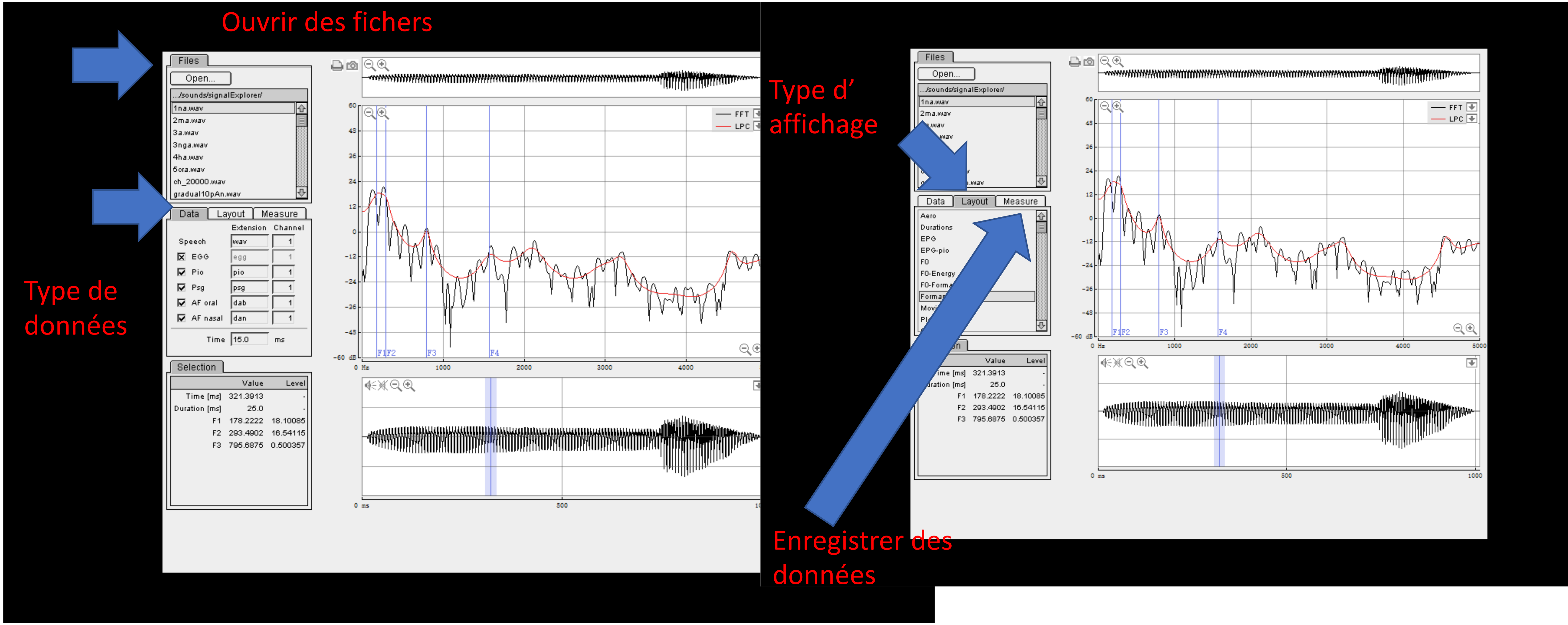
Signal Explorer (voir la video pour une demonstration avec des fricatives, consonnes nasales, voyelles nasales, voix craquée soufflée modale etc…

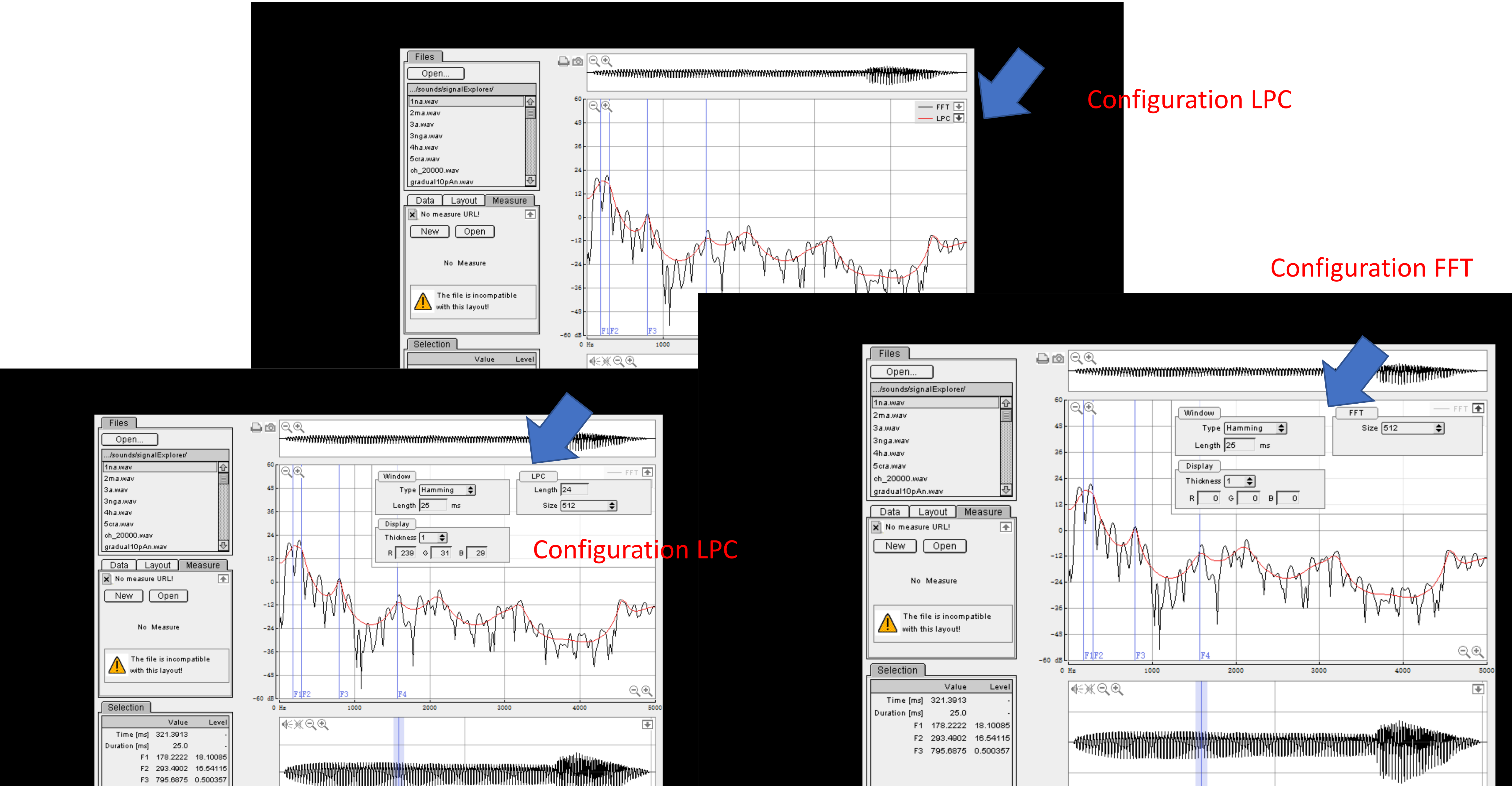
- 1, how to open files, what type of files
- 2, different displays
- 3, configuration FFT (precaution LPC, window length)
- 4, Screenshot
- 5, Mesures (correction of mesures)
- 6, Pratique (voice quality, fricative, N, VN)
- 7. How to quit the application

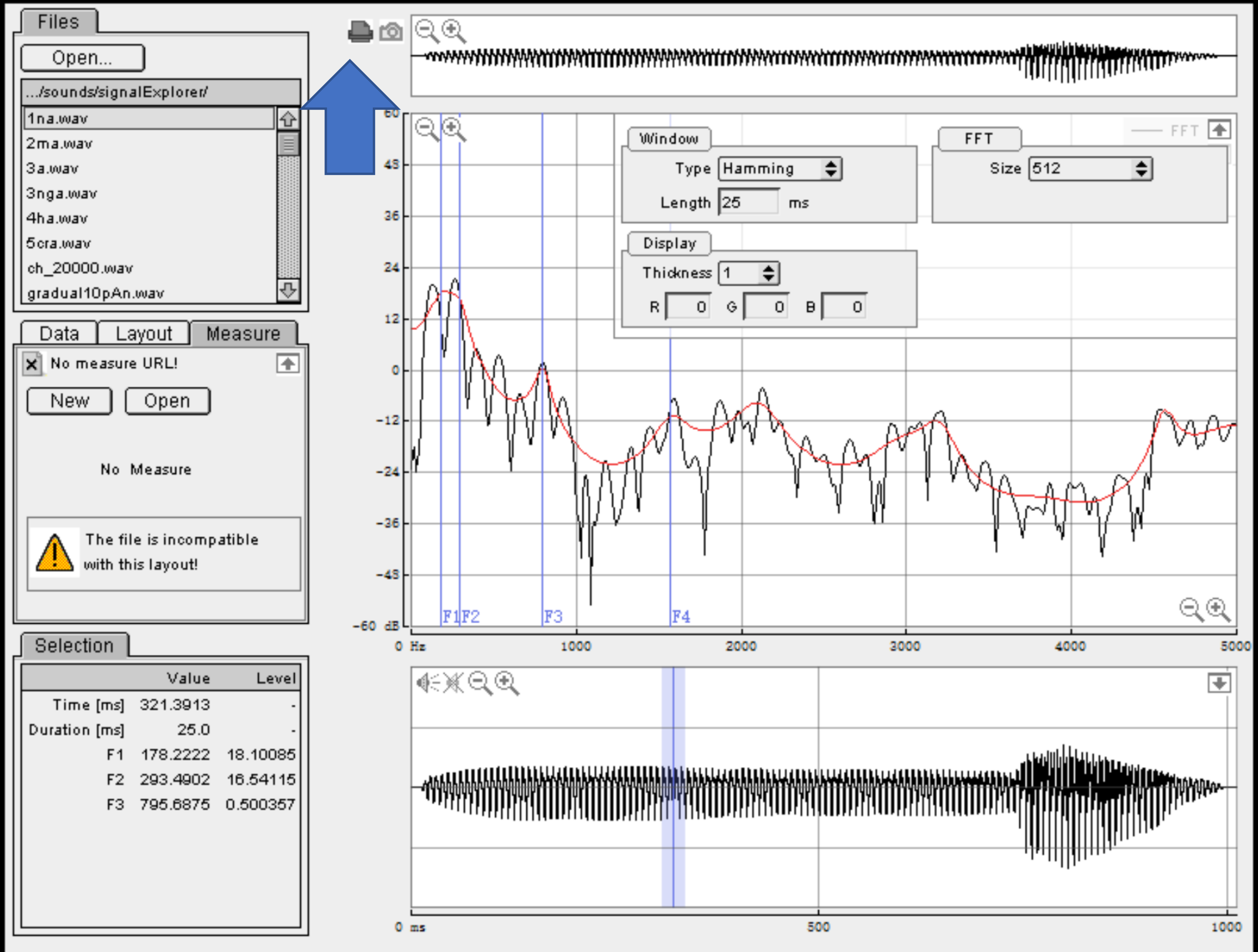
Signal Explorer (voir la video pour une demonstration avec des fricatives, consonnes nasales, voyelles nasales, voix craquée soufflée modale etc…



Configuration LPC

Configuration FFT



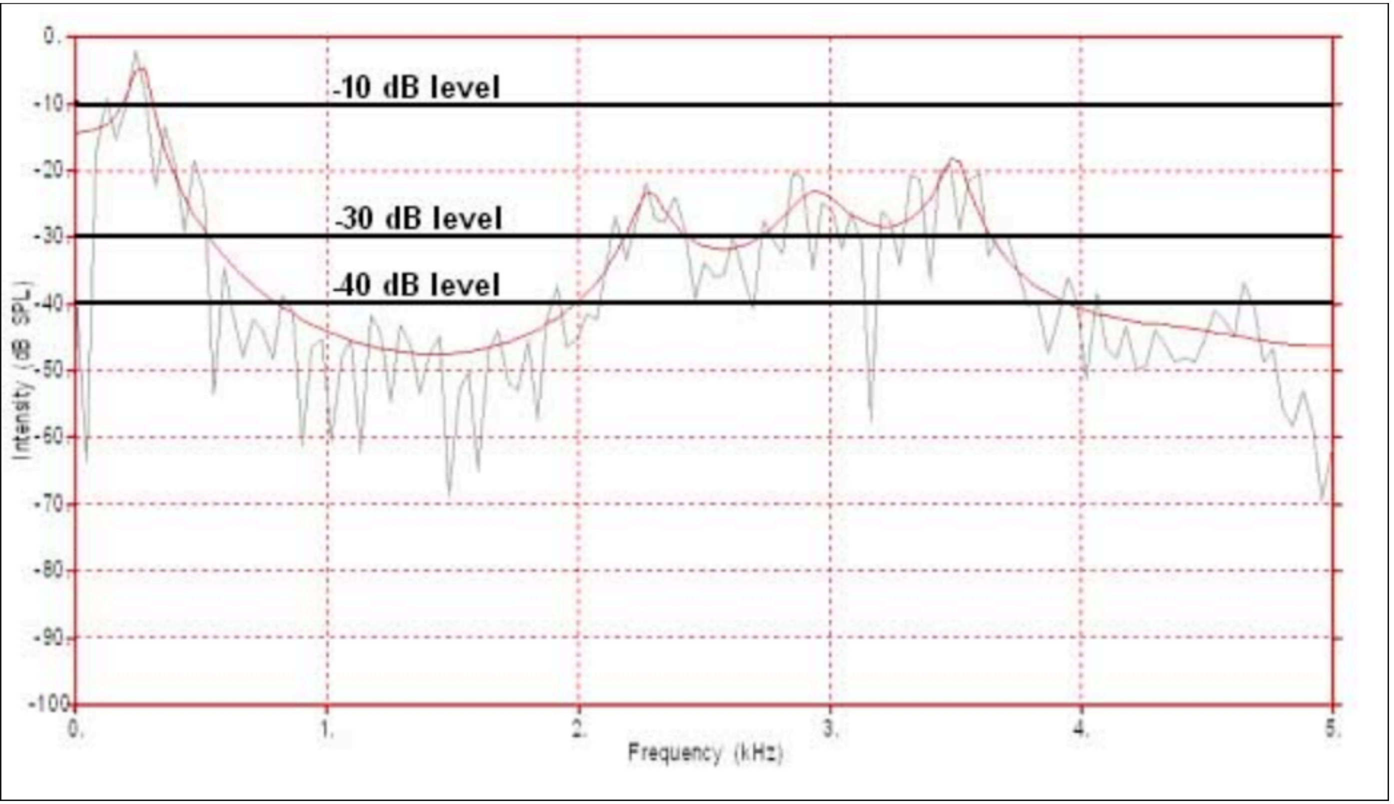


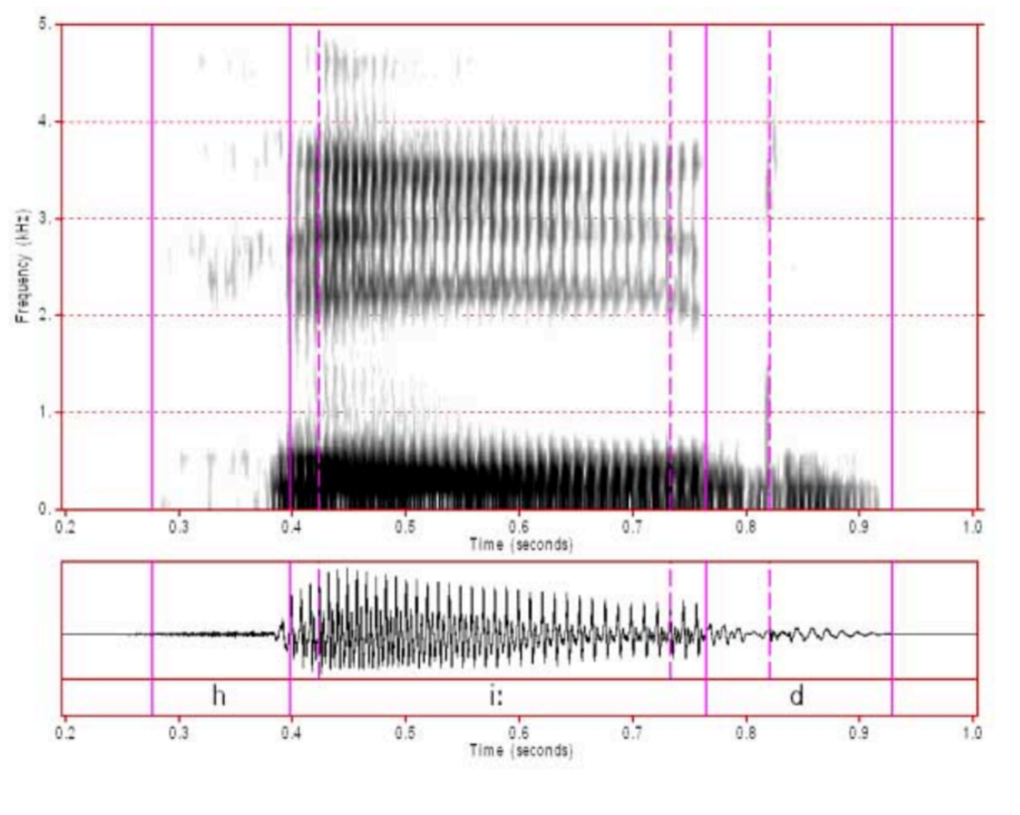
Capture d'écran

QUIT = Control + Q

Quelques notions en traitement du signal utiles pour l’utilization du logiciel

Spectrogramme





"heed":- No high-frequency pre-emphasis, top-clip -10 dB, depth 30 dB

LPC (Linear predictive coding codage par prédiction linéaire)

- This is because **Sound: To Formant (burg)...** lets you specify a maximum frequency, whereas the **To LPC** commands automatically use the Nyquist frequency as their maximum frequency. If you do use one of the **To LPC** commands for formant analysis, you may therefore want to downsample the sound first. For instance, if you want five formants below 5500 Hz but your Sound has a sampling frequency of 44100 Hz, you have to downsample the sound to 11000 Hz with the Sound: Resample... command. After that, you can use the **To LPC** commands, with a prediction order of 10 or 11.

LPC

the main parameter affecting LPC spectra is the number of LPC "coefficients" 12 coefficients is theoretically supposed to give a good representation of 5 poles (poles are similar to formants). This values is determined by predicting the number of formants in the spectrum frequency range, multiplying by 2 and then adding 2 (the last 2 coefficients help to represent the spectral slope).

synonyme :
filter order

Markel and Gray (1976, pp 154-156) recommend, for LPC speech analysis, choosing a number of coefficients (filter order "M") equal to the sampling rate in kHz, plus 4 or 5 additional coefficients.

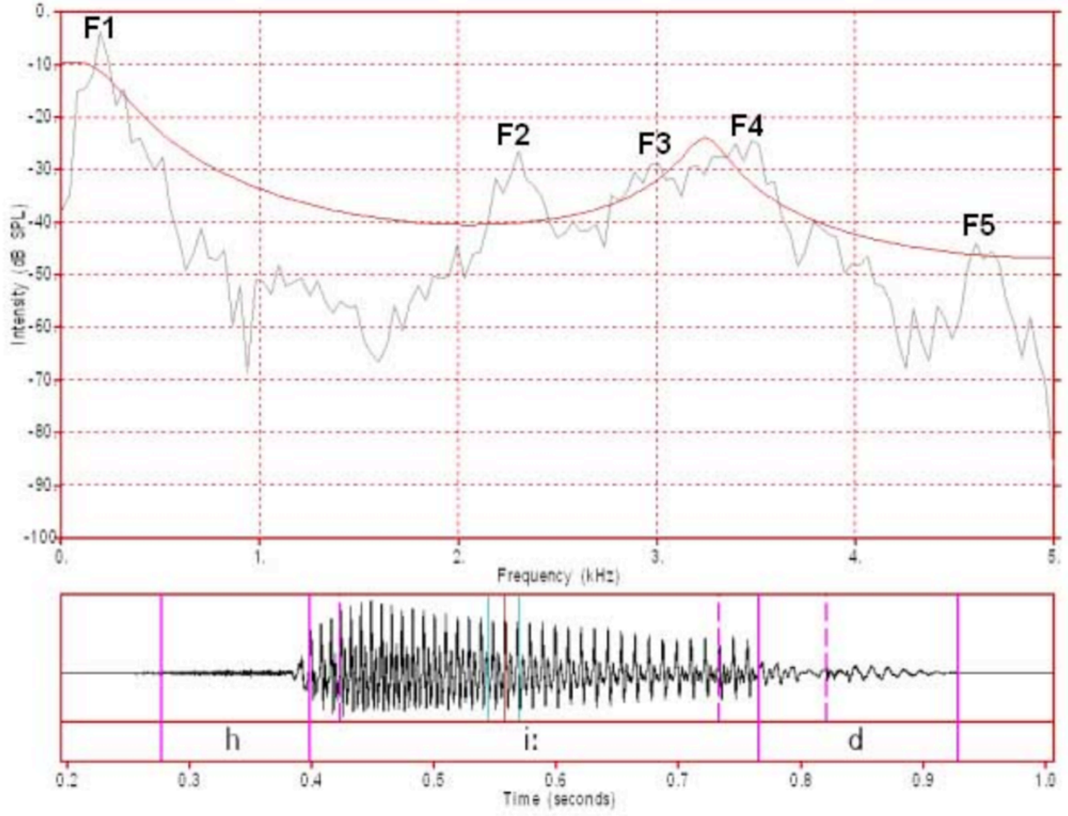


Figure 6: FFT/LPC of /i:/ with 4 LPC coefficients

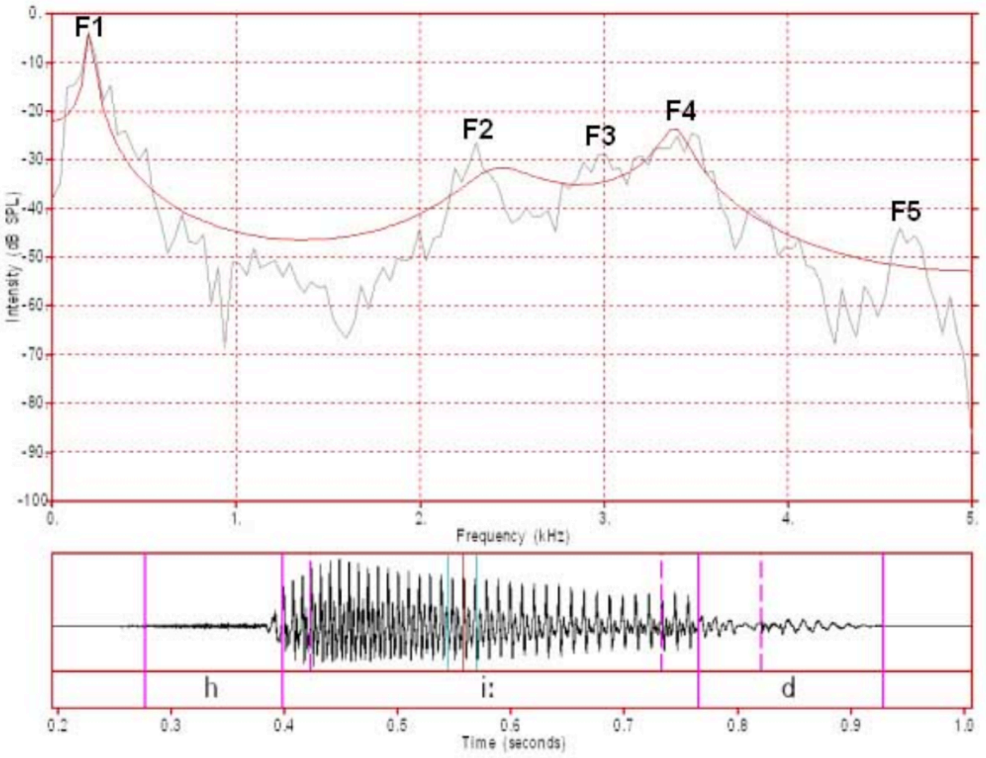


Figure 7: FFT/LPC of /i:/ with 8 LPC coefficients

FFT

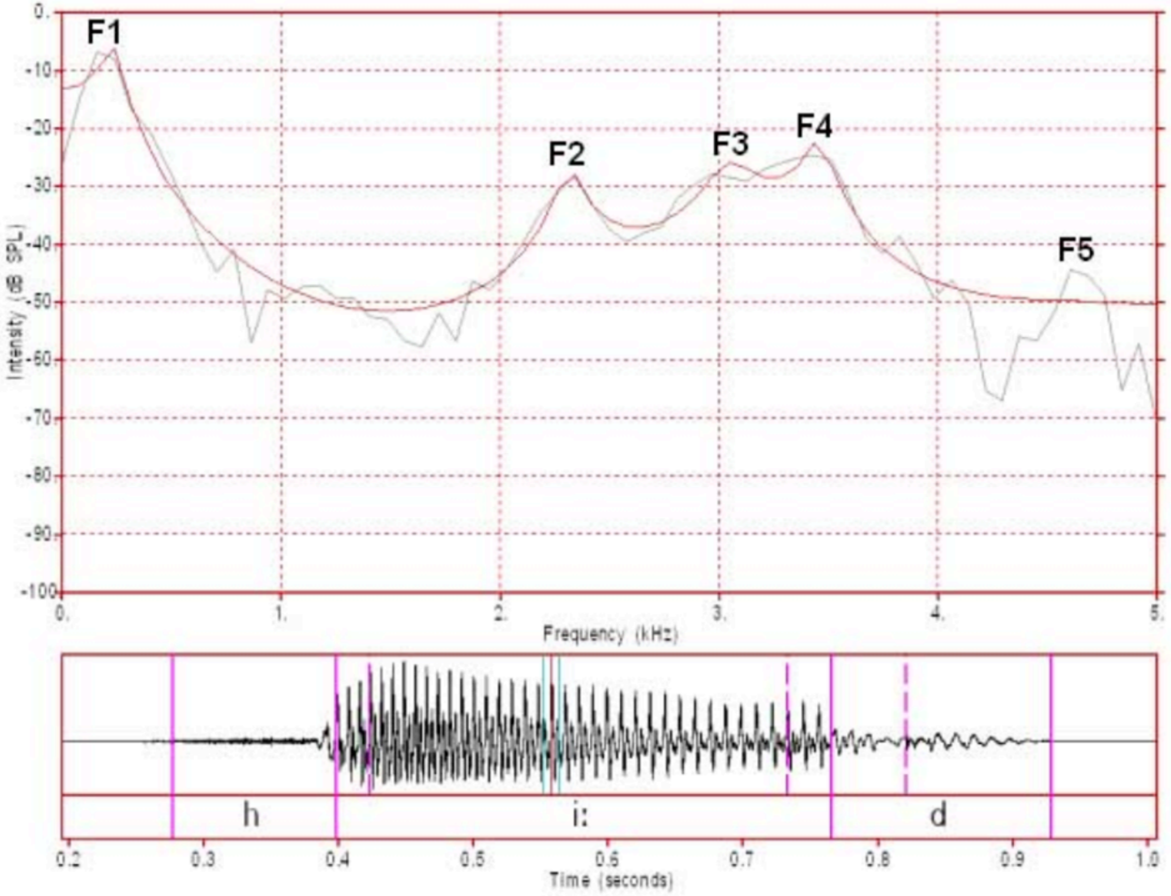


Figure 1: FFT/LPC of a male /i:/ FFT analysis window 12.8 ms (128 samples)

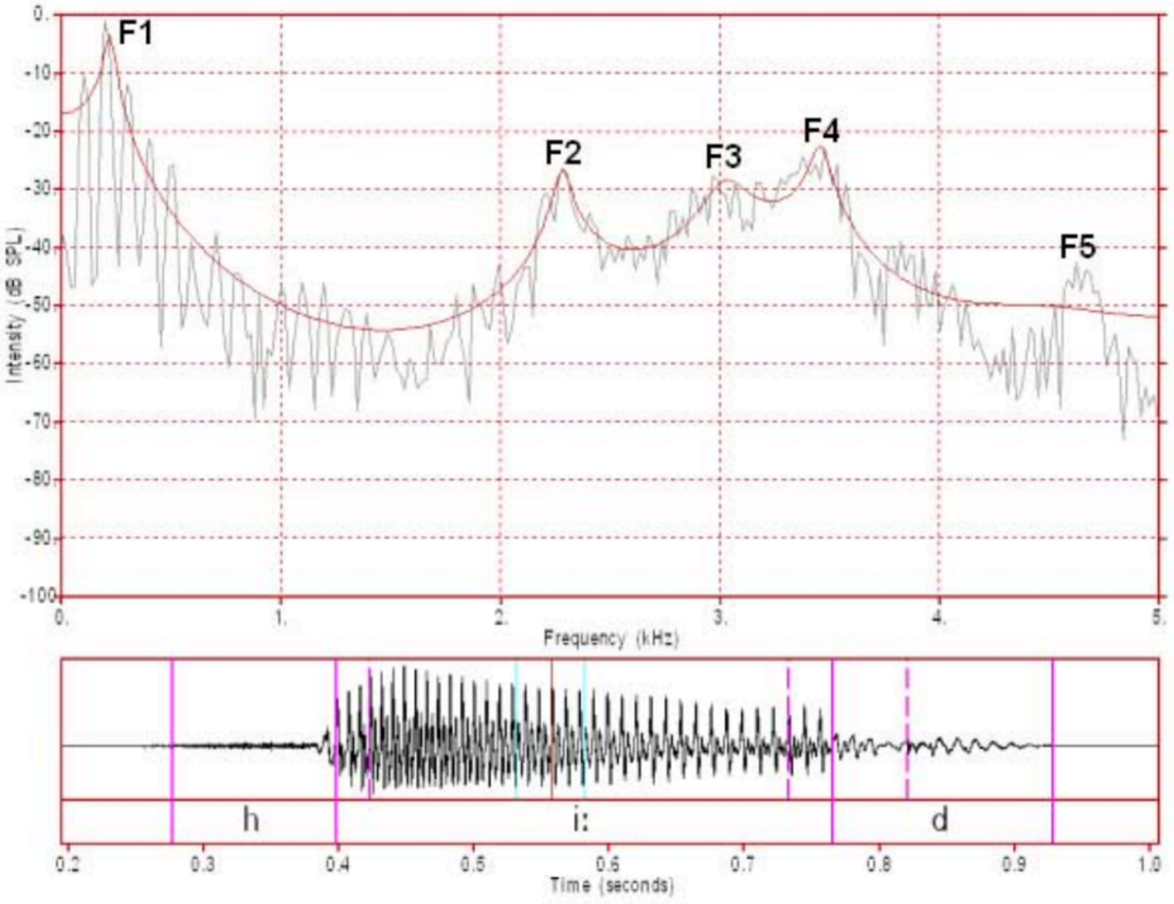


Figure 4: FFT/LPC of a male /i:/ FFT analysis window 51.2 ms (512 samples)

the FFT spectrum is similar to the LPC spectrum around these peaks when the analysis window length is close to one glottal period

captures about 5 glottal cycles

FFT

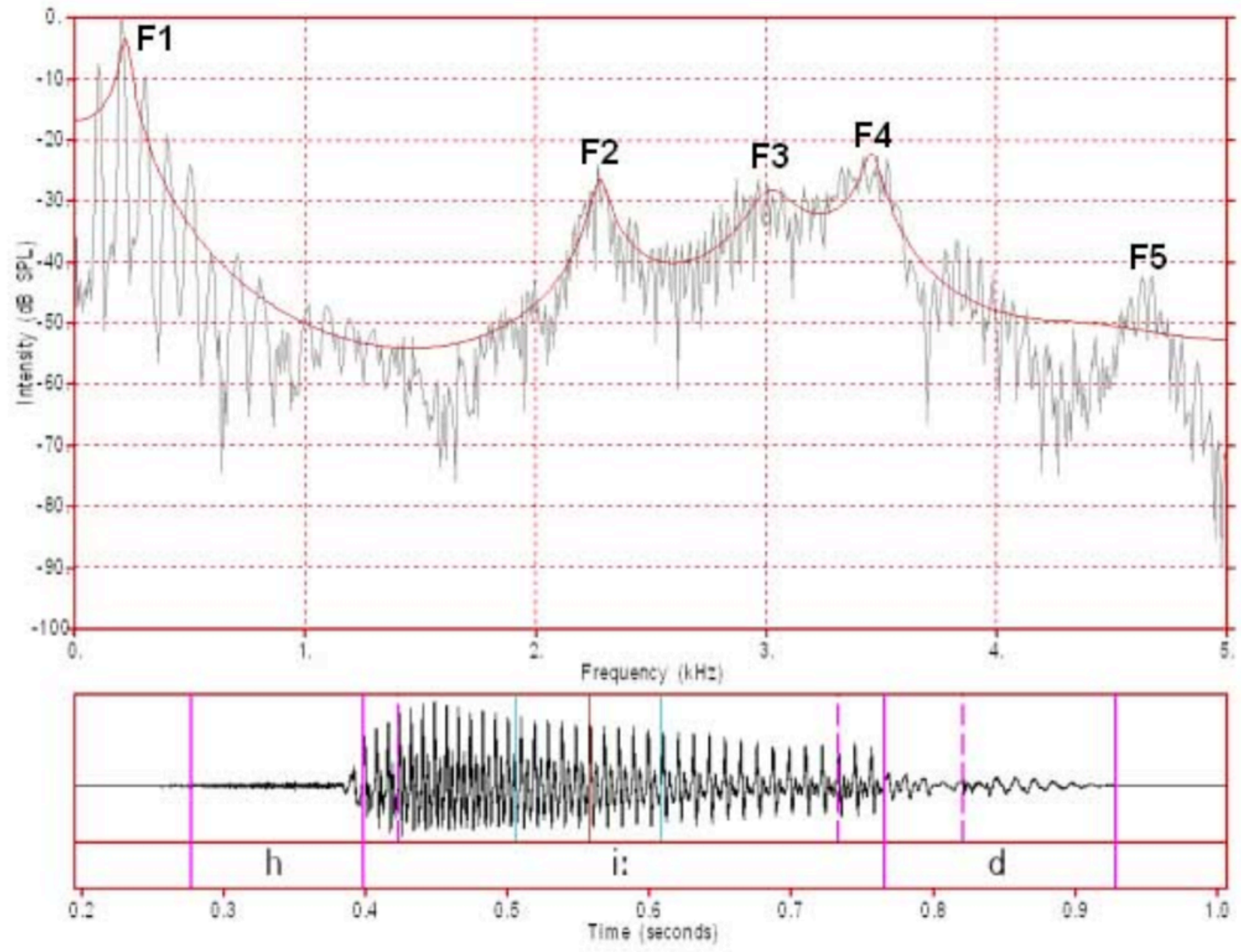


Figure 5: FFT/LPC of /i:/ FFT analysis window 102.4 ms (1024 samples)

- this analysis window captures about 10 glottal cycles and that over these cycles the F0 decreases from about 107 Hz to about 96 Hz.
- the range of H0 is 11 Hz (96 to 107 Hz). By the time we reach the 10th harmonic the range is 110 Hz (960 to 1070 Hz), by the 20th harmonic the range is 220 Hz (1920 to 2140 Hz) and so on up to 5000 Hz

When not LPC ?

- LPC = all poles (inadequat pour laterale, voyelles nasales ....)
- LPC = nombre de coefficients ? (surtout quand le formants sont proches)
- LPC = low frequency resolution (peu utile pour voir le detail des harmoniques et l’interaction entre les harmoniques)

When FFT -> fricatives

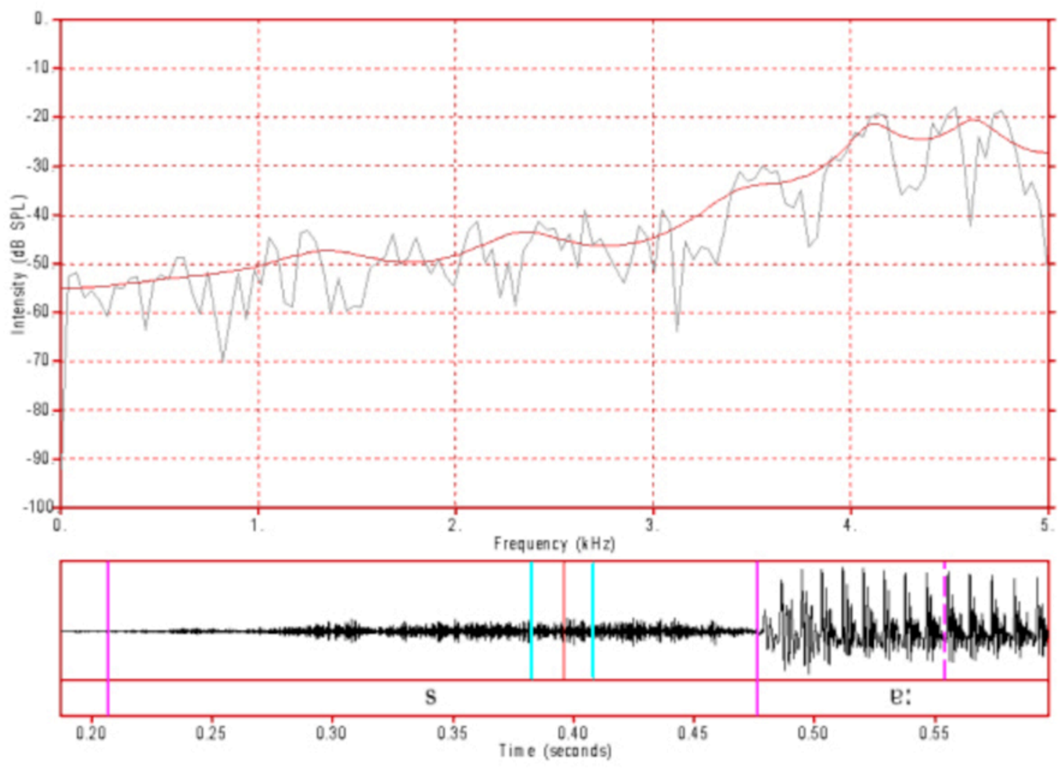


Figure 32: FFT/LPC spectrum of /s/. ***Click anywhere on the image to hear the s***

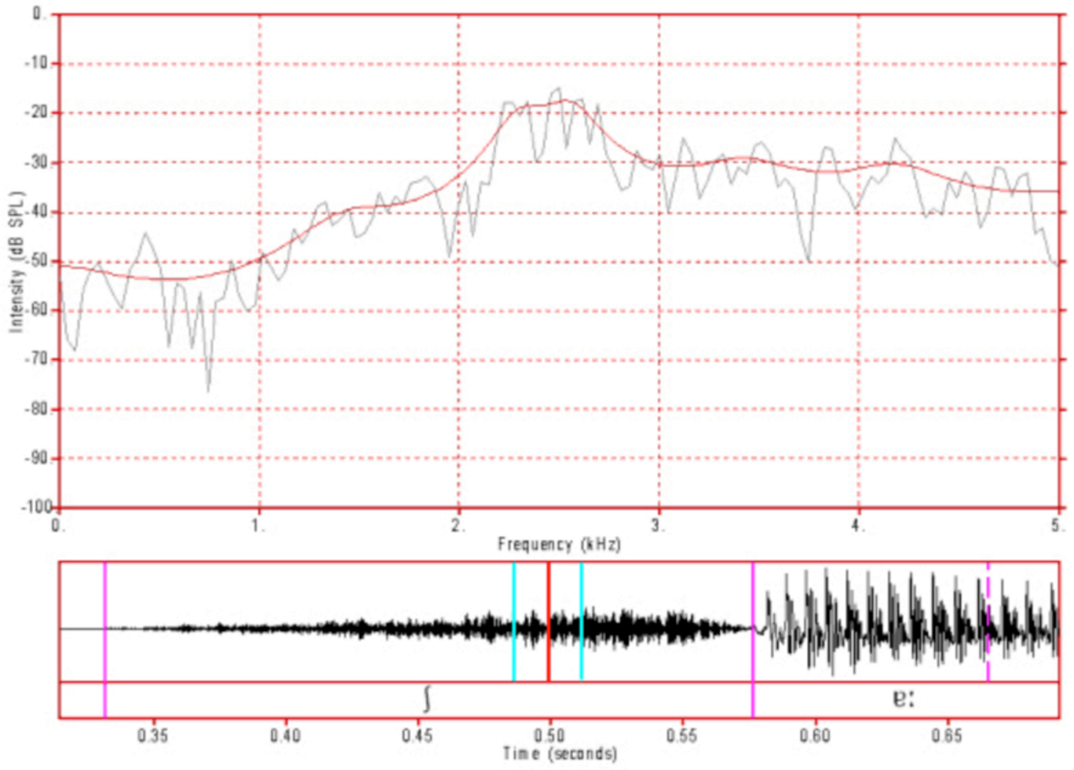


Figure 37: FFT/LPC spectrum of /S/. ***Click anywhere on the image to hear the sound.***

When FFT -> Voice quality

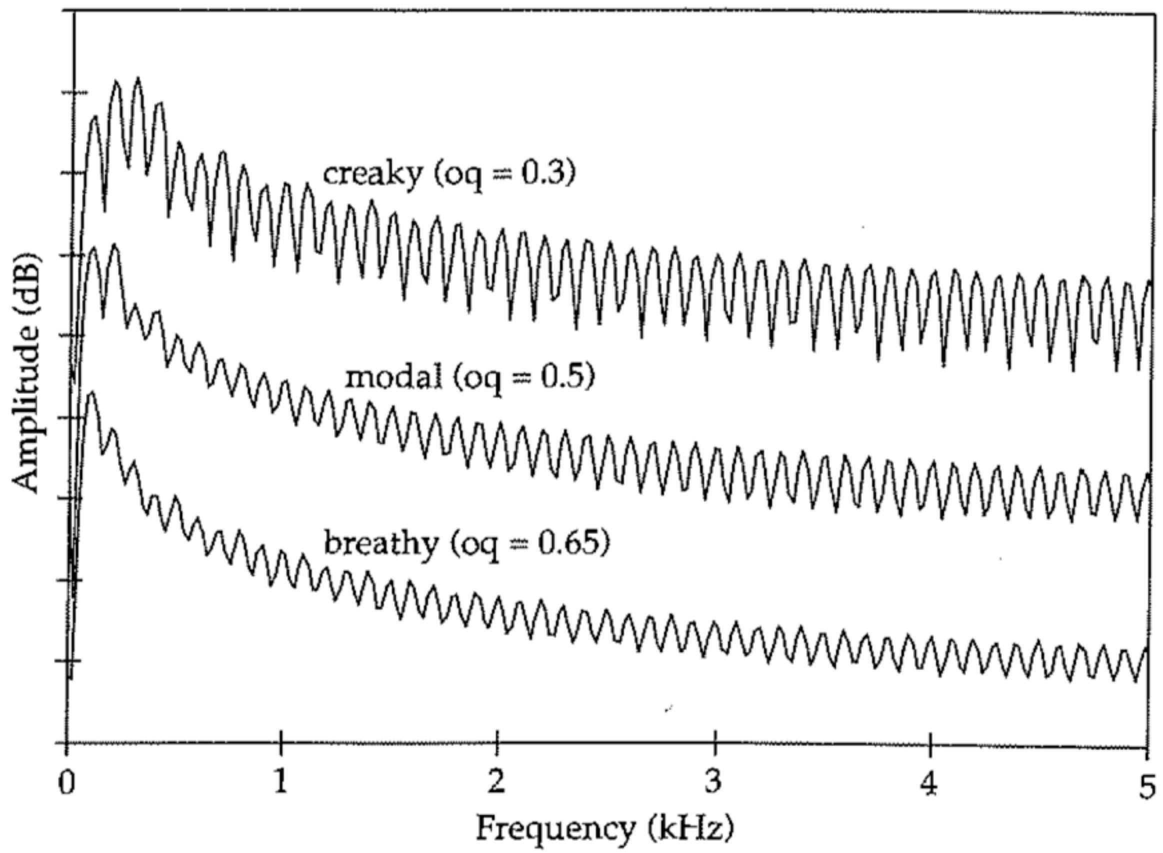
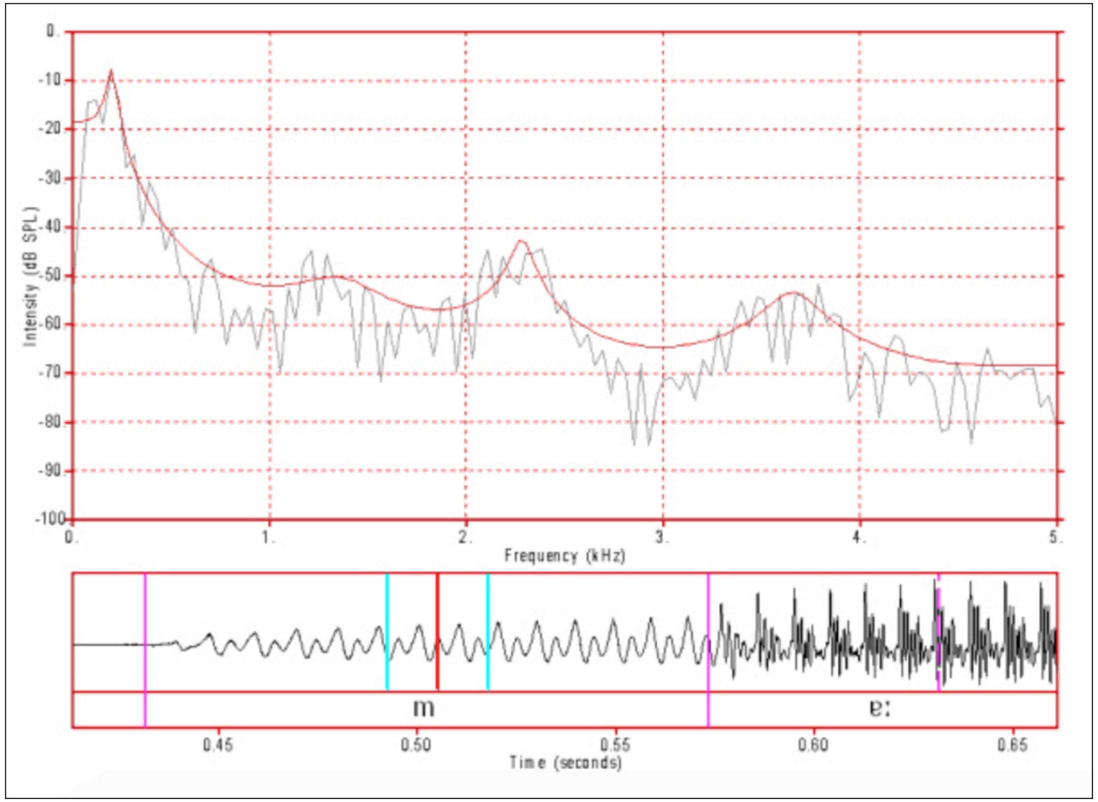


Figure 8.3 Power spectra of the synthetic glottal waveforms shown in figure 8.2. These spectra are offset on the amplitude axis to make them easier to distinguish. The interval between ticks on the vertical axis is 10 dB.

When FFT -> consonne nasale



Bilabiale

Assuming a length of the mouth tube of about 8cm, this gives (very roughly) about 1000Hz and 3000Hz for the first two resonance frequencies.

Thus we expect very little
energy in the output signal at these frequencies.

Here we can see possible antiresonances at about 1000, 1800 and 3000 Hz. The antiresonances at 1000 and 1800 Hz have most likely greatly attenuated the second formant peak. The main nasal resonance is paired with an antiresonance (a pole-zero pair) that usually cancels out the oral tract F1 unless its very low (say 200 Hz) and therefore reinforced by the nasal resonance.

When FFT -> consonne nasale

Switching of the nose and mouth output to nose alone for the nasal consonant introduces zeros to the transfer function, based on the distance between the vp opening and the oral closure

eliminates the spectral peak corresponding to the resonance of the cavity anterior to the oral constriction (Stevens, 1998)

alveolar nasal consonant, the oral closure is formed with the tongue tip 5}6 cm from the v}p port, introducing zeros around 1600-1900 Hz and 5 kHz. The cavity in front of the oral constriction is not excited during the nasal murmur so that the amplitude above 4500 Hz, which is the lowest natural frequency of the cavity, decreases from the vowel to [n]

velar nasal consonant is formed with the dorsum of the tongue body contacting the hard or soft palate about 3}7 cm from the lips, introducing zeros above 3 kHz in the murmur and eliminating the excitation of the front cavity with natural frequency in the range 1300-3000 Hz

When FFT -> consonne nasale

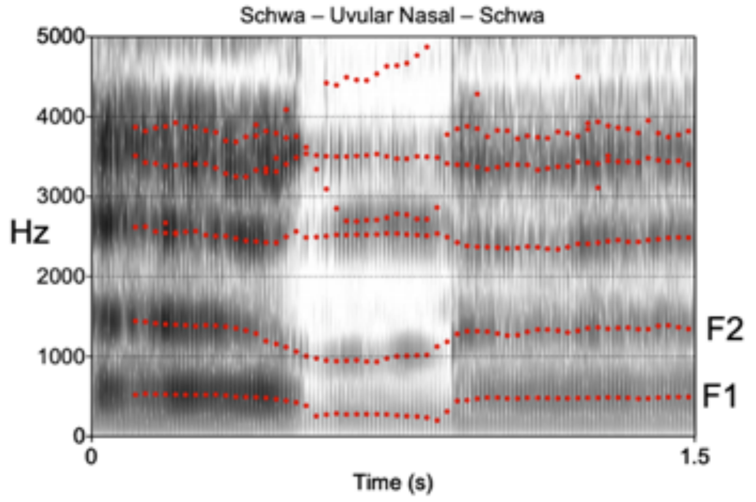


Figure 1

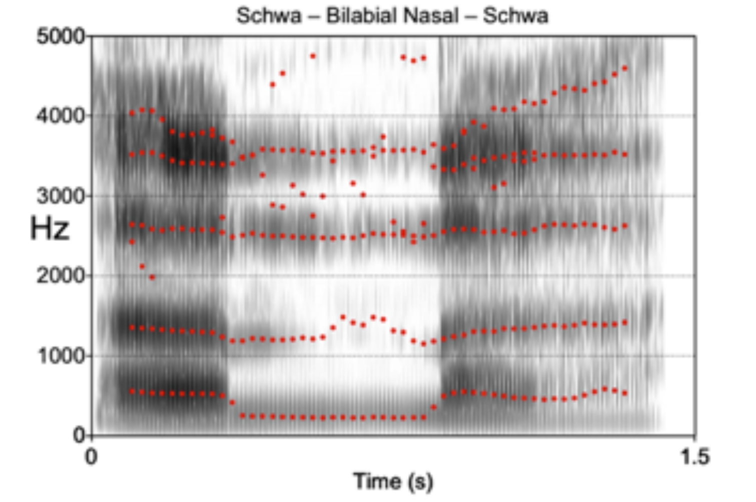


Figure 2

N

m

zero autour de 1khz pour [m]

zeros around 1600-1900 Hz and 5 kHz pour [n]

plus de 3Khz pour [ŋ]
eliminating the excitation of the front cavity
with natural frequency in the range 1300-3000 Hz

When FFT -> voyelles nasales

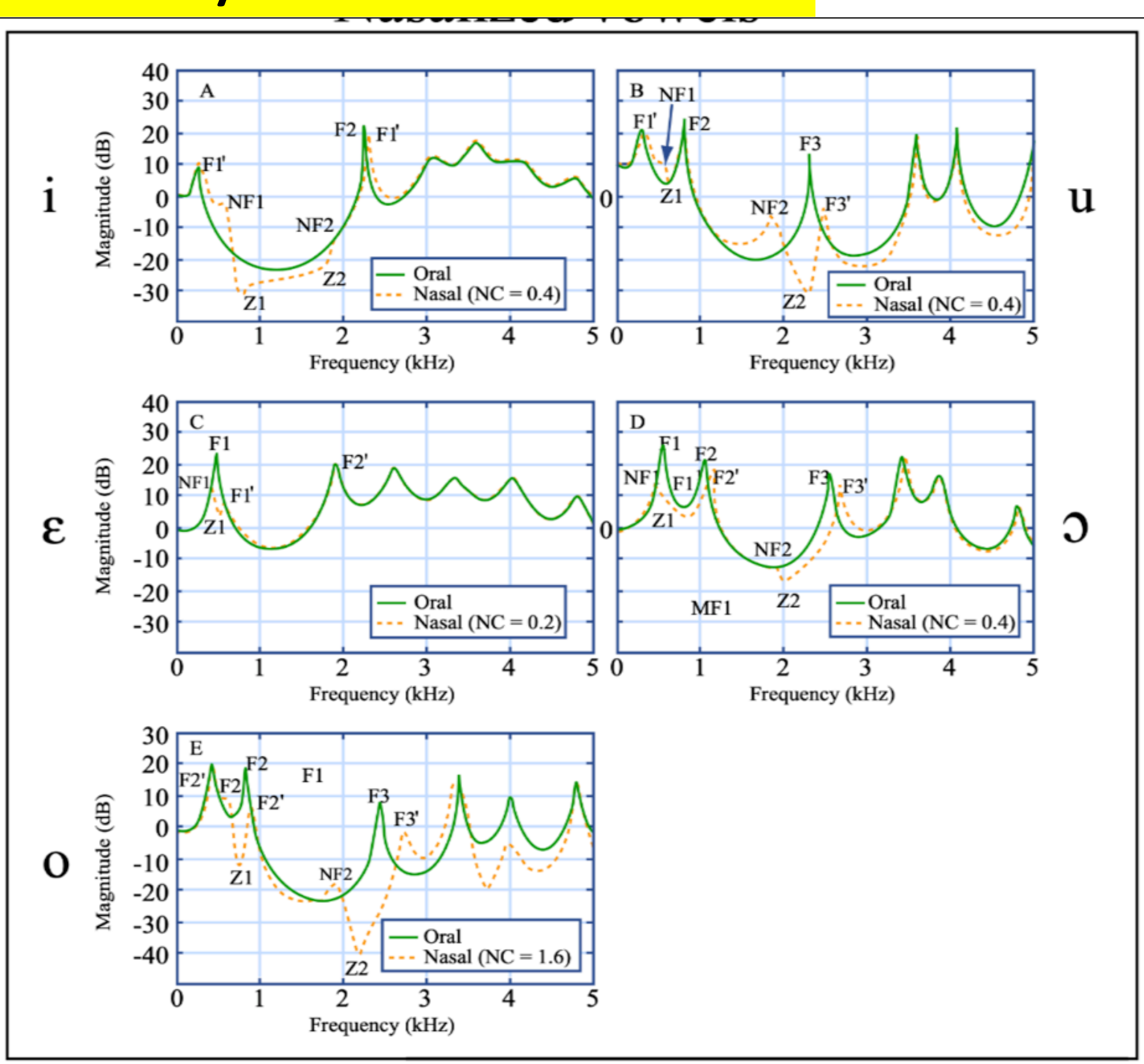
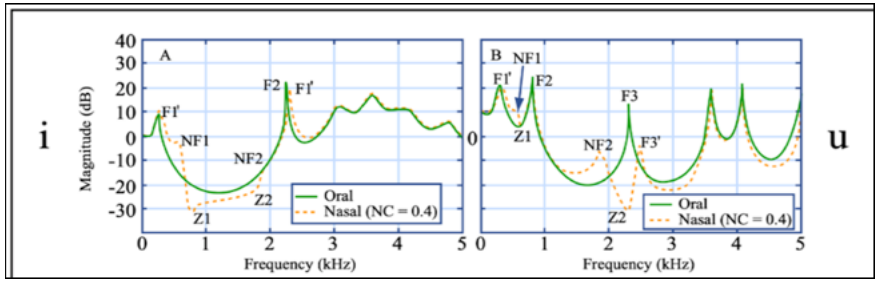
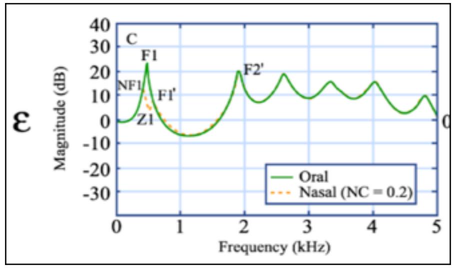


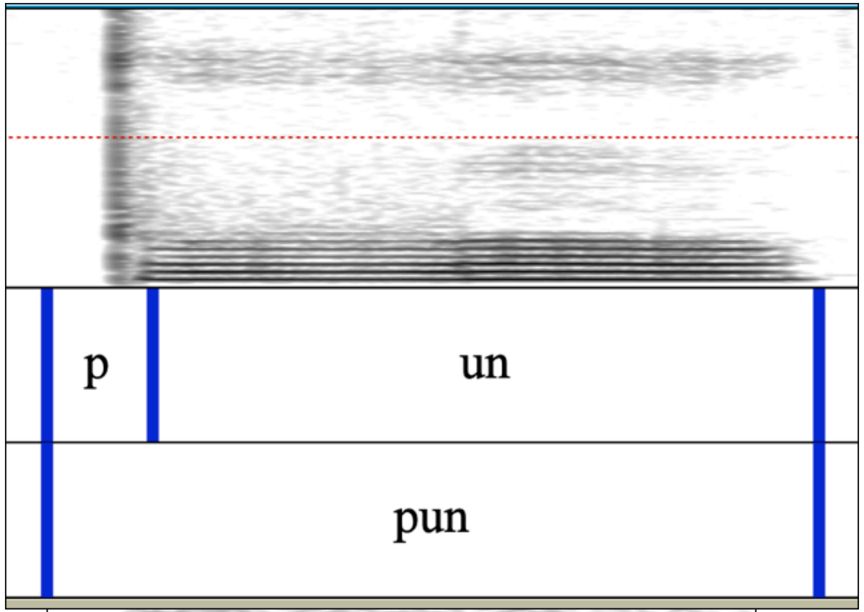
Image by MIT OCW.

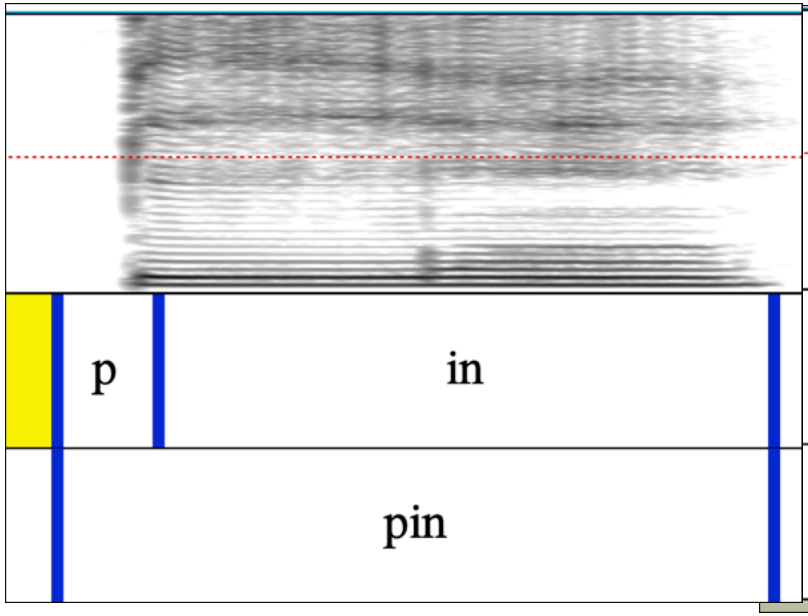
Adapted from Maeda, Shinji. "Acoustics of vowel nasalization and articulatory shifts in French nasal vowels."In *Nasals, Nasalization and the Velum*. Edited by M. Huffman and R. Krakow. New York, NY: Academic Press, 2003, pp. 147-170.

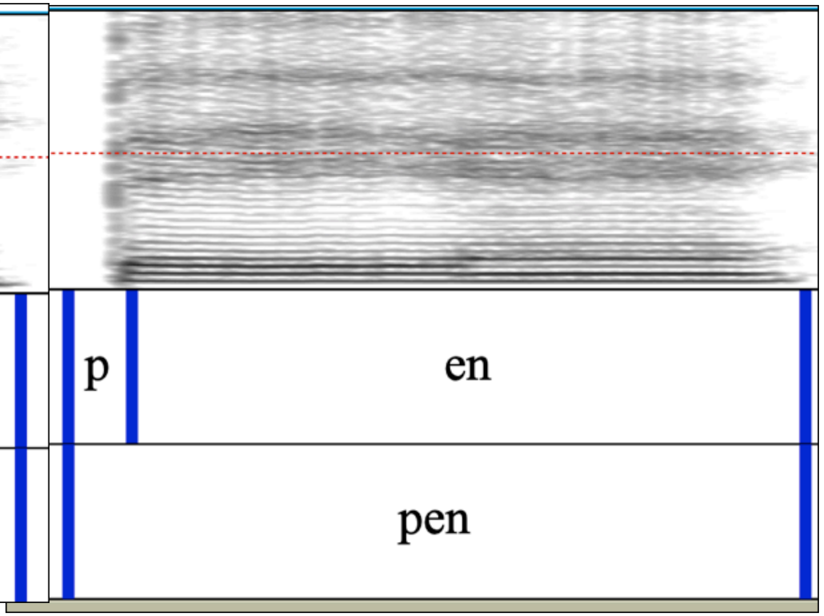
When FFT -> Voyelles nasales nasal eye ?

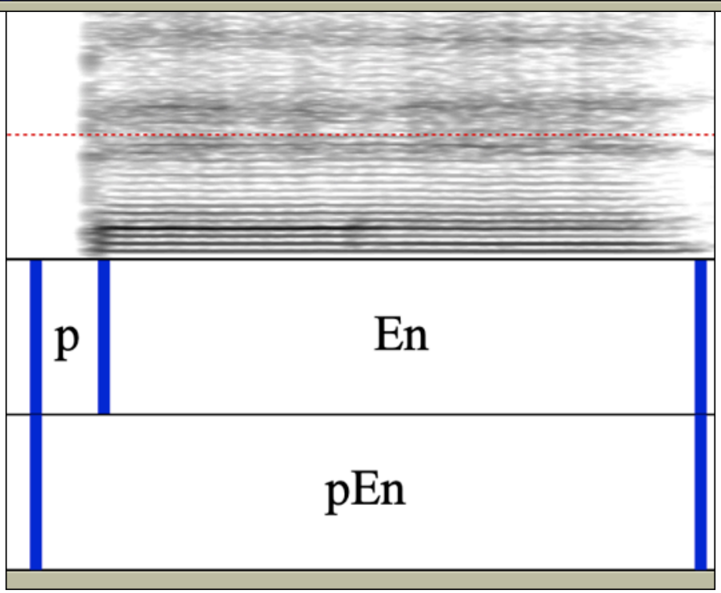




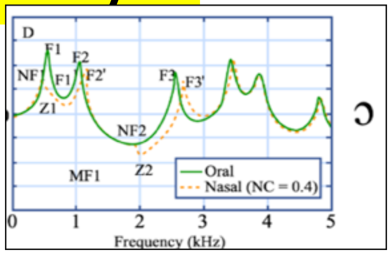


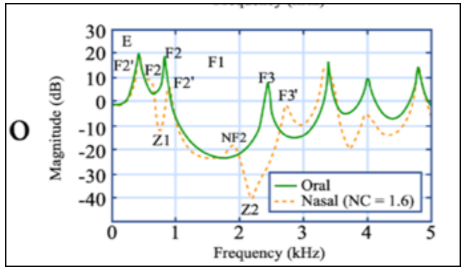


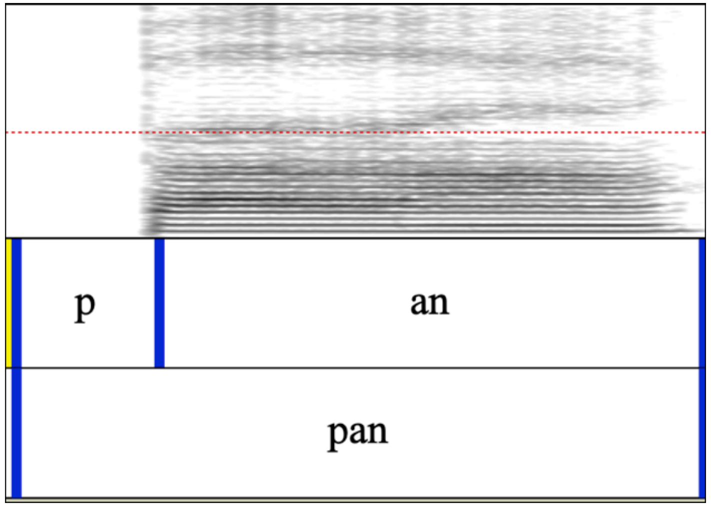


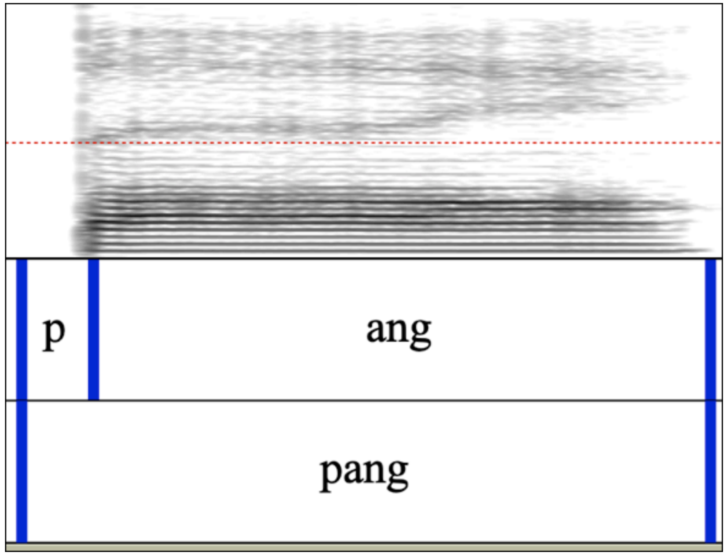


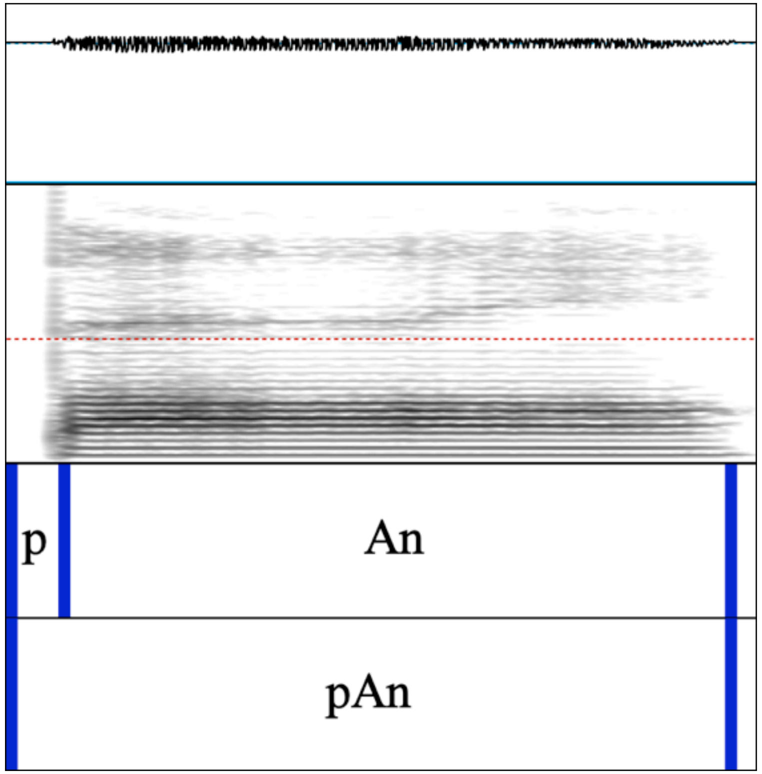
When FFT -> Voyelles nasales nasal eye + aplatissement dans les basses F

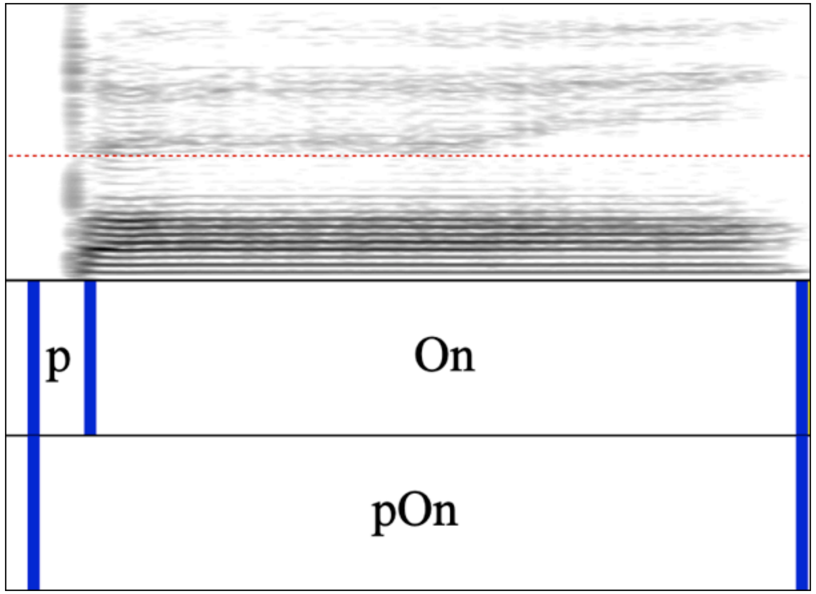


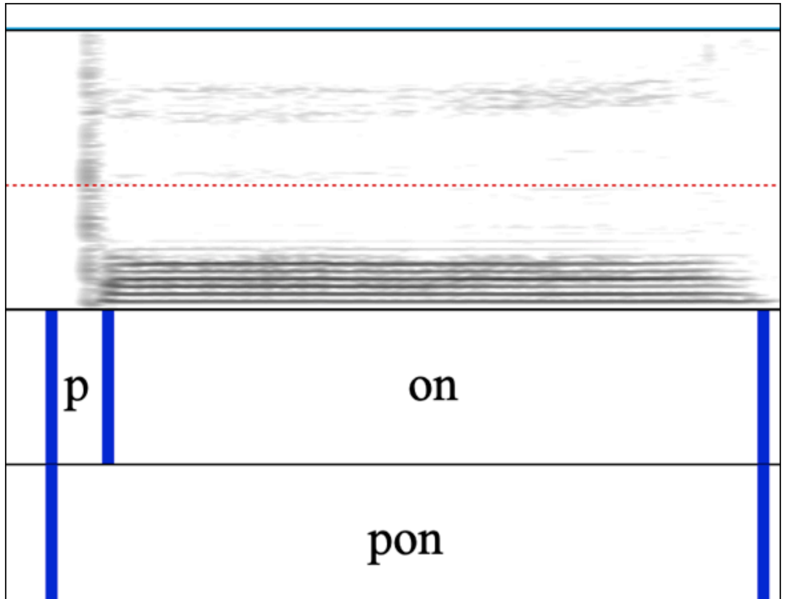












Ref

https://www.mq.edu.au/about/about-the-university/faculties-and-departments/faculty-of-human-sciences/departments-and-centres/department-of-linguistics/our-research/phonetics-and-phonology/speech/acoustics/speech-acoustics/fft-and-lpc-spectrum-settings

https://ocw.mit.edu/courses/linguistics-and-philosophy/24-915-linguistic-phonetics-fall-2015/lecture-notes/

Anderson, S. R., Keating, P. A., Huffman, M. K., & Krakow, R. A. (2014). *Nasals, nasalization, and the velum* (Vol. 5). Elsevier.