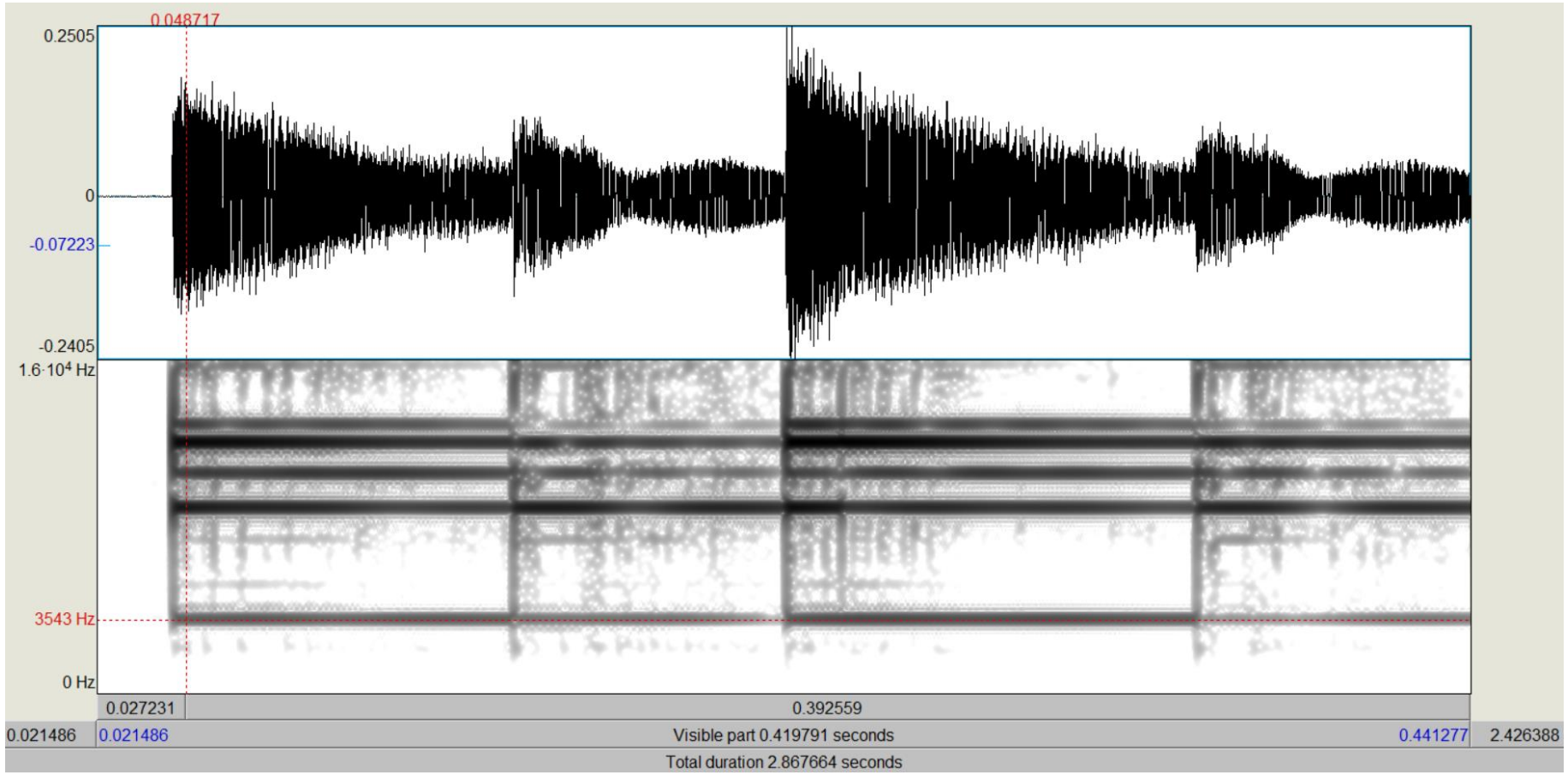
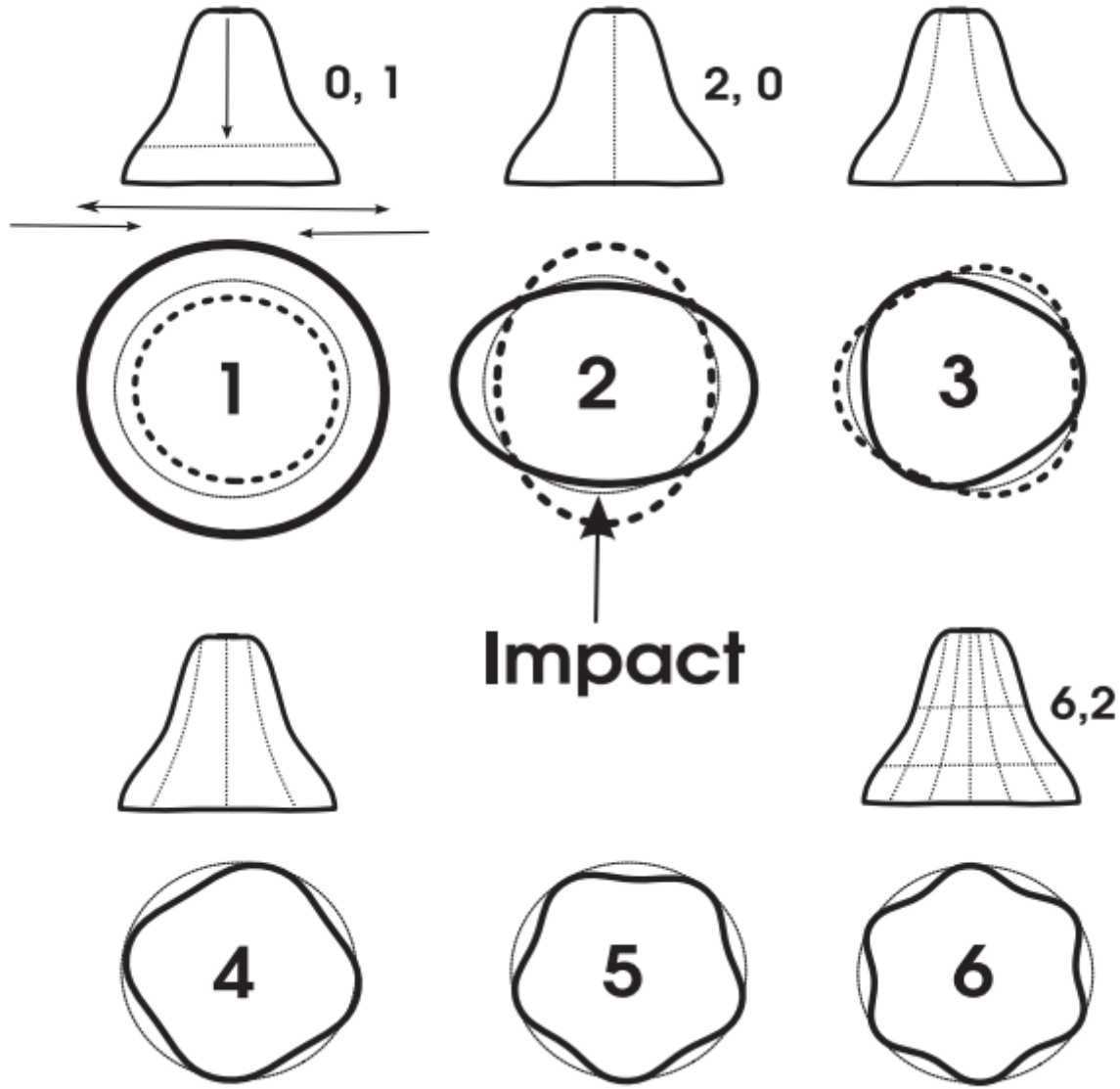
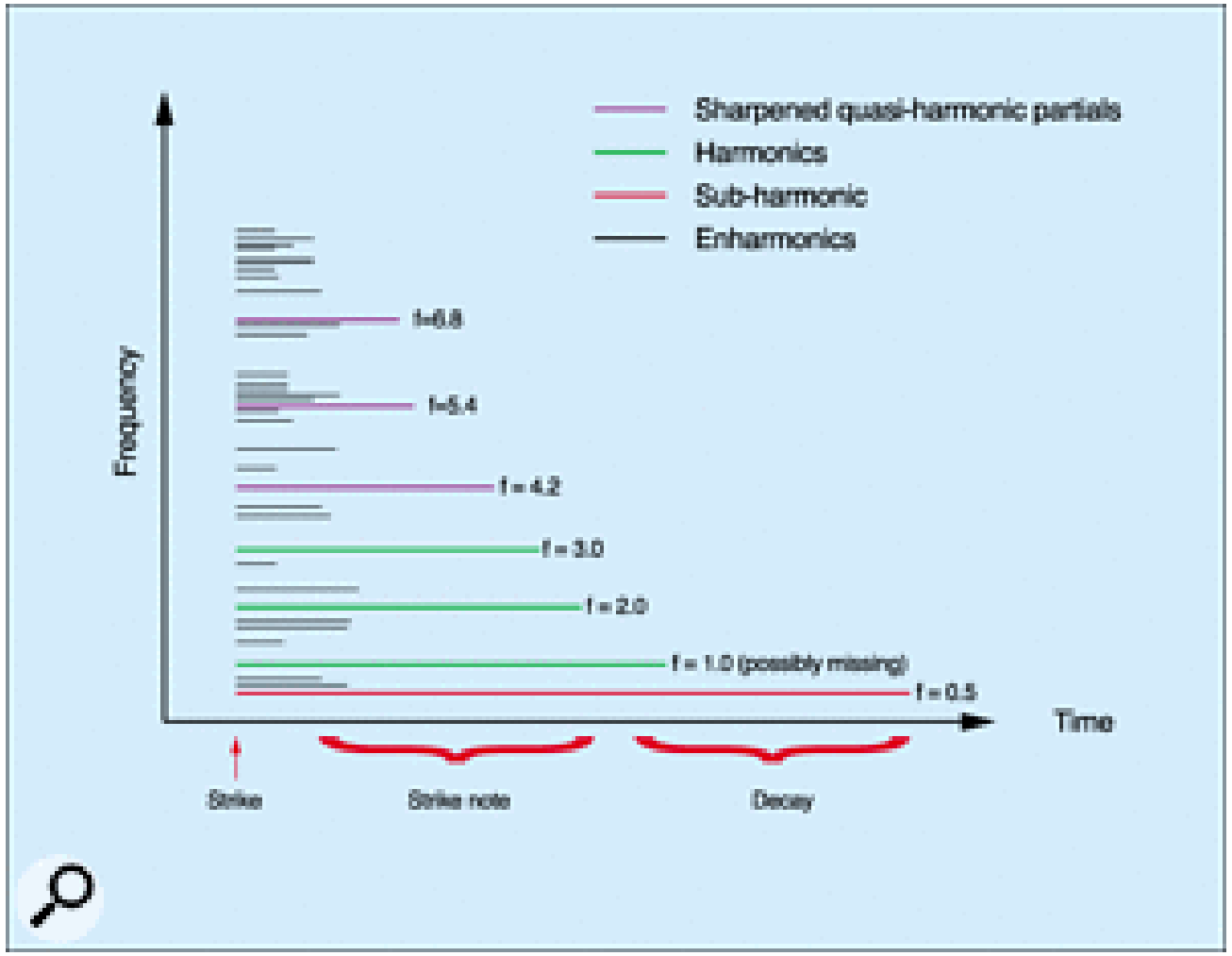
Analysis of the bell

Prasad Kamath

High-frequency energy from the initial hit decays away the fastest because there are no corresponding resonant modes; so, the bell sound starts out bright, with lots of frequencies, and these quickly shift into a handful of primary and secondary modes. As time goes by all the energy becomes heat, the bell stops vibrating at audible frequencies and amplitudes, and the sound dies away




0, 1
2, 0
1
2
3
Impact
6,2
4
5
6

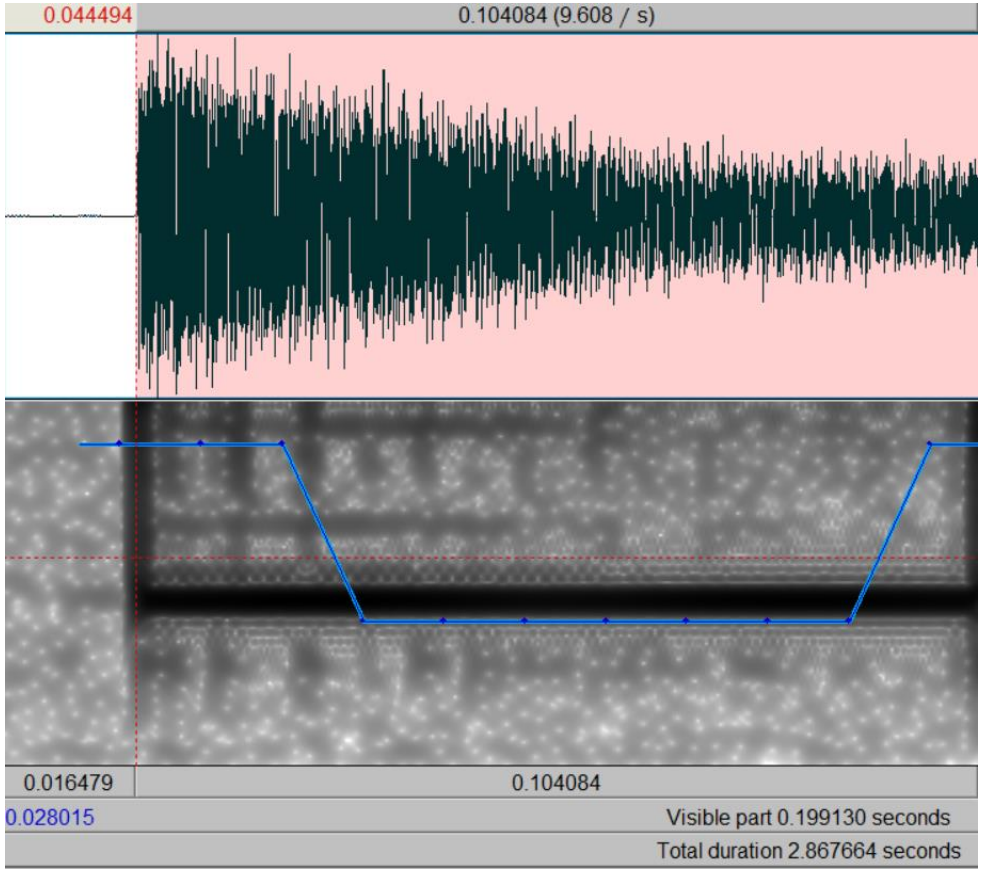

Sharpened quasi-harmonic partials
Harmonics
Sub-harmonic
Enharmonics
Frequency
f=6.8
f=5.4
f = 4.2
f = 3.0
f = 2.0
f = 1.0 (possibly missing)
f = 0.5
Time
Strike
Strike note
Decay

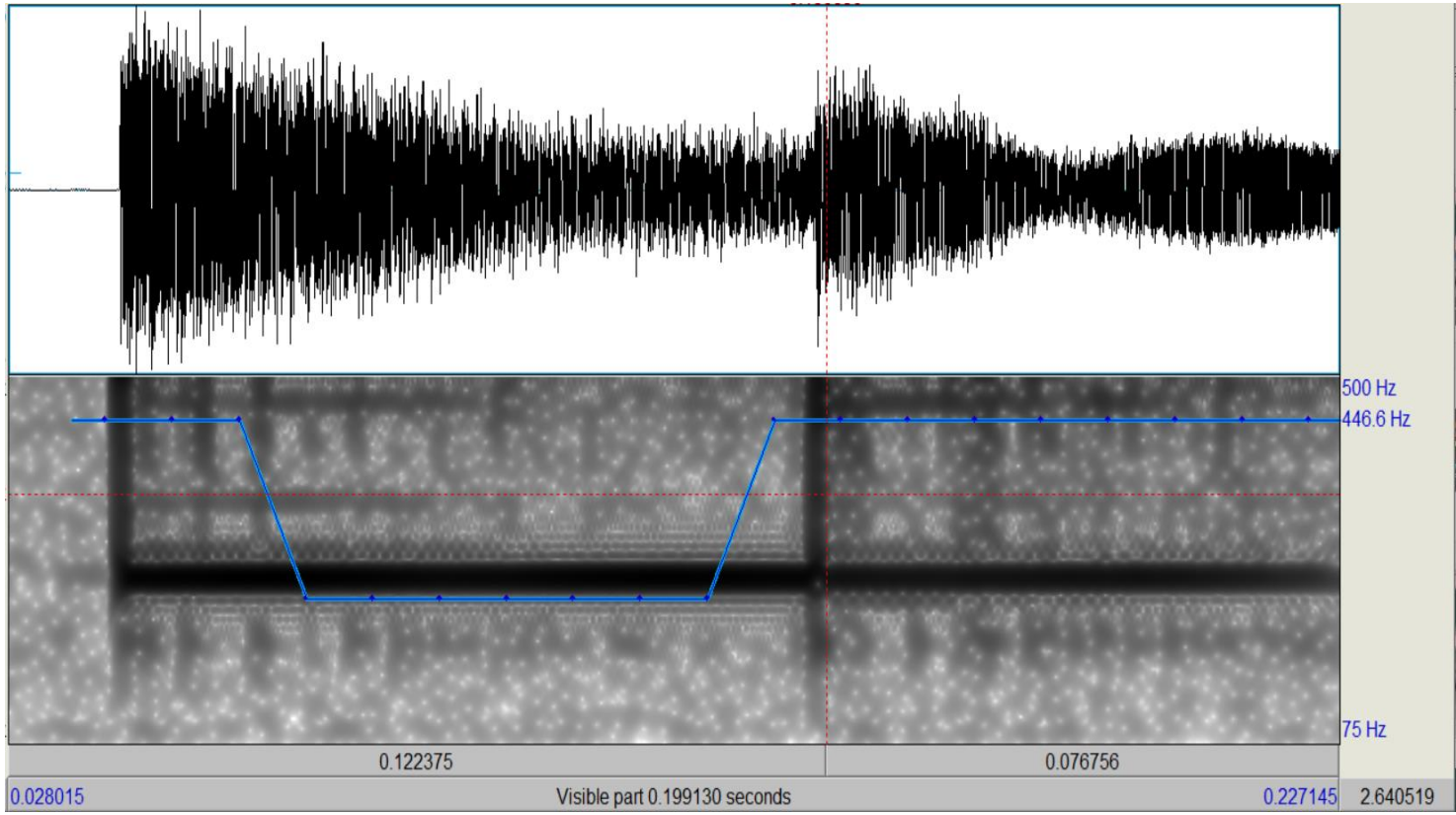
METHOD

- clapper impact causes initial high frequency harmonics- can be approximated by burst of noise (30ms)
- Then the modes will settle to 12-15 harmonics, estimate these using Sigmund peak finding or visual inspection of spectrum
- Group harmonics as per their attack and decay characteristics, we see groups that rise and decay togther
- Estimate the attack and decay times
- Model the two clapper strikes individually as two segments
- Repeat the segments using a metro block

onset	duration	Partial	Magnitude
0	120	3593	28.5
0	120	8952	40
0	120	10600	28.9
0	120	11649	8
0	120	12065	42
0	120	12913	26
0	70	15743	11.1
0	70	16725	6.3
0	70	17657	13.6
0	70	18322	3.4
0	70	19288	21.8
0	70	20120	9.5
0	70	21252	10.5

onset	duration(ms)	Partial	Magnitude
0.123	23	3593	28.5
0.123	23	8952	40
0.123	23	10600	28.9
0.123	23	11649	8
0.123	23	12065	42
0.123	23	12913	26
0.123	23	15743	11.1
0.123	23	16725	6.3
0.123	23	17657	13.6
0.123	23	18322	3.4
0.123	23	19288	21.8
0.123	23	20120	9.5
0.123	23	21252	10.5



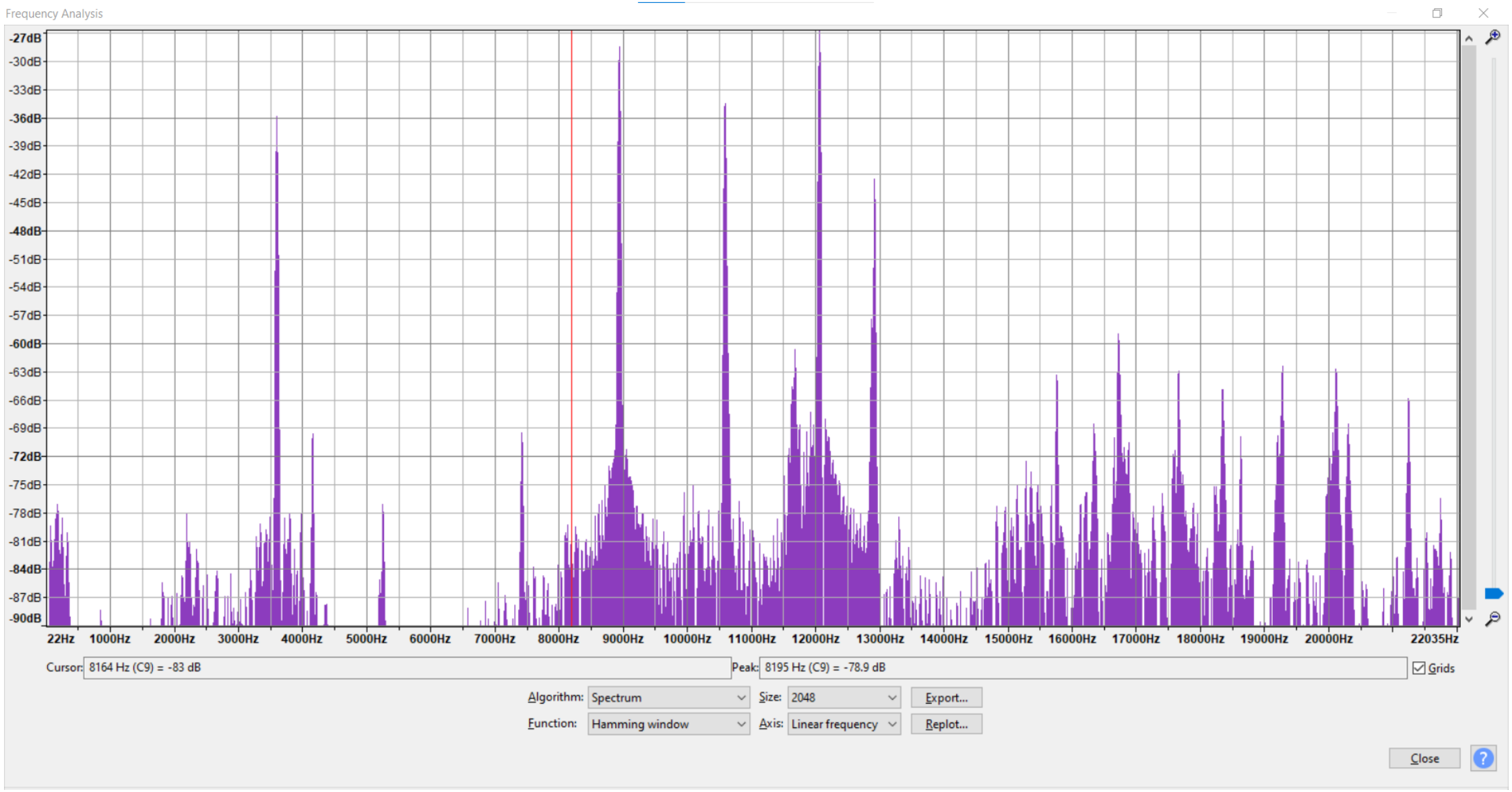


Estimated decay time for first strike – 0.1+ s
Estimated attack time= 0.0031s

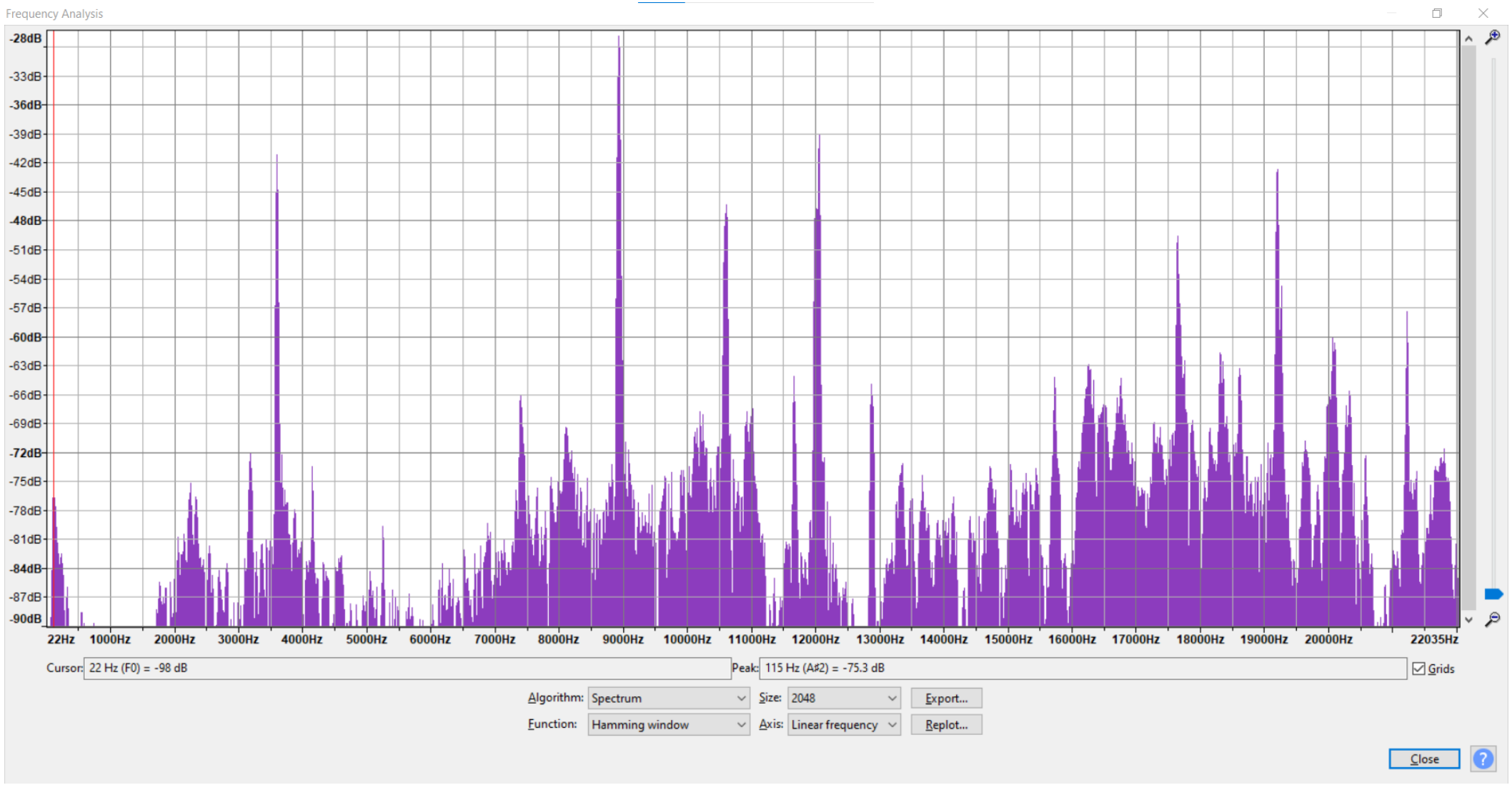
Estimated decay time for second strike – 0.03789+ s
Estimated attack time= 0.0031s

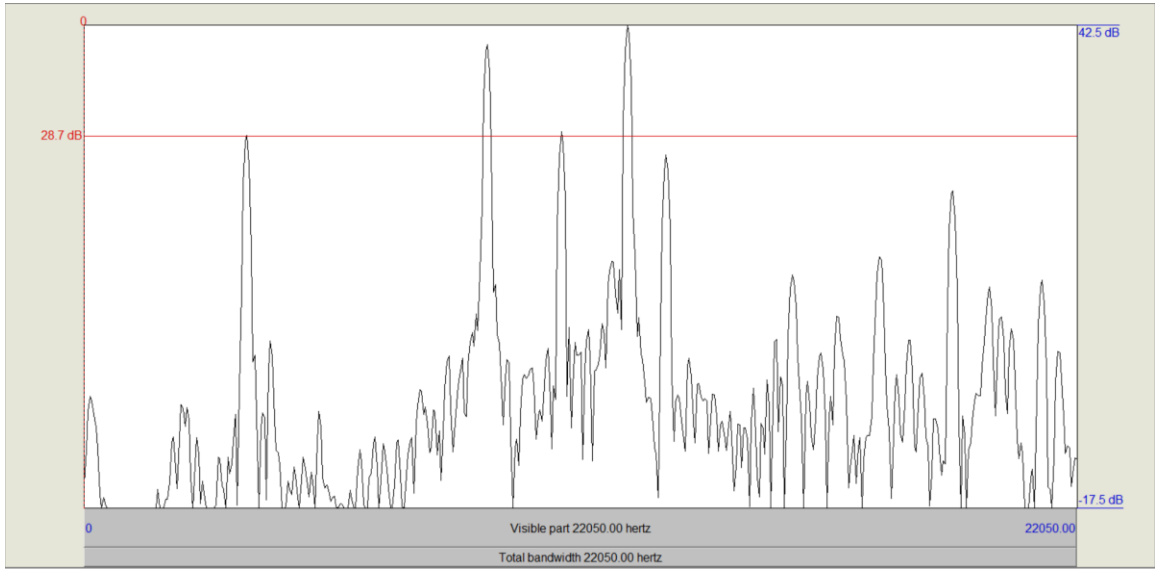
Followed by a tail of 0.04s

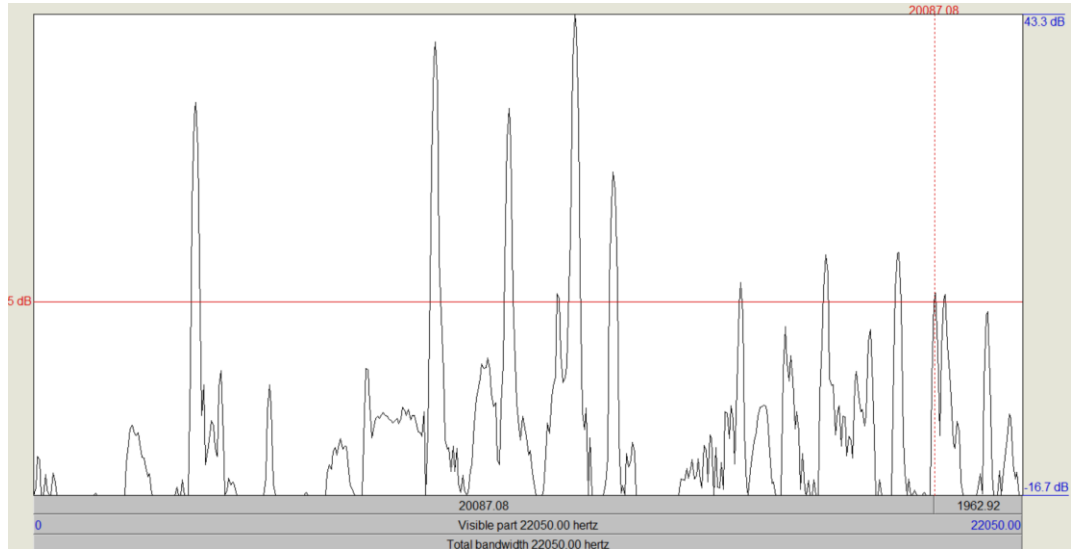
section1

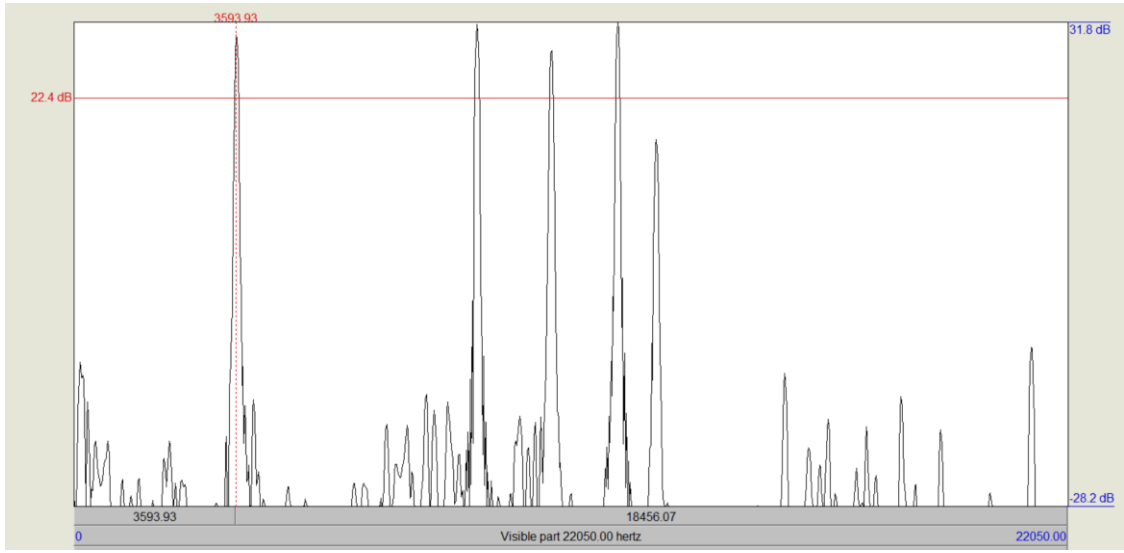

Frequency Analysis
-27dB
-30dB
-33dB
-36dB
-39dB
-42dB
-45dB
-48dB
-51dB
-54dB
-57dB
-60dB
-63dB
-66dB
-69dB
-72dB
-75dB
-78dB
-81dB
-84dB
-87dB
-90dB
22Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
22035Hz
Cursor: 8164 Hz (C9) = -83 dB
Peak: 8195 Hz (C9) = -78.9 dB
Grids
Algorithm: Spectrum
Size: 2048
Export...
Function: Hamming window
Axis: Linear frequency
Replot...
Close

section2


Frequency Analysis
-28dB
-33dB
-36dB
-39dB
-42dB
-45dB
-48dB
-51dB
-54dB
-57dB
-60dB
-63dB
-66dB
-69dB
-72dB
-75dB
-78dB
-81dB
-84dB
-87dB
-90dB
22Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
22035Hz
Cursor: 22 Hz (F0) = -98 dB
Peak: 115 Hz (A♯2) = -75.3 dB
Grids
Algorithm: Spectrum
Size: 2048
Export...
Function: Hamming window
Axis: Linear frequency
Replot...
Close


0
42.5 dB
28.7 dB
-17.5 dB
0
Visible part 22050.00 hertz
22050.00
Total bandwidth 22050.00 hertz


20087.08
43.3 dB
5 dB
-16.7 dB
20087.08
1962.92
0
Visible part 22050.00 hertz
22050.00
Total bandwidth 22050.00 hertz


3593.93
31.8 dB
22.4 dB
-28.2 dB
3593.93
18456.07
0
Visible part 22050.00 hertz
22050.00


tinkle
Mute
Solo
L
R
Mono, 44100Hz
32-bit float
Select
1.0
0.5
0.0
-0.5
-1.0
tinkle
bell_trial3
Mute
Solo
L
R
Mono, 44100Hz
32-bit float
1.0
0.5
0.0
-0.5
bell_trial3