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ISTITUTO NAZIONALE
DI RICERCA METROLOGICA

HASLERRail
Sécheron Hasler GROUP
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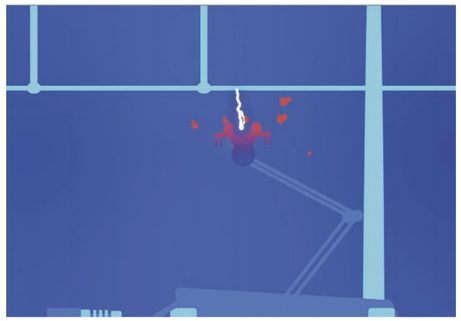
Overview

- ❑ Pantograph-Catenary Contact Issues
- ❑ Conventional monitoring system
- ❑ The innovative technique proposed
- ❑ The T.R.A.E. patent
- ❑ The energy meter as a detector of pantograph detachments – The Hasler Project - INRIM
- ❑ The TRENORD Trial
- ❑ Standardization Actions
- ❑ Future developments and conclusions

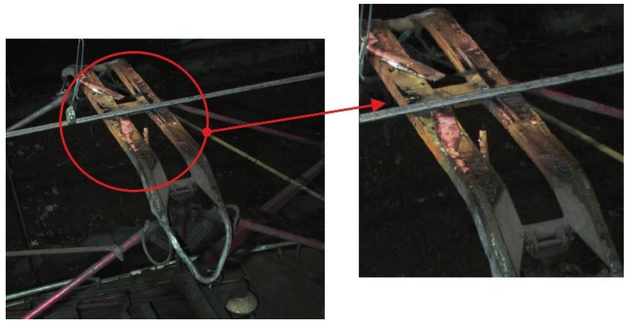
Pantograph-Catenary Contact Issues

In Italy, there are 11,000 km of railways powered by direct current, on which more than 7,000 trains run every day with possible service disruptions.

Their power supply relies on the sliding contact between the pantograph and the catenary.



A detachment can trigger an electric arc, which, due to the high temperature, generates significant damage to the surface of the pantograph and the catenary, as well as the collector strip.

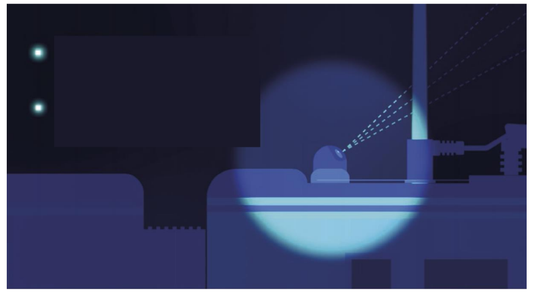


A faulty pantograph-catenary contact produces electric arcs that damage the contact systems, causing service disruptions.

Conventional monitoring systems

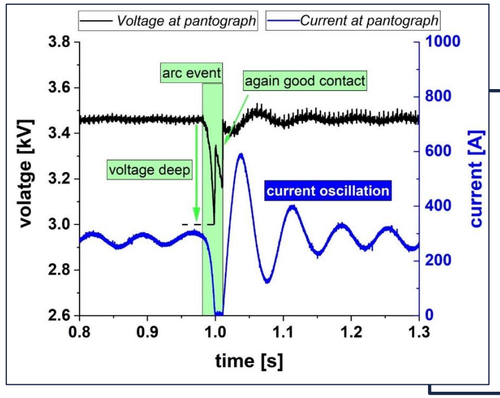
The current technology for monitoring the health status of the pantograph is based on cameras installed on board the train or in diagnostic portals.

- Camera
- Laser scanner
- Phototube
- Electromagnetic field

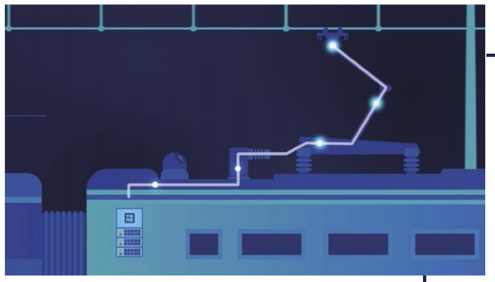


High installation and management costs plus large amounts of data to be processed hinder widespread adoption.

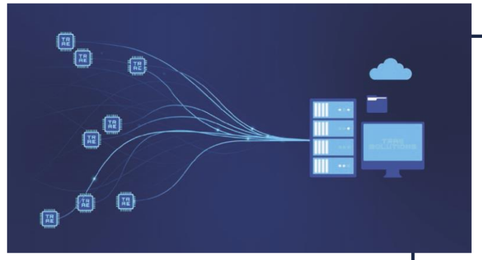
T.R.A.E. Patent – Tecnologia Rilevamento Arco Elettrico



The TRAE patent is based on real-time monitoring of voltage and current detected at the pantograph.



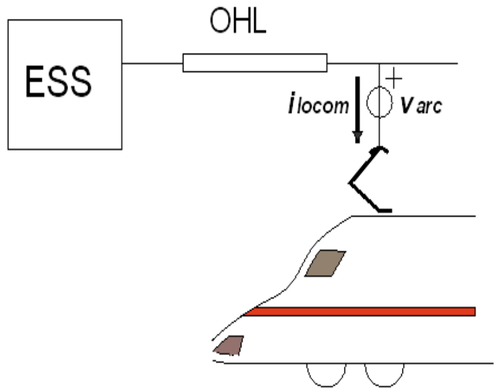
Easy integration into already installed energy meters –
Low installation costs facilitate widespread adoption.



The collection of arc events in the railway network through the existing energy billing infrastructure

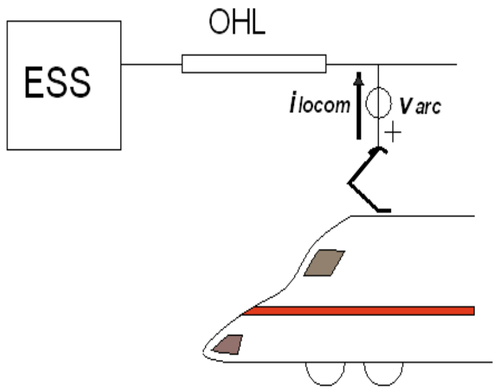
From the Theory…

The electric arc can be represented simply by a voltage generator that imposes an arbitrary voltage between the catenary and the pantograph.



Trazione

- Arc flash causes a voltage dip

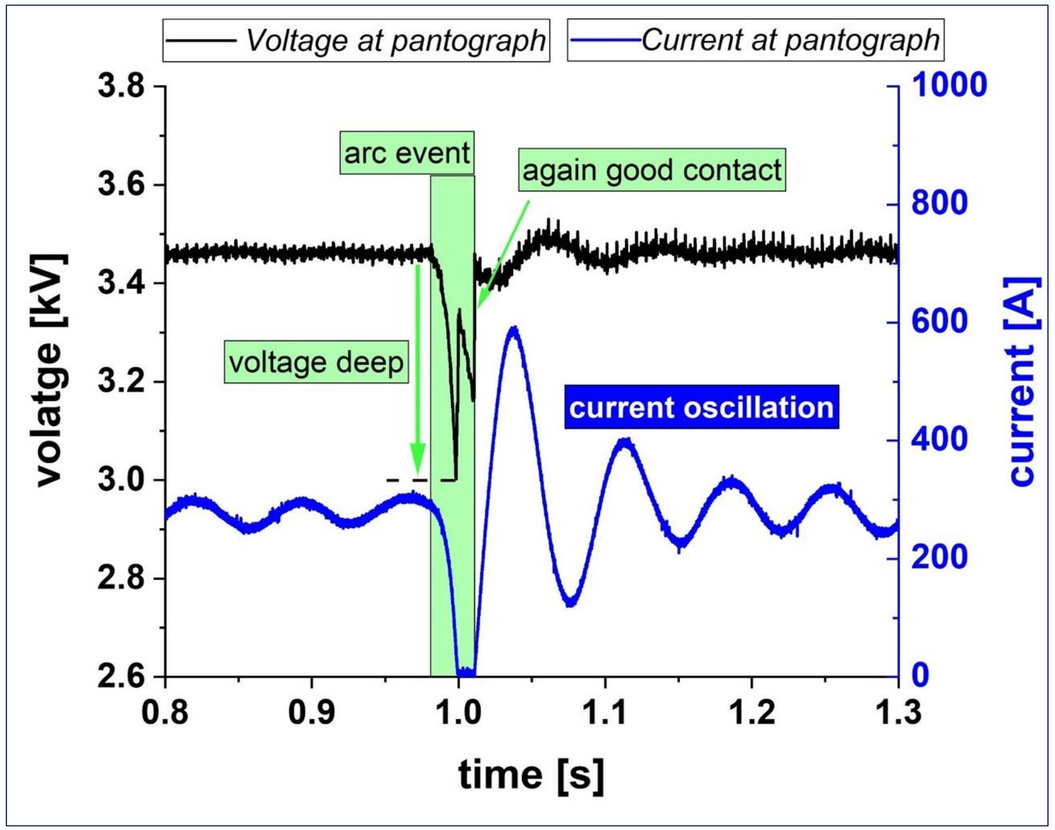


Frenatura

- Arc flash causes an overvoltage

TIP: the arc always absorbs energy

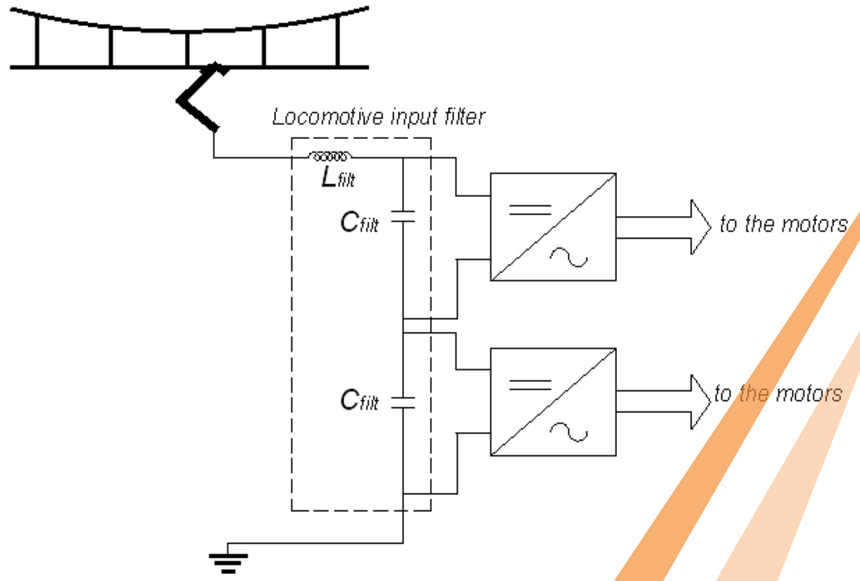
From the Theory…



Arc duration	About 20 ms
Current oscillation	400 A peak-to-peak
Voltage drop	450 V

During the traction stage

- Arc flash causes a voltage dip
- The current, due to the filter inductance, is reduced
- When the current reaches the zero value, causes the arc to shut off
- Pantograph re-contact triggers current oscillation



The HASLER – INRIM- TRENORD project

A pilot project started in middle 2024 with the following targets:

1. **To enhance** the understanding and management of pantograph arcing phenomena on DC overhead lines,
2. **To demonstrate** the feasibility of having an Arch Detection System permanently installed onboard of trains,
3. **To collect** a large number of recorded waveforms associated to arches in order to enable future developments involving AI technology for advanced maintenance tasks,
4. **To identify** arch event typologies and relate them with external system events or subsystem degradation useful for preventive maintenance (most of the time arc events are “physiological”)

TRENORD	Provinding loco E464 for long term tests
INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA	Providing Patent, technical experties, new algorithms for event cataloguing
HASLERRail	Providing advanced solutions integrating detection algorithm on standard EMS railway equipments

The HASLER – INRIM- TRENORD project

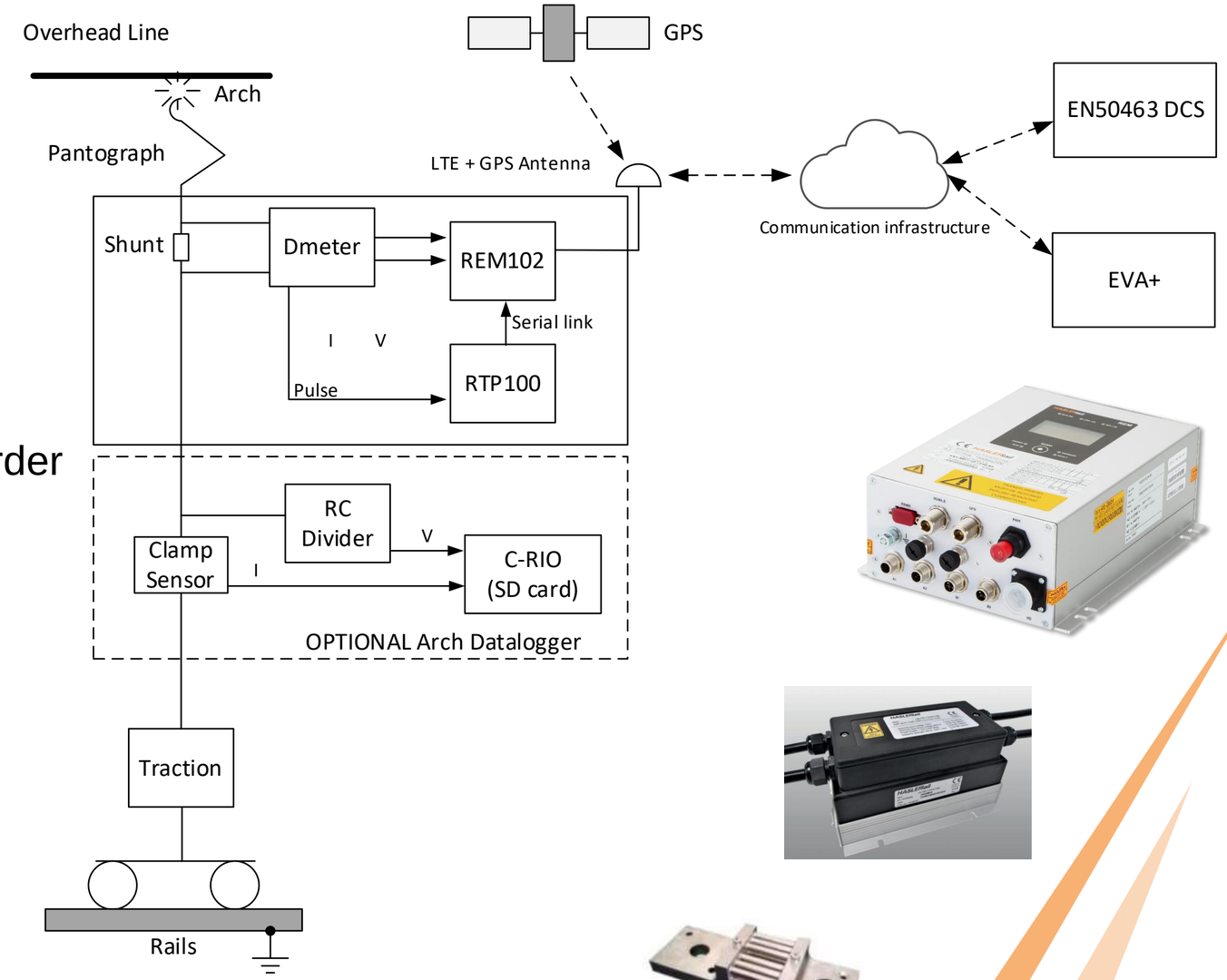
Main Project Phases:

- Phase 1: Conception (done)
- Phase 2: Design and Manufacturing of Equipment (done)
- Phase 3: Installation Onboard (done)
- Phase 4: Observation Period (on going)
- Phase 5: Post-Processing and Diagnostic Analysis (started)
- Phase 4: Project Closure – Re-commissioning (planned)

A system view:

On-board equipments:
- GPS/4G antenna
- DMeter sensor with shunt
- REM102 Energy Meter
- RTP100 oscilloperturbographics recorder

Landside systems
- DCS Data collecting System
- EVA+ arc data monitoring platform



All the elements are railway standard products designed by Haslerrail

What can be done with data:

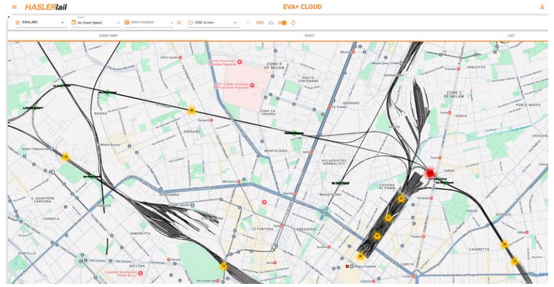
The following developments can be envisaged:

Post-Processing and Diagnostic Analysis

- Event Correlation (e.g., location, train speed, vibrations, track conditions, weather conditions)
- Pattern Recognition (I,V pattern associate to events typologies)
- Root Cause Analysis of arch events

System Performance Evaluation

- Impact Assessment on the electrical system's performance, including power quality and component wear.
- Effectiveness of Mitigations (e.g., maintenance practices, component design)



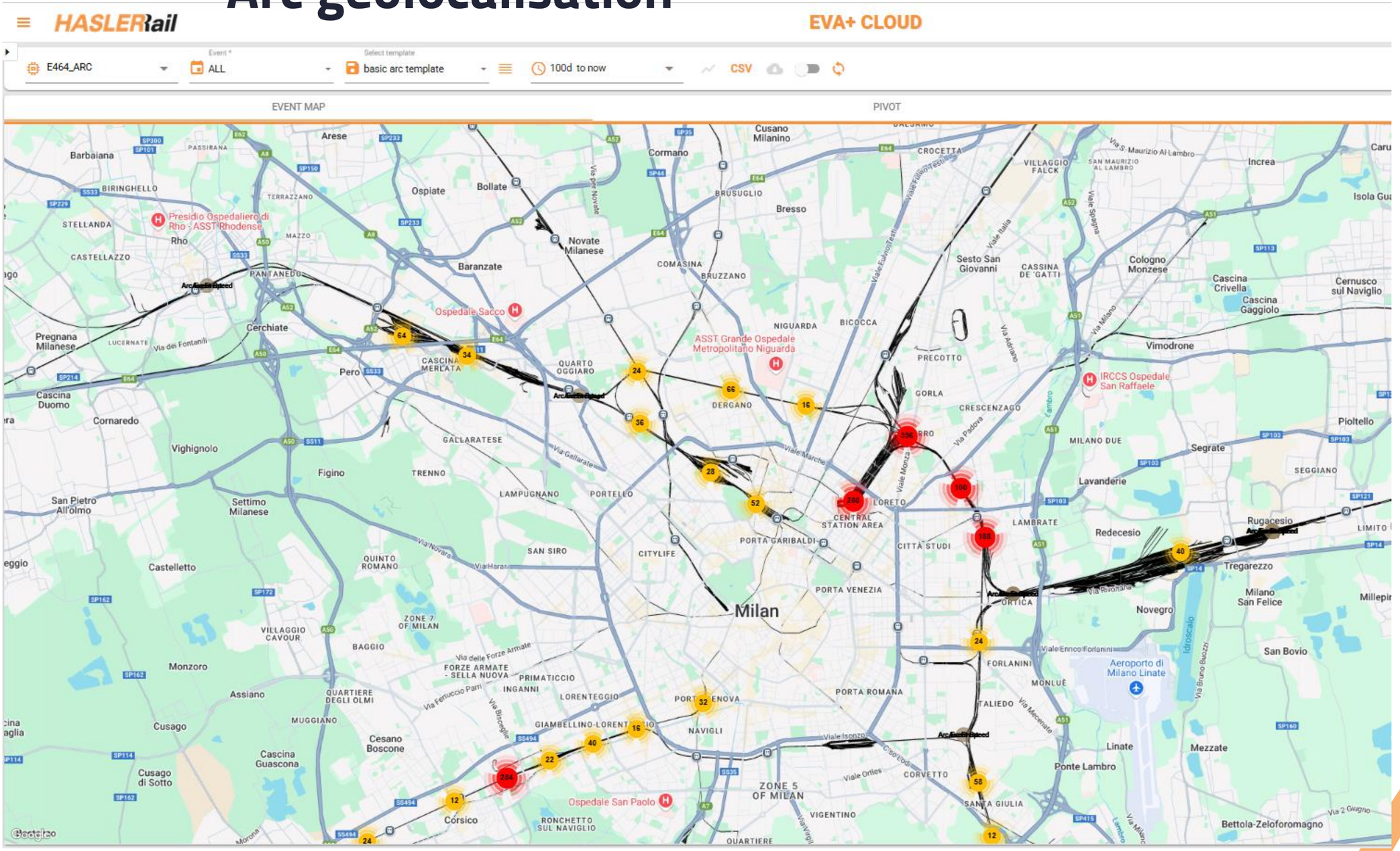
Predictive Maintenance and Optimization

- Predictive Algorithms to prevent arcing incidents.
- Optimize operational parameters (e.g., train speed, pantograph pressure)

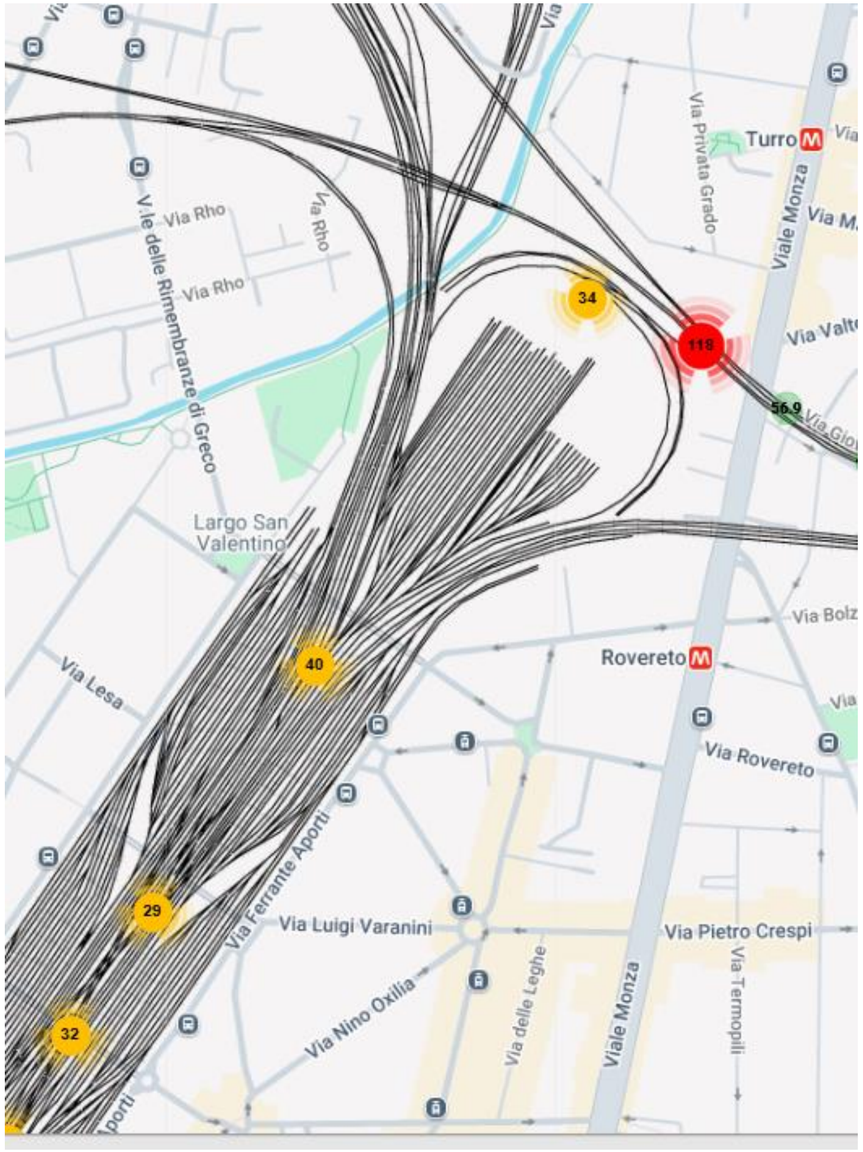
Enhanced Safety and Reliability

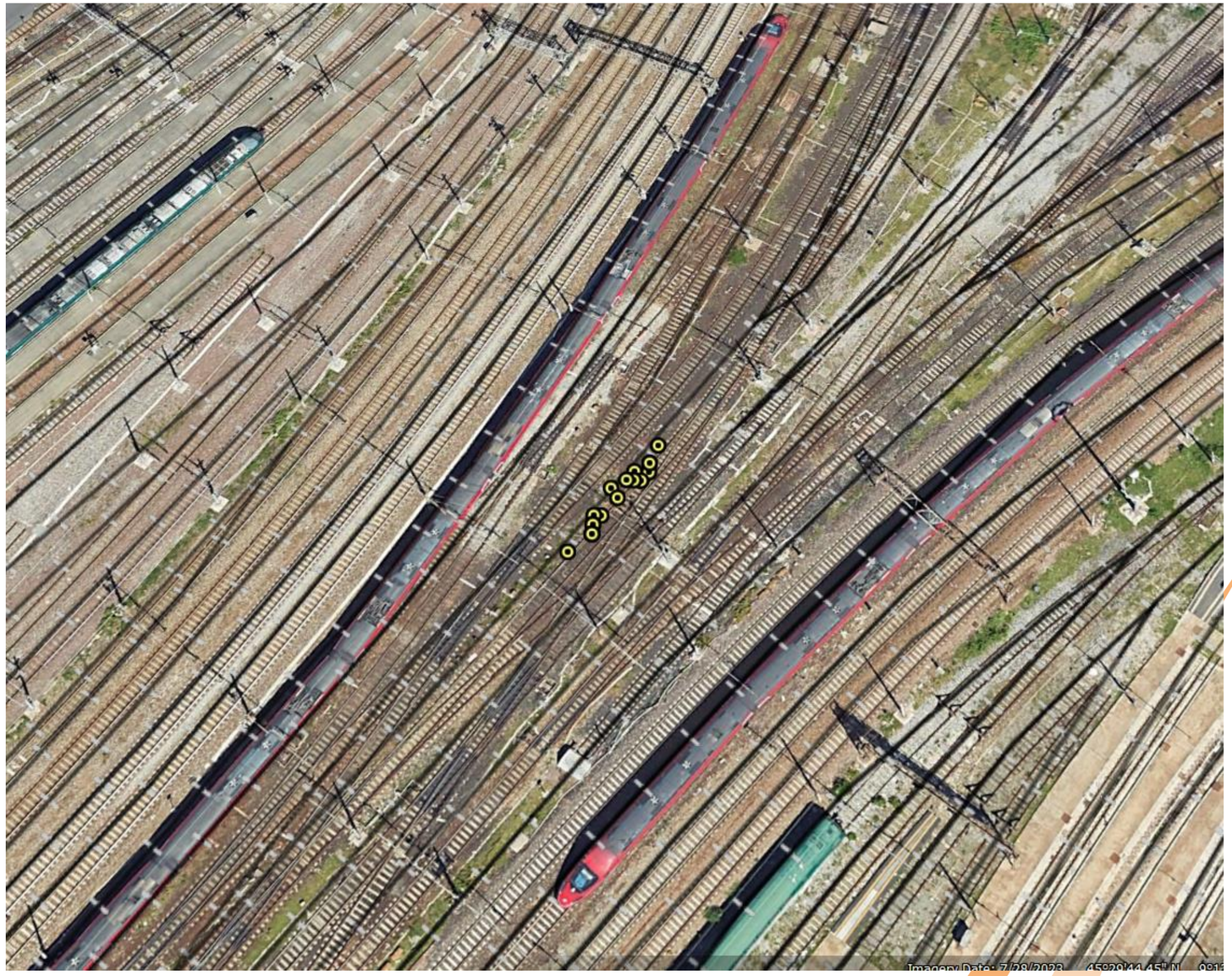
- Improve the safety of railway operations by mitigating the risks such as fire hazards and electrical faults.
- Enhance the overall reliability of the railway network by reducing service interruptions and equipment failures caused by arcing.

Arc geolocalisation



Arc geolocalisation – arc density map

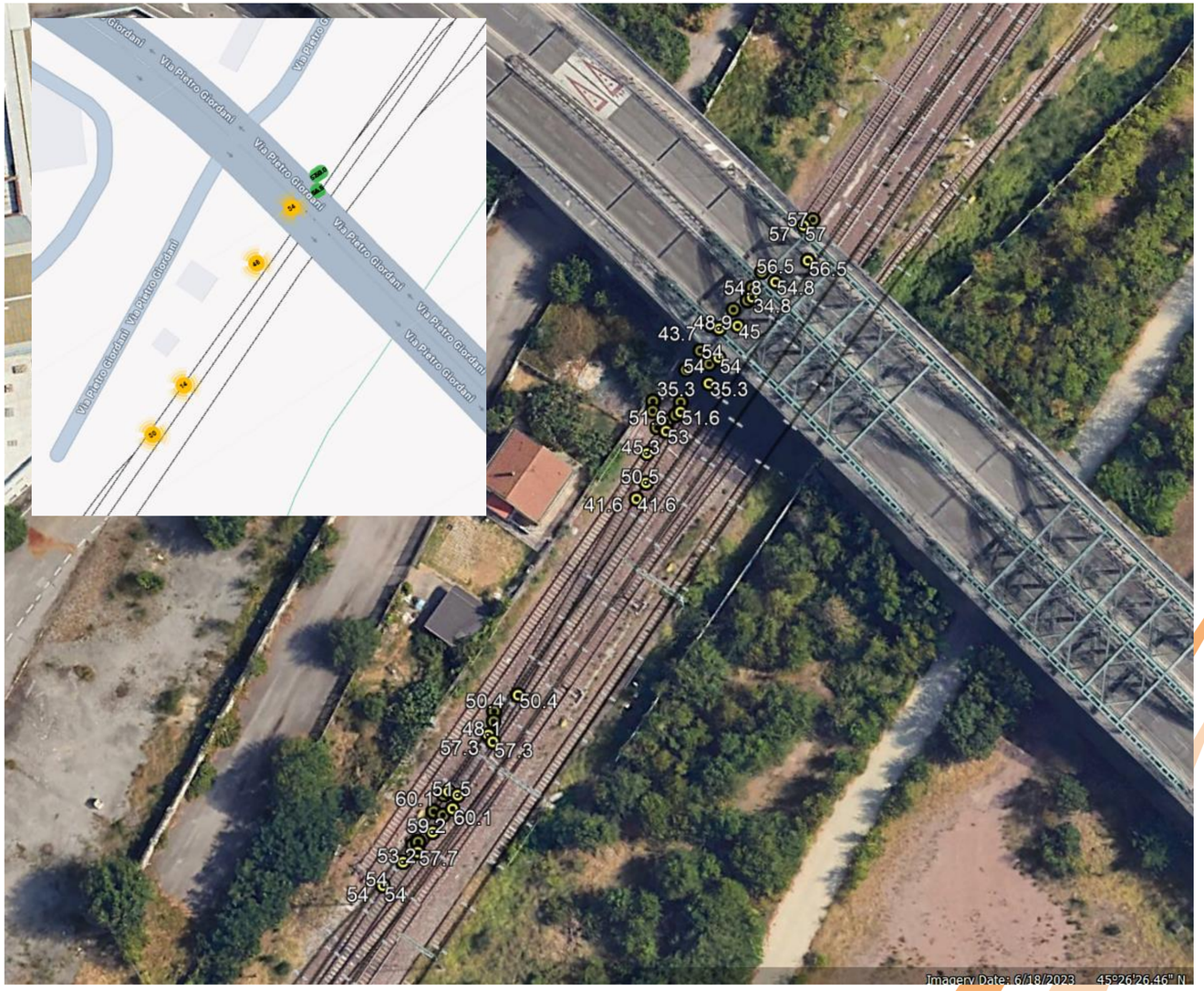




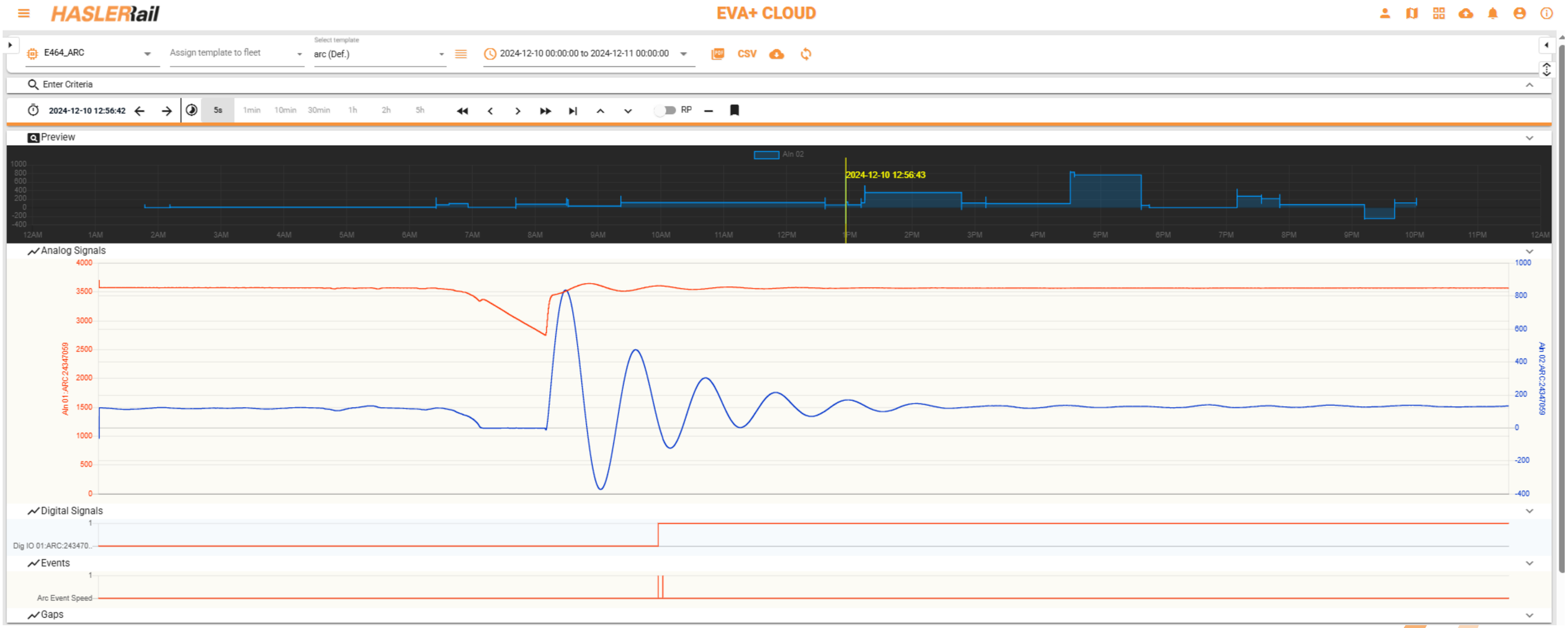
Arc geolocalisation

Normal panto up at stations

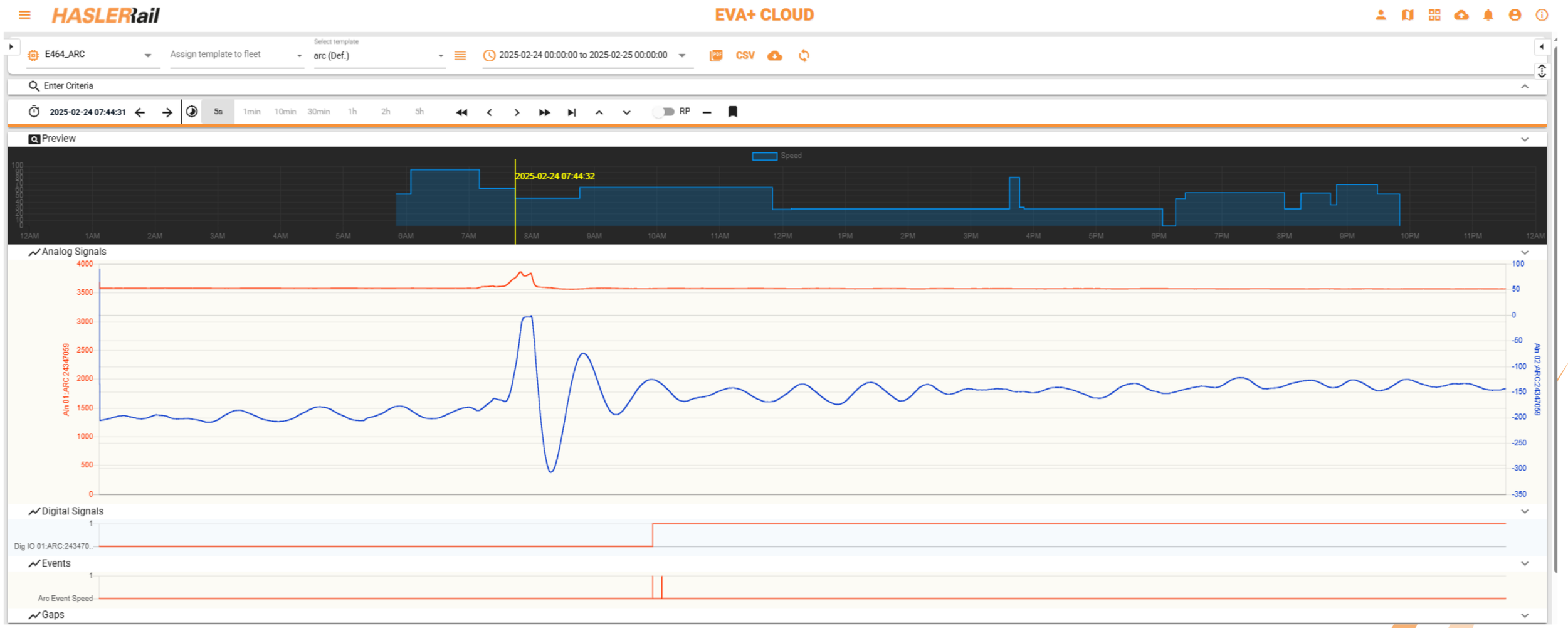
Travelling at 40-70 Kmh



Oscolloperturbography @ 150Arms



Oscolloperturbography @ -150Arms (regeneration)



Standardization action

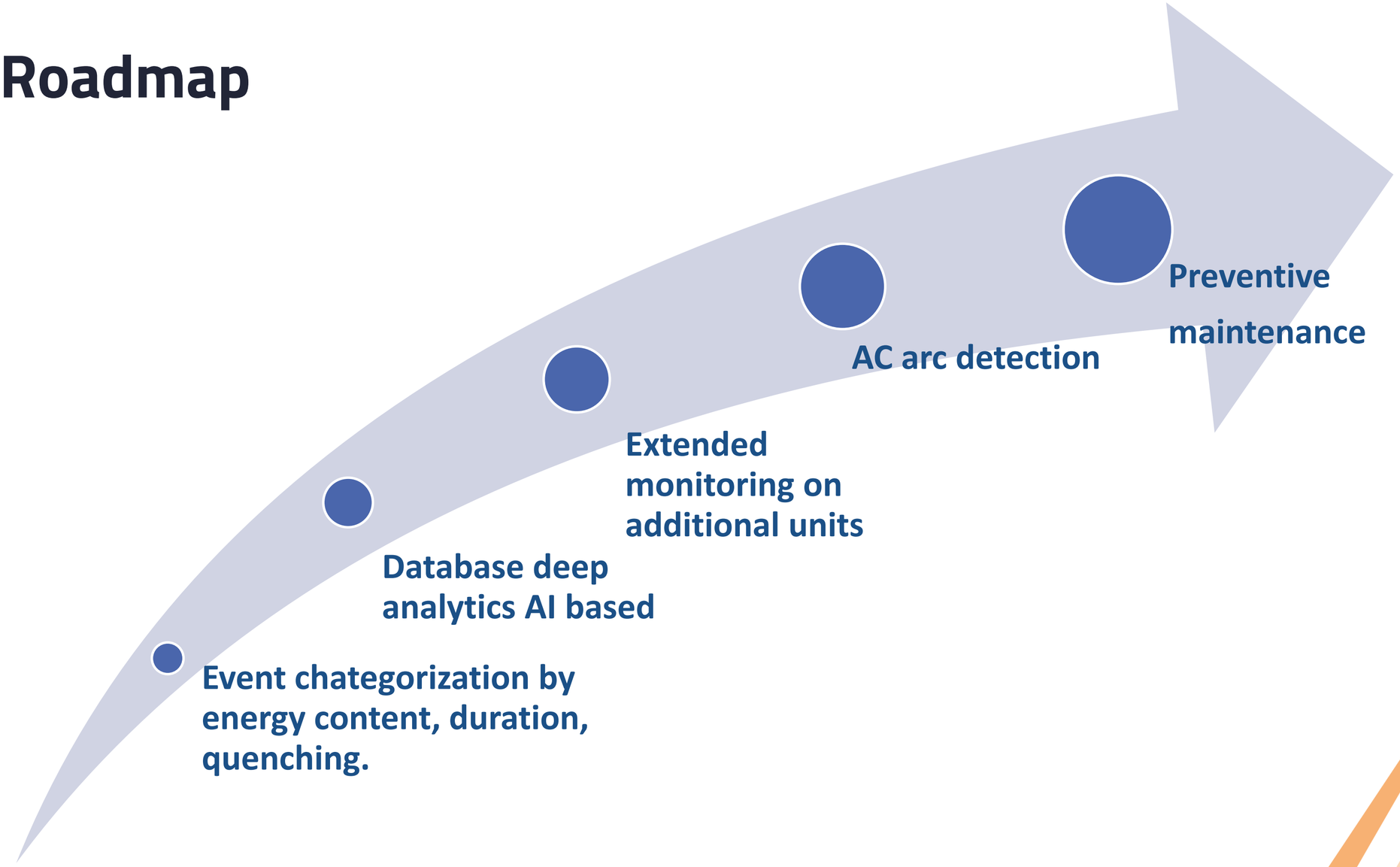
The energy meter is enhanced with new functionalities that need to be regulated. The Italian committee is actively working on this topic.

IEC	IEC 62888
CENELEC	EN 50463

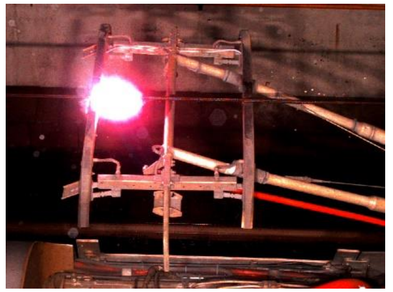
Level 2

…measuring energy for energy management, energy saving, benchmarking by suppliers or train operators, V/I harmonics analysis on the Catenary, Prognostic on the catenary status…

Roadmap


Event chategorization by energy content, duration, quenching.
Database deep analytics AI based
Extended monitoring on additional units
AC arc detection
Preventive maintenance

Conclusion



KEY TAKEAWAYS about ARC DETECTION PROJECT:

- it is possible to implement on permanent and standard EMS the ARC detection functionality
- Increasing the analysis on the amount of data provided to the cloud system is possible to identify potential issue related to OHL and/or Panto
- With support of advanced AI algorithms and additional derived parameters it will be possible to provide information useful to correlate arc events with OHL and/or PANTO issues
- Railways stakeholders are welcome to start additional test on the field !!!

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Thank you for your attention!