

Basic acoustics part 3
Vowels, manner and voicing cues

See Rogers chapter 7 8

Wideband band spectrogram: [aaiiaa]

- Spectrogram of [aaiiaa] on SAME pitch
- Wideband spectrogram
 - Looks at fairly short chunk of time
 - 2 to 3 ms only sees less than one full glottal period
 - Each glottal pulse about 10 ms long
 - Harmonic structure no longer clear
 - Dark bars show approximate location ‘formant peaks’
 - Formants change lots with VOWEL changes

Wide and narrowband spectrograms

- Narrowband spectrogram makes **harmonic** structure clear
 - Associated with **glottal source**
- Wideband spectrogram makes **formant** structure clearer
 - Dark formant bands that change with vowel, not with pitch)
 - Formants associated ‘filter properties’ of vocal tract above the larynx

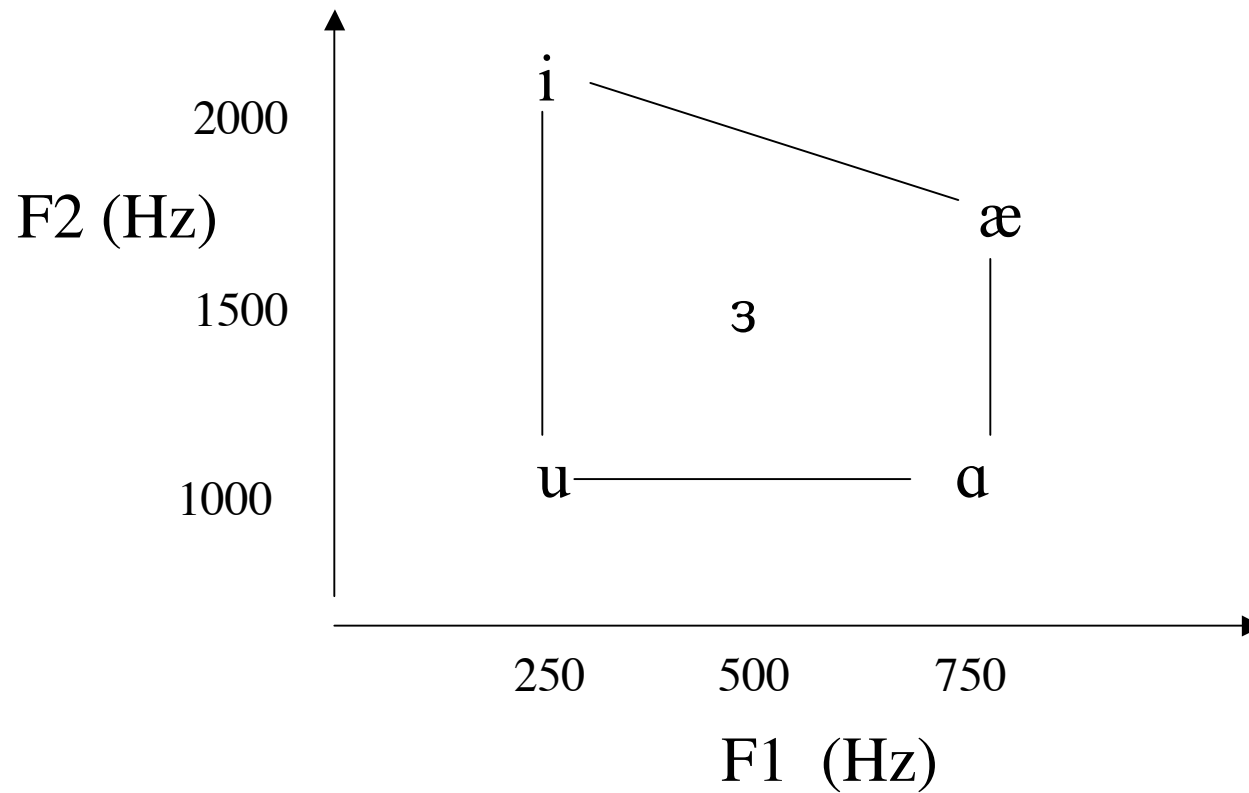
Except for pitch measurements, use wide band spectrograms

- To look at most speech phenomena, it is more useful to look at wide band spectrograms
 - Main exception... when we are interested in F0 or other characteristics of voicing

Vowels

- Vowels show strong, well-defined formants
- Formant patterns are different for different vowels
- General correspondence between vowels and formants
- Vowel height, and advancement related to F2

Vowels and formants F1 x F2



F1 inversely related to ‘vowel height’

- Low (‘tongue height’) vowels have high F1
- High vowels have low F1
- * May be easier to remember if you think of IPA ‘Close/Open’ terminology:
 - ‘Close’ vowel is a high vowel (tongue closer to roof of mouth)
 - ‘Open’ vowel is a low vowel (tongue far away from roof of mouth)
 - Then F1 corresponds roughly to degree of openness

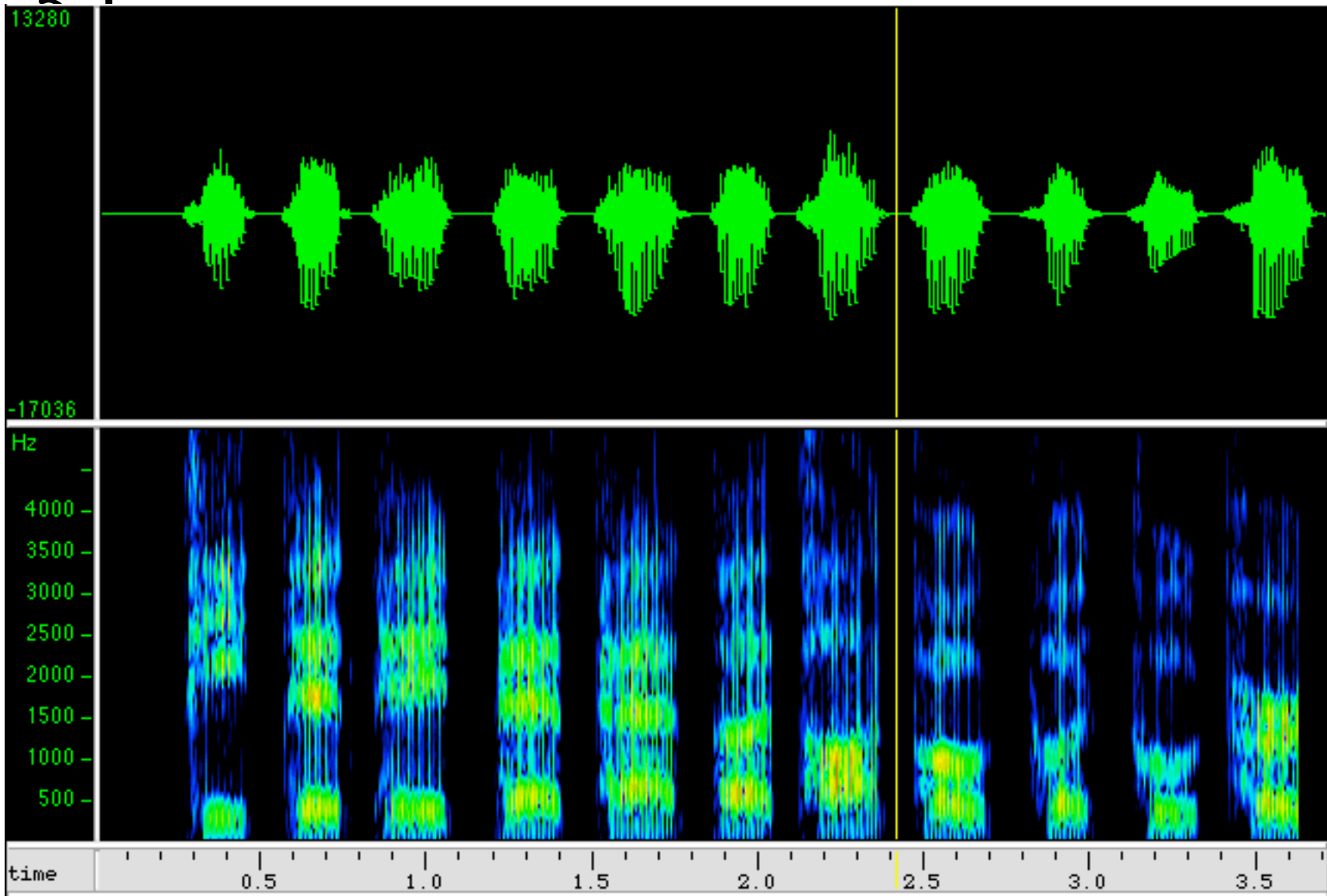
F2 directly related to ‘vowel advancement’

- F2 corresponds to roughly degree of ‘frontness’
 - Back vowels have lower F2
 - Front vowels have higher F2
- Note also... all other things equal, a rounded vowel of same advancement will have lower F2 than an unrounded vowel

Vowels and diphthongs

- Rogers Figure 8.3 (p 152) ‘pit, pet, pat, put’
 - Formant pattern
 - Our example ... pVt for many vowels
- Rogers Figure 8.5 (p 155) [aj aw ɔj ju]
 - WaveSurfer example

[i ɪ e j ε æ ʌ ɒ o w ʊ u
ɜ]



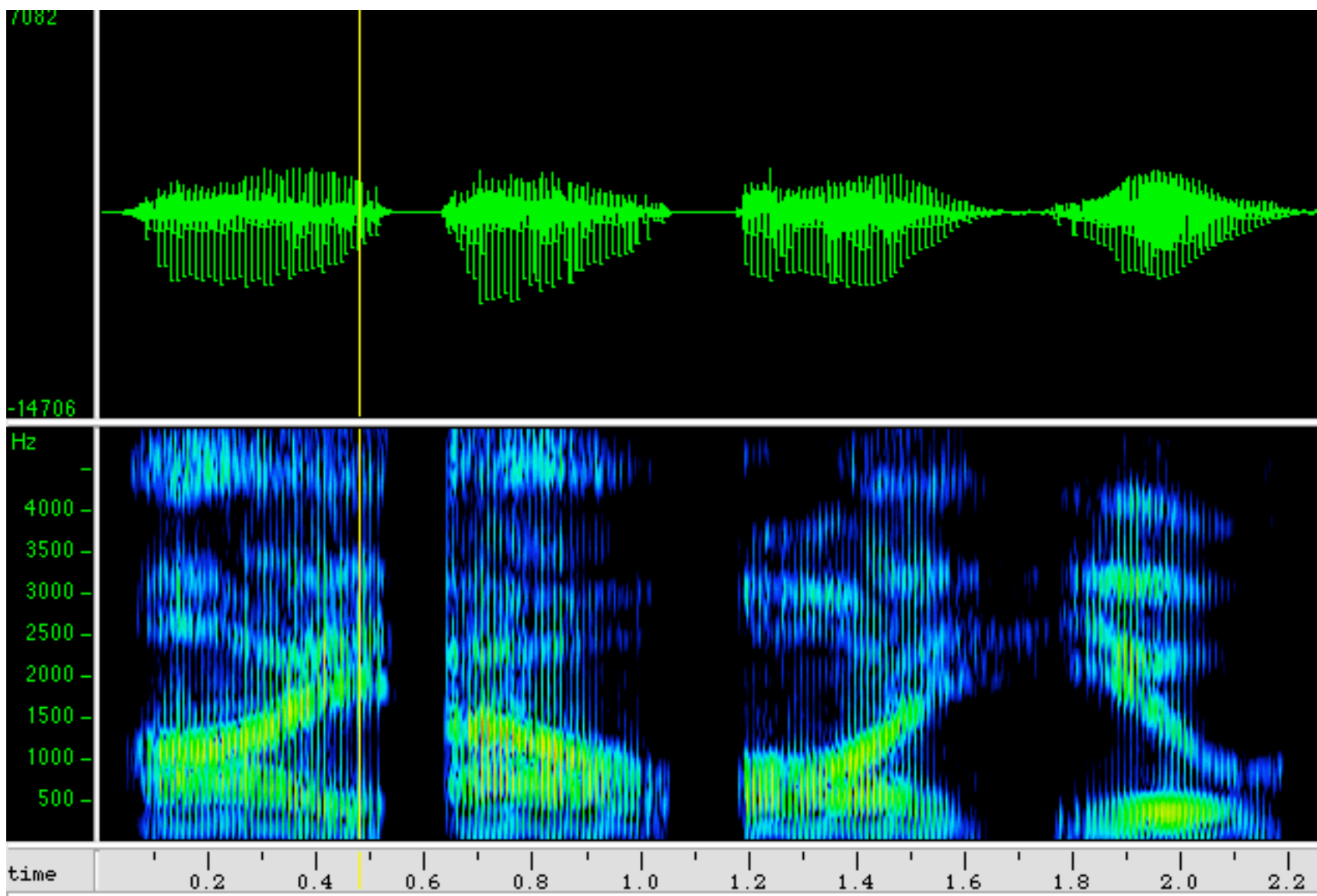
Vowels and diphthongs

- Rogers Figure 8.3 (p 152) ‘pit, pet, pat, put’
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 - Our example ... pVt for many vowels
- Rogers Figure 8.5 (p 155) [aj aw ɔj ju]
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Summary vowels and diphthongs

- Vowels and diphthongs...
 - Vowels show strong formants
 - So do diphthongs... but show more formant movement in expected direction
 - [aj] movement from [a]- like pattern toward [i]- like
 - (Even ‘monophthongs’ may show some formant movement)

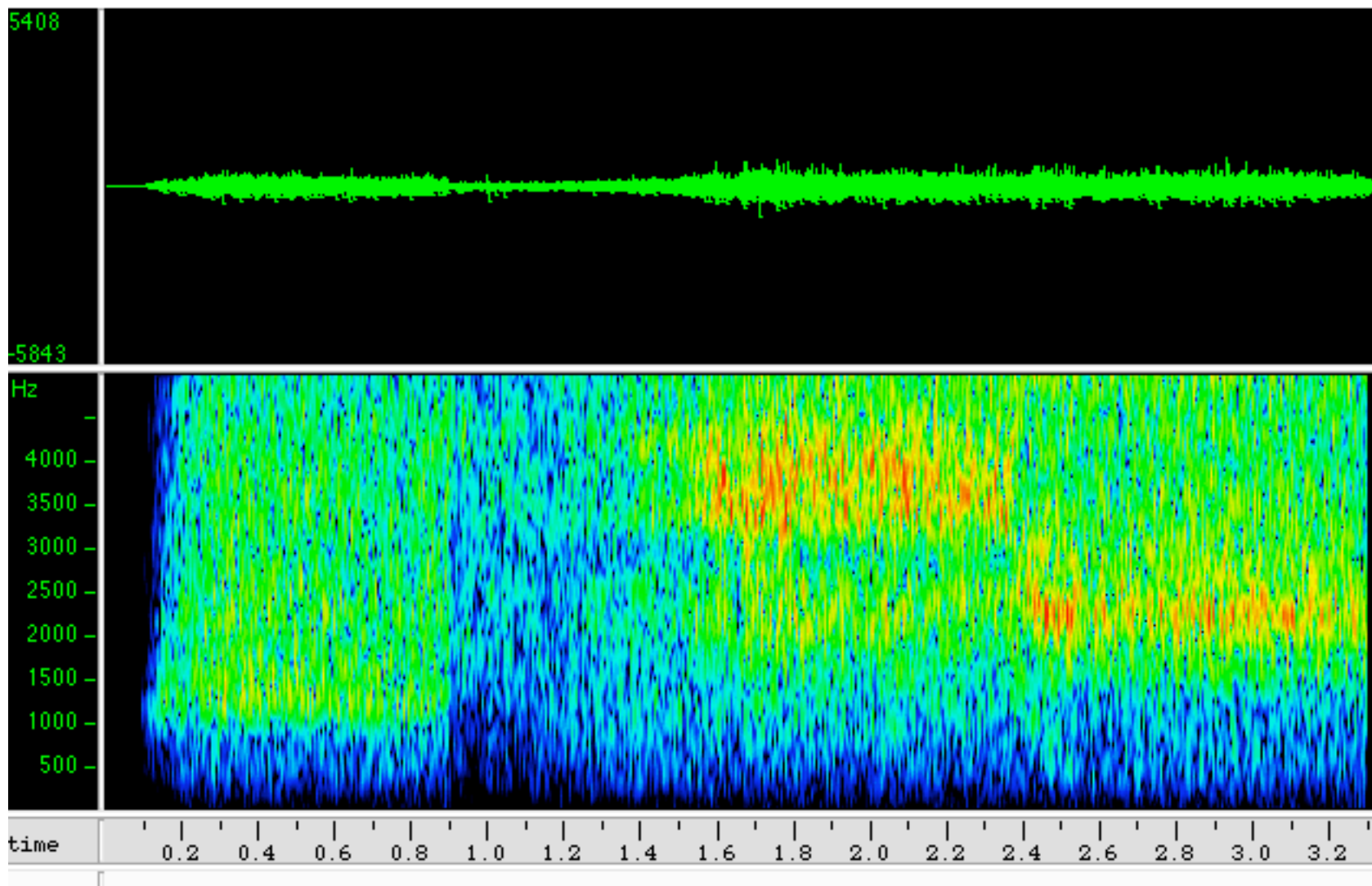
[aj aw oj ju]



Fricatives

- Vowels and diphthongs..
 - Voiced : sound source is glottis
- Other sounds different
- Voiceless fricatives have other sound sources
 - Local turbulence caused by chaotic airflow
 - Rapidly moving airstream generates noise
 - Garden hose example
 - Traffic jam to open road

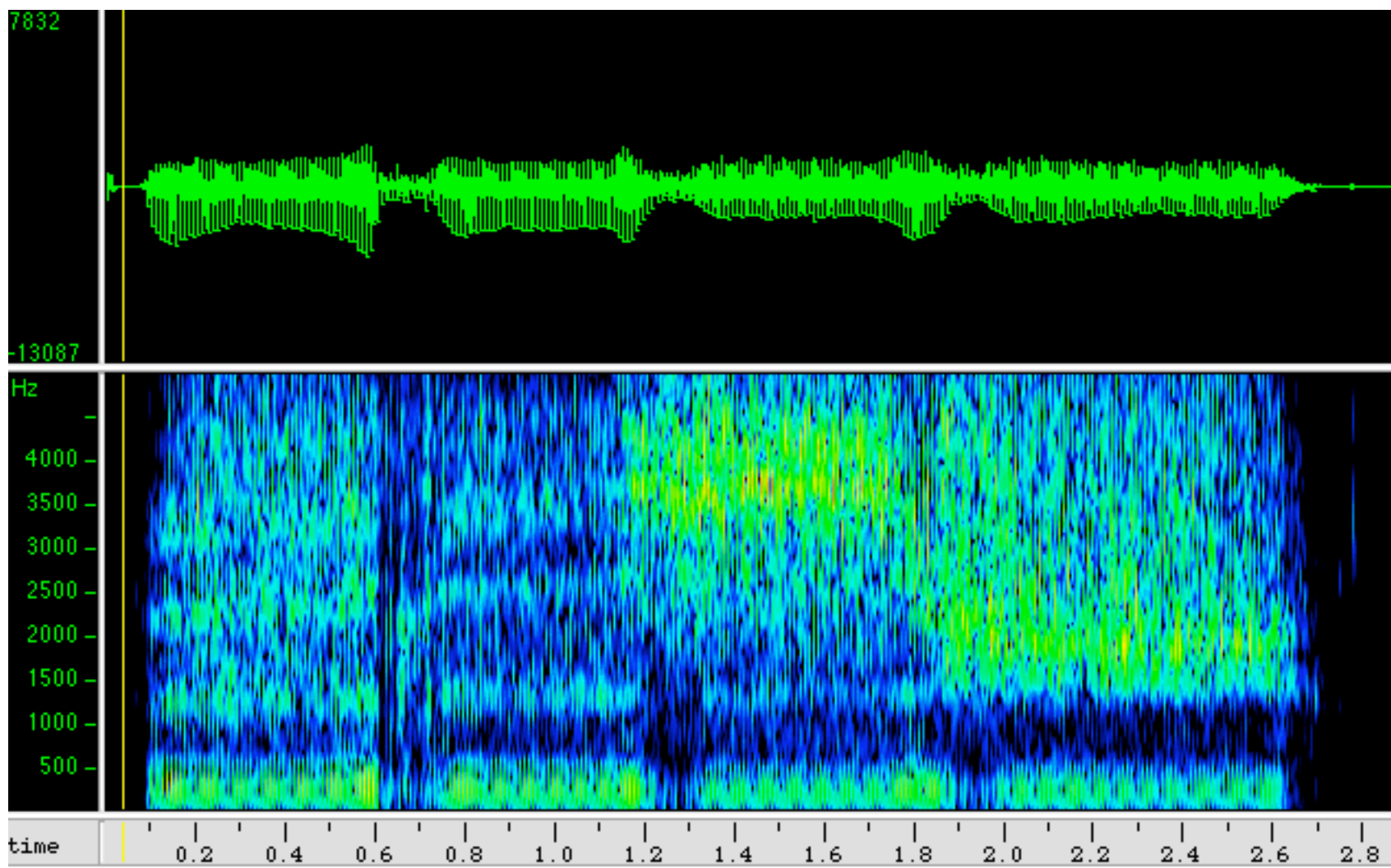
[f θ s \int]



Voiced fricatives

- Voiced fricatives have both glottal voice source and (usually) local turbulence noise
 - Strong (sibilant) fricatives [z, ʒ] show clear fricative noise when voiced
 - Weak fricatives [v, ð] may show little evidence for fricative noise when voiced
 - Especially when spoken softly

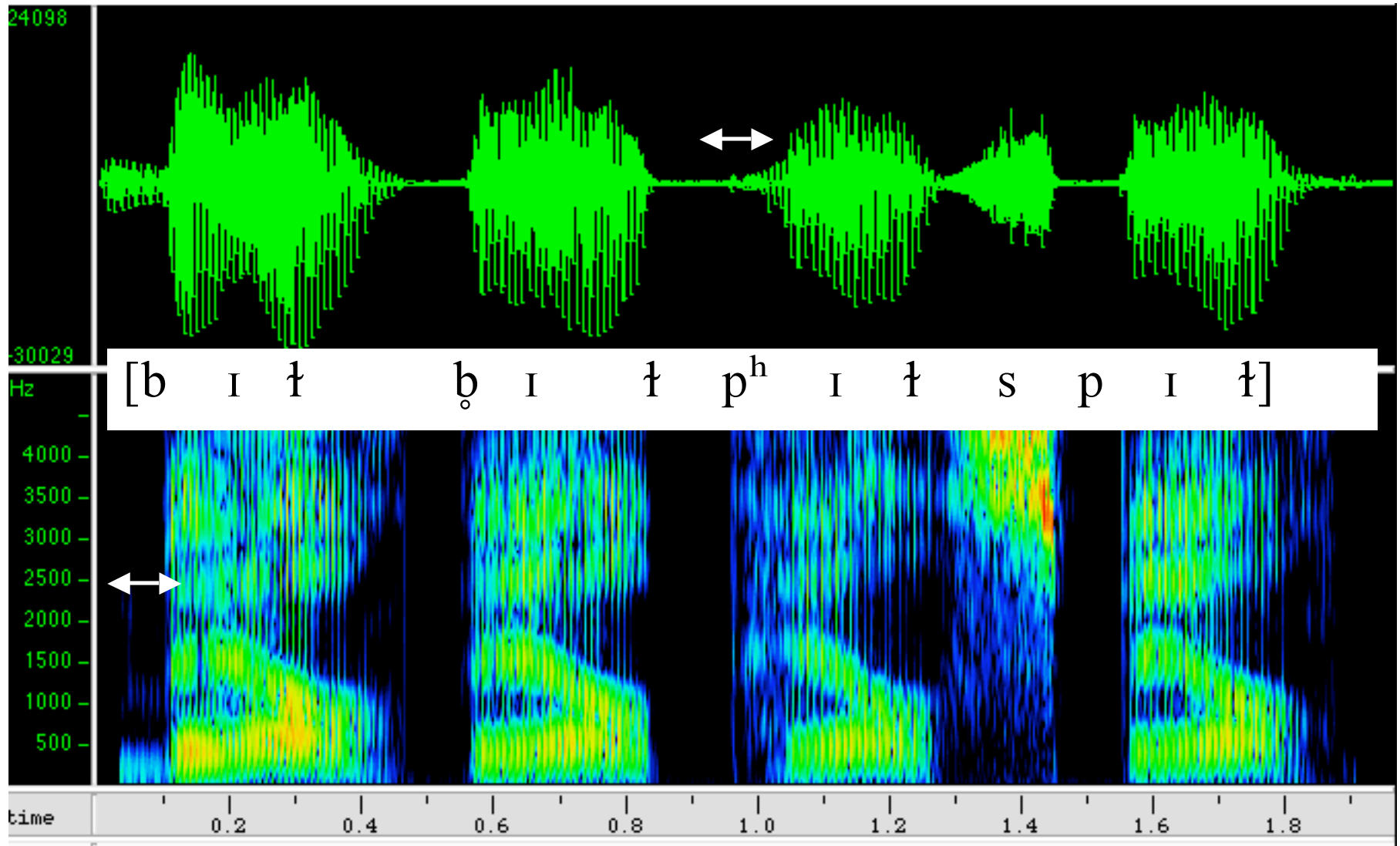
[v ð z 3]



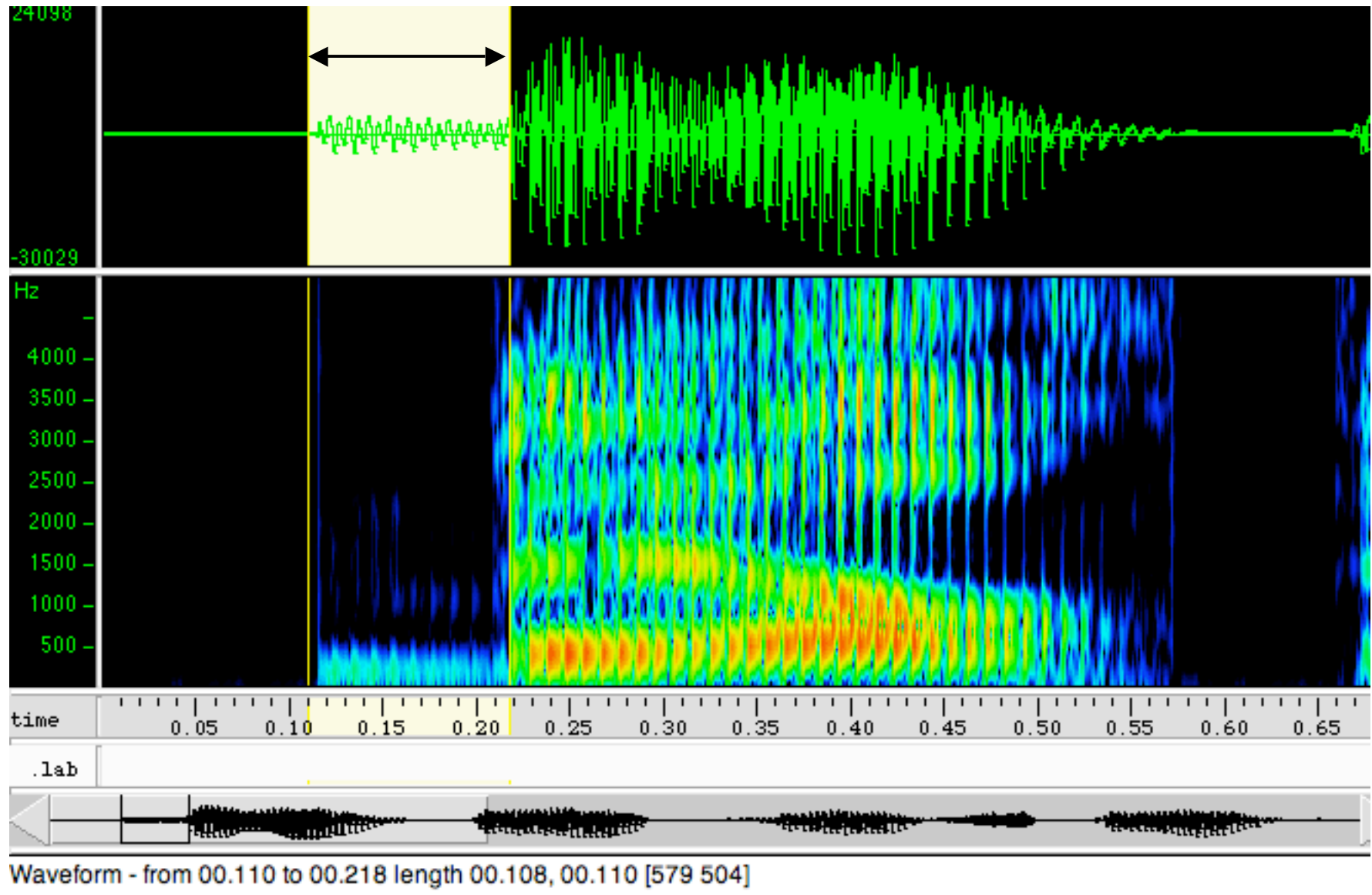
Stops

- During stop **closure** stops show either
 - Silent gap (when voiceless) or
 - ‘Voice bar’ (when ‘prevoiced’)
 - a.k.a. ‘Closure voicing’
- After stop release stops show
 - Onset of higher frequency energy (above 1 kHz)
 - Burst (plus [sometimes] brief frication noise)
- Voice onset time VOT varies for voiced, voiceless aspirated and voiceless stop

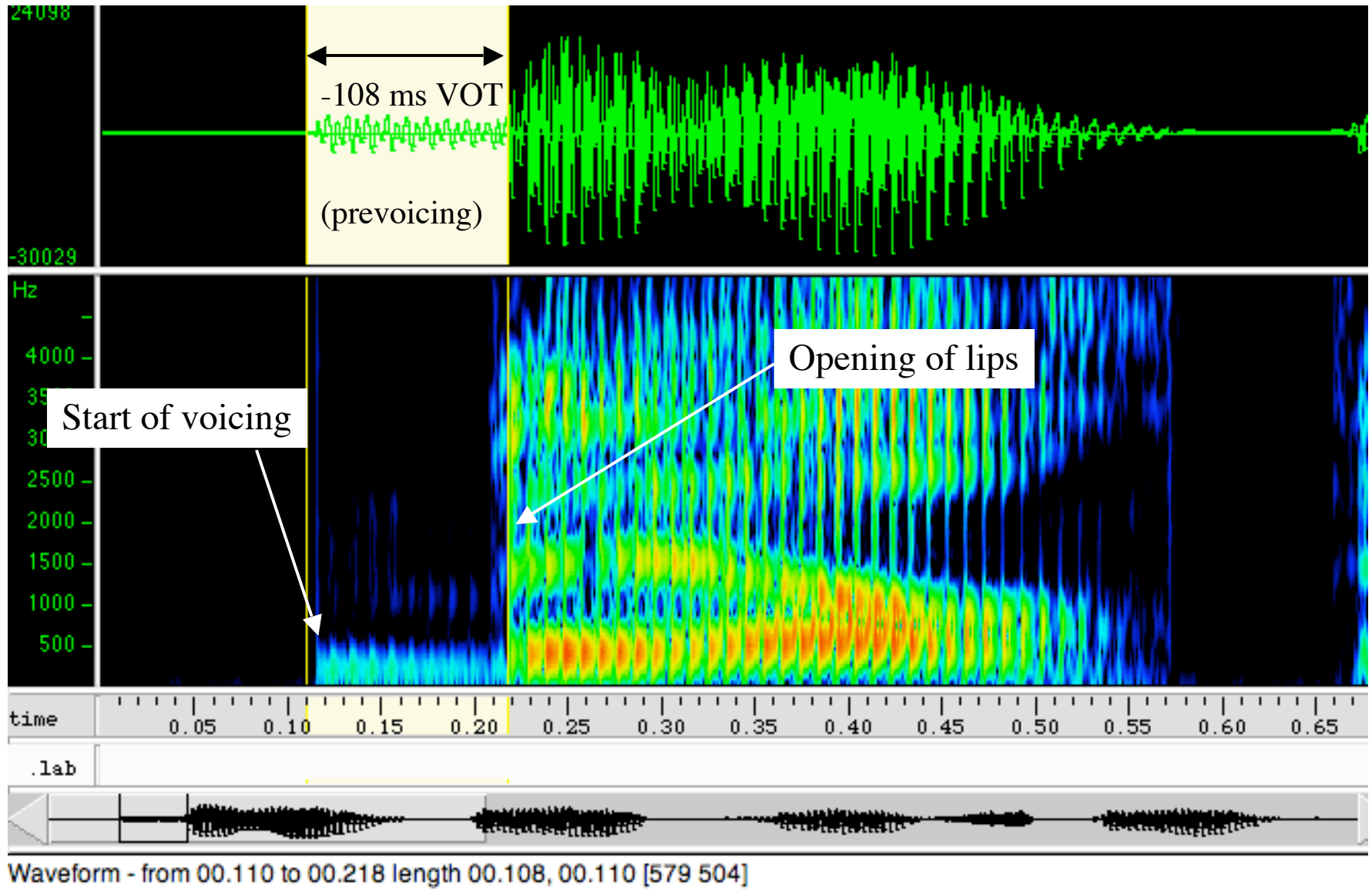
Measuring VOT: 'bill' (prevoiced), 'bill', 'pill', 'spill'



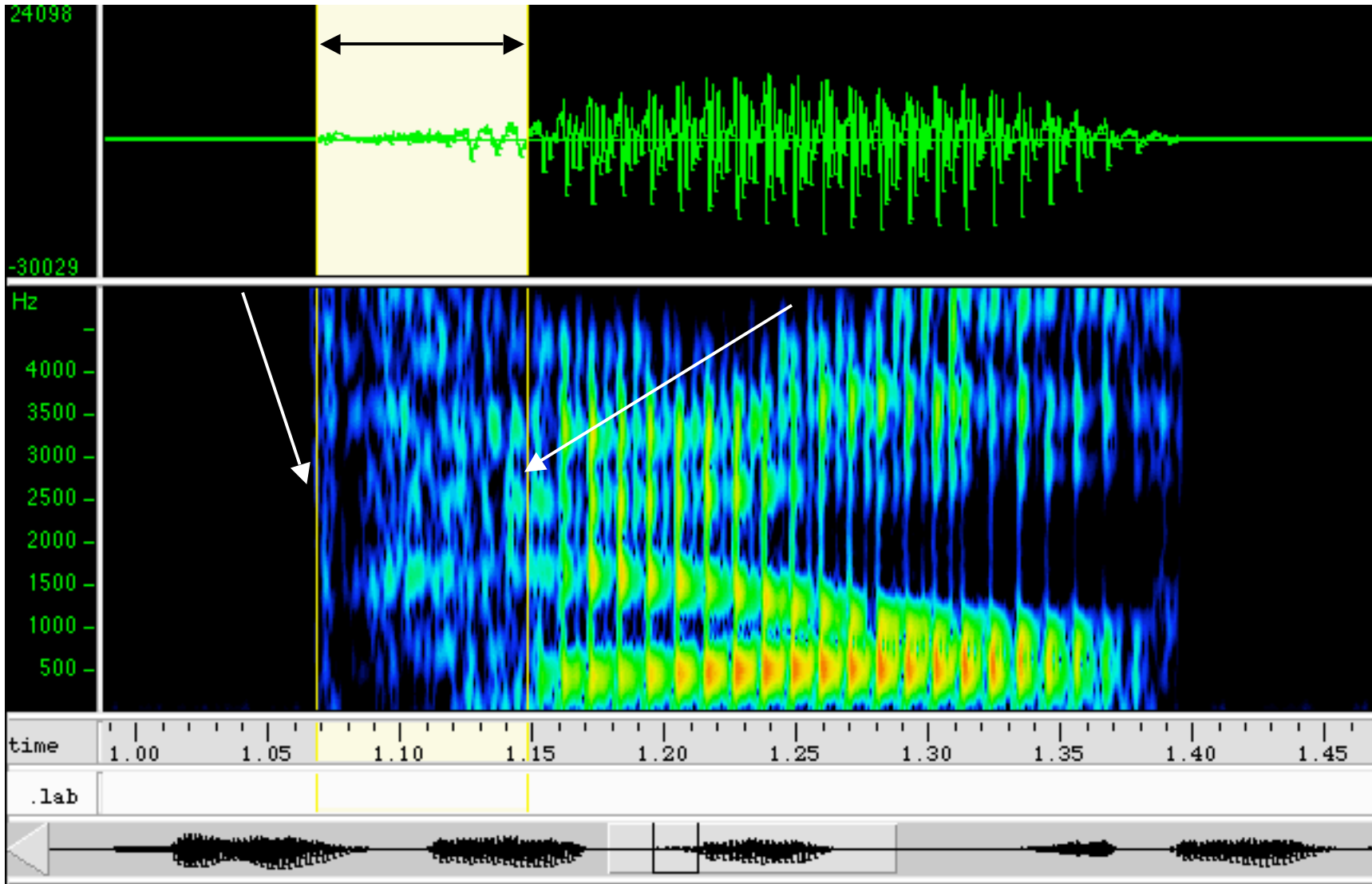
'Bill' prevoiced zoom-in (unlabeled)



'Bill' prevoiced zoom-in

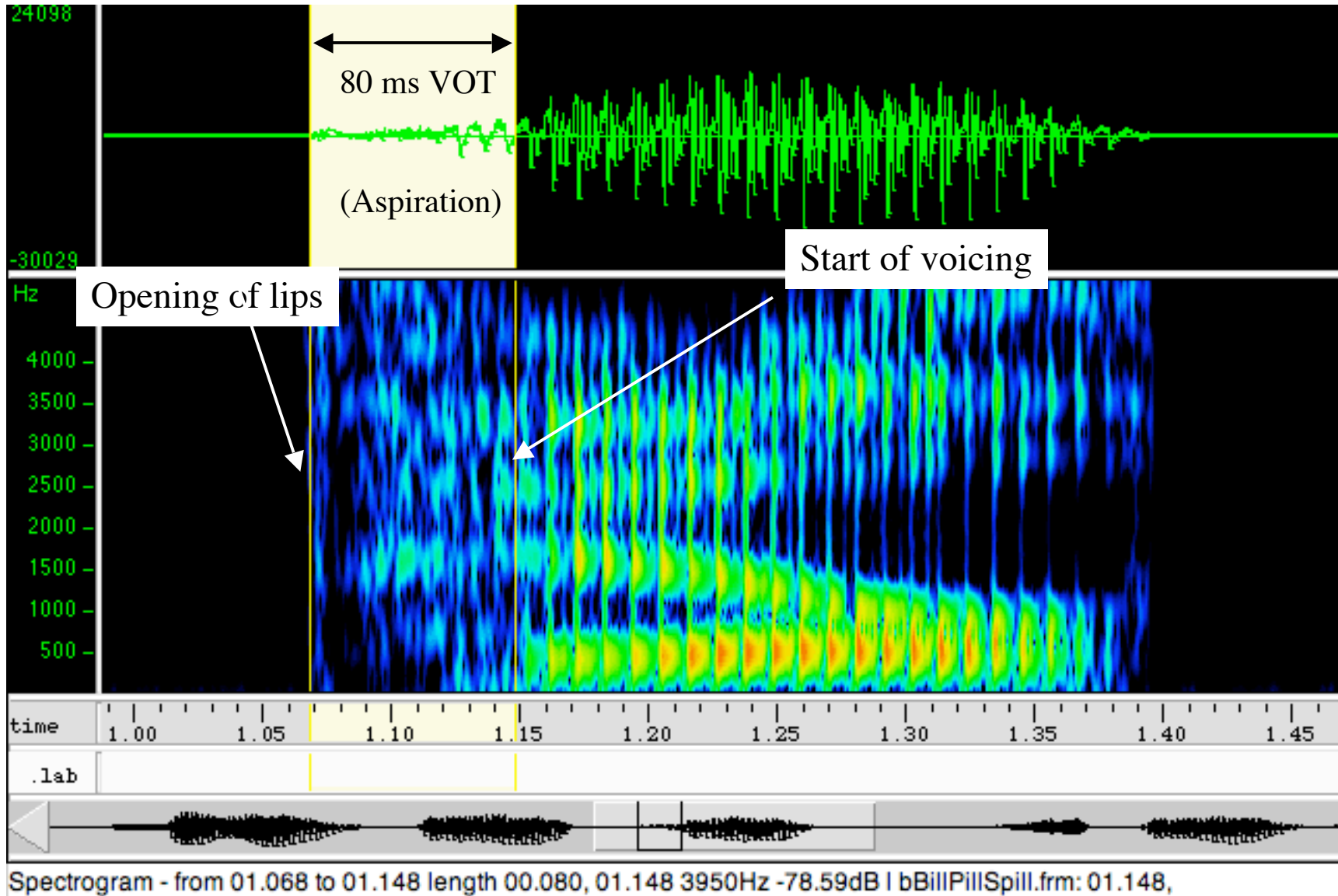


‘pill’ : aspirated zoom-in (unlabeled)

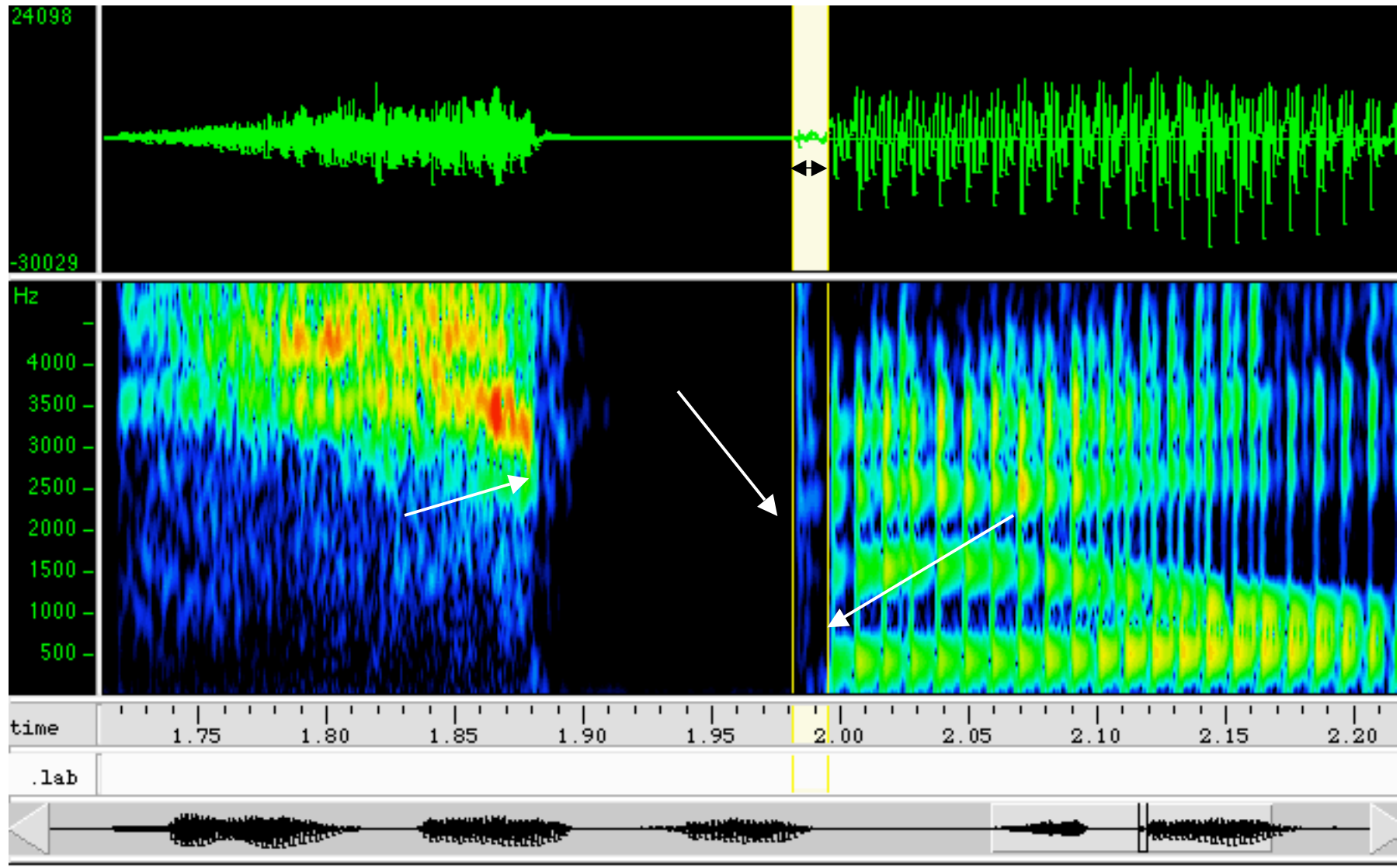


Spectrogram - from 01.068 to 01.148 length 00.080, 01.148 3950Hz -78.59dB | bBillPillSpill.frm: 01.148,

'pill' : aspirated zoom-in

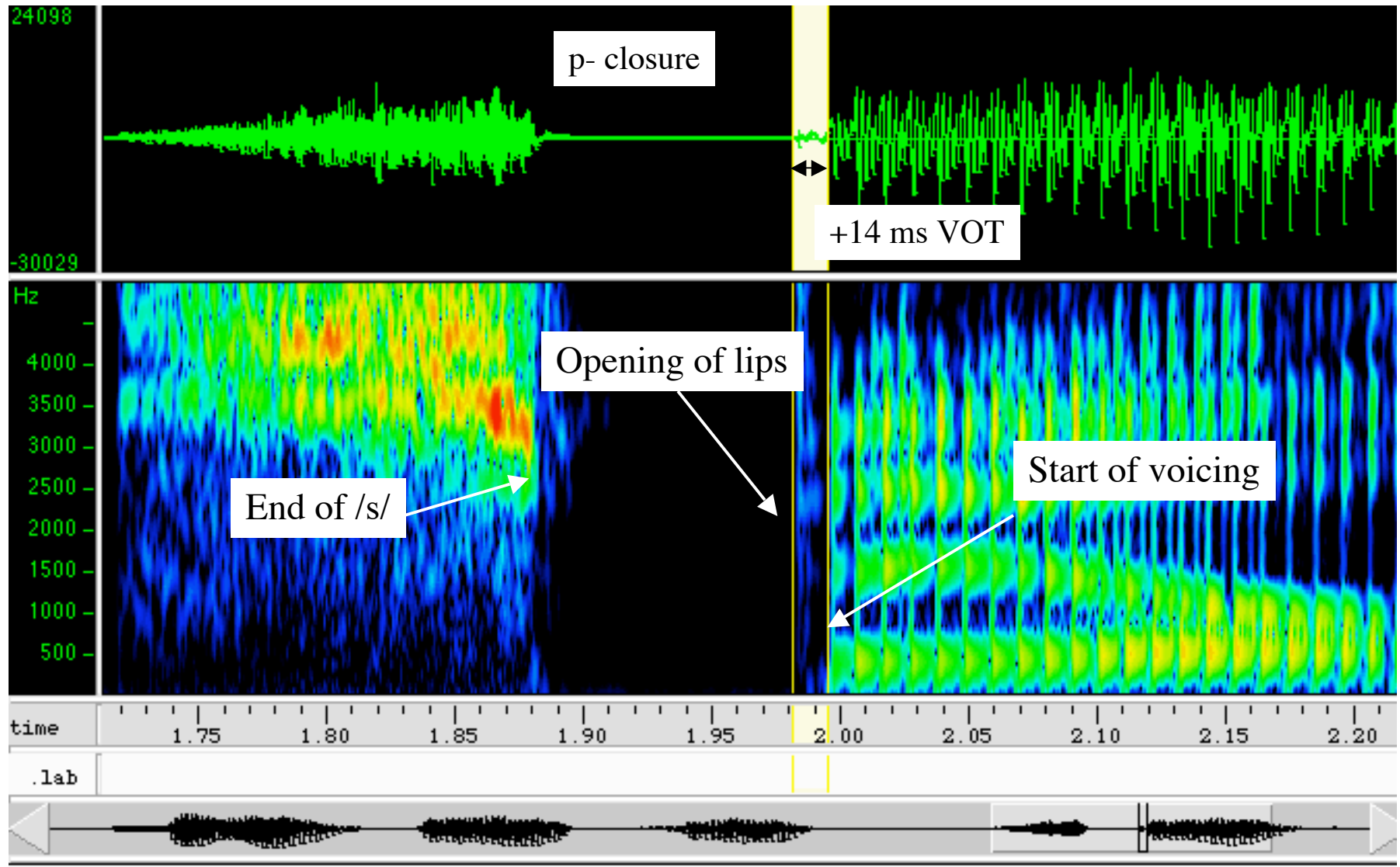


‘spill’ unaspirated (short lag) zoom-in (unlabeled)



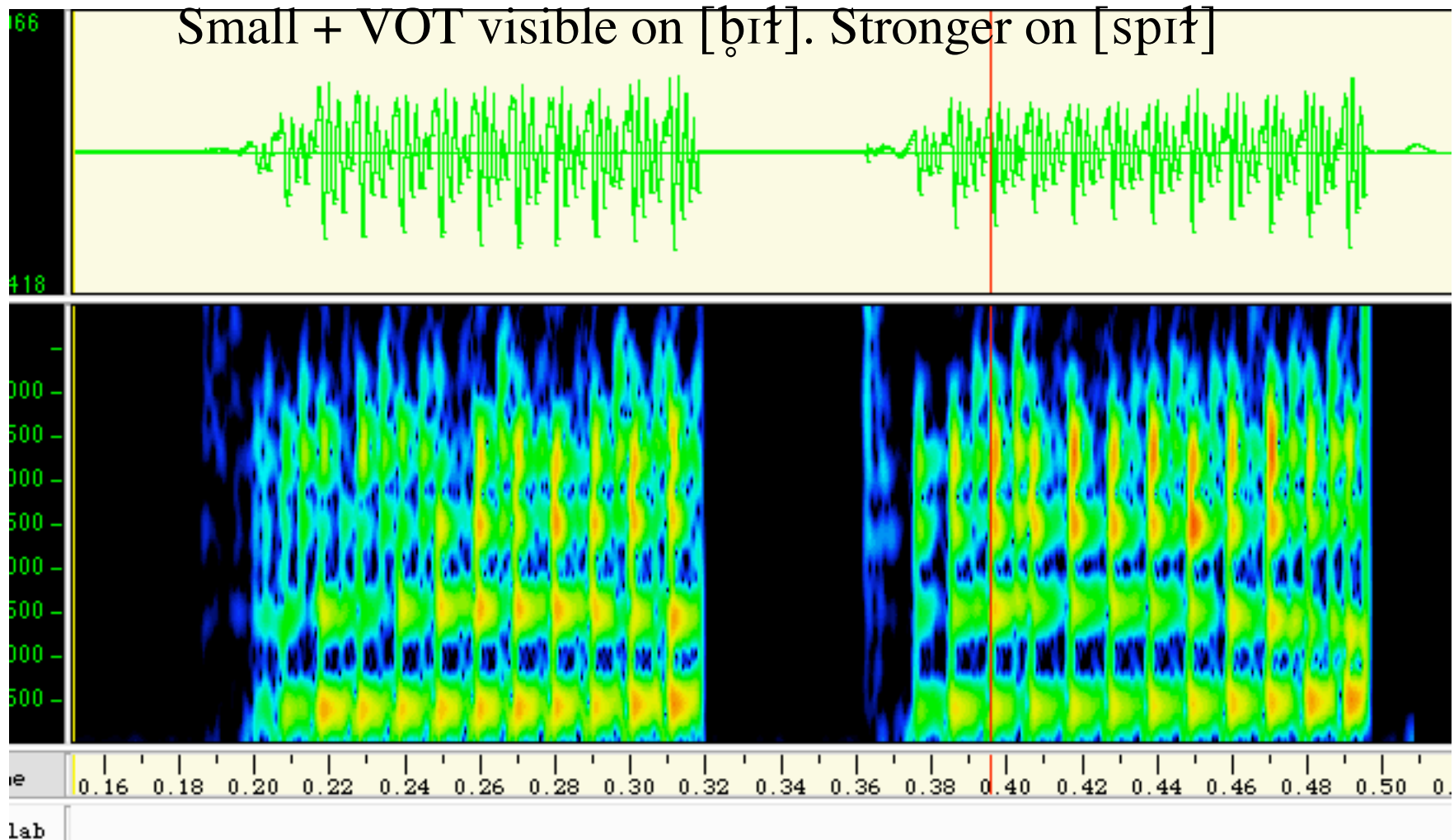
Waveform - from 01.981 to 01.995 length 00.014, 01.995 [3396 1906]

'spill' unaspirated (short lag) zoom-in



Waveform - from 01.981 to 01.995 length 00.014, 01.995 [3396 1906]

Snippets from bilabial stop opening from [bɪt̚] and [spɪt̚]



Demo... splice s off of spill and hear
?????

Sounds other than vowels stops and fricatives

- Affricates like combo of stop + fricative
- Sonorant sounds are somewhat vowel like
 - Glides and liquids show properties similar to vowels or the ‘moving parts’ of diphthongs
 - Weak voiced fricatives [v, ð] can be similar
 - Nasals show weaker energy in formants above F1
 - We will study some of these properties more later in the class