Investigating the Applicability of Standard Software Packages for Laser Scanner Based Deformation Analyses

FIG Working Week 2017

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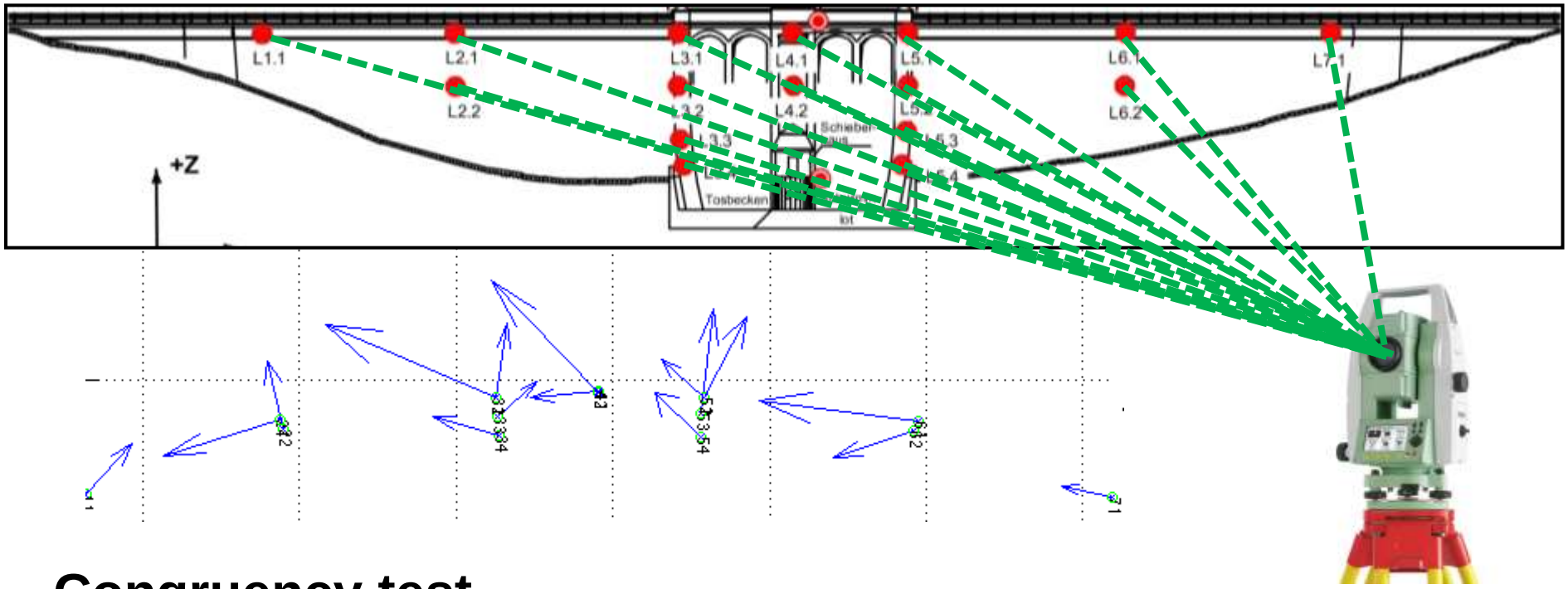
Point based deformation analysis



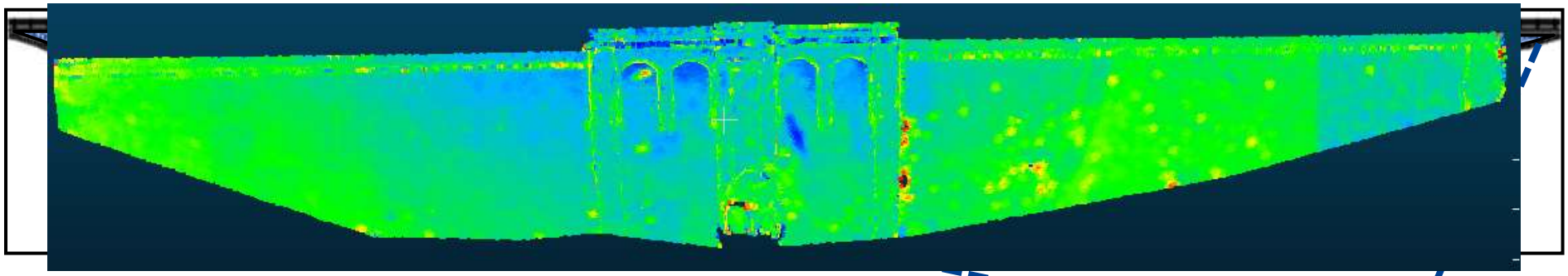
www.leica-geosystems.com

Congruency test

$$T = \frac{\boldsymbol{d}^T \boldsymbol{Q}_{dd}{}^{-1} \boldsymbol{d}/h}{{s_0}^2} \geq F_{h,f,1-\alpha}$$

1. **Differences between corresponding points**
2. **Stochastic model**

TLS-based deformation analysis



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1. Corresponding points ?

- One possiblity: Point cloud comparison

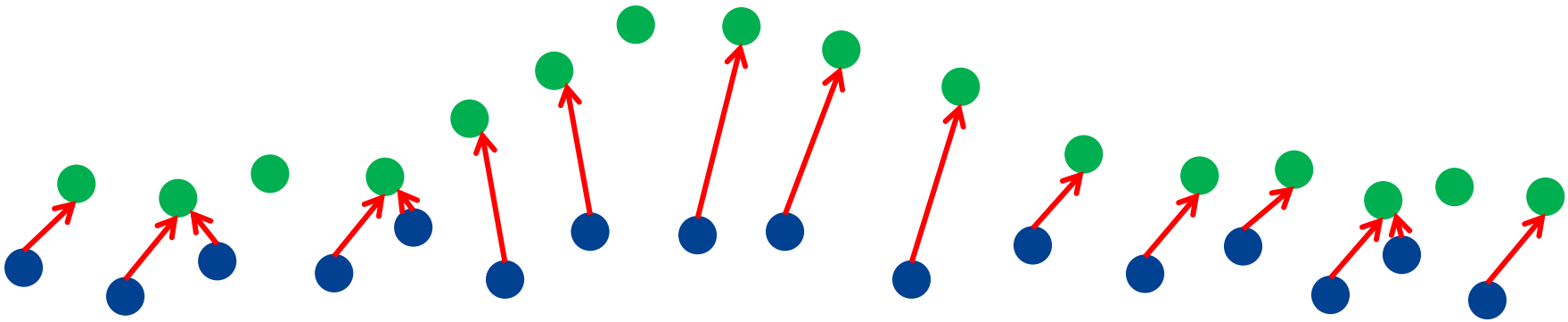
2. Stochastic model ?

- Difficult!
- Many influencing factors: misconstruction of laser scanner, incidence angle, reflectivity/material/color of surface

=> In practice:

$$T = \frac{\boldsymbol{d}^T \boldsymbol{Q}_{dd}{}^{-1} \boldsymbol{d}/h}{{s_0}^2} \geq F_{h,f,1-\alpha}$$

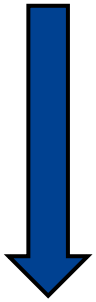
Point cloud comparison



Possibilities implemented in standard software

(e.g. 3DReshaper, CloudCompare, Geomagic Studio/Control)

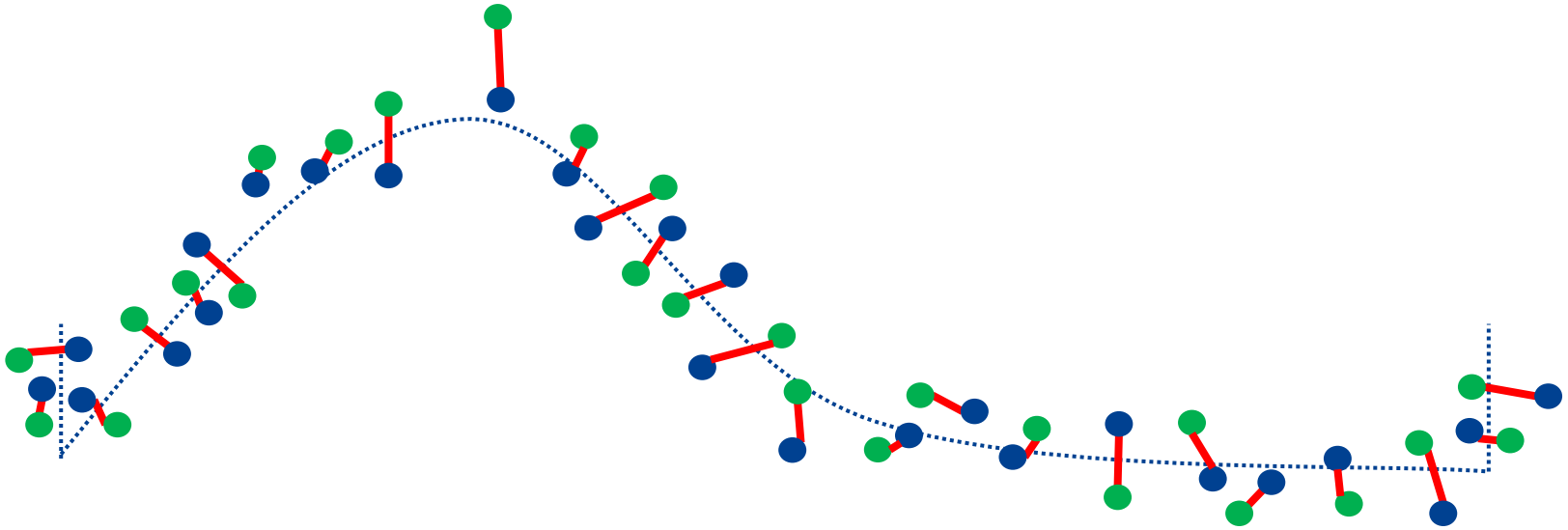
- Cloud to cloud comparison (C2C)
- Cloud to mesh comparison (C2M)
- Mesh to mesh comparsion (M2M)
- Multiscale model to model cloud comparison (M3C2)



Reduction of random errors

Is these point cloud comparison applicable for geodetic deformation analysis?

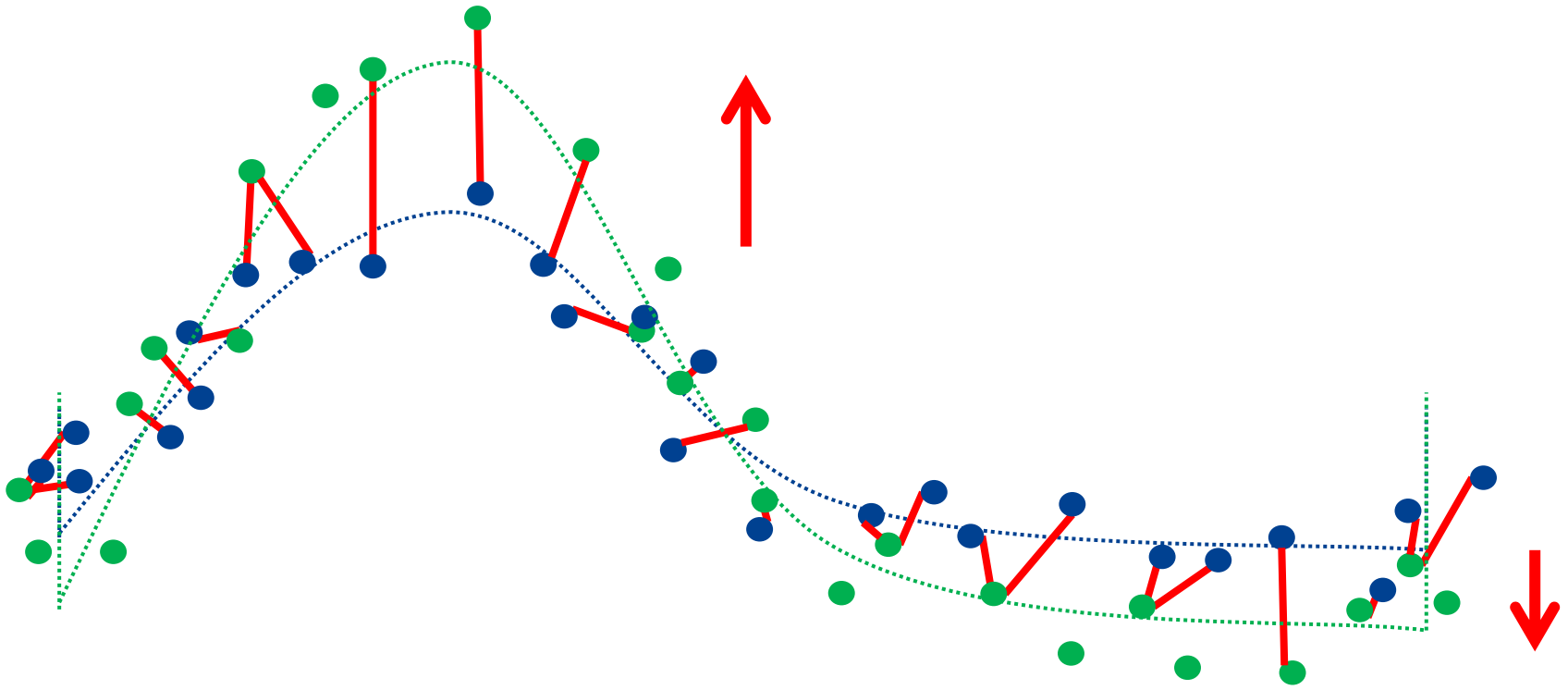
Case 1: Out-of-plane shape deformation



blue: **epoch 1**

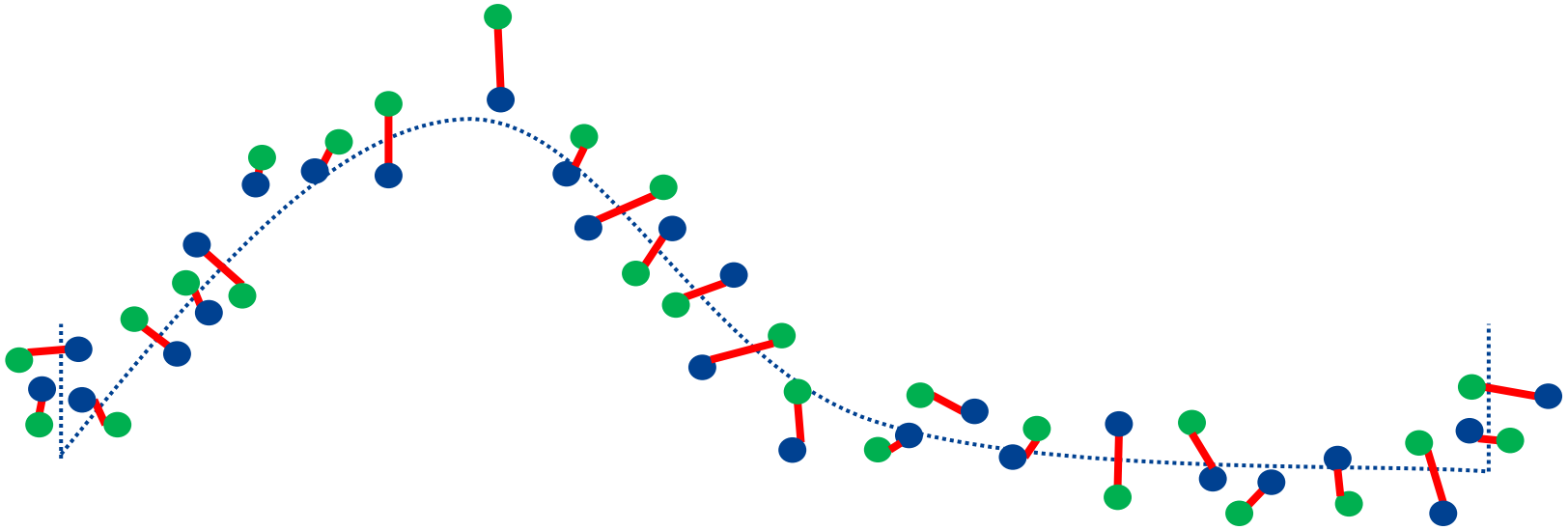
green: **epoch 2**

Case 1: Out-of-plane shape deformation

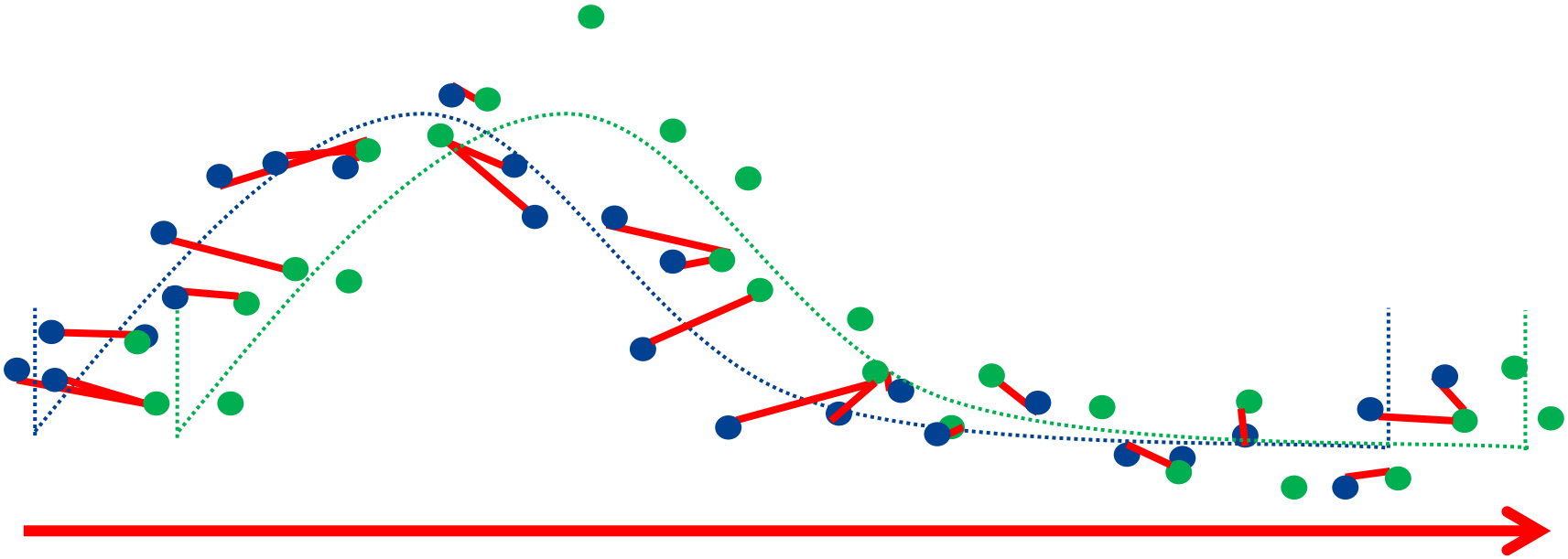


- **Yes: Large differences where shape is deformed**

Case 2: In-plane rigid body movement



Case 2: In-plane rigid body movement



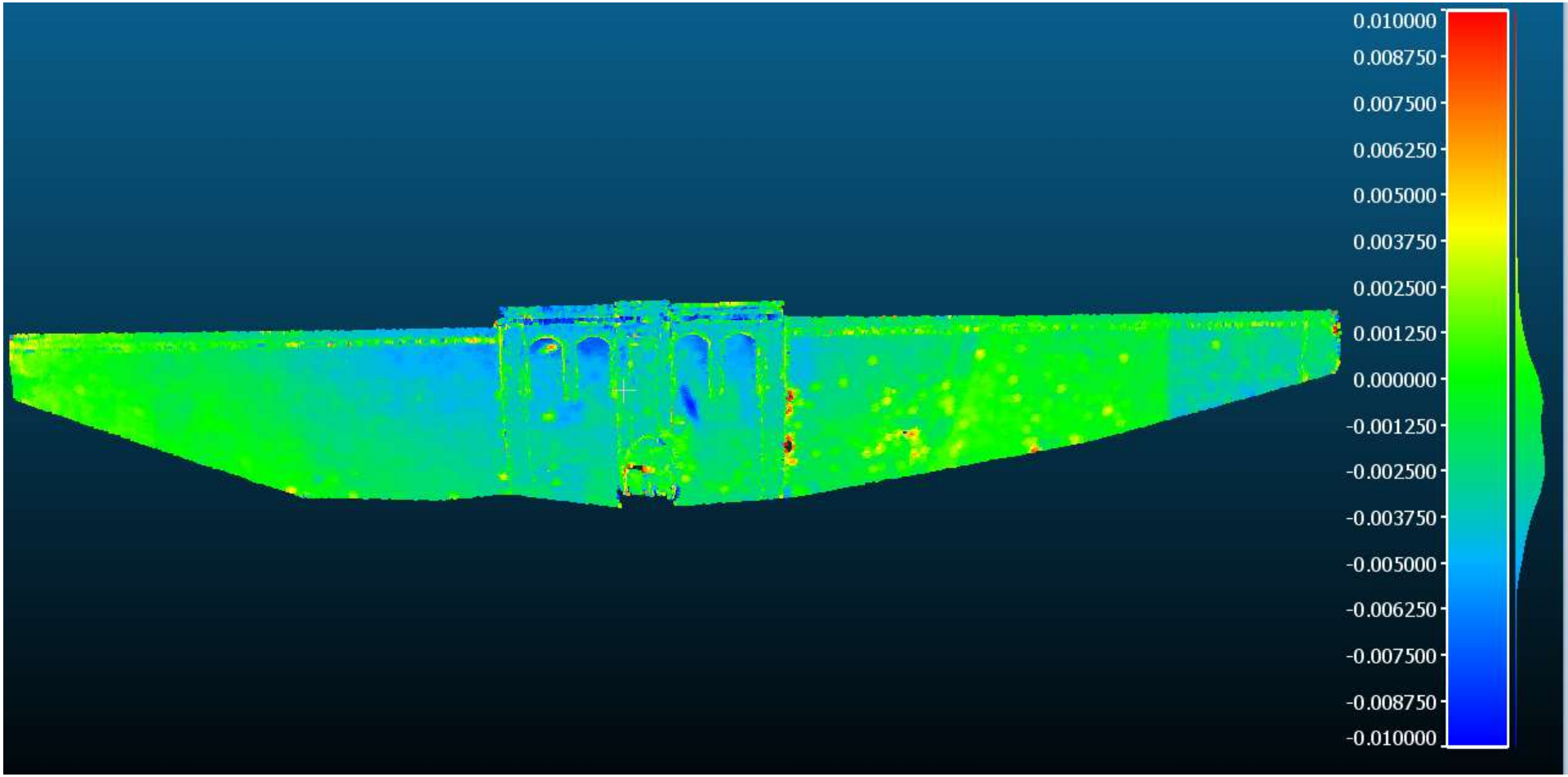
- **No: Large differences only at high surface curvature**

Two examples in paper

- **Wooden panel**
- **Water dam**

M3C2 (CloudCompare)

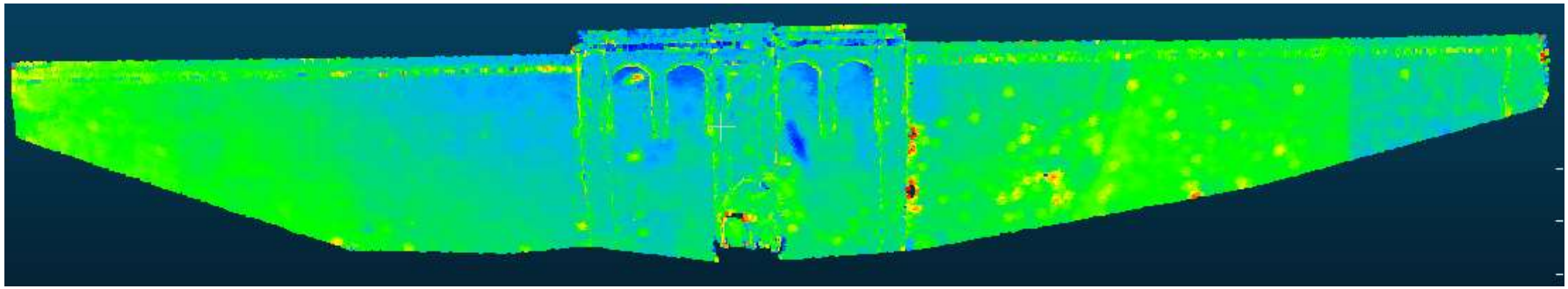
Leica P20, 2 epochs: march and june 2016



Shape deformation of 6 mm to water side

Conclusion

- At TLS-based deformation analyses, no corresponding points between epochs
- Detection of „deformations“ / differences by point cloud comparison is possible

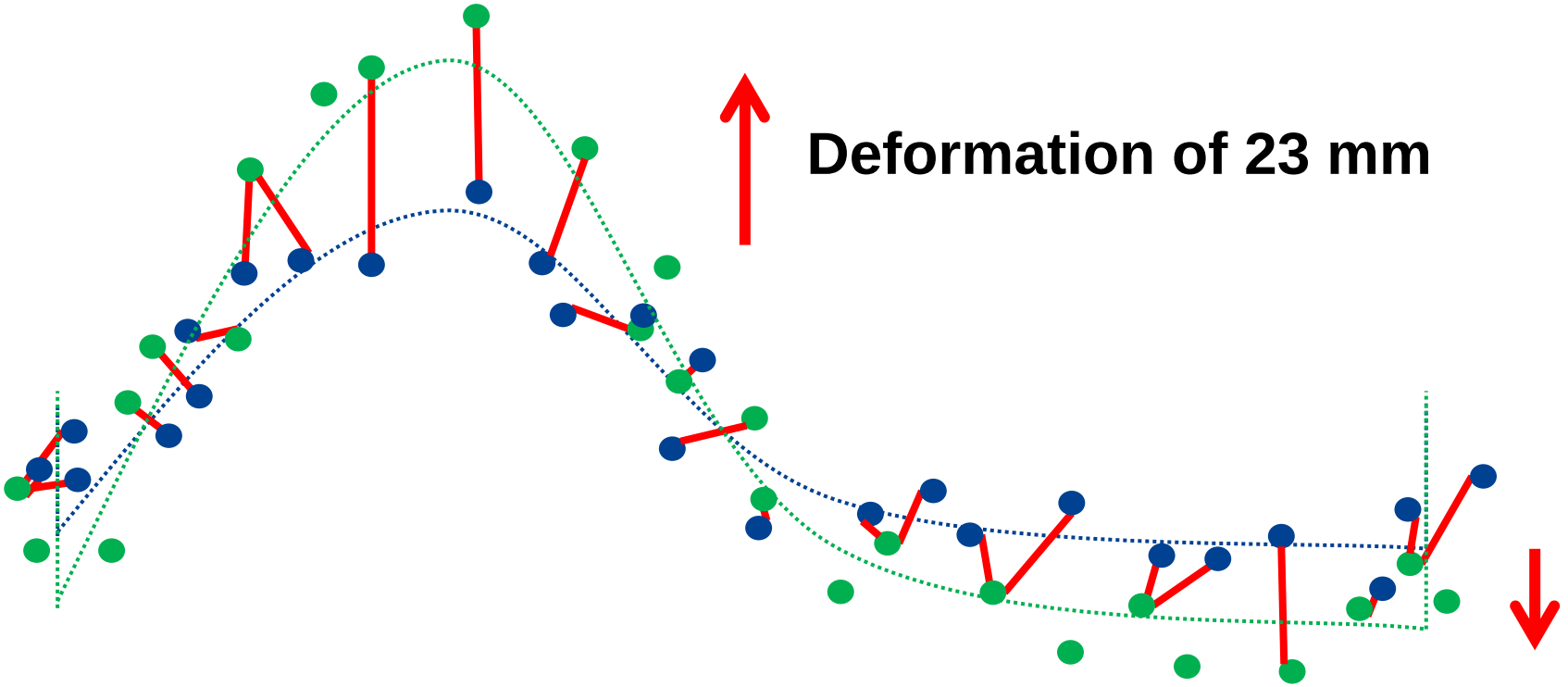


- Usefulness of point cloud comparison depends on direction of deformation (in-plane or out-of-plane)
- No stochstic model, no significance range

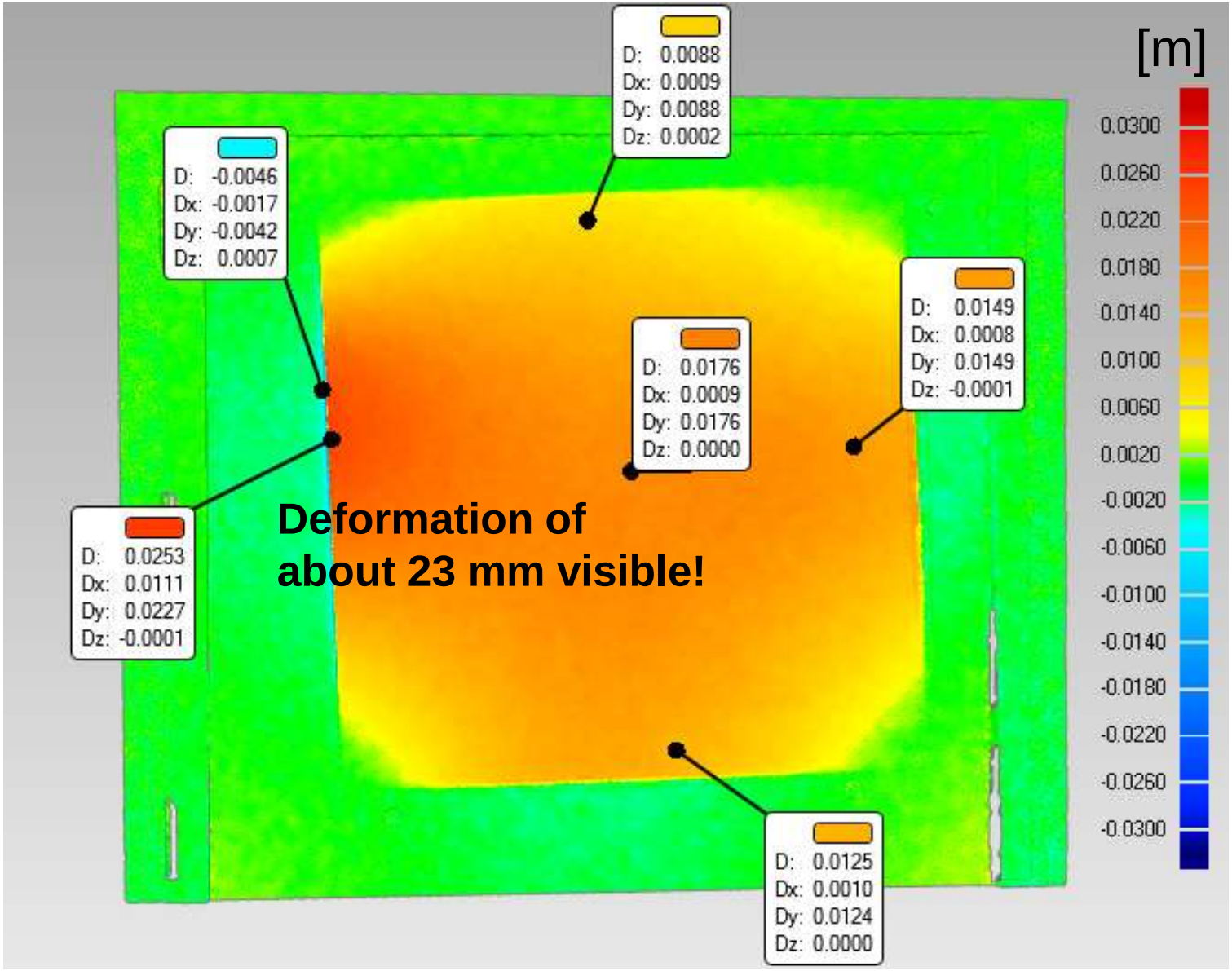
Thanks for your attention!

Example 1: Deformation wooden panel

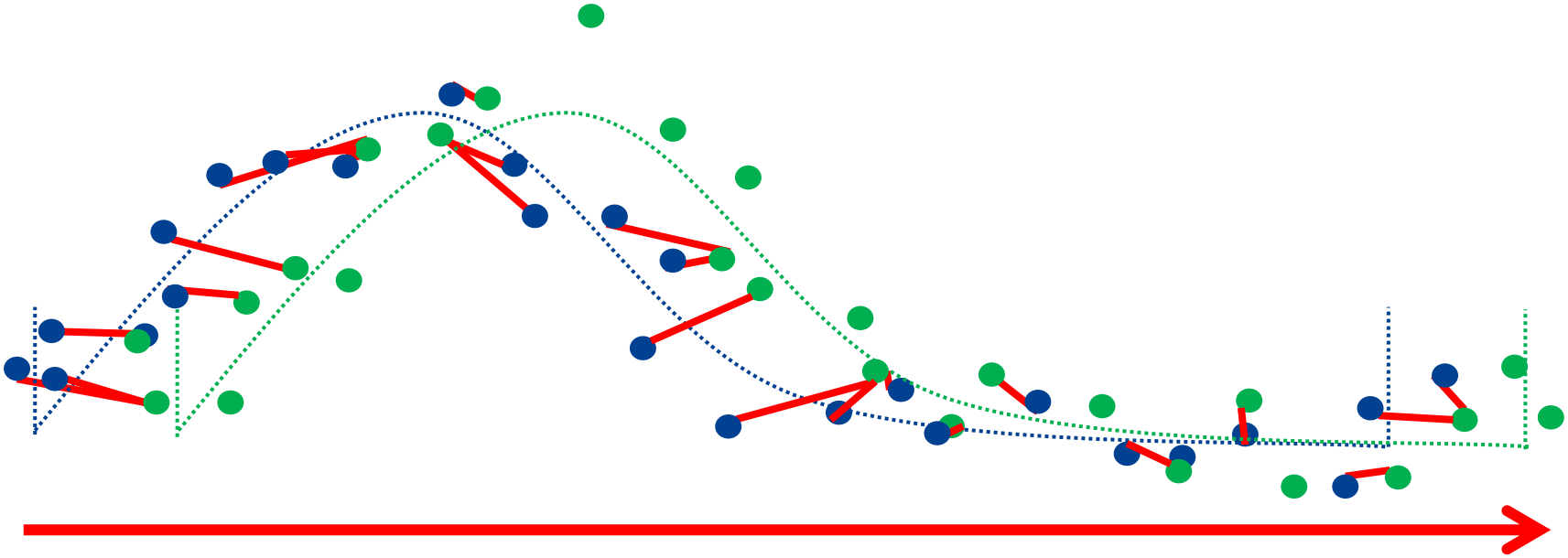
Out-of-plane shape deformation



C2M (Geomagic Control)

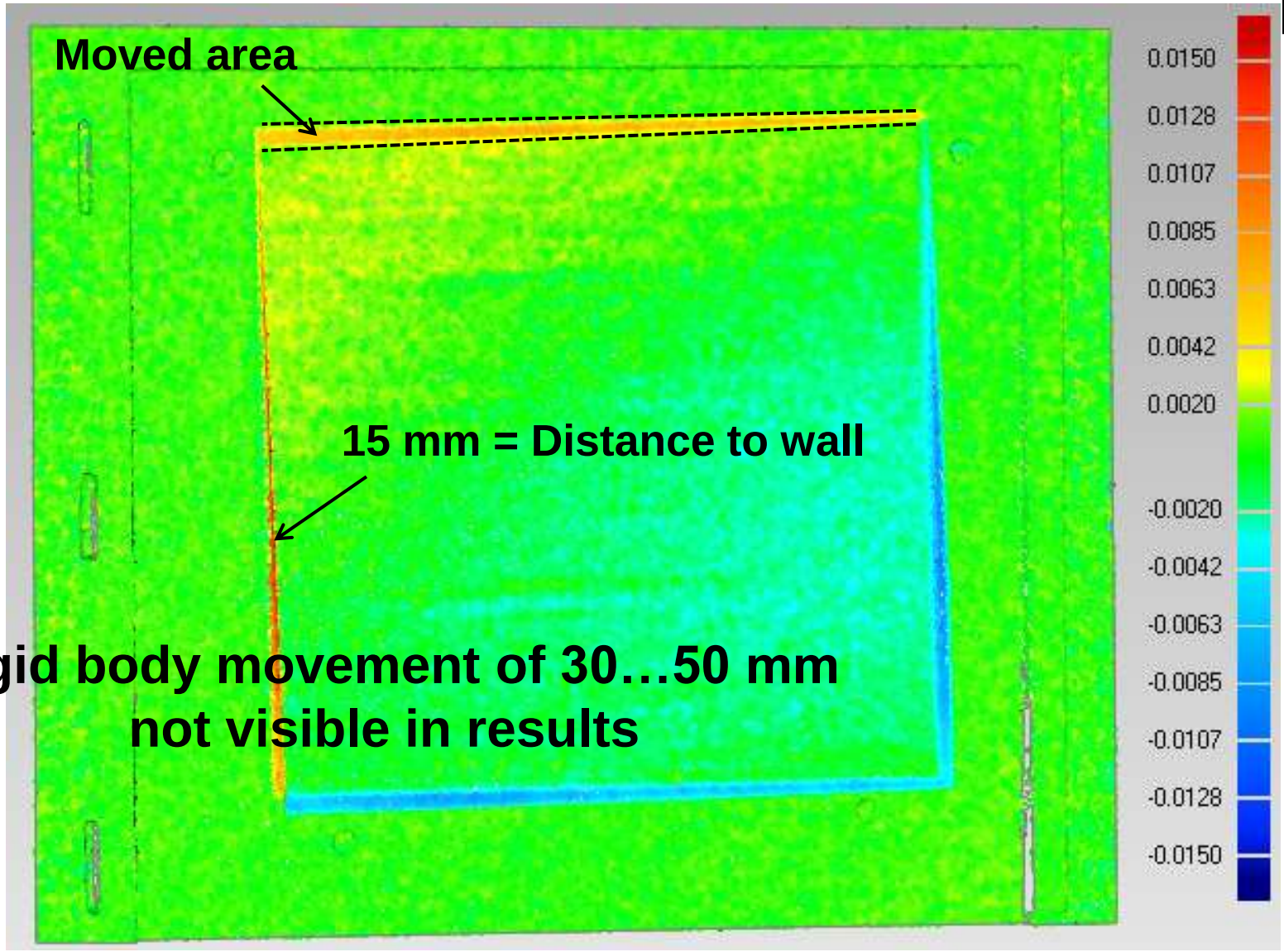


In-plane rigid body movement



Translation and rotation of about 30…50 mm

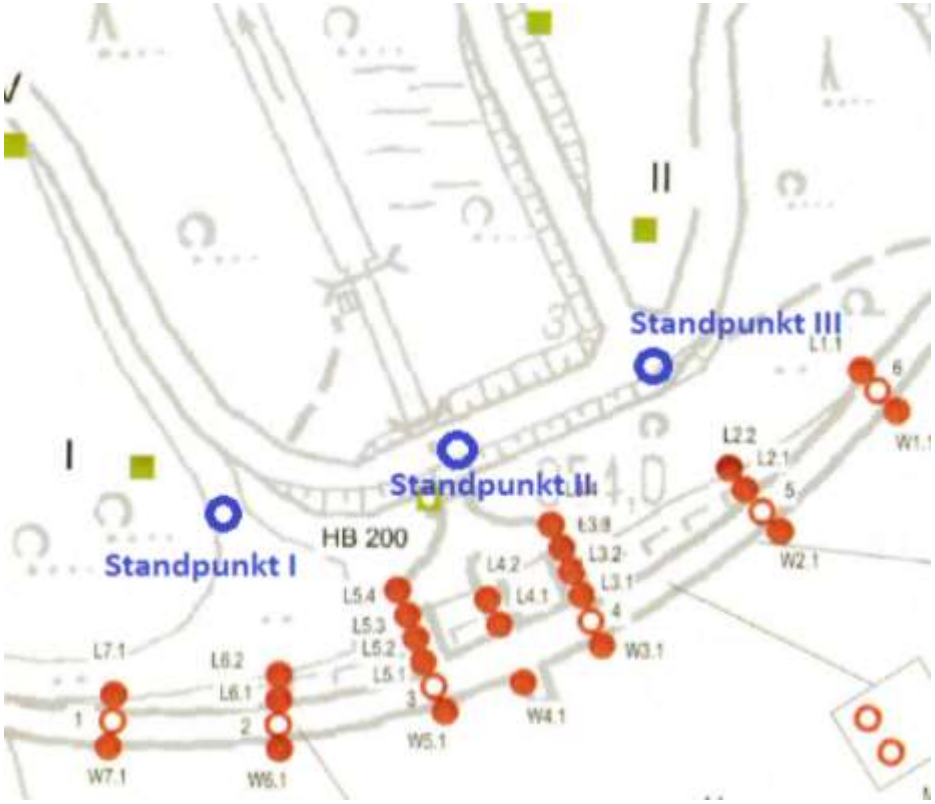
M2M (Geomagic Control)



Rigid body movement of 30…50 mm not visible in results

Example 2: Deformation water dam

- 3 stations
- 2 epochs
- Registration by targets



2 special issues in avn

AVN 6/2016

- Holst, Neuner, Wieser, Wunderlich, Kuhlmann: **Calibration of Terrestrial Laser Scanners**
- Kauker, Holst, Schwieger, Kuhlmann, Schön: **Spatio-Temporal Correlations of Terrestrial Laser Scanning**
- Wujanz, Holst, Neitzel, Kuhlmann, Niemeier, Schwieger: **Survey Configuration for Terrestrial Laser Scanning**

AVN 11/2016

- Neuner, Holst, Kuhlmann: **Overview on Current Modelling Strategies of Point Clouds for Deformation Analysis**
- Wunderlich, Niemeier, Wujanz, Holst, Neitzel, Kuhlmann: **Areal Deformation Analysis from Point Clouds – the Challenge**
- Bureick, Neuner, Harmening, Neumann: **Curve- and Surface-Approximation of 3D-point clouds**