

# Profiler Certification Using AASHTO R56

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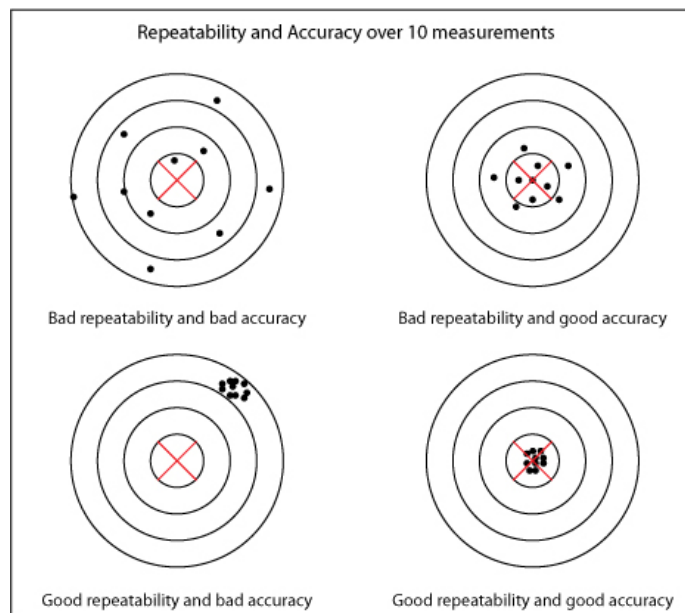
*SME*

*Plymouth, Michigan*



# What is Profiler Certification?

- Evaluating if a profiler can collect repeatable data.
- Evaluating if a profiler can collect accurate data.



## How do you Certify a Profiler?

- Establish test sections.
- Collect reference data using a “reference” device along the two wheel paths.
- Collect repeat runs of a profiler at the test sections.
- Analyze the data.

# Establishing Test Sections

# Location with Limited Access



**Minnesota DOT, MnROAD, Minnesota**



**NCAT, Auburn, Alabama**



**Abandoned Airfield, TTI, Texas**



# Location with Limited Access



**Pennsylvania, Rails to Trails**



**Abandoned Rest Area, New Jersey**



**Airport Taxiway, Georgia**



# Location with Limited Access



**Police Training Track, NC**



**Rocky Mountain Emergency Training Center, MT**



**Police Training Track, WA**



# Road with Traffic



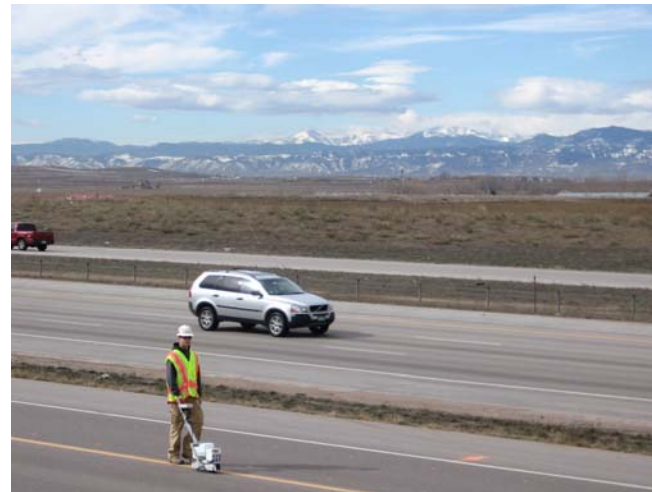
**New Mexico, Legan (2012)**



**2-Lane Road, Passing Area, Alaska**



**Median of a Road, Utah**



**Frontage Road, Colorado**



# AASHTO R56 Profiler Certification

## AASHTO R56 Criteria

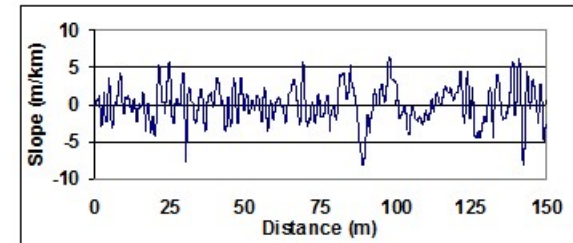
- **Distance Measuring Instrument (DMI) of profiler accurate to within  $\pm 0.15\%$ .**
- **Profiler Repeatability: IRI-filtered cross-correlation of at least 0.92.**
- **Profiler Accuracy: IRI-filtered cross-correlation of at least 0.90.**

# What is IRI-Filtered Cross-Correlation?

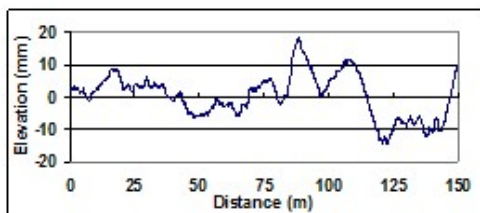
**Profile 1**



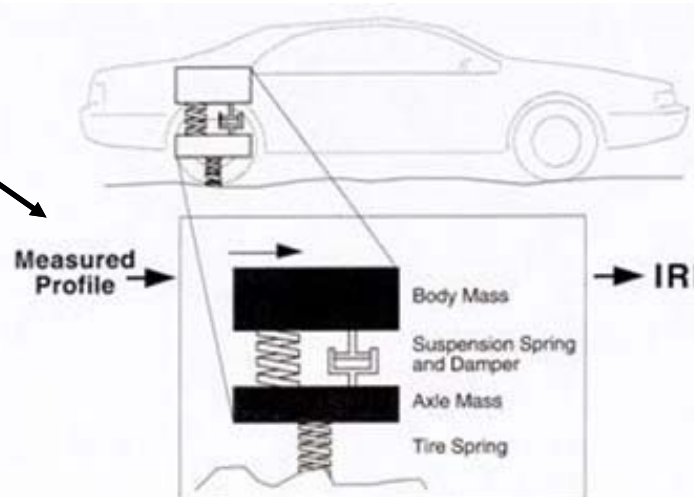
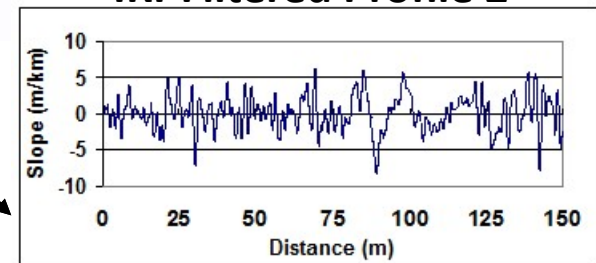
**IRI-Filtered Profile 1**



**Profile 2**



**IRI-Filtered Profile 2**



**IRI Program**

**Cross Correlation: Agreement between IRI-Filtered Profiles 1 and 2**

# Cross-Correlation

- **Cross-Correlation  $\geq 0.92$  (Repeatability)**
  - IRI of two profiles agree within 5% (95th percentile)
- **Cross-correlation  $\geq 0.90$  (Accuracy)**
  - IRI of two profiles agree within 6% (95<sup>th</sup> percentile).



# How Do You Do a Profiler Certification?

- **Set-up test sections.**
  - Smooth 30 to 75 in/mi
  - Medium-smooth 95 to 135 in/mi
- **Select sections without distress.**
- **Collect reference data along the wheel paths.**
- **Collect repeat runs at each test section with the profiler.**

# Profiler Repeatability

Repeatability - Left Correlations (%)									
Run	2	3	4	5	6	7	8	9	10
1	97.69	98.21	98.86	96.39	96.55	95.83	95.04	97.29	96.68
2		97.78	97.69	95.23	96.94	94.84	97.09	97.54	97.16
3			98.48	96.81	97.89	96.05	96.74	97.44	97.93
4				96.45	96.80	97.04	95.49	97.13	97.33
5					97.75	96.14	95.98	96.08	97.36
6						95.54	98.13	97.56	98.44
7							93.58	93.40	96.85
8								97.34	97.58
9									96.27

**Average = 96.8%.**

**Average must be  $\geq 92\%$  to Pass**

# Profiler Accuracy

Accuracy		
Run	Left	Right
1	98.04	98.27
2	96.16	97.34
3	96.73	98.12
4	97.92	99.04
5	94.82	97.60
6	94.88	97.99
7	95.80	96.94
8	93.27	96.62
9	95.64	96.27
10	95.11	97.50

**Average, Left = 95.8% and Right = 97.6%**

**Average for each sensor must be  $\geq 90\%$**

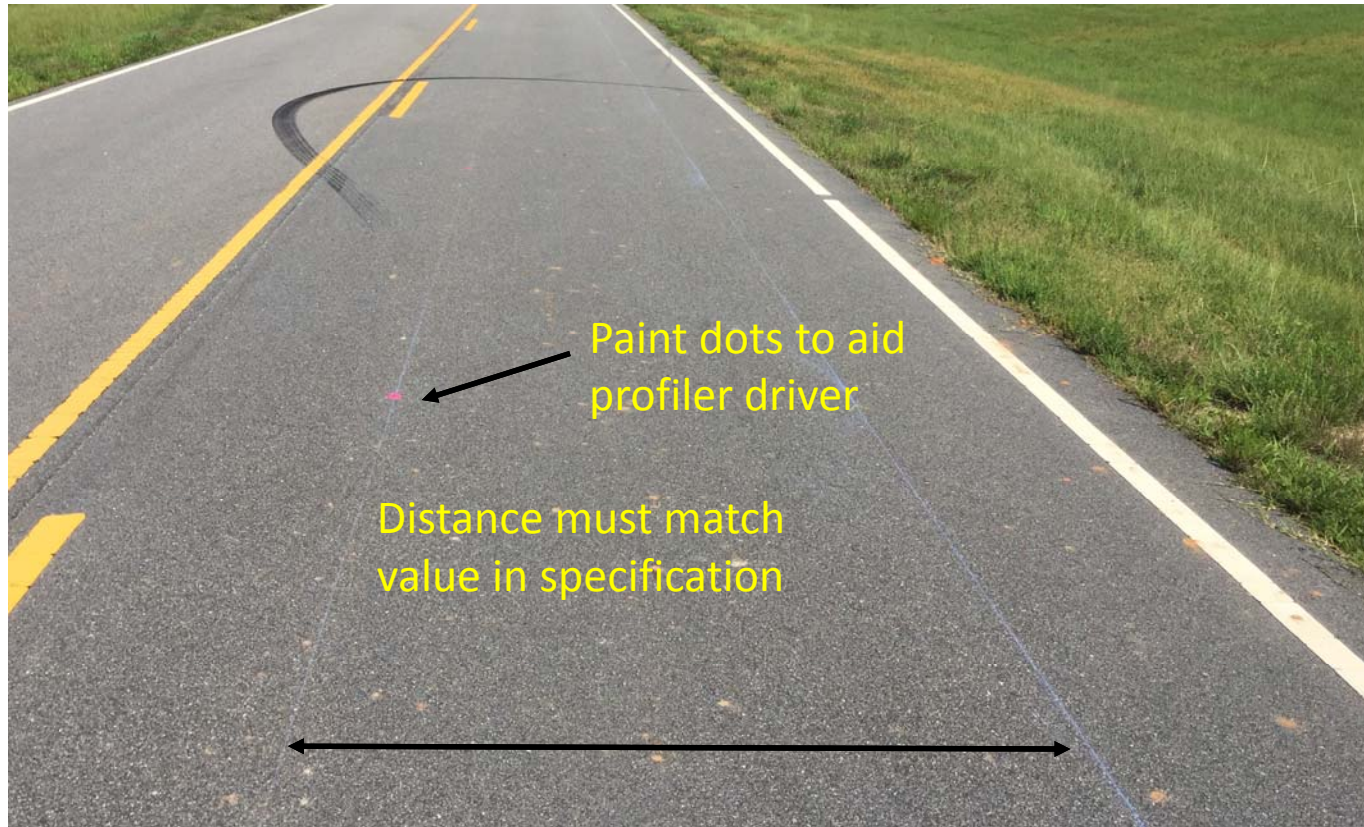
## Profiler Accuracy Cross-Correlation $\geq 0.90$

- **Cross-correlation of 0.90 (Accuracy)**
  - IRI of two profiles agree within 6% (95<sup>th</sup> percentile).
- **If reference IRI is 100 in/mi, profiler IRI can be within 94 and 106 in/mi (Range 12 in/mi)**
- **If reference IRI is 50 in/mi, profiler IRI can be within 47 and 53 in/mi (Range 6 in/mi)**



# Collecting Reference Profile Data

# Site Layout



**Profiler Sensor Spacing Must Match the Field Value**

# Collecting Reference Profile Data

- Make sure DMI of reference device is properly calibrated.
- Obtain at least three runs along each wheelpath.



# Evaluating the Collected Reference Data

Run	IRI (in/mi)
1	69.1
2	71.5
3	69.7

Run	IRI (in/mi)
1	59.9
2	59.9
3	59.7

Repeatability - Right Correlations (%)

Run	2	3	
1	80.64	79.89	
2		82.80	

Repeatability - Right Correlations (%)

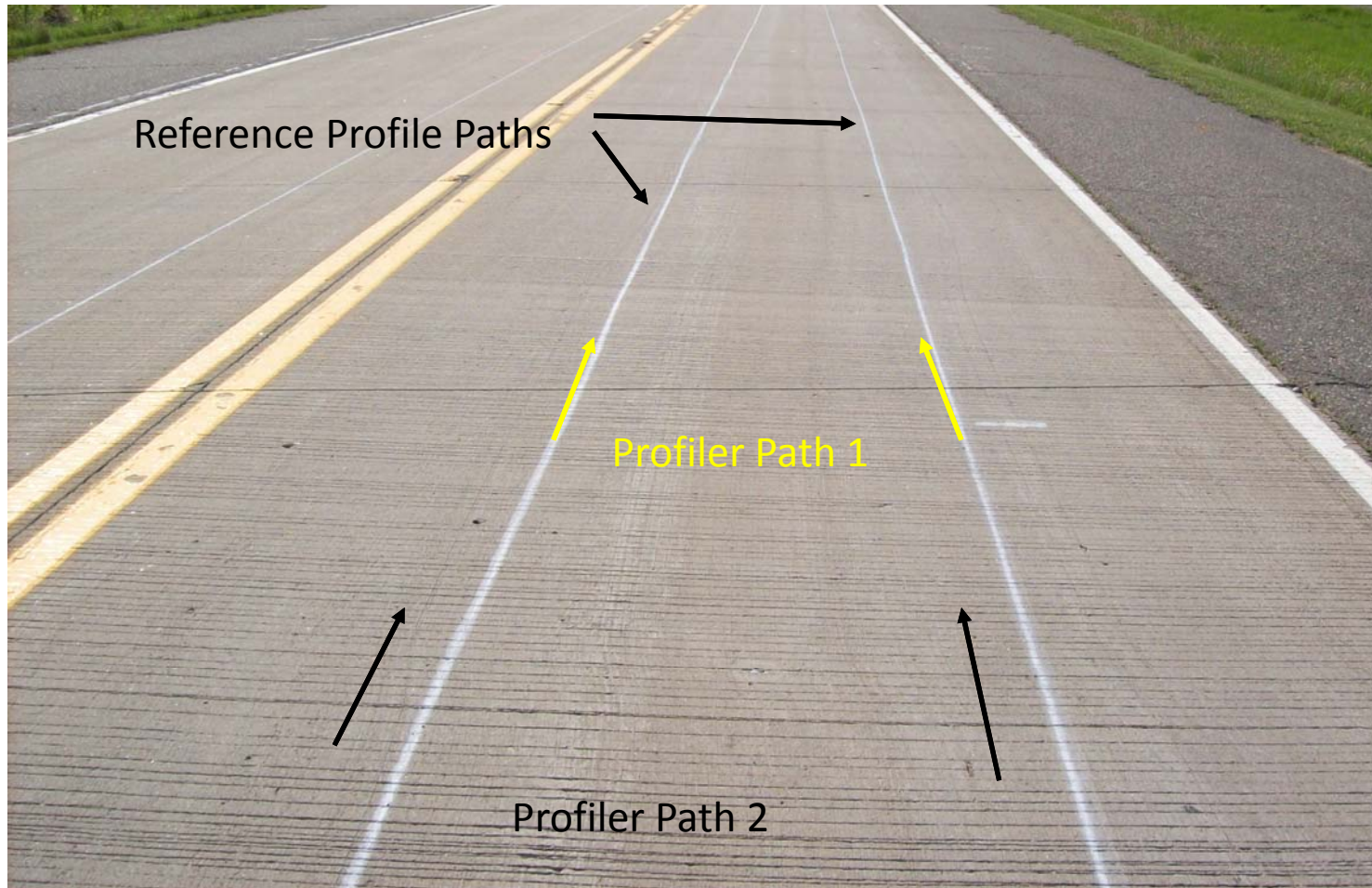
Run	2	3	
1	99.84	99.72	
2		99.72	

**EQUIPMENT  
PROBLEMS!!!**

**GOOD DATA!!**



# Collecting Profiler Data

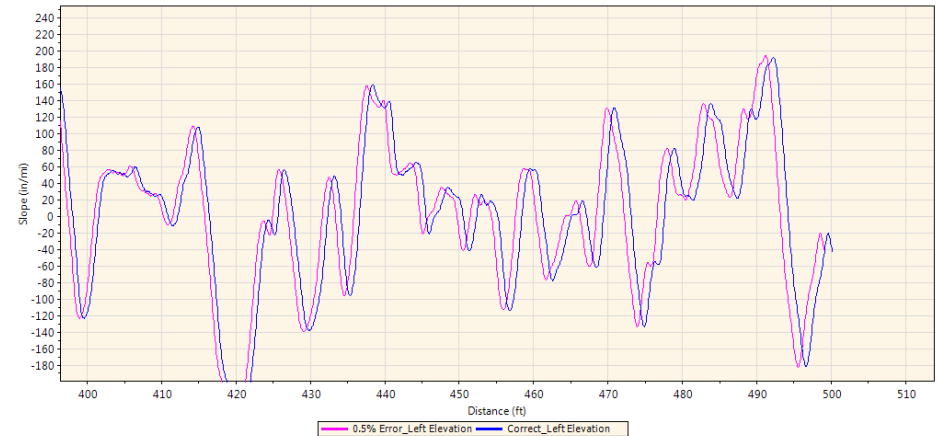
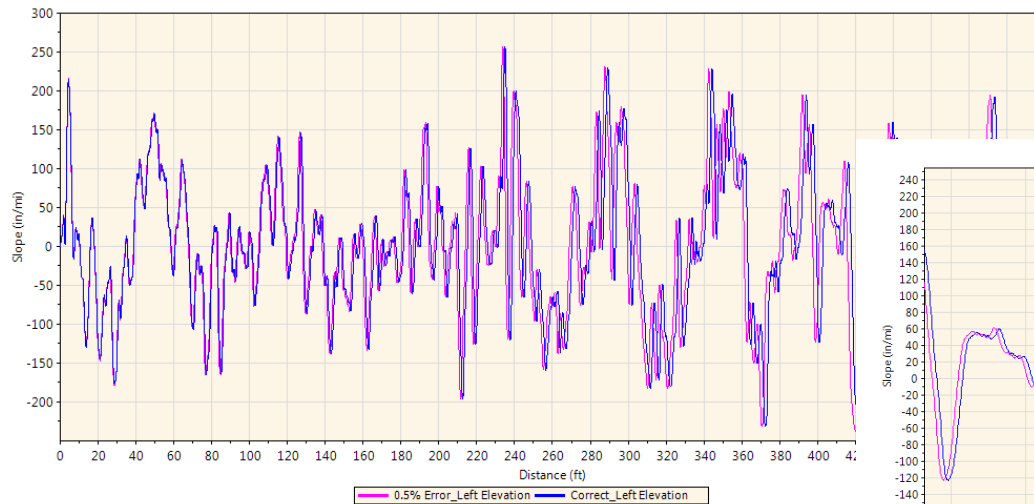


# Transverse Variability at a Test Site

- Need a site with a low transverse variability.

PARAMETER	FIRST SITE	MOVE 1000 FT SECOND SITE
IRI Left (in/mi)	62	58
IRI Right (in/mi)	52	60
Repeatability Left	89	97
Repeatability Right	96	97
Accuracy Left	91	97
Accuracy Right	96	97

# Effect of DMI Error on Cross-Correlation



DMI Error	Cross-Correlation (%)
0	100
0.05	99.8
0.1	99.5
0.2	98.3
0.3	96.5
0.5	91.5
1	75.8

## ProVAL Cannot Handle a DMI Error in a Profiler

- ProVAL can do a correction and compute cross-correlation correctly if two profiles do not start at exact location.
- ProVAL cannot do a correction to address a DMI error in a profiler.

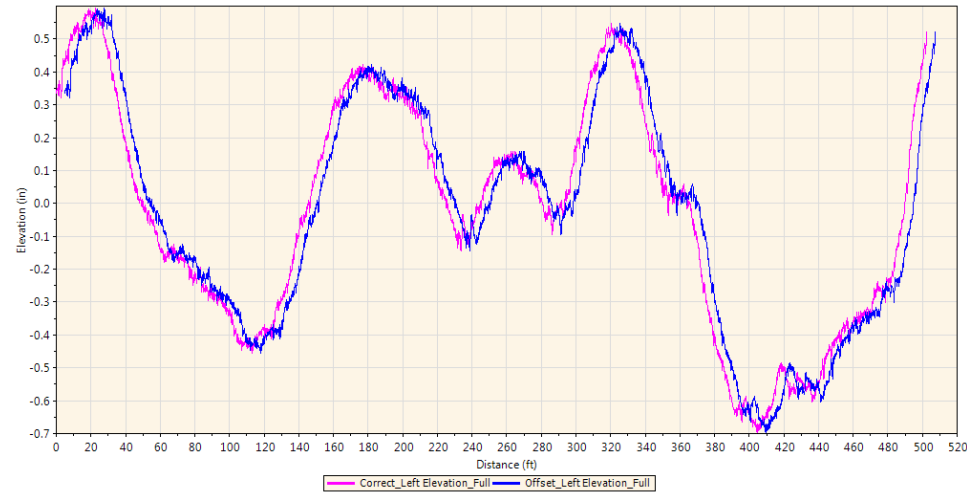
# ProVAL Cannot Handle a DMI Error in a Profiler

**Profiler Certification**

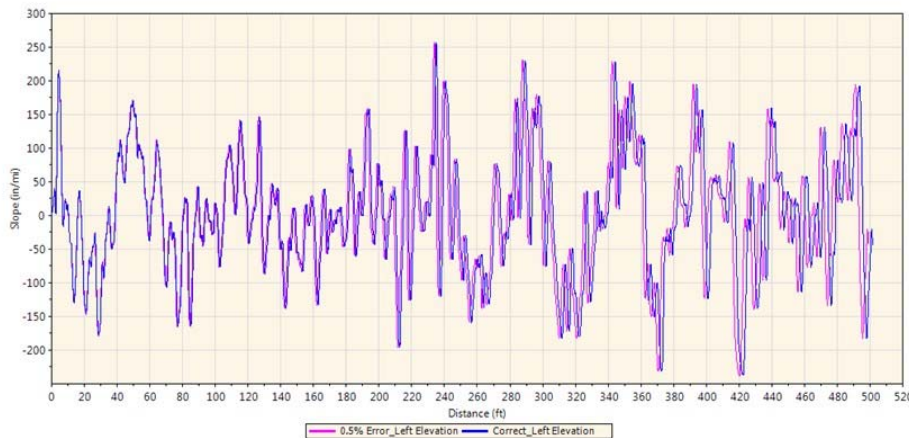
Maximum Offset (ft)	<input type="text" value="5.00"/>
Minimum Repeatability (%)	<input type="text" value="92"/>
Minimum Accuracy (%)	<input type="text" value="90"/>

Basis Filter  
[IRI \(with 250mm Filter\)](#)

Comparison Filter  
[IRI \(with 250mm Filter\)](#)



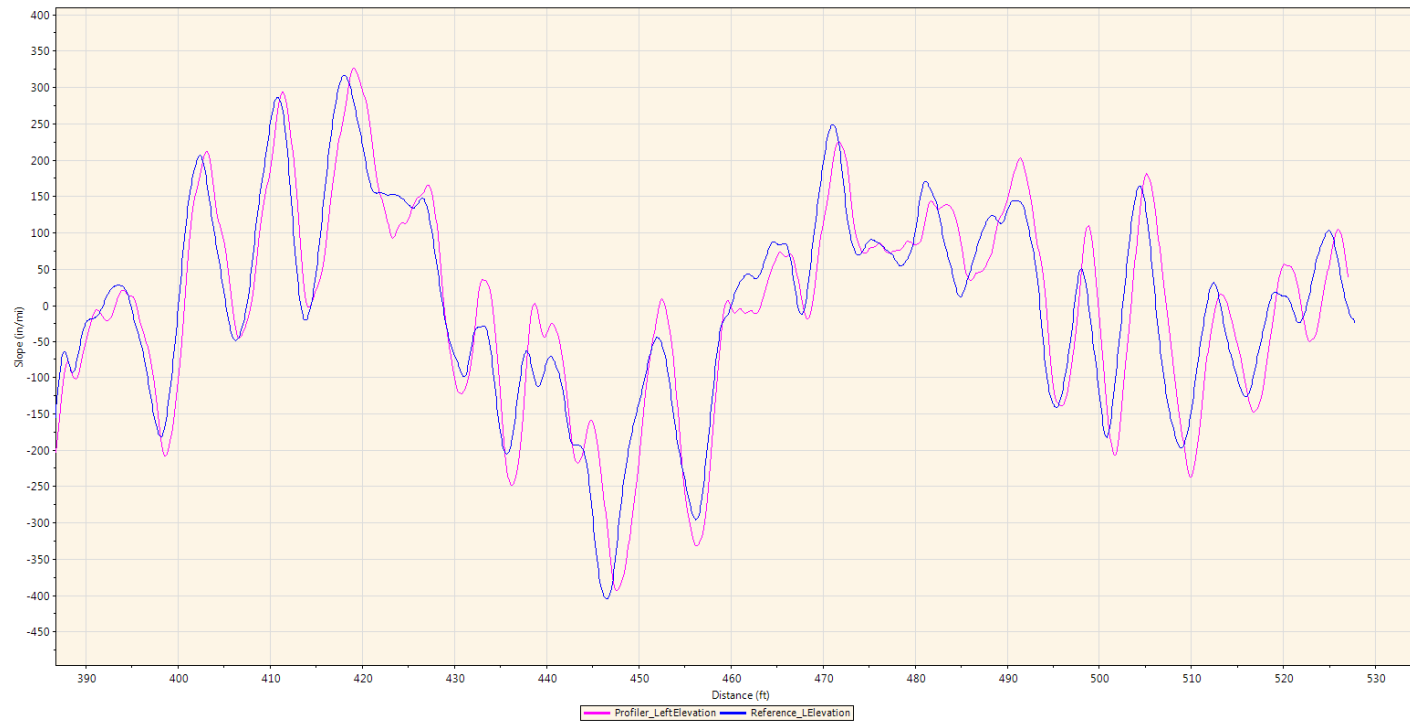
**Offset in Profile Start Location**



**DMI Error**



# Effect of DMI Error on Accuracy Cross-Correlation



<b>Accuracy Cross-Correlation (%)</b>	<b>79</b>
<b>Accuracy Cross-Correlation After DMI Correction (i.e., "Squeezing Profiler Profile")</b>	<b>91</b>

## Concrete Sections

- **Good practice to collect reference and profiler data after 12 PM.**
- **Collect profiler data immediately after reference data collection to avoid issues due to slab curling.**

# 9" Concrete, 15 ft Joints, 1.25" Dowels

Time	Temperature (°F)		IRI (in/mi)	Change (%)
	Ambient	Surface		
<b>Low (6:00 AM)</b>	<b>38</b>			
<b>8:29 AM</b>	<b>47</b>	<b>46</b>	<b>112</b>	
<b>10:28 AM</b>	<b>54</b>	<b>58</b>	<b>96</b>	<b>-15</b>
<b>12:40 PM</b>	<b>58</b>	<b>68</b>	<b>84</b>	<b>-25</b>
<b>2:27 PM</b>	<b>59</b>	<b>77</b>	<b>76</b>	<b>-33</b>
<b>4:49 PM</b>	<b>56</b>	<b>71</b>	<b>78</b>	<b>-30</b>
<b>6:03 PM</b>	<b>53</b>	<b>66</b>	<b>86</b>	<b>-24</b>



# 6" Concrete, 15 ft Joints, 1.25" Dowels

Time	Temperature (°F)		IRI (in/mi)	Change (%)
	Ambient	Surface		
Low (6:00 AM)	38			
8:07 AM	44	44	88	
10:11 AM	53	56	83	-5
12:09 AM	57	65	85	-3
2:12 PM	59	77	85	-3
5:06 PM	56	72	84	-4



*Thank You!!*