



Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

# A Novel Fourier Approach to Guitar String Separation

David Ramsay

Dr. Ted Burke

Dan Barry

Prof. Eugene Coyle



Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

# Motivation

# Approach to Solution

# Implementations

# Further Work

# Conclusion



# Why String Separation?

*Automatic note transcription*

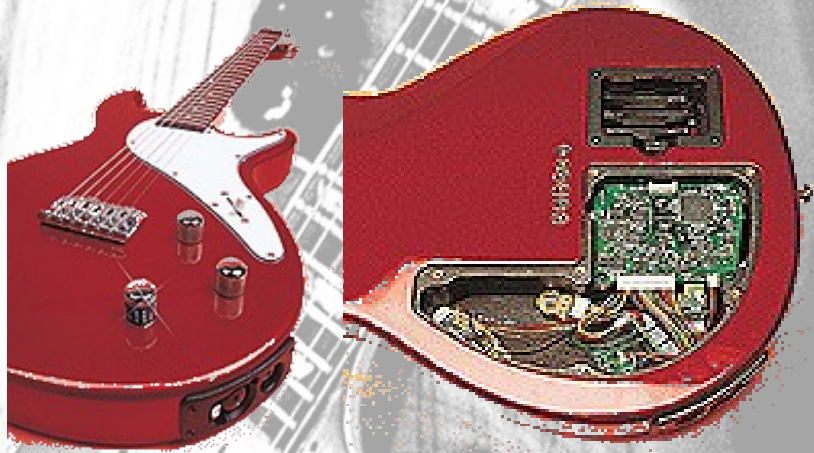
*Automatic Retuning*

*Unique Effects / Modeling*

*MIDI controller*

*Video game controller*

Line 6 Variax



**Expensive** and **Inflexible**

Roland GK-3





Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

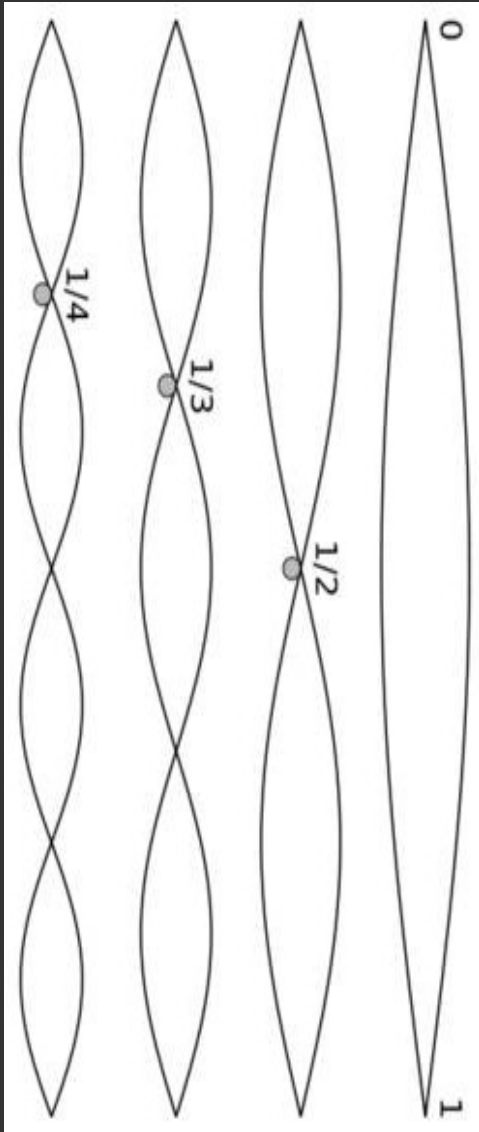
Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

*to review:* 1) string separation is useful for many applications  
2) DSP-based solution could catalyze its adoption

our research:

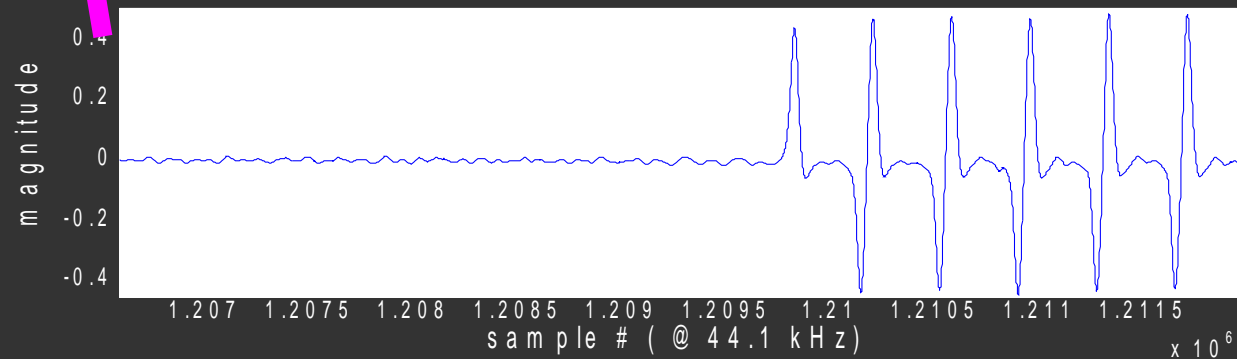
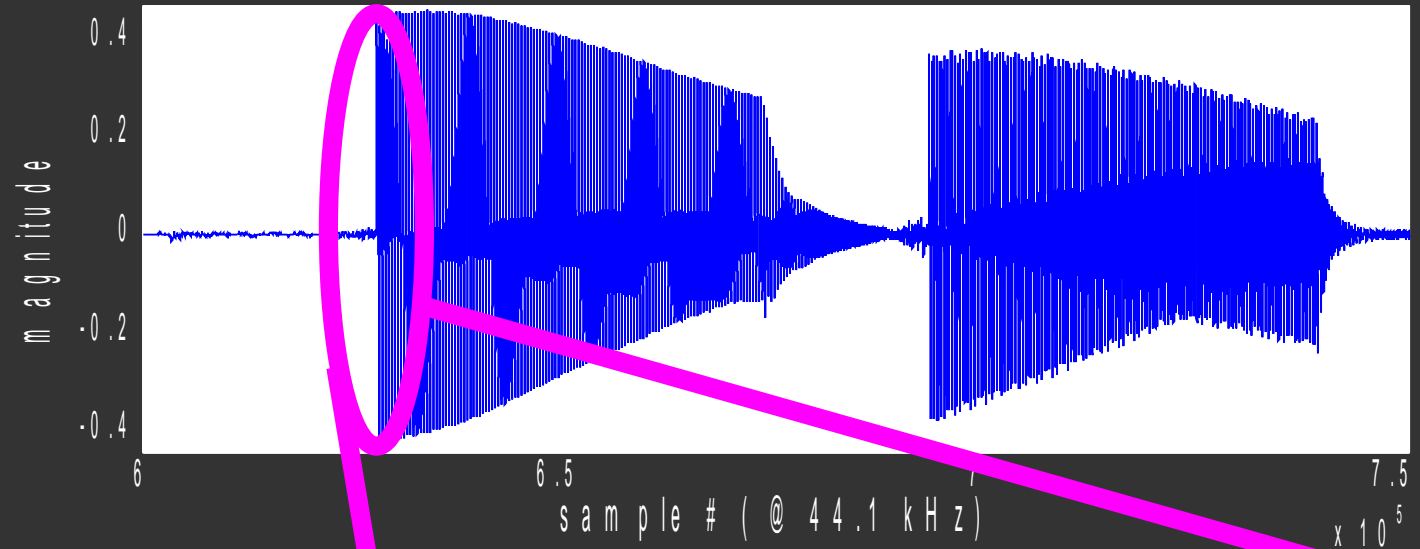
Special case of separating out  
*open, non-fretted* guitar strings

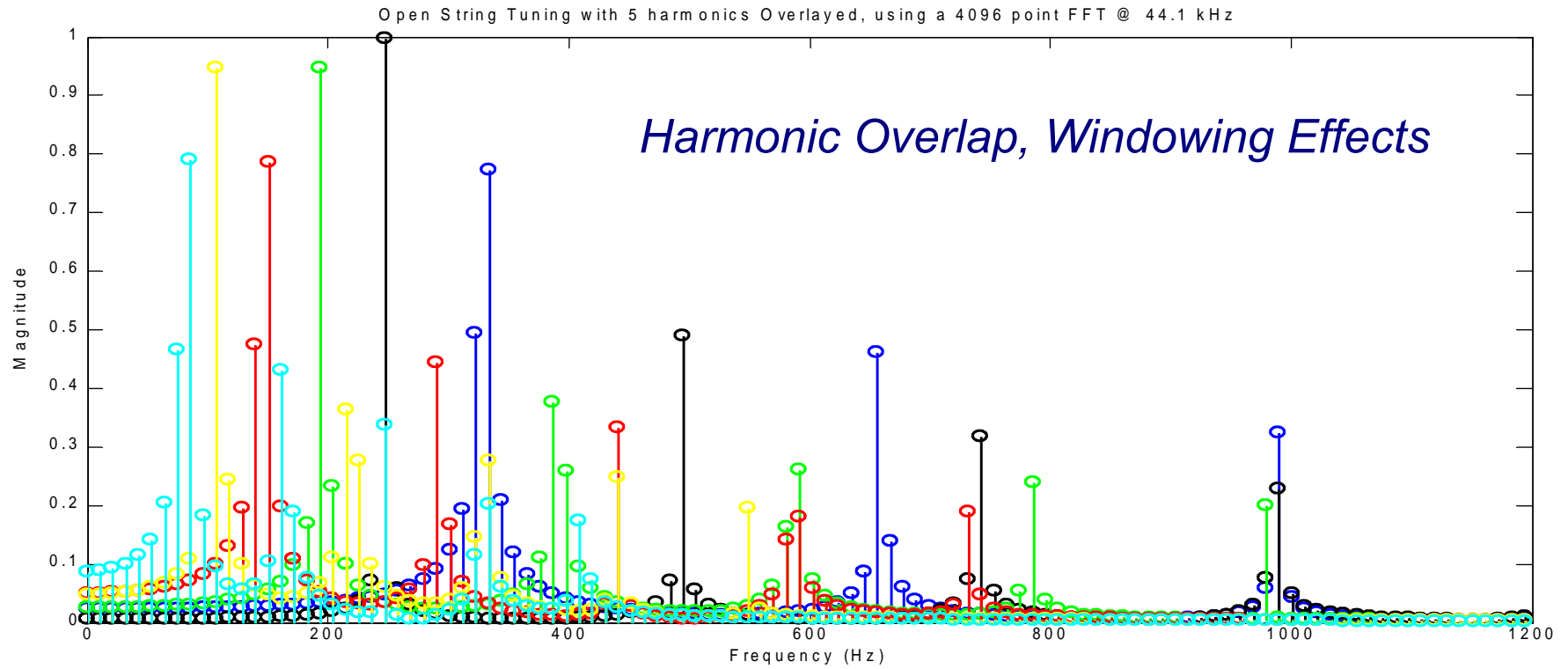
# The Guitar Signal



$F, 2 \cdot F, 3 \cdot F, 4 \cdot F, \dots$

Time Domain Electric Guitar Signal

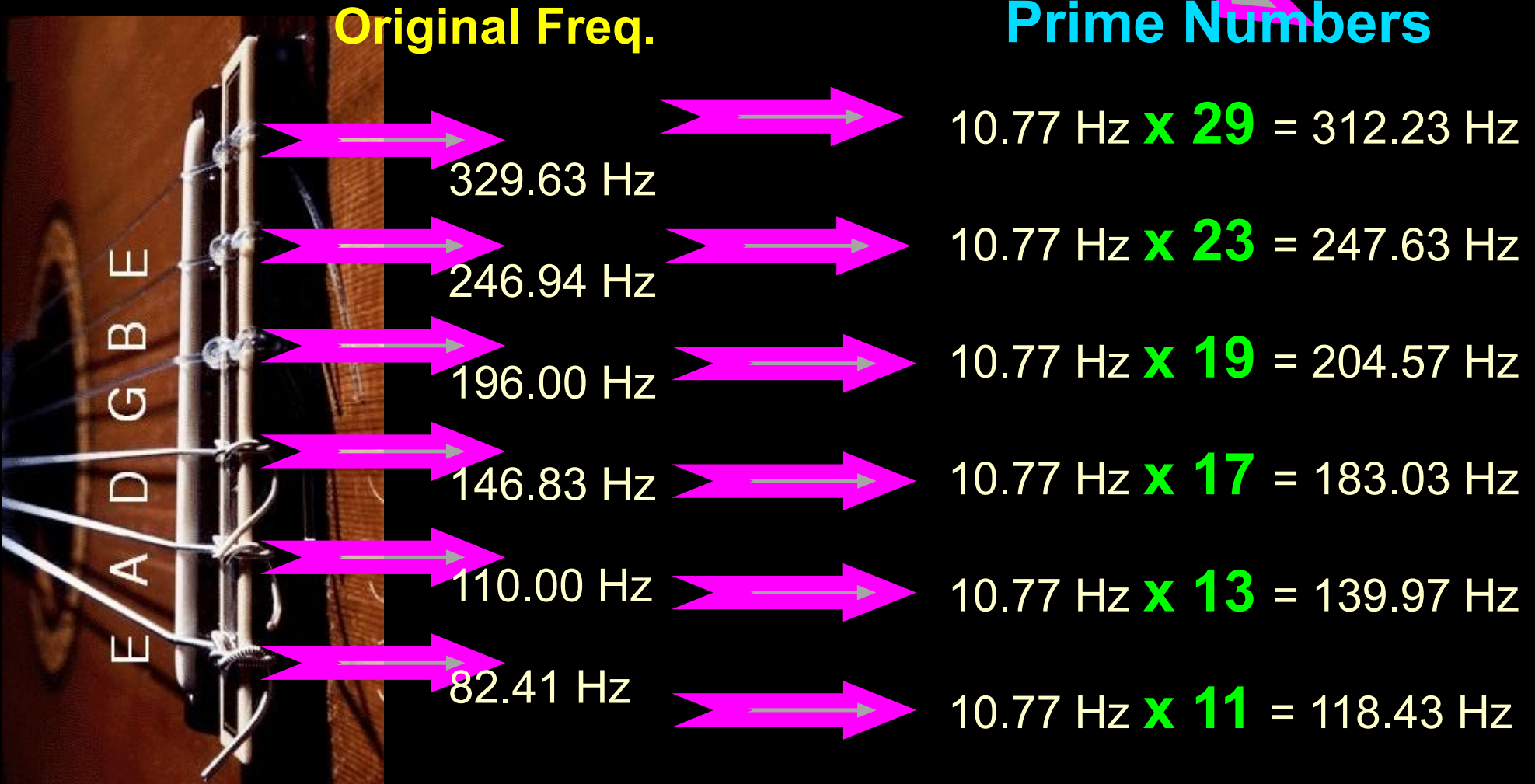




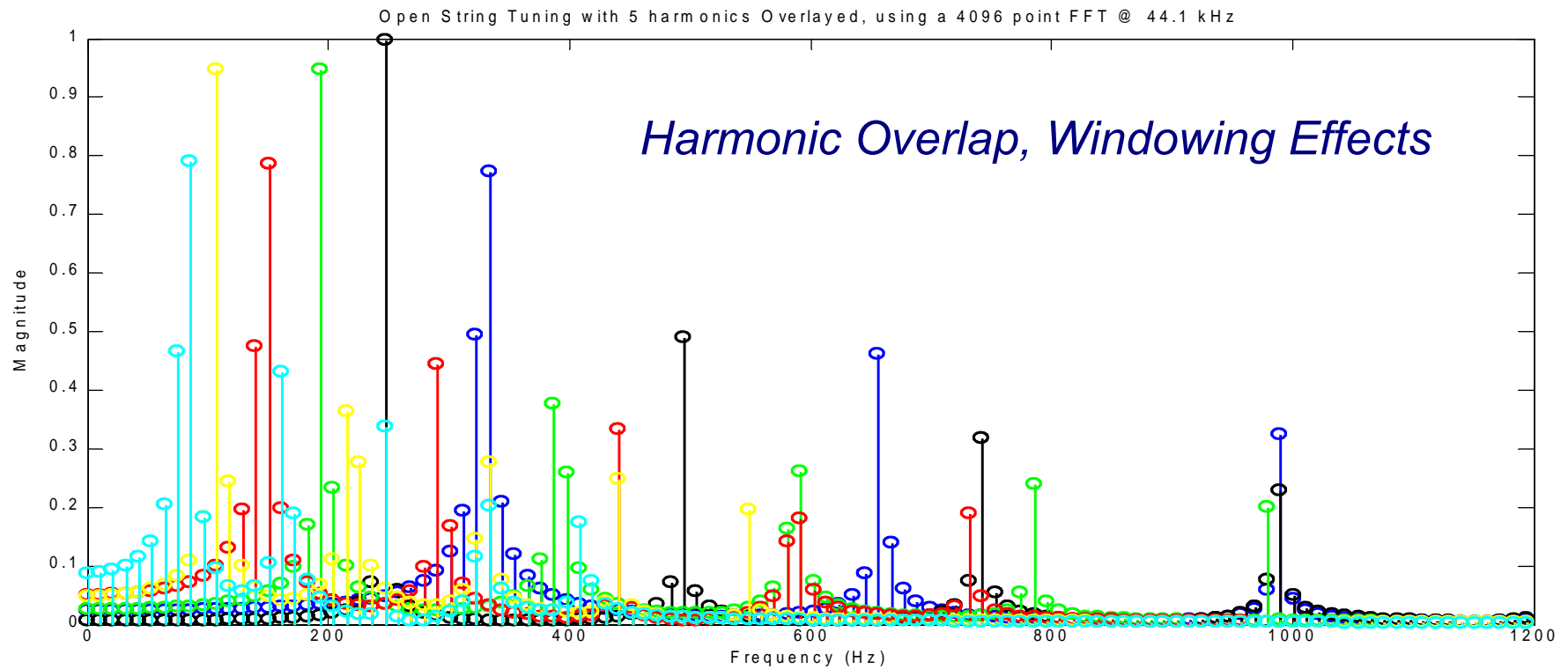
the **Frequency Resolution** for a 4096 point FFT

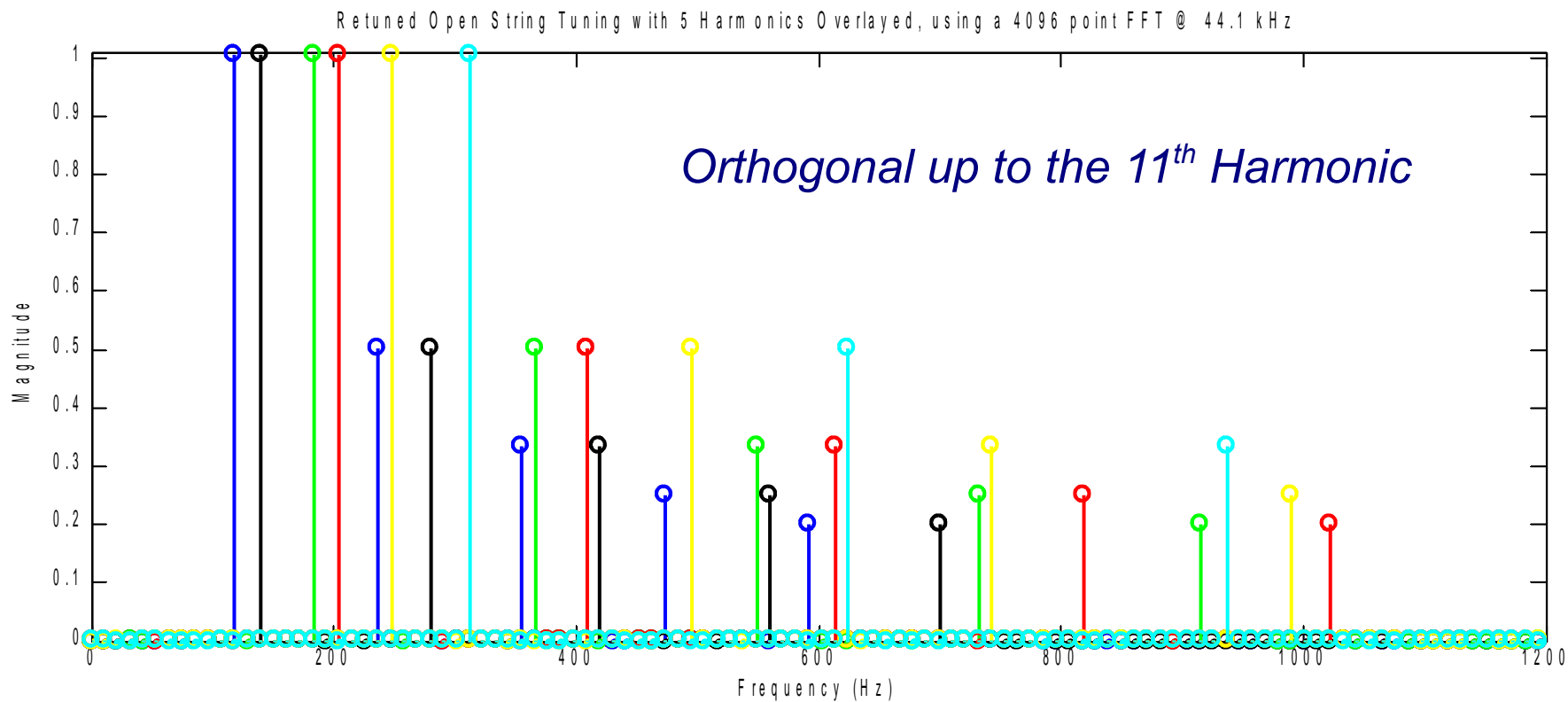
@ 44.1 kHz is **10.77 Hz.**

multiplied by  
**Prime Numbers**











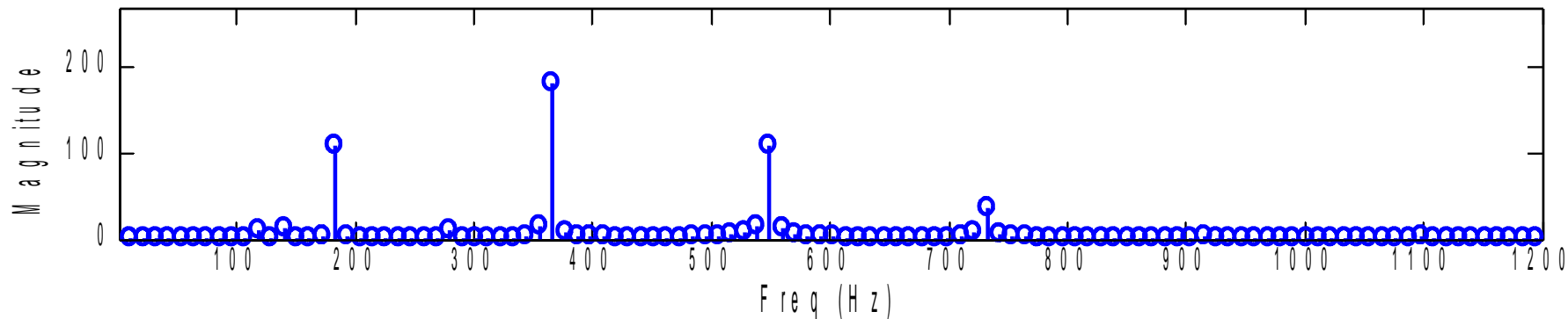
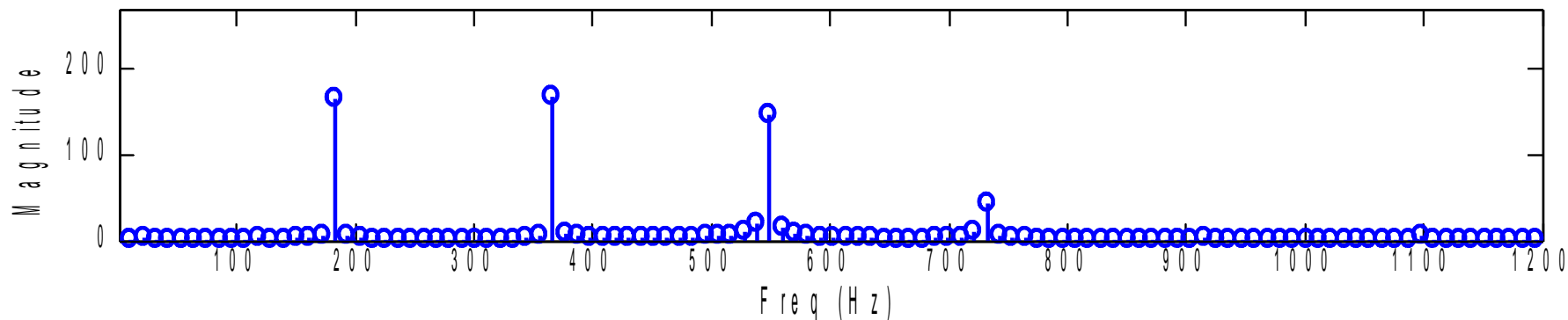
Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

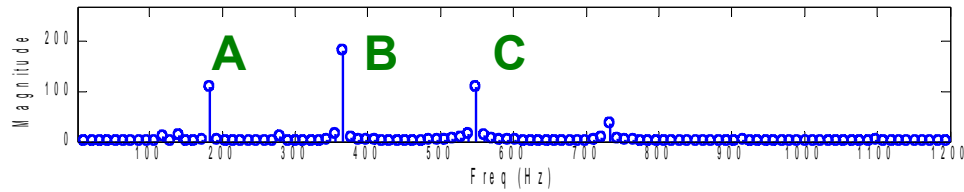
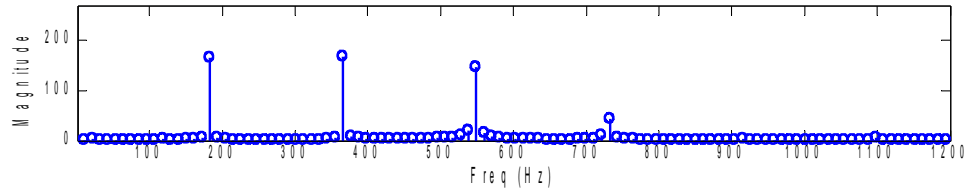
- to review:*
- 1) Choose tunings at multiples of FFT freq. resolution
  - 2) Orthogonalize harmonics maximally (prime # ratios)
  - 3) Make trade-offs as necessary

*But Does it Work?*

FFT of 2 Samples of Third Lowest Note (x17) Using a Rectangular Window

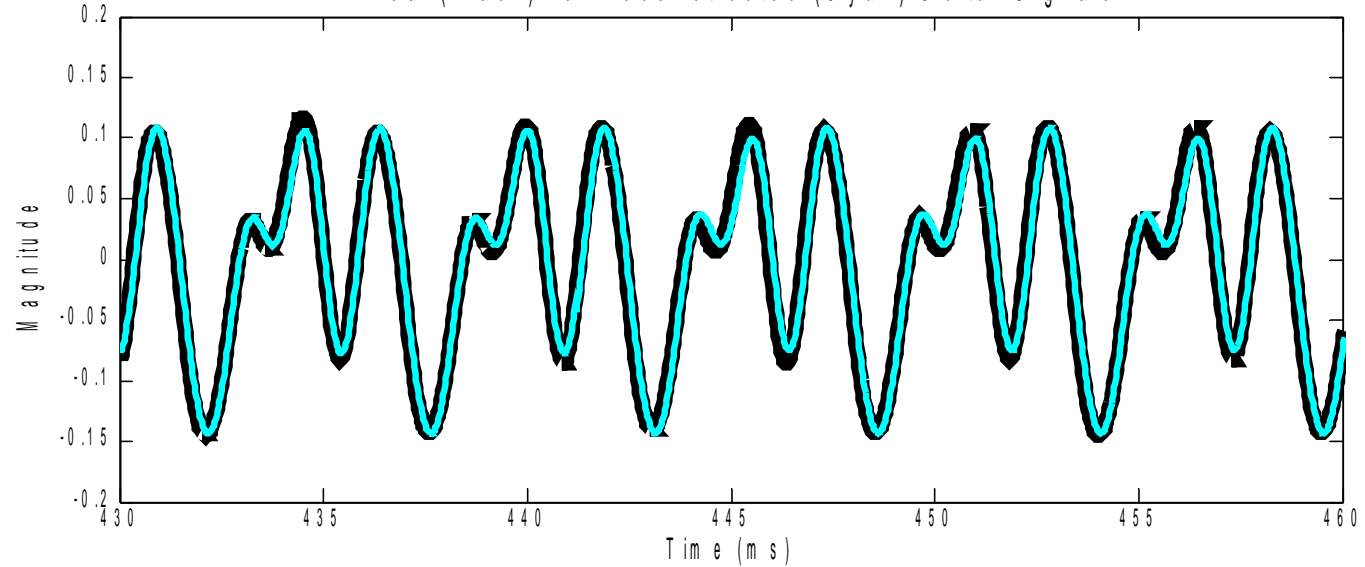


FFT of 2 Samples of Third Lowest Note (x17) Using a Rectangular Window



$$A \cdot \sin(F) + B \cdot \sin(2 \cdot F) + C \cdot \sin(3 \cdot F) + \dots =$$

Real (Black) vs. Reconstructed (Cyan) Guitar Signals



*1. adaptations for real-time*

*2. further development of the project*

*3. other applications of this work*

**1.** *adaptations for real-time*

**2.** *further development of the project*

**3.** *other applications of this work*

**1.** *adaptations for real-time*

**2.** *further development of the project*

**3.** *other applications of this work*



**1.** *adaptations for real-time*

**2.** *further development of the project*

**3.** *other applications of this work*



Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

# Conclusions

*<http://teapot.dit.ie>*



Dublin Institute of Technology  
Institiúid Teicneolaíochta Átha Cliath

Irish Signal and Systems Conference  
23-24 June 2011, Trinity College Dublin

Thank You

*<http://teapot.dit.ie>*

**focas**  
institute/dit

**FULBRIGHT**  
The Fulbright logo graphic consists of a stylized globe or oval shape with horizontal and vertical lines, positioned below the word 'FULBRIGHT'.