

This quick guide obtains just brief information. In case you need detailed instructions, read the **official manual from evico magnetics** for the Kerr microscope, for cooling the IP magnet read the **official manual for Aquaduct control unit**. Both are available in the lab.

KERR-MICROSCOPE

Intro:

Kerr microscope measurements: visualization of magnetic domains, magnetization processes and magneto-optical measurements of surface hysteresis loops. Mapping spot size is between 100 μm and units of mm, resolution limit corresponds to the optical microscopy limit and depends on the used objective. Possibility of both in-plane and out-of-plane magnetic fields. Cooling is available for the in-plane magnet only.

Starting up the setup:

- 1) **Magnet setup with connection** to KEPCO source (both IP and OOP: black wire to black input on left, red wire to red input on right. IP additional green on ground. Note: the two inputs of same colour are connected). Mode is set to the "DC ampers", i.e. to the right.
- 2) Switch on **microscope** (bottom left switch to I).
- 3) Switch on **LED source** (on shelf above Kerr).
- 4) Switch on **camera** (on top of the microscope).
- 5) Switch on the **KEPCO source** (by handle on left to upper position, in case it does not start try to repeat).
- 6) Start the **SW "KerrLab"**.

Shutting down the setup:

- 1) Set the **current/field to zero**.
- 2) Close the **SW windows** Looper, LED lamp control, Region Of Interest (ROI) ... **and close the SW "KerrLab"**.
- 3) Switch off the **KEPCO source** (by handle on left to lower position).
- 4) Switch off the **camera** (on top of the microscope).
- 5) Switch off the **LED source** (on shelf above Kerr).
- 6) Switch off the **microscope** (bottom left switch to o).
- 7) You may leave the magnet setup. Next user will adjust the magnet setup to his/her needs.

➤ IP magnet:

- ❖ Large yellow magnet, multiple pole options (no poles = empty, split poles/high field poles – fitted manually in magnet, **secure tightly with screws!**) and possibility of small or large coil (by manual switch on magnet). Each combination allows different field (approx. values see Tab.). The brass slide with stick is used with top sample holder (secured with screw), the bras slide should be fixed tightly during measurement (by screw in platform + rotation position fixed). **Limits of the magnet depend on current type (DC or AC) and time of measurement. Generally, the coils should not get too warm and having a cooling always attached is not a mistake.** For high field poles please have the cooling always attached. With no poles/split poles quasi-static measurements are possible without cooling for lower DC (below 100mT) and low frequency (AC max.4Hz). For higher values cooling is needed. Please **check during the measurement that coils are not overheating**.

The calibration date is noted in brackets and corresponds to the saved calibration files.

	No poles (empty)	Split poles	High field poles
Small coil	± 1.78 mT, linear (13.3.2015)	± 17.5 mT, linear (13.3.2015)	useless
Big coil	± 37.6 mT, linear (13.3.2015)	± 337 mT (13.3.2015) ± 359 mT (custom 8.2.2021)	10mm out: ± 353 mT 6mm out: ± 537 mT 4mm out: ± 756 mT (all custom calibration 8.2.2021)

- ❖ For inserting/changing the objective first set up the magnet and then carefully turn it right while turning the objective. Once the objective is in load/unload position change it and then move carefully back both the magnet and objective simultaneously until the objective clicks in. No need for disconnections of magnet.
 - ❖ In SW load the calibration: Preferences -> Magnetic field setup -> Field-Voltage-Current calibration -> Load calibration file -> choose the correct setup (IP: pole and coil type used). Then click accept & store -> done. You should see the min/max field value in message log.
 - OOP magnet:
 - ❖ Smaller silver magnet with in-built sample holder. For setting up this magnet first attach the black 3D printed cube to the brass slide (with screw) and set it in the microscope setup (platform needs to be at lowest height). Then fit the magnet using 4 smaller screws to the black cube. The objectives should be fitted/changed without any problems. **The limits of the magnet depend on current type (DC or AC) and time of measurement. Generally, the coil should not get too warm, for OOP magnet the cooling of coils is not possible.** Quasi-static measurements are possible to do for DC and low frequency AC (max.4Hz). Please **check during the measurement that coils are not overheating.**
 - ❖ In SW load the calibration: Preferences -> Magnetic field setup -> Field-Voltage-Current calibration -> Load calibration file -> choose the correct setup (OOP). Then click accept & store -> done. You should see the min/max field value in message log (approx. ± 112 mT according to custom calibration 8.2.2021).
 - LED lamp controlling: In the SW in tab "View" -> LED lamp controller. A new window opens, and one can choose the light source. The "pure" ones are subtracting the polar component. To change the LED source, unclick the current one and click to the desired one. In case your option is using lamps that are opposite each other (indicated by blue opposite dots) click "equalize pairs" option (depending on selected source type). This equalization should be performed for a focused image.
 - Measurement notes:
 - ❖ While focusing on sample one should see two spots in the right ocular (resp. 2 stripes). For focusing it may be advantageous to move to the edge of the sample. Further, move with stage to make sure you are not focusing on an optic effect but on the sample (i.e. it is moving with the moving stage).
 - ❖ Processing:
 - Manual (domains) – go to current value (e.g. +I), take BG, click SUB, AVG, go to opposite current value (i.e. -I). Domain formation can be seen, pictures need to be taken by clicking manually.
 - Looper (hysteresis) - automatic measurement with the parameters defined by user. The corrections of Drift (edges) and Faraday (tilt) are usually needed due to the objective optics. The button "1x" at the corrections change their range. Also define the path for data saving in looper (with or without the photos). Virgin curve: 0-> -I-> +I -> -I.
 - Other notes / reminders:
 - ❖ **When using the high field poles check first without the sample that the pole position in magnet is good for max. field you will use and that the poles do not move/collide (i.e. be sure there are fixed tightly)!**
 - ❖ **Be aware on which digit you have the cursor** (green rectangle) when manual processing! Move to lower digits with cursor or the remote.
 - ❖ The hall probe needs to be always connected even if it is not used (connection behind PC monitor).
 - ❖ Program "Image J" – examples of processing after measurement:
 - Making videos from images: File -> import -> image sequence (choose first file and click open + sort numerically + OK, wait for import), then File -> save as -> avi (JPEG) – set F/s.
 - Plot a profile: draw a rectangle/line over a structure and analyse -> plot profile.
 - Manually subtract background (bg) (it is advised to save the adjusted ones as a new set of files).
- If you experience any problems with the instrument (solved or unsolved) please contact the guarantor.**

In-plane magnet – cooling

The Mark3 aquaduct cooling station is used for the IP magnet cooling. This station is generally used for PC cooling but the connections are adjusted for the magnet and this cooling is sufficient for the measurements at higher AC and DC fields/longer measurement times. However, it is highly recommended to **check the warming of the coils and in case of higher temperatures it is advised to turn off the field, leave the magnet to cool down and continue only after it cools down**. The water outlet temperature should not get above 40°C, otherwise we are risking magnet damage.

To use the magnet cooling please follow these steps:

- 1) Check the amount of water in the cooling station – it should be filled up to 2-3cm below the top on the right side (i.e. at the side with screw).



- 2) If there is less water, fill it with distilled water until the 2-3cm below top. The distilled water with a funnel is located in the lower cabinet nearest the window in the lab. To fill the system, unscrew the large screw on right side (see red arrow in image above) under which the filling port is located. After filling, fasten the screw back.



- 3) Connect the hoses to the IP magnet. It does not have any specific order – the water circulation can be performed in both ways.



- 4) Connect the source cable to the cooling system and plug it in the socket. The cable is in the second drawer below the Kerr microscope (noted as IP magnet Kerr – cooling). The cooling system should lighten up and show values on the display. On the display go to the water temperature values (click lowest red dot of touch display).



- 5) You should see circulation of the water on the red indicator (i.e. indicator is spinning). If not, there is either not enough water or some air trapped – please check the water amount and squeeze the lines a bit (mainly at the transparent part) to move the air out. For getting air out of the system you may need to unscrew the screw on top right again.



- 6) After you finish your work, please disconnect the source cable from the socket and the cooling station and put it back in the drawer. Disconnect the hoses from the magnet and shift the cooling station in a safe spot. **Please clean up any water puddles due to safety reasons!!!**

Note: If there is visible amount of dirt in the water in the cooling station, it is advised to pour the water out (from the filling port) and refill again with clean distilled water.