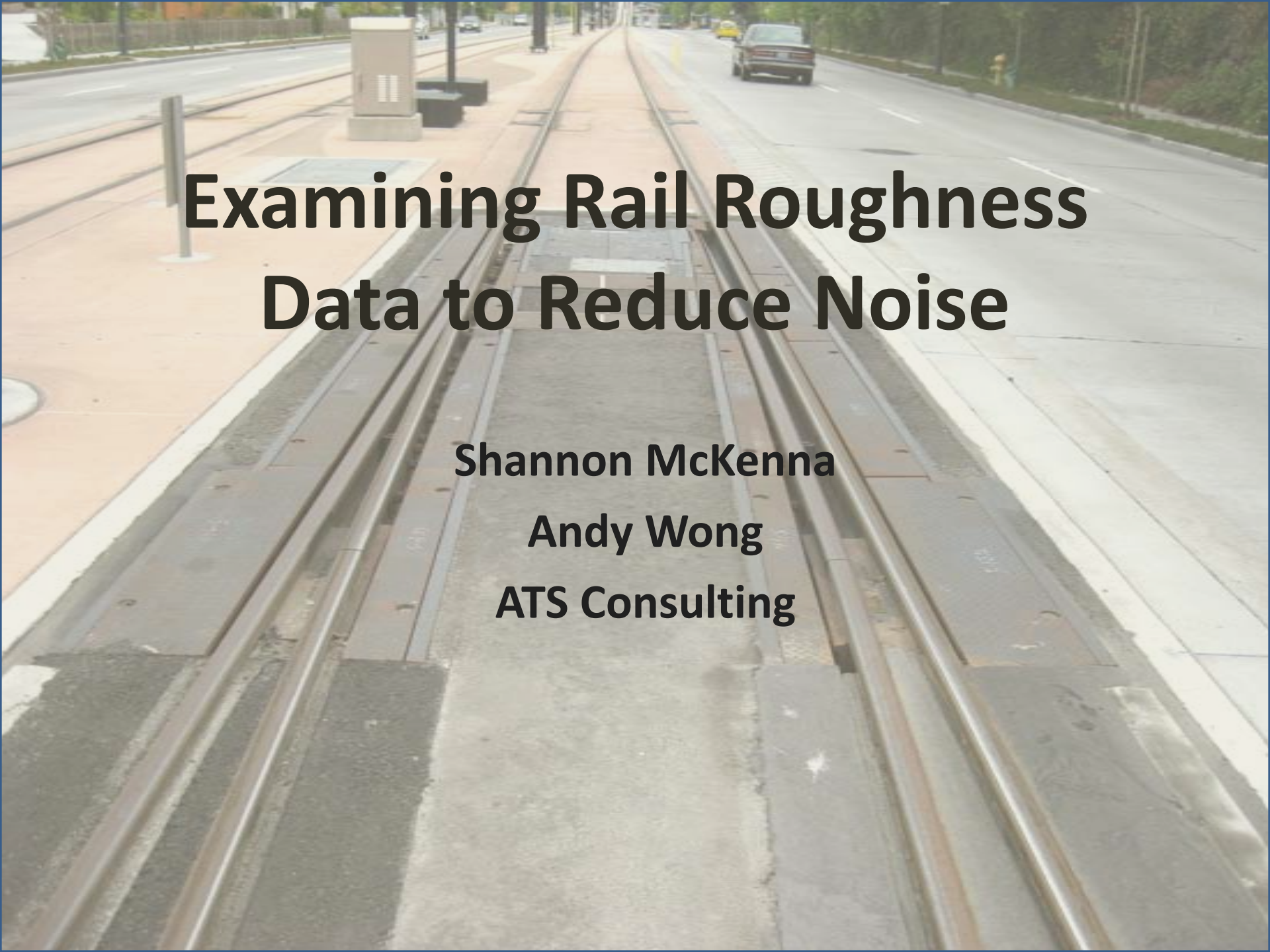


Examining Rail Roughness Data to Reduce Noise

Shannon McKenna

Andy Wong

ATS Consulting

Outline

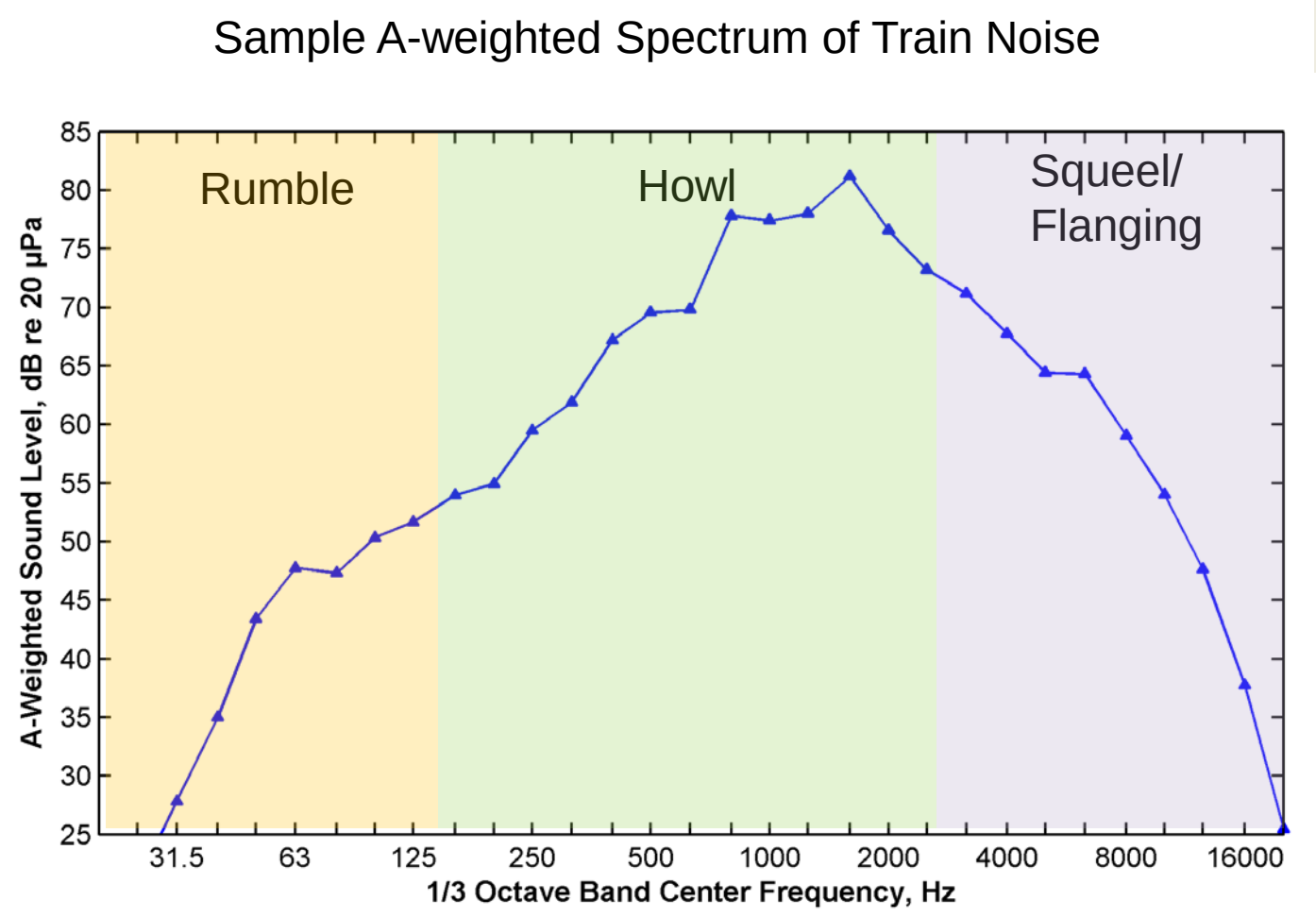
Background of rail noise and corrugation

Rail noise and rail roughness measurement techniques

Case Study: Solving SoundTransit's Rail Noise Problem

- Noise and rail roughness measurements
- Data analysis: 1/3 octave band and FFT

Rail Noise Background



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Rail Corrugation

Corrugation is the pattern of sinusoidal grooves in the rail

Causes ‘howling’ noise in the middle frequency range

$$frequency = \frac{velocity}{wavelength}$$

$$1760Hz = \frac{50mph}{0.5in} = \frac{880in/\sec}{0.5in}$$

Current Rail Noise Measurement Techniques

Wayside and between track noise measurements provide data at one location

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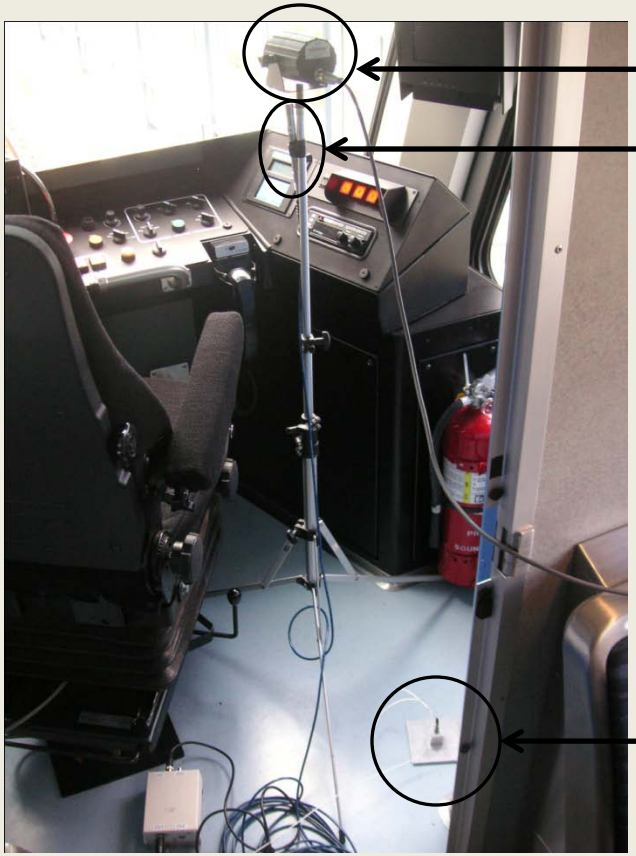
New Rail Noise Measurement Techniques

In-car noise measurements provide data throughout a rail corridor

Operator's Cab →



Radar gun to track location

Microphone

Accelerometer

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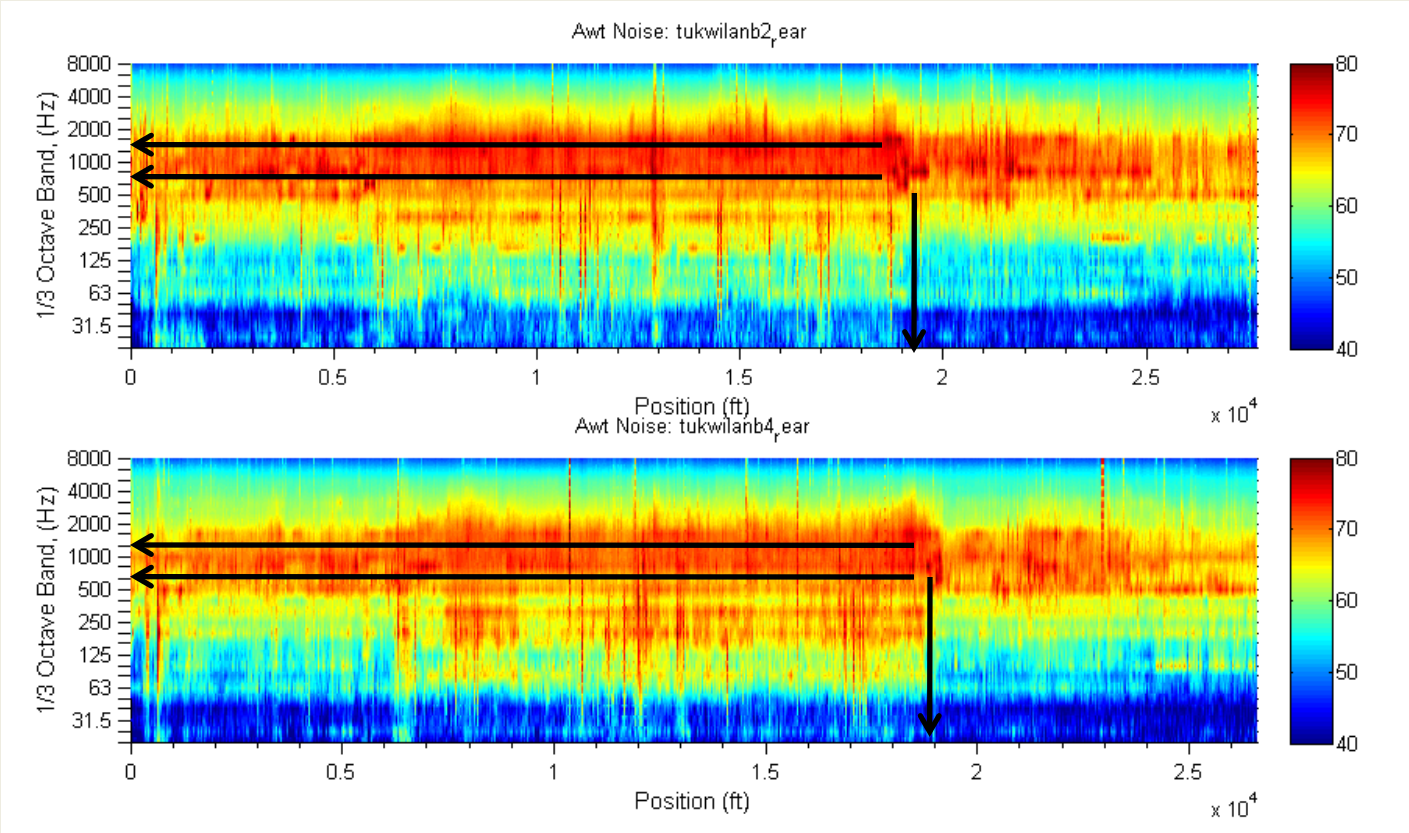
In-Car Noise Measurement Results

In-Car noise measurements identify the location and frequency of potentially corrugated rail



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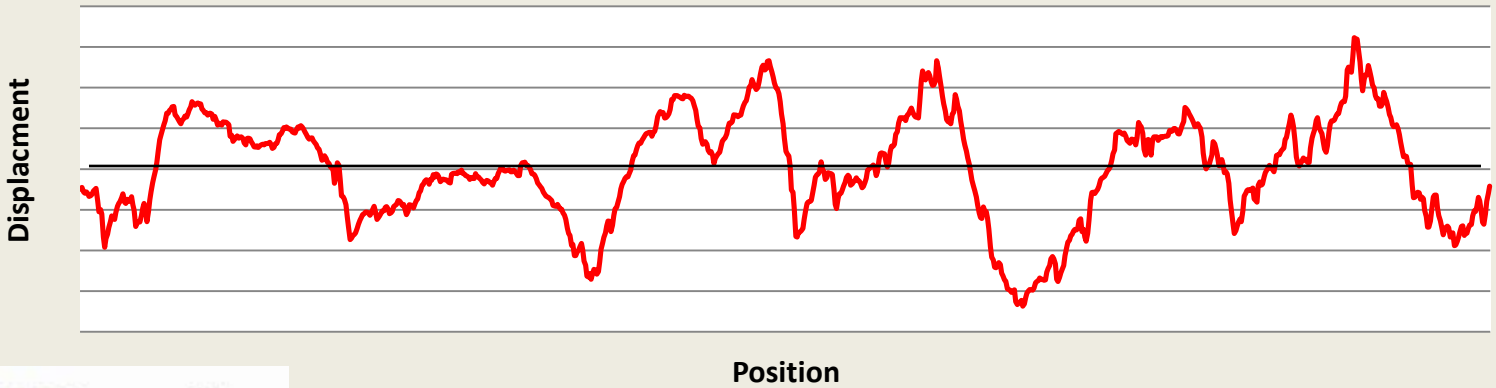
Rail Roughness Measurements

Measure vertical displacement in rail over a small track section



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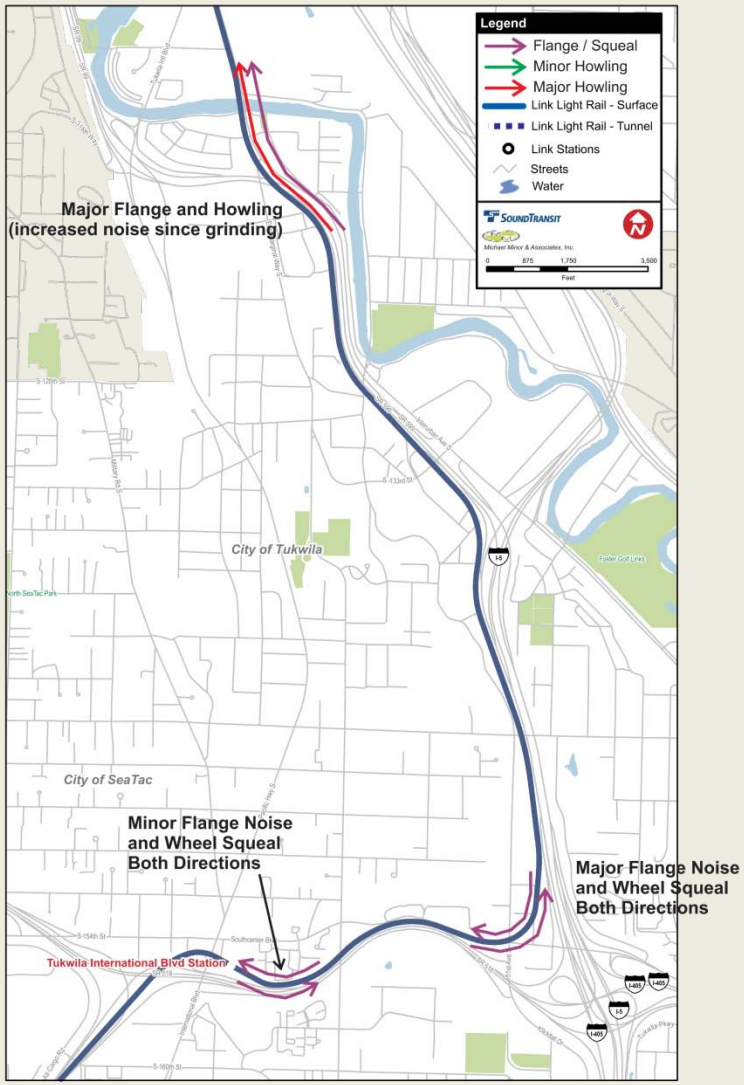
History of Seattle Sound Transit Line

Sound Transit LRT

- Opened in summer 2009
- Immediate noise complaints
- Winter 2010 – regrinding of entire system



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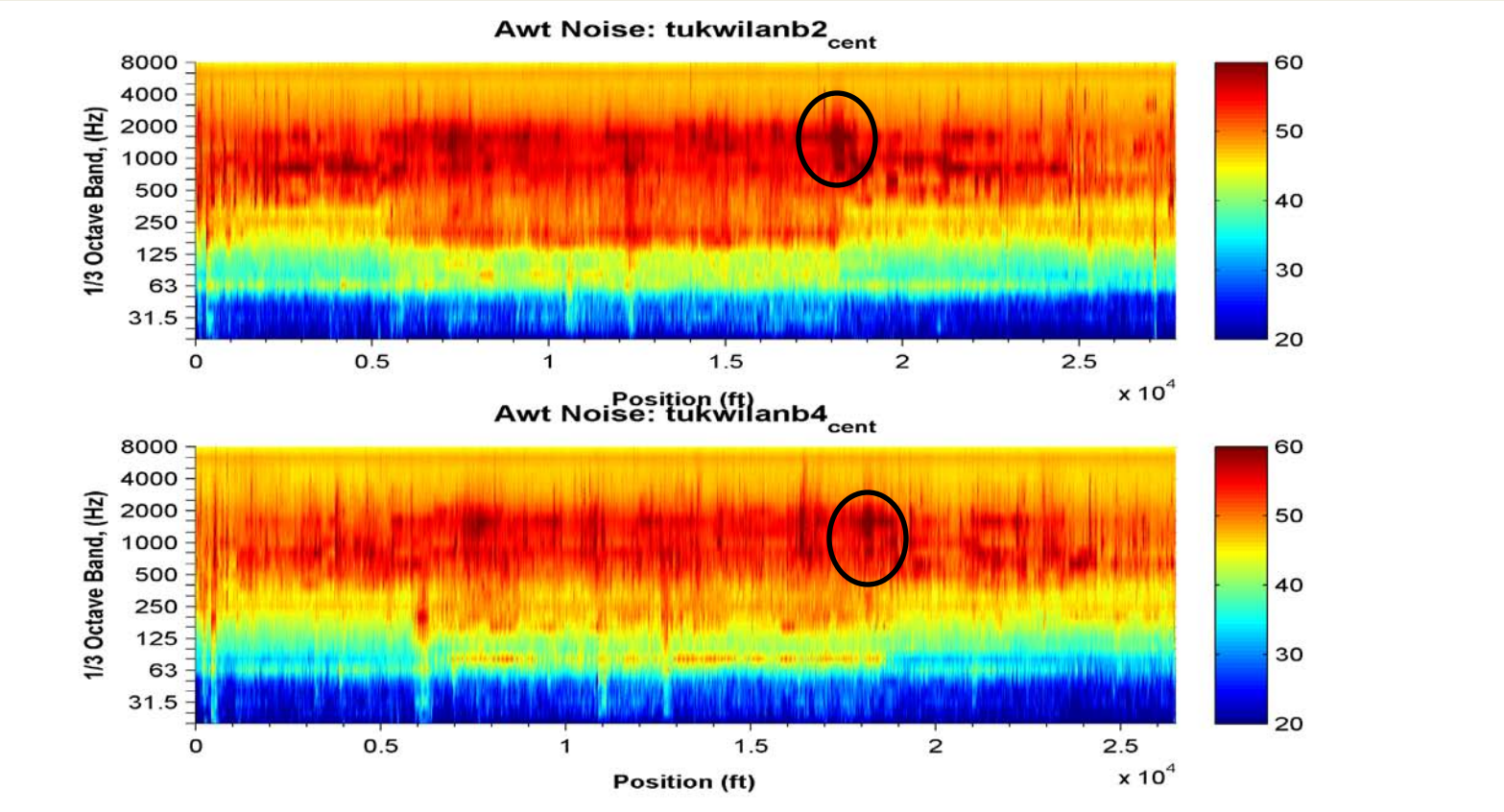
In-car measurements

Covered southern half of alignment

Measurements taken at center and rear of car



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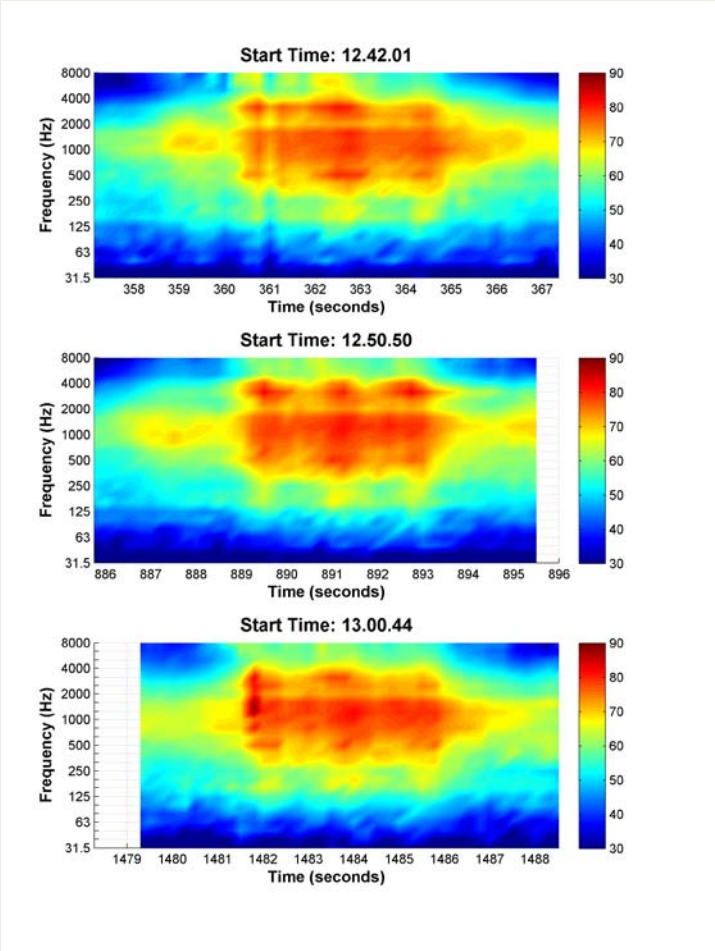
Between track measurements

Measured at 3 locations

- Duwamish River Curve
- 51st Street Curve
- MLK and Ferdinand



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Rail roughness measurements

Measurements taken by Dr. Stuart Grassie:

Left (low) rail **Right (high) rail**

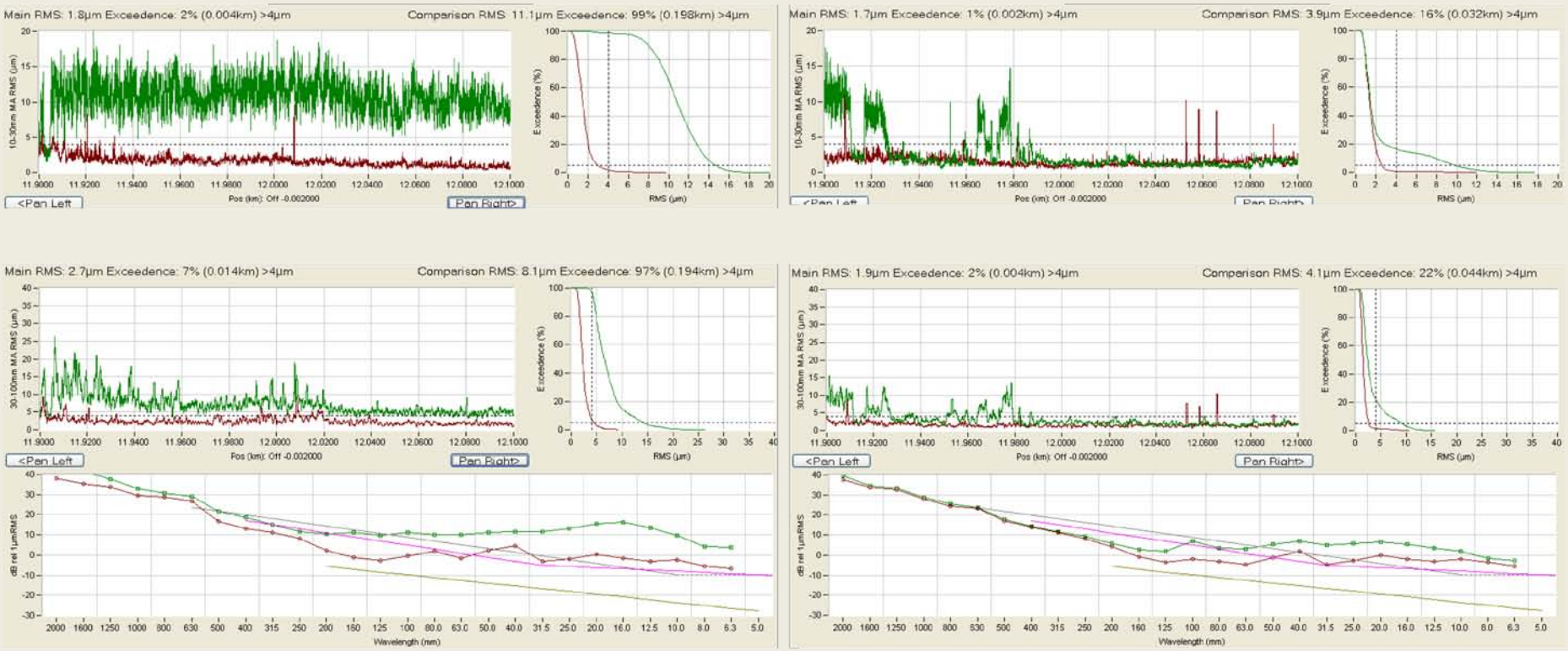

Figure 8 Rail roughness, SB line at 590+6.5 (red from 14th May 2010, green from 11th February 2010)

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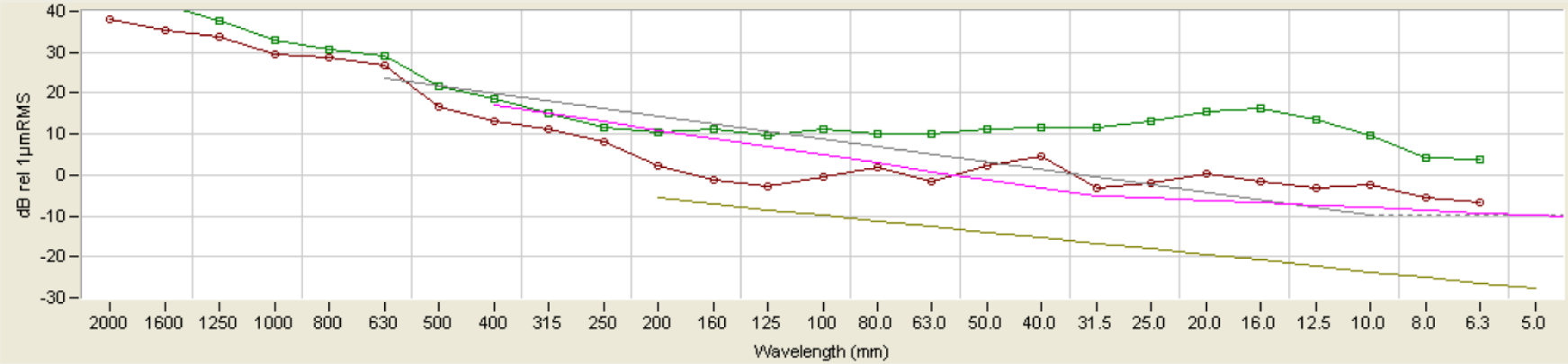
1/3 Octave Band Analysis

Filters signal at 1/3 octave bands and averages the signal

Tends to hide discrete peaks



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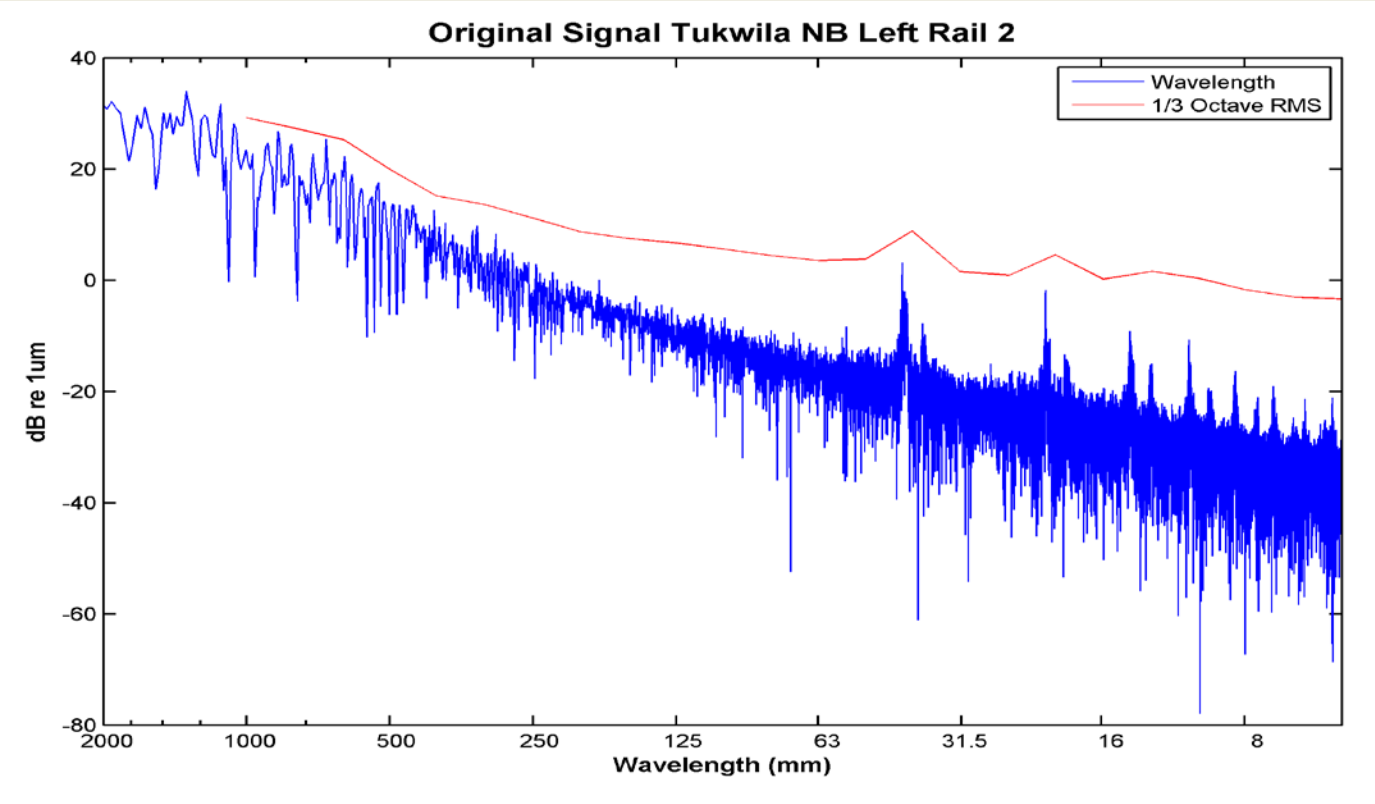
FFT Analysis

Fast Fourier Transform (FFT): converts directly to frequency domain



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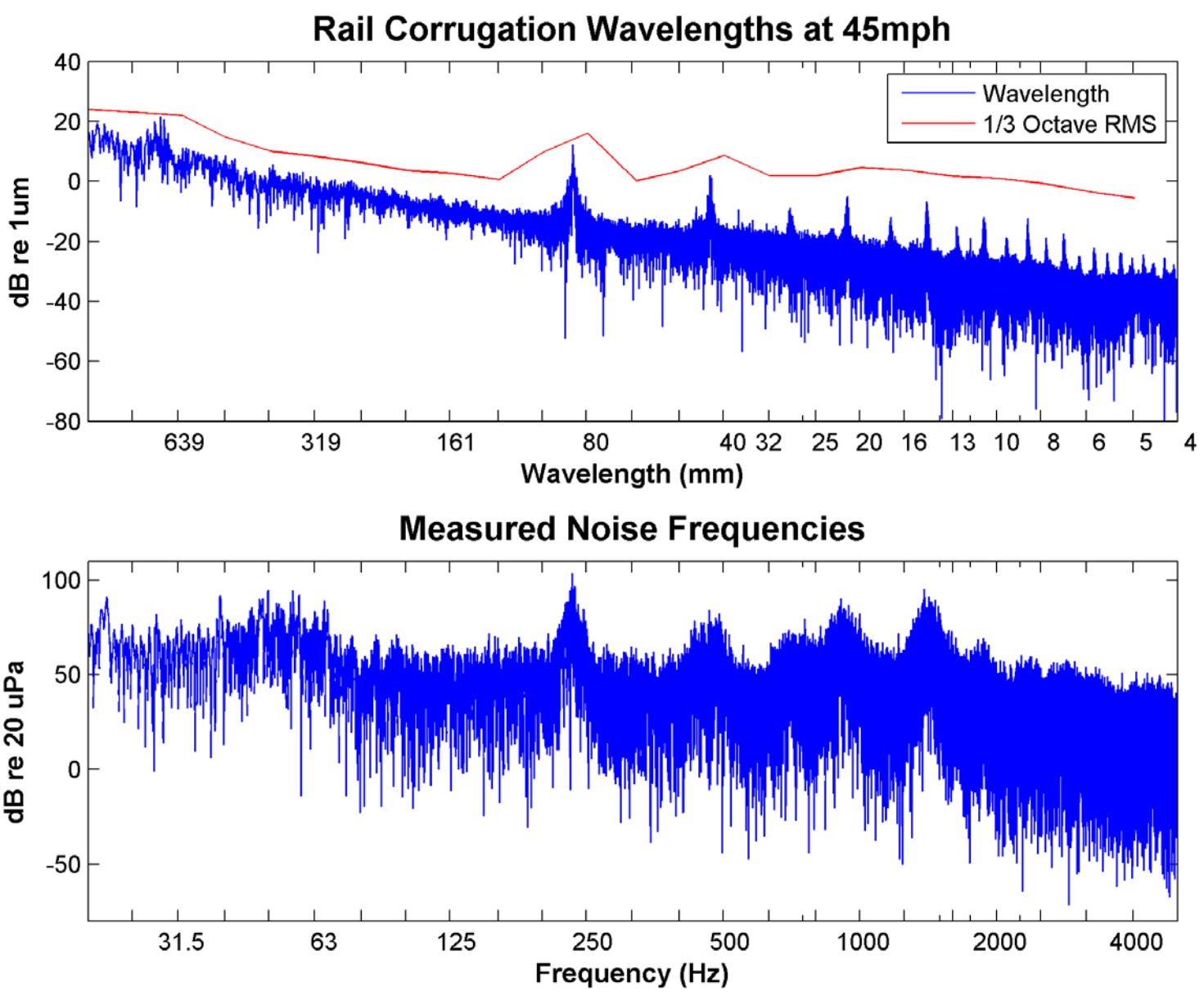

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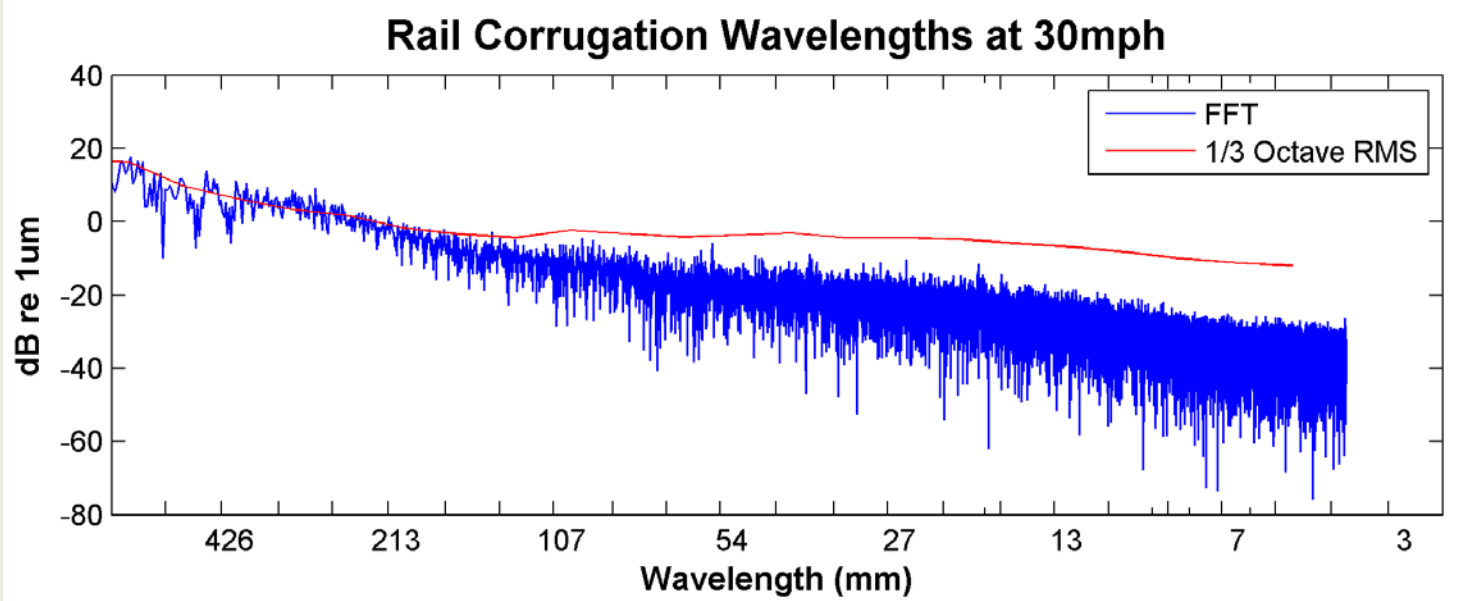

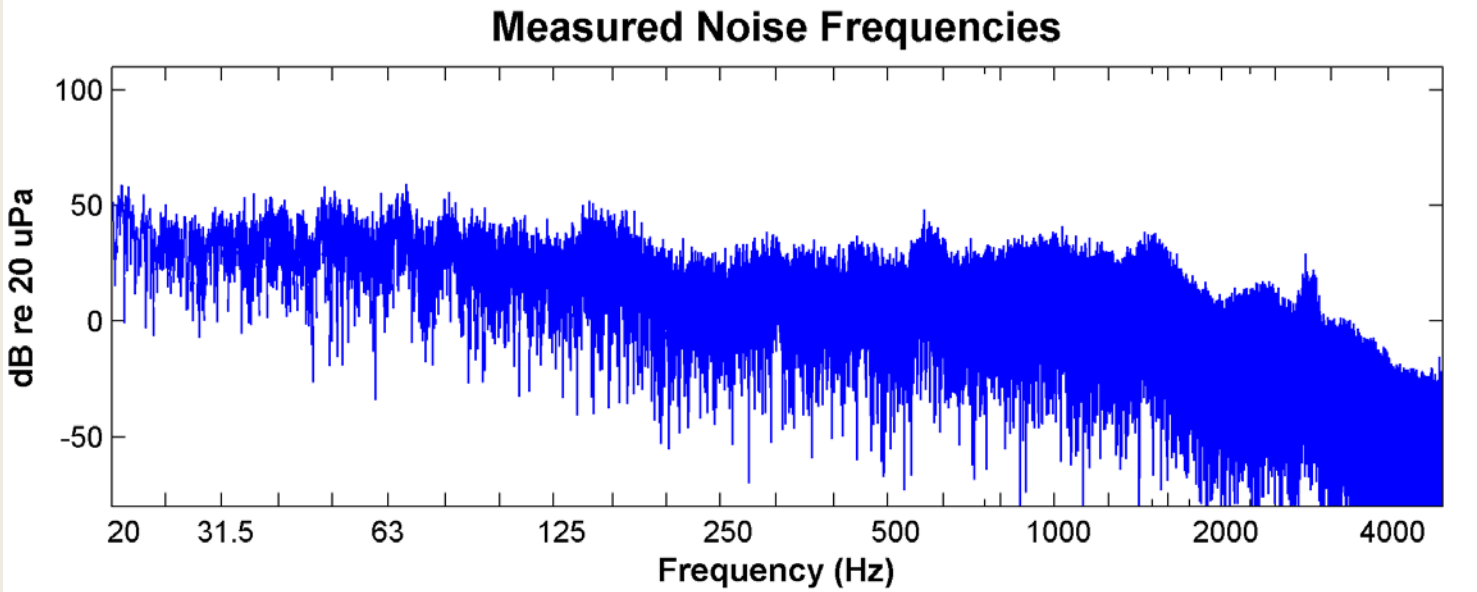

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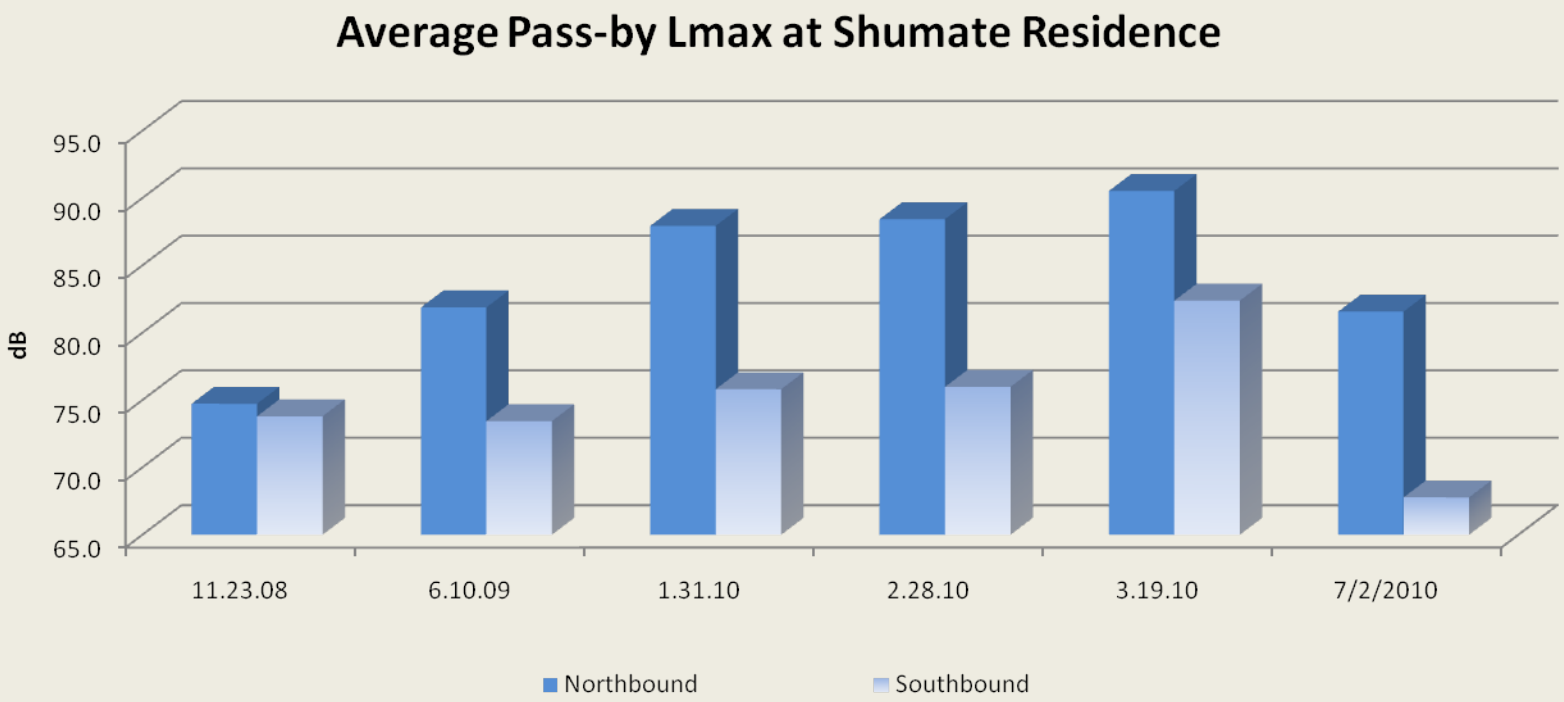
Future of Sound Transit Line

Regrinding was started in June 2010

Already seen improvement in noise at the Duwamish River Curve



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Conclusions

- Rail corrugation can be a major cause of noise
- In-car noise measurements and rail roughness measurements can help identify problem areas
- 1/3 Octave Bands can hide information
  - Narrower frequency bands should be used in analysis
- Specifications for grinding should be implemented and checked

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