

# **BART's Next Generation Fleet: Migration to a Contoured Wheel Profile**

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PreScience

Canada  
NRC-CNR

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# Outline

1. The BART system
2. Planned changes
3. Designing for migration
4. Managing the process



# BART System

- Created by State Legislature in 1957
- Began Operation in 1972
- Length: 112 Route Miles
- Stations: 46
- Gauge: 66 Inch
- Power: 1000 Volt Third Rail



# BART Vehicles

- Number: 669 Existing Revenue Vehicles
- Propulsion: Four 150 HP 1000 VDC Motors (All Axles)
- Construction: Aluminum body
- Axle Load: 27,500 lb. (Crush Load)
- Speed: 80 MPH Maximum
- MGT: 30 MGT Yearly on heaviest lines



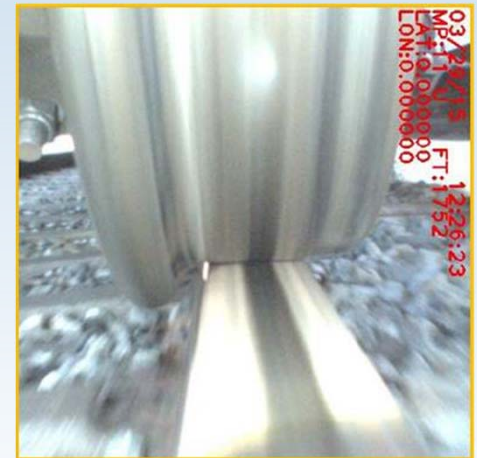
# Operations

- Operation: Fully Automated (Normal operation)
- Manual: Maximum 25 MPH (Road Manual)
- Crew: One Operator
- Train Length: 10 Car Maximum (Limited by Platform)
- Passengers: 435,000 Average Weekday
- Maintenance: Less than 24 hours available each week
- Operating Hours: 0400 to 0130 Weekday (21.5 Hours)  
0600 to 0130 Saturday (19.5 Hours)  
0800 to 0130 Sunday (17.5 Hours)



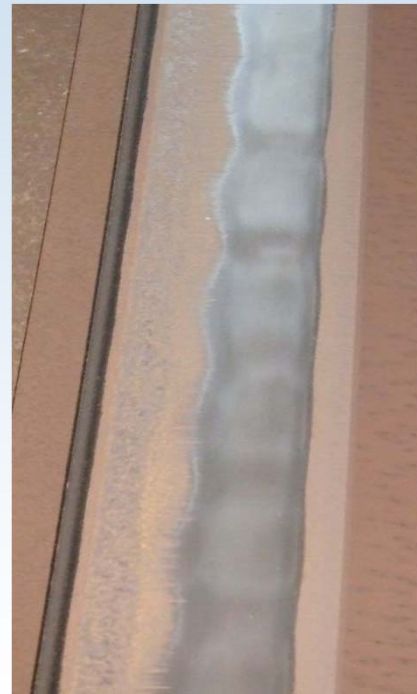
# Legacy (Cylindrical) Wheel Profile

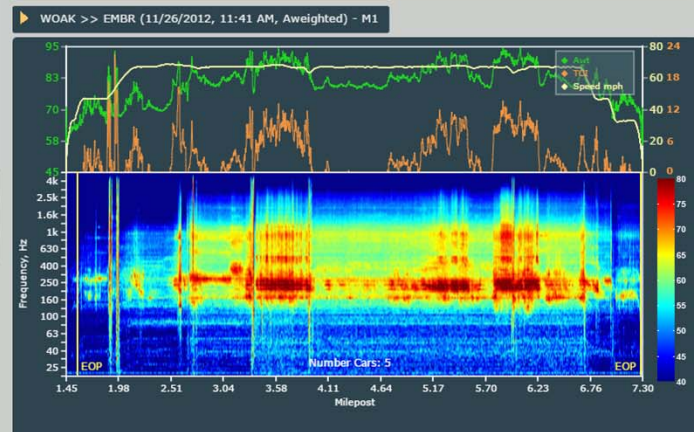
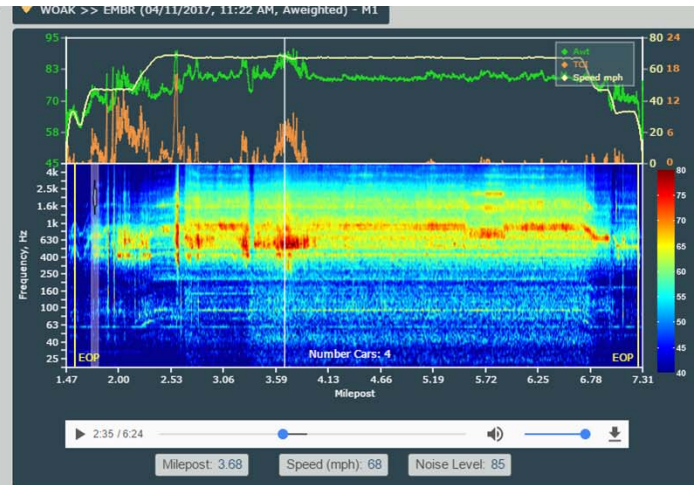
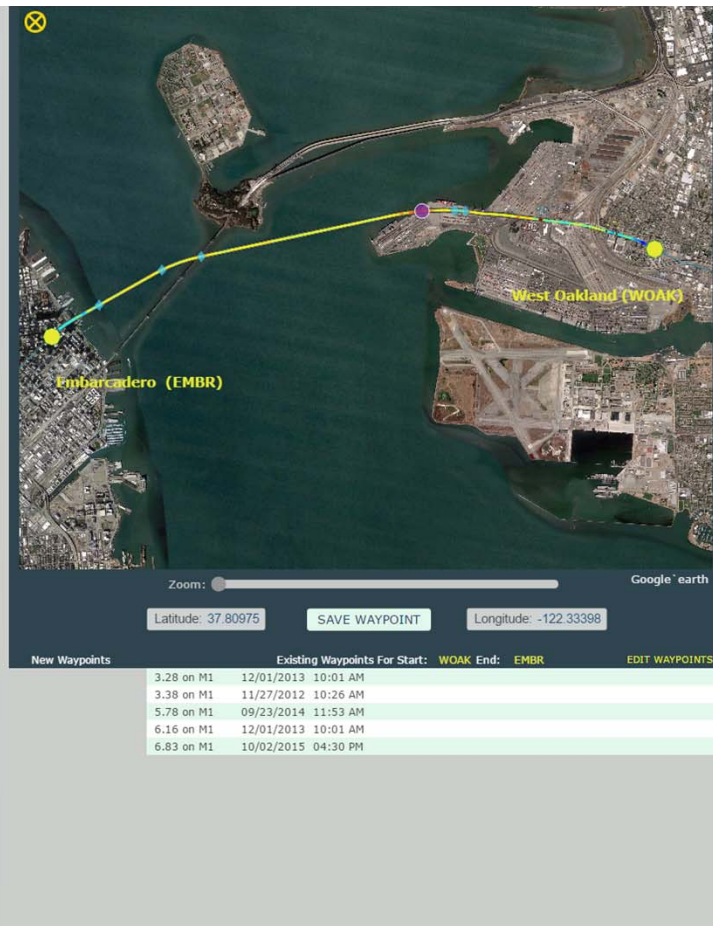
- BART is only system operating with cylindrical wheel at high speed
- Based on 1973 Study:
  - Measured Horizontal and Vertical Accelerations in side-frame, floor, and axle journal for several wheel profiles
  - Concluded that there was no appreciable difference in wheel profiles
- Acceptable performance when wheel and rail were new
- Problems accelerated as system aged



# Current W/R challenges

- Wheels replaced at or before 324,000 miles (average)
- Rail head corrugations
- Rolling contact fatigue
- Repetitive grinding effort targeted
- Reduced rail life
- Wheel and rail noise

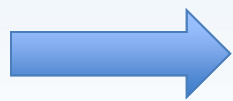




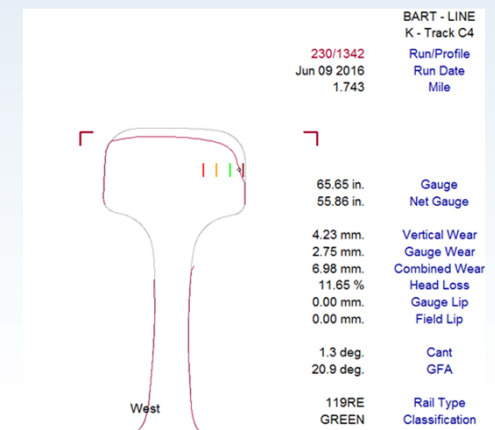


# Current Efforts at BART

- Improve measurement capabilities
- Automate data collection
- Automate data analysis
- Focus on trends as well as exceptions
- Adopt predictive rather than reactive approach



- Improve VTI
- Increase Rail and Wheel Life



# A new era at BART

- Over next five years
  - Will accept 775 new cars from Bombardier
    - All will arrive with new wheel profile (BT-3)
  - New rail purchase (to new shape?)
  - Upgrade rail grinding practices



# A (radically) new wheel profile



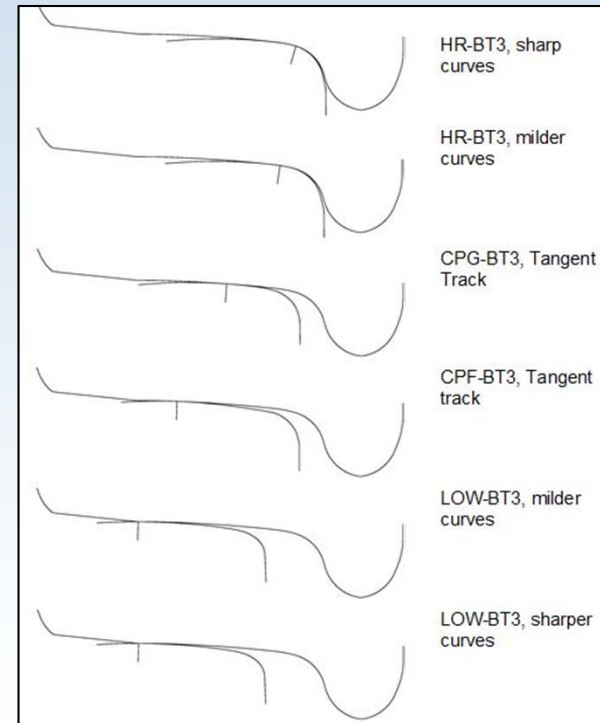
# Design of new rail profiles

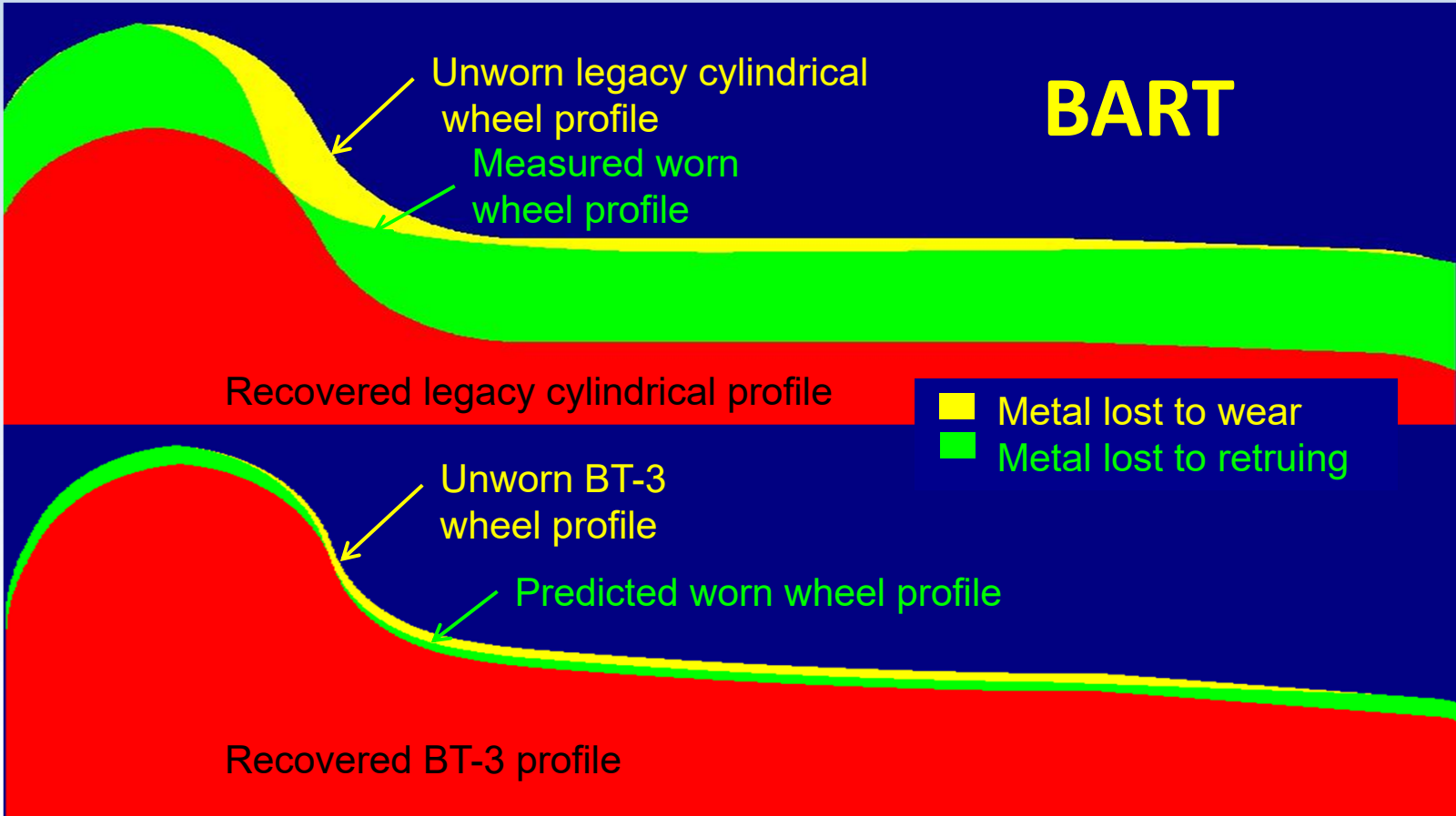
- Control contact stress
- Reduce wear
- Minimize grinding
- Spread wear across wheel



# Design of new rail profiles

- 1 high
- 1 low
- 2 tangent
  - CPG
  - CPF





		baseline conditions		new designs		transitional states		
Wheels		legacy	BT3	legacy	BT3	legacy	BT3	
Rails		worn	worn	legacy	BT3	BT3	legacy	
Frictional work	mild curves							
	contact	2 pt	1 pt	1 pt	1 pt	1 pt	1 pt	
	high	840/26	11.8	27.4	11.8	26	11	
	low	29	9.12	8.4	8.9	6.5	9	
	sharp curves							
	contact	2pt	2pt	1 pt	2 pt	1 pt	2pt	
high	1859/93	239/48	158	132/119	111	182/47		
low	160	81	71	80/71	48	83		
contact stress	mild curves							
	high	626/875	1451	937	1026	861	1962	
	low	1176	1380	1319	926	1351	926	
	sharp curves							
	high	758/772	1116/950	935	1034	1466	1778/1239	
	low	1175	1388	1314	2348	1351	926	



# Interim shapes

Average measured worn low rail  
LOW\_INT  
LOW\_BT3

Average measured worn tangent rail (TANG\_INIT)  
CPF\_INT  
CPF\_BT3





# Rail Profile Implementation

Grinding Cycle	High rails	Low rails	1/2 tangent	1/2 tangent
1	HR	LOW_int	CPG	CPF_int
2	HR	LOW	CPG	CPF_int
3	HR	LOW	CPG	CPF



# Concerns

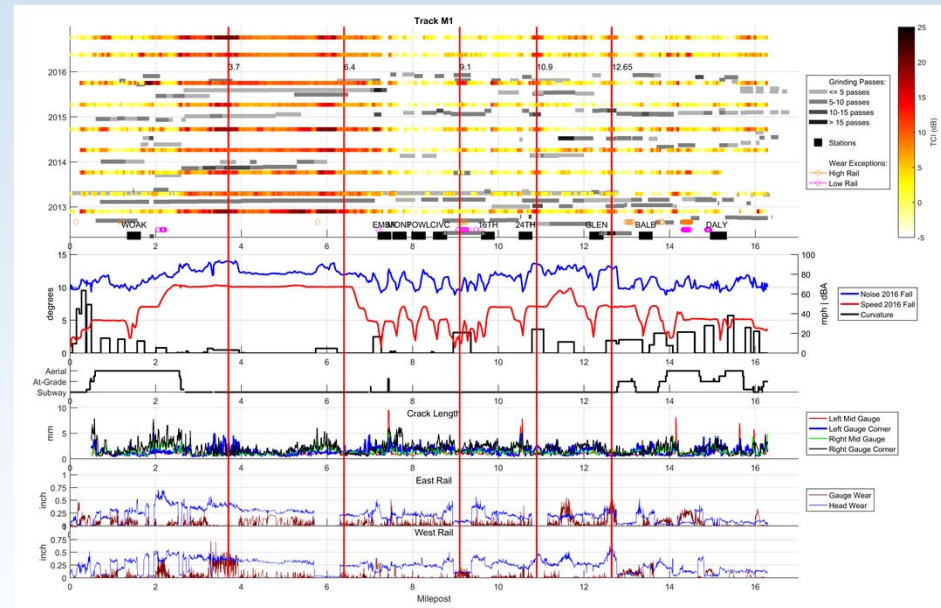
- Concerns during implementation
  - Effectiveness of grinding
  - Rail wear
  - Rolling contact fatigue formation
  - Gauge corner shelling
- Identified 50 locations for monitoring

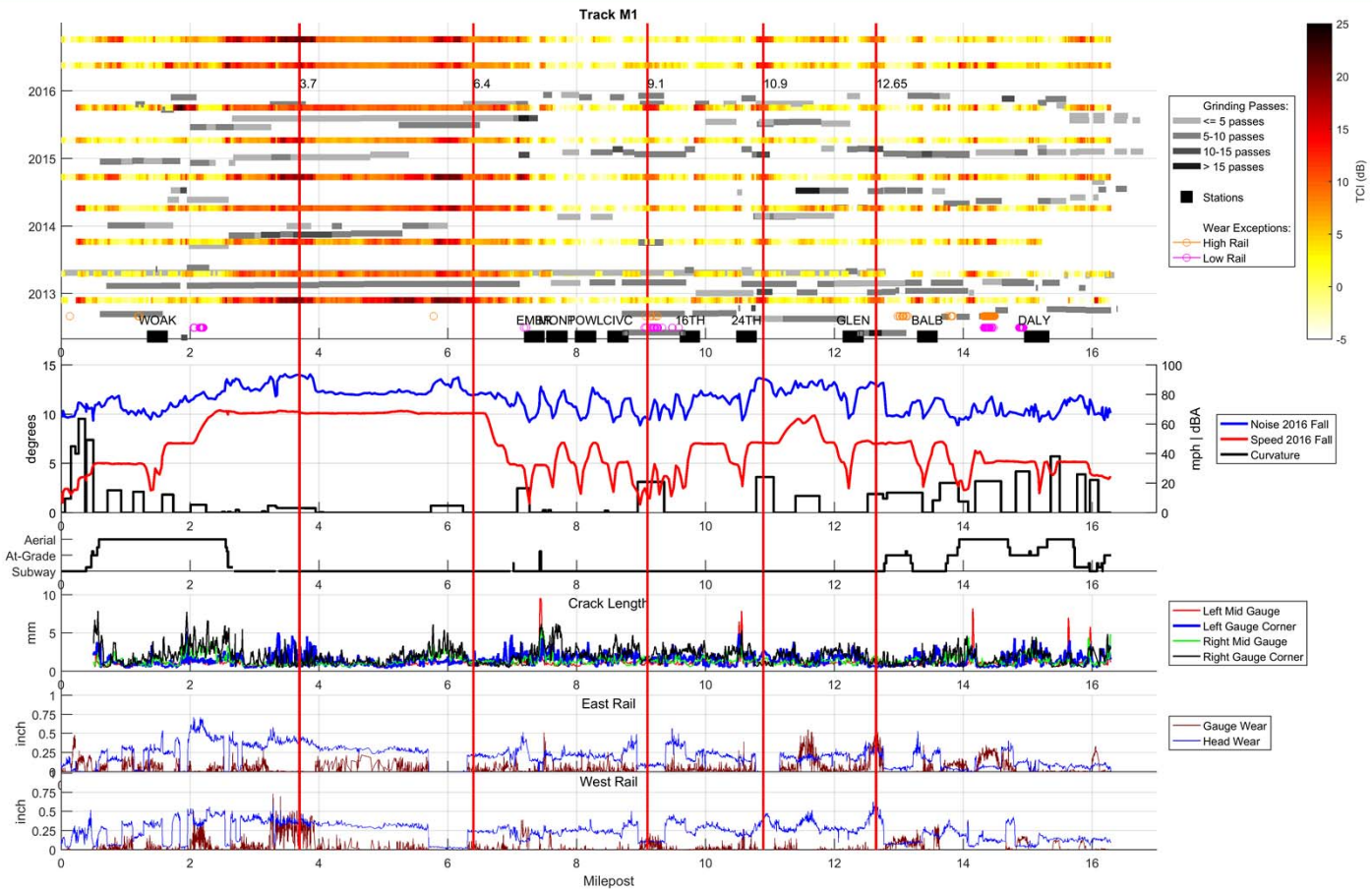


# Monitoring Locations

Selected by:

- Rail wear
- Frequent grinding
- High noise
- Presence of RCF





Vertical lines show monitoring locations



# Monitoring Purpose

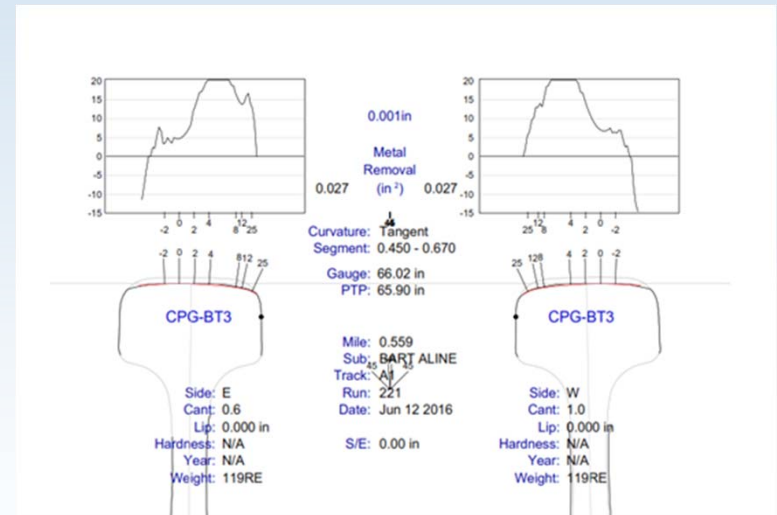
## Track changes in rail shape and condition

- Profile measurements with MiniProf
  - Deviation from Target Rail Profile
  - Monitoring radius of rail crown
- Magnetic particle inspection
  - Monitor for Rolling Contact Fatigue
- Surface photograph
  - Monitoring contact band
  - Rail surface finish after grinding
- Surface roughness after grinding

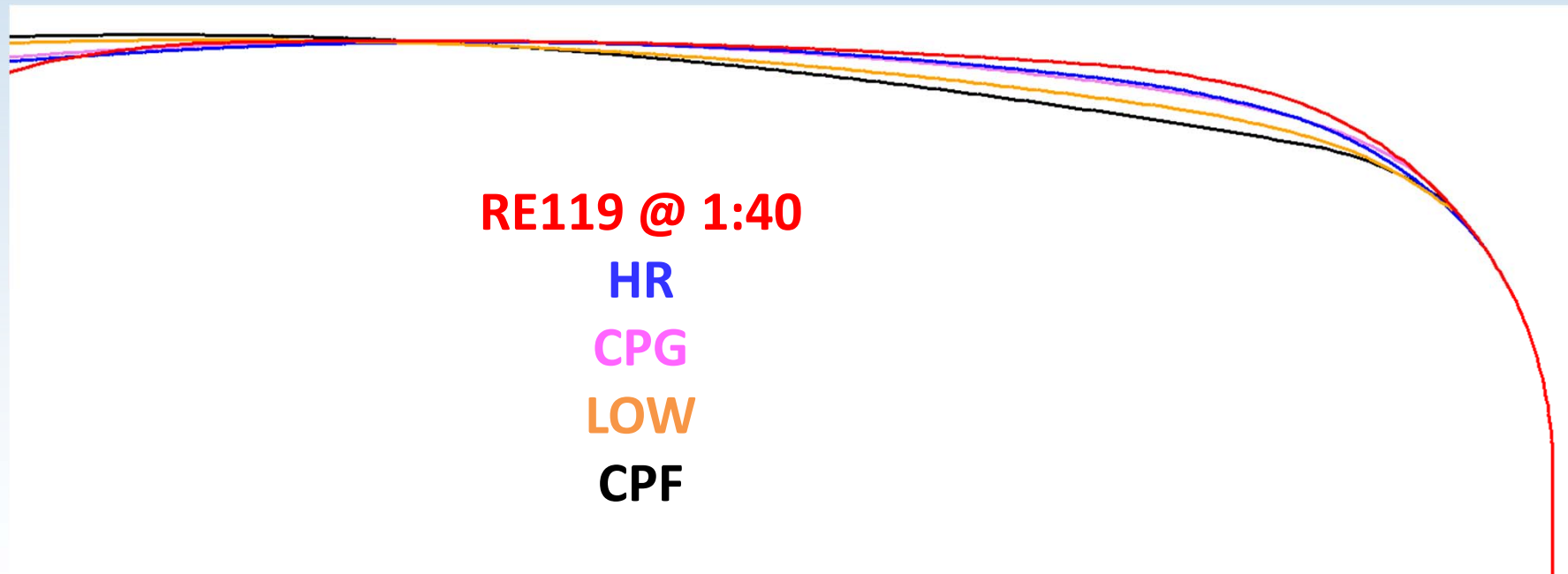


# Developing Grinding Plan

- Grinding to final profile requires significant metal removal
- Plan to progressively achieve LOW and CPF shapes
- Strategy, patterns, passes
- Equipment up-time



# A new 119 rail shape?



# Conclusions

- New cars, new wheel shape
- Better steering, less wear, reduce corrugation (?)
- New rail profiles to manage transition
- Improve grinding practices



Increased W/R life

Dramatic reduction in noise levels expected





# Thank you!

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