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Road Profile Users' Group

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2026 RPUG CONFERENCE ★ PITTSBURGH, PA ★ APRIL 28 - MAY 1

Performance Comparison between Slow Speed Profilers and Conventional Profilers

CHARLES GURGANUS, TEXAS A&M UNIVERSITY
ASSOCIATE PROFESSOR

Parent Project

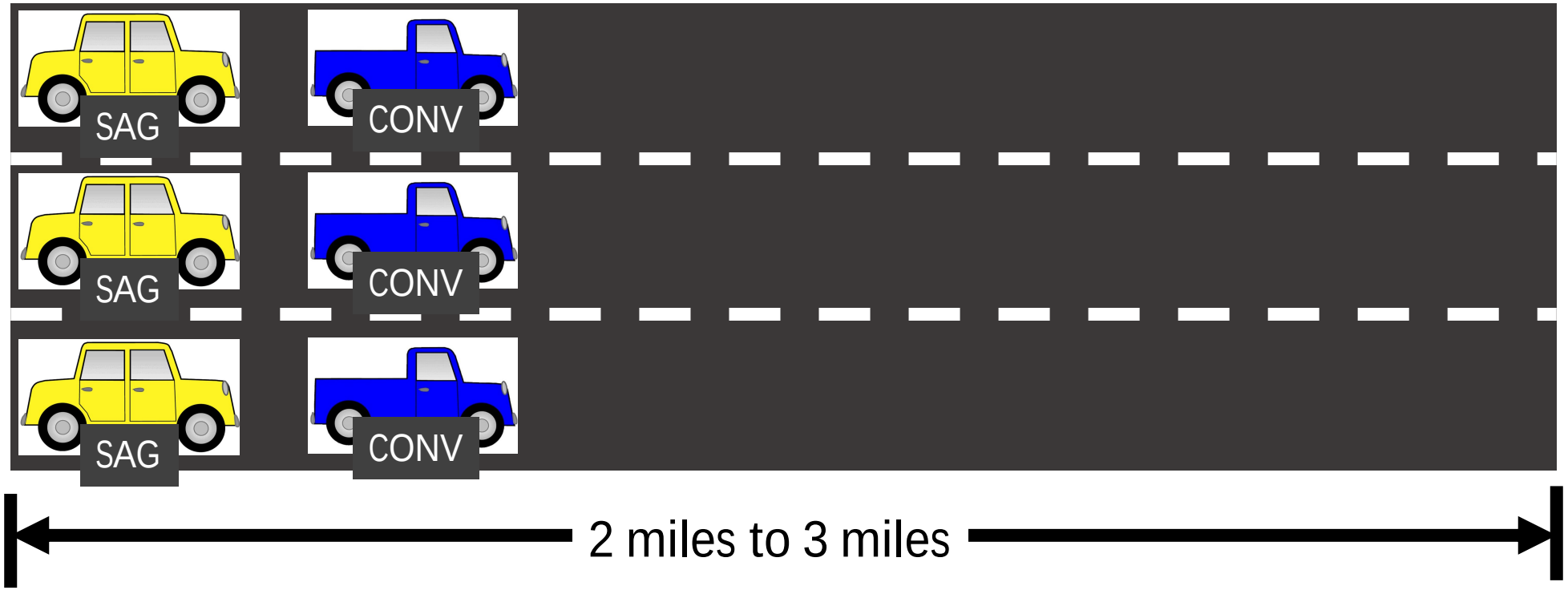
- Sponsoring Agency: Texas Department of Transportation
  - Dr. Jenny Li, PE: Technical lead
- *Evaluation of Low-Speed Profiler for Network-Level Pavement Management*
  - Task 1: Project Management
  - Task 2: Literature Review
  - Task 3: Analyze Existing Ride Quality Data and Identify Candidate Locations
  - Task 4: Evaluate “Zero” or Low-Speed Profiler(s) on Closed Test Tracks
  - **Task 5: Field Performance and Validation of the “Zero” or Low-Speed Profiler**
  - Task 6: Evaluate Network-Level Consequences

Field Performance Assessment

1) Assessment of IRI Difference
    i. Macro-Level
    ii. Micro-Level

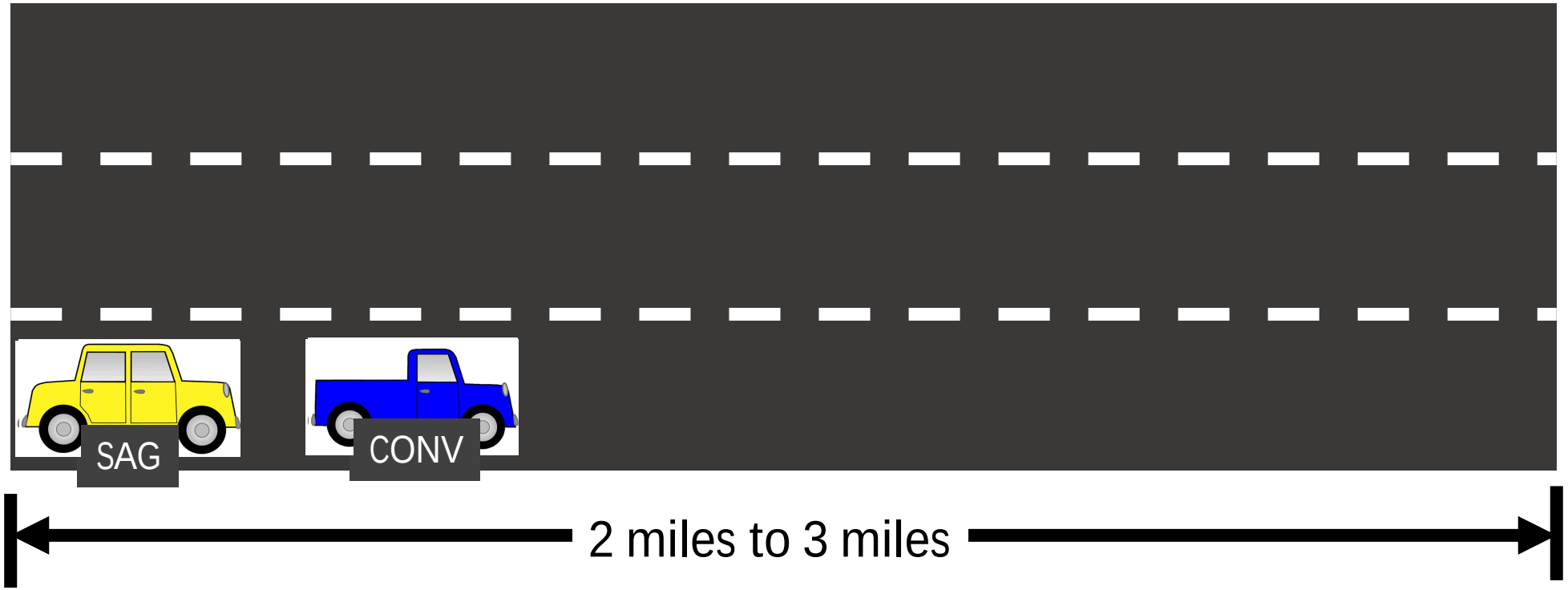
2) Assessment of Repeatability
    i. Macro-Level
    ii. Micro-Level

Test Procedure & Assessment Locations



- Shadowing testing in each lane
  - Compare overall average IRI values
  - Evaluate % of acceleration and deceleration movements
    - Compare IRI values in acceleration & deceleration regions

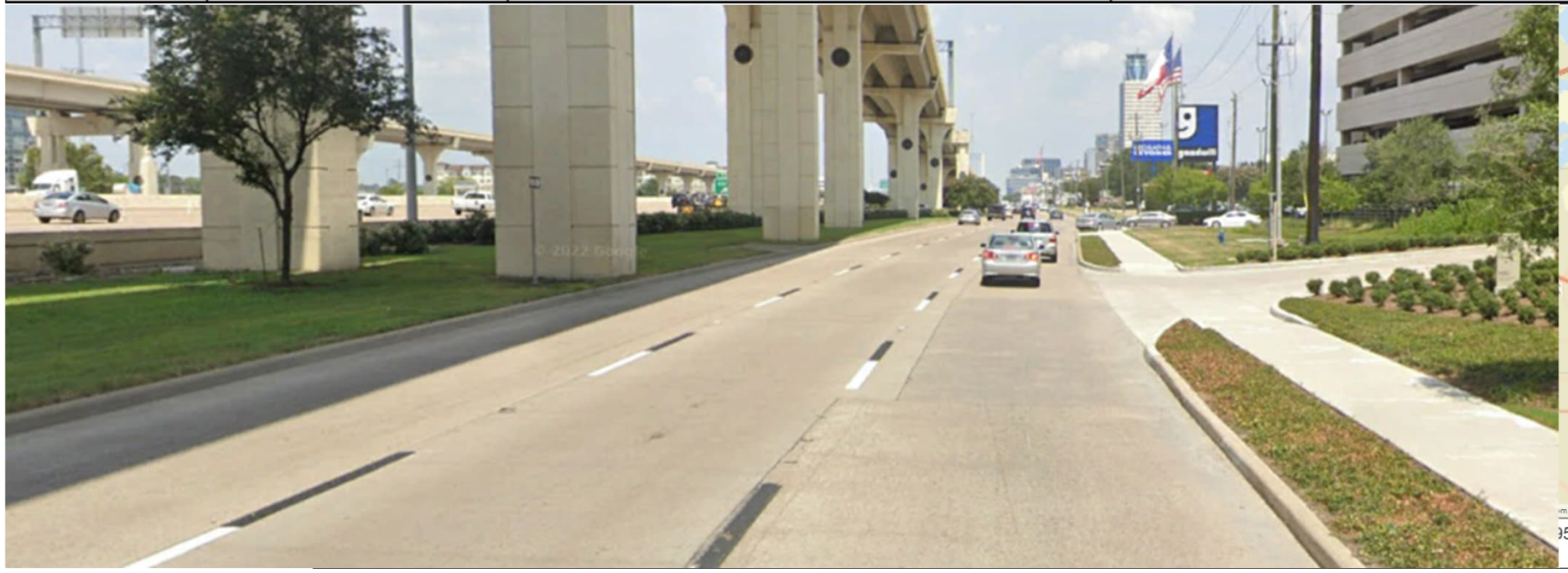
Test Procedure & Assessment Locations



- Repeat shadowing testing in a single lane
  - Compare overall average IRI values and repeatability
  - Evaluate % of acceleration and deceleration movements
    - Compare IRI values in acceleration & deceleration regions

30 Total Test Units (e.g., Houston District)

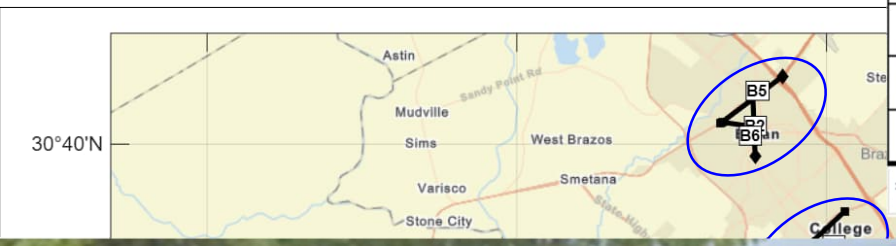
Site No.	Segment ID	Roadway	Lane(s) Tested
1	H1	IH 10 EB Frontage Road	Left, Center, and Right
2	H2	IH 10 WB Frontage Road	Center and Right
3	H3	US 90 EB Mainlane	Left, Center, and Right
4	H4	IH 69 SB Frontage Road	Left, Center, and Right
5	H5	IH 45 SB Frontage Road	Right
6	H6	SH 146 SB Frontage Road	Center

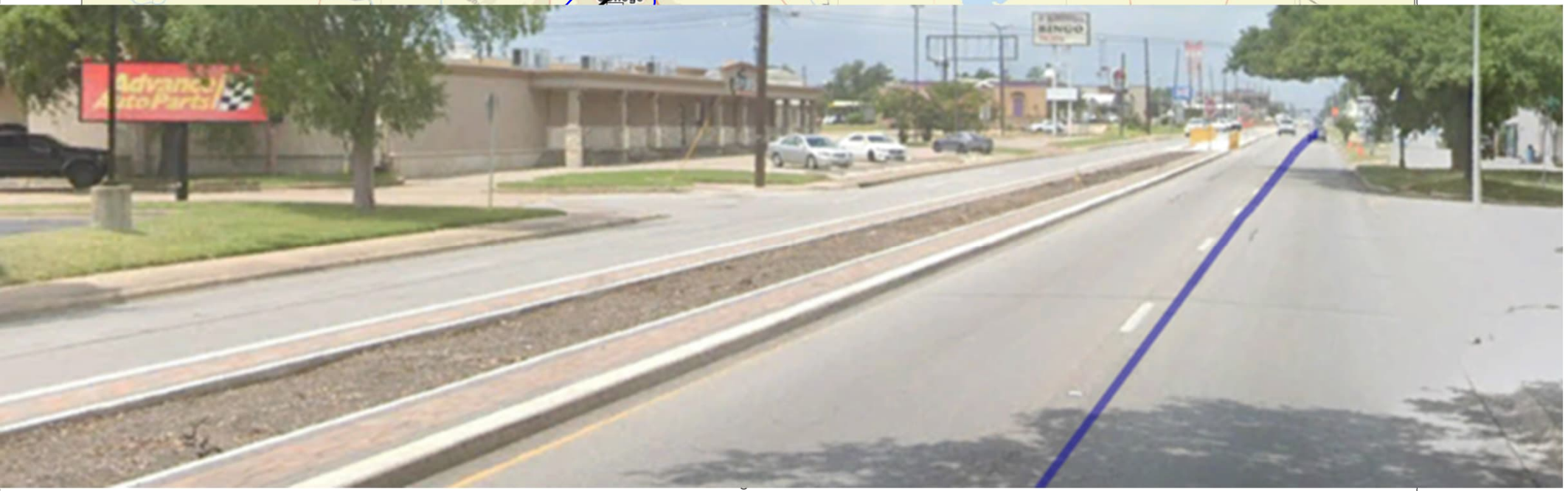


30 Total Test Units (e.g., Bryan District)

Site No.	Segment ID	Roadway	Lane(s) Tested
1	B1	FM 60 NB	Right*
2	B2	BS 06 NB and SB	Left and Right
3	B3	BS 06 EB and WB	Right
4	B4	FM 2347 NB	Right*
5	B5	East SH 21	Both Directions*
6	B6	FM 158 (William Joel Bryan Pkwy)	Right*

* Test for Repeatability





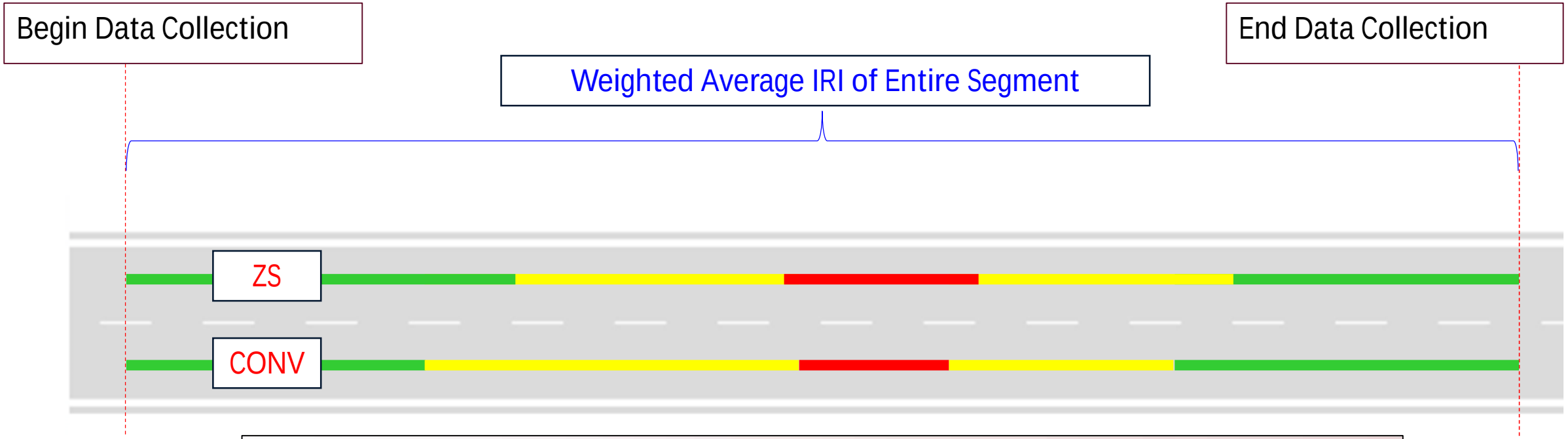
30 Total Test Units (e.g., Waco District)

Site No.	Segment ID	Roadway	Lane(s) Tested
1	W1	FM 2113 NB and SB	Left, Center, and Right
2	W2	SL 02	Left, Center, and Right
3	W3	US 84 EB	Right*
4	W4	US 84 WB	Right*
5	W5	US 84 EB	Right*

* Test for Repeatability

Macro-Level Assessment – IRI Difference

$$\Delta IRI = IRI_{CONV} - IRI_{ZS}$$



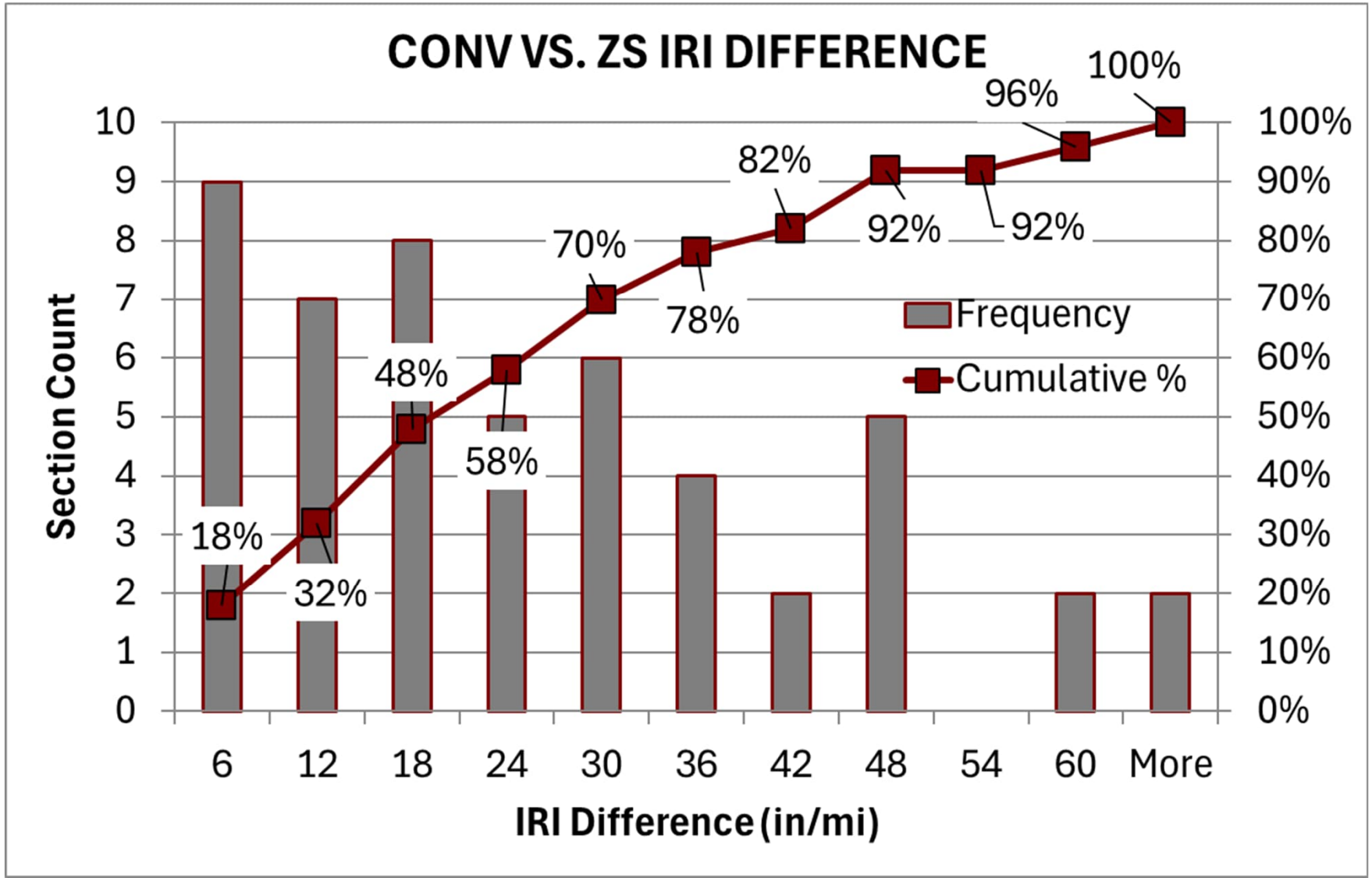
Zone (Segment)	Speed Range (mph)
1 (Red Segment)	0 – 15
2 (Yellow Segment)	15 – 30
3 (Green Segment)	30 – 65

Macro-Level Assessment – IRI Difference

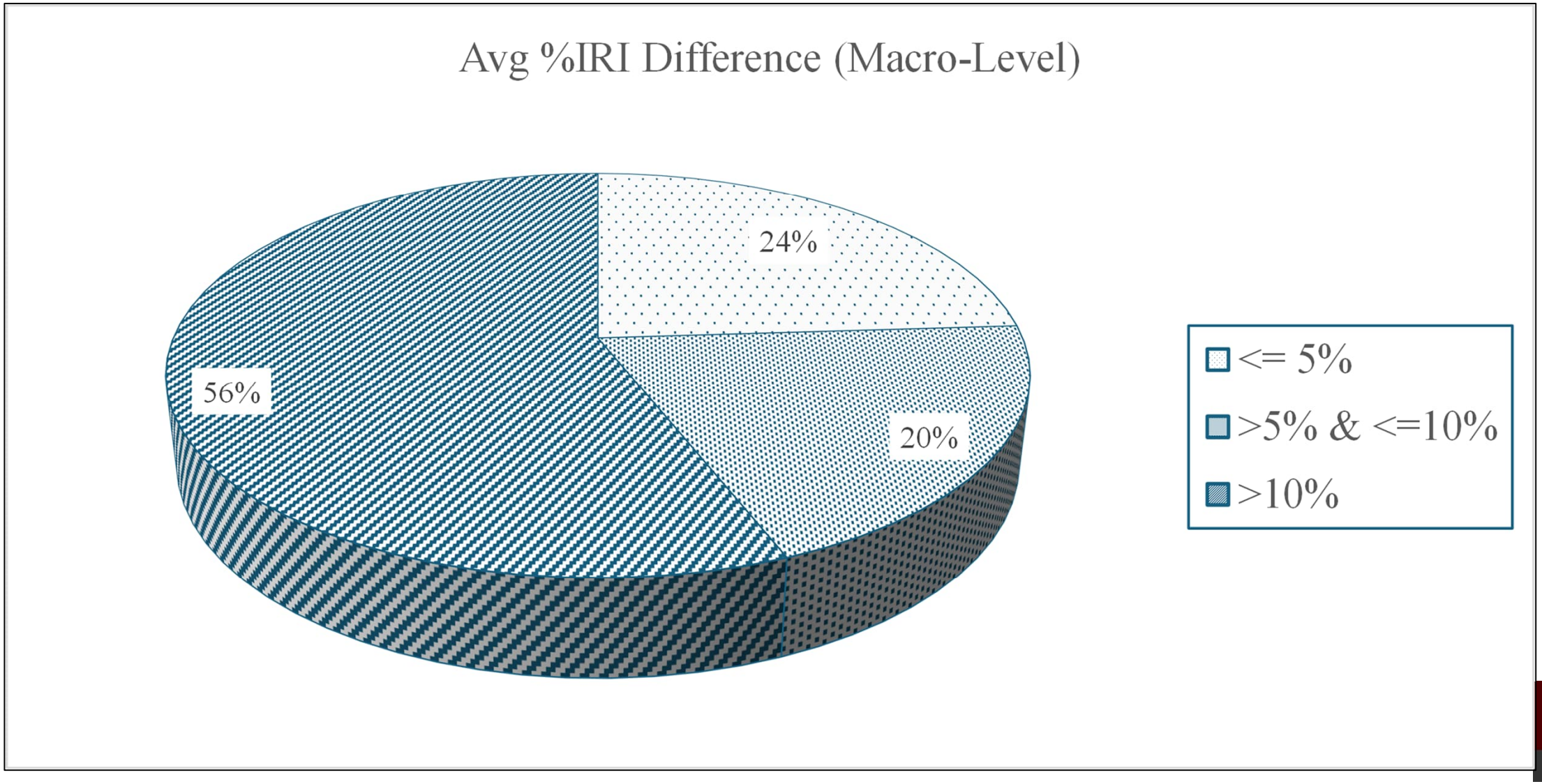
Macro-level analysis

POTENTIAL INSTABILITY
in the CONV profiler compared to ZS

Macro-Level Assessment – IRI Difference



Macro-Level Assessment – IRI Difference



Micro-Level Assessment – IRI Difference

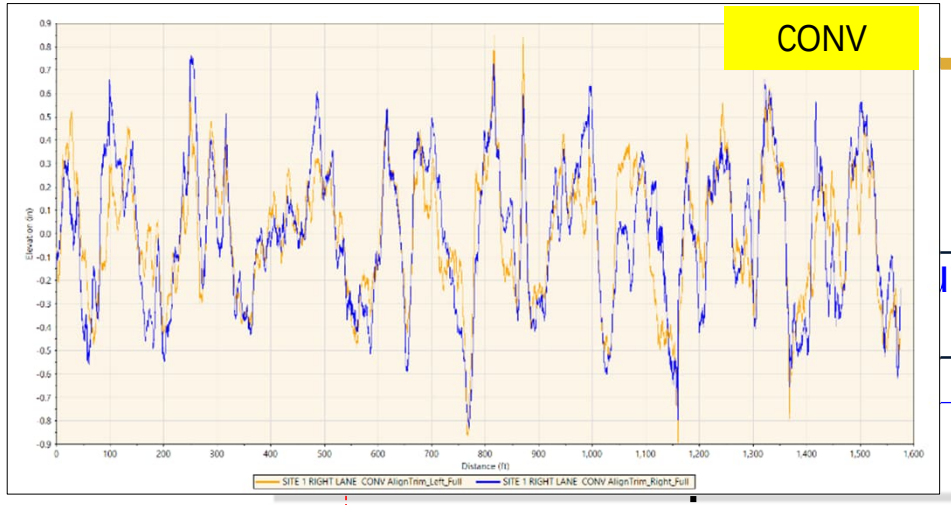
At steady speeds, both profilers deliver **CONSISTENT IRI MEASUREMENTS**.

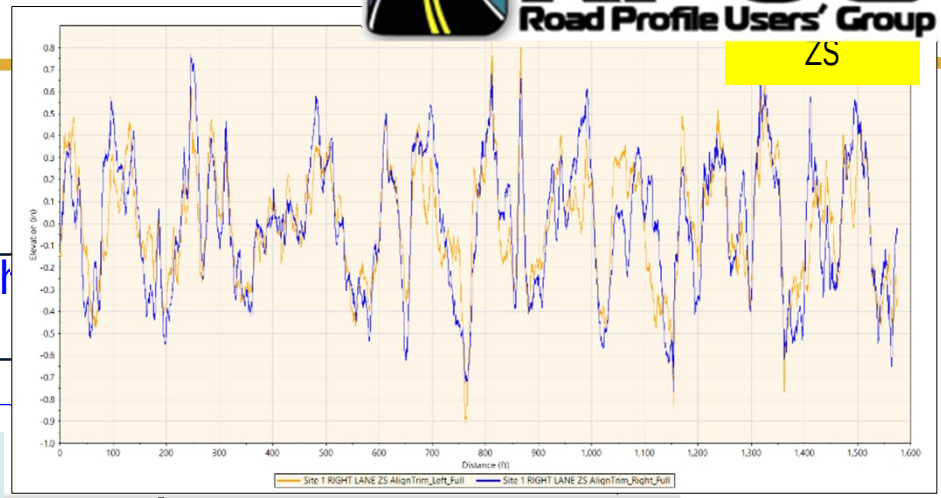
STOP-and-GO conditions

SYSTEMATICALLY DESTABILIZE CONV IRI, while **ZS remains STABLE**.

Observed differences arise from **TRANSIENT VEHICLE DYNAMICS**.

Micro-Level Assessment – IRI Difference

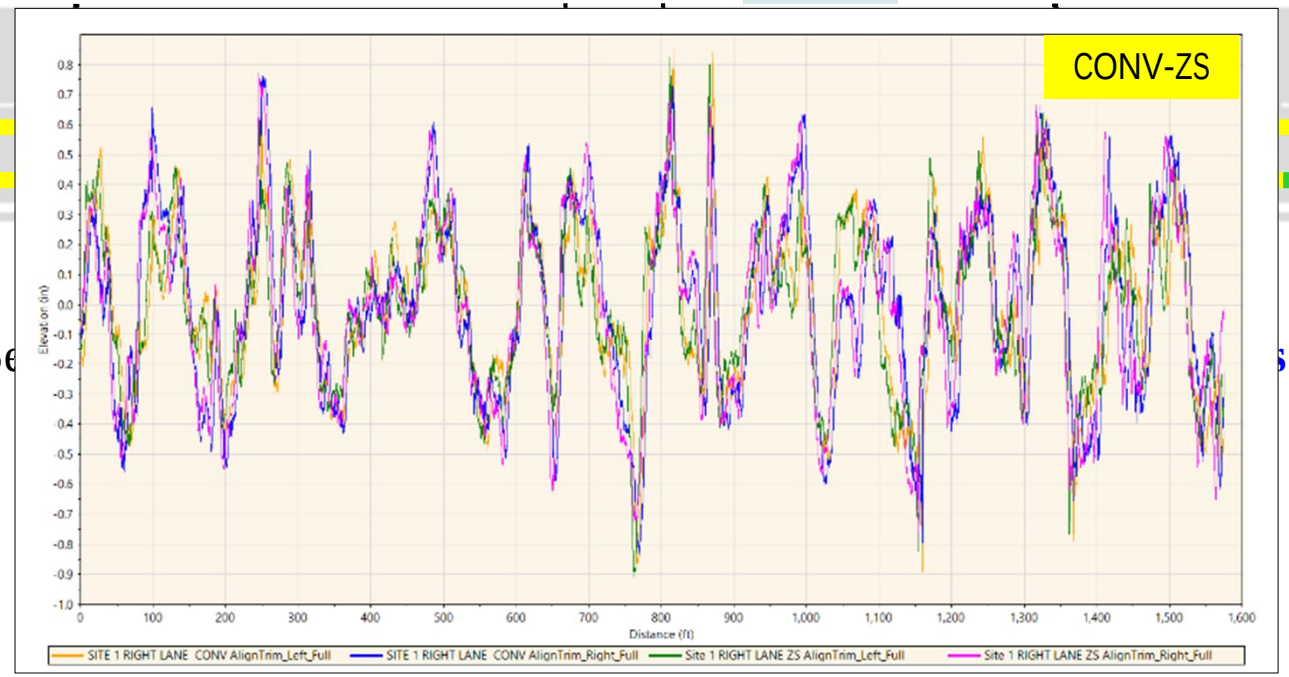




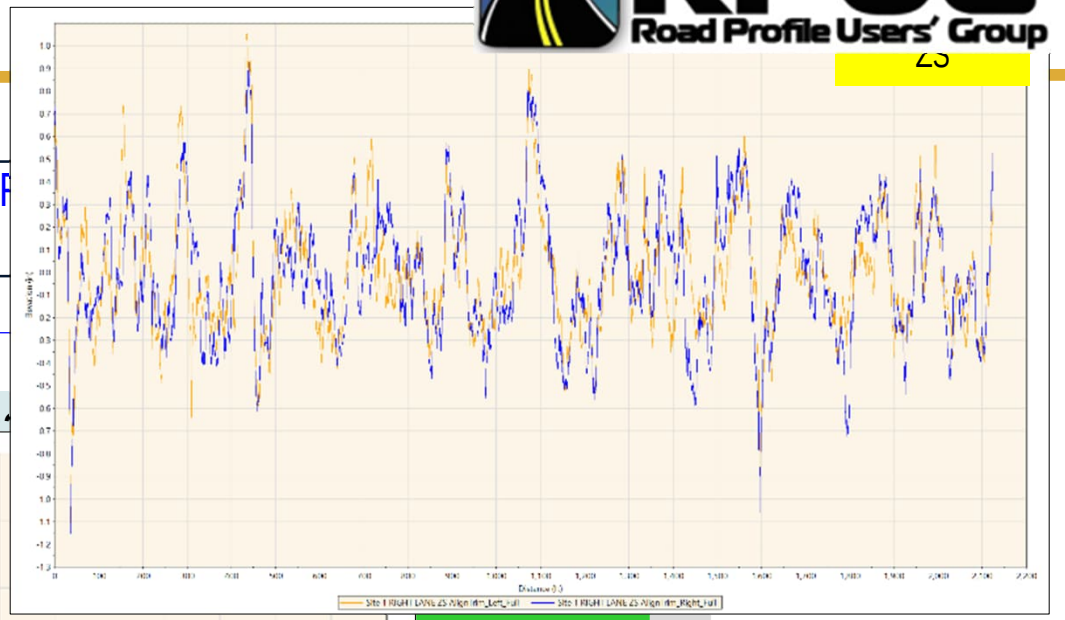
ute the Window-Level IRI for th
Overlapping Seg.

132 ft

Se s



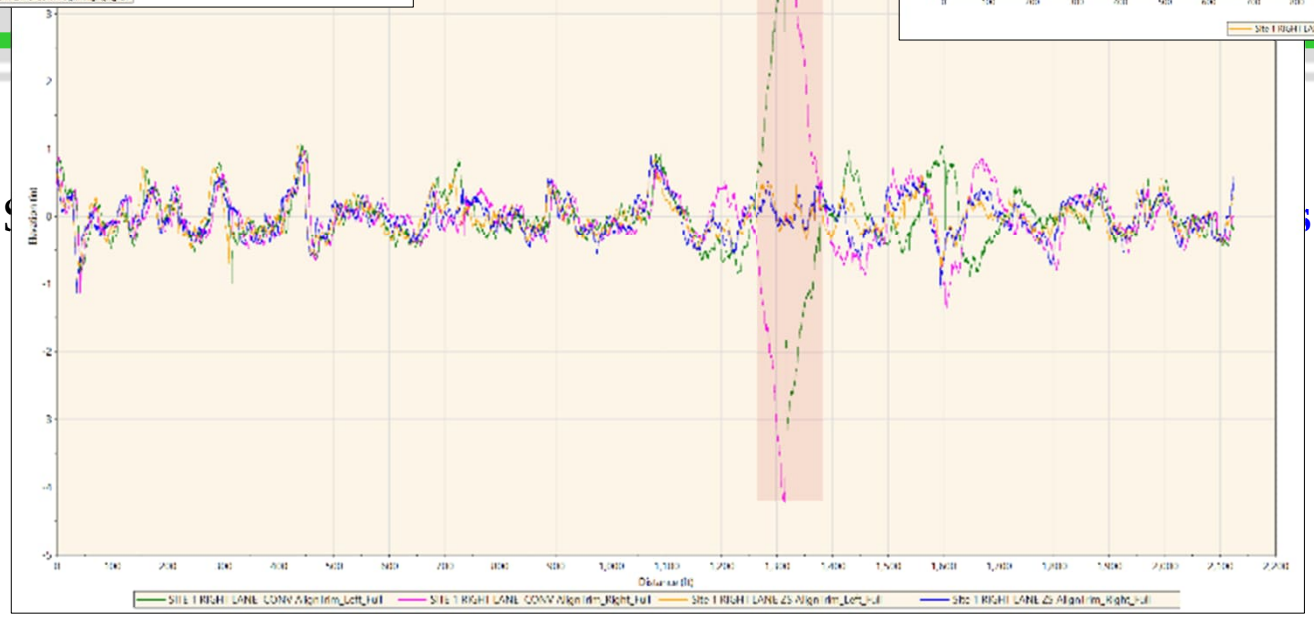
Micro-Level Assessment – IRI Difference



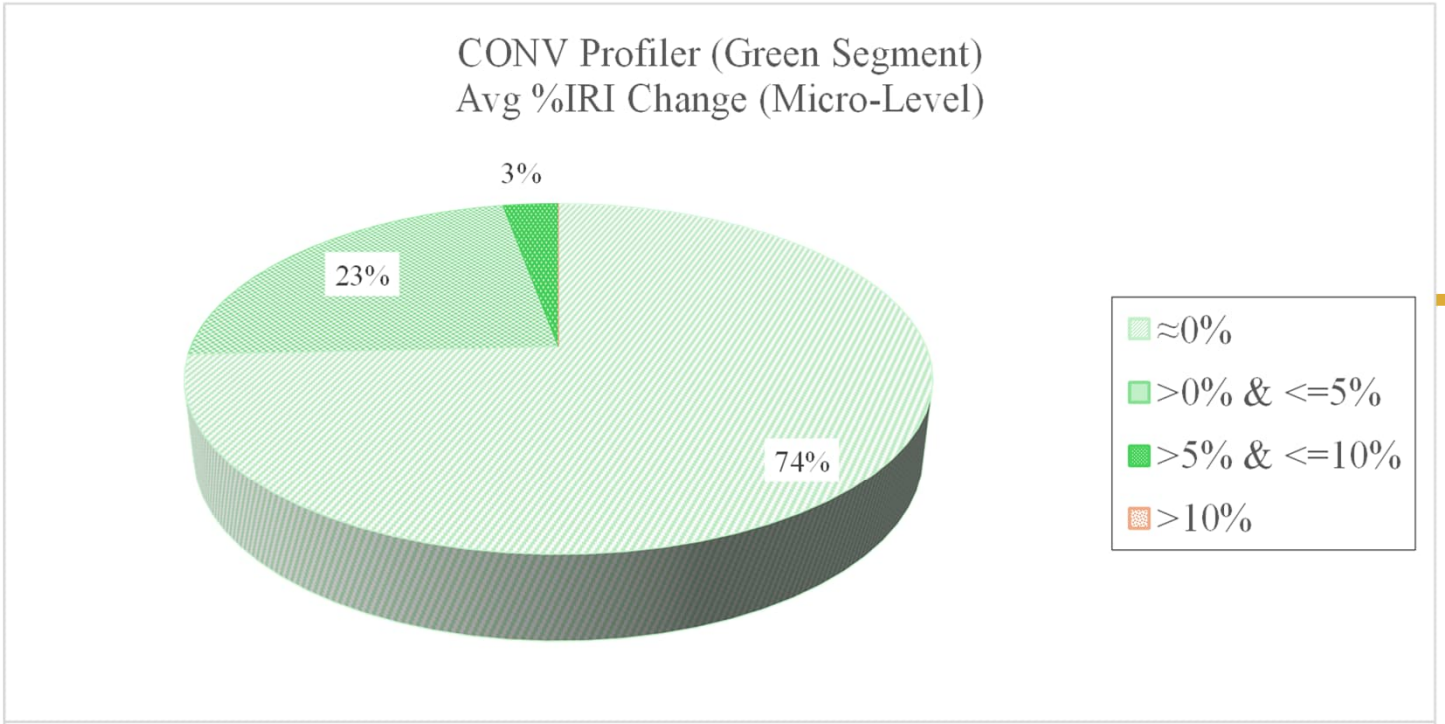
pute the Window-Level IR
Overlapping Seg.

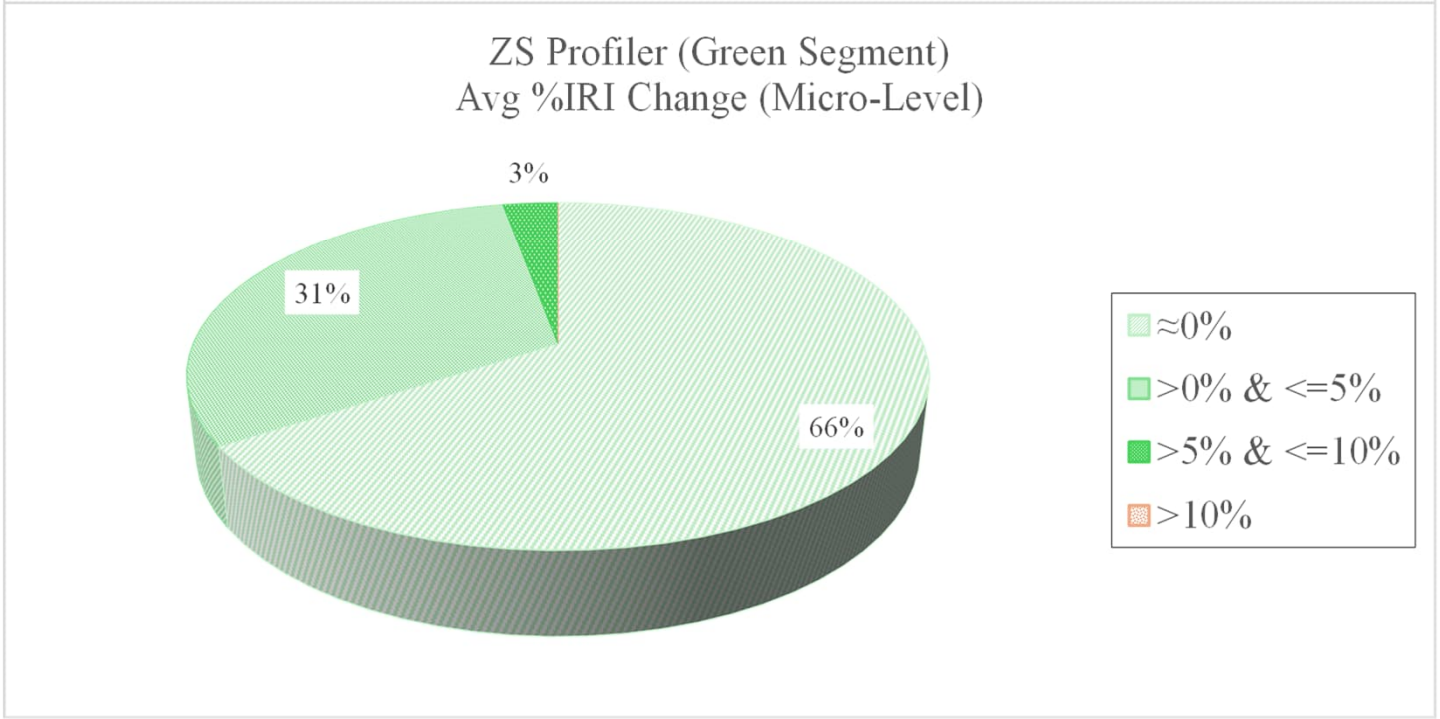
CONV

CONV-ZS



Micro-Level Assessment – IRI Difference





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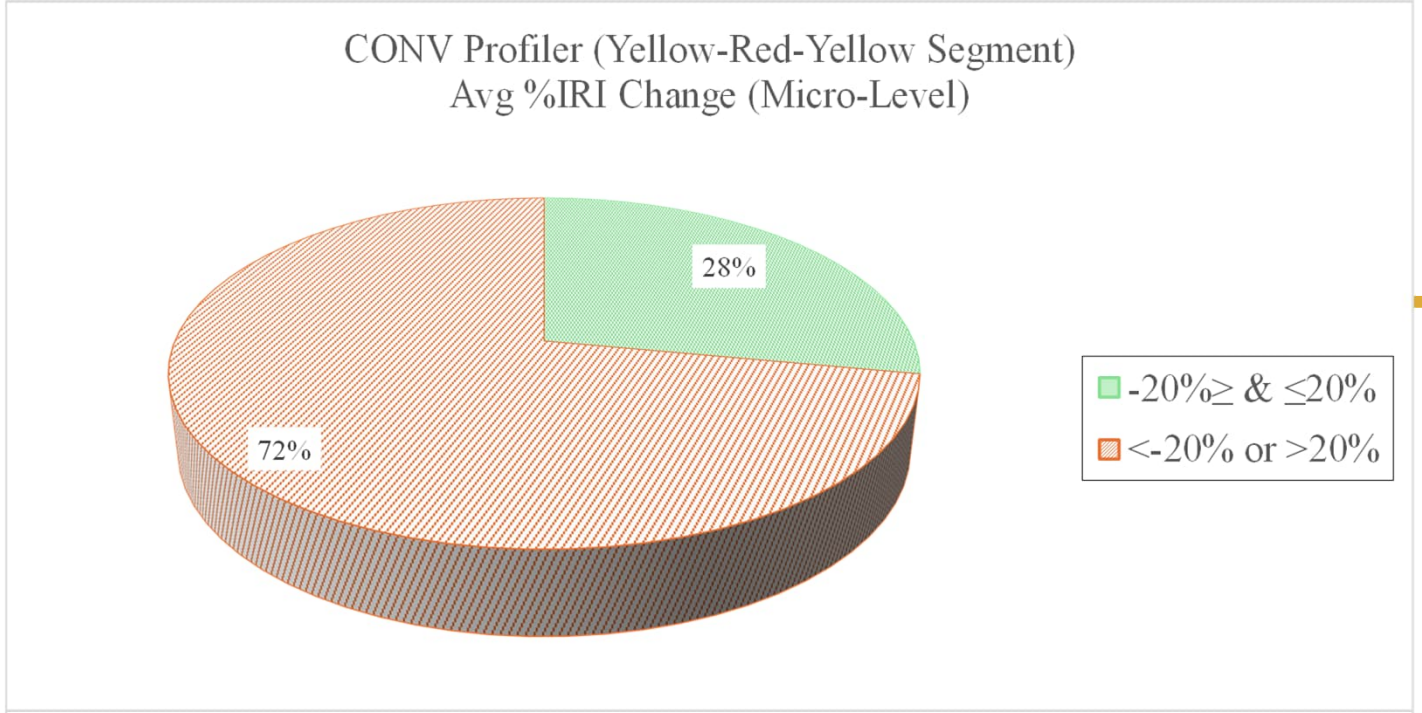
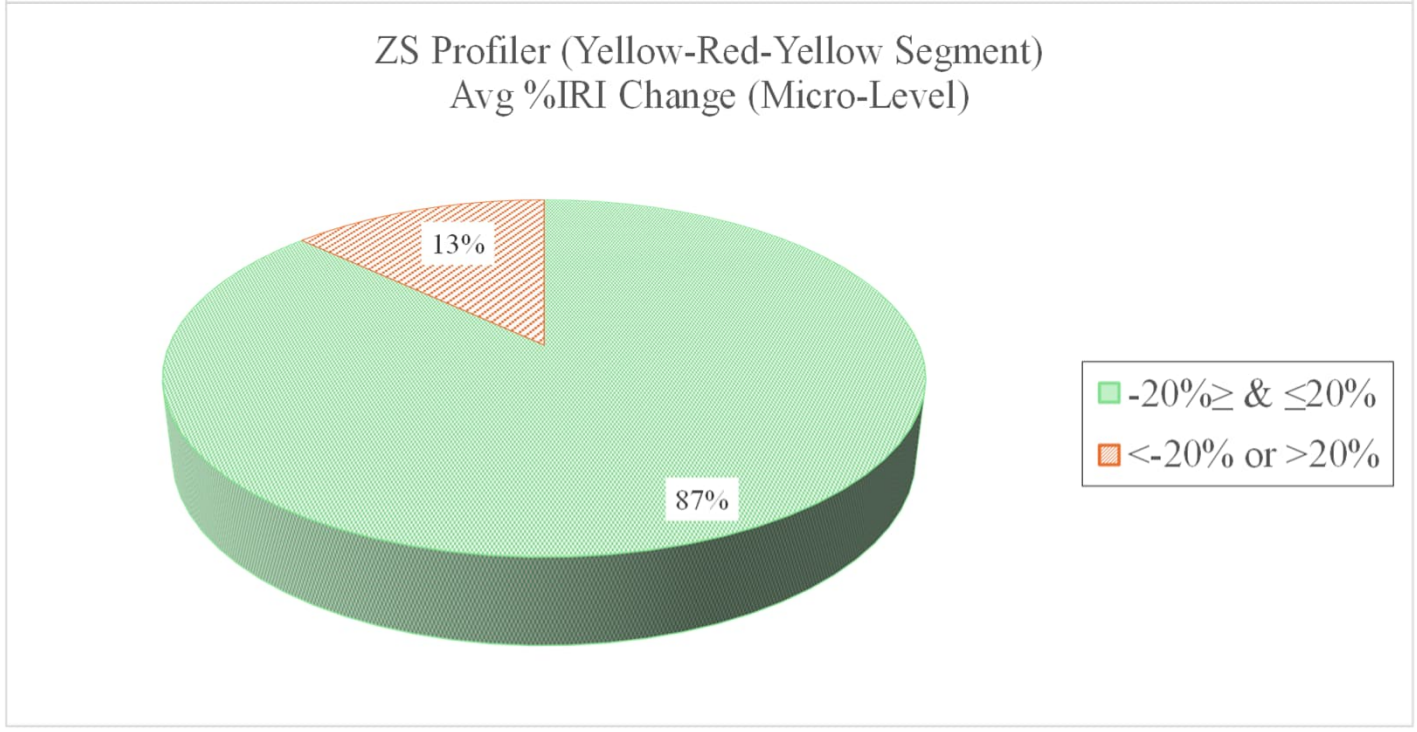
Micro-Level Assessment – IRI Difference





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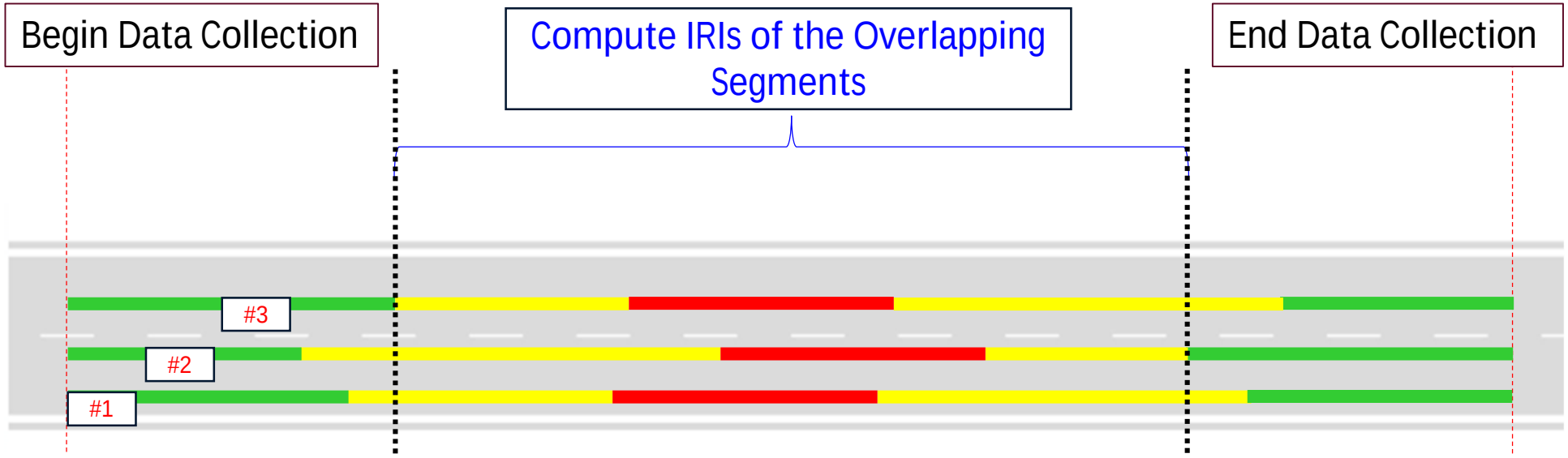
Assessment of Repeatability

- Macro-level assessment
  - quantify normalized run-to-run dispersion of segment-average IRI values.
  - Y-R-Y segment, used coefficient of variation

- Micro-level assessment
  - pairwise comparisons among independent runs
  - Y-R-Y segment, 132-ft window resolution
  - to evaluate localized percent-change behavior.

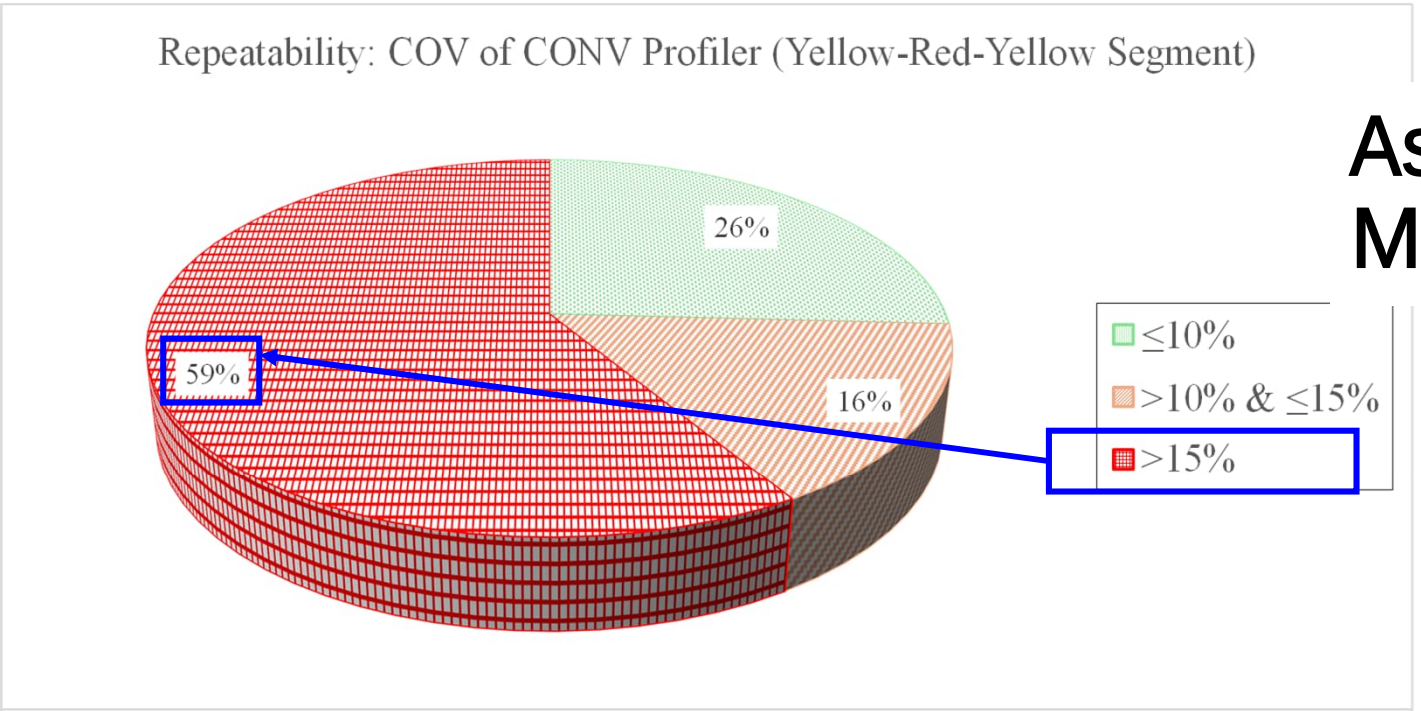
Assessment of Repeatability – Macro Level

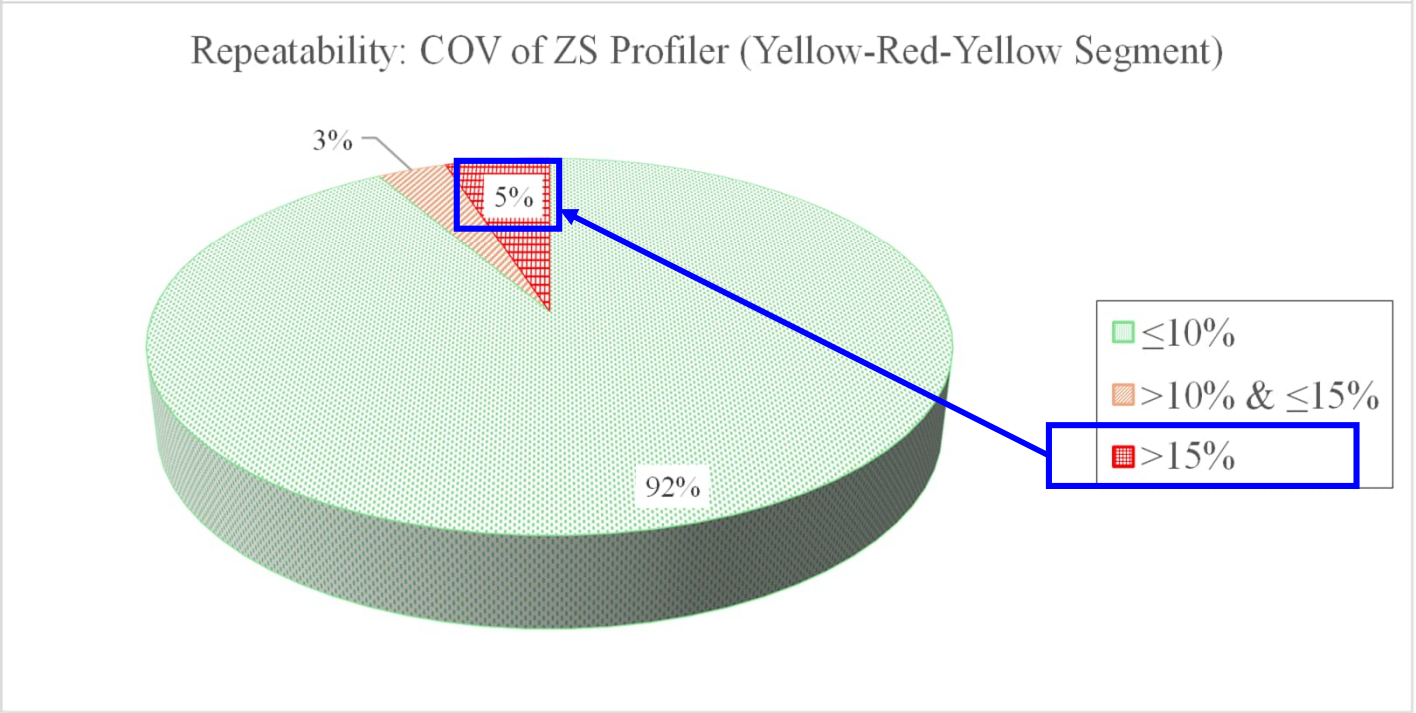


CONV - **HIGHER VARIABILITY** in low-speed

ZS - **STRONGER REPEATABILITY**

Assessment of Repeatability – Macro Level





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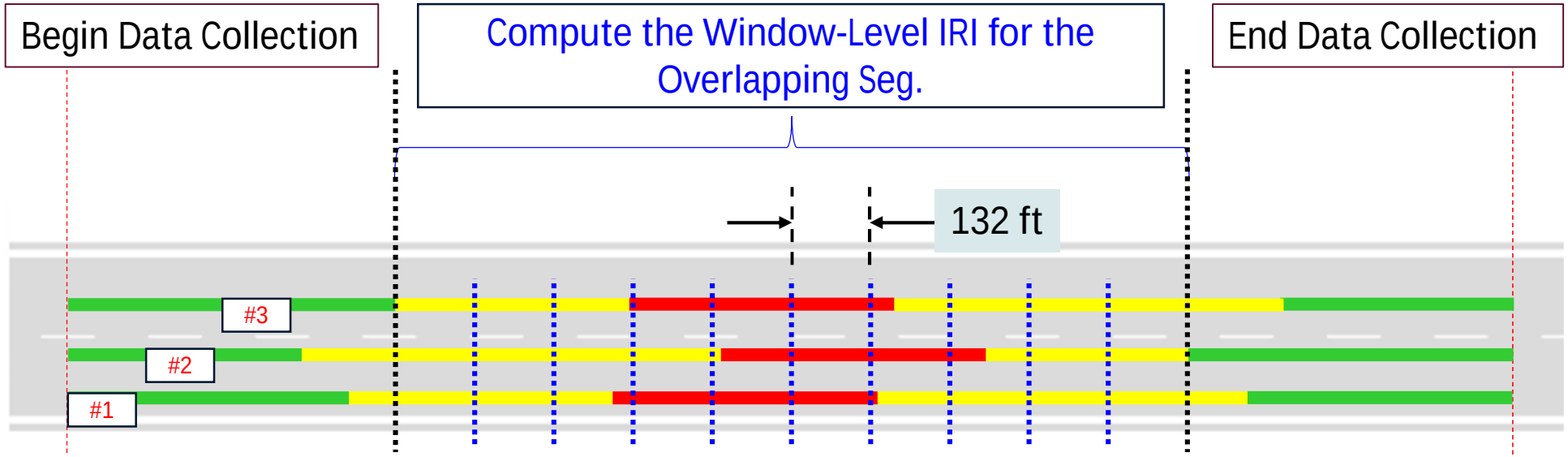
Assessment of Repeatability – Micro Level



Segments partitioned into consecutive 0.025-mile **(132-ft) windows**

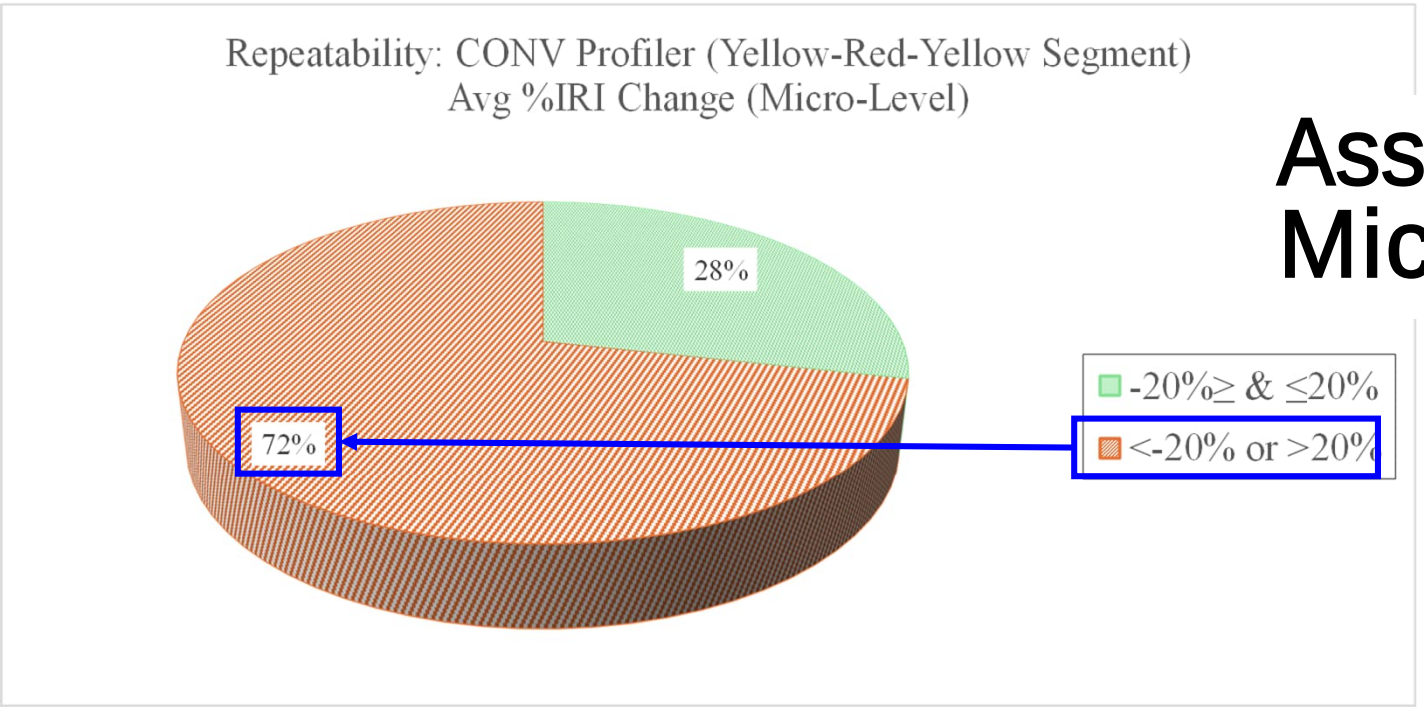
$\Delta IRI = IRI_{CONV} - IRI_{ZS}$ $|\Delta IRI| > 50$ in/mi

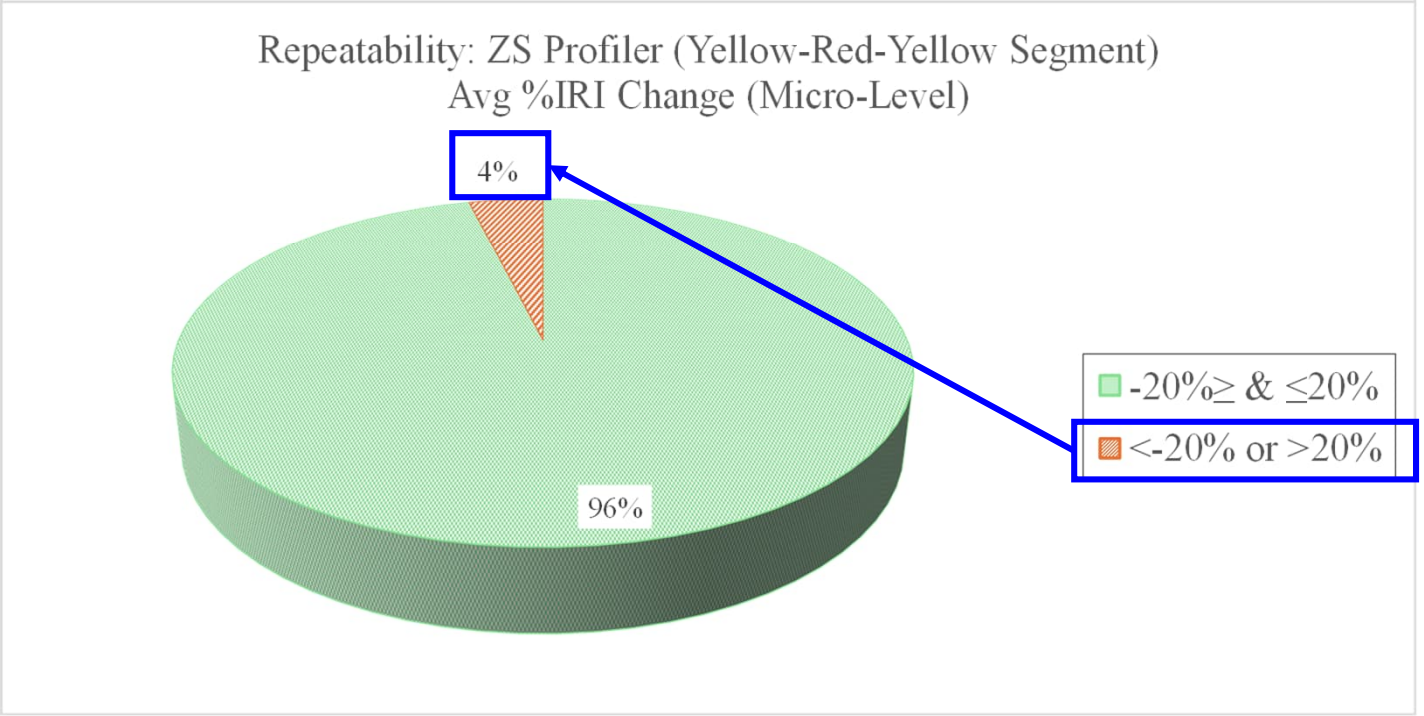
Micro-level analysis at low speeds

CONV - **HIGHLY VARIABLE**

ZS - **INTERNALLY CONSISTENT**

Assessment of Repeatability – Micro Level





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Conclusions

Steady-Speed Conditions (Zone 3, 30–65 mph)

- Both provide reliable, comparable IRI measurements
- Elevation profiles overlapped closely
- Fluctuations minimal under higher-speed travel.

Conclusions

Stop-and-Go Conditions (Zones 1-2, 0–30 mph)

- ZS outperforms the CONV profiler in repeatability and consistency
- Deceleration, slow speed, and acceleration zones can be isolated as the cause for differences
- To extrapolate to the network-level impact, you must understand the magnitude of the affected area in each run

Comments or Questions

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  ph.: 979-458-8141
  cell: 903-724-0563

Thank you!

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