# Davie/Cooper City Amateur Radio Club

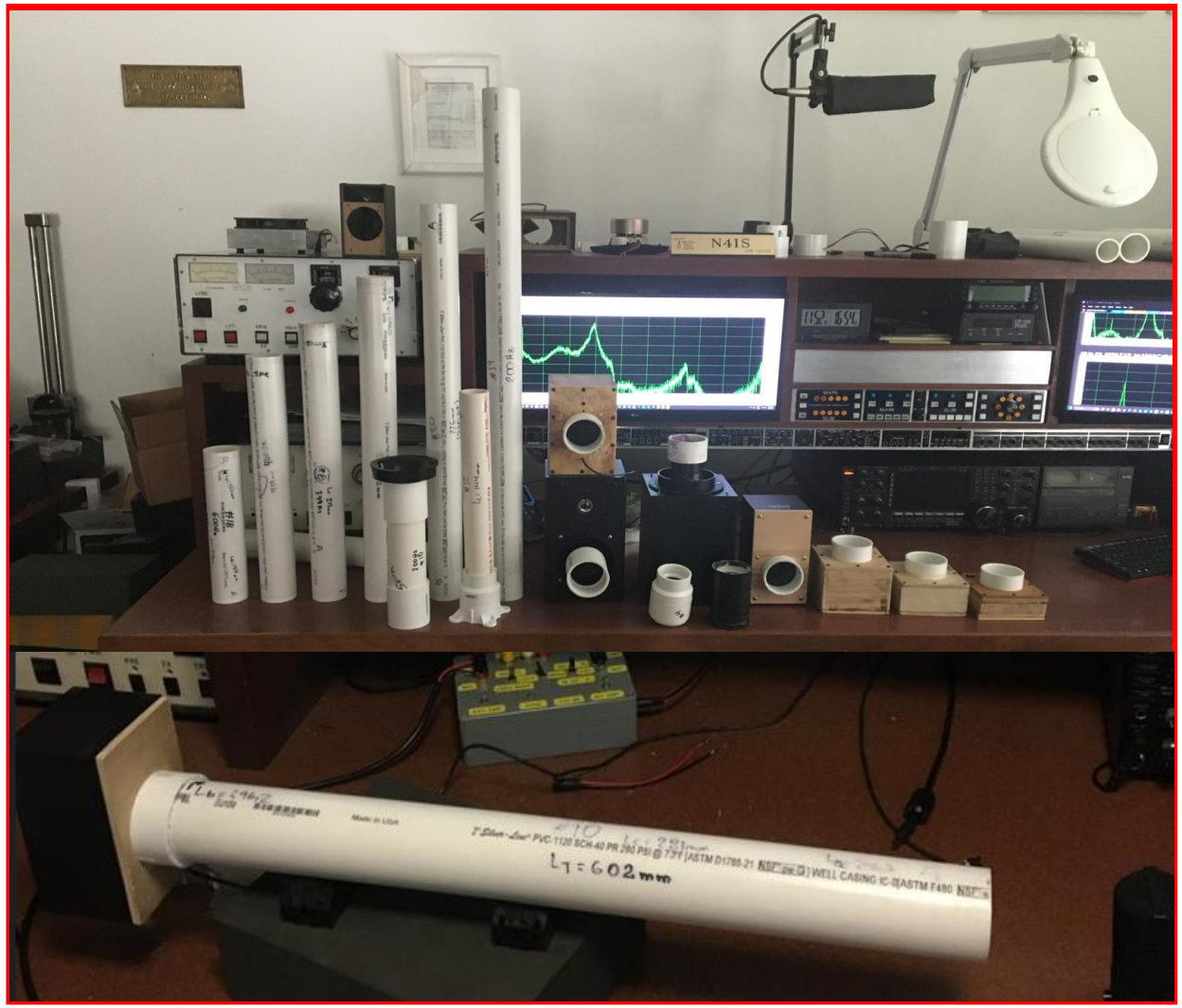
## High Performance CW Speakers


Jose Carlos N4IS

May 13th ,2025

# Super Selective Speaker for CW 3-S

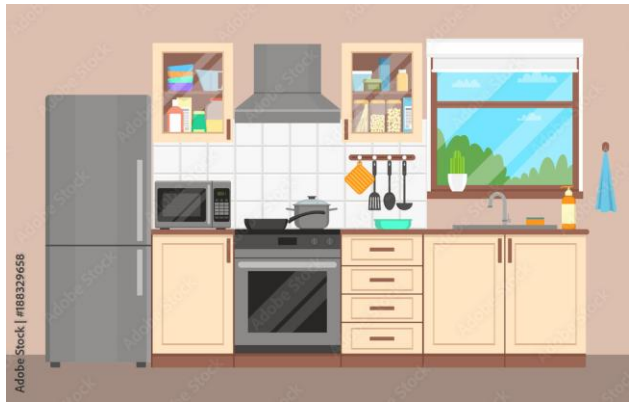
- The 3-S project.
- What it is ?
- How it works.
- How o use it.
- Live demo



# How this project started. 2017

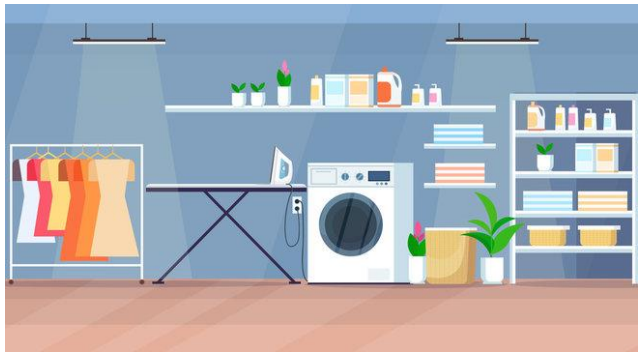
WALL

**Ed**
**N4II**



**Ed and Doug heard a clean CW signal on another room, far from the radio room.**

**Doug**
**NX4D**



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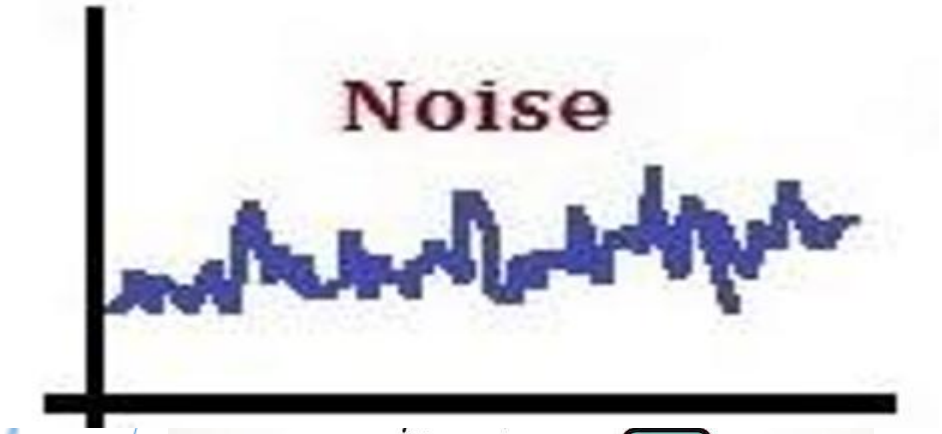
**Ed and Doug heard only noise on the radio room.**

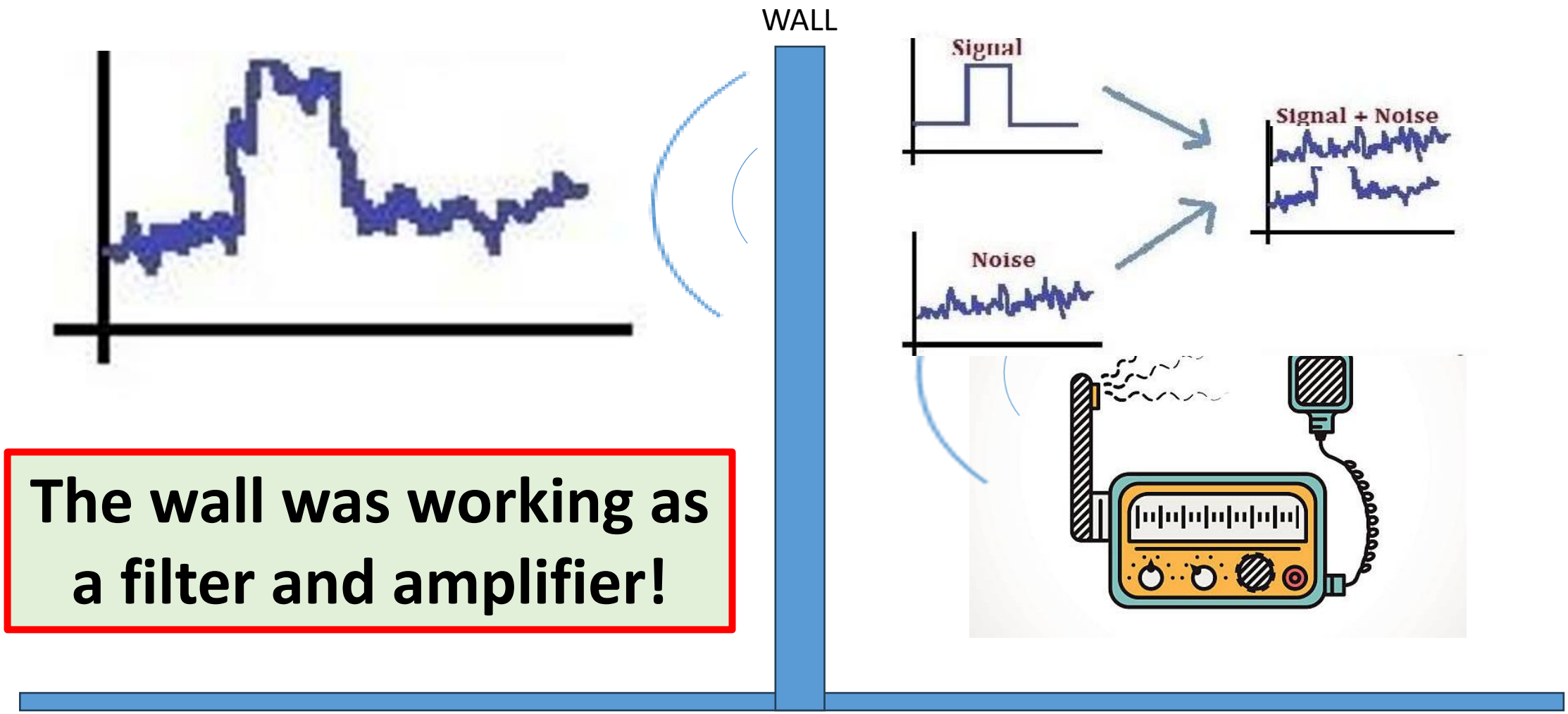
# What was going on?

- The wall was not isolating the noise ?
- Why Ed and Doug heard a clear CW signal on another room ?
- What happened with the noise?
- Why there was only noise and no cw signal on the radio room?

WALL



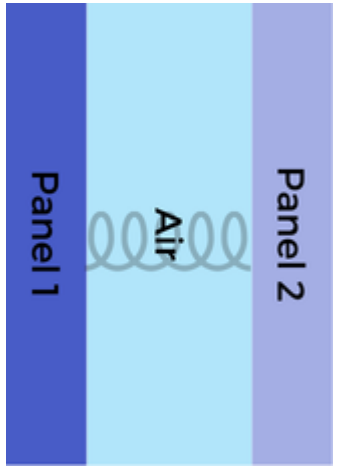

# What was going on?

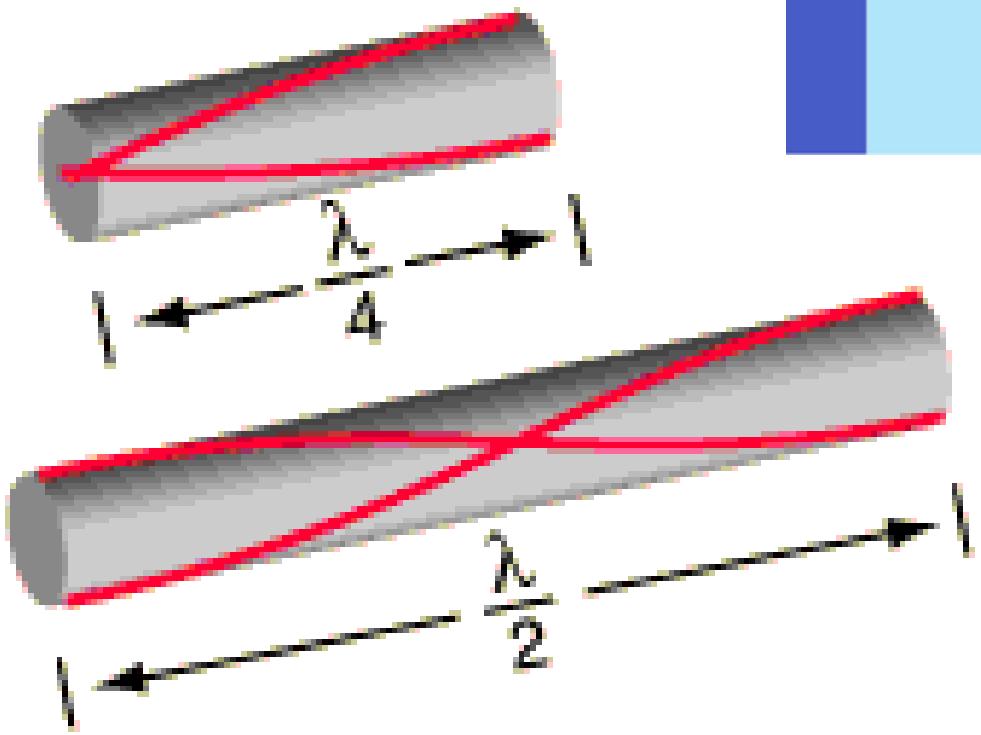


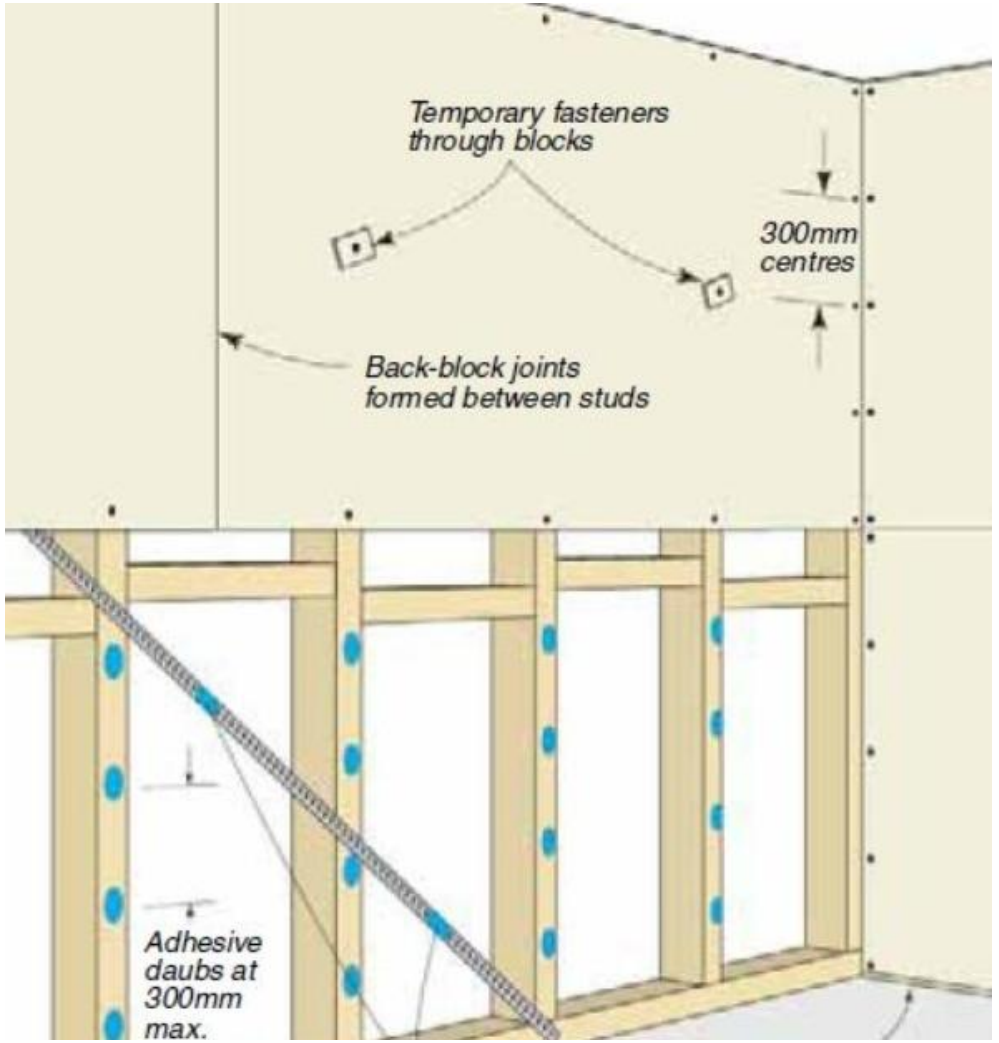

**The wall was working as a filter and amplifier!**

# The wall as acoustic filter and amplifier.

## Helmholtz Resonator



# CW resonant speaker *2018*

**This project was based on several QST articles about CW resonant speakers and the work of Ed Loranger (WE6W), and N5FC Resonant Speaker (N5ESE Prototype) found here >**

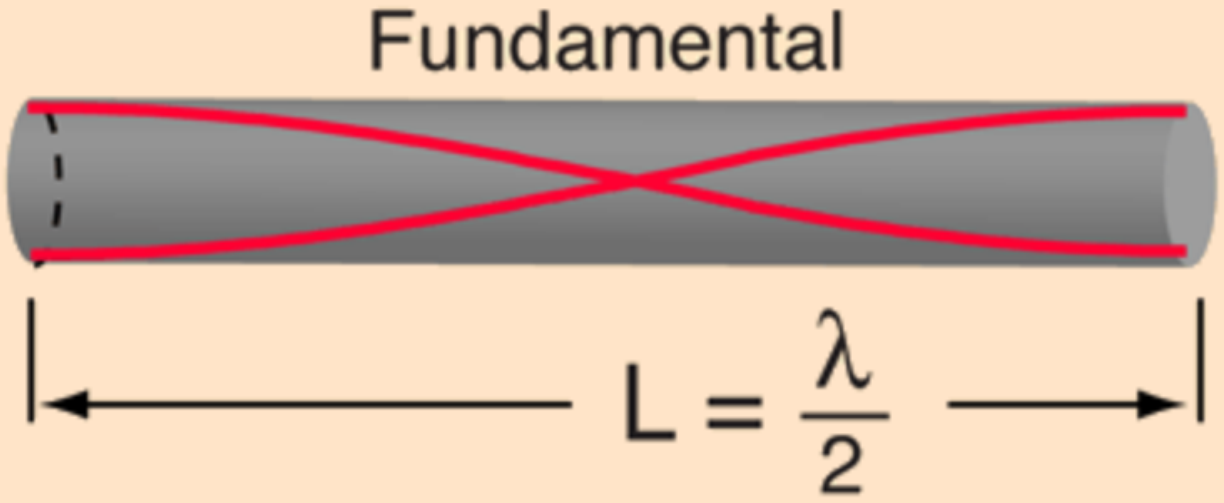
**https://www.n5ese.com/res_spkr.htm**

**Deep diving on organ pipe construction, psychoacoustic, the human ear, CW pitch and NASA 3-D sound.**

# Basic concept

## Open Cylinder Air Column

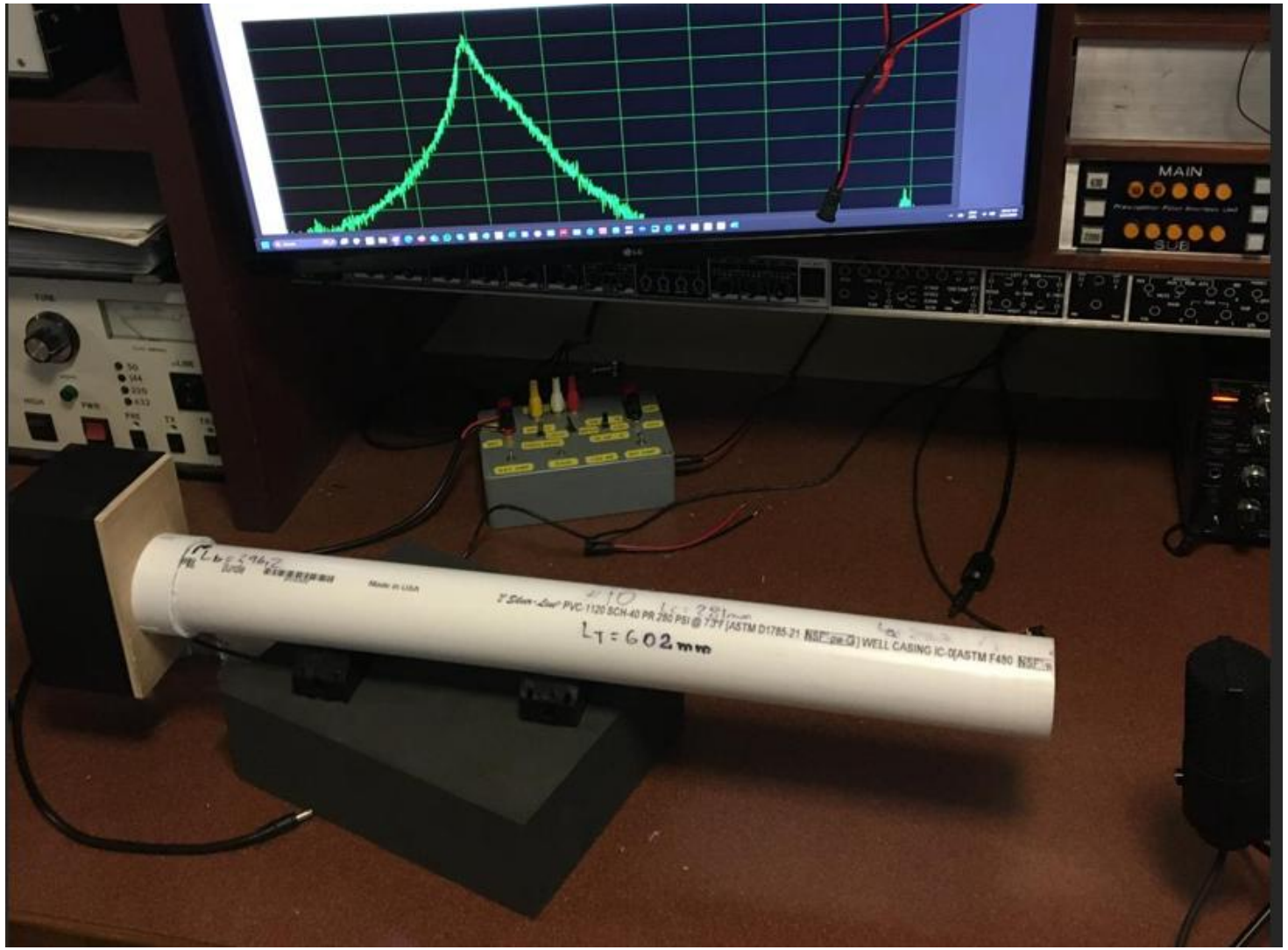
A cylindrical air column with both ends open will vibrate with a fundamental mode such that the air column length is one half the wavelength of the sound wave. Each end of the column must be an antinode for the air




$$f_1 = \frac{v_{sound}}{2L}$$

http://hyperphysics.phy-astr.gsu.edu/hbase/Waves/opecol.html

# Build and tested over 100 filters

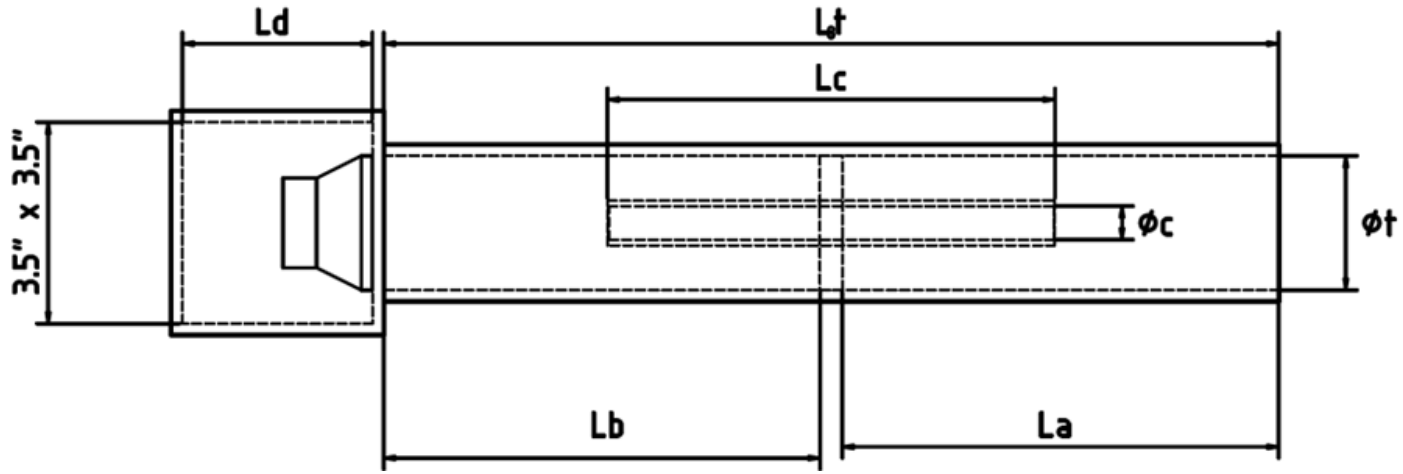



Biult and tested over 100 filters

Tested over 40 different speakers

# 3S Super - Selective – Speaker 2025

La = Lb = Lc




*Resonances*

Fa = 3-S resonant frequency peak

Fn = Inner tube resonant frequency notch ( 2 x Fa, notch 2nd harmonic )

Fb = Speaker resonant frequency inside the sealed box

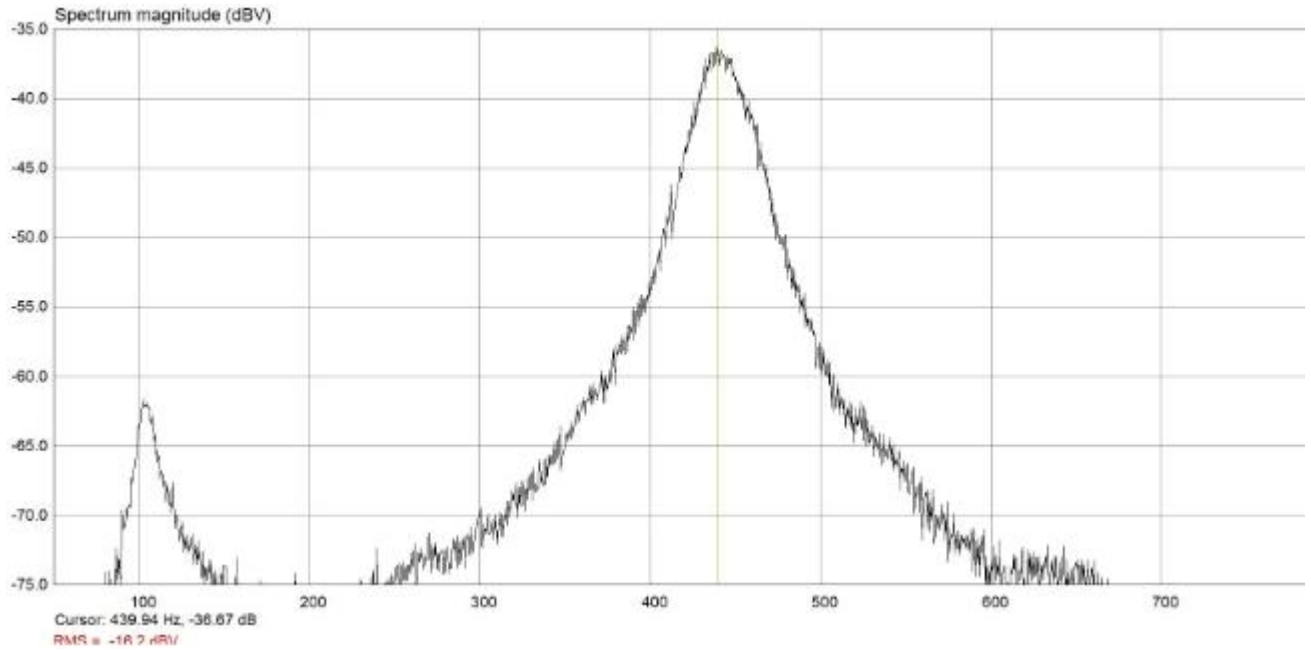
# 3-S construction *2025*


# ARTA Spectrum Analyzer

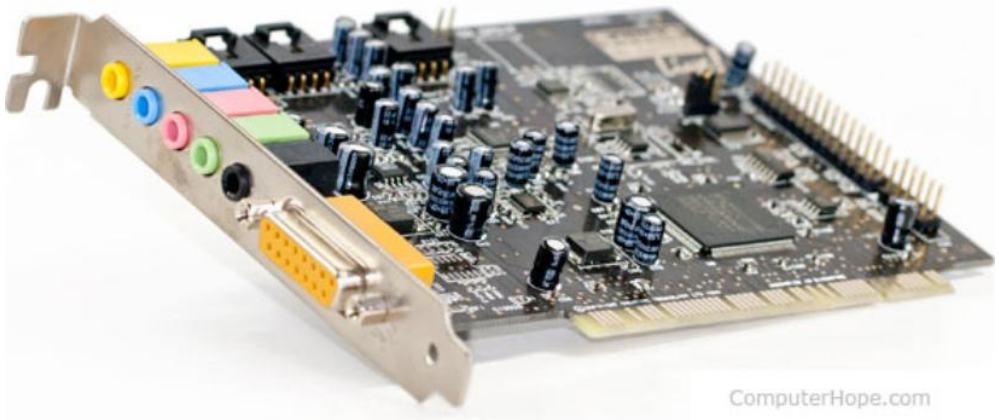
https://artalabs.hr/

ARTA Software

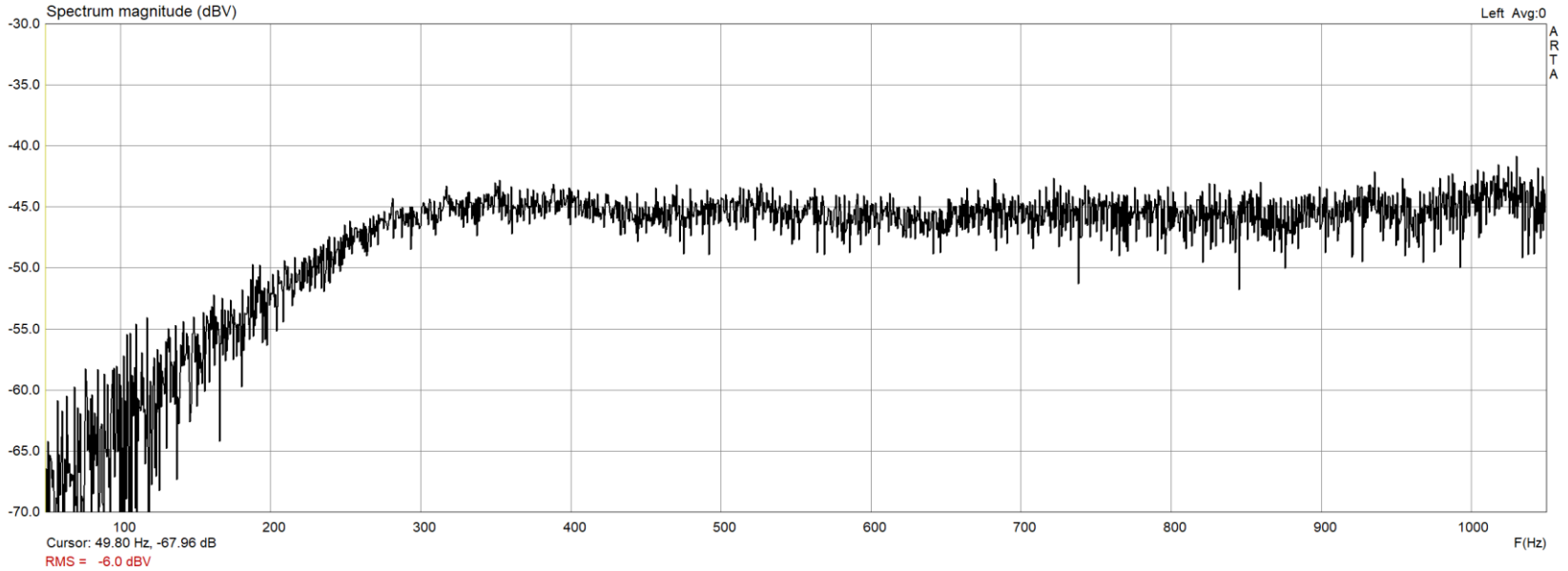
USB Microphone, Metal Condenser Recording Microphone

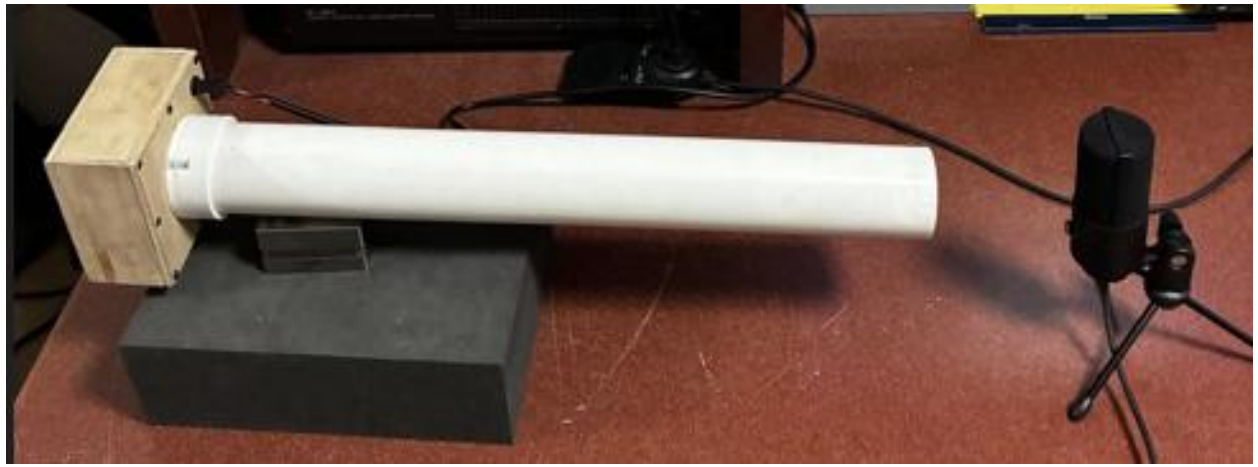




Computer Sound Blaster sound card



# 3-S Super Selective Speaker CW

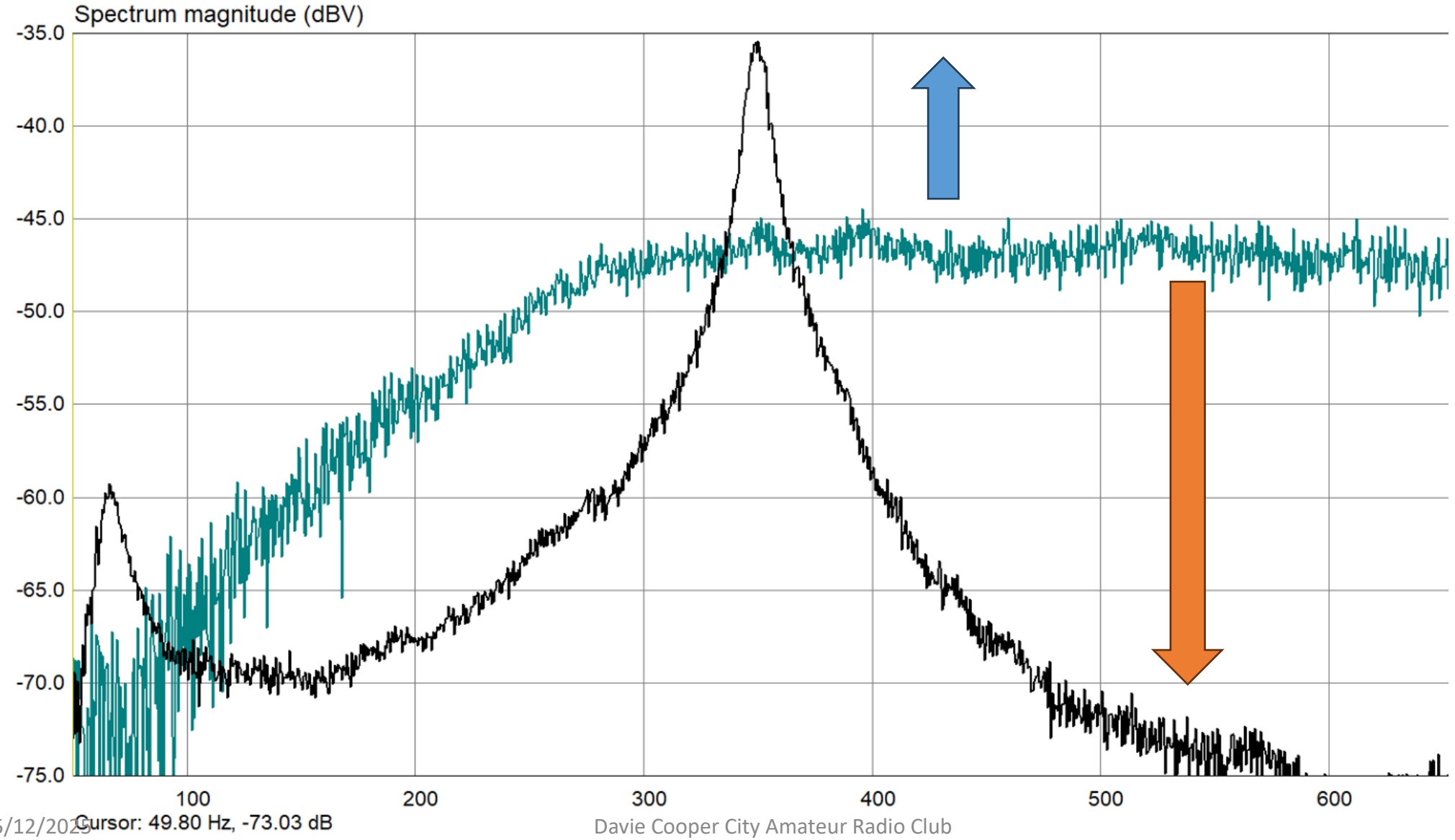


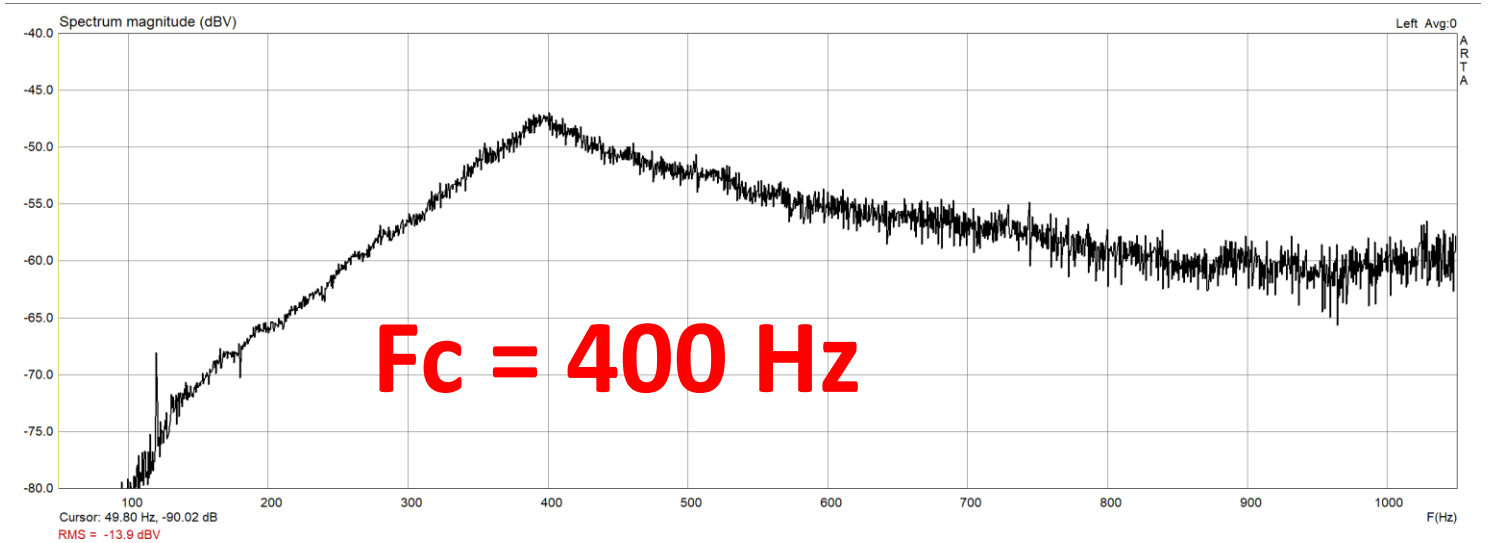
**350 Hz # 35 Peerless TC7FD04-04**
**box 3.5x3.5x1.5" Lt = 500 mm La = Lb = 244 mm**
**Lc= 240 mm ID = 18 mm PVC 3/4“ Q = 50**

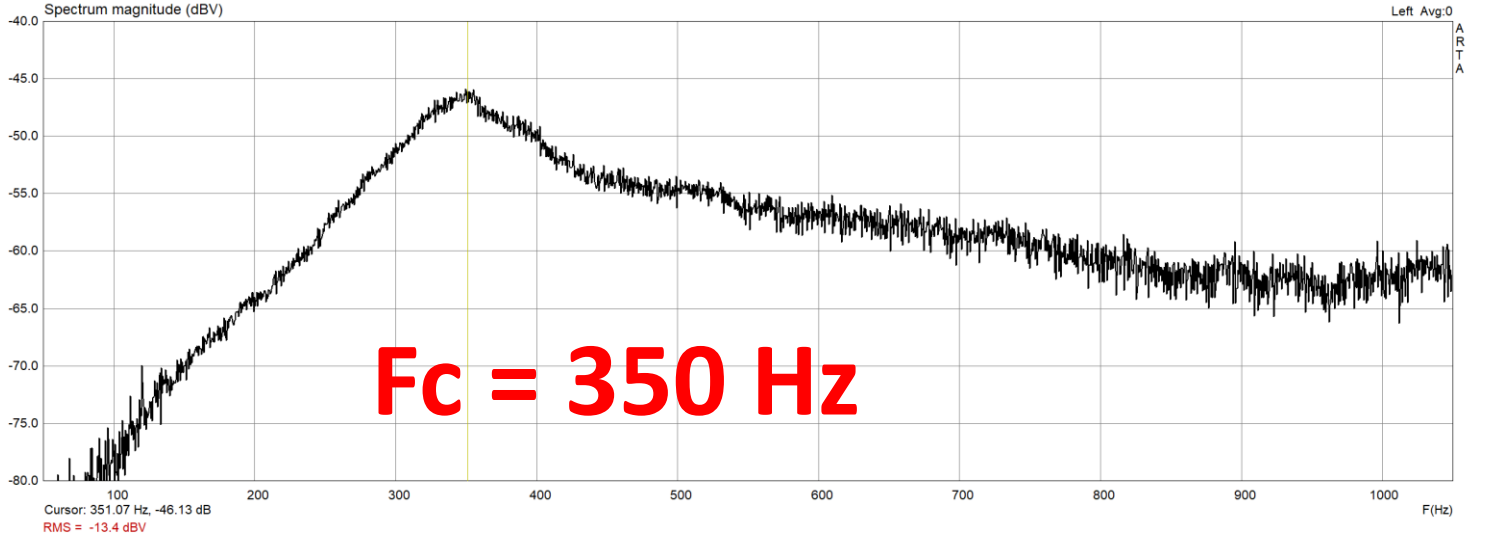
**BW -3db = 7 Hz - 6db = 13 Hz**
**-10 db = 22 Hz -20 db = 68 Hz**
**- 30db = 226 Hz**

# 3-S Super Selective Speaker 350 Hz Q = 50

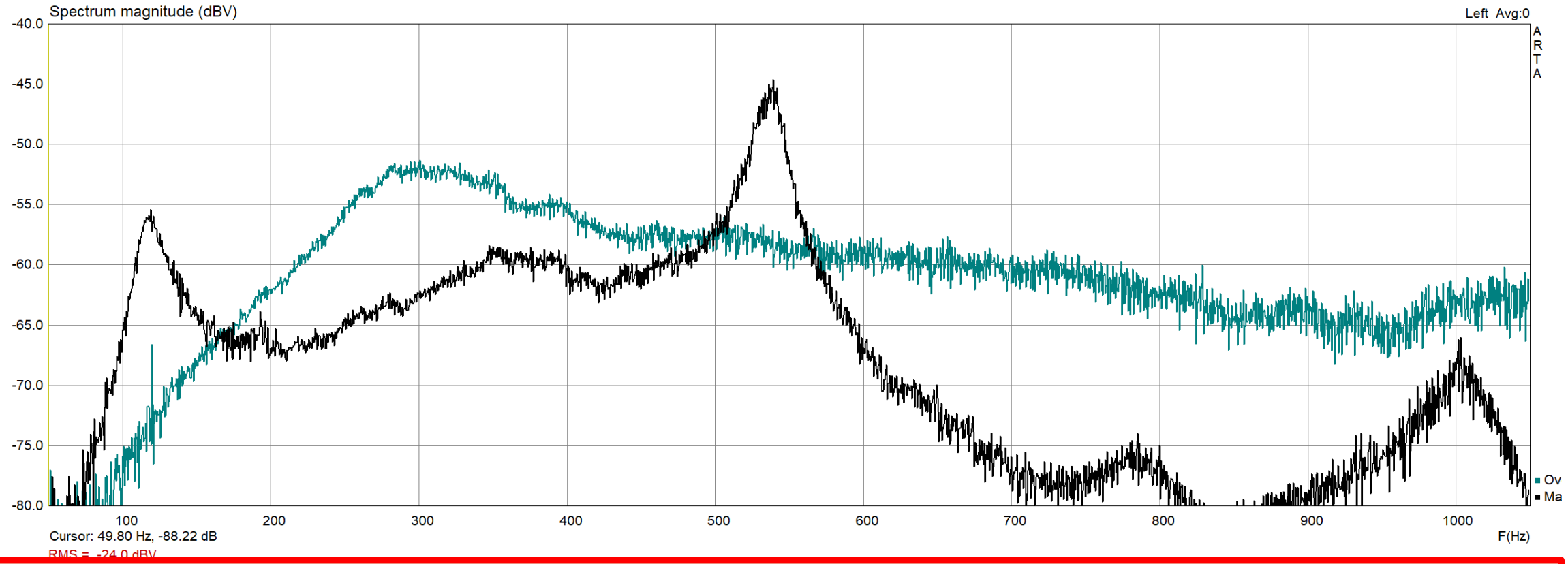


# Speaker box resonance

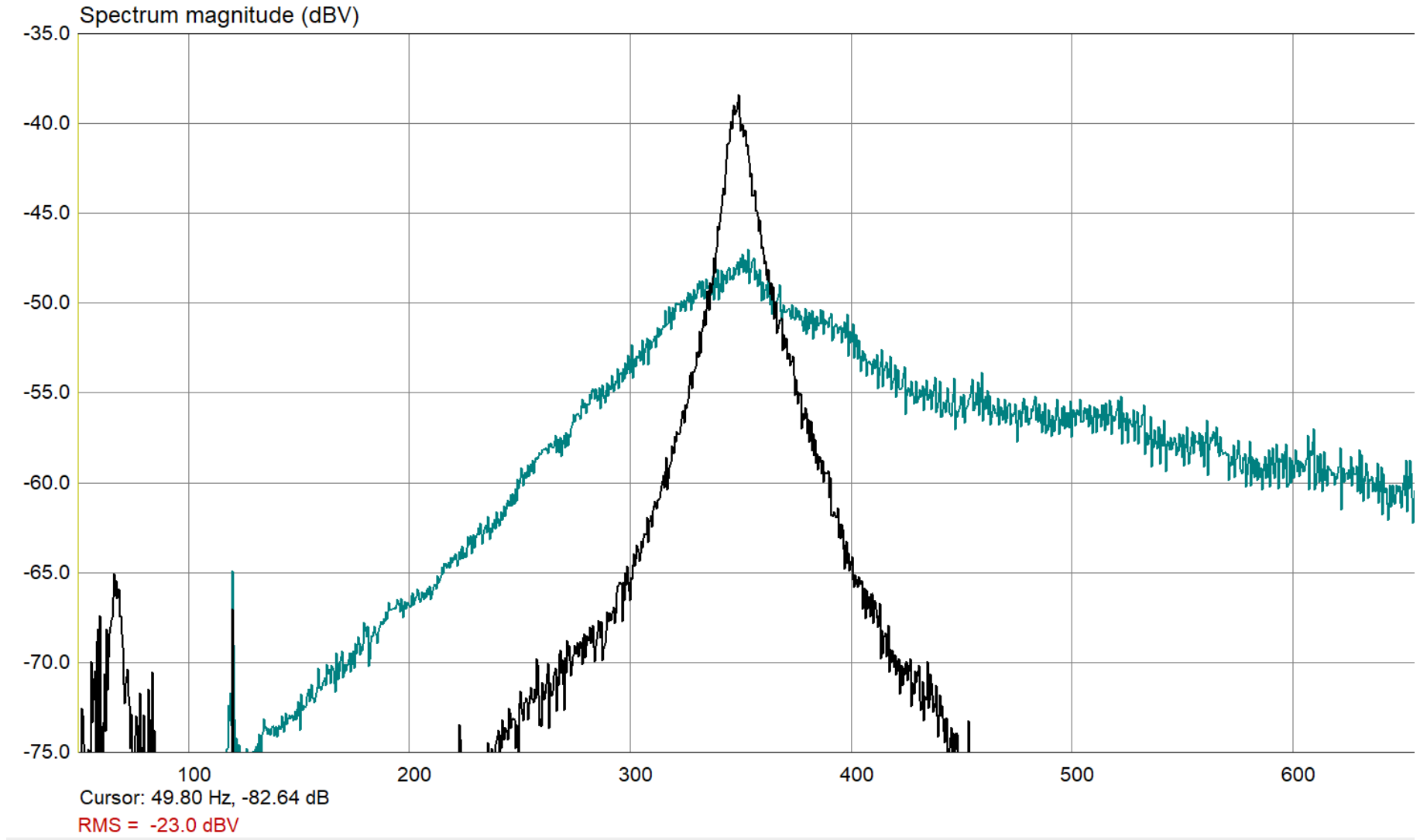



# 3-S bad results



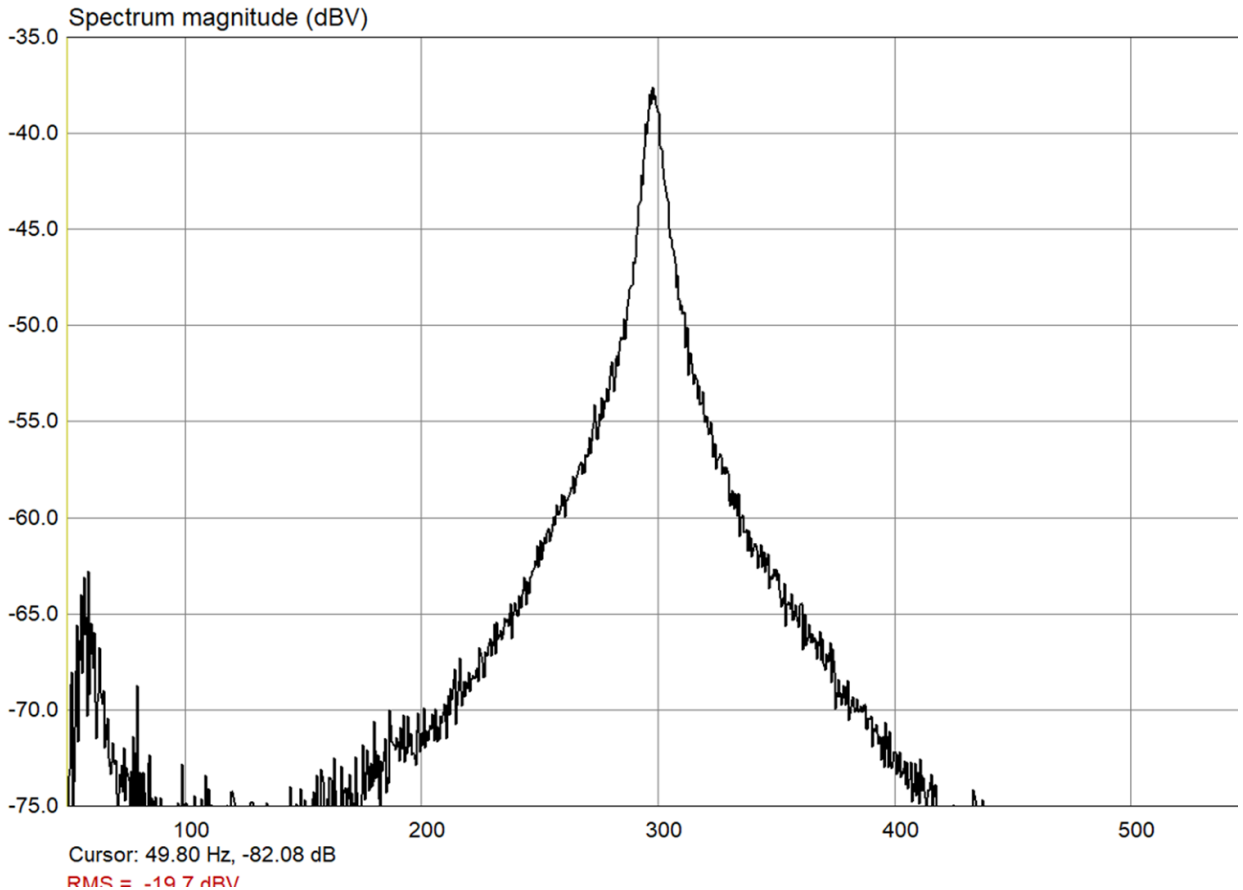

**The speaker box 350 Hz and 600 Hz filter is a bad combination, both must be at the same frequency**

# Speaker box  and filter with same resonance

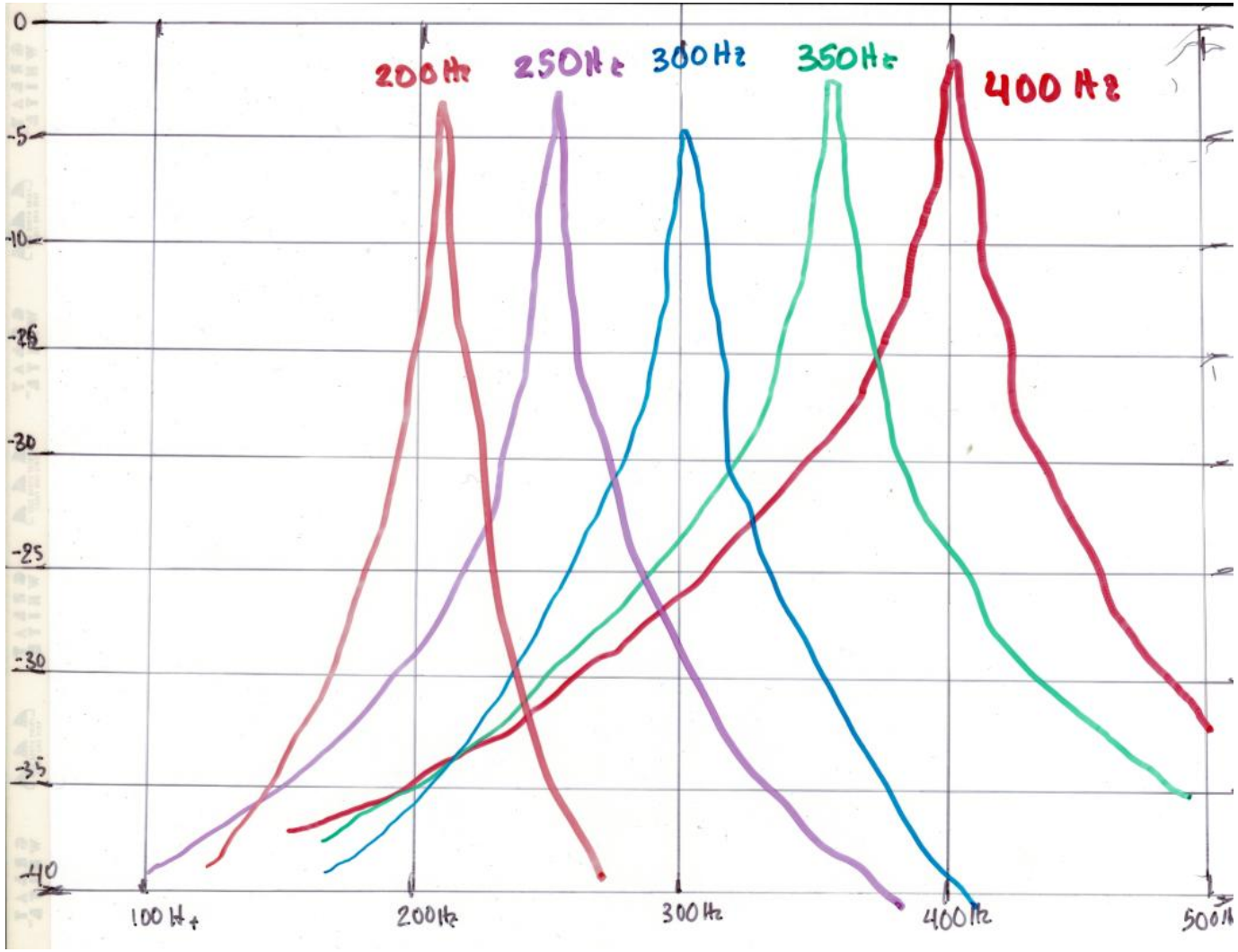


# 3-S optimization  Q = 50  Q = Fc / BW -3 db

- +10 db  SPL signal  gain
- -30 db noise attenuation
- No ring at high CW speed
- 3-S is an oscillator trigged by the disturbance or the air collum  by the  CW signal from the speaker



# Selectivity by CW pitch




**+ 10 dB SPL**

**BASE LINE**

**90 dB SPL / 1W input**

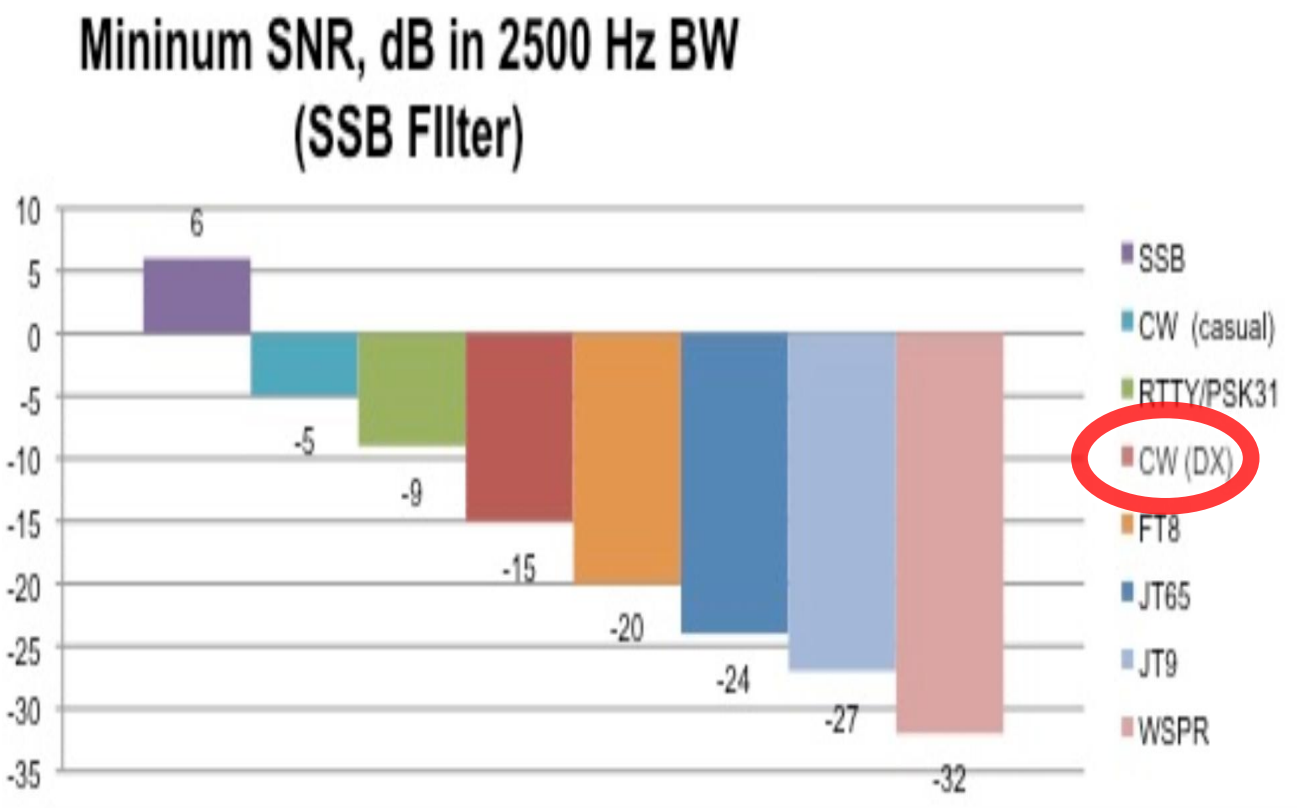
**Speaker is a transducer**
**It transforms electrical power, W into dB, Sound Pressure Level**

**-40 dB SPL**

# Super Selective Speaker 3-S

| N4IS 3S - APS | | CW PITCH CENTER FREQUENCY Hz | | | | | |
|---|---|---|---|---|---|---|---|
| *Feb 23,2025* | | 200 | 250 | 300 | 350 | 400 | 600 |
| SPL | Q | 43.5 | 41.6 | 44 | 50 | 50 | 35 |
| +10 | BW db | BW Hz | BW Hz | BW Hz | BW Hz | BW Hz | BW Hz |
| +7 | -3 | 4.6 | 6 | 6.8 | 7 | 8 | 17 |
| +4 | -6 | 6.6 | 10 | 9.5 | 13 | 15 | 33 |
| 0 | -10 | 10.7 | 16 | 20 | 22 | 29 | 51 |
| -10 | -20 | 31 | 47 | 61 | 68 | 88 | 111 |
| -20 | -30 | 72 | 133 | 136 | 140 | 200 | 190 |
| -30 | -40 | 153 | 270 | 290 | 236 | - | 330 |
| -40 | -50 | 200 | - | - | - | - | - |

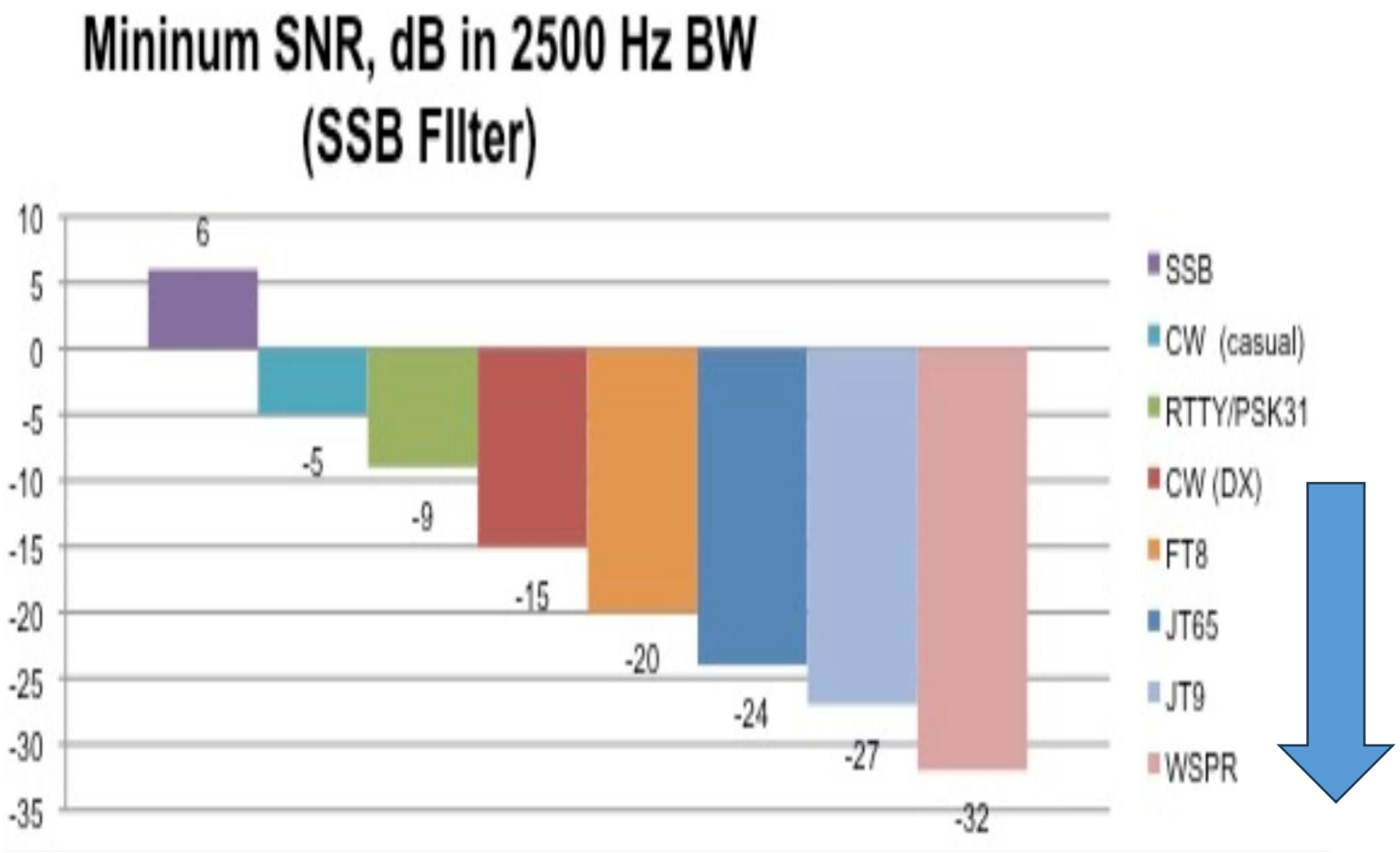
# BANDWIDTH for weak signal modes




**Human ear selectivity is**

**120 Hz BW near 1 KHz**
**and**
**90 Hz BW at 200 Hz**

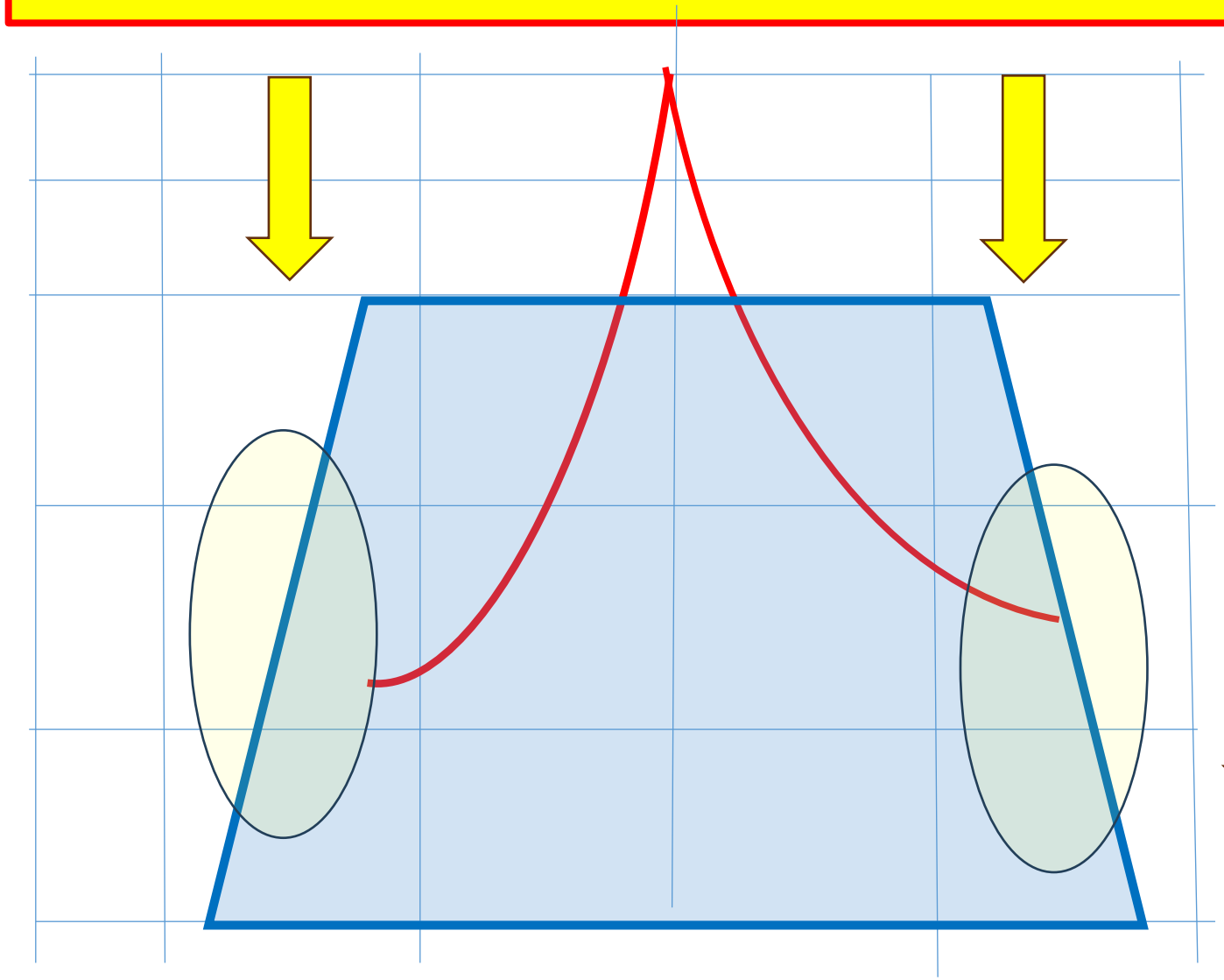
# 3-S SNR improvement




**1975 Coherent CW**
**BW 9 Hz**
**CW speed 12 wpm**
**20 db improvement**
**over a 2.5 KHz filter**

**3S Speaker**
**BW 4 Hz – 8 Hz**
**improving up to 30 db**

# How to use and improve the Super Selective Speaker 3-S



3-S is a < 10 Hz BW AUDIO PEAK FILTER

RADIO RF FILTER

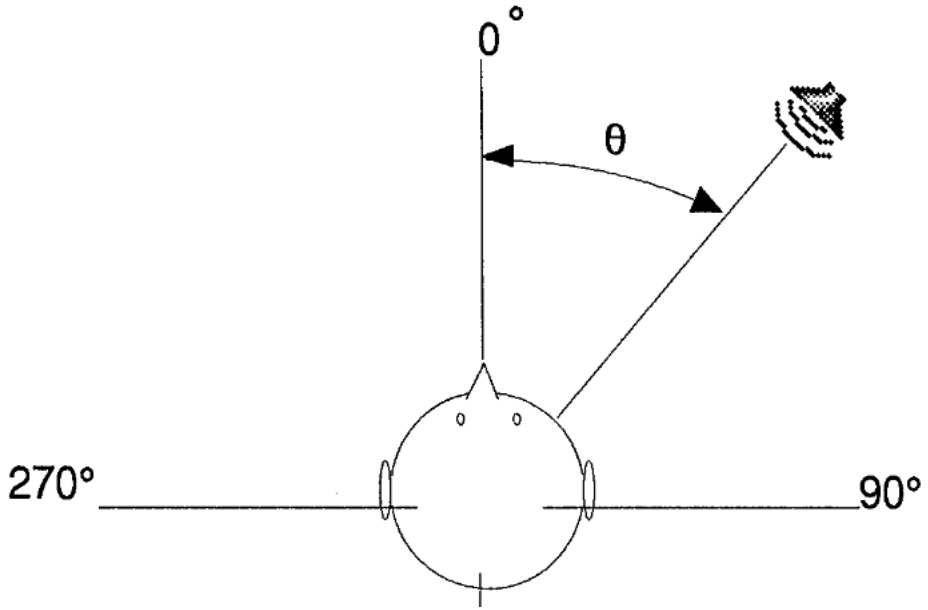
NOISE AT THE EDGE

**ADJUST RADIO RF BW FOR BEST SNR 100 Hz to 400 Hz**

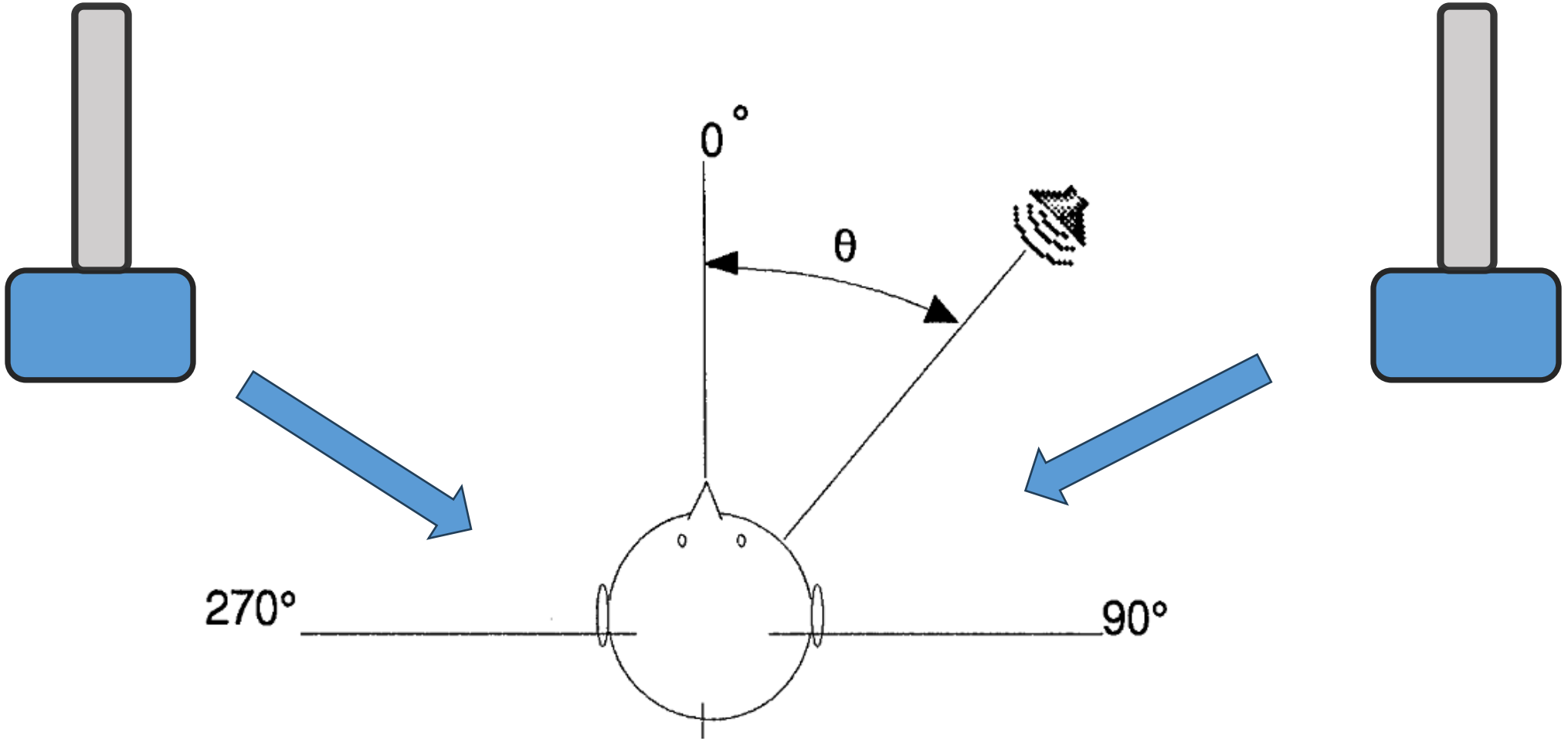
# 3-S with 3-D sound – another 6 db improvement

**The ears are able to receive sound and localize from the entire space surrounding the head. 3-D sound gives the perception of placing sound in surrounding space. The ears and the brain, the human audio system, work together to process sound. The processing allows a listener to selectively focus on one sound**

**"cocktail party effect."**

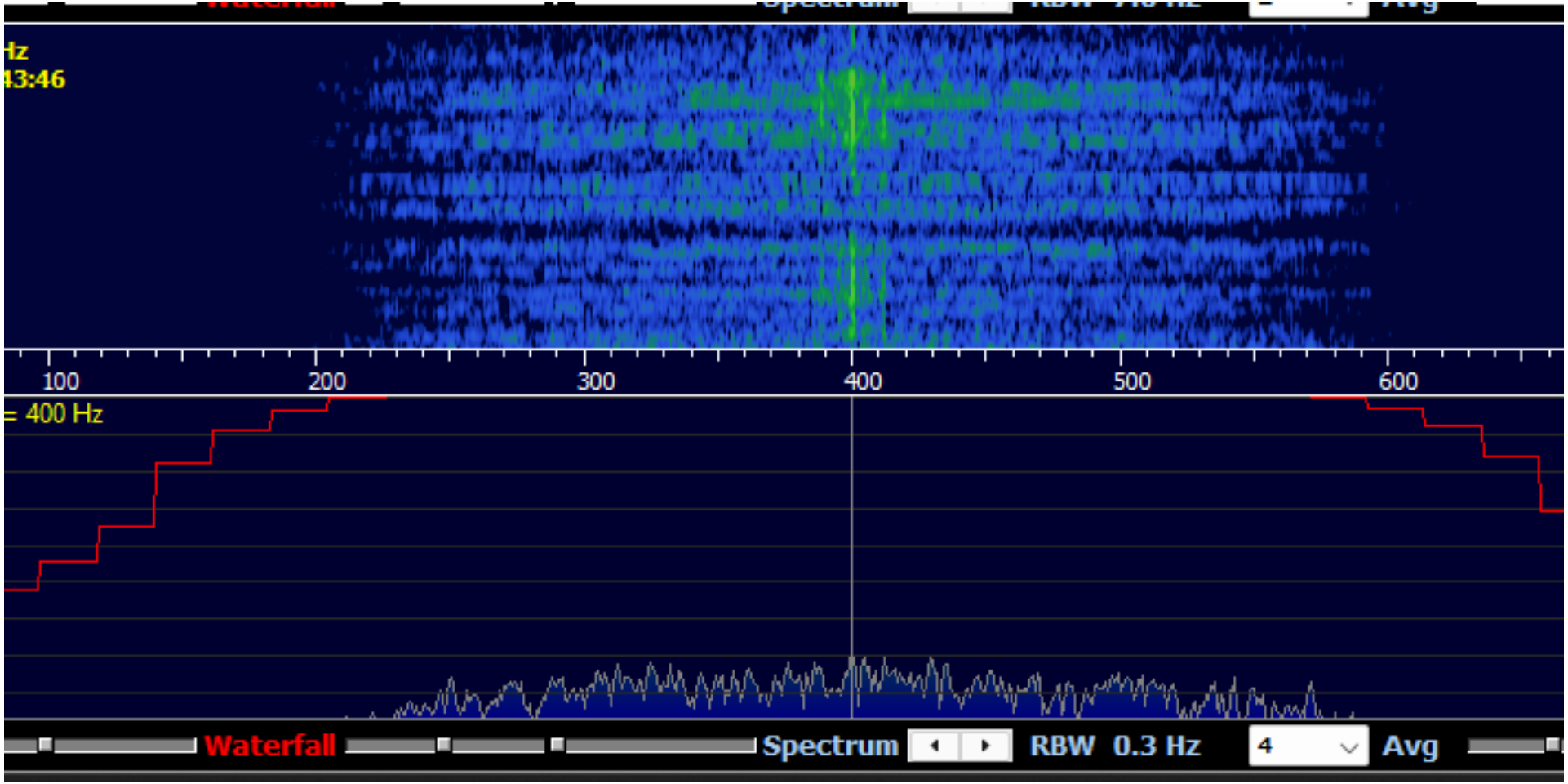


# 3-S with 3-D sound – another 6 db improvement

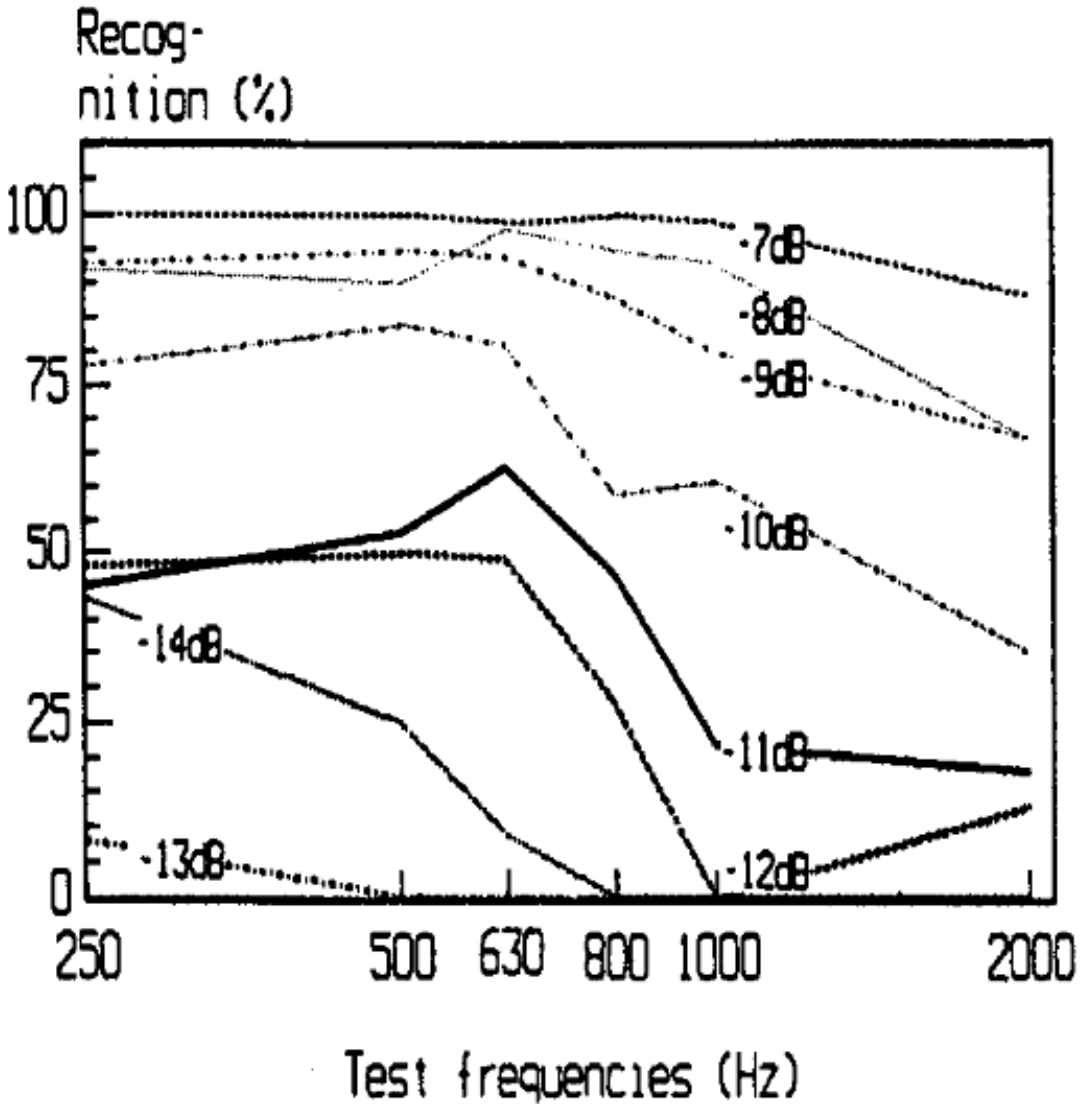


# 3-S is a great tool for your skill set

- DX Cluster and RBN + - 200 Hz
- SDR waterfall VBW < 1 Hz



# CW pitch is all about the noise




**Median value of recognition for all subjects at different tone frequencies, Different SNR (-7 to -14 dB), and 16 wpm telegraphy speed**

**630 Hz is the logarithmic center of the human ear 20 Hz to 20 KHz**

**TOP BAND operators learned to use low cw pitch due QRN**

**PY1RO preference was 200 Hz CW pitch**
**W4ZV likes 250 or 270 Hz**
**350 Hz - 400 Hz is very popular too**

# VK2WF acoustic CW filter

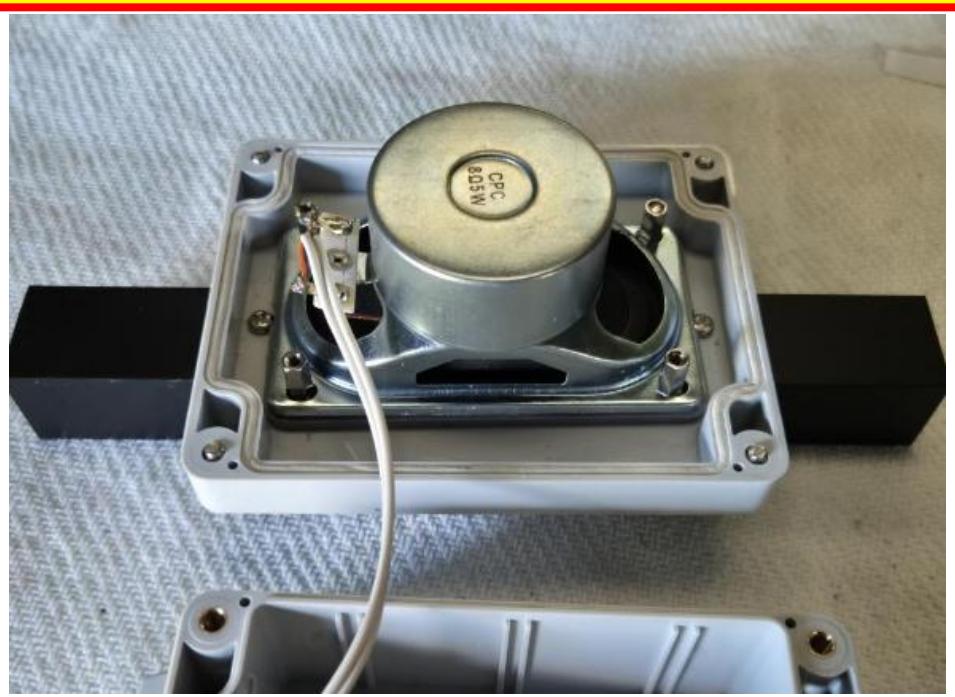
- The centre cavity is driven by one loud- speaker
- A second speaker is employed to compare tuned and broadband operation
- The outer 2 cavities are parasitic, giving increased noise reduction

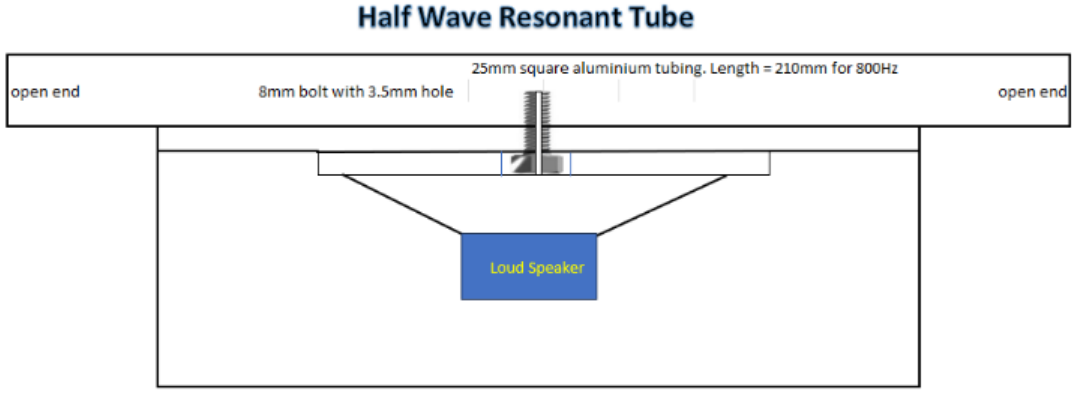
## Quarter Wave Cavities

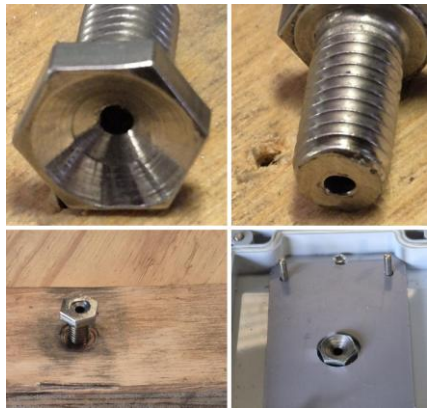

Being able to hear a Dx station before the others gives you a competitive advantage

- At sunspot cycle peak, Top Band conditions are poor, Acoustic Filtering still makes ATNO CW QSOs a possibility.
- 9M6NA is a recent example
- Signal strength mostly below noise floor

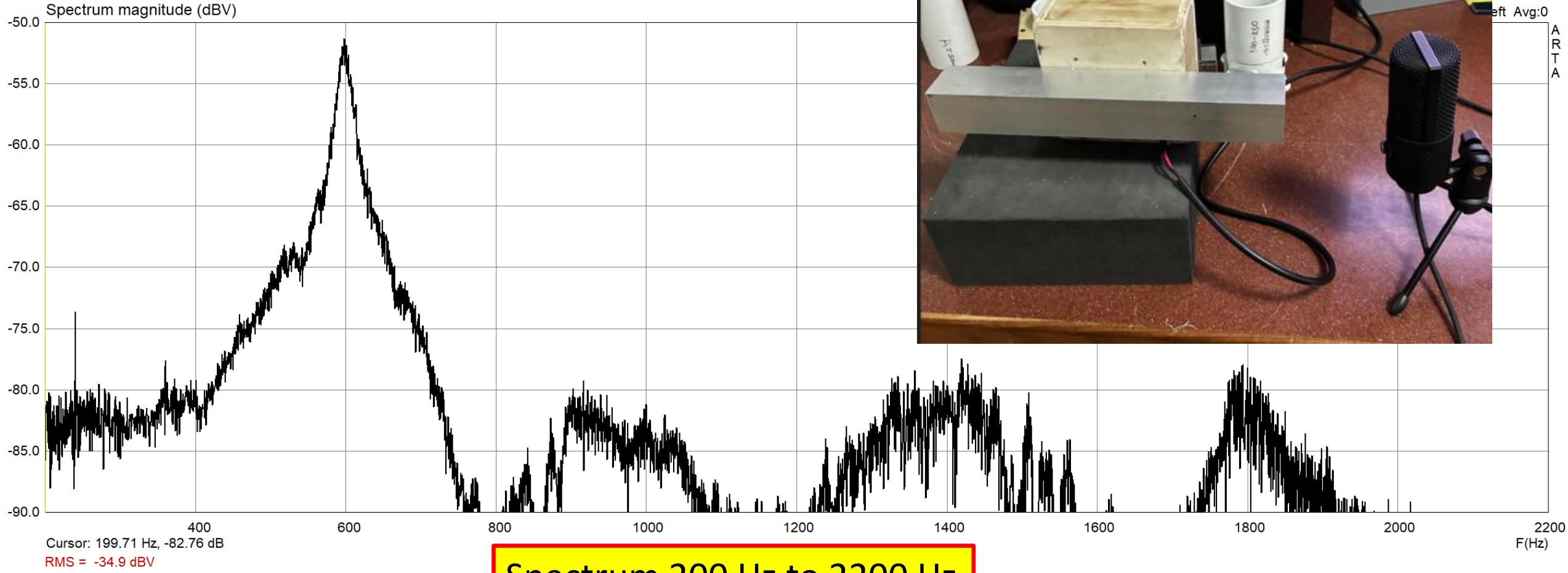
# VK2WF acoustic CW filter

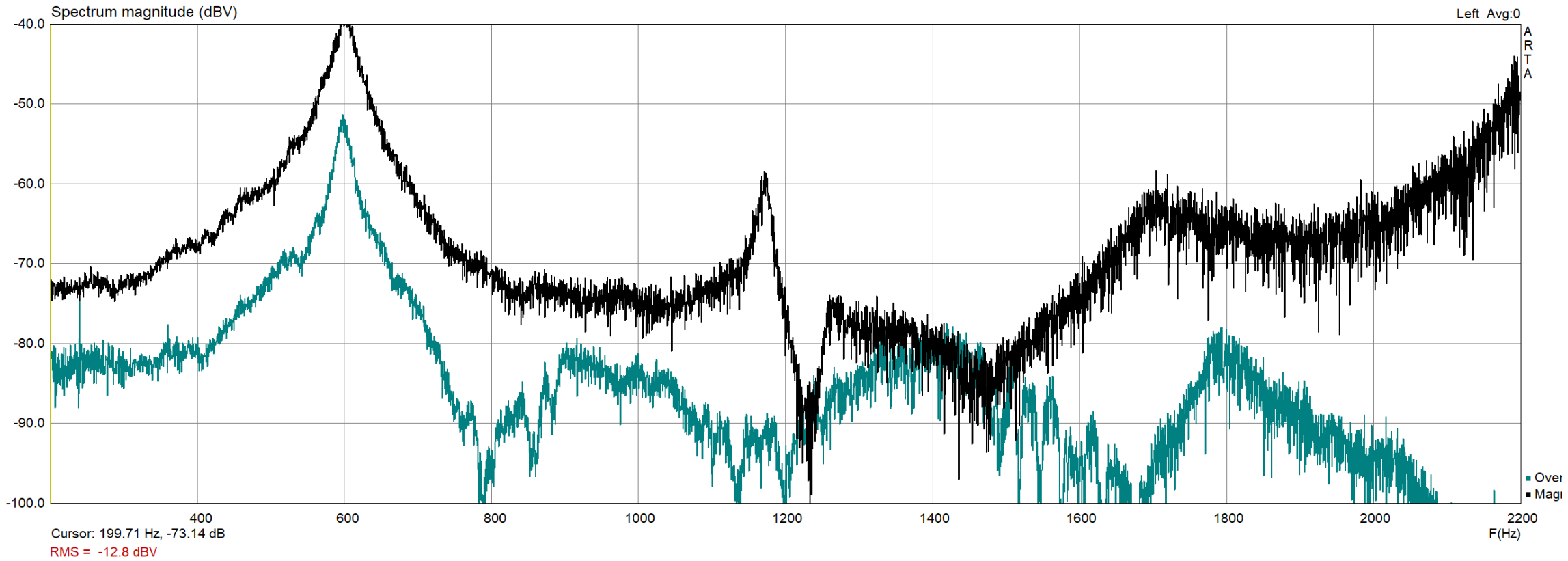



# VK2WF CW speaker 600 Hz



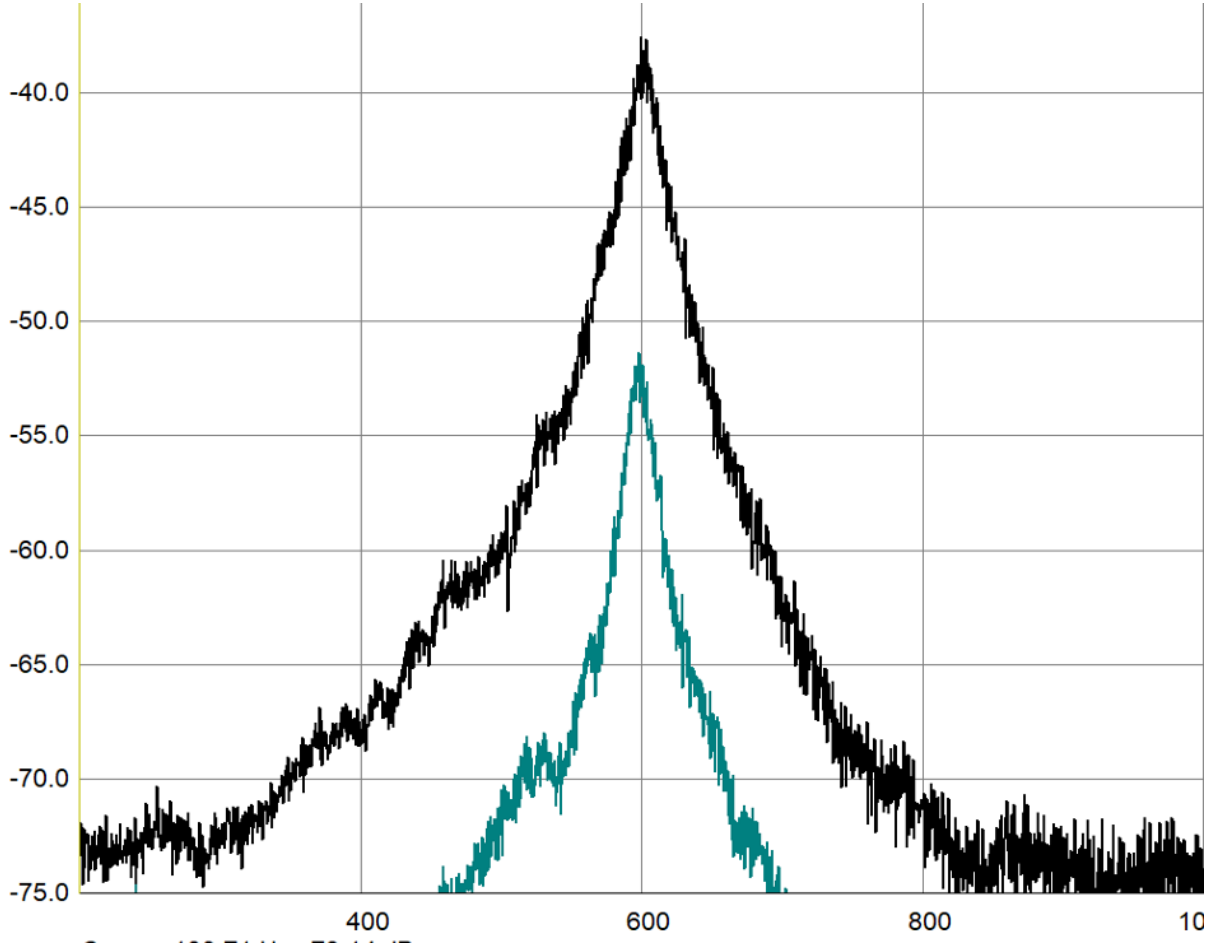

Spectrum 200 Hz to 2200 Hz

# VK2WF & 3-S same Q = 35



# VK2WF CW speaker & 3-S at 600 Hz

- Excellent performance
- Very good selectivity Q= 35
- VK2 has cleaner response
- 3-S has more SPL volume
- 3-S is a work in progress
- Can we get a higher Q?



# YouTube  acoustic CW filter

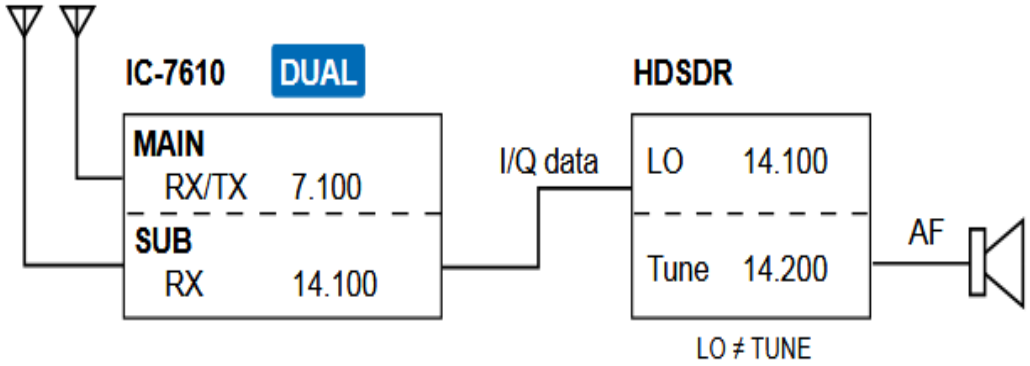
https://www.youtube.com/watch?v=seGoEtdW_NM

https://www.youtube.com/watch?v=C7KAT-HbriU

# 3S live demonstration using wav. and HDSDR

https://www.hdsdr.de/

IC-7610 with the HDSDR application

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