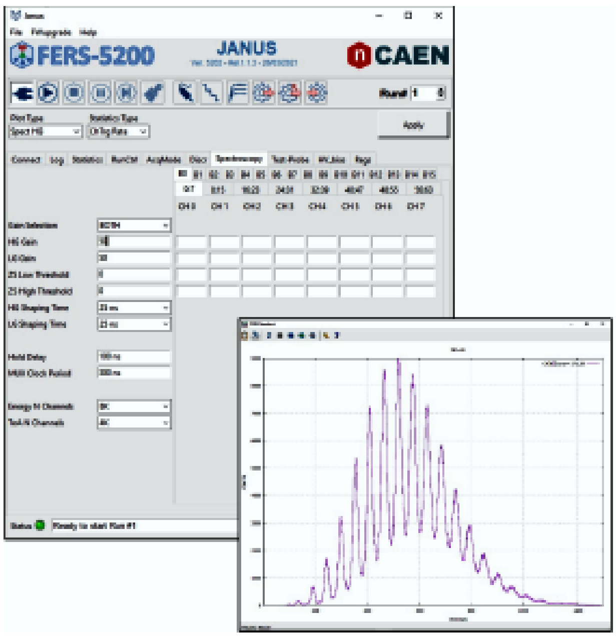
Rev. 3 - Feb 22nd, 24

Janus 5202

CAEN A5202/DT5202 Readout Software



CAEN Tools for Discovery

User Manual
UM7946

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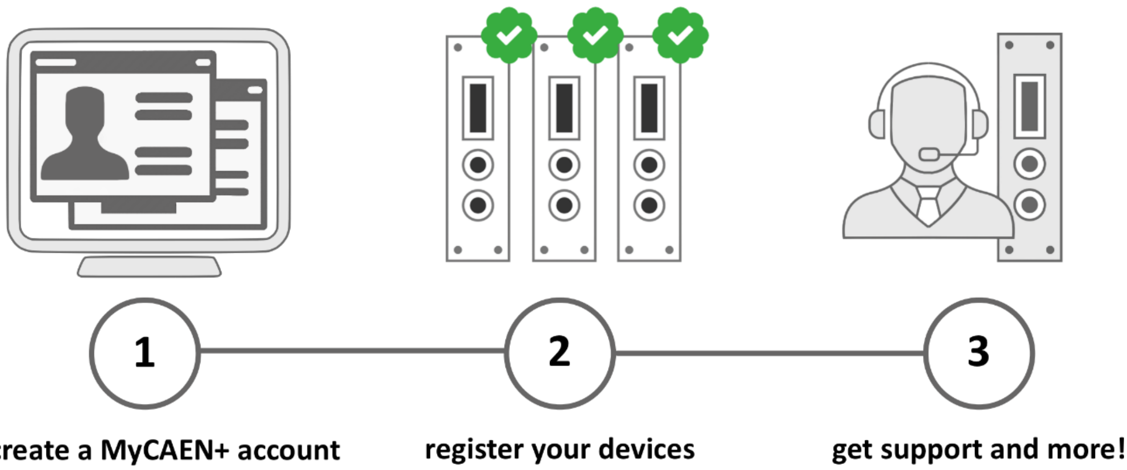
MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



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

Purpose of this Manual

The User Manual contains the description of the Janus 5202 readout software for the A5202/DT5202, the description of its architecture and parameters and instructions for its installation. This User Manual is compliant with Janus 5202 version 3.2.4 and A5202/DT5202 FPGA firmware version 5.0 (Build = 7703).

Change Document Record

Date	Revision	Changes
Apr 27th, 2021	00	Initial Release
Jul 6th, 2021	01	Inserted **GUI Mode Command** description. Updated the description of the "Plot Trace" window in Sec. **3.2**. Updated Sec. **3.14**. Updated the data format description, now described in Sec. **3.8**. Inserted the **Veto Source**, **Validation Source**, **Validation Mode** and **Trigger ID Mode** parameter description. Updated the options for the **Temp Sensor Type**, the **Tref Source** and the **Start Run Mode** parameters. Updated the console command list in Sec. **4.2**. Inserted FPGA temperature monitor description in Sec. **3.6**.
May 10th, 2022	02	Added support to Linux OS. Inserted the **Load Macro** option on Sec. **3.1**, **Bin to CSV Button**, **Multi Channel Scaler** option on Sec. **3.3**. Modified **Statistics Type** and Sec. **3.4**. Added **Event Building Mode**, **Tstamp Coinc Window**, **ToA/ToT Units**, **Sync List (ASCII)**, **Run Info**, **MCS Histo** on Sec. **3.7**. Updated Sec. **3.8** to data format 3.1. Added **Enable ToT**, **Counting Mode**, **Paired-Cnt Coinc Window**, **Tref Delay** on Sec. **3.9**. Modified **T0-OUT/T1-OUT** on Sec. **3.9**. Added **ToA Rebin** and **ToA Histo Min** on Sec. **3.11**. Modified Sec. **3.14**. Updated screenshots to version 2.2.10 of Janus. Modified Chap. **7**.
Feb 22nd, 2024	03	Replaced *Janus* with *Janus 5202* in the whole manual. Added Chap. **6**. Updated Sec. **3.1**, **3.2**, **3.4**, **3.5**, **3.8**, **3.9**, **3.10**, **4.2**, and Chap. **5**.

Symbols, Abbreviated Terms and Notation

ADC	Analog-to-Digital Converter
ASIC	Application Specific Integrated Circuit
DAQ	Data Acquisition
DCR	Dark Count Rate
FERS	Front-End Readout System
FERS-CB	FERS Collector Board
FPGA	Field Programmable Gate Array
FSR	Full Scale Range
GUI	Graphical User Interface
HG	High Gain

HV	High Voltage
IDLE	Integrated Development and Learning Environment (Python)
LG	Low Gain
LSB	Least Significant Bit
LVTTL	Low Voltage TTL
MUX	Multiplexer
OS	Operating System
PC	Personal Computer
PCB	Printed Circuit Board
PHA	Pulse Height Analysis
QD	Charge Discriminator
RMS	Root-Mean-Square
SiPM	Silicon Photo-Multiplier
ToA	Time of Arrival
TD	Time Discriminator
ToT	Time over Threshold
USB	Universal Serial Bus
ZS	Zero Suppression

Reference Documents

[RD1] Citiroc-1A Datasheet. available at https://www.weeroc.com/products/sipm-read-out/citiroc-1a

[RD2] UM6377 – A7585/DT5485 User Manual

[RD3] UM7945 – A5202/DT5202 User Manual

[RD4] DS8147 - A525x Adapters for FERS-5200 Board Inputs

[RD5] Available at https://www.hamamatsu.com/jp/en/product/type/S13361-3050AE-08/index.html

[RD6] Available at https://www.analog.com/en/products/tmp37.html

[RD7] Available at https://www.ti.com/product/LM94021

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

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Limitation of Responsibility

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

Disclaimer

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

Made in Italy

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

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1 Introduction

1.1 FERS-5200 System

Janus is an open source software for the control and readout of FERS-5200 boards.
The first board of the FERS-5200 family is the **A5202/DT5202** (see **Fig. 1.1**), based on Citiroc-1A ASICs from WeeROC and specifically designed for the readout of SiPMs **[RD1]**. The board has 64 readout channels, consisting of an analog front-end (i.e. Preamplifier, Shaper, Peak Sensing, Discriminator), a multiplexed ADC for amplitude conversion, a TDC for timing conversion, an FPGA for acquisition management and readout interfaces (USB, Ethernet, TDlink[1]). The 64 outputs of the discriminators, i.e. the channel self-triggers, are used in the FPGA both to feed the trigger logic (OR, Majority, etc.) and to acquire the Time Stamp (ToA) and Time over Threshold (ToT) timing information to be used in combination with the amplitude information (PHA) or even as an alternative. While the amplitude conversion with ADC (Spectroscopy Mode) provides a common trigger to the 64 channels (simultaneous acquisition) and has a certain dead time due to the conversion ($\sim$10 µs), the Timing Mode works independently on the channels and is almost dead timeless, at least until the data throughput does not saturate the reading bandwidth of the card, causing the filling of the internal buffer memory.
The A5202/DT5202 board also contains a HV channel (A7585D) for bias generation of SiPMs (range 20-85 V) **[RD2]**.

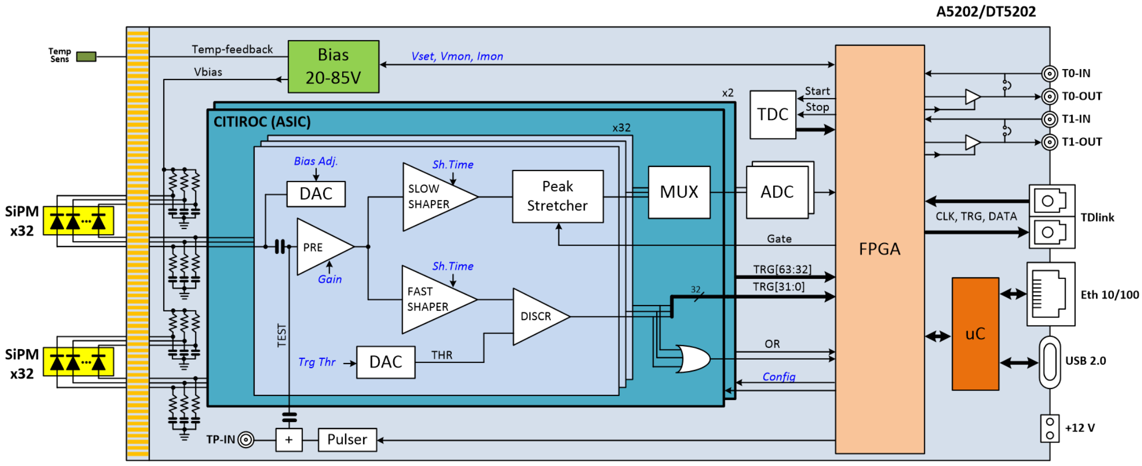


Fig. 1.1: Simplified block diagram of the A5202 FERS-5200 unit.

Janus 5202 can manage up to 16 A5202/DT5202 boards connected via Ethernet or USB, or up to 128 boards via the DT5215 FERS-5200 data concentrator board connection, configuring hardware parameters and managing the reading of data in various modes:

- **Spectroscopy Mode** (PHA).
- **Timing Mode** (ToA and ToT).
- **Spectroscopy + Timing Mode** (PHA + ToA and ToT).
- **Counting Mode**.

The read data are then used to create and save to disk lists and spectra (PHA, ToA, ToT). The file name has a suffix that identifies the run number, so that a different set of files can be saved for each acquisition,

[1]TDlink is a CAEN proprietary protocol for communication and synchronization, compatible with optical link.

without overwriting the previous ones. During acquisition, Janus 5202 can plot spectra, graphs and 2D images (pixel imaging). Moreover, Janus 5202 prints on screen (via console or GUI) some statistics of the run (counts, events lost, trigger rate, data throughput, etc.).
Janus 5202 manages also the FPGA Firmware upgrade.

1.2 Janus 5202 Architecture

Janus 5202 is an open-source software composed of two parts, one written in C, which is the real heart of the application, one written in Python which manages only the user interface and communicates with the C program via socket. The plots are executed through an external tool (*gnuplot*). All the configuration parameters, both of the board and of the software, are written on a textual configuration file.

It is possible to launch and use Janus 5202 in 2 different modes:

- **Console Mode**. In this case, the Python part of the software is not used. The user can edit the configuration file with any text editor and save the proper values for the desired parameters. Then, the user can launch "JanusC.exe", which starts in a purely textual console window. The application writes a series of messages (which are also saved in a log file) and, during the run, prints statistics on the screen. Commands are given via predefined keys (see Chap. **4**). The only graphical part is the plot, which is managed by gnuplot.
  In **Fig. 1.2** the software block diagram when working in Console Mode is shown.
  JanusC is open-source and can be used as a platform for the development of custom DAQ, tailored to the specific application. Indeed, the user can change the data treatment, the acquired statistics and the output file format.

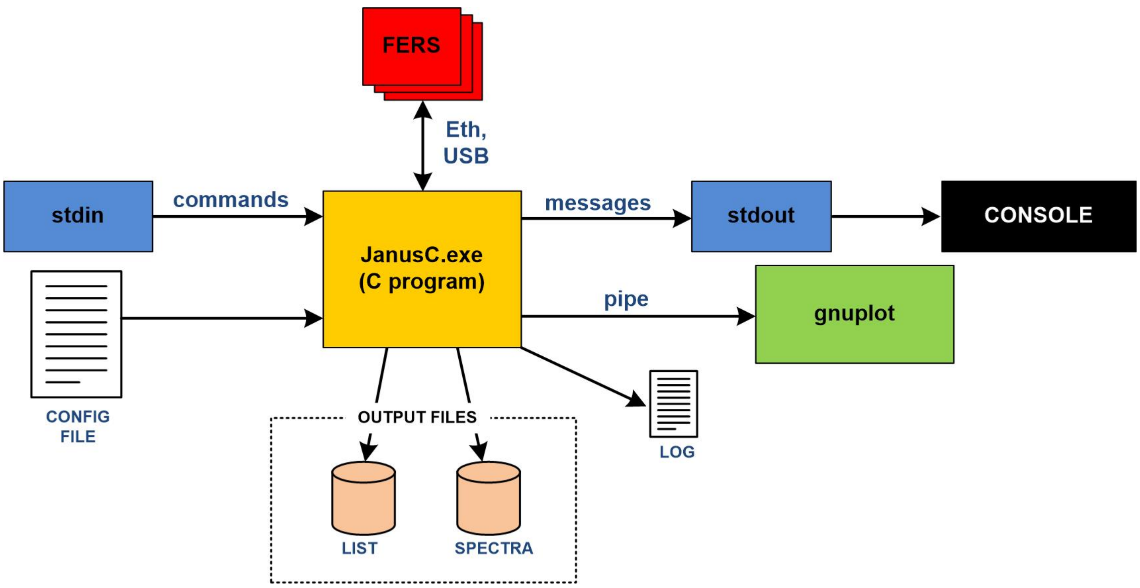


Fig. 1.2: Console Mode block diagram.

- **GUI Mode**: In this case, the user only have to run the Python program "JanusPy.pyw", which calls the C program "JanusC.exe" and connects to it via a socket to send commands and receive messages which are then displayed in the Python GUI (see **Fig. 1.3**).

Note: When operating in GUI Mode, the user can decide to connect or not via socket to the "JanusC.exe" file. In case the socket connection is not established, the GUI can be used to modify the configuration file, i.e. it is simply used as a configuration panel.

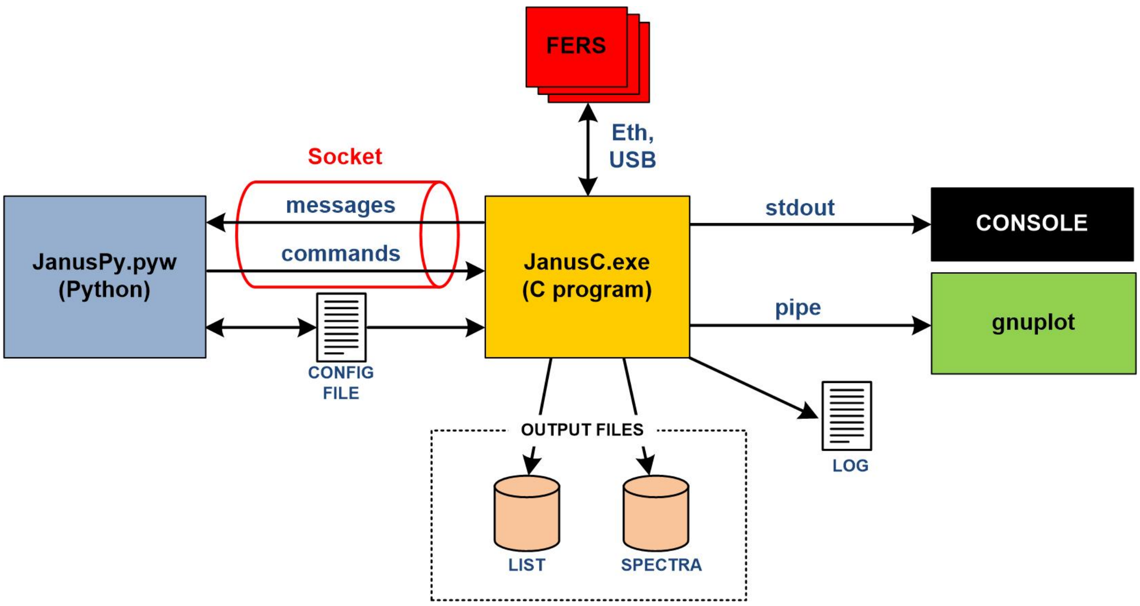


Fig. 1.3: GUI Mode block diagram.

2 Installation

The A5202/DT5202 is fully supported by the Janus 5202 software for Windows® and Linux®.

Janus 5202 runs on Windows OS, 10 or higher, and Linux OS, both 64-bit. Since the source codes are available, it is in principle possible to compile them in a 32-bit platform, prior the installation of the correct drivers, in case of USB connection.

Janus 5202 can run in "GUI" or "console" mode. For the GUI mode, Janus 5202 requires the third-party software Python release 3.8.1 or later, downloadable from the python website, while for the console mode it is sufficient to run the program "JanusC".

Before installing the software, please make sure that:

- The A5202/DT5202 hardware is properly installed (refer to the A5202/DT5202 User Manual **[RD3]** for hardware installation instructions).
- A cable connection is established between the host PC and the target board (either USB or Ethernet).
- The required USB driver (Windows only) is correctly installed in case of a USB connection to the board (refer to the A5202/DT5202 User Manual **[RD3]** for USB driver installation instructions).

As a summary, in order to use Janus 5202 the user needs:

- Windows 10 (or higher) / Linux OS (64-bit).
- Python interpreter, e.g. IDLE 3.8.1. (not necessary in Console Mode).
- Visual Studio Community Edition 2019. It is only needed in case the user wants to edit and/or recompile the C program "JanusC.exe".

2.1 Windows Installation

Janus 5202 does not have an installer. It is provided by CAEN as a compressed ".zip" file to be unpacked in a directory on the PC that the user has write access to. The user should follow the instructions below in order to properly run the software:

1. Download the installation package from CAEN website for Windows OS (login required).
2. Extract the files.
3. Open the "Janus_x.y.z" folder (with x, y, z being the numbers indicating the software release).

Included in the "Janus" folder there are the C and Python sources, the Microsoft Visual Studio project (Community Edition 2019) in case the user may want to modify and recompile the software, gnuplot, and a folder with the executables.

Here follows the list of folders contained in the software package (see **Fig. 2.1**):

- **bin**: folder containing executables, python scripts, configuration files, other service files needed by Janus 5202.
- **bin/DataFiles**: default folder for saving the output files of the acquisitions.
- **build**: folder containing the Microsoft Visual Studio project (see **Fig. 2.2**).
- **FERS_USB_driver**: folder containing the USB driver (Windows).

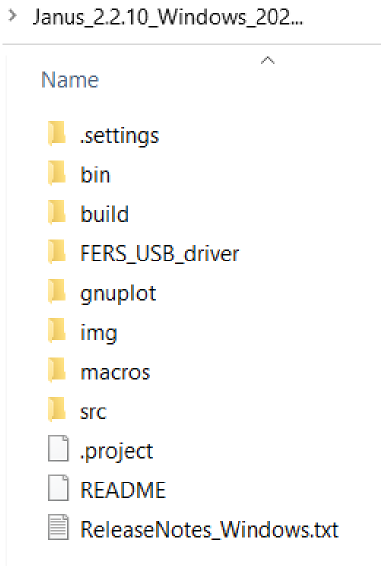


Fig. 2.1: Subfolders structure of Janus 5202 main directory.

- **gnuplot**: folder containing all gnuplot files.
- **img**: folder containing icons for the GUI.
- **macros**: folder containing useful macros that can be loaded into Janus 5202.
- **src**: folder containing the software C-source and header files (see **Fig. 2.3**).

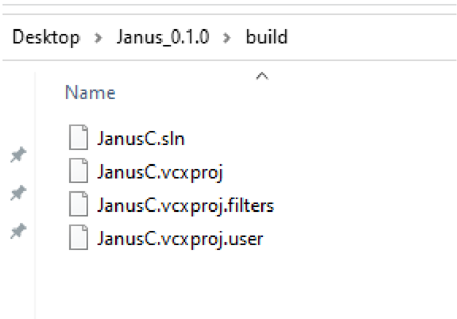


Fig. 2.2: Microsoft Visual Studio project files for the Janus 5202 software. The path is visible in the top bar.

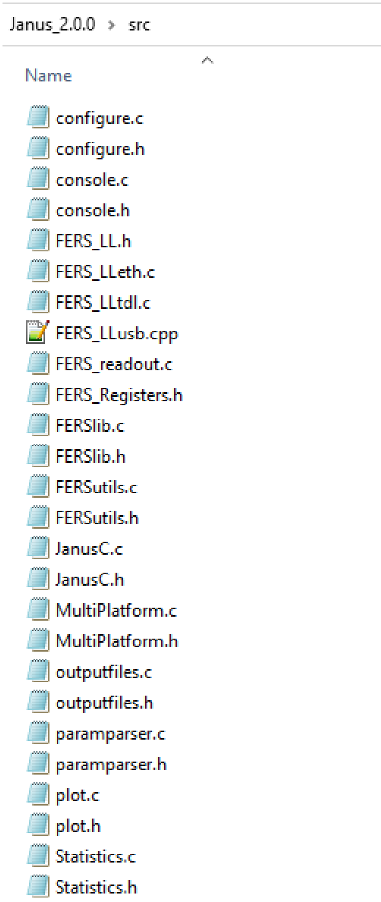


Fig. 2.3: C-source and header files. The path is visible in the top bar menu.

2.2 Linux Installation

Janus 5202 for Linux is provided by CAEN as a compressed ".tar.gz" file to be unpacked in a directory on the PC that the user has write access to. The user should follow the instructions below in order to properly run the software:

1. Download the Janus 5202 software from CAEN website for Linux OS (login required).
2. Extract the files in a folder with read/write permissions and enter the "Janus" folder.
3. Run
   `sudo sh Janus_Install.sh`
4. The script will search for missing packages. If any is found, please, install it and run again the Janus_Install.sh file.
5. Once completed, go into the folder "bin" and run
   `python3 JanusPy.pyw` for GUI mode or
   `./JanusC` for console mode

The folder structure is the same as described in Sec. **2.1**

3 GUI Mode

The Janus 5202 software features a Python GUI ("JanusPy.pyw") which is well suited to start getting familiar with the functionalities of the software itself. As explained in Sec. **1.2**, in this case the user only has to run the GUI, which calls the "JanusC.exe" application, and connects to it via a socket. The C program, when called by Python, no longer uses stdin and stdout for input and output, instead it uses the socket from which it receives commands and to which it sends messages, which are then displayed in the Janus 5202 GUI.

Note: The screenshots reported in this chapter may change between different versions of the software.

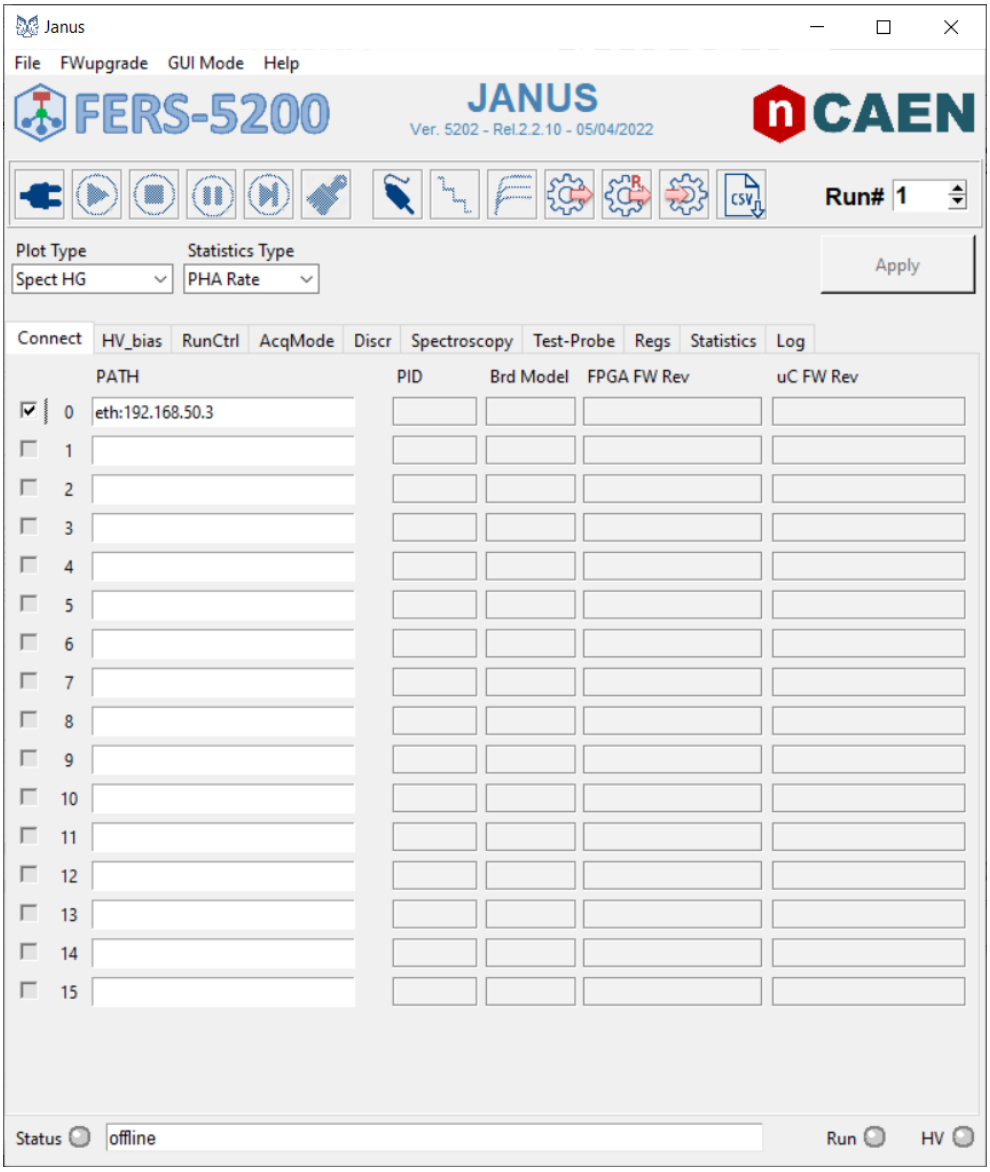


Fig. 3.1: Starting window of the Janus 5202 software GUI.

When the ”JanusPy.pyw” application is launched, an initial screen similar to that in **Fig. 3.1** is opened.
In the Connect Tab (see **Fig. ??**), the user has to define in the ”PATH” field the type of connection for the A5202/DT5202 board and then press the ”Apply” button in order to make the changes effective (see Sec. **3.5**).

Note: Every time the value of a parameter is changed, the user has to press the ”Apply” button to make it effective. By pressing the ”Apply” button the configuration file read by the ”JanusC.exe” application is overwritten.

Note: In the current version of the GUI, the user can connect more than one board (up to 16) via Ethernet by using, for instance, an Ethernet switch, via USB by using, for instance, an USB hub, or via the TDlink connection to the DT5215 Concentrator Board.

In order to establish a connection with the ”JanusC.exe” application, the user has then to click on the Connect button on the top left part of the Janus 5202 GUI window .
As soon as the connection is established, the gnuplot graphic interface is opened (see **Fig. 3.2**).

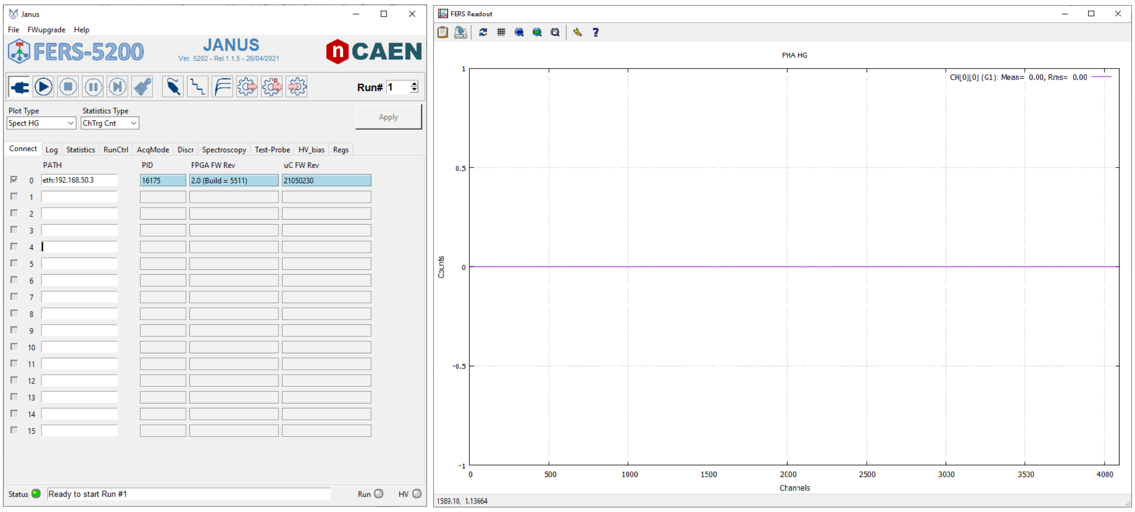


Fig. 3.2: Janus 5202 interface when the connection in established.

In the following sections all the parameters and commands of the Janus 5202 GUI are described in detail.

3.1 Menu Bar Items

The Menu Bar (see **Fig. 3.3**) in the top left part of the Janus 5202 GUI is constituted by the following items: ”File”, ”FWupgrade”, ”GUI Mode” and ”Help”.

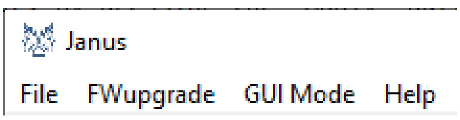


Fig. 3.3: Menu bar of the Janus 5202 GUI.

File

The **File** pull-down menu shows the following items: ”Load Config File”, ”Save Config File”, ”Save Config File As” and ”Quit”.

- *Load Config File*: The command allows the user to open an existing configuration file. A window will be opened in which the user can select the file to be load.
- *Save Config File*: The set of values currently used for the parameters are saved to a configuration file with default name ”Janus_Config.txt” which is the default name of the configuration file opened by the ”JanusC.exe” application.
- *Save Config File As*: The set of values currently used for the parameters are saved to a configuration file whose name can be defined by the user, as well as the destination folder. The configuration file can then be loaded via the ”Load Config File” command.
- *Load Macro*: Additional settings can be loaded by means of a .txt file and appended in the configuration of FERS (see **Fig. 3.4**). See for example, in the ”macros” folder, the file ”leds_off.txt”. To select a macro, click on ”Add Macro” button and select the specific file. Once ready, press the ”DONE” button to upload the macro. Finally, click on ”Remove Macro” and ”Remove All Macros” to remove one selected macro or all macros, respectively.

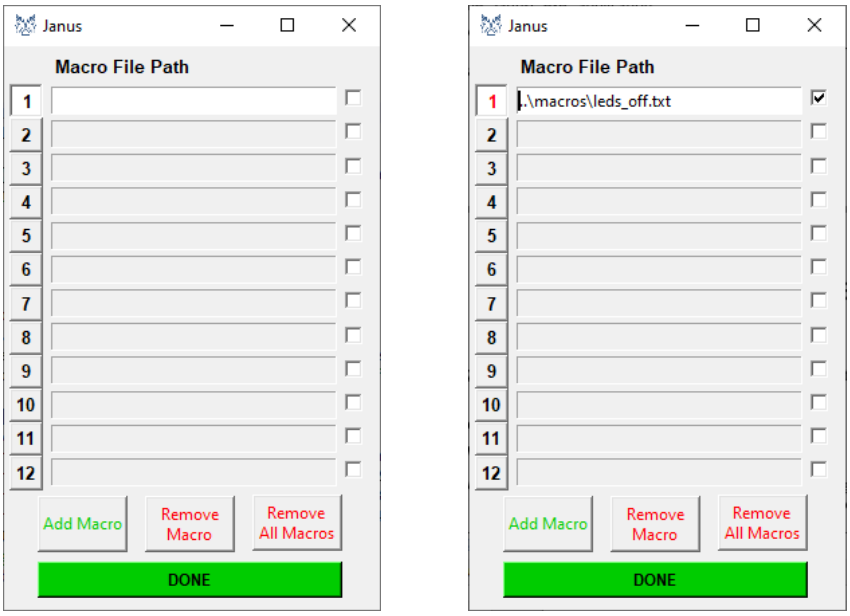


Fig. 3.4: ”Load Macro” window.

- *Quit*: The command allows the user to quit the Janus 5202 software.

Firmware Upgrade

The **FWupgrade** pull-down menu shows the following items:

- *Upgrade FPGA*: The command opens a window (see **Fig. 3.5**) that allows the user to browse the firmware file to upgrade the FPGA and to visualize the progress of the upgrade. Compliant firmware has .ffu extension.
- *Restore IP 192.168.50.3*: The command restores the default IP address in case the user has modified it previously through the web interface.

Note: Connect via USB to the board to restore the Ethernet IP address.

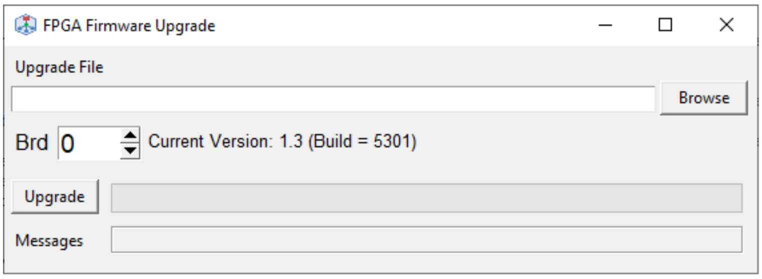


Fig. 3.5: FPGA firmware upgrade window.

GUI Mode Command

The **GUI Mode** pull-down menu allows the user to define which parameters are visualized in the Janus 5202 GUI:

- *Basic*: This option allows the user to remove from the GUI the list of parameters more suitable for an advanced use of the software. When working in Basic mode, the parameters which are removed from the GUI window are set to the values defined before switching to this operative mode.
- *Advanced*: This option allows the user to visualize all Janus 5202 parameters in the GUI.
- *Show warning pop-up*: This option enables/disables warning pop-up.
- *Verbose socket messages*: The selection of this option activates report messages received by the socket to be printed in the Log Tab, and enables a deeper level of C log file. Mostly used for debug purposes.

Help

The **Help** pull-down menu shows the following item:

- *About*: The command allows the user to access the software release number and the date of the release.

3.2 Icon Bar

An Icon Bar is present under the Menu Bar, where the different buttons are enabled/disabled depending on the process in progress (see **Fig. 3.6**).

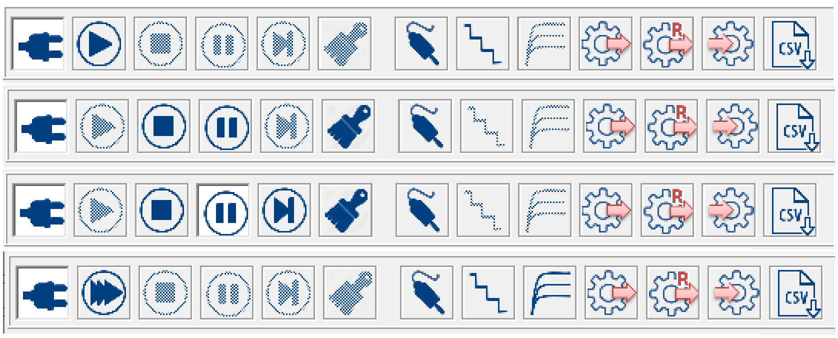


Fig. 3.6: Janus 5202 Icon Bar.

From the top to the bottom, the configurations presented in **Fig. 3.6** are:

- The Janus 5202 GUI is connected to the JanusC.exe application and the boards are connected.

- An acquisition is ongoing.
- The histograms update is paused.
- The jobs are enabled.

The above icons correspond to the functions described below.

Connect Button

The Connect command allows the user to enable/disable the socket connection of the Janus 5202 GUI with the "JanusC.exe" application.

Start Button

The Start command allows the user to start an acquisition.

Start Job Button

The Start Job command is only available when the **Enable Jobs** parameter is enabled. The command allows the user to start a job, i.e. several consecutive runs (see Sec. **3.16**).

Stop Button

The Stop command allows the user to stop the acquisition.

Pause Button

The Pause command allows the user to freeze the histograms update while the data acquisition continues.

Reset Button

The Reset command allows the user to restart an acquisition run and to reset the histograms.

Plot Traces Button

The Plot Traces command allows the user to access the Plot Traces window (see **Fig. 3.7**) to manage the traces to be visualized in the gnuplot window. A maximum of 8 traces from different channels can be visualized at the same time.

The commands present in the window are:

- *TN*: With *N* being a number between 0 and 7. By pressing the button, one of the available 8 traces is selected.
- *Brd*: The arrows next to the box allow the user to choose a trace from one of the connected boards. The trace number can also be written directly into the box.
- *Trace-OFF*: The command disables the visualization in the gnuplot window of the selected trace.
- *All-OFF*: The command allows the user to disable the visualization of all traces.
- *Online*: The command has to be enabled when the user is performing an acquisition and wants to visualize in the gnuplot window data from the ongoing acquisition for the selected trace.
- *Offline*: The command has to be enabled when the user wants to visualize in the gnuplot window a spectrum previously saved in the folder indicated via the **Data File Path** parameter. Only the selected

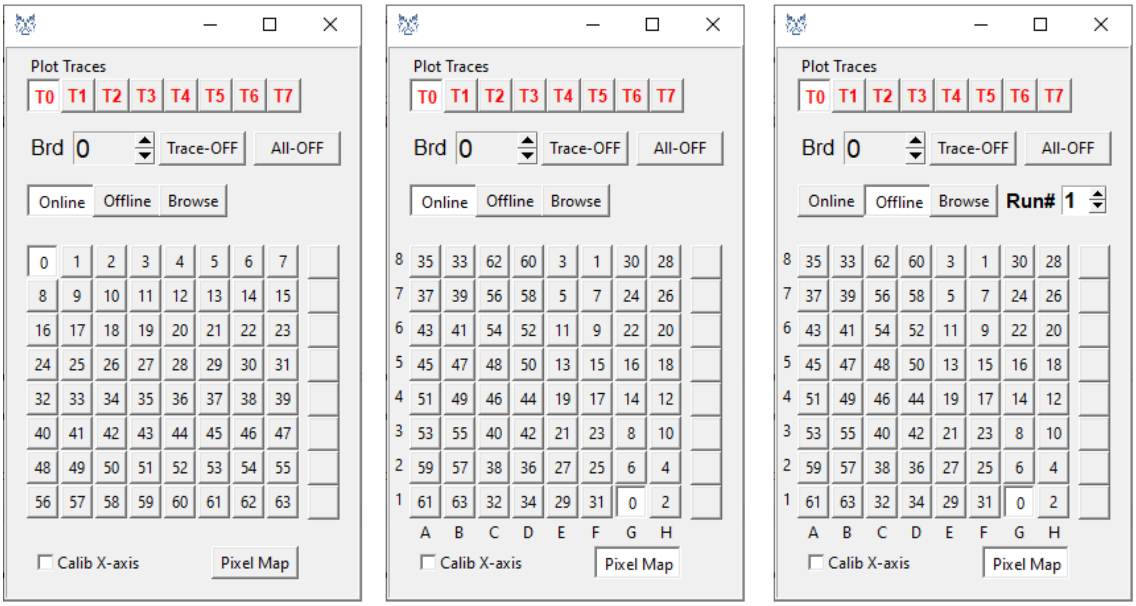


Fig. 3.7: Plot Traces window with the Pixel Map button disabled (on the left), enabled (in the middle) and with the Offline button enabled (on the right).

trace is set as an Offline trace. This option allows the user to visualize at the same time in the gnuplot window some traces associated to an ongoing acquisition and some traces from a previously saved run or to visualize only offline spectra.

- *Run#*: The command is active only when the Offline option is enabled in the Plot Traces window (see **Fig. 3.7**) and allows the user to select the ID of a previously saved run whose spectrum need to be visualized.

Note: The Offline option allows the user to visualize only the previously saved histograms, not the data from the Binary or ASCII list files (see Sec. **3.7**).

- *Browse*: The command allows the user to visualize in the gnuplot window a previously saved spectrum with any name and any path.

In **Fig. 3.8** an example of gnuplot window with some PHA spectra visualized is presented. As it is shown, the 1st trace (T0) is associated to the ongoing acquisition on Channel 24 of Board 0, the 2nd (T1) is the result of the acquisition from the same channel but for Run 1, the 3rd (T2) is the result of the acquisition from the same channel for Run 2 while the 4th trace (T3) is associated to a PHA spectrum previously saved, and whose name and path are visible in the gnuplot legend in the top right corner of the window.

A matrix is available in the Plot Traces window, where the user can choose the channel/channels to be plotted by selecting one of the following buttons:

- *N*: With N being a number between 0 and 63. The command allows the user to plot the output from channel N for the selected trace.
- *Empty Button*: The button (at the end of each row of channels) allows the user to visualize the 8 traces from the 8 channels in the corresponding row. For instance, if the first Empty Button from the top is pushed and the Pixel Map button is not enabled (see note below), trace T0 will be associated to channel 0, T1 to channel 1, etc.

- *Calib X-axis*: The command allows the user to enable/disable the calibration of the x-axis from channels to ns in case of a ToT or ToA histograms only. The spectra plots also display the mean and RMS values, expressed in channels or in the calibrated quantity depending on the option chosen.

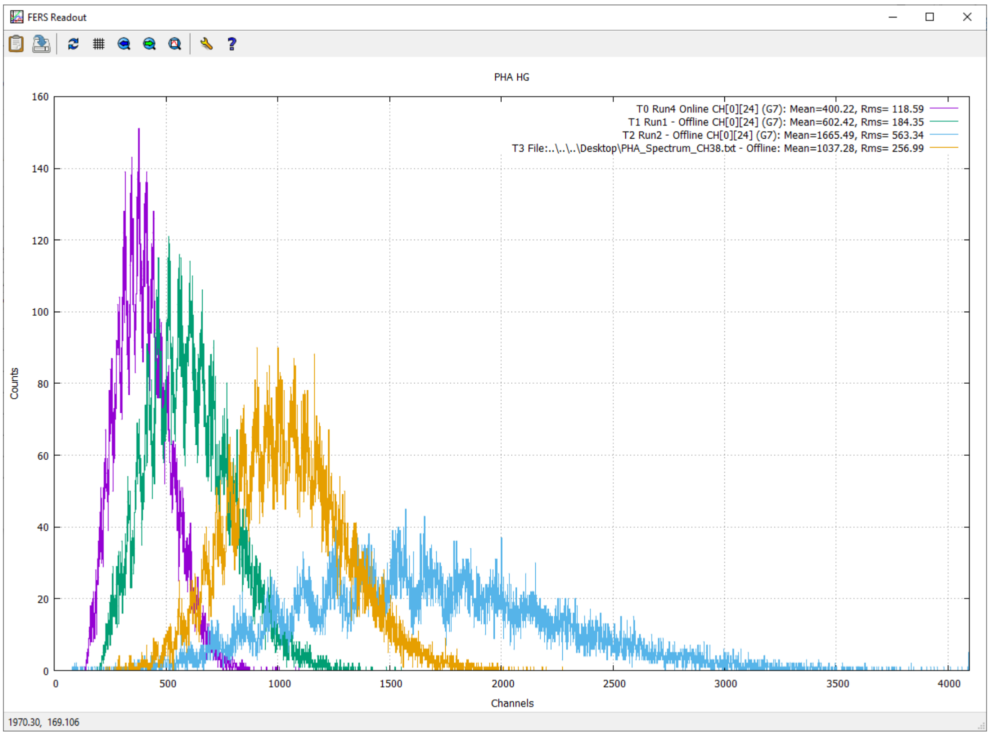


Fig. 3.8: Gnuplot window with online and offline traces visualized.

Note: If the user has selected the trace T0 and suddenly click on the Empty Button, then the 8 visualized traces will be online or offline depending on what option was selected for the trace T0. For instance, if trace T0 is an Offline trace and the user click on the Empty Button then all the 8 traces will be Offline and associated to the same run as that of T0 (e.g. Run1).

- *Pixel Map*: The button, if pressed, allows the user to visualize the correspondence between each channel and the physical position of the correspondent SiPM in a 8×8 SiPM matrix. For instance (see **Fig. 3.7** on the right), channel 50 is associated to the position D5 and thus corresponds to one of the central SiPMs of an 8×8 SiPM matrix. The pixel-channel association is loaded by Janus 5202 from the ”pixel_map.txt” file in the ”bin” folder.

Note: The Pixel Map can be set accordingly to the SiPM matrix used, by changing the ”pixel_map.txt” file. Pixel Maps for the Hamamatsu S13361-3050AE-08 SiPM matrix (coupled to the A5251 Adapter **[RD4]**), and for the OnSemi (ex SensL) ARRAYJ-60035-64P-PCB or ARRAYC-60035-64P-PCB SiPMs matrices (coupled to the A5254 Adapter **[RD4]**) are available in the ”bin” folder. The files name is ”pixel_map_Hamamatsu.txt” and ”pixel_map_ArrayJ_onsemi.txt”, respectively. The former is uploaded by default in the ”pixel_map.txt” file.

Staircase Button

The Staircase button allows the user to open the Staircase window (see **Fig. 3.9**) that permits to define the settings necessary to perform a threshold scan. The Staircase is defined as the rate of triggered events (from the TD line) by each channel as a function of the discriminator threshold. The Staircase is typically used to quote the Dark Count Rate (DCR) when no light is sent to the SiPMs as well as to establish the value of the discriminator threshold necessary to trigger a certain number of photoelectrons.

- *Min Threshold*: The command defines the minimum value of the threshold in the scan.

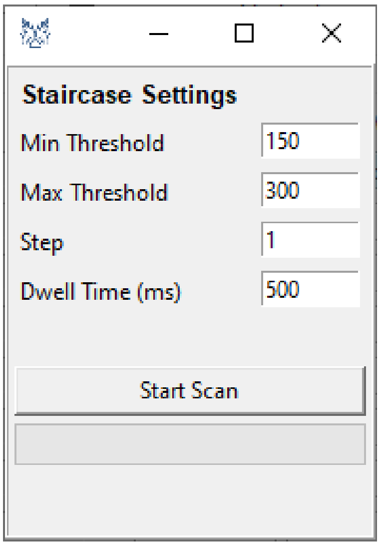


Fig. 3.9: Staircase Settings window.

- *Max Threshold*: The command defines the maximum value of the threshold in the scan.
- *Step*: The command defines the distance between two consecutive values of threshold in the scan.
- *Dwell Time (ms)*: The command defines the amount of time the self-triggers of each channel are counted.
- *Start Scan*: The button allows the user to start the scan.

Note: Typically, the scan is done in a range from about 150 to about 500 DAC units. If performed in steps of 1 DAC unit, it can take several minutes.

Note: The user is recommended to not close the Staircase Settings window while the scan is running.

Once the scan has been made, the results are saved to the "ScanThr.txt" file inside the "bin" folder and the plot can be displayed with the command in the **Plot Type** combo-box. The file is saved even after quitting Janus 5202, so the plot can also be displayed later, based on the previously acquired data. The file contains 67 columns: the first is the TD threshold, then there is a column for each channel with the channel self-triggers counted per second, and finally there are two columns with the T-OR (OR of the trigger from the TDs of all channels) and Q-OR (OR of the trigger from the QDs of all channels) signal counts. In **Fig. 3.10**, an example of a Staircase obtained with an 8×8 Hamamatsu S13361-3050AE-08 SiPM matrix **[RD5]** and no light sent to it is presented.

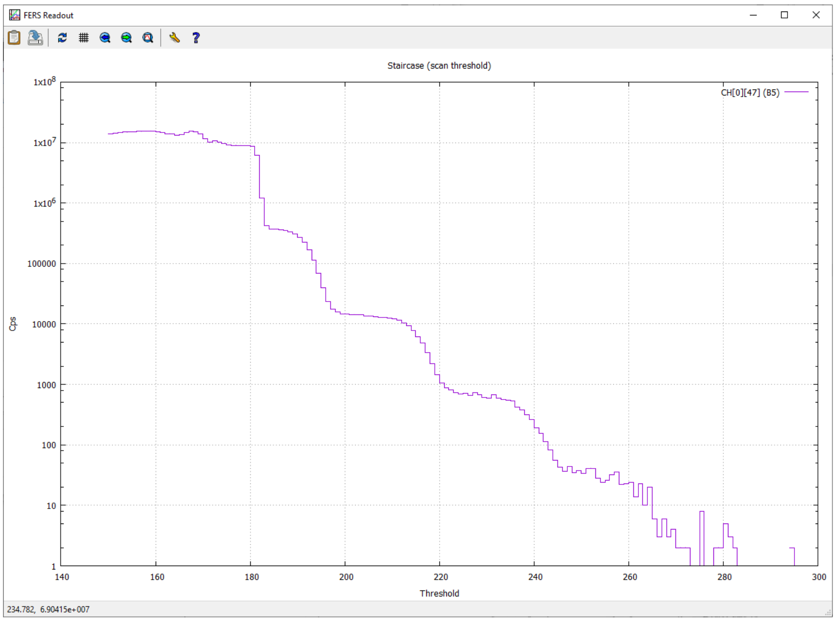


Fig. 3.10: Staircase obtained from the TD self-triggers of one channel. Each stair corresponds to a different number of photoelectrons triggered.

Hold Delay Scan Button

The Hold Delay Scan command allows the user to perform a scan of the **Hold Delay** parameter in order to select a proper value for the parameter itself during physics acquisitions when working in Spectroscopy Mode. Indeed, as explained in the A5202/DT5202 User Manual **[RD3]**, it is fundamental to set a correct value for the time distance between the trigger, which puts all channels in the Peak Detection Phase, and the Hold signal, which closes the Peak Detection Phase.
By pressing the Hold Delay Scan button, a window similar to that in **Fig. 3.11** is opened, which allows the user to define the Hold Delay Scan settings:

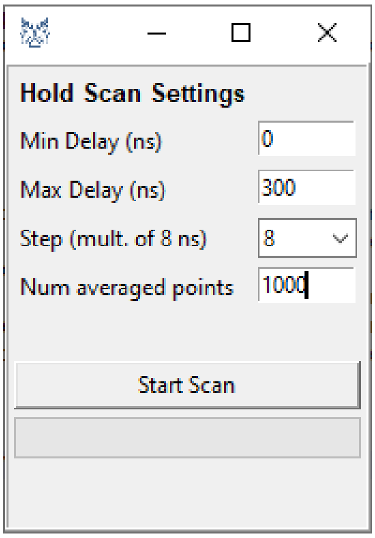


Fig. 3.11: Hold Scan Settings window.

- *Min Delay (ns)*: The minimum value for the Hold Delay parameter in the scan (suggested 0).
- *Max Delay (ns)*: The maximum value for the Hold Delay parameter in the scan.
- *Step (multipl. of 8) (ns)*: The time distance between two consecutive values of the Hold Delay parameter in the scan expressed in ns. The minimum value is 8 ns (FPGA clock period), and the scan is sensitive only to values multiples of 8.
- *Num averaged points*: The number of points, i.e. pulse height values, acquired for each value of the Hold Delay parameter.
- *Start Scan*: The button allows the user to start the scan.

Note: Before pressing the Hold Delay Scan button, the user has to select the "SPECTROSCOPY" option for the **Acquisition Mode** parameter. In the same Tab, the user should select for the **Bunch Trigger Source** parameter the same option as that to be used during physics acquisitions. For instance, if the user wants to perform a spectroscopic acquisition with an external bunch trigger (e.g. sent via the T1-IN connector), the same trigger source has to be used for the Hold Delay Scan (which has to be performed before the acquisition).

Note: The user is recommended to not close the Hold Scan Settings window while the scan is running.

In order to visualize the output of the Hold Delay Scan, the user has to choose the proper option in the **Plot Type** combo-box.
In **Fig. 3.12** an example of a 2D plot from an Hold Delay Scan obtained with an 8×8 Hamamatsu S13361-3050AE-08 SiPM matrix **[RD5]** is presented.

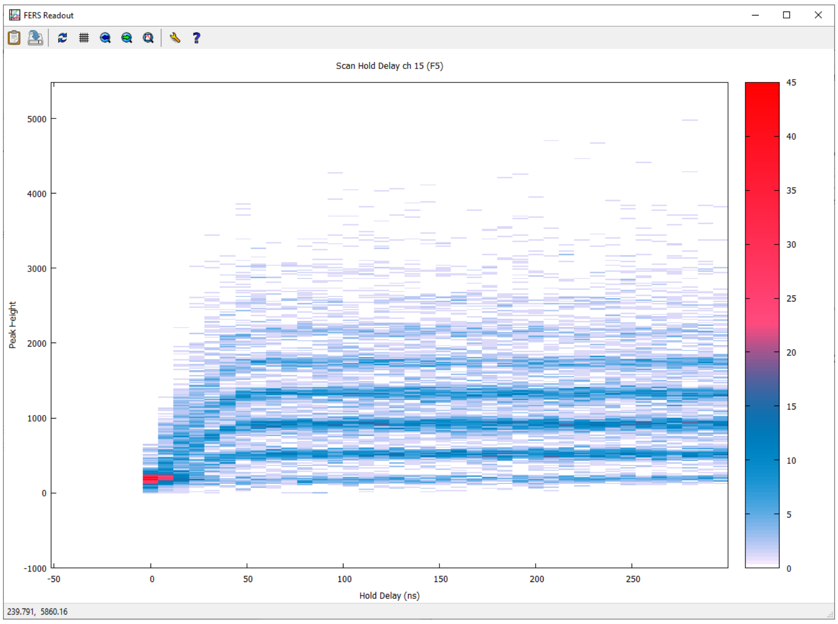


Fig. 3.12: Example of 2D plot from an Hold Delay scan. Each parallel line corresponds to a different number of photoelectrons triggered.

The plot is composed of two regions. The first one is that at low values of the Hold Delay parameter with the rising edge of the Hold signal arriving shortly after the trigger and thus not allowing to properly sample the pulse height value (a lower value is indeed saved). The pulse height value sampled increase as the Hold Delay value increases. The second region is characterized by a flat top, showing the user that the Hold Delay values in this region are high enough to properly sample the pulse height of the signal. According to **Fig. 3.12**, a value of 100 ns, for instance, for the **Hold Delay** parameter is large enough to guarantee a proper sampling of the pulse height amplitude. For **Hold Delay** parameter values lower than 50 ns, the pulse height value saved to data is lower than the effective peak amplitude. In this case, the Slow Shaper signal peaks after the hold signal is already active and thus a lower value of pulse height is A/D converted.

Save Configuration Button

The Save Configuration command has the same functionality of the *Save Config File* command of the **File** menu bar item.

Save Run Configuration Button

The Save Run Configuration command allows the user to save the current configuration of parameters in a configuration file named ”Janus_config_RunX.txt”. In this case, X indicates the run number, selected via the **Run#** command. The ”Save Run Configuration” command can be used when the user wants to perform a job composed of several runs (i.e. several consequential acquisitions) with each run corresponding to a different configuration of parameters. In this case, the user has to save for each run of the job a different configuration file. Every time a new run is started during a job, the correspondent configuration file is loaded together with the values of all the parameters. More information on how to perform a job and thus on how to properly use this command are reported in Sec. **3.16**.

Note: Before pressing the **Save Run Configuration Button**, the user should pay attention that the **Enable Jobs** switch is enabled.

Load Configuration Button

The Load Configuration command has the same functionality of the *Read Config File* command of the **File** menu bar item.

Bin to CSV Button

The Bin to CSV command allows the user to convert binary files into CSV files. The user can load a file by clicking on the numbered button 1 and browse to select a file to be converted. One single file has to be added for each row.

In case of multiple files to be converted, the user can write a generic file .txt with the list of names of all the files to be converted, then select the option ”List of binary files names”, and load the list into the row ”1”. As an example, a file called ”File_To_be_converted.txt”, which contains the following rows:

```
Run1_Spect.bin
Run2_SpectTime.bin
Run3_Time.bin
```

can be loaded into the first row and all the .bin files named in that file will be converted.

The option ”Force ToA/ToT to ns” is also available.

Once ready, press the ”Convert” button to convert the selected files.

The source code of the bin to .csv conversion is available in the ”macros” folder.

Fig. 3.13: Binary to CSV converter window.

3.3 Command Bar

A Command Bar is present below the Icon Bar of the Janus 5202 GUI (see **Fig. 3.14**).

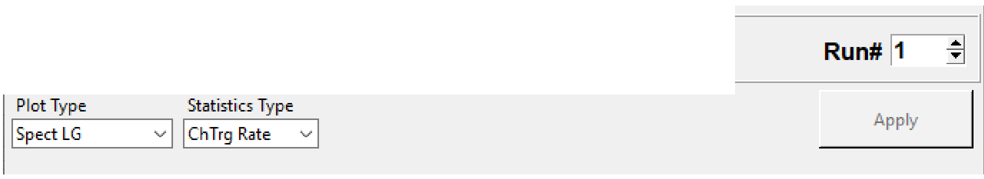


Fig. 3.14: Janus 5202 Command Bar.

Each command corresponds to the following functions.

Plot Type

The Plot Type combo-box allows the user to choose which plot has to be visualized in the gnuplot window. The available options are:

- *Spect LG*. Peak amplitude spectrum from the LG amplification chain (X-axis = Charge, Y-axis = Counts) **[RD3]**. The amplitude is saved as a 13-bit value. The spectrum can therefore have up to a maximum of 8192 channels. The user can define the number of channels visualized in the spectrum via the **Energy N Channels** parameter.
- *Spect HG*. Peak amplitude spectrum of the HG amplification chain (X-axis = Charge, Y-axis = Counts). See the "Spec-LG" option for more information.

- *Spect ToA*. Time of Arrival (ToA) spectrum (X-axis = ToA, Y-axis = Counts). The ToA is the time elapsed between the rising edge of a T_{ref} signal (defined by the **Tref Source** parameter) and the channel Time Discriminators (TD) self-triggers. In the case of Common Start Mode, the T_{ref} signal arrives before the trigger, so the ToA (which is then a ΔT) is positive. In Common Stop Mode, the T_{ref} signal arrives later and ΔT would be negative, but it is changed sign before being represented in the spectrum. The ToA has a dynamic range of up to 25 bits (1 LSB = 0.5 ns), or 16 bits when ToT is enabled. However, the spectrum is not made on 2^{25} nor 2^{16} channels, so a conversion factor is applied. The conversion is 1 LSB = 1 Channel and the value is truncated to the maximum number of channels which can be selected via the **ToA N Channels** parameter. For instance, in case the option "4K" is selected for the **ToA N Channels**, the maximum value represented for the ToA spectrum is 4096×0.5 ns = 2.048 µs .
- *Spect ToT*. Time over Threshold spectrum (X-axis = ToT, Y-axis = Counts). The ToT measurement is saved on 9 bits, so the spectrum is composed of 512 channels. The maximum ToT dynamic is therefore 256 ns (1 LSB = 0.5 ns).
- *TrgRate-Ch*: Histogram of the number of counts per second per channel (X-axis = Channel number from 0 to 63, Y-axis = Counts per Second).
- *MultiCh Scaler*: Histogram of the Multi-Channel Scaler (MCS), i.e. the frequency of self-triggers counted in a time interval, dwell time, which is defined by frequency of the Bunch Trigger Source. The spectrum has a maximum of 4k channels, after which the spectrum channels are overwritten.
- *Waveform*. Only available when the "WAVEFORM" option is selected for the **Acquisition Mode** parameter. It allows the user to plot the waveforms (only for debugging) from each Citiroc-1A MUX (X-axis = Time, Y-axis = ADC Channels). The HG amplification chain outputs from each Citiroc-1A are A/D converted sequentially. The LG amplification chain outputs are converted in parallel to these, as well as the outputs from the other Citiroc-1A chip. Each stair of the plots with the label "HG" or "LG" corresponds to the A/D converted values from a particular channel. The width of each stair is determined by the **MUX Clock Period** parameter. In the gnuplot window, also the logic signal labeled "adc-mean" is visualized, which allows the user to identify, between the A/D converted values in each stair, which one is saved to the data packet.
  To select the output from the Citiroc-1A associated to channels from 0 to 31 the user has to select any channel from 0 to 31 for the first trace in the Plot Trace window (see **Fig. 3.7**). The same instructions can be followed to select the output from the other Citiroc-1A chip.
- *2D-TrgRate*. Two-dimensional histogram (heat map) of the counts from all enabled channels. The pixels have coordinates from A to H for the X axis and from 1 to 8 for the Y axis. Pixel "A1" is the bottom left, "H8" is the top right. The correspondence between pixels and physical channels (from 0 to 63) is established on the basis of a text file named "pixel_map.txt" in the "bin" folder. The correspondence is visible also in the 2D plot (each pixel contains the channel ID number) or in the Plot Traces window (see **Fig. 3.7**) by pressing the Pixel Map button. If the "pixel_map.txt" file is not found, the default correspondence is A1 = CH0, A2 = CH1, ..., H8=CH63. The Z axis of the 2D plot displays the count rate (expressed in cps) of each channel.
- *2D-Charge LG*. Two-dimensional histogram (heat map) of the average charge read by the ADCs of all enabled channels from the LG amplification chain.
- *2D-Charge HG*. Two-dimensional histogram (heat map) of the average charge read by the ADCs of all enabled channels from the HG amplification chain.
- *Staircase*. Staircase Plot, i.e. the channel self-trigger count rate as a function of the TD threshold (X-axis = TD threshold, Y-axis = Counts per Second).
- *HoldDelay-Scan*. Only available once a Hold Delay scan has been performed. Two-dimensional histogram (heat map) from the Hold Delay scan (X-axis = Hold Delay, Y-axis = Pulse Height).

Note: When plotting the HoldDelay-scan only the trace 0 (T0) is visible in the plot, the other traces (T1-T7) are not visualized.

Statistics Type

The Statistics Type command allows the user to choose between the different values to be displayed in the Stats Tab (Sec. **3.14**) for each channel. Available options are:

- *ChTrg Rate*: The channel self-trigger rates are displayed (counting mode only).
- *ChTrg Cnt*: The channel self-triggers counted since the start of the acquisition are displayed (counting mode only).
- *Tstamp Rate*: The channel time stamp rates are displayed (timing and spect+timing mode only).
- *Tstamp Cnt*: The channel time stamped events since the start of the acquisition are displayed (timing and spect+timing mode only).
- *PHA Rate*: The rate of A/D conversions of pulse height values for each channel is displayed (spectroscopy and spect+timing mode only).
- *PHA Cnt*: The number of A/D conversions of pulse height values for each channel since the start of the acquisition is displayed (spectroscopy and spect+timing mode only).

Run#

The Run# command defines the ID number of the current run.

Apply Button

The button allows the user to save the current settings for all parameters. Every time the value of a parameter is changed, the button becomes red. The user has to press the button in order to let the changes become effective, i.e. to overwrite the ”Janus_Config.txt” file parsed by the ”JanusC.exe” application.

3.4 Status Bar

The Status Bar in the bottom part of the Janus 5202 GUI displays basic information regarding the connection, the HV and the Run status. In **Fig. 3.15** different configurations of the Status Bar are visible. From the top to the bottom the presented configurations are:

- The Janus 5202 GUI is connected to the JanusC.exe application and the boards are connected.
- The HV channel of at least one board is turned on.
- The acquisition is ongoing.
- The Janus 5202 GUI is connected, but there is some WARNING (visible in the Log). However, the Run is ready to start.

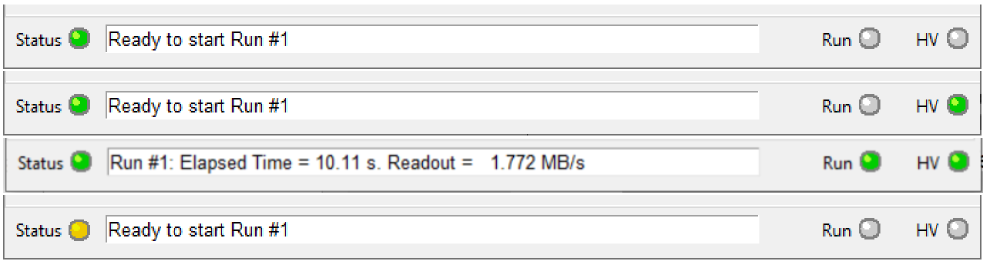


Fig. 3.15: Janus 5202 Status Bar.

3.5 Connect Tab

The Connect tab allows the user to set the connection properties of the FERS-5200 boards. Once one or more boards are connected, also information regarding the board identification number (PID) and firmware release are displayed (see **Fig. 3.16**). The number on the left of the PATH field defines the board ID number assigned by the software (between 0 and 15) once the board is connected.

PATH

This field allows the user to define the type of connection for the board. If using a USB connection there are two ways to connect the board:

1. By writing down the ”usb:PID” string, being PID the board identification number that is located either on the bottom of the A5202 PCB or on the front panel of the DT5202.
2. By writing down the ”usb:N” string, with N being an incremental number from 0 to 15.

Note: In case of a multi-board USB connection (see Sec. **3.5.1**), the option 1 is suggested to the user.

If using an Ethernet connection the user should write down ”eth:IP_ADDR”, being IP_ADDR the IP address of the board. By default, the IP address is 192.168.50.3, so that the user should write down ”**eth:192.168.50.3**” for the PATH fied.

Note: The user can change the Ethernet IP address by accessing the FERS-5200 Web Interface (see Sec. **3.5.1**). Note that the web interface is not accessible with USB connection.

In case of TDlink connection via the DT5215 Concentrator Board (single or multi board), the available options are:

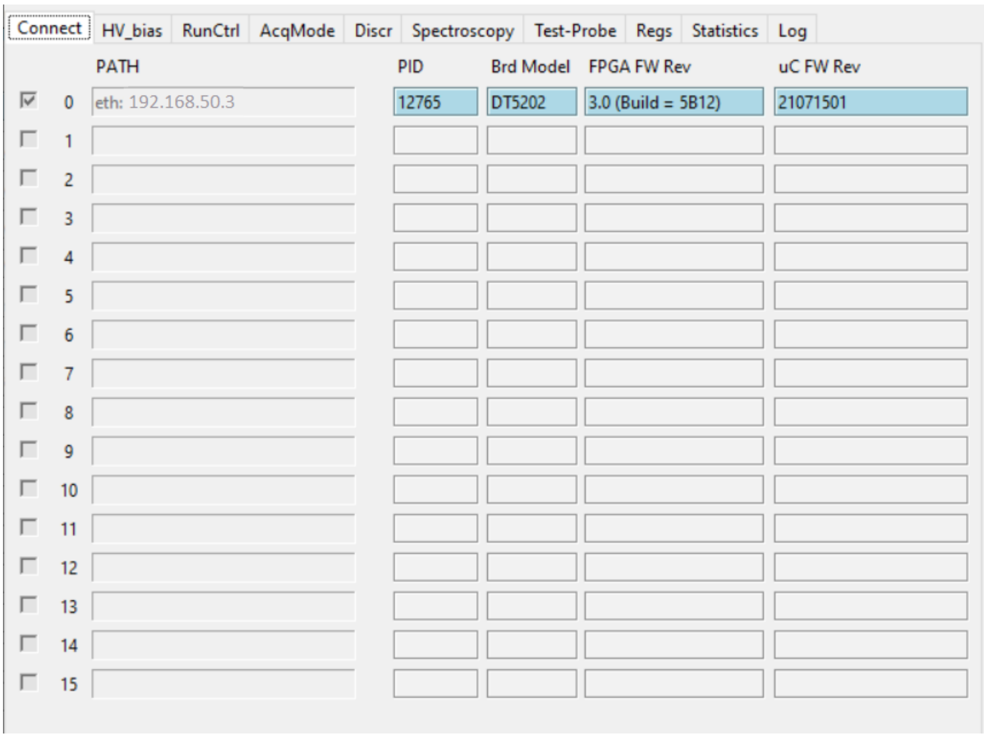


Fig. 3.16: Connect Tab.

- ”usb:IP_ADDR:tdl:x:y”, where IP_ADDR is the IP address for the USB connection to the DT5215, tdl=TDlink is the type of FERS-5200 board connection to the DT5215, and x and y the link number and board number, respectively. The default IP address of the DT5215 USB connection is: **172.16.0.11**.
- ”eth:IP_ADDR:tdl:x:y”, where IP_ADDR is the IP address for the ethernet connection to the DT5215, tdl=TDlink is the type of FERS-5200 board connection to the DT5215, and x and y the link number and board number, respectively. The default IP address of the DT5215 Ethernet connection is **192.168.50.125**.

For a single board connection to the TDlink, x=0 and y=0. For a multi board connection, refer to Sec. **3.5.1**.

In order to establish a connection with the ”JanusC.exe” application, the user has then to click on the Connect button on the top left part of the Janus 5202 GUI window .
Once the connection with the board is established, the following board parameters are visualized in the Tab:

- **PID**: The exclusive identification number associated to the specific board connected.
- **Brd Model**: The board model, between A5202 and DT5202.
- **FPGA FW Rev**: The FPGA firmware revision.
- **uC FW Rev**: The micro controller firmware revision.

3.5.1 Multi-Board Connection

The aim of this section is to describe how to perform a multi-board connection to the same PC in Janus 5202. Indeed, the software allows the user to connect up to 16 boards via Ethernet or via USB in order to control them and acquire data from all of them at the same time.

The connection PATHs should be written one after the other, starting from the first line (board number 0). As to enable the connection to the boards 1-15, the user should write the corresponding PATH and tick the box on the left side of the PATH.

Note: The PATH fields must be filled progressively.

Ethernet Connection

To control more than one board with the Janus 5202 software via an Ethernet connection the user can take advantage, for instance, of an Ethernet switch. Then, an IP address reassignment of all the boards that are needed to be connected is necessary. The user is kindly suggested to follow the instructions below in order to properly perform a multi-board Ethernet connection:

1. Connect only one board to the PC via an Ethernet cable.
2. Open the Web Interface (see A5202/DT5202 User Manual **[RD3]**) at the default IP address of the board, i.e. ”192.168.50.3” if this was not previously changed via the Web Interface.
3. Open the Configuration Tab of the Web Interface (see **Fig. 3.17**) and select for the ”IP address” parameter a value different from the IP address set for the PC. For instance, in the A5202/DT5202 User Manual **[RD3]**, the IP address of the PC was set to be ”192.168.50.4”. For this reason, the ”192.168.50.2” IP address was chosen in this example.

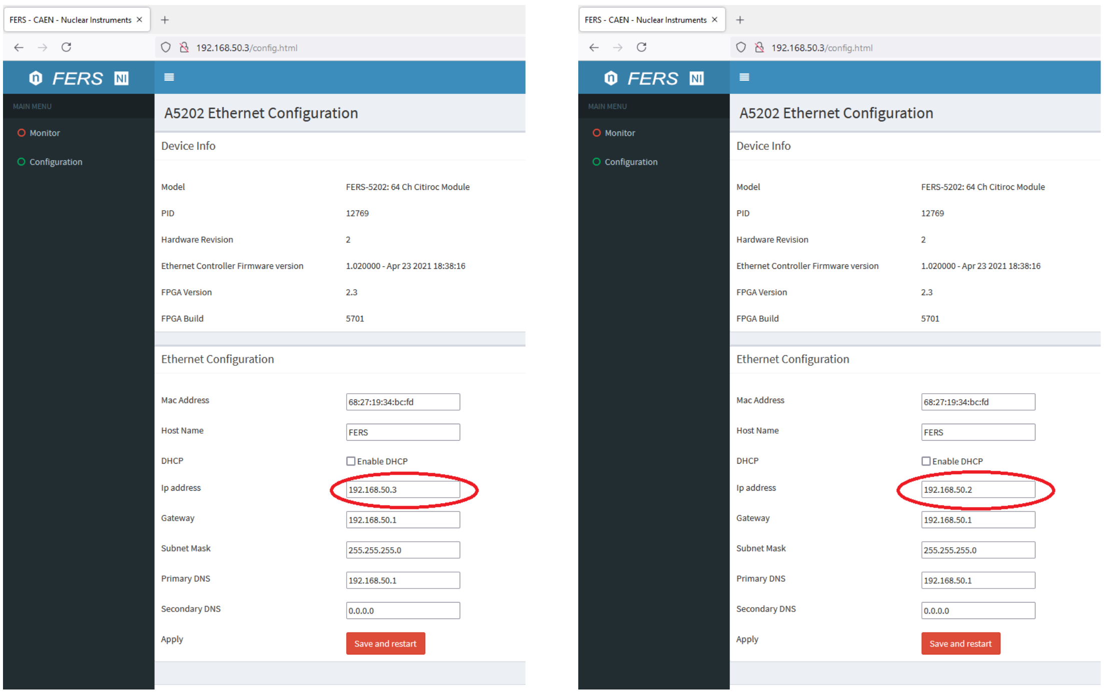


Fig. 3.17: Configuration Tab of the A5202/DT5202 Web Interface, with default settings on the left and modified IP address on the right.

4. Press on the Save and Restart button in the bottom part of the Tab, a message like that shown in **Fig. 3.18** will be displayed. The A5202/DT5202 board has been assigned with the selected IP address.

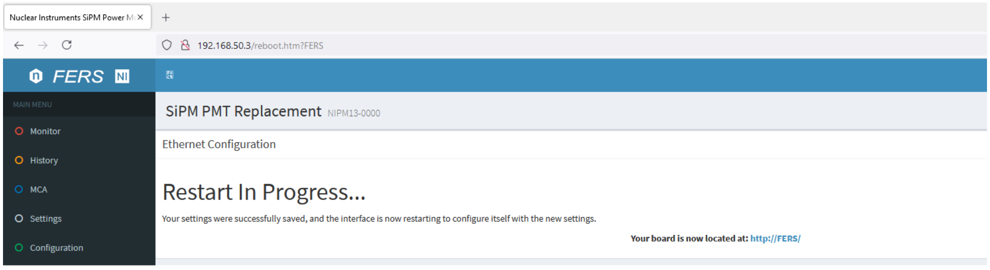


Fig. 3.18: Displayed message once the IP address of the board has been correctly changed.

5. The user can check that the connection is established by trying to ping the board via the Command Prompt (see **Fig. 3.19**) and checking the displayed message.

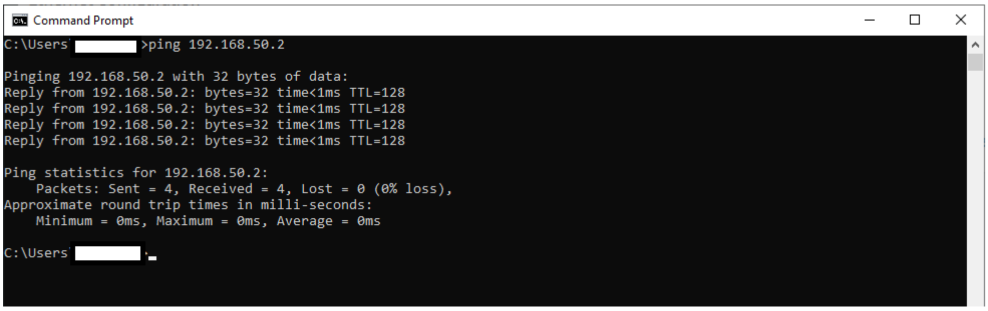


Fig. 3.19: Command prompt window with the command for testing the communication at the selected IP address.

6. The user should repeat the instructions above as many times as there are boards he/she wants to connect.

Note: Every board should have a different IP address with respect to the other boards and to the PC.

7. Connect the boards and the PC to the ports of an Ethernet switch for instance.
8. Open the Janus 5202 GUI. The IP addresses of all the boards have to be written in the PATH fields one below the other. The Connect button  can then be pressed. An example of a two-board Ethernet connection is presented in **Fig. 3.20**.

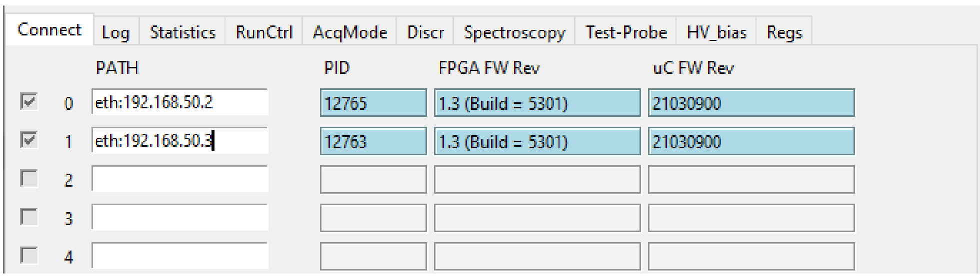


Fig. 3.20: The Janus 5202 GUI Connect Tab with a two-board Ethernet connection established.

USB Connection

In order to connect N boards via USB, the user can take advantage of an USB hub or alternatively use N USB ports of a single PC. The user should then follow the instructions below:

1. Connect all the boards via USB directly to the PC or via an USB hub.
2. Write down in the PATH field for each board "usb:PID", being PID the board unique identification number that is located either on the bottom of the A5202 PCB or on the front panel of the DT5202. Alternatively, the user should write down in the PATH field for each board the "usb:N" string, being N a progressive number ranging from 0 to 15 and depending on the number of boards which needs to be connected at the same time. An example of a two-board USB connection is presented in **Fig. 3.21**.

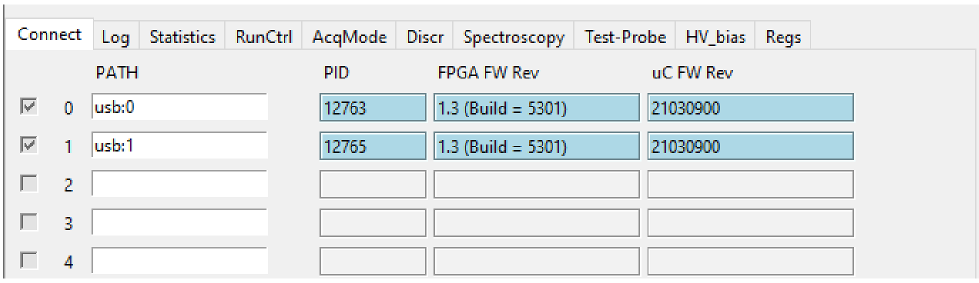


Fig. 3.21: The Janus 5202 GUI Connect Tab with a two-board USB connection established.

Note: The user can also perform a "mixed" connection by connecting some boards via Ethernet and others via USB.

TDlink Connection

Multiple A5202/DT5202 can be connected to Janus 5202 thanks to the TDlink connection of the DT5215 Concentrator Board **[DT5215]**. Each TDlink supports the connection of an individual board, or of multiple boards (up to 16) in daisy chain.
In case of a daisy-chain multi-board connection on a single DT5215 TDlink (see **Fig. 3.22**), the path of each board of the chain present a different board number y (see the PATH written in the previous lines), depending on the position of the board on the chain.
In case of single board connections on different TDlinks (see **Fig. 3.23**), the path of each board presents a different TDlink number x (see the PATH written in the previous lines), depending on the TDlink used. For further instructions on the TDlink connection, refer to **[DT5215]**.

Note: As to perform a Janus 5202 connection to the TDlinks 1-7, they must be enabled in the DT5215 Web Interface **[DT5215]**. The TDLinks must be sequentially enabled, starting from TDlink 0. Only effectively used TDlink must be enabled.

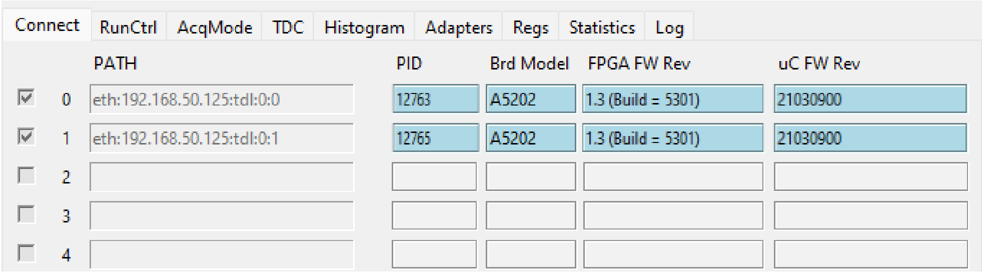


Fig. 3.22: The Janus 5202 GUI Connect Tab with a two-board TDlink connection to the DT5215, connected via Ethernet to the PC, in case of boards connected in daisy-chain.

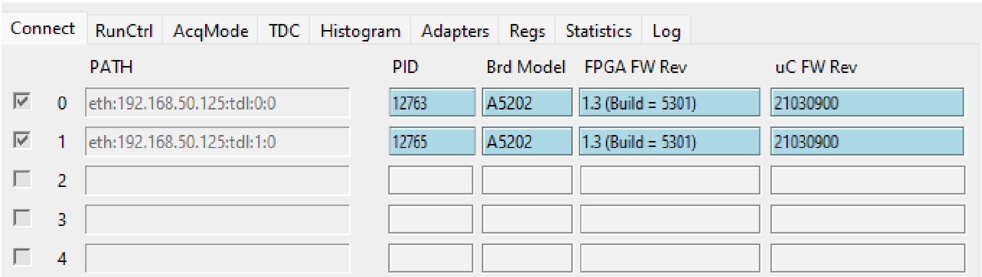


Fig. 3.23: The Janus 5202 GUI Connect Tab with a two-board TDlink connection to the DT5215, connected via Ethernet to the PC. Each board is connected individually to a TDlink.

3.6 HV_bias Tab

In order to manage the HV value provided to the SiPMs, the HV_bias Tab is available (see **Fig. 3.24**).

Note: The parameter values defined in the left part of the tab (in the fields near the parameter names) are set for all boards connected (and all channels for some parameters). In order to tune the values board-by-board and/or channel-by-channel, the user should act on the fields in the right part of the tab.

The HV_bias Tab allows the user to check and operate on the HV settings via the parameters described below.

HV VBias

The command defines the value for the bias voltage common to all channels. The available values range from 20.00 (V) to 85.00 (V). Board Tabs as those shown in **Fig. 3.25** are present in top left part of the HV_bias Tab and allow the user to define a different value of the **HV VBias** parameter for each board. For instance, the example reported in **Fig. 3.25** shows that a value of the **HV VBias** parameter of 53.80 V is set only for Board 2.

HV IMax

The command defines the limit to the current provided by the power supply module. The default value is 10.0 mA but the value can be reduced in order to protect the SiPMs. The value can be tuned individually for each board.

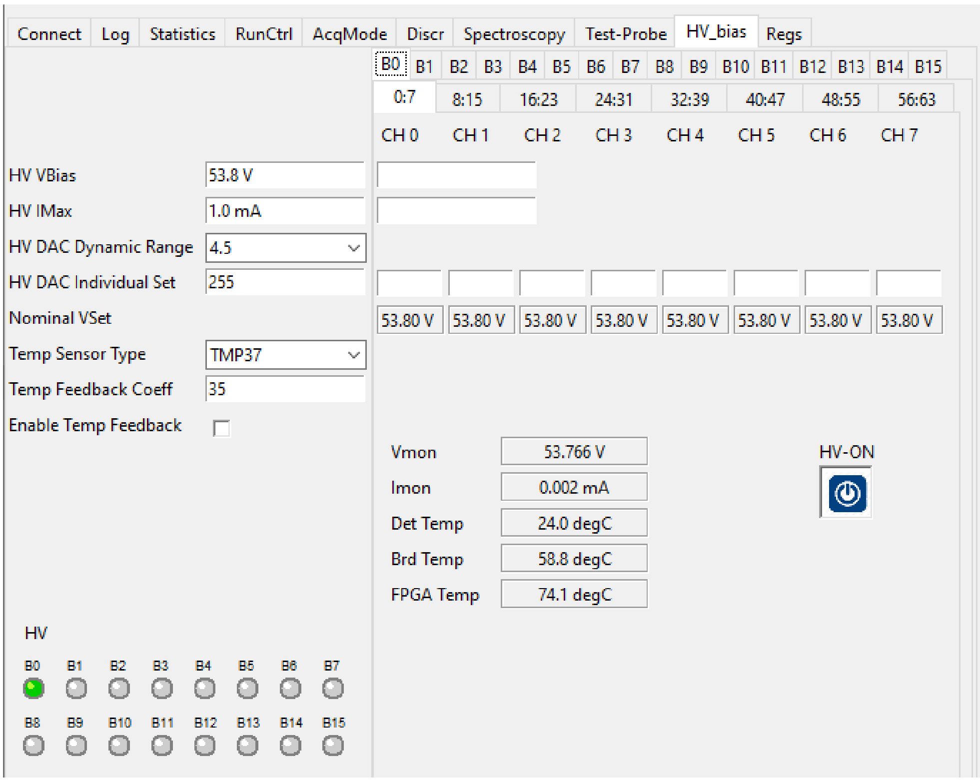


Fig. 3.24: The HV_bias Tab of the Janus 5202 GUI.

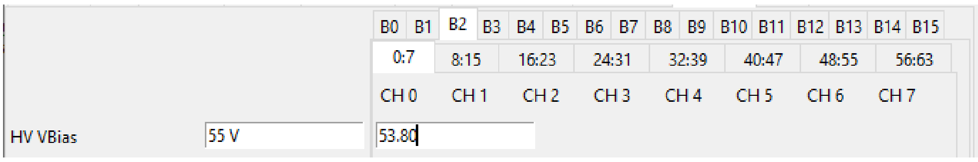


Fig. 3.25: Example of "HV VBias" parameter setting for a particular board.

HV DAC Dynamic Range

The command defines the dynamic range of the 8-bit DAC (inside the Citiroc-1A chip) for the channel-by-channel HV adjustment. The available options are:

- *4.5*: The dynamic range is set to 4.5 V.
- *2.5*: The dynamic range is set to 2.5 V.
- *DISABLED*: The DAC is disabled.

Note: When the DAC is disabled, the default tension value is measured to be 4.5 V.

HV DAC Individual Set

The command defines the value to be set for the 8-bit DAC defining the channel-by-channel HV adjustment. The value can be tuned board-by-board and/or channel-by-channel. The user should insert a value between 0 and 255. Defining with V_{DAC} the value in V units of the bias provided by the DAC, with V_{range} the DAC dynamic range and with DAC_{code} the value in LSB (between 0 and 255) of the DAC bias, then the following relation holds:

$$V_{DAC} = V_{range} \times \left(1 - \frac{DAC_{code}}{256}\right) \quad (3.1)$$

For instance if DAC_{code} is 180 and V_{range} is 4.5, then V_{DAC} is $\sim$ 1.34 V. The final value of the bias set for a particular channel (V_{bias}) is then defined starting from the common HV value and the V_{DAC} value according to the following relation:

$$V_{bias} = HV - V_{DAC} \quad (3.2)$$

Nominal VSet

Displays the channel-by-channel and board-by-board value set for V_{bias} by taking into account **Eq. 3.1** and **Eq. 3.2**.

Note: The value displayed for the "Vnom" parameter is the result of an algebraic calculation, it does not provide a monitor of the real V_{bias} value provided by the power supply module.

Temp Sensor Type

The command allows the user to select the type of temperature sensor used to measure the SiPM temperature. The available options are:

- *TMP37*. The TMP37 temperature sensor **[RD6]** (the one mounted in the A5251 FERS-5200 adapter) is used to monitor the detector temperature.
- *LM94021_G11*. The LM94021 temperature sensor **[RD7]**, with the highest gains of the temperature to voltage transfer function set, is used.
- *LM94021_G00*. The LM94021 temperature sensor **[RD7]**, with the lowest gains of the temperature to voltage transfer function set, is used.

Temp Feedback Coeff

The command defines the value of the slope for the temperature compensation curve of the A7585D power supply module **[RD2]**. Indeed, defining with T the SiPM temperature value measured by the sensor specified via the **Temp Sensor Type** parameter, the HV value provided by the A7585D module (V_{out}) is computed according to the equation below if the temperature compensation is enabled:

$$V_{out} = V_{set} + k \times (T - 25degC) \quad (3.3)$$

Being V_{set} the value defined for the **HV VBias** parameter and k the value of the feedback coefficient expressed in mV/degC.

Enable Temp Feedback

The switch allows the user to enable/disable the temperature compensation of the SiPMs according to **Eq. 3.3**.

Note: The settings regarding the temperature compensation have to be set by the user before pressing the HV-ON button in order to make them effective.

An HV Monitor window is present in the bottom right part of the HV_bias Tab, together with the HV-ON button:

- **Vmon**: The HV measured value provided by the A7585D power supply to all channels of the board selected via the Board Tab (see **Fig. 3.25**). The value does not take into account the voltage provided by the internal Citiroc-1A DACs.

- **Imon**: The current value provided by the A7585D power supply of the selected board.
- **Det Temp**: The temperature value measured by the SiPM temperature sensor. If no SiPM temperature sensors are present, a random value is displayed for this monitor.
- **Brd Temp**: The board temperature value measured by the A7585D internal temperature sensor.
- **FPGA Temp**: The measured temperature of the on-board FPGA.

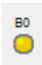
WARNING: The on-board FPGA operates correctly up to a temperature of 85 °C. The user must keep the temperature of the FPGA below this limit (e.g. by using a suitable ventilation system).

HV-ON

By pressing the HV-ON button  the HV ramp up of the board selected via the proper Board Tab (see **Fig. 3.25**) starts. During the ramp up, the user can monitor the HV and current values by looking at the Status Bar or the Vmon and Imon values (see Sec. **3.4**). To turn off the HV, the same button has to be pressed by the user.

In the bottom left part of the ”HV_Bias” tab 16 leds are present, allowing to monitor the HV status of the connected boards. Four statuses are possible:

- 

The HV channel of the board is off.
- 

The HV channel of the board is ramping up/down.
- 

The HV channel of the board is on.
- 

The HV channel of the board has been turned off because of an over-current.

3.7 RunCtrl Tab

The RunCtrl Tab allows the user to set the value of all the parameters managing the acquisition run and the format of the output files to be saved (see **Fig. 3.26**).

Start Run Mode

The command defines the source used to start the acquisition. The available options are:

- *ASYNC*. An asynchronous (between the connected boards) software command, i.e. from the **Start Button**, is used to start the acquisition.
- *CHAIN_T0*. The I/O T0 connector chain is used to transmit the Run signal **[RD3]**, which is in turn used as start acquisition signal, to several boards. If the start run signal has to be transmitted to N connected boards, the user should connect the T0-OUT connector of the i^{th} board to the T0-IN connector of the $i+1^{th}$ board, with i ranging from 1 to N-1. Then, the user should press the **Start Button** in order to start the acquisition on the board connected as Board 0 in the Janus 5202 software. The acquisition on the other boards will begin in cascade with a delay between the start of the acquisition on the i^{th} board and that on the $i+1^{th}$ of approximately 16 ns (2 FPGA clock cycles) summed to the signal delay provided by the connection cables.
- *CHAIN_T1*. The I/O T1 connector chain is used to transmit the Run signal **[RD3]**, which is in turn used as start acquisition signal, to several boards. See ”CHAIN_T0” above for further details.

Note: When the ”CHAIN_T0”/”CHAIN_T1” option is chosen for the **Start Run Mode** parameter, the option chosen for the **T0-OUT/T1-OUT** parameter is overwritten.

- *TDL*. In this case, the start command is a synchronous signal propagated via the Optical Link to all boards (connected in daisy-chain) and will be managed by the FERS-5200 Concentrator Board when available.

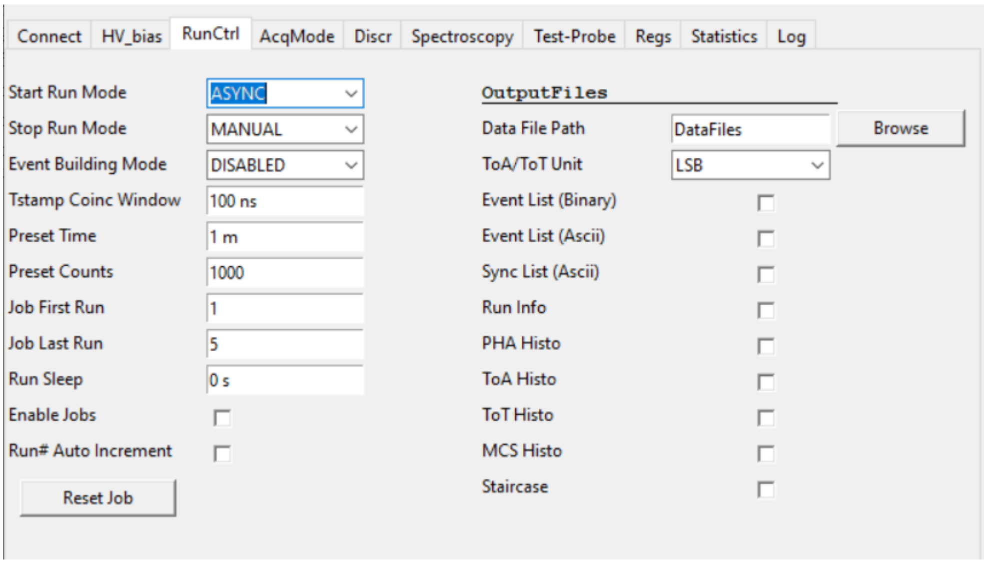


Fig. 3.26: Run Control Tab.

Stop Run Mode

The command defines the source used to stop the acquisition. The available options are:

- *MANUAL*. A software command (i.e. from the **Stop Button**) is used to stop the acquisition. This command is not available if jobs are enabled (via the **Enable Jobs** parameter).
- *PRESET_TIME*. The run is stopped after a time interval determined by the **Preset Time** parameter.
- *PRESET_COUNTS*. The run is stopped when a programmable number of events, determined via the **Preset Counts** parameter, has been acquired.

Event Building Mode

The command defines how the events from multiple boards are processed by the software and saved into the list. The available options are:

- *DISABLED*. No building is done, events are processed as received by the boards, unsorted.
- *TRGTIME_SORTING*. Events are processed according to their trigger time stamp. Events belonging to the same **Tstamp Coinc Window** are grouped in a single event in the list file.
- *TRGID_SORTING*. Events are processed according to their trigger ID. Events with the same trigger ID are grouped in a single event in the list file.

Tstamp Coinc Window

Value of time window to match the trigger time stamp of the events from multiple boards, when the ”TRGTIME_SORTING” option is selected for the **Event Building Mode** parameter.

Preset Time

The value set for this parameter defines the length of the run when the ”PRESET_TIME” option is selected for the **Stop Run Mode** parameter.

Preset Counts

The value set for this parameter defines the number of events composing the run when the ”PRESET_COUNTS” option is selected for the **Stop Run Mode** parameter.

Job First Run

The value set for this parameter defines the ID number of the first run of a series of runs, i.e. of a job.

Job Last Run

The value set for this parameter defines the ID number of the last run of the job.

Run Sleep

The command defines the time interval (expressed in s) between consecutive runs.

Enable Jobs

This switch allows the user to enable/disable the job structure of the acquisition (i.e. consecutive runs performed within the same acquisition). The run ID is automatically incremented when working with this option enabled and varies from the value set for the **Job First Run** to the value set for the **Job Last Run** parameter. More information on how to perform a job and thus on how to properly use this command are reported in Sec. **3.16**.

Run# Auto Increment

This switch allows the user to enable/disable the automatic incrementation of the run number ID. Every time a run is stopped, the ID number for the next run is incremented.

Reset Job

This button allows the user to interrupt the entire job and start over. If the user press the **Stop Button** from the ”Icon bar”, only the current run of the job is stopped.

3.7.1 Output Files Section

Data File Path

The command defines the destination folder where the data files are saved. Default location is ”DataFiles” folder under ”bin”. The user can modify the path by clicking on the ”Browse” button.

ToA/ToT Units

The command defines units of ToA and ToT when saved into file. The available options are:

- *LSB*. One LSB corresponds to 0.5 ns.
- *ns*. Time is saved in ns time unit.

Event List (Binary)

The command enables/disables the saving of the event list in binary format. One file is saved (with the data acquired from all boards) with the name ”RunX_List.dat”, being X the run number. The complete description of the binary data format for the different acquisition modes is presented in Sec. **3.8.1**.

Event List (ASCII)

The command enables/disables the saving of the event list in ASCII format. One list file is produced for each run with the name ”RunX_List.txt”, being X the run number. The complete description of the ASCII data format for the different acquisition modes is presented in Sec. **3.8.2**.

Sync List (ASCII)

The command enables/disables the saving of the event list in ASCII format writing just few information with respect to the **Event List (ASCII)**, like the board number, trigger time stamp (us), and the trigger ID. This file can be useful to check the alignnment of the events across multiple boards. One list file is produced for each run with the name ”RunX_Sync.txt”, being X the run number.

Run Info

The command enables/disables the saving of a file containing a summary of the run, like the run number, start/stop time of the measurement, firmware and software versions, and the configuration parameters.

PHA Histo

The command enables/disables saving data of the PHA spectra. The histograms (saved as a single column text file) can be that from the HG or that from the LG amplification chain depending on the selected value of the **Gain Selection** parameter. One file per channel and for each amplification chain is saved.

ToA Histo

The command enables/disables saving data of the ToA spectra. The histograms are saved as a single column text file for each channel.

ToT Histo

The command enables/disables saving data of the ToT spectra. The histograms are saved as a single column text file for each channel.

MCS Histo

The command enables/disables saving data of the MCS spectra. The histograms are saved as a single column text file for each channel.

Staircase

To be enabled only when performing a Staircase acquisition. The command allows the user to save one file per channel, where each file contains a column reporting the threshold values and one column with the corresponding frequency (cps) of TD self-triggers.

3.8 Data Format

Note: Starting from Janus 5202 software release $\geq$ 3.2.2, the data format has been modified according the description below. Data format version is 3.2.

3.8.1 Binary Format

Header structure

In binary format, each file is composed by a header containing the information regarding the data format and software version, the acquisition mode and the time stamp of the start of the acquisition:

FILE HEADER	
Data Format Version	(int, 16 bits)
Software Version	(int, 24 bits)
Board Type	(int, 16 bits)
Run Number	(int, 16 bits)
Acq Mode	(int, 8 bits)
Energy NChannels	(int, 16 bits)
Time Unit	(int, 8 bits)
Time conversion	(float, 32 bits)
Start Acquisition (ms)	(int, 64 bits)

For the *Acquisition Mode* information, the available values are:

- *0x01* for Spectroscopy Mode;
- *0x02* for Timing Mode;
- *0x03* for Spectroscopy + Timing Mode;
- *0x04* for Counting Mode;

Time unit can be:

- *0* time expressed in LSB (ToA should be read as uint32, ToT as uint16);
- *1* time expressed in ns (ToA and ToT should be read as float numbers).

Energy NChannels is the total number of channels of the Energy histogram.

Time conversion is the conversion value between LSB and ns for the timing information. For A5202/DT5202 this value is 1 LSB = 0.5 ns.

The "Start Acquisition" information is expressed in ms with reference to the UnixEpoch time.

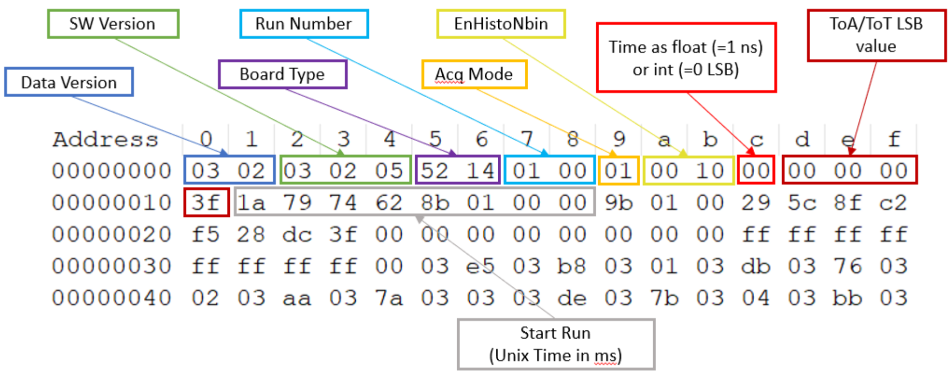


Fig. 3.27: File header example (binary format).

In **Fig. 3.27** an example of a file header in binary format is presented. The colors (the same used in the data format description) correspond to:

- Blue = Data Format Version = 0x0302 = 3.2
- Green = Software Version = 0x030205 = 3.2.5
- Violet = Board Type = 0x1452 = 5202
- Cyan = Run Number = 0x01 = 1
- Orange = Acq Mode = 0x01 = Spectroscopy
- Yellow = EnHistoNbin (Number of bins of the Energy Histogram) = 0x1000 = 4096 channels
- Red = Time Unit = 0x00 = Time in LSB
- Purple = ToA/ToT LSB value (Time Conversion) = 0x3F000000 = 0.5 ns
- Gray = Start Acquisition = 0x018B6274791A = 1698163882266 ms

The data format for the remaining part of the file depends on the particular acquisition mode selected. However, regardless of the acquisition mode, each event is constituted by a Header and a Data part.

Spectroscopy Mode

The structure of each PHA event is described below:

EVENT HEADER	
Event Size (byte)	(int, 16 bits)
Board ID	(int, 8 bits)
Trigger Time Stamp (µs)	(double, 64 bits)
Trigger ID	(int, 64 bits)
Channel Mask	(int, 64 bits)
EVENT DATA ($\times$N)	

where N=Number of Channels with PHA information written to file and the event data is composed by:

Channel ID	(int, 8 bits)
Data Type	(int, 8 bits)
LG PHA Value	(int, 16 bits)
HG PHA Value	(int, 16 bits)

Note: The "Event Size" information also includes the size of the variable itself, i.e. 2 bytes.

Note: The PHA values ranges from 0 to the value defined by the **Energy N Channels** parameter.

Note: The "Channel Mask" information is the mask of channels whose information is written in the output file for each event, not the mask of the enabled channels. More precisely, for every spectroscopy event, the PHA information from each enabled channel whose PHA values are above the **ZS Threshold LG** and/or the **ZS Threshold HG** value is saved.

The available options for the ”Data Type” information are:

- 0x01, if only the LG PHA values are saved.
- 0x02, if only the HG PHA values are saved.
- 0x03, if both LG and HG PHA values are saved.

In **Fig. 3.28** an example of a data file in binary format of spectroscopy data is presented.

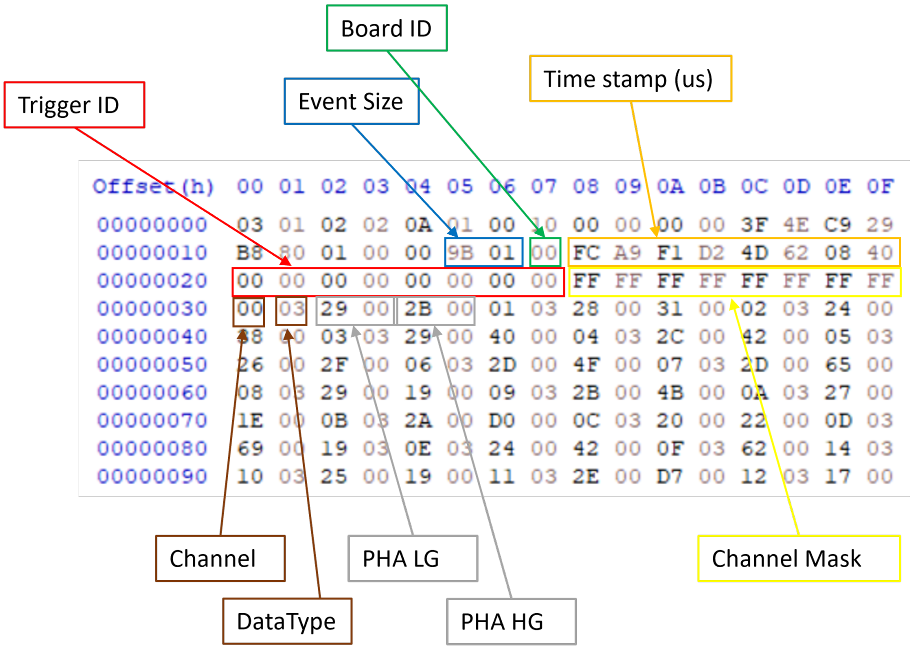


Fig. 3.28: Event List example in Spectroscopy Mode (binary format).

The colors (the same used in the data format description) correspond to:

- Blue = Event Size = 0x19B = 411 (dec) bytes
- Green = Board ID = 0
- Orange = Trigger Time Stamp = 0x4008624DD2F1A9FC = 3.048 (dec) µs
- Red = Trigger ID = 0
- Yellow = Channel Mask = 0xFFFFFFFFFFFFFFFF = All channel PHA values written to file
- Brown = Channel ID = 0
- Brown = Data Type = 0x03 = Both LG and HG PHA values stored
- Gray = LG PHA Value = 0x29 = 41
- Gray = HG PHA Value = 0x2B = 43

Timing Mode

The structure of each timing event is described below:

EVENT HEADER

Event Size (bytes)	(int, 16 bits)
Board ID	(int, 8 bits)
T_{ref} Time Stamp (µs)	(double, 64 bits)
Number of Hits	(int, 16 bits)

EVENT DATA (×N)

where N=Number of Recorded Hits and the event data is composed by:

Channel ID	(int, 8 bits)
Data Type	(int, 8 bits)
ToA (ch)	(float, 32 bits if ns, int, 32 bit if LSB)
ToT (ch)	(float, 32 bits if ns, int, 16 bit if LSB)

The available options for the ”Data Type” information are:

- 0x10, if only the ToA value is saved for that channel.
- 0x20, if only the ToT value is saved for that channel.
- 0x30, if both ToA and ToT values are saved.

In **Fig. 3.29** and **3.30** two examples of output file in binary format of timing data are presented, where ToA/ToT is expressed in LSB and ns, respectively.

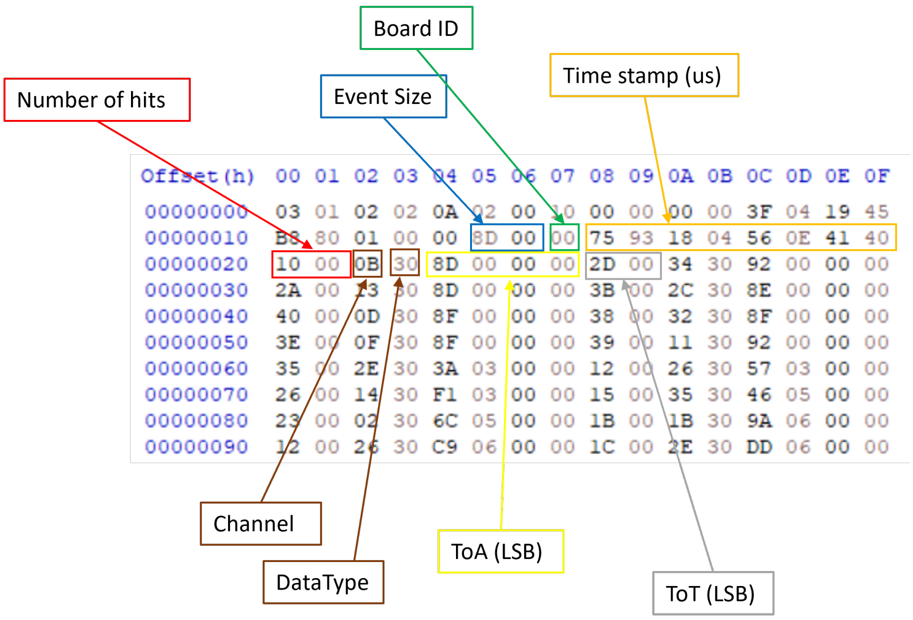


Fig. 3.29: Event List example in Timing Mode (binary format) when ToA and ToT are expressed in LSB.

The colors (the same used in the data format description) correspond to:

- Blue = Event Size = 0x8D = 141 (dec) bytes
- Green = Board ID = 0

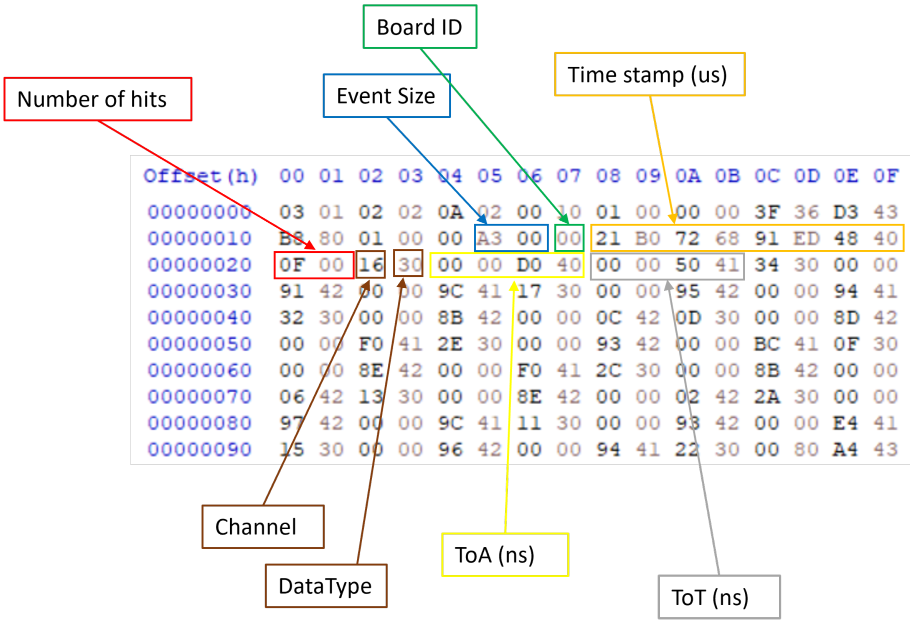


Fig. 3.30: Event List example in Timing Mode (binary format) when ToA and ToT are expressed in ns.

- Orange = Trigger Time Stamp = 0x40410E5604189375 = 34.112 (dec) µs
- Red = Number of Hits = 0x10 = 16 (dec)
- Brown = Channel ID = 0x0B = 11 (dec)
- Brown = Data Type = 0x30 = Both ToA and ToT values are saved
- Yellow = ToA = 0x8D = 141 (dec) LSB (= 70.5 ns)
- Gray = ToT = 0x2D = 45 (dec) LSB (= 21.5 ns)

Referring to **Fig. 3.30**:

- Yellow = ToA = 0x40D0 = 6.5 ns
- Gray = ToT = 0x4150 = 13.0 ns

Spectroscopy + Timing Mode

The structure of each time stamped energy event is described below:

EVENT HEADER	
Event Size (bytes)	(int, 16 bits)
Board ID	(int, 8 bits)
Trigger Time Stamp (µs)	(double, 64 bits)
Trigger ID	(int, 64 bits)
Channel Mask	(int, 64 bits)
EVENT DATA (×N)	

where N=Number of Channels with PHA information written to file and the "EVENT DATA" is made of:

Channel ID	(int, 8 bits)
Data Type	(int, 8 bits)
LG PHA Value	(int, 16 bits)
HG PHA Value	(int, 16 bits)
ToA (ch)	(float, 32 bits if ns, int, 32 bit if LSB)
ToT (ch)	(float, 32 bits if ns, int, 16 bit if LSB)

Note: When working in Spectrosocopy + Timing Mode some channels can be associated only to PHA values and not to ToA or ToT values. The user should always refer to the "Data Type" variable indicating which information is present for each channel.

The available options for the "Data Type" information are:

- 0x01, if only the LG PHA values are present for that channel.
- 0x02, if only the HG PHA values are present for that channel.
- 0x03, if both LG and HG PHA values are present for that channel.
- 0x10, if only the ToA information is present for that channel.
- 0x20, if only the ToT information is present for that channel.
- A combination of the previously described information. For example, the value 0x33 indicates that both LG and HG PHA values are present together with ToA and ToT values.

In **Fig. 3.31** and **3.32** two examples of output file in binary format of spectroscopy + timing data is presented, where ToA/ToT information is reported in LSB and ns, respectively.

Referring to **Fig. 3.32**, the colors (the same used in the data format description) correspond to:

- Red = File Header
- Blue = Event Size = 0x37 = 55 (dec) bytes
- Green = Board ID = 0
- Light Orange = Trigger Time Stamp = 0x407D870A3D70A3D7 = 472.44 (dec) µs
- Red = Trigger ID = 0
- Yellow = Channel Mask = 0x01 0x01 = Only channels 0 and 32 are saved in the output file
- Brown = Channel ID = 0x0, the current data belongs to ch0
- Brown = Data Type = 0x33 = Both LG and HG PHA values stored, together with ToA and ToT values
- Gray = LG PHA Value = 0x224 = 548 (dec) ch

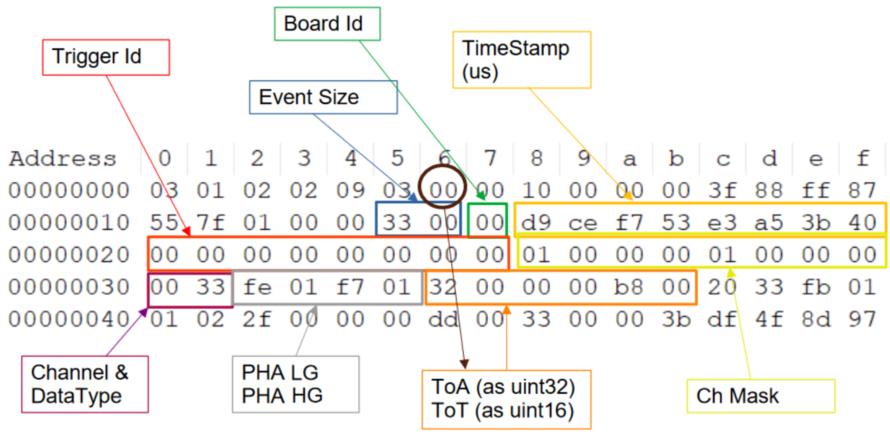


Fig. 3.31: Event List example in Spectroscopy + Timing Mode (binary format), where ToA and ToT are reported in LSB.

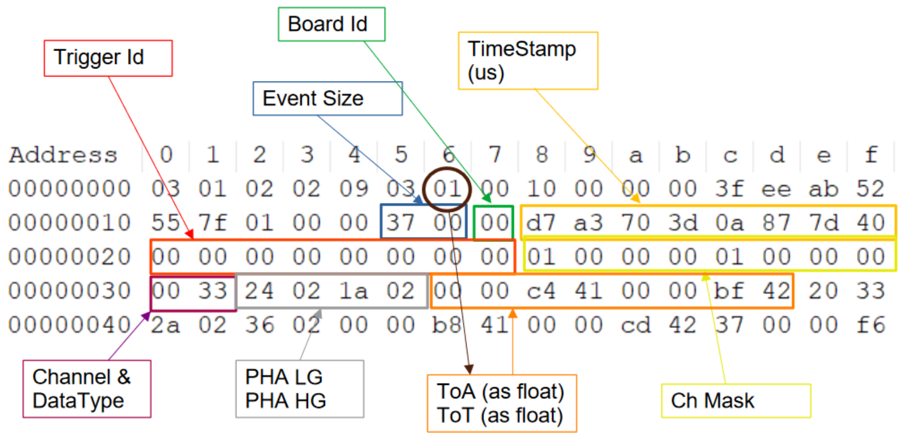


Fig. 3.32: Event List example in Spectroscopy + Timing Mode (binary format), where ToA and ToT are reported in ns.

- Gray = HG PHA Value = 0x21A = 538 (dec) ch
- Orange = ToA = 0x41C40000 = 24.5 ns
- Orange = ToT = 0x42BF0000 = 95.5 ns

Referring to **Fig. 3.31**:

- Orange = ToA = 0x32 = 50 LSB
- Orange = ToT = 0xB8 = 184 LSB

Counting Mode

The structure of each counting event is described below:

EVENT HEADER

Event Size (bytes) (int, 16 bit)

Board ID (int, 8 bit)

Trigger Time Stamp (µs) (double, 64 bit)

Trigger ID (int, 64 bit)

Channel Mask (int, 64 bit)

EVENT DATA (×N)

where N=Number of Enabled Channels and the event data is composed by:

Channel ID (int, 8 bit)

Counts (int, 32 bit)

In **Fig. 3.33** an example of output file in binary format of counting data is presented.

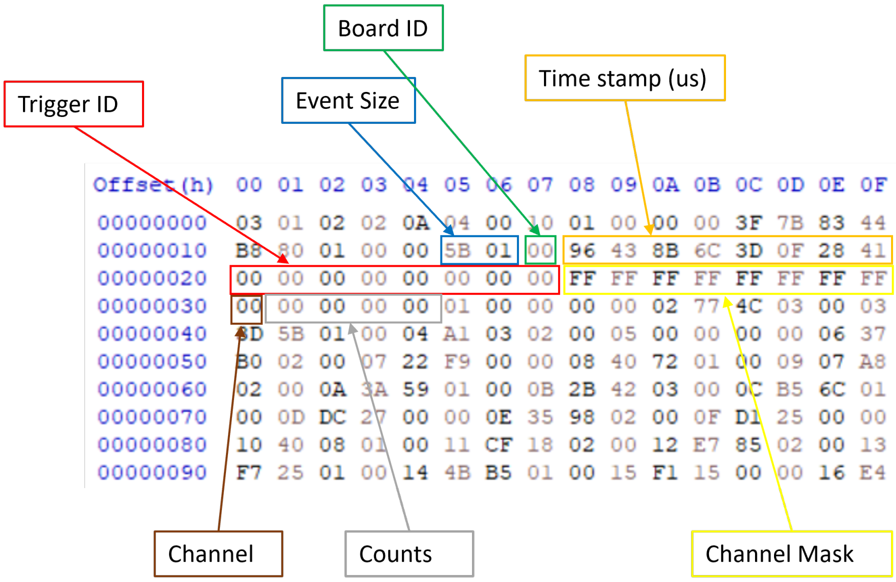


Fig. 3.33: Event List example in Counting Mode (binary format).

The colors (the same used in the data format description) correspond to:

- Green = Event Size = 0x15B = 347 (dec) bytes
- Orange = Board ID = 0
- Light Blue = Trigger Time Stamp = 0x41280F3D6C8B4396 = 788382.712 (dec) µs
- Violet = Trigger ID = 0
- Olive = Channel Mask = 0xFFFFFFFFFFFFFFFF = All channel counts written to file
- Black = Channel ID = 0
- Gray = Counts = 0x0 = 0

Note: When operating in Counting Mode, the counts from all channels are saved to the data packet by the FPGA and transmitted to the PC. However, only the counts from the enabled channels are written in the output file at software level.

3.8.2 ASCII Format

In ASCII format, as for the binary format, each file is composed by a **header** with the information regarding the data format and software version, the acquisition mode, the energy spectrum total channels, time conversion, and the time stamp of the start of the acquisition. The remaining information that is saved in the output file depends on the selected acquisition mode and is described below.

Spectroscopy Mode

As for the correspondent binary file, the data part of the file contains the list of PHA values recorded for each enabled channel (with PHA values over ZS threshold). Trigger time stamp in µs, Trigger ID, board and channel are reported as well for each event. An example of output file in Spectroscopy Mode saved in ASCII format is presented in **Fig. 3.34**.

```
//************************************************
// File Format Version 3.2
// Janus Release 3.2.5
// Acquisition Mode: Spectroscopy
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Tue Oct 24 16:11:22 2023 UTC
//************************************************
         Tstamp_us          TrgID    Brd  Ch         LG         HG
             3.048              0     00  00         41         43
                                      00  01         40         49
                                      00  02         36         56
                                      00  03         41         64
                                      00  04         44         66
                                      00  05         38         47
                                      00  06         45         79
                                      00  07         45        101
                                      00  08         41         25
                                      00  09         43         75
                                      00  10         39         30
                                      00  11         42        208
                                      00  12         32         34
                                      00  13        105        793
                                      00  14         36         66
                                      00  15         98        788
                                      00  16         37         25
                                      00  17         46        215
                                      00  18         23         75
```

Fig. 3.34: Event List example in Spectroscopy Mode (ASCII format).

Note: The PHA values ranges from 0 to the value defined by the **Energy N Channels** parameter.

Timing Mode

The output file contains, after the header, the list of channels that triggered together with the ToA and ToT values (see **Fig. 3.35** and **3.36** for the representation in LSB and ns, respectively).

```
//**************************************************
// File Format Version 3.2
// Janus Release 3.2.5
// Acquisition Mode: Timing
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Tue Oct 24 16:11:22 2023 UTC
//**************************************************
       Tstamp_us        TrgID   Brd  Ch   ToA_LSB   ToT_LSB
          34.112            0   00   11     141        45
                                00   52     146        42
                                00   19     141        59
                                00   44     142        64
                                00   13     143        56
                                00   50     143        62
                                00   15     143        57
                                00   17     146        53
                                00   46     826        18
                                00   38     855        38
                                00   20    1009        21
                                00   53    1350        35
                                00   02    1388        27
                                00   27    1690        18
                                00   38    1737        28
                                00   46    1757        21
         130.544            0   00   39       3        29
                                00   11     138        57
                                00   50     142        62
                                00   13     146        49
                                00   46     144        46
                                00   15     146        49
                                00   44     142        68
                                00   17     146        46
                                00   52     144        49
                                00   19     141        69
                                00   42     148        46
                                00   21     150        42
                                00   23     150        40
                                00   28     759        18
                                00   44     866        20
                                00   10    1380        15
```

Fig. 3.35: Event List example in Timing Mode (ASCII format) when ToA and ToT are expressed in LSB.

```
//************************************************
// File Format Version 3.2
// Janus Release 3.2.5
// Acquisition Mode: Timing
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Tue Oct 24 16:11:22 2023 UTC
//************************************************
      Tstamp_us        TrgID   Brd  Ch    ToA_ns    ToT_ns
         49.856            0    00  22       6.5      13.0
                                00  52      72.5      19.5
                                00  23      74.5      18.5
                                00  50      69.5      35.0
                                00  13      70.5      30.0
                                00  46      73.5      23.5
                                00  15      71.0      30.0
                                00  44      69.5      33.5
                                00  19      71.0      32.5
                                00  42      75.5      19.5
                                00  17      73.5      28.5
                                00  21      75.0      18.5
                                00  34     329.0      16.5
                                00  40     455.5       8.5
                                00  52     550.0       8.5
        146.296            0    00  13      71.0      27.5
                                00  52      73.5      21.0
                                00  15      71.0      28.0
                                00  50      70.0      34.0
                                00  17      71.5      25.0
                                00  44      71.0      31.5
                                00  19      69.5      35.0
                                00  11      76.0      16.5
                                00  04     170.0      10.0
                                00  60     219.0      23.5
                                00  06     253.5       6.5
                                00  09     316.5      10.5
```

Fig. 3.36: Event List example in Timing Mode (ASCII format) when ToA and ToT are expressed in ns.

Spectroscopy + Timing Mode

As for the correspondent binary file, the output ASCII file can contain, after the header, the PHA, ToT and ToA information for each event. An example of output file in Spectroscopy + Timing Mode saved in ASCII format is presented in **Fig. 3.37**, where ToA and ToT are expressed in ns. The corresponding file with time expressed in LSB is also possible.

Note: When working in Spectrosocopy + Timing Mode some channels can be associated only to PHA values and not to ToA or ToT values.

```
//************************************************
// File Format Version 3.2
// Janus Release 3.2.5
// Acquisition Mode: Spect_Timing
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Tue Oct 24 16:11:22 2023 UTC
//************************************************
       Tstamp_us        TrgID   Brd  Ch       LG       HG   ToA_ns   ToT_ns
           2.880            0    00  00       39       39        -        -
                                 00  01       36       35        -        -
                                 00  02       36       20    919.0      8.0
                                 00  03       42       55        -        -
                                 00  04       30        9        -        -
                                 00  05       40       41        -        -
                                 00  06       36       12        -        -
                                 00  07       38       69        -        -
                                 00  08       33       13        -        -
                                 00  09       31    32766    955.0      5.5
                                 00  10       38      160    140.0     14.0
                                 00  11       37      282     74.0     20.0
                                 00  12       45      141        -        -
                                 00  13      105      785     71.0     28.0
                                 00  14       35       14        -        -
                                 00  15      105      768     71.0     28.5
                                 00  16       35       69        -        -
                                 00  17       36      101    855.0      8.5
                                 00  18       38      100        -        -
                                 00  19      117      861     71.0     29.5
                                 00  20       35       32        -        -
                                 00  21       44      236     83.5      8.5
                                 00  22       38       25        -        -
                                 00  23       57      240     83.0      9.0
                                 00  24       36    32767        -        -
                                 00  25       32       12        -        -
                                 00  26       39       53        -        -
                                 00  27       33       49        -        -
```

Fig. 3.37: Event List example in Spectroscopy + Timing Mode (ASCII format), where ToA and ToT are expressed in ns.

Counting Mode

The output file contains, after the header, the list of channels together with the events counted since the previous trigger (see **Fig. 3.38**).

```
//************************************************
// File Format Version 3.2
// Janus Release 3.2.5
// Acquisition Mode: Counting
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Tue Oct 24 16:11:22 2023 UTC
//************************************************
       Tstamp_us        TrgID   Brd  Ch          Cnt
      788382.712            0    00  00            0
                                 00  01            0
                                 00  02       216183
                                 00  03        88893
                                 00  04       132001
                                 00  05            0
                                 00  06       176183
                                 00  07        63778
                                 00  08        94784
                                 00  09       174087
                                 00  10        88378
                                 00  11       213547
                                 00  12        93365
                                 00  13        10204
                                 00  14       170037
                                 00  15         9681
                                 00  16        67648
                                 00  17       137423
                                 00  18       165351
                                 00  19        75255
                                 00  20       111947
                                 00  21         5617
                                 00  22       109028
                                 00  23         5304
                                 00  24        89803
                                 00  25        66000
```

Fig. 3.38: Event List example in Counting Mode (ASCII format).

3.9 AcqMode Tab

The AcqMode Tab allows the user to set the value of all parameters concerning the different acquisition modes of the FERS-5200 unit, the trigger logic to be used as well as the settings of the front panel I/Os (see **Fig. 3.39**). Settings may differ according to the selected ”Acquisition Mode”.

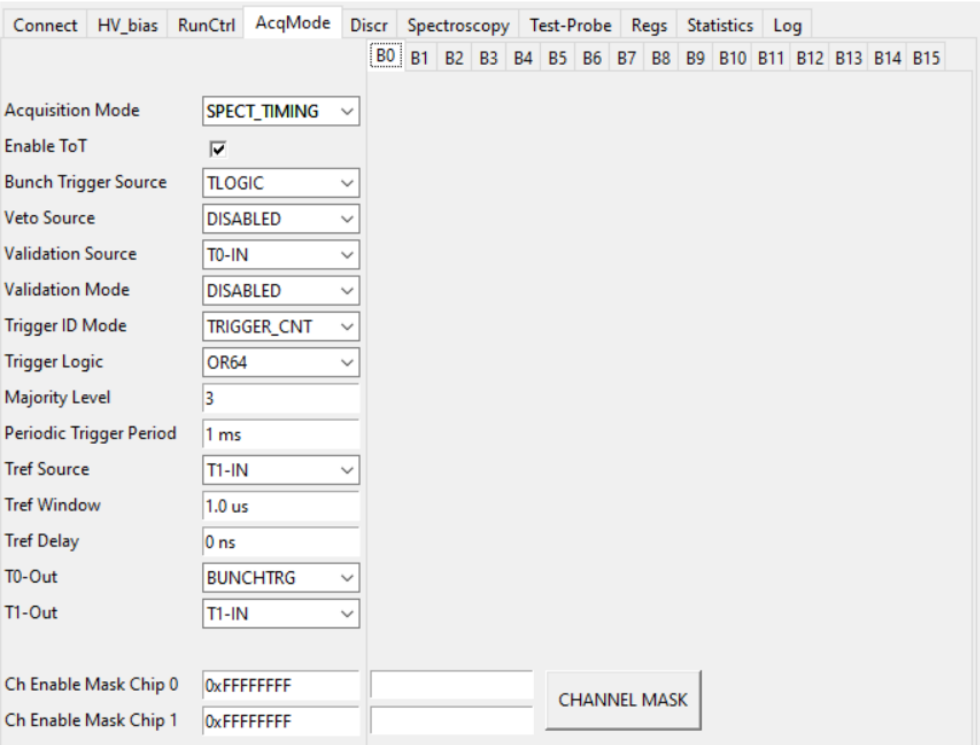


Fig. 3.39: Acquisition Mode Tab in case of Spectroscopy and Timing acquisition mode.

Acquisition Mode

The command allows the user to choose between the different acquisition modes, see **[RD3]** for more details. Possible values are:

- *SPECTROSCOPY*. The Spectroscopy Mode is selected as acquisition mode.
- *SPECT_TIMING*. The Spectroscopy + Timing Mode. PHA, ToA and ToT information is stored for each event.
- *TIMING_CSTART*. The Timing Mode (Common Start Mode) is selected as acquisition mode.
- *TIMING_CSTOP*. The Timing Mode (Common Stop Mode) is selected as acquisition mode.
- *COUNTING*. The Counting Mode is selected as acquisition mode.
- *WAVEFORM*. The Waveform Mode (only for debugging) is selected as acquisition mode. It allows the user, by selecting the ”Waveform” option via the **Plot Type** combo-box, to visualize the waveforms from each Citiroc-1A MUX.

Note: When operating in Spectroscopy + Timing Mode, the **Bunch Trigger Source** parameter defines the signal starting the A/D conversion, while the **Tref Source** parameter defines the signal opening (Common Start), or closing (Common Stop), the gate of hit acquisition.

Enable ToT

The checkbox enables/disables the ToT in the data throughput. When enabled, the time information is made of ToA (16 bits) and ToT (9 bits); when disabled, the time information is made of ToA (25 bits) only.

Bunch Trigger Source

The command defines the bunch trigger source. The bunch trigger is the trigger transmitted to all channels and defining the start of the A/D conversion sequence (Spectroscopy Mode) or the signal defining the counters latching time (Counting Mode). The available options are:

- *T0-IN*. The signal from the T0-IN connector is used as bunch trigger source.
- *T1-IN*. The signal from the T1-IN connector is used as bunch trigger source.
- *Q-OR*. The OR signal from the channel QDs is used as bunch trigger source.
- *T-OR*. The OR signal from the channel TDs is used as bunch trigger source.
- *TLOGIC*. A digital signal given by the logic combination (OR, AND, etc.) of the individual TD self-triggers. The logic associated to this signal is determined by the **Trigger Logic** parameter.
- *PTRG*. The internal periodic signal of the board is used as bunch trigger source.

Note: When operating in Timing Mode, the option chosen for the **Bunch Trigger Source** parameter is not used.

Veto Source

This parameter allows the user to define the signal source that, as far as it is in an high logic level, inhibits all bunch trigger signals. The available options are:

- *DISABLED*. The Veto is disabled.
- *SW_CMD*. A software command sent by the user. Currently, no software commands are implemented nor for the GUI, nor for the Console operative modes and the user who would like to use this option should modify the software to include it.
- *T0-IN*. The signal transmitted to the T0-IN connector is used as veto.
- *T1-IN*. The signal transmitted to the T1-IN connector is used as veto.

Validation Source

This parameter defines the source of the Validation signal. Indeed, when the **Validation Mode** parameter is set to ACCEPT/REJECT the validation signal allows to accept (thus allowing the A/D conversion of the PHA values to start if working in Spectroscopy Mode)/reject the bunch trigger signal. The validation signal, in order to be effective, must arrive in the time interval between the arrival of the bunch trigger and T_V, being T_V approximately the sum of 120 ns and the value set for the **Hold Delay** parameter. Otherwise, the user can visualize the validation window at the oscilloscope by selecting the appropriate option for the **Digital Probe** parameter. The available options for the **Validation Source** parameter are:

- *SW_CMD*. A software command sent by the user. Currently, no software commands are implemented nor for the GUI, nor for the Console operative modes and the user who would like to use this option should modify the software to insert a command.
- *T0-IN*. The signal transmitted to the T0-IN connector is used as trigger validation.
- *T1-IN*. The signal transmitted to the T1-IN connector is used as trigger validation.

Validation Mode

This parameter allows the user to define the working mode for the validation signal:

- *DISABLED*. The Validation operative mode is disabled, i.e. all bunch trigger signals are accepted.

- *ACCEPT*. In this operative mode, if the validation signal goes to an high logic level within the validation window, the trigger is accepted, otherwise is discarded.
- *REJECT*. In this operative mode, if the validation signal goes to an high logic level in the validation window, the trigger is rejected, otherwise is accepted.

Counting Mode

This parameter defines how events are counted in Counting mode. Options are:

- *SINGLES*. Each channel counts its own self trigger.
- *PAIRED_AND*. Couple of channels counts in coincidence, according to the coincidence windwow defined by **Paired-Cnt Coinc Window**.

Note: Counting mode must be set to ”SINGLES” when Acquisition mode is set to ”SPECTROSCOPY”.

Paired-Cnt Coinc Window

Sets the coincidence window in case the ”PAIRED_AND” option is selected for **Counting Mode**. Values ranges from 8 ns to 2032 ns with steps of 8 ns.

Trigger ID Mode

This parameter allows the user to define which value is saved for the Trigger ID information in the saved data file. More precisely:

- *TRIGGER_CNT*. In this case, the Trigger ID defines the ID number of the particular bunch trigger transmitted to the board (both accepted or not via the validation signal if enabled).
- *VALIDATION_CNT*. In this case, the Trigger ID information defines the ID number of the validation signal transmitted to the board (both associated or not to a trigger signal).

Trigger Logic

The parameter determines the logic associated to the TLogic signal. The user should refer to the A5202/DT5202 User Manual for a more detailed description of the TLogic signal **[RD3]**. A channel mask (see **TLogic Mask Chip 0** and **TLogic Mask Chip 1** parameters) allows the user to determine which channels participate in the TLogic signal determination. The available options for this parameter are:

- *OR64*: The logic OR of the 64 channel TDs. With respect to the T-OR signal, which is directly sent out by the Citiroc-1A chip, the OR64 logic signal is created at firmware level. For this reason, the signal is much slower than the T-OR but, unlike this one, the OR64 can be masked. The user can indeed define the channels participating to the trigger logic definition via the **TLogic Mask Chip 0** and **TLogic Mask Chip 1** parameters.
- *AND2_OR32*: Triggers of consecutive channels are sent to an AND logic operator (e.g. CH0&CH1, CH2&CH3, etc.). The 32 outputs are then sent to an OR logic operator.
- *OR32_AND2*: Triggers of each Citiroc-1A (32 channels each) are sent to an OR logic operator. The 2 output signals (one for each Citiroc-1A) are then sent to a logic AND operator.
- *MAJ64*: The logic signal is the majority of the 64 channels, i.e. it goes to an high logic level when a minimum number of channels (set via the **Majority Level** parameter) had a signal over threshold.
- *MAJ32_AND2*: Two majority logic functions are performed separately on the triggers from the two Citiroc-1As. The two outputs are sent to a logic AND operator.

Note: Users who need to make logic combinations of the channels are strongly recommended to use the **TLOGIC** option of **Bunch Trigger Source** and select one of the above options.

Majority Level

Defines the minimum number of channels determining a high logic level for the Majority signal. This setting is applied only when "MAJ64" or "MAJ32_AND2" option is enabled from **Trigger Logic**.

Periodic Trigger Period

The command defines the period of the internal periodic pulser of the board. The signal can be used as periodic trigger in order to force triggers not related to the physics (for debugging) or more typically it can be used to define the length of the counting intervals in Counting Mode if the "PTRG" option is chosen for the **Bunch Trigger Source** parameter. The value for this parameter can be set between 40 ns and $\approx$ 34 s.

Tref Source

The command defines the signal to be used as time reference (T_{ref}) when operating in Timing Mode. The available options are:

- *T0-IN*. The signal from the T0-IN connector is used as time reference.
- *T1-IN*. The signal from the T1-IN connector is used as time reference.
- *Q-OR*. The OR signal from the channel QDs is used as time reference.
- *T-OR*. The OR signal from the channel TDs is used as time reference.
- *PTRG*. The internal periodic signal of the board is used as time reference (for debugging).
- *TLOGIC*. The TLOGIC signal is used as time reference. The available options for the correspondent trigger logic are determined by the "Trigger Logic" parameter.

Note: When operating in Spectroscopy or in Counting Mode the option chosen for the "Tref Source" parameter is irrelevant.

Tref Window

The command defines the length of the gate during which channel self-triggers are accepted when operating in Timing (Common Start or Common Stop) Mode.

Tref Delay

The command defines a positive or negative delay of the TRef. Negatve delays might be useful to acquire hits that are too close to the TRef and could be lost. This parameter is irrelevant in Spectroscopy and Counting modes.

T0-OUT/T1-OUT

The command defines the digital signal driving the T0-OUT connector. The available options are:

- *T0-IN/T1-IN*. The signal sent as input to the T0-IN/T1-IN connector is propagated to the T0-OUT/T1-OUT connector, respectively (after having being processed by the FPGA).
- *BUNCHTRG*. The bunch (global) trigger source.
- *T-OR* (Only for T0-IN). The OR signal from the channel TDs.
- *Q-OR* (Only for T1-IN). The OR signal from the channel QDs.
- *TLOGIC*. The TLogic signal (see **Trigger Logic** parameter).
- *RUN*. The Run signal (high logic level when the acquisition is ongoing).
- *PTRG*. The internal periodic signal of the board.
- *BUSY*. The Busy signal.
- *DPROBE*. The Digital Probe is propagated to the T0-OUT connector. The signal associated to the digital probe is defined by the **Digital Probe** parameter.

- *SQ_WAVE*. A square wave having the same period of the internal periodic pulser of the board.
- *TDL_SYNC*. Signal of synchronism from TDlink. The user can visualize the TDL_SYNC from multiple boards to check that they are all latched together.
- *RUN_SYNC*. Signal of start run from TDlink. The user can visualize the RUN_SYNC from multiple boards to check that the starts run are all latched together.
- *ZERO*. A constant low logic level is sent as output. To be used when performing a daisy chained trigger distribution in a multi-board system (refer to the A5202 User Manual **[RD3]**).

Ch Enable Mask Chip 0

The command allows the user to enable/disable Citiroc-1A channels from 0 to 31 of all boards connected. The default value (all channels enabled of all connected boards) is 0xFFFFFFFF.

Note: The parameter values defined in the left part of the tab (in the fields near the parameter names) are applied to all connected boards (and all channels for some parameters) with no individual settings. In order to tune the values board-by-board and/or channel-by-channel, the user should act on the fields in the right part of the tab (see **Fig. 3.40**).

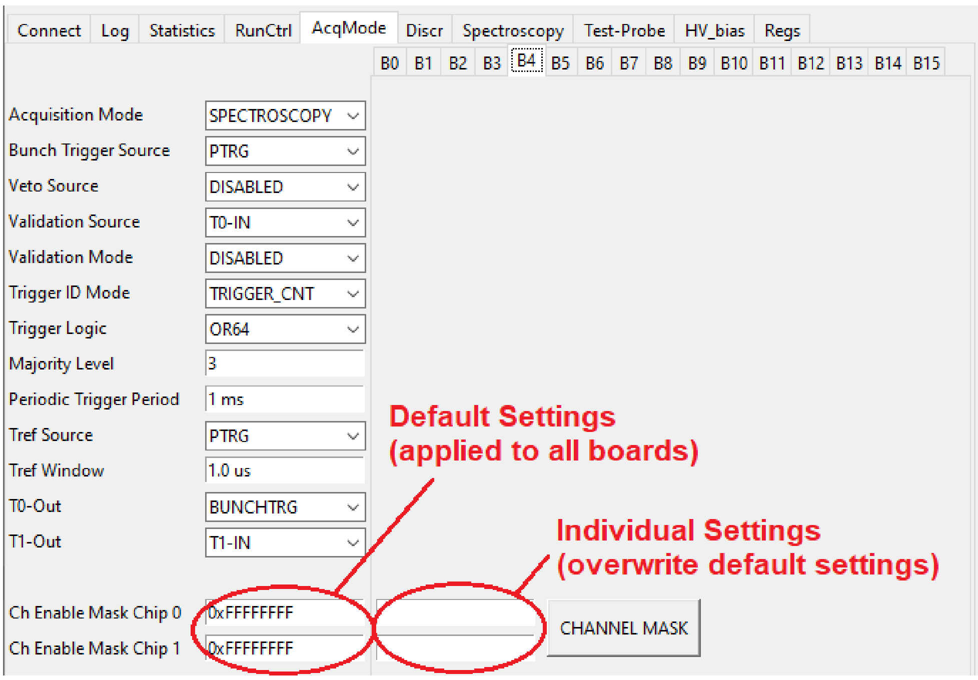


Fig. 3.40: The AcqMode Tab with underlined the two fields allowing the user to set the same Channel Mask for every board connected (fields on the left) or individually for each board (fields on the right).

Note: The Citiroc-1A channel disabling means that no signal is sent as input to that channel Citiroc-1A Preamplifier.

Ch Enable Mask Chip 1

The command allows the user to enable/disable Citiroc-1A channels from 32 to 63 of all boards connected. The default value (all channels enabled of all connected boards) is 0xFFFFFFFF.

CHANNEL MASK

By pressing the button, a Channel Mask window similar to that in **Fig. 3.42** will be opened. The user can then select which channels have to be enabled/disabled for the selected board. The user can switch between different boards (from 0 to 15) via the Board Tabs in the top right part of the AcqMode Tab (see **Fig. 3.41**) or via the Brd combo-box that is present in the Channel Mask window. Via this combo-box, the user can also define the default mask, i.e. the mask of all connected boards, by selecting the Global option. Once the selection is finished, the user should press the Done button in order to make the changes that have been made effective.

Note: The channel mask for the selected board overwrites the channel mask defined by the ”Ch Enable Mask Chip 0” and ”Ch Enable Mask Chip 1” parameters for all boards.

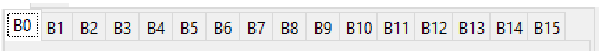


Fig. 3.41: Board Tabs.

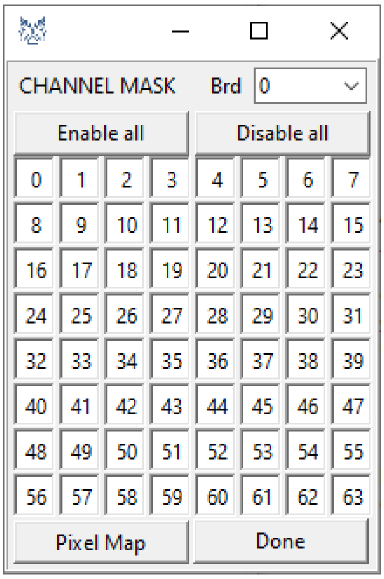


Fig. 3.42: Channel Mask window.

3.10 Discr Tab

The Discr Tab allows the user to set the value of all parameters regarding the trigger threshold as well as to enable/disable channels involved in the trigger logic definition (see **Fig. 3.43**):

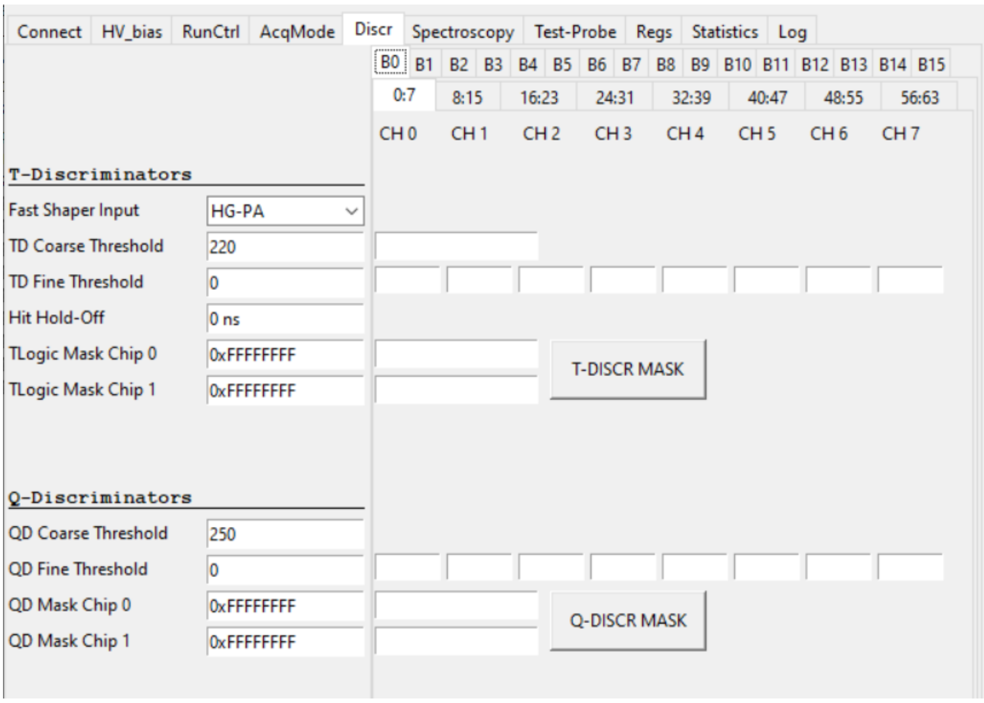


Fig. 3.43: Discriminator Tab.

Fast Shaper Input

The command defines from which amplification line the inputs of the Fast Shaper have to be taken. The available values are:

- *HG-PA*. The output of the HG Preamplifier is fed into the Fast Shaper of each channel.
- *LG-PA*. The output of the LG Preamplifier is fed into the Fast Shaper of each channel.

TD Coarse Threshold

The command defines the value (common to all channels) of the threshold of the channel TDs (regulated by a 10-bit DAC). This parameter can be individually set for each connected board.

Note: The channel TDs baseline is not 0, but presents an offset (introduced by the Fast Shaper), different for each channel. The exact baseline level can be estimated in two ways:

1. Performing a staircase
2. Setting the T-OR as Bunch Trigger Source, enabling only one channel in the channel mask, varying the TD Coarse Threshold and checking at what value the threshold is triggered.

The minimum suggested value for the TD Coarse Threshold is 300, but can vary from channel to channel, and from chip to chip.

Note: The parameter values defined in the left part of the tab (in the fields near the parameter names) are applied to all connected boards (and all channels for some parameters) with no individual settings. In order to tune the values board-by-board and/or channel-by-channel, the user should act on the fields in the right part of the tab (see **Fig. 3.44**).

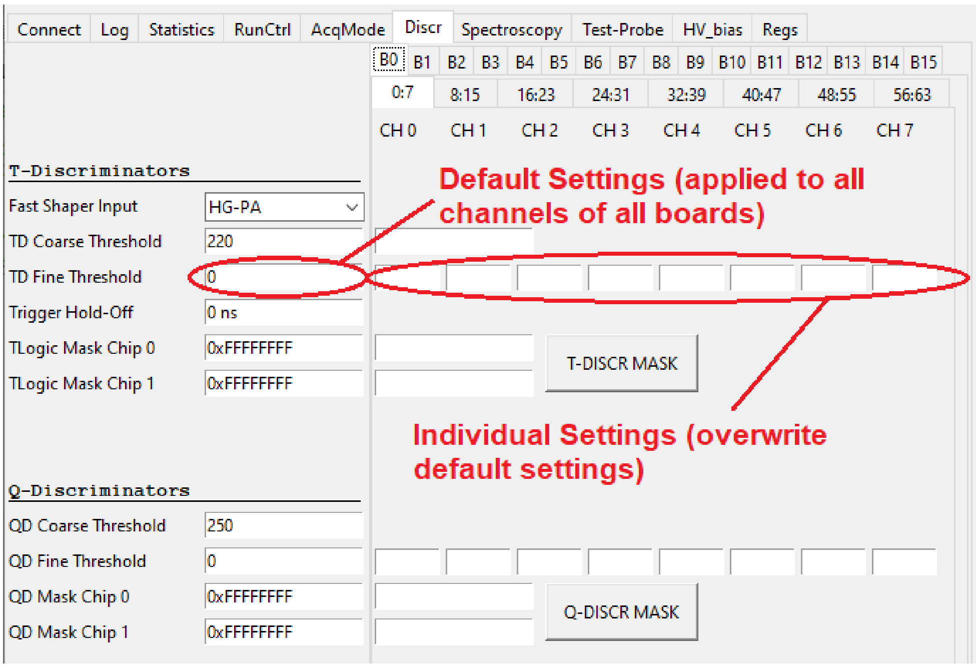


Fig. 3.44: The Discr Tab with underlined the two fields allowing the user to set the same TD Fine Threshold for all channels of all connected boards (fields on the left) or individually for each channel (fields on the right).

TD Fine Threshold

The command allows the user to finely regulate the value of the TD thresholds between different channels (4-bit DAC). The fine threshold adjustment acts approximately on 1-2 LSB of the **TD Coarse Threshold** value. As it is shown in **Fig. 3.45**, Board and Channel Tabs are present in the top right part of the Discr Tab, allowing the user to choose between different boards and different channels the values to be set for the **TD Fine Threshold** parameter.

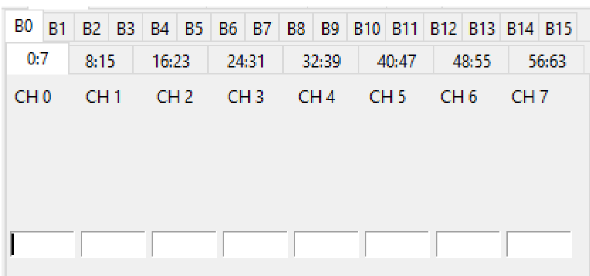


Fig. 3.45: Board Tabs with the Channel Tabs below. For each Board Tab, 8 Channel Tabs are present grouping each one 8 consecutive channels (e.g. from 0 to 7, etc.).

Hit Hold-Off

The command allows the user to define the minimum value between two consecutive accepted self-trigger signals when working in Timing Mode. This command allows the user, for instance, to inhibit the acquisition of more than one hit per channel once a timing gate has been opened.

Note: The ”Hit Hold-Off” parameter has no effect when working in Spectroscopy or Counting Mode. Moreover, the TLogic signal (see **Trigger Logic** parameter) is not affected by the value set for this parameter.

TLogic Mask Chip 0

The command allows the user to enable/disable Citiroc-1A channels from 0 to 31 participating in the TLogic signal definition (see **Trigger Logic** parameter). The default value (all channels enabled) is 0xFFFFFFFF.

TLogic Mask Chip 1

The command allows the user to enable/disable Citiroc-1A channels from 32 to 63 participating in the TLogic definition (see **Trigger Logic** parameter). The default value (all channels enabled) is 0xFFFFFFFF.

T-DISCR MASK

By pressing the button, a window similar to that in **Fig. 3.42** will be opened. The user can then select which channels have to be enabled/disabled in the TLogic mask for a specific board, selected via the corresponding option in the Brd combo-box. Once the selection is finished, the user should press the Done button in order to make the changes effective.

Note: The TLogic mask for the selected board overwrites the TLogic mask defined by the ”TLogic Mask Chip 0” and ”TLogic Mask Chip 1” parameters for that specific board.

QD Coarse Threshold

The command defines the value (common to all channels) of the threshold of the channel QDs (regulated by a 10-bit DAC).

Note: The Citiroc 1A chip presents an internal baseline offset. The minimum value that can be set for the QD Coarse Threshold is 180.

QD Fine Threshold

The command allows the user to finely regulate the value of the QD thresholds between different channels (4-bit DAC). The fine threshold adjustment acts approximately on 1-2 LSB of the **QD Coarse Threshold** value. The user can modify the individual threshold by acting on the same Board and Channel Tabs as those visualized in **Fig. 3.45**.

QD Mask Chip 0

The command allows the user to enable/disable Citiroc-1A channels from 0 to 31 in the charge discriminator (QD) mask. The default value (all channels enabled) is 0xFFFFFFFF.

QD Mask Chip 1

The command allows the user to enable/disable Citiroc-1A channels from 32 to 63 in the charge discriminator (QD) mask. The default value (all channels enabled) is 0xFFFFFFFF.

Note: The QD Mask is applied directly inside the Citiroc-1A chip, while the TD Mask is applied at firmware level (see **Trigger Logic** parameter).

Q-DISCR MASK

By pressing the button, a window similar to that in **Fig. 3.42** will be opened. The user can then select which channels have to be enabled/disabled in the QD mask for the specific board, selected via the corresponding option in the Brd combo-box. Once the selection is finished, the Done button has to be pressed in order to make the changes effective.

3.11 Spectroscopy Tab

The Spectroscopy Tab contains all the parameters to which a spectroscopic analysis is sensitive and to be used when operating in ”Spectroscopy” and ”Spectroscopy and Timing” Mode (see **Fig. 3.46**):

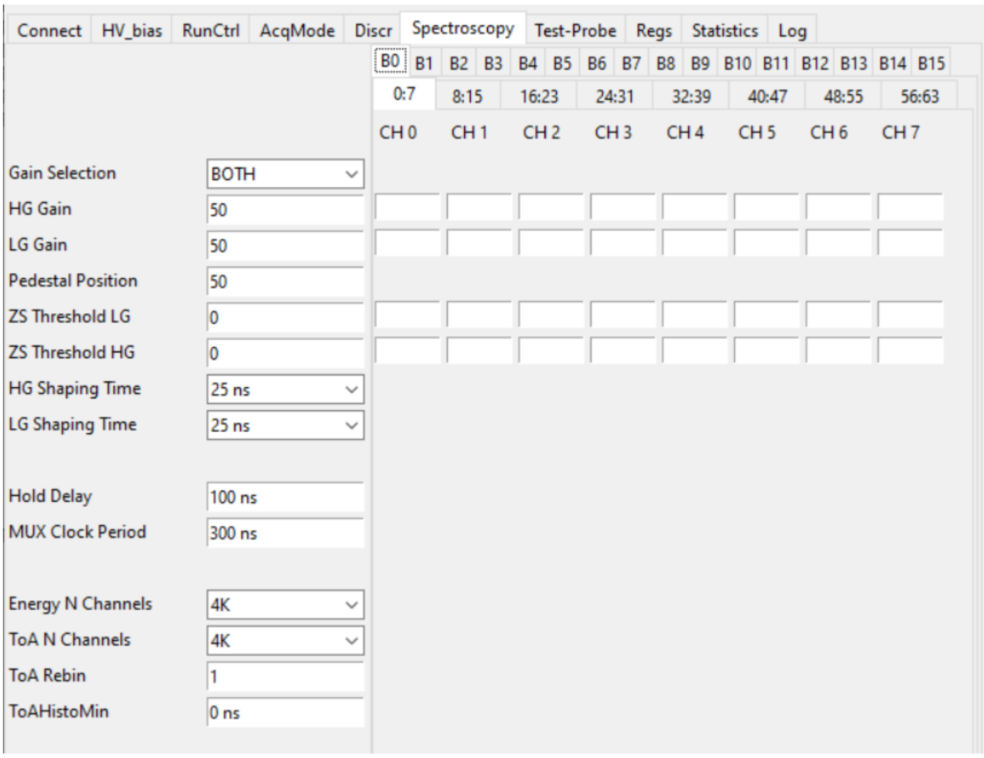


Fig. 3.46: Spectroscopy Tab.

Gain Selection

The command allows the user to define from which amplification chain A/D converted signals have to be saved in the data packets. The available options are:

- *HIGH*. The A/D converted signals from the HG amplification chain are saved.
- *LOW*. The A/D converted signals from the LG amplification chain are saved.
- *AUTO*. With this option, the pulse height values saved to the data packet are those coming from the HG line if it is not saturated, otherwise the LG is used.
- *BOTH*. The A/D converted signals from both amplification chains are saved.

Note: The parameter values defined in the left part of the tab (in the fields near the parameter names) are applied to all connected boards (and all channels for some parameters) with no individual settings. In order to tune the values board-by-board and/or channel-by-channel, the user should act on the fields in the right part of the tab.

HG Gain

The command defines the gain of the HG amplification chain. The values for this parameter may range from 0 to 63. Note that the gain values are not linear. Channel Tabs identical to those in **Fig. 3.45** allows the user to set different values from channel to channel and from board to board.

LG Gain

The command defines the gain of the LG amplification chain. The values for this parameter may range from 0 to 63. Note that the gain values are not linear. Channel Tabs identical to those in **Fig. 3.45** allows the user to set different values from channel to channel and from board to board.

Pedestal Position

The parameter defines the position of the pedestal, i.e. of the pulse height converted values when no signal is present, for all channels. The value for this parameter can range from 0 to the value defined by the **Energy N Channels** parameter.

ZS Threshold LG

The threshold allowing zero suppression of PHA values from the LG amplification chain. The value set for this parameter can range from 0 to the value set for the **Energy N Channels** parameter which determines how many channels the PHA spectrum is composed of. Then, depending on the value set for the **Gain Selection** parameter, a different result is obtained:

- *LOW*. Only the A/D converted PHA signals from the LG amplification chain which are higher than the value of the threshold are saved to the data packet.
- *AUTO*. If the PHA values from the LG amplification chain are saved, then only those that are higher then the value of the threshold are saved to the data packet.
- *BOTH*. In this case, the PHA values from LG and HG amplification chains are discarded from the data packet if both are lower than the values set for the **ZS Threshold LG** and **ZS Threshold HG** parameters respectively.

ZS Threshold HG

The threshold allowing zero suppression of PHA values from the HG amplification chain. The value set for this parameter can range from 0 to the value set for the **Energy N Channels** parameter which determines how many channels the PHA spectrum is composed of. Then, depending on the value set for the **Gain Selection** parameter, a different result is obtained:

- *HIGH*. Only the A/D converted PHA signals from the HG amplification chain which are higher than the value of the threshold are saved to the data packet.
- *AUTO*. If the PHA values from the HG amplification chain are saved, then only those that are higher then the value of the threshold are saved to the data packet.
- *BOTH*. In this case, the PHA values from LG and HG amplification chains are discarded from the data packet if both are lower than the values set for the **ZS Threshold LG** and **ZS Threshold HG** parameters respectively.

HG Shaping Time

The command defines the time constant of the Slow Shaper circuit for the HG amplification chain. 7 different values are available between 12.5 ns and 87.5 ns with a 12.5 ns pitch.

LG Shaping Time

The command defines the time constant of the Slow Shaper circuit for the LG amplification chain. 7 different values are available between 12.5 ns and 87.5 ns with a 12.5 ns pitch.

Hold Delay

The command defines the value of the time distance between the trigger, which puts all channels in Peak Detection Phase when operating in Spectroscopy Mode, and the Hold signal (see **[RD3]** for more details).

Note: The default value of 100 ns is consistent with a shaping time of 25 ns. If the shaping time is increased, the user must increase the Hold Delay too, according to the **Hold Delay Scan Button** result.

MUX Clock Period

The command allows the user to define the conversion time of the MUX for each Citiroc-1A channel output. The minimum value is 200 ns but CAEN suggests a value of 300 ns according to the study reported in the A5202/DT5202 User Manual **[RD3]**.

Energy N Channels

The command defines how many ADC channels the PHA spectra consist of. Indeed, the PHA values are A/D converted and saved as 13-bit values (thus ranging from 0 to 8191 ADC channels) but the user can rebin the energy value to a lower number of channels:

- *256*: The pulse height values are divided by a factor 32.
- *512*: The pulse height values are divided by a factor 16.
- *1K*: The pulse height values are divided by a factor 8.
- *2K*: The pulse height values are divided by a factor 4.
- *4K*: The pulse height values are divided by a factor 2.
- *8K*: The pulse height values are not divided.

ToA N Channels

The command defines how many channels the ToA spectrum consists of. The available options are:

- *256*: The ToA spectrum ranges from 0 ns to 128 ns.
- *512*: The ToA spectrum ranges from 0 ns to 256 ns.
- *1K*: The ToA spectrum ranges from 0 ns to 512 ns.
- *2K*: The ToA spectrum ranges from 0 ns to 1024 ns.
- *4K*: The ToA spectrum ranges from 0 ns to 2048 ns.
- *8K*: The ToA spectrum ranges from 0 ns to 4096 ns.
- *16K*: The ToA spectrum ranges from 0 ns to 8192 ns.

ToA Rebin

The command defines the rebin of the ToA spectrum. Options are 1, and multiples of 2. This option is valid for the spectra visualization, while in the list file the ToA is written at the maximum of its resolution.

ToA Histo Min

The command defines the minimum value of the ToA spectra. This option can be useful in case the user wants to have the ToA spectra starting from higher values when high time differences are involved.

3.12 Test-Probe Tab

The Test-Probe Tab allows the user to define the settings of the test signal to pulse one or more Citiroc-1A channels, as well as to define the settings of the analog and digital probes of the board (see **Fig. 3.47**).

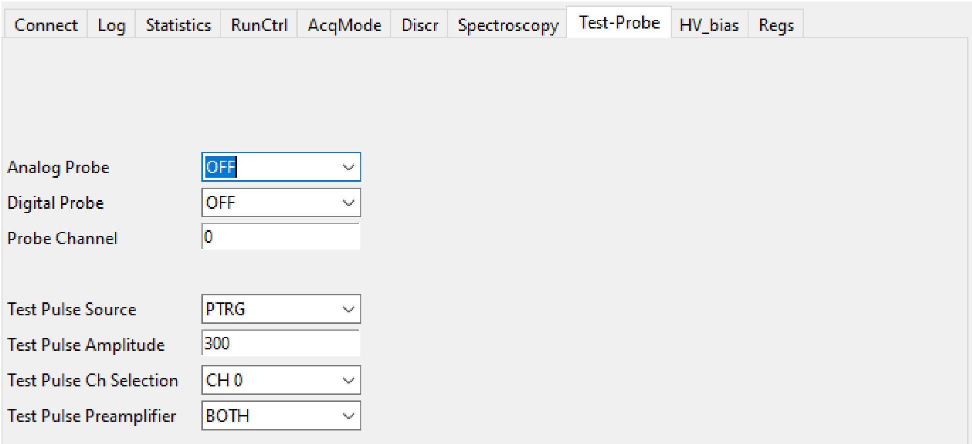


Fig. 3.47: The Test-Probe Tab.

Analog Probe

The command defines from which stage of the Citiroc-1A amplification chain the analog signal has to be retrieved. The signal is that from a particular software selectable channel defined via the **Probe Channel** parameter, and is propagated to one of the two A5202/DT5202 Probe connectors **[RD3]**. The available options are:

- *OFF*. The Analog Probe is disabled (to be used during physics runs).
- *FAST*. The signal from the Fast Shaper of the selected channel is propagated to the Probe connector.
- *SLOW_LG*. The signal from the LG Slow Shaper of the selected channel is propagated to the Probe connector.
- *SLOW_HG*. The signal from the HG Slow Shaper of the selected channel is propagated to the Probe connector.
- *PREAMP_LG*. The signal from the LG Preamplifier of the selected channel is propagated to the Probe connector.
- *PREAMP_HG*. The signal from the HG Preamplifier of the selected channel is propagated to the Probe connector.

Note: A 1 MΩ impedance should be set when looking at the analog probe on an oscilloscope.

Digital Probe

The command defines which digital signal has to be propagated to one of the two digital output connectors **T0-OUT/T1-OUT**. More information on the digital probe signals can be found in the A5202/DT5202 User Manual **[RD3]**. The available options are:

- *OFF*. The Digital Probe is disabled.
- *PEAK_LG*. The digital signal defining the peaking time of the LG Slow Shaper amplifier is used as digital probe.

- *PEAK_HG*. The digital signal defining the peaking time of the HG Slow Shaper amplifier is used as digital probe.
- *HOLD*. The Hold signal is used as digital probe.
- *START_CONV*. The Start of A/D Conversion signal is used as digital probe.
- *DATA_COMMIT*. The Data Commit signal is used as digital probe (see A5202/DT5202 User Manual **[RD3]**).
- *DATA_VALID*. The Data Validation signal is used as digital probe.
- *VAL_WINDOW*. The signal defining the validation window (within which the validation signal must arrive to accept/reject bunch triggers) is used as digital probe.

Probe Channel

The command defines to which of the 64 channels the analog and digital probe are directed.

Test Pulse Source

The command allows the user to choose, among the different signal sources, the one to be used as test pulse. A detailed description of the test pulser circuit can be found in the A5202/DT5202 User Manual **[RD3]**. Available values are:

- *OFF*. The Test Pulse is disabled.
- *EXT*. The signal sent to the MCX test input connector labeled P15 in the PCB (A5202 board) is used as test pulse.
- *T0-IN*. The digital signal from the T0-IN connector is sent to the internal test pulser of the board. A test signal is generated by the internal pulser at every rising edge (TTL signal) or falling edge (NIM signal) of the logic signal from the T0-IN connector. The amplitude of the test pulse is determined by the **Test Pulse Amplitude** parameter (see below).
- *T1-IN*. See T0-IN.
- *PTRG*. The internal periodic signal is used to define the time stamp of the test pulse.
- *SW-CMD*. A software command sent by the user. Currently, no software commands are implemented nor for the GUI, nor for the Console operative modes and the user who would like to use this option should modify the software to insert a command. When the FERS-CB will be available, the command could be transmitted via the TDlink.

Note: Apart from the "EXT" option, all other options only define the time stamp of the pulse, not the amplitude which is defined by the **Test Pulse Amplitude** parameter.

Test Pulse Amplitude

The command defines the amplitude of the signal to be used as test pulse.

Test Pulse Ch Selection

The command defines to which of the Citiroc-1A channels the test pulse is sent. The available options are:

- *NONE*. The test pulse is disabled.
- *ALL*. All channels are pulsed with the test signal.
- *EVEN*. Only even channels are pulsed with the test signal.
- *ODD*. Only odd channels are pulsed with the test signal.
- *CHANNEL N*. Only channel N (with N being a number between 0 and 63) is pulsed.

Note: WeeROC suggests to send the test pulse to one channel at a time **[RD1]**.

Test Pulse Preamplifier

The command defines to which Preamplifiers of the Citiroc-1A amplification chain the test pulse is sent. Indeed, as explained in the A5202/DT5202 User Manual **[RD3]**, the test pulse is fed into the Preamplifier stage of the selected channels via a dedicated test circuit. The available options are:

- *LG*. The test pulse is sent to the LG Preamplifier of the selected channels.
- *HG*. The test pulse is sent to the HG Preamplifier of the selected channels.
- *BOTH*. The test pulse is sent to both HG and LG Preamplifier of the selected channels.

3.13 Regs Tab

In order to properly manage the registers access, the Janus 5202 GUI also features the Regs Tab (see **Fig. 3.48**).

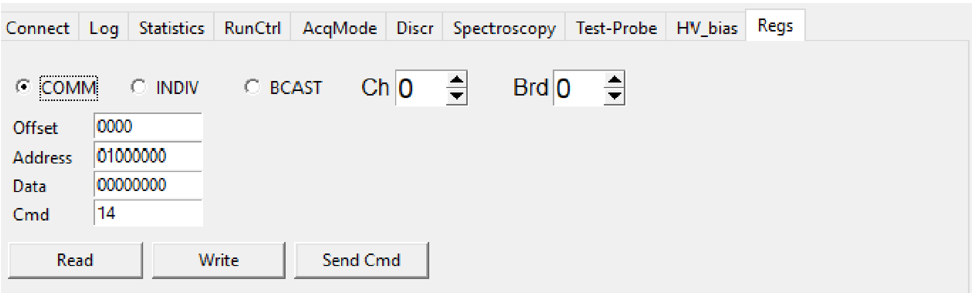


Fig. 3.48: The Regs Tab of the Janus 5202 software GUI.

The user can take advantage of the ”macros” file to add a list of register settings in the Janus 5202 configuration. Refer to Sec. **3.1** for additional details.

3.14 Statistics Tab

The Statistics Tab displays the channel-by-channel values of the variable selected via the **Statistics Type** combo-box, as well as the last event triggered time stamp, the trigger ID, the lost triggers, etc. (see **Fig. 3.49**).

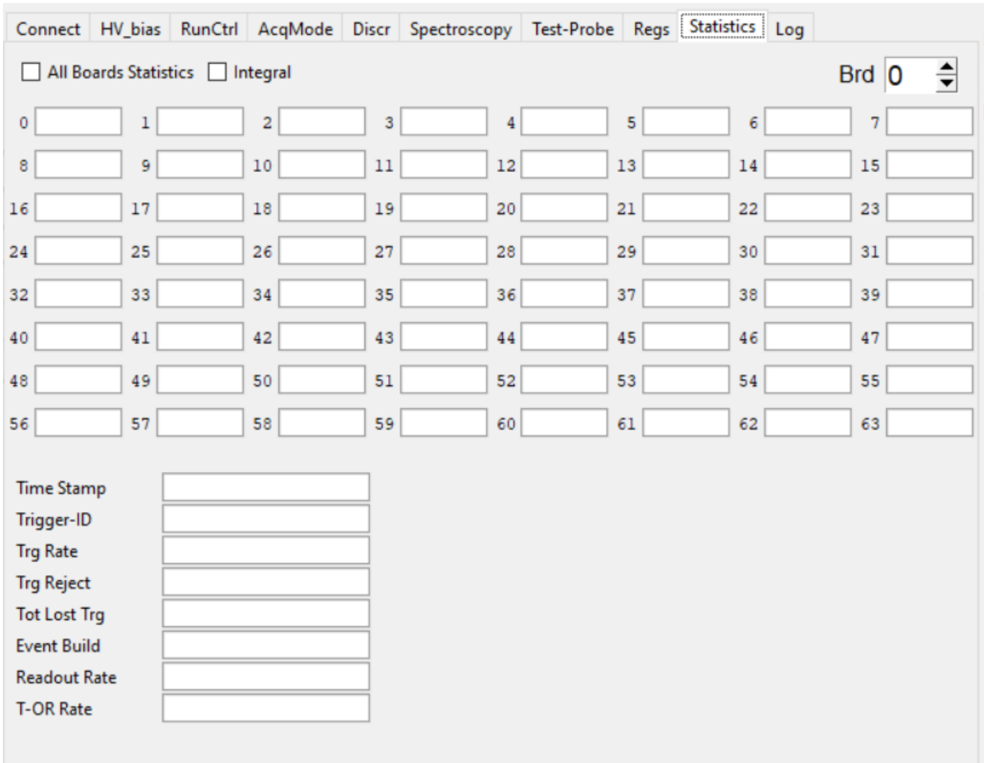


Fig. 3.49: Statistics Tab.

The user can select the board from the **Brd** switch on the top right part of the Statistics tab, to visualize the channel statistics of one of the connected boards.

The checkbox **Integral** allows the user to show the statistics in Instantaneous (unchecked box) or Integral (checked box) mode.

The values displayed in the table are:

- **N**: Where N is the channel number (from 0 to 63). The user can choose via the **Statistics Type** command which value has to be displayed (see Sec. **3.3**).
- **Time Stamp**: The time stamp of the latest event read out.
- **Trigger-ID**: The ID number of the latest event read out is displayed.
- **Trg Rate**: The bunch trigger rate of the acquisition.
- **Trg Reject**: The percentage of lost triggers over the total trigger counted by the board. See also next parameter.
- **Tot Lost Trg**: The total number of lost triggers. For instance, when working in Spectroscopy Mode, if a bunch trigger occurs while the A/D conversion is already started (because of another trigger), the PHA information of that event is lost but the trigger ID number is saved. This information allows the user to visualize the number of triggers that were counted but not acquired because of the board busy condition.
- **Event Build**: Percentage of the events sorted when the **Event Building Mode** is enabled.
- **Readout Rate**: The data readout rate.

- **T-OR Rate**: The rate of the T-OR trigger logic (i.e. the OR of the Time Discriminator trigger signals).

By clicking on the **All Boards Statistics** button, the Statistics Tab will look like that presented in **Fig. 3.50**. This option allows the user to visualize the statistics described above (except those regarding individual channels as well as the T-OR rate) for all connected boards in the same screen.

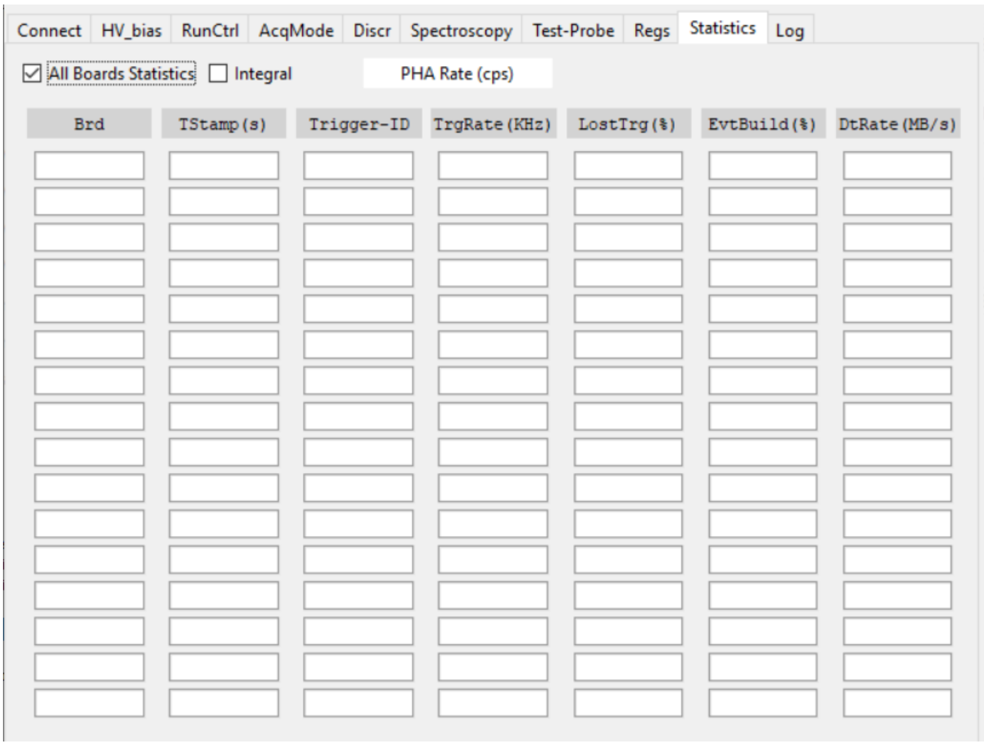


Fig. 3.50: Statistics Tab with the "All Boards Statistics" option selected.

3.15 Log Tab

The Log Tab contains information about the sequence of operations performed by Janus 5202, such as board configuration, status monitor, board information, HV status, etc. (see **Fig. 3.51**). If an error occurs when loading the configuration file (e.g. because of a syntax error), a warning message is displayed in this tab.
All the messages visualized in the Log Tab are also saved in the "MsgLog.txt" file inside the "bin" folder of the Janus 5202 software.

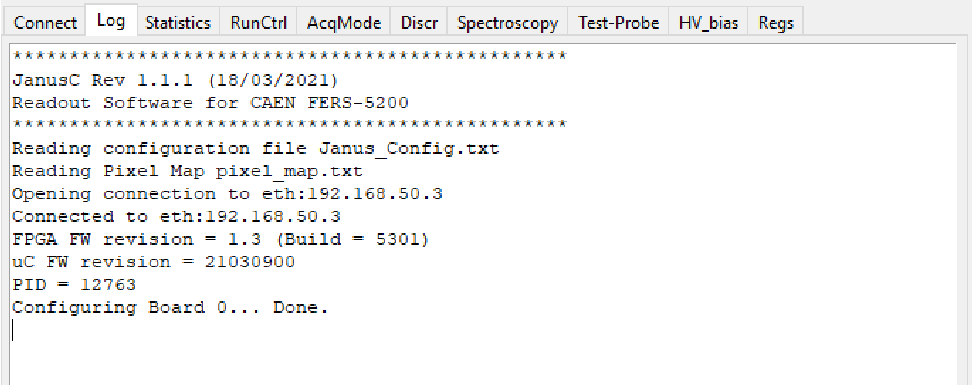


Fig. 3.51: Log Tab.

3.16 How to Perform a Job

The aim of this section is to provide the user with a brief introduction on how to perform a job with Janus 5202. A job is a series of consecutive runs, i.e. acquisitions, with programmable time length or with programmable number of events. The number of runs composing each job is also programmable. There are two ways to perform a job in Janus 5202:

1. With the same configuration of parameters for each run, defined inside the "Janus_Config.txt" file. This case is suitable if the user needs to perform several acquisitions changing, e.g., the intensity of the light pulse directed to the SiPMs from one run to the other, but acquiring data with the same DAQ settings.
2. With a different configuration of parameters for each run. The set of parameter values for the run X of the job are defined inside a configuration file named "Janus_config_RunX.txt" created by the user via the **Save Run Configuration Button**. This case is suitable if the user needs to perform several acquisitions by changing the settings of one crucial parameter for each run, e.g. the **HG Gain** value.

The instructions for both ways of operating are described below:

1. Select the RunCtrl Tab and put a thick in the **Enable Jobs** parameter.
2. Select the "ASYNC" option for the **Start Run Mode** parameter. For the **Stop Run Mode**, the user has to select:
   - "PRESET_TIME", if the user would like to perform runs of the same duration.
   - "PRESET_COUNTS", if the user would like to perform runs having the same number of events.
3. Select a value for the **Preset Time** parameter different from 0 (e.g. 1 m for a one-minute acquisition) if the "PRESET_TIME" option was chosen for the **Stop Run Mode** parameter. Select a value for the **Preset Counts** parameter different from 0 (e.g. 1000 for an acquisition of a thousand events) if the "PRESET_COUNTS" option was chosen for the **Stop Run Mode** parameter.
4. Select the ID number of the first run in the job via the **Job First Run** parameter (e.g. 1) and for the last run in the job via the **Job Last Run** parameter (e.g. 5).
5. Select a value for the **Run Sleep** parameter (e.g. 10 s), which determines the time distance between the end of a run and the start of the next one.
6. Select one or more options for the output files to be saved for each run (e.g. "List (ASCII)").
7. Select via the **Run#** parameter in the Command Bar a value identical to the ID of the first run in the job, i.e. the value chosen for the **Job First Run** parameter (in this case 1).
8. Press the Apply button. The JanusC.exe application will suddenly close and restart (in about 5 s) without any further action to be performed by the user. At the end of this operation, the **Start Button** will be replaced by the **Start Job Button**.
9. In **Fig. 3.52** the settings chosen to perform a job acquisition are presented.
10. If all runs have to be executed according to the configuration of parameters actually saved, the user has to push the **Start Job Button**. The user can check the status of the job in the Status Bar (see Sec. **3.4**) and the data files creation in the destination folder.
11. If a different configuration of parameters is needed for each run, the user has to:
    (a) Press the **Save Run Configuration Button**. The user can check that in the "bin/DataFiles" folder a configuration file named "Janus_config_RunX.txt" has been created, being X the value of the **Run#** parameter (in this case 1).
    (b) Select the values of the parameters for the second run in the job. Once finished, press the Apply button.
    (c) Select via the **Run#** parameter a value identical to the ID of the second run in the job (in this case 2).
    (d) Press the **Save Run Configuration Button**. Another configuration file is suddenly created in the "bin/DataFiles" folder named "Janus_config_RunY.txt", being Y the **Run#** parameter value for the second run in the job.

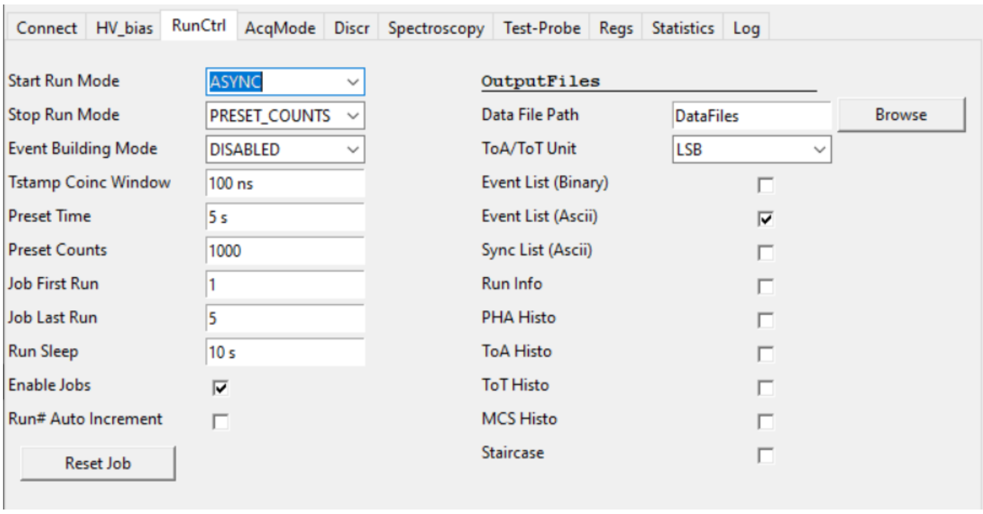


Fig. 3.52: Example of settings for a job acquisition.

(e) The user has to repeat the instructions above as many times as the number of runs composing the job.

(f) Press the **Start Job Button**. The user can check the status of the job in the Status Bar (see Sec. **3.4**) and that the data files are created in the destination folder.

4 Console Mode

In this operative mode, the user can edit the configuration file (”Janus_Config.txt” in the ”bin” folder) with any text editor and save the proper values for the desired parameters (see Chap. **3** for details regarding the complete list of available parameters). Then the user can launch ”JanusC.exe”, which starts in a purely textual console window (see **Fig. 4.2**).

Note: If using Windows 11 with Windows Terminal as default shell, please consider to modify the shell settings as shown in **Fig. 4.1** to get the expected behavior of JanusC console mode.

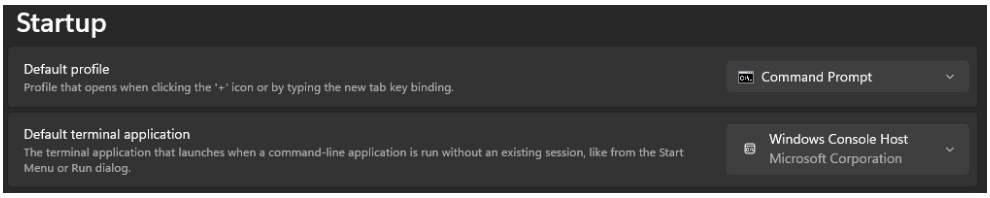


Fig. 4.1: Windows 11 shell settings for JanusC console mode.

Note: In Console Mode, the user can modify the ”Janus_Config.txt” file also by accessing the parameter values in the ”JanusPy.pyw” application without pressing the Connect button. In this case, the Janus 5202 GUI is simply used as a configuration panel and every time the Apply button is pressed the configuration file is overwritten.

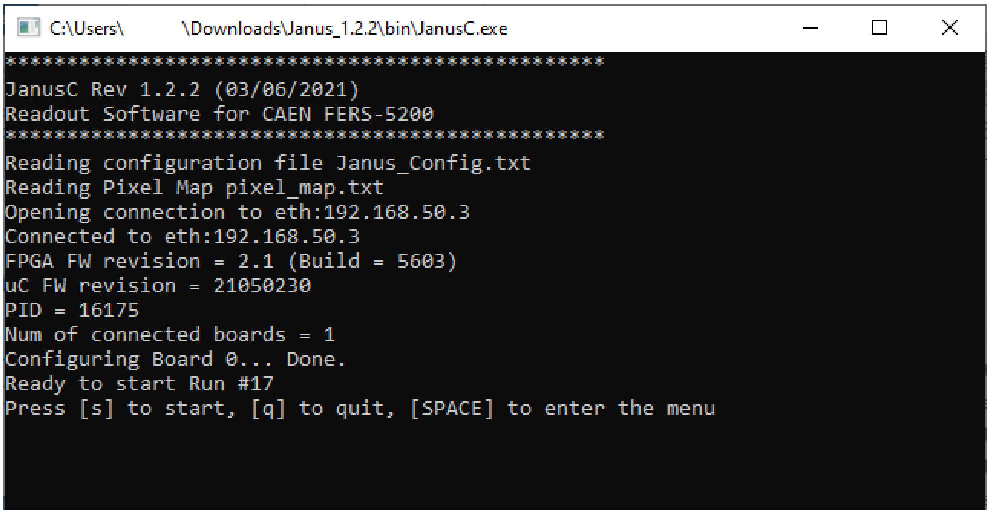


Fig. 4.2: Starting window of the Janus 5202 software when operating in Console Mode.

Once started, the ”JanusC.exe” application parses the configuration file. If a formal error occurs, it is displayed in the console window. Possible not valid parameter values or syntax errors in the configuration file are indicated by the software by displaying a warning message. After having established the connection with the board, Janus 5202 programs it with the parameters read. Finally, by pressing the command ”s”, the acquisition is started.

During the acquisition loop, a special menu (bindkeys) allows the user to send commands to the program by previously selecting the "JanusC.exe" console window.
The list of all console commands is presented in Sec. **4.2**.

4.1 Configuration File Syntax

This section describes the structure of the Janus 5202 configuration file ("Janus_Config.txt") and the syntax of all the defined parameters. The parameters are the same described in Chap. **3** and the user should refer to that chapter in order to have more detailed information about their functions.
The Janus 5202 configuration file is divided in three main parts:

- **Connection Settings**, indicated in the initial "Connect" section of the file.
- **Common Settings**, indicated in the initial "Common and Default settings" section of the file. The value of these parameters is applied to all channels of all connected boards.
- **Individual Settings**, indicated in the section "Board and Channel settings". The value of these parameters is applied individually to specific connected boards and/or to specific channels.

The individual settings can be performed also in the common settings part: in this case, they are applied to all channels of all connected boards.

Note: Settings are executed sequentially, therefore commands written at the end of the file (in the part of the individual settings) may overwrite settings written at the beginning (in the part of the common settings).

4.1.1 Connection Settings

This part of the configuration file allows the user to define the type of connection of the boards. An example is shown in **Fig. 4.3**. The "Open" word is followed by the ID number of the board between square brackets (by default the ID number is 0 if only one board needs to be connected). The user has then to specify the type of connection.

```
# ------------------------------------------------------------------------------------------
# Connect
# ------------------------------------------------------------------------------------------
Open[0] eth:192.168.50.3
```

Fig. 4.3: Example of connection settings in the "Janus_Config.txt" file.

4.1.2 Common Settings

This part of the configuration file allows the user to define all the settings that have to be applied to all channels of all boards connected. This part of the file is organized as the different tabs in the Janus 5202 GUI. An example is shown in **Fig. 4.4**.

Note: The parameter names can be different to that in the Janus 5202 GUI. Indeed, the parameter names appearing in the Janus 5202 GUI are defined in the "param_rename.txt" file inside the "bin" folder.

```
# ----------------------------------------------------------------------
# AcqMode
# ----------------------------------------------------------------------
AcquisitionMode                    SPECTROSCOPY
BunchTrgSource                     T1-IN
TriggerLogic                       OR64
MajorityLevel                      5
PtrgPeriod                         1 ms
TrefSource                         T1-IN
TrefWindow                         1.0 us
T0_Out                             T-OR
T1_Out                             BUNCHTRG
ChEnableMask0                      0xFFFFFFFF
ChEnableMask1                      0xFFFFFFFF
```

Fig. 4.4: Example of common settings in the "Janus_Config.txt" file.

4.1.3 Individual Settings

This part of the configuration file allows the user to define all the settings that have to be applied to a particular board and/or to a particular channel. The user has to write down the parameter name followed by the board number in square brackets ([0] if only one board is connected) and by the channel number in square brackets. An example is shown in **Fig. 4.5**.

```
# ****************************************************************************************
# Board and Channel settings (overwrite default settings)
# ****************************************************************************************
HV_IndivAdj[0][48]                 100
```

Fig. 4.5: Example of individual setting for the 48th channel of the board 0 in the "Janus_Config.txt" file.

If the parameter can differ only board-by-board, but not channel-by-channel, the parameter has to be written in the same part of the configuration file. In this case, the parameter has to be written down followed only by the board number in square brackets. An example is presented in **Fig. 4.6**.

```
# ****************************************************************************************
# Board and Channel settings (overwrite default settings)
# ****************************************************************************************
HV_Vbias[2]                        53.80
```

Fig. 4.6: Example of individual board setting in the "Janus_Config.txt" file.

4.2 Console Commands

Key	Function
q	**Quit**. Exit from the Janus 5202 software.
s	**Start Run**.
S	**Stop Run**.
t	**Single Software Trigger**. This command sends a software trigger (single shot), useful especially when the card has no data (no trigger) because it forces the acquisition of an event.

Key	Function
C	**Toggle Count Mode**. Allows the user to change between the different statistics printed on the Janus 5202 console window during the acquisition. The available options (the same reported in Sec. **3.3** for the "Statistics Type" parameter) are: • **0**. ChTrg Rate: The channel self-trigger rates are displayed. • **1**. ChTrg Cnt: The channel self-triggers counted since the start of the acquisition are displayed. • **2**. Tstamp Rate: The channel time stamp rates are displayed. • **3**. Tstamp Cnt: The channel time stamped events since the start of the acquisition are displayed. • **4**. PHA Rate: The rate of A/D conversions of pulse height values for each channel is displayed. • **5**. PHA Cnt: The number of A/D conversions of pulse height values for each channel since the start of the acquisition is displayed.
P	**Set Plot Mode**. Janus 5202 has several plot modes that can be activated one at a time. More information about the different plots can be found in Sec. **3.3**. The available options are the following: • **0**. PHA spectrum of the LG amplification chain (X-axis = Charge, Y-axis = Counts). • **1**. PHA spectrum of the HG amplification chain (X-axis = Charge, Y-axis = Counts). • **2**. ΔT (ToA) spectrum (X-axis = ΔT, Y-axis = Counts). • **4**. Histogram of the number of counts per channel (X-axis = Channel number from 0 to 63, Y-axis = Counts per Second). • **5** Plot of the waveforms from the Citiroc-1A MUX (X-axis = Time, Y-axis = ADC Channels). See Sec. **3.3** for a more detailed description. • **6**. Two-dimensional histogram of the counts from all enabled channels. • **7**. Two-dimensional histogram of the average charge from the LG amplification chain read by the ADC for each channel. • **8**. Two-dimensional histogram of the average charge from the HG amplification chain read by the ADC for each channel. • **9**. Plot of the "SiPM Staircase", i.e. the variation of the number of channel self-triggers as a function of the TD threshold (X-axis = TD Threshold, Y-axis = Counts per Second). • **a**. 2D plot of the Hold Delay Scan (X-axis = TD Threshold, Y-axis = Counts per Second). **NOTE**: Before displaying the Staircase plot, it is necessary to execute a run to acquire the Staircase using the "y" key. Once the run has been made, the results are saved to the "ScanThr.txt" file and the plot can be displayed. The file remains saved even after quitting Janus 5202, so the plot can also be displayed later, based on the previously acquired data. **NOTE**: Before displaying the Hold Delay Scan plot, it is necessary to perform an Hold Delay Scan via the "Y" key.
x	**Enable/Disable X Axis Calibration**. Some spectra (ToA and ToT) can have the X axis scale expressed in Channels or in a calibrated quantity (ns). This key toggles between the two modes. **NOTE**: The spectra plots also display the mean and RMS values, expressed in channels or in the calibrated quantity depending on the option chosen.
c	**Change Channel**. During the acquisition, only one channel is enabled in the plots in Console Mode and in the analog probe output (although all enabled channels acquire and save data). With this key, the channel enabled in the plots and in the analog probe is changed. It is possible to scroll through the channels by pressing '+' (next channel) and '-' (previous channel). In addition, it is possible to indicate the channel both with the physical index (0...63) and with the pixel address (format 'A1').

Key	Function
b	**Change Board**. This command, when more than one board is connected at the same time, allows the user to change between active boards (e.g. to turn on/off the HV of a particular board, since by default the board 0 is the active one).
f	**Enable/Disable Freeze Plot**. During the acquisition run, the plot is automatically updated (approximately once per second). However, it is possible to stop the histogram update (while the acquisition continues) to observe the one-shot plot by pressing this command. Pressing again the command re-enables the automatic histogram update.
o	**One Shot Plot**. Force a plot update when the ”Freeze Plot” is enabled.
r	**Reset Histogram**. The command resets the content of all histograms and the values of the statistics.
j	**Reset jobs (when enabled)**. This command allows the user to interrupt the entire job (if enabled) and start over.
y	**Threshold Scan**. The command allows the user to perform a threshold scan run (”SiPM Staircase”). The program asks for the minimum threshold, the maximum threshold and the step, then it scans the threshold and counts the channel self-triggers for each step performed. At the end, it saves a file with 67 columns: the first is the threshold, then there is a column for each channel with the read counts per second, and finally there are two columns giving the T-OR (OR of the trigger from the TDs of all channels) and Q-OR (OR of the trigger from the QDs of all channels) signal counts. **NOTE**: Typically the scan is done in a range from about 150 to about 500. If performed in steps of 1, it can take several minutes.
D	**Pedestal Calibration**. The command performs a pedestal calibration run. Indeed, in the Citiroc-1A, each Preamplifier has a certain offset that makes the level of the ADC ”zero” uneven across the 64 channels. Through this run, the offset values of each channel are acquired and saved to a file, from which they are then read back each time Janus 5202 is run.
Y	**Hold Delay Scan**. The command allows the user to perform an Hold Delay Scan run. The program asks for the minimum value of the Hold Delay parameter, the maximum value, the step (at least 8 ns and multiples of 8) and the number of pulse height values acquired for each step. The software then scans the Hold Delay parameter and acquires the A/D converted pulse height values for each step performed. At the end, the user can visualize the correspondent 2D plot by selecting it via the ”P” command. **NOTE**: Typically the scan is done in a range from 0 to about 300 ns, with a value for the step of 8 ns. These settings may need to be changed according to the type of bunch trigger used.
h	**HV Controller**. The command opens a sub-menu allowing the user to change the HV channel settings: • **v**. Set the value for the common HV (from A7585D). • **i**. Set the maximum value of the output current from the HV module. • **H**. HV on/off. • **a**. Register Address of the A7585D power supply module **[RD2]**. • **t**. Data Type of the HV register value **[RD2]**. • **r**. Allows the user to read the register value. • **w**. Allows the user to write down the register value. • **q**. Quit the sub-menu.

<table>
<tr><th>Key</th><th>Function</th></tr>
<tr><td>M</td><td>Citiroc-1A Controller. The command opens a sub-menu which allows the user to change the value of some specific settings of the Citiroc-1A chip. The available commands in the sub-menu are:
s. Set the value of the LG Slow Shaper amplifier shaping time.
S. Set the value of the HG Slow Shaper amplifier shaping time.
g. Set the value of the LG Preamplifier gain.
G. Set the value of the HG Preamplifier gain.
t. Set the value of the common threshold of the Citiroc-1A TDs.
T. Set the value of the common threshold of the Citiroc-1A QDs.
q. Quit the sub-menu.</td></tr>
<tr><td>p</td><td>Set Citiroc-1A Probe. The Citiroc chip has an internal analog probe that allows an internal signal to be taken off-chip (and therefore onto one of the MCX connectors on the A5202 PCB or DT5202 front panel). The output can be that from a particular stage of the Citiroc-1A amplification chain:
0. Analog Probe disabled.
1. Fast Shaper.
2. LG Slow Shaper.
3. HG Slow Shaper.
4. LG Preamplifier.
5. HG Preamplifier.
NOTE: The output is that from a particular channel selected via the ”c” button.
NOTE: When a channel is connected to the output probe, a slight change in the analog chain gain occurs, so it is important to disable the analog probe (option ”0”) during acquisition runs.
NOTE: A 1 MΩ impedance should be set when looking at the analog probe on an oscilloscope.</td></tr>
<tr><td>m</td><td>Register Manual Controller. The command opens a sub-menu which allows the user to directly access the board registers (manual controller). The available commands in the sub-menu are:
b. Change Base.
c. Change Channel.
+. Select the next channel.
-. Select the previous channel.
a. Set Address (e.g. 02000014 is the address to access the HV individual fine adjustment).
r. Read Register.
w. Write Register.
s. Send Command.
R. Read Flash Page.
W. Write Flash Page.
p. Read Pedestal Calibration. The values of the pedestal for each channel (both LG and HG) are displayed. The visualized values are then set to a user-defined value common to all channels via the Pedestal Position parameter.
q. Quit.</td></tr>
<tr><td>U</td><td>Upgrade firmware. The command allows the user to upgrade the FPGA firmware of a particular connected board.</td></tr>
</table>

!	**Reset IP address**. This command resets the IP address of the board to 192.168.50.3. **NOTE**: This command can be used only when connected to the board via USB.
#	**Print Pixel Map**. Print the channel-pixel map (read from the ”pixel_map.txt” file) on the console.
Space Bar	**Print Command Menu**. Print on screen the list of all console commands.

Tab. 4.1: Janus 5202 console commands.

5 Plot Window and Commands

Plots in the Janus 5202 software are managed by *gnuplot*, which is an external plot engine. The plot data are written to a support file, then, via pipe, a series of commands are sent to gnuplot which displays the requested plot. The commands include setting the dimensions, titles, X and Y axis labels, plot type, colours, etc.
When working in GUI Mode, the user can select different traces at the same time to appear in the gnuplot window thanks to the Plot Traces window (see **Fig. 3.7**). In particular, in the top right part of the gnuplot window a legend is displayed (see **Fig. 5.1**).

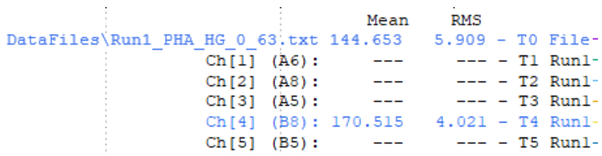


Fig. 5.1: Traces legend in the gnuplot window.

The information reported there are:

- **Channel ID**, displayed as CH[Board ID][Channel ID]. The Board ID is shown when using multiple boards only. It is not present in case of a single board usage.
- **Mean**, Mean value of the selected spectrum for the particular channel. The units for that value are those displayed in the X-axis and selected via the ”Calib X-axis” command in the Plot Traces window (see **Fig. 3.7**).
- **RMS**, The RMS value of the selected spectrum for the particular channel. The units for that value are those displayed in the X-axis.
- **Trace ID**, displayed as TN, being N the Trace ID.
- **Run ID**.

In case of an Offline run, the relative line on the legend is written in Ocean Blue color.

Gnuplot has some predefined ”bindkeys”; other bindkeys are set (depending on the type of plot) by Janus 5202 via the command pipe. A bindkey is activated by pressing a key when the gnuplot window is active. In **Tab. 5.1** the main bindkeys for gnuplot (valid for most of the plots) are listed.

Key	Function
a	**X & Y Autoscale**. Performs the autoscale of both X and Y axis.
x	**X Autoscale**. Performs the X axis autoscale.
y	**Y Autoscale**. Performs the Y axis autoscale.
g	**Grid**. Set a grid along the X and Y axis.
r	**Enable/Disable Ruler**. Enable or disable the ruler. In the bottom part of the window, the X and Y coordinates of the starting position of the cursor are displayed, together with the value of ΔX and ΔY of the new cursor position with respect to the starting position.
Right Click + Move + Left Click	**Zoom**. Performs a zoom in a region of the plot. To perform a zoom the user has to right click with the mouse (e.g. on the top left-hand corner), release the right mouse button, move the cursor (e.g. to the bottom right-hand corner) and then left click.
p	**Previous Zoom**. Return to the previous zoom.
u	**Un-Zoom**. Return to the initial zoom status.
l	**Enable/Disable Y Log Scale**. The command allows the user to enable or disable the logarithmic scale on the Y axis.
L	**Enable/Disable X or Y Log Scale**. The command allows the user to enable or disable the logarithmic scale on the axis closer to the cursor.

Tab. 5.1: Gnuplot window commands.

The gnuplot window also features an Icon Bar (see **Fig. 5.2**).

Fig. 5.2: Icon Bar of the gnuplot window.

The available commands (part of them can be performed also via the previously described bindkeys) are:

- Copy the plot to the clipboard .
- Save the plot in various formats .
- Refresh the plot .
- Display the grid .
- Return to the previous zoom .
- Apply the next zoom settings .
- Apply the autoscale .
- Open a *gnuplot* configuration window similar to that in **Fig. 5.3** .
- Open an help dialog window .

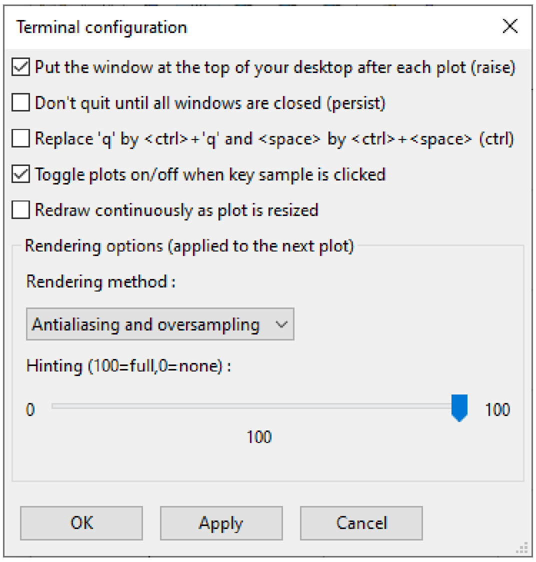


Fig. 5.3: Gnuplot configuration window.

6 DebugLog Mask

Janus 5202 provides a default log file for each data acquisition run. The log file (Msg_log.txt) can contain a greater or lesser amount of information depending on the verbosity enabling/disabling in the GUI mode menu (see Sec. **3.1**). The information saved in the log file are the same that are displayed in the Janus 5202 GUI Log Tab (Sec. **3.15**), or console, during a run. If more information are needed, it is possible to enable/disable bits of the DebugLog Mask via a macro (see Sec.**3.1**). The macro should contain:
`DebugLogMask value`
where `value` is an hexadecimal number, that can be:

- `0x1` - a FERSlib_log.txt file is created. The file contains the FERS library log. It is updated only if an error happens during the data acquisition.
- `0x2` - a RawEvents.txt file is created. A dump of the data, already divided per events, is saved on the file.
- `0x4` - a ll_log_x.txt file is created, where x is the board number. A dump of the raw data arriving from each board, with no processing performed, is saved on the file.
- `0x8` - a ll_log_x.txt file is created, where x is the board number (information added to the same file created for the 0x4 log). The start and stop of the run information, for each board, are saved on the file.
- `0x10` - a queue_log.txt file is created. This log is used just in the case of data building enabled, and it prints to the file the que of each event.
- `0x20` - a RawDecodeLog_x.txt file is created, where x is the board number. The board payload and other information are saved on the file.
- `0x40` - a ll_readdata_log_x.txt file is created, where x is the board number. Same information given by the 0x4 settings, with the only difference that the data are dumped after having passed by the memory buffer of the board.

7 Technical Support

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

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

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


CAEN
Tools for Discovery

SAFETY, STORAGE AND SETUP INFORMATION

PRODUCT SUPPORT AND SETUP INFORMATION

INFORMAZIONI SU SICUREZZA STOCCAGGIO E INSTALLAZIONE

ASSISTENZA E RIPARAZIONE DEL PRODOTTO

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

https:/www.caen.it/safety-information-product-support

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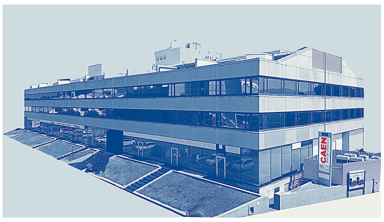

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