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# Demonstrators

TU Dresden



TECHNISCHE  
UNIVERSITÄT  
DRESDEN

TU Delft



UNIVERSITY  
OF LEEDS



E-TECH

aimen  
TECHNOLOGY CENTRE

evopro

EURNEX

UIC

ProRail

RET

*XCROSS Project – Mid-Term Public Workshop*

05 February 2026

# Agenda



## **Purpose & Scope:**

What the demonstrators aim to validate in real operational environments.



## **Key Requirements & Workflow:**

Short overview of Monitoring → Inspection → Maintenance and the tools used.



## **Common Elements Across All Demonstrators:**

Shared workflow, QR anchoring, Digital Twin use, AR guidance, QC loop.



## **Types of Demonstrators:**

Intercity • Metro • Tram – why each site was selected and what makes it unique.



**Validation Objectives:** What the demonstrators will actually test.



**Outcomes & Impact:** Expected benefits.

# Purpose

- 1. Validate new technologies in real operations**  
Demonstrators test solutions/technologies on intercity, metro, and tram lines
- 2. Stakeholder engagement and feedback**  
Maintenance teams assess usability, practicality, and workflow impact.
- 3. Accelerate Technology Readiness Level (TRL)**  
Field tests support progression toward TRL 4/5 and future deployment.
- 4. Quantify performance improvements**  
Demonstrators measure inspection speed, repair consistency, and lifecycle benefits.



# Scope

Planning &  
Site  
Selection



Maintenance  
Assessment



Deployment  
of XCROSS  
Tools



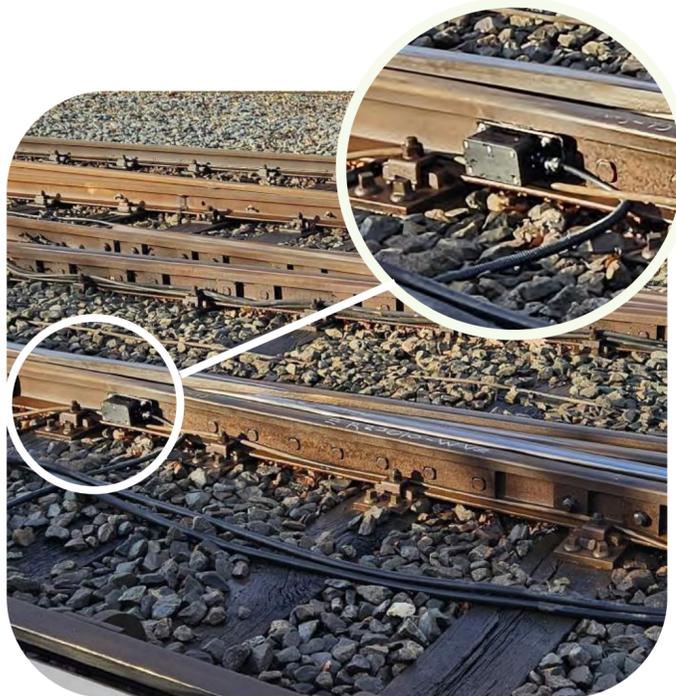
Post-  
Maintenance  
Validation

Identify intercity,  
metro, and tram  
assets for testing.

Capture baseline  
geometry with handheld  
3D scanning and produce  
DT results.

AR guidance, and  
3D-printed aids during  
maintenance.

Re-scan and  
compare before/after  
improvements.

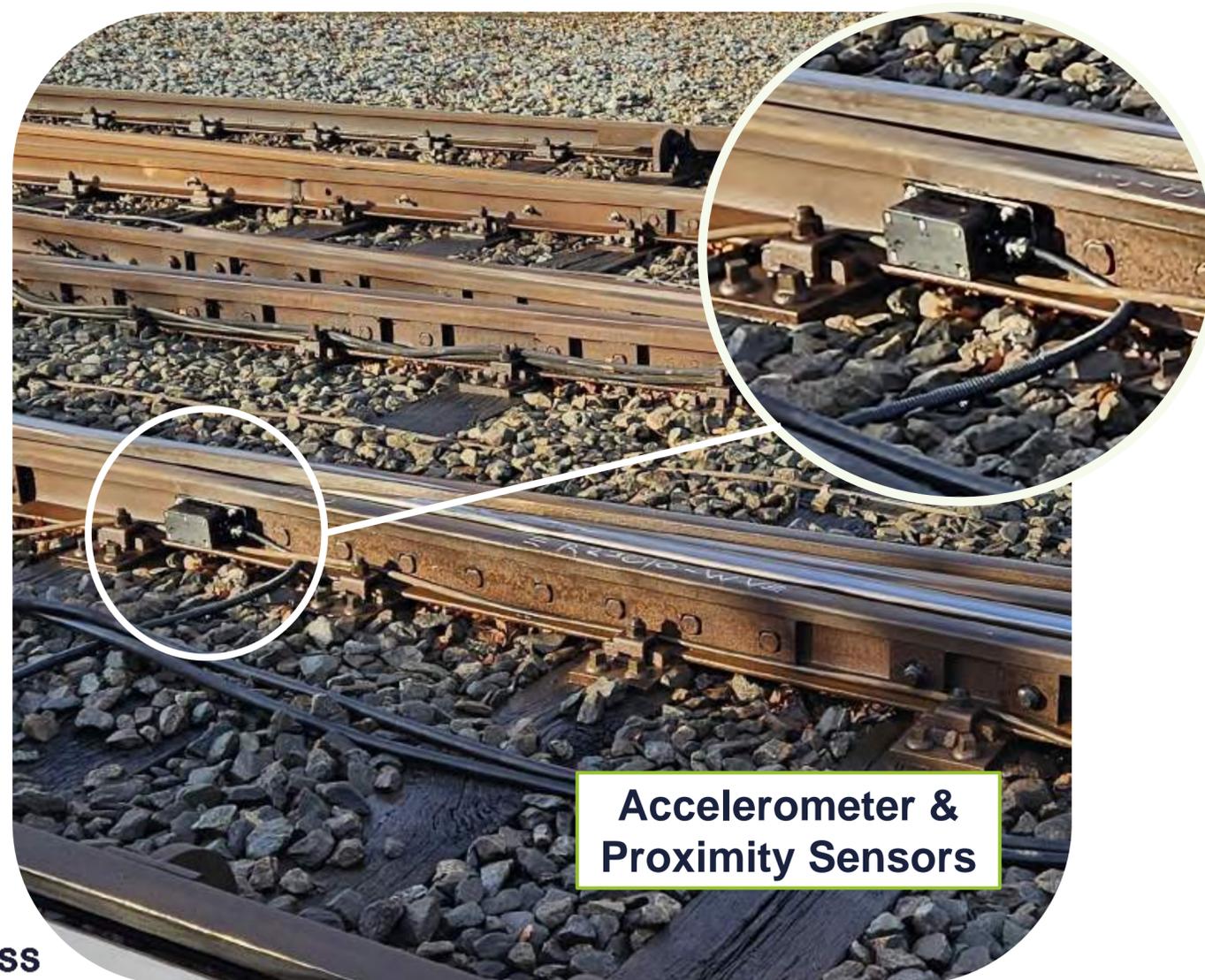


# Key Requirements

## 1. MONITORING & CONDITION ASSESSMENT

### 1.1. Sensors

- Portable accelerometers for impact detection.
- High-precision wheel position + impact measurement.
- Real-time data transfer for targeted inspections.



*Intervention Loop*

## MONITORING & ASSESSMENT

## INSPECTION

- 3D scanning
- DT

## MAINTENANCE

- AR Visualisation
- 3D templates

# Key Requirements

## 1. MONITORING & CONDITION ASSESSMENT

### Demonstrator focus:

- ✓ Test permanent vs portable setups
- ✓ Validate alert → Intervention Loop
- ✓ Check sensor reliability across different line types
- ✓ Adaptability to operational constraints (access limits, traffic patterns, crossing geometry)



*Intervention Loop*

## MONITORING & ASSESSMENT

## INSPECTION

- 3D scanning
- DT

## MAINTENANCE

- AR Visualisation
- 3D templates

# Key Requirements

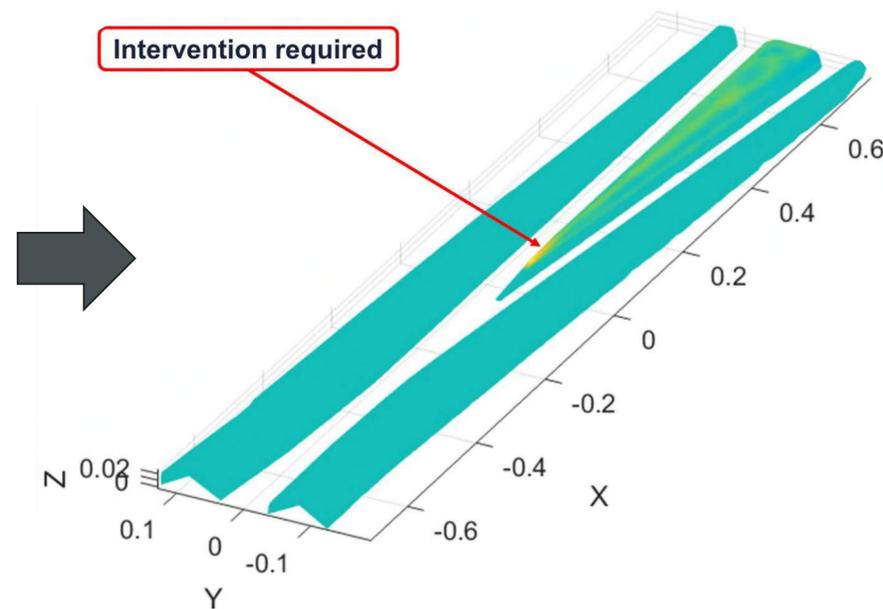
## 2. INSPECTION

### 2.1. 3D Scanning

- Fast handheld scanning to capture crossing geometry.
- Automated, repeatable data collection in field conditions.

### 2.3. Digital Twin Processing

- Integration of scans + sensor data into a single model.
- Deviation maps + scenario generation for maintenance decisions.



*Intervention Loop*

**MONITORING & ASSESSMENT**

**INSPECTION**

- 3D scanning
- DT

**MAINTENANCE**

- AR Visualisation
- 3D templates

# Key Requirements

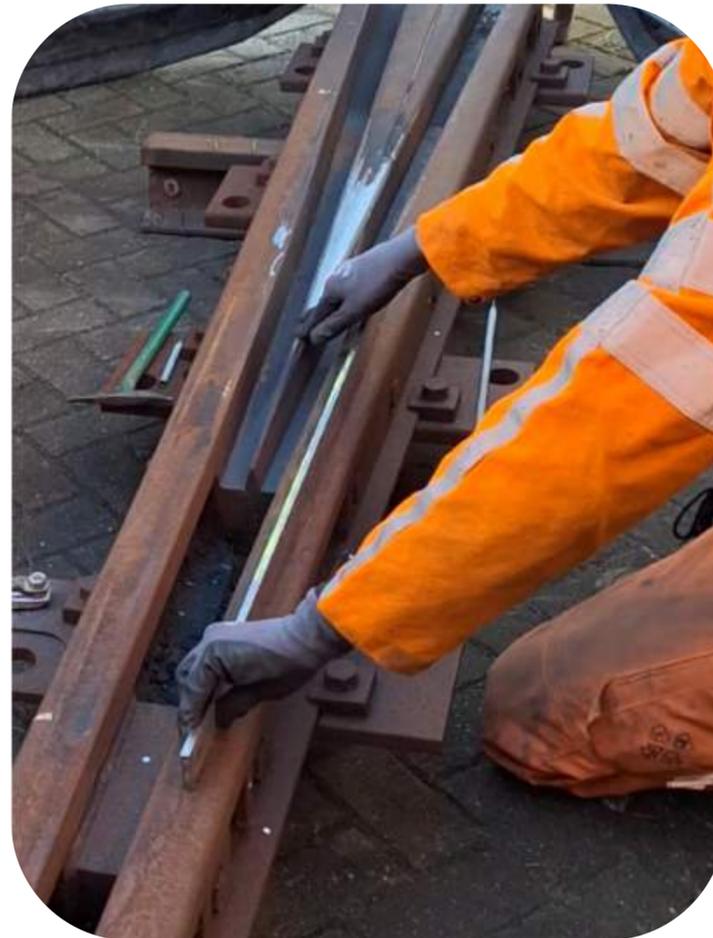
## 2. INSPECTION

### Demonstrator focus:

- ✓ Validate scan repeatability across environments
- ✓ Test DT thresholds for different geometries
- ✓ Evaluate operator usability during fast inspections
- ✓ Compare against traditional manual inspection techniques



VS



**MONITORING & ASSESSMENT**

**INSPECTION**

- 3D scanning
- DT

**MAINTENANCE**

- AR Visualisation
- 3D templates

*Intervention Loop*

# Key Requirements

## 3. MAINTENANCE

### 3.1. AR-Guided Maintenance

- Grind/weld overlays with tolerance prompts.
- Stable alignment using QR codes placed during inspection.

### 3.2. 3D-Printed Aids

- Physical templates for complex geometry checks.
- Durable and adaptable for different crossing types.

### 3.3. Quality Control & Documentation

- QC re-scans post-repair; AR confirmation vs DT.
- Before/after data, reports, and operator feedback logging.



*Intervention Loop*

**MONITORING & ASSESSMENT**

**INSPECTION**

- 3D scanning
- DT

**MAINTENANCE**

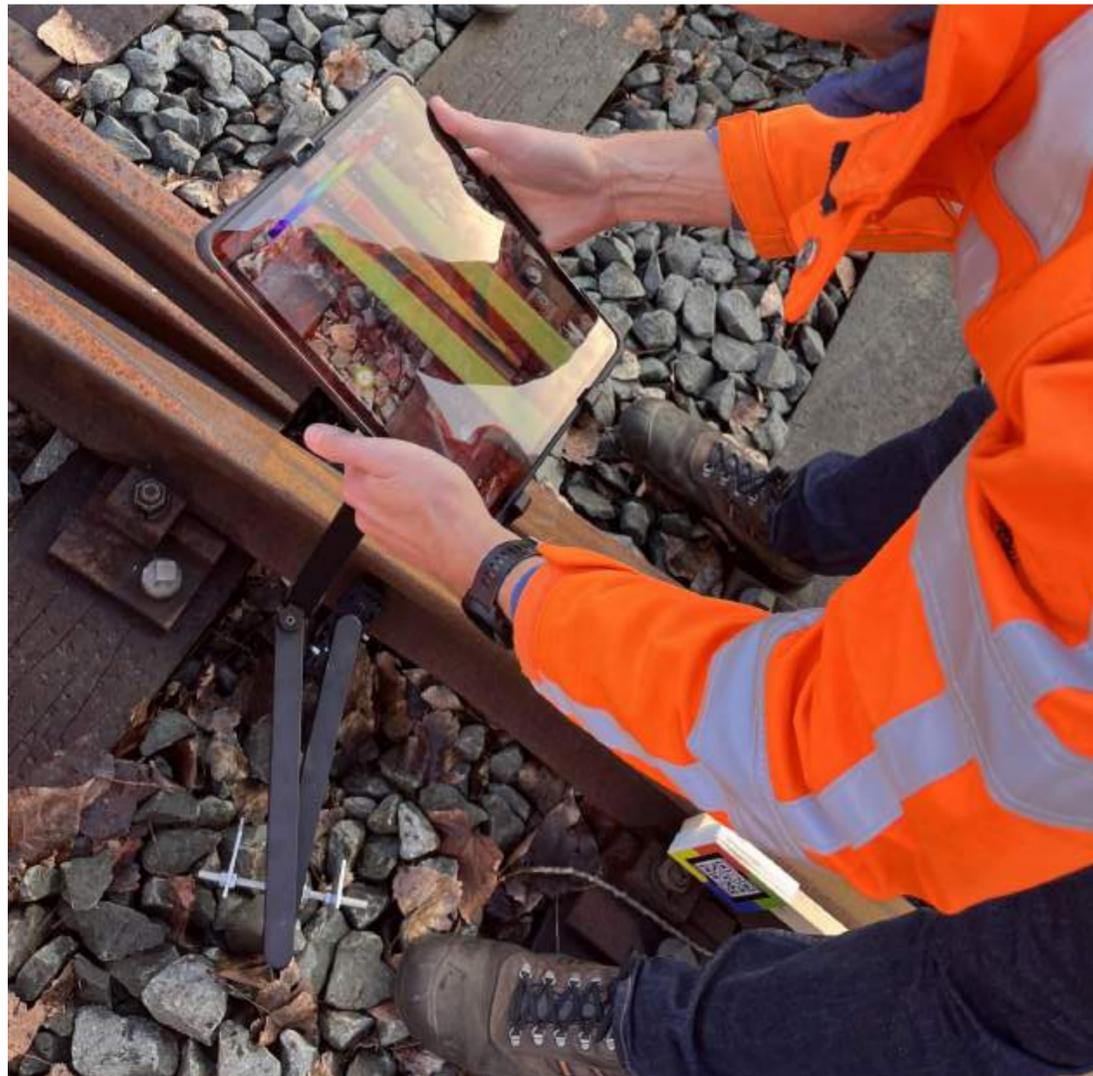
- AR Visualisation
- 3D templates

# Key Requirements

## 3. MAINTENANCE

### Demonstrator focus:

- ✓ Validate AR alignment stability (QR codes staying in place)
- ✓ Compare AR vs template decisions (especially in tram)
- ✓ Measure QC loop time and reduction in rework



*Intervention Loop*

**MONITORING & ASSESSMENT**

**INSPECTION**

- 3D scanning
- DT

**MAINTENANCE**

- AR Visualisation
- 3D templates

# Core Technologies Used in All Demonstrators

- ✓ Sensors-based monitoring
- ✓ 3D scanning for fast geometry capture
- ✓ Digital Twin deviation maps for analysis and decision support
- ✓ AR overlays for grind/weld guidance
- ✓ QR codes for stable AR alignment
- ✓ 3D-printed aids
- ✓ QC re-scan to verify post-repair geometry

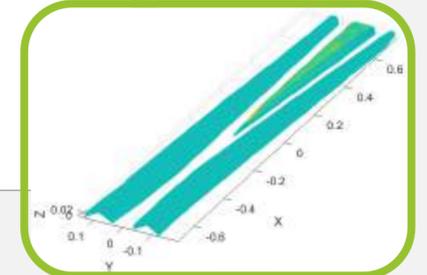
Intervention Loop

## MONITORING & ASSESSMENT



## INSPECTION

- 3D scanning
- DT



## MAINTENANCE

- AR Visualisation
- 3D templates



# Project Scenarios

Aspect



**Intercity**



**Metro**



**Tram**

<b>Environment</b>	<ul style="list-style-type: none"> <li>• High-speed</li> <li>• Mixed freight/passenger</li> </ul>	<ul style="list-style-type: none"> <li>• Medium-speed</li> <li>• High-frequency passenger traffic</li> </ul>	<ul style="list-style-type: none"> <li>• Low-speed</li> <li>• High-frequency passenger</li> <li>• Embedded rails</li> </ul>
<b>Main challenge</b>	<ul style="list-style-type: none"> <li>• Strong impact loads</li> <li>• Long crossing geometry</li> </ul>	<ul style="list-style-type: none"> <li>• Repeated fatigue</li> <li>• Low-light/underground</li> </ul>	<ul style="list-style-type: none"> <li>• Dust, sand, braking debris</li> <li>• Tight geometry</li> </ul>
<b>What it tests</b>	<ul style="list-style-type: none"> <li>• DT accuracy at speed</li> <li>• AR alignment under time pressure</li> </ul>	<ul style="list-style-type: none"> <li>• Fast, repeatable inspections</li> <li>• Simplified AR for preventive grinding</li> </ul>	<ul style="list-style-type: none"> <li>• Scan &amp; QR adhesion on embedded rails</li> <li>• AR visibility outdoors</li> </ul>
<b>Unique constraints</b>	<ul style="list-style-type: none"> <li>• Short possession windows</li> <li>• Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Confined spaces</li> <li>• Visibility</li> <li>• Inspection/maintenance during nighttime</li> </ul>	<ul style="list-style-type: none"> <li>• Urban access</li> <li>• Pedestrians</li> <li>• Pavement interfaces</li> </ul>
<b>Why included</b>	<ul style="list-style-type: none"> <li>• Heavy mainline operations</li> </ul>	<ul style="list-style-type: none"> <li>• Dense metro operations</li> </ul>	<ul style="list-style-type: none"> <li>• Embedded/contaminated track types</li> </ul>
<b>Led by</b>	<ul style="list-style-type: none"> <li>• ProRail</li> </ul>	<ul style="list-style-type: none"> <li>• RET (+ own welding &amp; grinding teams)</li> </ul>	<ul style="list-style-type: none"> <li>• RET (+ own welding &amp; grinding teams)</li> </ul>

# Outcomes & Impact

## 1. Validate technology

- Tests on intercity, metro, and tram lines confirm real-world effectiveness.

## 2. Reduce inspection time

- By triggered/conditional inspections on demand
- Handheld 3D scanning + DT: rapid & high-accuracy inspections (target: >50% reduction compared to manual methods)

## 3. Improve repair quality

- AR and 3D-printed tools improve intervention precision, supporting a shift to preventive maintenance.

## 4. Extended Crossing Lifespan

- Through earlier detection and more consistent interventions (target: x2 crossing life, ↓ renewals, ↓ delays)



# Testing Performed to Date

## The UK

1. **NR Intercity Line (Doncaster – 19 Nov 2024)**
  - Early Scanning & Data Collection.
2. **University of Leeds Turnout Lab (Leeds, >2025)**
  - All Workflow.

## Hungary:

1. **EVOPRO, MAV Line (Budapest – 12 Nov 2025)**
  - Monitoring system tests.

## The Netherlands

1. **RailPro Yard (Hilversum – 25 Nov 2024,**
  - 3D scanning of new and worn crossings.
2. **DekraRail Yard (Utrecht – 25 Nov 2024)**
  - Scanning of damaged crossings.
3. **RailCenter outdoor lab (Amersfoort – 27 Nov 2024)**
  - Scanning, measuring, and expert insights.
4. **RET facility (Rotterdam – 28 Nov 2024, 25 Nov 2025)**
  - Scans across inspection, welding, and grinding stages.
  - Scanning, AR app and QR codes.
  - 3D prints temperature test.
  - Expert interview and feedback.
5. **RET Intercity Line (Rotterdam – 28 Nov 2024)**
  - Scanning crossings at 2 different locations.
6. **RET Metro Line (Slinge station, Rotterdam – 28 Nov 2024)**
  - Scanning of multiple crossings at Slinge metro station.
7. **RET Intercity Line (Avelingen – 23 Nov 2025)**
  - Prototype monitoring system.



RailPro Yard



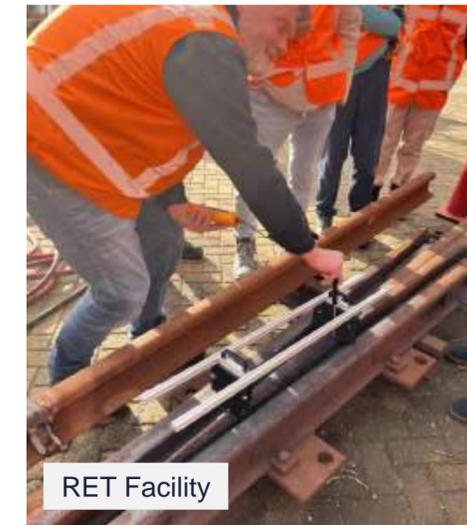
DekraRail



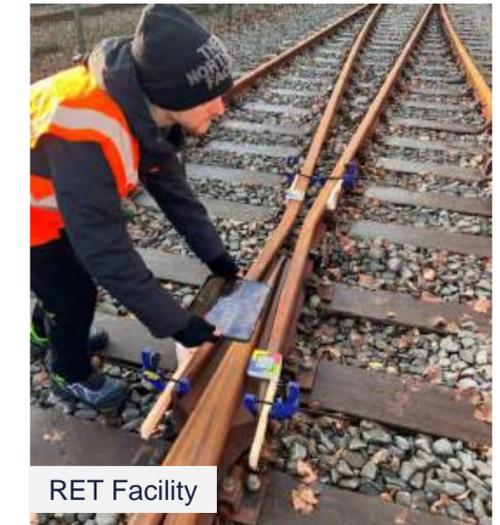
RailPro Test



RailCenter



RET Facility



RET Facility



MAV Line



Doncaster Intercity



Rotterdam Intercity



Avelingen Intercity



Rotterdam Metro

# Future Testing

## Planned Demonstrations (2026)

### 1. Intercity Line

- Full workflow
- Pre- and post-grinding scans
- Sensor-to-geometry correlation
- Target window: Q3-Q4 2026

### 2. Metro Line

- High-frequency inspection repeatability
- Preventive grinding scenarios
- Operator usability evaluation
- Target window: Q3-Q4 2026

### 3. Tram Line

- QR durability on embedded rails
- AR visibility in bright outdoor environment
- Template vs AR decision comparison
- Target window: Q3-Q4 2026

### 4. Cross-site evaluation

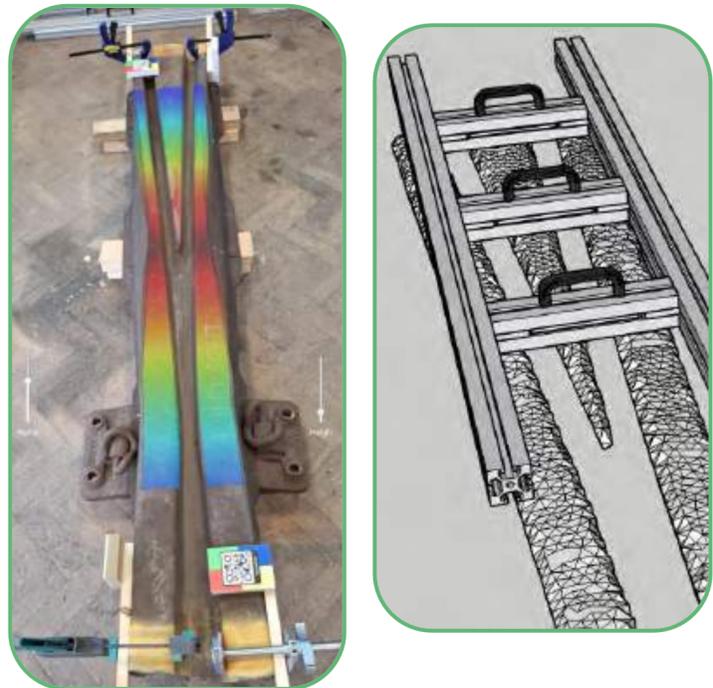
- KPI measurement: scan repeatability, AR alignment error, QC time, etc.
- Comparison of performance across intercity, metro, and tram environments
- Consolidated performance report for TRL review.
- Operator and stakeholder feedback analysis



# TRL Progression

## TRL 3: Experimental proof of concept

- Early scanning tests (UK, NL, HG)
- Leeds turnout lab
- Early prototypes:
  - ✓ AR overlay
  - ✓ 3D printing frame concept and slices
  - ✓ DT algorithms
  - ✓ Monitoring sensor setup, proximity sensor development



## TRL 4: Validation in laboratory environment

- Lab Tests (controlled env.): Scanning + alignment DT deviation mapping validated against measured geometry
- AR second prototype
- 3D prints and frame
- Sensor box prototype



## TRL 5: Validation in relevant environment

- NL Tests: RET, RailPro Yard
- QR validation
- Early AR grind/weld overlay tests
- NL (RET) Tests: validation of monitoring system



## TRL 5-6: >2026 Demonstrations

- Full workflow: Scan → DT → AR → QC
- Multi-site real operations
- Usability & operator acceptance
- KPI and performance evaluation



# Questions





**Thank you**  
**for your attention**

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