

Amptek Digital Processors & Gamma-Ray Analysis Software

Amptek, Inc. provides a range of radiation detection systems and components used in gamma-ray spectroscopy. This includes the Gamma-Rad5 (a scintillation detector system), the TB-5 digital tube base (for use with scintillators and PMTs), the PX5-HPGe (a digital signal processor optimized for use with HPGe gamma-ray detectors), along with the MCA-8000D and the DP5G and DP5 digital processor boards. Amptek's hardware comes with software to acquire the spectrum but not to analyze the spectrum, i.e. to identify the isotopes present and to quantify the activities.

Amptek is now teaming with Dr. Westmeier GmbH to provide high performance gamma-ray analysis software. This software takes the spectra acquired by Amptek's processors and analyzes it to determine the radioisotopes which are present and to quantify the activity. There are two separate software packages available: SODIGAM is designed for scintillators, such as NaI(Tl) and LaBr₃, while GAMMA-W is designed for HPGe detectors.

Our standard DPPMCA data acquisition and control software obtains the raw spectra, adjusts the hardware parameters, and can perform the energy calibration. DPPMCA then spawns a Sodigam or Gamma-W process, passing the data into the analysis software, which then processes the spectrum and prepares a report. To use Amptek's hardware with the Westmeier gamma-ray analysis software, one needs the analysis software and a security plug, available through Amptek.

This document is a brief guide to the analysis software and its interface with DPPMCA. There are four sections to this guide:

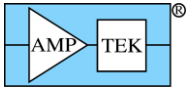
- Section 1 describes the software interface between the two packages, i.e. the dialog boxes found in DPPMCA which pass the data to the analysis software.
- Section 2, "Getting Started", is an overview of the process of installing the two software packages, configuring the hardware, taking a spectrum, and then analyzing it.
- Section 3 lists the more detailed documents available for the Amptek hardware, the DPPMCA acquisition software, and for the Westmeier analysis software.
- Section 4 provides a brief overview of the process of setting up, configuring, calibrating, and then analyzing gamma-ray spectra. The SODIGAM/GAMMA-W packages are targeted for experienced gamma-ray spectroscopists.

1) DPPMCA and SODIGAM/GAMMA-W

DPPMCA

DPPMCA is a data acquisition and control software package. It interfaces to the spectrometer, i.e. to the signal processing hardware. It supports Amptek's family of digital processors, including the PX5-HPGe, the TB-5 digital tube base, and the Gamma-Rad5 scintillation spectroscopy system. DPPMCA is used to configure the hardware, to start the acquisition, to read the data, and to save the raw spectrum file. It has very limited analysis capabilities: one can use it to perform an energy calibration, set regions of interest, and obtain count rates. To use DPPMCA with SODIGAM or GAMMA-W, one must

- Have DPPMCA.EXE version 1.0.0.15 or later
- After installing the software, in the directory with DPPMCA.EXE you will find a file named "_GammaW_DppMCA.INI". Edit the filename to remove the underscore.
- After the spectrum is taken with DPPMCA, it can be analyzed with SODIGAM or GAMMA-W. The DPPMCA software first saves the spectrum from DPPMCA into a special file format and location recognized by the analysis software. It then spawns the analysis software with one of a



SODIGAM/GAMMA-W

SODIGAM and GAMMA-W are gamma-ray analysis software packages. They read in raw spectra, allow one to carry out the range of necessary calibrations and set up the nuclide library and photopeak files, and then analyze the spectra. SODIGAM is optimized for scintillation spectroscopy systems, e.g. an NaI(Tl) scintillator with a PMT, while GAMMA-W is optimized for the much higher energy resolution HPGe detectors. They are written by Westmeier GmbH (<http://www.westmeier.com/>) and require a security plug to run.

There are two main options when spawning the analysis software:

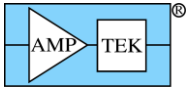
- Option (1) is used for routine analyses of spectra, after the system has been calibrated, the nuclide library has been configured, etc. All of the calibration, nuclide, and other data are stored in a "procedure" (.PRC) file. When you spawn the analysis software, you select the appropriate .PRC file and pass this to the analysis software. The analysis software then analyzes the spectrum and prepares a report.
- Option (2) is used when you are setting up the system, i.e. doing the energy calibration, efficiency calibration, etc to prepare a .PRC file.

Spawning SODIGAM/GAMMA-W from DPPMCA

To spawn SODIGAM or GAMMA-W, click on the icon which is shown circled below. For this icon to appear, you must have DPPMCA.EXE ver 1.0.0.15 or later and the .INI file must be renamed. The dialog box shown below then appears. There are several key parts of to this dialog.

The screenshot shows the Amptek DppMCA software interface. The main window displays a spectrum plot with energy in keV on the x-axis (ranging from 0 to 14.28) and count on the y-axis (ranging from 0 to 6000085). A red histogram shows the spectrum data. A dialog box titled "Run Gamma-W/Sodigam Spectrum Processing Program" is open in the foreground. The dialog has two main sections: "Run Analysis" and "Setup Program". In the "Run Analysis" section, there are radio buttons for "No Additional Arguments", "Attach Additional Arguments", and "Run Procedure". Below these are buttons for "Run Spectrum Processing Program" and "Tw". In the "Setup Program" section, there are fields for "Spectrum Processing Program" (C:\Projects_Unsupported\GammaGamma-W.Win\GammaGamma-W_Demo.EXE), "Filename" (137Cs), "Spectrum File Extension" (.spc), "DTS Format" (%Y%m%d_%H%M%S), "Processed Spectrum File Path" (C:\Projects_Unsupported\GammaGamma-W.Win\Spectra\137Cs_20140507_141325.spc), and "Please Select Spectrum File" (C:\Projects\DP5 Software\GammaGammaW\TestSpectra\GammaGammaW_Cal.mca). A circled icon in the top toolbar is labeled "Run". Callout boxes point to "Options", "Setup", "File", and "Select Procedure" within the dialog.

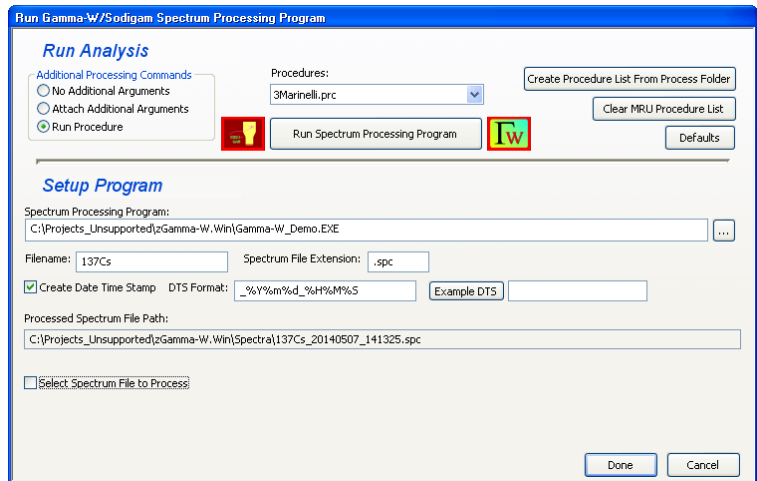
Parameter	Value
DP5 (s/n)	5472
Tag	live_data
Mode	MCA
Channels	1,024
LLD Thresh	1.66% FS
Fast Thresh	38
Peak Time	11.2uS
Gain	99.578x
Gain Delta	1.00
Preset Mode	None
Preset	
Accum Time	101,312.77
Real Time	101,330.88
Total Count	80,426,142
Input Count	82,042,978
Input Rate	809.86
Dead Time	1.98%
Start:	05/07/2014 14:11:51
Status:	acquiring
Peak Information:	
Centroid (G)	5.90
FWHM (G)	0.1445
Net Area	66,024,470
Uncertainty	0.01
Net Rate	664.85
Gross Area	67,128,606
Det. Temp	234K
Det. HV	-240V



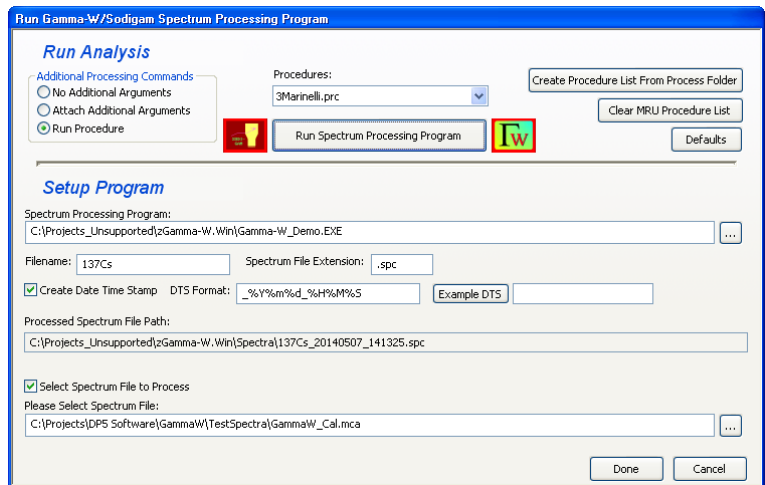
- RUN: When you have all the options set correctly, click this button to run the analysis software.
- OPTIONS: With this set of buttons, you can run a selected procedure (.PRC) file, as shown. To do this, you must first calibrate and configure the analysis software to prepare the .PRC file. You can also just pass the spectrum into the analysis software, by selecting the “No additional arguments” button. The “Additional Arguments” button lets one send additional arguments.
- SELECT PROCEDURE: This set of buttons lets you select the procedure. The “Create procedure list” will read the folder where .PRC files are stored and populate a list. Clicking the “Procedures” pulldown will show you the .PRF files in that folder (most recently used files are listed first). You can also clear the list or return to defaults, if desired.
- SETUP: The setup buttons allow one to change default parameters. For example, if the SODIGAM or GAMMA-W program was not installed in the default location, you can browse to the correct folder (this is where the files will be stored to transfer). By default, this transfer filename is a “base” name with an added date/time stamp. You can change the base name and the date/time options. When you have changed setup parameters, click “Done” to update the .INI file.
- FILE: If this box is checked, the software will open a stored .MCA file and pass it to SODIGAM or GAMMA-W rather than the “live” spectrum in DPPMCA. You must select the file to be processed.

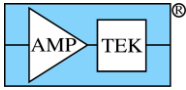
Examples

This dialog shows how to send the live spectrum to GAMMA-W and run the “3 Marinelli.PRC” procedure.

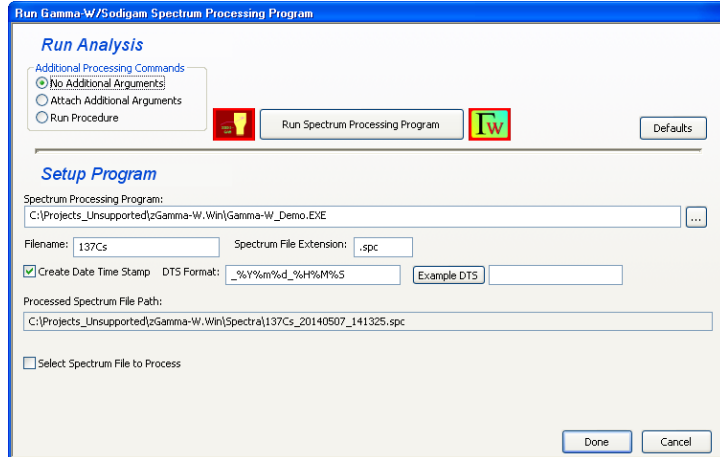


This dialog shows how to send a stored spectrum to GAMMA-W and run the “3 Marinelli.PRC” procedure.

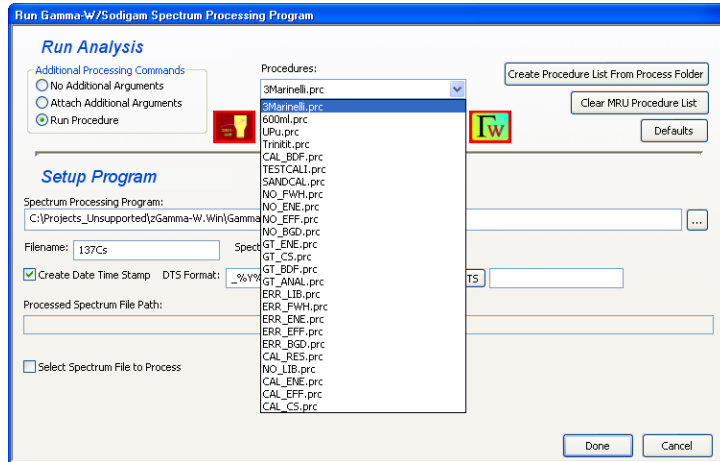




This dialog shows how to send the live spectrum to GAMMA-W without a procedure, e.g. to run an efficiency calibration.

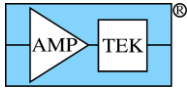


This dialog shows how to select a procedure from the procedure list.



2) Getting Started

- 1) Setup and install the digital processor and the DPPMCAs acquisition software using the product's "Quick Start" guide. These guides are provided with each product and are on Amptek's website and also on the installation CD provided with the processor.
- 2) After installing the software, in the directory with DPPMCA.EXE you will find a file named "_GammW_DppMCA.INI". Edit the filename to remove the underscore.
- 3) Turn on the processor, launch DPPMCA, connect to the system, and verify that it is functioning properly. Optimize the configuration for your application and calibrate the energy scale. Then close DPPMCA and turn off the hardware.
- 4) Download the gamma-ray analysis software from <http://www.westmeier.com/>. Note that scintillation detectors use the SODIGAM program while HPGc detectors use the GAMMA-W program.
 - a. You will download a ZIP file from the website. Open the ZIP file and copy the contents into a folder on your computer. You may make a shortcut on your desktop to the .EXE file.
 - b. Download also the driver for the security plug, unzip these files, and follow the enclosed directions.



- c. Install the security plug into an available USB port.
- 5) Open the SODIGAM or GAMMA-W program. We recommend working through the demonstration examples which are supplied, referring to the "Quick Guide" which is in the documentation folder. When finished, close the program.
- 6) Turn the processor back on, open DPPMCA, and acquire a spectrum for calibration.
- 7) Click the "SODIGAM/GAMMA-W" icon on the toolbar.
 - a. In the dialog box, choose the proper file locations (wherever you installed the analysis software).
 - b. The software uses default file names for the transfer spectrum: the file is given a "base" name and then a time and date tag is added. You may change this.
 - c. If you have defined procedure files, then select the proper procedure file. You must calibrate the system before creating procedure files.
 - d. Click on the "Run" button.
- 8) The analysis software package will open with the spectrum from DPPMCA. You can now carry out calibrations, analyses, etc. as discussed in the SODIGAM/GAMMA-W documentation.
- 9) When you are finished in SODIGAM/GAMMA-W, first close this program, then close the spawning dialog, and then you can use DPPMCA. It cannot be used to acquire more data when the daughter processes are running.

3) Documentation

Amptek's hardware (TB-5, PX5-HPGe, etc) is supplied with Quick Start Guides, User Manuals, Application Notes, and other documentation. This is on the installation CD and on the Amptek website. If you have questions on the hardware, please refer to these and contact Amptek technical support if you cannot find the answers.

The DPPMCA software has a "Help" file with much information about the software and about the hardware configuration options. There is also documentation on the installation CD, including installation instructions and a programmer's guide. If you have questions on the DPPMCA software, please refer to these and contact Amptek technical support if you cannot find the answers.

The SODIGAM/GAMMA-W software package comes with some example files and a "Quick Guide" that walks one through sample calibrations and analysis. We strongly recommend that users refer to this document. If you have any questions about the analysis software or procedures, contact Westmeier GmbH directly.

<http://www.amptek.com/>

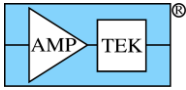
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4) Understanding the analysis software flow

The flow chart to the right illustrates how the analysis software processes the data. The raw spectrum is acquired from the spectrometer hardware (e.g. an HPGe detector with a PX5 processor, an NaI(Tl) scintillator with PMT and TB-5, a Gamma-Rad5, etc) using Amptek's DPPMCA software. This software transfers the spectrum to the analysis software (GAMMA-W for HPGe detectors and SODIGAM for scintillators).

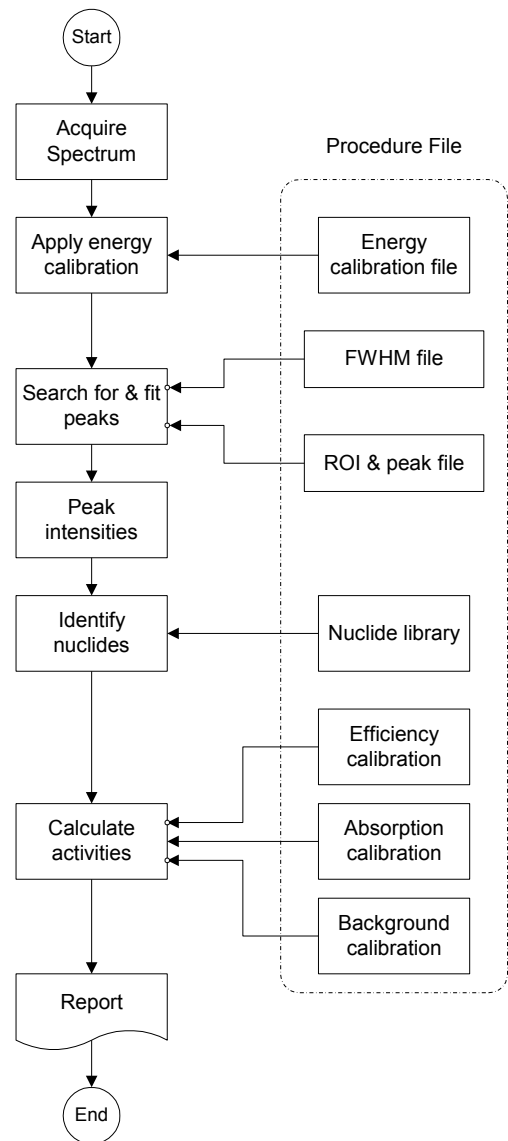
The analysis software first applies the predetermined energy calibration. The software then searches for photopeaks which have been chosen, in predetermined regions of interest, and fits those peaks, based on a response arising from the calibrations. This gives the photopeak intensities.

From these, the software identifies the nuclides present, accounts for background, accounts for the efficiency as a function of energy (from a prior calibration), and finally yields the activities of the radioisotopes which are present. This is given in a report, the final output.

Setting up the system

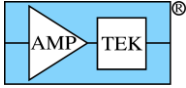
To carry out this analysis, the system must be configured and calibrated. There are three key steps:

- 1) Set up and configure the radiation detector, signal processing hardware, and data acquisition and control software. One can then acquire a spectrum.
- 2) Calibrate the system. In general, one should calibrate the energy scale, measure the energy resolution as a function of energy, calibrate the photopeak efficiency as a function of energy, and measure the background radiation spectrum. It is possible to use default values but the accuracy of the results is directly related to the accuracy of the calibrations.
- 3) Select the isotopes to be analyzed, along with the gamma-ray lines and regions of interest which will be used for each isotope. There are 1500 radioisotopes in the analysis library, each with dozens of emission lines. If one were to try to compare all the isotopes and lines in the library to a given sample, the problem is poorly constrained and will not give a useful answer. The user must select a subset of the isotopes which are expected in the sample, and for these must select the lines to be analyzed and their regions of interest (ROIs)



You should use a calibration source with at least five strong photopeaks of known energy and intensity which are widely separated in energy and span the energy range of interest. Further, the photopeak efficiency depends strongly on the sample to detector geometry. Calibration data must be taken under the same conditions as the samples; if the sample is in a beaker, put the calibration source in a beaker at the same distance from the detector.

- 3) Select the isotopes to be analyzed, along with the gamma-ray lines and regions of interest which will be used for each isotope. There are 1500 radioisotopes in the analysis library, each with dozens of emission lines. If one were to try to compare all the isotopes and lines in the library to a given sample, the problem is poorly constrained and will not give a useful answer. The user must select a subset of the isotopes which are expected in the sample, and for these must select the lines to be analyzed and their regions of interest (ROIs)



- 4) Prepare a procedure file (.PRC), a file which lists all the critical data: the energy calibration file, the efficiency calibration file, the nuclide library file, the photopeak file, and so on. A single spectrometer will typically have several procedure files, with different nuclide libraries (for different samples) or different efficiency calibrations (for different source geometries).

Analyzing spectra

Once all the necessary calibrations have been generated and the project files prepared, analyzing samples is straightforward.

- 1) Place the sample in front of the detector, in the same location as the calibration source, and acquire the spectrum using DPPMCA.
- 2) In DPPMCA, click the "SODIGAM/GAMMA-W" icon. In the dialog that appears, select the proper .PRC procedure file, then "Run".
- 3) This spawns the analysis software and loads the calibration files. Check that the values are correct and click "Start".
- 4) The analysis results are written to a text file, which is opened and can be printed.

Background on gamma-ray analysis

For those new to gamma-ray spectroscopy, a classic textbook is

*G. Gilmore, **Practical Gamma-ray Spectroscopy**, 2nd edition, Wiley, 2008.*

Some online resources include:

<http://nsspi.tamu.edu/nsep/courses/basic-radiation-detection/gamma-ray-spectroscopy/introduction/introduction>

http://www.phys.ufl.edu/courses/phy4803L/group_1/gamma_spec/gamspec.pdf

<http://www.cnstn.rnrt.tn/afra-ict/NAT/gamma/html/Gamma%20Spec%20V1.pdf>