LEEM2000 Control Software

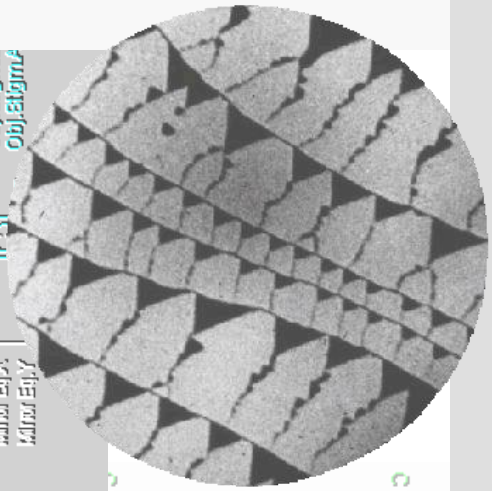
for Elmitec Electron Microscopes

Manual 2021

LEEM2000 software developed by Uwe Knipping

For Software Release 41

LEEM2000 & Uview now in their 27th year of continuous development



Software developed with Microsoft Visual C++ 2019 ™

Working with Windows XP™ through 10™

Please visit our website at http://www.elmitec.de/.

For questions about LEEM2000 software and LEEM, PEEM or SPLEEM instruments please contact mail@elmitec.de.

CONTENTS

Setup

Computer and Operating System Requirements

A standard desktop for medium to high end business applications (i.e. DELL Precision, HP Z-line) is recommended (Multi-core CPU, 8GB RAM, >=500GB drive, graphics card, audio output with simple speakers and as many USB-2.0 or 3.0 connectors as possible (>=6)). On 32bit Operating system more than 4GB RAM are not useful. A good quality 24" LCD monitor should suffice.

Simultaneous use of U-view imaging software

If you also use ***U-view*** with a PCO Sensicam or others for image acquisition, you should run both programs on **ONE PC** with **2 monitors (or more)**. Please see the ***U-view*** manual for computer requirements. For this dual monitor configuration you need a video card supporting 2 monitors and a second 24" LCD monitor (i.e. 1920x1200 resolution). There are no special speed requirements for the graphics card.

The advantages of using U-view imaging software, are the ability to embed LEEM parameters and information, such as field of view, temperature, etc., in saved and live images. Online-analysis tools (distance measurements, particle counting, Fourier analysis, etc.) are also available. U-view is intrinsically connected to LEEM2000, therefore all changes in LEEM power supply settings are immediately recorded in U-view.

Operating Systems

The operating system must be Microsoft Windows 7,8 or preferably 10 or 11.
The operating system should be 64-bit, 32-bit will still work too.

LEEM2000 Installation

LEEM2000 will come to you fully installed and configured by Elmitec.

But there will be cases in which you may have to reinstall LEEM2000, for instance when replacing the control computer, after a hard-disk crash etc.. The following *only* concerns such cases: Elmitec will supply an installation file which contains a complete installation of LEEM2000 on the click of the mouse, just like any other software you purchase for your PC.

- LEEM2000 must be installed in an account with administrators (power user) privileges. This is the case when the PC is setup for just one user.
- When first starting LEEM2000 you will be asked to register the software. Please write down the displayed serial number and email it to *mail@elmitec.de*. You will get an unlock code back from us which you can use to register the software.
- When setting up LEEM2000 or U-view on multiple computers for a remote access, through a network, you have to follow the detailed instruction in the DCOM setup manual.

- Windows 7-10: LEEM 2000 must run with administrator rights. To achieve that please right click the LEEM2000 ICON on the desktop. Select *Properties* and the *Compatibility* tab. Check the box '*run this program with administrator rights'*. Close the Properties window.
- Windows 7&8: it is recommended to set the 'user account control' to the lowest level. This should be done to avoid annoying pop up messages by Windows each time you start LEEM2000.

Driver Installation for Elmitec USB devices

Run the Elmitec program: *SetupElmitecUSBInstaller.exe*. This is a hands-off installation. It installs all Elmitec USB drivers.

To verify that, as an example, the Elmitec *fieldbus adapter* is connected and recognized by Windows you may at any time open the Windows *Device Manager*:

MyComputer -> Control Panel -> *System -> Device Manager*
and find the line *USB controllers.*
There you should see one or more entries for *Elmitec USBXpress Device.*
Right click on each of those lines and choose *Properties.*
In the *Details* tab you'll see "Elmitec Fieldbus interface II".

You may also open the 'System Configuration' Window in LEEM2000 to check which Elmitec devices are currently connected. In that window you may also reconnect to an Elmitec device.

Trackball installation

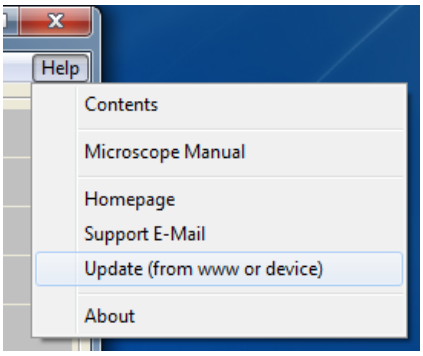
This section only applies if you are reinstalling LEEM2000 on a new computer or changing the trackball.

LEEM2000 requires a **serial** (rs232) trackball from Itak systems :
http://www.itacsystems.com/.

Some PCs may not have a serial interface (COM, RS232), in that case a standard USB to RS232 adapter must be used.

There are no drivers to install. But after connecting the trackball it is necessary to tell Windows not to use it as the main Windows pointing device. To do that select *My Computer->Control Panel->System->Hardware-Device Manager*, open "*Mice and other pointing devices*", select the trackball (shown as a Microsoft Mouse), double click to show the properties of that device and at the bottom of that window select "disable". Apply and close the System window. If done right, moving the trackball will not move the Windows cursor any longer (the mouse of course should still move the Windows cursor).

Software updates



You may check for updates through the internet anytime. In the help menu select Update.
Assuming that you have a working internet connection click OK in the window which will be displayed next. From there the update will run automatically. If an error occurs it will be displayed. Your PC must be registered at Elmitec for the updating process to work. After an update is finished you will be notified. The actual replacement of the old files with the new ones will be done after you quit LEEM2000. This means that next time you start LEEM2000 again it will be done with the new files.
If your files are already up-to-date when clicking 'Update' a message will be shown to that regard and no further actions will be taken.
A manual update is also possible if no internet connection is available at the LEEM PC site. In that case please contact Elmitec directly.
Please make sure to update the software frequently. So far LEEM2000 is about 15 years old and during that time about once every month updates are released.

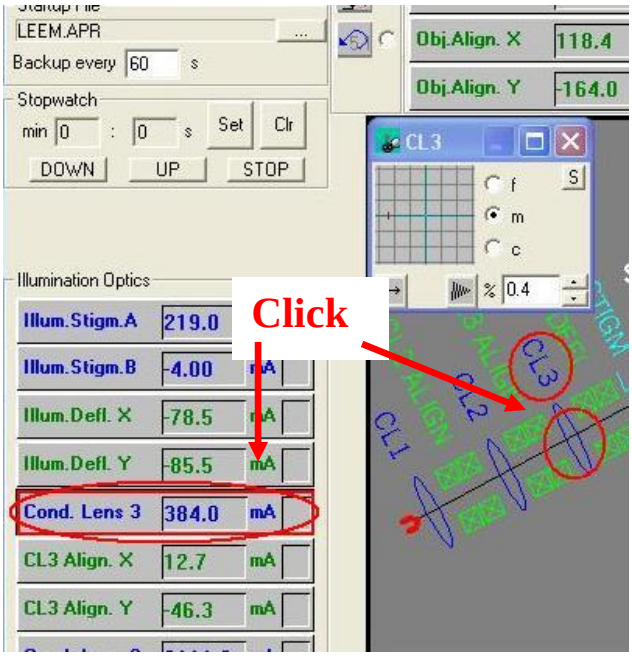
LEEM2000 License Registration

In case LEEM2000 is accessed from a user-account for the first time or LEEM2000 has been reinstalled, a registration window will be displayed. You need to enter your PC specific unlock code to proceed. This unlock code can be obtained from Elmitec. To get the unlock code you need to email, fax or phone the serial number which is shown in the first line of the registration window to Elmitec. You will receive the unlock code. Please enter it into the appropriate line and hit the Continue button. You will now be able to use LEEM2000.

Also available is a movable license on an USB stick. If you need this option please contact Elmitec.

Quick Guide to getting started with LEEM2000

- Make sure all LEEM power supplies are turned on
- Make sure the USB to fieldbus adapter is connected to an USB port on your computer and the power supply is attached to the fieldbus adapter and plugged into the AC.
- Connect and turn on all other Elmitec USB devices, for instance MCP control unit, manipulator motors, azimuth motor, Mitutoyo or Renishaw micrometers etc. . .
- Make sure the trackball is connected to a serial port on your computer and disabled for use as a pointing device by Windows.
- Start your image acquisition hardware & software or camera and TV-monitor.
- Double click the LEEM2000 icon  on your desktop or select LEEM2000 from the Windows ***Start*** menu. If you use Uview then LEEM2000 will be started automatically when you start Uview.
- LEEM2000 will display a progress bar and error messages if it can't connect to the LEEM modules. In the absence of an error message you can now begin using LEEM2000.
- To select a lens, deflector etc.:
    - click on the name or symbol of the lens, deflector, etc., *in the schematics*
    - **OR:** click in the *box* with the name of the lens, deflector, etc.. in the area surrounding the schematics.



- To change the settings of the lens, deflector etc. power supply move the trackball and observe the changes in numerical values displayed in the associated box in the LEEM2000 window. Changes can of course also be observed in the LEEM image.
- To close LEEM2000 click on the 'x' in the upper right corner of the LEEM2000 window. A message with several options will be displayed (see reference manual below for details). During closing all settings will automatically be backed up and restored when you start LEEM2000 the next time.

Reference Manual

This section contains the description of all menus and tools used in LEEM2000.

LEEM2000 Startup

Note: In the following text all power supplies for lenses and deflectors as well as HV power supplies housed in the HV rack and all other electronic devices attached to the Elmitec fieldbus will be called for simplicity sake 'modules'.

Before you start LEEM2000:

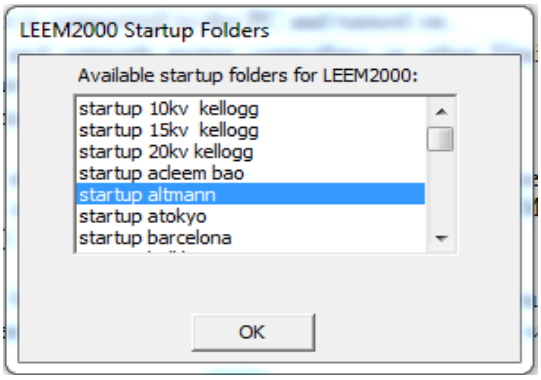
- Make sure all LEEM power supplies are turned on
- Make sure the USB to fieldbus adapter is connected to an USB port on your computer and a power supply (5V) is attached to the fieldbus adapter and plugged into the AC.
- Make sure the trackball is connected to a serial port (possibly through USB adapter) on your computer
- If you are using micrometers supplied by Elmitec (Mitutoyo or Renishaw), make sure they are connected to the Elmitec Mitutoyo or Renishaw adapter and that the adapter is plugged into an USB port on your computer.
- Make sure the Varian or Vacom gauge controller(s) are hooked up through a USB cable to the PC and set to the correct Baudrate (32kB see Varian/Vacom manual on how to set Baudrate in the controller).
- Make sure the MCP controller is connected to the PC and turned on.
- The same with manipulator and azimuth motor controllers or other Elmitec motor controllers, make sure those are also powered up and plugged in.
- Start your image acquisition hardware & software.

Note: If the fieldbus adapter or any other Elmitec USB devices becomes disconnected while LEEM2000 is running they can be reconnected without leaving LEEM2000 (see system configuration window)

Note: If any LEEM power supplies become disconnected while LEEM2000 is running they can be reconnected without leaving LEEM2000 (see *system configuration window*)

To start LEEM2000 double click the LEEM2000 icon  on your ***desktop*** or select LEEM2000 from the Windows ***Start*** menu or the ***Taskbar***.

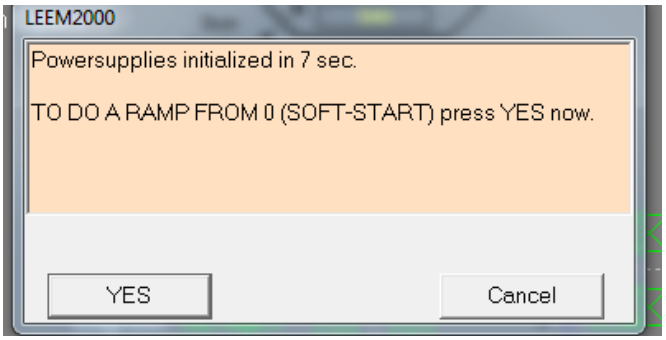
Parameter-set selection



If you want to use LEEM2000 with different parameter sets, for instance for different types of microscopes or different base voltage, you can create sub folders named 'startup *xyz'* in the LEEM2000 folder. '*xyz'* can be any name you want within the limitation of Windows. After you created a folder like this you need to copy a parameter file (.apr) and a layout file(.lay) as well as a startup file (.sta) for instance from the main LEEM2000 folder into the new folder. When starting LEEM2000 it will display the startup folder in a window for you to select (or hit Esc to abort). The parameter set in the main LEEM2000 folder will be displayed as 'startup.sta in leem2000 folder' at the end of the list. The parameter files in the startup sub-folder will be maintained separately and independently from each other.

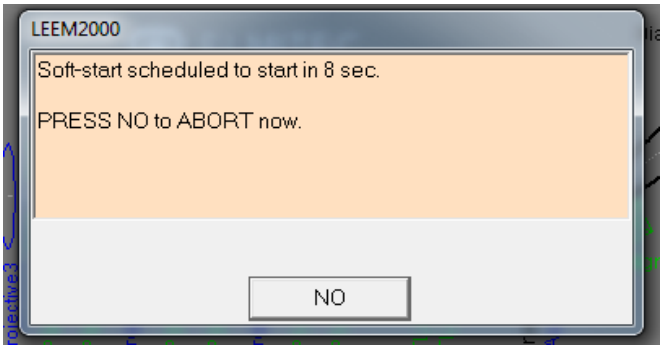
Startup options

After starting LEEM2000 a window will be shown with an option to slowly ramp all constant current sources. After a countdown of 10 seconds the software will automatically proceed

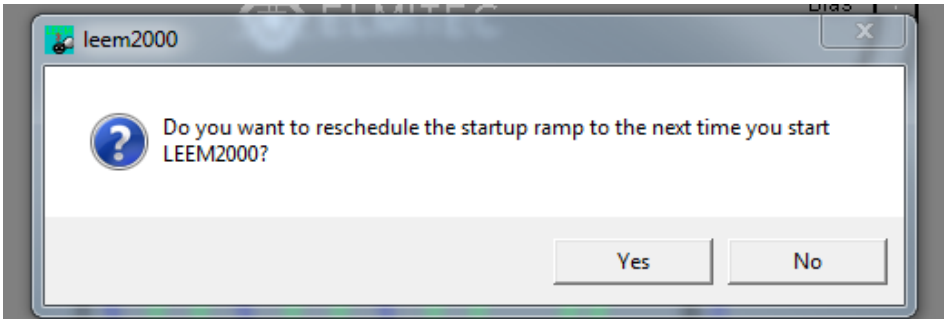


unless you press 'YES'. If you click Cancel than the program will proceed immediately without the 'soft start' ramp. This 'soft-start' ramp is only necessary after a complete and *unexpected* power-down of the microscope power supplies.

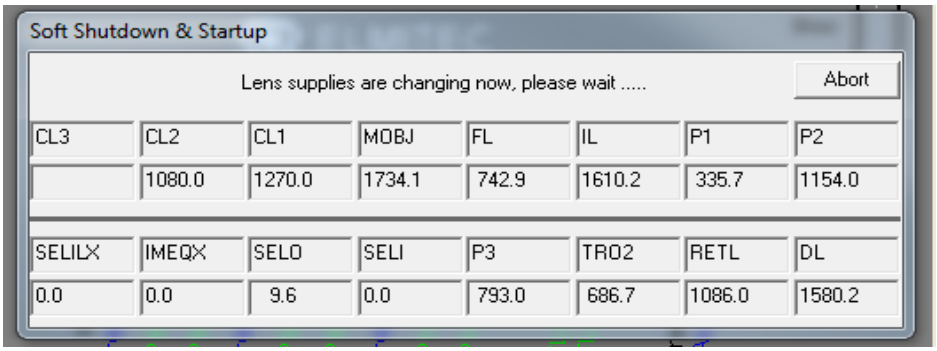
If the LEEM program was previously closed with the 'ramp all lens powers supplies to 0' option to prepare for a regular power shutdown, than a different message window will appear:



This gives you the option to ***not*** do a 'soft-start' ramp or to ***postpone*** it. Normally the countdown will run down and the soft-start ramp will proceed.
If you click **NO** the following will appear allowing you to postpone the 'soft-start' ramp.

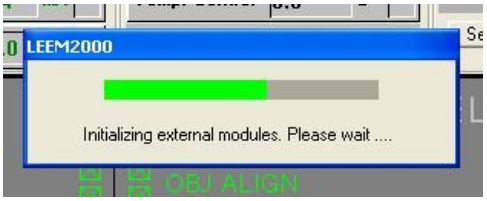


In case a 'soft-start' is performed, the following window will be displayed:



When *aborting* a *soft-start* values of the power supplies will **jump** to the setting valid before the last ramp-down.

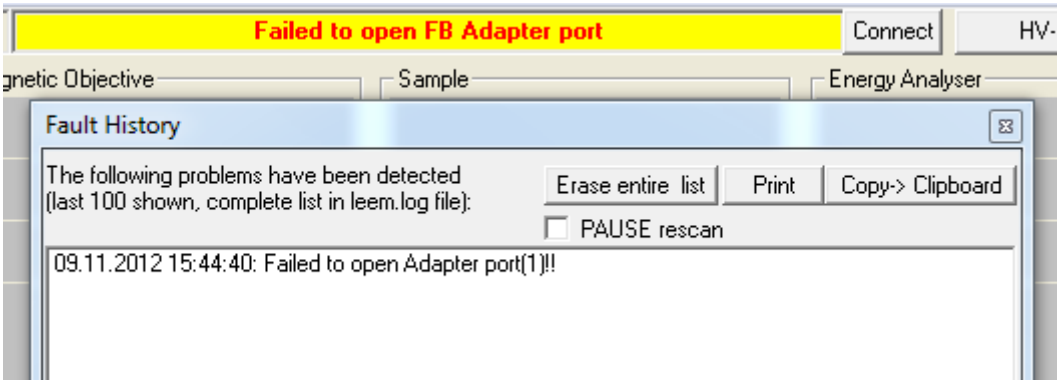
Without a 'soft-start' LEEM2000 will first initialize all modules while displaying a progress bar:



If no further messages are displayed the system has been started successfully and you can begin your experimental work.

Possible Error Messages during Startup

If LEEM2000 can't connect to the LEEM electronics because the fieldbus adapter is missing or faulty a window 'Fault History' will be displayed and all controls in the main LEEM2000 window will be blanked out. You will still be able to use certain features of the program, i.e. the configuration dialog.



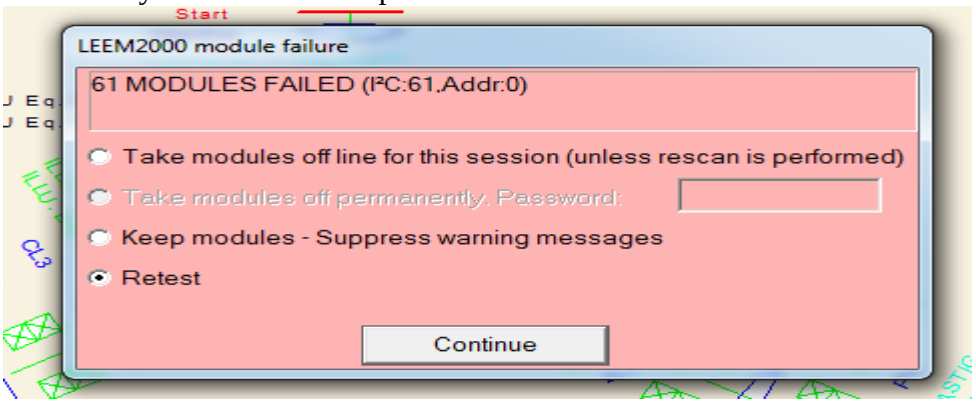
If the fieldbus adapter is not connected to its power supply or if this supply is not connected to AC or it is faulty a dialog box is displayed. The fault history window is also opened and displays the same error. Connect the power adapter or replace it. Click 'Connect' button in LEEM2000 window or restart LEEM2000.

Other hardware interface related messages are:

Communication fault between port and adaptor. Interface terminated.
Failed to open Adapter port: # . Error: -# . Interface terminated.

In these unusual cases Elmitec customer service needs to be contacted. The user could possibly try to check if the USB cable is firmly connected and also restart the PC.

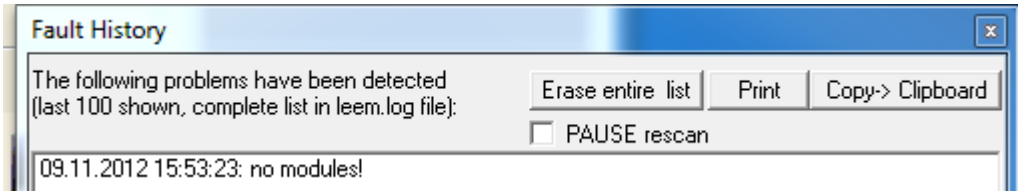
If one or more modules do not work properly a message is displayed indicating the type of fault. The fault history window is also opened.



You then have the option to take the faulty modules off line, to keep the modules on line but to suppress further messages like this or to repeat the test. Usually the modules should be taken off line.
Once taken off line, modules can be taken on line again by pressing RESCAN in the *System Configuration Window*. This of course requires that any fault has been fixed in those modules.
All modules which are not online will be blanked out in the main LEEM2000 window.

Note: This dialog may be shown not only at program start, but whenever a power supply fails.

If no modules are found at all, the message changes accordingly and all modules boxes in the LEEM2000 window will be blank and a message in the Fault history window will be displayed,



If the parameter file is corrupt or obsolete one of the following message will be displayed:

One or more modules have corrupted setting.
Please check 'fault history' in 'View' menu for details.

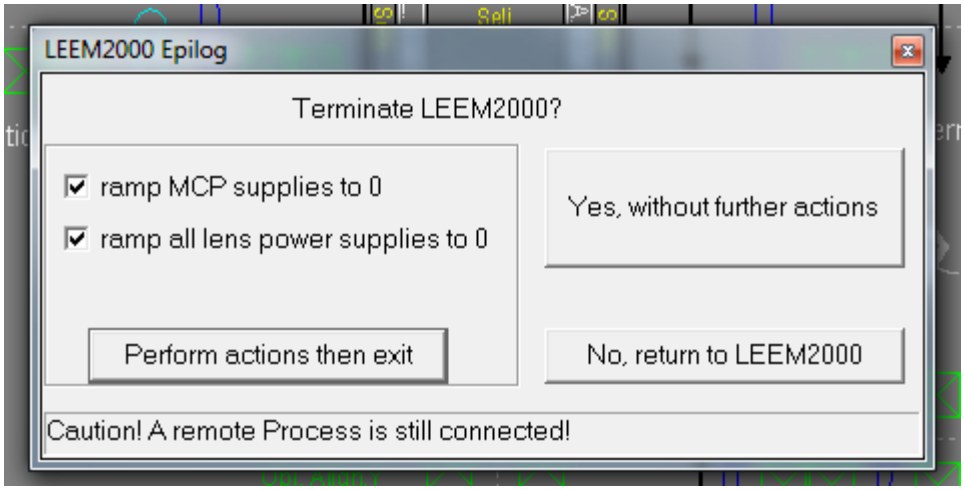
Multiple address assignments found.
Please check 'fault history' in 'View' menu for details.

Incorrect status bit register address(es) found.
Please check 'fault history' in 'View' menu for details.

In that case you have to replace the startup parameter file (extension APR) with your own backup or get a backup from Elmitec.

Note: Information about the startup sequence, i.e. any occurring faults are logged into a file called LEEM.log in the LEEM2000 installation folder.

LEEM2000 shutdown:



This is the final Dialog shown before closing LEEM2000.
If you click:

- *Yes without further actions:* LEEM2000 will be closed down immediately.
- *No, return to LEEM2000:* the program will not close but continue
- *Perform actions then exit:* the actions shown and checked will be performed before closing down LEEM2000. The actions displayed vary depending on the options installed on your microscope.

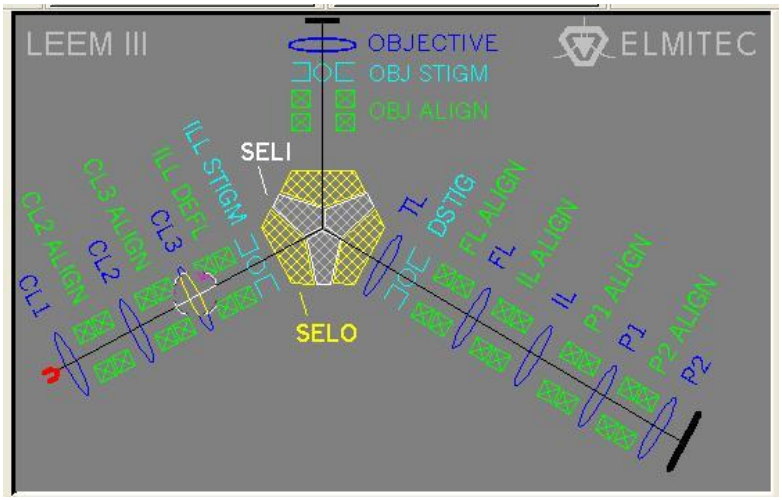
Note: because of hysteresis in the coils magnetic fields successive power-down and power-up cycles of the LEEM electronics will not yield reproducible results, in most cases you will not get the image back you had before the shutdown, even if using the soft shutdown and startup feature. Therefore:

The LEEM power supplies should be turn off only for maintenance and NOT between sessions, during weekends or holidays etc..

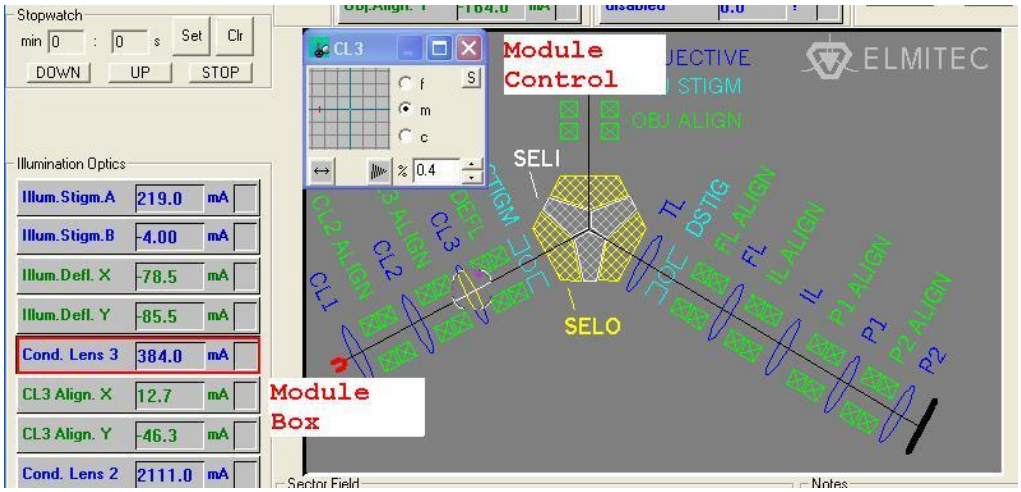
The LEEM2000 software on the other hand can be closed and opened anytime needed, the same applies to the computer on which LEEM2000 runs, it also can be turned off and on without changing any of the LEEM power supplies settings (if 'without further actions' is selected when closing LEEM2000).

Main LEEM2000 window elements

A stylized schematic diagram of the microscope is in the center of the LEEM2000 window. This schematic will be different for each type (LEEM, SPLEEM etc.) of microscope. It not only gives you a simplified view of the arrangement of the various lenses, deflectors and stigmators but also allows you to interactively select the module you want to control. To do that, you may simply click on or near the desired symbol i.e. CL3. The sensitive area on the screen which reacts on a mouse-click is generally the symbol itself and the associated text area. Once you click that area a semitransparent **circle** moves to that element and starts **flashing**.



When a module is selected the associated box for that module gets highlighted by a red frame.



At the same time a module control window is placed on the screen. Depending on a setting in the configuration window that box is either placed at a fixed position (upper left of schematics) or at a user defined position which can be different for each module.

Note: A few modules, the temperature control for instance, do not have an associated module control window accessible to user or supervisor. When

you click the module box of such a module either no window or a specialized window will pop up. In case of the temperature control, the Sample Heating Control window will appear. In factory level the Module Setup Window will appear for these special cases.

There are 3 types of module control windows:

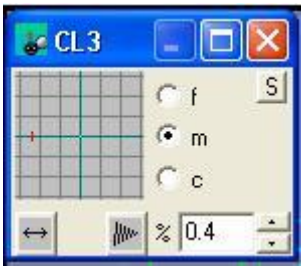
1) Lenses and other devices with a single power supply
2) Deflectors and Stigmators with X/Y pairs of power supplies
3) Motors

The first two types can be displayed in 2 views: maximized and minimized. Switching between views is done with the minimize / maximize button in the title bar 

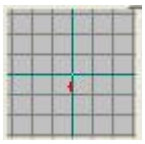
. The title bar also contains the abbreviated name of the module.

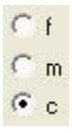
As soon as a **Module Box** is selected you can use the **trackball** to adjust the settings. It makes no difference if the minimized or maximized or no control window is visible.
If no trackball is available you can use the mouse wheel instead. To change a Y component (of an x/y control window) with the mouse wheel, press it down first, then scroll the wheel.

Lens (single power supply) control window

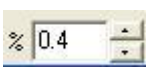


Minimized


Coordinate system visualizes the trackball position and indicates the value of the power supply. The red cross moves when moving the trackball.



The resolution buttons **f**, **m**, **c** allow selection of **fine**, **medium** or **course** trackball resolution. The resolution buttons can be selected by mouse-click **OR** clicking the right trackball button. The numerical values associated with each resolution can be set in the *Setup Window* individually for each module.



The **amplitude** of the toggle can be adjusted either by typing in a numerical value or by adjusting the spin button. The amplitude is set in percent of the **full-range** of the supplies.

Function Buttons:

Depending on the type of module one or more special functions are available.
These functions can be activated for different modules and with parameters specific to the module (i.e. different amplitude for each module activated).

Toggle 

The module will be toggled at a rate specified in the **frequency** field of the maximized control window. Toggle amplitude can be specified in the **amplitude** field. Toggling starts when clicking the toggle button and stops when you click it again. As an indication that toggling is in progress the toggle button turns green  and a toggle symbol  is placed in the module box in the LEEM2000 window.

Stopping the toggle can also be done for all modules at the same time by clicking on the **Stop All Toggle** button in the LEEM200 window.

Note: This function can also be transferred to the right mouse button (menu tools→mouse right button).
Note: Toggling can be done at multiple modules at the same time.

Degauss 

Note: Degauss should only be used by qualified personnel!

A degauss sequence for the selected lens power supply can be started by pressing this button. The button will turn green  and a degauss symbol  is placed in the module box in the LEEM2000 window. The degauss sequence will take several seconds and when finished the button will change from green back to the inactive gray color and the degauss symbol will disappear from the module box in the main LEEM2000 window.

Zero (off) 

The output of the selected module is set to 0.
A special case is the *Wehnelt* module. Here *0* (*off)* refers to the electron emission. This makes it necessary to apply a high voltage to the *Wehnelt* to turn off the electron emission. The high (or off) voltage for the *Wehnelt* can be assigned in the *System configuration window*.

Setup Button 

The setup buttons will display the setup window for the selected module. Please see the paragraph about the **Module Setup Window** for more details.

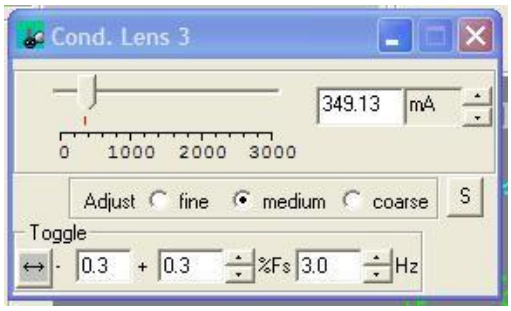
Lock  

Module controls may be locked, to protect a power supply from accidental, unintended changes. A module can be unlocked temporarily by clicking the lock button. The button will then turn green to indicate that the lock has been disengaged. When selecting another module the lock will be activated again.

Negative 

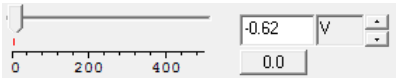
Negative checkbox. Available on some high constant current sources. When selected, the power supply will ramp to 0.0, change polarity to negative and ramp back up to the previous value, thus inverting the output current. When this box is activated, the current has a negative sign.

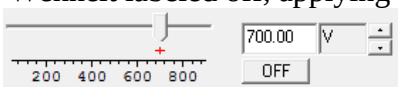
Maximized Control



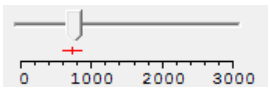
in addition to the minimized control the following features are available:

- full mouse control by using a slider and spin button to set the output value of the module. The small vertical red line underneath the slider pointer indicates the current value of the power supply.
- use of cursor keys (left & right) to move the slider from the keyboard – first you need to click on the slider to select it.
- edit box to manually enter the precise numerical value for the output of the module.
- button to set output value to 0.0. For Wehnelt labeled off, applying a high voltage:

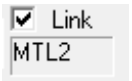


or


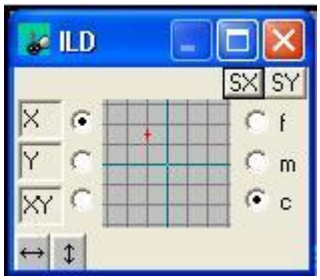
- edit and spin controls to set the toggle frequency.
- edit and spin controls to set the range of the toggle function. This range is visualized with a horizontal red line below the slider pointer as shown here:



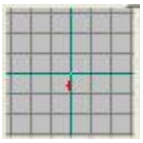
- *Link* control. Any module can be linked to any other or several others. Various ways of interdependency can be defined in the



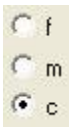
Deflector/Stigmator (pair of power supplies) control window



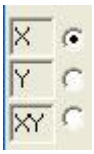
Minimized



Coordinate system visualizes the trackball position and indicates the value of the power supply. The red cross moves when moving the trackball.



The resolution buttons **f**, **m**, **c** allow selection of **fine**, **medium** or **course** trackball resolution. The resolution buttons can be selected by mouse-click **OR** by clicking the right trackball button. The numerical values associated with each resolution can be set in the *Setup Window* individually for each module.



Enabling of x/y axis for user changes can be done with this set of buttons (**Axis Enable**). You may either select x or y or both x and y axis. This prevents you from accidentally modifying the setting of a deflector you don't want to change. I.e. if you only want to modify deflector X but not Y, select only X. The letters X,Y may be changed to A and B where space coordinates do not apply (e.g. stigmators and special deflectors).

Function Buttons

Depending on the type of module, two special functions are available.
These functions can be activated simultaneously for different modules and with parameters specific to the module (i.e. different amplitude for each module activated).

Toggle X 

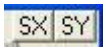
Toggle Y 

The module will be toggled at a rate specified in the **frequency** field of the control and amplitude specified in the **amplitude** field. Both are accessible only in the maximized view. Toggling starts when clicking the toggle button and stops when clicking it again. As an indication that toggling is in progress the toggle button turns green  or  and a toggle symbol  or  is placed in the module box in the LEEM2000 window.

Stopping the toggle can also be done for all modules at the same time by clicking on the **Stop All Toggle** button in the LEEM200 window.

Note : This function can also be transferred to the right mouse button (menu tools→mouse right button).

Note: Toggling can be done in multiple modules at the same time.

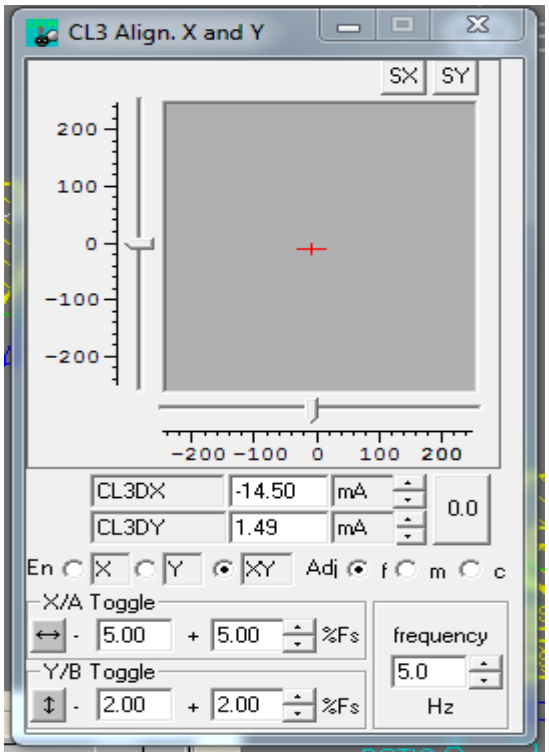
Setup Buttons 

The setup buttons will display the setup window for the selected module. Please see the paragraph about the **Module Setup Window** for more details.

Lock 

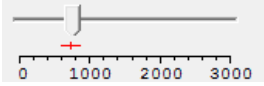
Module controls may be locked, to protect a power supply from accidental, unintended changes. A module can be unlocked temporarily by clicking the lock button. The button will then turn green to indicate that the lock has been disengaged. When selecting another module the lock will be activated again.

Maximized Control

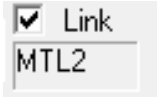


In addition to the minimized control the following features are available:

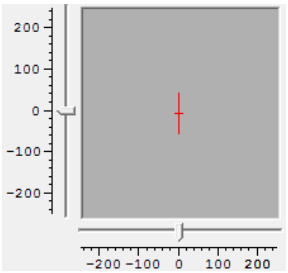
- edit and spin controls to set the range of the toggle function. This range is visualized with a horizontal red line below the slider pointer as shown here:



- *Link* control. Any module can be linked to any other or several others. Various ways of interdependency can be defined in the System Configuration Window and enabled with the '*Link*' button.



- full mouse control by using two slider and spin buttons to set the output value of the power supply
- use of cursor keys (left & right) to move the slider from the keyboard – first you need to click on the desired slider to select it.
- edit boxes to manually enter the precise numerical value for X and Y output
- button to set value of X and Y output to 0.0 at the same time (optional)
- edit and spin controls to set the toggle frequencies for X and Y (optional)
- edit and spin controls to set the range of the toggle for X and Y separately. Toggle range is visualized with proportionally sized red lines making up the cross marker. (optional: depends on whether toggling is enabled in the *module setup window*)



Note: the toggle values are entered as percent full range of the associated module. The values for the full range can be looked up in the setup window of the associated module.

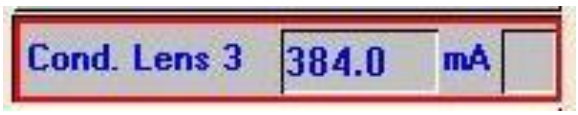
Note: Depending on the setting of the Axis Enable buttons, the controls for X or Y may be inactive. To indicate that the edit fields for the inactive axis will be grayed.

Module Box

Each module box contains the following information

- name of the module
- numerical value of the output or input (in case of temperature or analog readout)
- unit of value
- icon field which may display a status icon or a fault icon.

The color of the text in the module box reflects the type of module (Lens, Deflector etc.).
A red frame around the module box indicates that it is selected and the output values for that module can be controlled in real-time with the trackball/mouse or keyboard.



name value unit icon

Status Icons

Local (module has been switched manually to local operating mode)


Flash heating in progress (heating started by LEEM2000 software)


Temperature equilibrium reached (heating started by LEEM2000 software)


Toggling in X activated


Toggling in Y activated


Degauss in progress

Fault Icons

Over-current (reduce output value, if this doesn't help check connections to selected coil)

General fault, programmed output voltage or current not reached

the following fault icons are rarely seen:

Address fault

Fieldbus fault

DAC fault

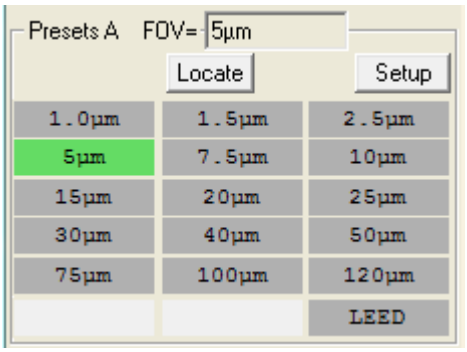
Internal supply fault

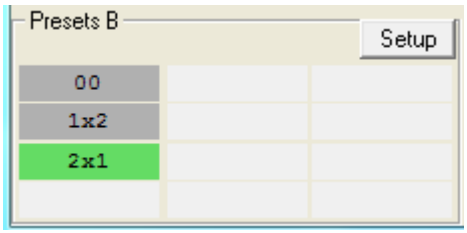
Explicit module status

Left click over the icon field (see above) will display a pop-up box with the status of the module written out as text.

Presets (FOV)

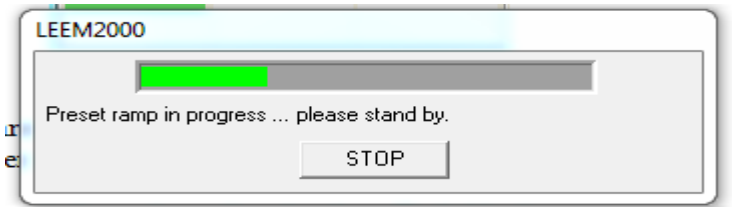
The Presets or Field of View (FOV) feature allows the user by pressing a single button to change the output values of a group of up to 10 modules simultaneously. Two blocks of Presets (18 in Presets A and 12 in Presets B) are available, some of which are preprogrammed to archive certain field of views (FOV's) i.e. 5, 10 or 100 micrometers. The update to the new output values is not an immediate jump but the values are ramped at a module specific user defined speed (module setup window ramp/s) to their new value.





When the outputs for the selected modules are exactly equal the preset values, that preset-button will be highlighted in **green**.
There are 2 blocks of presets available. Presets A are associated with FOVs (Field of Views). Both presets are independent of each other. If the blocks modify the same devices, care has to be taken because selecting Presets in A or B will affect the selected preset of the other group.
Presets A: If the user modifies a preset value associated with a FOV (in Setup) then any highlight will disappear. If a preset value not associated with a FOV is changed then the highlight will change to yellow.
The currently active FOV is also displayed next to the Presets A label. It will disappear when the green or yellow highlight disappears. FOVs have a strong effect on the way images are labeled in *Uview*. FOV are also associated with ***rotation*** angles, which will be applied to images displayed in Uview.

STOP Button (Presets)



During the period the module outputs are ramped to their new preset values, which may take from under a second to several seconds, a progress bar with a STOP button is shown and the user can stop the updating of the supplies.

Locate Preset (A)

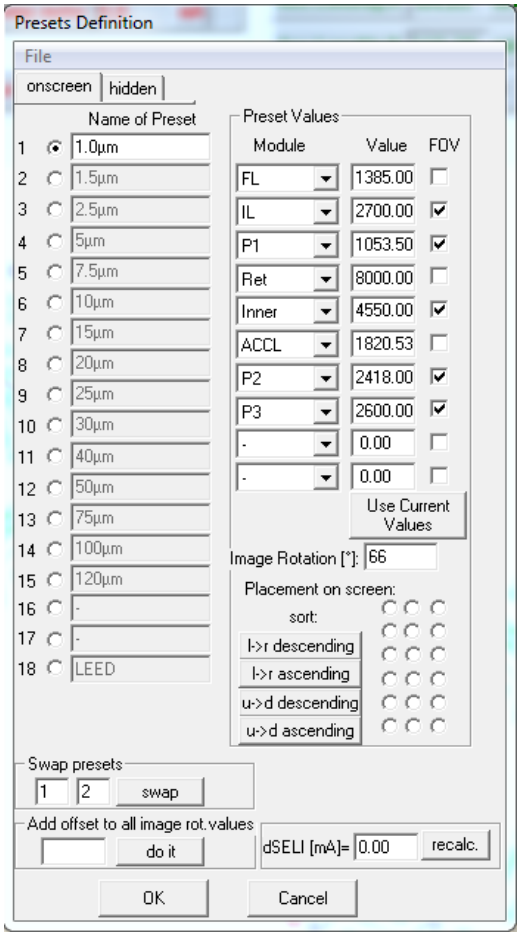
Pressing this button will highlight (in purple) the closest preset and also display a message telling you the closest preset and the deviation of your current position from it. This is

supposed to help in case no preset is highlighted and you are not sure where you are relative to any preset.

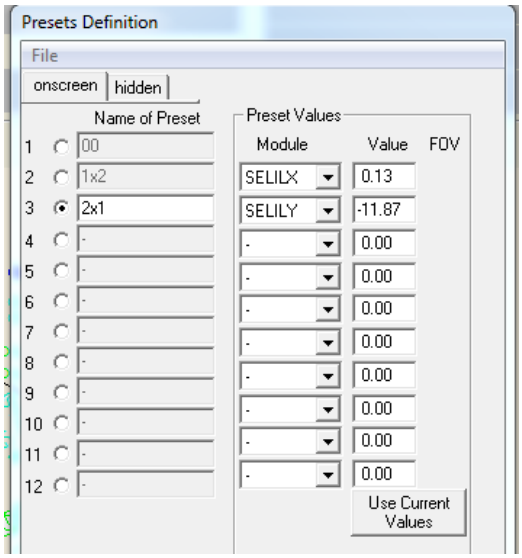
Setup Buttons (Presets)

Clicking on “Setup A” (supervisor & factory level only) or “Setup B” (all access levels) will bring up the “Preset Definition” window of the respective block of presets. It allows the user to define the groups of modules taking part in a preset action. The user can also label the preset, enter the preset values and assign FOVs and rotation angles. The user can also swap values, sort presets by name on the main screen, save and load presets from file. Last but not least presets can be printed in form of a table.

Supervisor & factory level:

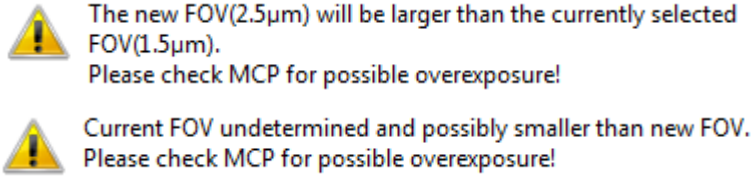


User level:



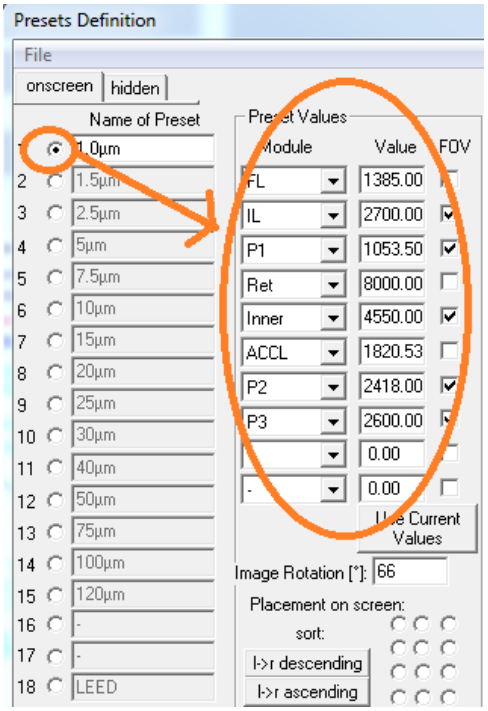
Overexposure Warning

To prevent overexposure of the MCP and camera one of 2 warning messages are displayed when selecting a preset with a larger FOV than the current. You may reduce the MCP voltage in that case.

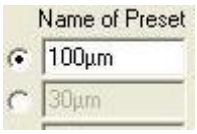


Elements of the Presets Definition Window (supervisor & factory)

The Preset group can be selected by clicking on one of the buttons in the leftmost column. The name (label) of the group will then be activated while all other group names will be grayed. At the same time the names and values of that group will be shown and can be modified.

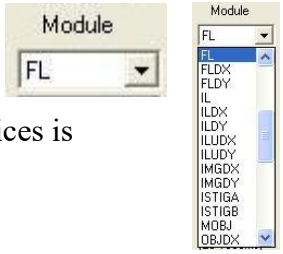


Name



Enter the name which best described the selected group of preset values.

Module



Use the drop-down list to select the name of the module which should become part of the selected group. A '-' indicates that no devices is selected.

Value

Enter the desired preset output value of the selected module.

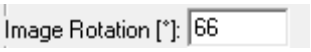
Use Current Value

Instead of manually entering a value for the desired preset (see above), click this and the current module value will be entered into the Value field above.

FOV

Check if the selected module has part in determining the Field of View (FOV). If checked, then any change the user makes in the main LEEM2000 window to that module will result in removing the green highlight of the Preset name. When using U-view the effect will be that the preset 'name' is removed from the image.

Rotation



Associated with each FOV is a rotation angle for the image acquired in Uview. The value for that angle is entered as part of the alignment of the microscope and should not be changed. Reason for the rotation it is to keep images oriented the same way independent of the FOV.

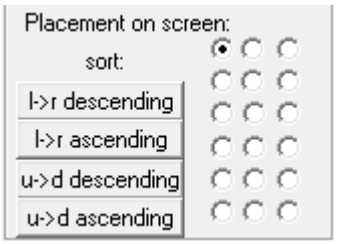
OK Cancel

OK will use all the values you have entered and save them. Cancel will discard any changes.

Swap Preset

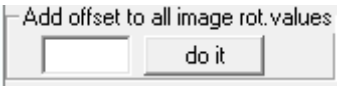
Swaps names and all associated modules and values of the 2 specified preset entries.

Show Placement and Sort by name



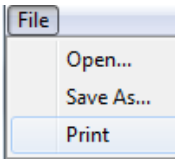
Displays the position the currently selected preset is placed on the LEEM2000 screen.
Click on any other radio button to swap that preset with the currently selected one.
Use the 4 sorting buttons to sort the presets by their name on the LEEM2000 screen. Cancel will restore the old positions on screen.

Internal use only

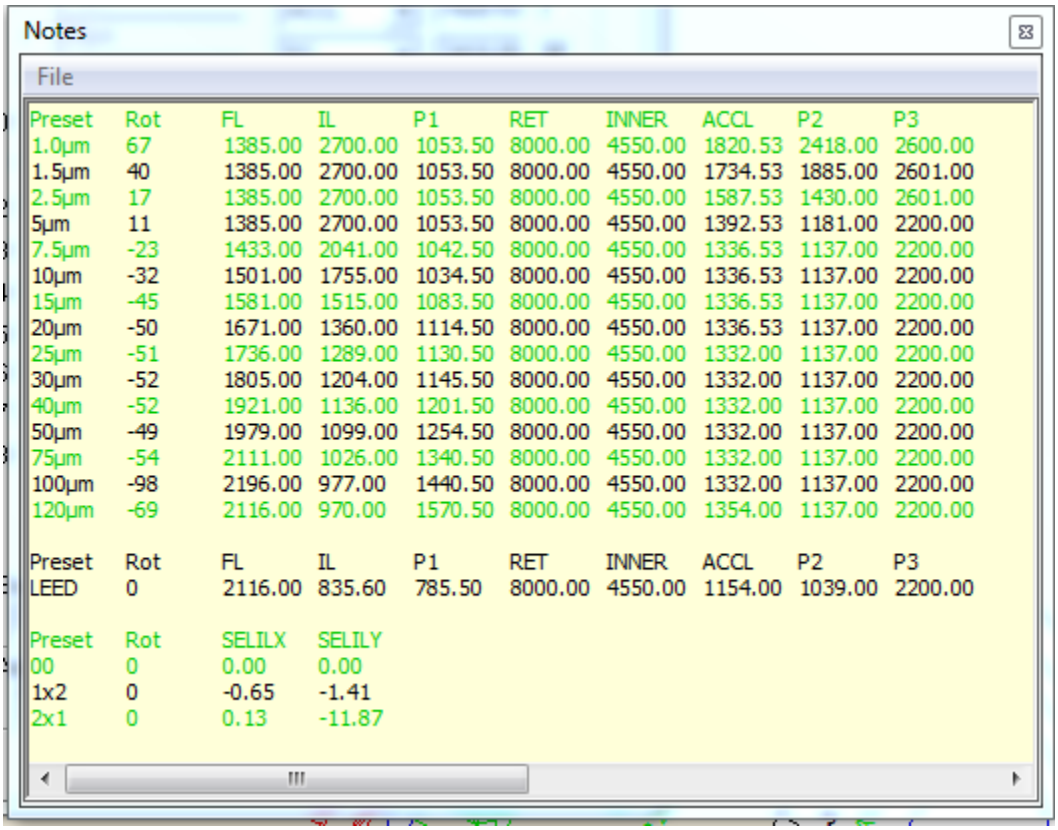


Add an offset to all image rotation angles.

File Menu: Loading, Saving and Printing Preset Data



Under the File Menu you can select 'Save As' to save your set of preset data into a text file.
The Menu entry 'Load' lets you import a set of preset data, assuming that this loaded set is compatible with your instrument.
'Print' generates a multicolor listing of the Presets and places it into the 'Notes' windows. From there it can be "print'ed to paper.



Preset	Rot	FL	IL	P1	RET	INNER	ACCL	P2	P3
1.0µm	67	1385.00	2700.00	1053.50	8000.00	4550.00	1820.53	2418.00	2600.00
1.5µm	40	1385.00	2700.00	1053.50	8000.00	4550.00	1734.53	1885.00	2601.00
2.5µm	17	1385.00	2700.00	1053.50	8000.00	4550.00	1587.53	1430.00	2601.00
5µm	11	1385.00	2700.00	1053.50	8000.00	4550.00	1392.53	1181.00	2200.00
7.5µm	-23	1433.00	2041.00	1042.50	8000.00	4550.00	1336.53	1137.00	2200.00
10µm	-32	1501.00	1755.00	1034.50	8000.00	4550.00	1336.53	1137.00	2200.00
15µm	-45	1581.00	1515.00	1083.50	8000.00	4550.00	1336.53	1137.00	2200.00
20µm	-50	1671.00	1360.00	1114.50	8000.00	4550.00	1336.53	1137.00	2200.00
25µm	-51	1736.00	1289.00	1130.50	8000.00	4550.00	1332.00	1137.00	2200.00
30µm	-52	1805.00	1204.00	1145.50	8000.00	4550.00	1332.00	1137.00	2200.00
40µm	-52	1921.00	1136.00	1201.50	8000.00	4550.00	1332.00	1137.00	2200.00
50µm	-49	1979.00	1099.00	1254.50	8000.00	4550.00	1332.00	1137.00	2200.00
75µm	-54	2111.00	1026.00	1340.50	8000.00	4550.00	1332.00	1137.00	2200.00
100µm	-98	2196.00	977.00	1440.50	8000.00	4550.00	1332.00	1137.00	2200.00
120µm	-69	2116.00	970.00	1570.50	8000.00	4550.00	1354.00	1137.00	2200.00

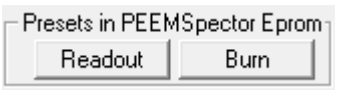
Preset	Rot	FL	IL	P1	RET	INNER	ACCL	P2	P3
LEED	0	2116.00	835.60	785.50	8000.00	4550.00	1154.00	1039.00	2200.00

Preset	Rot	SELILX	SELILY
00	0	0.00	0.00
1x2	0	-0.65	-1.41
2x1	0	0.13	-11.87

Onscreen and Hidden Presets Tab

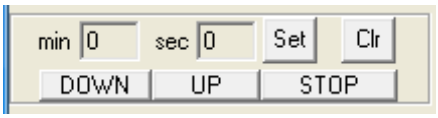
A second page of 18(12) presets is available for temporary storage of presets and their values. Between pages presets may be swapped using the '*swap'* button.

PEEMSpector: Read, Update PEEMSpector EPROM



This button allows the transfer of preset data from and to the PEEMSpector Control Unit. 'Burn' will overwrite the settings which are selected by the front panel 'field of view' switch. The 'Burn' button is protected by a password. This password is "Elm123".
Presets can be read from internal EPROM of the controller to the PC. They will be placed into the hidden page, preventing local presets to be overwritten. The 'Readout' button is therefore only visible when selecting the Hidden Presets Tab.

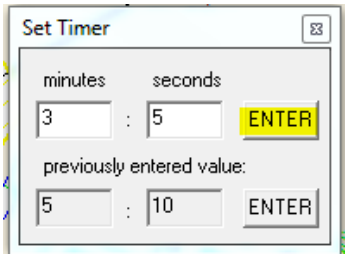
Timer



The timer can be used to measure an elapsed time or used to count down a preset time. In that case an alarm will sound when the time has reached 0.

Note: the alarm will require a speaker connected or inside your computer.

Set Button (Timer)



A dialog to preset the timer with two sets of values (minutes and seconds) will be displayed.
You either type in desired minutes and seconds into the upper row and press (highlighted) Enter. Or you may use previously entered values which will be displayed in the lower row. In that case press the lower ENTER button.

Clr Button (Timer)

The minutes and seconds in the stopwatch display will be cleared (set to 0).

DOWN Button (Timer)

Begin count down to 0. This assumes the timer has been previously set to a value > 0. Count down can be halted with STOP button. Once the timer reaches 5 seconds an audible tone indicates each second elapsed. Another sound indicated that the timer has reached 0. This sound will continue for another 10 seconds unless STOP is pressed to terminate the sound.

UP Button (Timer)

Begin counting seconds and minutes starting from 0 until STOP is pressed.

STOP Button (Timer)

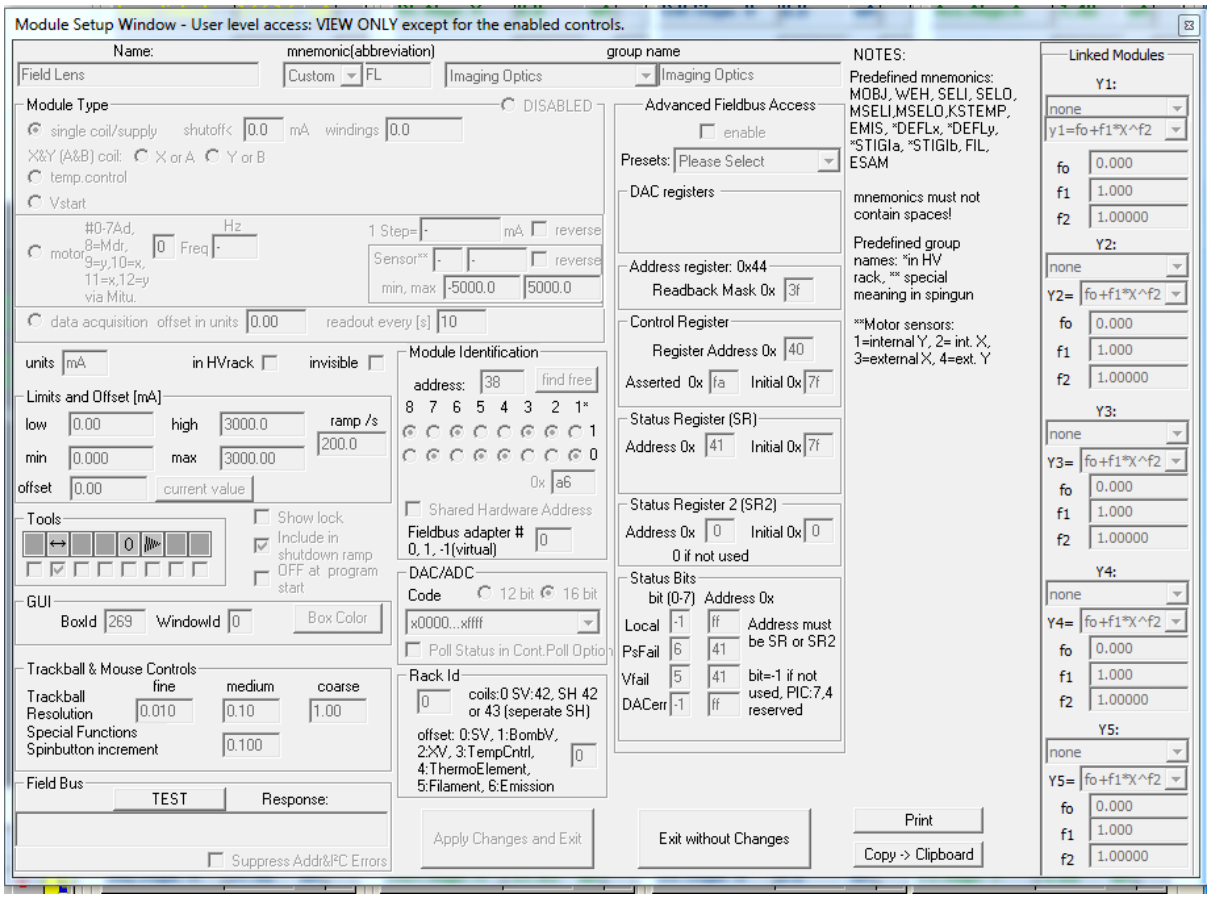
Stop timer. Either count down or count up is stopped.

Setup window

The settings in the **Setup Window** define how **LEEM2000** communicates with its hardware, i.e. a power supply. It also determines the appearance of the user interface for each module. Each module has its own **Setup Window**.

User level

Settings in this window are preset by Elmitec and can't be changed in the **user level.** This is indicated by a 'VIEW ONLY' text in the message field and the fact that most controls are grayed. Some fields are enabled for change in the **supervisor level**.



In the user level the Setup Window may be **printed** or **copied**. Also the **TEST** function is enabled. Pressing it will force the status of the module to be shown in the box below.

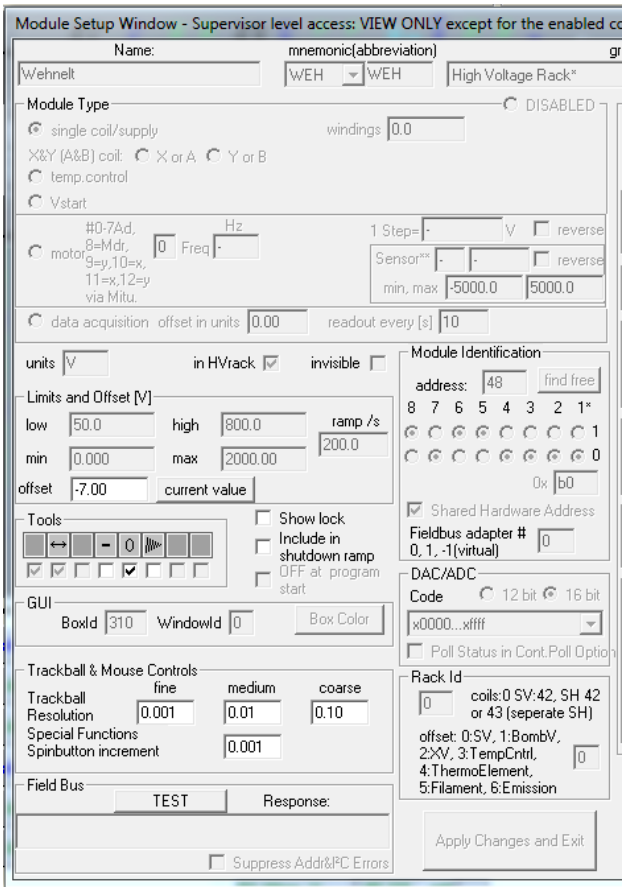
Some other useful information for the user:

- **Power Supply Limits**
  - min/max these are the limits of what the supplies can generate
  - low/high these are the limits the lens coils are designed for

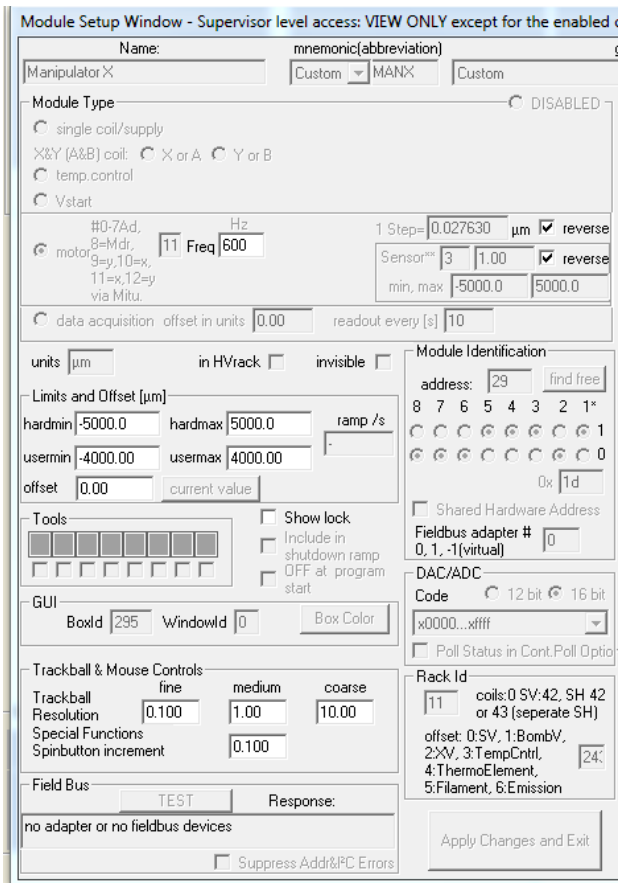
Supervisor level

The supervisor level allows access of a few items in the Module Setup Window. Some module types, motors for instance, have access to other settings enabled than others.

Single coil



Motor



Following items can be modified by the supervisor:

- **Trackball & Mouse Controls: Trackball resolution**: Each **f***ine*, **m***edium* ,**c***oarse* button in the control window have a numerical value associated with it. These values can be modified here.
- **Trackball & Mouse Controls: Special functions increment**: This is the numerical value for each click on one of the amplitude or range spin buttons in the module control window
- **Limits and Offset: Power supply offset** field
- **Include in Shutdown ramp** (single supplies only)**:** If this is set the module will take part in the soft shutdown & startup feature if that feature is activated.
- **Tools: zero** checkbox**.** If selected the Zero button will appear in the toolbar of the minimized and maximized module control.
- **Tools: degauss** checkbox (single supplies only)**.** If selected the Degauss button will appear in the tool buttons of the minimized module control.
- **Tools: Negative polarity** checkbox (only available on selected single supplies).
- **Tools: Show lock** checkbox.

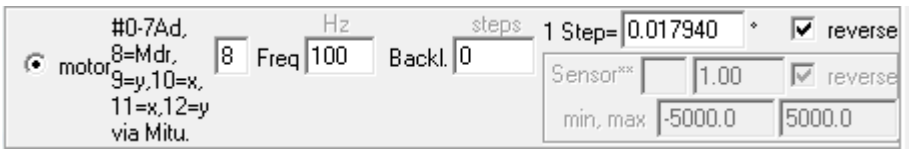
- **Motor Frequency** (speed): This is the number of steps per second. Too high frequencies will result in lower torque.
- **Motor hardware limits.** This only changes the numerical values on the axis of the module control window.
- **Motor user limits.** These values define in which range the user can move the motor.
- **Motor Reverse.** Reverses the motor direction compared to the buttons and scales on screen. This is used to make the motor and image move into the same direction. For instance clicking the up button should move the image up.
- **Sensor Reverse.** Motor and sensor must move (sense) in the same direction. If the motor moves from left to right to more positive distances , the sensor (micrometer) display must also go to more positive numbers or else the "move with micrometer' option cannot work! Also mounting the micrometer on the opposite side vs. the same side of the motor will reverse the reading of the micrometer. For the Mitutoyo micrometer this can be corrected at the micrometer itself by reprogramming it.

Sample Entries (motors):

Manipulator motors connected directly to Mitutoyo controller:

Manipulator motors with built in sensors

MDrive motor



Note: some special settings regarding acceleration and deceleration of the MDrive motor must be set at initial installation time in the **leemcom** window.

Linking Modules

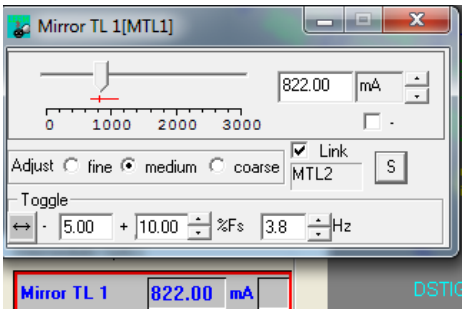
Making changes requires factory access. We describe it here for completeness only.

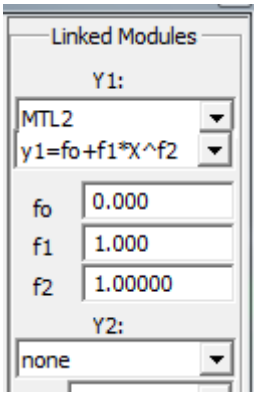
When a module is selected which is linked to one or more others then these linked module(s) will be marked with a red and white frame.

Single unidirectional link:

When changing the values for one module (here MTL1) the values for a second module (here MTL2) will be set to the same value (factor=1). The overall settings of MTL2 are not affected and it is not obvious that MTL1 will change MTL2 by looking at MTL2 settings only; therefore care has to be taken when using single one-directional links! When changing MTL2 in this example, MTL 1 will not be changed.

Setting for MTL1:

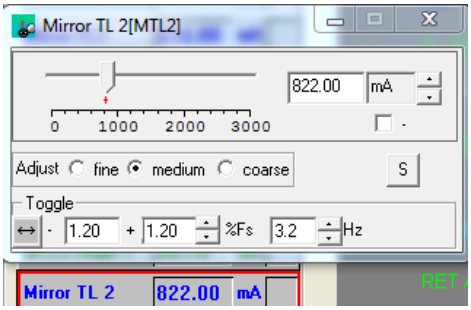


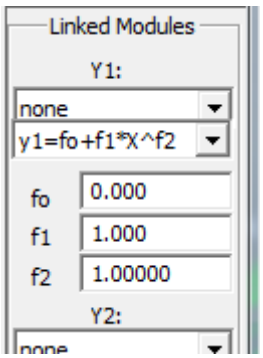


MTL2= f0+f1*MTL1^f2
With f0=0, f1=1, f2=1
MTL2=0.0+1.0*MTL1^1.0

Therefore **MTL2=MTL1**

Setting for MTL2:



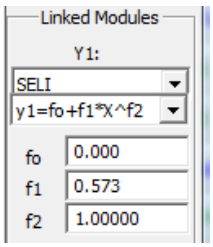


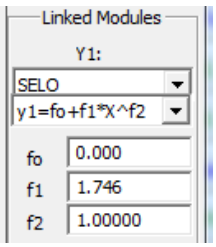
Please note that the *Link* checkbox has to be checked. Otherwise the link will be ignored. This can be used to temporarily cut the link the other module.

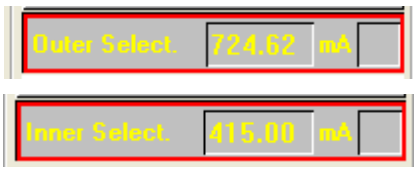
Single bidirectional link (SELO/SELI ratio):

When changing the values for one module (here SELI) the values for a second module (here SELO) will be set to a SELI value times a factor **f1**. When changing SELO in this example, SELI will change accordingly multiplied by **1/f1**
In case of SELO/SELI a special info box was added on the main screen to show and change this ratio.

Settings for SELO: SELI:



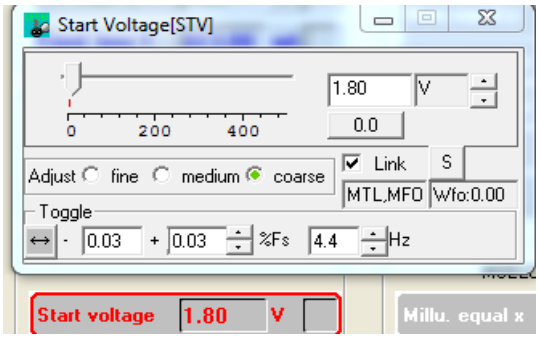


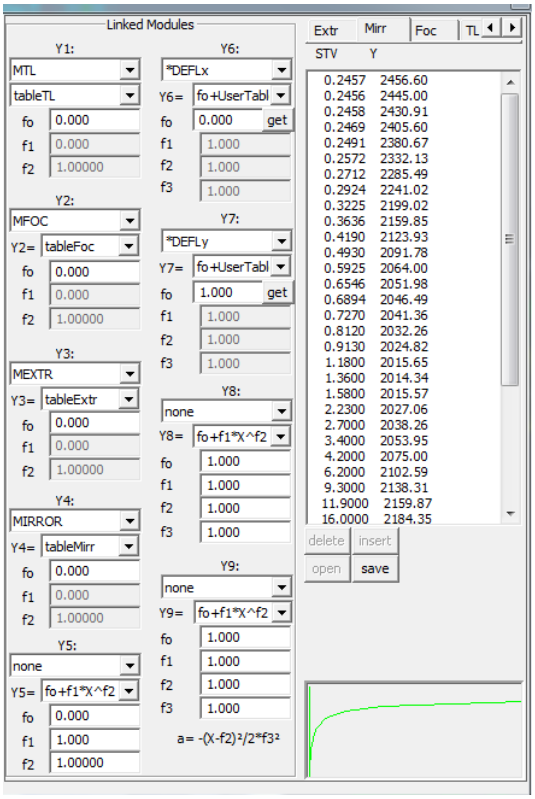


Please note that the *Link* checkboxes on both modules have to be checked. Otherwise the link will be ignored respectively functions only one way. This can be used to temporarily cut the link the other module.

Multiple unidirectional links for Start Voltage:

LEEM with electrostatic mirror requires changes of *MTL, MFOC, MEXTR, MIRROR* lenses as well as the deflectors *DEFLx and *DEFLy whenever *Start voltage* changes are made. The required adjustments to those lenses are taken from previously calculated lookup tables by fitting to the closest table values. In the *linked modules* section of the *Setup Window* for the *Start Voltage* this can be easily configured, as seen on the right. When this is done and the *Link* box is checked, then every change made to STV will produce appropriate changes in the other 4 power supplies. All can be observed on the LEEM2000 screen and in the image itself of course.





The lookup-tables are shown in the *Start Voltage* setup window. A graphical view for each table is also provided in the lower right of that window. Apart from the 4 fixed tables are also 2 user tables available which are used for the mirror alignment deflectors X and Y.
These tables can be *load*ed initially from simple text files containing STV, *DEFLx or *DEFLy value pairs. Alternatively the table values can be entered or deleted manually. For that purpose set the STV, align the image with *DEFLx, press *insert* to insert the new value pair into the table1, select table2 to insert the STV,*DEFLy pair. Repeat until the table is built. Finally you may *save* both tables manually for safekeeping.
Upon leaving LEEM2000 the tables will be saved in the .apr file and loaded back when starting LEEM2000.
If a user realignment becomes necessary, the user table values need to be adjusted by an offset. Do enter that offset do the following:

.turn the link button in the STV control box off
.select and adjust *DEFLx and *DEFLy to align the image
.select STV and the STV setup window
.press the 'get' button next to Y6 fo to obtain the offset for *DEFLx
.press the 'get' button next to Y7 fo to obtain the offset for *DEFLy
.turn the link button in the STV control box ON.
After that, when STV is changed *DEFLx (y) will follow the values in the UserTable1(2) plus the respective offset.

Virtual modules to switch Wehnelt on or off

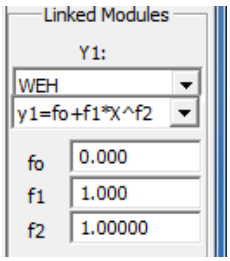
In this example a virtual module will be used to switch the Wehnelt ON or OFF when pressing a preset ‘Wehnelt On’ or a preset ‘Wehnelt Off’.
To do that the virtual module adds an offset voltage to a second virtual Wehnelt control module. This is used by the operator to set the Wehnelt voltage.
It is linked to a module (invisible) which actually connects to the Wehnelt power supply.

<- Adds offset to Wehnelt

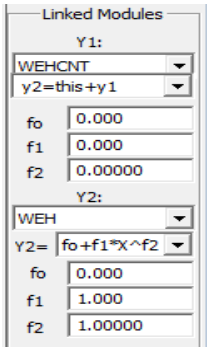
<-Controls Wehnelt

Sum of both is send to (invisible) ->

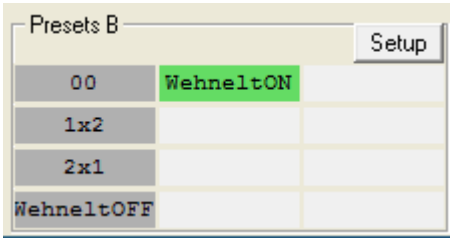
Links set for *Wehnelt Cntrl*:



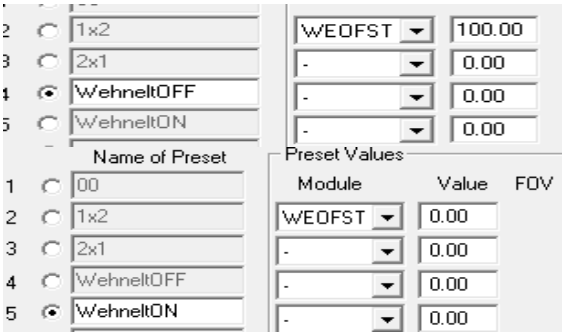
Links set for *Wehnelt Offset*:



Presets:

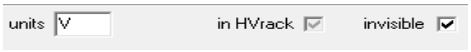


Setup of Wehnelt On/OFF:



***Note*:** Link boxes must be checked in Module Window *for Wehnelt Cntrl* and *Offset*

Note: to make *Wehnelt box* on screen invisible, check *invisible* in Wehnelt *Module Setup Window.*



Tool tips

When moving the cursor across a button or list box a short tool tip will appear, showing a short explanation of the function of the selected item. These tool tips are implemented for some buttons in LEEM2000.

Switch to previously selected module

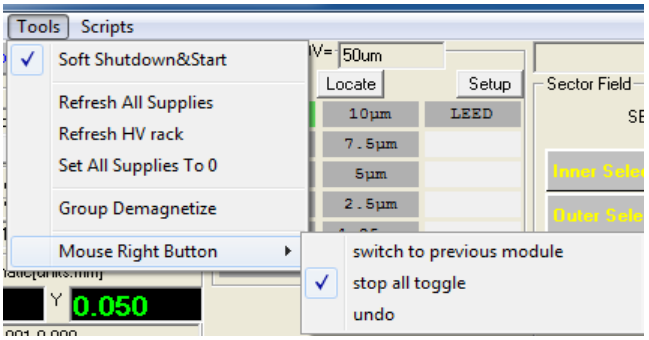
Pressing this button switches to the previously selected module. If pressed again will switch back, thus you can switch back and forth between 2 modules.

Stop all toggling

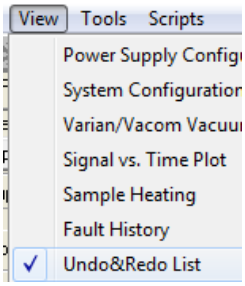
Terminates all toggle action of all modules. The button is grayed when no toggling is going on.

Right mouse button

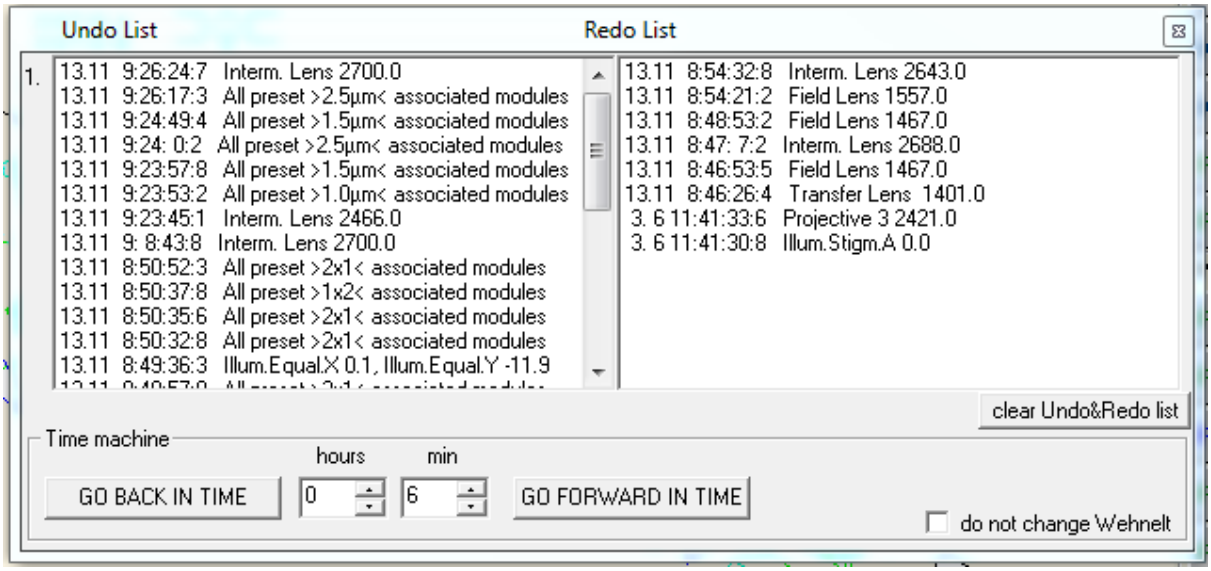
One of the two features above as well as the **UNDO** function may be associated to the right mouse button by Means of the Menu **Tools**->**Mouse Right Button.** Once this association is done, clicking the right mouse button will executed the associated function.



Undo, Redo and “Time machine”



A virtually unlimited number of Undo and Redo operations are possible (currently 10000). When performing an Undo or Redo the information regarding this operation are logged with time and date into the Undo&Redo list which can be accessed through the menu *View→Undo&RedoList*. When closing LEEM2000 the list is saved to undoLEEM2000.txt and loaded again at startup of LEEM2000.



Undo

This will undo any change you made to the output value of a module by keyboard, slider, spin button or trackball. The behavior of the *Undo* depends on the input device. Trackball changes are un-done back to the point the module was selected. The same happens for spin button and slider inputs. Values typed in from the keyboard and entered by the ‘Enter’ button are undone to the value previously entered.
Presets can also be undone and redone.

Redo

Reverses the last *Undo* operations. See *Undo* above for more details.

Time machine

By entering a time and pressing **‘go back in time’** all items on the undo list will be consecutively undone until the target time (current time – (entered hours + minutes)) has been reached. This includes all changes including presets. To safeguard against MCP overexposure during the process of undoing one should select ‘do not change Wehnelt’.
And turn the Wehnelt voltage up. ‘Go forward in time’ will ‘redo’ all changes done over the minutes or hours specified.

Micrometer Readouts

This control box displays the measurements by the Mitutoyo or Renishaw micrometers.

The Rensihaw device displays one more gray colored digit (100nm resolution). A yellow colored display indicates that the Renishaw device has not been zeroed (see '*Mitutoyo Digimatic, Renishaw Micrometers'* in **System Configuration Window**)

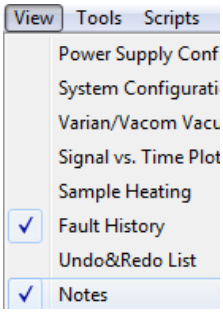
If one or both micrometers are not connected or turned off, **Fault** will be displayed. Simply turn the micrometer(s) in question on or reconnect it. After a few seconds the display will be updated with the correct values. LEEM2000 need not be restarted.
If the Mitutoyo adapter is not connected to the USB port of the PC then **offline** is displayed.

In that case you may connect the adapter, enter the **System Configuration** window then click the **Connect** button next to Mitutoyo I or II or respectively Renishaw to re-establish the communication between LEEM2000 and the micrometers. LEEM2000 need not be restarted.

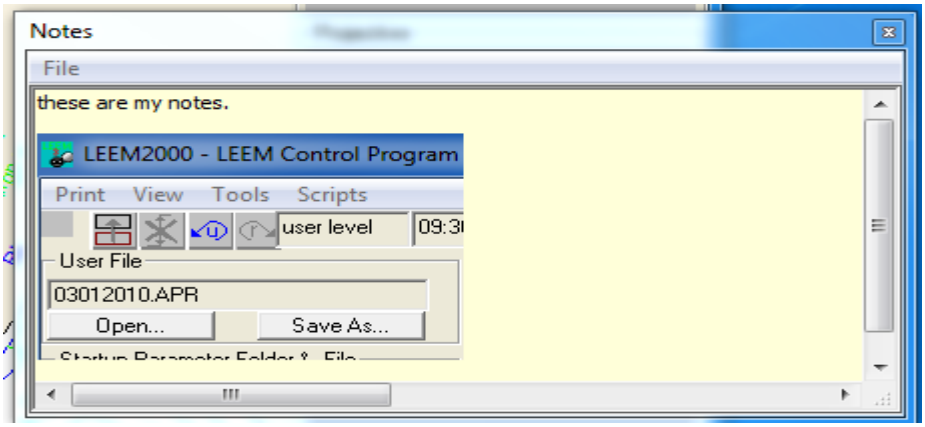
Keep button

Press the **Keep** button to save the current readings and display them in the box right under the **Keep** button. These values will be saved in the parameter file.

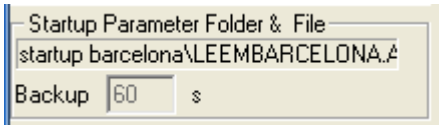
Notes



The notes window can be opened from the View menu.



Text can be entered; images can be copied and pasted into this window. Its menu offers the options to **Print**, **Open** or **Save** the contents in rtf format. This format can be imported into every word processing program. Special characters can be pasted into the notes from the Windows "Character Map". There are no size limitations to the entered text as in prior versions of LEEM2000. Notes are saved in file "notes.rtf" when closing LEEM2000 and loaded when reopening LEEM2000. "notest.txt" is located in the LEEM2000 installation folder.



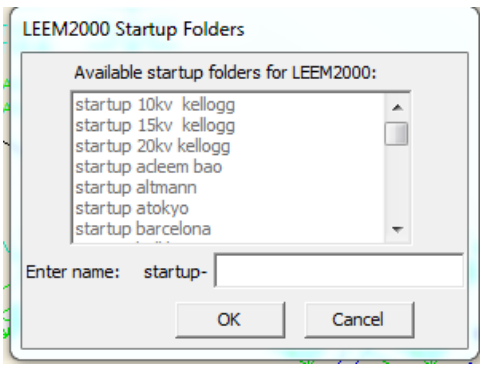
Startup Parameter File

The name of the startup parameter file is fixed and depends on the configuration of the microscope. Valid names are for instance LEEM.APR, PEEM.APR and LEEMEA.APR.
At the end of a LEEM2000 session the startup parameter file is updated with the latest values for all modules.
The startup parameter file can be backed up automatically every X seconds. Where X is the number entered into the **Backup every _ s** field. An entry of 0 means no periodic backup is done (not recommended). Periods of 10 to 6000 s can be entered. This **Backup time** is also used to refresh the **fault history** *current status* list.

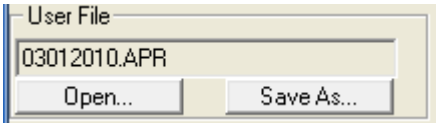
Supervisor level or higher:

- Changes to the backup period can be made.
- 

Create new startup folder.
When entering a *name xyz*, a new startup folder will be generated named "startup xyz". It will contain copies of the current startup.sta file as well as the current .apr and .lay file.



User Parameter File



The user can **open** and **save** a snapshot of all the settings in LEEM2000 into a user parameter file. This file can be given any name the user chooses. The exception for naming the file is that it cannot be the same as the name of the **startup parameter file**.

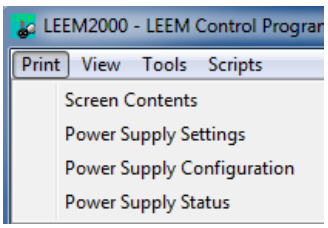
The **startup** and **user parameter files** are identical in the kind of information they contain. Yet when the user opens a file, only certain values are read, mainly the module output values. This prevents a user parameter file from corrupting internal settings like hardware addresses.

Note: Once a **user parameter file** is loaded, the user settings it contains (values for powers supplies etc.) will replace those of the originally loaded **startup parameter file**. The next time the **startup parameter file** is backed up or upon closing LEEM2000, the original **startup parameter file** will be overwritten with the new values. It may also be useful to make a backup copy of the original **startup parameter file**.

Menu Bar

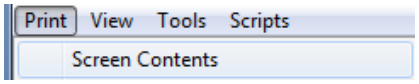
A standard Windows menu bar allows the user to select Print, View, Tools, Scripts and Help.

Print Menu

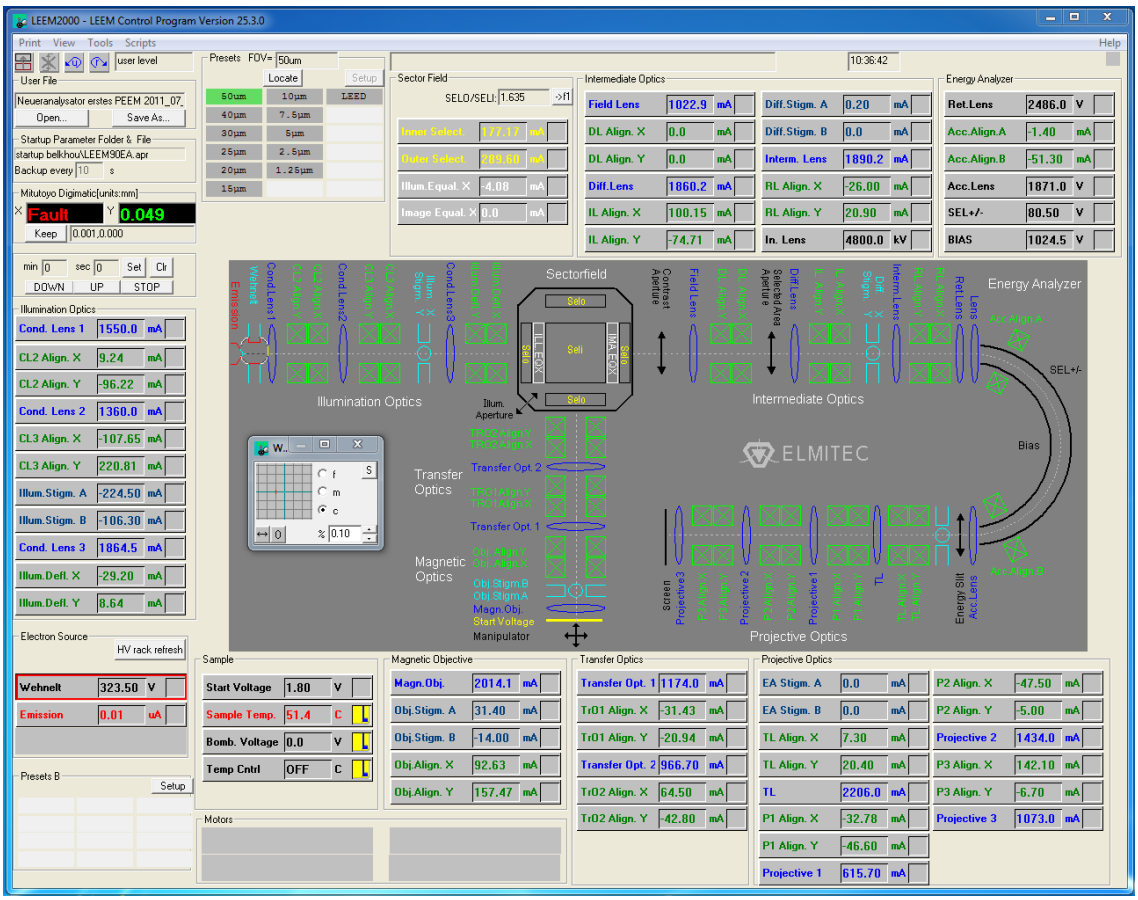


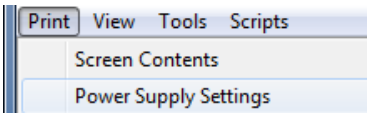
The *LEEM2000 window* or *lists of data* or *status information* can be printed. Prior to printing a standard Windows printer dialog lets you select printer and options.

Screen Contents



The *LEEM2000 window* is printed exactly as it appears on screen.





Power Supply Settings

Current settings of all modules (power supplies and other control elements) are printed. The printout is grouped by sections of similar function.
A printout will look like this (excerpt):

Elmitec GmbH: Power Supply Settings

date & time: 11.15.2012 09:10:48 type:LEEM90EA *note: date in US format (month.day)*

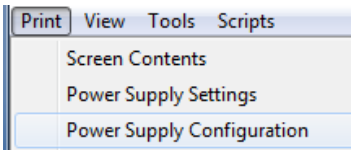
Illumination Optics:

Illum. Stigm.A	16.00	mA	Illum. Stigm.B	-106.00	mA
Illum.Defl. X	-63.00	mA	Illum.Defl. Y	-63.00	mA
Cond. Lens 3	1864.50	mA			

Objective

Objective	1696.30	mA
Obj.Stigm. A	-5.03	mA
Obj.Stigm. B	1.18	mA
Obj.Align. X	-12.50	mA
Obj.Align. Y	-6.00	mA

…
User parameter file: LEEMuser.apr *or startup parameter file depending which is loaded*



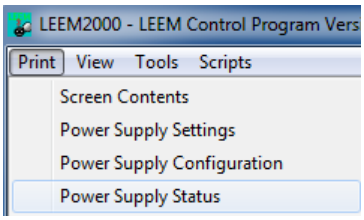
Power Supply Configuration

Prints information about the configuration of all modules (power supplies & other control elements), i.e. current limit, fieldbus address. This printout is geared towards maintenance by Elmitec personnel.
A printout will look like this (excerpt):

Elmitec GmbH: power supply configuration

date & time: 08.04.2003 09:10:48 type:LEEM90EA *note: date in US format (month.day)*

module	short form	min COIL	max	min SUPPLY	max	Address	rk#
Illum.Stigm.A	ISTIGA	-250	250	-250	250 mA	x7(7)	0 0
name of supply	*abbreviation*	*minimum/maximum allowed current for coil/deflector*		*minimum/maximum output of power supply*		*address of module*	*HV rack*



Power Supply Status

Prints the status of all modules (power supplies & other

control elements) as well as how many fieldbus faults have occurred and the current state of the fieldbus fault line.

A printout will look like this (excerpt):

Elmitec GmbH: power supply status

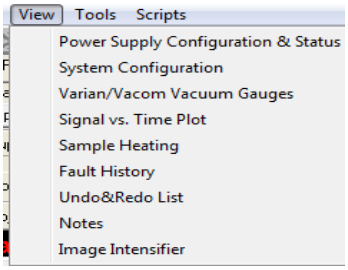
date & time: 08.04.2003 09:10:48 type:LEEM90EA *note: date in US format (month.day)*

I^2C fault: 0, Fault line: H

module	status
Illum.Stigm.A	ok
Illum.Stigm.B	ok
Illum.Defl. X	ok
Illum.Defl. Y	ok
.	
Sample Temp.	local

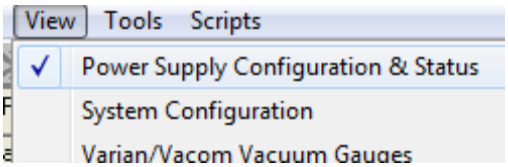
For explanations on the possible **status** messages please see the paragraph **Status of Power Supplies and Other Components on Fieldbus** in the **View Menu** below**.**

View Menu

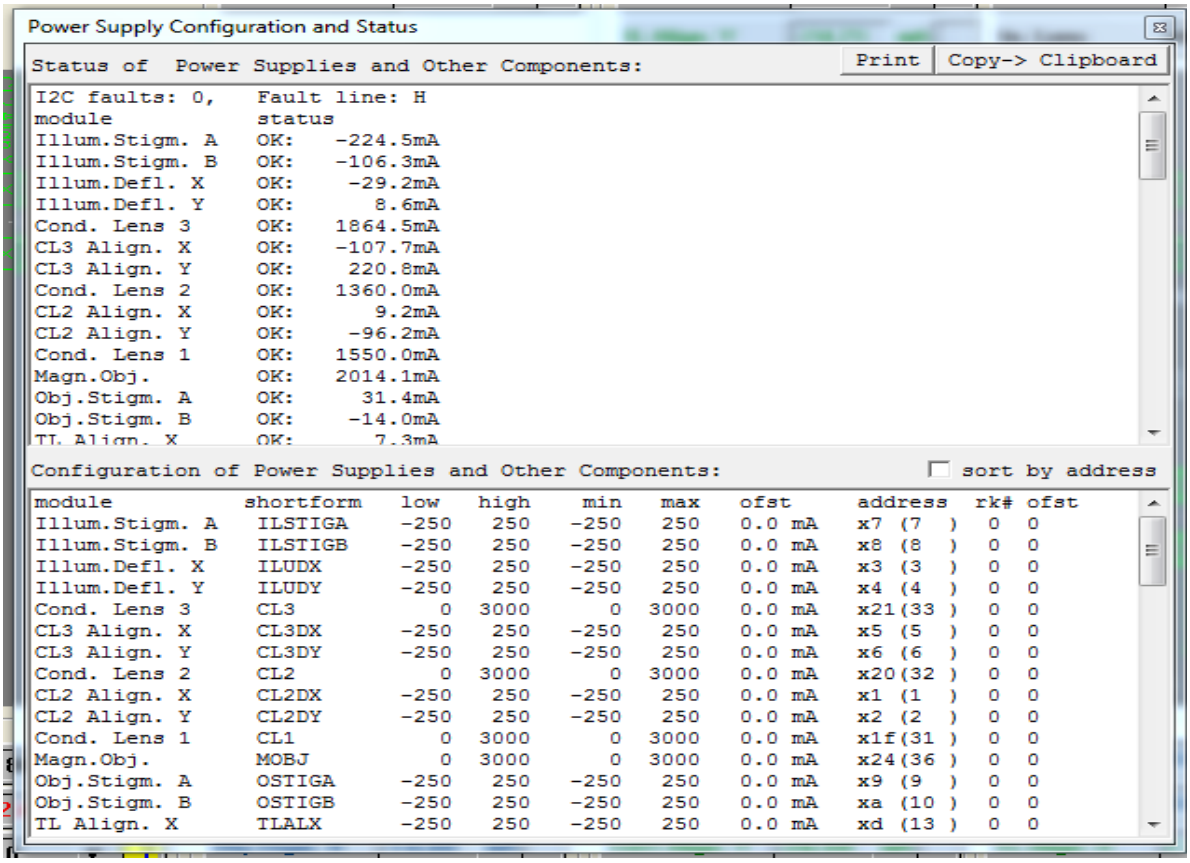


Through the view menu you can display a number of windows containing for instance *status information*, *fault history* and *system configuration* of LEEM2000. If your instrument features a spin rotator, the View menu will contain an entry for displaying the *spin rotator* control.

View Power Supply Configuration & Status



This window displays status and configuration information on all modules. The **Power Supply Configuration & Status window** is split into 2 lists: *Status* and *Configuration*. The information is arranged in a similar way as in the **Print Power Supply Status** and **Print Power Supply Configuration** menu. The later can be **sorted** by fieldbus hardware *addresses*. The visible portion of the window can be **Printed** or **Copied** to clipboard.



Status of Power Supplies and Other Components

Displays the status of all modules (power supplies & other control elements) as well as how many fieldbus faults have occurred and the current state of the fieldbus fault line.

If a status cannot be displayed because of a missing or faulty fieldbus adapter or no power to fieldbus adapter the following message is displayed:

No communication with power supply rack(s)

If a status can be obtained then it is displayed in the following format:

I^2C faults: number of transmission errors since start of program

Fault line:

H = logic high, ok

L = logic low, at least one module is faulty

This is followed by a header line:

module	*status*	*value*

and one status line for each module:

Illum.Stigm.A	ok	-224.5mA

Status messages:

ok module is functioning

local certain modules have *local* switches on the front panel. This status message reflects the position of that switch. 

NOT FOUND, REGISTER FAULTS Addr + [Dl? + Dh? +Ctr?] 

module not found or internal failure of module

REGISTER FAULTS

followed by:

Dlow internal failure of module data low byte

Dhigh internal failure of module data high byte

DAC internal failure of module DAC 

I2C FAULT(no ACK) failure of module or fieldbus 

No Ack refers to a missing acknowledge signal on the fieldbus.

Voltage Faults: V limit over current detected, power supply can not provide sufficient voltage. This can have several reasons, i.e. cable to coil not connected or settings in LEEM window to high for power supply/coil combination or the temperature of the coil is too high and the resistance of the coil has increased too much 

+/-15V,+5V: internal failure of module supply 

- Several of the above messages could theoretically appear in a combined form if multiple faults happen at the same time, which is unlikely.
- The icon shown will appear in the control box of the module in question. Only one icon can appear at a time.
- The icons shown are the ones appearing in the **Icon Field** of the affected **Module Box.** See under the **Module Box** paragraph. Clicking the left mouse button onto this field will display the status message (except for ADCs).

Configuration of Power Supplies and Other Components (on Fieldbus)

Displays information about the configuration of all modules (power supplies & other control elements), i.e. current limit, fieldbus address. This information is geared towards maintenance by Elmitec personnel.

An entry looks like this :

module	*shortform*	*low COIL high*		*min SUPPLY max*		*ofst*	*address*	*rk# ofst*
Illum.Stigm.A	ISTIGA	-250	250	-250	250 mA	0mA	x7(7)	0 0
name of supply	abbreviation	minimum/maximum allowed current for coil/deflector		minimum/maximum output of power supply			address of module	HV rack

System Status Messages

This field displays important status messages. It is placed at the top of the LEEM2000 window yet its exact position depends on the microscope type.

No (Power Supply) Modules

meaning: LEEM2000 cannot find any external power supplies.
possible fix: Turn power to LEEM electronics on.
Check fieldbus cable; make sure it is plugged in properly.

Corrupted Module Settings

meaning: startup parameter file (XYZ.APR) is damaged.
possible fix: replace XYZ.APR from backup.

Multiple Address Assignments

meaning: One or more modules have the same fieldbus address.
This can only happen when the .apr file has been modified incorrectly.
Or a very old version of the .apr file is used with a new LEEM2000.
possible fix: Replace .apr file with a newer version from Elmitec or check 'fault history' and change the conflicting address.

Failed to open FB Adapter port

meaning: LEEM2000 cannot open USB port and talk to fieldbus adapter.
possible fix: try other USB port, make sure correct up-to-date drivers are installed.

Communication to FB Adapter failed

meaning: adapter broken
possible fix: replace adapter

Adapter Power Failed

meaning: power supply for adapter is offline or broken
possible fix: plug power supply into adapter, replace power supply

LEEMCOM Program Failed

meaning: leemcom is the program which does all the real time i/o for LEEM2000. It may hang because Windows has a problem or Elmitec USB devices have been disconnected unexpectedly.

possible fix: restart computer

No LEEMCOM Program

meaning: can only happen when LEEM2000 is first installed

possible fix: close and restart LEEM2000, possibly restart computer

Unknown Fault

meaning: software bug, this should never be displayed

possible fix: none, contact Elmitec

No adapter or no remote server

meaning: only occurs if LEEM2000 is connected remotely to another LEEM2000 hooked up to a microscope.

possible fix: Check network connections.
In case it is the first time remote connection is tried check DCOM and other access settings, firewalls etc.. Make sure remote computer name and folder is entered correctly in the configuration window.

Hardware Failure (abcd) = source

meaning: a device in the LEEM HV electronics asserts the FAIL signal
abcd: consists of 16 logically ORed fail bits written in hexadecimal code.
source can be:

- SV power
- SV HV-amp
- SV DAC
- SV&SH power
- SV&SH HV-amp
- SV&SH iso-amp
- SV&SH X-volt
- SH power
- SH iso-amp

possible fix: disable the module in question, remove it, contact Elmitec for repair

Hardware Failure: FAIL active

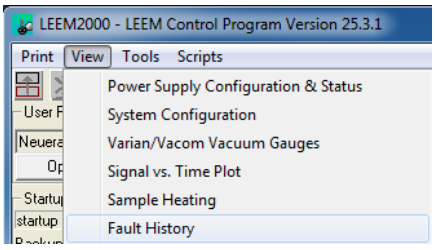
meaning: a LEEM module asserts it fail signal.

possible fix: find power supply which causes the error in 'Fault list', 'Power supply status list' or on main screen (F or other symbol in module field).
Check power supply circuit board (LEDs), remove, replace.

Modules faulty! Reporting disabled

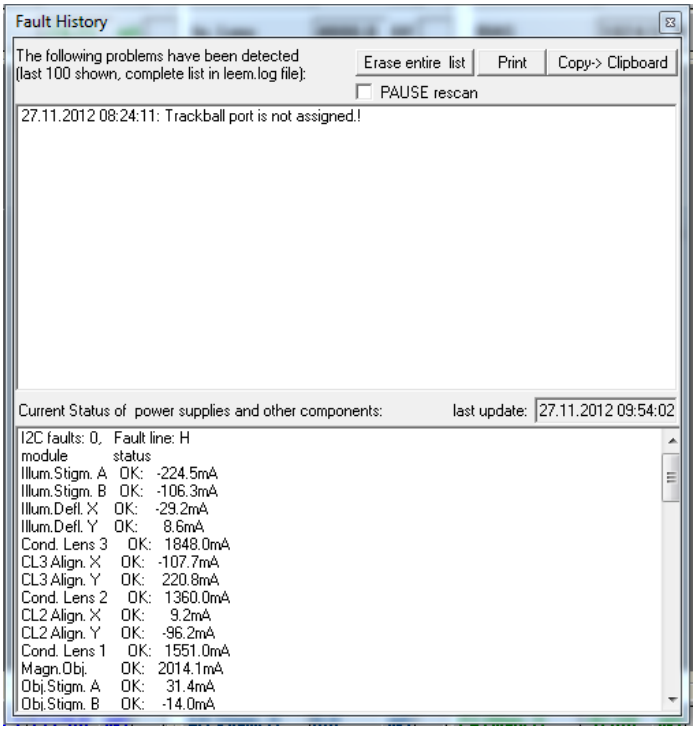
meaning: same as above but user has disabled fault reporting in the dialog box which is displayed when modules fail. See also:
'Possible Error Messages During Startup'

possible fix: disable the module in question, remove it, contact Elmitec



Fault History

This window contains 2 lists.



- The upper list displays all error messages since LEEM2000 was last started. The error which occurred first is displayed in the top line, followed by the next fault etc. etc. If the numbers of errors exceed the height of the window a vertical scroll bar is displayed. Buttons are provided to **erase** the entire list, to **print** or to **copy** the window to the clipboard. Rescanning the power supplies in response to a fault occurred can also be temporarily suspended with a **pause** button.
- The lower list displays the current status of each module. The number of I²C fieldbus faults and the state of the fault line are shown on top of the list. This list is refreshed every **Backuptime** as indicated by the time stamp called ‘last update’.

Note:

Error messages can be generated:

- At startup when LEEM2000 makes consistency checks on the parameter files.
- At startup when trying to connect with the fieldbus.
- During operation if modules fail.
- In instruments with a Schottky field emitter, every time the HV is turned on or off the connection is temporarily lost and the fault history is displayed along with two error messages: the first reports the loss of the connection and the second the reestablishment of the connection. This is completely normal.

PAUSE rescan 

As a response to a **FAIL** signal on the fieldbus several actions can be selected in the **system configuration** window. One of the actions is a rescan (reselection and reprogramming) of all power supply modules. In case of a recurring FAIL signal this means an interruption of the normal LEEM2000 operation every few seconds. To stop this temporarily, select the PAUSE rescan button.

Possible messages in Fault History Window

At startup *comments*

Fieldbus adapter & LEEM electronics related: *if occurring: check adapter,*

Failed to open Adapter port(1) (2) or (3)! *send to Elmitec*
Communication to Adapter failed at TIME
No adapter power at TIME
Adapter Firmware outdated 1.23 should be 1.24
no modules, TIME

.apr file related: *if occurring: Elmitec*
module (window #123) removed from apr *send .apr file to*
mod ABC mod DEF : addr 123
mod ABC stat bit addr!=SR,SR2
X has invalid >resolution< setting
X has invalid >DAC code< setting
Calibration Matrix XXX not found in align.txt file! *refers to alignment - ignore*

leemcom and DCOM related: *if occurring: restart PC,*
leemcom.exe version 123 wrong. Must be changed to 456. *not fixed contact Elmitec*
LEEMCOM started and registered.
DCOM exception: No LEEMCOM.
LEEMCOM: Set I2C speed failed
LEEMCOM: Init SV and SH failed

Misc. hardware related:
Trackball port is not assigned.
Mdrive init failed: either power is off or Baud rate is incorrect.

during operation
Unknown Module Failed
Module ABC Failed
123 Modules Failed (I²C:123,Addr:123)
module failed at TIME
FAIL signal changed to 0/1
Fail: mod ABC status 0x1234 STATUS Failsource= FAILSOURCE
mod ABC I2C and Address fault
mod ABC I2C fault
mod ABC Address fault

Legend for above:

X	name of a module
ABC, DEF	abbreviations(mnemonics) of modules
123	number (version, address)
TIME	time the error occurred
0/1	logic level
STATUS	one or several of the following:

For lenses, deflectors, STV:

Status bits	Label	high=
(or'ed in case of multiple faults)		
0x8000	FAIL	fail line activated
0x0040	Vs	Supply Voltage fault

0x0020	Lcl	local
0x0001	Vo	over current
0x0010	I²C	I²C faults
0x0080	Adr	Address fault – not found
0x0008	Dlo	Register fault
0x0004	Dhi	Register fault
0x0002	DAC	Register fault

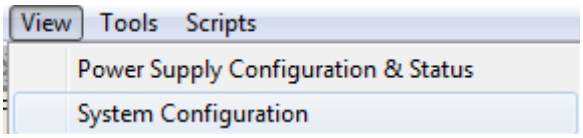
For the stigmator/deflector unit:

0x8000	FAIL	
0x0010	U1-8:I²C	
0x0080	U1-8:Adr	
0x0040	#1 U1-4:Vs	
0x0020	U1-4:DAC	first ‘quaddac’ board
0x0008	U4:Vo	
0x0004	U3:Vo	
0x0002	U2:Vo	
0x0001	U1:Vo	
0x4000	#2 U5-8:Vs	
0x2000	U5-8:DAC;	second ‘quaddac’ board
0x0800	U8:Vo	
0x0400	U7:Vo	
0x0200	U6:Vo	
0x0100	U5:Vo	

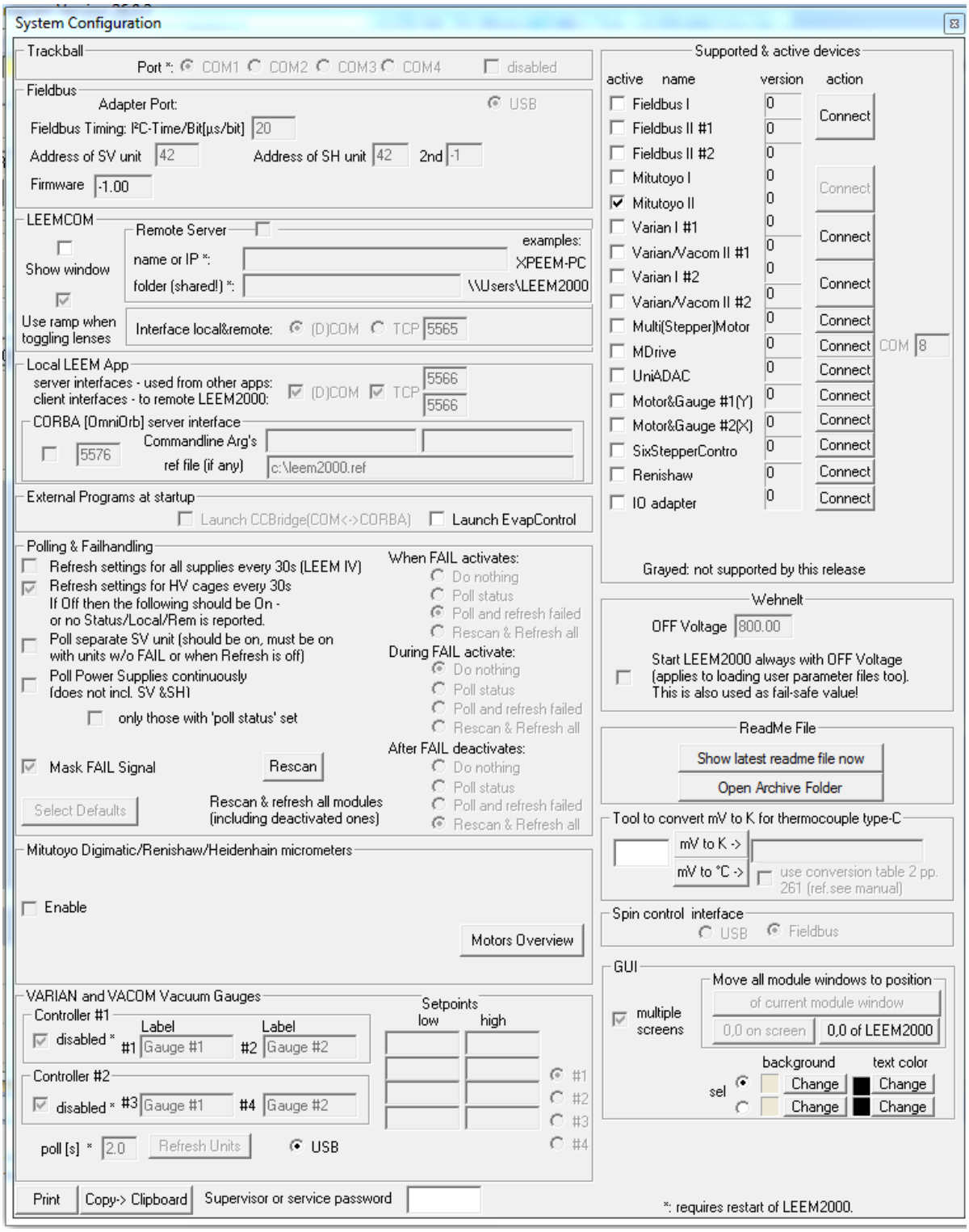
FAILSOURCE Start Voltage and sample heater units generate the following errors:

	Message displayed
0x0002	SV power
0x0004	SV HV-amp
0x0008	SV DAC
0x0010	SV&SH power
0x0020	SV&SH HV-amp
0x0040	SV&SH iso-amp
0x0080	SV&SH X-volt
0x0100	SH power
0x0200	SH iso-amp

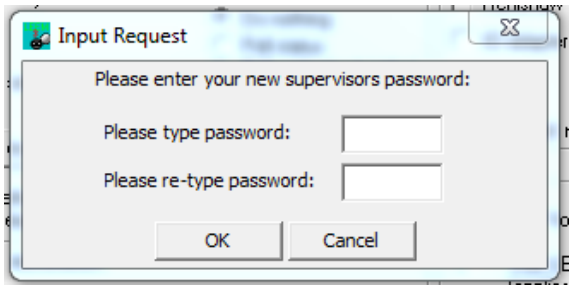
View System Configuration



The system configuration window lets you review and change settings applying to LEEM2000 in general, like the com port for the trackball or the way LEEM2000 reacts to hardware faults. Some entries are grayed and only visible after entering a password, those are restricted in use by the supervisor or Elmitec technicians.



Print and **Copy->Clipboard** allow printing and copying the **System Configuration** window.
Password:
Either a supervisor or factory password can be entered. As soon as you begin typing an 'Enter' button will appear to the right of the input field. After typing the password press 'Enter'. If you are entering a valid 'supervisor' password than a button 'Changed' is displayed next to it. This allows the supervisor to change the password:

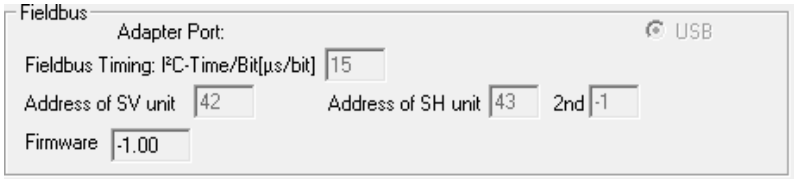


In addition there is a general password for the supervisor access which can be obtained from Elmitec just in case the supervisor forgets his/her password.
A wrong password will display a message 'access denied' with no further consequences.

Trackball:

Port
Selects Windows COM Port for trackball or disables trackball.
Please see **TRACKBALL INSTALLATION** for further details.
Change requires supervisor or factory access level.

Fieldbus:

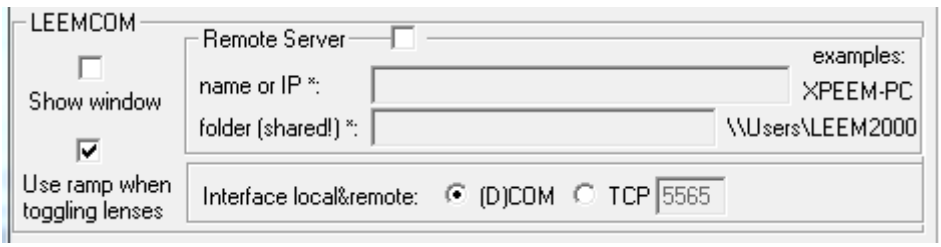


Adapter Port
Always USB port.
On very old Elmitec LEEMs a RS232 device was used. This is no longer supported.

Fieldbus Timing
Adjusts the speed of the data transmission on the fieldbus.
Change requires factory access level.

Address of SVunit, Address of SH unit and second SH unit
SV=start voltage unit, SH= sample heater unit
Addresses depend on which generation LEEM HV electronics is used.
If no second sample heater is installed a -1 is displayed.
Change requires factory access level.

Firmware
Displays the current fieldbus firmware version.



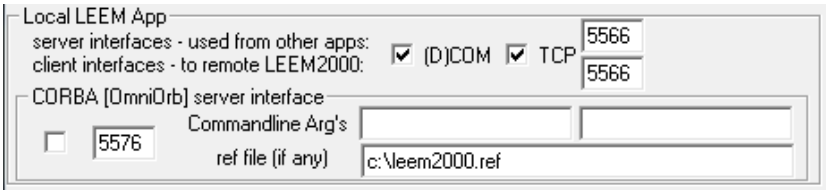
Leemcom:

Remote server
This box is only checked if the microscope hardware is not connected to the PC this instance of the LEEM2000 program runs on, but to a different computer which is connected through the network. If you check this you also have to enter the name of the remote control computer into the *Server Name* field and the name of the LEEM2000 folder on that PC.
Change requires supervisor or factory access level.

Interface (local and remote)
The communication between LEEM2000 and LEEMCOM can be done either through the Windows DCOM protocol or TCP, an internet communication protocol. On request another protocol called ZeroMQ is available. For TCP and ZeroMQ a communication port 5565 is selected, which of course must be the same for LEEM2000 and LEEMCOM. On request a different port can be provided. LEEM2000 acts as a TCP client and LEEMCOM as the server.
TCP communication is quite easy to setup contrary to DCOM. If DCOM is used on both computers all the access rights have to be set correctly which may be quite challenging.
Factory access level.

Show Leemcom window
Displays the *leemcom* window for debugging purposes. This window contains no usable information for the user. Leemcom is the program with is in direct contact with the microscope hardware and usually runs silently in the background. It should only be interacted with directly when instructed so by Elmitec.
All access levels

Use ramp when toggling lenses
Generates smoother image movement and less demagnetizing effects when toggling. Without it a toggled lens is switched continuously between a low and a high value. On the other hand ramping is slower and limits the toggle speed somewhat.
Change requires supervisor or factory access level.



Local LEEM app:

LEEM2000 is capable to act as DCOM, TCP, ZeroMQ or CORBA server or combinations of those. DCOM is always activated. CORBA uses an implementation by OmniOrb.
Not all options may be available due to licensing restrictions.
A general overview over the available interfaces is shown in the appendix.

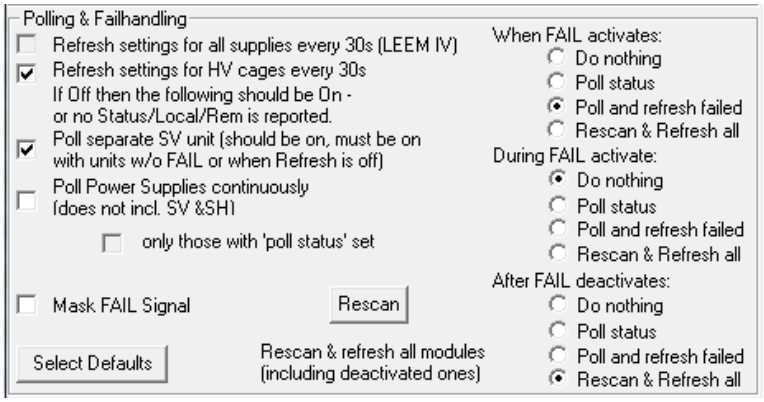
External Programs launched at startup:

Launch CCBridge at startup
Checking this will immediately start the CCBridge Program and also enable automatic start of this program whenever LEEM2000 is started.
CCBridge is used as a bridge to CORBA. It allows CORBA enabled programs to access a wide variety of functions within LEEM2000 (and Uview).
CCBridge utilizes OMNIORB™. CORBA.
Change requires supervisor or factory access level.

Launch EvapControl at startup
Checking this will immediately start the EvapControl Program and also enable automatic start of this program whenever LEEM2000 is started.
EvapControl is Elmitec control software for its evaporator powers supply, but only if that is outfitted with the optional RS232 or USB interface.
All levels

Polling & Fail handling:

All changes require supervisor or factory access level.



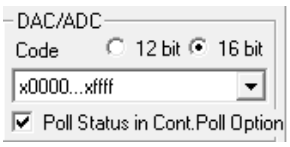
Refresh settings for all supplies every 30s (LEEM IV)
LEEM IV: *Electrostatic flange-on LEEM.*
Default: on (for LEEM IV)
This option only applies to and is only enabled for LEEM IV. As it suggests all power supplies will be refreshed every 30 sec.

Refresh settings for HV cages every 30s.
Default: on
All modules in the HV cages (group 5: ”High Voltage Rack”, group 6: “Energy Analyzer” and group 7: “Spin Rotator”) will be refreshed ca. every 30 seconds. This is done to restore settings in case of a HV breakdown. If this is not selected no status reporting is done and “Poll separate…” and “Poll power supplies…” must be selected instead.

Poll Start Voltage unit
Default: on
This applies to older Elmitec HV racks where the Start Voltage unit does not feature a fail signal line on its fieldbus interface. For newer Start voltage units this should also be on because it reduces the response time for status message to be displayed in the LEEM2000 window. It must be selected if 'Refresh … HV…" is not selected.

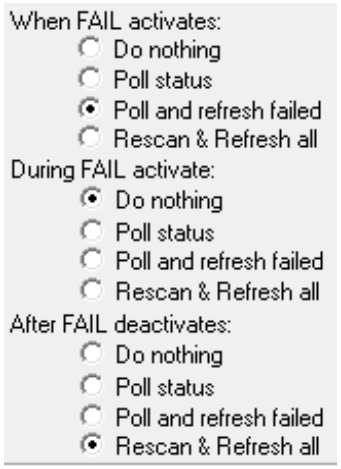
Poll power supplies continuously
Default: off
This checks the status of all power supplies, except Start Voltage and Sample Heater, at a rate of ca. 0.5 seconds each. This is especially necessary if "Refresh…" is not selected. Without it the removal of a power supply is not detected!

Only those with 'poll status' set
Default: off
Only those modules are polled which in the *Module Setup Window* have the box *'Poll Status'* checked.



Mask fail signal
Default: off
Turns the fail signal reporting off. This should only be done for testing purposes when instructed by Elmitec.

Preprogrammed responses to FAIL signal
The picture to the right shows the default settings for the computer response to FAIL signal states.
These setting should only be modified for failure analysis and to circumvent temporarily small faults which would otherwise endanger significant experimental work. In that case select 'do nothing' for a short period of time.

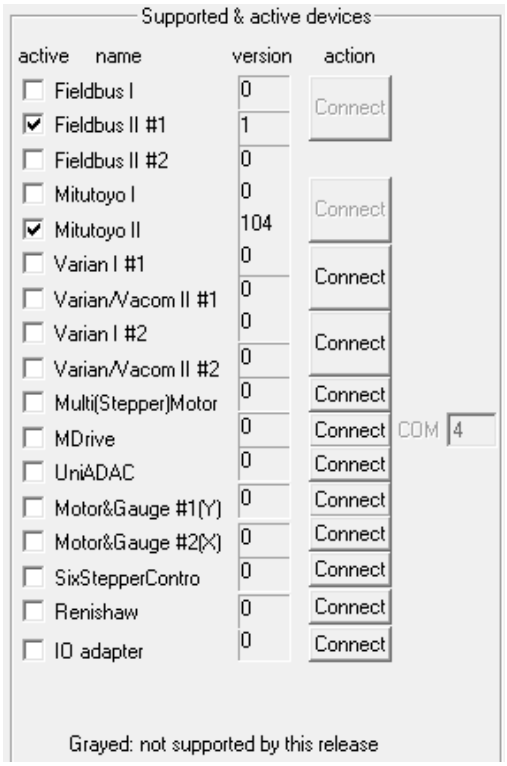


Rescan will initialize and reprogram all power supplies and refresh the onscreen status displays. A progress bar is displayed during that time (a few seconds) on the LEEM2000 screen.
In the View->**Fault History** windows rescanning can be paused by the user.

Select Defaults
Pressing this button will reset all options for *the Polling & Fail handling* to their factory default values which were previously shown in this paragraph.

Rescan
Pressing this button will instruct the program to check all power supplies defined in the parameter file, including those which were previously taken off line due to errors.
May be used after power supply cards have been replaced (hot swapped) or after HV transient has taken supplies temporarily offline.
All access levels

Supported and active devices



This is a list of all external Elmitec USB devices. It does not mean that all of those devices are actually present and connected to your microscope.
A checkmark in front of the name indicates that the device is connected and accessible by LEEM2000. In this state the 'Connect' button is grayed.
If the device becomes physically or by electrical fault disconnected from the PC the checkmark disappears and the 'Connect' button becomes enabled. After you plug-in or replace the device and press 'connect' the device should be recognized and a checkmark should be place to indicate its active state.

Note: disconnect is automatically detected, connection of a device is not. For this reason 'Connect' must be pressed.

In case of a question regarding a particular device check the **Windows Device Manager** and there the **USB devices**. Checking the device manager will get you the definitive answer if Windows recognizes the device or if some kind of error exists. Grayed device names mean that those devices are not supported by the version of LEEM2000 currently used. The **version** field displays the current firmware version of the device.

Note: If a device is not connected or cannot be connected, first check under **Windows Device Manager** and there the **USB devices** if the device is available to Windows. If not, LEEM2000 will have no possibility of using it!

Mitutoyo Digimatic, Renishaw Micrometers:

If you want to use the Micrometers attach to your LEEM through Elmitec adapters the Enable box must be checked.
Change requires supervisor or factory access level.

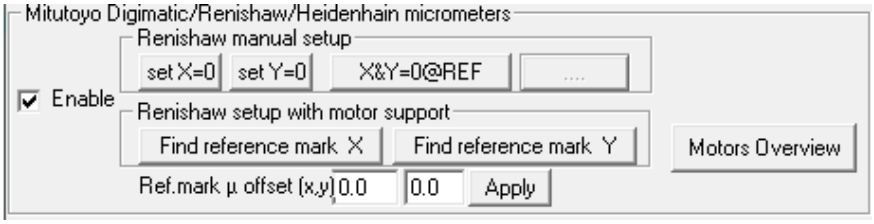
Note: The Mitutoyo respectively Renishaw adapter referred to is a product of Elmitec. If an USB adapter would exists which is made by Mitutoyo or anyone else, it **cannot** be used with LEEM2000.

In the LEEM2000 main window indicators for the micrometers will become visible as soon as they are enabled.

The micrometer readout can also be laid over the LEEM images in *U-view*.
For further information see **Micrometer Readouts.**

The Mitutoyo micrometer needs no further in LEEM2000 adjustments to work. They may need to be set at the micrometer itself to correct direction, 0 point etc..

Renishaw



Compared to Mitutoyo micrometers have the Renishaw micrometers the advantage of optically measuring the movement, having 10x the resolution (100nm) and measuring much faster which becomes important when using them as feedback devices for manipulator motors.

Supervisor:
The Rensihaw devices need some simple calibration steps for them to 'know' where they are when powering them up. In the following we list the steps necessary to connect them and get them working:

- Connect the Renishaw Tonic read-head and Ti-interface-connector (see Renishaw instruction pamphlet for explanation of these terms) to the Elmitec Dual-Renishaw controller. Hook up the controller to an USB port of the LEEM computer. The display of the controller indicates where to plug in the X respectively the Y Renishaw devices.
- Make sure the LED indicator on the read-head is green and the LED in the Ti-interface is green (good) or blue (best). A yellow light will still work but should be improved on.
  If the indicators are red then loosen the mounting screws of the read head or the tape mount and adjust one or the other until the correct operating conditions are met. A green plastic gauge is provided which can be inserted between read head and tape for the correct spacing.
- In LEEM2000 go to the *System Configuration* Window and check if the Renishaw controller is activated. If not press the *connect* button.
- In the same window the micrometer option should be **Enabled**
- When powered on, the Renishaw devices show a 0.0 µm readout. In the LEEM2000 windows as well as the controller box display this is indicated by a yellow color of the displayed micrometer values. This indicates that measurements are relative to the position at power up.

  To move to always the same fixed *Preset Positions*, the Renishaw devices have to be synchronized to a reference mark on the measuring tape. After that they do measurements referenced to a fixed 0 position. That mark is a dark line on the tape scale and is aligned to the center of the sample. The synchronization is done by moving the read head over the reference mark, either manually or preferably by motor.
  - Automatic referencing (preferred method):
    Press the *Find reference mark X* (or Y) button.
    The software will activate the motor of the selected axis and move the manipulator all the way from one limit position to the opposite until it passes the reference mark. Then the motor is stopped and the user is asked if the program should synchronize motor position display and micrometer (answer

YES). During the referencing procedure various fault conditions are checked (i.e. movement stalls). If a fault is detected then the procedure is aborted and the user is alerted.

- Manual referencing:
  Press the *X&Y=0@REF* button (see above screenshot)
  - This will arm the reference mark detection circuit
  - The display in the controller box will start flashing
  - The ... button (see above) will display '*waiting'*

  To abort the referencing sequence press the *waiting* button.
  Move the manipulator either by hand or by motor back and forth over the place where the reference mark is supposed to be until
  - Micrometer display in controller will stop flashing.
  - Micrometer display on screen and in controller will turn green for the referenced axis - 'waiting' will change to *ref* X or *refY or refXY*
- An offset can be entered for the X and Y reference marks. This may be necessary to position 0.0 at the center of the motor axis display in the module control box for the manipulator motors.

Changes requires supervisor or factory access level except for the reference mark offset

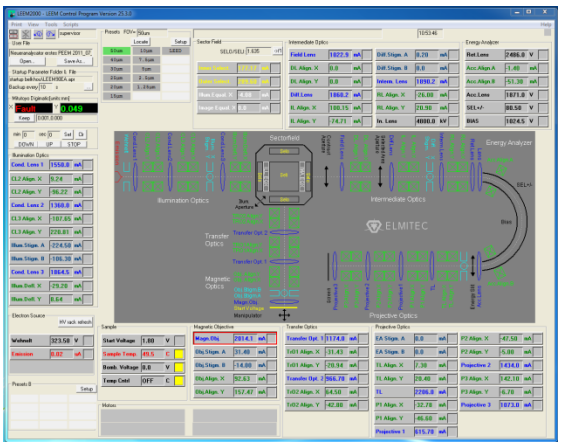
GUI:

Multiple screens
If LEEM2000 is used on a PC with 2 monitors and LEEM2000 has been moved to the second monitor, then this box should be checked. It allows the various windows to be displayed at startup on the 2nd monitor. If on the other hand only 1 monitor is used this box must be unchecked otherwise the checking for out of bounds windows is turned off. This is especially important if you switch from a dual monitor PC configuration to a single monitor, in that case the LEEM2000 windows would still be placed on the 2nd non existing monitor and therefore become HIDDEN. If the Dual Monitor is unchecked in that case, then LEEM2000 will automatically adjust the window positions at startup and move the windows from the 2nd to the 1st monitor.
Change requires supervisor or factory access level.

Move all 'module windows' to position of current 'module window'
Originally LEEM2000 was designed to allow the **module control windows** individually at any place on the screen. Some users found this confusing so this feature was added. If it is checked then all **module control windows** will be placed at the same position which is the position of the currently displayed **module control window**.
Change requires supervisor or factory access level.

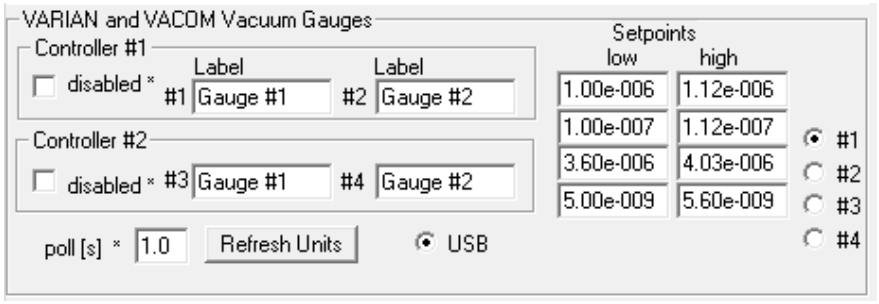
Move all 'module windows' to position 0,0 on screen
This will move all module control windows to the upper left corner of the first monitor.
Change requires supervisor or factory access level.

Select background and text color
This feature allows selection of two different color schemes for LEEM2000, for instance a dark one for a low light environment and a light one for normal ambient light. The 4 buttons labeled **Change** will display the standard Windows color selection window for the user to pick the respective colors.



Example for 2 color schemes selectable by clicking one of the *sel* buttons.
All access levels

Vacuum Gauges (Varian, Vacom):



Controller #1 selection:
If a **Varian multi-gauge-control** or **Vacom controller** with an Elmitec USB interface is connected to the PC and operating, then "disabled" should be unchecked to allow LEEM2000 to read and display the pressure readings.

Controller #2 selection:
If a second **Varian multi-gauge-control** or **Vacom controller** is present, connected and operating, then "disabled" should be unchecked to allow LEEM2000 to read and display the pressure readings of this second unit.

Gauge Label #1 to #4
A label (up to 32 characters) can be entered in each field. Those labels will be displayed in the Gauge Window of LEEM2000 and also in U-view where pressure readings are selected to be displayed over the images. The column gauge should be labeled ***COL*** because it used in the MCP control for detecting overpressure (if not, the MCP controller will not be able to shut down the MCPs when the pressure is too high)..

Refresh Units
If the pressure units are manually changed at the Varian multi-gauge controller, clicking this button will read and display the new units in LEEM2000 and U-view. Button will be enabled only when at least one of the gauge controllers are connected and working. Yet in most cases unit changes or made by selecting the units from a list in the *Varian/Vacom Vacuum Gauges* Window.

Poll (s)
Specify here the interval in seconds between readout of the gauges. 0.1s is the minimum interval. Usually 1 to 2 s are used.

Setpoints
For the Vacom controllers *readout* of the set points of a particular controller can be done by pressing one of the buttons labeled #1 to #4. Initially the setpoints of controller #1 are shown. *All changes require supervisor or factory access level.*

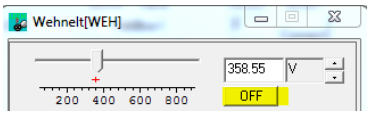
Spin Control Interface

Selection depends on the type of hardware for the spin control.

Wehnelt

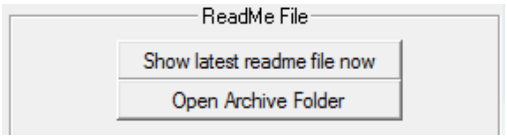
The Wehnelt OFF voltage is defined through this window. This voltage should be set to a value which will turn the electron beam off for safety reasons.

This OFF voltage is used in the module control window for the Wehnelt:



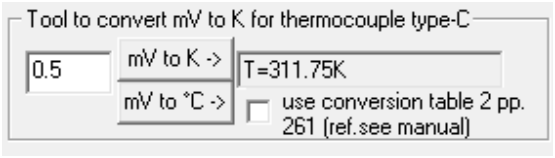
The OFF voltage can also be applied automatically at startup of LEEM2000 or when loading new parameters during operation. For that you need to check the 'Start LEEM2000 always..' box.
This change requires supervisor or factory access level.

ReadMe File



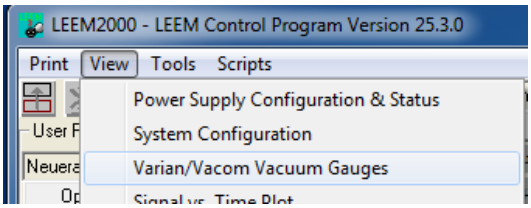
In most cases a new LEEM2000 comes with a readme file showing the latest changes.
FirstReadMeLEEM.pdf is the name of the initial readme files. It will be shown when starting LEEM2000 the first time or by pressing the button **Show latest readme file now**
When you close the viewer window where this file is displayed, a message box will be displayed. It gives you the option, to move this file to the archive folder and not show it again.
Readme files are archived in the \LEEM2000\ReadmeArchiv.
The button **Open Archive Folder** will open this folder. You may use this feature to look at previous readme files. Those are named *ReadMeLEEM* followed by the date they were archived.

Tool to convert mV to K

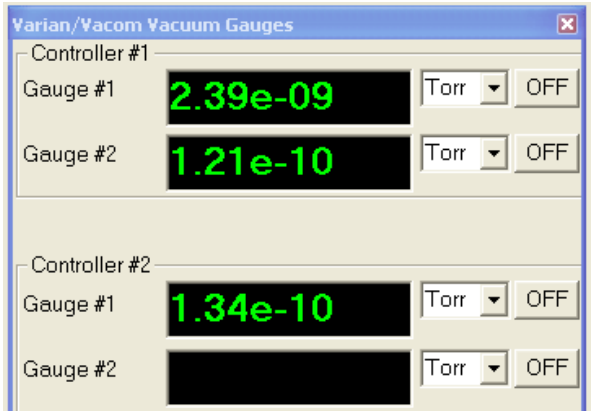


Handy tool to type in Millivolts and convert them to Kelvin or degrees Celsius for the W/Re thermocouple type C used in Elmitec microscopes.
The selection of the conversion table determines the way all mV to temperature conversions are made throughout LEEM2000!
Conversion table 1:
coefficients for 10th order polynomial fit taken from J.Vac.Sci.Technol. A, Vol.14, No. 1, Jan/Feb 1996 p.263. This selection is suitable for measurements 77 < T < 2588 (+/-4K).
Conversion table 2:
coefficients for 10th order polynomial fit taken from J.Vac.Sci.Technol. A, Vol.14, No. 1, Jan/Feb 1996 p.261. This selection is suitable for measurements in the range 32-2588 K.
For details please read:
Universal calibration of W5%Re vs W26%Re (type-C) thermocouples in the temperature range of 32-2588K. Vincent S. Smentkowski and John T. Yates, Jr., J.Vac.Sci.Technol. A, Vol.14, No. 1, Jan/Feb 1996 p.260-265.
Change of conversion table requires supervisor or factory access level.

Vacuum Gauges Readout

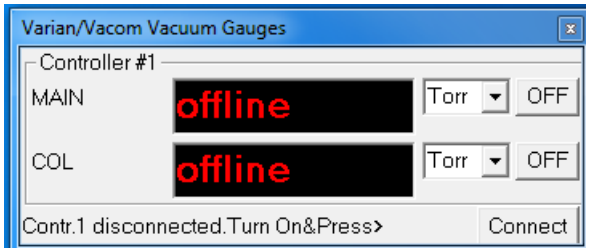


Displays the Varian or Vacom Vacuum Gauges dialog window. This window displays the real-time readouts of 2 or 4 gauges depending on the selection in the LEEM2000 setup and your hardware.

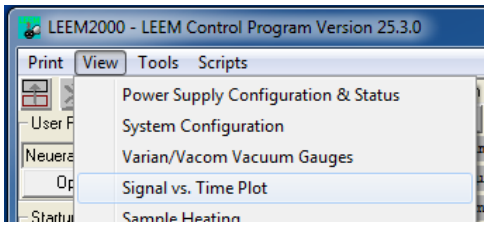


In the drop down list to the right of the display you may select the units the pressure is displayed in. ON/OFF buttons are provided to turn the filaments of the gauges on/off.
If OFF is displayed, pressing the button will turn the gauge OFF, if ON is displayed gauges are turned ON when pressing button.

In case one or both gauge controller(s) are not connected or become disconnected from the PC "offline" will be displayed and one or two "connect" buttons will appear. In that case please reconnect the controller(s) or turn them on, then press the "connect" button, below the offline section, once or twice. A restart of LEEM2000 is generally not necessary. A set of Connect buttons with the same function is also located in the **System Configuration Window**.

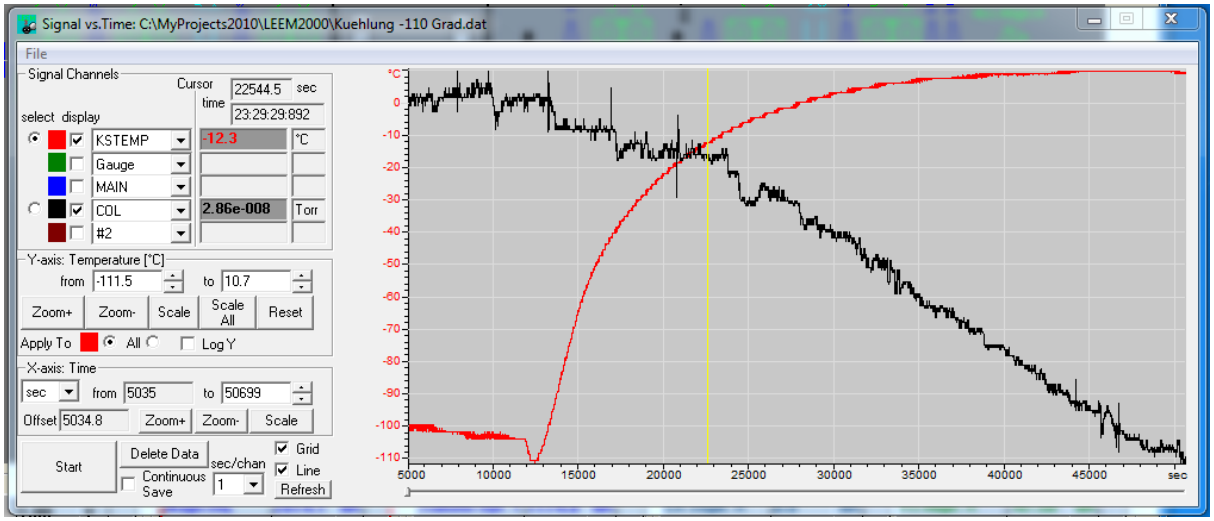


Note: Certain options displayed here require the latest adapter firmware (for instance selections of units, OFF/ON button). The firmware version is displayed in the **System Configuration Window**.

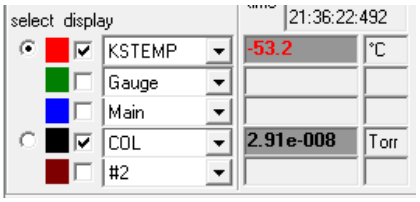


Signal versus time plot

This window features multi-channel *signal versus time* data acquisition of up to 5 sources, i.e. sample temperature, emission current or pressure readings. Data can be saved and loaded.

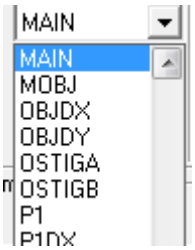


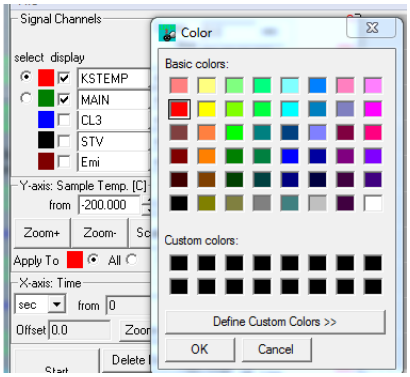
The data can be exported in text format for later import into Excel or Word.
The plot can be saved (as jpg for instance), printed or copied. A 'continuous save' function allows real-time and virtually infinite acquisition and saving of data.
X and Y axes can be zoomed, scaled or set to individual start and end values. The Y axis can be either linear or logarithmic (useful for pressure readings over time). A cursor allows precise readout of absolute as well as relative time (from start of measurement).



Signal Sources

First select which signal should be collected. For each of the 5 channels a drop down list contains in alphabetical order all signal sources. Those are all LEEM power supplies, sample Temperature, emission, Vacuum gauges, micrometers, MCP voltages and even the state of the FAIL signal.

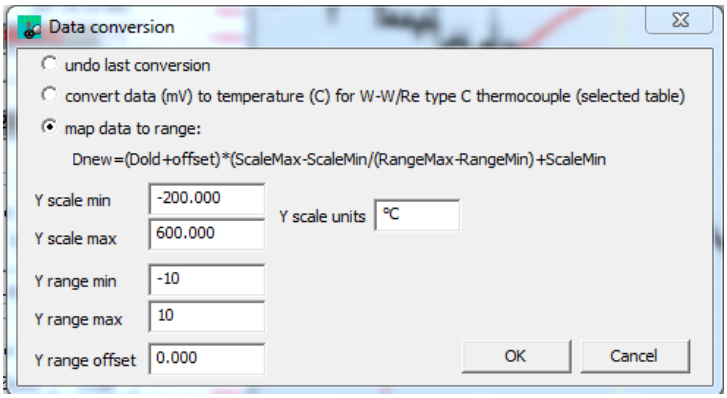




A color for the trace of the selected source can be assigned by clicking on the colored rectangle in front of it.
A Windows color dialog is displayed from which you may select a color for the trace.

Data Conversion & Scaling

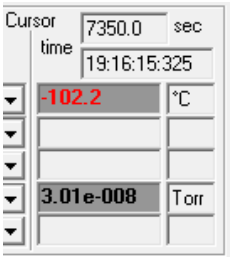
In this window you may select converting the acquired type C thermocouple data from mV to deg. C and add an offset. Or you may rescale acquired data using the given equation. Relabeling the displayed units is also possible. If you don't like the result you can undo the conversion. Press OK to execute the selected feature.



To show the trace for a signal source in the data acquisition plot, check the box in front of the source.

Note: even if no checkmark is made, the selected source is actually acquired after pressing **Start.** The checkmark just tells the program to display the trace in the plot. After loading data from a file this checkbox can therefore be used to switch the display of a particular trace or traces off or on.

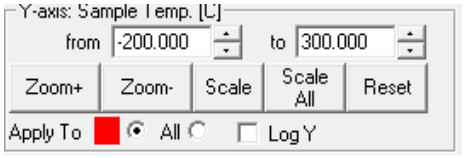
The round button in front of the source appears as soon as the check mark is set. With this button you select one source for which the Y axis is displayed and for which the Y axis controls are active.



The values of the data points where the cursor is located are displayed in the box labeled **Cursor.** On top are displayed the time from the beginning of the sweep (seconds or minutes) and the time the data points have been acquired in *hour:minutes:seconds:milliseconds* format.

X & Y axes

In the Y axis control box the minimum and maximum of the axis can be set. This can be done either by typing the value into the **'from'** and **'to'** boxes or by using the scroll buttons to the right of those boxes. To zoom around the cursor position (yellow line) use the **Zoom+** and **Zoom-** buttons (for zoom-in and zoom-out, respectively), and to scale around the cursor positions use the **Scale** button or the **Reset** button to reset the scaling values (full scale).

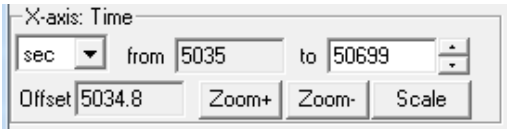


Note that for the zoom and scaling to work, the cursor must be placed on a data point (that means somewhere in between the first and last data point).
The **Scale All** button scales all (checked) traces so they will fit vertically into the plot.

With the button **LogY** the Y axis can be switch to logarithmic display.

There is also the feature of applying the settings and buttons either only to the selected trace or to all. 

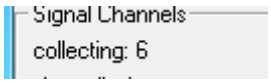
Note: that *Apply to All* sets Y axis min (*from*) and max (*to*) values for all checked traces to the same values, which are the values of the selected trace. The *Scale All* button on the other hand scales each trace individually so it fits vertically into the plot window.



In the X axis control box one can adjust the units on the X axis to either seconds or minutes and the maximum value of time displayed (by entering a value or using the scroll button). Buttons to **zoom** in or out of the cursor position are provided. **Scale** will set the left and the right sides of the axis to the first and last data point acquired, respectively, thus fitting the data horizontally into the display window. As in the Y axis control those functions only work when the cursor is located within valid data.
In the current version 40000 channels, each with up to 5 traces, can be acquired in memory before a scroll of the data occurs. This means at 1 s/channel about 11 hours worth of data can be acquired. At 10 s/channel about 4.5 days. At the slowest rate of 60 s/channel nearly 28 days! After that time a scroll will erase the first data whenever a new data set is acquired: **F**irst **I**n **F**irst **O**ut. The new data will be appended to the end of the data set.
The time offset from the start of the measurement to the first displayed channel is shown in the **Offset** box.

Sweep Start

Start will start the acquisition. If there were already data previously collected a message is displayed whether to erase the old data or keep them and append the new ones. The button will then change its label to Stop. Pressing Stop will stop the acquisition. In case continuous save was activated, you will be asked if you want to close the file.
While collecting a message showing the currently acquired channel flashes in the upper left corner of the 'Signal Channels box.
A moving black cursor indicates during acquisition the front of the data traces, the most recently collected channel.



Delete Data

All already acquired data will be erased without further notice.
This button is disabled during acquisition.

Continuous Save

When checking this box the standard Windows dialog to *open a file* is displayed. Once you have entered a file name and close that window data storage can begin. Each acquired data point is saved to disk immediately. By selecting **continuous save** a virtually endless amount of data can be saved. When loading huge data sets back, the program will automatically compress the data set in a way that it is displayed in its entirety on screen.

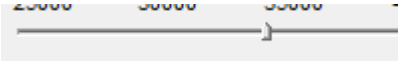
Show Grid, Show Line

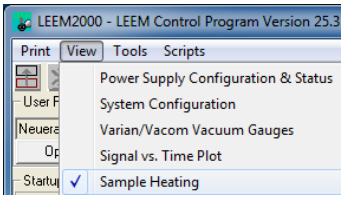
Gridline are displayed in the plot window if this **Grid** is checked.
The data points are connected by a line when **Line** is checked. Otherwise each data point is just that colored point in the plot.

Sec/chan
This drop list contains entries for 1, 10 and 60 *seconds/per channels.* Depending on the time period you are intending to collect data, choose one of the settings. Usually 1 second/channel is used. With 40000 available channels you can collect more than 11-hours continuous data before the first data point is overwritten in memory.

Refresh Plot
This button refreshes the plot (draws it again).

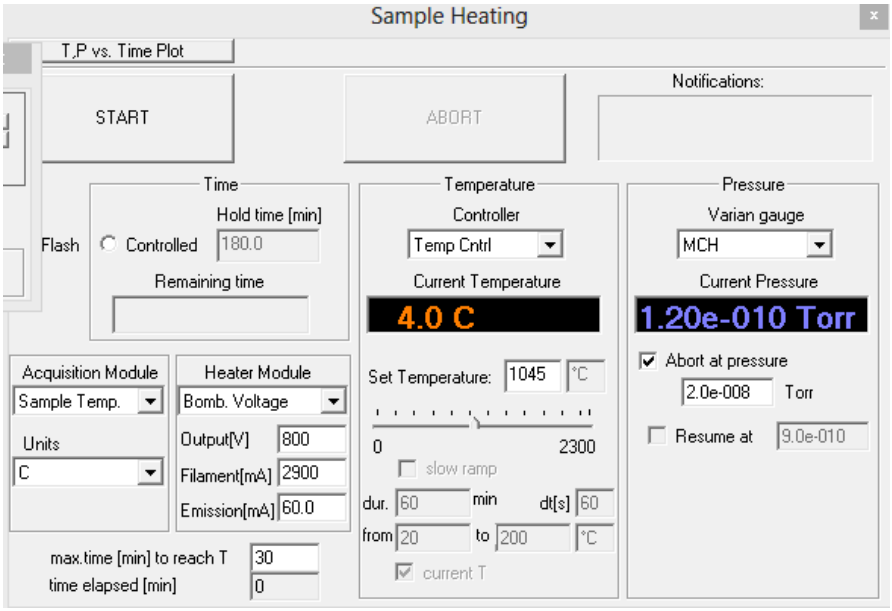
Scroll Slider
To scroll the entire plot click the handle of the slider and move it to the right or left. The Plot will scroll with it. X-axis **from** and **to** values will be adjusted accordingly.





Sample Heating

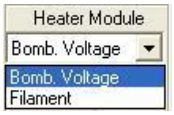
This dialog window allows setting the parameters for software programmed heating. Most items will be preset by Elmitec, like the **acquisition module**, **heater module** and **temperature controller**.



An icon  will be shown in the **sample heating window** as well as in the **module box** of the *Temp.Control* in the LEEM2000 window while heating is in progress and the final temperature has not been reached. Once that has happened and **Controlled** heating is selected another icon  will become visible. In case of an error, that will be displayed there too.

Acquisition Module:
Due to the fact that there is only one **acquisition module** and **temperature controller** hardware the choices in the list boxes for those modules are limited to 1 each.

Heater Module:
The **heater sources** are ‘Bomb.Voltage’ and ‘Filament’.



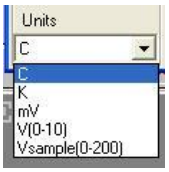
Older hardware allows only manual control of filament and emission currents:

- *Bomb.Volt*: the voltage entered in the **Output** field is applied to heat the sample, afterwards is set to a value near 0, more precise the value entered as ‘low’ in the setup window for that module.
- *Filament:* **Output** field is fixed to ‘manual’ . You need to set the desired current by hand.

With newer hardware two additional fields **Filament** and **Emission** are available:

- *Bomb.Volt*: Here you can enter the bombardment voltage in the **Output** field, filament current and emission current applied during heating.
- *Filament:* Filament and Emission fields are fixed to 0. Bomb.Voltage can be set in the **Output** field and will be applied during heating.

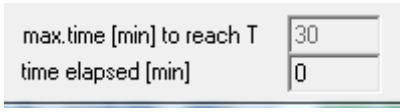
Sample Temperature Display Units:
The sample temperature can be displayed in mV (thermocouple reading), in degrees C or Kelvin. Alternatively are readings of Volts in the range of 0 to 10 possible. For some newer LEEMs it is possible to display sample voltage in a range of 0 to 200 V.



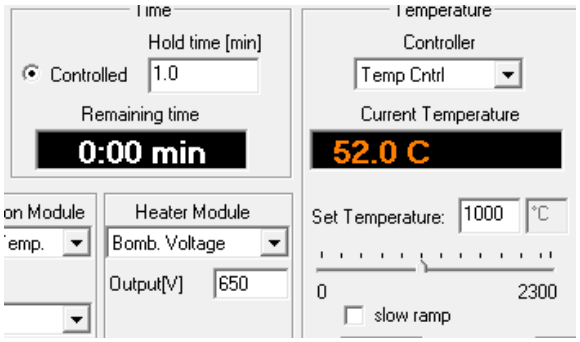
Note: Prerequisite for the software programmed heating is that the modules involved are set to **remote**.

Two options are available for the heating cycle:
Both types of heating can be aborted any time by pressing ABORT.

Flash: the sample will be heated to the desired temperature and then heating is automatically terminated by setting the heater module to the minimum configured in the setup window. As a safety measure the user can set a maximum time to reach the temperature. The time elapsed is displayed and when larger than the preset *time to reach*, the heating is aborted to avoid damage to the sample.



Controlled: the sample is heated to the desired **Set Temperature** and then the temperature is kept stable for the amount of minutes entered in the **Hold time** field. The remaining part of the hold time is updated continuously in the **Remaining Time** field.
Note: The software allows changing the temperature while heating is in progress.

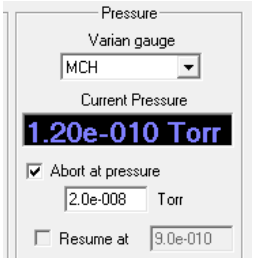


A **slow ramp** feature allows defining a time (**dur**ation) in which the temperature is ramped from an initial value (**from**) to a final value (**to**). Instead of a (**from**) value the user may select to start from the **current T**emperature.

This is currently the only available option.
As in flash heating a maximum time to reach to temperature is preset by the user, unless a slow ramp is chosen. Time elapsed is displayed and when larger than the preset *time to reach*, the heating is aborted to avoid damage to the sample.

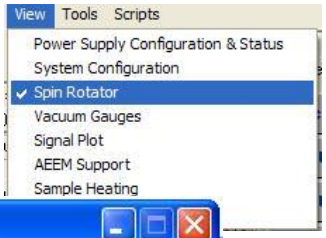
Safety measures during heating:

Due diligence is expected when heating a sample. Despite of software mechanisms to detect hardware and software faults the user must observe the sample temperature and chamber pressure during heating constantly to avoid a possible destruction of the sample.

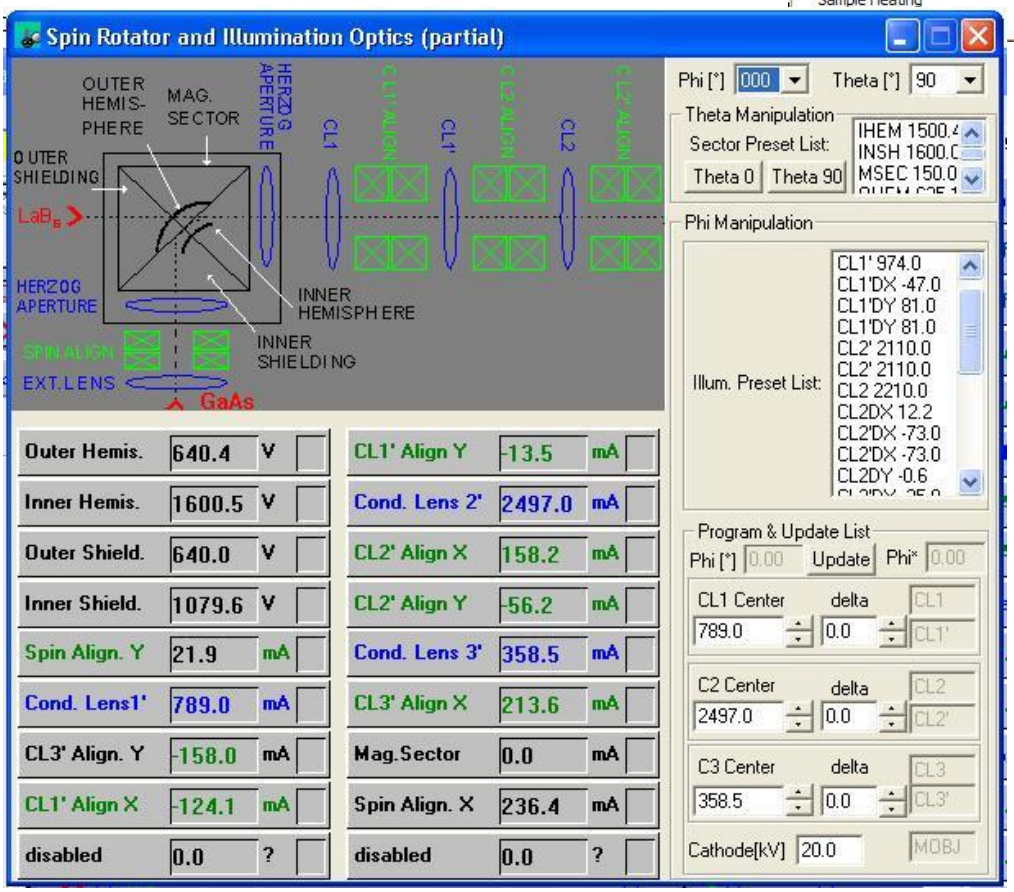


Abort at Pressure
The pressure reading of a selected gauge can be monitored and if a preset pressure is exceeded the heating cycle will be aborted. There is a further option to resume heating once the pressure has dropped below a set value. The current pressure is displayed and updated in real-time.

Spin-Rotator (optional)



The spin-rotator window displays the additional modules for the spin-rotator electronics and it contains controls for presetting and selecting phi and theta.

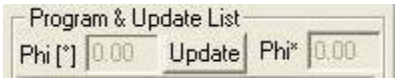


Condenser Lens Center Controls

This control simplifies the adjustments of the Condensor Lenses CL and Condensor Lenses CL' pairs by allowing the user to set a Center value and a delta. By changing the Center values, either by entering a value or using the spin button, the user can change simultaneously CL and CL'.
The relation between CL, CL' , Center and delta are as follows:

CLx = CLx Center + delta/2
CLx' = CLx Center - delta/2

Phi Preset Generation



While adjusting CLx Center and delta you can observe the values for Phi and Phi* change in the 2 fields labeled Phi[°] and Phi*. Phi* includes MObj. If you want to save the setting for a particular Phi, i.e. 45° you adjust CLxCenter and Delta until Phi[°] shows the desired value i.e. 45, then you press **Update**.
Update will save all the relevant setting for the Illumination optics and Spin rotator for that Phi.

Each Phi between 0 and 360° has one complete set of values for the Illumination optics and Spin rotator modules associated with it.

Phi List

Once all values for Phi have a set of values for the Illumination optics and Spin rotator modules associated with it, you can recall those settings simply by selecting a value for Phi from the Phi list.

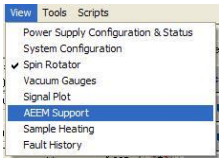
Theta Preset Generation

The list of Theta Presets is much simpler to generate then the Phi Presets. You adjust the spin rotator modules for a Theta=0° and press the Theta 0 button, the same for Theta=90°. LEEM2000 will then generate by interpolation a preset list for all theta values between 0° and 90°.

Theta List

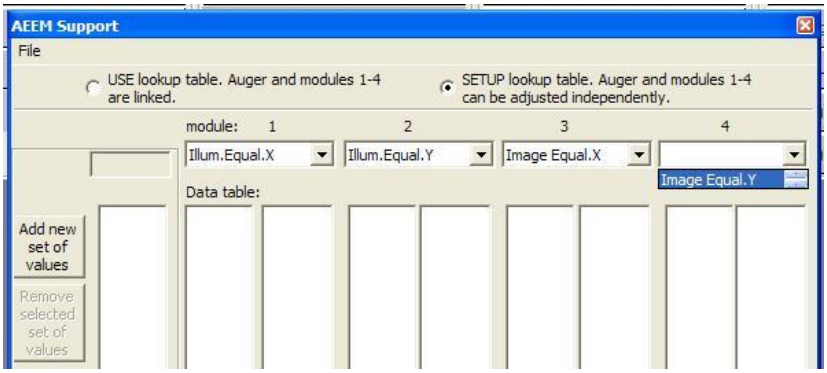
Once a Theta Preset List has been generated you can recall those settings simply by selecting a value for Theta from the Theta list.

Auger emission electron microscopy (AEEM)-support (optional)



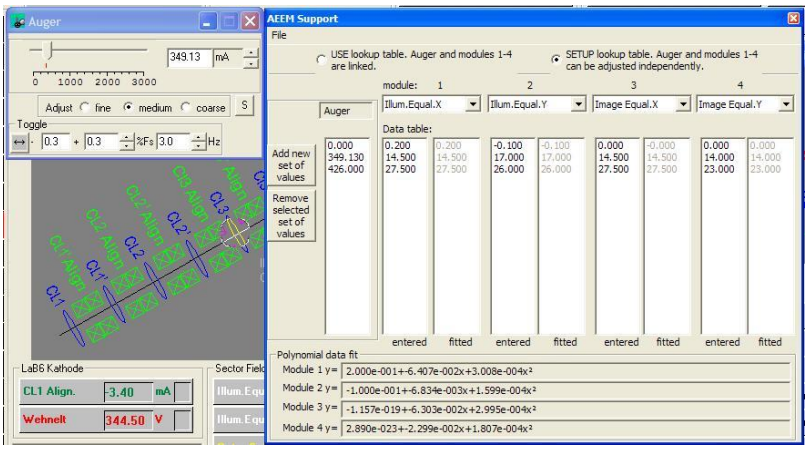
This dialog window is used to build a data table and fit those data points to obtain a relationship between the primary energy and the illumination and image equalizers. These equations obtained from a polynomial fit of these data points are used to simplify the operation of the LEEM. Once the data table has been entered, any user of the LEEM can simply change the primary energy power supply (called Auger supply in the following) and the image will be kept optimized by the automatic and simultaneous adjustments of the Illumination and Image equalizers.

1. Setting up the primary energy dependent power supply modules:



Click the SETUP lookup table button. This will enable all the controls necessary to select the power supplies and enter the values into the lookup table.
The top part of the window shows 4 lists containing each the names of all available LEEM power supplies. If not already done by Elmitec GmbH, click on the ‘down’ button next to each power supply module field and use the appearing list box the scroll through the available names to select the power supplies you want to make up the column of your lookup data table, i.e. Illum.Equal.X, Y, Image Equal.X and Y.

2. Entering the values for the primary energy data table



Start with the lowest primary energy you want to use, set the “Auger” named power supply and adjust the 4 equalizers to suit you.
Then press the ‘Add new set of values’ button. The program now enters the value for the Auger power supply and the 4 equalizer power supplies into the first row of the data table.
Then set the primary energy to the next value, again adjust the 4 equalizers, press the ‘Add..’ button… and so forth.

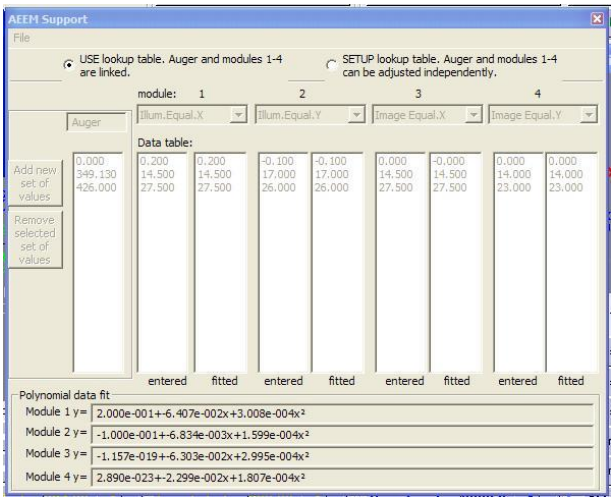
You may at most enter 16 rows of data. Probably far less are sufficient. If you feel that you need more data rows, please contact Elmitec GmbH.
When the table contains more than 1 row the program will automatically fit the data in each of the 4 columns (linear polynomial fit). With each row the number degree of the polynomial fit will increase up to a maximum of 7. Next to the 4 column of entered data is a column for fitted data (gray numbers) located. This is done to indicate the quality of the polynomial fit for when the number of points exceeds the number of parameters.

3. Saving and loading the data table

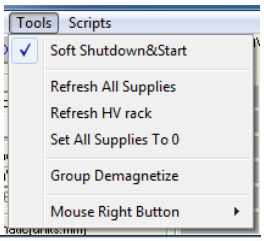
All the values in the data table will be saved automatically into the current parameter file when leaving LEEM2000 or during regularly scheduled backups. Nevertheless it is strongly advisable to save them into a separate file once you have entered them. Saving is done by selecting “Save As” in the “File” menu and then entering a file name in the standard Windows save file dialog. This file can be read by LEEM2000 and because it is a text file can be viewed by any non-formatting editor (i.e. WordPad, the editor supplied with every Windows edition).

4. Using the data table

To use the data lookup table simply press the “USE …” button and adjust the primary energy through the ‘AUGER’ power supply. You will observe the dependent equalizers to adjust according to the fitted equations.
Once you press the “USE …” button all the data table setup controls will be grayed (disabled). On the main LEEM2000 screen the equalizer modules will not be selectable anymore and they will be marked with a label “Function of Auger”. When starting LEEM2000 the program will be in the mode which uses the lookup table as described above.

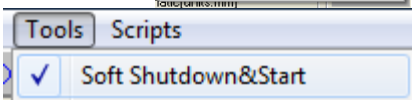


Tools Menu



This menu contains a series of tools and options for the user to select.

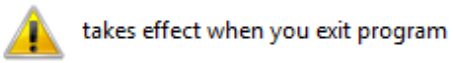
Soft Shutdown & Start



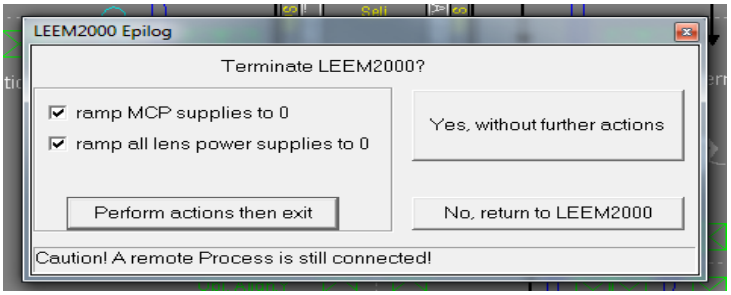
All modules can be slowly started up and slowly shut down by selecting this feature. During shutdown the selected power supplies will be ramped from their current value down to 0.
At startup the ramps will go from 0 to the value last used before shutting down LEEM2000.

Only if a module has the **Include in Shutdown** box checked in its **Module Setup Window** can it participate in this feature. The speed of the shutdown/startup ramps are determined by the **ramp** entry in the same window.

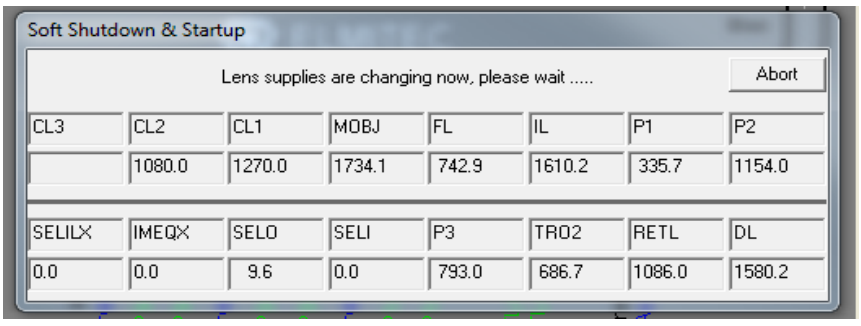
As soon as **Soft Shutdown & Start** has been checked the following message appears:



When **Soft Shutdown & Start** is selected a checkbox is added to the LEEM2000 Epilog. When this box is checked the program will start the ramp-down after '**Perform actions then exit**' is pressed.



During ramp-down a window will appear on the screen displaying how the output values for the ramped modules are changing in real time until they reach their final values:

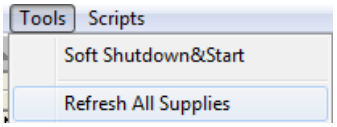


This window also allows to **Abort** shutdown ramping cycle. The same window is displayed during ramp-up at program start.

Note: Because of hysteresis in the coils magnetic fields, successive shutdown and startup cycles may not yield reproducible results. In some cases you will not get the image back you had before the shutdown. It is therefore better to

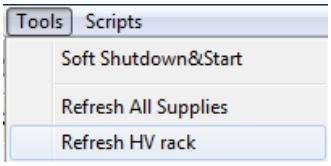
leave the LEEM power supplies **on** between sessions or during weekends and holidays.

Refresh All Supplies



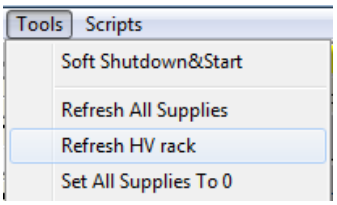
All power supplies will be refreshed with their respective values. This may become necessary if a glitch in the line voltage or high voltage breakdown corrupts the output settings of any supply. It may also become necessary if an individual power supply is removed and reinserted while the rack supplies are on (hot swap).

Refresh HV Rack

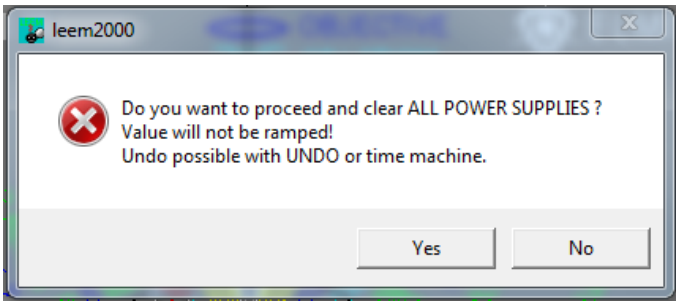


All power supplies in the high voltage rack will be refreshed with their respective values. This may become necessary if a glitch in the line voltage or high voltage breakdown corrupts the output settings of any HV supply.

Set All Supplies to 0

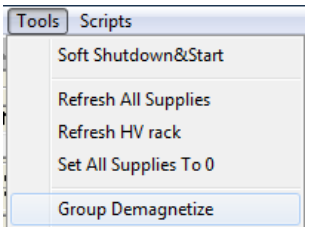


This feature is for testing purposes only and should be used very carefully, because it resets all supplies to 0. Before the output values are changed to 0 a warning message is displayed. Once YES is pressed, all outputs will be set to 0 immediately.



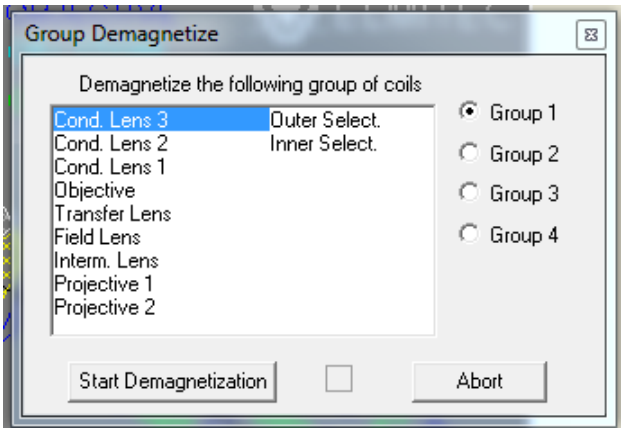
Note: to restore the previous settings use **UNDO**. The easiest way to reset all the values to its previous state is to use the **time machine** feature in the **Undo&Redo** Window.

Group Demagnetize (Degauss)



This dialog allows the user to define 4 groups of coils to be demagnetized (degaussed) simultaneously. This dialog also has a button to start the degauss cycle and to abort it.
The list of modules available for demagnetize is only displayed if those modules are present, that is, if their boxes are displayed on the main LEEM2000 window. A further condition is that the degauss has been enabled for those modules by Elmitec in the **Module Setup Window**.

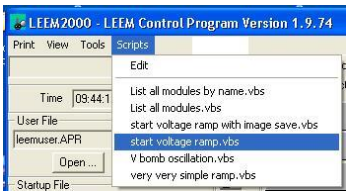
Selection of the group is done by clicking the group button
Selection of the modules is done by clicking on one or more module names. Clicking a second time on the same name will unselect this module again.
After **Start Demagnetization** is pressed the degauss symbols are displayed behind each module in the main LEEM2000 window  and in the selected **Module Control Window**  .
To abort degauss and to return to the main LEEM2000 windows hit **Abort**.



Right Mouse Button Assignment

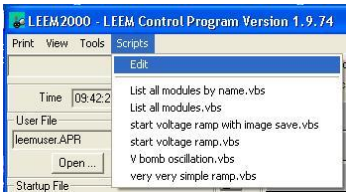
The functions *Undo*, *Stop all toggling* and *Switch to previously selected module* can be assigned to the right mouse button. Which function is done by the right mouse button can be selected in this menu by clicking on one of the available choices.

Script Menu

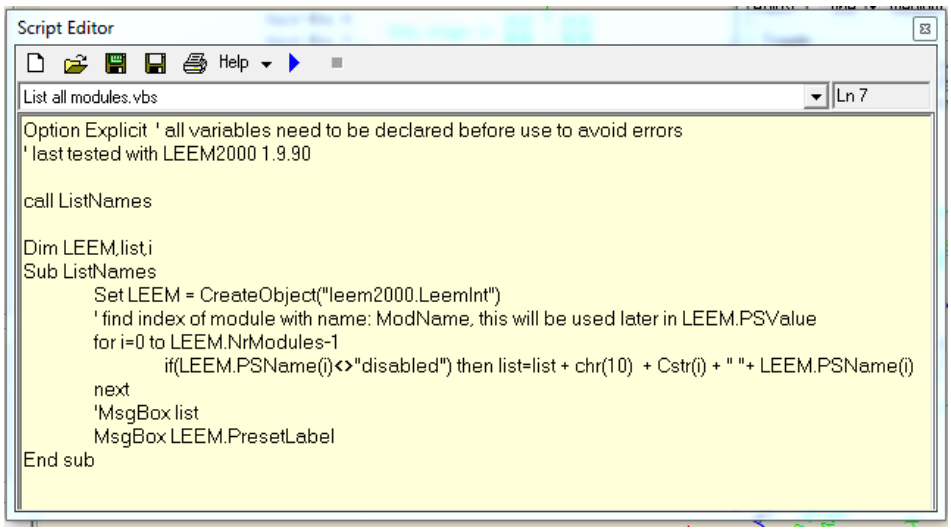


To start the execution of a script, selects its name in the *Script menu*.
While the script is running a checkmark is placed next to its name. It is usually not necessary to abort a script, unless it was written to run endlessly. But in case a script needs to be aborted you can click its name in the menu again.
What scripts appear in the Script Menu? All files with the extension *vbs*, *js*, or *exe* which are located in the *Scripts* folder, a sub folder of the LEEM2000 folder, will appear listed in the *Scripts menu*.

Script Editor



Select the *Script Editor* if you want to look at the contents of an existing script or edit an existing script or write a new script. Visual Basic Scripts(.vbs) and Java Script(.js) files can be edited, executable files(.exe) are applications generated by other means and cannot be edited.
The editor is based on Microsoft Word-pad. That means you can use the left mouse to select text, cut, copy and paste it within the script or to and from an outside source.
When you made changes to a script, you will always be prompted to save it when closing the script editor or selecting a new script or hitting the run button.



New Script 

The *New Script* button will clear the editor window.
Type in the script and save when you are done.

Open Script 

Opens an existing script. A standard windows *open file* dialog is displayed for the selection of the script.

Save Script 

This button will save the current script.

Save Script As 

Select this button if you want to save the current script under with a certain name. A standard Windows *Save File As* dialog is displayed.

Print Script 

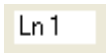
Prints the text of the script in the script editor window. A standard Windows *Print* dialog is displayed.

Run Script 

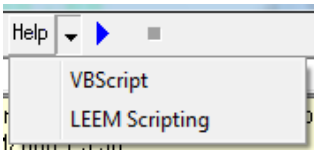
This button will start the execution of the script. Only one script can be running at one time.

Script Selector 

Choose the script you would like to edit by clicking on the down arrow and selecting the desired script with the mouse. If you current script was changed since it was opened you will be prompted to save it.

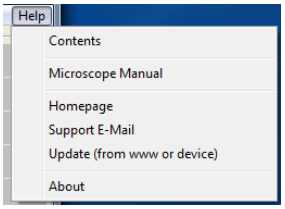
Script Line Indicator 

The line in which the cursor is positioned is indicated in the *Script Line Indicator* box.

Script Help 

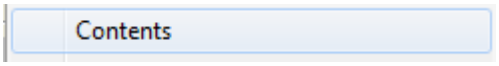
Two help files can be accessed from the *Help menu* in the script editor. The most important is a download of the Microsoft Scripting Help. It explains in great detail what a script is, how it works, how to write it and contains a complete reference of all VBscript and Jscript features and language elements. The second help file lists the properties and methods available in LEEM2000 for use in a script.

Help Menu



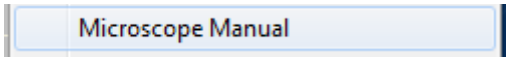
Offers a series of standard Windows help features.

Contents



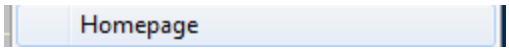
Opens Windows Help and loads *this* manual in pdf or htm format.

Microscope Manual



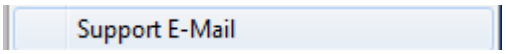
Opens Windows Help and loads the manual (pdf) for your specific Elmitec Microscope.
Note: This feature may not be supported for your instrument.

Homepage



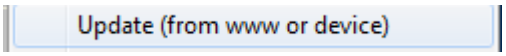
Opens the Elmitec GmbH Homepage at http://www.elmitec.de/ .

Support E-Mail



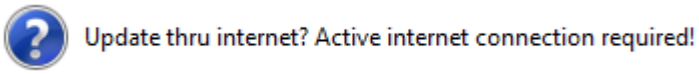
Opens your local email program and creates new email with the destination address mail@elmitec.de. For this feature to work you need to have an email account setup and a mail program on your PC.

Update

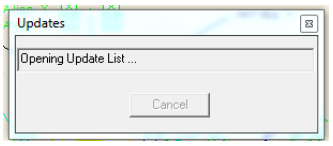


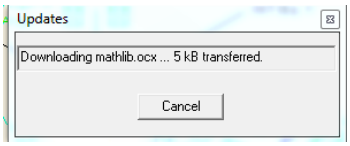
Download the latest LEEM2000 updates from the Elmitec server or a USB stick.
Updates can include just one file or several files. A check is done to avoid updating when the software is already up-to date.

When clicking **Update**… the following message will appear:



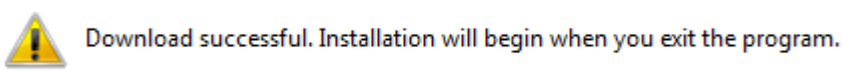
If you answer **Yes** a window will be opened and the process of the download will be shown.





If you answer **No**, a standard window appears displaying the directory structure of your PC. Please select a folder containing the updates. This must in contain a file ‘UpdateList.txt”. Usually the entire folder is downloaded on another PC from our website, copied to USB stick and then plugged into the LEEM control PC, if that is not hooked up to the net.

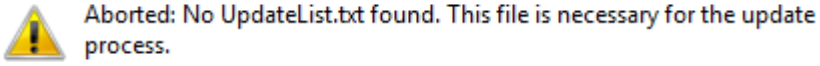
After a successful finish of the data transfer, the following message appears:



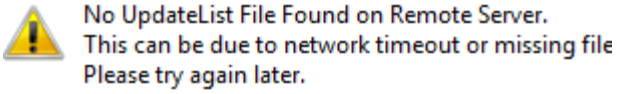
As indicated in this message, the actual update, meaning the replacing of files, will not start until you have closed LEEM2000. Then the new files, which are temporarily stored in the folder '\LEEM2000\updates' are copied to their destination. The old files will not be overwritten but copied into the folder '\LEEM2000\backup'. Overwriting those files will not occur until next time you perform an update.

Some possible error messages during update process are:

This message may appear when updating manually from stick which does not contain a correct set of update files.

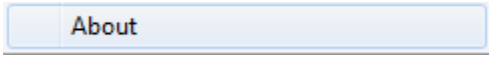


May indicate faulty network connection.



Note: The unlock code of your LEEM2000 installation must be registered with Elmitec or the Update will fail.

About



Displays the LEEM2000 About box. It contains release information, a copyright notice, Elmitec company address and information about the user license. A list of software options is also shown.
There is also a button to remove the license (supervisor level). The only possible use for that button would be to remove a temporary license and replace it with a permanent one. Once the license is removed you will not be able to start LEEM2000 again unless you have the unlock code.

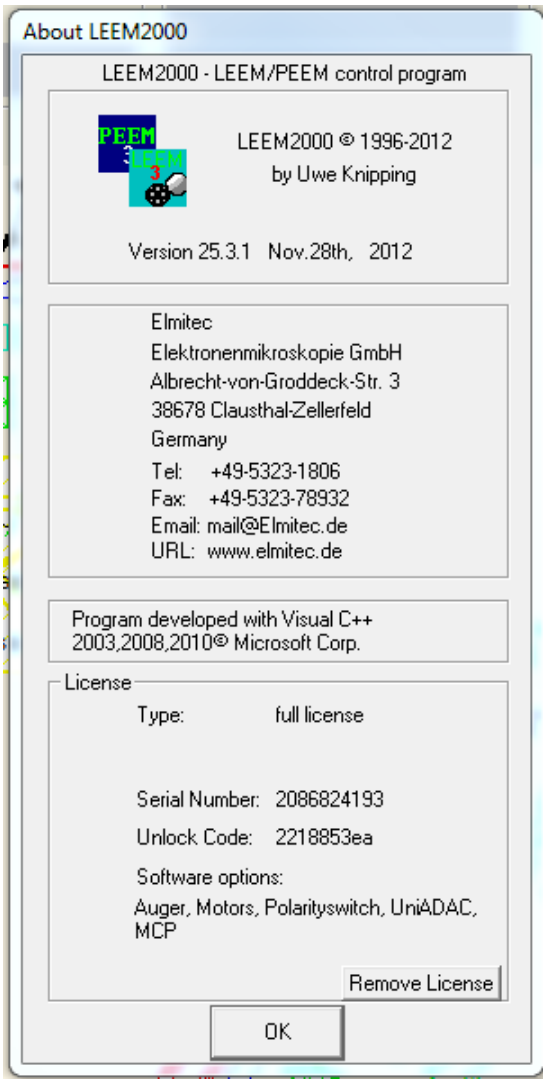


Image Intensifier (MCP) Power Supply

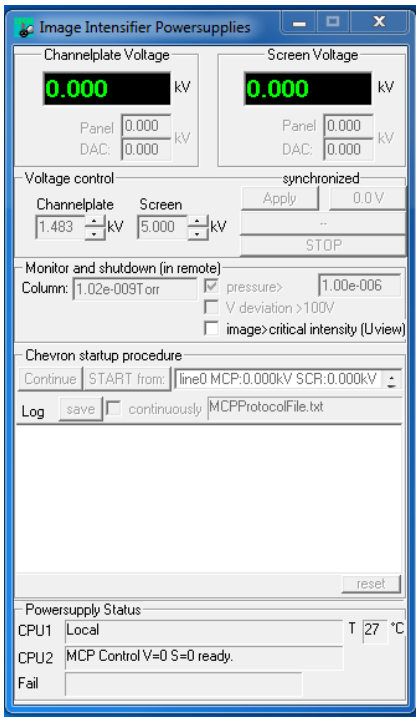
Image Intensifier

The remote control for the *image intensifier power supply* allows a controlled setting of the channel-plate and screen voltages. To avoid damage to the channel-plates, both voltages need to be ramped in unison at a specific ratio and UHV conditions need to be maintained. This software takes care of that.
The user must of course take care not to exceed a high voltage level where excessive local image intensity might damage the MCP.
The Image Intensifier Power Supply can be operated in **local** and **remote** mode: When switching between both, both voltages must be at 0 V. This can be achieve in local mode by turning the pots on the front panel to 0 V, and in remote by setting the voltages to 0 V in the MCP control window. If the **remote** button is pressed before the voltages have reached 0 V it starts flashing. It will continue to flash until the outputs are near 0 V, then it will light continuously and the MCP control window will be in remote state.

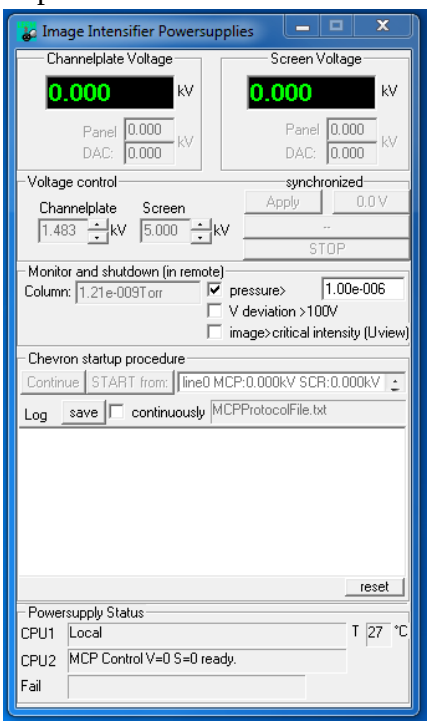
Local operation

When turning the power the MCP supply on or after having pressed the Local button, the supply finds itself in local mode. In this mode the user has full control over the channel-plate and screen voltages through the pots on the front panel. This means of course that no supervision of the voltage ratio and speed of voltage changes are available. A not experienced user may very well destroy the channel-plates in this mode.
On the PC side the MCP Control Window displays the two voltages in large green numbers and the settings of the front panel pots below that, in small numbers. All other controls are disabled in user mode and most in supervisor mode. A ‘Local’ will be displayed in CPU1 line of the Power Supply Status box. CPU2 line indicates that the power supply is turned on and ready. The internal Temperature of the MCP supply is also shown in °C.

User access:



Supervisor access:



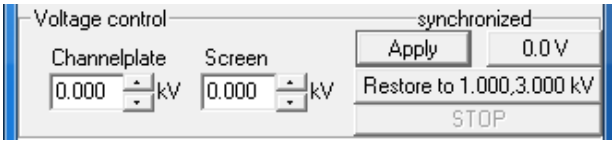
Safety measures implemented: none

The green color of the displayed voltages will change to yellow, then to red if the output deviates significantly from the set values of the front panel potentiometers.

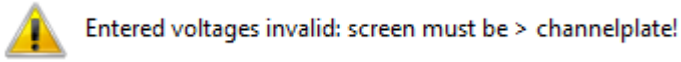
Note: the control elements enabled in supervisor mode are only enabled so that the supervisor can make changes to the settings while the MCP supply is in local. None of these controls actually work while the MCP operates locally.

Remote Operation

After the pots on the front panel have been turned to 0 V and the remote button has been pressed the MCP supply is in remote and is controlled by the LEEM2000 software.
In the MCP Control window most controls will be enabled and a 'Remote' will be displayed in CPU1 line of the Power Supply Status box. The CPU2 line indicates that the power supply is turned on and ready. The internal Temperature of the MCP supply is also shown in °C.
MCP Control Window displays the two voltages in large green numbers and the settings of the front panel pots below that in small numbers (in case of the remote setting those should be near 0). Below that the output values for the DAC are shown. If a DAC output differs from the voltage output the green color changes to yellow in case of a small deviation. This may happen during ramping of the supplies to a new value and if it changes to green shortly thereafter, it is nothing to worry about.
A red color in the display indicates a large deviation of the actual output from the expected value. If this persists it indicates a hardware fault and the unit needs to be send to Elmitec for a repair.
Voltages can be entered by typing them in and hitting **Apply** or using the scroll buttons. If the voltages do not conform to the MCP limits or relation between Screen and Channel-plate voltages, then error messages are displayed and the input is rejected:

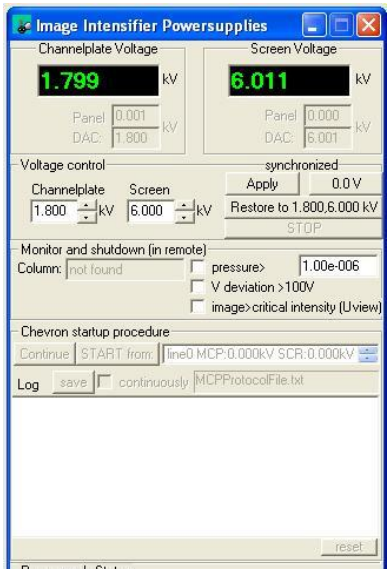


For instance:

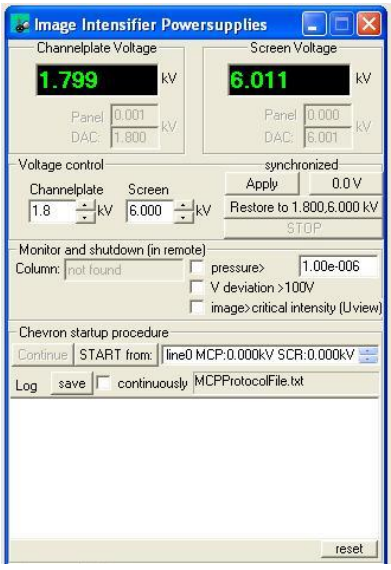


Pressing **Apply** will ramp the voltages slowly to its final levels. This ramp can be aborted by pressing **STOP.**
To reset the voltages to **0** a separate button **0.0V** is provided. When pressed, the current setting is saved and displayed underneath on the **Restore** button. It can be pressed later to restore the voltages to a valid level.

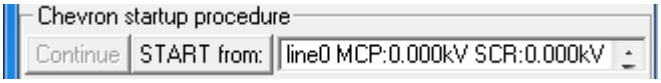
User access:



Supervisor access:



Difference between user and supervisor access is the availability of the **Chevron™ Startup Procedure**. It needs to be performed every time the MCP was exposed to air. Details about that procedure can be found in the Photonis/Burle document 'Scientific Detector Products Technical Briefs' 'Chevron™ Start-up procedure'. The lengthy procedure (>6 hours) runs fully automatic. The individual steps are displayed as the procedure progresses. It can be stopped and continued by pressing the provided buttons. Or it can be started from a preselected state of the start-up sequence.



MCP Log

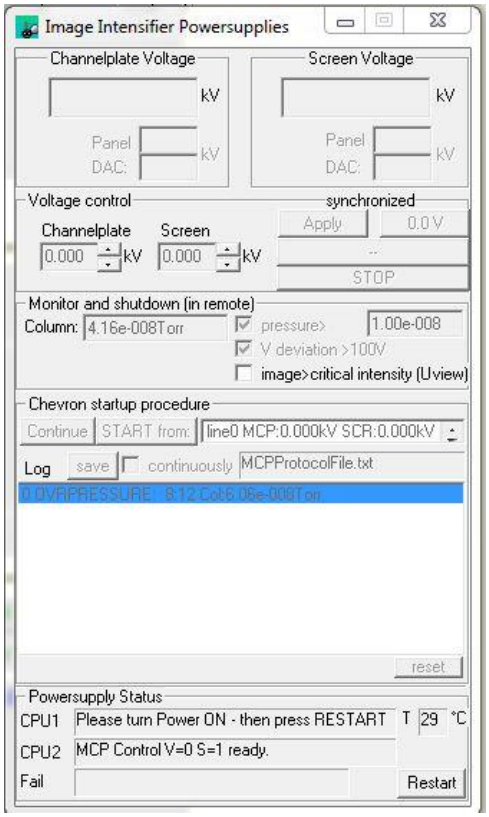
Status messages from the MCP will be logged on screen and can be saved on demand or continuously recorded to a file named *MCPProtocolFile.txt*. A multitude of messages regarding the Chevron startup procedure and Error messages may be displayed.
In supervisor mode a **Reset** button allows clearing the on-screen log list.

MCP safety measures implemented

shutdown at a predefined pressure - recommended
shutdown at a measured voltage difference of more than 100V - recommended
shutdown at image intensity higher than a predefined level - optional

MCP restart

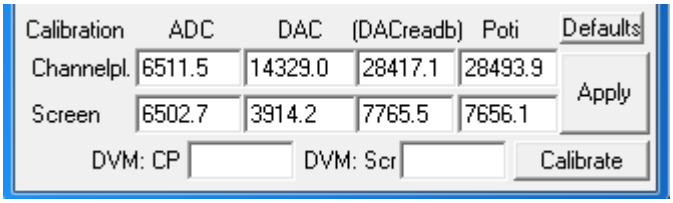
If the MCP supply is turned off, the following appears in the MCP Control Window.



Please note the messages in the **Status** Box at the bottom of the window and the **Restart** Button. Follow the instructions displayed. In this case for instance, turn the Power to the MCP supply on and press the Restart button. If successful the window will be displayed as shown 2 pages back with the voltages displayed in green. Then press **Remote** on the units' front panel and the window will be shown as on the previous page.

MCP calibration

The following additional items will be shown at factory access level:



Calibration factors and Calibrate Button. The factors are just for information purposes and while they can be changed manually, this will not be necessary because of a very simple *calibration feature* described in the following:

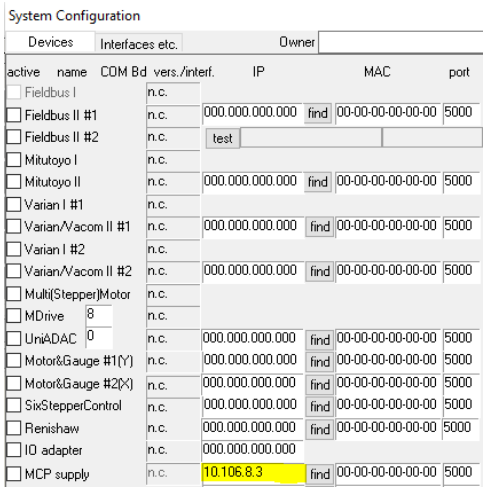
- Please set the voltages to a relatively high value, for instance 1.5 and 5kV. Don't forget that the values must be in kV not Volts.
- Then look at the front panel displays (DVMs) of the unit.
- Read the values.
- Enter those values into the fields DVM CP and DVM Scr.
- Press **Calibrate.** An instruction window will be shown. Simply press OK. After that a second window will ask for an OK. Press it.

That is all. Now the software will calibrate the voltage outputs and displays in the 'Image Intensifier Window'. Then the voltages will be adjusted such a way that, what has been entered, will be set in the image intensifier unit and both the displays on screen and on the front panel will be identical.

Note: It is assumed the Chevron™ Startup-procedure has been completed and that the value entered are chosen not to harm the MCP.

TCP Interface Setup

In *the system configuration* window, *devices* page, enter the IP address into the MCP field and restart LEEM2000. Port is 5000. MAC does not have to be entered.



Motors in LEEM2000

Safety Considerations

The possibility of unexpected movements can never be completely excluded. In that case or whenever the motor behaves erratically TURN POWER OFF at the control unit immediately!

- Make sure no wiring or other obstructions are in the way of the movement!
- Do not let motors run unsupervised!
- Do not let motors run over extended period of time!
- Check regularly for motor overheating and turn motors off if overheating!
- Avoid excessive humidity and water spills (i.e. sprinklers)!
- Some of the motors are not bakeable and must be removed during bakeout Others may be left at the microscope above the bakeout tent if sufficient cooling air flow is provided.
- Controllers and motors must always be properly grounded!
- No user adjustable or serviceable parts inside!
- Servicing of this equipment only to be done by Elmitec GmbH.

Specific Warning for the MDRIVE (motor for rotation platform)

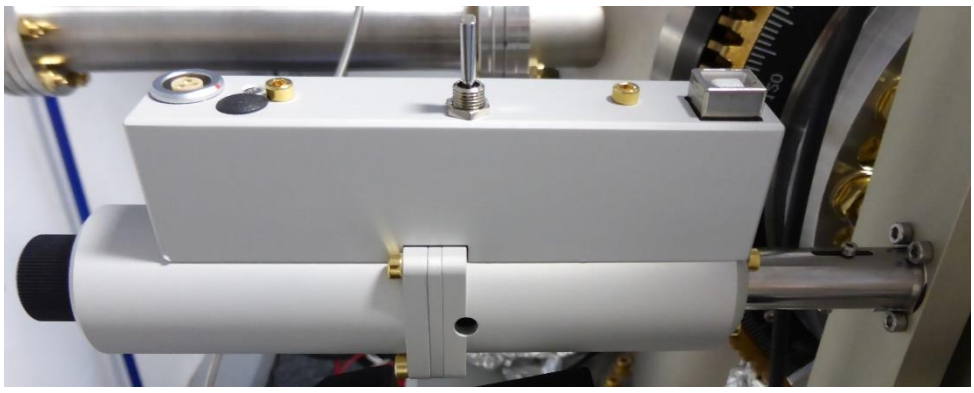
DO NOT HOT PLUG ANY CONNECTIONS!
Do not connect or disconnect power, logic or communication while the device is in a powered state.
Remove DC power by powering down at the AC side of the DC power supply.
Failure to follow these instructions can result in equipment damage.

Motortypes

Manipulator motor

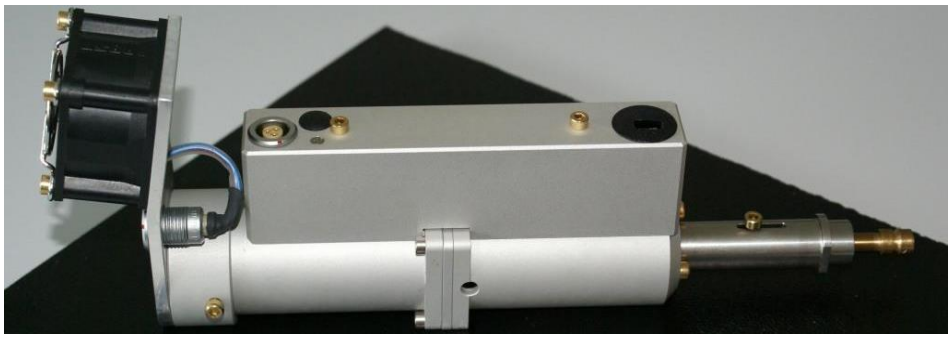
Type A. With internal sensor and built in controller with USB interface:

Motor section:	
Manufacturer:	Faulhaber
Type:	2224-AV-18-14, 377:1 gear
Electrical specs:	2-phase, bipolar, 4-wire, 12-24V 0.25A/phase
Lead screw linear motion:	0.02763 µm/half-step (supplied by controller)
Computer interface:	Standard or mini USB receptacle. Motor driver section and controller with USB interface are electrically isolated thru optocouples.
Manual controls*	(a) toggle switch for manual back and forward movement. No software needed, power and USB must be connected. (b) hand knob to move in micrometer range (positioned before the 377:1 gear). 1 turn corresponds to ca. 1.3µm (500/377µm)
Sensor (intern):	V1: 256pixel sensor array (obsolete) V2: 512pixel sensor array (obsolete) V3and later: left, right and center-optocouples These sensors are only for detecting limit and center positions.
Encoder (extern):	Software supports Mitutoyo micrometers or Renishaw distance sensors. These are used to position the motors with high accuracy in X and Y. (+/-1µm Mitutoyo, +/-100nm Renishaw)
Bakeable:	**NO**. Maximum operating temperature 80°C ! But a special fan assembly can be connected to the motor. In that case and with the fan running, the motor and controller can be left at its position above the bake-out-tent at the microscope. At your own risk.



*latest model with manual movement switch and hand knob (2020)

Manipulator motor Y



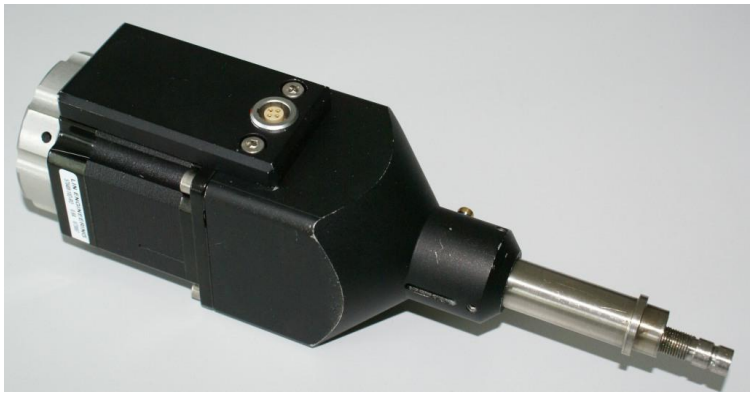
Fan assembly attached

Hint: these motors can be moved forward and backward with the toggle switch (where available)
without LEEM2000 running. One only needs the power and USB cables plugged in.

Type B. Motors with no sensors and no built in controller (*obsolete*):

Manufacturer:	Lin Engineering
Type:	5704M-10D-R0
Electrical specs:	2-phase, bipolar, 4-wire, 12V 0.9A/phase max.
Step size:	400 steps/revolution, 0.9 degrees/step,
Lead screw linear motion:	0.45 µm/half-step (supplied by controller)
Bakeable:	NO

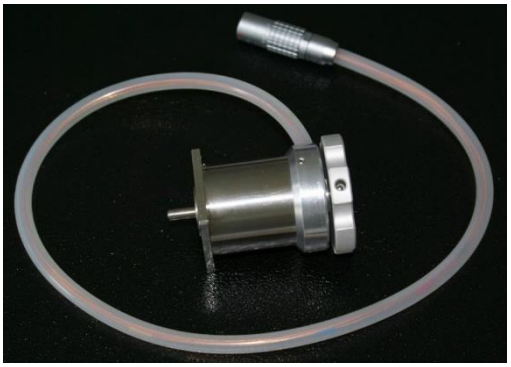
Limit switches, Encoder, Computer interface: none



Aperture motor

Manufacturer:	Phytron
Type:	VSS 42.200 0,6-E-HV-4ls, High vacuum motor
Electrical specs:	2-phase, bipolar, 4-wire, 12V 0.6A/phase max.
Step size:	200 steps/revolution, 1.8 degrees/step,
Lead screw linear motion:	1.25 µm/half-step (supplied by controller)
Bakeable:	YES, up to 200 °C

Limit switches, Encoder, Computer interface: none
Note: other motor types have been used, all 2-hase, bipolar, 4-wire

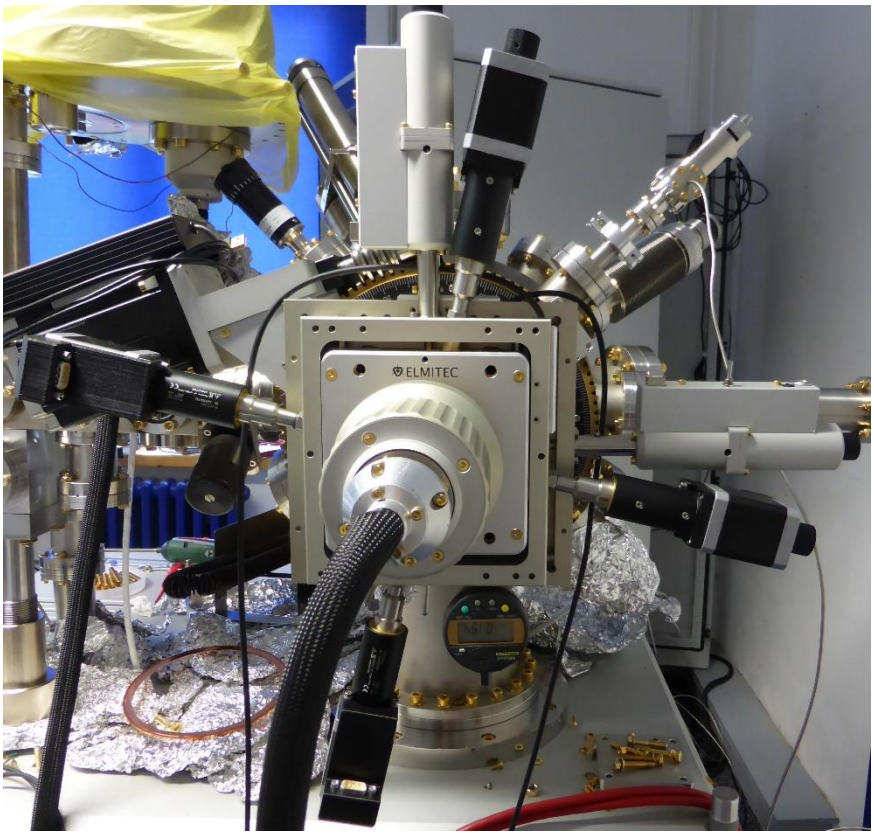


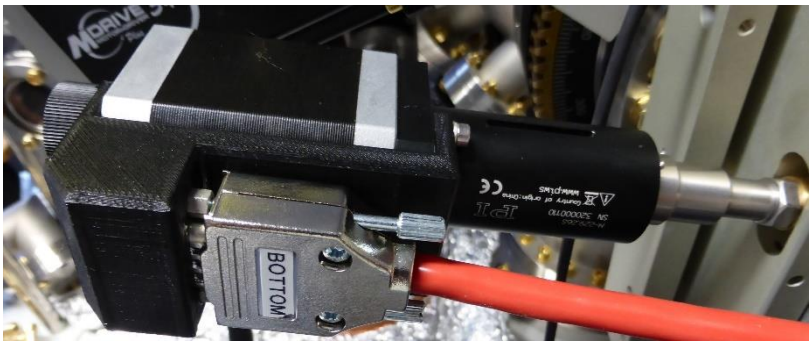
Motor for platform rotation (MDrive)

Manufacturer:	Schneider Electric USA
Type:	MDrive34Plus, MDI1FRD34C7-EQ, integrated controller and driver
Step size:	rotational step of platform: 0.01794 degrees
Electrical specs:	48V supply voltage
Bakeable:	NO
Computer interface:	external RS-422 to USB converter, MD-CC4
Limit switches:	2 external
Encoder:	built-in

Mounted on McAllister rotary platform

Tilt actuators





modified Elmitec M229-26S

original PI M229-26S

Manufacturer:	PI and Elmitec
Type:	modified PI M229-26S
Motor (Elmitec mod.):	Oriental-motor PKP245D15B2 (0.66Nm),

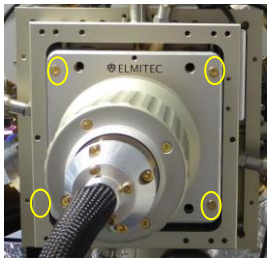
PKP246D15B2 (1Nm).

Electrical specs:	2-phase, bipolar, 4-wire, 24V, 0.66Nm or 1Nm
Actuator:	
Lead screw linear motion:	25mm
Thread pitch:	0.5mm/rev.
Backlash:	10µm
Reference pos. repeatability:	1µm
Step size:	full steps: 1.8 °degrees, 200 steps/rev. with Elmitec microstep controller: 3200 steps/rev.
Design resolution:	with Elmitec microstep controller: 1step = 0,15625µm
Bakeable:	NO
Limit switches:	Reference and limit outputs, Hall effect, OC TTL level, act.low
Manual controls:	hand knob for positioning: clockwise: retract away from manipulator counterclockwise: advance towards manipulator
Connector:	9pin sub-d male
Connector pinout:	

1	Phase 1a
2	Phase 2a
6	Phase 1b
7	Phase 2b
4	REFS
3	NLIMIT
5	GND
8	PLIMIT
9	VCC(+5V)

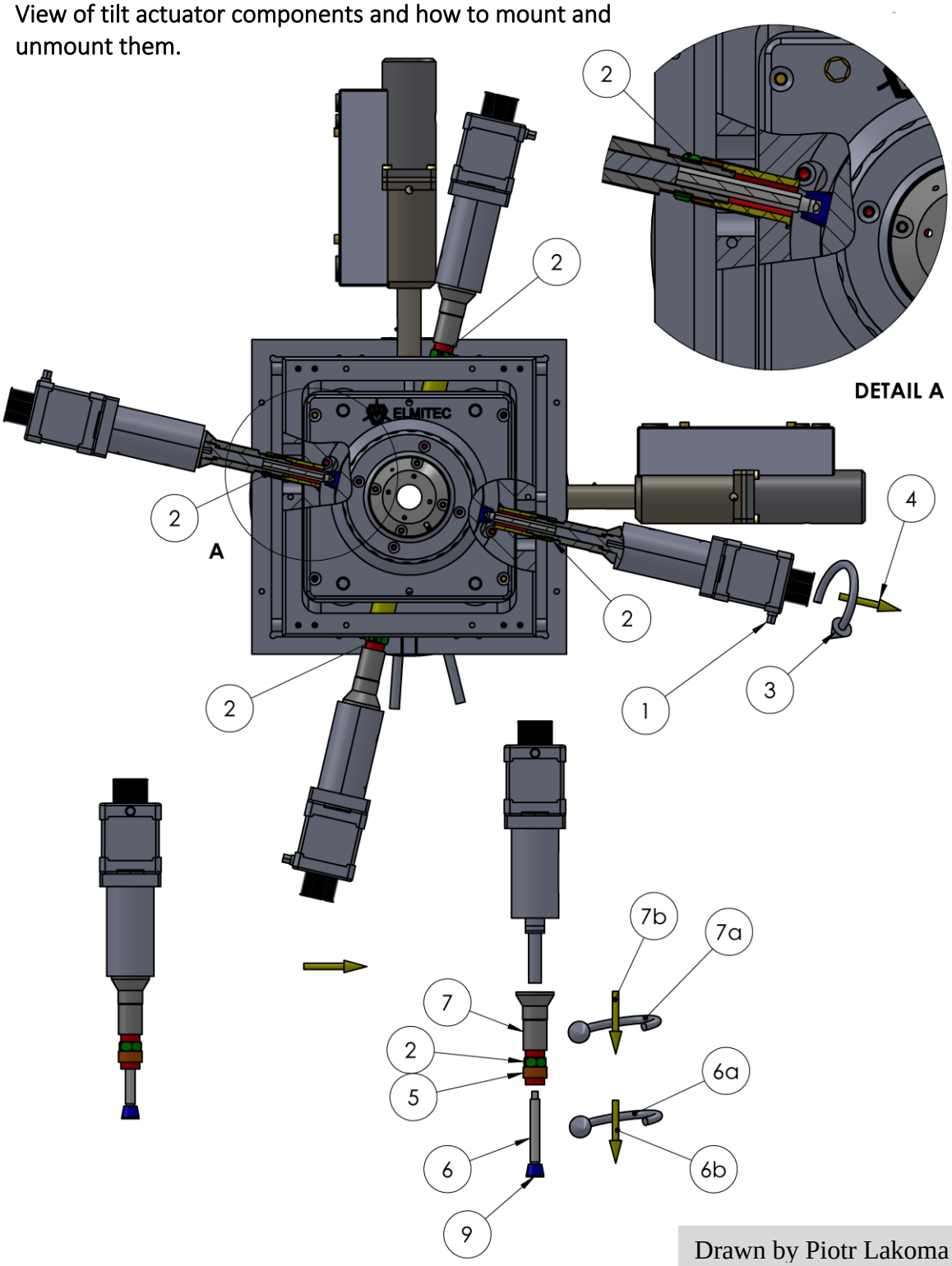
Note: The current position of the actuator can be observed through a slit in the top of the case. A red dot marks the center of the actuator's scale.

Note**:** Make sure to use the correct cables for each actuator and plug them into the correspondingly labelled receptacles in the back of the controller. If this is not done then the centering function in LEEM2000 will *not* work. This means the actuators will *not stop* at the mechanical tilt limit and may damage the manipulator and/or the actuator. Keep in mind that each actuator pair (opposite sides of manipulator) need one 8-conductor cable (thicker) and one 4-conductor cable (thinner). And the 8-conductor cable must be plugged into one of the upper 15pin receptacles (BOTTOM respectively LEFT).
Read the labels attached to actuators, cable connectors and controller back panel and connect accordingly.



Note**:** If one of the motors makes a loud noise check if the handwheel is turning. If not then the tilt mechanism is hard going or stuck. Stop the motors. Try loosening the 4 screws holding the cover plate of the manipulator a bit (circled yellow). Start the motors again. If this does not help the entire tilt mechanism could be stuck – contact Elmitec.

View of tilt actuator components and how to mount and unmount them.

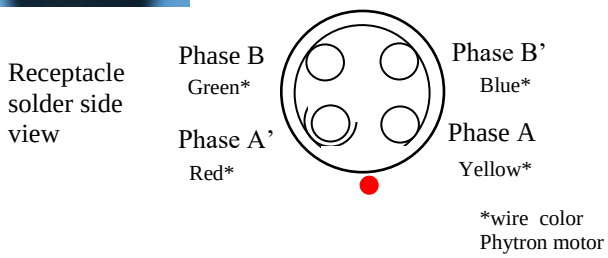


Drawn by Piotr Lakoma

Motor Cables:

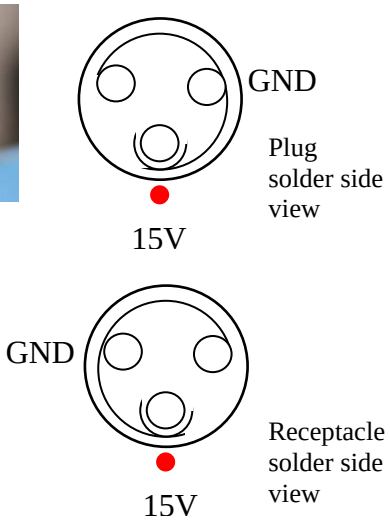
Cable for Aperture motor and Manipulator motor Type B:

Type: 4-conductor, shielded, high temperature
Length: 5m or 10m, Lemo connectors 4pol: FGG.1B.304.CLAD62Z



Cable (power) for X&Y Manipulator motor Type A:

Type: 2-conductor
Length: 5m or 10m, Lemo connectors 3pol: FGG-1B.303.CLAD62Z



Cable for rotary platform motor (MDrive):

Length: 5m or 10m, XLR connectors (Neutric)

Pin 1: GND
Pin 2: n.c.
Pin 3: +48V

Cable for Tilt Actuators

A cable set for the tilt actuators consists of 2x 4-conductor and 2x 8-conductor cables.
Connectors: 15pos sub-d male on the controller end of the cable,
9pos sub-d female on the actuator end of the cable.

A) 8-conductor cable:

Type: 8-conductor, shielded, high temperature
Length: 10m
The 15-pos connector corresponds to the PI layout regarding pins 1,2,9,10,6,7,15

pin	
1	Phase 1a
2	Phase 2a
9	Phase 1b
10	Phase 2b
6	VCC(+5V)
7	GND
14	NLIMIT & PLIMIT
15	REFS

9-pos connector hookup

pin	
1	Phase 1a
2	Phase 2a
6	Phase 1b
7	Phase 2b
3	NLIMIT jumpered to pin 8 PLIMIT
4	REFS
5	GND
9	VCC(+5V)

B) 4-conductor cable:

Type: 4-conductor, shielded, high temperature
Length: 10m
The 15-pos connector corresponds to the PI layout regarding pins 1,2,9,10.

pin	
1	Phase 1a
2	Phase 2a
9	Phase 1b
10	Phase 2b

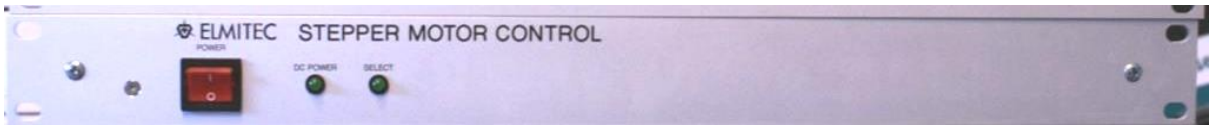
9-pos connector hookup:

pin	
1	Phase 1a
2	Phase 2a
6	Phase 1b
7	Phase 2b

Stepper Motor Control Units

Operating instruction: Turn power on after connecting the motors and before starting LEEM2000 software.

Note (except Control #1): In case the USB/LAN communication with LEEM2000 is lost, turn unit power off and on again after a few seconds. Then open the 'configuration window' in LEEM2000 and wait a few seconds for auto reconnect or press the 'connect' button next to the 'sixstepper controller' respectively 'multimotor'. You may also check the Windows device manager for an Elmitec USB device called 'sixstepper' respectively 'multimotor'.



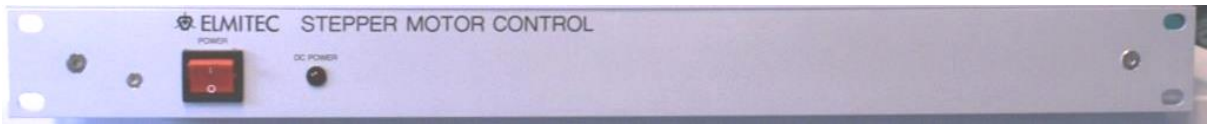
front panel

Front panel indicators: DC-POWER is lit when the internal supply voltage is on. SELECT is lit while the unit is selected by the LEEM2000 software.

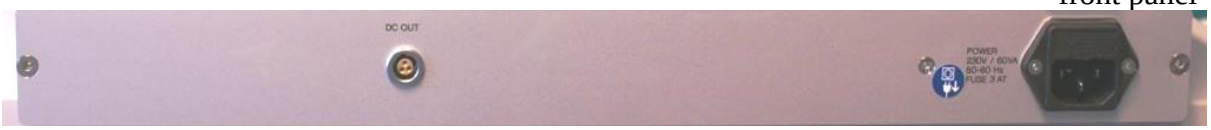
Stepper Motor Control 1

Power supply only

Line voltage:	85-264 V, 50-60 Hz
Fuse:	2 A slow (2 pcs.)
Operating temperature:	-20 to +60 degrees C
EMV-conform according:	EN 50081-1 and EN 50082-1
Computer Interface:	none
Supported motors:	Manipulator Motor A with USB interface



front panel

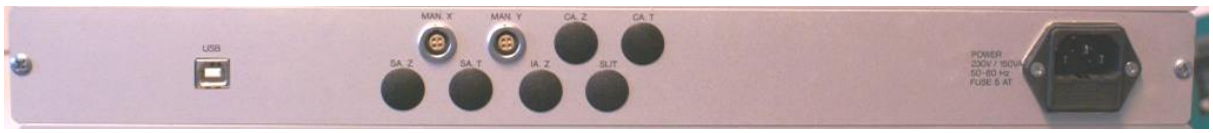


back panel

Stepper Motor Control 2

With up to 8 built in stepper motor controllers and drivers. USB and in some models LAN interface.

Line voltage:	85-264 V, 50-60 Hz
Fuse:	5 A slow (2 pieces). Rating may vary depending on motors used.
Operating temperature:	-20 to +60 degrees C
EMV-conform according:	EN 50081-1 and EN 50082-1
Computer Interface:	USB 2.0 and LAN(optional for selected models)
Supported motors:	Manipulator B motor, Aperture motor and others



back panel

Motor Control 2 [Wuerzburg]

Single stepper motor for translation stage (Oriental Motors PKP-268, 2.8A 0.9degr.).
Unit contains driver circuit, microprocessor, LAN and USB interfaces.
Uses one I.V.B. ES 3 00/ TTL driver module (compared to 2 in the standard *Motor Control 2*)
The unit can be operated stand alone with a simple remote control box (IN and OUT buttons). Pressing any button for a short time will move the motor slowly, holding the button down will increase the motor speed in 3 successive steps.
2 limit switches assure that the motor only runs within a safe range.
Note: because the preparation chamber can be closed with a valve you must make sure you that you do not crash the sample stage into that closed valve. There is no hardware protection to prevent this.

Connectors in the back:

15-pin sub-D (female):

Pin#	*function*
1	phase 1a
9	phase 1b
2	phase 2a
10	phase 2b
3	
11	
4	manual button IN (left button on remote control box)
12	
5	manual button OUT (right button on remote control box)
13	
6	
14	limit switch OUT (normally closed)
7	GND
15	
8	limit switch IN (normally closed)

Motor Control 2 [Juelich]

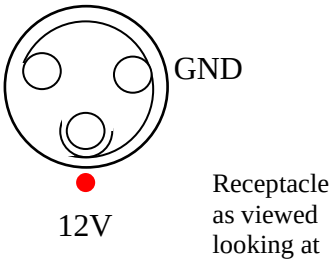
Supports four stepper motor driven actuators for tilt stage (Physical Instruments (PI) M-235.22S)
These four motors are organized in pairs of two with one push and one pull motor each.
When not moving, relays switch the motors from the driver to a fixed voltage.
This is done to hold the motors in place when not moving. Motor drivers are set to ½ step.
Unit contains driver circuits, microprocessor, LAN and USB interfaces.

Connectors on the back panel:

15-pin sub-D (female):
The connectors, as well as cables and motors for the tilt stage are labeled **A1, A2** for one axis and **B1, B2** for the other axis.

Pin#	*function*
1	phase 1a
9	phase 1b
2	phase 2a
10	phase 2b
3	
11	
4	
12	
5	
13	
6	
14	
7	
15	
8	

3-pin Lemo (for X &Y motors):



Motor Control 2 (2020) [DLS, SLS, ELETTRA]

Supports four stepper motor driven actuators for a tilt stage.
Actuator type: Physical Instruments M-229.26S modified to fit Elmitec manipulator and fitted with stronger motors: Oriental-motor PKP245D15B2 (0.66Nm) or PKP246D15B2 (1Nm).
Note: Other PI actuators (with stepper motors) may also be used, but the limit and ref signals could differ!
These four actuators are organized in pairs of two. The reason for 2 actuators per direction is that
we can only 'push' the tilt stage. So, if we want to move "tilt" to the right, the left actuator pushes while the right actuator retracts. If we want to "tilt" to the left then the left actuator retracts and the right actuator pushes.
Center and end positions are supported for "bottom" and "left" actuators. Those two require 8-conductor cables, while "top" and "right" only require 4-conductor cables.

This control unit can optionally include:

a. 48V (200W) supply for platform rotation motor MDrive
b. up to 3 drivers for aperture motors (CA.T, CA.Z and SLIT).
c. 24V supply for X and Y motors.

Unit contains driver circuits, microprocessor control, LAN (Lantronics Xport) and USB 2 interfaces.

Specs:

Line voltage:	110-230V, 50-60 Hz, 410W (ELETTRA), 210W(DLS & SLS)
Fuse (2pcs.):	3.15 A slow (ELETTRA), 2.5A (DLS & SLS)
Internal power supplies: (Meanwell HRP)	24V 200W (Meanwell HRP), opt: 48V 200W
Operating temperature:	-20 to +60 degrees C
Computer Interfaces:	USB 2.0, LAN
Stepper drivers:	microsteps (1/16 step) for "Tilt", ½ step for apertures

Connectors on the back panel:

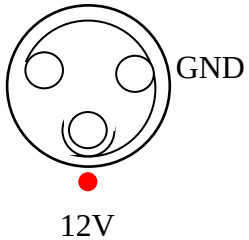
15-pin sub-D (female):
The connectors, as well as cables and actuators for the tilt stage are labeled **BOTTOM, TOP** for one axis and **LEFT, RIGHT** for the other axis.

Pin#	*signal*
1	Phase 1a
9	Phase 1b
2	Phase 2a
10	Phase 2b
3	
11	
4	
12	
5	
13	
6	+5V supply
14	(PLIM)
7	GND
15	REFS
8	NLIM

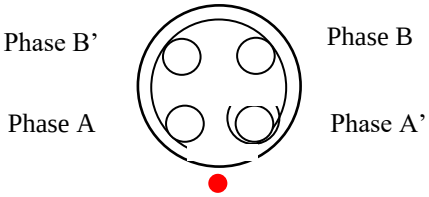
Note: both limit switches (NLIM, PLIM) are tied together inside the 9pin connector. The decision which limit position has been reached is done by controller firmware in conjunction with the reference signal, which is high over one half of the actuator travel range and low over the other half.

Pins 6,7,8,15 are only connected at “bottom” and “left” connector.

3-pin Lemo (24V for X &Y motors):



4-pin Lemo (for aperture motors):

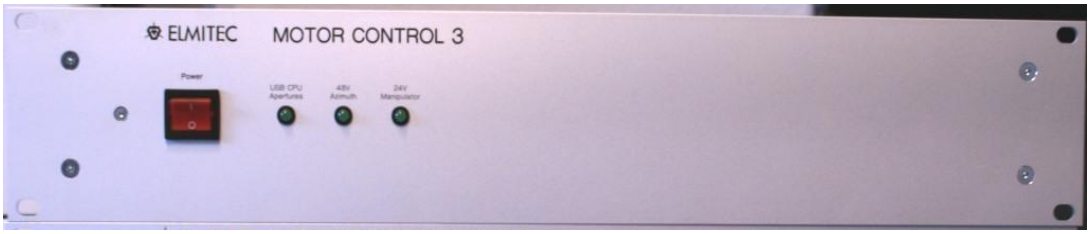


Receptacle as viewed from the backpanel

Motor Control 3

Power supply for platform rotation motor MDrive (48V)
Power supply for manipulator motors
Optional up to 6 stepper motor controllers and drivers with USB interface

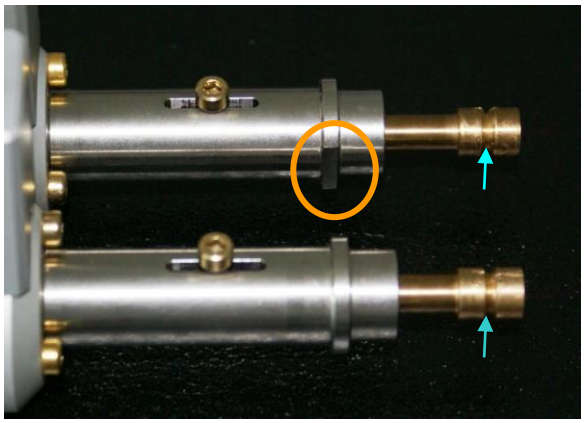
Line voltage:	85-264 V, 50-60 Hz
Fuse:	3.15 A slow (2 pcs.)
Operating temperature:	-20 to +60 degrees C
EMV-conform according:	EN 50081-1 and EN 50082-1
Computer Interface:	USB2
Supported motors:	Manipulator Motor A and B, Aperture motor, Motor for rotary platform



Installation

Manipulator motor

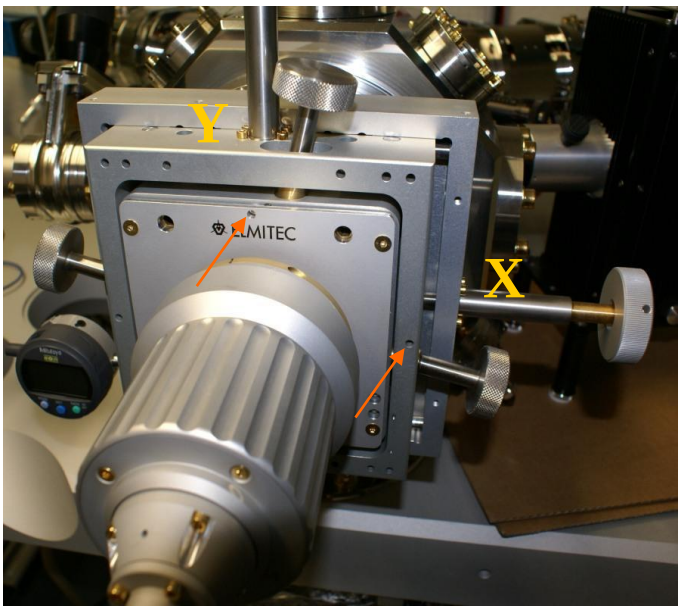
- Attach motors to the manipulator.
  X and Y motors are slightly different. Apart from being recognized by the computer as X or Y they also have small mechanical differences:



Comparison between X and Y motor:

Y: **L**ong pusher and notch (marked orange)

X: **S**hort pusher



After removing the manual drive, insert the motor at the same position and re-fasten the 4 Allen-head screws.
Orientation: the X motor moves the large table, the Y motor the smaller table (see picture).
The Y motor assembly has a notch – without that flattened part it would not fit at its place.
The flattened part must be aligned exactly parallel to the table (else problem with motion)!
The pusher of each motor is locked with a set screw. It is accessible thru a deep hole in the front of both tables (red arrows on left picture).
Prior to affixing the motors, the pusher of each motor must be positioned in a way that the top of the set screw fits into the groove of the pusher (marked blue in picture above);
Moving the pusher can only be done after attaching it to the control unit and using the software (see below).
Note: There is an alternate mounting position on the opposite side of each table for each motor.

Electrical & computer connection of type A motors:

- Connect this motor with the supplies Y cable to the Motor Control unit.
- Connect the USB receptacle (mini or standard depending on model) to the USB host connector in your PC. Use a high quality USB-2 cable up to 5m in length. If necessary use an active USB extender to increase the cable length to 10 m. The motor controller is USB powered. The motor driver section is powered thru an external Motor Control

unit (power supply). It is advisable to used a powered USB hub to connect both motors as well as MDrive
USB converter and Renishaws close to the microscope!

- On your PC the USB devices should be recognized immediately. Follow the Windows driver installation instruction:
    - Supported operating systems are Microsoft Windows 7 and all releases of Win10 (32 and 64bit)
    - On successful installation the 'device manager' will show under Universal Serial Bus:
      Elmitec Steppermotor Interface 1 (Y motor) and/or
      Elmitec Steppermotor Interface 2 (X motor)
- Then start LEEM2000.
    - In the window *System Configuration* (menu *View -> System Configuration*) the boxes next to *Motor&Gauge #1Y* and/or *Motor&Gauge #2X* are checked

Warning: the motor must be mounted to the microscope body or the internal limit contacts will not work and the motor will not stop at the limit position. This will cause damage to some of the motor components!

Warning: motor and electronics must not be subjected to temperatures > about 50 C. A fan can be connected during bakeout, as long as airflow can be maintained (above the bakeout tent).

Electrical connection of type B motors:
Connect this motor with the supplies cable to the Motor Control unit. No further installation necessary.

Aperture motor

Connect this motor with the supplies cable to the Motor Control unit. No further installation necessary.

Motor for platform rotation (Schneider Electric MDrive)

Install Windows driver software (supplied by manufacturer of the motor):
Plug power cable in to connection box and turn *motor control 3* on. Start LEEM2000. Assign COM port for the motor adapter in the *System Configuration Window* right side next to MDrive:

To see which COM port # was assigned by Windows go to device manager (see below)

Warning: never disconnect MDrive power cable unless power supply is turned off!

Driver installation:

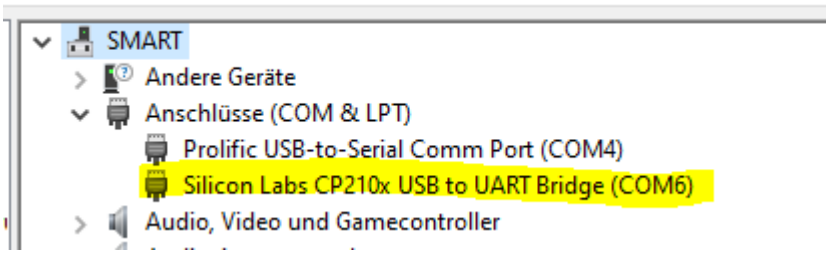
For interface cable: **MD-CC40x-001**

The MD-CC40x-001 drivers are applicable to MDrivePlus and MForce Motion Control RS-422/485 products. This device is "plug-n-play" and the drivers should automatically install to an Internet connected PC. Should your network block automated driver installs or the PC not be connected, the drivers may be downloaded from:

MD-CC40x-001 Drivers (Silicon Labs CP210x USB to UART Bridge VCP)

Installation tutorial

Note: These links will open in a new browser tab/window.



Motor Control 1

- Unpack the unit, insert the unit into your 19” rack and fasten it.
- Connect the power cord to a 110V or 220V outlet.
- Connect the motors through the supplied 5 or 10m Y-cable to the 3 pin LEMO receptacle in back of the unit.
- Continue with installing the motors.

Motor Control 2 (older models with FTDI interface IC)

- Unpack the unit, insert the unit into your 19” rack and fasten it.
- Connect the power cord to a 220V outlet.
- Connect each motor through the supplied 5 or 10m cable to the labelled 4 pin LEMO receptacles in the back of the unit.
- Connect the USB receptacle to the USB host connector in your PC. Use a high quality USB-2 cable up to 5m in length. If necessary use an active USB extender to increase the cable length to 10 m.
- Turn the PC on, if not already done so.
- Close Uview and LEEM2000, if not already done so.
- Turn the unit on using the front panel power switch.
- On your PC the USB device should be recognized immediately. Follow the Windows driver installation instruction:
    - Supported operating systems are Microsoft Windows 7 and all releases of Win10
    - On successful installation the ‘device manager’ will show under Universal Serial Bus:
      Elmitec USB MMOTOR V4 (or other Version number)
    - Then start LEEM2000.
    - In the window *System Configuration* (menu *View -> System Configuration*) the box next to *Multi(Stepper)Motor* is checked

The control unit may also be accessible by virtual COM port to support 64-bit Windows

Motor Control 2 (newer models) and Motor Control 3

- Unpack the unit, insert the unit into your 19" rack and fasten it.
- Connect the power cord to a 110V-220V AC outlet.
- Connect aperture motors through the supplied 5 or 10m cable to the labelled 4 pin LEMO receptacles in the back of the unit.
- Connect manipulator motors through the supplied 5 or 10m Y-cable to the 3 pin LEMO receptacle labelled "manipulator (24V)" in back of the unit.
- Connect azimuth motor (optional) through the supplied 5 or 10m cable to the XLR receptacle labelled "Azimuth (48V)" in the back of the unit.
- Connect tilt motors (optional) using 8- and 4- conductor cables according to the labels.

USB interface:

- Connect the USB receptacle to the USB host connector in your PC. Use a high quality USB-2 cable up to 5m in length. If necessary, use an active USB extender to increase the cable length to 10 m or beyond.
- Turn the PC on, if not already done so.
- Close Uview and LEEM2000, if not already done so.
- Turn the unit on using the front panel power switch.
- On your PC the USB device should be recognized immediately.
    - Supported operating systems are Microsoft Windows 7 and all releases of Win10
    - On successful installation the 'device manager' will show under Universal Serial Bus:
      Elmitec USBXpress device and opening the associated window the 'Detail' tab will read: *Elmitec SixSteppermotor Interface*
    - Then start LEEM2000.
    - In the window *System Configuration* (menu *View -> System Configuration*) the box next to *SixStepperControl* is checked

  LAN interface:
    - Enter the IP address of the Control unit into the corresponding field in the LEEM2000 *system configuration* window (menu *View -> System Configuration*).
    - Restart LEEM2000. In *system configuration* window the box next to *SixStepperControl* is checked if the control unit is recognized.
    - To find the ip address do a network scan (i.e. Advanced IP scanner) or use the supplied tools for the network chip built into the controller. (AKNORD, WIZNET or LANTRONIX)

Motor Operation under LEEM2000

Features:

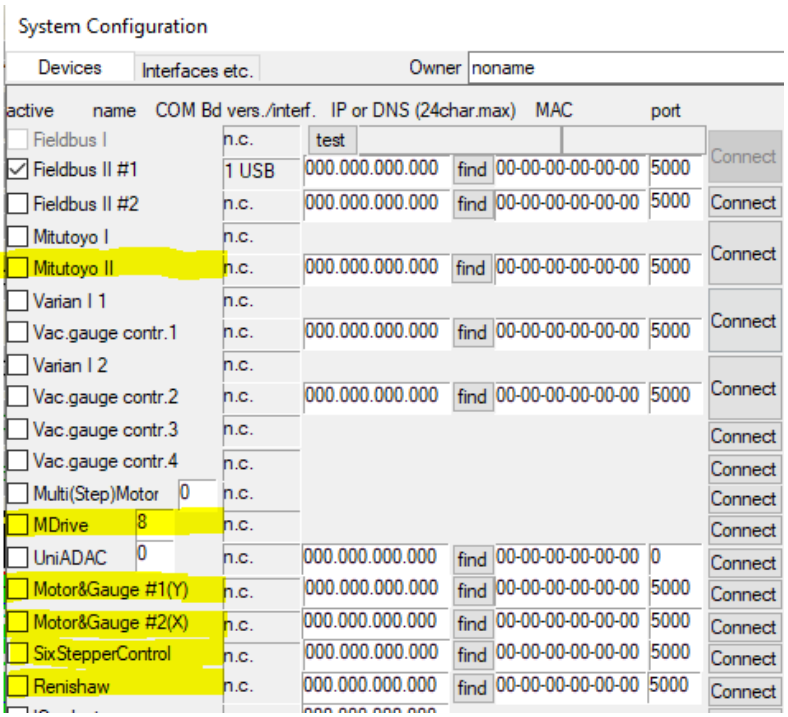
LEEM2000 user interface for motors:
Each motor has an associated control box which contains controls for:

- motion in both directions with selection of distance in micrometers
- movement to up to 7 different pre-programmed position (X and Y)
- movement home (0,0)
- travelled distances displayed in real time
- set-up section allows speed definition, definition of backlash, calibration in micrometer
- all controls either in steps or micrometers
- backlash compensation by software
- one button backlash determination
- support for external micrometers by Mitutoyo and Renishaw as feedback devices for precise movement
- scale calibration, motor test, exercise and calibration functions.

System Configuration Window and Motors

The following sections assume PC to be powered up and LEEM2000 and Uview running.
Also assumed is that motors and controllers are powered up and drivers are installed.

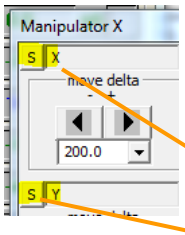
To get to this window click menu *View -> System configuration*.
Under the tab *Devices* you will find all external devices which can be controlled by LEEM2000. The motion related devices are highlighted in the picture to the right. If a device (i.e. manipulator X motor) is physically connected to the PC, powered up and operational then a checkmark is placed to the left of that device. Its version number is being displayed in the *Version* field (not all devices support this feature in which case a 0 is shown).
Should the device become unconnected then LEEM2000 will remove that checkmark automatically and enable the "Connect' button to the right of the device.



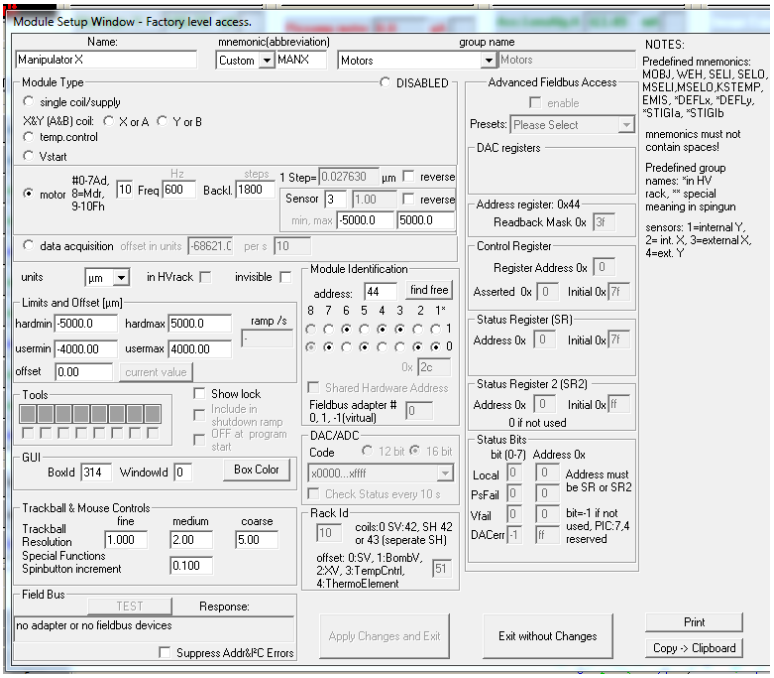
If the device has become disconnected then try press ‘Connect” and see if LEEM2000 can reconnect to that device. If this does not lead to the desired result, try and unplug the device and then plug the USB cable back in. Then press ‘Connect”.
Note: LEEM2000 automatically checks if any device is still connected every few seconds. If LEEM2000 does not find the device it removes the checkmark and disables all controls related to that device. But LEEM2000 does not automatically reconnect to a device unless you press the *Connect* **or** *Connect All* button **or** the *System Configuration - Devices* window is open and *Auto reconnect* is checked **or** LEEM2000 is restarted. Restarting LEEM2000 should rarely, if ever be necessary. Neither will a PC restart be necessary except for power fail conditions or when after strong arcing at the LEEM HV supplies the PC does not work any longer.

Configuration:

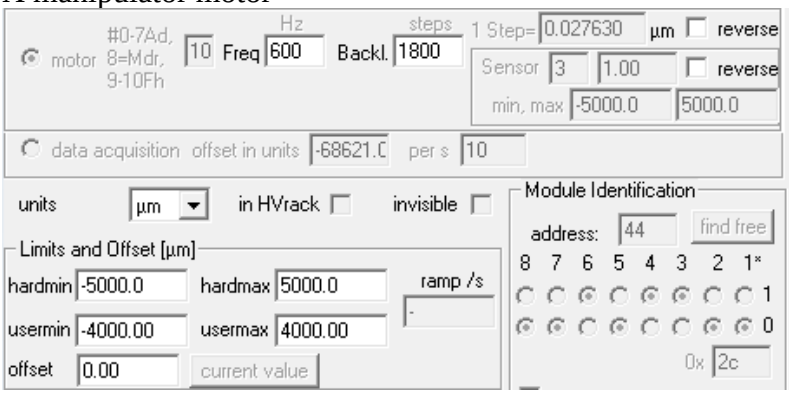
Manipulator Motors Type A:



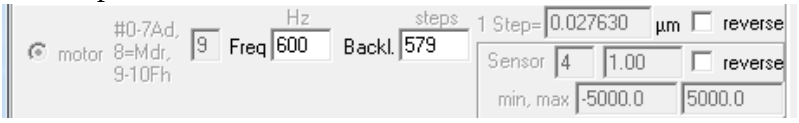
The ‘Setup’ windows for each motor is opened by clicking the ‘S’ button in the Manipulator motor control box.



X manipulator motor



Y manipulator motor

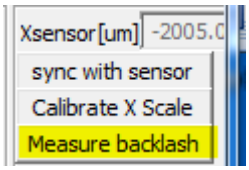


In user mode all of the controls are grayed because they are not supposed to be changed by the user. In supervisor mode some controls are editable:

1. **Frequency** of pulses applied to motor. This determines the speed of the motor. Certain limits must be observed for the maximum frequency: 800Hz. This value may

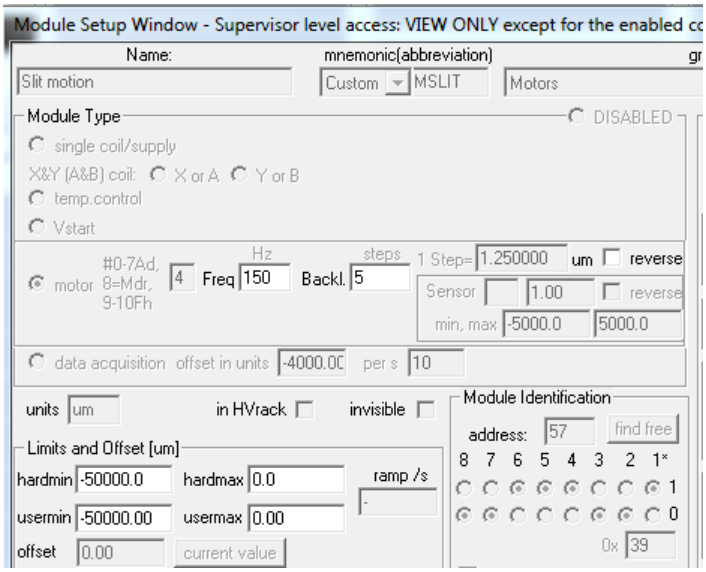
even be lower depending on load and wear of motor components. Values between 200 and 600Hz are recommended. Too high a frequency and the motor just hums, gets hot and does not move at all.

2. **Backlash**: This value describes the number of steps to be applied to the motor when the motor changes direction. Only after these steps are applied the manipulator starts moving in the new direction. The backlash can be determined automatically, assuming a micrometer is connected to the X resp. Y axis of manipulator. To perform this step press "Measure Backlash" in the control box of the desired motor.



3. **Units:** µm or steps. Use µm only. Steps are only for diagnostic purposes and do not support features like *backlash measurement, move under micrometer control* etc. When changing units the software automatically recalculates the *limit setting*.
4. **Limits and Offsets**:
    a. *hardmin, hardmax*: position of contact limiting the movement of the motor.
    b. *Usermin, usermax*: limitation of movement range for the user. This value should be set by the supervisor to a suitable range. If min=max then this feature is disabled.
    c. *offset*: used for version of the motor which uses an internal sensor: allowed values either -2500 or 0 depending on motor type – do not change unless motor is changed
5. **Reverse**: depending on which side of the manipulator the motor is mounted, the manipulator moves in a different, opposite direction when pressing the 'move right' button of the motor control. To correct that the 'reverse' box must be checked if the motor is mounted at the alternate place.
6. **Sensors:** 0: no sensor, 1:internal sensor for Y motor, 2:internal sensor for X motor 3:external sensor X, 4:external sensor Y. External: Mitutoyo or Renishaw. The internal sensor should not be used, they are only for coarse positioning (+/-100 µm). With the use of the Mitutoyo the manipulator may be positioned at an accuracy of +/- 1 µm. The Renishaw gauges allow even higher precision (0.1 µm). But motor motion is limited in reality by drift, motor creep and vibrations etc. .

Aperture motors and tilt actuators:
(and obsolete Manipulator motors type B):

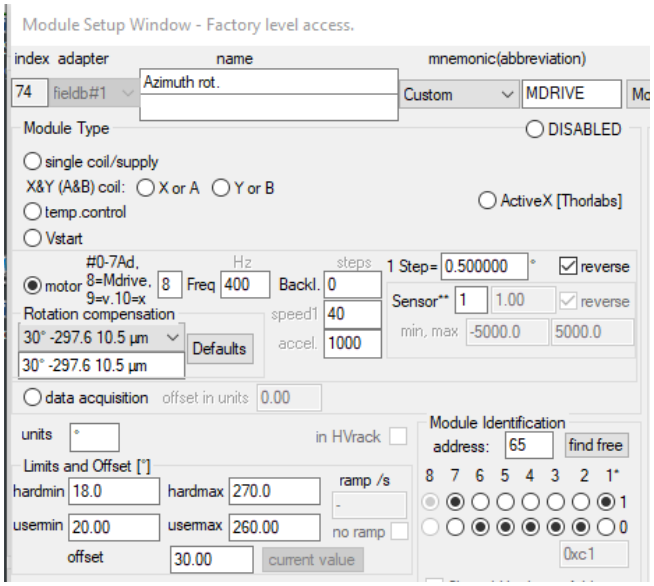


In user mode all of the controls are grayed because they are not supposed to be changed by the user. In supervisor mode some controls are editable:

1. **Frequency** of pulses applied to motor. This determines the speed of the motor. Certain limits must be observed for the maximum frequency: 400Hz. This value may Even be lower depending on load and wear of motor components. Value around 200Hz is recommended.
2. **Backlash**: This value describes the number of steps to be applied to the motor when the motor changes direction. Only after these steps are applied the manipulator starts moving in the new direction. The backlash value has to be determined manually.
3. **Limits**:
    a. *hardmin, hardmax*: position of contact limiting the movement of the motor.
    b. *Usermin, usermax*: limitation of movement range for the user. This value should be set by the supervisor to a suitable range. If min=max then this feature is disabled.
    c. Units: This value can only be set with 'factory' privilege. At the same time units are changed the value for *1 Step*= must be set to 1 and changed back to 1.25* when reverting to µm. Also all the *limit values* must be adjusted manually accordingly.

*value per steps is 0.45µm for the obsolete Manipulator motors type B.

Motor for rotation platform (MDrive)



In user mode all of the controls are grayed because they are not supposed to be changed by the user. In supervisor mode some controls are editable:

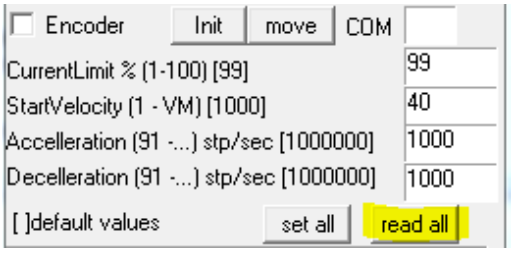
1. **Frequency** of pulses applied to motor. This determines the speed of the motor. Certain limits must be observed for the maximum frequency: 400Hz. This value may

Even be lower depending on load and wear of motor components. Value around 150Hz is recommended.

2. **Backlash**: This value describes the number of steps to be applied to the motor when the motor changes direction. Only after these steps are applied the manipulator starts moving in the new direction. The backlash value has to be determined manually. If backlash has a 0 value then the *Compensate Backlash* button does not appear in the motor control window.
3. **Rot.x,y shift:** After rotating the sample it needs to be shifted in x and y to keep the sample center in its position. There are preset x and y shift values for 30, 45, 60 and 90 degrees rotation. This list only allows to look at the values not to change them.
4. **Rot.x,y shift Defaults:** Set the shift values to their default values as determined by Elmitec.
5. **Limits**:
    a. *hardmin, hardmax*: position of contact limiting the movement of the motor. The values for hardmin and hardmax must be exactly the position of the limit Switches affixed to the rotation table. During automatic scaling the software rotates the table to the limit switches and sets the scale to the *hardmin* and *hardmax* values.
    b. *Usermin, usermax*: limitation of movement range for the user. This value should be set by the supervisor to a suitable range. If min=max then this feature is disabled.
6. **Units**: This value can only be set with 'factory' privilege. At the same time units are changed the value for *1 Step*= must be set to 1 and changed back to **0.01794** when reverting to °. Also all the *limit values* must be adjusted manually accordingly.
   If the MDRIVE has an encoder (part number contains EQ) then each step is 0.44°.
7. **Offset**: for drawing the circular scale, position of the vernier.
8. **Speed1**: motor parameter *startvelocity* (see below)
9. **Accel**: motor parameter *acceleration* (see below) *deceleration* is set to the same value.
10. **Sensor**: '1' encoder present. This must only be set if the motor is equipped with an encoder (-EQ in part number label on motor) '0' no encoder
11. **Step**: with encoder enter: 0.44, without: 0.01794 if unit °(degree) is selected.

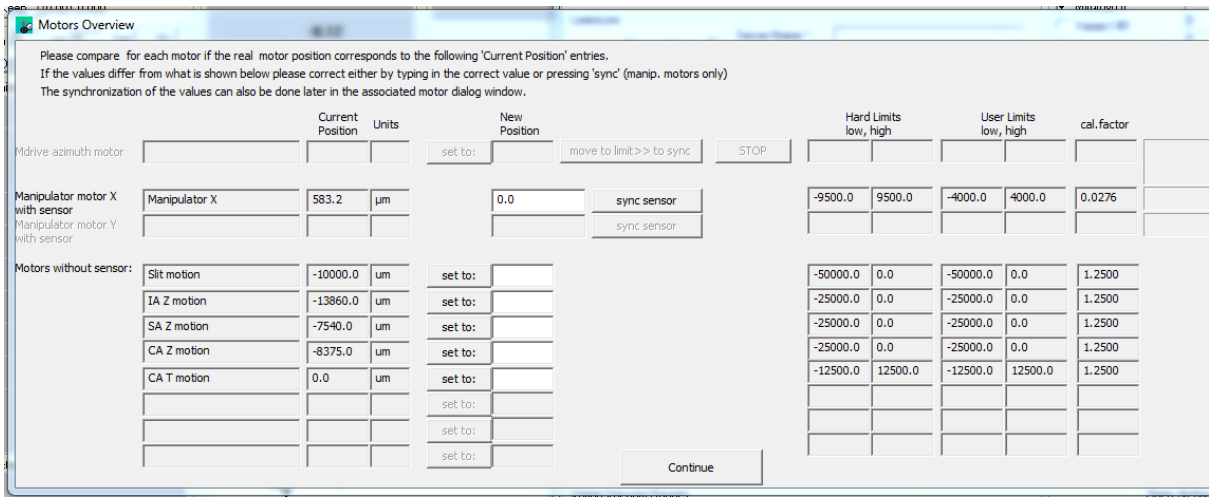
Due to the circular motion the limit values have to be interpreted the following way in the example above: *(hardmin*=310° and *hardmax*=185°):
Rotation possible continuously between angles of 310° thru 360°(0°) to 185°.
Allowed rotation for user 330° thru 360°(0°) to 50°
In case the limit switches are set to for instance 10° and 200°, set *hardmin*=10°,and *hardmax*=200° then a continuous rotation between 10° and 200° is possible.

The MDrive motor controller implements a complex scheme of acceleration and deceleration. These can be viewed and modified thru the *leemcom* interface as well as in the LEEM2000 setup window.
Note*:* ***local access*** must be selected
read all: press this to update the values.



Motors Overview Window:

This window can be opened from within the *System Configuration Window*.
The Motors Overview window should give a summary over which motor is connected and what the current position and limit values are. Some motors do not keep their positions when power has been turned off. This window allows you to enter the current position of each motor manually or where possible synchronize the motor position readout with a sensor (Mitutoyo or Renishaw). The position of MDrive motor, which rotates the platform, can also automatically determined by rotating to a known limit position. All adjustments can also be made at any time in the control box of each motor.



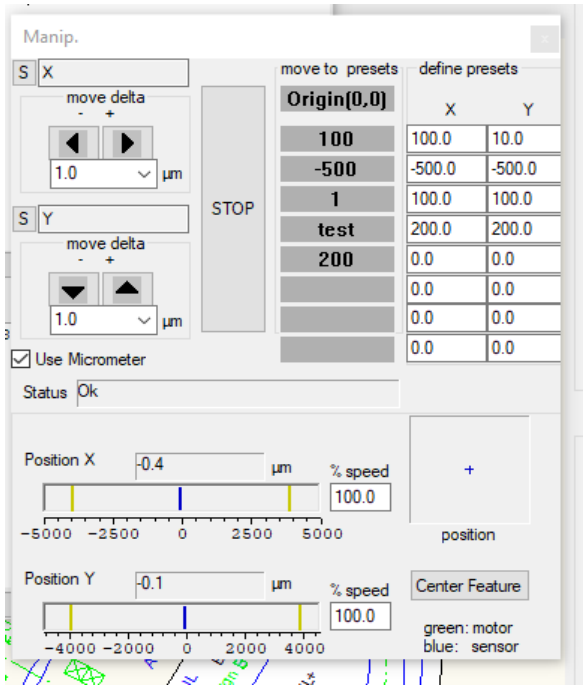
Note: in the following text the words *sensor* and *micrometer* are used synonymously.

Manipulator motors:

User level:

Note 1: The following applies to manipulator motors type A (id '9','10') with external sensor (id '3,'4'). Other motor types or configurations have less options: *Use Micrometer* is not available for type A, sensor '0','1','2', type B (obsolete).
Note 2: It should also be obvious that without a working and connected micrometer some of the features requiring a micrometer do not work. If a Renishaw is used, it has to be synchronized to its reference mark so it reads absolute distances.

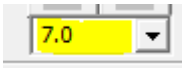
This box contains the controls for:



- **Moving the manipulator in x and y**:

Press one of the buttons and the manipulator will move a certain distance. How much can be selected from the drop-down list below the movement buttons:

The units are displayed next to the list.
You may also enter a value (within limits) into the edit field of the drop-down list, before you press the movement buttons.



During the movement the user-min and max values (defined in *setup window*) are enforced.

- **Stopping the motion:**
  Press the STOP button at any time when you want to stop the movement. This also applies *to move to presets* and all the other supervisor-only procedures (*backlash measurement, calibrate scale, exercise, and the Calibration scan* in factory mode)

  Note: when pressing STOP during x&y *presets* it may be necessary to press STOP times.

- **Move to preset positions**
  Click on one of the 8 *move to preset* buttons to

move the manipulator to the X and Y position displayed in the X and Y fields right next to the button.
  A special case is the *Origin(0,0)* button which will move the manipulator to position 0,0.

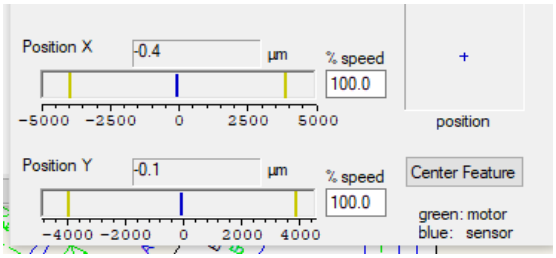
Note that all these positions were referenced to a 0 mark. Prior to using the preset feature, the scale must be calibrated. As long as power is applied to the Mitutoyo or Renishaw micrometers, the calibration remains valid. After that the supervisor has to press *calibrate X scale* and *calibrate Y scale* once before using the Presets. In case of the Renishaw devices, a movement across the reference mark has to be done or else the values displayed have no relation to any real position of the manipulator. As for the Renishaw a green display means that you read referenced distance values. Once the preset position is reached the associated field is colored GREEN.

- **Enter preset positions**
  The user can change the values for a preset X and Y position prior to executing *the move to preset* command. The values must be in range of the *usermin* and *usermax* values in the setup window for the particular device. If these values are exceeded a message showing the limit values is displayed.

- **Compensate backlash**
  When reversing direction, additional steps have to be done by the motor before the manipulator begins moving to overcome the play or backlash of the mechanical components.
  When *Compensate backlash* is selected these steps are inserted by the software automatically.
  If this is selected then moving backwards 100 µm and then moving forward 100 µm will get you to the same spot on the sample. This assumes of course that at one time the number of backlash steps have been correctly determined and entered into the motor setup window.
  With the *Use Micrometer* mode active, the backlash value is not used! Instead the software automatically moves to the correct position under feedback of the micrometer.

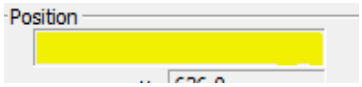
- **Use Micrometer**
  This mode of operation should be activated all the time if micrometers are present
  To see this button enabled, a Mitutoyo micrometer or Renishaw measuring device has to be connected to the axis of the motor and working.
  When active the motor is moved with feedback from the micrometer and positioned exactly at the desired position. When not active, the motor is moved a certain number of steps calculated from a theoretical distance per step value. Under ideal circumstances this will also position the motor at the exact destination position, but with changing backlash, unexpected load condition or obstructions in the way of the movement or a motor power failure the target position is not reached perfectly or not at all. The only draw back is a reduced speed close to the destination position, done to avoid overshooting the target.

- **Position displays**
  If *Use Micrometers* is <u>not</u> checked or <u>not</u> available all numbers and indicators in this control box show the position for the motors where they are supposed to be (either in µm or steps as defined in the setup). If *Use*

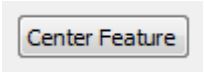


micrometer is checked then the absolute positions are displayed as measured by the micrometers.

- X and Y scales display movement range in µm. Square box to the right displays current position in a 2D space.
- Yellow: user limits
- Red: motor hardware limits
- Green: current motor position
  Blue: current micrometer position
- Message field: displays status and error messages about motor and sensor, for instance:
  Sensor deviation, limit>>, limit>>, no sensor, userlimit!



- **Open the 'Setup' window** 

- **Center Feature**
  This works only 

in conjunction with Uview. You click with your mouse anywhere on the currently acquired image. Then you press *Center Feature*. The motors will now move the sample such that the selected spot on the image will be moved to the center of the image. This will work only correctly only if:
  - a FOV is selected
  - the FOV angle is set correctly
  - the angle shown in the rotation platform (azimuth) motor control window reflects the real angle of the platform.
  - Micrometers are connected – because this feature utilizes *Use Micrometer*

  The current rotation angle of the image is automatically taken into account.

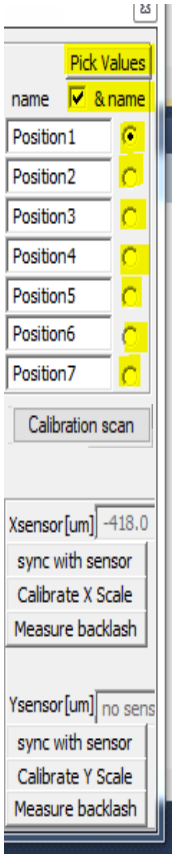
Note: motion control by the trackball is also possible. But due to the large backlash it appears to be very unresponsive and erratic. We therefore discourage that mode of operation.

Supervisor level

Note: the following applies to manipulator motors type A (id ‘9’,’10’) with external sensor (id ‘3,’4’)
Other motor types or configurations have less options

- *Calibrate X(Y)Scale* not available for Type A id ‘0’,‘1’ and ‘2’ and Type B
- *Measure Backlash* not available for Type A id ‘0’,‘1’ and ‘2’ and Type B
- *Sync With Sensor* not available for Type A id ‘0’ and Type B. Instead an edit field *<-sync with input* is displayed. It allows to type in a value which you determine is the correct position of the motor. For instance you can measure and enter the position of the index screw in  the outer motor shaft:

The following additional features become visible and accessible:



- **Name presets (Pick Values, &name):**
  This allows entering a name for the preset (press Enter key afterwards)
  When pressing *Pick values* the current X and Y values are put into the preset field which was selected by clicking the radio button next to it.
  With *&name* checked, the program automatically generates a new name for the preset as follows: *(x value, y value).*
  Note: the values picked by the program are depending on the setting of *Use Micrometer* either the readout of the micrometer or the current motor values. It should be obvious that the entered values must be referenced to a know position or else they will not repeatable if power is turned off.

- **Sync with sensor**
  Sets the current motor position to the readout of the micrometer

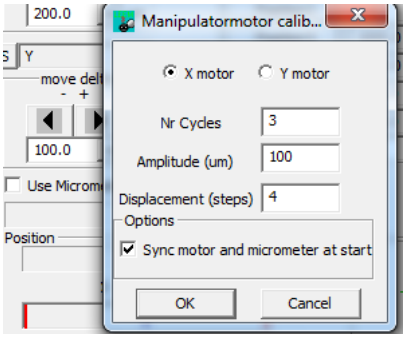
- **Calibrate Scale (X or Y)**
  (Works only with micrometers connected and working)
  - moves the motor until it reaches its built-in limit switch
  - reads at that point the micrometer
  - moves to the opposite limit switch
  - reads micrometer again
  - moves half the full distance back
  - asks to set the Mitutoyo to 0.0 or in case of the Renishaw does this automatically
  - sets the scale to the values of the micrometer
  - sets the current motor position to the same as the micrometer readout
    This procedure takes several minutes. At each step the program asks if you want to continue.
    Make sure the Mitutoyo is mounted in a way that it does not bottom out (reach end of its range) or else a message “movement stalled’ is displayed and the procedure is aborted.

  During the procedure a box with progress bar and progress messages is displayed.
  The procedure can be interrupted at any time by pressing STOP.

- **Measure backlash**
  (Works only with micrometers connected and working)
  - motor is moved in one direction a certain distance (100 µm) much bigger than any backlash.
  - the motor position (in steps) N1 is noted
  - motor is moved in opposite direction until a motion is detected at the micrometer
  - the motor position (in steps) N2 is noted
  - the difference N2-N1 is the backlash
  - user is asked if this new value should be entered as the backlash into the motor setup

  During the procedure a box with progress bar and progress messages is displayed. The procedure can be interrupted by pressing STOP.

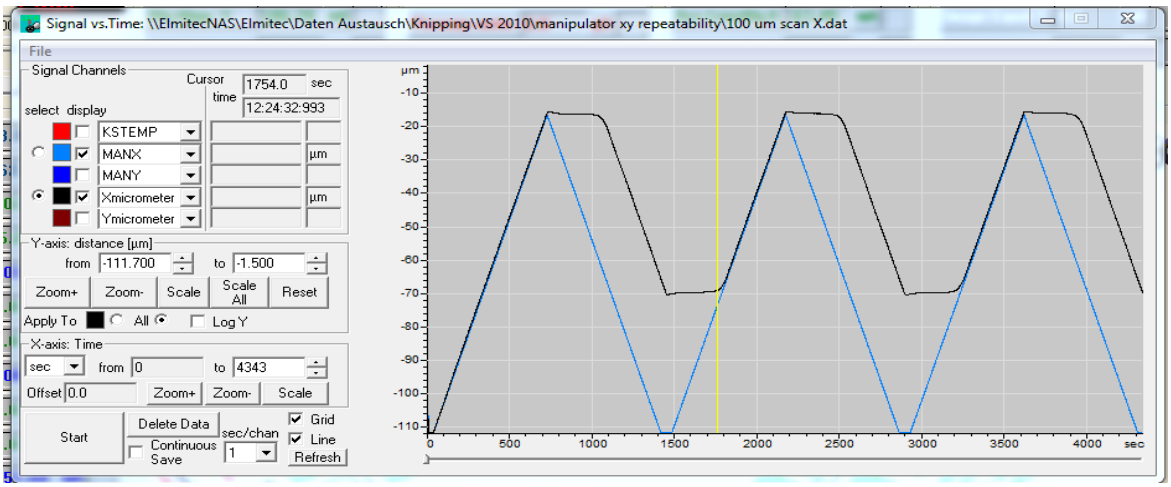
- **Calibration scan**



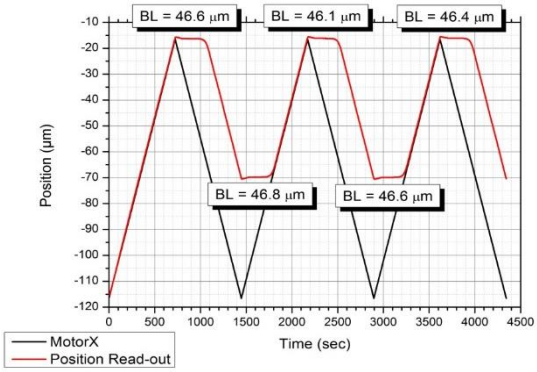
A saw tooth ramp is generated with a user defined Amplitude, *Number of cycles* and *size of ramp steps (displacement)* for either the X or Y motor. The data are recorded in *the Signal vs. Time* graph. Motor steps and micrometer readouts are synchronized.
When clicking on *Calibration Scan* the initial window (left) is displayed, allowing you to enter the ramp parameters. After clicking OK the Signal vs. Time window is opened, the channels are automatically set to the correct values and data acquisition is started together with the ramp. Acquired are the steps to the X and Y motors and the readouts of both micrometers.

Note: *Use micrometer* button is ignored (off during procedure)
Comp. Backlash is ignored (off during procedure)
Calibration scan not available for Type A id '0', '1' and '2' and Type B.

The resulting graph for a 100um scan looks like:

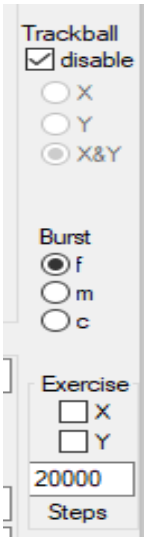


A calibration scan can be used to easily determine the backlash.



Note: for type A manipulator motors position information is lost when disconnecting USB cable from motor or turning off/disconnecting USB hub or turning PC off if PC is directly connected to motor without a hub. But LEEM2000 retains the last position value even after closed. A discrepancy will occur if a motor is exchanged with another or if the motor is moved externally.
Closing LEEM2000 or disconnecting motor power cable has no effect on retaining the current position.
Turning off and then on the Micrometers will in case of the Renishaws change their position value.
The must be synchronised with their reference mark.
Making any position changes on the micrometers or motors will of course require a recalibration of the X or Y scale. Micrometers are only mentioned here if motor setup is made for external sensors.

Factory level

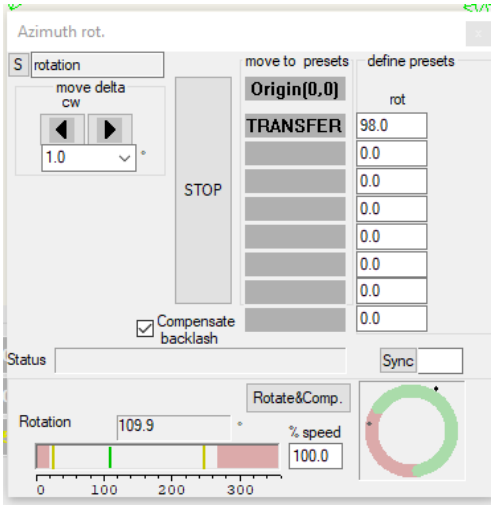


Note: the following applies to manipulator motors type A (id ‘9’,’10’) with external sensor (id ‘3,’4’)
Other motor types or configurations have less options.

Two more features become visible:

- **Exercise**
  A saw tooth ramp with a selectable number of S*teps* is performed on the X and/or Y motor. To start the ramp click the X or Y box. Stop by clicking the box again.
  This ramp can be plotted in the *signal vs. time* window.
  In *the Signal Channel lists* select MANX, MANY, X Micrometer (channel 4 only) and Y micrometer (Channel 5 only).
  Use micrometer must be <u>off</u> or you will get the same data for the MANX, XMicrometer pair and also for MANY, YMicrometer.
  Note: in this mode of operation the signal vs. time plot is not synchronised and quite coarse because only every second a measurement is taken. If you need a precise record of the motor movements use the *Calibration Scan* above.
- **Trackball** Control motor(s) with trackball.
  - Move only X, Y or both motors or disable this feature
  - Make small, medium or large bursts of movements with trackball.

Motor for platform rotation (MDrive)



User level:

same as described under *Manipulator Motors* except for:

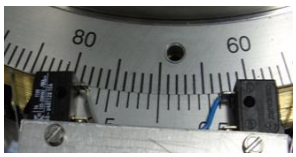
- Controls related to micrometers are missing
- Units are degrees.
- Circular nature of rotation requires a different interpretation of the displayed scale. In the current case the minimum value for the movement is 20° and maximum is 280° - set by 2 limit switches.
  The scale (see right picture) has to be interpreted this way: valid range 20° to 280° (green). Invalid range: 0° to 19° to 281° to 360° (red). User range set from 25° to 175° (yellow lines)
  There is a second circular display which will show the vernier position (black dot outside the ring). 0° is marked with a black dot on the inside of the ring.
  The ring will rotate in sync with the motorized manipulator rotation.

  Note: Depending on the microscope setup, the range of movement could be split at 0° into 2 parts (one above 0°, one below 360°). The software will support this and the user interface enforces these ranges. For instance, when you press the < button near 0° the green cursor will move to the right of the scale and continue there at values <360° and so forth.
- Transfer position: position to transfer the sample. This is also the position for measuring the FOV angles. This must be entered correctly or features like "center-feature" will not work correcly!

Supervisor level:

same as described under *Manipulator Motor* except for:

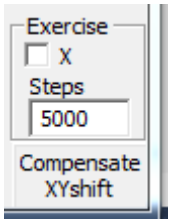
- *Sync with input*: sets the current MDrive position display to the value entered into the edit field *with input.* This value above <-*sync* must be read of the vernier scale of the rotation table.



- *Sync to closest limit.* Automatic method of obtaining the rotation angle of the rotation platform. The motor rotates until the low (high) limit switch activates. Then it takes the value in the Motor setup for the minimum (maximum) angle and uses that for the current rotation angle position. Because of certain tolerances of the limit switch this position may not be more accurate than 1°.
  Whether the motors turns towards the low or to the high limit switch will depend on the current position of the motor. Of course that may be unknown, so you either enter an approximate values into *the sync with input* field or you let the motor turn on its own.
  Note: the search for a limit switch will be terminated for safety reasons automatically after a rotation of 90° (if no switch was found of course).

Note: position information (degrees) are lost when turning motor supply off. Closing LEEM2000, turning PC off, disconnecting USB cable has no effect on retaining the current position.

Factory level:



- *Exercise function:*
  A saw tooth ramp with a selectable number of S*teps* is performed.
  Start by clicking box X. Stop by clicking the box again.

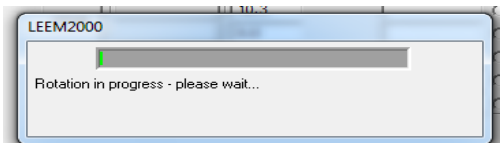
User level (continued):

- *Rotate and Compensate XY shift*
  After a rotation is performed the centre of the sample maybe displaced.
  This displacement is compensated by a software procedure. A window is displayed guiding the user. This procedure works together with Uview to display 2 images – one before the rotation, one afterwards. At any time this procedure can be aborted or stepped back to the previous operation step. Here are the messages displayed in sequence:

1. The user is instructed to move a memorable object into the center of the image.
   Press *continue*.

2. Then the rotation (between +/-1° and 90°) is performed.
   Enter *rotation* angle & Press *continue*.

While moving a progress bar is show:

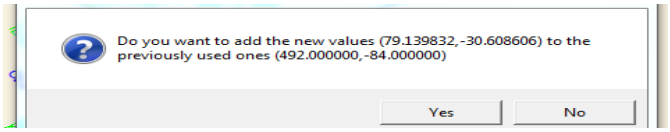


3. After that the displacement is corrected thru a movement of the x and y manipulator motors.
   Press *continue*.

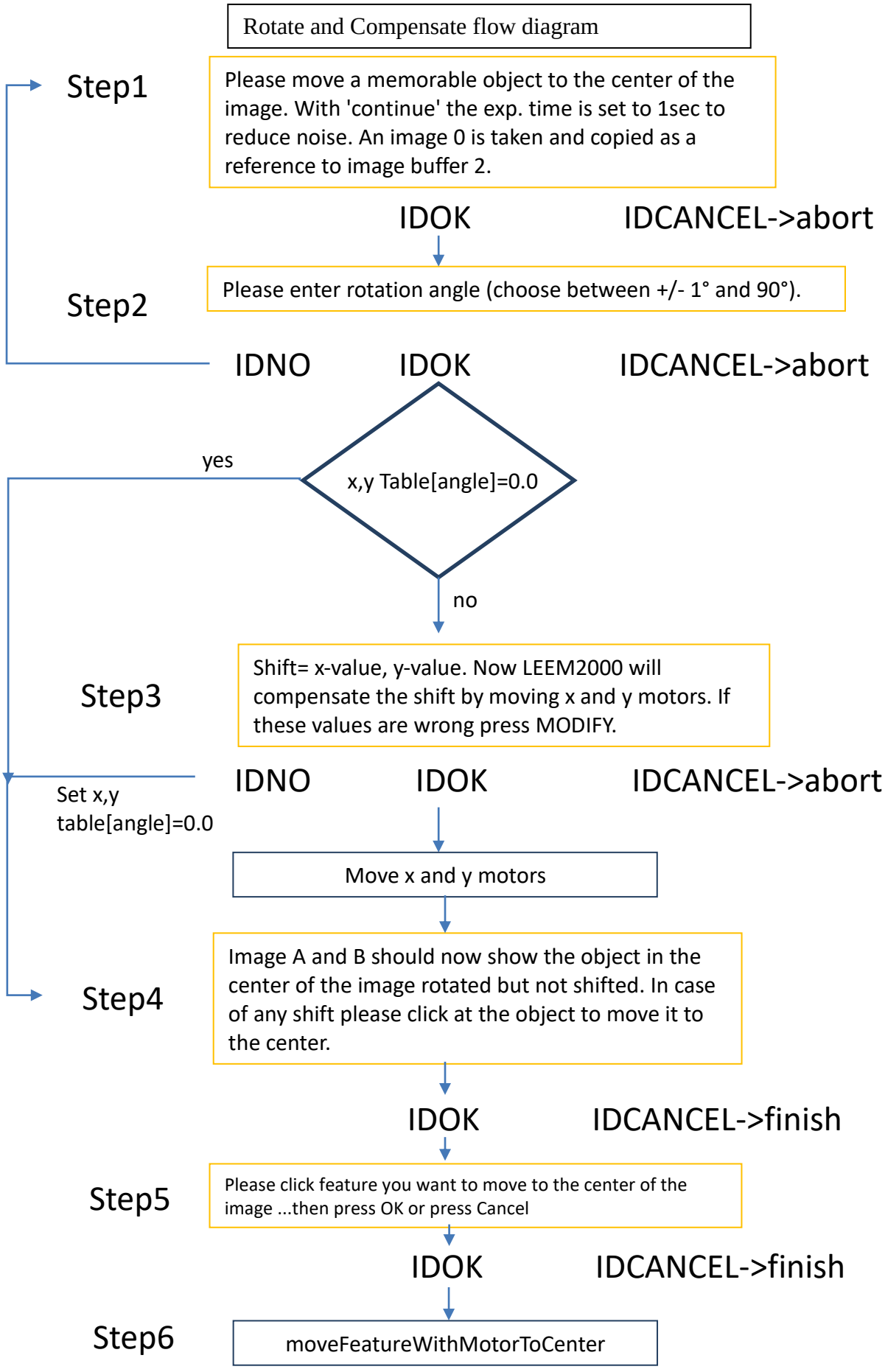
4. The user is then asked if the memorable object is indeed centered now.
   Press *continue* Or *Abort.*

5. If not, the user may click on the object and perform a *Center Feature* operation.

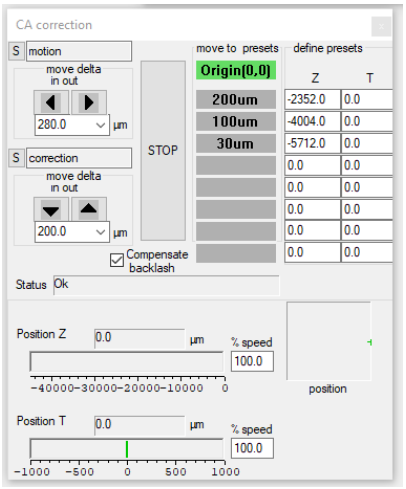
6. After that the difference in shifting distances may be added to the current values for the next time the rotation is performed.



See also the flow diagram on the next page.


Rotate and Compensate flow diagram
Step1
Please move a memorable object to the center of the image. With 'continue' the exp. time is set to 1sec to reduce noise. An image 0 is taken and copied as a reference to image buffer 2.
IDOK
IDCANCEL->abort
Step2
Please enter rotation angle (choose between +/- 1° and 90°).
IDNO
IDOK
IDCANCEL->abort
yes
x,y Table[angle]=0.0
no
Step3
Shift= x-value, y-value. Now LEEM2000 will compensate the shift by moving x and y motors. If these values are wrong press MODIFY.
IDNO
IDOK
IDCANCEL->abort
Set x,y table[angle]=0.0
Move x and y motors
Step4
Image A and B should now show the object in the center of the image rotated but not shifted. In case of any shift please click at the object to move it to the center.
IDOK
IDCANCEL->finish
Step5
Please click feature you want to move to the center of the image ...then press OK or press Cancel
IDOK
IDCANCEL->finish
Step6
moveFeatureWithMotorToCenter

Aperture motor & Manipulator motor type B



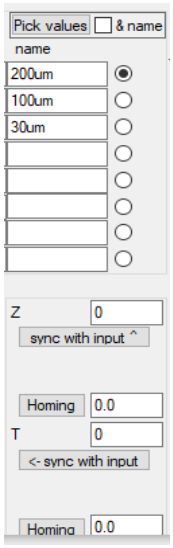
User level:

same as described under *Manipulator Motors* except for:

- Controls related to micrometers are missing

Supervisor level:

- *Name presets* (Pick Values, &name):
  This allows entering a name for the preset (press Enter key afterwards)
  When pressing *Pick values* the current X and Y values are put into the preset field which was selected by clicking the radio button next to it.
  With *&name* checked, the program automatically generates a new name for the preset as follows: *(x value, y value).*
  Note: the values picked by the program are depending on the setting of *Use Micrometer* either the readout of the micrometer or the current motor values.



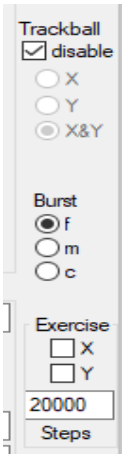
- *Sync with input*: sets the current motor position equals the value entered into the edit field above <-*sync with input.*
  To set the motor position to a certain value proceed as follows:
  - Move the motor to a defined position,
  - Type corresponding position value (i.e. 0.0) into the <-*sync with inpu*t edit field
  - Press the <-*sync with inpu*t button

Note: Position information is saved in LEEM2000. Closing LEEM2000, turning PC off, disconnecting USB cable has no effect on retaining the position value.
But because the motors itself have not measureing capabilities, the position values saved in LEEM2000 become meaningless once the motors or linear feedthoughs for the apertures are removed, exchanged or manually altered. In that case do a *sync with input* .

- *Homing*: The aperture motors do not have limit switches. When homing is performed the motor moves a distance as defined in the field next to *homing*. This distance should be a bit larger than the maximum distance a motor can move, so it is assured that the motor actuator can reach the start position even if it was positioned far away prior to *homing*. Be aware that the motor will not stop at the mechanical limit.

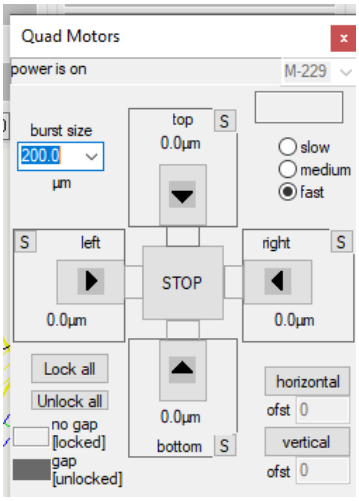
  When finished the displayed position is set to 0.0.
  This operation can also be performed when exiting LEEM2000.

Factory level:



- *Exercise:*
  A saw tooth ramp with a selectable number of S*teps* is performed on the X and/or Y motor. To start the ramp, click X or Y box. Stop by clicking the box again.
- *Trackball*: Control motor(s) with trackball.
  - Move only X, Y or both motors or disable this feature
  - Make small, medium or large bursts of movements with trackball.

Tilt actuators



This window depicts the way the motors are mounted and the way they move the tilt mechanism. This diagram shows the initially assumed position: all motors locked

The four tilt motorized actuators are organized in pairs of two. The reason for two actuators per direction is that the tilt stage can only be 'pushed'. So, if you want to move "tilt" to the right, the left actuator pushes while the right actuator retracts. If you want to "tilt" to the left then the left actuator retracts and the right actuator pushes.

When the movement switches directions, the actuator which previously 'pushed' will be retracted by ¼ turn or 800 steps before it begins moving backwards. The opposite actuator will move forward ¼ turn.
This ¼ turn '*gap'* value can be changed with supervisor privileges.

The actuators mounted perpendicular to the active ones will also be retracted by this amount. This may not be necessary and can be turn off in supervisor level.
Be aware that because of those additional motor movements it will take 2 or 3 seconds for the selected actuator to actually do what you expect.
The software keeps track of the locked and unlocked states and depicts them in the diagram shown in the *Quad Motor* window (see right).

Next to each movement button the travel distance is displayed. Where the value for the right (resp. bottom) actuator is the negative of the value for the left (resp. top) actuator.

Note: Labelling is done for a vertically mounted manipulator. If the manipulator is mounted horizontally then *upward*, *downward* becomes *backward*, *forward*.

User level:

- *Symbols:*


depicts an actuator which is locked, that means moved close to the tilt mechanism such that it touches it (no gap). This can be achieved manually by turning the hand-knob ccw (counter clockwise) until resistance is felt. Don't tighten too much.


Depicts an actuator which is unlocked. This can be achieved by turning the hand knob about ¼ turn cw (clockwise). This corresponds to a actuator movement of 800 (micro)steps.

- *Movement buttons:*


Left actuator pushes tilt mechanism to the right


Right actuator pushes to the left


Bottom actuator pushed upwards


Top actuator pushes downwards

Stops all actuator movements immediately.

- *Burst size:* the distance the actuators move when pressing one of the *movement buttons*. You can either use small burst sizes and press multiple times the *movement button* or use a large burst size and hit the STOP button when you see that the desired tilt has been reached while observing the live image.

- *Actuator Speed:* movement speed of the actuators. These are derived from percentages of the speed defined in the setup window (for instance *fast*=100% of the *frequency* value in the module setup window)

- *Automatic centering:* The actuators have a reference sensor (Hall effect type sensor) which is situated in the middle if the actuator's scale. By pressing the *horizontal* or *vertical centering* buttons, the motor moves the selected actuator to this position. The software does a first approach at high speed, then, once the reference position has been reached, reverses at a very low speed to stop exactly at that position.
  Also because the repeatability of reaching this position strongly depends on the approach direction, the software always approaches the reference position from the same side.
  This is the reason that the centering may take some time (about 1 min). Please be patient

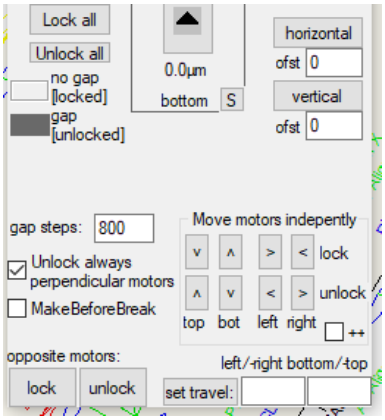
- *Centering offsets:* Because the actuator center position does not match the tilt center (zero) position an offset movement is performed after the actuator center has been reached. The amount of movement done for horizonal and vertical offset can be entered into the corresponding fields by the supervisor and has to be determined once.

- *Lock all:* moves all actuators which are presently not *locked* ¼ turn (or *gap* size) towards the center of the manipulator, thus locking the tilt mechanism in place.

- *Unlock all:* opposite of above: moves all actuators which are presently *locked* ¼ turn (or *gap* size) away from the center of the manipulator, thus unlocking the tilt mechanism.

- *Actuator type:* Supported types are PI M239 or L228. Selection can only be made as supervisor. Both actuators have different *limit* and *centering* signal levels, thus *centering* will not work with the wrong setting and may damage both manipulator and actuator. The L228 also needs a slightly modified controller because the limit signals cannot be connected together. *Note*: the limit switches are not utilized presently because the maximum actuator movement for both types of actuators is larger than the tilt mechanism movement which means the actuator limits will never be reached. The only case the limit switches activate occurs when the actuators are not mounted correctly.

Supervisor and Factory level:

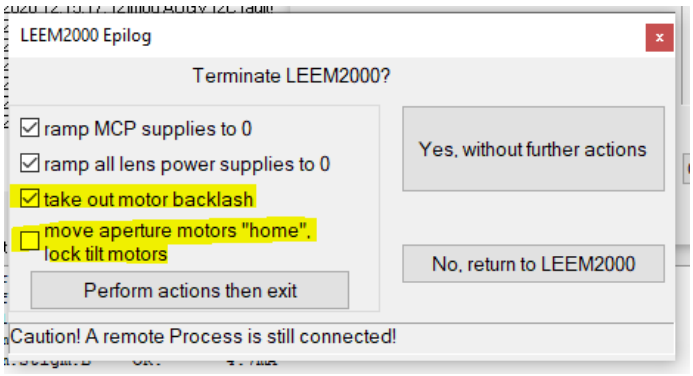


- *Centering offsets:* see description in previous section
- *Gap size:* see text throughout previous section
- *Actuator type:* see description in previous section

- *Unlock perpendicular actuators always:*
  When checked, both actuators perpendicular to the currently selected and still locked are retracted by ¼-turn (or gap size) when current movement commences for the first time. This procedure will slow down switching from one actuator axis to the other.
  If unchecked, no retraction is done, which would mean that at least one perpendicular actuator has contact with the tilt mechanism. This may or may not be hampering the movement of the currently selected actuators.
- *Make-before-break:* experimental setting (not saved when closing LEEM2000):
  When switching directions, closing the gap at one end of the tilt mechanism and opening the gap at the other end is done simultaneously if this option is not selected.
  This saves time.
  If *Make-before-break* is selected, then the actuators at each end are moved individually, first closing the gap on one end, then opening the gap at the other. This slows down switching directions.
- *Lock & unlock actuators independently:* Here each actuator can be individually advanced or retracted by one gap size, if the diagram not already shows the actuator to be in the requested state. This restriction can be circumvented by clicking the ++ button.
- *Lock & unlock opposite actuators:* Does just as the labels indicate, left and top actuators are locked (respectively unlocked) if there is not already one on each axis locked (respectively unlocked).
- *Set travel* display: sets the in the diagram displayed distance values for each actuator-pair to the value entered in the associated field.

Motor related messages when closing LEEM2000:

When closing LEEM2000 the following messages are displayed if any motors are present.



Take out motor backlash:
This option is displayed if the least recent motor movement on at least one motor was *backward*s.
This is done to put all motors into the same known state at the close of LEEM2000. At startup LEEM2000 would not know otherwise in which direction each motor has moved last. It could not apply the correct backlash correction if the movement direction was different from the one just before the close of LEEM2000. So please press YES and wait a moment for the movement to complete.
Applies to all motors.

Move aperture motors "home" and lock tilt motors (actuators):
If any of those motor types are present this option is shown.
Aperture motors will be moved to the home position.
Tilt actuator will be locked, which means a 1/4 turn ccw movement on all unlock tilt actuator.

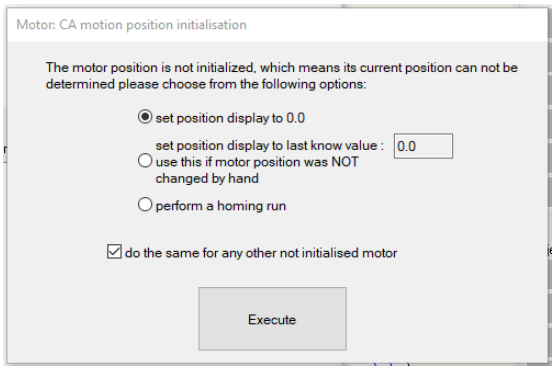
Motor related messages when starting LEEM2000:

Elmitec motor controllers do not keep position information after power is turned off.
LEEM2000 on the other hand saves this information when closed.
This means when the controller is turned on the last motor positions can be restored through LEEM2000. For this purpose, LEEM2000 will display motor initialisation windows

- if motor controller was turned on prior to starting LEEM2000
- if motor controller was turned off and on while LEEM2000 is running

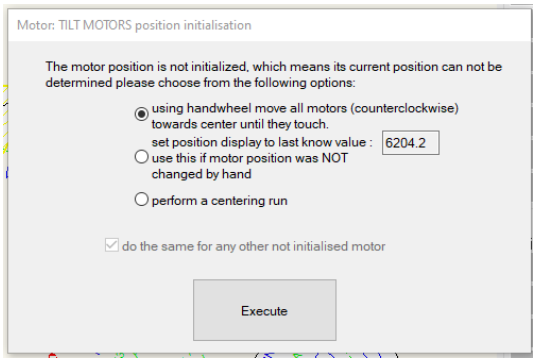
The initialisation windows look a little different for aperture motors versus tilt motors.

For aperture motors the following options are presented



- set position display to 0.0
- set position display to last known value. This is the value saved by LEEM2000.
  Choose this option if you have not moved the motor position by hand or otherwise
  Since LEEM2000 was last connected to this motor.
- perform a *homing* run. This will move the motor a certain distance as defined in the motor control window. Most of our motors do not have end switches, so *homing* will move the motor to likely beyond the mechanical limit to make sure the initial position has been reached.
- The box “do the same for any other not initialised motor” if checked means the option selected
  above will be performed on all other aperture motors.

For tilt actuators the following options are presented

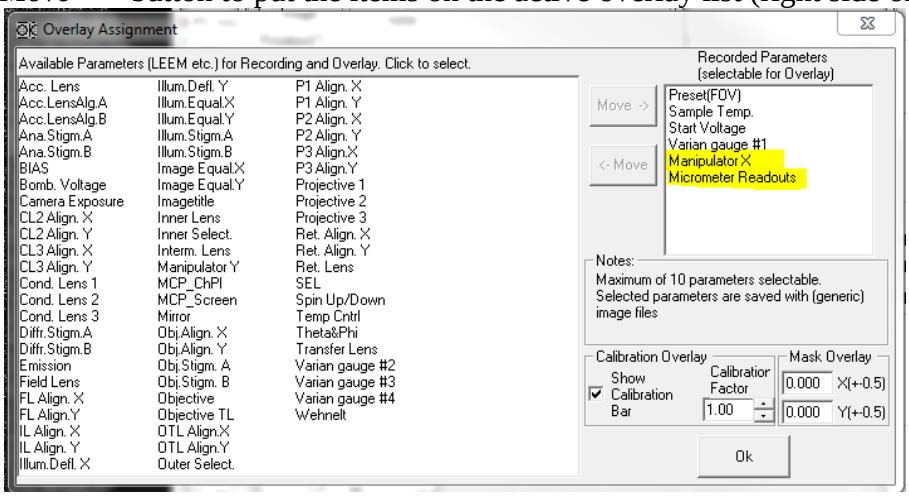


- Turn each of the 4 handwheels counter clockwise until you feel a resistance. This will *lock* the tilt actuator.
  This is a very important step after the actuators have been mounted or the manipulator shipped. LEEM2000 does not know the position of the actuators, so when starting LEEM2000 the program makes the assumption that the actuators are locked. All further operations the software performs with the actuators depend on this assumption.
- set position display to last known value. This is the same as for aperture motors.
- perform a *centering* run. Tilt actuator have a *reference* indicator. The centering run will move the actuator until this indicator is reached, then move further depending on the offset value given in the *quad motor* window and then set the position indicator to 0.0.
  This operation can also be done from within the *quad motor* window.
- The box “do the same for any other not initialised motor” if checked means the option selected
  Above will be performed on all four tilt actuator.

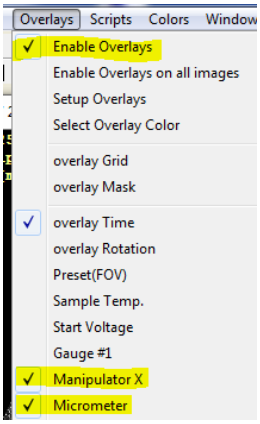
Motor support in Uview:

Motor steps and micrometer readout can be displayed as overlays on all images acquired with Uview.

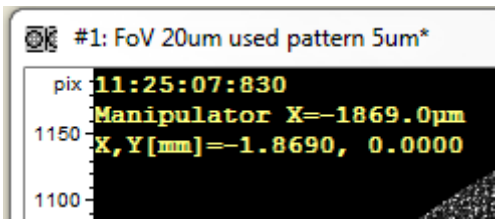
- In the *Setup Overlays* window, select either *Manipulator X, Y and/or Micrometer Readouts*
  Press *Move >>* button to put the items on the active overlay list (right side on screen)



- In the *Overlays menu* click *Enable Overlays* and click one or more of the items you just selected in *Setup Overlays*.

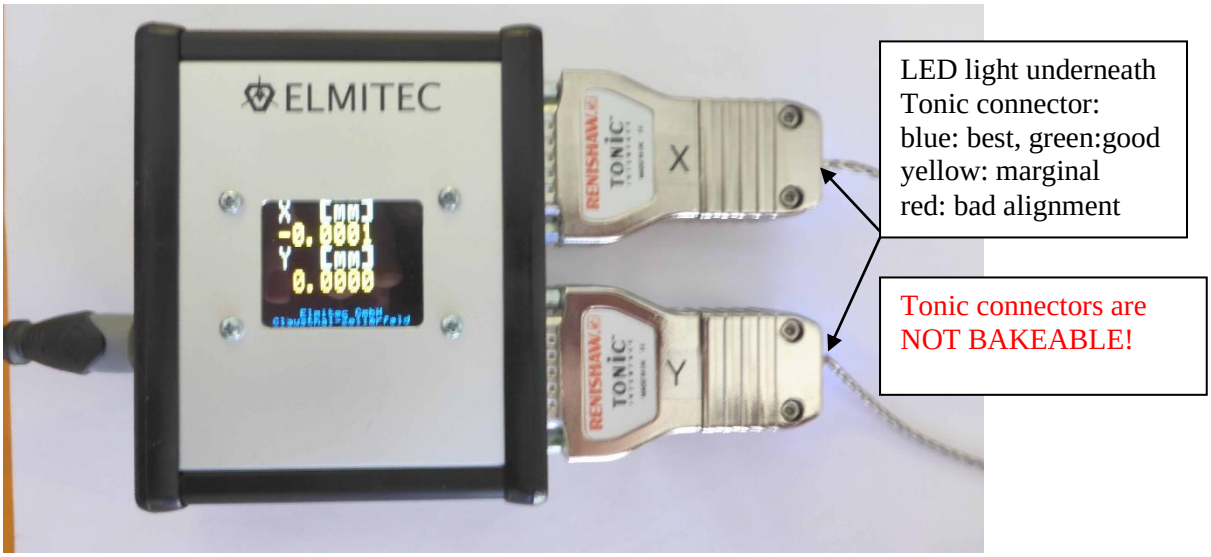


- Start image acquisition. The selected overlays will be displayed and also saved with the image (if you save in generic Uview format .dat).



Note: When *Use Micrometer* is on, motor steps and micrometers show the same value

Renishaw setup



- Connect the Renishaw Tonic read-head and Tonic-interface-connector to the Elmitec Dual-Renishaw controller. Hook up the controller to an USB port of the LEEM computer. The display of the controller indicates where to plug in the X respectively the Y Renishaw devices.

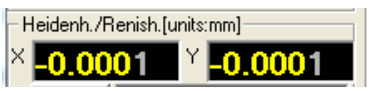
- Max. operating & storage temp. 70°C! There is a UHV version available which can be baked.
  But even with the UHV version only read-head and cable are bakeable, NOT the Tonic-connectors! The UHV version can be recognized by the bare metal mesh cables.

- Make sure the LED indicator on the read-head is green and the LED in the Tonic-interface is green (good) or blue (best). A yellow light will still work but should be improved on.
  If the indicators are red then loosen the mounting screws of the read head or the tape mount and adjust one or the other until the correct operating conditions are met.

- In LEEM2000 go to the *System Configuration* Window and check if the Renishaw controller is activated. If not press the *connect* button.

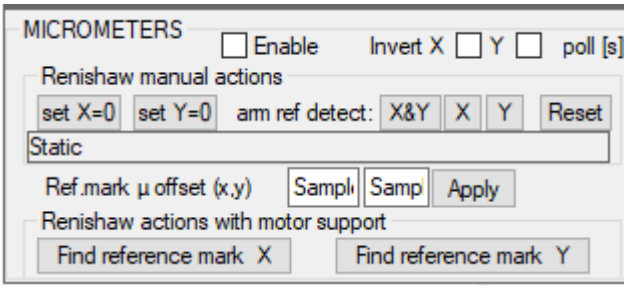
- In the same window the general micrometer option should be enabled (see screenshot below)

- When powered on, the display of the controller box shows a 0.0 µm readout for each Renishaw device connected and working properly. The yellow colour indicates that measurements are relative to the position at power up. In case no Renishaw is connected or the read head it misaligned a red error display is shown.



On the LEEM2000 main window the same values are displayed and the same color scheme is used to indicate relative or absolute measurement and error conditions.

To move to always the same fixed *Preset Positions*, the Renishaw devices have to be synchronized to a reference mark on the measuring tape. After that they perform measurements referenced to a fixed 0 position. That mark is a dark line on the tape scale and is aligned to the center of the sample. The synchronization is done by moving the read head over the reference mark, either manually or preferably by motor.



- Automatic referencing (<u>preferred method</u>):
  Press the *Find reference mark X* (or Y) button.
  The software will activate the motor of the selected axis and move the manipulator in a predefined pattern back and forth searching for the reference mark. Depending on the initial position, this may take several minutes.
  Having found the reference mark the motor will stop and the user will be asked if the program should synchronize motor position display and micrometer (answer YES). During the referencing procedure various fault conditions are checked (i.e. movement stalls). If a fault is detected then the procedure is aborted and the user is alerted.

- Manual referencing:
  Press the *X or Y or X&Y* button (see above screenshot)
  - This will arm the reference mark detection circuit
  - The display in the controller box will start flashing
  - The status line underneath the buttons will display '*waiting'*

  Move the manipulator either by hand or by motor back and forth over the place where the reference mark is supposed to be until
  - Micrometer display in controller will stop flashing.
  - Micrometer display on screen and in controller will turn green for the referenced axis - 'waiting' will change to *ref* X or *refY or refXY*

  To abort the referencing-sequence press the *Reset* button.

The *micrometers* window also allows to set the display to 0 for X and Y (referencing will be lost). Furthermore offsets can be applied to the X and Y values (referencing remains).

Software interface for Motors thru DCOM and TCP

Supported Operating systems:	Microsoft Windows 7, 8, 10
Interfaces:	DCOM and TCP methods to set and read motor parameters and to move motors. (CORBA not supported any longer)
Motor related commands:	*MoveMotorDistance* *MoveMotorPosition* *PSValue* *GetValueFromModule* *GetChangedModulesExt*

For details please see the LEEM2000 scripting manual.

Sample script (VBScript):

What it does: X Motor is moved 50 units.
Units are either micrometers or motor steps as selected in LEEM2000 motor setup.
Use Micrometers should be activated or the result may not what you expect.

```
' LEEM2000  must be running when this script is started !
' 10 Y motor 11 X motor
'units as in LEEM2000 setup

call ramp

Dim LEEM

Sub ramp
        Set LEEM = CreateObject("leem2000.LeemInt")
        LEEM.MoveMotorDistance 11,-50                   '11=X motor, 10=Y motor
        WScript.Sleep(1000)
        while LEEM.MoveMotorDistance(11,888888.0)=1    ' wait until motor is done moving
                WScript.Sleep(100)
        wend
        msgbox "done"
End sub
```

Not to forget:
**Windows, Windows XP, Windows Vista , Windows 7, Windows 8, Windows 10* as well as *Visual Studio* are trademarks of Microsoft Corporation.

Appendix

File Formats

Warning: Although ASCII files listed below could be edited by a non-formatting editor (for instance Windows Notepad) it is not recommended doing so. Any incorrect modification may prevent LEEM2000 from working or even starting up.

Parameter File (system)

extension: apr
name: follows strict rules: only predefined name are allowed like LEEM, LEEMEA.
destination: startup folder, if any, else LEEM2000 installation folder
format: ASCII, tag describing line-item followed by data
contents (partial):
header lines
for each module a set of ca 50 lines with parameters
backup time
selected control
degauss information
heater information
Mitutoyo readouts
Coordinates of flashing spots on schematics
user changeable: no (see warning)

Parameter File (user)

Same as Parameter Files (system). Yet these files can be freely named by the user.
When loading, only certain parameters are loaded by LEEM2000. For instance valid power supply output values. Parameters which define the power supplies or the specific microscope are not loaded. Generally everything disabled to user access in LEEM2000 is not loaded. This applies to all access levels.

Backup parameter file

destination: startup folder, if any, else LEEM2000 installation folder
When opening LEEM2000 a backup file is made from the apr file and named xxx.apr.old. xxx is the name of the apr file. This file is not modified by LEEM2000. In case a LEEM2000 or computer crash occurs the contents of active apr file may be corrupted or erased. In that case you may simply delete the corrupted file and rename xxx.apr.old into xxx.apr and start LEEM2000 again.

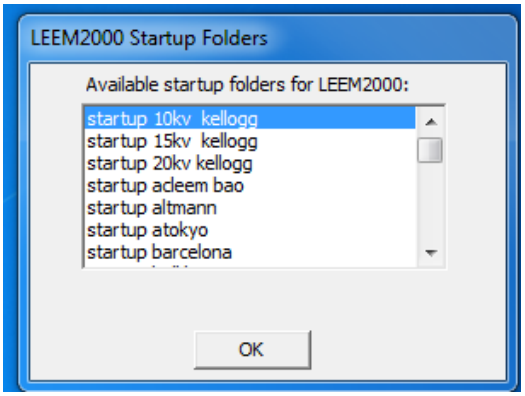
Layout File

extension: lay
name: follows strict rules: only predefined name are allowed like LEEM, LEEMEA.
destination: startup folder, if any, else LEEM2000 installation folder
format: ASCII, tag describing line-item followed by data
contents: information of screen layout of LEEM2000, i.e. active areas in schematics. Presets are also save in this file
user changeable: no (see warning)

Startup File

extension: sta
name: fixed: startup.sta
destination: startup folder, if any, else LEEM2000 installation folder
contents: information about type of microscope and options
format: ASCII, tag describing line-item followed by data
user changeable: no (see warning)

Startup folders



Contain a set of files necessary to run an Elmitec microscope in a predefined mode.
A particular microscope can use several startup folders. For instance one can be called **startup 15kV**, another **startup 20kV** etc. All names must start with **'startup '.**
A startup folder is *not* mandatory, because LEEM2000 can also use a set of startup files in the LEEM2000 installation folder.
When starting LEEM2000, the program first searches for and displays a list with all startup folders if more than one startup.sta files are found.
The startup file in the LEEM2000 folder is shown last in that list.
The LEEM2000 session can be aborted at this point by pressing the ESC key.

Notes File

extension: rtf
name: fixed: notes.rtf
destination: startup folder, if any, else LEEM2000 installation folder
contents: text and pictures
format: so called 'rich text' file. Standard format can be imported to most editors.
user changeable: yes

Presets File

extension: dat
name: user defined.dat, *default name*: presets.dat
destination: anywhere
contents: all presets, can be saved from and loaded to LEEM2000
format: ASCII, tag describing line-item followed by data
user changeable: no

Log File

extension: log
name: fixed: LEEM.log
destination: LEEM2000 installation folder
contents: LEEM2000 session details and errors incl. status dumps of all modules
all entries contain the relevant timestamp
format: ASCII simple unformatted text file readable by most editors.
user changeable: no

The log file is automatically cropped by removing the first 200 lines if it reaches 100kB.
For more info on /STATUS DUMP see **Power Supply Status.**

The following example shows what is written into the log file if fieldbus adapter has no power:

	comments:
/SESSION: Version 1.9.74; USB SL11R 1.90(req);	LEEM2000 & Adapter version
/STRT: 18.08.2003 12:21:55	LEEM2000 started at
/No Adapter Power 12:22:02	error occurred at
/STATUS DUMP	system status
No communication with power supply rack(s)	
/EXIT 18.08.2003 12:22:06 /USB SL11R -1.00(det)	LEEM2000 closed at

MCP protocol file

extension: txt
name: fixed: MCPProtocolFile.txt
destination: LEEM2000 installation folder
contents: MCP supply status and faults, Chevron™ startup protocol
format: ASCII, tag describing line-item followed by data
user changeable: no
example:

Elmitec GmbH LEEM2000
Starting Chevron start-up procedure on 4.12.2012 at 16:11
Approximate finish in: 6h 10min!
0 min, 16:11, MCP:0.000kV, SCR:0.000kV Col:-4.00e+000Torr

Undo file

extension: txt
name: fixed: undoLEEM2000.txt
destination: startup folder, if any, else LEEM2000 installation folder
contents: all entries in undo and redo list. *Maximum entries*: 10000each
format: ASCII, tag describing line-item followed by data
user changeable: no
example:

UKSOFT LEEM2000
version 25.3.1
UndoList 0 11 0 11 0 2000.000000 0.000000 129973787338490000 Objective

UndoList 1 10 0 10 0 951.599121 0.000000 129973787343960000 Cond. Lens 1
UndoList 4 4 0 4 0 1623.000000 0.000000 129984030304360000 Cond. Lens 3
RedoList 0 0 1 0 1 -21.000000 1.500000 129991084392520000 Illum.Stigm.A
Last_entry

Alignment file

extension: txt
name: fixed: align.txt
destination: startup folder, if any, else LEEM2000 installation folder
contents: alignment data for the Automatic LEEM Alignment Procedure
format: ASCII, tag describing line-item followed by data
user changeable: no

Signal versus time file

extension: dat
name: user defined.dat,
destination: anywhere
contents: signal versus time data and header with information on acquired channels
data contain relative time, absolute time and measured values for each channel
format: ASCII, tag describing line-item followed by data
user changeable: no
example:

UK SOFT: LEEM2000
Version 24 1 9
FileVersion 4
SubFileType SignalVSTime
IchanDescr2 0 1 3 0.001000 -250.000000 2300.000000 SampleTemp. mV KSTEMP
IchanDescr2 1 1 3 0.001000 -10.000000 10.000000 ADC1 V UADC1
IchanDescr2 2 0 4 0.000000 0.000000 0.000001 Pressure Torr MCH
IchanDescr2 3 0 4 0.000000 0.000000 0.000001 Pressure Torr COL
IchanDescr2 4 0 0 1.000000 0.000000 2.000000 State FAIL COL
StartChannel 0
DataSectionFl 2
0.000000e+000 1cc4875e790ecf0 3.396973e-001 2.902915e+000 0.000000e+000
0.000000e+000 0.000000e+000 0.000000e+000 0.000000e+000 0.000000e+000
3.285000e+000 1cc4875e8c74a10 3.306641e-001 2.894065e+000 0.000000e+000
0.000000e+000 0.000000e+000 0.000000e+000 0.000000e+000 0.000000e+000
Last_entry

Software prerequisites

Operating system Windows 10, 64bit (also 32bit still supported)
Support Packages : Visual Studio 2019 redistribution pack.
PDF© (Adobe Systems) viewer
Installation pack for LEEM2000

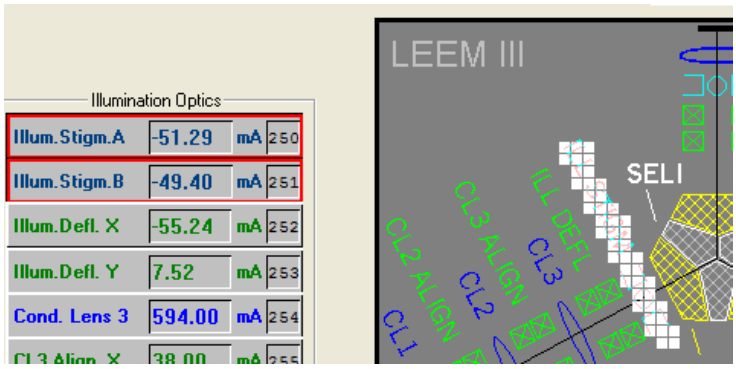
Layout

This paragraph describes how to change the active ‘touch’ areas on the microscope schematics and the flashing spots indicating the selected module. Active touch area means that if you click or touch this area on the schematics, then this module will be selected.

In **factory** access click **Edit layout** 

.

Then select any module box.
The area in the drawing which will be the active ‘touch’ area for that module will we displayed covered with white squares.
Use the left mouse button to click anywhere on the drawing to generate or to toggle those while squares. Wherever they are this area becomes active for the selected module. You can keep the left mouse button down to ‘draw’ an active area of white squares. To remove the areas you may either click to toggle the white squares or you may select **erase** , click and keep the left button down and erase while moving the mouse over the white areas.



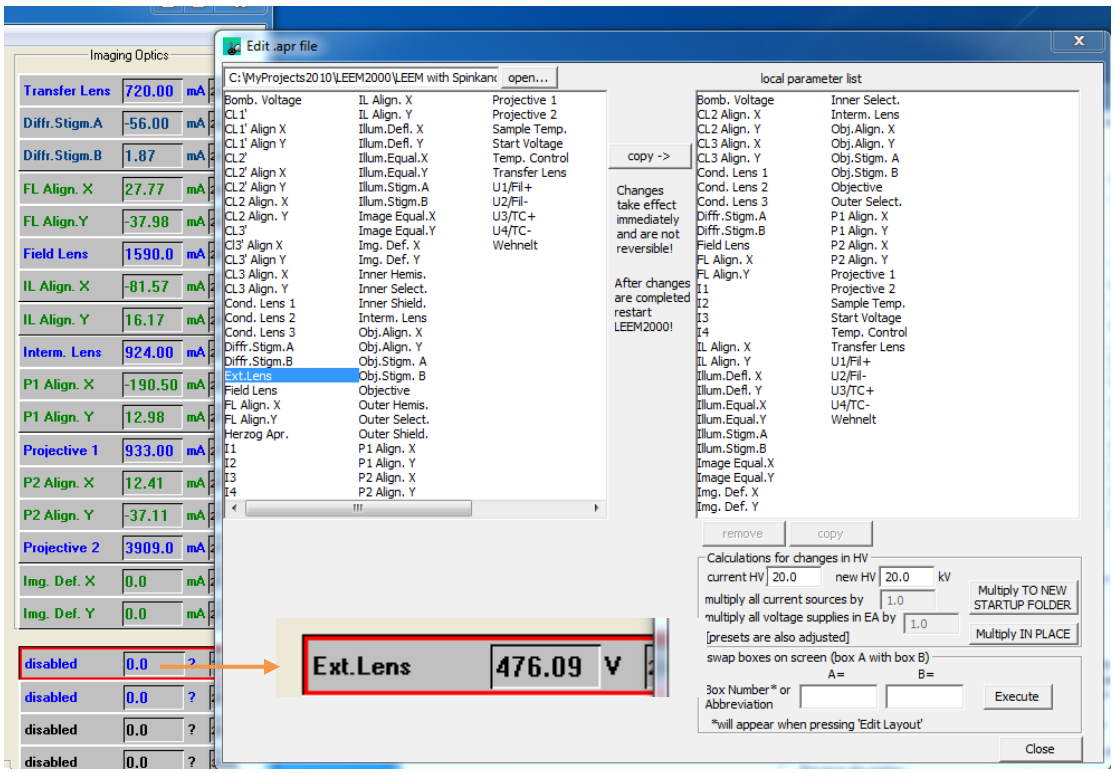
Use the right mouse button and click where you want the flashing spot to appear for the selected module. The response will not be apparent immediately. Uncheck the ‘Edit Layout’, then the spot starts flashing at the place you selected.

Note: the active areas are mutually exclusive for one module, that means if you over paint an area which was previously assign to another module, then that assignment will be lost. The **clear** button will remove <u>all active areas for all modules</u> – so use it wisely!

Modify .apr in System Configuration Window

This feature will become available in **factory** access mode. It allows to

- Copy module parameters from one .apr file to the current .apr file, thus adding a module defined for another configuration to the current one and have it appear on the LEEM2000 screen.
  To do that, select a **disabled** module box on the LEEM2000 screen.
  Use the **open** button to open another apr file which contains the module you want to use. All modules in that file will be displayed in the left list. All current modules in the right list. Select the module you want on the left, click copy. The module will now appear on the right list and on the LEEM2000 screen. In the example below it is the **Ext.Lens** module which was copied. This can be continued until all free (disabled) boxes on the LEEM2000 screen are used up.
  A final step is necessary. Close the 'Edit .apr file' window, open the Module Setup window for each of the added modules. Then check the address. If it has already been assigned, then click **find free** to assign a new address. The associates power supply need to be set to that same address (depicted underneath the address field). To check if 2 modules have the same address you can use the View->Power supply configuration window or restart LEEM2000 and check the fault history.



- Swap module boxes on screen
- Generate a new startup folder which will contain an automatically modified apr file for another HV! All current sources including Presets will be multiplied by a user defined factor.

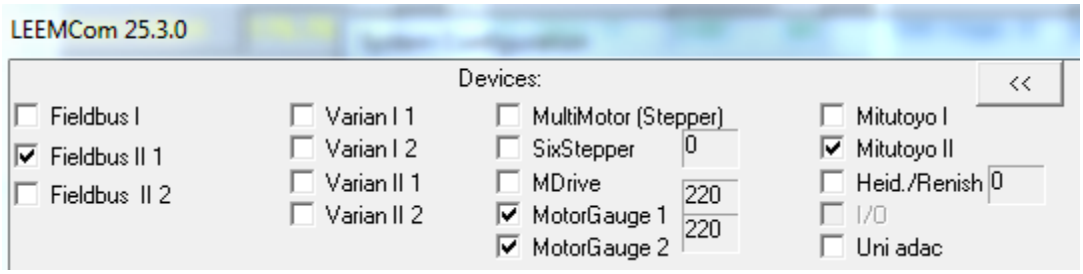
LEEMCOM

This window becomes visible when clicking **Show leemcom window** in **System Configuration**. It can be viewed by anyone, modified only through factory access. Leemcom.exe is a separate program connected with LEEM2000 through the DCOM software interface. It handles all the realtime access to the exterrnal components connected by USB bus and RS232. It acts as an intermediary between microscope hardware and LEEM2000. Leemcom can even run on a different computer, connected thru a local network or the internet to LEEM2000. Leemcom may contain undocumented features which have been added temporarily to debug certain components.

Abbreviated look over the leemcom window:

Devices

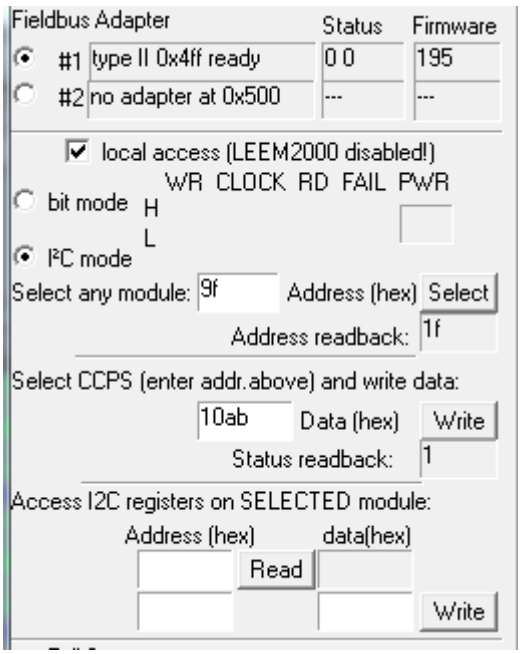
List with a currently connected devices. In some cases the current firmware number is shown. Read Only.



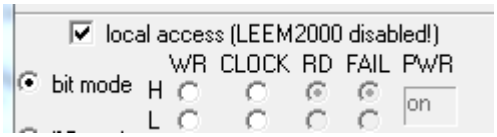
Fieldbus adapter

Shows which type and how many fieldbus adapters are connected and their firmware. Local access is only possible with the newer type II fieldbus adapters (in alu enclosure). If **local access** is selected then the fieldbus can be controlled directly through the controls in this box. LEEM2000 has no more access while the local access is enabled.

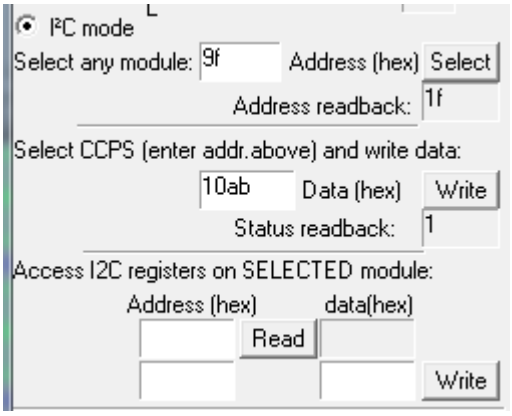
***Note**: if you are planning to debug the fieldbus manually then close LEEM2000 and start leemcom.exe on its own. Otherwise LEEM2000 may get stuck. Interference in the local access of the fieldbus can also not be totally excluded while LEEM2000 is running.*



Local access can be on a bit-level or in I²C mode.

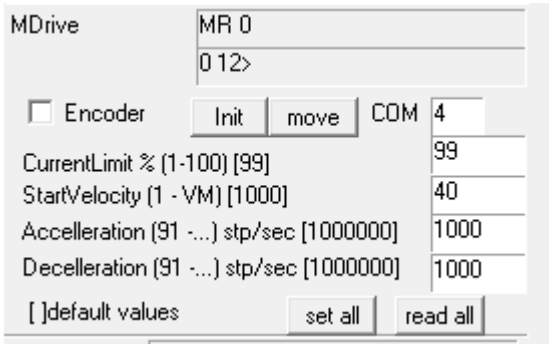


In **bit mode** the fieldbus signals can be viewed or modified on an elementary level. **RD**(read) and **FAIL** and the fieldbus **power** can be monitored and **CLOCK** and **WR**(rite) bits can be set or reset.



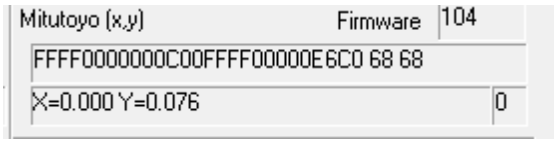
In **I²C mode** individual registers on the fieldbus can read or written to. On an even higher level an address of a device on the fieldbus can be selected. Data can be written directly to a Constant Current Source and its status be displayed. All of those actions require in-depth knowledge about the fieldbus and the devices attached to it. Input of addresses and data in hexadecimal numbers required. Info's on addresses can be found in the hardware manual or in the module configuration windows. In example on the left Cond.Lens.1 is selected.

MDrive™



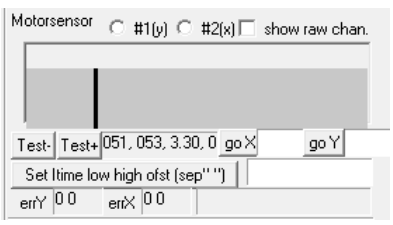
Mdrive™ is the motor for azimuth control with built in stepper motor controller. It is connected to the PC via an USB to rs-422 adapter. Commands send to the MDrive controller and status message coming back are shown in real-time in the top 2 lines of this window. Quite important are the fields below that which show certain parameters of the Mdrive controller. They specify the acceleration and deceleration behavior of the motor and **must be set if** a new MDrive is first attached to the microscope. In the example above those values a shown. On a new MDrive those values are quite different. So please type them into the provided fields and press **set all** to transfer and store them in the MDrive permanent memory. To read them back from the MDrive press **read all**. The other buttons in this field are just for debugging and should not be touched. The COM channel should be set in LEEM2000. It will be send from there to LEEMCOM automatically.

Mitutoyo



This window displays firmware version, raw data from USB/Mitutoyo converter incl. status messages and x and y distances in mm. those values are read in real-time from the two Mitutoyo micrometers.

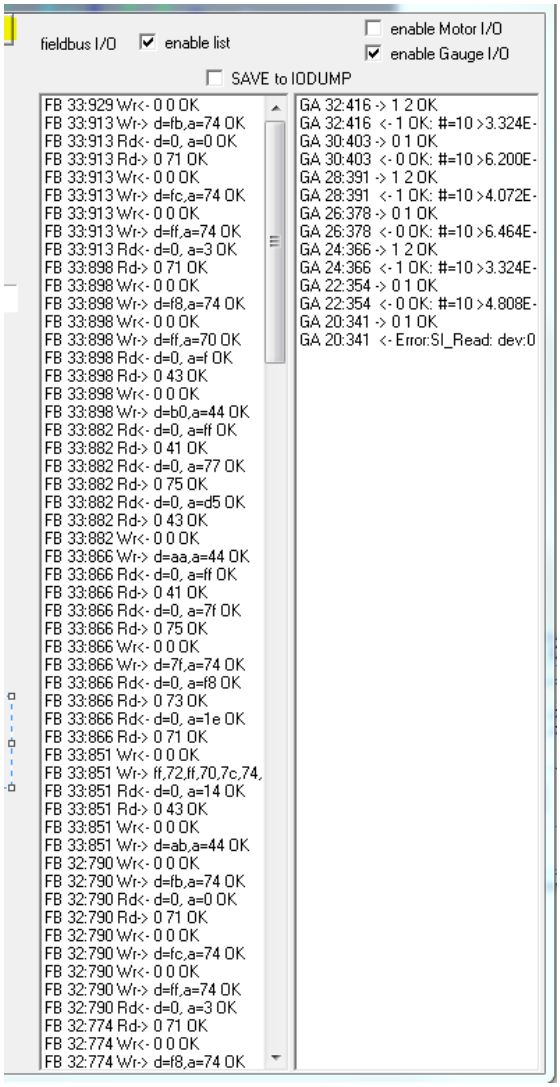
Motorsensor



Some of our Manipulator X/Y motors contain position sensors. Their position can be shown here. Either the true readout of the optical position array or the fitted position can be displayed for alignment purposes. Other buttons allow further tests, like a predefined move to the left or right or to set internal parameters of the motor controller.

LEEMCOM Log file IODUMP

It is possible to view in real-time all data flowing from and to the fieldbus adapter and X/Y Motor or Vacuum gauges and to save them in to a file (IODUMP.txt in boot folder c:\).
To do this press the >> **button** und click the enable list box next to **fieldbus I/O** and/or enable **Motor I/O**, enable **Gauge I/O**.
The last two share a common list. The entries are labeled **GA** for gauge and **MO** for motor and in the left list **FB** for fieldbus. Each entry has a time stamp (sec and msec).



Note: the newest entry is at the top of the list, then the next oldest etc.

Field bus entries:

Wr is a write to a fieldbus register, consist of two parts:
1.->write command: **d**=data(hex) to **a**=address (hex)
2.<-read status (hex)

Rd is a read from fieldbus register,
Consists of two parts:
1.-> write command: read from address
2.<- read: returns **s=** status(hex) d=data (hex)

Gauges and Motors entries:

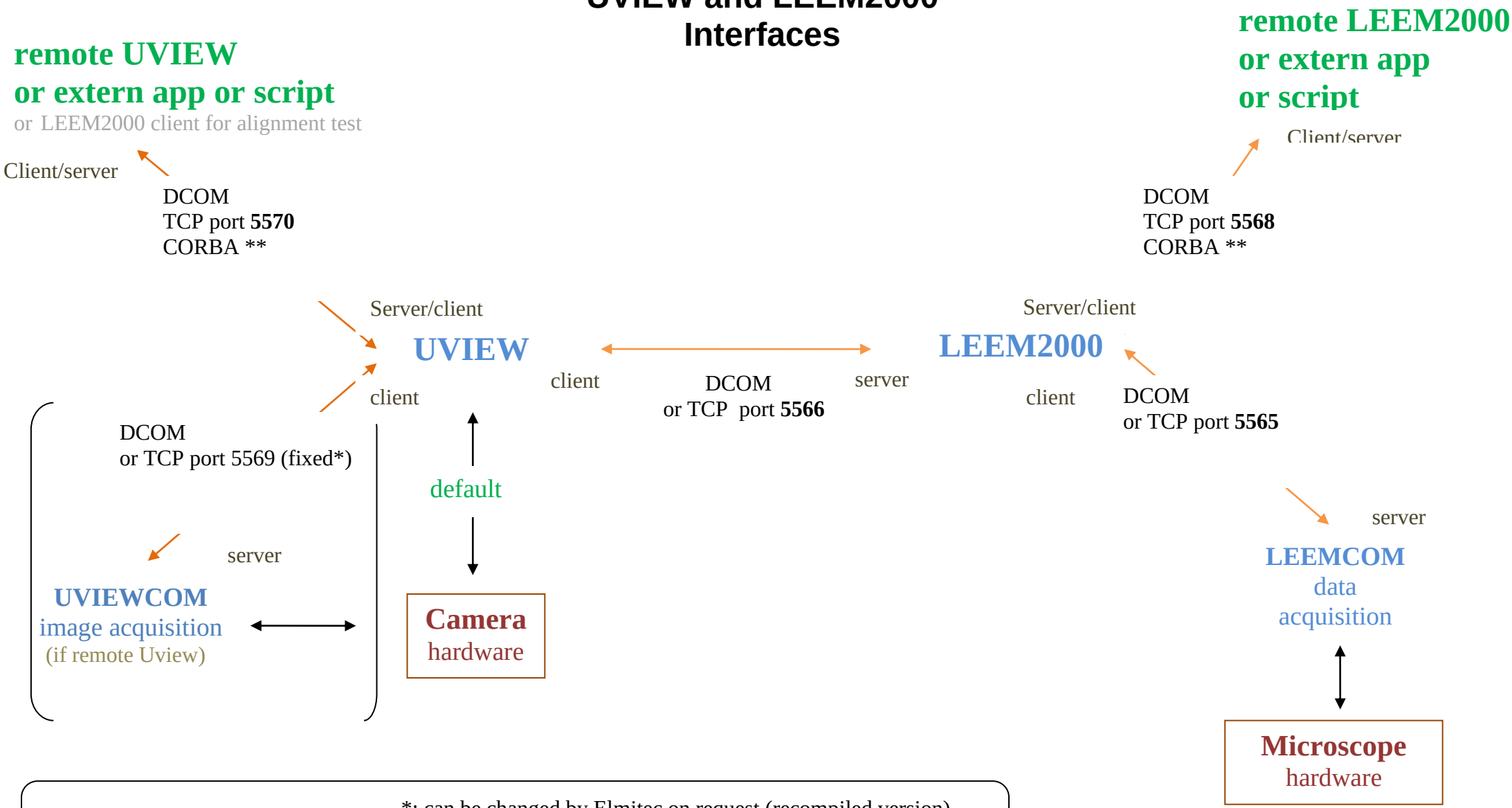
->send to gauge/motor. For instance request for a pressure reading
<- read from gauge/motor. For instance pressure readouts or errors.

Further entries in LEEMCom window like for MCP, Varian/Vacom Gauges or Rensihaw duplicate the controls and status elements already discussed in the LEEM2000 section.

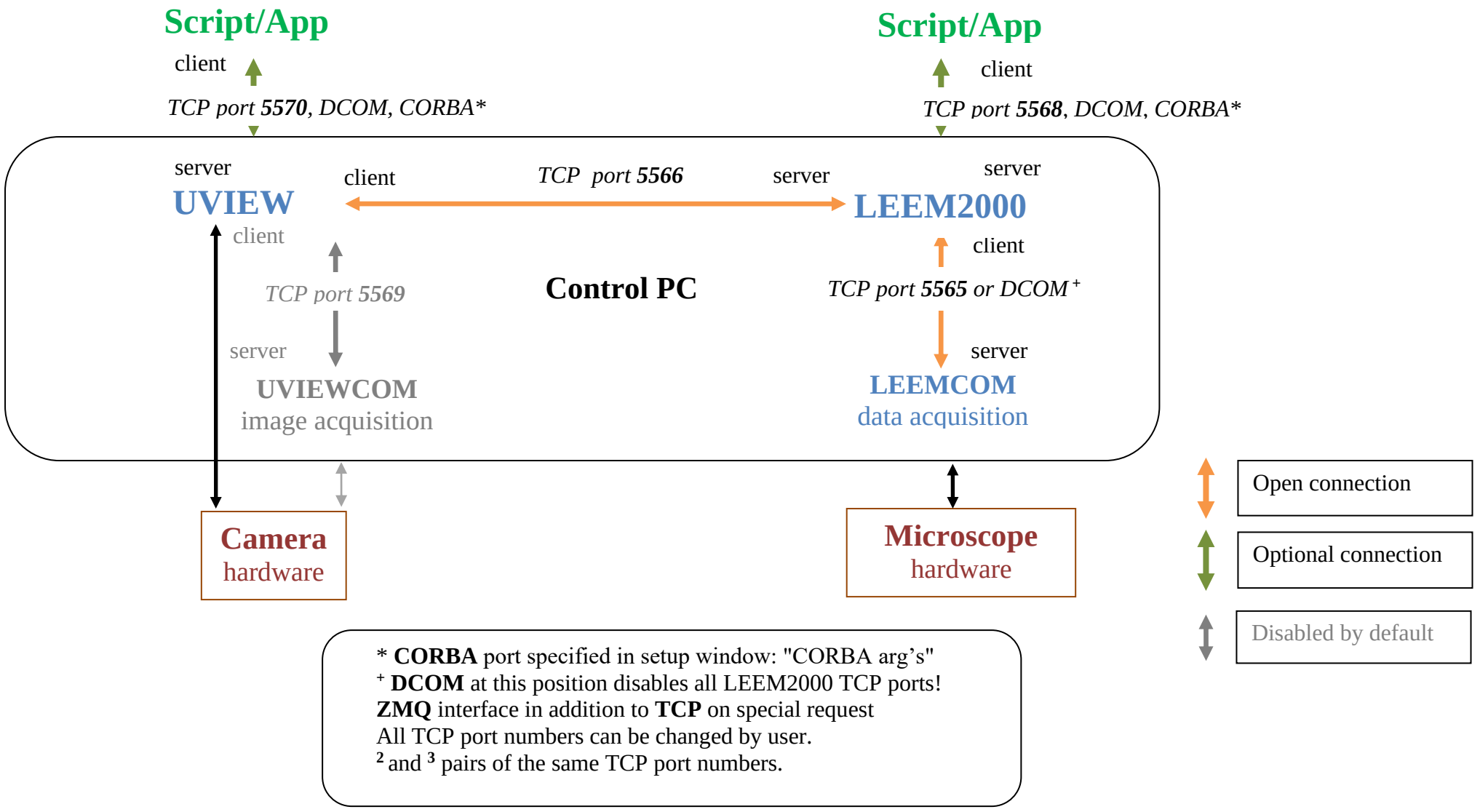
Acronyms

MCP	Multi Channel Plate
LEEM	Low-Energy Electron Microscopy
I ²C	Inter-Integrated-Circuit serial data bus. In our case used, modified to a bi directional bus (read and write data lines are separate) in our fieldbus to connect the various power supplies with each other and an USB converter.

UVIEW and LEEM2000 Interfaces



Standard UVIEW and LEEM2000 interconnections on single PC



* **CORBA** port specified in setup window: "CORBA arg's"
+ **DCOM** at this position disables all LEEM2000 TCP ports!
ZMQ interface in addition to **TCP** on special request
All TCP port numbers can be changed by user.
[2] and [3] pairs of the same TCP port numbers.

Remote UVIEW and LEEM2000 access through a network