5T3: Sinusoidal Model (3 of 3)

Xavier Serra
Universitat Pompeu Fabra, Barcelona
&
Stanford University

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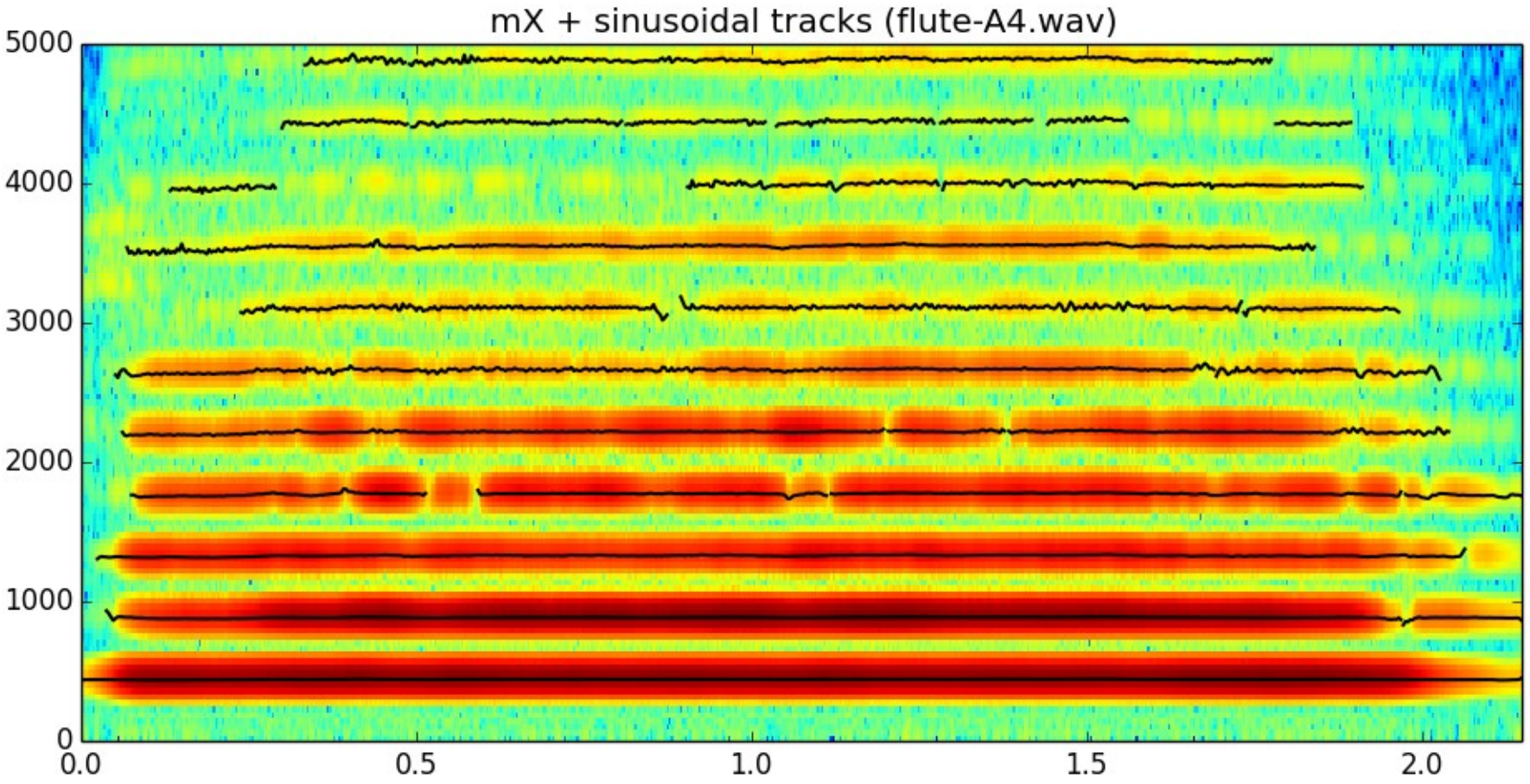
- Sinusoidal model and spectral peak tracks
- Sinusoidal (additive) synthesis
- Sinusodal model system

Sinusoidal model

$$y[n] = \sum_{r=1}^{R} A_r[n] \cos\left(2\pi f_r[n] n\right)$$



Sinusoidal model

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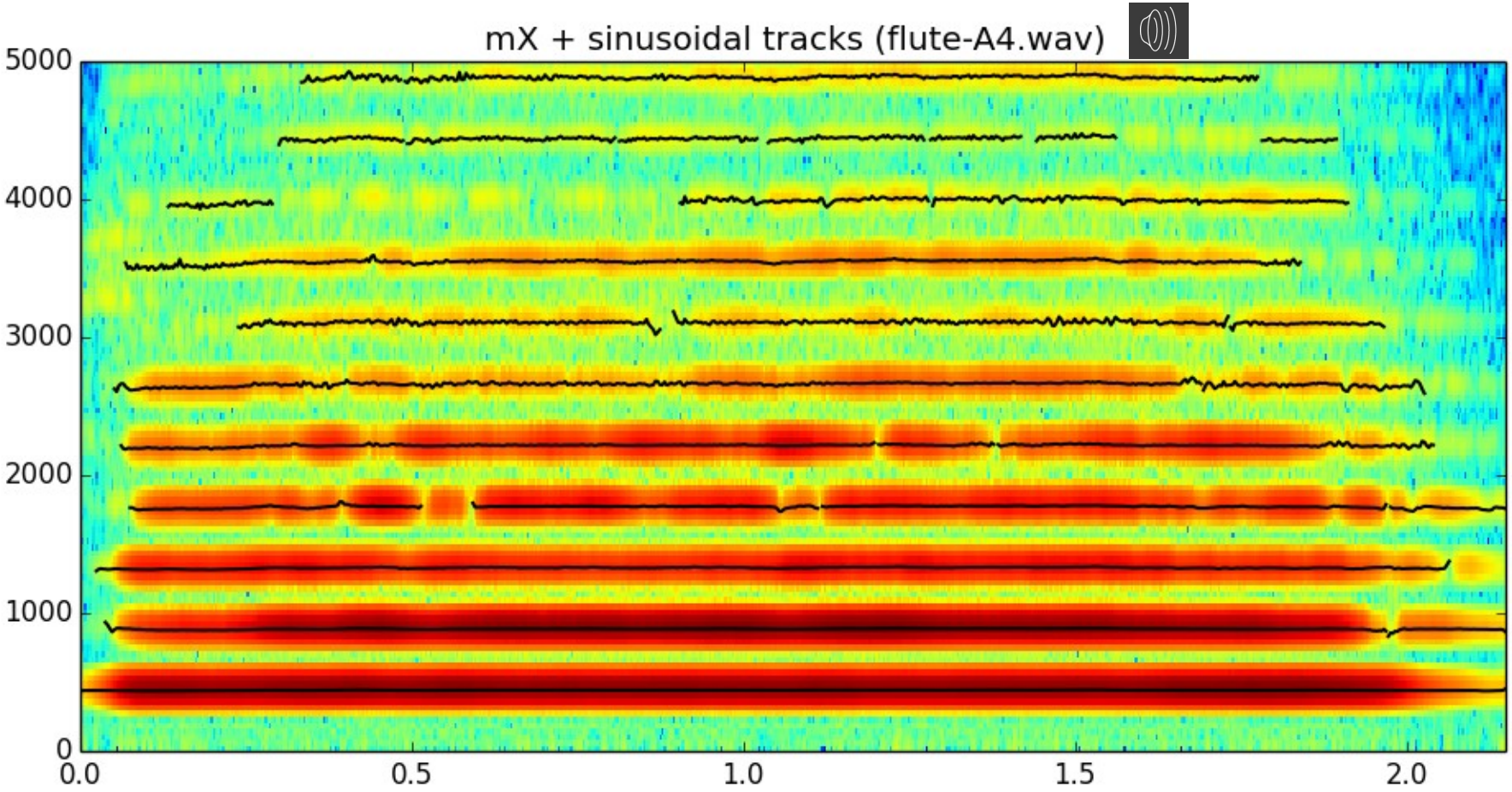
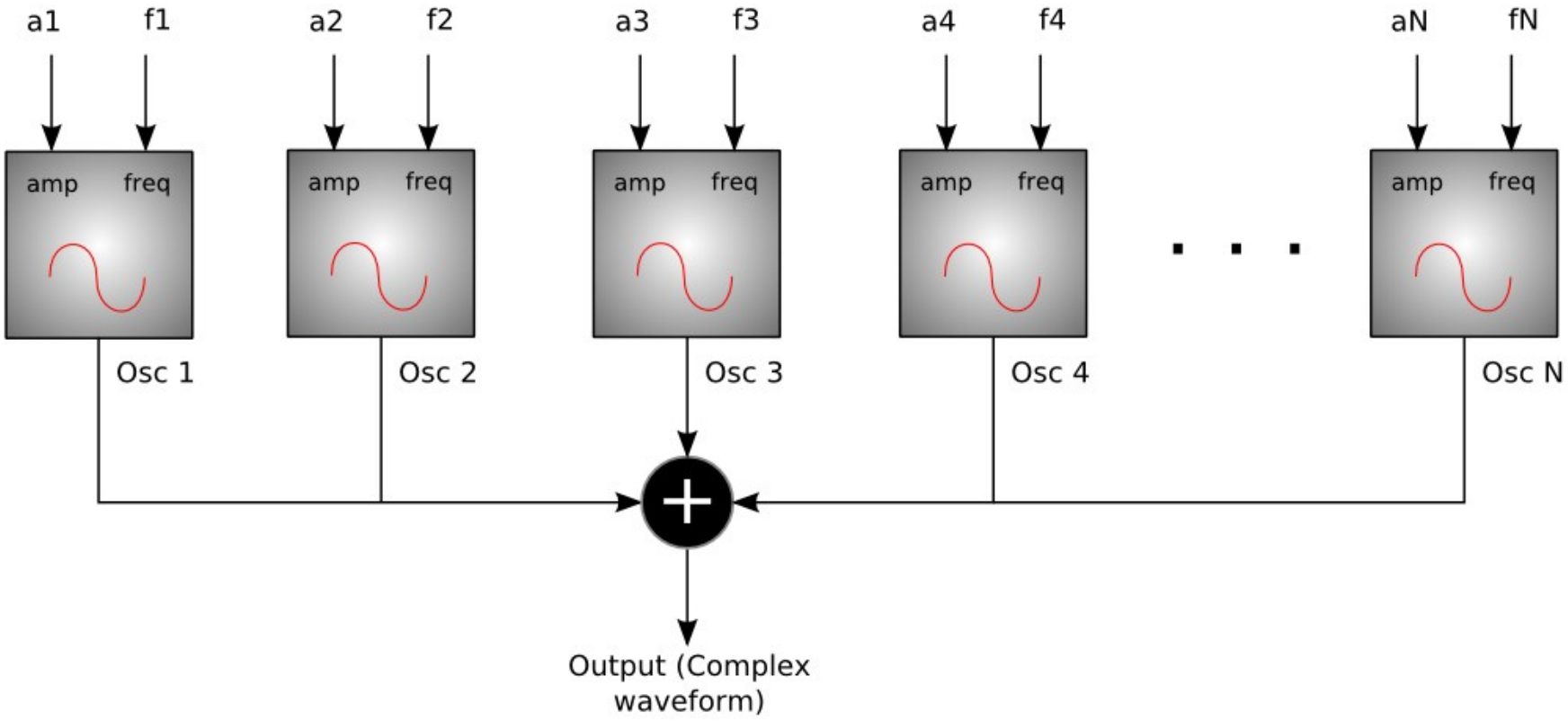


Sinusoidal (additive) synthesis



http://en.wikibooks.org/wiki/File:SSadditiveblock.png

Sinusoidal synthesis

$$y[n] = A_r[n]\cos\left(2\pi f_r[n]n + \varphi_r\right)$$

$A_r[n]$: instantaneous amplitude ; $f_r[n]$: instantaneous frequency

φ_r: initial phase

```
Ar = .8
fr = 2.0
phi = pi/2
fs = 100
t = arange(-1, 1, 1.0/fs)
x = Ar * cos(2*pi*fr*t+phi)
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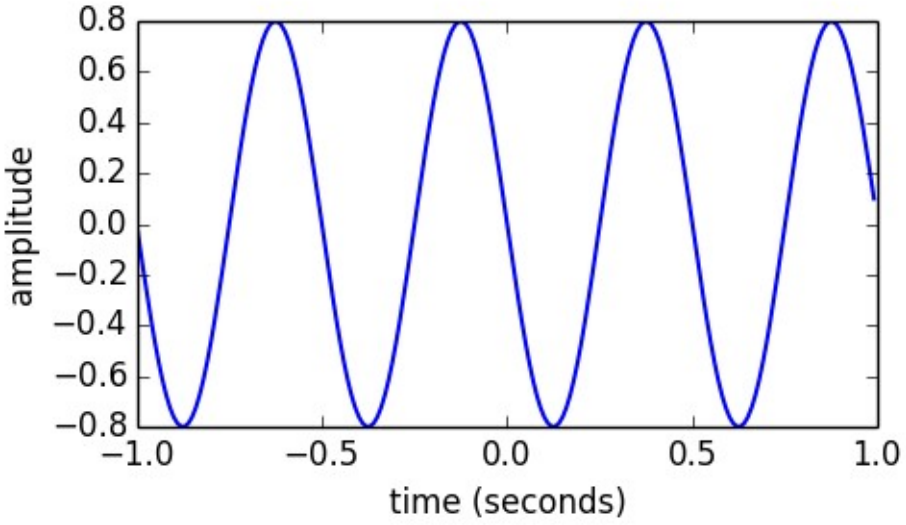
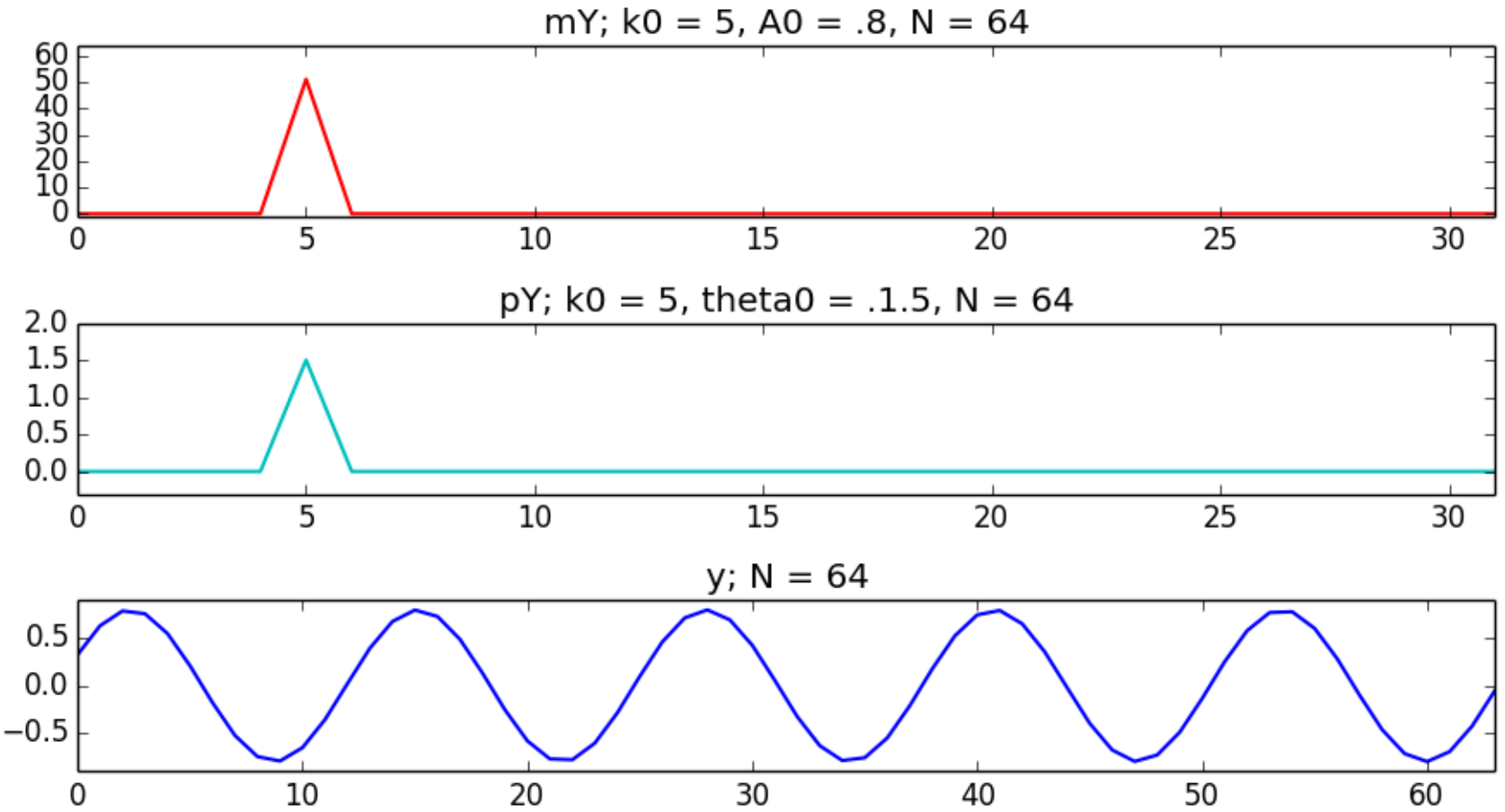


Sinusoidal synthesis: discrete frequency

$$y[n] = IDFT\left(mY[k] * e^{j * pY[k]}\right)$$

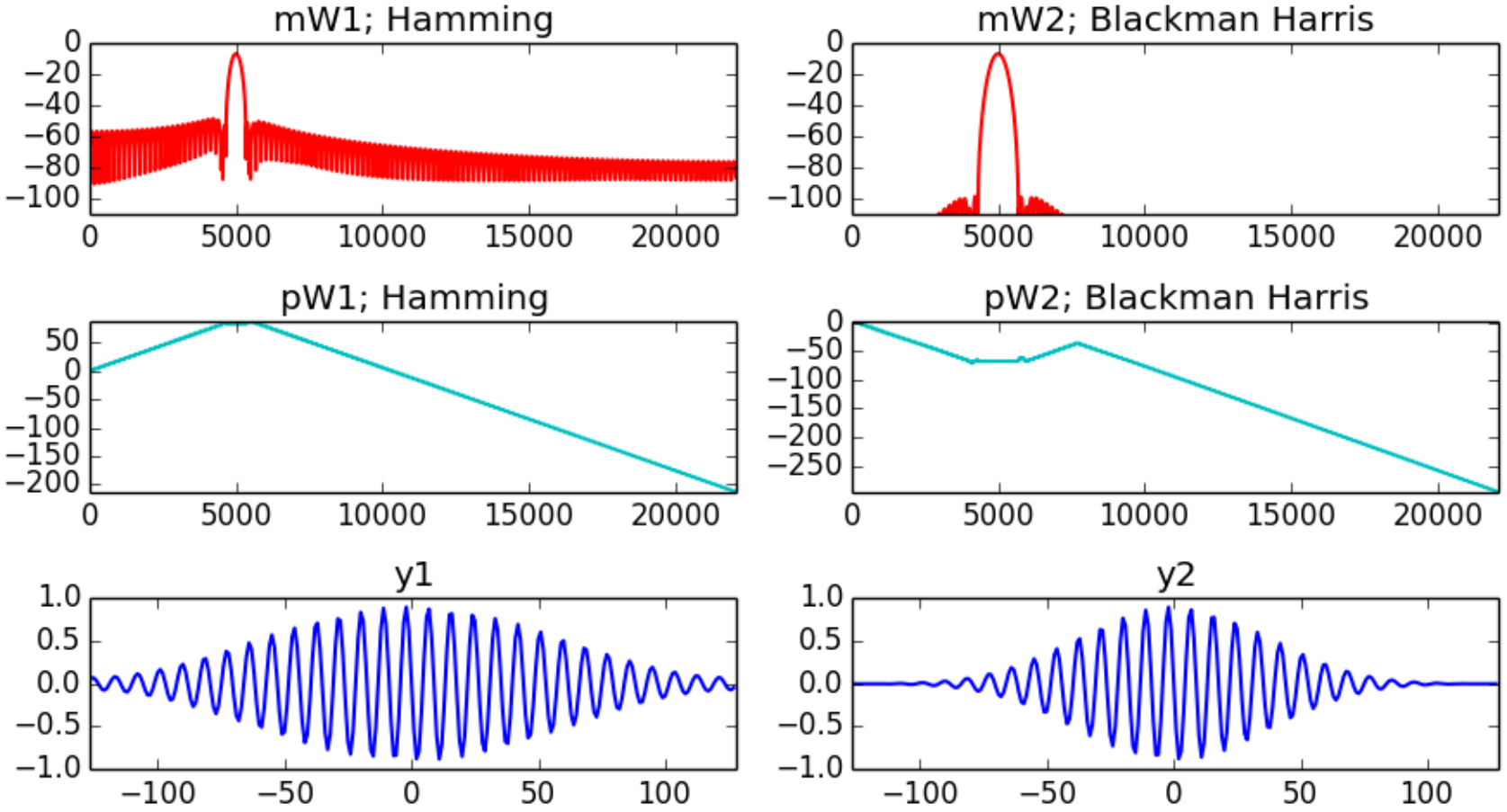
$$mY[k] = A_0 \text{ for } k = k_0 \text{ and } 0 \text{ for } k \neq k_0;\ pY[k] = \varphi_0 \text{ for } k = k_0 \text{ and } 0 \text{ for } k \neq k_0$$



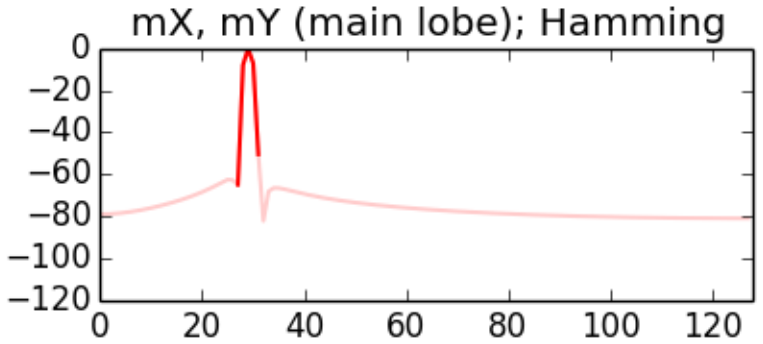
Sinusoidal synthesis: any frequency

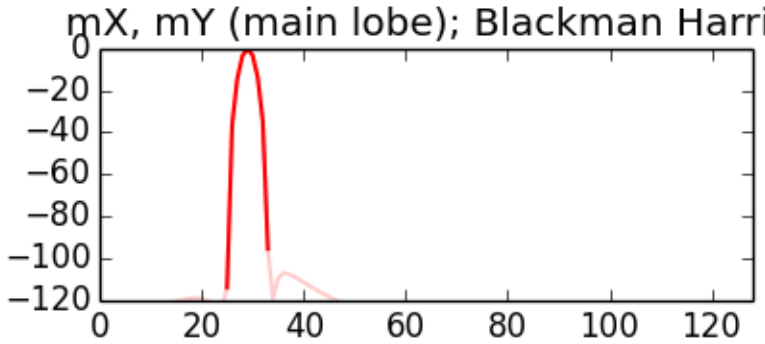
$$y[n] = IDFT\left(A_0 * mW[k-k_0] * e^{j*(pW[k-k_0]+\varphi_0)}\right)$$

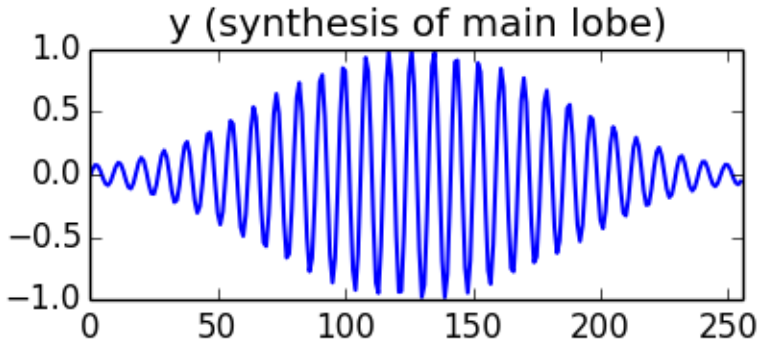
$mW[k]$, $pW[k]$ magnitude and phase spectrum of window

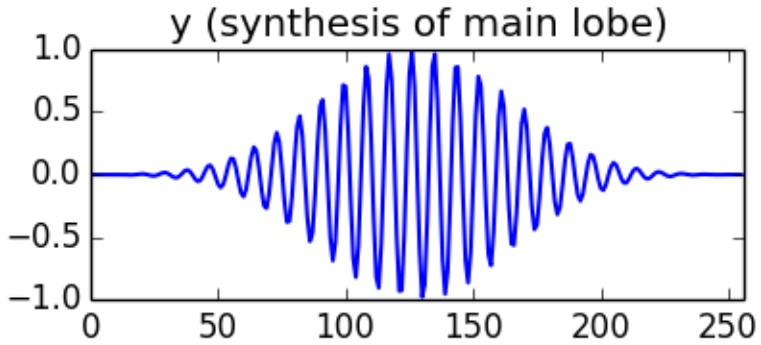


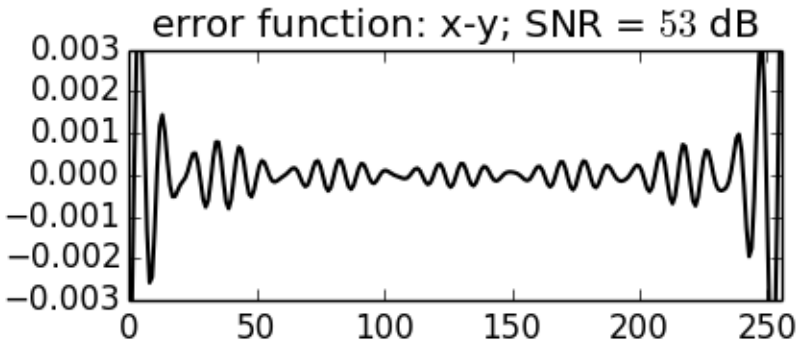
Sinusoidal synthesis: only main lobe

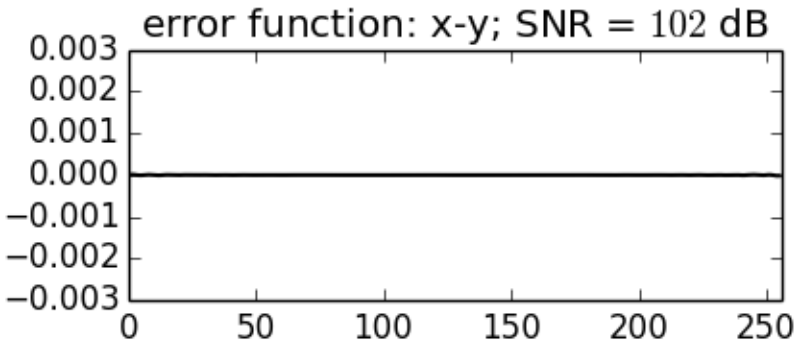








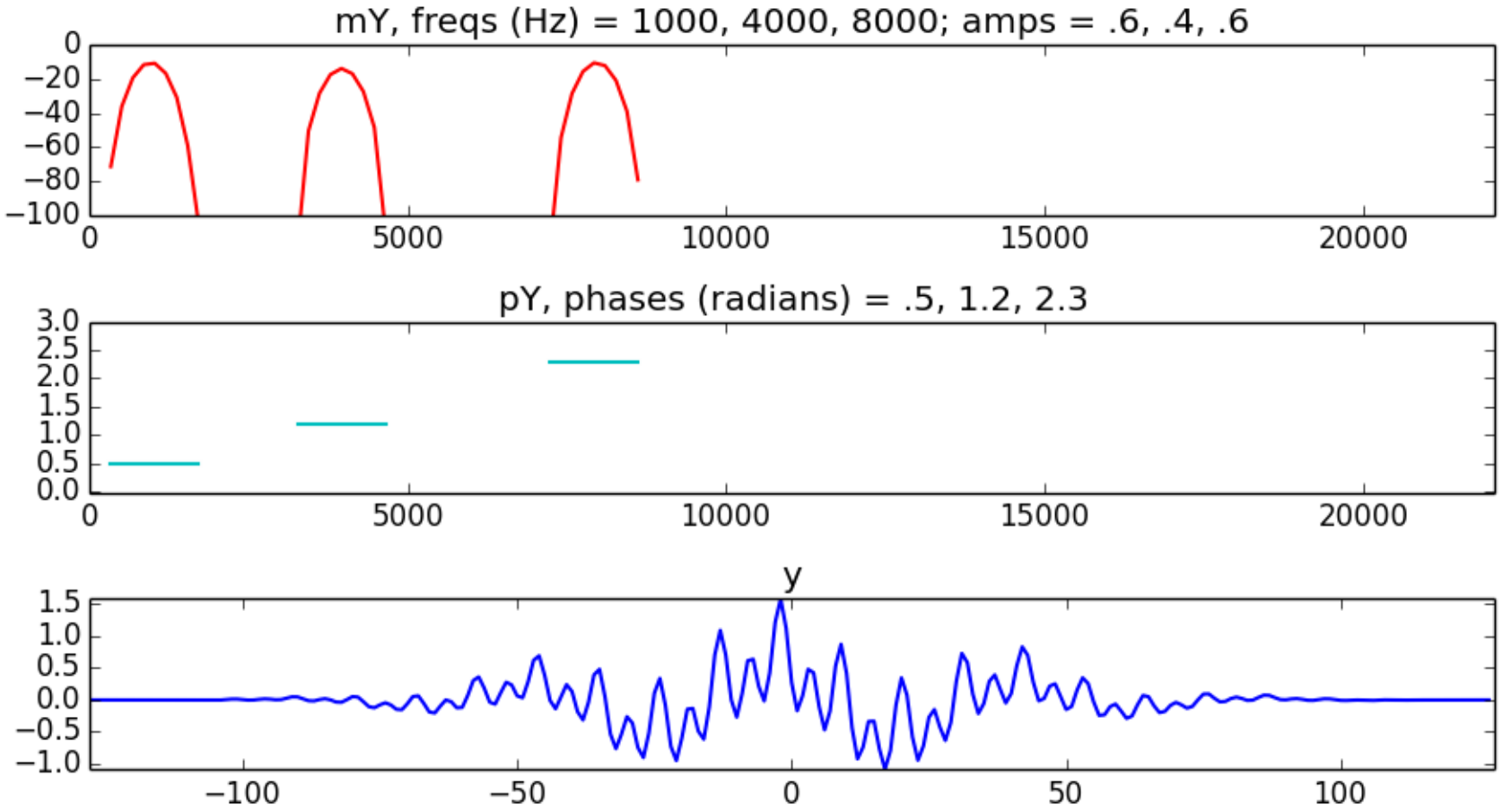




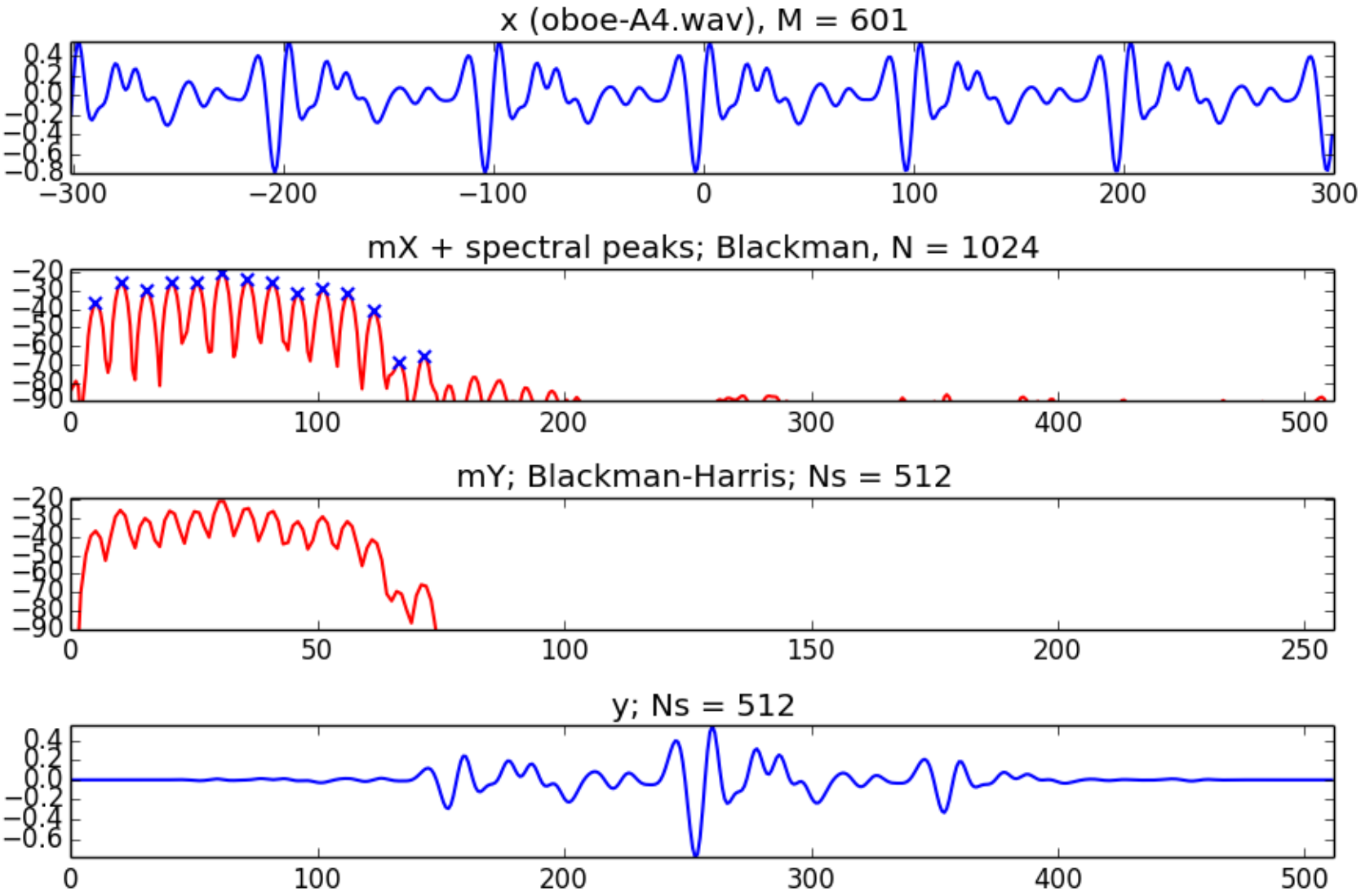
Additive synthesis

$$y[n] = IDFT\left(\sum_{r=0}^{R} A_r * mWl[k - k_r] * e^{j*(pWl[k-k_r]+\varphi_r)}\right)$$

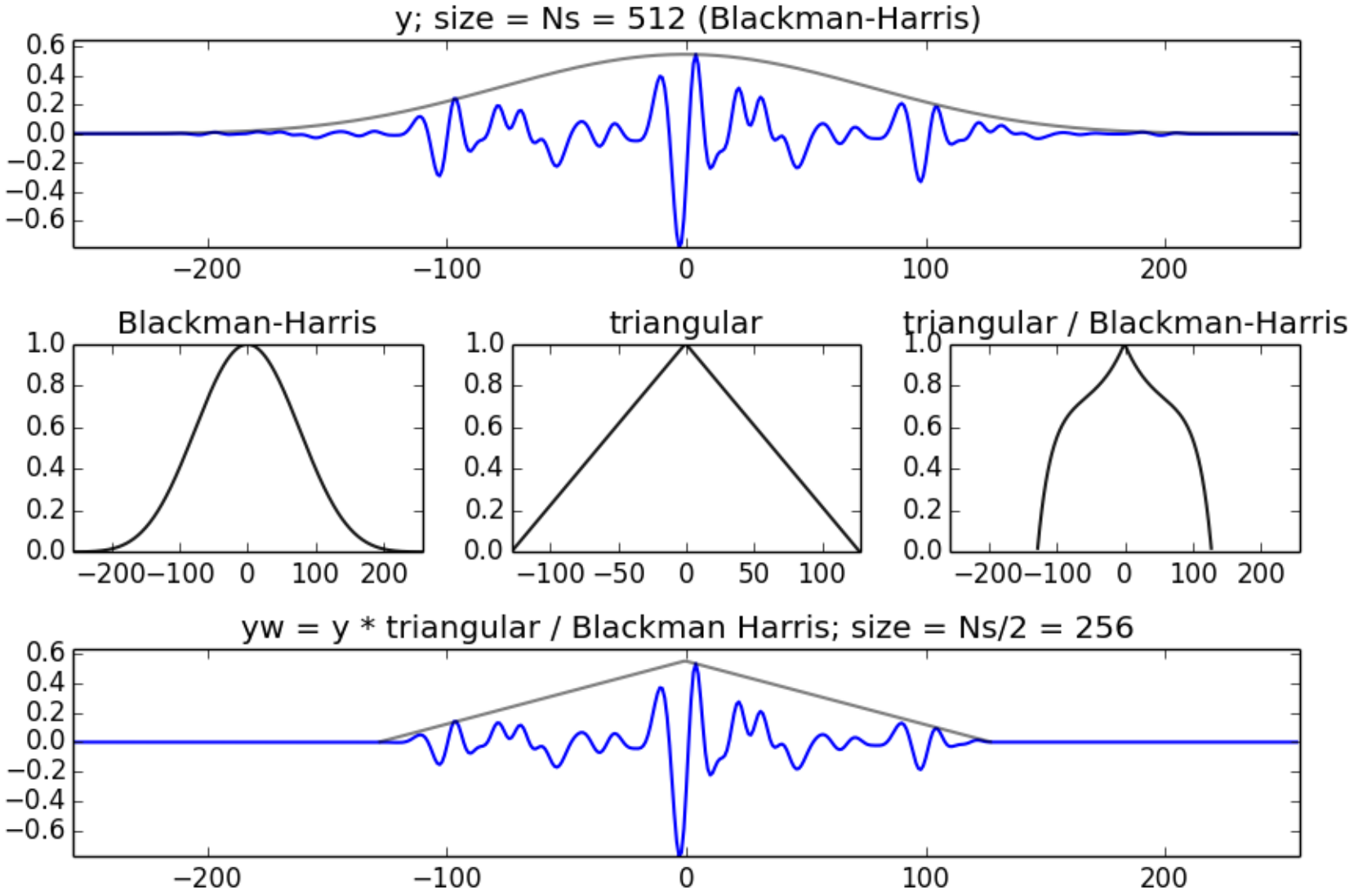
$mWl[k]$, $pWl[k]$ magnitude and phase spectrum of window main lobe



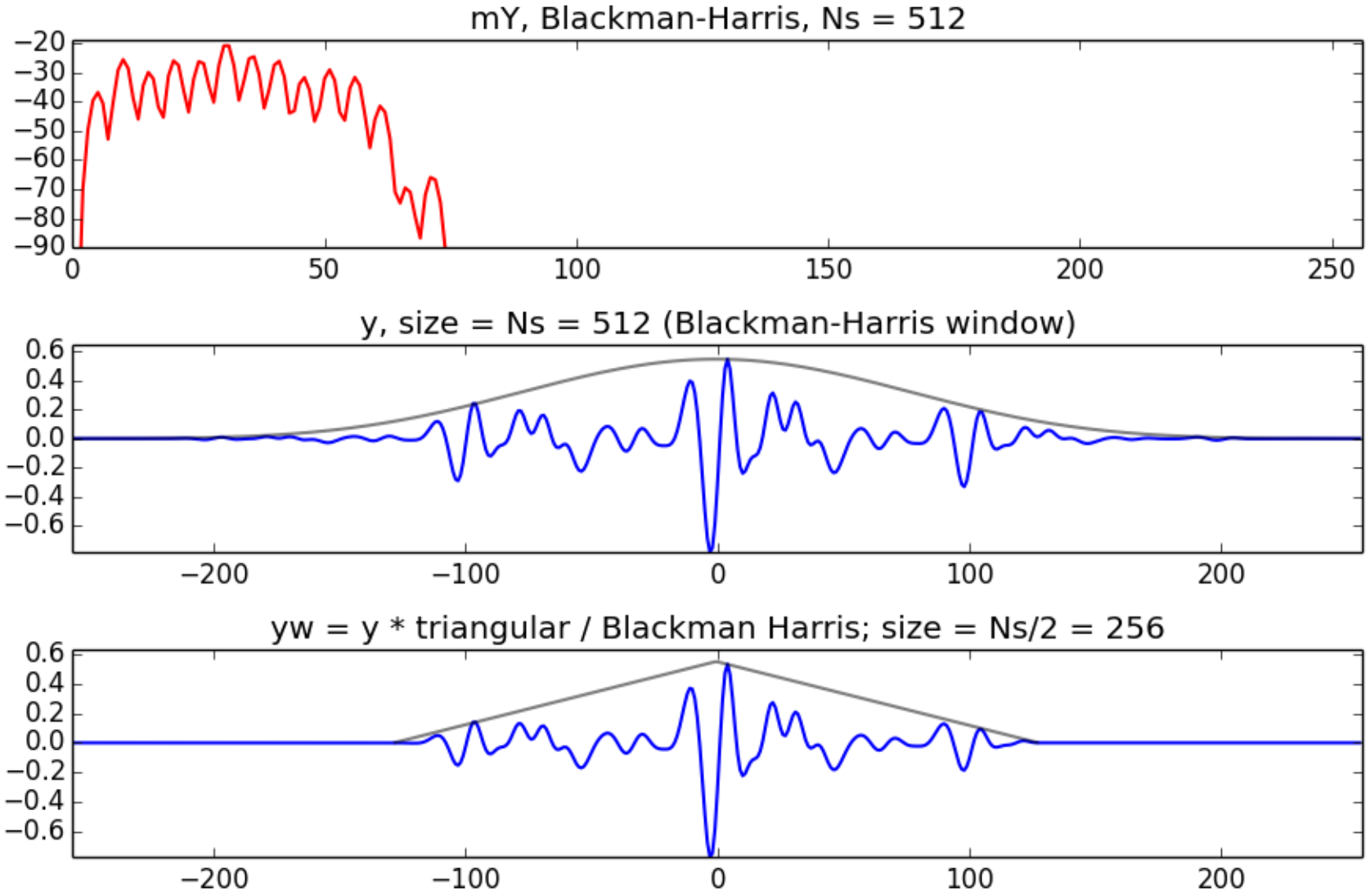
Analysis / Synthesis



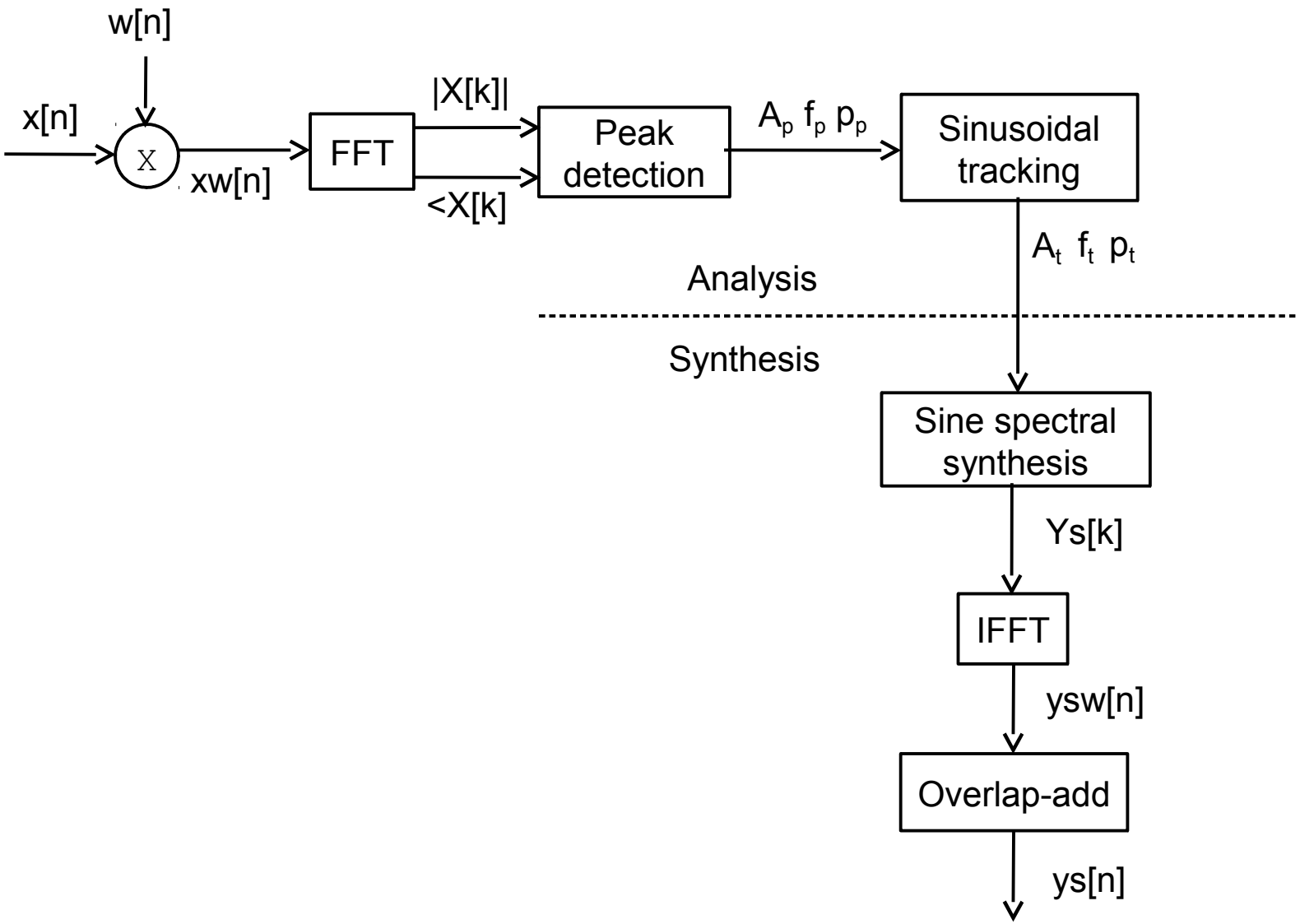
Synthesis window

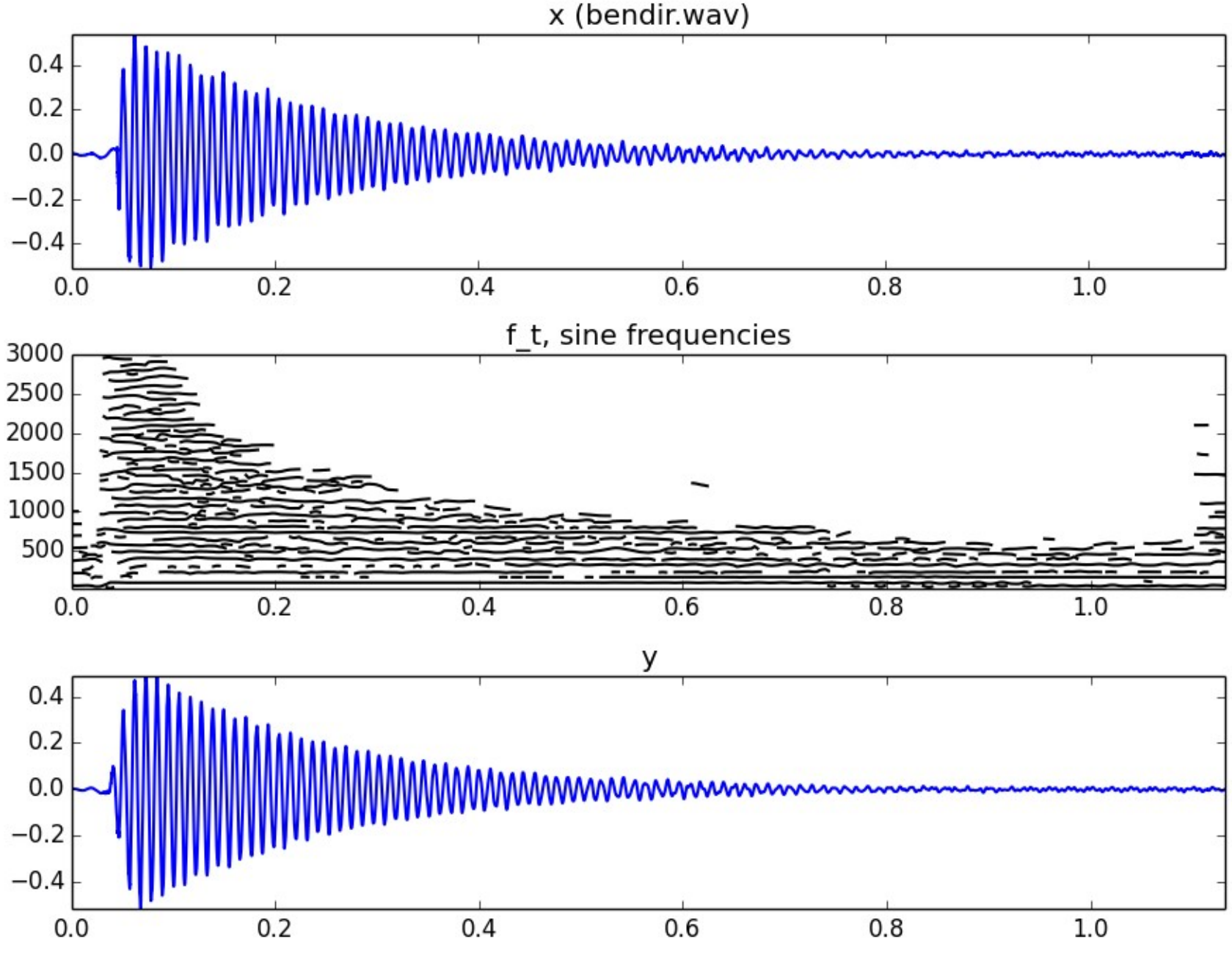


Synthesis for overlap of 25%



Sinusoidal model system




x (bendir.wav)
0.4
0.2
0.0
−0.2
−0.4
0.0
0.2
0.4
0.6
0.8
1.0
f_t, sine frequencies
3000
2500
2000
1500
1000
500
0.0
0.2
0.4
0.6
0.8
1.0
y
0.4
0.2
0.0
−0.2
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0.2
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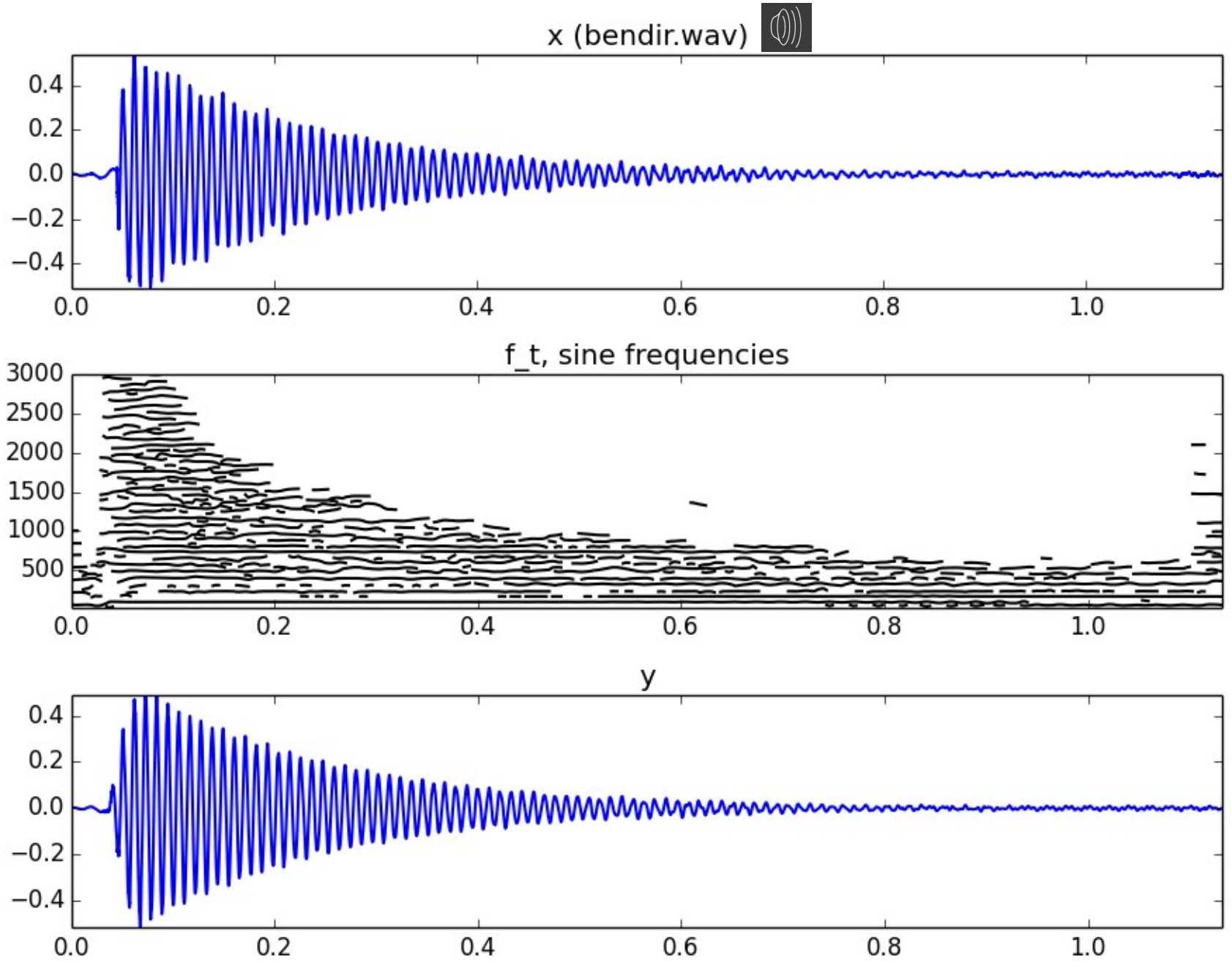
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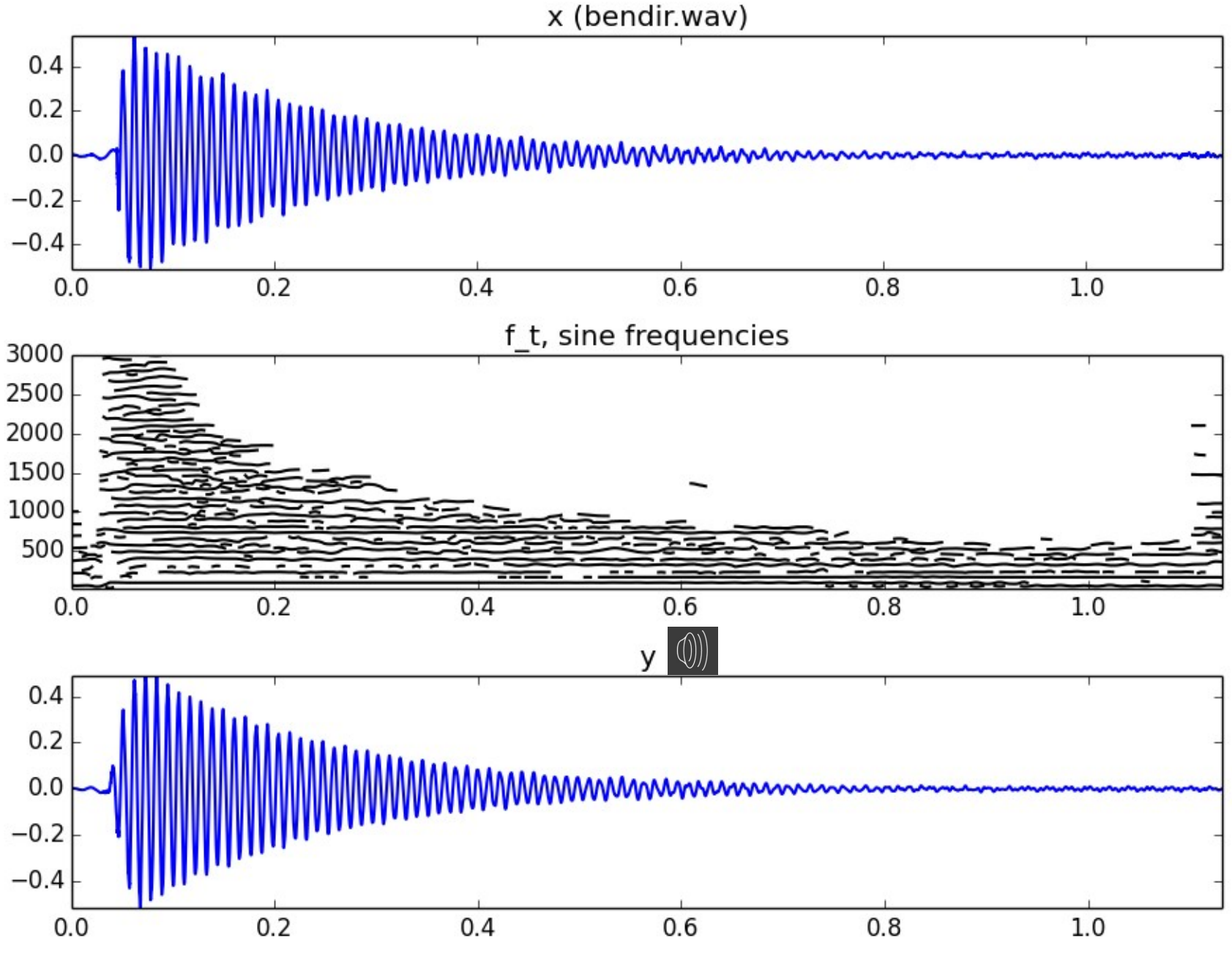
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0.4
0.6
0.8
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References and credits

- More information in:
  - http://en.wikipedia.org/wiki/Additive_synthesis
  - http://en.wikipedia.org/wiki/Sinusoidal_model
- Reference on sine modeling by Julius O. Smith: https://ccrma.stanford.edu/~jos/sasp/Spectrum_Analysis_Sinusoids.html
- Sounds from: http://www.freesound.org/people/xserra/packs/13038/
- Slides and code released using the CC Attribution-Noncommercial-Share Alike license or the Affero GPL license and available from https://github.com/MTG/sms-tools

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