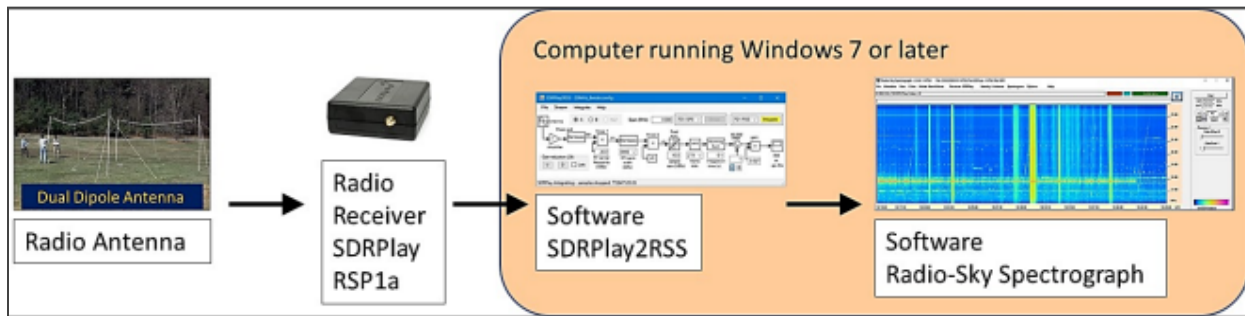


SunRISE Radiolab Software Set up and Data Collection Manual Using an SDRplay*RSP1A

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(This manual is recommended to be displayed on an electronic device)



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Main Menu

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Basic Theory of Operation

(Takes 3-5 minutes to read; having knowledge of the science is not critical to the set up)

Receiver

Radio signals from Jupiter are very weak - they produce less than a millionth of a volt (1 microvolt, $1\mu\text{V}$) at the antenna terminals of the receiver. These weak radio frequency (RF) signals must be amplified and filtered by the radio receiver. The SDR receiver, the accompanying software Radio-Sky Spectrograph (RSS), and the radio antenna, are designed to operate over an 8 MHz (Megahertz) wide range of frequencies centered on 20 MHz. This frequency range is optimum for detecting Jupiter radio signals, and is excellent for detecting solar radio emissions, the galactic background from the Milky Way, and natural and artificial Earth-based radio emissions. The particular radio we are using is the SDRplay RSP1A. This radio is incredibly versatile, and with the right antenna, it can detect radio frequencies over a very broad range, from 1.0 kHz – 2.0 GHz including the radio bands VLF, LF, MW, HF, VHF, UHF and L-band. For example, it will detect longwave and shortwave radio communications, AM and FM radio stations, and aircraft beacons. See <https://www.sdrplay.com/> for more information about this radio and its abilities.

Antenna

The antenna intercepts weak electromagnetic waves which have traveled hundreds of millions of miles to the Earth. When these electromagnetic waves strike the wire antenna, a tiny RF voltage is developed at the antenna terminals. Signals from the antenna are delivered to the antenna terminals of the receiver by a coaxial transmission line, which minimizes losses and distortion. The radio antenna recommended, and included with the SunRISE kit, is a dual dipole antenna (see cover image).

Computer and Software

The computer and software will record and provide a real-time display of the strength of the digital radio signal on a frequency vs. time graph (a spectrogram). We require a computer

running Windows 7, Windows 8 or Windows 10 operating system because the SDR requires a reasonable CPU speed to process the signals. Ideally, the computer should be dedicated to data collection when in operation.

Windows 11 does not support our analytical software and a working computer of Windows 7, 8, or 10 is required.

Radio Antenna Components

Antenna – collects the radio waves



Antenna cable and connectors – connects the radio antenna to the receiver


Receiver – detects, amplifies, and filters the radio signals

USB Cable – transmits the signal to the computer and powers the radio

Computer and software – records and displays the radio signals for analysis

Receiver Parts

Part Name	Figure
A. 1 * SDRplay RSP1A receiver	 A photograph of a rectangular, black, textured SDRplay RSP1A receiver. The device has a small gold SMA connector on the left side. The SDRplay logo and a stylized antenna icon are embossed on the top surface.
B. 1 * USB 2.0 type B socket to USB 2.0 type A socket	 A photograph of a black USB 2.0 cable. One end features a USB Type B connector, and the other end features a standard USB Type A connector. Both ends are secured with black plastic strain relief boots.

C. Antenna Parts	See SunRISE antenna manual
D. Computer running Windows 7, 8, or 10 system	

Introduction – SDRPlay2RSS/Radio-Sky Spectrograph Software

This document will take you through the process of installing and configuring the software to get your SunRISE kit working as a radio telescope. Three pieces of software are needed:

- (1) SDRUno is the commercial software to control the SDRplay radio,
- (2) SDRPlay2RSS software is custom made intermediate software that controls the SDRplay receiver settings, and
- (3) The Radio-Sky Spectrograph (RSS) software displays and records the data as signal strength on a frequency versus time chart.

This document will take you through the process of installing and configuring SDRUno, Radio-Sky Spectrograph (RSS), and SDRPlay2RSS with the ultimate goal of utilizing a SDRplay receiver as a radio-science spectrograph. The Radio-Sky Spectrograph download also includes the SDRPlay2RSS software. These instructions were established using the SDRplay1A model receiver. Image representation for the software-hardware relationship is in Figure 1.

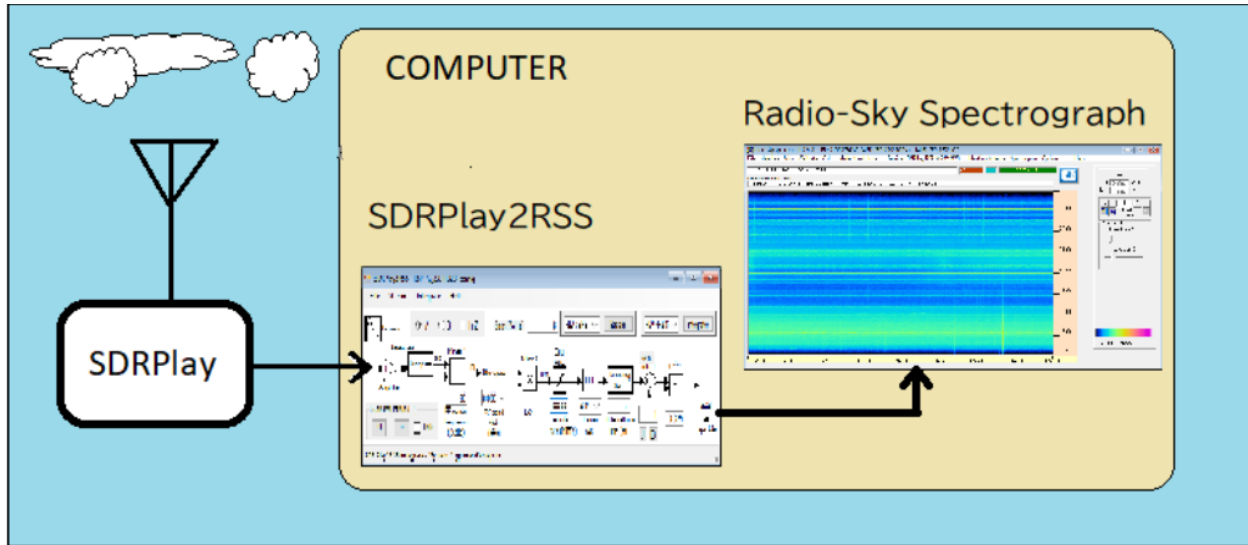


Figure 1

RSS uses a separate program, SDRPlay2RSS, to gather spectral data from the SDRplay receiver and feed it to RSS for display and archiving. This program installs automatically along with RSS, and is our most tested tool for working with the SDRplay receivers.

Detailed Software and Hardware Setup Menu

Important: follow these instructions in order. You must install the software before connecting your SDR radio to the computer.

Click the links below to go to corresponding pages.

- [1. Go to the SDRplay website download page.](#)
- [2. Connect the RSP receiver to the pc with the USB 2.0 type B socket to USB 2.0 type A socket cable.](#)
- [3. Start SDRUno to verify that your radio is working. Tune the radio signal.](#)
- [4. After installing and successfully establishing that the SDRplay radio is working, close SDRUno.](#)
- [5. Download and install Radio-Sky Spectrograph \(RSS\) version 2.9.63](#)
- [6. Run Radio Sky Spectrograph in Administrator mode.](#)
- [7. When you run RSS for the first time, click the Identity/Antenna menu](#)

8. In RSS, Click on Receiver and select the SDRplay option.

9. After selecting the SDRplay option, open RSP1A_20211028.config from the pop up window when asked to select a new configuration.

10. Finish the setting of the Program Priority.

11. Start the data transmission.

12. When an SDRplay receiver is selected in RSS and the Start button is pushed, RSS will check to see if SDRPlay2RSS is already running.

13. When the designated observation time is finished, stop the data transmission by clicking the “Stop Saving” button.

14. Collect the data. We need the data in image and SPS (comma separated value format, and first we need to find the session log file.

15. Now Load the sps session log file that you saved.

16. Click the double-arrow button to display the spectrogram of the entire observation session.

17. Save the data as image format.

18. Make sure you collect the data in all required format and inspect the data collected.

Instructions

1. *Go to the SDRplay website download page*

****Important: Radio-Sky Spectrograph software requires certain .dll files from an older version of SDRUno; thus, we require SDRUno v1.41.1 or older.**

- a. Click this to install an older, working version of SDRUno. SDRUno with the installer is here:
https://www.sdrplay.com/software/SDRplay_SDRUno_Installer_1.33.exe
 [Version 1.33 is the oldest and smallest file version that SDRplay has for downloading on their website that works for us.]
- b. Install SDRUno. Click: I accept the agreement -> next -> next -> next -> next -> install -> next -> finish
- c. **Do not connect the SDRplay radio to the computer until the install routine tells you to connect it.** Connect the SDRplay radio to the computer using the USB cable, finish the software installation, and install all the plug-ins.

2. Connect the RSP receiver to the PC with the USB 2.0 type B socket to USB 2.0 type A socket cable.

- a. In this step, you should have finished the antenna installation and established the connection between the antenna up to the SDR receiver. That is to say, you should already connect 1, 2, 3, and 4. Now, connect the SDRplay RSP1A receiver to your laptop with USB 2.0 type B socket to USB 2.0 type A socket cable.

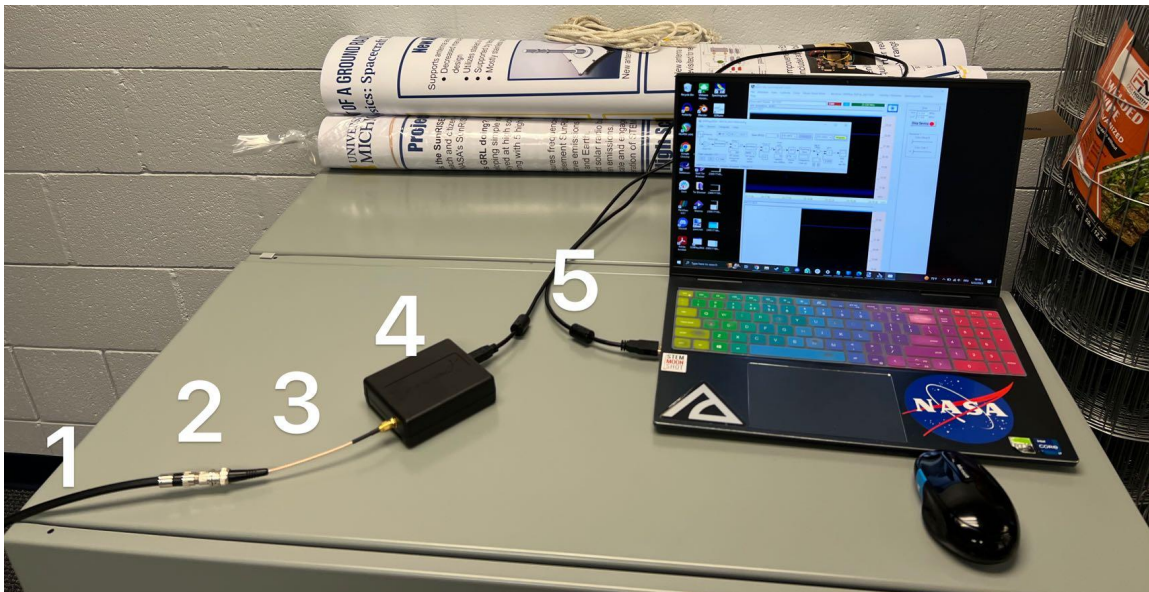


Figure 2: Step 2a

- 1: Antenna Coaxial Cable
- 2: BNC-female-to-female connector
- 3: SMA male-to-BNC-male cable
- 4: SDRplay RSP1A receiver
- 5: USB 2.0 type B socket to USB 2.0 type A socket cable

- b. For the detailed picture of the cables, see [Receiver Parts](#).
- c. While connecting the antenna coaxial cable (1), the BNC-female-to-female connector (2), and the SMA male-to-BNC-male cable (3), put the switch between the BNC-female-to-female connector and the SMA male-to-BNC male cable in the position shown in the image below. This is important because otherwise one can accidentally turn off the signal from the antenna.

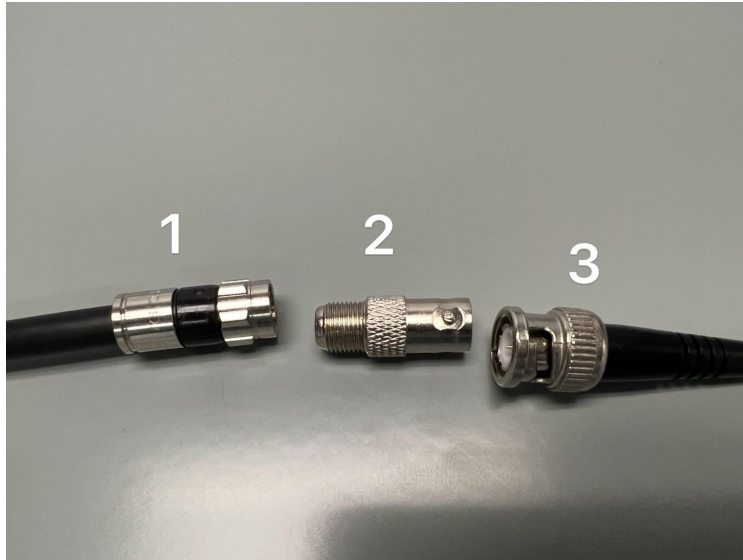


Figure 3: Step 2c

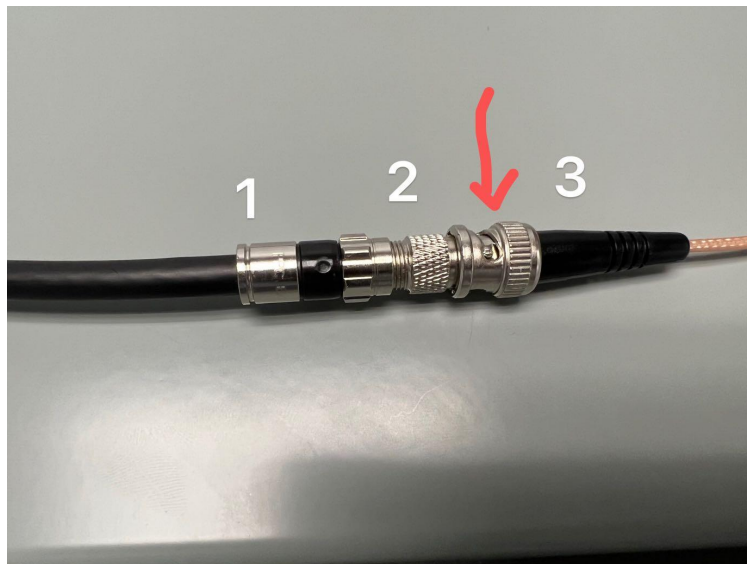


Figure 4: Step 2c

3. *Start SDRuno to verify that your radio is working. Tune the radio signal.*

- a. Click on the SDRuno icon on the desktop and multiple windows will open to let you control the radio.

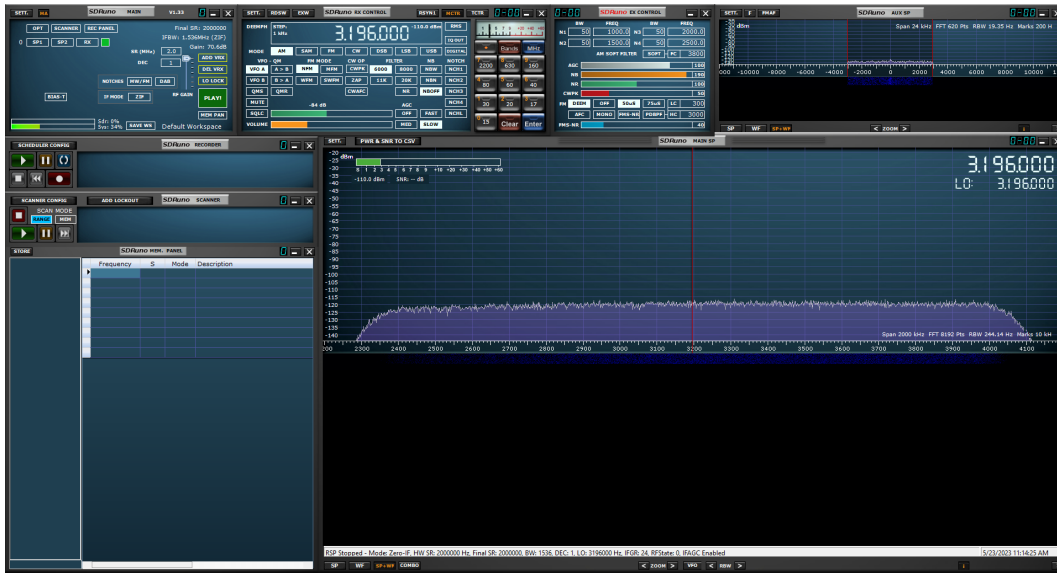


Figure 5: Step 3a

- b. The only requirements in the SDRuno setting are Gain, Frequency, and Mode. First, set the Gain to Maximum.

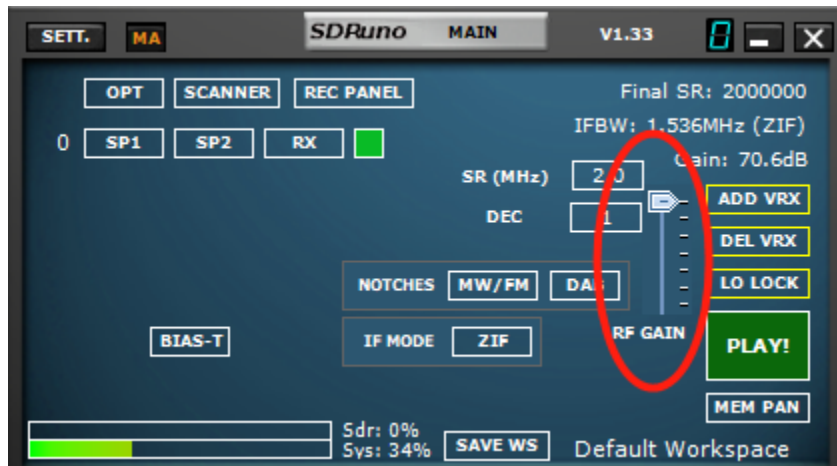


Figure 6: Step 3b

c. Set the Mode to AM



Figure 7: Step 3c

d. Unmute the audio on your PC and press “Play”. You should see a waterfall spectrum and you may hear the hiss of static.

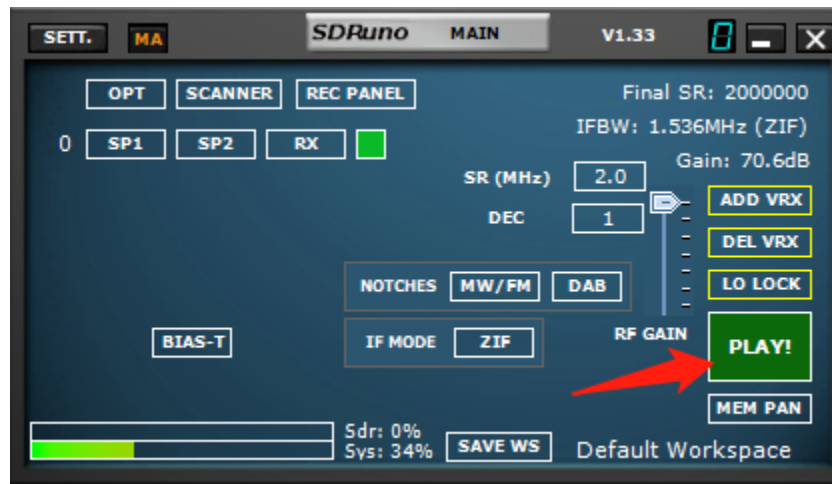


Figure 8: Step 3d

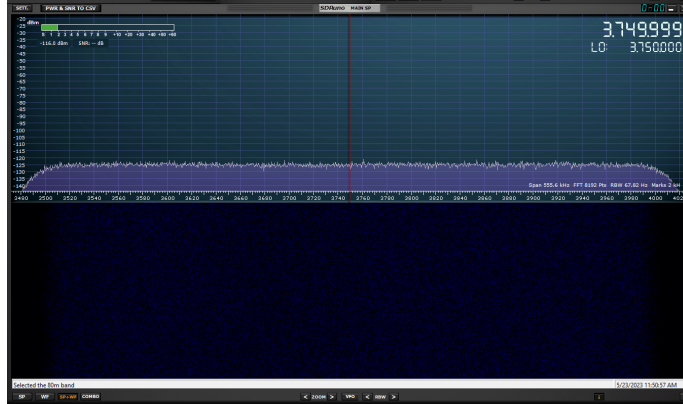


Figure 9: Step 3d

4. *After the tuning and verifying that the SDRplay receiver is working, close SDRuno.*
 - a. SDRuno cannot be used when the SDRplay receiver is connected to Radio-Sky Spectrograph (RSS) so make sure it is always closed after tuning.

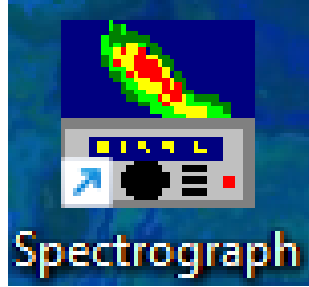
****Important: SDRuno and RSS are conflicting data collection softwares; you must close the RSS software to use the SDRuno software separately.**

5. *Download and install Radio-Sky Spectrograph (RSS) version 2.9.63*
 - a. Here is the link to download the software:
http://radiosky.com/spec/Spectrograph_2_9_63.exe
 Google is likely to fail in redirection of this download link; if this occurs, manually copy and paste the link to your browser and the download will start
 - b. For installation, click: I accept the agreement -> next -> install

****Important: If you get a warning, click More Info → Run Anyway. Proceed to download the software. The Radio-Sky Spectrograph download also includes the SDRPlay2RSS software.**

 - c. Optional: If you want to know more info regarding the software, visit:
<https://www.radiosky.com/>

6. *Run Radio Sky Spectrograph in Administrator mode.*
 - a. After installing RSS on your Windows computer, it will automatically run as Administrator each time you run it. Open the RSS software and select “Yes” in the User Account Control window if it shows up to allow the software to run.



7. When you run RSS for the first time, click the Identity/Antenna menu

- a. Click the Identity/Antenna tab. At a minimum, fill in your name and observatory name (school/club name, limit 20 characters), latitude, longitude, and location. Keeping good identity data is key to the usefulness of your observations. The observatory file you created will be saved for you to choose later, such as “UM.obs” as your observatory identity/antenna file.

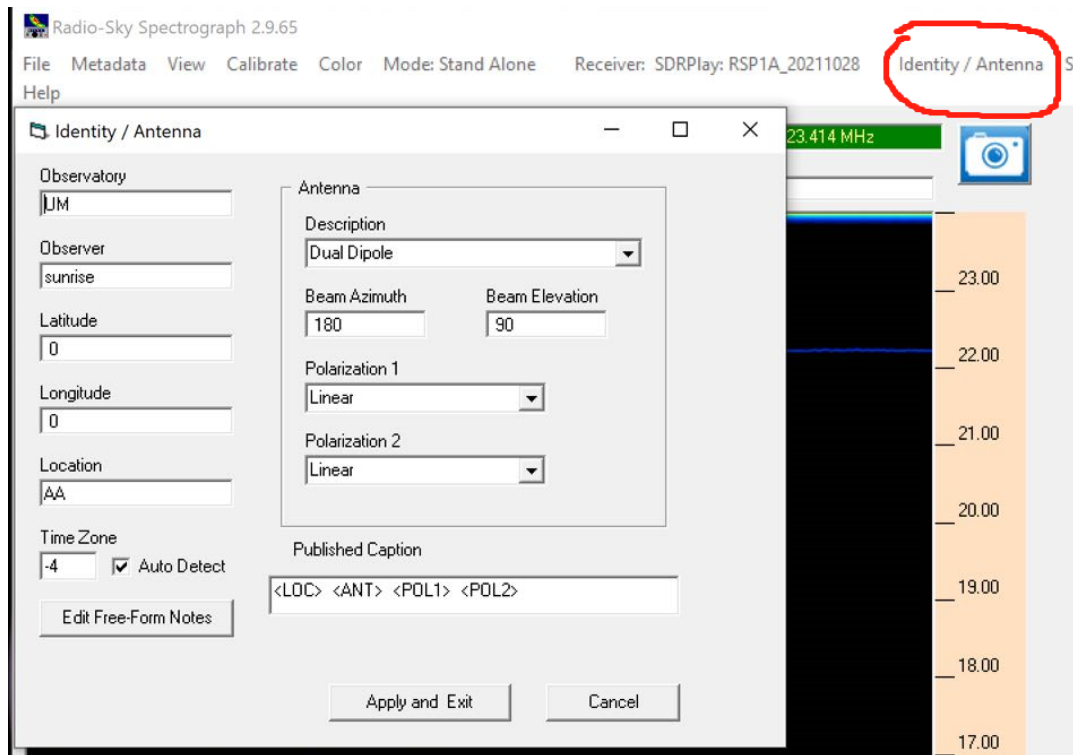


Figure 10: Step 7a

8. In RSS, Click on Receiver and select the SDRplay option.

- a. Click Receiver -> SDRPlay

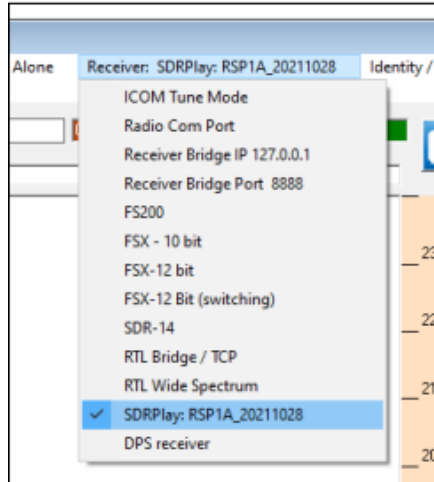


Figure 11: Step 8a

9. After selecting the SDRplay option, open *RSP1A_20211028.config* from the pop up window when asked to select a new configuration.

- a. When you run the software thereafter, you will see SDRPlay: RSP1A_20211028 in the Receiver section.

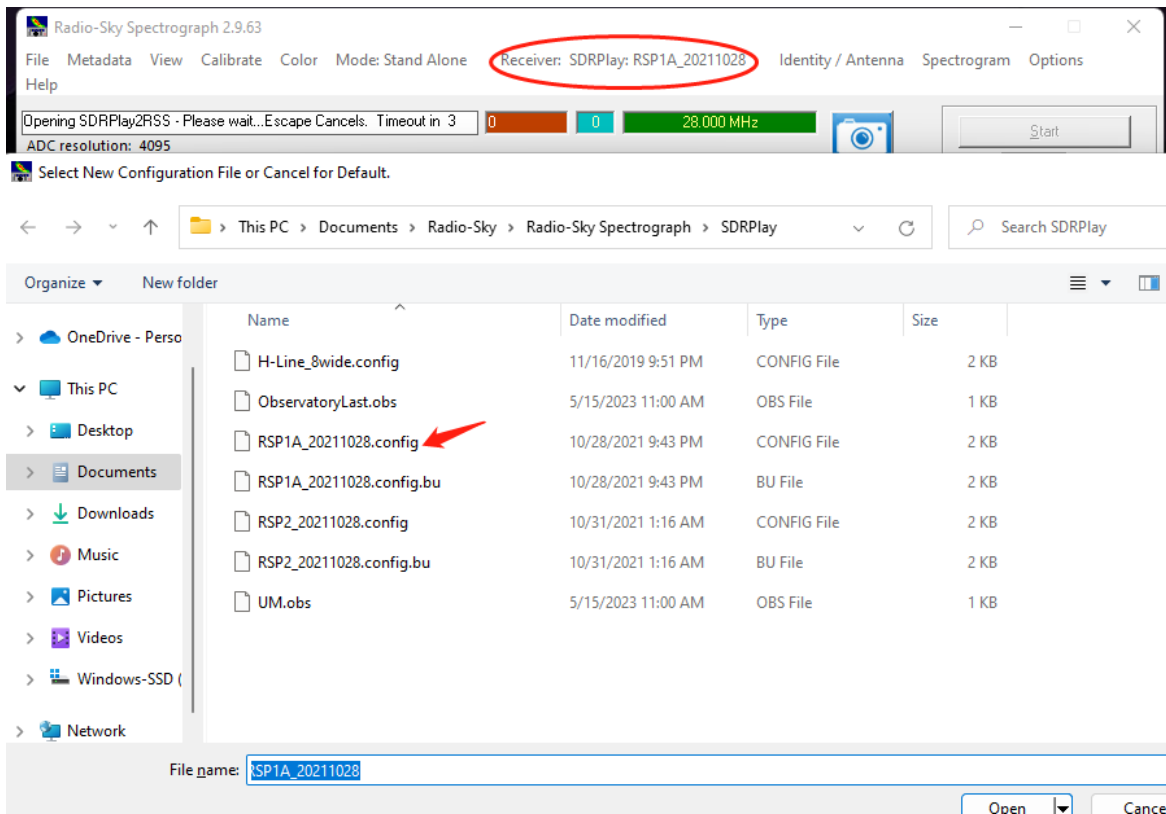


Figure 12: Step 9a

10. Finish the setting of the Program Priority.

- a. Your data transmission can be unintentionally interrupted by the PC auto screen-lock. Turn off the auto screen-lock for your PC before starting the data transmission, or set it to 2 hours (the timing for your observation session).
- b. In the software, click on “Options” and set the “Program Priority” to “High” to allocate more resources to the software such that the data transmission will remain stable.

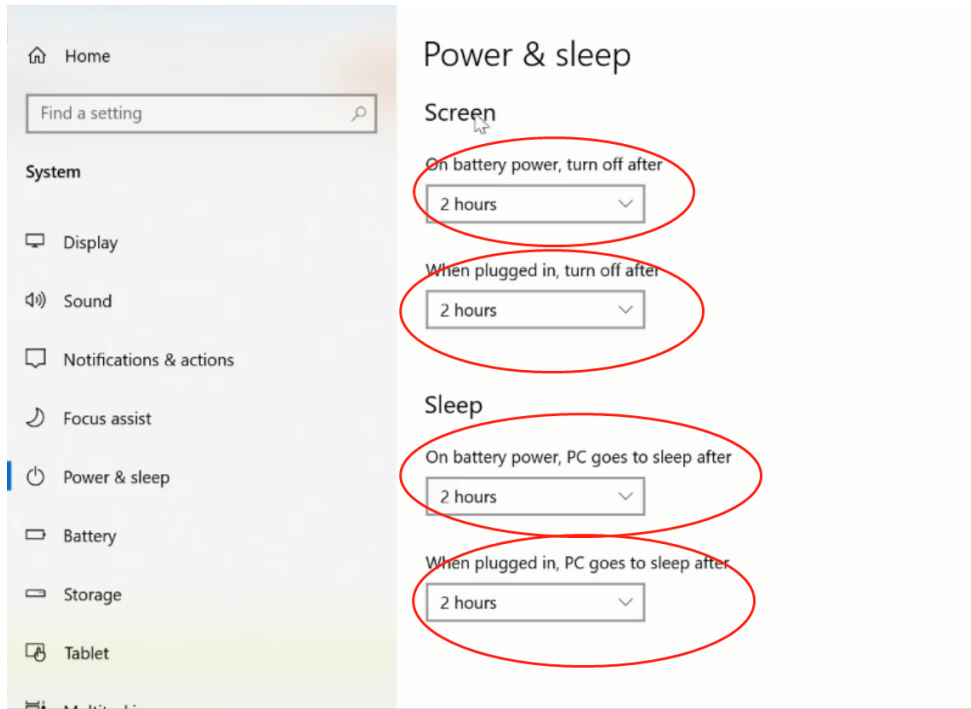


Figure 13: Step 10a

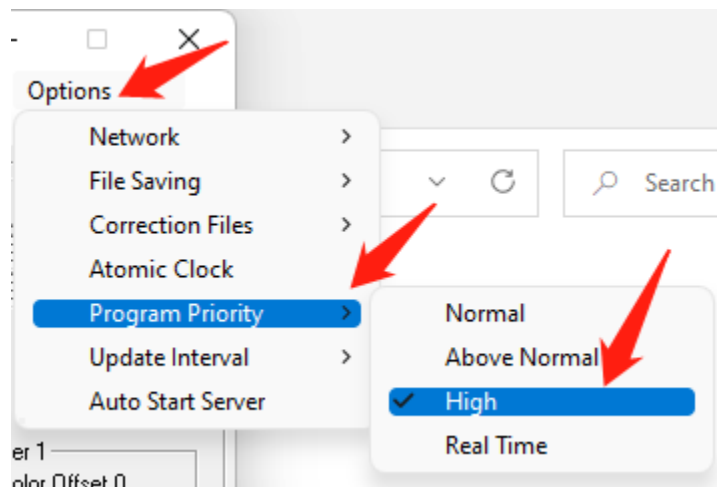


Figure 14: Step 10b

11. Start the data transmission.

- a. Now click the “Start” Button.
- b. If you get a Windows pop-up requiring a download of .NET Framework 3.5. Please download it and let the .NET Framework 3.5 install.

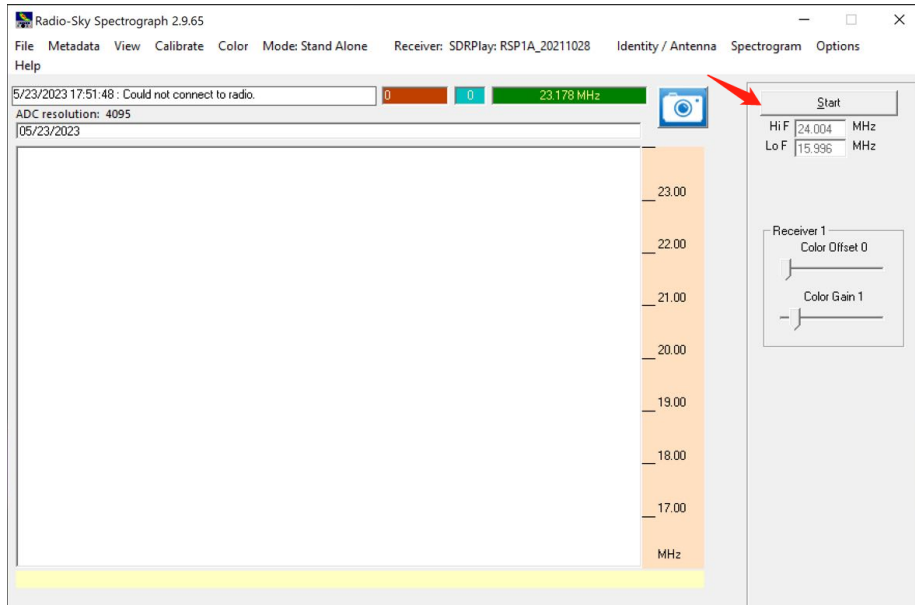


Figure 15: Step 11a

- c. You will also be asked for observatory data requiring you to select a .obs file. Choose the previous observatory file you created.

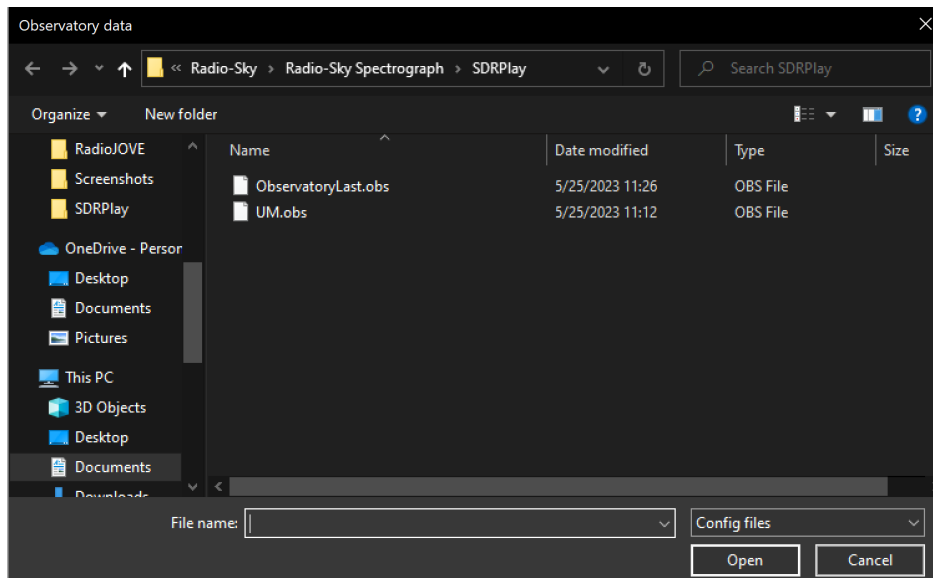


Figure 16: Step 11c

12. When an SDRplay receiver is selected in RSS and the Start button is pushed, RSS will check to see if SDRPlay2RSS is already running.

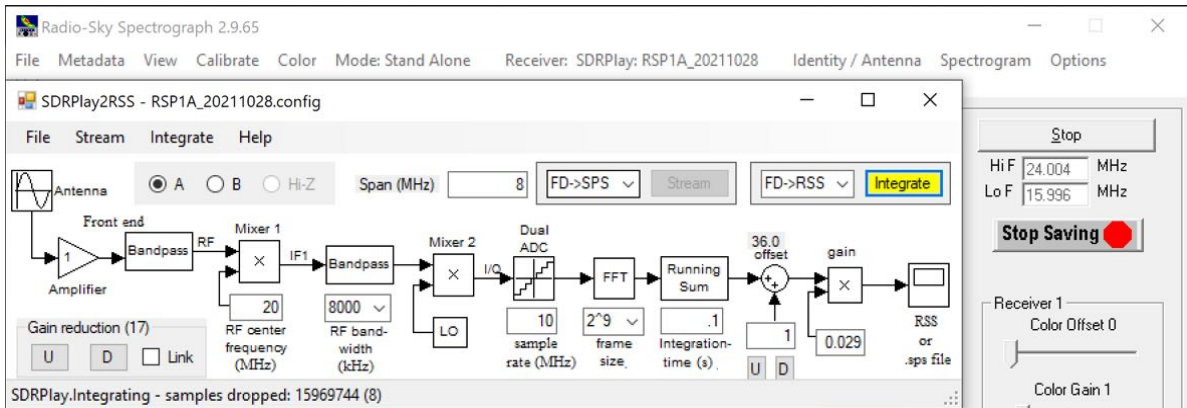


Figure 17: Step 12a

- a. After a few seconds the SDRPlay2RSS window will open and your spectrograph should begin taking data. The “Integrate” button in SDRPlay2RSS should be yellow (See Figure 12.1) and **you should see the spectrogram scrolling in RSS**. This can take several seconds.
- b. After 10 seconds, if the integrate button is yellow and the spectrogram is not scrolling, click the start button again.
- c. The visual look of the spectrogram will appear like the image below.

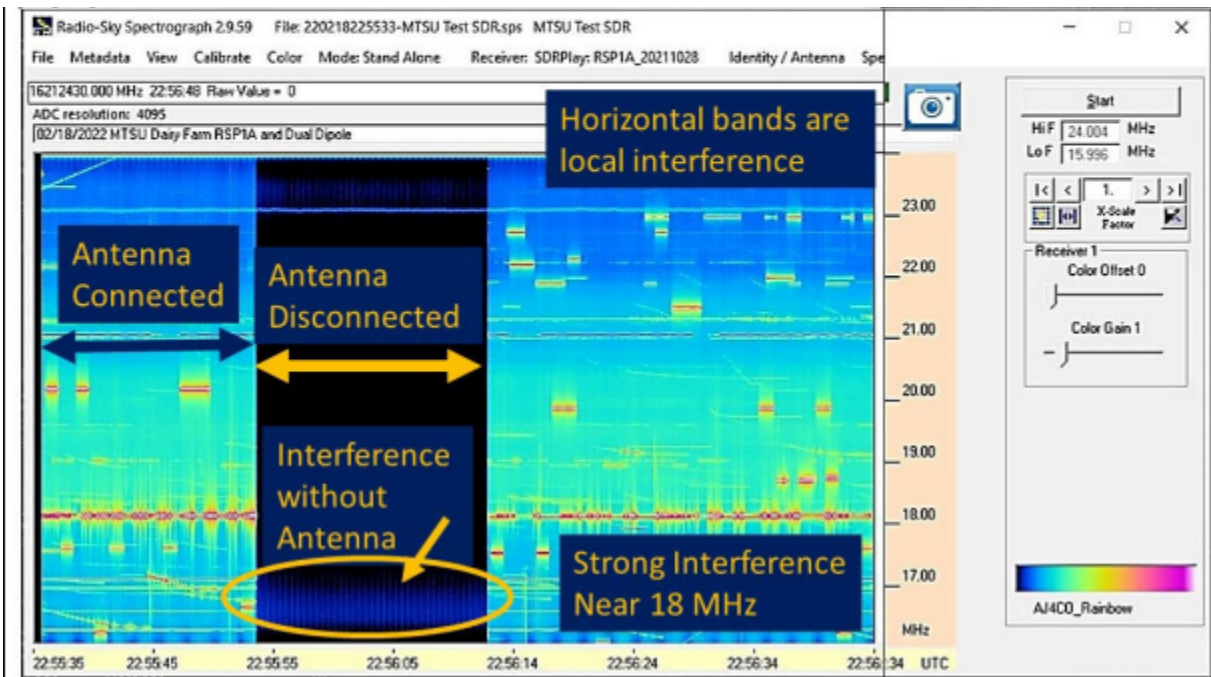


Figure 18: Step 12c

- d. Once the Integrate button turns yellow, there is no need to turn it off in SDRPlay2RSS every time you stop saving data. In other words, after the Integrate button turns yellow, RSS can start and stop collecting data without doing anything in SDRPlay2RSS.
- e. When the system integration fails, the SDRPlay2RSS will display the message “System Argument Exception” and the “integrate” button will **NOT** turn yellow. **This is likely caused by the connection error between the RSP data receiver and the laptop and/or connection error between RSP data receiver and the antenna, therefore check both the USB and coaxial cables.**
- f. Additionally, terminating the software SDRuno can potentially solve the problem as SDRuno and RSS are conflicting data collection softwares. **If that does not work, restart the computer, open RSS again, and you will be good to collect data. If the connection is good but you cannot get data rolling, restarting the PC and reopening the software can solve the problem.**

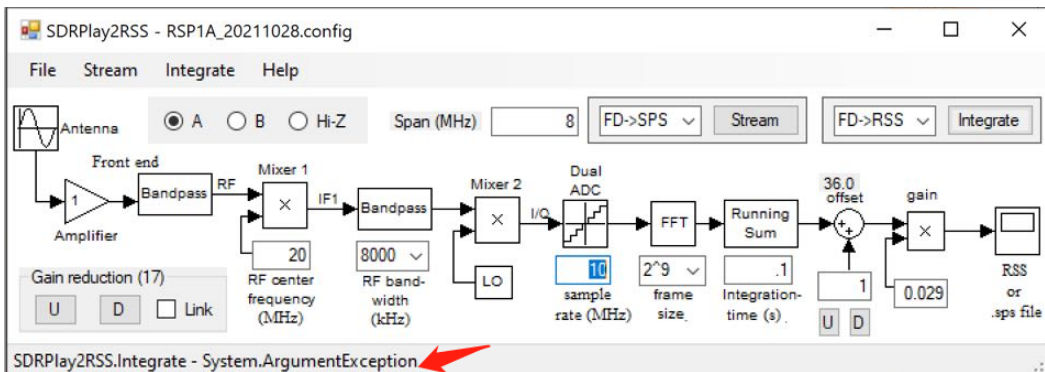


Figure 19: Step 12e

- g. After you click the “Start” button, if the SDRPlay2RSS is not automatically started and RSS is not responding and not scrolling any data (not even a black spectrogram), **restart the computer and open RSS again, you will be ready to collect data.**

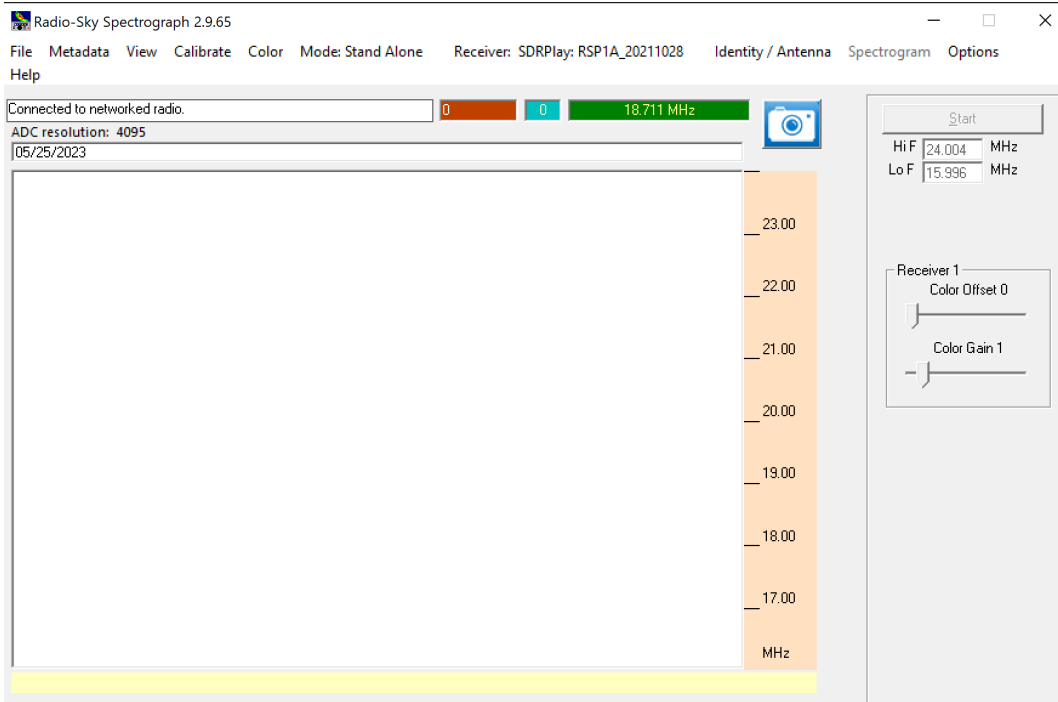


Figure 20: Step 12g

- h. Make sure the connection to the antenna is successful; if the laptop is only connected to the RSP receiver but NOT correctly connected with the antenna, a black spectrogram output will be shown.

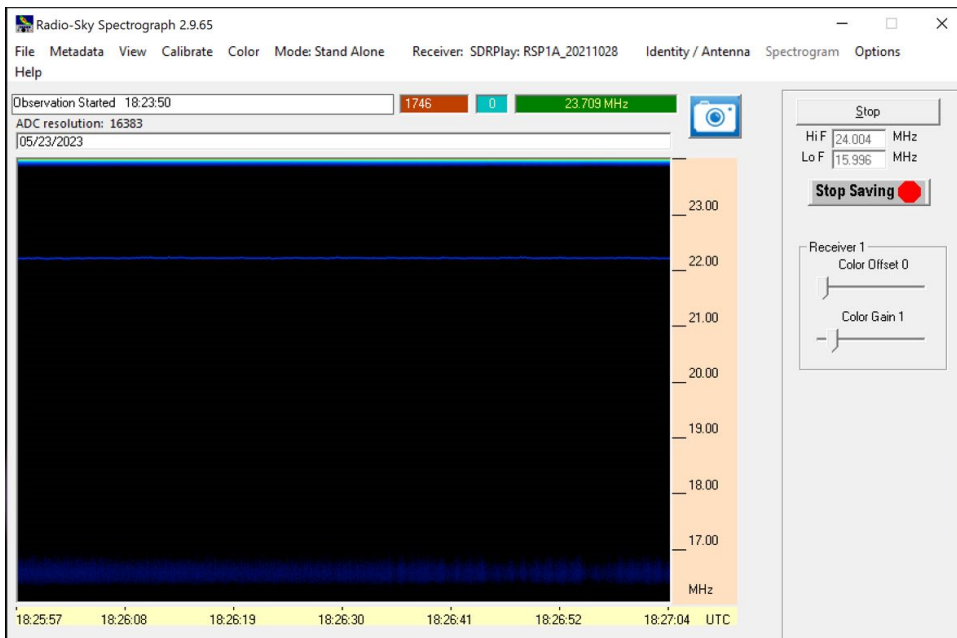


Figure 21: Step 12h

- i. To correctly connect the antenna to the RSP receiver, check: [2. Connect the RSP receiver to the PC with the USB 2.0 type B socket to USB 2.0 type A socket cable.](#) (Click this link for details about the cable connections). If the connection is successful, you will receive a colorful spectrogram.

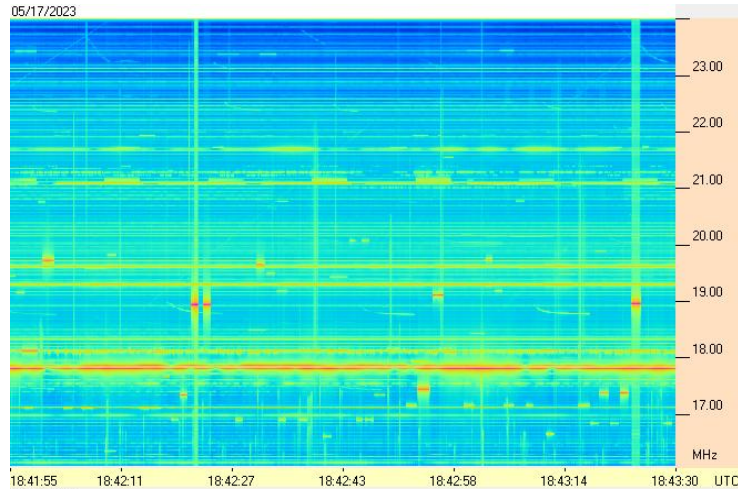


Figure 22: Step 12i

13. When the designated observation time is finished, stop the data transmission by clicking the “Stop” button.

- a. Click the “Stop” button once your observation period is over.

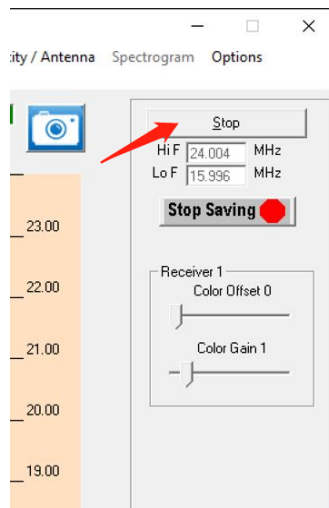


Figure 23: Step 13a

14. Collect the data. We need the data in image and SPS (samples per second binary file format), so first we need to find the session log file.

- a. To get all of this data, we need the session log file in SPS format (which is auto saved). The default file folder location is Documents -> SpecData -> Observatory Name -> Month -> Date.

- b. The file is auto-named after the year-month-date-hour-minute-second-observatory name. Such as 230621175902-Alex-Obs.sps. This file name means that the observation is taken at starting time 2023, June 21th,17:59:02 in UTC time by Alex-Obs. Make sure you are finding the corresponding log file for your current session

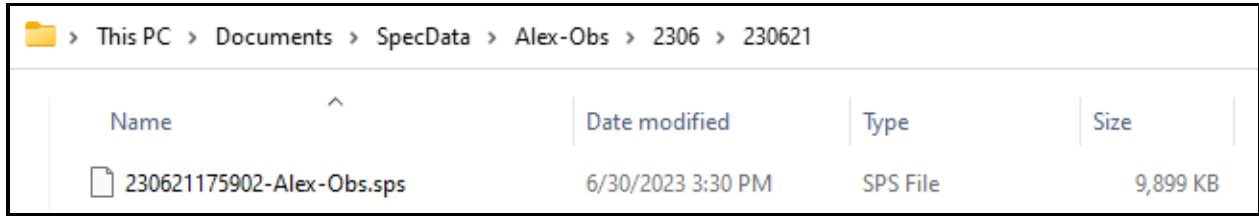


Figure 24: Step 14b

15. Now load the sps session log file that you saved.

- a. Go to File -> Load Data File in the software.
b. Once you see the file in the location mentioned above you want to open it.

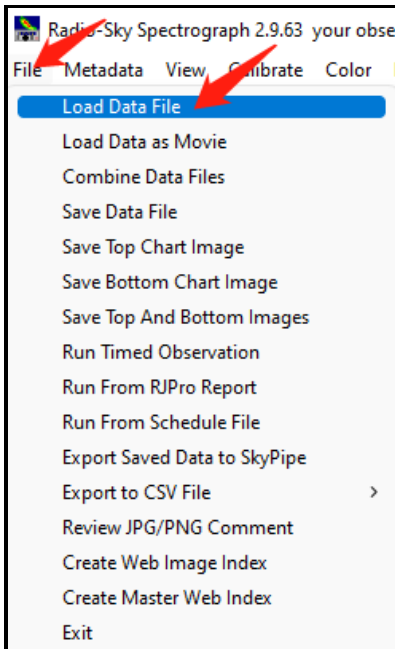


Figure 25: Step 15a

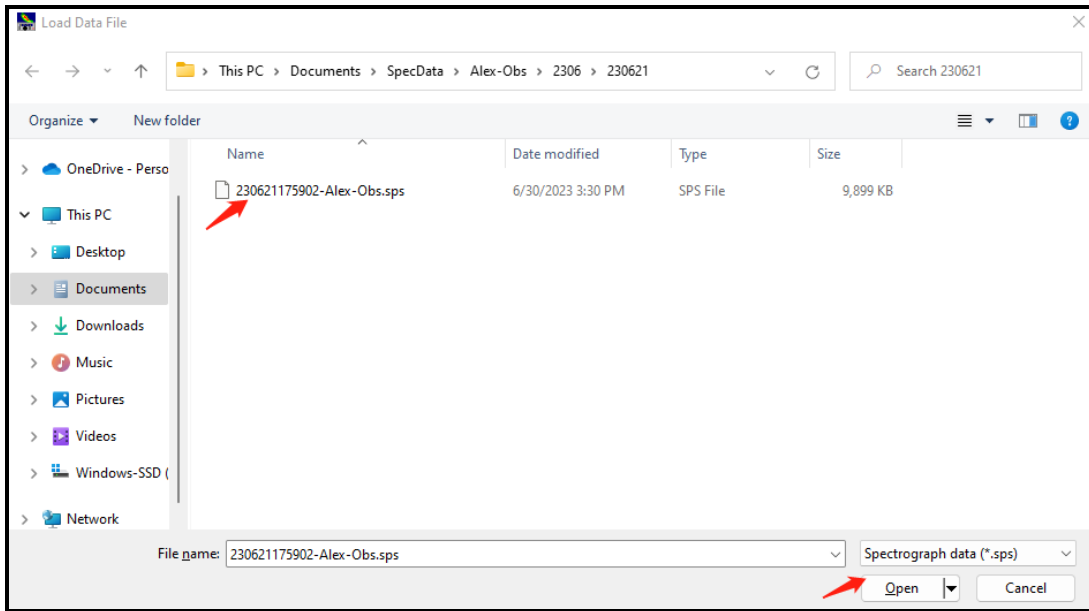


Figure 26: Step 15b

16. Click the double-arrow button to display the spectrogram of the entire observation session.

- a. After loading the SPS file, the first minute of the spectrogram observed will be displayed in the window.

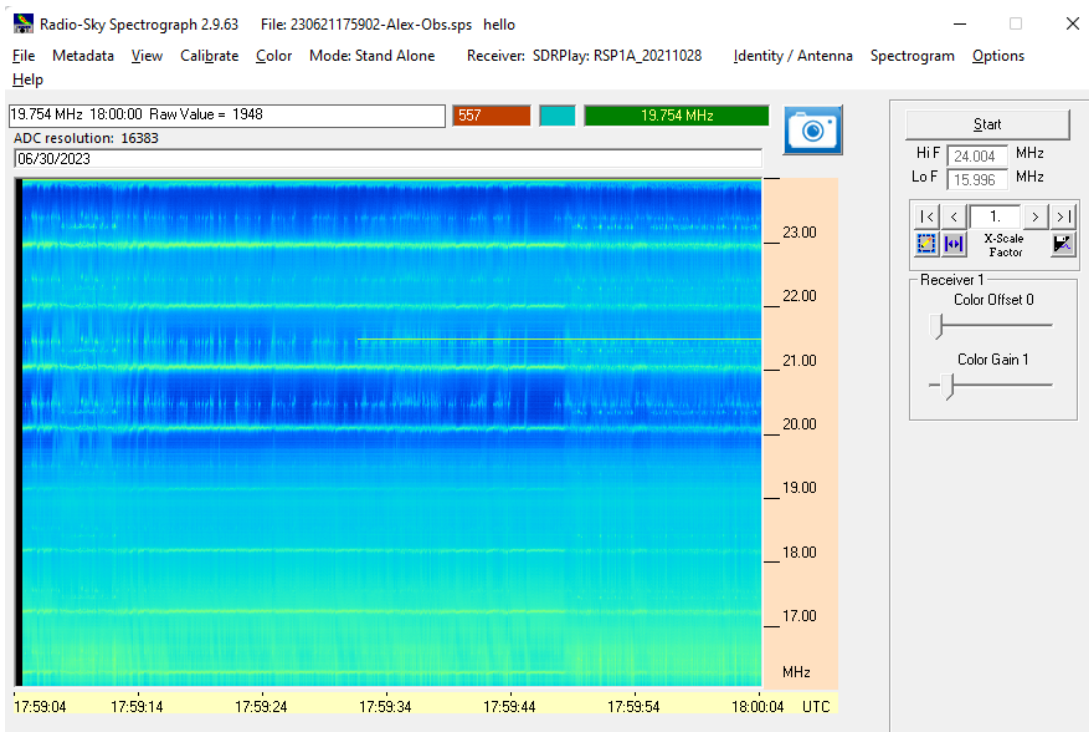


Figure 27: Step 16a

- b. Click the double-arrow button as shown below. The spectrogram for the entire observation session will be displayed. In this example, the image displays the spectrogram of a 20-minute observation.

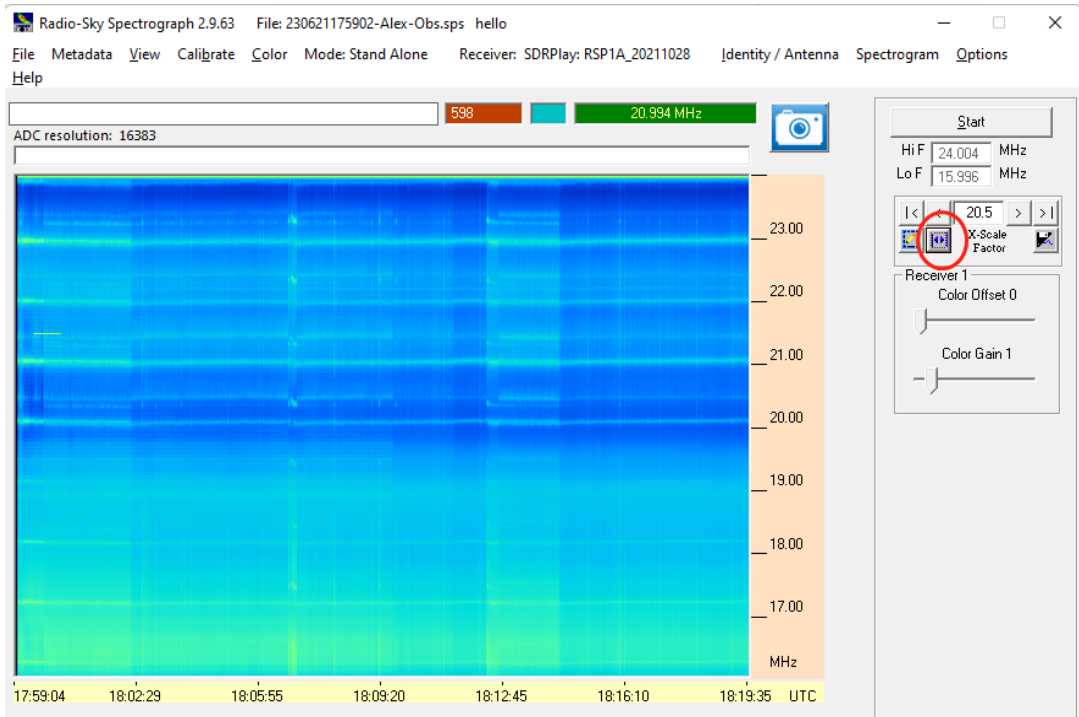


Figure 28: Step 16b

17. Save the data as image format.

- a. Click File -> Save Top Chart Image.

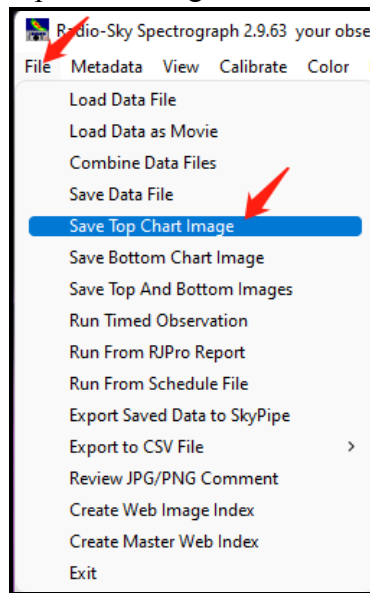


Figure 29: Step 17a

- b. Save it as a JPEG file (.jpg) on your designated file location. You can choose the Desktop as your file location, which is easier to find. But the default file location is Documents -> SpecData

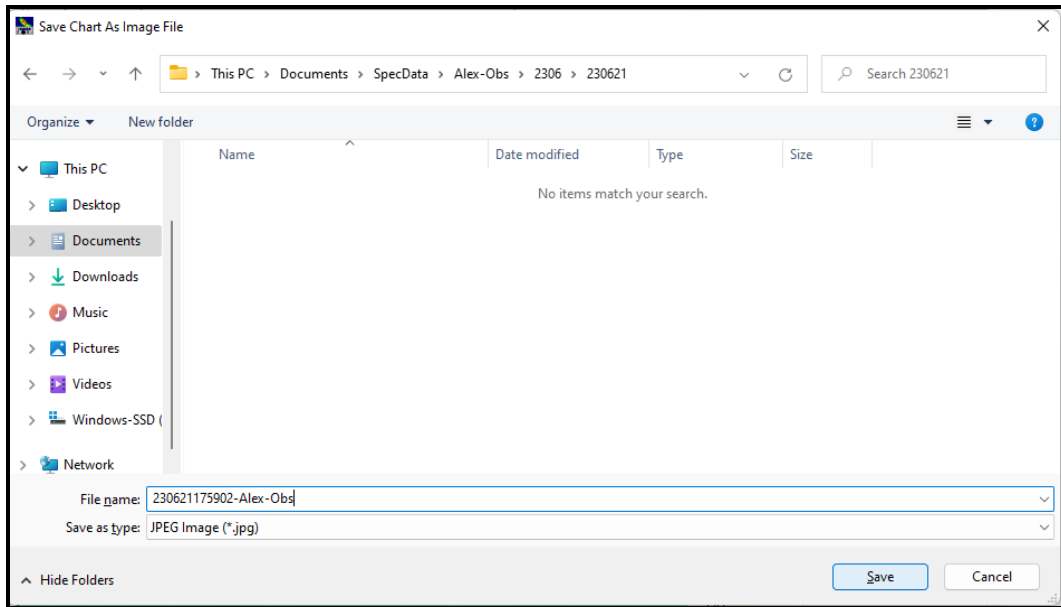


Figure 30: Step 17b

- c. The JPEG image you saved will look something like this.

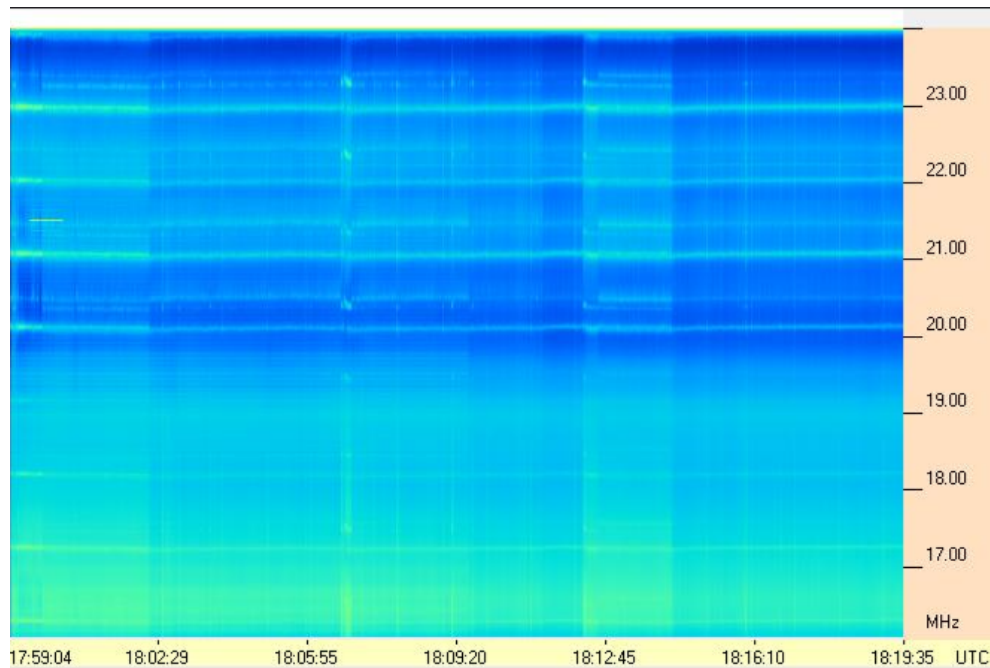
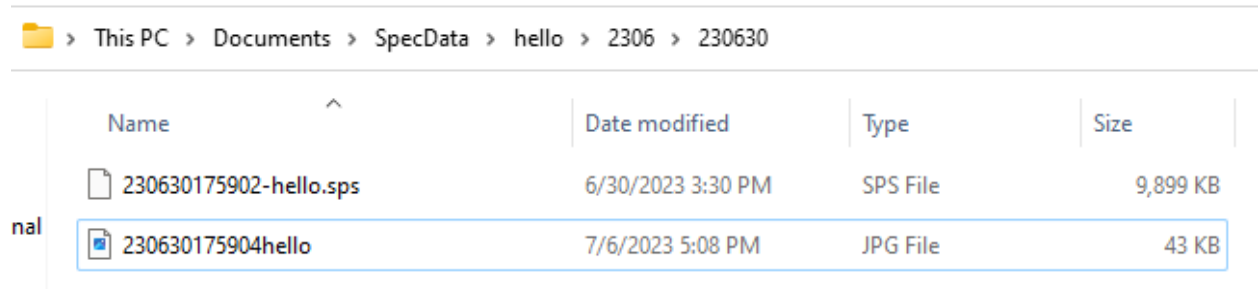


Figure 31: Step 17c

18. Make sure you collect the data in all required formats and inspect the data collected.

- a. The SPS file and image will be located in the same folder. If you see all of these two files, your data collection is complete.



The screenshot shows a Windows File Explorer window with the following path: This PC > Documents > SpecData > hello > 2306 > 230630. The window displays a table of files with the following columns: Name, Date modified, Type, and Size. The file '230630175904hello' is selected and highlighted with a blue border.

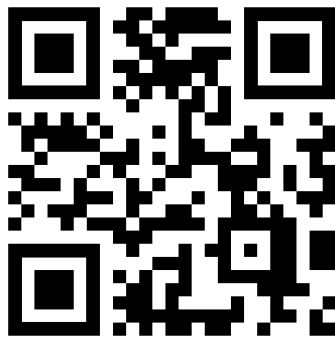
Name	Date modified	Type	Size
230630175902-hello.sps	6/30/2023 3:30 PM	SPS File	9,899 KB
230630175904hello	7/6/2023 5:08 PM	JPG File	43 KB

Figure 32: Step 18a

Congratulations! You are now ready to make radio astronomy observations.

Acknowledgements

SunRISE GRL was sponsored by NASA grant #AWD006989, and hosted at the Department of Climate and Space Sciences and Engineering (CLaSP), University of Michigan College of Engineering, Ann Arbor, MI. The SunRISE GRL team would like to thank 1) the RadioJOVE team for providing the initial antenna design and providing feedback throughout the development of this document (visit <https://radiojove.gsfc.nasa.gov/>); and 2) the students and staff at Skyline High School, Ann Arbor, MI for their support in testing the manual and providing feedback. For more information, visit the SunRISE GRL webpage:



sunrise.umich.edu