LUDLUM MODEL 70
SPECTROMETRIC PERSONAL RADIATION DETECTOR/IDENTIFIER

May 2021

Model 70

Spectrometric Personal Radiation Detector/Identifier

SYSTEM MANUAL

May 2021

STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

LUDLUM MEASUREMENTS, INC.
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SWEETWATER, TX 79556

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Spectrometric Personal Radiation Detector (SPRD) – Radioisotope Identifier (RIID)

1. GENERAL SYSTEM DESCRIPTION

The Model 70 Spectrometric Personal Radiation Detector (SPRD) represents a major breakthrough in the field of radiation monitoring, offering the user not only the ability to search for and locate radioactive material, but also to identify the radioactive nuclides present. This capability in a fully portable hand-held unit that will permit its use in a wide variety of applications including:

- Hazard identification and risk assessment
- Inspection of incoming and outgoing material for radioactive contamination
- Inspection of radioactive gauges for leaks
- Search of waste sites for radioactive material
- Employee exposure rate and dose monitoring
- Radioactive source monitoring
- Government inspection for material compliance
- Identification of unknown radioactive material
- Regulatory control of radioactive material
- Classification of radioactive material for a wide variety of users
- Detection of illicit trafficking of nuclear materials
- Monitoring of the radiation situation at nuclear facilities

1.1 HARDWARE VERSIONS

70/1 – the basic Model 70 is a single detector system utilizing a CZT (Cadmium Zinc Telluride) hemispherical detector for high-energy resolution and sensitivity
70/2 – the Model 70 with single CZT detector and Li6-based neutron detector
70/3 – the advanced model with large 1.6 cm^3 CZT
70/4 – the advanced model with large 1.6 cm^3 CZT and Li6-based neutron detector

2. SYSTEM DESCRIPTION & FEATURES

This manual fully describes the system functionality of the unit along with the associated PC software program.

2.1 OPERATIONAL FUNCTIONS

The Model 70 can be operated in two primary radiation monitoring functions.

1. **Search + Dose Mode** – In this mode, the Model 70 acts as a radiation search/survey meter displaying the current dose rate and count rate. A "chart-record" of the last 60 data points is displayed on the screen during the search. This mode is typically used to search for radioactive material or to carry out total-count search. This mode also displays the current dose rate up to user selection in Sv/h or in Rem/hr, as well as cumulated radiation dose from the time the mode was engaged. The dose meter is used to determine the relative hazard level and to assess handling requirements of a radioactive material.

    The yellow line represents 20-second dose rate running average.

    Visual, Audio, and Vibration mode alarms will be activated if the dose rate exceeds the defined threshold.

2. **Identify Mode** – (Nuclide Identification) In this mode, the Model 70 accumulates spectral data from a sample and analyzes the spectrum in terms of emitted energy and net count contribution. The nuclides responsible for producing the spectrum are identified by comparison to a nuclide library and presented in tabular form on the screen. This essential information can then be used to determine the radiation risk to the individual.

2.2 SYSTEM FEATURES

Instrument Body – The instrument body consists of a single, rugged, plastic housing. The housing has an option for the instrument to be mounted on a belt for ease of carrying during a constant dose monitoring situation. In addition, included is a carrying case to carry and protect the unit when not in use.

Detector
1. **CZT** – A 0.5 cm^3 or 1.6 cm^3 (optional) CdZnTe semiconductor hemispherical crystal is used for the detection of gamma radiation and provides a high-resolution signal for the systems nuclide ID capability. CZT is a specialized detector with a resolution several times better than that of widely used inorganic scintillators (i.e Sodium-Iodide, Cesium-

Iodide) thus allowing discrimination of gamma peaks that are impossible to see on a scintillation-based detector. The detector is strategically mounted on the front of the assembly and optionally the center is indicated by the dot on the outside of the housing.

2. **Li6** – based neutron detector, optional.

Operational Buttons – The Model 70 has three operating control buttons. The buttons are all enclosed in one easy-to-clean plastic membrane. All system functions are controlled by these buttons that permit easy instrument handling**.**

The buttons are specially arranged for use and to toggle between the menus and operational options with three actions – START, ENTER/SAVE, and CANCEL/SET. The buttons and use of menu-driven functions make the Model 70 very easy to operate and avoid the necessity of "memorizing" complex sequences of action.

Display – A color LCD is used for the Model 70 to permit a full range of alphanumeric and graphic display capabilities. The display contrast may also be manually adjusted depending on ambient light conditions. The unit also incorporates automatic temperature compensation to maintain correct contrast even when the external temperature substantially changes.

Indicators – The Model 70 has two LED indicators. One, a green LED, indicates the unit is operating. The second, a red/green LED, serves as an addition to the screen to indicate a warning or an alarm condition.

Batteries – An internal, lithium-ion, rechargeable battery is shipped fully charged.

Battery Charger – In the Model 70, the battery charger is external. To get the battery fully charged requires 4 to 5 hours.

System Support Software, Graphic User Interface (GUI) – Support software, GUI GalaxrayWiz, is provided with the Model 70 on USB flash memory. This is a Windows-based program and operates in Windows 7 and higher. The program is described in Appendix B and provides data downloading, spectrum display and spectrum analysis, and various other features.

Vinyl Carrying Case – The system is supplied with a vinyl carrying case. An easy-open flap allows access to the instrument while providing additional mechanical and weather protection.

Manual – This user manual is supplied with the instrument on USB flash memory.

3. QUICK START

This section offers a simplified guide to system operation; a more complete description is available in Section 4.

Button Operations - the three buttons on the instrument face are the only controls for the unit. Basic actions are START, CANCEL/SET, and ENTER/SAVE. Some operations require a short activation where SHORT = less than 0.5 seconds or LONG = 3 seconds.

Power ON/OFF – Press down the ENTER/SAVE button for at least three seconds, and the unit will power ON. After successful completion of a power-on self test and a few seconds, the unit will automatically go into the Search + Dose mode. When the unit is powered on, the green

power indicator LED will be illuminated. To power off the unit at any time and in any screen, press and hold the ENTER button for more than 3 seconds.

USB connector – The USB connector is used to transfer recorded dose time chart, gamma-spectra, and other data to and from a PC.

Search + Dose – After power ON, the "Search + Dose" is activated automatically. The system display will show the current dose rate in Sieverts per hour (Sv/hr) or Rem/hr, usually in relevant radiation level scale like nano Sievert (nSv/hr), or micro Sievert (µSv/hr), µRem/hr, and count rate in counts per second (cps) while the internal "audio meter" will give an audio response.

Identify – by pressing the ENTER button shortly, the unit displays the second main screen with nuclide ID function for a gamma-spectrum acquisition for a pre-set duration. As the spectrum is being accumulated, it is displayed on the screen so the user can observe the spectrum as time progresses. At the end of accumulation period, **Nuclide Identification** is displayed on the screen. The accumulated spectrum is then automatically stored with system name composed of the date and time the spectrum was collected. All spectrums are stored for later analysis when output to a PC.

To switch between the Search/Dose screen and the Identify screen at any time, press the ENTER button shortly.

4. DETAILED OPERATION GUIDE

This section offers a detailed guide to system operation.

4.1 CONTROL BUTTONS

The Model 70 is equipped with three control buttons on the front face. These are the **only** controls on the instrument.

START and CANCEL/SET – is used to scroll through menus displayed on the screen.

ENTER/SAVE - is used to activate the selection highlighted on the display. Some operations require a short press and some require a long press.
> Short = less than 0.5 seconds
> Long = 3 seconds

Power OFF – To power the unit OFF, press the ENTER button and hold for approximately three seconds. The display shows the seconds counting down: "3, 2, 1." After this the message,

Please release the button appears, and upon doing that, the power will be OFF. At any time during the countdown, releasing the ENTER button will cancel the power OFF.

4.2 DISPLAY CONTRAST

The contrast is automatically adjusted by temperature compensation using an internal temperature sensor.

4.3 EXTERNAL AUDIO

On the lower left side of the unit is a special connector (external audio) or earphone jack (shown on page 4). Users with the optional external earphone can plug it into this socket. When this is done, the internal audio is silenced and the audio tones are only audible through the earphone. This silencing of the unit's audio is especially useful in covert scanning or when the operator does not wish to alarm anyone with sudden audio tone increases.

4.4 SEARCH+DOSE, Screen 1

Search Mode
The search and dose mode is used to search out radioactive sources along with monitoring the radiation dose to which the unit is exposed.

The top graph in the prior photo shows the graphical profile of the dose rate along with the current date/time. The second window displays the current dose rate as detected by the instrument. Using these two windows the user can easily identify the direction to the source as necessary before the spectrum is acquired and a source ID is performed.

The last box shows the cumulated dose over the time period selected by the user in the setting screen as described in the parameter setting screen section below.

The cumulated dose bar is in logarithmic scale since cumulated dose threshold is relatively large in comparison with dose rate. The dose profile, dose rate, and cumulated dose will always be calculated and displayed when the unit is in the Search + Dose screen. The user can simply watch the current dose rate and the cumulative dose from Screen 1 without recording.

The neutron detection is shown as N/C, which is neutron counts in a one-minute running average.

Saving Dose
The instrument can save up to 24 hours of dose rate records.

To begin recording the dose time profile from Screen 1, the user can press the START (Up arrow) button. The dose rate time profile is recorded into memory for the pre-set time as selected in the settings window (default is 60 sec). The red circle (recording) will appear in the right upper corner of the display with recording time remaining in the format "hh:mm:ss."

1. The user can stop recording at any time by pressing CANCEL/SET (Down arrow). After stopping recording, the following tips will appear at the bottom of the screen: **Resume**, **Save**, and **Cancel**. The tips are assigned over each of three buttons accordingly for further actions:

   Save Dose - ENTER/Save

   Cancel Save - Cancel/Set

   Resume Dose - Start
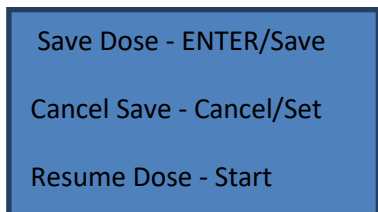
   ➔ Pressing ENTER/SAVE will save the current dose recording (the unit will automatically assign the file name).

➔ Pressing CANCEL will cancel the current dose recording and clear all data associated with this Dose recording (completely cancel the recording).

➔ Pressing START will resume recording of the Dose.

Upon the Model 70 completing the dose recording by reaching the preset time as determined in the settings screen, the dose rate profile will be automatically saved. The unit automatically assigns the dose rate file name in the same way as spectra. The dose profiles can be downloaded to a PC using GalaXrayWiz GUI software.

2. After saving the dose profile, the following tips appear on the display:

Start, Spectra Acq, Settings

➔ Press **Start** to start over the dose recording until pre-set time or next interruption.
➔ Press **Spectra Acq** to get to **Nuclide ID** Screen 2.
➔ Press **Settings** to change the instrument settings.

To get back to original Screen 1 **Search + Dose**, the user has to get to Screen 2 **Nuclide ID**, and then by pressing ENTER/SAVE, the instrument will get back to Screen 1

3. The user can save as many dose recordings as the instrument memory allows by consequently pressing START/STOP and ENTER/SAVE.

4.5 IDENTIFY, Screen 2

Spectrum/Identify Mode
The Spectrum/Identify mode is used to display the spectrum of the radiation isotope being monitored and to use the internal library to help identify the isotope.

Identified nuclides are given the categorizations as following:

I – Industrial

N- Naturally Occurring Radioactive Materials (NORM)

M- Medical

S- Special Nuclear Materials (SNM)

The top graph on the photo above shows the spectrum as it is accumulated along with the acquisition time of the spectrum above. Below the spectrum, **Nuclide ID** is displayed if it has been determined.

1. To begin spectrum acquisition on Screen 2, the user must press START (up arrow). The spectrum will be recorded for the pre-set time as selected in the settings screen.

   Alternatively, the user may select **Continuous ID** (select **conti**) in the instrument Acquisition menu.

2. If the user desires, acquisition can be stopped at any time with the results of nuclide ID by pressing the CANCEL/SET button. Otherwise, the nuclide ID will be displayed on completion of the spectrum acquisition time.

3. After stopping spectrum acquisition, the results of the nuclide ID analysis will be displayed in the Nuclide ID box on in the following format:

Nuclide ID   Strength

Cs-137   15.7

Where the strength represents signal-to-noise ratio for a nuclide identified, the user may consider the values as:

- Below 10 as low confidence
- Between 10 and 15 as moderate confidence
- Above 15 as strong confidence

A maximum of up to five identified nuclides can be displayed. If there are more than five nuclides identified, the user will be able to be scroll down.

If no identification can be made, the unit indicates a message of **No Nuclides Found.** In case of presence of the nuclide not in the instrument's database, the message of **Unknown** will be displayed.

Setting Spectrum Nuclide ID Screen

If in the parameter Settings window of the Spectrum option is set to default **Display: ON**, the accumulated gamma-spectrum will appear on the screen only upon a completed spectrum acquisition. If the Spectrum option is set to **Display: Continuous**, the gamma-spectrum accumulation progress will be displayed continuously over accumulation time.

Saving Spectrum

1. The user can stop recording at any time by pressing CANCEL/SET (down arrow). After stopping acquisition, the following messages on the screen's bottom window will appear: **Resume, Save,** and **Cancel**.

Save Spectrum - ENTER/SAVE

Cancel Save - Cancel/SET

Resume Spectrum -START
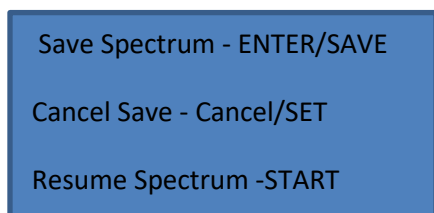
➔ Pressing the ENTER/SAVE to save the spectrum (the unit will automatically assign the file name).

➔ Pressing CANCEL will cancel the current dose recording and clear all data associated with this spectrum recording (completely cancel the spectrum acquisition). The original Screen 2 will appear.

➔ Pressing START will resume recording of the spectrum.

If during the intermediate stop (prior of reaching the pre-set time) the ENTER/SAVE button was pressed, the spectrum will be saved with an automatic file name.

2. After saving the spectrum, the following tips over corresponding button controls appear on the display: UP, BACK, and DOWN. The UP and DOWN are inactive in this version.

➔ Press BACK to get back to Screen 2 **Nuclide ID**.

The instrument can be switched to Screen1 (**Search + Dose**) by pressing the ENTER/SAVE button.

3. The user can save as many spectrums as the instrument memory allows by consequently pressing START and ENTER/SAVE. The instrument can save up to one thousand of 1024 channel spectra.

However, it is not recommended to keep a large number of spectra in memory since it will substantially increase the downloading time onto a PC.

4.6 SETTINGS, Screen 3
The settings screen is used so the users can configure the system to operate for their particular monitoring environment.

Long press on the CANCEL/SET button (>3 sec) on Screen 1 (**Search + Dose**) or Screen 2 (**Spectrum/Identify**). If the START/STOP button option is not active, Screen 3 will appear.

This menu permits the user to set up the required operating parameters. Use the UP/DOWN buttons to select (highlight) the required selection then ENTER to activate this selection. Inside each menu use UP/DOWN button action to select a parameter, and then utilize the ENTER and UP/DOWN button action to change the item.
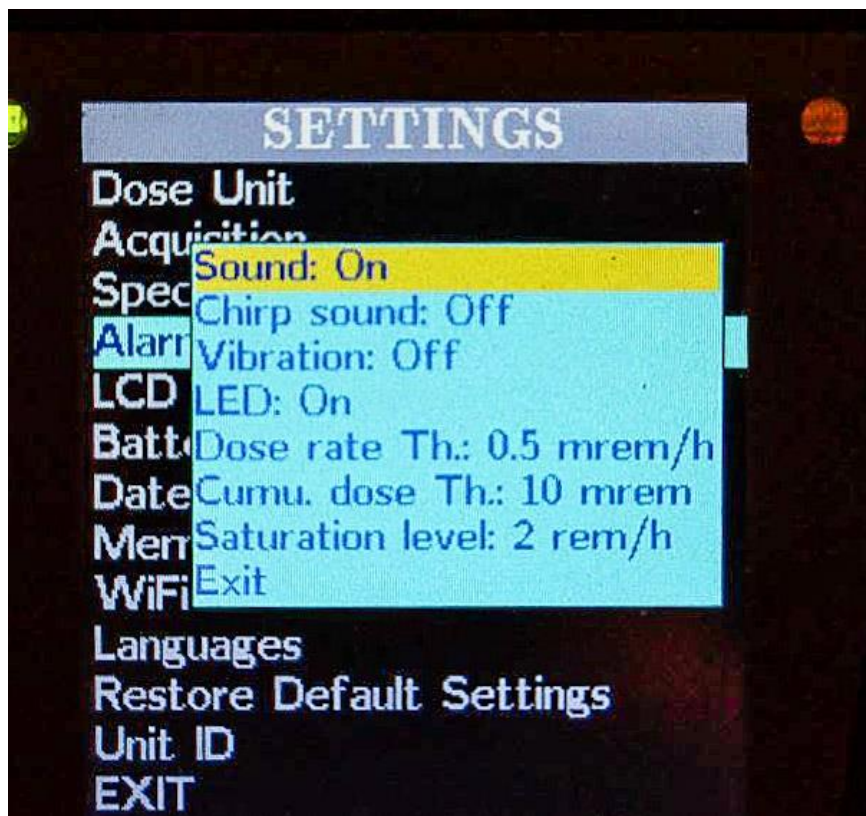
1. The user can select the various parameters desired to modify from the displayed list on Screen 3 by pressing the '↑' up or '↓' down buttons to navigate through the settings menu. The parameter selected to be modified will be highlighted.

2. To display the list of options available for the specific parameter, press ENTER/SAVE once the selected parameter has been highlighted. A list of optional values for the parameter in question is displayed as shown in the figure above.

3. The user can navigate through the list of values by pressing the '↑' up or '↓' down arrows until the desired value has been highlighted.

4. When the desired value has been highlighted, press ENTER/SAVE to select the value.

5. Once the selection is made, the program returns to the main Settings screen category (main Screen 3).

6. The user can select and modify another parameter if desired and update the settings as described above, or if the user is finished modifying the settings, the user can exit and return to the Search + Dose screen (Screen 1).

7. To get back from the Settings screen to the Search + Dose Screen (Screen 1), the user has to select the Exit parameter at the end of the parameter settings list and press the ENTER/SAVE button.

8. There are some parameters/information the user cannot change e.g. unit serial number, calibration coefficients, etc.

The following is a list of settings, their values, and defaults (for Screen 3). The defaults are highlighted by green.

Dose Unit: user can select Sv/hr or Rem/hr.

Acquisition: user can set acquisition time for spectrum and dose rate profile.

Spectrum Accumulation Time: Conti (continuous), 10s, 30s, 60s, 100s, 300s, 1000s, 1hr, 2hr

The dose record time can be set from 10 seconds to 24 hours according to the following parameters: 10s, 30s, 60s, 100s, 300s, 1000s, 1 hr, 2 hr, 8 hr, 12 hr, 24 hr.

Spectra

Spectrum Display: ON, Continuous

Peak ID Threshold: 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10

Nuclide ID Threshold: 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10, 15

V-scale: Count, Logarithmic

Alarm: set alarm sound (on/off), vibration (on/off), LED (on/off), chirp (on/off)

Dose Rate Alarm Threshold: (in µS/h): 0.1, 0.2, 0.3, 0.4, 0.5, 1, 5, 10, 100

Dose Rate Alarm Threshold: (in µrem/h): 10, 20, 30, 40, 50, 0.1 mrem/h, 0.5 mrem/h, 1 mrem/h, 10mrem/h. Upon reaching this threshold, the message **High dose rate** will appear in bold in a pop-up window. The Alarm LED will turn from green to red, and the unit will beep/vibrate if the sound/vibrate parameter is set to ON.

Neutron Alarm Threshold (cpm): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Cumulative Dose Threshold (in Sv): 1 µSv, 5 µSv, 10 µSv, 50 µSv, 100 µSv, 1 mSv, 10 mSv, 100 mSv, 250 mSv

Cumulative Dose Threshold (in Rem): 0.1 mrem, 0.5 mrem, 1 mrem, 5m mrem, 10 mrem, 100 mrem, 1 rem, 10 rem, 25 rem

Upon reaching this level, the message **Cumulative dose alarm** will appear in a pop-up window. The alarm LED will turn from green to red, and the unit will beep/vibrate if the sound/vibrate parameter is set to ON.

In this box, the saturation alarm level is also shown: 20 mSv/hr or 2 rem/ hr. This is a hard-programmed parameter.

> **IMPORTANT:** If all types of alarms (sound, LED, vibrator) are turned OFF, the instrument will project NO alarms on display. This mode allows the user to investigate the radiation field without interruptions.

LCD: regulates the brightness (from 1 to 10, with default 7)

Backlight Off Time: 30 s, 60s, 120s, and Never

Battery: showing battery voltage (full battery 4.2 V) and battery temperature

Date/Time: current date and time. This can be changed from PC GUI GalaxrayWiz.

Memory: user can select option **clean memory** to completely erase spectral and dose information. This item displays the percentage of internal memory available.

Wi-Fi: it offers selection for Wi-Fi Enable/Disable, Status of connection, and unit |IP address.

Languages: English as a default

Restore Default Settings: it allows the user to restore factory settings.

Unit ID: it displays unit serial number, FW, and SW versions and information about ownership.

Exit: allows user to get back to the dose or nuclide ID screen

5.0 SPECIFICATIONS

DETECTORS
Model 70/1 or 70/2 CZT detector: Volume 0.5 cm^3 (typically 5 x 10 x 10 mm CZT)

Model 70/3 or 70/4 CZT detector: Volume 1.6 cm^3 (typically 16 x 10 x 10 mm CZT)

Neutron detector (included in Models 70/2 and 70/4): 15 mm x 40 mm, Li6-based

CZT Energy Resolution: Usually used ^{137}Cs, the FWHM at 662 keV: 1.8% to 2.5%

ANALOG TO DIGITAL CONVERTER
Type: Successive Approximation ADC
Number of channels: 1024
Lower Threshold: Internally adjustable – set at 20 keV
Upper Threshold: Fixed to Channel 1023, all pulses above this level are cosmic and are accumulated and displayed in Channel 1024
ADC Offset: Internally adjustable
Nuclide ID Over-Range Dose Rate: 0.5 mSv/hr

DOSIMETER
Energy Range: 30 keV to 3.0 MeV set by the spectrometer
Measuring Units: Sv, rem, cps
Gamma Dose Rate: within 30% accuracy per ANSI N42-48, from 0.05 µSv/h to 3 mSv/h (5 µR/hr to 300 mR/hr)
Output: Memory or PC

CLOCK/CALENDAR
Type: Built-in 24-hour clock, 4-year calendar (including leap year)

DATA STORAGE
Type: 1 GB flash memory, extended memory 16 MB
Capacity: 100,000 samples, including time/date (**Search + Dose** mode) or 500 spectra (**Identify** mode - 1024 channels), including time/date
Stored Data Retrieval: Via USB and/or Wi-Fi to a computer

DATA OUTPUT
Type: USB port, Wi-Fi

DISPLAY
Type: LCD graphics color, LED backlight
Viewing Area: 3.5 inches diagonal
Contrast: Automatically adjusted

POWER SUPPLY OPTIONS
Internal Rechargeable Battery
Type: Lithium-ion rechargeable battery, external charger 110-240 V
Continuous Work: with WiFi on and backlight on – up to 14 hours
Continuous Work: with WiFi off and screensaver on – up to 26 hours
Charging: External, full charge indication by LED

External
Type: External adapter 4.2 V, 0.8 A

CONNECTORS
Charger (External Power Supply)
PC Communication Channel: mini USB cable
Audio Jack Connector: audio jack

PHYSICAL
Dimensions: L = 165 mm (6.5 in.), W = 81 mm (3.2 in.), H = 25 mm (1 in.)
Weight: 0.25 kg (0.55 lb) with battery

ENVIRONMENTAL
Operating Temperature Range: -10 to +50 ^{o}C (14 to 122 °F)
Storage Temperature Range: -20 to +60 ^{o}C (-4 to 140 °F)
Protection: Weatherproof, dust and water sealed (no immersing)
Non-condensing Relative Humidity: Less than 90% at 40 ^{o}C (104 °F)
Vibration: 0.5 G maximum (10 to 300 Hz, XYZ directions, 1 h)
Shock: 3 G (10 mS, XYZ directions, 1 time each)
RFI/EMI Emission: Complies with FCC rules (47 CFR Part 15) for class A
Full CE Certification

ACCESSORIES
Standard Model 70 Unit
- 110/220 Vac charge adapter for battery charging
- mini USB cable for PC connection
- Vinyl carrying case
- Flash memory stick with GALAXRAYWIZ Windows-based software
- Operating Manual

APPENDIX A: GalaXrayWiz SOFTWARE, Graphic User Interface

1. General

GalaXrayWiz is a specially designed software program supplied and used to download data from the Model 70 instrument and view/analyze/format the data.

2. Installing the Software

- Load the GAMMALEAN Program/Document Support Flash card into the PC.
- Select **Run** and **Browse**, then navigate to the **GALAXRAY\Software\GalaXrayWiz release version xxx\disks** directory, where xxx is the version number. Select the file **setup.exe** and click **OK**.
- Select desired install location (default = **C:\GalaXrayWiz**).
- Click **FINISH**. After some screen activity, the screen should show **Successful Installation**.
- Once the GalaXrayWiz Application program appears, right-click and use **Send-to** to set up an icon on the Desktop.

3. Software, GUI

Using GUI
Upon opening GalaxrayWiz GUI, the user will see the following screen:
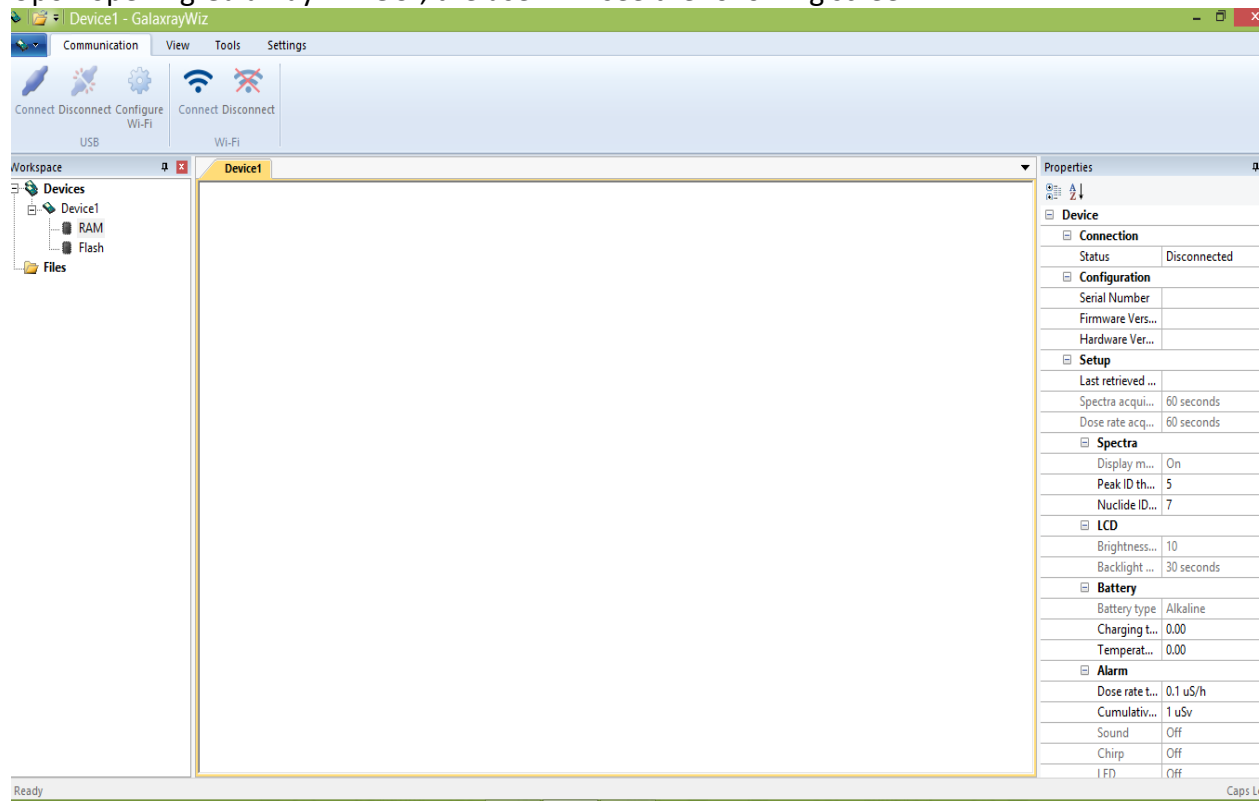
There are four major menu functions at the top of the screen: **Communication, View, Tools**, and **Settings**. Let's consider their functionality one-by-one.

Communication: this item means setting connection between the Model 70 spectrometer and the PC in two ways – by USB and through Wi-Fi. Wi-Fi will be described in a separate section. To establish connection through USB, the user has to connect the Model 70 to the PC with the USB cable (enclosed).

The user then has to click on **Connect** as shown in the following screenshot, and the pop-up window will ask the user to select an appropriate port. In case of several ports, the user has to select the port with the largest number and click **OK**.
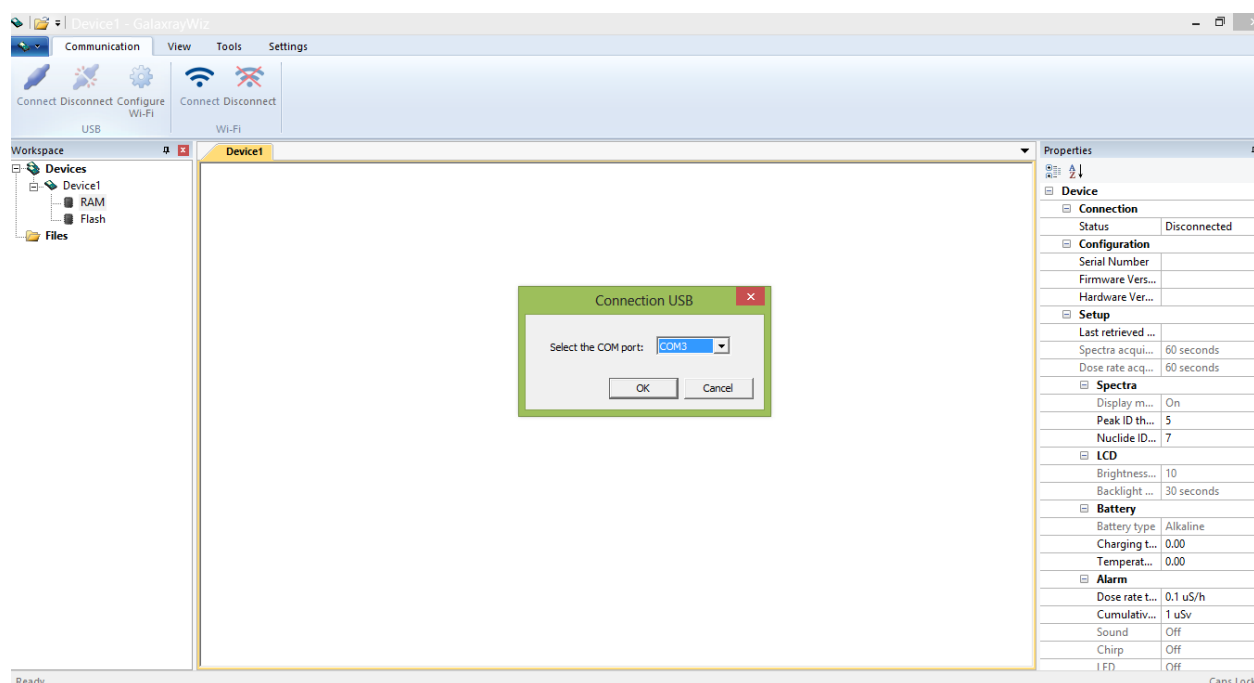
Upon establishing a connection, **Disconnect** will be highlighted. By clicking on **Disconnect**, the user can cancel the connection between the unit and the PC.

If a connection is established, the user can select **Tools** to perform the following operations: Upload data (spectra and/or dose rate profiles) from unit to PC, erase the data, set the **Region of Interest** (ROI) on **spectra**, and remove the ROIs.

By clicking **Upload Data,** the data transfer begins as shown in the following screenshot.
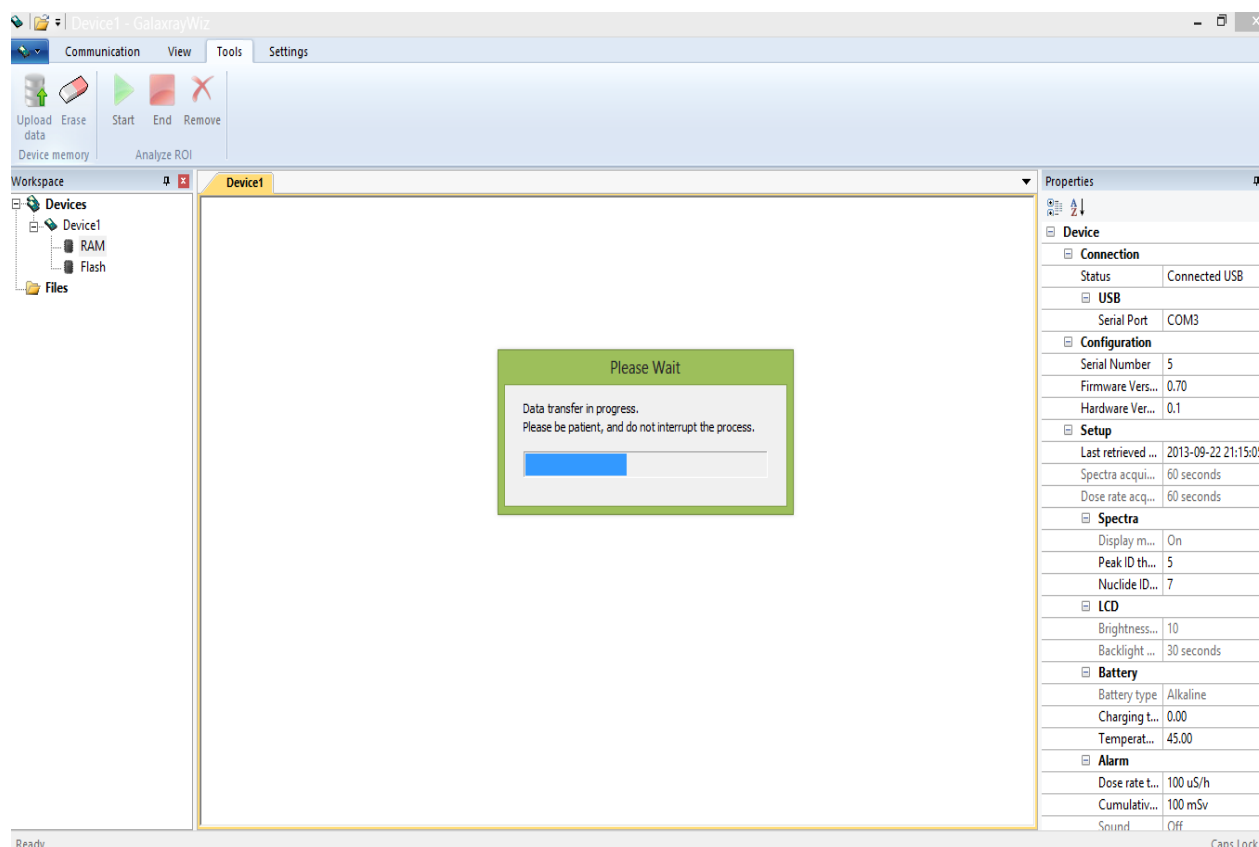
If the transfer is complete, the user would see the list of all the records stored in the Model 70 flash memory. The files have clear markings if it is a spectrum or dose rate profile. See the screenshot on the following page.

If the user selects spectrum file (file marked with blue curve), the spectrum will be displayed on the screen and associated information on the right side of GUI. Example: nuclide ID (if it was identified), screen cursor position in terms of channels or energy: 'X' value; and content of this channel as counts: 'Y' value. In addition, the maximum count over the entire spectrum is in one channel, **Maximum** and the total sum of counts in entire spectrum **Total sum**, with spectrum accumulation time in seconds **RealTime**.

If the user selects dose rate file (file marked with red curve), the radiation dose rate profile chart will be displayed.
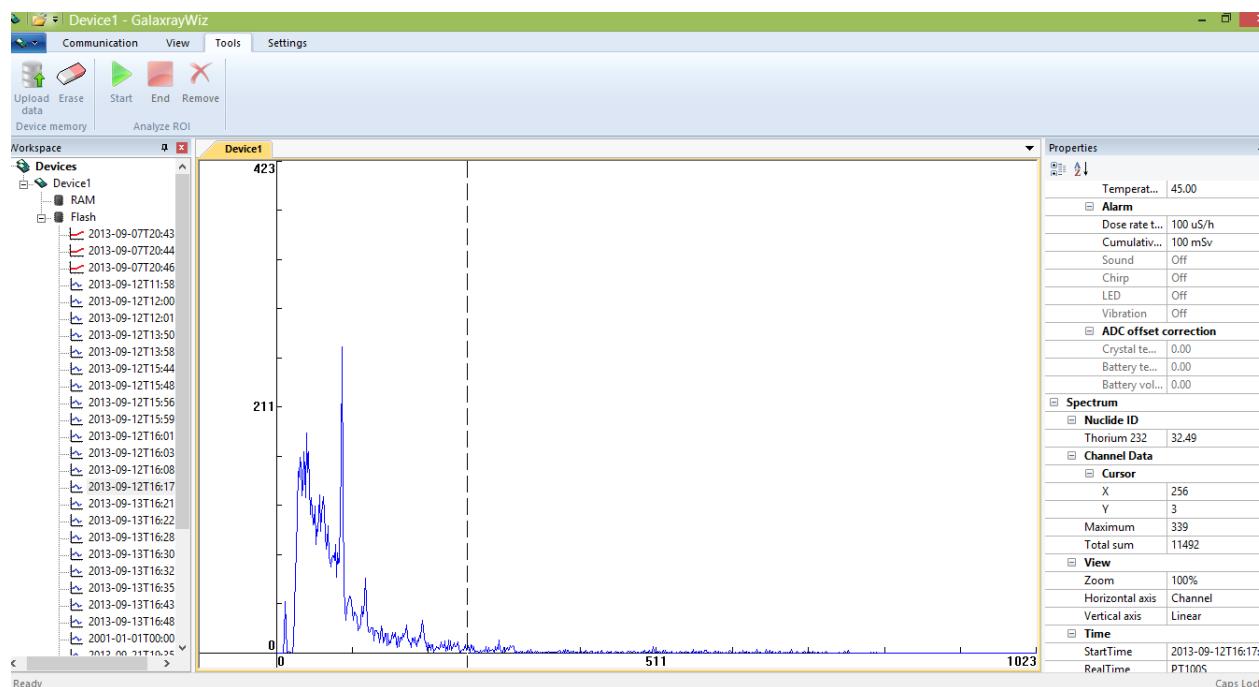
Using the **Tool** screen, the user can set or highlight the Region of Interest on the spectrum to get some basic characteristics of ROI, e.g total area and centroid.

To set ROI around a desirable part of gamma-spectrum, the user has to place the cursor on the beginning channel, and then press the green arrow **Start** on the menu bar. Pull the cursor over the desired area, and at the final channel, press the squared button **End**. The ROI area gets painted as shown in the following screenshot. The user can change the color by clicking on color square located in the left **Properties** column. Select color from the palette.

To remove ROI, the user has to place the cursor on an ROI channel and click **X** located on the top menu bar.
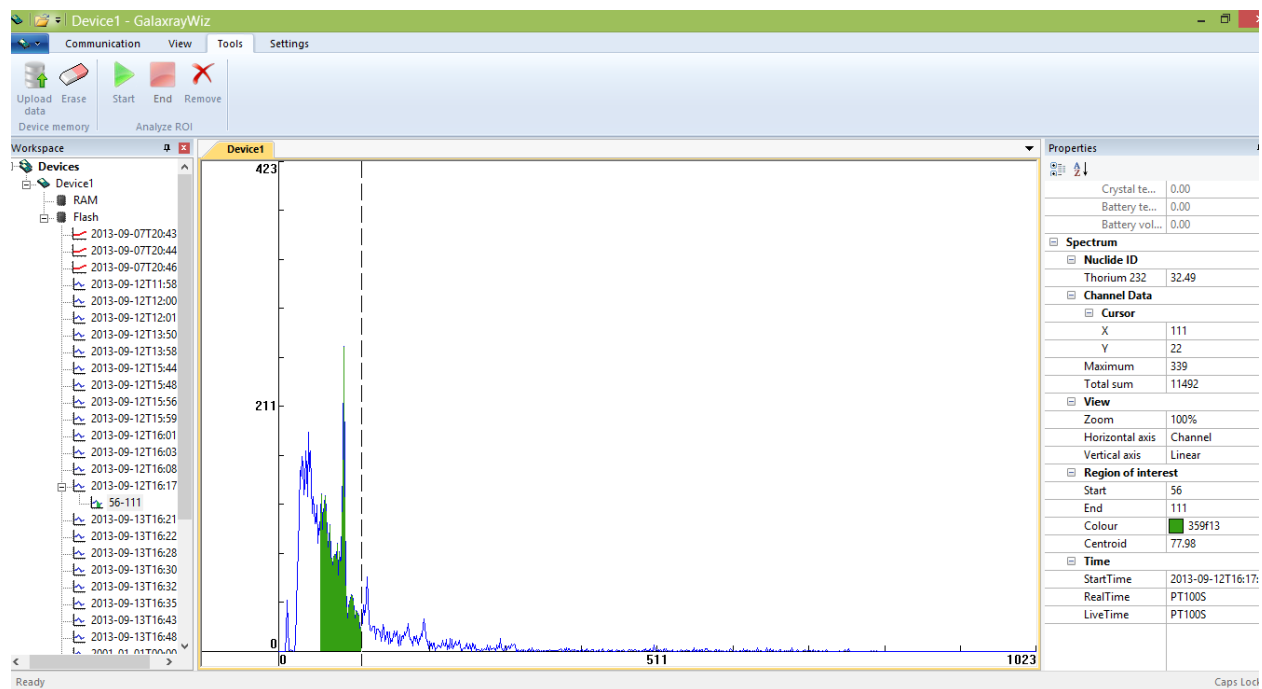
Radiation dose rate profile chart:
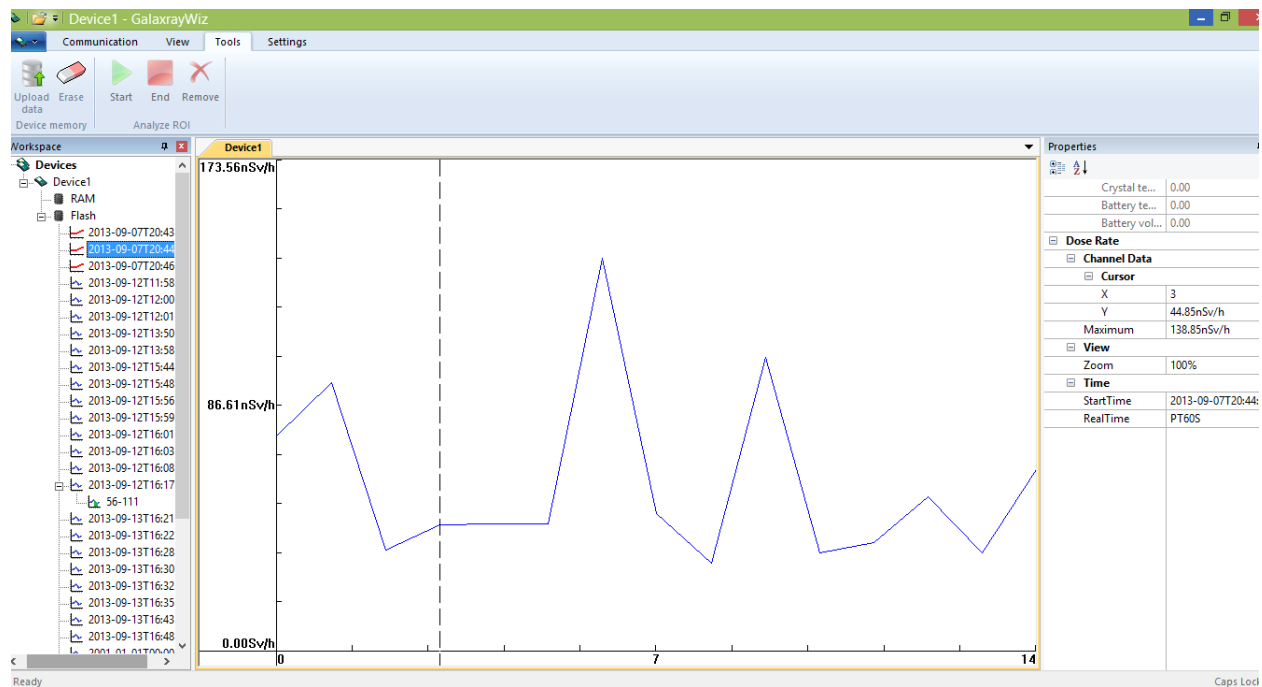
By selecting **View**, the user can switch the channel axis to energy axis, select logarithmic count scale, and change the zoom. The user may also disable or enable windows associated with **Workpace** – file list, **Properties** window, and **Status** bar.
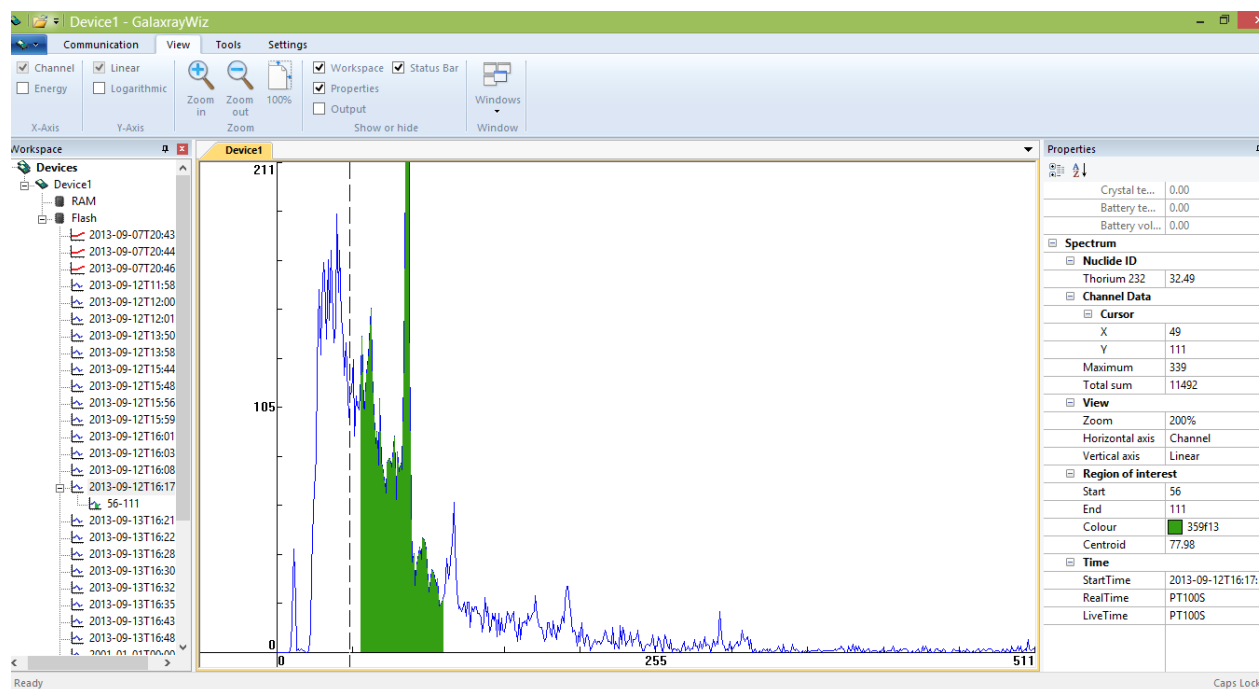

In **Settings**, the user can **Save** and **Recall** the unit parameters and set or get the unit time/clock. To use it, the unit has to be connected to the PC.
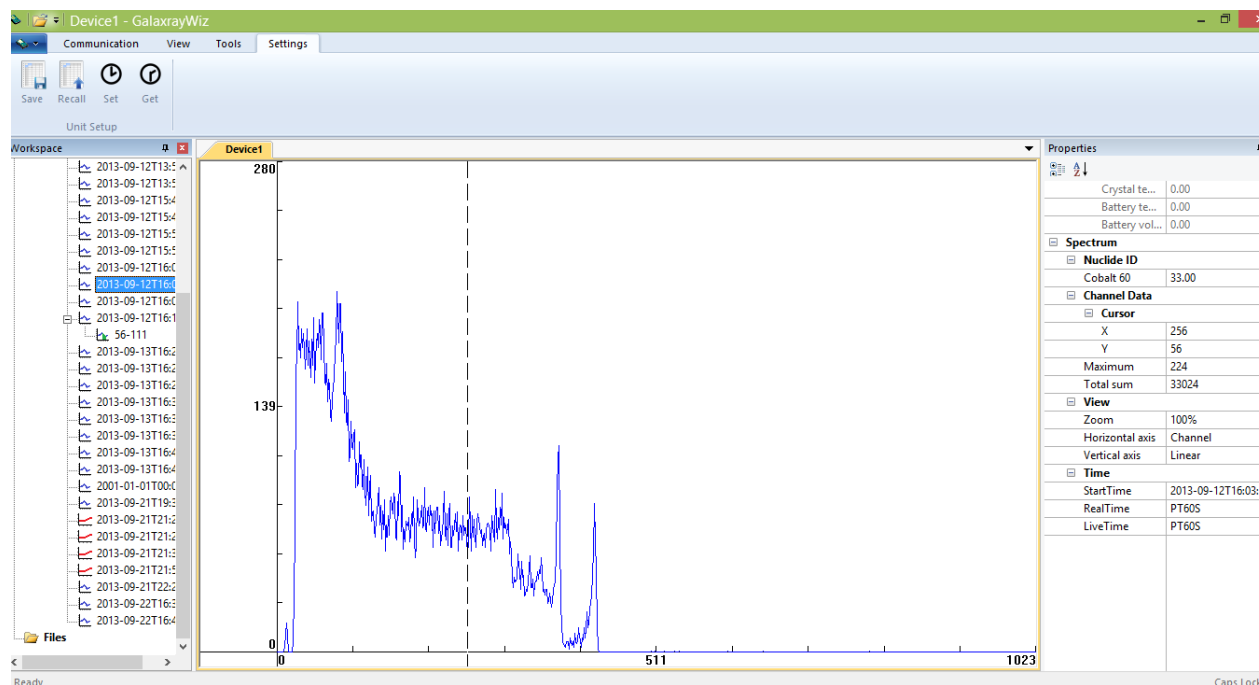
Working with Wi-Fi

In order to enable the unit to communicate through Wi-Fi, the user must do the following:

1. From the internal unit **Settings**, the user has to select **Wi-Fi** and set it to **Enable**.
2. Connect the unit to the PC and set USB communication as it's described in the section above.
3. In the **Communication PC GUI** menu, click on **Configure Wi-Fi** and the window of **Wi-Fi** settings will pop up as is shown in the screenshot below.
4. The user has to provide the name of the Wi-Fi network (SSDI) and set security type. It is usually WPA2 most secure; however, it might be an "open" network with no security, like in hotels and other public places.
5. Provide network password.
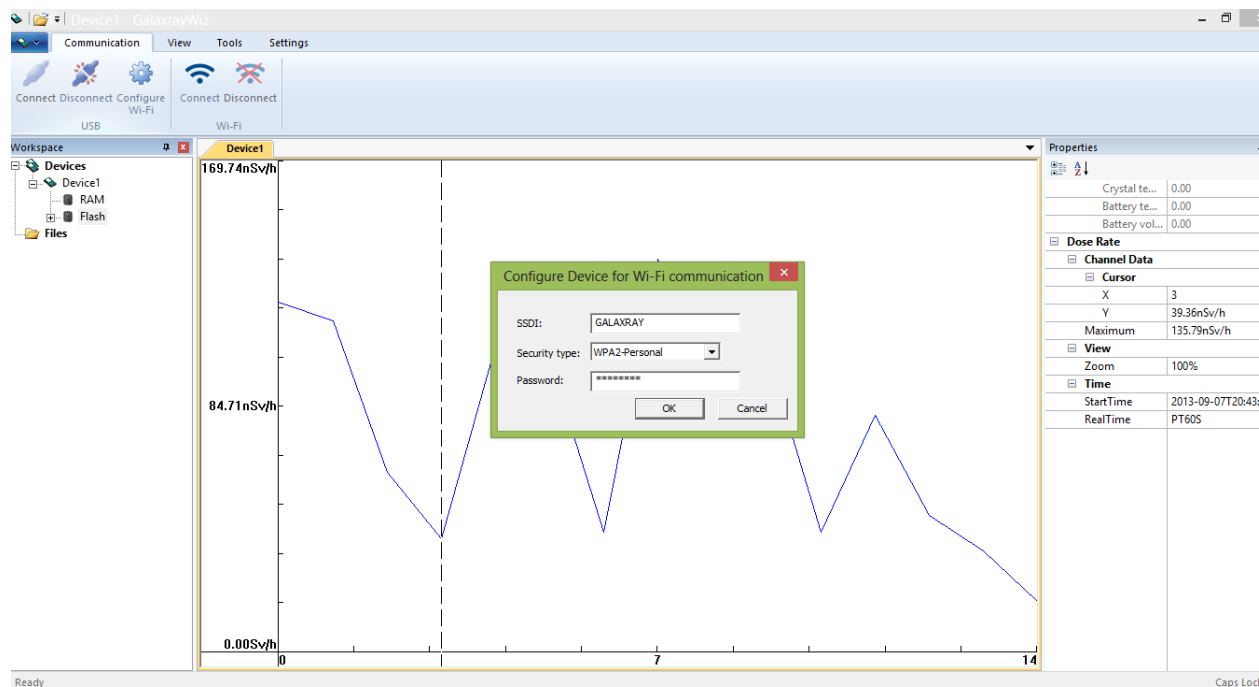
If all network parameters are set appropriately, the Wi-Fi configuration will be complete and the message will pop up as shown on the following page.
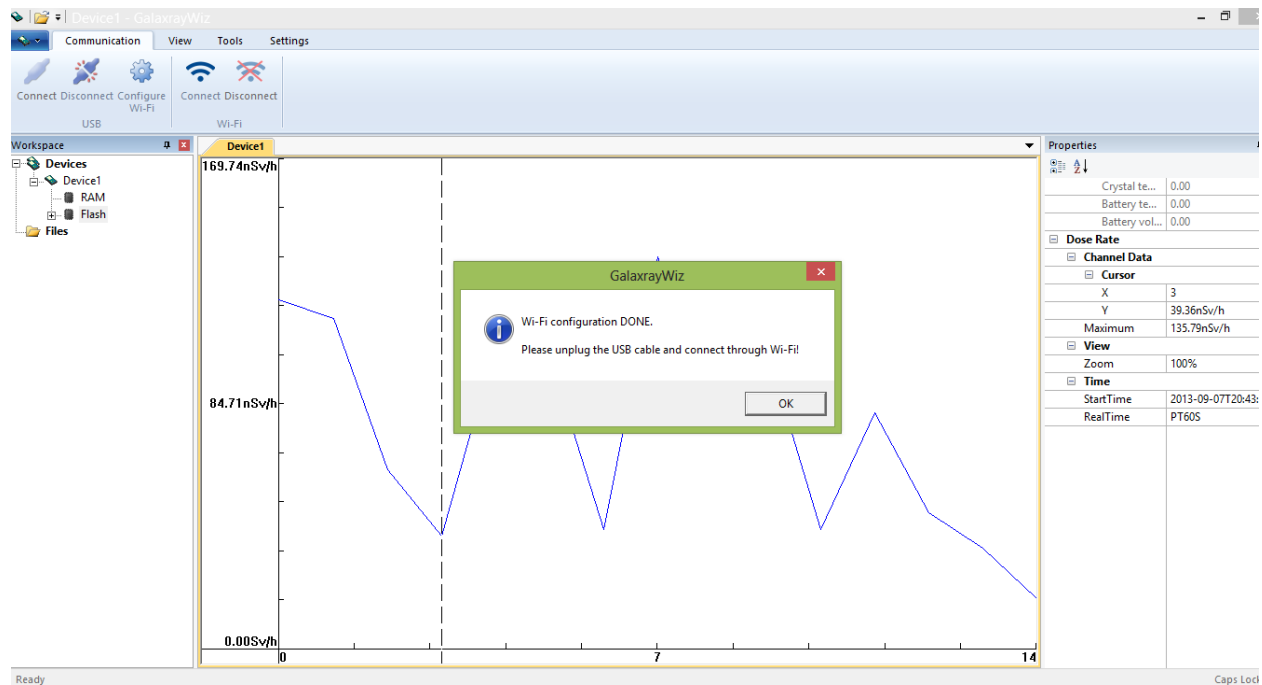
Now the user has to unplug the unit from the USB connector and click on **Connect Wi-Fi**. The window containing the unit IP address will appear, and the user has to click on **OK** in this window.
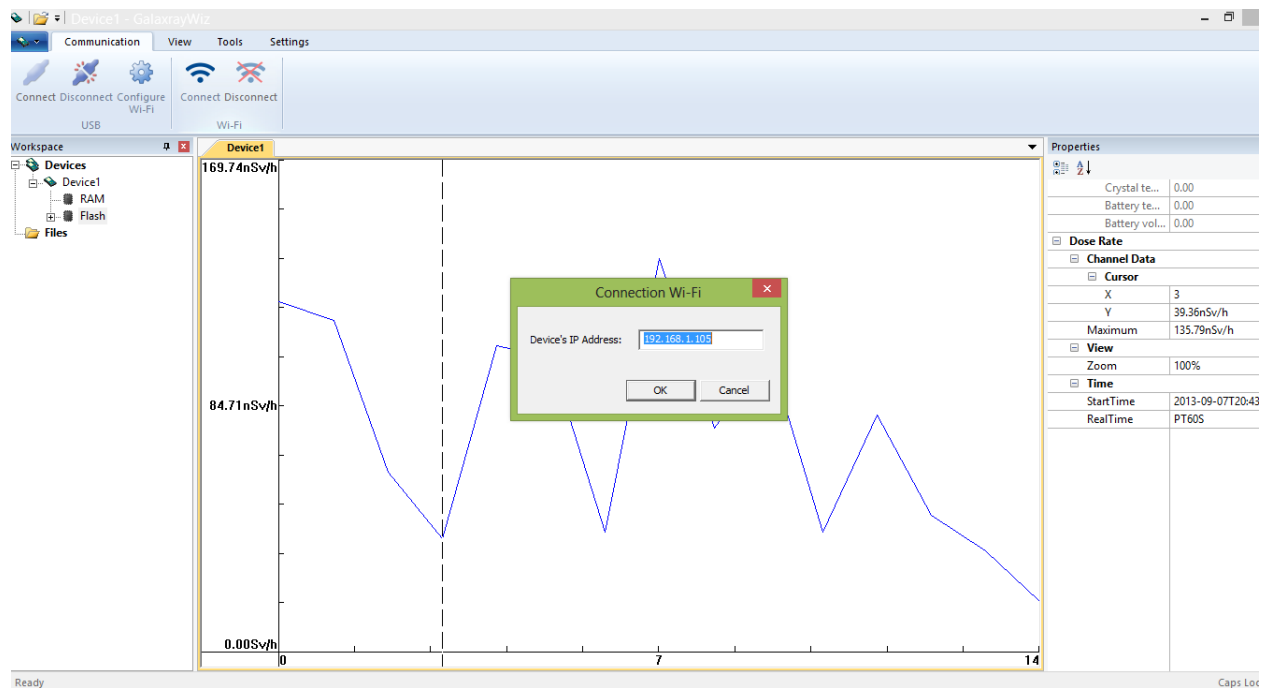
The process of connection will take several seconds with a progress window as shown below.
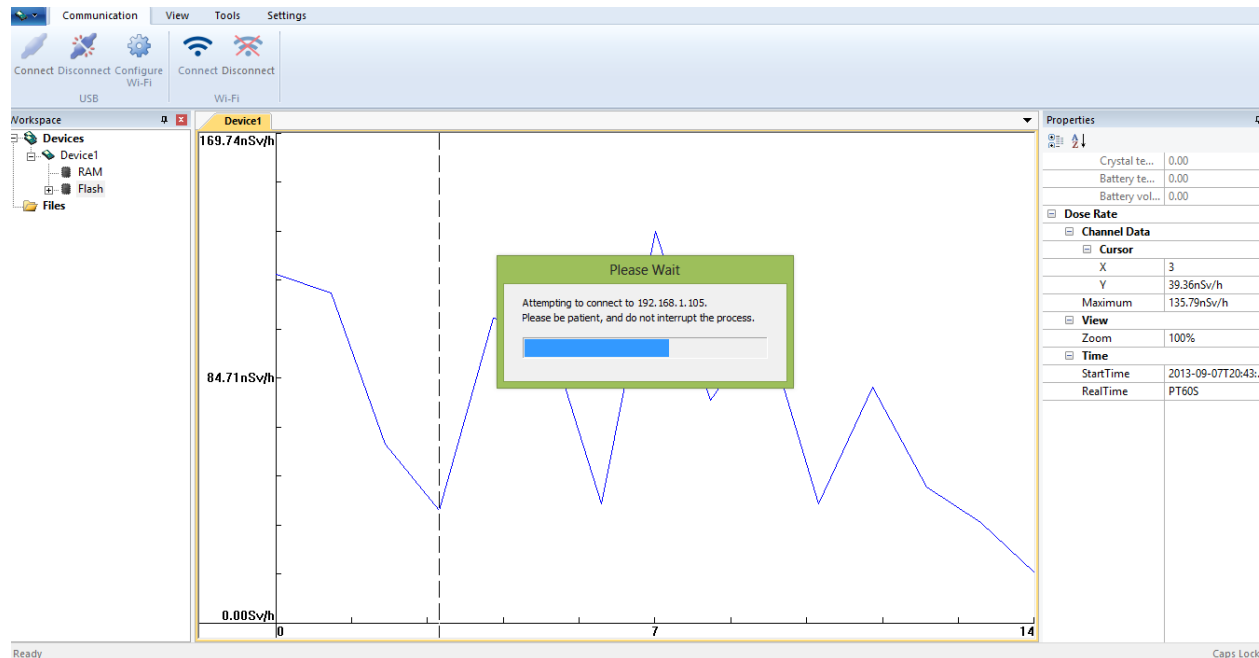

Upon completing the Wi-Fi connection, the message **Wi-Fi connection was successful** will be on the GUI screen. Now the user can transfer spectral and dose data through Wi-Fi in the same way as with a USB cable.
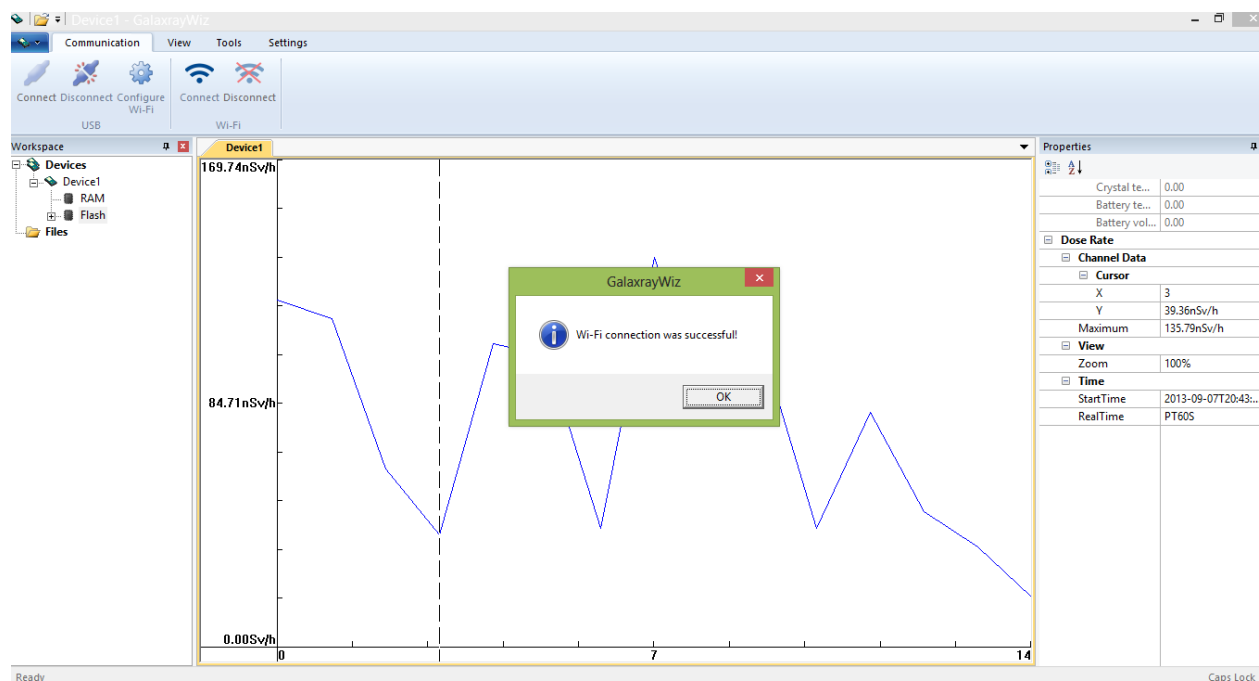
Warning: Since Wi-Fi substantially consumes battery power, it is recommended to use Wi-Fi only if necessary. Disable the Wi-Fi from the unit menu if not in use.

The previously saved data is stored on the PC in the default directory with the name "Galaxray." By clicking on file folder name located at the top left GUI corner, the user can download the previously stored data.
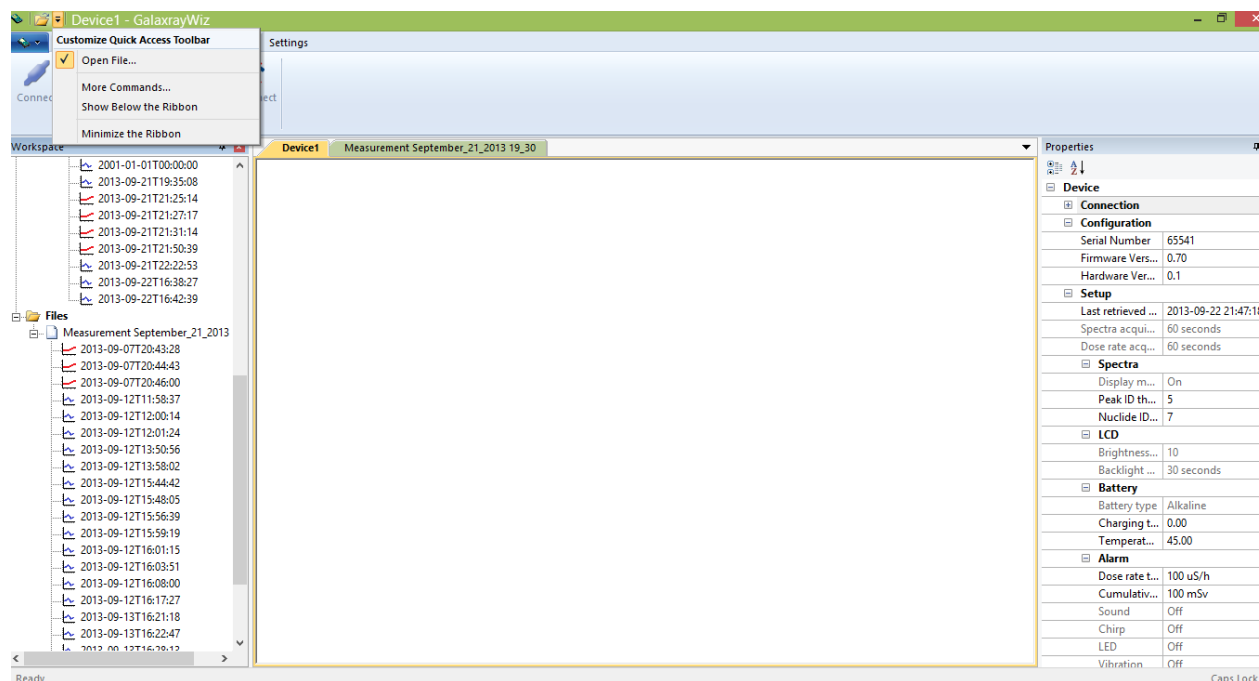
APPENDIX B: NUCLIDE LIBRARIES

Library Names
Standard

List of Nuclides:

Uranium 233,Uranium 235, Uranium 238, Plutonium 239, Neptunium 237, Thorium 232, Radium 226, Potassium 40, Americium 241, Barium 133, Cesium 134, Cesium 137,Cobalt 60, Cobalt 57, Europium 152, Iridium 192, Gallium 67, Iodine 131,Technetium 99m, Thallium 201

APPENDIX C: MANUAL CHANGES

May 2021: Initial release version