FTA Office of Research Project NY-26-7113 Wheel/Rail Characterization, Monitoring and Analytics

Eric E. Magel, National Research Council, Canada
Bruce Alexander, New York City Transit

RAIL TRANSIT SEMINAR • APRIL 30, 2018

WRI 2018

Outline

- Brief introduction
- Wheel wear
- Energy consumption
- Wayside monitoring
- Wheel-Rail forces (and track maintenance)
- Noise and vibration

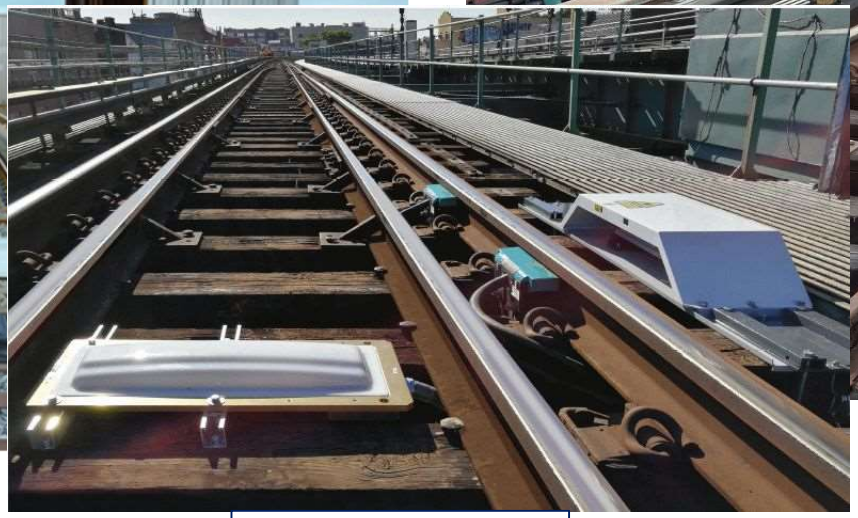
Collaborative wheel/Rail Research Team

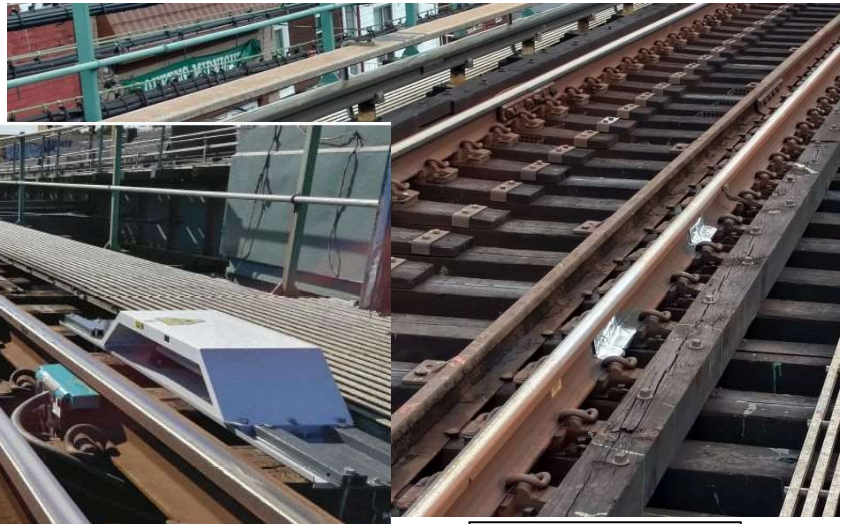
Data Collection Consist (DCC)

- 2 instrumented wheelsets
- Gives accurate measurements of wheel/rail contact forces (vertical, longitudinal, lateral)

- accelerometers, acoustic recording equipment and propulsion energy recording equipment
- Part of an 11 car consist in revenue service

Wayside Technologies





KLD LABS
MEASUREMENT TECHNOLOGIES

WID | WAYSIDE INSPECTION DEVICES

INSTRUMENTATION SERVICES, INC.

NYCT – Track Geometry Car and Host Site #7 Line

Flushing Line At A Glance

- 27.5 Miles of Track
- 22 Stations
  - 34th Street-Hudson Yards opened in September, 2015
- Average Daily Ridership:
  - Weekday = 525,000
  - Saturday = 350,000
  - Sunday = 300,000
- 7 line (tied with the 6 line) has the most frequency of service in the entire system.
- 27 Trains per hour in each direction during Weekday Peak

Track Geometry Car

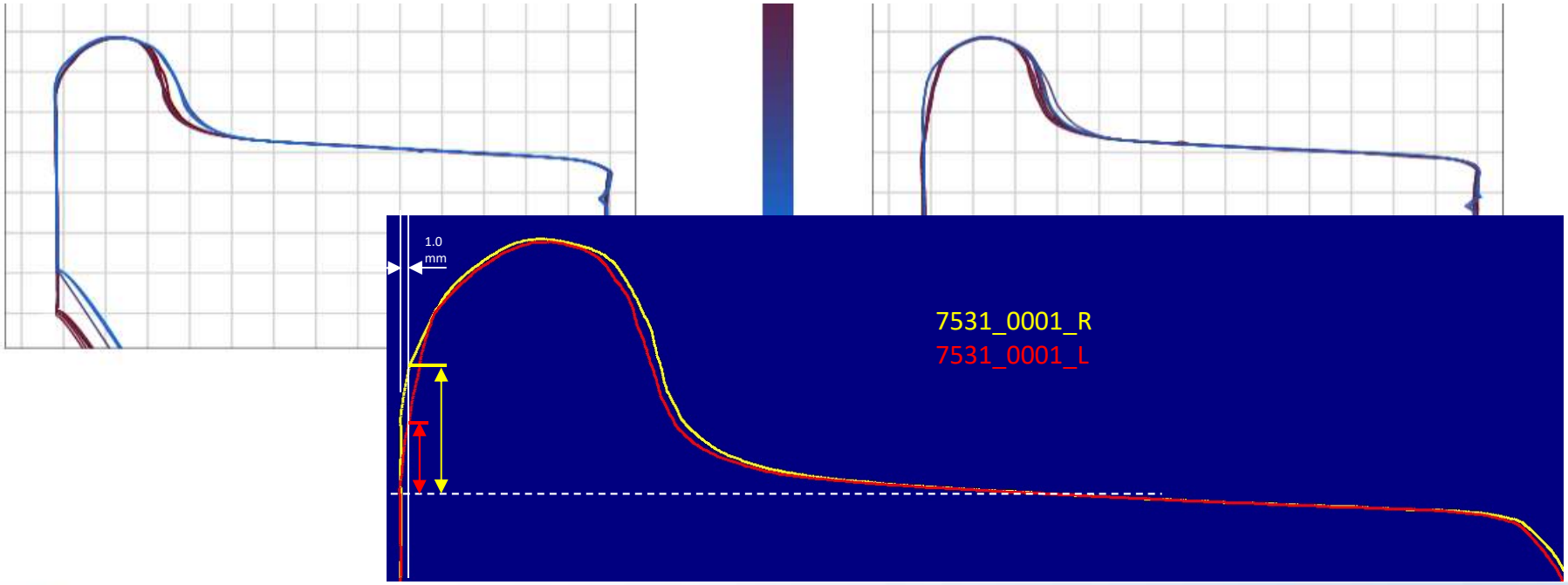
Canada NRC·CNRC

WRI 2018

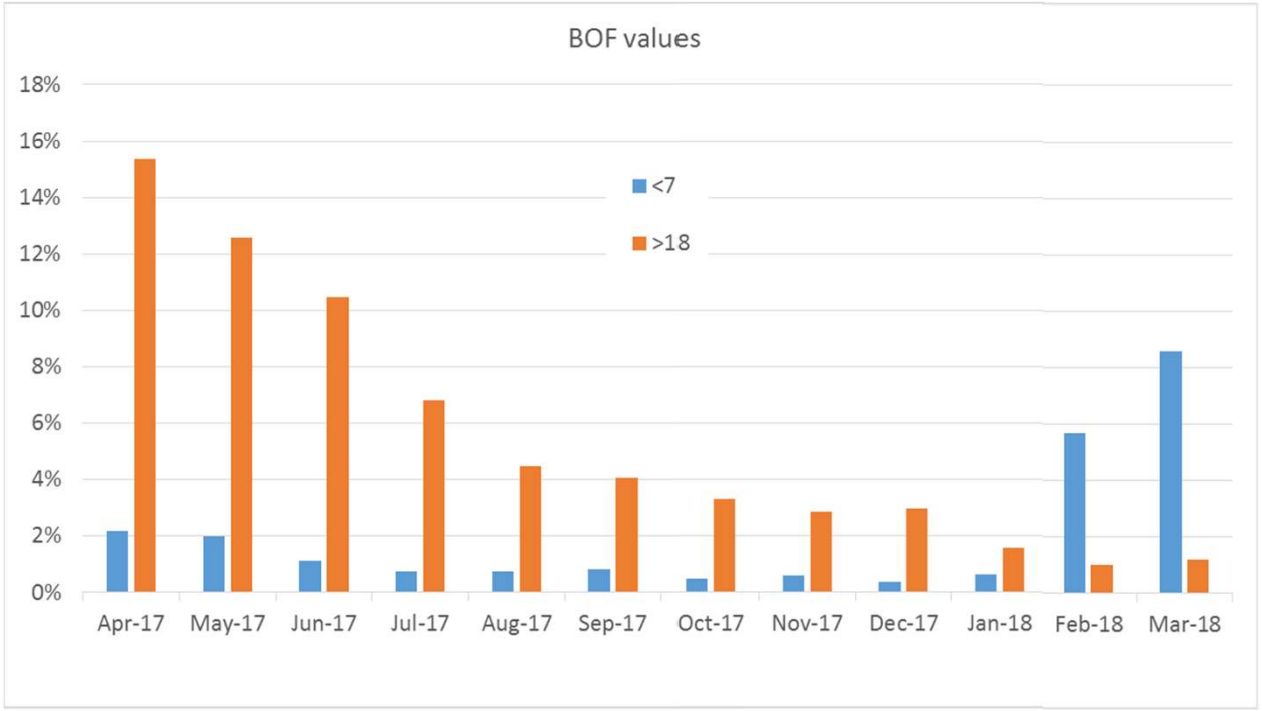
WHAT HAVE WE FOUND?

WHEEL WEAR ANALYTICS

Back of Flange Wear

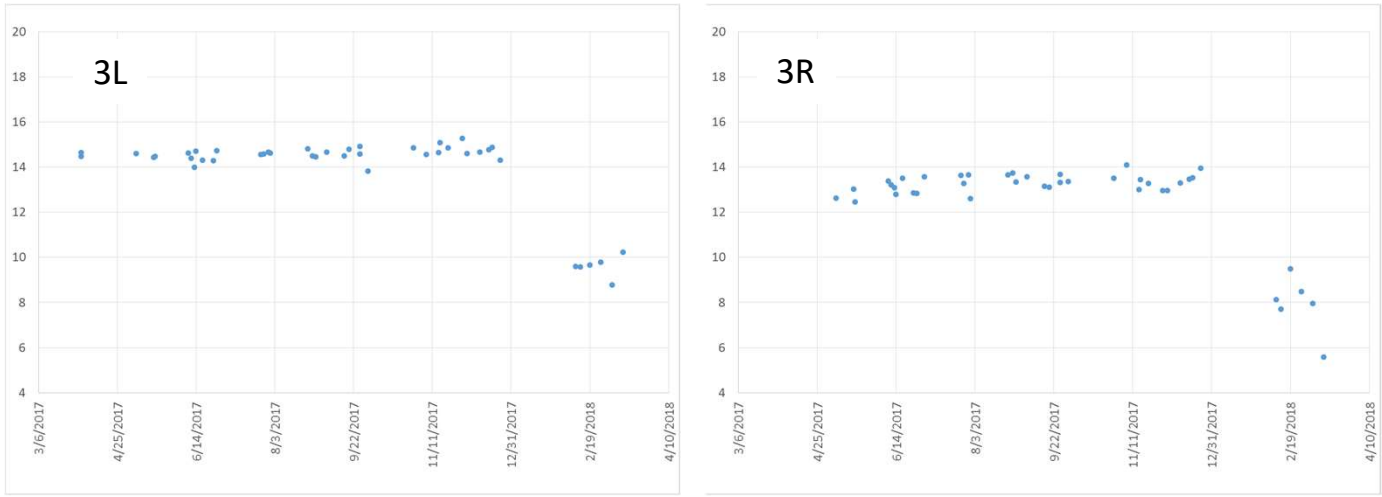


Back of Flange Values



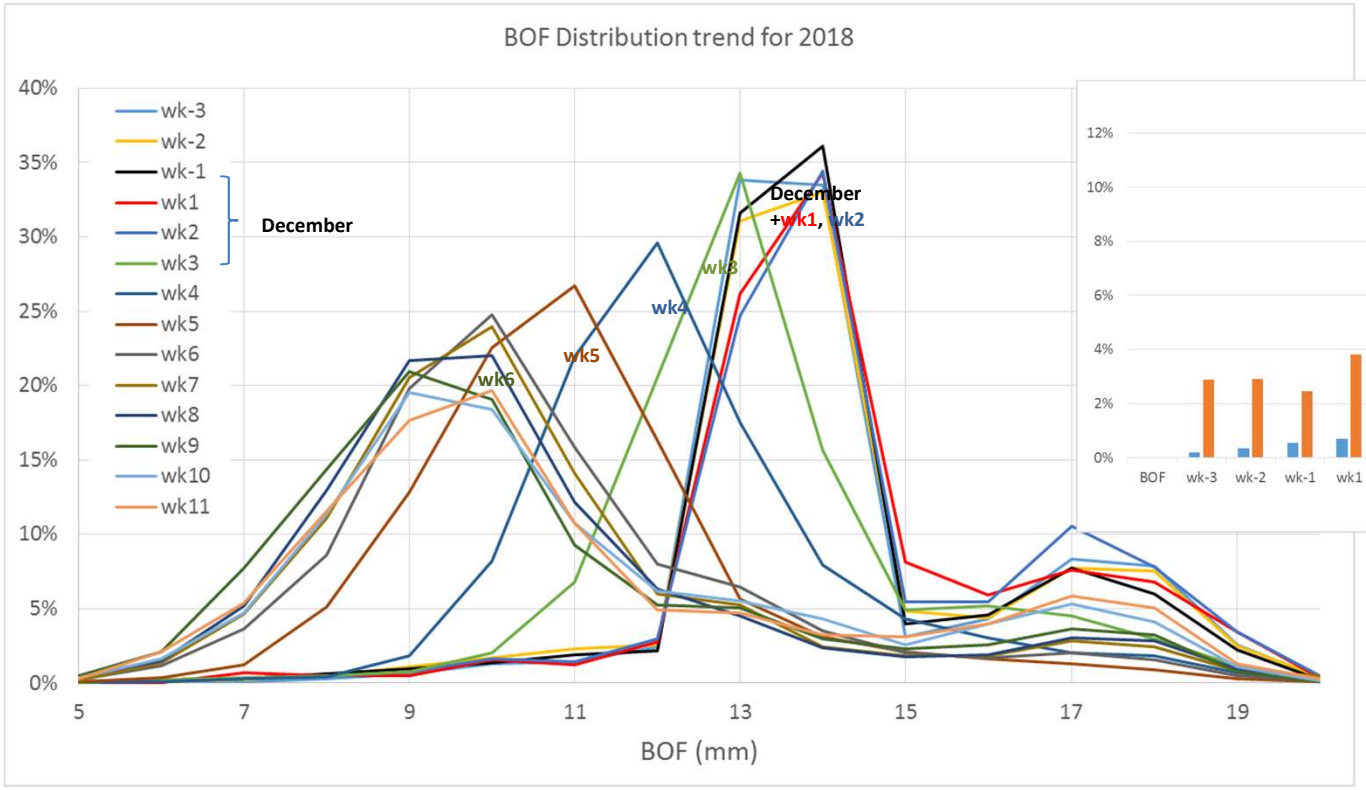
Typical BOF Change through Jan/18

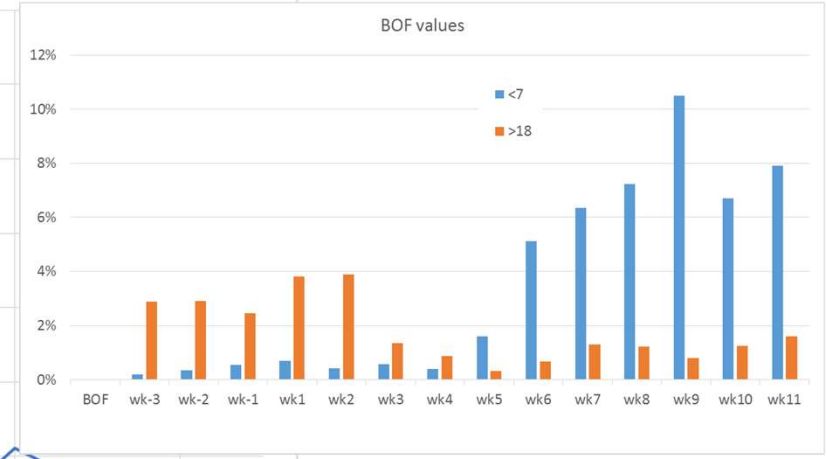
Car 7502 (IWS Axles)



Axles 3 and 4 showing sudden decrease in BOF values, on both sides.

These wheels have not been retrued.





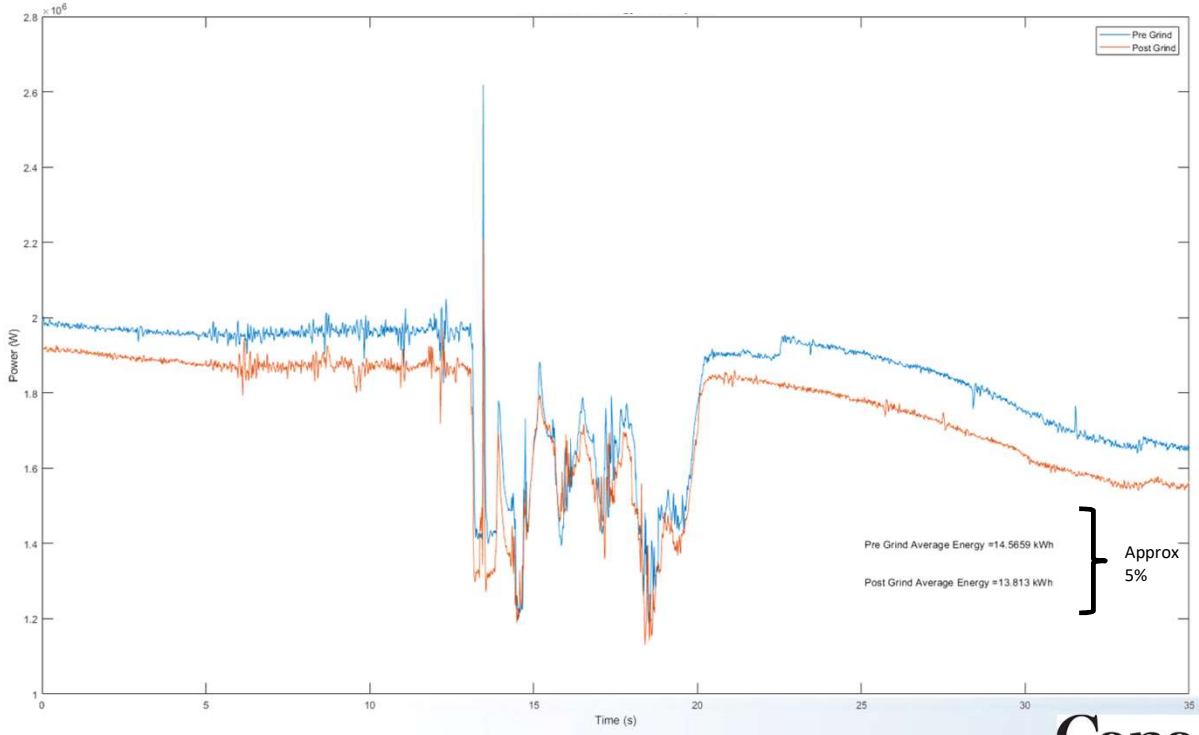
What happened in mid-January?

THE IMPACT OF RAIL CORRUGATION ON ENERGY CONSUMPTION

Keith Cummings – Dayton T. Brown

NB Track CC2 Energy Consumption

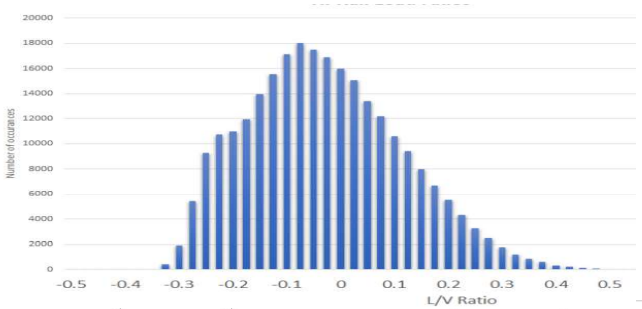
Hudson Yds. 34th St. Curve



OUTCOMES FROM THE TBOGI AND L/V WAYSIDE SYSTEMS

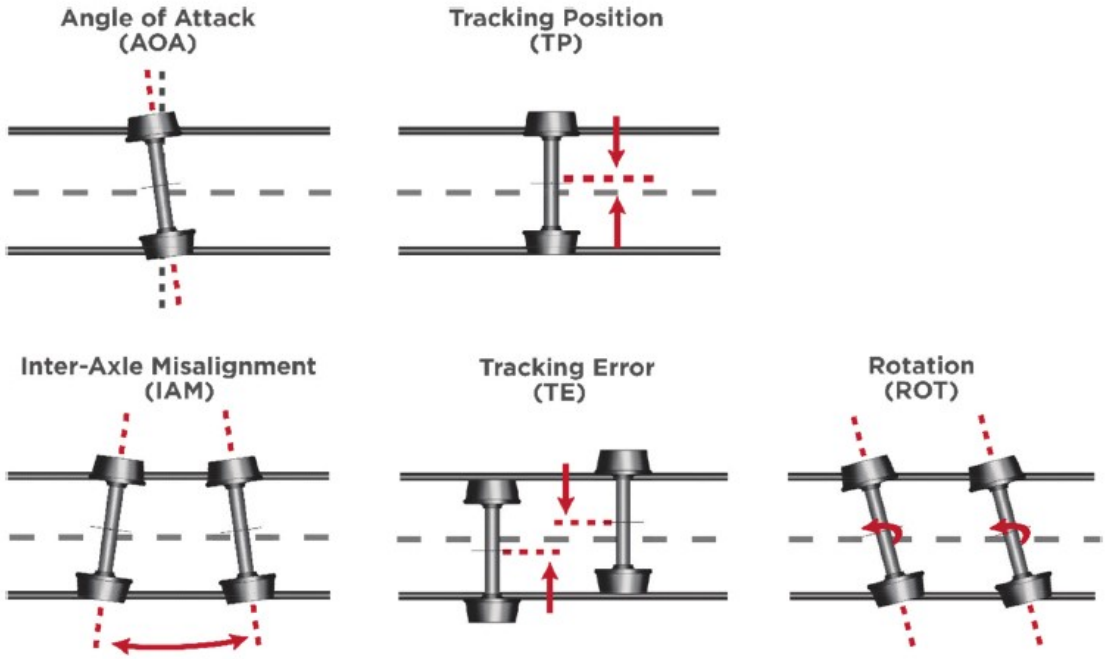
Eric Magel and Merrina Zhang – NRC Canada
Denis D'Aoust – Wayside Inspection Devices
John Mazza - Instrumentation Services Inc.

L/V Values for DCC cars



- Shows L/V values for DCC compared with distribution for entire fleet.
- Identifies car 7505 as an outlier.

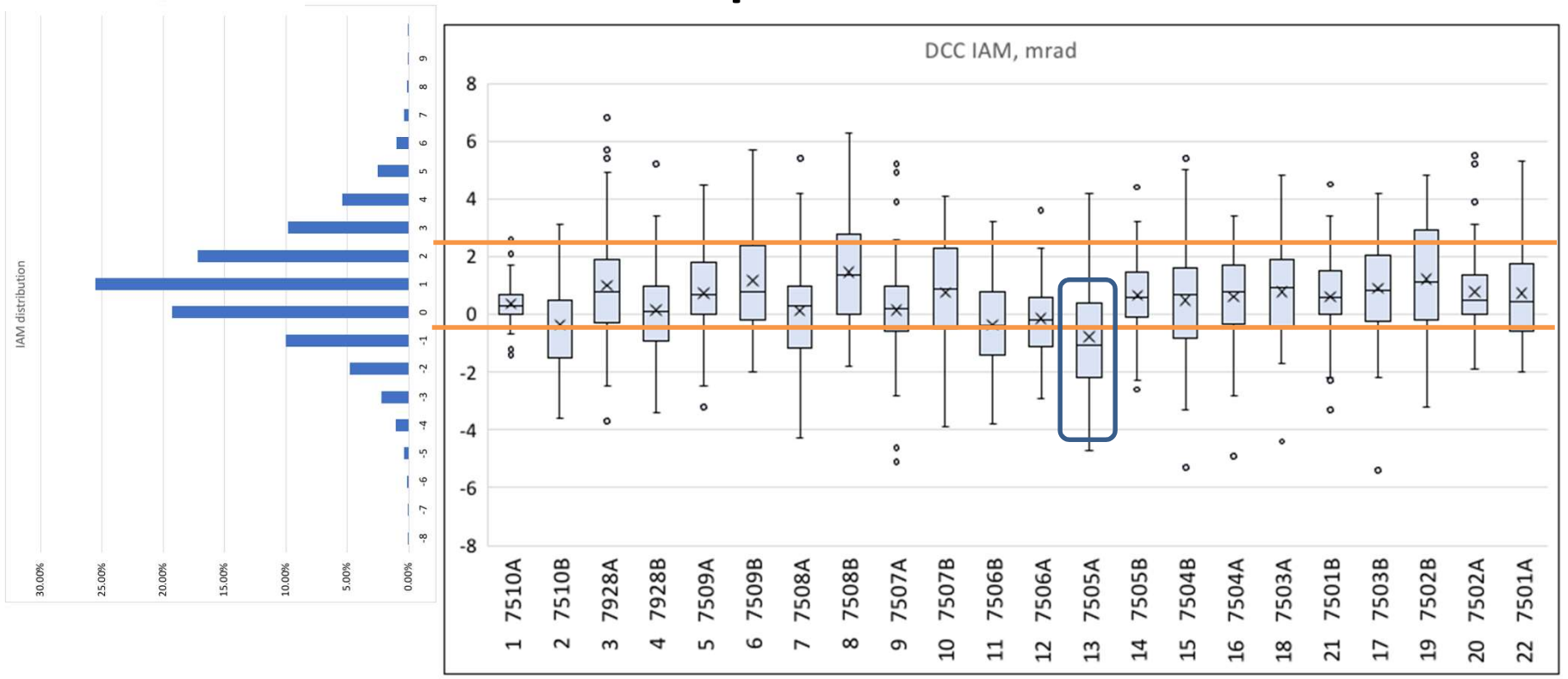
TBOGI - Definitions



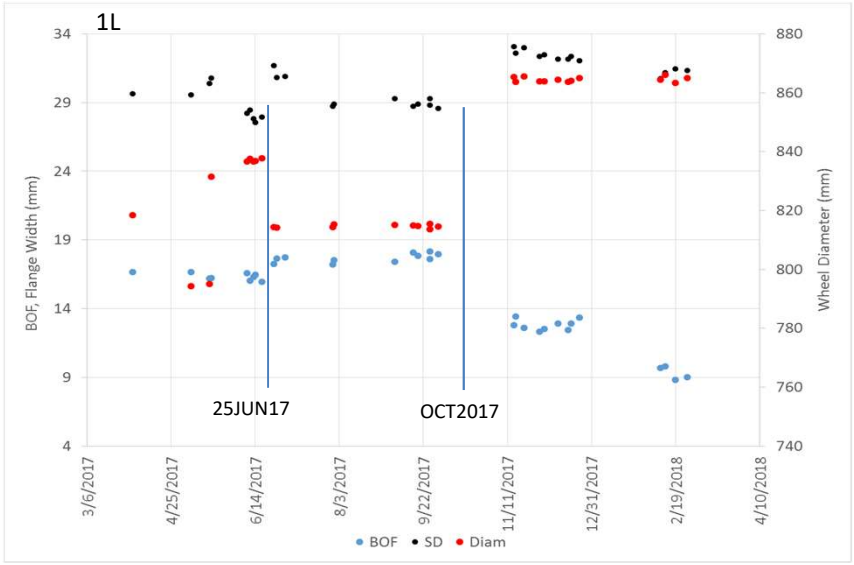
WID WAYSIDE INSPECTION DEVICES

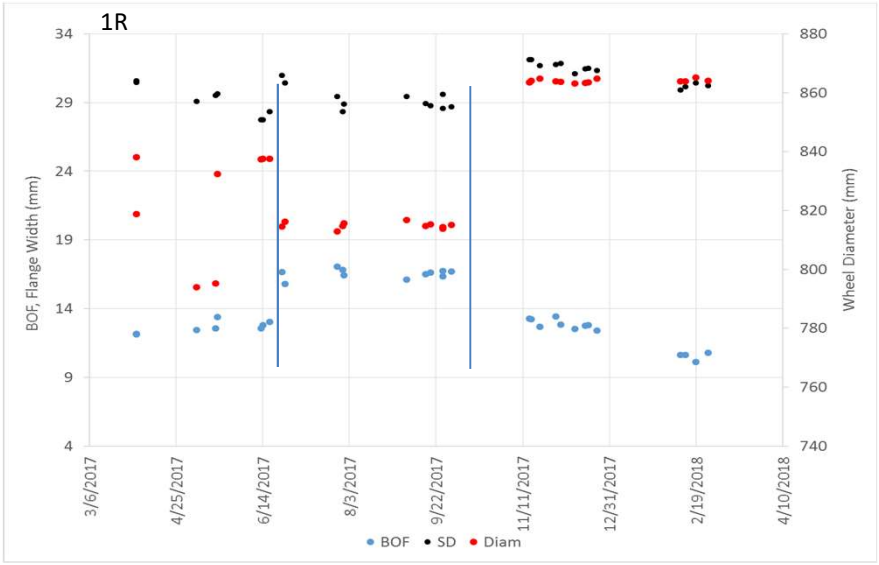
WID WAYSIDE INSPECTION DEVICES

DCC IAM performance



DCC Car 7505



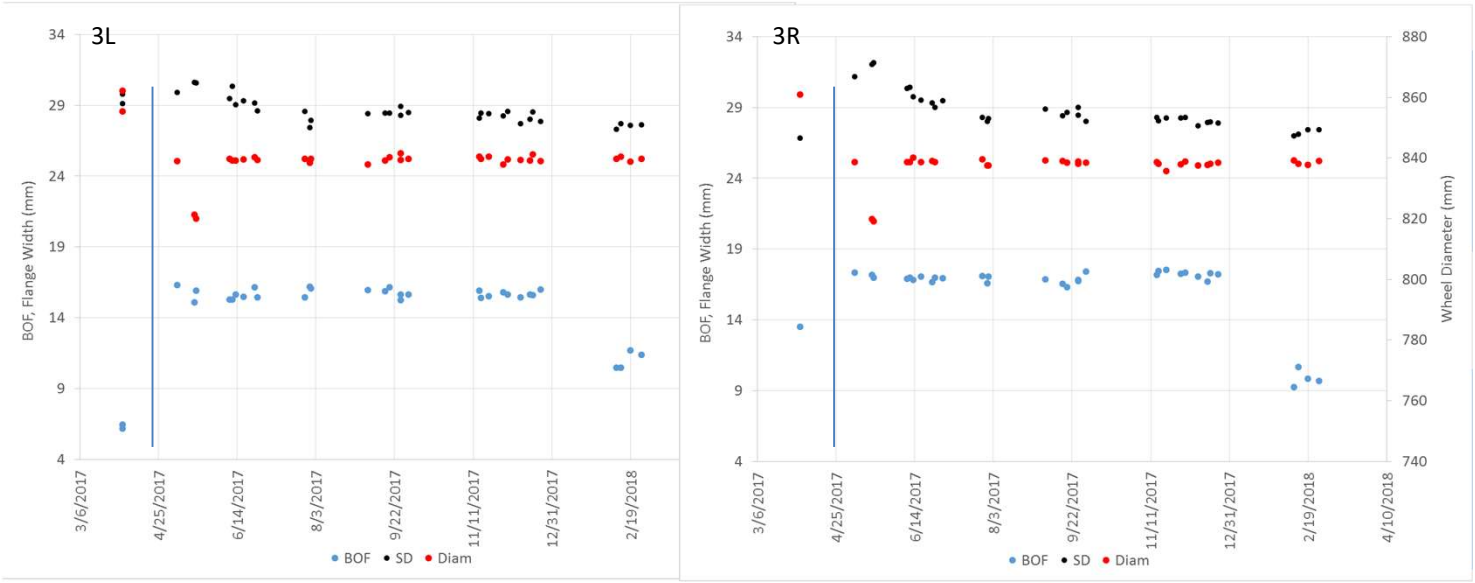


- Retrued June 25 2017
- Renewed October 2017

Comparison: Other DCC cars

Car	retrued
7501:	Jan2018
7502:	Jan2018
7503:	Jan2018
7504:	Apr2017
7506:	Apr2017
7507:	Apr2017
7508:	Apr2017
7509:	Apr2017

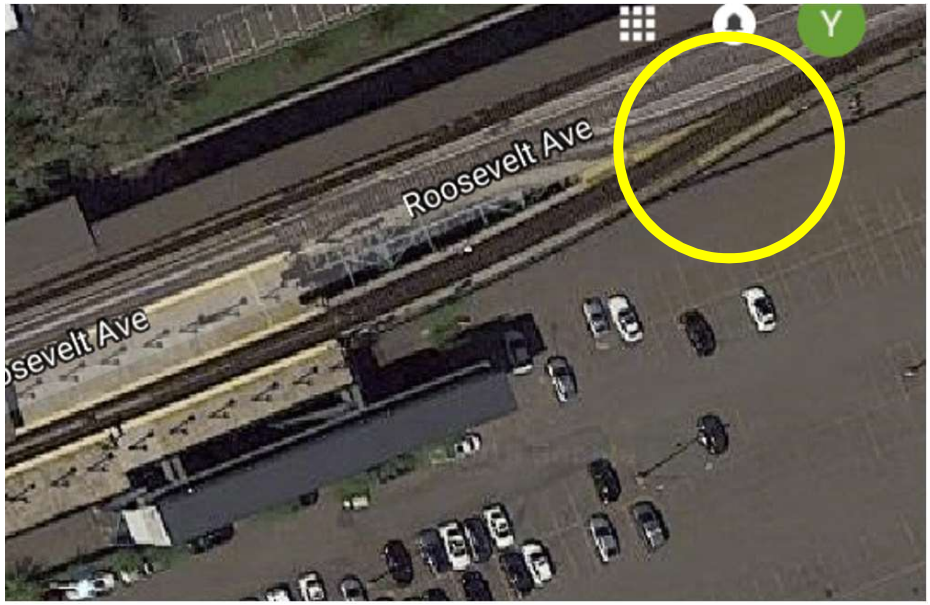
Car 7504



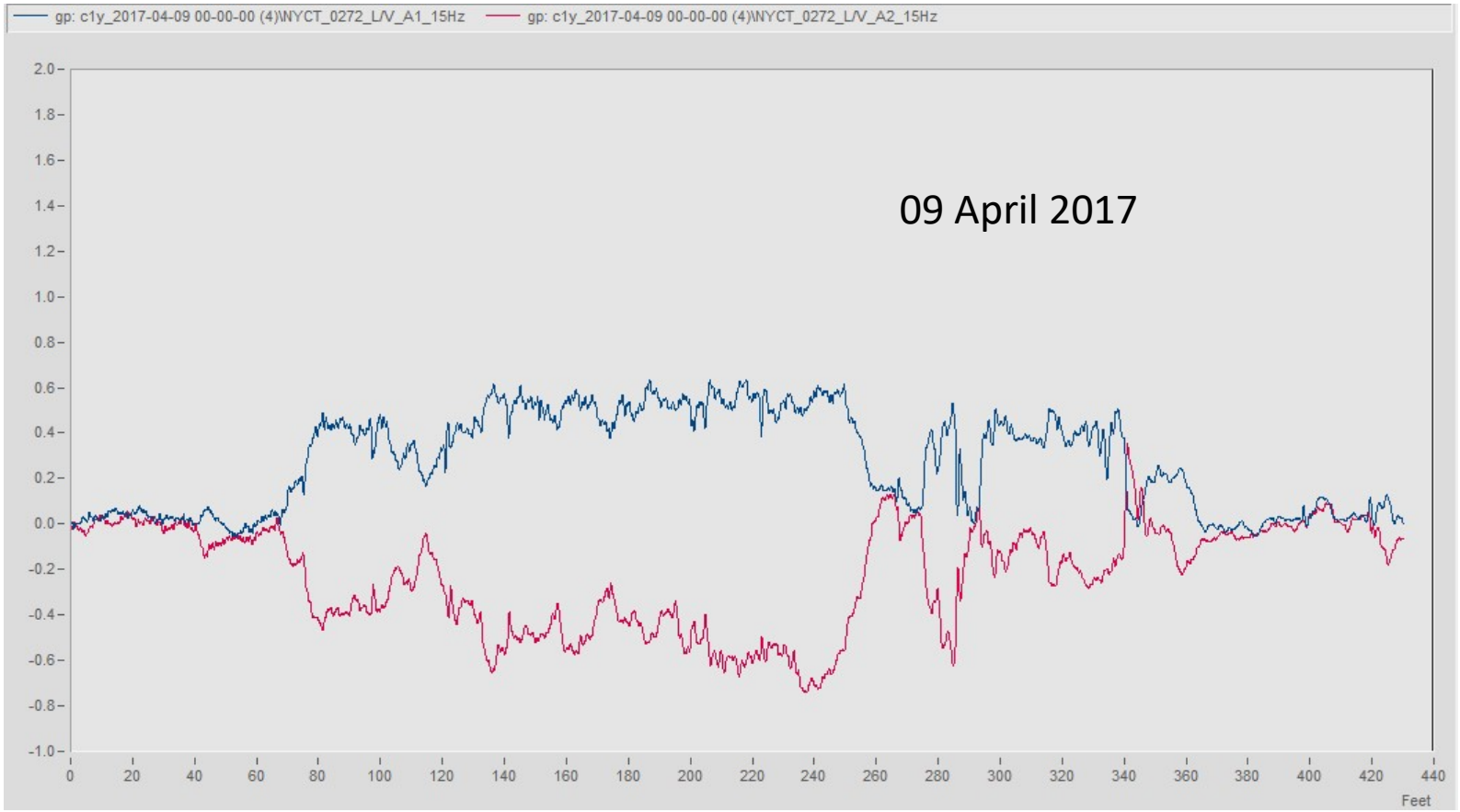
W/R FORCES MEASURED BY IWS - SOME FINDINGS

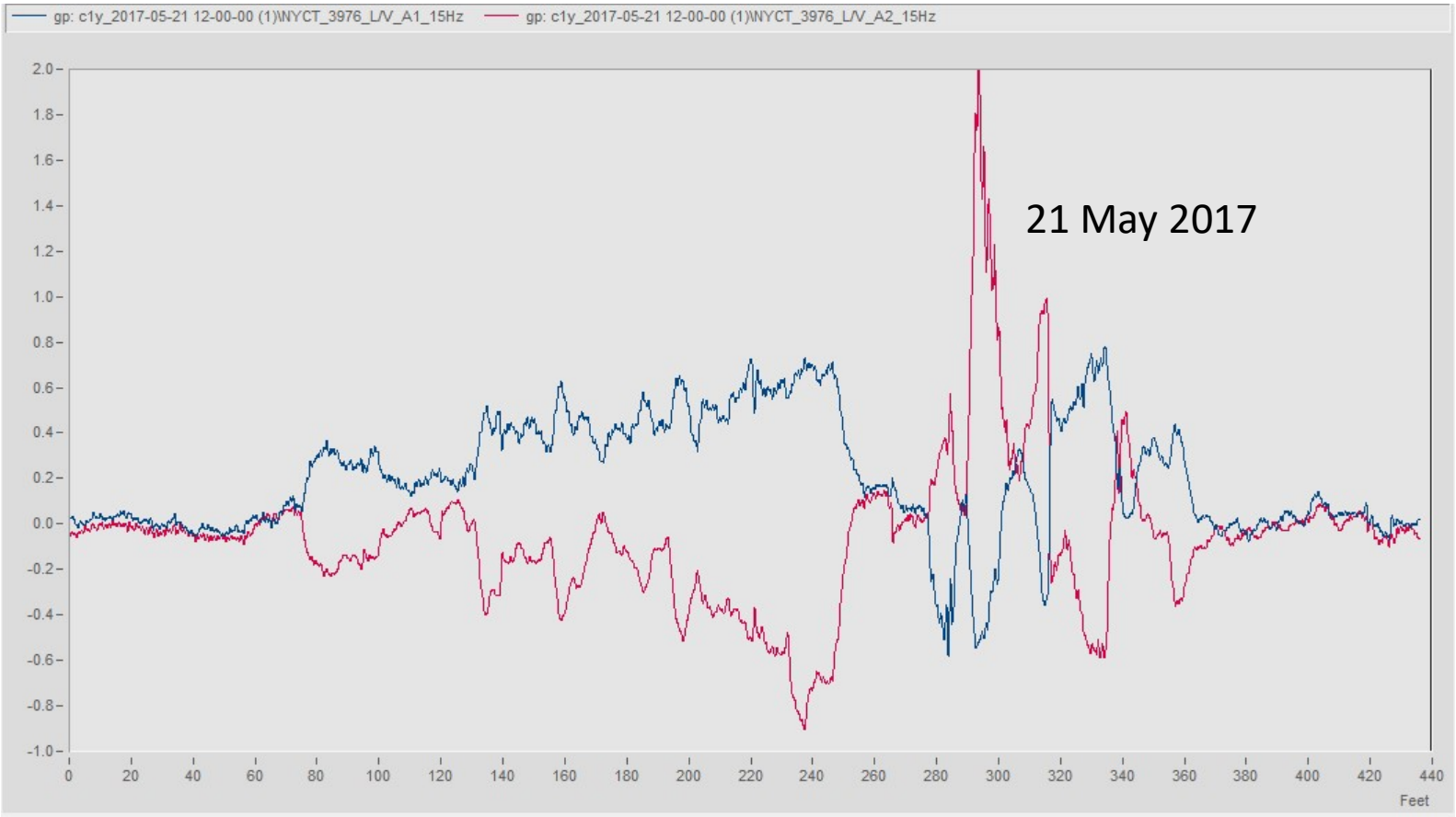
Yan Liu – NRC Canada

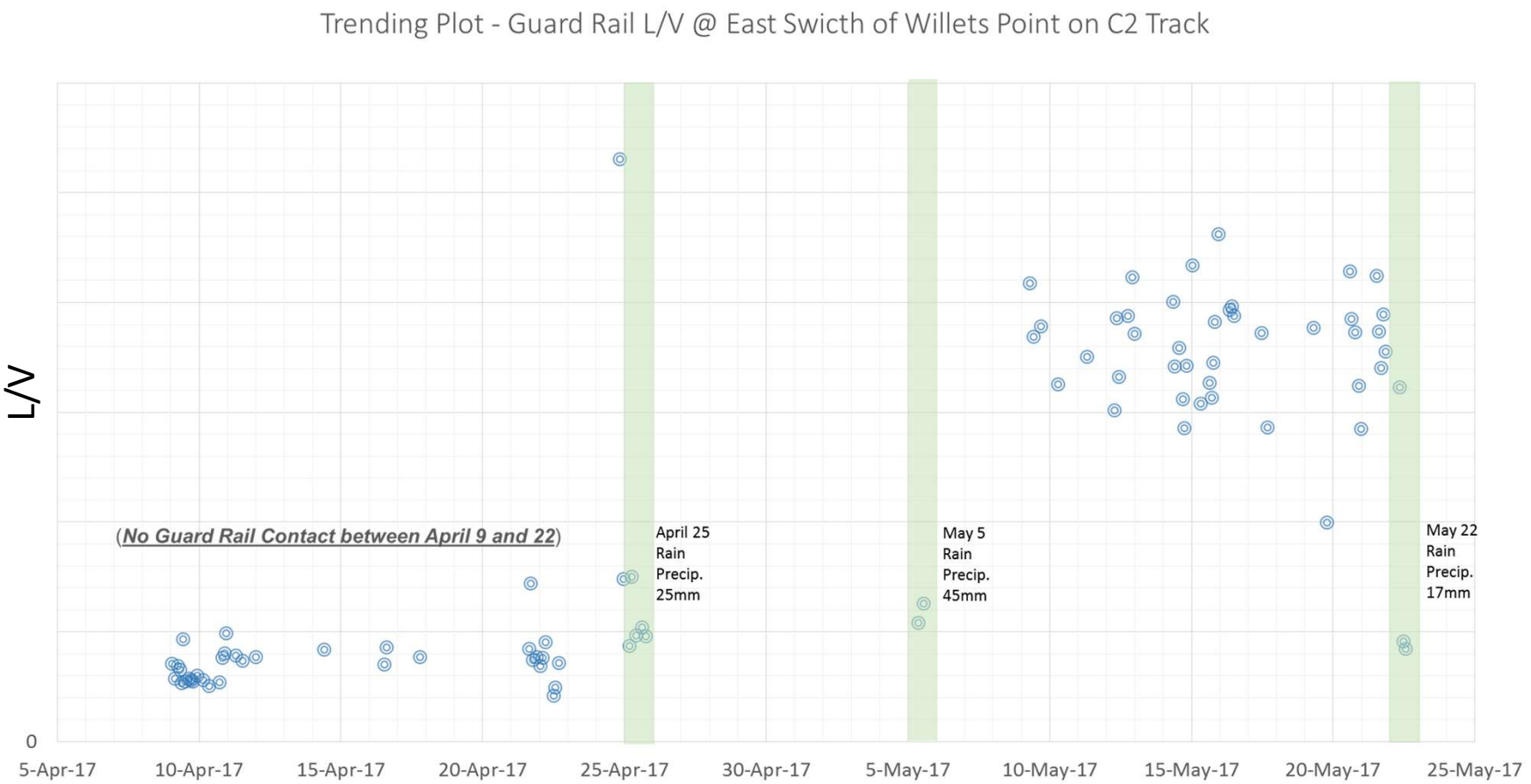
High Force due to Tight Flangeway Clearance at Turnouts



Turnout N/O Willets Point where high IWS forces have been identified

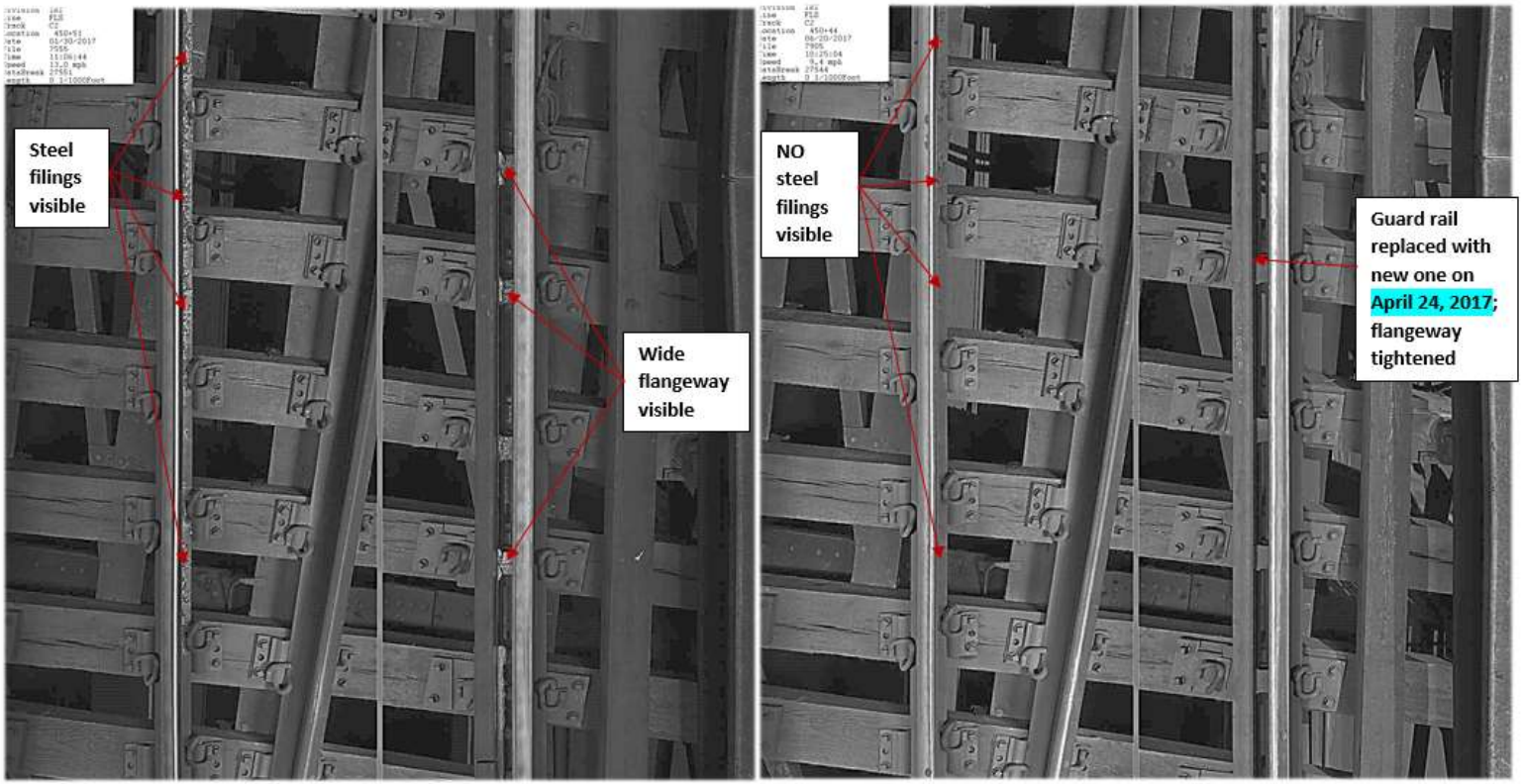

gp: c1y_2017-04-09 00-00-00 (4)\NYCT_0272_L/V_A1_15Hz
gp: c1y_2017-04-09 00-00-00 (4)\NYCT_0272_L/V_A2_15Hz
09 April 2017
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
Feet


gp: c1y_2017-05-21 12-00-00 (1)\NYCT_3976_L/V_A1_15Hz
gp: c1y_2017-05-21 12-00-00 (1)\NYCT_3976_L/V_A2_15Hz
21 May 2017
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
Feet


Trending Plot - Guard Rail L/V @ East Swicth of Willets Point on C2 Track
L/V
0
(No Guard Rail Contact between April 9 and 22)
April 25
Rain
Precip.
25mm
May 5
Rain
Precip.
45mm
May 22
Rain
Precip.
17mm
5-Apr-17
10-Apr-17
15-Apr-17
20-Apr-17
25-Apr-17
30-Apr-17
5-May-17
10-May-17
15-May-17
20-May-17
25-May-17

Information provided by NYCT

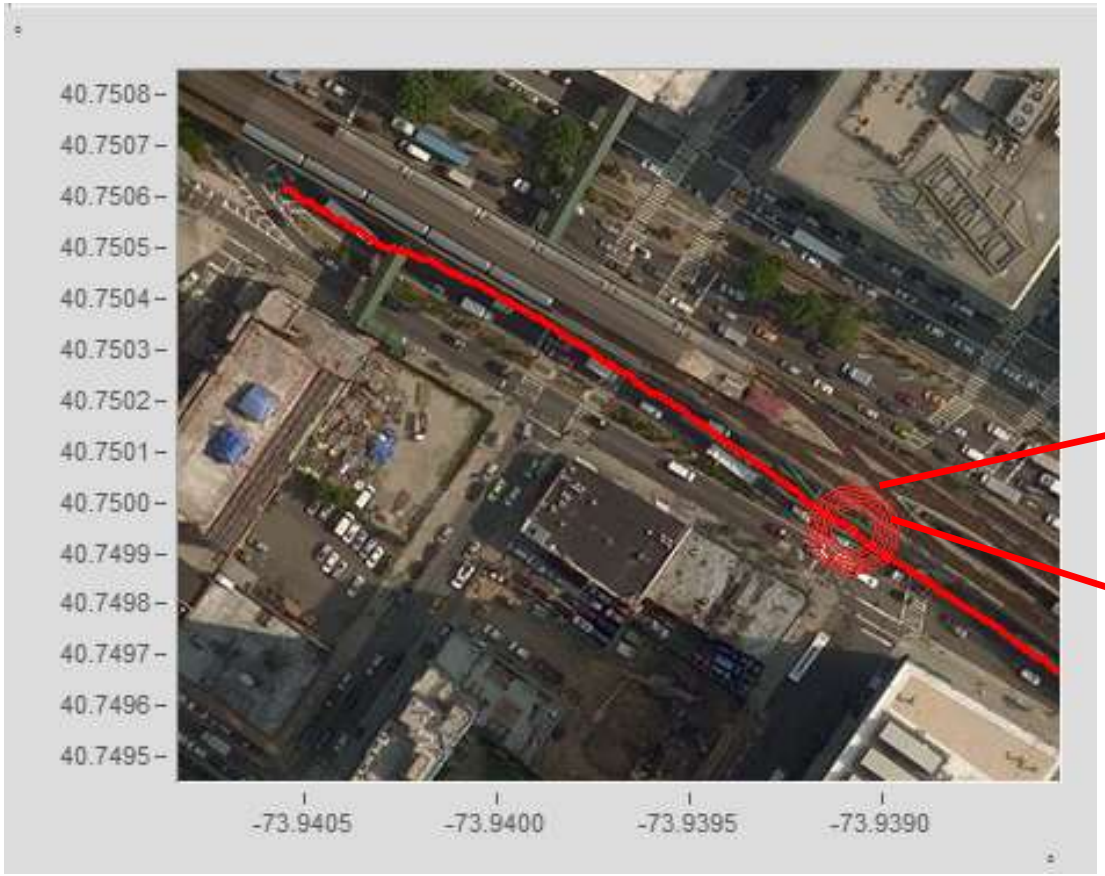
Track C2 N/O Willets Point, Switch 755B - January 30 vs. June 20, 2017

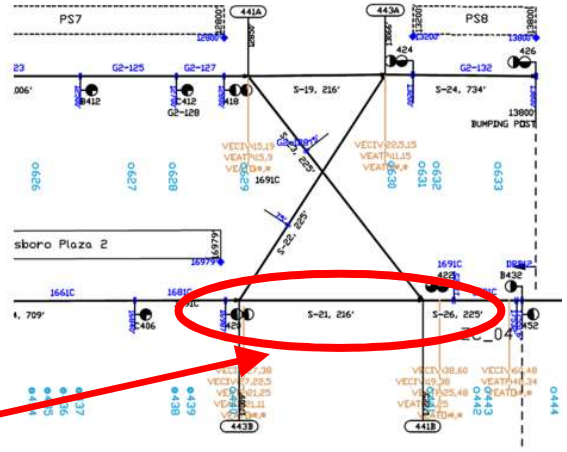


N/O Willets Point, Sw. 755B, track C2
January 30, 2017

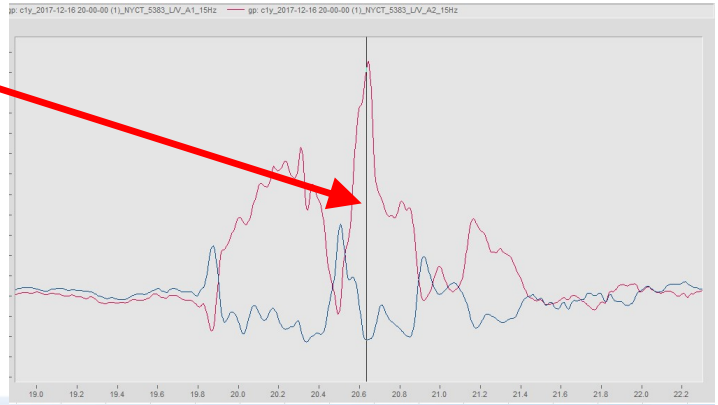
N/O Willets Point, Sw. 755B, track C2
June 20, 2017

2018

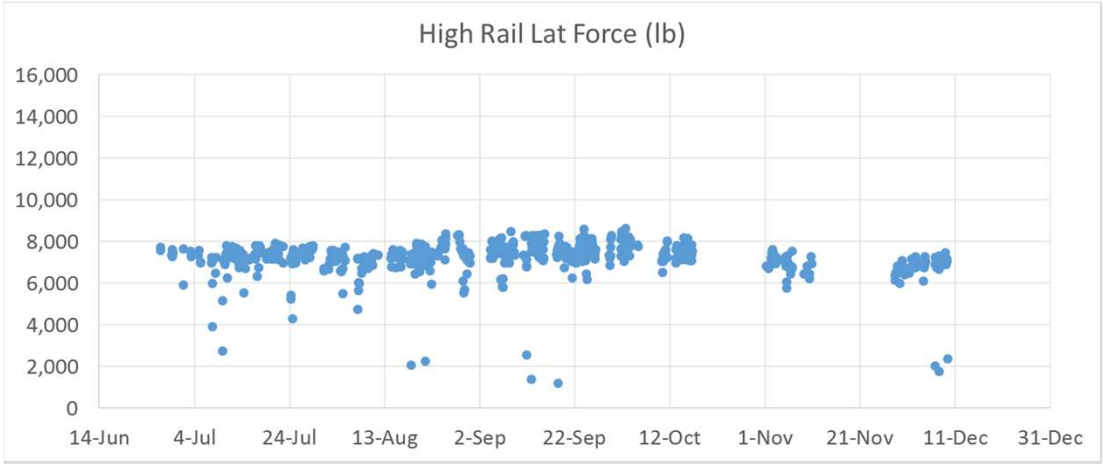

40.7508
40.7507
40.7506
40.7505
40.7504
40.7503
40.7502
40.7501
40.7500
40.7499
40.7498
40.7497
40.7496
40.7495
-73.9405
-73.9400
-73.9395
-73.9390

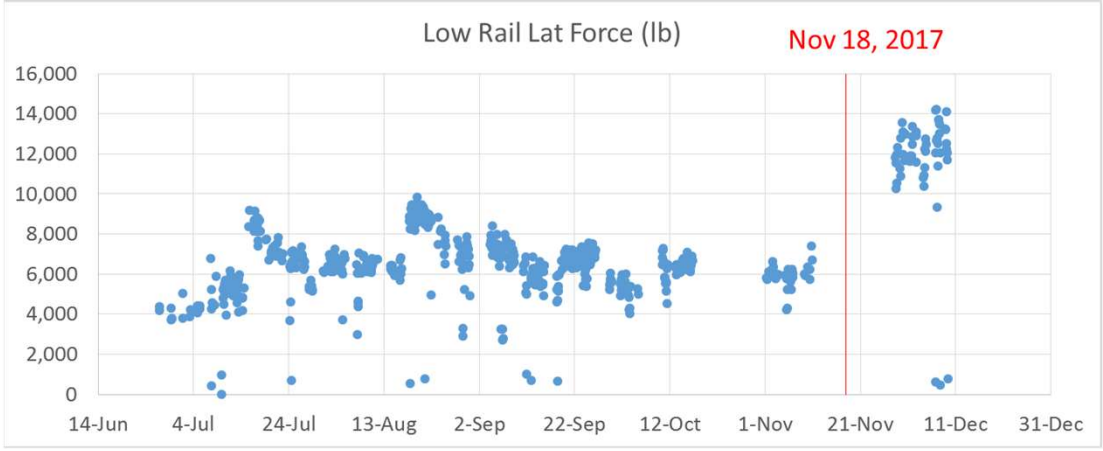

PS7
PS8
441A
443A
G2-125
G2-127
G2-132
G2-128
S-19, 216'
S-24, 734'
BUMPING POST
1691C
sboro Plaza 2
S-21, 216'
S-26, 225'
4433
4418

switch 441B

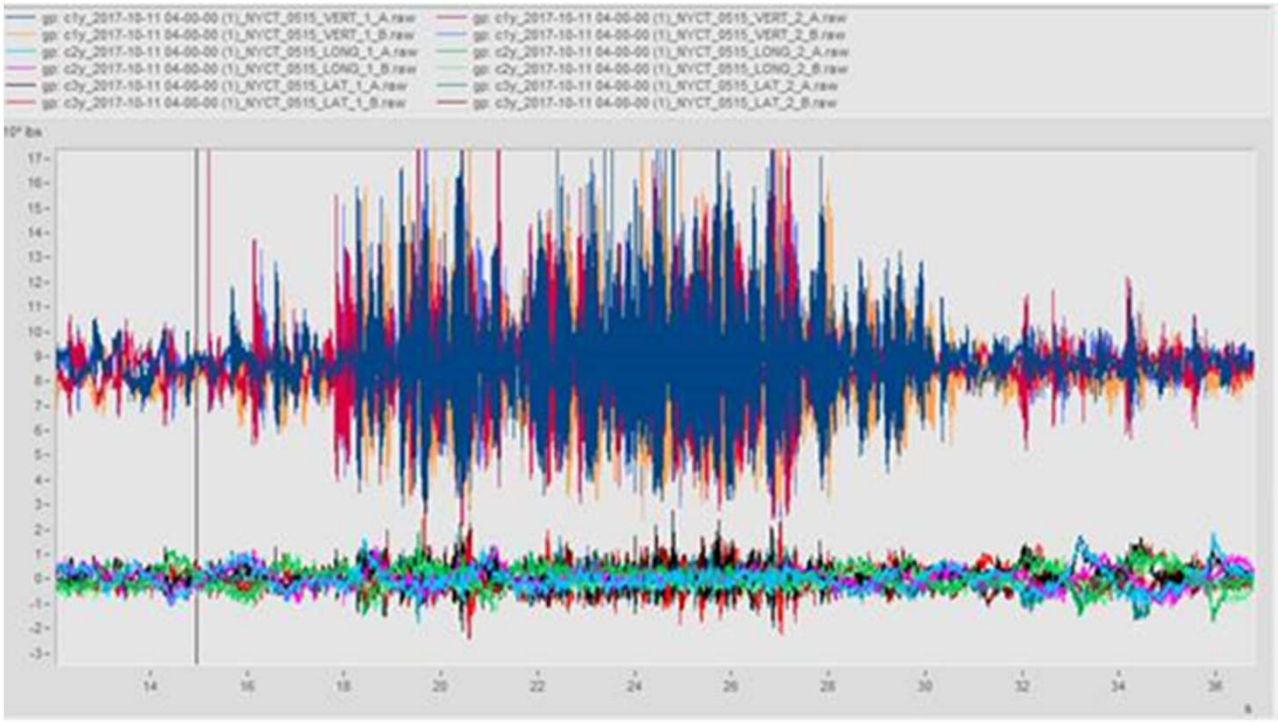


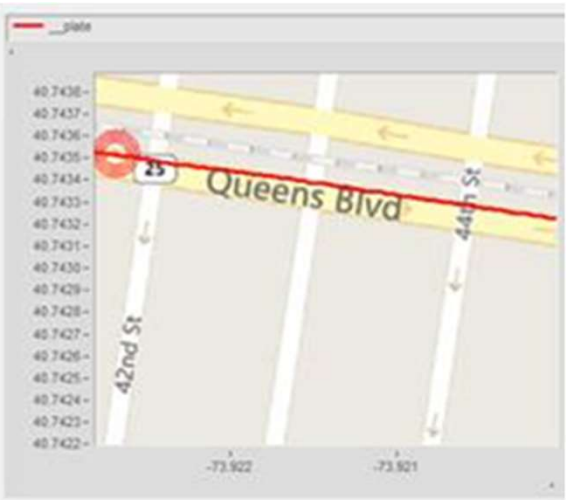
Track maintenance replaced the switch point, stock rail and frog of switch 441B on track C2 N/O Queensboro Plaza on November 18, 2017, due to rail and frog point defects.





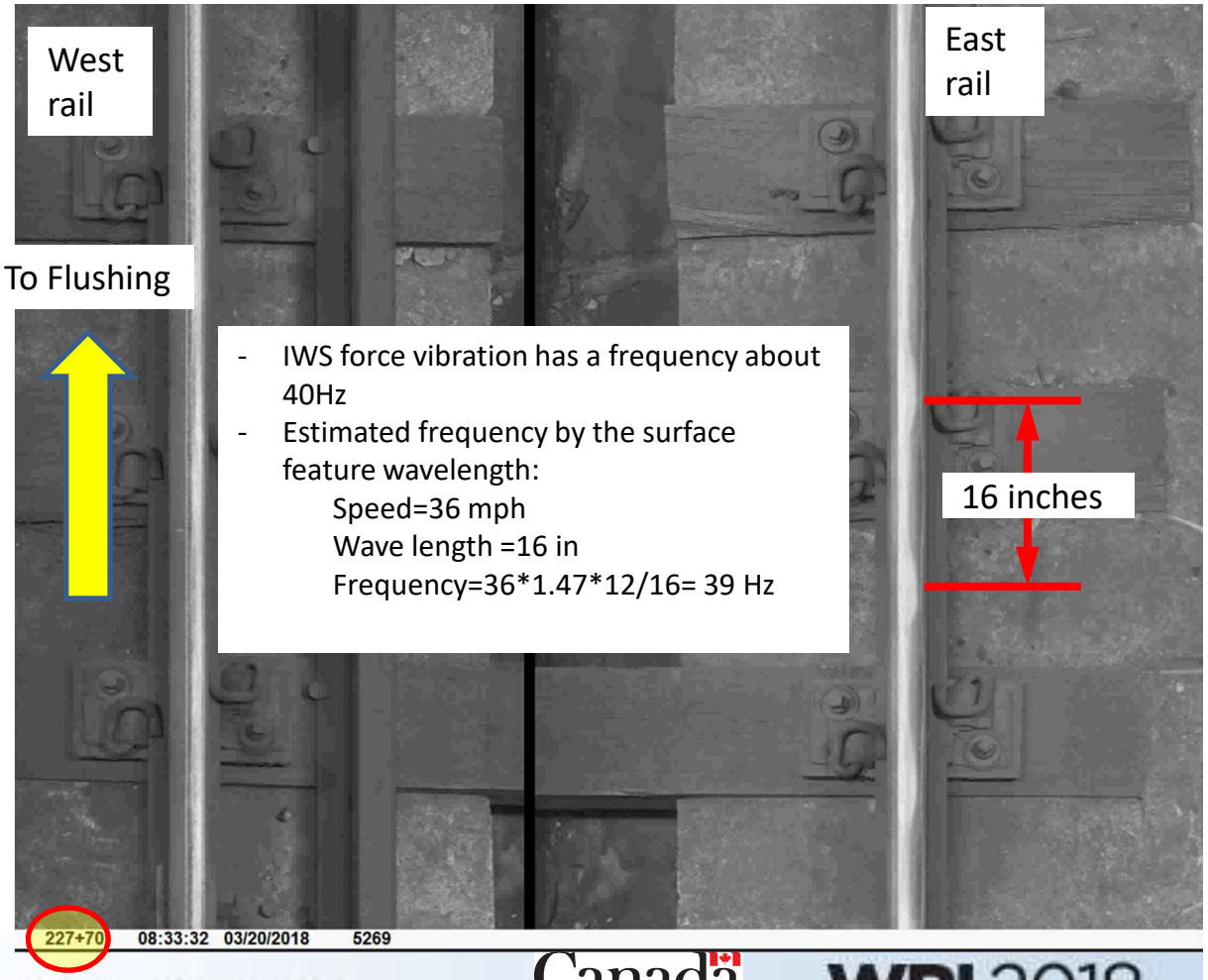
2g Vertical Force Oscillation





November 2017

- Track gauge: 0.3” to 0.4” tight.
- All the running rails are 39’ long, bolted
- 20+ running rails replaced btw Dec. 2017 and Feb.2018
- New rails are interspersed with old ones

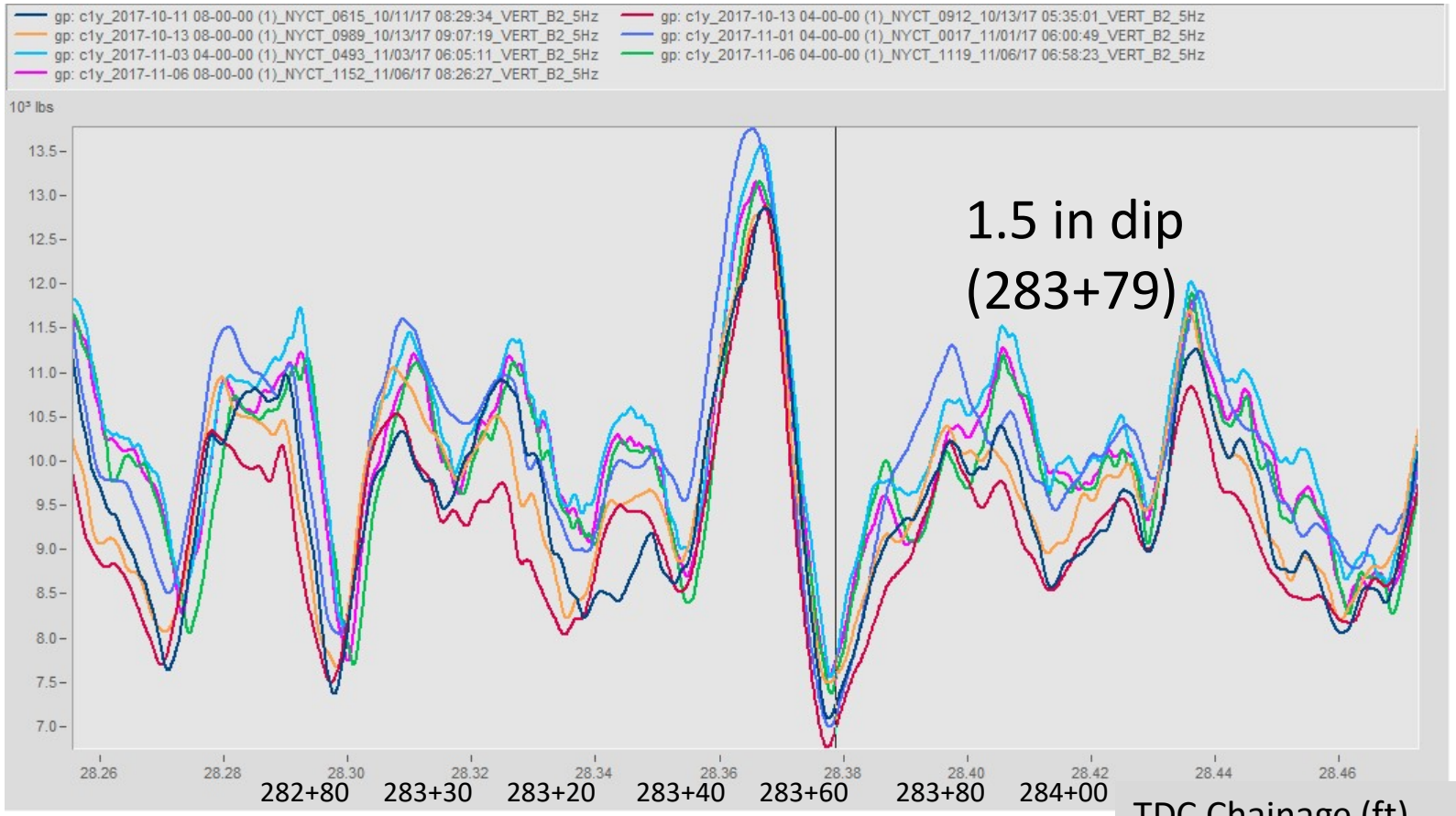


IWS Force vs Track Geometry

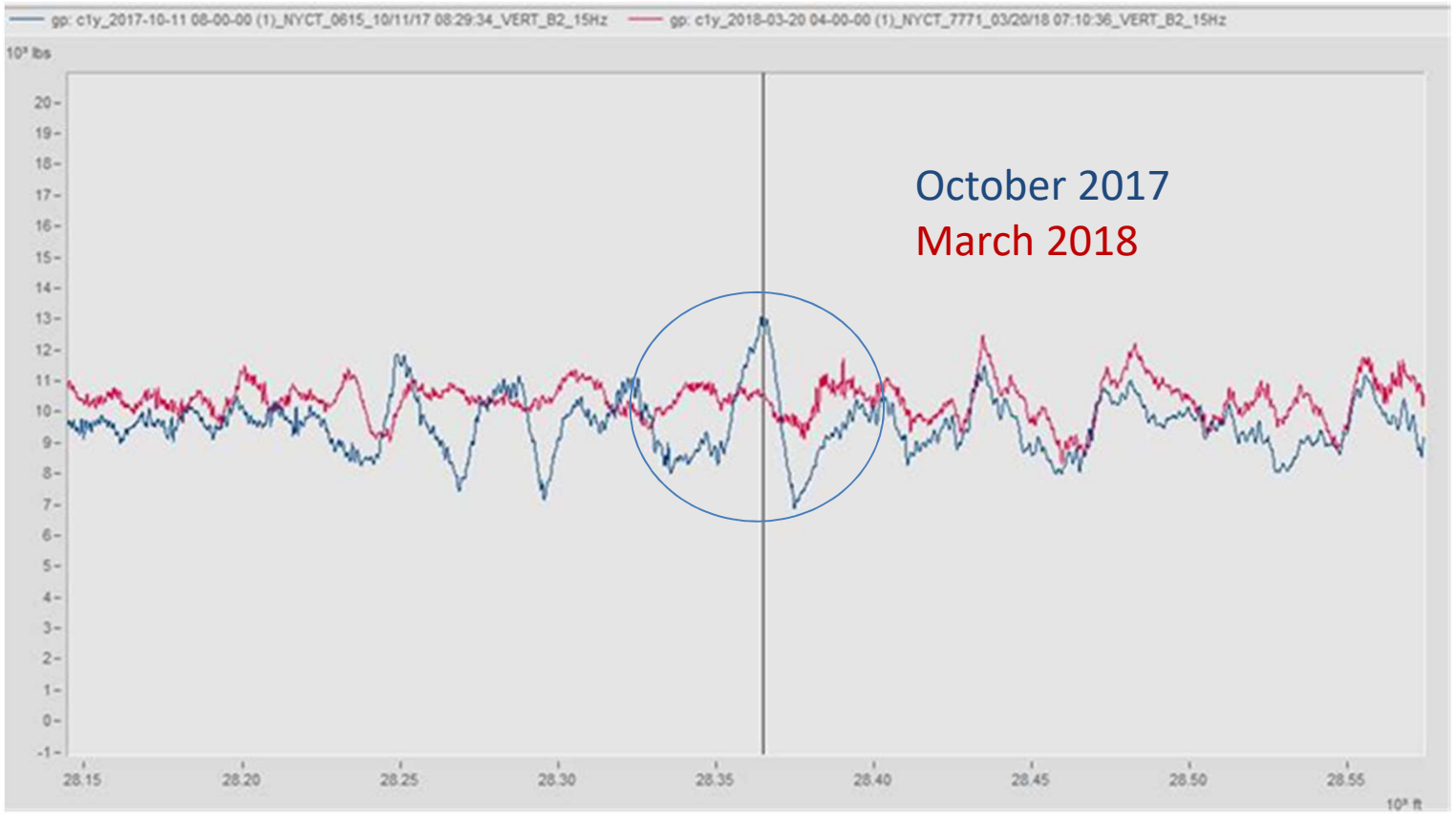
TGC runs on October 23, 2017

Priority 1 dip

From DATA file of NYCT Spet TG run				
28371	283	71	-0.547	-0.383
28372	283	72	-0.633	-0.598
28373	283	73	-0.703	-0.805
28374	283	74	-0.762	-0.992
28375	283	75	-0.805	-1.164
28376	283	76	-0.828	-1.316
28377	283	77	-0.848	-1.43
28378	283	78	-0.855	-1.504
28379	283	79	-0.816	-1.551
28380	283	80	-0.742	-1.543
28381	283	81	-0.625	-1.48
28382	283	82	-0.473	-1.352
28383	283	83	-0.309	-1.133
28384	283	84	-0.156	-0.84

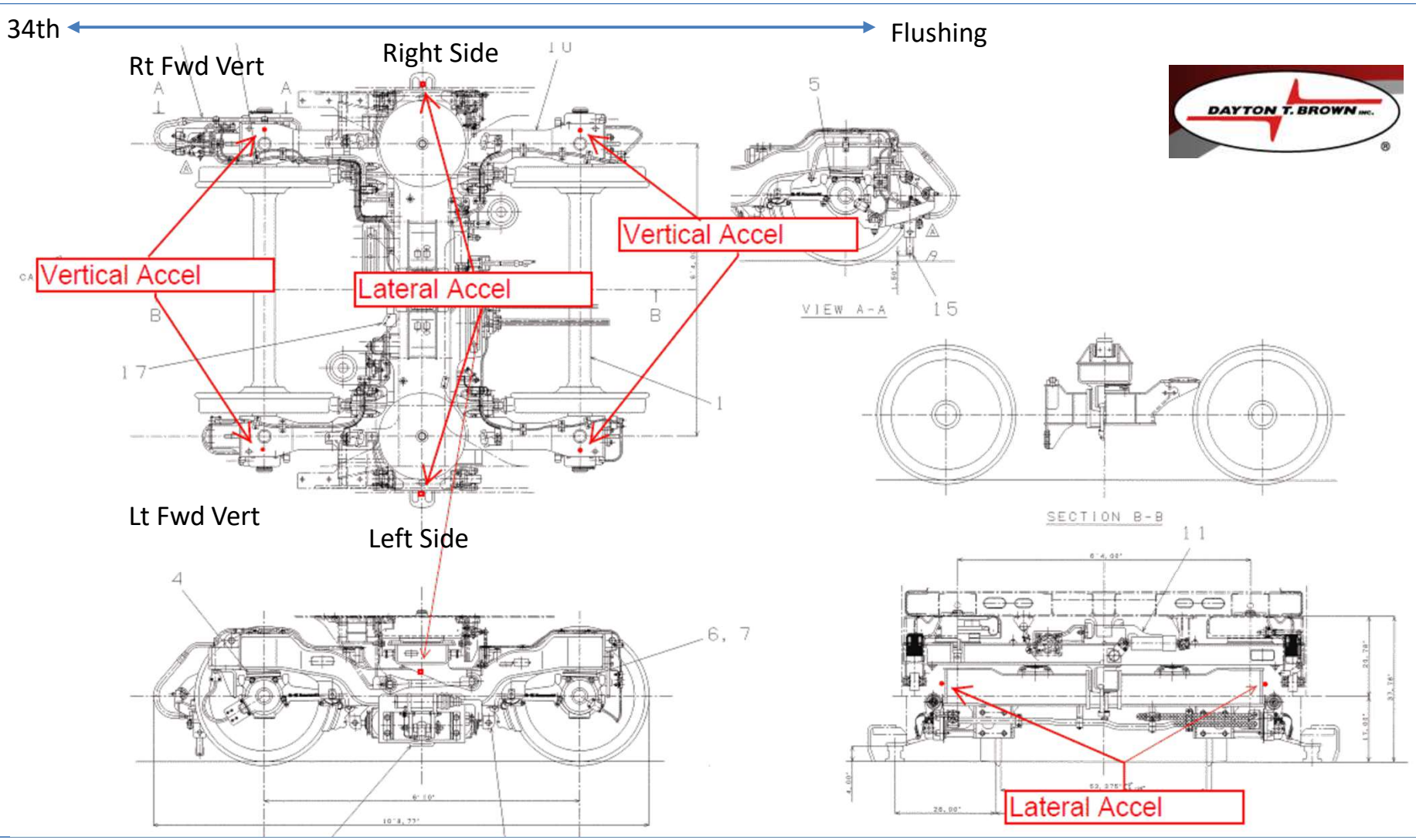

gp: c1y_2017-10-11 08-00-00 (1)_NYCT_0615_10/11/17 08:29:34_VERT_B2_5Hz
gp: c1y_2017-10-13 08-00-00 (1)_NYCT_0989_10/13/17 09:07:19_VERT_B2_5Hz
gp: c1y_2017-11-03 04-00-00 (1)_NYCT_0493_11/03/17 06:05:11_VERT_B2_5Hz
gp: c1y_2017-11-06 08-00-00 (1)_NYCT_1152_11/06/17 08:26:27_VERT_B2_5Hz
gp: c1y_2017-10-13 04-00-00 (1)_NYCT_0912_10/13/17 05:35:01_VERT_B2_5Hz
gp: c1y_2017-11-01 04-00-00 (1)_NYCT_0017_11/01/17 06:00:49_VERT_B2_5Hz
gp: c1y_2017-11-06 04-00-00 (1)_NYCT_1119_11/06/17 06:58:23_VERT_B2_5Hz
10³ lbs
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
1.5 in dip
(283+79)
28.26
28.28
28.30
28.32
28.34
28.36
28.38
28.40
28.42
28.44
28.46
282+80
283+30
283+20
283+40
283+60
283+80
284+00
TDC Chainage (ft)
South bound

An IWS run on March 20, 2018 confirmed that the force peak has been removed

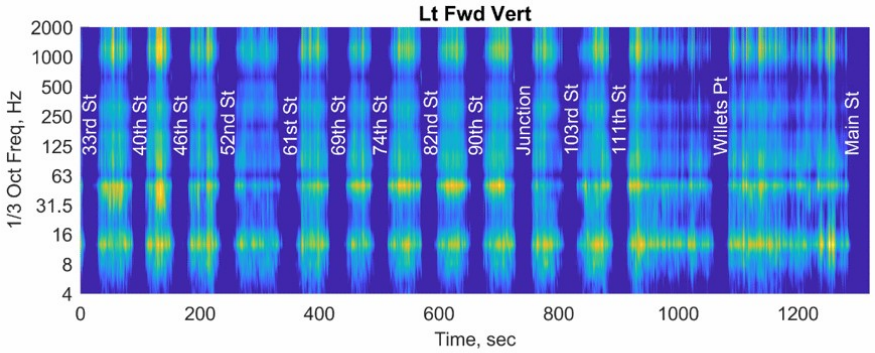


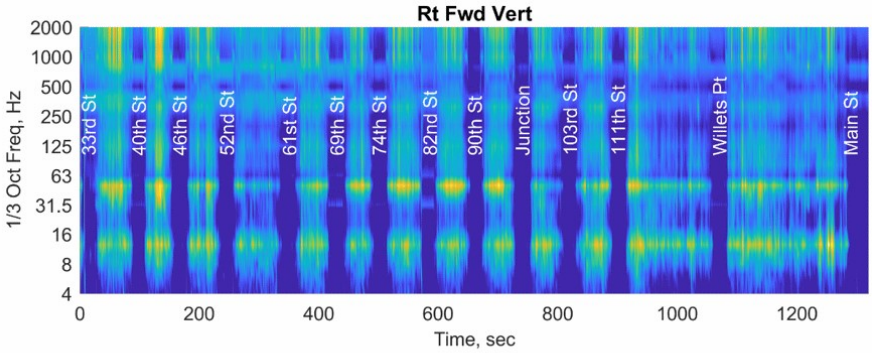
ACCELERATION AND WHEEL/RAIL NOISE MEASUREMENTS

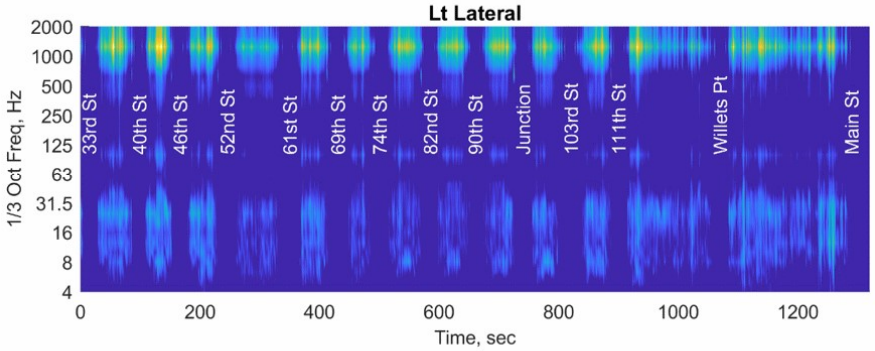
Keith Cummings - Dayton T. Brown
Hugh Saurenman and Shawn Duenas – ATS Consulting
Raman Pall – NRC, Canada

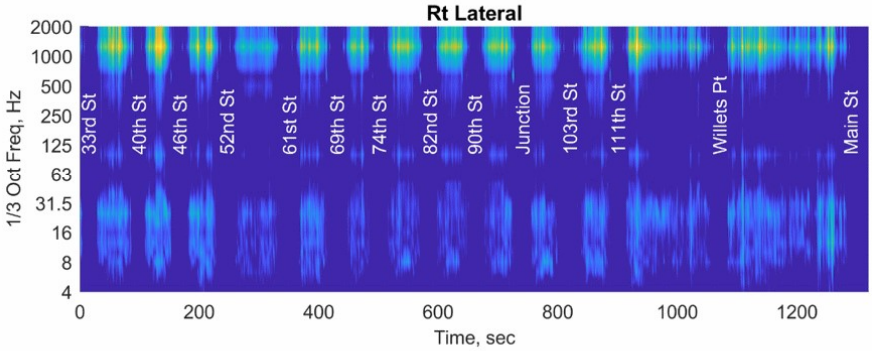

34th
Flushing
Rt Fwd Vert
Right Side
Vertical Accel
Vertical Accel
Lateral Accel
Lt Fwd Vert
Left Side
VIEW A-A
SECTION B-B
Lateral Accel

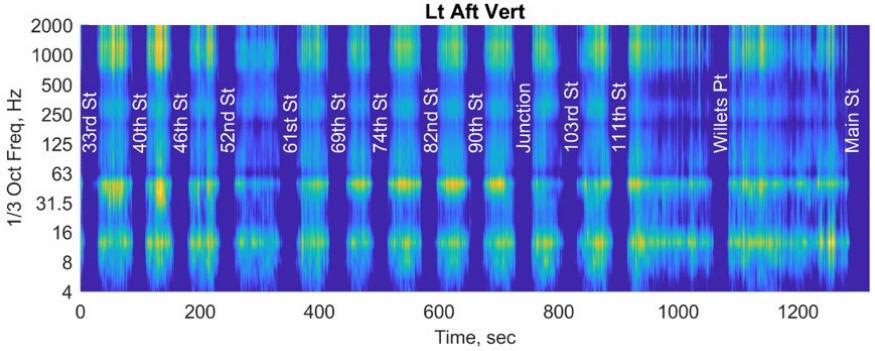
ATSConsulting
acoustics, transportation + strategy

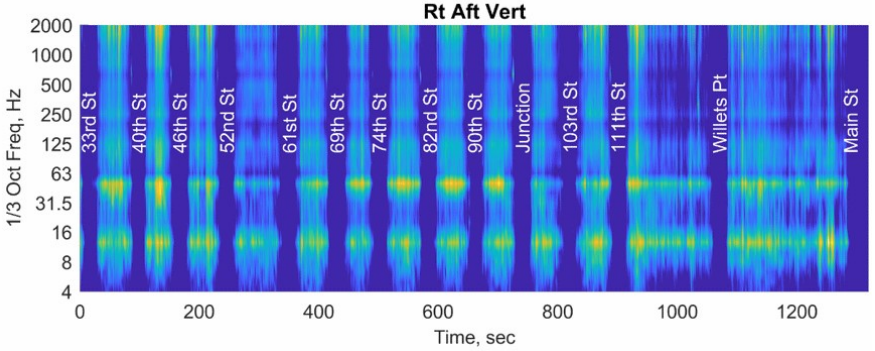


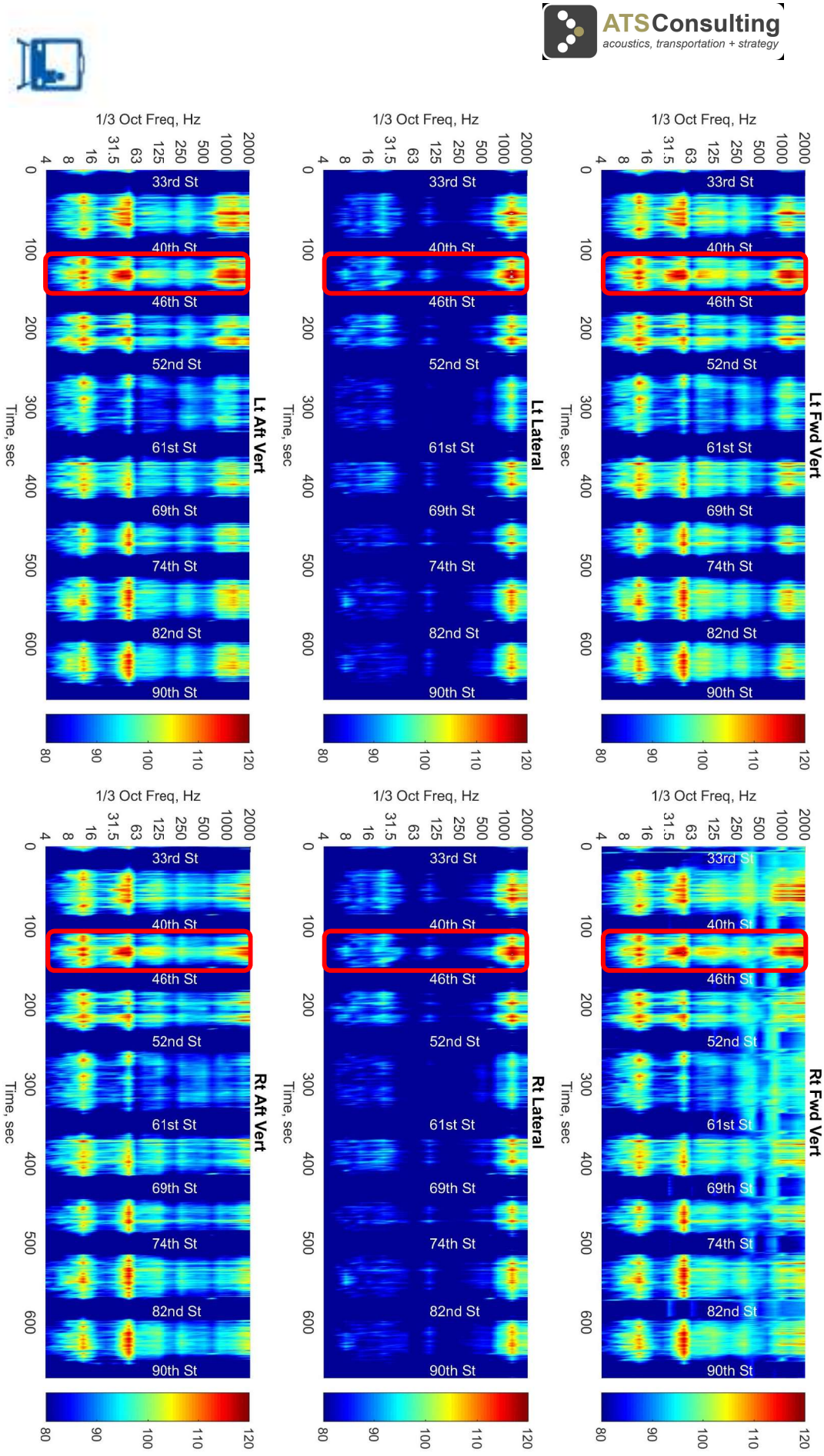




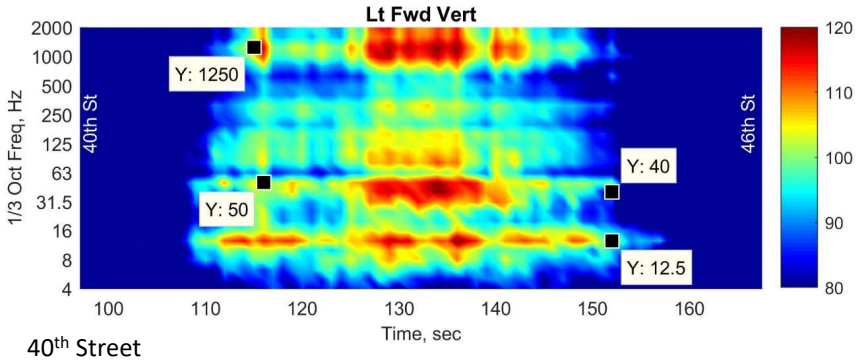


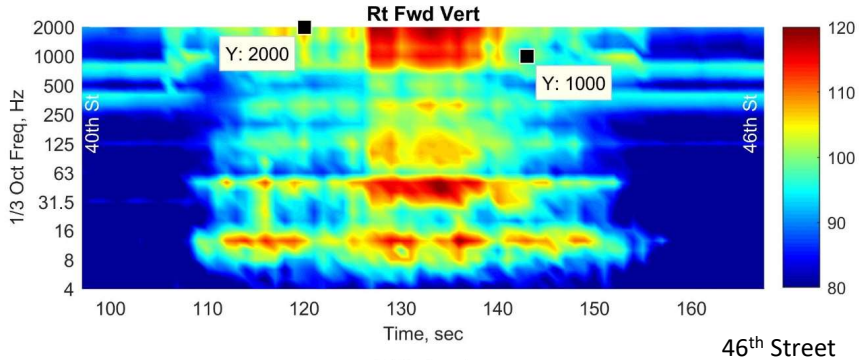





ATSConsulting
acoustics, transportation + strategy
1/3 Oct Freq, Hz
Time, sec
33rd St
40th St
46th St
52nd St
61st St
69th St
74th St
82nd St
90th St
Lt Fwd Vert
Lt Lateral
Lt Aft Vert
Rt Fwd Vert
Rt Lateral
Rt Aft Vert

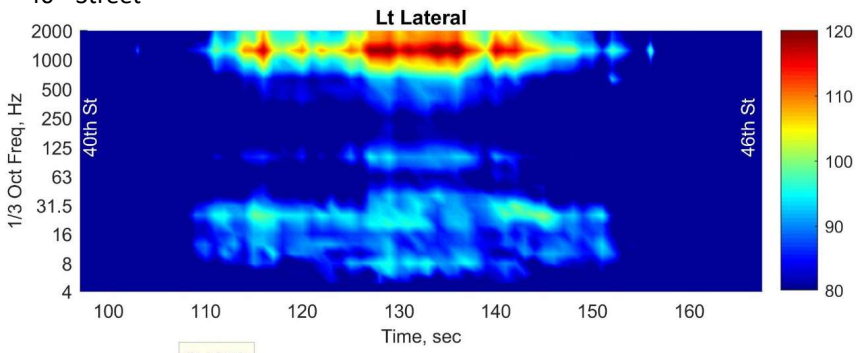
ATSConsulting
acoustics, transportation + strategy

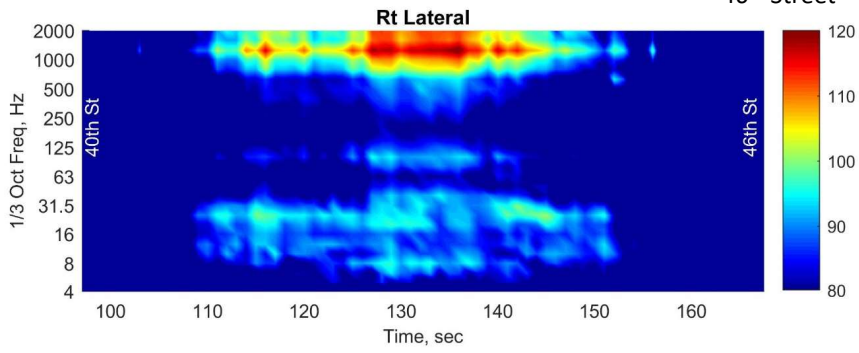


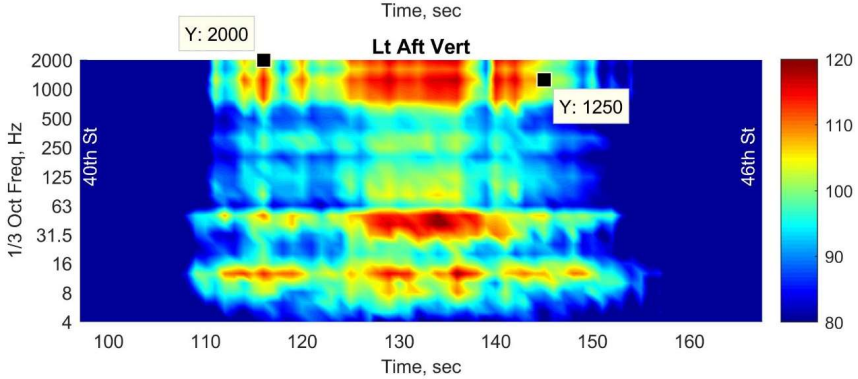


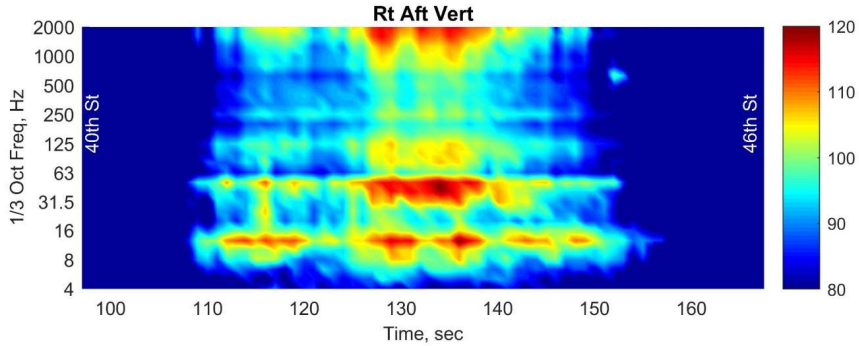
40th Street

46th Street

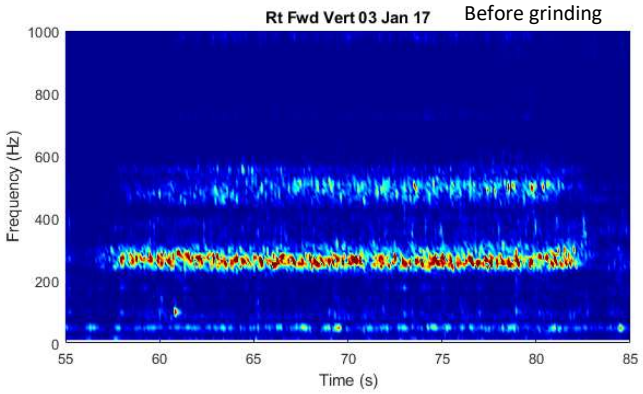




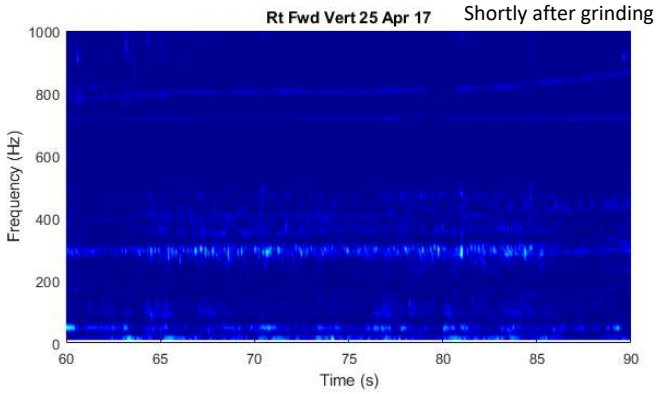




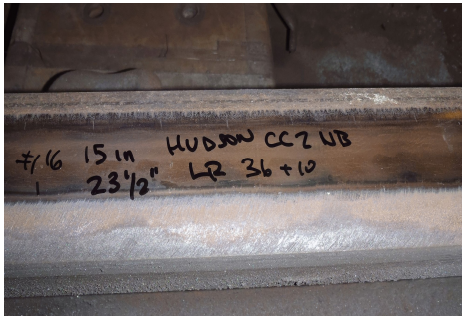
Approximately 280Hz at 29mph equates to 1.8 inch wavelength



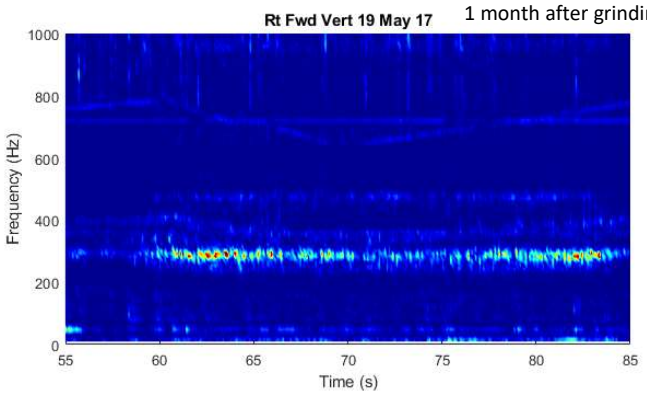
Before grinding



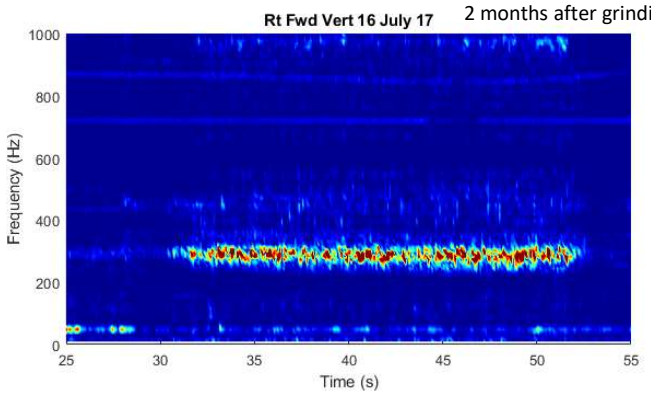
Shortly after grinding



Wavelength averages 1.6 inches in this photo

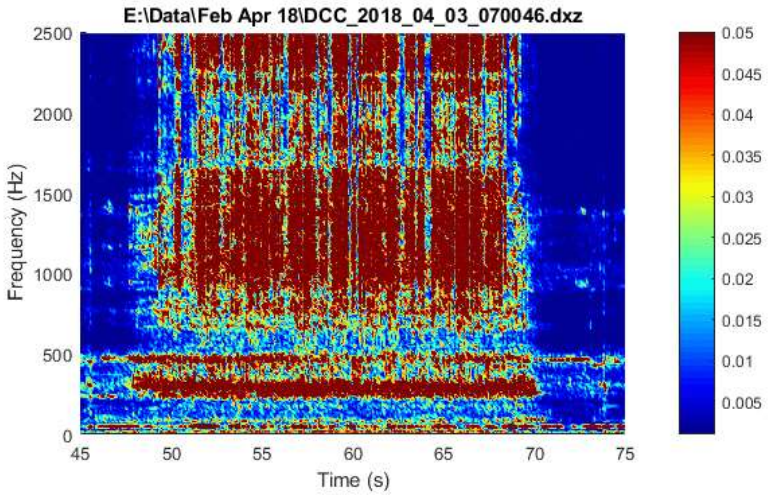


1 month after grinding



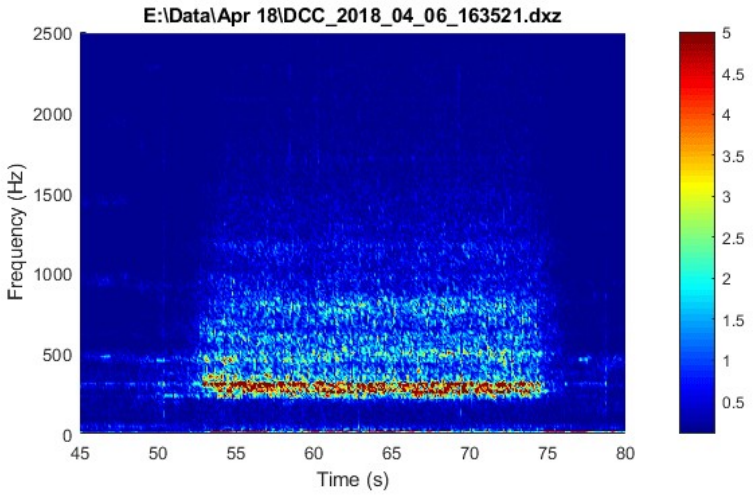
2 months after grinding

April 2018

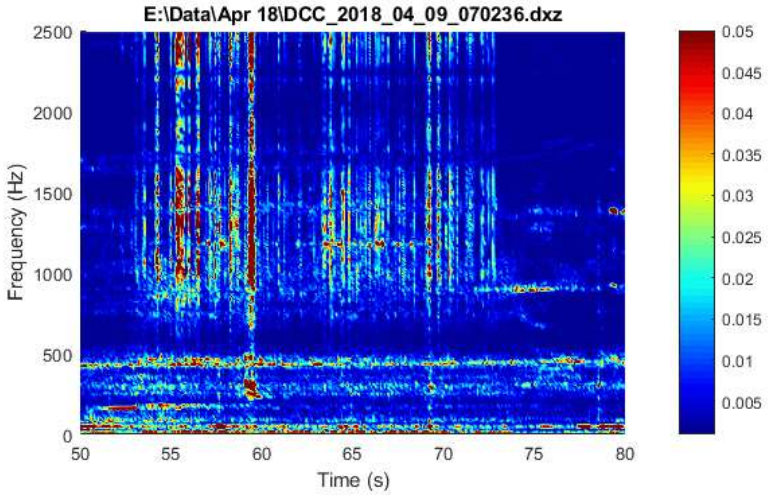


Pre-grind

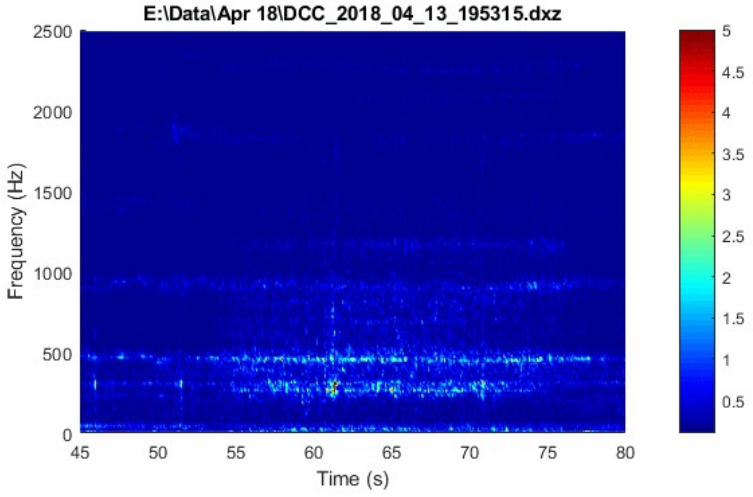
Vertical Acceleration



Noise Data



Post-grind



Wheel-Rail Analytics Project

- Future Work
  - System end-to-end noise analytics – comparison for two dates at least
  - Wheel/rail contact analytics
    - Effective conicity, Contact Stress, Wear, Optimal Shapes
  - Impact of test wheel profile on forces and wear
  - L/V and TBOGI correlations – statistics, outliers
    - Relation to wheel wear (severity and patterns)
  - Impact of friction management at Hudson 34th curve