

# Wheel & Rail Modernization at San Francisco BART



**Charles Franz**  
Vehicle Systems Engineer  
Rolling Stock & Shops

**Gregory Shivy**  
Principal Track Engineer  
Maintenance & Engineering



RAIL TRANSIT SEMINAR • APRIL 30, 2018



**WRI 2018**

# Agenda

- System Overview
- History of the BART Wheel & Opportunity for Change
- Rail Profile History & Opportunity for Change
- Project & Scope
- Conversion Effort
- Preliminary Results
- Next Steps



# System Overview - Railcars

- ❑ 3 Generations of 679 Cars
- ❑ Accepting 775 New Generation Cars Over 10 Years for a 1,048 Target Fleet
- ❑ 80mph Max Speed
- ❑ Full ATO Operation
- ❑ 63,000lbs Empty, 110,000lbs Loaded
- ❑ 5 ½ ft Track Gauge

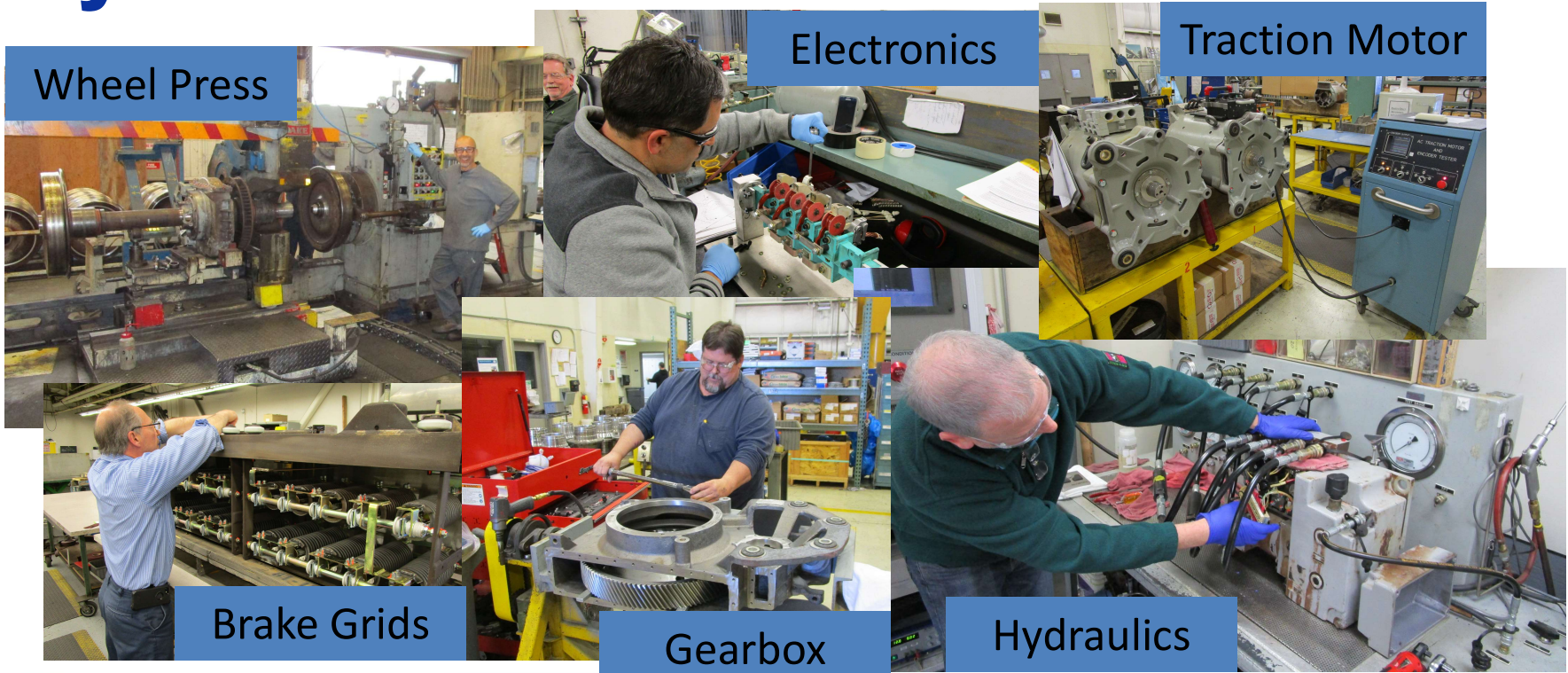


RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

# System Overview – Railcars



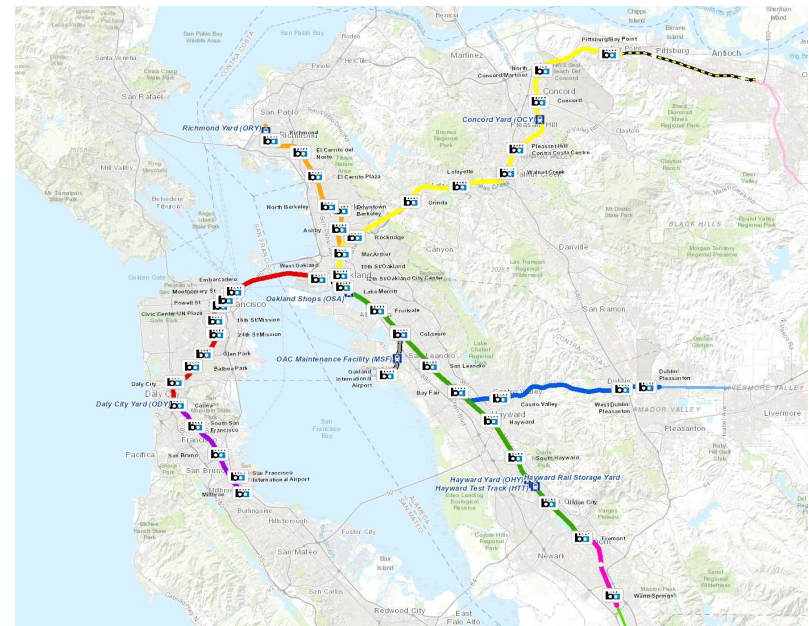
RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

# System Overview - Track

- ❑ 110 Route Miles, 235 Mainline Miles
- ❑ 4% Ruling Grade, 500' Max Curve
- ❑ 28% Aerial DF, 27% Subway DF
- ❑ 45% at Grade Ballasted Tie
- ❑ 29 Interlockings, 289 Mainline Turnouts
- ❑ 119RE CWR & Level Point Frogs



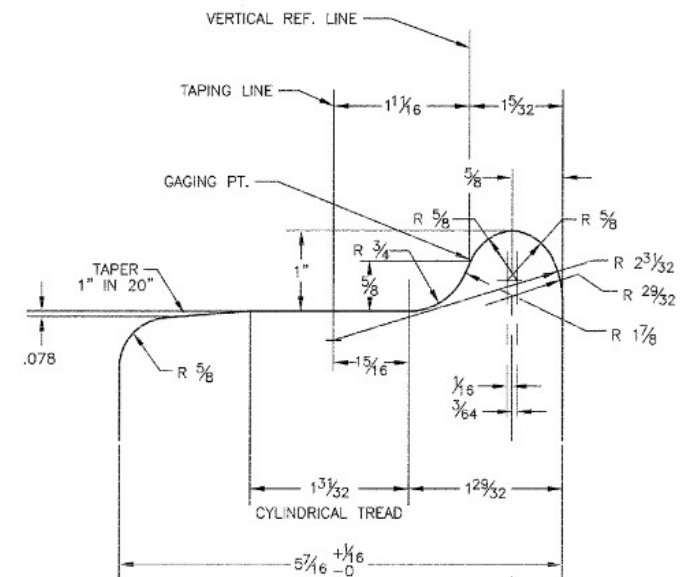
RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

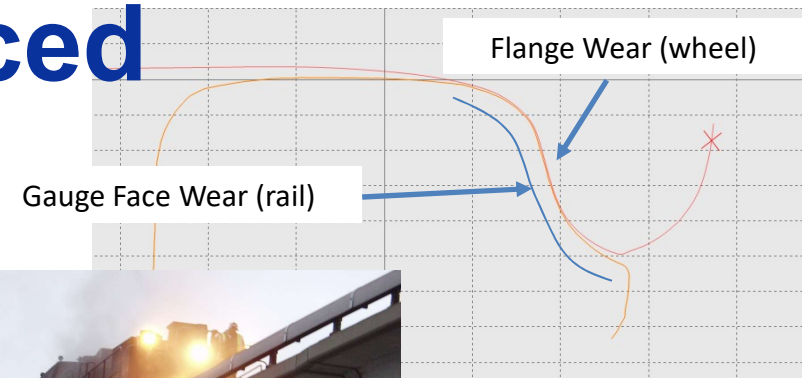
# Why Choose Cylindrical in 1972?

- ❑ Not uncommon at the time, (MUNI, CTA, PATH)
- ❑ Good ride quality
- ❑ Mostly tangent track
- ❑ High speed (80mph)
- ❑ No hunting at high speed on tangent
- ❑ Expected 1 million mile wheel life



# Problems Experienced

- ❑ Relies on flange to steer
  - ❑ Causes premature flange and gauge face wear
  - ❑ Two point contact
  - ❑ Promotes rail corrugation & noise – corrected by grinding
- = High Maintenance & Material Costs**



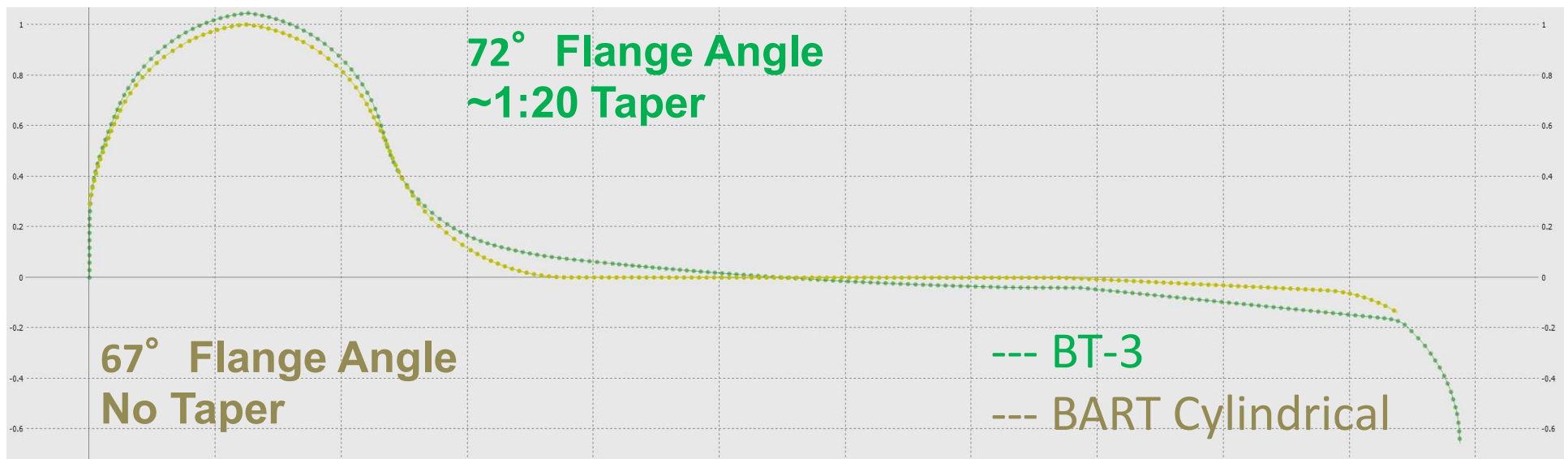
# Opportunity for Change – BT-3

- ❑ Collected profile measurements of BART new and worn wheels and rail
- ❑ Tested ride quality and dynamic characteristics of the network
- ❑ Bombardier confirmed a poor wheel / rail interaction with pervasive two point contact, corrugation, excessive noise, and severe wear
- ❑ Ran simulations to design an optimized wheel profile specific to the BART network
- ❑ Result was the BT-3 modified tapered wheel designed by Bombardier



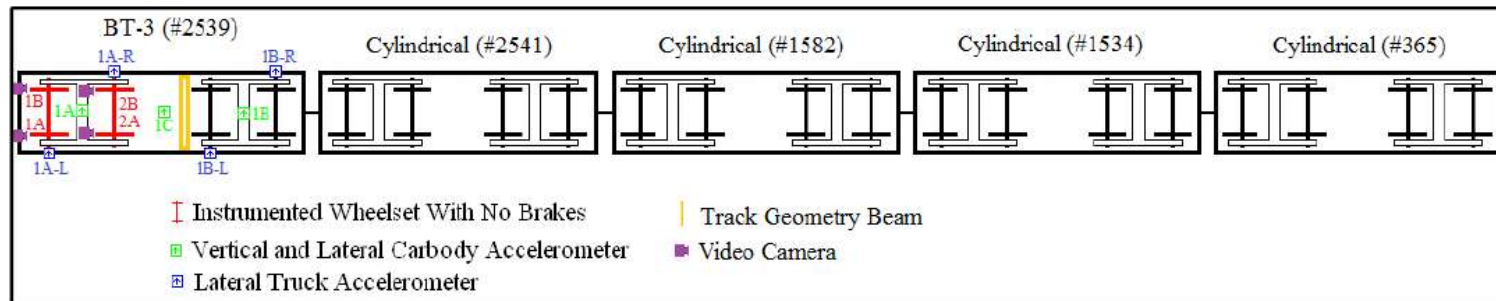


# Opportunity for Change – BT-3



# BT-3 Evaluation – ENSCO / LTK

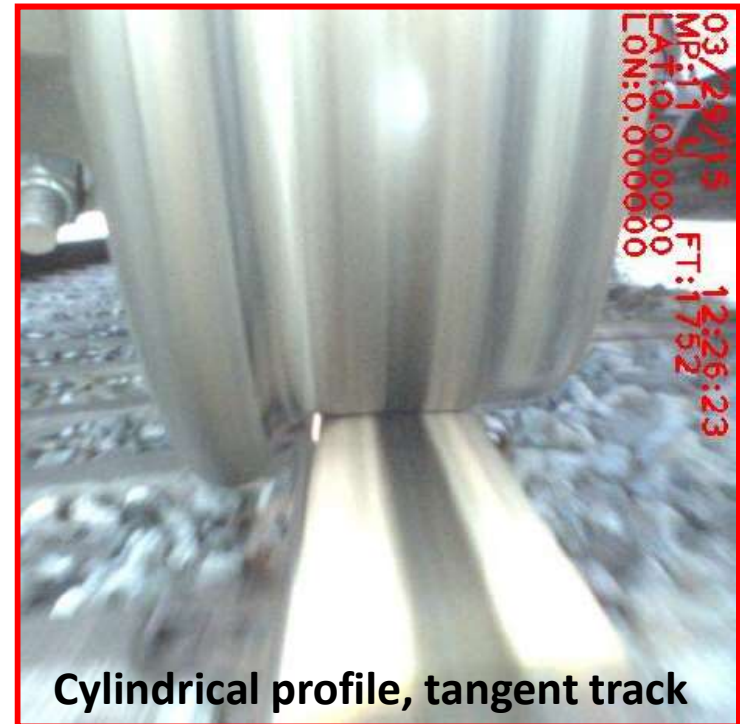
- ❑ Dynamic mainline tests of BT-3 with instrumented wheelsets
- ❑ Track geometry and rail profile map of the system
- ❑ Special trackwork compatibility analysis
- ❑ Computer simulation to corroborate Bombardier analysis



# BT-3 Evaluation – ENSCO / LTK



BT-3 profile, tangent track



Cylindrical profile, tangent track



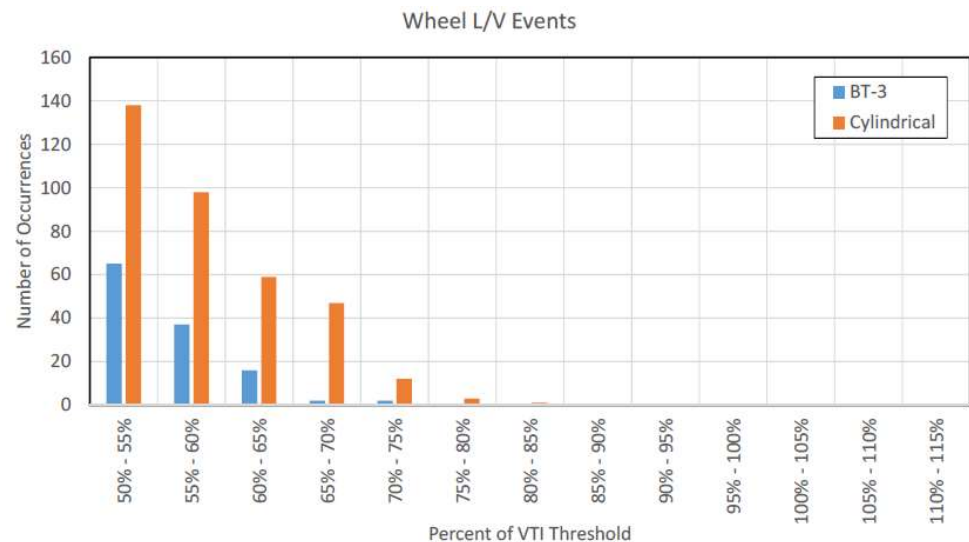
# BT-3 Evaluation – ENSCO / LTK

## □ ENSCO and LTK confirmed definite operational improvements

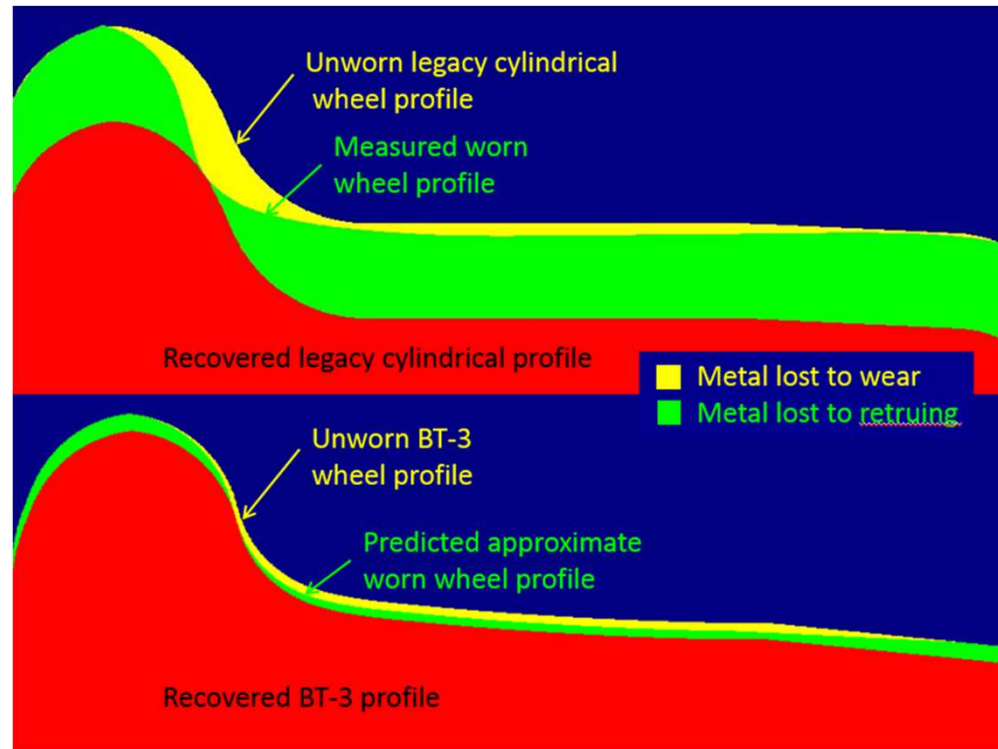
- Safe
- Compatible with special track work
- Good stability and ride quality

## □ Confirmed long term expectations

- Slower corrugation growth
- Reduced wear
- Less noise

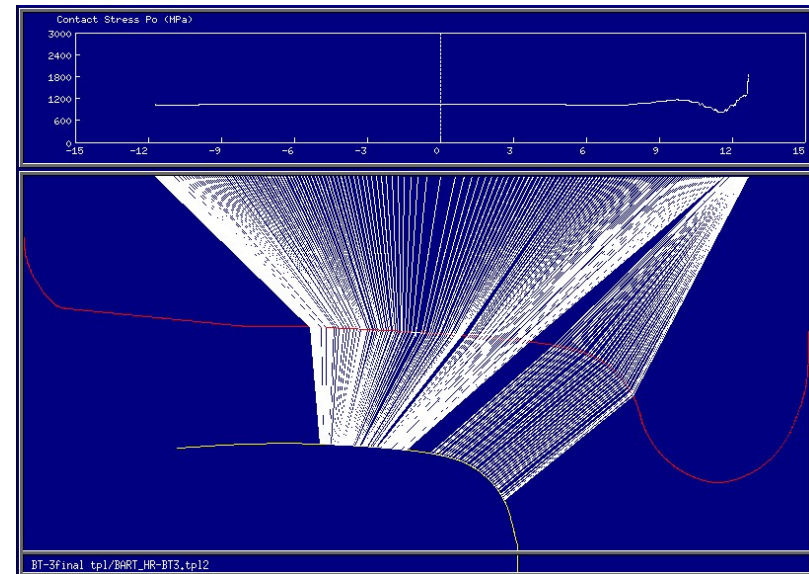


# BT-3 Evaluation – ENSCO / LTK



# Rail Profile Opportunity

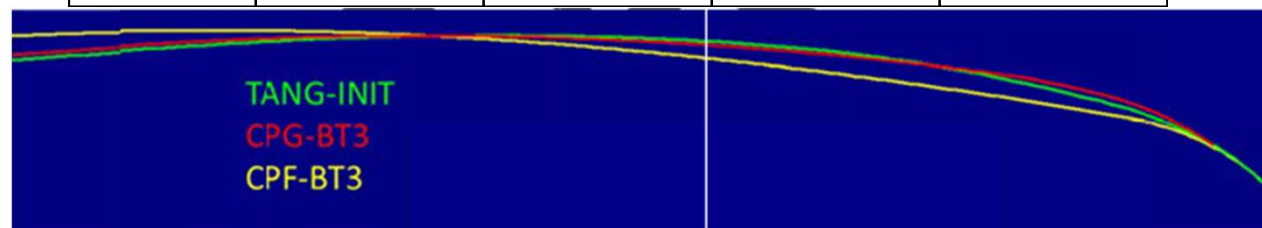
- ❑ BART used singular profile predominantly over its history, concentrates wear in BT-3 wheels.
- ❑ Contracted with National Research Council of Canada & Eric Magel to develop 4 optimized rail profiles to complement BT-3 and minimize wear.
- ❑ Replacing / grinding level point frogs to tapered point AREMA design.



# Rail Profile Opportunity

- Grind for new rail profile based on new BT-3 wheel over 6 years.
- Grind in three strategic stages as BT-3 equipped fleet grows to maximize grind time and effectiveness.

	High rails	Low rails	T1 tangent	T2 tangent
stage 1	HR_int	LOW_int	TANG-init	TANG-init
stage 2	HR_int	LOW_BT3	CPG_BT3	CPF_int
stage 3	HR_BT3	LOW_BT3	CPG_BT3	CPF_BT3



# Project & Scope

## RS&S



- ❑ **CONVERT** – 669 railcars by cutting or replacing – projected completion Nov '18, 1.5yrs total.
- ❑ **ANALYZE** – Monitoring 200 wheels with MiniProf and soon GoPro video for 6 years.
- ❑ **OPTIMIZE** – Review condemning limits, preventative cutting.

## M&E



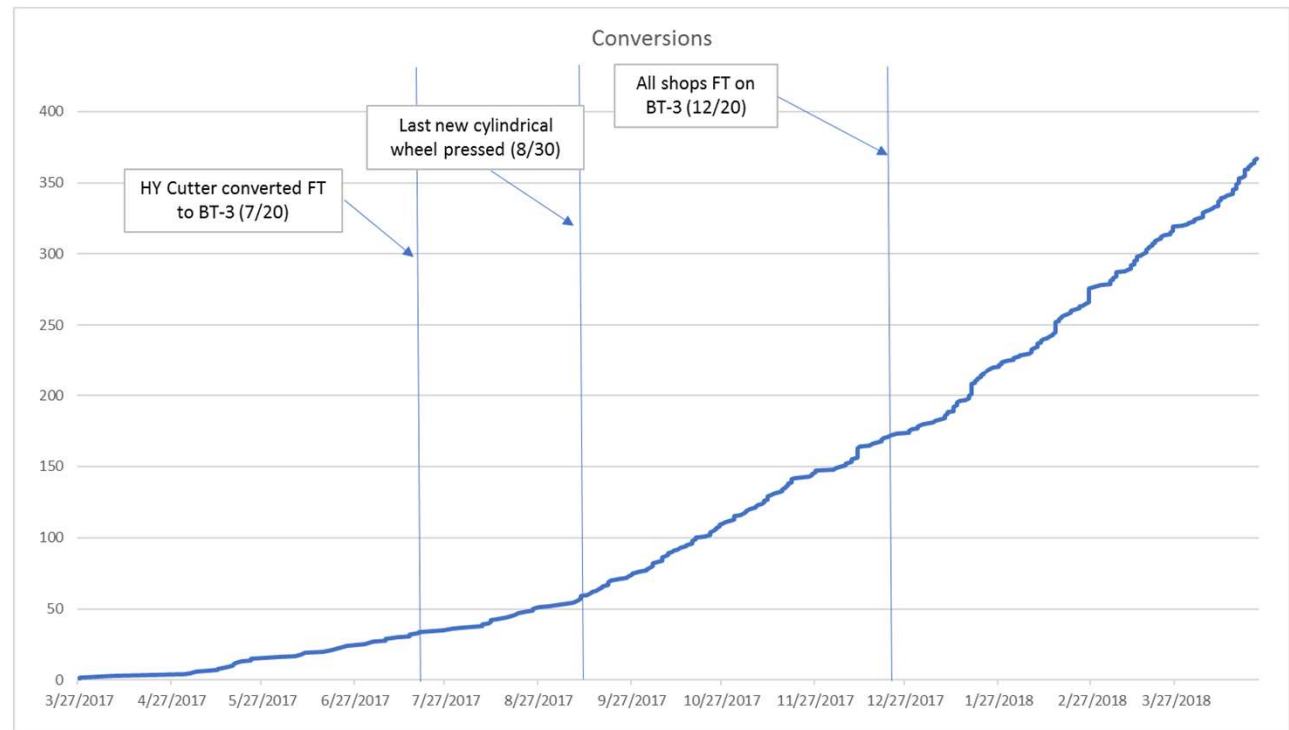
- ❑ **CONVERT** – Grinding 4 new profiles (high, low, 2 directional tangents) with interims over 6 years.
- ❑ **ANALYZE** – Monitoring 50 critical rail locations with MiniProf, mag-particle, photographs.
- ❑ **OPTIMIZE** – Preventative grinding, and friction management study.





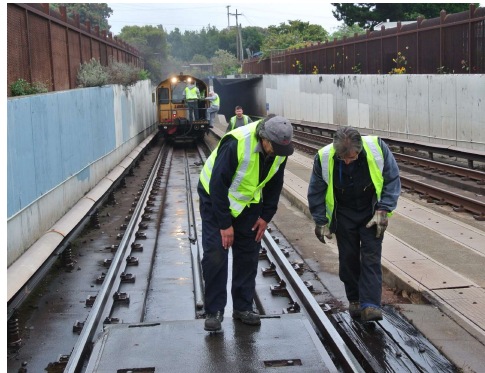
# Conversion Effort - Wheels

- ❑ 367 cars converted, 55% of fleet.
- ❑ Converting 11 cars/week.
- ❑ Expected completion November 2018
- ❑ 745 wheels inspected since March 2017.



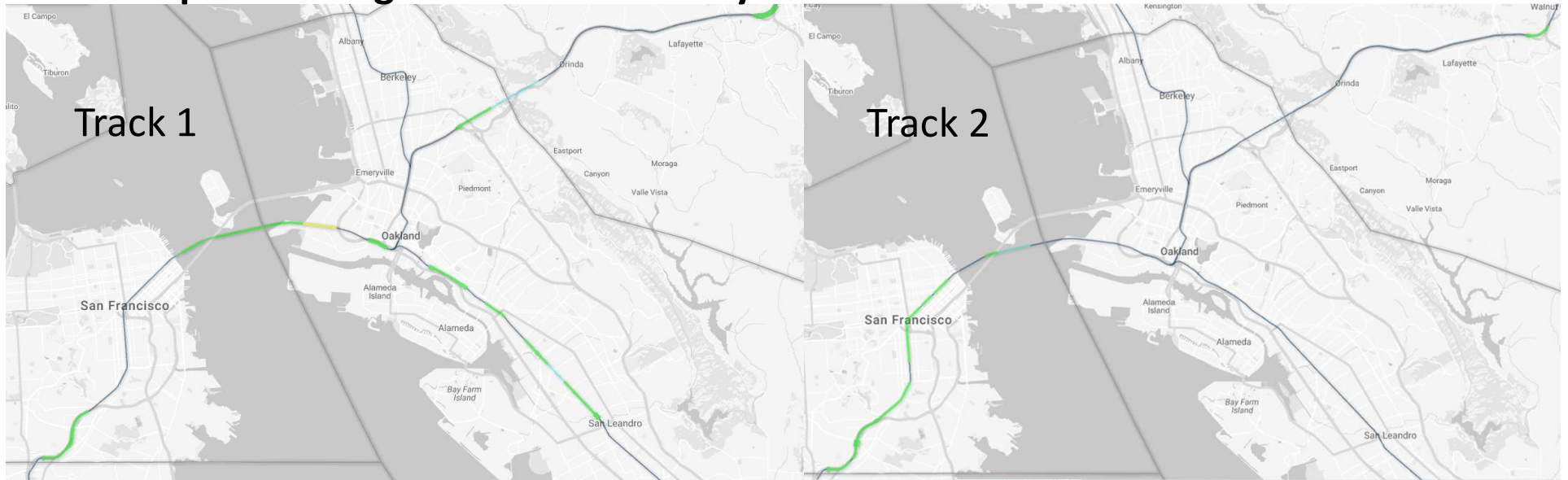
# Conversion Effort - Rails

- ❑ Contract with Advanced Rail Management to assist in grinding strategy and operator training.
- ❑ Reassigning grinder operators to line-specific reporting locations to optimize spark time.
- ❑ Grinder availability currently at 30%, contract with Loram to train 6 grinder maintenance personnel.



# Conversion Effort - Rails

- ☐ 36 total miles ground since January 2018
- ☐ 278 pass miles ground since January 2018



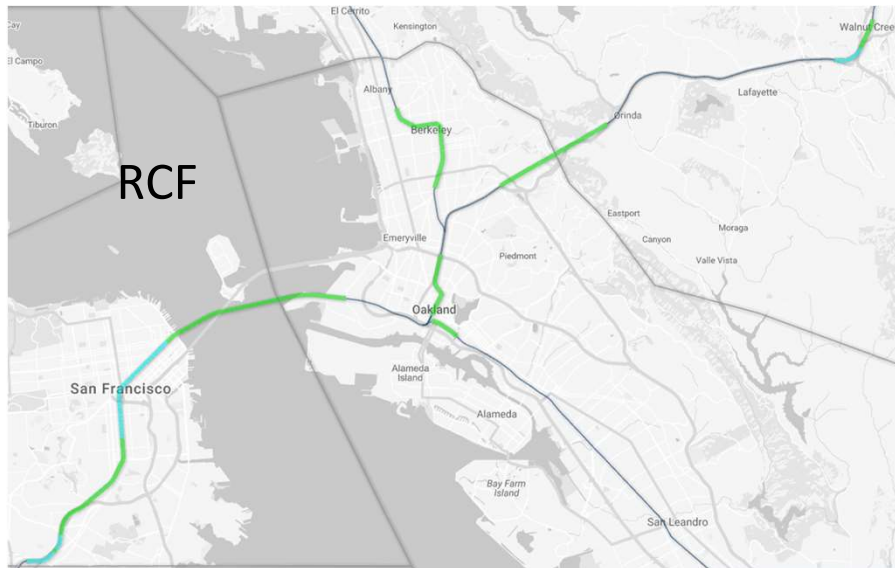
RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

# Conversion Effort - Rails

- Pre / post eddy current measurement of RCF – 84 miles since Jan 2018
- Pre / post cat trolley measurement of corrugation – 31 miles since Jan 2018



RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

# Conversion Effort - Rails

- ❑ 50 locations wayside
- ❑ Monitoring 3x/year
- ❑ MiniProf, Mag-Particle, photographs

W2 MP 17.20 E H

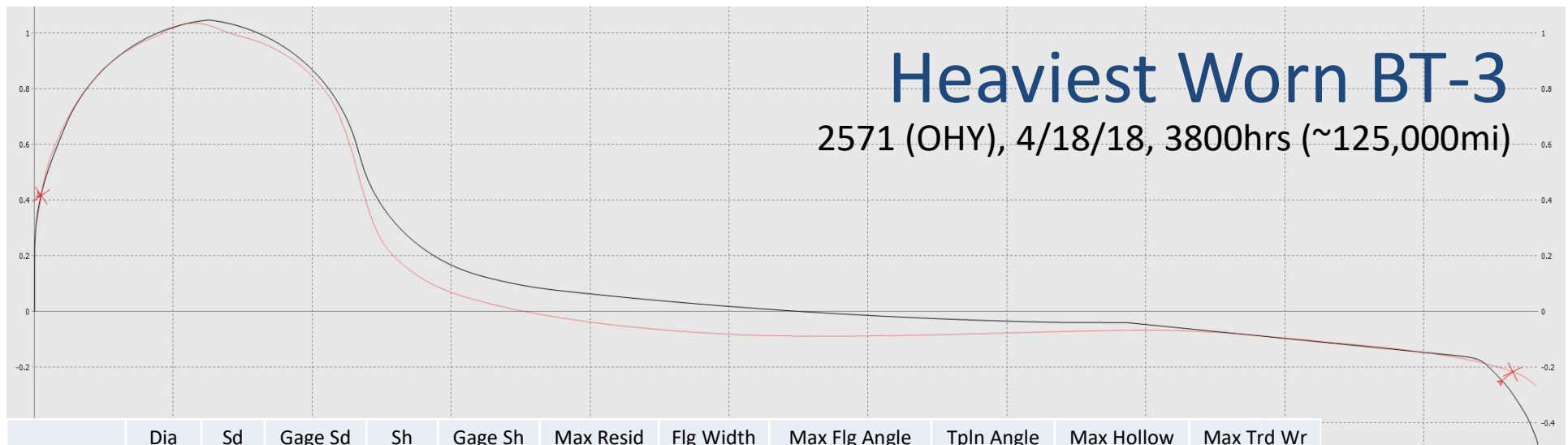
Rail Details and MT		Images	
Line: W		06/04/17	
Track: W2			
Milepost: 17.20			
Rail: East			
Curve: TRUE			
Section: 119RE			
Rolled: Nov-88			
Magnetic Particle Test	Test	FALSE	Magnetic Particle Test Results
	Max	0.000	
	Min	0.000	
	Avg	0.000	
	Gauge	NDA	
<b>AREMA 4.2 Condition</b>			
Corr	FALSE		
k	0.00		
Amp	0.00		
Gauge	TRUE		
Width	NDA		
Pos	Undefined	Surface Condition	
Spall	FALSE		
Rough	NDA		
Check	FALSE		
Flake	FALSE		
Spall	LIGHT		
Shell	FALSE		
<b>MiniProf or Manual</b>			
Area	NDA		
Top Wear	0.1539		
Side Wear	-0.0396		
GFA	NDA		
Metal to Rem	NDA		
Area ↑ Target	NDA	MiniProf Measurement	
Area ↓ Target	NDA		
Grind Quality	NDA		
Top	NDA		
Gauge	NDA		
Field	NDA		
Pre/Post Grind	BASE		

W2 MP 17.20 E H

Rail Details and MT		Images	
Line: W		01/28/18	
Track: W2			
Milepost: 17.2			
Rail: East			
Curve: TRUE			
Section: 119RE			
Rolled: 3248			
Magnetic Particle Test	Test	FALSE	Magnetic Particle Test Results
	Max	0	
	Min	0	
	Avg	0	
	Gauge	NDA	
<b>AREMA 4.2 Condition</b>			
Corr	FALSE		
k	0.00		
Amp	0.00		
Gauge	TRUE		
Width	NDA		
Pos	Undefined	Surface Condition	
Spall	FALSE		
Rough	NDA		
Check	FALSE		
Flake	FALSE		
Spall	LIGHT		
Shell	FALSE		
<b>MiniProf or Manual</b>			
Area	NDA		
Top Wear	0.1450		
Side Wear	0.1050		
GFA	NDA		
Metal to Rem	NDA		
Area ↑ Target	NDA	MiniProf Measurement	
Area ↓ Target	NDA		
Grind Quality	NDA		
Top	NDA		
Gauge	NDA		
Field	NDA		
Pre/Post Grind	BASE		



# Preliminary Results



	Dia	Sd	Gage Sd	Sh	Gage Sh	Max Resid	Flg Width	Max Flg Angle	TpIn Angle	Max Hollow	Max Trd Wr
Measured	29.420	1.235	0	1.124	18	0.104	1.113	74.25	1.011	0.022	0.104
Reference	30	1.26	0	1.053	17	0	1.132	72.3	3.5	0	0
Difference	0.581	0.025	0	-0.071	-1	-0.104	0.019	-1.950	2.489	-0.022	-0.104

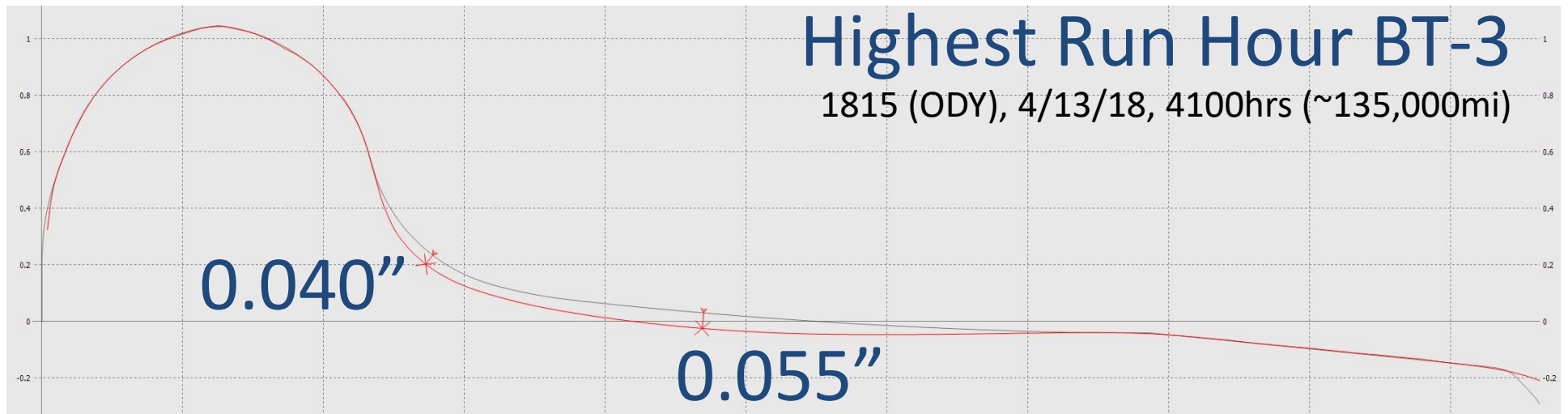


RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

# Preliminary Results



RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018

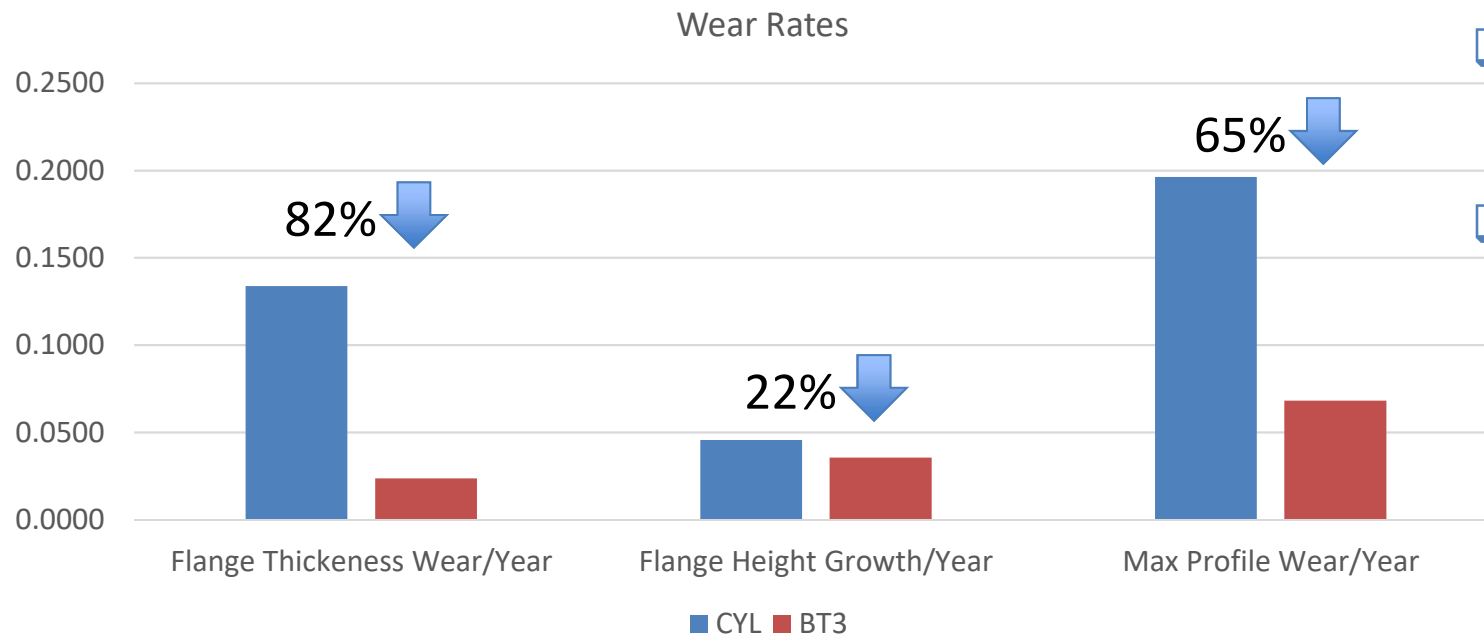
# Preliminary Results





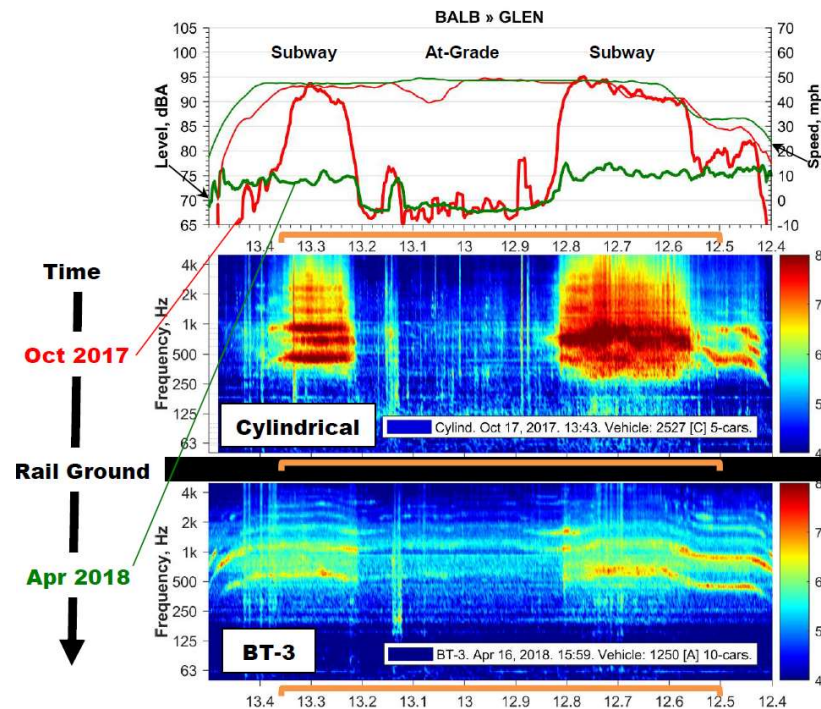
# Preliminary Results

- 533 BT-3 wheels
- 120 CYL wheels
- Assumes 10.45hr run days per 365 days/year



# Preliminary Results

- Preliminary study showing the biggest improvement from about 94dB to 74dB.
- Anticipate further noise reductions when rail grinding strategy implemented.



# Next Steps

- Grinder overhaul / supplementary grinder contract – 1 year
- Friction management
- Wheel condemning
- Wayside detector



# Conclusion - Q&A



RAIL TRANSIT SEMINAR • APRIL 30, 2018



WRI 2018