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# Classical and new-age technologies for monitoring and early alarm-systems

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## FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

from disaster

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## Overview

### MULTY SENSOR SYSTEMS FOR DEFORMATION MONITORING

- Geodetic instruments as complex sensor systems. Methods and applications

### LASER SCANNING TECHNOLOGY FOR STRUCTURAL MONITORING

- Terrestrial Laser Scanning (TLS)
- Mobile Laser Scanning (MLS)



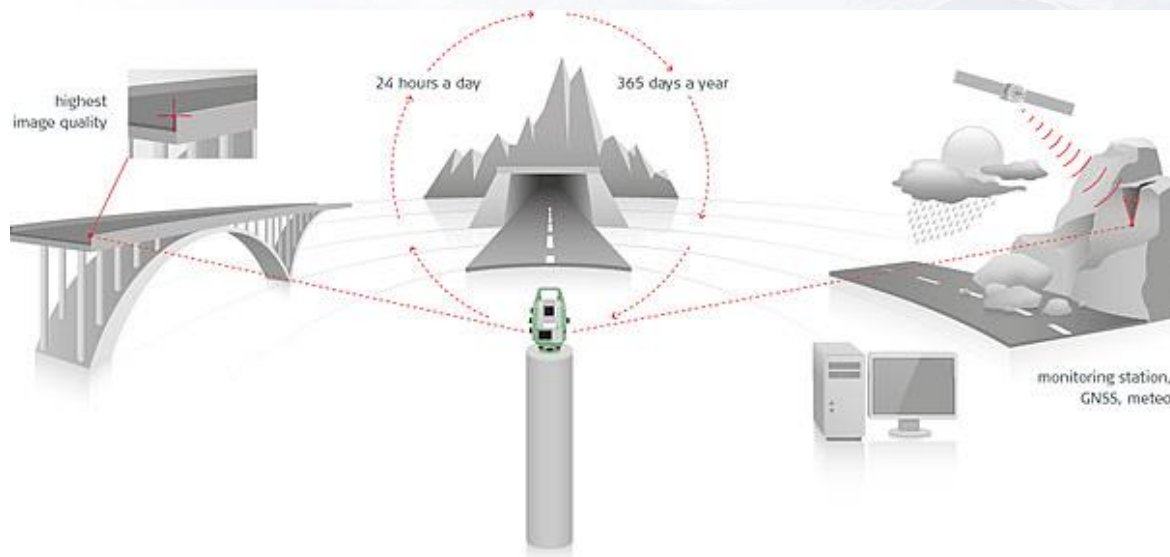
## Application areas

- Structural monitoring
- Railway scanning and monitoring
- Road transportation system management and monitoring



## From classical to new-age geodetic surveying instruments and methods

- Long-term monitoring of structural objects such as bridges, dam walls, buildings, tunnels, wind powers and etc.
- Automated angular and length measurements in minute, hourly, daily or weekly intervals
- Automated network adjustment and near-real time deformation analysis.
- Data storage and management system





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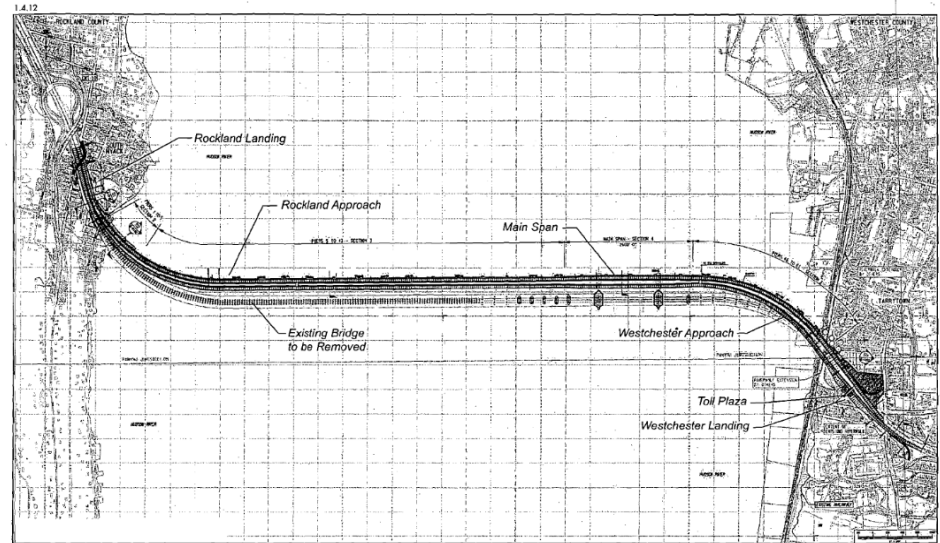
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- 24/7 Monitoring process during reconstruction process.
- The old bridge must not be damaged
- New railway line is built simultaneously on the bridge

## Tappan Zee Bridge- New York Jersey



UNITED STATES DEPARTMENT OF COMMERCE  
 National Oceanic and Atmospheric Administration  
 NATIONAL MARINE FISHERIES SERVICE  
 NORTHEAST REGION  
 55 Great Republic Drive  
 Gloucester, MA 01930-2276

JUN 22 2012

Figure 1  
**Approach Spans, Main Span, and Ancillary  
 Facilities of the Replacement Bridge**



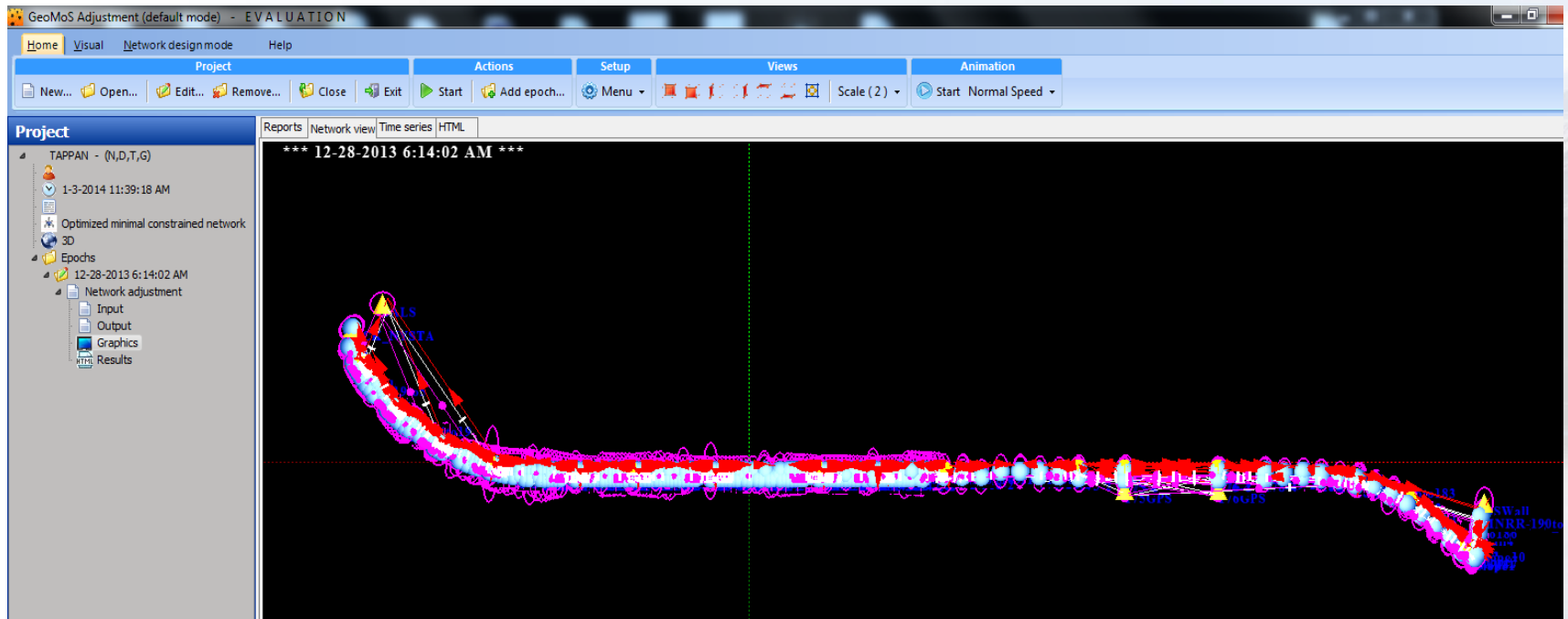
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- 16 Leica AMTS and 491 Prism mounted on the bridge pillars outside and inside the deformation area
- Automated process of data collections, simulations network adjustment, deformation analysis, early –alarm system in case of deformation, data management system



Ref. Douglas S. Roy, P.E., GZA



## Terrestrial Laser Scanning for structural monitoring

- Complete surface representation and high data redundancy
- Deformation analysis not only is single benchmarks but for the whole surface nor only



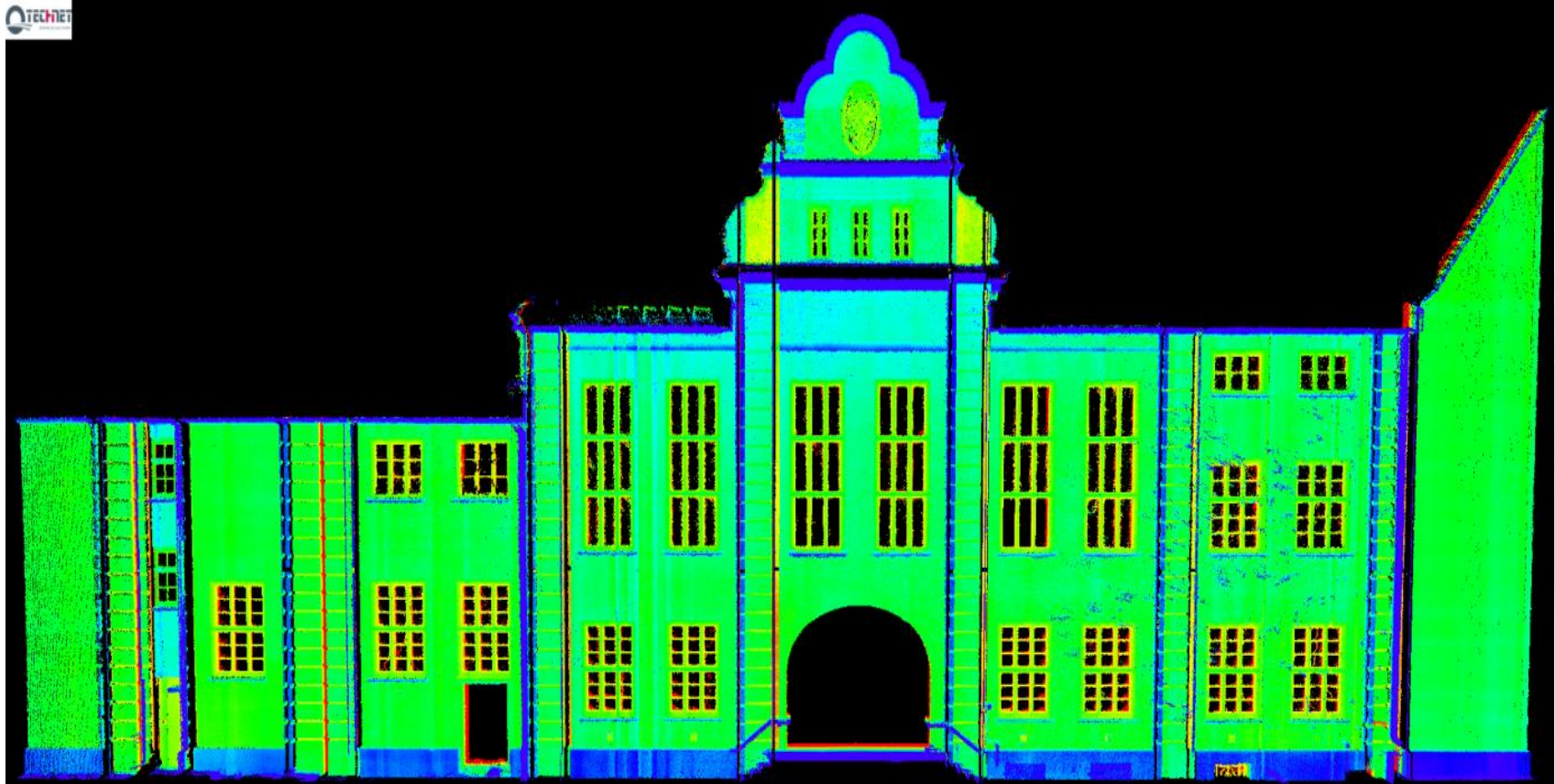


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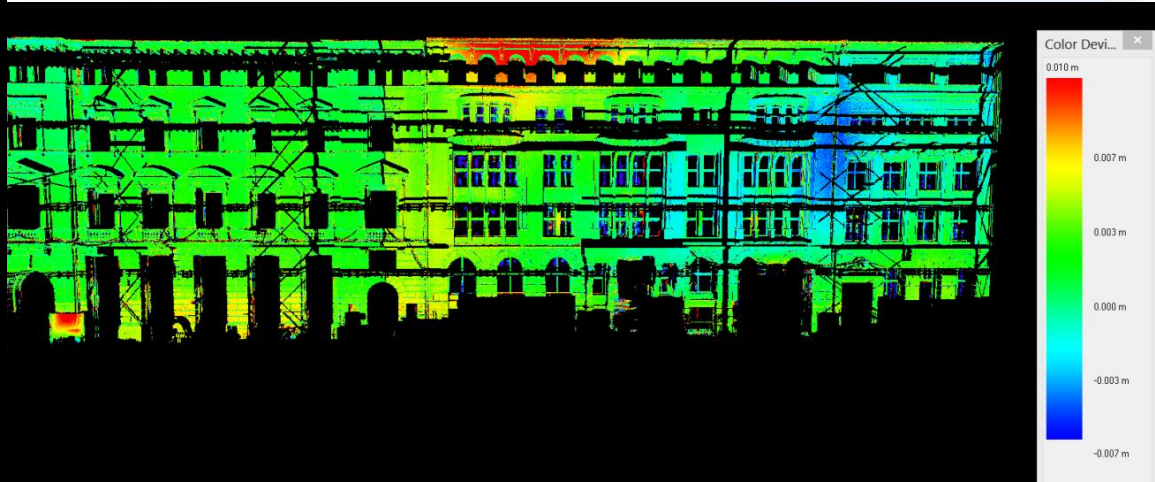
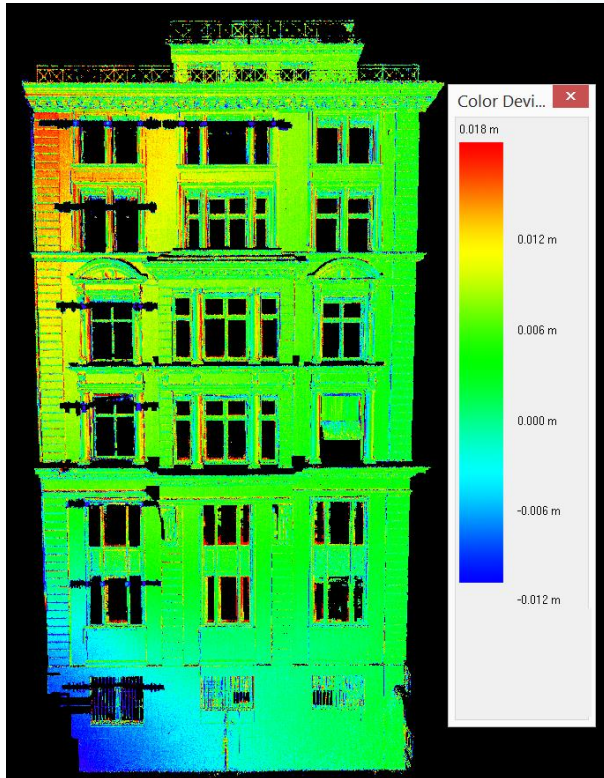
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## Terrestrial Laser Scanning for structural monitoring





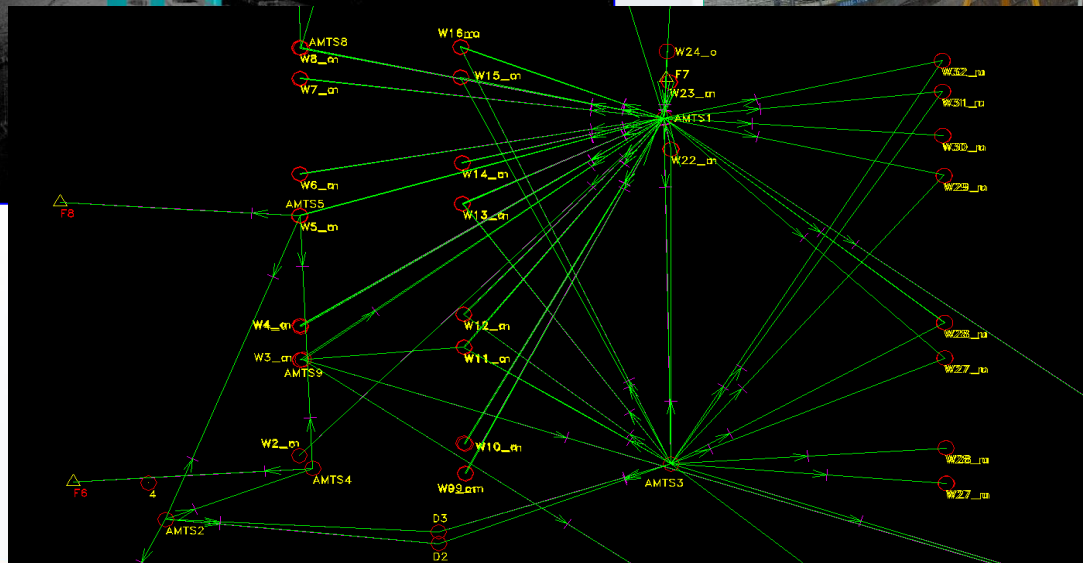
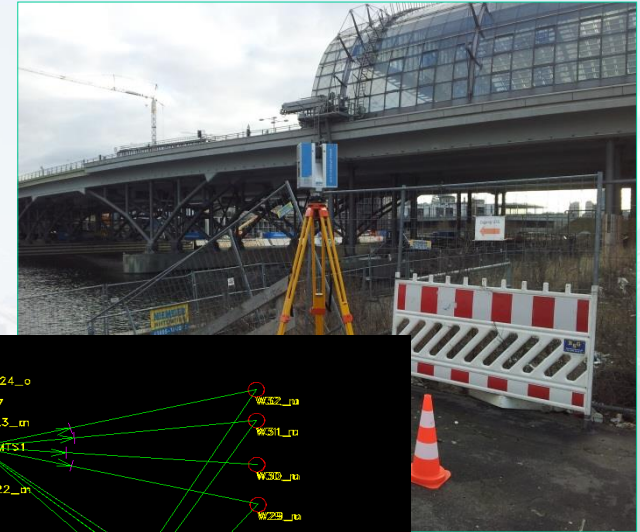
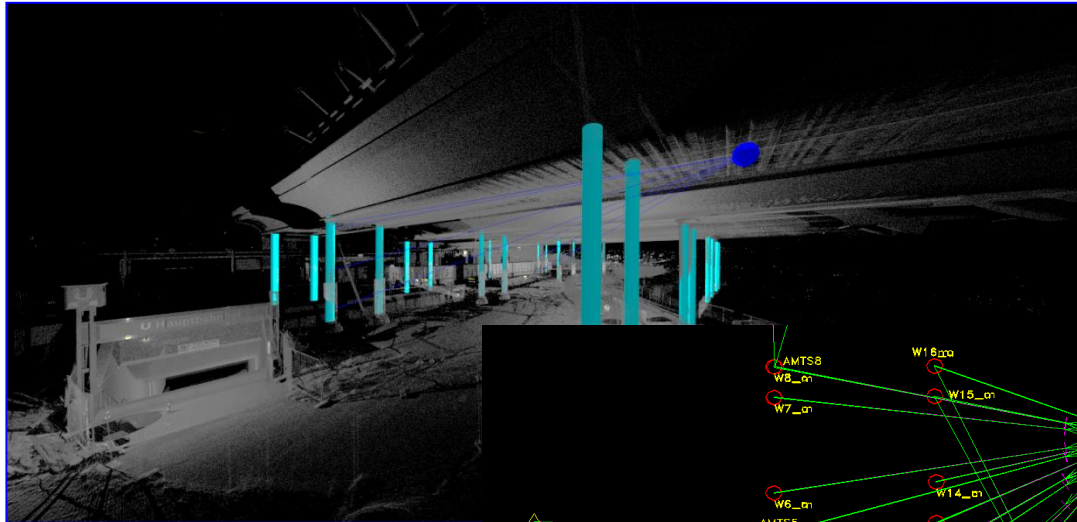
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## Combined approach between Terrestrial Laser Scanning and ATMS for structural monitoring. 24/7 monitoring process



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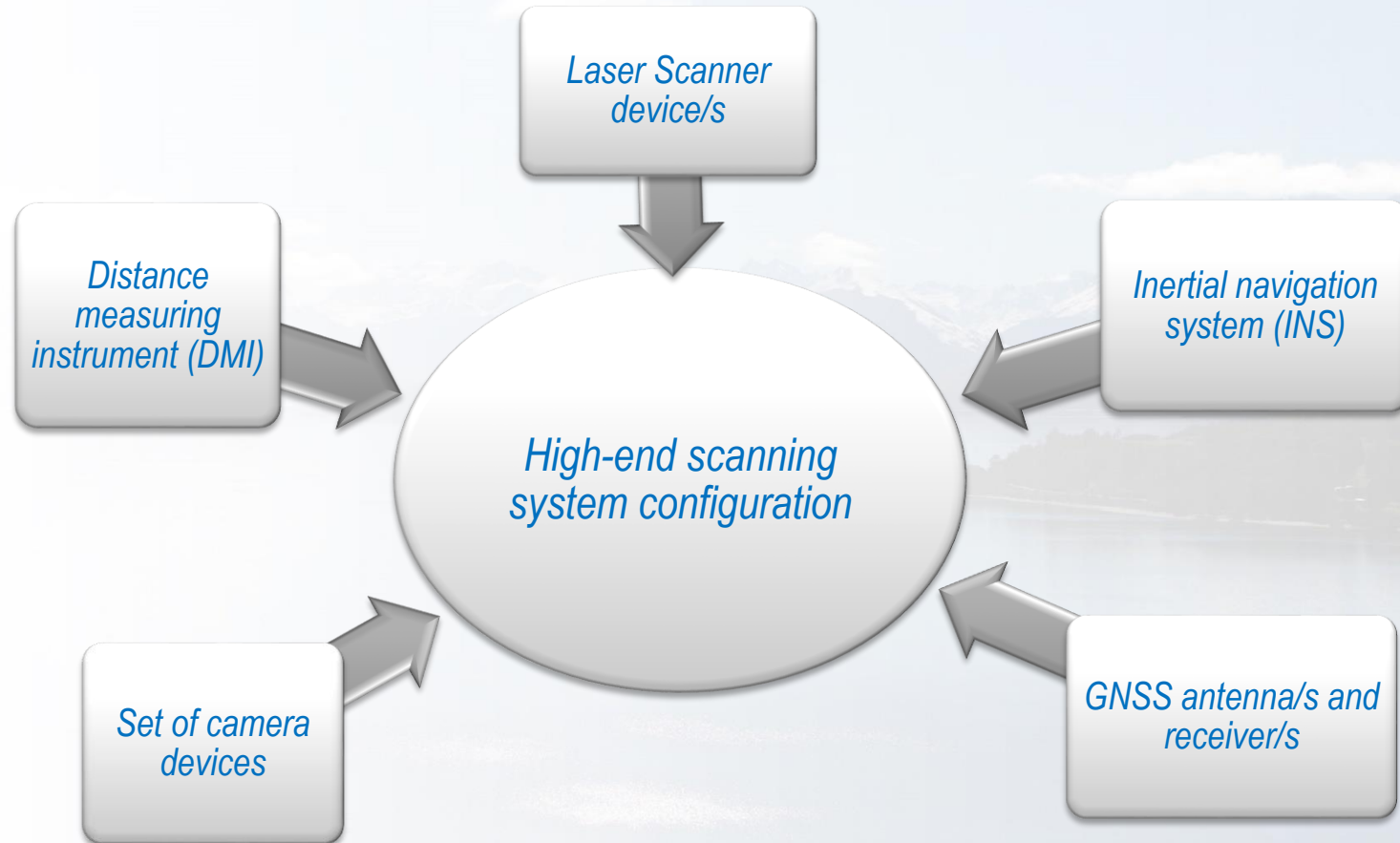


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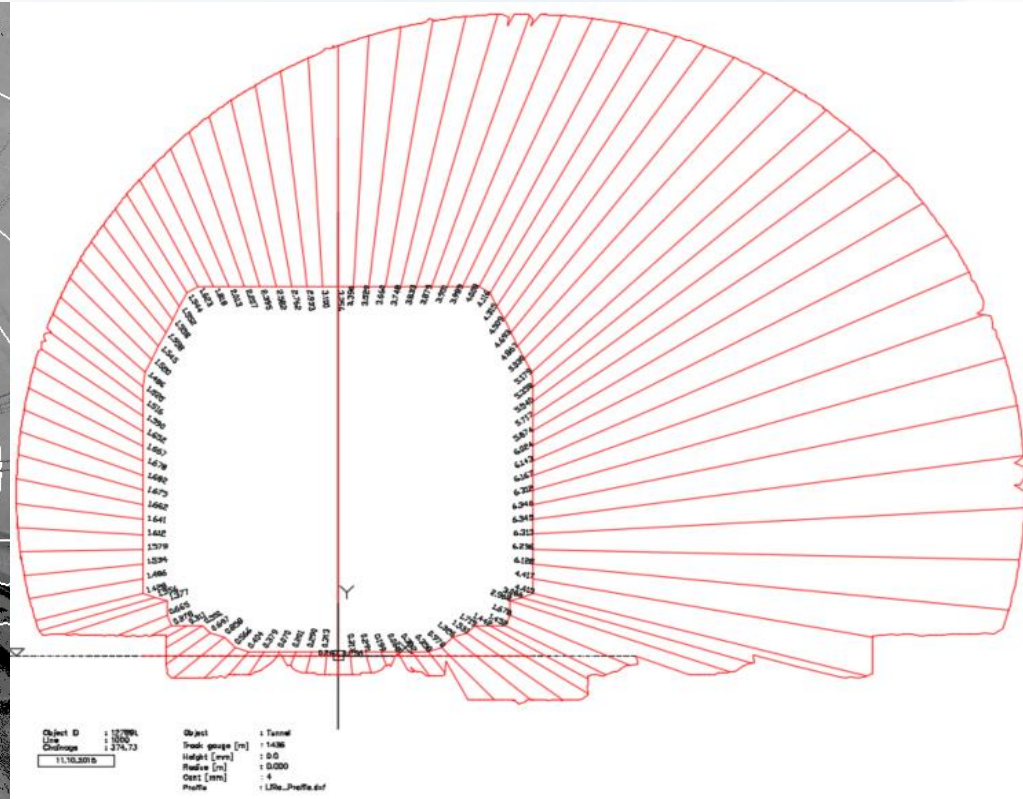
## Mobile Laser Scanning





## MLS for railway infrastructure monitoring

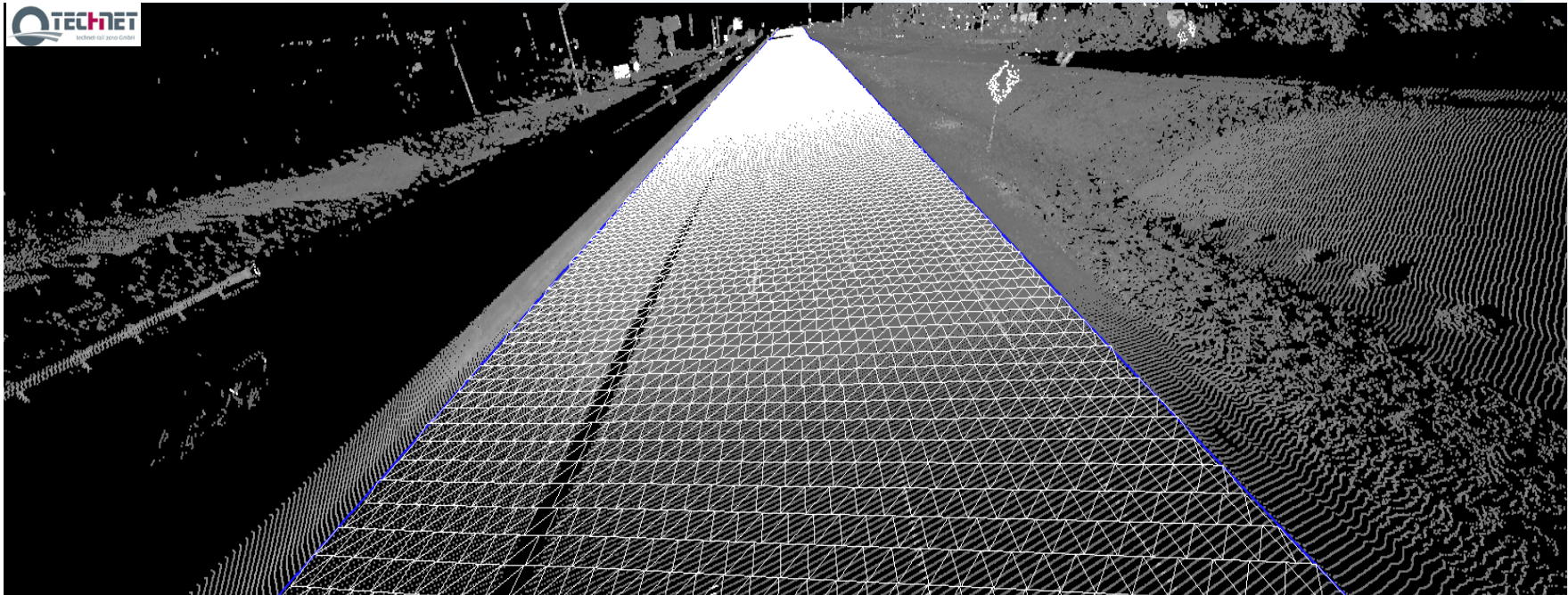
- Tunnel deformation monitoring designed-as built and clearance analysis





## MLS for road infrastructure management

- Automated calculation of the road boundary lines and road surface model





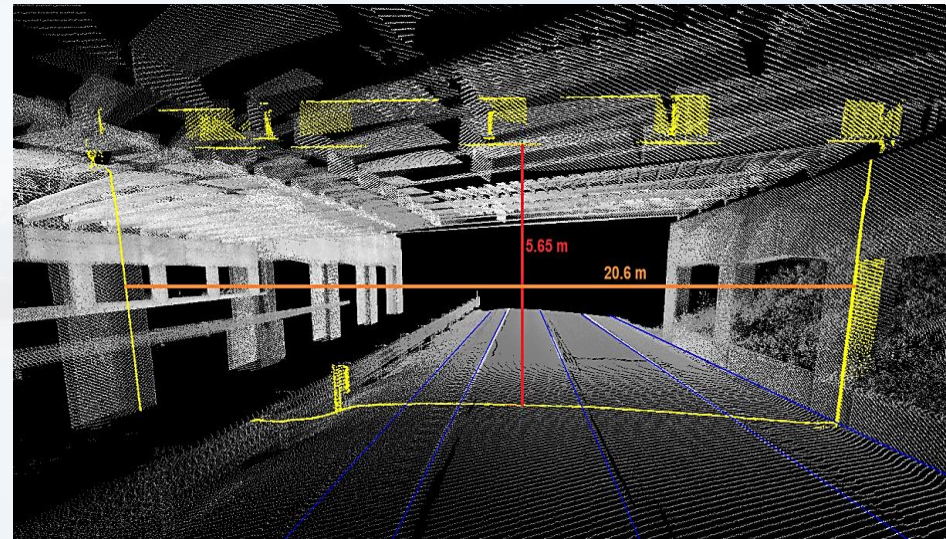
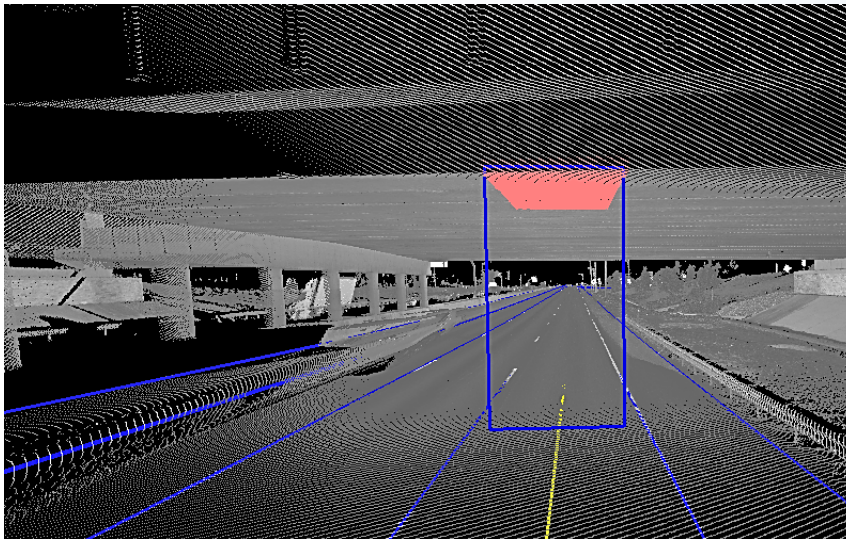
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- Road detected clearances
- Automated as-built measurements from road surface to the infrastructure object





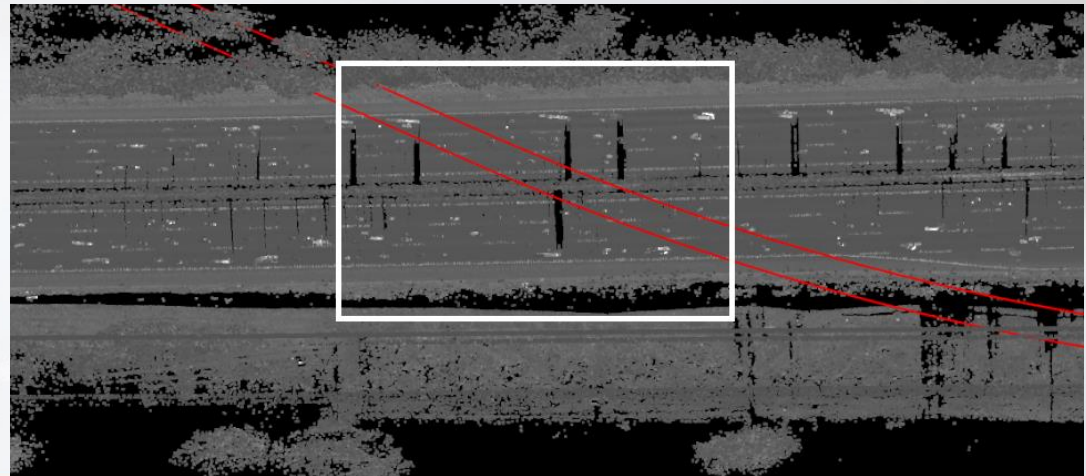
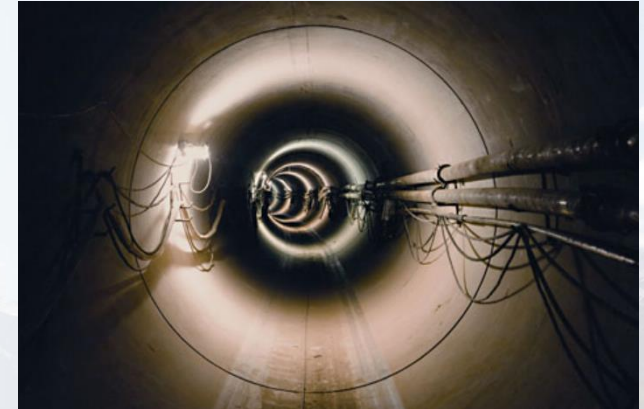
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- Deformation monitoring of current operating national highway with unground TBS tunnel drilling
  - New construction of 400 km culvert
  - Object: Culvert (up to 3m diameter, up to 40m depth) crossed national roads and highways
  - Task: Determination the vertical deformation of the street surface of highways through the construction culvert
  - Result: Comprehensive statement about the vertical deformations from highway





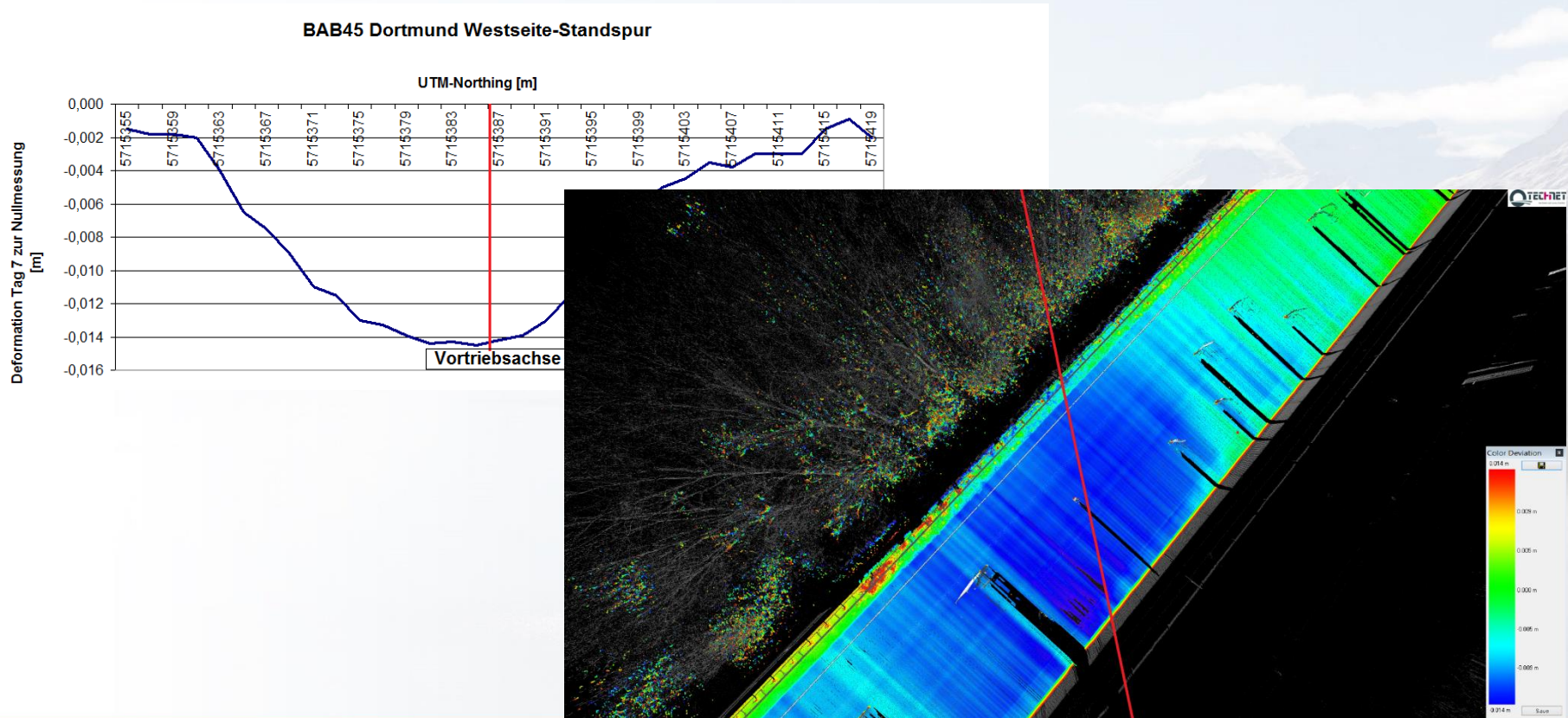
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- Epoch-wise deformation analysis. Comparison between the zero epoch and current measurement
- Results of the analysis in color-coded images and as subsidence curve







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