MAXPEEM Documentation

MAXPEEM team

Apr 03, 2025 - 19:36 UTC

FOR GENERAL USERS

Welcome to maxpeemdocs, an html-based manual for the MAXPEEM beamline and Elmitec SPELEEM microcope endstation, located at the synchrotron radiation facility MAX IV in Lund, Sweden.

Here are some useful links

- Overview of key specifications (MAXPEEM beamline)
- Important sample size, electrical conductivity, etc. considerations (User information)
- Beamline paper
- Reference/text book on Surface Microscopy with Low Energy Electrons, written by a pioneer in the field
- Operational status of the ring/machine here

CHAPTER

ONE

IMPORTANT PHONE NUMBERS (SWEDEN COUNTRY CODE IS +46)

1.1 For use by everybody

- Life-threatening emergencies 112
- Floor coordinators 046 222 16 61 or 073 597 30 55
- Lund University Security 046 222 07 00

1.2 For use by the beamline staff only

- ICT (Electronics, Scientific Data, IT, Software) 046 222 66 00
- PLC 046 222 69 70
- Electricity 046 222 69 40
- Infrastructure and cooling water 046 222 69 60
- KITOS 070 379 86 65
- Machine operators 072 247 29 45

Caution

House rules

- Leave no trace (leave the beamline environment in the same or better condition than how you found it)
- Eating permitted only in the control hutch, not in the measurement hutch nor in the prep lab
- Drinking is permitted in the measurement hutch, provided the containers are closable
- The hutch can comfortably accommodate three people (including the beamline scientist); the rest of the user group should occupy the control hutch
- The beamline staff need to work uninterrupted occasionally, be considerate and have phone conversations, play video games, etc. outside of the measurement hutch

*Credit to the MAX IV BLOCH team for establishing and sharing the documentation framework

1.2.1 Overview of the ring, beamline, spectro-microscopy endstation

Ring

The MAX IV 1.5 GeV (or R1) electron storage ring, one of the two storage rings at the Lab, is based on a compact double-bend achromat lattice and produces bright soft X-ray and ultraviolet radiation. At the center of the MAXPEEM straight section, the RMS values of the electron beam size and divergence are 184 (h) x 13 (v) um and 33 (h) x 5 (v) urad, respectively.

A schematic of the R1 ring is shown in Figure 1, relative to the LINAC and the R3 ring. The R1 ring currently hosts 5 beamlines, with room for 5 more.

Table 1. Summary of key specifications of the R1 or 1.5 GeV electron storage ring.

Parameter	Specification
Energy [GeV]	1.5
Main radio frequency [MHz]	99.931
Circulating current [mA]	500
Number of achromats	12
Circumference [m]	96
Hor. emittance (bare lattice) [pm rad]	5982
Ver. emittance [pm rad]	60
Energy spread [e-3]	0.75
Beam lifetime [hours]	10

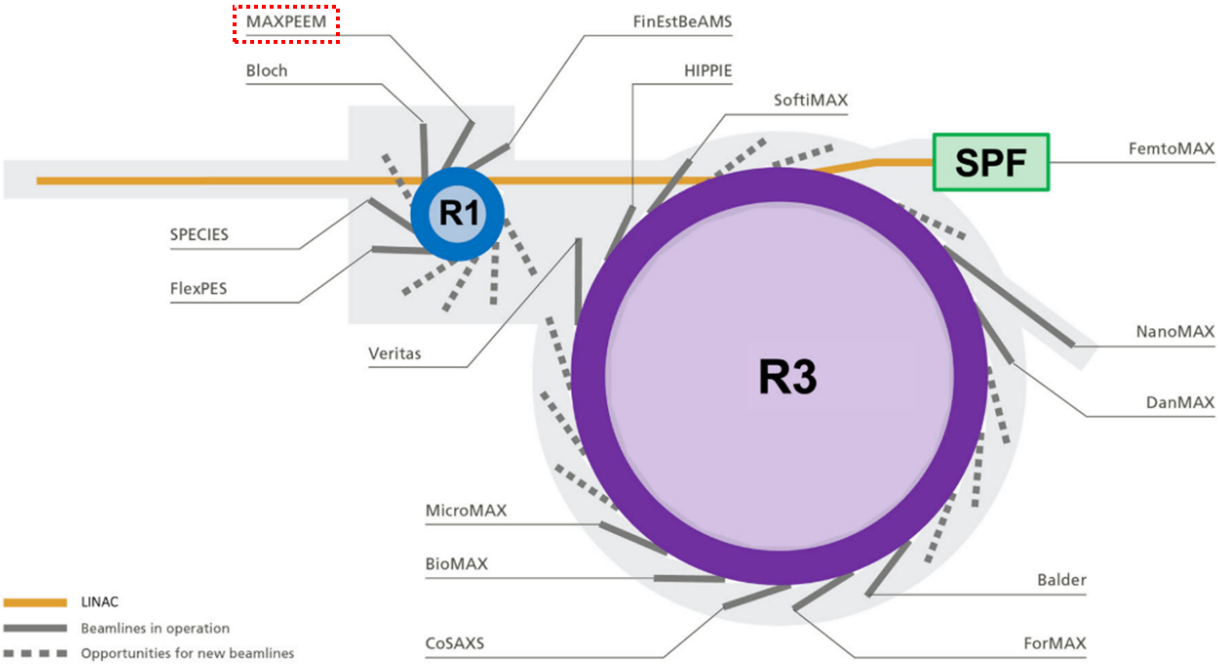


Figure 1. Schematic of MAX IV, showing the three major components: (i) linear accelerator (LINAC), (ii) 1.5 GeV electron storage ring (R1), and (iii) the 3.0 GeV electron storage ring (R3).

Beamline

A schematic of the beamline is shown in Figure 2, and the functions of the beamline elements are described in Table 2. Figure 3(a) shows the photon flux available from the beamline as a function of photon energy; the flux depends on the grating and harmonic used. The inset of Figure 3(a) shows a nitrogen K-edge absorption spectrum recorded from nitrogen gas, used to monitor the beamline resolution. Figure 2(b) shows the beam profile at the sample position, where inset (i) shows a simulation of the beam profile performed with the X-ray tracing software and inset (ii) shows the experimental beam profile in the photoelectron microscope. Figure 3(c) shows a map of the circular polarization (undulator gap versus photon energy), where the light colors indicate a higher percentage of circular polarization.

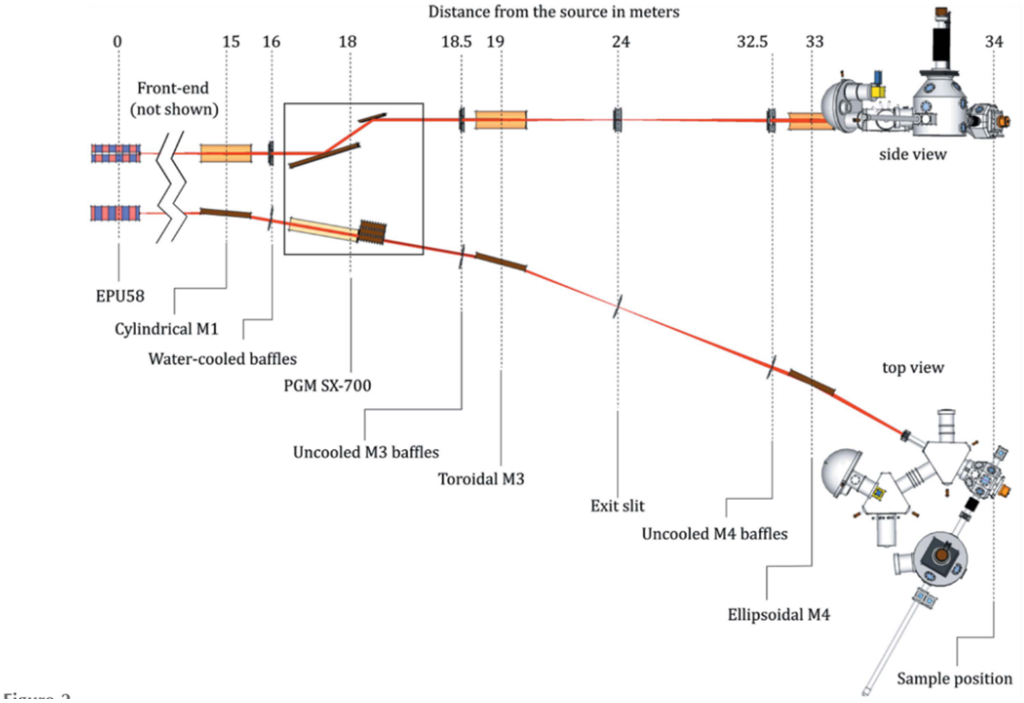


Figure 2. Schematic of the optical layout of the MAXPEEM beamline.

Table 2. Overview of key beamline elements and their functions.

Beamline element	Description
Light source	Elliptically polarizing undulator of Apple-II type (EPU58, period length of 58 mm and 42 periods)
Cylindrical M1 mirror	EPU radiation deflected horizontally (by 4 deg) and collimated vertically
Water-cooled baffles	For reducing the horizontal and vertical acceptance of the beamline
PGM SX-700	Collimated plane grating monochromator, operates with one of three plane gratings (300 l/mm, 650 l/mm, 1200 l/mm)
Uncooled M3 baffles	Beam-defining aperture for M3
Toroidal M3 mirror	Focus the dispersed radiation both vertically and horizontally onto the exit slit
Exit slit	Define the beam spot size at the sample position (h x v dimensions of the beam spot on the sample is roughly 10x smaller than the h x v settings of the exit slit)
Uncooled M4 baffles	Beam-defining aperture for M4
Ellipsoidal M4 mirror	Final refocusing onto the sample by deflecting the beam horizontally.

Table 3. EPU58 parameters for specific modes of operation

EPU58 parameter	Horizontal model	Helical model	Inclined model	Vertical mode
Phase [mm]	0	17.38	16.01	29
Vert. field [T]	0.9164	0.5385	0.3854	0
K-value	4.964	2.917	2.088	3.610
hv [1st harmonic, eV]	30	40	70	50
Power [kW]	1.46	1.01	0.5	0.77

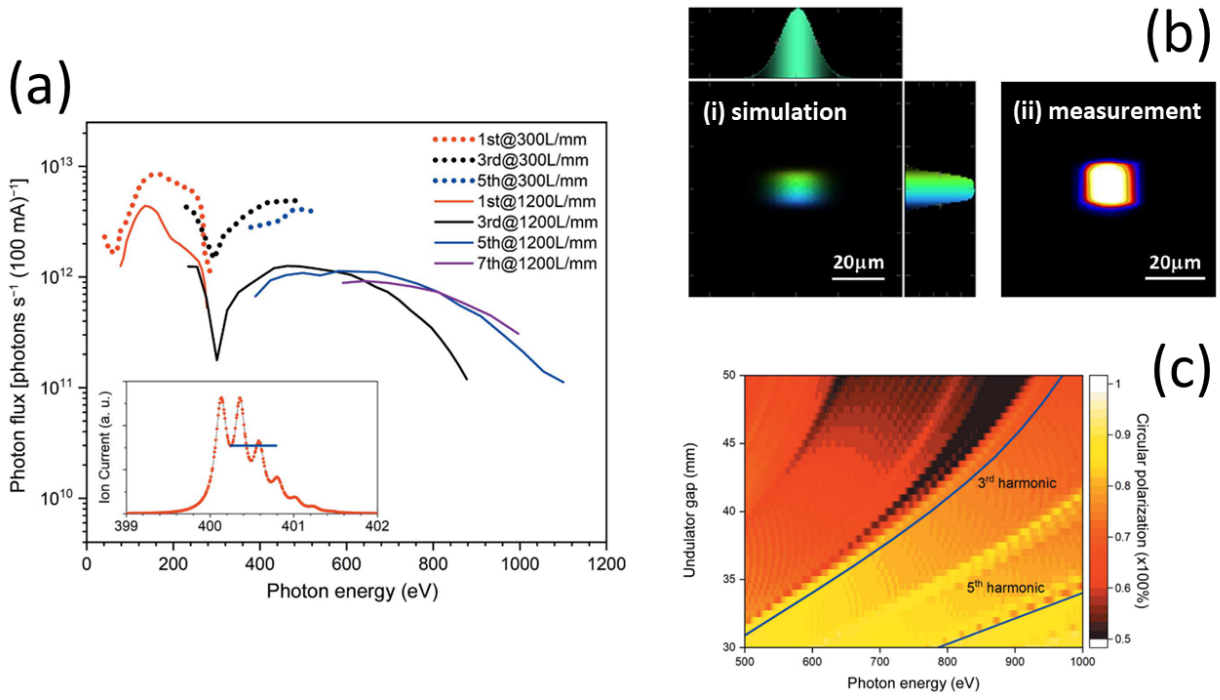


Figure 3. Several key performance parameters of the MAXPEEM beamline.

Spectro-microscopy endstation

The endstation consists of an Elmitec LEEM III direct surface imaging microscope, various upgrades to the microscope (e.g. aberration corrector, larger energy analyzer for improved energy resolution (R200 versus R100), higher pixel count CMOS camera detector, motorized manipulator, etc.), and vacuum chambers added in-house (e.g. preparation and storage chambers). A top view schematic of the endstation is shown in Figure 4.

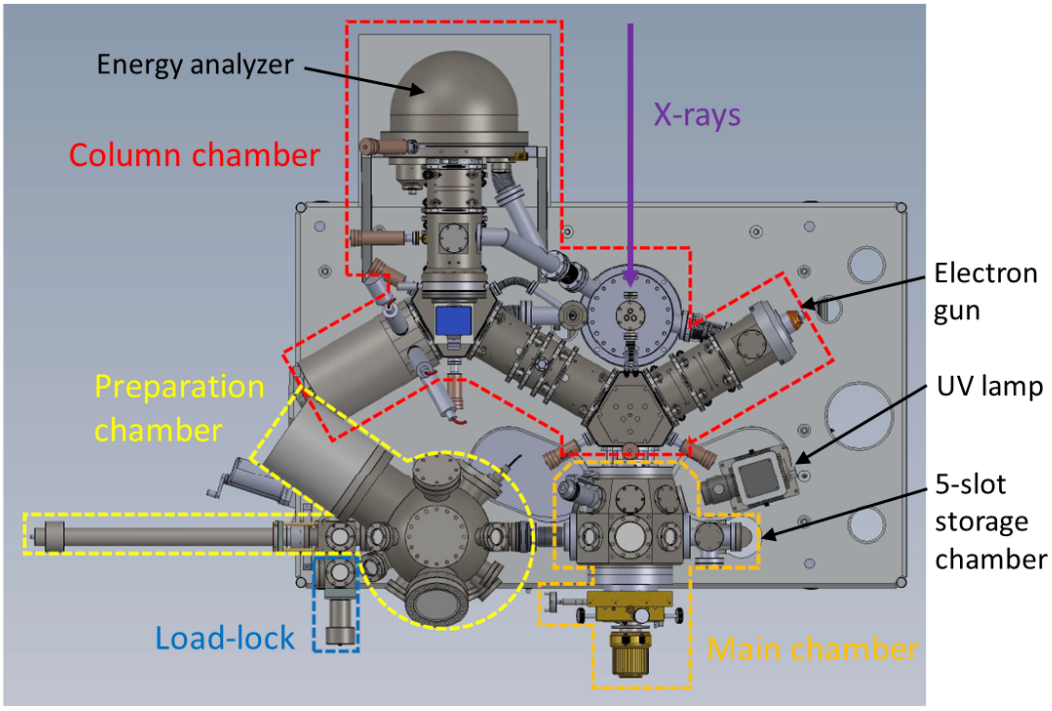


Figure 4. Top view schematic of the MAXPEEM spectro-microscopy endstation, showing key vacuum chambers and the three (photo-)excitation sources: (i) beamline, (ii) UV lamp and (iii) electron gun.

The following actions can be performed in the prep chamber:

- material deposition,
- LEED measurements,
- gas dosing, and
- sputtering and annealing up to 2000 K.

The microscope can perform **live imaging**:

- while the sample temperature is varied (89 K to 1600 K),
- under operando conditions (varying magnetic field, applied electric potential, etc.), and/or
- while metals/molecules/etc. are deposited.

The most important imaging modes of the microscope are summarized in Table 4. **One of the most powerful aspects of this instrument is that it can image a given sample with structural, chemical, electronic and magnetic contrast.**

Table 4. Summary of the key imaging modes of the microscope.

Operation mode	Information yielded
X-ray Photoemission Electron Microscopy (XPEEM)	Energy filtered imaging. The technique can be used for slow secondary electrons (utilizing a work function contrast) as well as for core-level electrons characteristic of the studied material. This allows for performing elemental/chemical mapping.
X-ray Magnetic Circular/Linear Dichroism (XMCD/XMLD)	Utilizing the circular polarization of the photon beam to exploit the magnetic circular dichroism effect (MCD), the imaging of magnetic domains in ferromagnets is possible on the nanometer scale (XMCD-PEEM). Using the linear polarization of the photon beam to exploit the magnetic linear dichroism (MLD) effect, magnetic domains in antiferromagnets can also be imaged on the same scale.
Micro X-ray Photoemission Spectroscopy (micro-XPS)	Valence band and/or core level photoemission spectroscopy from extremely small areas down to a fraction of a micron. High flux on the samples yields both high spatial and high energy resolution.
Micro X-ray Absorption Spectroscopy (micro-XAS)	The microscope images the secondary electron emission at fixed kinetic energy as a function of the photon energy, enabling spatially-resolved X-ray absorption spectroscopy (XAS or NEXAFS).
PhotoElectron Diffraction (PED)	The intensity of a core level line as a function of energy and emission angle is measured. The technique can provide spatially resolved information on the surface crystallographic structure and is therefore complementary to LEED and STM.
Micro Angle Resolved Photoemission Spectroscopy (micro-ARPES)	If the valence band electrons form a diffraction pattern, the band- and Fermi surface mapping in the full cone become possible.
Low Energy Electron Microscopy (LEEM)	This is one of the most powerful techniques for imaging the morphology of crystalline surfaces. Several contrast mechanisms (including Dark Field Imaging) allow the determination of the lateral dimensions of regions with a given crystal structure, the thickness distribution of thin overlayers with monolayer resolution, the imaging of monoatomic surface steps and other morphological features.
Micro Low Electron Energy Diffraction (micro-LEED)	By simply switching one lens and removing the contrast aperture the LEED pattern of the imaged area can be obtained. The imaged area can be as small as 100 nm, so the diffraction pattern from such a small area can be obtained.

Further reading

1. Leemann, S. C. Recent Progress on the MAX IV 1.5 GeV Storage Ring Lattice and Optics. IPAC 2012 - Int. Part. Accel. Conf. 2012, 1662–1664.
2. Zakharov, A.; Preobrajenski, A.; Sankari, R. MaxPEEM Beamline (1.5 GeV Ring at MAX IV) Detailed Design Report; 2014.
3. Robert, A.; Cerenius, Y.; Tavares, P. F.; Hultin Stigenberg, A.; Karis, O.; Lloyd Whelan, A.-C.; Runéus, C.; Thunnissen, M. MAX IV Laboratory. Eur. Phys. J. Plus 2023, 138 (6), 495. https://doi.org/10.1140/epjp/s13360-023-04018-w
4. https://elmitec.de/Leem.php?Bereich=LEEM3
5. Niu, Y.; Vinogradov, N.; Preobrajenski, A.; Struzzi, C.; Sarpi, B.; Zhu, L.; Golias, E.; Zakharov, A. MAXPEEM: A Spectromicroscopy Beamline at MAX IV Laboratory. J. Synchrotron Radiat. 2023, 30 (2), 1–11. https://doi.org/10.1107/S160057752300019X

6. Niu, Y.; Golias, E.; Man, G.; Zakharov, A. MAX IV Beamline Review Report: MAX-PEEM; Lund, Sweden, 2023. https://www.maxiv.lu.se/wp-content/plugins/sharepoint-plugin/ajax/downloadFile.php?site_id=MAXIV&version_series_id=16&repository_id=0df38c7e-6f77-43c7-8ab8-bd7153273666

7. Nyholm, R.; Andersen, J. N.; Johansson, U.; Jensen, B. N.; Lindau, I. Beamline I311 at MAX-LAB: A VUV/Soft X-Ray Undulator Beamline for High Resolution Electron Spectroscopy. Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip. 2001, 467–468, 520–524. https://doi.org/10.1016/S0168-9002(01)00399-0.

8. Bauer, E. Surface Microscopy with Low Energy Electrons; Springer New York: New York, NY, 2014; Vol. 9781493909. https://doi.org/10.1007/978-1-4939-0935-3.

1.2.2 Pre-beamtime checklist

Once the beamtime has been scheduled in DUO

- Email the *local contact* for your beamtime if they haven't made contact with you yet, and initiate a dialogue.
- Create an *experimental session* for the beamtime in DUO, well ahead of time, and declare all samples, sources, lasers, etc. The Experimental Safety Team needs time to review this information.
- Ensure your samples are **compatible** with the MAXPEEM sample holders - see important note below.
- Make your *travel arrangements*, and plan to arrive *one day prior* to the official start of the beamtime to load a sample into the system, etc.
- Assemble your on-site (and possibly, virtual also) *team* - see important note below.
- Book *accommodation* - see important note below.
- Consider whether the simple *prep lab* at the beamline is sufficient for your sample preparation needs. If not, …
- Request access to a *chemistry lab*, if needed. The closest chemistry lab to MAXPEEM is the D3 lab (located close to the FlexPES beamline).
- Discuss the *feasibility* of measuring on your samples (electrical conductivity, surface flatness/roughness, size, etc.) with your local contact.
- Determine what samples/tools/consumables/etc. need to be *shipped*, to MAX IV - see note below.
- Install MAXPEEM *data analysis tools*, and become familiar with them - see note below.

Roughly three weeks before the beamtime

- Check whether an *experimental session* has been created in DUO.

Roughly one week before the beamtime

- Create a preliminary *experimental plan*, and share it with your local contact.
- If your experiment has *non-standard requirements* (e.g. laser usage, hazardous samples, hazardous gas usage, etc.), update your local contact on the progress of your preparations and inquire about the status of their preparations.
- If your arrival time at MAX IV is outside of the opening hours of the reception (08.00-16.00), email reception@maxiv.lu.se to arrange for your *access card* to be left in a safe deposit box.
- If the *safety test* has not been completed yet, follow these instructions to complete it.
- Install the *Skånetrafiken app* on your smartphone, for riding the tram/bus/etc. in Lund.

Warning

For sample shape and size constraints, see User Information

Bringing samples/substrates that are:

- too thick,
- too small or large (length x width) to fit onto the sample holder,
- electrically insulating,
- rough on the surface, and/or
- etc.

could prematurely end your beamtime. At the least, it would lead to a poor start (cleaving substrates to fit the sample holder, additional surface preparation, etc.) If you have any concerns about sample feasibility, discuss with your local contact ASAP.

Description of the sample holder/cartridge

CAD drawings of the standard Elmitec sample holder/cartridge are shown in Figure 1. The standard Elmitec sample holder features a heating filament, four foil-based spring contacts on the underside (two for the filament, two for the thermocouple), and a thermocouple that is spot-welded to a point that's close to the sample. The standard cartridge is made of non-magnetic materials, can be flashed up to 2000 K, and cooled down to ~100 K with liquid nitrogen.

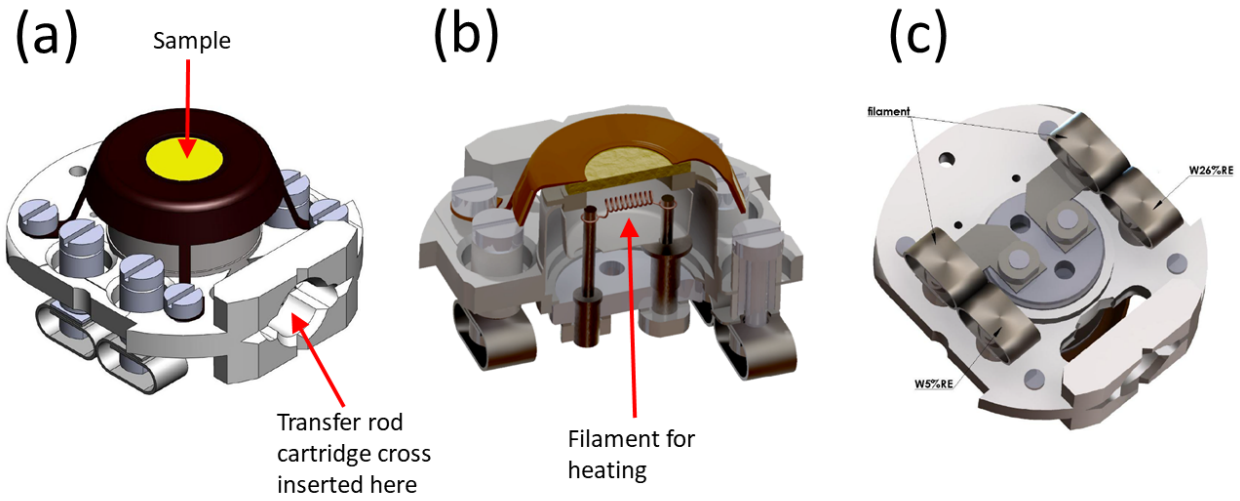


Figure 1. CAD drawings of the Elmitec sample holder, showing (a) the fully assembled sample holder with sample, (b) a cut-away of the sample holder exposing the heating filament, and (c) the underside of the sample holder.

MAXPEEM offers an array of modified sample holders.

- For better low temperature performance, a sample cartridge built from copper can be used.
- For studying magnetic domains in a magnetic field, a sample cartridge with a built-in electromagnet can provide a bipolar out-of-plane magnetic field up to 72 mT.

- …

User team

When planning for this beamtime, remember that your team must consist of enough people to safely and effectively use the beam 24 hours per day. We will expect all members to be sleeping, outside of the lab, for at least 6 hours out of every 24.

Between the local contact and second contact, the beamline staff aims to cover user operation for ~12 hours a day.

After the experimental session has been created in DUO, each participant must apply for their own access card.

Accommodation

MAX IV officially recommends the university guest house, which is 3 km away. Unless price is dictating the decision, we at the beamline highly recommend *Forskarhotellet* as the best option (100 m away, https://www.forskarhotellet.com/), followed by Motel L (1 km away, https://www.booking.com/hotel/se/motel-l-lund.en-gb.html). Bicycles are available on loan from MAX IV, or for hire from the guest house.

Experimental plan

If possible, share your (preliminary is OK) experimental plan at least a week before the beamtime with your local contact. A good format is to list the samples, in order of priority, and list the measurements to be performed on each sample. Your local contact may have suggestions, regarding the sequence of samples/measurements, that could improve the efficiency of the beamtime.

Transportation or shipping of samples/tools/supplies/etc.

If you are shipping equipment/samples/tools/etc. to MAX IV, first inform your local contact, then use the following address:

Att. *name of local contact*
LUNDS UNIVERSITET, MAX IV, GODSMOTTAGNING
Fotongatan 8
224 84 Lund, Sweden

Provide the tracking number to your local contact.

We recommend using DHL and similar shippers. Historically, packages shipped with Postnord have ended up at a nearby post office which isn't too close.

1.2.3 Post-beamtime checklist

Near the end of the beamtime

- Make arrangements with your local contact to *remove* all of your samples from the microscope and prep chamber.
- *Clean up* your work area in the *chemistry lab*, if applicable.
- Clean up your work area in the *MAXPEEM prep lab* (next to the measurement hutch), if applicable.

Caution

At the end of the beamtime

- Clean up any *leftover food, cups, paper scraps, etc.* from the hutches.
- Put away any *power supplies, cables, tools, etc.*

- Erase any markings from the *whiteboards* that are directly related to your beamtime.
- Copy your *data* from the appropriate folder on the network drive offline-2
- If *shipping* samples and/or equipment back to your home institute, package everything up and transfer the package to your local contact.
- Pack up all of your samples, and *clean up* your work area on the sample prep table in the measurement/microscope hutch.
- *Tell* your local contact what worked well and not well.

Shortly after the beamtime has ended

- Submit beamtime *feedback* in DUO.
- Submit an experiment *report* in DUO.

1.2.4 Beamtime hacks

Tips for designing an optimal measurement plan

Below are a list of considerations. It's non-exhaustive. As development work is ongoing, some of these considerations may be outdated. Consult with your local contact.

- Multi-hour, automated overnight measurements with the beamline may be infeasible, due to heat-induced deformation of the M1 mirror (need to periodically re-tune M1 pitch, etc.). The measurements could be semi-automated, if a user periodically stops by the hutch.
- Unless the surface is ultra-clean, chemical mapping with XAS-PEEM is preferred to XPEEM, as the yield of secondary electrons is expected to be higher versus primary photoelectrons
- The continuous application of a high voltage between the microscope objective and sample surface generally leads to carbon deposition - periodic surface regeneration may be needed
- Scangui (ascan macro) enables most beamline and microscope parameters to be swept –> automated scans
- Five slots exist in the storage chamber attached to the main chamber, though 2-4 slots are typically occupied. Talk to your local contact about storing sample(s) inside.
- Micro-ARPES typically works well with photon energies up to ~100 eV. The photon flux decreases above 100 eV for the 1200 lines/mm grating, plus the photoionization cross-sections decrease with increasing photon energy.
- The beamline elements are contaminated with carbon, yielding lower-than-expected photon flux at energies at and near the carbon K-edge
- The beamline lacks proper i0-type normalization, needed for generating high-quality X-ray absorption spectra. A gold mesh exists upstream of the M4 mirror, but the mesh is dirty and we cannot deposit fresh gold onto it.
- When XAS measurements are desired, check the literature (and/or use Google Image search) to determine if the edge has been measured before - *having a core level doesn't mean you have an absorption edge*

Tips for operating the beamline

- Track the beamline flux by periodically inserting the photodiode into the beam path; tuning the pitch of the M1 mirror is usually sufficient to maximize the flux.
- The spot size at the sample position is around 15 um (H) x 15 um (V) with a 0.15 mm exit slit opening in the vertical and horizontal directions (the image at the exit slit is demagnified by a factor of 10 at the sample position).
- Peak photon flux is obtained at ~100 eV (for the 1200 lines/mm and 300 lines/mm gratings)

Toilets and water/tea/coffee stations

Tea, coffee, hot chocolate, etc. are available for free, 24/7. The approximate locations of the drink stations and toilets are displayed in the schematic layout of the Lab.

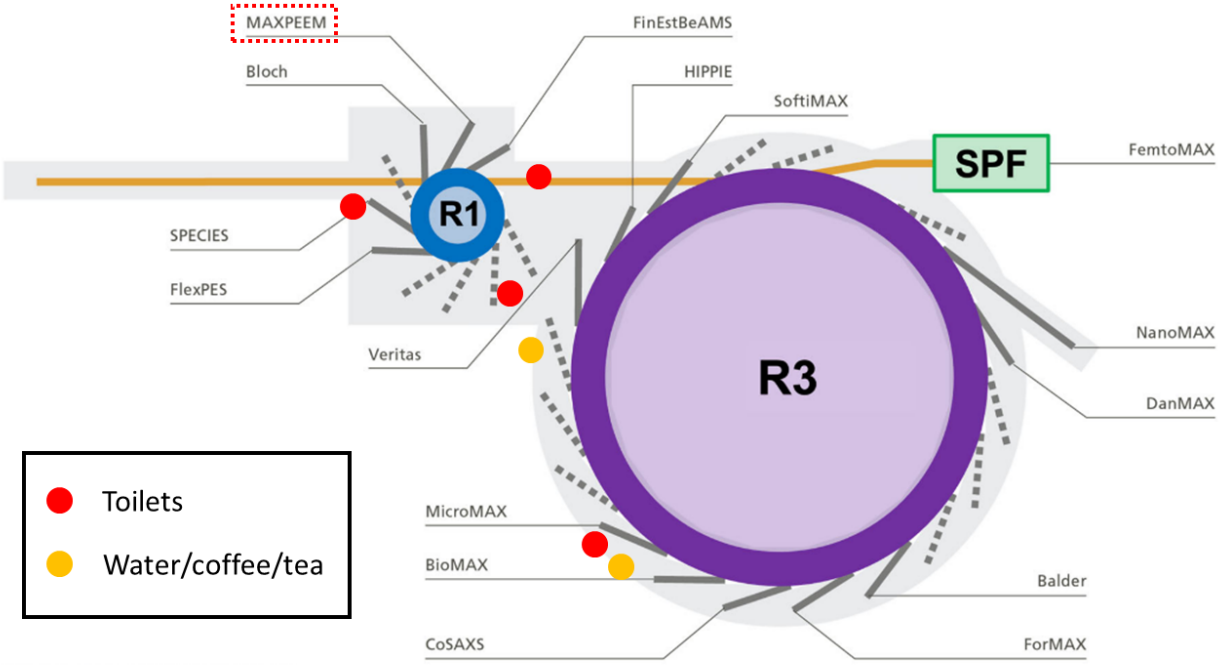


Figure 1. Schematic of MAX IV, showing the toilets and drink stations that are easily accessible from MAXPEEM.

WiFi

- maxiv_user (log in with MAX IV DUO username and password)
- maxiv_visitors (intended for 1 day users, Internet access only, receive a token through your email address)
- eduroam (Internet access only)
- maxiv_staff (not applicable to users)

For more details on access privileges, etc. see https://www.maxiv.lu.se/beamlines-accelerators/controls-it/it-services/wifi/

Food options

In short, the main options are: * visiting food trucks (usually located close to the main entrance, where the reception is, from 11-13 Monday - Friday); call Reception (+46462229872) for the latest schedule. * cooking in the user kitchen at MAX IV and/or in the guestrooms at Forskarhotellet * microwaving frozen food purchased from the vending machines * ordering food delivery (e.g. foodora.se) * stationary food truck “Dagens lunch 60” serving burgers and daily specials (5 minute talk from the Lab, Odarslövsvägen 50)

See https://blochdocs.maxiv.lu.se/food.html for more details.

Resting and exercise rooms

A sleeping room is available in the basement of the E-building. First come, first served. An exercise room, equipped with a pull-up bar, bench, weights and cardio training machines, is also available in the basement.

Tools and supplies available in the MAXPEEM prep lab

- Hand tools: tweezers, pliers, screwdrivers, wrenches, etc.
- Vacuum parts
- Kapton tape
- Dessicator
- Optical microscope

EPO-TEK epoxies, pastes, etc. stored in the D3 chemical lab (fridge). **Ask if you need something special.**

1.2.5 Beamtime Problem-Solving Guide

> **Note**
>
> If you are uncertain about the procedure, please consult the beamline scientist.

Get familiar with setup

1. Get familiar with *LEEM2000* and *U-view* software interface
2. Get used to checking the *pressure of chambers* often
3. Understand *high voltage rack*, *interlock* and *arc*

Before measurements

1. *Fix data storage path* (must do before scan!)
2. *Sample remove from main chamber* or *Sample insertion from load lock/air*
3. *Annealing/degasing* in preparation chamber or main chamber
4. *Sputtering in preparation chamber*
5. *Cooling in main chamber*

Alignments and setup-relates

Alignment examples location: c:/program data/leem2000/2025alignment example

1. *How to switch on High Voltage Rack*
2. *LEEM alignment*
3. *Insert slit and apertures in LEEM mode*
4. (Normally not needed) *Detailed alignment start with UV-PEEM*
5. *What if camera is not responding?*

Beamline (x-ray)

1. *How to open valve in front end* after beam dump
2. *How to align beamline* before measurement

Measurements

1. *Table of available modes* for checking which slit/aperture is needed
2. *How to insert slit/apertures*
3. How to set up *camera parameters for scangui*
4. How to set up *sequencer in scangui*
5. Example about how to *name data files*
6. Example about how to *determine beamline energy (range)*

Change setup from LEEM to another mode

1. *XPEEM mode*
    - *Scan start voltage*
    - *Scan beamline energy*
    - *Continuous acquisition when cooling/heating*
    - *XMCD measurement*
    - *XMLD measurement*
2. *micro-XPS/Dispersive plane mode*
3. *LEED mode*
4. *Micro-ARPES/PED mode*

1.2.6 Operating the loadlock / fast entry chamber

Changing sample in main chamber

Danger

Turn off the high voltage rack before changing sample!

Caution

Ensure that the tilt is properly initialized by physically verifying it before adjusting the manipulator head, especially if you plan to insert the sample into storage!

1. Close the valve to the X-ray beam, turn off the electron gun (-290 V), and either turn off the UV lamp or close its iris entirely, as appropriate.
2. Initialize the manipulator's position (X, Y) and tilt to 0 (X, Y, tilt = 0). Double-check the values in both the software and the manipulator head physically. Ensure that the holes are fully exposed and not partially obstructed.
3. Remove slit and apertures, and double check that the **high voltage rack is off**!
4. Before operating the transfer arm, verify the holder's location in the prep chamber to avoid collisions. Open the valve between the prep chamber and the main chamber, and remember to close it once finished. Always be aware of the transfer arm's position and any objects in its path, adjusting its orientation as needed.

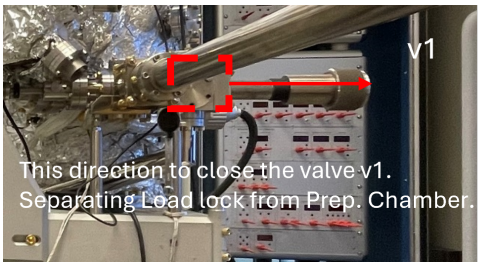
- If the microscope has been aligned, most likely the alignment is good enough for measurements after correcting the sample tilt.
- The standby mode generally is FOV = 10 μm and STV = 0V.

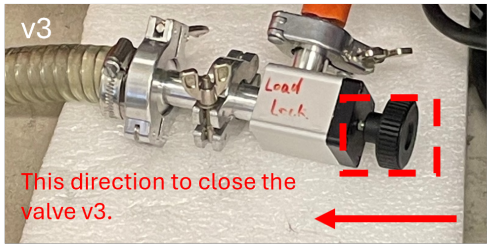
Sample insertion from air

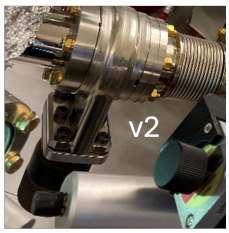
> **Caution**
>
> Frequently check the pressure of chambers. After insertion, remember to check the pressure of prep chamber in case of leakage.

Venting

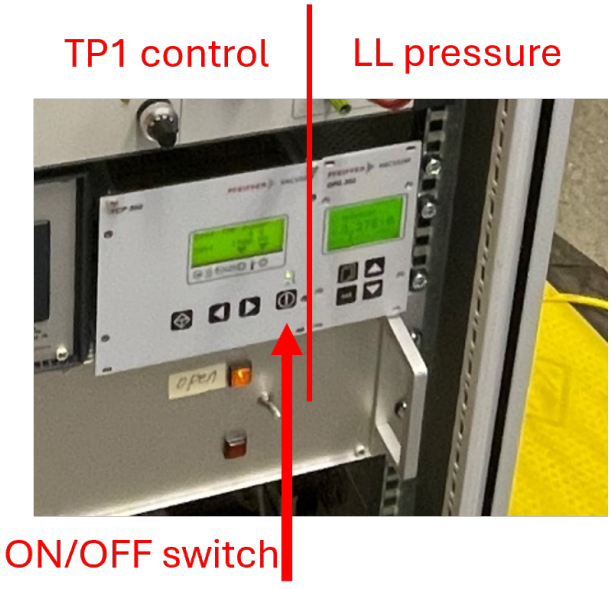
1. Check that the valve from load lock to prep chamber (v1), and valve to forepump (v3), and valve from prep chamber to main chamber (v2) are closed.





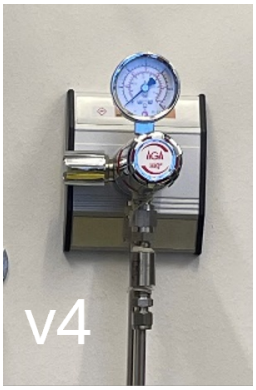


2. Turn off the small turbo pump (TP1): The green light above the switch will start blinking and speed will decrease from 1500 Hz. Can hear the sound of deaccleration of TP1.



3. Loose the bolts of load lock but keep them in the holes.

4. Set the nitrogen gas regulator (v4) around 0.4-0.6 on the low-pressure side (clockwise to open). You will hear the nitrogen flowing through the load lock.

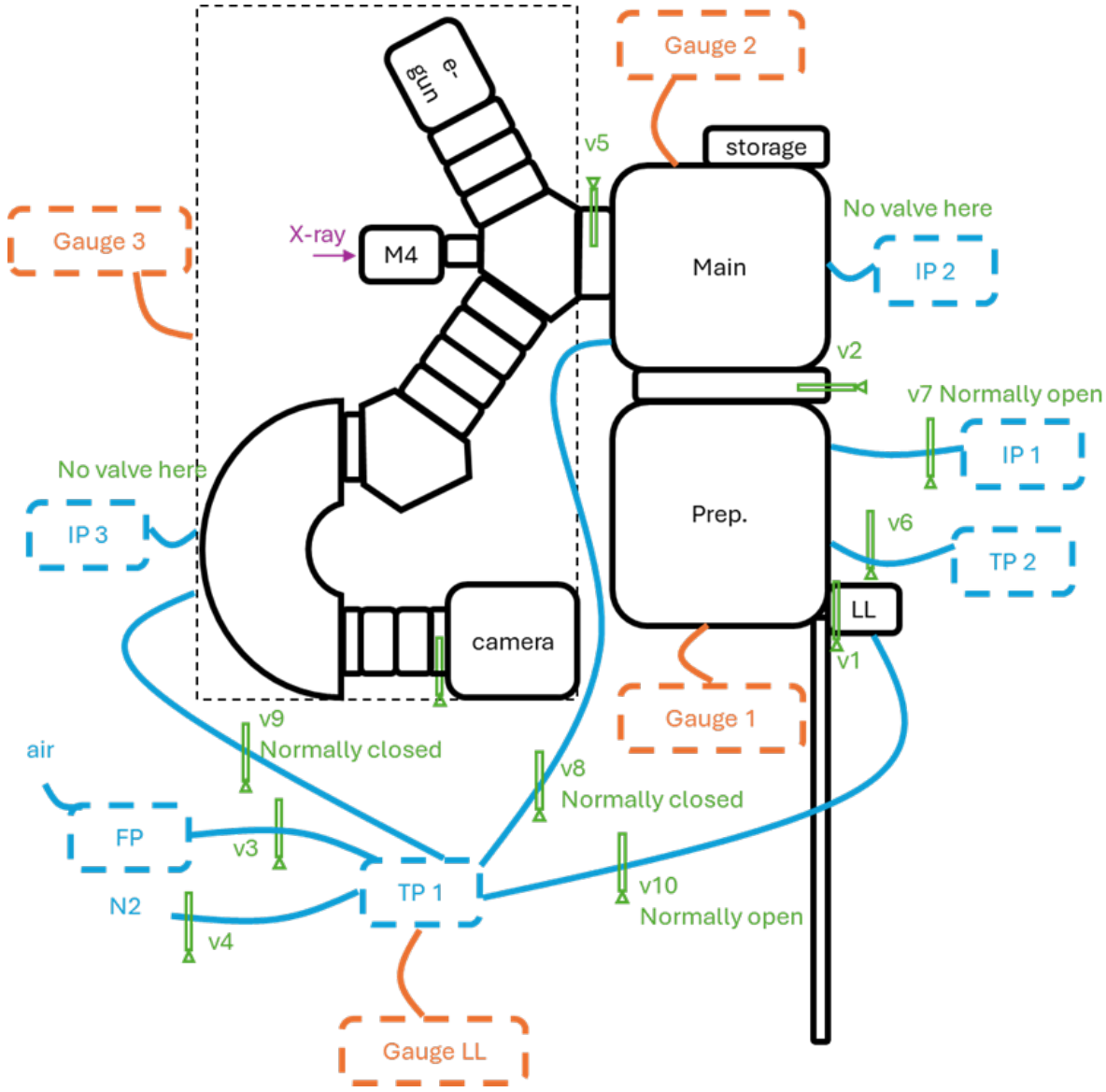


5. Fully remove the load lock bolts and flange when LL pressure reads 1000 mbar – insert sample (gloves must on) – stop the nitrogen flow via v4 – close the Load lock bolts (one up right, one down left) and flange. Hand tighten the two bolts instead of using a wrench, to avoid over-tightening.

Pumping down after sample insertion

6. Slowly open valve to forepump (v3) and switch on small turbo pump TP1. Hear the noise from forepump pumping.
7. Slowly close v3 when reads 50 mbar on load lock pressure.
8. Wait until the load lock pressure reads at least 3x10^-6 mbar to transfer the sample into prep chamber. This might take 15-30 minutes.
9. Leave sample in prep chamber to degas. Close v1 to separate load lock and prep chamber.

Schematic Layout of the UHV System



Vacuum suitcase connected to the load-lock

For air-sensitive samples, MAXPEEM offers the option of transferring the sample in argon. One needs to book a chemistry lab with a glovebox (e.g. D3) https://lab-booking.maxiv.lu.se/

- Transfer the suitcase, sample cartridge, sample(s), etc. into the glovebox, using the large antechamber

Vacuum suitcase connected to the prep chamber

To transfer

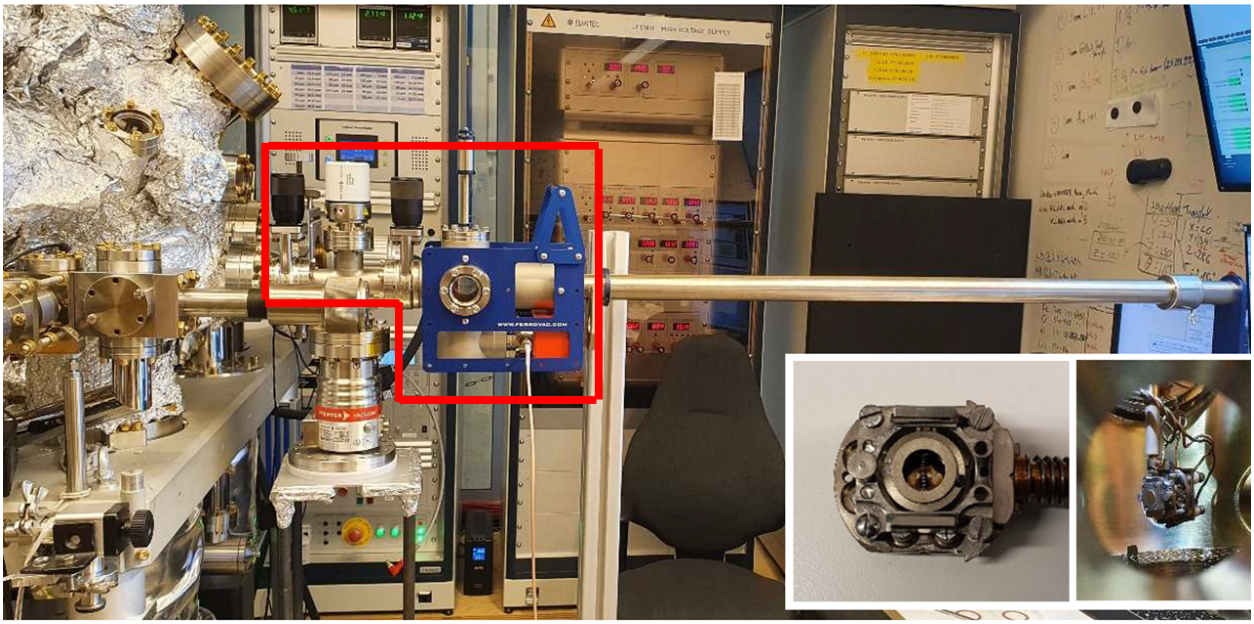


Figure 1. Photo of the Ferrovac UHV suitcase connected to the prep chamber. The inset shows the Elmitec-Omicron adaptor,

In the prep chamber, an Omicron flag-type sample plate can be transferred using an Omicron-Elmitec adaptor via a Ferrovac UHV suitcase.

How to exchange the sample

1. Install the cartridge in the aluminum holder.
2. Loosen the four M2 screws holding the sample down.
3. Remove the sample cover
4. Remove the sample
5. Install the new sample
6. Install the sample cover
7. Fix the cover with the four screws (suggestion: tighten the screws in an X pattern)

Caution

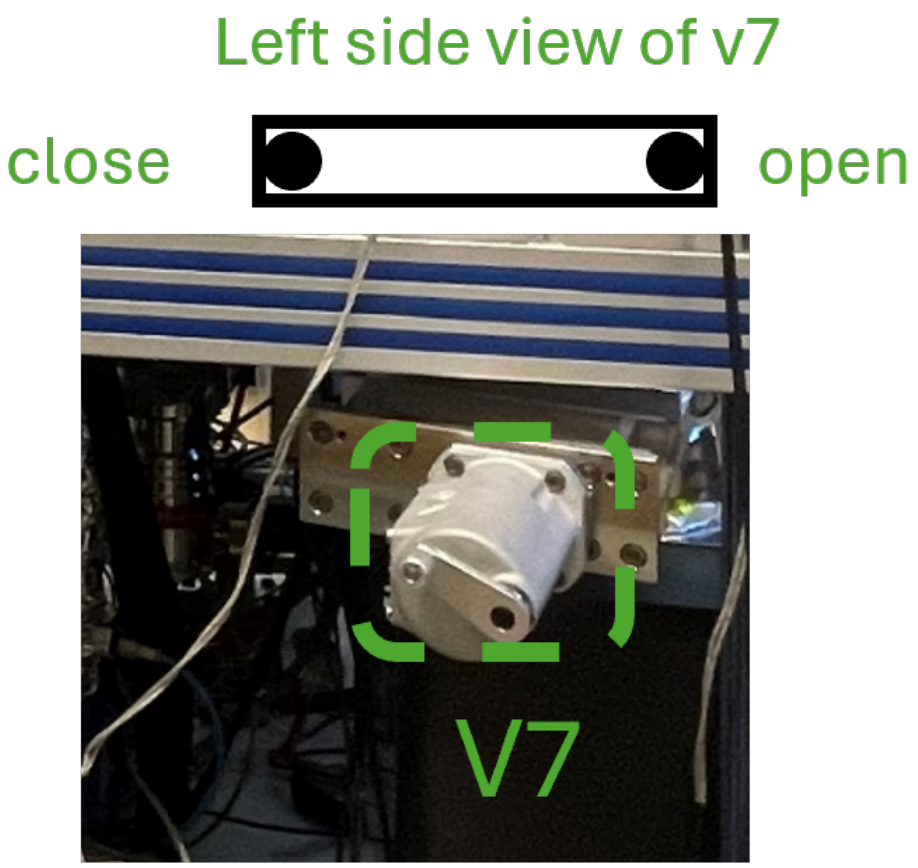
The tilt on the manipulator can only be adjusted up to +/- 2 degrees. Mount the sample onto the cartridge as flat as possible.

1.2.7 Operating the prep chamber

Sputtering with argon

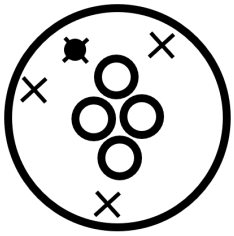
Caution

Make sure the v7 is closed so that IP1 will not be affected by gas insertion.



1. Ensure the mini-cylinder connected to the ion source is labeled with argon. Check if argon is clean with Mass spectrometry (spectrum with argon – spectrum without argon).
2. Rotate the sample 90° to face right side, so that the sputter will happen at 45° incident; remember the direct to rotate the manipulator so that later it will be rotate back instead of going through a circle rotation; when changing the height of manipulator always make sure it is clear to move, so that nothing will be bent; the motor of manipulator will not automatically stop, so always be careful and aware of the manipulator location.
3. Link the sputter gun with control unit. Connect to the power supply and turn on the power supply (top shelf), and the four lights will be blinking on and off.

Connect sputter gun to control unit

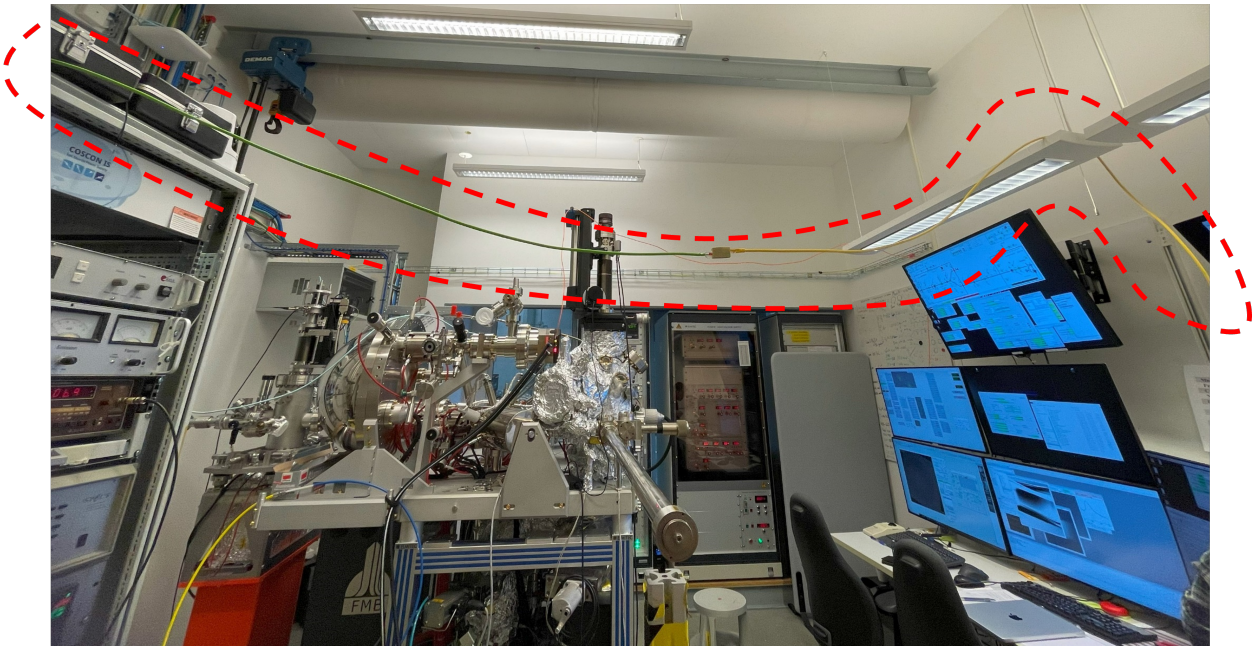


There is only one direction that the plug can be pushed to the end and be fixed.

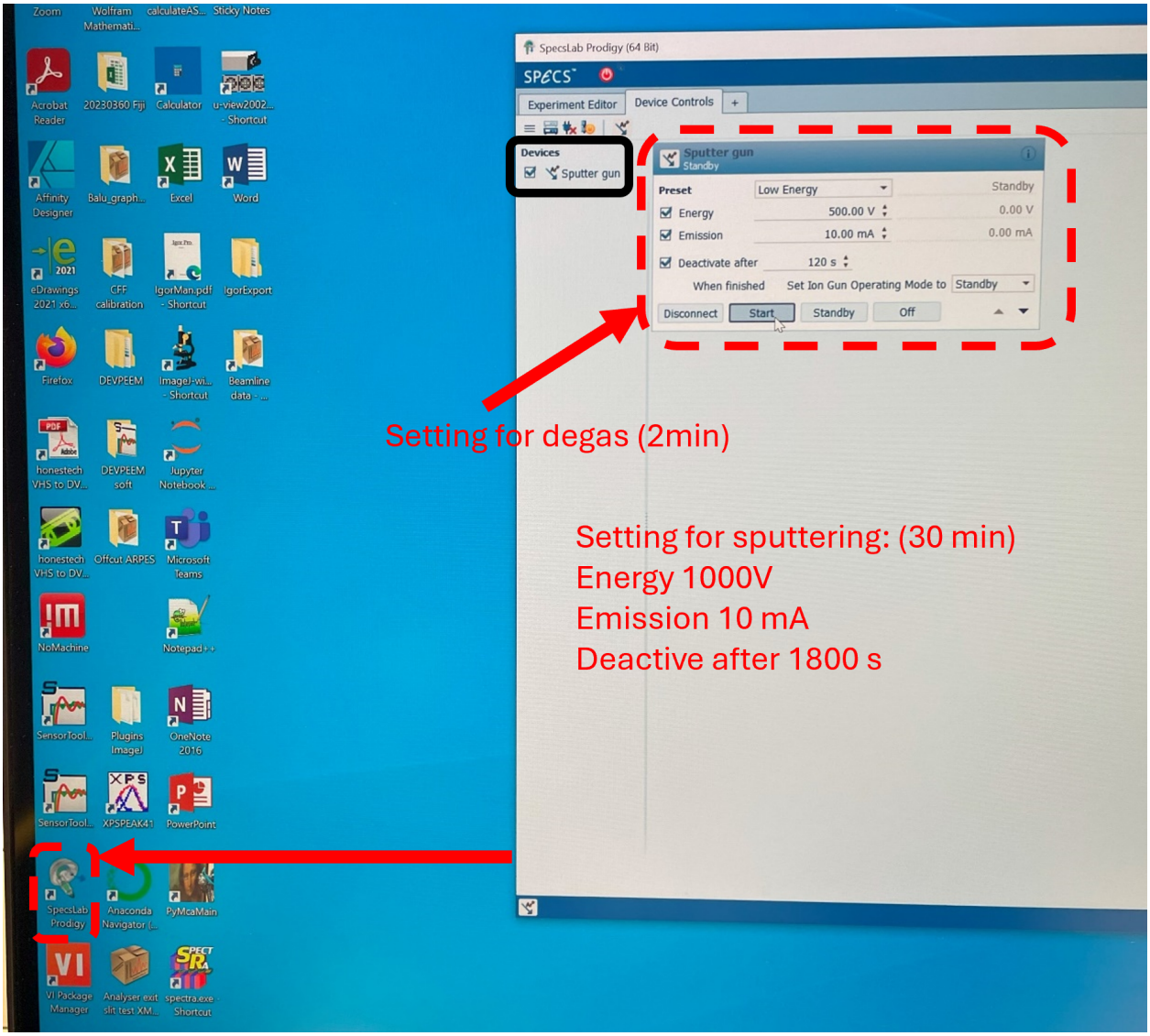
Power supply for sputter gun

4. Ensure the Ethernet cable from the Specs supply is connected to a cross-over Ethernet cable that's plugged into the User Data Analysis workstation.

Connect the control unit to the analysis computer via network cable



4. Start the Specs Prodigy software on the workstation and connect the sputter gun by clicking on the box.



5. Degas for 2 min while watching the pressure, which might reach 10^-9 torr.
6. Start argon flow while watching the pressure: slowly open the gaskets for argon, and stop opening it while reach 10^-8 torr and let it slowly reach 10^-7 torr.
7. Change the setting for sputtering operation and there should be some emission current. Maximize the emission current to ~ 5.0 mA by adjusting the X and Y of manipulator in prep. chamber, instead of rotation. Argon flow can be adjusted a bit if needed.

- The pressure increases to 2x 10^-6 torr and emission current to ~ 6.6 mA are also fine.
- Check the connection of wires on the backside of shelf if there is no emission current.

Annealing/Degassing the sample in the prep chamber

Remember to close argon flow before annealing. Default parameters: Filament current = 2.65 A and voltage = 50 V for annealing for ~ 30 min. Remember to set timer for this.

Information about details refers to *this page*.

In-glovebox crystal cleaving, and air-free transfer to the microscope

The general idea is to:

1. Bring the sample, vacuum suitcase, a sample cartridge, and the necessary hand tools into a glovebox (for example, the argon glovebox in the D3 lab)
2. Cleave the crystal with a scalpel blade.
3. Mount the freshly cleaved crystal into the sample cartridge
4. Load the sample cartridge into the vacuum suitcase, close the gate valve in argon.
5. Bring the suitcase out of the glovebox, connect to the load lock, and pump down.

In-vacuum post-cleaving of the crystal

This method is still under development. Talk to the beamline staff about it. Ensure the crystal sample will not outgas substantially in vacuum. If the sample needs to be degassed first (due to, for example, trapped water in the crystal since the crystal was grown in air), one can use the vacuum oven at DanMAX sample environments and equipment.

The general idea is to:

1. Glue the crystal sample to a rigid, electrically conductive plate with EPO-TEK H20E vacuum-compatible silver epoxy. The conductive plate could be made out of copper, and should be sized appropriately (14 mm diameter max. for a disc, 2.5 mm max. thickness). The standard epoxy recipe involves mixing parts A and B in a 1:1 ratio and curing the epoxy at 100C, for 1 hour, on a hotplate in air.
2. Glue a cylindrical post to the vacuum-facing side of the crystal, using EPO-TEK H21D epoxy with parts A and B mixed in a 10:1 ratio. Cure the epoxy at 100C on the hotplate for 1 hour. Ensure the length of the post will not collide with the load-lock cartridge holder, once the sample is assembled into the sample cartridge.
3. Cleave the crystal in-vacuum by carefully extending a wobble stick into the path of the transfer rod, and hitting (just) the post with the edge of the wobble stick.

Talk to the beamline staff about making the posts from 316 stainless steel.

Note

The diameter of the post, diameter of the opening in the cap, epoxy curing time, etc. are all parameters that need to be optimized for each sample

1.2.8 Operating the microscope

Danger

The microscope utilizes high voltages (~ 20 kV). Under normal operating conditions, users do not need to worry about electrical shock. If you experience an electrical shock, immediately switch off the high voltage (green button) and report the incident to your local contact.

For detailed alignment, one can start with UV-PEEM for aligning intermediate column and image column with field of view typically > 50 µm, without influence from illumination column.

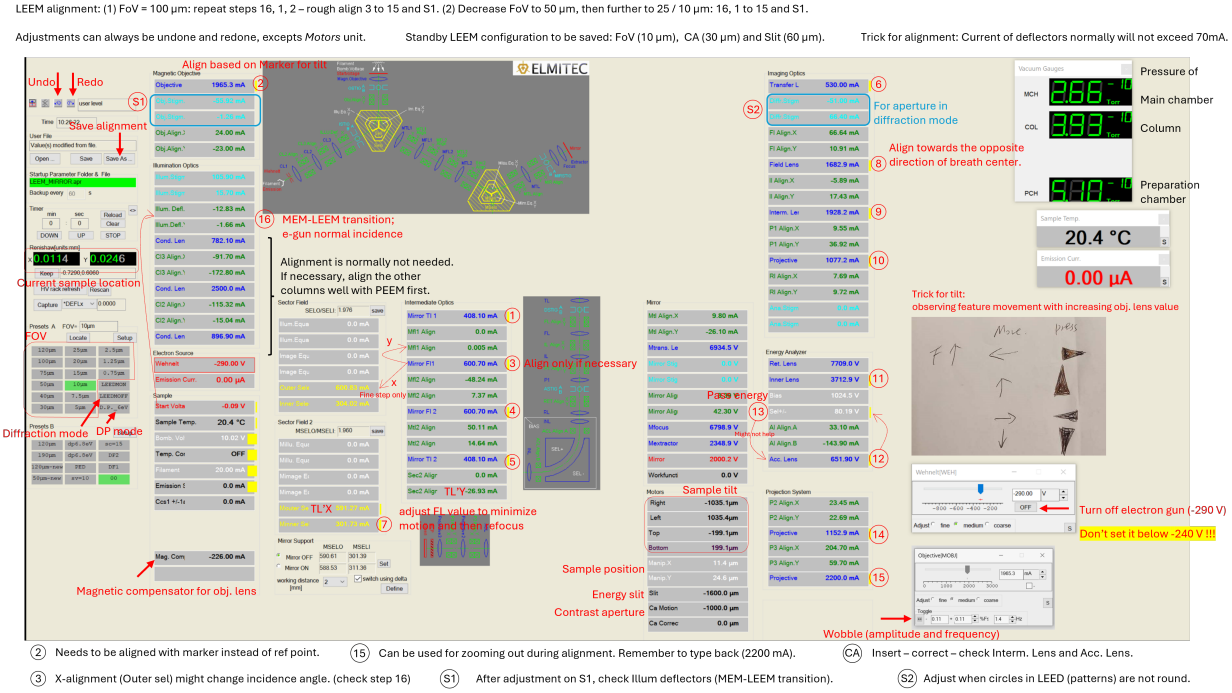
For simple alignment, one can directly start with LEEM or XPEEM with a smaller field of view and do steps 16, 1→15. Repeat steps (16, 1, 2) as needed during the initial process.

The setup inherited from the previous week is normally well-aligned, allowing for a simple alignment check first. During alignment, one can always use 'undo' to return to previous setting of lens, but not manipulator motors.

The descriptions of these steps are explained in detail at the end of this page, as well as about slit and aperture insertion. The screenshot of LEEM2000 and the file detailing the alignment steps are available for download on the manual page.

Modes

Modes	ILA	SAA	CA	ES	Comment
Imaging mode (LEEM, PEEM)			x	x	ES must be inserted in LEEM mode
Dispersive plane mode (XPS)		x	x		ES must be removed to start acquisition
µ-ARPES (PED)		x		x	No CA is needed, ES 25 µm or smaller
LEED	x			(x)	IA is preferred over SAA, ES is optional



ILA : Illumination Aperture

SAA : Selection Area Aperture

CA : Contrast Aperture

ES : Energy Slit

Frequently used parameters: Select area aperture = 100 / 50 µm (real image size = SAA/20), Contrast aperture = 30 µm, Energy slit = 60 µm, Illumination aperture = 30 µm.

For detailed info about slit and aperture insertion, refer to the section below with the same name.

XPEEM

From LEEM alignment to XPEEM measurement

1. Close electron gun by set Wehnelt voltage to OFF value (-290 V).
2. Set start voltage to a value like 1.5 V instead of 0.
3. Open x-ray valve and align beam with observing image. Refocus with objective lens and adjust Obj. Stigmator. Maximize signals with adjusting start voltage.

- If feature has shadow, it means Field Lens X, Y needs adjustment. And likely signal will become stronger if aligned well.
- Sometimes checking value of Acc. Lens is needed, but normally not.

Micro-XPS (Dispersive mode) measurement

1. Save the LEEM setting in case of changing back to imaging mode later, normally with FOV ~ 10 µm.
2. Insert SAA (e.g., 100 or 50 µm) in LEEM mode.

3. Set the Start Voltage to desired values if known, e.g. (Pt 4f) hv = 250 eV with peaking at STV = 174.6 V and 171.6 V. Or set the Start Voltage to a higher value if targeting at secondary electron, e.g. (Au WF) hv = 150 eV, STV = 40 V and later (after finishing rest of steps) decreases to 9 V for measuring work function.
4. Set to D.P. mode.
5. Adjust P2 value and P3' x and y deflectors to observe the sharp edge of slit.
6. Remove Slit. Careful about setting start voltage!
7. Remember to turn off the electron gun and check the X-ray alignment. X-ray alignment (M1_pitch) can be done with viewing DP signals if M4 alignment has been checked.

LEED Measurement

From LEEM alignment to LEED measurement

1. Save the LEEM setting in case of changing back to imaging mode later, normally with FOV ~ 10 μm.
2. Insert illumination aperture IA = 30 μm or other value based on requirements.
3. Set the Start Voltage to a higher value (e.g. 40 V).
4. Set to LEEDMOFF mode.
5. Remove Slit. Careful about setting start voltage!
6. Remove CA.
7. Decrease start voltage accordingly for measurement while observing LEED pattern.
8. Use P3'x and y deflectors to centralize LEED pattern.
9. Normal incidence might be changed and needs to be checked.
10. Use the diffraction stigmator to make the pattern circle. One can use the marker generated by clicking three points to guide eyes. However, this step might make the (0, 0) being away from the center of LEED pattern.
11. Alignments on lenses after Field Lens need to be checked. Try to centralize the (0, 0) dot in pattern. If all the lenses are aligned well but the (0, 0) is still not in the center, one can use RI'x and y deflectors (without toggle Inner Lens) to manually centralize the (0, 0).

- The plot can be visualized with LEED(log) mode for clearer judgement.

Micro-ARPES measurement

From LEEM alignment to LEED measurement

LEED = electron gun + LEEDMOFF mode; ARPES = X-ray + LEEDMOFF mode

- If coming from LEED mode, remember to remove illumination aperture.

1. Save the LEEM setting in case of changing back to imaging mode later, normally with FOV ~ 10 μm.
2. Insert SAA (e.g., 100 or 50 μm) in LEEM mode.
3. Set to LEEDMOFF mode.
4. Insert Slit (25 μm) in LEED mode.
5. Remember to turn off the electron gun and check the X-ray alignment.
6. The patten should be like facing front instead of tilted. Toggle IL (which is most important for facing front) and P1 for optimization. Adjustments on P1's value, acc. Lens' value might also be needed. Alignment on Ana. Stigmators is normally not needed.
7. Toggle Acc. Lens and correct it with Sel+/-.

8. Toggle Sel+/- and correct it with Acc. Lens when slit is not in the path, otherwise with very small amplitude for toggle or skip this step.
9. The start voltage can be adjusted accordingly for measurement.

- Due to the polarization of beam, the ARPES patten will be partially unclear.
- The plot can be visualized with LEED(log) mode for clearer judgement.

Detailed alignment with UV-PEEM and LEEM

Refer to the PDF titled "Detailed Alignment with UV-PEEM and LEEM" in the Equipment Manuals for Users section for a comprehensive guide. Below are the essential steps summarized without detailed explanations.

Prepare the setup for high voltage

1. Position the Manipulator Head (3 mm to objective lens) and **Use aluminum foil to temporarily fix the position of the head**
2. Check the pressure of chambers (Main chamber < 2x10^-9 torr), X-ray valve is closed, electron gun is off and the Start voltage is set to 0 V. Camera can be at acquisition mode. Check the sample temperature if it has been heated
3. Set the coarse screw to a lower value (e.g., 5) and turn on high voltage rack. Increase slowly with eyes on pressure

UV-PEEM alignment

For rough alignment, all apertures and slit in the beam path should be removed.

Prepare the setup for UV-PEEM

1. Be sure the electron gun is OFF: Wehnelt potential as -290 V by default
2. Prepare the UV Lamp with mechanical iris being closed
3. Monitor the Microscope Image and Main Chamber Pressure and Slowly open the iris partially.

> **Caution**
>
> Be mindful of scattering and reflection of UV light.

Alignment of intermediate column

(1) **Find the Optical Axis and set marker**

1. Wobble the Mirror Transfer Lens 1 (MTL1), find breathing center and mark it.

(2) **Adjust the Sample Tilt (based on marker)**

- Start voltage is set to 0V when start aligning tilt.

1. Wobble the Objective Lens and Align the breathing center to the previously set marker, minimizing image movement behind the marker.
    - The marker represents the optical axis. Keep in mind that image features may change while aligning the sample tilt.

- A trick to align the tilt: Observe the direction of feature movement with **increasing value of objective lens** and click on the corresponding bottom in the motor control panel.

If feature moving **left**: Click on in panel; If moving **right**: Click on in panel; If feature moving **up**: Click on in panel; If feature moving **down**: Click on in panel

Move a Feature to the Optical Axis (marker)

(3) **Wobble Mirror Field Lens 1 (MFL1) and check**

- X direction: Outer sel; Y direction: MFL1 Align Y

(4) **Wobble Mirror Field Lens 2 (MFL2)**

(5) **Wobble Mirror Transfer Lens 2 (MTL2)**

Alignment of imaging column

(36) **Wobble the Transfer Lens (TL)**

- X-axis: Mouter Se; Y-axis: Sec2 Align

(7) **Wobble Minner Se and minimize the motion of reference point with FL value**

(8) **Wobble the Field Lens (FL) and align towards the opposite direction of breath center**

(9) **Wobble the Intermediate Lens (IL)**

1. Align X if wobble in Y direction and align Y if wobble in X direction.

(10) **Wobble Projective Lens 1 (P1)**

Alignment in energy analyzer and projection system

(11) **Wobble the Inner Lens (instead of RL)**

1. X and Y axes: RL Align

(12) **Wobble the Acceleration Lens (AL)**

1. Center it with Sel+/-
2. Can try adjusting AL Align A, B but it might not help alignment

(13) **Wobble Sel +/- and minimize the motion with the Acc. Lens value**

1. This step may not help alignment. The adjustment on Acc. Lens value might decrease the image sharpness.

(14) **Wobble Projective Lenses 2**

(15) **Wobble Projective Lenses 3**

1. Breathing center should be centered in the image window.

- Go back and check the whole column, make corrections if required.
- During alignment, P3'x and y can be used for moving reference feature (optical axis) to center of view.

LEEM alignment

The setup inherited from the previous week is normally well-aligned, allowing for a simple alignment. One can start with 100 μm FoV to find the sample. Steps are marked in *LEEM2000* software interface.

Prepare the setup for LEEM

Set start voltage as 0 V and Slowly decrease Wehnelt potential to observe MEM image.

> **Caution**
>
> Do not set the Wehnelt voltage below -240V.

Align Electron Gun Incidence Perpendicular to Sample

(16) **Using transition from MEM to LEEM**

1. Set start voltage to a value that provides a uniform dark spot within the bright image, and Use the ILUDX, Y deflectors to maximize and center the dark spot.
2. Decrease start voltage and repeat step 1 until reaches the lowest STV value (low enough value e.g., 0.5V).

Alignment of intermediate column

(1) **Find the Optical Axis and set marker**

1. Wobble the Mirror Transfer Lens 1 (MTL1), find breathing center and mark it.

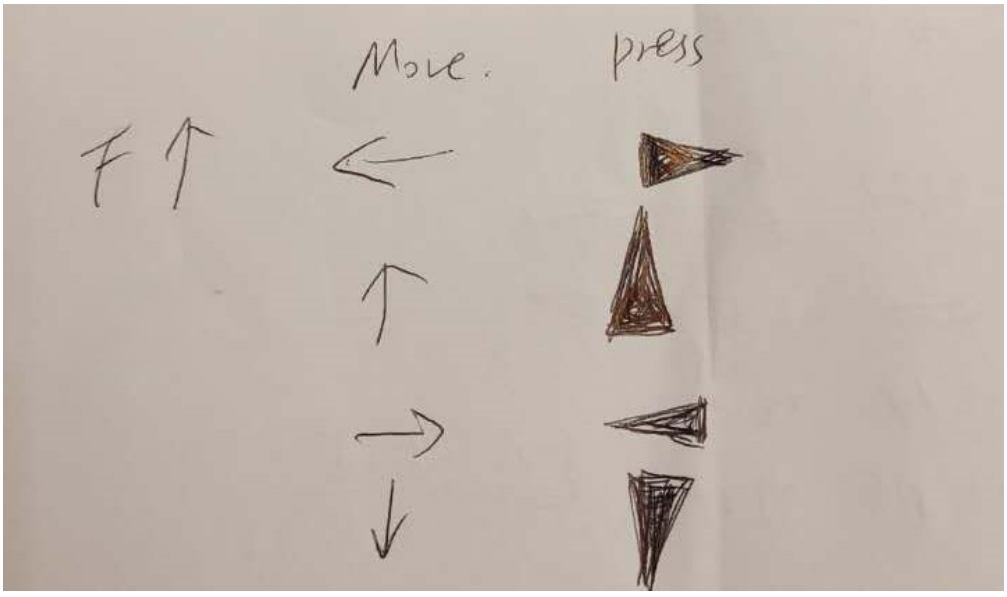
(2) **Adjust the Sample Tilt (based on marker)**

- Start voltage is set to 0V when start aligning tilt.

1. Wobble the Objective Lens and Align the breathing center to the previously set marker, minimizing image movement behind the marker.
    - The marker represents the optical axis. Keep in mind that image features may change while aligning the sample tilt.

- A trick to align the tilt: Observe the direction of feature movement with **increasing value of objective lens** and click on the corresponding bottom in the motor control panel.

  If feature moving **left**: Click on in panel; If moving **right**: Click on in panel; If feature moving **up**: Click on in panel; If feature moving **down**: Click on in panel



Move a Feature to the Optical Axis (marker)

(3) **Wobble Mirror Field Lens 1 (MFL1) and check**

- X direction: Outer sel; Y direction: MFL1 Align Y
- The **incidence angle will be affected by X-direct alignment**, so do previous steps to adjust back to normal incidence.

(16,1,2) **Repeat the steps for perpendicular incidence (16), finding the optical axis (1), and adjusting the sample tilt (2) until no further adjustments are needed.** Step 3 may need to be checked.

(16, 1→15) **Check and repeat the alignment of all lens until no further adjustments are needed.** Steps 4 to 15 refer to *UV-PEEM alignment* part or *LEEM2000* software interface.

Alignment after decreasing FoV

(16, 1→15) **Decrease the field of view and repeat over the checking and alignments if needed, until the desired field of view is reached.**

- FOV can be aligned as UVPEEM (100 µm, then 50 µm, sometimes can try 25 µm), then LEEM (50 µm, 25 µm, 10 µm). The setup inherited from previous week is normally well-aligned, and possibly standby with FOV as 10 µm. Most likely, due to the change of sample, the tilting is the most needed to be aligned.

(S1) **Check the astigmatism of objective lens by adjusting Obj. stigm A, B to observe a sharper image.**

- One may need to adjust the objective lens to refocus. Since the Obj. stigm is to some extent coupled to illum. Defl, so check that too if using electron gun.

P3 can be used to enlarge the field of view without changing lens alignment.

- Record the P3 value beforehand, so that later the value can be typed in to adjust back.

Slit and apertures

The apertures and slit are inserted in the sequence determined by their position along the path, e.g., CA then Slit.

(CA) **Observe the PEEM/LEEM image on the screen and move the contrast aperture CA (LEEM, PEEM)**

- TL value and Diffraction Stigmator (S2) can be used for optimization (normally not needed).
- Trick: One can remember the TL value and increase the TL value for observing image before CA insertion, e.g. 550 to 720 or even up to 800 mA. One can also remember the P3 value (e.g. 2200) and decrease it to have a larger view (e.g. 1700+).

1. Insert the aperture (e.g. 30 µm or larger) and center it with CA motion and CA correction in CA control panel.
2. One can try 100 in one direction (step=20), and change to the opposite direction if image not found. Decrease the step size and correct it until step = 2.
3. Toggle Interm. Lens and Acc. Lens and align them accordingly if needed.

(Slit) **Insert the energy selection slit (in LEEM mode)**

- Can be done with UVPEEM but with LEEM is easier.

1. You should see a uniformly illuminated image. If not, adjust position in the slit panel, from step=20 to fine step, e.g. step=2.

- (Normally not needed) If uniformly illuminated image cannot be achieved, one can try adjusting P1 value. Focus the image with FL value if needed. In DP mode, slit can be inserted for adjusting P2 and P3 to observe a sharp edge.

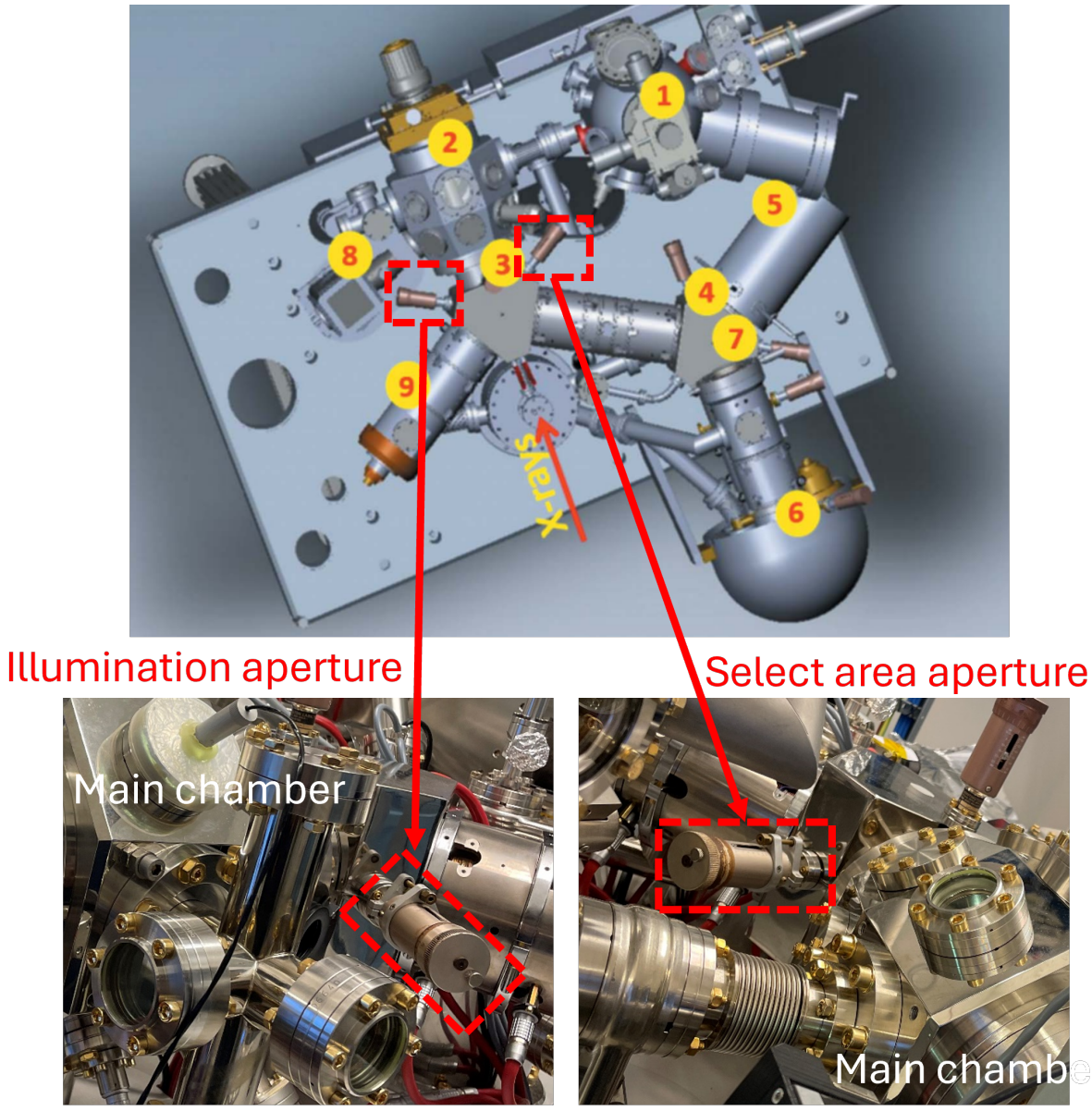
(IA) **Insertion of illumination aperture (LEEM, LEED)**

Location: In the first beam separator, between electron gun and sample

1. Observe the mirror image and move the aperture mechanism
    - Move the aperture and try to put it close to the center of the observed image. (Yellow) Allen key might be needed. Don't use too much force when adjusting.
2. Check if the aperture is in focus otherwise correct the objective lens a little bit.
3. After both operations are finished check once more the image column and make corrections if required.

(SAA) **Insert the select area aperture SAA**

- The image is enlarged 20 times, so that the real scale of observed sample image is (the size of SAA)/20.



Camera operating

In case of misoperation, the steps will be provided in text rather than images. If any referenced items are unclear, please consult the beamline scientist before proceeding.

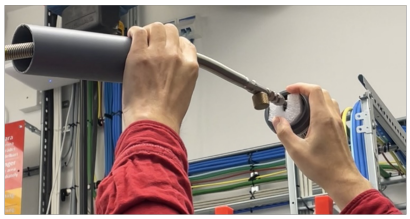
1. Log out of the system via Task Manager: **Sign Out**
2. Sign in as **Other User**. Follow the on-screen hint. (Enter as instructed, case does not matter, all lowercase is fine.)
3. If U-view was not closed before signing out, you may need to restart the camera. Wait a minute before turning on the camera from off.

1.2.9 Sample cooling and heating

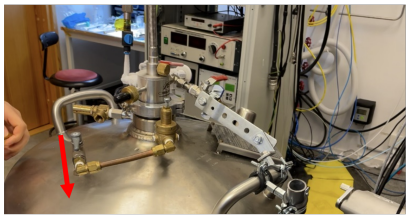
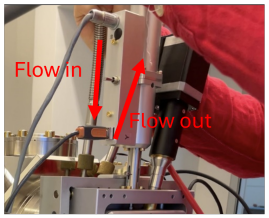
Cooling

1. Connect metal hose (flow out), fix tube position with foam holder (stopper), adjust the plastic cover position to connecting area.
2. Tighten up Swagelok (flow out) to main chamber.
3. Cover the electron gun with aluminum foil just in case of water dropping and prepare a bucket where the water drops might fall.
4. Release the gas in liquid N2 tank (valve 1) to air and wait until the gas release becomes slow and calm (e.g. pressure < 0.02 bar after 5 - 10 min).
5. Connect the metal hose to main chamber (flow in) and tighten up Swagelok (flow in) to main chamber.
6. Close valve 1 and open valve 2 for cooling sample with N2 gas. It takes around 1 hour to cool down to - 198 °C.
7. Check sample temperature constantly. If it response abnormally, the offset of senser might be wrong, adjust “Sample temperature” of “Sample heater control” unit in high voltage rack.

Metal hose (flow out) Foam stopper Plastic cover


(Valve 1) This direction for gas releasing to air.

(Valve 2) This direction for gas flowing to main chamber.

Caution

After finish using it, remember to release the gas via valve 1 before disconnecting N2 gas to main chamber.

Note

Prepare room temperature N2 gas with low pressure to plug in after disconnecting liquid N2 gas, so that warming up sample faster and avoid forst.

Cooling without magnetic field (Needs to be updated)

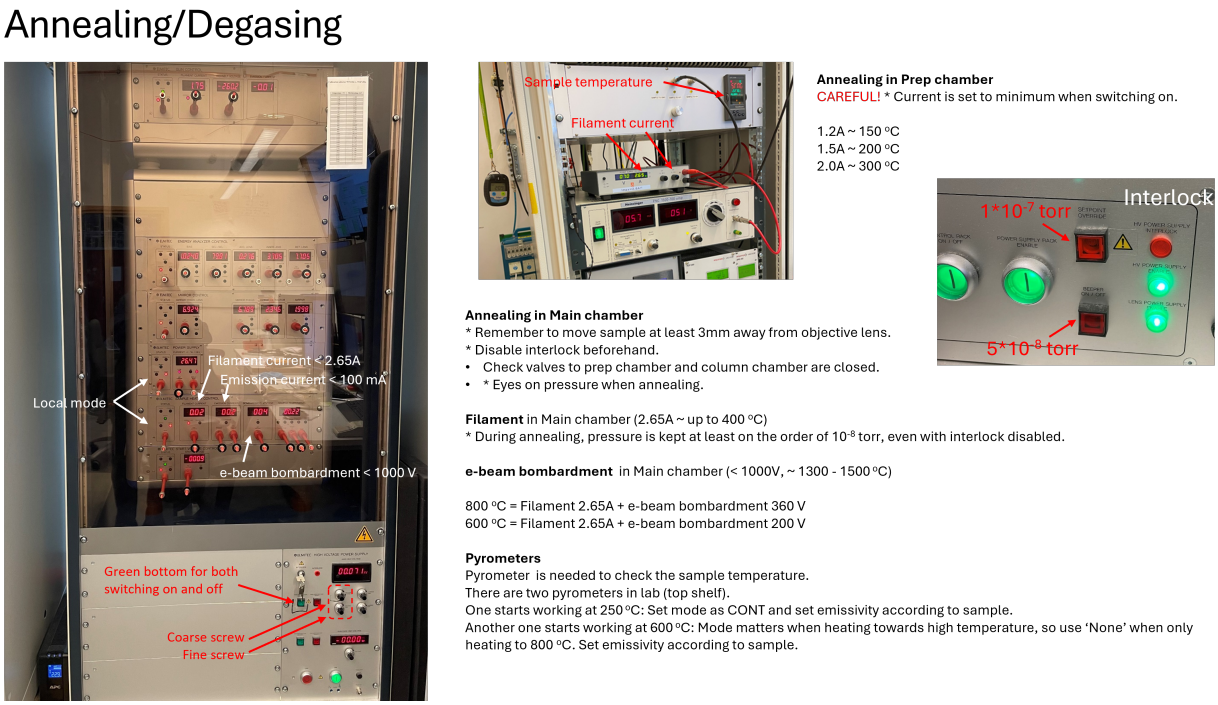
Method 1: Use the magnetic compensation coil to compensate the magnetic field of objective lens. The value for the compensation coil can be found in this manual.

- Values might not be accurate, try out is needed.

Method 2: Turn off objective lens while cooling.

1. Make sure the value of magnetic compensation coil is set to 0.
2. Set objective lens value to 0.
3. Enable the demagnetic control of objective lens.
4. Set objective lens value to -60.

Annealing in chambers



Heating in Preparation chamber

Caution

Filament current must be set to minimum before switching on.

The sample temperature can be estimated from filament current as: 1.2 A ~ 150 °C ; 1.5 A ~ 200 °C; 2.0 A ~ 300 °C

Heating in Main chamber

> **Warning**
>
> Remember to move sample at least 3 mm away from objective lens. Disable interlocks before annealing, as the beeper starts at 5x10^-8 torr and override activates at 1x10^-7 torr. Check valves from main chamber to prep chamber and to column chamber are closed. Eyes on pressure when annealing. Increase the temperature slowly while keeping pressure at least on the order of 10^-8 torr, even with interlock disabled.

Filament current in main chamber: 2.65 A ~ 400 °C

e-beam bombardment in main chamber: < 1000 V, ~ 1300 - 1500 °C

Examples for sample temperature:

800 °C = Filament 2.65 A + e-beam bombardment 360 V

600 °C = Filament 2.65 A + e-beam bombardment 200 V

Pyrometers

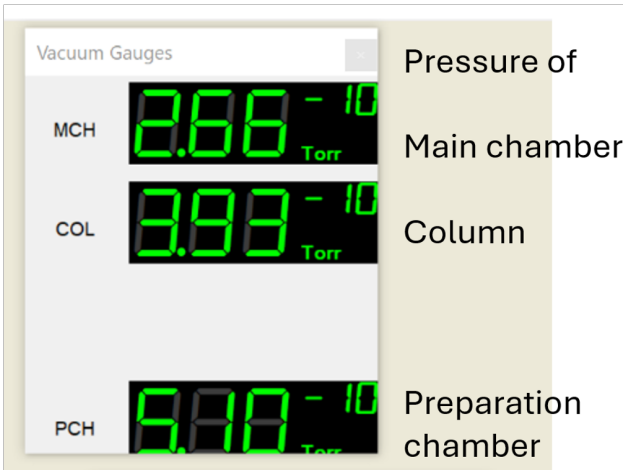
Pyrometer is needed to check the sample temperature.There are two pyrometers in lab (top shelf).

- One starts working at 250 °C : Set mode as CONT and set emissivity according to sample.
- Another one starts working at 600 °C: Mode matters when heating towards high temperature, so use 'None' when only heating to 800 °C. Set emissivity according to sample.

Gauges

1. Preparation chamber
2. Main chamber
3. Column chamber

In LEEM 2000 interface



Interlocks

Two interlock buttons locate at the bottom of the control rack. They are square and in green when the interlock is activated.

1. When the pressure in the main chamber or the column chamber is higher than 5x10^-8 torr, a warning beep will be given.
2. When the pressure exceeds 1x10^-7 torr, the HV rack automatically switches off to protect the sample and power supplies.

When HV switches off due to an arc

1. Ramp down the cathode current (Gun control unit - Filament current: 1.75 A to 0 A)
2. Put the power supply unit of the cathode Gun control unit, the electron analyzer Electron analyzer control unit, the aberration corrector Mirror control unit and the start voltage Start voltage control unit into the “local” control mode by rotating the knob to the right. Status 1 for switch on HV rack: Every unit stands by at local mode.
3. Switch on the HV rack by pressing the round green button at the bottom of the HV rack
4. Wait for 10 to 20 seconds
5. Put the power supply units back to the “remote” control. The LED displays of the individual power supplies

should go to the values close to the values in the LEEM2000 program. Status 2 for 20 kV: Every unit stands at remote mode, except Sample heater control unit! Power supply unit can be left at either local or remote mode.

6. Ramp up the cathode current to 1.75 A slowly (in 10 to 20 seconds for instance) Gun control unit - Filament current: 0 A slowly to 1.75 A
7. Ramp up the main 20 kV until the pressure is recovered, i.e., when the pressure is below 1x10^-9 torr in the main chamber.

1.2.10 Data access and acquisition

Getting your data

Your options include:

- copying data directly from the network drive where it's stored - see note below
- using SFTP - see note below
- using Globus Connect - see note below

The beamline staff typically use the first option.

> **Caution**
>
> The use of USB drives to transfer data is convenient, but poses a security risk. Get permission from your local contact.

To speed-up post-beamtime data analysis and reduce the amount of raw data to be taken home, we recommend:

- using the User Data Analysis workstation in the measurement hutch,
- creating one or multiple Igor project files and saving them locally,
- importing the *good measurement files* into the Igor project file(s) and working with them (e.g. performing drift correction, extracting spectra using z-profiles, etc.),
- using folders within the project file(s) to organize the data, and the notebooks within Igor to perform logging,
- copying the Igor project files to your PC and/or hard drive(s) at the end of your beamtime, and
- backing up your Igor project file(s) to the *processed* sub-folder, under your proposal folder.

Copying data directly from the network drive

Connect to the *maxiv_user* Wi-Fi network (which requires your DUO username and password).

Map/mount the network drive folder relevant for your proposal. On a Windows computer, you would mount \offline-2.maxlab.lu.se\offline-visitors\maxpeem\12345678

where 12345678 is your 8 digit proposal number. Use the username *MAXLAB\xxxx* where xxxx is your DUO username, and your DUO password.

Note that practical data transfer speeds are ~5 MB/second.

SFTP

See the MAX IV SFTP webpage.

Globus Connect

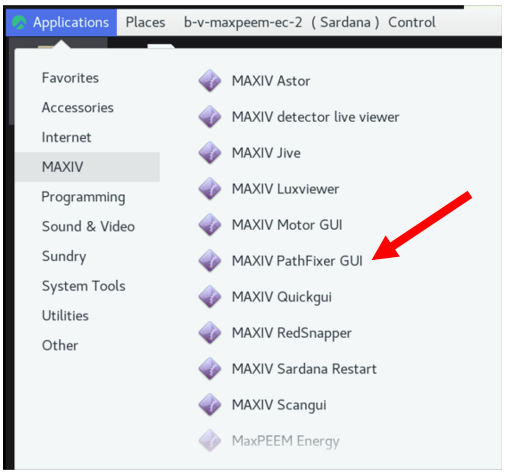
See the MAX IV Globus Connect webpage

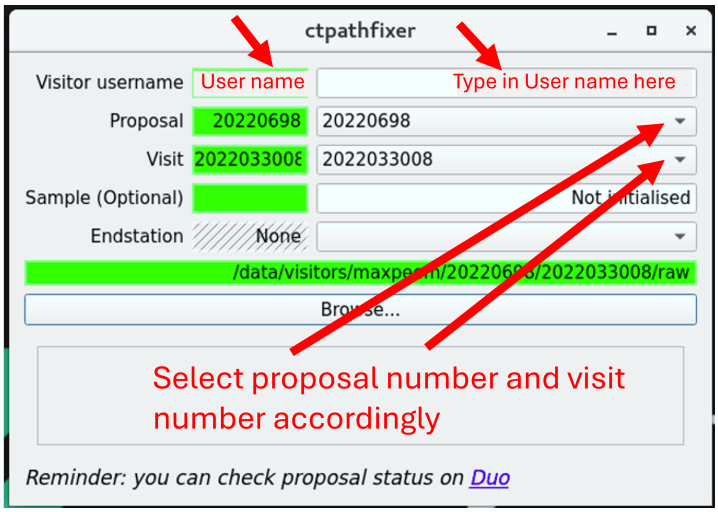
To-do before measurement

User-related information (type in before measurements)

Application – MAXIV – PathFixer GUI // ctpathfixer – user type in username (DUO) and select the proposal and visit accordingly.

The scanning data will be automatically saved in the 'raw' folder in this Visit folder. Cut out '.dat' files into user defined folder or rename after each measurement, but leave '.h5' file which contains reference spectra and will be automatically updated after each measurement.

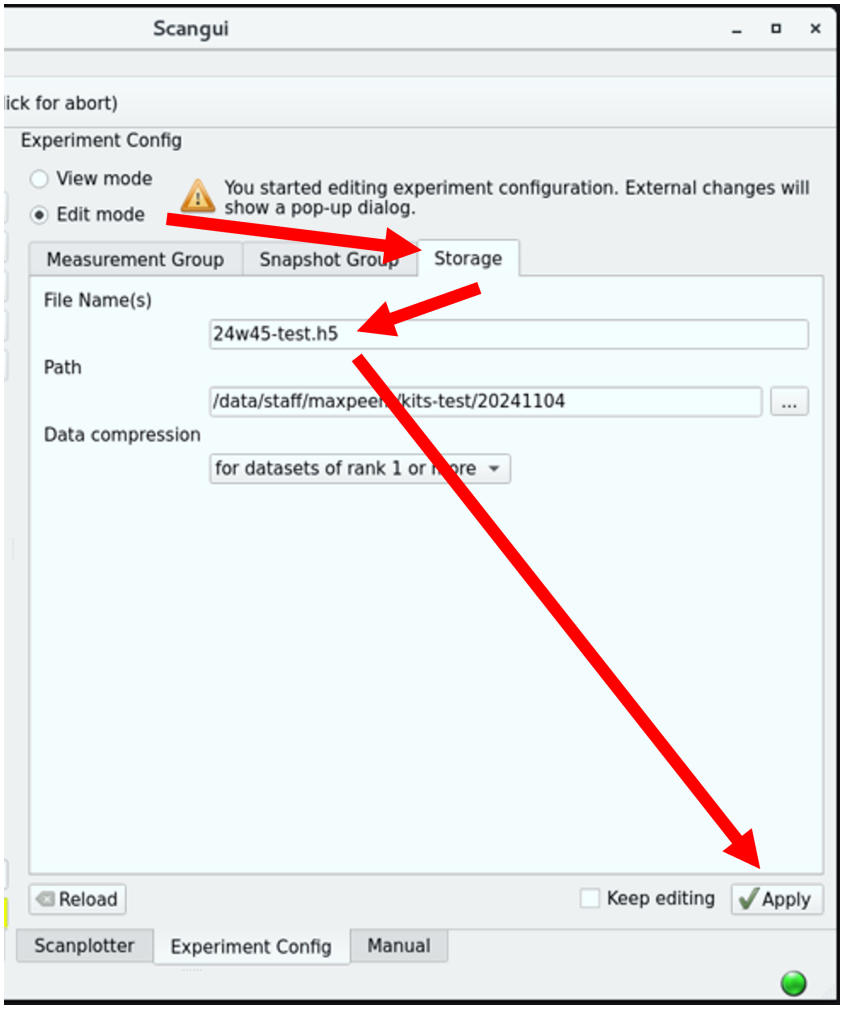




Storage location of data (check before starting the sequence)

Edit mode – Storage – Change the file name accordingly if wants to, e.g. date.

- File path will be automatically updated to raw folder once finish ctpathfixer.



Note

The generated `.h5` file (dated format) contains valuable information, such as the beam intensity measured with the gold mesh for normalization.
To review the collected data: Check the **Measurement Group** and **Snapshot Group** in **scangui**.

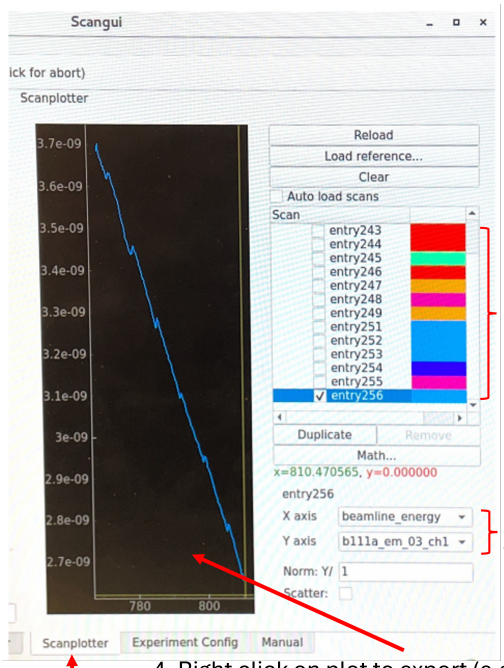
Gold mesh related info (02/04/2025)

The channel for gold mesh might differ: b111a_em_03_ch2

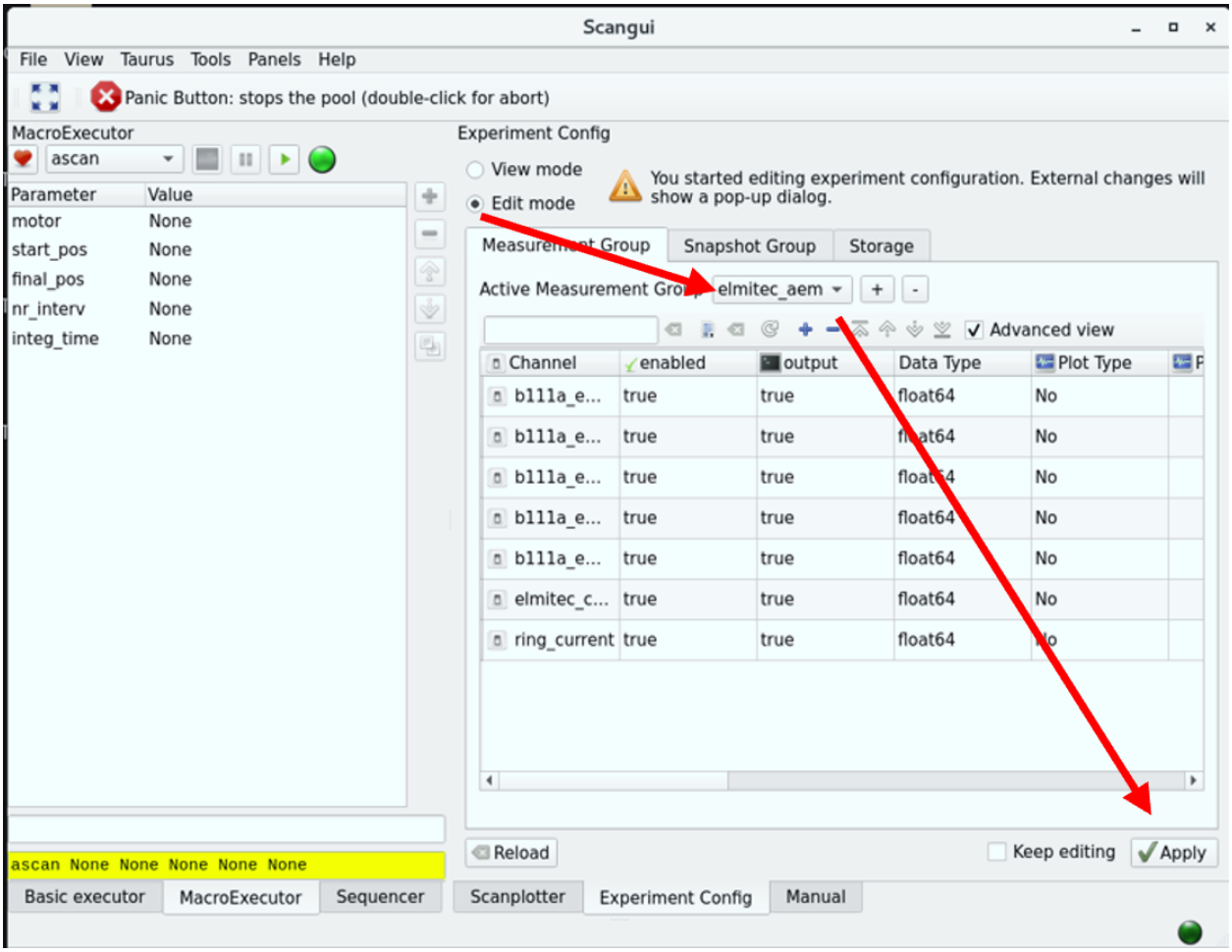
Gold deposition once for one week of usage: filament 4.4A for 10 minutes.

Active measurement Group: elmitec_aem (default)

Edit mode – select elmitec_chan – apply



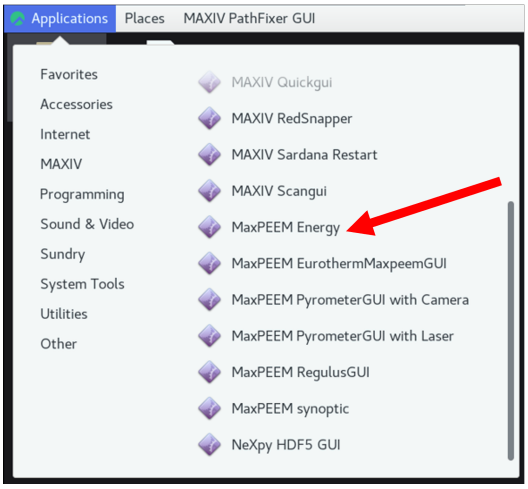
Gold mesh current ranges for XMCD and XMLD are different!!!



Beamline alignment

Control panel (MaxPEEM energy)

Application – MAXIV – MaxPEEM energy (during measurements, use the standard mode only) Extended view with Expert mode is used for aligning M1_Pitch.



1. Maximize beam intensity using *M1_pitch*, step=2
    - One can use the photodiode in beam path (value=78 means photodiode is inserted).
2. Localize beam at center of image and make it uniform using *M4_pitch* (step = 2) and *M4_roll* (step = 10)

If defocusing is needed, use *M4_yaw* (step = 10) and then correct beam position with *M4_pitch* and *M4_roll*.

> **Note**
>
> During beamline alignment, field of view can be enlarged with decreasing **P3 value**, instead of change FoV setting.

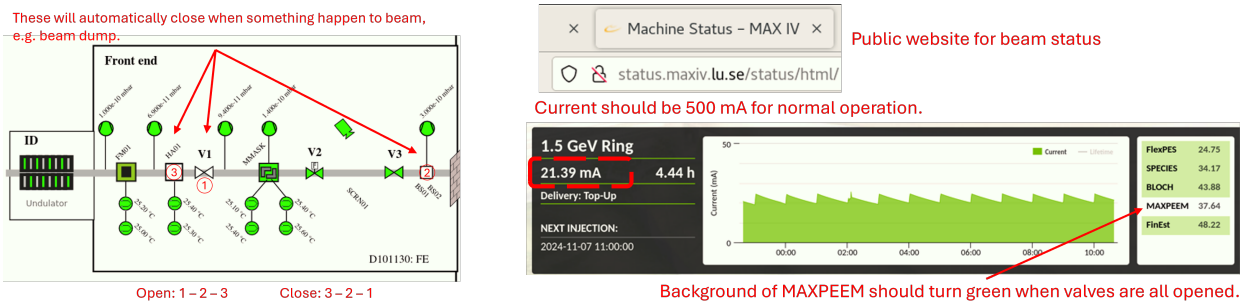
When Beam dump unfortunately happened: valves automatically closed and beam current was not 500 mA. Check the chat panel for updates.

Open valves in front end

Public website for machine status

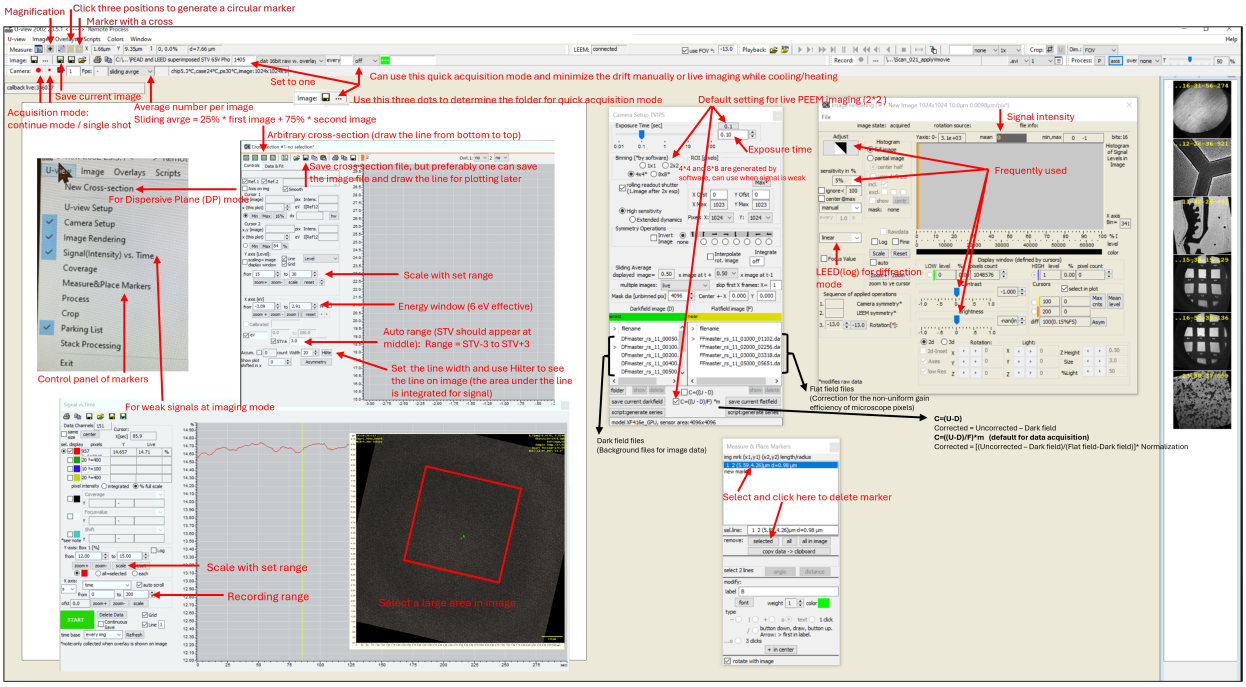
To open: V1, BS-01, HA-01

To close: HA-01, BS-01, V1



- HA-01 and BS01 are used for blocking beam, and V1 is used for isolating the vacuum of storage ring.
- The beam is opened or closed in this order to prevent direct illumination of beam on V1, which is metal and might melt under illumination.

U-view software interface with frequently used function

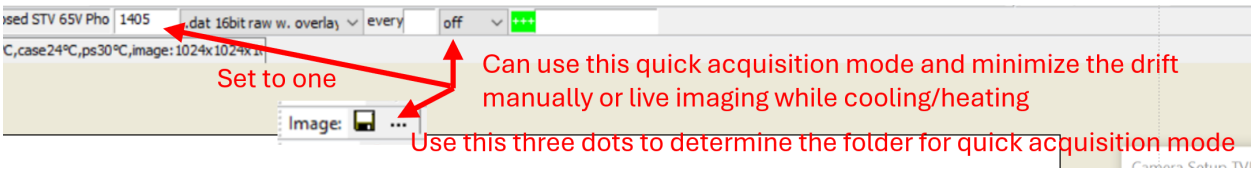


Continuous quick acquisition

This function is useful when the drift is severe or collecting live images while cooling or heating.

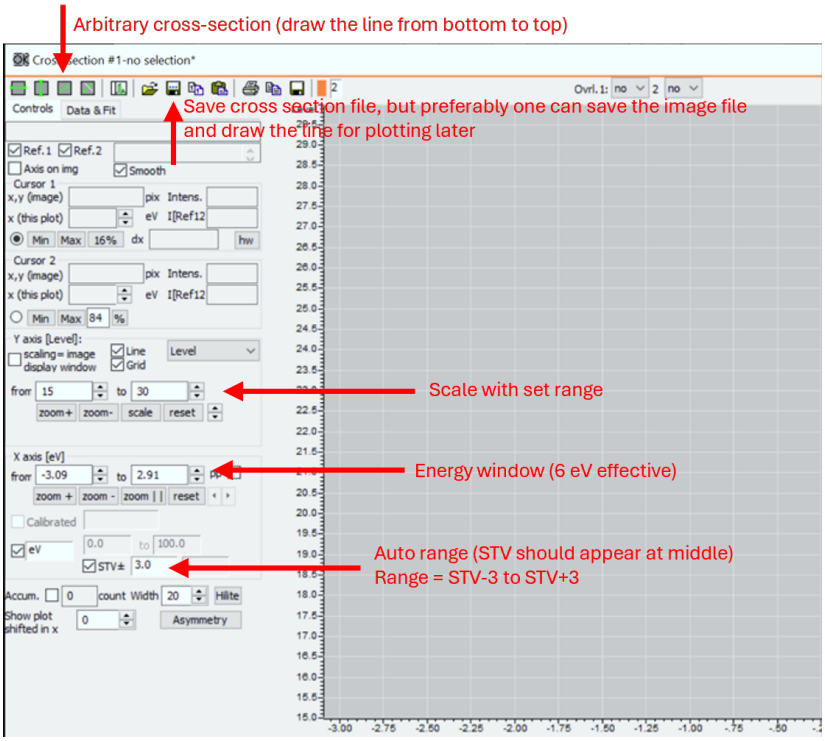
1. Determine the folder for saving the image sequences with the three dots in Image channel.
2. (Optional) Set the start file number to 1.
3. Set up suitable exposure time and averaging times.
4. Set up suitable collection way, for example ‘every 5 sec’ means the image will be saved every 5 seconds, with the set exposure time and averaging times.
5. Turn on live mode of micrscope. (Click on red big circle)

- Remember to turn off this function after finish using it.



μ-XPS (DP mode)

> **Caution**
>
> Since the energy slit is not in the path, be careful about setting Start Voltage!



U-view – Arbitrary cross-section – draw a line from bottom to top – (if available) adjust start voltage to see Au doublet with energy difference ~3.6 eV *Save the spectrum as reference!

Useful values: Available energy window: ~ 6 eV; Work function: ~ 4.85 eV

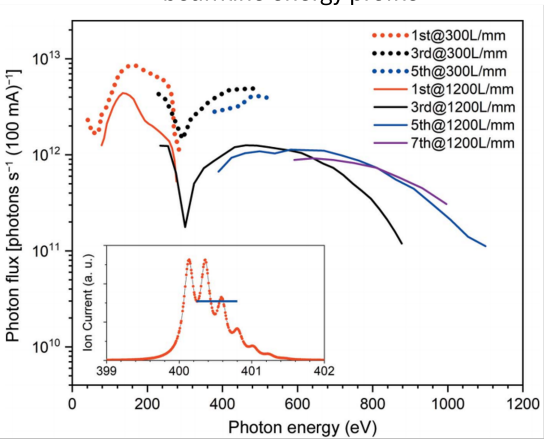
- Energy window is limited to 6 eV (effective range) but the energy resolution (~ 0.2 eV, depends on SAA, can be better) is better than XPS in XPEEM mode (~ 0.5 eV, depends on step setting and signal intensity).
- Steps for determining the measurement parameters are same as XPS in XPEEM mode.
- Click on the box for eV and STV±3, so that the set STV should appear at middle of energy range.
- Click on Hilte, which can change the line width with maximum as 40. Intensity is integrated from the area marked by the line, so increasing line width can provide strong signal.

XPEEM (scan start voltage)

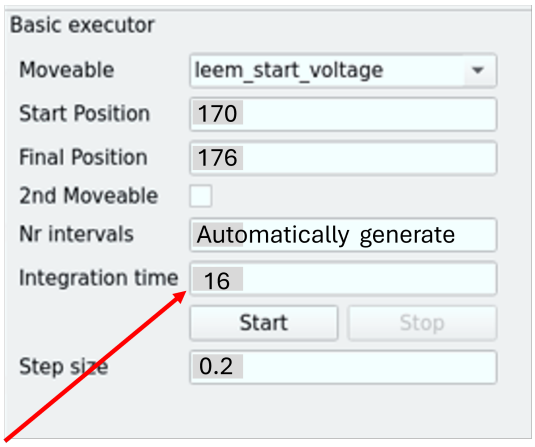
Moveable in scan = leem_start_voltage

1. Check the coefficient plot of desired element, e.g., Pt. Determine the target orbit, e.g. Pt 4f based on the plot.
2. Determine the photon energy (e.g., hv = 250 eV) based on the coefficient plot and beamline energy profile, i.e. where it emits most and where the beamline intensity is highest.
3. Check the binding energy of target orbit, e.g., Pt 4f has binding energies as 74.5 and 71.2 eV.
4. Calculate the corresponding start voltage, e.g., as 170.5 (250-5-74.5) and 173.8 (250-5-71.2) V.
5. Set up scangui or script or IPython to scan the range.

beamline energy profile



Scangui



16 = (in U-view) 0.5 s exposure time * 32 averaging time

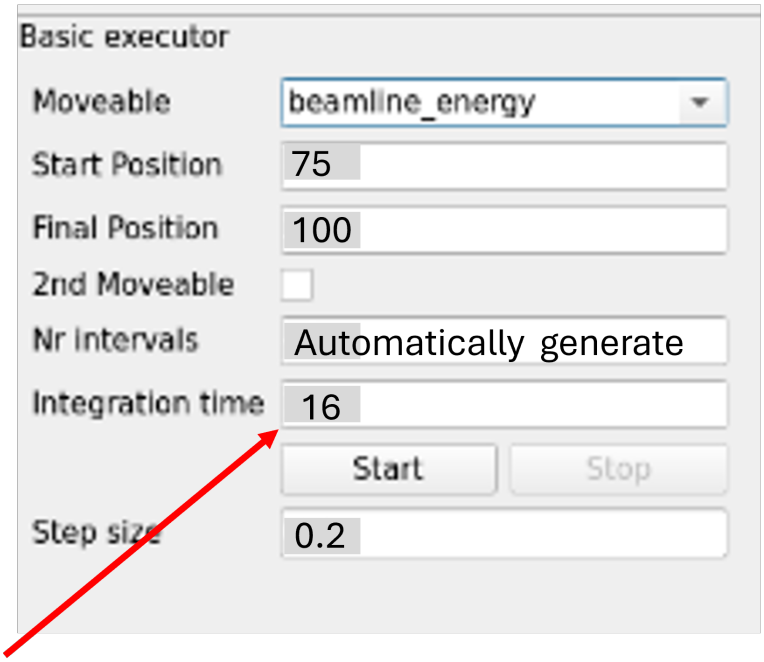
- If the signal is too weak, one can use the 'IntensityVsTime' in LEEM2000 software, with selecting a large area on sample. Change the start voltage slowly in the calculated range and observe the change in intensity. Write down the values for determining the scan range later. In addition, the written down values can be compared to the calculated values as checking. Check *U-view software interface* for details.

XAS

Moveable in scan = beamline_energy

1. Set the start voltage to a higher value.
2. Set photon energy accordingly, e.g. 75 eV for Al as scan range (written on the paper on wall behind the screen) is Al 75 to 100 eV. The *table* can be found at end of this page or in online source.
3. Reduce the start voltage to identify the secondary electron peak, i.e., aiming to maximize the image intensity.
4. Set up scangui or script or ipython to scan the range.

Scangui



16 = (in U-view) 0.5 s exposure time * 32 averaging time

XMCD-/XMLD-PEEM

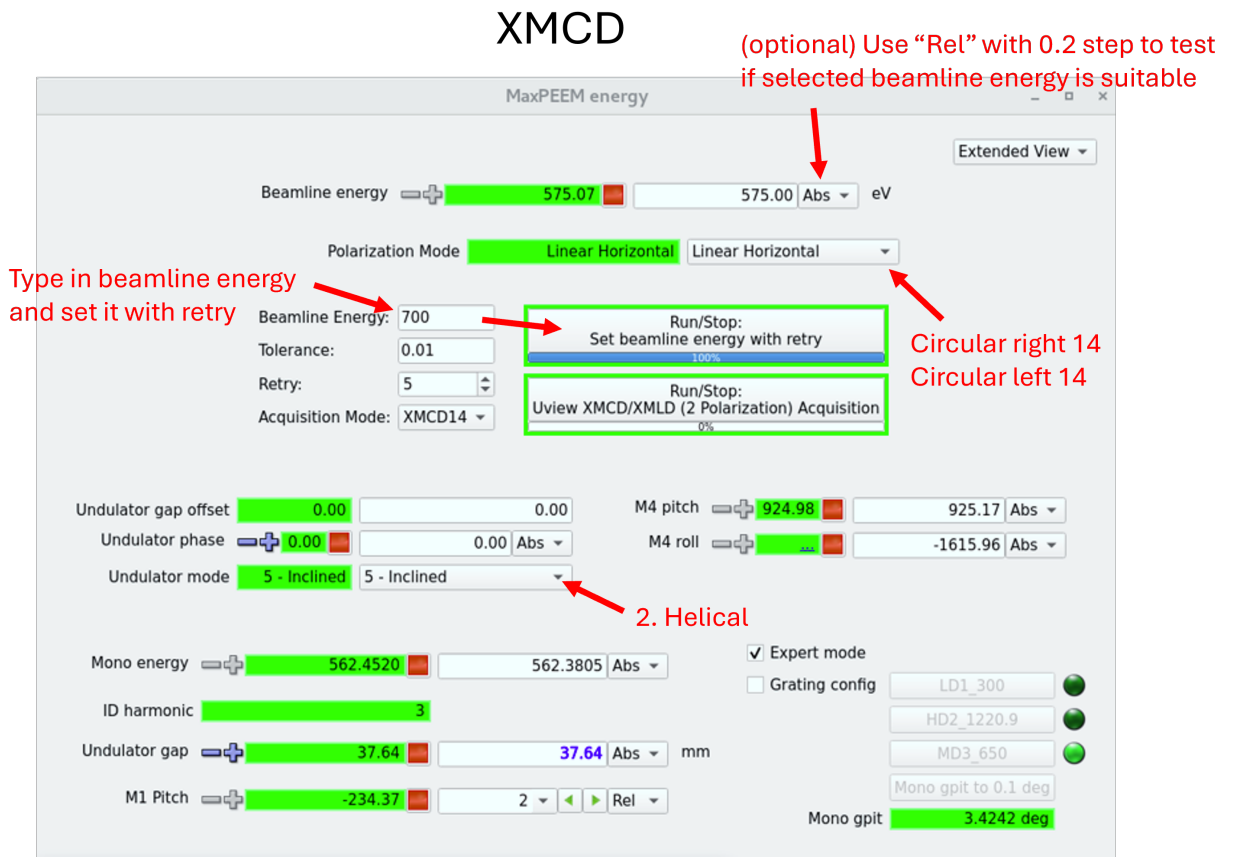
> **Note**
>
> The ranges of gold mesh current (measured for normalization) are different for XMCD and XMLD as the beamline intensity differs significantly in these two modes. Check the interface *here*.

Collect individual image for XMCD (circular left, circular right)

(if haven't done before) Save LEEM alignment setting, electron gun OFF, open x-ray valve and check beam alignment.

1. (Optional) One can start with XAS to determine the photon energy, as well as checking if sample is oxidized.
2. Change to the desired photon energy, change the undulator mode to **2.Helical** and change the polarization mode to **circular left 14** or **circular right 14** which are frequently used.
3. Set up U-view camera parameters, exposure time and averaging time, collect the image data and save it.

- The **Rel** function, which adjusts the beamline energy relatively, can be used with a step size of 0.2 to test the suitability of the selected energy while observing the image.
- **Set gold mesh current range to 10 nA.**

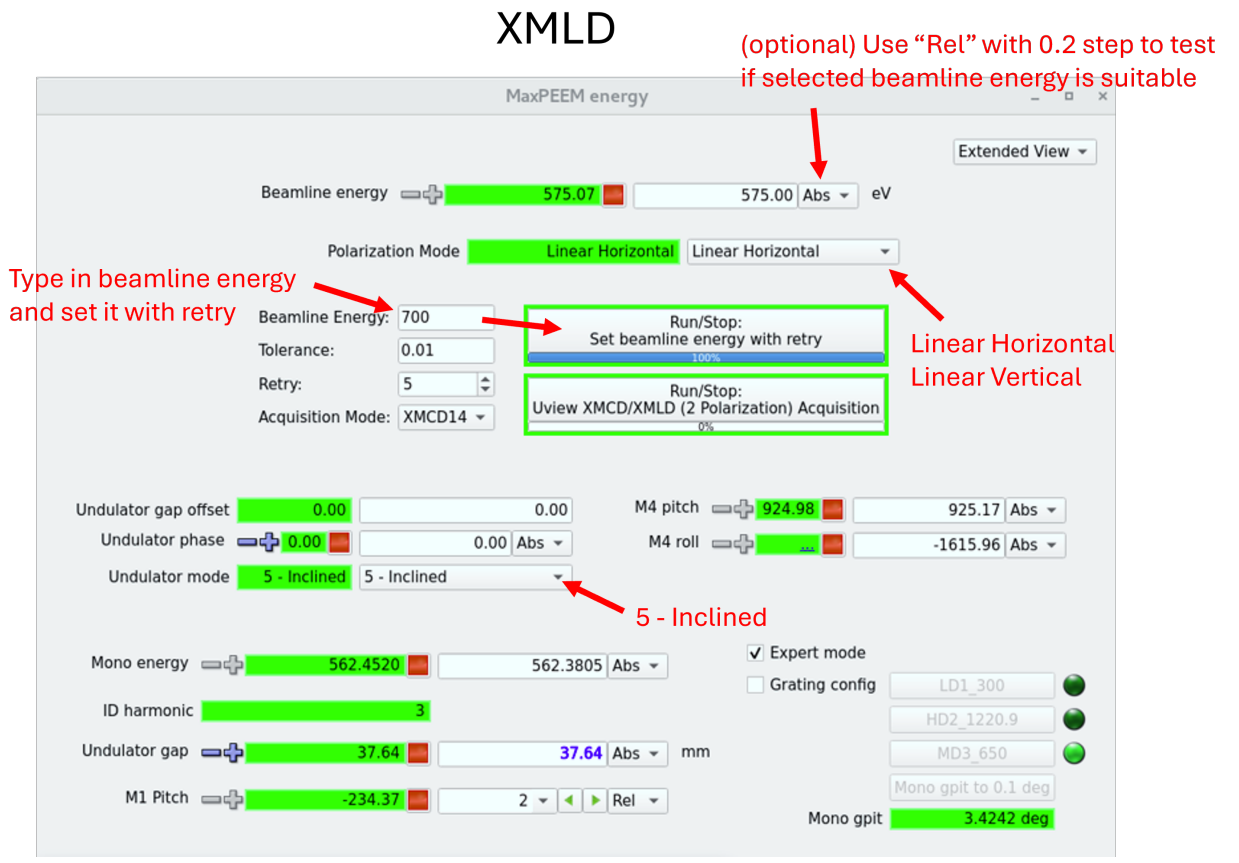


Collect individual image for XMLD (linear horizontal, linear vertical)

(if haven’t done before) Save LEEM alignment setting, electron gun OFF, open x-ray valve and check beam alignment.

1. (Optional) One can start with XAS to determine the photon energy, as well as checking if sample is oxidized.
2. Change to the desired photon energy, change the undulator mode to **5 - Inclined** and change the polarization mode to **linear horizontal** or **linear vertical** which are frequently used.
3. Set up U-view camera parameters, exposure time and averaging time, collect the image data and save it.

- The **Rel** function, which adjusts the beamline energy relatively, can be used with a step size of 0.2 to test the suitability of the selected energy while observing the image.
- **Set gold mesh current range to 100 nA.**



Scangui

Caution

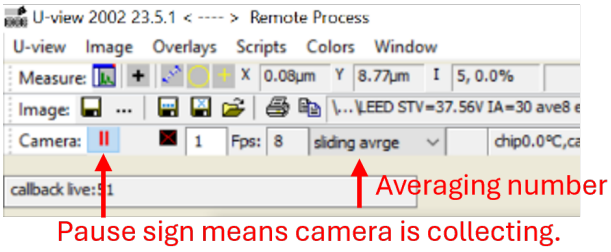
Camera must not be in collecting mode when starting scan. During acquisition (before progress reaches 100%), don’t hit any part of setup which will cause vibrations and blur the image, e.g. transfer arm, concrete base of setup, etc.

- Check the storage location of data files. Filename can be changed.
- Parameters need to be matched between camera setting and scangui setting. For example, the integration is set as 80. In U-view (microscope software), the image is collected with ‘average 16’ and exposure time is 5. So that parameters are matched as 80=16x5.

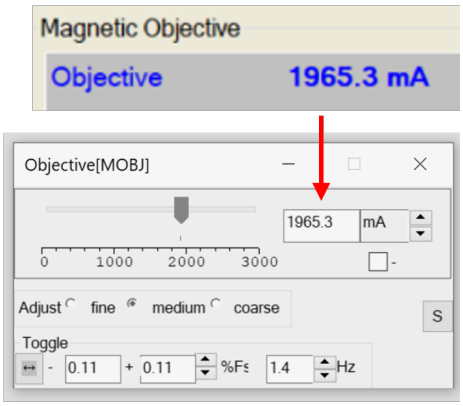
Note

If beamline energy is changed in sequencer, e.g. XPEEM of Au 4f (E_ph = 250 eV) and Au VB (E_ph = 70 eV), remember to add executor to change objective lens value for each scan. Check *equation and examples*.

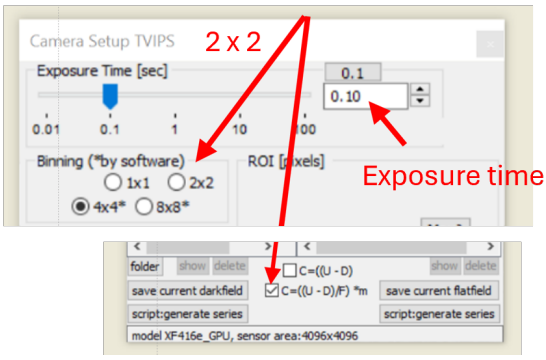
Set parameters in U-View



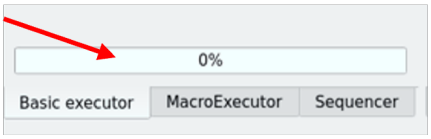
Set focus in LEEM-2000



Default setting for live imaging



Progress bar in scangui



Sequencers

Two commonly used ways to set up the sequencer:

1. Basic executor: normally only one moveable is used, but the second one can be activated if needed
2. MacroExecutor: more customizable functions can be used, e.g. ascan, IVCurve, mesh, mv, uview_acquisition, uview_ascan, uview_xmcd_xmld_acquisition, etc. Move moveables can be added from panel.

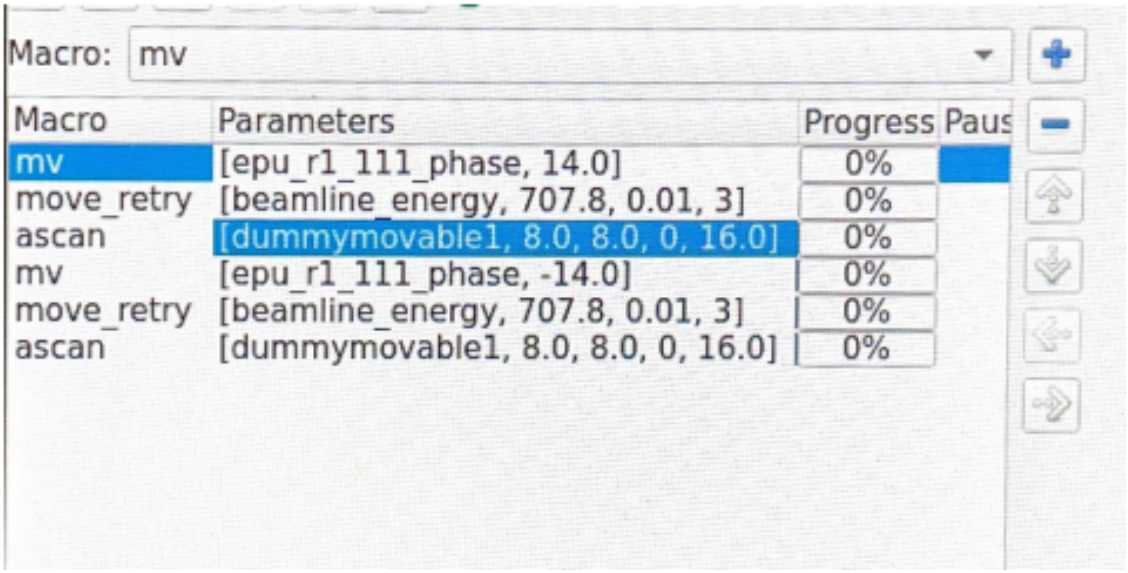
- Select the moveable, type in start and final positions, type in integration time (averaging number*exposure time) and step size. The Nr internals will be calculated automatically based on the set parameters.
- Check the storage and change filename if needed.

Set up Macroexecutor

Check the saved macros in the commissioning folder to see if they meet your requirements. The following outlines the logic for building a macro for XMCD measurements with Circular Left (CL) and Circular Right (CR) polarization:

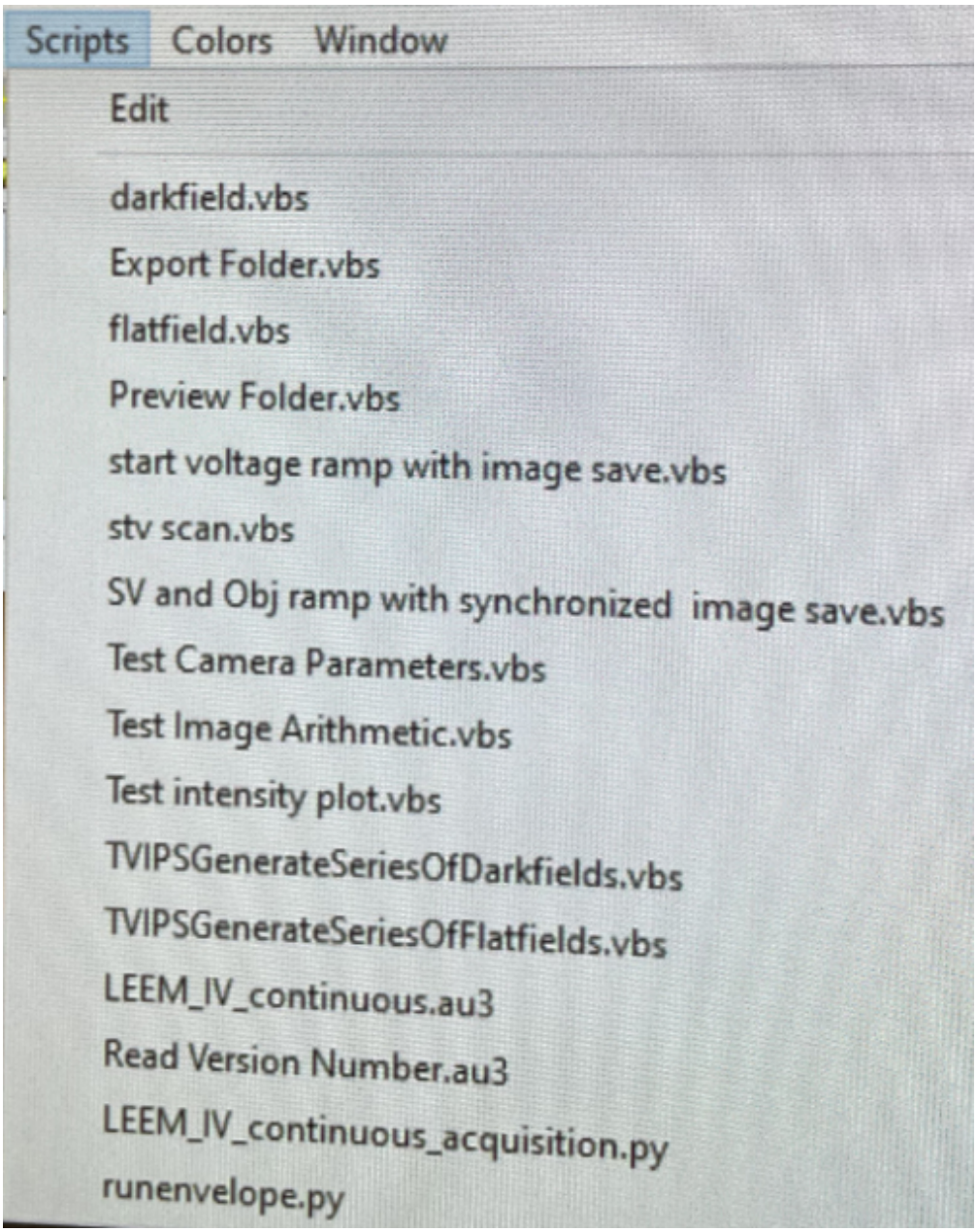
1. **Set Polarization to Circular Left (CL):**
   `mv` - Change phase to 14.
2. **Set Energy with Retry:**
   `move_retry` - Target beamline energy to 707.8 eV.
   - Allowable deviation: ± 0.01 eV
   - Maximum retries: 3

3. **Collect Image:**
   `ascan` - Capture one image with:
   - `integ_time=16` (0.5 s × 32 averaging)
   - `start_pos=final_pos` (e.g., 8)
   - `nr_interv=0`
4. **Set Polarization to Circular Right (CR):**
   `mv` - Change phase to -14.
5. **Repeat Energy Retry:**
   `move_retry` - Same settings as above.
6. **Capture Second Image:**
   `ascan` - Use the same settings as in Step 3.



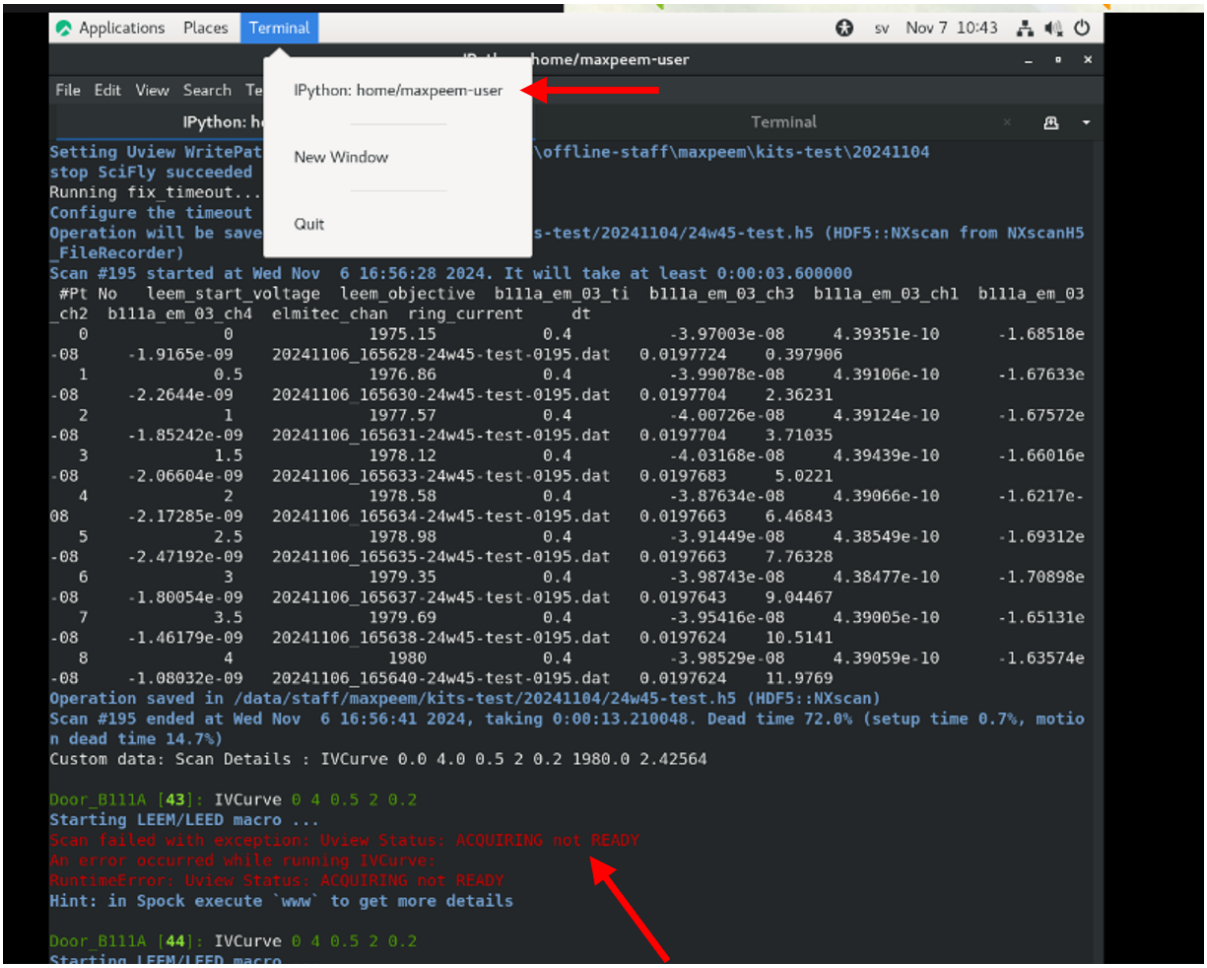
Scripts (Might be updated)

*Data can only be written into 'This PC' instead of online user folder.



Ipython

For users who prefer to scan via Terminal: Type in parameters as if in scangui



Scan will not start if microscope is at acquisition mode

Naming data files

- Naming of data file:

Mode name (XPEEM/LEEM/DP/ARPES/LEED) + Sample name + Element + Orbit + Photon energy + Start Voltage + IA value (if used) + SAA value (if used) + CA value (if used) + Slit value (if used)

Naming of data folder for sequence: Mode name (XPS/XAS) + Sample name + Element + Orbit + Photon energy (or range) + Start Voltage (or range) + Integration time (averaging number + exposure time in U-view software) + Step size + IA value (if used) + SAA value (if used) + CA value (if used) + Slit value (if used)

- If sample has been moved more than hundreds of μm (1-2 mm) at any direction, alignment needs (has) to be double checked.
- Example for Values needed before starting sequences: Photon energy, Start Voltage, Slit and Apertures, Averaging time and Exposure time, Value of Objective lens for each sequence

Examples for mapping ranges

Work function of setup ~ 4.85eV

Remember to find the focus (Value of Objective lens) for each sequence:

When KE = 0, $f = f_0$

When KE 0, $f = f_0 + *\sqrt{KE}, = 3.576$

The ranges advised below are just examples. If uncertain, please consult with beamline scientist.

XAS measurement by scanning beamline energy

Element (Edge)	Range (eV)
Mn (L)	635-660
Fe (L)	703-730
Cr (L)	570-595
Ni (L)	847-880
Co (L)	770-810
O (K)	528-553
Ti (L)	458-479
Ca (L)	345-360
N (K)	395-440
S (L)	150-190?
Al (L)	75-100
Si (L)	100-125
Zn (M)	325-360

Technique	E_Ph (eV)	STV	Exposure	Average	Step	Objective Value	BE (eV)	Notes
XPS (XPEE								
Au 4f	250	155.8 to 156.4	5	16	0.2	1867	84	
Au VB (5d)	70	55 to 68 (65)	2	16	0.2	1857		
Au WF	70	-3 to 4	0.1	16	0.1	1835		
PED (ARPE								
Au + Graphe	70	63 to 66.5 (65)	5	8	0.1			
PES (DP mode)								
Si 2p	150	44						PES Si 2p SAA=50 µm CA=30 µm h=150 eV STV=44 V
Si 2p	200	94						Add 50 eV in photon energy and start voltage
Au 4f (doublet)	200	109						Use the energy difference of doublet (3.6 eV) to calibrate pixel
Au VB (+SiC, C)	200	194						
C 1s	350	61.5						
VB	100	94						Beam at 100 eV is stronger than at 200 eV; measure with stronger signals. Same spectrum with better signal-to-noise ratio. 100=200-100, 94=194-100.

1.2.11 Data analysis

The following tools are typically used to analyze MAXPEEM measurement data:

- athina is an in-house developed analysis toolbox for Igor Pro 9 or newer.
- ImageJ
- Python-based MAX IV Jupyterlab notebook

Igor Pro (athina package)

athina provides a comprehensive package for PEEM/LEEM/PES/ARPES/XMC(L)D-PEEM/STM data analysis.

Check athina's documentation hosted at MAXIV's intranet or publicly at gitlab. There you can find instructions on how to install *athina* and how to use it to process your data.

> **Note**
>
> You can use Igor Pro for during you beamtime and still be able to access your analysis at home even if you do not have an Igor Pro license. Save your analysis as HDF5 packed experiment file (.h5xp, which is the default option at MAXPEEM) and you will be able to access your files using any HDF5 program (Silx for example). **We can also provide a python script to extract all images, image stacks, plots, and notes from the Igor Pro file.**

> **Tip**
>
> Access to the source code outside MAXIV at gitlab.

ImageJ

Background image substraction with ImageJ

1. Import both images
2. Select Process > Image Calculator
3. Choose the original image as Image1, the background as Image2, and select Subtract.

Drift correction with ImageJ

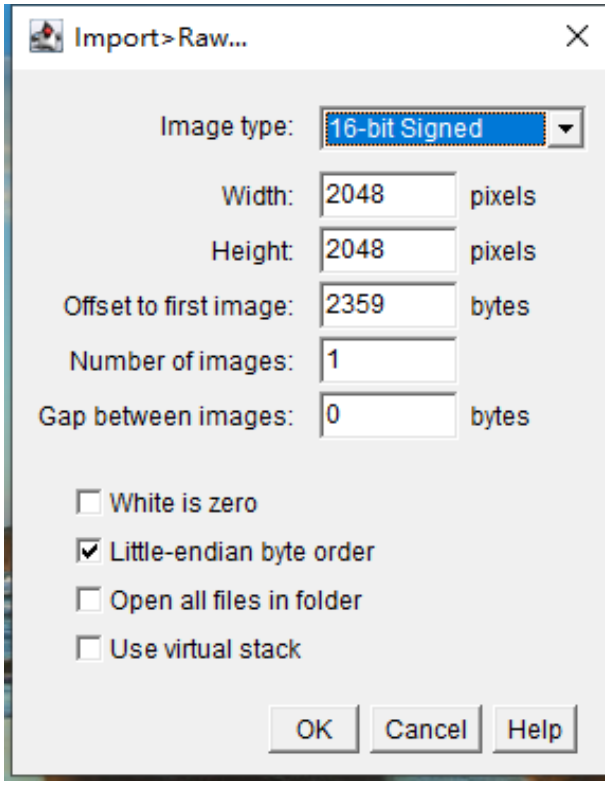
1. **Import sequence**: File – Import – Image sequence
2. **Check spectra**: Image – Stack – Plot z-axis profile
3. **Adjust image**: Image – Adjust – Brightness/Contrast
4. **Drift correction**: select a rectangle area – Plugins – Template Matching – Align slices in stack – search area 20 (100) pixels for small (large) drift

Plugins: https://sites.imagej.net/Template_Matching/plugins/

Plotting LEED with ImageJ

1. **Import data**:File – Import – Raw
2. Calculate the `Offset to first image = file size in byte - 2*2048*2048`

- The size of file can be found in the Property of data file.



Calculate XMCD with ImageJ

1. Import sequence from folder(two files): circular left and circular right, e.g. named as CL, CR.
2. Drift correction.
3. File-Open-calculateAS.ijm (file locates at c disk - Fiji - micro) and run on the drift-corrected images. The created image represents CL/CR.

- If user has clicked on other image, remember to click on the XMCD image before running the code.

Python with Jupyterhub

Guide's coming soon.

1.2.12 Troubleshooting

Beamline software gets stuck

If the beamline staff are not around, try:

- Restart in Astor
- Kill the process using the sardana-restart script
- Calling the Floor Coordinators

Scangui crashes

1.2.13 Equipment manuals for users

Microscope hardware and software

Elmitec LEEM III Microscope Manual (v1.7)

Elmitec LEEM2000 Microscope Control Software Manual (release 41)

Elmitec U-VIEW2002 Camera Software Manual (v18.4)

Manual_20241125:

pic_manual_for_print_out(20241125)

manual_for_print_out(20241125)

Detailed_Alignment_with_UV-PEEM_and_LEEM.pdf

Magnetic compensator for objective lens

1.2.14 Equipment manuals and documentation for staff

All relevant manuals for the beamline and endstation, in PDF, docx, etc. are stored here.

Surface prep

Pumps, valves, gauges

Prep chambers

Bakeout equipment

Beamline reports and papers

1.2.15 Updating MAXPEEM Documentation

What is Git and why do we need to use it?

Git is an open source distributed version control system. A version control system is needed for maxpeemdocs, as it:

- records the changes made to the source (markdown) files over time,
- enables changes to be undone,
-

The documentation is automatically built and published when pushing to the main branch. To get your changes reviewed, open a MR.

Source for MAXPEEM documentation hosted on GitLab pages:

https://gitlab.maxiv.lu.se/maxpeem/maxpeemdocs

The documentation is built using Sphinx and MyST, stylized with the Read the Docs theme. Both Markdown and reStructuredText format can be used.

Working locally

Initial setup on a Windows PC

1. Ensure you have Git installed. Press “Window”, type “cmd”, type “git –version”. If you do not see a response with the version number, you’ll need to install Git.

- dd

2.

These instructions were adapted from an hour-long Youtube tutorial on Git. https://youtu.be/8JJ101D3knE?si=UTAvyI_2ZvohfwNc

MAX IV Gitlab

To use git commands you need to install git first.

> **Note**
>
> Windows ends lines in `CRLF`, and everyone else in just `LF`. To properly deal with this, there is the `core.autocrlf` option in `git`. Use `git config --global core.autocrlf true` if you are on windows.
>
> There is now a command to correct line ending in a repo: `git add --renormalize .`

1. Clone remote repo if you have not cloned the reop yet.

```
git clone https://gitlab.maxiv.lu.se/MaxPEEM/maxpeemdocs.git
cd maxpeemdocs
```

2. Create a new branch with a name to add your changes. `branch-name` should have no space.

```
git checkout -b "<branch-name>"
```

Now you can add any changes you want and save them.

If you want to check the final web pages locally, you have following two options:

pixi (option 1)

To build the full html documentation locally, it is recommended to use pixi. It makes it easy to install the needed requirements on any platform. Just install `pixi` if you haven't already.

Build the documentation by running: `pixi run make html`.

Open `build/html/index.html` in your browser.

docker (option 2)

Another option is to use the same docker image as the CI pipeline. The image is quite big as it includes LaTeX:

```
docker run --rm -it -v $(pwd):/docs harbor.maxiv.lu.se/sphinxdoc/kits-maxiv/sphinx-doc␣
↪make html
```

To create the pdf locally, this is the recommended approach as LaTeX is required:

```
docker run --rm -it -v $(pwd):/docs harbor.maxiv.lu.se/sphinxdoc/kits-maxiv/sphinx-doc␣
↪make latexpdf
```

4. Push your local changes to the gitlab when you feel your changes are good.

- Add your changes

```
git add . # add all your changes
git add <path-to-file/file-name> # add specific files
```

- Commit your changes

```
git commit -m "<some-commit-msg>"
git commit # will open a editor to add commit msg. save and close file
```

- Upload your changes

```
git push --set-upstream origin <branch-name> # for first push
git push
```

5. Open a MR for others to review if needed

1.2.16 DEVPEEM

1.2.17 How to local contact at MAXPEEM

(adapted from blochdocs by GM)

Useful links

Ask Yuran or Alexei for the master spreadsheet.

Check whether a session has been created in DUO.

Online booking system for chemistry labs.

Scheduling of beam availability on Tuesdays, see the applicable Commissioning schedule pages . (Only on white network)

Our mailing address:

: [Your name] MAX IV Laboratory Fotongatan 8 SE-22484 Lund Sweden

Responsibilities of the local contact:

Once the PAC has issued their decision about beamtime allocations, a single person (typically beamline manager (Alexei)) will take responsibility for making initial contact to gather information relevant for setting the schedule. In parallel, the beamline group will meet to discuss the beamtimes and assign a local contact to each. If you are a local contact, here is what you need to do:

Review the proposal

Pay attention to whether they need anything outside of the most basic functionality (e.g. prep chambers, STM), so that you will be able to flag to the team if repairs of something have to be expedited.

Make initial contact

Include all proposal participants, and (if previously agreed) other members of the beamline group. Proposer email addresses are available from DUO. The purpose of this mail is:

- Let them know that you will be their point of contact for this beamtime
- Warn them about accomodation and the Forskarhotellet
- Warn them about expected staffing levels (i.e. don't send just one person)
- Prompt them to create a session in DUO and declare samples
- Let them know what/when they should expect to hear from you again

Here is a template that you might find useful:

Dear [Name1],[Name2],etc.,

Your proposal [proposal number] ”[Proposal name]” is scheduled at the MAXPEEM beamline of MAX IV, with light being available from [Start time and date] until [End time and date]. You should have received an automated email from the DUO system about this. For this beamtime, I will be your local contact, meaning that you should write to me if you have any questions or requests about the beamtime and also that I will be following up with you closer to the time to complete the necessary arrangements.

Well ahead of time, it is essential that you sign into DUO and create a ‘session’ for this beamtime (Click “Experiment sessions”, then find this proposal number and choose [Manage]). The declaration of samples, sources, lasers, etc. is very important - your experiment will not be permitted to go ahead unless the experimental safety group approves it, and they need this information to give that approval. If there are questions you don’t know or don’t understand, just leave them blank. It is important to declare ALL samples that you intend to bring to the beamtime.

Samples should be mounted and loaded into the system before beam is available, so that measurements can start immediately when you get the beam. Therefore, plan to arrive a day ahead of time, and also plan to arrive well within normal hours (0900-1700) so that we will be here to receive you.

When planning for this beamtime, remember that your team must consist of enough people to safely and effectively use the beam 24 hours per day. We will expect all members to be sleeping, outside of the lab, for at least 6 hours out of every 24. Beamline staff support is guaranteed for roughly 12 hours a day (shared between two members with an offsetted schedule).

You can find practical information about the beamtime here: https://www.maxiv.lu.se/users/practical-user-information/ However! Regarding accommodation: MAX IV officially recommends the university guest house, which is 3km away. Unless price is dictating the decision, we at the beamline **highly** recommend Forskarhotellet as the best option (100m away, https://www.booking.com/hotel/se/forskarhotellet-brunnhog.html), followed by Motel L (1km away, https://www.booking.com/hotel/se/motel-l-lund.en-gb.html). Bicycles are available on loan from MAX IV, or for hire from the guest house. Food options include (a) cooking at the user kitchen at MAX, (b) cooking at Forskarhotellet, (c) purchasing food from the food trucks that visit MAX IV between 11-13, (d) purchasing food from the vending machines at MAX IV, and (e) ordering food delivery (i.e. using foodora.se).

If the sample preparation you plan to perform here involves using epoxy, solvent cleaning, a hot plate, etc., you will need access to the chemistry labs at MAX IV. In that case you will need to have a 30 minute introduction to the chemistry lab by one of the safety staff, and this has to be arranged in advance. After you make a booking at one of the MAX IV chemical labs (https://lab-booking.maxiv.lu.se/labs/), you will be contacted to arrange a training session if it is required. The optimal chemistry lab to book for MAXPEEM beamtime is the ‘D3 chemical lab’ (located next to the FlexPES beamline). Aim to do this at least 1 week before you arrive. The MAX IV chemistry labs are well-equipped with common consumables, laboratory hand tools and glassware, which should reduce the number of items you need to bring to the beamtime. Please contact <mailto:anicee.guglielmi@maxiv.lu.se> if you have questions regarding lab supplies, tools, etc.

If spare time is available pre-beamtime, your team could get famliar with our data analysis tools: https://www.maxiv.lu.se/beamlines-accelerators/beamlines/maxpeem/user-information/data-analysis-soft/ Measurement data is quickly transferred to user computers using our USB hard drives so the use of SFTP, etc. is not necessary.

You will also find useful practical information on our website: https://www.maxiv.lu.se/beamlines-accelerators/beamlines/maxpeem/user-information/ and on the beamline documentation page: https://www.peemdocs.maxiv.lu.se

In summary: Please register a session in DUO, and choose carefully when booking accomodation. I will write again closer to your beamtime - at that point, I would appreciate receiving a brief, bulleted list summarizing the samples to be measured (in order of priority) and the types of measurements to be performed on each sample. A rough/preliminary list is absolutely OK. Feel free to write anytime with questions.

Regards, [Name]

Request VPN access

If partial remote access is requested, you will need to arrange VPN credentials. At least 1 week before the beamtime starts, write an email to mailto:issues@maxiv.lu.se. Here is a template you can use, fill in the capitalized details. Let them know the proposal number and date range. Allow one day before the beamtime for testing.

Hej, Soon we will have users at Bloch that would like remote access through the VPN. Can the users associated with proposal [Proposal number] ([Proposer name]) please be offered temporary access to BlochRemoteUser on the Blue network, starting [time and date] and expiring [time and date]. Thanks, [Name]

Configure their data directory on the network drive

On the beamline PC, open a terminal and launch `ctpathfixer`. Write in the proposal number in the Username field and press enter. Now select the proposal number and visit number from the pulldown fields (there will probably only be one choice for each). Once you've done that, their directory is configured.

Final check-in

The purpose of this email is to: : - Remind them that they have a beamtime coming up!

- Reassure them that everything is still working (or update them if it's not. . .)
- Chase them if there is somehow any paperwork still missing
- Remind them to take the safety test (now online in DUO, info at https://www.maxiv.lu.se/safety/safety-for-users/) before they arrive
- Remind them about the opening hours of reception (0800-1600). If they will arrive outside of these hours but want access immediately, they can write to mailto:reception@maxiv.lu.se to arrange for their card to be left in a safe deposit box outside the main door.

Brief the beamline team

On the Monday before the beamtime, during the group meeting, describe the experiment to the team. Coordinate who will be available to help the users.

Coordinate removal of their samples and general cleanup

Shortly after the beamtime finishes, ensure that all of their samples have been removed from the system so the next group is not obstructed. If they are not taking samples home with them (or if it was a mail-in experiment), ensure that their samples are collected and stored away in a clearly labelled spot until you have time to arrange shipment back to them.

Put away any power supplies, cables, tools etc in the experimental area that were out for the experiment,

Clean up any leftover food, cups, paper scraps etc from the hutch.

Debrief the team

Before the users leave, try to solicit comments from them about what they liked, what was difficult, where they think we could improve. Remind them also that they should submit a feedback form (in DUO), and stress the importance of filing an experimental report about the beamtime (also in DUO). During the Monday meeting after the beamtime, describe to the team how the experiment went and what their user comments were.

1.2.18 Remote access (for staff)

Zoom

Details for the Bloch zoom account can be found here.

Syncing data with rsync (linux/mac)

To sync a data folder to to the current directory, use the terminal command:

rsync -avzh [MAX-IV user name]@offline-fe1:/data/staff/bloch/StaffData/sshTest ./

If there are spaces in the target path, put it in quotes and escape the sapces with backslashes. For example:

rsync -avzh mailto:crapol@offline-fe1:"/data/staff/bloch/StaffData/Craig/2022.06.21Aucheckup" ./

You need to be on the white network for this to work.

Mounting remote drives with sshfs (linux)

To mount a remote folder to a local folder on your machine:

sshfs [USERNAME]@offline-fe1:/data/staff/bloch/StaffData ~/[LOCAL FOLDER]

To unmount:

fusermount -u -z ~/[LOCAL FOLDER]

Graphical clients

See 'getting your data' page on the public blochdocs

1.2.19 Baking the vacuum chambers at MAXPEEM

Procedure for baking the main chamber

- Switch off the high voltage electronics rack
- Close LEEM2000
- turn down the objective current to ~1000 mA
- check that the gate valve between the prep and main chambers is closed
- close the valve to the column
- disable the main chamber pressure interlocks
- turn the main chamber pressure gauge off
- turn off the main ion pump controller
- open the valve between the load lock and main chamber
- vent the load lock normally
- use a 5 m tape for wrapping the main chamber, connected to an independent heating controller
- don't wrap the manipulator casing
- standard load lock pump down procedure
- use the prep chamber to pump the main chamber
- bake the main chamber at 120 - 130 C
- bake the ion pump neck

Degassing

Notes

- main chamber manipulator is bakeable up to 180 C.
- After a few successive bakeouts, the threads of the X and Y-axes as well as the threads of the tilt screws should be lubricated with a silicon lubricant
-

1.2.20 Microscope maintenance

Oxygen cleaning of the microscope

1. Connect the high voltage lens to the cage.
2. Disconnect the electron gun's cable from the chamber and put it into a clean glove. Leave it on a plastic board or foam board for protection and ensure no one touches it
3. Prepare the oxygen gas line and use the mass spectrometer to check the cleanliness of the oxygen. At this point, one may close the valve to the ion pump of the prep chamber.
4. Open the valves to the load lock (normally open by default) and column chamber (from the back of the LEEM table).
5. Switch off the column's ion pump.
6. Turn the loadlock in to connect it to the prep chamber.
7. The pressure in the prep and column chambers should be lower than e-8 Torr.
8. Switch off the ion gauge in the prep chamber as the pressure here is expected to be high, potentially up to e-2 Torr. The valve to the turbo of the prep chamber should be closed as well.
9. Open the oxygen leak valve to introduce oxygen into the column chamber up to 5e-6 Torr.
10. Gradually increase the high voltage to 22 kV and leave it on for an hour.
11. Reduce the HV and oxygen flow rate. Keep the chambers pumped with the small turbo and try to switch on the ion gauge. The pressure will guide you to open the valves or switch on the ion pump.
12. Switch on the prep ion gauge.
13. Open the prep turbo valve.