Tutorial for Raspberry Shake seismometer users

Prepared for the Seismo@School project in Switzerland
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This tutorial includes:

1. Where and how to install the RaspberryShake seismometer
2. How to configure the RaspberryShake seismometer
3. How to view data recorded by the RaspberryShake seismometer
4. How to stop the RaspberryShake seismometer (do not just unplug!)

Detailed information is available at: https://manual.raspberryshake.org/

The RasperryShake-1D seismometer (from www.raspberryshake.org)

1. Where and how to install the RaspberryShake seismometer

1.1 Where to install? Choose an appropriate location

- As much as possible, the site should be away from sources of seismic noise (vibrations): road, train, machines, etc. In Switzerland you can get an idea of the expected seismic noise level at the http://map.geo.admin.ch website, then looking for the "*Anhtrop. seismic noise CH*" layer. Red colour is noisy, yellow and green are good. Getting away from red areas would be nice, but often difficult to achieve in urban environment such as schools. Still, try to do your best within the existing conditions.
- The lowest floor of a building (basement or ground floor) is recommended.
- Library, Science Lab or any of the less busy rooms could be a potential location.
- The room must be connected with stable, cabled internet connection (ethernet port), and continuous power supply.
- It is better to install the seismometer closer to the corner of the room than at the wall (can be OK) or in the middle of the room (not advised).
- A nearly flat surface is required. Level the seismometer using the three provided screws.

1.2 How to prepare the installation? List of required items and conditions

There are two main situations to install the RaspberryShake seismometer (abbreviated to **RS** hereafter), depending on the number of ethernet connections in the room.

	Case I (a bit easier)	**Case II** (still not too difficult)
Room condition	**2 ×** available ethernet ports 1 × electric power socket	**1 ×** available ethernet port **2 ×** electric power sockets (or 1 × socket and 1 × multiplug)
Items needed to run the RS, staying in the room	1 × RS with its power cable + ethernet cable + levelling screws 1 × transparent portable box (optional, recommended for protection and security)	
Items needed only during the installation of the RS	1 × desktop/laptop with an ethernet port[A] 1 × ethernet cable[B]	1 × desktop/laptop with an ethernet port[A] 2 × ethernet cables[B] 1 × router[C] and its power cable

[A] If your computer doesn't have an ethernet port, an adapter to your computer's USB-port is necessary.

[B] The ethernet cable is also known as RJ45, the name of the connector at its ends.

[C] The router needs at least 3 available ethernet ports, this is usually the case

As long as the computer stays connected to the same IP address as the RS, you can see the waveforms from the RS directly. Otherwise, you can see the waveforms through the internet (see section 3).

1.3 How to install the seismometer?

For the setup of the RS, the RS and a computer need to be connected to the internet using the same IP address. Follow these steps to set up all the necessary cables and connections. On the next page you also find a sketch of the connections during and after installation.

Case I: if 2 ethernet connections are available in the room (a bit easier)

- ✓ Plug one end of the RS's ethernet cable into the ethernet port on the RS, and the other end into one ethernet socket in the room.
- ✓ Plug one end of the other ethernet cable into the ethernet port on your computer, and the other end into the other ethernet socket in the room.

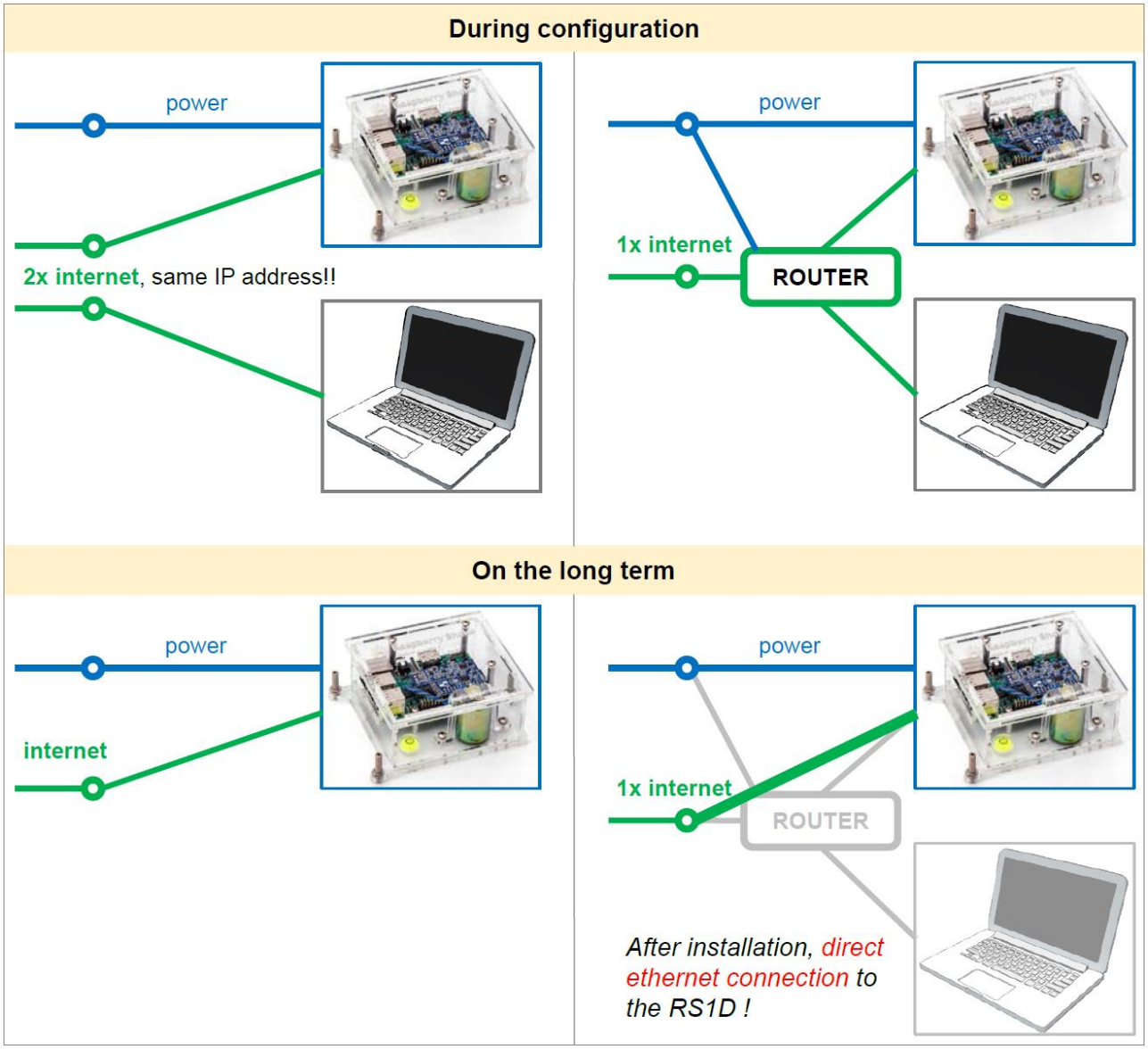
Case II: if only 1 ethernet connection is available in the room (still not too difficult)

- ✓ You will need to use a router. The router can take the single incoming ethernet connection in the room, and make it accessible to multiple users (cables) at the same time. Therefore:
- ✓ Take the 1st ethernet cable and connect the room's ethernet socket to the router.
- ✓ Take the two other ethernet cables (1 from the RS kit + 1 of yours), and plug them into the grouped ethernet ports on the router. These are often labelled "LAN" (local area network), or "LAN1," "LAN2," etc. If you have difficulties finding these connections, please follow the instructions of your router to find out how to do it.
- ✓ Plug the router to the power supply (directly to one of two sockets, or using a multiplug), and power it on. Now, you have cabled internet connection on both output ethernet cables with the same IP address.
- ✓ Plug the free end of the RS's ethernet cable into the RS's ethernet port.
- ✓ Plug the free end of the remaining ethernet cable into the ethernet port on your computer.

Case III: There is no ethernet socket available in the room

It is possible to find a solution in this case as well, but the RS manufacturing company does not recommend it. The reason is that this solution uses wireless internet (Wi-Fi), and that will introduce a high-amplitude noise and spikes to the waveform recording, often seriously compromising the seismic signal. This appears to be a result of the proximity of the Wi-Fi antenna to the Raspberry board itself. Moreover, as the installation requires anyways the computer to be connected to the same IP address as the RS, following Case I or II is preferred. If you still wish to use the Wi-Fi to observe or stream the waveforms, please follow the RS manual (under your own responsibility): https://manual.raspberryshake.org/.

Here is a sketch of the connections for Case I (left) and Case II (right).



2. How to configure the RaspberryShake seismometer

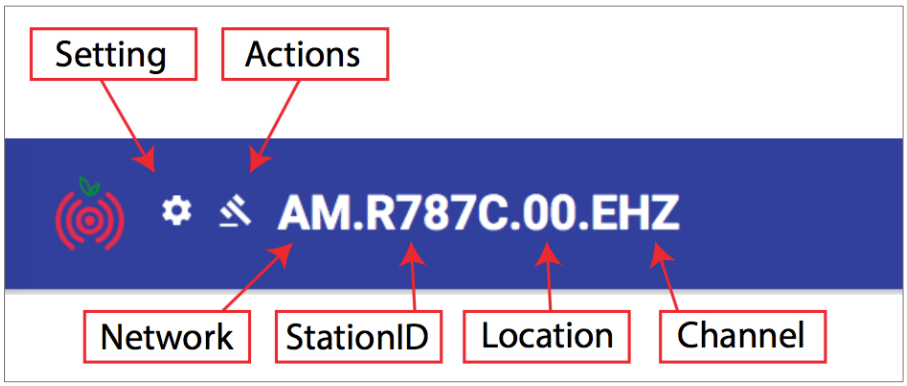
It is here assumed that the previous steps were successful: the RS and the computer are connected to the internet at the same IP address. If this is the case:

- ✓ Level the RS using the three provided screws and the bubble on the RS:  .
- ✓ Then plug the RS to a power supply: this will automatically start it.

  NOTE: *When running your RS for the first time, it will update the software automatically. Depending on your bandwidth and the time since manufacturing, this update could take between a few seconds to several minutes.*
- ✓ Start the computer, and open a web-browser. Go to the page http://rs.local/, which is the interface communicating with the RS (see screenshots below).

  NOTE: *It is here assumed that following section 1 your computer is connected to the internet with an ethernet cable, and* ***not*** *Wi-Fi, otherwise the configuration below will not work. Regarding the web-browser, Google Chrome is preferred as it actively supports web elements. Other browsers may work as well, but not Internet Explorer.*
- ✓ At the top of this page, you will see the menu with two icons: Settings and Actions, followed by a text identifying your seismometer in the following format: *Network.StationID.LocationCode.Channel* .

  The Network is always "AM"; the StationID is your RaspberryShake seismometer's unique identification number; the LocationCode is typically "00"; and the Channel is typically "EHZ" for this kind of seismometer ("Z" refers to vertical-component sensor).



- ✓ Click Settings to access the page where the RS should be configured.
- ✓ Under the first tab "GENERAL", insert the following parameters:

Did you receive the geophone with the Raspberry Shake?	**Yes**
How will you use your Shake?	**Education**
First name	*Enter your name*
Last name	*Enter your name*
E-mail	*Enter your e-mail address*[A]

Latitude	*Enter the RS location's latitude*[B]
Longitude	*Enter the RS location's longitude*[B]
Elevation	*Enter the RS location's elevation*[B]
Floor the instrument is on	*Enter 0 for ground floor, or 1 for 1st floor, –1 for underground basement, etc.*
Total floors in building	*Enter the number of the highest floor*

[A] Your e-mail address will only be used if your station has not been working for 3, and then for 31 days; in that case you'll receive a notification message from RaspberryShake.

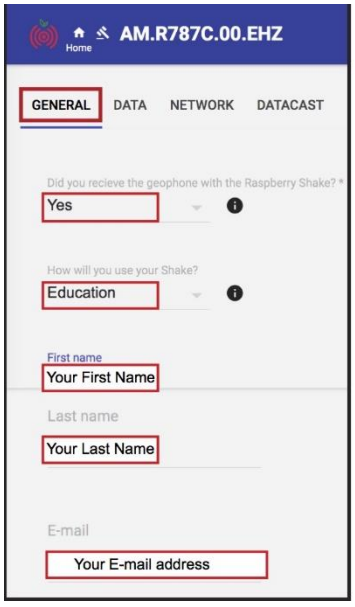
[B] In Switzerland you can find out the **latitude**, **longitude**, and **elevation** of the sensor location using https://map.geo.admin.ch/. By default, the coordinates (see bottom left) are in "CH1903+/LV95" format, change this to "WGS 84 (lat/lon)". For example, Le Sommet des Diablerets is at 46.3039°N latitude, 7.1809°E longitude, and 3210 meters elevation. Always use the decimal co-ordinate format, and do not use the degrees-minutes-seconds format. Please find and enter the location of your sensor precisely.

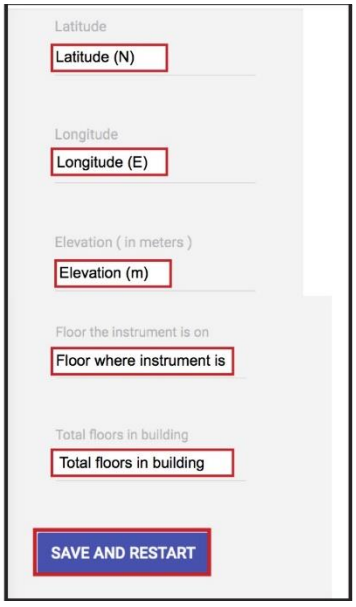
✓ When the "GENERAL" tab is complete, scroll to the top (don't press yet "SAVE AND RESTART"!), and select the second tab "DATA"; then fill the parameters as follows:

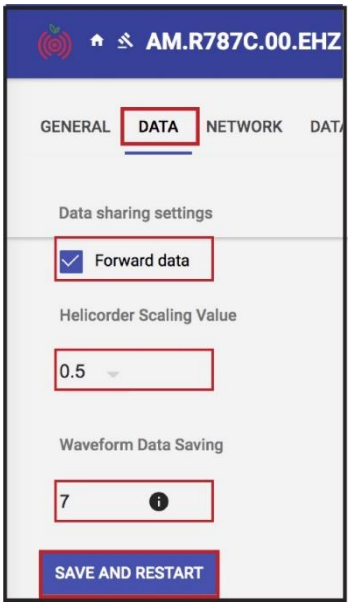
Data sharing settings	**Tick** "Forward data"
Helicorder Scaling Value	**0.5**
Waveform Data Saving	**7**[A]

[A] This is the number of days during which the waveforms are saved on the memory disk in the RS. The expected amount if data is around 6 MB per day and per channel.

Here are example screenshots of the configuration: the GENERAL and DATA tabs.



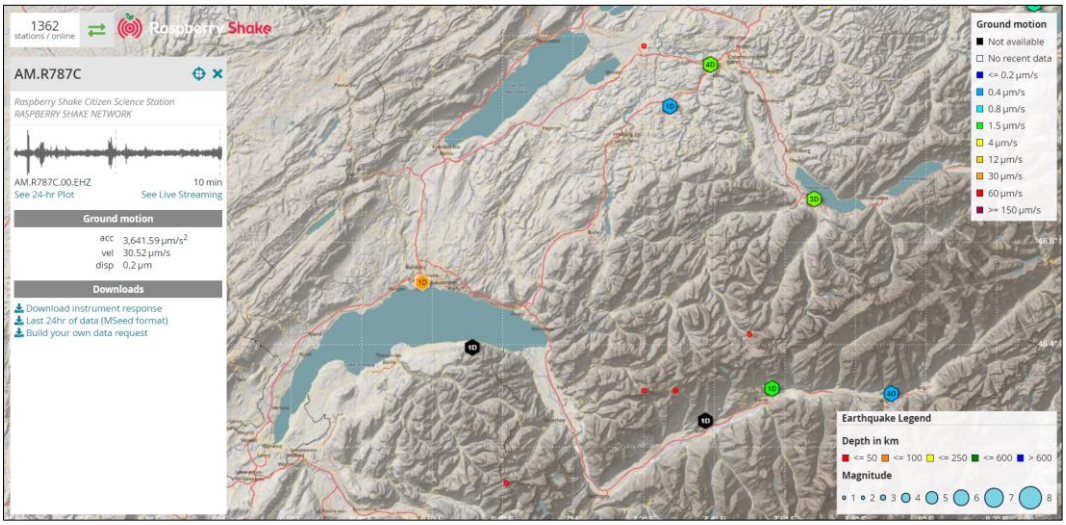




- ✓ When both the "GENERAL" and "DATA" tabs are completes, save these settings by pressing the "SAVE AND RESTART" button at the bottom. Wait a few minutes, and then you should see status of the seismometer on the screen, as on the screenshot below. (NOTE: if you are prompted to enter a password, the default is "**shakeme**".)

Raspberry Pi Model	: 3 Model B
System Status	: RUNNING
System Version	: XXX
Ethernet Local IPv4	: 130.XXX.XX.XXX
Ethernet MAC	: XXX
Data Producer	: ON
Data Consumer	: ON
Stand-Alone	: OFF
Data Forwarding	: ON
Server Connection	: Connected
Latitude	: XX
Longitude	: XX
Elevation	: XXX m

- ✓ Your station will soon be visible in real-time on the RaspberryShake's "StationView" webpage: https://stationview.raspberryshake.org/. The update time of that map is beyond our control, but you can expect your station to appear there typically between a couple of minutes and one hour. Click on the symbol at your location, then a frame with the last 10 minutes of waveforms will open. Jump near your station, the effect should be visible directly on the web.
- ✓ EVERYONE on Earth can see that!
- ✓ NOTE: please send us an e-mail with StationID, Latitude, Longitude, Elevation, or/and a screenshot of successful http://rs.local page. We will share the station information across the Seismo@School network.



3. How to view data recorded by the RaspberryShake seismometer

There are numerous ways to visualize the waveforms recorded by your RS, both using a smartphone app or a computer program. Here we mention a few easy and useful options.

Mode / Name	Computer, local connection mode	Computer, remote mode	Smartphone app, Android	Smartphone app, iOS
EQInfo	no	no	YES	no
ShakeNet	no	no	YES	YES
Helicorder	YES	no	no	no
jAmaSeis	YES	YES	no	no
Swarm	no	YES	no	no

3.1 EQInfo – a smartphone app suitable for classroom and home use

- ✓ Install the EQInfo application on your smartphone (Android only), available from here in several languages: https://play.google.com/store/apps/details?id=de.gempa.android.eqinfo
- ✓ Open the EQInfo application on your smartphone.
- ✓ Go to the **Settings** option at top right corner.
- ✓ Go to the **Seismic data** option and enable the **Show** option.
- ✓ Tick the **Use my own RaspberryShake** option.
- ✓ **Your RaspberryShake ID**: enter the 5-letter stationID of your seismometer, starting with 'R' or 'S' (the one used as an example in this tutorial was *R787C*).
- ✓ **Select the channel to be displayed**: enter the channel name, typically EHZ or SHZ for vertical component seismometers (in this tutorial it was *EHZ*).
- ✓ Go back twice, and click on **Shake Live** (right-pointing triangle on the top right corner) to display the real-time waveform recordings.
- ✓ To see waveforms of specific earthquakes, you can simply click on any earthquake from the displayed list. The corresponding time window with the assumed P-wave arrival will appear.

3.2 ShakeNet – a smartphone app from RaspberryShake directly

Recently, RaspberryShake lunched its own application, called ShakeNet. It is available for all devices at: https://play.google.com/store/apps/details?id=org.raspberryshake.app

There is a very rich choice of options, e.g., to see waveforms, spectra, earthquakes; moreover, the app is being further developed. Explore the available options yourself – full options may be available only following registration using the same e-mail address as during RS setup!

3.3 Helicorder – with your computer in directly connected mode

The Helicorder plot (http://rs.local/heli/) is a web-based application and it works only if your computer is connected to the same IP address as your RS. Go to the page above, and select from the time windows: the pictures display 12 hours of data. These are static image files, the latest one is the most recently updated one. Earthquakes, day vs. night seismic noise differences, and other perturbations should be easy to see this way.

3.4 jAmaSeis – a computer program both for connected and remote mode

The main advantage of this software is the capability to display waveforms from several stations simultaneously, and that it works both for local connection mode (same IP address as RS) and remotely as well. Moreover, jAmaSeis can be used to determine earthquake locations and magnitudes. It was developed by IRIS for the "Seismographs in Schools" program. Raspberry Shake funded the changes need to make jAmaSeis compatible with RaspberryShake in early 2017. The jAmaSeis software can be installed on all computer platforms (Windows, Mac, Linux), and can be downloaded from the IRIS website at http://www.iris.edu/hq/jamaseis/. To see waveforms on your screen, you need to add the respective stations one by one manually in jAmaSeis. Below are the step-by-step instructions.

Installation on Windows and Mac

- ✓ For Windows and Mac, there is a designated installer for each operating system: a .exe-file for Windows and a .dmg-file for Mac.
- ✓ For Windows, you might need to determine whether you are running a 32- or 64-bit system. You can use this link to find out the answer: http://windows.microsoft.com/en-us/windows/32-bit-and-64-bit-windows#1TC=windows-7.
- ✓ The Java software is required for running jAmaSeis on your computer. If the computer does not have Java yet, please visit https://java.com/en/download/ for information and instructions.
- ✓ Download the appropriate version of the jAmaSeis software from https://www.iris.edu/hq/jamaseis/. Double-click the downloaded file, and install jAmaSeis on your computer.

Observing waveforms of your or any other RaspberryShake

- ✓ Open the jAmaSeis software.
- ✓ Go to **File** >> **Add Source**. Click on the "**Raspberry Shake**" button. There are two options:

  A. To add your local RS (if the computer is connected to the same IP address):
     - Enter "**rs.local:18000**", (or your RaspberryShake's actual IP address with port 18000, for example *XXX.XXX.XXX.XXX:18000*).

  B. For any remote RaspberryShake seismometer around the world:
     - Enter RaspberryShake's SeedLink IP port: "**raspberryshakedata.com**".

- Click on the "**Get Stations**" button below the IP port field. This will interrogate the Raspberry Shake server and automatically populate the fields for you. Once the drop-down list in the first line is available for selection, select the remote station by its ID, for example AM_R787C_00_EHZ for the example in this tutorial.

✓ Press **OK**. You should see your recently selected RaspberryShake listed as a source. Repeat from "Add source" (now in the bottom left) if you would like to add other stations (the maximum is 3).

✓ When ready with selecting sources, press the "**OK**" button which will close the "**Sources Manager**" window.

✓ The recorded waveforms at the selected stations should now appear in the main window. Wait a while (a minute or two) to see the screen getting populated with data.

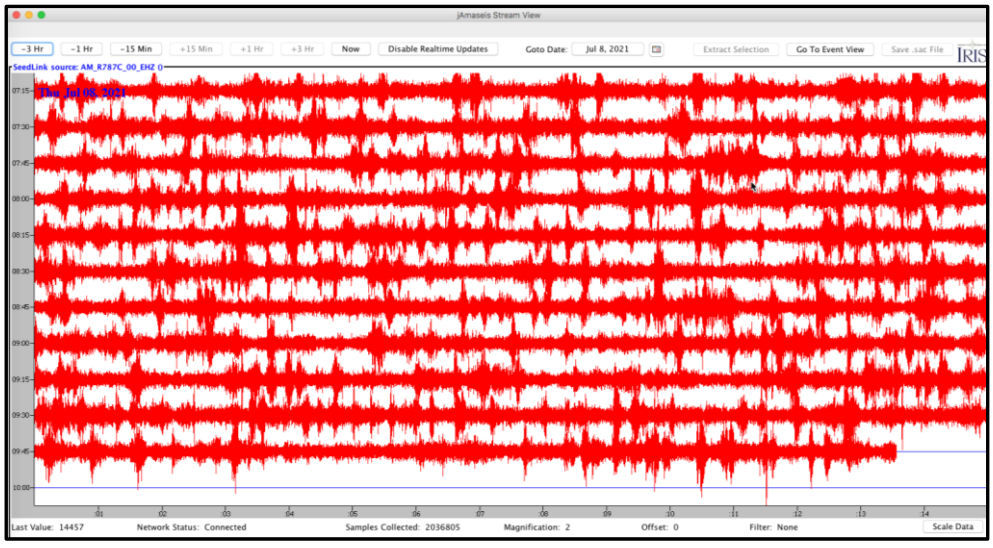
✓ To change the default display settings, go to **File** (on top left corner) >> **Settings** >> **Stream View** and adjust the following parameters according to your preferences:

- **Number of Helicorder Lines:** the number of waveforms lines: 1, 2, 4, 8, 12 or 24 (e.g., 12 on the screenshot below)

✓ **Time per Line (in minutes):** the time window on a single waveform line: 1, 2, 5, 10, 15, 30 or 60 (e.g., 15 on the screenshot below)

✓ To change the waveforms' colour, go to **File** >> **Settings** >> **Fonts and Colors** >> **Plot Color**. Select your preferred color and click "**OK**".

✓ Please try any other setting.



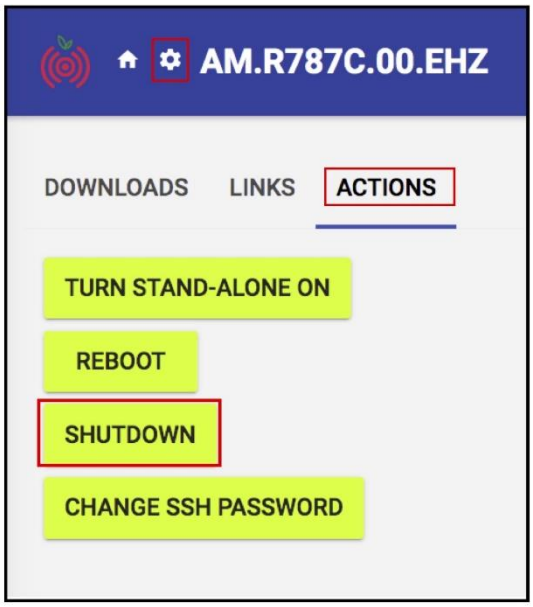
NOTE: You can add several type of remote seismometers into the jAmaSeis interface, the available options being: Mars, Local, Remote, IRIS DMC, Web Services, Raspberry Shake, SeedLink. Note that to add different sources, you need to specify a valid SeedLink IP port. In this tutorial we only explain the setup of Raspberry Shake sources.

3.5 Swarm – for advanced use

The Swarm software is provided by the United States Geological Service, and is available for download at https://volcanoes.usgs.gov/software/swarm/download.shtml.
Its usage is suitable for amateurs and students but also for scientists and professionals. We think this tool is very good but goes beyond the level most schools may use Seismo@School data. However, for anyone interested in filters, spectra, more physics that can be done using seismic waveforms, we really encourage you to try it.

4. How to stop the RaspberryShake seismometer (do not just unplug!)

- ✓ If you plan to move the RS seismometer to another location, or simply plan to stop recording, please **DO NOT** unplug the power cable without proper shutdown of the seismometer. It would cause damage to the memory card (SD card) in most of the cases.
- ✓ To shut down the RS properly, you need to have a computer or laptop connected as for installation. It is OK to manipulate the ethernet connection of the RS as long as the power remains connected.
- ✓ Once your computer is connected to the same IP address as the RS, go to the RS interface page as usual: http://rs.local/ >> **Actions** >> **ACTIONS** Tab (see screenshot below).
- ✓ Press the "**SHUTDOWN**" button.
- ✓ Press "**OK**" in the pop-up window for confirmation, and wait for a couple of seconds until the "Raspberry Shake is down" message appears.
- ✓ Once you are sure that the RS is shut down, you can disconnect everything.



The most likely trouble

It is possible that in your school the internet network has a very restrictive firewall that prohibits useful communication with the outside world. It is not uncommon in schools for even internal communications to be restricted. If you experience communication problems (e.g., your RS does not appear on StationView after 1 hour) and suspect this is because of firewall permission issues, please contact to your school's system administrator and ask their help to access/open the required internet ports. They will probably ask for your RS seismometer's IP address and MAC address, which are displayed at the http://rs.local page.