

2. SOFTWARE DESCRIPTION

2.1. Getting Started with a basic SINGLE measurement

The MPA-3 software consists essentially of two applications, a server program MPA3.EXE that controls the hardware and the data, and a graphical user interface MPANT.EXE that all displays and controls the server program via a DLL.

What we are going to setup now is a simple SINGLE measurement using one external ADC. The acquired spectrum will have a range of 1k channels corresponding to a 1k ADC conversion gain setting.

First step is to start the MPA3 software by double clicking the corresponding icon. This will automatically start the MPANT program. On startup the MPA-3 Server is iconized and one does not have to worry about it since all hardware settings are also accessible from the MPANT program which actually is the graphical user interface and which will appear now on your screen (ref. Figure 2.1).

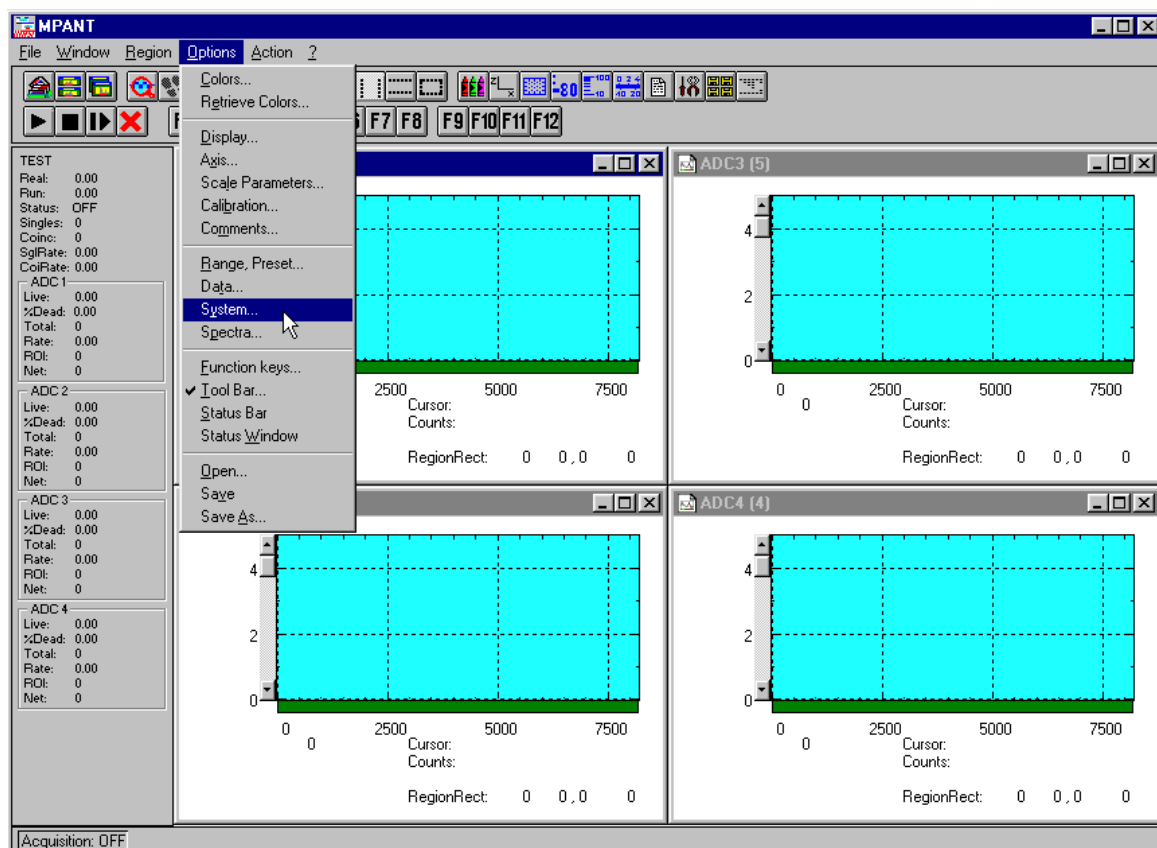


Figure 2.1: MPANT program startup screen

Now we have to change the system settings to one ADC (default is four) only. Open the **System...** menu in the **Options** pull-down menu.

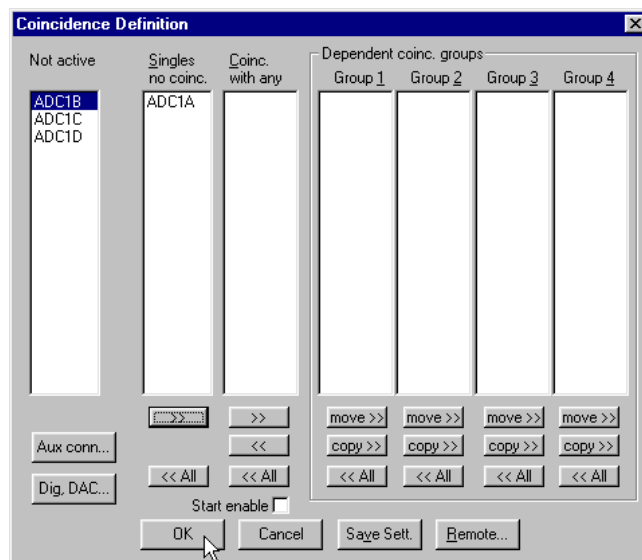


Figure 2.2: 'Coincidence Definition' dialog with one SINGLE ADC

Now the *Coincidence Definition* window should look like Figure 2.2. Close the window with **OK**. The MPANT window will change to display one ADC window.

Now we must set the range of the ADC to 1k. Open **Options – Range, Preset...** Change the **ADC Settings – Range** to 1k = 1024 (ref. Figure 2.3) and click **OK**. The spectrum display of ADC1 in the MPANT window changes to a full scale range of 1024 channels.

Be sure you connected an external pulse height analyzing ADC (set to 1k conversion gain) to the ADC port A of module 1. Input analog signals to that ADC, e.g. from a pulser.

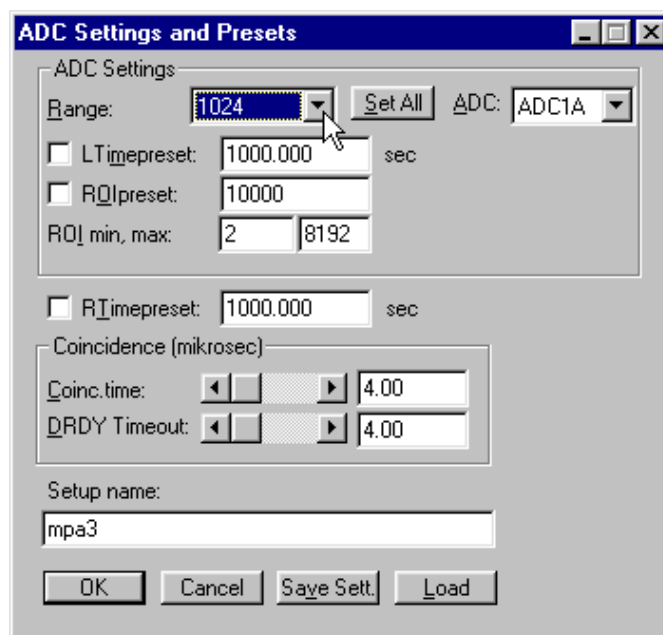




Figure 2.3: Set ADC range to 1k range

Now start data acquisition by a click on the **START** button . Recognize that when you move the mouse pointer over a button a help message appears in the lower left corner of the MPANT window. In this case it is 'Erases and starts a measurement' meaning that the contents of the histograms is erased and then a new acquisition is started. Click **OK** in the message window that appears after clicking the **START** button.

See that the *Status* changes to *ON*. The *Real* time will begin to run also indicating that data acquisition is *ON*. Depending on your input signals a histogram should start to be accumulated (ref. Figure 2.4). When you want to finish data acquisition click on the STOP button . The corresponding help message is 'Halts a measurement'.

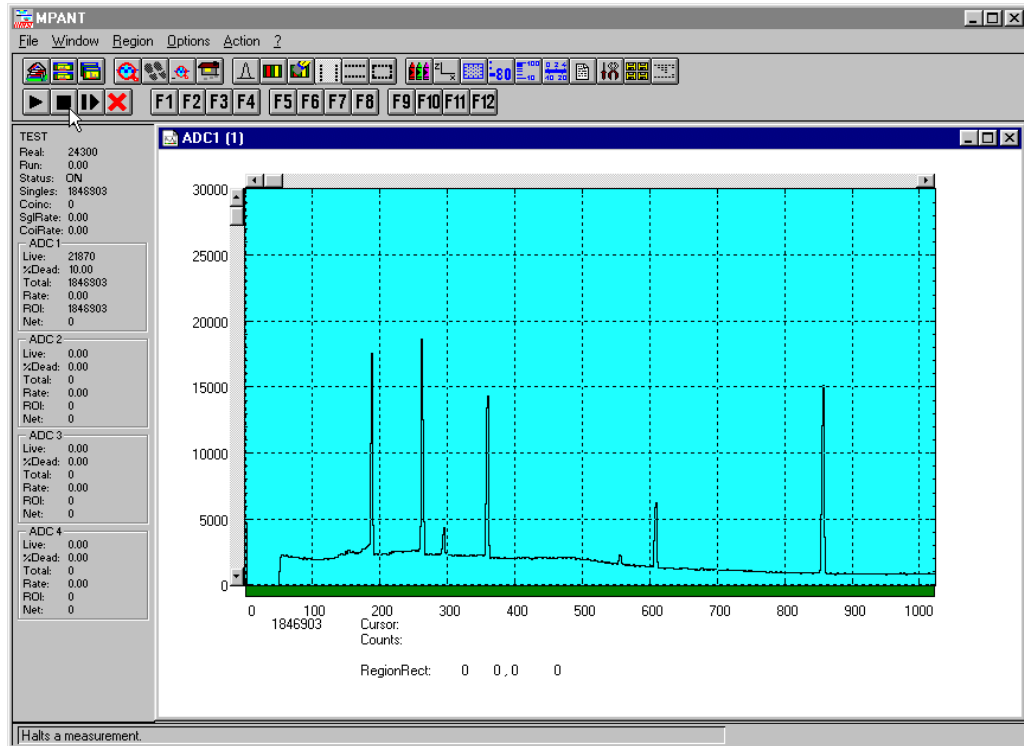



Figure 2.4: Spectrum of a basic SINGLE measurement

2.2. Getting Started with a basic COINCIDENCE measurement

What we are going to do is to setup a basic COINCIDENCE measurement using two ADCs. The ADCs will be set to a conversion gain of 4k. The on-line displays are set to a single spectrum for each ADC and a two-dimensional spectrum of ADC1A x ADC1B with a resolution of 256 x 256 channels.

First open the *Coincidence Definition* window by a click on the **System options** button . Use the << **All** buttons to move all ADCs to the **Not active** box and then move ADC1A and ADC1B to the **Coinc. with any** box with the >> button below this field. By default they are displayed with a 'S' appended indicating that they are allowed to start a coincidence resolving time window. If the 'S' is not appended check the **Start enable** check box for each ADC. The *Coincidence Definition* window should look like Figure 2.5 now.

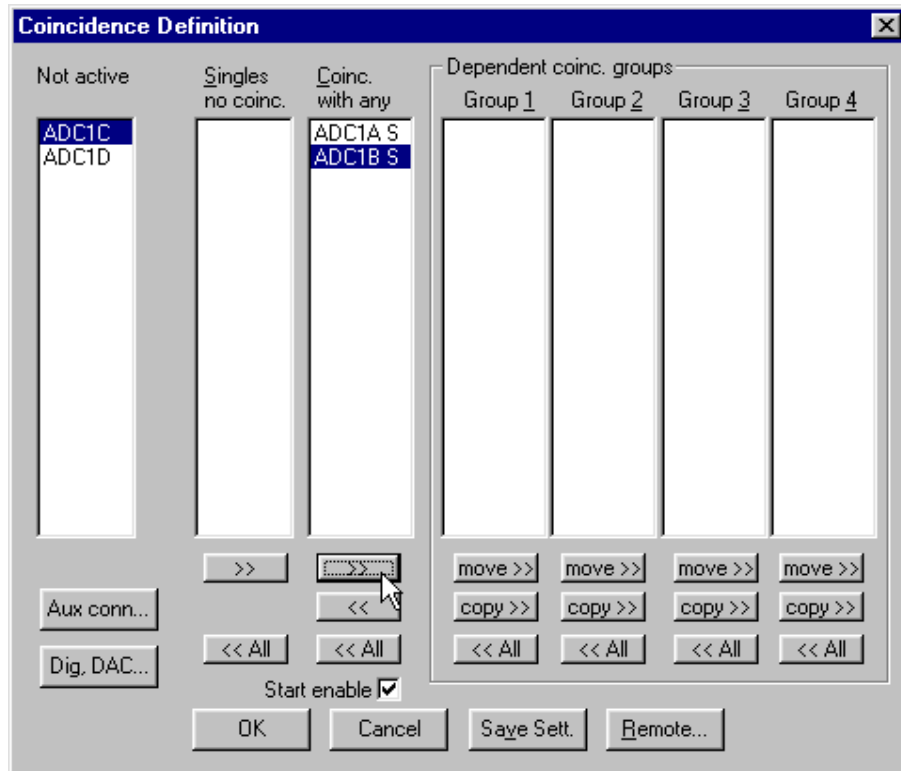



Figure 2.5: Setup two ADCs for a COINCIDENCE measurement

Set the ADC ranges to 4096 using the **Range, Preset...** button  to get into the *ADC Settings and Preset* window. Set the **Coinc time** to 10.00µs using the scrollbar. Then click into the data field of **DRDY Timeout** and type in 50.00 to set the DRDY timeout to 50.00µs. This is in accordance to a 100MHz Wilkinson type ADC ($4k \times 10ns \approx 40\mu s + 10\mu s$ overhead for safety) like our model 7074 Quad ADC. The DRDY timeout is the maximum time the system waits for converted data (DRDY goes true) after a DEADTIME signal of the corresponding is received. Click **OK** to accept the new settings and to close the *ADC Settings and Preset* window.

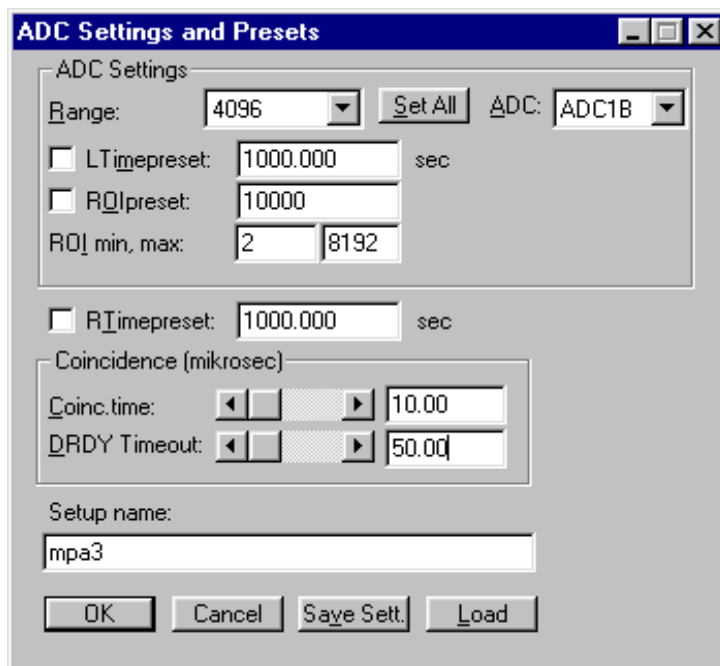



Figure 2.6: Setup ADC range and coincidence resolving time

Now we will still have to define a two-dimensional spectrum of ADC1A x ADC1B. Open the spectra definition window *Map and Calculated spectra* by a click on the **Spectra** button .

In the *Map and Calculated spectra* window click on **Add Multi...** button to add a new multiparameter spectrum. The *Multi Display Setting* window opens.

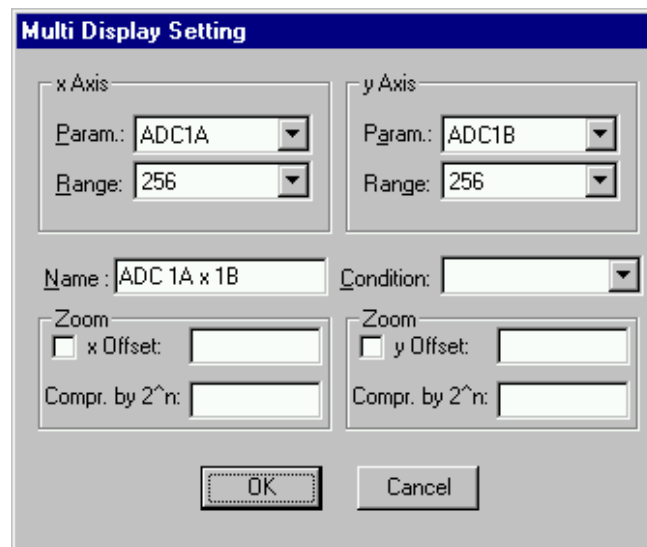


Figure 2.7: Add a two-dimensional spectrum

Set the x-axis of the new spectrum to ADC1A with a range of 256 and the y-axis to ADC1B with also range 256. Type in a name for the spectrum, e.g. 'ADC 1A x 1B' like in Figure 2.7. Click **OK**. In the *Map and Calculated spectra* window the new map appears (ref. Figure 2.8).

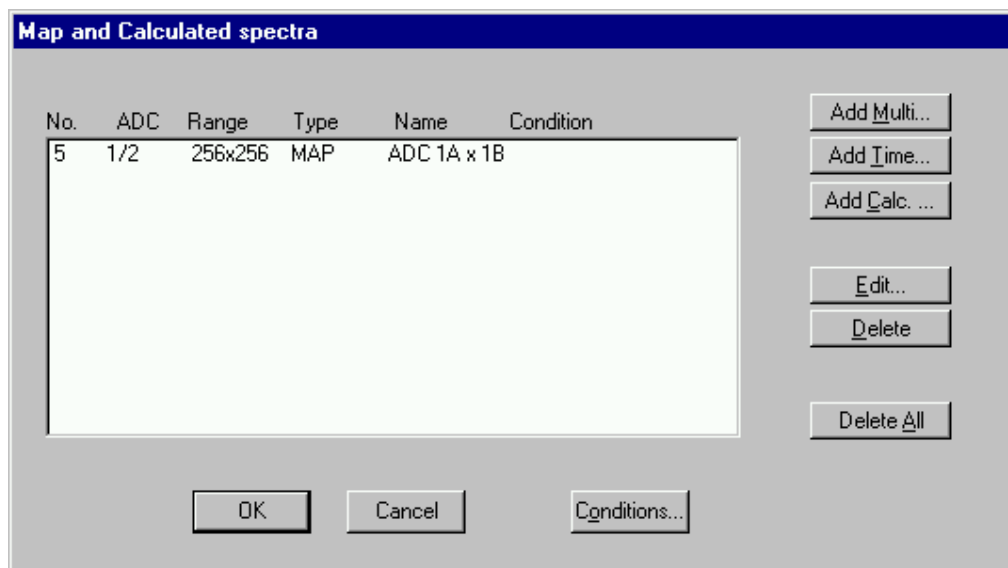


Figure 2.8: New spectrum defined

Close *Map and Calculated spectra* and the MPANT display should show up with two single spectra (ADC1A and ADC1B) and one multiparameter map (ref. Figure 2.9).

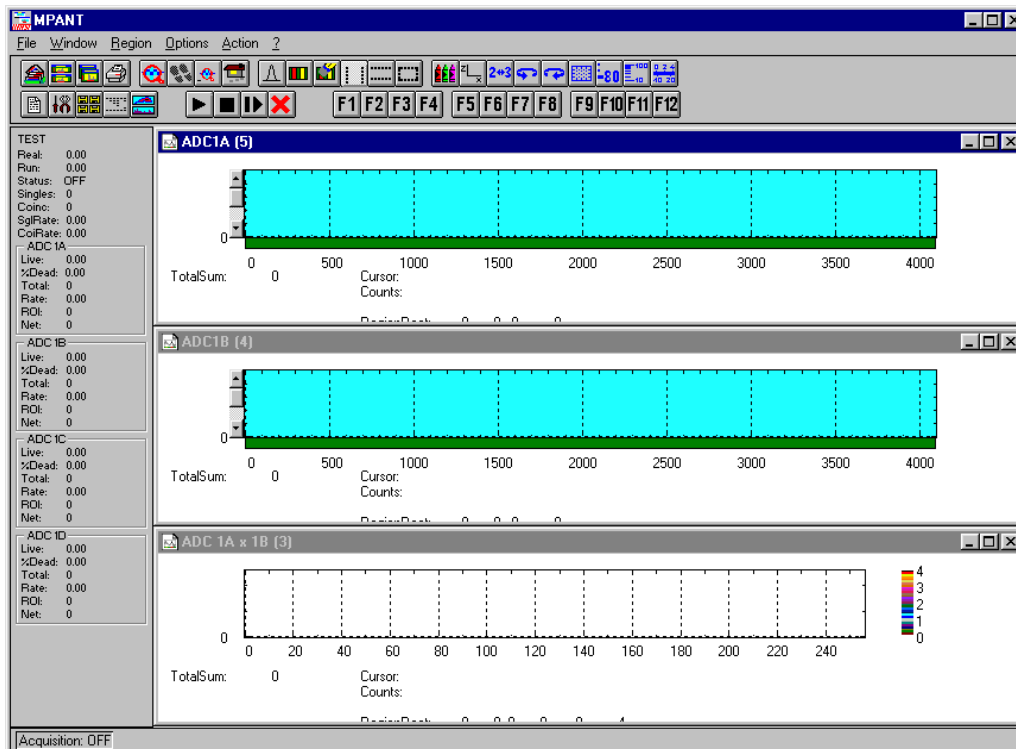




Figure 2.9: Two single and one multiparameter spectra display

Connect input signals to the ADCs. In case of a pulser being the signal source split the pulser output to both ADCs since only pulses that reach ADC1A and ADC1B within a $10\mu\text{s}$ time window (the coincidence time) are counted. Actually in this case not coincident signals are also counted but in the map display they will show up on the base of x- and y-axis (zero) since the respective other ADC is read as a 'ZERO'.

Start data acquisition with the START button . Depending on your signals spectra are shown. End data acquisition by a click on STOP .

2.3. Basic Usage of the Real Time Clock Option

To familiarize with the usage of the 48 bit Real-Time-Clock / Timer / Counter option a simple experiment is setup. The intention is to measure the arrival time of single ADC events relatively to a start (trigger) signal like it might be done in Time-of-Flight or similar experiments. To do so a variable delay is used to shift analog output pulses relatively to the TTL trigger pulse that on the other hand resets (reloads) the 48 bit counter via the AUX 1 input. Thus, in terms of TOF, the trigger signal acts as start and the ADC deadtime signal as stop input. The delay time is then measured with a resolution of 50ns and a time spectrum of the very ADC is accumulated.

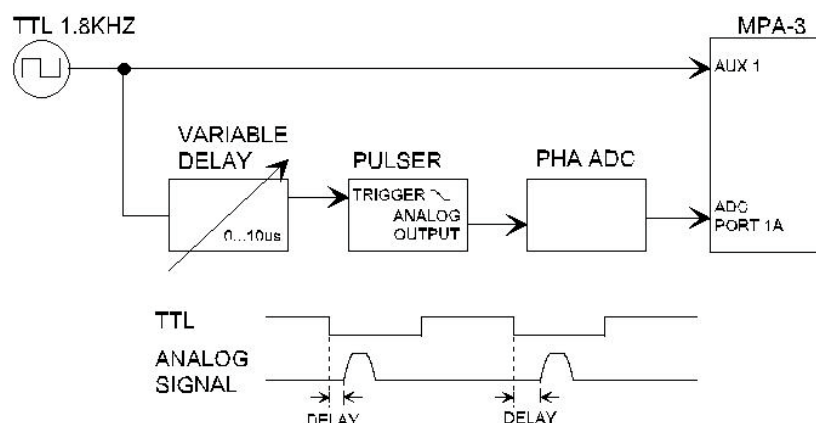


Figure 2.10: Basic RTC Experiment

First, ADC 1A is defined as a SINGLE mode ADC (ref. Figure 2.11). Now the RTC / Timer / Counter is set to reload (restart) with the auxiliary input AUX 1 (ref. Figure 2.12). The timer value capture command is derived from ADC 1A DEADTIME signal (ref. *OR-ed DEAD of ADC 1A* in Figure 2.12). And, last but not least, timestamps must be inserted into the data stream to transfer the corresponding time and ADC data together. The preset value is not important in this case but must be at least greater than the desired time range (or zero which will automatically change to the maximum value). For the count source 20MHz is selected to use the internal 50ns crystal clock.

Take care that the AUX 1 interface is used as input (output disabled – ref. Figure 2.13). Since the here used analog pulser triggers on the falling edge the AUX 1 input polarity is 'active high' to reload the timer when the TTL signal is high and let the timer free run when it is low.

To visualize the timing relationship a spectrum is defined that shows the arrival time on the x-axis, the ADC pulse height on the y-axis and the count rate in z-direction (ref. Figure 2.14). Also a one dimensional spectrum is defined (set ADC range to 1) to show just a time spectrum (projection onto the x-axis).

In Figure 2.15 the resulting spectra can be seen. Watching the map display (window (1)) amplitude variations show up as vertical lines whereas delay time variations result in horizontal lines. Window (4) is the corresponding three-dimensional view, window (3) the pulse height analysis and (5) the time spectrum.

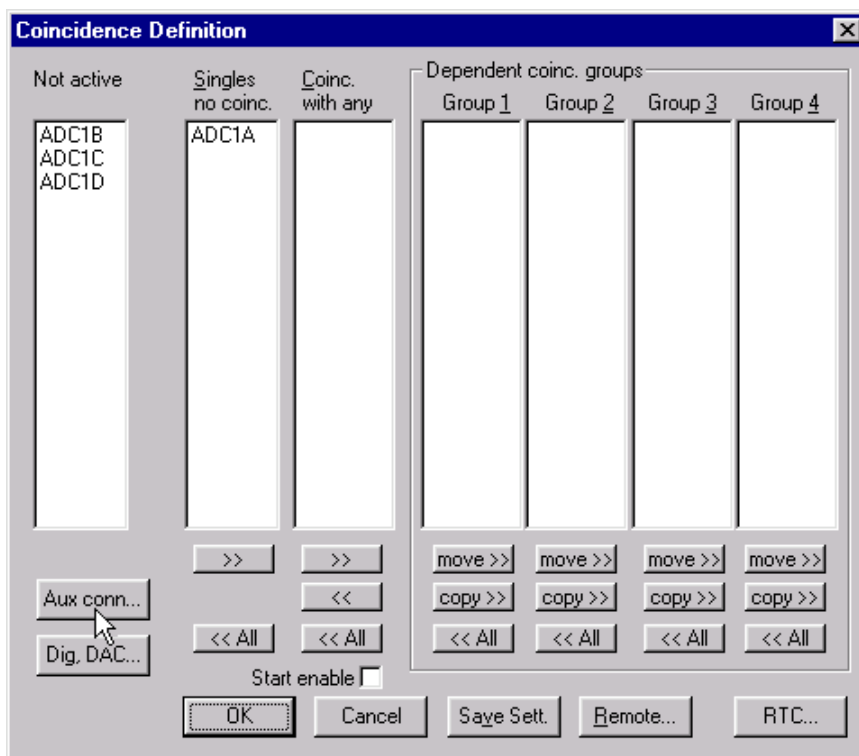


Figure 2.11: System Options for RTC Experiment

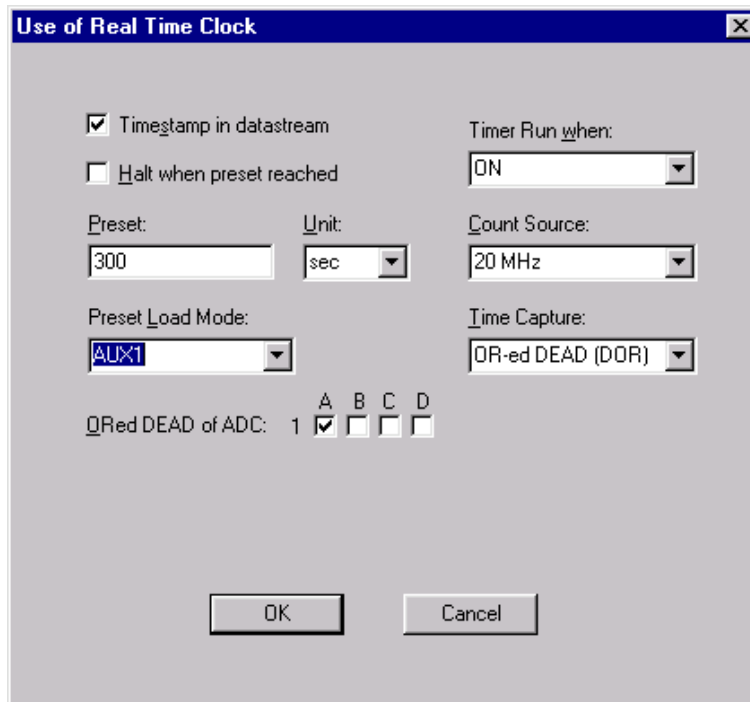


Figure 2.12: Real-Time-Clock Setup for basic Experiment

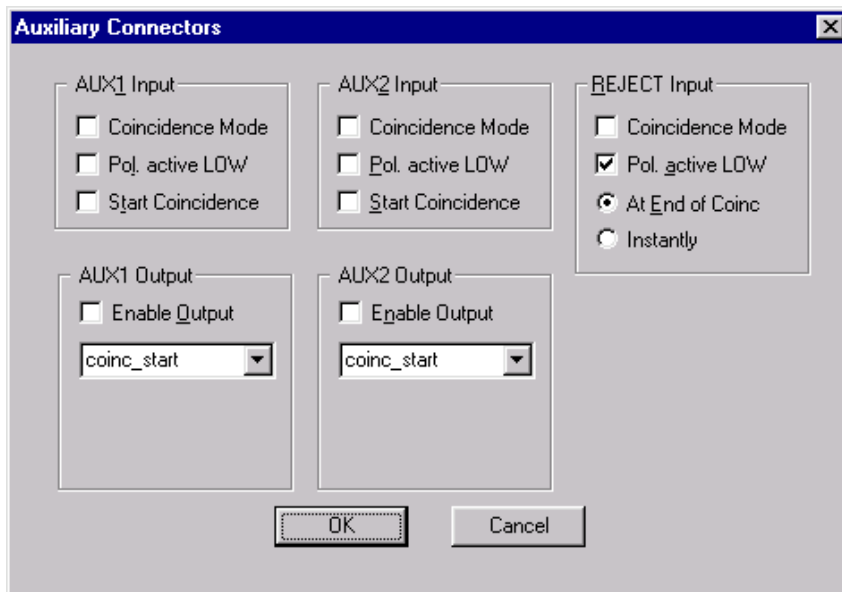


Figure 2.13: Auxiliary Connectors Setup for basic RTC Measurement

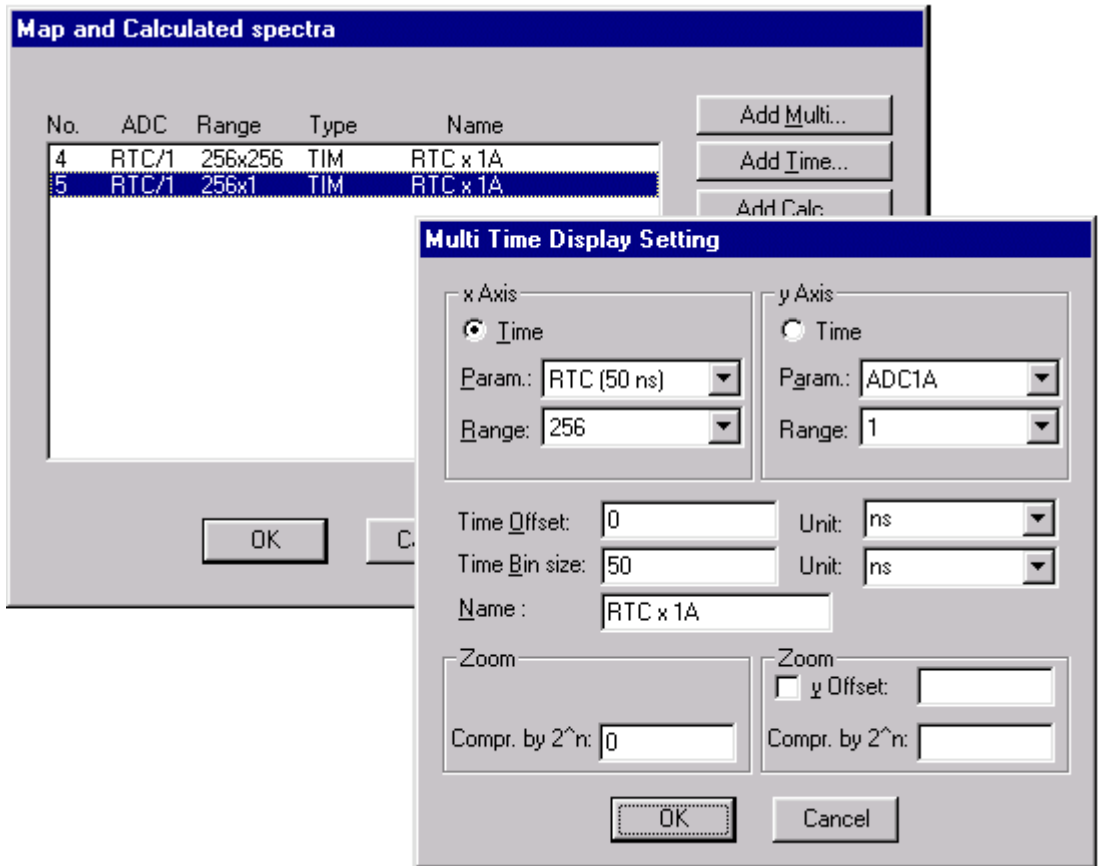


Figure 2.14: RTC Spectrum Definition

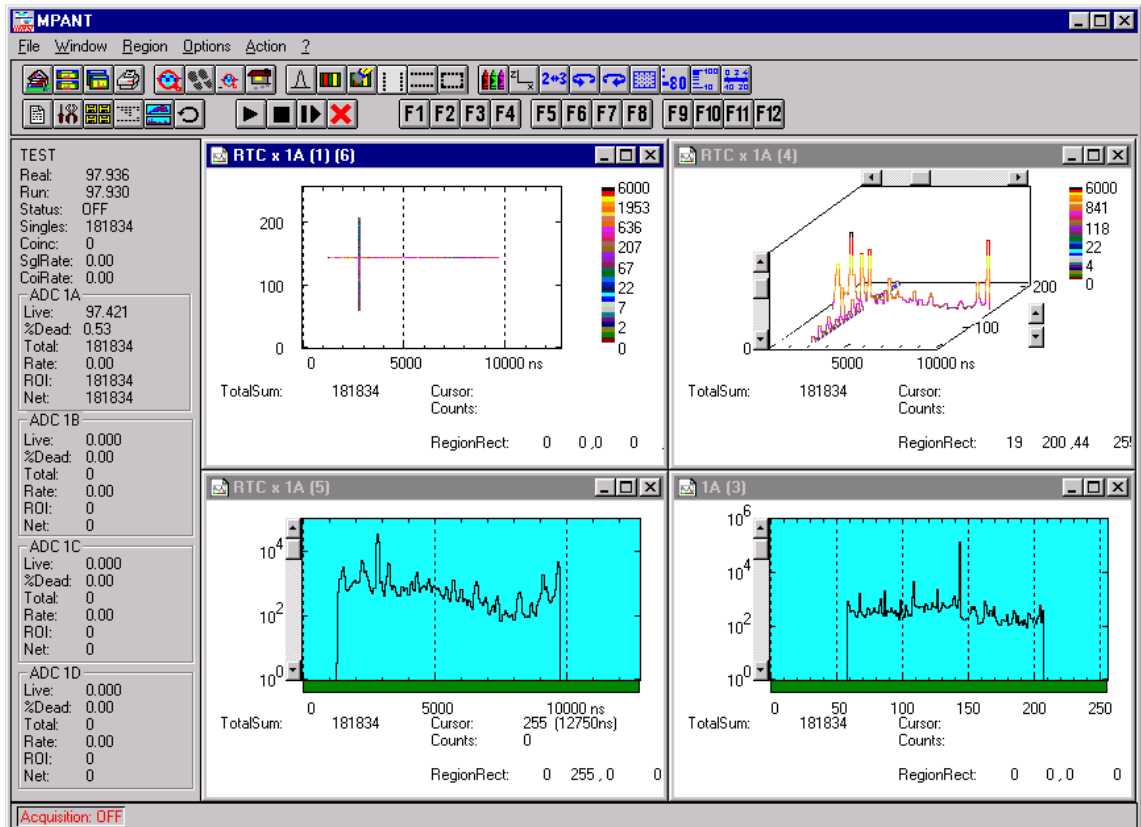
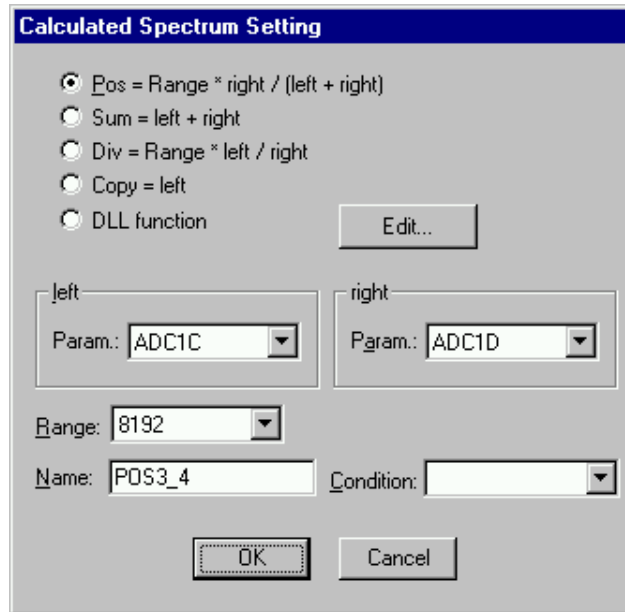


Figure 2.15: Basic Time Spectra of a Single ADC

2.4. Calculated Spectra

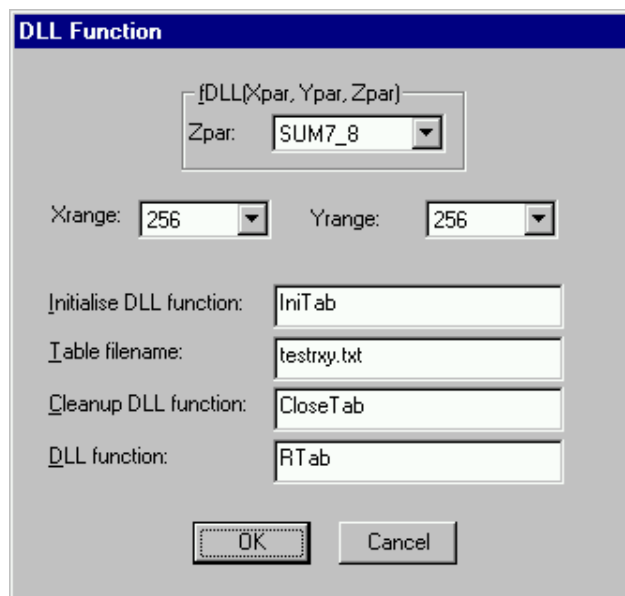
Press **Add Calc** from the Map and Calculated Spectra dialog to define a new calculated single spectrum in the **Calculated Spectrum Setting** dialog.



The dialog box is titled "Calculated Spectrum Setting". It contains several radio buttons for formula selection: "Pos = Range * right / (left + right)" (selected), "Sum = left + right", "Div = Range * left / right", "Copy = left", and "DLL function". An "Edit..." button is located to the right of the "DLL function" option. Below the radio buttons are two input fields: "left" with a dropdown menu showing "ADC1C" and "right" with a dropdown menu showing "ADC1D". Below these are "Range:" with a dropdown menu showing "8192", "Name:" with a text field containing "POS3_4", and "Condition:" with a dropdown menu. At the bottom are "OK" and "Cancel" buttons.

Figure 2.16: Calculated Spectrum Setting

You have a choice between several formulas to combine two ADC parameters: $Pos = Range * right / (left + right)$ is a formula often used with position sensitive detectors read out from both sides. $Sum = left + right$ makes a sum spectrum, and $Div = Range * left / right$ can be used to divide two spectra. The **Range** and **Name** can be defined in the edit fields or default values will be taken. Any such calculated spectrum can be used as a parameter for a multi parameter spectrum. If Conditions are defined, one can be selected as a necessary **Condition** for incrementing a channel in this spectra. The COPY type of spectra allows to set conditions for copies of primary ADC spectra. By selecting "DLL function" and pressing the **Edit...** button a dialog "Dll Function" is opened.



The dialog box is titled "DLL Function". It features a text field containing the function signature "{DLL(Xpar, Ypar, Zpar)}". Below it is a dropdown menu for "Zpar" showing "SUM7_8". There are two dropdown menus for "Xrange:" and "Yrange:", both showing "256". Below these are four text input fields: "Initialise DLL function:" with "IniTab", "Table filename:" with "testxy.txt", "Cleanup DLL function:" with "CloseTab", and "DLL function:" with "RTab". At the bottom are "OK" and "Cancel" buttons.

Figure 2.17: DLL Function Dialog

The calculated spectrum is a function programmed in the DMPA3.DLL. In the optional available DLL software interface for LabVIEW and Visual Basic the complete sources of the DMPA3.DLL and the shown example are included to allow own written applications for calculated spectra based on this example (the customer dependent functions of the DLL are in a small module "custom.c").

Press **Conditions...** from the Map and Calculated Spectra dialog to define or edit ROI Conditions in the **Conditions** dialog.

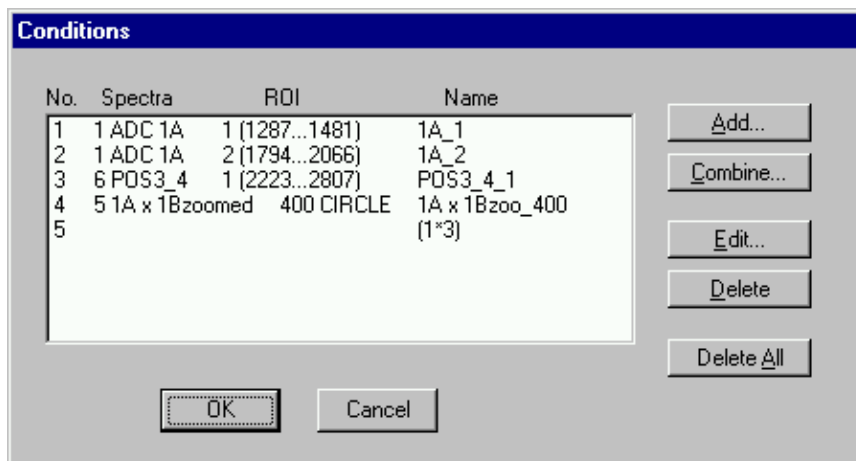


Figure 2.18: Conditions

To define a new condition, press **Add...** to open the **ROI Condition** dialog.

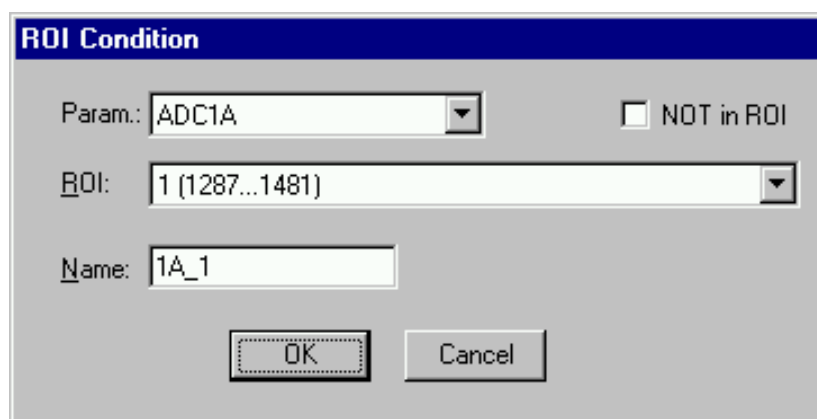


Figure 2.19: ROI Conditions dialog

Here it is possible to define a Condition as an event inside or outside of an ROI in any spectra. There are two drop-down list boxes for the **Parameter** and **ROI**. Of course the ROI must be defined before by using the MPANT program, it is not possible here to add any new ROI. A checkbox labeled **NOT in ROI** allows to define a condition as an event outside the ROI. Using the edit field **Name** it is possible to define a name for the Condition. A default name built by the parameter name and ROI number will be set automatically.

Press **Combine...** to open the **Combine Conditions** dialog.

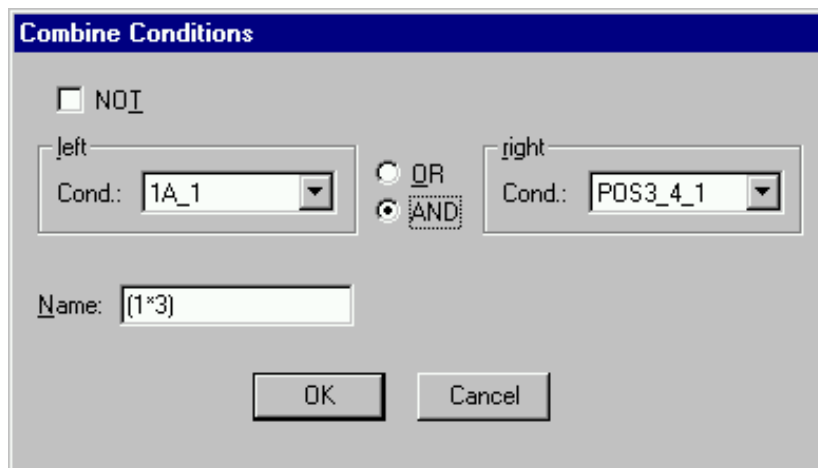


Figure 2.20: Combine Conditions dialog

Here it is possible to define a Condition as a combination using the Boolean operators **NOT**, **OR** or **AND** of already defined conditions. The OR will be symbolized in the automatically generated name by a plus sign "+", the AND by an asterisk "*".

2.5. Data Operations

Clicking in the File menu on the Data... item opens the Data Operations dialog box.

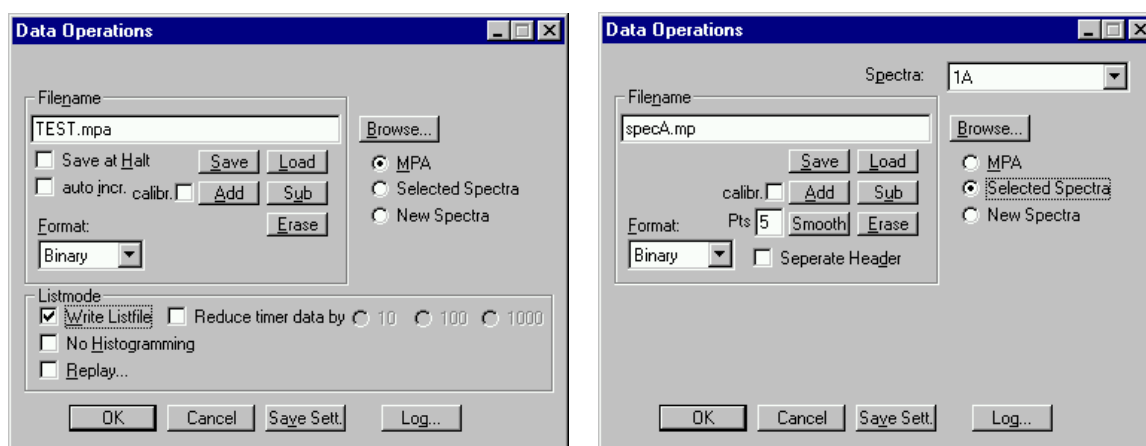


Figure 2.21: Data Operations dialog boxes for MPA data (left) and selected spectra (right)

This dialog allows to edit the data format settings and perform operations like Save, Load, Add, Subtract, Smooth and Erase. The Radio Buttons provide a choice between handling of the complete data set (**MPA**) or **Selected spectra**, or to load selected **New Spectra** for compare. Mark the checkbox **Save at Halt** to write a MPA file containing the configuration and all spectra at the stop of a measurement. The filename can be entered. If the checkbox **auto incr.** is crossed, a 3-digit number is appended to the filename that is automatically incremented with each saving. The format of the data can be ASCII (extension for separated spectra .ASC), binary (.DAT), GANAAS (.SPE), CSV (.CSV). If **Separate Header** is not checked, the Header and data is saved together in a file, otherwise the header containing the configuration and the data is written separately into a file with appropriate extension. With **Add** and **Sub** spectra can be added or subtracted from the present data. The checkbox **calibr.** can be checked to use a calibration and to shift the data then according to the calibration. The **Smooth** button performs an n-point smoothing of selected single spectra. Check the **Write Listfile** checkbox to write a listfile during a run. It is possible to reduce the size of list files by writing reduced timer data. When "Write Listfile" is enabled in the data operations dialog, a checkbox **Reduce timer data** will be visible and you have a

choice between a factor of 10, 100 or 1000 corresponding to timer events every 10, 100 or 1000 msec instead of every 1 msec.

A log file can be written. The log file options can be edited in a dialog that can be entered from the data options dialog pressing the **Log...** button.. See for the set of control commands that support opening, closing and writing text into log files in the on-line help or in chapter 5.2.

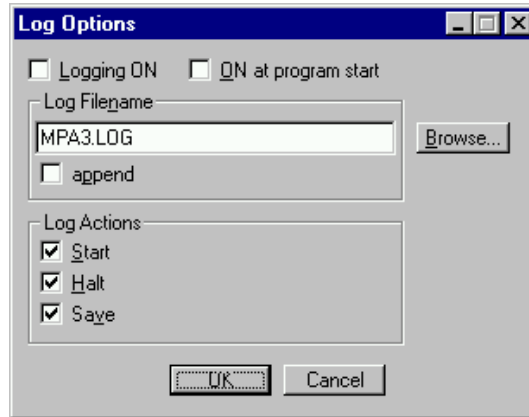


Figure 2.22: The Log Options dialog

If the Replay software option is enabled in the MPA3 Base module or via the Replay Key module connected to the printer port, the menu item **File – Replay...** opens the Replay dialog.

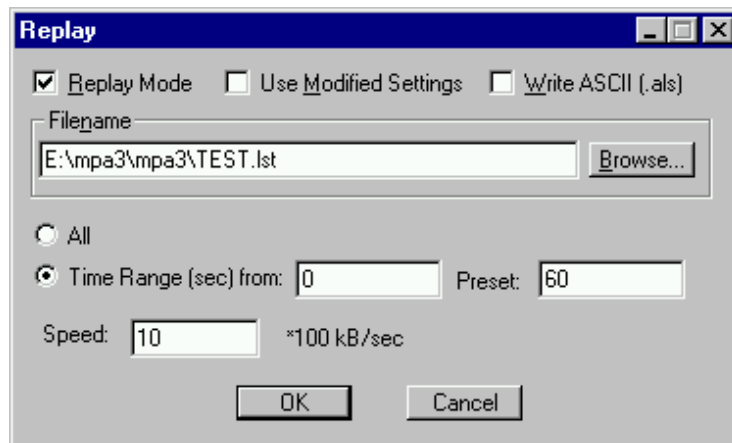


Figure 2.23: Replay Settings dialog

Enable **Replay Mode** using the checkbox and specify a **Filename** of a list file (extension .LST) or search one by pressing **Browse...** With the radio buttons it is possible either to choose the complete listfile by selecting **All** or a selected **Time Range**. Specify the real time range in seconds by editing the respective edit fields **from:** and **Preset:** . The **Replay Speed** can be specified in units of 100 kB per sec. To **Use Modified Settings** enable the corresponding checkbox, otherwise the original settings are used. To start Replay press then Start in the Action menu or the corresponding MPANT toolbar icon. The Replay dialog has an additional Checkbox "Write ASCII (.als)". It allows to convert the binary listfile into an ASCII file.

2.6. Control Language

A sequence of commands that are stored in a file with extension .CTL can be executed by the MPA-3 server program or MPANT with the „Load “ command. Also the configuration files MPA3.CNF or the header files with extension .MP contain such commands to set the parameters. Each command starts at the beginning of a new line with a typical keyword, the case is ignored. Any other characters in a line may contain a value or a comment.

Following methods are available to execute commands:





- Load the command file using the Load command in the file menu.
- Enable remote mode in the server and send commands via the serial connection. A special DLL is necessary which is part of the optional available MPA-3 EXTERNAL CONTROL software.
- Open a DDE connection and send the commands via DDE .
- Send the commands over a TCP/IP net using a remote shell and the optional available MPA-3 EXTERNAL CONTROL software. It is necessary to have a TCP/IP Winsock installed like the Trumpet winsockets and that the remote shell daemon program MPWNET is running. See the readme file on the installation disk.
- Send the commands via the DLL interface from LabVIEW, a Visual Basic program or any other application (software including the complete source code of the DLL and examples optional available).
- From your own Windows application, register a Windows message and then send the command as can be seen in the DLL source code.

2.7. ROIs








Regions of Interest (ROIs) can be defined in single and in dual parameter spectra. A Region can be defined by marking it in a display, with the mouse using the right mouse button and dragging a rectangle over the area one is interested in. One can zoom into a ROI in a single spectra by double-clicking with the left mouse button on the corresponding colored area in the bar at the bottom of the spectra display. A single mouse click with the left button on the corresponding colored area makes this to the selected ROI and lets the counts contained in this ROI be displayed in the information lines of the respective window. Advance the selected ROI to the next or previous one using the "+" or "-" key from the numeric keypad.

Polygonal and curved ROI's in MAP displays are implemented in addition to the rectangular ROIs. The boundaries can be polygonal, circular, annular or pie. Define the ROI using the and save the ROI using the toolbar icon "Create new ROI". The ROI boundary is displayed by lines or circles and the ROI area can in addition be displayed in inverted color by enabling the checkbox "Invert ROI Pixel" in the MAP Display options dialog. The sum and net sum of counts within the selected ROI is displayed. The net sum is calculated by subtracting a background integral.



Zoom operations:

Zoom	. Back	Zoom Out	Home
			

ROI Shapes:

Rectangle	X-Slice	Y-Slice	Polygon	Circle	Annular	Pie
						

Create, Delete, Edit:

Create	Delete
	

Edit...

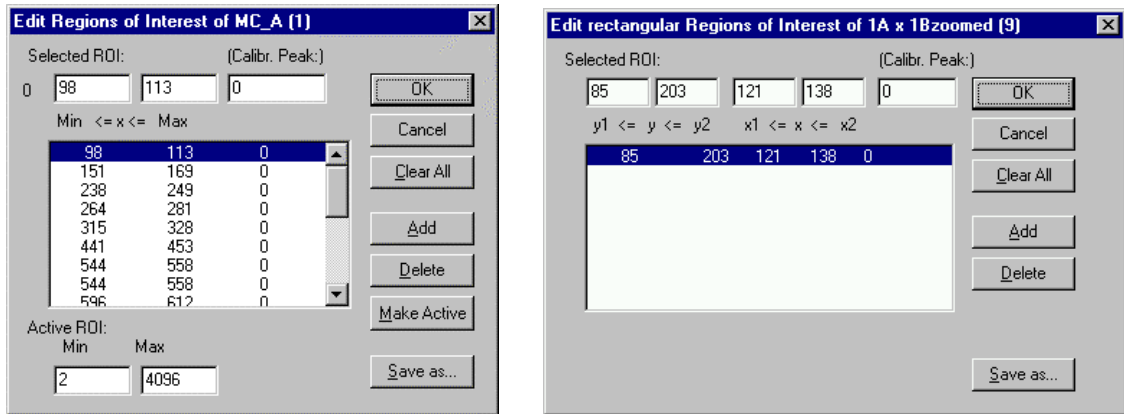


Figure 2.24: Slice and rectangular ROI Editing dialog box, left: Single spectra, right: 2D spectra

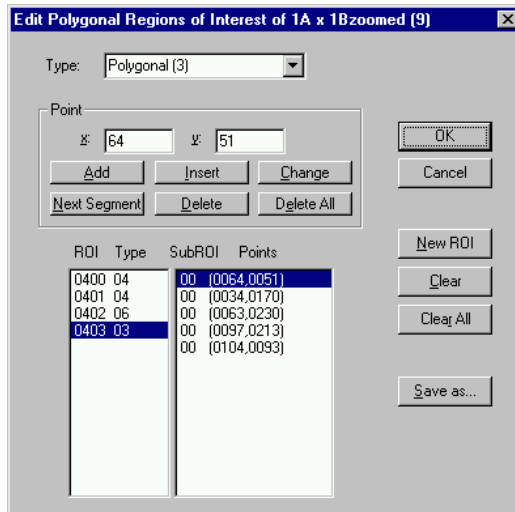


Figure 2.25: Polygonal ROI Editing dialog box

For polygonal, circular, annular and pie ROIs there is a special dialog to select and edit all the parameters. The ROI definition parameters can be saved into a .CTL file and reloaded using the File menu like any control file. Note that the selected ROI can be advanced in any activated spectra display by pressing the "+" and "-" key from the numeric key pad.

X-Projection, Y-Projection



Projections of ROIs in dualparameter spectra to the x- and y-axes are now implemented. There are new menu items "X-Projection" and "Y-Projection" in the Region menu. They create new single spectra displays showing the respective projection of the selected ROI in a dualparameter spectra in the active window.

Fit...



By selecting the Fit... menu item or the respective icon, A single Gaussian peak fit with linear background is performed for the currently marked region. The fitted curve is displayed and a dialog box shows the results. All values are displayed also in calibrated units and with the standard deviations. Click on Save to append a line containing the results to a Logfile with the specified name. Options... opens a new dialog box to define the information in the logfile:

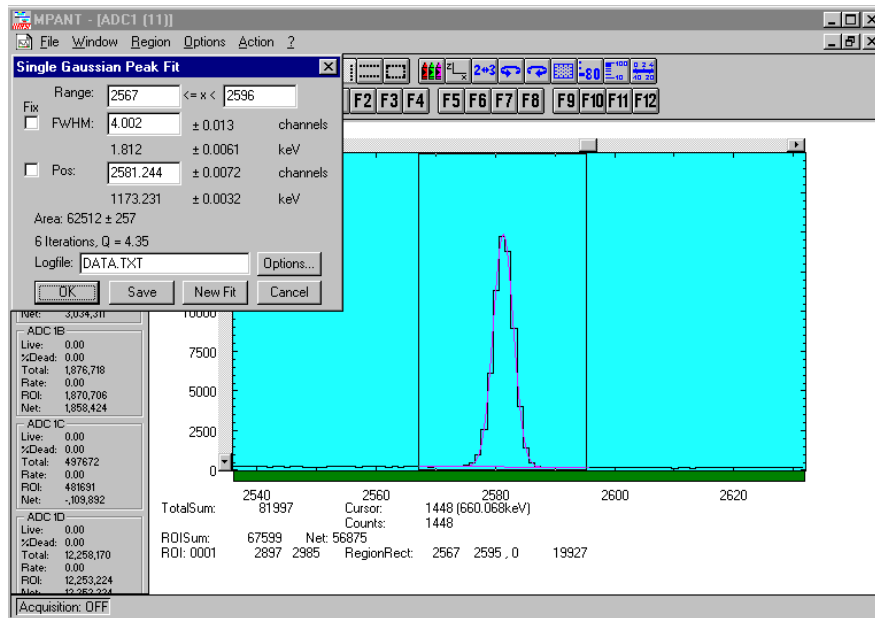


Figure 2.26: Single Gaussian Peak Fit

Fit ROIs, Auto Calib

With the Fit ROIs item, for all ROIs a Single Gaussian Peak Fit is performed and the results are dumped into the logfile. Auto Calib makes a Gauss fit for all ROIs in the active Display for which a peak value was entered, and performs a calibration using the fit results.

Slice...



The Slice option allows to create new single spectra displays, showing a slice in a dualparameter spectra. Click on a dualparameter spectra display to make it the active window, then select the Slice menu item or toolbar icon. The Slice dialog box is displayed.

Select "x=const" or "y=const" for the slice direction, and the coordinate. Clicking the "create" button creates the new display window. In the title bar of the new window the name of the dualparameter spectra and the slice coordinate is shown.

The slice position can be changed using the scroll bar in the Slice dialog, or by entering the value in the edit field and pressing the button which is labeled "Set" after creation of the slice view.

The Slice dialog can be closed by clicking its close field. Created slice spectra displays remain visible and their coordinates can be changed later using the Slice utility again. The position of the Slice dialog with respect to the MPANT main window can be saved in the MPANT.CFG file. Rectangular ROIs are visible in the slice spectra display and can be created here.



Figure 2.27: Slice dialog box

2.8. 32-bit DLL and VIs for LabVIEW and Visual Basic for MPA-3

Features:

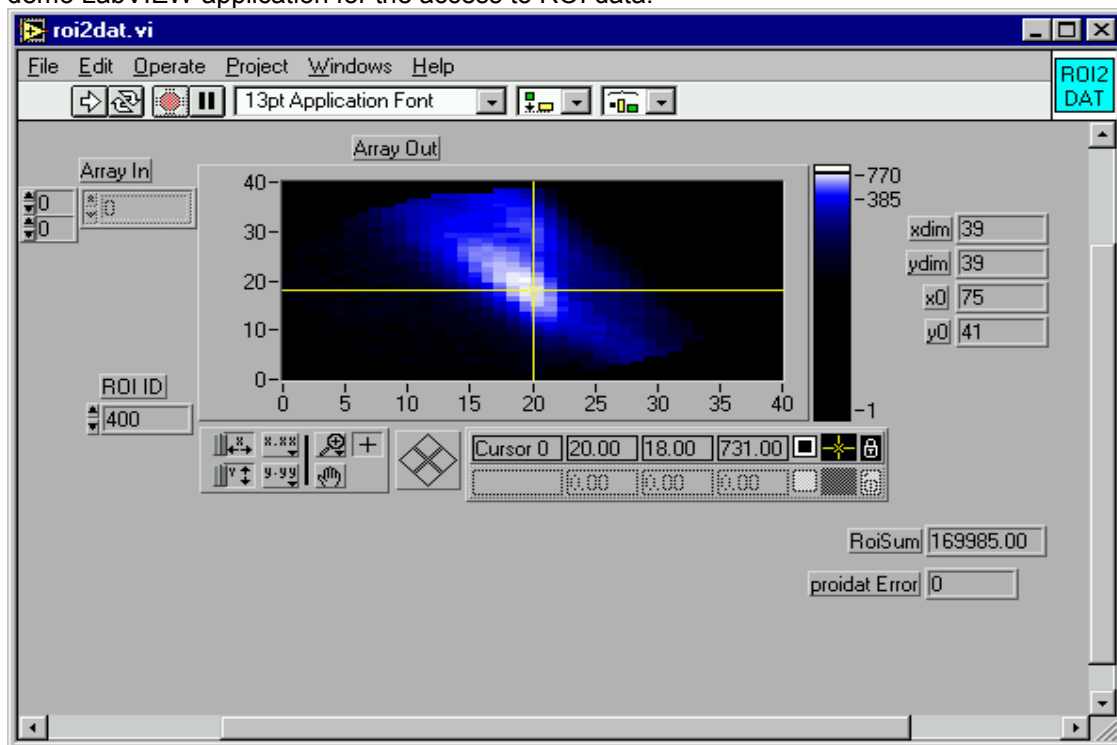
- MS-Windows based customer-specific user interfaces can be easily made using supplied documentation, libraries and examples
- Example program in Visual Basic
- Example LabVIEW application and library containing basic LabVIEW VI's
- Automatic execution through MACRO commands
- Custom DLL functions allow user-defined calculated parameter spectra
- A special DLL including source shows calculated spectra with routing bits in MPANT
- Local Area TCP/IP Network support for remote control via optional MPA-3 Control software

Description:

The 32 bit MPANT software for the multiparameter system MPA-3 consists of a hardware-dependent server program with DLL and a general graphics program that controls the hardware via the DLL. Any other Windows application can also control the hardware via the DLL. To support the programming of such customer-specific user interfaces, as an option we deliver documentation such as sourcecode and example programs for Visual Basic and LabVIEW.

The software includes the complete sourcecode of the DMPA3.DLL that controls the hardware via the server program. A custom module allows own calculated parameter spectra, as an example for a 2D position dependent detector a position-dependent energy spectra correction is implemented via a lookup table.

A special new FMPA3.DLL including source code with examples like $F \cdot (x-x')/(x+x')$ where x' is marked by a routing bit allows to display calculated spectra including calculated error bars in the MPANT program. Here is the demo LabVIEW application for the access to ROI data:



The following MPA-3 additional software products are presently available:

Model No.	Description	Order no
MPA-3RPlay	Replay program for off-line reconstruction of spectra from list mode	MP3S02
MPA-3RPlayEx	Replay program, runs on computer without MPA3 system	MP3S04
MPA-3EXTCTL	External Control Software, Commands via TCP/IP and/or RS232	MP3S03
MPA3_NTDLL	DLL for LabVIEW / Visual Basic	MP3S80