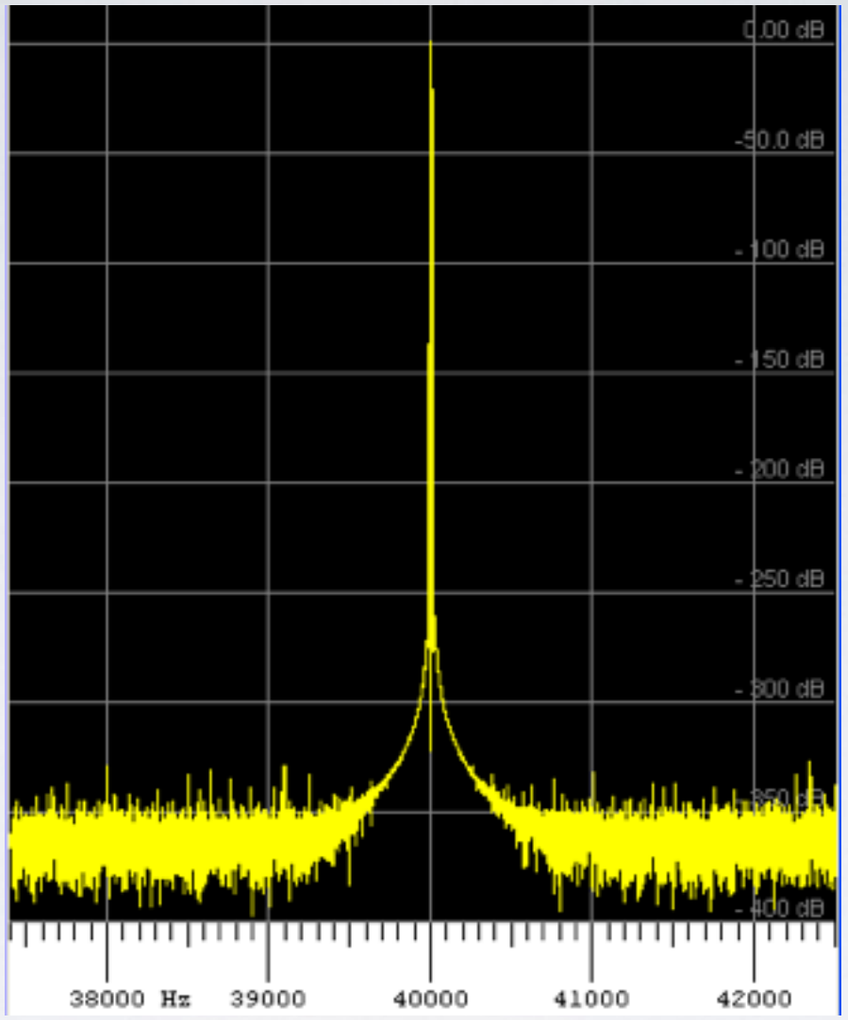

PRECISION FREQUENCY MEASUREMENT, TRANSCEIVER CALIBRATION, AND THE FREQUENCY MEASURING TEST

George, K1IG
K1IG@arrl.net

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ARRL FREQUENCY MEASURING TEST

- Began in 1931
- Twice a year — April and November
- Measure frequencies over the air
- Goal is 1 Hz or better accuracy — measure and report to the nearest 0.01 Hz
- 100 - 130 participants worldwide

MINIMUM SETUP?

WHAT YOU NEED

WHAT YOU NEED

Rig

WHAT YOU NEED

Rig

Computer

WHAT YOU NEED

Rig

Audio Cable

Computer

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Rig

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Computer

These Three Things and Some Free Software
Get You Measuring Within 1 Hz

THREE STEP PROCESS

1. Load software and set it up
2. Calibrate your computer
3. Calibrate your rig

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Total Time = One Hour

FREE SOFTWARE

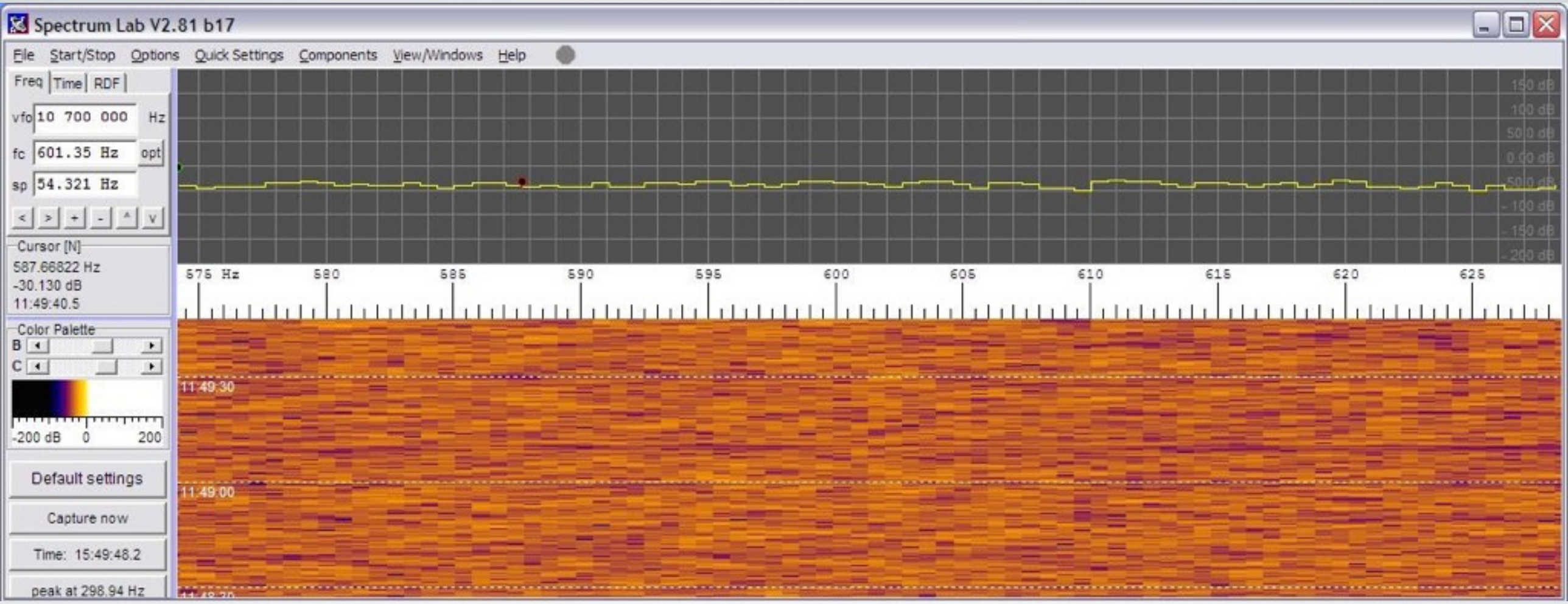
Windows

- Spectrum Lab
  - http://www.qsl.net/dl4yhf/spectra1.html
- Installation tutorial at:
  - http://www.ve2azx.net/technical/FMT/SpecLabInfo.pdf

Mac/Linux/Windows

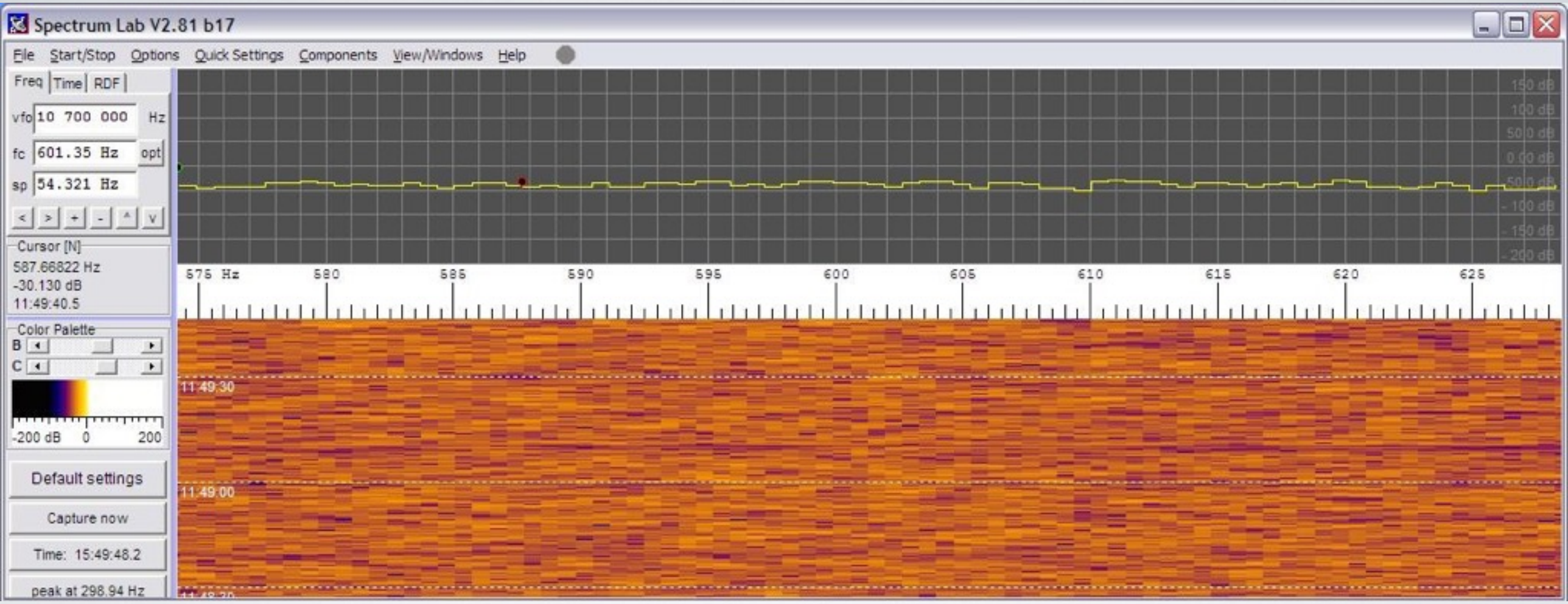
- Fldigi
  - http://www.w1hkj.com/Fldigi.html
  - Download, installation and help files on main webpage
- WSPR
  - http://physics.princeton.edu/pulsar/K1JT/wspr.html
  - http://physics.princeton.edu/pulsar/K1JT/FMT_User.pdf

SPECTRUM LAB



- Very versatile and accurate
- Will run in Linux/Wine or Mac/Parallels at reduced capability

SPECTRUM LAB SETUP



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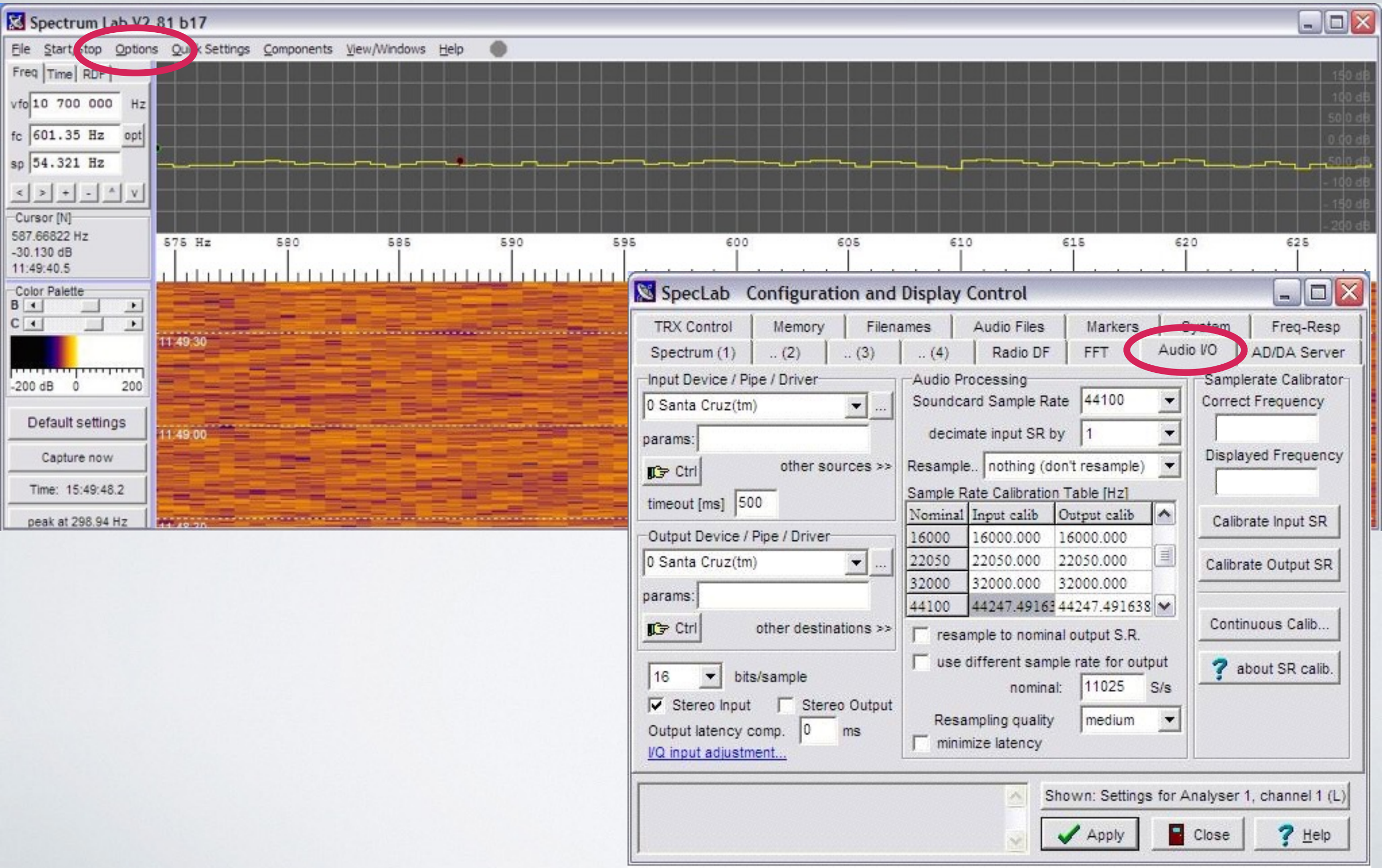

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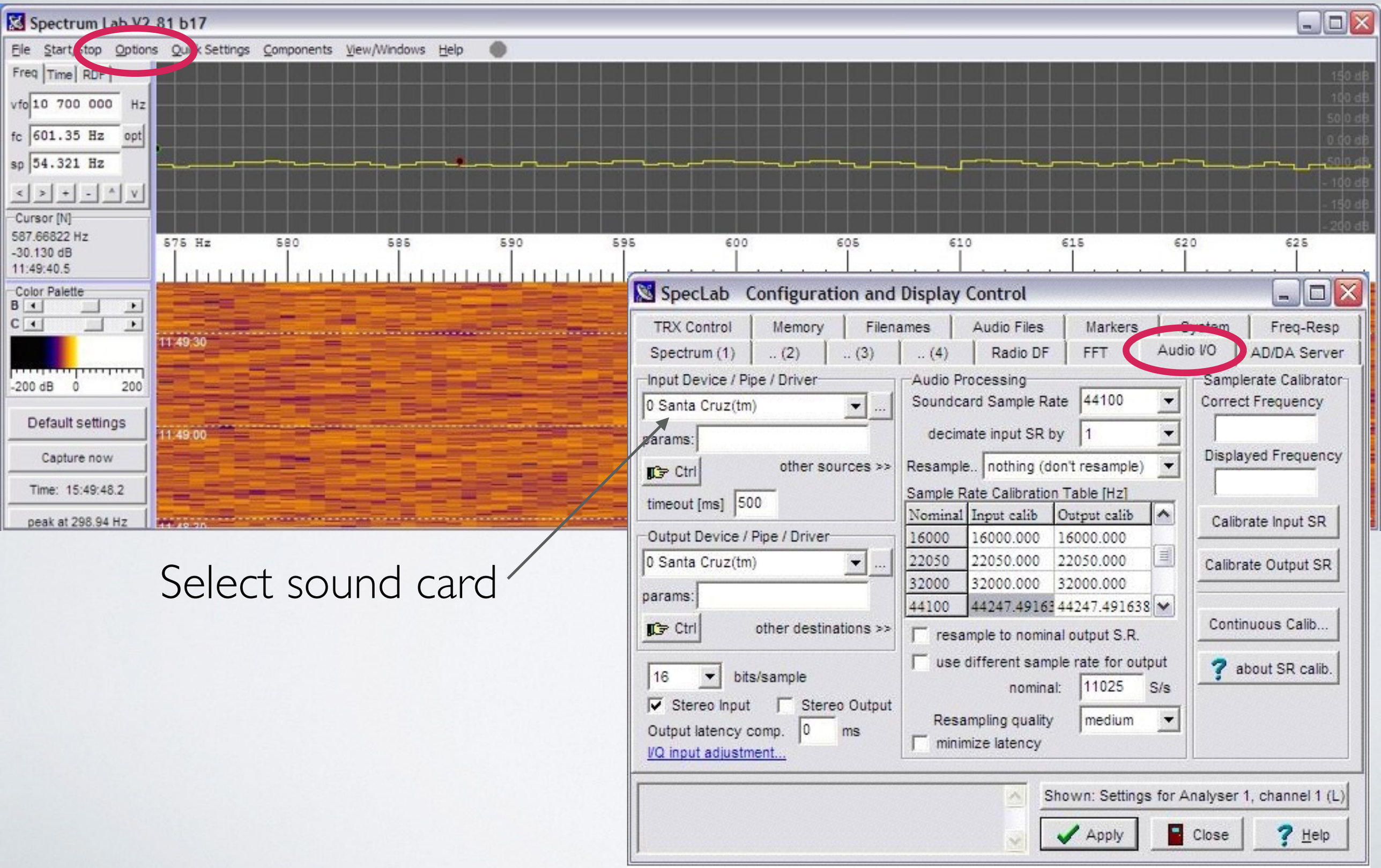


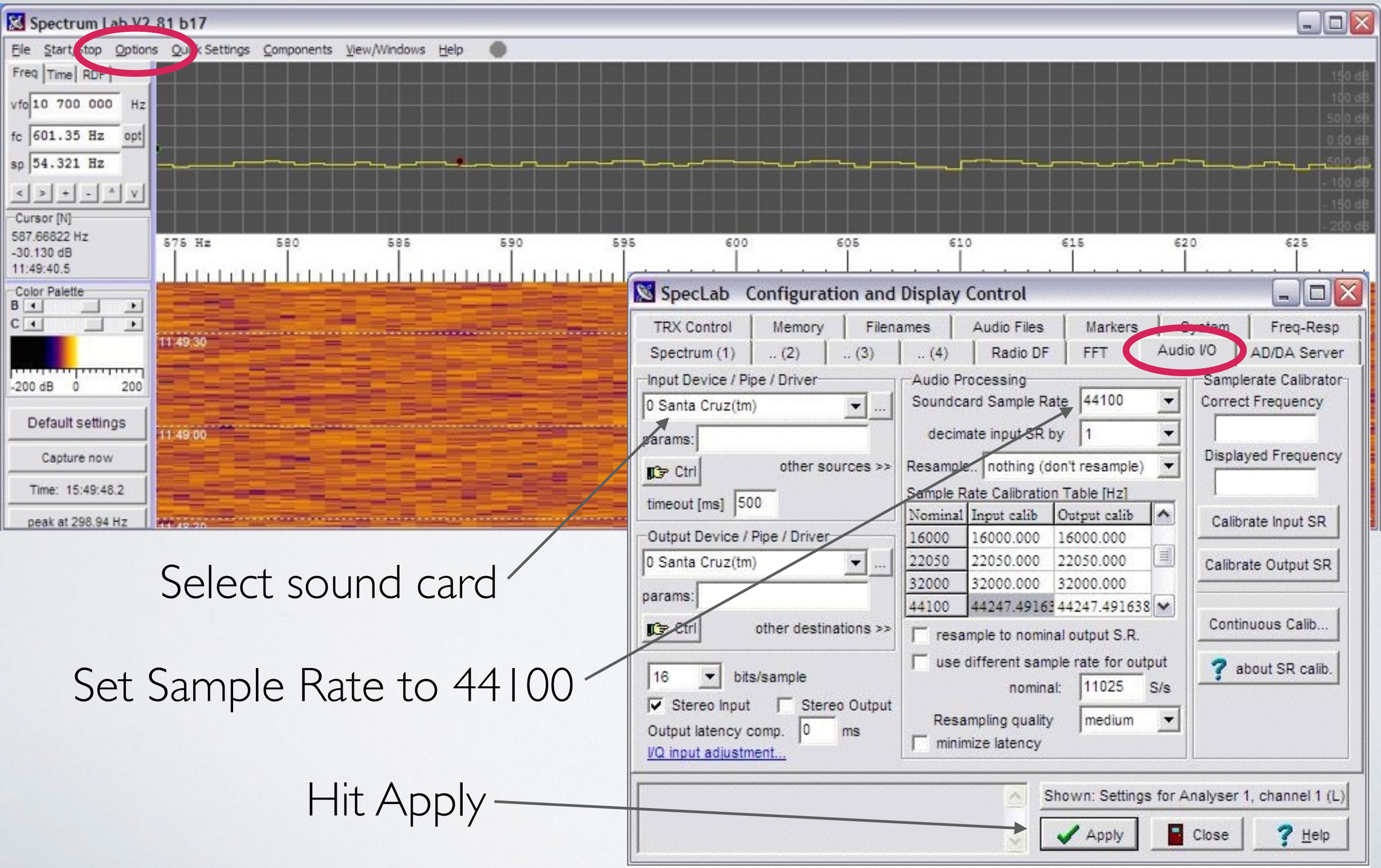
Select sound card

SPECTRUM LAB SETUP

Select sound card

Set Sample Rate to 44100

SPECTRUM LAB SETUP

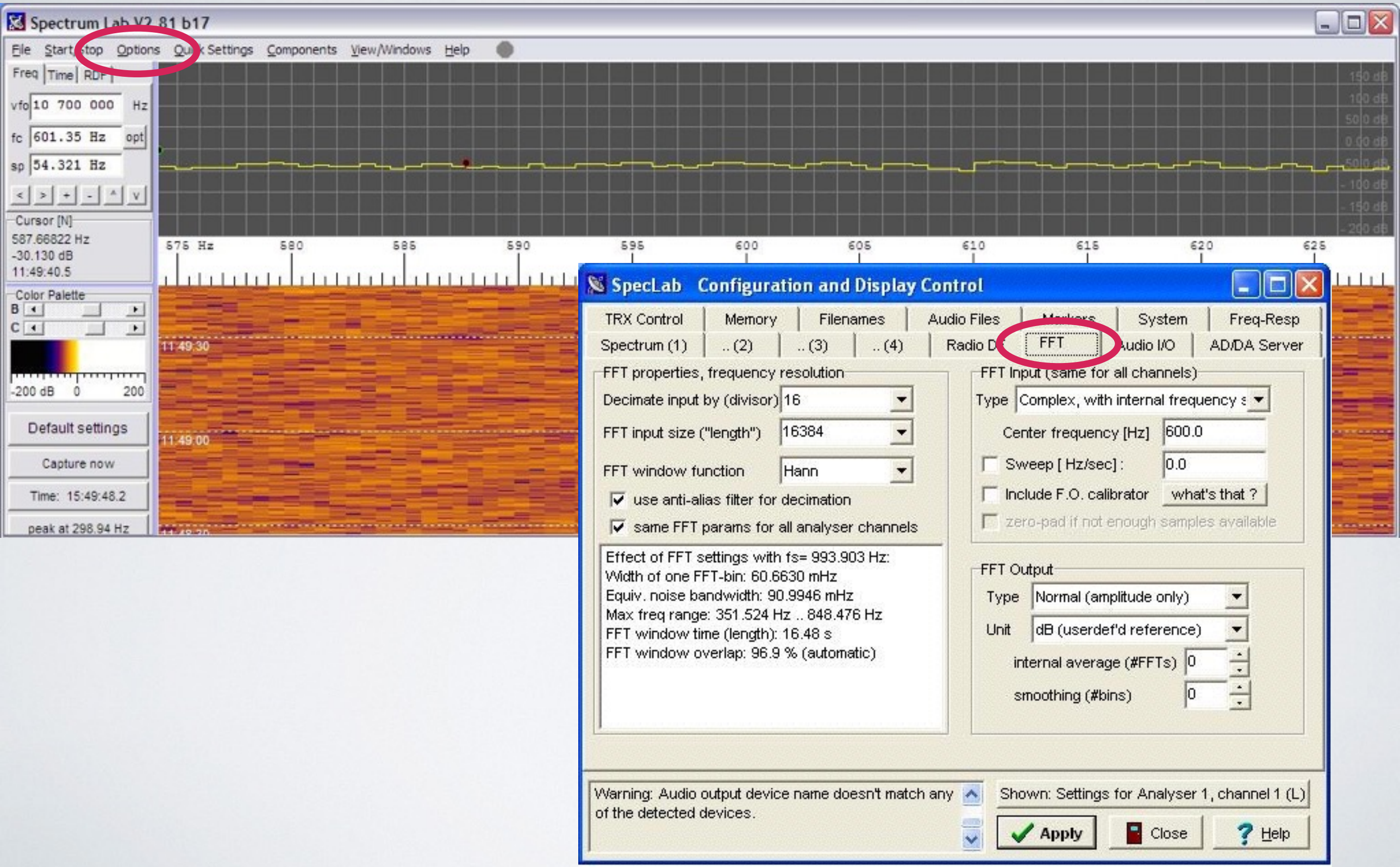


Select sound card

Set Sample Rate to 44100

Hit Apply

SPECTRUM LAB SETUP



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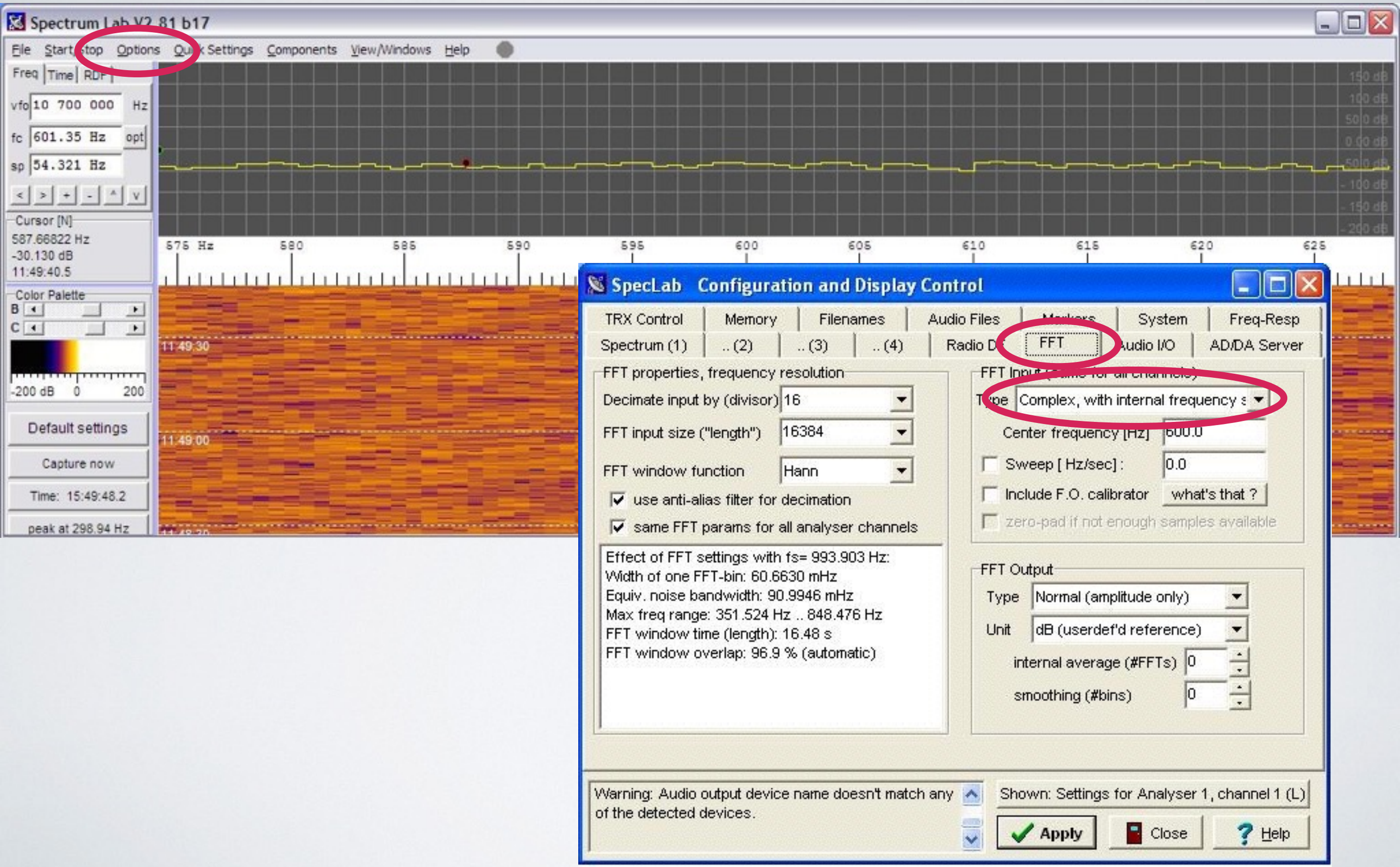

SPECTRUM LAB SETUP

Try these settings. If the display freezes, reduce them. Accuracy will suffer.

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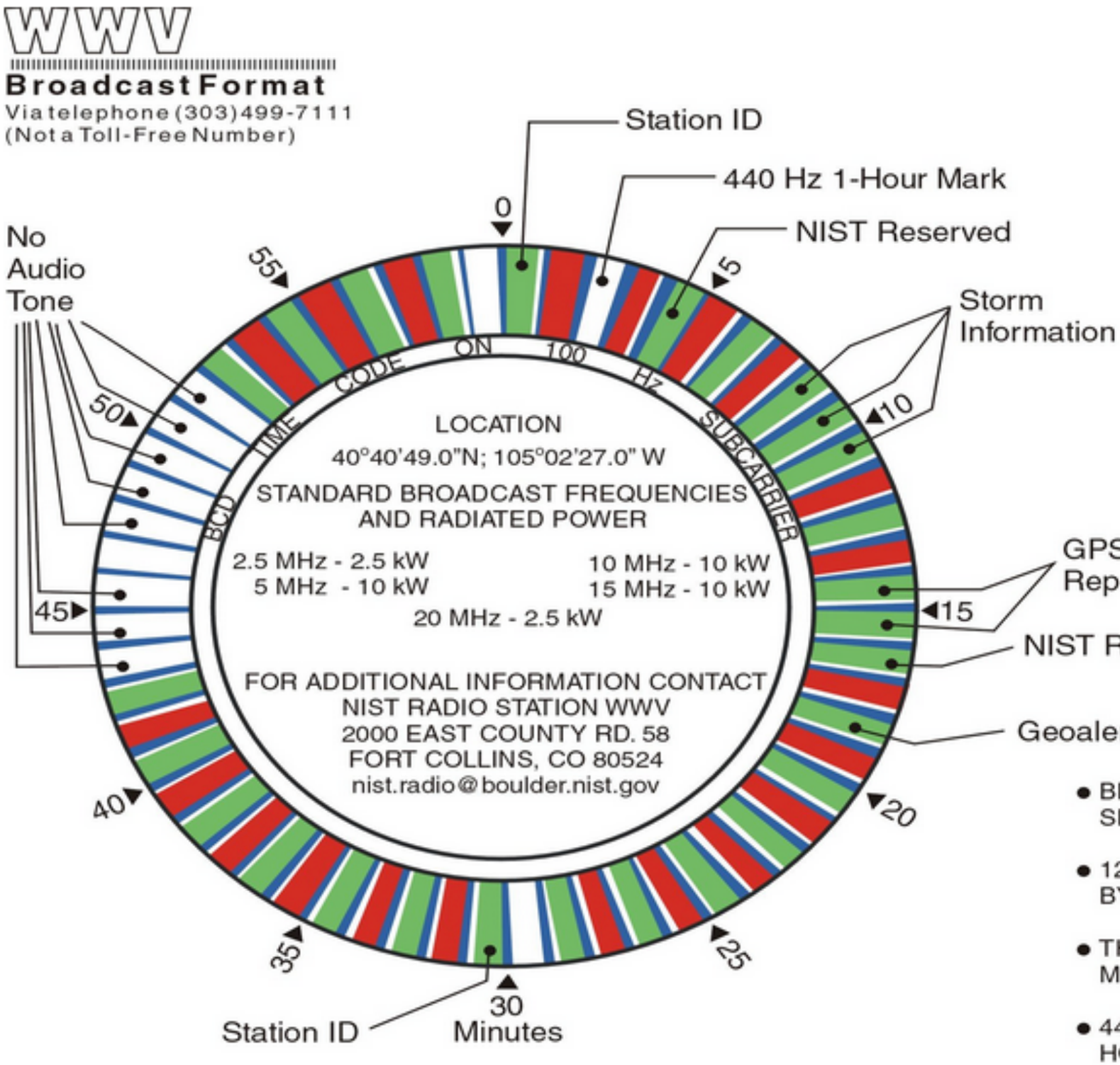
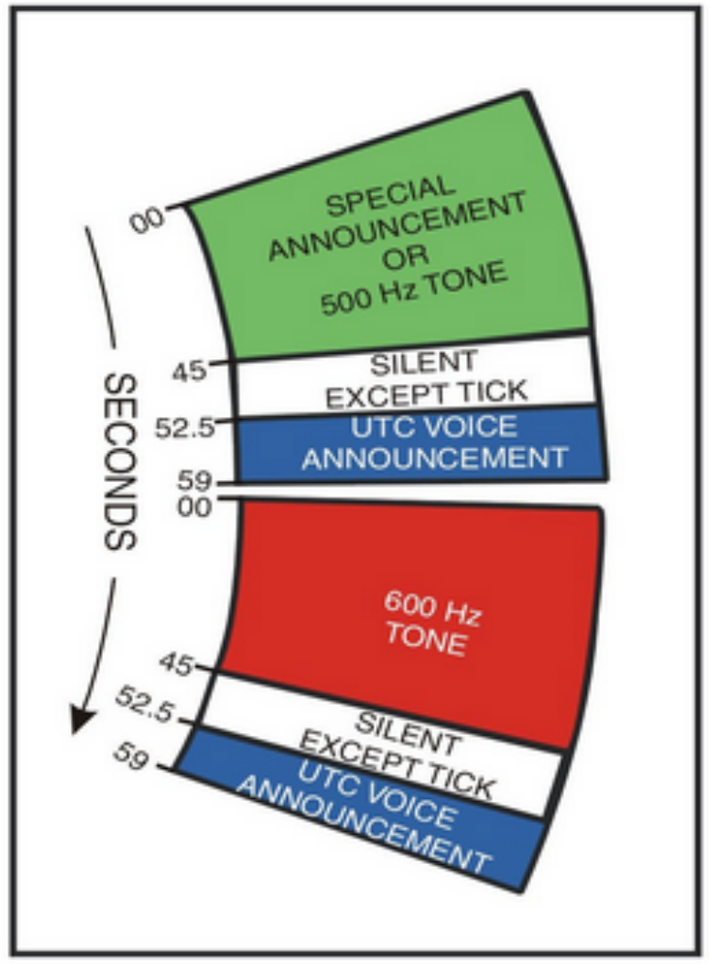
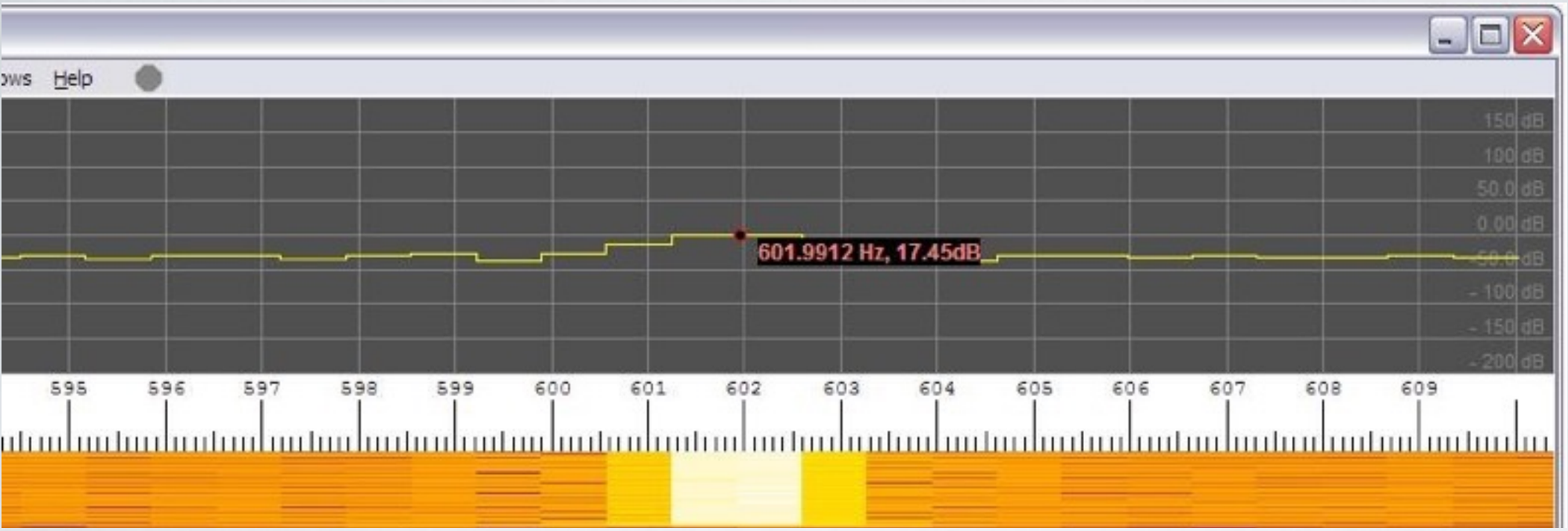
WWV





- BEGINNING OF EACH HOUR IS IDENTIFIED BY 0.8 SECOND LONG, 1500 Hz TONE.
- 12BEGINNING OF EACH MINUTE IDENTIFIED BY 0.8 SECOND LONG, 1000 Hz TONE.
- THE 29TH AND 59TH SECOND PULSES OF EACH MINUTE ARE OMITTED.
- 440 Hz TONE IS OMITTED DURING FIRST HOUR OF EACH DAY.

COMPUTER CALIBRATION



- 2-3 hour warm-up
- Tune to any WWV in AM mode
- Measure frequency during 600 Hz tone
- Apply correction

Avoid sunrise/sunset times (WWV Doppler)

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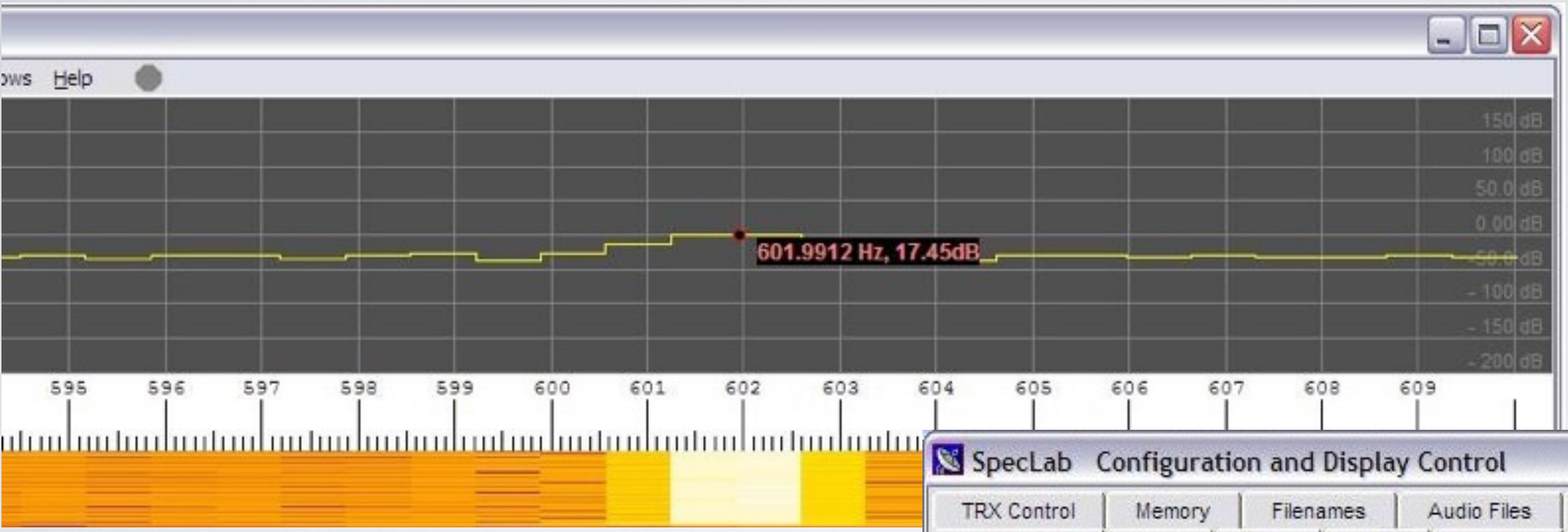

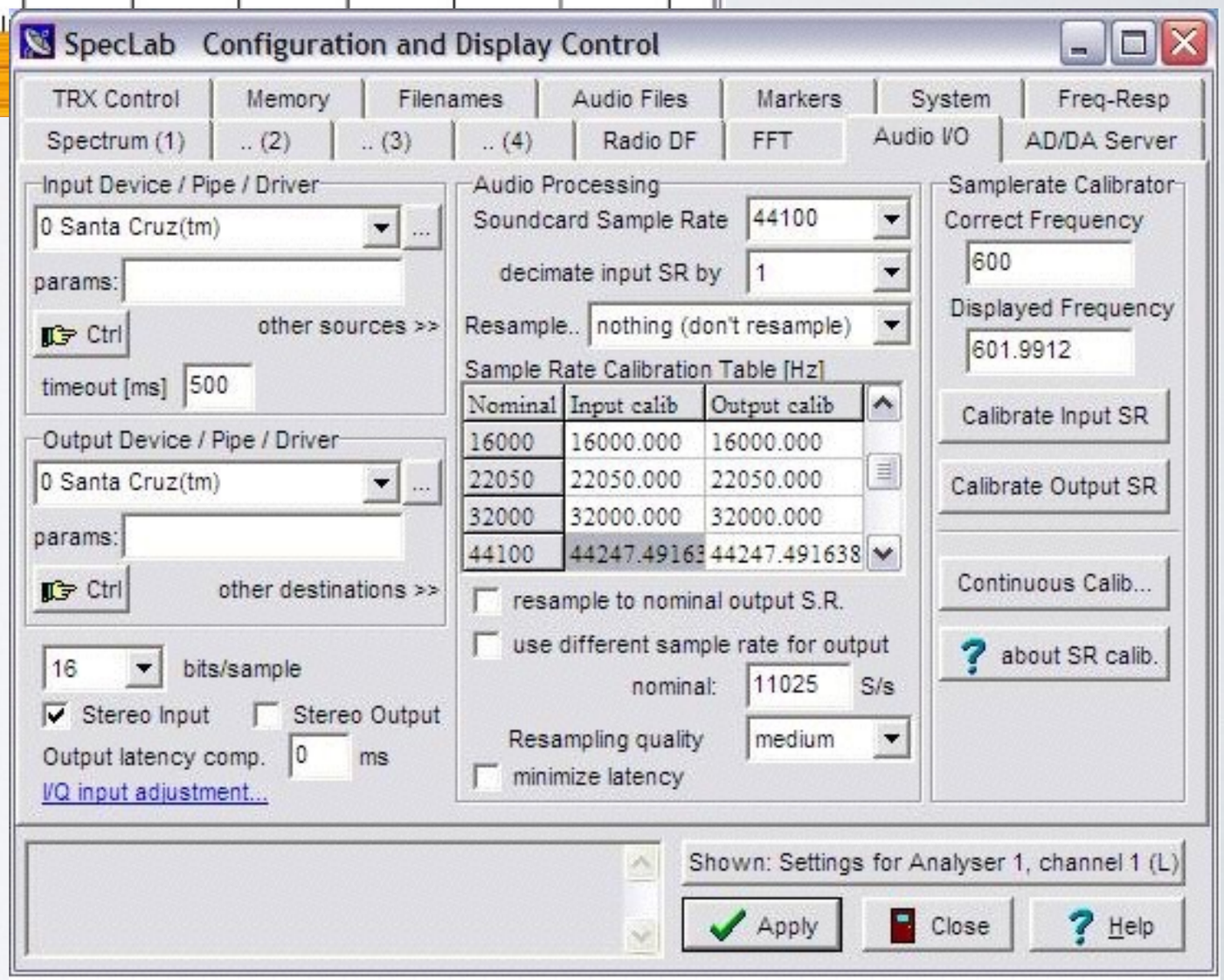

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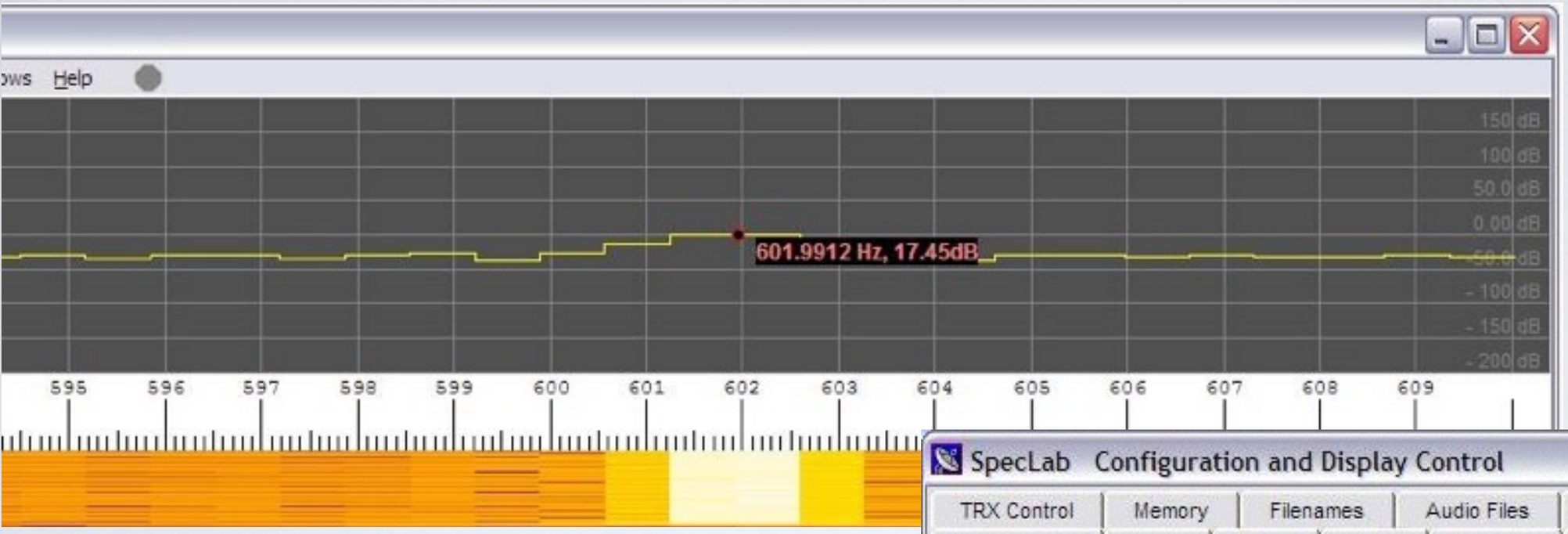

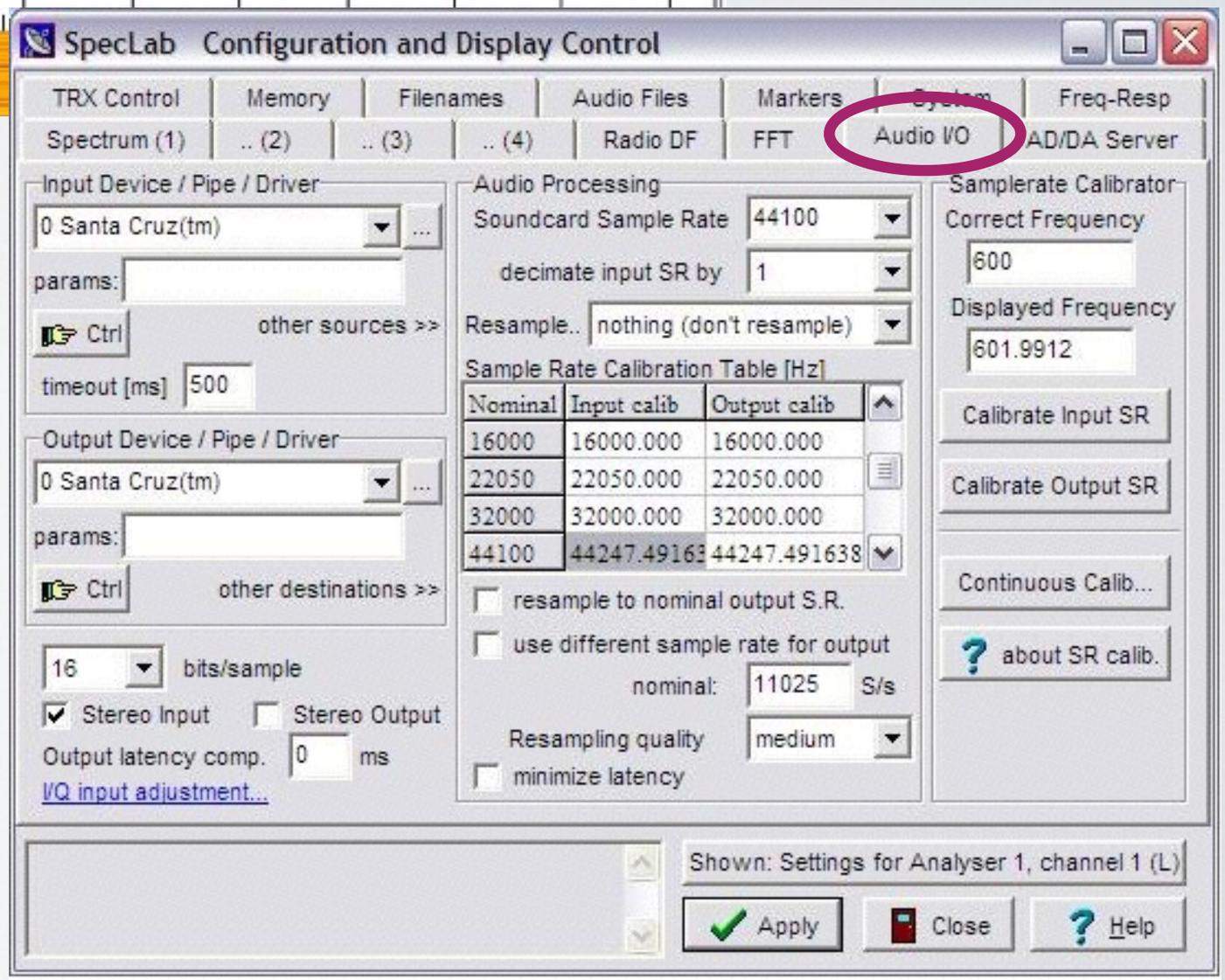

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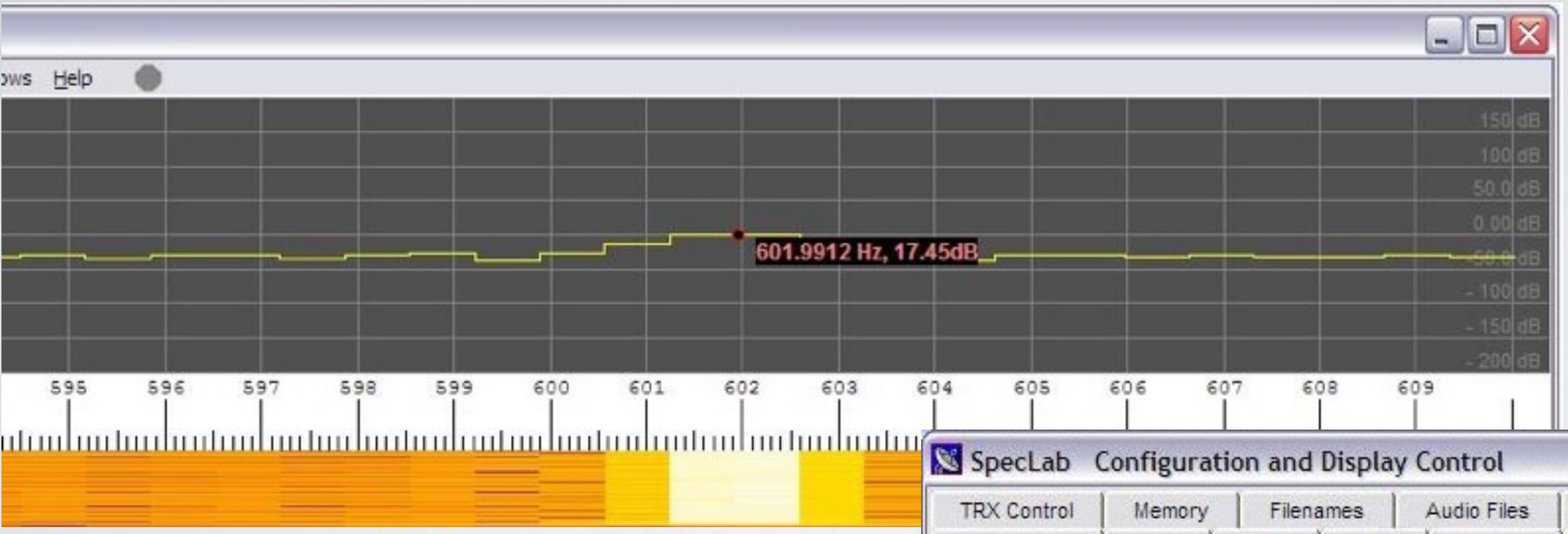

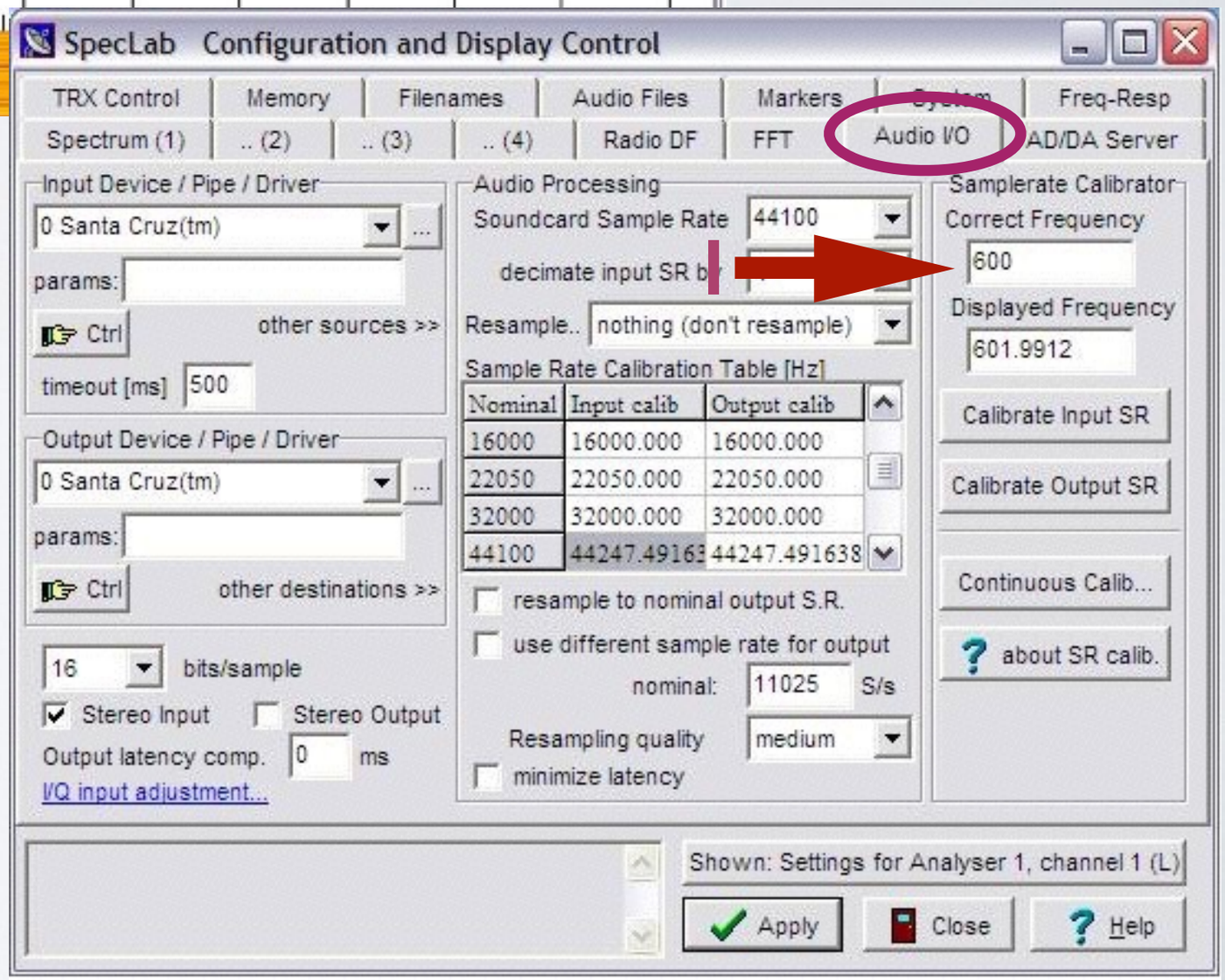

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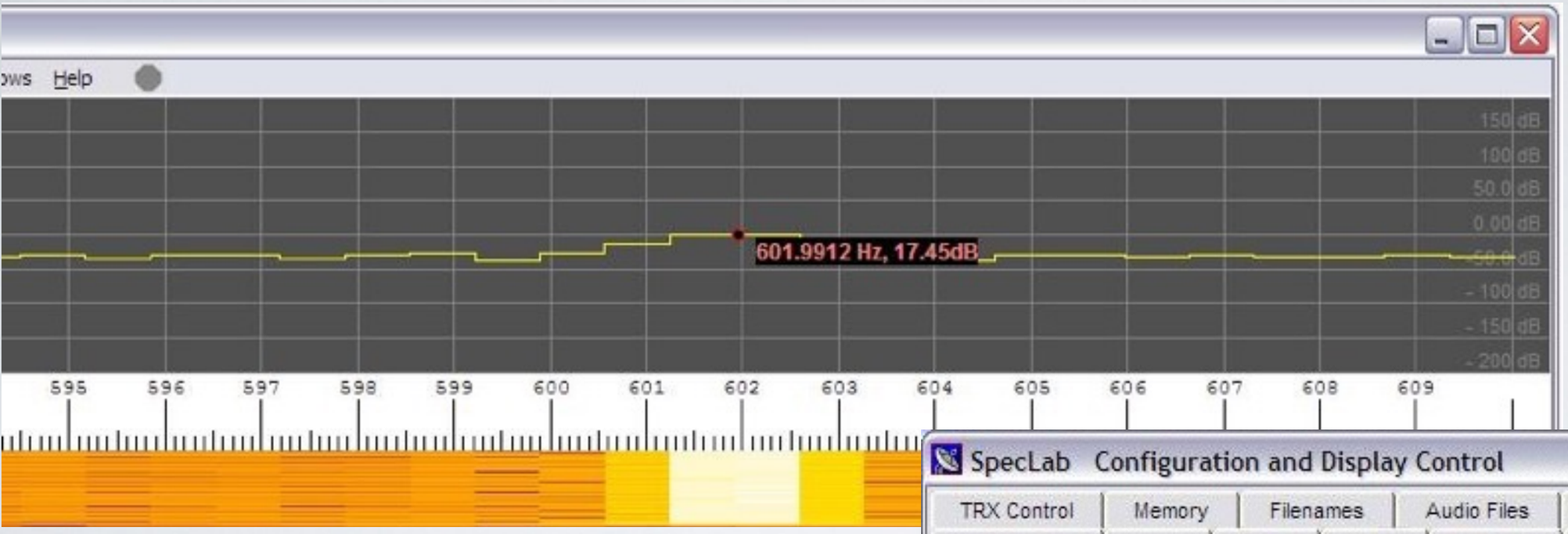

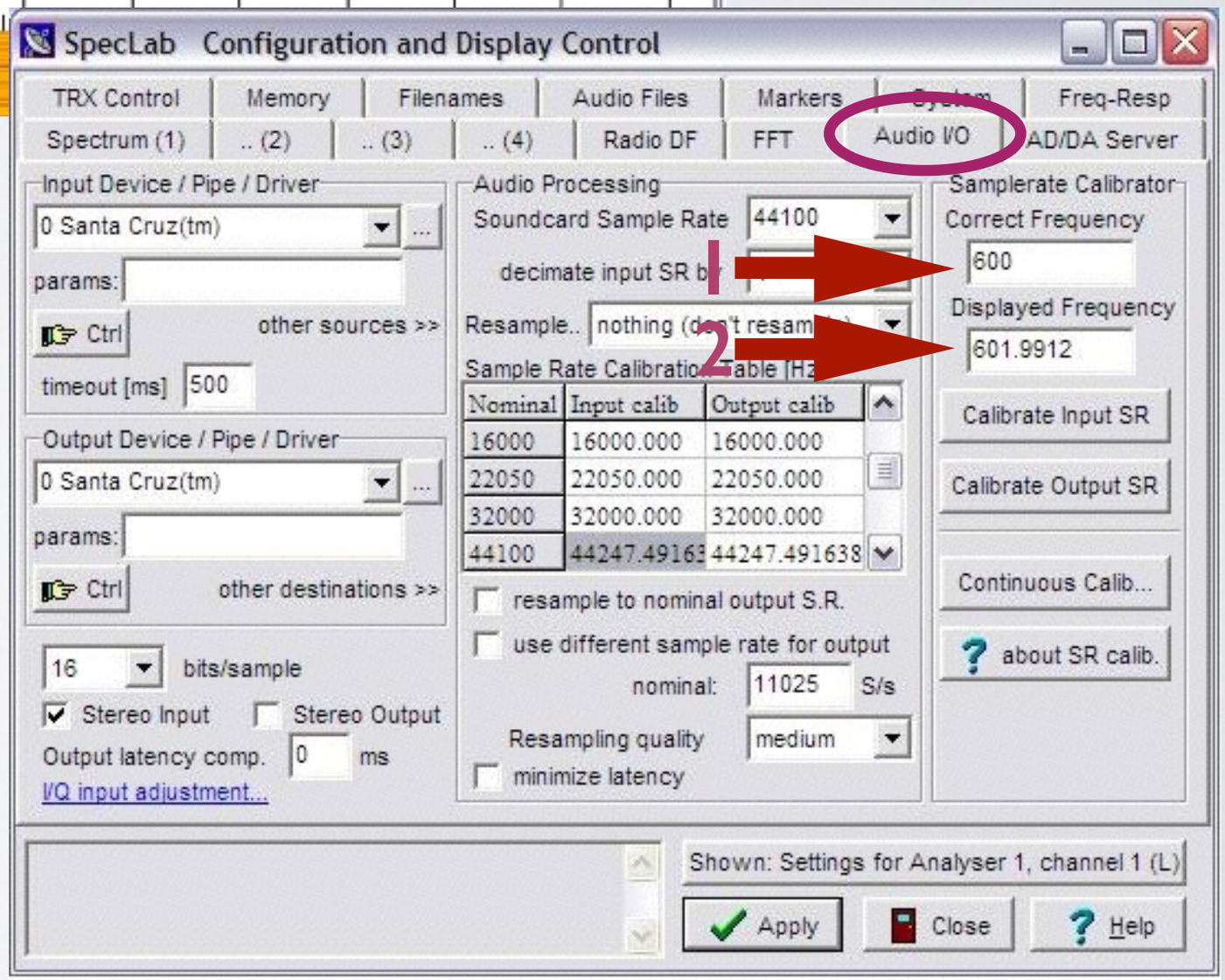

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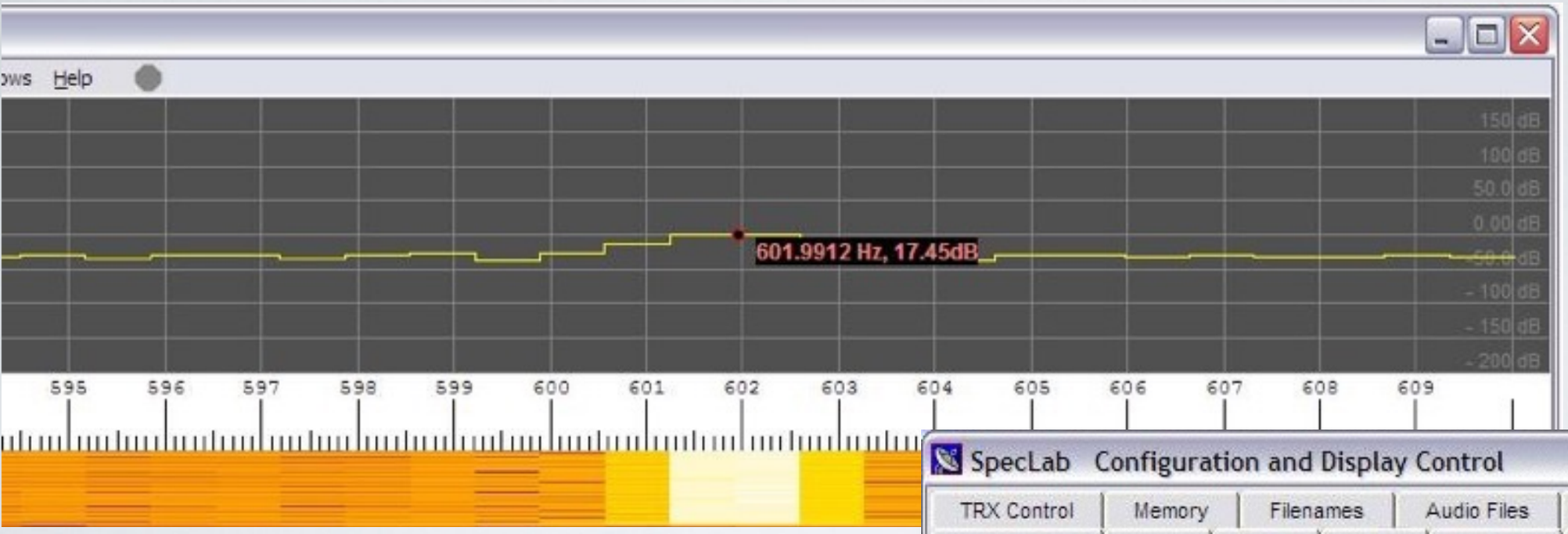

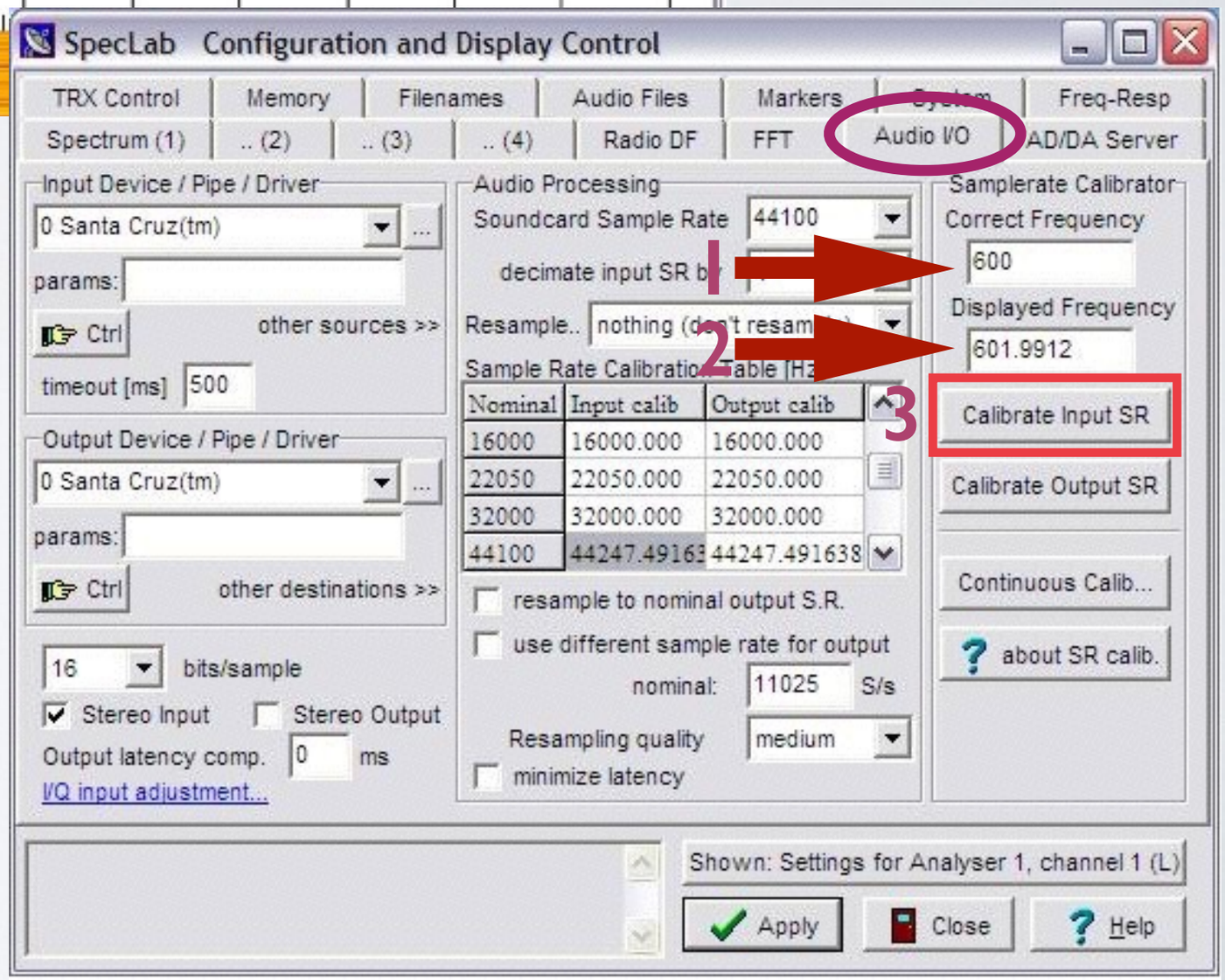

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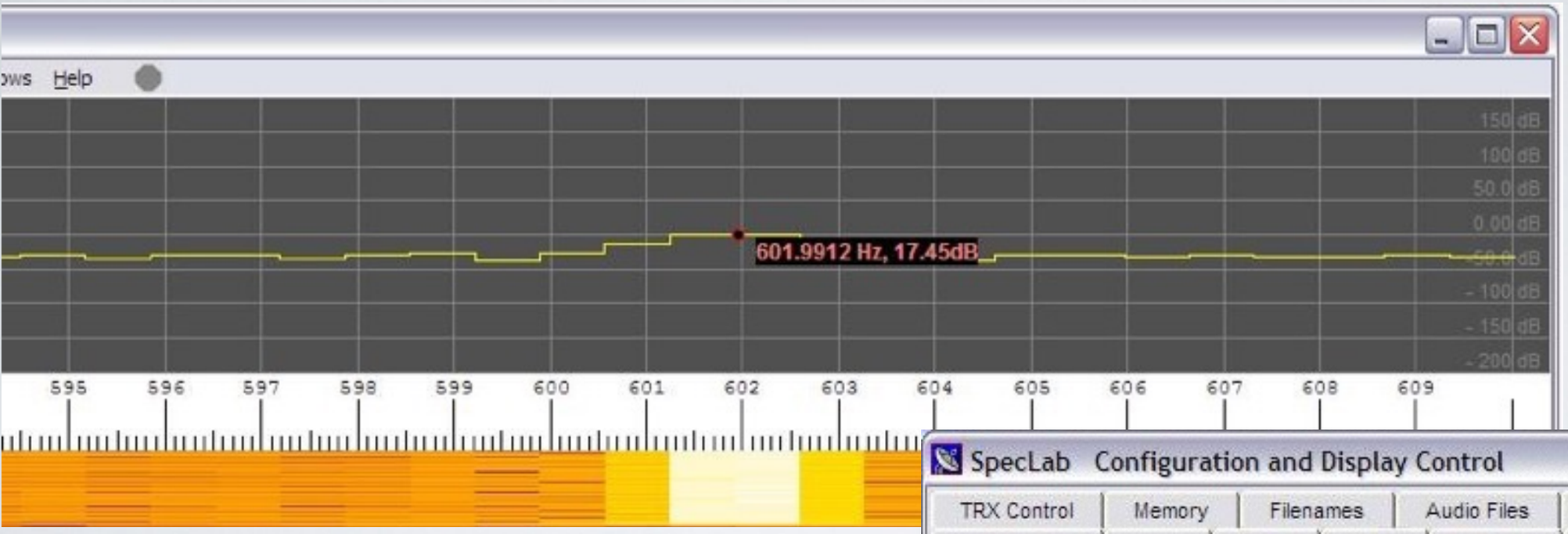

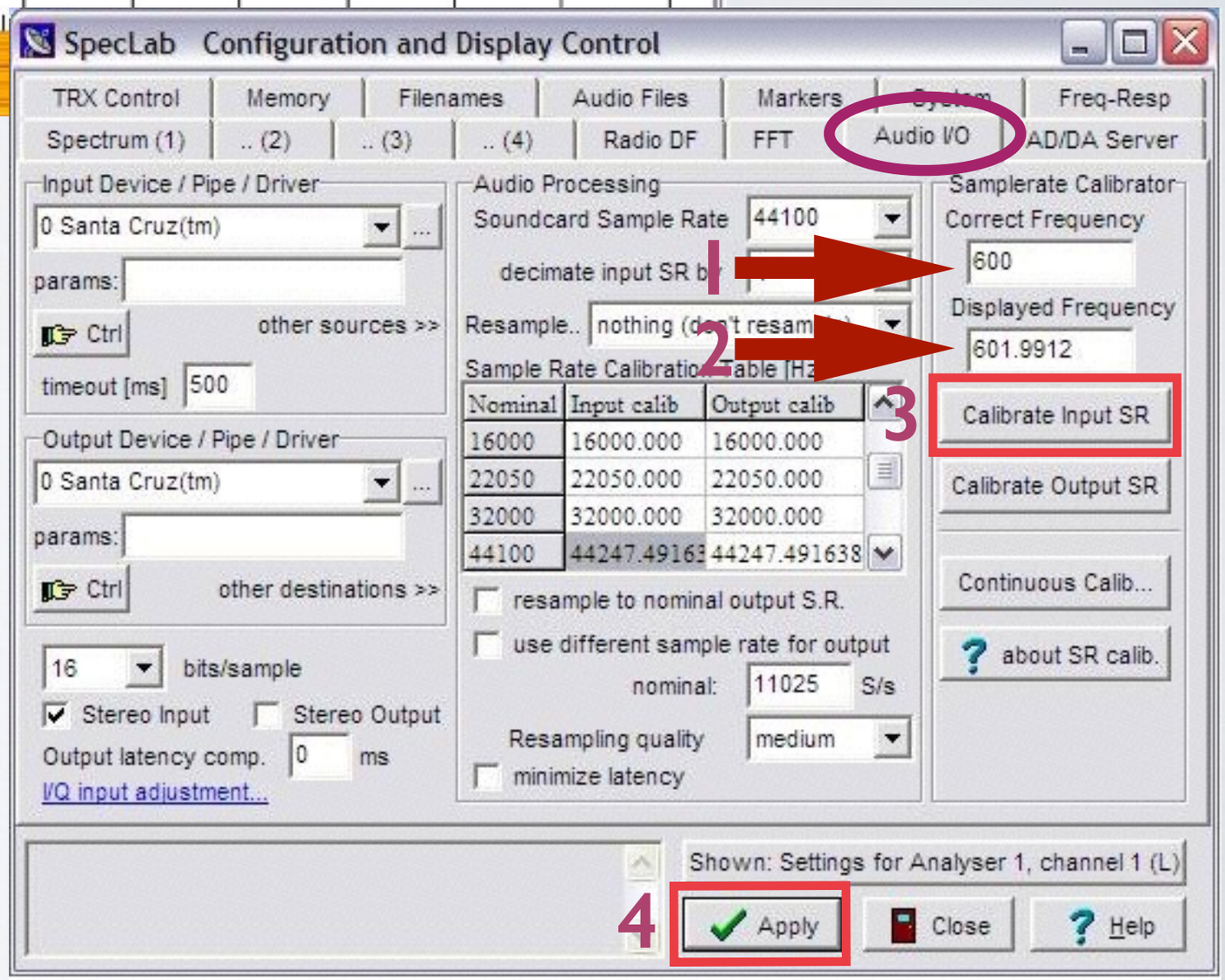

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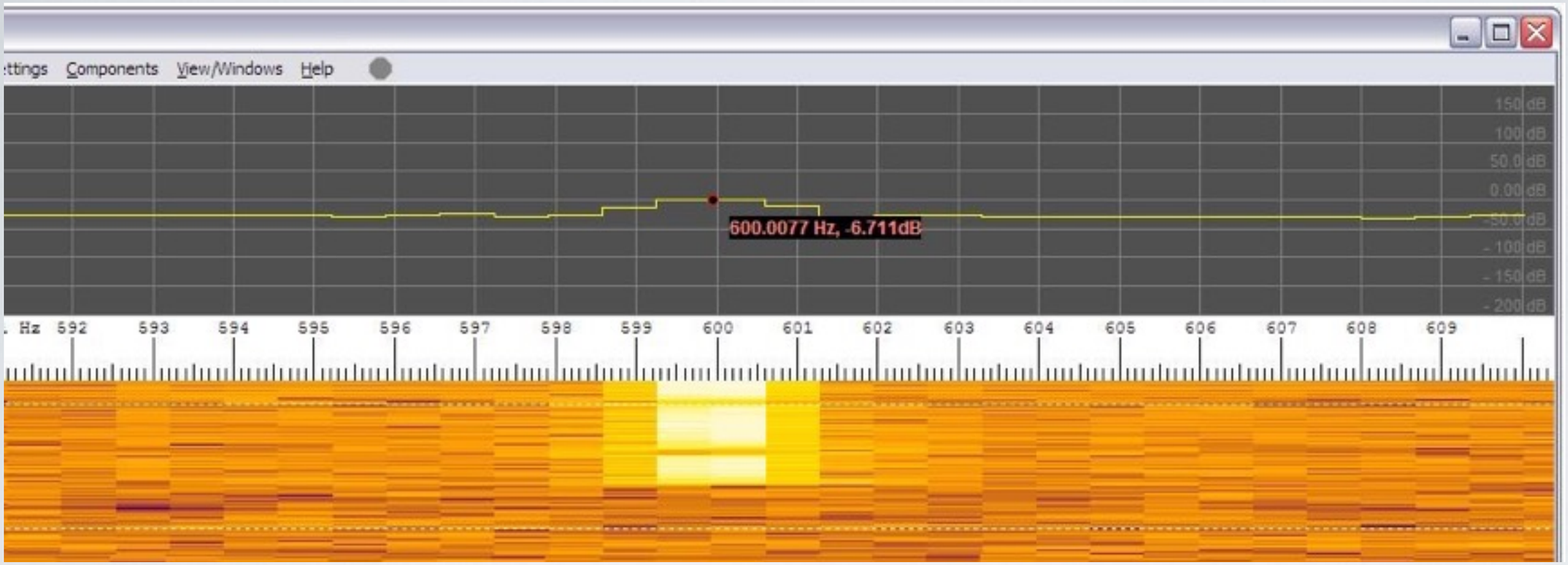

After calibration, we're within 0.0023 Hz

RIG CALIBRATION

1. Set rig to USB
2. Tune to 15 MHz WWV
3. Re-tune to 14,999.400 KHz = WWV - 600 Hz
4. Measure the frequency of the carrier
5. Adjust your rig (if possible) to center the carrier at 600 Hz — consult manual

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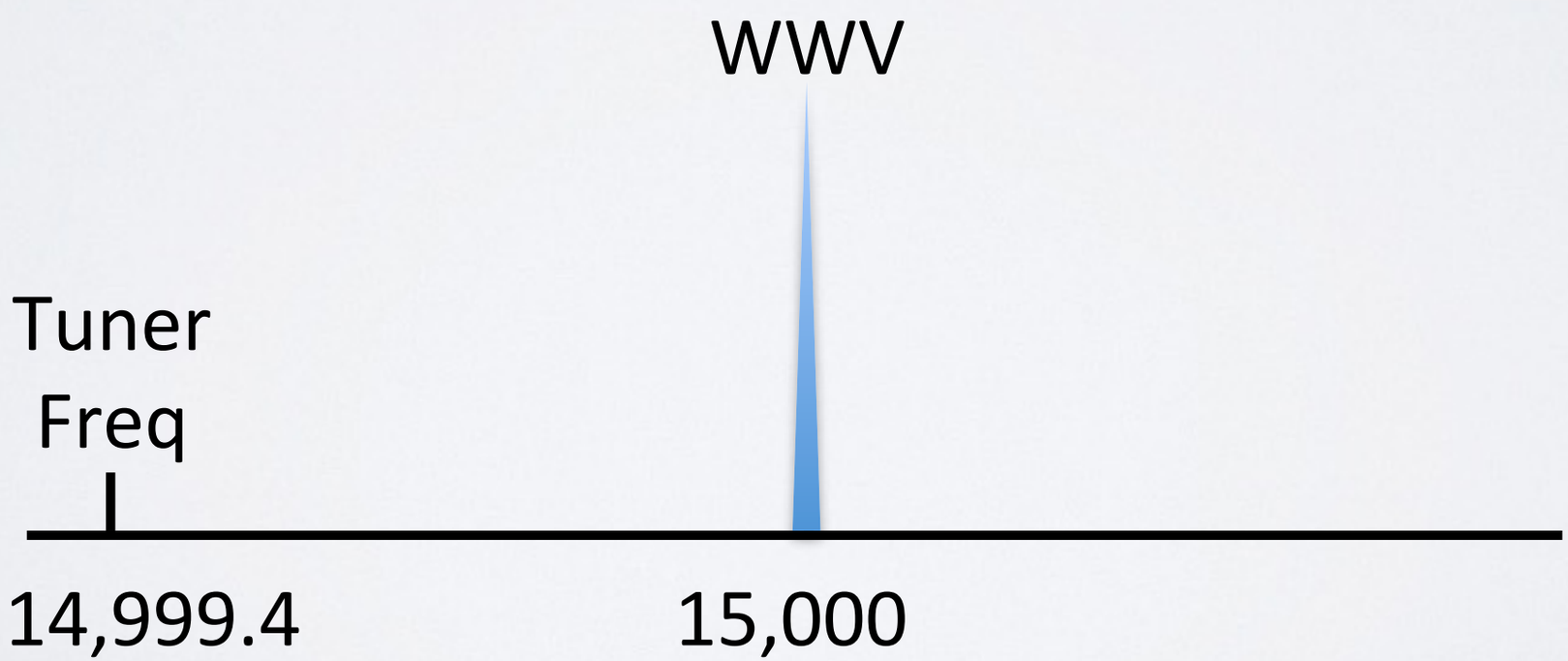

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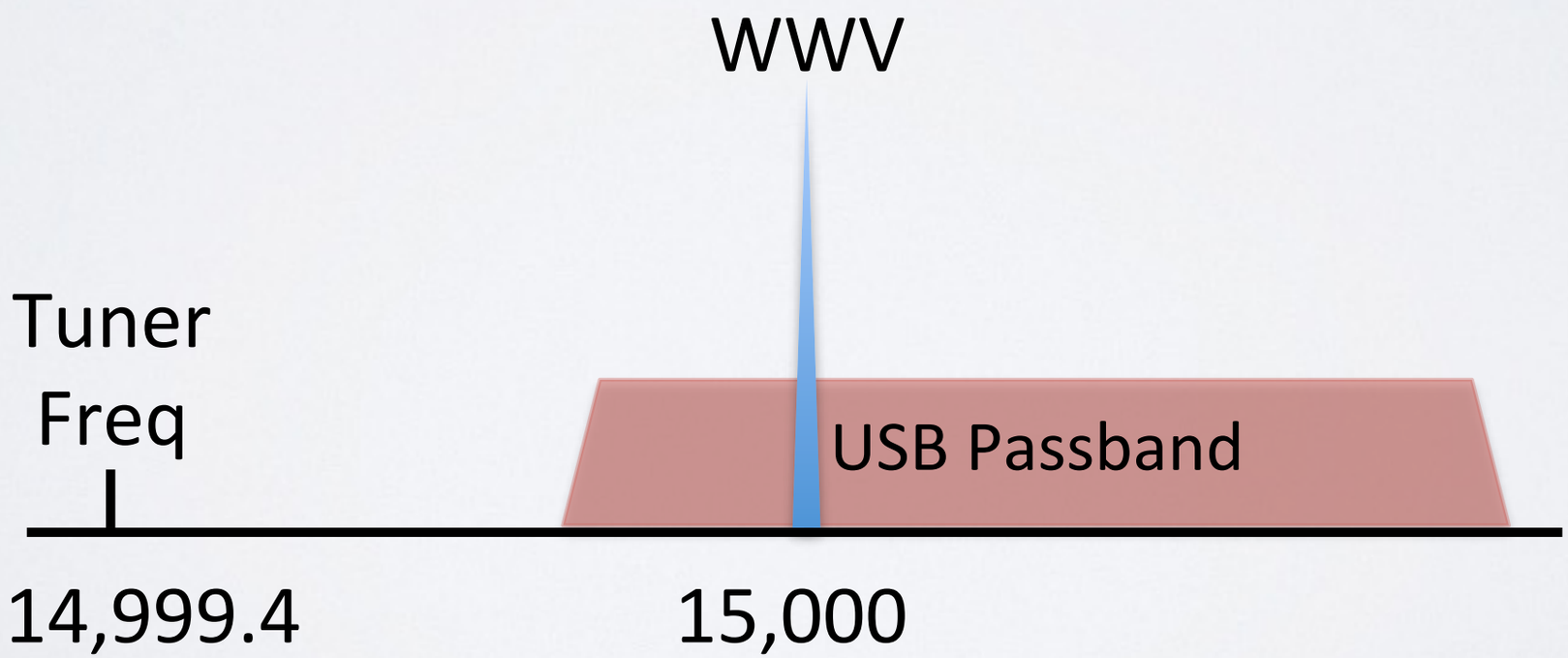

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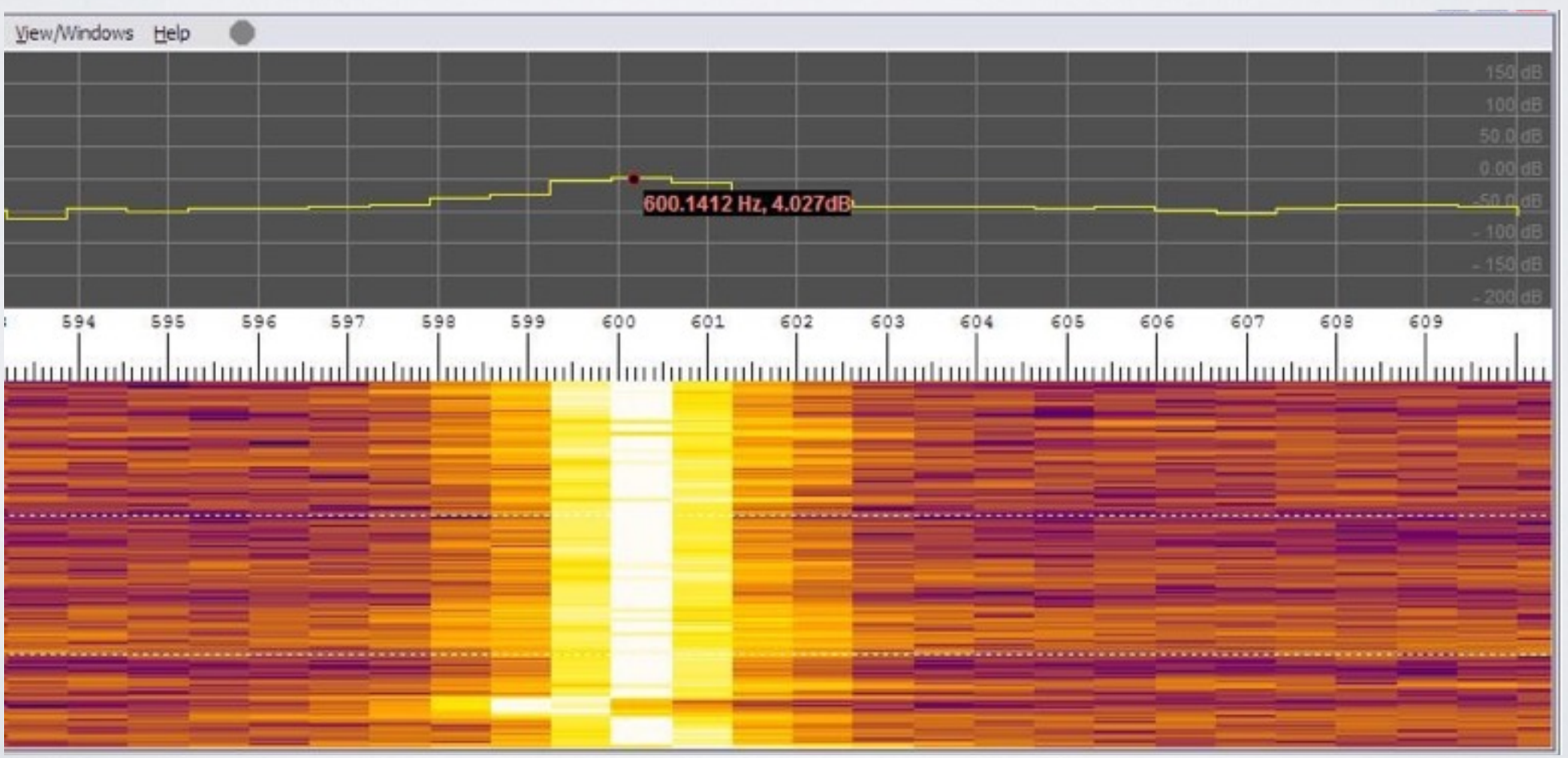

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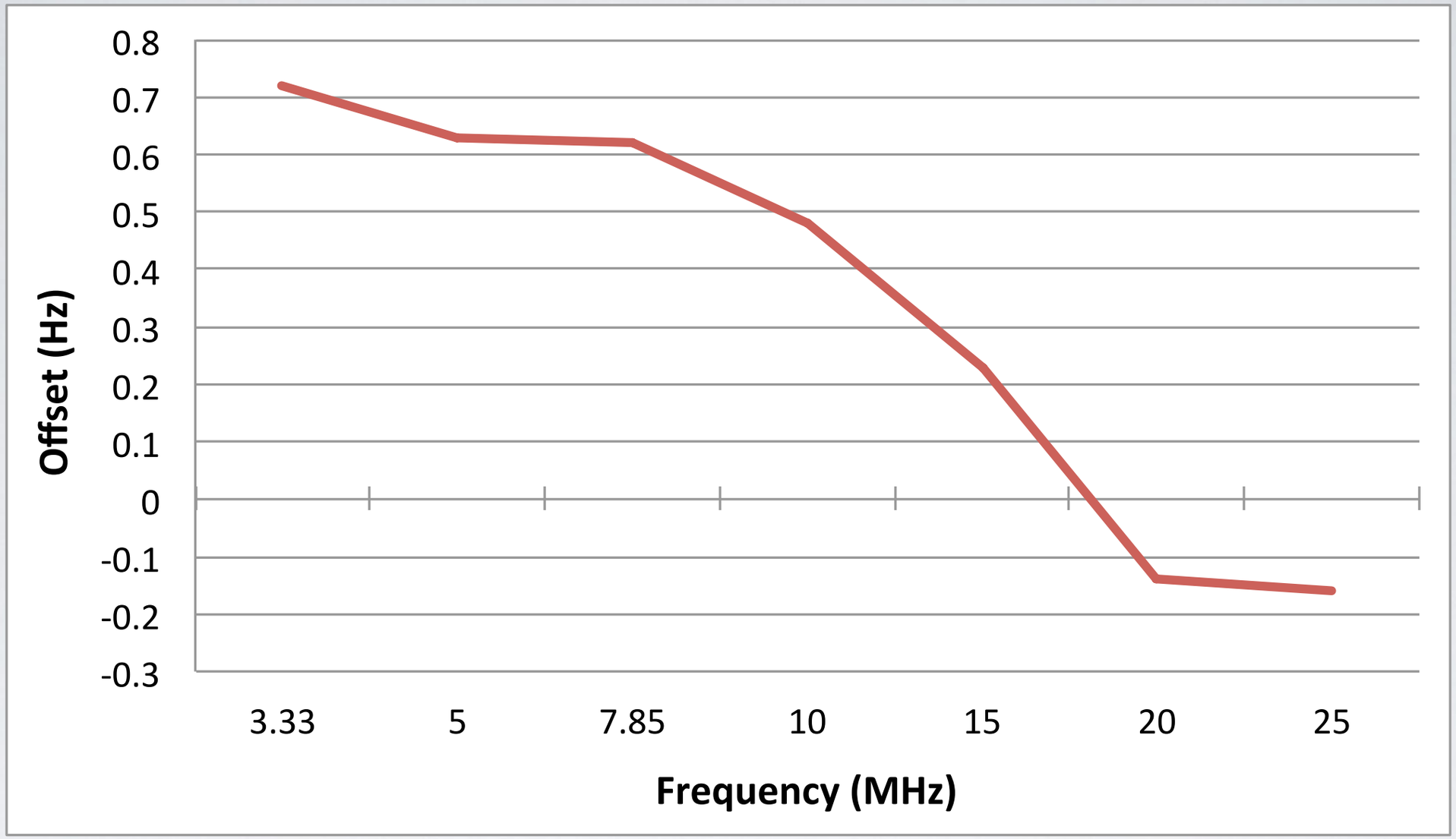
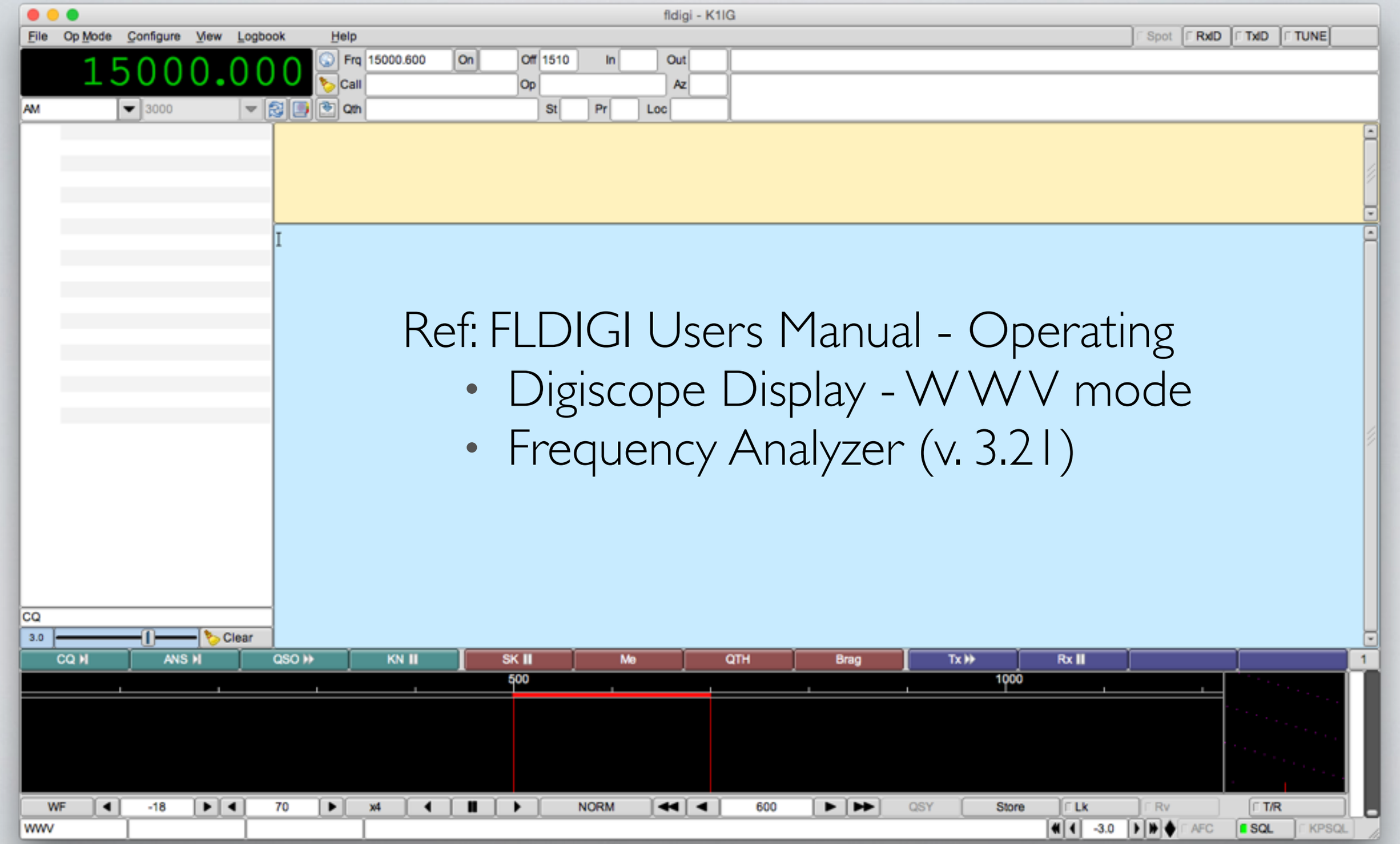


- Measure all WWV and CHU frequencies (-600 Hz)
- Make a correction chart based on WWV and CHU measurements

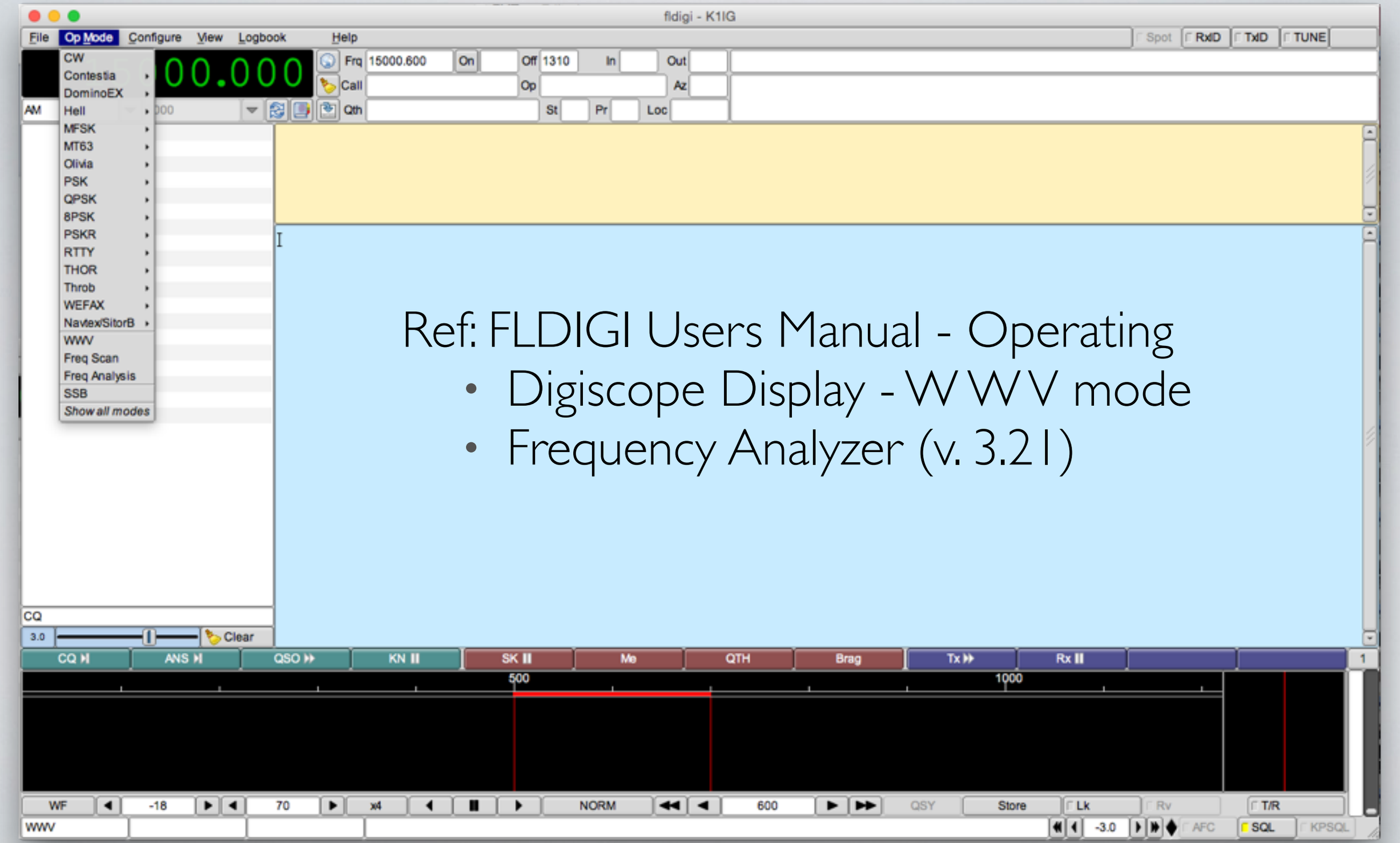
FLDIGI



Ref: FLDIGI Users Manual - Operating

- Digiscope Display - WWV mode
- Frequency Analyzer (v. 3.21)

FLDIGI



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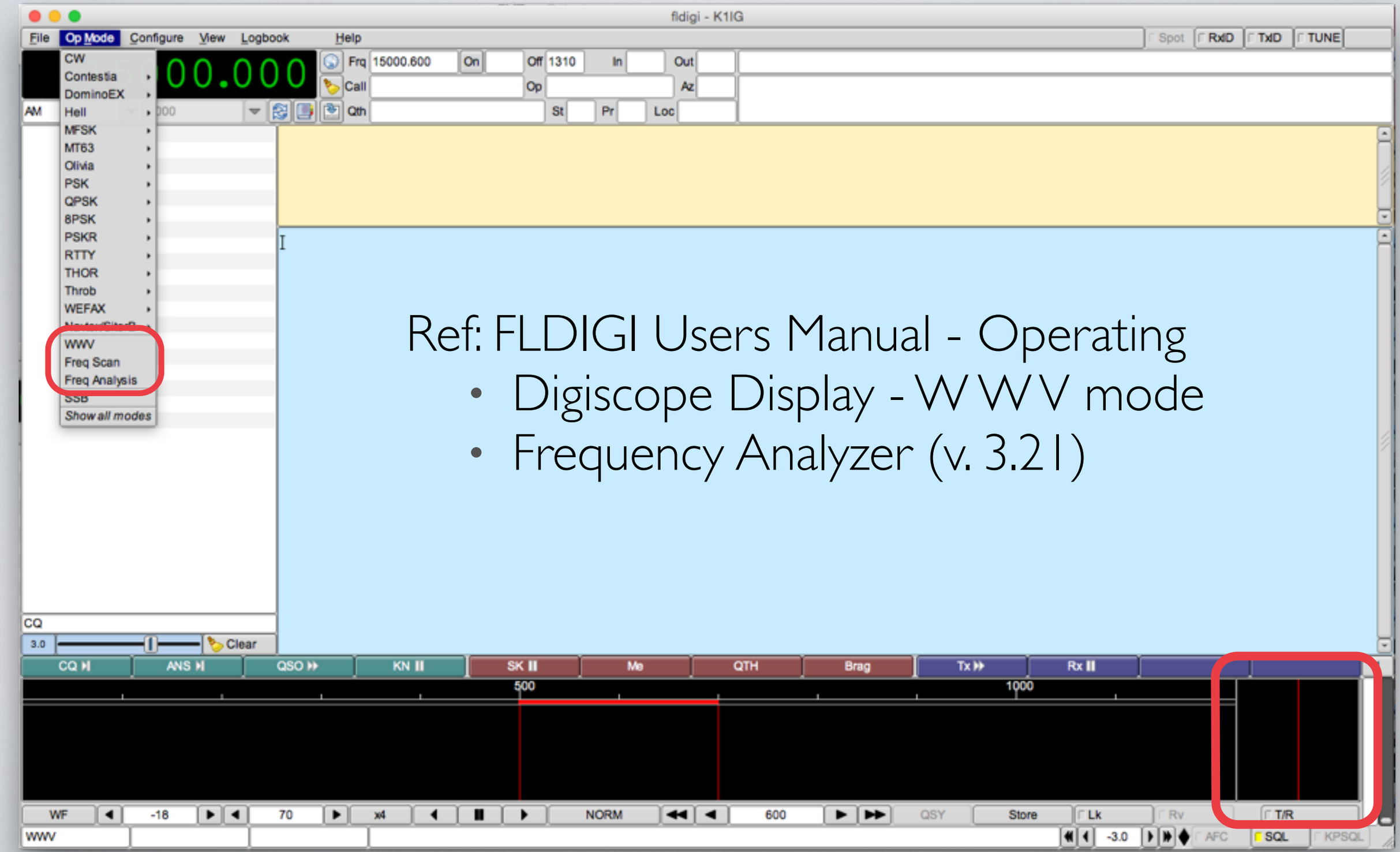

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FLDIGI SETUP

Computer Calibration — Part I

1. Select Op Mode - WWV
2. Select View - Floating Scope
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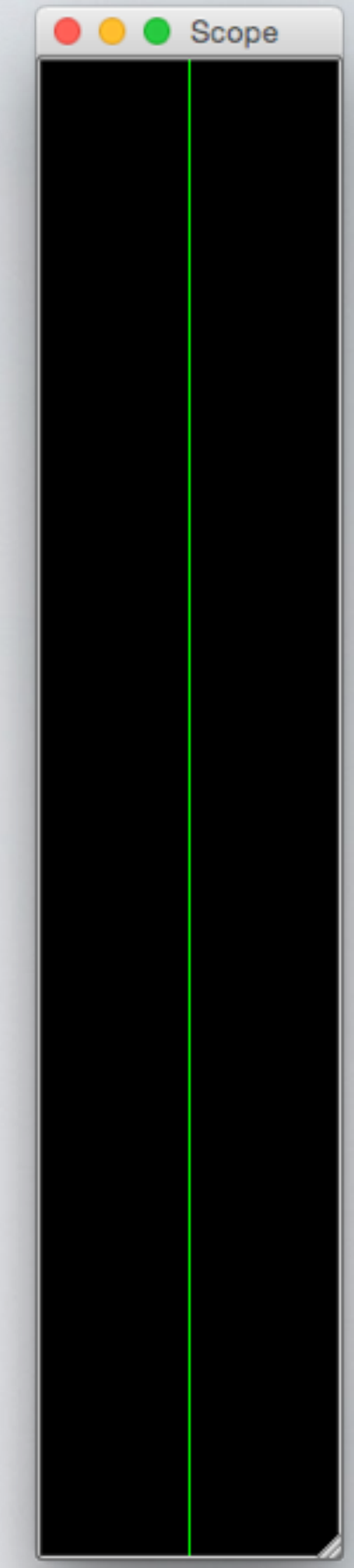

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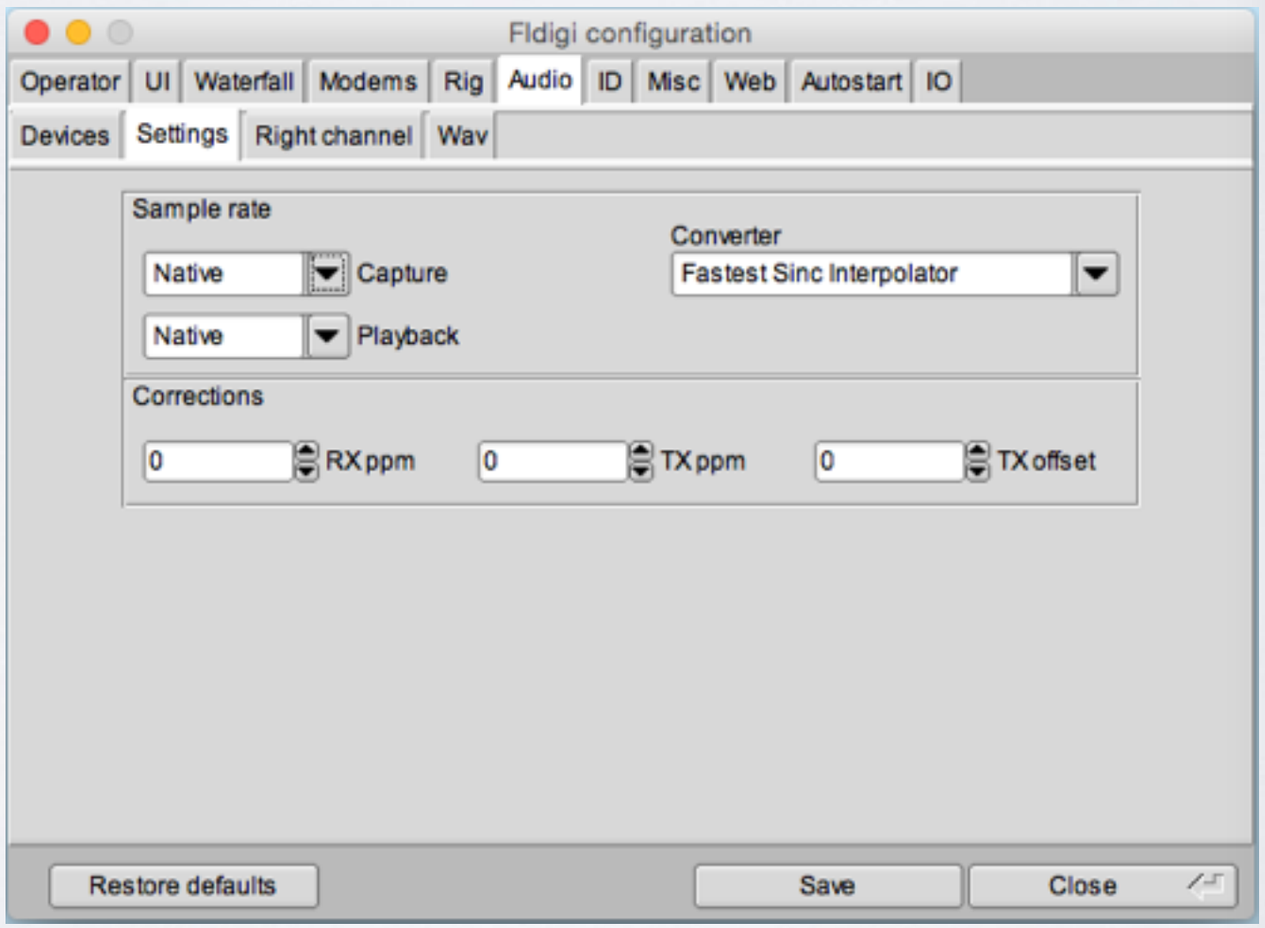

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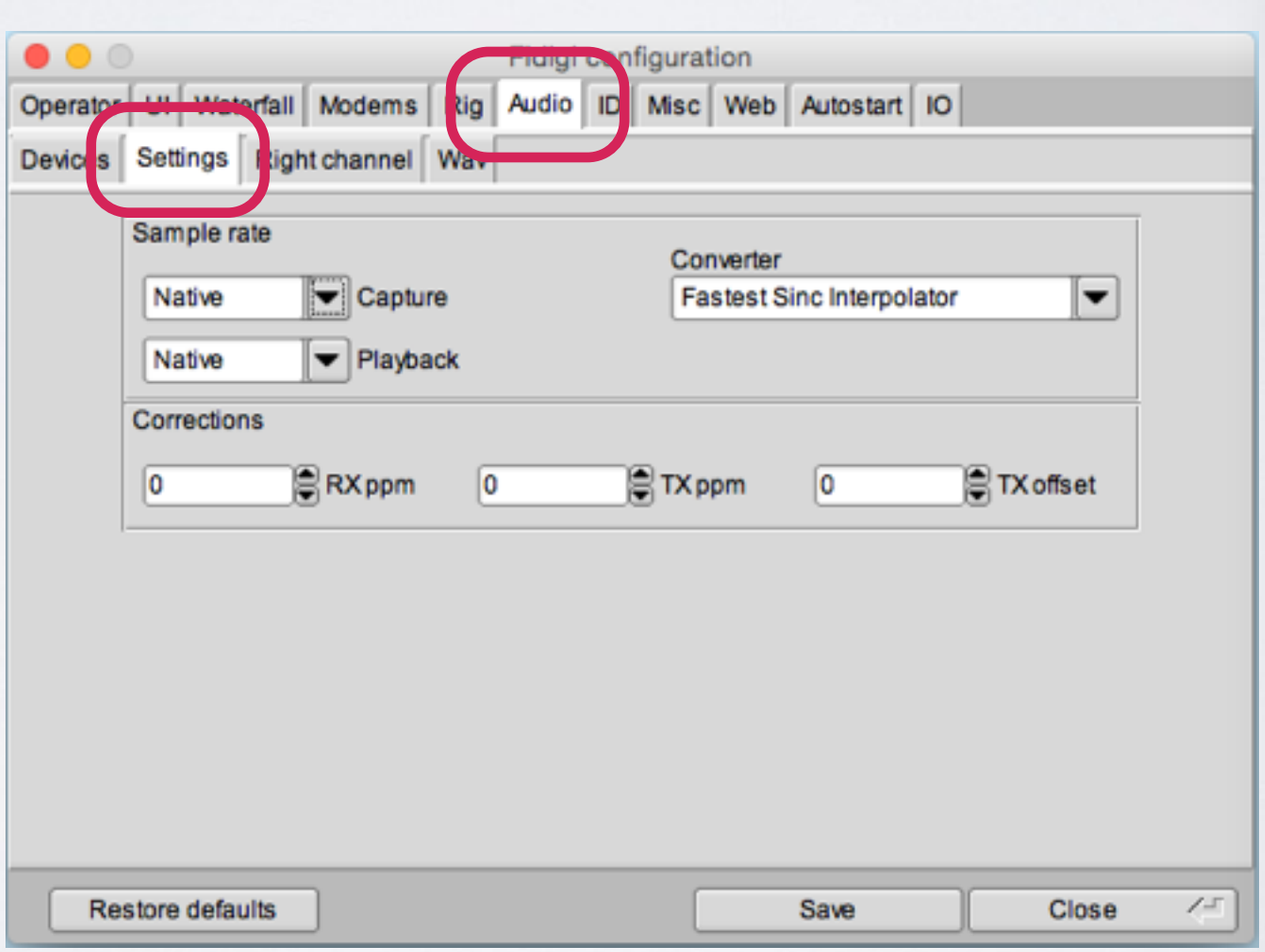

FLDIGI SETUP

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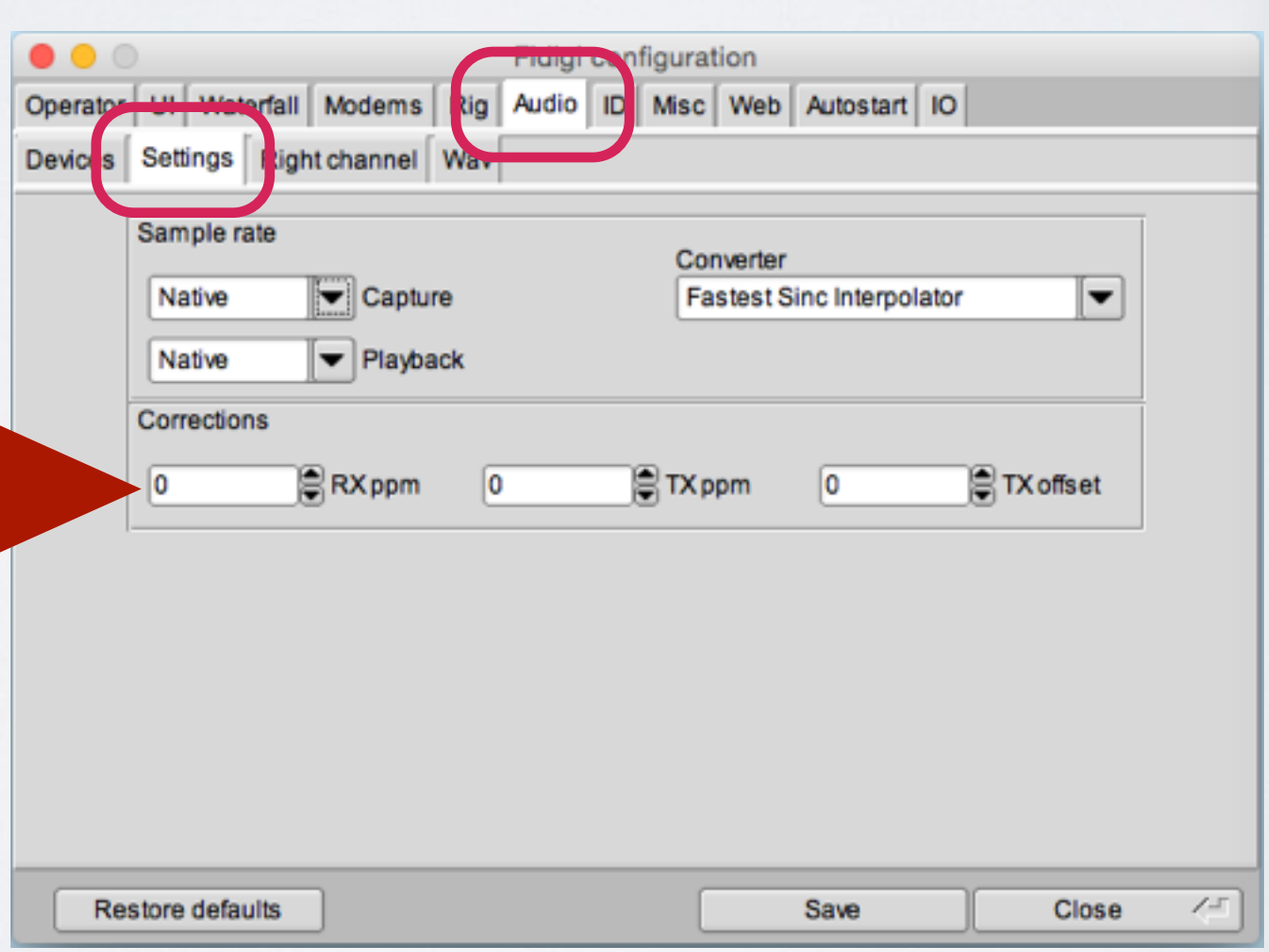
Make corrections here

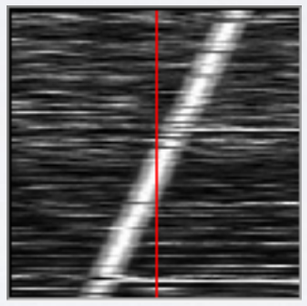


FLDIGI SETUP

Computer Calibration — Part II

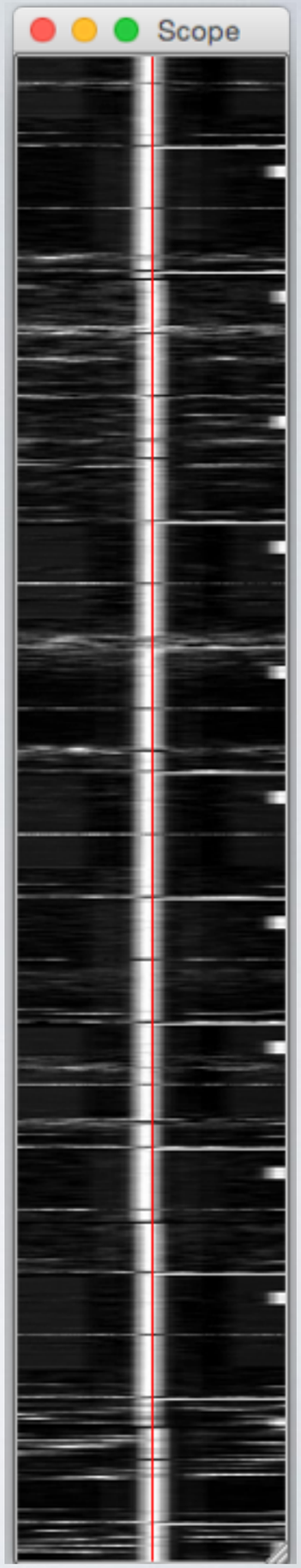
1. Set Rig to AM — tune to any WWV
2. Apply "RX ppm" corrections to make the scope line vertical

-1000 ppm



+1000 ppm

Ref: FLDIGI Users Manual
Digiscope Display — WWV Mode



FLDIGI RIG CALIBRATION

1. Set Rig to USB — tune to WWV - 600 Hz
2. Select Op Mode - Freq Analysis
3. Adjust rig so waterfall is exactly at 600 Hz

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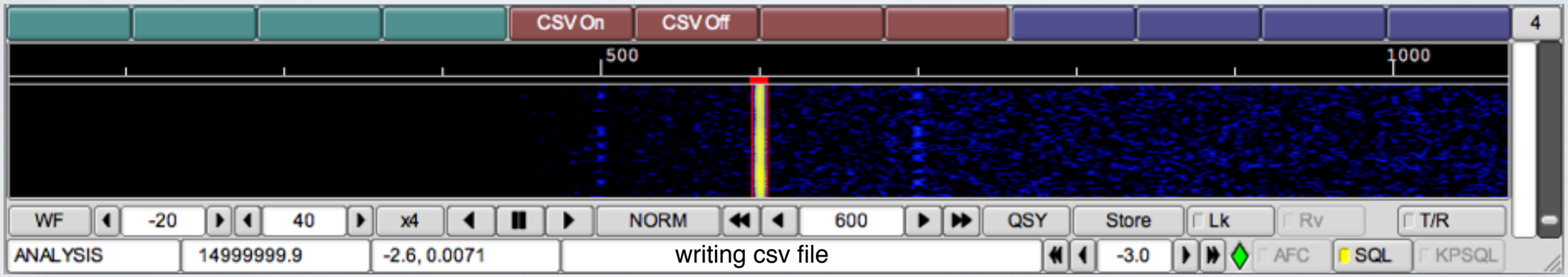

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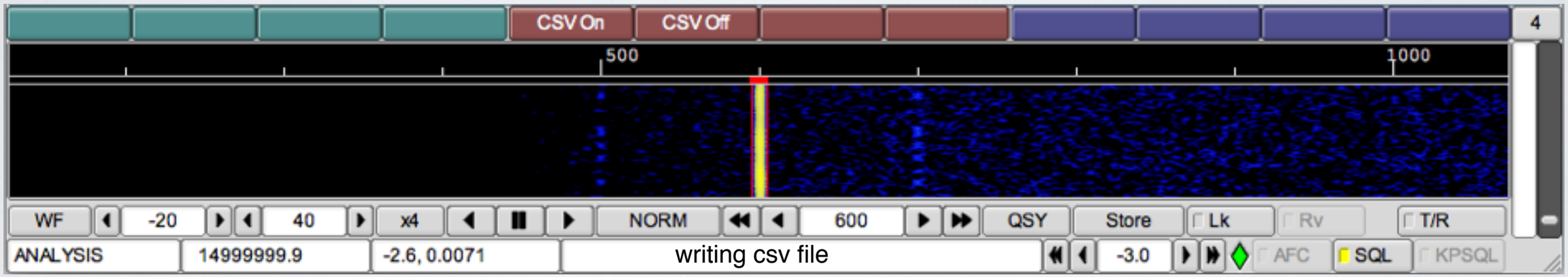
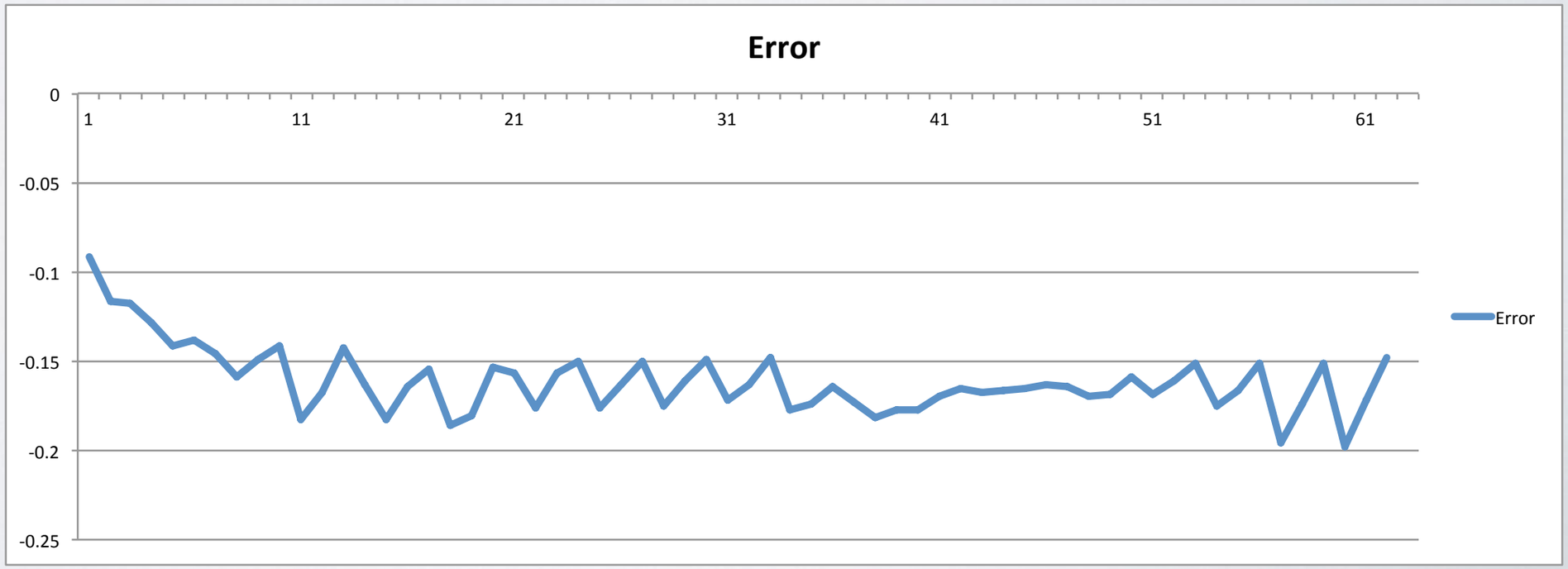


You'll get a data file that you can import into a spreadsheet



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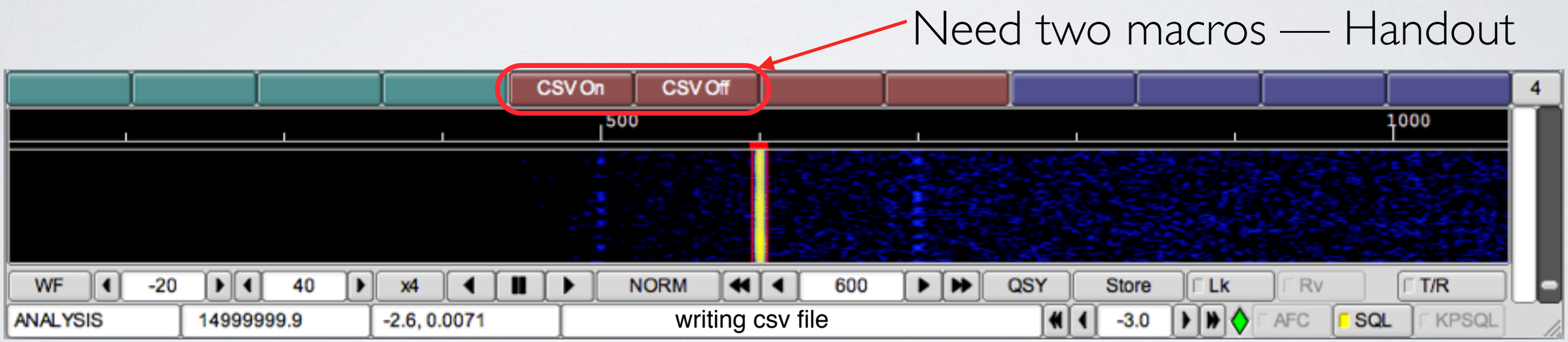

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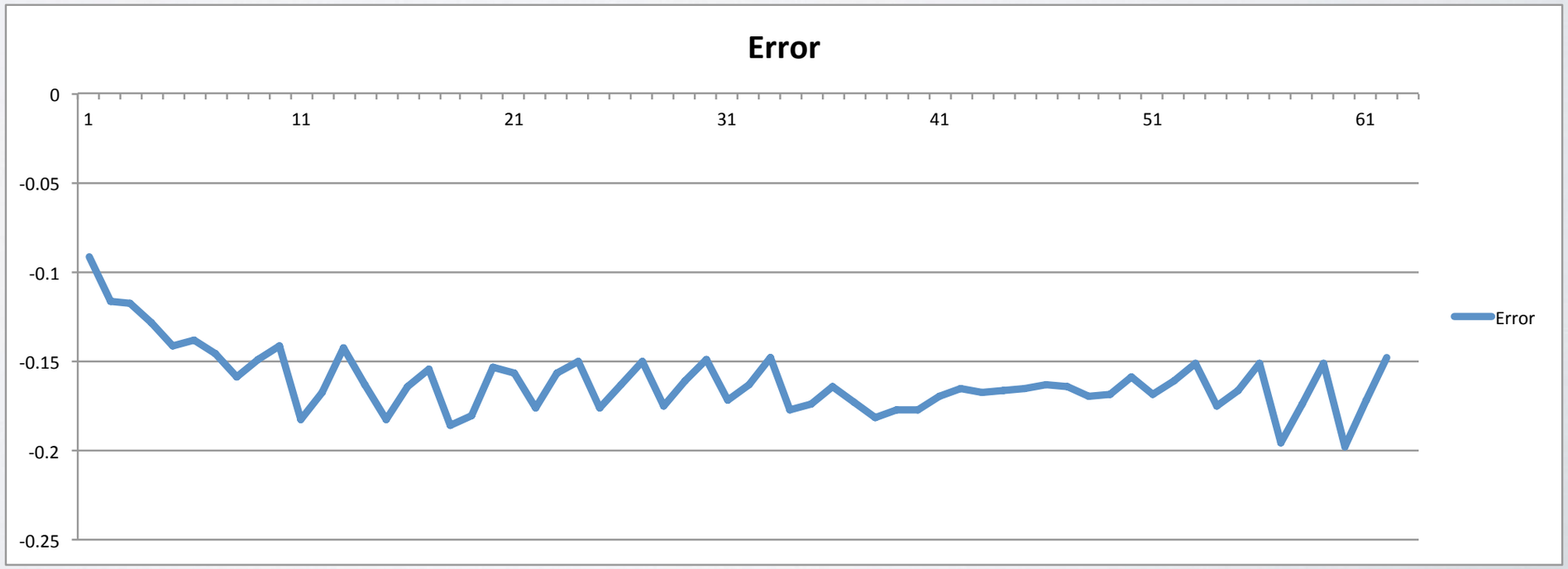

SMARTPHONE RIG CAL

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- Hams have successfully participated in the FMT with Android tablets

FREQUENCY MEASURING

Tune below frequency so sidetone is about 600 Hz

Broadcast Frequency = 9,980 KHz

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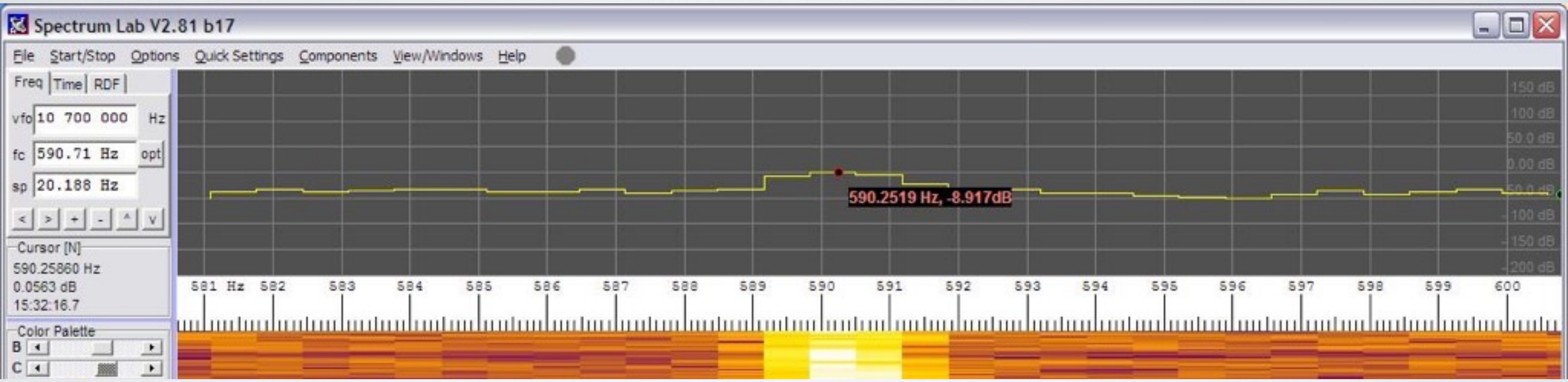

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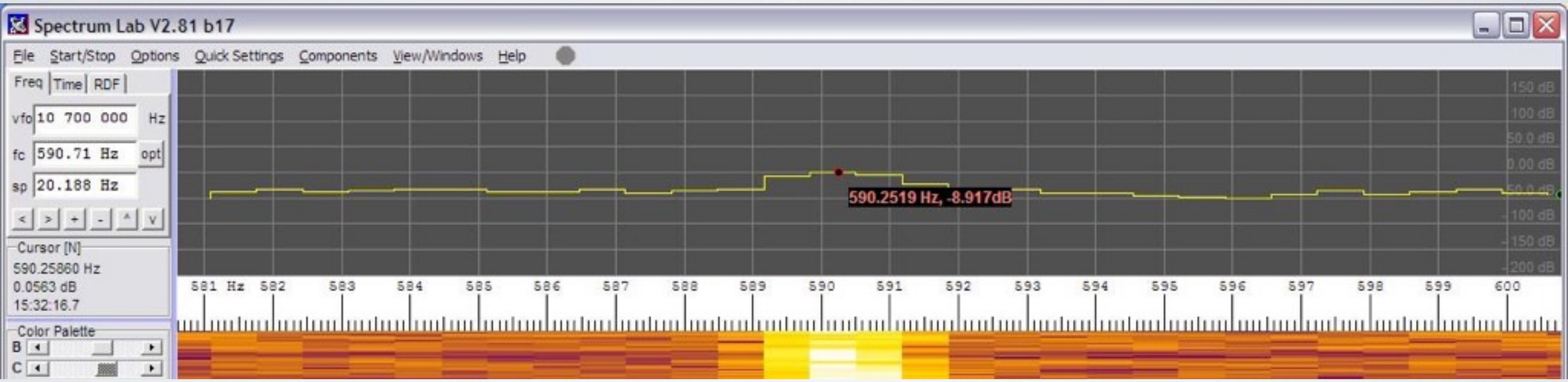

Offset error = +0.141 Hz, so offset is subtracted

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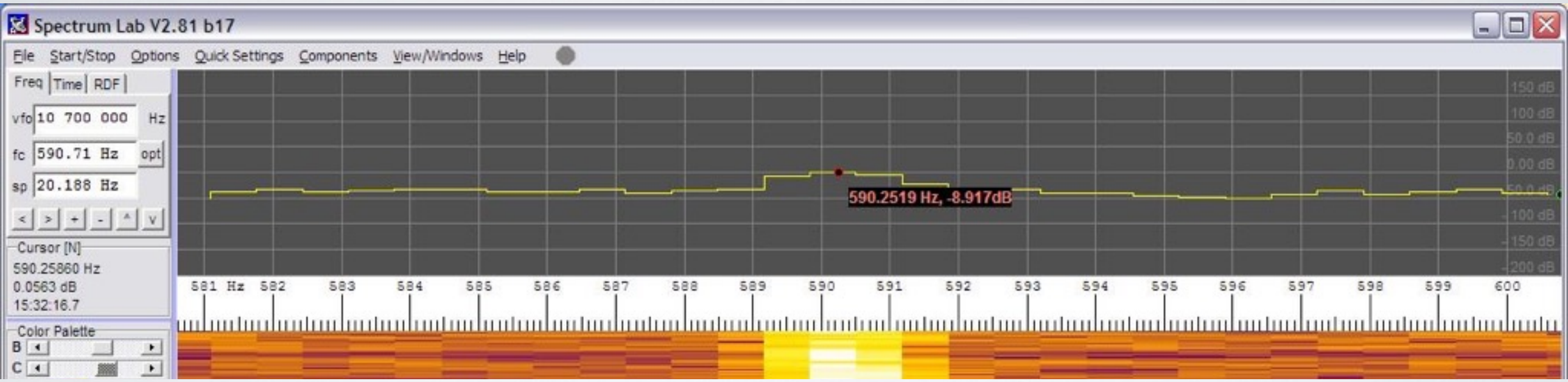

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Tuner + Spectrum Lab ± Offset = Frequency

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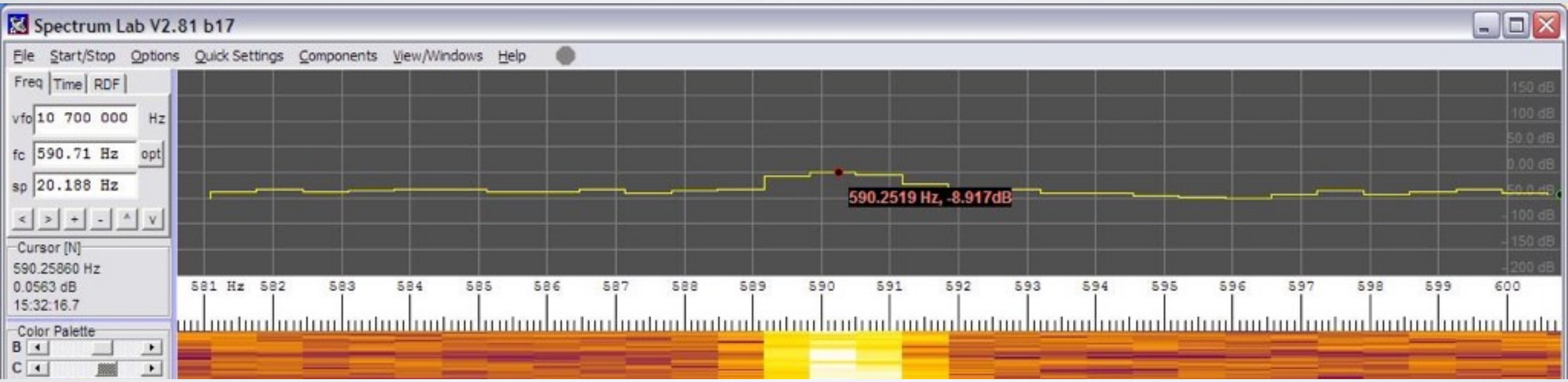

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9,979,400 + 590.252 - 0.141 = 9,979,990.111 Hz

FREQUENCY MEASURING TEST

Test announcement in QST and:

http://www.arrl.org/frequency-measuring-test

Data entry page and previous results are at:

http://www.b4h.net/fmt/

Test Format (three frequencies):

- 5 minute call-up
- 2 minute test (carrier or tone)
- 1 minute sign-off

Go to designated website and enter data to nearest .01 Hz

Perform calibrations before <u>and</u> after the test!

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April 2015 Frequency Measurement Test

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April 9, 2015

Actual Radio Frequencies (Hz):

	80m	40m	20m
K5CM	3,598,437.38	7,055,633.92	
WA6ZTY			14,121,570.83

Note: The requirement to be included in the *green box* was changed to +/- 1.5 Hz for 20 meters due to calibration issues at the transmitter that were discovered after the FMT. These issues have been corrected and will not be a problem in subsequent FMTs.

K5CM/WA6ZTY All (<=1/1.5 Hz):
AA6LK, AB2UW, AB4RS, AC2DE, AF9A, AG2M, K1GGI, K2LYV, K3JQ, K3KO, K4BYN, K4KJQ, K4TRH, K5CM, K5RKS, K6APW/7, K6IQL, K6LU, K6OQK, K7HIL, K7KMQ, K9KK, KB2MN, KB8W, KC9DOA, KD2BD, KG6HSQ, KI5EE, KJ8S, KK6JTL, KM6QX, KU4PY, N0EXM, N3CRT, N3FG, N3IZN, N4AU, N5DM, N6SKM, N7EP, N8OB, NR5ON, NY7T, VE2IQ, W0CZ, W0HBK, W1KU, W2FD, W3JW, W3SA, W4JLE, W5LAC, W6BM, W6IHG, W6OQI, W7PUA, W8IMA, WA1ABI, WA4FJC, WA6RZW, WB0LXZ, WB3AKD, WB4ALM, WB6BNQ, WB8TFV

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AA0CL, AA6LK, AB2UW, AB4RS, AC2DE, AD3Y, AF9A, AG2M, K1GGI, K2LYV, K3JQ, K3KO, K4BYN, K4KJQ, K4TRH, K5CM, K5RKS, K6APW/7, K6IQL, K6LU, K6OQK, K7HIL, K7KMQ, K9KK, KB2MN, KB8W, KC2LNC, KC2SYK, KC9DOA, KD2BD, KD5MMM, KG0HY, KG6HSQ, KI5EE, KJ8S, KK6JTL, KK6KFQ, KM6QX, KN1H, KU4PY, N0EXM, N3CRT, N3FG, N3IZN, N4AU, N5DM, N5LUL, N6SKM, N7EP, N8OB, N8SBE, N9CIF, NR5ON, NY7T, VE2IQ, W0CZ, W0HBK, W0PHD, W1KU, W2FD, W3FAY, W3JW, W3SA, W4JLE, W5AJ, W5LAC, W5TV, W6BM, W6IHG, W6OQI, W7KPZ, W7PUA, W8IMA, W9ZB, WA1ABI, WA1N, WA4FJC, WA6RZW, WA6ZTY, WB0LXZ, WB0OEW, WB3AKD, WB4ALM, WB6BNQ, WB6HYD, WB8TFV, WC8J, WX4TW

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TECHNIQUES FOR THE TRULY SERIOUS

TECHNIQUES FOR THE TRULY **FANATICAL***

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* No guarantee of accuracy improvement

RIG CALIBRATION

■ Calibration the Frequency (approximate)

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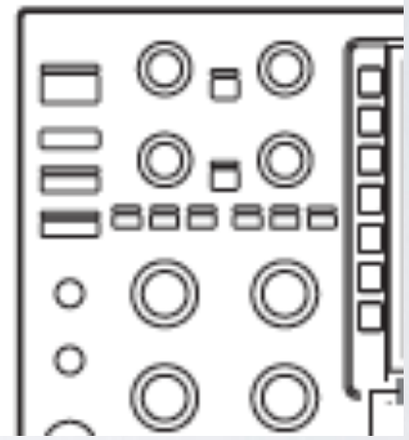

RIG CALIBRATION

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EXACT!

A very accurate frequency counter is required to calibrate the frequency of the transceiver. However, a rough check may be performed by receiving radio station WWV, WWVH, or other standard frequency signals.