



## Topics

1. Apollo Bridge characteristics
2. Bridge monitoring
3. Measurement system development
4. Data processing and analysis
5. Conclusion



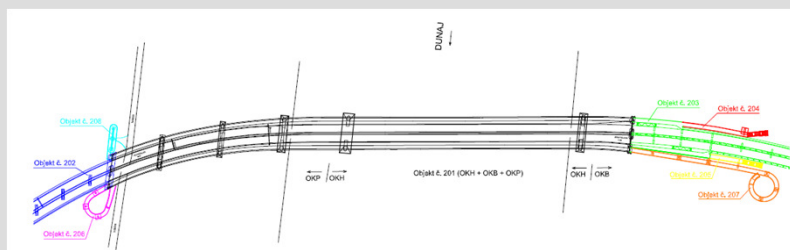
## Apollo Bridge

- 8 parts (SO 201 až SO 208)
- total length 854,0 m



### SO 201 – main bridge object

- main steel structure over the Danube
- steel structure at Petržalka river bank
- Steel structure at Bratislava river bank



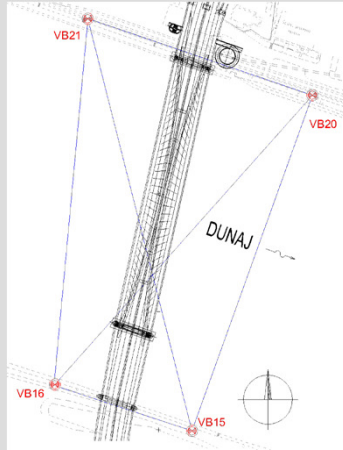
## Bridge monitoring

- 3D deformation of bridge structure – points situated at the bottom part of the main structure and the top of the bridge arch,
- horizontal deformation of points situated at the top of the bridge arch,
- transversal and longitudinal inclination of the main bridge structure (at route level),
- dynamic deformation of the main steel structure

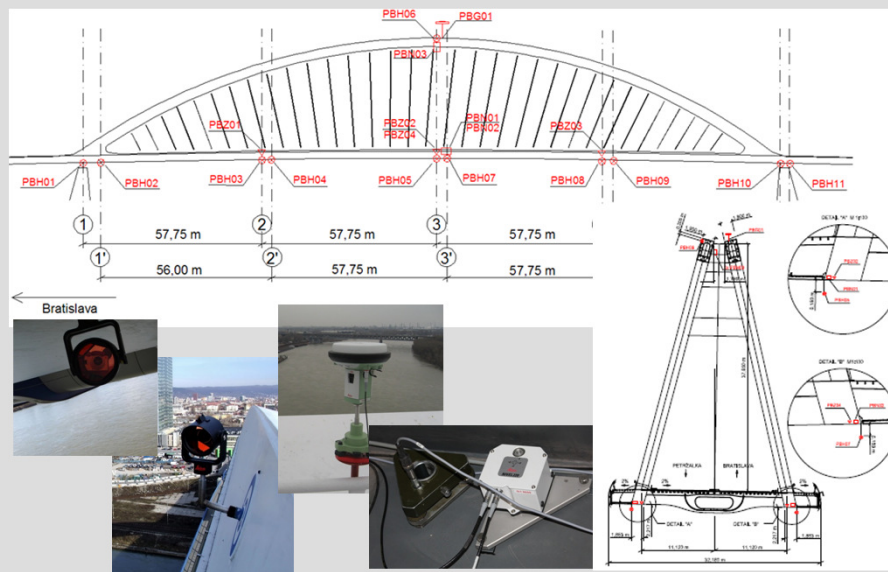


## Control network points

- control points VB15, VB16, VB20 a VB21



## Measuring points



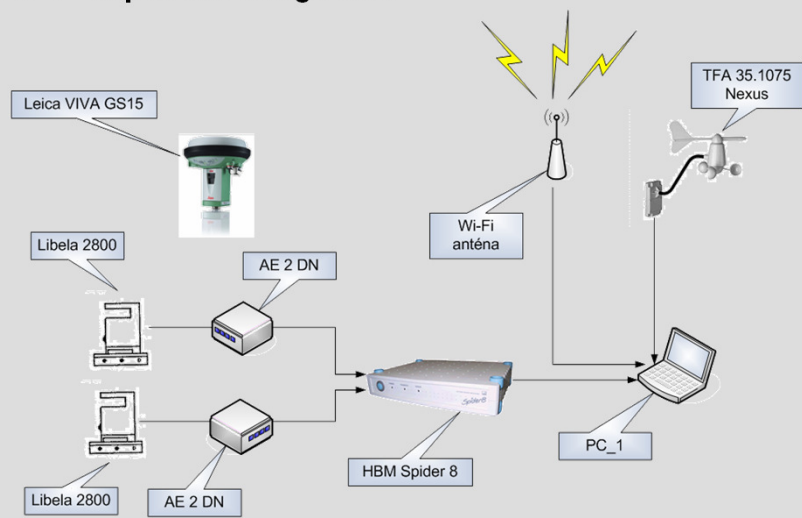
## Measuring system

- UMS Leica TS30
- GNSS Leica Viva GS15
- inclination sensors Leica Nivel 210, Leica Nivel 220 a Libela 2800
- accelerometers HBM B12
- meteo station with temperature, airpressure, wind force and direction sensors
- time server – Local Time Server
- PC with data processing and registration software
- equipments – power supply, cables and data cables



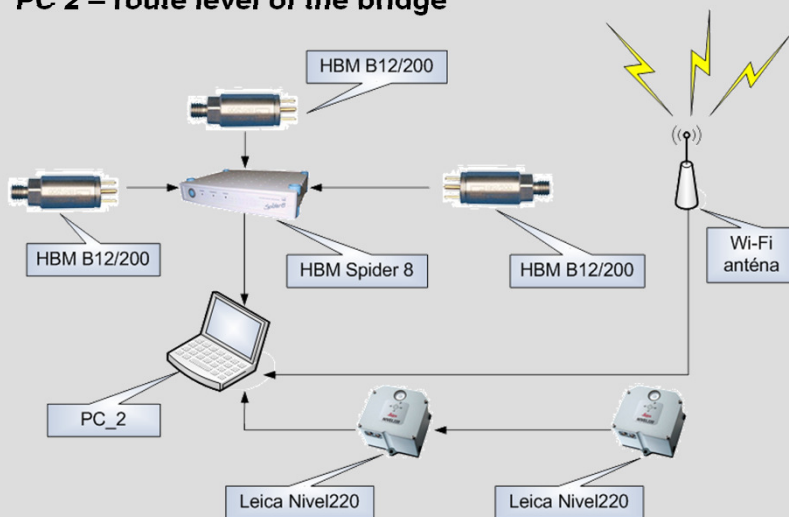
## Measuring system

### PC 1 – top of the bridge arch



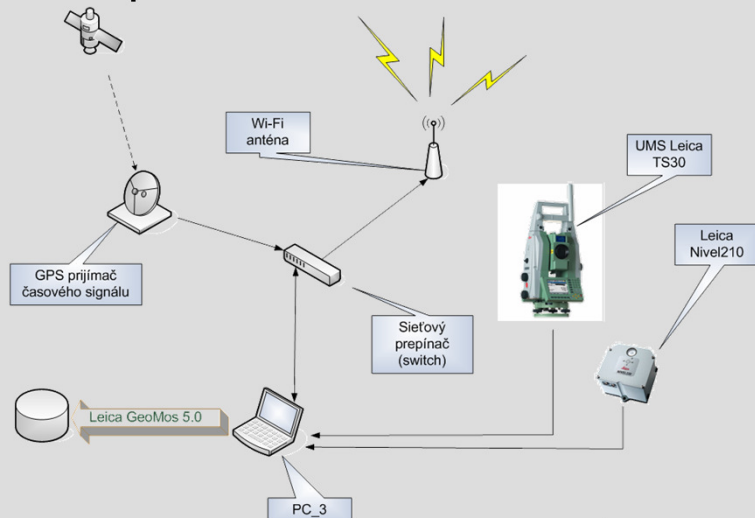
## Measuring system

### PC 2 – route level of the bridge



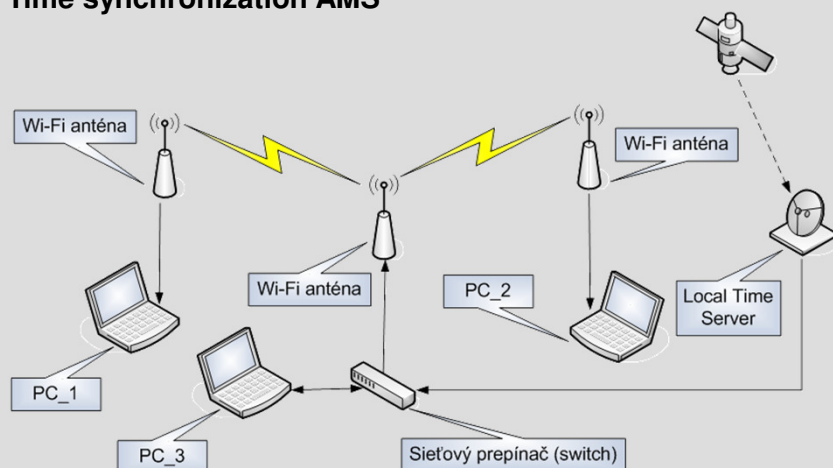
## Measuring system

### PC 3 – control point VB16



## Measuring system

### Time synchronization AMS



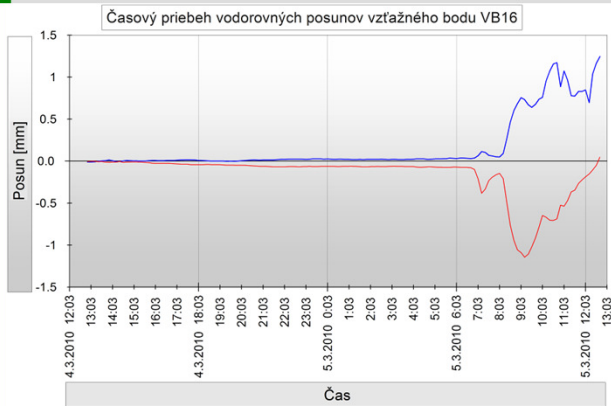
## Geodetic monitoring – 24 h

Termín: 4.3.2010, 13.00 hod – 5.3.2010, 13.00 hod.

<b>3D deformation</b> <ul style="list-style-type: none"> <li>➤ UMS Leica TS30</li> <li>➤ Meas.periode – 10 Minute</li> </ul>	<b>Horizontal deformation</b> <ul style="list-style-type: none"> <li>➤ GNSS Leica Viva GS15</li> <li>➤ Meas. frequency – 1 Hz</li> </ul>
<b>Inclination</b> <ul style="list-style-type: none"> <li>➤ Leica Nivel 220, Libela 2800</li> <li>➤ Meas.frequency – 1 Hz</li> </ul>	<b>Dynamic deformation</b> <ul style="list-style-type: none"> <li>➤ HBM B12</li> <li>➤ Meas.frequency – 1 Hz</li> </ul>

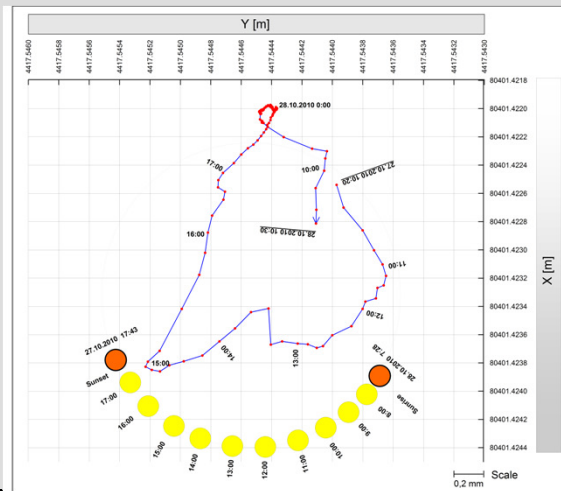
## Data analysis

- Stability of the control point VB16



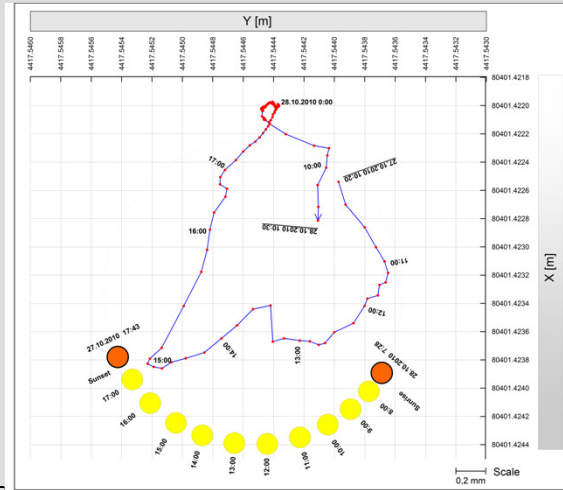
## Data analysis

- Stability of the control point VB16



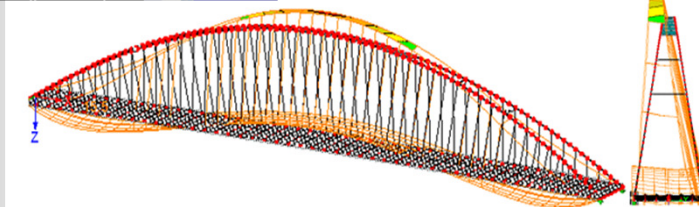
### Data analysis

- Stability of the control point VB16

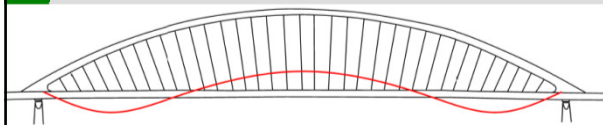


### Data analysis

- Bridge deformation – temperature loading



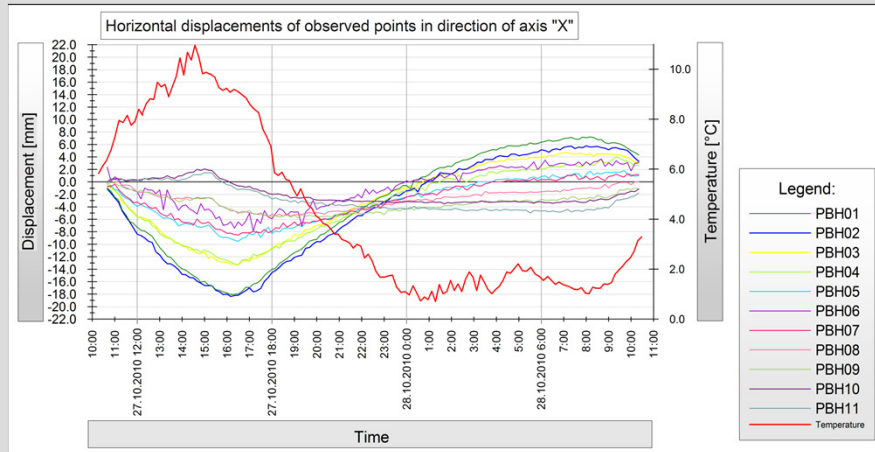
Posun [mm]: 0.0 15.5





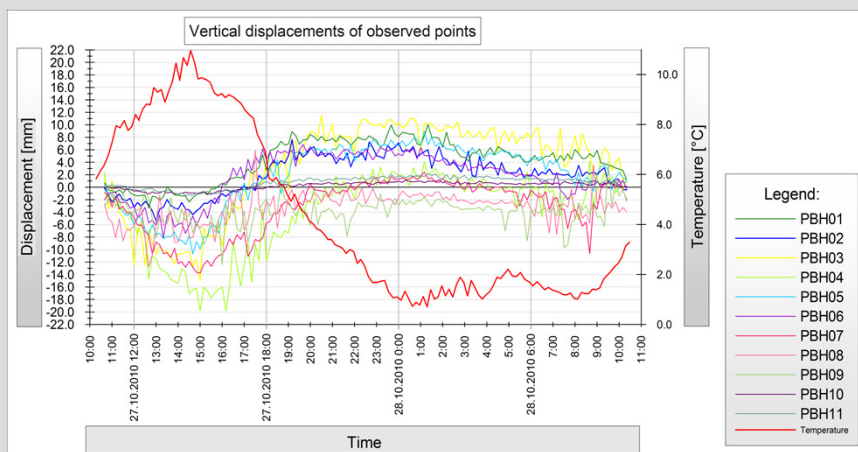
## Data analysis

- 3D deformation of meas. points PBH01 - PBH11



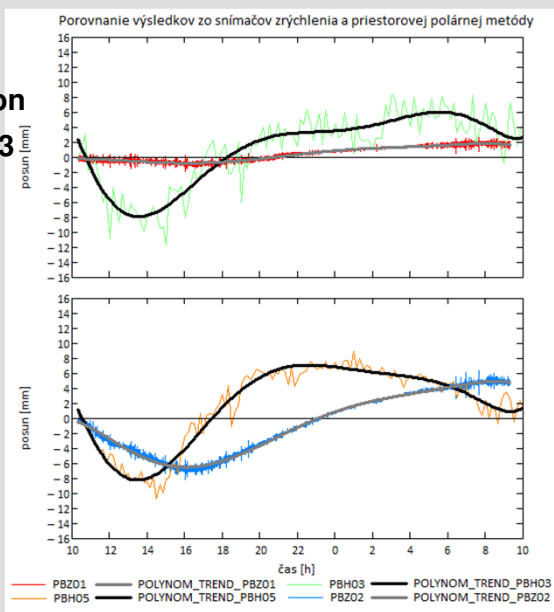
## Data analysis

- Vertical deformation of PBH01 - PBH11



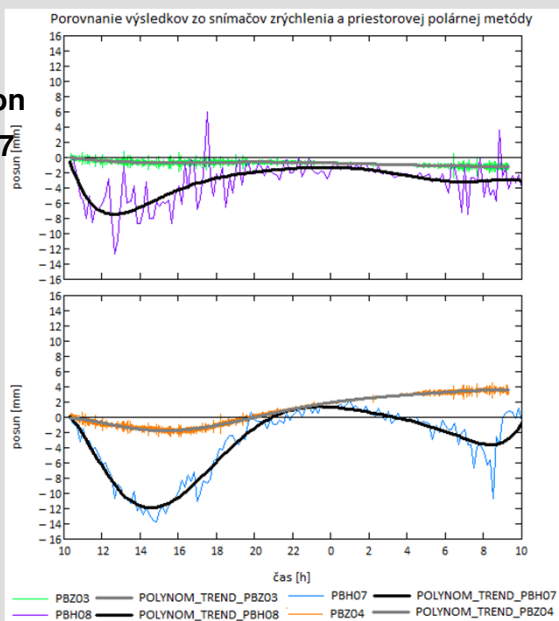
## Data analysis

- Vertical deformation of PBH05 and PBH03



## Data analysis

- Vertical deformation of PBH03 and PBH07



## Conclusion

**Measuring system – operating, bridge characteristics, combination of geodetic method and other sensors, measuring points, data processing and analysis base on time series analysis**

### Outcomes

- strength cooperation is needed with bridge designers (sensor location, temperature loading)
- permanent monitoring possible with mm-resolution
- detailed (time, position) structure changes could be determined
- sensor calibration (laboratory, on the fly), sensor drift elimination
- user friendly software – include all this req. + req. of civil engineers



## INGEO 2011

5th International Conference on Engineering Surveying  
September 22-24, 2011, Brijuni, Croatia

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Slovak University of Technology in Bratislava  
Faculty of Civil Engineering  
Department of Surveying  
and  
University of Zagreb  
Faculty of Geodesy  
Institute of Applied Geodesy

5th International Conference  
on Engineering Surveying

## INGEO 2011

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FIG Commission 6



Faculty of Civil Engineering  
Slovak University of Technology



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### Conference Topics

New methods and tools to support the effective data collection were developed in the last ten years worldwide. Many of producers are coming with new technology at market, which determined the revolutionary evolution of methodology. The questions of effective application and usage of new technology, their reliability and operability must be discussed actually. The quality of these instruments and data processing software is the second but very important question too. The aim of the conference is to bring together professionals in the field of engineering surveying and facility management, to discuss the new technologies, their applicability and operability. The conference discussion will be focused on present-day questions of laser scanning, usage of laser scanners in industry surrounding, for measurement of dynamic deformations, data acquisition and processing.

The topics of the conference are the following

- actual tasks of engineering surveying,
- trends in methodology and technology development,
- engineering surveying procedures for industry (power plants, nuclear facilities, etc.),
- industrial metrology in production, assembling and finishing processes in-situ calibration of used technology,
- lasers and laser measurement systems, with special emphasis on terrestrial laser scanning,
- new technology for deformation measurement,
- data integration in facility management,
- local information systems for cities and industrial applications,
- permanent GNSS networks, application in industry projects,

Internet



**Thank you for your attention!**

**Department of Surveying  
Faculty of Civil Engineering  
STU Bratislava**

**Phone: ++421 2 5927 4472, 390  
Mail: [alojz.kopacik@stuba.sk](mailto:alojz.kopacik@stuba.sk),  
[peter.kyrinovic@stuba.sk](mailto:peter.kyrinovic@stuba.sk)  
web: [www.svf.stuba.sk](http://www.svf.stuba.sk)**

