LAB: VOICE

This lab is conducted at TMH on 4th floor, Lindstedtsvägen 24 (same as guitar lab).

Learning outcomes

Be able to perform basic temporal and spectral analysis of vocal sounds, that is,

- Be able to identify voiced/unvoiced/silent portions Periodic Sine wave / Random Noise
- Be able to identify and locate harmonics/glottal excitation times, and formant 共振峰 regions Integer multiples of Fundamental Freq / Fast Falling Points
- Understand the resolution tradeoff between time and frequency ↗time resolution ↘ fre res
- Try to match some of your own vowel sounds with a source-filter synthesizer
- Map the range of your voice in SPL dB and fundamental frequency
- Quantify the relationship between voice SPL and voice spectrum slope

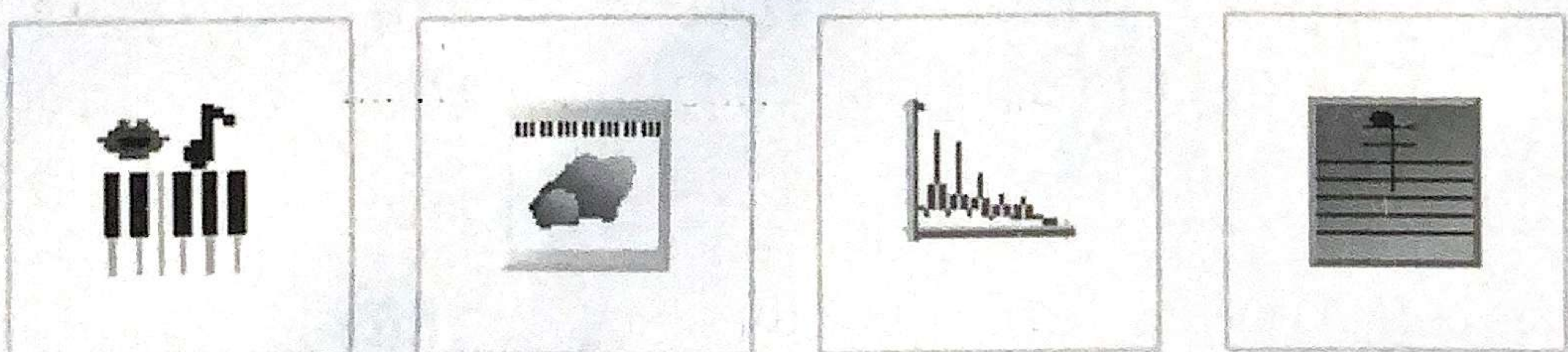
Preparations

If you don't already know, review on Wikipedia what is meant by A-weighting and C-weighting in sound level meters.

If possible, download the free Windows programs *RTSect* and *Madde* from www.tolvan.com and explore a bit how they work. (All the programs at Tolvan are single, self-contained .EXE files that just need to be copied to a suitable folder on a PC. No installation program is needed. On Macs they work also in Wine.)

Equipment

- Computer with the programs below (all freewares for Windows)
- A good microphone
- Sound level meter



madde.exe RecVox.exe RTSect.exe Sopran.exe

WaveSurfer

PART ONE – VOWEL ANALYSIS

元音

Here you will record a number of your own vowels and analyze their formant 共振 frequencies. You will use the results later, in the Synthesis assignment.

Task 1.1 – the tools

Familiarize yourself briefly with *WaveSurfer*: recording, plotting spectrograms, plotting spectrum sections, and formant tracking. Right-click and Apply Configuration "Speech Analysis" for a convenient analysis display. Select a sampling rate that is suitable for analyzing 0-12 kHz. Note how the 频谱 spectrogram and spectrum sections change, when you change the spectrum analysis bandwidth and the FFT length. Note also how Wavesurfer can estimate the first four formant frequencies and draw coloured contours 轮廓 of them over the spectrogram. 前四个共振峰

Task 1.2 – formant frequencies of vowels

元音

Record a soundfile containing a sequence of spoken or sung vowels, in your native language, for example /ɑ/ /u/ /i/ /œ/ (*Sw.* "hat" "hot" "hit" "hör", *Eng.* "far" "foo" "fee" "fur"). Make each vowel at least two seconds long. Start at a fairly low fundamental frequency (f_0), and then repeat at a medium and a high fundamental frequency. Note that you may need to change WaveSurfer's range for the maximum f_0. Analyze each vowel with regard to formant frequencies F_1 ... F_4 and f_0. WaveSurfer offers a suggestion, but it is not always reliable. Try to estimate also F_5, visually (it is less 突出 prominent, and will usually be less than 5 kHz in males and less than 6 kHz in females). Fill in the results in a table like the one below. Save the soundfile(s) on a USB stick, or by e-mailing them to yourself. You will use these results later, in Assignment 2.

a 爸 妈
o 我 坡
e 了 喝
i 你 衣
u 书 土
ü 绿 鱼

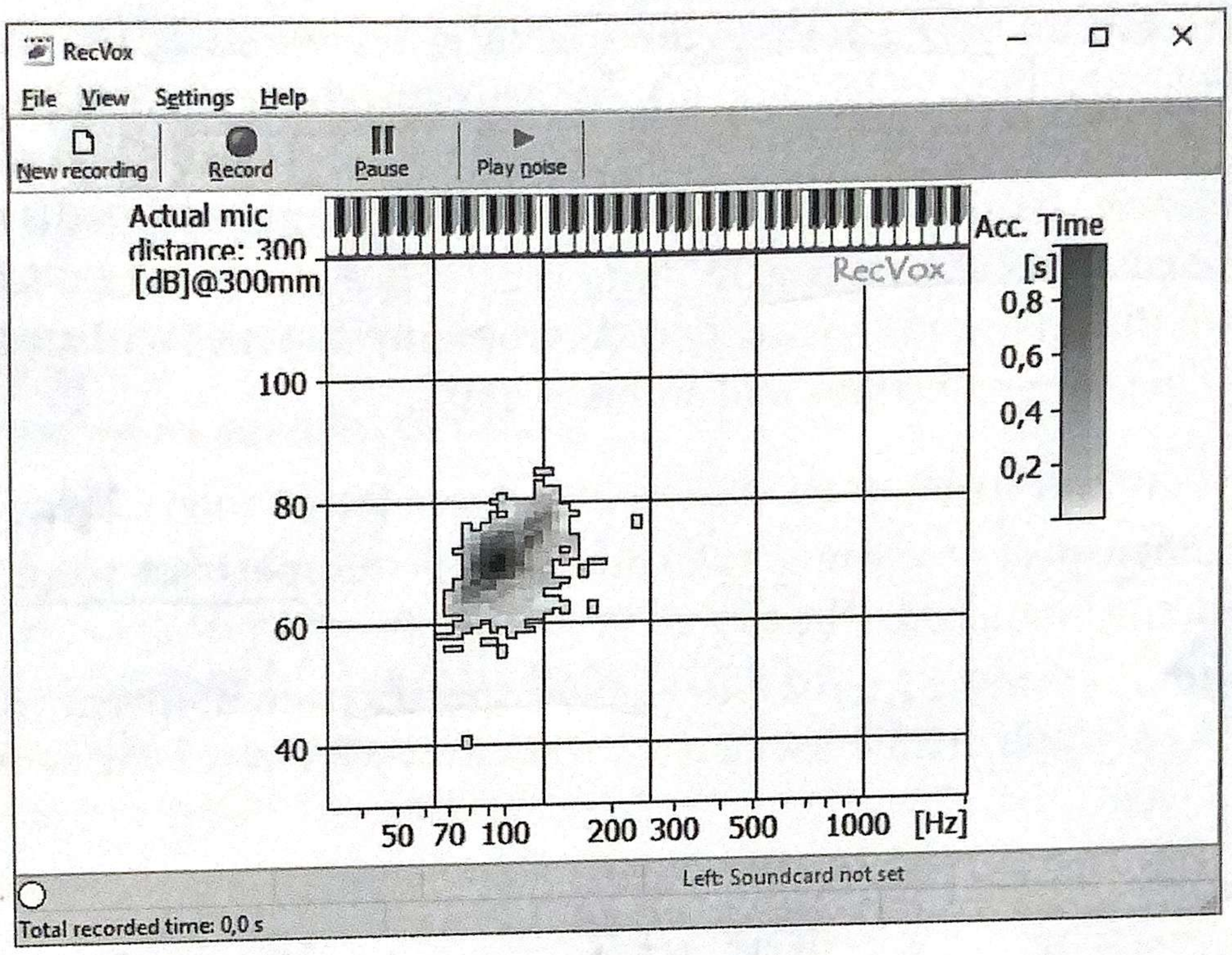
Vowel	f_0 [Hz]	F_1	F_2	F_3	F_4	F_5
/ɑ/	105	840	1360	2520	3640	5000
~~/u/~~ o	103	320	760	3240	4240	7080
~~/i/~~ e	104	560	1240	2600	3400	4480
~~/œ/~~ i	105	360	2200	2800	3600	4400
u	107	360	800	2160	3520	4320
ü	105	320	1800	2440	3440	4440

Task 1.3 – try to synthesize imitations of your own vowels

Start the Madde synthesizer, and using the values from Task 3 as a starting point, try to recreate the sounds of your own vowels. You can analyze the spectra either in files with WaveSurfer or Sopran, or in RTSect in real time. Have Madde save the sound to a soundfile.SMP and open it in WaveSurfer (which understands .SMP files if you tell it to). If you prefer, you can use the freeware *Sopran* for analysis, rather than *Wavesurfer*. Comparing spectra is easier in Sopran, but analyzing formant frequencies is much harder.

PART TWO – acoustic range of the voice

A human voice, even if it is untrained, has a larger maximum range both in sound level and in frequency than any other of the musical instruments that produce sustained tones. Here you have the opportunity to measure the range of your own voice, by acquiring a so-called voice range profile (VRP), using the *RecVox* program.



Task 2.1 SPL weighting

Set the *sound level meter* to **Slow** time response. Keep quiet and measure the background noise level in the room, with both A-weighting and C-weighting. Is there a difference? Why? Most sound level meters start up with A-weighting by default, but don't use that in the following. A. 35.4 C 53.

校准

Task 2.2 Calibrating the SPL in RecVox

Maintain a microphone distance of 30 cm and follow the SPL calibration routine that is built into the software.

Task 2.3 Acquiring your VRP

Start with a few vocalizations at a comfortable loudness and pitch, and explore how you can move the cursor around on the plane of the display. What happens when you change the vowel?

轮廓

From now on, use only the vowel /ɑ/ . Map your very *softest* vocalization for low to 音调 high pitches, so that you establish a lower contour in the VRP. This is a difficult motor task that gets easier with practice. Then explore how *strongly* you can vocalize. It may help to start high and moderately loud in falsetto and do downward glides. Then gradually extend the upper contour until you cannot raise it at any frequency. If you feel that your voice is hurting or getting tired, stop.

假声

When you stop RecVox, it will ask you if you want to save the voice map and/or the audio recording. Save both. You will use the audio recording for the next task.

Background: The reference for acoustic sound pressure is 20 µPa, while the reference for acoustic power from a source is W_{ref} = 1 pW. We can express the sound level of a voice as the sound pressure level (SPL) in dB, relative to 20 µPa. However, the SPL depends on the distance to the source. When we study the voice, we are more interested in how much power the voice is producing; not what the sound level is at any particular distance. One reason that we choose 0.3 meters as a standard distance is that it gives approximately the same level in dB as that of the radiated power relative to 1 pW. Another reason is that it strikes a fair compromise between on the one hand sensitivity to microphone distance and on the other hand sensitivity to room reflections and ambient noise.

Task 2.4 – voice spectrum slope

斜率

An important aspect of any musical instrument is the spectrum slope, and how it varies with the loudness of the tone.

Use the audio recording from 2.3 to analyze spectra from different voice sound levels. Make a graph of how the spectrum slope of your voice varied with the sound pressure level.

Issues to deal with: 频谱斜率

- How can one define the spectrum slope? Note that a spectrum can be quite irregular, so it is not obvious how best to define its slope.
- Looking at spectrum sections, could there be some other metric that is easier to measure than the spectrum slope, yet gives similar information?
- Will the choice of vowel matter?

Repeat tasks 2.1 to 2.4 for all members of the lab group. Note the individual differences.

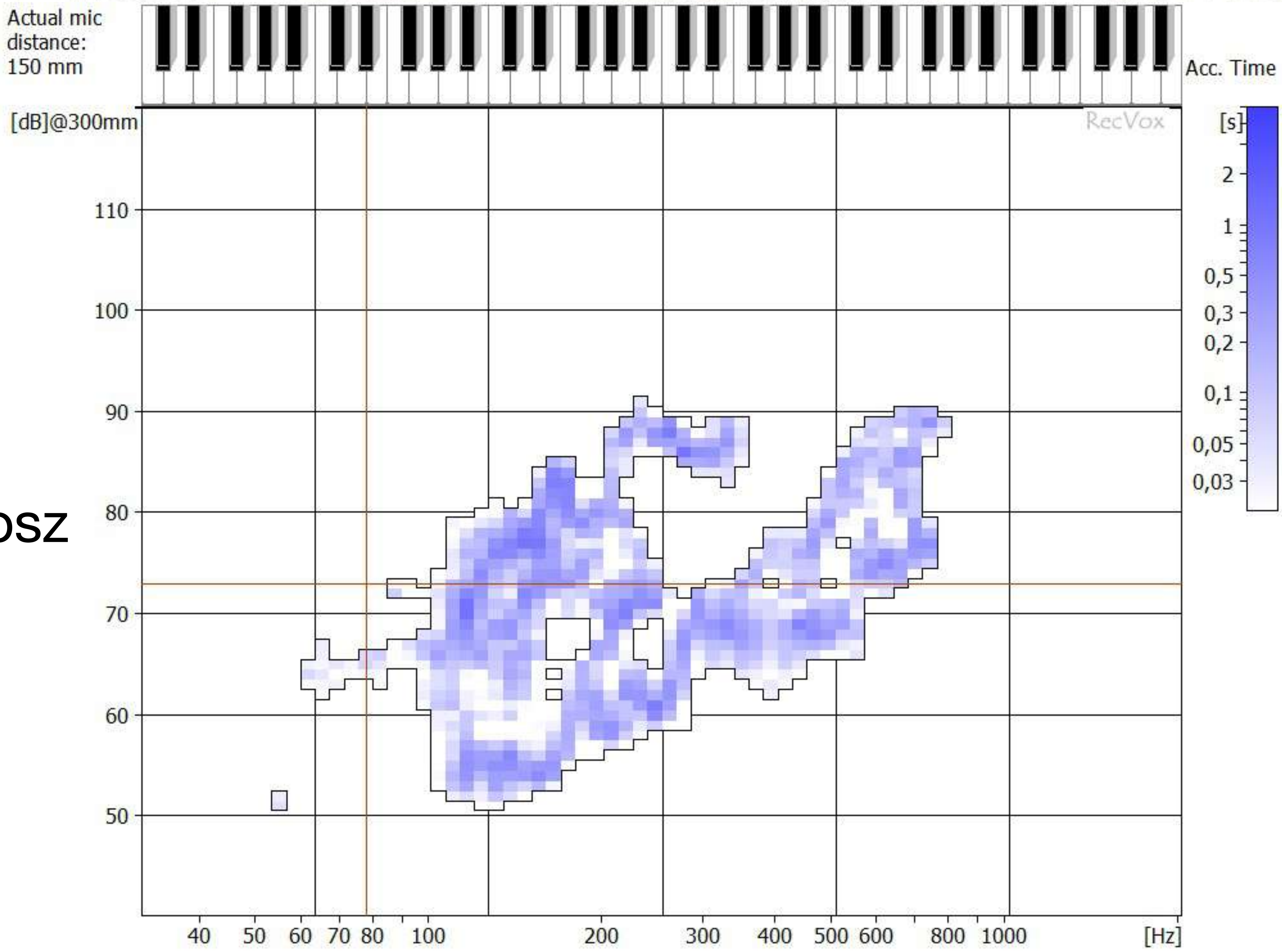
Task 2.5 – voice power (if time permits)

Action point: Compute the radiated power (in mW) that your voice radiated at some different effort levels. **Make a suitable graph** of the result. The formula for radiated power W is

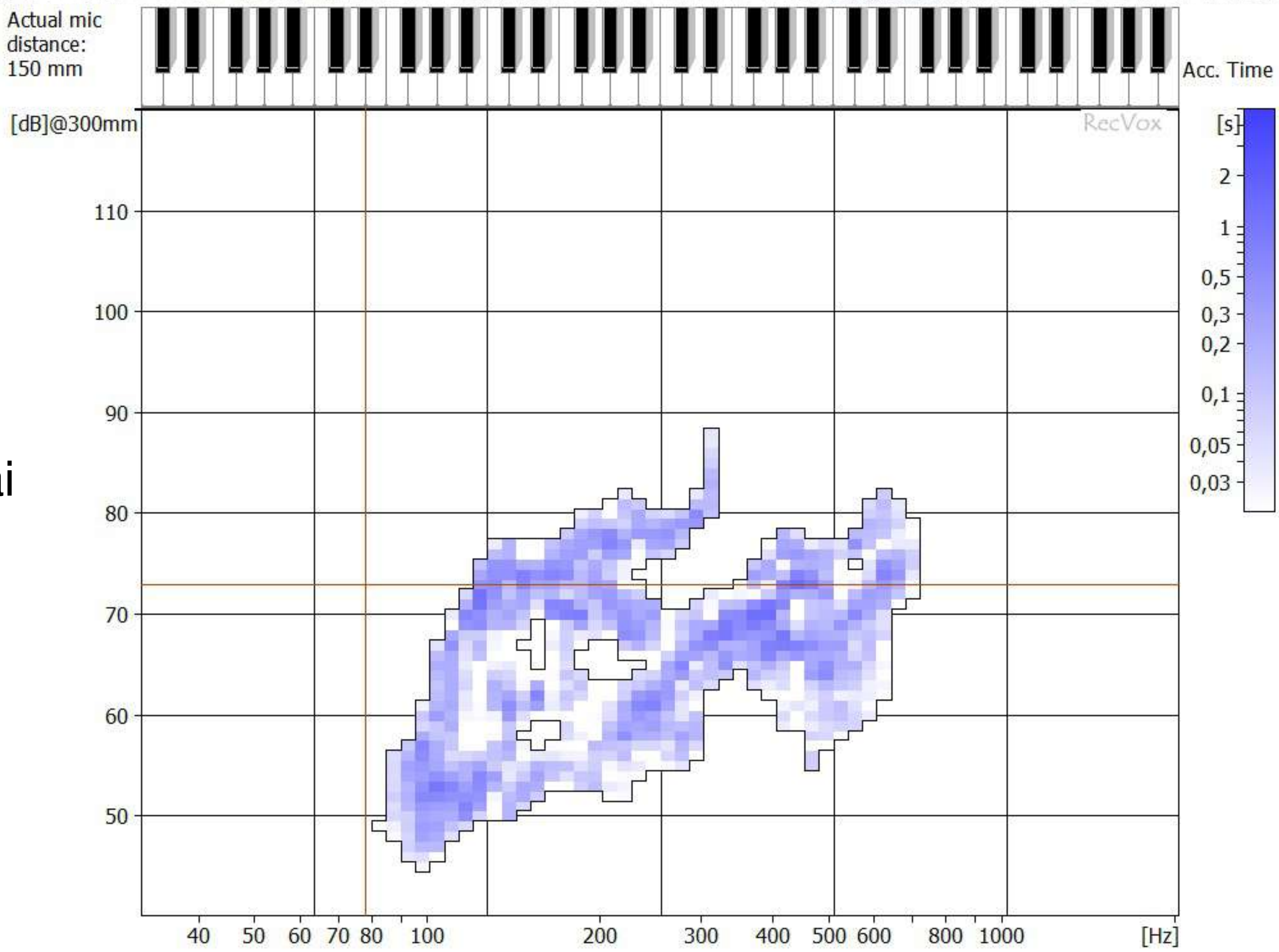
$$W = W_{ref} \cdot 10^{\left(\frac{L_P}{10}\right)}$$

where L_P is the sound pressure level at 0.3 m distance (which is also approximately equal to the *intensity* level).

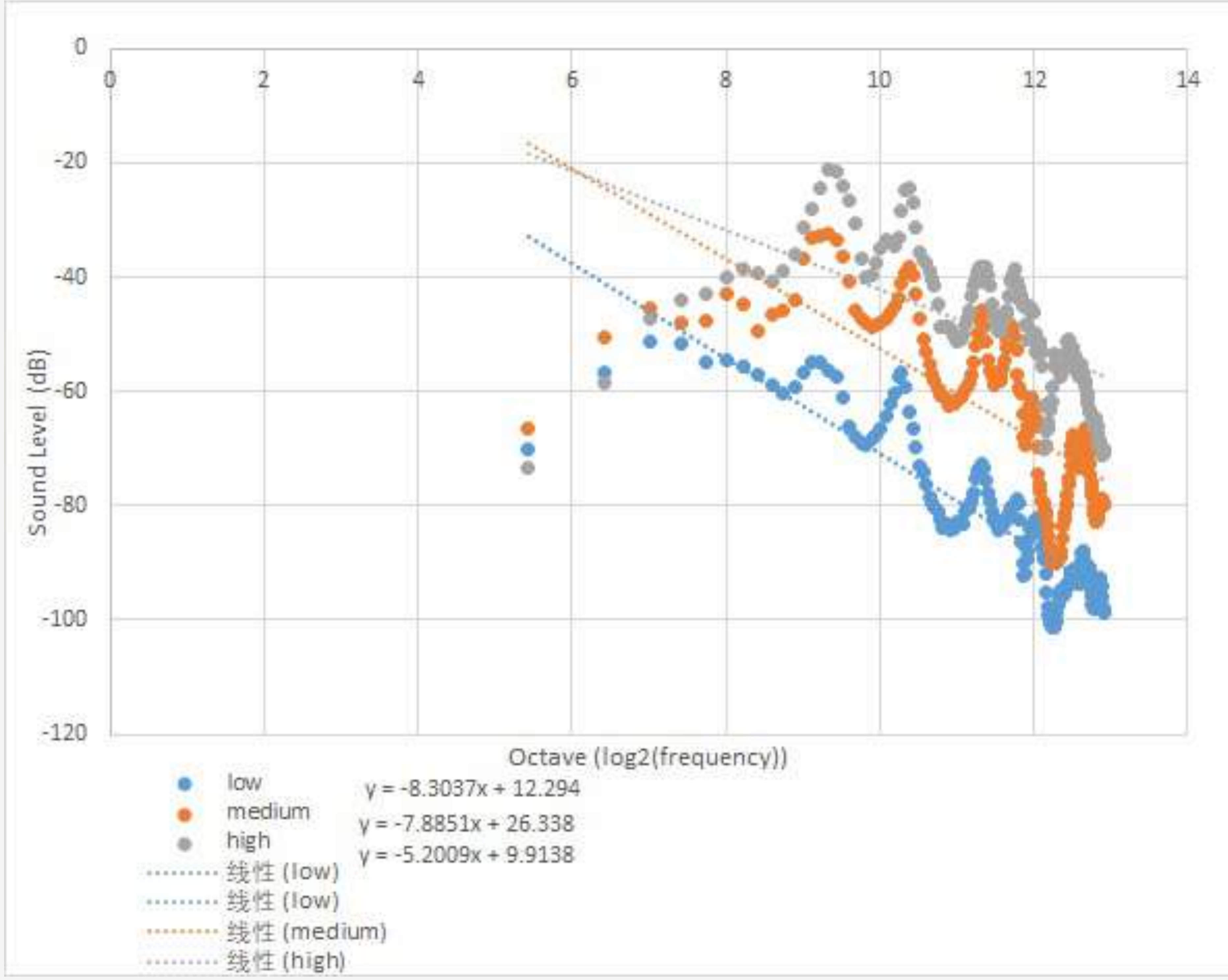
Bartosz



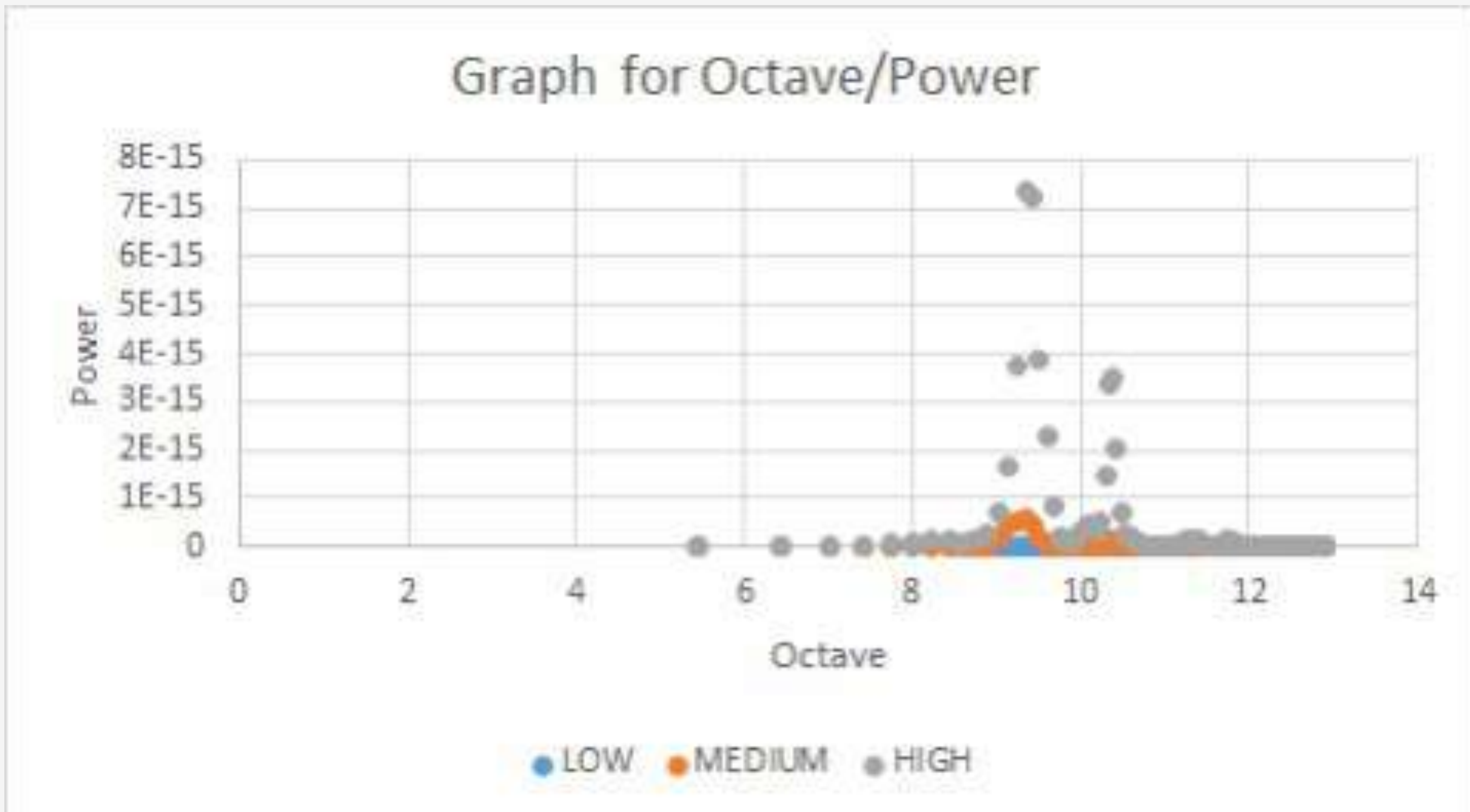
Yilai



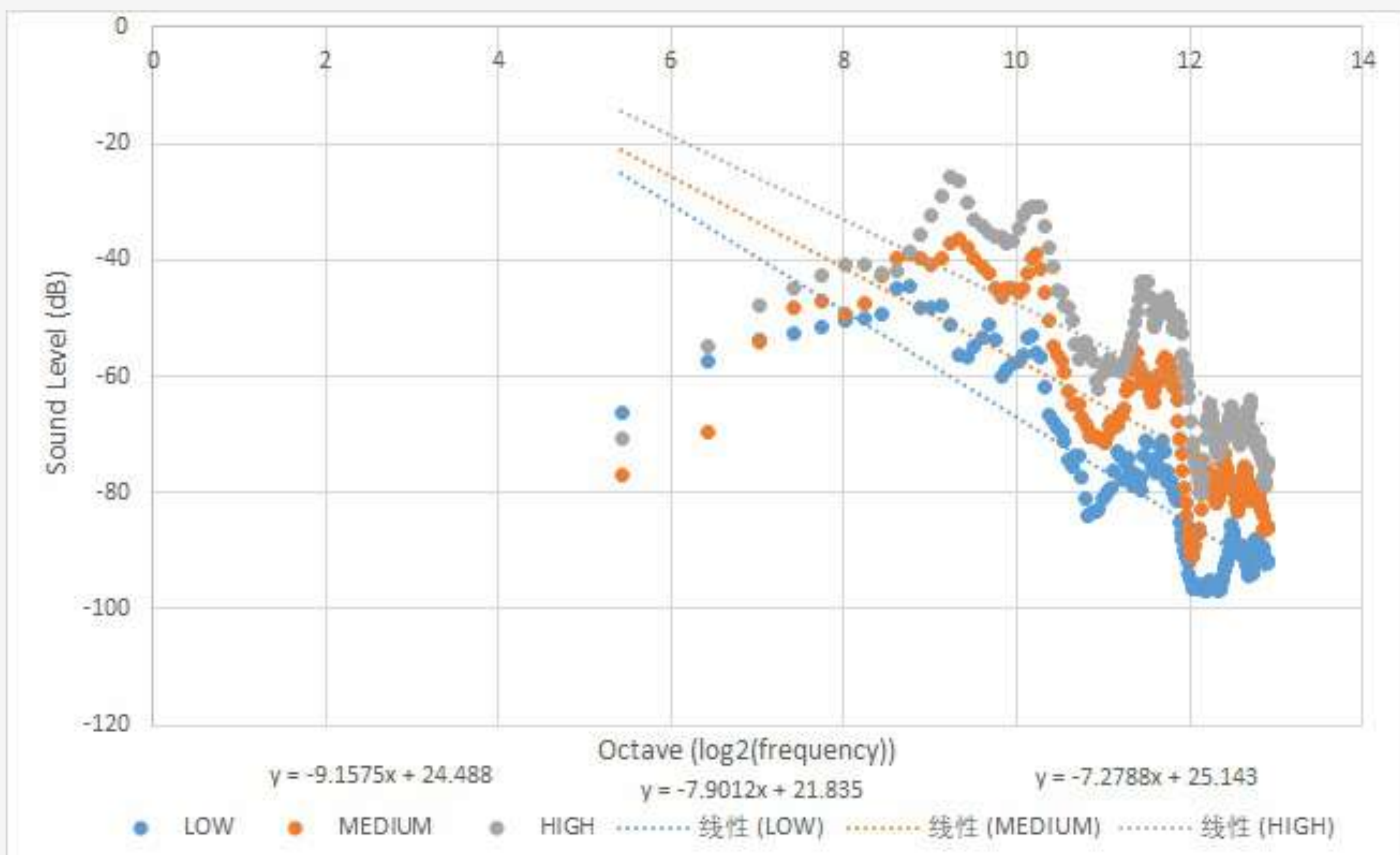
Task2.4 Bartosz



Task2.5



Task2.4 Yilai



Task2.5