DGF-4C Online Help

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Disclaimer

- **Getting Help for the DGF-4C**

There are several ways to get help for the DGF-4C. You can use IGOR's built-in help browser to access the DGF-4C specific help file by selecting Help -> Help Topics from the top menu bar. Choose "DGF4C-Help" in the popup menu on the left, and select the appropriate help topic from the list on the right.

Each DGF-4C Run Control Panel also has a "Help" button, which directly displays the help topic for that panel. In the help topics, click on blue underlined links to jump to cross references.

- **Getting Started**

Preparations

1. Install Wavemetrics IGOR Pro.

2. Install the DGF4C software from XIA (see file readme.txt on CD-ROM).

3. Install the DGF-4C modules and CAMAC controller in the CAMAC crate. Connect detector signals to the DGF-4C modules using the cables supplied by XIA.

4. Find DGF4C.pxp in the installed folder and double-click it to open the DGF-4C Viewer.

Initial Startup

When the DGF-4C Viewer has been loaded, the DGF-4C Start Up Panel should be prominently displayed in the middle of the desktop. It will prompt you to do the following:

1. Specify the DGF-4C modules:

First select the number of DGF-4C modules in the system. Then specify the CAMAC slot number in which each module reside and the name of the FPGA configuration file to be used with each module. By default the Viewer assigns every module the same FPGA configuration, but you can edit it by entering different FPGA file names for different modules. The file name has the format FDGF4C##.BIN, where the first # represents the decimation and the second # represents the module revision (C or D or E). So if you have a DGF-4C Rev. E module and you want to use a FPGA file with decimation 4, you should put in a file name of FDGF4C4E.BIN. All the FPGA configuration files are stored in the Firmware subfolder of the DGF4C folder.

2. Specify the controller type:

- J73A using Jorway 73A controller
- CC32 using Wiener CC32 controller
- Offline for offline analysis without DGF-4C modules attached

For the Jorway 73A, you have to select the proper SCSI bus number and Crate ID. The SCSI ID usually is either 0 or 1 and may vary between 0 and 7. If it is unknown, set it to 0. After system is boot up, it will return the correct SCSI bus number and automatically correct it on the DGF-4C Start Up Panel. The Crate ID should match the Crate number on the controller.

For CC32 controllers, you only need to select the Crate ID which should match the Crate number on the controller.

3. Choose several advanced options if necessary:

Check the "Fast CAMAC option" to use the Level-1 FAST CAMAC transfer if the CAMAC controller supports it.

In case the main controller can handle Look-At-Me signals (LAMs), check the "Raise LAMs at the end of a run". The DGF-4Cs can raise a LAM when run data are available to support interrupt driven data read out. Leave this box unchecked if the CAMAC controller used for data read out cannot send an interrupt to the data acquisition host. The Jorway 73A falls into that category. Alternatively the host could poll for LAMs.

The "IGOR talks to master controller" option is used when the Jorway controller is the master controller in the CAMAC crate. When checked the Viewer will broadcast certain commands to all DGF-4Cs in the system.

After making the above selections, click "Start Up System". If no error messages appear in the IGOR history window, the system is initialized. You will now see the main DGF-4C Control Panel from which all work is conducted. The tabs in the Control Panel are arranged in logical order from left to right. For most of the actions the DGF-4C Viewer interacts with one DGF-4C module at a time. The number of that module is displayed at the top right corner of the Control Panel (inside the "Module" control). Next to the “Module” control is the “Channel” control which specifies the current channel the DGF-4C viewer is interacting with. The "Module" and the “Channel” are the target for all actions executed from the Viewer. Proceed with the steps below to configure your system.

1. In the Calibrate tab, click on the Oscilloscope button.

   This opens a graph that shows the untriggered signal input. Click "Refresh" to update the display. The pulses should fall between 10% and 90% on the right axis. If no pulses are visible or if they are cut off above 100% or below 0%, click "Adjust Offsets" to automatically set the DC offset. There is a control called “Baseline [%]” on the Oscilloscope which can be used to adjust the DC offset for each channel. If the pulse amplitude is too large to fall in the display range, decrease the "Gain" in the Calibrate tab of the DGF-4C Control Panel. Since the offsets might drift, for example after changes in input count rate, it is useful to leave the display open and check the offsets once in a while.

2. In the Calibrate tab, input an estimated preamplifier RC decay time for Tau in µs then click on "Auto Find" to determine the actual Tau value for the current channel of the current module. Repeat this for other channels if necessary. The Tau finder works best for a Tau value from 20 µs to 200 µs.

3. In the Settings tab, click on "Save" to save the system parameters found so far. You can save the settings into either an existing settings file or a new file.

4. Click on the Run tab, set "Run Type" to 0x301 MCA Mode, “Polling time” to 1 second, and “Run time/time out” to 30 seconds or so, then click "Start Run". After the run is complete, select the Analyze tab and click on the “MCA Spectrum” button. The MCA spectrum shows the MCA histograms for all four channels. You can deselect other channels while working on only one channel. You can do a Gauss fit on a peak by entering values in the "Min" and "Max" fields as the limits for a Gauss fit. You can also use the mouse to drag the Cursor A and B in the MCA spectrum to the limits of the fit. Make sure Cursor A and B are put on the same trace by looking at the left bottom corner of the MCA spectrum. If not, mouse click on the left bottom corner to select the trace. Click "Gauss Fit" to perform the fit. Enter the true energy value in the "Peak" field to calibrate the energy scale.

   If you are not getting a nice-looking spectrum, you may need to adjust some settings such as filter rise time and flat top etc. Refer to the User’s Manual for details.

• DGF-4C Control Panel

The Main Control Panel is displayed on the desktop after starting the IGOR experiment file "DGF4C.pxp". Using the four control tabs, arranged in logical order from left to right, you can set up the system, set run parameters, take data, and view the results.

Control Tabs:

Settings
Calibrate
Run
Analyze

- **Settings**

The "Settings" Tab of the DGF-4C Control Panel contains parameters that control the operation of the DGF-4C. Most settings are changed on a channel-by-channel basis. The only exceptions are the module control/status register Module CSRA, and the coincidence pattern, which affect the module as a whole. The "Settings" Tab also contains controls used to load, save, copy, and extract settings.

Energy and Trigger Filter

In this section you can set the rise and flat top times for the energy and trigger filter of each channel. The units of time are μs. The energy filter uses averaging of the ADC data and then operates the same filter core at a decimated (i.e. reduced) clock rate. As a result, there is a granularity of 0.050μs for 1-bit (times 2) decimation, 0.100μs for 2-bit (times 4) decimation, 0.200μs for 3-bit (times 8) decimation, 0.400μs for 4-bit (times 16) decimation, 0.800μs for 5-bit (times 32) decimation and 1.600μs for 6-bit (times 64) decimation, corresponding to one cycle of the decimated clock. The DGF-4C Viewer knows which decimation has been loaded, and adjusts the parameters you typed in accordingly. The trigger filter is always operated at the ADC sampling rate. Its rise time can be varied between 25ns and 775ns. Its flat top however is valid between 0ns and 750ns. The trigger filter will most often use a flat top comparable with the average signal rise time. In applications with very short rise times a flat top of zero will give the best pileup rejection performance.

Employing a trapezoidal filter avoids the kind of ballistic deficit that occurs when a finite rise time signal is used in conjunction with a Gaussian shaper. The energy filter flat top time should thus be a little larger than the longest rise time expected. The output of the energy filter is sampled one decimated clock cycle before the end of the flat top, plus the signal arrival may jitter by up to one decimated clock cycle with respect to the decimated clock. You should therefore make the flat top two notches longer than the signal rise time.

The sum of energy filter rise time and flat top cannot exceed 31 decimated clock periods. If you type in a rise time or flat top value that violates this bound, the DGF-4C Viewer will adjust it accordingly.

The trigger threshold can be set in units of ADC steps. You can get an idea of what the noise in your system is by looking at the trace acquired in the Oscilloscope located on the Calibrate Tab. Use the mouse to zoom in on parts of the displayed trace(s) and estimate the noise.

Optimize Energy Filter

In DGF-4C Viewer version 3.04 or higher, a new tool was added to aid DGF users optimize the energy filter settings. The optimization is carried out by scanning all possible combinations of energy filter rise and flat top within their respective limits specified by the user, examining the energy resolution at each combination, and picking the optimal combination which gives the best energy resolution. Results of this optimization, including energy filter rise time, flat top and energy resolution, are stored in an output file whose name is specified by the user in the beginning of the run. Another file which has the same name as the output file but with a different extension (*.tmp) is used to store step-by-step intermediate results.

Before starting the optimization, all conditions listed on the "Auto Optimization of Energy Filter" panel should be fulfilled first. This is to ensure that valid MCA spectra will be produced during the optimization and Gauss Fit of energy peaks on the MCA spectra will generate meaningful results. The four channels of a DGF module can be used to optimize four different Auto Scanning Limits at the same time when the same detector signal is split and input into the four channels. This would speed up the scanning of a large range of energy filter rise time and flat top. You could change the Auto Scanning Limits of each channel by changing the "Channel" control on the left upper corner of the DGF-4C Run Control panel. At any time, the DGF module used to carry out this optimization is the current module, i.e. the module indicated by the "Module" control on the left upper corner of the DGF-4C Run Control panel. So if you want to use a different module, change the "Module" number before you set the Auto Scanning Limits for each channel.

Pulse Shape Analysis

The trace length and delay values to be entered here, both in units of µs, govern the waveform acquisition. Especially if you request pulse shape analysis these two parameters have to be set correctly. You can use the delay parameter to move the trace. Delay measures the trigger time with respect to the beginning of the recorded trace. For ordinary data taking the trace lengths are up to 25.600µs for each channel. If less than four channels are marked as good channels, the trace length could be longer than 25.600µs for the good channels. The waveforms will be read in 25ns increments from FIFO memory.

The PSA Start and PSA End specify the trace range for Pulse Shape Analysis (PSA). Currently DGF-4C supports two types of PSA: XIA_PSA and USER_PSA. XIA_PSA reports the signal arrival time by measuring the time when the trace reaches a preset percentage level of its magnitude. The preset percentage threshold is defined in the DSP parameter CFDTHR. The arrival time is relative to the starting time of the trace. So for XIA_PSA, the PSA Start and PSA End should be set to include the rising edge of the trace. USER_PSA is a user-defined PSA value.

Action Buttons

[Edit] (Module CSRA)	MCSRAEditPanel
[Edit] (Channel CSRA)	CCSRAEditPanel
[Edit] (Coincidence Pattern)	HitEditPanel
[Copy] (Copy settings)	CopyPanel
[Extract] (Extract settings)	ExtractPanel
[Files/Path] (Files and path)	AllFilesPanel
[Load] (Load settings)	
[Save] (Save settings)	

MCSRAEditPanel

= Settings -> Module CSRA Edit

In the Module control/status register (MCSRA), options are set that affect the module as a whole.

The options "Set Switchbus 2 (DSP Trigger Termination)" and "Set Switchbus 5 (Fast Trigger Termination)" are Bits 10 and 13 of MCSRA, respectively. They are used to provide termination for external triggers from the backplane bus connector. Even pins on the connector should be connected to the corresponding odd pins on the neighboring module to the right (as seen from the front).

Setting Bit 10 (DSP Trigger Termination) terminates the DSP trigger line with 50 Ohm. This bit should be set for a module at the end of the trigger bus (thus also for a module operated individually). Bit 13 (Fast Trigger Termination) terminates the fast trigger line, and should be set for a module at the end of the trigger bus (or for a module operated individually). Any changes in bits 10 and 13 will be applied to the module when you click the check boxes. At startup, the bits are set according to the settings file.

Note: Bits 10 and 13 are stored in the DSP memory but do not affect the operation of the DSP. They have to be written to the Interface FPGA with a "writeICSR" command to become effective.

CCSRAEditPanel

= Settings -> Channel CSRA Edit

Each channel has its own channel control/status register. Click a check box to set or clear particular bits. We give a brief description of all relevant bits here. In the CCSRAeditPanel they appear in top to bottom order.

Bit 0: Group trigger mode
This bit controls waveform acquisition. To stop the FIFO and store a waveform two conditions must be fulfilled. A fast trigger primes the FIFO to stop after a programmed delay, but only if by that time a valid trigger is recorded. When bit 0 is cleared the source for that valid trigger is the locally generated event trigger of this channel. When bit 0 is set, the trigger source will be a signal on the distributed DSP-trigger line. This allows for master slave operation as outlined in the User's Manual.

Bit 1: Measure individual live time
This bit will in almost all applications be opposite to bit 0. Its setting decides who asserts the live time control. When cleared, the DSP ensures that during the event interrupt no channel can generate another trigger and latch new event data, at least not after the coincidence time window (see HitEditPanel below). This setting is useful in master slave operation and almost in all cases where list-mode data are required. On the other hand, when channels are operating independently and only MCA information is needed (MCA mode), but not list mode data, then this bit should be set to achieve the highest throughput.

Bit 2: Good channel
Only channels flagged as good will be read out. This setting has no bearing on the channel's capability to issue a trigger. There can be a triggering channel whose data are discarded.

Bit 3: Read always
Set this bit if you want a good channel to be read out even if it did not report a hit. It cannot report valid energy or timing data in that case, but if operated in group trigger mode you will get a valid waveform. This way you can collect waveforms not biased by trigger requirements.

Bit 4: Enable trigger
You can switch on any channel's ability to contribute to the event trigger with this bit.

Bit 5: Trigger positive
For channels with triggering enabled, this causes triggering on the rising edge of the input signal when the bit is set, and triggering on the falling edge when the bit is not set. The core of the trigger/filter FPGA can only trigger on a rising edge. So, if the bit is not set the FPGA will invert the signal before storing it in the FIFO and sending it to the core.

Bit 6: GFLT required
In a larger experiment you may want to exercise control over which events to accept and which to reject in a way that takes into account multiplicity information from many modules and possibly signals from other devices as well. The external logic may be fast enough to make a trigger decision within an energy filter rise time. If so, it should send out a pulse that is logic 1 (NIM levels, 1=-0.8V) during the time when the channel would latch data and generate a trigger, which happens no earlier than one energy filter rise time and no later than rise time + flat top + 2 decimated-clock cycles after event arrival. When bit 6 is set the channel requires the presence of a global first level trigger (GFLT) to latch data and issue a trigger.

Bit 7: Histogram energies
Switch on incrementing an energy histogram in the DSP's MCA memory with this bit. You can choose to have histogramming in list mode runs. The histograms will continue to be updated over multiple runs, started with the resume run command.

Bit 10: Compute constant fraction time

The DSP can use pulse shape analysis to compute a precise signal arrival time using the digital equivalent of a constant fraction discriminator. For this to work correctly the rising part of the signal should be fully contained in the recorded trace. The time computed is the arrival time after the start of the acquired waveform in units of 1/256th of an ADC sampling interval. This information can be used to replace the recorded channel time which is derived from a (digital) leading edge discriminator, cf the User's Manual.

The DSP code shipped with the DGF-4C has some pulse shape analysis capabilities already built in. One of these functions, the digital constant fraction discriminator takes an input parameter---the threshold percentage. The default value is 25% since it is a commonly used threshold fraction for this type of discriminator. The result of the computation is the time of signal arrival measured with respect to the start of the acquired waveform. The result is written into the channel header in the linear output data buffer, cf the User's Manual for details.

Bit 11: Enable contribution to multiplicity
You can switch on any channel's ability to contribute to the multiplicity output with this bit. It also comes with a programmable width set by the variable “Pulse width”. The pulse width is given in sampling clock periods of 25ns.

HitEditPanel

= Settings -> Coinc. Pattern Edit

The coincidence pattern mask is useful for DGF-4C channels operating independently from each other, though they may be sharing clocks and triggers. With this mask you may require that an event as witnessed by an individual channel match any of the preset hit patterns to be accepted by the DSP.

An example shall illustrate this feature. Assume a single module connected to 4 detectors which observe a Na-22 source, emitting back to back 511keV gamma-rays from positron annihilation. Channels 0 and 1 are connected to one pair of back to back detectors and channels 2 and 3 are connected to a second pair of back to back detectors. You are interested only in gammas from positron annihilation. Thus a coincidence in channel 0 and 1 or a coincidence in channel 2 and 3 is required. If all 4 channels were in coincidence, that would be fine too. So, the acceptable hit patterns would be (0,0,1,1), (1,1,0,0) and (1,1,1,1), where the right most digit indicates channel 0 and the left most is for channel 3. To achieve the desired behavior, you have to select the three acceptable hit patterns in the HitEditPanel by checking the appropriate boxes, and deselect all other hit patterns by not checking their boxes.

In general, with 4 channels there are 16 distinct possible hit patterns, and you can select any combination of these to be a valid event. If you want to disable this feature, you should check all boxes in the HitEditPanel, i.e. accept any hit pattern.

Coincidence Window

A delay time set in the Pulse Shape Analysis section increases the overall event time. Consequently, the width of the coincidence window (in 25ns ticks) has to be adjusted to accommodate the full event. Usually, this is done automatically by the DGF Viewer and there is no need to edit the HitEditPanel manually.

On the other hand, if the delay time is decreased, a smaller coincidence window is possible. This would reduce data processing time and allow for a higher event rate. However, to avoid overwriting a large coincidence window intentionally set by the user, the value is not adjusted automatically. Instead, the HitEditPanel displays both the minimum coincidence window and the actual coincidence window. The user can set the actual coincidence window, but it should not be smaller than the minimum coincidence window.

CopyPanel

= Settings -> Copy

This panel can be used to copy parameter settings from one module to another. The source module and channel are selected at the top of the panel. The parameters to be copied are organized into list box in the left-hand column. The right-hand column shows the destination channels and modules for the copy operation. The Items to copy shown on the Copy Panel and the actual variables to be copied are listed below.

Items	**Actual variables to be copied**
Gain	Gain [V/V]
Offset	Offset [V]
Sum	SUMDAC
Filter	Energy Filter Rise Time and Flat Top, Baseline Cut
Trigger	Trigger Filter Rise Time and Flat Top, Trigger Threshold
FIFO	Trace Length, Delay, dT [µs], PSA Start, PSA End, CFDTHR
CSR	Channel CSRA, Channel CSRB, Module CSRB
Coinc.	Coincidence Pattern, Coincidence Window
MCA	Cut-Off Energy, Binning Factor
TAU	Tau [µs]

After selecting source, destination and parameters, click on the "Copy" button to execute the copy operation.

ExtractPanel

= Settings -> Extract

This panel can be used to extract parameter settings from a file to selected modules and channels. The source file is specified at the top of the panel. Clicking on the "Find" button to locate the source file. Parameters to be extracted and destination modules or channels are selected in the same manner as in the copy panel. Click the "Extract" button to execute the operation.

AllFilesPanel

= Settings -> Files/Paths

This panel gives you access to the underlying files of the DGF-4C software. Usually, these files are already loaded in the memory of the DGF-4C Viewer. You only have to change these files when you receive updates from XIA.

The directory locations are specified as complete (not relative) search paths: the DSP Path for the DSP code; and the FPGA Path for the trigger/filter FPGA configuration. Use a colon (:) as the separator between drive name, directory, and subdirectories. Do not use backslashes (\). For example use "D:XIA:data" rather than "D:\XIA\data".

• Calibrate

Analog Signal Conditioning

In the Analog Signal Conditioning section you can set the digital to analog converters (DACs) in the selected channel and module. There are two DACs per channel. One controls the gain of the analog amplifier stage preceding the waveform digitizing ADC. The other controls the DC-offset that is subtracted from the input signal to bring it into the ADC range. Note that the ADCs are dc-coupled to the DGF-4C inputs, and thus compensation for any DC-offset is necessary. You will rarely have to set this manually, as the DC-offsets can be adjusted automatically through clicking on “Adjust Offsets” on the Oscilloscope. The DAC settings are given in units of V/V and V, respectively. The voltage gain computed is the ratio between the pulse height at the module input to the pulse height at the ADC input. Note that the ADC has a 1V input range, which is mapped onto integers from 0 to 16k.

Histogram Control

This section shows the parameters controlling the operation of the multichannel analyzer built into the DSP memory. Energy values are reported as 16-bit fixed-point numbers.

In Revision C modules, the scaling is such that the LSB corresponds to 1/16th of an ADC step (12bit ADC). The MCA memory is limited to 8192 words. It can all be used for one channel or be shared equally among 2 or 4 channels. If you want to map the full energy range into the available MCA memory, you have to combine bins; at least 2^3=8 bins for a single channel spectrum. One "bin" means 1 LSB of the energy word.

In Revision D modules, the scaling is such that the LSB corresponds to 1/16th of an ADC step (12bit ADC). Spectra are stored in the extended memory of 32768 words for each channel. To see the full energy range, you have to combine at least 2^1=2 bins (Binning Factor = 1).

In Revision E modules, the scaling is such that the LSB corresponds to 1/4th of an ADC step (14bit ADC). Spectra are stored in the extended memory of 32768 words for each channel. To see the full energy range, you have to combine at least 2^1=2 bins (Binning Factor = 1).

If you want to see a certain range of the spectrum at higher resolution you can enter a minimum energy in the line "Cut-Off Energy, Emin =" and reduce the number of bins that have to be combined.

Decay Time

The "Decay Time" is the exponential RC time constant of the preamplifier. It is required in order to properly calculate corrections to measured energy values. To set and measure the decay time, enter an estimated value then click on the "Auto Find" button. This "Auto Find" routine will try to measure the Tau 10 times, then give its average value and standard deviation as the "Sigma". You can also enter a known good value directly in the control. The RC calibration needs to be performed only once for a given preamplifier. The result is then stored in the parameter database, and can be saved in the settings file by clicking on the "Save" button in the Settings tab.

In DGF-4C Viewer version 3.04 or higher, two new tools were added to aid DGF users find the correct decay time. The first tool is the "Manual Fit" which helps user manually fit the untriggered ADC traces with a single exponential decay constant. The second tool is the "Optimize" routine which can be used to scan a range of decay times and find the optimal one which gives the best energy resolution.

Manual Fit

"Manual Fit" is done on a channel-by-channel basis. First, choose the channel on which you want to do the manual fit by changing the "Channel" control on the left upper corner of the DGF-4C Run Control panel. Then set proper dT on the TauDisplay panel, and click the "Run" button to bring in untriggered trace for the chosen channel. The exponential fit range can be set either by putting the Cursors A and B on the trace or changing the "Fitting_start" and "Fitting_end" controls on the TauDisplay panel. Clicking the "Do exponential fit" button will perform the exponential fit on the portion of the trace specified by the fitting range. The fitted tau is going to be reported in the "Fitted tau" control and the deviation between the fitting curve and original ADC trace is shown in the "Deviation" control. Click the "Tau Ok" control to download the Tau value to the DGF module.

Optimize Tau

The Tau optimization is carried out by scanning all Tau values within the scanning limit specified by the user, examining the energy resolution at each Tau, and picking the optimal Tau value which gives the best energy resolution. Results of this optimization, including the Tau value and energy resolution, are stored in an output file whose name is specified by the user in the beginning of the run. Another file which has the same name as the output file but with a different extension (*.tmp) is used to store step-by-step intermediate results.

Before starting the optimization, all conditions listed on the "Auto Optimization of Decay Time" panel should be fulfilled first. This is to ensure that valid MCA spectra will be produced during the optimization and Gauss Fit of energy peaks on the MCA spectra will generate meaningful results. The four channels of a DGF module can be used to optimize four different Decay Time Limits at the same time when the same detector signal is split and input into the four channels. This would speed up the scanning of a large range of Tau values. You could change the DecayTime Limits of each channel by changing the "Channel" control on the left upper corner of the DGF-4C Run Control panel. At any time, the DGF module used to carry out this optimization is the current module, i.e. the module indicated by the "Module" control on the left upper corner of the DGF-4C Run Control panel. So if you want to use a different module, change the "Module" number before you set the DecayTime Limits for each channel.

- ## Oscilloscope

= Calibrate -> Oscilloscope

The Oscilloscope shows 8192 untriggered ADC samples from the input for each channel. The time between samples can be set using the "dT" variable. The display is updated through its "Refresh" button. The DC offset of the preamplifier signal has to be compensated for in order to bring the DC-coupled input into the ADC range. The exact DC value has no bearing on the acquired spectrum and its origin, which is always at zero. The DC-adjustment is used only to ensure that the signals to be measured fall comfortably into the ADC range. When clicking the "Adjust Offsets" button, the DGF-4C Viewer will set the DC offset to a percentage of the full ADC range specified in the “Baseline [%]” control.

The offset calibration must be performed with the preamplifiers connected to the DGF-4C inputs and with both the preamplifier power and detector HV switched on. One should also repeat the offset calibration each time measurement conditions change in any major way, e.g., when the count rate changes greatly. All such changes may influence the DC offset value of the preamplifier signal.

To analyze the noise spectrum of the acquired trace, click on the "FFT Display" button, which opens the FFTDisplay.

- ## FFTdisplay

You can analyze the noise spectrum in the trace captured in the Oscilloscope, by observing the Fourier transform of the signal. For best results, remove any source from the detector and only regard traces without actual events. The chart shows a plot of amplitude vs. frequency. The plot is calibrated such that a sine wave with 100 ADC units amplitude (200 units peak-to-peak) will show up with an amplitude of 100. To convert a noise floor measurement into ADC units/sqrt(Hz) use the variable FFTbin displayed at the top of the chart, which tells the width of each frequency bin in the Fourier spectrum. The conversion from amplitudes to rms ADC units/sqrt(Hz) is accomplished by multiplying with 1/sqrt(2*FFTbin). Now, observe that an ADC unit corresponds to 61µV (Rev. E) or 244µV (Rev. D). Using the known gain of the DGF-4C you can convert the noise into an input noise voltage density measured in V/sqrt(Hz). Or, given a particular energy calibration, the noise density can be expressed as eV/sqrt(Hz).

If you click on the “Apply Filter” button, you can see the effect of the energy filter simulated on the noise spectrum.

- ## Run

Run Type

This popup menu is used to set the run type to one of the following modes:

List Mode

List mode is the general data acquisition run. Waveforms, energies and time stamps are collected on an event-by-event basis. The data is stored in various formats (see section 4.2 of the user manual for details):

0x100	full event data (9 words), plus waveforms
0x101	full event data (9 words), no waveforms
0x102	compressed event data (4 words), no waveforms
0x103	compressed event data (2 words), no waveforms

Since available memory limits the number of events that each module can store in its buffer, the DGF-4C Viewer computes the maximum number of events. When the maximum is reached, the run is stopped and the buffer is read out. For a longer run in list-mode, you can request several spills, or buffer fills. For example, if you request a run with 10 spills, you will get 10 list mode buffers worth of data. At start of the first run all previous run history is cleared. For instance MCA memory and run and live time information are cleared. The next nine sub-runs are started with a Resume Run command, which leaves previous run information intact. Run times and live times and spectra in MCA memory are updated.

You can also manually adjust the maximum number of events stored before the run is stopped. Some data acquisition systems, which are geared towards event-by-event readout and are not able to handle large buffers, may benefit from the capability to reduce the maximum number of events per spill.

Fast List Mode

Fast list mode is an event-by-event data acquisition run without waveforms. Since no traces are read out, the data acquisition is faster than a regular list mode; however, no pulse shape analysis (PSA) values are available. There will also be no check if the event buffer is filled faster than the event processing rate. So keep the average trigger rate well below the processing rate. Otherwise, the data from the remainder of the run will be corrupted. The data is stored in various formats (see section 4.2 of the user manual for details):

0x200	full event data (9 words), no waveforms
0x201	full event data (9 words), no waveforms
0x202	compressed event data (4 words), no waveforms
0x203	compressed event data (2 words), no waveforms

MCA Mode

MCA mode puts all modules into a typical spectrum-only acquisition mode in which there are no list-mode data required. The event data is not stored in the output buffer, but only used to calculate the energy for incrementing the spectrum. Runs end after the time specified in the "RunTime/TimeOut" control counts down to zero. The “Maximum no. of Events” control is set to zero for MCA runs since it is not used to end the run.

Polling Time

The polling time indicates the time interval at which the DGF-4C Viewer checks if the run in the selected modules has ended. If so, runs are stopped in all modules, if they have not stopped already, and the data are read out.

Run Time/Time Out

This variable is used to indicate the total run time for MCA runs or the timeout limit for list mode runs.

Number of Spills

The variable indicates the number of repeated runs. It is only used in list mode runs. If it is set to 0, there will be at least one spill.

Maximum no. of Events

This variable indicates the maximum number of list-mode events the DGF-4C module can store in its buffer for each run.

Synchronization

The first check box asks if all modules should start and stop simultaneously. In almost all multi-module systems this will be the case and the box should be checked. For this to work all Busy outputs on the front panel of DGF-4C have to be connected to a common OR-gate, whose outputs must be sent to all Synch inputs on the DGF-4C front panels (NIM signal levels).

If you also want all timers in all modules to be reset with the start of the next data acquisition run, click the box "Synchronize clocks". For this feature to be useful all DGF-4C modules should be operating from the same master clock as described in the user's manual. If you want to reset timers "in every new run "check the corresponding box; else the synchronization request will be cleared after the clocks were reset.

Output File

You can choose a base name and a run number in order to form an output file name. The run data will be written to a file whose name is composed of both. The run number is automatically incremented at the end of each run if you select “Auto update run number” on the Data Record Options panel, but you can set it manually as well. Data are stored in files in either the MCA folder if the run is a MCA run or the PulseShape folder if the run is a List Mode run. These files have the same name as the output file name but different extension as described below.

For list mode runs, buffer data are stored in a file with name extension ".bin". For both list mode runs and MCA runs, MCA spectrum data are stored in a file with name extension “.mca” if you select “Auto store spectrum data” on the Data Record Options panel, and module settings are stored in a file with name extension “.set” after each run if you select “Auto store settings” on the Data Record Options panel.

Start Run

After you have set all parameters, you can start a run to take data. During the run, the “Run time/time out” control shows the remaining time for MCA runs or time out count down for list mode runs. If you select multiple spills for list mode runs, the number of spills will also count down during the run. In a multi-module system, the sequence of starting a run in the modules is described below.

For list mode runs, when the first module reaching the preset maximum number of events stops its run, it will also stop the runs in all other modules. (The Busy/Synch connectors need to be connected as described in Module Synchronization if the module operation is to be synchronized.) Then the data buffer of each DGF-4C module will be read out and saved into a file. If more than one spill is requested, the run will resume in all modules.

For MCA runs, when the “Run time/time out” control counts down to 0, the DGF-4C Viewer will issue a run stop command to stop the runs in all modules. Then the MCA histogram of each module will be read out and saved into a file.

Stop Run

If you want to stop a run before it finishes by itself, you can click on this button to manually stop it. This will end runs in all modules and read out and save the data.

Data Record Options

This panel gives you four options for automating tasks after each run. Except the last one, they are all checked by default to ensure all data are saved for each data run.

"Auto increment run number" will increase the run number in the file name of the data files to avoid overwriting of files.

"Auto store spectrum data as binary .mca file" will store the spectrum data automatically after a run.

"Auto store settings after a run" will store the run parameters (including run statistics) automatically after a run.

"Save parsed list mode data to .dat file" will extract the energies and timestamps from the binary data and save it in an ".dat" file in ACSII format.

"New files every N spills" will increment the run number in the file name every N spills (in MCA runs, every N seconds). This can be used to break up long data runs into several files. It is equivalent of repeatedly starting runs with N spills manually by clicking the Run Start button

- **Analyze**

The top left part of the Analyze tab shows the run time and the measured event rate for the selected module. The right part shows for each channel the fractional live time and the input count rate. Note that the run time is the sum of time spent in sub-runs (called spills), but ignoring the time it took the host to read out the data from DGF-4C modules. Similarly, the live time was measured only while one of the sub-runs was ongoing.

MCA Spectrum

Pulse-height spectra accumulated in the internal DGF-4C memory can be displayed after pressing the MCA Spectrum button. Pulse heights are computed to 16 bits precision, i.e. correspond to 64k spectra. As the memory allows for only 32k words per channel (for Revision C modules, 8192 words total for all channels), bins have to be combined according to the Binning factor for each channel.

You can select the module you want to inspect and you can add or remove individual channel displays by clicking the MCA check boxes.

For energy spectra you can make Gaussian fits to peaks in the histograms. On a channel-by-channel basis you can set fit ranges. The GaussFit button calls the fitting routine. The routine does take a constant background term into account, though its value is not displayed. The fit results that are displayed include the peak position, the number of counts in the peak, and its relative and absolute full width at half maximum (FWHM), calculated from the Gaussian fit. For best results be sure to extend the fit range to cover some of the constant background.

To calibrate your energy scale, you can after the fit type the true energy value into the field "Peak" and the scale will automatically be adjusted.

The Sum Histo button computes the number of histogram entries between the limits set in the "min" and "max" fields (minus background). The result is displayed in the "area" field.

The Save and Read buttons allow to store individual spectra and read back stored spectra from disk.

List Mode Traces

After a list mode run has finished, the pulse shape can be displayed on an event-by-event basis in the List Mode Traces panel. The most recently acquired data file will be searched for the event required in the Event number field. The display will show the ADC traces from the selected module, and the associated energy for those channels that reported a hit in this event. Traces are scaled as 16-bit numbers, but to match the ADC, the associated energies are scaled as 12-bit numbers, i.e. divided by 16. This is true even for Revision E modules with a 14-bit ADC. In order to display traces from an earlier experimental run one needs to change the Data File name by entering it directly in the “Data File” control or clicking the “Find” button.

If you want to see the response of the energy and trigger filters for the current event, click on the "Digital Filter" button, which opens the Filter Display tab. This window is mainly intended for diagnostic purposes. For information how to use the DGF-4C for more detailed pulse shape analysis, please contact XIA.

Filter Display

This graph is used to see the simulated response of the energy and trigger filters in an event. You can browse the leading edge trigger filter response and the energy filter response of individual events. The latter requires a trace length of at least twice the peaking time plus the gap time to be displayed. The trace is shown in red. The trigger filter is shown in blue (FF is for fast filter), and the energy filter is shown in green (SF is for slow filter).

List Mode Spectrum

Pulse height spectra can be reconstructed from list mode data stored on the disk. The file shown in the "Data File" field will be processed and the resulting histograms will be displayed for the selected DGF-4C module. Use [**Read**] after changing the data file to process the new data, and [**Histo**] to update the displayed spectrum. The full spectrum length is equal to 64k channels. Use "No. of bins" and "Delta E" settings to compress the spectrum such that it fits the display. Hint: use 8000 and 4 to see the full range of data, and then adjust these numbers to zoom into the range of interest. The number of bins and the deltaE variables are kept in memory for each channel individually. Be sure to select the channel of interest prior to changing these variables. Use the mouse to zoom in on peaks of interest. In the max and min fields you can select a fit range. [**Gauss fit**] will produce a Gaussian fit with constant background. Displayed results are the area under the peak and the energy resolution. Again the min and max variables are stored for each channel.