

# **DATV-Red Release-V4.9**

## **User Manual**

github pages of Ohan ZS1SCI

collected by Rolf DJ7TH

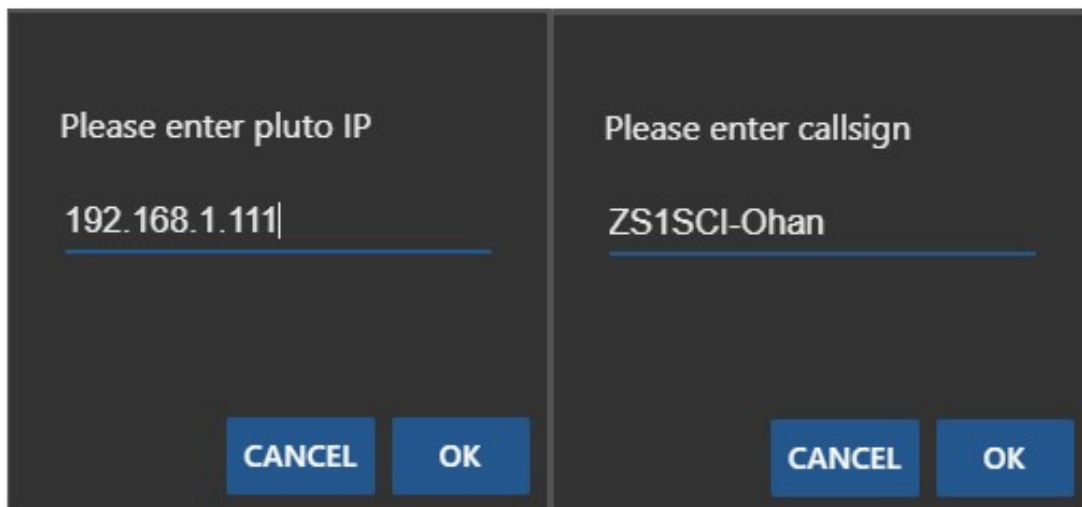
May-June 2024

## Prerequisite

- Latest PlutoDVB2 [firmware](#)
- Please see [flashing steps](#)

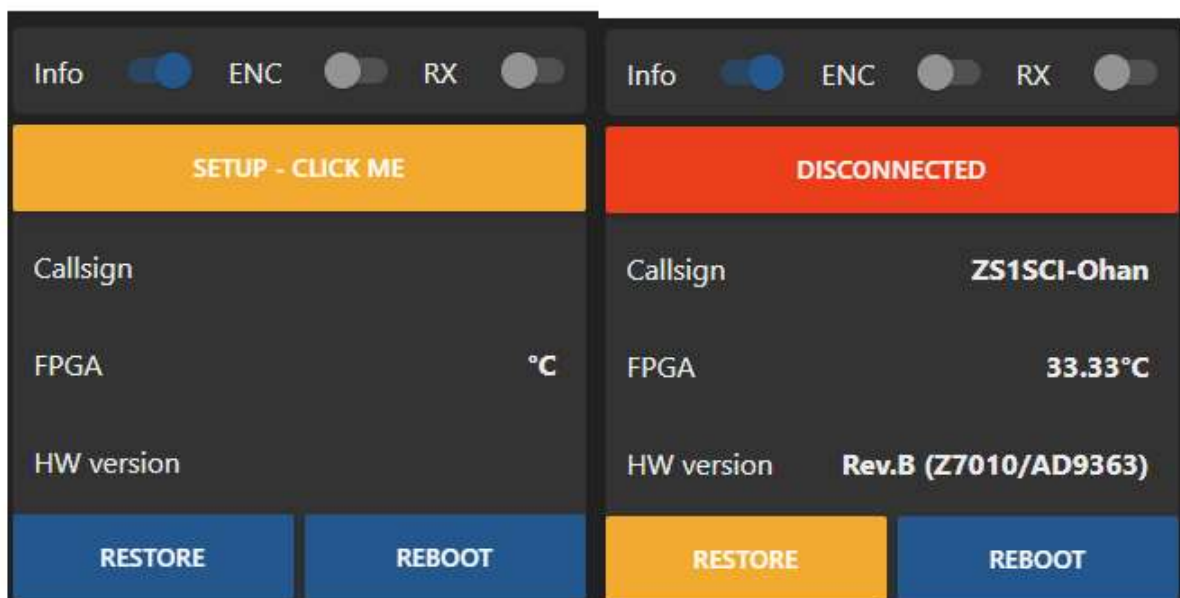
## Setup and use

1. Download [latest release](#) and extract to folder `DATV-Red`
2. Open the `DATV-RED.exe` on windows or `./DATV-Start-Linux.sh` on Linux
3. Fill in pluto IP and callsign when prompted



<p>Please enter pluto IP</p> <p>192.168.1.111</p> <p>CANCEL OK</p>	<p>Please enter callsign</p> <p>ZS1SCI-Ohan</p> <p>CANCEL OK</p>
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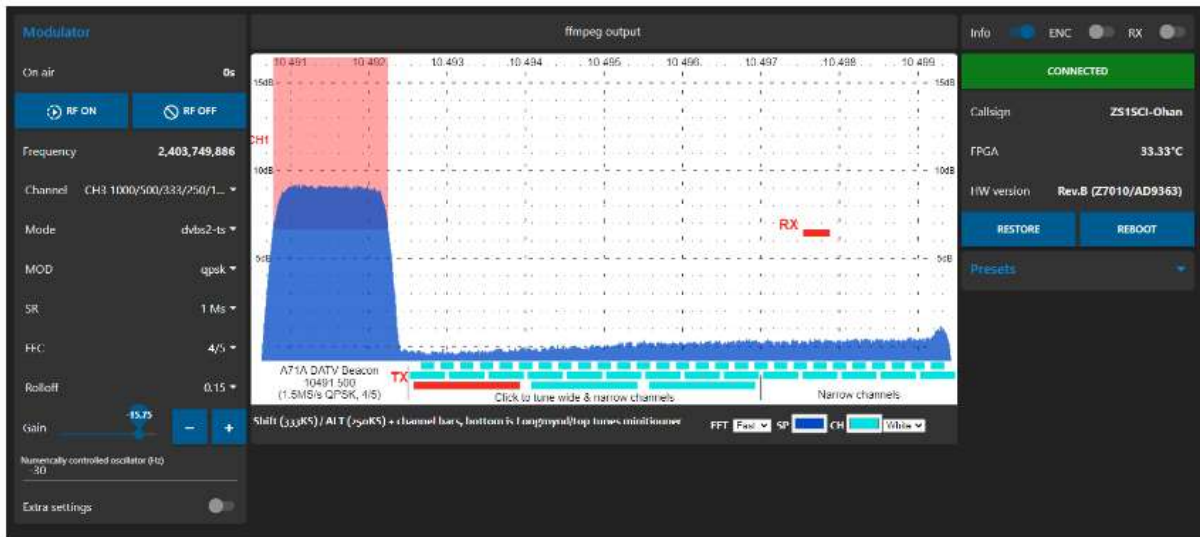
- If you missed this prompt or cancelled, please click the setup button after which the mqtt paths will be set and the pluto will restart, wait about 15s



<p>Info <input checked="" type="checkbox"/> ENC <input type="checkbox"/> RX <input type="checkbox"/></p> <p><b>SETUP - CLICK ME</b></p> <p>Callsign</p> <p>FPGA °C</p> <p>HW version</p> <p>RESTORE REBOOT</p>	<p>Info <input checked="" type="checkbox"/> ENC <input type="checkbox"/> RX <input type="checkbox"/></p> <p><b>DISCONNECTED</b></p> <p>Callsign <b>ZS1SCI-Ohan</b></p> <p>FPGA <b>33.33°C</b></p> <p>HW version <b>Rev.B (Z7010/AD9363)</b></p> <p>RESTORE REBOOT</p>
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4. Please refer to the [Wiki](#) for more setup details (see below)

5. You will see the default view, please toggle the radio buttons to enable and disable UI components to your liking.



## Thanks

Batch files previously used in this project were from DL5OCD Michael and his [DATV-NotSoEasy project](#)

Node Red flows inspired by project from PE2JKO [from this post](#)

## Supporting my hobby

If you'd like to say thanks, please feel free to buy me some [coffee](#) or [time](#)

# Welcome to the DATV-Red wiki!

- The South African German army knife of all things DATV

This project was build out of curiosity and brute force will by Ohan ZS1SCI :)

## If there is a problem

Please raise an [issue](#) and include a copy of `device.json` and `settings.json` from the settings directory in the project.

## Motivation

DATV transmissions normally have the following programs open:

1. OBS (Presentation layer)
2. DATV-Easy/FreeStreamCoder/ your own scripts (encoder)
3. Browser page for PlutoSDR
4. OpenTuner / Minitioune
5. QuickTune / Chat

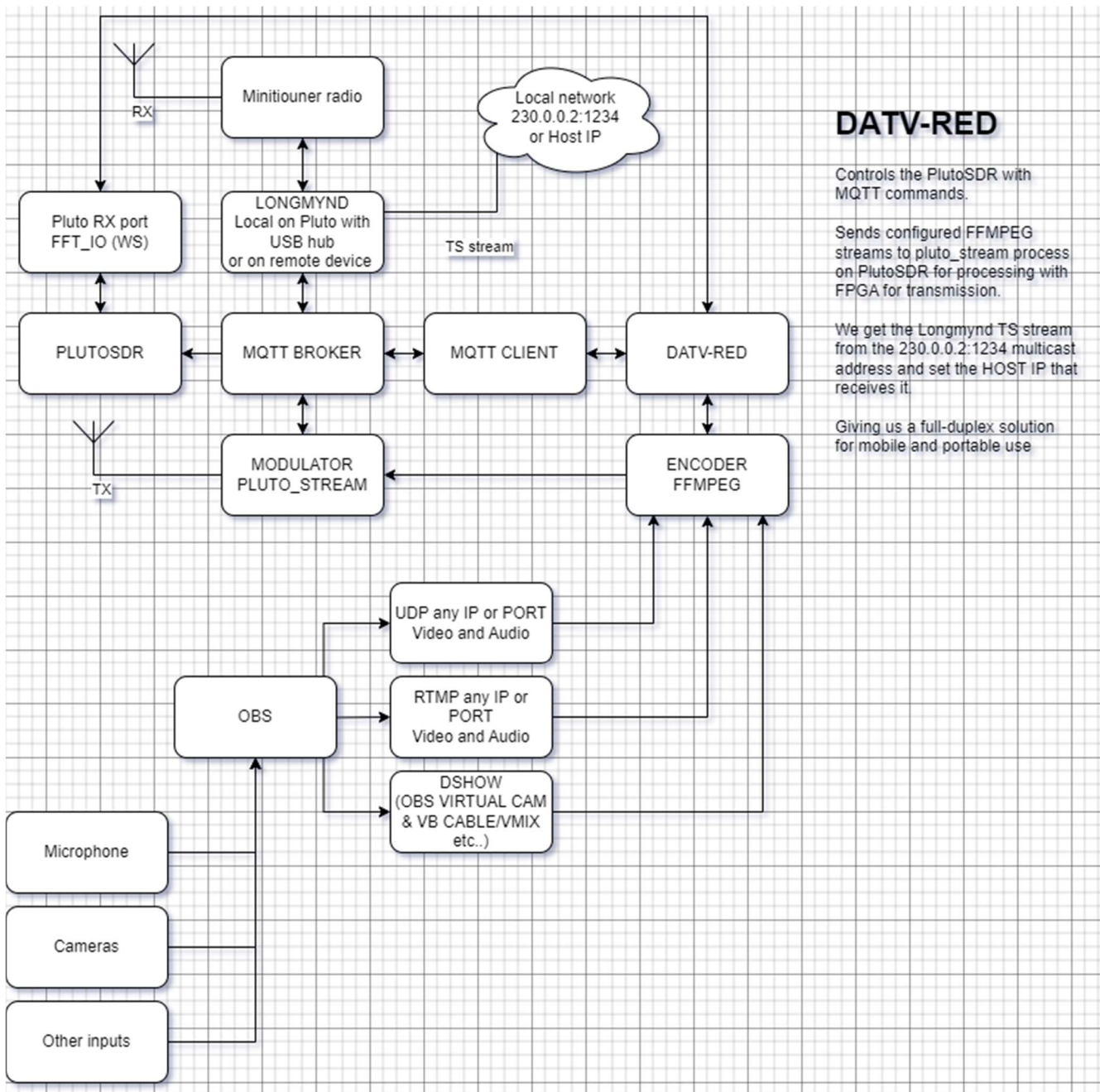
DATV-RED tries to combine most of these functionalities into one interface.



# Capabilities of DATV-Red

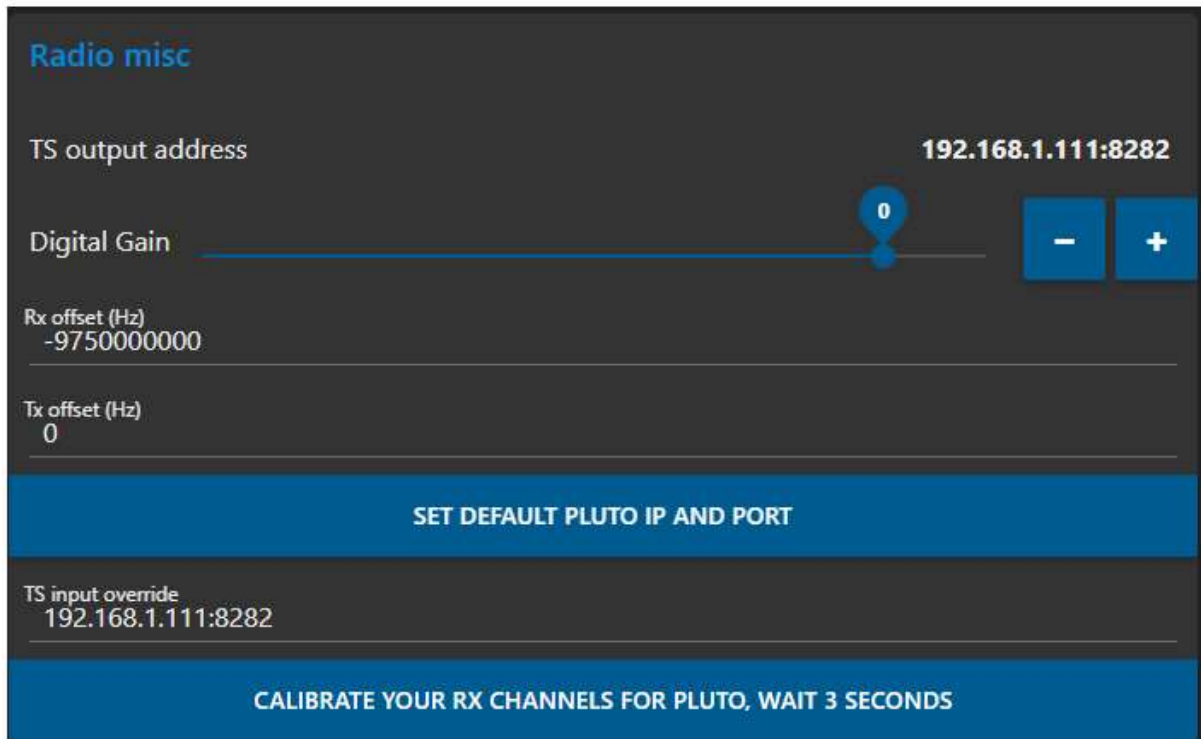
- Encoding of TS data (Tx)
- Tuning of onboard longmynd server
  - Requires `USB hub` or `Longmynd mqtt` on local network connected to pluto broker.
  - Refer to [wiki](#) (Rx)
  - Further eliminates software dependencies
- Operation of PlutoSDR RF modulator parameters (Tx)
- **DVB-GSE** (Tx & Rx)
  - You can view each others dashboard on tunnel IPs
  - AV1 QSO's using SRT
- **(Windows)** Sends UDP payload to `Minitioune` software control address (Rx)
  - Tunes Minitiouner radio using `Minitioune` software
  - Tunes `WinterHill` too
  - OpenTuner support pending
- Optional chat (QoL)
- Optional SONOFF tasmota support (QoL)
  - HTML and MQTT support
    - Switch must be connected to pluto mqtt broker
- Cross-platform
- **No internet needed** also supports `FFT` from pluto rx port
  - Use onboard spectrum from pluto to tune to signals
    - Enables simple mobile operation of DATV
  - Supports separate BATC spectrum sources
    - Requires that you have a `Raspberry Pi 4` and an `Airspy R2`
    - Please see Tom ZR6TG's [post](#) on setup

# DATV-Red visual flow chart



# First steps

- Calibrate the rx table, so that if you click on the spectrum bars it has the right frequencies in modulator channel dropdown



- It take about three seconds, stepping through all known frequencies

## SSH host key checking

add to .ssh/config the following, my pluto IP is 192.168.1.111

```
Host 192.168.1.111
  HostName 192.168.1.111
  User root
  StrictHostKeyChecking no
```

- Windows
  - `ssh -o UserKnownHostsFile=\\.\NUL 192.168.1.111`
- Linux
  - `ssh -o UserKnownHostsFile=/dev/null 192.168.1.111`

## Flashing steps

- Always find the latest firmware [here](#)
- Use the update script like this using pluto IP Address and path to FW file

```
.\scripts\update_firmware.cmd 192.168.1.111 '.\pluto.frm'
```

```

PS F:\Radio\Q0-100\DATV-Red\scripts> .\update_firmware.cmd 192.168.1.111 '.\pluto.frm'
Warning: Permanently added '192.168.1.111' (ED25519) to the list of known hosts.
root@192.168.1.111's password:
pluto.frm                                                    100%  22MB  7.5MB/s  00:02
Updating firmware
Warning: Permanently added '192.168.1.111' (ED25519) to the list of known hosts.
root@192.168.1.111's password:
350+1 records in
350+1 records out
Done
Rebooting pluto
Press any key to continue . . .
PS F:\Radio\Q0-100\DATV-Red\scripts> |

```

- If coming from firmware lower than 0303 please first upgrade to [0303](#)
- If you're unfamiliar with the procedure please see my [0303 to latest FW flashing walk through video](#)

## Multicast support for pluto

- Change `config.txt`
- This is so that onboard `longmynd` can send to `230.0.0.2:1234`.

```

# Analog Devices PlutoSDR Rev.B (Z7010-AD9363)
# Device Configuration File
# 1. Open with an Editor
# 2. Edit this file
# 3. Save this file on the device USB drive
# 4. Eject the device USB Drive
# Doc: https://wiki.analog.com/university/tools/pluto/users/customizing

[NETWORK]
hostname = pluto
ipaddr = 192.168.2.1
ipaddr_host = 192.168.2.10
netmask = 255.255.255.0

[WLAN]
ssid_wlan =
pwd_wlan =
ipaddr_wlan =

[USB_ETHERNET]
ipaddr_eth =
netmask_eth = 255.255.255.0
gateway_eth = 192.168.1.1

[SYSTEM]
xo_correction =
udc_handle_suspend = 0

[ACTIONS]
diagnostic_report = 0
dfu = 0
reset = 0
calibrate = 0

```

- Add `gateway_eth = x.x.x.x` with your internet gateway IP
- Then reboot pluto



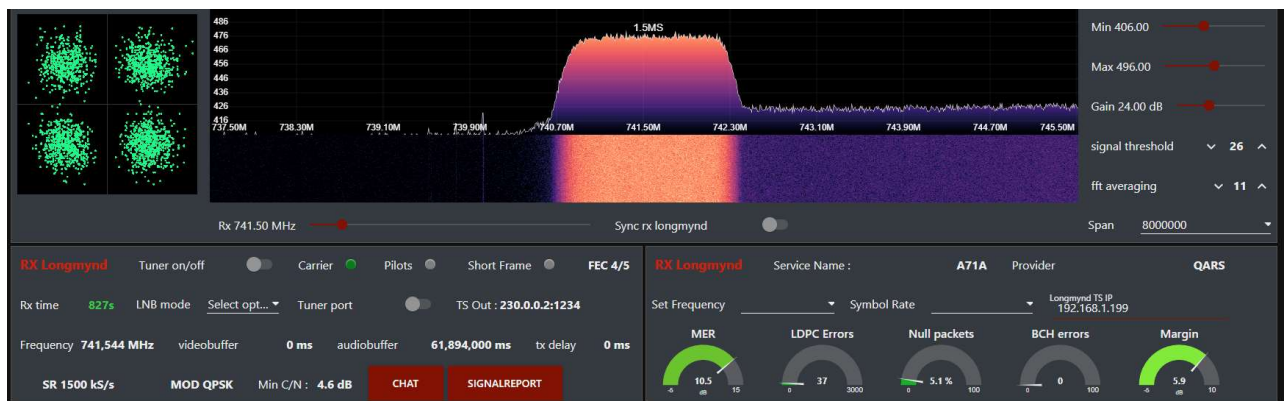
# DATV Red pages

## Transmission and profiles

- Transmission section
  - All settings related to encoding and transmitting a DATV signal
  - Clicking on signals in the spectrum tunes your setup receivers
  - Bottom signal is longmynd
  - Top of signal is for setup receivers
  - Left in modulator settings(radio)
  - Right is encoder settings(ffmpeg)

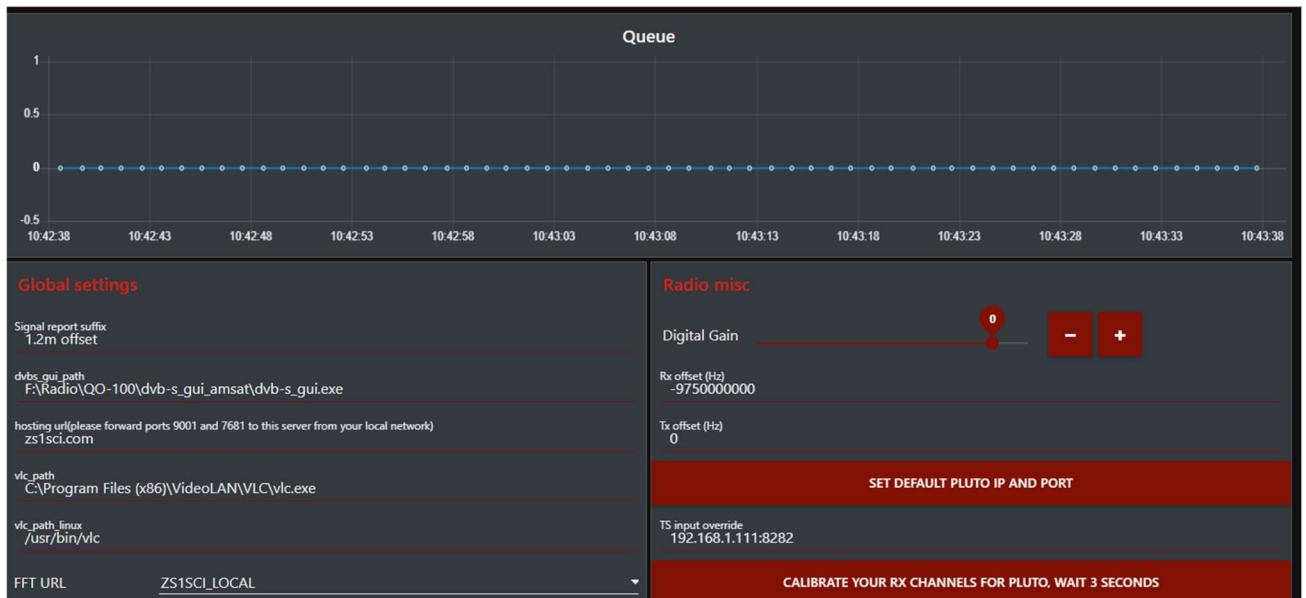


- Reception section
  - You can manipulate the spectrum with
  - Frequency, span, min/max, gain and averaging
  - Click on signals to tune onboard longmynd
  - Set the Host IP for receiving TS stream from 230.0.0.2:1234



# Stats and settings

- Signal report suffix
- Application paths for Windows and Linux
- Hosting URL (<http://zs1sci.com:1880/ui>)
  - Please port forward pluto IP address's 9001 and 7681 to this domain(<http://zs1sci.com:1880/ui>) on your network
  - Our remote browser instance (<http://zs1sci.com:1880/ui>) must be able to get the MQTT (9001) and FFT (7681) from pluto at this domain
- FFT spectrum source
- Radio miscellaneous
  - Rx offset
  - Tx offset
  - Override pluto TS input IP
  - Calibrate Tx channel frequencies



# GSE

- Setting for DVB-GSE operation

Network	44.0.0.0/24
Computer receiving UDP IP	230.0.0.2
Your computer IP	192.168.1.129
Portstart UDP	1000
Portend UDP	11000
Tunnel IP	44.0.0.3
Portstart TCP	1880
Portend TCP	1880
Remote Tunnel IP (internal encoder sends the stream to this IP on port 8282)	44.0.0.3
Remote Tunnel Port	6969
Firewall	Firewall disabled

# Encoder advanced v4

- This is all settings relevant to your setup
- Please change accordingly
- Codec options are available in the terminal with the Encoder options button

**ffmpeg command line**

```
ffmpeg command
.\ffmpeg\ffmpeg.exe -itsoffset -0.65 -f dshow -thread_queue_size 10K -rtbufsize 400M -i "video=OBS Virtual Camera" -f dshow -thread_queue_size 10K -rtbufsize 400M -i "audio=CABLE Output"
```

<p><b>Inputs</b></p> <p><b>ffmpeg paths</b></p> <p><b>Intel HW Encoder</b></p> <p>libmfx - HW INTEL preset <span style="float: right;">slow ▾</span></p> <p>Intel H265 options -scenario 5 -avbr_convergence 1 -profilev main</p> <p>Intel H264 options -profilev main -pix_fmt nv12</p> <p><b>NVIDIA HW encoder</b></p> <p>NVIDIA hardware preset <span style="float: right;">p7 - slowest (best quality) ▾</span></p> <p>NVIDIA tune <span style="float: right;">hq - High quality ▾</span></p> <p>NVIDIA profile <span style="float: right;">high ▾</span></p> <p>h264_nvenc options -no_scenecut 1 -zerolatency 1 -b_ref_mode 0 -bf 0 -rc cbr_ld_hq</p> <p>hevc_nvenc options -no_scenecut 1 -zerolatency 1 -b_ref_mode 0 -bf 0 -rc cbr_ld_hq</p>	<p><b>ffmpeg related options</b></p> <p><b>libx264/libx265 encoder</b></p> <p>libx264 and libx265 preset <span style="float: right;">medium (default) ▾</span></p> <p>Use CRF <input type="checkbox"/></p> <p>Constant Rate Factor(CRF) libx264/265 <span style="float: right;">20</span></p> <p>Libx264 options -pix_fmt yuv420p -x264-params rc-lookahead=10:no-scenecut=1</p> <p>Libx265 options -pix_fmt yuv420p</p> <p><b>Global</b></p> <p>Keyframe multiplier <span style="float: right;">5</span></p> <p>Group of pictures (GOP) <span style="float: right;">125</span></p> <p>Mux delay <span style="float: right;">300 ms ▾</span></p> <p><b>ENCODER OPTIONS</b></p> <p><b>AV1 encoder</b></p> <p>libsvtav1 options -preset 5 -crf 32 -svtav1-params tune=0:rc=1</p> <p>libaom-av1 options -cpu-used 4 -row-mt true -threads 8 -crf 30 -usage realtime</p>
---	--

```
# May 11:41:01 - [Info] [debug:Encoder options]
Encoder libx265 [Lib265 H.265 / HEVC]:
  General capabilities: dsl delay threads
  Threading capabilities: other
  Supported pixel formats: yuv420p yuvj420p yuv422p yuvj422p yuv444p yuvj444p gbrp yuv420p10le yuv422p10le yuv444p10le gbrp10le yuv420p12le yuv422p12le yuv444p12le gbrp12le gray gray10le gray12le
Libx265 AVOptions:
-crf <float> E..V..... set the x265 crf (from -1 to FLT_MAX) (default -1)
-cp <int> E..V..... set the x265 cp (from -1 to INT_MAX) (default -1)
-forced-idr <boolean> E..V..... if forcing keyframes, force them as IDR frames (default false)
-preset <string> E..V..... set the x265 preset
-tune <string> E..V..... set the x265 tune parameter
-profile <string> E..V..... set the x265 profile
-udu_sel <boolean> E..V..... Use user data unregistered SEI if available (default false)
-a53cc <boolean> E..V..... Use A53 Closed Captions (if available) (default true)
-x265-params <dictionary> E..V..... set the x265 configuration using a :-separated list of key=value parameters
```

# Receiver setup

- Receiver channels galore
- This is a `proof of concept`, we need to be able to drive as many receivers as possible from a particular spectrum
- Is driven by

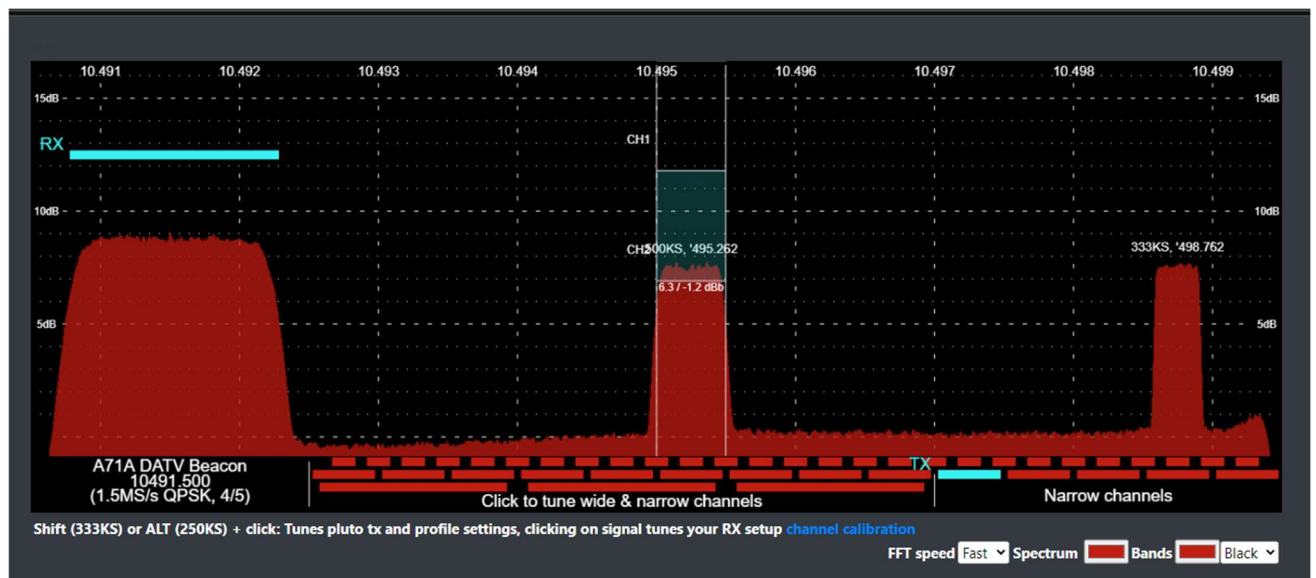
**Receiver settings**

rx config for device control  
232.0.0.11

minitioune path  
F:\Radio\QO-100\DATV-Red\minitiouner\MiniTioune\_V1\_0\_1\_1c\_beta.exe

Minitioune receiver	Winterhill receiver
ip_address *	ip_address *
port *	port *
offset *	offset
rx_socket *	rx_socket *
lnb_volts *	lnb_volts *
lnb_22khz *	lnb_22khz *
dvb_mode *	
wide_scan *	
low_sr *	

- 📍 CH1 -> Minitioune - IP: 232.0.0.11 - Port: 6789 - Offset: 9750000 kHz - Socket: A
- 📍 CH2 -> Winterhill - IP: 192.168.1.45 - Port: 9921 - Offset: 9750000 kHz - Socket: A



# FFmpeg debugging

- ffmpeg command for debugging why it might not work, copy and paste in project root to see ffmpeg error...
- the command output in GUI clears when you press stop profile button

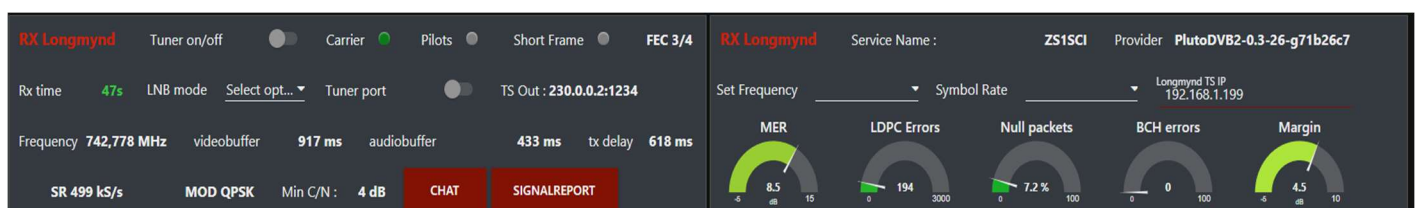
```
PS F:\Radio\QO-100\DATV-Red> .\ffmpeg\ffmpeg.exe -itsffset -0.65 -f dshow -thread_queue_size 10K -rtbufsize 300M -i "video=OBS Virtual Camera" -f dshow -thread_queue_size 10K -rtbufsize 300M -i "audio=CABLE Output (VB-Audio Virtual Cable)" -ar 48000 -vcodec libx265 -r 25 -minrate 618.62k -maxrate 618.62k -b:v 618.62k -bufsize 618.62k -g 150 -acodec libfdk_aac -ac 2 -b:a 48k -f mpegts -auxrate 793.598k -streamid 0:256 -streamid 1:257 -max_delay 1000k -max_interleave_delta 4M -pcr-period 20 -pcr-period 0.4 -mpegts-original_network_id 1 -mpegts-transport_stream_id 4895 -mpegts-pmt_stream_id 4895 -mpegts-start_pid 256 -metadata service_name=ZS1SCI -metadata service_provider=DATV-RED -ar aresample=async=1 "udp://192.168.1.111:8282?pkt_size=1316&overrun_nonfatal=1&fifo_size=50M" -hide_banner
Input #0, dshow, from 'video=OBS Virtual Camera':
  Duration: N/A, start: 23994.362000, bitrate: N/A
  Stream #0:0: Video: rawvideo (NV12 / 0x3231564E), nv12, 2560x1440, 25 fps, 25 tbr, 10000k tbn
[libx265 @ 0:0:0] Guesseed Channel Layout: stereo
Input #1, dshow, from 'audio=CABLE Output (VB-Audio Virtual Cable)':
  Duration: N/A, start: 11997.545000, bitrate: 1411 kb/s
  Stream #1:0: Audio: pcm_s16le, 44100 Hz, 2 channels, s16, 1411 kb/s
Stream mapping:
  Stream #0:0 -> #0:0 (rawvideo (native)) -> hevc (libx265)
  Stream #1:0 -> #0:1 (pcm_s16le (native)) -> aac (libfdk_aac)
Press [q] to stop, [?] for help
x265 [info]: HEVC encoder version 3.5+111-786b4e2d4
x265 [info]: build info [windows][GCC 13.2.0][64 bit] 8bit+10bit+12bit
x265 [info]: using cpu capabilities: MMX2 SSE2Fast LZCNT SSE3 SSE4.2 AVX FMA3 BMI2 AVX2
x265 [info]: Main profile, Level-4 (Main tier)
x265 [info]: Thread pool created using 24 threads
x265 [info]: Slices : 1
x265 [info]: Frame threads / pool features : 4 / wpp(17 rows)
x265 [info]: Coding QT: max CU size, min CU size : 64 / 8
x265 [info]: Residual QT: max TU size, max depth : 32 / 1 inter / 1 intra
x265 [info]: ME / range / subpel / merge : hex / 57 / 2 / 3
x265 [info]: Keyframe min / max / scenecut / bias : 15 / 150 / 40 / 5.00
x265 [info]: Lookahead / bframes / badapt : 20 / 4 / 2
x265 [info]: b-pyramid / weightp / weightb : 1 / 1 / 0
x265 [info]: References / ref-limit cu / depth : 3 / off / on
x265 [info]: AQ: mode / str / qg-size / cu-tree : 2 / 1.0 / 32 / 1
x265 [info]: Rate control / qcompress : ABR-G18 kbps / 0.60
x265 [info]: BBV/HRD buffer / max-rate / init : 618 / 618 / 0.751
x265 [info]: tools: rd=3 psy-rd=2.00 early-skip rskip mode=1 signhide tmp
x265 [info]: tools: b-intra strong-intra-smoothing lslices=6 deblock sao
Output #0, mpegts, to 'udp://192.168.1.111:8282?pkt_size=1316&overrun_nonfatal=1&fifo_size=50M':
  Metadata:
    service_name : ZS1SCI
    service_provider : DATV-RED
    encoder : Lavf60.17.100
  Stream #0:0: Video: hevc, yuv420p(tv, progressive), 1920x1080, q=2-31, 618 kb/s, 25 fps, 90k tbn
  Metadata:
    encoder : Lavc60.33.100 libx265
  Side data:
    cpb: bitrate max/min/avg: 618000/0/618000 buffer size: 618000 vbv_delay: N/A
  Stream #0:1: Audio: aac, 48000 Hz, stereo, s16, 48 kb/s
  Metadata:
    encoder : Lavc60.33.100 libfdk_aac
[frame= 5 fps=3.2 q=48.0 size= 26kB time=00:00:01.92 bitrate= 110.5kbits/s dup=0 drop=15 speed=1.22x
```

# Linux specific

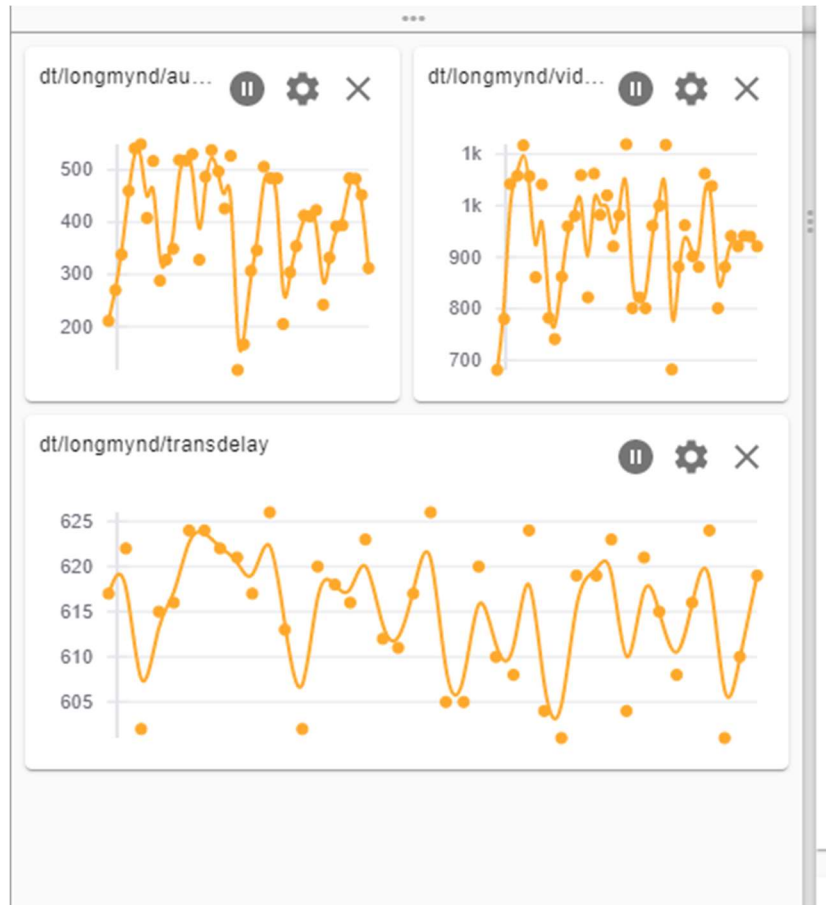
- run `sudo ./scripts/install.sh` script
- run `./DATV-Start.sh`
- Then use RTMP or UDP under ffmpeg settings INPUT CHOICE

# Onboard longmynd controls and analysis information

- Click signal report and CTRL+V paste it in chat
- SigReport: ZS1SCI/PlutoDVB2-0.3-14 - D3.4 - QPSK 4/5 (8.0 dB) - 499 - 10494.773 1.2m offset
- Set your PC's IP address for receiving the multicast TS from longmynd whilst enabled
- Audio and video buffer delays for decoded signal



- If signal has pluto sending NTP synced timestamps, we can calculate tx delay



We can do this by running this script

```
.\set_NTP_pluto.cmd 192.168.1.111 192.168.1.127
```

```
PS F:\Radio\Q0-100\DATV-Red\scripts> .\set_NTP_pluto.cmd 192.168.1.111 192.168.1.127
Setting up NTP server on pluto
Warning: Permanently added '192.168.1.111' (ECDSA) to the list of known hosts.
root@192.168.1.111's password:
Stopping ntpd: OK
server 192.168.1.127
server ntp.metas.ch
server swisstime.ethz.ch
server chronos.cru.fr
server ntp.univ-lyon1.fr

# NTP via GPS
server 127.127.28.0
fudge 127.127.28.0 time1 0.183 flag1 1 refid GPS
server 127.127.28.1 minpoll 4 prefer
fudge 127.127.28.1 refid PPS
tinker panic 0
1 Jan 05:53:08 ntpd[20956]: ntpd 4.2.8p15@1.3728 Fri Jun 30 08:31:48 UTC 2023 (1): Starting
1 Jan 05:53:08 ntpd[20956]: Command line: ntpd -gq
1 Jan 05:53:08 ntpd[20956]:
-----
1 Jan 05:53:08 ntpd[20956]: ntp-4 is maintained by Network Time Foundation,
1 Jan 05:53:08 ntpd[20956]: Inc. (NTF), a non-profit 501(c)(3) public-benefit
1 Jan 05:53:08 ntpd[20956]: corporation. Support and training for ntp-4 are
1 Jan 05:53:08 ntpd[20956]: available at https://www.nwtime.org/support
1 Jan 05:53:08 ntpd[20956]: -----
1 Jan 05:53:08 ntpd[20956]: proto: precision = 2.118 usec (-19)
1 Jan 05:53:08 ntpd[20956]: basedate set to 2023-06-18
1 Jan 05:53:08 ntpd[20956]: gps base set to 2023-06-18 (week 2267)
1 Jan 05:53:08 ntpd[20956]: Listen and drop on 0 v4wildcard 0.0.0.0:123
1 Jan 05:53:08 ntpd[20956]: Listen normally on 1 lo 127.0.0.1:123
1 Jan 05:53:08 ntpd[20956]: Listen normally on 2 eth0 192.168.1.111:123
1 Jan 05:53:08 ntpd[20956]: Listen normally on 3 gse0 44.0.0.2:123
1 Jan 05:53:08 ntpd[20956]: Listening on routing socket on fd #20 for interface updates
1 Jan 05:53:08 ntpd[20956]: 127.127.28.0 local addr 127.0.0.1 -> <null>
1 Jan 05:53:08 ntpd[20956]: 127.127.28.1 local addr 127.0.0.1 -> <null>
1 Jan 05:53:08 ntpd[20956]: refclock_newpeer: clock type 28 invalid
1 Jan 05:53:08 ntpd[20956]: refclock_newpeer: clock type 28 invalid
21 Dec 10:39:21 ntpd[20956]: ntpd: time set +1703133966.494401 s
ntpd: time set +1703133966.494401s
Starting ntpd: OK
      remote      refid      st t when poll reach  delay  offset  jitter
-----
192.168.1.127    .GPS.         1 u  1  64  1  1.037  +0.046  0.002
195.176.26.215  .INIT.        16 u  -  64  0  0.000  +0.000  0.002
81.94.123.17    (n .INIT.     16 u  -  64  0  0.000  +0.000  0.000
dns.univ-lyon1. .INIT.        16 u  -  64  0  0.000  +0.000  0.002
Thu Dec 21 10:39:24 UTC 2023
Press any key to continue . . . |
```

## Software client

- You can also set up the longmynd on another local pc and have it connect to pluto broker
- This way the pluto only has network adapter connected, for remote pluto setups.
- So the pluto still controls the minitiouner radio since its connected to its mqtt topic and doesn't mind the different IP address
- Please see [mqtt longmynd repo](#)

## Hardware

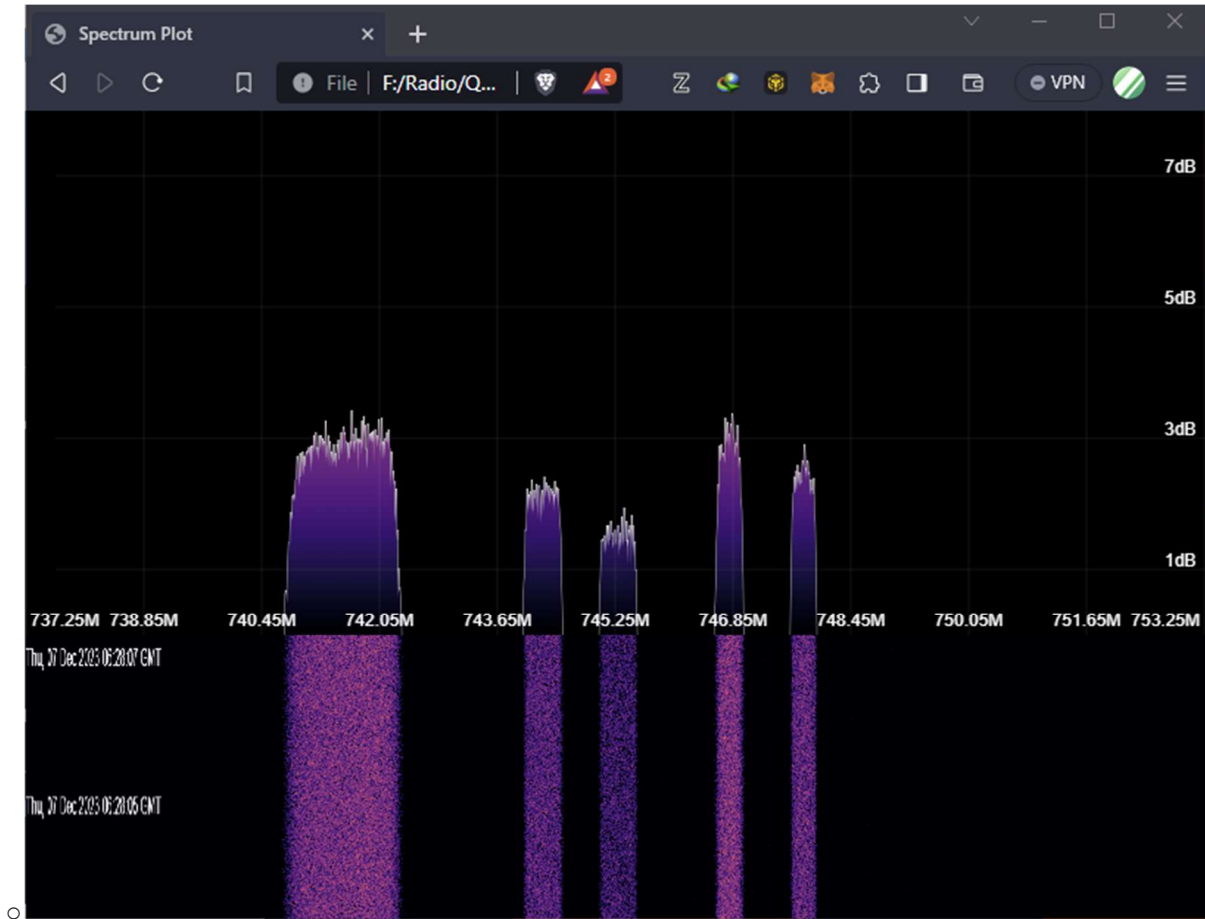
- USB hub used



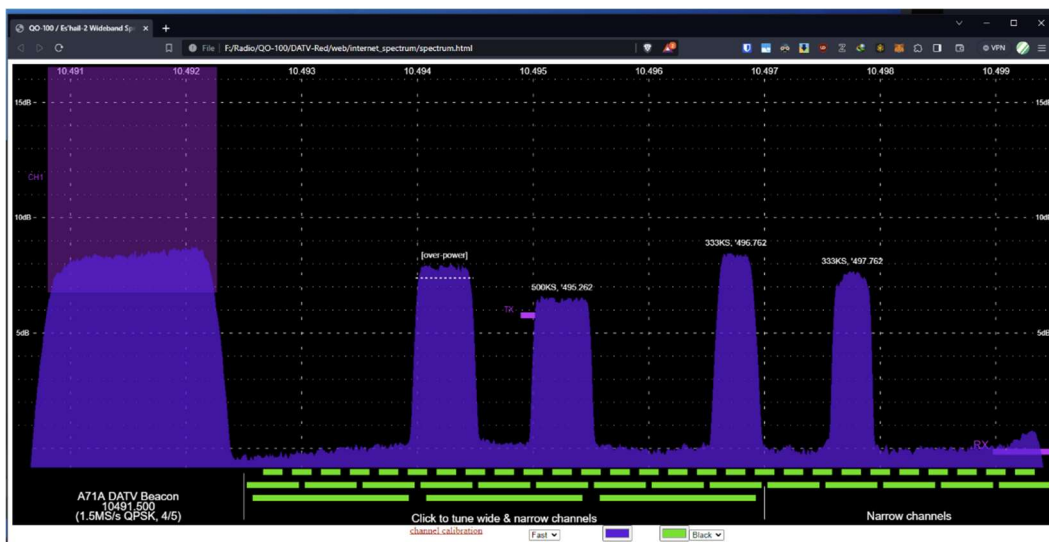


# Static html files

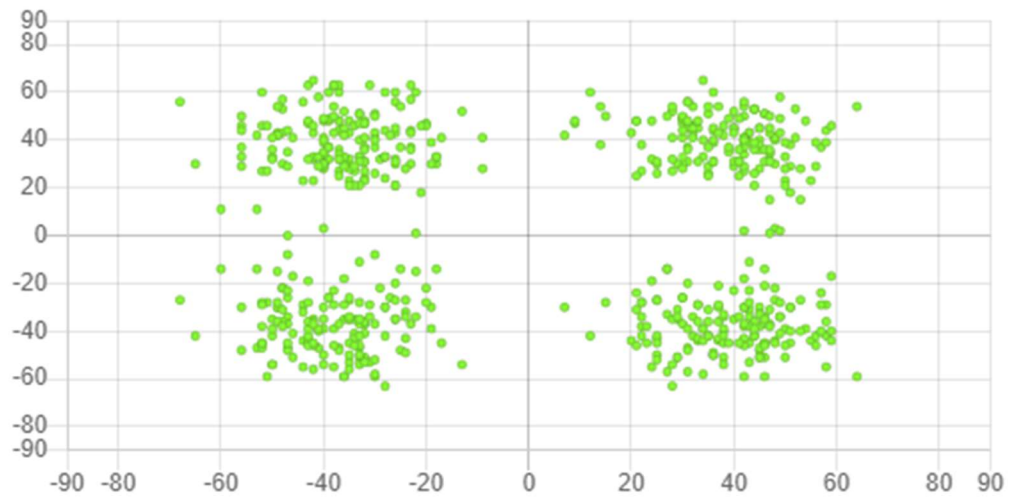
- `web/pluto_spectrum/index.html` can be ran locally by adding you pluto address and callsign to the URL
  - `index.html?url=192.168.1.111&call_sign=ZS1SCI`



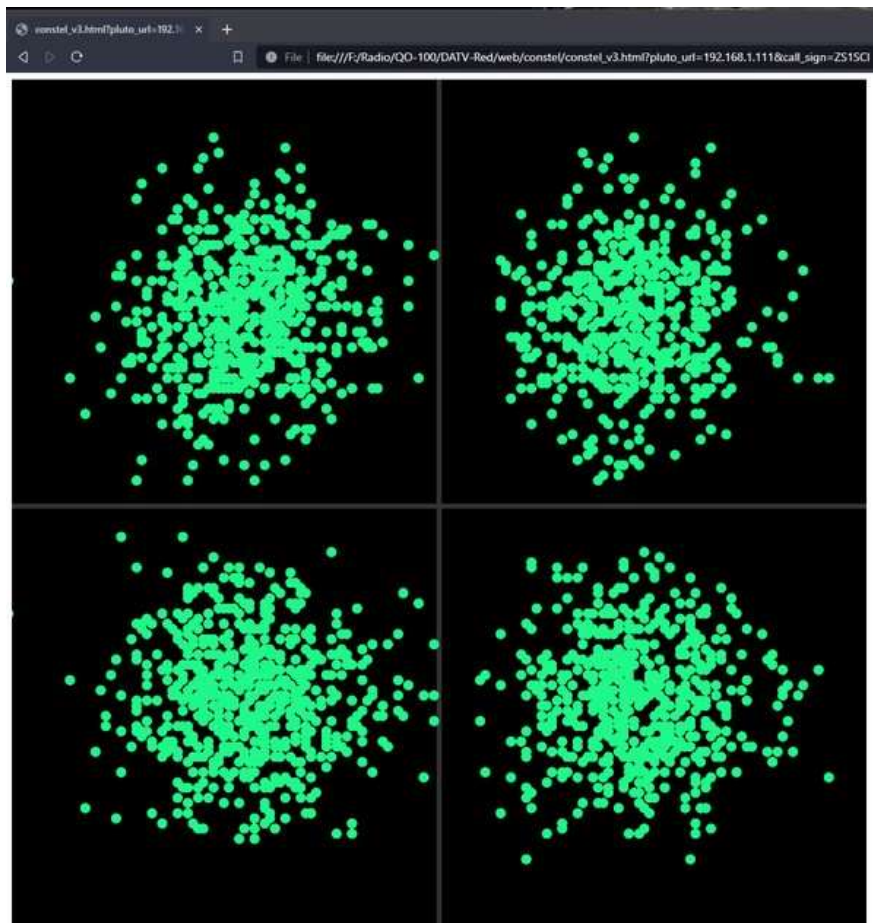
- `web/internet_spectrum/spectrum.html`
  - works separately in a browser
- If `DATV-Red` is running, it acts as a sperate spectrum for tuning, setting tx etc., so you may disable the one in `DATV-Red` if you plan on moving things around.



- web/chat.html
  - portable chat file
- web/constel\_v2.html can be ran locally by adding you pluto address and callsign to the URL
  - `constel_v2.html?pluto_url=192.168.1.111&call_sign=ZS1SCI`



`web/constel/constel_v3.html?pluto_url=192.168.1.111&call_sign=ZS1SCI`



- somethings work better when built from scratch