press CTRL + f** (Acknowledges a working distance of 7 mm)
- Optional: Double click LMB in the chamber view to update the 7 mm marker.

Demonstration: Nav Cam photo

Prerequisites:

Focused imaged

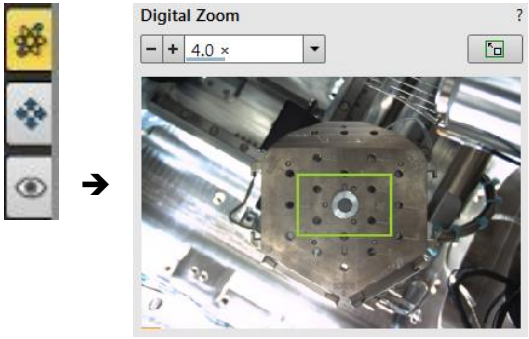
Eucentric height set

Learn about the the Navigation camera

Nav Cam

The navigation camera (Nav Cam) will show the stage from a bird's eye perspective and can be used as an interactive map. It is linked to the positions and can be moved by double clicking. CTRL + / - will digitally zoom in / out.

Moving around in a digitally zoomed nav cam picture:



Experiment: Take Nav Cam Photo

A Nav Cam photo must be taken after proper eucentric height setup[4] because the NavCam has a focal point that is reached when the stage is linked and in eucentric heigth.

Stage > take Nav Cam Photo

[4] Which is why it is not recommended to do this during the pumping of the chamber (see p. 12)

Demonstration: Basic SEM imaging

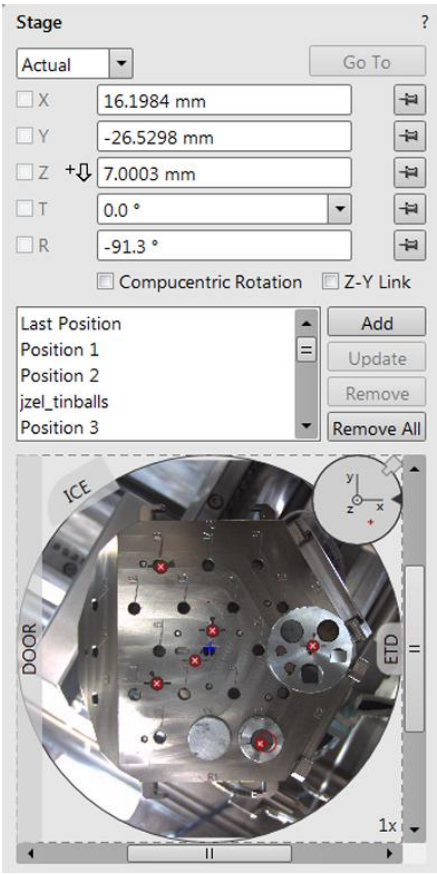
Prerequisites:

Eucentric height

Nav cam recorded

Lens alignment, Beam shift reset, astigmatism, Videoscope, …

Stage module



Three modes are possible via the list box:

- Actual mode (default) – shows actual position coordinates in the edit boxes.
- Target mode – activates when clicking on a stored position or when editing a coordinate value.
- Relative mode – used to move stage by a given value and to repeat it several times if needed.

Clicking on the Go To button drives the stage to a new location. During the stage motion the Go To button changes to the **Stop button, which stops the stage immediately.**

If the symbol next to Z is  : You must first **LINK THE STAGE**!

Experiment: Moving around in X and Y

LMB double click in the e-beam image will move the stage.
LMB double click in the Nav Cam image will move the stage.
→, ←, … will move the stage roughly ½ field of view.

Location list
The Location list shows stored stage positions. There is the Last Position (the stage position before latest movement) in the list by default, which is updated during stage operations. The position selected becomes the actual active position and it is highlighted in the list and also in the map area. Clicking on a position name allows a user to edit it.

Map area
In the map area, the stage schema is represented showing all stored positions, which are listed in the Location list.

Reduced area (=Focus window)

This mode is useful when focusing and correcting astigmatism as the imaging update is faster in the smaller area.

Experiment: Reduced area (F7)

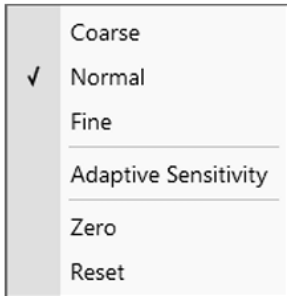
What is it? Reduced area allows to set and select a sub-area in the image. This assures a faster refreshing rate and is useful to focus, stigmate, …

In case of electron sensitive samples, alignments can be made in the reduced area, away from the region of interest.

Beam shift reset

Controls the beam shift with respect to the objective lens axis. It is useful for fine imaging shifts without stage movement.

Right-clicking on the Beam Shift 2D box opens a context menu:



• **Zero** sets the Beam Shift value to zero

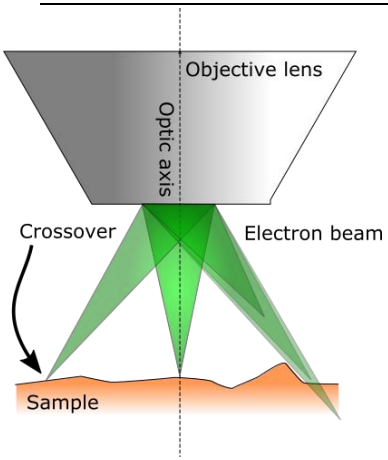
• **Reset** sets the Beam Shift value to zero and moves the stage to compensate the resulting imaging shift (same as the Stage menu / Beam Shift Reset function).

Experiment: Reset beam shift

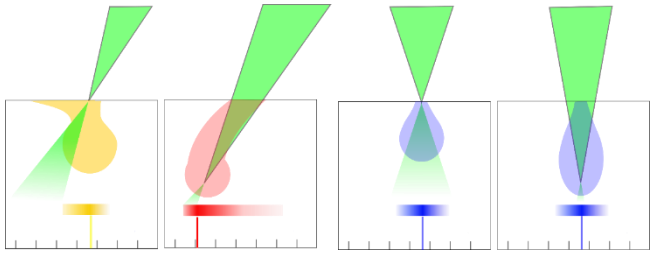
What is it? Beam shift is often needed for fine alignments: it allows the image to be moved very precisely (much more precisely than a piezo stage would do). Resetting the beam shift at the start of your session is recommended to have the full range of the beam shift available.

Beam control > Beam > RBM click > Zero

Lens alignment



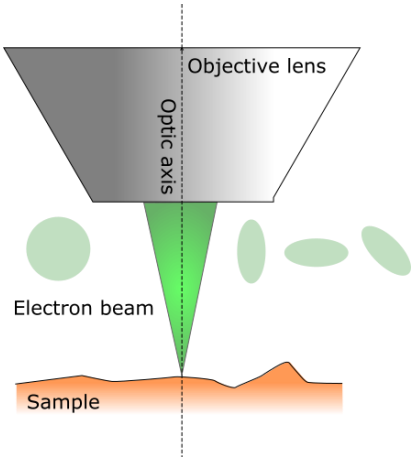
Lens alignment assures that the beam is concentric around the optic axis. A wrong lens alignment will be apparent at high magnifications: the object will shift with change of focus.

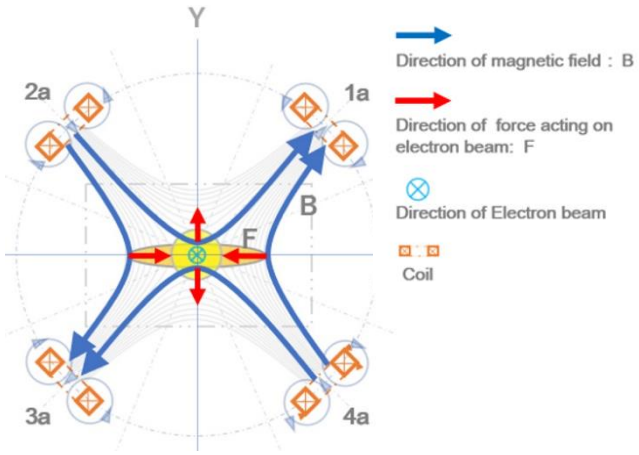


Lens alignment

- Lens alignment is needed at magnifications > 2000X. It assures that there is no beam shift during focusing.
- Select a reduced area, preferable with sufficient contrast (press F9)
- Exposure time < 500 ns
- Column: standard, 2-5kV, 0.40 nA.
- From the top menu: Start the lens alignment. The goal is minimal movement of the object in the reduced area
- Grab the green cross that appears in the center 
- Move the cross with the LMB until the movement of the object is minimal
- A slight rotation is not problematic. Unclick Lens alignment, reduced area

Astigmatism





Astigmatism

To correct for astigmatism (typically at magnifications > 10 000X):
- Find an object, preferably round
- Make a reduced area
- Use the X and Y under stigmator on the panel OR Shift + RMB and hold. Move left right / up down to correct
- AutoStigmator. First make a reduced area, then use the auto stigmator
- Switch to FFT to manually correct the astigmatism.

Videoscope

This tool facilitates manual contrast and brightness optimization. Three yellow horizontal lines are placed over the display:

- Topline: whitest pixel
- Middle line: median grey
- Bottom line: blackest pixel

The oscillogram signal amplitude reflects the contrast / brightness of the just scanned line. If the oscillogram is cut by the bottom / top line, the signal level is clipped in black / white, Clipping should be avoided.

Videoscope

1. Select a slow scan in an active display.

2. Activate the Videoscope in an active display (F3 / clicking on toolbar icon / Scan menu) or in all live displays (Shift + clicking on toolbar icon).

3. Reduce the contrast to zero (front panel) and adjust the brightness level to the lower dashed line (black).

4. Increase the contrast so that the signal level just touches the upper dashed line (white).

5. If necessary, adjust the brightness level so that the average signal level is roughly in the middle.

6. The high and low peaks should just touch the dashed lines.

Note: Auto Contrast Brightness (F9) usually corrects these settings automatically.

Demonstration: Beam and lens parameters

Prerequisites:

Eucentric height

Nav cam recorded

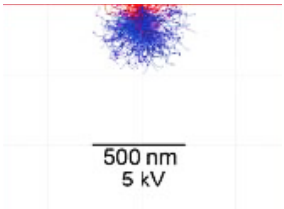
Set magnification, high voltage and beam current

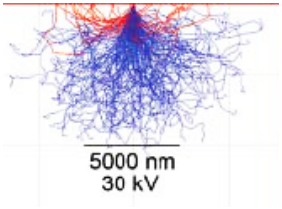
- Magnification

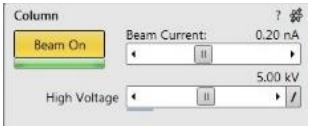
Sets the magnification for the SEM image in the upper left quadrant.

- High voltage (=acceleration voltage, =high tension)

Defines the interaction volume: Higher KV = less surface information, better resolution







- Beam current (=probe current)

Is the flux of electrons in the beam (electrons per second per area).
Higher beam current = better signal, more beam damage, lower resolution. Unlike the Tescan SEM, the beam current at the FIB SEM is calibrated (units in pA to nA).

Demonstration: Imaging settings

Prerequisites:

Eucentric height

Nav cam recorded

Save optimization and image settings

- Image setup and filters

The image scan is a combination of:

Image size (in pixels). The larger, the longer scan will take.

Dwell time the amount of time each pixel is scanned.

Scan interlacing Splits an imaging area into n number of blocks. The first line of each block is scanned followed by the second one etc. This imaging method significantly **reduces sample charging**. Abbreviation: SI

Line integration Each line scan is repeated n times. Data are integrated. This imaging method reduces sample charging and improves overall image quality. Abbreviation: LI

The use of these tools is visible in the dwell time adjuster:

- Image averaging

Three settings are possible:

Live. The default mode. One frame follows the other.

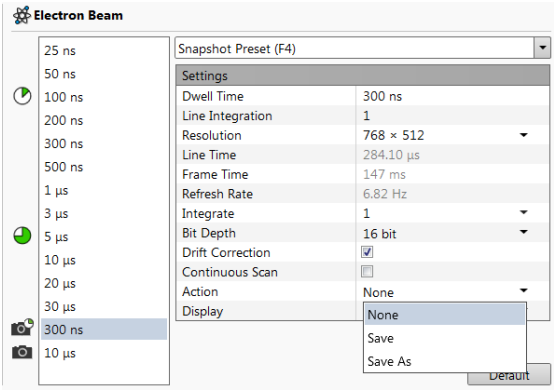
Average. Continuously averages n images to improve the signal to noise. Setting n > 4 will create difficulties to operate a live image (focusing, moving, …).

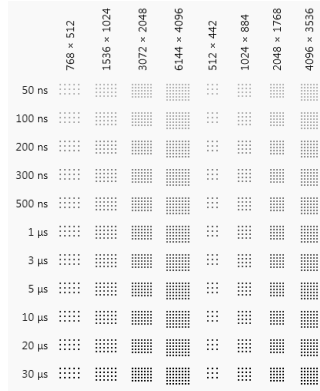
Integrate. Collects n images and integrates (=sums) them. Not compatible with live imaging.

- Snapshots

A snapshot (**CTRL+F4**) is a quick recording using preset choices. The preset can be changed in the top menu or changed ad hoc using the dropdown menu.
The settings for the shortcut can be set in the preferences:

Click the top left quadrant (SEM) → Menu Tools > preferences > Scanning





The presets allow to set 8 bit (**don't!**) / 16 bit (**do!**) settings, and the proceeding function, e.g. Save as (with a dialog for a file name) or Save (with a generic name).

- Photo

A photo is a high quality, slow recording using preset values. The preset can be setup as explained above for the acquisition of a photo (**F2**). There is no *ad hoc* change of dwell times / image sizes.

Demonstration: Image presets

Prerequisites:

Eucentric height

Nav cam recorded

Image parameters sets

Scanning presets simplify switching imaging conditions

By default, there are 6 factory toolbar Scanning presets (labelled s#) for each beam. Clicking on any one starts image acquiring with corresponding parameters.

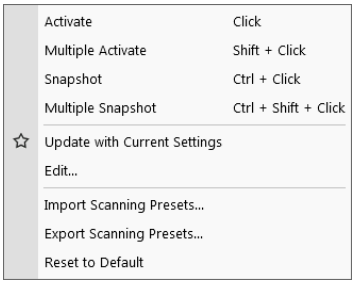
Scanning presets (s1 – s6) 

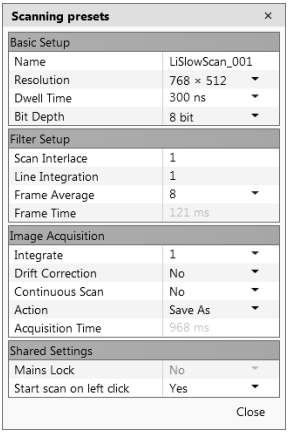
At the top right, 6 scanning presets can be chosen and edited.

Actions:

Select a preset: LMB

Edit a preset: RMB > edit… (click apply to save)





Mains Lock — When ticked, the scanning (line sawtooth signal) is synchronized with the mains AC oscillation. This greatly diminishes blurring and jittering of the electron imaging resulting in smooth image edges at higher magnifications.

Demonstration: Align Feature / scan rotation

Prerequisites:

Eucentric height

Nav cam recorded

Image parameters sets

Rotate the scan angle and align your sample of interest

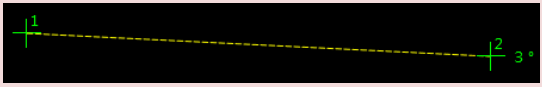
The scan rotation can be adjusted to align the image with possible objects.

Experiment: scan rotation

Click the Align feature button in the top row.

A window will appear:

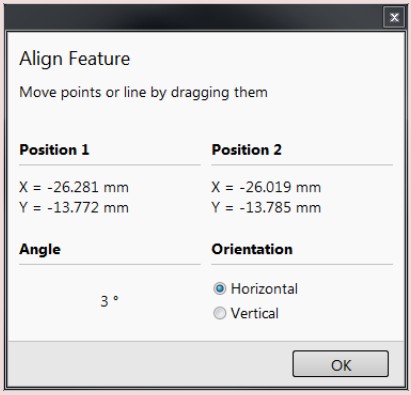
- You can now by LMB click and draw a yellow dotted line in the electron beam quadrant. The angle of the line will be shown.



You can now choose to:

Rotate the stage

Rotate the scan



Click OK: the image will rotate (either by scan or stage) to align the feature

Demonstration: Column cases

Prerequisites:

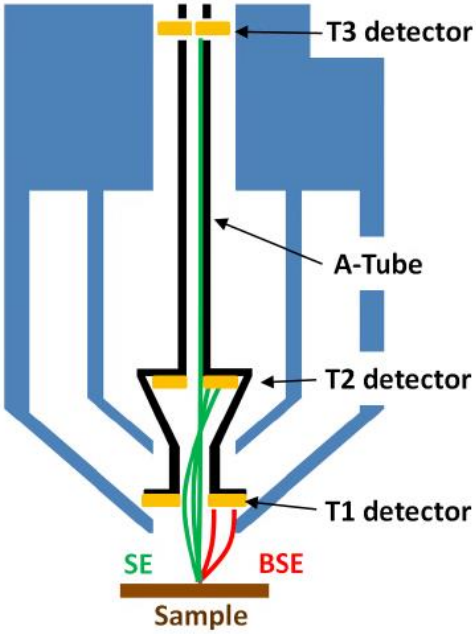
Eucentric height

Nav cam recorded

Image parameters sets

Learn about the three column cases: Standard, OptiPlan, OptiTilt

The electron column can be operated in different Use Cases optimized for specific applications: Standard, OptiTilt and OptiPlan.



In the OptiTilt and OptiPlan Use Cases: primary electrons are accelerated by the potential of the Acceleration tube (A-Tube) and pass through the column at high energy (i.e. reducing aberrations). They are decelerated between the T1 detector and the sample. Secondary as well as backscattered electrons are also collimated into the final lens by the A-Tube electrostatic field and detected by detectors T1 and T2.

- Standard mode

This is the basic mode, used for survey and TEM sample preparation mode. It is ideal for navigating and reviewing sites at lower magnifications. Maximum e-beam current is 13 nA.

- A-tube: deactivated
- Typical detector: ETD
- Advantage: largest field of view, all currents available
- Disadvantage: not suitable for high resolution (no beam deceleration)

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* OptiPlan mode

This mode is used for ultrahigh resolution electron imaging at 0° of the sample at short working distances (1 – 2 mm. Exceptionally not at 7 mm). The A-tube is at the highest potential and the T1 and T2 detectors should be used. Full range of the Beam Deceleration mode (see below) is available.

- Typical detector: T1 & T2 (note that the ETD detector signal will drop)
- WD can be set to < 5 mm (you anyway will not tilt, it is only useful at 0°)
- Advantage: high resolution, more signal
- Disadvantage: smaller field of view, not all currents available

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* OptiTilt mode

The OptiTilt Use Case is optimized for operation at eucentric working distance (i.e. 7 mm, 52° tilt). It is ideal for FIB cross section preparation and subsequent ultra-high resolution electron imaging at low accelerating voltages. The A-Tube is on the high potential, the T2 or ETD detectors are used to obtain topographical images and T1 to gain the
composite information. A small positive stage bias (see below) to improve the image quality is applied automatically when the stage is tilted.

- Typical detector: T1 & T2 (note that the ETD detector signal will drop)
- WD should be at 7 mm (or about there, depending on BCP)
- Advantage: high resolution at 52°
- Disadvantage: smaller field of view, not all currents available

Demonstration: Detectors

Prerequisites:

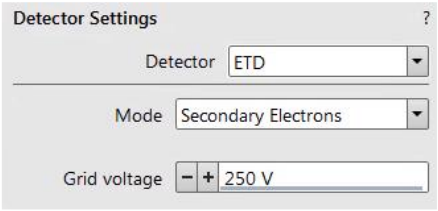
Imaging of samples

Overview of all installed detectors

The system has 8 detectors installed.

STANDARD DETECTOR: ETD (=Everhart Thornley detector = standard SE detector)

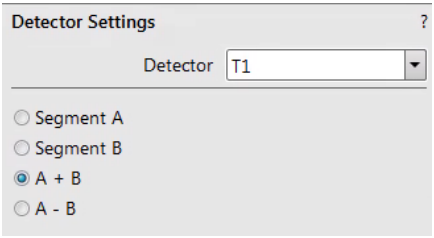
Detects low energy (=secondary electrons) electrons generated by the primary beam interaction with the specimen surface. It is permanently mounted in the chamber over and to one side of the sample.



Mode: keep this the Secondary electrons
Grid voltage: Bias applied by the collector. The higher, the stronger SE (and noise) are attracted. Sweet spot at +250 V. Negative voltage repels SE from the ETD detector and only BSE are detected.

IN LENS BSE DETECTOR: Trinity 1

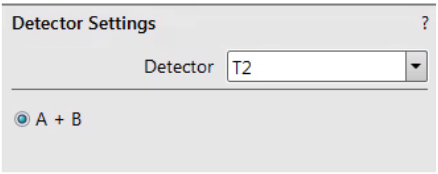
Electrons generated by a primary beam can be collected by the in-lens Trinity detectors T1 and T2, which are located inside the final lens. Whenever the T1 or T2 is selected, the CCD camera infra-red LED's are switched off not to emit the photons. The T1 detector is primarily designed to **collect backscattered electrons** (BSE) and provides composite sample contrast. In the OptiTilt and OptiPlan column Use cases, it detects backscattered electrons through the whole range of accelerating voltages.



In the Standard column Use case, the T1 provides strong BSE contrast at accelerating voltages of 5 kV and higher.
The active detector area is split into two halves and the detector can be operated in four modes. Apart from the composite mode A + B the detector can be operated in the topographical mode A - B, where a pseudo-topographical imaging with suppressed atomic number contrast and maximum topographical contrast is obtained. Signal from each half can be also collected separately in mode Segment A / B.

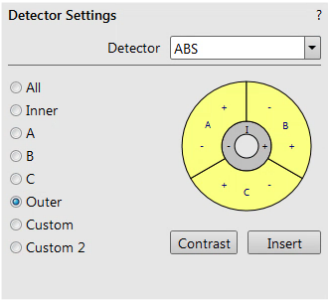
IN LENS SE DETECTOR: Trinity 2

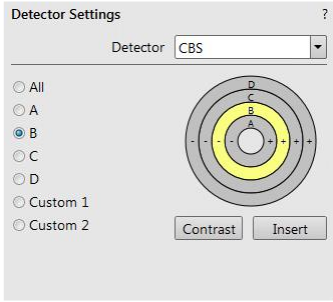
The T2 detector is primarily designed to collect secondary electrons (SE) and provides information of the sample topography in the OptiTilt and OptiPlan column Use cases.
It can be operated in Standard column Use case as well. In this case, backscattered electrons are collected, but the accelerating voltage must be 5 kV at least. The intensity of the signal in the Standard column Use case is dependent on the beam current and working distance – the higher the beam current and shorter the WD the higher the T2 signal. There are no options to select.



RETRACTABLE BSE DETECTORS: CBS and ABS[5] detector

The CBS uses concentric segmentation of the detector diode to distinguish between backscattered electrons scattered close to the beam axis – inner segment (preferentially composite contrast) and electrons scattered far from the beam axis – outer segment (more topographical signal).





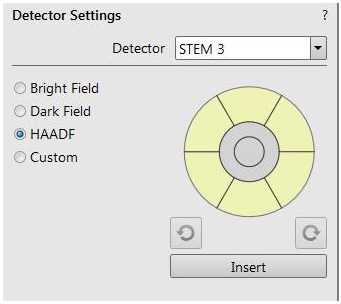
Do not use the detector with high ion beam currents (the solid-state diode can degrade). When working with ion beam for longer time, retract the detector! Be aware of sample and final

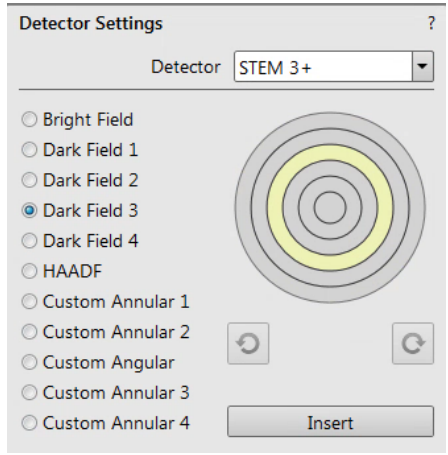
[5] Concentric and Annular backscattered electron detector

lens collision when tilting large samples!
Select the CBS or ABS from the Detector Settings module > Detector list box. Choose the required diode segment(s) by selecting the relevant radio button. The Custom mode is used to define the segments to be used for detecting. Clicking on the + / - sign in particular segment activates it to add (yellow background) / subtract (blue background) the segment signal. By double-clicking on the segment its background turns grey and it is switched off. The Contrast button equalizes signals (contrast) from different segments not to override one another. Distribution of electrons collected by detector segments changes with setting of working distance, lens mode and Beam Deceleration mode. It is also possible to set different concentric segments in particular displays and thereafter to use the Enhanced Image module / Mix 3 or Mix 4 tab to mix color coded signals to create color images.

SCANNING TRANSMISSION ELECTRON MICROSCOPY: STEM and STEM+ detector

This detector is retractable and is mounted below the sample. It is only useable in conjunction with the rowbars. The detector has selectable segments that allow to operate the diode in Bright Field, Dark field and High Angle Annular Dark Field mode. The resolution of the STEM is 0.9 nm maximum.





EDX DETECTOR: analytics

Not part of this introduction.

Demonstration: Beam deceleration

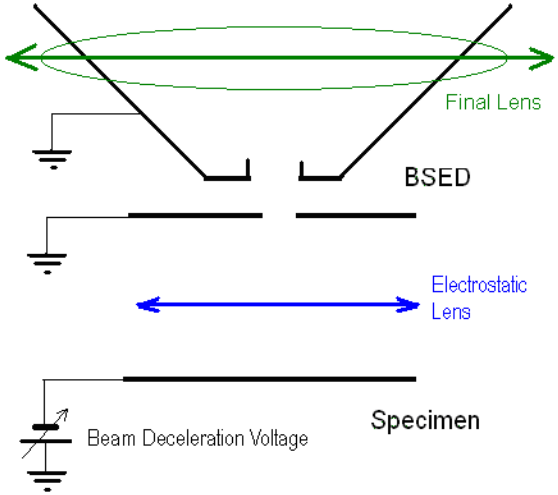
Prerequisites:

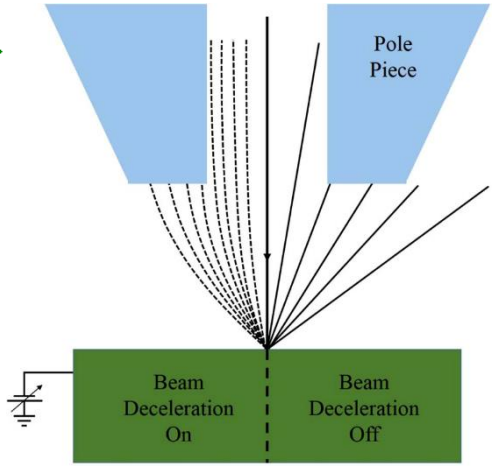
Imaging of samples

Learn about beam deceleration

The Beam Deceleration (BD) mode is based on a negative voltage (bias) applied to a stage (i.e. a sample). The electrical field between the sample and the nearest surface over (a column bottom or a detector) is formed, acting as the additional electrostatic lens. Its power is described by the Immersion Ratio parameter:

$$ImRatio = \frac{HV + Bias}{HV}$$





As the sample is at the negative potential with relation to the ground and detectors, the initial SE and BSE energy (when leaving the surface) is accelerated by the Stage Bias before the detection.

The higher the Immersion Ratio, the lower is the difference between SE and BSE energies when detected. Signal electrons are accelerated upwards and deflected towards the column axis.

The secondary electrons

The SE's have a low initial speed and they are usually absorbed into the detector central hole, continue through and can be detected by in-column detectors (T2). Equally like the BSE heading upright.

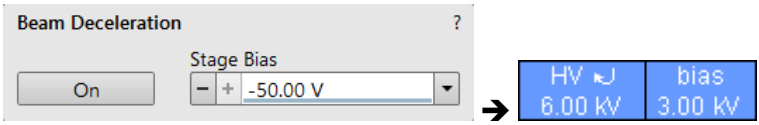
The back scattered electrons

Conversely the BSE heading nearly parallel to a surface (which normally cannot be detected) are driven to a detector.

By changing the Stage Bias an output angle of electrons leaving a surface can be changed.

OptiPlan and OptiTilt mode will apply a stage bias.

The stage bias, typically 20V, will create the immersion effect. This increases the electron yield on the in-beam detectors T1 and T2. When active, note the small arrow after the KV value. The beam deceleration accelerates the beam in the column by 8 kV (this reduces chromatic aberration in the lenses) and decelerated before the beam exits the pole piece.



Demonstration: Finishing your session

Prerequisites:

Data recorded

Concepts of shutdown and standby

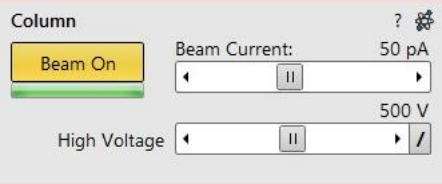
As a rule of thumb SHUTDOWN: when FIB is not in use for 2 nights or more (36h)
STANDBY: when the FIB will be used again within 36h

Experiment: Standby

1. Electron beam

Select the electron beam quadrant (top left)

In the Beam control > Column. Click the yellow button “Beam On”

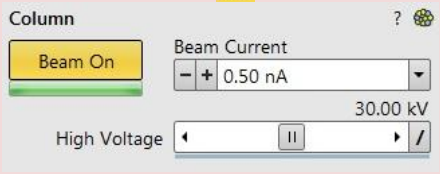


← This icon symbolizes electrons

2. Ion beam

Select the ion beam quadrant (top right)

In the Beam control > Column. Click the yellow button “Beam On”



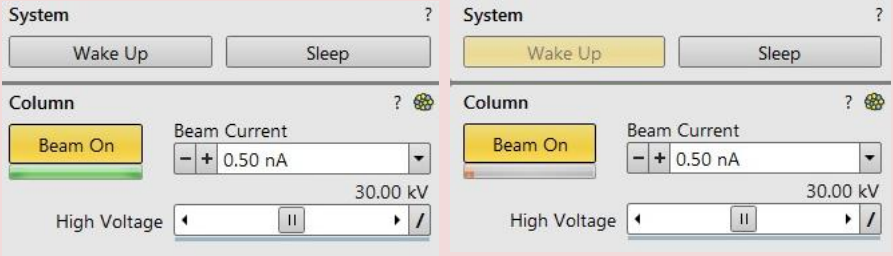
← This icon symbolizes ions

Experiment: Shutdown

1. Electron beam and ion beam: same procedure as standby (see above)

2. Sleep

Click the sleep button in the System menu, just above the Column window.



The green bar below the Beam On button of the ion beam turns yellow, then red and reduces in size.

Quick summary

Start
- Login
- Vent the chamber, then load your samples (tallest on the right)
- Pump the chamber + Assure the door is tightly closed / Lean against the chamber door
- Home the stage during pumping

Beam
- Switch on the beams
- Choose a proper HV setting / Beam intensity
- go to minimum magnification (< 100X), find your sample
- Focus and link your image

Sample
- Eucentric height: decrease the Z position iteratively until Z=7mm. CTRL+F
- Perform beam coincidence point: go in steps to 52°. Use MMB to shift the Z position
- Match e-beam and ion beam using Shift + LMB. Use ion beam shift.

Data
- Define image scanning properties
- Record your data
- Save data on D:/sharedData

End
- Secure your data through the support PC
- Remove your samples and pump the chamber + + Assure the door is tightly closed / Lean against the chamber door
- Switch off the e beam and the ion beam and Log out

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