

8T2: Spectral-based sound transformations (2 of 2)

Xavier Serra

Universitat Pompeu Fabra, Barcelona

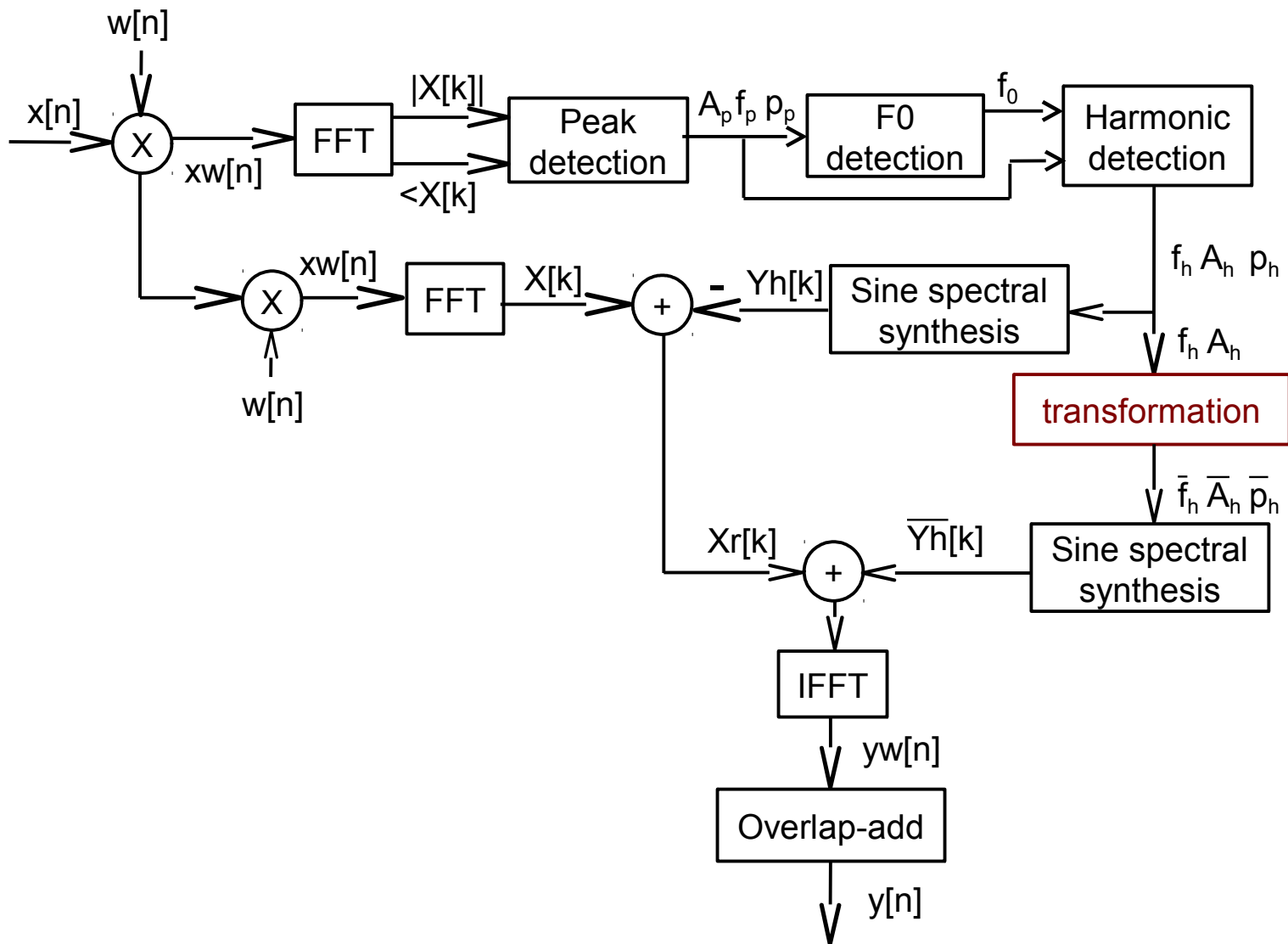
&

Stanford University

Index

- Harmonic plus residual model
 - Frequency transformations
- Harmonic plus stochastic model
 - Time scaling
 - Morphing

Harmonic plus residual model



Frequency transformations

frequency transposition: $\bar{f}_h[l] = sf[l] f_h[l]$

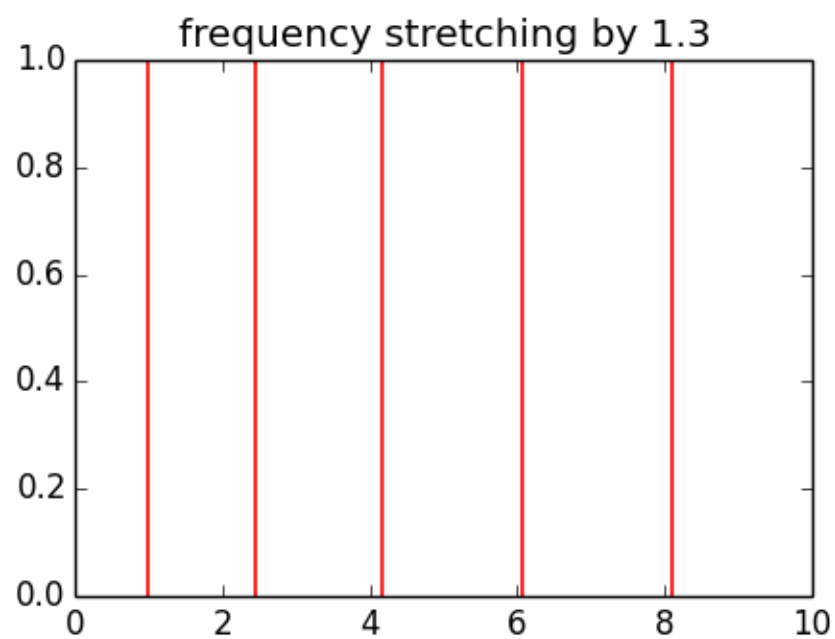
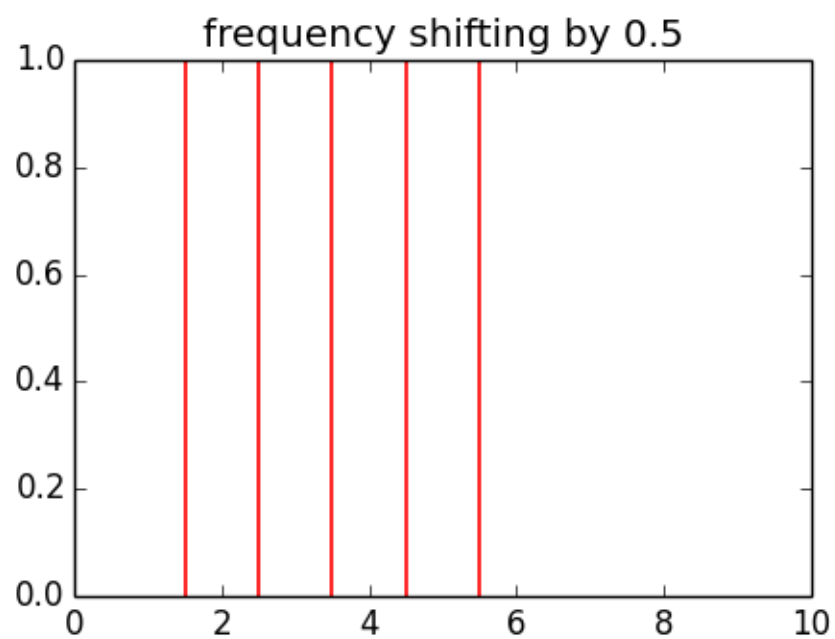
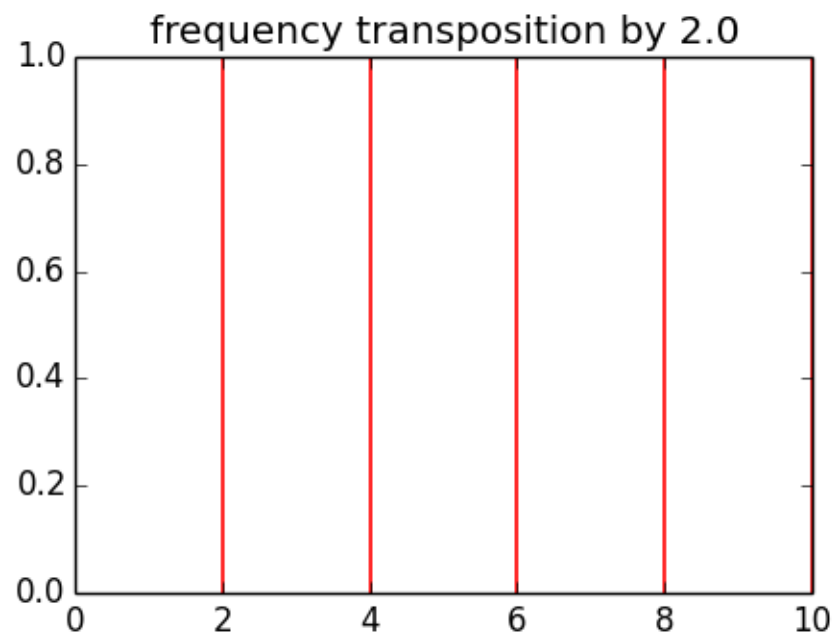
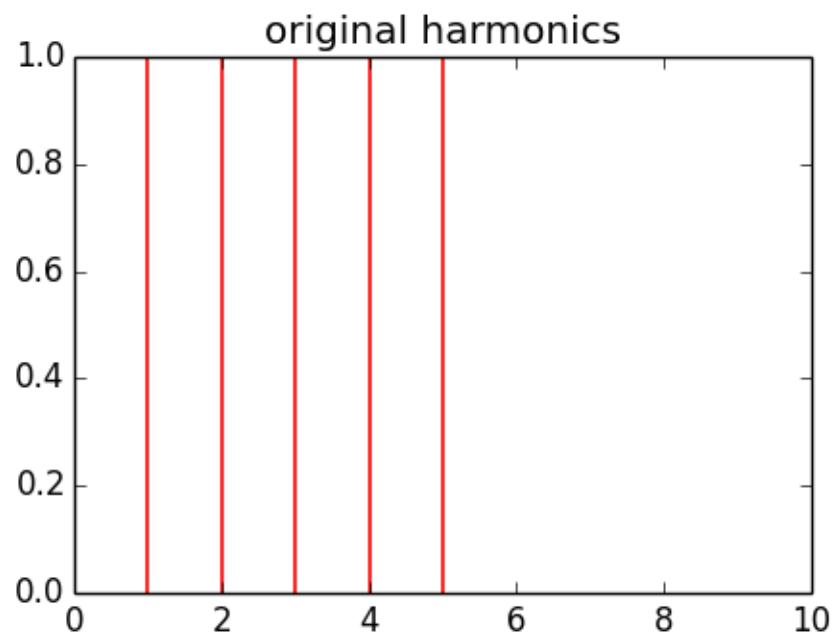
frequency shifting: $\bar{f}_h[l] = sf[l] + f_h[l]$

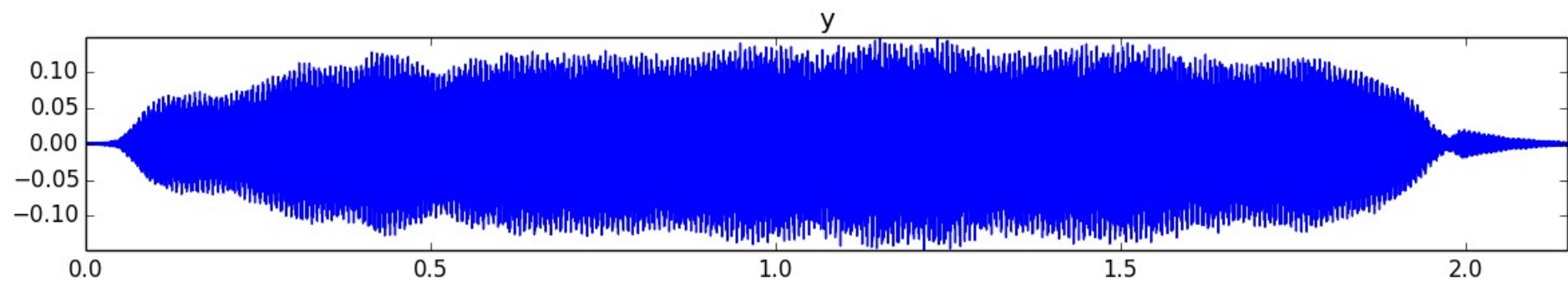
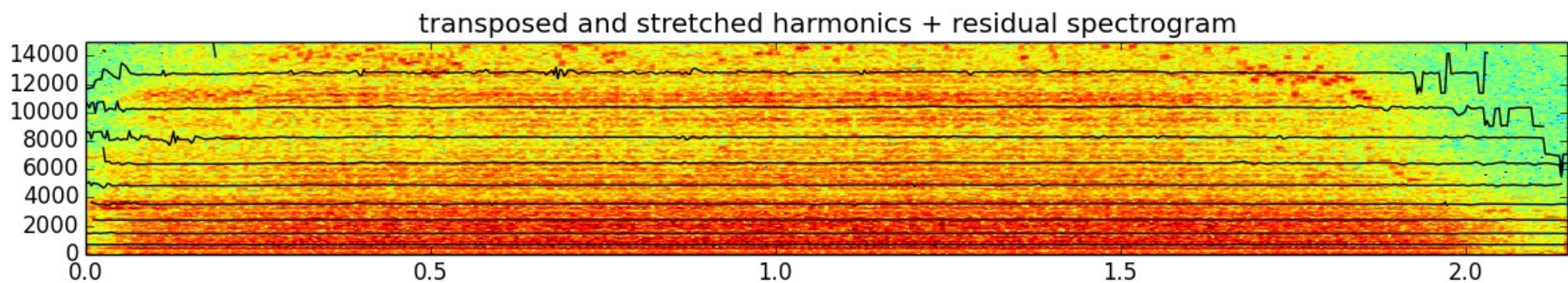
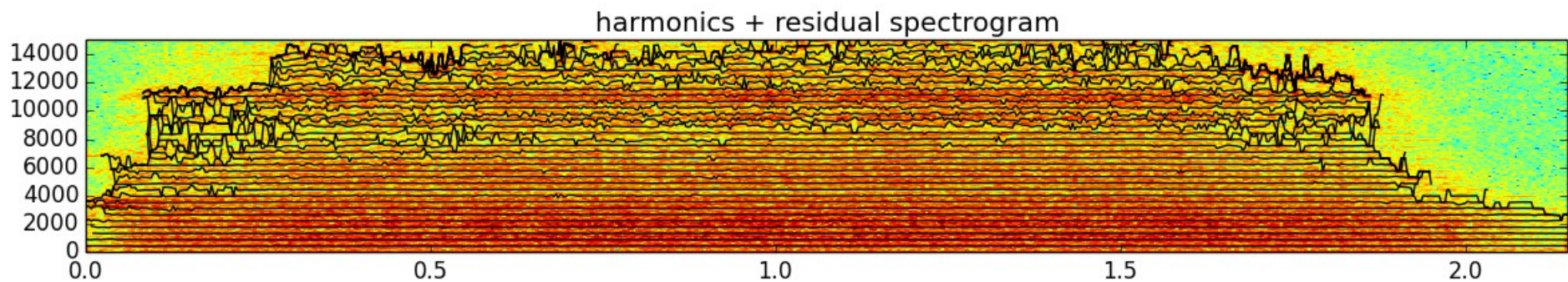
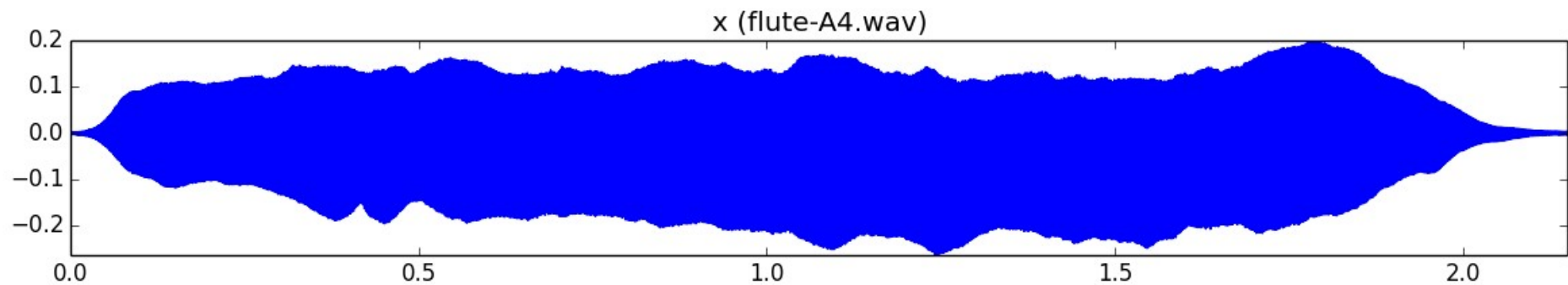
frequency stretching: $\bar{f}_h[l] = (f_h[l] / h) * h^{sf[l]}$

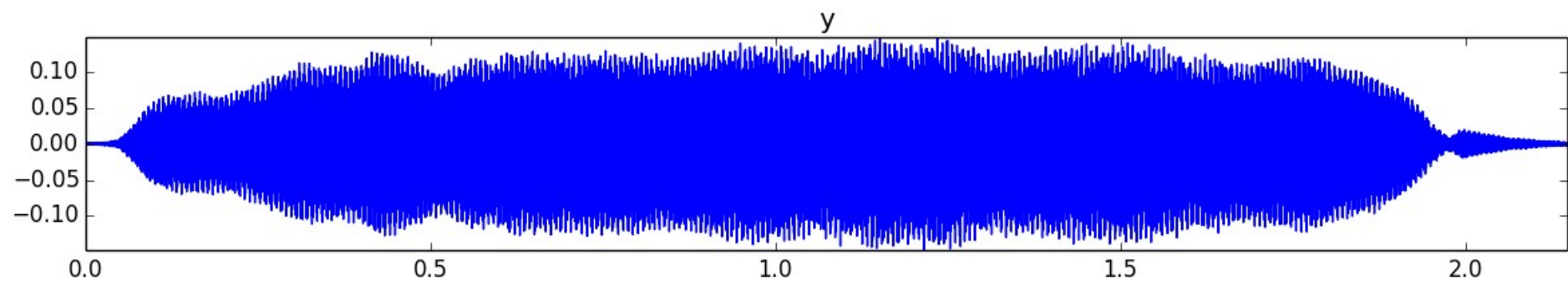
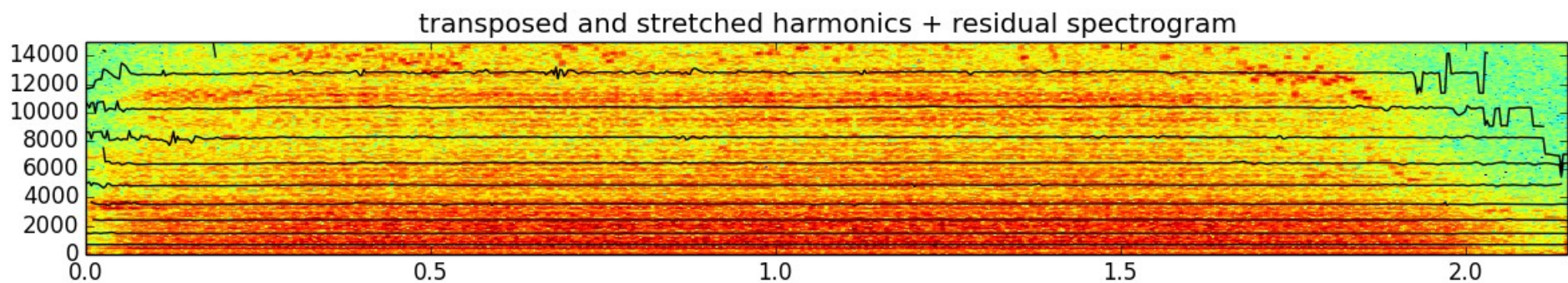
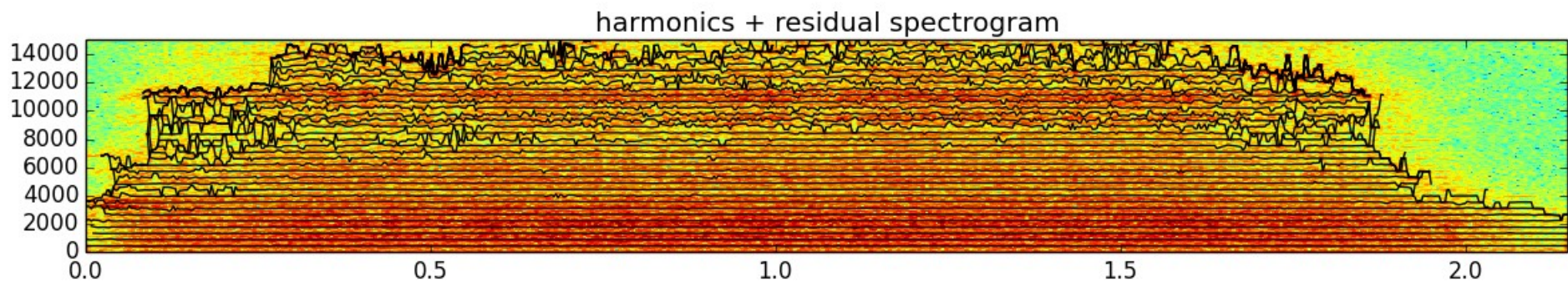
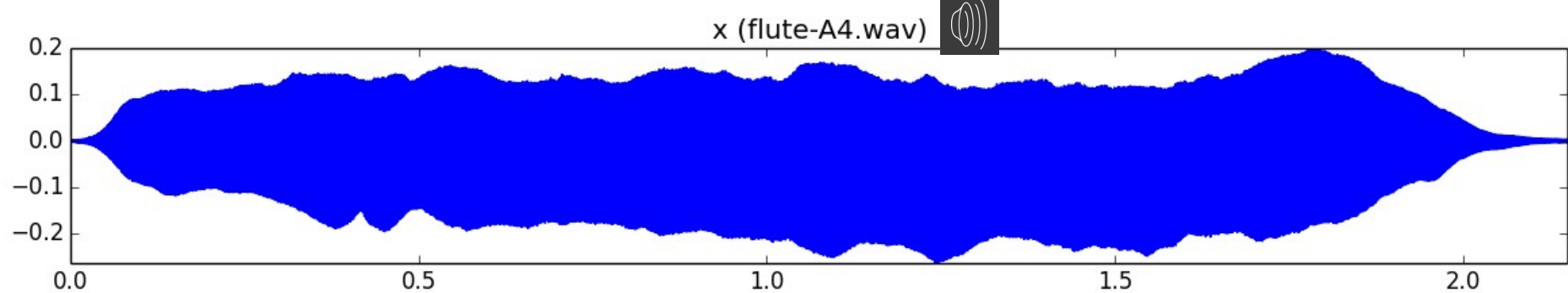
f_h : input frequency of harmonic h

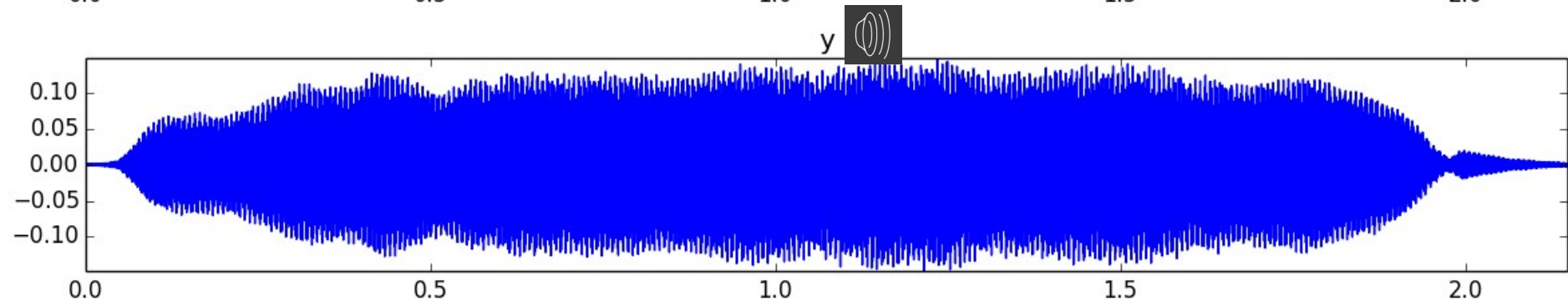
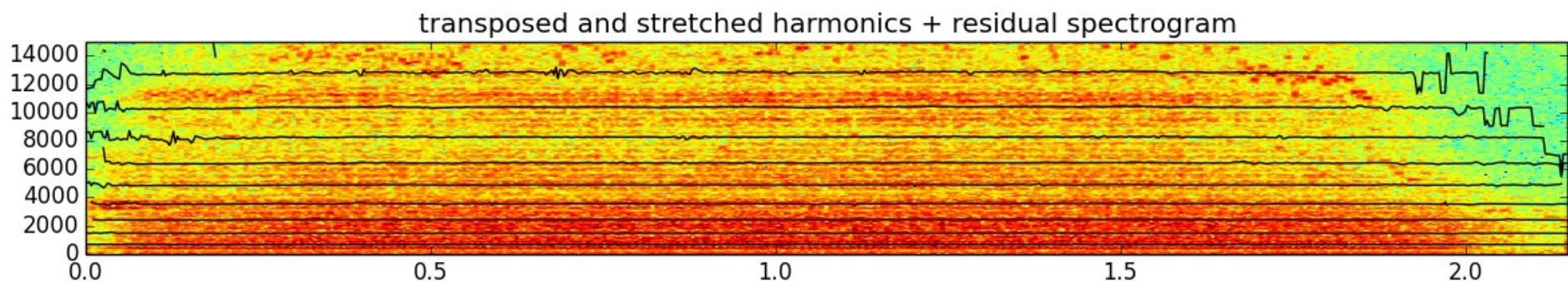
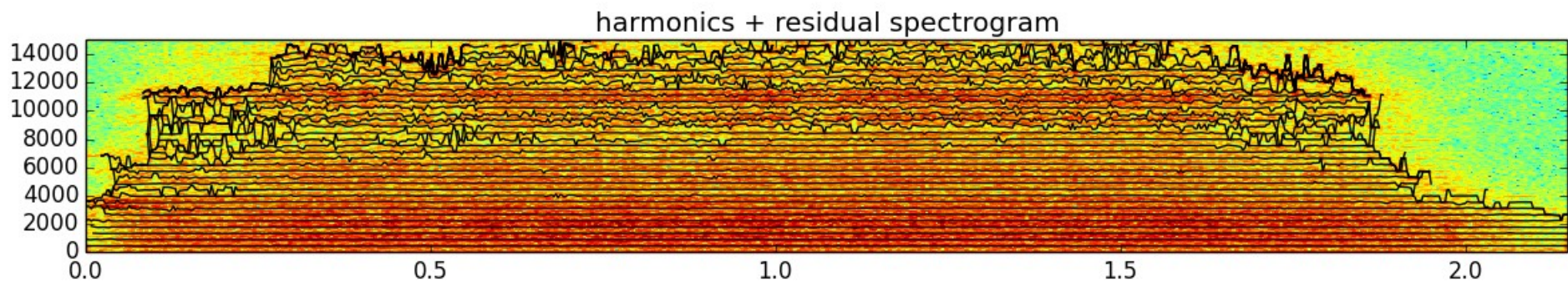
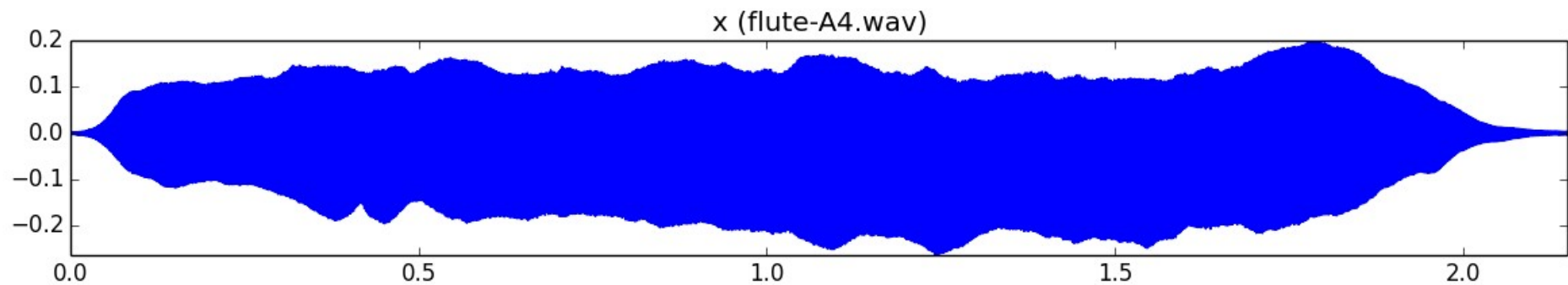
sf : scaling frequency

\bar{f}_h : output frequency of harmonic h

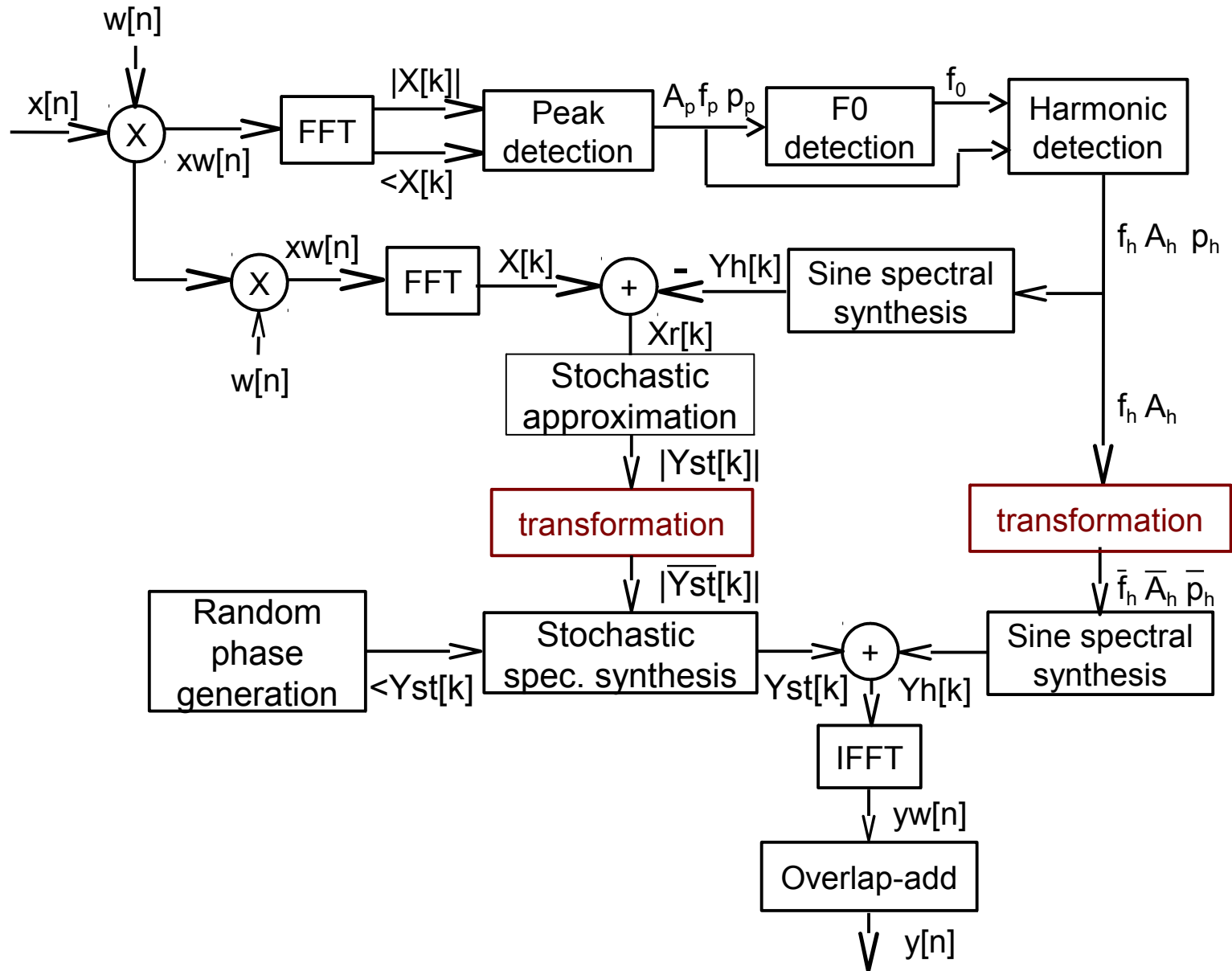








Harmonic plus stochastic model



Scaling amplitude, frequency and time

$$\bar{f}_h[q] = sf_h[l] f_t[st_h[l]l]$$

$$\bar{A}_h[q] = sA_h[l] + A_t[st_h[l]l]$$

$$\bar{\varphi}_h[q] = \varphi_h[q-1] + f_h[q]$$

$$\bar{st}_k[q] = sst_k[l] st_k[st_k[l]l]$$

q : output frame ; l : input frame ; h : harmonic

f : input frequency ; A : input amplitude ; st : input stochastic envelope

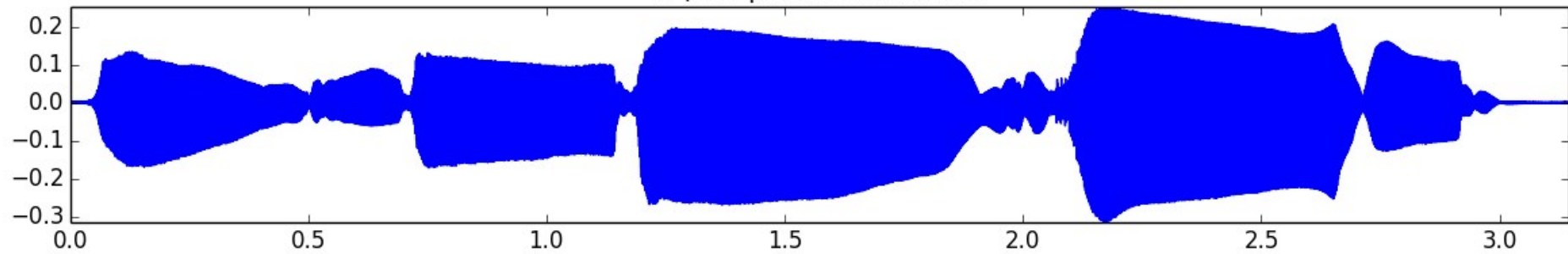
sf : scaling frequency ; sA : scaling amplitude ; st : scaling time ;

sst : scaling stochastic

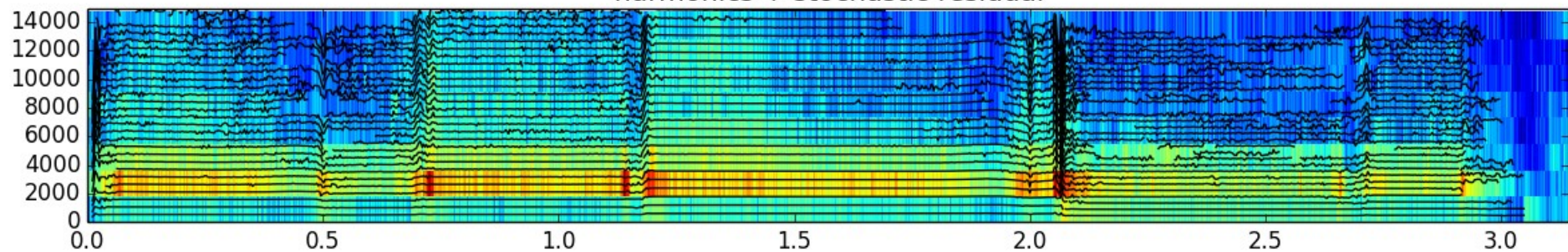
\bar{f} : output frequency ; \bar{A} : output amplitude ; $\bar{\varphi}$: output phase ;

\bar{st} : output stochastic

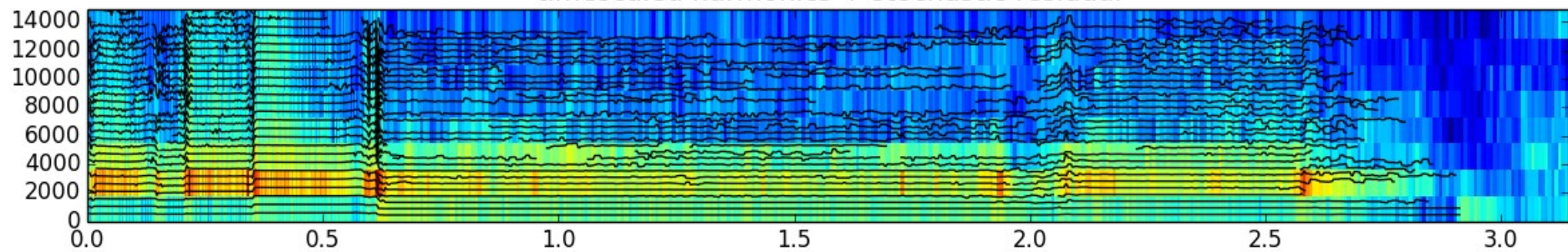
x (sax-phrase-short.wav)



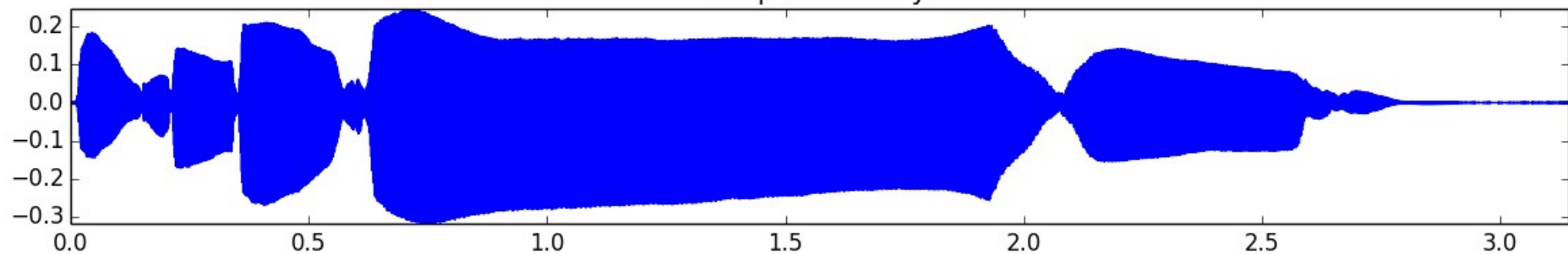
harmonics + stochastic residual



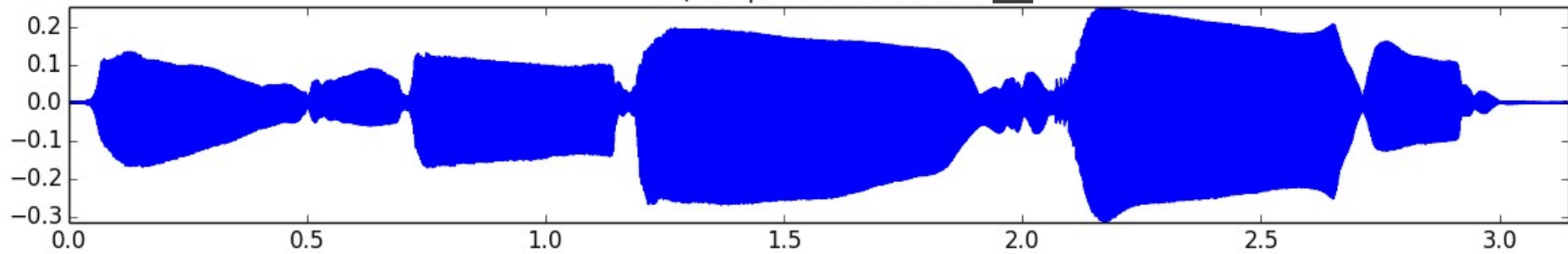
timescaled harmonics + stochastic residual



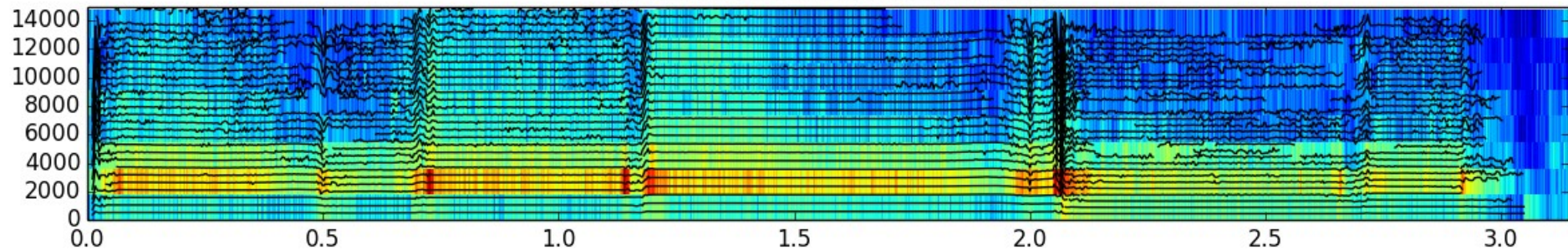
output sound: y



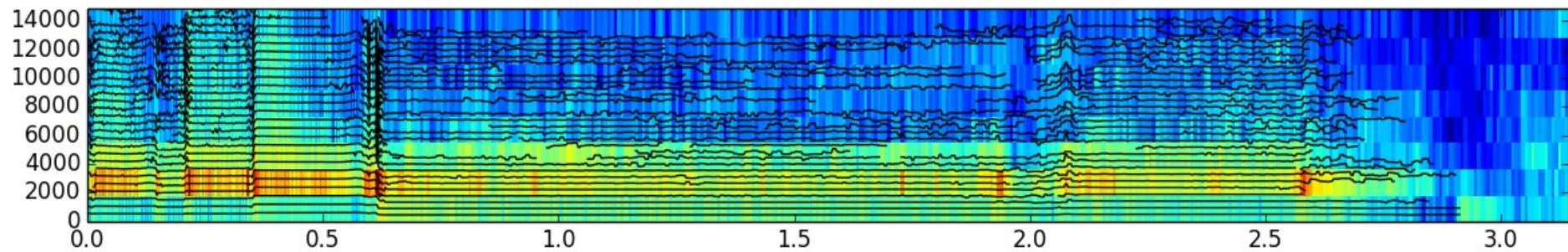
x (sax-phrase-short.wav)



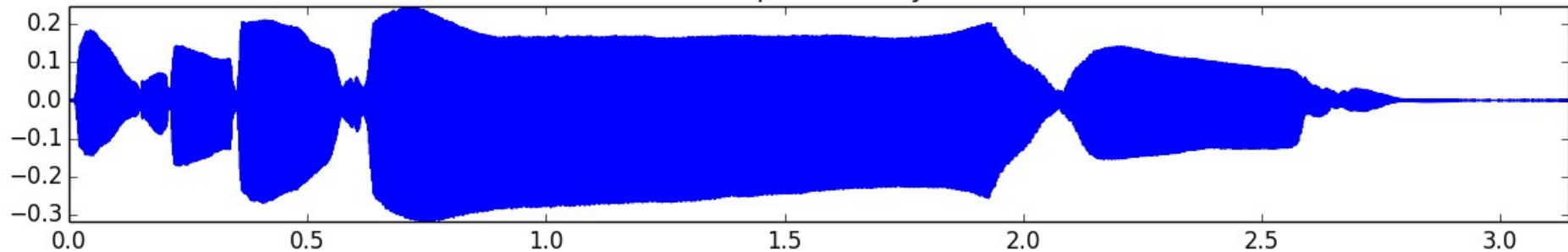
harmonics + stochastic residual



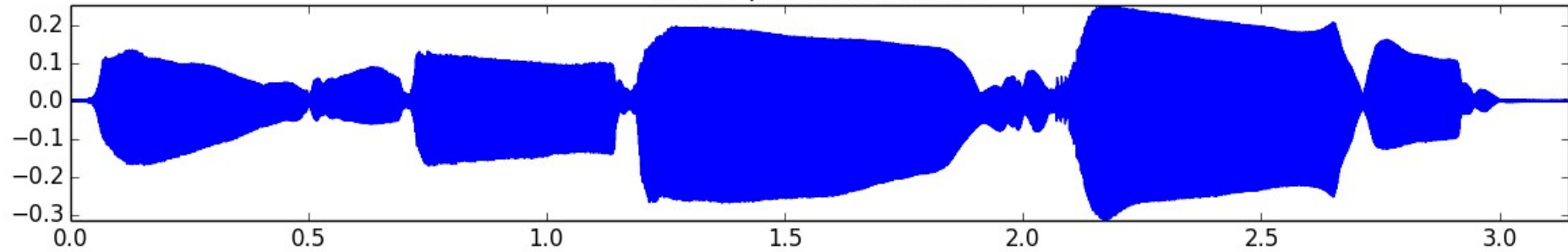
timescaled harmonics + stochastic residual



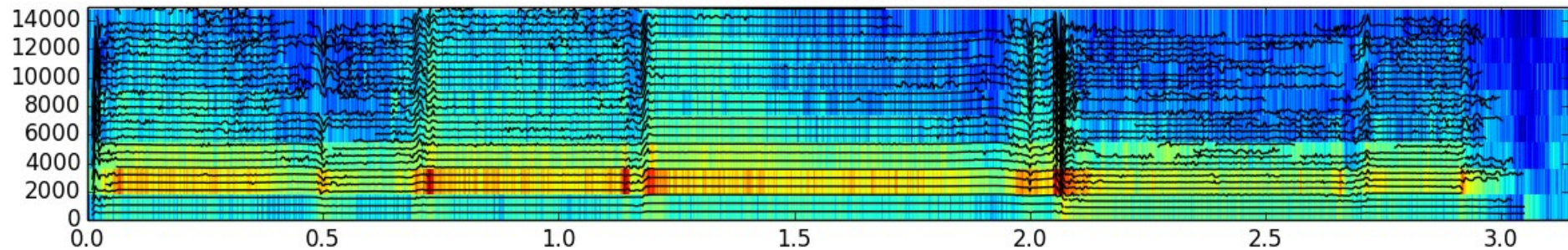
output sound: y



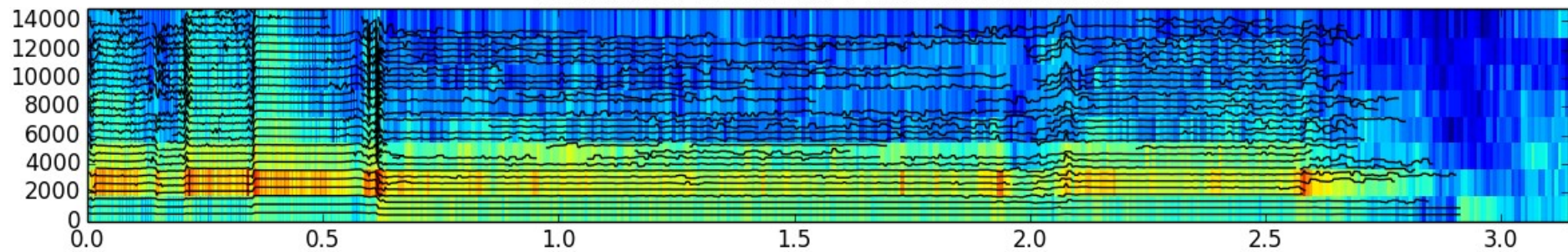
x (sax-phrase-short.wav)



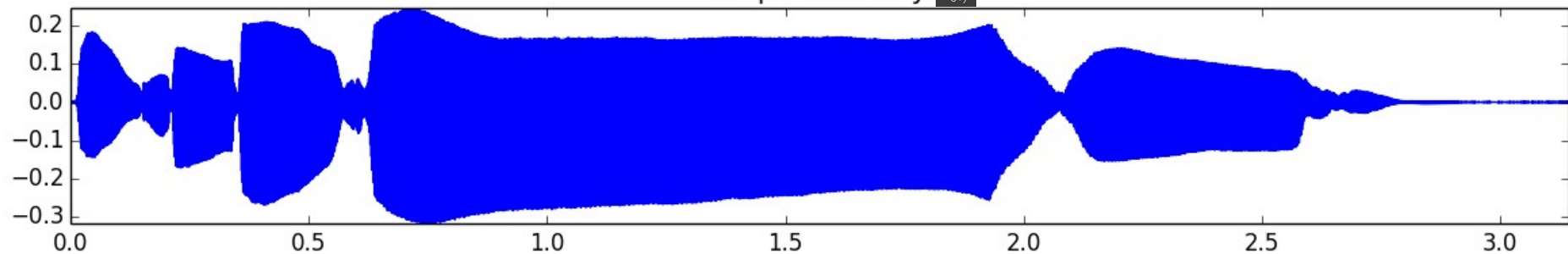
harmonics + stochastic residual



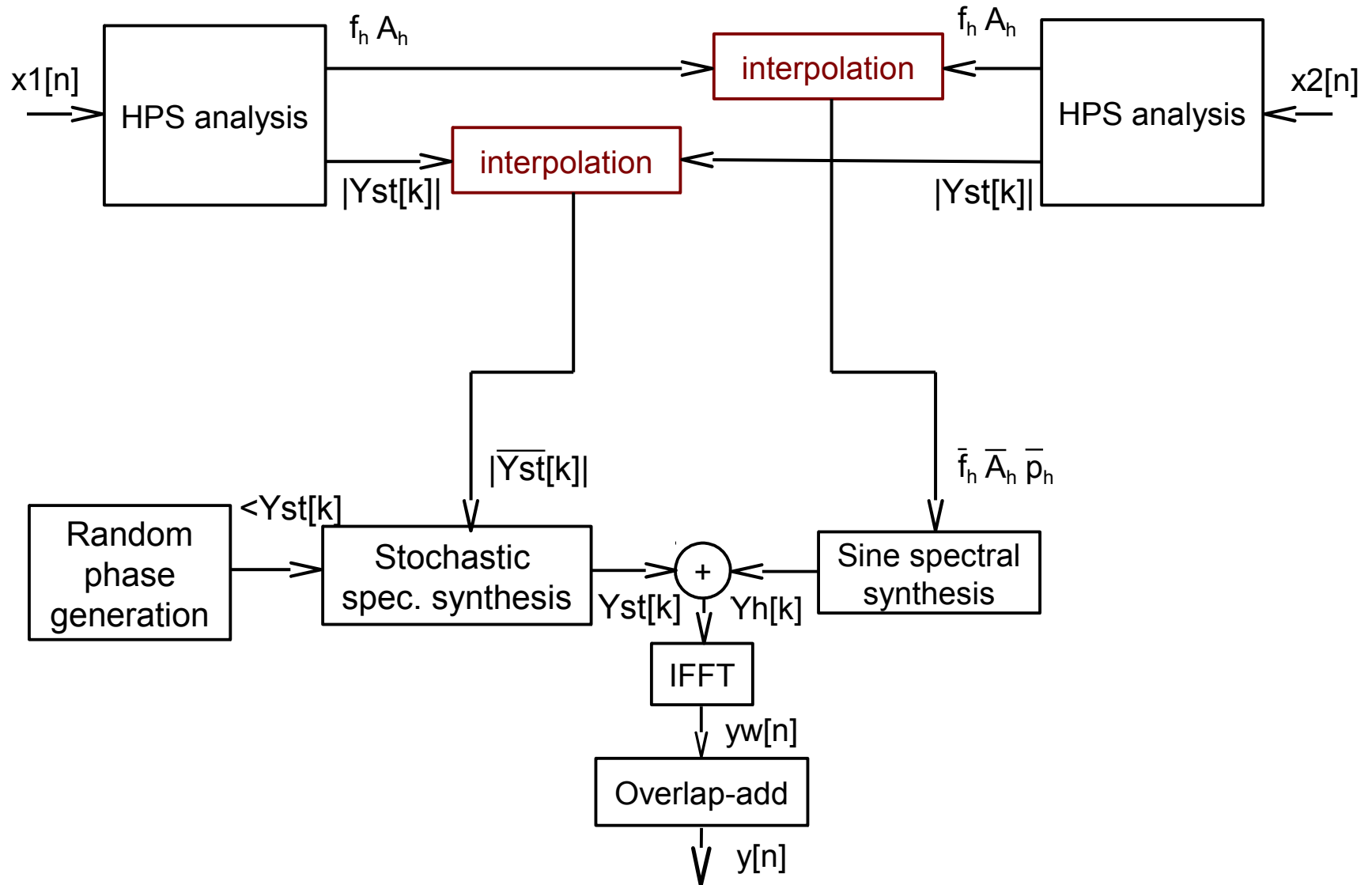
timescaled harmonics + stochastic residual



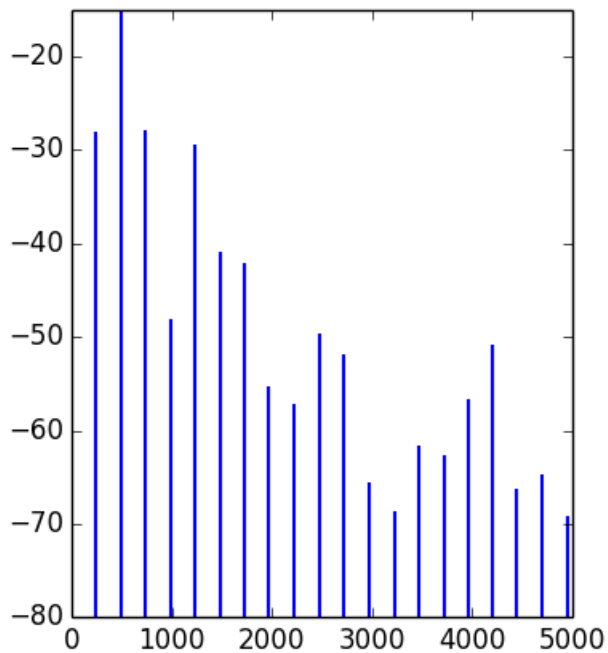
output sound: y



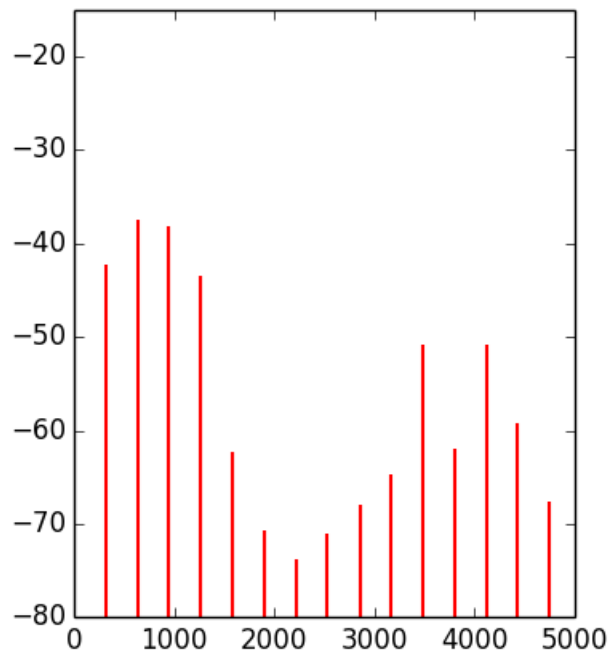
Morphing



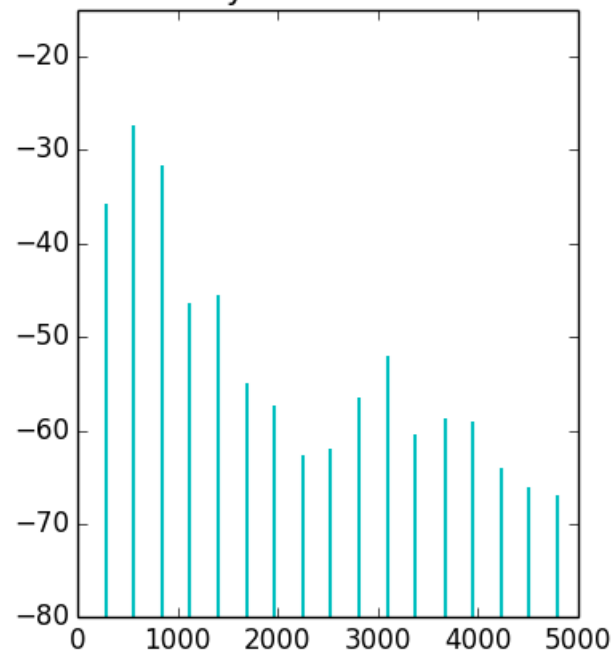
x1: harmonics



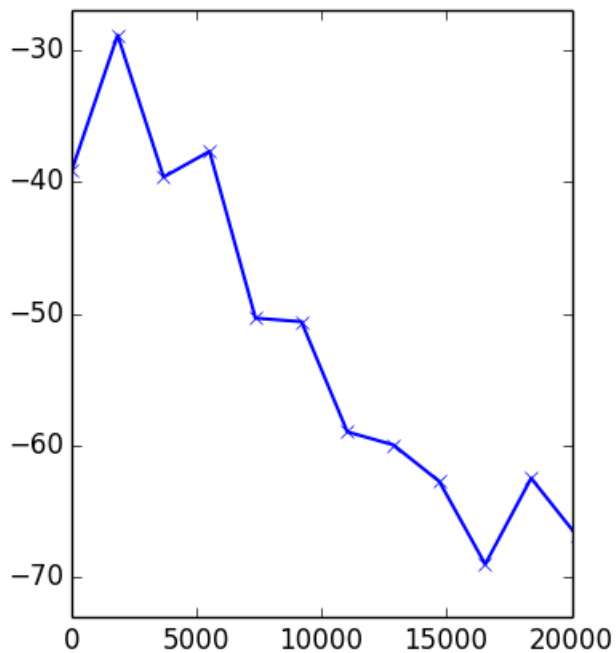
x2: harmonics



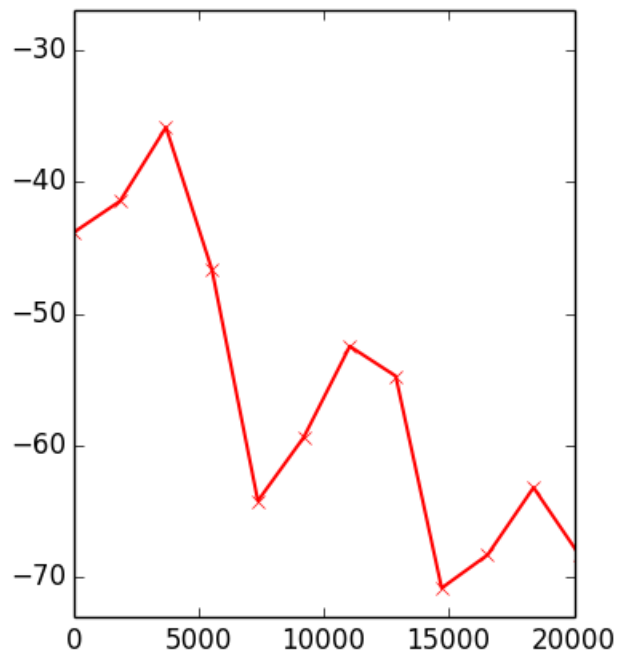
y: harmonics



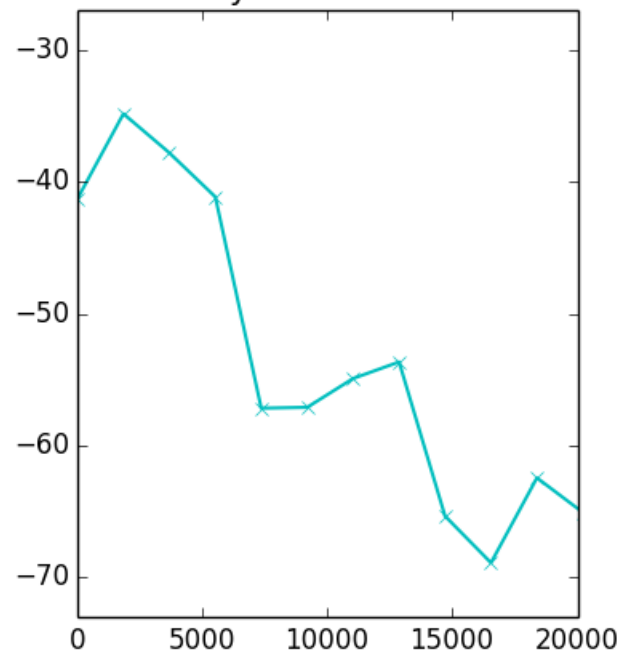
x1: stochastic



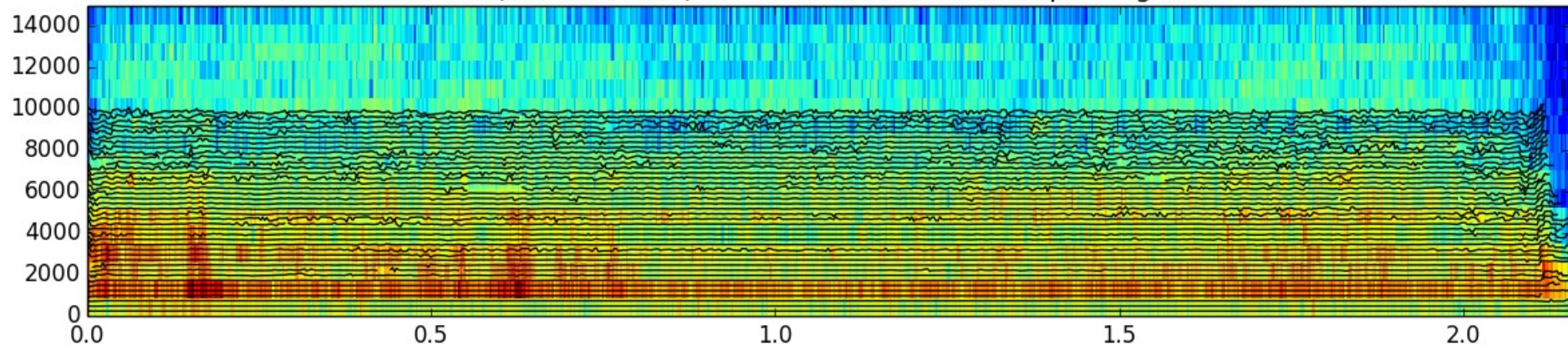
x2: stochastic



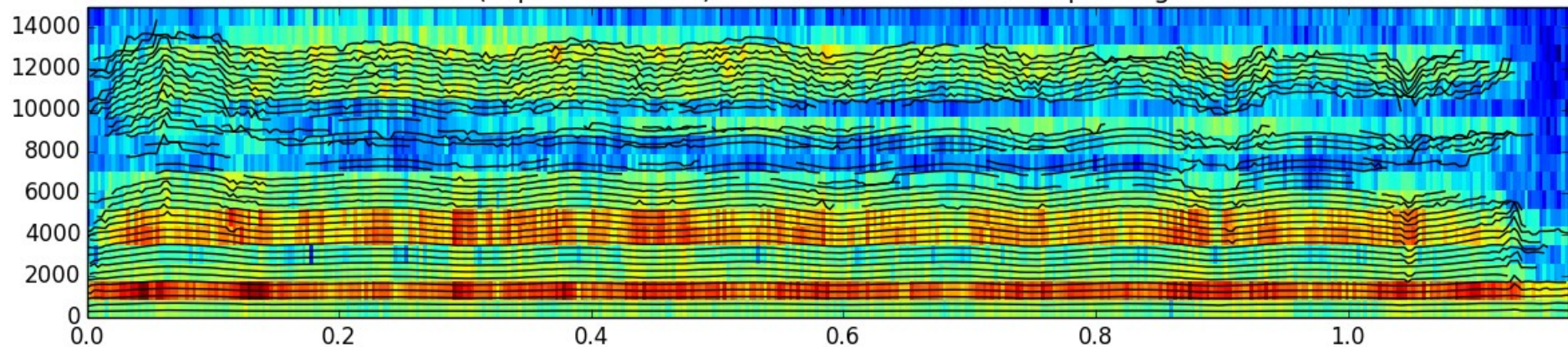
y: stochastic



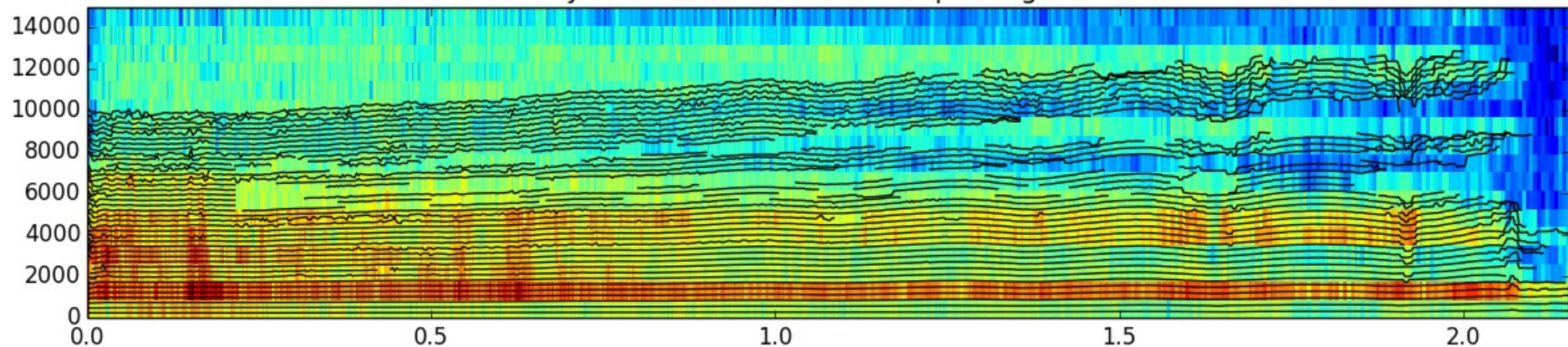
x1 (violin-B3.wav): harmonics + stochastic spectrogram



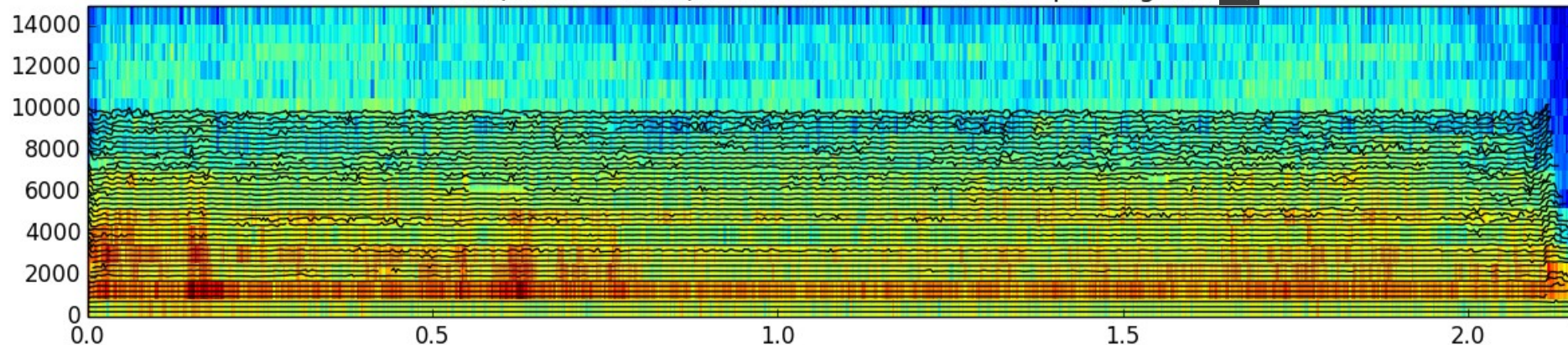
x2 (soprano-E4.wav): harmonics + stochastic spectrogram



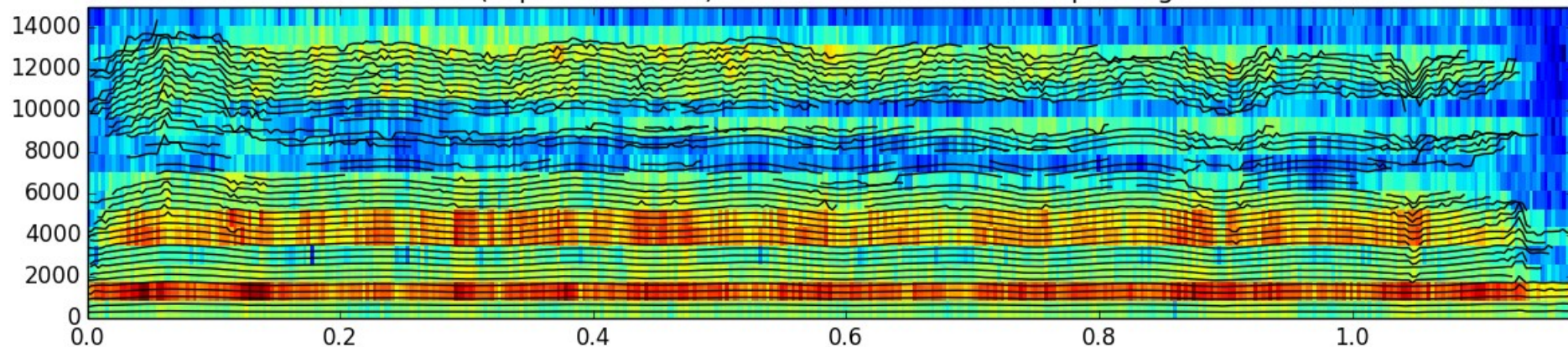
y: harmonics + stochastic spectrogram



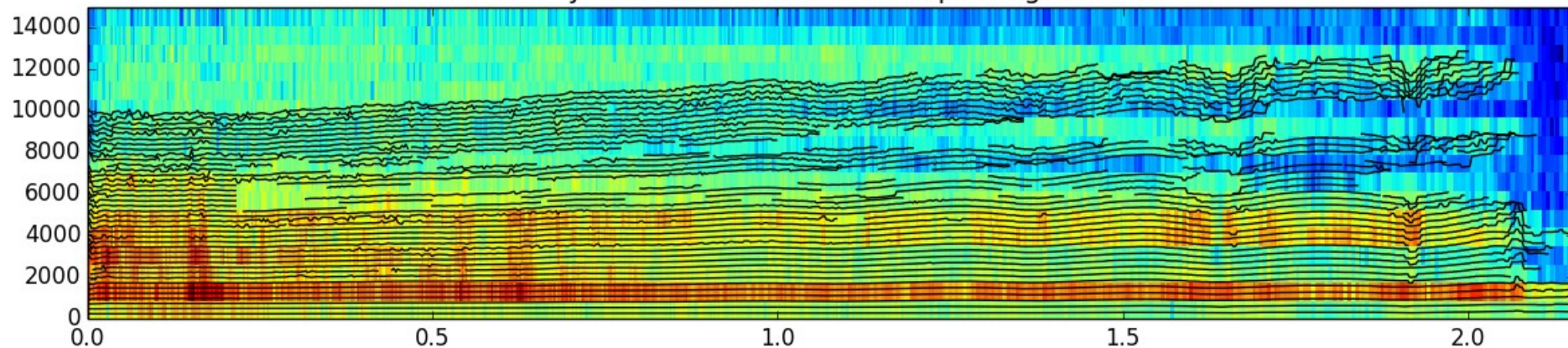
x1 (violin-B3.wav): harmonics + stochastic spectrogram



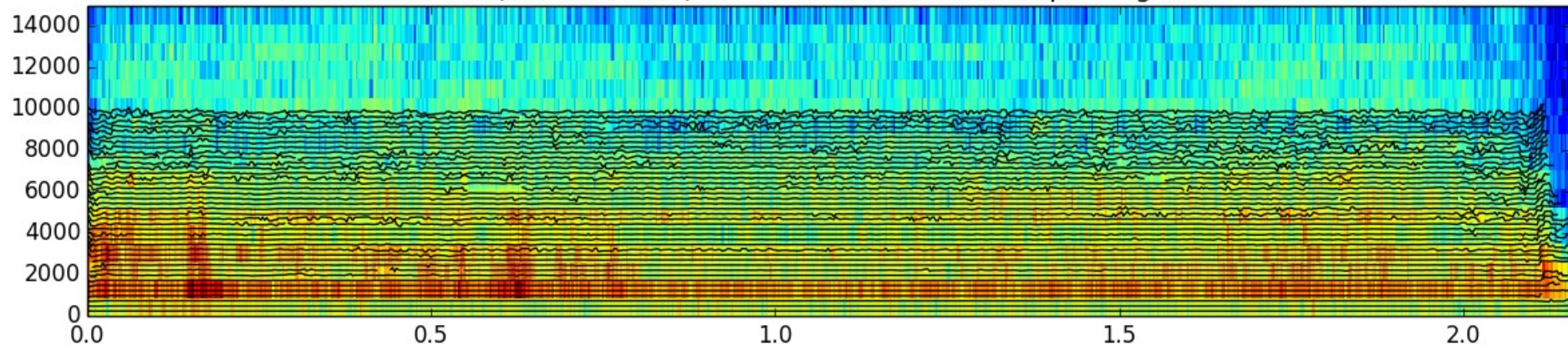
x2 (soprano-E4.wav): harmonics + stochastic spectrogram



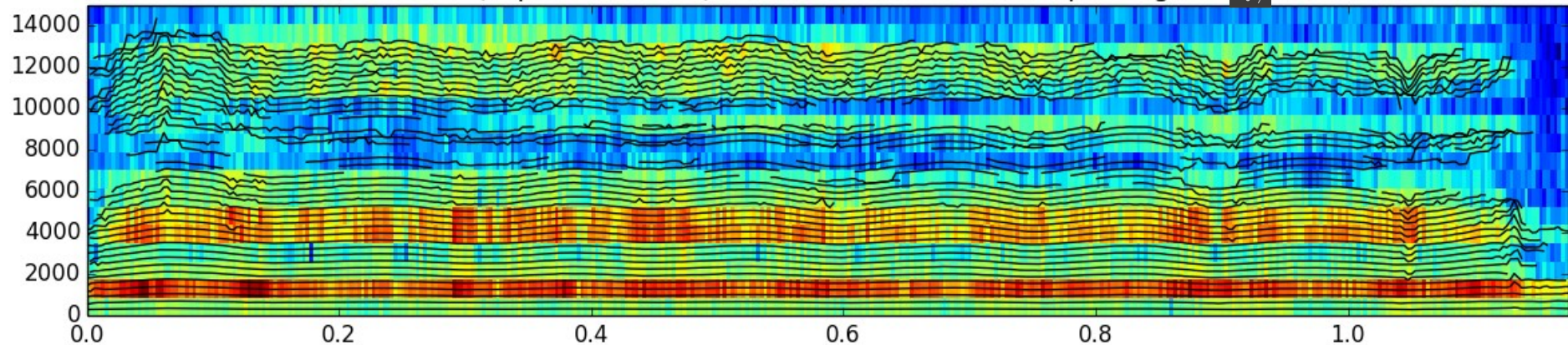
y: harmonics + stochastic spectrogram



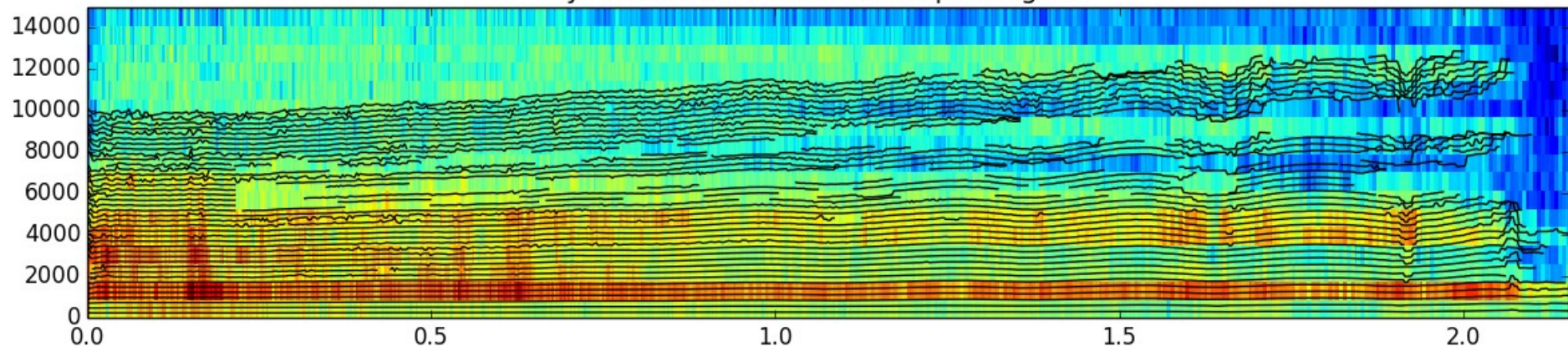
x1 (violin-B3.wav): harmonics + stochastic spectrogram



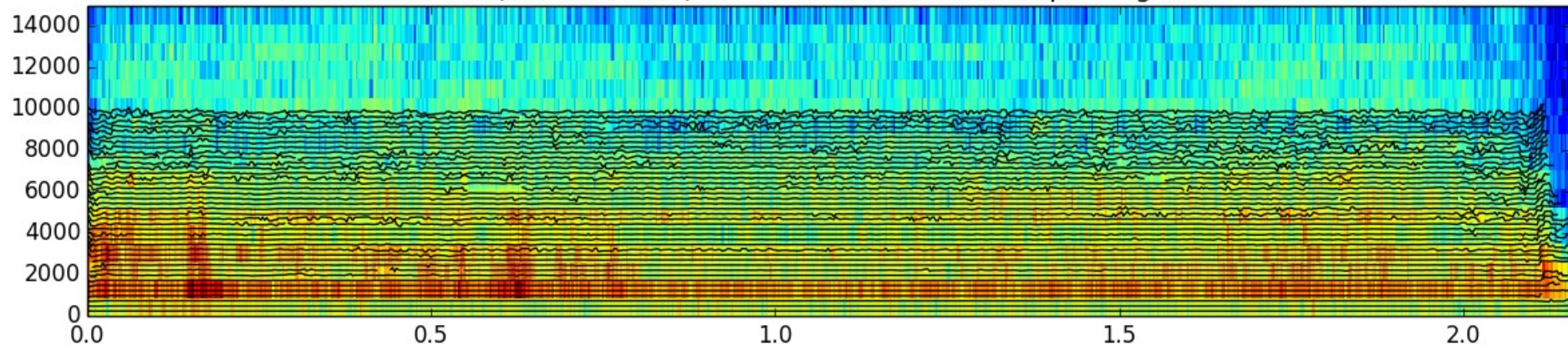
x2 (soprano-E4.wav): harmonics + stochastic spectrogram



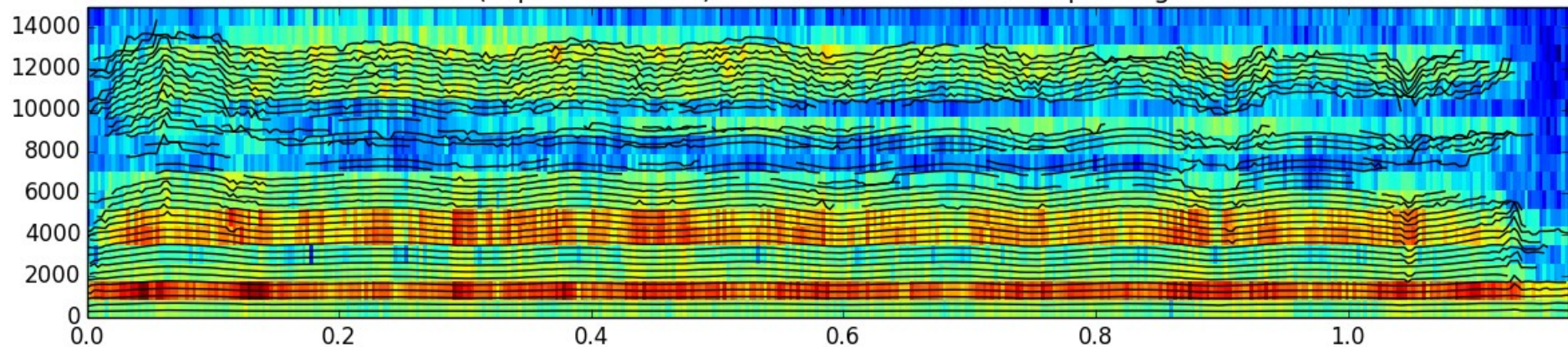
y: harmonics + stochastic spectrogram



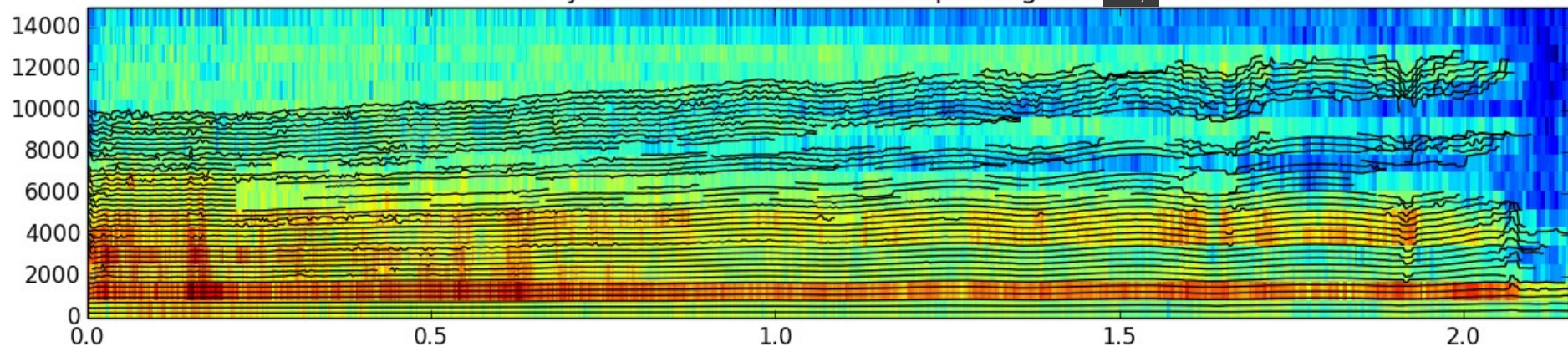
x1 (violin-B3.wav): harmonics + stochastic spectrogram



x2 (soprano-E4.wav): harmonics + stochastic spectrogram



y: harmonics + stochastic spectrogram



References

- More information on this topic from Wikipedia:
 - http://en.wikipedia.org/wiki/Sound_effects
 - http://en.wikipedia.org/wiki/Audio_timescale-pitch_modification
- Sounds: <http://www.freesound.org/people/xserra/packs/13038/>
- The slides and code are released using the CC Attribution-Noncommercial-Share Alike license or the Affero GPL license and available from <https://github.com/MTG/sms-tools>

8T2: Spectral-based sound transformations (2 of 2)

Xavier Serra

Universitat Pompeu Fabra, Barcelona

&

Stanford University