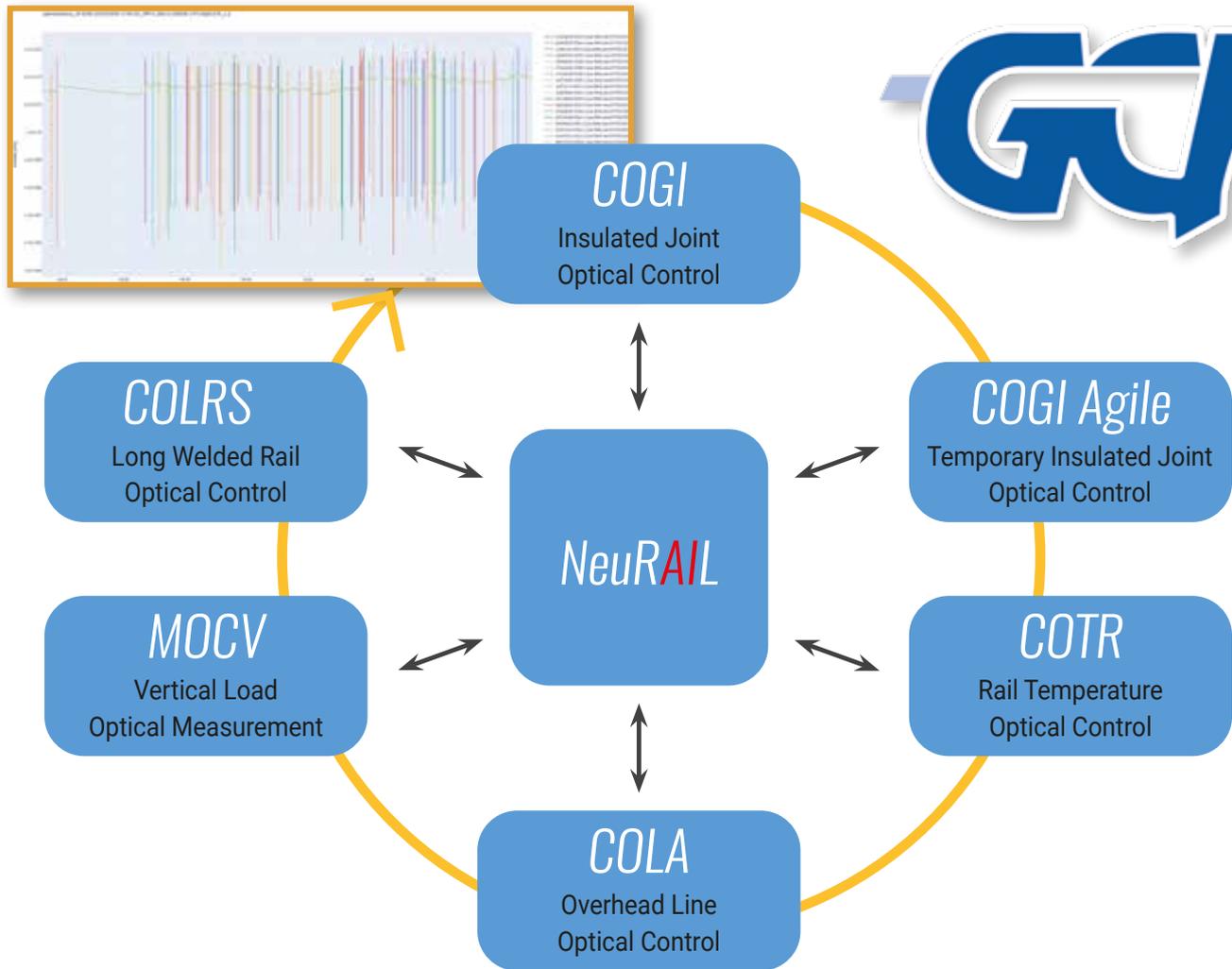


# NeuRAIL System

MODULAR SYSTEM FOR PREDICTIVE DIAGNOSTIC ANALYSIS



Rome, September 2021

*The framework and diagnostic apps*

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MODULAR SYSTEM FOR PREDICTIVE DIAGNOSTIC ANALYSIS

*Description of the Framework and diagnostic app*

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# 1. NeuRAIL

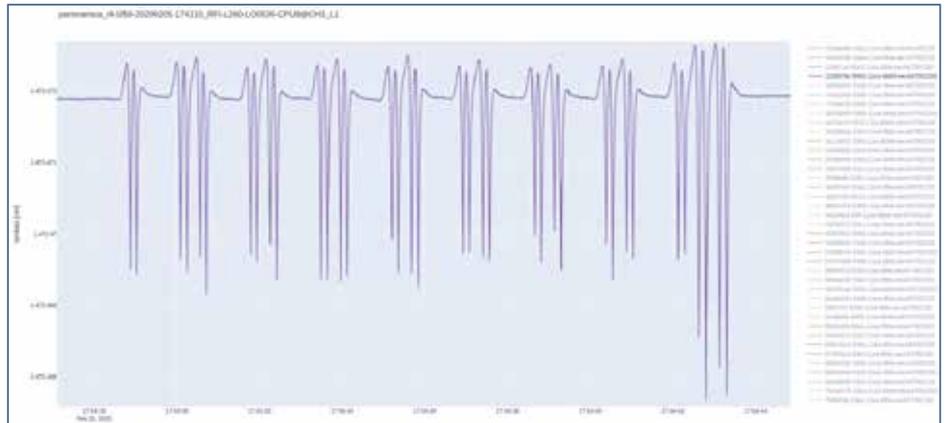
## Framework for railway predictive diagnostic

NeuRAIL is GCF's framework conceived to respond to current remote and continuous control needs of railway assets.

Conceived in 2018, it was created according to the most modern IT and remote control techniques.

NeuRAIL is thus the "operating system" above which it is possible to install specific applications based on diagnostic modules made with "custom" sensors.

A single installation of NeuRAIL allows hosting one or more applications that can be implemented also at different times, quickly responding to the client's needs.



## ➤ Characteristics and competitive advantages

- ➔ **FLEXIBLE** it can be installed in cloud or on dedicated systems
- ➔ **INTRINSICALLY REDOUNDED** system, natively distributed and based on microservices
- ➔ **HORIZONTALLY SCALABLE** natively based on BigData techniques, naturally integrated with Machine Learning and Deep Learning analyses
- ➔ **SAFE** the natively coded data transmission with TLS v1.3 technologies guarantees the maximum standards in terms of integrity and confidentiality
- ➔ **CONFIGURABLE** since it is a framework, it does not feature specific user or machine interfaces, but offers tools to customise them
- ➔ **LONG-LASTING and EXTENDABLE** thanks to the constant development of new applications

## CURRENT DEVELOPMENTS



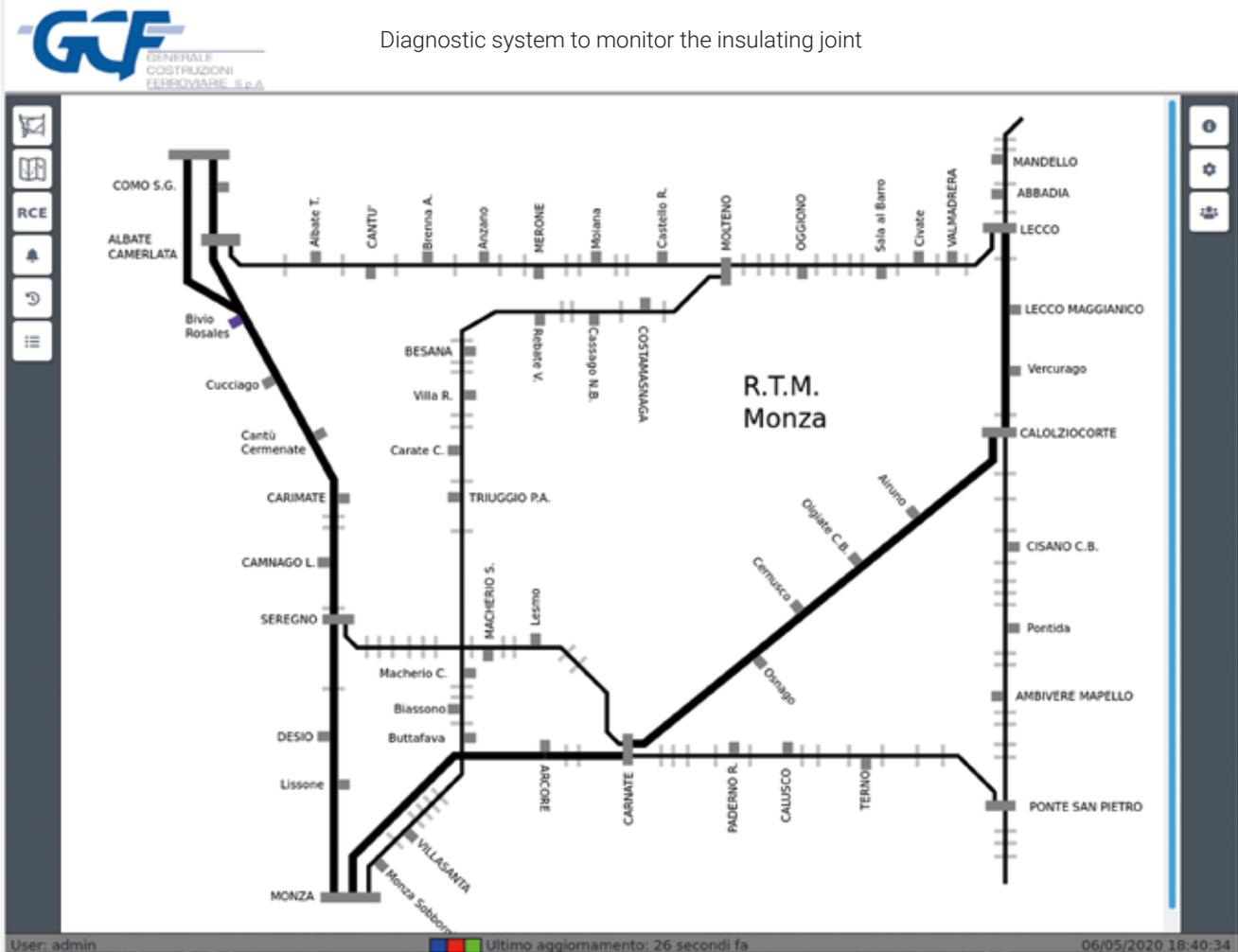
- Mobile Interface for maintenance operators with geo-localization function (GPS Glonass Galileo) and RFID functions
- Alarms management system integrated with RFI maintenance processes
- SAP integration



## TESTS AND RESULTS

“Tailor made” interface conceived in collaboration with RFI CUM (Maintenance Unit Chief), Monza Diagnostic system to monitor the insulating joint

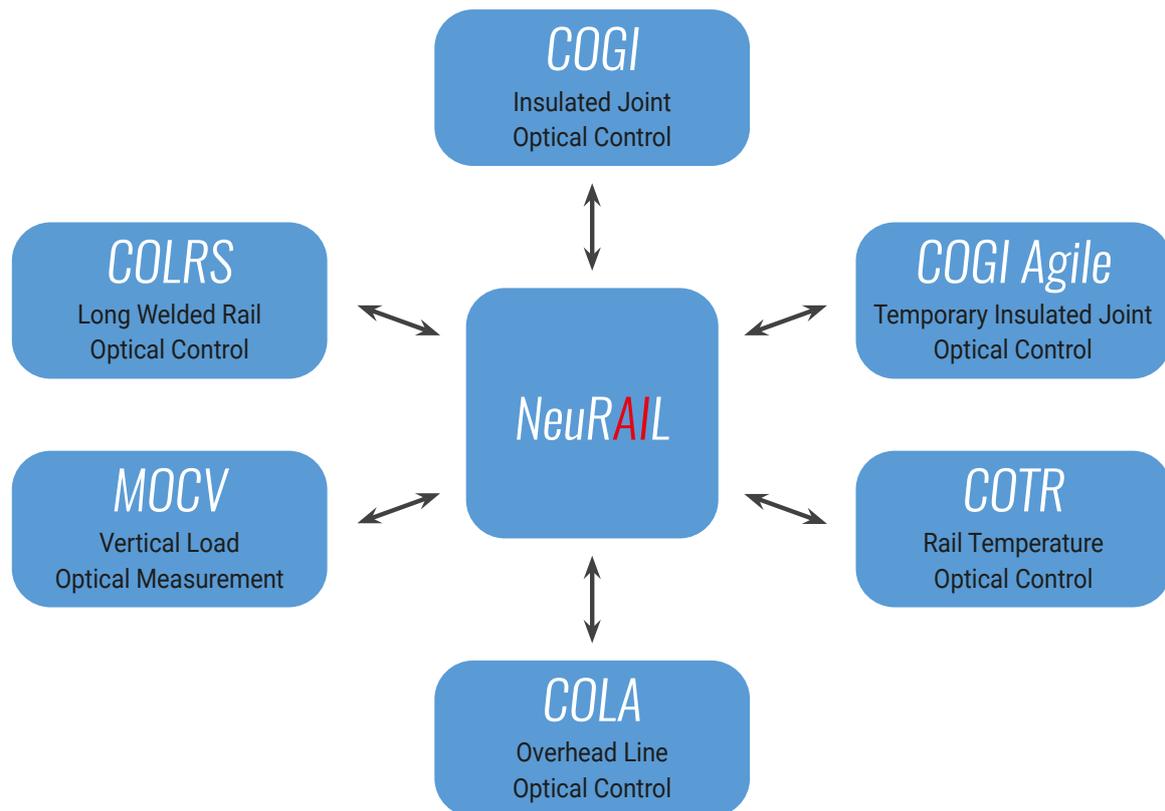
Diagnostic system to monitor the insulating joint



## 2. NeuRAIL, a modular system

The diagnostic modules and relative applications can be added, removed, extended or streamlined according to maintenance requirements, without the need to modify the infrastructure.

The system re-configuration allows excluding the sensor with any anomaly, thus avoiding intervening on-site.



### SYSTEM'S HARDWARE STRUCTURE

- Acquisition nodes connected to the sensors through in optical backbone
- Sensors connected to the backbone through plug and play connection systems
- Acquisition nodes connected to the processing node through communication systems 3G/4G/5G or optical fibre

### THE SENSORS OF NEURAIL'S DIAGNOSTIC MODULES ARE:

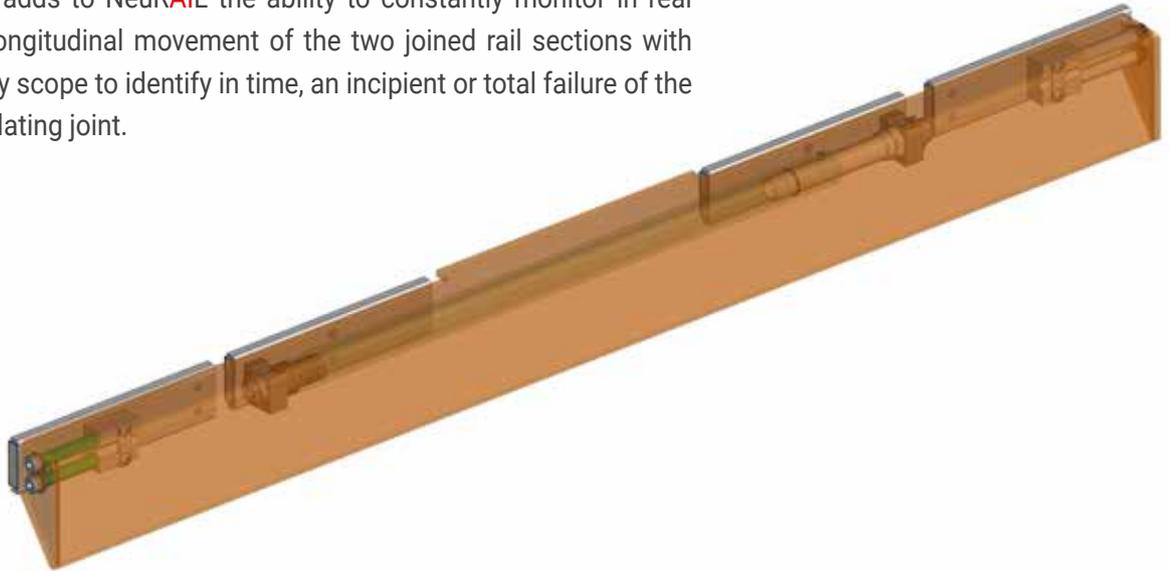
- Passive, in optical fibre and without power supply
- Inert to signalling interferences and traction current
- Magnetic and/or integrated, easily removable
- "Invisible" during the maintenance works of the Rail track and Overhead Contact Line
- Reliable: measurement accuracy is retained over time
- Immune: they can be used in any environmental context, also unfavourable (mud in the tunnel, ice, dust, ...)

A1

## COGI (Controllo Ottico Giunto Isolante)

### Insulated Joint Optical Control

COGI app adds to NeuRAIL the ability to constantly monitor in real time the longitudinal movement of the two joined rail sections with the primary scope to identify in time, an incipient or total failure of the glued insulating joint.



The constant high-frequency measurement allows performing predictive analyses based on:

- The count of the number of axles in transit during the life cycle of the joint
- Data inferred from constant environmental monitoring
- The statistic parameters required to implement the available models



## Characteristics and competitive advantages

- QUICK INSTALLATION thanks to the anchoring with high-retention magnets, a single operator can install the sensors in just a few minutes also on joints in service
- REMOVABLE through a simple mechanical tool
- PREDICTIVE through constant measuring, it is possible to isolate behavioural anomalies concerning the normal operating status
- DYNAMIC it is possible to record the measurement range according to the needs



## VALIDATIONS AND RESULTS

2019. Validation of the measurement through tests performed at an EN 17025 accredited laboratory.

2020. The accuracy of the measurements and estimates was verified on-site at Bivio Rosales, where a damaged joint was found and reported. The anomaly found was documented in report "Evaluation of the damage of a glued insulating joint through remote monitoring system".

2021. After a validation period of three months on-site, the Evaluation Report of the On-site Validation tests released by an accredited Certification Body was obtained.

**COGI COMPLIES** with the functional and acceptance criteria set forth by Functional Specification RFI «RFI TCAR SF AR 12 004 A».



## A2 MOCV (Misura Ottica Carichi Verticali)

### Vertical Load Optical Measurement

**MOCV** app, developed in collaboration with Politecnico di Milano, adds to NeuRAIL the ability to measure the vertical load of every wheel during the transit of a train proceeding at controlled speed.

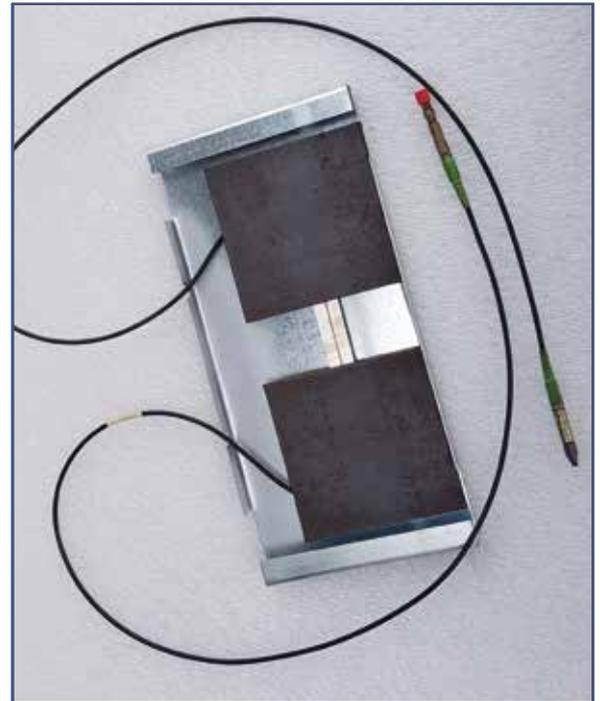
**MOCV** consists of 12 (or more) sensors installed on a section of flat and rectilinear track for a length of 15-20 metres of rail.

The measures provided by the app comply with UNI EN 15654-1 standard:

- Vertical load (force) for wheel
- Axle load
- Sum of the axle loads for bogie
- Weight of the carriage
- Weight of the entire train

It is also possible to detect measures concerning the carriage's axial and longitudinal unbalance.

**MOCV** system is designed in compliance with UNI EN 15654-1 standard and can be certified on-site in accordance to UNI EN 15654-3 standard.



## ► Characteristics and competitive advantages

- **EASY TO INSTALL** thanks to the anchoring with high-retention magnets, it is possible to install the sensors without replacing the track or performing invasive operations on the existing track
- **REMOVABLE** through simple mechanical tool, without leaving "traces" on the track
- **AVAILABLE FOR LONG DISTANCES** from the acquisition point
- **REDOUNDED** the system is able to work also after a single or double failure on the sensors' network



## CURRENT DEVELOPMENTS

Studies at various level of completion are underway, on the following topics:

→ Reduction of the measurement error below 2% on the single axis

→ Deep Learning study on the characterisation of the wave forms in transit in order to detect anomalies on the wheels



## USER INTERFACE

XML. XML generation in compliance with UNI EN 15645-1 standard

The screenshot shows a software window titled "Build the train 14/09/2021 08:33:06". It features a table with columns: "Ass", "Peso", "Dist", "Carri", "CarriB", "Tipo", and "Numero". The table contains 11 rows of data. To the right, there is a "Salva e genera XML" button and a preview of the generated XML code, labeled "Anteprima XML".

Ass	Peso	Dist	Carri	CarriB	Tipo	Numero
1	25.48 t	0.0 m	1	1		
2	22.22 t	2.49 m		A		
3	23.63 t	7.16 m		2 V		
4	22.83 t	2.48 m	A	1		
5	12.7 t	4.38 m	2 V	1		
6	4.56 t	1.85 m		A		
7	4.81 t	7.09 m		2 V		
8	5.31 t	1.81 m		A		
9	5.98 t	1.3 m	3 V	1		
10	4.78 t	1.85 m		A		
11	5.13 t	7.1 m		2 V		

OUTPUT GRAFICO. Weight in tons of a train in transit

The screenshot shows a software window titled "Build the train 15/09/2021 07:28:57". It features a table with columns: "Ass", "Peso", "Dist", "Carri", "CarriB", "Tipo", and "Numero". The table contains 7 rows of data. To the right, there is a "Salva e genera XML" button and a graphical representation of the train's weight in transit, showing a grid with blue bars representing the weight distribution over time.

Ass	Peso	Dist	Carri	CarriB	Tipo	Numero
1	12.08 t	2.5 m	1	1		
2	12.05 t	13.71 m		A		
3	12.62 t	2.5 m		2 V		
4	10.49 t	5.22 m	A			
5	9.31 t	2.5 m	2 V	1		
6	12.01 t	13.71 m		A		
7	12.36 t	2.5 m		2 V		