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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

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ASSOCIATE PROFESSOR

# Parent Project

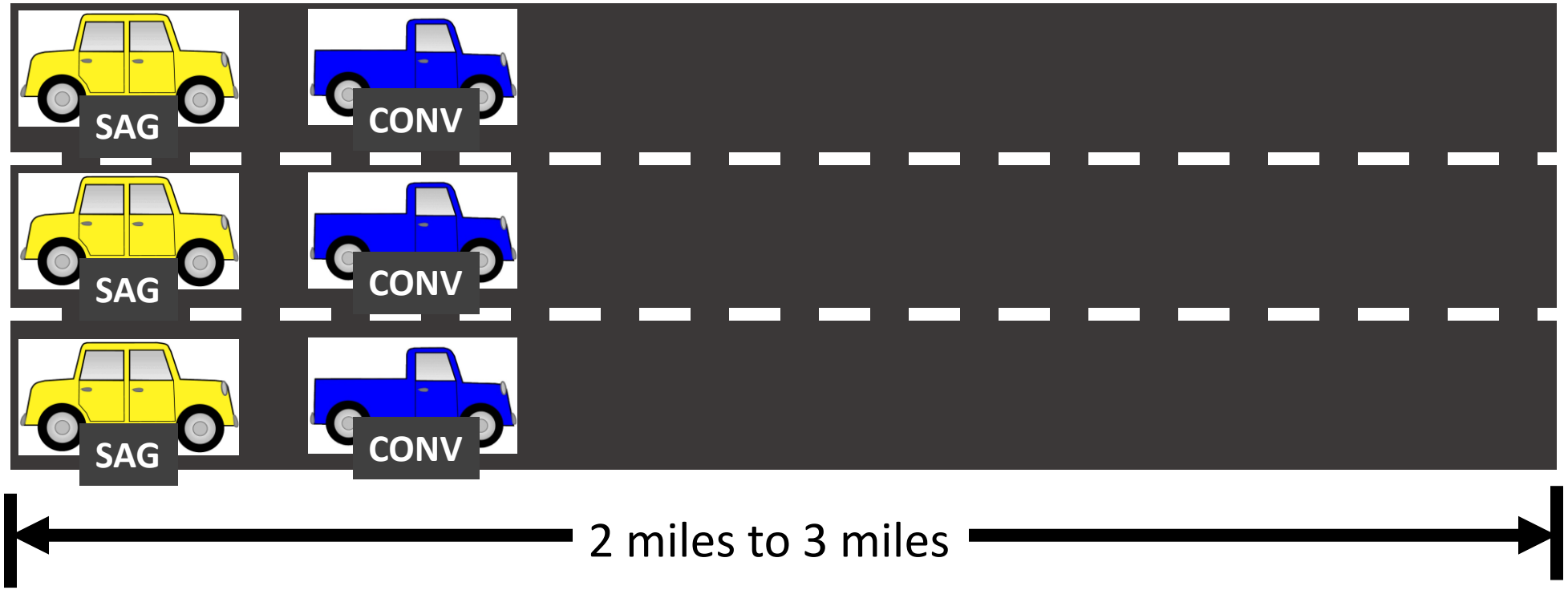
- Sponsoring Agency: Texas Department of Transportation
  - Dr. Jenny Li, PE: Technical lead
- *Evaluation of Low-Speed Profiler for Network-Level Pavement Management*
  - Task 1: Project Management
  - Task 2: Literature Review
  - Task 3: Analyze Existing Ride Quality Data and Identify Candidate Locations
  - 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

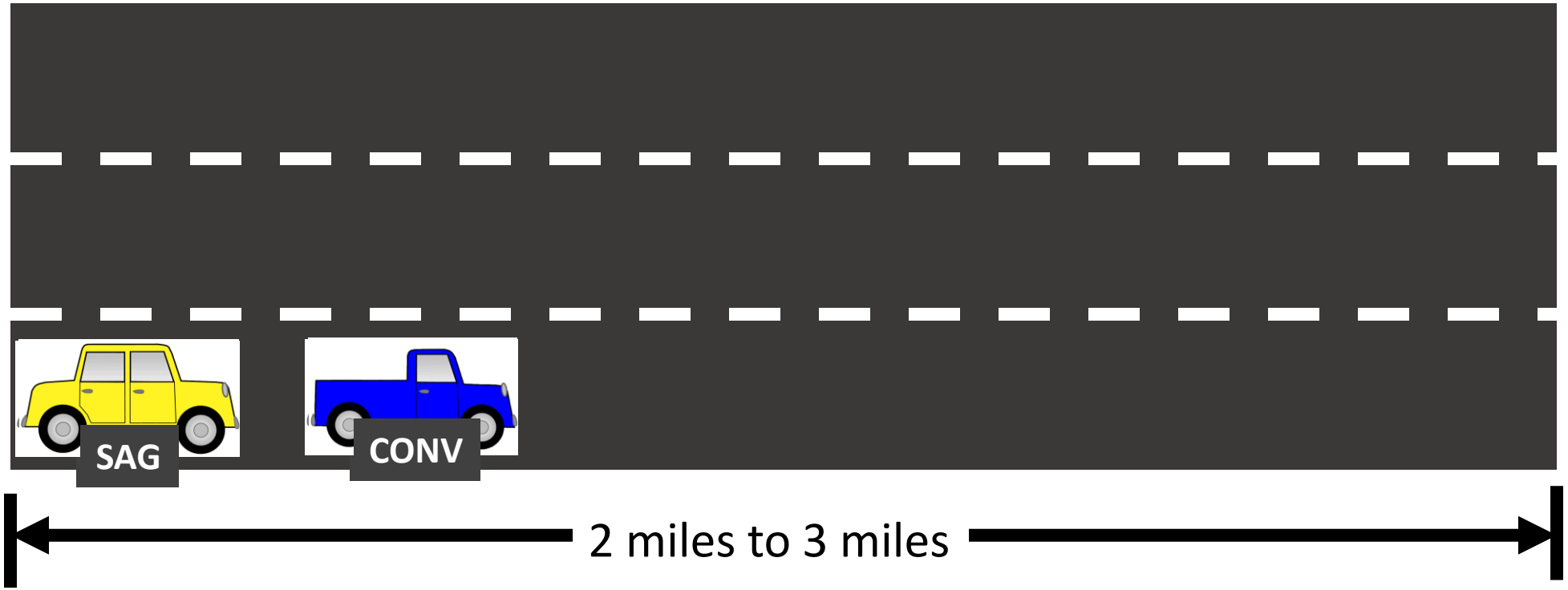
2) Assessment of Repeatability
    i. Macro-Level
    ii. Micro-Level

# 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

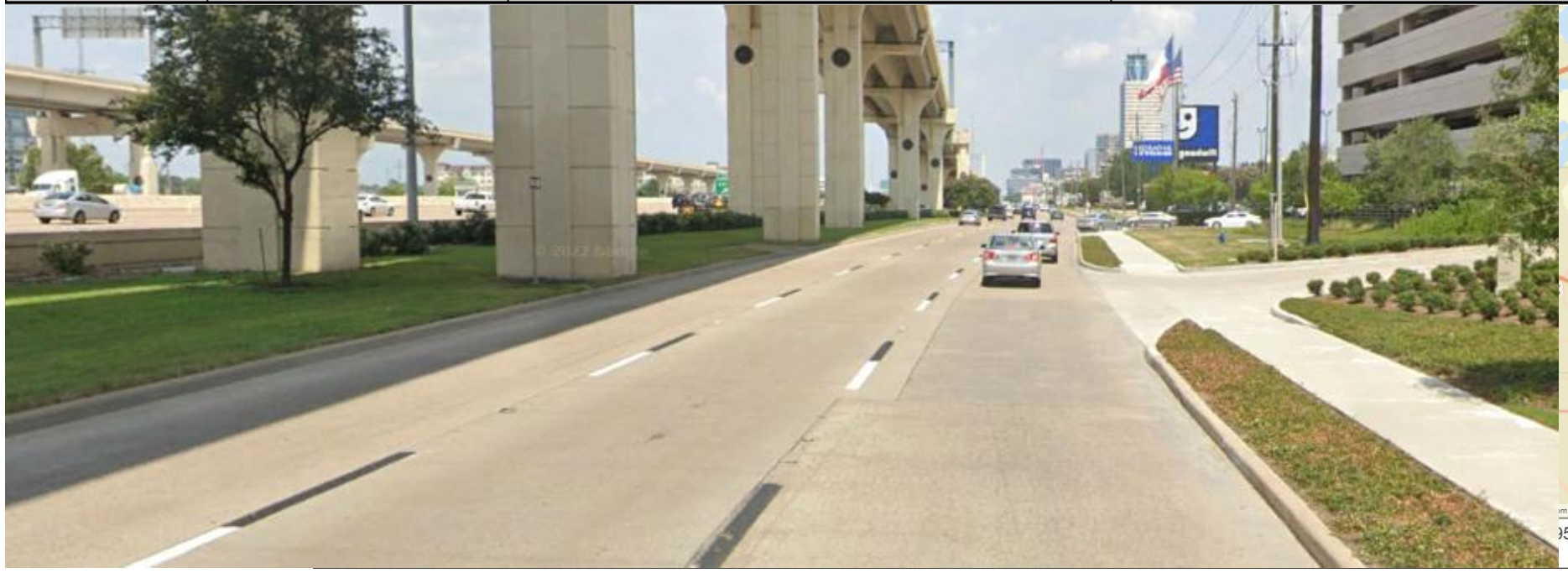
# Test Procedure & Assessment Locations




- 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)

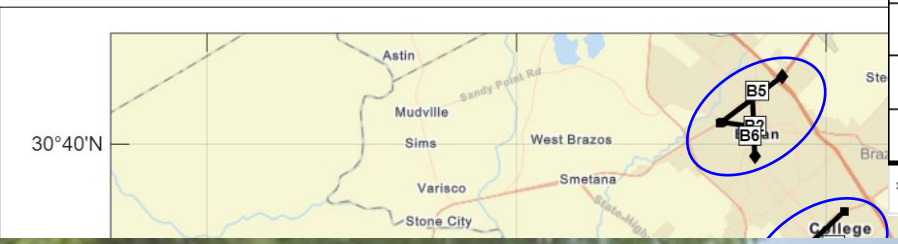
| Site No. | Segment ID | Roadway | Lane(s) Tested |
|---|---|---|---|
| 1 | H1 | IH 10 EB Frontage Road | Left, Center, and Right |
| 2 | H2 | IH 10 WB Frontage Road | Center and Right |
| 3 | H3 | US 90 EB Mainlane | Left, Center, and Right |
| 4 | H4 | IH 69 SB Frontage Road | Left, Center, and Right |
| 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



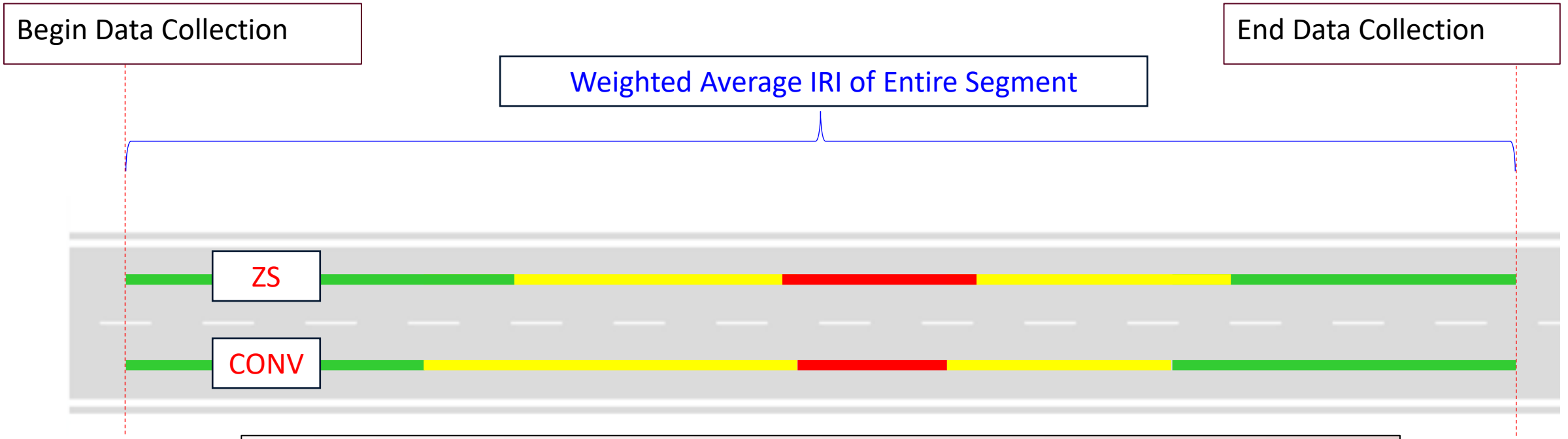

# 30 Total Test Units (e.g., Waco District)

| 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

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



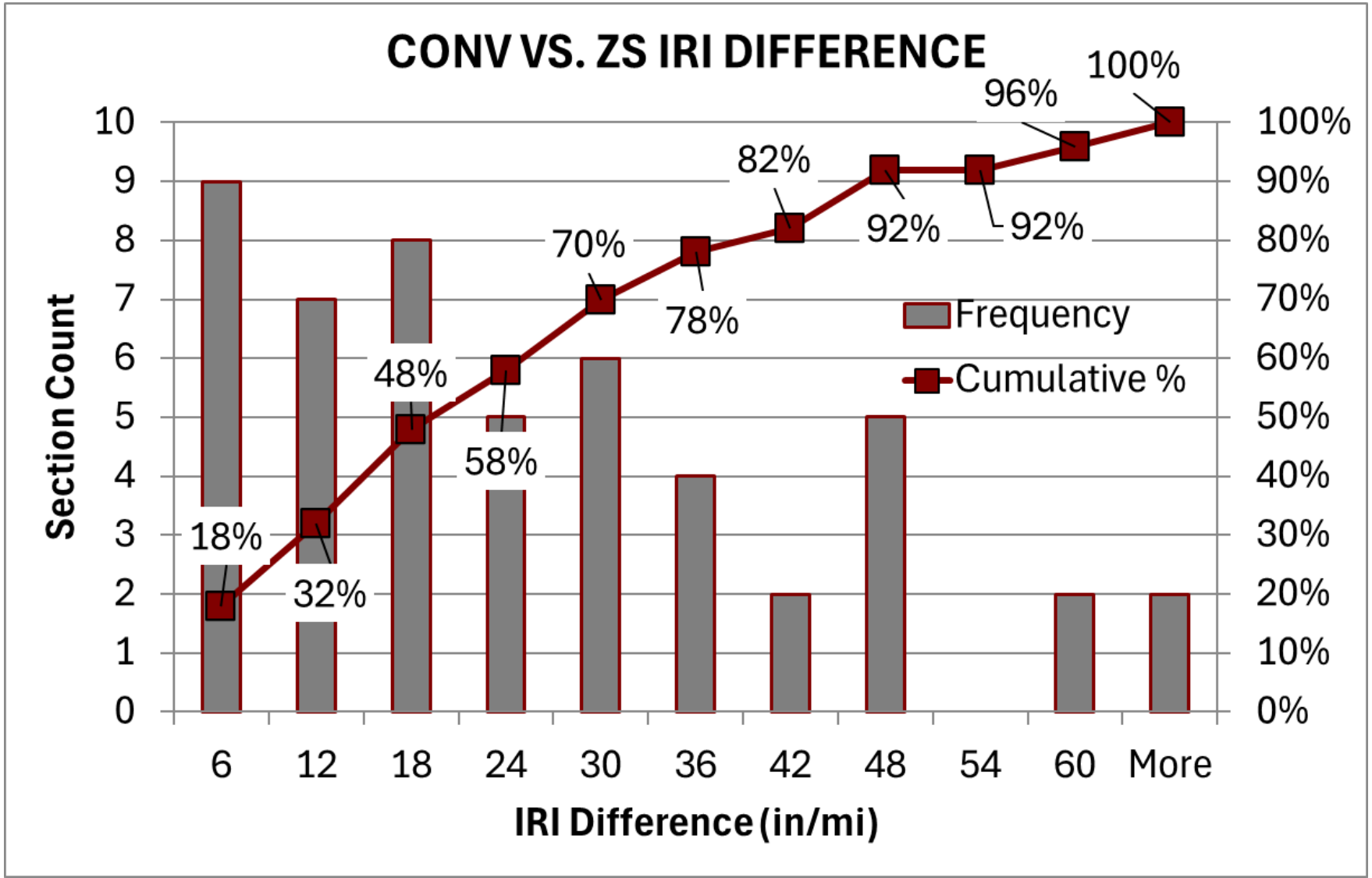

| Zone (Segment) | Speed Range (mph) |
|---|---|
| 1 (Red Segment) | 0 – 15 |
| 2 (Yellow Segment) | 15 – 30 |
| 3 (Green Segment) | 30 – 65 |

# Macro-Level Assessment – IRI Difference

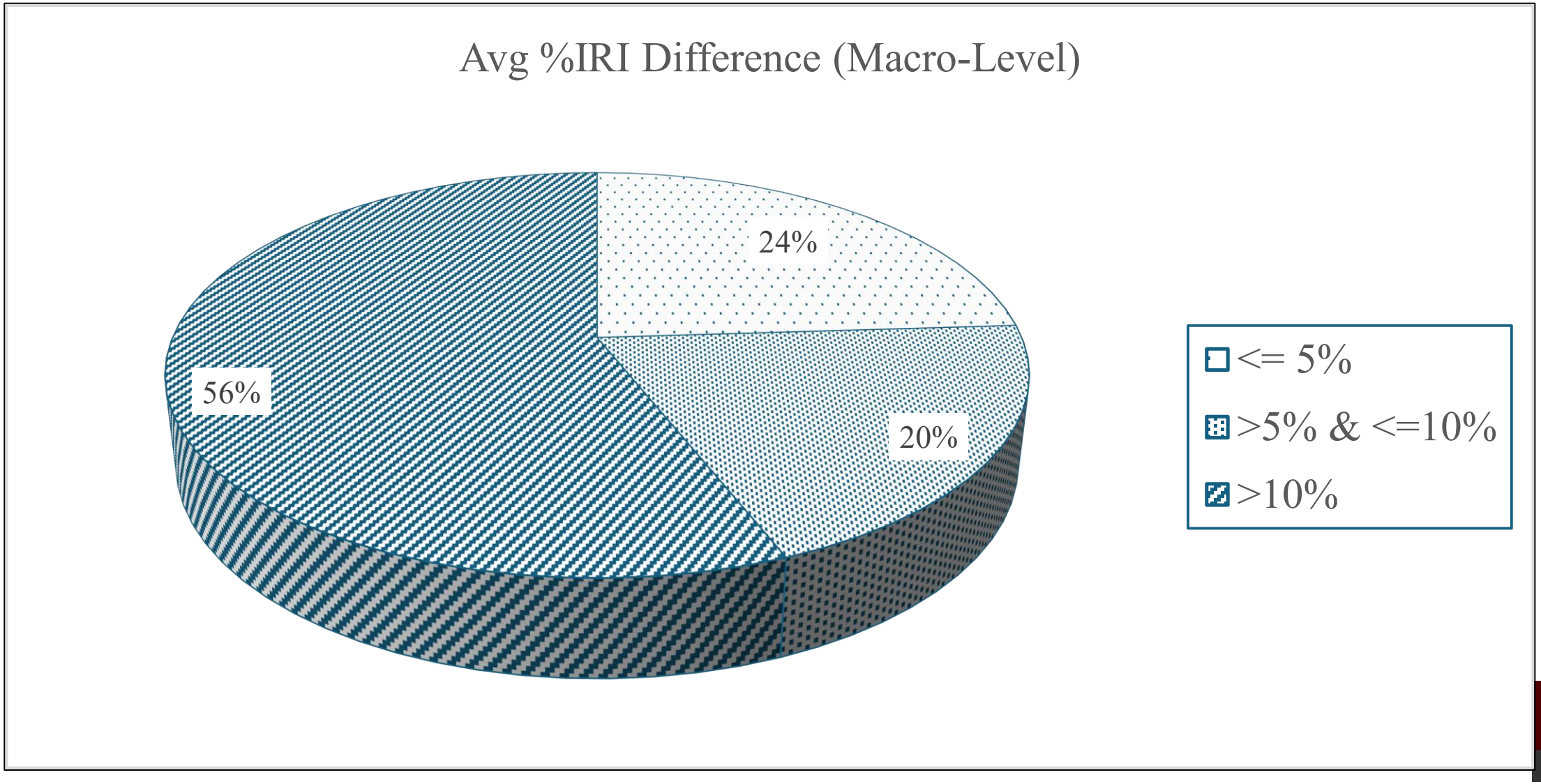
Macro-level analysis

**POTENTIAL INSTABILITY**
in the CONV profiler compared to ZS

# Macro-Level Assessment – IRI Difference



# Macro-Level Assessment – IRI Difference



# Micro-Level Assessment – IRI Difference

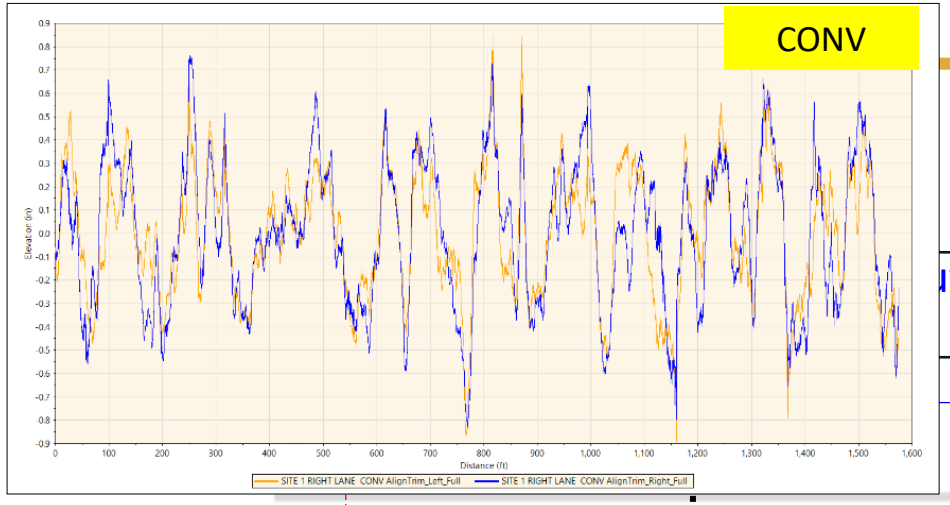
At steady speeds, both profilers deliver **CONSISTENT IRI MEASUREMENTS**.

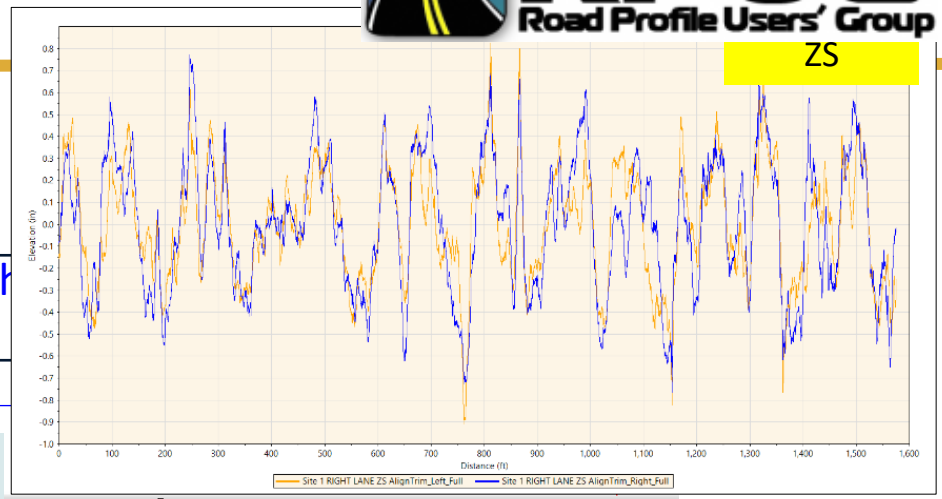
STOP-and-GO conditions

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

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

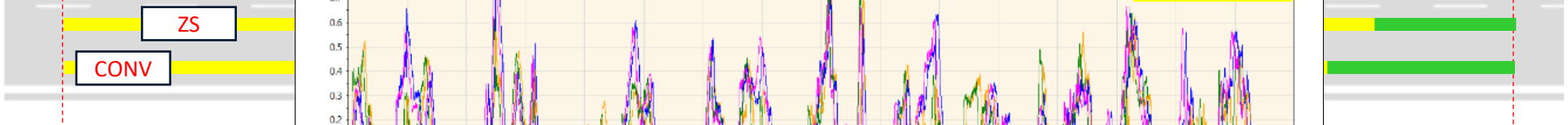
# Micro-Level Assessment – IRI Difference

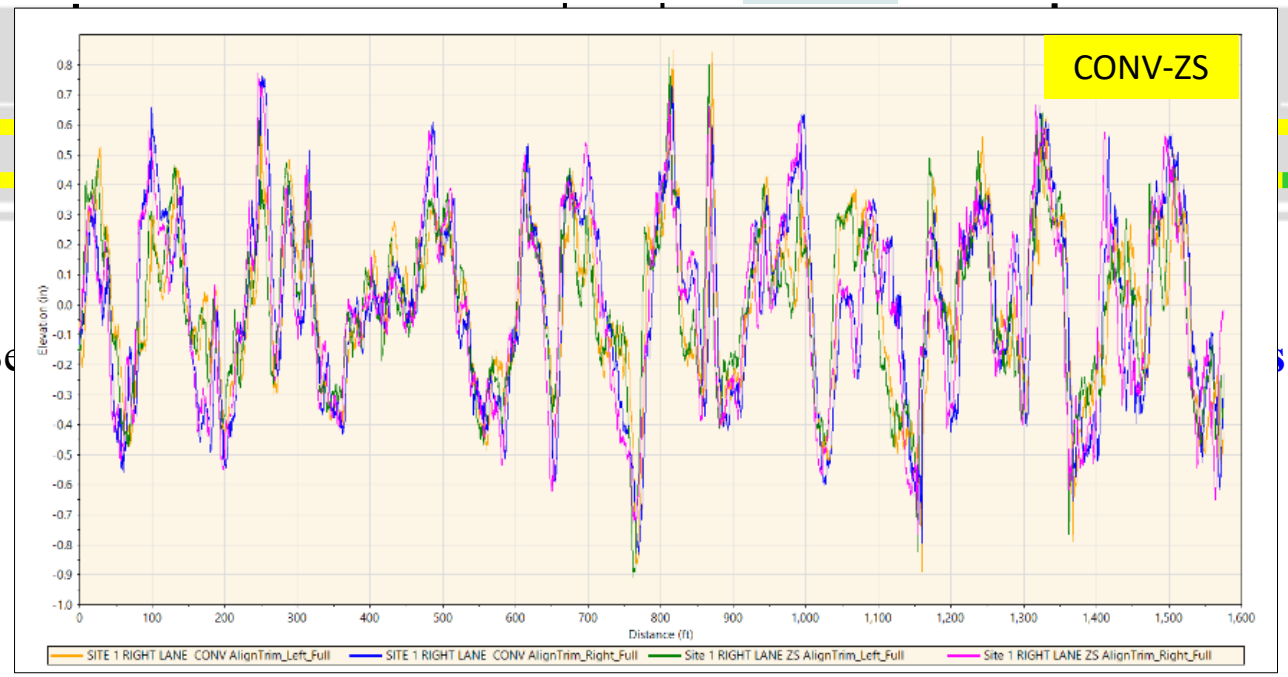



ute the Window-Level IRI for th
Overlapping Seg.

132 ft

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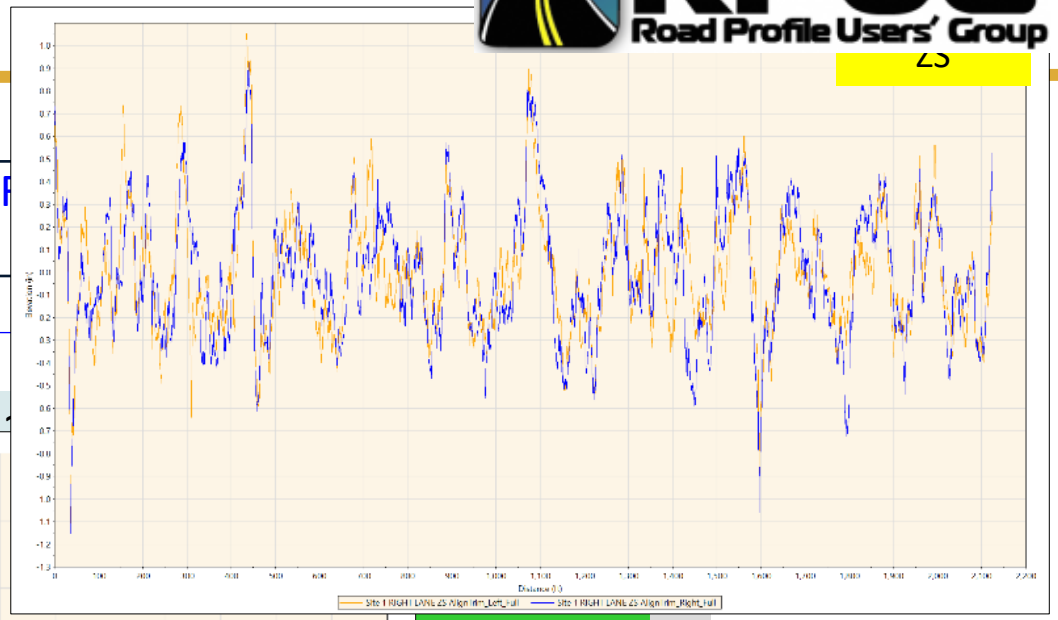
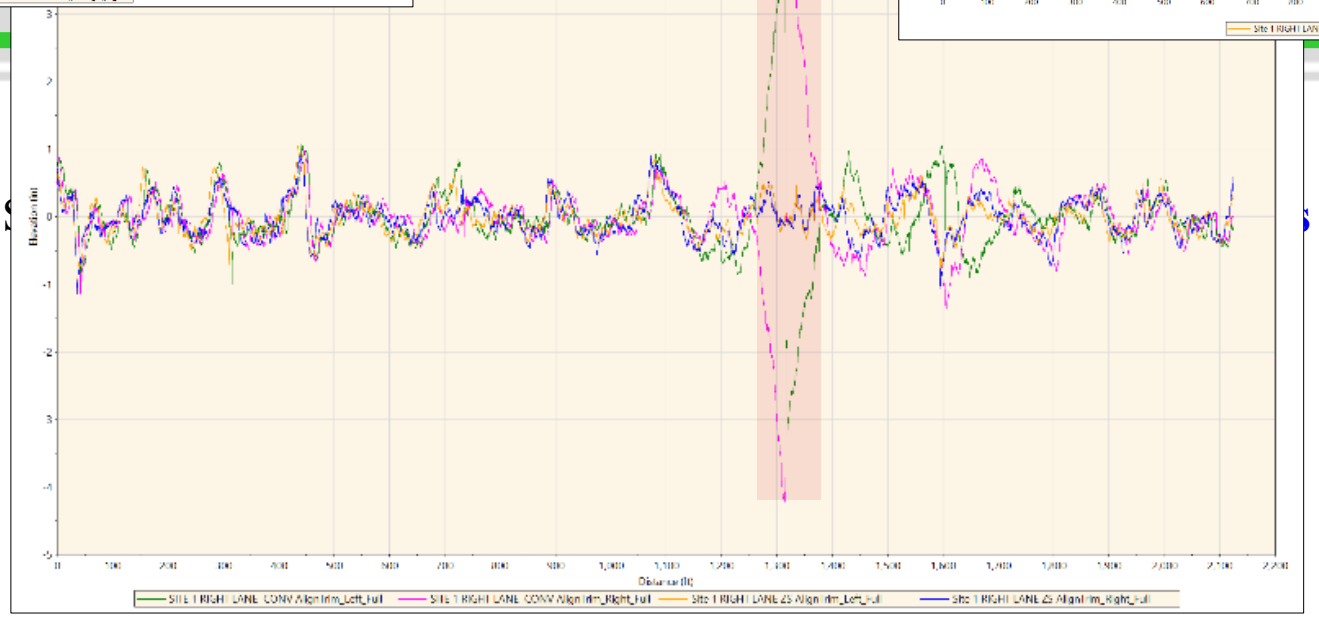
# Micro-Level Assessment – IRI Difference

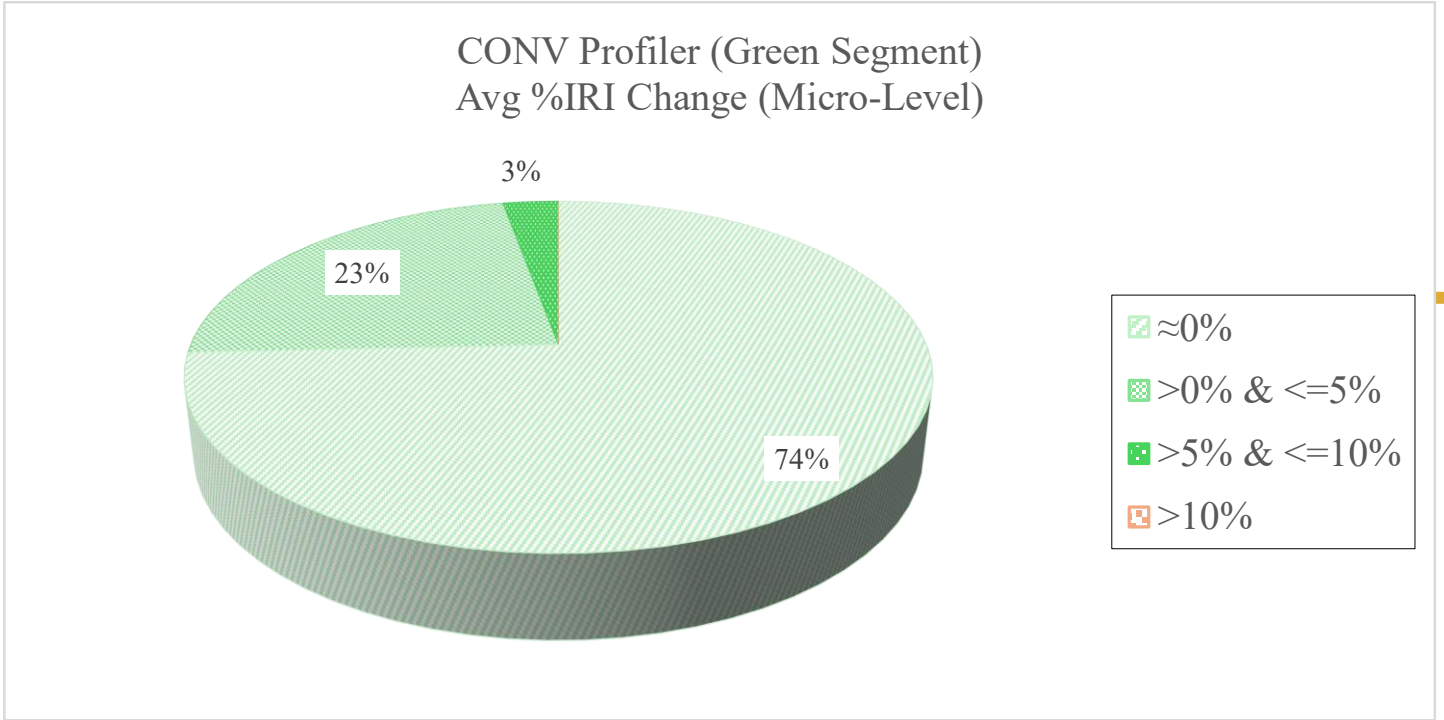

pute the Window-Level IF
Overlapping Seg.

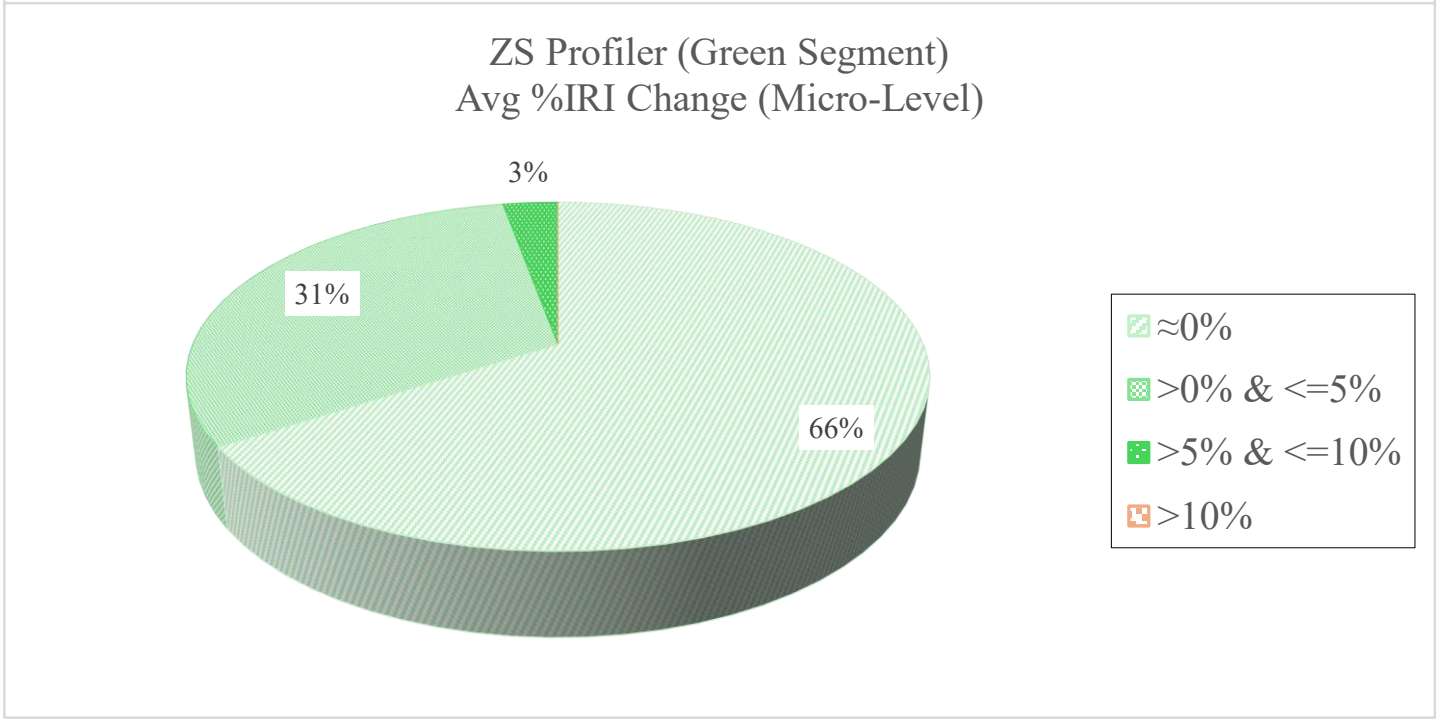
CONV

CONV-ZS



# Micro-Level Assessment – IRI Difference

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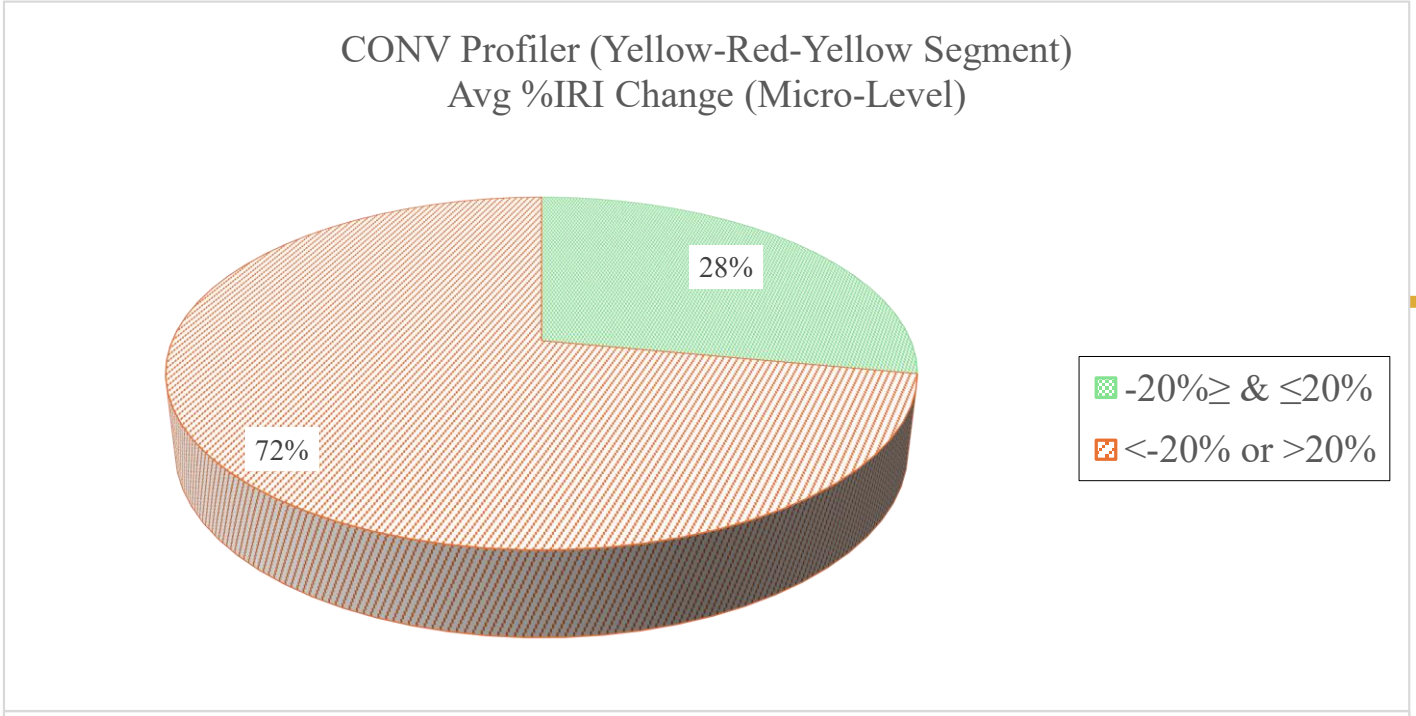
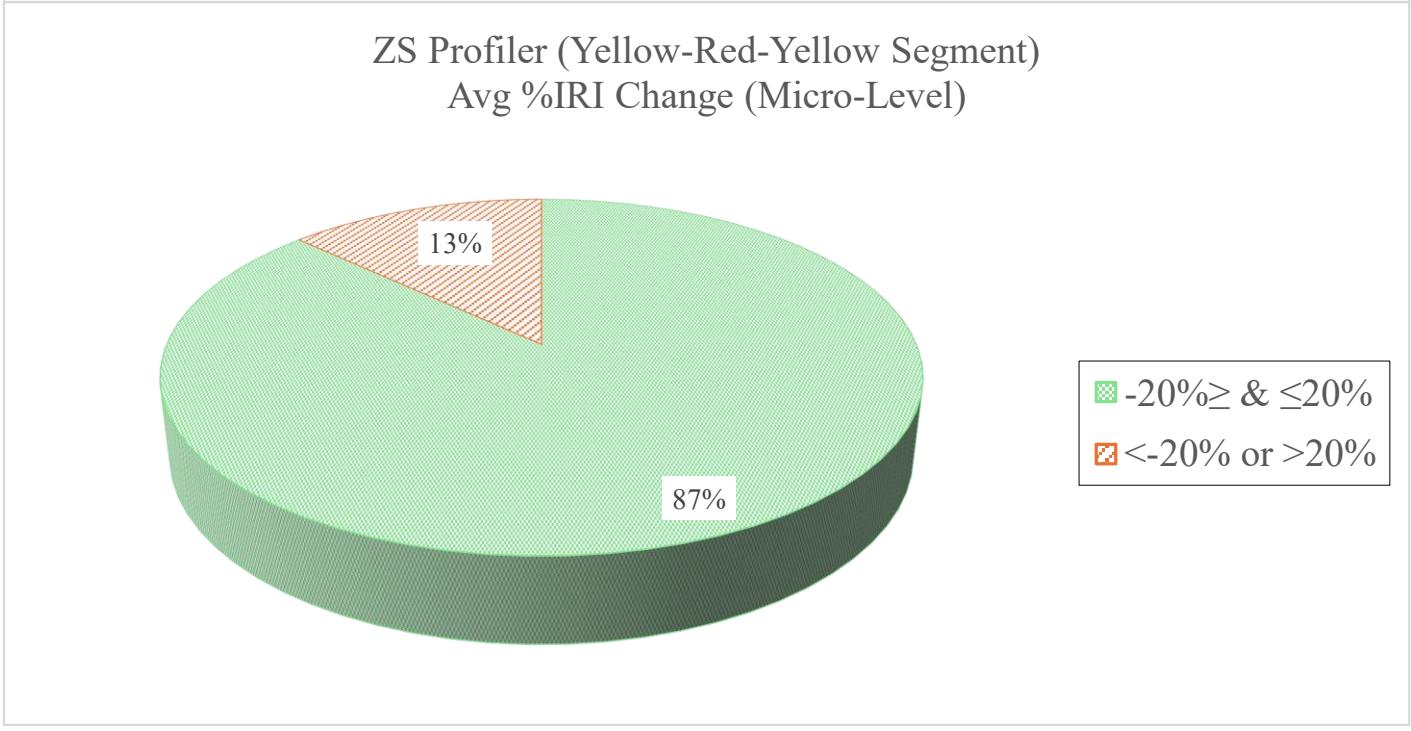
# Micro-Level Assessment – IRI Difference

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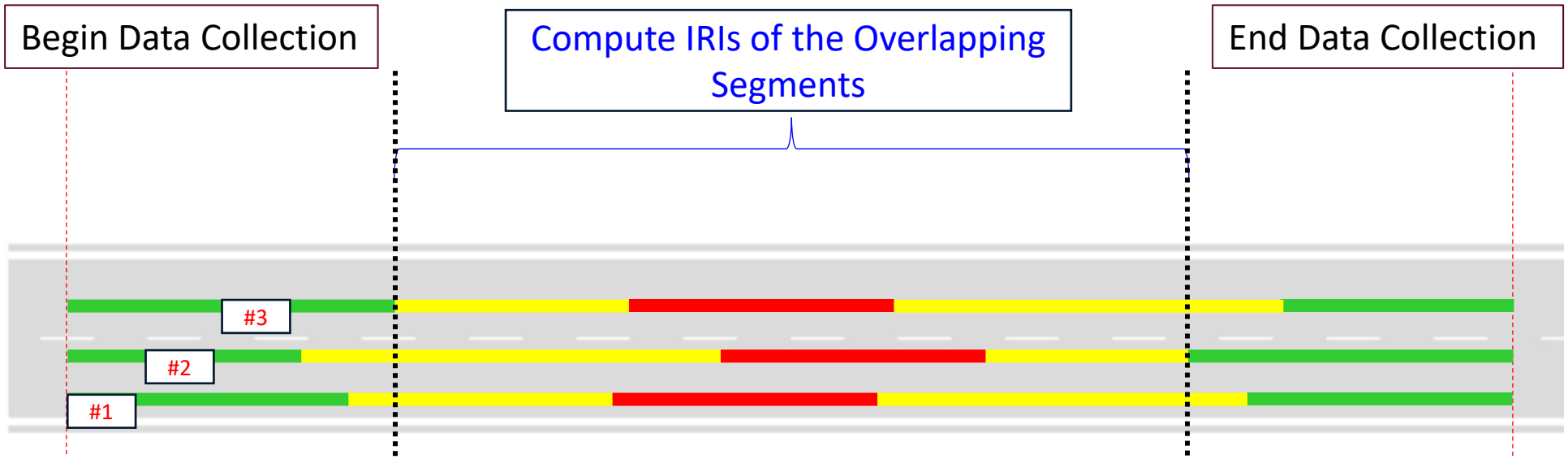
# Assessment of Repeatability

- 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.

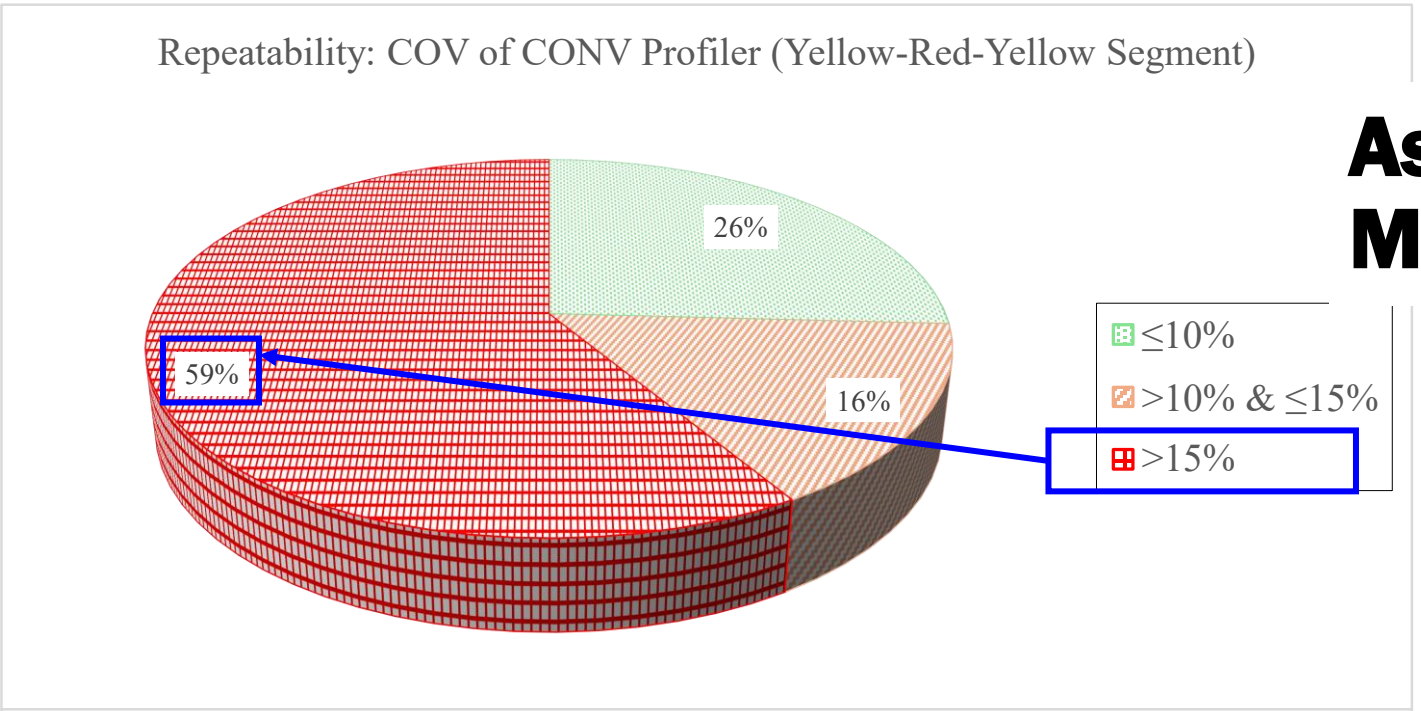
# Assessment of Repeatability – Macro Level

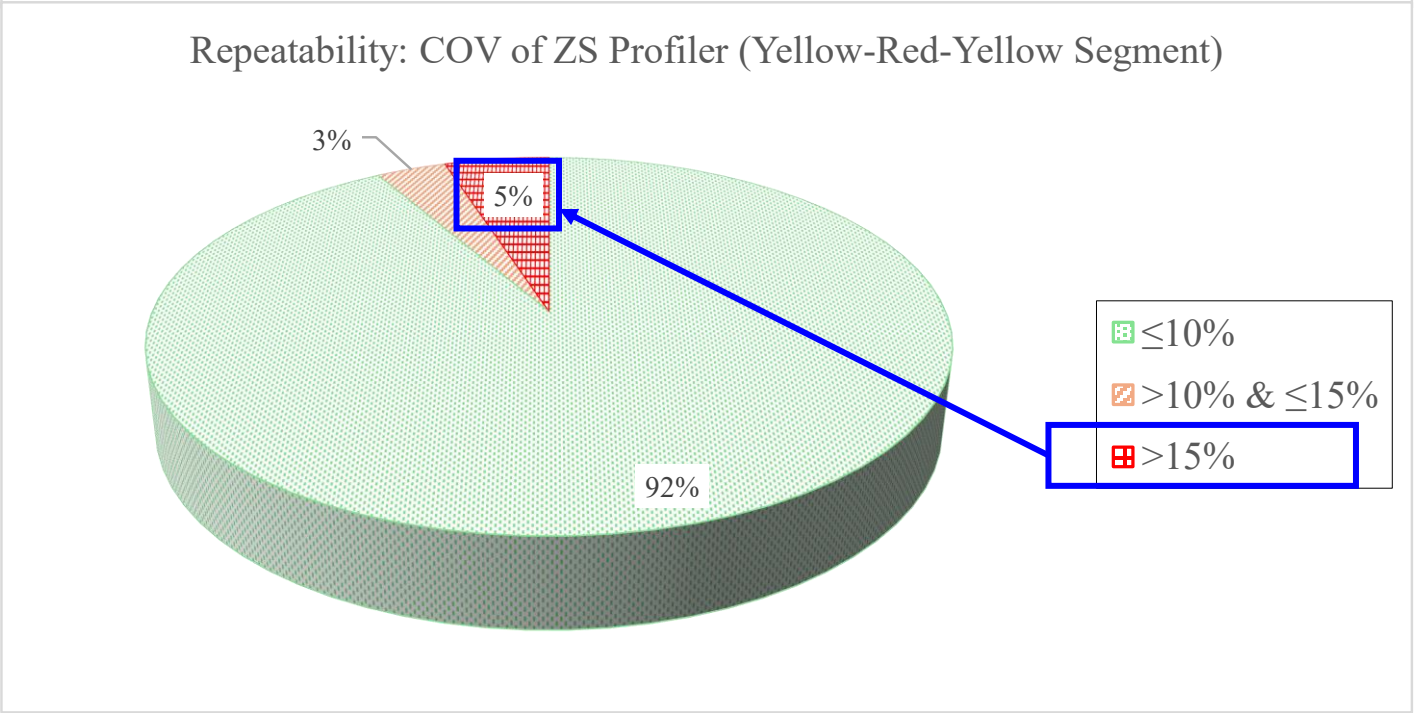



CONV - **HIGHER VARIABILITY** in low-speed

ZS - **STRONGER REPEATABILITY**

# Assessment of Repeatability – Macro Level

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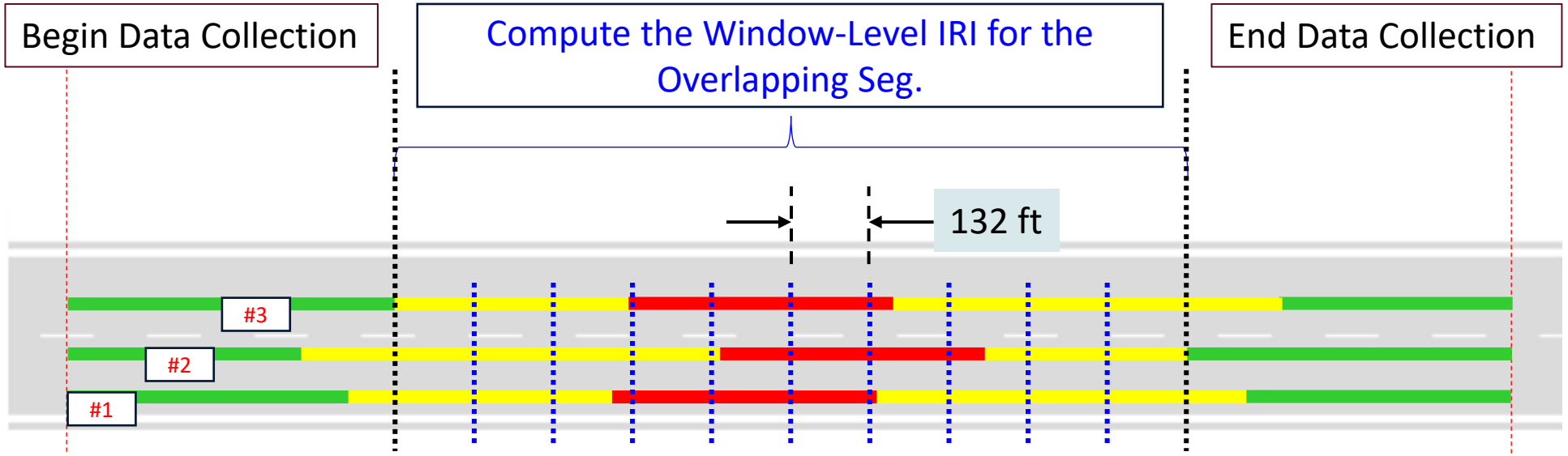
# Assessment of Repeatability – Micro Level



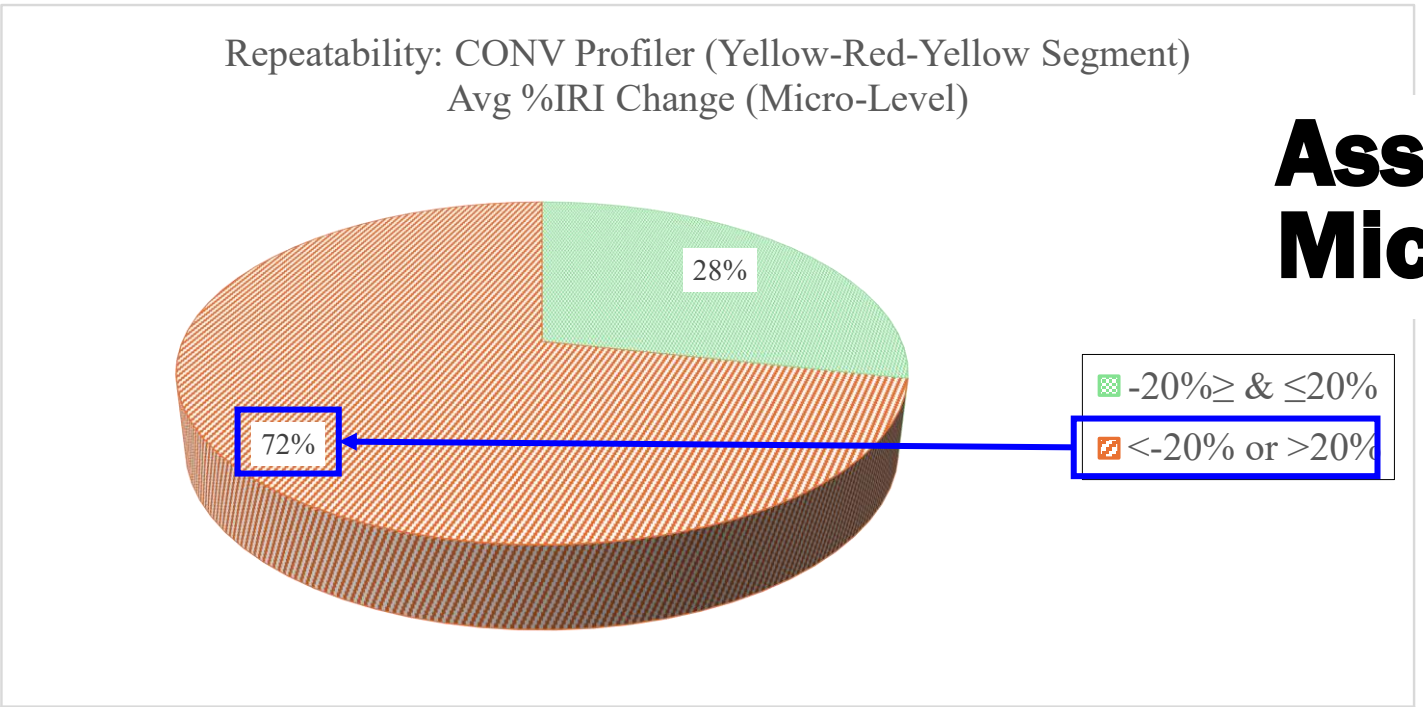

Segments partitioned into consecutive 0.025-mile **(132-ft) windows**

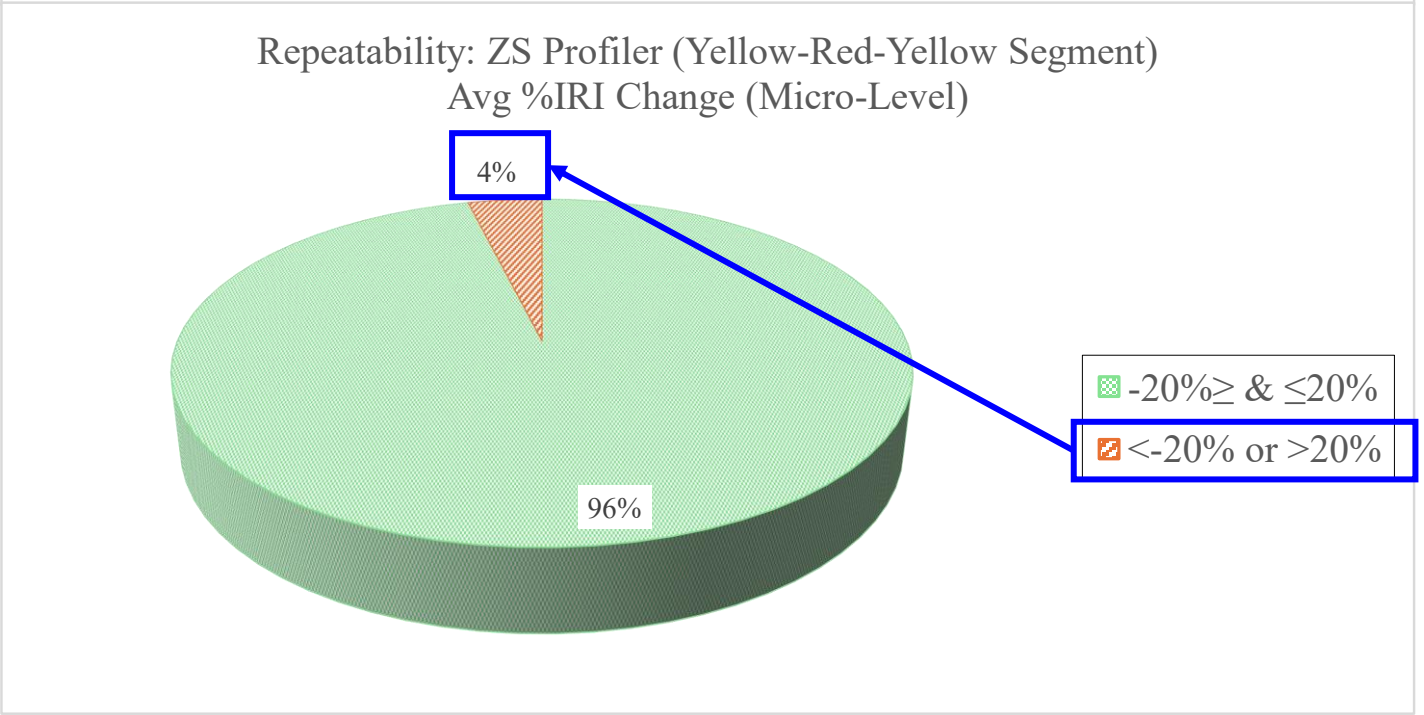
$\Delta IRI = IRI_{CONV} - IRI_{ZS}$ $|\Delta IRI| > 50$ in/mi

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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