

# NEW YORK



THE RACE TO BETTER DATA  
APRIL 25TH-28TH, SARATOGA SPRINGS

**Piloting Certification and Verification Methods for Transverse Pavement Profiles**

**Amanda Gilliland**

Project Manager, The Transtec Group



# Summary of Pilot Projects



- 2 consultants
- 5 locations
- 7 participating DOTs
- 5 participating vendors
- 23+ vehicles tested

# Piloted Tests (Published AASHTO Standards)



Static Performance

Body Motion Cancelation

*\*GRE Certification and Ground Reference Collection\**

Highway Performance

Navigation Drift

# Test Method

## Static Performance

Body Motion Cancelation

*\*GRE Certification and Ground Reference Collection\**

Highway Performance

Navigation Drift

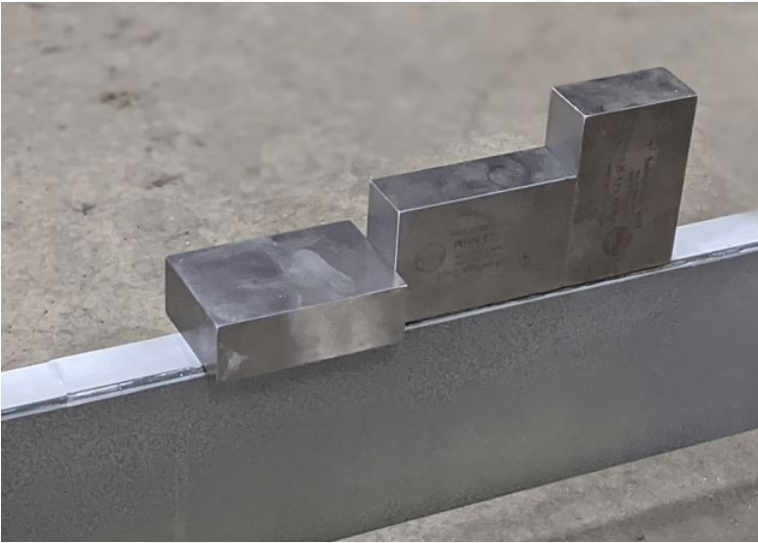


# Static Performance

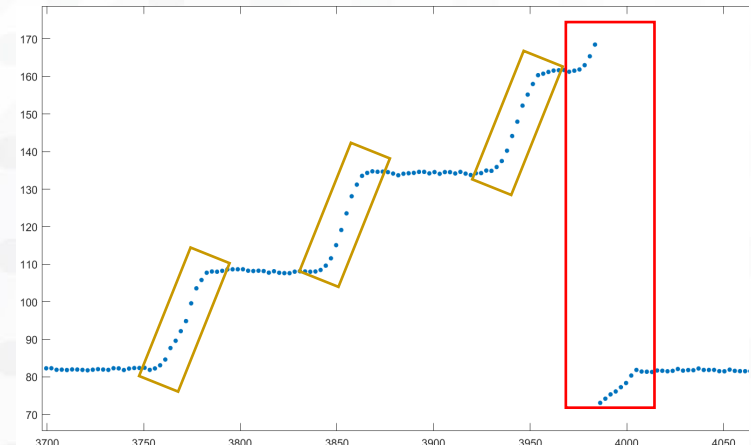
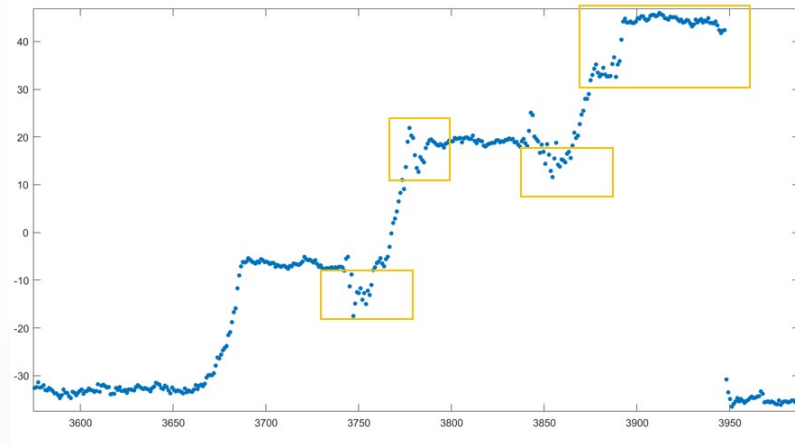
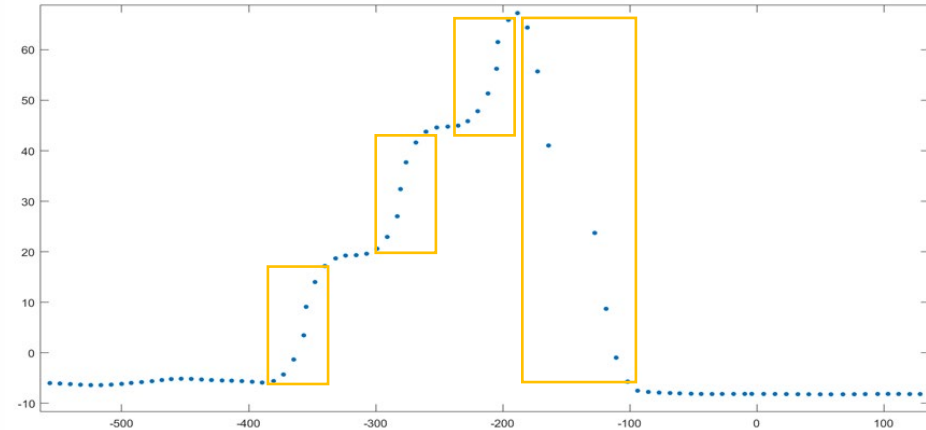




# Static Performance – Viewing Data



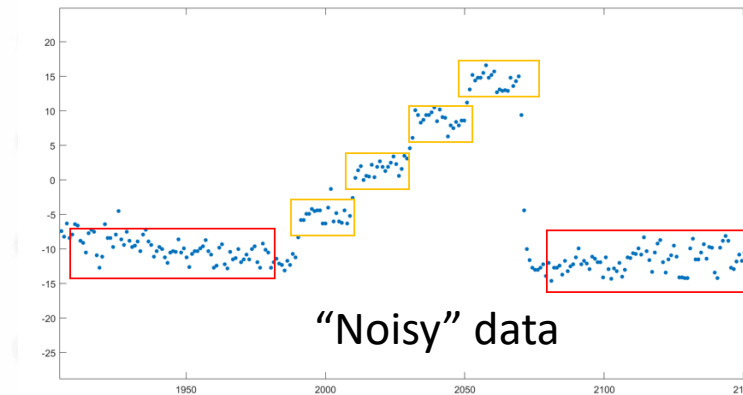
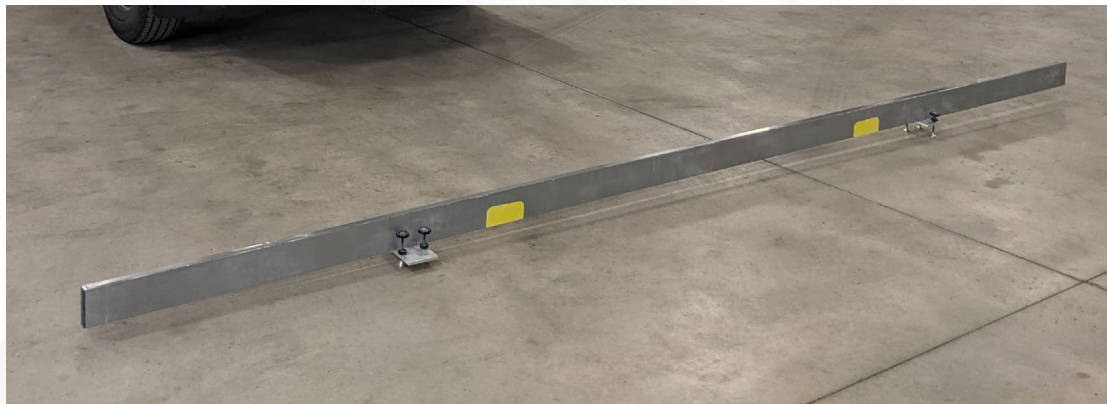
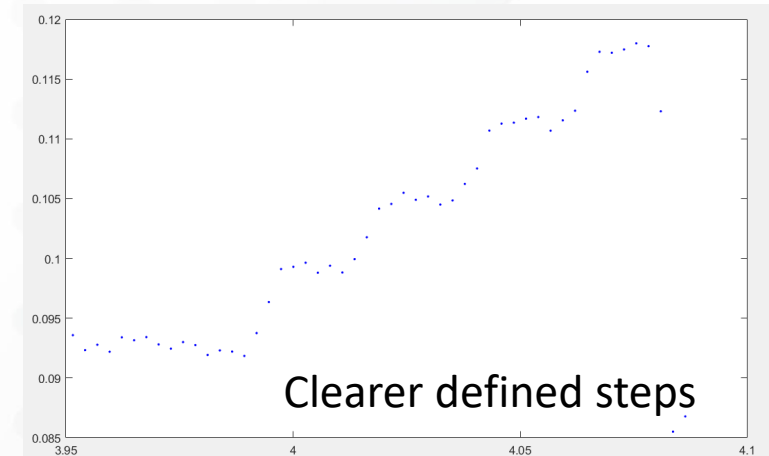
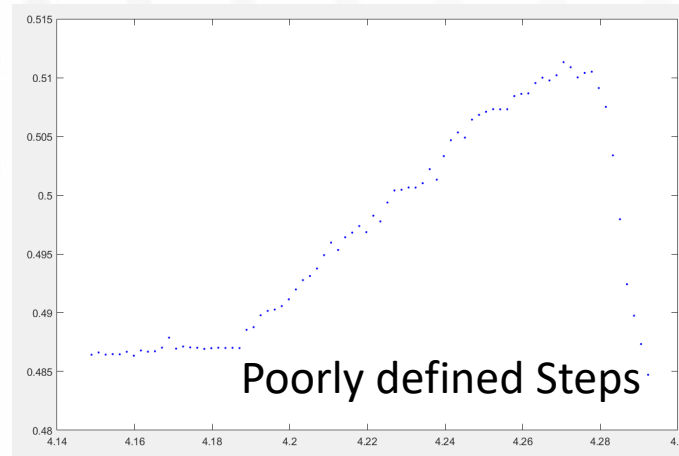
How do the vehicle sensor measurements match the certified objects?



# Static Performance – Viewing Data



How do the vehicle measurements match the certified objects?



# Static Performance – What We’ve Learned

- Low-pass filtering may be smoothing the data.
- The scans may be smoothed when averaging multiple profiles over a period during emulated vehicle motion.
- Need *unfiltered* data to verify. Actively working on this with vendors.
- Other techniques may be needed for reducing/removing “noise”.
- Even with noise and smoothing, some systems still meet current criteria.



# Test Method

Static Performance

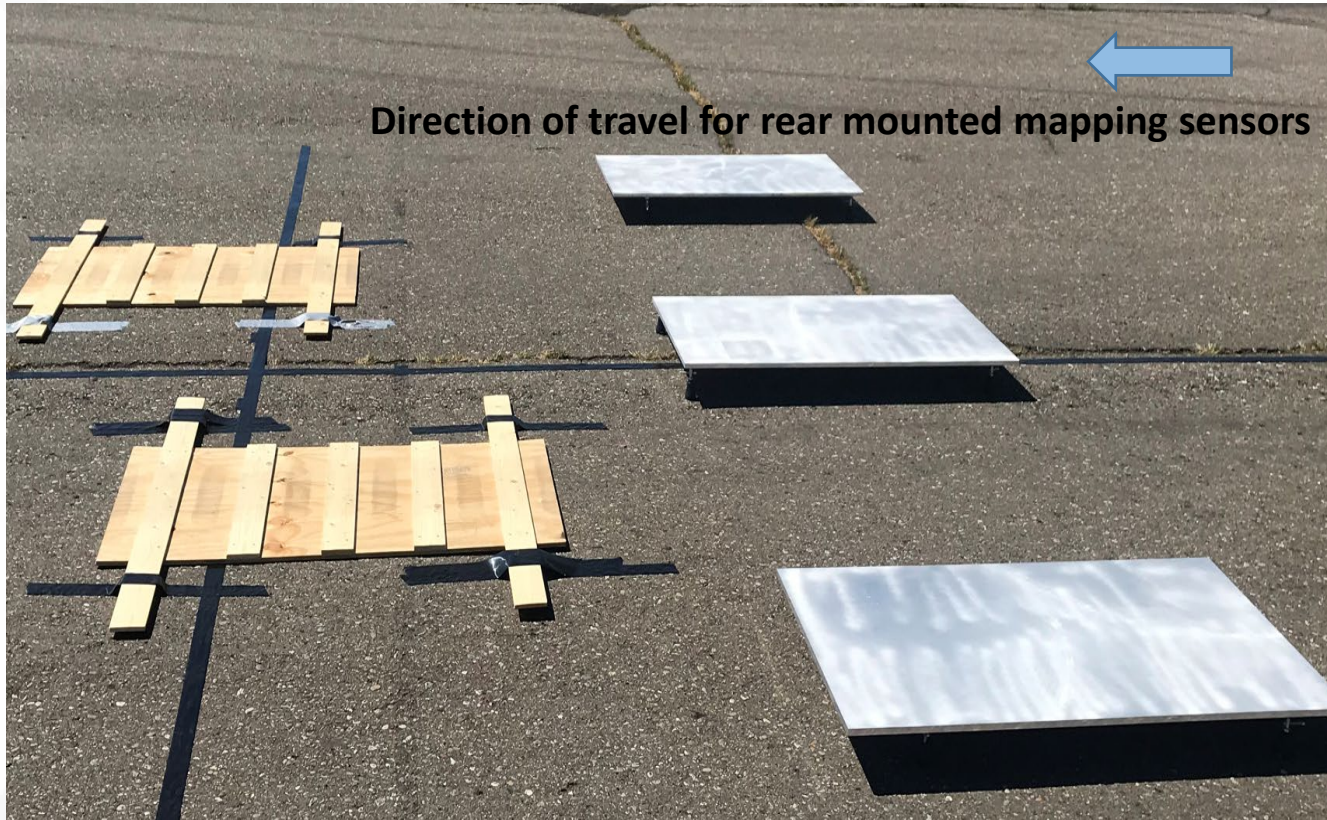
**Body Motion Cancelation**

*\*GRE Certification and Ground Reference Collection\**

Highway Performance

Navigation Drift

# Body Motion Cancelation



Testing speeds: 5, 8, 12 mph – can still be set up in a parking lot

Machined Flat Plates – strict tolerances.

How flat are the plate measurements when the vehicle is excited?

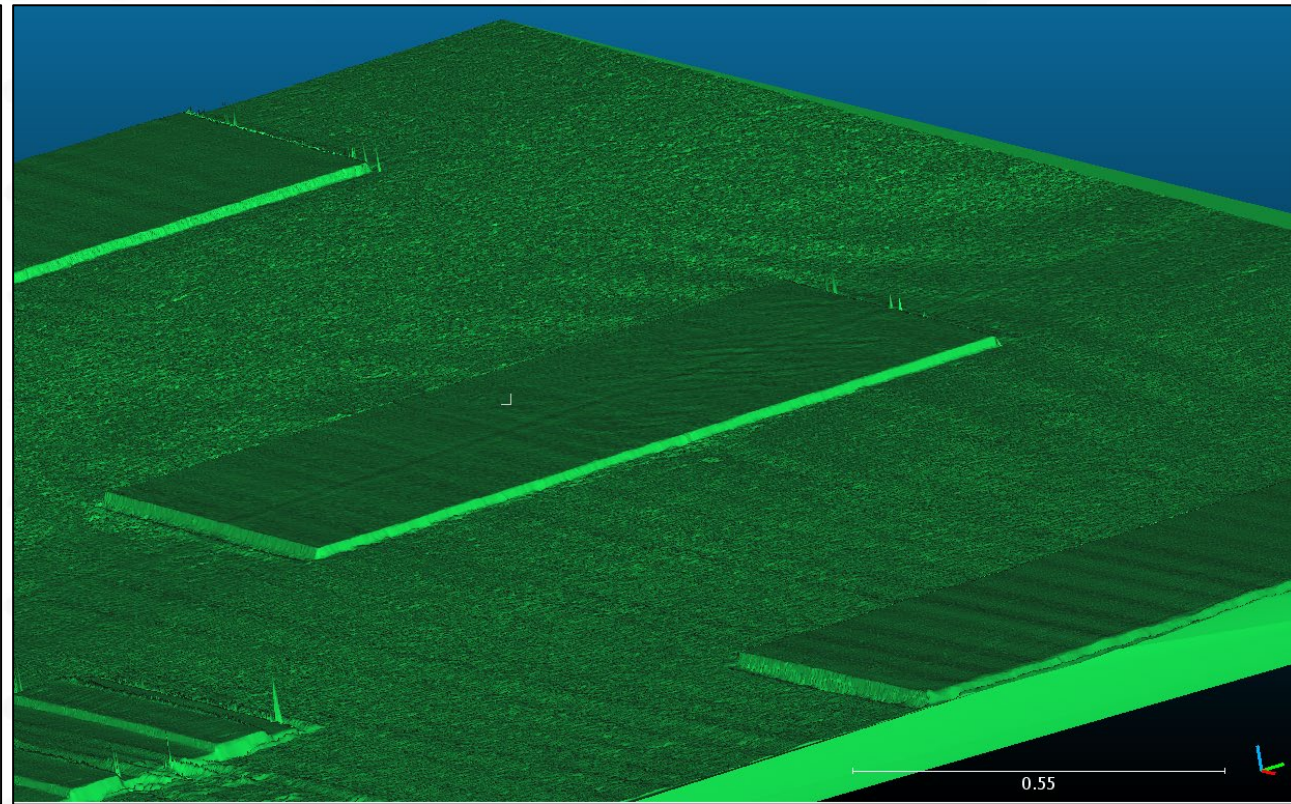
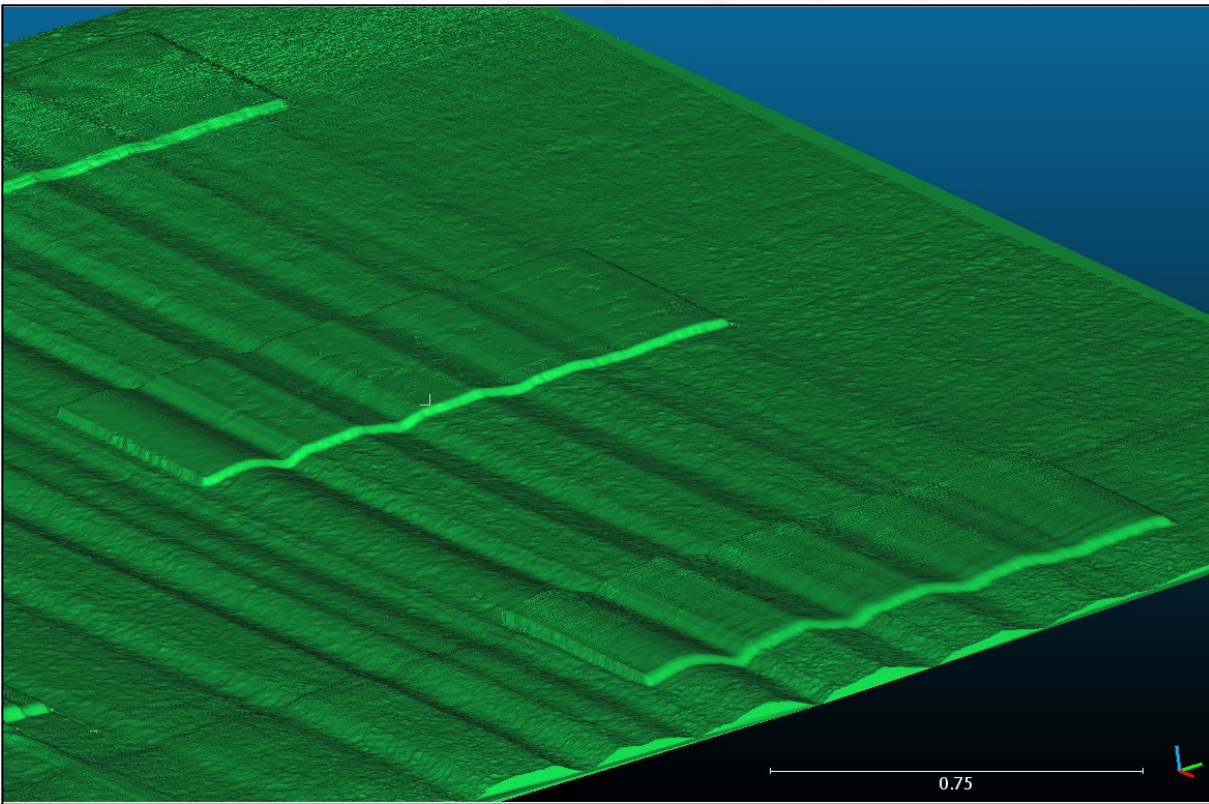
Fusion of mapping and localization sensors.

Induce

- ✓ Pitch
- ✓ Roll
- ✓ Primary Bounce
- ✓ Secondary Bounce



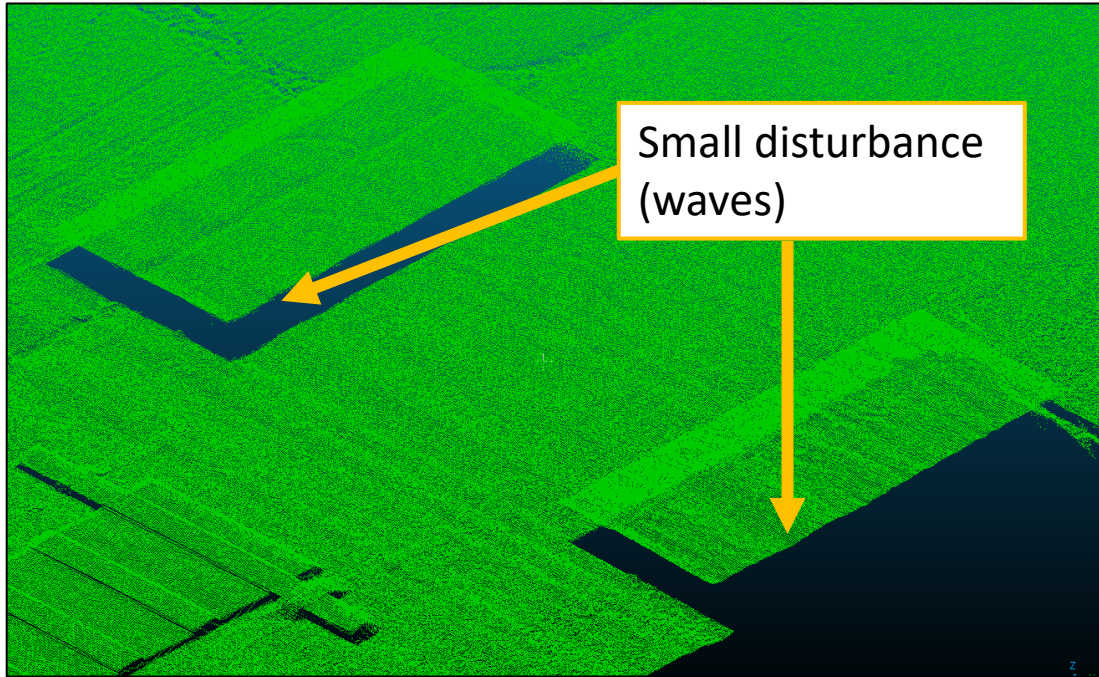
# Body Motion Cancellation – Viewing the Data



Similar systems – appears to be different sensor setting or data fusion.



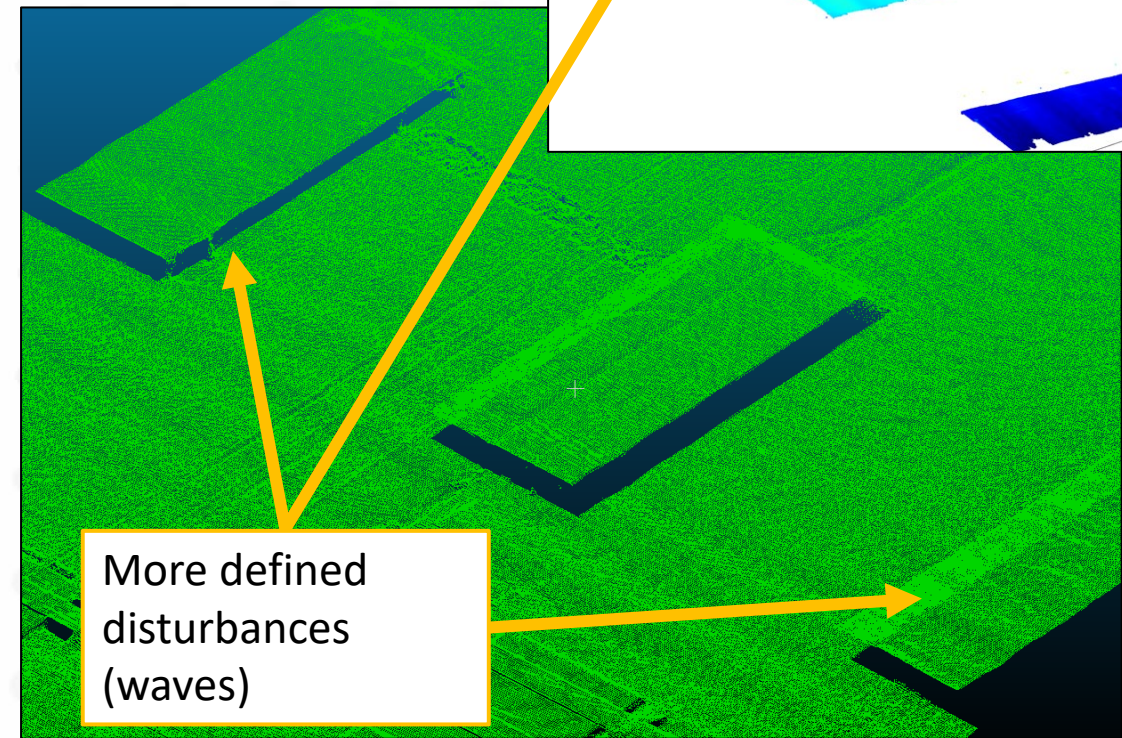
# Body Motion Cancellation – Viewing the Data



5 mph

Effects of speed

12 mph



# Body Motion Cancellation – What We've Learned

- Some systems performed well in reducing body motion error.
- Some systems appeared to be affected by vehicle speed.

# Test Method

Static Performance

Body Motion Cancelation

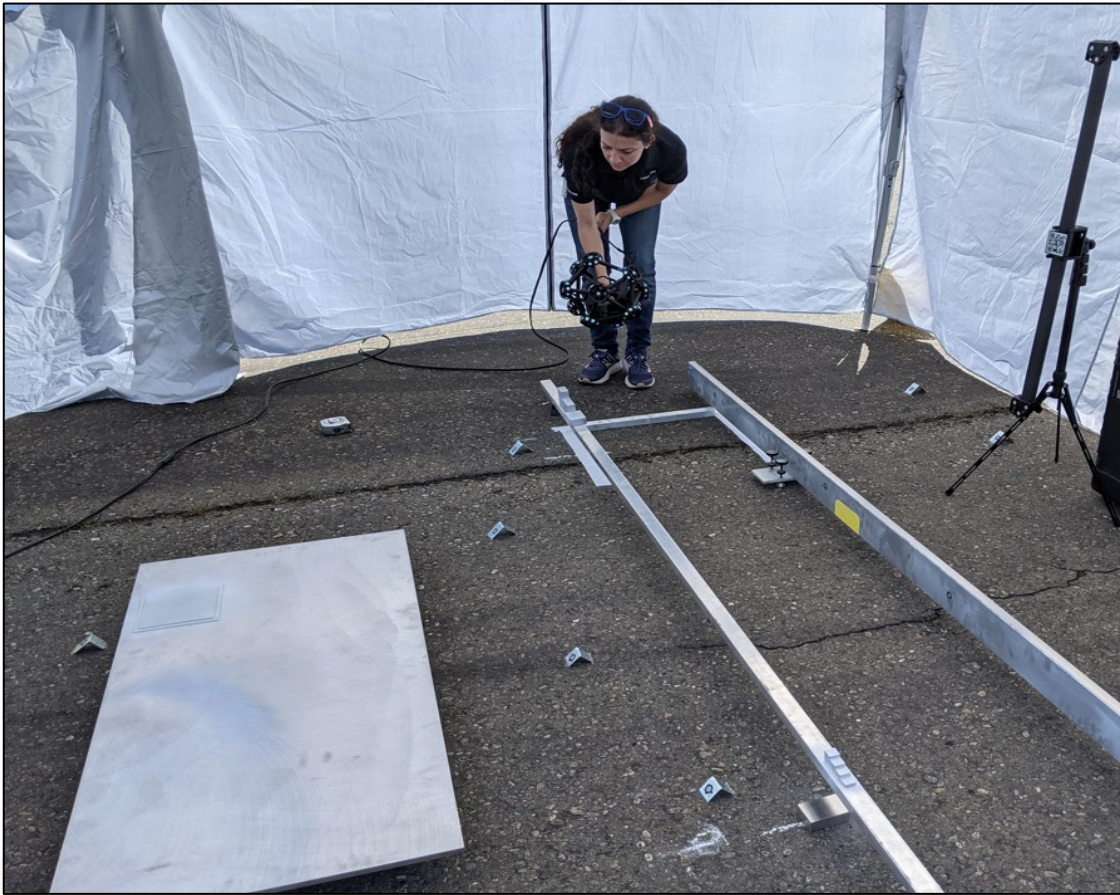
***\*GRE Certification and Ground Reference Collection\****

Highway Performance

Navigation Drift

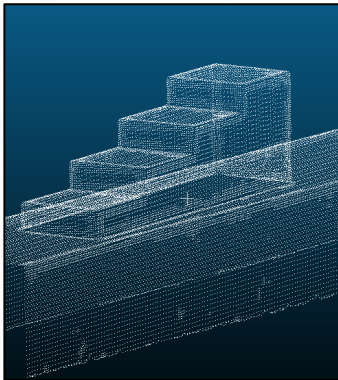
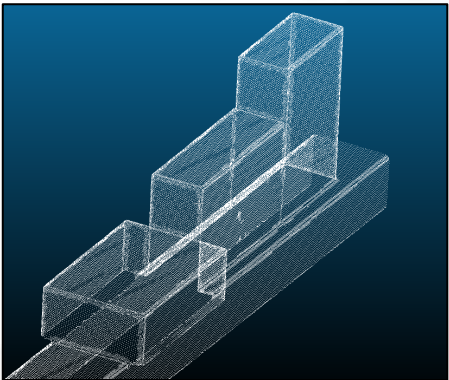
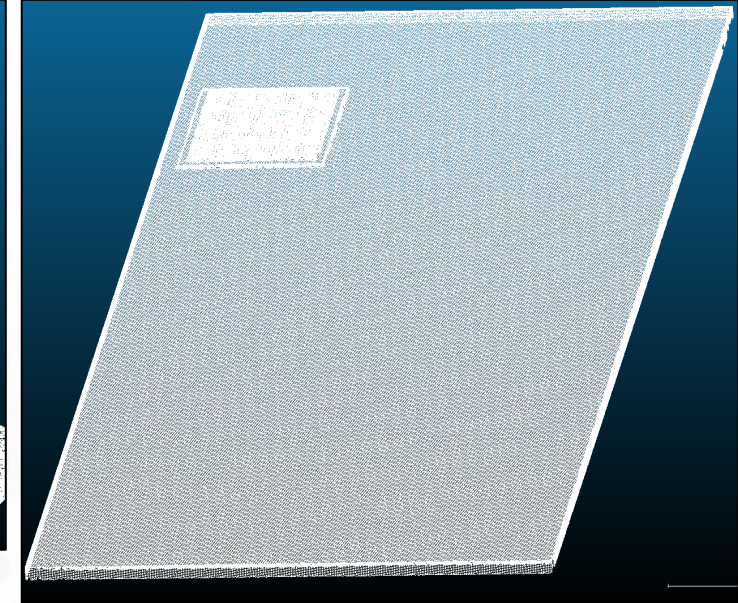
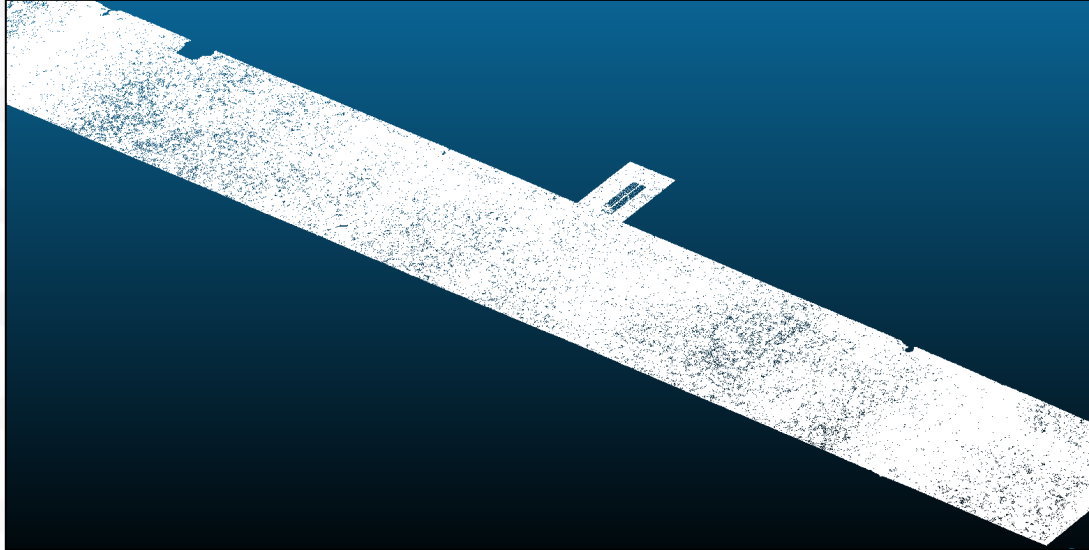
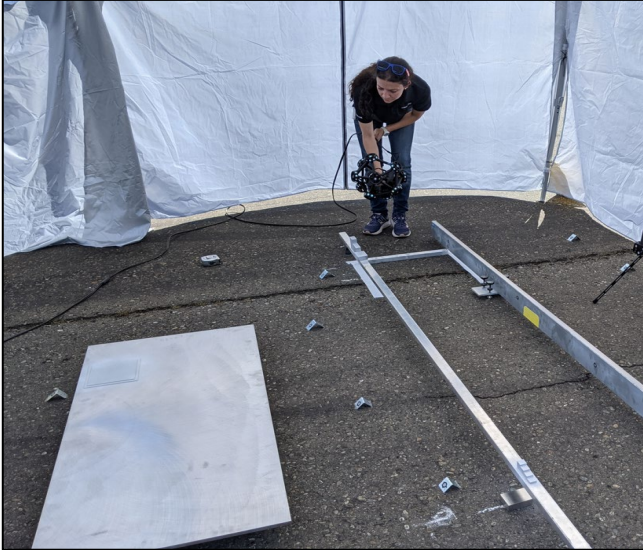


# GRE Certification and Ground Reference Collection

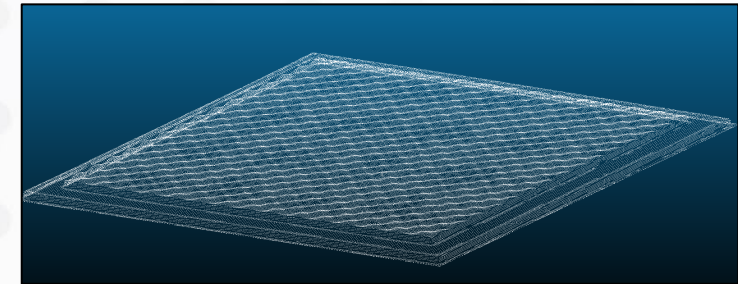




# GRE Certification and Ground Reference Collection



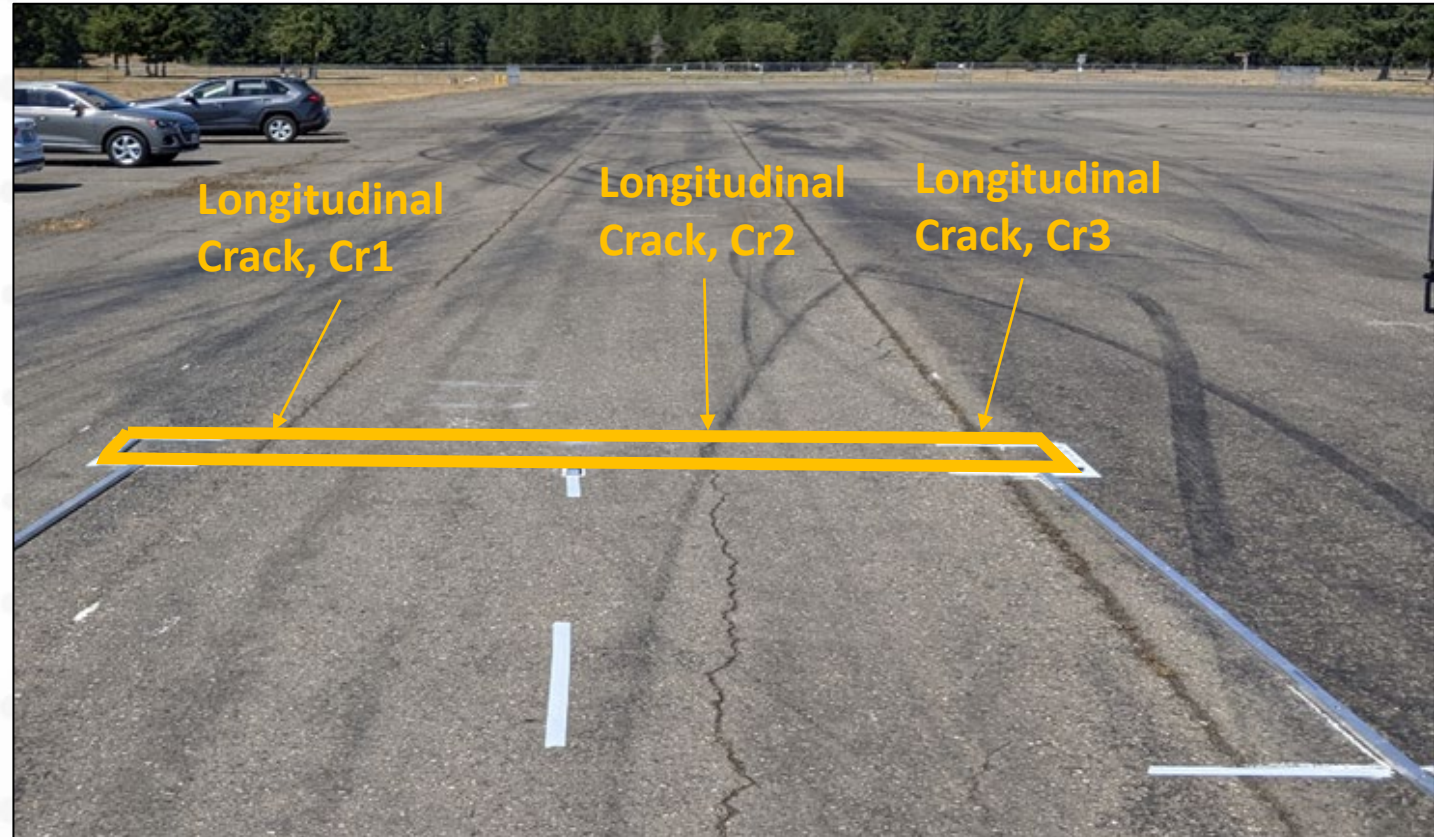
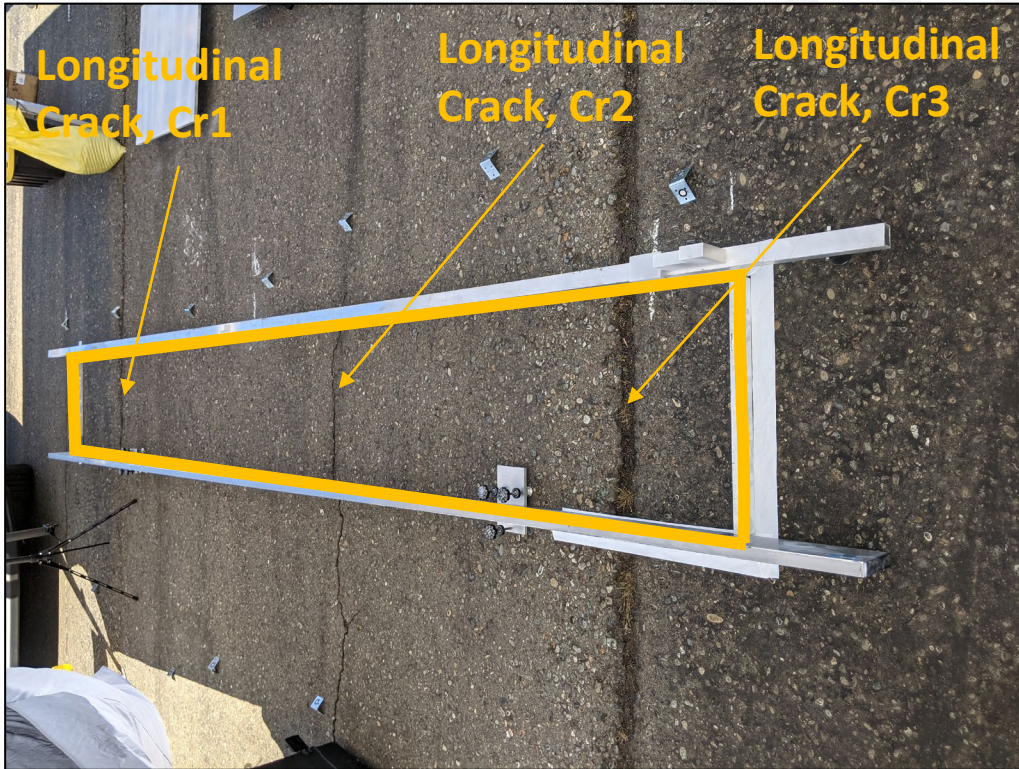
- ✓ How well does GRE data compare to certified objects?
- ✓ Denser point cloud.
- ✓ Stricter tolerances.
- ✓ Collected simultaneously in one scan with no changes to settings.
- ✓ Trustworthy ground reference.





# Highway Performance

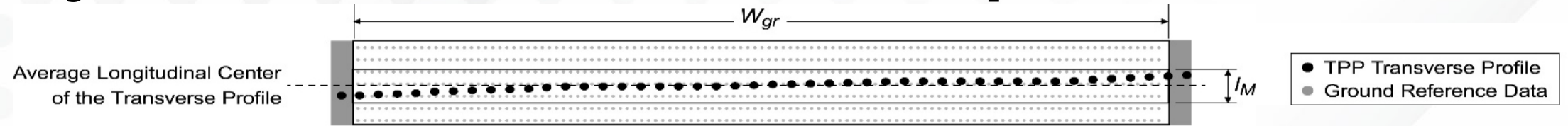
Speeds ranging from 10 mph to 65 mph.



Exact same location as ground reference.

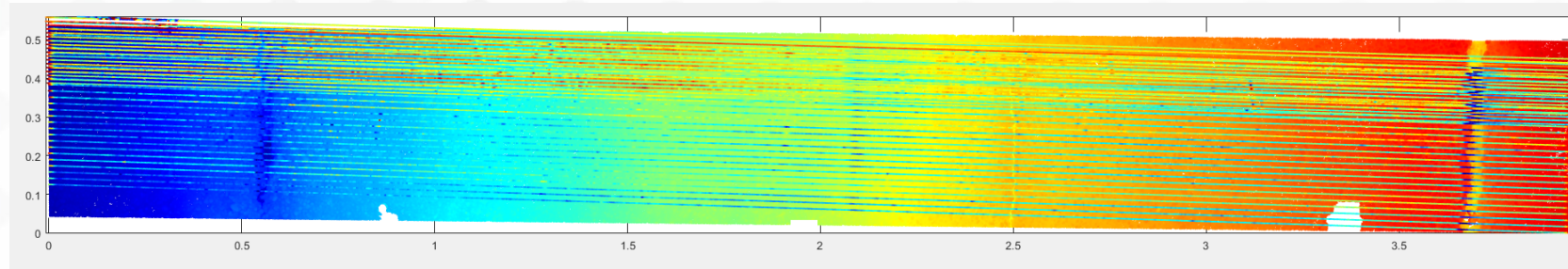


# Highway Performance and GRE Comparison

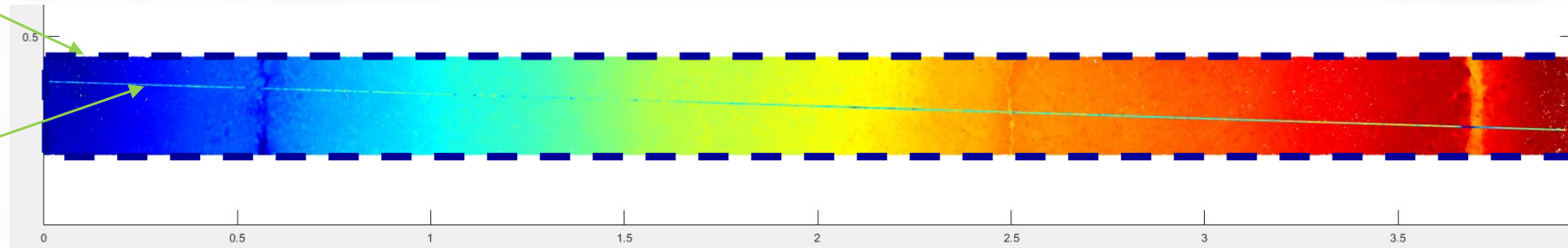


Virtual rectangle

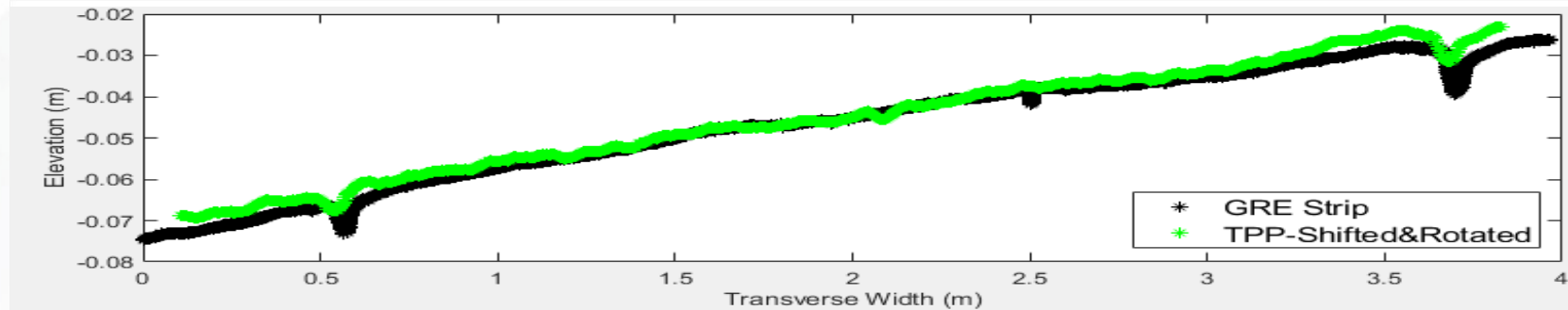
TPP profile



65 mph-Run 2

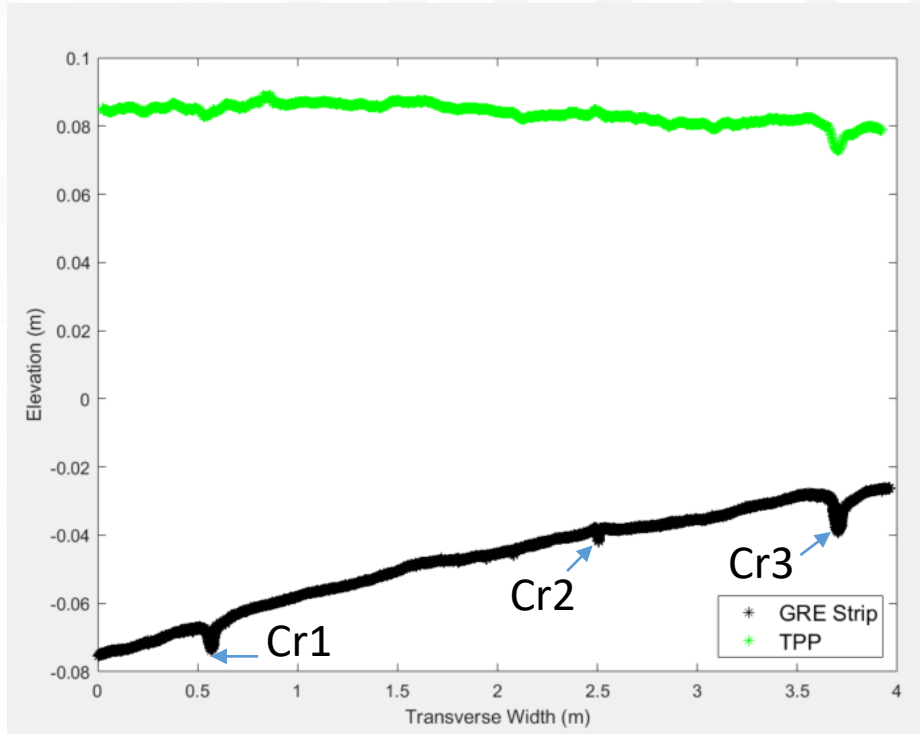


Strip 17  
(Top view)



Strip 17  
(Cross section)

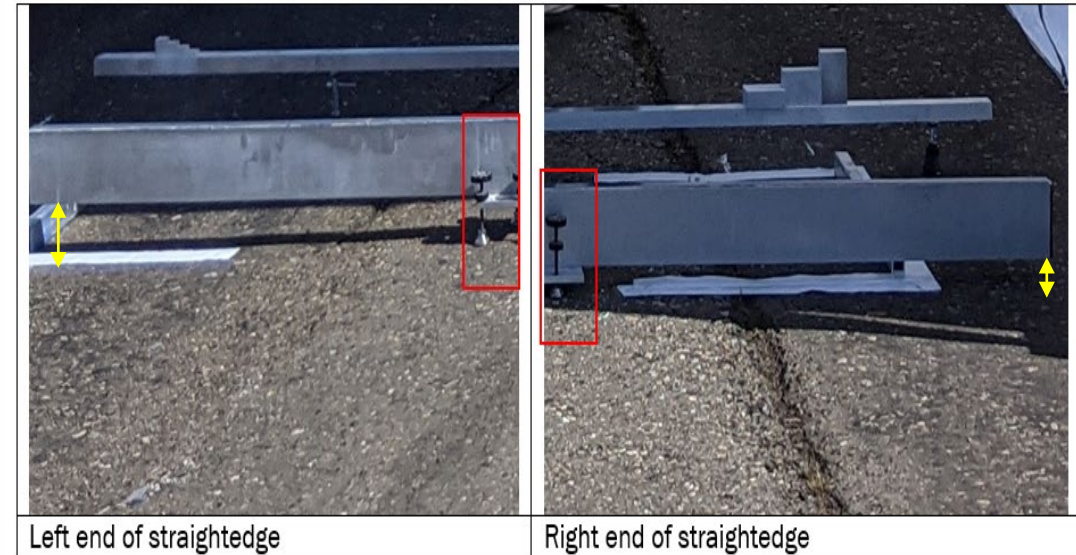
# Highway Performance and Ground Reference Viewing the Data



TPP shows no to  
negative cross slope

GRE has cross  
slope with  
respect to the  
horizontal axis  
based on  
leveled  
straightedge

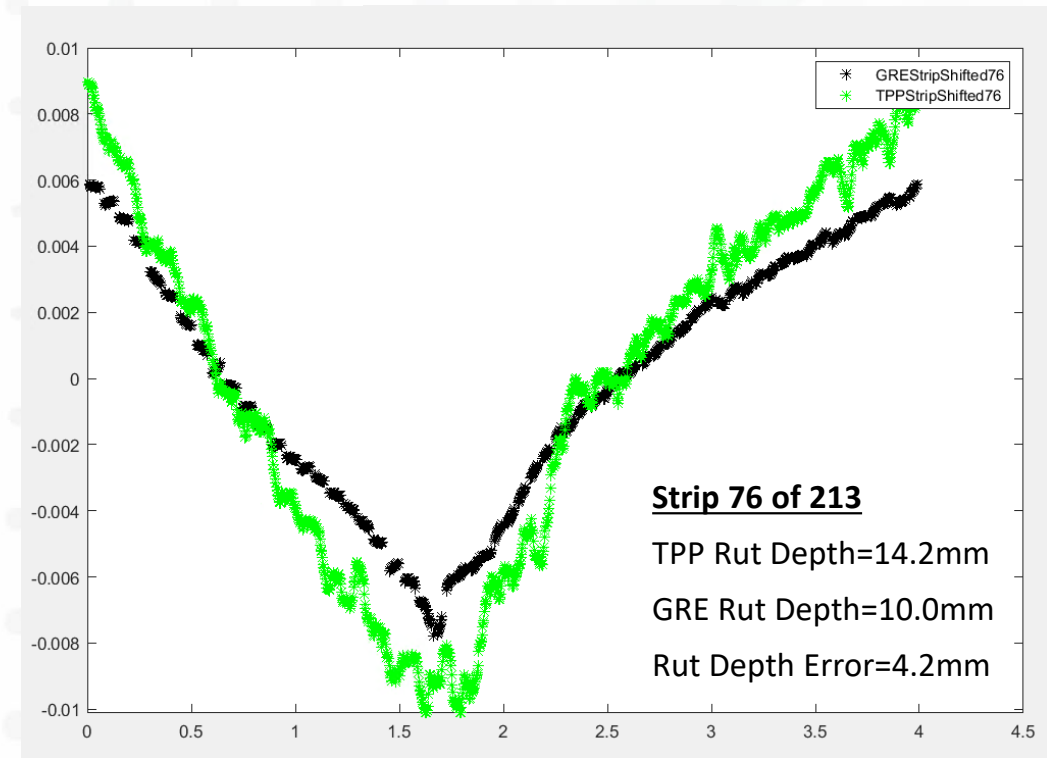
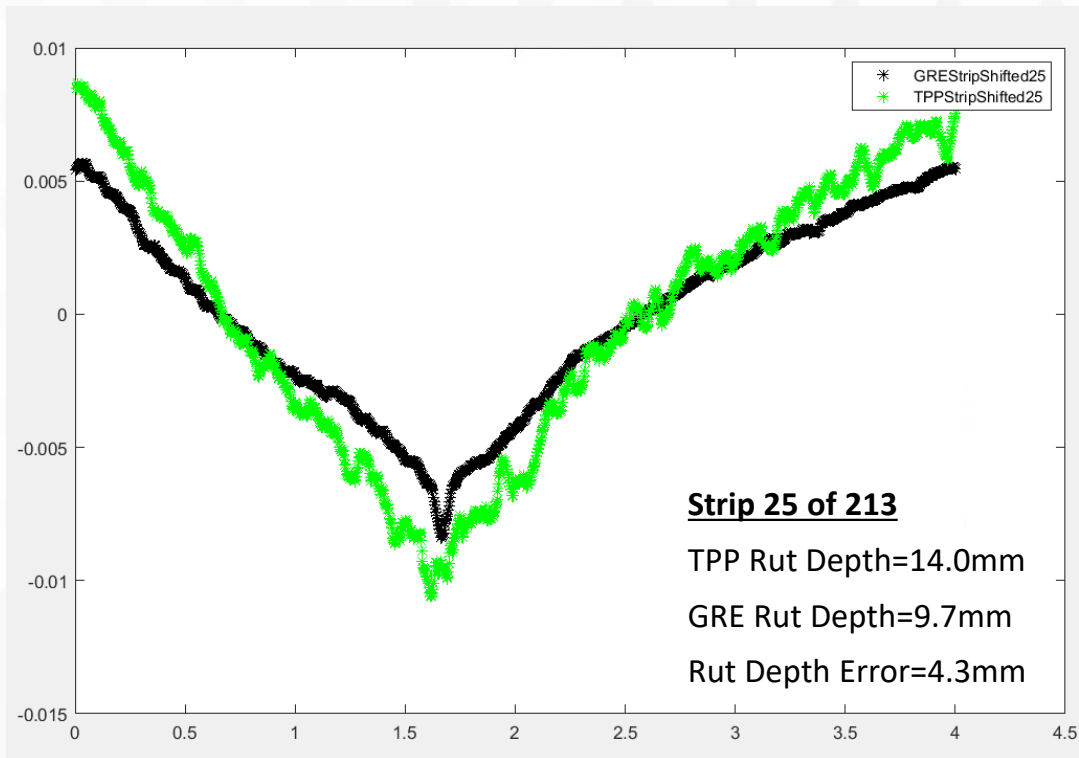
Leveled Straightedge



Cross slope seen  
in the field

# Highway Performance and Ground Reference Viewing the Data

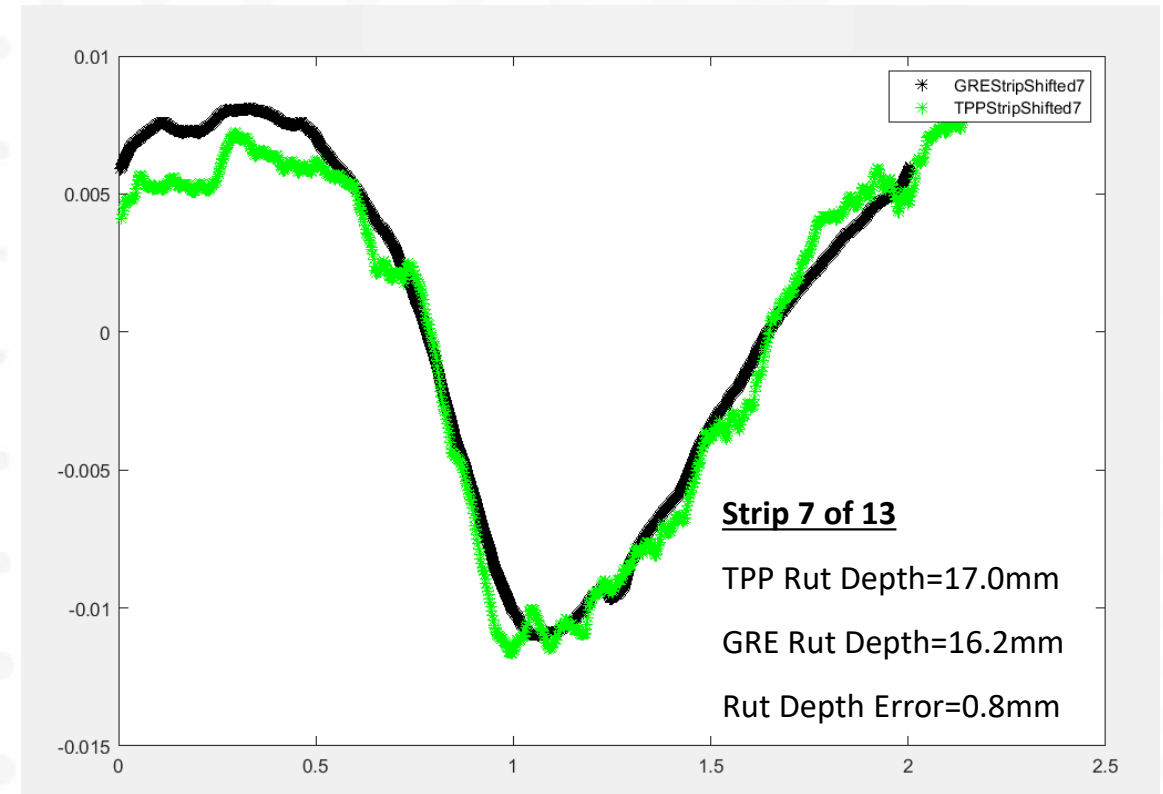
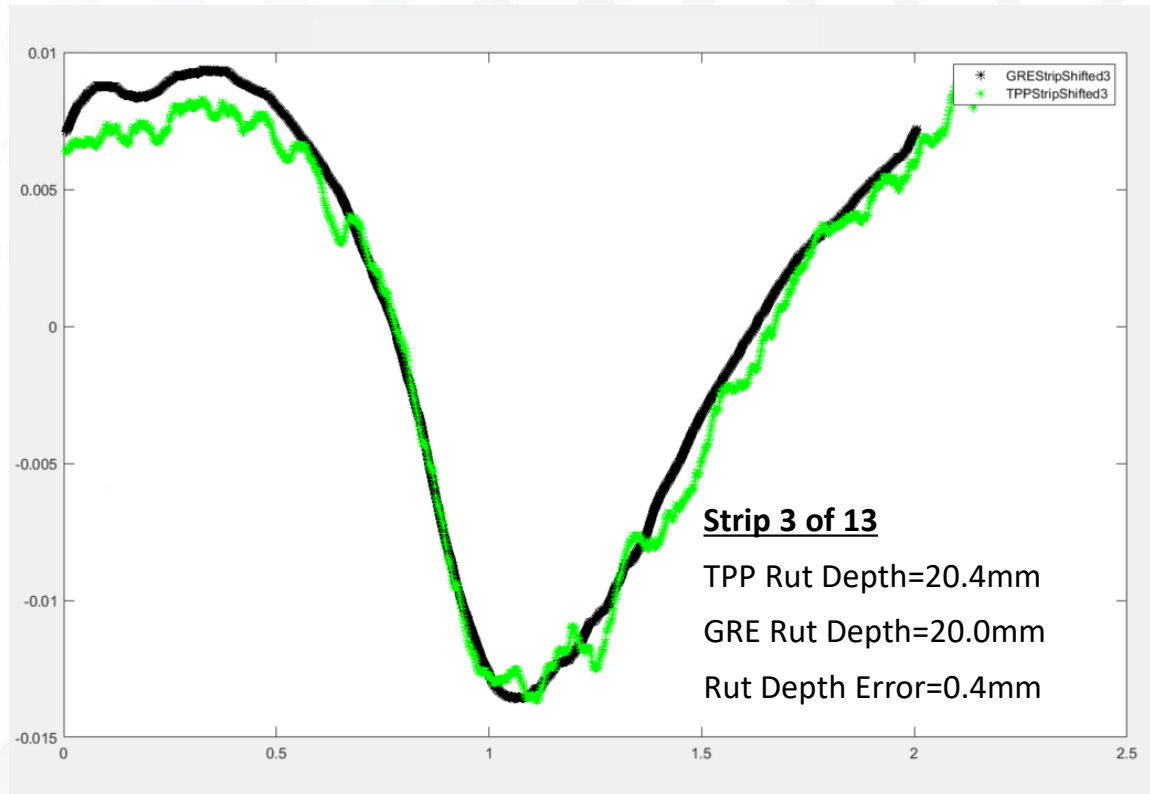
Pass 1 (approx. 10 mph)  
Had 213 strips in the section





# Highway Performance – Rut Depth

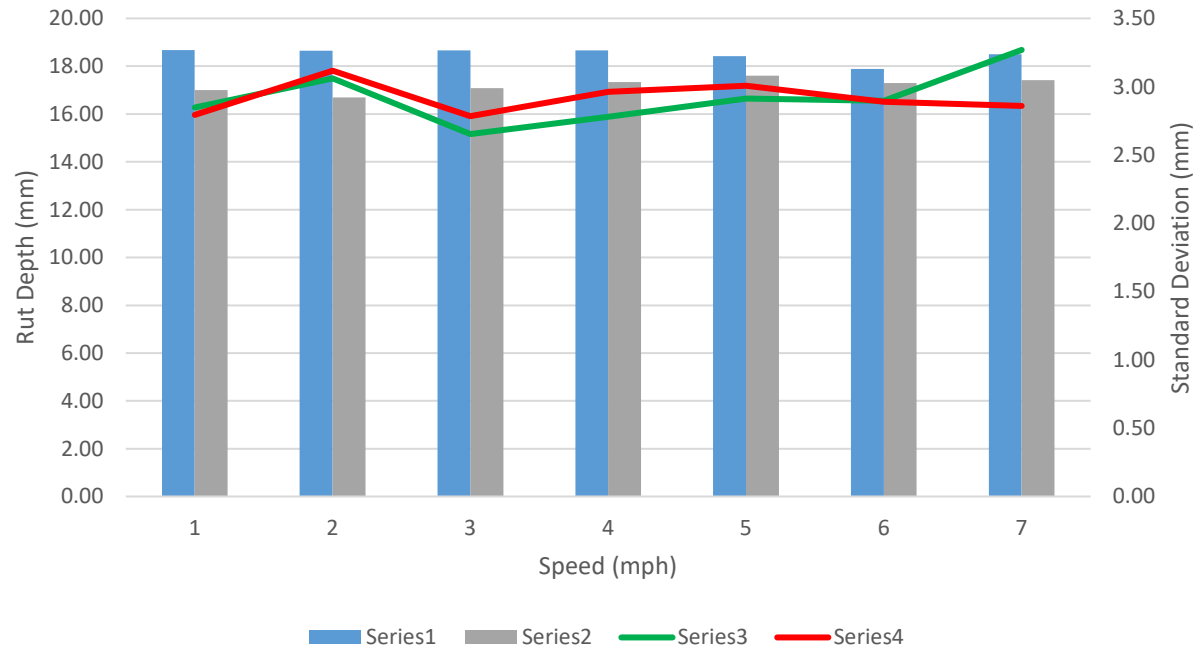
Pass 6 (approx. 30 mph)  
13 strips in GRE section



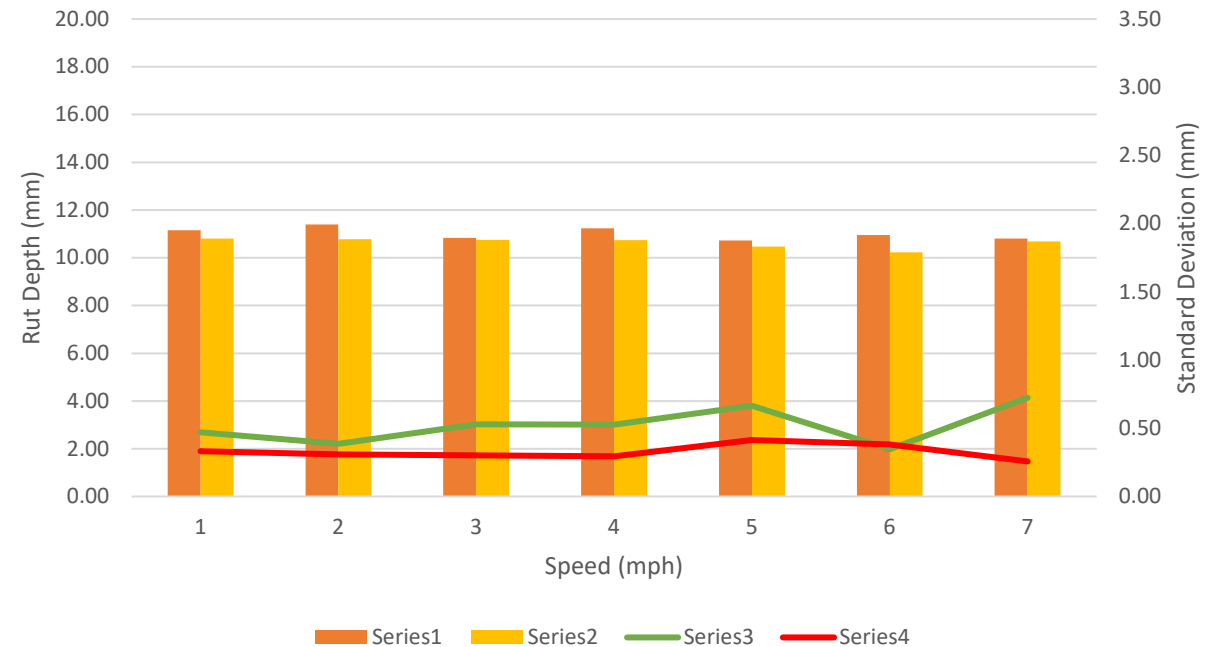
# Rutting by Speed Results – Vendor 1

Approx Speed (mph)	TPP Rut Mean (mm)		TPP Rut Standard Dev (mm)		GRE Rut Mean (mm)		GRE Rut Standard Dev (mm)		Total Number of Strips
	LWP	RWP	LWP	RWP	LWP	RWP	LWP	RWP	
10	18.67	11.16	2.85	0.47	17.00	10.81	2.79	0.33	638
20	18.64	11.40	3.06	0.39	16.69	10.78	3.12	0.31	337
30	18.66	10.84	2.65	0.53	17.08	10.75	2.78	0.30	212
35	18.67	11.24	2.78	0.53	17.33	10.74	2.96	0.30	171
45	18.42	10.72	2.91	0.66	17.61	10.48	3.01	0.41	136
55	17.89	10.96	2.90	0.35	17.30	10.23	2.89	0.38	114
65	18.50	10.81	3.27	0.72	17.42	10.69	2.86	0.26	64

Vendor 1 TPP Rutting by Speed - LWP



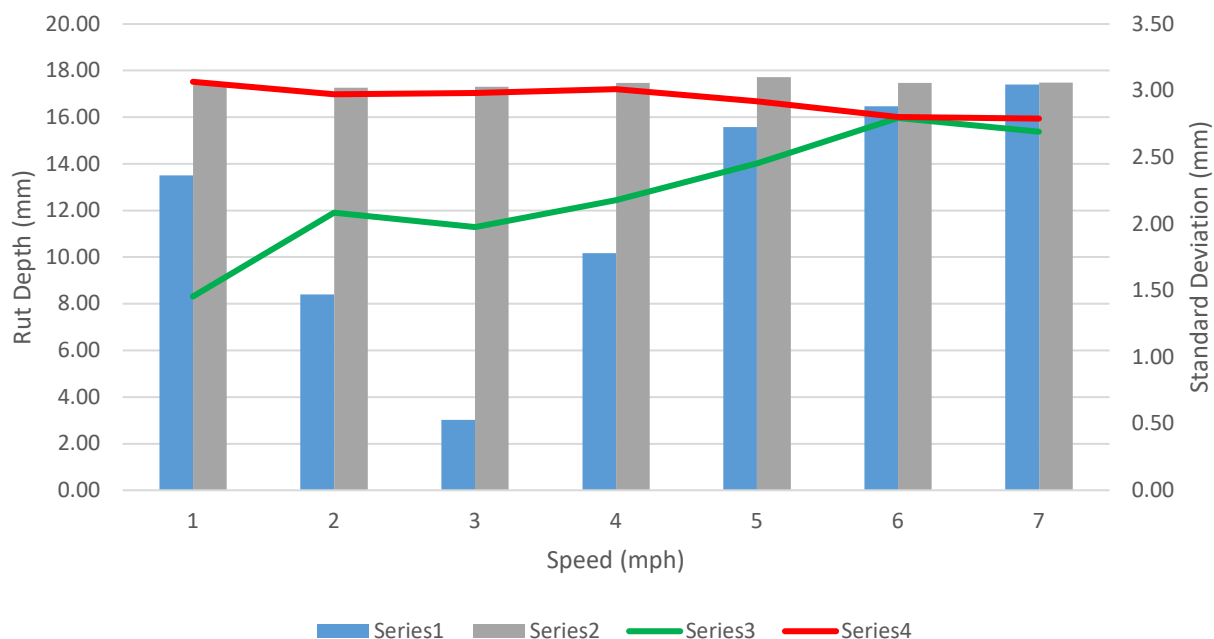
Vendor 1 TPP Rutting by Speed - RWP



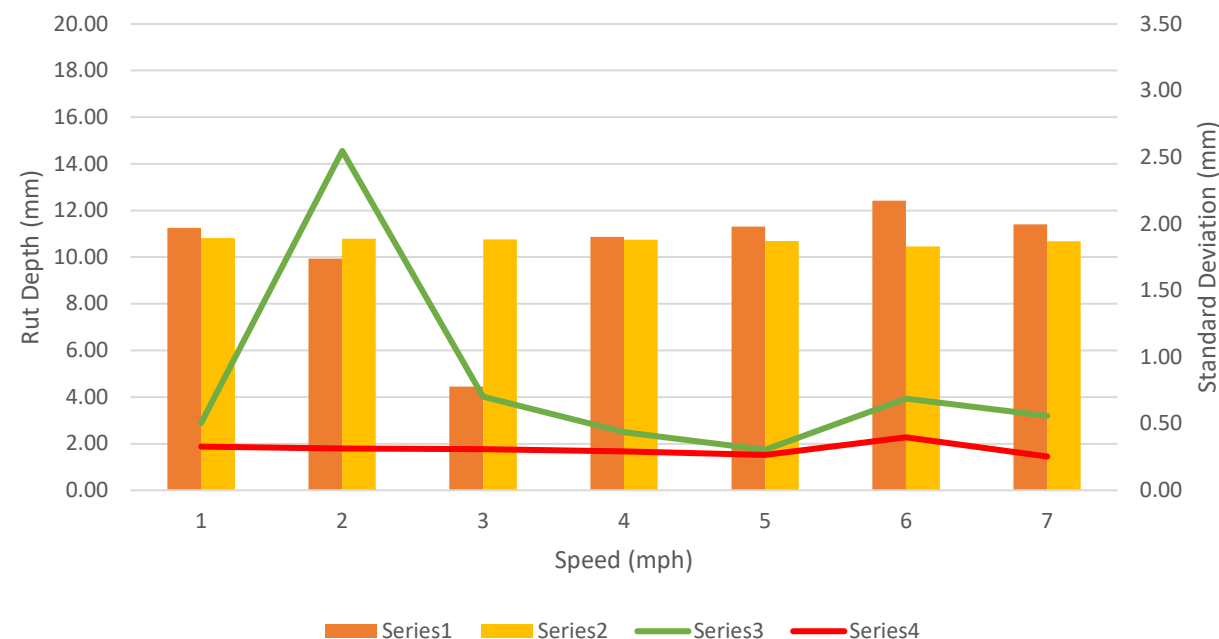
# Rutting by Speed Results – Vendor 9

Approx Speed (mph)	TPP Rut Mean (mm)		TPP Rut Standard Dev (mm)		GRE Rut Mean (mm)		GRE Rut Standard Dev (mm)		Total Number of Strips
	LWP	RWP	LWP	RWP	LWP	RWP	LWP	RWP	
10	13.51	11.26	1.45	0.51	17.39	10.82	3.07	0.33	718
20	8.40	9.94	2.08	2.55	17.26	10.79	2.97	0.31	331
30	3.02	4.46	1.98	0.70	17.30	10.76	2.98	0.31	153
35	10.17	10.87	2.18	0.44	17.48	10.74	3.01	0.29	171
45	15.58	11.32	2.45	0.30	17.72	10.70	2.92	0.27	130
55	16.47	12.43	2.79	0.69	17.48	10.46	2.80	0.40	109
65	17.40	11.41	2.69	0.56	17.48	10.68	2.79	0.25	90

Vendor 9 TPP Rutting by Speed - LWP



Vendor 9 TPP Rutting by Speed - RWP





# Highway Performance and Ground Reference

## What We've Learned

- Efficiency by minimizing GRE scan of flat plates in test section.
- Hot glue objects in place to avoid resetting of test section.
- Be cautious of tape and other objects that may produce outliers.
- Use centerline objects for scanning equipment with FOV less than test section (with wander).
- Revisions to the test criteria are being made to consider allowable error in ground reference data.
- Working with vendors to produce the desired data files for analysis.
- Working with vendors to produce accurate cross slope.
- Ensure test section is straight and has enough lead in/lead out to get to testing speeds. Issues with data alignment on curves.

# Test Method

Static Performance

Body Motion Cancelation

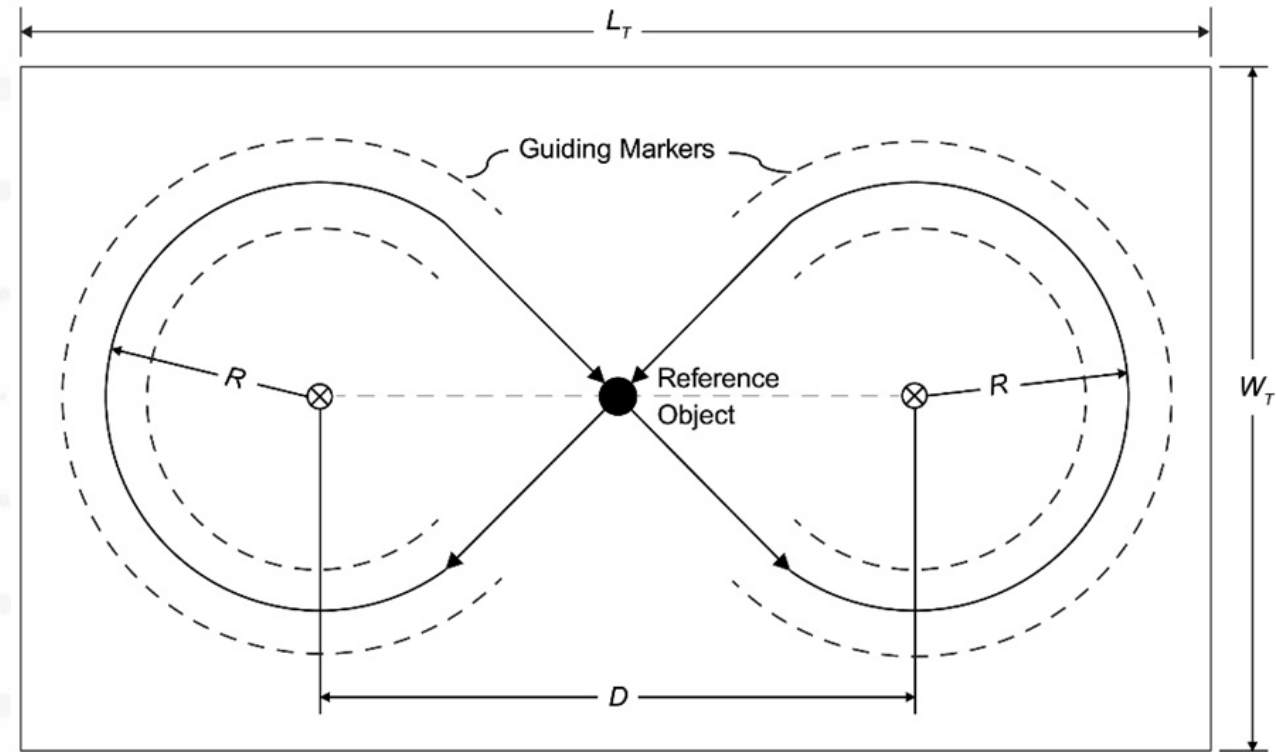
*\*GRE Certification and Ground Reference Collection\**

Highway Performance

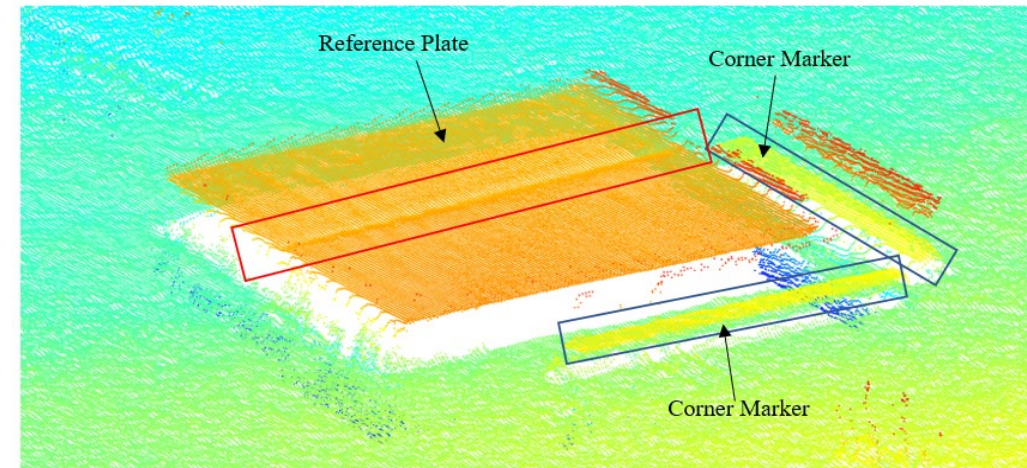
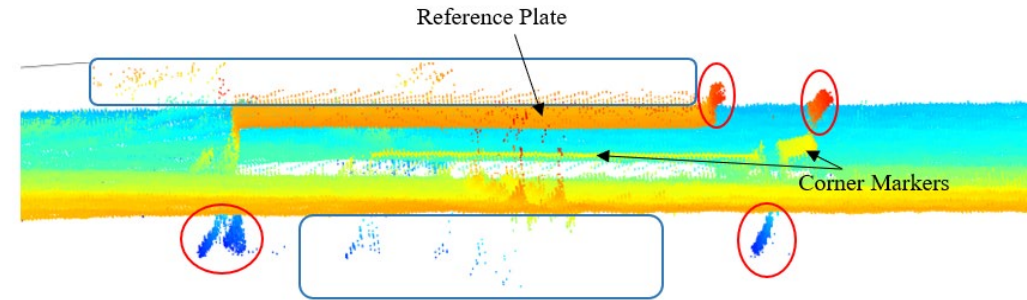
Navigation Drift



# Navigation Drift

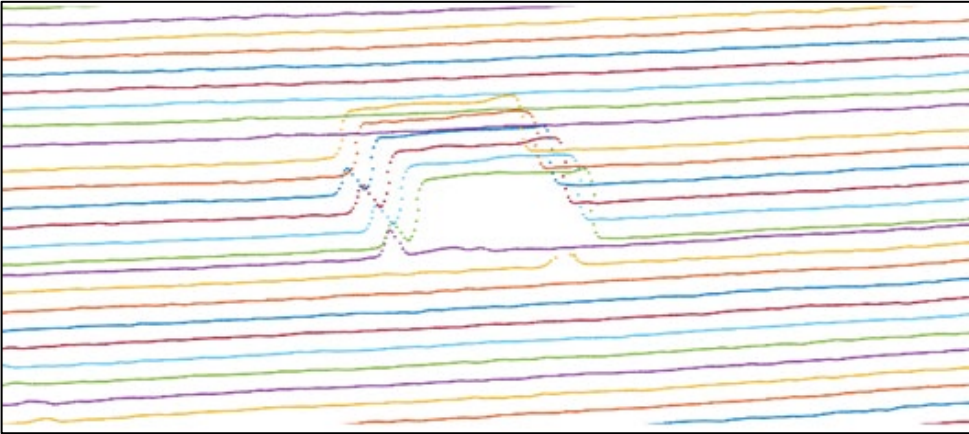


# Navigation Drift Viewing the Data

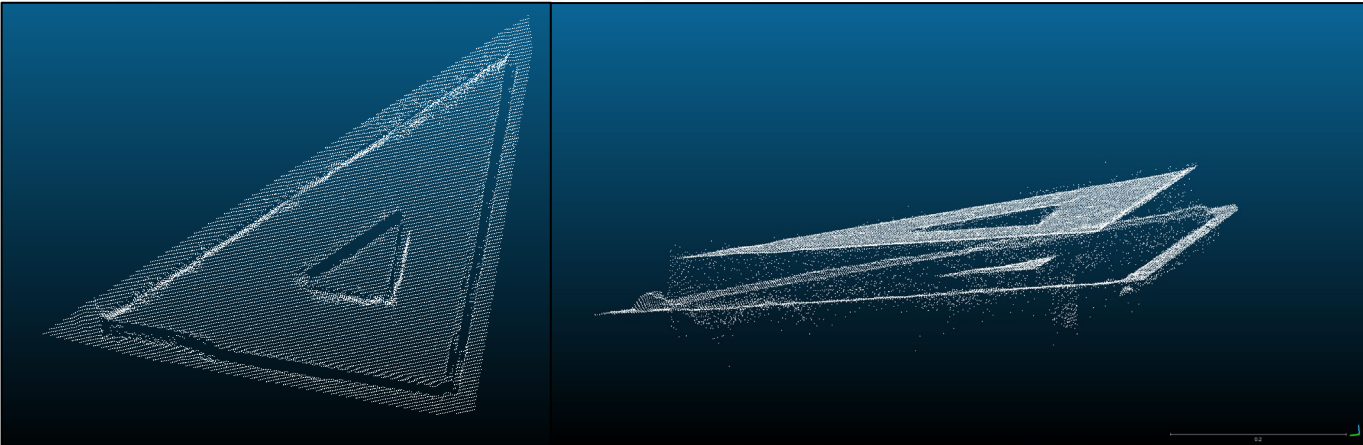
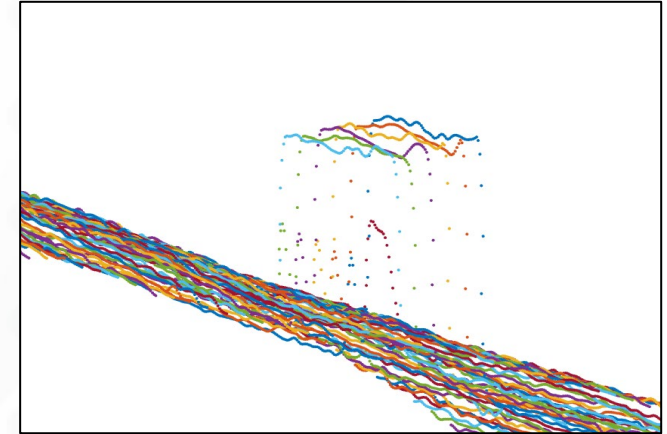




# Navigation Drift – Viewing the Data



Reference  
object shape



Effects of resolution and  
data pre-processing

# Navigation Drift – What We've Learned

- Some systems met criteria.
- Considering test modification – definition of reference object enhancements.



# Thank you!

