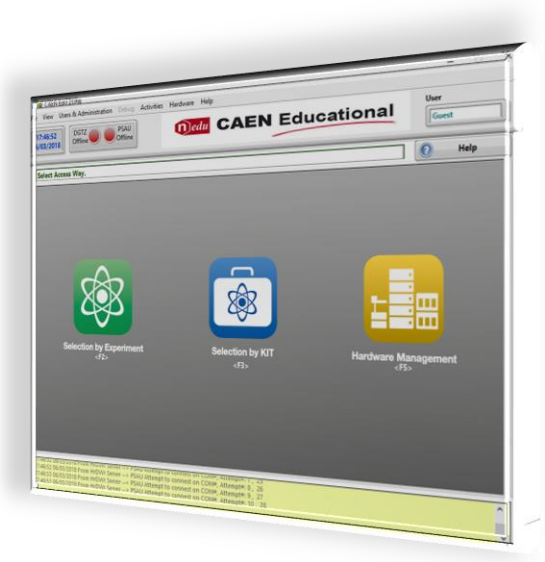
Rev. 0 - March 1st, 2021

HERA

HERA - Handy Educational Radiation Application Software Suite for CAEN Educational Kits



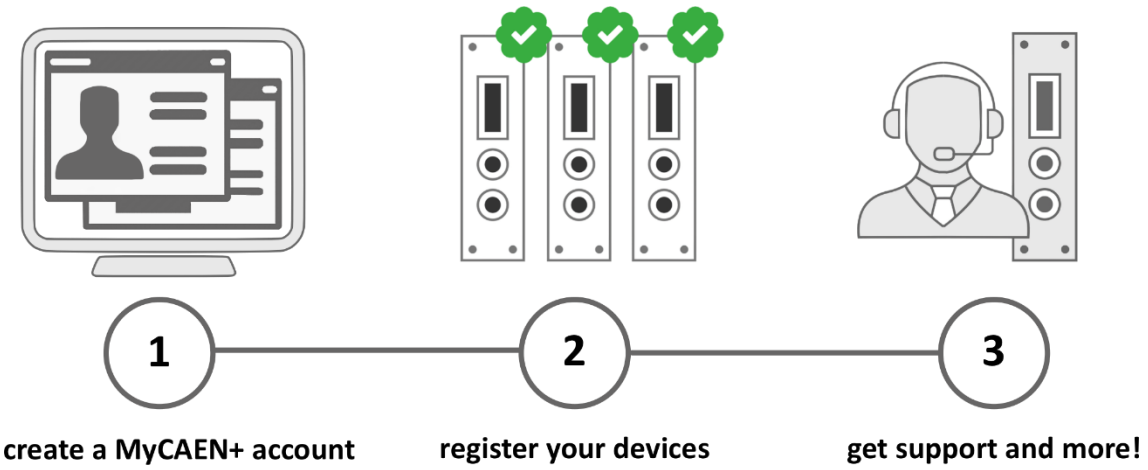
CAEN Educational

User Manual
GD7947

Register your device

Register your device to your **MyCAEN+** account and get access to our customer services, such as notification for new firmware or software upgrade, tracking service procedures or open a ticket for assistance. **MyCAEN+** accounts have a dedicated support service for their registered products. A set of basic information can be shared with the operator, speeding up the troubleshooting process and improving the efficiency of the support interactions.

MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



https://www.caen.it/become-mycaenplus-user/

Purpose of this Guide

This document is the HERA User Guide. It contains information about the compatibility with CAEN Educational Kits, the installation of the software, its main functions, and a brief description of the GUI.

Change Document Record

Date	Revision	Changes
March 1st, 2021	00	Initial release

Symbols, Abbreviated Terms and Notation

DPP	Digital Pulse Processing
OS	Operating System
PSAU	Power Supply & Amplification Unit
DGTZ	Digitizer
GUI	Graphical User Interface
DC	Direct Current

Reference Documents

[RD1] GD2783 - First Installation Guide to Desktop Digitizers & MCA

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

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1. Introduction

CAEN brings the experience acquired in more than 40 years of collaboration with the High Energy & Nuclear Physics community into the University educational laboratories.

CAEN realized different modular Educational Kits, mainly based on Silicon Photomultipliers (SiPM) state of-the-art sensor of light. Thanks to the most advanced instrumentation developed by CAEN for the major experiments Worldwide, together with the University teaching experience at the University of Insubria (IT), a series of experiments covering several applications has been carried out.

HERA (Handy Educational Radiation Application) is a user-friendly software developed by CAEN to make the educational product complete in every perspective. HERA allows the user to manage almost all CAEN Educational kits indeed (see **Tab. 1.1**).

The software represents a modern and flexible platform for teaching the fundamentals of Statistics, Particles Detection, and Nuclear Imaging thanks to the simple graphical interfaces and the embedded documentation.

The initial access multiplicity makes the software very flexible and suitable both for expert users as well as for beginner ones. With a simple selection, the user can decide how to execute the activity by choosing the direct access to the suggested experiments or access to devices management.

In the first case, a complete experiments suite with different difficulty levels, from basic experiments to more complex applications, is provided and the data analysis is supported by advanced tools implemented in the software itself. These tools can be enabled or disabled structuring the experiment depending on the user level. With this approach, the experiments proposed can be performed at high school level (grade 11, 12) science classes up to undergraduate physics laboratory, PhD courses and training courses. The main goal is to inspire users and guide them towards the analysis and comprehension of different physics phenomena with a series of experiments based on state-of-the art technologies, instruments, and methods.

In the second case, the user can manage all the parameters of both the Power Supply & Amplification Unit and the Digitizer. In few easy steps, the user can control the SiPM bias voltage and the signal gain and modify the thresholds and the digital outputs. In a dedicated window, the digitized signals can be monitored for real-time fine-tuning of the setup. Energy Spectra, Charge vs time, Counting, Staircase plots, and Waveforms are also displayed together with the possibility to save the data to file for further analysis.

An interesting summary of the HERA features classified according to the type of user is the following:

- **Beginner Users**
  - A wide range of experiments covering Nuclear and Particle Physics fields: From the radioactive decays (β and γ) to the cosmic rays, from the light quanta to the advanced statistics.
  - Frame and Pre-setting for Each Experiment.
  - Data Saving & Analysis Tools.
  - Data can be retrieved offline for additional analysis.
  - Embedded Step-by-step guides.
- **Intermediate Users**
  - Full access to hardware management.
  - Access to Experiments Frame covering Nuclear and Particle Physics fields.
  - Pre-setting for Each Experiment.
  - Data Saving.
  - Embedded Help.
- **Expert Users**
  - Full control of the Power Supply & Amplification Unit: Bias Voltage and active feedback in temperature, Gain, Thresholds, Digital Output Width, two channels coincidence.
  - Full control of the Digitizer settings: Gate, Baseline, Trigger.
  - 6 plot tabs available: Waveform, Histogram, Charge Vs. Time, Two Channels Histogram, Frequency Scan, Counting.
  - Data saving in two formats: ASCII, Binary.
  - Embedded Help.

Supported Educational Kits		
Code	**Description**	**Picture**
WK5600XEAAAA	SP5600E - Educational Photon kit	
WK5600XDAAAA	SP5600D - Educational Beta kit	
WSP5609XAAA	SP5600C - Educational Gamma kit	
WK5600XANAAA	SP5600AN - Educational Premium kit	

Tab. 1.1: Table of the CAEN Educational Kits supported by HERA.

2. Requirements & Installation

The HERA software, LabVIEW™ based, is compliant with Windows 7, 8 and 10 OS, both 32 and 64 bit.

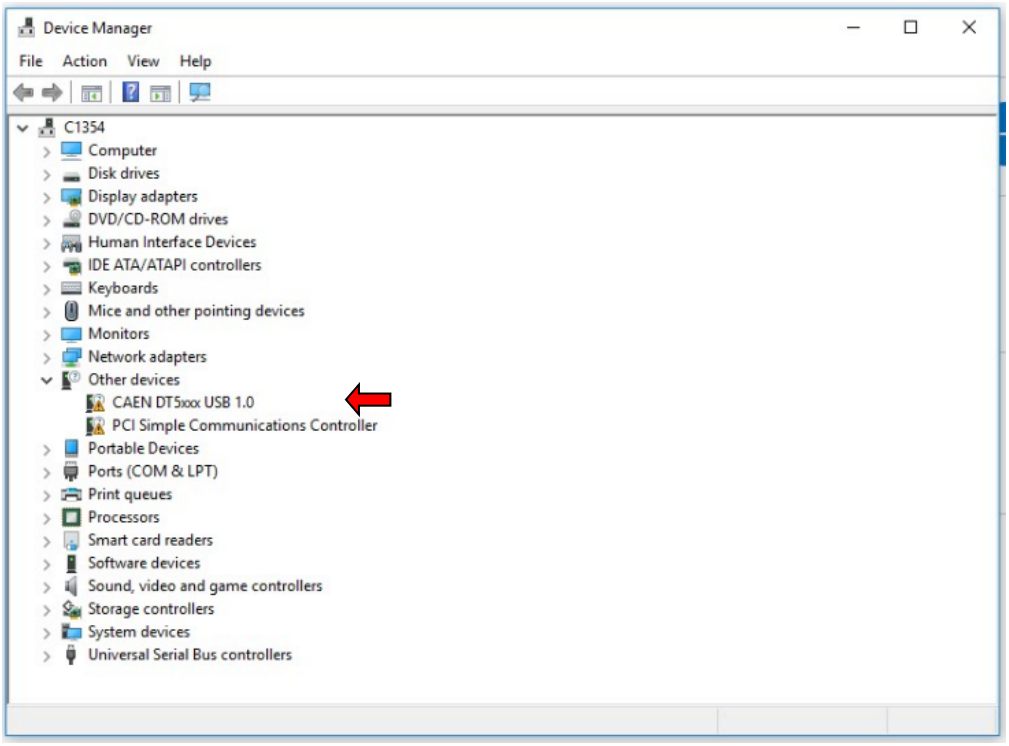
Requirements

OS	Hardware	CAEN drivers required
Microsoft Windows 10 (64-bit)	2 available USB2.0 ports	DT5720 USB driver (32/64-bit) SP5600 USB driver (32/64-bit)

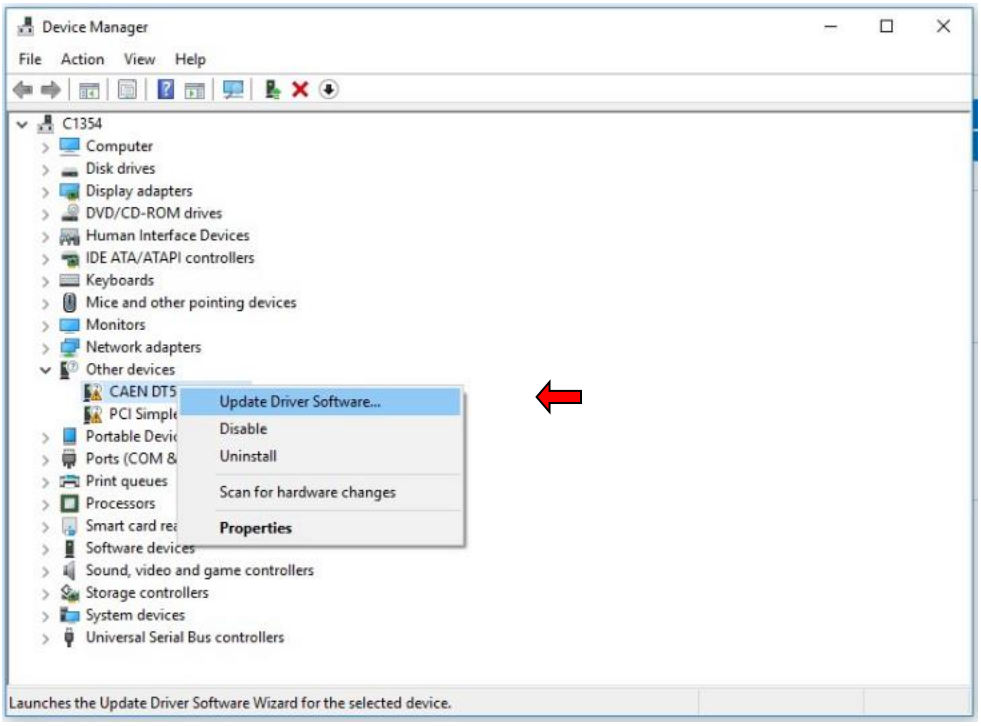
Tab. 2.1: Host PC requirements.

- Download the USB drivers for both DT5720 and SP5600 compliant to the Windows version (32 or 64-bit) on CAEN website: Educational kit webpage > "Download" > "Software" tab > Driver section (login is required before the download).
- **Install the DT5720 drivers** following the instruction of the setup wizard. The OS will automatically recognize the DT5720 when it is connected to the PC. If the automatic installation fails, perform it manually from the Device Manager by selecting the driver update and pointing to the driver folder you downloaded from CAEN website.

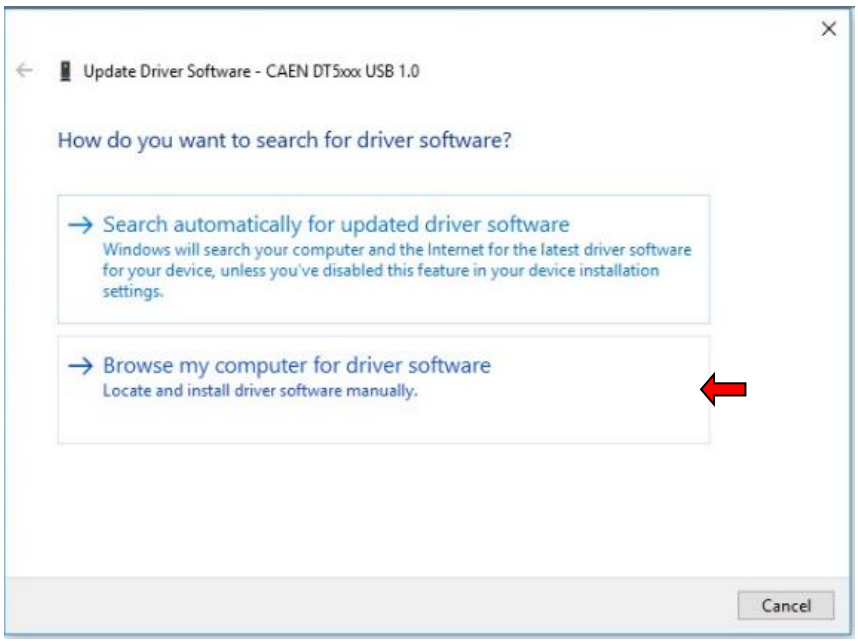
  For example (Windows 10 – 64bit), once connected and powered on the digitizer, you can do it going to Control Panel -> System & Security -> System -> Device Manager. In the Device Manager window, find the unknown **CAEN DT5xxx USB 1.0** in the list **Other Devices**:



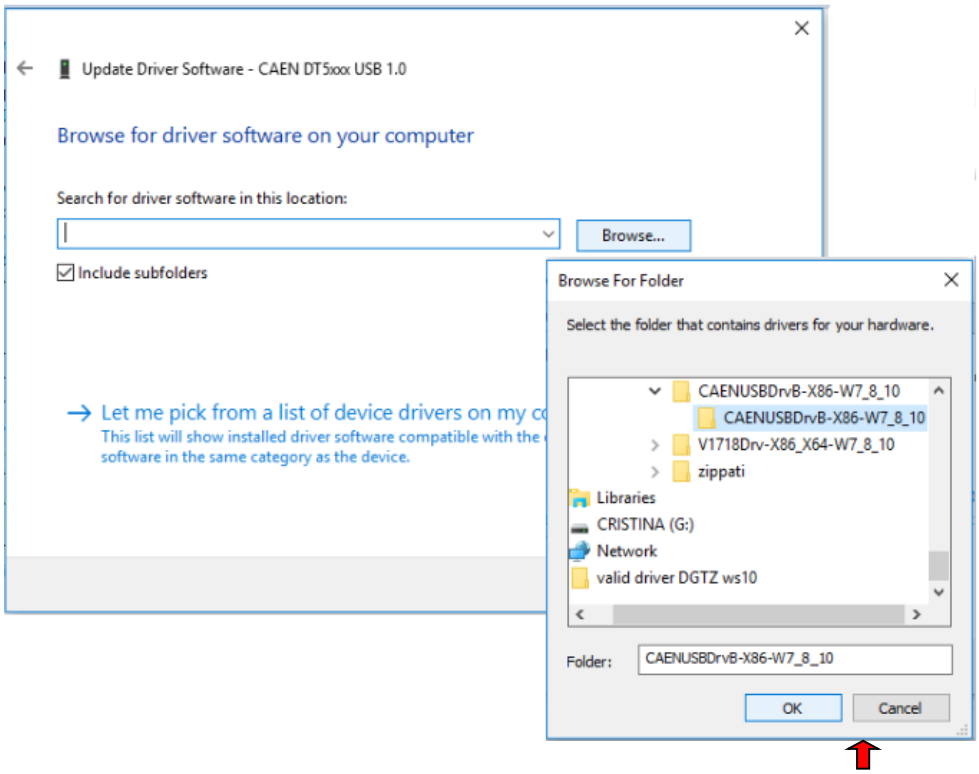
Right click on **CAEN DT5xxx USB 1.0** and select **Update Driver Software** option in the scroll menu.



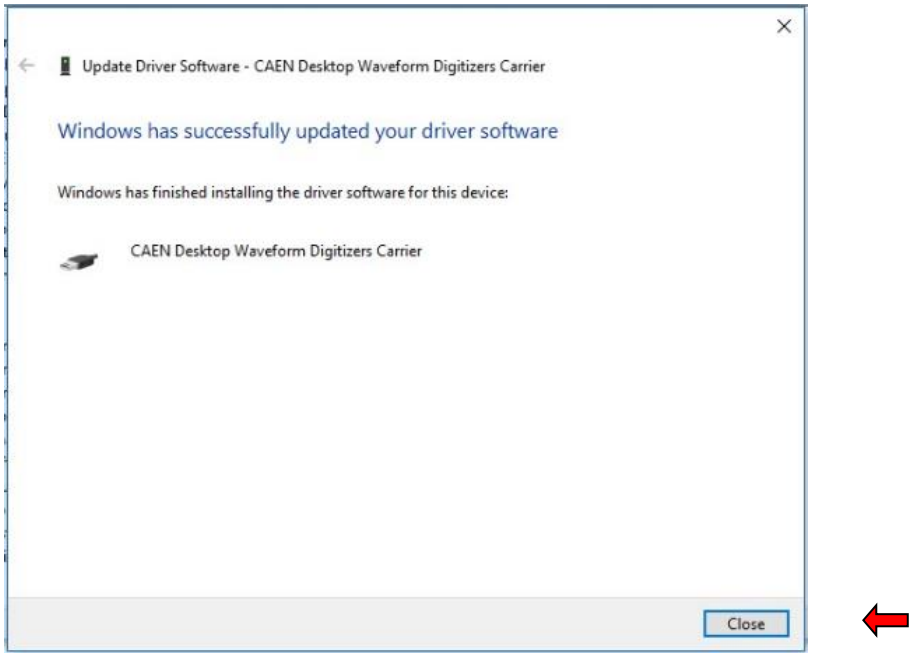
Select **Browse My Computer for driver software**.



Click **[Browse]** to point to the Windows drivers' folder you have previously unpacked, click **[OK]** to include the path in the search and click **[Next]** to continue.



When the driver installation will be completed, click **Close** to close the window.

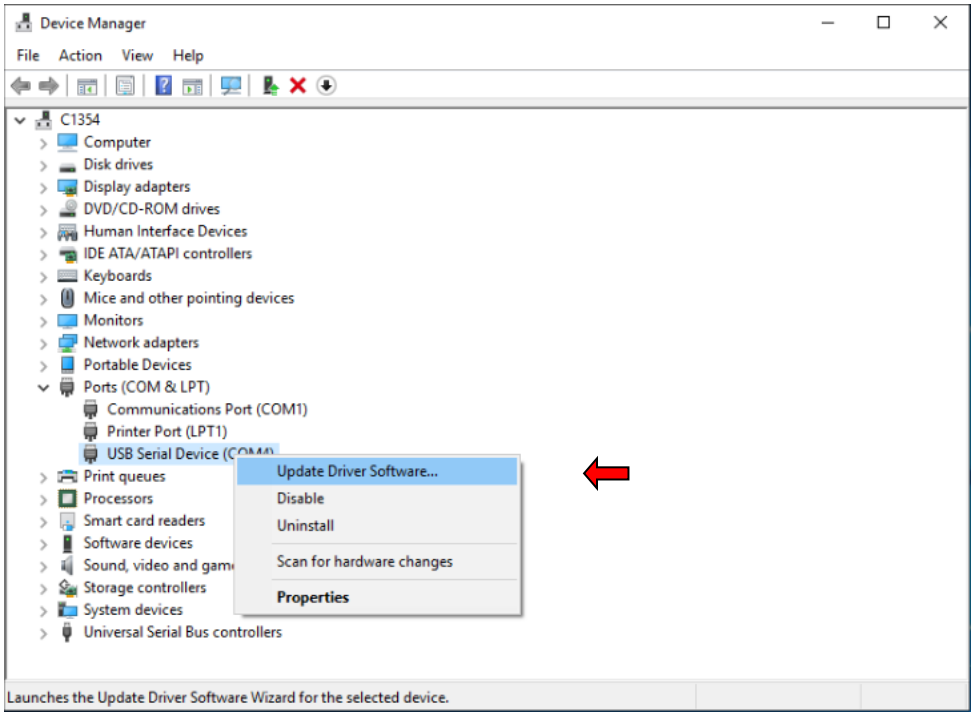


Refer to [RD1] for detailed installation OS-dependent.

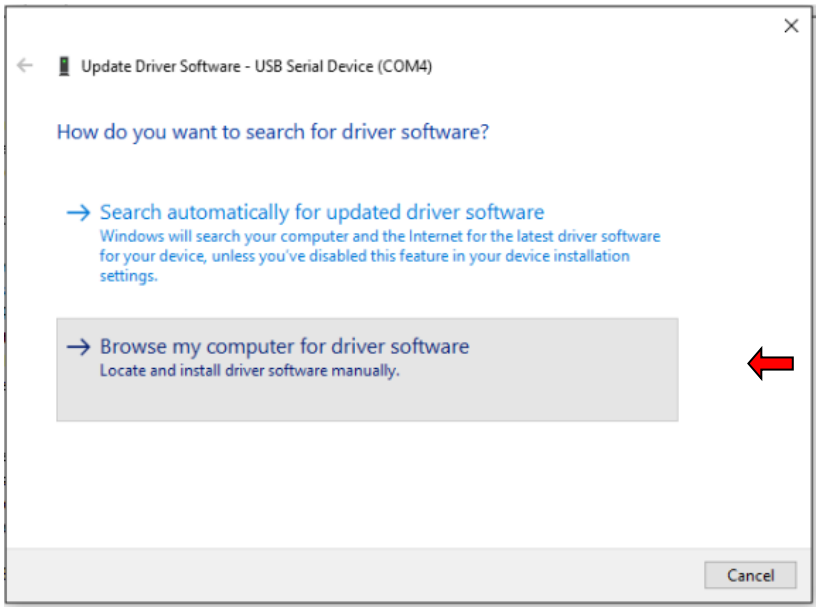
- Connect to the PC and power ON the **SP5600**; the PC will recognize as a new peripheral by the OS. Perform the driver installation manually from the Device Manager by selecting the driver update and pointing to the driver folder you downloaded from CAEN website. Finally, a COMM port will be associated to SP5600.

  For example (Windows 10 – 64bit), once connected and powered on the SP5600, you can follow the previous instructions going to Control Panel -> System & Security -> System -> Device Manager -> Controller USB [Ports (COM)] Manager.

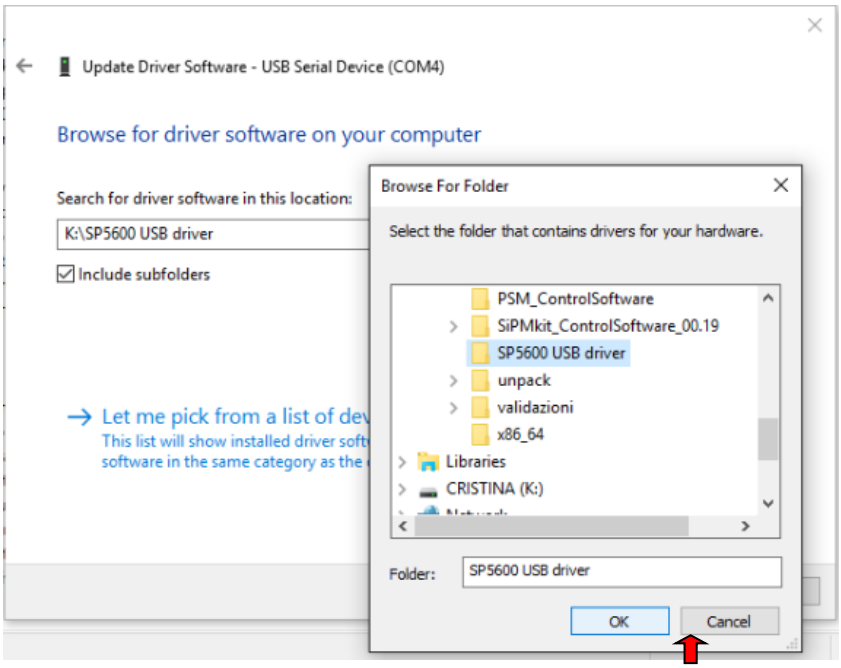
Right click on **USB Serial Device** and select **Update Driver** Software option in the scroll menu.



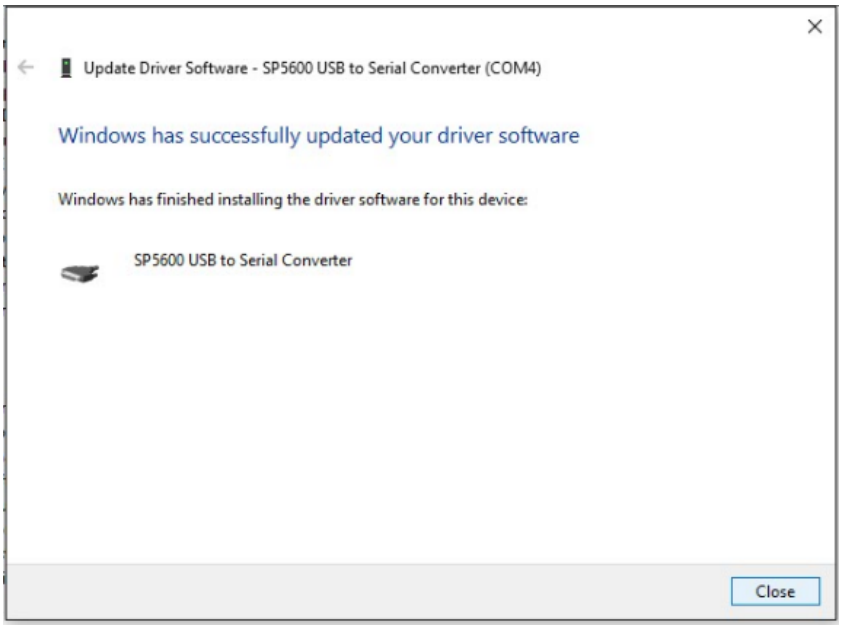
Select **Browse My Computer for driver software**.



Click **[Browse]** to point to the Windows drivers' folder you have previously unpacked, click **[OK]** to include the path in the search and click **[Next]** to continue.



When the driver installation will be completed, click **Close** to close the window.



Finally, a COM port will be associated to SP5600; please check the port number as shown in **Fig. 2.1**.

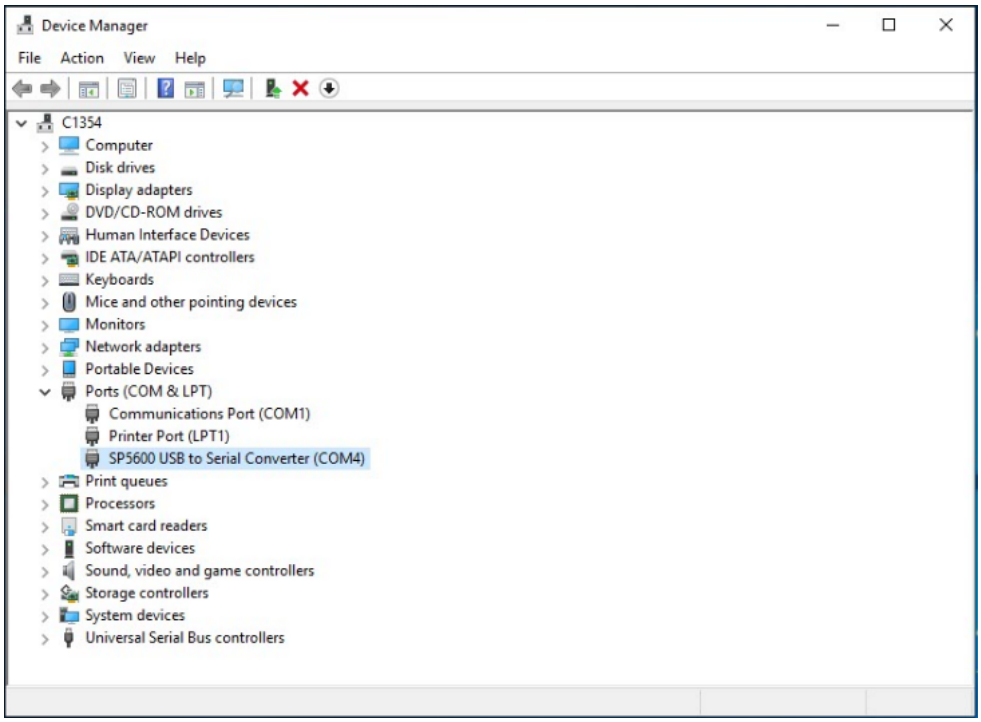


Fig. 2.1: Tracking the PSAU port assignment on a PC running Windows 10.

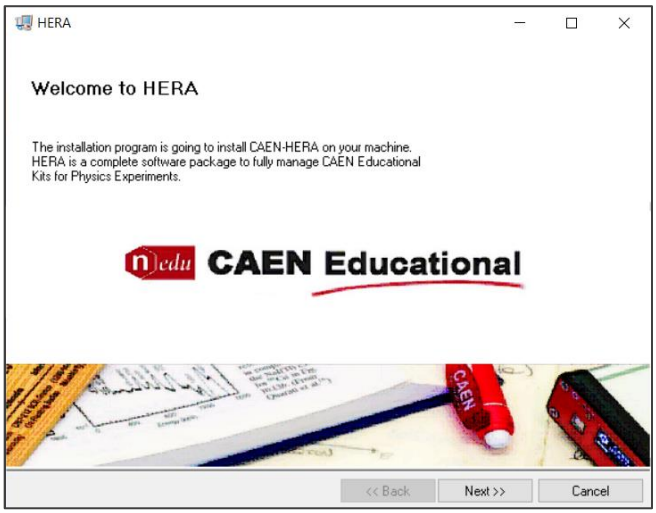
Important Note: HERA rel. 1.0.0 Build: 1.5.21.0103 or higher:

- does not require LabVIEW™ Run-Time Engine. or LabView™ version 2018 (or higher). The installation of LabVIEW™ Run-Time Engine 2018 is already implemented in the HERA.
- does not work with a digitizer USB Driver release < 3.4.7, if running in a 32-bit Windows environment.

Software Installation

Download the standalone HERA Software revision **1.0.0 - Build: 1.5.21.0103** full installation package on CAEN website: Educational kit webpage > "Download" > "Software" tab > Application SW section (login is required before the download).

Unpack the installation package, login as administrator, launch the setup file, and complete the Installation wizard.



The setup automatically creates a link on the PC Desktop.

3. Software Description

When the installation procedure has been completed, the user can run the program by clicking the correspondent icon.

The opening window is shown in **Fig. 3.1**. Via this main GUI, it is possible to visualize the devices status, server messages and, last but not least, to access to data (log file, data stored, configuration files, etc.).

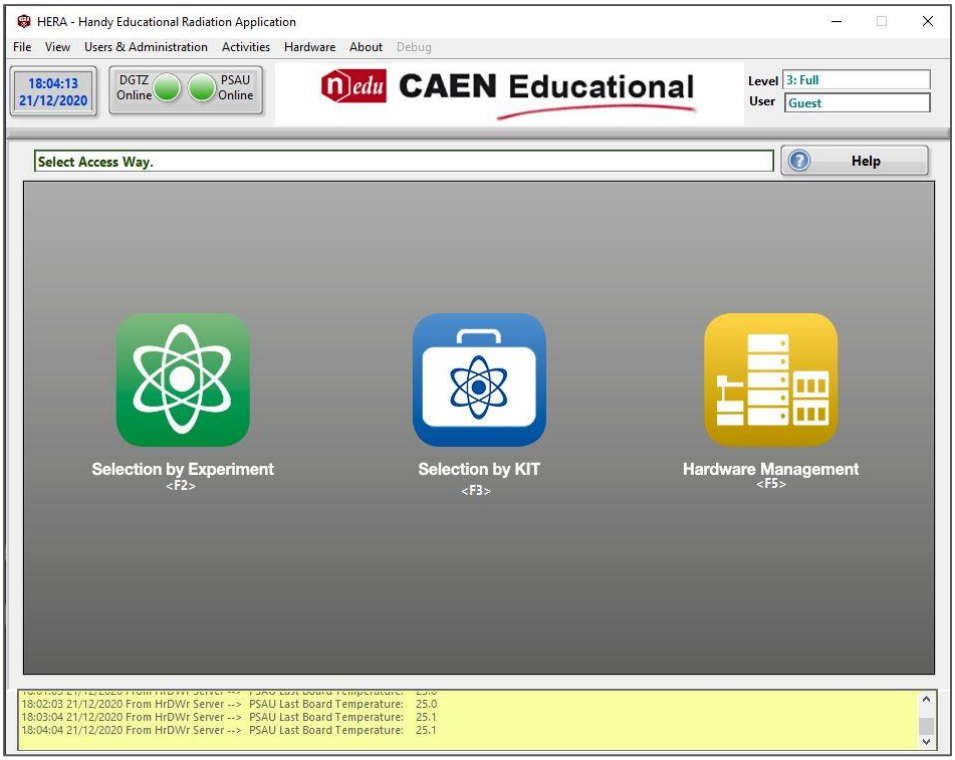


Fig. 3.1: Main GUI of the HERA software.

Before running the software, the user should wait the hardware connection. The software recognises the hardware automatically and start the connection. Two connection indicators, "Online Hardware", are present on the opening window:

- **Green light** means that the connection is ok.
- **Red light** means that there is no connection.
  If the PSAU is power on, but the light colour is red, the software can be forced to search for a new connection via the rescanning procedure from the Verbose Menu: Hardware-> PSAU Server Scanning -> Restart Scanning.
- **Yellow light** means that either the DGTZ is not a DT5720A/C, or its firmware is not compliant with Hera software, and another firmware type is probably running on the board.

The special firmware compatible with HERA Software is the Digital Pulse processing for Charge Integration for SiPM Kit (DPP-CI for SiPM) for DT5720A and the Digital Pulse Processing for Charge Integration and Pulse Shape Discrimination (DPP-PSD) for DT5720C [COMING SOON]. The firmware can be download from CAEN Website. Without any licenses, it will run in a 30-minute-per-power-cycle fully functional trial version.

To upload the firmware on the digitizer, use the CAENUpgrader Software (free download on CAEN Website): https://www.caen.it/products/caenupgrader/

The Main GUI clearly shows that several ways of operative openings are available:

- "**Selection by Experiment**": access to experiments frame covering Nuclear and Particle Physics fields.
- "**Selection by Kit**": access to operative options allowed by the educational kit in use.
- "**Hardware Management**": direct access to the management of the device parameters and data readout.

The chosen option can be run by double clicking on the relative box or by selecting it and then by the press on the "Select" button.

The user can easily access to the GUI description via the “Help” button. Each window of the software is equipped with a dedicated “Help” button that must be closed before starting any activity.

Two points in particular deserve to be mentioned: Software Access Mode and Detector Safety.

Software Access Mode

Three access levels to the software are implemented and are available through the “Limit Access…” selection in the drop-down menu. The first one, “Level 1”, just gives access to the Hardware Management. The second one, “Level 2”, allows the user to access the Hardware Management and the guided procedures to perform the experiments listed in the CAEN Educational Handbook. This access level does not include analysis tools. The third one, “Level 3”, gives full access to all software functionalities and all the analysis tools are included.
The initial option, “Selection by Kit”, is accessible by all the three access levels.

The user needs the Master Password to change the access mode. The Password is unique, not changeable, and not declared in the embedded Help to give this type of modification power to the tutors only.

This functionality allows to the tutors deciding what each user can access and therefore, structuring the courses depending on the course attendee levels.

The Master Password is the build of the HERA release in use. The build is displayed in the "About HERA" window via the about label in the GUI verbose menu.

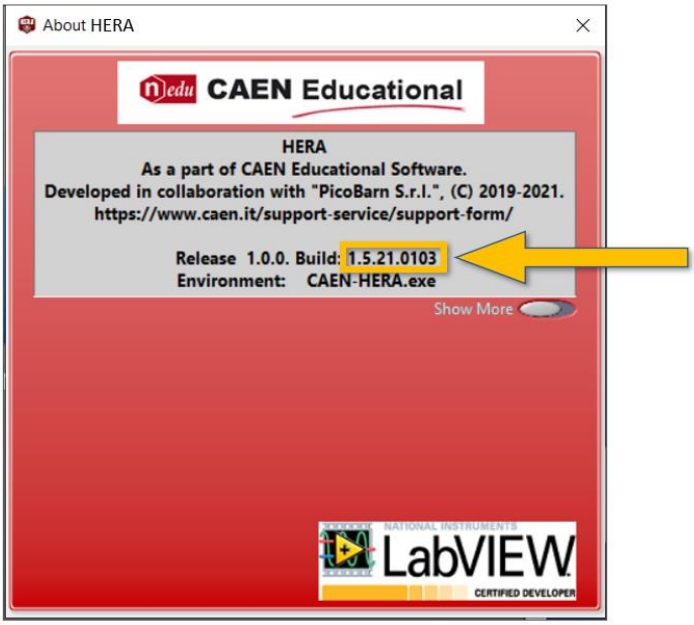


Fig. 3.2: About window.

Detector Safety

The Bias Voltage Limits can be modified from the main window of the GUI only, before selecting the experiment or hardware. The user can set the detector safety condition via the “Hardware” drop-down menu.
This functionality is very important for preventing action related to the possible detectors damaging.

The SP5600 module houses two detectors (SiPM). The module provides independent bias voltages (up to 130 V) to the sensors with gain stabilization. The user can apply a safety measure to prevent detector damage due to a wrong and too high bias voltage. Via “Safety and Serial Number Setting…” selection, the user can set the recommended operating voltage for each channel and, discretionary, the serial number to identify the detector itself. The software stabilizes the maximum value of bias voltage that can be applied to the sensor as a percentage (2,5%) of the operating one. To change the voltage limit is requested to modify the value in the “Bias Setting window” (see **Fig. 3.3**).

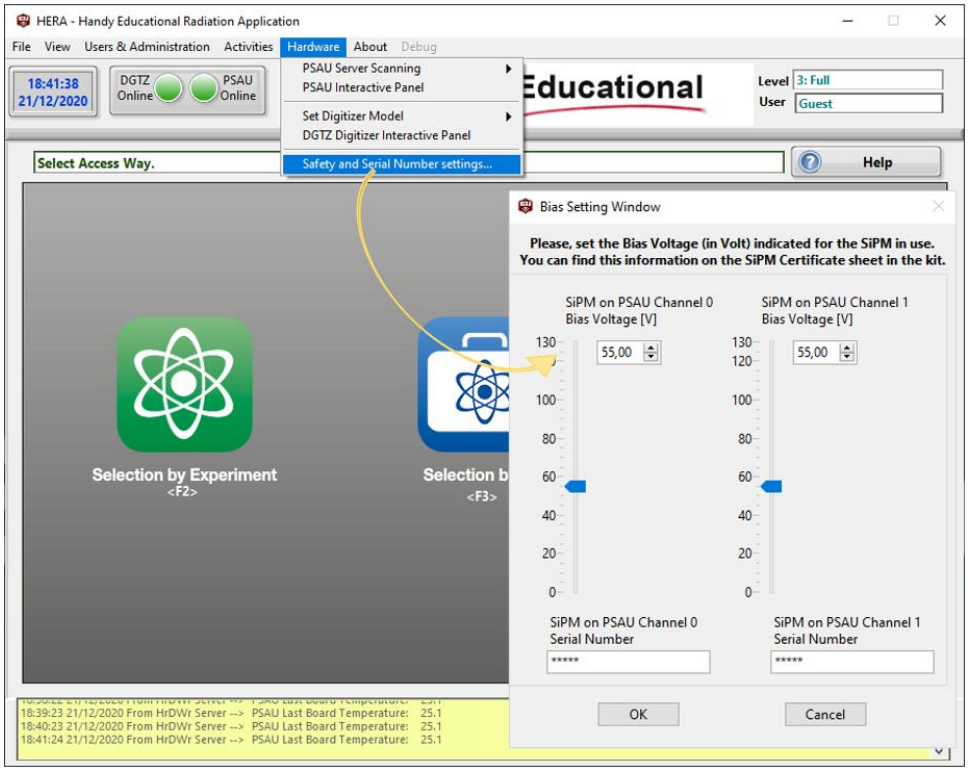


Fig. 3.3: Bias Setting Window.

Selection by Experiment

This option allows the user to access the experiment menu listed in the CAEN Educational Handbook.

By selecting the Physics topic of interest, a series of experiments can be performed. The software programs a predefined settings of the devices and gives a detailed guide into the “Help” button.

The option “Selection by Experiment” can be run by double click on the relative icon or by selecting it and then by pressing the “Select” button.

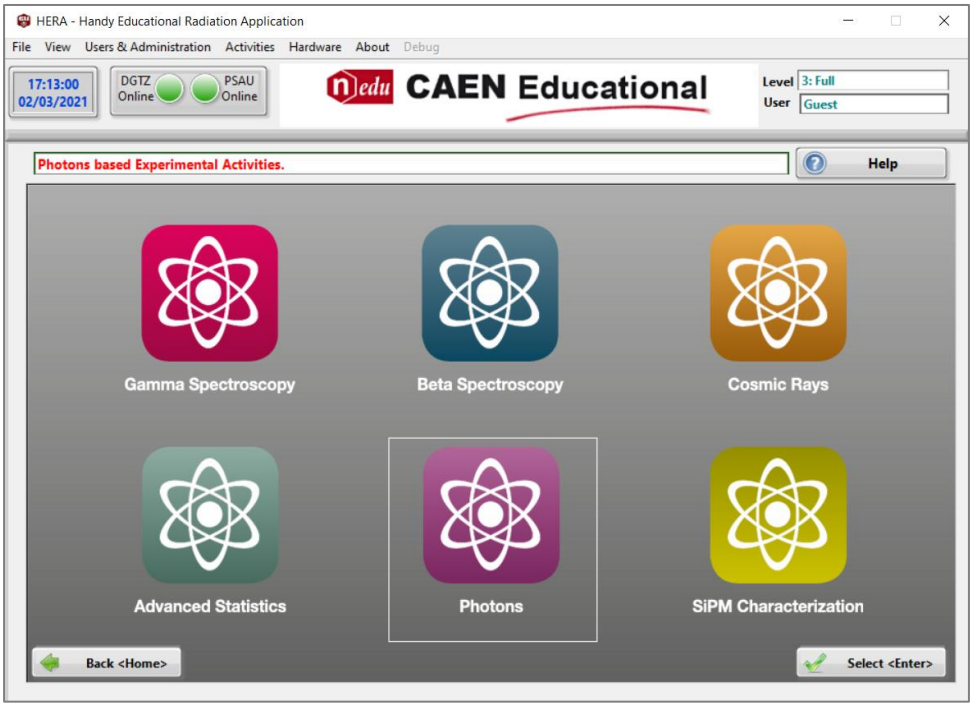


Fig. 3.4: Selection by Experiment.

The “Help” button is present in all the windows in use and provides guides and advices about the experimental procedures.

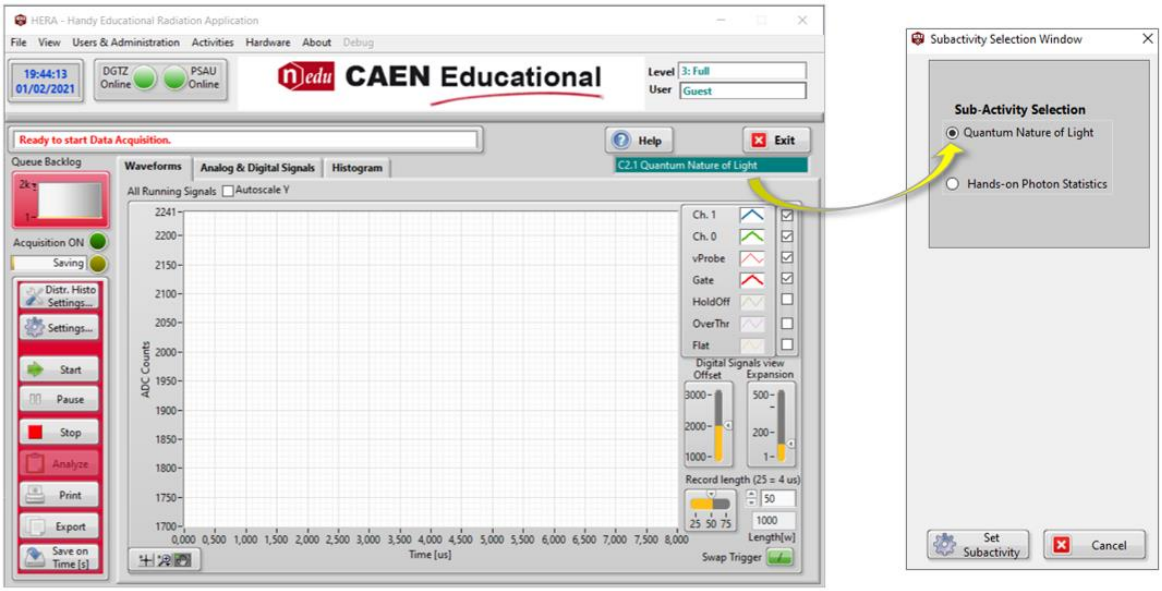


Fig. 3.5: Example of experimental activity.

Selection by Kit

This option allows the user to access the experiment menu listed in the CAEN Educational Handbook.

By selecting the Physics topic of interest, a series of experiments can be performed. The software programs a predefined settings of the devices and gives a detailed guide into the “Help” button.

The option “Selection by Experiment” can be run by double click on the relative icon or by selecting it and then by pressing the “Select” button.

The “Help” button is present in all the windows in use and provides guides and advices about the experimental procedures.

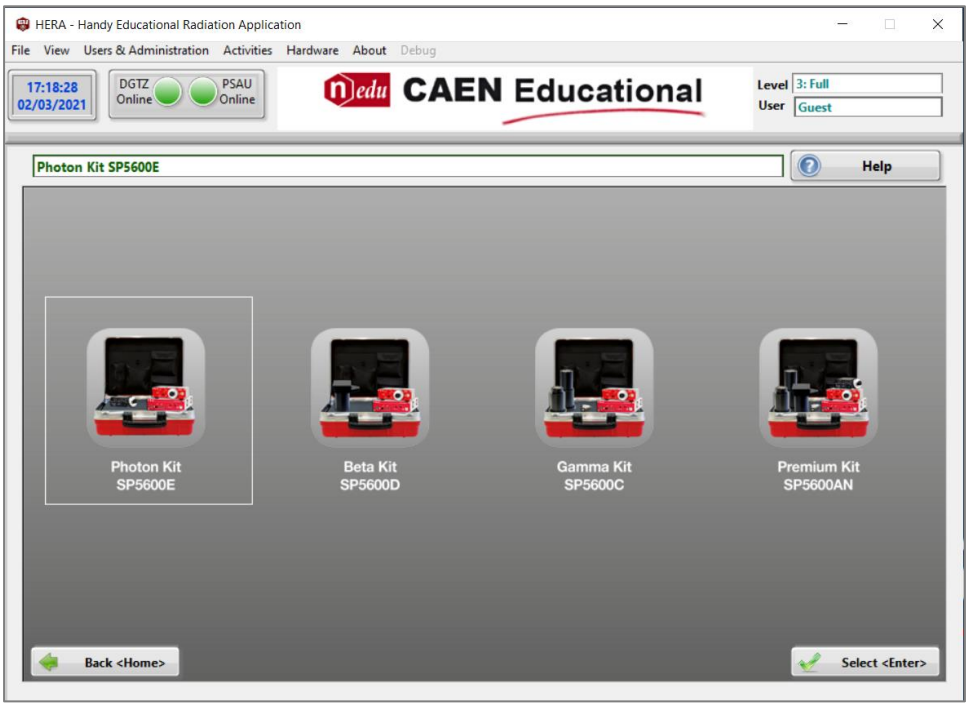


Fig. 3.6: HERA: Selection by kit.

Hardware Management

The main units of the Educational kit, which are common among all the systems, are:

- Power Supply and Amplification Unit (PSAU) - SP5600
- Desktop Digitizer (DGTZ) - DT5720A

The “Hardware Management” section allows the user to manage all the parameters of both PSAU and DGTZ giving the highest flexibility in the operating modes.

With few easy steps, the setting of bias voltage, gain, thresholds, and digital outputs are possible. The digitized signals can be monitored for a real-time fine-tuning of the set-up. Energy spectra, trends of the charge as a function of the time, signal frequency versus threshold, and frequency counting are also displayed in the visualization tabs of the main GUI.

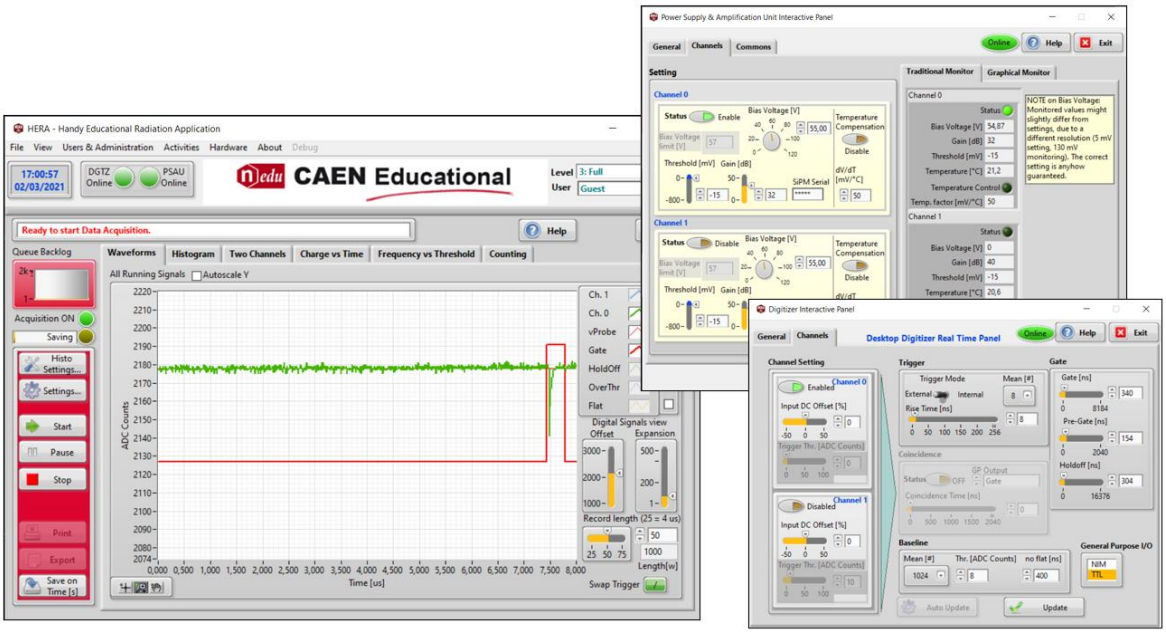


Fig. 3.7: Hardware Management.

Plots and data can be saved on file for the offline analysis processes.

The details about PSAU and DGTZ are present in the Help associated with their management window.

Data Storage

The HERA system allows the user to save data in several ways:

- Save data during the run (streaming mode).
- Save the data for an offline run (snapshot mode).
- Save an image.
- Export data in Excel.

The generation of the files due to the experimental activity deserves a dedicated discussion and it is referred to the step-by-step guides of each experiment.
All directories and files are generated under the following path: *C:\ProgramData\HERA\UserName* .
Where *UserName* is the name of the logged user. If no specific username is chosen, the default name used is “Guest”.
The list of the directories created by the HERA system during Hardware Management usage is the following:

- PSAU Temperatures
- Waveform
- Histograms

- Charge-Time
- TDMS

HERA generates several file formats: ASCII (.txt), binary (.dat), and another special file format of Labview (.TDMS) format. National Instruments defined a new flexible technical data management (TDM) data model, which is accessible through LabVIEW, LabWindows™/CVI™, Measurement Studio, SignalExpress, and DIAdem.
The TDMS file format saves both the raw data and the metadata in the binary format in one file with the .TDMS extension. When creating or opening a .TDMS file, HERA automatically creates a .TDMS_index file, used to speed up random access to the .TDMS file.
The .TDMS files can be open via a simple Add-In for Microsoft Excel (https://www.ni.com/example/27944/en/) or by using the "Convert data files (.TDMS)" in the File Menu.

PSAU Temperature

Regardless of the type of acquisition and the tab in use, a new file (ASCII format) is stored at every change of date (Log file type).

.txt Structure			
Typical Filename	PSAU_Temperature_*date(mmm-dd-yy)*.txt	Ex.: *PSAU Temperature_ Jan-15-21.txt*	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:		***Name***	***Type***
Structure	5 columns		
Separation character	TAB		
Channels	Channel(s): 5	Date	Date (O.S. format)
		Time	24 h format
		Board Temperature	Decimal float
		Ch.0 Temperature	Decimal float
		Ch.1 Temperature	Decimal float
Data Format	Decimal separator: point (.)		
Data Type Recorded	Single points of measures		
Length	Depends on the running time of the Main Program		

Waveform tab

In addition to the waveforms export in a Bitmap Image to the Clipboard or "Excel" numerical data via the “Export" button, the Waveforms can be saved in both modes, streaming, and snapshot. The generated files are in .TDMS format (see **Tab. 3.1**).

Folder	Streaming Mode	Snapshot Mode
Waveform	.TDMS *streaming*	--
TDMS	--	*.TDMS*

Tab. 3.1: Waveforms saving scheme.

- *Streaming Mode*

TDMS Structure		
Typical Filename	*Activity Acronym*_Wave*(Time or events xx)_date(mm-dd-yy)-T-time(hhmm).TDMS*	Ex.: *HRDW_Wave(#Evn 1000)_01-08-21-T-1155.TDMS*
General	TDMS Structure (NI standard), readable by Excel with “TDM Importer Plugin”.	
File Properties recorder	**Dataset Conditions:** string record (*)	
Organisation:		**Name**
Existing Groups	Group(s): 1	Analog Waveforms
Channels	Channel(s): 2	Trace Ch. 1
		Trace Ch. 0
Channel Range	0..4095	
Data Format	DT_Float (floating point double precision, 64 bits)	
Data Type	Array	
Length	Depends on the acquisition time or # of triggers	

- *Snapshot Mode*

TDMS Structure		
Typical Filename	*Activity Acronym _Wave.TDMS*	Ex.: *SiPM_Wave.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** string record (*)	
Organisation:		**Name**
Existing Groups	Group(s): 2	Analog Waveforms
		Digital Waveforms
Channels	"Analog Waveforms" Channels: 2	Trace Ch. 1
		Trace Ch. 0
	"Digital Waveforms" Channels: 5	Virtual Probe
		Gate
		Hold Off
		Over Threshold
		Flat
Channel Range	0..4095	
Data Format	DT_Long (Long 32 bits integer)	
Data Type	Arrays	
Length	Depends on the x scale extension of the Waveform plots originating the file	

Histogram tab

The histograms can be export in a Bitmap Image to the Clipboard and in "Excel" numerical data via the "Export" button. Moreover, as the waveforms saving, the histograms can be saved in streaming and snapshot mode. The generated file formats are summarized in **Tab. 3.2.**

Folder	Streaming Mode	Snapshot Mode
Histogram	*.txt* (ASCII)	*.txt* (ASCII) [Under request]
TDMS	--	*.TDMS* [Under request]

Tab. 3.2: Histograms saving scheme.

- *Streaming Mode*

.txt Structure			
Typical Filename	*Activity Acronym*_Charge_Histo*(*Time *or* events xx*)_date(mm-dd-yy)*—Time *(hhmm)*.txt	Ex.: *HRDW_Charge_Histo(Time 10)_02-10-21 Time 1610.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

- *Snapshot Mode*

.txt Structure			
Typical Filename	*Activity Acronym*_Charge_Histo_*date(mm-dd-yy)*-Time-*time(hhmm)*.txt	Ex.: *HRDW_Charge_Histo_01-25-21 Time 1048.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***

Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

TDMS Structure		
Typical Filename	*Activity Acronym*_Charge_Histo.*TDMS*	*Ex.: HRDW_Charge_Histo.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** empty	
Organisation:		***Name***
Existing Groups	Group(s): 1	Charge Histogram
Channels	Channel(s): 2	X coord
		Histo(X)
Data Format	DT_Float (floating point double precision, 64 bits) DT_Long (long 32 bits integer)	
Data Type Recorded	Array	
Length	Depends on the number of bins present in the Histograms	

Two Channels tab

The storage of the histograms in the *Two Channels tab* can be occurred in snapshot mode only, as showed in **Tab. 3.3.**

Folder	Streaming Mode	Snapshot Mode
Histogram	--	.txt (ASCII), 2 separate files
TDMS	--	*.TDMS* (2 files) [Under request]

Tab. 3.3: Two channels saving scheme.

- *Snapshot Mode*

.txt Structure			
Typical Filename	Hardware Management (generic)Ch*x*(channel number)*_date(mm-dd-yy)*-Time-*time(hhmm)*.txt A file is generated for each channel.	Ex.: *Hardware Management (generic)Ch1_02-09-21 Time 1238.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	Rate bin	Decimal float
		Counts/bin	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histograms		

TDMS Structure		
Typical Filename	*Activity Acronym*_2Ch_Charge_Histo.*TDMS*	Ex.: *HRDW_2Ch_Charge_Histo.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** empty	
Organisation:		***Name***
Existing Groups	Group(s): 2	Channel 0 Histogram Channel 1 Histogram
Channels	Channel(s): total 4, (2 per group)	X coord

	Histo(X)
Data Format	DT_Float (floating point double precision, 64 bits) DT_Long (long 32 bits integer)
Data Type Recorded	Array
Length	Depends on the number of bins present in the Histograms

Charge vs Time tab

The Charge vs Time data can be saved in streaming and snapshot mode. The generated file formats are summarized in **Tab. 3.4.**

Folder	Streaming Mode	Snapshot Mode
Charge-Time	.TDMS streaming	--
TDMS	--	*.TDMS* (2 files) [Under request]

Tab. 3.4: Charge vs Time saving scheme.

- *Streaming Mode*

TDMS Structure		
Typical Filename	*Activity Acronym*_ChargeVSTime(Time *or* events xx)*_date(mm-dd-yy)*-T-*time(hhmm).TDMS*	Ex.: *HRDW_ChargeVSTime(Time 5)_02-09-21-T-1245.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** string record (*)	
Organisation:		***Name***
Existing Groups	Group(s): 1	ChargeVSTime
Channels	Channel(s): 2	Charge DGTZ-Ch.0
		Charge DGTZ-Ch.1
Data Format	DT_Float (floating point double precision, 64 bits)	
Data Type Recorded	Array	
Length	Depends on the acquisition time or # of triggers	

- *Snapshot Mode*

TDMS Structure		
Typical Filename	*Activity Acronym*_ChargeVSTime.*TDMS*	Ex.:*HRDW_ChargeVSTime.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** empty	
Organisation:		***Name***
Existing Groups	Group(s): 1	ChargeVSTime
Channels	Channel(s): 2	Trace Ch. 0
		Trace Ch. 1
Channel Range	Full range	
Data Format	DT_Float (floating point double precision, 64 bits)	
Data Type	Array	
Length	Depends on the acquisition time or # of triggers	

Counting tab

The Counting tab data can be saved in snapshot mode only. The generated file formats are summarized in **Tab. 3.5**.

Folder	Streaming Mode	Snapshot Mode
Histogram	--	3 files *.txt* (ASCII)
TDMS	--	*.TDMS*

Tab. 3.5: Counting saving scheme.

- *Snapshot Mode*

.txt Structure			
Typical Filename	• *ActivitymAcronym*_Counts_HistoFrequency_*date (mm-dd-yy)* Time *time(hhmm)*.txt • *ActivityAcronym*_Counts_HistoLeft_*date(mm-dd-yy)* Time *time(hhmm)*.txt • *ActivityAcronym*_Counts_HistoRight_*date(mm-dd-yy)* Time *time(hhmm)*.txt	Ex.: • *HRDW_Counts_HistoFrequency_01-23-21 Time 1219.txt* • *HRDW_Counts_HistoLeft_01-23-21 Time 1219.txt* • *HRDW_Counts_HistoRight_01-23-21 Time 1219.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns (all)		
Channels	Channels: 2 (Histo Left and Right)	X coord	Decimal float
		Histo(X)	Integer
Channels	Channels: (HistoFrequency)	Freq. or #of pulses	Decimal float
		Event Index	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of events present in the Plot		

TDMS Structure		
Typical Filename	*ActivityAcronym*_Counts_Histo.*TDMS*	Ex.: *HRDW_Counts_Histo.TDMS*
General	TDMS Structure (NI standard), readable by Excel with "TDM Importer Plugin".	
File Properties recorder	**Dataset Conditions:** empty	
Organisation:		***Name***
Existing Groups	Group(s): 3	Count Histogram Left Count Histogram Right Frequency
Channels	Channel(s): total 6, (2 per group)	X coord
		Histo(X)
Data Format	DT_Float (floating point double precision, 64 bits) DT_Long (long 32 bits integer)	
Data Type Recorded	Array	
Length	Depends on the number of bins present in the Histograms	

(*) Dataset Conditions description

STRING Structure	
type	ASCII STRING, readable by any text editor. Variable. Terminated by \n (new line == 0x13 character). The string can be read abruptly until footer, and reproduced in any desirable context (comment, reports, screen fields,…)
HEADER	*** Start of Header ***
FOOTER	*** End of Header ***
Number of Records	56
Structure of records	*Description* <tab> *value* <nl> .OR. *Description* <nl> *Value* <nl>
Data Type Recorded	Single points of measures
Length	Fixed: 56 + 5 lines.

Contents

Example of a typical Dataset Condition header follows (with sample values)

*** Start of Header ***

Signature: HERA Writer V 1.0
Separator TAB
Decimal Separator .
Date: 05/01/2021
Time: 10.51.45
Username:
Description:
Dataset Channels: 2
Dataset Samples: 200

Data taking Conditions:

Dataset metadata
Date / Time creation: 20210105-T105144
User:
Activity code: 25
Sub-Activity code: 0
Sub-Activity: D2 After-Pulses studies

PSAU settings:
Channel in use: 0

Channels setting follow:
Ch.: 0
SiPM Serial: *****
Bias Voltage [V]: 55,00
Gain [dB]: 32,00
Threshold [mV]: -15,00
Channel Temperature [°C]: 25,50
T Compensation: Off
dV/dT 50,00
Ch.: 1
SiPM Serial: *****
Bias Voltage [V]: 55,00
Gain [dB]: 32,00
Threshold [mV]: -15,00
Channel Temperature [°C]: 21,00
T Compensation: Off
dV/dT 20,00

DGTZ settings:
Model: DT5720A
Model #: 9
Serial #: 812
Channel 0 Status: On
Channel 1 Status: Off
DC Offset 0: 0
DC Offset 1: 0
Trigger Mode: FALSE
Trigger Rise Time: 8
Trigger Mean: 8
Trigger 0 Thresh.: 0
Trigger 1 Thresh.: 10
Gate Mode: FALSE
Gate Width|Pre|Hold: 340 | 154 | 304
Baseline Mean|Thresh.|NoFlatTime: 1024 | 8 | 4008
Coincidence Status: FALSE
Coincidence on GPO|Time: 0 | 0
*** End of Header ***

Notes: <nl> stays for "new line character". <tab> stays for Tab character.

Note:
Legend of the *Activity Acronyms*

- *HRDW:* Hardware Management
- *SiPM:* SiPM Experiments
- *ADV-AfterP:* Advanced Statistics Experiment (After-Pulses)
- *BETA:* Beta Spectroscopy Experiments
- *GAMMA*: Gamma Spectroscopy Experiments
- *PHOTONS*: Photons Experiments
- *COSMICS:* Cosmic Rays Experiments

Files generated during experimental activities.

The files generated during experimental activities are saved in different data formats. In addition to the previous data saving, each experimental activity generates a directory every time the activity is undergoing or has been completed. The file and directory names, the structure, and contents of these directories must not be changed. Moreover, no files can be added to those directories because it would affect data analysis procedures with different issues, including wrong results or the inability in performing the analysis.
The file formats are ASCII (.txt) and binary (.dat).
The .dat files contain direct binary copy of data in memory. Data represent a single histogram and is composed of two arrays of the same number of elements. This number depends on the number of bins included in the Histogram saved.
Arrays represent respectively the bin values sequence (float) and the counts per bin (integer).
No header or footer is present, so no data length information is present.
Arrays are aligned one after the other and data representation is, in the order: Double Precision Float (64 bits) and Long integer (32 bits). Therefore, the physical structure of the file is the following:

First array	Element 0	DB_F 7	DB_F 6	DB_F 5	DB_F 4	DB_F 3	DB_F 2	DB_F 1	DB_F 0
First array	Element 1	DB_F 7	DB_F 6	DB_F 5	DB_F 4	DB_F 3	DB_F 2	DB_F 1	DB_F 0
First array	Element 2	DB_F 7	DB_F 6	DB_F 5	DB_F 4	DB_F 3	DB_F 2	DB_F 1	DB_F 0
First array	…	DB_F 7	DB_F 6	DB_F 5	DB_F 4	DB_F 3	DB_F 2	DB_F 1	DB_F 0
First array	Element n	DB_F 7	DB_F 6	DB_F 5	DB_F 4	DB_F 3	DB_F 2	DB_F 1	DB_F 0
Second array	Element 0	I32 3	I32 2	I32 1	I32 0				
Second array	Element 1	I32 3	I32 2	I32 1	I32 0				
Second array	Element 2	I32 3	I32 2	I32 1	I32 0				
Second array	…	I32 3	I32 2	I32 1	I32 0				
Second array	Element n	I32 3	I32 2	I32 1	I32 0				

Tab. 3.6: Physical structure of the .dat files. Each coloured box indicates a single byte (8 bits).

Since no array length is prepend, the only way to locate and separate the two blocks is to consider that the first one must occupy the 2/3 of the total number of bytes and the second one the remaining 1/3.
Data are in Little Endian coding (Windows). Double Float is in 64-bit IEEE double-precision format.
For example, a .dat file of 72,000 bytes, contains:

1. The DB_Float array in the first 48,000 bytes
2. The I32 array in the following 24,000 bytes

And this principle must be used to locate and separate them.

- **Section A1: Silicon Photomultipliers**

The following table reports the organization of the data files generated by HERA during the experimental activities of Section A: Silicon Photomultipliers.

File generating experiment	Folder	Generation during the run	Description
A1.1 *Histogram TAB*	**20-1-DateTime-Histo_aaaa..**	• .dat (histogram binary) • .txt (ASCII) • Dataset Condition .txt	• Histogram of charge in binary • ASCII translation of the histogram

			• Dataset Condition.txt logfile
A1.2 *Histogram TAB*	**20-2-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) + • ***n*** .txt (ASCII) + • Dataset Condition .txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile.
A1.2 *Counting TAB*	**20-2-DateTime-Count_aaaa..**	• ***n*** .txt (counts summary) • Dataset Condition .txt	• Summary of measured counts • Dataset Conditions.txt logfile
A1.3 *Histogram TAB* (generates a series of directories. User can flag the directories with a mnemonic to find them during analysis)	**20-3-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) • ***n*** .txt (ASCII) • Dataset Conditions .txt • Temperat. Monitor.wvf • Temperat. Monitor.txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile • Temperature trends (binary waveform) • Temperature trends (ASCII)
A1.3 *Counting TAB* (generates a series of directories. User can flag the directories with a mnemonic to find them during analysis)	**20-3-DateTime-Count_aaaa..**	• ***n*** .txt (ASCII) • Dataset Condition .txt • Temperat. Monitor.wvf • Temperat. Monitor.txt	• Summary of measured counts • Dataset Condition.txt logfile • Temperature trends (binary waveform) • Temperature trends (ASCII)
in background for **all experiments**	**PSAU Temperatures**	.txt (ASCII) New file at every change of date (Log file type	

Tab. 3.7: Data saving scheme of the Experiments Section A1.

Activity 20.1: A1.1- SiPM Characterization

.txt Structure

Typical Filename	20-1-Raws_SiPM Basic.txt		
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	20-1-Raws_SiPM Basic.dat		
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 20.2: A1.2 - Dependence of the SiPM Properties on the Bias Voltage [Histogram TAB]

.txt Structure

Typical Filename	20-2-Raws_Bias[V] xx,xx.txt	Ex.: *20-2-Raws_Bias[V] 55,20.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	20-2-Raws_Bias[V] xx,xx.dat	Ex.: *20-2-Raws_Bias[V] 55,20.dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Conditions are replicated in the file names. Never change the names of the .bin files.

Activity 20.2: A1.2 - Dependence of the SiPM Properties on the Bias Voltage [Counting TAB]

.txt Structure (Dark Count vs Bias)		*Summary of measured counts*	
Typical Filename	20-2 Dark_Bias[V]*xx,yy*.txt *Never change filename and contents of this file.*	Xx,yy indicates Bias conditions in Volts	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Channels	Channel(s):	Rate 0.5	Decimal float
		Rate 0.5 error	Decimal float
		Rate 1.5	Decimal float
		Rate 1.5 error	Decimal float
		OCT	Decimal float
		OCT Error	Decimal float
Data Format	Decimal separator: O.S. dependent (" , " or " . ")		

Data Type Recorded	Single points of measures during execution of the experiment
Length	Fixed

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 20.3: A1.3 - Temperature Effects on SiPM Properties [Histogram TAB]

.txt Structure

Typical Filename	20-3-Raws_Bias[V] xx,xx -Temp[°C] xx.txt	Ex.: *20-3-Raws_Bias[V] 55,00 -Temp[°C] 30.txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	20-3-Raws_Bias[V] xx,xx -Temp[°C] xx.dat	Ex.: *20-3-Raws_Bias[V] 55,00 -Temp[°C] 30.dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Conditions are replicated in the file names. Never change the names of the .bin files.
The file "*Temperature Monitor.wvf*" is used internally by the Analysis procedure. Not provided for custom analysis. Never change the name file of this file.
The "Temperature Monitor.txt" file = ASCII translation of the Waveform TM file.

.txt Structure (Temperature Monitor)

Filename	Temperature Monitor.txt
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).

File Properties recorder	**Dataset Conditions:** absent		
Organisation:		***Name***	***Type***
Structure	4 columns		
Separation character	TAB		
Channels	Channel(s): 4	Timestamp	Date Time (O.S. format)
	PSAU Board	Y[0]	Decimal float
	PSAU Ch. 0	Y[1]	Decimal float
	PSAU Ch. 1	Y[2]	Decimal float
Data Format	Decimal separator: O.S. dependent (" , " or " . ")		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Depends on the running time of the Experiment		

Activity 20.3: A1.3 - Temperature Effects on SiPM Properties [Counting TAB]

.txt Structure		*Summary of measured counts*	
Typical Filename	20-3-Dark_Bias[V] xx,xx -Temp[°C] xx *Never change filename and contents of this file.*	Ex.: *20-3-Dark_Bias[V] 55,00 -Temp[°C] 28.txt*	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Channels	Channel(s):	Rate 0.5	Decimal float
		Rate 0.5 error	Decimal float
		Rate 1.5	Decimal float
		Rate 1.5 error	Decimal float
		OCT	Decimal float
		OCT Error	Decimal float
Data Format	Decimal separator: O.S. dependent (" , " or " . ")		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Fixed		

.txt Structure (Dataset Conditions)	
Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

- **Section B1: Gamma Spectroscopy**

The following table reports the organization of the data files generated by HERA during the experimental activities of Section B1: Gamma Spectroscopy.

File generating experiment	Folder	Generation during the run	Description
B1.1 *Counting TAB*	**21-1-DateTime-Count_aaaa..**	• .txt (ASCII) • Dataset Condition .txt	• Summary of measured counts • Dataset Condition.txt logfile
B1.2 *Counting TAB*	**21-2-DateTime-Count_aaaa..**	*Not yet implemented!*	
B1.3 *Histogram TAB*	**21-3-DateTime-Histo_aaaa..**	• .txt (ASCII) • .dat (histogram binary) • Dataset Condition .txt	• Histogram of charge in binary

			• ASCII translation of the histogram • Dataset Conditions.txt logfile
B1.4 *Histogram TAB*	**21-4-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) • ***n*** .txt (ASCII) • Dataset Conditions .txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile
B1.5 *Histogram TAB*	**21-5-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) • ***n*** .txt (ASCII) • Dataset Conditions .txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile
B1.6 *Histogram TAB*	**21-6-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) • ***n*** .txt (ASCII) Dataset Conditions .txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile
B1.7 *Histogram TAB*	**21-7-DateTime-Histo_aaaa..**	• ***n*** .dat (histogram binary) • ***n*** .txt (ASCII) Dataset Conditions .txt	• Histogram of charge in binary • ASCII translation of histogram • Dataset Condition.txt logfile
in background for **all experiments**	**PSAU Temperatures**	.txt (ASCII) New file at every change of date (Log file type	

Tab. 3.8: Data saving scheme of the Experiments Section B1.

Activity 21.1: B1.1- Detecting γ-Radiation

.txt Structure	*Summary of measured counts*		
Typical Filename	20-2 Dark_Gamma Spectroscopy.txt *Never change filename and contents of this file.*		
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Channels	Channel(s):	Rate Src	Decimal float
		Rate Src error	Decimal float
		Rate NO Src	Decimal float
		Rate NO Src error	Decimal float
Data Format	Decimal separator: O.S. dependent (“ , “ or “ . “)		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Fixed		

.txt Structure (Dataset Conditions)	
Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 21.3: B1.3- γ Spectrum and Energy Resolution

.txt Structure

Typical Filename	21-3-Raws_En.Spectrum –(Time or Events *xxx*).txt	Ex.: *21-3-Raws_En. Spectrum -(Time 300).txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	21-3-Raws_En.Spectrum –(Time or Events *xxx*).dat	Ex.: *21-3-Raws_En. Spectrum -(Time 300).dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 21.4: B1.4- System Calibration: Linearity and Resolution

.txt Structure

Typical Filename	21-4-Raws_Source -*nnn-AAA* (Time *xxx*).txt	Ex.: *21-4-Raws_Source -22-Na (Time 300).txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	21-4-Raws_Source -*nnn-AAA* (Time *xxx*).dat	Ex.: *21-4-Raws_Source -22-Na (Time 300).dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

Activity 21.5: B1.5- Scintillator Crystals Comparison: Light Yield and Decay Time

.txt Structure

Typical Filename	21-5-Raws_Crystal -*AAA* (Time *xxx*).txt	Ex.: *21-5-Raws_Crystal-BGO (Time 300).txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	21-5-Raws_Crystal -*AAA* (Time *xxx*).dat	Ex.: *21-5-Raws_Crystal-BGO (Time 300).dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).	
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer	
Organisation:	No further structures are present	
Data Format	Decimal separator: point (.)	

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

Activity 21.6: B1.6- γ-Radiation Absorption

.txt Structure

Typical Filename	21-6-Raws_ Tower[mm] *xx Thick.yy* (Time *zzz*).txt	Ex.: *21-6-Raws_Tower[mm] 50 Thick.20 (Time 300).txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	21-6-Raws_ Tower[mm] *xx Thick.yy* (Time *zzz*).dat	Ex.: *21-6-Raws_Tower[mm] 50 Thick.20 (Time 300).dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

Activity 21.7: B1.7- Photonuclear cross-section/Compton Scattering cross-section

.txt Structure

Typical Filename	21-7-Raws_ Source *-xxx-AAA* (Time *zzz*).txt	Ex.: *21-7-Raws_Source -22-Na (Time 300)txt*
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).	
File Properties recorder	**Dataset Conditions:** string record (*)	

Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	21-7-Raws_ Source -*xxx-AAA* (Time *zzz*).dat	Ex.: *21-7-Raws_Source -22-Na (Time 300).dat*
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.	
File Properties recorder	**Not applicable**	

Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

- **Section B2: Beta Spectroscopy**

The following table reports the organization of the data files generated by HERA during the experimental activities of Section B2: Beta Spectroscopy.

File generating experiment	Folder	Generation during the run	Description
B2.1 *Counting TAB*	**22-1-DateTime-Count_aaaa..**	• .txt (ASCII) • Dataset Condition .txt	• Summary of measured counts • Dataset Condition.txt logfile
B2.2 *Histogram TAB*	**22-2-DateTime-Histo_aaaa..**	• .txt (ASCII) • .dat (histogram binary) • Dataset Condition .txt	• Histogram of charge in binary • ASCII translation of the histogram • Dataset Conditions.txt logfile
B2.3 *Counting TAB*	**22-3-DateTime-Count_aaaa..**	• ***n*** .txt (ASCII) • Dataset Conditions .txt	• Summary of measured counts • Dataset Condition.txt logfile
B2.4 *Counting TAB*	**22-4-DateTime-Count_aaaa..**	• ***n*** .txt (ASCII) • Dataset Conditions .txt	• Summary of measured counts • Dataset Condition.txt logfile
in background for **all experiments**	**PSAU Temperatures**	.txt (ASCII) New file at every change of date (Log file type	

Tab. 3.9: Data saving scheme of the Experiments Section B2.

Activity 22.1: B2.1- Response of a Plastic Scintillating Tile

.txt Structure	*Summary of measured counts*		
Typical Filename	20-2 Dark_Gamma Spectroscopy.txt *Never change filename and contents of this file.*		
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***

.txt Structure	*Summary of measured counts*		
Typical Filename	20-2 Dark_Posn[i].txt *Never change filename and contents of this file.*	*i* indicates position of the radioactive source on the detector	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Header	Positional: Rates[Hz], Ratio[%]		
Channels	Channel(s):	Rate Src	Decimal float
		Rate Src error	Decimal float
		Rate NO Src	Decimal float
		Rate NO Src error	Decimal float
		Ratio	Decimal float
		Ratio error	Decimal float
Data Format	Decimal separator: O.S. dependent (" , " or " . ")		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Fixed		

.txt Structure (Dataset Conditions)	
Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 22.2: B2.2- β Spectroscopy

.txt Structure			
Typical Filename	22-2-Raws_En.Spectrum –(Time or Events *xxx*).txt	Ex.: *22-2-Raws_En. Spectrum - (Time 300).txt*	
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	22-2-Raws_En.Spectrum –(Time or Events *xxx*).dat	Ex.: *22-2-Raws_En. Spectrum - (Time 300).dat*	
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Activity 22.3: B2.3- β-Radiation: Transmission through Matter

.txt Structure	*Summary of measured counts*		
Typical Filename	22-3 Dark_NumS[n] *x*-Mpp MAI[mm]*y,yy*.txt *Never change filename and contents of this file.*	*x* indicates number of layers used; y,yy width in mm Ex.: *22-3-Dark_NumS[n] 0-MPp[mm]1,00*	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Header	Radiation Transmission: Rate[kHz], Dev[kHz]		
Channels	Channel(s):	Rate [kHz]	Decimal float
		Rate [kHz]	Decimal float
Data Format	Decimal separator: O.S. dependent (“ , “ or “ . “)		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Fixed		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

Activity 22.4: B2.4- β-Radiation as a Method to Measure Paper Sheet Grammage and Thin Layer Thickness

.txt Structure	*Summary of measured counts*		
Typical Filename	22-3 Dark_NumS[n] *x*.txt *Never change filename and contents of this file.*	*x* indicates number of layers used. Ex.: *22-4-Dark_NumS[n] 0.txt*	
General	ASCII File, readable by any text editor. Fixed length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** absent		
Organisation:	Name and value per line	***Name***	***Type***
Structure	2 columns, 7 rows (fixed)		
Separation character	TAB		
Header	Radiation Transmission : Rate[kHz], Dev[kHz]		
Channels	Channel(s):	Rate [kHz]	Decimal float
		Rate [kHz]	Decimal float
Data Format	Decimal separator: O.S. dependent (" , " or " . ")		
Data Type Recorded	Single points of measures during execution of the experiment		
Length	Fixed		

.txt Structure (Dataset Conditions)	
Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

- **Section C2: Photons**

The following table reports the organization of the data files generated by HERA during the experimental activities of Section C2: Photons.

File generating experiment	Folder	Generation during the run	Description
C2.2 *Histogram TAB*	**24-2-DateTime-Histo_aaaa..**	• .txt (ASCII) • .dat (histogram binary) • Dataset Condition .txt	• Histogram of charge in binary • ASCII translation of the histogram • Dataset Conditions.txt logfile
in background for **all experiments**	**PSAU Temperatures**	.txt (ASCII) New file at every change of date (Log file type	

Tab. 3.10: Data saving scheme of the Experiments Section C2.

Activity 24.2: C2.2- Hands-on Photon Counting Statistics

.txt Structure

Typical Filename	24-18-Raws_LEDS[n] 0,00.txt		
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).		
File Properties recorder	**Dataset Conditions:** string record (*)		
Organisation:		***Name***	***Type***
Structure	2 columns		
Channels	Channel(s): 2	ADC Channel	Decimal float
		Counts	Integer
Data Format	Decimal separator: point (.)		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.dat Structure (histogram Binary)

Typical Filename	24-18-Raws_LEDS[n] 0,00.dat		
General	Direct Binary. Used by Analysis procedure only. Not recommended for custom analysis.		
File Properties recorder	**Not applicable**		
Organisation:		***Name***	***Type***
Structure	Cluster of 2 elements		
Elements	Arrays	Not applicable	Decimal float
		Not applicable	Long Integer
Data Format	Not applicable		
Data Type Recorded	Array(s)		
Length	Depends on the number of bins present in the Histogram		

.txt Structure (Dataset Conditions)

Filename	Dataset Conditions.txt
General	ASCII File, readable by any text editor. Variable length records. Terminated by \n (new line == 0x13 character).
File Properties recorder	**Dataset Conditions:** string record (*) without Header and Footer
Organisation:	No further structures are present
Data Format	Decimal separator: point (.)

Note: Conditions are replicated in the file names. *Never change the names of the .bin files.*

4. Technical Support

CAEN makes available the technical support of its specialists for request concerning the software and the hardware. Use the support form available at the following link:

https://www.caen.it/support-services/support-form/

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