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Problems:

- Train rail is critical in transportation safety as it could lead to train derailment
- **Track anomaly detection & Remaining Useful Life (RUL) modeling** are essential for diagnostics and prognostic health management

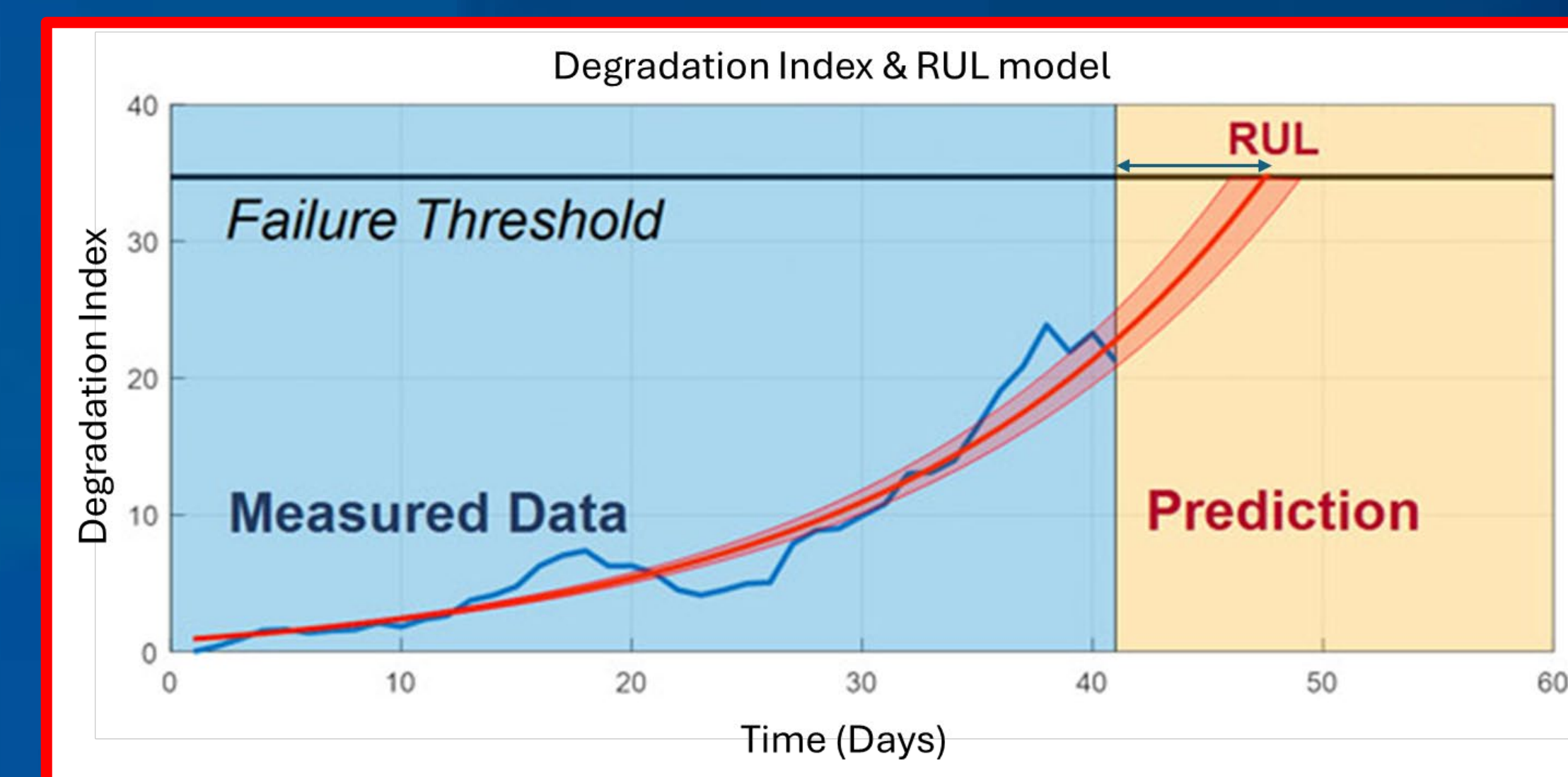
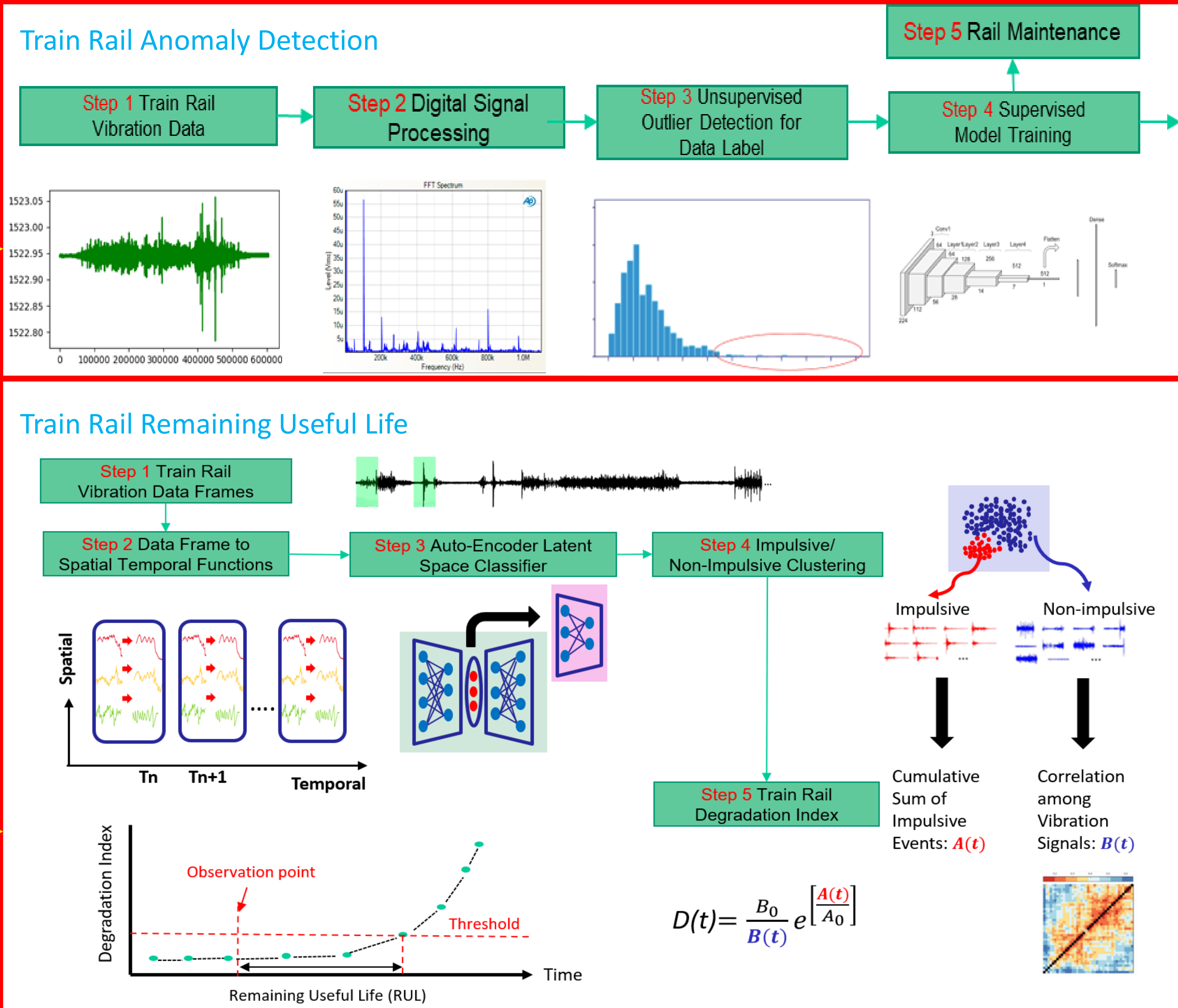
Objectives:

- Determine train rail defective location by **AI Data Driven Methodologies**
- Build train rail degradation model & estimate the RUL
- **Apply novel train rail prognostic health/prescriptive management**

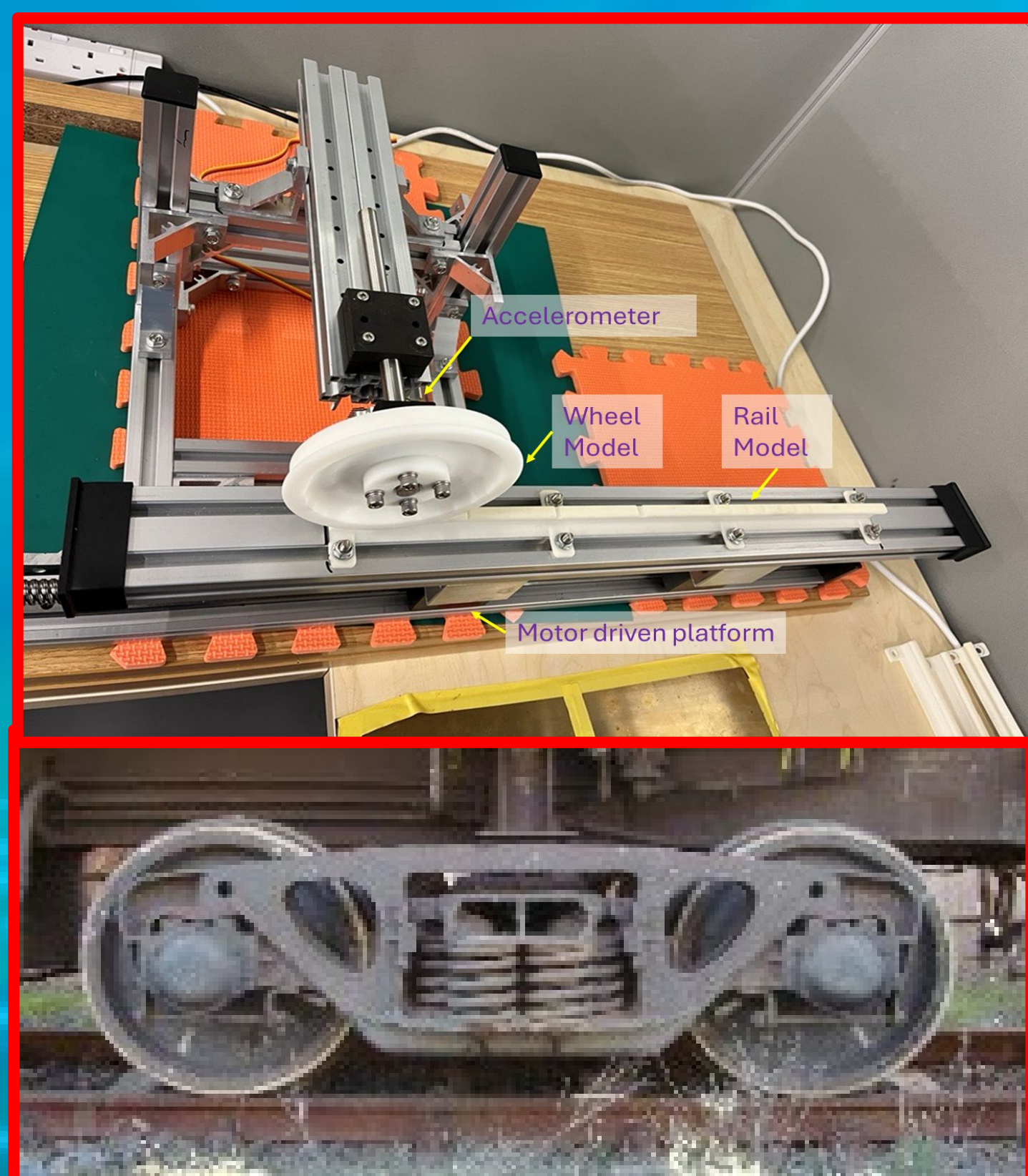


Methods:

- Anomaly Detection: Fast Fourier Transform (FFT)/ResNet
- RUL: Functional Data Analysis/Auto-Encoder/Degradation Index

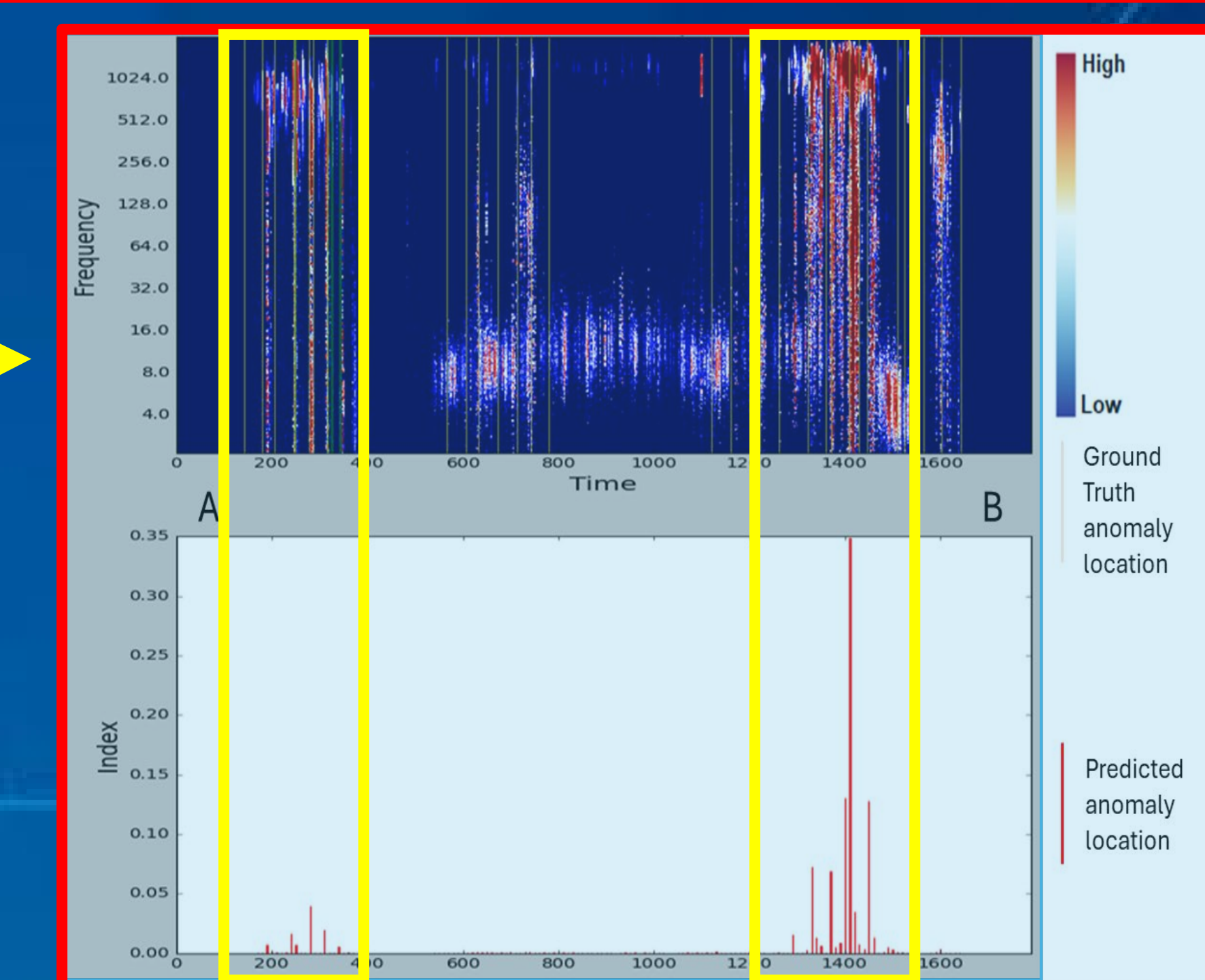


Custom Scale Down Model

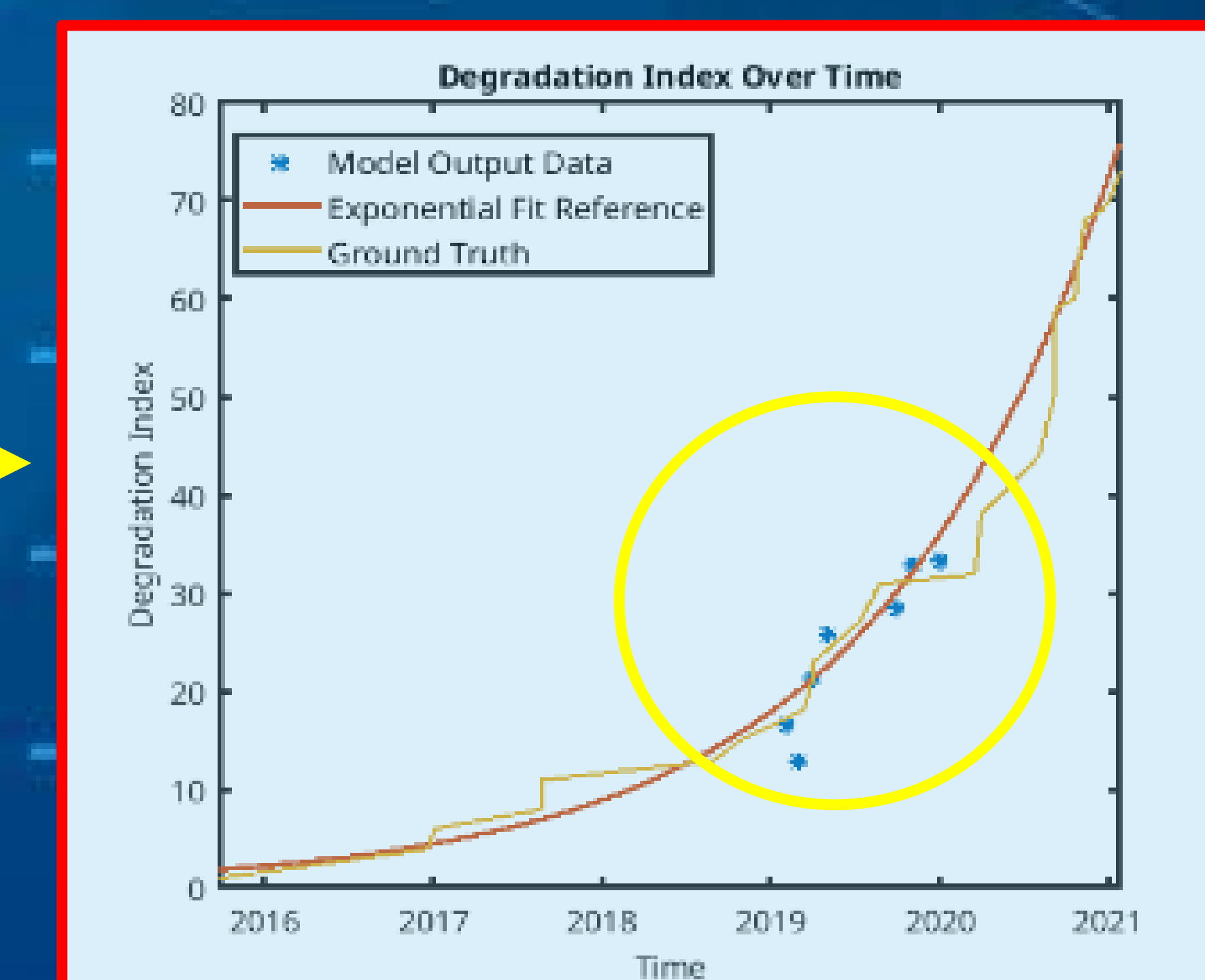


Train Rail Axle Box

Vibration Data



Anomaly Detection



RUL Model

Results:

- ✓ Accurately predict probability of rail anomaly (approx. 85%)
- ✓ Accurately predict rail RUL (Root Mean Square Error <10%)

Patent:

Title: Method and system for monitoring health condition of a railway track.
Registered region and date: Hong Kong, 12/01/24
Hong Kong Short Term Patent Publication No: 30097997 A

Publication:

Title: Functional Subspace Variational Autoencoder for Domain-Adaptive Fault Diagnosis.
Mathematics 2023, 11(13), 2910
<https://doi.org/10.3390/math11132910>

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