Epiq™ ERA

RF Sensing • Spectrum Analysis

USER MANUAL

V5.14.0 - APRIL 16, 2020

CHANGELOG

Revision	Date	Description	Author
5.14.0	2020-04-16	Recording Import	SS
1.2.0	2017-11-02		SS
1.1.0	2017-09-07		SS
1.0.0	2016-12-05	Initial Release	SS

TABLE OF CONTENTS

INTRODUCTION

The Epiq Radio Analyzer (ERA) is an application that controls an Epiq radio, providing the following primary features:

- Realtime view of RF spectrum

- Radio frequency, sample rate, and filtering configuration

- Recording of signals in the Time or frequency domain (*Pro License Feature*)

- Playback of signal recordings

INSTALLATION

ERA is officially supported on Ubuntu 14.04 and 16.04. ERA is untested on other Linux distributions. For best recording results, use an ext3 or ext4 filesystem.

This guide assumes that you already have an ERA installer software package for the target platform in your possession; if that is not the case, please contact Epiq Solutions: https://epiqsolutions.com/support/index.php

LINUX

To install or upgrade ERA on Ubuntu, double click on the provided Debian package and follow the instructions.

Alternatively, open a terminal and type:

```
sudo dpkg -i <path/to/package/>epiq-era<version>.deb
```

You can find the ERA Spectrum Analyzer in the Applications section of the Ubuntu Home Button; alternately, the startup script `/usr/bin/startEra.sh` may be run from a terminal window.

MATCHSTIQ™

Please ensure that your Matchstiq is running the latest System Software, which may also be found on the Support Forums: https://epiqsolutions.com/support/index.php?f=260

COPYING FILES TO MATCHSTIQ

Matchstiq uses the SCP (Secure Copy) protocol to transfer files to and from the unit. Depending on your operating system, this can be done one of several ways:

Linux / MacOS

In a terminal window enter the following command:

```
scp <filename> root@<Device's IP address>:/tmp
```

Windows

Download and install WinSCP. Open WinSCP and connect to the Matchstiq's IP address using the username `root`. Copy the desired file to the `/tmp` directory.

LOGGING INTO A SHELL ON MATCHSTIQ

Matchstiq uses use the SSH (Secure Shell) protocol to provide command shell access to the unit. Generally, the unit's default login credentials use the username `root` with the password `root`. Depending on your operating system, a connection can be established:

Linux / MacOS

In a terminal window enter the following command:

```
ssh root@<Device's IP address>
```

Windows

Download and install PuTTY. Open PuTTY and connect to the Matchstiq's IP address using the username `root`.

INSTALLING ERA ON MATCHSTIQ

To install the ERA package, please choose one of the two below methods:

Using the command line

1. Transfer the install package to the Matchstiq via SCP:

```
scp epiq-era-<version>.ipk root@<Matchstiq's IP address>:/tmp/
```

2. Connect to the Matchstiq via SSH:

```
ssh root@<Matchstiq's IP address>
```

3. Install the Package:

```
dpkg -i /tmp/epiq-era-<version>.ipk
```

Using the Matchstiq Updater

Download the Matchstiq Updater (from this post on the Epiq Solutions Support Forums)

To start the Updater, uncompress the Matchstiq Updater and run matchstiq-updater (for Linux/MacOS) or matchstiq-update.exe (for Windows); if you're running MacOS, you may need to install a Java Runtime Environment (JRE) first (see http://www.oracle.com/technet-work/java/javase/downloads/jre8-downloads-2133155.html).

Instructions to use the Updater to install the updated ERA can be found in the PDF `Installing_ERA_on_S10_Using_Matchstiq_Updater.pdf` that can be found on the ERA forum of the Epiq Solutions Support Forums.

Please note that when installing the Controller via Matchstiq Update, the line `Command failed: Not found` isn't a fatal error. The installation succeeded if the phrase `Update completed successfully` appears at the bottom of the window. If the window contains a lot of version numbers and package names, then the install failed; send Epiq Solutions those contents.

To use ERA, open Chrome and enter the address in the navigation bar:

```
http://192.168.1.100:3000
```

- Adjustable visualization and measurement tools

OVERVIEW

Upon launching **ERA**, the loading screen will appear while the UI loads any user preferences and establishes a connection to the **Epiq** radio.

Figure 1: *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 2: 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.
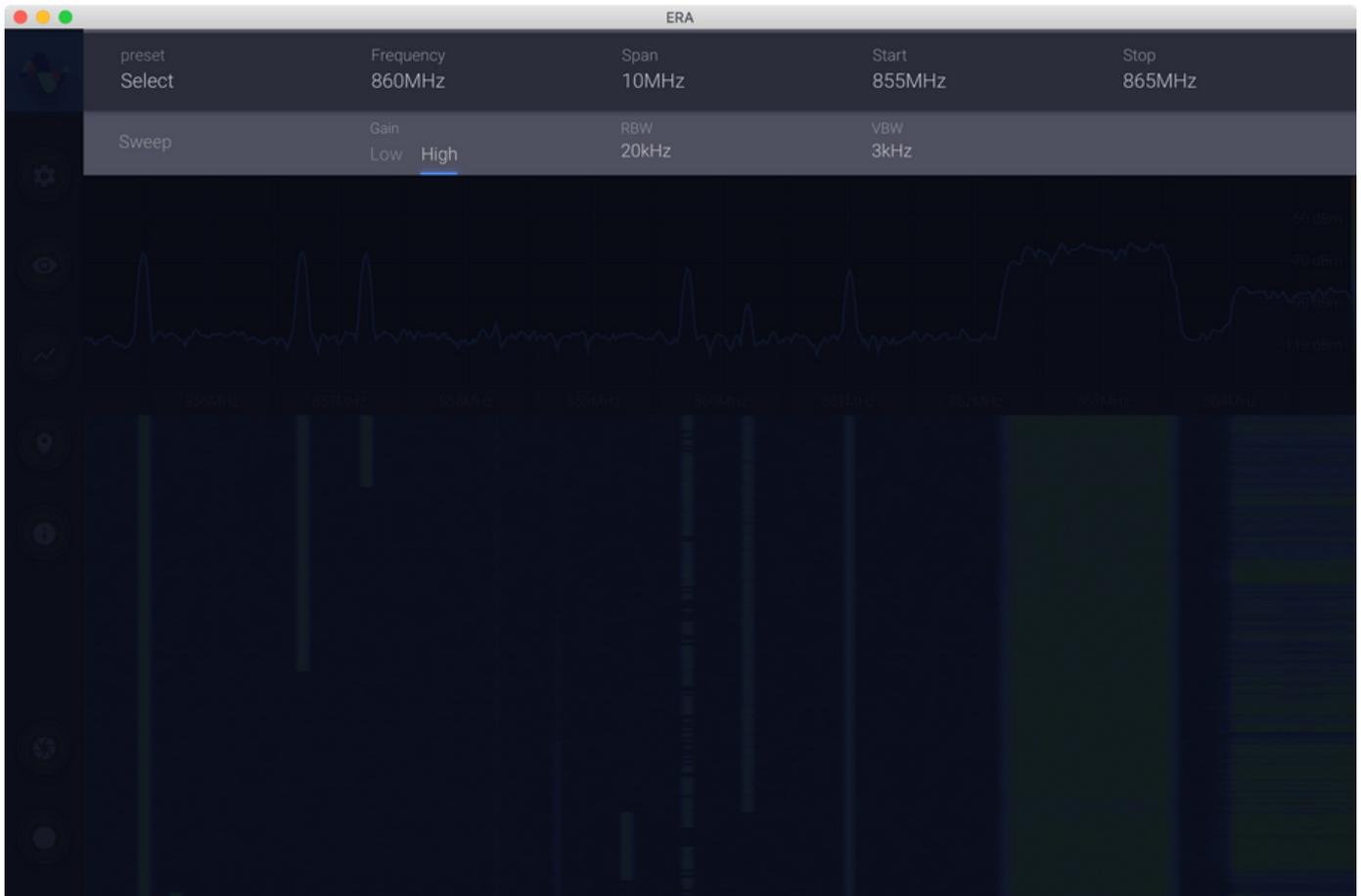
Figure 3: Primary Controls

SPECTRUM DISPLAY

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

Figure 4: 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.
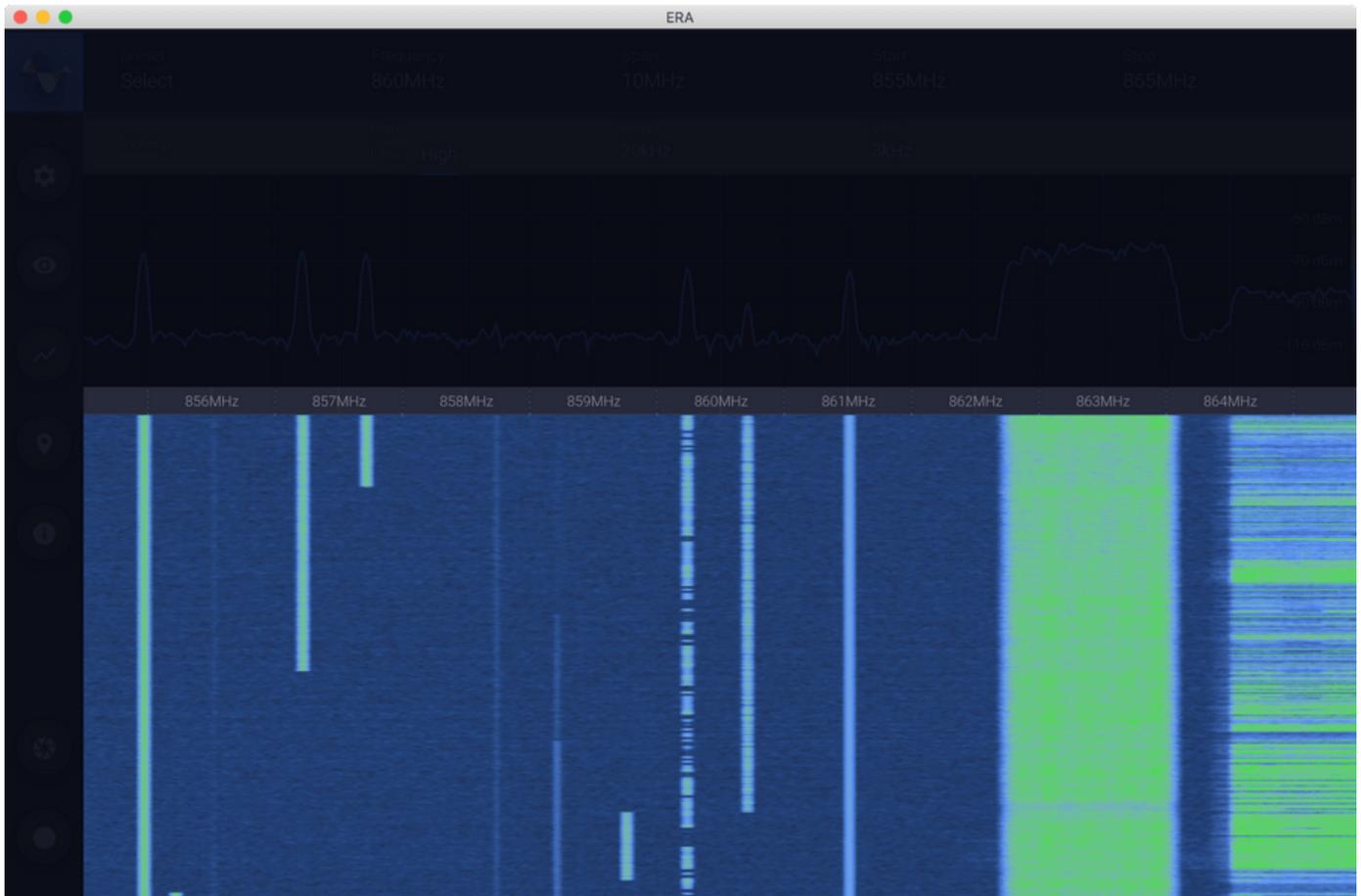
Figure 5: *Spectrum Waterfall Display*

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.
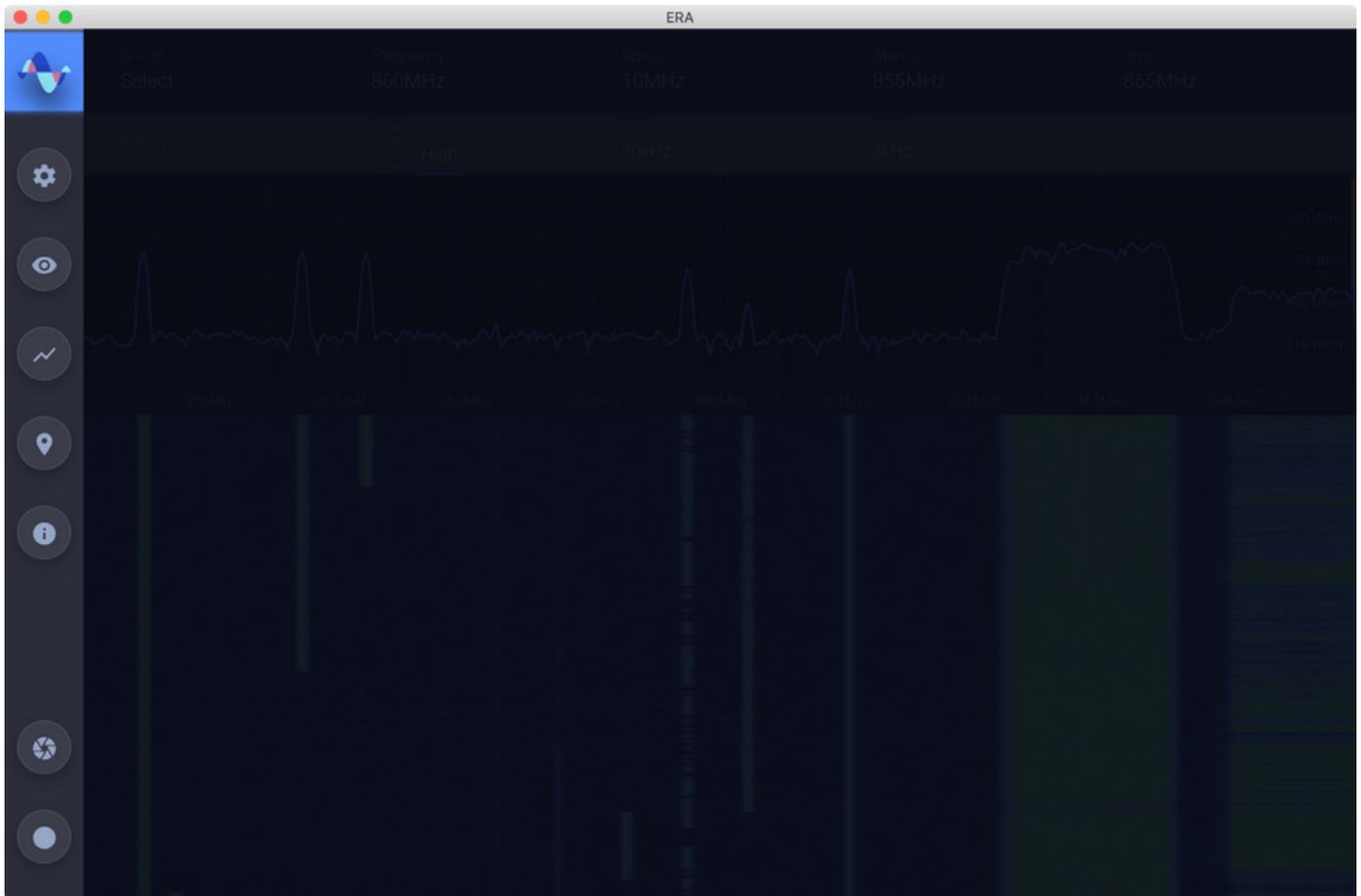
Figure 6: *Source Selector, Auxiliary Controls and Capture Buttons*

SOURCE SELECTOR

This button is in the top-left corner and displays the ERA icon. It will bring up a list of available signal sources, either an RX Channel on the Epiq radio or a previously made recording.

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 7: *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.

CAPTURE BUTTONS

These buttons give the user a quick way to capture information from the live Spectrum.

SCREEN CAPTURE

Pressing this button will cause ERA to capture a screenshot of the UI. The resulting screenshot will be stored on your *Desktop*, by default.

.. note:: This feature is not supported when the UI is loaded in a web browser, as is the case when running on a Matchstiq.
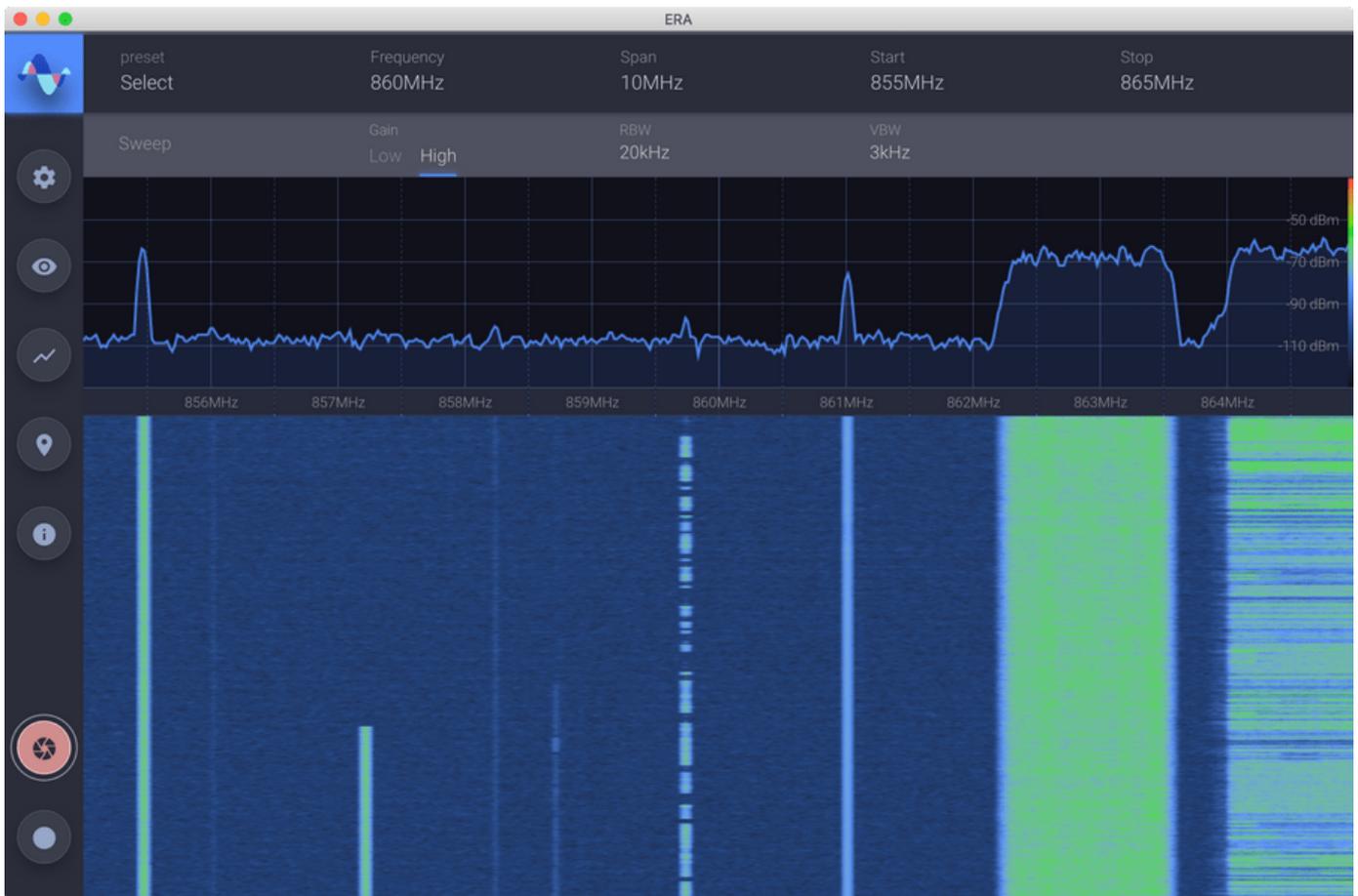
Figure 8: Screen Capture Button

RECORD

Pressing the button will cause ERA to begin either a IQ or Visual recording at the configuration, depending on whether ERA is in Stare or Sweep mode, respectively. Pressing the button again will stop the recording. Previously created recording are accessibly via the Source Selector. For more info, see the section on Recording

.. note:: This feature is only available with a Pro License.
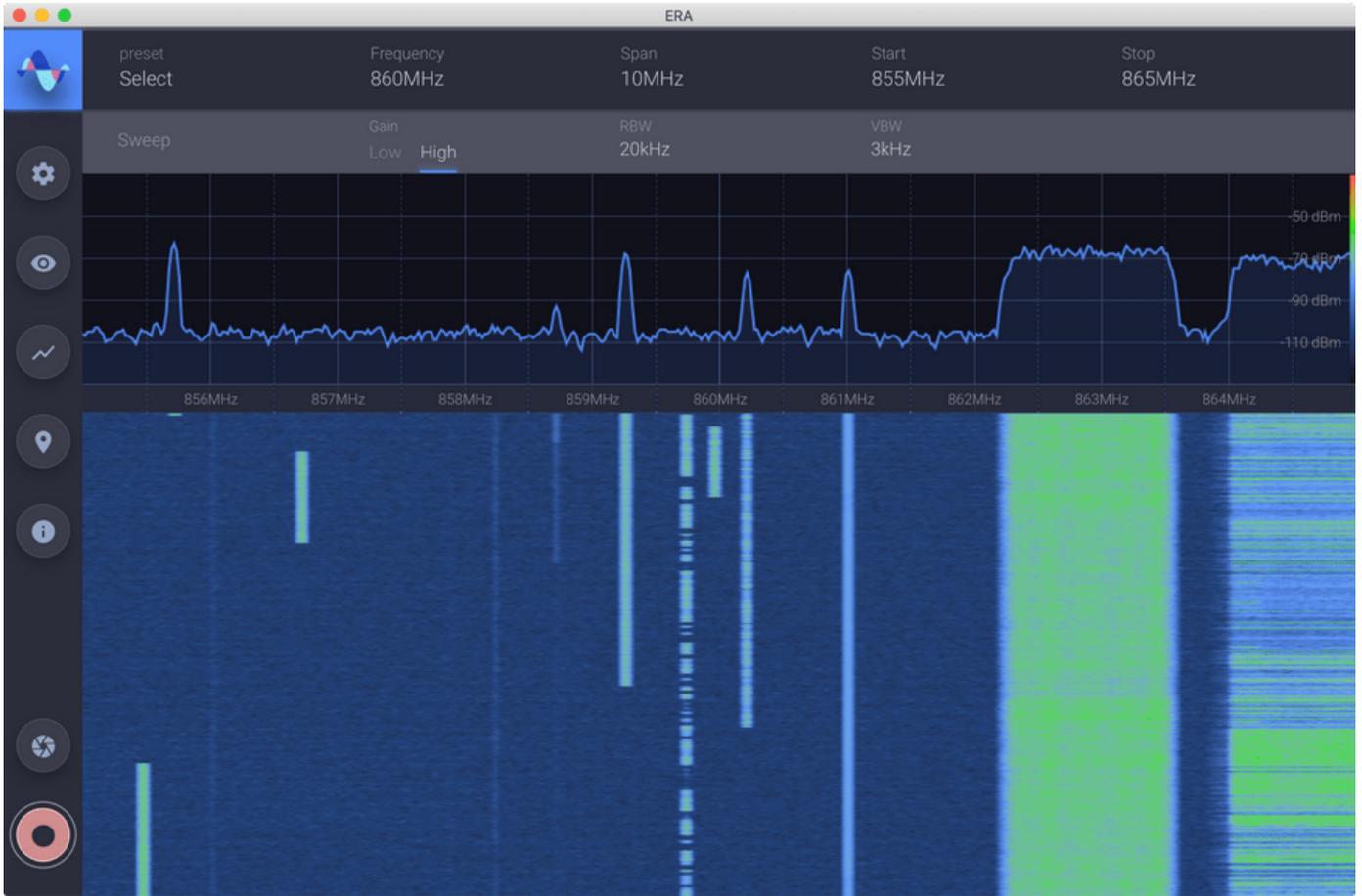
Figure 9: *Record Button*
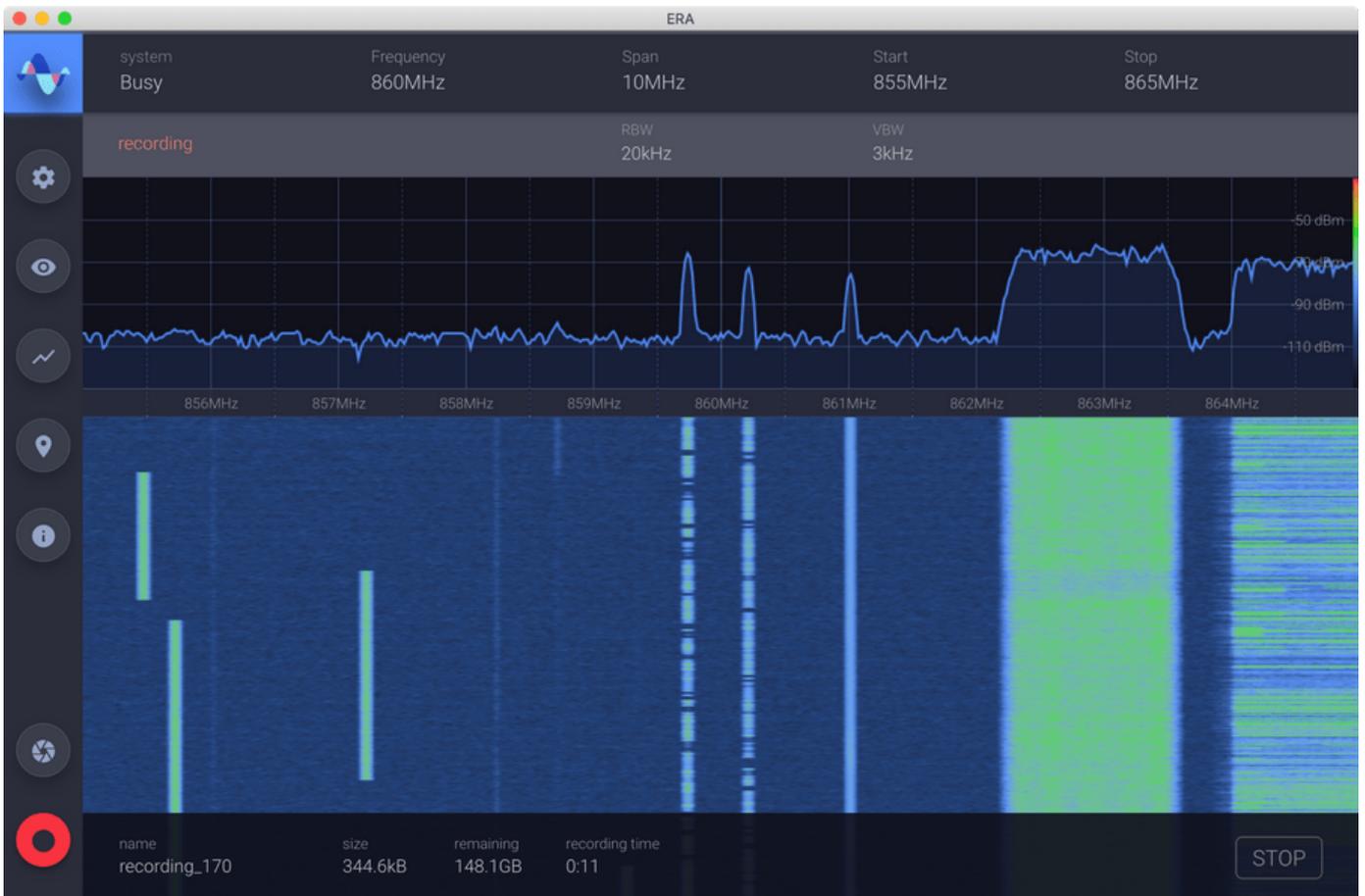
Figure 10: *ERA Making a Recording*

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

ERA 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.
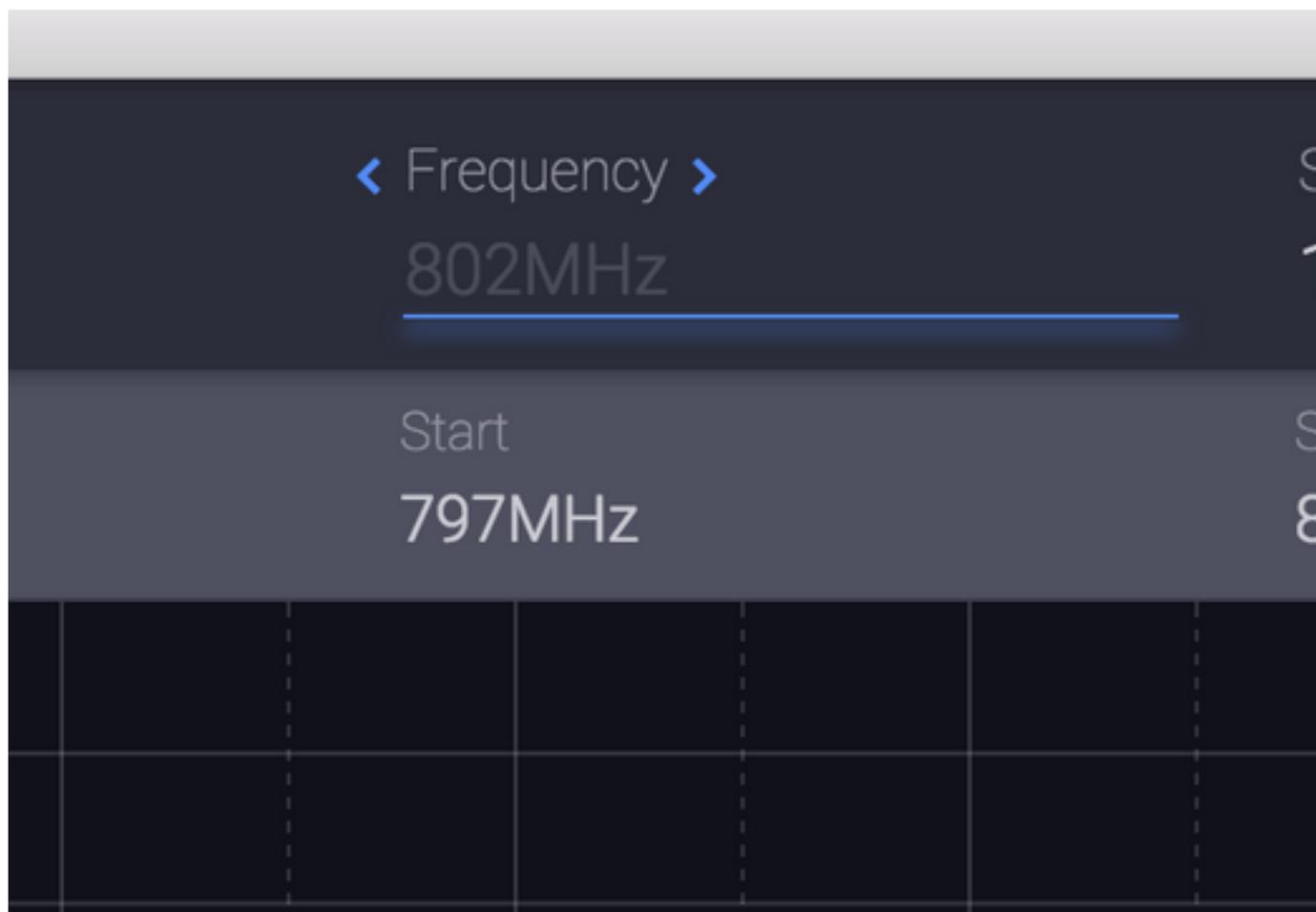
Figure 11: *Editing a Tuning Field*

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.

RECEIVER CONFIGURATION

To see the effective configuration of the receiver, including the current sample rate, open the Additional Information Panel in the Auxiliary Controls.

SWEEP AND STARE MODES

.. note:: A valid ERA Pro license required to switch to Stare Mode - please contact Epiq Solutions for licensing information.

ERA has two modes for tuning the receiver: Sweep and Stare. To switch between modes, open the System Settings Auxiliary Controls, either by selecting the System Settings button in the sidebar or clicking the mode text in the Primary Controls (e.g. Sweep). The current mode is displayed on the left-hand side of the Primary Controls panel. The differences between each mode are discussed below:

Figure 12: *Selecting Config Mode*

SWEEP MODE

The tuning controls discussed above are available in Sweep mode. This mode allows a "span" to be set which is wider than the highest available sample rate. This means that the spectrum being viewed is acquired in some sequence of "steps", creating several restrictions with regard to other features of the system. These restrictions will be discussed when applicable, but for quick reference, they include:

- Visual recordings only (IQ recording not available)

- Sample Rate is not directly configurable

- Less continuous samples will be represented visually in the Spectrum or Waterfall displays

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. ERA 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.

STARE MODE

In this mode, you configure the Sample Rate directly, which becomes the effective "span". The resulting stream of samples is therefore continuous and IQ recording is available. There are also a few restrictions in this mode worth noting:

- The visual range or "span" of the spectrum is limited to the set Sample Rate

- RBW and VBW are not editable in this mode

- FFT size is set to a predetermined size

SAMPLE RATE

In Stare Mode, Span is replaced by Sample Rate in the Primary Controls, which allows you to directly configure the receiver's sample rate. The configurable Sample Rate is limited by the type of radio used in your system's configuration. The "Radio Type" is listed in the Additional Info panel in Auxiliary Controls. ERA will not accept values that are outside of the radio's supported range.

BANDWIDTH

Sets the channel bandwidth. Note: the bandwidth is limited to 80% of the current Sample Rate

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 Auxiliary Controls 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.
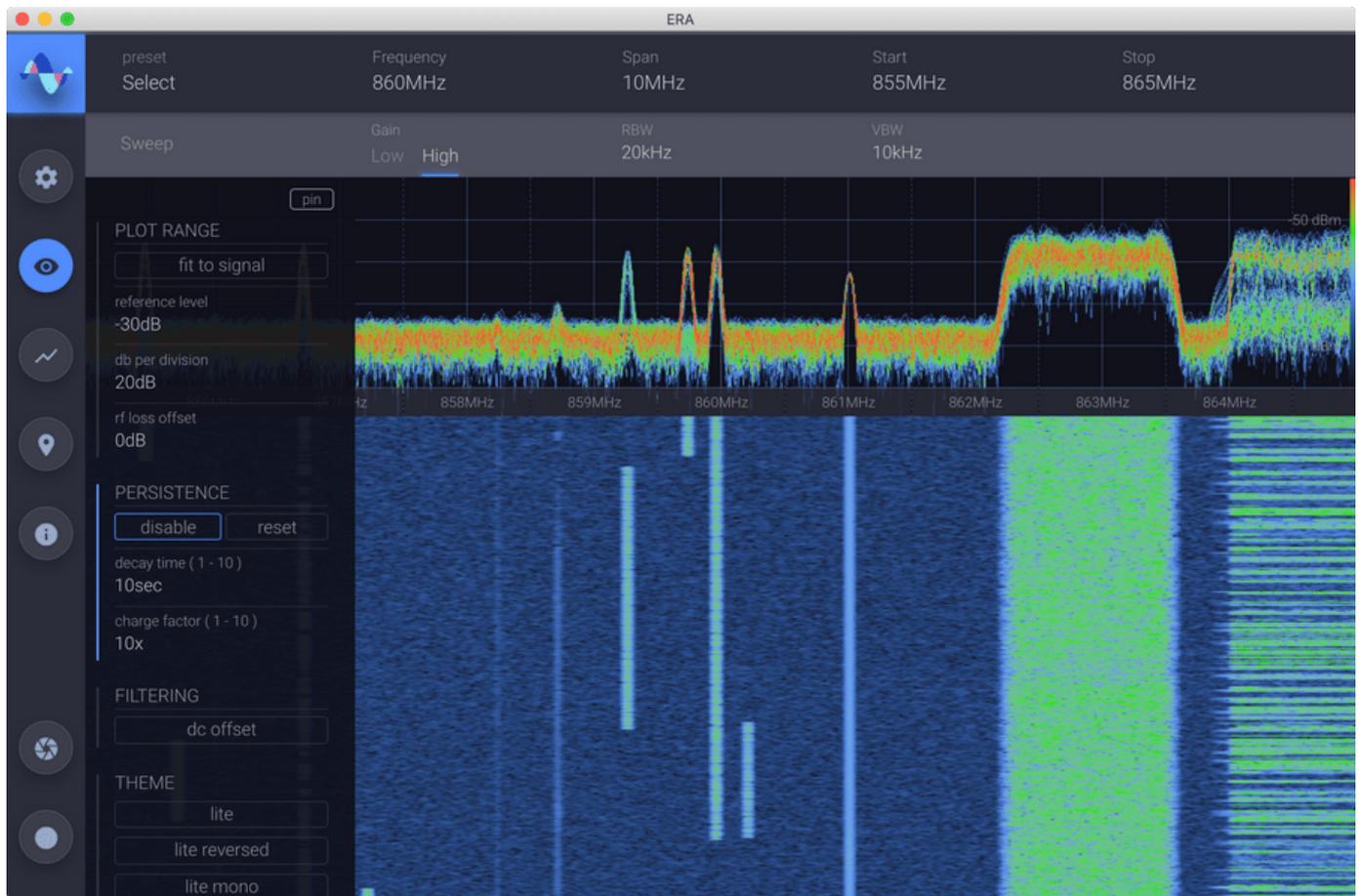
Figure 13: *Persistence Enabled*

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.

.. note:: When WebGL is not supported, this option will not be present.

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.

RESOLUTION BANDWIDTH (RBW)

The resolution bandwidth is configurable in the Primary Controls. Changing this value will affect the resolution, in frequency, of each point on the plot in the spectrum view. Decreasing this value will give you a higher resolution, increasing the number of points on the graph. Not every value entered will be valid, but ERA will choose the closest valid value to the one entered.

VIDEO BANDWIDTH (VBW)

The video bandwidth is also configurable in the Primary Controls. Changing this value will affect the resolution, in frequency, of trace updates in the spectrum view. Increasing this value will result in more frequent updates, effectively giving you a higher resolution. Not every value entered will be valid, but ERA will choose the closest valid value to the one entered.

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.
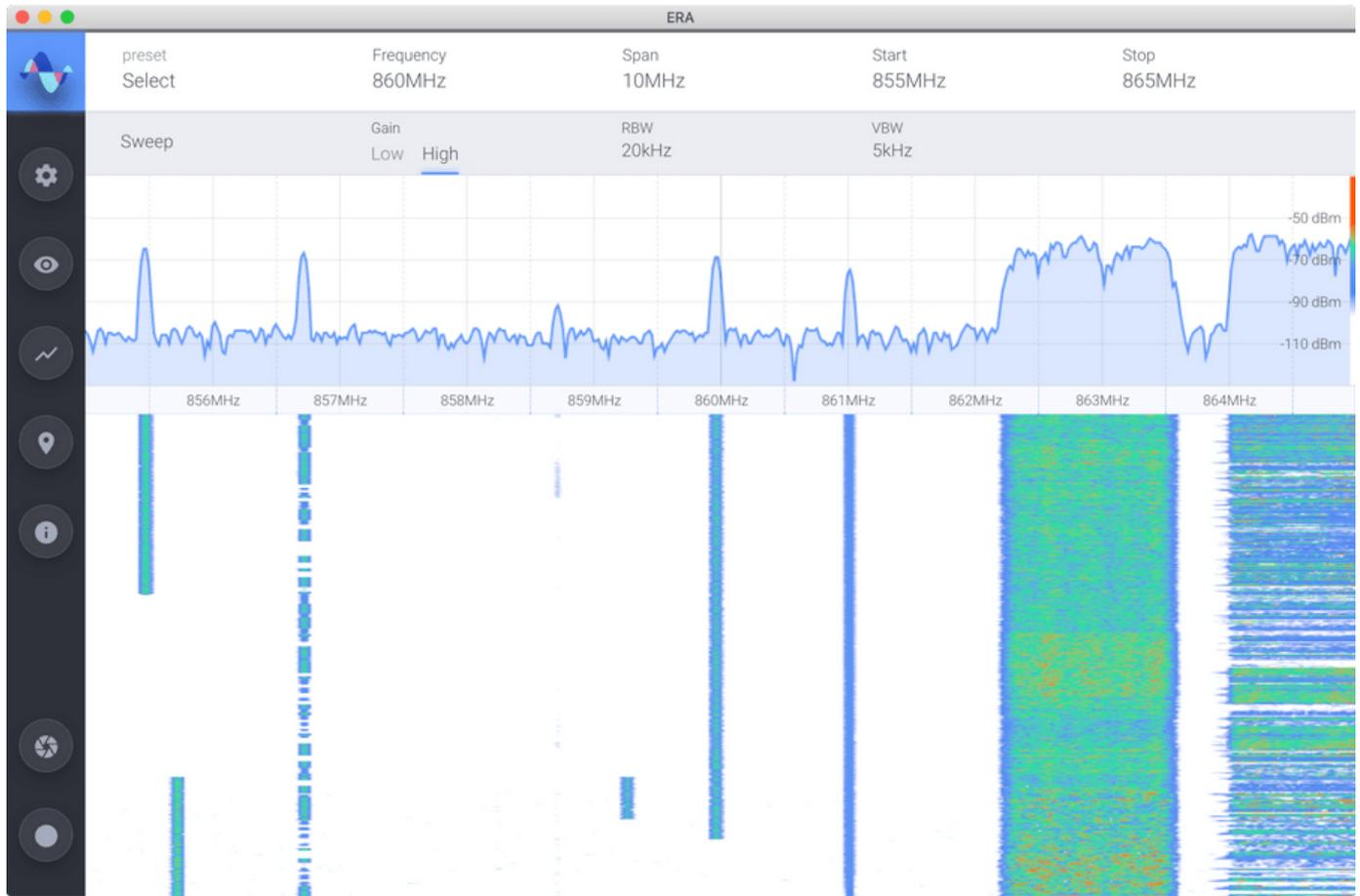
Figure 14: *Light Color Theme*

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 15: *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.

IQ VISUALIZATION

.. note:: This feature requires a Pro License

It may be useful at times to view the I & Q samples. To do this, select "I/Q" under "Visualization Type" in the System Settings panel of the Auxiliary Controls. When using this visualization type, you are given the same receiver tuning controls as when you are using Stare Mode for viewing the frequency domain.

DISPLAY SETTINGS

When visualizing the I & Q samples, the options available in the Display Settings panel of Auxiliary Controls changes accordingly. It should also be noted that you can zoom the amplitude range of both plots by using the mouse wheel or clicking and dragging up or down.

I TRACE

In the time domain plot, the I trace can be disabled/enabled with this option.

Q TRACE

In the time domain plot, the Q trace can be disabled/enabled with this option.

CONNECT THE DOTS

In the I vs Q scatter plot, a line can be drawn between each point.

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.
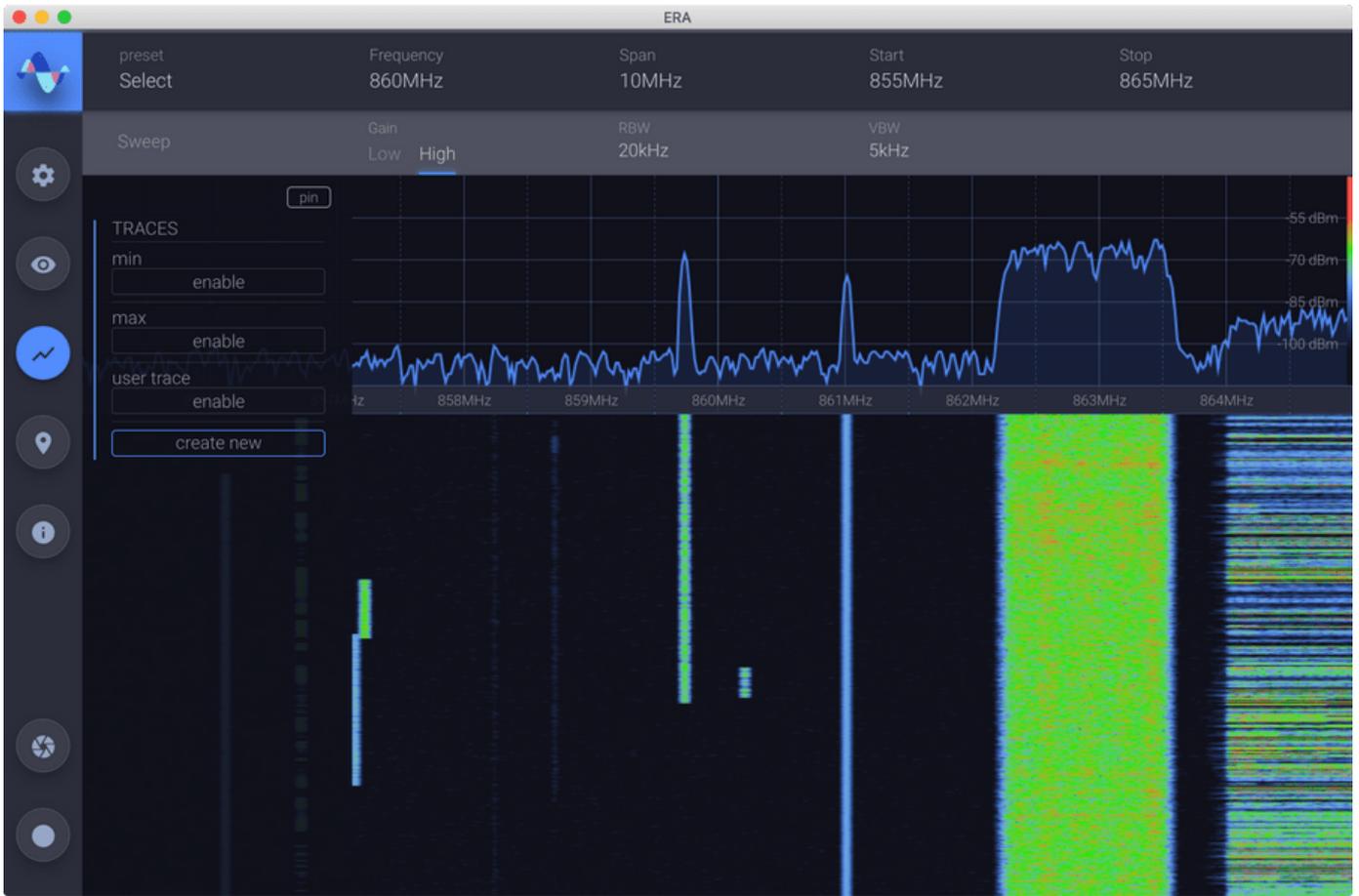
Figure 16: Create a New Trace
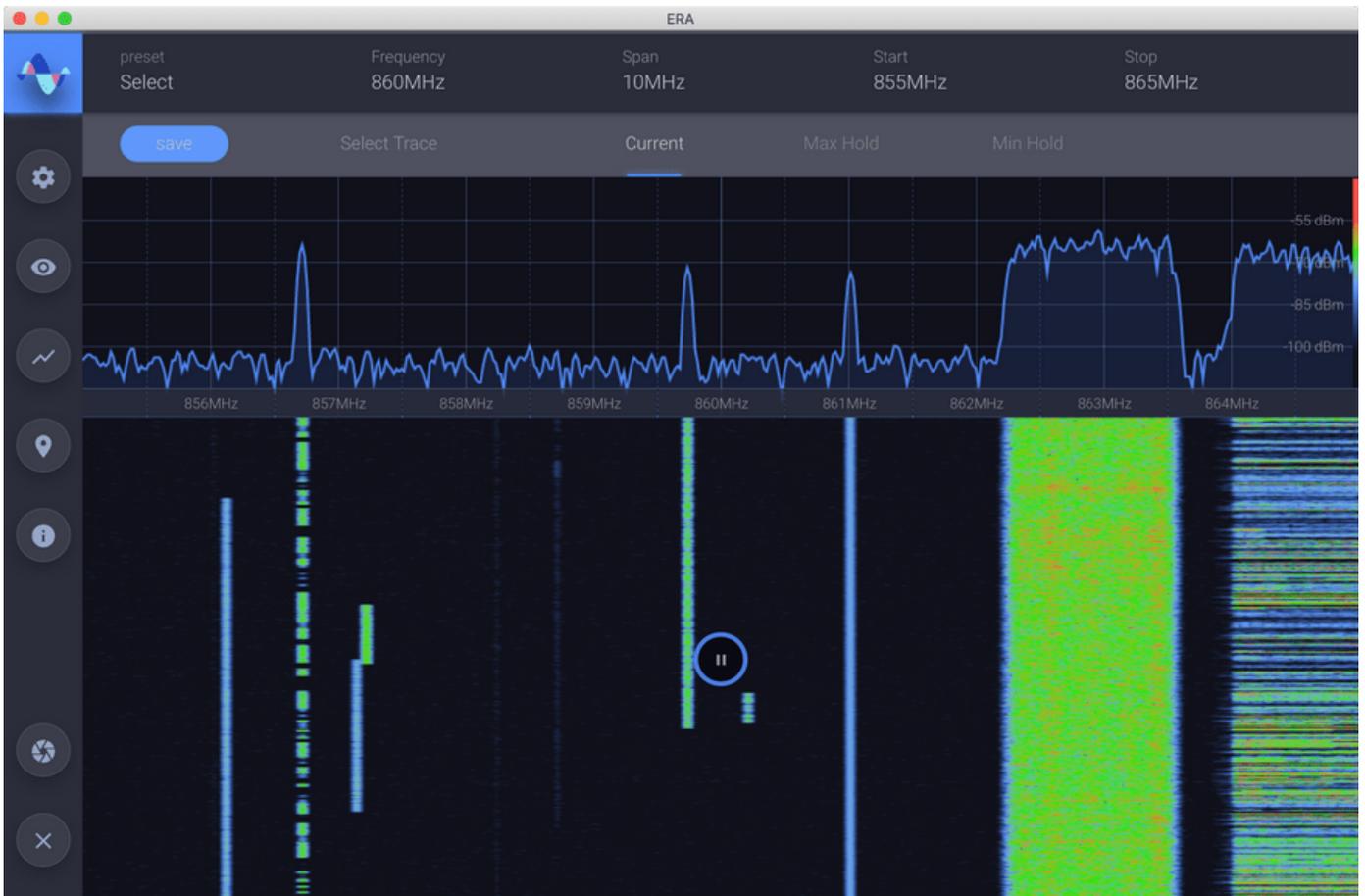
Figure 17: Choose a New Trace

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 18: *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 19: *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.
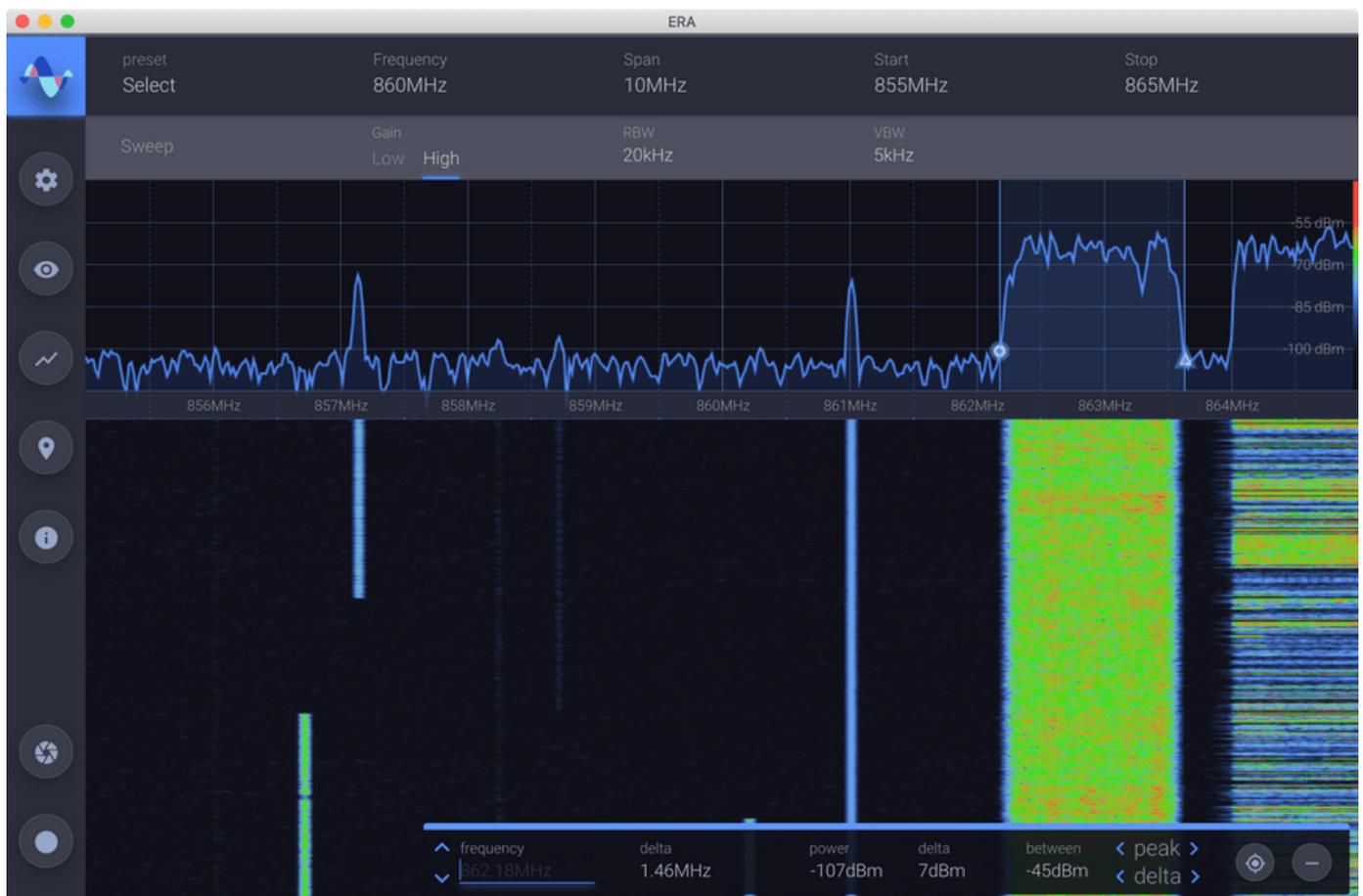
Figure 20: *Editing a Marker*

All markers and their delta values are also accessible in the Markers Auxiliary Controls. These values can be edited from here, as well.
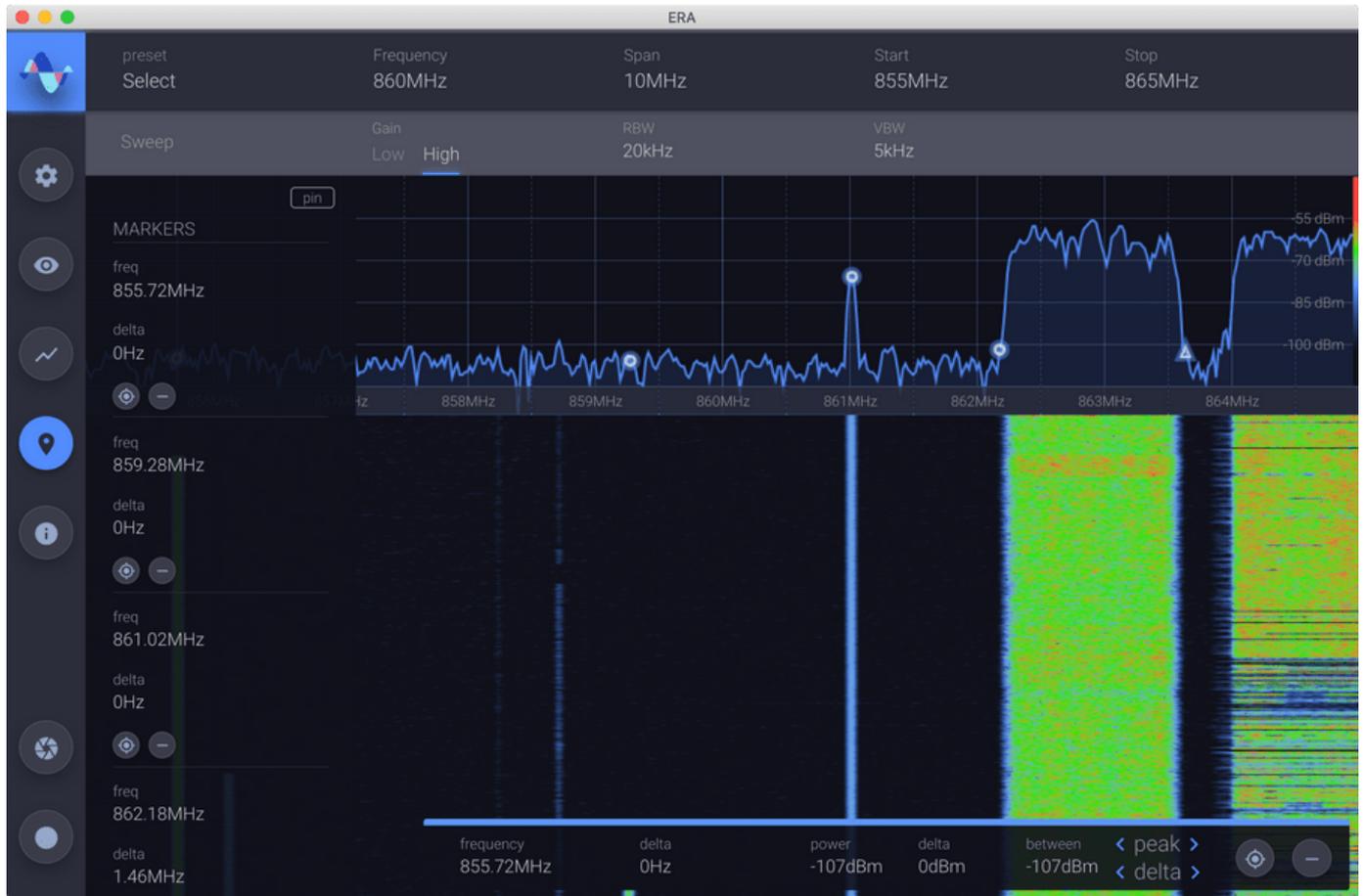
Figure 21: *Marker List*

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.