

***CSPA Charge Sensitive
Preamplifier and
DSP module***

**User's manual
Version 1.1
(29/7/2014)**



*Institute for Nuclear Research
Hungarian Academy of Sciences
Debrecen, Hungary*

2014

OVERVIEW	4
SPECIFICATIONS.....	4
INSTALLATION.....	5
CONNECTION TO THE HARDWARE.....	5
SETTING UP THE MEASUREMENT PARAMETERS.....	8
OPERATION MODES	9
THE MAIN WINDOW.....	13
THE IMAGE AREA AND THE COLOR SCALE	14
IMAGE TRANSFORMATIONS	14
CONTROL WINDOW	15
STARTING THE ACQUISITION	15
FILE MENU COMMANDS.....	17
OPEN COMMANDS	17
SAVE/EXPORT COMMANDS	17
EXIT COMMAND	17
MEASUREMENT MENU COMMANDS	17
PRESETS	17
START/STOP/CLEAR	17
SET THRESHOLD	18
ROI MENU COMMANDS.....	18
ADD ROI COMMAND.....	18
DELETE ROI	18
DELETE ALL ROI(S)	18
LOAD ROI COMMAND.....	18
SAVE ROI COMMAND.....	19
SHOW ROI COMMAND	19
SAVE ROI TABLE COMMAND.....	19
RECALCULATE ROI TABLE COMMAND.....	19
EXPRESSION MENU COMMANDS.....	19
ADD EXPRESSION	19
DELETE ALL EXPRESSION	19
LOAD ROI COMMAND	19
SAVE ROI COMMAND.....	20
SHOW ROI COMMAND	20
SAVE ROI TABLE COMMAND.....	20
VIEW MENU COMMANDS	20
SHOW LOG WINDOW	20
RESET IMAGE VIEW	20
SHOW RULER.....	20
SHOW PULSE HEIGHT DISTRIBUTION.....	20
SHOW PROJECTIONS	20
SHOW ROI TABLE	20
SHOW IMAGE TRANSFORMATION	21
ABOUT MENU COMMANDS	21
ABOUT COMMAND.....	21
ANALOGUE INPUT	22
FILE FORMATS	23
PROJECTION FILE FORMAT.....	23

Overview

The DSP module and the charge sensitive preamplifier are intended to collect images coming from Quantar micro channel plate (MCP). A computer with a gigabit Ethernet interface is necessary to operate the DSP module. External power supplies (5V) are required to operate both the preamplifier and the DSP module.

Specifications

Preamplifier:

Input: BNC connectors

Input Range:

Output: Lemo connectors

Power consumption: 350 mA.

Dimensions: 110x130x40 mm

Mass: 200 g.

DSP unit:

Input: Lemo connectors

Detector signal Input Range:

Analogue input range:

INTERFACE (I/O): Standard RJ45 Ethernet connector.

Power consumption: 600 mA.

Dimensions: 200x100x50 mm

Mass: 400 g.

Installation

The acquisition software is designed to run on Windows XP/Vista/7/8 (32 or 64 bits). It will not run under previous versions of Windows such as 95, 3.1 or DOS. A dual core Pentium 1.5 GHz equivalent computer with 2 Gb of RAM, 1024X768 screen resolution, medium screen color depth is recommended. The Ethernet interface is required for data collection.

Note: You might need system administrator privileges to install/run the software.

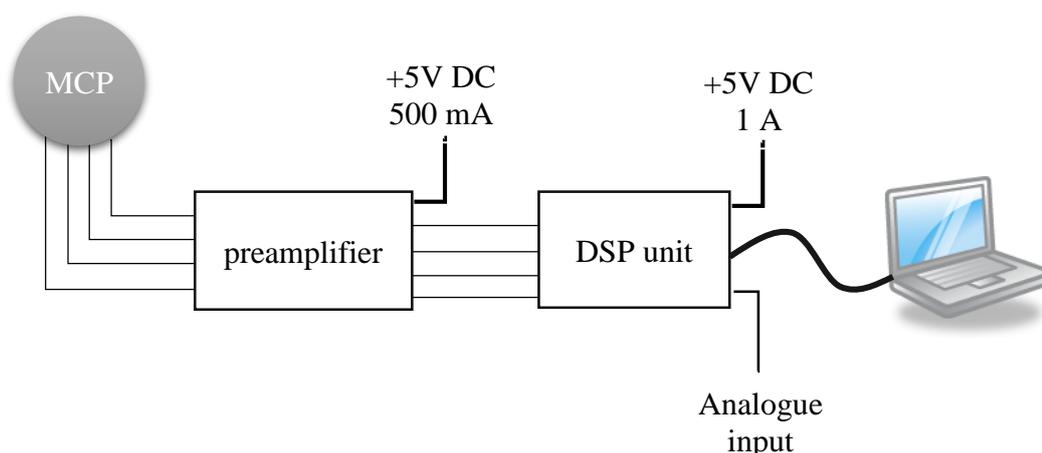
Copy the software to any directory on the hard disk. Launch the mqmcp.exe application and at the first time the firewall (if installed) asks that mqmcp.exe want to connect to the internet. Allow the connection.

Connection to the hardware

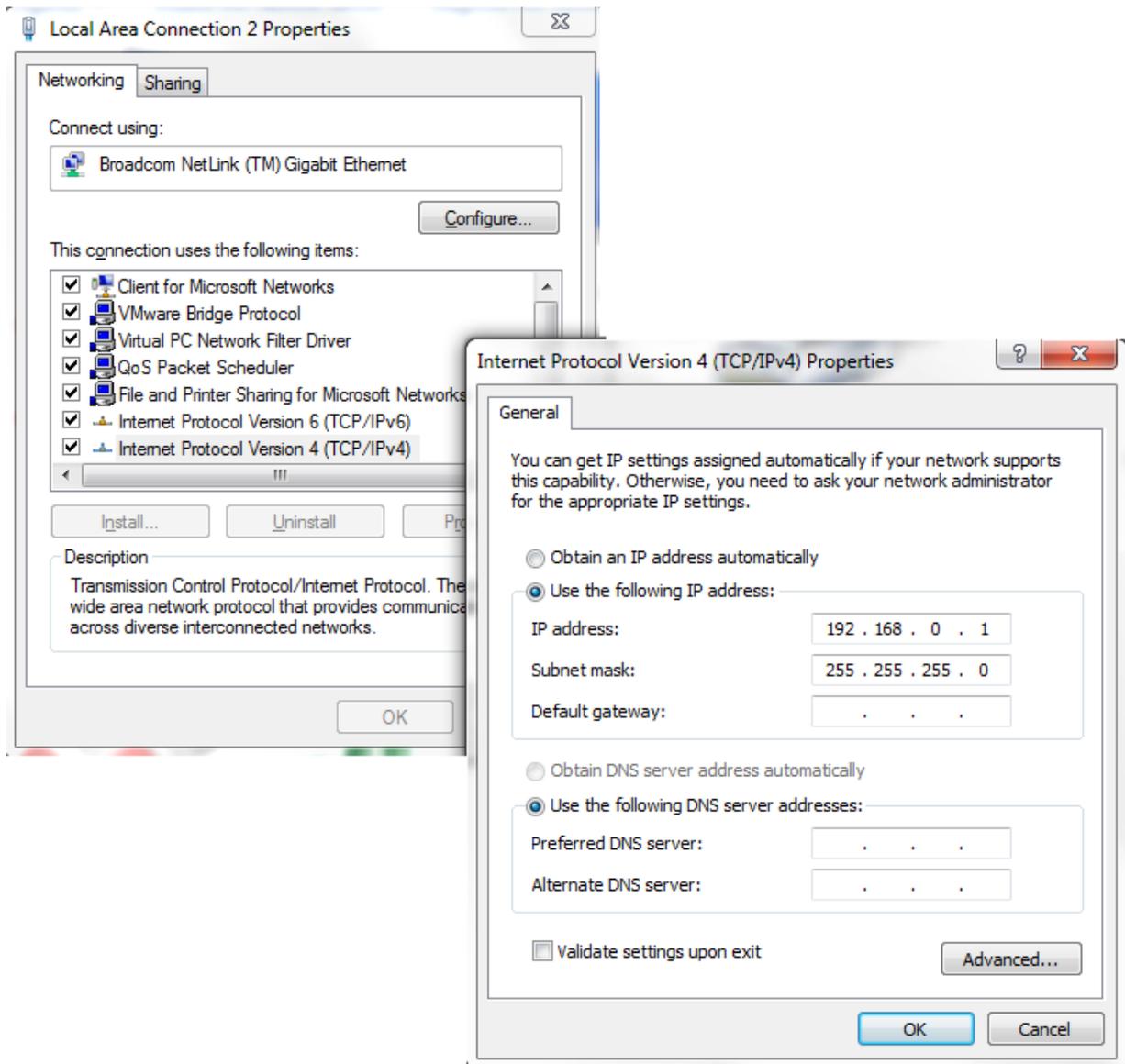
Connect the 4 output channels of the preamplifier to the DSP unit using Lemo-Lemo cables. Connect the four corner signals of the detector to the 4 BNC input of the preamplifier. Then connect the power supplies to the preamplifier and to the DSP module.

The DSP can be connected to the computer in three different ways:

- a) Connecting the Ethernet cable directly to the PC. In this case the PC uses a local and closed network for communication with the DSP module. This is the safest and most reliable solution. The Ethernet cable is directly plugged into the PC.

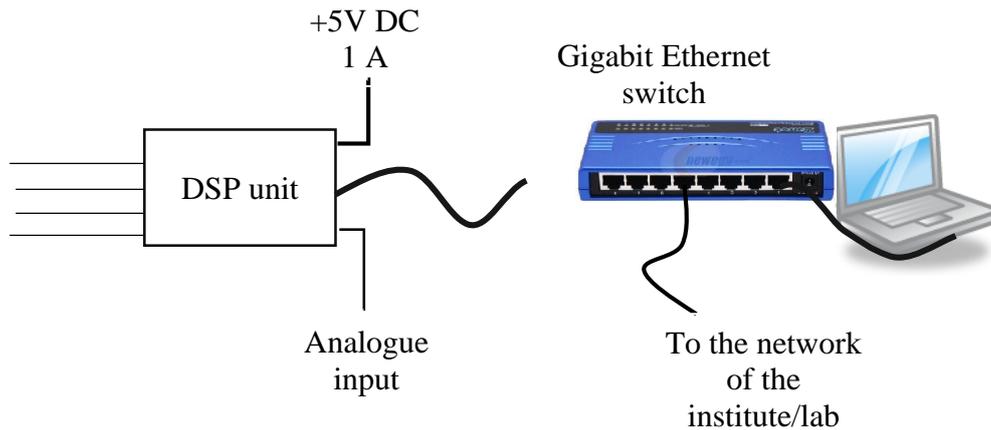


In this case the DSP module uses its own static IP address which is 192.168.0.XXX. The IP address of the computer must be set to 192.168.0.1 where the last 3 digits differ from the address of the module. The subnet mask must be 255.255.255.0. Open the Control panel in Windows, select the Network and Sharing Center, then the Change Adapter Settings. The following window appear:



Select the Internet protocol (or Internet Protocol Version 4) (TCP/IP) and click on the “Properties” button. In the next window select the “Use the following IP addresses” radio button and set the 192.168.0.1 IP address and 255.255.255.0 subnet mask. Also select the “Use the following DNS server addresses” radio button. Click on the OK button.

- b) Connecting the Ethernet cable to the local area network of the lab/institute using a gigabit Ethernet switch. In this case the DSP module is available on your local network and you may start remote data acquisition, i.e. the PC can be located in another room. This option connection type requires a gigabit Ethernet switch and a DHCP server which automatically provides IP address for the DSP module. In this case the DSP module and the computer are connected to the switch with separate Ethernet cables and the switch is connected to the network of the lab/institute. This connection is less reliable because the data transfer capability slightly depends on the network of the lab/institute. However its advantage is that you can establish remote access to the DSP module. The wiring schema is shown below:



In this case the DSP module acquires IP address from the DHCP server (installed at the institute/lab) and the computer also has to use either DHCP or static IP address according to the lab/institute network setting and policies.

- c) Install 2 different network adapter in the PC. Connect the DSP to one and set the static IP according to chapter a) above. Connect the lab/institute network to the other network adapter and follow the internet settings of your lab.

After starting the program the following window appears on the screen (Figure 1).

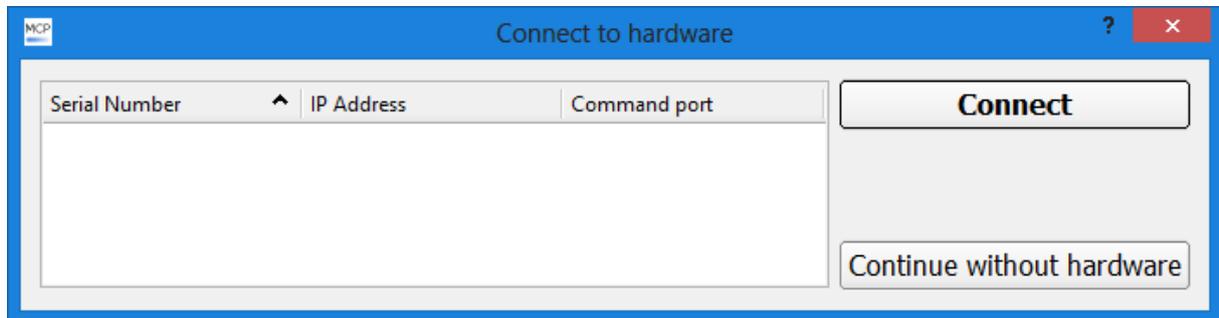


Figure 1: Hardware selection dialog

The user may select two options:

- a) If the DSP module is connected to the computer, then its serial number, IP address and the port is displayed in the list. Select a module from the list and click on the “Connect” button. Then the program establishes the connection to the DSP module and the program is ready for data taking. The list refreshes after 5 seconds, but after the power on the DSP requires 30-60 seconds to acquire an IP address.
- b) If no DSP module is connected or the user doesn’t want to acquire data then click on the “Continue without hardware” button. All functions are available, except the data collection (Start/Stop), however the user may load existing data and evaluate it.

Setting up the measurement parameters

Launch the mqmcp.exe program and select the “Presets” item in the “Measurement” menu. The following window appears:

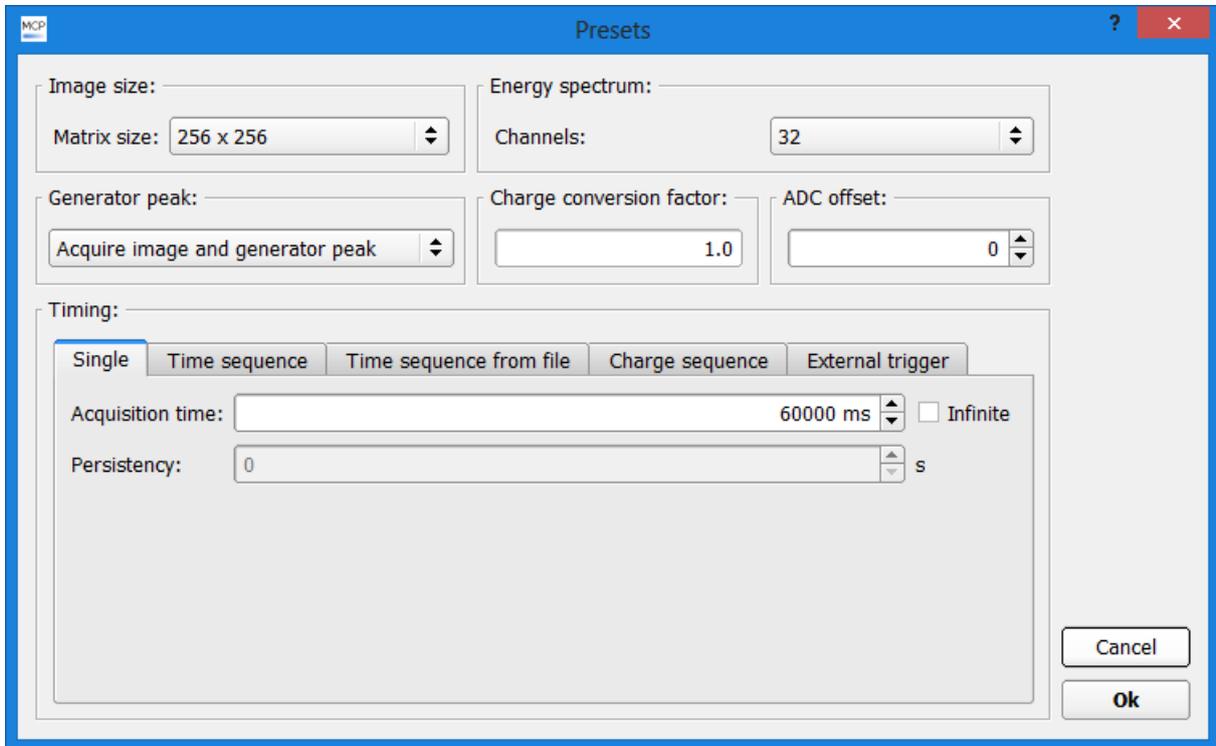


Figure 2: The measurement preset window

The program stores the parameters and uses these parameters in every new measurement.

- Matrix size: the size of the image (possible values: 64x64, 128x128, 256x256, 512x512, 1024x1024, 2048x2048 pixels).
- Energy spectrum channels: The sum signal of the MCP is calculated in the acquisition program for each incoming events, and the amplitude distribution is displayed in the software (so called pulse height distribution). This variable controls the number of channels of the amplitude distribution. *Note:* The number of image pixels times the energy spectrum channels should not exceed $1.4 \cdot 10^8$.
- Generator peak: The DSP module contains a so called generator peak which is an artificial spot generated by the DSP. Its role is to test the system without real detector. It is located on the left side and vertically in the middle on the image. The rate of the generator peak is 1 kHz. The user may choose from 3 different options:
 - Acquire an image where both the generator peak and events from the detector are present
 - Acquire an image where only the events from the detector are present
 - Acquire an image where only the generator peak is present

- Charge conversion factor: This is a floating point number which converts the values of the analogue input of the DSP to charge (for further details see the Analogue input chapter)
- ADC offset: This shift the analogue input value with the given value. (for further details see the Analogue input chapter)

Operation modes

The presets window also contains the acquisition modes in the “Timig” frame. The program supports 5 different timing options. The program uses that timing mode which tab is active.

- **Single:** The program collects data for the predefined time (or infinite) then it stops automatically. User may set the “Acquisition time” in milliseconds. If “Infinite” checkbox is selected, then the program doesn’t stop the acquisition automatically, the user has to stop it by clicking on the “Stop” button. In the infinite case the field “Persistency” is active, and the program erases the image after the time, defined in this field, is elapsed.

Time sequence: (Figure 3) The program is able to collect data in time sequence. A sequence consists of the following structure:

<i>Cycle number</i>	<i>Description</i>
-	Start time
1	Launch external command before the cycle
1	Delay between cycles
1	Acquisition time/cycle
1	Launch external command after the cycle
2	Launch external command before the cycle
2	Delay between cycles
2	Acquisition time/cycle
2	Launch external command after the cycle
...	
N	Launch external command before the cycle
N	Delay between cycles
N	Acquisition time/cycle
N	Launch external command after the cycle

Each step in the cycle has the same acquisition time and delay time between the steps. User may run external commands before and after the steps (always the same commands). The program stores the images after each step automatically in the same folder with different file names. The file name contains the cycle number.

Start time: This is a delay to start the first step.

Acquisition time: The program collects image during this time

Delay between cycles: The program doesn’t save the image during this period, however is collect the charge if the analogue input is connected to a current meter.

Run command before the cycle: Before a cycle step start the acquisition software launch an external program specified in this filed. This field is optional.

Run command after the cycle: After a cycle step is finished the acquisition software launch an external program specified in this filed. This field is optional.

Wait for execution of external commads: If selected, and any of the external program field is not empty then the acquisition program waits until the external program exits. Otherwise the cycle steps and the external programs run parallel.

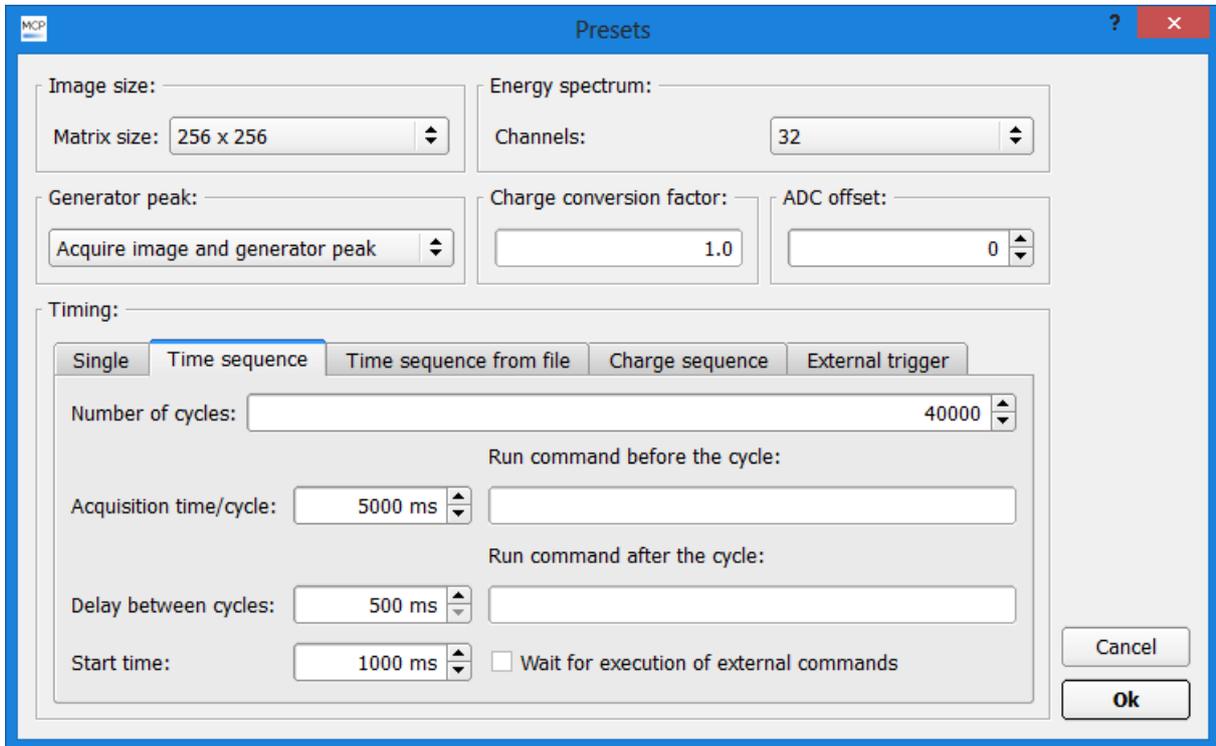


Figure 3: The time sequence operation mode

Time sequence from file: (Figure 4) This is similar to the *Time sequence* mode, but the program reads the timing information from a text file.

In this case, the cycle start/ delay between cycle and the external programs can be change from steps to steps in order to provide full flexibility.

The structure of such a text file is the following:

The first line is the start time in milliseconds, then each following lines are one step:

DelayTime is the *Delay between cycles*, frameTime is the *Acquisition time*, comandbefore and commandAfter are the external commands and true or false is the *Wait for execution of external commads*. The external commands and the [true|false] options are optional. If neither true nor false are at the end of the line, the program uses true as default value.

```
start time
DelayTime frameTime ;commandBefore; commandAfter; [true|false]
DelayTime frameTime ;commandBefore; commandAfter; [true|false]
DelayTime frameTime ;commandBefore; commandAfter; [true|false]
...
...
...
DelayTime frameTime ;commandBefore; commandAfter; [true|false]
```

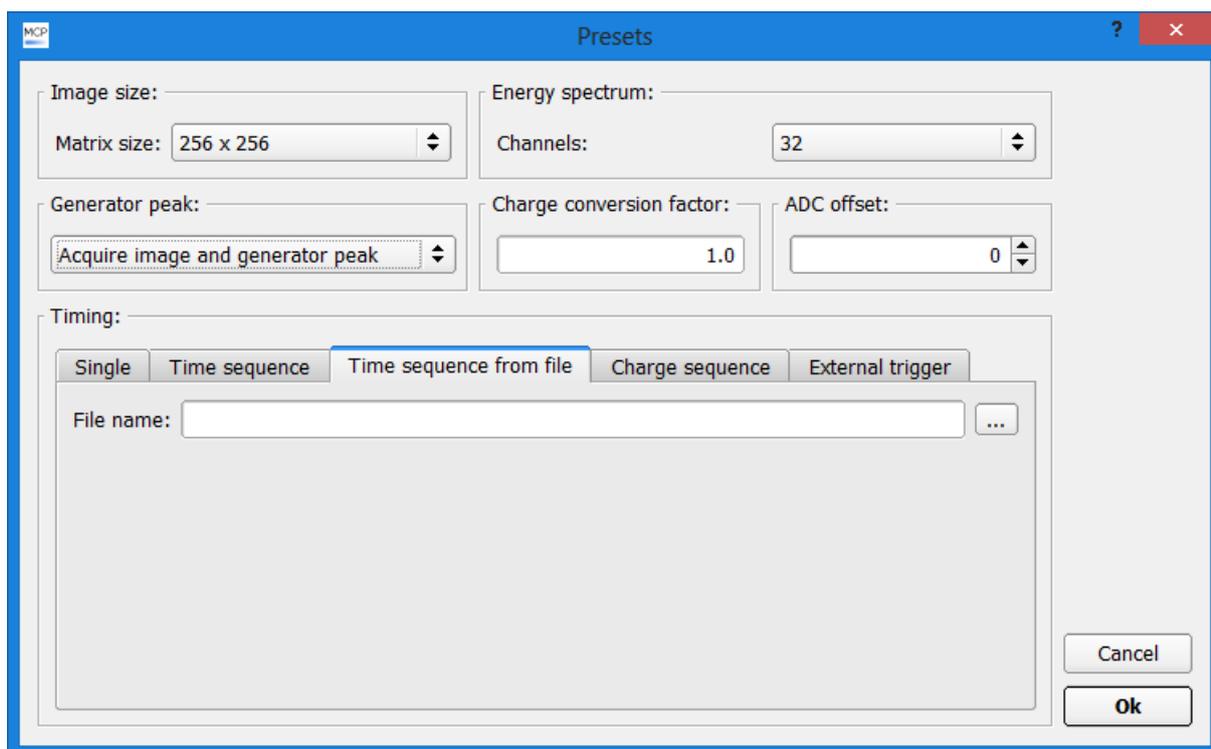


Figure 3: The time sequence from file operation mode

Charge sequence: (Figure 4) The program is able to collect a sequence of images using the amount of collected charge as stopping condition. This option requires a current meter connected to the analogue input of the DSP module and the proper charge calibration value. The user may run external commands before starting the sequence and between the steps. The user may add as much steps to the table as necessary and the program is able to save/retrieve the table to a text file. Before starting a new measurement, the user has to load the file saved earlier. *Wait for execution of external commands:* see the Time sequence chapter above.

A sequence consists of the following structure:

Start command: This command runs before the sequence. This field is optional.

Each sequence consists of the charge to be collected and an external command launched after the given amount of charge is collected. The external command is optional.

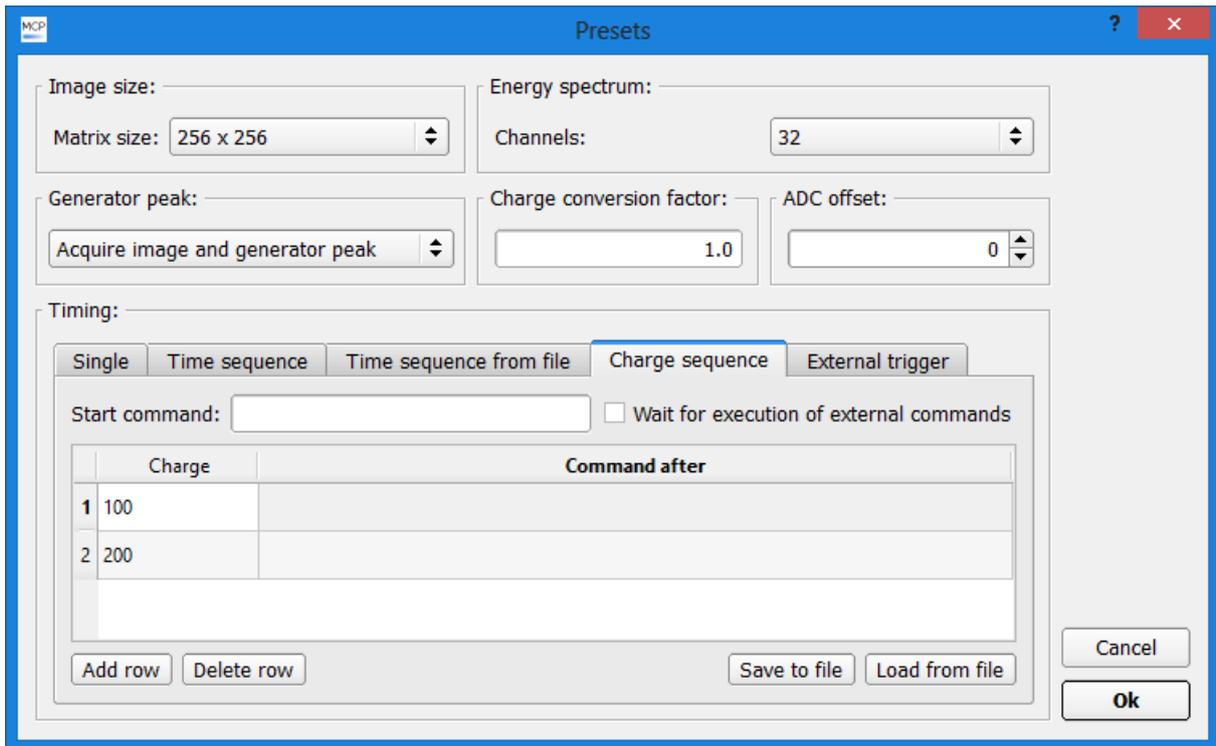


Figure 4: Charge sequence mode

External trigger: (Figure 6) The program is able to collect a sequence of images using an external trigger signal as start and stop condition. This option requires a rectangular shaped analogue signal connected to the analogue input of the DSP module. The shape of the signal is shown in Figure 5. The user may run external commands between the steps. The user has to add as much steps to the table as necessary and the program is able to save/retrieve the table to a text file. However running external programs between the steps are optional, but the table has to contain the same number of rows as the number of cycles. Before starting a new measurement, the user has to load the file saved earlier. The threshold of the external trigger signal is adjustable using the “Trigger threshold box”. Signals exceed the threshold limit considered as high level, and image collection is starts while the trigger signal is in high state. The minimum width of the high and low state is 3 milliseconds. *Wait for execution of external commads:* see the Time sequence chapter above. The program stores the image after the external signal goes to low state.



Figure 6: Shape of the external trigger signal

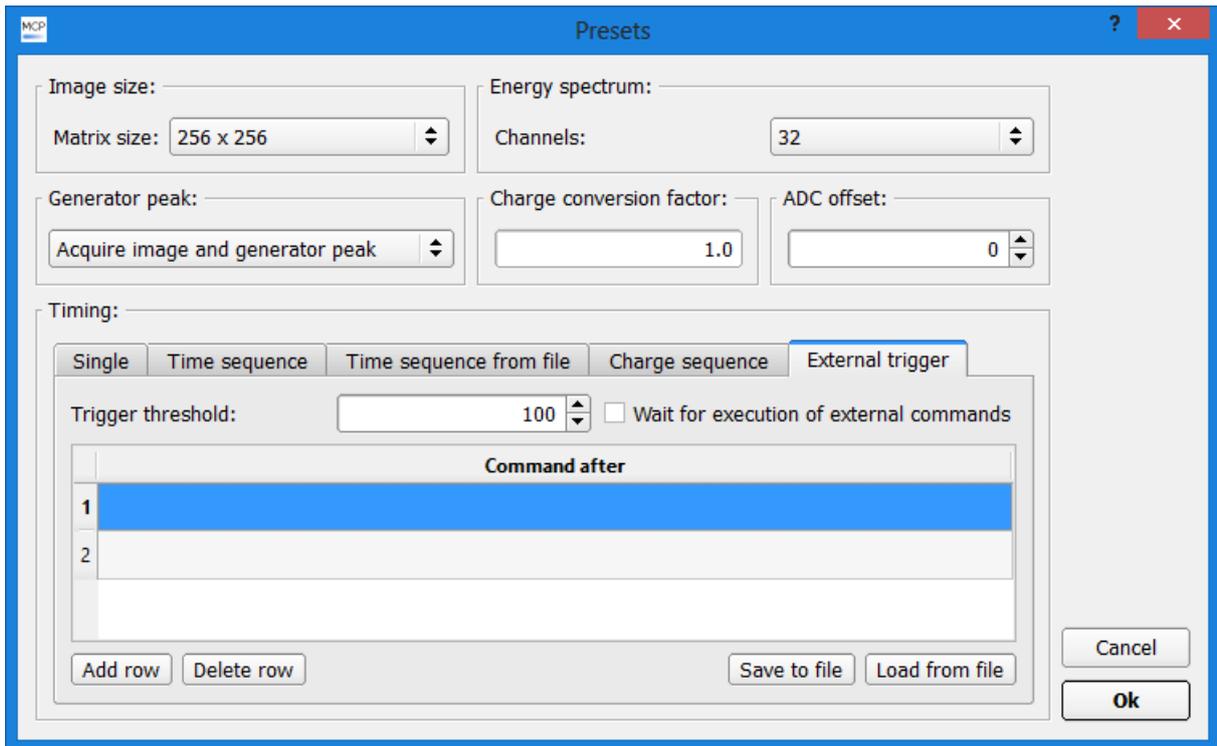


Figure 6: External trigger mode

The main window

The main window is shown in Figure 7. It displays the image, the pulse height distribution, ROI statistics, the results of the predefined expressions, horizontal and vertical projection curves and it also contains the control panel. All functions are accessible from the menu bar.

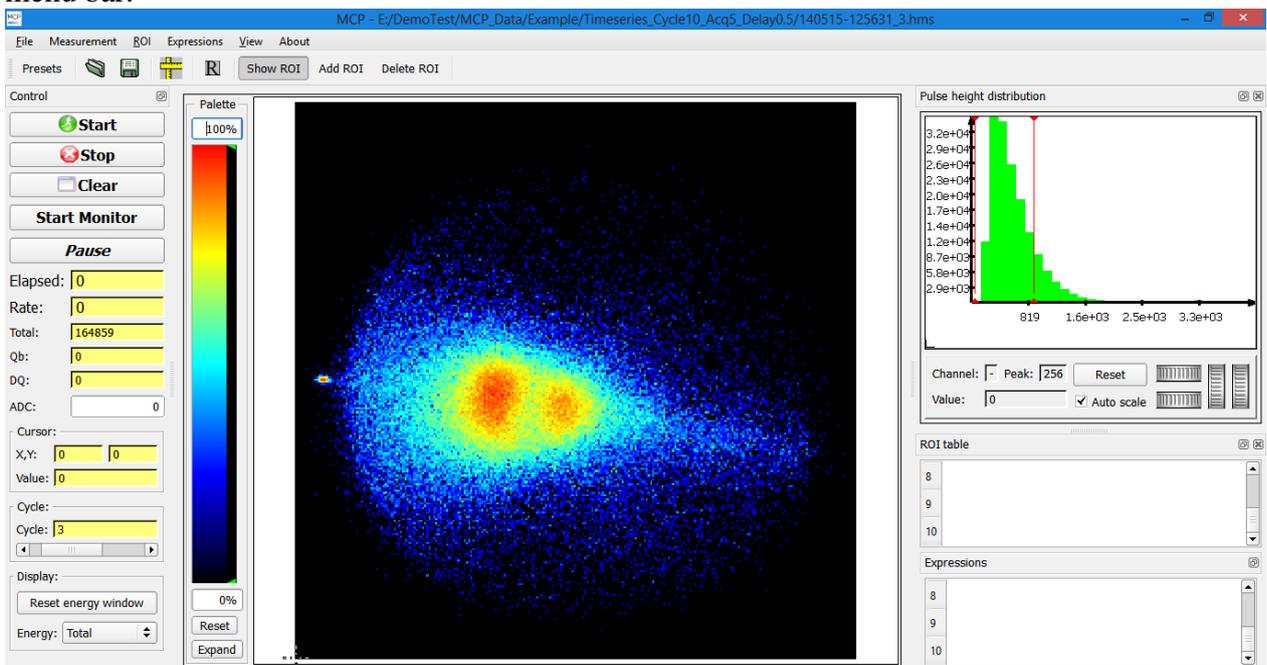


Figure 7: The main window of the program

The image area and the color scale

The program is able to display the image using different color scales (figure 8) and levels. Using the right button of the mouse on the rainbow, a menu appears with different color scales. This menu also contains the logarithmic or normal display mode. (The default is the logarithmic). The user may modify the lower and upper limits of the color scale by moving the green triangles with the mouse (left button). The reset button sets the lower and upper limits to 0%, 100% respectively.

The image can be zoomed using the middle button of the mouse. Press and hold the middle button and move the mouse to zoom the image. The zoom also works in the same way by pressing the Ctrl button and the left button of the mouse. User may shift the image both in horizontal and vertical direction using the Shift key and the left mouse button. Note that neither zooming nor translation of the image do not modify the original data, these functions serve for better visualization. The user may reset the default zoom and translation by clicking on the **R** icon or from the „View” menu „Reset image view” command.

The image area contains a cursor, its position and the pixel value is displayed on the Control window.

The user may show/hide the ruler by clicking on the  icon or using the „View” menu „Show ruler” item. The value is displayed in pixels. The user may move the end of the ruler to any position on the image.

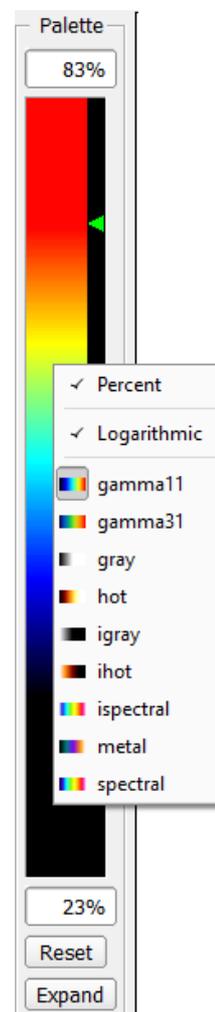


Figure 8: The color scale

Image transformations

The user may rotate the image and translate the matrix in X and Y directions. The function is available from the “View” menu using the “Show image transformation” command. Transformation window appears (see figure 9). The user may define the rotation in degrees and the translation in pixels. Note: This transformation modifies the image data, if some data are outside the image area (i.e. too much shift in one direction) then it is not possible to recover the cutted data.

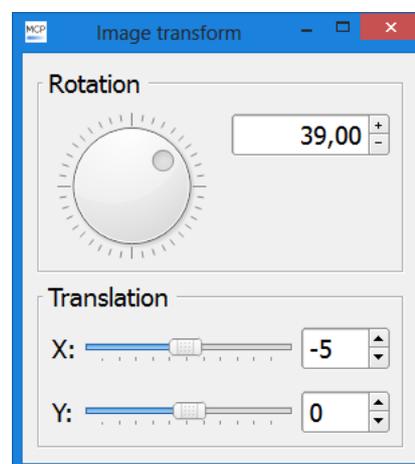


Figure 9: Image transformation window

Control window

The control window (Figure 10) controls the acquisition (Start/Stop/Clear the image) and displays information related to the acquisition.

The following information are displayed:

- Elapsed time
- Count rate
- Total counts accumulated
- Qb: The charge during the delay period (in case of time sequence mode)
- Dq: The charge difference between the previous cycle and the current cycle (in case of time sequence mode)
- ADC: The value of the analogue input ADC
- Cursor: X,Y position and the pixel value
- Cycle: The current cycle number. User may select the current step using the scrollbar in case of multi cycle acquisition after the acquisition is finished.
- Energy: Total or Window. The pulse height distribution window contains two red markers which are the window. The program is able to cut the image using that window on the raw data so only those events will be displayed which amplitude is between the two red lines.

The user may start/stop the acquisition or clear the image using the buttons. The user may suspend/continue the measurement using the “Pause” button. The log file contains the pause/continue time.

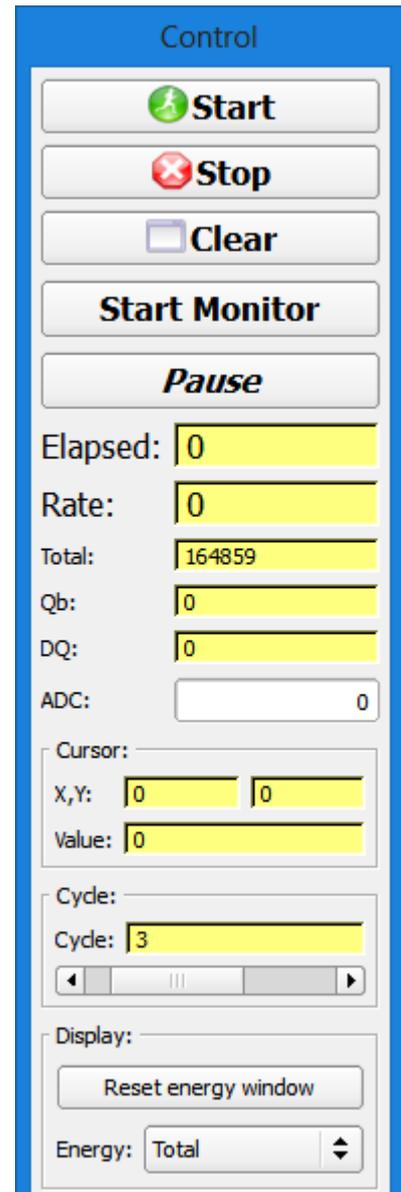


Figure 10: Control window

Starting the acquisition

The program contains a dedicated acquisition mode, called monitor. In this mode, all presets are used, even the timing mode. This acquisition mode corresponds to the Single mode with infinite acquisition time. Click on the “Start Monitor” button to start the data acquisition. The program displays the image however it does not stop automatically the acquisition and does not save the data. The goal of this mode is to test the detector, the setup, the beamline before the final measurement.

The other option is the normal data acquisition. Press the “Start” button and the following window appear (Figure 11). If “Enable saving” option is not selected, then the program does not save the data automatically. User may also save images in ASCII format and list mode data automatically by selecting the checkboxes.

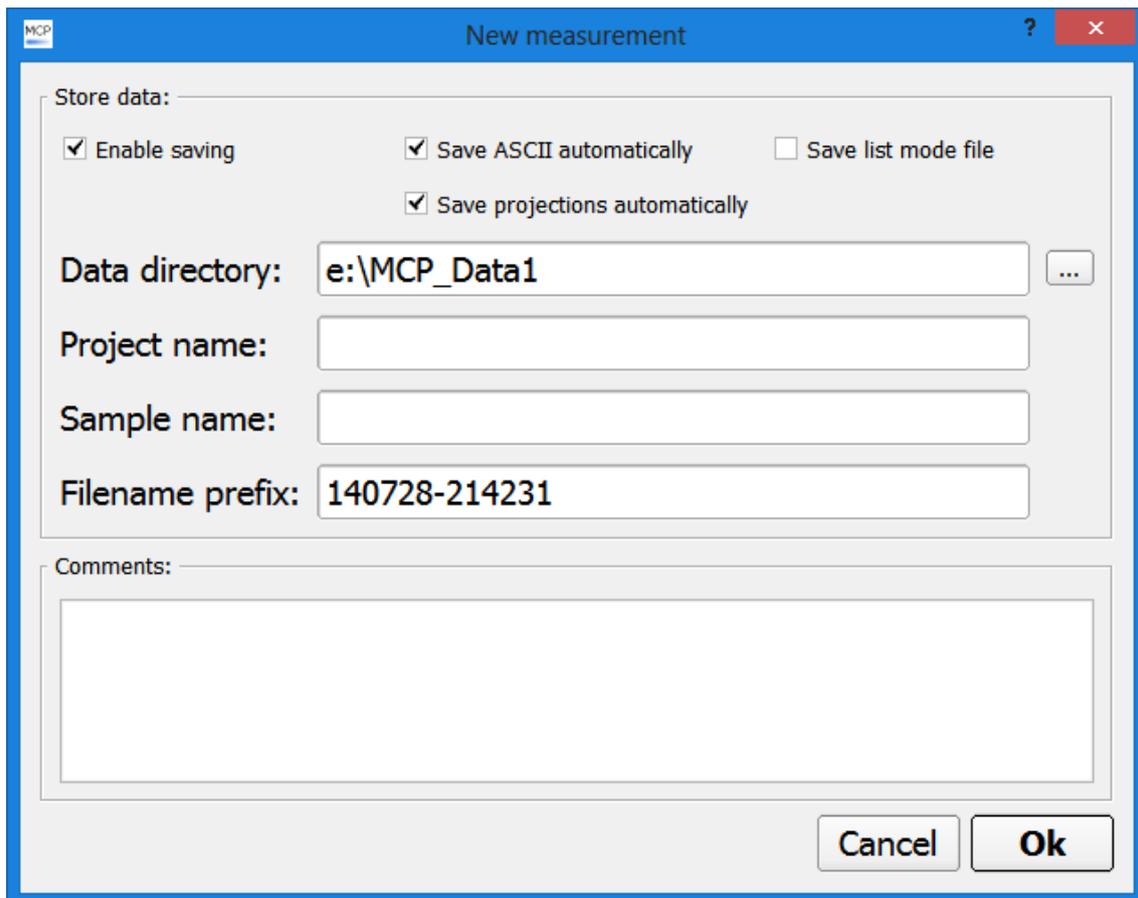


Figure 11: The new measurement dialog after starting the data collection

The “Data directory” is the folder where the files are stored. This directory must exist. “Project name” this folder is created by the program if it does not exist. This will be created within the “Data “directory” folder. “Sample name” is the directory for the current sample within the “Project” directory. “Filename prefix” is generated by the program automatically it contains the YearMonthDay-HourMinuteSecond. User may modify or extend the prefix. The user may add comments to the measurement, which is stored in the log file of the measurement.

For each sample a log file is created with extension “log”. The sample folder contains the log file, the data files (with “hms” extension), the ASCII files (if the ASCII check box is selected) and the list mode files (“raw”) if the list mode check box is selected).

The projections are also stored in the sample folder as ASCII files if the “Save projections automatically” checkbox is selected. The filename has the same convention (i.e. YearMonthDay-HourMinuteSecond) but followed with “_projections.txt”.

The user may interrupt the data acquisition by clicking on the “Stop” button.

File menu commands

Open commands

Use these commands to open an existing data file that has been saved by the mqmcp program.

Three different file formats are supported:

- List mode files: this contain every hits detected by the MCP and processed by the DSP module. This file contains all information therefore it is possible to apply different settings or acquisition modes (i.e. different matrix size, pulse height windowing)
- Histogram files: compressed files containing less information compared to list mode files. Pulse height windowing is possible, but the matrix size is fixed. Shortcut for this function is available on the toolbar ().
- ASCII files: only ROI analysis and expressions are available.

Save/Export commands

Use these commands to store the projections in ASCII format or the current image in ASCII/jpg format.

Exit command

Use this command to end your mqmcp session. The software automatically stores its window layout, size and position on the screen. These values are loaded automatically by the next start.

Measurement menu commands

Presets

Opens the “Presets” dialog. See chapter “Setting up the measurement parameters”

Start/Stop/Clear

The same functions are available on the Control window. These menus starts, stops the acquisition and clear the image.

Set Threshold

This function sets the signal detection threshold in the DSP module. Sum signals with amplitude smaller than the threshold value are rejected by the DSP module. This function is intended to reject the noise coming from the detector. If the user increases the threshold, the left part of the pulse height distribution spectrum will be cutted. The threshold window is shown in figure 12.

Note: After changing the threshold value, clear the image by clicking on the “Clear” button.

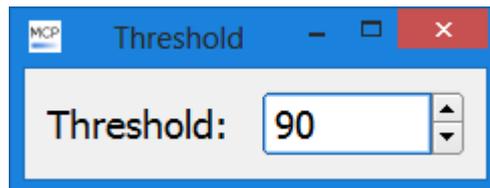


Figure 12: The signal detection threshold window

ROI menu commands

A Region of Interest (ROI) is an area marked in the image. ROI selection is an advanced feature which provides instantaneous computation of the sum of the pixel values (displayed in the ROI table and used in the expressions). ROIs have different colors. Regions may be set up using the mouse controls. User may modify the size and the position of the ROI using the handlers and the mouse.

The use may store and retrieve regions independently from the data acquisition.

Add ROI command

Add ROI to the image.

Delete ROI

Delete the selected ROI.

Delete All ROI(s)

Delete all available ROIs.

Load ROI command

Loads ROI(s) from a text file. The previous ROIs are deleted. The program calculates the ROI values from the current spectrum if “Auto calculation” is enable. The color of the ROIs are automatically generated by the software.

When Load ROI(s) is selected, the File Open dialog box will appear. The filename may be directly entered into the File Name edit box or a file can be chosen from the available names in the list box. The default extension for the files in the list box will be *.roi.

Save ROI command

Stores all ROIs from the ROI table. in a text file. When Save ROI(s) is selected the Save As dialog box will appear, so you can name your document. The default extension for the files in the list box will be *.roi.

Show ROI command

This function shows/hides ROIs on the image. The ROIs are hidden, but the program uses the ROI values in the expression calculation and in the ROI table.

Save ROI table command

The program can save the content of the ROI table to ASCII text file in a tabulated form. Therefore the user may load the values from the ROI table to other programs (Excel, Matlab, ...). When Save ROI table is selected the Save As dialog box will appear, so you can name your document. The default extension for the files in the list box will be *.txt.

Recalculate ROI table command

The user may recalculate the values displayed in the ROI table manually. This function refreshes the values.

Expression menu commands

Add expression

Opens the “Presets” dialog. See chapter “Setting up the measurement parameters”

Delete all expression

The same functions are available on the Control window. These menus starts, stops the acquisition and clear the image.

Load ROI command

Loads ROI(s) from a text file. The previous ROIs are deleted. The program calculates the ROI values from the current spectrum if “Auto calculation” is enable. The color of the ROIs are automatically generated by the software.

When Load ROI(s) is selected, the File Open dialog box will appear. The filename may be directly entered into the File Name edit box or a file can be chosen from the available names in the list box. The default extension for the files in the list box will be *.roi.

Save ROI command

Stores all ROIs from the ROI table. in a text file. When Save ROI(s) is selected the Save As dialog box will appear, so you can name your document. The default extension for the files in the list box will be *.roi.

Show ROI command

This function shows/hides ROIs on the image. The ROIs are hidden, but the program uses the ROI values in the expression calculation and in the ROI table.

Save ROI table command

The program can save the content of the ROI table to ASCII text file in a tabulated form. Therefore the user may load the values from the ROI table to other programs (Excel, Matlab, ...). When Save ROI table is selected the Save As dialog box will appear, so you can name your document. The default extension for the files in the list box will be *.txt.

View menu commands

Show log window

This function shows the log window of the current measurement. The log file is created automatically and contains the preset values and the date and time when the acquisition started.

Reset image view

This function resets the default zoom and translation values. For more information see “The main window” chapter.

Show ruler

This function shows/hides the ruler on the image

Show pulse height distribution

This function shows the pulse height distribution window if the window is not visible.

Show projections

This function shows horizontal and vertical projection windows and also shows two boxes in the image area. The red box is the vertical projection and the green is the horizontal. The user may change the position and size of the boxes using the handlers in the corner (circular shaped and rectangular shaped). The projection curves follow the changes of the boxes.

Show ROI table

This function shows the ROI table. The ROI table contains the sum of each pixels within the ROI. The user may define any number of regions using the Add ROI/Delete ROI buttons. To delete a ROI, the user has to select the corresponding ROI column in the ROI table then press the delete ROI button.

Show Image transformation

See chapter “Image transformations”

About menu commands

About command

Use this command to display the version number of your copy of mqmcp.

Analogue Input

File formats

Projection file format

The projection file format is plain text format (ASCII). This file contains three columns, the first column is the channel number (from 1 to the number of image pixels), the second column is the horizontal projection and the third column is the vertical projection.

The projections padded with zeroes if the projection rectangle is smaller than the image or part of the rectangle is outside from the image area.