Epiq™ PRiSM

RF Sensing • Application

USER MANUAL

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CHANGELOG

Revision	Date	Description	Author
2.0.0	2022-10-26	Major updates to reflect significant changes to PCI Survey UI in release 2.1.0	seth
1.3.1	2022-08-25	Minor updates regarding GPS status/permission settings. Additional updates/corrections for Spectrum Analyzer screenshots	Chad S
1.3.0	2022-06-21	Added Appendix A: Software Updates	seth
1.0.3	2022-03-15	Added GPS Section	Gary S
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1.0.0	2021-10-22	Initial draft	Gary S

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PRISM USER MANUAL

PRiSM converts mobile devices into a 5G, 4G, and P25 network survey, scanning, testing, and troubleshooting scanner and spectrum analyzer. The PRiSM scanner can be connected to a compatible laptop, tablet, or smartphone with no apps to download.

PREPARING PRISM

CONNECTING THE ANTENNA

Connect the antenna to the SMA port labeled RF1.

> **CAUTION:** Take care to tighten the antenna to the PRiSM unit by rotating the nut and holding the antenna stationary. Rotating the antenna to attach to the unit will damage the connector.

CONNECTING TO THE DEVICE

The PRiSM connects to PCs, tablets, and smartphones by a USB-C port.

Mobile devices with an available USB-C port and those which support USB-OTG can be used with PRiSM.

Laptops can be connected to a PRiSM device using a USB-A to USB-C cable (not included) if a USB-C port is not available.

> **NOTE:**
>
> When using PRiSM with an Android device, first switch the device to airplane mode and disable Wi-Fi. Android is limited to supporting only a single network adapter.

Upon connecting the PRiSM to the device, it will boot in about 10 seconds (the status LED will go from solid to heartbeat). It will be ready to access 15-20 seconds after plugging it in.

GETTING STARTED WITH PRISM

Connect to the PRiSM by opening a browser and setting the URL to http://192.168.3.1

> **NOTE:** Be sure to use HTTP, not HTTPS.

OPENING THE PCI SCANNER

At the opening splash screen, choose the PCI Survey option.

> **NOTE:** If PRiSM is not licensed for any PCI scanning technologies, the PCI Survey selection will not function.

PCI SCANNER APPLICATION

The PRiSM PCI scanner application supports configuration, viewing, and saving PCI scanning results. Results will be displayed as they come in, organized by technology and frequency band. To change the configuration, click the cog icon at the top-right corner of the UI.

TECHNOLOGY SELECTOR

Use the Technology Selector toward the bottom right edge of the window to choose which technology to show in the channel list.

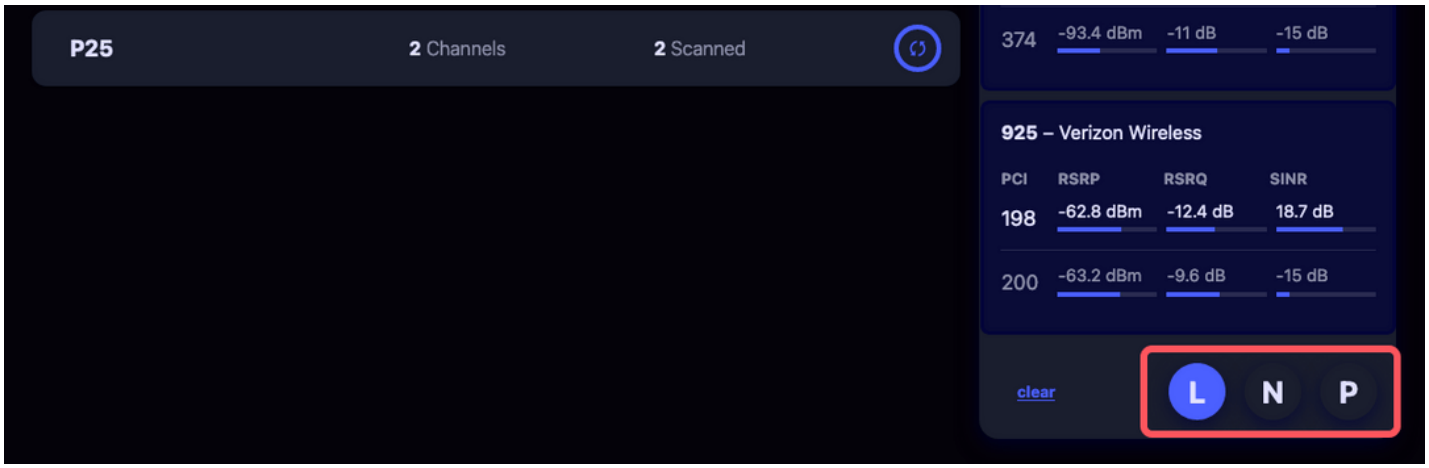


Figure 1: *Technology Selector*

CHANNEL LIST

The Channel List displays the channels discovered by PRiSM for the selected technology. The list contains unique entries sorted by channel number. All entries are further divided by the frequency band in which they were found, when applicable. Select a channel to see its Channel Details.

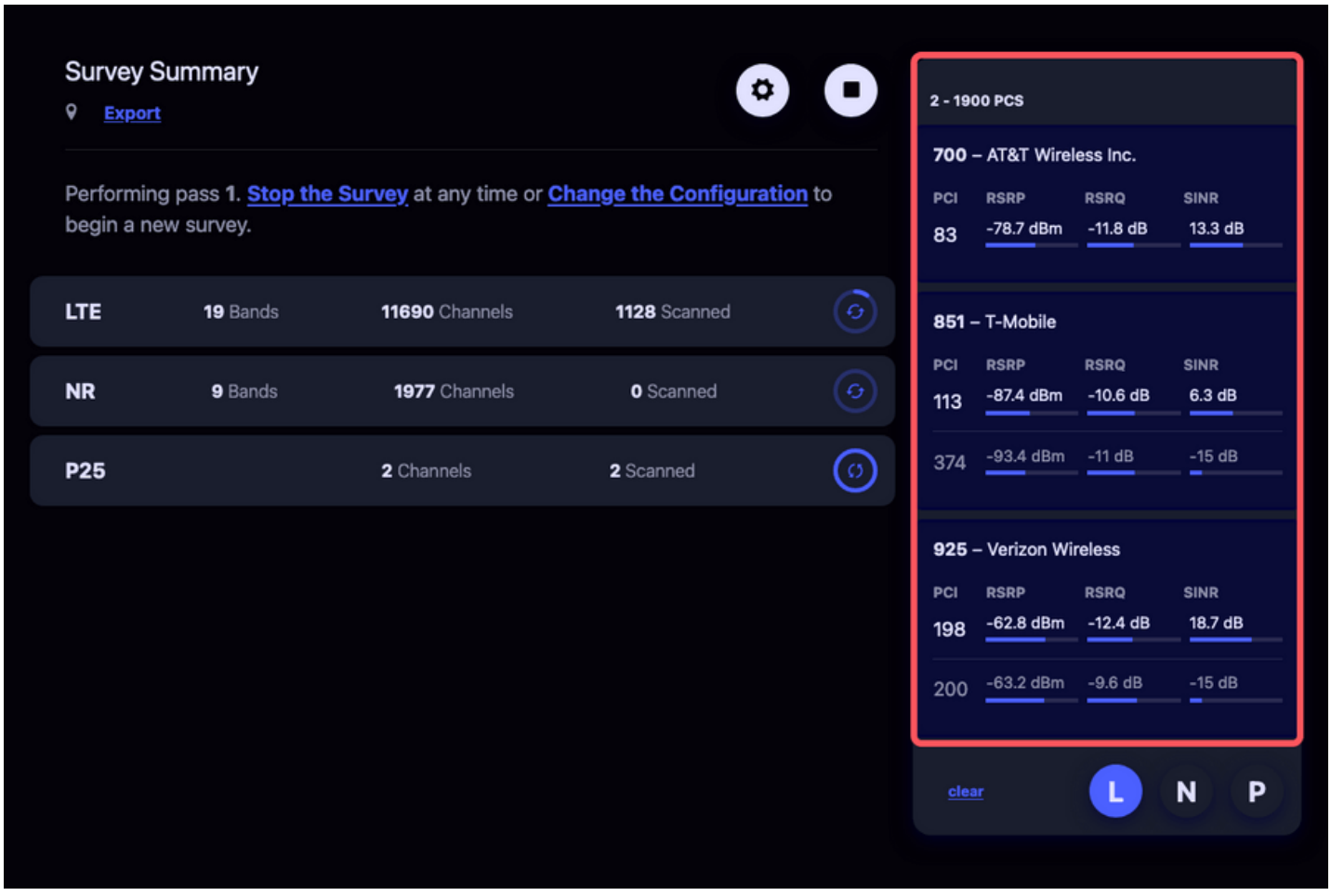


Figure 2: *Channel List*

SURVEY SUMMARY

When no channel is selected, the rest of the window displays a summary of the currently configured survey. It includes information about how many passes of the configured survey have occurred and it tracks progress through the current pass.

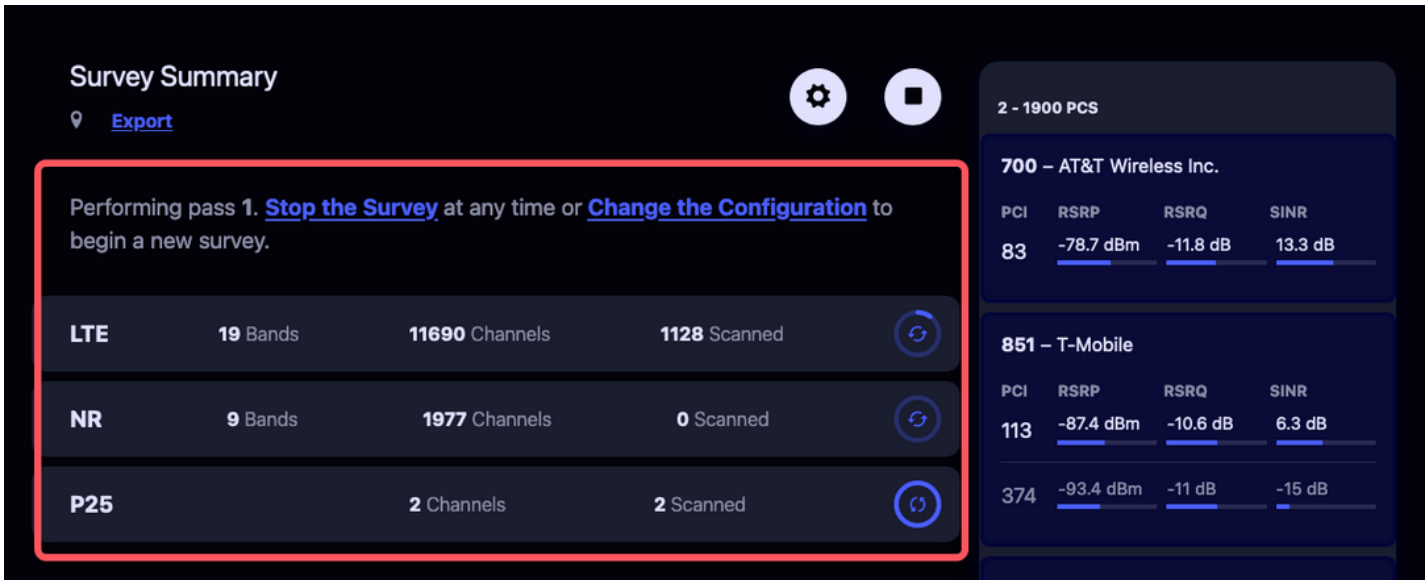


Figure 3: *Survey Summary*

STOP CURRENT SURVEY

While a survey is in progress, a Stop button is displayed in the upper right corner of the UI. Pressing this button will cause the scanner to discontinue looking for channels, making it idle.

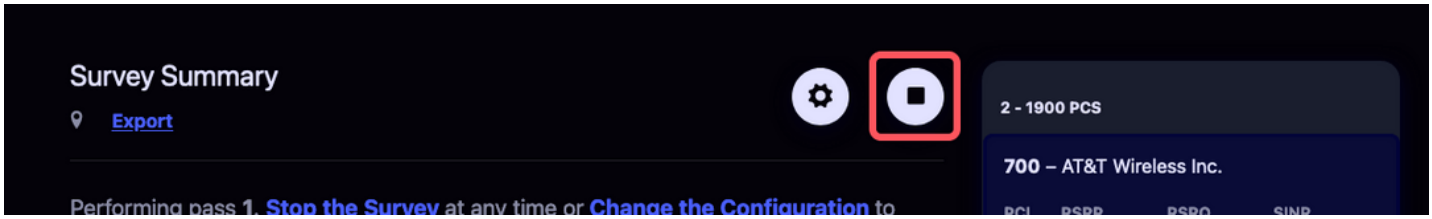


Figure 4: *Stop Current Survey*

RESTART LAST SURVEY

While the scanner is idle, the Stop button becomes a Restart button. Pressing the Restart button will start a new survey with the same configuration as the most recent survey.

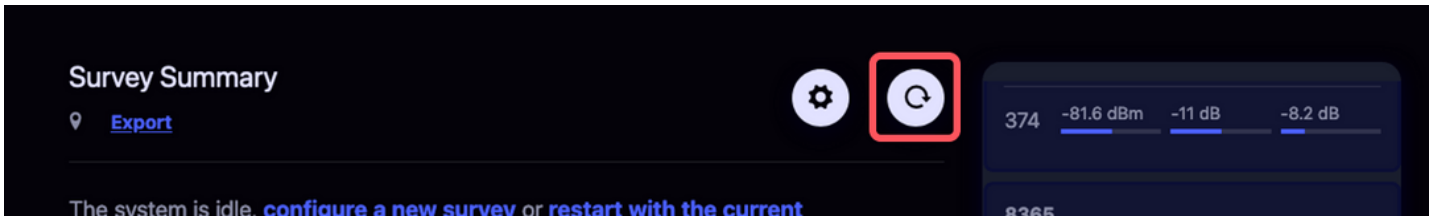


Figure 5: *Restart Last Survey*

CHANNEL DETAILS

When a channel is selected in the Channel List, a panel with details for that channel is displayed. The details displayed will depend on the channel's technology.

Cellular channels details will include an entry for each decoded PCI found on the channel's carrier frequency. Any PCI that has been decoded further, with at least a SIB1 decode will include additional fields and be colored differently to indicate that carrier information has been decoded for the PCI.

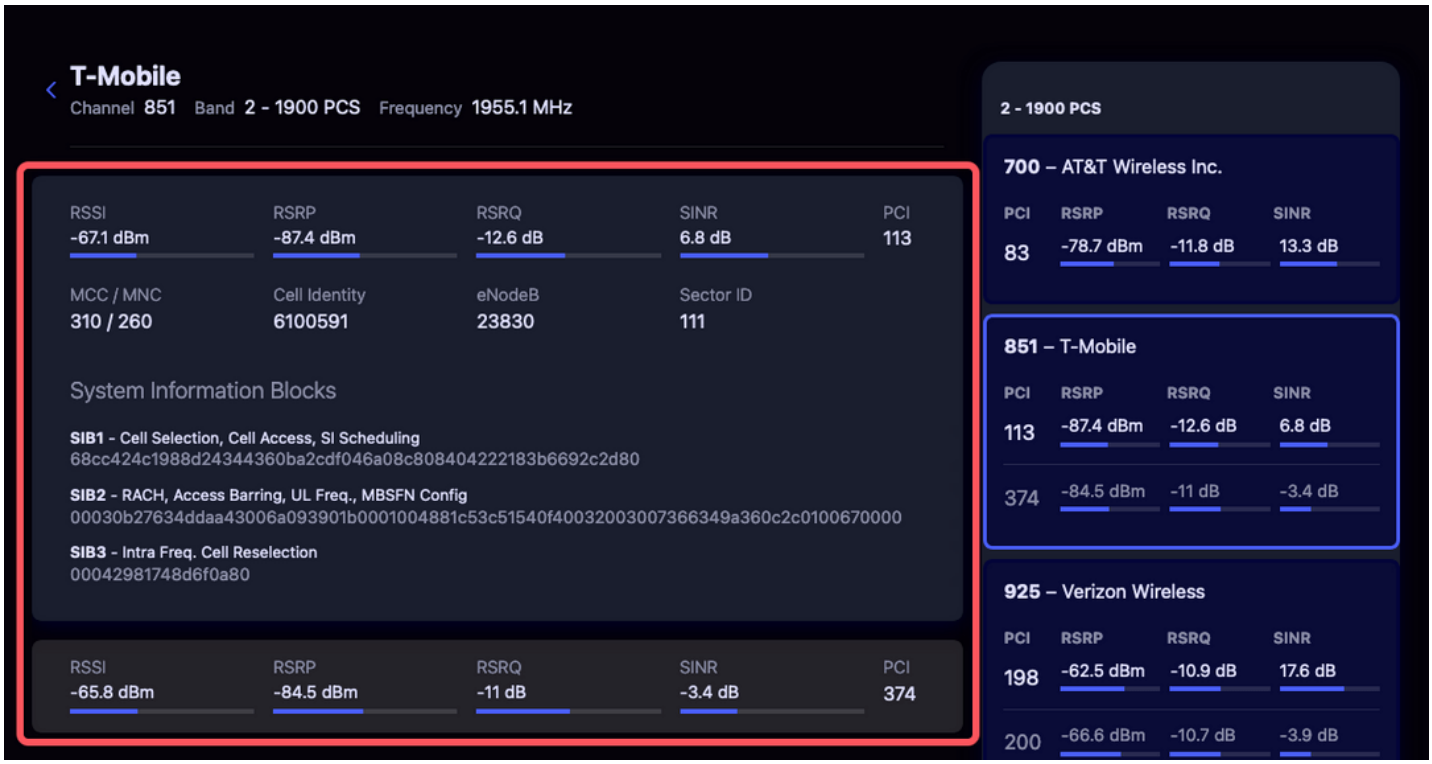


Figure 6: *Channel Details*

> **TIP:** To return to the Survey Summary, either de-select the channel or click the back button at the top of the Channel Details section.

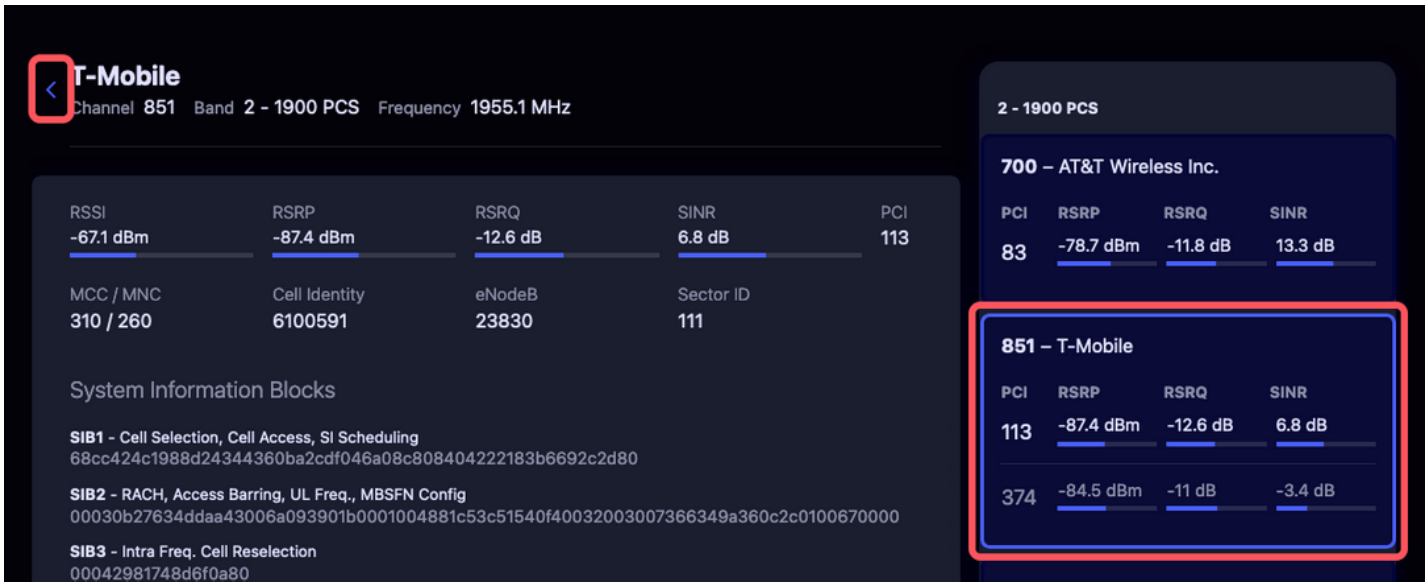


Figure 7: *Deselect Channel*

EXPORTING SURVEY RESULTS

The results of the currently-running survey can be exported to a CSV (Comma Separated Values) file. To download the complete set of scan records for the current Survey, from the Survey Summary, click the "Export" button. All scan records for the current Survey will be downloaded into individual `.csv` files per configured technology.

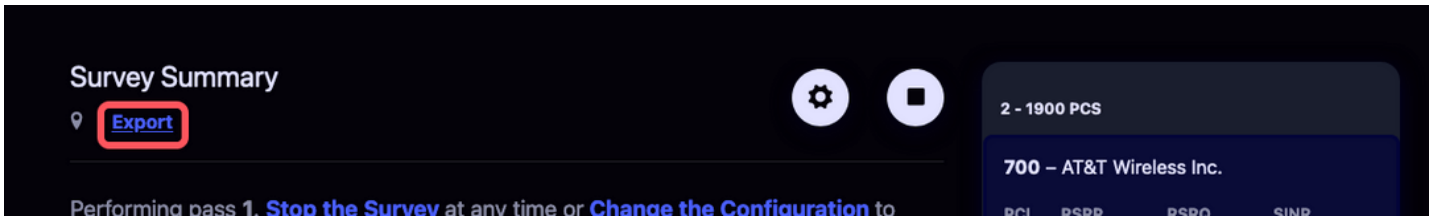


Figure 8: *Download Scans Button*

> **NOTE:** The current version of PRiSM only captures records for the current survey *since the moment the UI connected to the scanner*. This means that if the user refreshes the browser in the middle of a survey, only the records received after the refresh will be exported. A future release will improve this functionality.

SURVEY CONFIGURATION

This view provides an easy way to configure the scanner. You can either select a Regional Preset, a User Preset, or manually configure the technology and frequency bands to be scanned. When you have made changes to the current configuration and are ready to apply them, click the apply (✓) button in the top-right corner. To return to the Survey Summary without making any changes, click the cancel (**x**) button.

MANUAL CONFIGURATION

In the Survey Configuration section, you may switch on and off desired technologies. When a technology is switched *on*, the scanner will survey the bands and channels as described in the technology's section. When a technology is switched *off*, it will not be included in the survey.

> **NOTE**: Only licensed technologies will be present in the Survey Configuration section.

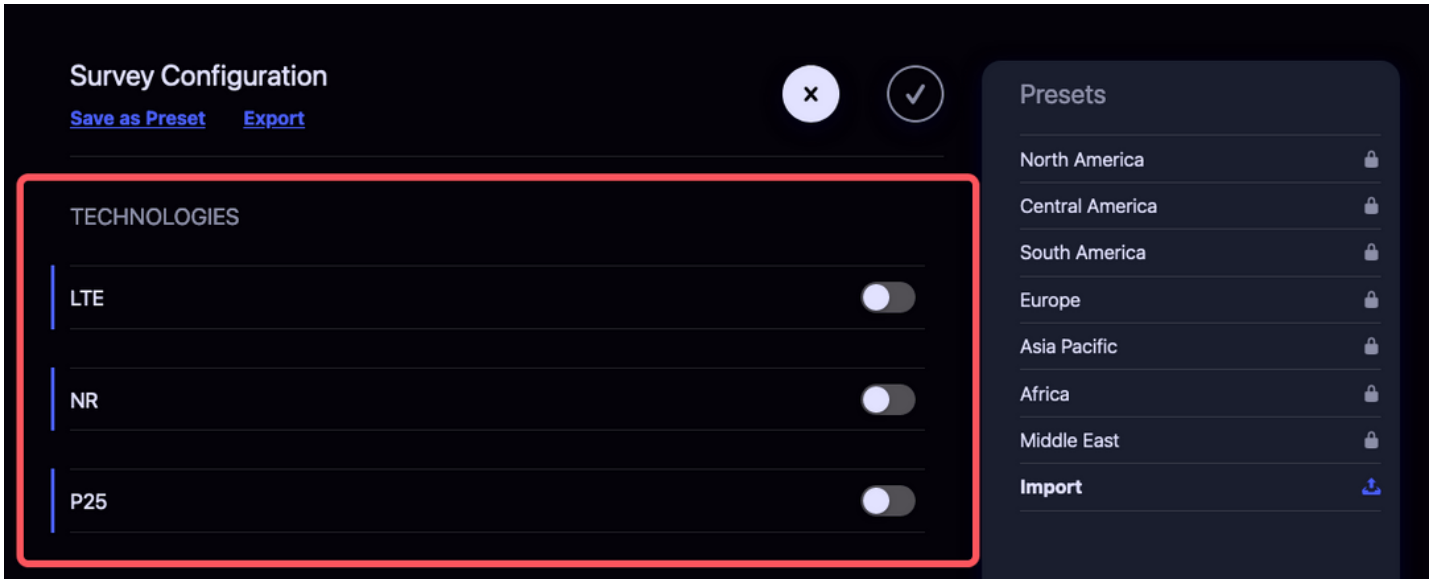


Figure 9: *Manual Configuration*

Configuring Bands

To specify which bands should be scanned, click the "Edit" button for the desired technology, once it has been enabled. A list of available bands will load. You may determine whether or not the scanner will survey each band by switching them *on* or *off* in the panel on the right.

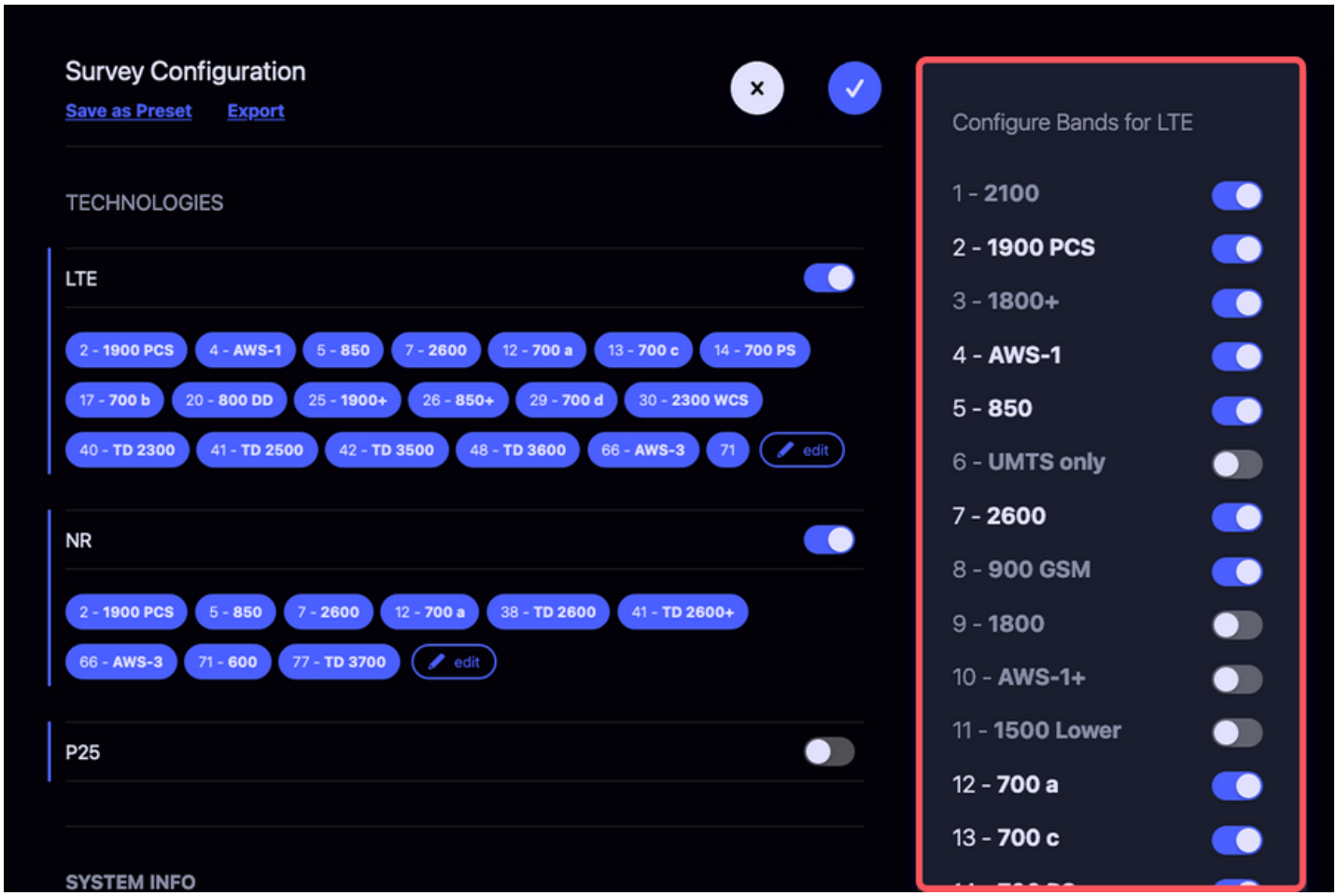


Figure 10: *Configure Bands*

> **IMPORTANT**: There is a bug in the PRiSM application preventing surveys with no bands selected from being started. **NOTE:** When no bands are selected, the scanner will Survey *ALL* bands and *ALL* channels for that technology.

SURVEY PRESETS

It is possible to save a Survey Configuration as a preset to be recalled later. Click "Save as Preset" to save the currently displaying configuration as a preset. The preset will appear in the list of presets with the prefix "User Survey" and a number (e.g. "User Survey 1")

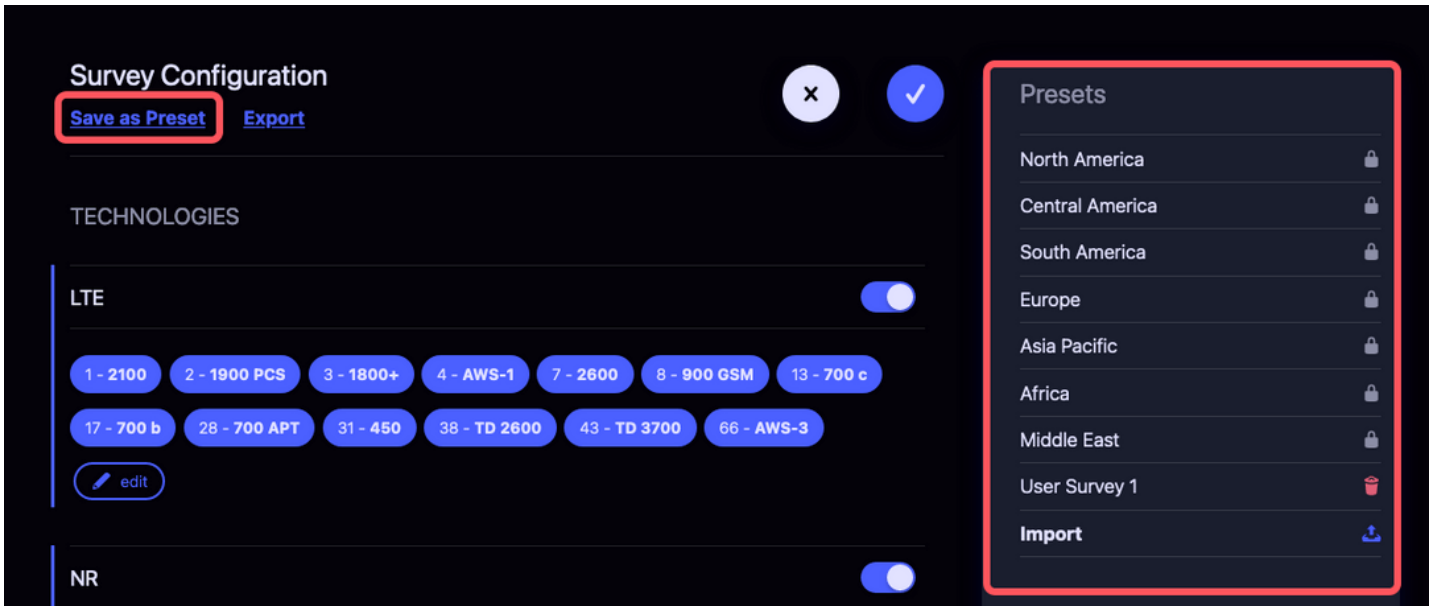


Figure 11: *Survey Presets*

> **NOTE:** User Presets are saved in the browser, so they will not be present when connecting to the scanner from another machine or browser. User Presets will also not be saved when using a private window.

The scanner also includes several regional presets that can be used, as-is, or tweaked before being applied.

Importing and Exporting Presets

To export your current configuration to a file that can be loaded onto another system, from the Configuration view, click the "Export" button and your current working configuration (whether you have applied it or not) will be downloaded to a JSON file that can be imported to another system.

To import a previously saved configuration, click the "Import" button at the bottom of the Presets list, then select the file from the file browser.

Example Preset File:

`my-prism-preset.json`

```
{
  "config": {
    "rx_port": "J3",
    "survey_parameters": [
      {
        "tech": "lte",
        "bands": [
          { "band": "2", "channels": [] },
          { "band": "4", "channels": [] },
          { "band": "5", "channels": [] }
        ],
        "type": "band"
      },
      {
        "tech": "nr",
        "bands": [
          { "band": "5", "channels": [] },
          { "band": "71", "channels": [] }
        ],
        "type": "band"
      }
    ]
  },
  "name": "My PRiSM Preset"
}
```

LICENSING

To view or update the current license, go to the Survey Settings view and scroll past the Survey Configuration section. Under the "License Info" heading, you can see which technologies are currently licensed.

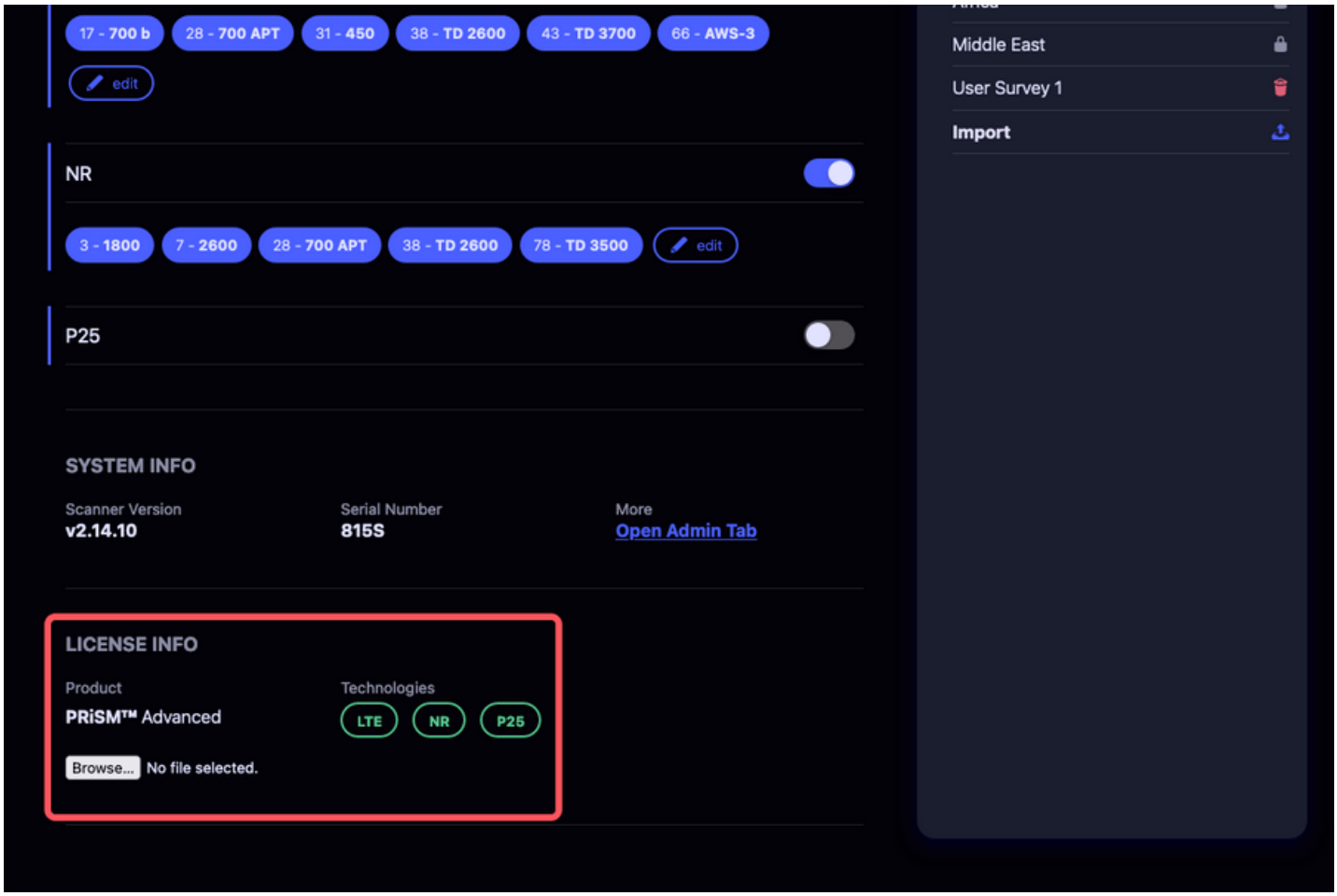


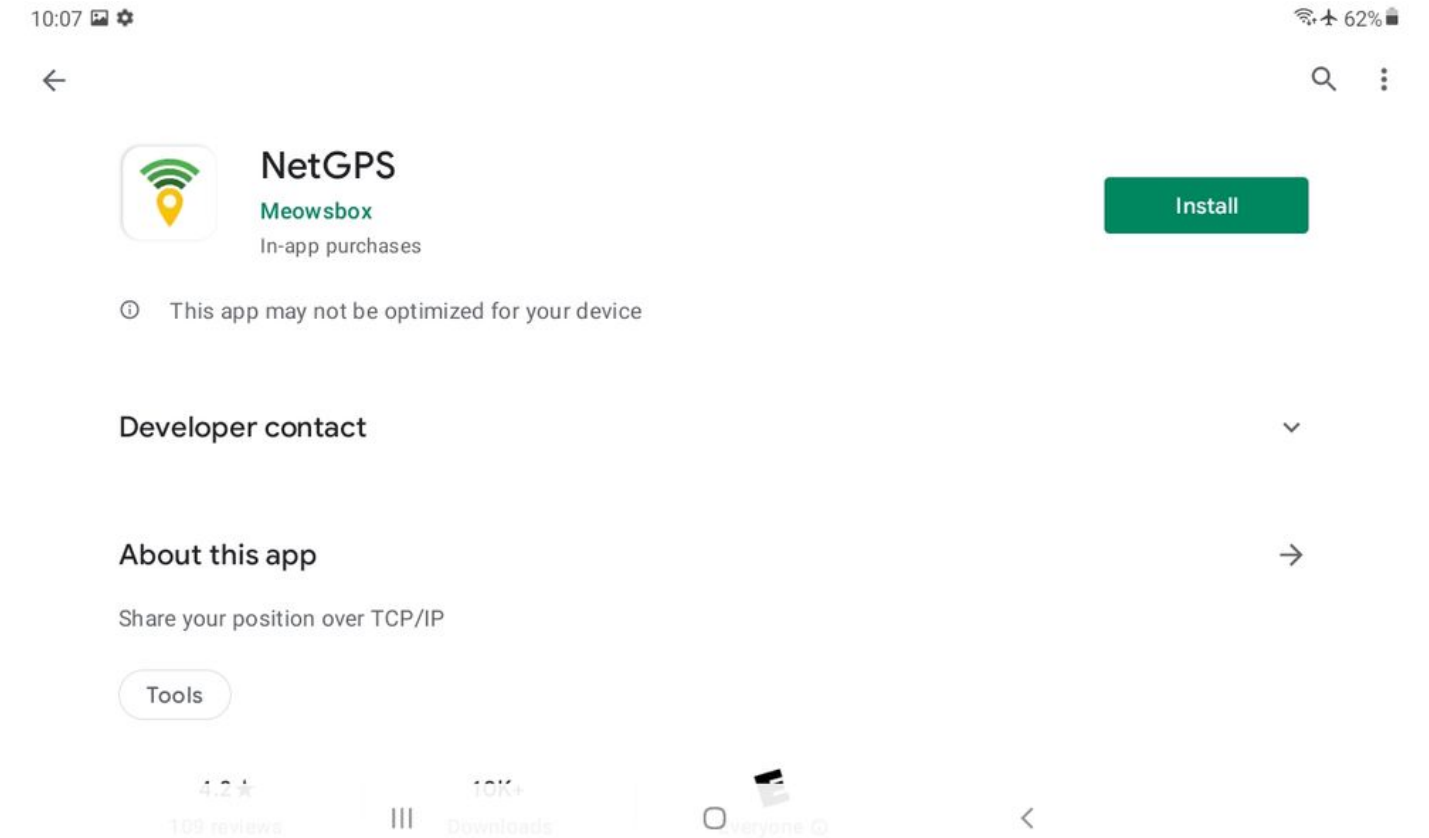
Figure 12: *License Section in Configuration View*

To Update the license, click the "Browse" button and select the new license file using your native file browser. If a survey is currently running, it will be stopped before the license is updated.

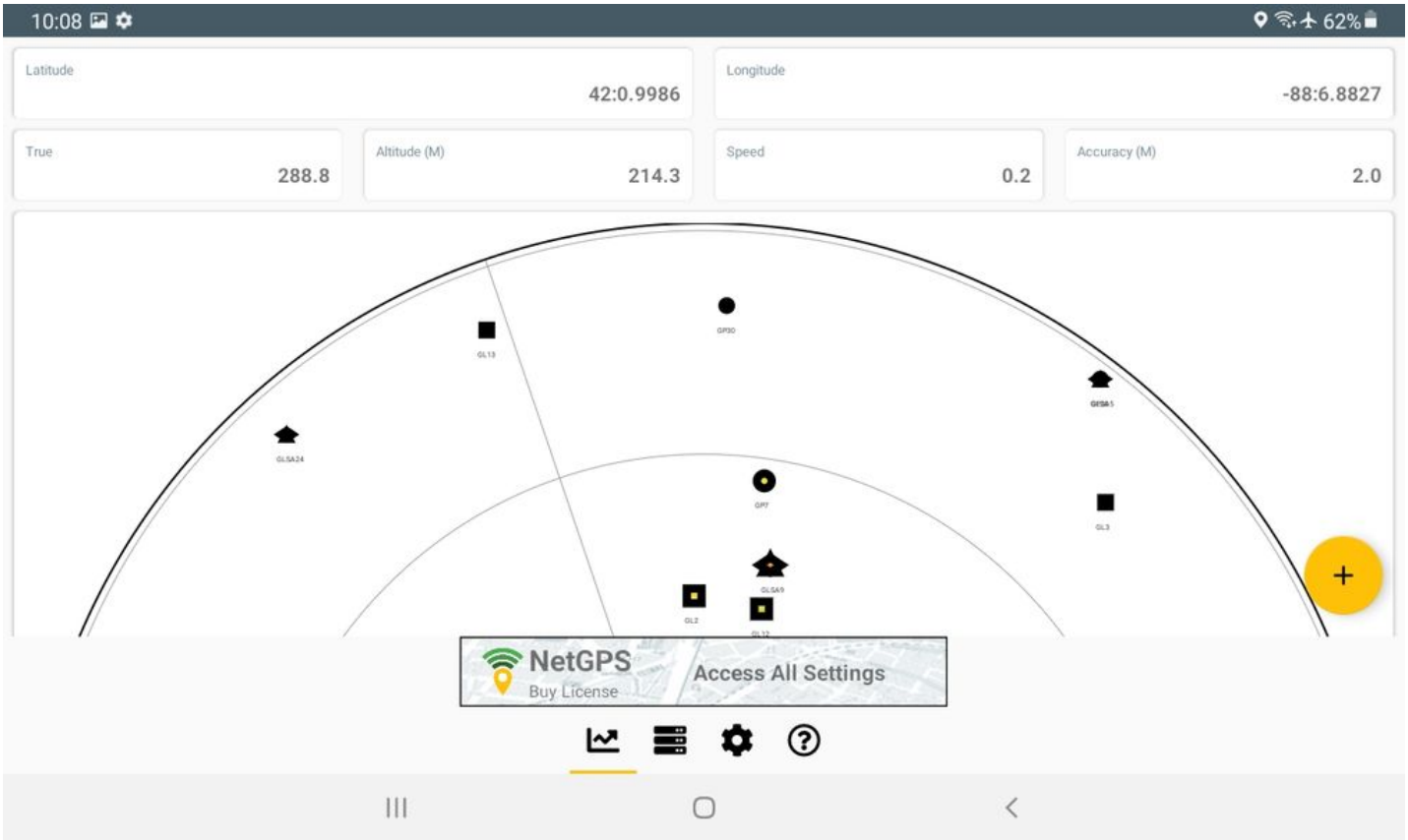
CONFIGURING GPS

Exported data can be tagged with GPS using the GPS from the host device. In order to enable this feature, configure a GPS application that provides a NMEA GPS server on the device. One such application is NetGPS available from the Google Play Store. Without an NMEA helper application configured properly, exports will not contain GPS coordinates.

To configure NetGPS, be sure you're logged into the Google Play Store and Install NetGPS.



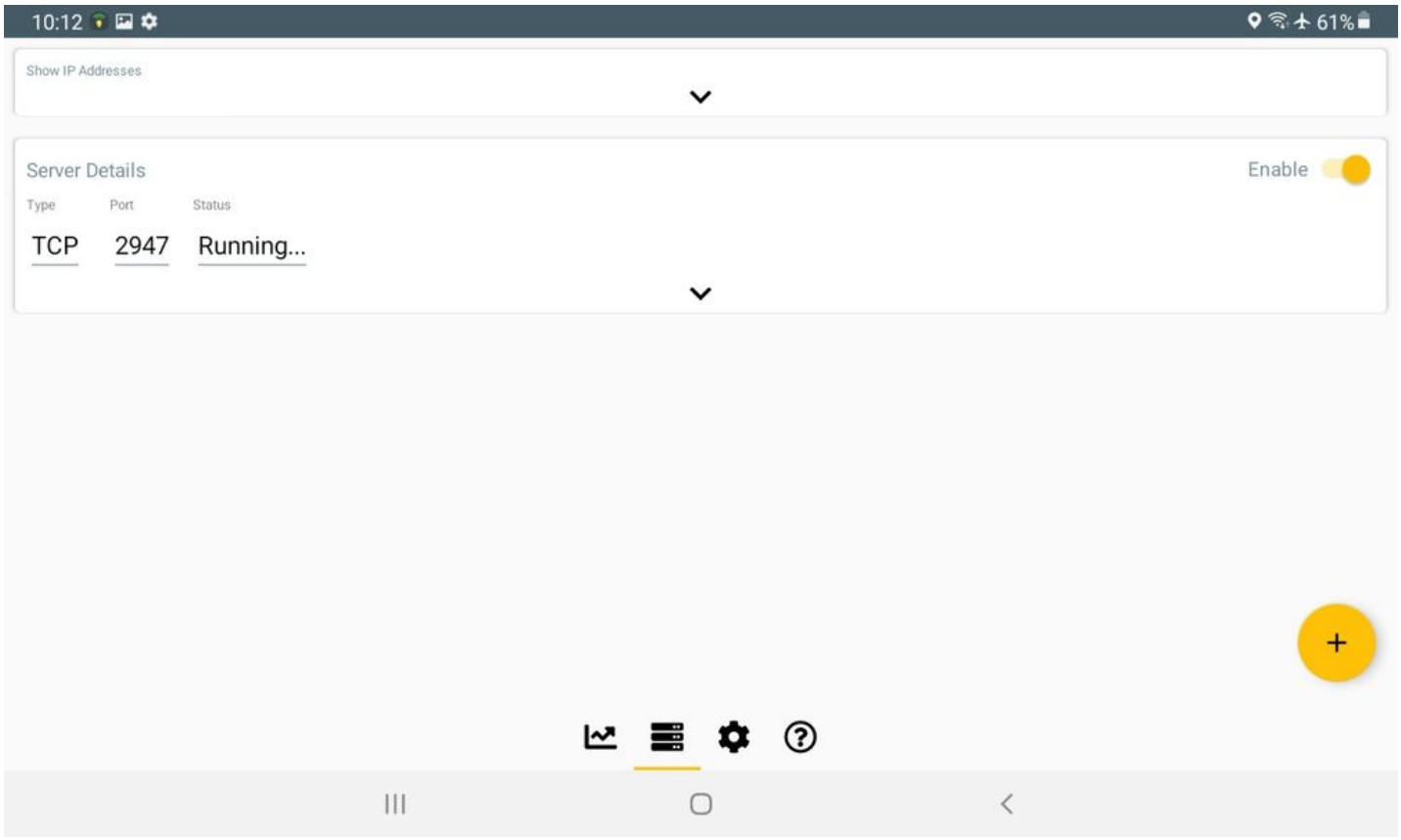
It is recommended to purchase the license to get all the settings available in the app. Do so by selecting the Buy License popup.



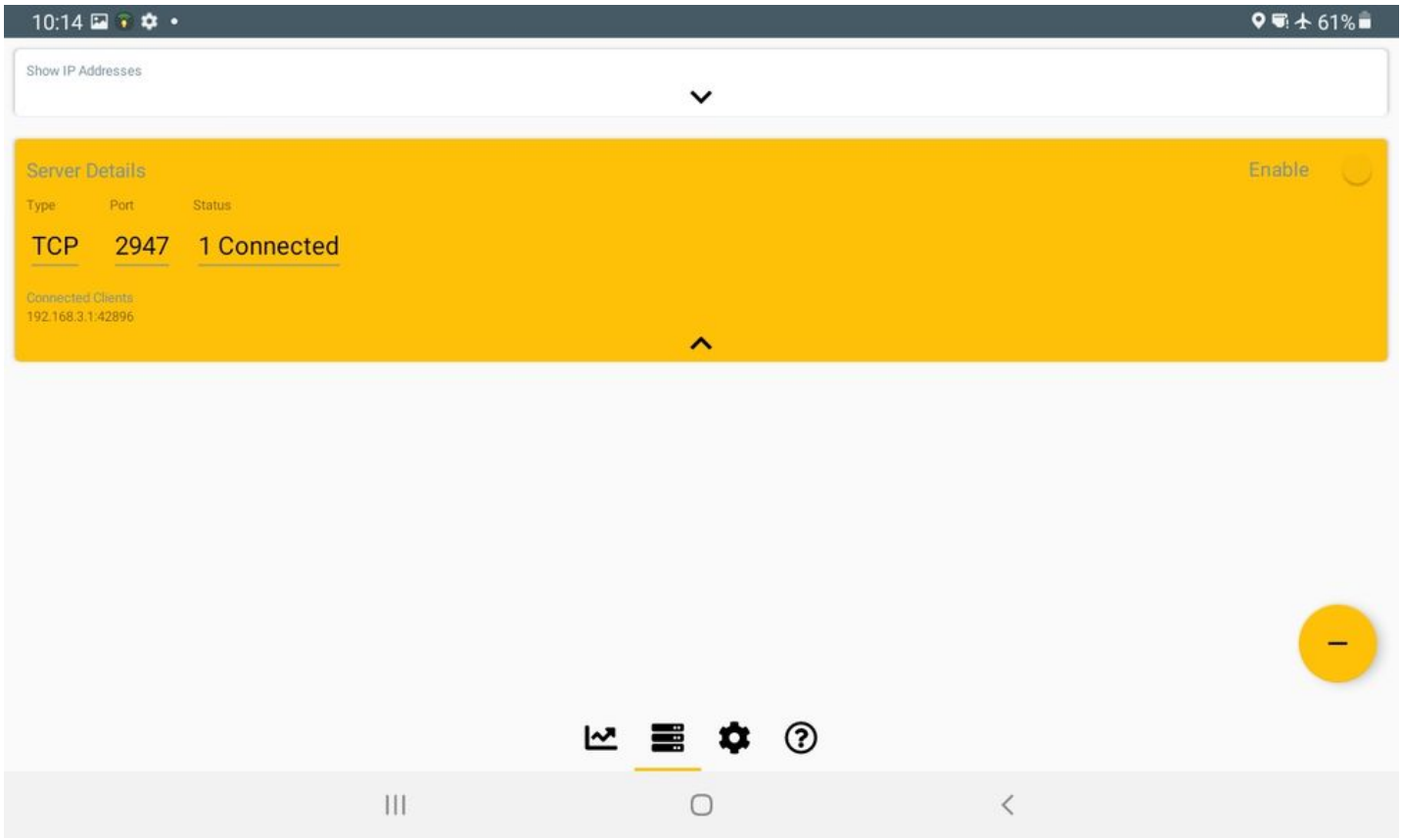
Ensure that the application has a GPS fix -- this can be done by verifying it is showing a latitude and longitude in the main window. It should also be noted that the user should ensure that the GPS application be given adequate Location permissions which allows for location access all the time. As

a check, typically, a GPS icon will be present in the notification bar when GPS is being utilized (as shown in the screenshot above).

Configure the server function by setting the port number to 2947 and clicking enable.



Finally, configure a PCI scan and run a survey. Switching back to NetGPS should show that there is a server connection and PRiSM is using the GPS coordinates from the device.



GPS Status Icon

The PCI Scanner application provides a GPS status icon which can be referenced to quickly determine the GPS Fix state. The images below show a "No Fix" status (left) and a "Has Fix" status (right).

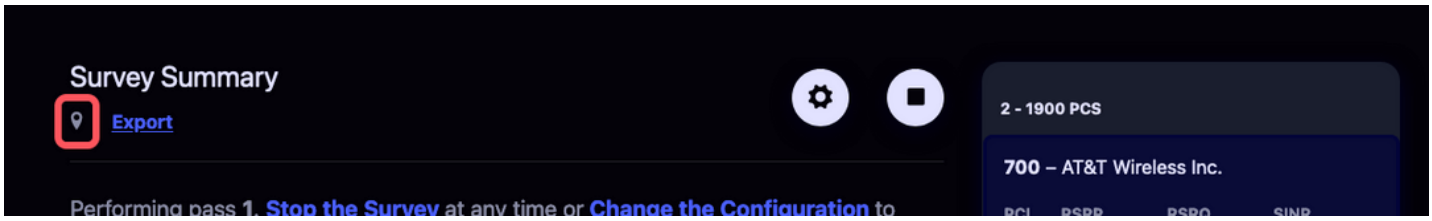


Figure 13: *GPS Fix Indicator*

SWITCHING TO SPECTRUM ANALYZER

When in the PCI Scanner application, switching to the spectrum analyzer can be done from the configuration menu. Select the cog icon from the top right of the window. At the bottom of the screen, select the button labeled "Switch To Spectrum Analyzer".

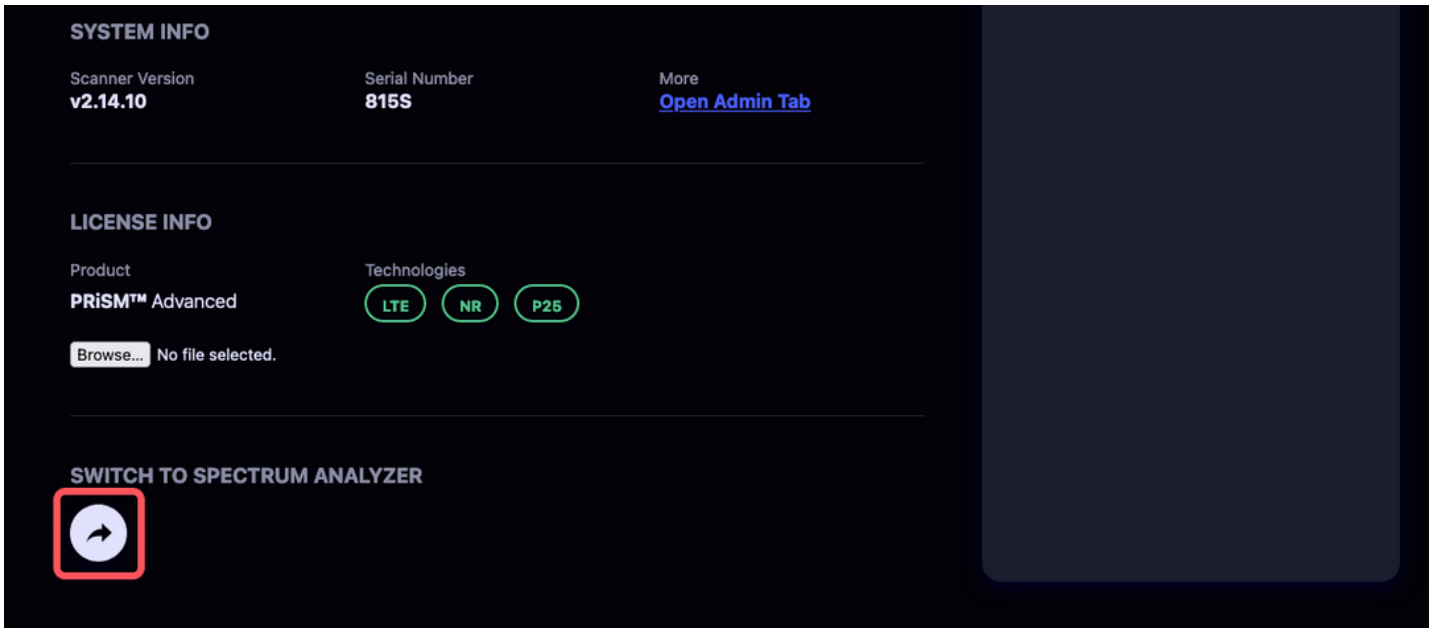


Figure 14: *Switch to Spectrum Analyzer*

PRISM SPECTRUM ANALYZER

The PRiSM Spectrum Analyzer is an application that provides a realtime view of RF spectrum based on a flexible configuration of radio frequency, sample rate, and filtering configuration.

USING THE SPECTRUM ANALYZER

Upon launching the spectrum analyzer, the loading screen will appear while the UI loads any user preferences and establishes a connection to the PRiSM unit.

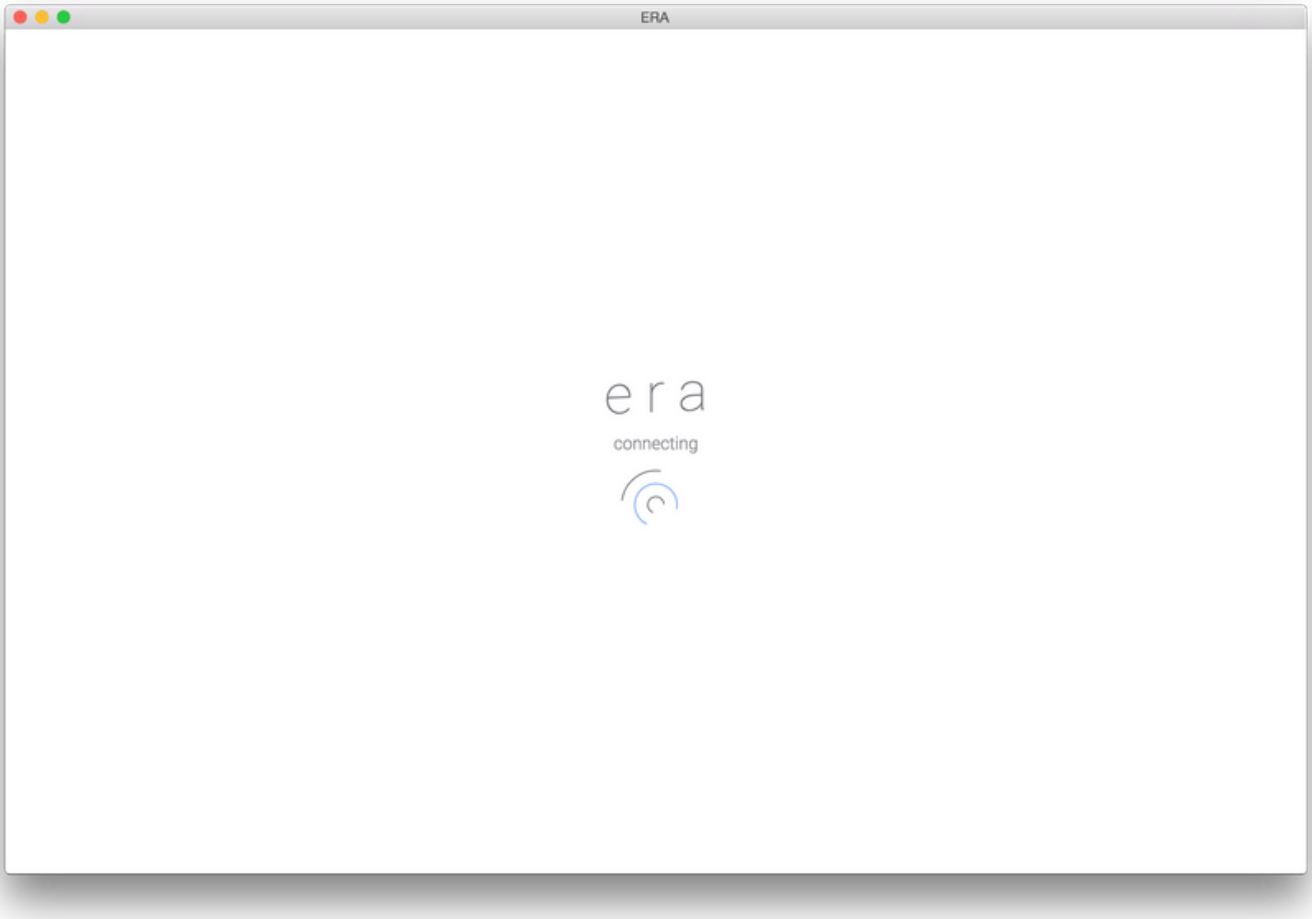


Figure 15: *ERA Connecting to Radio*

Once everything is ready, the UI will begin displaying the live spectrum and the radio's configuration. Below is a brief overview of each section in the UI:

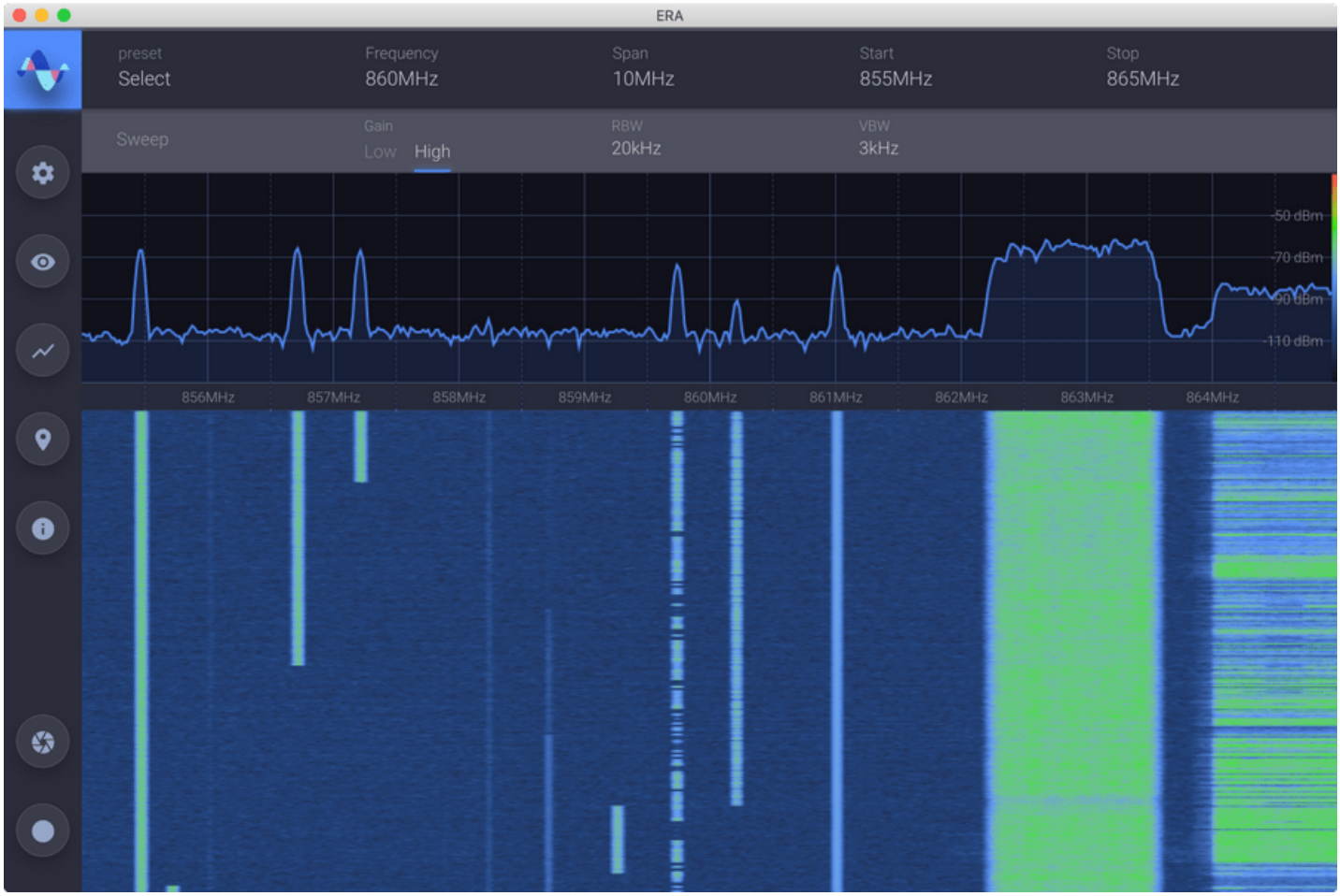


Figure 16: *ERA User Interface*

PRIMARY CONTROLS

The most commonly used parameters are always visible along the top of the application. These display the current configuration of the radio and spectrum processor.

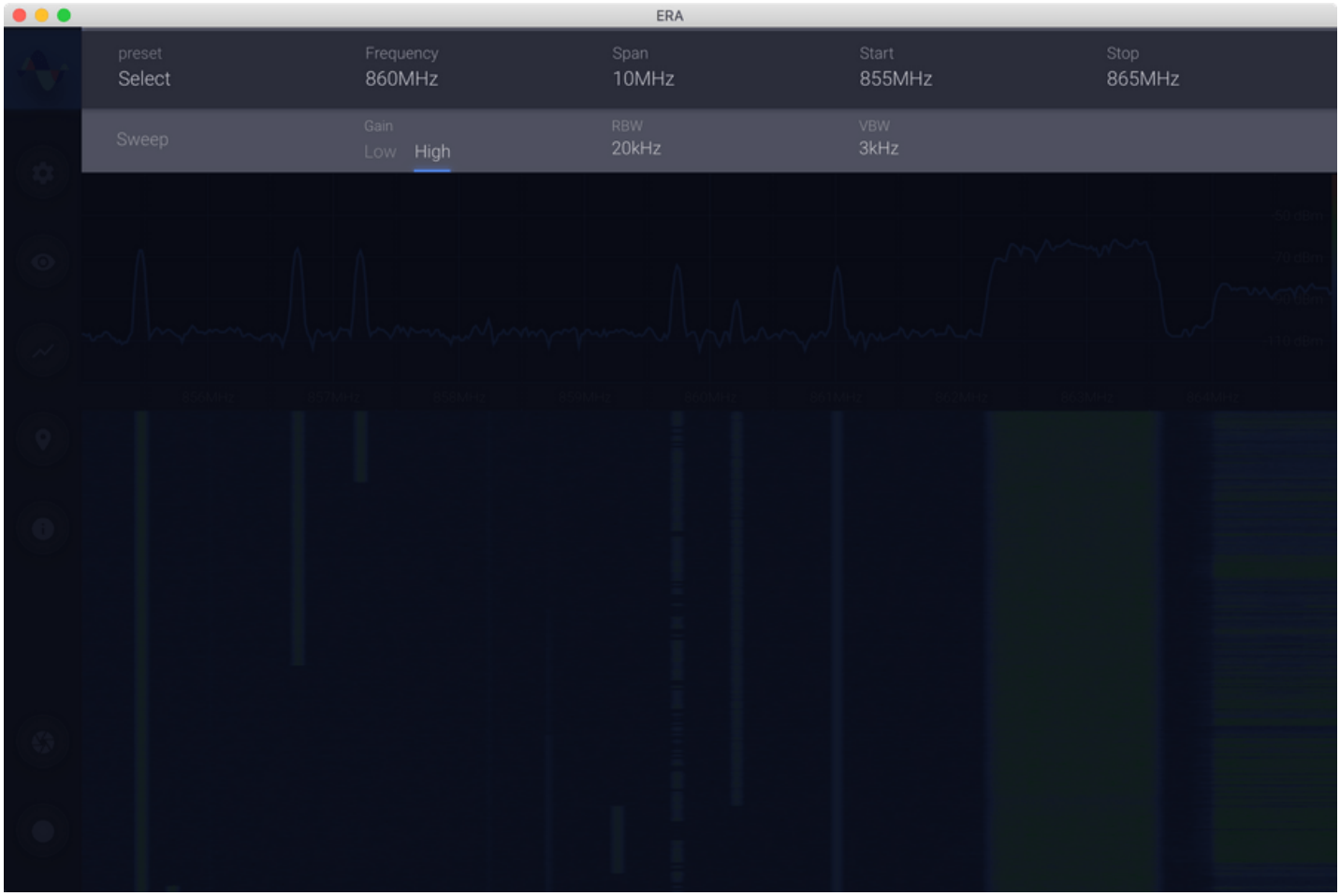


Figure 17: *Primary Controls*

SPECTRUM DISPLAY

Directly below the Primary Controls is a view of the live spectrum, in the frequency domain.

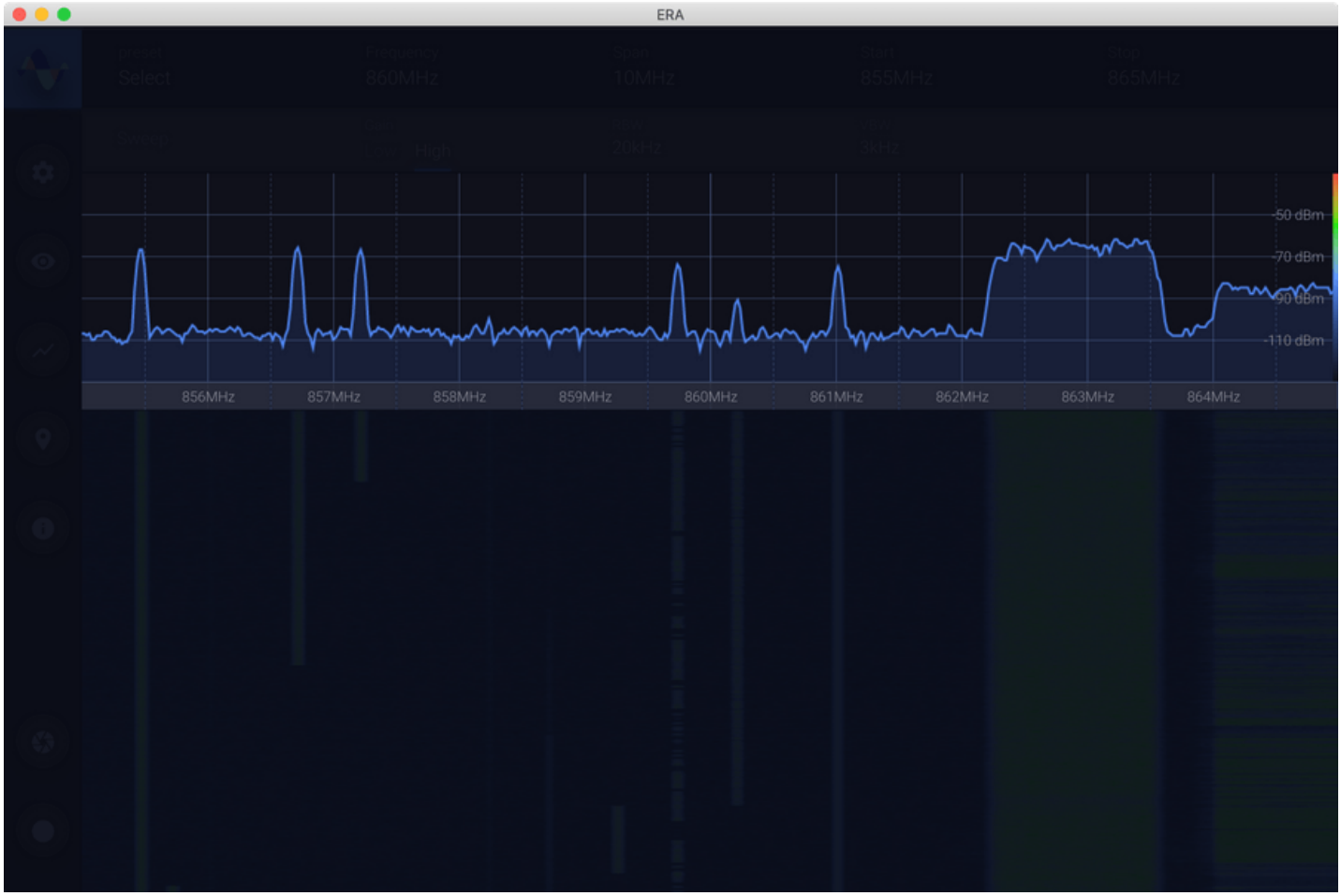


Figure 18: *Live Spectrum View*

WATERFALL DISPLAY

Below the live Spectrum Display is a waterfall display showing historical data about received signals; it is a frequency vs time plot where the color represents the power of the signal. This window can be resized by dragging the header of the pane up or down. Likewise when using a tablet, holding/dragging the header will resize the pane.

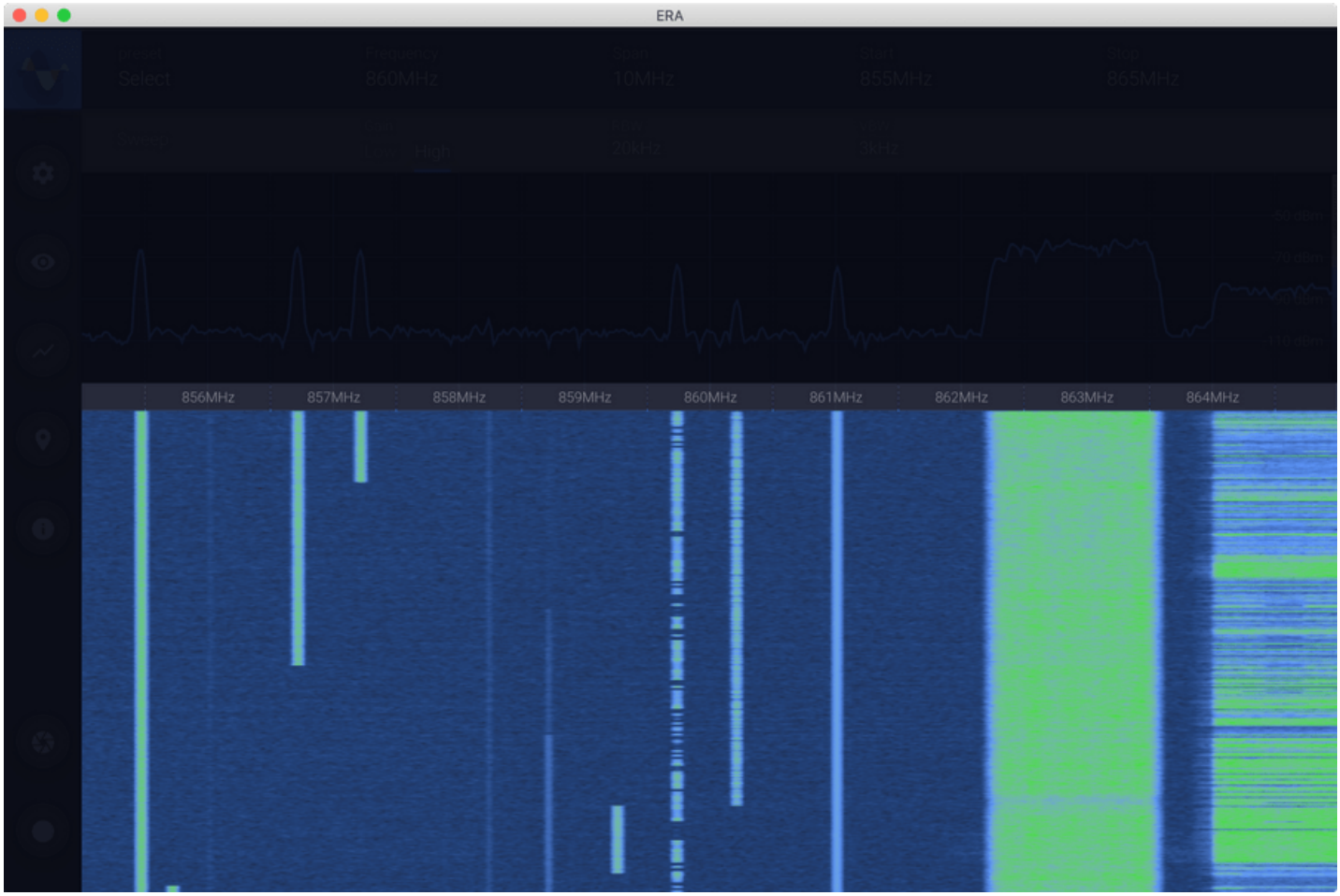


Figure 19: *Spectrum Waterfall Display*

You can see the color:power correspondence represented by the gradient to the right or the y-axis in the view of the live spectrum.

SIDEBAR

The Panel on the left of the screen provides additional information and actions.

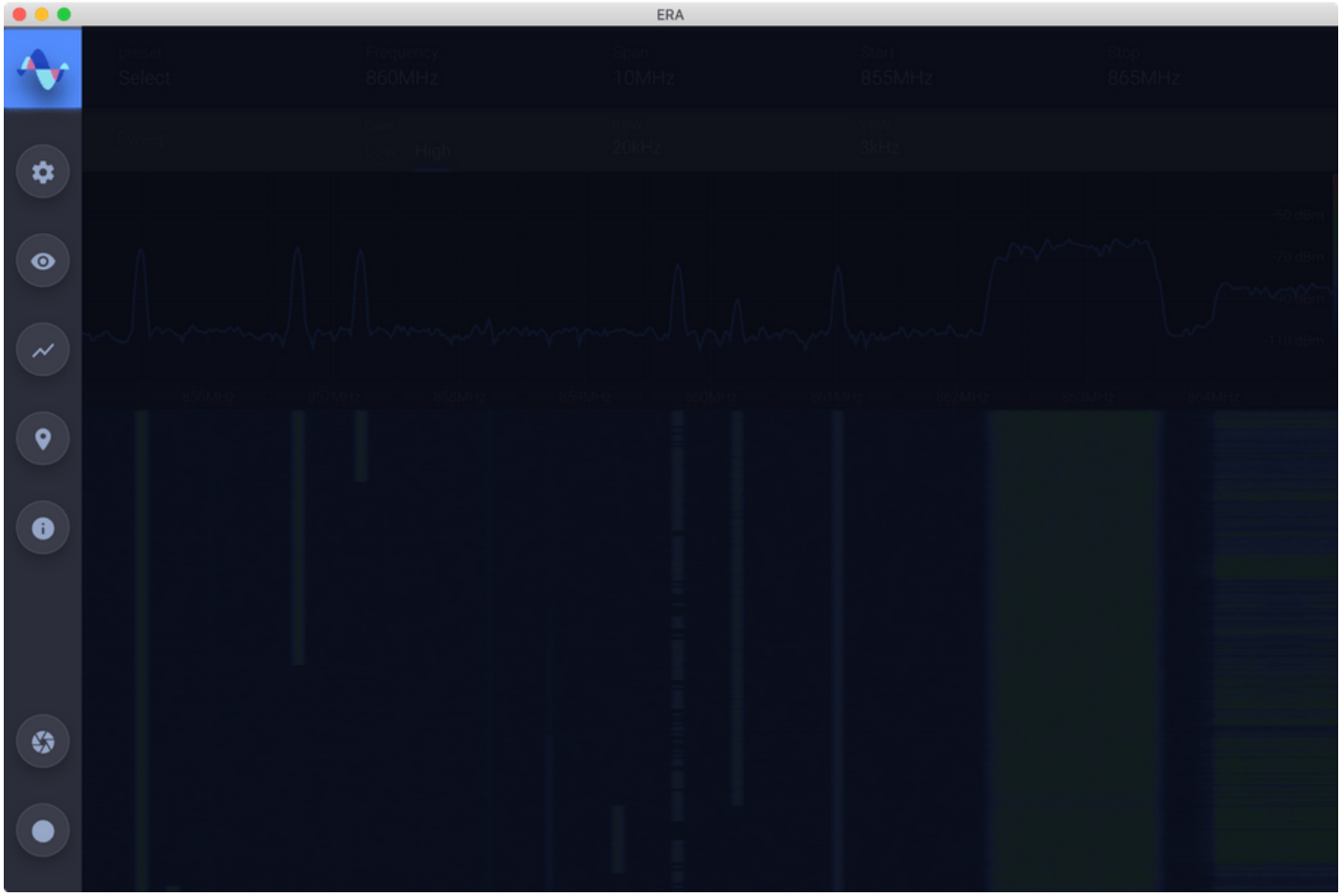


Figure 20: *Source Selector, Auxiliary Controls and Capture Buttons*

AUXILIARY CONTROLS

The Auxiliary Controls section contains additional parameters and information not displayed in the Primary Controls. Each section of the Auxiliary Controls will be covered later. Moving the mouse over the panel with the Auxiliary Control selectors will automatically show the last selected section. Clicking on one of the other section icons will show the controls for that section. Moving the mouse back into the Spectrum or the Waterfall section will automatically hide any Auxiliary Controls.

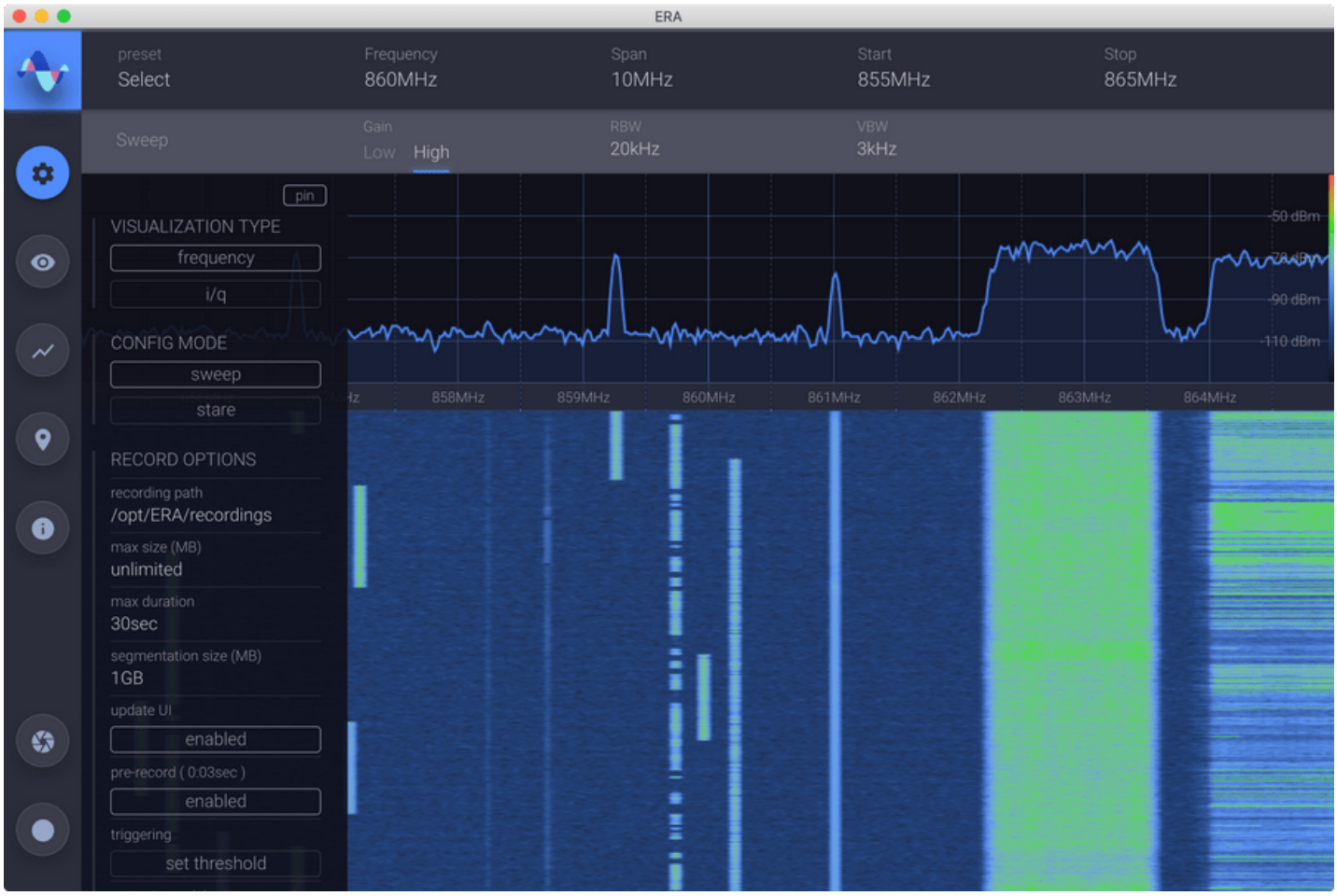


Figure 21: *Auxiliary Controls*

If you find that there are auxiliary controls that you often need and you don't want them to be hidden every time you move your mouse into the Spectrum area, you can use the *pin* toggle, which will cause the selected Auxiliary Controls to always be shown. When *pin* is enabled, the Spectrum area will also be resized so the auxiliary controls will not obscure the live spectrum.

TUNING THE RECEIVER

With a radio RX channel selected as the signal source, you can adjust the frequency and range of the section of spectrum you are viewing. The following fields will affect this viewing range:

Frequency

Sets the center frequency of the receiver.

Span

Sets the range of spectrum you are viewing.

Start

Sets the beginning frequency of the viewable range.

Stop

Sets the ending frequency of the viewable range.

Gain

The spectrum analyzer provides two gain settings: Low and High. Determining the best setting depends on the strength of the present signals. Use Low if the signal is causing the “overloaded” indicator to appear in the Spectrum Display.

USING FREQUENCY FIELDS

Number Entry

Any of the fields that allow you to edit a value representing a frequency can be used in the same way. Click on the current number to begin editing. When you begin typing, the current value will be shown crossed out, so you can confirm the change you are making before applying it. While editing a field, you can change the units to kHz, MHz or GHz, by pressing "k", "m" or "g" respectively. Pressing `Enter` will apply the value.

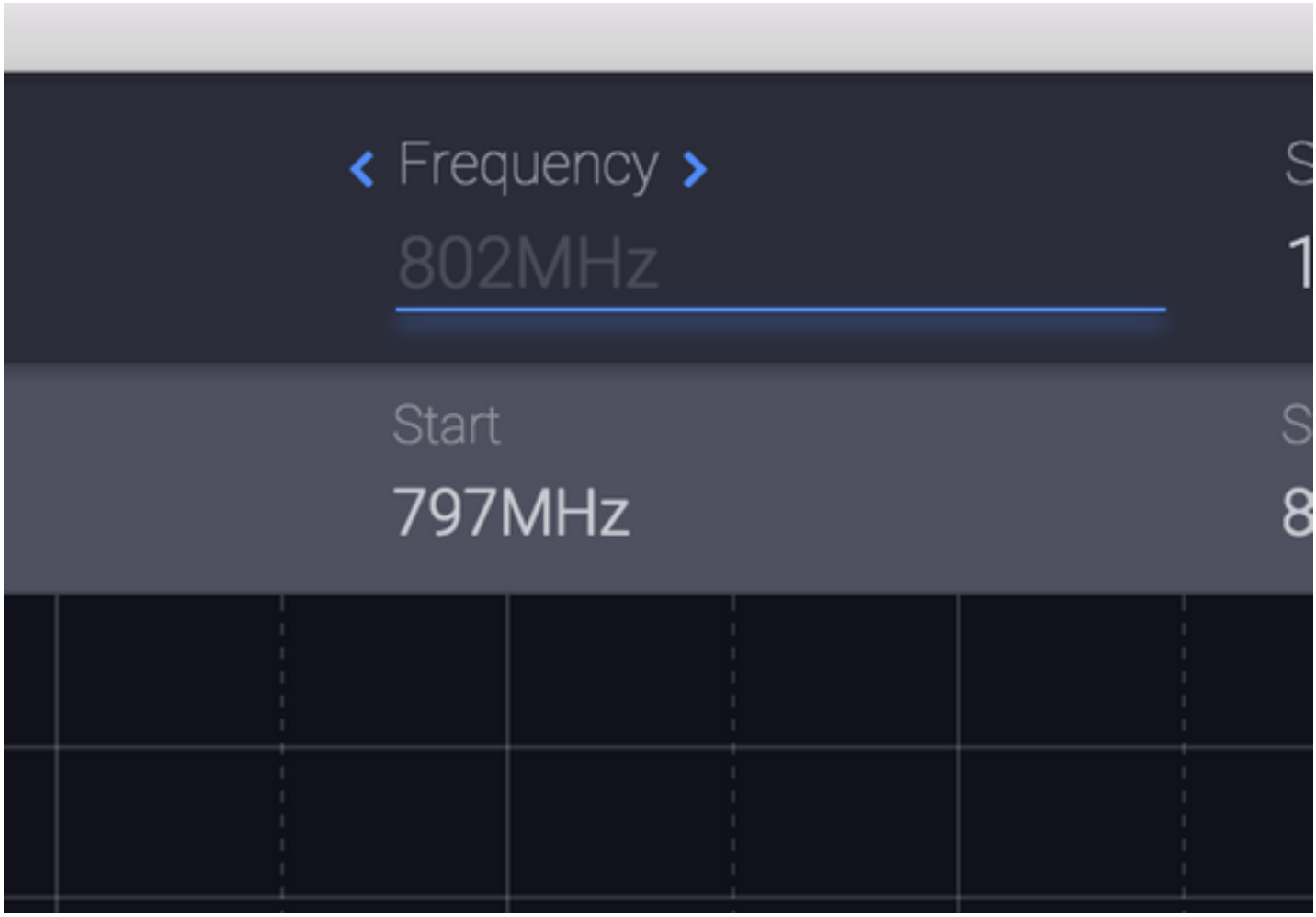


Figure 22: *Editing a Tuning Field*

Stepping

When you hover the mouse over any tuning field that is editable, two arrows will appear around the title of the field (e.g. < Span >). You can click these arrows to increase or decrease the current value by the step size specified by the **step** field. Additionally, after clicking on the current value of a frequency field, but before typing any values, you can use the **up** and **down** arrow keys to apply the same stepping function.

Resolution Bandwidth (RBW)

RBW indicates the frequency resolution of the Spectrum and Waterfall displays. For example, an RBW of 1kHz means that each point in the Spectrum display represents 1kHz. The spectrum analyzer automatically selects an RBW value depending on the user-configured “span”.

Video Bandwidth (VBW)

VBW emulates a low-pass filter found in traditional spectrum analyzers to smooth out the Spectrum display. A VBW value that is equivalent to the RBW value will result in no smoothing; the smoothing effect will increase as the VBW is set to lower values. It is possible to increase this smoothing effect to the extent that transient signals are difficult to detect in the Spectrum and Waterfall display; for

this reason, it is important to consider the characteristics of the signal of interest when setting this value.

RECEIVER CONFIGURATION

To see the effective configuration of the receiver, including the current sample rate, open the Additional Information Panel from the Sidebar.

Figure 23: *Additional Infomation Panel*

ADJUSTING THE SPECTRUM DISPLAY

Above, it was described how RBW and VBW affect the Spectrum and Waterfall displays. There are several other parameters which can be used to adjust these displays to better suit the signal you are analyzing. Most of these are accessible in the Display Settings panel. In this section, each of these parameters will be discussed.

Plot Range

The following parameters and operations can be used to set the range of the Spectrum Plot:

Fit to Signal

This button fits the minimum and maximum power values in the Spectrum Display to show the entire signal.

Reference Level

The maximum signal amplitude level displayed.

dB per Division

The Spectrum display has a set number of divisions (horizontal lines along the y-axis, 5 or 10) depending on the height of the Spectrum display. This field allows you to set the size of each division, which will affect the y-axis' range.

RF Loss Offset

This field allows you to specify the amount of source power loss if you know that there is a certain amount of attenuation resulting from your RF input configuration. A value of 3dB is interpreted as 3dB of loss. The Spectrum Display will be adjusted by the entered value.

Persistence

Color graded persistence can be added to the live spectrum view by toggling the enable button under "Persistence" in the Visual Configuration panel in the Auxiliary Controls.

Figure 24: *Persistence Enabled*

The color grading represents a histogram of the presence of a signal. This is particularly useful for bursty signals that may be difficult to see with the instantaneous trace alone.

Charge and Decay

Each pixel will "charge" from the background color to red as the signal is present. When a signal is no longer present in that space, the pixel will "decay" back to the background color. Charge and Decay are both configurable in the Visual Configuration panel of the Auxiliary Controls.

Waterfall Threshold

It is possible to change the color range for the waterfall display. In the waterfall display, the color changes based on the power level of the signal present at each point on the spectrum plot. Moving the mouse near the gradient scale to the left of the spectrum view will reveal two threshold lines which can be dragged to increase or decrease the dynamic range of the color grading in the waterfall. Placing the bottom threshold above the noise floor can be useful for removing noise from the waterfall display.

Color Theme

Several color theme alternatives are provided to suit any preference between a light & dark UI. Monochromatic themes are also provided to maximize contrast for challenging lighting conditions. Lite themes display on a white background, while dark themes display on a black background. The default lite and dark themes display color gradients from “cool” to “hot” (blue to red) to indicated degrees of signal intensity. An alternative “reversed” theme is also provided which displays color gradients from “poor” to “good” (red to green) to indicate degrees of signal intensity.

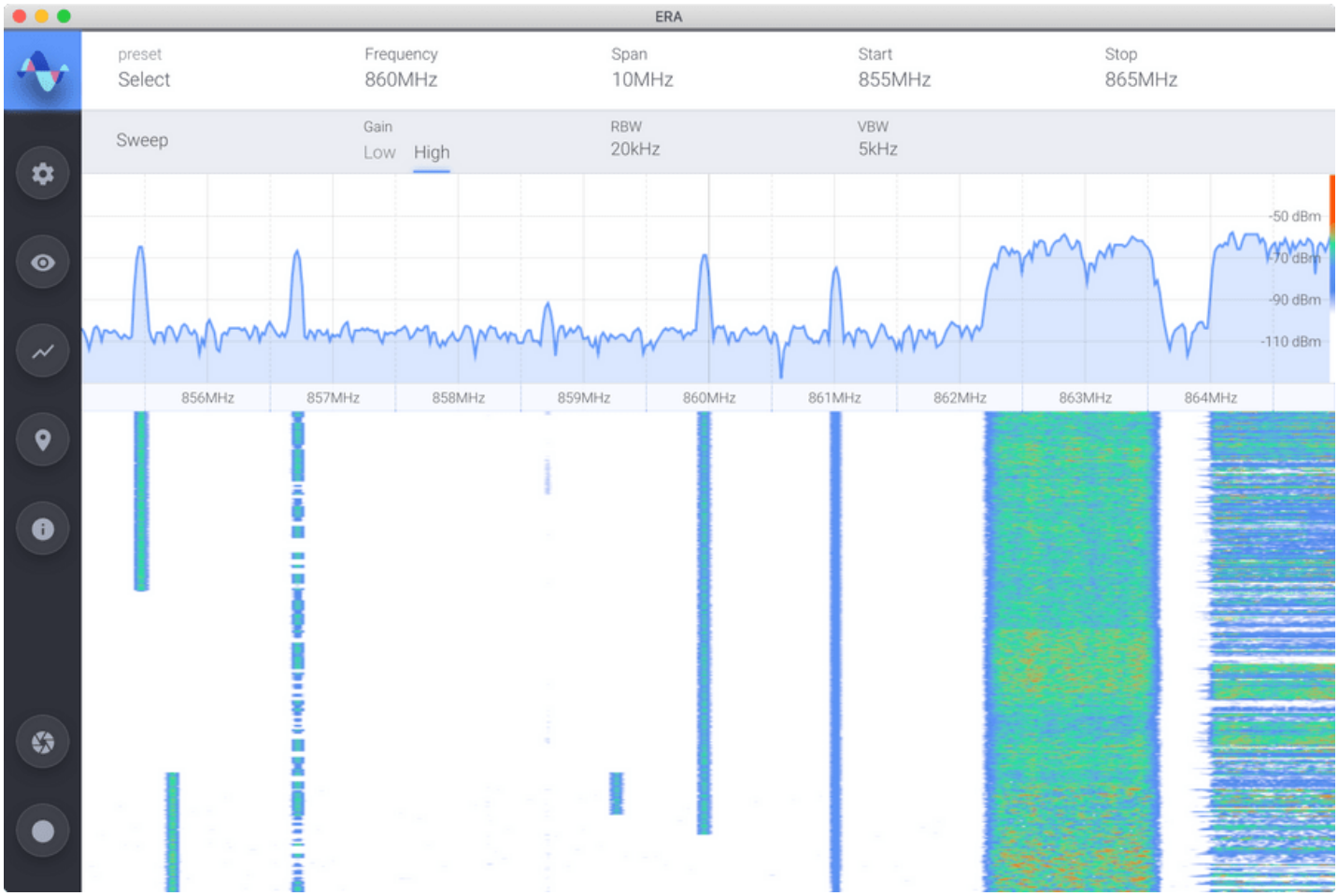


Figure 25: *Light Color Theme*

Pausing Live Spectrum

While the Waterfall Display shows a short history of measured activity within the selected spectrum, sometimes it may be useful to stop the Spectrum and Waterfall displays from updating so you can further investigate activity of interest. To do this, click the mouse anywhere in the Waterfall or press the Spacebar.

A pause icon will briefly appear over the Waterfall Display and if Persistence is enabled, it will not be visible while the live spectrum is paused. A limited trace history is kept and is reviewable while the Spectrum and Waterfall displays are paused.

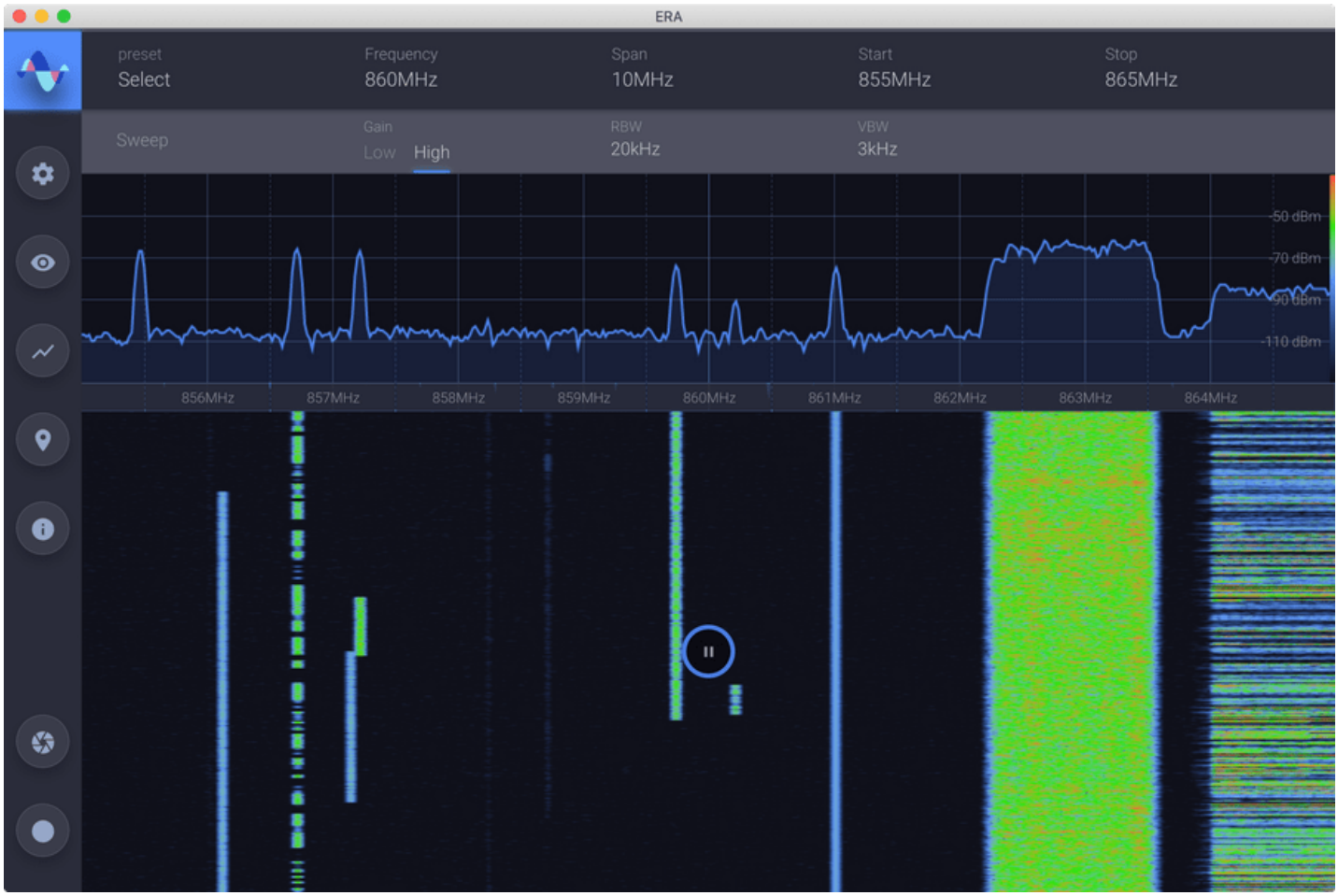


Figure 26: *Live Spectrum Paused*

Scroll Through the Waterfall

To step through the available history, you can use the up and down arrows on the keyboard. Pressing the keyboard arrow keys while holding down Shift will result in larger steps to allow you to seek through the history quicker. Additionally, mouse wheel or trackpad scrolling also works within the Waterfall Display.

To resume Spectrum and Waterfall display updates, click again in the Waterfall Display or press the Spacebar again. Any activity that occurred during the time the displays were paused will be lost.

USING TRACES

There are several available types of traces that can be displayed in the Spectrum Plot. The settings for these traces can be accessed in the Traces panel of the Auxiliary Controls.

current

This trace represents the most recent power measurement. It is always visible, as long as Persistence is not enabled.

min

This is a min-hold trace, which will draw a line representing the minimum power measurement at each of the plot’s points since the last time it was reset or the receiver configuration changed.

max

This is a max-hold trace, which will draw a line representing the maximum power measurement at each of the plot’s points since the last time it was reset or the receiver configuration changed.

user

It is also possible to save an instant of one of the above traces for later recall to the screen. To save a trace, open the Trace panel and select “create new” under “user trace”. The plot will automatically pause and you may scroll through the available history, as described in Scrolling Through the Waterfall, to choose the desired instant of the current trace. Alternatively, selecting “Max Hold” or “Min Hold” in the Primary Controls section will cause the Spectrum Display to resume updating, displaying the appropriate trace. Once the desired trace is displayed on the screen, press “save” in the Primary Controls to apply the selection. The newly created user-trace will be displayed on the screen and highlighted in the Auxiliary Controls panel.

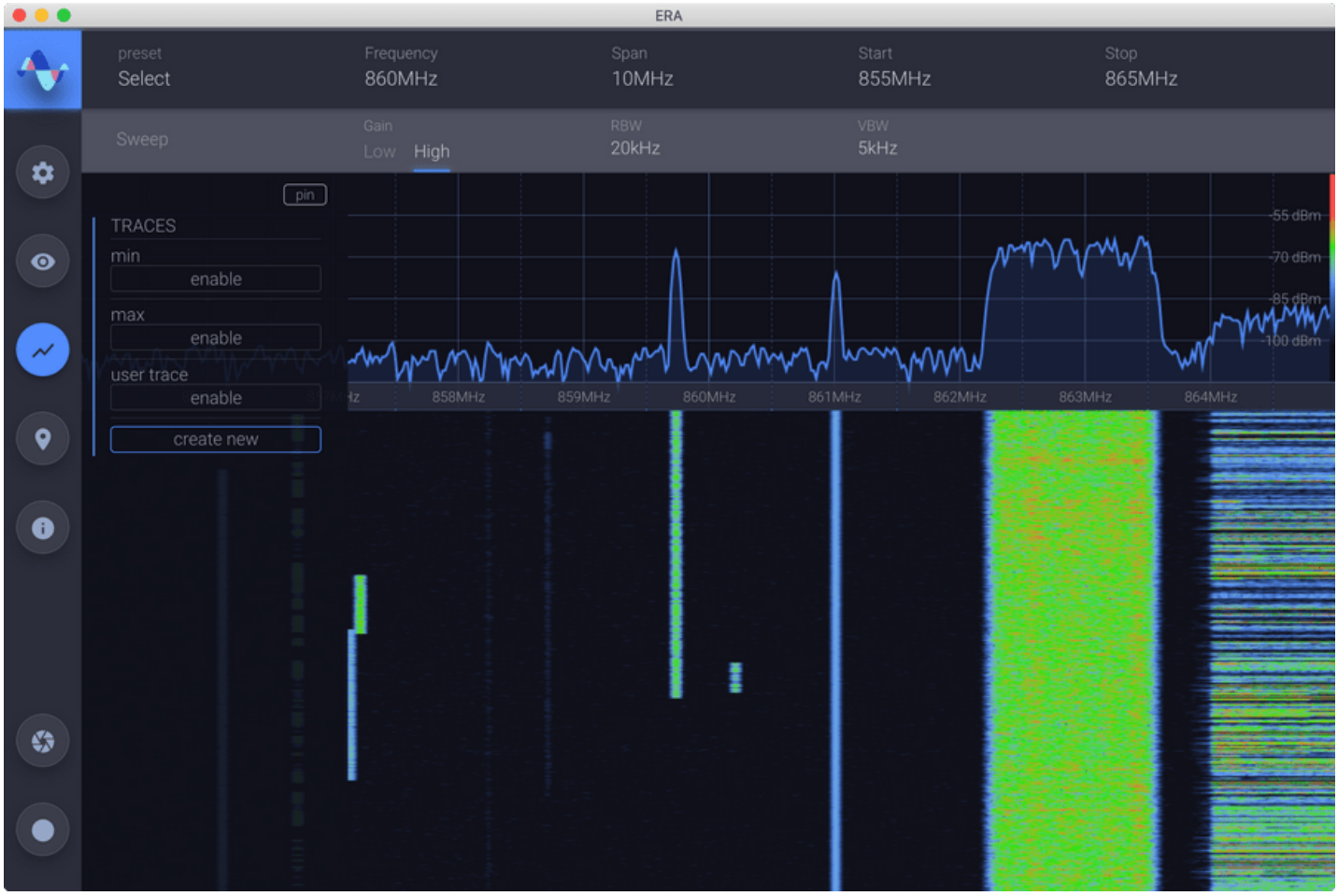


Figure 27: *Create a New Trace*

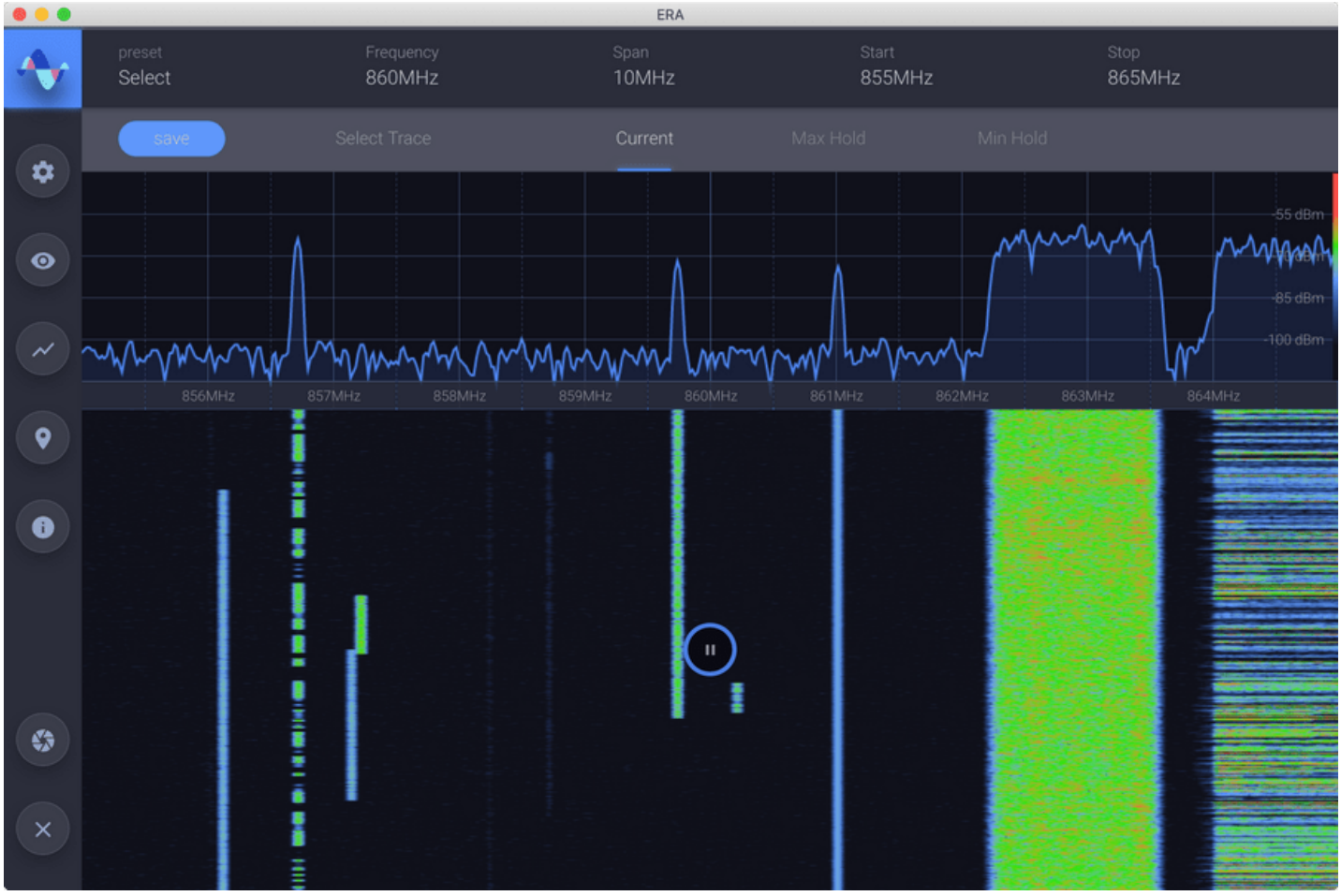


Figure 28: *Choose a New Trace*

You may recall any previously stored trace here by selecting the ‘enable’ option, which will list previously saved traces. User-traces that were made while tuned to a different frequency will be labeled with the warning “will cause the radio to retune”; selecting one of these marked user-traces will result in a radio configuration matching the frequency and span at the time in which they were created.

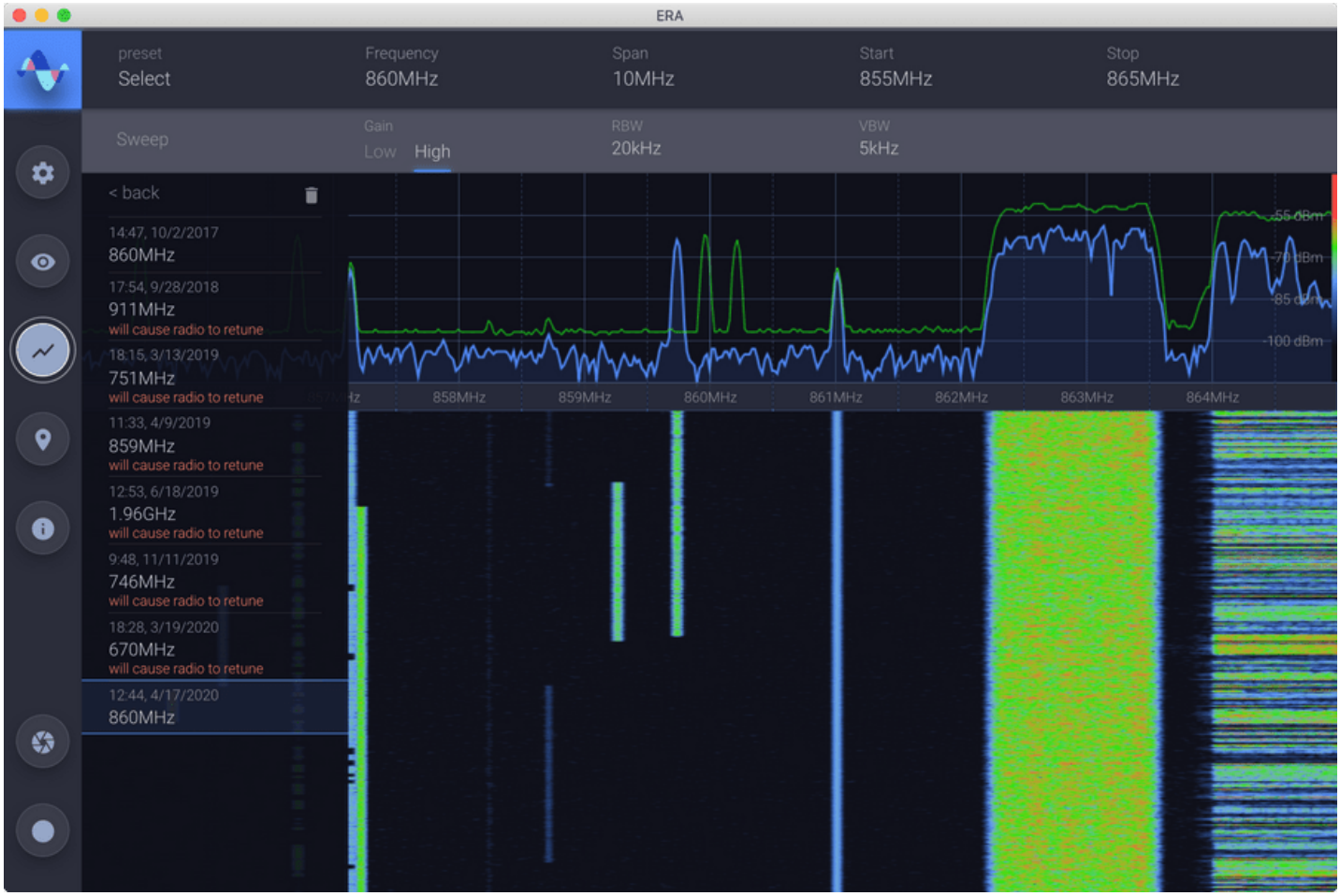


Figure 29: *List of Saved Trace*

To delete a user-trace, press the delete icon, then select the traces which are no longer needed.

USING MARKERS

Adding a Marker

You can add a marker to the spectrum view by clicking on the plot. The marker will be “snapped” to the nearest frequency determined by the current RBW. While you hover the mouse over a marker, information about that marker will appear at the bottom right of the screen over the waterfall. This is meant as a quick way to access the frequency and delta (if any) of a single marker.

Figure 30: *Marker added*

While hovering the mouse over a marker, information about that marker will appear at the bottom right of the screen, over the waterfall. This is meant as a quick way to access the frequency and delta (if any) of a single marker.

Adding a Delta Marker

To add a delta marker to an existing marker, simply select and type a delta value into the "delta" field in the panel at the lower right corner of the screen when a marker is highlighted. Hit enter will apply the delta and it will appear in the spectrum plot. With a delta set for a marker, the differences in frequency and power to be displayed as well as the power between the two points.

Moving a Marker

There are several ways to move a marker. You can grab the marker with the mouse and drag it to the desired position on the plot. Again, this will "snap" to frequency values based on the "Step" size. Dragging the marker will more the marker and its delta, while dragging the delta will move only the delta. Editing the frequency and delta fields in the panel at the bottom right of the screen will move the marker and delta, respectively. The "stepping" functionality described in the Tuning the Receiver section is also available for these fields.

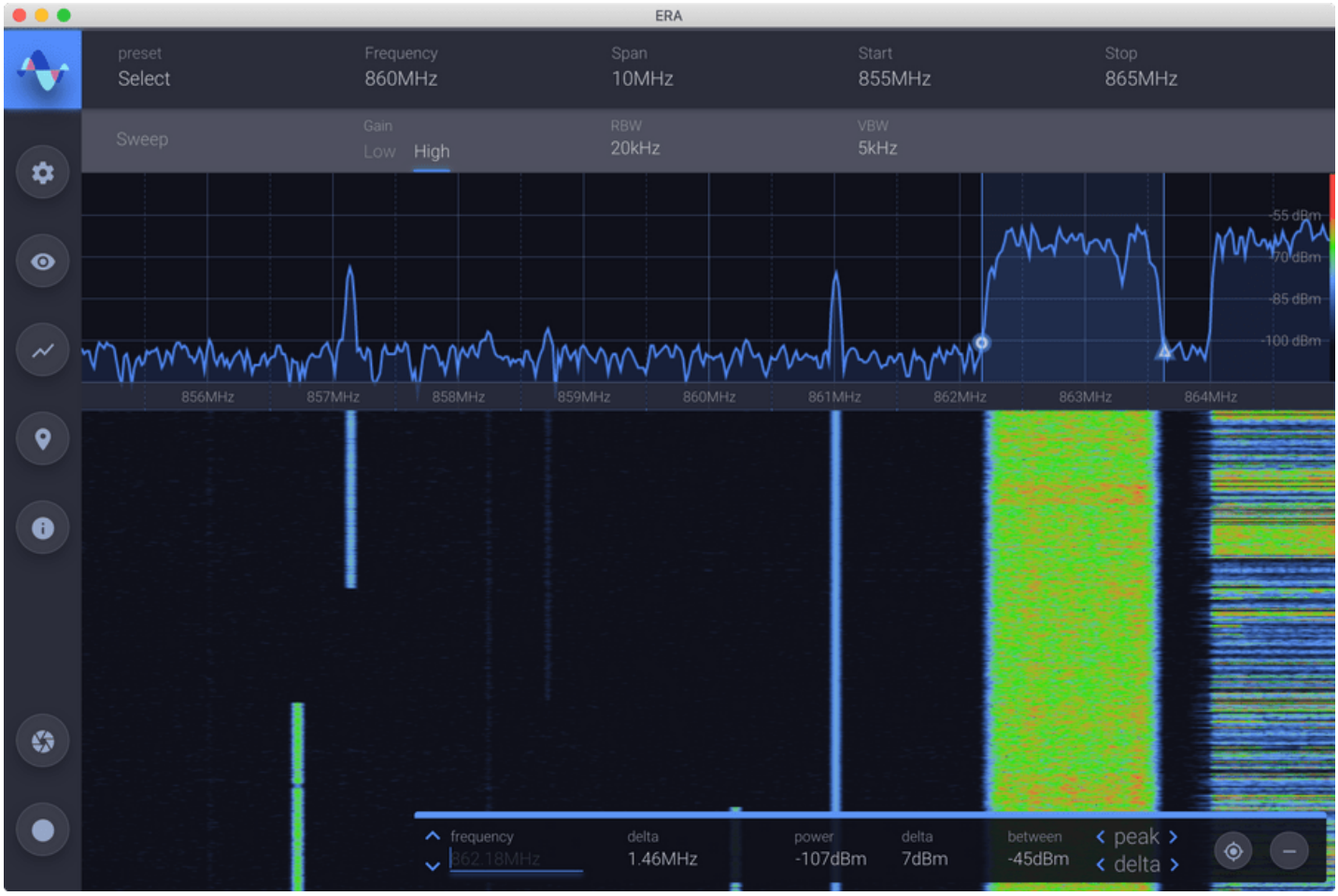


Figure 31: *Editing a Marker*

All markers and their delta values are also accessible in the Markers Auxiliary Controls. These values can be edited from here, as well.

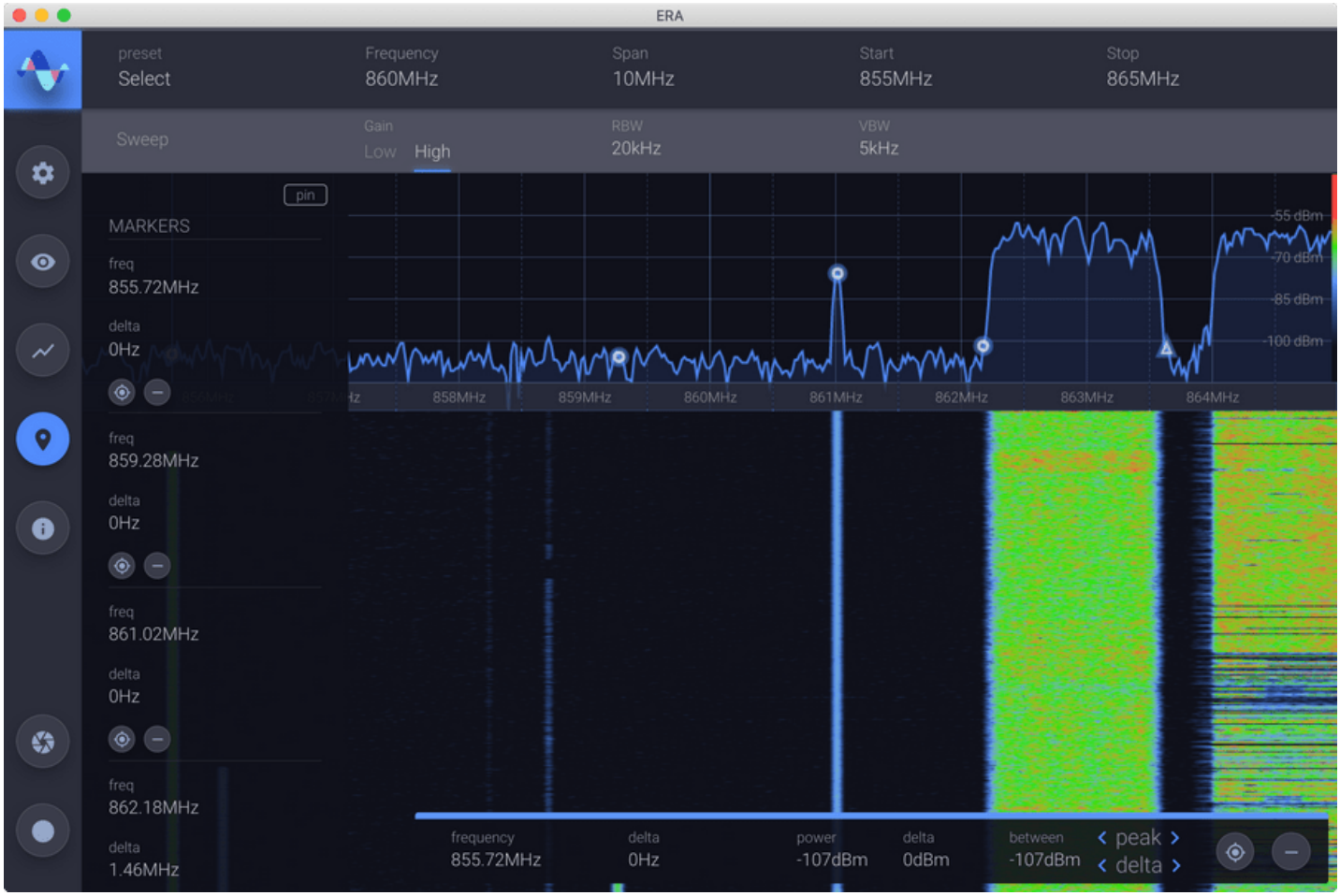


Figure 32: *Marker List*

Moving a Marker to the Nearest Peak

When a marker is highlighted, at the bottom right of the screen, there are arrows for moving the marker and its delta to the nearest peaks to the left or right of their current positions.

Removing a Marker

There are several ways to remove a marker. Grabbing a marker and dragging it into the waterfall area will make the marker appear red. Release the mouse while it is red will remove the selected marker. Also, while a marker is highlighted, pressing the remove button at the bottom right of the screen will remove the marker. Finally, a remove button is provided for each marker in the Visual Configuration panel of the Auxiliary Controls.

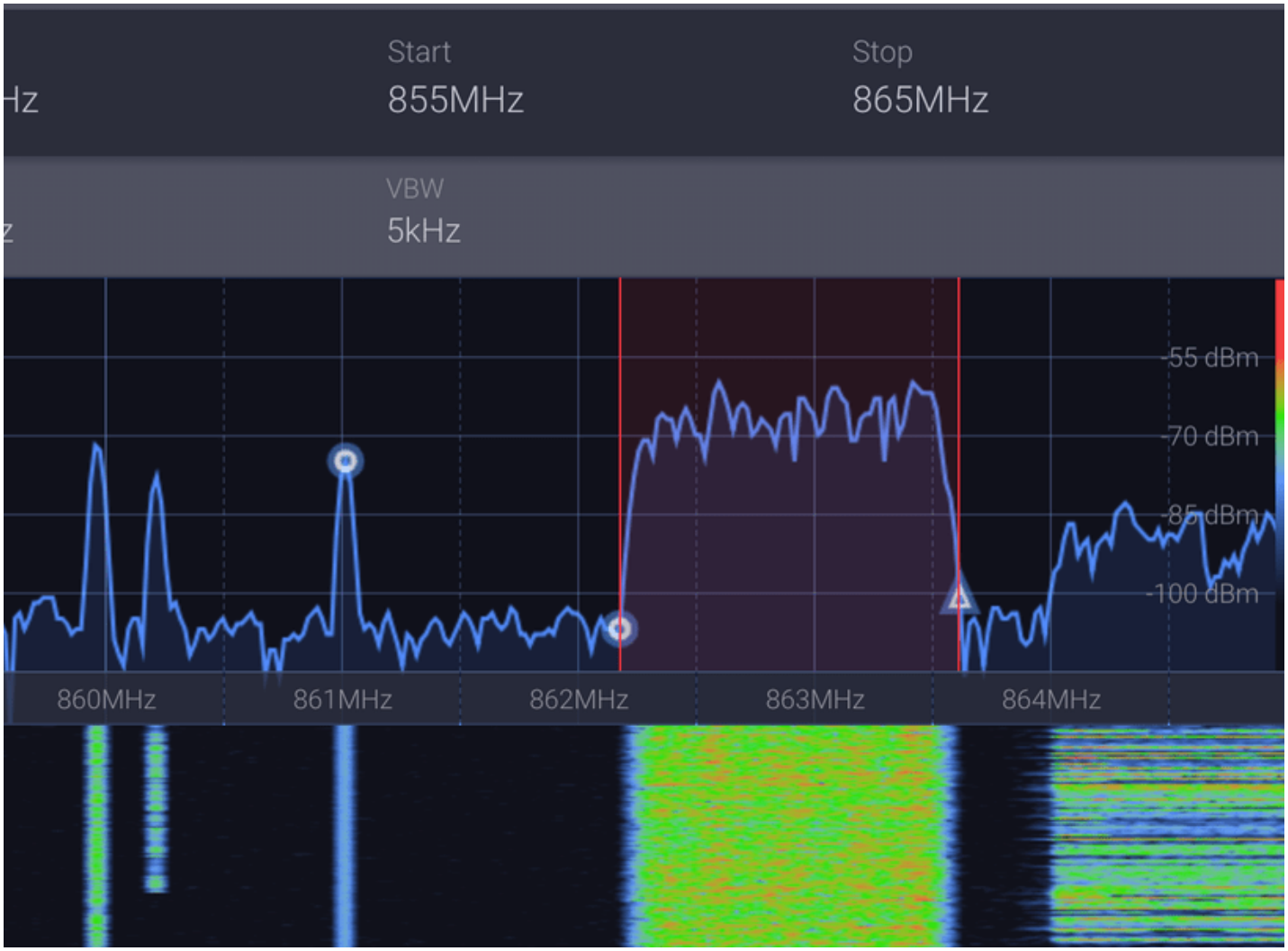


Figure 33: *Removing a Marker*

Centering the Receiver on a Marker

The panel at the bottom right and the Visual Configuration panel of the Auxiliary Controls also provide a "center" button which will cause the radio receiver to center on the marker and its delta (if any). This can be useful for jumping between marked frequencies.

SWITCHING TO THE PCI SCANNER

To return to the PCI scanner from the spectrum analyzer, select "PCI Scanner" from the information menu.

Figure 34: *Switching to PCI Scanner*

APPENDIX A - SOFTWARE UPDATES

The PRiSM application is updated by installing a single software package file (`.ipk`). There are two methods for installing the software package:

1. Web Browser - uploading the package with the Admin Web UI (requires that your current PRiSM version is `v1.3.0` or newer)
2. Manually - opening an `ssh` session to the PRiSM sensor.

SOFTWARE UPDATE IN THE WEB BROWSER

> **NOTE**: This requires that your current PRiSM version is `v1.3.0` or newer

OPEN THE ADMIN PAGE IN YOUR WEB BROWSER

Connect the PRiSM sensor to the computer from which you would like to perform the update. Make sure you have downloaded the software package file. Enter the PRiSM sensor's address in your browser's address bar:

```
http://192.168.3.1
```

You should see the PRiSM splash screen. Press the `Admin` button.

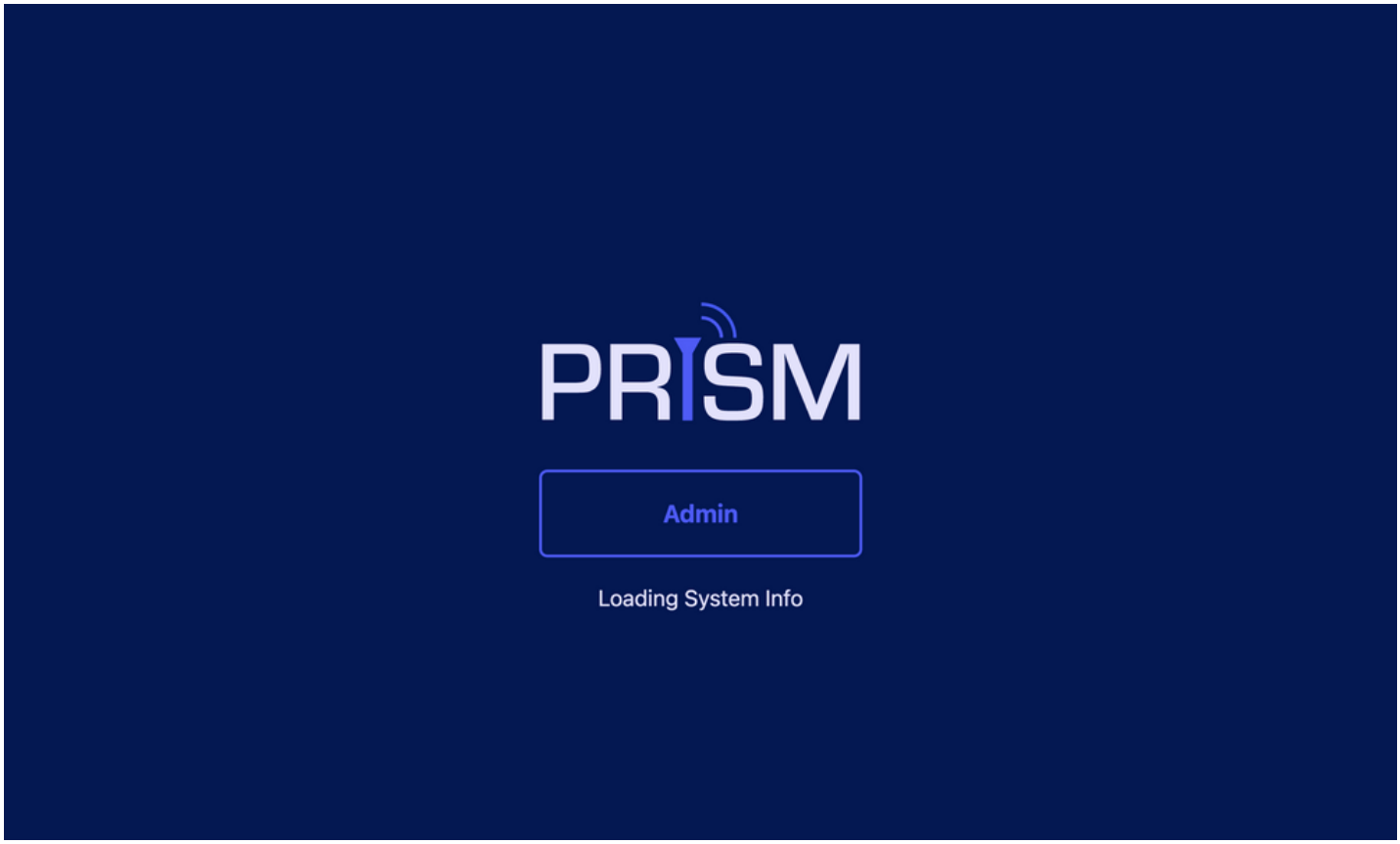


Figure 35: *Navigate to the Admin page*

LOGIN TO THE ADMIN PAGE

After pressing the `Admin` button, you should see a loading screen.

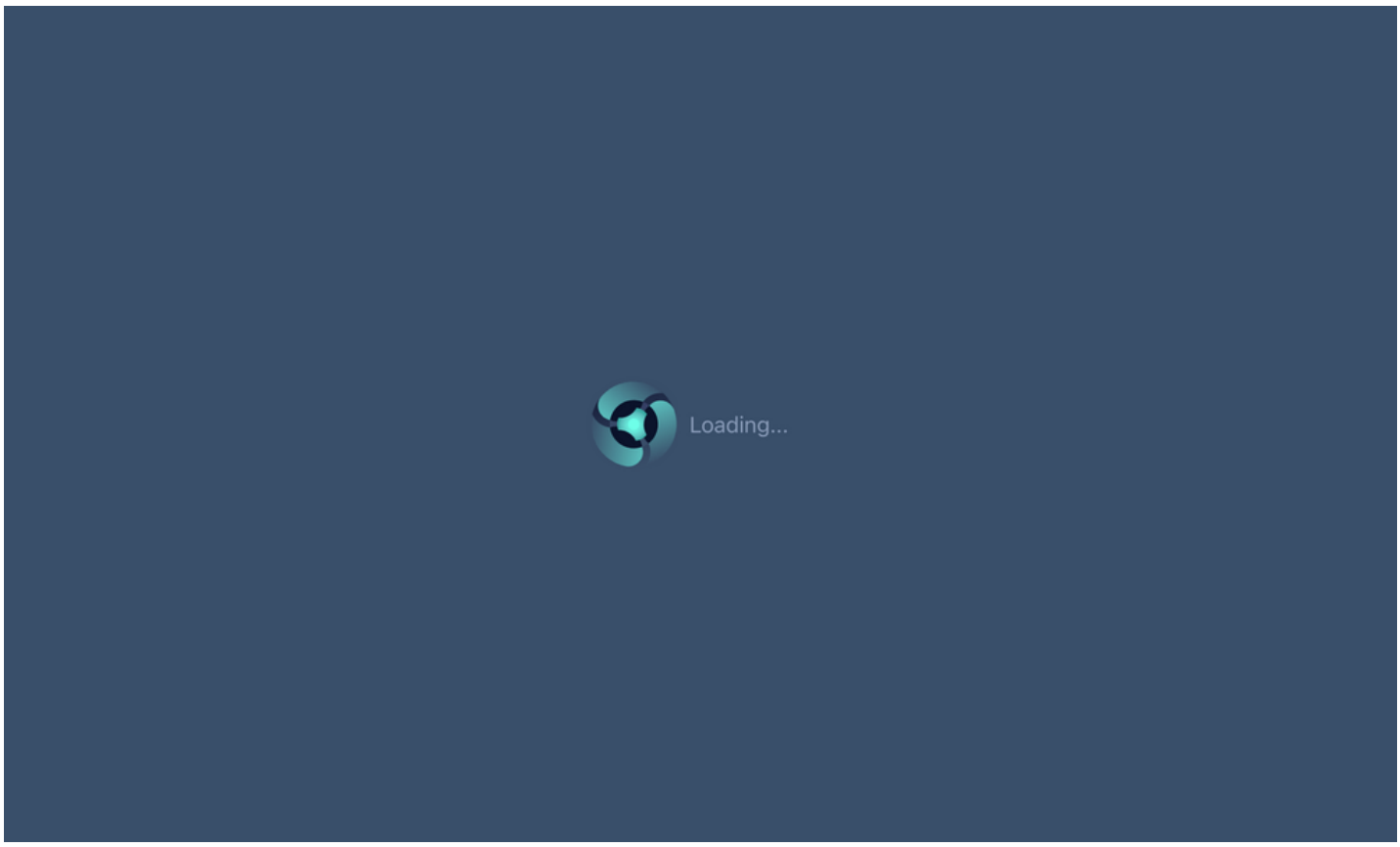


Figure 36: *EMP loading screen*

After a moment, you will be presented with a login screen. The default password is `epiq`. Type the password and press the `Login` button.

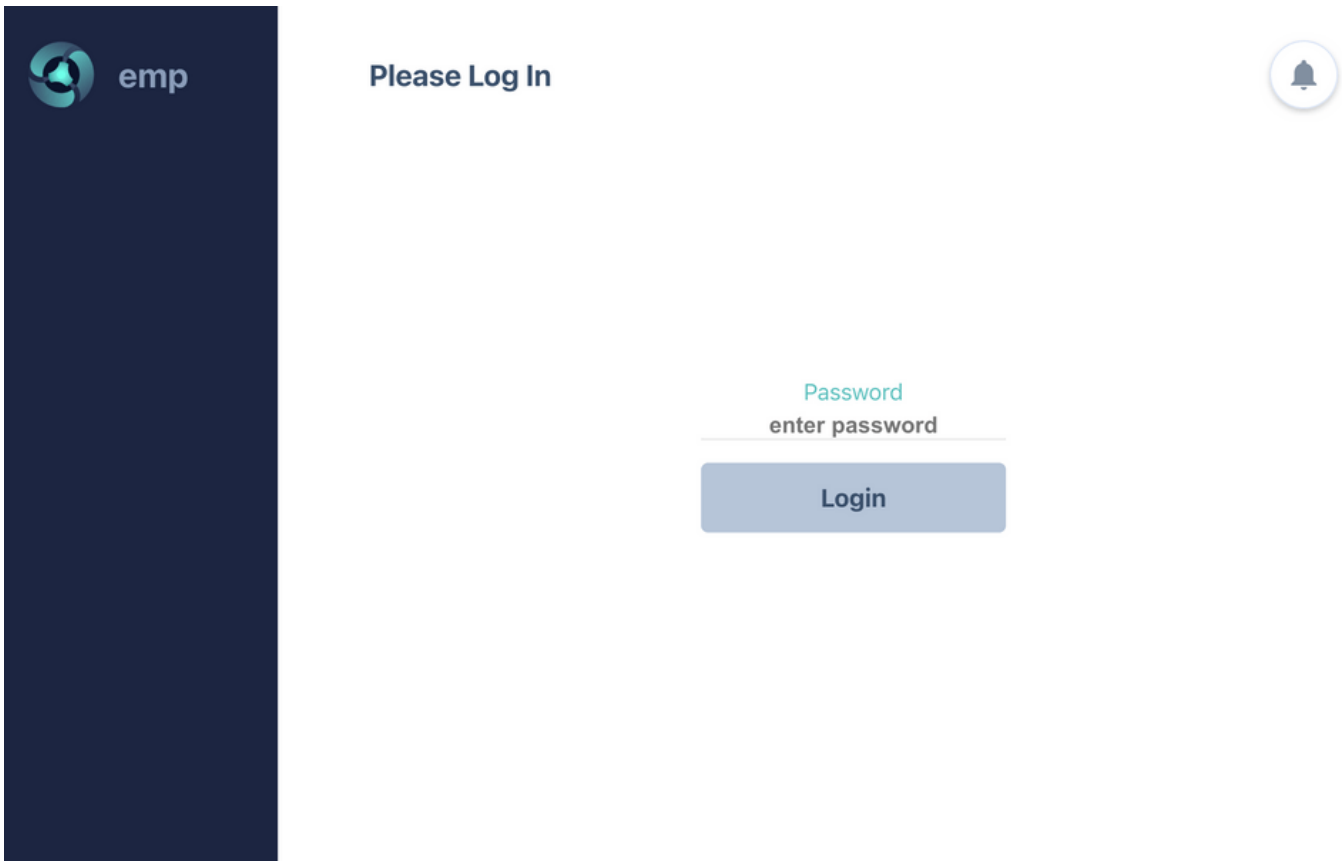


Figure 37: *EMP Login screen*

UPLOAD THE SOFTWARE PACKAGE

From the Admin dashboard, press the `New Package` button.

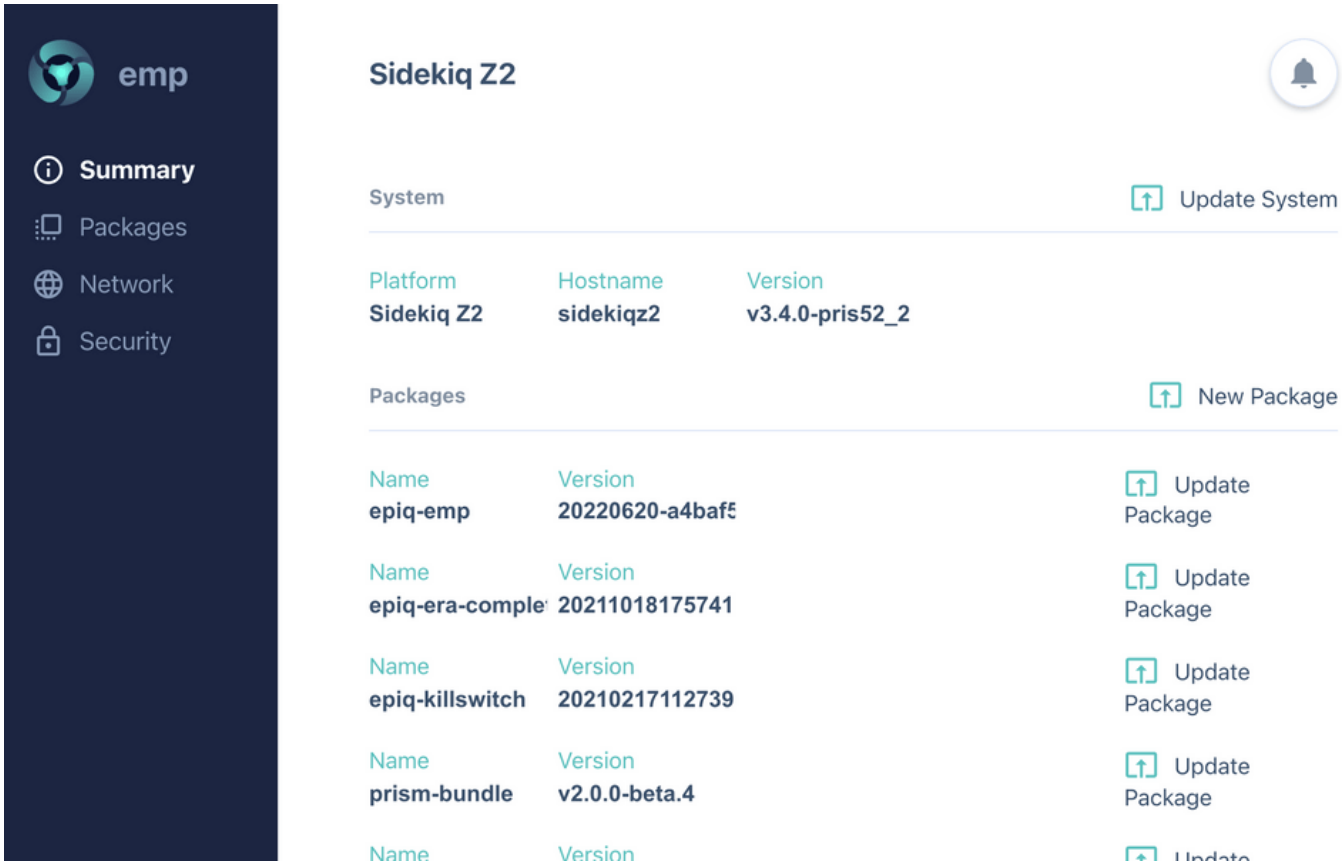


Figure 38: *Admin dashboard*

The browser will open your native file browser; choose the software package.

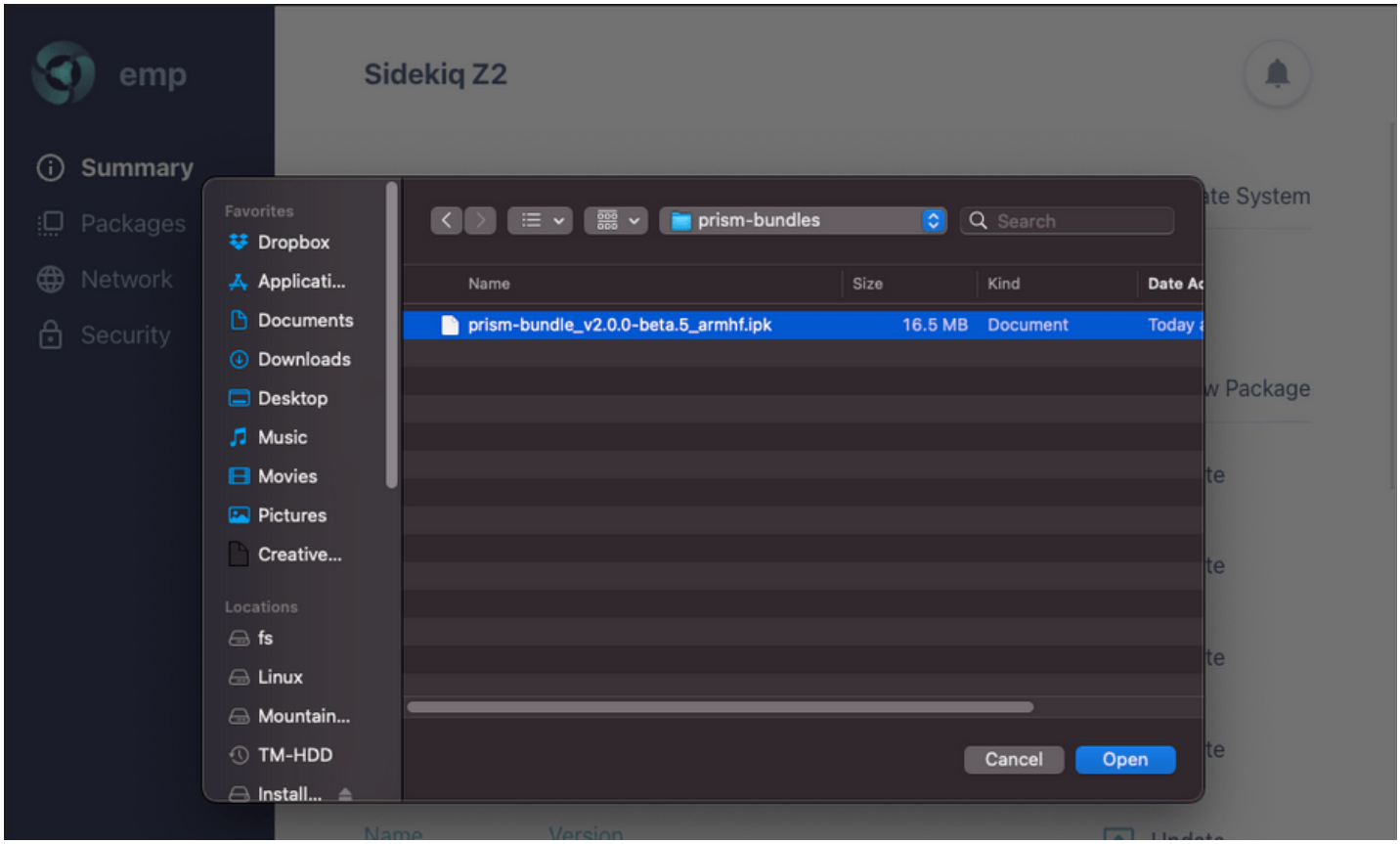


Figure 39: *File Browser*

Once the package has been selected, confirm that you are ready to update the software.

Figure 40: *Confirm Installation*

WAIT FOR UPDATE TO COMPLETE

This process takes several minutes. During most of the update time, you will see a "loading..." screen

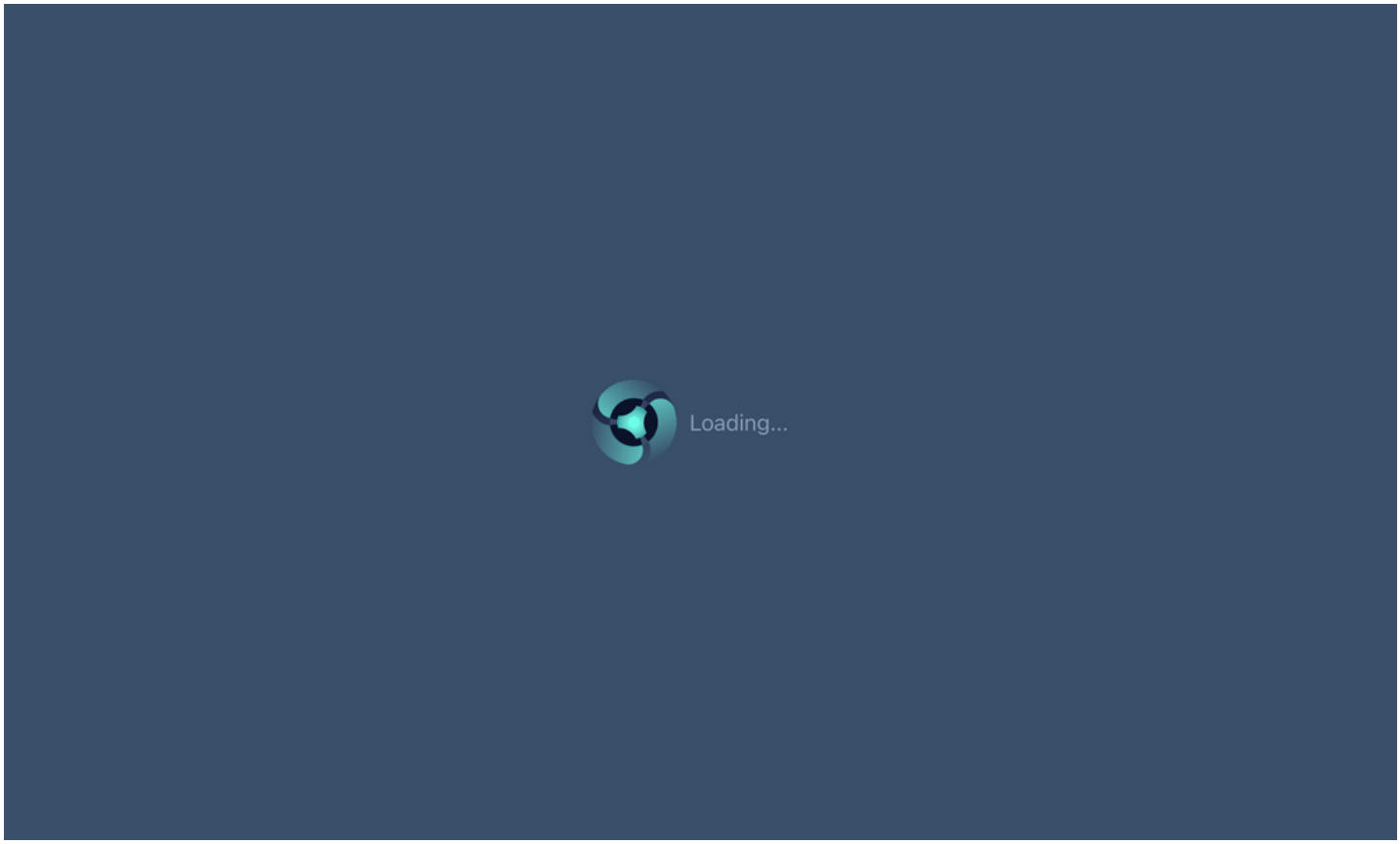


Figure 41: *EMP loading screen*

Do not disconnect the PRiSM sensor or refresh the browser while the update is in progress. When the update is wrapping up, you will briefly see the following screen:

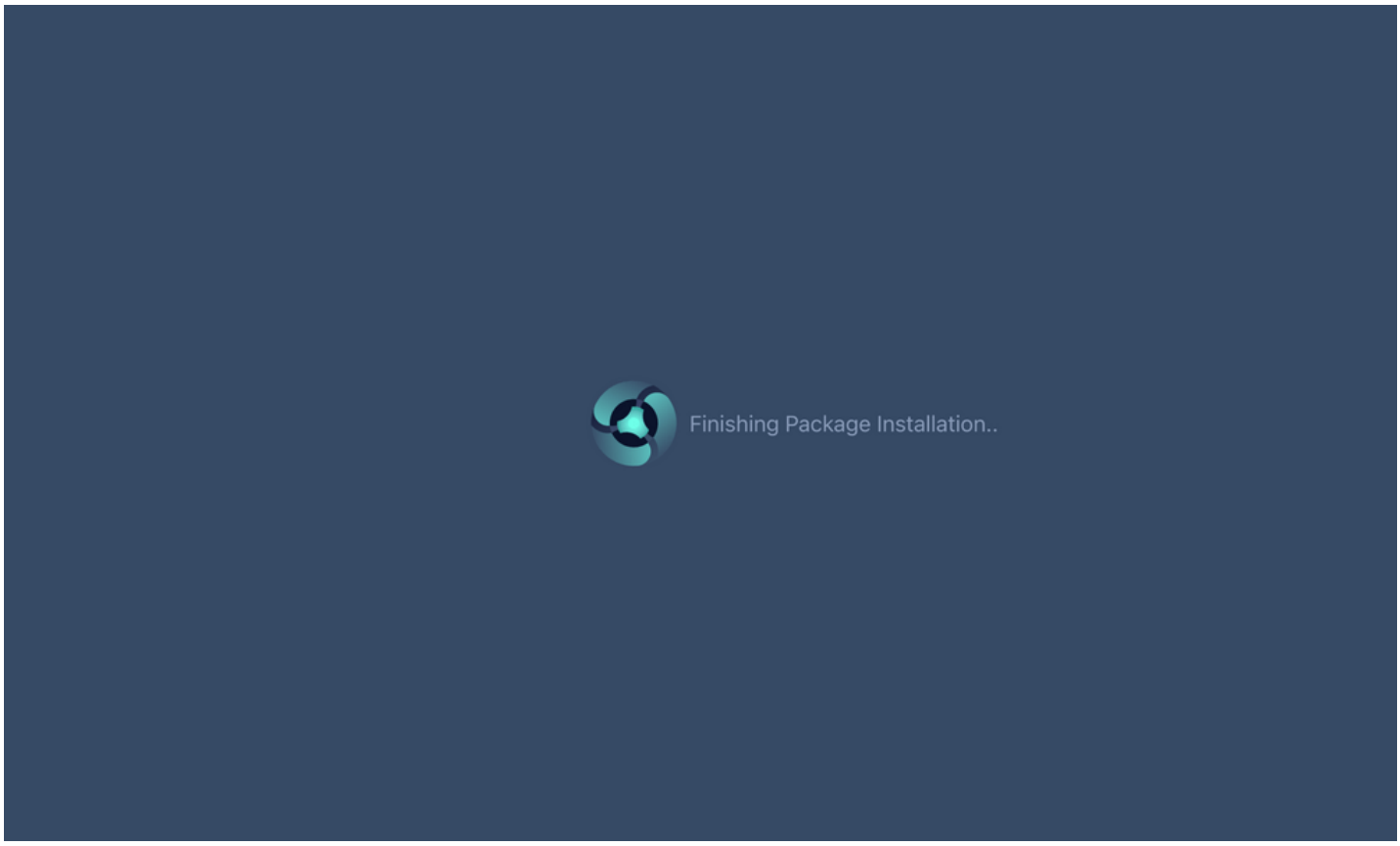


Figure 42: *Update almost complete*

When the update has successfully completed, you will be returned to the Admin dashboard.

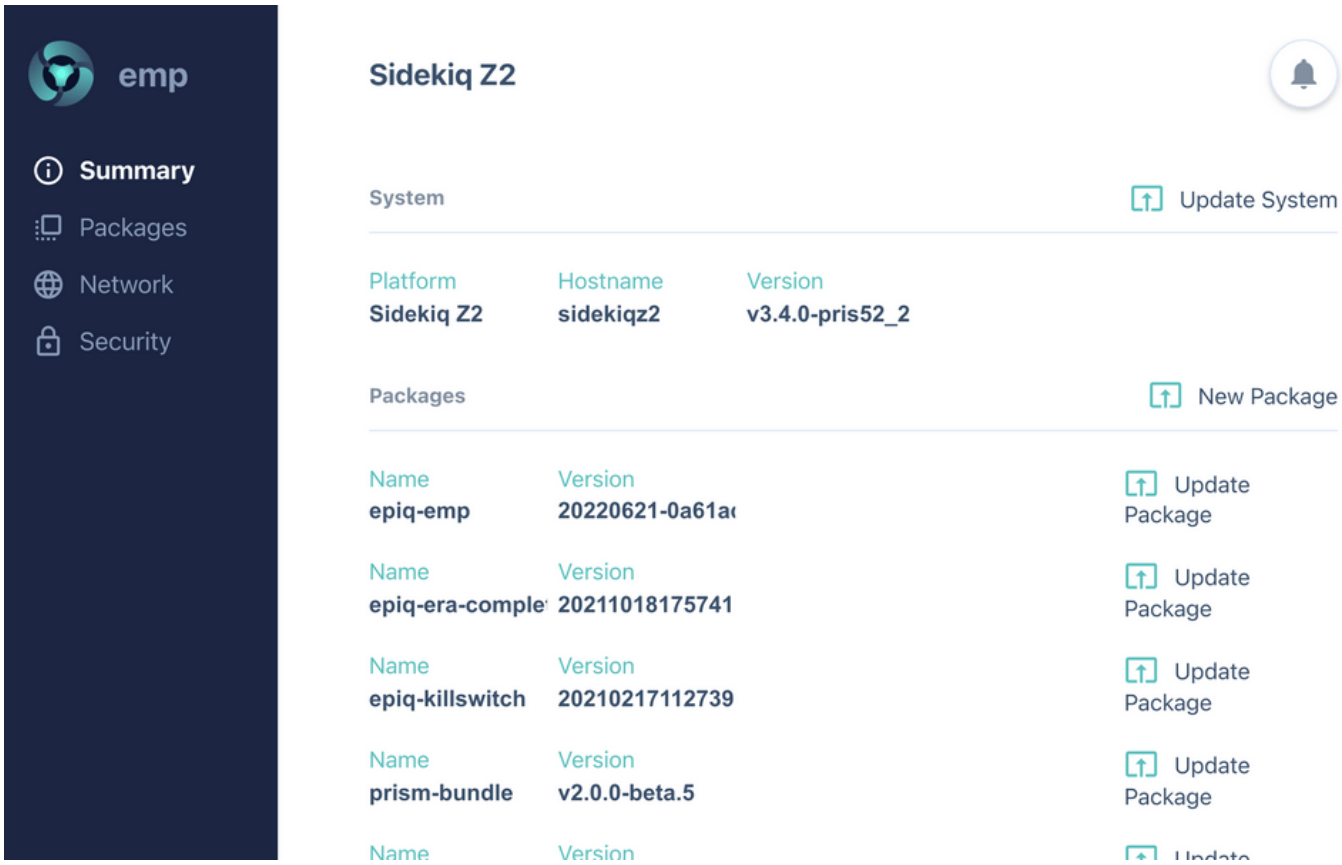


Figure 43: *Admin dashboard*

REBOOT

Finally, to make the update fully take effect, reboot the PRiSM sensor, by unplugging it from the USB port, waiting 10 seconds, and plugging it back in.

MANUAL SOFTWARE UPDATE

> **NOTE**: The following steps should be very similar from both Linux, MacOS and Windows 10 machines. In Linux or MacOS, use a Terminal application. In Windows use PowerShell.

Connect the PRiSM sensor to the computer from which you would like to perform the update. Make sure you have downloaded the software package file. With the command line application appropriate to your host machine, perform the following steps:

COPY THE PACKAGE FILE TO THE PRISM SENSOR

Copy the software package file to the PRiSM sensor with `scp`

```
scp <path-to-directory>prism-bundle_v2.0.0_armhf.ipk root@192.168.3.1:/tmp/
```

Where `<path-to-directory>` is the path to the directory/folder holding the PRiSM software package.

LOG IN TO THE PRISM SENSOR

Open an `ssh` session to the PRiSM sensor

```
ssh root@192.168.3.1
```

The default password is `epiq`. Type the password and hit `Enter`.

> **NOTE**: The system will not provide any feedback as you type the password.

> **NOTE**: You may be asked to verify the host. Type `yes` and hit `Enter`, if prompted.

> **NOTE**: If you have previously used `ssh` with a different PRiSM sensor, your terminal application may warn that something has changed and reference a line number in your `.ssh/known_hosts` file. The line number in the referenced file needs to be removed before you try again. Open the file in a text editor and remove the referenced line, then try `ssh` again.

Upon successful login, you will see the following on your screen:

```
    === Sidekiq Z2 ===
 === Release v3.4.0-pris52_2 ===

root@sidekiqz2:~#
```

INSTALL THE SOFTWARE PACKAGE

Once logged into the PRiSM sensor, install the package, by running the following:

```
opkg install /tmp/prism-bundle_v2.0.0_armhf.ipk
```

The installation will take a few minutes to complete. Please do not unplug the sensor while the upgrade is in progress.

REBOOT THE PRISM SENSOR

Reboot the system and exit the `ssh` session by entering the following:

```
/sbin/reboot & exit
```