Rev. 2 - June 2nd, 2023

R7771

Control Software User Manual

CAEN
Tools for Discovery

User Manual
UM7284

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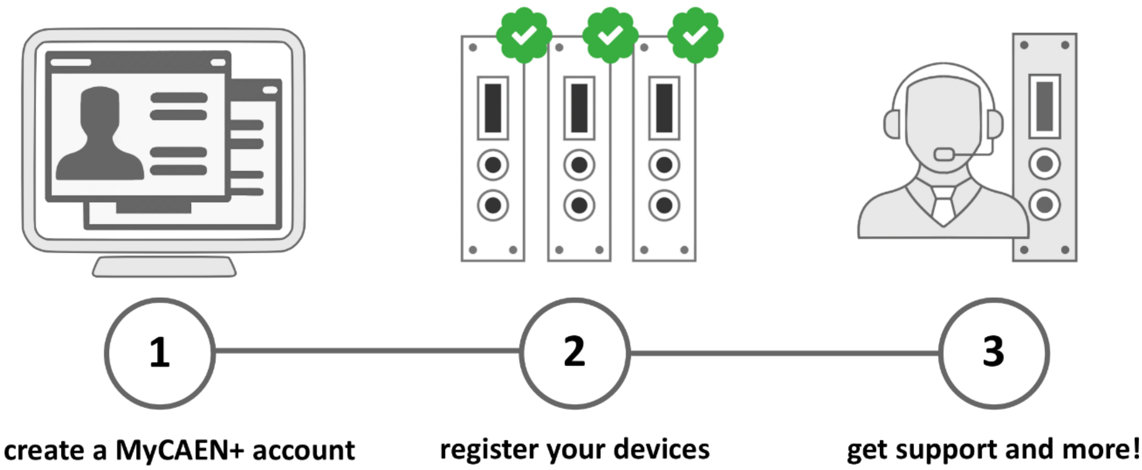

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Purpose of this Manual

This document contains the full description of R7771 software tools.

Change Document Record

Date	Revision	Changes
September 30th, 2020	00	Initial Release
July 6th, 2021	01	Updated software GUI screenshots, new files save modes described in Sec. **2.3.1**, new count rate plot option added in Sec. **2.5**.
June 2nd, 2023	02	Added Multi-Channel Scaler functionality description. Updated manual layout.

Symbols, Abbreviated Terms and Notation

HPGe	High Purity Germanium detector
HVPS	High Voltage Power Supply
MCA	Multi-Channel Analyzer
MDA	Minimum Detectable Activity
OS	Operating System
PC	Personal Computer
PMT	Photo Multiplier Tube
USB	Universal Serial Bus

Reference Documents

[RD1] UM7292 – R7771 Neutron Pulse Train Recorder User Manual

All CAEN documents can be downloaded at:
`https://www.caen.it/support-services/documentation-area/`

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Limitation of Responsibility

If the warnings contained in this manual are not followed, CAEN will not be responsible for damage caused by improper use of the device. The manufacturer declines all responsibility for damage resulting from failure to comply with the instructions for use of the product. The equipment must be used as described in the user manual, with particular regard to the intended use, using only accessories as specified by the manufacturer. No modification or repair can be performed.

Disclaimer

The information contained herein has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. CAEN SpA reserves the right to modify its products specifications without giving any notice; for up to date information please visit www.caen.it.

Made in Italy

We remark that all our boards have been designed and assembled in Italy. In a challenging environment where a competitive edge is often obtained at the cost of lower wages and declining working conditions, we proudly acknowledge that all those who participated in the production and distribution process of our devices were reasonably paid and worked in a safe environment (while this is true for the boards marked ”MADE IN ITALY”, we cannot guarantee for third-party manufactures).

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Index

List of Figures

1 Introduction

The CAEN R7771 is a 32-Channel Neutron Pulse Train Recorder (PTR) **[RD1]** and Multi Channel Scaler (MCS). The embedded FPGA generates a time stamped list of input TTL pulses coming from a neutron detector. When the device works in PTR mode, the pulse train from each of the board channels can be recorded on a PC for later analysis. In MCS acquisition mode, the device uses input channel 1 as a start of the acquisition. 4 logic MCS are integrated: MCS 0 counts signals from channels 2-26, MCS 1 counts signals from channels 27-28, MCS 2 counts signals from channels 29-30 and MCS 3 counts signals from channels 31-32.

The module integrates an ARM based CPU. The default device configuration is stored in the internal memory together with the most recently used configuration. When the device is powered up, the last configuration is automatically reloaded and all the parameter values are set accordingly. The CPU stores also the system Log files: a new Log file is created when the board is powered up and when a new day starts. The R7771 board can be operated in ATTENDED mode and controlled by means of a specific software, the R7771 Control Software.

2 The R7771 Control Software

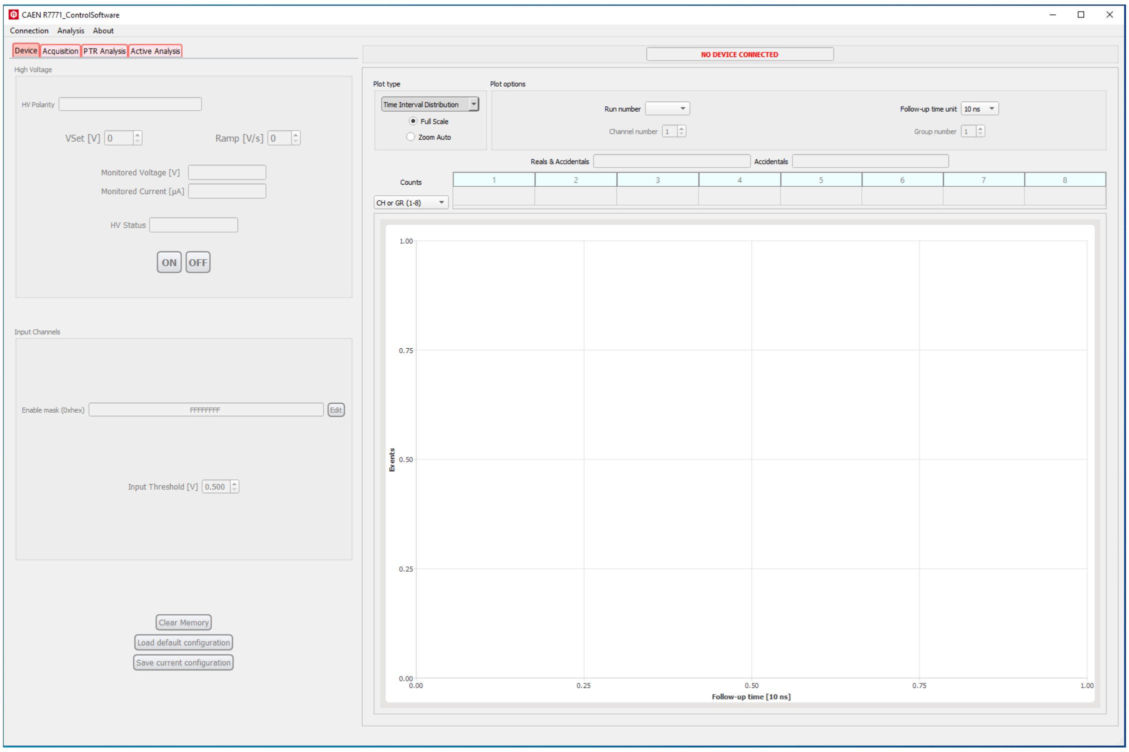

Fig. 2.1: Main window of the R7771 Control Software.

The R7771 Control Software software fully configures the R7771 devices and to handle data acquisition. In particular, the software saves the recorded pulse trains and the MCS spectra on the PC for offline analysis. It also recalls previously stored pulse trains or MCS spectra and to execute the coincidence and multiplicity analysis or ROI analysis in post-processing respectively. The main window of the software is shown in **Fig.2.1**.

2.1 Device Connection

To establish a new connection with the device, select *Connection*→*Connect device* from the main menu. To start a *ETHERNET* connection, the IP address of the device must be typed directly in the dedicated section. For a *USB* connection instead, the board PID must be entered (see **Fig.2.2**).

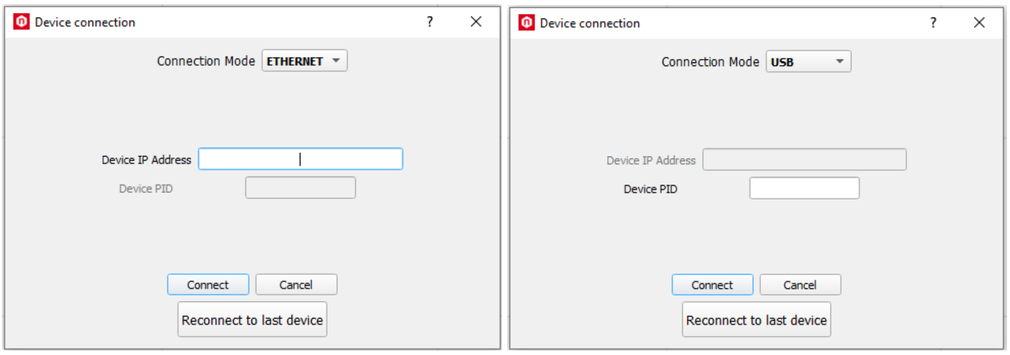

Fig. 2.2: Connection dialog showing the two possible connection options.

If the connection is successfully established, the Device and Acquisition tabs will become enabled and the current device settings will be shown on the GUI. The software automatically reloads all the acquisition and analysis settings that are stored in the device internal configuration.

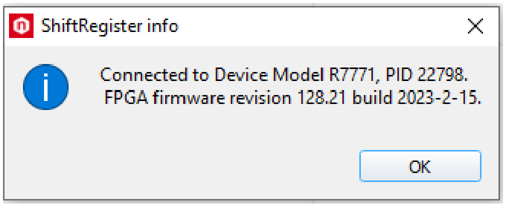

Fig. 2.3: Info dialog confirming that the connection has been successfully established.

2.2 Device Settings

The main device settings are collected in the *Device* tab (**Fig.2.4**): from this tab it is possible to setup and monitor the HV channel, to configure the input channels that will be enabled for data acquisition, to save the current configuration, and to reload the default configuration.

The *VSet* and *Ramp* parameters can be adjusted to set the desired high voltage value and the speed of the HV ramp-up/down respectively. When a new value is entered in the corresponding spinbox, it is automatically applied. The monitored output voltage and current and the *HV Status* are periodically updated in the monitoring sections. A status led on the device front panel is also used to show the HV channel status: when HV is off the HV led color is off, it becomes green when HV is ON and red in case an over-voltage or over-current condition is detected.

The *Channels* section shows the enable status of the device input channels: before starting acquisition it is possible to select what input channels will be enabled for acquiring data (when the device is acquiring data, this section is disabled). The *Enable mask* is a hexadecimal number, associated to a 32 bit register of the board FPGA, where every bit corresponds to one of the input channels. If the channel bit is set to 1, that channel will be enabled for acquiring data. By clicking the *Edit* button, it is possible to modify the enable state of the channels (**Fig.2.5**). Editing the single channels enable mask is possible only if channels are configured to acquire data individually, not in groups (see Sec. **2.3** for a description of the possible channels aggregation modes).

From the *Channels* section it is also possible to set the input threshold (from 0.5 V to 3.5 V) and to adjust it on the basis of the input signal amplitude.

The *Clear Memory* button can be used to clear the device internal data buffers in case an error occurrs during data acquisition. From the *Device* tab it is also possible to reset the whole device configuration to default (acquisition settings and device parameters will be reset to default preset values stored inside the device internal memory). Furthermore, the current acquisition and analysis settings can be saved to the device internal memory so that they can be reloaded when the device is reconnected to the software.

When a new device is connected, the software shows the device information (the PID, the FPGA firmware revision and the working mode) and leaves full control to the user. The user can modify the device settings and start a new data acquisition (see Sec. **2.3**). Data acquisition should be off at the time of disconnection. In case data acquisition is running at the moment of the device disconnetion, it will be automatically stopped.

Fig. 2.4: Device tab showing the HV channel status and the input channels enablemask. High voltage is on, the ramp-up/down is set to 100 V/s and the VSet value is 1000 V. All the 32 input channels of the device are enabled and the input threshold is 1 V.

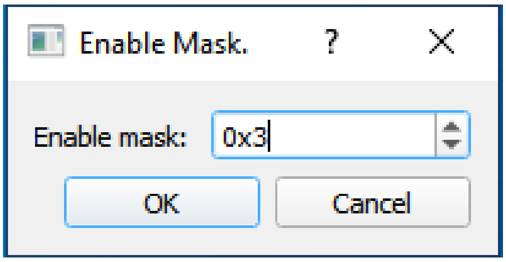

Fig. 2.5: Example of manual editing of the channels enable mask. Only channel number 1 and number 2 are being enabled for acquiring data.

2.3 Data Acquisition Control

The *Acquisition* tab, is shown in **Fig.2.6**. It gives the possibility to control data acquisition, to monitor the acquisition status and to change the device working mode (PTR or MCS). Depending on the working mode, only the specific acquisition settings sections will be enabled.

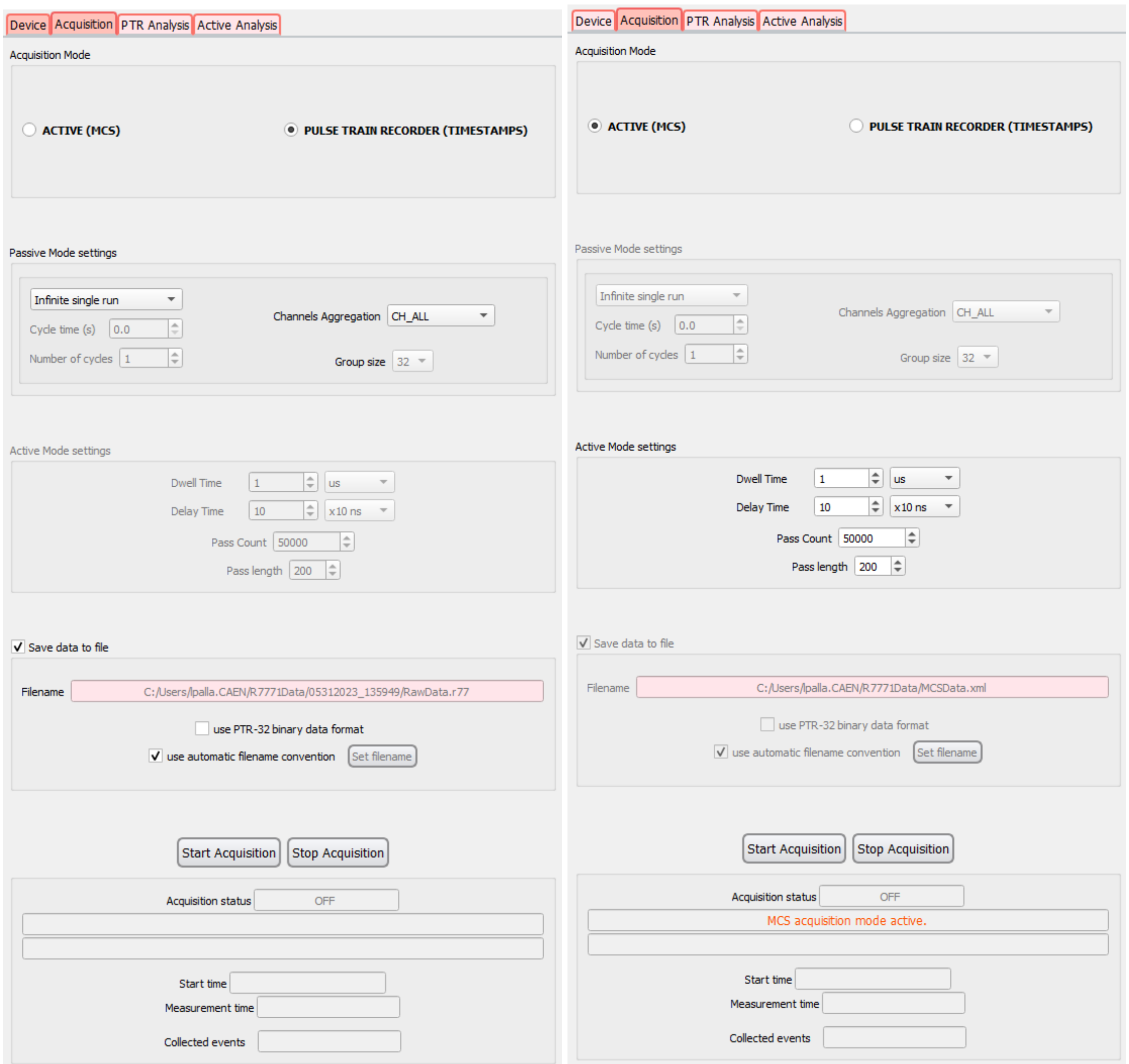

Fig. 2.6: Acquisition tab of the R7771 Control Software.

In case of errors while acquisition is running, an error message is shown in the *Acquisition status* section. Typical error condition could be caused by high input count rates, or by the complete fullness of the internal memory of one or more channels. In this case, the software automatically stops the acquisition, because results will be invalidated due to data loss.

2.3.1 Pulse Train Recorder mode

The software allows the user to manage the device input channels in three different ways. The incoming data from the enabled channels will be saved to binary files that will be managed according to the selected channels configuration.

From the *Pulse Train Recorder Settings* section the channels aggregation mode can be managed. Three aggregation modes are allowed for the input channels:

- **All channels together (CH_ALL)**: the incoming data from all the enabled channels are merged together and considered as a single pulse train. If the data saving is enabled, the pulse train is saved to a single binary file. If this mode is chosen, the collected events that are saved to file contain also the channel information. For this reason, for a offline analysis, a different channels aggregation can be chosen (see also Sec. **2.5**).
- **Individual channels (CH_INDIVIDUAL)**: the incoming data are processed independently from each channel and different pulse trains are saved for each enabled channel (if data saving is enabled). If this option is chosen, the file will contain only events collected by the corresponding channel. The enable mask can be entered as a 32 bit hexadecimal number in the *Channel enable mask* section.
- **Grouped channels (CH_GROUPED)**: the input channels are grouped and every group is considered separately; the pulse train from a single group is saved to a different file (if the data saving is enabled). In this case the file will contain data from a single channels group. The channels group size can be selected from the *Group size* combobox; channels can be grouped 2 by 2, 4 by 4, 8 by 8 or 16 by 16.

The section at the top on the left of the *Pulse Train Recorder Settings* section is dedicated to global acquisition control. Two different acquisition modes are allowed:

- **Infinite single run**: acquisition is started/stopped manually by the user using the *Start Acquisition* and *Stop Acquisition* buttons.
- **Multiple cycles**: acquisition is broken down into a given number of cycles and it is automatically stopped when the total preset time has elapsed (all the planned cycles are finished). The single *Cycle time* can be entered in the corresponding section and the *Number of cycles* can also be set. By setting the number of cycles to 0, the device repeats the same acquisition cycles until acquisition is stopped manually by the user.

After setting the channels aggregation mode and the acquisition time, the *Start Acquisition* button can be pressed to start data acquisition. Every time a new acquisition is started, the current device configuration is stored in the device internal memory (also analysis settings are included and saved); the last configuration is reloaded when the device is powered on.

2.3.2 Active mode

The *Active Mode settings* section is dedicated to the data acquisition for active interrogation with neutron generators for differential die-away analysis. This section allows the user to set the 4 MCSs integrated in the device firmware. Before starting MCS data acquisition, the hardware *Dwell Time*, *Delay Time*, the number of acquisition triggers (*Pass Count*) and the number of bins of the MCS spectra (*Pass Length*) must be set. By setting the *Pass Count* value to 0, data acquisition will run on until the *Stop Acquisition* button is pressed by the user. The MCS start is given by the signals arriving on channel 1. When a logic signal is fed into channel 1, an acquisition window is opened after the programmed *Delay Time*. The acquisition window is divided in the programmed number of *Dwell Time* length sub-windows. Each dwell window represents a bin of the final histograms. The acquisition window is automatically closed when the last bin is filled. As soon as a new start signal is received, the acquisition increments the previous histogram.

The software saves the 4 resulting MCS histograms to a single file for offline analysis and performs online ROI calculation according to the active analysis settings.

2.4 Output files

If the *Save data to file* option is checked, the software will save the incoming pulse train(s) or the MCS spectra to a file for later analysis.

The *use automatic filename convention* option is the default setting for assigning the names to the data saving files. Files are saved to a dedicated folder (called *R7771Data*) that is created inside the user home directory, and files are located inside a subfolder that is named according to the date and time of the start of the acquisition. The base name of the files for PTR mode is *RawData* or *PTR* depending on the used file format (see the options below) and the files are in binary format. The base name of the binary file is expanded by appending a suffix that specifies the channel/group number (_chXX or _GXX where XX is the number of the channel or the group).

Two possible binary formats can be used for the output files:

- CAEN binary format: this is the default option for the binary raw data file. This specific format includes a 22 bytes header at the beginning of the file, containing some information about the device and measurement configuration. The header contains the following data: device operating mode (1 byte unsigned word), number of cycles of the acquisition (4 bytes unsigned word), acquisition cycle length in seconds (8 bytes unsigned word), channels aggregation mode (1 byte unsigned word), channel or group number (1 byte unsigned word), channel enable mask (4 bytes unsigned word), group enable mask (2 bytes unsigned word), group size (1 byte unsigned word). The header is followed by the pulse train events. If the channels aggregation mode is CH_ALL, every event is made of the timetag (8 bytes unsigned field), channel number (2 bytes unsigned field) and flags (2 bytes unsigned field). In the CH_INDIVIDUAL and CH_GROUPED mode the event does not contain the channel number field because the channels/groups data are automatically stored to different binary files. If the acquisition is made of more than one cycle, a unique file is created, but the single cycles will be analysed individually (see also Sec. **2.5**).
- PTR-32 binary format[1]: for retro-compatibility, the binary format that is supported by the INCC software is also allowed. For every acquisition cycle a new PTR files pair (.bin and .chn) is created inside the subfolder.

For Active mode the output file base name is *MCSData* and the file format is xml.

The destination folder and the base name of the generated files can be changed by clicking the *Set filename* button, which becomes enabled when the default setting is disabled.

[1] For the structure of PTR data files see: http://www.iki.kfki.hu/radsec/groups/ptr_en.shtml

2.5 Data Analysis

The R7771 Control Software analyses the raw pulse trains and the MCS spectra collected from the device in PTR and MCS mode respectively.

2.5.1 Pulse Train analysis

The raw binary file containing the list of the channel timestamps are analysed according to the coincidence and multiplicity counting technique. Neutron coincidence and multiplicity counting are well established nondestructive assay techniques for nuclear materials based on the detected neutron pulse trains. The recorded pulse stream from a neutron detector contains a combination of spontaneous fission, induced fission and background neutrons. Neutrons from fission are correlated in time, while background neutrons from other production processes present poisson random distribution. To determine whether the neutron events are time-correlated, two equal time periods (*gates*) are sampled by the analysis routine for every event. The first gate window is opened some time (the *predelay*) after the neutron detection time and is referred to as the R+A (*Reals + Accidentals*) gate; the second gate, the A (*Accidentals* only) gate is delayed by the *long delay* time with respect to the R+A gate. Within counting statistics, the number of accidentals events measured in the A gate is the same as in the R+A gate. Thus the difference between the counts collected in the R+A gate and those collected in the A gate is the desired real coincidence signal R.

The multiplicity counting routine measures also the multiplicity distribution for the R+A and A gates, by determining the number of times each multiplicity occurrs in the corresponding gate. At the end of the whole analysis, the Singles (S), Doubles (D) and Triples (T) event rates are calculated by means of the formulae:

$$S = \frac{\sum_{i=0}^{n}(R+A)_i}{T_m} = \frac{\sum_{i=0}^{n}(A)_i}{T_m} \tag{2.1}$$

$$D = \frac{\sum_{i=1}^{n} i(R+A)_i - \sum_{i=1}^{n} i(A)_i}{T_m} \tag{2.2}$$

$$T = \frac{\sum_{i=1}^{n} \frac{i(i-1)}{2}[(R+A)_i - (A)_i] - \frac{\sum_{i=1}^{n} i(A)_i}{S.T_m}[\sum_{i=1}^{n} i(R+A)_i - \sum_{i=1}^{n} i(A)_i]}{T_m} \tag{2.3}$$

where $(R+A)_i$ and $(A)_i$ are the measured multiplicity values for multiplicity i in the two windows, and T_m is the measuring time.

If the *apply calibration* section is checked, the software gives the possibility to reload the calibration coefficients from a calibration file and to calculate the spontaneously-fissioning mass $^{240}PU_{eff}$Mass from the Doubles rate.

If the Rossi Alpha analysis routine is activated, a new time window is opened after every detected event (the initiating event). The time differences between the initiating event and the next events that follow in the stream is calculated until the time difference is less than the previously set time window. The Rossi Alpha distribution is obtained by binning the time differences according to the *Step* value.

In the R7771 Control Software, all the parameters involved in the data analysis are collected in the *PTR Analysis* tab and can be adjusted before starting the analysis itself (see fig. 2.7). The *Follow-up time unit* is an extra parameter that can be used to set the unit time for the time plot (see Sec. **2.6**). From this tab it is possible to load a previously stored pulse train data file and to start the offline analysis. By default, coincidence and multiplicity counting are enabled, the Rossi Alpha analysis can be activated as an option.

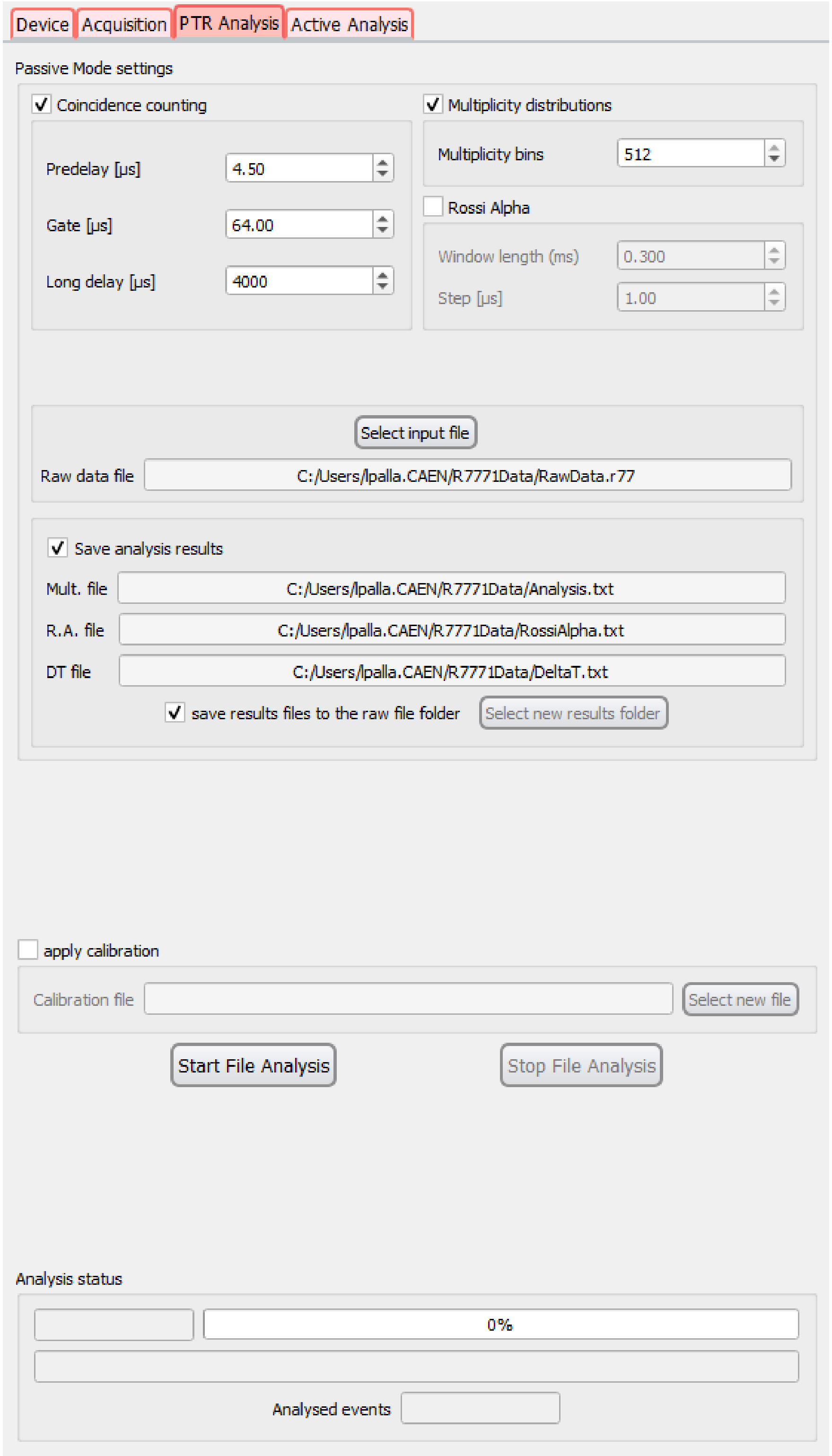

Fig. 2.7: PTR analysis tab of the R7771 Control Software.

2.5.2 MCS spectra analysis

The xml files containing the 4 MCS spectra can be reloaded and reanalysed after defining different ROIs for the differential die-away analysis calculations or simply to calculate the integrals of specific ROIs. For this purpose, from the *Active Analysis* tab it is possible to select between *Differential Die Away* and *Default* analysis mode. Differential die-away analysis is a non destructive assay technique that gives the possibility to detect the presence of fissile materials such as ^{235}U and ^{239}Pu. The technique uses a high-energy (14 MeV) pulsed neutron generator to interrogate a target sample suspected of containing fissile material. The highly energetic neutrons that are delivered into the sample penetrate deep and create secondary neutrons primarily by means of induced fission. These secondary neutrons are then detected by a set of detectors that surround the sample. The detection time distribution is analyzed to deduce information about the fissile material properties. In particular, the number of detected neutrons between the pulses is proportional to the mass of fissile material. The system calibration is performed according to mass of fissile material vs Normalized Counts:

$$N = \frac{E_G - L_G}{SM} \tag{2.4}$$

The Normalized Counts are then corrected for matrix effects to obtain the Real Counts:

$$R = N * \frac{(\frac{OBM}{SM})_{air}}{(\frac{OBM}{SM})_{matrix}} \tag{2.5}$$

The Real Counts are obtained from 3 MCS spectra resulting from the measurement:

- the *Neutron Chamber detectors spectrum* obtained couting the pulses from all the detectors surrounding the chamber. Two ROIs are significant for this spectrum: the Early Gate E_G, which is due to thermal source neutrons including fission in fissile material with subsequent detection of the fast prompt fission neutrons and the Late Gate L_G, which is the signal that is un-correlated to the triggering event.
- the *Source Monitor (SM) spectrum* obtained counting the pulses from a detector placed outside the chamber that it only detects the source neutrons produced from the neutron generator tube. Only one ROI is needed for this spectrum.
- the *On Barrel Monitor (OBM) spectrum* obtained counting the pulses from a detector installed inside the neutron chamber very close to the sample on the opposite site of the neutron source, that detects the thermal neutron flux coming from the sample used to correct for matrix effects.

The software gives the possibility to define up to 2 ROIs for every MCS spectrum. The ROI is active if the corresponding checkbox is checked, in this case the ROI integral is calculated. The ROI limits are expressed in channels: one channel corresponds to the MCS dwell time. The ROI labels can be edited and they will be shown in the final analysis report. If *Differential Die Away* mode is selected, the software automatically changes the labels of the relevant MCS spectra according to the application and enables the needed ROIs for the calculations: MCS 0 is reserved for the Neutron Chamber spectrum (channels 2-26 can be connected to the detectors), MCS 1 is reserved for SM spectrum, MCS 2 is reserved for OBM spectrum, MCS 3 is not used but it available in case of need.

The ROIs configuration (ROI limits and enable state) can be saved inside the device together with the acquisition settings so that is will be possible to reload previously defined ROIs when the device is reconnected. If the *apply calibration* section is checked, the software gives the possibility to reload the calibration coefficients from a calibration file and to calculate the fissile mass.

2.5.3 Output analysis results files

If the *Save analysis results* option is checked, the multiplicity counting results will be saved to ASCII files of the same format as INCC Test data files. The DeltaT distribution is also saved to a simple ASCII file (the distribution of the time difference between the timestamp of every event and that of the next one). If the Rossi Alpha analysis is also enabled, a corresponding ASCII file is also generated. By default, the *save results*

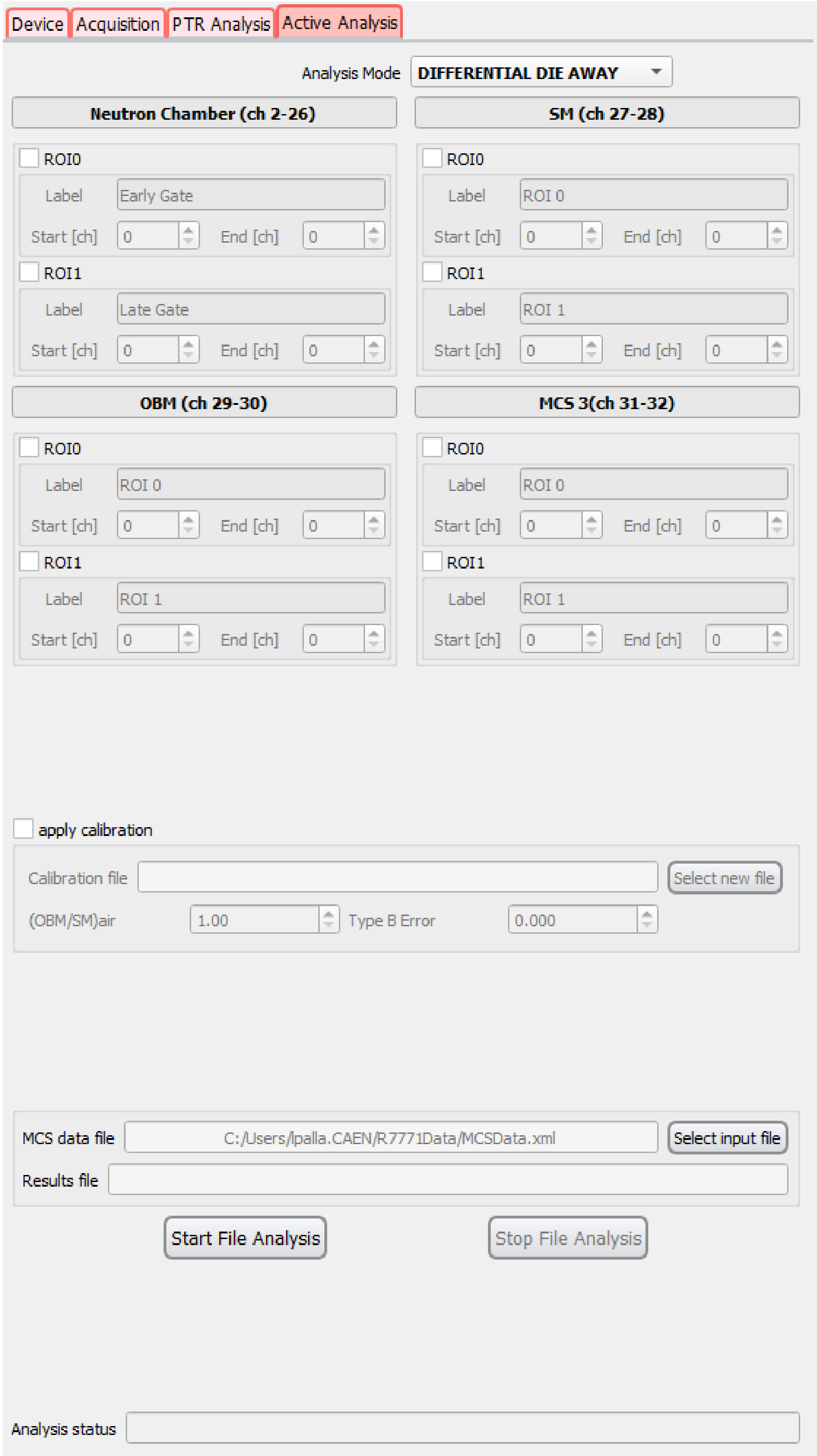

Fig. 2.8: MCS analysis tab of the R7771 Control Software.

files to the raw file folder option is selected and the results files are saved inside the same folder where the binary file under analysis is stored. The save path for the results can be changed by means of the *Select new results folder* button, which becomes enabled when the automatic save option is disabled. The base names of the multiplicity results files, Rossi Alpha and DeltaT distributions files are *Analysis*, *RossiAlpha* and *DeltaT* respectively. A suffix is appended to the base names if the channels aggregation mode is set to INDIVIDUAL or GROUPED (the same convention as for the binary files is used, see Sec. **2.4**).

Before starting a new file analysis, a previously saved binary file must be selected by clicking the button *Select input file*. Supported file formats are the CAEN .r77 binary format and the PTR-32 binary files couple (see Sec. **2.4**).

File analysis can be started/stopped by means of the *Start Analysis* and *Stop Analysis* buttons. The pulse train binary file can contain data collected by more than one channel (see also Sec. **2.3** for the CAEN binary format). In this case, a dialog is shown (see **Fig.2.9**) and the software allows to choose the data analysis mode between 3 options:

- **All channels together (CH_ALL)**: data from all channels are merged and analysed together as a unique data stream. A single results file will be generated by the analysis routine.
- **Individual channels (CH_INDIVIDUAL)**: data from every channel will be separately accounted for, single channel distributions are calculated and single channel results files are generated. The results filename will have a _chXX suffix, where XX is the channel number.
- **Grouped channels (CH_GROUPED)**: channels data are grouped and data from a single group of channels are merged together. A result file for every channel group and for every analysis routine is created and the filename will have a _GXX suffix, with XX being the group number. The group size can be set from 2 to 16 channels, scaling by a power of 2.

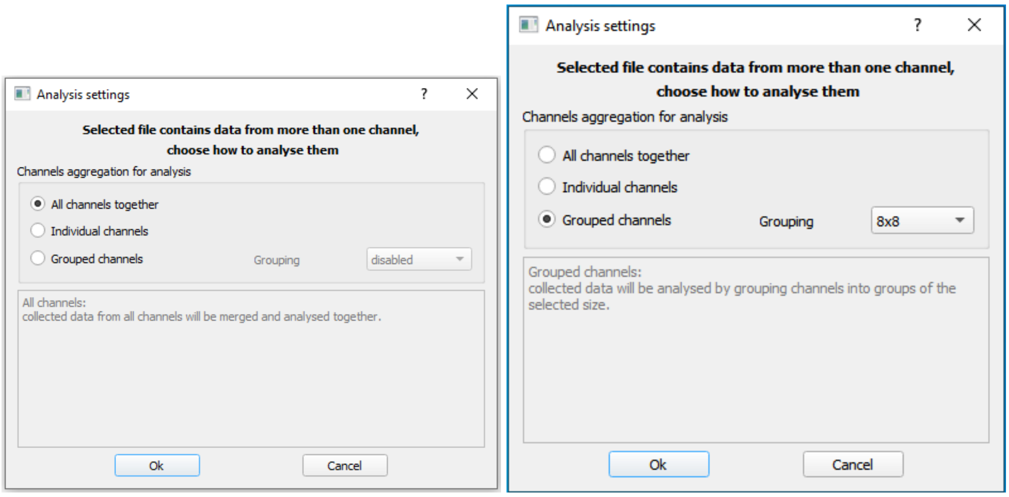

Fig. 2.9: Analysis configuration dialog shown when the file under analysis contains data from more than one channel.

The software allows the user to repeat the analysis of a given file several times setting different analysis parameters and different channels aggregation modes.

The raw file can contain data collected during a multi-cycle acquisition. In this case every measurement run is analysed separately, and the results are appended to the results file. At the end of the analysis, the average value of S, D and T rates is also calculated. If one or more cycles give invalid results they are automatically excluded when the average values are calculated. A cycle is considered invalid if the Singles rate differs of more than 3 sigmas from the average Singles rate from the start of acquisition, or if the Triples rate is bigger than the Doubles rate (these effects could be due to cosmic rays interactions in the sample material that would invalidate the measurement).

While data analysis is in progress, the *Analysis status* section allows the user to monitor the total number of analysed events and a progress bar indicates the percentage of the analysis that has been completed.

When the analysis is complete, the main results are summarized and shown in a dedicated window, see for example **Fig.2.10** and **Fig.2.11**.

The results report starts with the event counting results: for every acquisition cycle the total trigger counts and the events readout rate are shown. This first section is followed by the coincidence and multiplicity counting results: for every cycle the number of analysed events is reported together with the Singles, Doubles and Triples rates and the average multiplicity calculated from the R+A and A measured distributions.

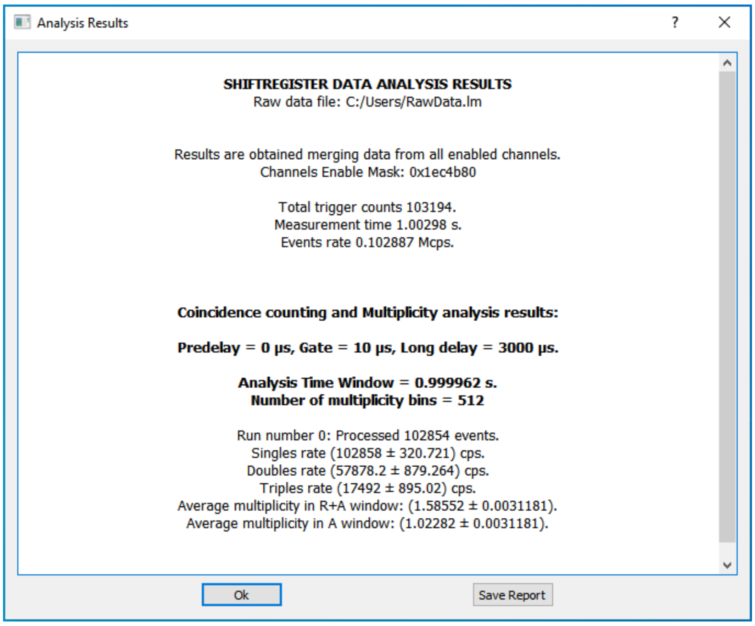

Fig. 2.10: Analysis results report with the summary of the results. For this analysis the channels aggregation mode was set to CH_ALL and the measurement is made of a single run lasting about 1 second.

When a MCS xml file is analysed, a new xml file is created inside the input file folder and its name contains the date and time of the analysis. In this case the analysis report shows the raw counts inside the active ROIs for all the MCS spectra. If the Differential Die Away mode is selected, the normalized and real counts are also shown. Finally, if a calibration has been loaded, the derived fissile mass is also shown.

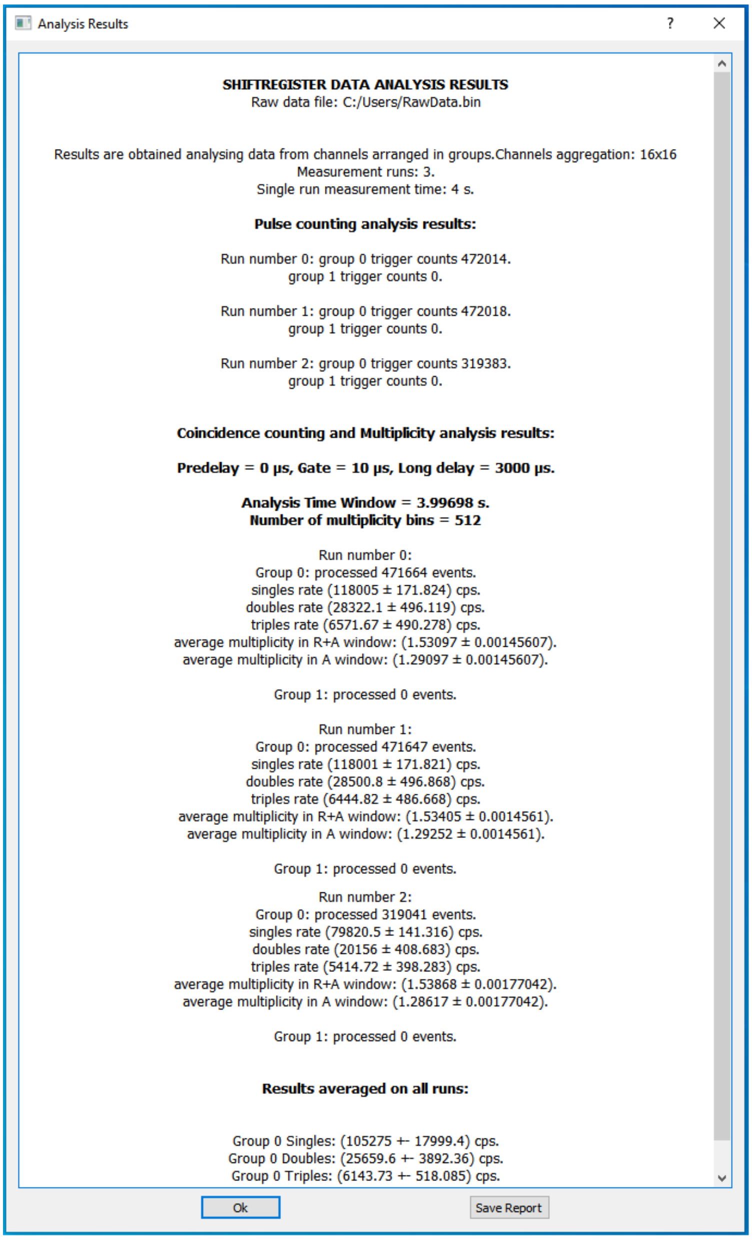

Fig. 2.11: Analysis results report with the summary of the results. For this analysis the channels were arranged into groups of size 16 and the measurement was made of 3 runs lasting 4 seconds each. Results are reported for every run and for every channel group even if no event has been detected by channels group 1. In the last section the average values for S, D and T in the 3 runs are reported.

2.5.4 Online analysis

The R7771 Control Software gives the possibility to perform online data analysis while PTR data acquisition is running. To enable the feature, the menu option *Analysis*→*Online Analysis* should be checked. By activating the online analysis, the software will analyse incoming raw data while they are being collected. By default the raw pulse train will not be saved (the *Save pulse train* option is deselected), even though it is possible to re-enable the option.

It must be pointed out that this feature is intended only for testing and for debug purposes and it is not recommended to enable it during routine operation, in particular in long measurements with a high data throughput, because the software performances are reduced. It is very useful if used for short measurements to verify the analysis parameters are correctly set and if the device is collecting data (see for example **Fig.2.12**).

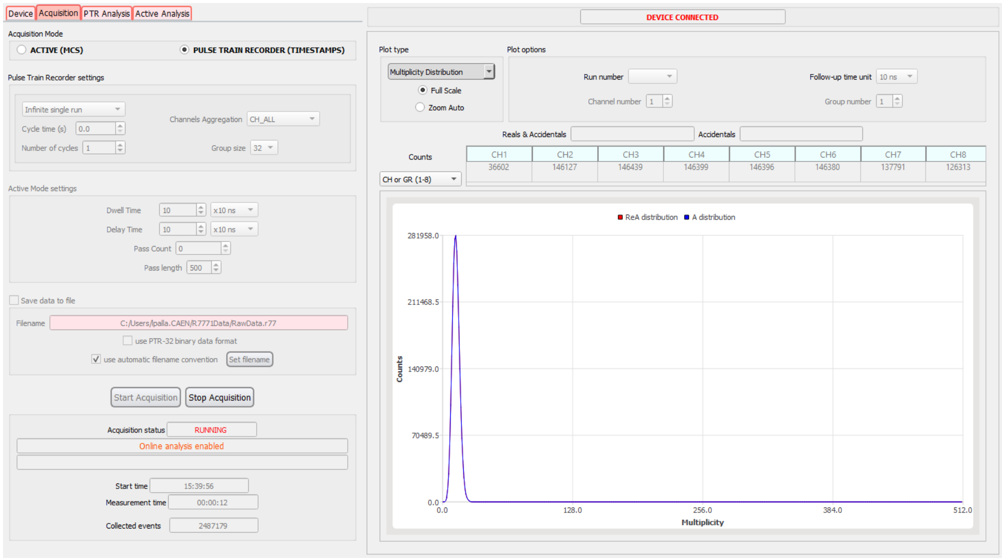

Fig. 2.12: Online analysis running while the device is acquiring data. The resulting multiplicity distributions are clearly visible. This indicates that the collected data are ok, so the real acquisition can be started and the pulse train can be saved.

2.6 The Plot Section

The right side of the main window of the R7771 Control Software is dedicated to the plot of the distributions obtained by the analysis routine. The *Plot type* section is used to select and identify the kind of distribution to be loaded for the plot. The possible plots are:

- **Time Interval Distribution**: this is the distribution of the time differences between one event and the following one inside the pulse train. A histogram is filled with the ΔT values and the width of a single bin of the histogram corresponds to the *Follow-up time unit*, and can be set to 10 ns, 100 ns, 1µs, 10µs, 100µs, 1 ms. Two plot examples are shown in **Fig.2.13**.

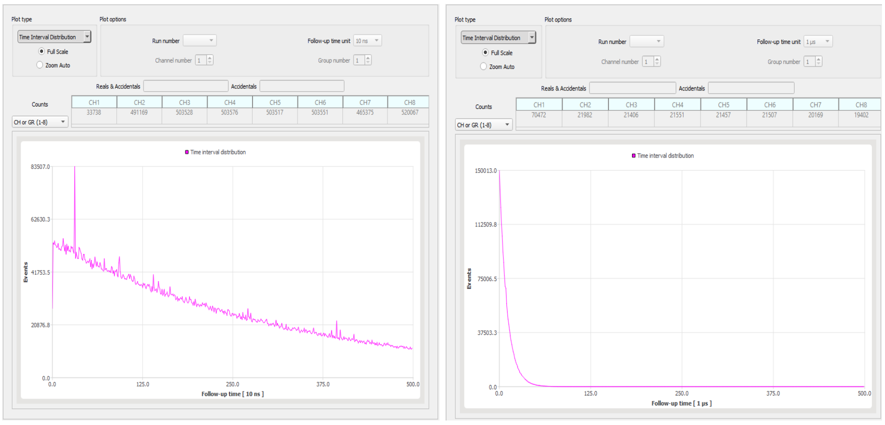

Fig. 2.13: Two different examples of time interval distributions.

- **Multiplicity Distribution**: in this case the distributions of the multiplicity of events detected in the R+A and the A gates are shown in different colors. Every bin of the histogram corresponds to an increasing multiplicity value. Two plot examples are shown in **Fig.2.14**.

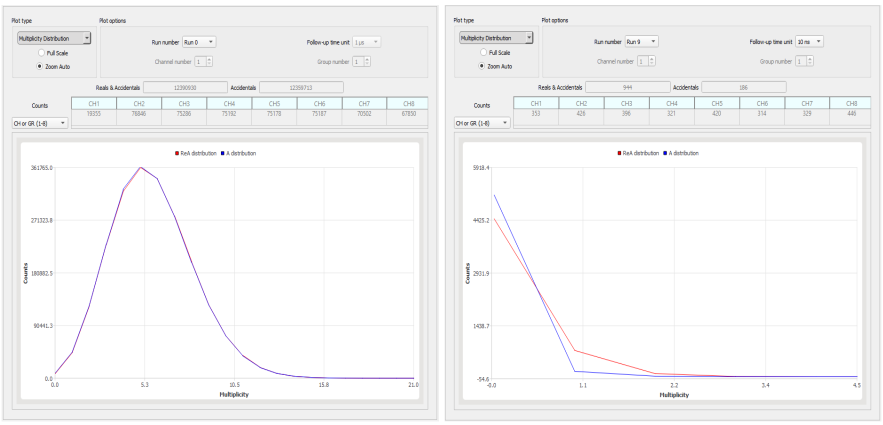

Fig. 2.14: Two different examples of multiplicity distributions. The R+A distribution is shown in red, the A didtribution is superimposed on the same plot in blue.

- **Rossi Alpha Distribution**: this is the distribution in time of events that follow after an arbitrary chosen starting event. The time window used for the measurement can be defined in the *Analysis* tab as also the bin size (the *Step*). Two examples are shown in **Fig.2.15**.
- **Count Rate Plot**: this is a graph showing the measured count rate of the device input channels as a function of time. Up to 8 channels data can be shown at the same time, the range of the channels to visualize can be selected by means of the *Counts* combo box at the top of the plot. Two examples are shown in **Fig.2.17**.

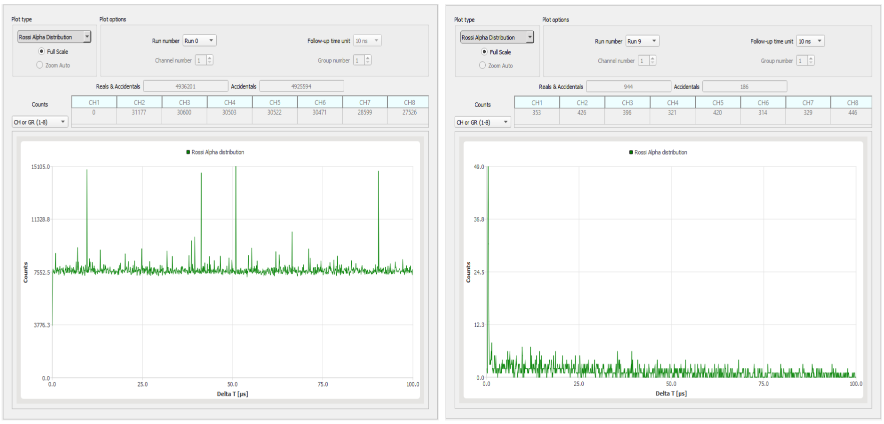

Fig. 2.15: Two different examples of Rossi Alpha distributions. On the left only random uncorrelated events are present, while on the right the distribution shows an exponential decay due to the presence of correlated events from fission.

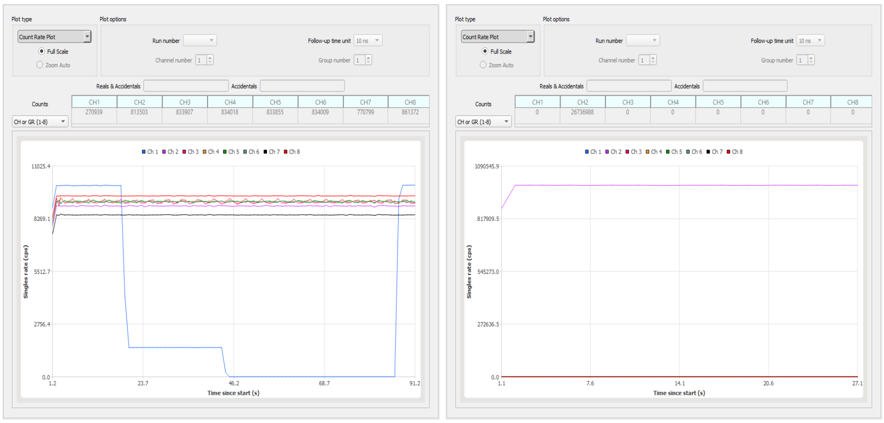

Fig. 2.16: Two different examples of Count Rate plots. On the left channel 1 count rate varies from about 10 kcps to 0 cps, while for channels 2, 3 and 4 it is about 9 kcps. On the right, channel 4 is counting at about 1 Mcps.

- **MCS 0-3 Plots**: graphs showing the 4 MCS spectra filled with the sum of the hits from the corresponding input channels detected inside the acquisition window.

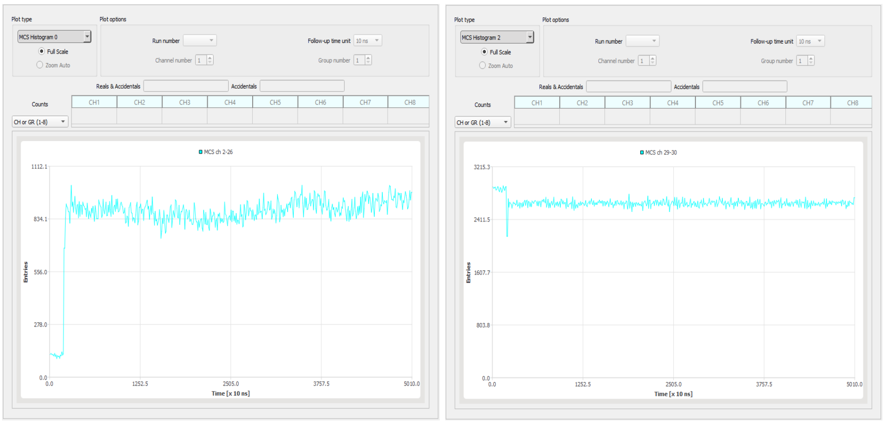

Fig. 2.17: Two different examples of MCS plots. On the left MCS 0 is visible (channels 2-26), while on the right MCS 2 is selected (channels 29-30).

The *Plot options* section summarizes the possible settings for the plot; some sections are disabled/enabled according to the plot type, the channels aggregation and the acquisition status (when a device is connected).

- When a device is connected, the plot shows the measured time interval distribution or one of the MCS spectra while acquisition is running and it is automatically updated. Depending on the channel aggregation mode, the *Channel number* or *Group number* section becomes enabled and in this case it is possible to visualize the distribution relative to a single channel/group. If a multi-cycle acquisition is in progress, the *Run number* section indicates the current measurement run number; but the time distribution contains all data since acquisition start. The *Counts* table above the plot shows the total number of events detected by every input channel, the values are updated throughout the acquisition.
- When the offline analysis of a binary file is in progress, the *Plot Type* section is enabled and it is possible to select the distribution to plot. The plot is refreshed automatically while the analysis is progressing. As in the previous case, the plot is relative to the current measurement cycle that is being analysed and the *Channel number* and *Group number* sections are enabled according to the channels aggregation. Also the DeltaT distribution is relative to the last run under analysis. When the analysis is completed, also the *Run number* section becomes enabled and it is possible to represent the distributions relative to a given run from the list of runs present in the file. If the *save DeltaT distributions* option is checked, it will also be possible to replot the DeltaT distribution of a given run, otherwise only the last one will be available to replot.
- When the online analysis is running, it is still possible to select the distribution to plot, and the channel or group number but the run number will be always the current one.

It is always possible to interact with the plot to zoom in and out the x and y axis scale. By selecting the *Full Scale* option, no zoom is applied to the x axis of the plot, while the vertical axis range is automatically rescaled. The *Zoom Auto* option automatically rescales both the plot axes. By positioning the mouse pointer on one of the plot axes, it is possible to zoom-in/out using the mouse wheel. A mouse double click on the plot allows to revert the axes ranges to full scale.

3 Technical Support

To contact CAEN specialists for requests on the software, hardware, and board return and repair, it is necessary a MyCAEN+ account on www.caen.it:

https://www.caen.it/support-services/getting-started-with-mycaen-portal/

All the instructions for use the Support platform are in the document:


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A paper copy of the document is delivered with CAEN boards.
The document is downloadable for free in PDF digital format at:

https://www.caen.it/wp-content/uploads/2022/11/Safety_information_Product_support_W.pdf

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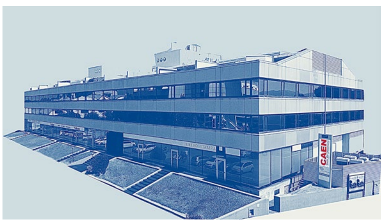

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