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AnalisaCAEN, a simple software suite to reduce and analyze coincidence data collected using CAEN v1724 digitizer

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Abstract. In this work a small software suite for the reduction and analysis of coincidence data collected using CAEN's proprietary software was developed. These software check the output files for coincidences, generate a single list mode file with the coincident events, build histograms for each input, plus a time difference histogram and a 2-detector data matrix, perform time gates and allows for the subtraction of accidental coincidences, and perform energy gating on the final data matrices, generating histograms with the gated spectra. Moreover, the suite has an integrator that guides the user through all the required steps.

1. Introduction

The CAEN v1724 is an 8-channel 14-bit 100MS/s digital pulse processing (DPP) digitizer that allows for quite flexible data acquisition arrangements. Pulse shaping parameters can be individually adjusted for each of the 8 inputs, and several data acquisition constraints can be set between any number of inputs, allowing for singles, coincidence and/or anticoincidence combinations for data acquisition, for instance. The data collection can be performed either in the form of individual histograms for each input or in list mode, which can be outputted either in ASCII or binary data formats.

The ASCII list mode output consists of one file for each input channel, with 5 header lines and then one line for each registered event with the absolute timestamp (in tens of nanoseconds, in the case of the v1724 digitizer) and the corresponding channel of the energy event; however, even when set to strict coincidence mode, the digitizer registers some unpaired events related to events registered in the same channel that set the "coincidence start" signal while the coincidence window was still open.

The digitizer comes with two distinct option of software. There is a very complex and technical option, called *DPP Runner*, which requires programming knowledge, and a very basic and simple option, *MC2 Analyzer*, which allows for simple set-up of the acquisition, but won't perform decent spectrum analysis.

To allow for the analysis of coincidence data acquired using this digitizer, a small software suite was developed that: 1) checks the output files for coincidences and generates a single list mode ASCII file with the coincident events and their time difference (nanoseconds); 2) for each detector pair, builds histograms for each input, plus a time difference histogram and a 2-detector data matrix; 3) performs time gates in the data and allows for the subtraction of

accidental coincidences, also generating histograms and a matrix; and 4) performs the requested energy gates on the final data matrices, generating ASCII histograms with the gated spectra. In order to simplify the usage for non-experts, the suite also features an integrator that guides the user through all the required steps.

2. Software Design

The software suite was developed using the *Pascal* programming language, and at the present stage runs only in command-line mode. The compiler used was the open-source *FreePascal*, version 3.0 [1], and the software was only tested within the Windows operating system (though, as FreePascal is cross-platform, it should be reasonably easy to implement in Linux too, if required).

The conceptual design was to develop individual command-line utilities that perform each of the required steps, in order to allow for a latter integration into a graphical user interface (GUI). Each of the utilities should accept all required input via command-line parameters but, in order to simplify the usage, they can also ask for these inputs interactively.

3. The Software Suite

The suite consists of 5 pieces of software that perform simple tasks, plus an integrator to simplify the use of the suite.

3.1. LeCAENCoinc

It's the first piece, which at the present stage reads only the text-mode outputs, compiling them in a single ASCII output file – the next versions should also be able to deal with the binary data format. While reading, it checks for coincidences within a given coincidence gate time – this is done on-the-fly in a line-by-line basis (skipping the "unpaired" lines on each file), reading the whole inputs before doing so would be unfeasible due to the enormous number of events that can be present in each input file. The output file is in ASCII format, consisting of a list of coincidence events in the form (γ_1, γ_2, dT), where γ_1 and γ_2 are the amplitudes registered in channel 1 and 2, respectively, and dT is the time difference in ns between channels.

3.2. HistoCAEN

This program is the next in line, as it reads the output coincidence file and produces two 1-D histograms for the gamma channels, plus a time difference 1-D histogram and a 2-D gamma-gamma matrix. This software can also optionally perform time-gating, which is applied to all outputs, in order to allow for selection of total or accidental events. The output files are compressed to 4096 channels (energy histograms) in order to reduce memory and disk usage.

3.3. SomaMatriz

This is a program designed to sum or subtract two or more 2-D data matrices, allowing for the subtraction of accidental events from the total events gate, producing an output matrix that should only contain the real coincidence events. This sum is a simple matricial summation, with each matrix multiplied by a user-input weight in order to account for the difference in the number of time channels used in each gate – the weight should be the inverse of the number of time channels, and the accidental events matrices should have a negative weight. The results are output as one 2-D matrix and 2 1-D histograms, one for each channel.

3.4. FatiaMatriz

This is the final step so far, as it performs channel gating on a 2-D matrix, producing a gated 1-D histogram. Only a single gate can be performed at a time, and the software requires the

detector in which to do the gating, as well as the initial and final channel of the gate. The output file contains an ASCII histogram of the gated events – at the present stage this is a simple 4096-line file with each line containing the number of counts in the respective channel.

3.5. AnalisaCAEN

This is a simple, command-line integrator for the suite, which performs the required steps, requesting for the necessary information. At the present stage, energy gating isn't yet implemented, and it has be performed manually using FatiaMatriz. In its present stage it requires the use of an external software (Cambio [2]) to display the time spectrum in order to allow for time-gating.

3.6. HistoSingles

This is an extra program which reads the original text-mode outputs and produces the full 1-D histogram for each input, which can be useful if acquisition was not performed in coincidence mode.

4. Programmed Future Implementations

In its present stage, the software suite is usable, having been thoroughly tested by a few non-technical users. Some upgrades are required, though, if these software are to be easily usable.

The first upgrade required is the implementation of energy gating into the AnalisaCAEN integrator. This task, albeit seemingly simple, isn't easy to implement as it requires knowledge on the spectrum analysis results in order to properly define the gates.

Another very important feature that should be added soon is the ability to automatically convert the output 1-D histograms in a more widespread format as Ortec's CHN [3] or the ANSI/IEEE N42.42 Standard [4]. This would allow for the inclusion of non-spectral data as energy calibration, counting times and so on.

Finally, a major step in making this software easily usable for non-technical users would be the implementation of a Graphical User Interface. It should be noted that, as of now, the inclusion of spectrum analysis into the suite is not foreseen, as this is the most delicate step in nuclear data analysis and there are quite a few excellent choices for that purpose [5].

5. Conclusions

The software suite developed proved to be useful, allowing users to perform coincidence data reduction in a quick and reliable manner. The most delicate step in the development of this software is the verification of coincidences within the initial list-mode output files, as it contains both paired and unpaired events. There are still some important features to be added, but in its present stage the suite is absolutely usable.

References

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