



4D-IT GmbH
... beyond 3D

Highly Accurate Photorealistic Modeling of Cultural Heritage Assets

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Motivation

- Requirements for Documentation and Visualization are different:

Documentation Model

- Geometrically accurate representation of object
- Geometrically rich in detail
- Foundation for
 - Planning
 - Restoration
 - Monitoring
 - etc.

Visualization

- Geometrically generalized to support rendering requirements
- Richness in detail through texture
- Foundation for
 - Visual Inspection
 - Marketing
 - Public Relations
 - etc.



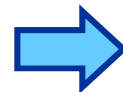
What are the requirements to generate multipurpose geometric models?

Motivation

- **Fast data acquisition:**
 - Provided by Laserscanning with > 1 mio points per second
- **Automation in data processing:**
 - Realize efficient workflows
 - Develop automated methods



- **Open new fields of application**
 - Archaeology
 - Cultural heritage
 - Virtual museum
 - etc.



JUST A VISION?

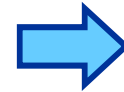
Examples

- **Staircase at Schönbrunn Palace:**
 - Restoration Documentation & Change Detection
- **Fountain at Schönbrunn Palace:**
 - Restoration Documentation
 - Visualization
- **Ephesos Terrace House 2**
 - Archaeological Analysis
- **Exhibits**
 - Documentation
 - Visualization
 - Marketing

Restoration of staircase at Schloß Schönbrunn

■ Data acquisition

- Campaign 2007 (before restoration): 42 scans à ~ 15 mio points
- Campaign 2008 (after restoration): 41 scans à ~ 15 mio points



1,300 mio points

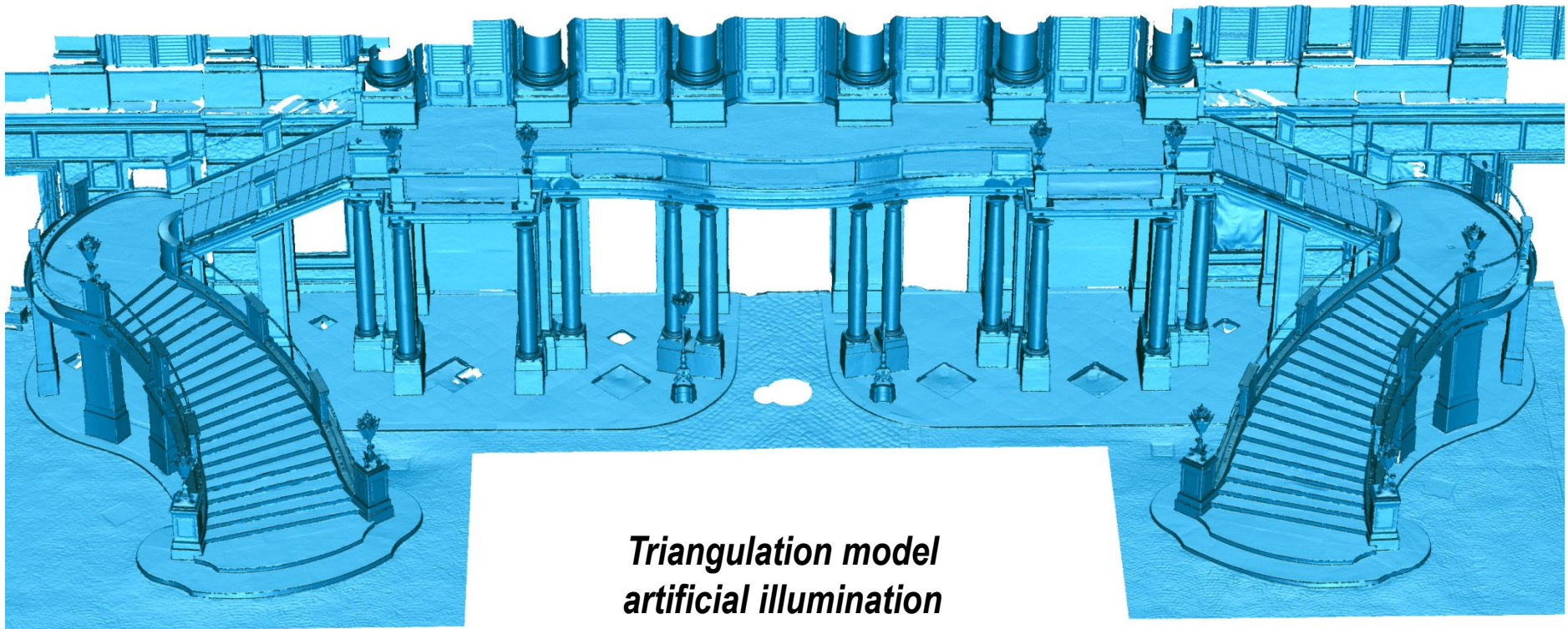
■ Processing effort per campaign

- Scanning: ~ 24 hours
(incl. tachymetric measurement for registration)
- 3D-filtering (automated): ~ 48 hours (~ 1 hour per scan)
(PC: 8-core, 16 GB RAM, 64 bit-Windows)
- Registration (automated): ~8 hours
- Merging and triangulation: ~8 hours
(incl. ~ 2 hours of interactive work)

3D-Model

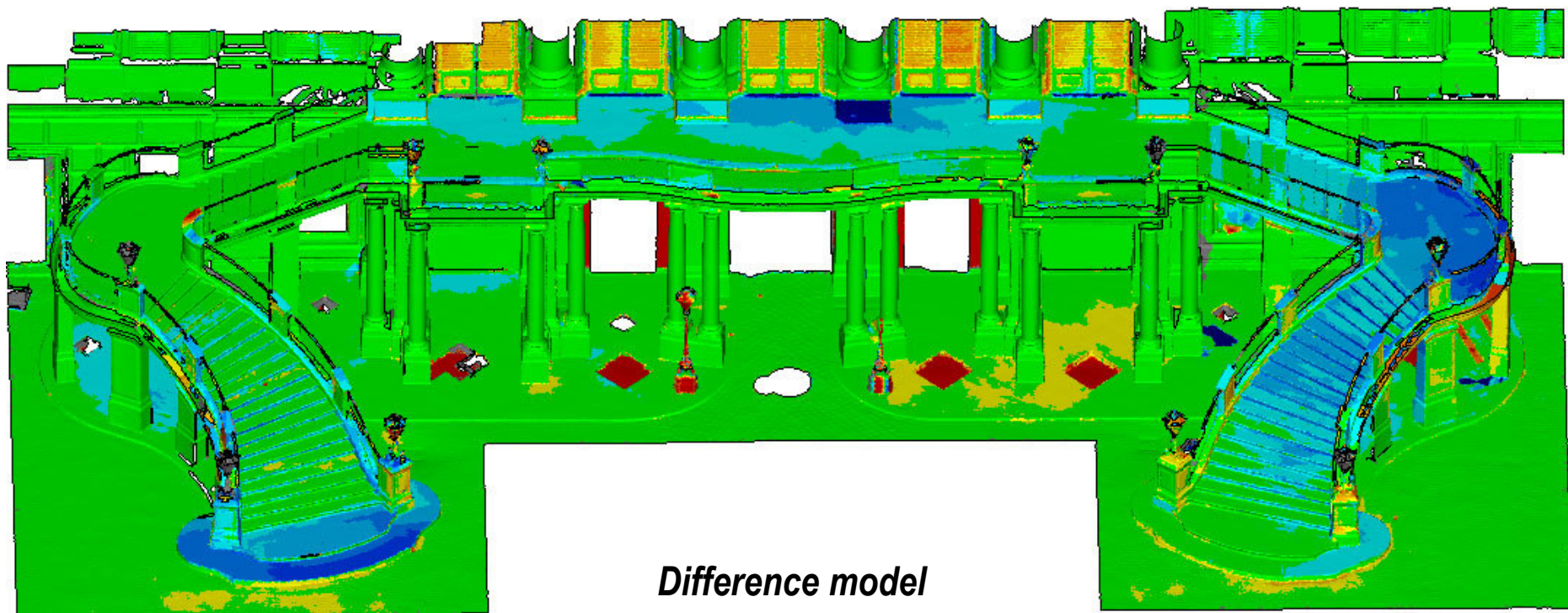
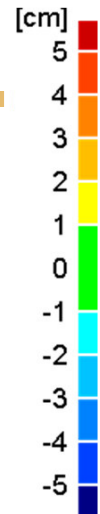
- **Model after restoration**

- Point cloud after 3D-filtering and registration: **~ 23 mio points**
- Triangulation model: **~ 11 mio triangles**



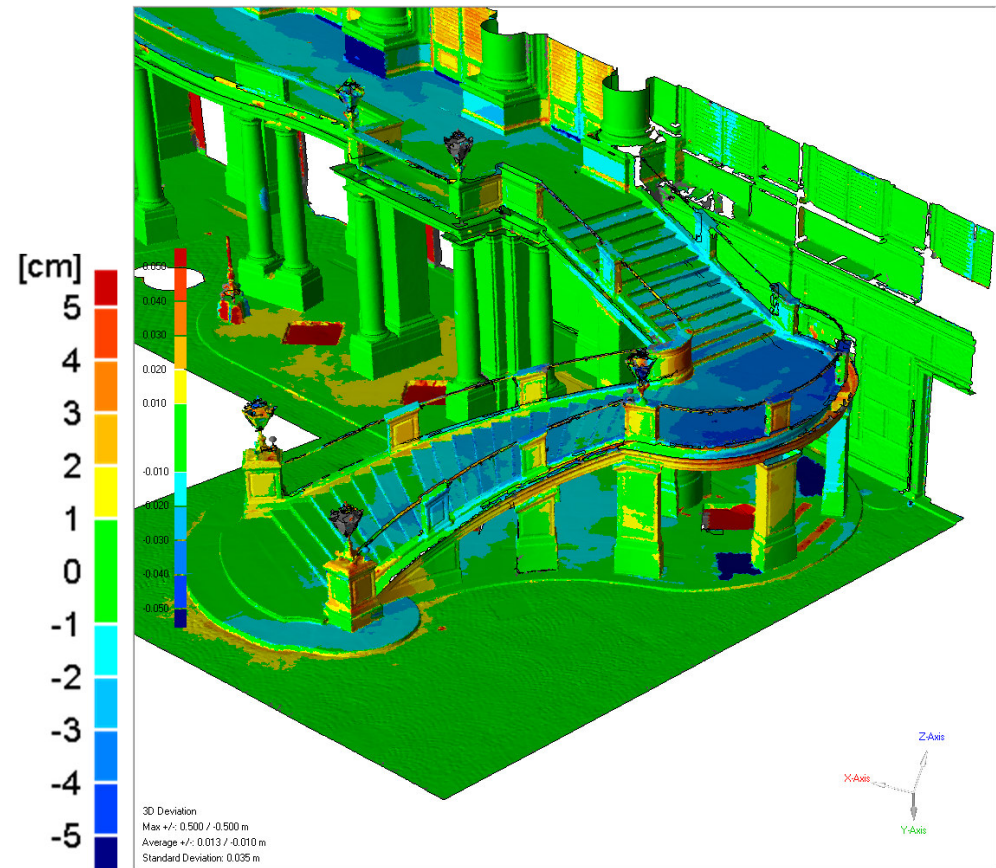
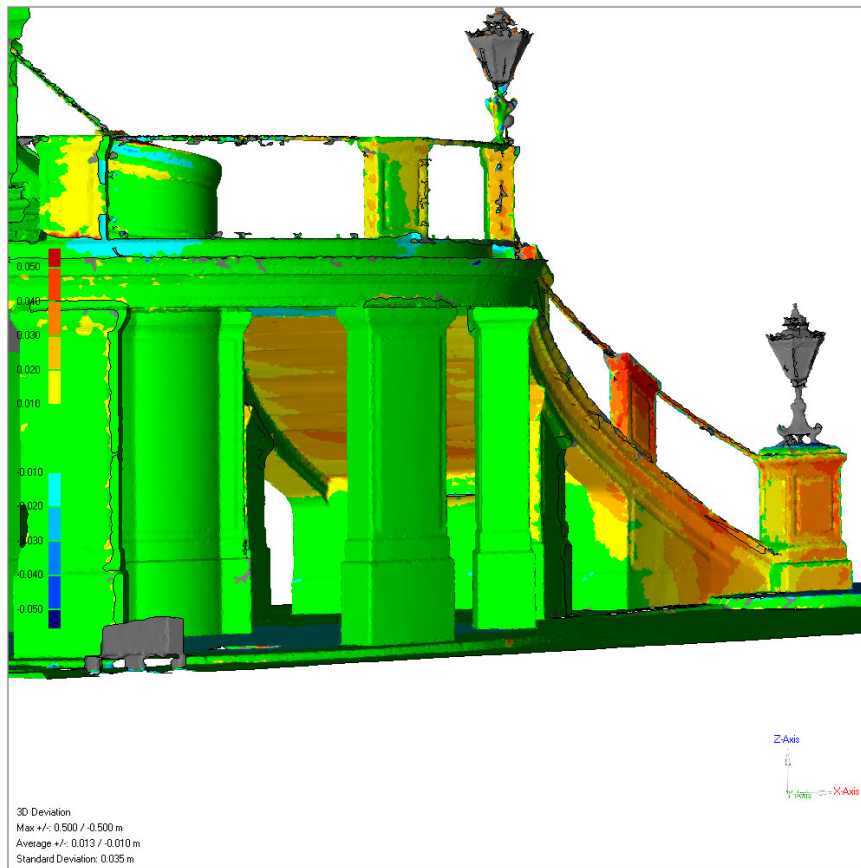
3D-Model Analysis

- Differences before vs. after restoration
 - unchanged: ± 1 cm (~ accuracy)
 - maximal differences: ± 5 cm



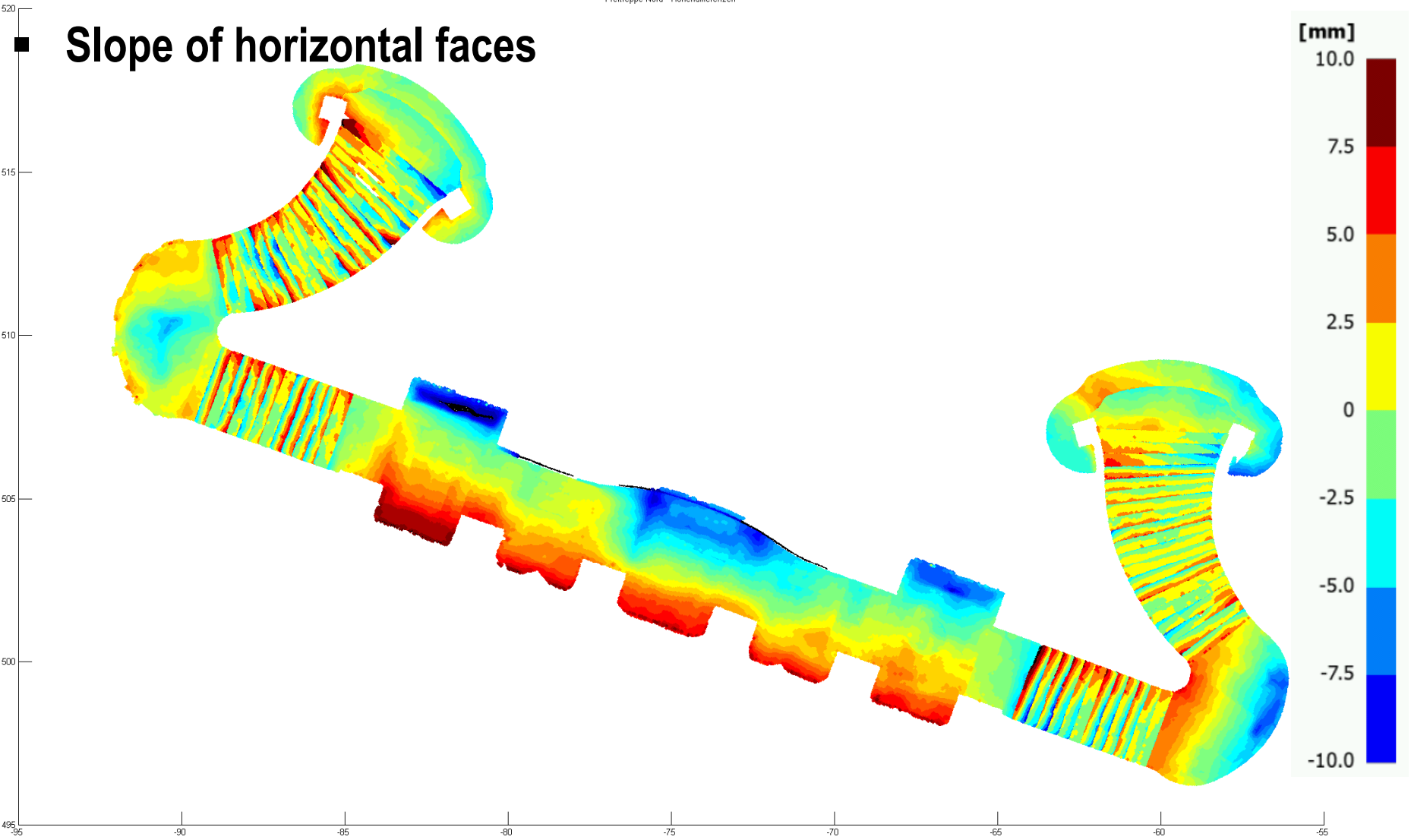
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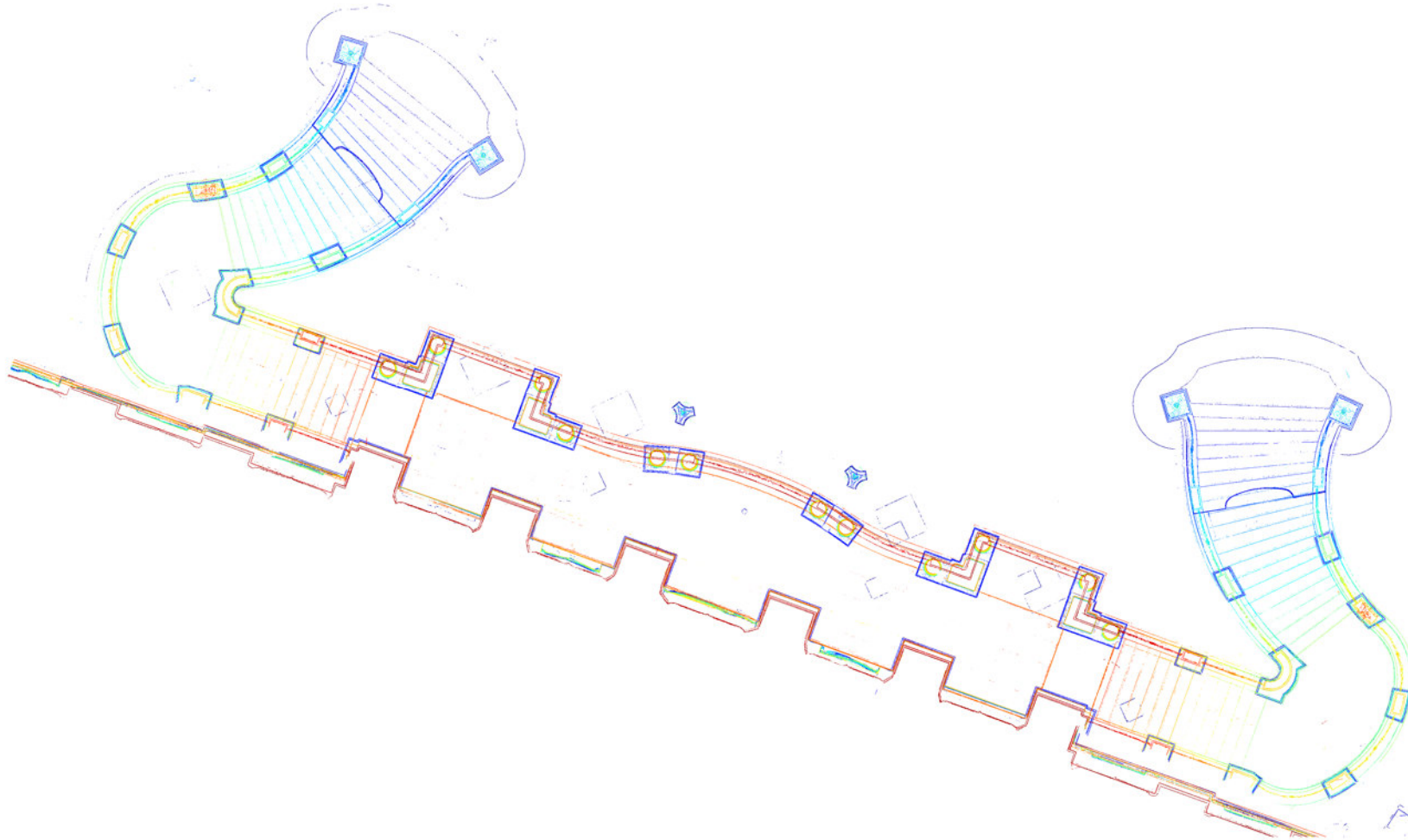
3D-Model Analysis

Freitreppe Nord - Höhendifferenzen



3D-Model Analysis

- Vertical Structures



3D-Model

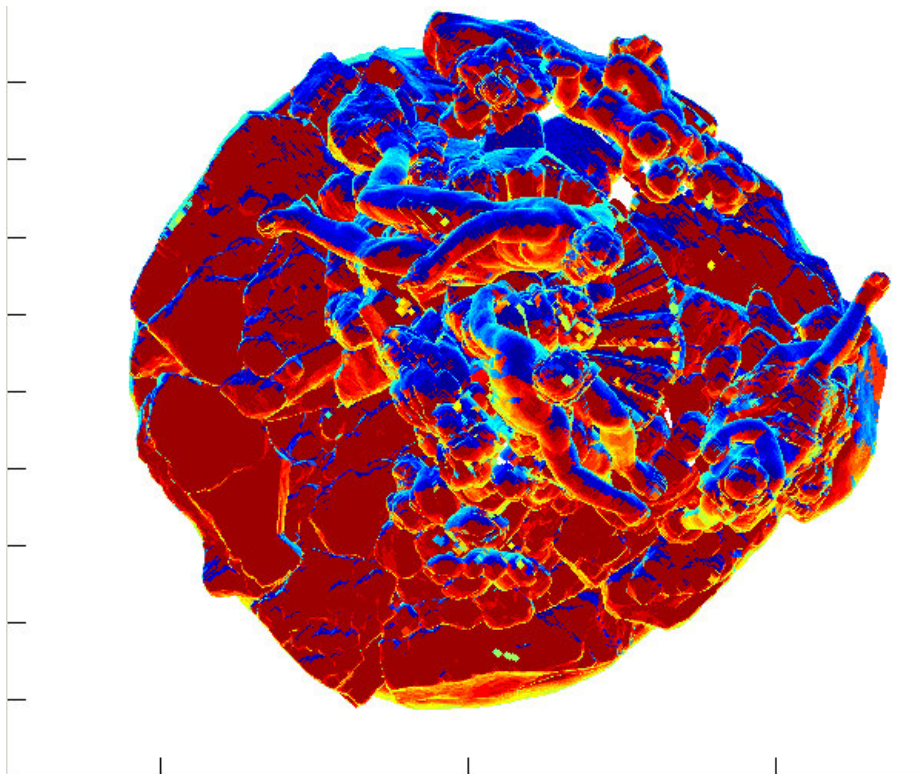
■ Fountain at Schloß Schönbrunn

- 43 scans: ~ 6 hours
sampling distance: ~ 1.5 to 3 mm (per scan)
scanning distance: ~ 3-6 m
object height: ~ 3.5 m
object diameter: ~ 4.5 m
- local registration: ~ 3 hours



3D-Model Analysis & Rendering

- Fountain at Schloß Schönbrunn



Horizontal profiles – Animation



Rendering with artificial texture

3D-Model and Rendering

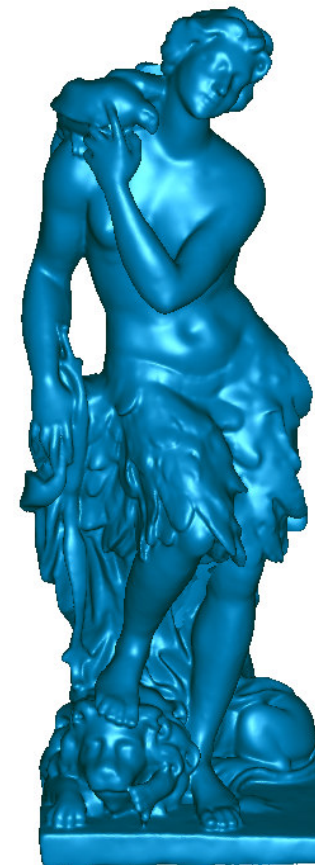
- **Attika Sculpture – Schloß Schönbrunn**



Image



Rendering – Animation



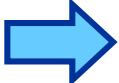
Documentation Model

Ephesos – Terrace House 2

- **Data acquisition**

- Mai/June 2010: 172 scans à ~ 60 mio points (incl. roof construction)
 **10,000 mio points**

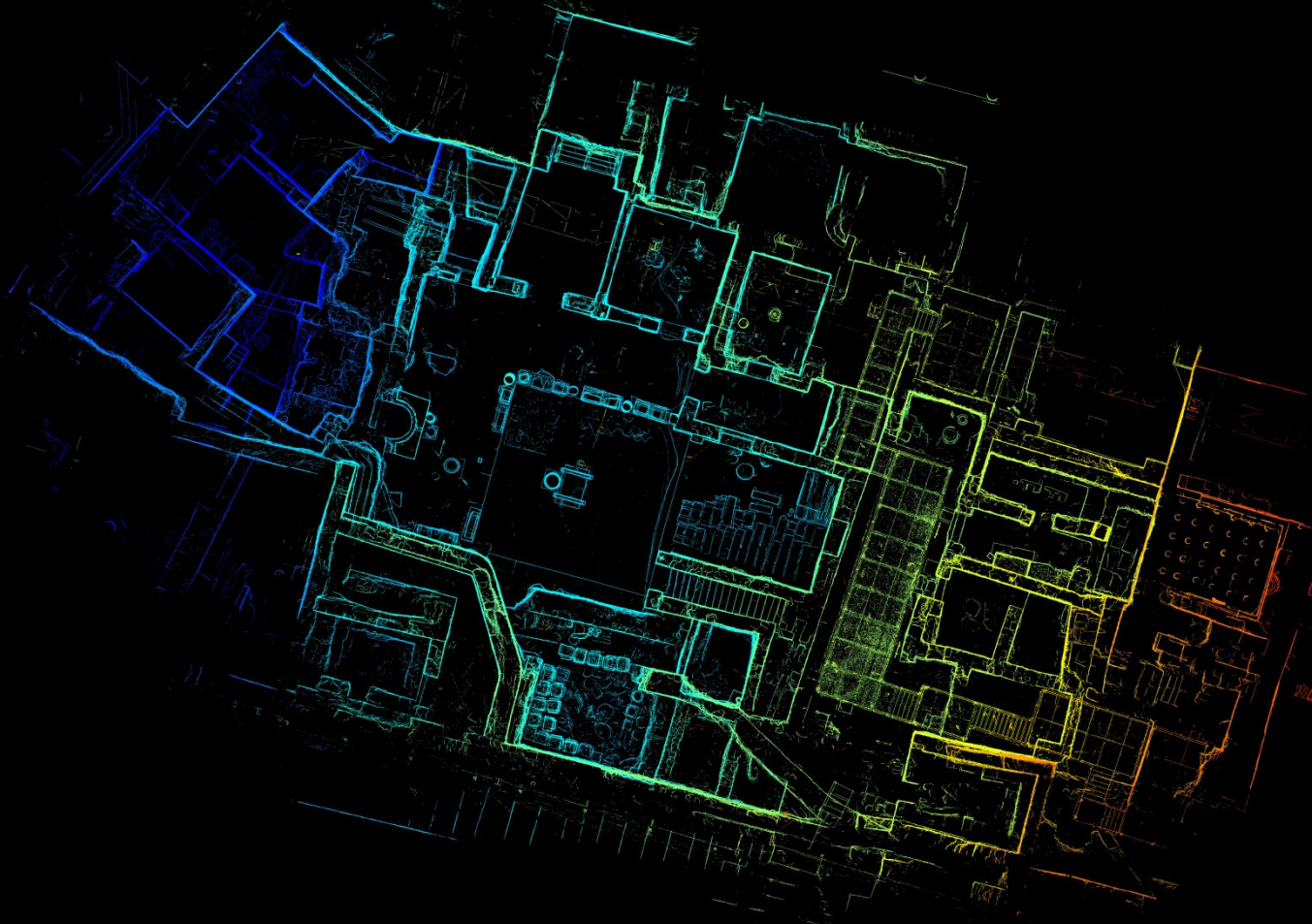
- **Processing effort per campaign**

- Scanning: ~ 7 days (1 person)
(+ *tachymetric measurement for registration*)
- 3D-filtering (automated): ~ 168 hours (~ 1 hour per scan)
(*PC: 8-core, 16 GB RAM, 64 bit-Windows*)
- Registration (automated): ~ 8 hours (*single core*)
- Merging (automated): ~ 8 hours
 **500 mio points** (glob. analysis: **125 mio**)
- Triangulation only partially

[in cooperation with ÖAW (Rathmayr, Adenstedt) and TU Wien-E280 (Kalasek), FWF project P 22102]

Ephesos – Terrace House 2

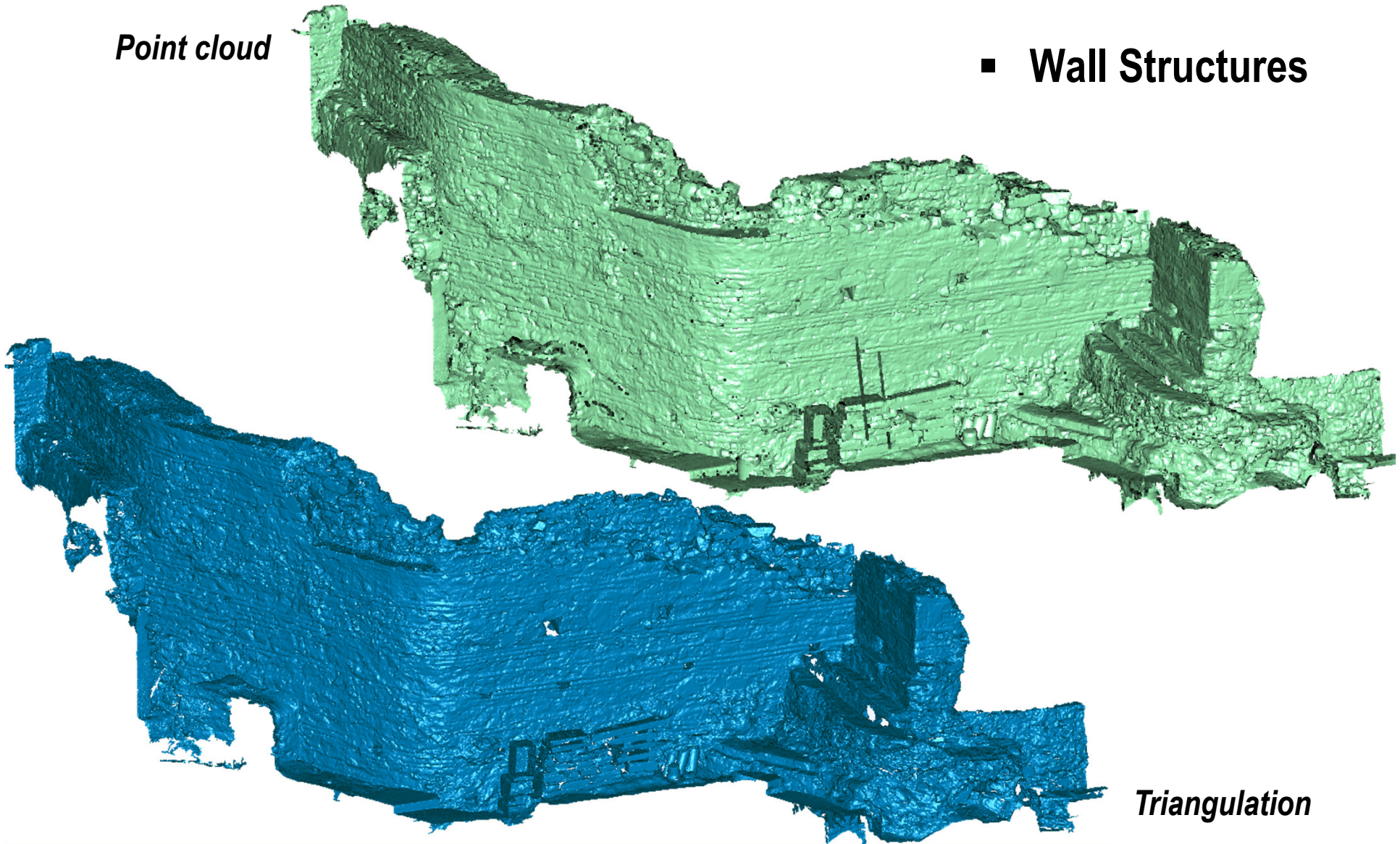
- Vertical Structures



Ephesos – Terrace House 2

Point cloud

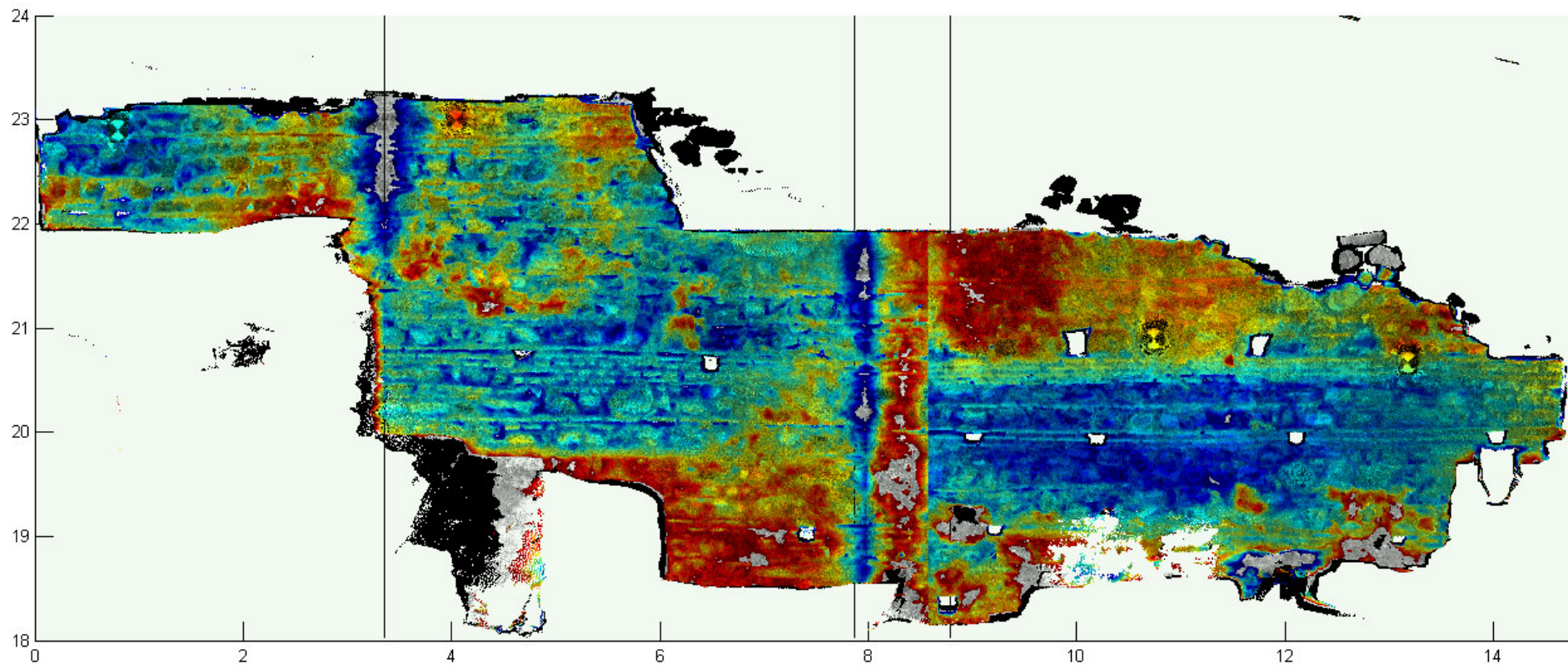
■ Wall Structures



Triangulation

Ephesos – Terrace House 2

- Wall Projection



Sacred Cup

- Close range scanning
 - Scanning: *FaroArm* @ ~15 min
 - Images: *Canon 20D* @ ~15 min

Animation



Tutankhamun

■ Data acquisition

- Faro Photon 80
77 scans @ ~10 hours
3 mm @ 5 m
- Canon 20D, 14-18mm
~5 hours

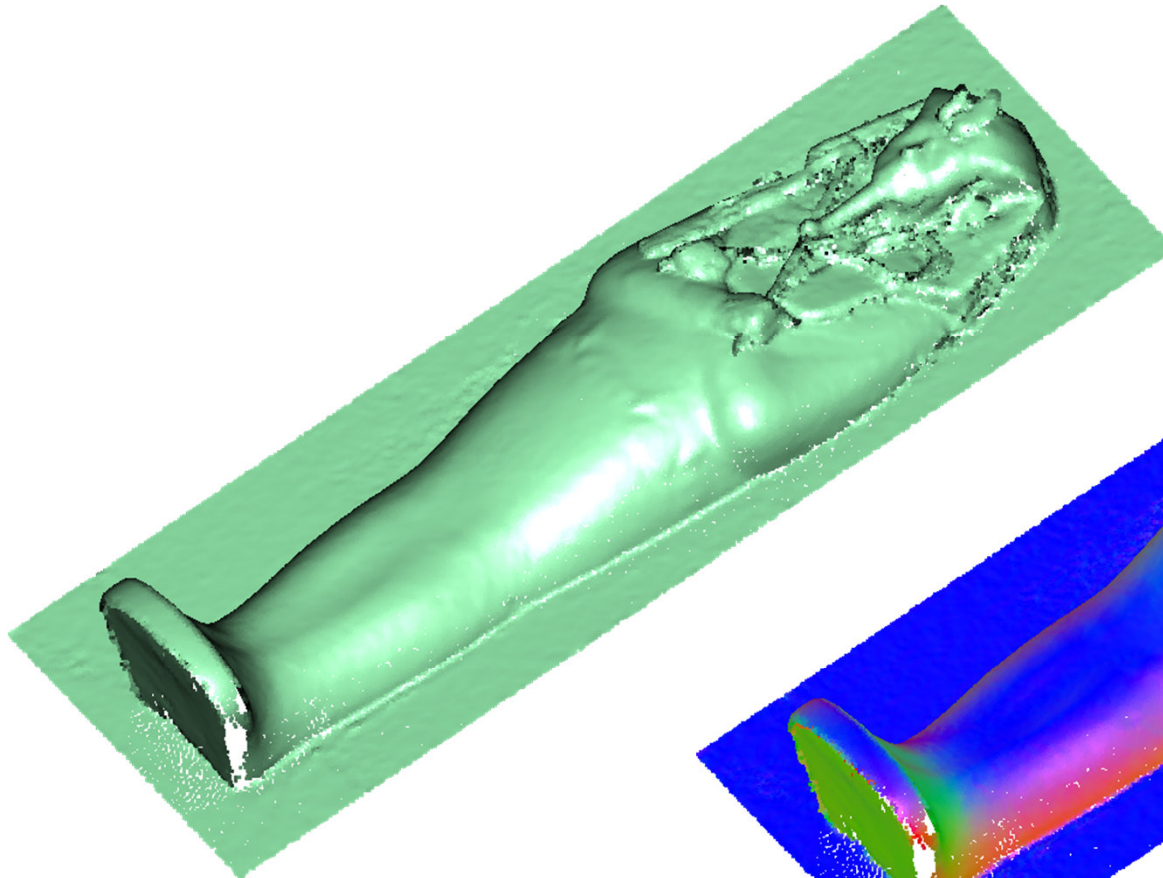


Polar image of point cloud (intensity)

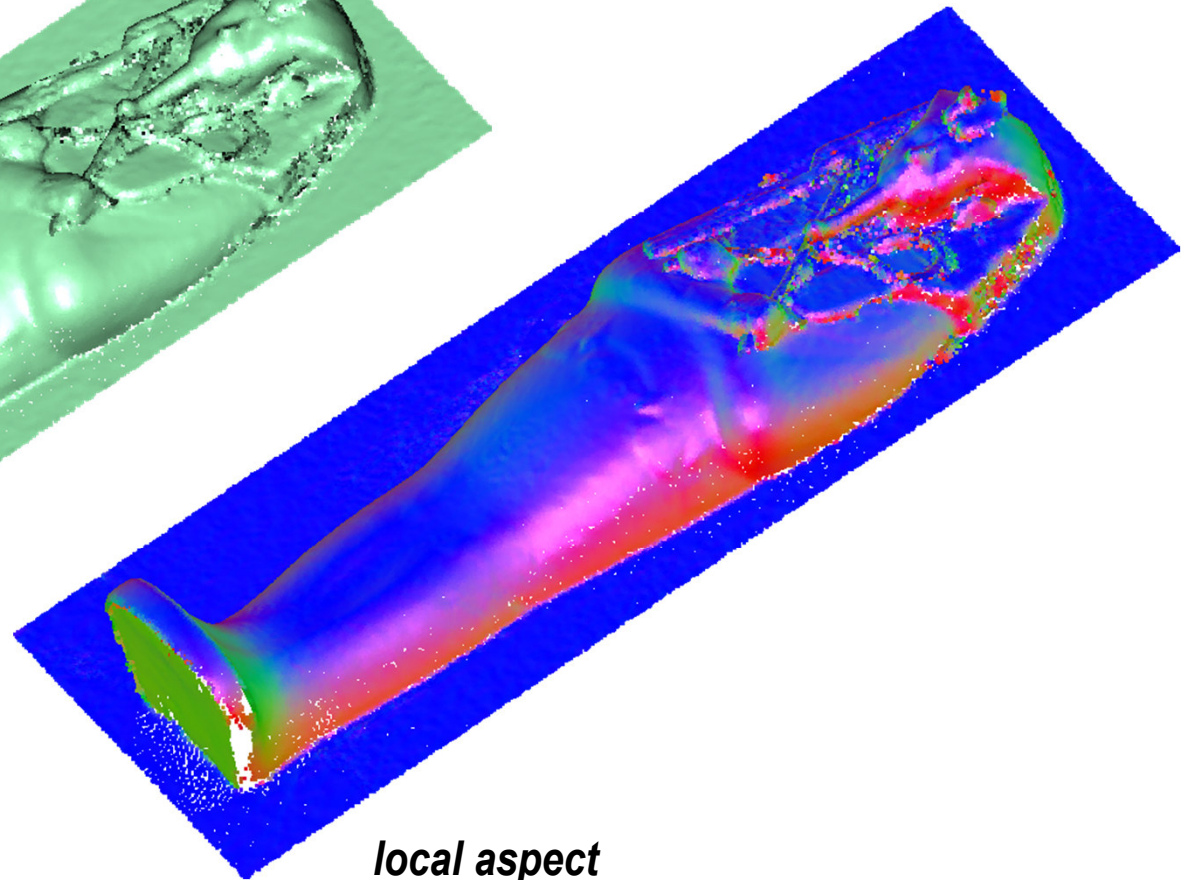


Tutankhamun

- Point cloud after filtering



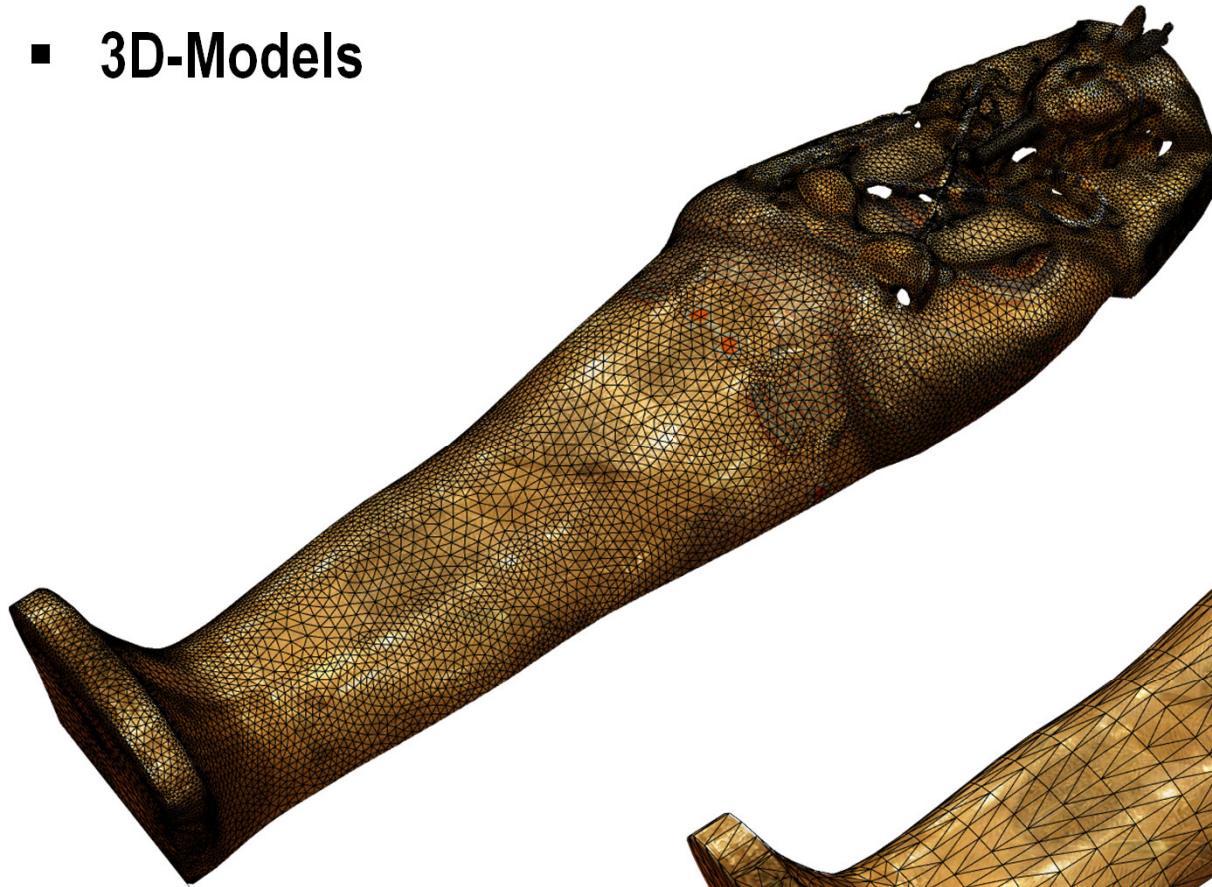
shaded points



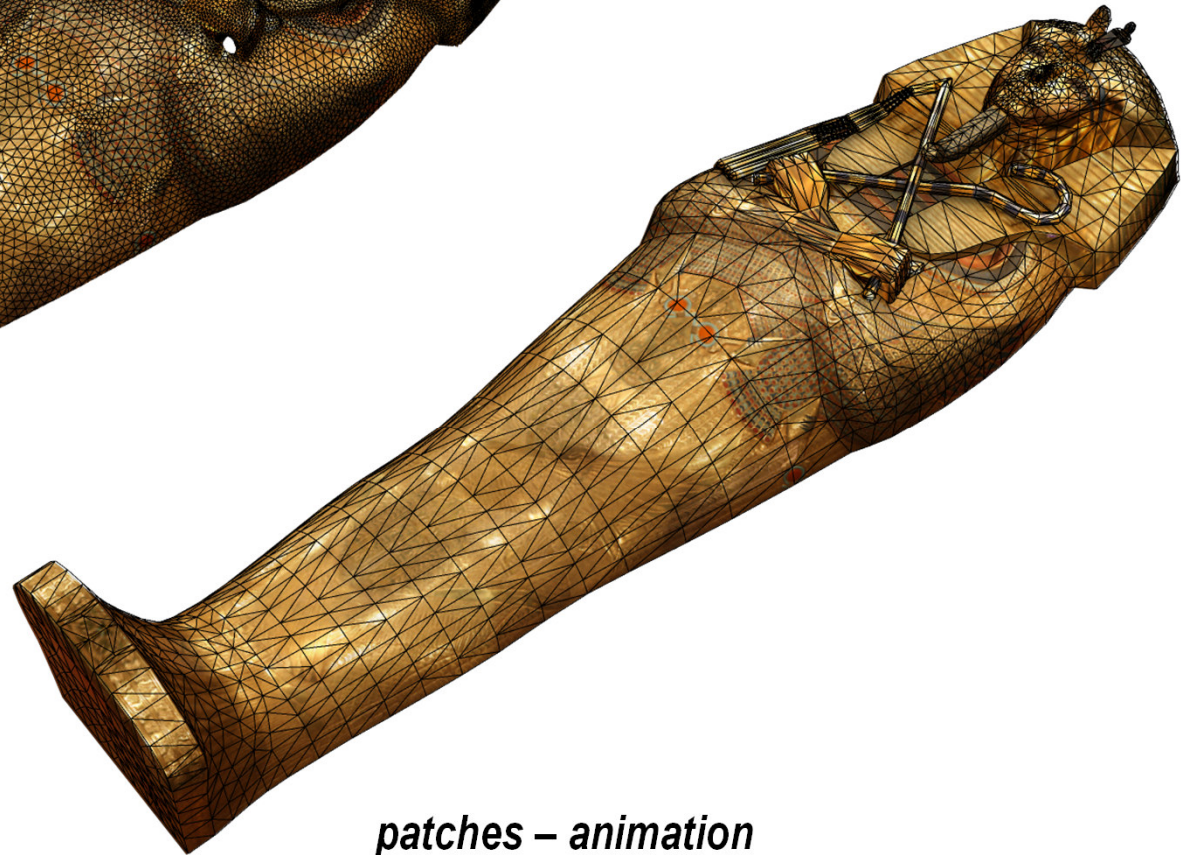
local aspect

Tutankhamun

- 3D-Models



automated triangulation



patches – animation

Tutankhamun

- iPhone-App



Conclusions

- **3D-documentation model generation from TLS data allows for automation**
- **By appropriate generalization and by integrating textures, the same model are appropriate for visualization**
- **Such multipurpose models opens extensive fields of applications**
 - **documentation: Distinct objects and whole sites**
 - **analysis: Change detection, mapping, etc.**
 - **public relations: From huge projection installation to website and smartphone representation**



FROM A VISION TO REALITY



4D-IT GmbH
... beyond 3D

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