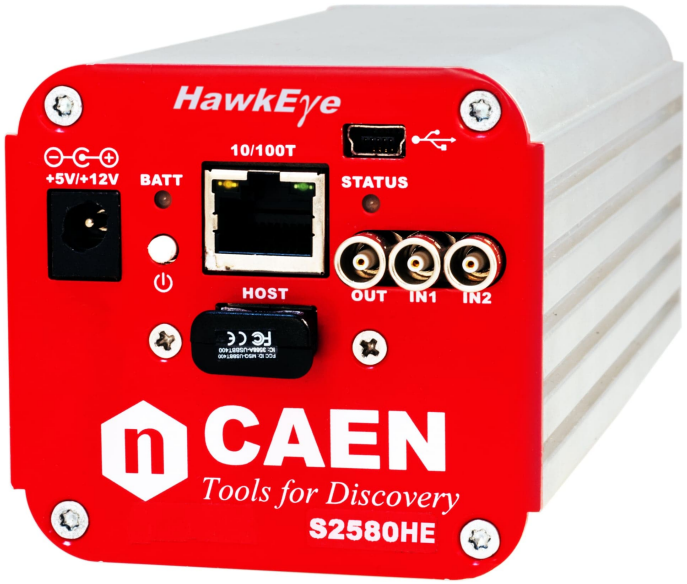
Rev. 1 - June 20th, 2024

HawkEye

Digital MCA Tube Base for Gamma-Ray Spectroscopy



CAEN
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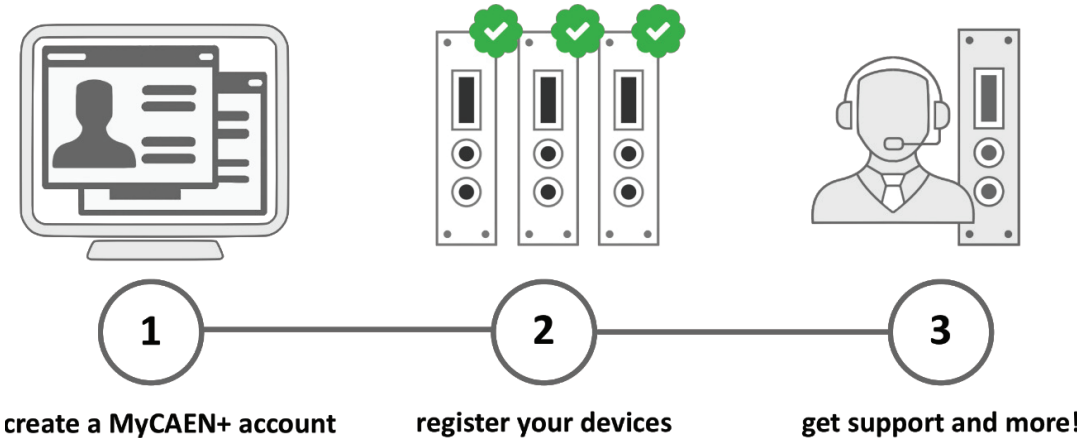
User Manual
UM9761

Register your device

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

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



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

Purpose of this Manual

This document contains the full hardware and software description of the *Hawkeye* device in the provided versions, as listed in the tab below.

Type	Description	Ordering Option
S2580HE	HawkEye Digital MCA Tube Base for Gamma-Ray Spectroscopy	WS2580HEXXXA
S2580HELB	HawkEye Digital MCA Tube Base for LaBr3 Gamma-Ray Spectroscopy	WS2580HELBXA
S2580HEG	HawkEye Digital MCA Tube Base with GPS for Gamma-Ray Spectroscopy	WS2580HEGXAAA
S2580HELBG	HawkEye Digital MCA Tube Base with GPS for LaBr3 Gamma-Ray Spectroscopy	WS2580HELBGXA

Change Document Record

Date	Revision	Changes
June 20th, 2024	00	Initial Release
June 20th, 2024	01	Modified Chapt. **Introduction** and **Getting Started**.

Symbols, Abbreviated Terms and Notation

ADC	Analog-to-Digital Converter
DPP	Digital Pulse Processing
DPP-PHA	DPP for Pulse Height Analysis
HVPS	High Voltage Power Supply
MCA	Multi-Channel Analyzer
OS	Operating System
PC	Personal Computer
PMT	Photo Multiplier Tube
USB	Universal Serial Bus

Reference Documents

[RD1] UM3182 – DPP-PHA and MC2Analyzer User Manual.

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

CAEN Electronic Instrumentation

Manufacturer Contacts

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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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Safety Notices

N.B. Read carefully the "Precautions for Handling, Storage and Installation document provided with the product before starting any operation.

The following HAZARD SYMBOLS may be reported on the unit:

	Caution, refer to product manual
	Caution, risk of electrical shock
	Protective conductor terminal
	Earth (Ground) Terminal
	Alternating Current
	Three-Phase Alternating Current

The following symbol may be reported in the present manual:

	General warning statement

The symbol could be accompanied by the following terms:

- **DANGER**: indicates a hazardous situation which, if not avoided, will result in serious injury or death.
- **WARNING**: indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**: indicates a situation or condition which, if not avoided, could cause physical injury or damage the product and / or the surrounding environment.

CAUTION: To avoid potential hazards

USE THE PRODUCT ONLY AS SPECIFIED.
ONLY QUALIFIED PERSONNEL SHOULD PERFORM SERVICE PROCEDURES

CAUTION: Avoid Electric Overload

TO AVOID ELECTRIC SHOCK OR FIRE HAZARD, DO NOT POWER A LOAD OUTSIDE OF ITS SPECIFIED RANGE

CAUTION: Avoid Electric Shock

TO AVOID INJURY OR LOSS OF LIFE, DO NOT CONNECT OR DISCONNECT CABLES WHILE THEY ARE CONNECTED TO A VOLTAGE SOURCE

CAUTION: Do Not Operate without Covers

TO AVOID ELECTRIC SHOCK OR FIRE HAZARD, DO NOT OPERATE THIS PRODUCT WITH COVERS OR PANELS REMOVED

CAUTION: Do Not Operate in Wet/Damp Conditions

TO AVOID ELECTRIC SHOCK, DO NOT OPERATE THIS PRODUCT IN WET OR DAMP CONDITIONS

CAUTION: Do Not Operate in an Explosive Atmosphere

TO AVOID INJURY OR FIRE HAZARD, DO NOT OPERATE THIS PRODUCT IN AN EXPLOSIVE ATMOSPHERE

THIS DEVICE SHOULD BE INSTALLED AND USED BY SKILLED TECHNICIAN ONLY OR UNDER HIS SUPERVISION

DO NOT OPERATE WITH SUSPECTED FAILURES.
IF YOU SUSPECT THIS PRODUCT TO BE DAMAGED, PLEASE CONTACT THE TECHNICAL SUPPORT

See Chap. **9** for the Technical Support contacts.

1 Introduction

CAEN *Hawkeγe* is a compact and portable system for gamma ray spectroscopy with scintillation detectors, which provides an active Multi-Channel Analyzer (MCA) integrated in a 14-pin photo-multiplier tube (PMT) base. *Hawkeγe* fully integrates in a stand-alone device the high voltage to bias the PMT, the preamplifier to shape the signal from detector, and the MCA for a complete Pulse Height Analysis online.

Hawkeγe makes easy the measurements with scintillation detectors, such as NaI(Tl) or CsI(Tl), with no need of additional cables. Its socket and voltage divider can supply standard 14-pin and 10-stage PMTs.

Hawkeγe has been designed to work stand-alone, with no need of additional devices, cables, nor human assistance. *Hawkeγe* features internal rechargeable Li-Ion battery providing long-term duration for unattended on-field acquisitions. Once *Hawkeγe* is programmed via computer or mobile phone, it then acquires and logs data in an internal SSD memory. An embedded CPU, running Linux® OS, controls the acquisition and data recording, as well as the supported communication interfaces.

Multi-interface communication capability by Ethernet, USB 2.0, Bluetooth® or Wi-Fi, makes possible the remote control via computer or smartphone.

Hawkeγe can be fully controlled by the MC^{2}Analyzer software **[RD1]** running on Windows® OS PC. In addition to *Hawkeγe* , MC^{2}Analyzer has been designed to manage all CAEN Digitizers running the DPP-PHA firmware (Digital Pulse Processing for Pulse Height Analysis) and the PHA-based family of CAEN Desktop/NIM MCA, such as DT5780 and DT5781. Besides the standard board and spectra configuration, the software features functionalities like spectra calibration, peak search and analysis, etc.

Considering that scintillation detectors are usually sensitive to temperature changes, an advanced algorithm for gain stabilization is available. The user can select a specific range where the algorithm recognizes a peak and adjust its position according to the temperature variations.

Hawkeγe features are described in the following section.

1.1 Advantages using *Hawkeγe*

Hawkeγe features make the instrument a ”plug-and-play” device for gamma spectroscopy from scintillation detectors.

The following sub-sections focus on the main advantages of the device.

1.1.1 Fully Stand-alone

Hawkeγe is a compact and portable instrument that provides all-in-one HVPS (High Voltage Power Supply) to bias the PMT, pre-amplification stage, and digital MCA. It is just sufficient to plug the *Hawkeγe* socket base into the 14-pin PMT. To ensure the correct alignment, the PMT has a key which mates with the *Hawkeγe* keyway. The proper settings and acquisition can be fully managed by software or mobile application, via several communication interfaces, both wired and wireless. In particular, *Hawkeγe* can be connected to a PC via wired USB 2.0 and Ethernet connection. Also, wireless connection is available on request via Wi-Fi.

1.1.2 Wireless Connectivity

Wi-Fi or Bluetooth interfaces provide wireless connectivity to *Hawkeγe* . The device can therefore work without need of any cable. Bluetooth and Wi-Fi dongles are both provided together with the *Hawkeγe* device. Either Bluetooth or Wi-Fi dongle can be plugged into the Host USB connector at a time, thus allowing for a single communication interface at a time. Also the wired communication of USB and Ethernet are exclusive. Refer to Sec. **5.3** for detailed instructions on how to configure the desired communication interface.

In case the communication is lost during the acquisition, *Hawkeγe* will continue the data collection, thus avoiding undesired data losses. Data can be then retrieved by Web Interface (see Chap. **7**).

1.1.3 Multiple Acquisition Modes

Hawkeγe supports the following acquisition modes:

1.1.3.1 PHA Mode

In the PHA (Pulse Height Analysis) mode, the energy from radiation detector signals is converted into a digital value through an internal trapezoidal filter. The filter is able to transform the exponential shape from the pre-amplifier into a trapezoid, whose height is proportional to the signal energy. Further details on the trapezoid algorithm are described in **[RD1]**. The energy values are then used to produce an energy spectrum over 4096 (4k) channels. Rebin option of 2048 (2k) and 1024 (1k) channels are supported by MC^2Analyzer software. Each channel ”i” contains the frequency of occurrence of events with energy E_i - E_{i-1}.

1.1.3.2 List Mode

In List mode, a time-stamp is associated to each event together with the energy value. The time-stamp reflects the time of occurrence of the event. For more details about the trigger filter, please refer to **[RD1]**. The time stamp is expressed with an accuracy of 16 ns.

1.1.4 Gain Stabilization

Compensation of the detector sensitivity for environmental temperature variations is a feature supported by *Hawkeγe* . The device integrates a gain stabilizer based on natural or calibration radioactivity that is managed by the software. The user defines a region of interest in the energy spectrum around a known peak, then the algorithm works by continuously tuning the fine gain (i.e. trapezoidal gain in MC^{2}Analyzer) to keep the peak at the same channel.

1.1.5 Digital I/O

Three general purpose digital I/Os support LVTTL (3.3V) signals. One output connector provides Fast Trigger Detection information; two input connectors are programmed for Veto and Synchronization functionality respectively. See Sec. **3.2** for details.

Note: additional options (e.g. Coincidence/Anticoincidence and Start/Stop Acquisition) and software configurability are coming soon.

1.1.6 Spectrum Analysis

MC^{2}Analyzer makes easy interfacing the *Hawkeγe* device with a Windows OS personal computer. The user can set the PHA parameters, manage the HV channels configuration, collect the spectra and perform mathematical analysis on them, like energy calibration, peak search, background subtraction, peak fitting, etc..

2 Technical Specifications

MECHANICAL	**Dimensions** 71.2 W x 66.4 H x 163.8 L mm^3 (including connectors)	**Weight** 700 g
DETECTOR & PMT	- Scintillation detectors - 14-pin 10-stage PMTs (S2580HE)	
DIGITAL SIGNAL PROCESSING	- 12-bit and 62.5 MHz ADC - Software selectable coarse gain: x1, x2, x4, x8 - Trapezoidal filter for the energy calculation with software adjustable rise time in the range 0÷16 µs and flat top in the range 0÷16 µs - Trigger threshold software adjustment - Software fine tuning of the Pole-Zero cancellation - Digital fine gain . Automatic gain stabilization - Pile-up rejection and Live Time correction - Baseline restorer with programmable averaging - Time stamp: 16 ns resolution - High frequency noise filter	
DATA STORAGE	Internal SSD memory can guarantee data logging for the whole battery autonomy	
HIGH VOLTAGE POWER SUPPLY	- Output Bias Voltage: 0 ÷ +1500 V - Output Bias Current: 500 µA max. - Output ripple (full load): Typical < 5 mVpp; Maximum < 10 mVpp - Setting resolution: steps of 1 V - Safety alarms (OverVoltage/UnderVoltage, OverCurrent, OverTemperature)	
OPERATING MODES	- PHA (Pulse Height Analysis): pulse height histogram over 1k-2k-4k channels - List mode: pulse height and time stamp for each event - Signal Inspector: input and internal filters waveforms	
TRIGGER MODES	- Stand-alone: triggering based on the channel self-trigger - Correlated: Veto with other *Hawkeye* ; - External: triggering based on an external trigger	
FRONT PANEL DIGITAL I/O	**OUT (LEMO LVTTL 3.3V, Rt = 50 Ohm)** General Purpose Output OUT option: Fast Trigger Discrimination signal	**IN1 & IN2 (LEMO LVTTL 3.3V, Zin = 1000 Ohm)** General Purpose Inputs IN1 option: Veto signal IN2 option: external reset of trigger time stamp
INDICATORS	Status and battery LEDs	
COMMUNICATION INTERFACE	**Ethernet** 10/100 Mbit interface RJ45 connector **Wi-Fi** USB host port (USB2.0) compliant to the Wi-Fi Micro Adapter included in the kit.	**Bluetooth** USB host port (USB2.0) compliant to the BT dongle included in the kit **USB** Mini-USB client port USB 2.0 compliant Up to 30 MB/s transfer rate
FIRMWARE	Firmware can be upgraded via USB/Ethernet/WiFi	
SOFTWARE	Fully controlled by the MC^2 Analyzer spectroscopy software for Windows PC	
POWER CONSUMPTION	**Blue-Tooth** 300 (typ.) ± 10% mA	**Ethernet** 320 (typ.) ± 10% mA Battery discharging time (HV and acquisition on, list mode continuous dump): about 6 hours	**WiFi** 330 (typ.) ± 10% mA

Tab. 2.1: Specification table

3 Packaging and Panels Description

3.1 Packaging and Compliancy

Hawkeye is housed in a EMC compatible compact aluminium tube case.

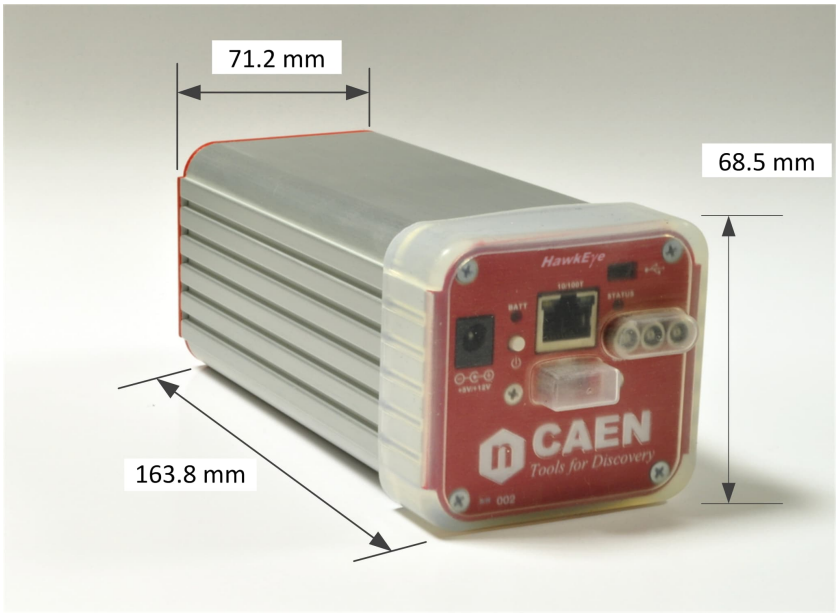


Fig. 3.1: *Hawkeye* view

In order to protect from dust and splashes of water, the device is provided with a flexible silicon front cover easy to apply and perfectly fitting the connectors profile. The resulting device maximum amount of space is:

71.2 W x 68.5 H x 170.06 L mm^3 (including connectors and cover)

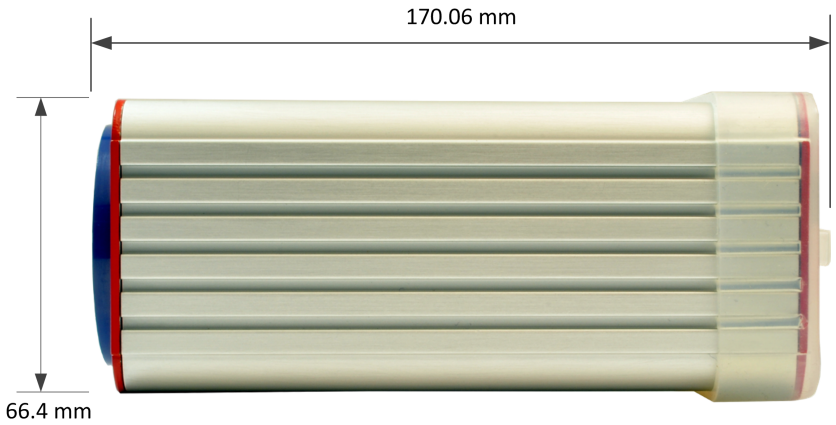
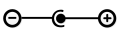


Fig. 3.2: *Hawkeye* side view

3.2 Front Panel

DC INPUT	
	**FUNCTION** Input connector for the *Hawkeye* external power supply from the AC/DC adapter (included in the kit). **ELECTRICAL SPECS** Operational Input voltage: 5 V or 12 V (Typ.). **MECHANICAL SPECS** Series: DC Power Connectors. Type: KLDX-0202-A-LT. Inside contact diameter: 2 mm. Manufacturer: KYCON **PINOUT** 

Tab. 3.1: DC Input

GPIO		
	**FUNCTION** General Purpose Digital Inputs (typical 100 ns of pulse duration): • IN1: Veto signal (level sensitive, vetoes on high level). • IN2: Synchronization signal (trigger time stamp reset, edge sensitive, resets on high-low transitions). General Purpose digital Output: • OUT: Fast Trigger Discrimination signal (160 ns pulse from the trigger detection PHA algorithm). **ELECTRICAL SPECS** Signal logic: LVTTL (3.3V). Input impedance (Zin): 50 Ω.	**MECHANICAL SPECS** Series: 101 A 004 connectors. Type: DLP 101 A 004-28. Manufacturer: FISCHER. **Alternatively:** Type: EPL 00 250 NTN. Manufacturer: LEMO.

Tab. 3.2: GPIO

ETHERNET PORT		
	**FUNCTION** 10/100 Ethernet input to control the *Hawkeye* for configuration, data taking and firmware update. Any standard 100M Ethernet cable should work. **ELECTRICAL SPECS** N.A.	**MECHANICAL SPECS** RJ45 female connector. **ETHERNET CABLE**  2m ethernet cable included in the *Hawkeye* kit.

Tab. 3.3: Ethernet port

USB HOST PORT	
	**FUNCTION** USB2.0 port provides wireless connectivity via interchangeable Bluetooth or Wi-Fi dongle for data taking and configuration. **ELECTRICAL SPECS** N.A. **MECHANICAL SPECS** Series: USB connectors. Type: 292303-9. Standard A series. Manufacturer: TE. **BT DONGLE**  Included in the *Hawkeye* kit. **Wi-Fi DONGLE**  Logilink® Wireless LAN 150 Mbit/s USB 2.0 Micro Adapter included in the *Hawkeye* kit. **Note:** Tested coverage range of 70 m with a TOSHIBA PORTEGE Z830 -11K laptop in open-field conditions without obstructions.

Tab. 3.4: USB Host Port

USB CLIENT PORT	
	**FUNCTION** USB port, USB2.0 compliant, for the wired control of the *Hawkeye* concerning configuration, data taking and firmware update. **ELECTRICAL SPECS** N.A. **MECHANICAL SPECS** Series: mini-USB connectors. Type: Standard B series. Manufacturer: N.A. **USB CABLE**  1m cable, USB Type A to mini USB Type B, included in the *Hawkeye* kit.

Tab. 3.5: USB Client Port

ON/OFF BUTTON	
	**FUNCTION** Pushbutton switch to power on/off the *Hawkeye* . Press the button to power on the device; for power-off, keep the button pressed as long as the STATUS LED (see Tab. **3.7**) becomes orange, then release the button, the STATUS LED will then turn on red and the device will definitely shut down. To force the power-down, keep the button pressed for around seven or eight seconds, until the device will shut down.

Tab. 3.6: ON/OFF Button

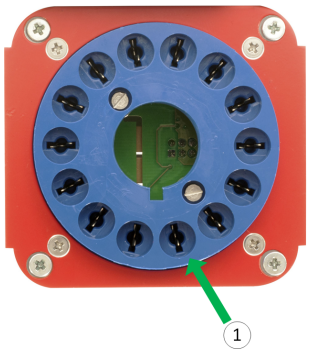
DIAGNOSTICS LEDs	
 	• **BATT** indicates the battery status: **BLINKING ORANGE** = battery close to discharge; **RED** = battery discharged (entering the power-off procedure); **BLINKING GREEN** = battery in charge from external power supply unit; **GREEN** = battery fully charged and external power supply unit plugged in; **ORANGE** = battery in discharging progress mode. • **STATUS** indicates the device status: **ORANGE** = device is entering the power-off procedure; **RED** = device is powering ON/OFF; **GREEN** = device is ready; **BLINKING GREEN** = device is running.

Tab. 3.7: Diagnostic Leds

3.3 Rear Panel

PMT SOCKET BASE

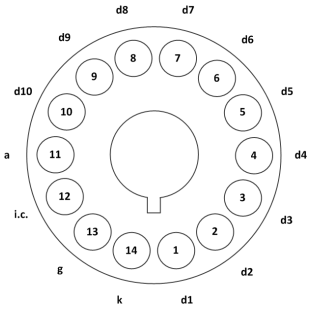
S2580HE



FUNCTION
Hawkeye socket for PMT connection.

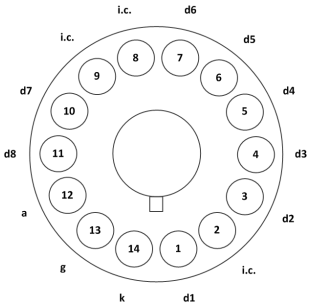
MECHANICAL SPECS
Compliant with JEDEC B14-38 PMT pin bases.

S2580HE



Pin Code	Pin Description
d1-d10	dynodes 1-10
a	anode
i.c.	internal connection
g	grid
K	kathode

S2580HELB



Pin Code	Pin Description
d1-d8	dynodes 1-8
a	anode
i.c.	internal connection
g	grid
K	kathode

Tab. 3.8: PMT socket base pinout description

4 Power Requirements

4.1 External Power Supply

Hawkeye is provided with an external 12V-45W power supply unit deputed to the battery recharge (see **Fig. 4.1**).

Fig. 4.1: External power supply unit and relevant cable

4.2 Power Consumptions

POWER CONSUMPTION	Blue-Tooth	Ethernet	WiFi
	300 (typ.) ± 10% mA	320 (typ.) ± 10% mA	330 (typ.) ± 10% mA

Tab. 4.1: Power Consumption table according to the selected communication interface (HV and acquisition ON).

4.3 Battery Power Supply

Hawkeye is equipped with an on-board rechargeable battery pack suitable for stand-alone and on-field operations that is recharged by using the external power supply unit.

Tab. 4.2 reports the battery main specifications.

TYPE	rechargeable, non extractable Li-Ion 3-cell pack
NOMINAL VOLTAGE	3.6 V (Typ.)
NOMINAL CAPACITY	6750 mAh (Typ.)
MAX. CHARGE VOLTAGE	4.2 V
DURATION	about 6 hours (HV and acquisition on, list mode continuous dump)

Tab. 4.2: Battery Specifications

For a safe and correct use of the device, pay attention to the following reminders:

- **It is recommended to fully charge *Hawkeye* before using it for the first time.**
- **The battery charge process starts when the device is connected to an external power supply and powered on.**

4.4 Recharging Process

In the battery operating mode, the BATT LED (see Tab. **3.7**) normally lights on orange. Entering the blinking orange status means that the battery operating time is close to the end. The user can then recharge the battery in few simple steps:

- Connect the external power supply unit to the net. The green LED on the unit lights on.
- Plug the jack of the external power supply unit in the *Hawkeye* front panel DC INPUT connector (see Tab. **3.1**). The BATT LED will be blinking green during the recharging time.
- As soon as the BATT LED remains on green (i.e. stop blinking), the recharge is over, and *Hawkeye* is ready for new operations. The user can then remove the external power supply unit and the BATT LED will now light back on orange.

Note: *Hawkeye* can be operated even while recharging, thanks to the external power supply unit. On the other hand, this will result in a longer recharging time.

5 Getting Started

5.1 Hardware Setup

Hawkeγe is able to power supply and manage the acquisition from scintillation detectors with PMT tube base compliant with the pin socket described in Tab. **3.8**.

Note: *Hawkeγe* provides positive power supply only. Check that the PMT is compliant with positive power supply and with the diagram of Tab. **3.8**.

1. The rear panel of *Hawkeγe* (see Sec. **3.3**) has to be mounted on the corresponding pin socket of the scintillation detector PMT. The *Hawkeγe* bottom shows a small cavity that correctly fits into the PMT base (see Fig. **5.1**).

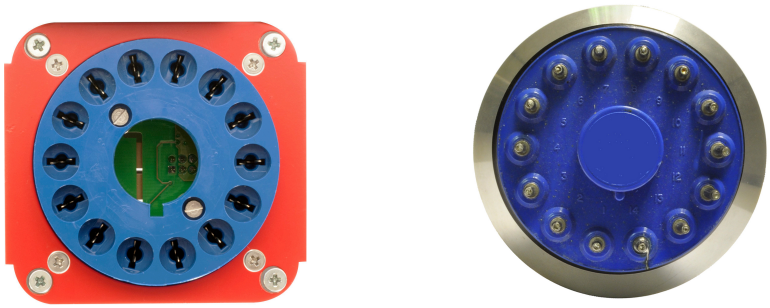


Fig. 5.1: The socket cavity of *Hawkeγe* is designed to fit into the PMT base socket. Check the correct mounting of *Hawkeγe* on the PMT itself

Mount *Hawkeγe* as in Fig. **5.2**, where on the left is shown the proper way of coupling, and on the right the mounted assembly.

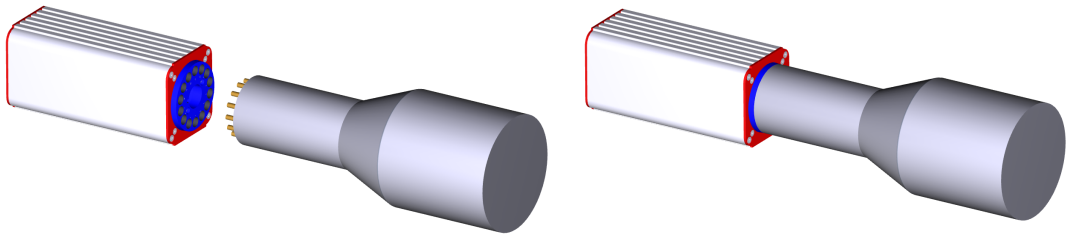


Fig. 5.2: How to mount *Hawkeγe* on a PMT tube base

In order to guarantee the EMC compatibility, it is suggested to:

- **shield at the junction between detector and electronics;**
- **realize a common connection between the detector case and the electronics case.**

2. Press the **ON/OFF** button (Tab. **3.6**) to power on *Hawkeγe* .
   The STATUS LED (Tab. **3.7**) becomes red. When the board is ready the STATUS LED becomes green. The BATT LED works according to Tab. **3.7**.
3. Choose the desired communication interface to link the *Hawkeγe* and control it through the dedicated software. CAEN makes available a software interfaces for *Hawkeγe* : the MC^{2}Analyzer software **[RD1]**, to configure and acquire via PC.

5.2 How to Power ON/OFF *Hawkeγe*

To power ON *Hawkeγe* , press the ON/OFF button.

To power OFF the device, press the ON/OFF button as long as the STATUS LED becomes orange, then release the button, the STATUS LED will then become red and the *Hawkeγe* will definitely shut down.

In the case it is needed to force the power down, keep pressed the ON/OFF button for around seven or eight seconds and *Hawkeγe* will shut down.

CAUTION: it is strongly recommended not to force the power-down in the common operating, especially if an acquisition is running with the HV powered on!

5.3 How to Connect to *Hawkeye*

5.3.1 Ethernet Connection to the PC

1. Connect the Ethernet cable from *Hawkeye* to the PC.
2. Configure the Ethernet network of your PC.
   a. Open the path:
   `Control Panel - Network and Internet - Network and Sharing Center`
   as in Fig. **5.3**

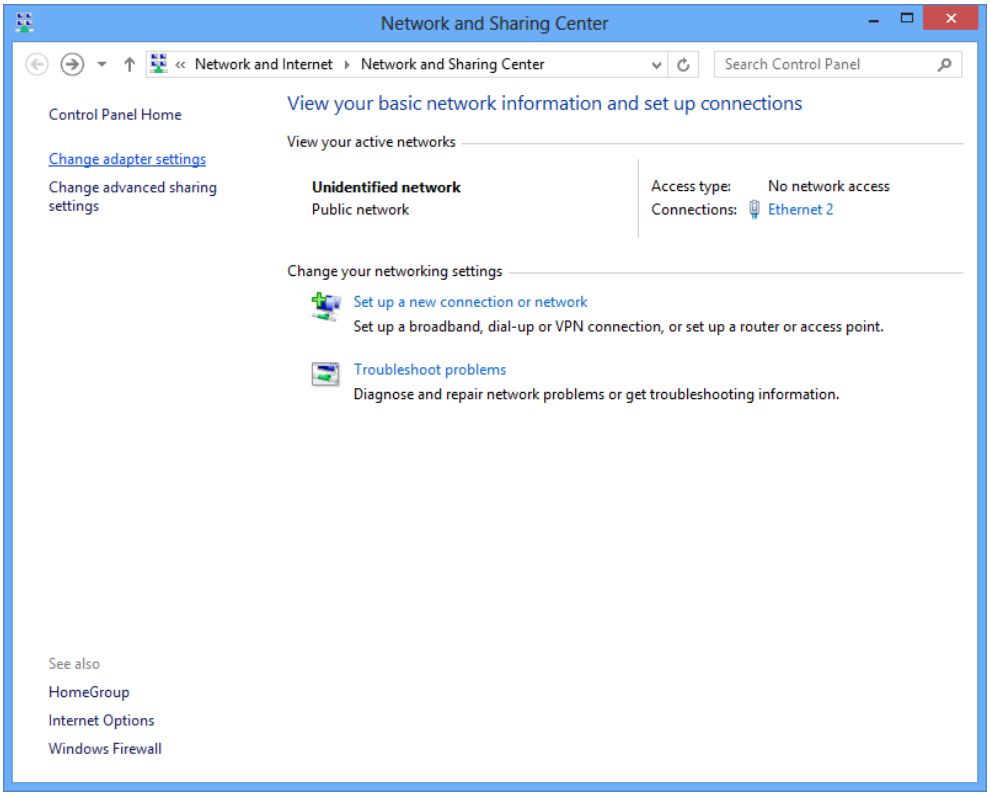


Fig. 5.3: The Network and Sharing Center window

   b. Click on ”Change adapter settings”.

c. Right click on the Ethernet icon and select ”Properties”, as in Fig. **5.4**.

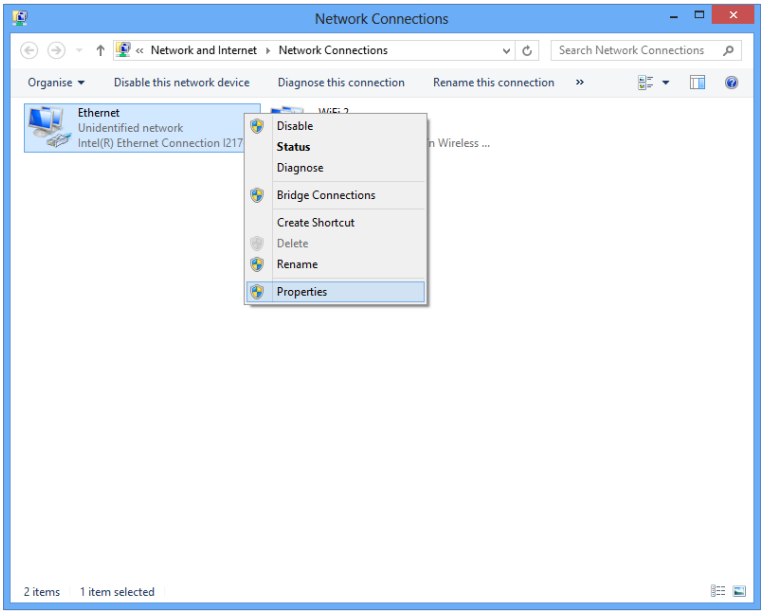


Fig. 5.4: Properties window of the Ethernet network

d. Click on ”Internet Protocol Version (TPC/IPv4)”, and select ”Properties”, as in Fig. **5.5**.

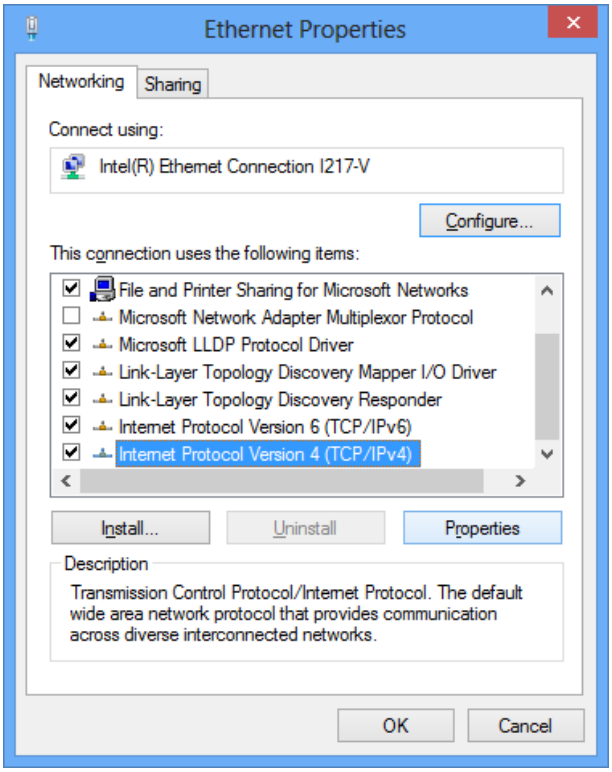


Fig. 5.5: Properties window of the ”Internet Protocol Version (TPC/IPv4)”

e. Copy the following configuration on the ”Internet Protocol Version (TPC/IPv4) Properties” window, as in Fig. **5.6**.

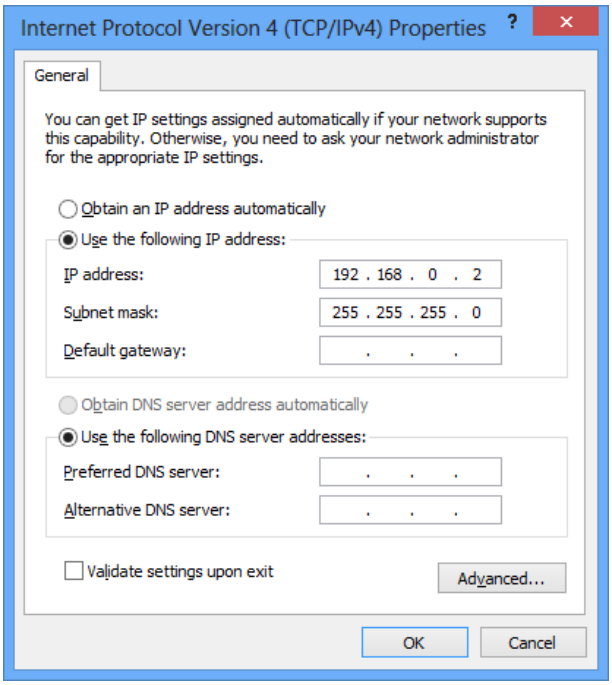
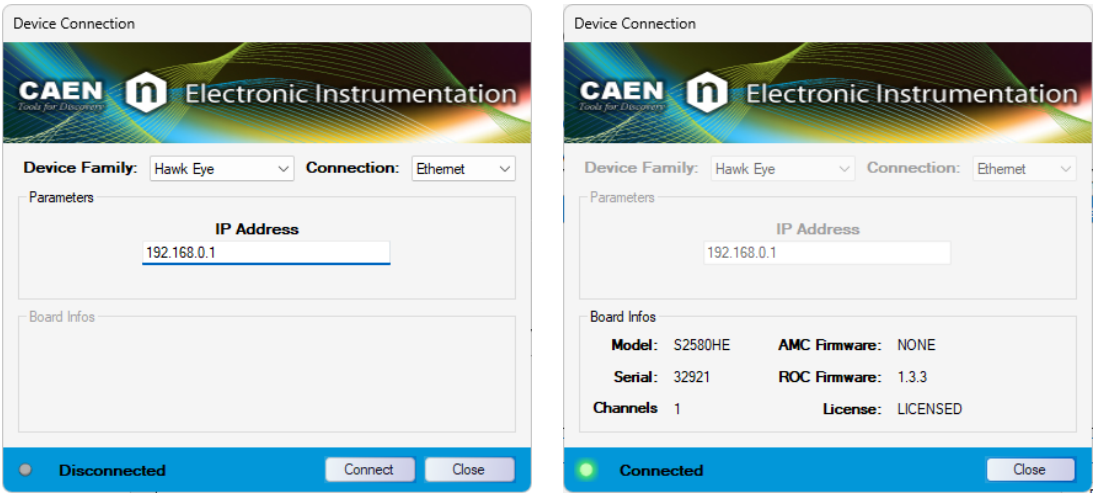


Fig. 5.6: Properties window of the ”Internet Protocol Version (TPC/IPv4)”

3. Connect *Hawkeye* to the MC^{2}Analyzer software through Ethernet connection. Check Sec. **6.2.1** for more details.



5.3.2 Mini USB Connection to the PC

1. Download from the *Hawkeye* website the required USB driver according to you PC platform and install them.
2. Connect the mini USB cable from *Hawkeye* to the PC and power on the device.
3. The device is recognized by the operating system and listed in the ”Device Manager” window among ”Universal Serial Bus controllers”.

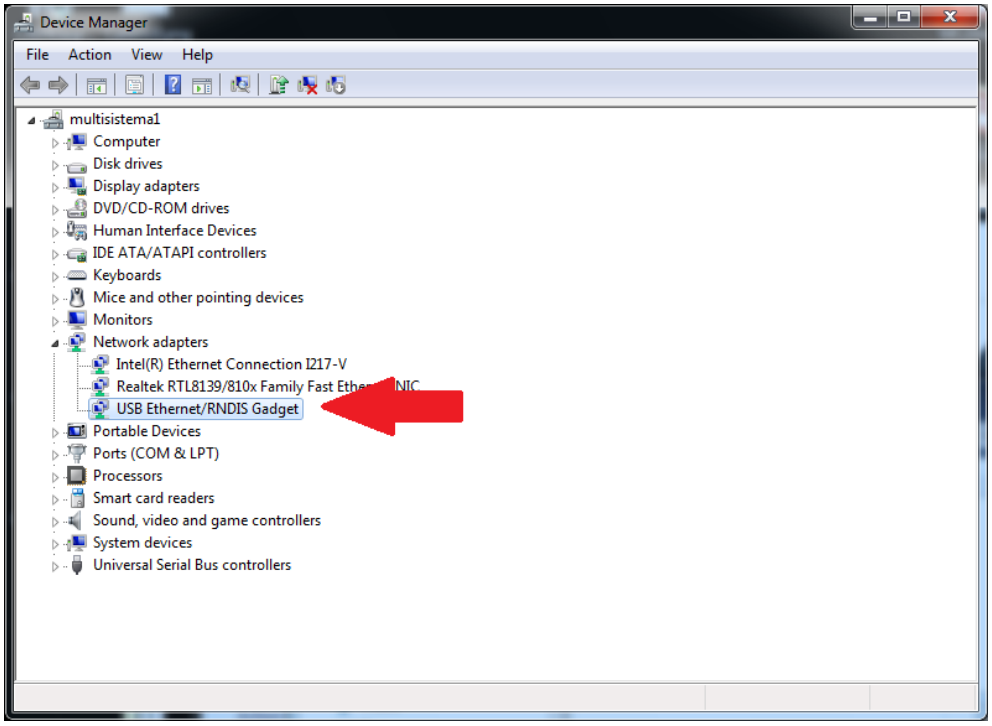
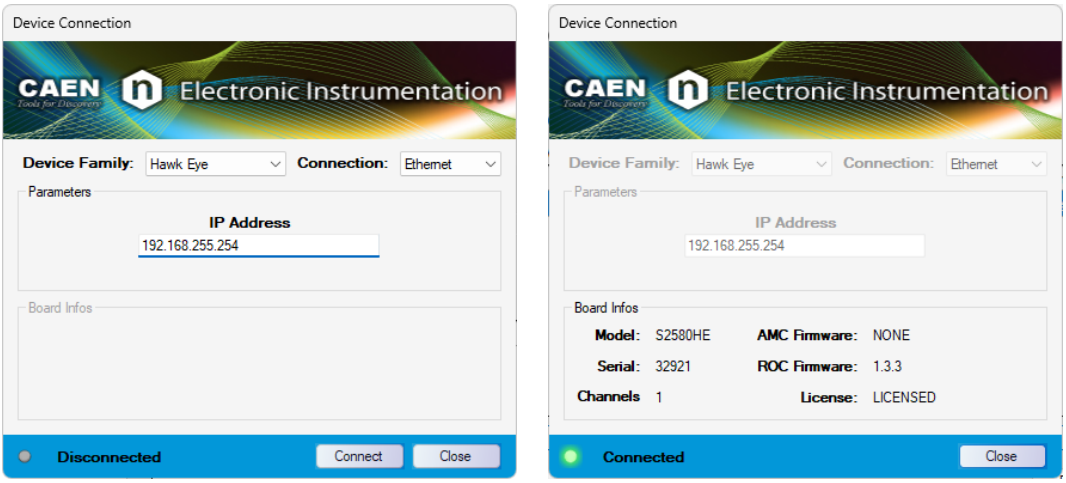


Fig. 5.7: Device recognized

4. Connect *Hawkeye* to the MC^{2}Analyzer software through mini USB connection.



Check Sec. **6.2.2** for more details.

6 MC^{2}Analyzer Software Interface

This Chapter is mainly intended to provide a quick overview of the MC^{2}Analyzer software, with particular attention to the features related to *Hawkeye* . A detailed description of the overall functionality of MC^{2}Analyzer can be found in the MC^{2}Analyzer User Manual **[RD1]**.

Note: *Hawkeye* can be managed by MC^{2}Analyzer software from official version 2.1.13 on.

6.1 Software Installation

In order to manage the MC^{2}Analyzer software, the host station needs a Windows OS. The Linux version is currently not supported. The software requires the third-party software Microsoft® .NET Framework 4.0 or later, downloadable from Microsoft website.

Note: Check that the hardware is properly connected to the PC according to steps described in Sec. **5.3**.

CAEN provides the full installation package for the MC^{2}Analyzer software in a **standalone version** for Windows OS. This version installs all the binary files and required libraries.

1. Download the MC^{2}Analyzer software from CAEN website;
2. extract the files and run the executable ”MC2Analyzer_x.x.x.exe”;
3. the CAEN MC^{2}Analyzer Setup Wizard will guide you throughout the installation procedure. Click on ”Next” to proceed to the following step.

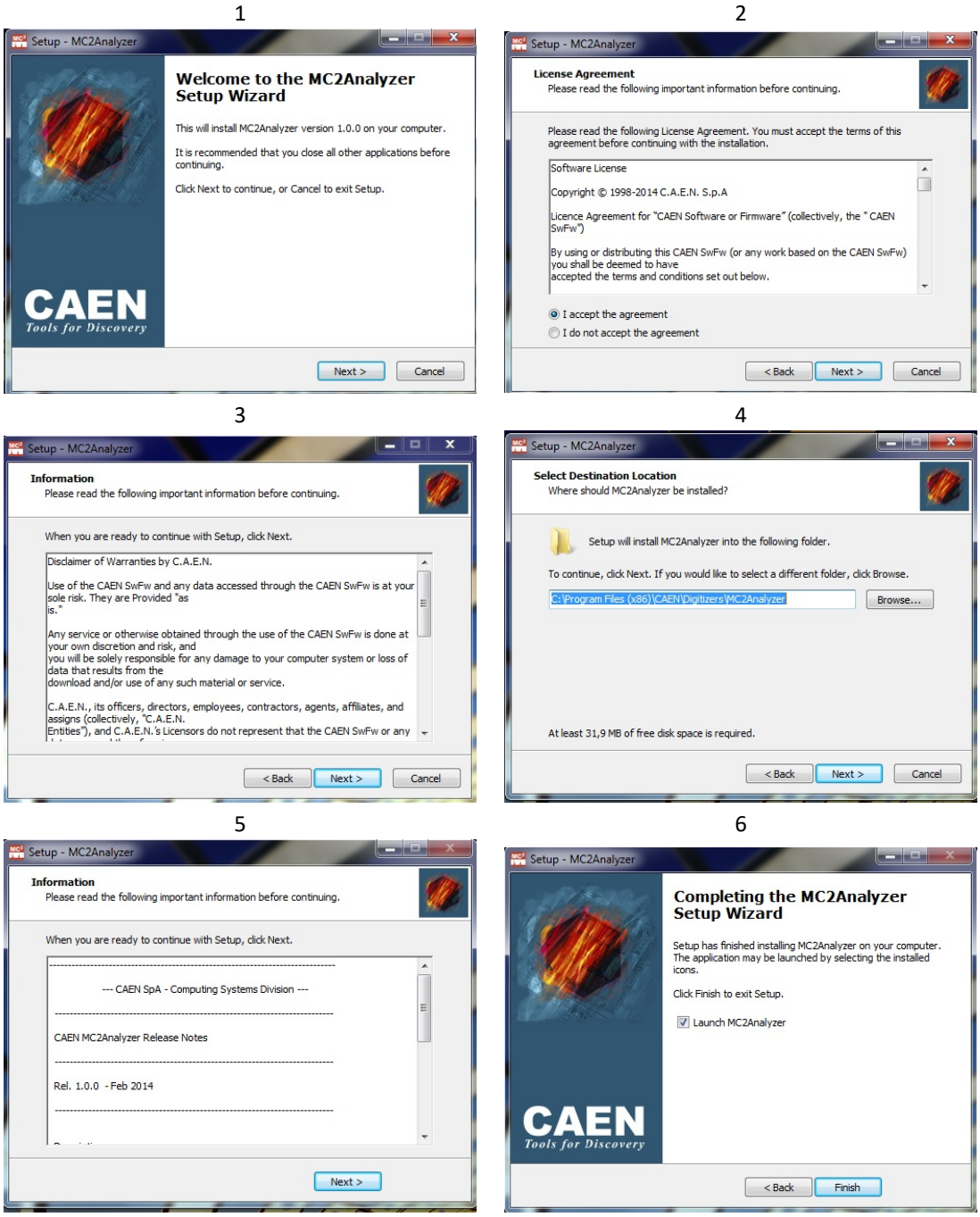


Fig. 6.1: The MC^{2}Analyzer installation steps

6.2 Software Connection

1. Make sure to have configured the properly communication interface as described in Sec. **5.3**.
2. Open the MC^{2}Analyzer software.
3. From the main panel of the MC^{2}Analyzer software GUI select:
   FILE -> Add Spectrum, or press the button
4. Select **Online Spectrum** to connect MC^{2}Analyzer to *Hawkeye* and click on "New Board Connection".

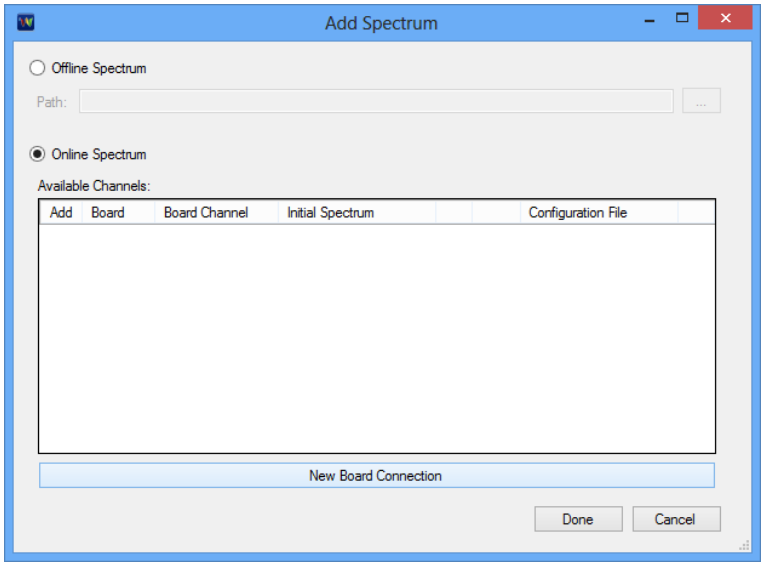


Fig. 6.2: *Add Spectrum* window of MC^{2}Analyzer

6.2.1 Ethernet Connection

Note: Check that *Hawkeye* is powered on, the Ethernet cable is connected, and the Network is configured according to Sec. **5.3.1**.

Select "Type = Ethernet" on the "Device Connection" window, and write the IP Address of *Hawkeye* . By default, IP Address = 192.168.0.1.

It is possible to change the IP Address via the web interface (refer to Sec. **7**).

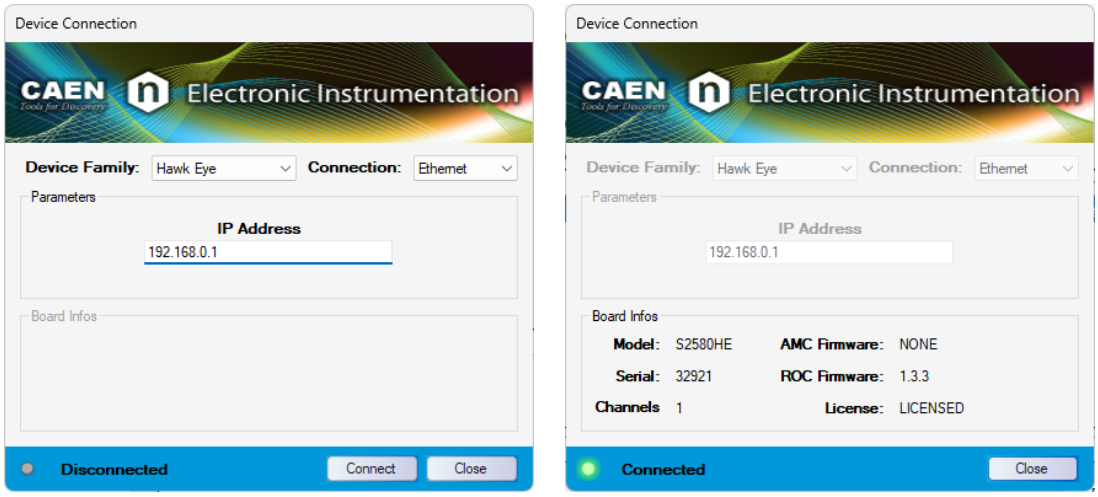


Fig. 6.3: Ethernet connection settings of MC^{2}Analyzer

6.2.2 Mini USB Connection

USB link is managed by the software as an Ethernet virtual connection.

Note: Check that *Hawkeye* is powered ON, the mini USB cable is connected, and the driver is installed according to Sec. **5.3.2**.

Select "Type = Ethernet" on the "Device Connection" window, and write the "IP Address = 192.168.255.254". This is a fixed IP Address that cannot be changed.

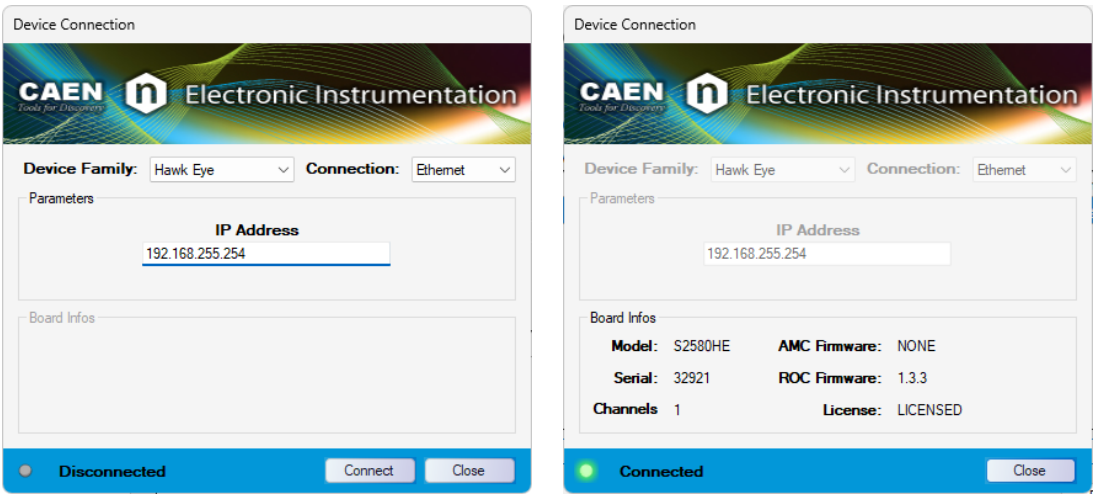


Fig. 6.4: Mini USB connection settings of MC^{2}Analyzer

6.2.3 Wi-Fi Connection

The Wi-Fi network is managed by the software as an Ethernet virtual connection.

Note: Check that *Hawkeye* is powered ON, the Wi-Fi dongle is connected, and the Wi-Fi network is configured as described in Chap. **8**.

Select ”Type = Ethernet” on the ”Device Connection” window, and write the ”IP Address = 192.168.3.1”.

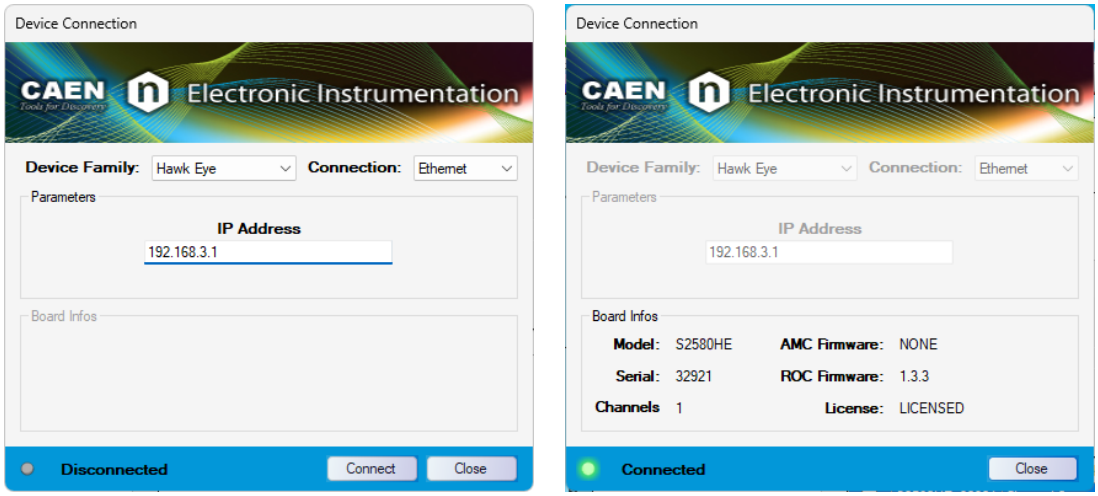


Fig. 6.5: Wi-Fi connection settings of MC^{2}Analyzer

6.3 Select the *Hawkeγe* Channel

Once connected, MC2 Analyzer will automatically select the *Hawkeγe* channel to enable the configuration and acquisition.

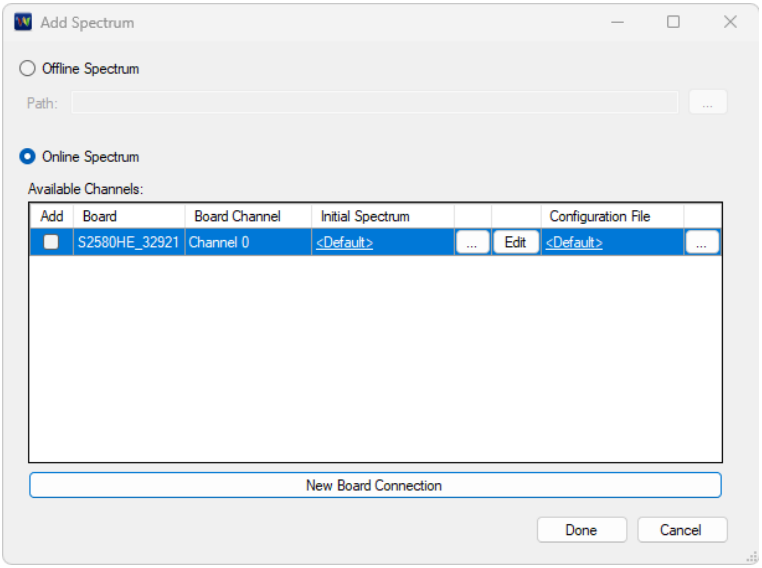


Fig. 6.6: *Add Spectrum* window of MC^{2}Analyzer

6.4 Power ON the HV

1. Open the **HV Channels** window.
2. Set the required positive High Voltage value (**VSET**) and the maximum value of the current (**ISET**).
3. Press ON when ready.

Note: **VMAX**, **RUP**, and **RDOWN** are disabled.

Note: The HV remains ON even when the software is disconnected. Once connected again the software automatically reloads the last HV settings.

6.5 Board Configuration

For a correct configuration of *Hawkeye* , it is necessary to open the **Signal Inspector** window through the icon.

Select the *Hawkeye* channel to visualize the waveform.

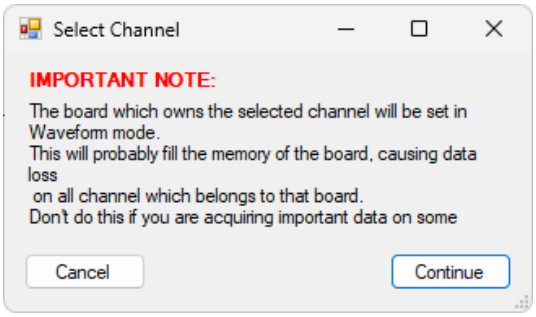


Fig. 6.7: Select Channel window of MC^{2}Analyzer

For a complete description on how to configure the settings, refer to the MC^{2}Analyzer User Manual **[RD1]**, particularly to **Sect. How to configure the channel settings**.

1. From the **Acquisition Setup** window, configure the **Input Range** by selecting the analog gain option among x1-x2-x4-x8.

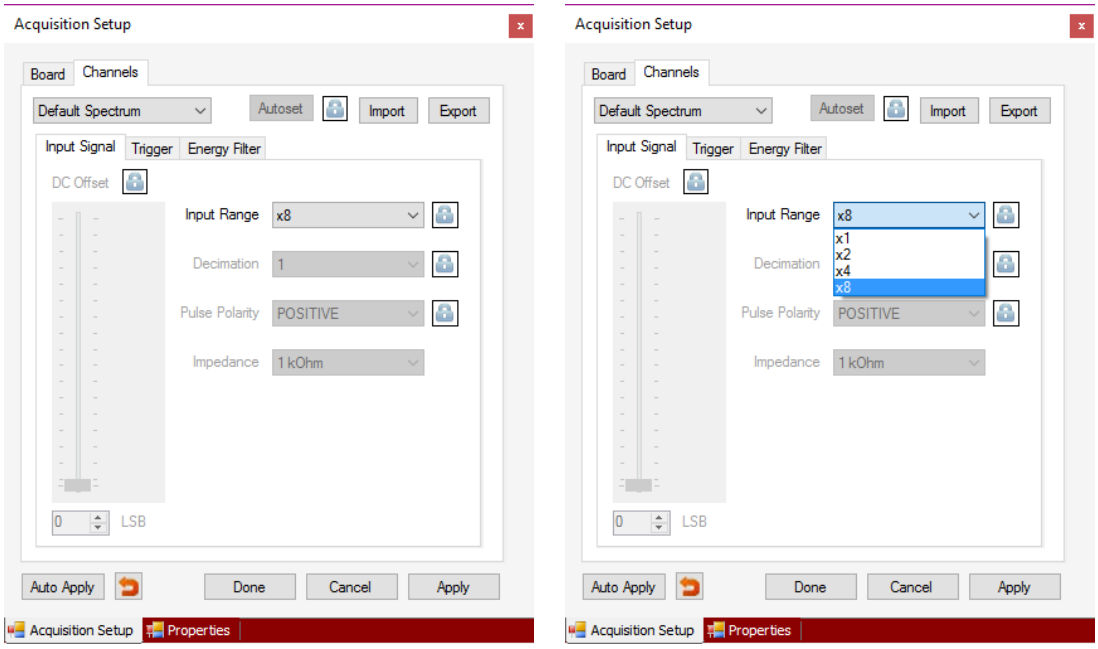


Fig. 6.8: Input Signal tab in the Acquisition Setup window of MC^{2}Analyzer

2. From the **Acquisition Setup** window, configure the **Trigger** settings. The trigger fires when the RC-CR2 trace crosses the zero. It is possible to visualize the **Input** and the **RC-CR2** traces. Change the **RC-CR2 Smoothing** and the **Input Rise Time** to have the RC-CR2 height as close as possible to the Input height. Also, increase the RC-CR2 Smoothing factor to average the RC-CR2 signal and reduce high frequency noise. Finally the Threshold has to be referred to the RC-CR2 noise level.

   In Fig. **6.9** it is shown the typical trigger settings for a *Hawkeye* coupled with a NaI(Tl) detector, and in Fig. **6.10** it is shown how the RC-CR2 trace should look like with respect to the Input.

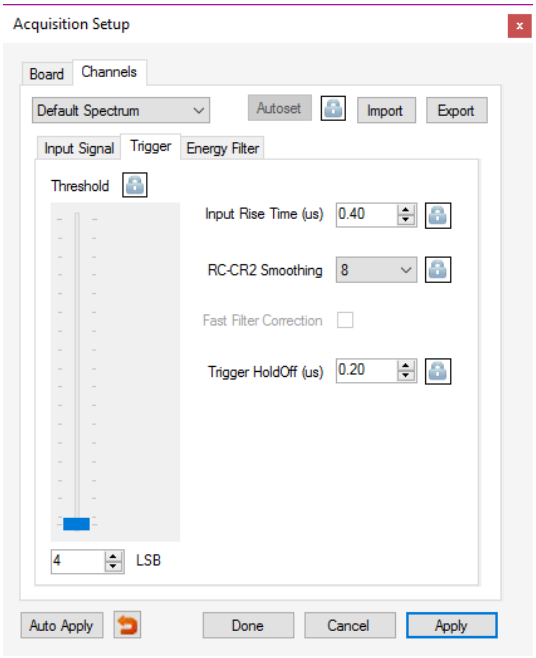


Fig. 6.9: Trigger tab in the Acquisition Setup window

In case of a faster scintillation detector as a $LaBr_3$(Ce), or $CeBr_3$, the settings can be changed as in the following Fig. **6.11** and Fig. **6.12**.

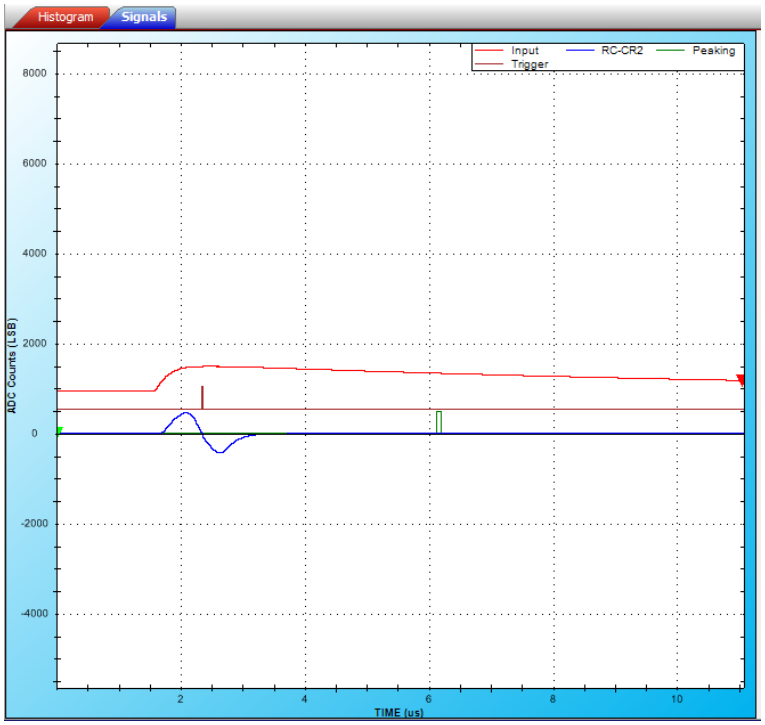


Fig. 6.10: Signal Inspector view showing the Input and the RC-CR2 traces

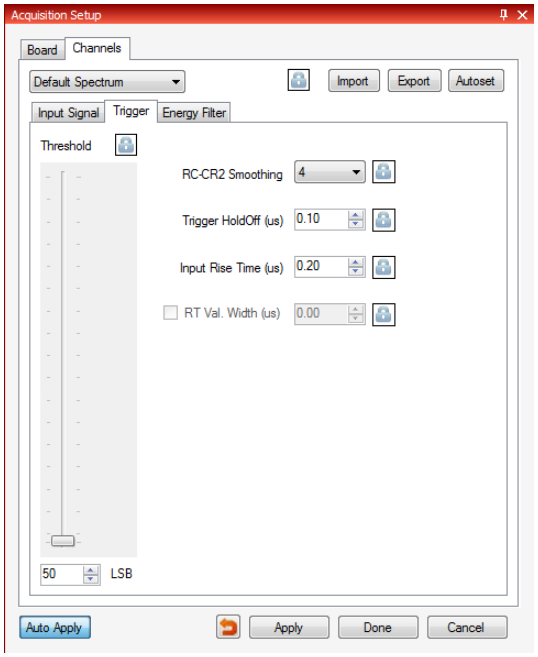


Fig. 6.11: Trigger tab in the Acquisition Setup window. Settings are chosen for faster signals

Fig. 6.12: Signal Inspector view showing the Input and the RC-CR2 traces in case of faster signals

3. From the **Acquisition Setup** window configure the **Energy Filter** settings. The **Input** and the **Trapezoid-Baseline** traces ca be visualized. Modify **Trap. Rise Time** and **Flat Top** to increase the resolution.

Note: Verify that the Peaking trace (which corresponds to the region where the energy is evaluated) is in the flat part of the Flat Top itself.

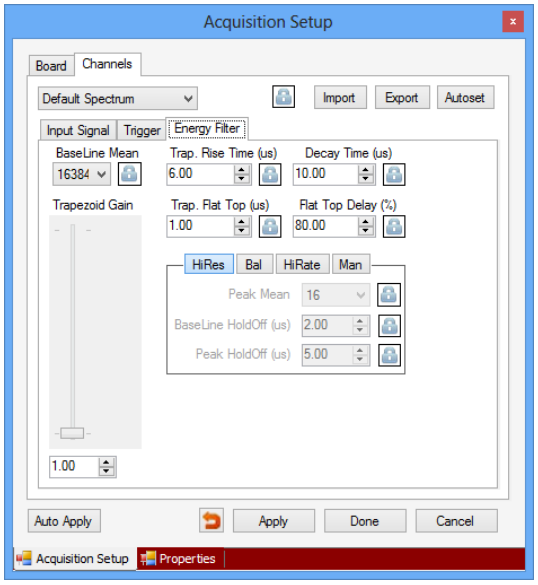


Fig. 6.13: Energy Filter tab in the Acquisition Setup window

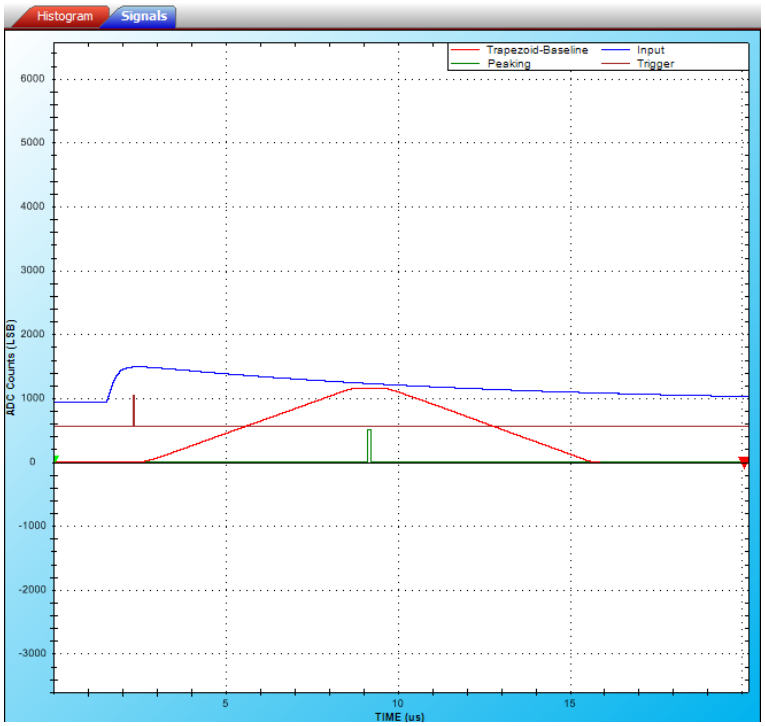
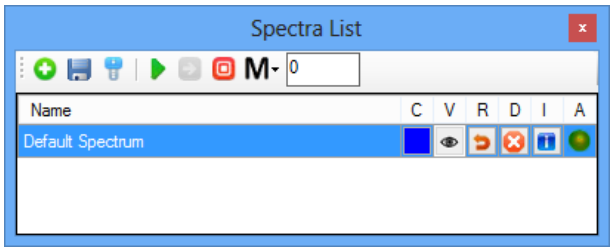


Fig. 6.14: Signal Inspector view showing the Input and the Trapezoid-Baseline traces in case of NaI(Tl) detector

6.6 Spectrum Acquisition

Close the ”Signal Inspector” window and reset the histogram plot by means of the ”reset” button (click either on **R** or on) under the ”Spectra List” window.



The spectrum accumulation will appear in the main ”Histogram” window. In Fig. **6.15** it is shown a typical natural background acquisition with a NaI(Tl) detector. In Fig. **6.16** it is shown a typical ^{60}Co spectrum acquired with a $LaBr_3$(Ce) detector.

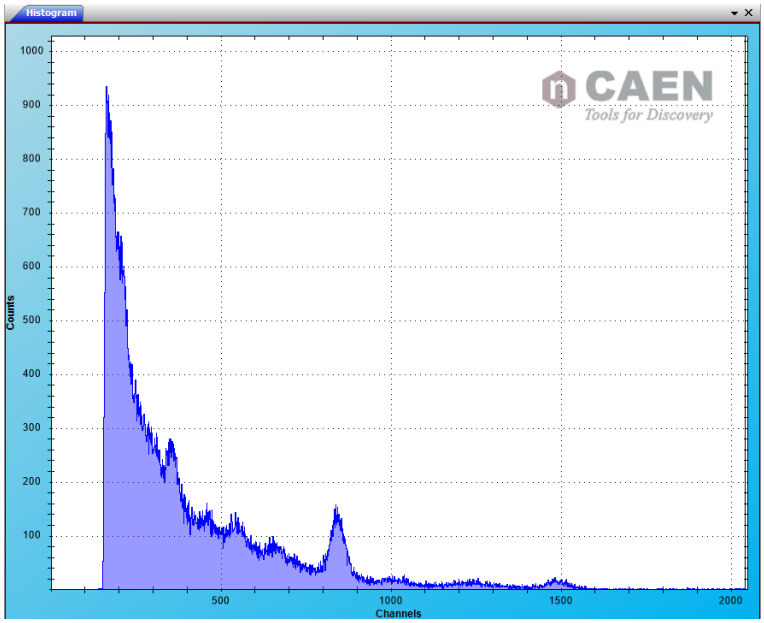


Fig. 6.15: Typical natural background acquisition with a NaI(Tl) detector and *Hawkeye*

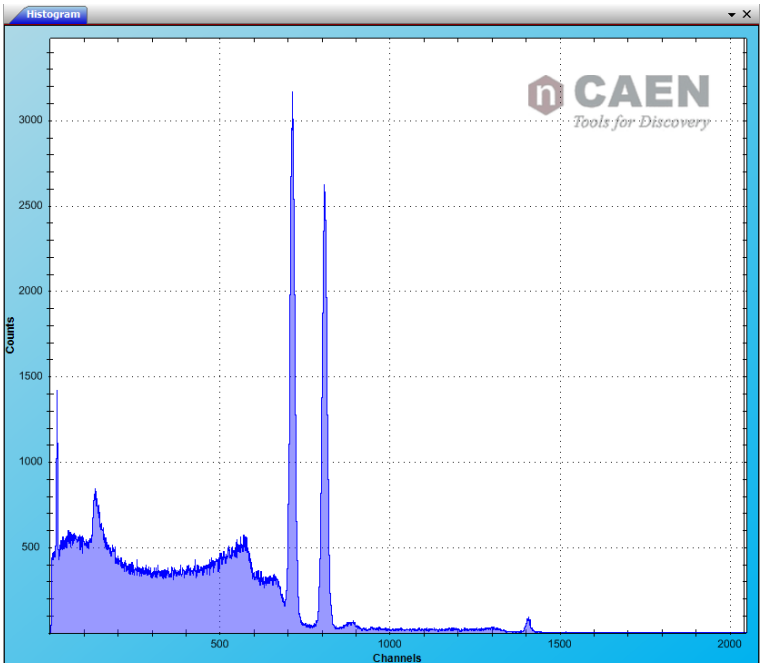


Fig. 6.16: ^{60}Co spectrum acquisition with a $LaBr_3$(Ce) detector and *Hawkeye*

6.7 ROI Editor and Spectrum Calibration

From the **ROI Editor** window add a ROI by pressing the icon. Then left click on the spectrum window to select the left limit of the ROI and click again to select the right limit of the ROI. It is also possible to write the limits in the **"Range"** field of the ROI Editor window itself. Press **Done** when ready.

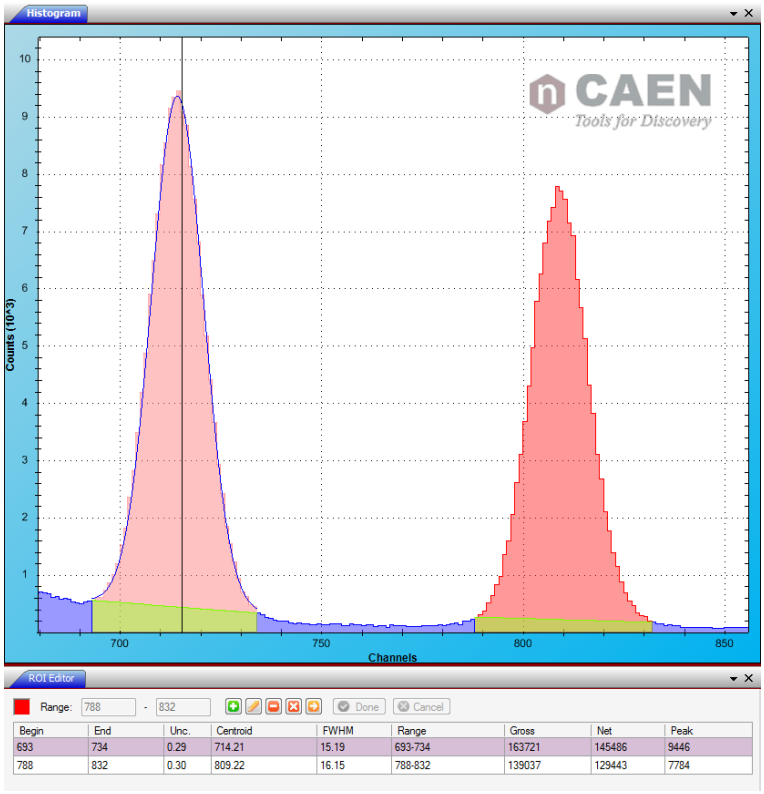


Fig. 6.17: ROI selection in MC^{2}Analyzer software

The peak is fitted with a Gaussian function, and the background is fitted with a line crossing the two limits of the ROI range. The relevant ROI parameters are shown on the ROI Editor window.

To calibrate the spectrum press the icon. Write the channel value and the corresponding energy in keV or MeV (see Fig. **6.18**). It is also possible to select the Centroid of the ROI itself. Press OK to calculate the calibration curve. Then press to enable the calibration.

The resulting spectrum is then calibrated in keV, according to the calibration curve. Also the ROI settings are converted in keV.

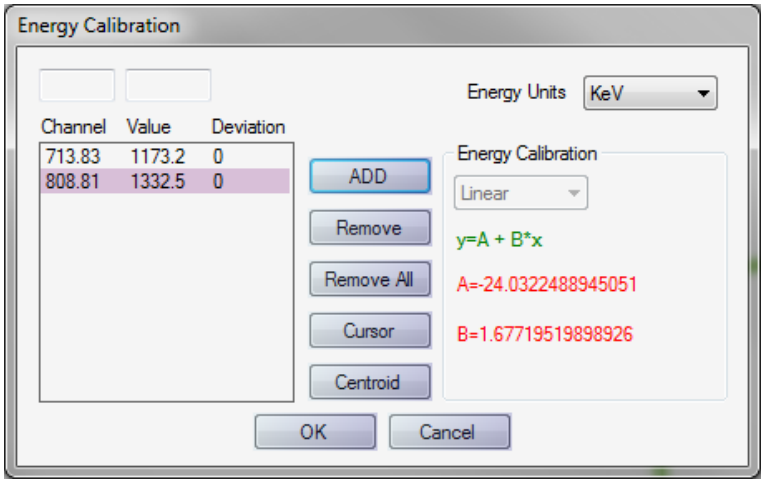


Fig. 6.18: Calibration window. Add points for a linear/quadratic calibration

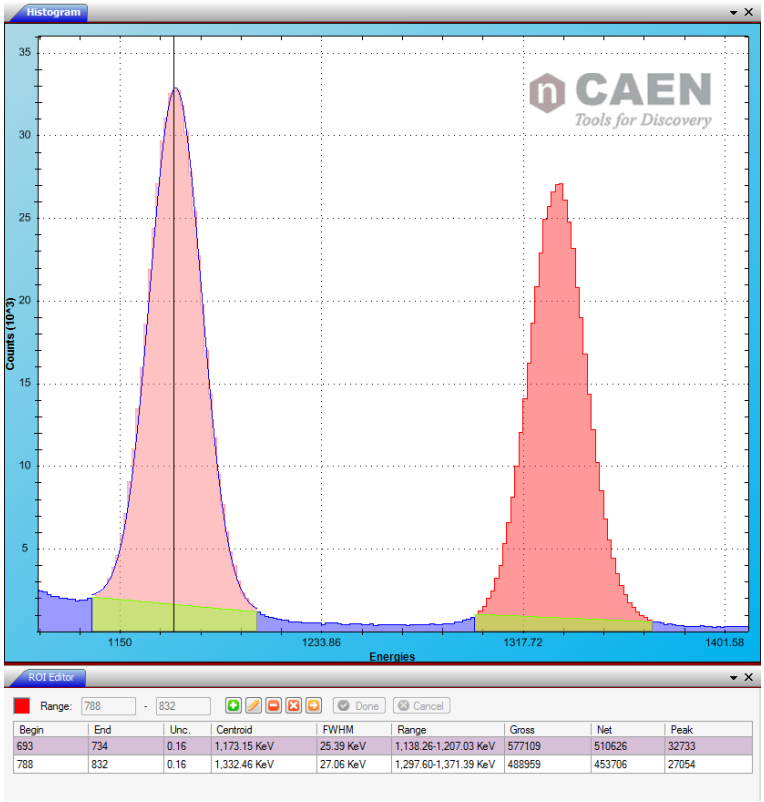


Fig. 6.19: Calibrated ^{60}Co spectrum in MC^{2}Analyzer software

6.8 Gain Stabilization Control

The Gain Stabilization feature allows the user to select a region of the spectrum with a known peak. Any local temperature change produces a shift of the peak position. When the control is enabled, the fine gain of *Hawkeye* (i.e. Trapezoidal Gain in MC^{2}Analyzer) is modified to have the peak centered in the same ADC position.

Typically, the procedure consists in:

- acquiring a sufficient environmental statistics, tuning the full scale in order to see the potassium peak;
- identifying the potassium peak, defining a ROI around it;
- typing the begin and end channel of the ROI in the **General** sub-tab of the **Board** tab in the **Acquisition Setup** window (these edges will be used by the algorithm to find the peak and evaluate the fine gain value).
- enabling the **"Gain Stabilizer"** checkbox.

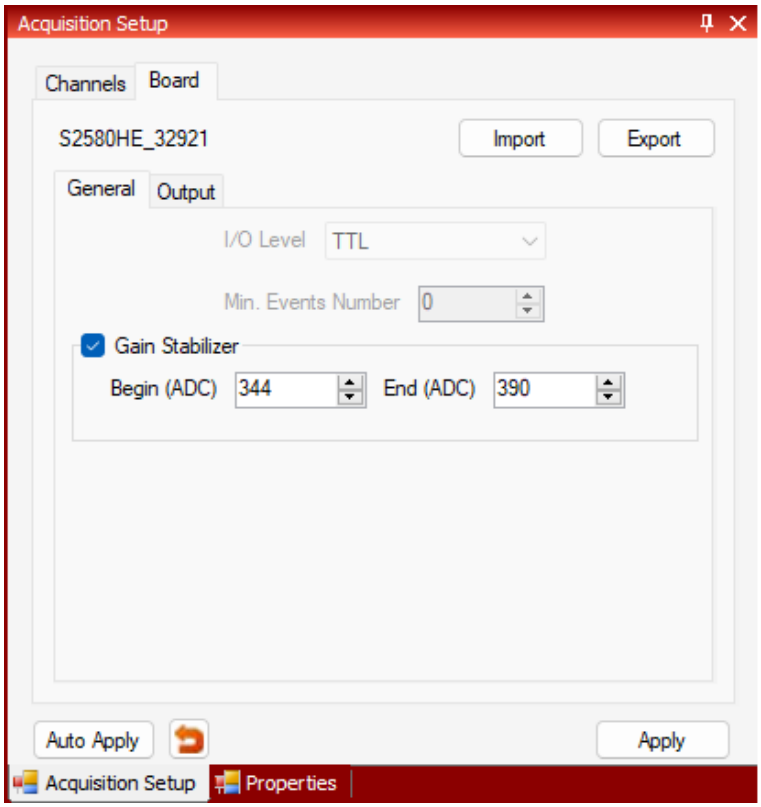


Fig. 6.20: Gain Stabilization feature

The resulting spectrum will have all the corrected energy values.

6.8.1 Data Saving

MC^{2}Analyzer allows to configure the data to be saved on *Hawkeye* as well as on the host PC. In the first case, the user must open the **"Acquisition Setup"** menu, accessible from ***"Tools -> Acquisition Setup"***, then open the **"Board"** tab as shown in the picture below:

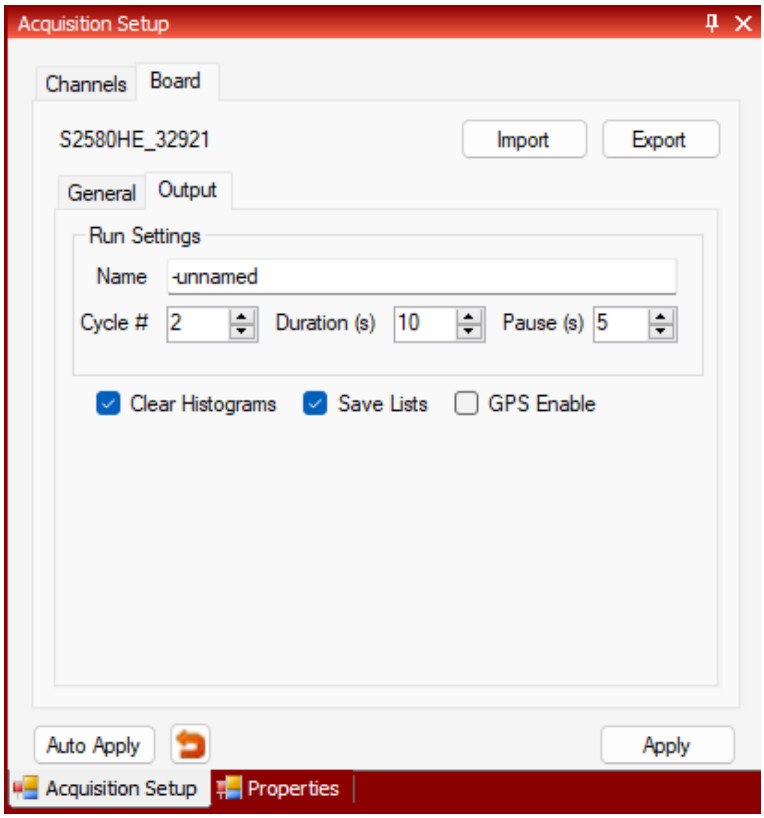


Fig. 6.21: Output data saving menu

Through the **Run Settings** options, the user can define the **Name** of the run output file. The name of generated files will be composed by the defined name (**Name**), plus a progressive number which identifies the run, plus a suffix identifying the content of the file itself (i.e. lists, histograms). Moreover, the user can optionally split a run in more than one cycle (**Cycle #**), set the cycle duration (**Duration (s)**) and, possibly, the pause between consecutive cycles (**Pause (s)**).
Additional settings can be edited by the following checkboxes:

- **Clear Histograms** can be used to clear the histogram graphs whenever a run is launched
- **Save Lists** can be used to save the file containing the lists of the acquired events (time stamp, energy, ...)
- **GPS enable** (if GPS is supported by the *Hawkeye* model) can be used to save inner GPS information position.

All the settings must be confirmed by pressing the **"Apply"** button. The user can access and download the saved data by the *Hawkeye* Web Interface in (see Sec. **7.1**).

It is possible to save data on the host PC in different ways:

1. Save the energy spectrum through the path: ***"File ->Save"***. Supported file formats are: **.n42**, **.asc**, **txt**. For the .txt file, there are several options, as shown in the figure below.

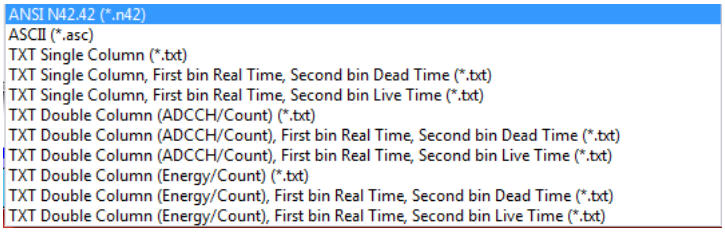


Fig. 6.22: Energy spectrum output file formats

   In the .n42 file, the spectrum and the relevant properties are saved.

2. Save an image of the energy spectrum through the path: ***"File ->Export"*** or by right clicking on the spectrum and selection **"Saving Image As"**. The spectrum can be exported in various formats as listed in the following figure.

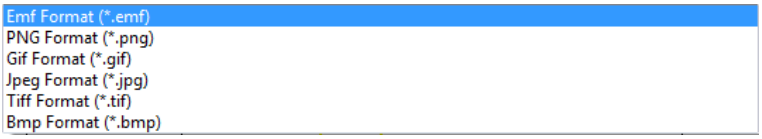


Fig. 6.23: Spectrum image file formats

7 *Hawkeye* Web Interface

Note: Check that *Hawkeye* is powered on, the Ethernet cable is connected, and the Network is configured according to Sec. **5.3.1**.

Open the web browser and type the IP Address of *Hawkeye* as web address. In the default case, the IP Address is 192.168.0.1.

Insert **Username = admin**, and **Password = admin** to login into the web interface (see Fig. **7.1**).

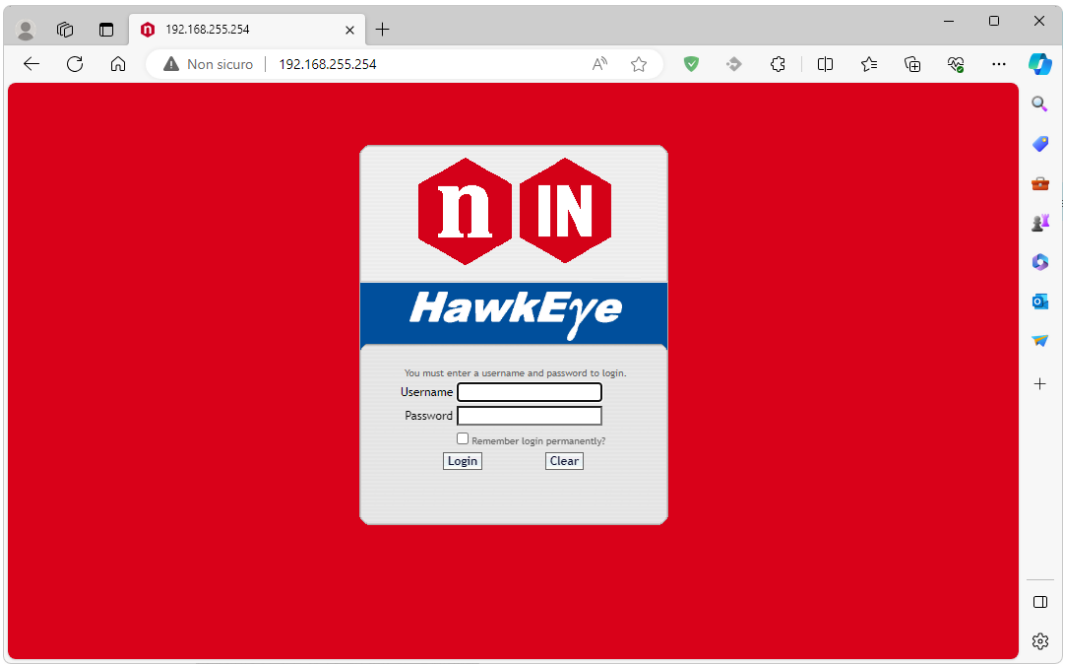


Fig. 7.1: Login page

From the main page of the *Hawkeye* web interface (see Fig. **7.2**) it is possible to select three items in the menu:

- File Browser;
- Network Settings;
- Firmware Upgrade.

Click on the **Sidebar** label to get the information about *Hawkeye* and the memory (see Fig. **7.3**).

From the sidebar menu it is possible to get the *Hawkeye* **Model Type**, its **Serial Number** and **Firmware Version**. Date and Time are also reported, as well as the information related to the internal **CPU load averages**, the **Real Memory**, corresponding to the RAM, and the **Local Disk Space**, which is the internal memory partition.

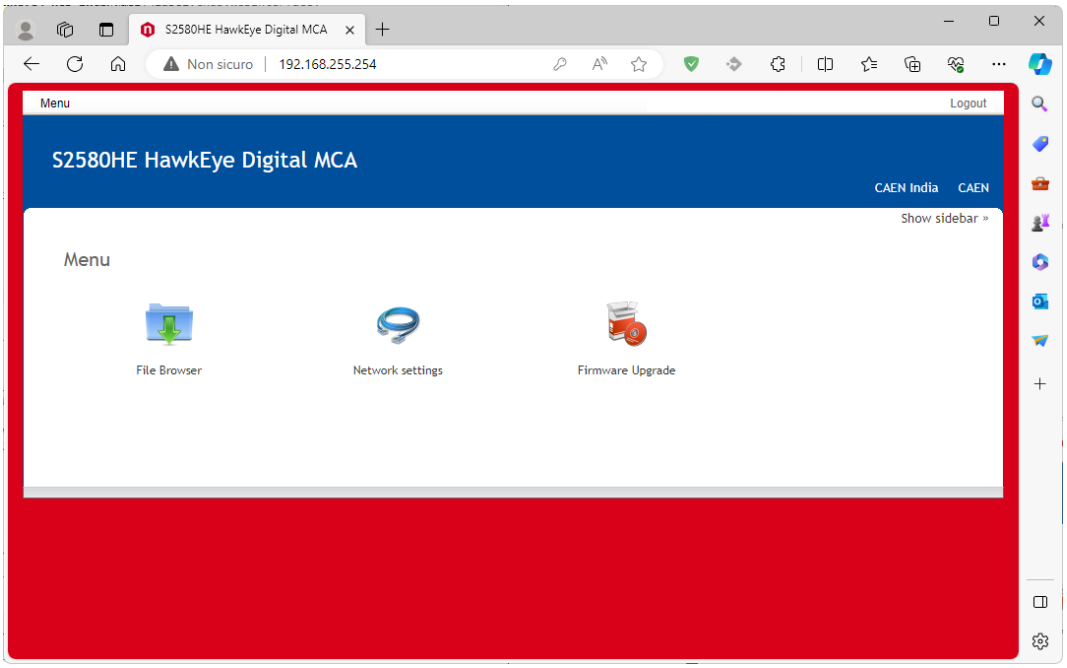


Fig. 7.2: Main page

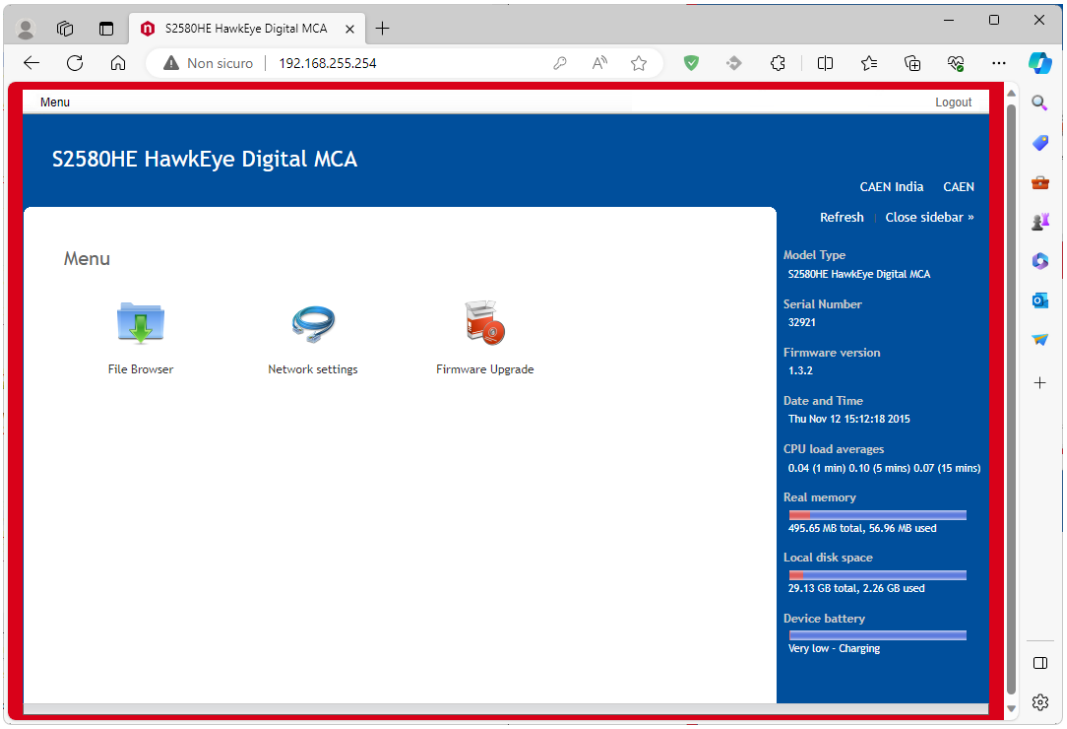


Fig. 7.3: Side bar

7.1 File Browser

In the File Browser menu (see Fig. **7.4**)it is possible to get the list of files saved into *Hawkeye* . The histogram file is always saved when pressing Start acquisition from GammaTOUCH, while the list file has to be enabled by the ”Advanced Settings” tab, via the **Save List Mode** option.

Selecting the desired run name through the **Run Name** option and clicking **Open**, allows to get the list files grouped by the same **Run Name** (see Fig. **7.5**). Note that also those files related to an acquisition in progress will be included in the list.

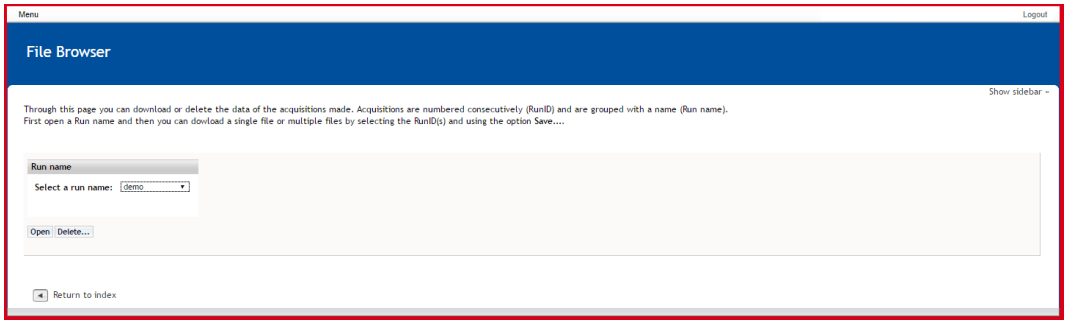


Fig. 7.4: File Browser menu

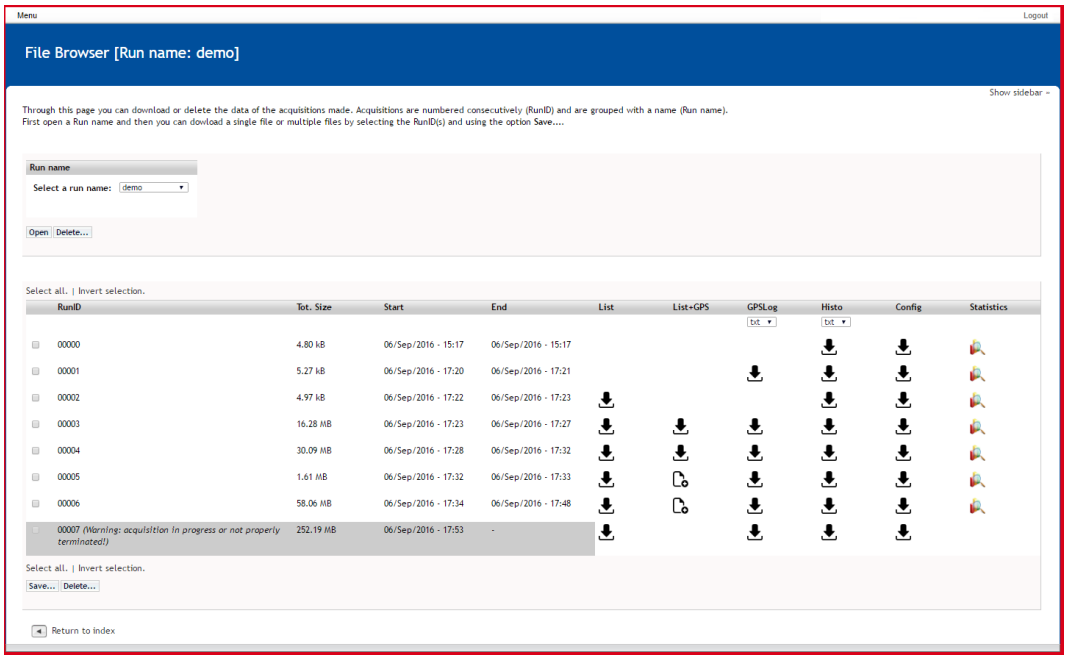


Fig. 7.5: List files grouped by run name

The **Delete** option cancels all the files grouped by the same **Run Name** (See Fig. **7.6**).

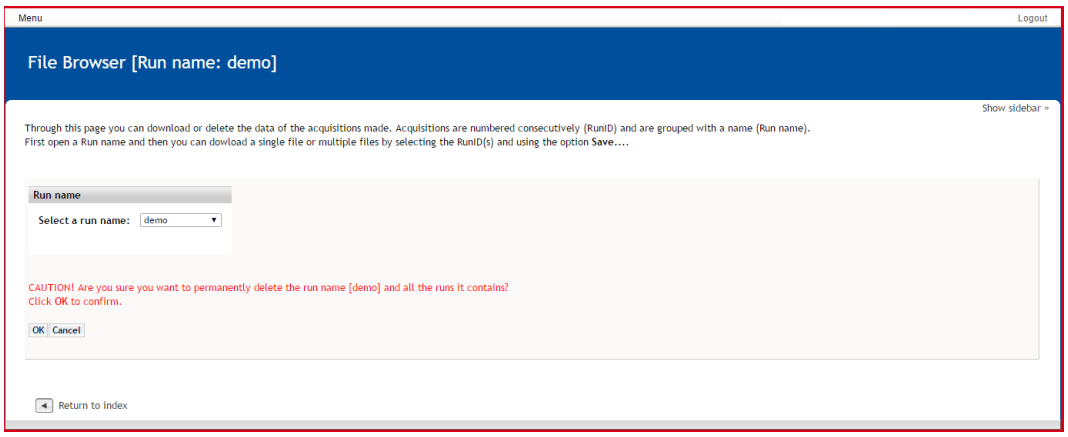


Fig. 7.6: Delete function

In the File Browser, each row is associated to a specific run and contains a set of information directly visible or downloadable (if the icon is present) as shown in Fig. **7.7**:

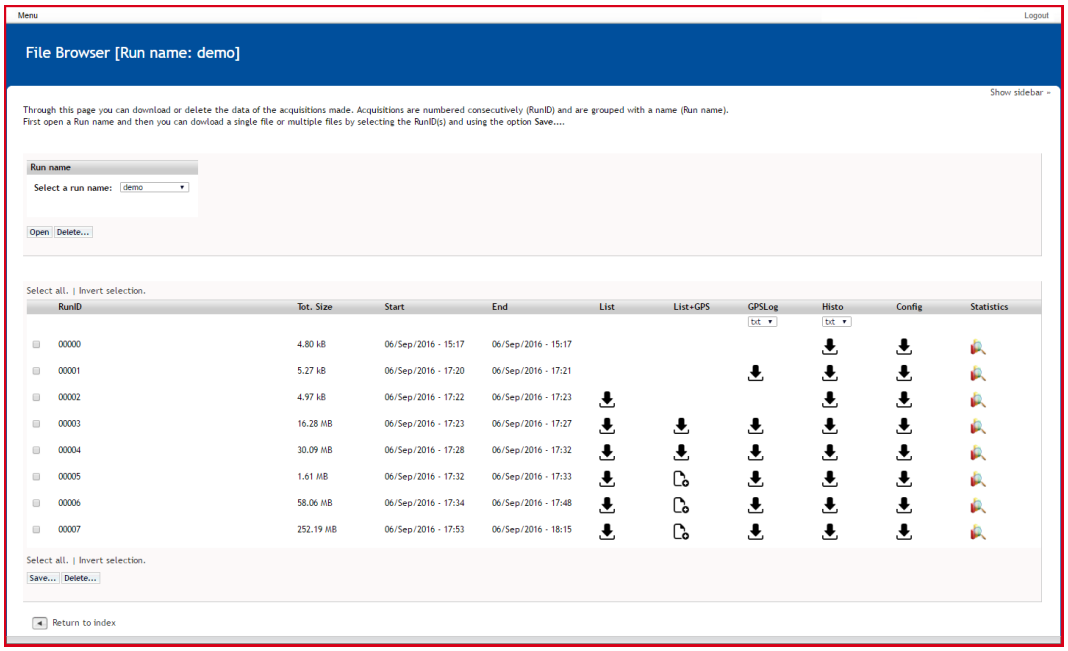


Fig. 7.7: Run information

- **Run ID**. This is the incremental number identifying the run.
- **Tot. Size**. It is the total size in bytes of the files associated to the run.
- **Start** / **End**. Indicate the calendar date and the hour the run is started and stopped.
- **List**. Allows to download the event list file.
- **List+GPS**. Allows to download the merged file between List and GPSLog data in order to geolocalize each event. By clicking on the icon, the merged file will be generated and is then available for download (see Fig. **7.8**).

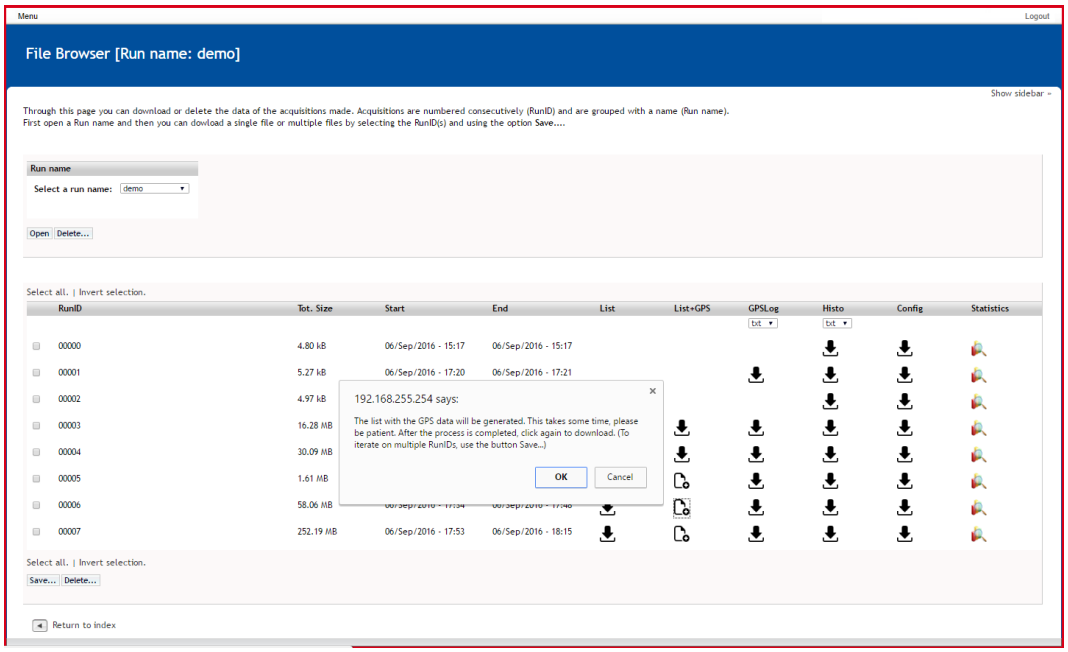


Fig. 7.8: List+GPS function

Note: concerning **List** and **List+GPS**, if data are split into multiple files, they will be downloaded as a unique .zip file which is generated on the first download (see Fig. **7.9**).

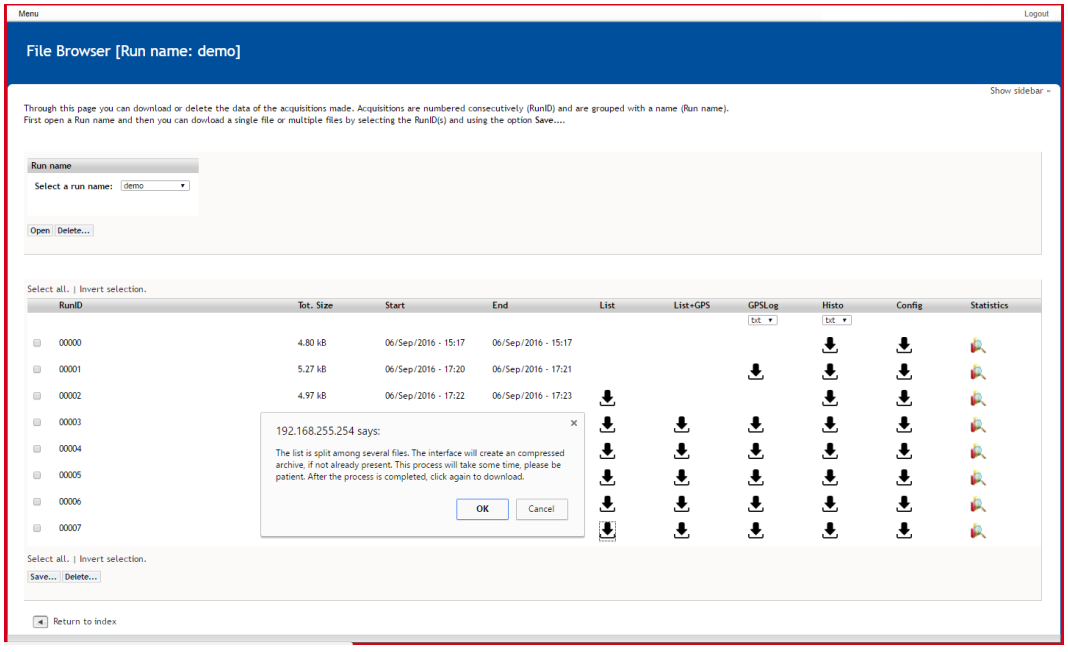


Fig. 7.9: List+GPS function in case of data splitting to multiple files

- **GPSLog**. Allows to download the available data retrieved from the inner or mobile GPS. The file format (txt or KML) can be chosen through the column select box (txt)
- **Histo**. Allows to download the energy histogram file. The file format (txt or N42) can be chosen through the column select box (txt)
- **Config**. Allows to download the run setting text file.

- **Statistics**. Information about the run is displayed just by moving the mouse pointer over the icon (see Fig. **7.10**).

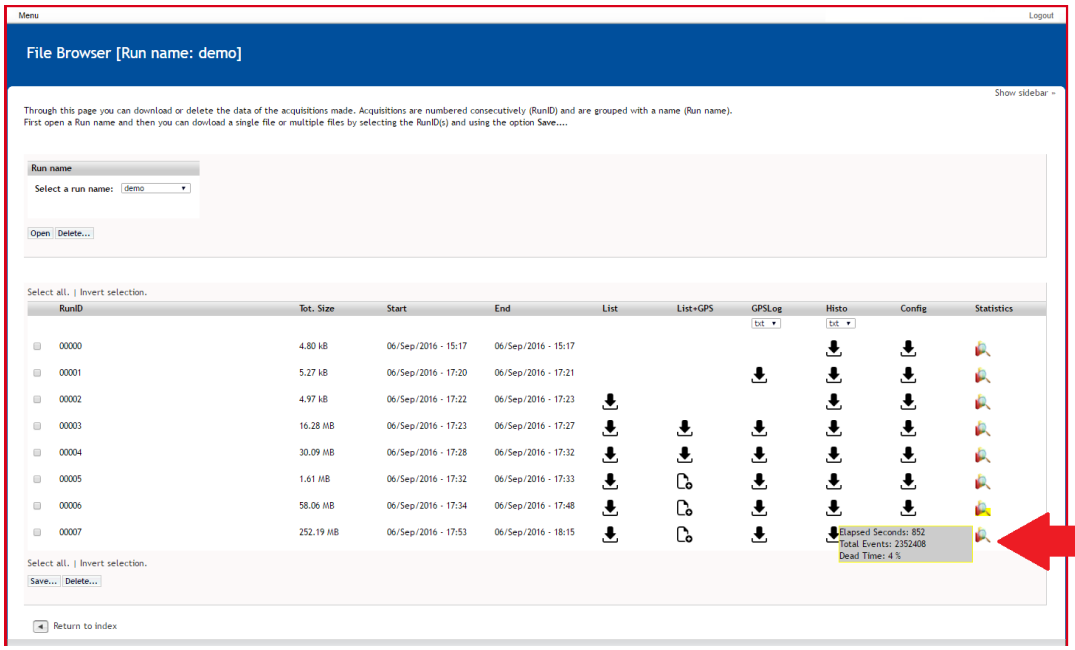


Fig. 7.10: Statistics function

It is possible to save multiple runs at once by selecting the relevant rows. Choose which file to save and which format for the supported files from the check-boxes on the bottom of the window. Press **OK** to generate a zip archive including all the selected files, then press **Download**. The sequence of actions is described in Fig. **7.11**, Fig. **7.12**, and Fig. **7.13**.

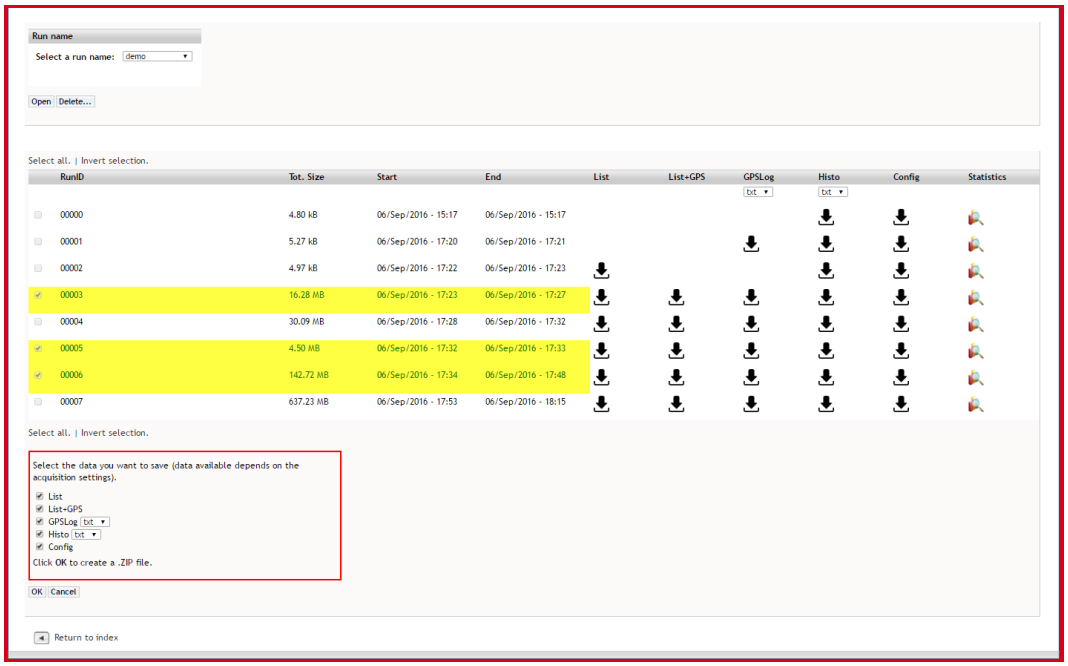


Fig. 7.11: Row selection in saving multiple files: step 1

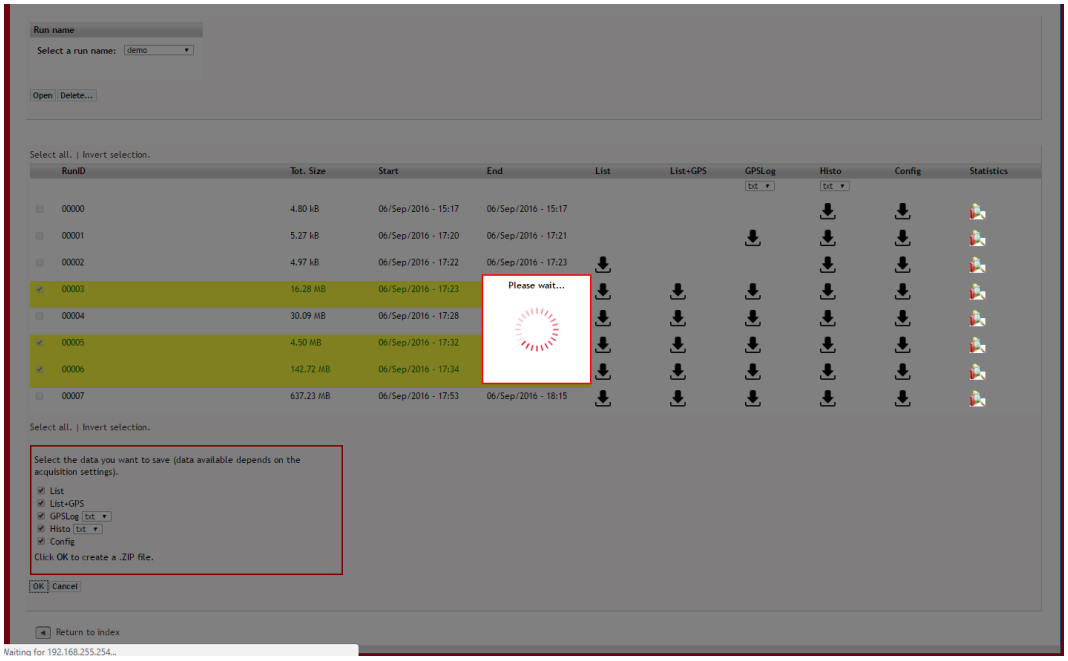


Fig. 7.12: Row selection in saving multiple files: step 2

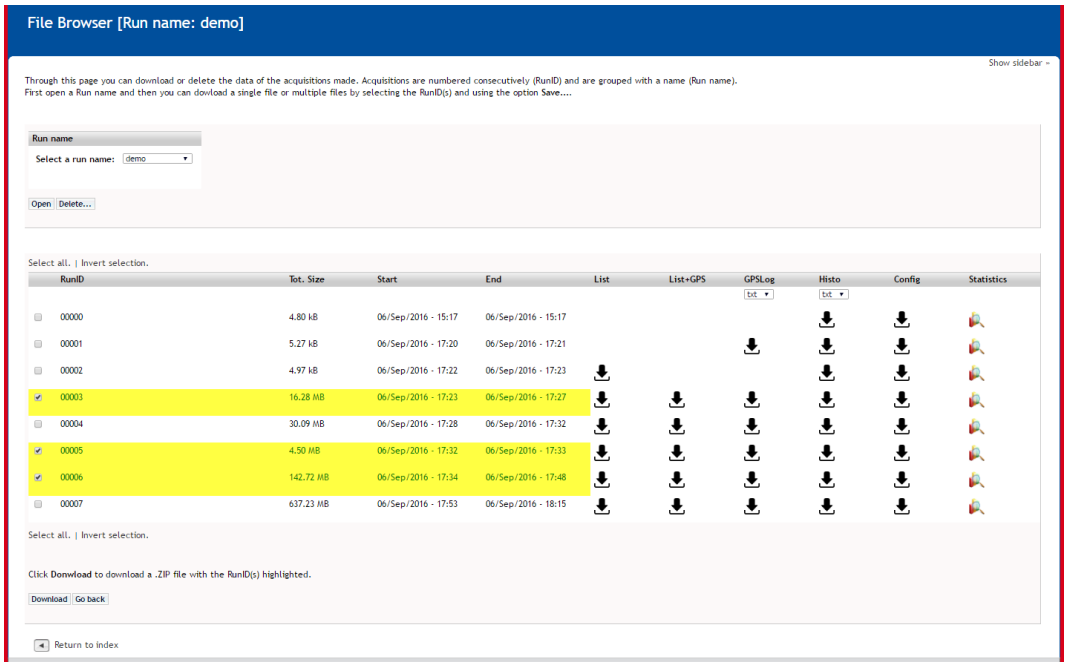


Fig. 7.13: Row selection in saving multiple files: step 3

In order to delete one or more files, select the relevant rows and press **Delete** (see Fig. **7.14**).

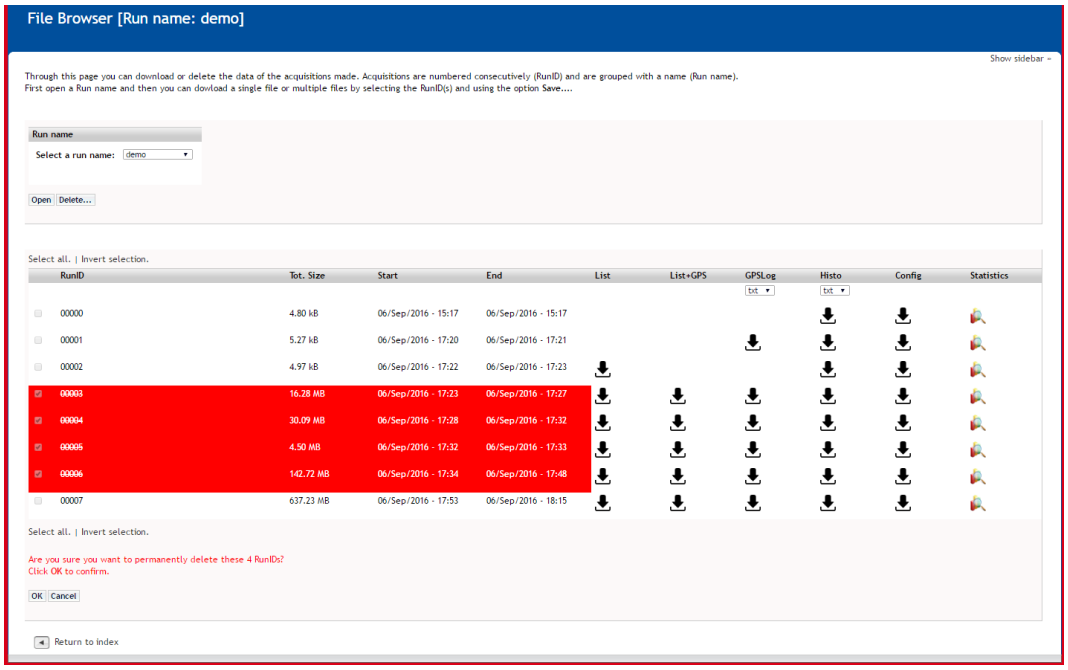


Fig. 7.14: Row selection in saving multiple files: deleting file(s)

7.2 Network Settings

In the Network Settings menu it is possible to get and modify the current IPv4 Address of *Hawkeye* , to configure the LAN settings and Gateway, if required (see Fig. **7.15** and Fig. **7.16**). If the IP Address is modified from the website interface, the network has to be configured again with the new settings.

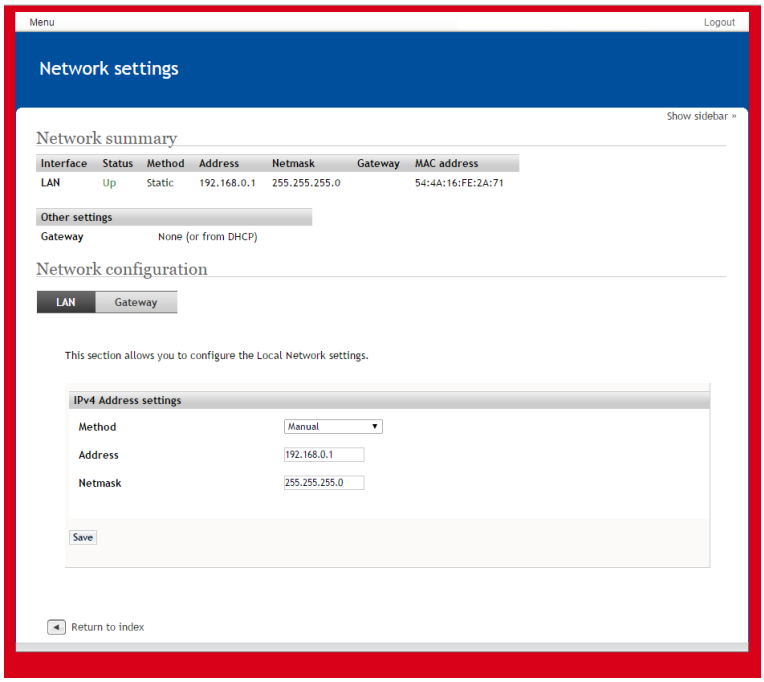


Fig. 7.15: Network settings menu: LAN

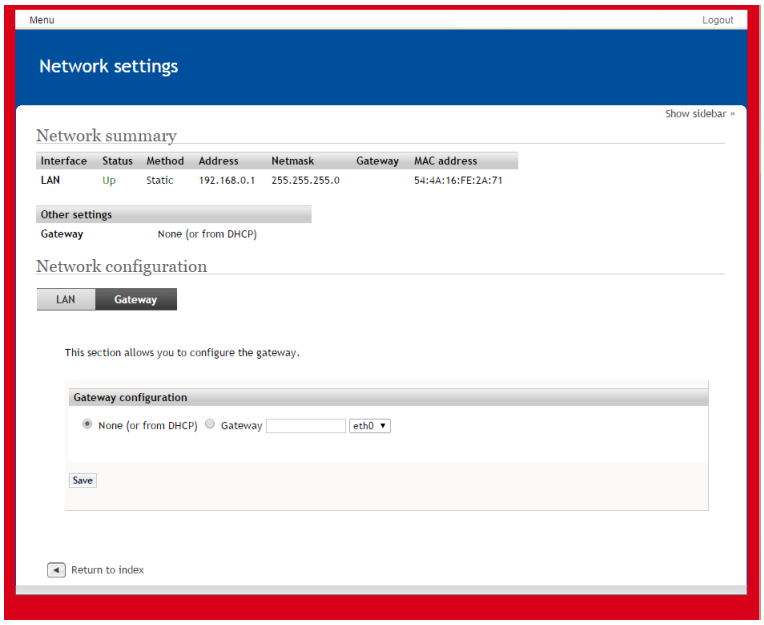


Fig. 7.16: Network settings menu: Gateway

In presence of Wi-Fi connection, a dedicated tab is available for wireless settings (see Fig. **7.17**).

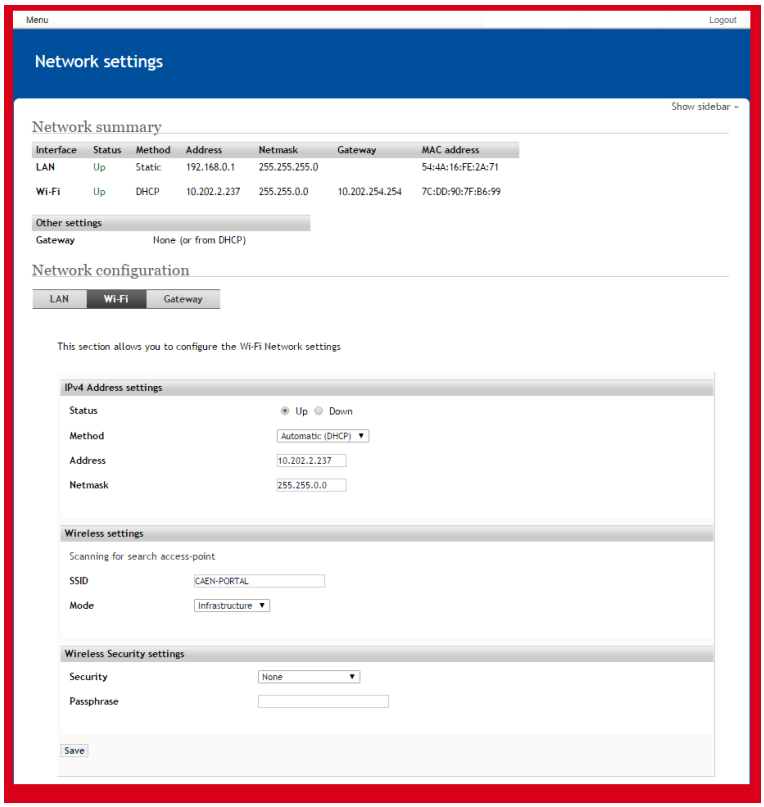


Fig. 7.17: Network settings menu: Wi-Fi

Note: In case of Wi-Fi or ETHERNET configuration loss for whatever reason, it can be modified again only by accessing via mini-USB link, which is managed as virtual ETHERNET with fixed configuration.

7.3 Firmware Upgrade

In the Firmware Upgrade menu (Fig. **7.18**) it is possible to retrieve the current firmware revision and to upload a new firmware revision on *Hawkeye* . Download the firmware file from CAEN web site, on the *Hawkeye* product page. From the web interface use **Choose File** to point the file and press **Upload** to upgrade the firmware of *Hawkeye* .

Note: Reboot *Hawkeye* to complete the firmware upgrade.

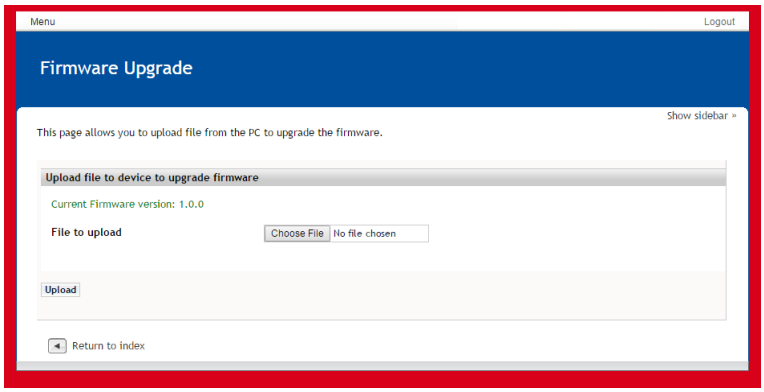


Fig. 7.18: Firmware Upgrade menu

In order to operate *Hawkeye* at the best, it is recommended to keep the firmware always updated to the latest web available release!

8 Wi-Fi Quick Guide

To connect to *Hawkeye* through Wi-Fi it is possible to proceed by enabling the Gammastream Access Point mode.

8.1 How to Configure Wi-Fi (Access Point Mode)

1. Connect to *Hawkeye* Web Interface alternatively through:
   - Ethernet (192.168.0.1 default);
   - mini-USB (192.168.255.254).

   Refer to Sec. **5.3** for more details.
2. Make sure the Wi-Fi adapter is properly plugged in the USB host port of *Hawkeye* .
3. Click on **Network Settings**.

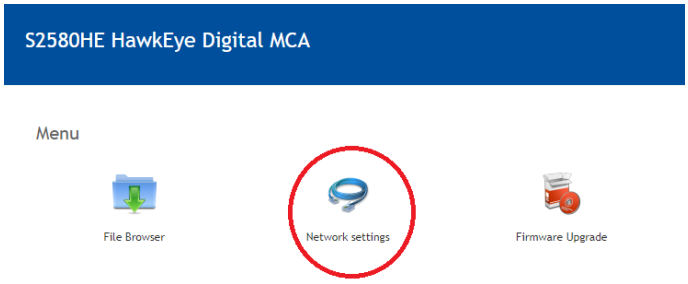


Fig. 8.1: Verify the possibility to enable hosted network in your PC.

4. Configure the network through the following few steps:
   - Enable the Wi-Fi (**Up**);
   - Select the Method (**Manual**);
   - Type the IP Address (address **192.168.3.1** can be used if no other network is present);
   - Type the Net Mask (**255.255.255.0**);
   - Choose a name (SSID) for the Wi-Fi (e.g. **HawkEye**);
   - Select the mode (**Access Point**);
   - Select the channel;
   - Select the Wi-Fi security mode (**WPA/WPA2 Personal**).
   - Insert the Pass-phrase (**12345678**).
   - Save the settings.

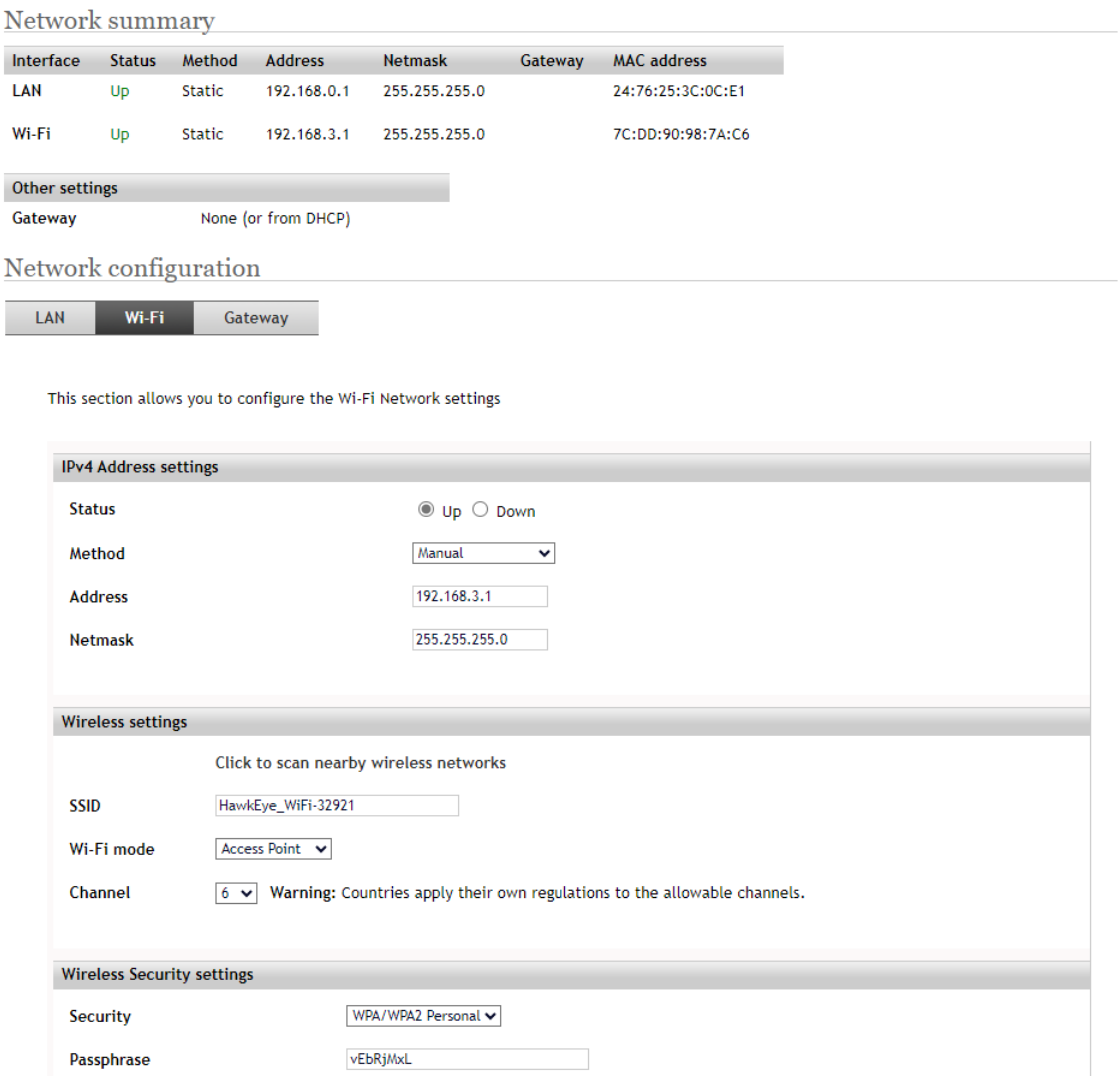
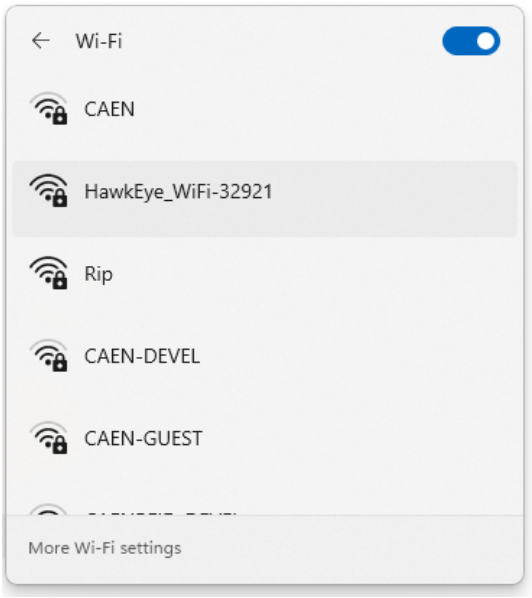


Fig. 8.2: Wi-Fi configuration of *Hawkeye* as Access Point.

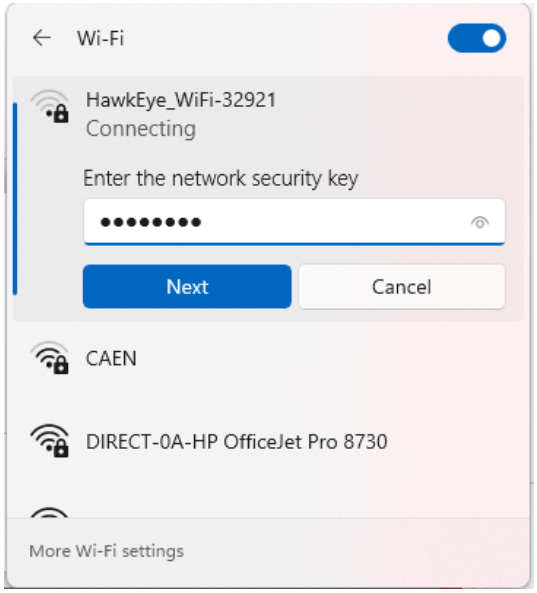
8.2 How to Connect with Windows OS

8.2.1 Network configuration - Access Point mode

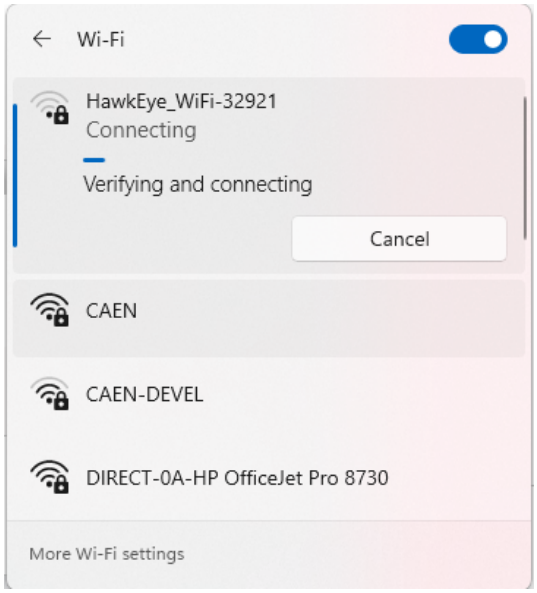
Once the *Hawkeye* is configured in Access Point mode its network will appear among the available wireless connections.



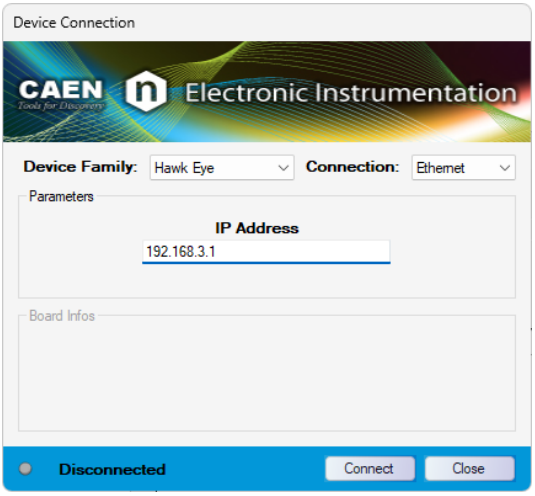
Connect to Hawkeye_Wifi and enter the network security key according to the configuration set in the *Hawkeye* Web Interface.

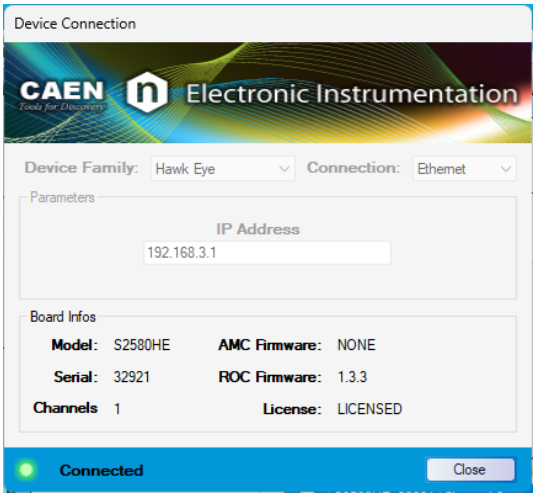


Wait until the connection is established.



Connect *Hawkeye* to MC^{2}Analyzer.





9 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:

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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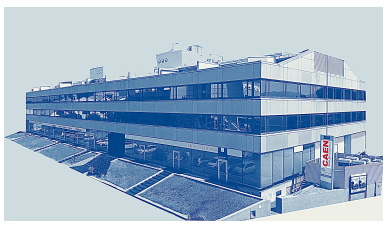

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