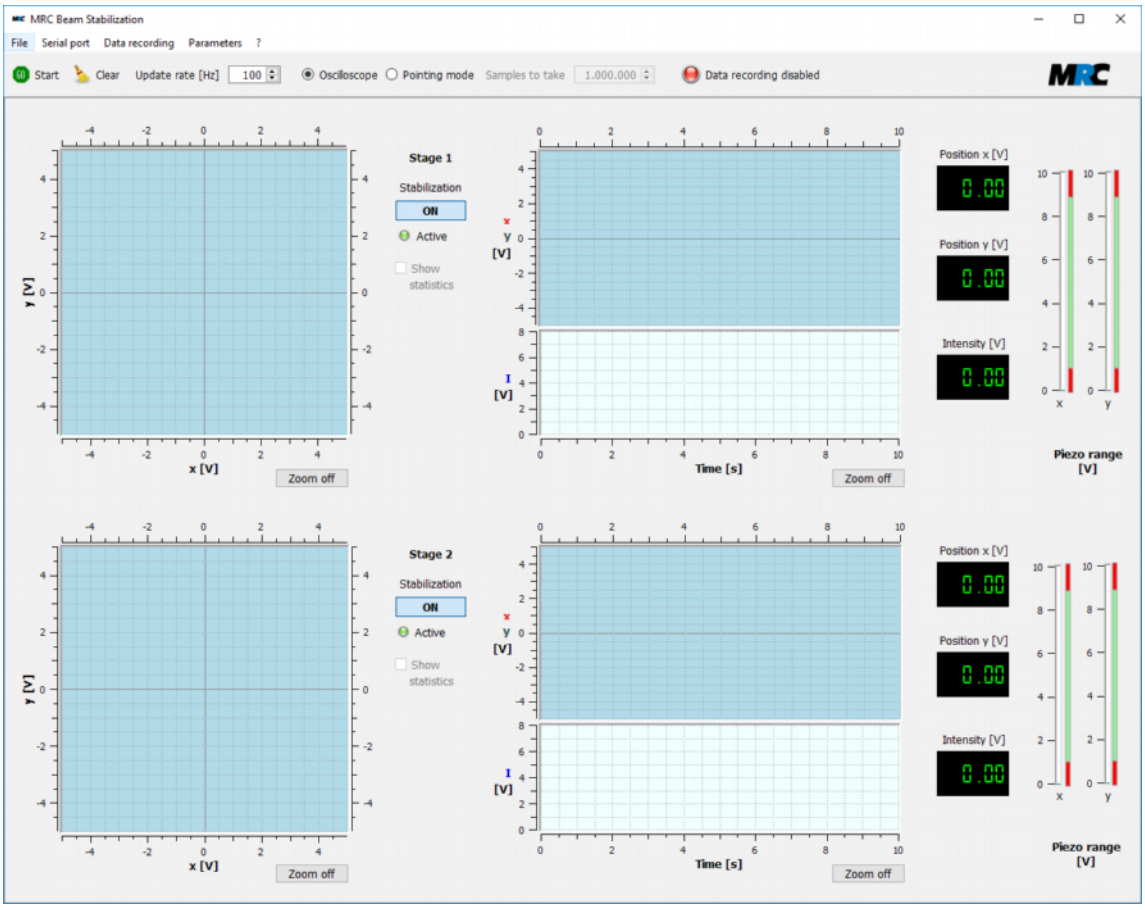
Laser Beam Stabilisation

Description of the communication and visualisation software



Contents

1. Introduction

The *Compact* laser beam stabilisation system can be equipped with a serial interface, which allows the setting of parameters and the read-out of values. The communication runs via USB. As an option, RS232 is also available.

The software described here makes use of this interface and communicates with the stabilisation system. It offers real-time displays of the positions, intensities, and piezo voltages and includes some functions to control the stabilisation system.

2. System requirements, installation

The software works with a 4-axes stabilisation, i.e. a *Compact* system with two position detectors and two piezo-driven 2D actuators.

It can be used on any PC with a USB plug (2.0).

Versions are available for the following operating systems:

- Windows 7 and Windows 10, 32bit
- Windows 10, 64bit
- Linux Ubuntu (tar archive, Debian package)

Under Windows you can start the installation by executing the Microsoft Installer .msi file. Depending on your installation it might be necessary to additionally install the FTDI driver. In most cases this takes place automatically.

For higher data rates you can decrease the USB latency timer in the Windows driver from the default 16ms to e.g. 2 or 1ms. For that purpose, start the Device Manager and find your USB port. Then call

Properties, call *Advanced*, and change the latency timer from 16 to 2 or 1 ms.

Under Linux you can unpack the archive with *tar -xzf mrc-beamstabil-1.0-Bxxxx.tar.gz* or use the Debian package with *dpkg -i mrc-beamstabil-1.0-bxxxx-X64.deb.*

3. Configurations

The standard configuration of the serial interface and the software includes the following functions:

a) Start and stop of control loop
b) Activity display
c) Display of x and y positions on both detectors (voltage values, x/y plots, position-time-plots)
d) Display of intensities on both detectors (voltage values, intensity-time-plots)
e) Display of voltages applied to the piezos of both actuators
f) Data recording
g) Setting of P factor values for stages 1 and 2 of the control loop
h) Basic statistics of beam pointing

If your *Compact* system is equipped with the respective hardware, you can further use the following functions:

i) Set&hold function
j) Adjust-in function

4. Program start, connection of serial interface

When the program is started, the serial interface is connected automatically. Therefore all serial ports of the PC are scanned and it is checked, if an MRC beam stabilisation is connected. If no serial port can be connected, you are informed by a respective message:

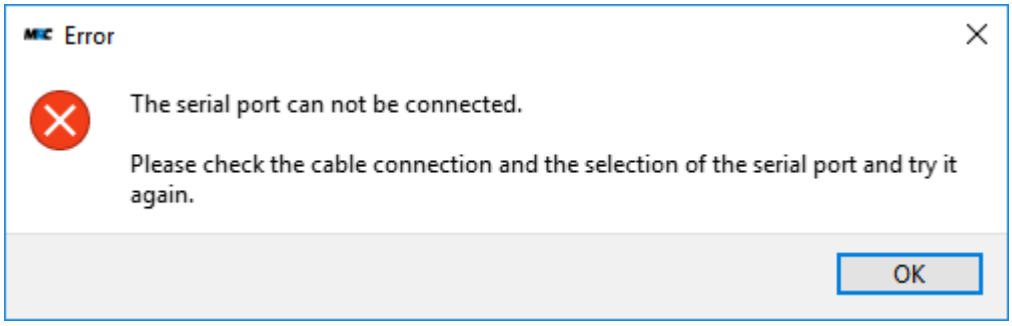


Figure 1: Error message: No connection to serial port.

In this case you should check if the cable is connected and try to establish a new connection via *Connect* in the *Serial Port* menu. To check the settings of the serial port you can open the *Settings* dialog window in the same menu. You can find more information on setting the serial interface in section 6.

If you click on *OK* in the error box you can start the program without connection.

Once you exit the program, the serial connection will be released automatically.

5. Main window

Figure 2 shows the main window of the program. It includes a menu bar, a control bar, and the display area. The size of the window can be adjusted. If the window does not allow to display all contents, you can use the scrollbars to shift the visible part.

5.1. Menu bar

You can call up further functions or dialog windows via the menu bar:

- *File:* This menu only includes the function *Exit* to exit the program.
- *Serial Port:* This menu includes items to (dis-)connect the serial interface. Furthermore you can call up the dialog window with the settings of the serial port (see chapter 6).
- *Data recording:* In this menu you can call up the dialog window to set, start, and stop the data recording (see chapter 7).
- *Parameters:* In this menu you can call up the dialog window to display, insert, and transfer parameters (see chapter 8).
- Under *?* you can find information about the software and the vendor.

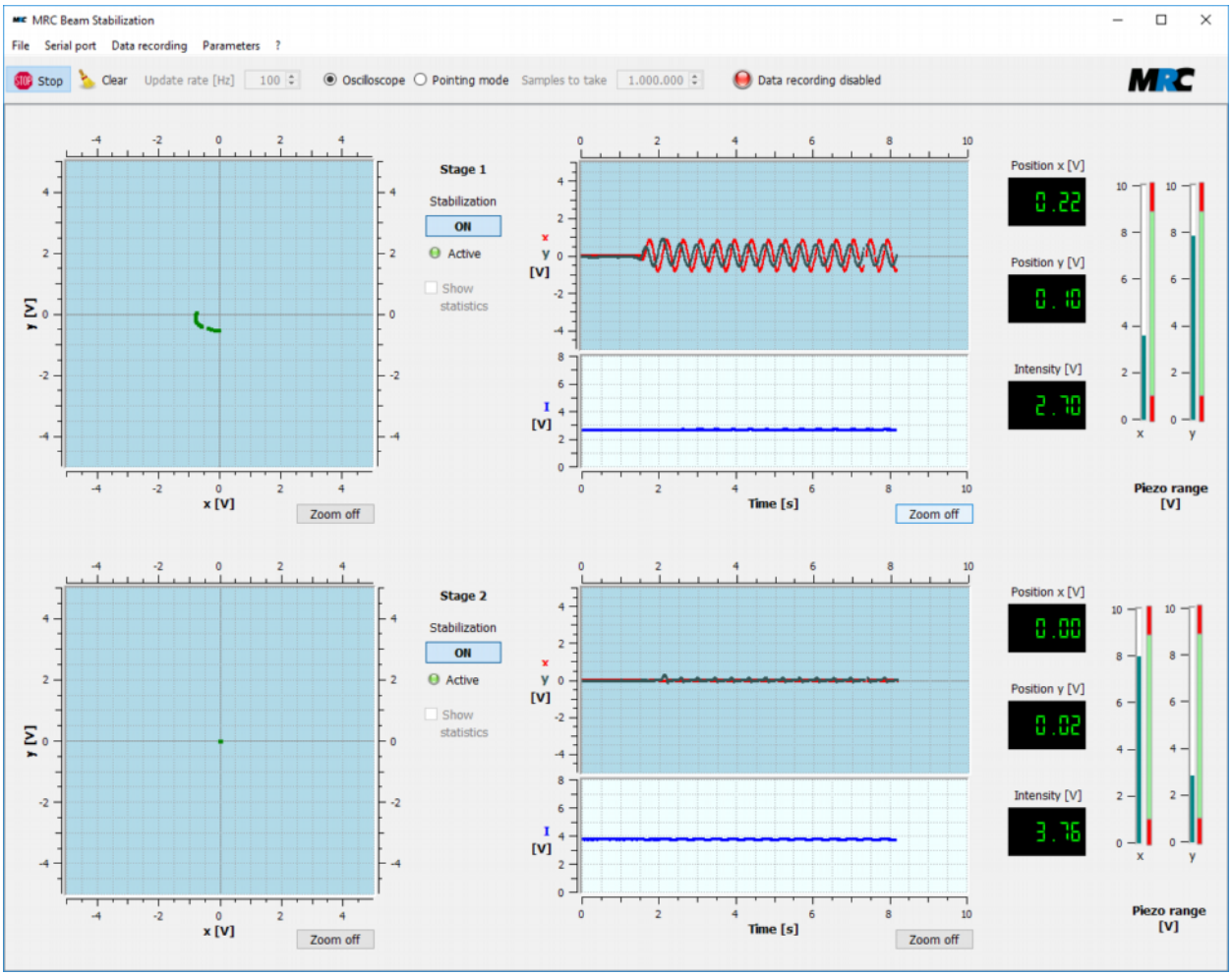


Figure 2: Main window of the communication and visualisation software

5.2. Control bar

The control bar offers the following functions:

- *Start/Stop:* This button enables to start and stop the display of values in the different plots.
- *Clear:* With this button you can clear the plots.
- *Update rate:* Here you can select the update rate for the data transfer.
- *Oscilloscope / Pointing mode:* This button allows to choose between different presentations in the x/y plots. "*Oscilloscope"* means a presentation like you are used from an oscilloscope, i.e. each displayed point is cleared immediately. In contrast, in the *Pointing* mode all points remain so that a cloud of points is built up over time.
- *Samples to take:* Here you can set the number of points which shall be sampled in the *Pointing* mode. The display automatically stops when the entered number is reached.
- *Data recording enabled / disabled:* This display shows if the data recording is currently activated or not.

Note: Please consider that only update rates of up to approx. 100 Hz can be selected. If you enter larger values, the display might get disturbed, and values might get lost in the data recording. If the display of data is not correct, you should try it with a reduced update rate.

5.3. Display area

In the display area there are x/y plots, position-time-plots, intensity-time-plots, big displays of the measured positions and intensities, as well as bar graph displays of the piezo voltages of both control stages.

You can zoom into the x/y plots by dragging a rectangle with the left mouse button pressed. By clicking on *Zoom off* you can return to the standard zoom level. If you click into an x/y plot, the coordinates of the mouse cursor are displayed.

In the position-time-plots the time line is adjusted automatically like in an oscilloscope. You can alternatively open an entry mask by clicking on the time axis where you can define a desired time frame. The x/y axis can also be zoomed. Just click on the x/y axis to open the respective entry mask.

Further functions in the display area are:

- *Stabilization ON/OFF:* Here you can (de-)activate the control loop. The software switch has the same function as the "Start/Stop" button at the keyboard of the system's controller box. Switching at the box is still possible. The system always takes up the last action at the hardware or in the software.
- *Active/Inactive:* This signal indicates if the control loop is active or not. It has the same meaning as the "Active" signal on the keyboard of the controller box. You can find more information about this signal in the user manual of the *Compact* beam stabilisation system.
- *Show statistics:* In the *Pointing* mode you can fade in additional information into the x/y plot (see the following section 5.4).

5.4. Beam pointing statistics

If you have sampled a cloud of points in the *Pointing* mode, you can display the centre and the variance (RMS deviation) of the points. The centre position (x, y), the number of samples, and the variance are displayed in the upper left corner of the plot. The centre and the variance are also visualised in the plot. The variance corresponds to the root mean square of the distances of the sampled points from the centre. Figure 3 shows an example.

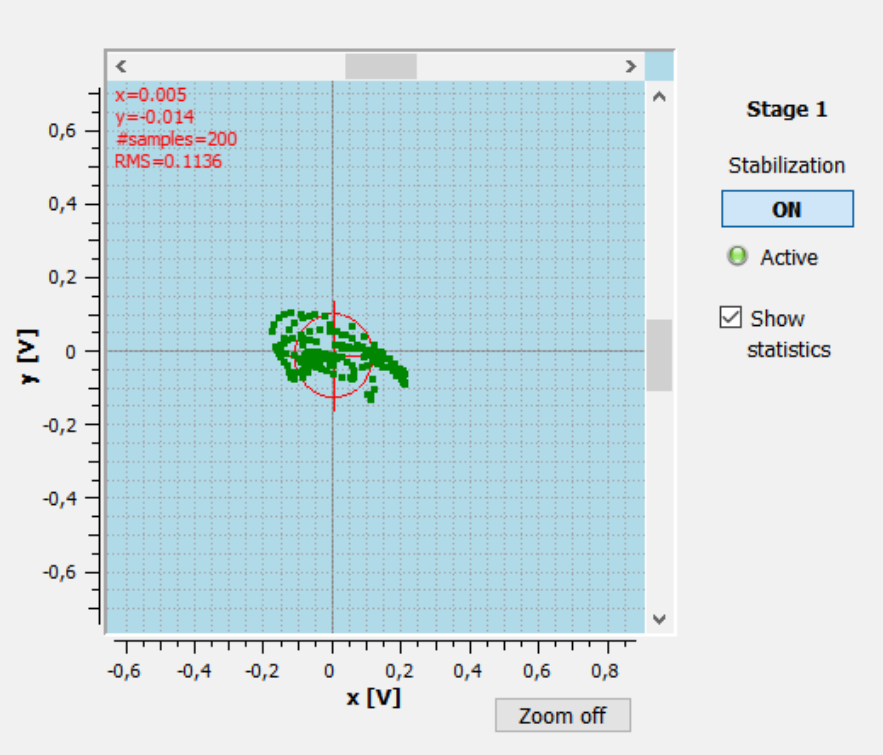


Figure 3: Presentation of beam pointing statistics in Pointing mode

6. Serial port settings

You can disconnect and reconnect the beam stabilisation system at any time. For this purpose there are the *Disconnect* and *Connect* items in the *Serial port* menu. Alternatively, you can also manage the connection via a dialog window which you reach via *Settings*.

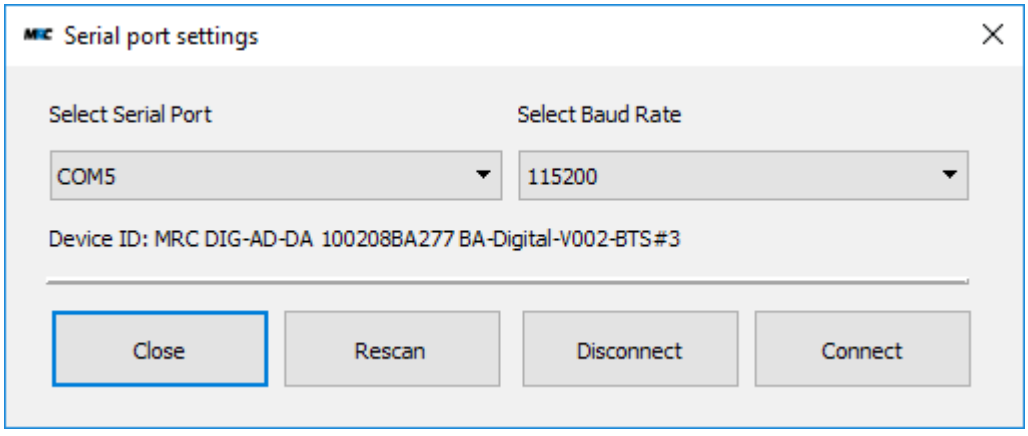


Figure 4: Dialog window for serial port settings

In this dialog window only those ports are displayed in the combo box *Select Serial Port* to which an MRC beam stabilisation system is connected. If you do not find the correct system, you can check the ports again by clicking *Rescan*. If you have more than one beam stabilisation system which you want to control via the same software, you can select the desired one. Via the automatic search routine at the

program start that beam stabilisation system gets connected which is detected first.

In *Select Baud Rate* you can select a baud rate. Since a fixed baud rate is defined in the firmware of the beam stabilisation, you should not change this value.

The other port parameters are pre-set as follows:

Parameter	***Values***
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None (→ Hardware)

If the software detects a beam stabilisation system, additional information about the device (configuration and serial number) and the firmware version are displayed after *Device ID*.

7. Save function

With the software you can save measurement data in the same way as with a storage oscilloscope. For this purpose you can call up the *Data recording* dialog window via the menu item of this name.

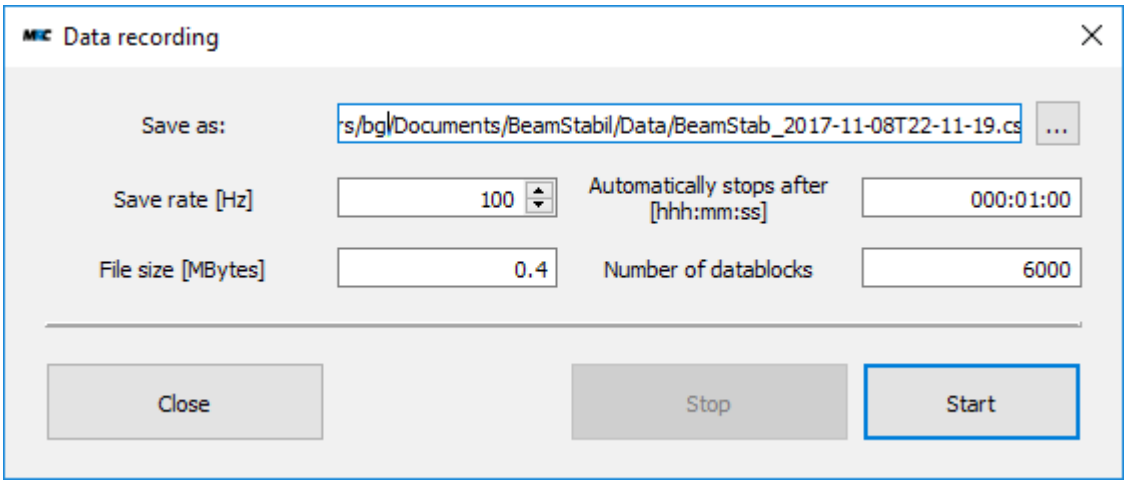


Figure 5: Dialog window to set the parameters for data recording

With the items behind *Save as y*ou can select a path and enter a file name.

In *Save Rate* you can enter the rate for the data storage. By default the update rate of the main window is entered here. Especially for long-term recordings it can make sense to enter a lower rate. You can define the duration of the recording by entering a time into the field *Automatically stops after*.

For the values entered into *Save rate* and *Automatically stops after* the software automatically calculates the expected file size and the number of datablocks. In this way you get an orientation on how large the file would get so that you can change the values if necessary.

In case of file sizes larger than 2 GB you will also get a warning (see figure 6). If you wish, you can

record larger files anyway, as long as your operation system and your hard disk drive allow.

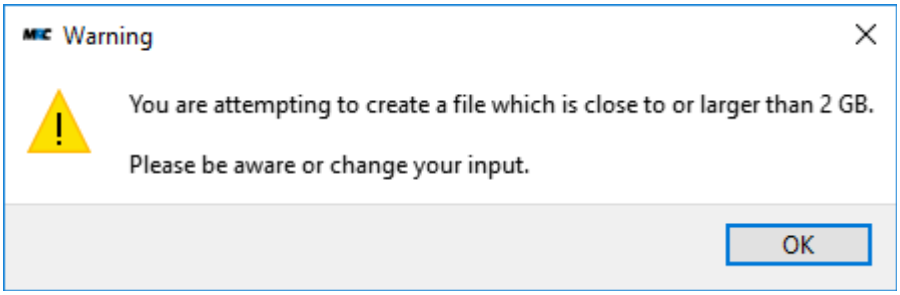


Figure 6: Warning message regarding the file size for saving

The recording is started by clicking *Start*. With *Stop* you can stop it even before it would stop at the time defined in *Automatically stops after*. On the right side of the control bar you can see an indication if the data recording is currently running or not.

Figure 7 shows the structure of the data file. The time (counted in ms after the start of the recording) is followed by the position and the intensity signals of both detectors as well as the piezo ranges ("R"). All values are given in Volts [V].

Start: 2017-11-17T16:26:57

ms	X1	Y1	I1	X2	Y2	I2	RX1	RY1	RX2	RY2
0	0.778	0.350	2.70	-0.083	-0.083	3.76	7.65	7.27	1.82	0.41
9	0.851	0.175	2.69	-0.026	-0.108	3.76	7.83	7.96	1.45	1.19
19	0.845	0.072	2.69	0.001	-0.114	3.76	7.79	8.36	1.42	1.67
29	0.792	-0.080	2.69	0.036	-0.116	3.75	7.59	8.95	1.56	2.43
39	0.696	-0.219	2.69	0.068	-0.104	3.76	7.25	9.50	1.91	3.16
49	0.391	-0.370	2.68	0.114	-0.036	3.75	6.31	10.05	3.09	4.25
59	0.176	-0.365	2.68	0.131	-0.009	3.75	5.73	10.04	3.86	4.41
69	-0.067	-0.360	2.67	0.145	-0.003	3.74	5.14	10.04	4.71	4.48
79	-0.317	-0.357	2.67	0.153	-0.003	3.73	4.56	10.04	5.63	4.53
89	-0.715	-0.324	2.67	0.113	0.019	3.73	3.72	9.90	7.35	4.58
99	-0.787	-0.206	2.67	0.055	0.076	3.73	3.59	9.33	7.88	4.29
109	-0.773	-0.062	2.67	-0.006	0.117	3.73	3.67	8.70	8.06	3.69
119	-0.581	0.242	2.67	-0.101	0.132	3.74	4.23	7.50	7.40	2.11
129	-0.429	0.376	2.67	-0.132	0.116	3.75	4.65	7.01	6.69	1.37
139	-0.247	0.479	2.68	-0.149	0.093	3.76	5.12	6.64	5.86	0.74
149	-0.044	0.540	2.68	-0.153	0.060	3.76	5.63	6.43	4.98	0.30
159	0.412	0.529	2.68	-0.142	0.021	3.76	6.73	6.50	3.24	0.00
169	0.610	0.465	2.69	-0.121	-0.026	3.76	7.23	6.79	2.48	0.00
179	0.763	0.363	2.69	-0.088	-0.081	3.77	7.62	7.22	1.88	0.35
189	0.846	0.076	2.69	0.001	-0.113	3.76	7.79	8.35	1.42	1.66
199	0.792	-0.080	2.69	0.036	-0.116	3.76	7.59	8.94	1.56	2.42
209	0.696	-0.219	2.69	0.067	-0.106	3.75	7.26	9.49	1.91	3.15
219	0.561	-0.339	2.69	0.093	-0.090	3.75	6.82	9.96	2.43	3.80
229	0.180	-0.366	2.68	0.131	-0.011	3.75	5.75	10.05	3.85	4.41
239	-0.063	-0.360	2.68	0.145	-0.001	3.75	5.15	10.04	4.70	4.48
249	-0.316	-0.355	2.68	0.152	-0.001	3.74	4.57	10.04	5.62	4.52
259	-0.714	-0.324	2.68	0.113	0.019	3.74	3.72	9.90	7.34	4.59
269	-0.787	-0.206	2.67	0.057	0.078	3.73	3.59	9.33	7.88	4.30
279	-0.774	-0.067	2.67	-0.004	0.116	3.74	3.67	8.71	8.06	3.69
289	-0.699	0.086	2.67	-0.057	0.134	3.74	3.89	8.08	7.87	2.93
299	-0.432	0.376	2.67	-0.132	0.117	3.75	4.64	7.01	6.70	1.37
309	-0.250	0.478	2.69	-0.149	0.093	3.75	5.11	6.65	5.87	0.75

Figure 7: Example of the typical content in a saved data file

Note: If the save rate is not identical to or a divider of the update rate, the data will not be recorded equally spaced. Instead the recording will always wait for the next datablock which corresponds to the update rate. If you need to have equally spaced data for a further analysis, you must choose a save rate which is identical to or a divider of the update rate.

8. Display, insertion, and transfer of control parameters

Via the menu item *Parameters* you can call up the *Control Parameters* dialog window to display, insert, and transfer control parameters (see figure 8). When you call up this window the parameters are updated by the values currently set in the beam stabilisation system. If you want to read in the currently set values from the system at a later time, you can click *Update*.

The respective entry masks for *P-Factors* and *Adjust-In* allow you to set new values which are transferred to the stabilisation system after clicking *Apply*. When you close the window with *Close* without clicking *Apply* no parameters will be transferred.

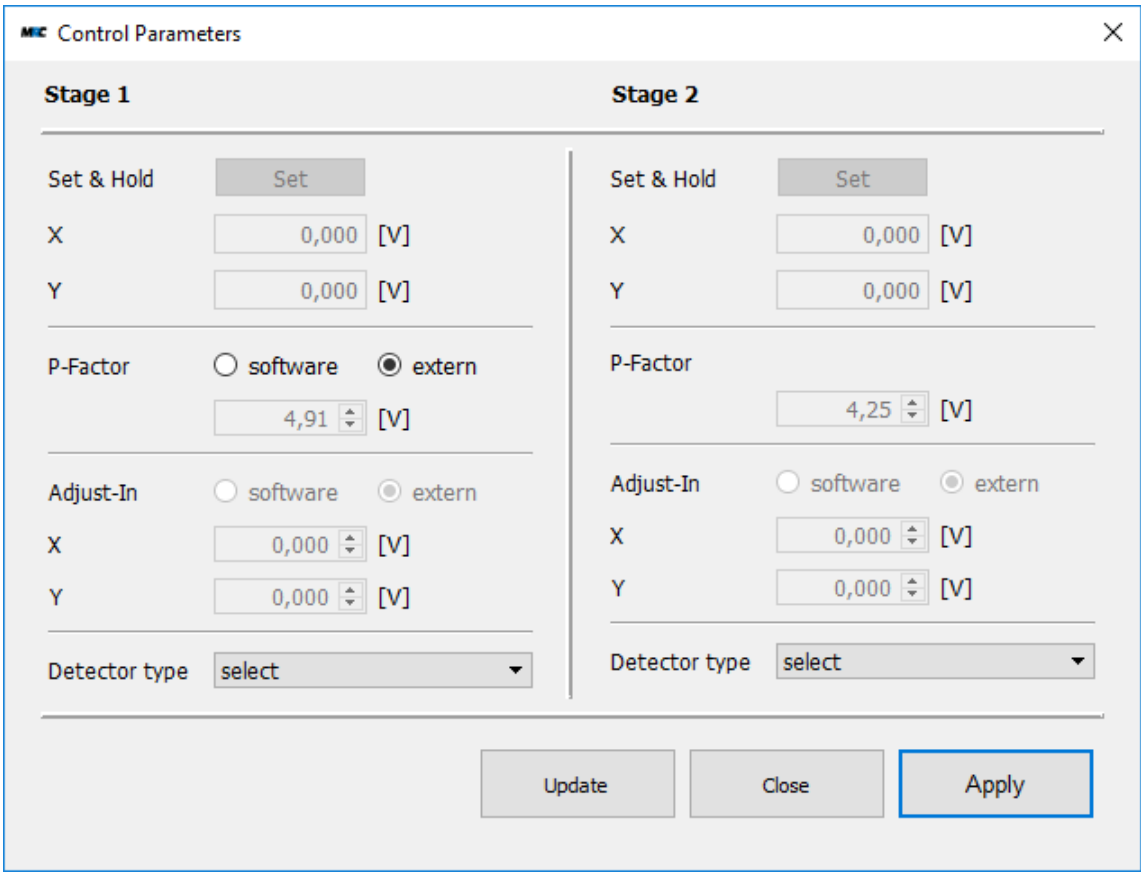


Figure 8: Dialog window to display, insert, and transfer control parameters

The functions have the following meaning and ranges:

- *Set&Hold:* With this function you can read in the current beam positions on the detectors and use them as the target positions for the beam stabilisation. The position voltages are displayed in the respective fields. The function is only available if you have selected a PSD as the *Detector type*.
- *P-Factor:* The P factor function has the same meaning as the corresponding hardware function

which is described in the user manual of the *Compact* beam stabilisation system. You can insert values between 0 and 5 Volts.

- *Adjust-in:* The Adjust-in function is also similar to the function of the optional Adjust-in inputs at the controller box of the beam stabilisation system. Here it is respectively realised in software. You can insert values between -5 and +5 Volts.
- *Detector type:* Here you can select different detector types.
- With the switches *software / external* you can define independently if the P-factor and adjust function shall react to the adjustments at the controller box (hardware) or to the software.
- In the case of the *P-Factor* the switches on the left side (stage 1) define the behaviour for both stages.

Notes:

1) If you have set a position using the *Set&Hold* function you can further adjust it with the *Adjust-In* function.
2) If you enter the voltage "O" (zero) into the *P-Factor* or the *Adjust-In* masks, the software will transfer slightly increased values (0.001 mV). The reason for this change is that the values "0" are interpreted as switches to the external settings.
3) If you set values with the *Set&Hold* function or enter voltages for the *Adjust-In* function, the control loop with the ADC might slightly change these values. I.e. if you click *Update* the actual values might slightly differ from the set or entered values. The accepted changes are very small so that they do not affect the stabilisation accuracy.

9. Error messages

In addition to the already mentioned error and warning messages there are a number of further messages which can occur in specific cases. Most messages concern errors or time delays of the serial communication. They shall not be reproduced here. If a message pops up frequently and you do not find a reason for that, please do not hesitate to contact us.

10. Contact

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Subject to change