CSX Experience With ENSCO ZERO SPEED Compact Autonomous Track Geometry Measurement System

Bernhard Metzger
ENSCO Rail Inc., Vienna, VA, USA

Brad Spencer
CSX, Jacksonville, FL, USA

IHHA 2025
13TH INTERNATIONAL HEAVY HAUL ASSOCIATION CONFERENCE 2025

November 17-21, 2025 | The Broadmoor, Colorado Springs, CO, USA

Introduction

CSX and other railroads are increasingly deploying fully autonomous track geometry measurement systems to achieve continuous, high-density network coverage. These systems are typically installed on locomotives or boxcars within the train consist. When freight trains operate at low speeds —due to signaling, infrastructure constraints, or temporary speed restrictions— conventional inertial-based systems often experience data dropouts, especially in alignment and longitudinal level measurements.

To address this, ENSCO developed a compact, zero-speed capable autonomous track geometry measurement system that consolidates a traditional two-beam setup into a single integrated unit. The system records all track geometry parameters regardless of train speed. Since 2024, CSX has adopted and successfully deployed the technology on its first boxcar, with two additional installations now underway. This innovation enables complete geometry data capture at any speed, ensuring that defects are not missed in areas only traversed at low speeds.

The ability to measure at zero speed is especially critical in yards and industrial tracks, where 91% of track-related derailments occur. CSX's goal of expanding inspections in these areas is now achievable, improving safety, reducing derailments and derailment-related costs through comprehensive, low-speed data acquisition.

Experimental work

ENSCO has been familiar with the concept of zero-speed track geometry measurement for some time. The recent innovation lies in ENSCO's new method of deriving track geometry using a combination of sensors, which enables the system to be implemented within a highly compact footprint. Initial experiments utilized data from an existing large-footprint implementation. These data were reprocessed using the new method, demonstrating improved accuracy and stability, while simultaneously supporting a significantly smaller hardware configuration. Looking ahead, future iterations aim to reduce the system footprint even further. Additionally, upcoming experiments will explore how sensor and component redundancy can be leveraged to increase system availability, a critical requirement for unmanned and fully autonomous deployments.

Results

Since integrating the upgraded system onto the boxcar, CSX has been able to record all track geometry parameters without interruption, resulting in an **increase** of approximately **7%** data coverage. The compact zero-speed track geometry measurement system has had a particularly strong impact in yards and other low-speed areas, locations where conventional inertial-based systems typically fail to capture alignment and level data. As expected, the most significant coverage gains occurred in track yards, where zero-speed capability ensures consistent, uninterrupted data collection. Please refer to Figure 3 for a visual representation of the coverage improvement.

Conclusions

CSX has realized significant operational benefits by installing the zero-speed track geometry measurement system, which allows for uninterrupted data capture of all geometry parameters, even at low speeds. Beyond boxcar deployment, the system presents additional opportunities. One such application is on tamping or other low-speed maintenance machines, enabling real-time quality control during maintenance activities such as tamping or stabilizing. This eliminates the need for a separate post-maintenance inspection run, increasing efficiency and ensuring immediate validation of work quality.

Acknowledgments

We thank **CSX** for their support in deploying the compact zero-speed track geometry measurement system. We also gratefully acknowledge **Brightline** for their collaboration in implementing this solution on a high-speed passenger train coach.

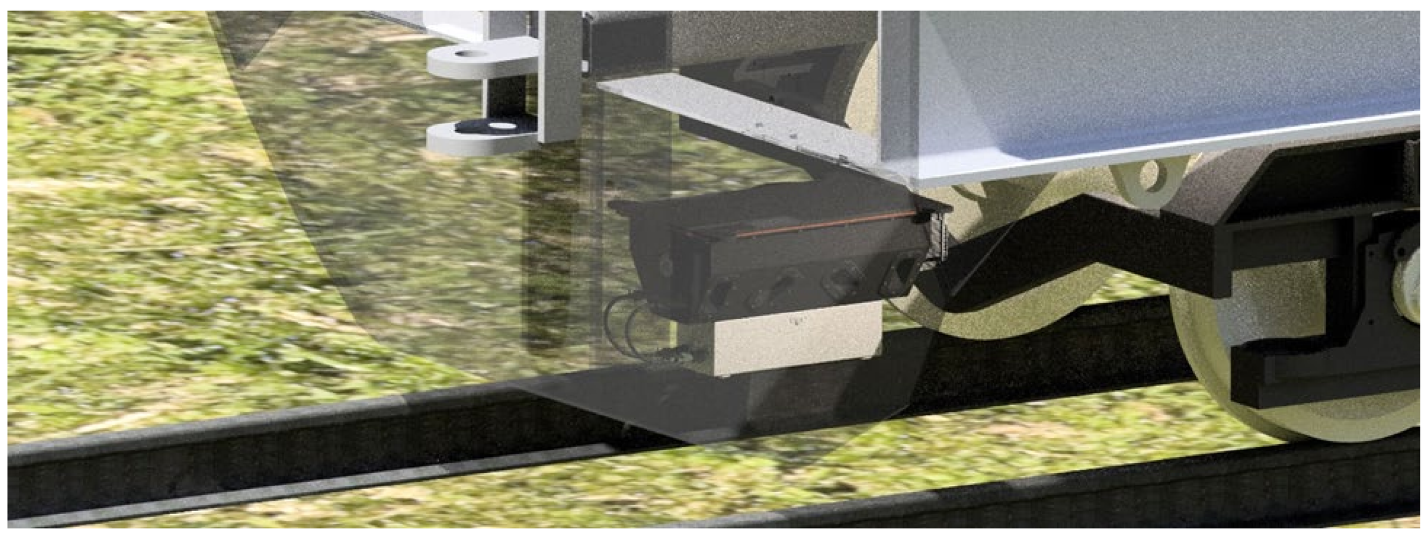

Figure 1. System on Locomotive

Figure 2. CSX Boxcar

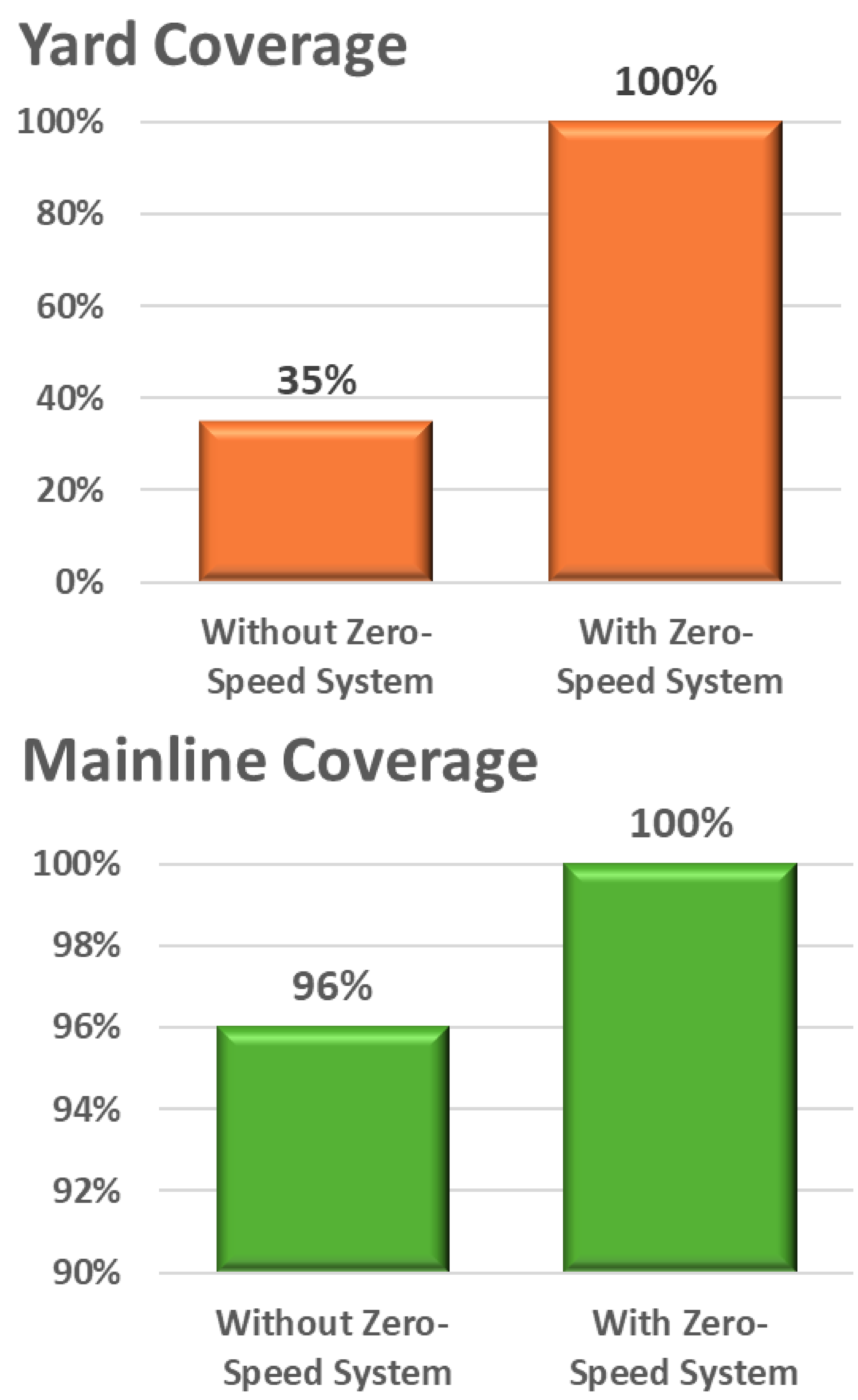

Figure 3: Coverage Comparison

For further information please contact:
Bernhard Metzger, ENSCO Rail Inc., metzger.bernhard@ensco.com
Brad Spencer, CSX, brad_spencer@csx.com