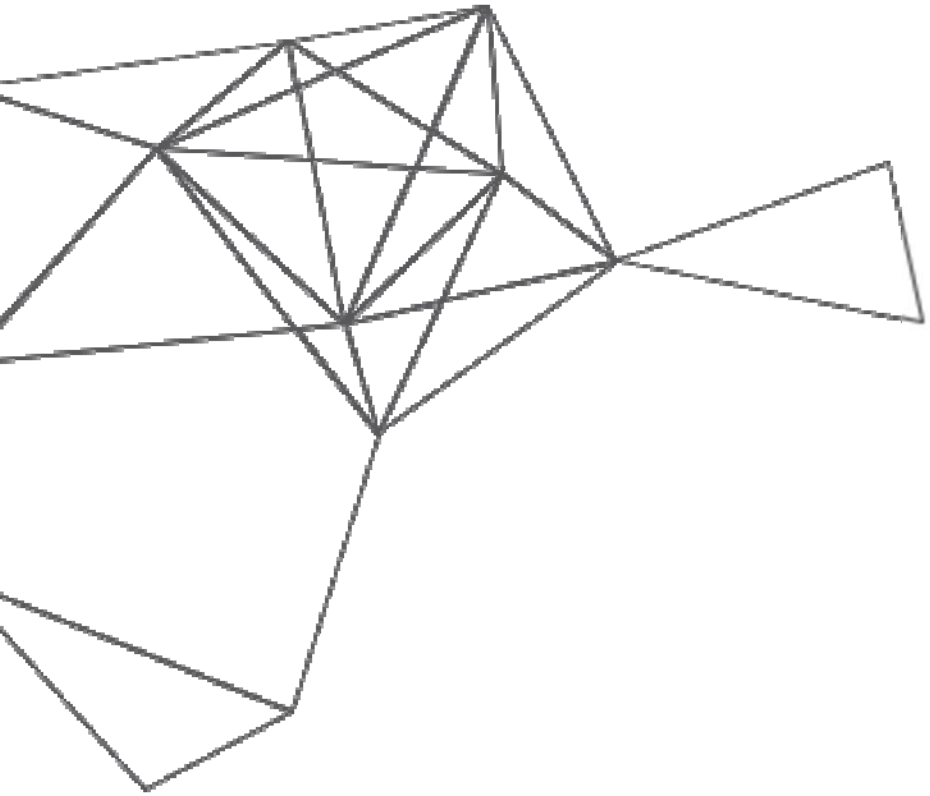
SISGEO LATINOAMERICA

— HIGH SPEED RAILWAY MONITORING

Gianfranco Iannaccone



WHY RAILWAY MONITORING?

SISGEO

WHY RAILWAY MONITORING?

NOW IS TOO LATE…

HOW MUCH MONEY THEY HAVE LOST?

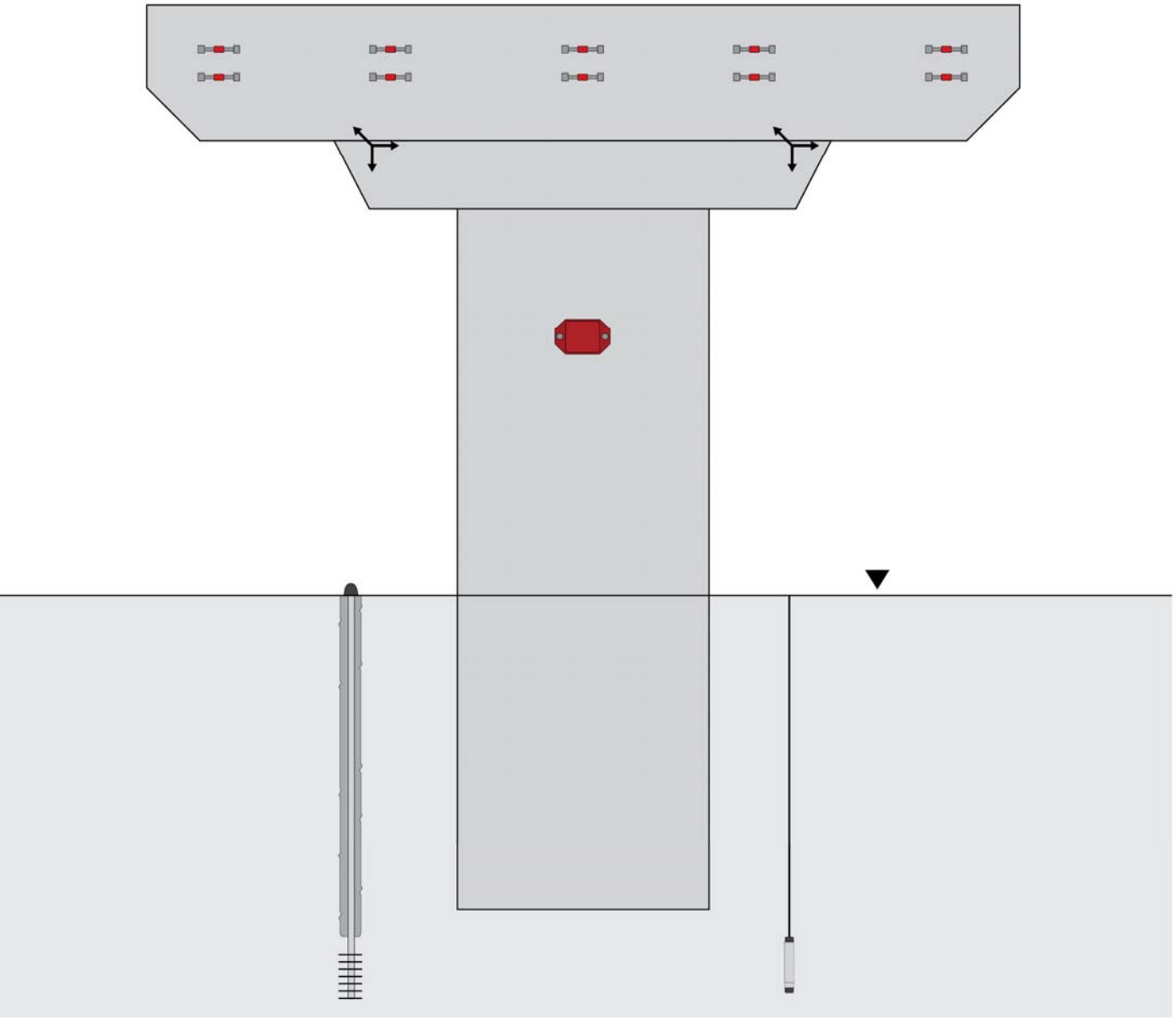
A WELL DONE PROJECT:
High speed railway milan-rome, italy

MONITORING SYSTEM: MAIN TASKS

- *Monitoring of viaducts / bridges*
- *Monitoring of embankments*
- *Monitoring of critical sections with RDS system*

MONITORING OF VIADUCTS

MONITORING OF VIADUCTS



VW strain gauge

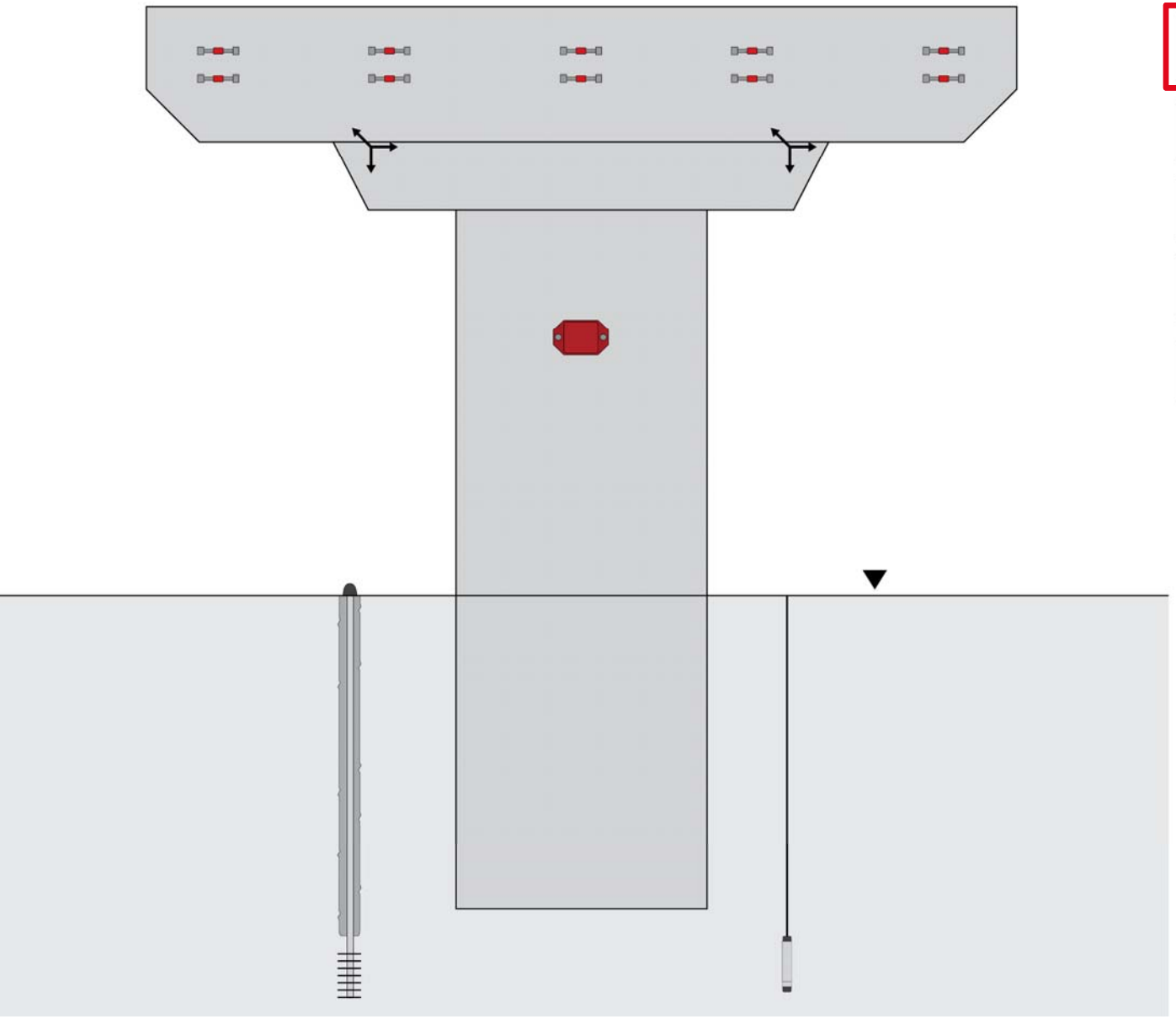
3-axial joint meter

Biaxial tiltmeter

piezometer

Tell tale extensometer

VIBRATING WIRE STRAIN GAUGES

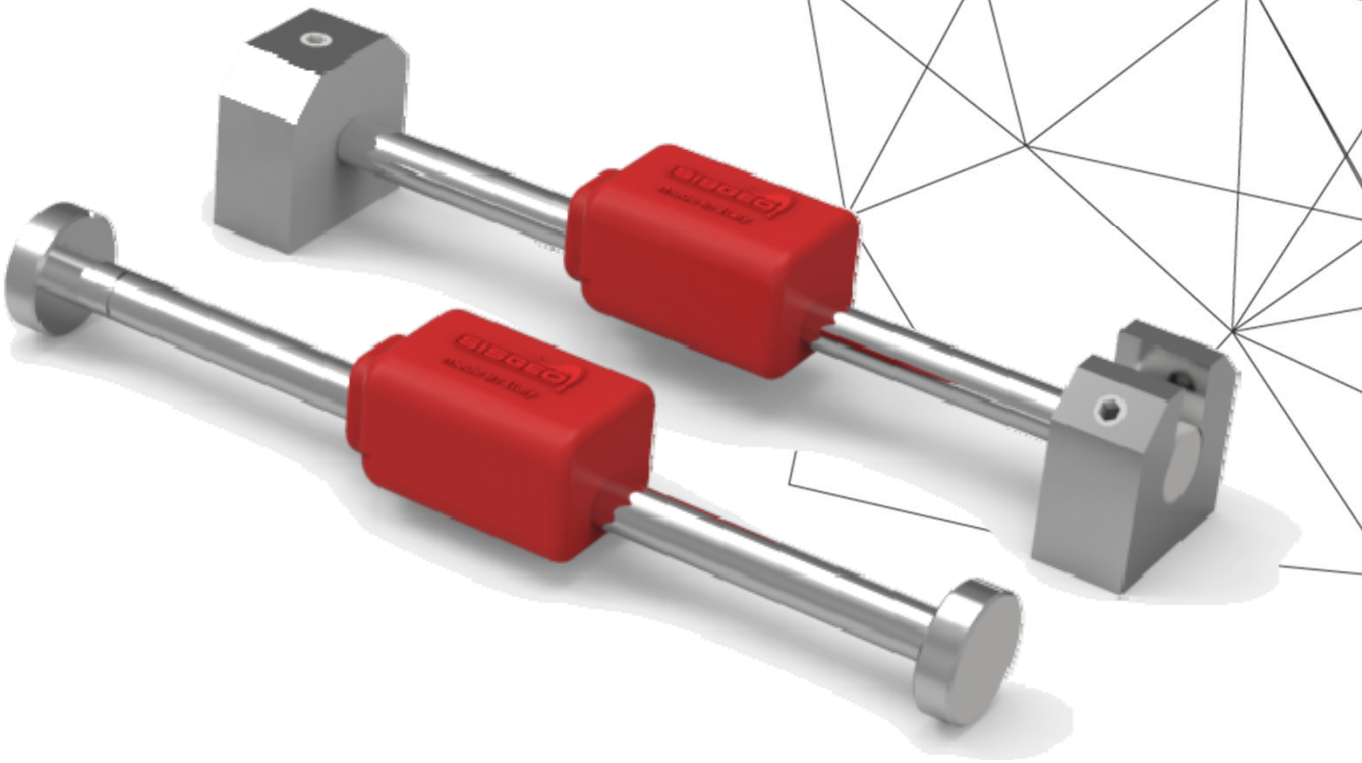


- VW strain gauge
- 3-axial joint meter
- Biaxial tiltmeter
- piezometer
- Tell tale extensometer

VIBRATING WIRE STRAIN GAUGES

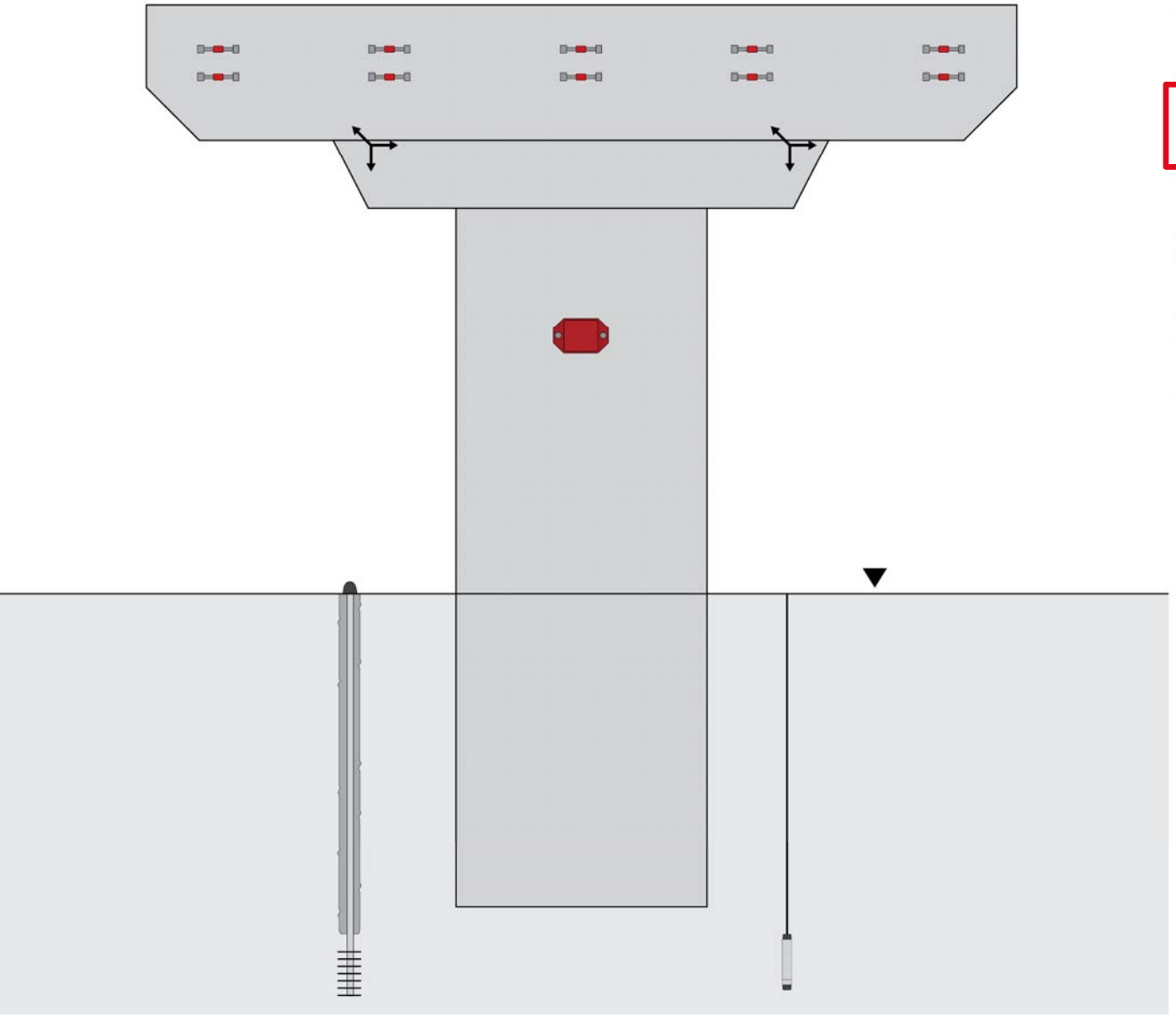
Aim: monitor the stress into concrete.

VW strain gauge should be installed in deck but also in the pile or foundation



VIBRATING WIRE STRAIN GAUGES

3-AXIAL JOINT METERS



VW strain gauge

3-axial joint meter

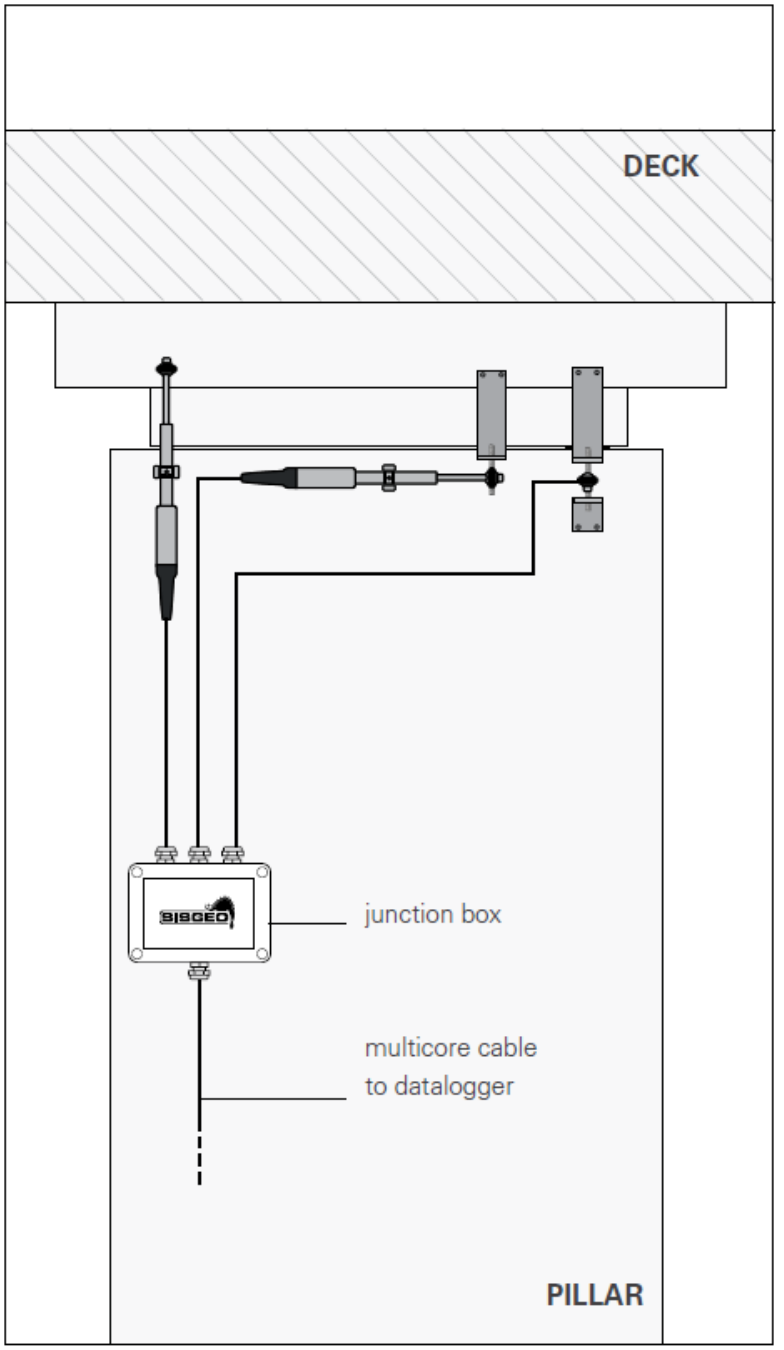
Biaxial tiltmeter

piezometer

Tell tale extensometer

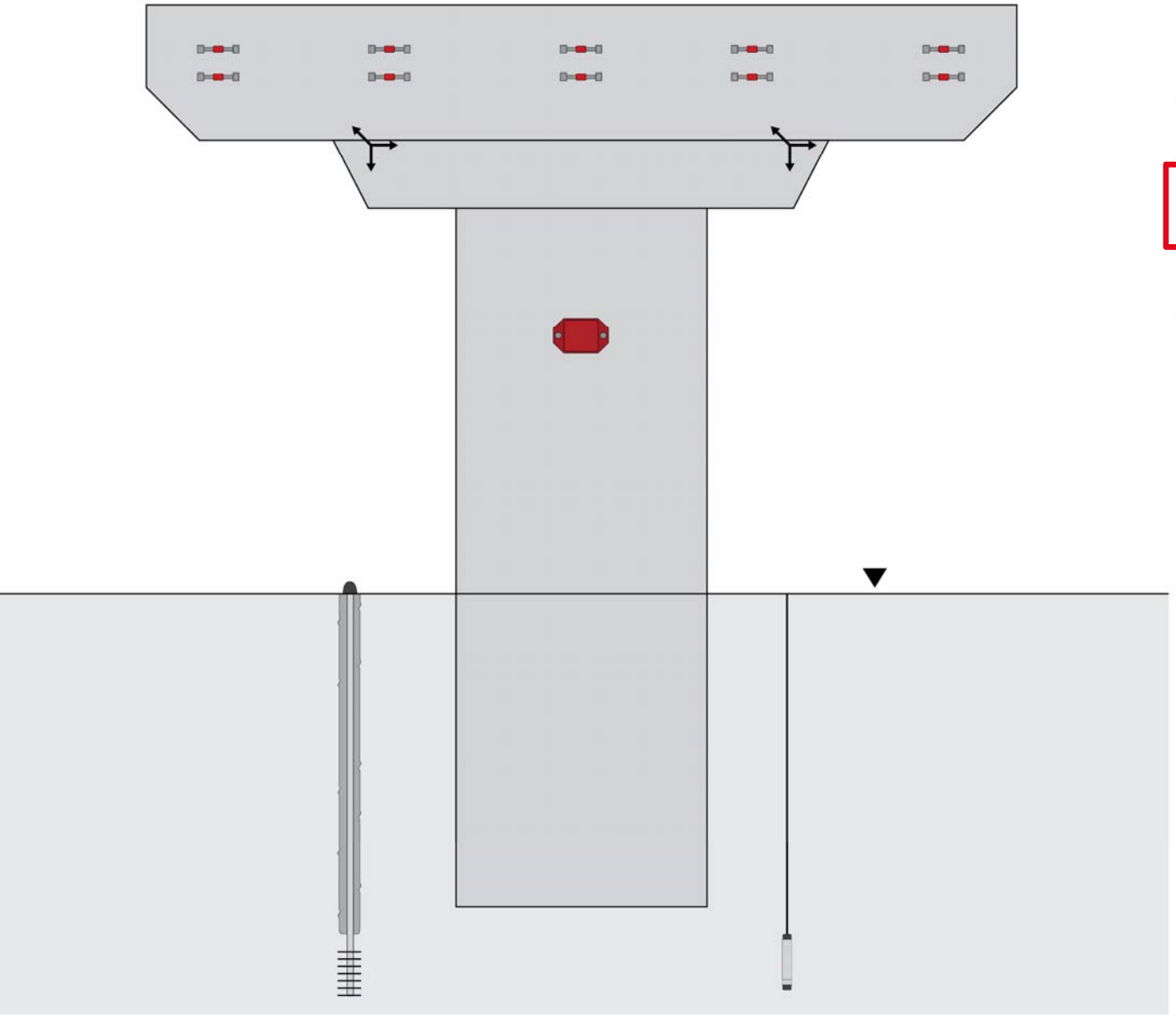
3-AXIAL JOINT METERS

Aim: monitor the relative movement/displacement between pile and deck



3-AXIAL JOINT METERS

BIAXIAL TILTMETER



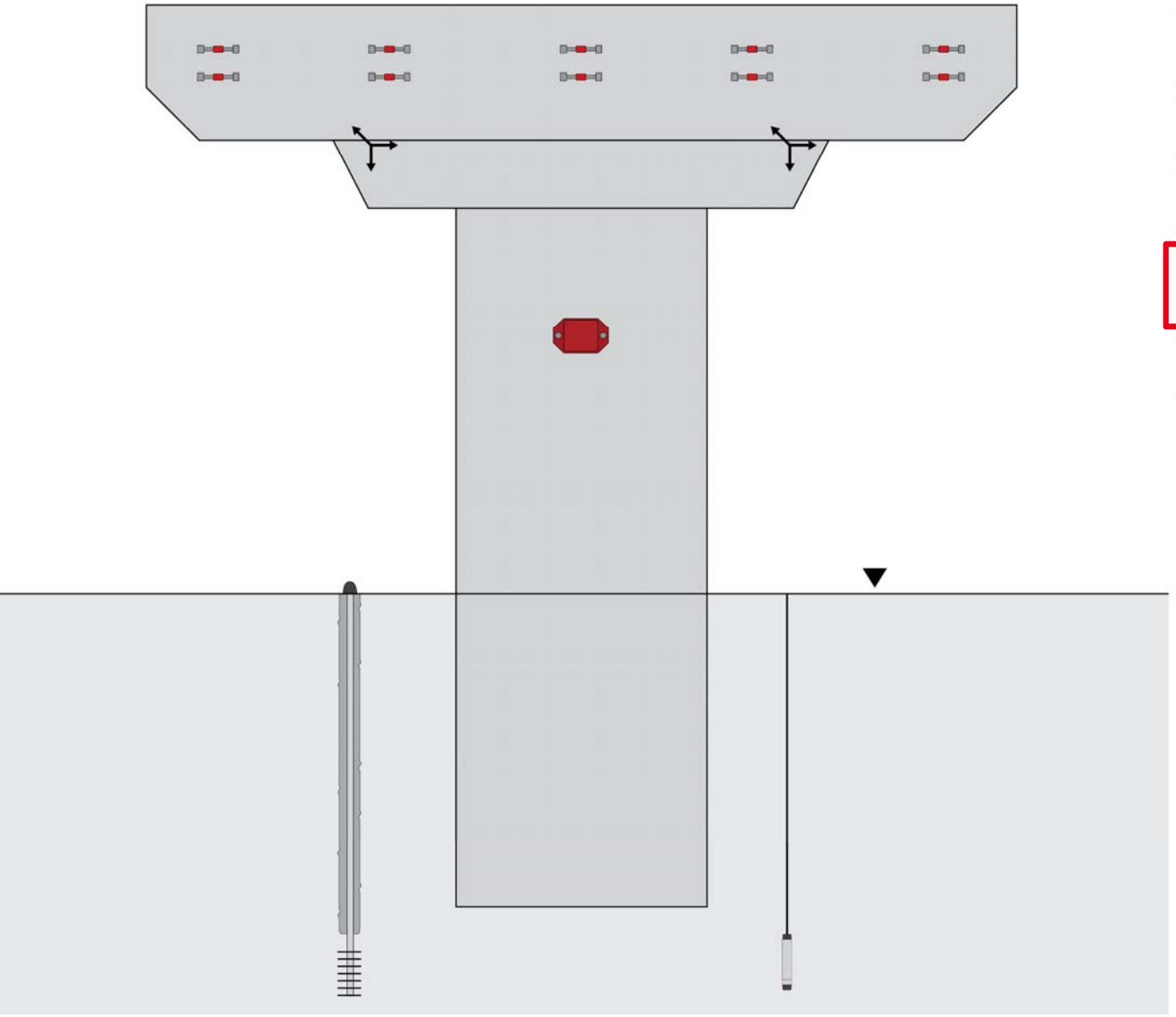
- VW strain gauge
- 3-axial joint meter
- **Biaxial tiltmeter**
- piezometer
- Tell tale extensometer

BIAXIAL TILTMETER

Aim: monitor the inclination in X and Y directions of viaduct pile.

BIAXIAL TILTMETER

VIBRATING WIRE STRAIN GAUGES



VW strain gauge

3-axial joint meter

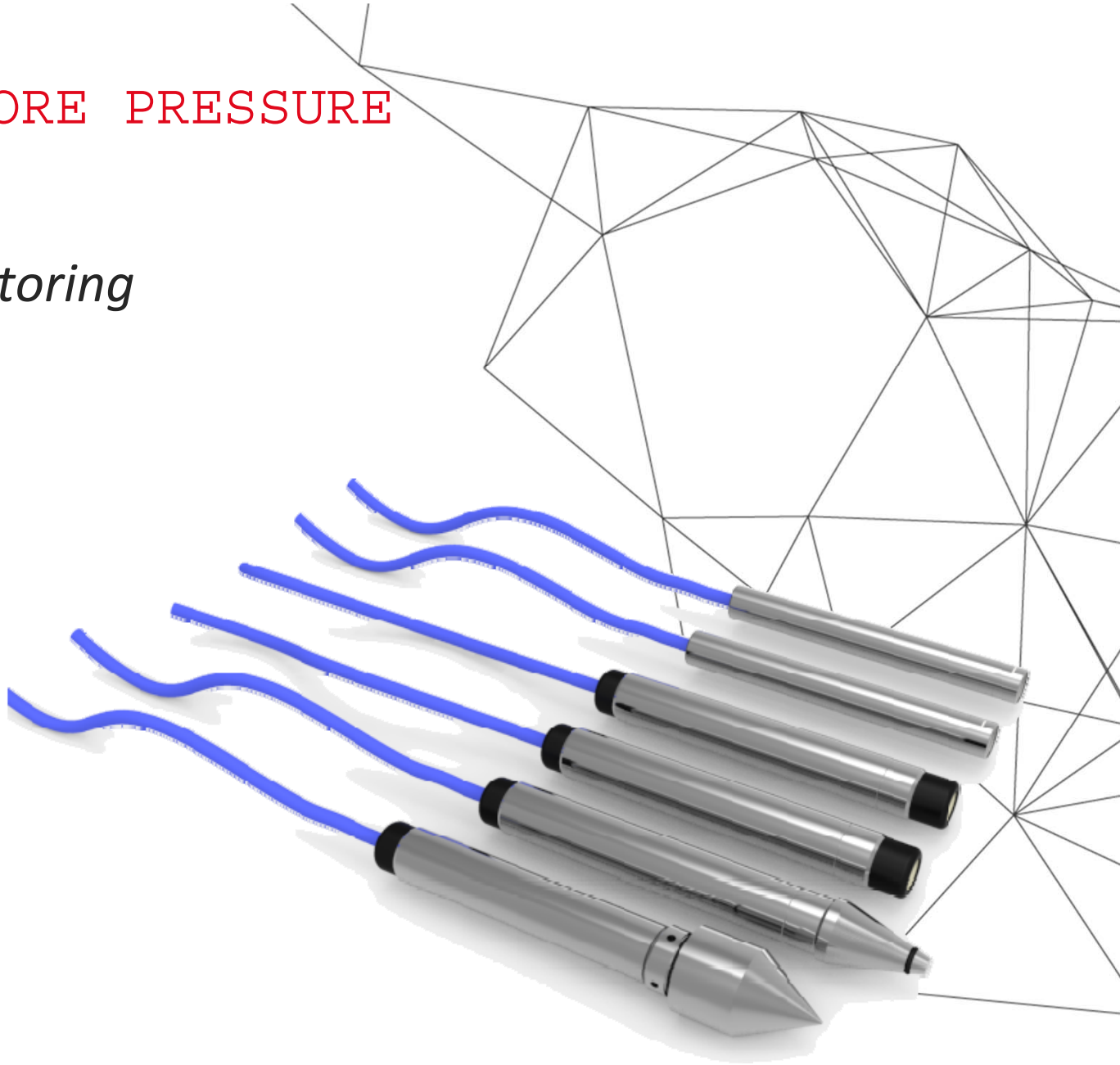
Biaxial tiltmeter

piezometer

Tell tale extensometer

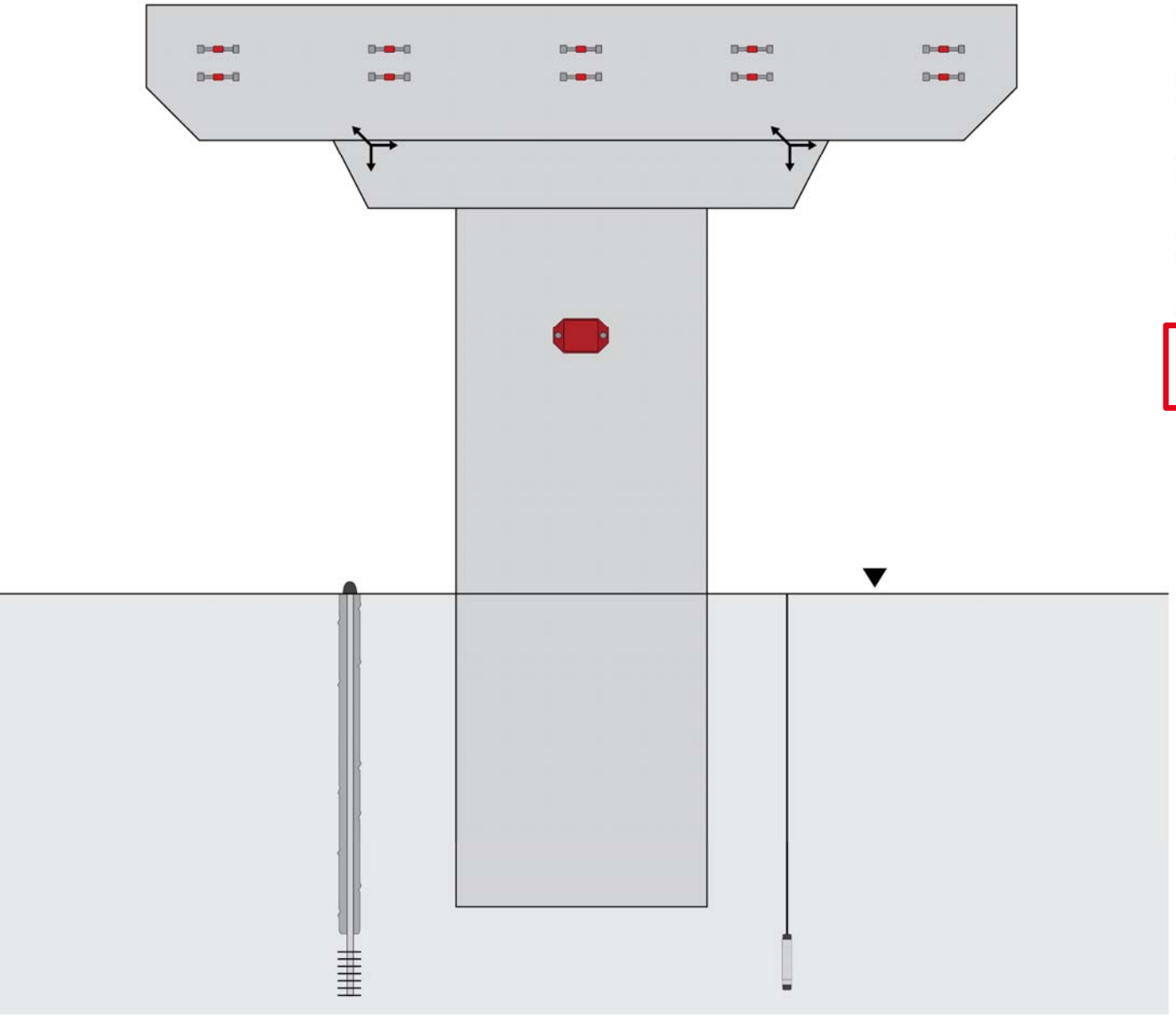
PIEZOMETERS FOR PORE PRESSURE

Aims: Pore pressure monitoring



PIEZOMETERS FOR PORE PRESSURE

TELL-TALE EXTENSOMETER



VW strain gauge

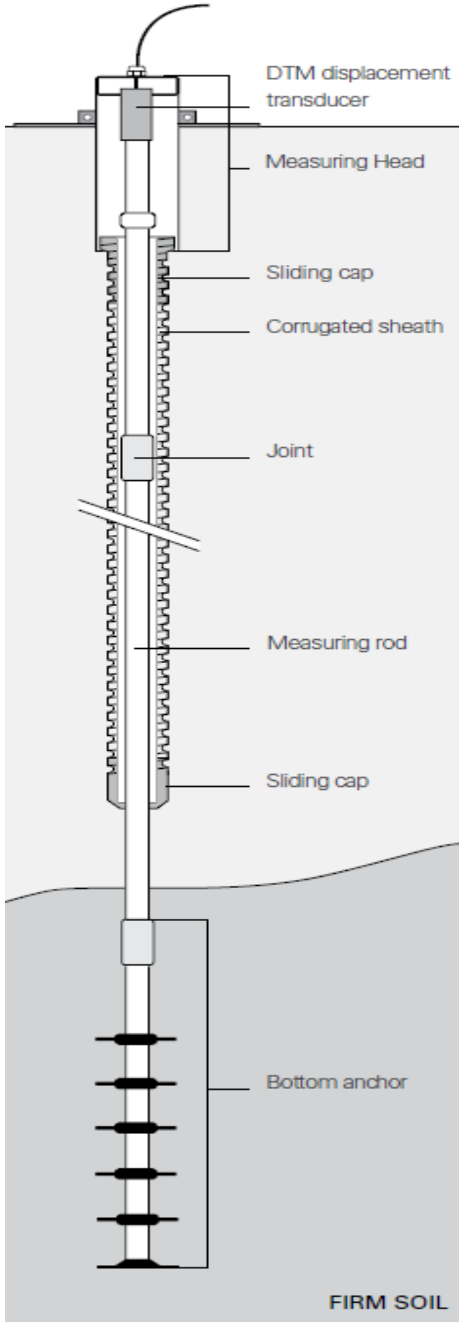
3-axial joint meter

Biaxial tiltmeter

piezometer

Tell tale extensometer

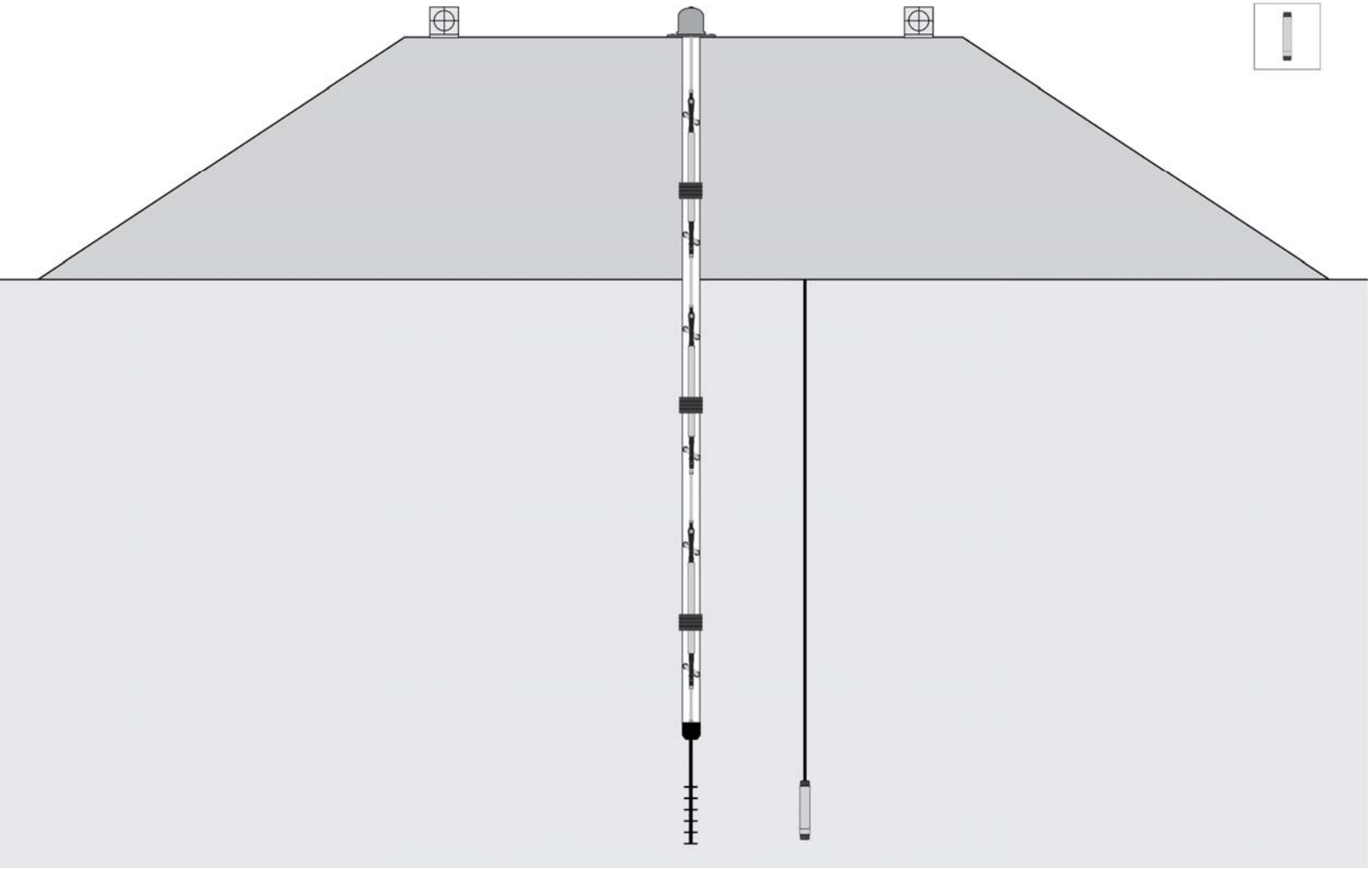
TELL-TALE EXTENSOMETER



Aim: monitor ground settlement caused by viaduct construction and during railway life

TELL-TALE EXTENSOMETER

MONITORING OF EMBANKMENTS

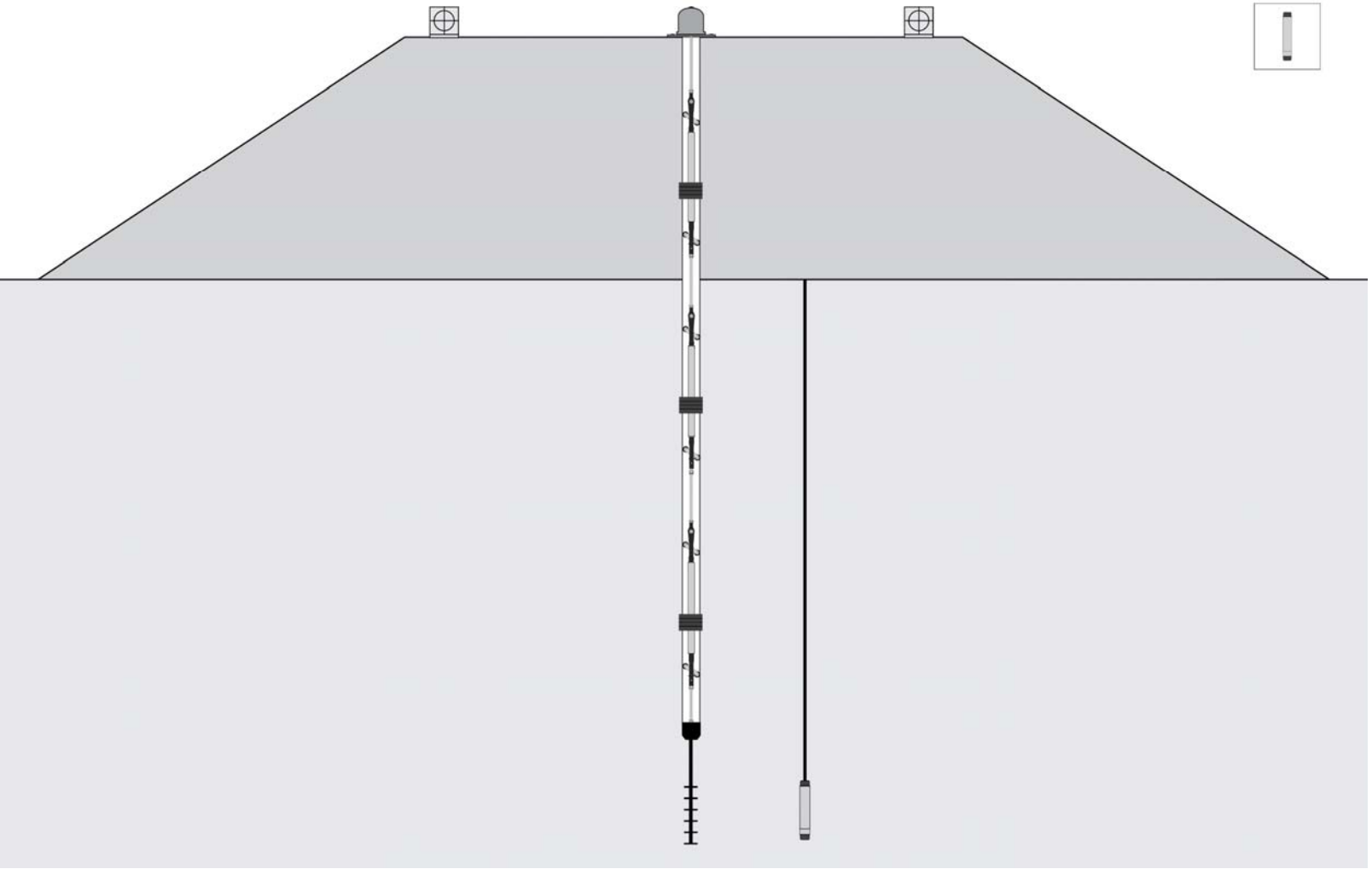


Geodetic target

DEX settlement column

Piezometer

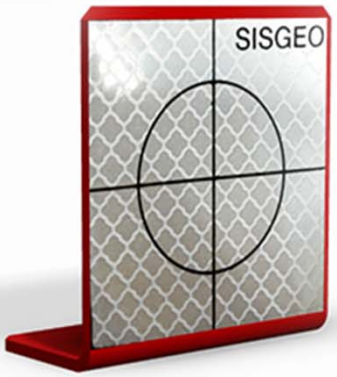
GEODETIC TARGETS



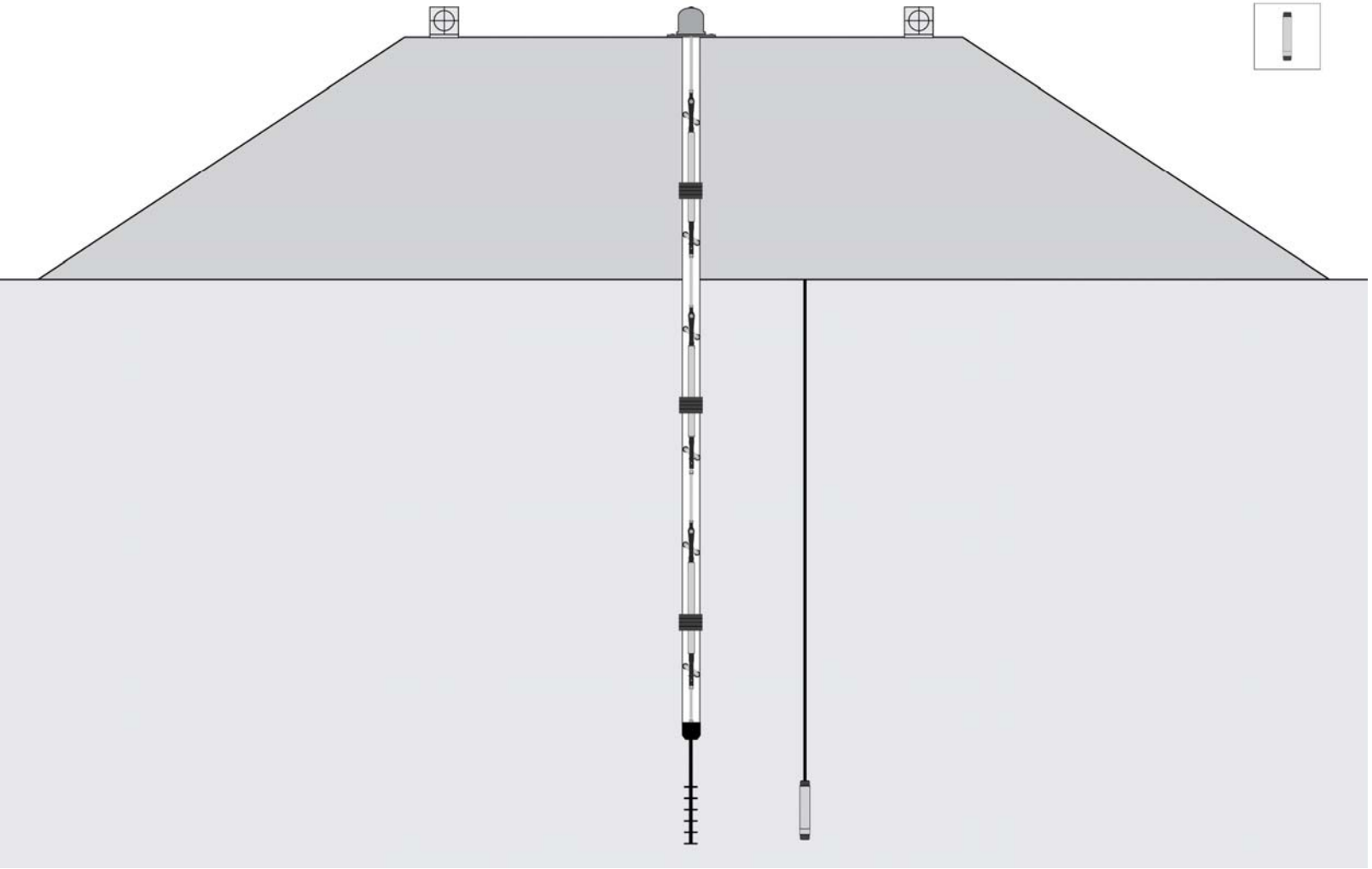
- Geodetic target
- DEX settlement column
- Piezometer

GEODETIC TARGETS

Aims: monitor embankment body settlement / displacement



DEX SETTLEMENT COLUMN



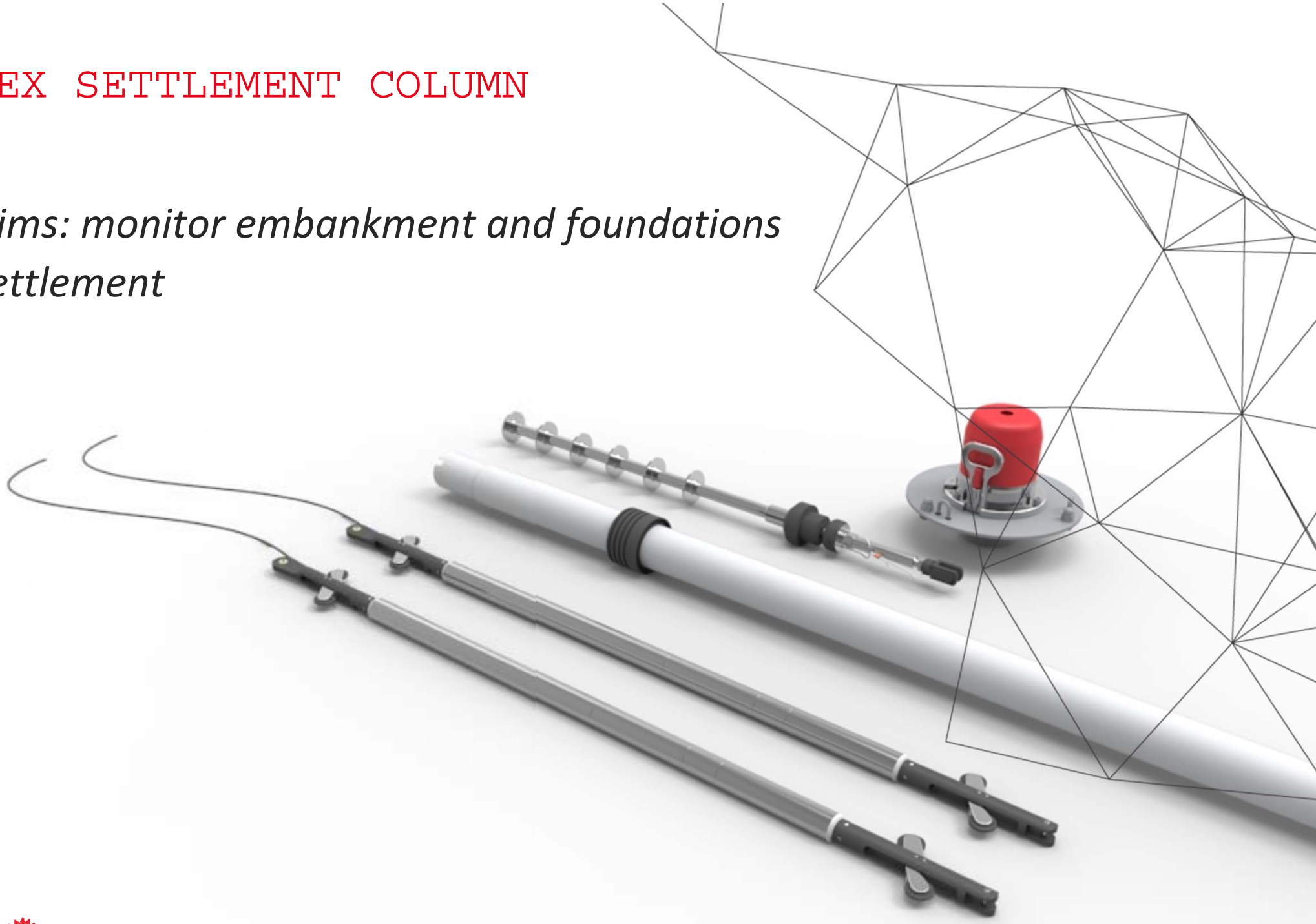
Geodetic target

DEX settlement column

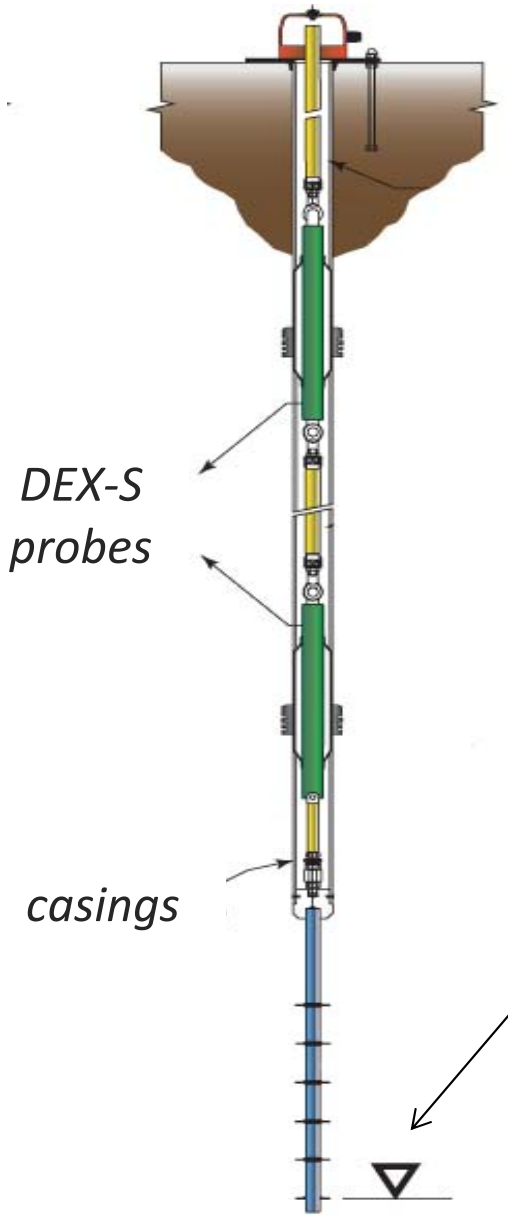
Piezometer

DEX SETTLEMENT COLUMN

Aims: monitor embankment and foundations settlement



DEX SETTLEMENT COLUMN



DEX chain with lower reference (stiff chain <u>connected to the bottom</u> anchor)

DEX SETTLEMENT COLUMN

DEX column allows:

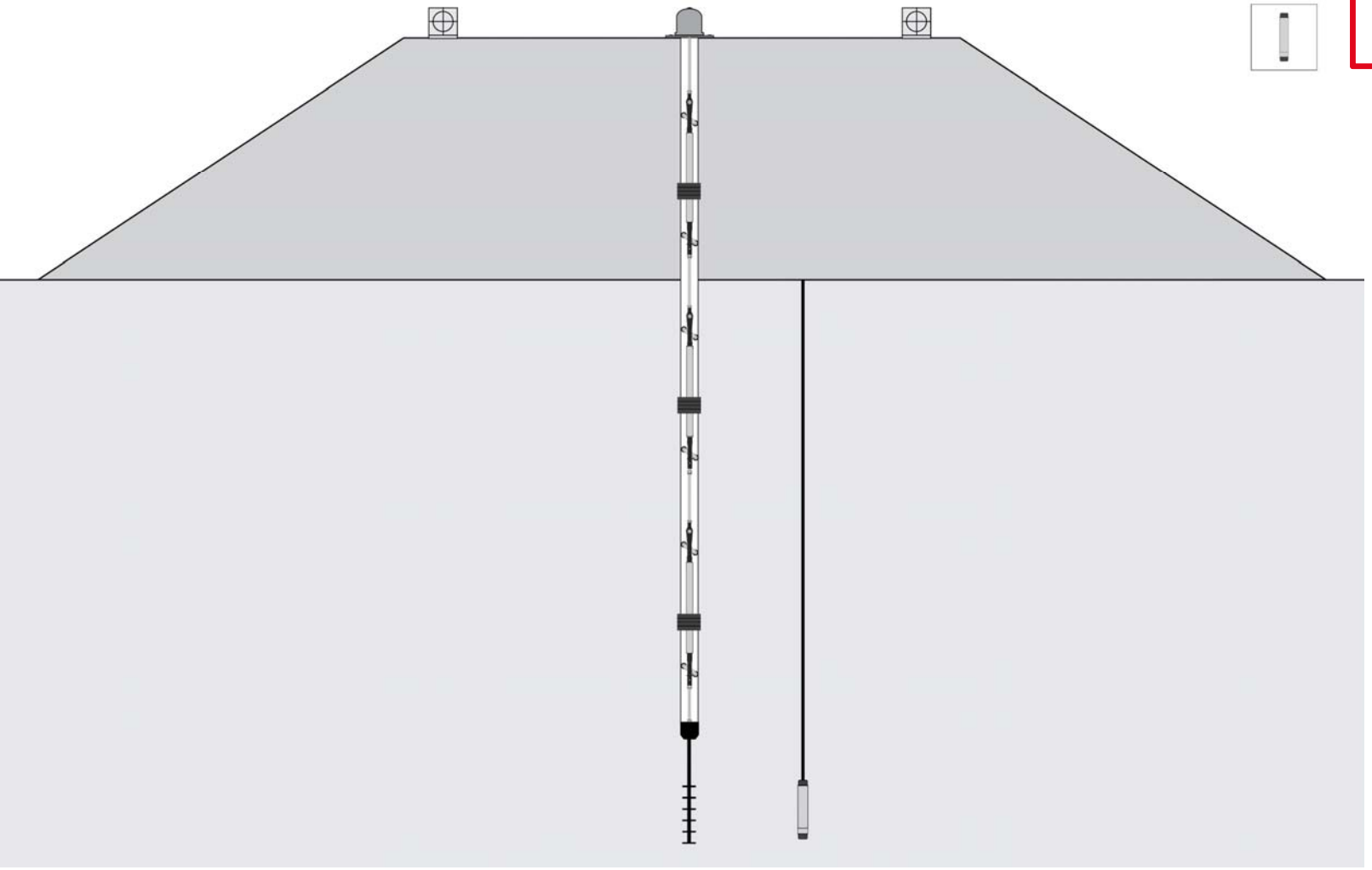
- absolute settlement monitoring

- High accuracy

- Removable probes for re-installation at different locations and maintenance (if needed)

- Real-time monitoring in unattended location

PIEZOMETERS FOR PORE PRESSURE



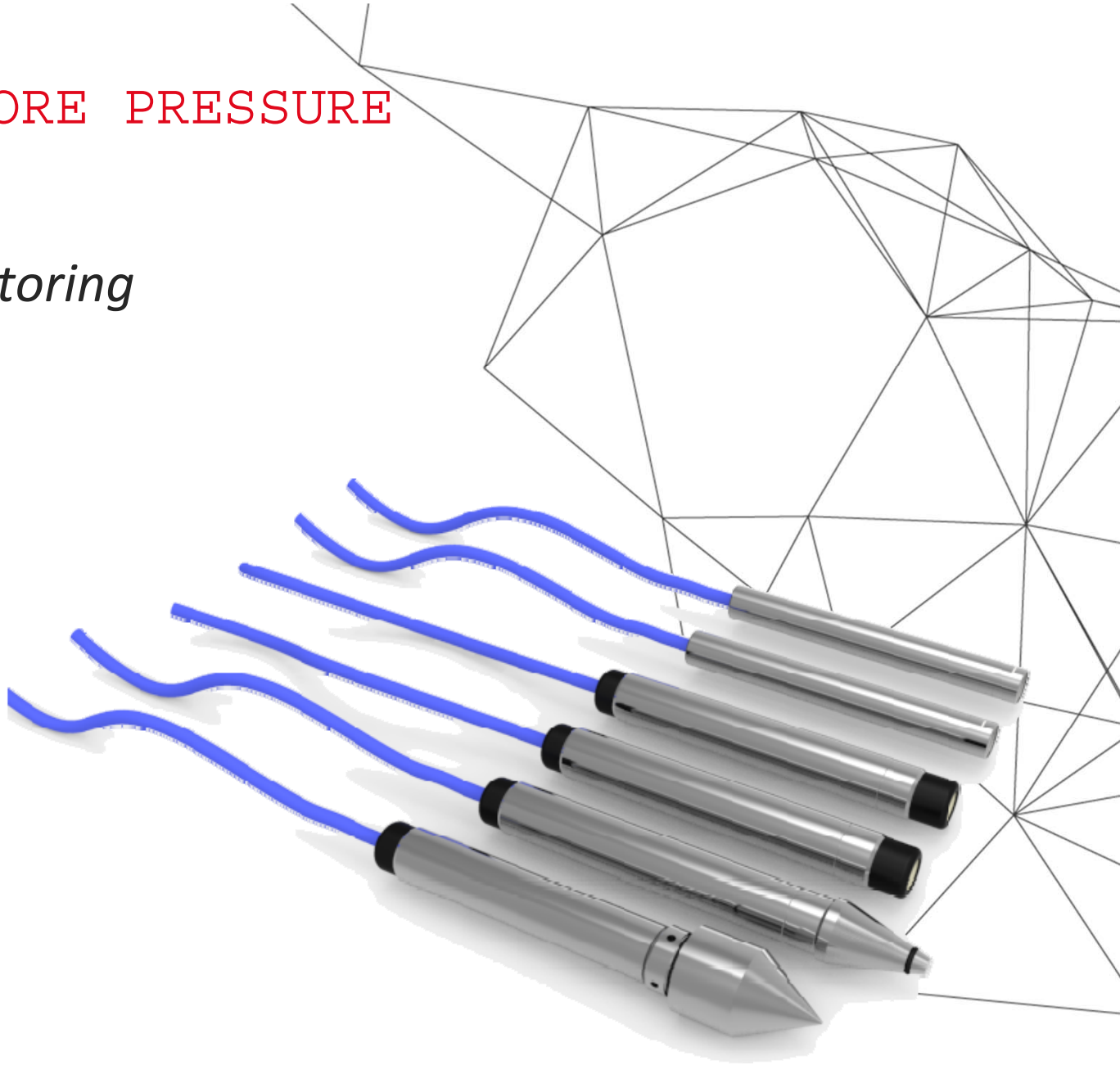
Geodetic target

DEX settlement column

Piezometer

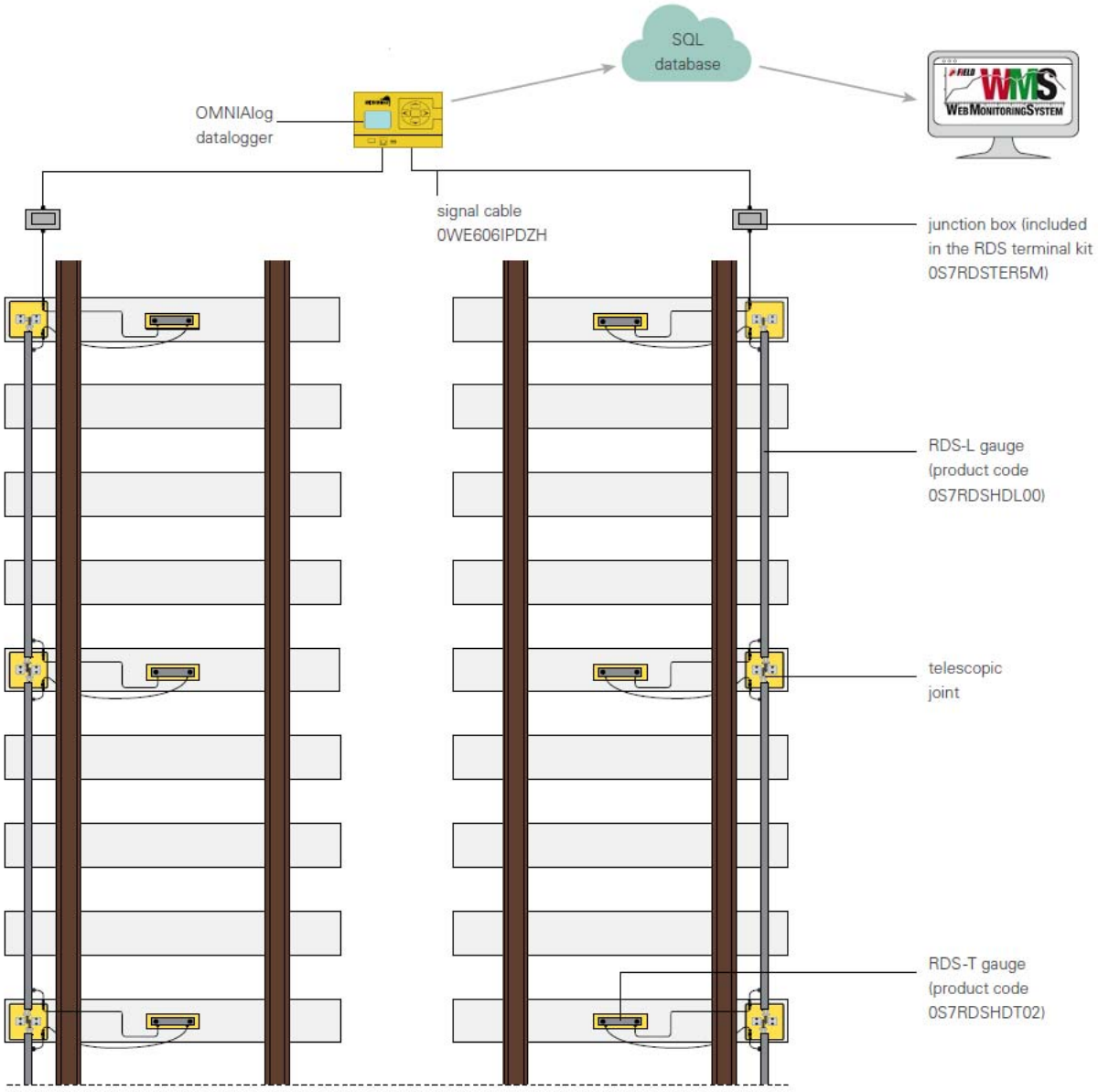
PIEZOMETERS FOR PORE PRESSURE

Aims: Pore pressure monitoring



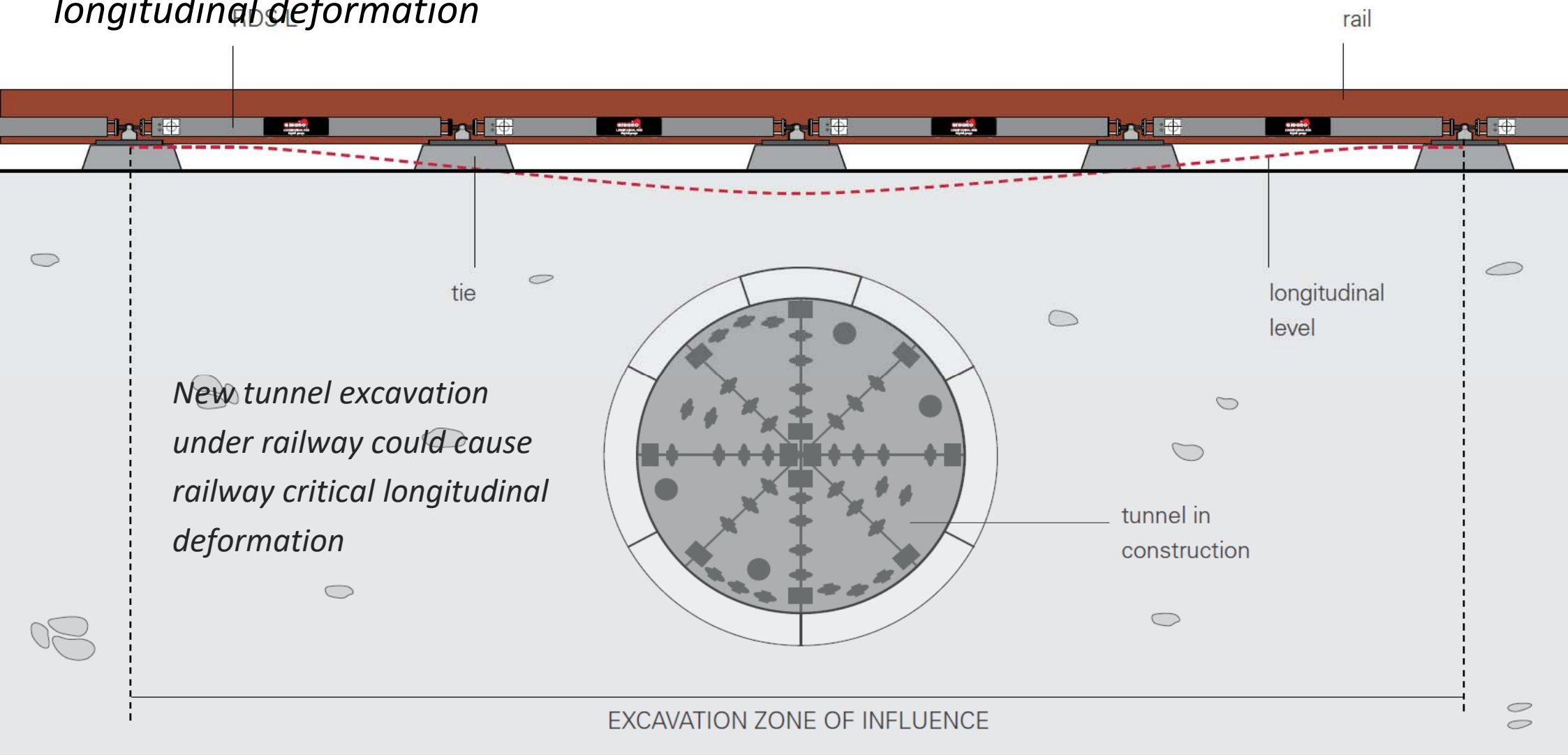
PIEZOMETERS FOR PORE PRESSURE

RDS - RAILWAY DEFORMATION SYSTEM



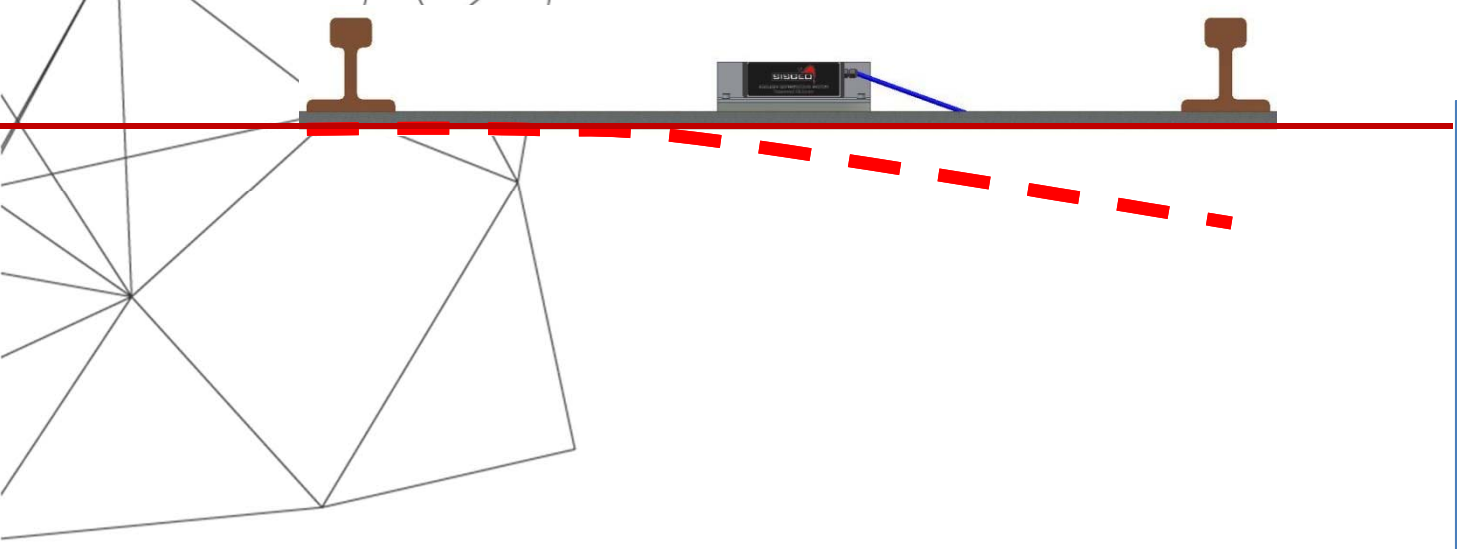
RDS - APPLICATIONS

For the measure of potential collapses or subsidences along a railway section, is important the use of a chain of longitudinal sensors in order to measure the railway longitudinal deformation



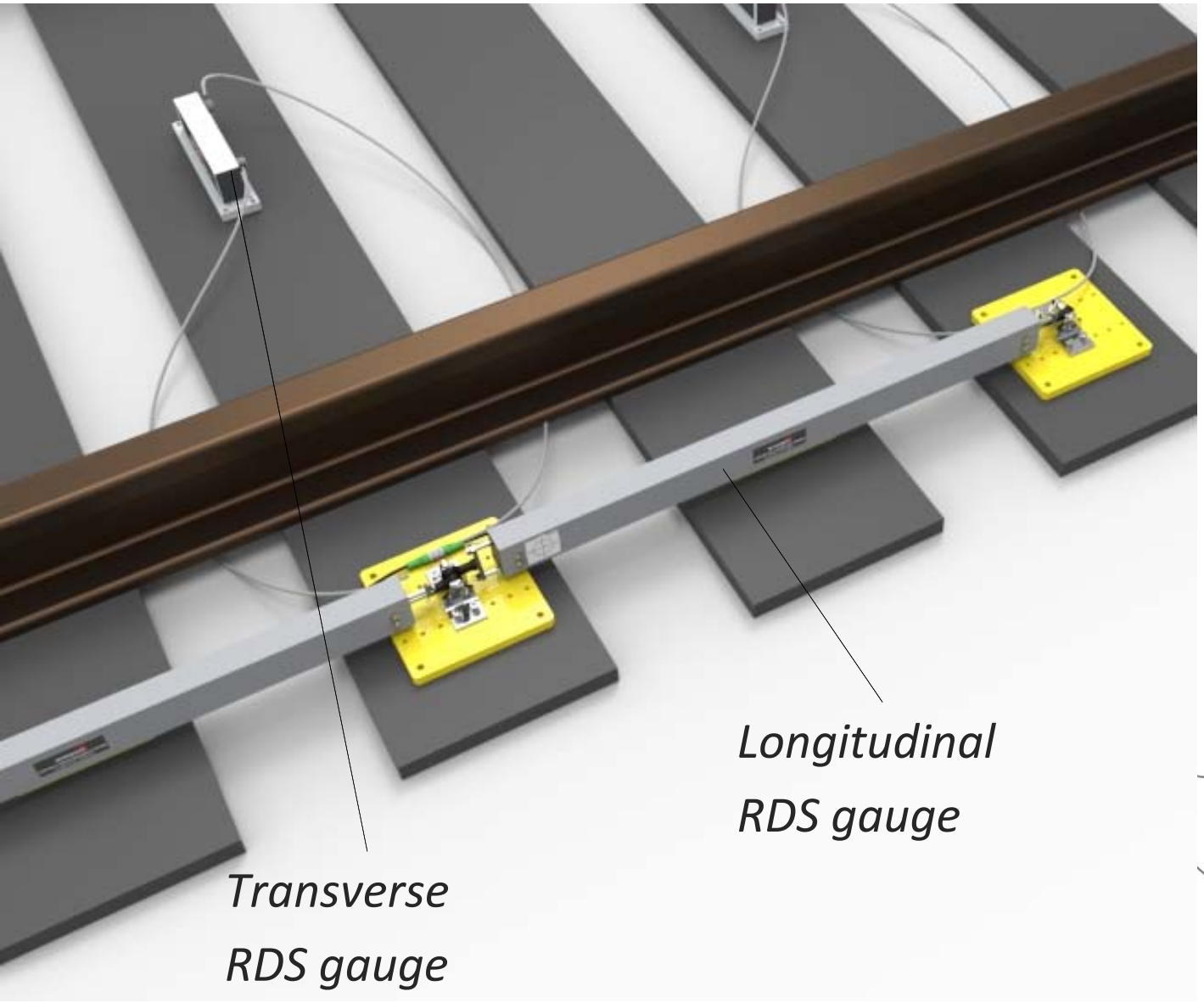
RDS - APPLICATIONS

In case of works nearby railway lines (injections, jet-grouting, drillings, pilings etc.) a major importance is given to the evaluation of the twist, and so the application of the transversal sensor.



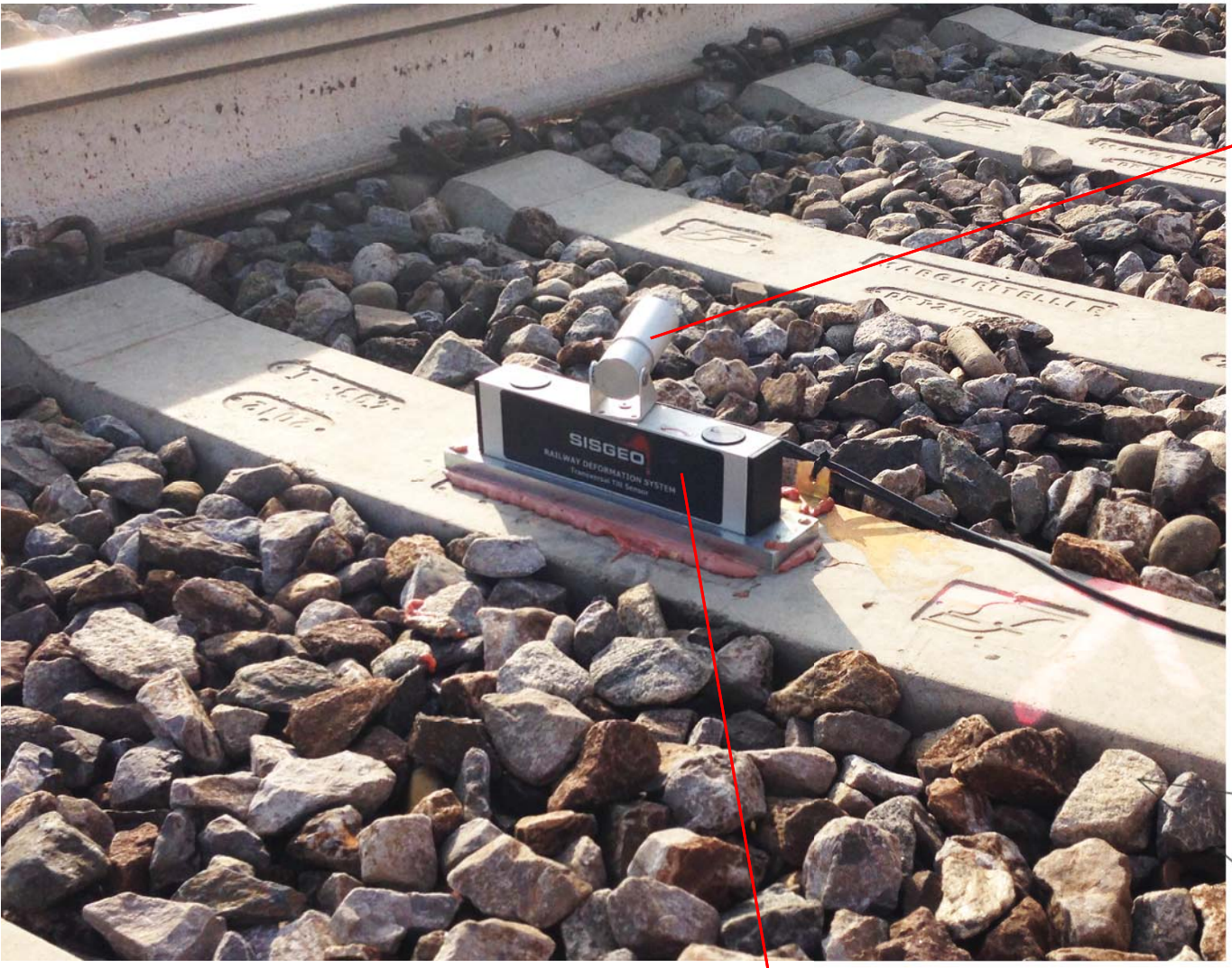
Nearby excavation could cause differential settlement and so railway transverse deformation

PURE RDS SYSTEM: LONGITUDINAL AND TRANSVERSE GAUGES



They are digital MEMS tilt meters with ***high accuracy*** *and* ***low thermal dependence***

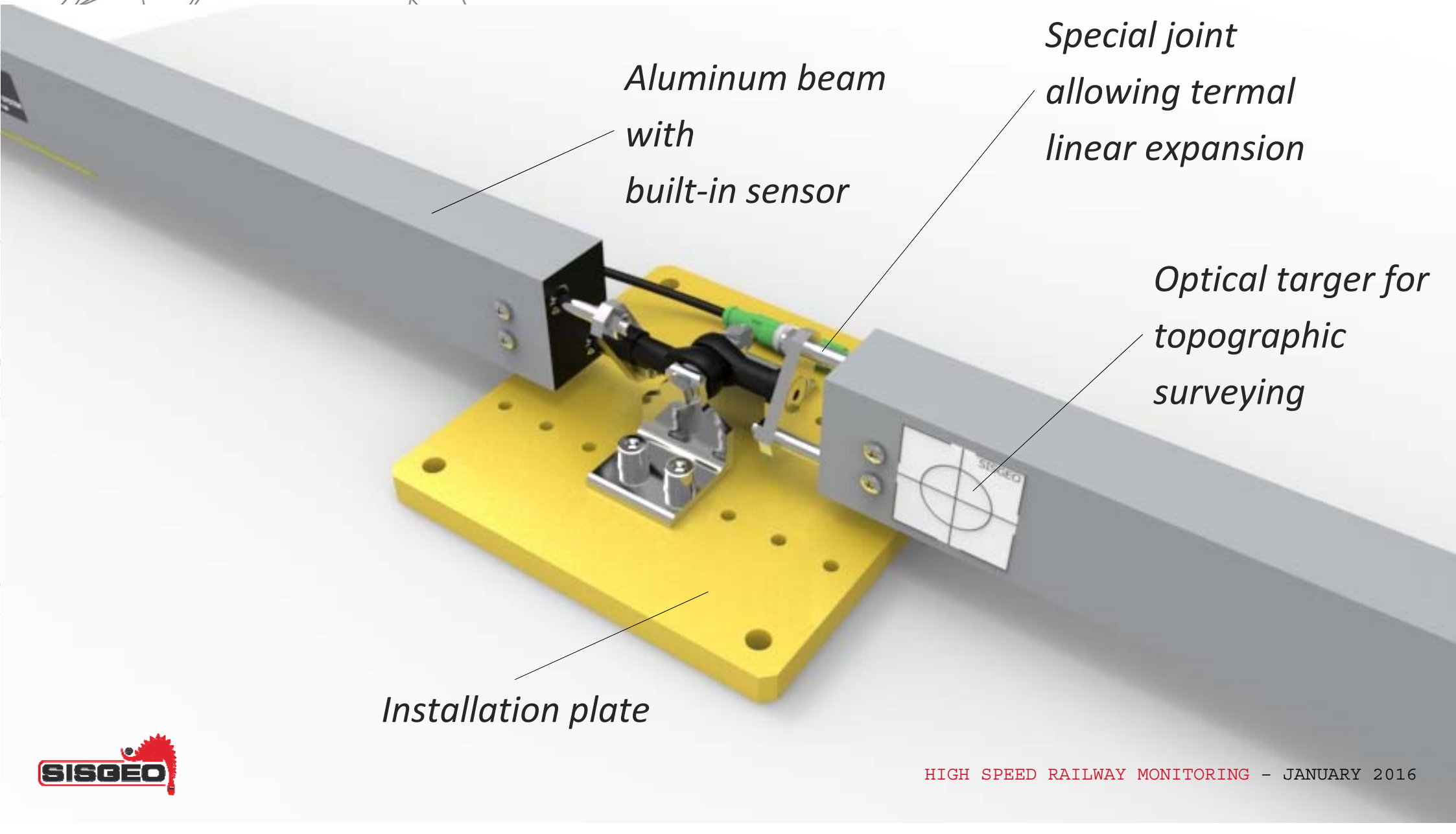
OPTICAL-RDS INTEGRATED SYSTEM



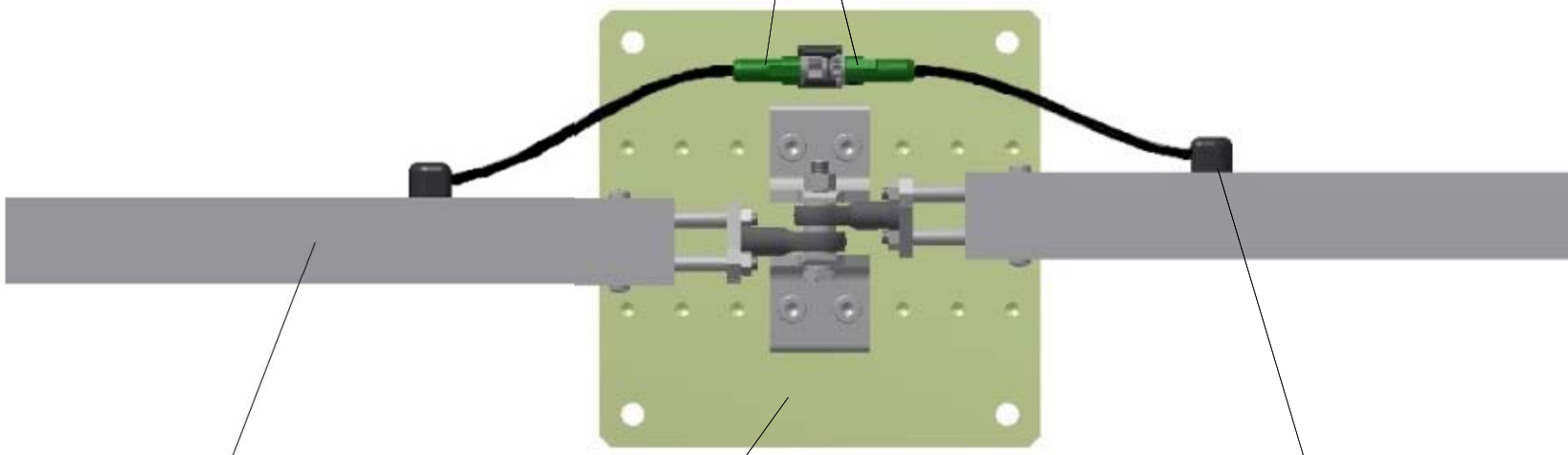
Microprism for logitudinal geodetical monitoring

Transverse RDS gauge

RDS LONGITUDINAL GAUGES

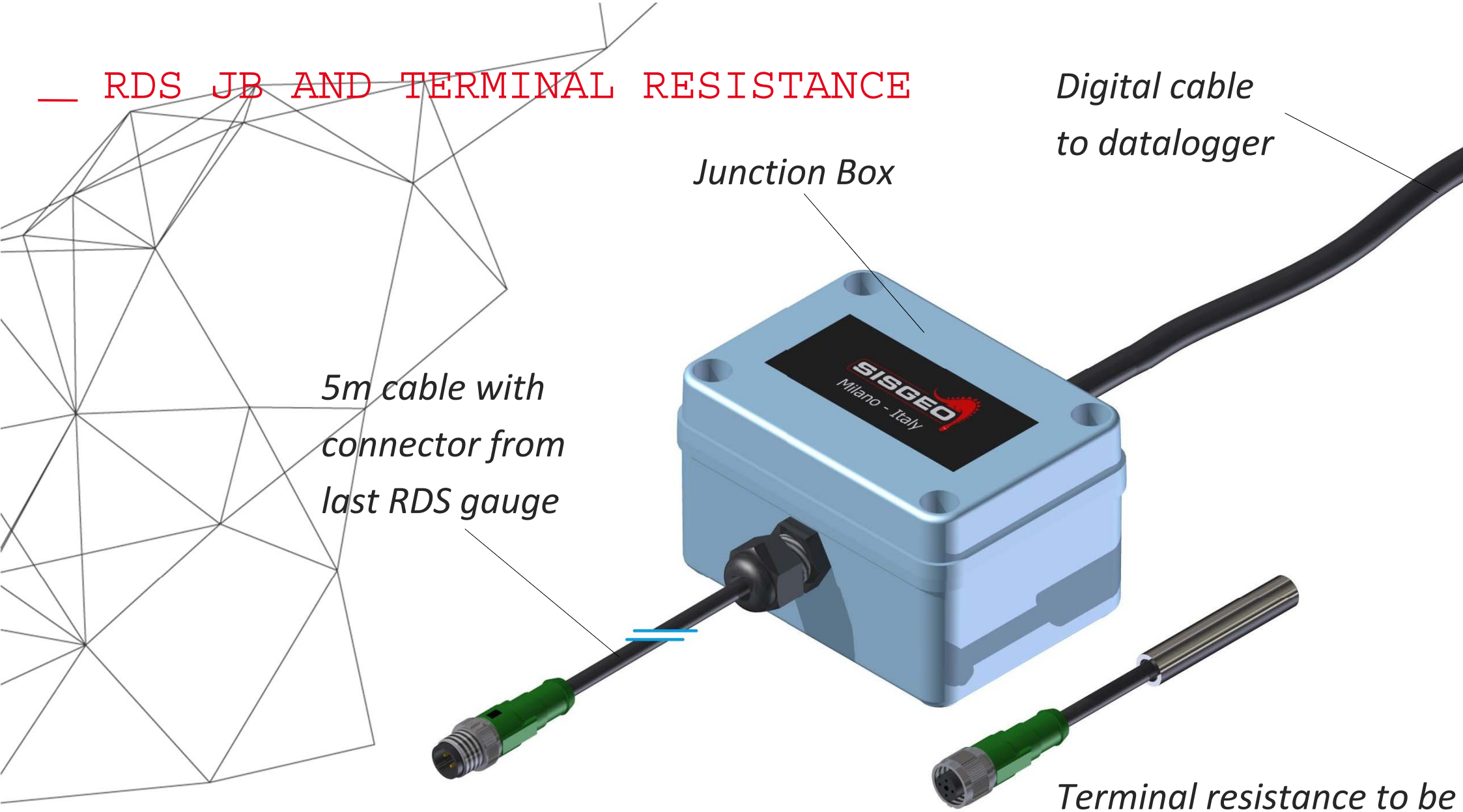


RDS LONGITUDINAL GAUGES - THE JOINT



RDS TRANSVERSE GAUGES

RDS JB AND TERMINAL RESISTANCE



INSTALLATION PROCEDURES

Installation usually takes place with railway cut-off power, so RDS gauges installation must take less time as possible → RDS has been designed to be simple and quick to be installed.

1. *Supports are positioned and fixed with mechanical bolts or with appropriate resins*
2. *Gauges are fixed to the supports and fast connected one to each other by connectors*
3. *Using the terminal JB, RDS gauge chain(s) is connected to OMNIAlog data acquisition system*

DATA ACQUISITION SYSTEM

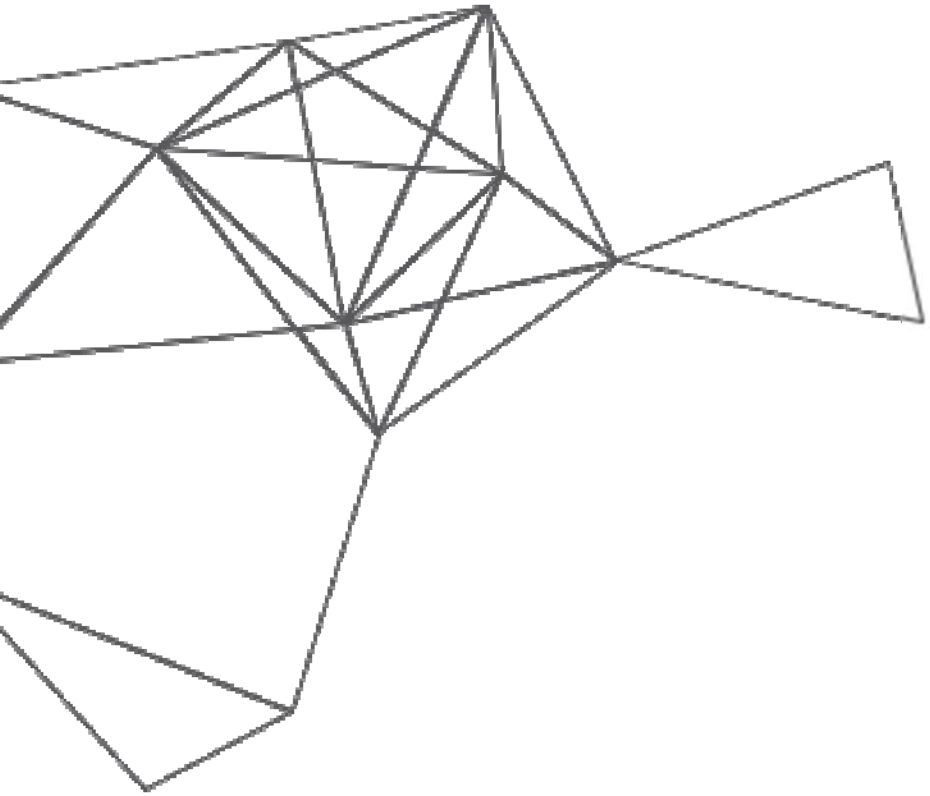
OMNIAlog is the right solution for RDS automatic monitoring, data transmission and allerting:

1. *OMNIAlog, through 3G router or other communication interface, sends the data packages at a preset intervals to a dedicated server*
2. *Data are subjected to a first automatic validation in order to delete peaks and abnormal readings*
3. *OMNIAlog can be set to send alarms (i.e. through SMS/email) or activation of sirens / flashings at the pre-set thresholds overcoming.*

DATA MANAGEMENT AND INTERPRETATION

WMS Web Monitoring System is a SW platform for data management for geotechnical and structural monitoring systems, with the possibility to import data from both automatic data acquisition systems or manual readings. With WMS platform, data are sorted, converted into engineering units, validated, corrected by temperature variations, processed and plotted on special navigable and interactive charts.

EXAMPLE OF APPLICATIONS



- *PURE RDS SYSTEM:*

Milan-Bologna

high speed railway

- *OPTICAL-RDS INTEGRATED SYSTEM:*

Milan M5 metro line,

Domodossola Station

MILAN-BOLOGNA HIGH SPEED RAILWAY

MILAN-BOLOGNA HIGH SPEED RAILWAY

Installation of support plates

MILAN-BOLOGNA HIGH SPEED RAILWAY

Longitudinal RDS gauge mounting (3m length)

MILAN-BOLOGNA HIGH SPEED RAILWAY

Transverse RDS gauge (1m length)

MILAN-BOLOGNA HIGH SPEED RAILWAY

Junction box for analogue gauges

"JB" NOT needed anymore.

New digital RDS gauges are installed in chain (ModBUS)

MILAN-BOLOGNA HIGH SPEED RAILWAY

Final results

MILAN-BOLOGNA HIGH SPEED RAILWAY

Data acquisition system

GPRS antenna

Battery pack for solar panel

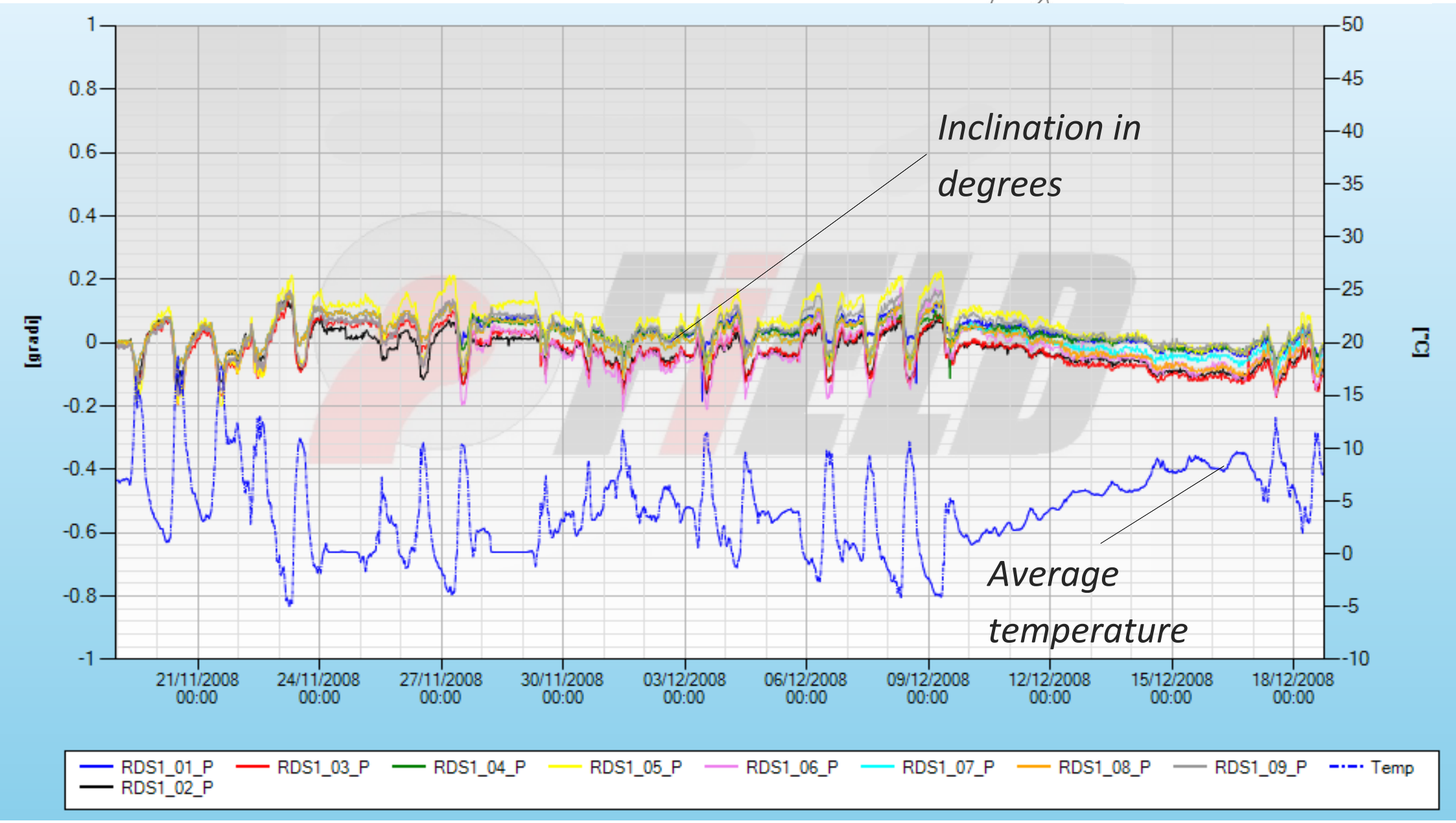
Data acquisition system

MILAN-BOLOGNA HIGH SPEED RAILWAY

Solar panel for data acquisition system

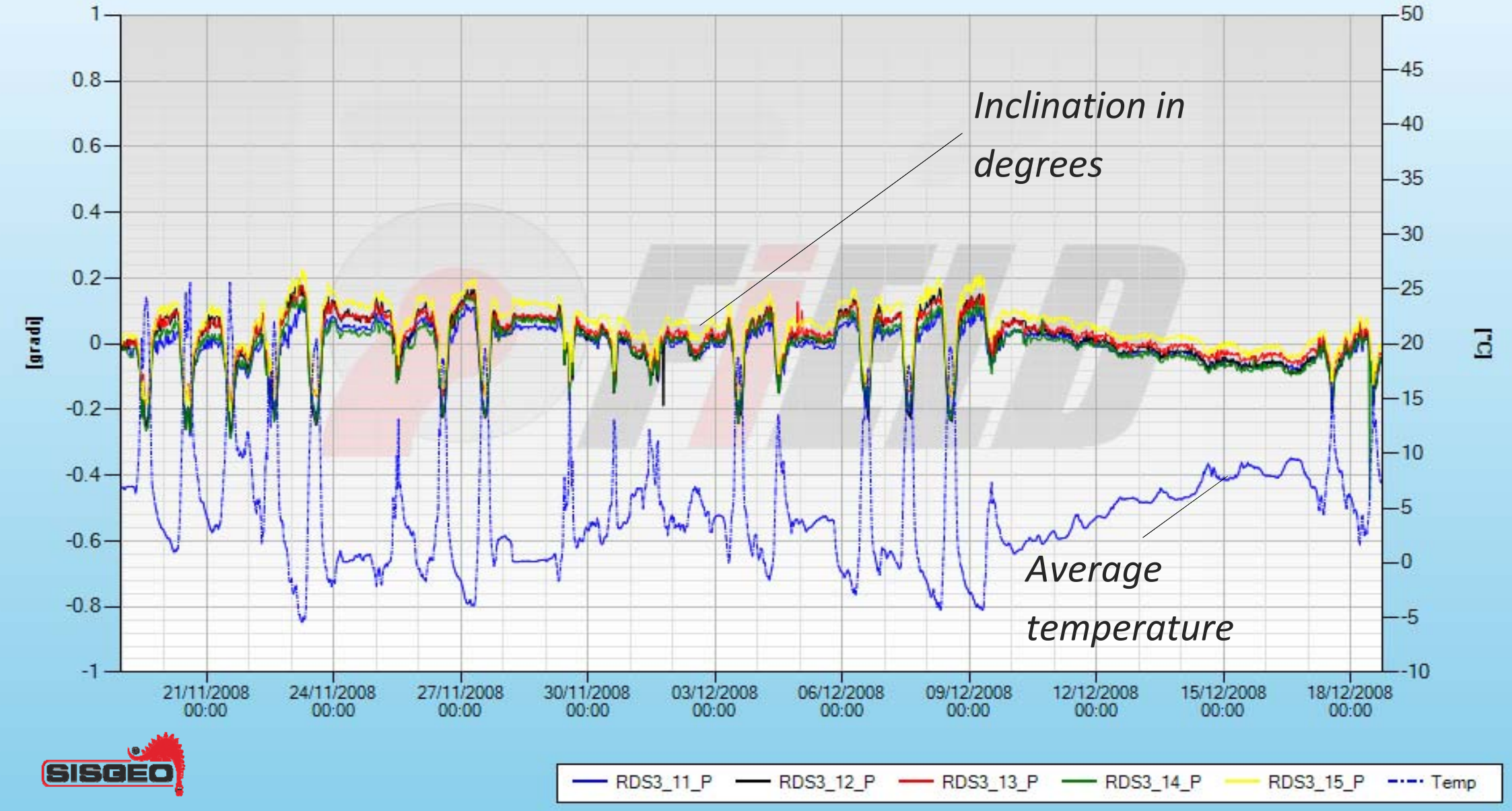
MILAN-BOLOGNA HIGH SPEED RAILWAY

RDS Tranverse gauges – Raw data



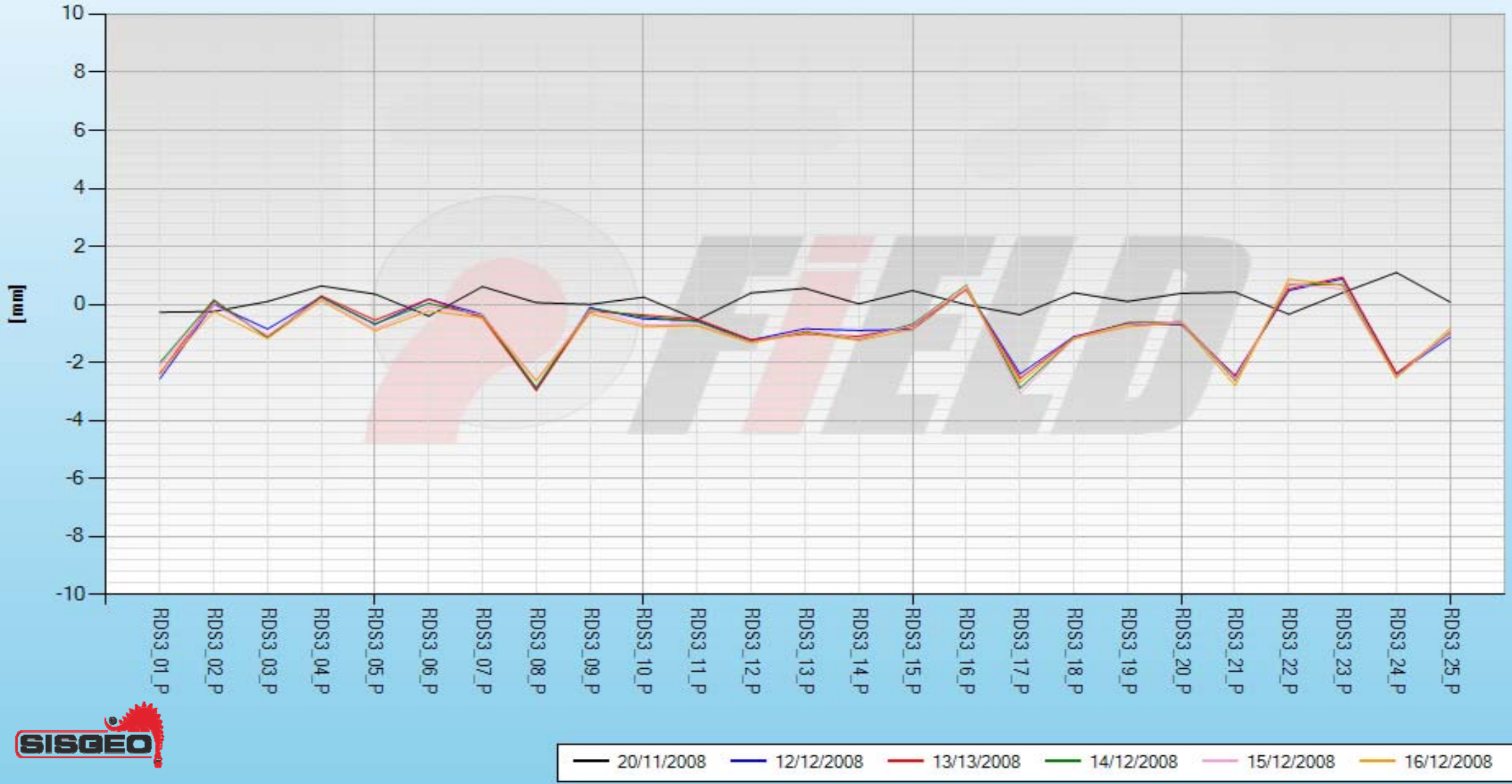
MILAN-BOLOGNA HIGH SPEED RAILWAY

RDS Longitudinal gauges – Raw data



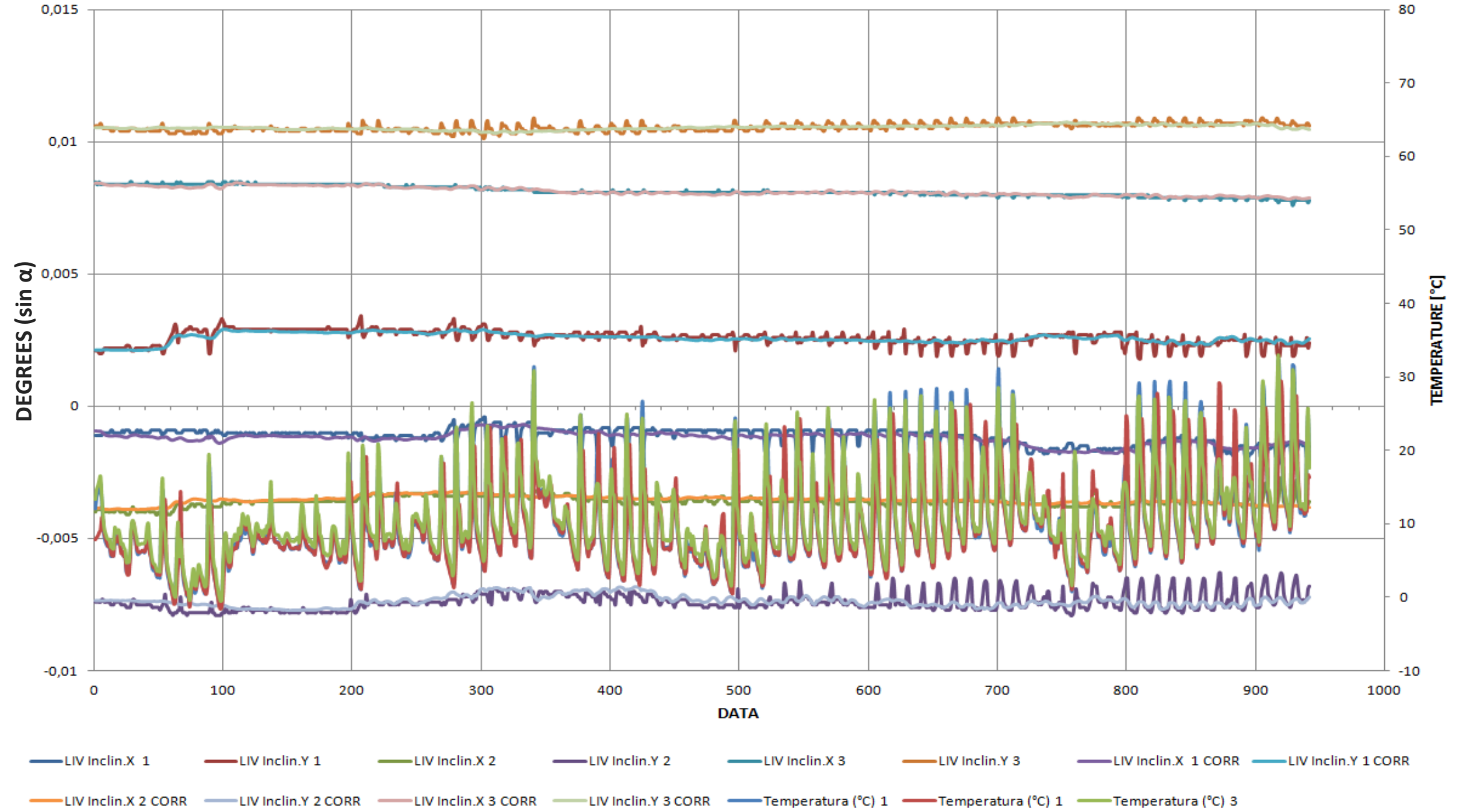
MILAN-BOLOGNA HIGH SPEED RAILWAY

Longitudinal RDS Data elaborated with FieldStat - zero reading @ 19.11.2008

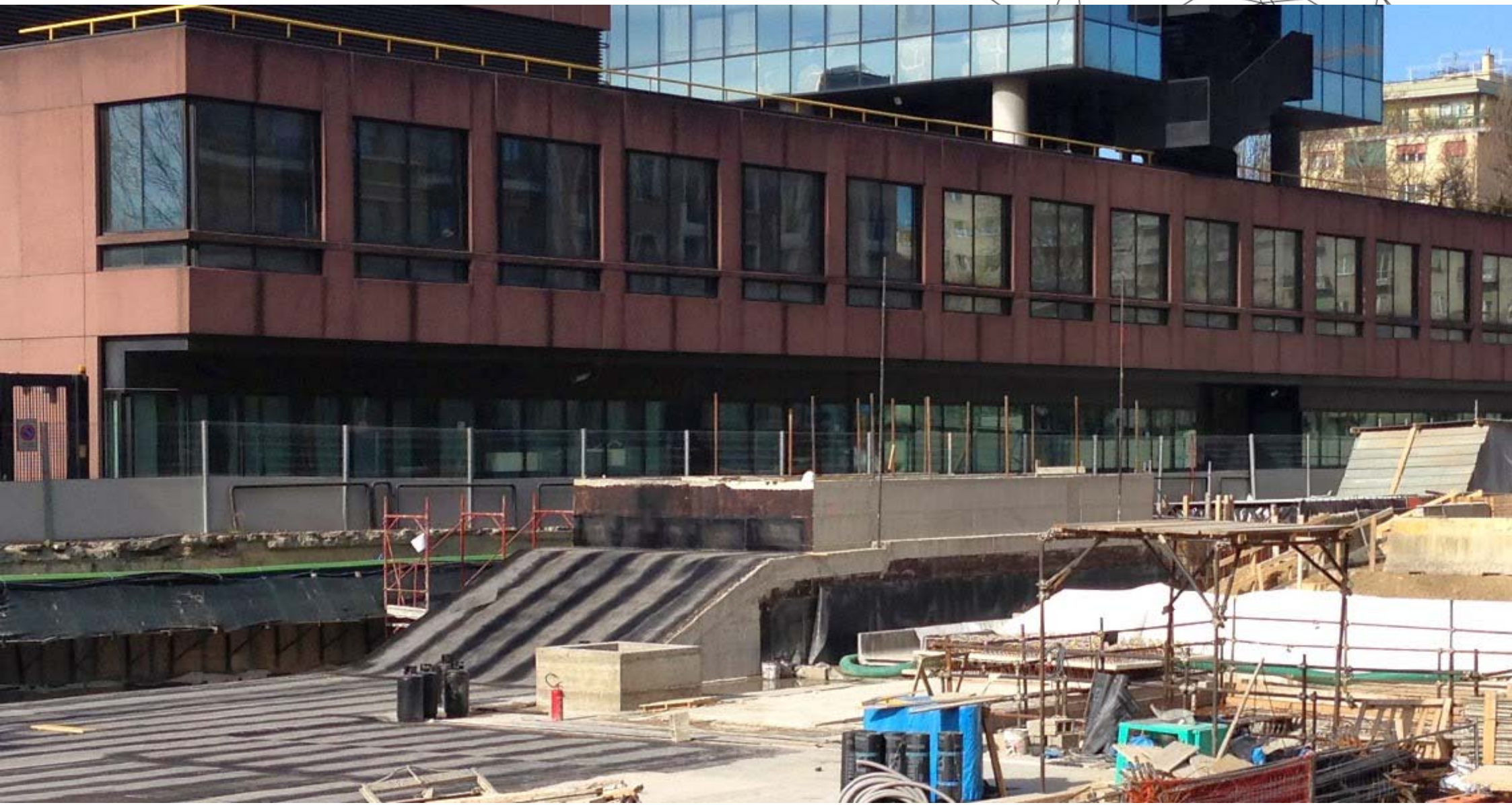


MILAN-BOLOGNA HIGH SPEED RAILWAY

New digital tiltmeters data



“DOMODOSSOLA” TRAIN STATION MONITORING, MILAN



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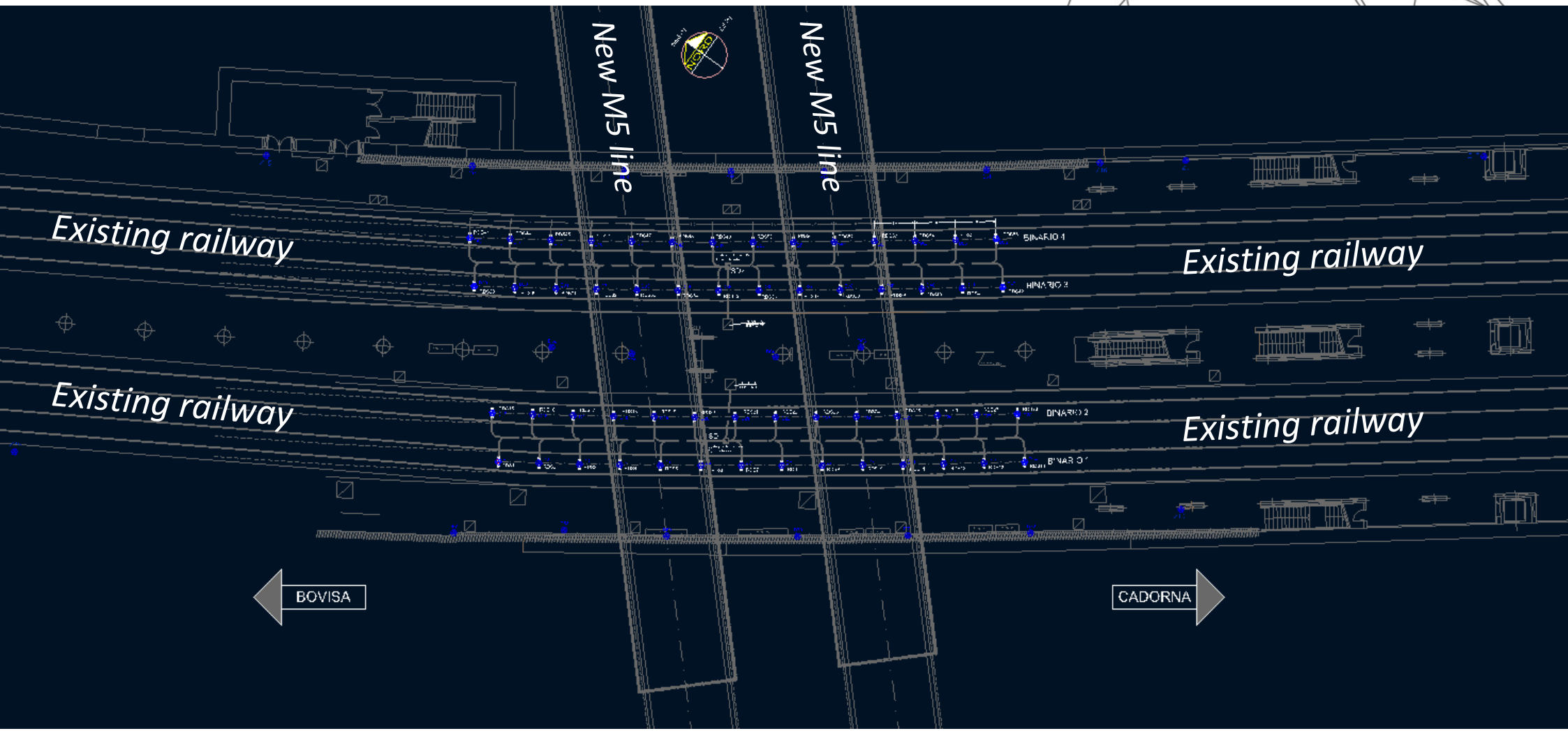
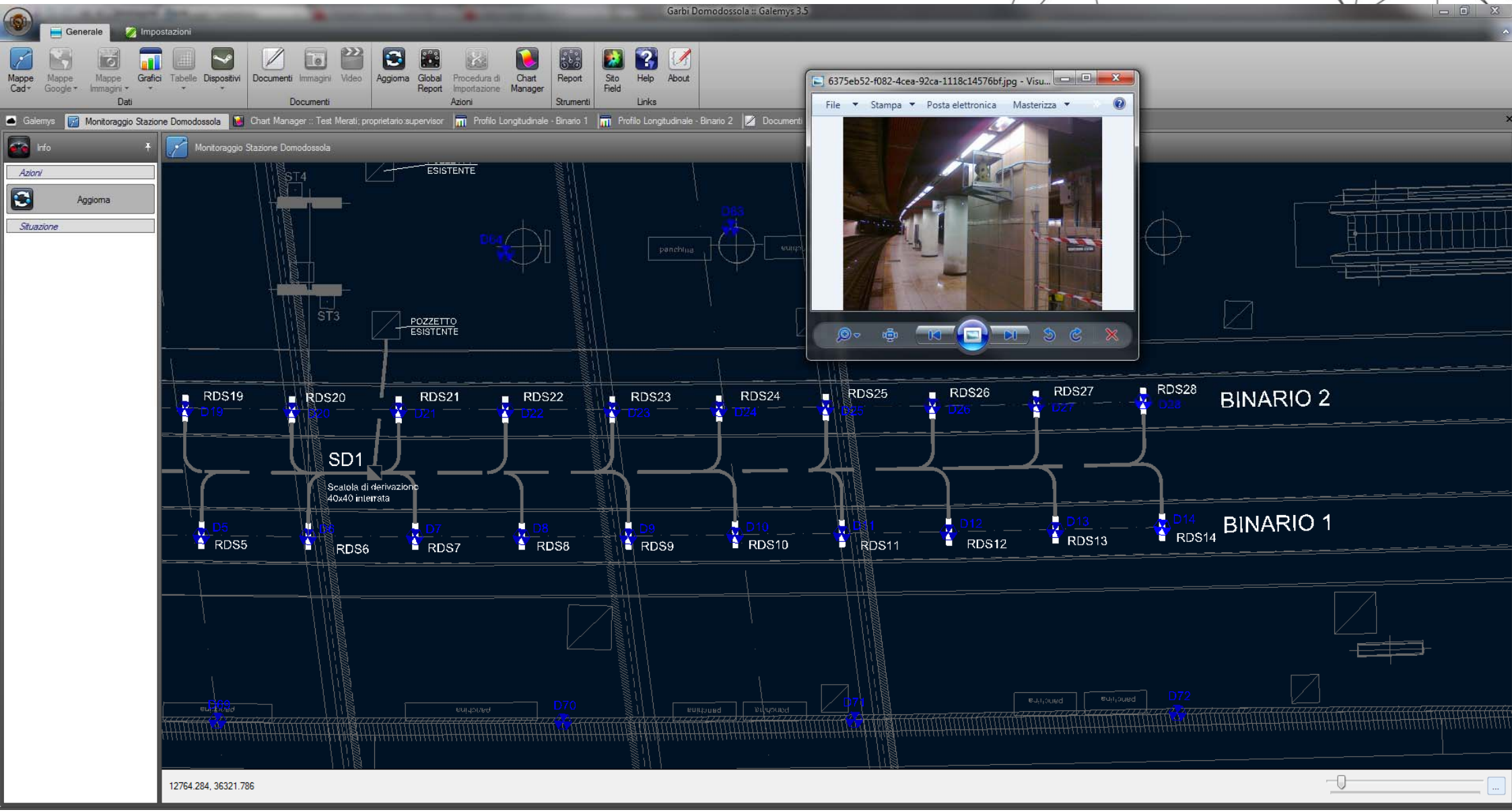


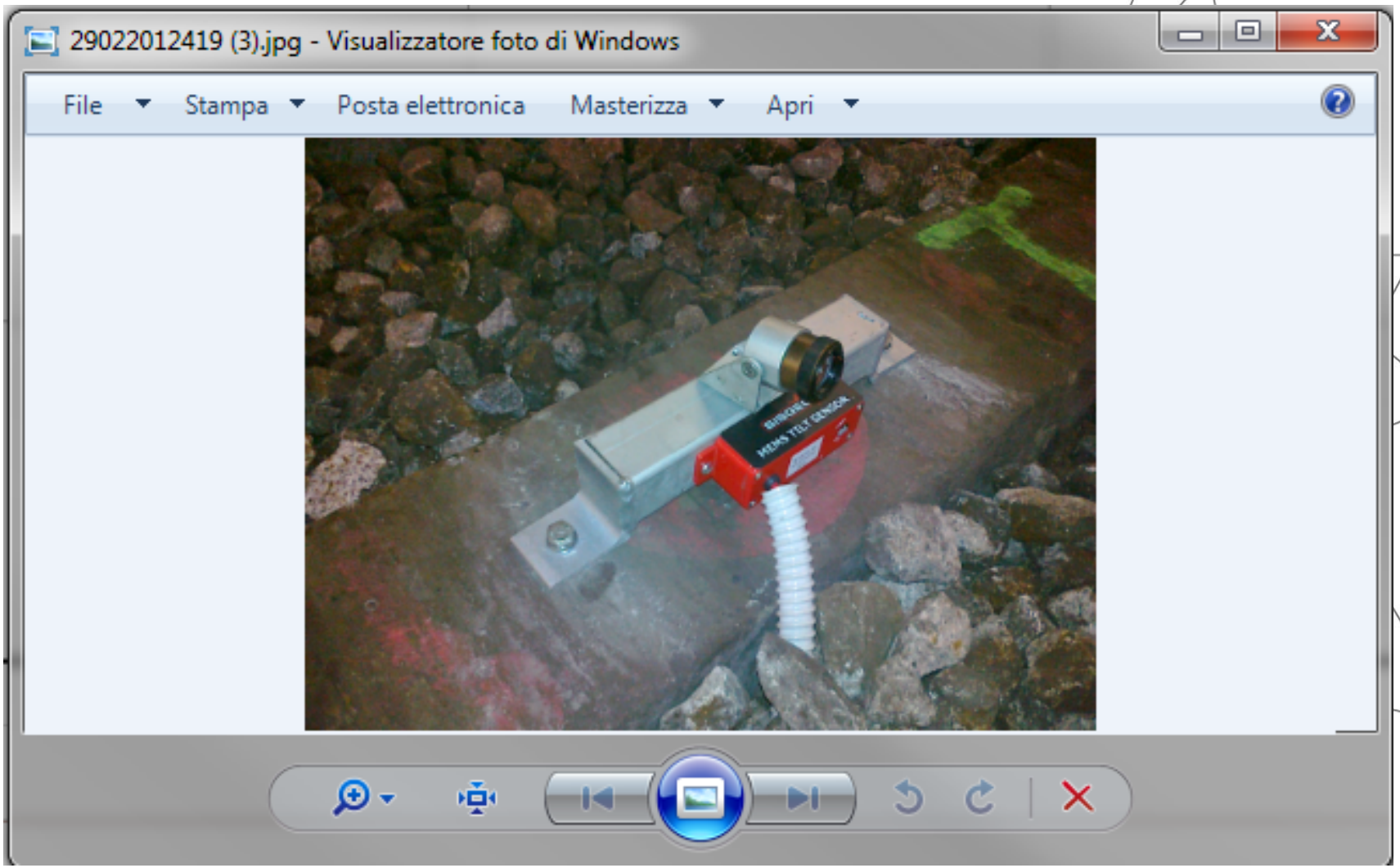
"DOMODOSSOLA" TRAIN STATION MONITORING

RDS system scheme



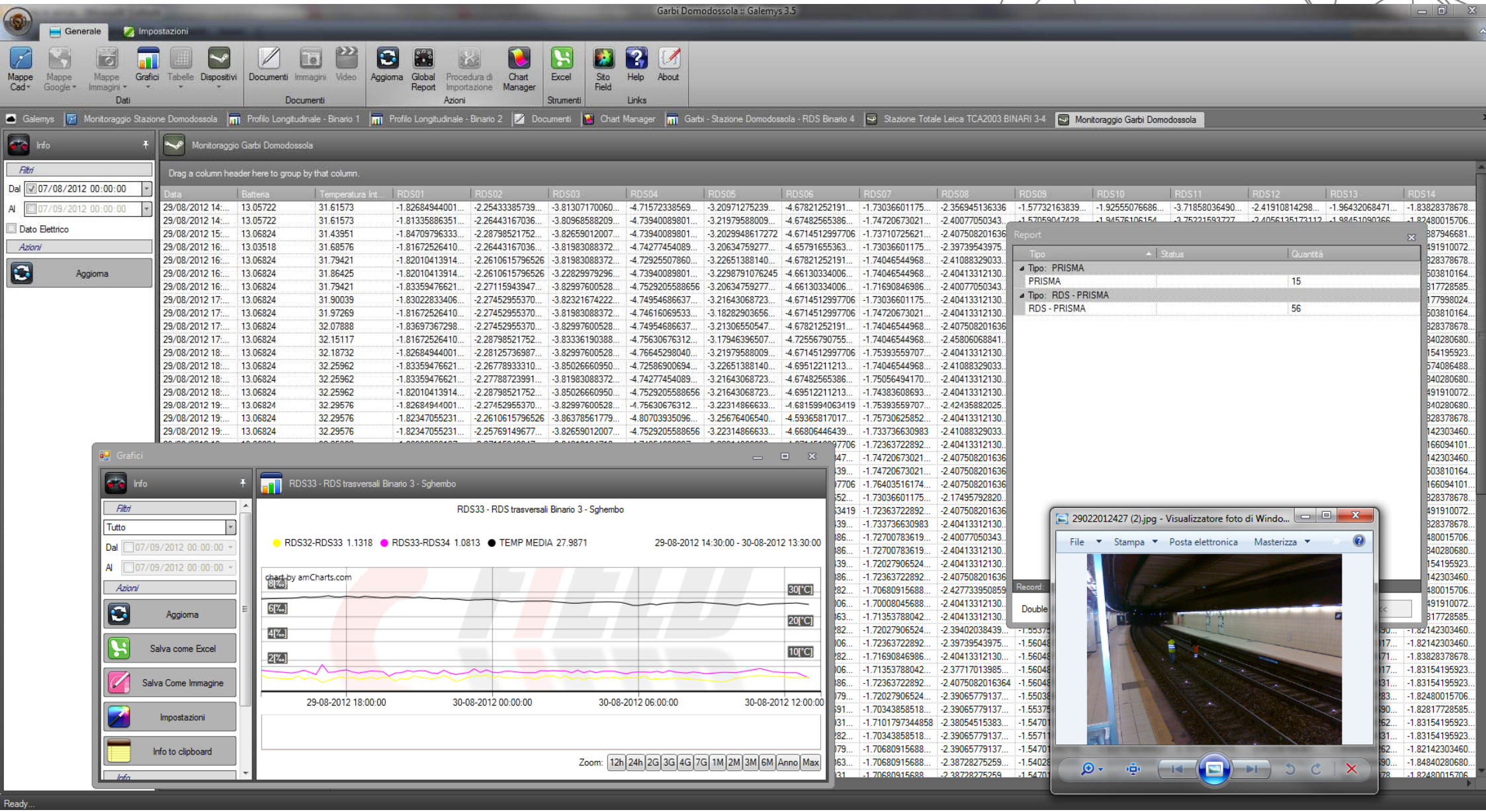
"DOMODOSSOLA" TRAIN STATION MONITORING

RDS transverse gauge + prism



"DOMODOSSOLA" TRAIN STATION MONITORING

RDS transverse gauge data and graphs



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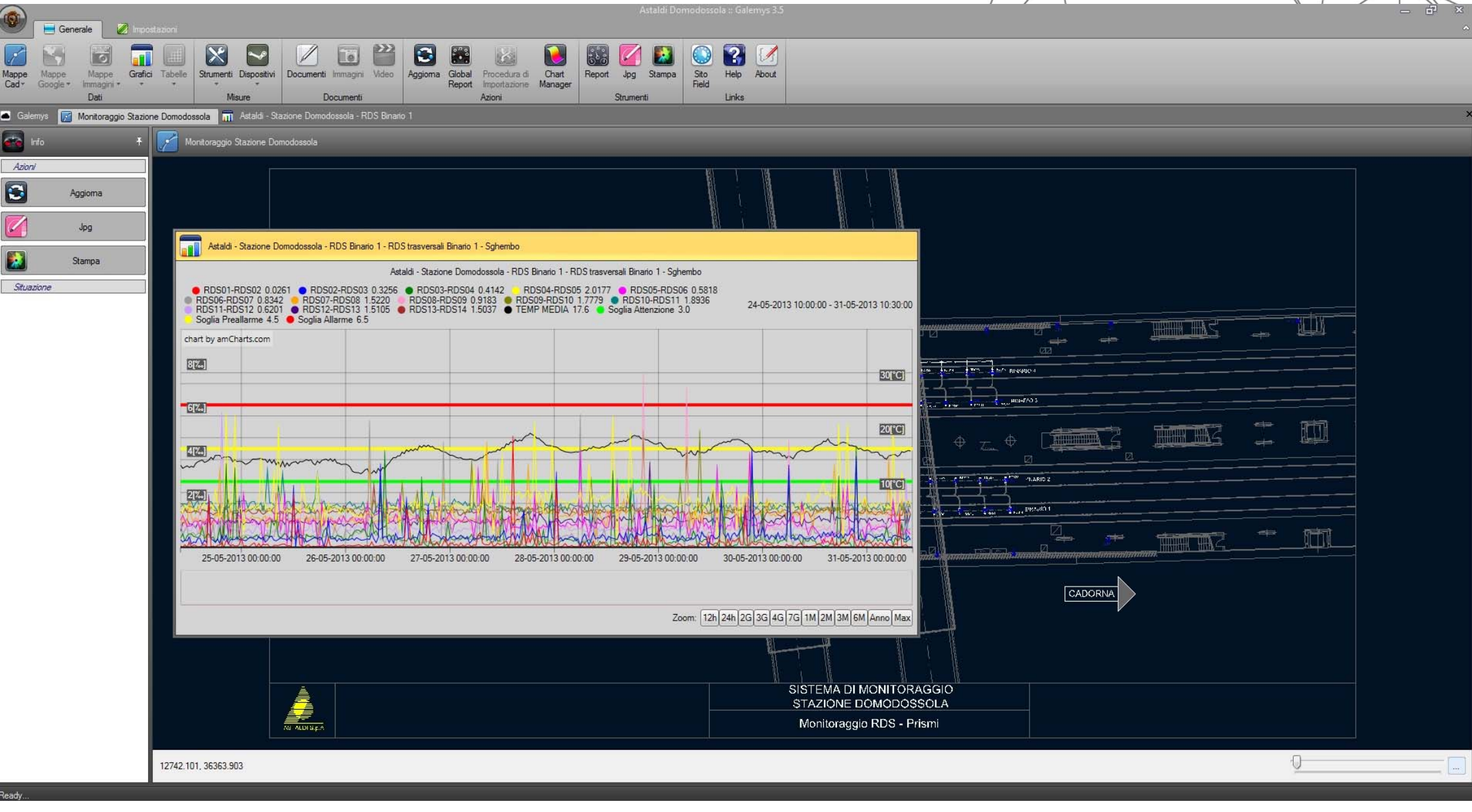
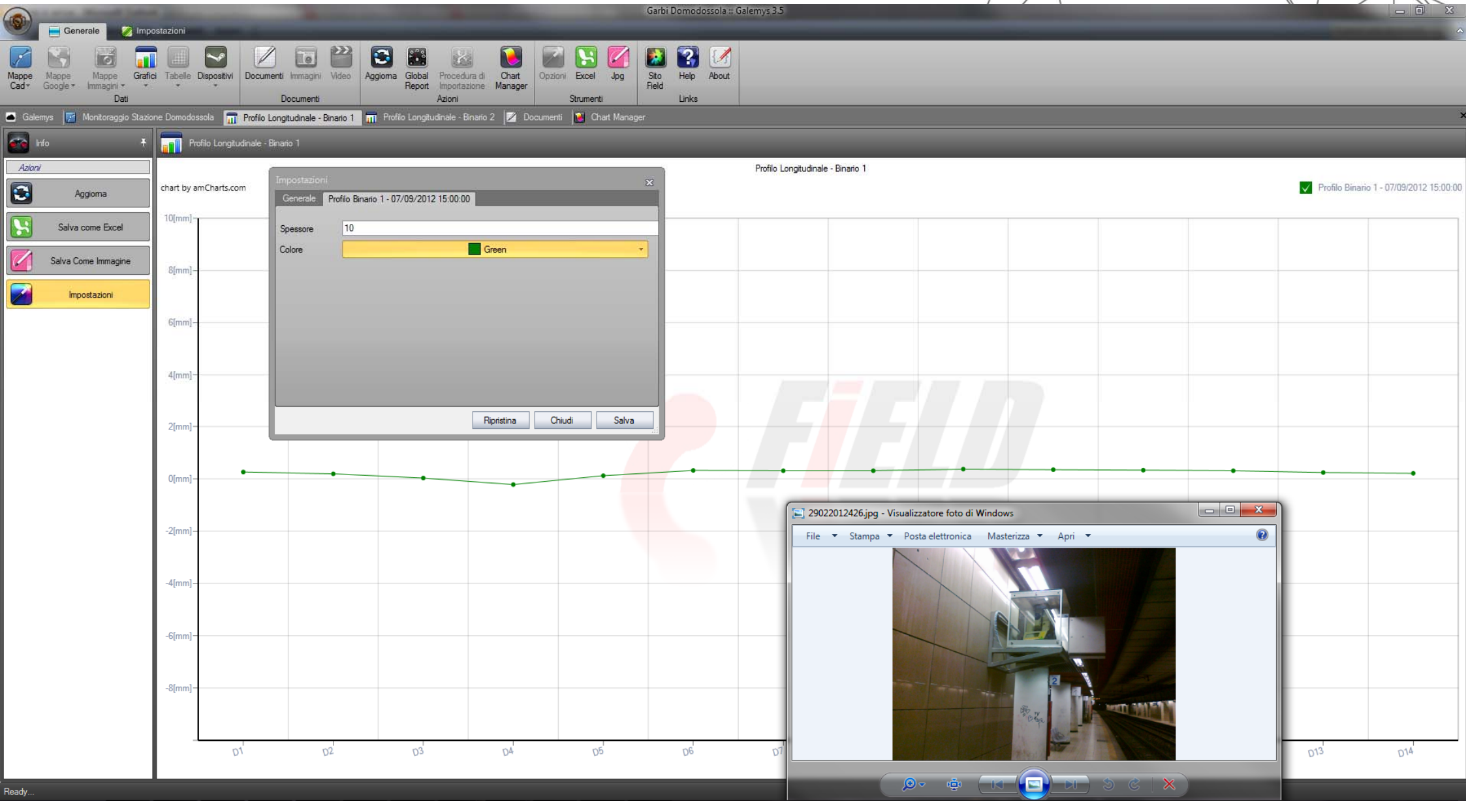


“DOMODOSSOLA” TRAIN STATION MONITORING

Railway longitudinal profile



CONCLUSINS

- *RDS System can be effectively used to guarantee the safety of the railways and the safety of the passengers.*
- *RDS can be easily installed and, if needed, could be dismounted and installed on other railway line.*
- *If correctly designed, installed and managed, RDS can offer to the Customers an amazing cost reduction by erasing the need of on-site technicians*

SISGEO®
LATINOAMERICA

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