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Operating Instructions

 The unit complies
with the applicable
EU regulations



Fig. 1: 09500-99 Compact MRT

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This operating manual for the instrument includes
operating instructions for the software in the second
part of this document.

1 SAFETY INSTRUCTIONS



- Read the operating instructions thoroughly and completely prior to starting the unit.
- Only use the unit for its intended purpose.
- The unit is intended solely for use in dry, dust-free rooms where there is no risk of explosion.
- Ensure that the voltage and polarity values that are stated in the data sheet of the unit match the values of the power supply unit.
- Ensure that the unit is set up in a vibration-free manner. Comply with the set-up and transport instructions in this manual. The mains power switch and the device connectors must be freely accessible. Ensure that the venting slots of the unit are not blocked or covered.
- Do not connect any devices to the unit other than the ones that are intended for this purpose. This could damage the control unit as well as the unintended device.
- Ensure that no liquids or objects penetrate the unit through the venting slots or the magnet through the openings.
- Do not use the unit if the mains power cable, the unit itself, or the connected cables are damaged.

- Switch the unit off after using it. Continuous operation is not permissible. The maximum recommended runtime per day is 10 hours.
- If damaged, the unit must be returned to the manufacturer for repair. Only the manufacturer or a certified company that has been appointed by the manufacturer are authorised to repair and maintain the unit.
- Strong magnets can damage technical equipment and storage media. This is why a sufficient safety distance from these objects must be kept.
- Objects in danger of damage include: computers, monitors, TV sets, hard drives, floppy disks, magnetic tapes (also audio and video tapes), USB sticks, credit and cash cards, watches, loudspeakers, microphones, electricity meters, hearing aid devices, cardiac pacemakers, and RFID chips (animal chips, transponders).
- Metallic objects may be attracted by the magnet. Keep a sufficient safety distance from these objects.
- Prevent any foreign objects from penetrating the magnet. Liquids, metallic objects, and dust can damage the magnet or the integrated component beyond repair.



Attention!

Disconnect the unit from the mains power supply prior to loosening, replacing, or removing any of the cable connections.



Attention!

Pregnant women as well as people with cardiac pacemakers must keep a distance of at least 1 m from the magnet.

Care instructions:

- Remove any dirt with suitable solvents and a soft cloth.
- Do not use thinners or cleaning agents that attack the surface.

Transport instructions:

- We recommend transporting the unit solely in the transport case that is intended for this purpose.
- Strong vibrations or shocks during the transport can damage the control unit as well as the magnet.
- Carry the magnet only by the handles that are intended for this purpose.

2 FUNCTIONAL AND OPERATING ELEMENTS

The compact magnetic resonance tomography unit (MRT) includes a control unit and a magnet. The following sections describe the connection options.



Fig. 2: Front of the control unit

2.1. Front of the control unit

Connector: **Gradient**

The *Gradient* connector is the output of the gradient amplifier of the control unit. It must be connected to the magnet (see section 2.3). Use only the supplied cable for the connection. Other cables may require a calibration of the gradient unit for correct operation.

In addition, this interface supplies the necessary current for the optional upgrade "B₀ shift".

The *Gradient* socket is equipped with two status LEDs (not labelled in the picture):

- **Yellow:** The unit is connected to the power supply unit and it is supplied with voltage.
- **Green:** The internal gradient amplifier is activated and voltage is applied.



Attention!

When the green LED is on, do not disconnect the gradient cable from the control unit or magnet!

Connector: HF

The HF BNC connector is used as an output for the high-frequency pulses (HF pulses) and also as an input for signal detection. It must be connected to the magnet (see section 2.3).

Use only the supplied BNC cable for the connection. It is standardised and has an impedance of 50 ohms. All other cables may require a calibration for correct operation.

LED: Status

The Status LED provides information concerning the current status of the unit.

- *Green*: The unit is switched on and ready for the measurement.
- *Yellow, flashing*: A measurement is active.
- *Red*: There are unit or software errors. Please restart the unit.



Attention!

If the status indicator continues to flash or light red, disconnect the unit from the mains power supply and disconnect all of the connected cables. Please contact the Phywe after-sales-service.

2.2. Back of the control unit



Fig. 3: Back of the control unit

Connector: DC 12V 2A (power supply)

The DC 12V 2A power supply connector must be connected to the supplied power supply unit.



Attention!

Use only the supplied power supply unit. Deviating voltages may destroy the unit.

Connector: USB

The connection between the control unit and measurement computer is to be established via the USB interface. Use only the supplied USB 2.0 high-speed cable. In order to ensure reliable operation, the cable must not be longer than 2 m.

Switch: POWER

The POWER rocker switch is used to switch the unit on and off.

In the training mode, the unit will be automatically set to standby, or activated from standby, by the software. If you do not use the unit for a long time, it should be switched off completely by way of the POWER switch. This disconnects the entire control unit from the mains power supply.

2.3. Front of the magnet

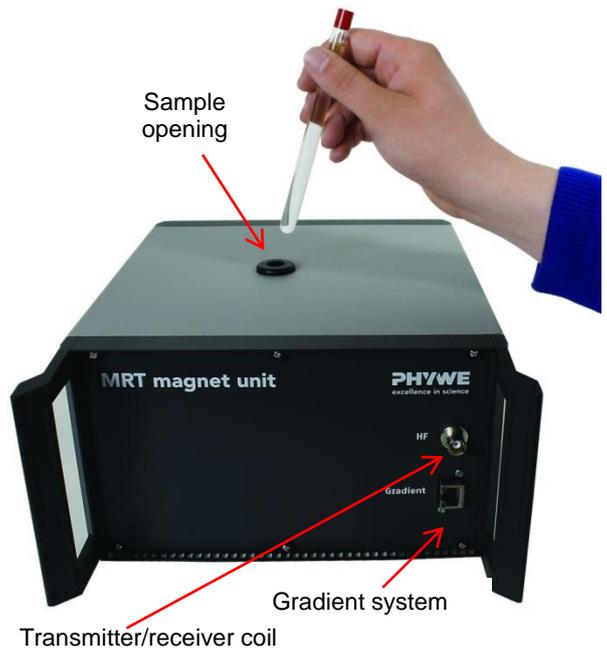


Fig. 4: Front of the magnet

Connector: Gradient

The Gradient connector leads the integrated gradient system of the magnet to the outside.

Connect the gradient amplifier of the control unit (Gradient) (see section 3.1) to the gradient system of the magnet (Gradient). Use only the supplied cable for the connection. Other cables may require a calibration of the gradient unit for correct operation.

In addition, this interface supplies the necessary current for the optional upgrade "B₀ shift".

Connector: *HF*

The *HF* BNC connector is connected to the transmitter and receiver coil via a coupling network. It ensures the high-frequency excitation and the signal detection.

Connect the *HF* connector of the magnet to the *HF* connector of the control unit (transmitter/receiver unit) (see section 3.1).

Use only the supplied BNC cable for the connection. It is standardised and has an impedance of 50 ohms. All other cables may require a calibration for correct operation.

Opening: *Sample*

The sample chamber is located at the top of the magnet. The magnet can hold samples up to a diameter of 10 mm.



Attention!

This opening provides access to the inside of the magnet. Do not insert any magnetic objects or objects made of ferromagnetic materials into the magnet. Protect the magnet against the ingress of dust and moisture.

3 START-UP

This section describes the start-up of the training unit and provides an overview of its handling. Please read this section thoroughly in order to avoid operating errors.

Place the unit on a stable and flat surface. Do not place the magnet on a metallic surface.

Connect the supplied external power supply unit to the *DC 12V 2A* connector on the back of the control unit (see section 2.2). Ensure that the *POWER* switch is set to off. Then, connect the power supply unit to the mains power via an IEC power cable.

Connect the measurement computer to the control unit. To do so, connect the USB cable to a free USB port of the measurement computer and to the *USB* connector of the control unit.

Connect the magnet to the control unit. The magnet and the control unit both have an *HF* and *Gradient* connector. Connect them by way of the BNC cable or gradient cable, respectively.



Attention!

Do not connect other devices to the control unit, only the magnet. This would result in damage to the control unit as well as to the other, improper device.

Switch the control unit on by actuating the *POWER* switch at its back.

The operating system of the measurement computer will now recognise the control unit. Install the device drivers and the "measure MRT" software. Please follow the instructions that are given in the measurement software instruction manual.

The unit is now ready for use. Start the "measure MRT" software for the measurements.

Please refer to the software instructions for further information.

4 OPERATING INSTRUCTIONS

The present quality unit fulfils the technical requirements that are summarised in the current directives of the European Community. The product characteristics entitle the unit to bear the CE mark.

The unit must be used under the supervision of an expert and only after the briefing of the user. The unit must be used in the electromagnetically controlled environment at research, teaching, and training facilities (schools, universities, institutes, and laboratories).

This means that, in such an environment, radio transmission devices, e.g. mobile phones, should not be used in the direct vicinity of the unit.

The connected cables must not be longer than 2 m. Use only cables that have been authorised by the manufacturer.

Electrostatic charges may affect and damage the unit so that it will not work within the specified data range.

Comply with the following points in order to avoid electrostatic charging: avoid carpets; provide equipotential bonding; perform the experiments on a conductive, earthed surface, use shields and shielded cables. Do not use radiofrequency transmitters (radio sets, mobile phones) in the direct vicinity of the unit.

The unit may be used only in non-residential areas.

5 TECHNICAL DATA

Control unit		Sound box	
PC connector	USB-B	Connection	2 x RJ45 1 x Line Out (jack)
Imaging unit connector (gradient)	RJ45	Weight	~100 g
Transmitter/receiver unit connector	BNC	Dimensions	86 mm x 57 mm x 22 mm
Power supply	12 V DC, 2 A	Sample set	
Power supply unit (external)	100-240 V, 50/60 Hz, 2 A	Sample case	Plastic Foam inlay
Dimensions (length x width x height)	27 cm x 9.5 cm x 14 cm	Sample set including:	10 mm oil, 10 mm water, 10 mm structure sample, 10 mm empty test tube, 5 mm oil, and 5 mm water
Weight	2.3 kg	Weight	~300 g
Magnet		Dimensions (length x width x height)	19 cm x 14.5 cm x 4 cm
Field strength	500 mT	Cable	
Field homogeneity	< 100 ppm	BNC cable	1 x 50 cm, 50 ohms BNC cable
Sample diameter	up to 10 mm	Gradient	1 x 50 cm RJ45 cable
Imaging unit connector (gradient)	RJ45	Gradient for sound box	1 x 50 cm RJ45 cable
Transmitter/receiver unit connector	BNC	Data cable	1.8 m USB-AB connecting cable
Dimensions (length x width x height)	27 cm x 25 cm x 14 cm	Power supply	100-240 V AC cable with IEC power connector ("Schuko" plug (CEE 7/7) for Germany included)
Weight	17.5 kg	Sturdy transport case	
Software "measure MRT"		Special features	Robust telescopic handles, transport castors, and foam inlay
Languages	German/English (can be extended as desired)	Weight	~11 kg
Product licence	Licence for measure MRT	Dimensions (length x width x height)	64 cm x 36 cm x 29 cm
Data formats	DICOM, JPEG, CSV, TXT	Board case	
Media type	USB stick or DVD	Steel box (internal)	
System requirements		Special features	lockable
Operating system	Windows XP (32-bit version)/Windows Vista (32-bit version)/Windows 7	Weight	~16 kg
Processor	Intel Atom 1.6 GHz or higher	Dimensions (length x width x height)	77 cm x 42 cm x 31 cm
Free RAM	1 GB or more	Flight box (external)	
Graphics	256 MB DirectX 9.0-compatible or higher	Special features	lockable, with lifting slots for forklift trucks
Free hard disk space	1 GB or more	Weight	~37 kg
Other	USB 2.0	Dimensions	91 cm x 43 cm x 56 cm

6 SCOPE OF SUPPLY

- Control unit
- 230 V power supply unit for the control unit
- Magnet
- Sample set
- USB cable, gradient cable, and BNC cable
- Operating instructions, software instructions
- Experiment descriptions

7 ACCESSORIES

The following accessories are included:

- Sturdy transport case
- Board case
- Sound box with gradient cable

The following accessories are available:

- Pre-configured measurement computer
- Pre-configured measurement laptop computer
- 3D sample with "PHYWE" signature
- B₀ field variation upgrade

8 DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.



Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

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9 PRODUCT INFORMATION

Please visit our website for information concerning the product or manufacturer:

www.phywe.com

Or contact:

service@phywe.de

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Software Instructions



The unit complies with the applicable EU regulations



Fig. 1: 09500-99 Compact MRT

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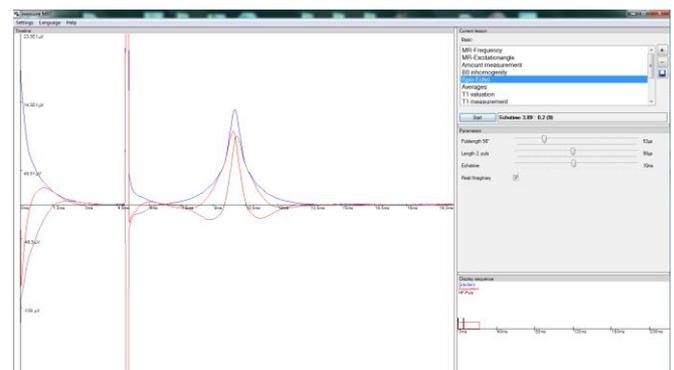
5.3 Error "The device cannot be found"

6 PRODUCT INFORMATION

1 FIRST START-UP

The control unit must be connected to the magnet and PC as described in the hardware instructions. The control unit can be switched on by way of a switch at the back of the unit.

When the program is started for the first time, the following window will be displayed automatically:



The program has four areas: the area for selecting the lessons, the area for adjusting the parameters in a lesson, the time-resolved representation of the sequence in the lesson, and a graphical representation of the last measurement results.

In area (1), the lessons of the current course can be selected and started. Select a lesson by clicking an element on the list.

The system will display the parameters for the lesson in area (2) and the sequence that is used in area (3).

The results of the last measurement will be displayed in area (4).

Current lessons (area 1):

Select the desired experiment by clicking it in the list. During a running experiment, the selection cannot be changed. The system will automatically load a basic course that begins with the lesson *MR frequency*. The course that will be loaded can be selected as desired. Details can be found in the section "Courses → Specifying a standard course".

The buttons next to the list can be used to add new lessons/courses (+) or to remove lessons/courses (-). The current selection of lessons can also be saved as a course. This will be described in greater detail in section 4.

Measurements can be started via the "Start" button. Many measurements are continuous measurements that need to be stopped via the "Stop" button. Otherwise, they would continue infinitely.

The progress of the measurement is indicated by the "progress bar". In the case of continuous measurements, the number of runs is also indicated.

Parameters (area 2):

For every experiment, a specific parameter set will be displayed in area 2 of the measurement software. This parameter set is limited to the parameters that are actually required for the selected lesson.

The standard experiments include the following sliders:

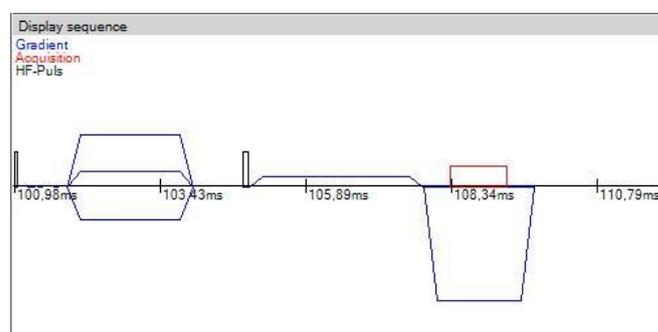
Frequency	Selects the excitation frequency of the HF pulses.
Data points	Determines the number of recorded data points.
Phase steps	Number of phase steps performed.
Slice orientation	Determines the orientation of the slice.
Repetition time	Time up to the repetition of the HF excitation.
Pulse length 90°	Duration of the 90° HF pulse.
Echo time	Adjusts the point of time of the spin echo.
Real/Imaginary	Determines whether the real part and the imaginary part will be displayed.
Shim X/Y/Z	Selects the strength of the magnetic field gradient in the X/Y/Z direction.
Length 2 nd pulse	The length of the second pulse must be adjusted separately.
Averages	Adjusts the number of averages that need to be taken for the measurement.
Time step	The change of the point of time of the measurement between two runs.
Number of points	Indicates the number of points for scanning the curve.
Number of echoes	Determines the number of echoes that is to be used for fitting the curve.
Gradient X/Y/Z	Selects the gradient strength in the X/Y/Z direction.
Read gradient	Determines the strength of the read gradient (or readout gradient).

Phase gradient	Determines the strength of the phase gradient.
Angle	The excitation angle of the HF pulse.

The sliders can be used for directly changing the parameters of the measurement (during the measurement run). In the case of continuous measurements, the settings will be used for the next repetition. For all other measurements, the parameters must be set first before a new measurement is started via "Start". The parameters do not affect a running measurement. If, for example, the gradient strength is changed during a running *Spin Echo 2D* measurement, this has absolutely no consequences for the running measurement.

Sequence (area 3):

For every lesson, there is a characteristic measurement sequence that is displayed in area 3 of the measurement software. This sequence provides information concerning the point of time of the HF pulses and of the magnetic gradient fields, including their respective durations and strengths. On the other hand, the sequence also provides information concerning certain parameters, e.g. the echo time or repetition time.



Measurement sequence concerning the spin echo 2D lesson

Results (area 4):

This area shows the results of the last lesson. Depending on the lesson, this can include up to two representations. The following representations are used:

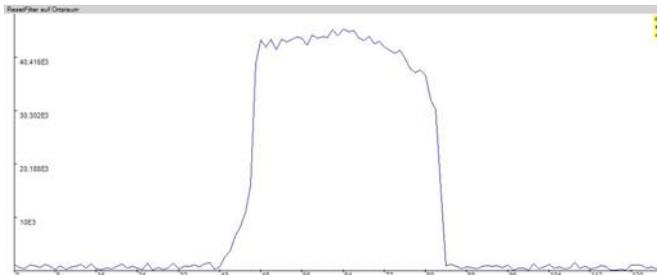
Image 2D:

Shows either the image or the unedited data of the scan. This representation uses standard shades of grey for the contrast. The black areas correspond to pixels in which no signal was measured, whereas a white area corresponds to pixels with a maximum signal.

Clicking the yellow P opens the profile view of the scan. In this view, an individual line of the image is displayed in the form of a graph. The line can be selected by way of the "+" and "-" in the upper right-hand corner. The image view can be called up by clicking the number in the yellow box.



2D image of a homogeneous sample

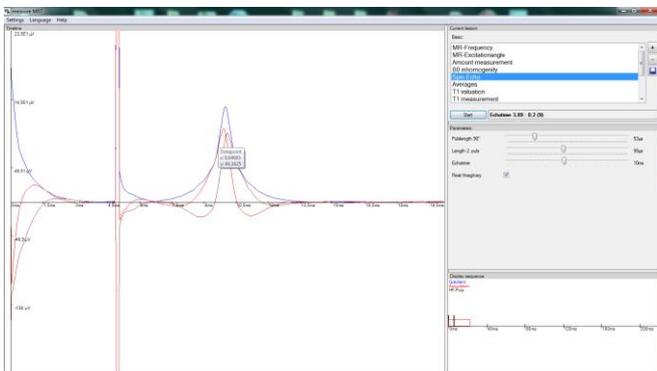


Profile of the 43rd line of the image above

Double-clicking opens a window with the same image so that images can be saved in between for a later comparison with other images.

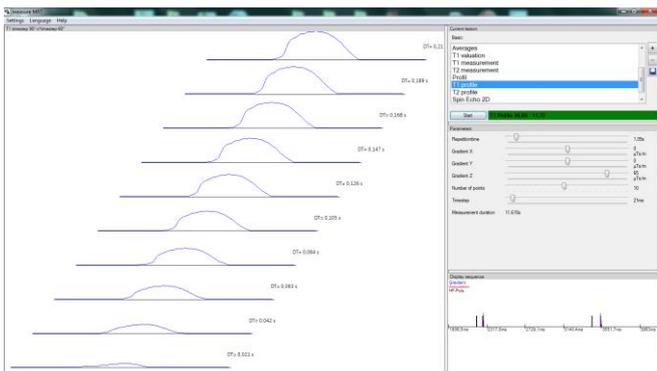
Graph:

The graph shows the course of the measurement signal over time or as a function of the frequency. The section of the signal that is displayed depends on what is relevant for the current lesson. Clicking the graph displays the corresponding data point. The X- and Y-coordinates are displayed in a popup window.

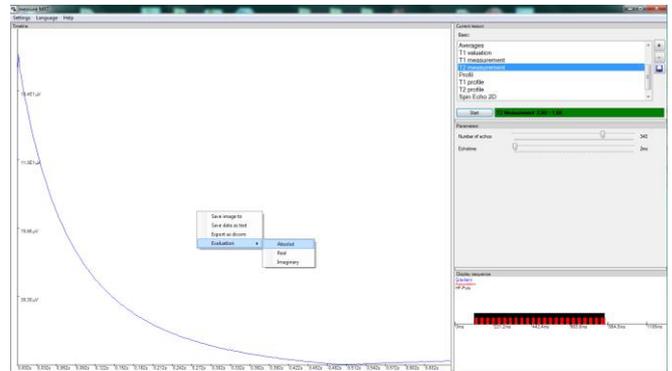


Stack plot:

The stack plot displays several signal courses stacked one above the other. Later points of time are displayed with growing depth.



The contextual menu of the results can be opened by right-clicking the result. Here, additional options are available:



Save image to → Exports the image as a bitmap file with its original resolution to the file path that is stated.

Save data as text → The measurement data are output as a (tabulator-separated) text file.

Export as DICOM → The data are output in DICOM format and can be evaluated with an external DICOM viewer.

Evaluation → Absolute/Real/Imaginary → The absolute value/real part/imaginary part can be analysed separately.

2 MENU

Settings

- ⇒ Load data set
- ⇒ Choose magnet
- ⇒ Program settings

Help

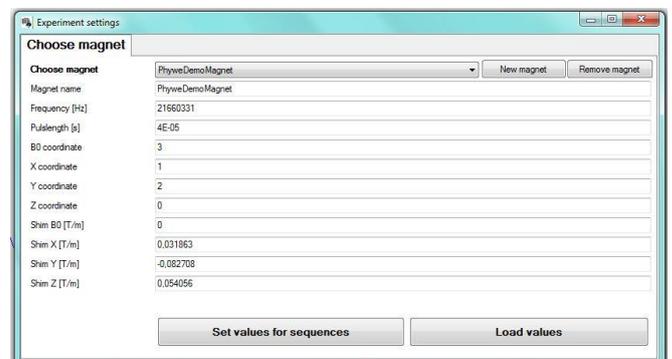
- ⇒ Reset display
- ⇒ Reset magnet settings
- ⇒ Insert activation key
- ⇒ Check for updates
- ⇒ About

Language

- ⇒ Deutsch
- ⇒ English

Settings → Choose magnet:

This menu item opens the settings for the magnet. They should be modified only by advanced users, since they are default values of the magnet.



Frequency → Selects the excitation frequency of the HF pulses and the mixing frequency of the system.

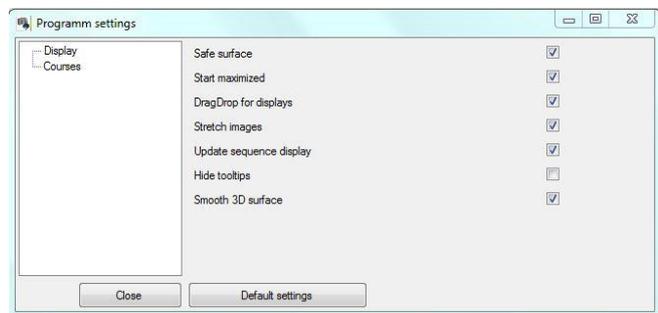
Pulse length → Indicates the standard pulse length of the system for a 90° pulse.

B0/X/Y/Z coordinate → Determines the connection and, thereby, the orientation of the gradient system.

Shim B0/X/Y/Z → Defines the standard offset on the gradient channels. This corresponds to a first-order shim (linear).

Settings → Program settings:

Opens the settings for the program.



This includes the following settings:

Display:

Save surface → Changes to the user interface will be saved and restored during the next start.

Start maximised → The program will always start in a maximised state.

DragDrop for displays → The position of individual display elements can be changed.

Stretch images → Recorded 2D images will be expanded over the entire window.

Courses:

Automatically loaded course → This course will be loaded automatically when the program is started (see the section "Specifying a standard course").

The settings can be reset to the factory settings via "Default settings".

Help → Reset display:

Resets the user interface to the delivery status.

Help → Reset magnet settings:

Resets the magnet settings to the factory settings. Here, the settings concerning the frequency, pulse length 90° and shim X/Y/Z will be reset.

Help → About:

Opens a window indicating the contact data of the manufacturer and the version number of the program.

Language → Deutsch/English:

Defines the selected language of the program. The selected language will be maintained when the program is started the next time.

3 MEASUREMENT

The courses are structured so that the user should start with the first lesson and then continue from thereon. A selected lesson is colour-highlighted. Click "Start" to start the lesson with the selected parameters.

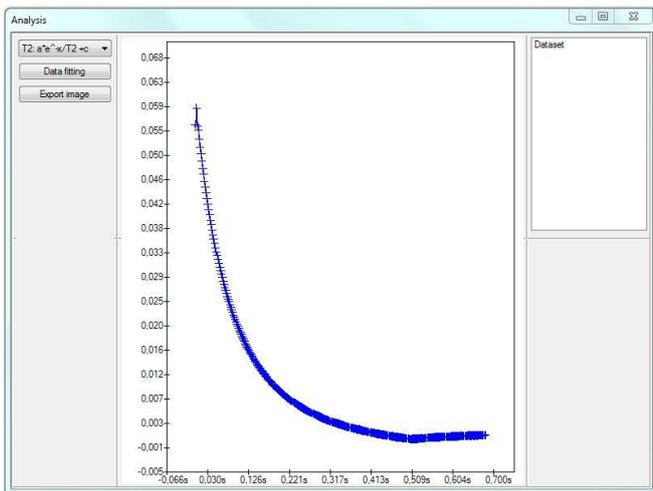
After the measurement, the results will be displayed in area 4. Quick measurements are continuous measurements. They continue infinitely until the measurement is stopped via the "Stop" button. In the case of the continuous measurements, the parameters can be set directly during the runtime.

All the system parameters (frequency, pulse length, shim X/Y/Z) are forwarded from lesson to lesson. This means that if a very bad shim was adjusted for a measurement, for example, this will also lead to an image of poor quality during the subsequent lessons.

3.1. Saving data

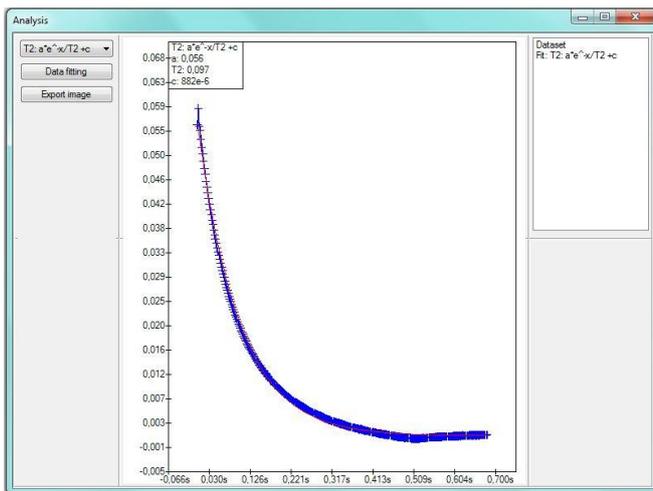
Measured data can be saved directly by right-clicking the results window. The image can be saved with its original resolution. Alternatively, it is also possible to save the data set as a text file in the TSV format (tab-separated values).

3.2. Data fitting/calculation of T1 and T2



Evaluation window

If a curve is to be laid through the data, a corresponding form can be opened by right-clicking an image and selecting "Evaluation → Absolute". Here, the T1 or T2 curve can be selected. If "Data fitting" is selected, the program tries to lay an optimally fitted curve through the data set. The fitting parameters and also the T1 or T2 time are displayed in the upper left-hand corner of the window.



Evaluation window with data fitting

After fitting, the curve will be automatically displayed in the centre area. The curve will be displayed in red over the fitted points. The representation can also be exported in image form. To do so, click "Export image" and select a path.

4 COURSES

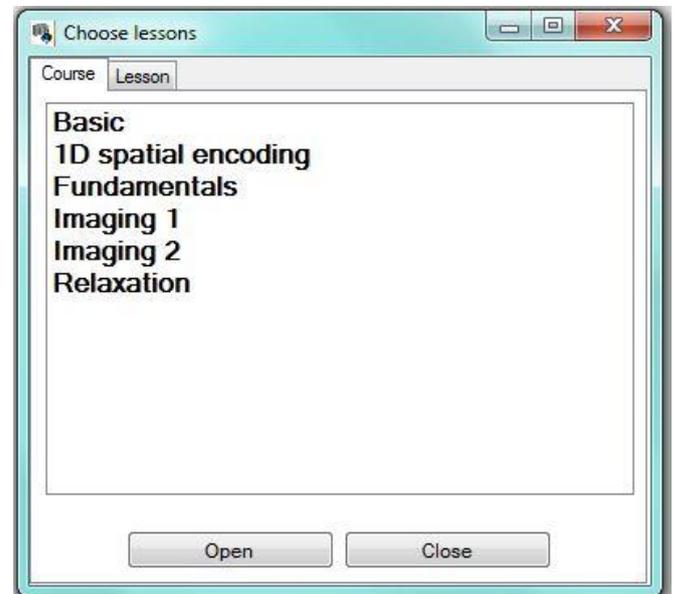
4.1. Selecting and compiling a course

The course selection can be called up by clicking "+" in the upper right-hand area. Here, a set of lessons can be loaded by double-clicking or via "Open".

The courses can be compiled as desired. After a course has been loaded, lessons can be added or removed. Individual lessons can be added via the "Lessons" tab. To remove a lesson, select it from the list and confirm the selection with "-".

4.2. Saving a course

A course thus compiled can also be saved. To do so, select the floppy disk symbol and enter a name for the course. The course will be automatically added to the course list. It will be available at the next program start.



Course selection: double-click an element or select and confirm with "Open" in order to load a course.

4.3. Specifying a standard course

The standard course will be loaded when the program is started. A standard course can be selected via "Settings → Program → Automatically loaded course". To do so, enter the name of the course. You can select the supplied courses or courses that you have compiled and saved yourself.

5 TROUBLESHOOTING

5.1. No signal/weak signal

Sample?

Check whether a sample is present and whether it is positioned in the area of the coil, i.e. on the middle height of the magnet.

Frequency?

The Larmor frequency of the magnet can be affected by strong temperature fluctuations, e.g. by an open window through which cold air flows in. This can be checked, for example, by way of the "MR frequency" lesson. To do so, move the frequency slider to a higher value and check whether a signal can be found. The factory settings concerning the Larmor frequency can be restored by a reset to the default values (see the section "Reset to the default values").

Measurement parameters in a useful range?

Different substances (oil, water, etc.) require different measurement parameter settings. Water, for example, requires a considerably longer repetition time.

5.2. Reset to the default values

The values will be automatically reset to the factory settings via "Help → Reset magnet settings".

5.3. "The device cannot be found" error

Unit started?

There is a switch at the back of the control unit. This switch must be used to switch the unit on.

Unit connected?

The control unit must be connected to the computer by way of the supplied USB cable. When this connection is established for the first time, the device driver will be installed automatically. This may take some time.

If the device has been successfully connected, the Device Manager (System → Device Manager (Windows 7), Control Panel → Device Manager) shows a device with the name "li-busb-win32-devices → MRI-ControlUnit".

6 PRODUCT INFORMATION

Please visit our website for information concerning the product or manufacturer:

www.phywe.com

Or contact:

service@phywe.de

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