Innovative Structural Health Monitoring for Railway Infrastructure

Snapshot

TM / November 2020
(Version 1)

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Content

- Concept
- Case Studies
- Technology
- Value Proposition

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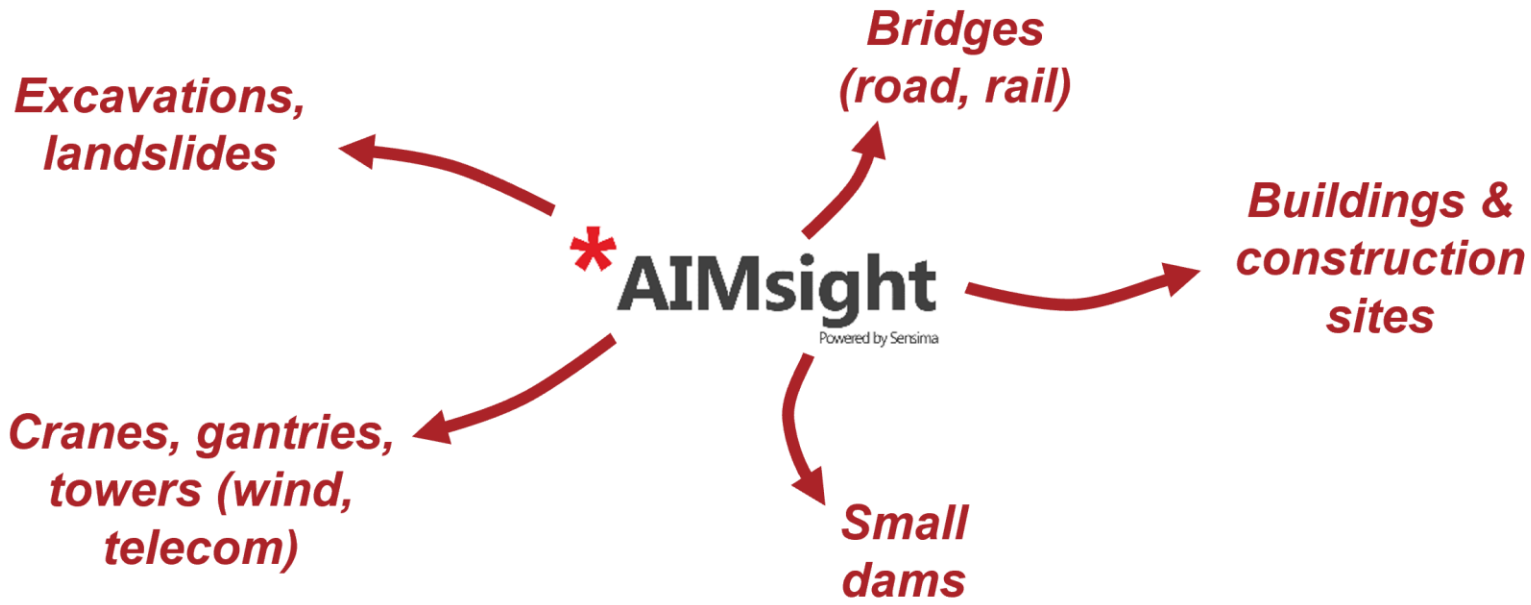
AIMSIGHT – STRUCTURAL HEALTH MONITORING

- AIMsight is SGS' innovative solution for structural health monitoring (SHM)
- AIMsight technology can integrate any SHM sensor – in particular:
  - Proprietary NDT sensors for crack monitoring
  - Proprietary smart camera sensors for optical displacements monitoring
- AIMsight technology offers solutions to many structural issues and situations:



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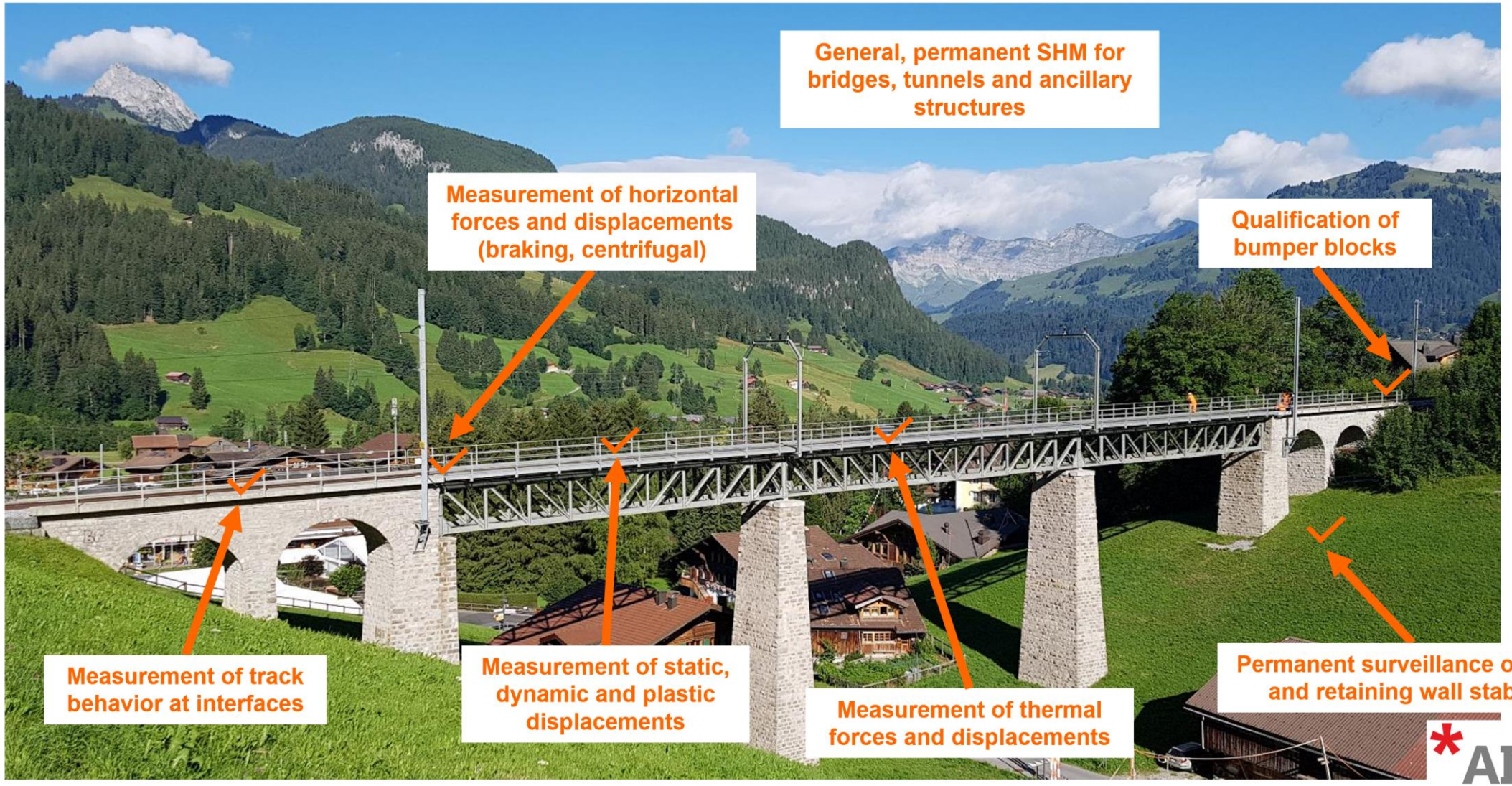
AIMSIGHT – RAILWAY APPLICATIONS



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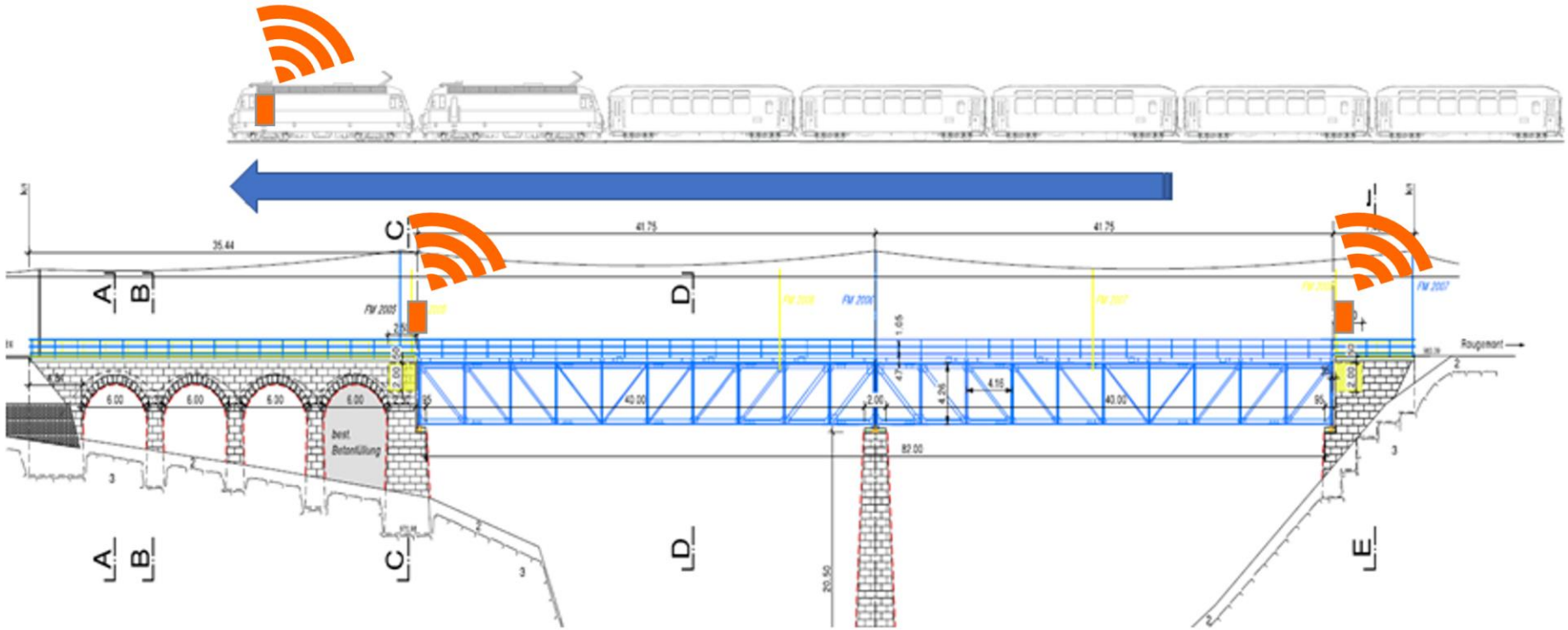
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

- Monitoring of the termal behaviour
- Dynamic monitoring approach: Dynamic measurements of emergency braking tests and commercial trains



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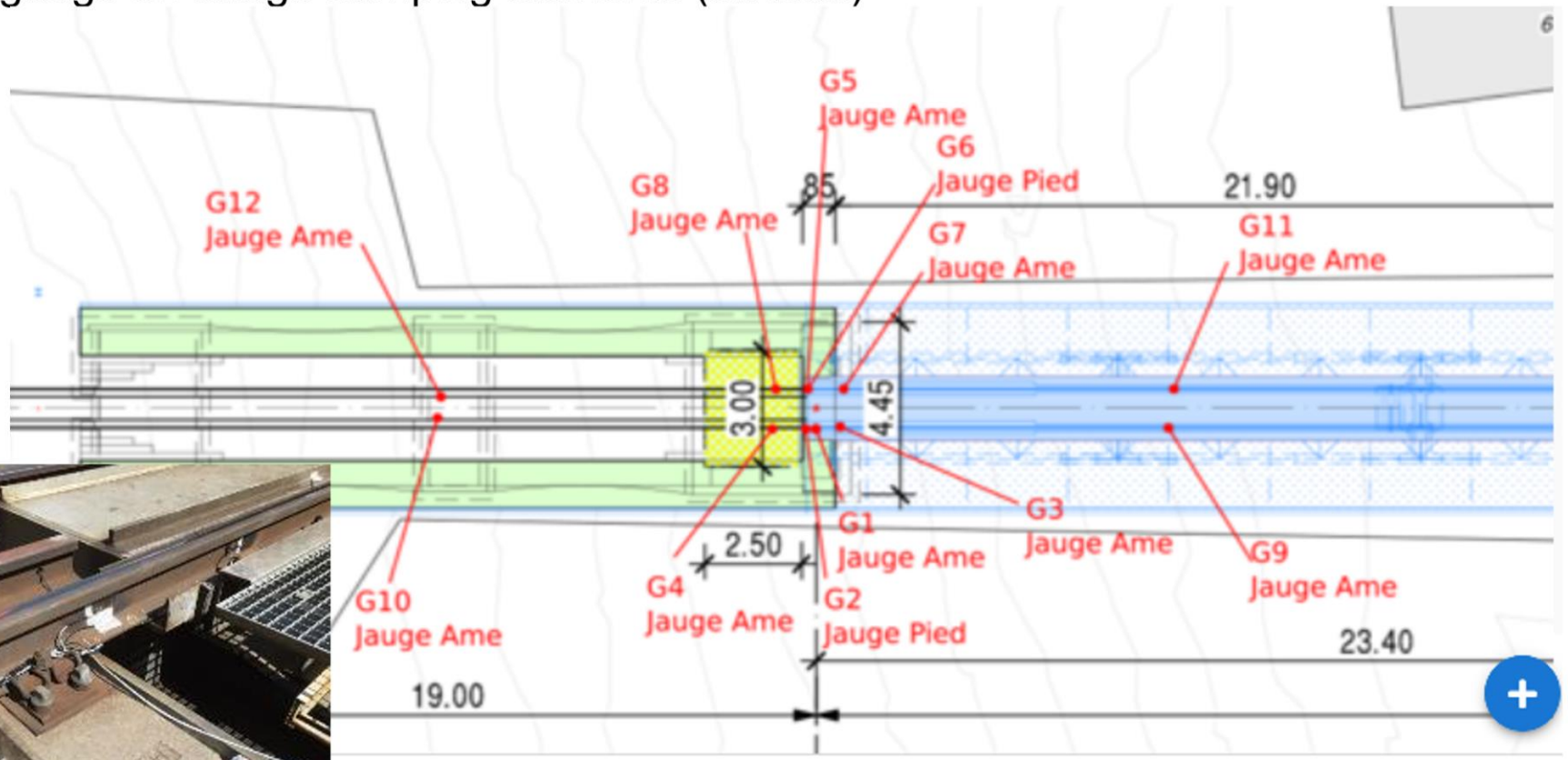
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

- Strain gauges on rails (48x)
- Strain gauge on bridge damping elements (8x total)



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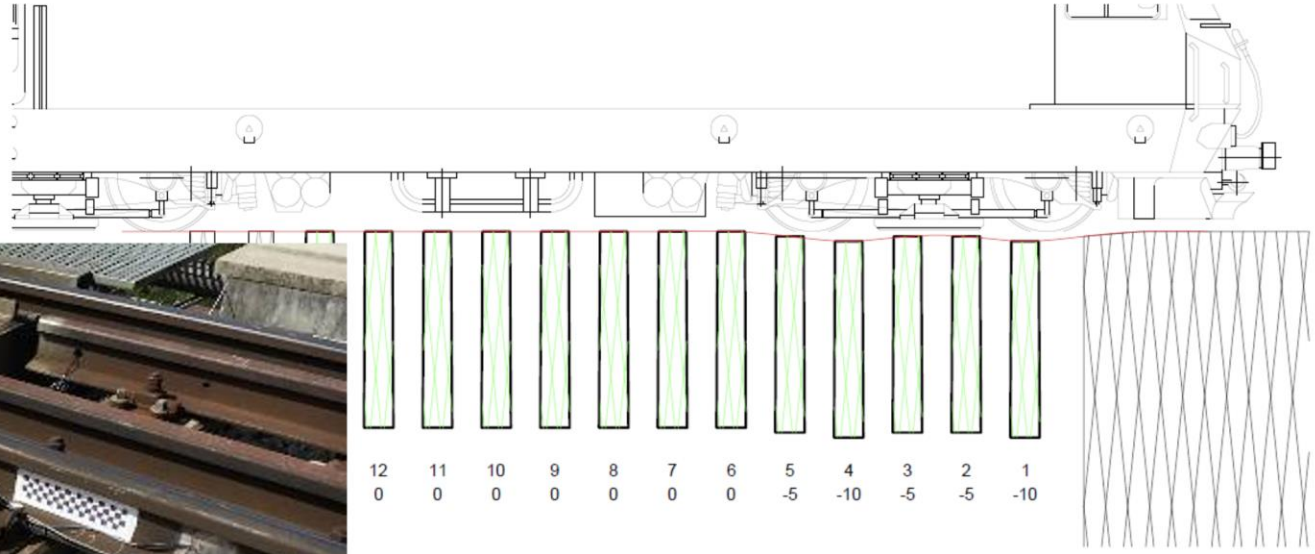
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

- Optical 2D displacement monitoring of rail ties



Video

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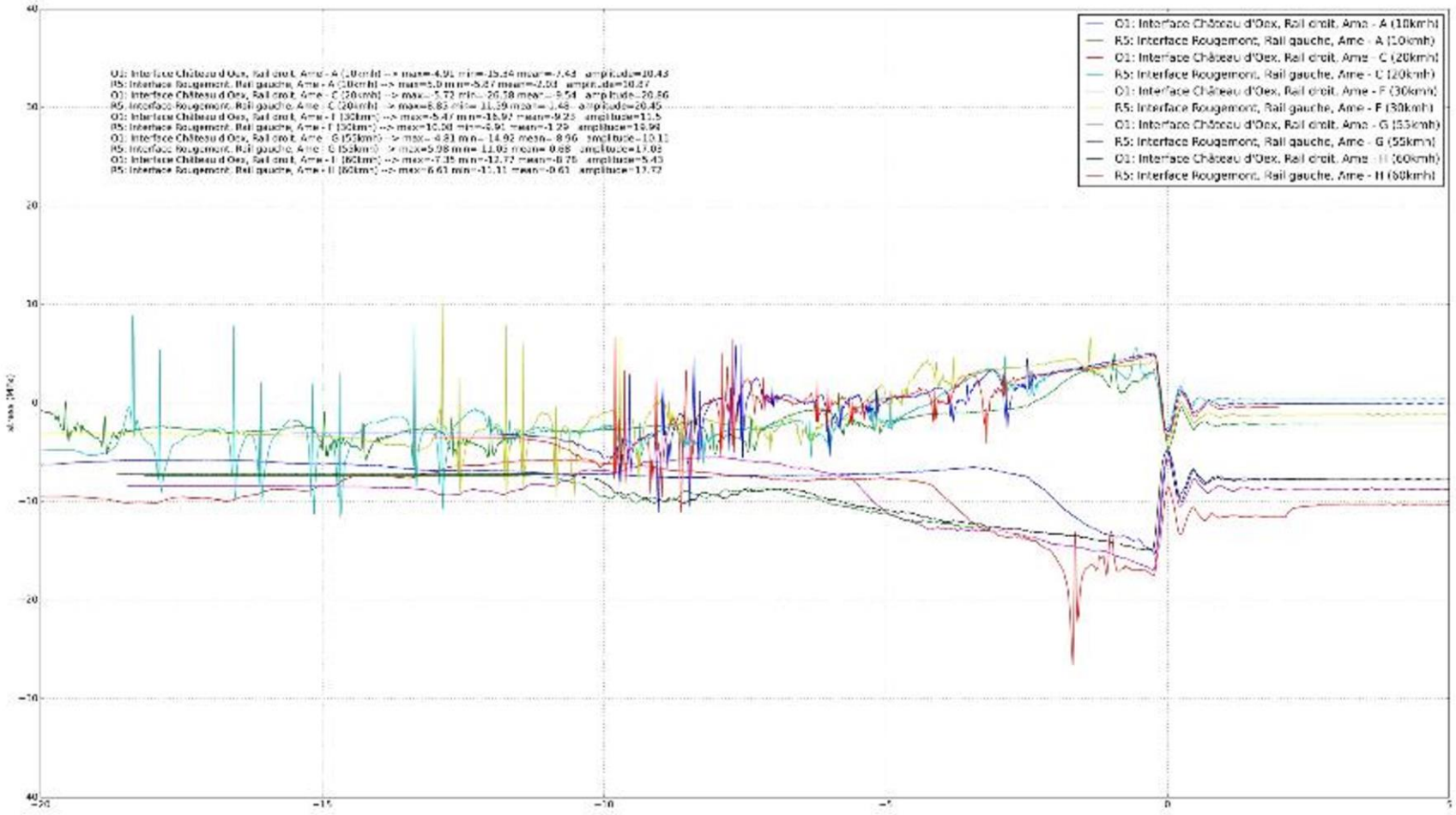
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

Strain gauges:

- Strain in rails during emergency braking



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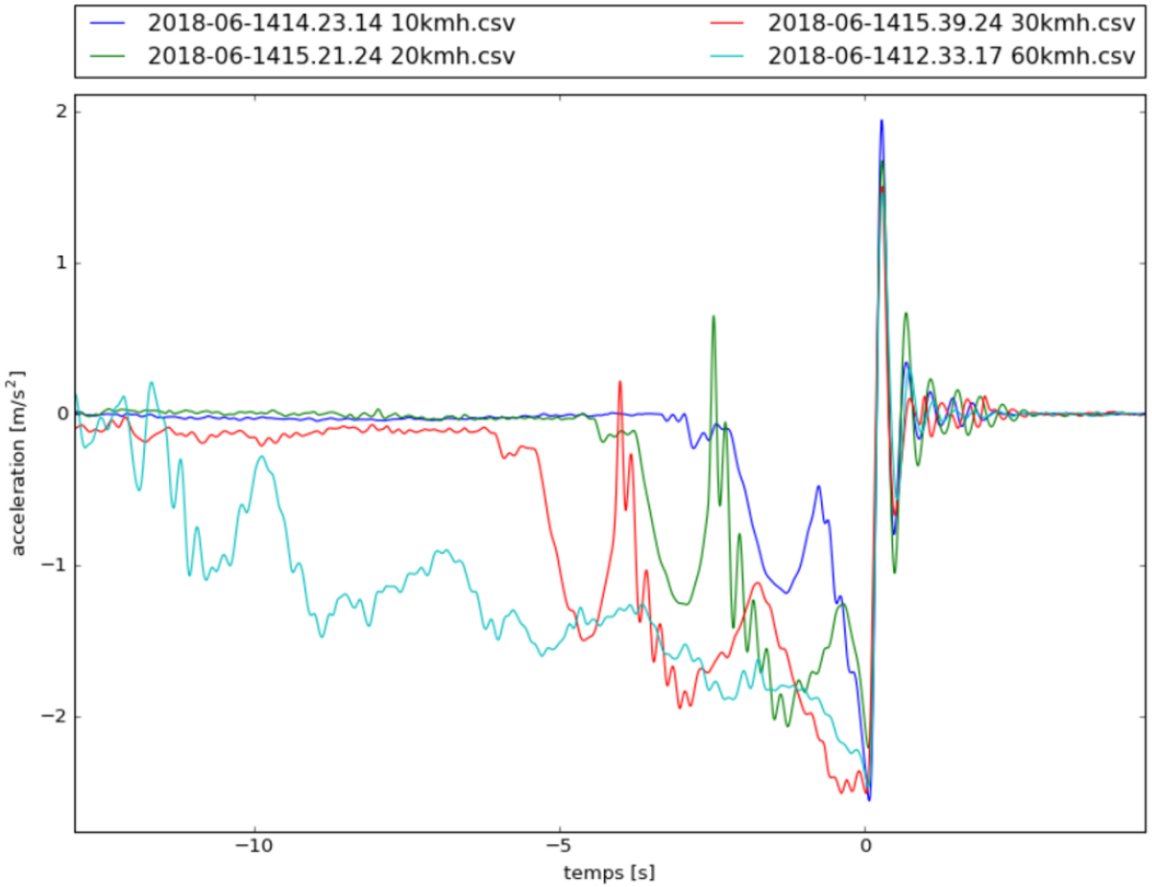
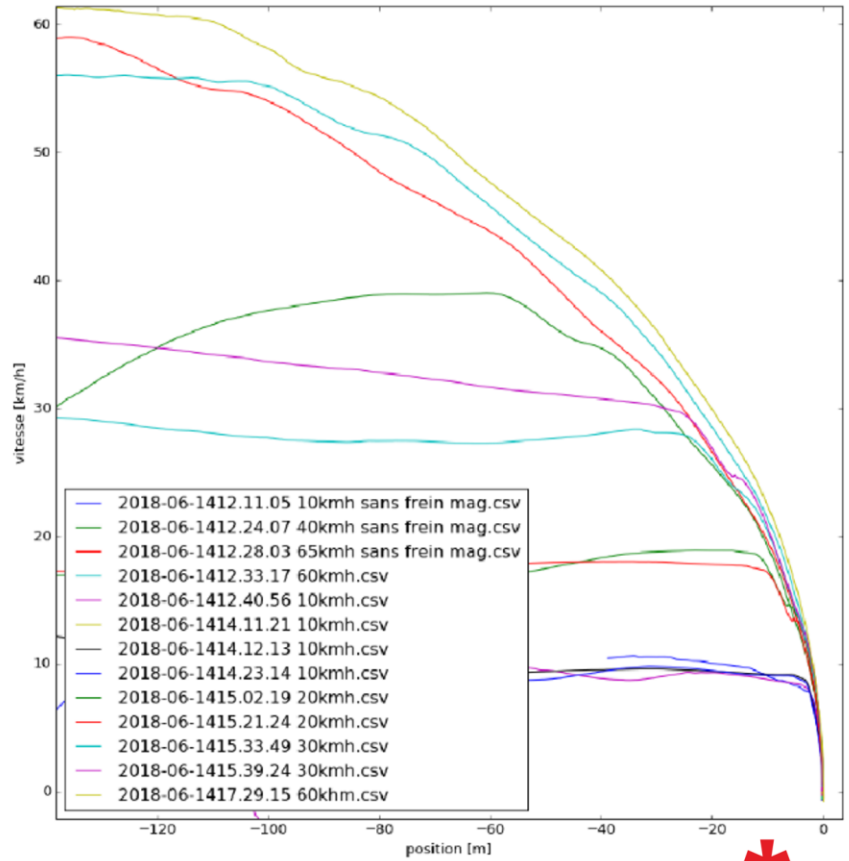
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

Accelerometer installed in the train:

- Total horizontal input forces during braking





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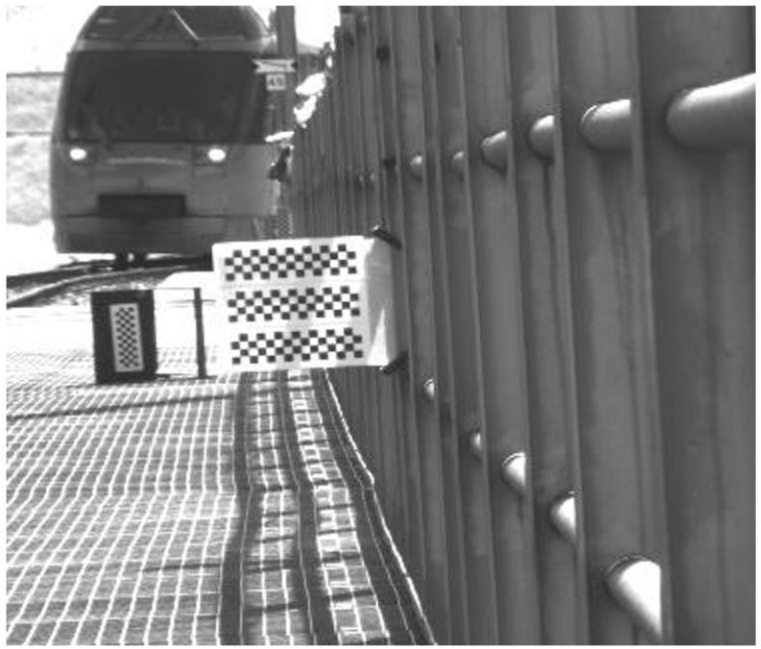
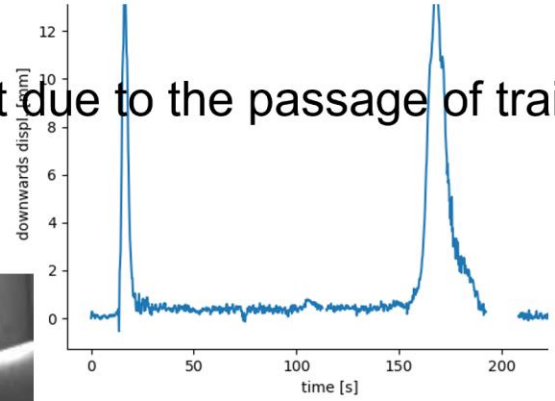
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND

Optical sensors:

- Vertical mid-span displacement due to the passage of trains





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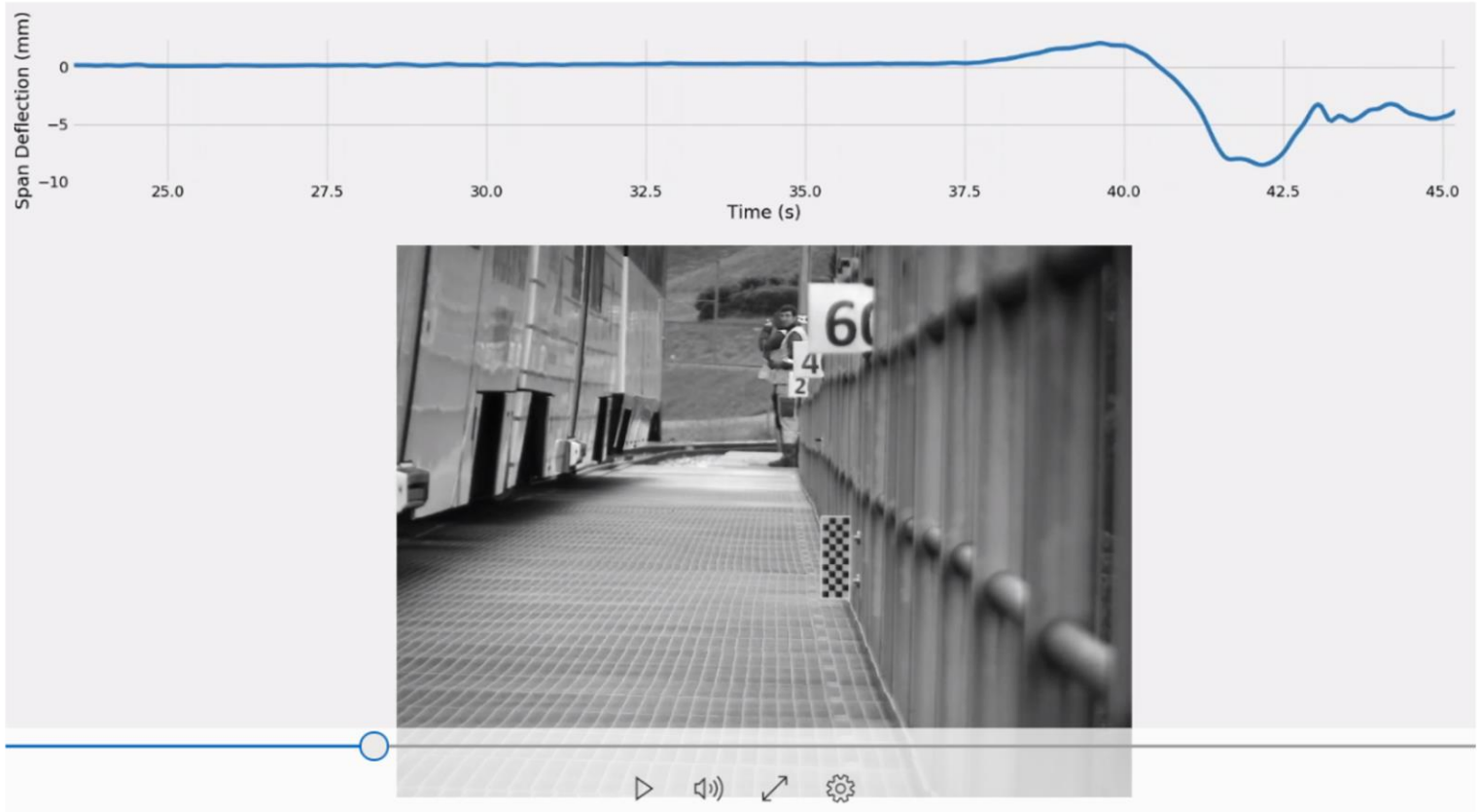
CASE STUDY: BRIDGE USE MONITORING, SWITZERLAND



Video

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CASE STUDY: RACK RAILWAY MONITORING, SWITZERLAND

Preparation of the compliance documentation for a historical bridge

- Measurement of the horizontal forces and rail motion
  - Optical 2D displacement monitoring of rail ties
- Measurements of strain in the tracks and the racks
- Solar-powered autonomous measurement system
- Long-term monitoring
- Dynamic tests: Emergency braking measurements

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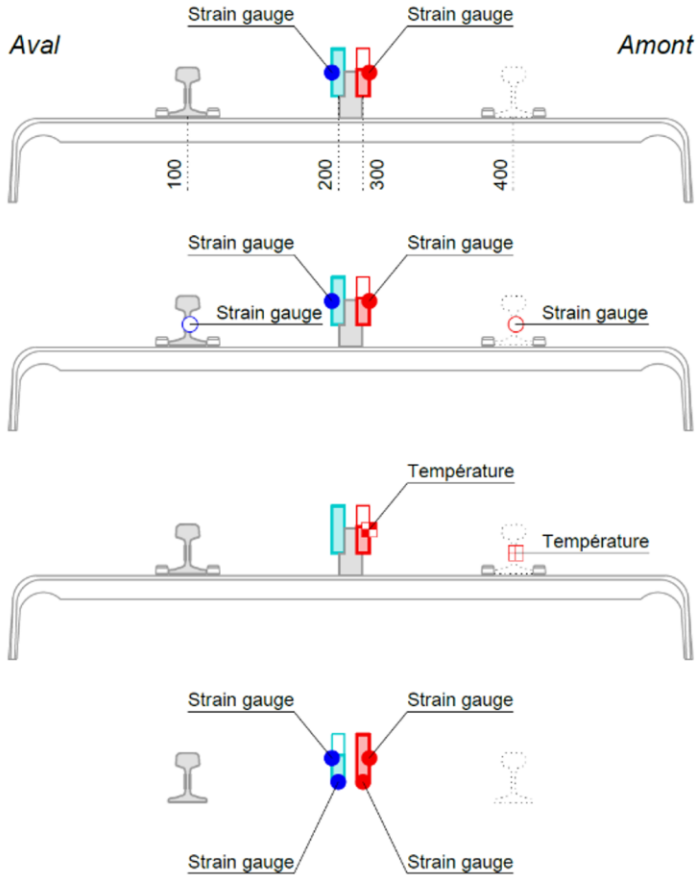
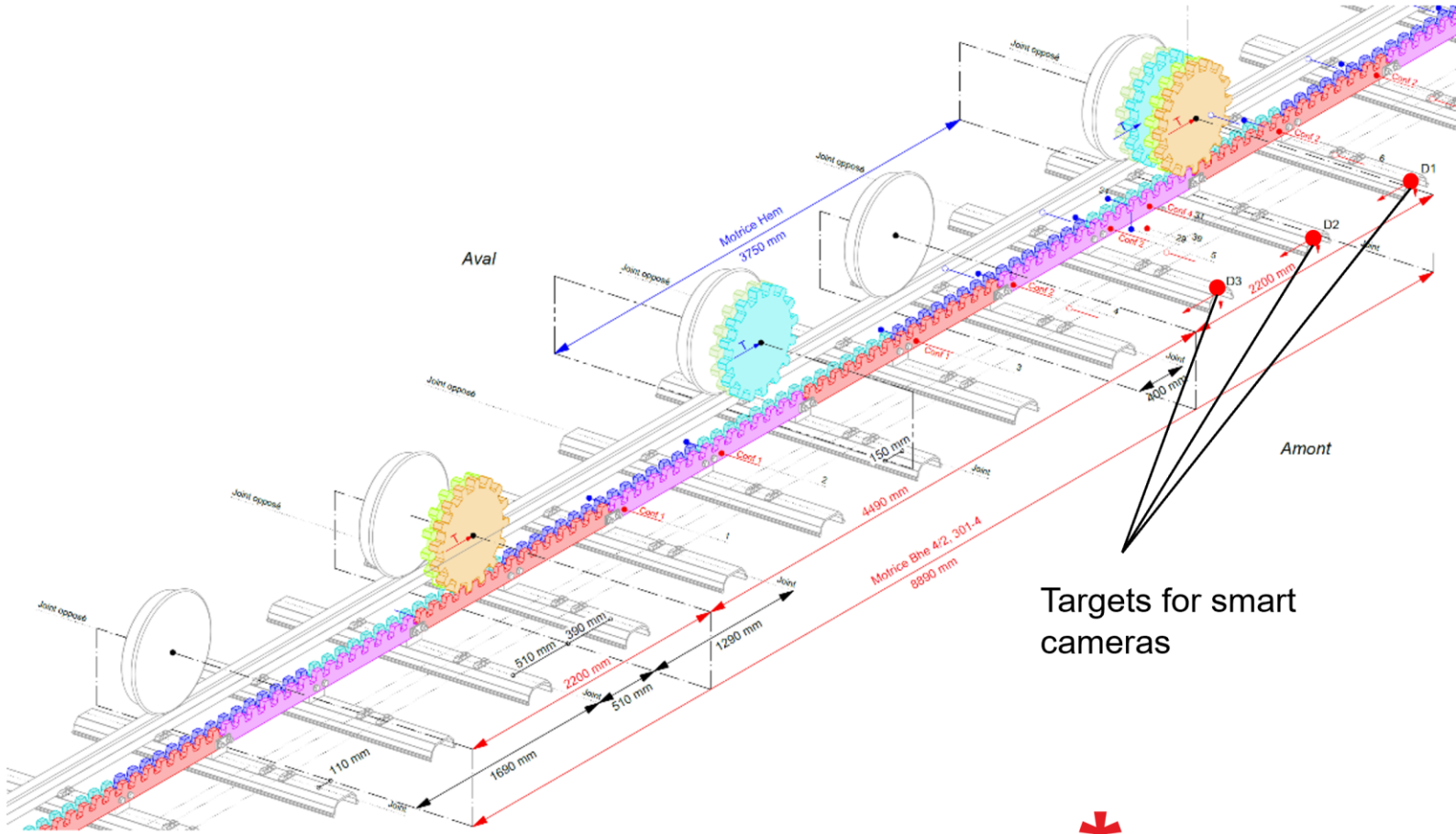
CASE STUDY: RACK RAILWAY MONITORING, SWITZERLAND

Sensor Locations





Targets for smart cameras

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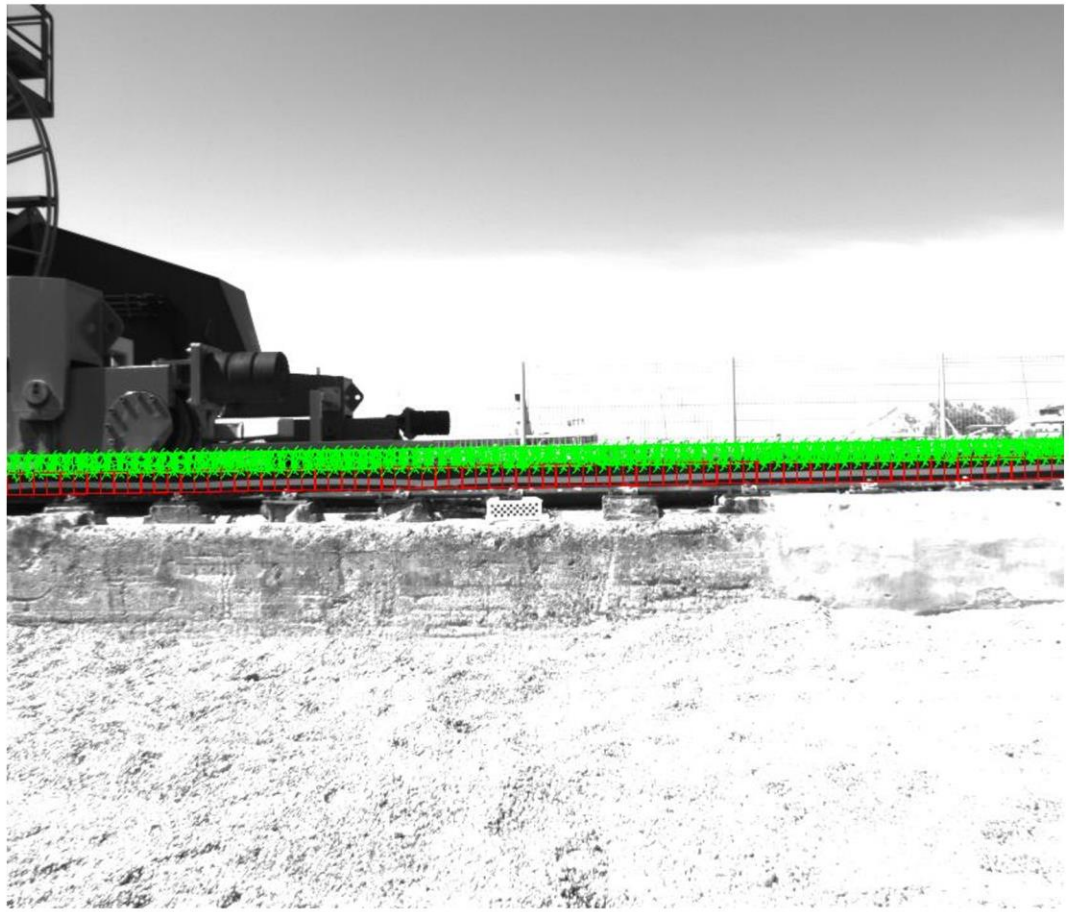
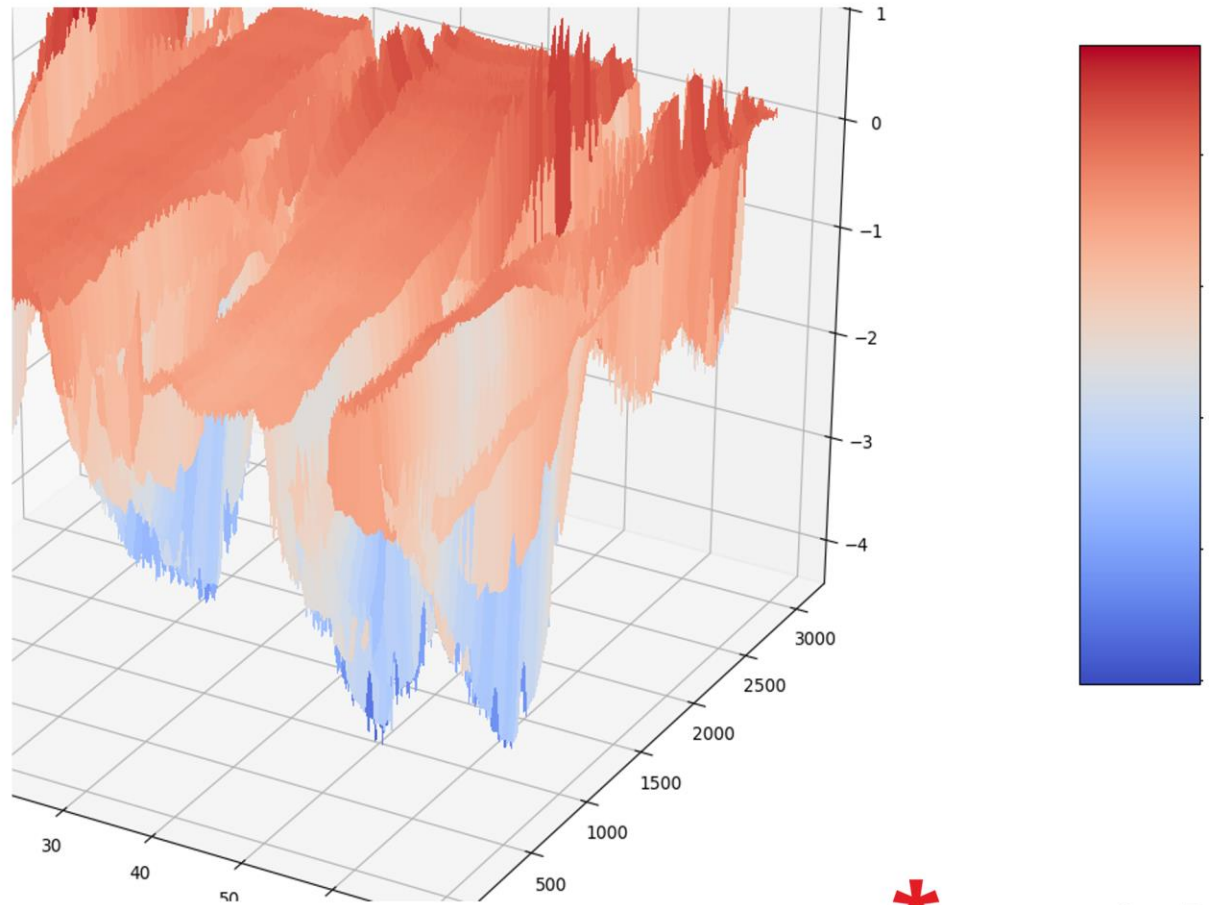
CASE STUDY: CRANE ON RAILS, SWITZERLAND

- High-resolution rail motion measurement and diagnostics





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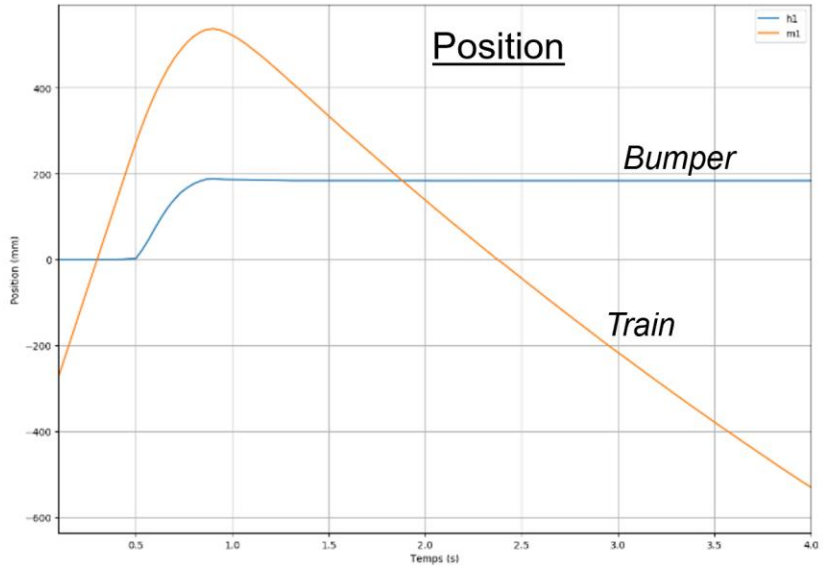
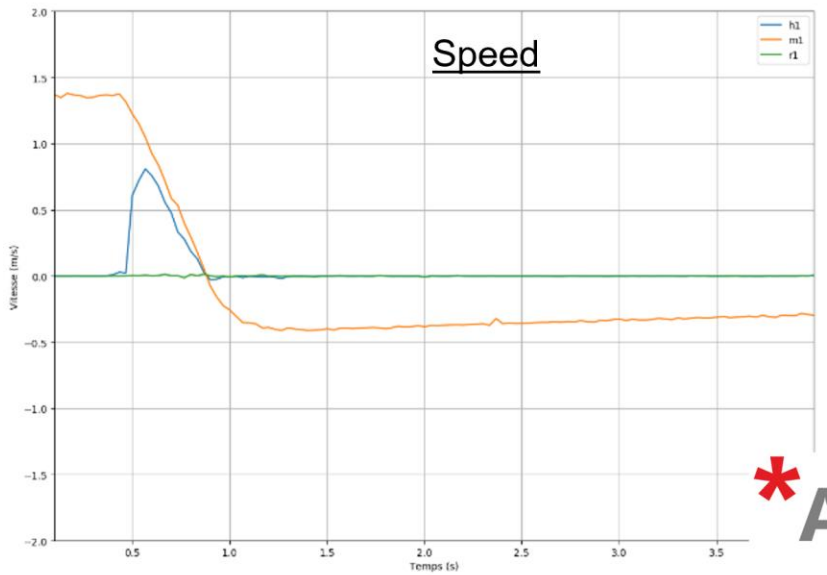
CASE STUDY: BUMPER BLOCK BEHAVIOUR, SWITZERLAND

Video





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CASE STUDY: PILOT BRIDGE IN HAMBURG, GERMANY

- Highway steel bridge
- Construction year: 1960
- Highly corrosive environment; significant dynamic loading
- Higher frequency of inspection needed to extend asset life
- 2013 vertical cracks discovered at the abutment cross sections

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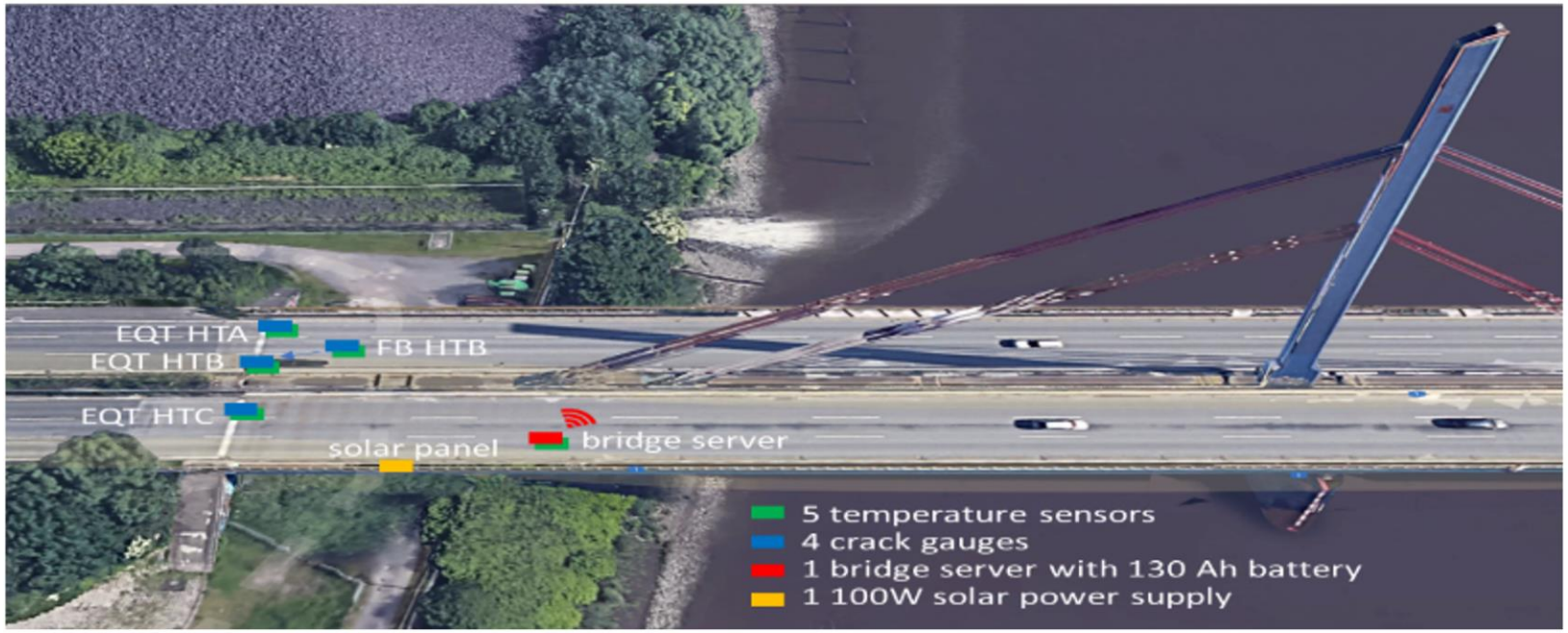
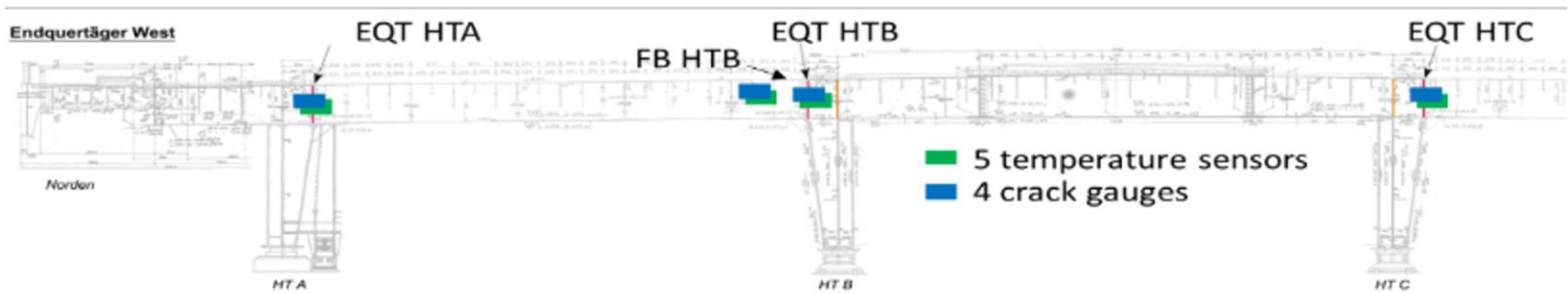
CASE STUDY: PILOT BRIDGE IN HAMBURG, GERMANY



Location of monitoring sensors:



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CASE STUDY: HIGHWAY BRIDGE IN HAMBURG, GERMANY

AIMsight's crack monitoring sensors measure initiation and growth of specific cracks

Sensor 1: EQT HTC

Sensor PN	**EMXBA0**
Sensor type	0001B_RECT_15X20_SHM
Sensor PS	AD196N
Location on plan	EQT HTC
Description	Crack, with welded plate repair
Comment	Installation on 30.05.18; tip of crack on sensor loop #2
Status (01.10.18)	Sensor is live; no crack growth since installation

Before repair (2013)

Before and after installation of sensor (2018)

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CASE STUDY: HIGHWAY BRIDGE IN HAMBURG, GERMANY

Video

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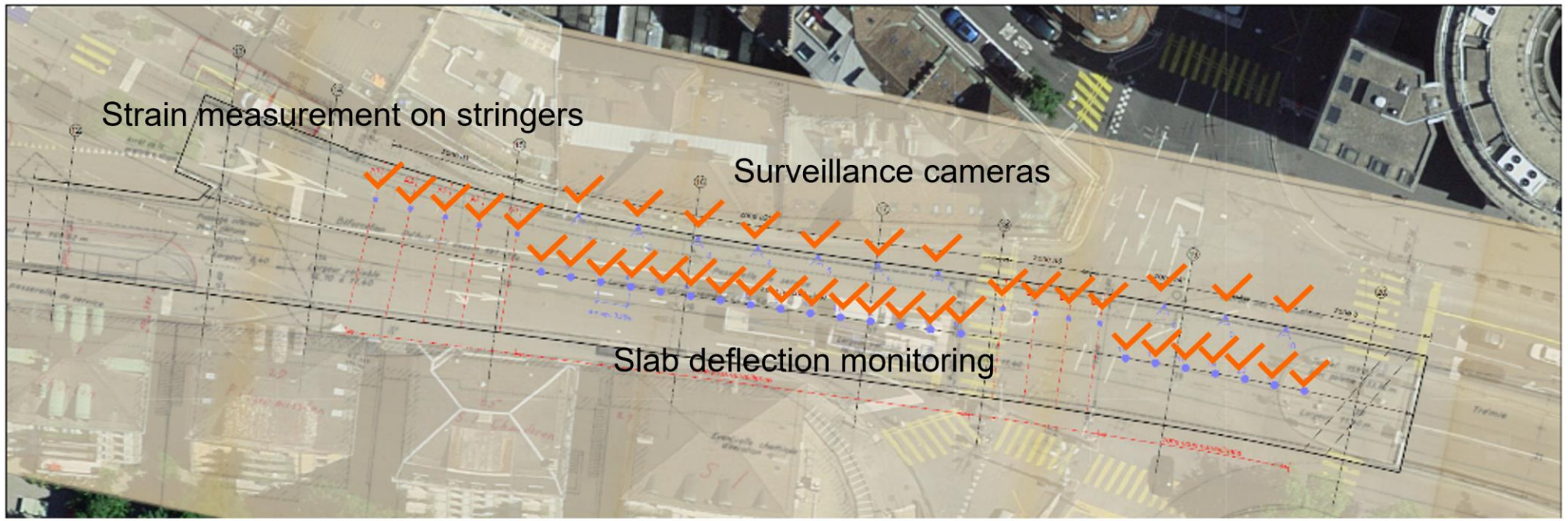
CASE STUDY: CUT-AND-COVER TUNNEL MONITORING, SWITZERLAND

- SHM of a prestressed concrete structure



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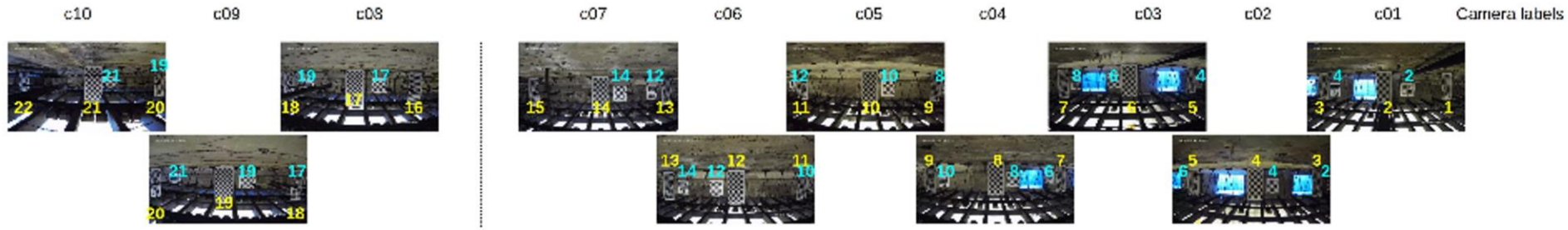
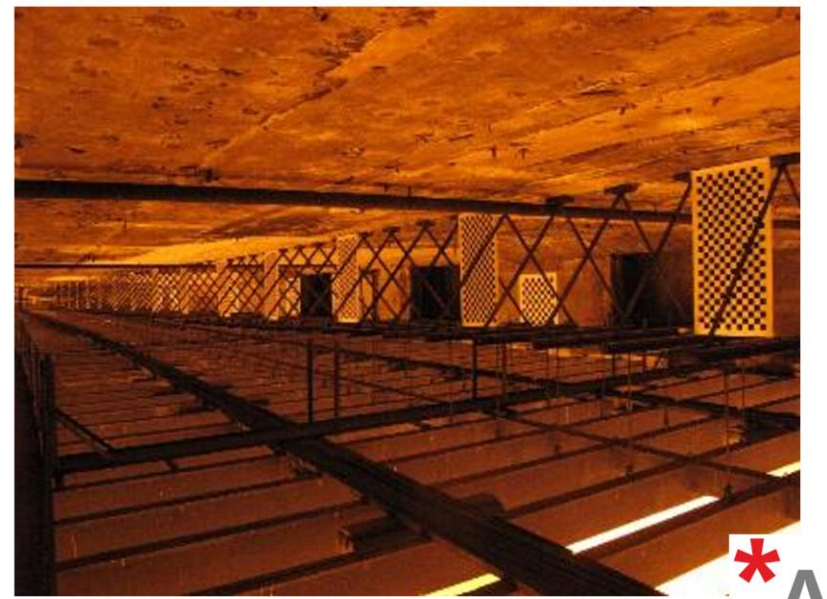
CASE STUDY: CUT-AND-COVER TUNNEL MONITORING, SWITZERLAND

- Static deflection monitoring





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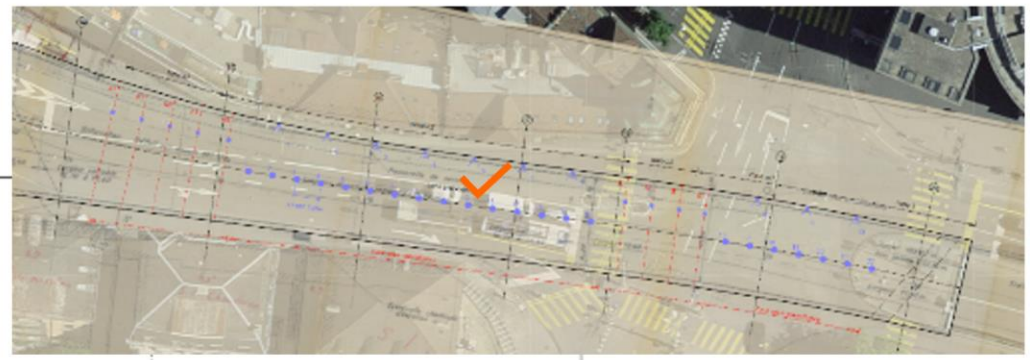
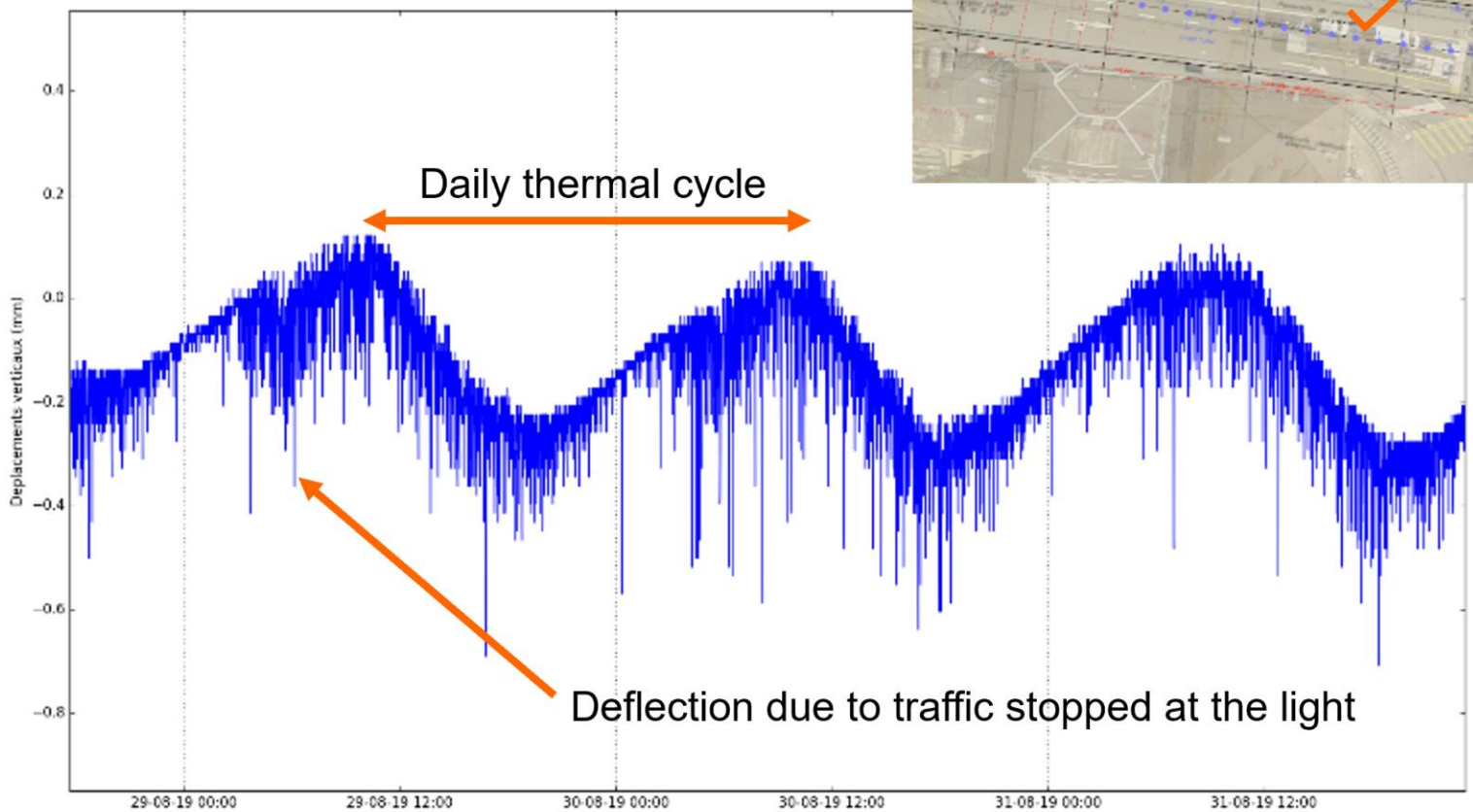
CASE STUDY: CUT-AND-COVER TUNNEL MONITORING, SWITZERLAND

- Long-term & dynamic monitoring data





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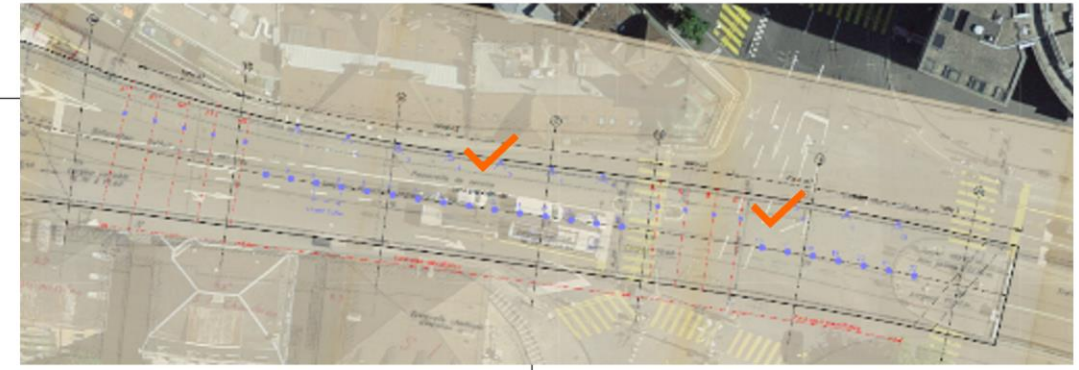
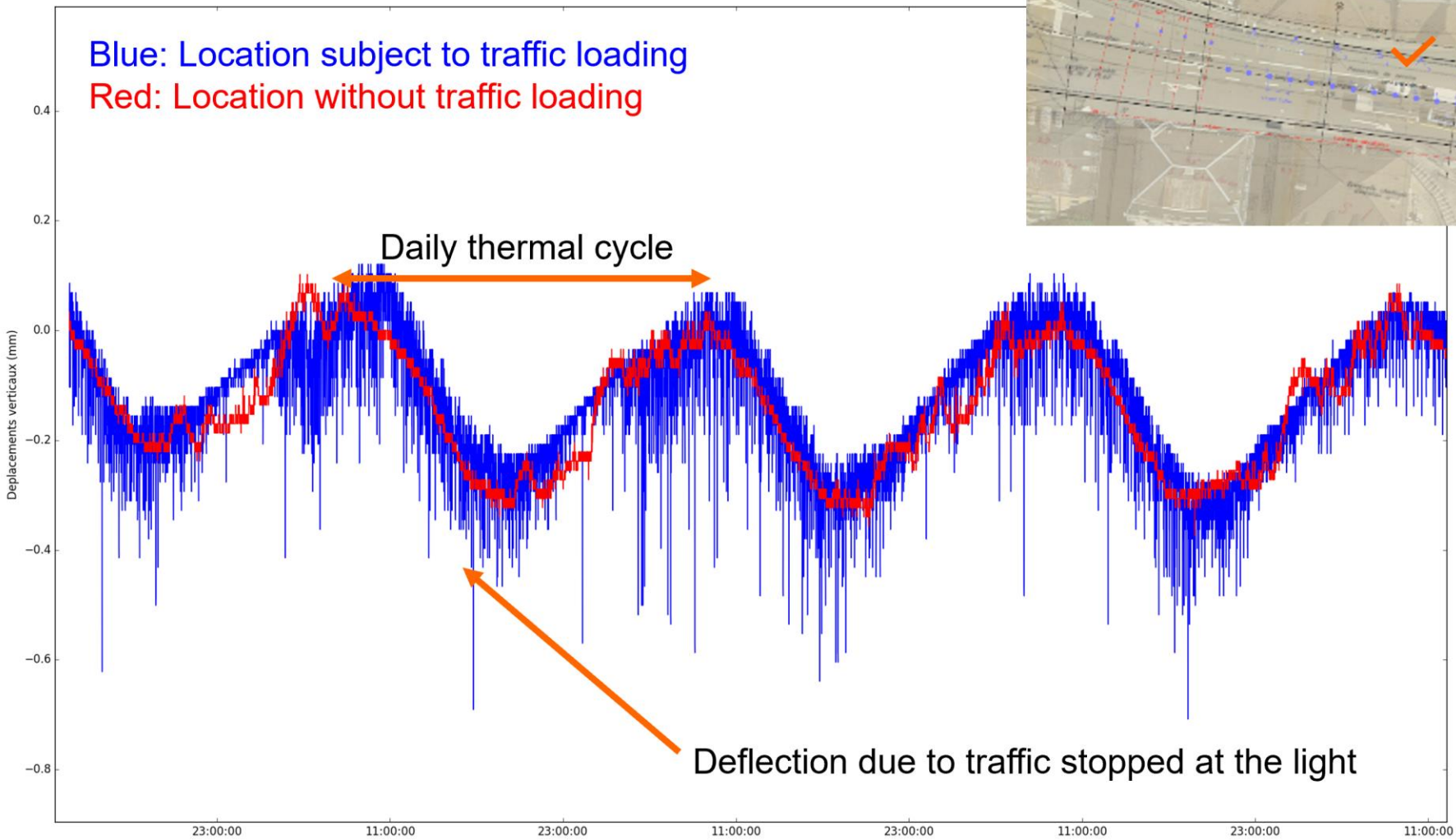
CASE STUDY: CUT-AND-COVER TUNNEL MONITORING, SWITZERLAND





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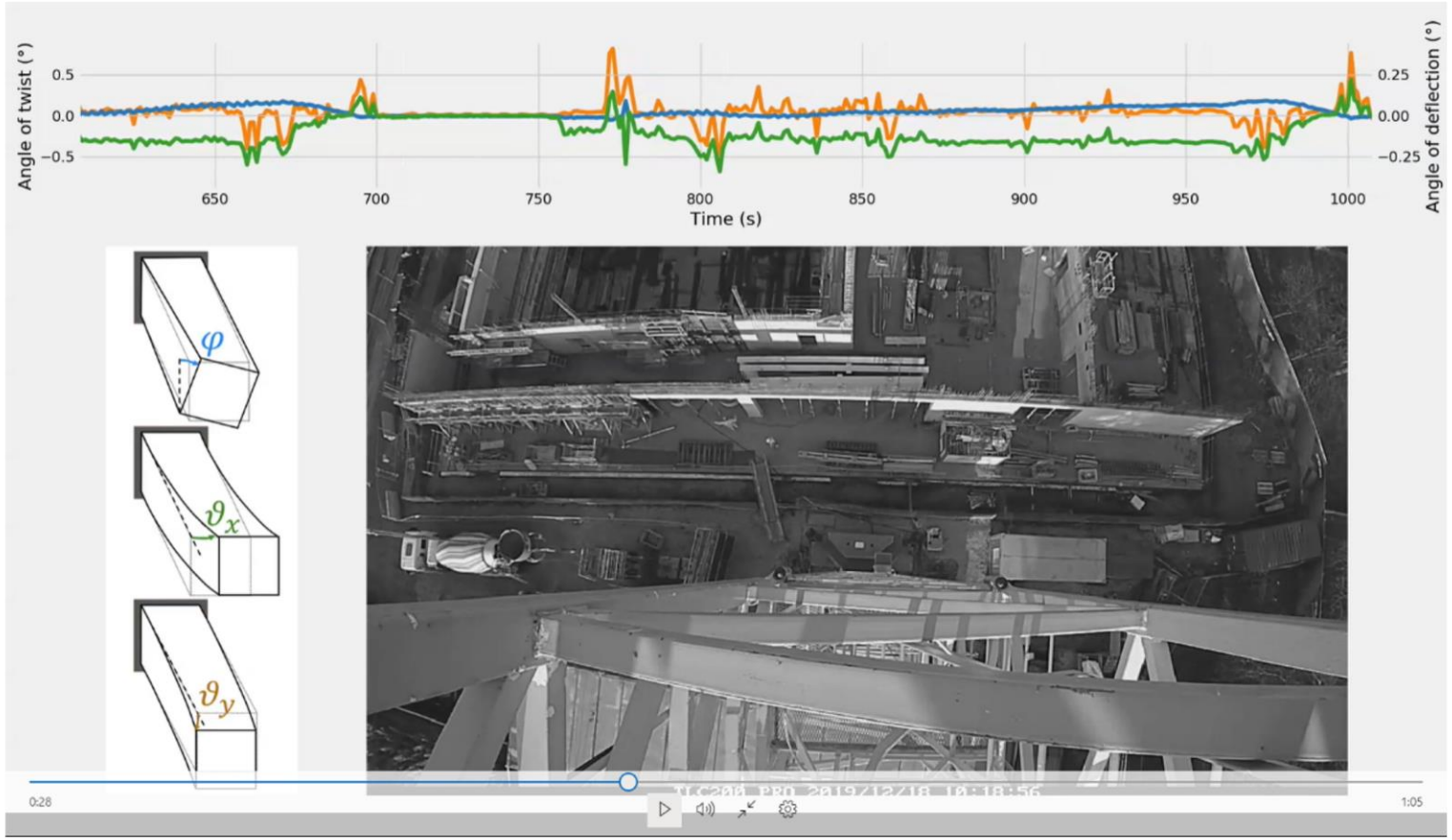
CASE STUDY: CONSTRUCTION CRANE MONITORING, SWITZERLAND



Video

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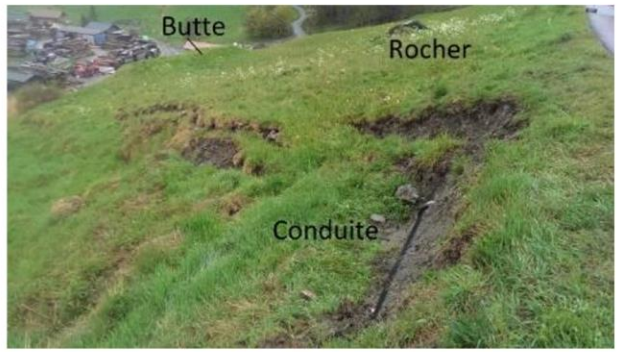
CASE STUDY: LANDSLIDE MONITORING, SWITZERLAND

- Monitoring of the displacements of a small penstock after a landslide
- Autonomous solar installation
- High 4K camera
- Active infrared lighting
- Edge processing and wireless data transmission



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CASE STUDY: LANDSLIDE MONITORING, SWITZERLAND

Position markers

- Easy to install
- Applied on existing structures or on posts
- Compatible with total station measurements

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CASE STUDY: LANDSLIDE MONITORING, SWITZERLAND

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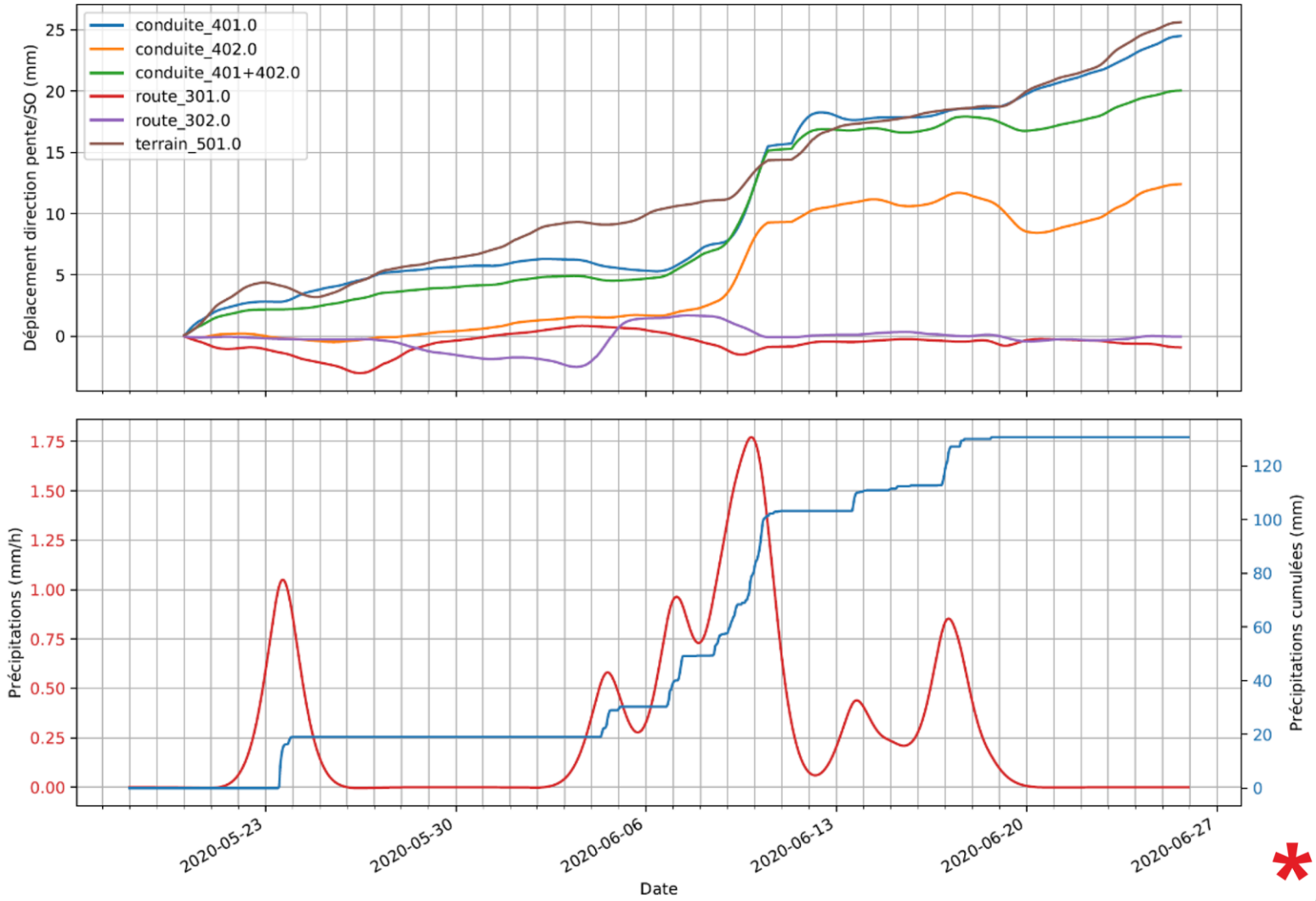
CASE STUDY: LANDSLIDE MONITORING, SWITZERLAND

Displacements

Rainfall



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CASE STUDY: TUNNEL CONSTRUCTION – CONVERGENCE MONITORING, SWITZERLAND

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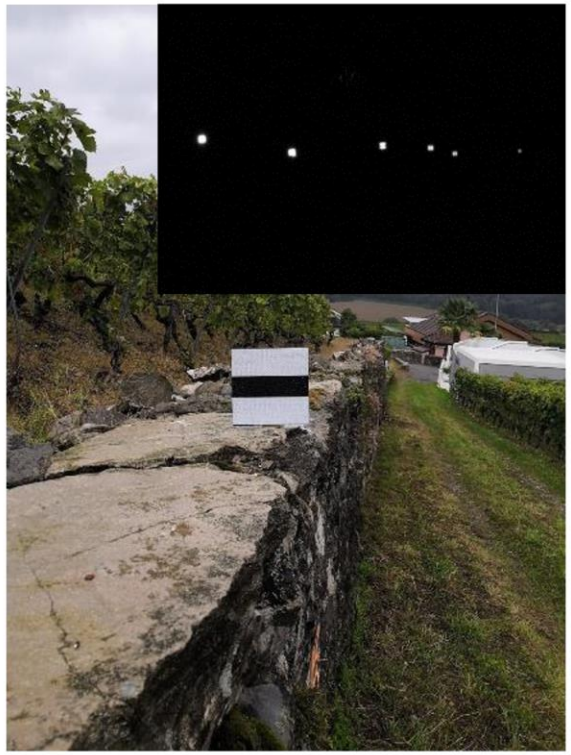
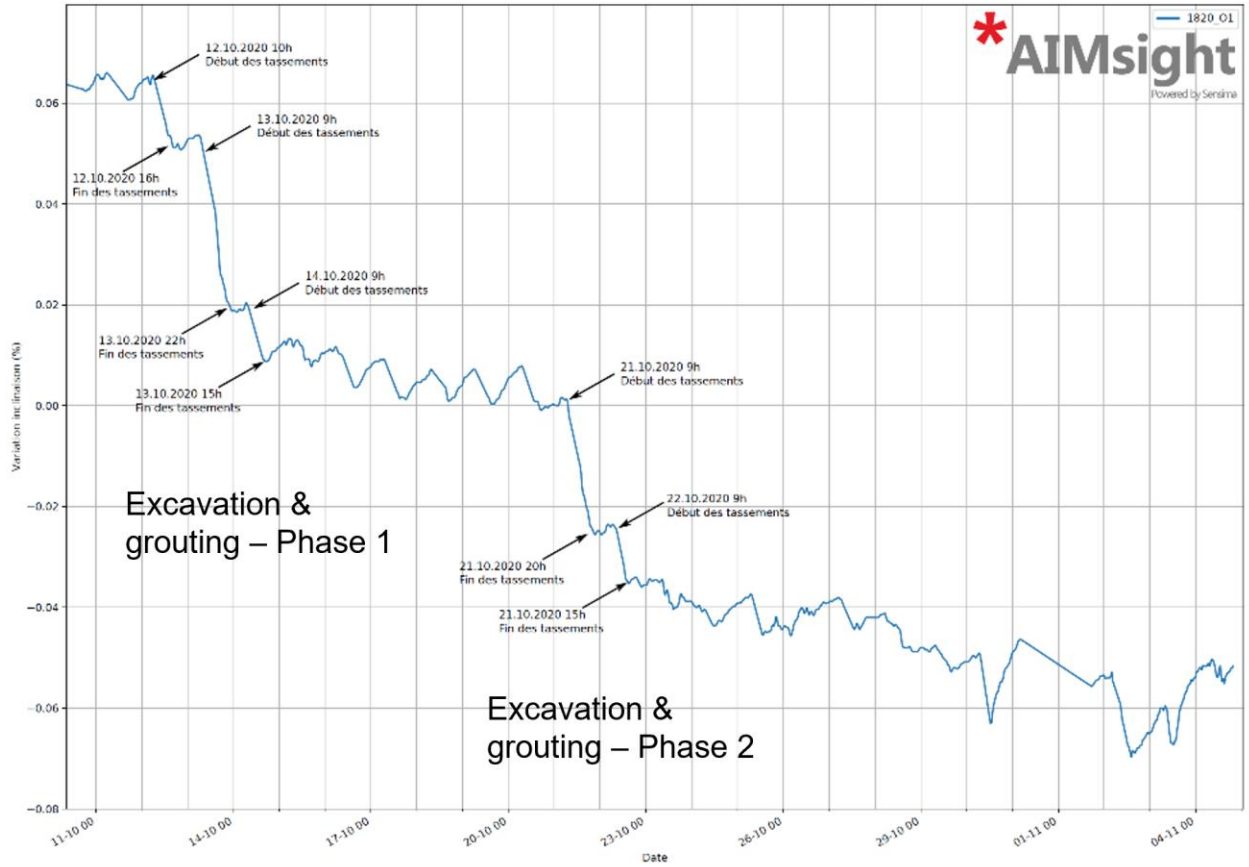
CASE STUDY: TUNNEL CONSTRUCTION – SURFACE DAMAGES MONITORING, SWITZERLAND





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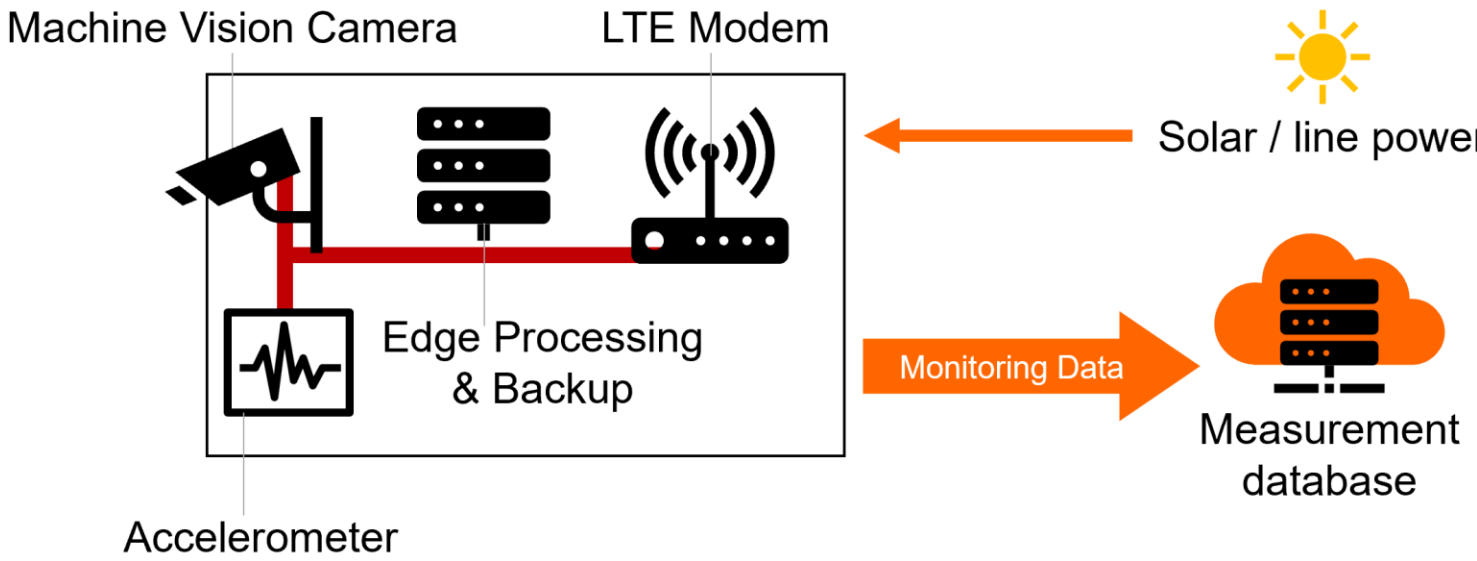
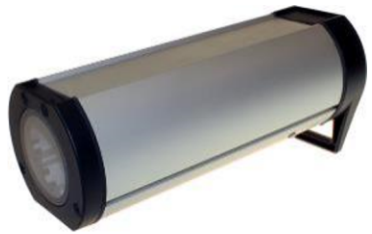
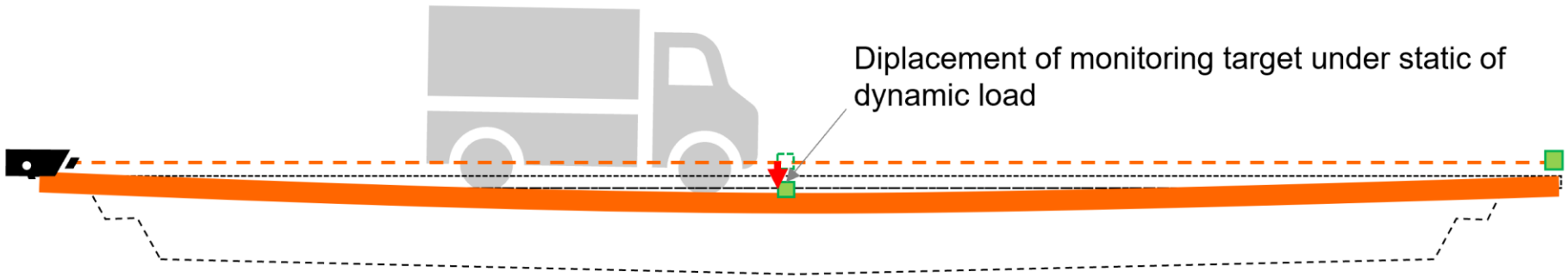
AIMSIGHT: SMART MONITORING CAMERAS CONCEPT





- Highest performance
- Lower power requirements
- Lower bandwidth requirements



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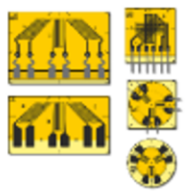
AIMSIGHT TECHNOLOGY



EMX – Eddy Current Array
- Crack size, crack initiation

VIB – Seismic-grade Accelerometer
- Vibration measurement, modal analysis
- Wire-break detection, impact detection

ADS – Strain Gauges
- Strain measurements, concrete crack gauges
- Load cells

ADI, ADV, ADD – Anlalog Sensors
- Displacement measurements, industrial sensors

MPP – Digital Sensors & I/O
- LIDAR vehicle counter
- Frequency measurements, rpm, encoders

PoE Cameras
- 2D displacement measurements, site surveillance

Microphones
- Acoustic monitoring, falling debris, impact detection

CAN bus

PoE

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Cellular Master Node

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SHM: SERVICE LEVELS

	Analysis Level			
Service Level		**Basic** *Basic sensor fee (setup)* *Displacement processing fee (bundle for N monthly data points)*	**Dynamic** *Basic sensor fee (setup)* *Video processing fee (bundle for N video files with max. M data points)*	**Advanced** *Project planning* *Advanced sensor fee (setup)* *Processing fee (bundle for N monthly data points)*
	Cloud: Image collection is handled by a third-party No SGS / AIMsight on-site technician intervention	Conventional monitoring, typically 24-100 points per day Attractive if a video surveillance system is already in place	Higher bandwidth requirements Potential reuse of existing surveillance camera system	Multiples tracking points and references per image
	Edge: SGS / AIMsight handles the image collection and processes the images, on site if necessary	SGS / AIMsight is the full service provider Simple camera bundle Lowest bandwidth requrements	Dynamic load measurements Can operate with low bandwidth	Optional high accuracy mode with installation and calibration by a SGS / AIMsight technician Tracking of complex motions Difficult measurement scenarios

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AIMSIGHT: VALUE PROPOSITION

- Monitoring technology is the result of several leaps in sensor design and data analytics: radical miniaturization of well established NDT instruments and sensors; and optimized image processing for accurate displacement detection
- Versatile: the chip-based solution is compatible with the most relevant SHM sensors
- Dynamic NDT: more than a snapshot of an asset's condition, the technology tracks the evolution of structural defects and behaviors, and their real-time response to stress events
- Certified IoT: advanced self-check features inspired by NDT & certification procedures
- Multi-modal NDT: several parameters can be measured – crack length and opening, temperature, stress, acceleration and vibration, displacements – at selected frequencies

Permanent surveillance – Increased asset availability – Safe extension of asset life – Effective maintenance planning – Inspection costs reduction

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