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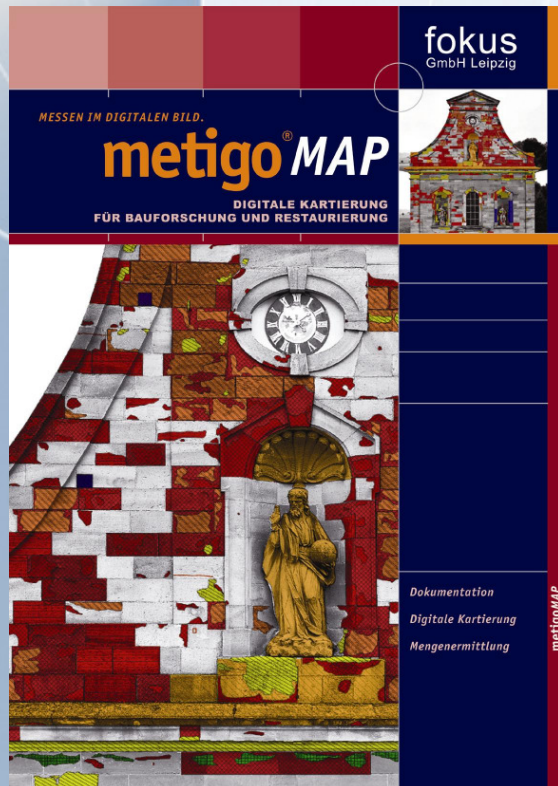
Modern methods of documentation

for conservation –

Digital mapping and automated

3D object documentation in

software metigo®

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Dipl.-Ing. G. Siedler, Dipl.-Inf. (FH) S.Vetter,
First Working Group Meeting at the FH Mainz,
University of Applied Sciences in Mainz

Mainz, 2013 March 27

# Mapping software **metigo *MAP***

- Structure of a mapping project:
  - mapping basis
  - mapping classes
  - mapping groups
  - legends

- Digital image rectification

- mapping tools

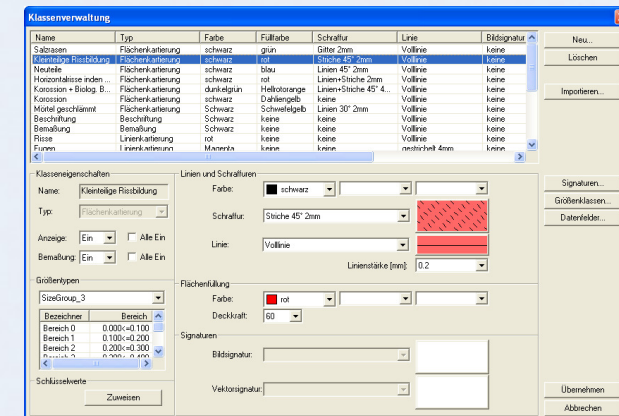- Object hierarchy

metigo *MAP* – Mapping basis
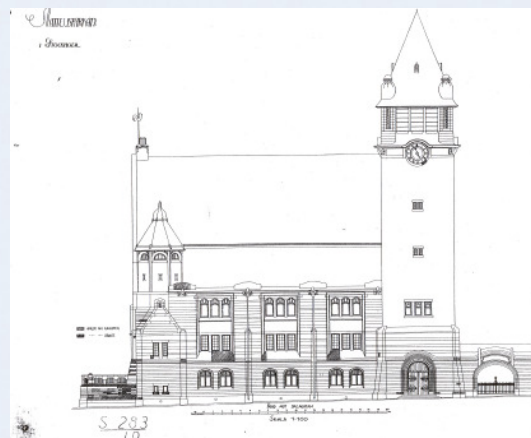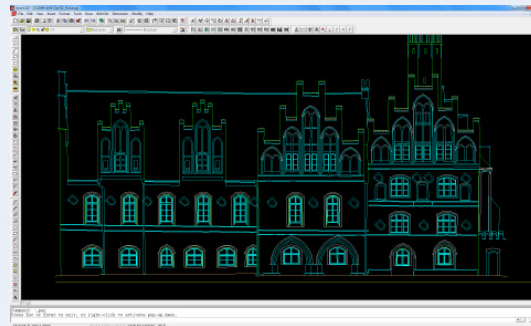
- Digital mapping on true to scale mapping basis

- rectified images, CAD drawings or scaled plans are scaled by project scale into the display of mapping project

- areas, lengths and quantities of mapped elements are automatically calulated

- mapping signatures are scaled by project scale into the display of the mapping project...
  (hatchings, line types and symbols)
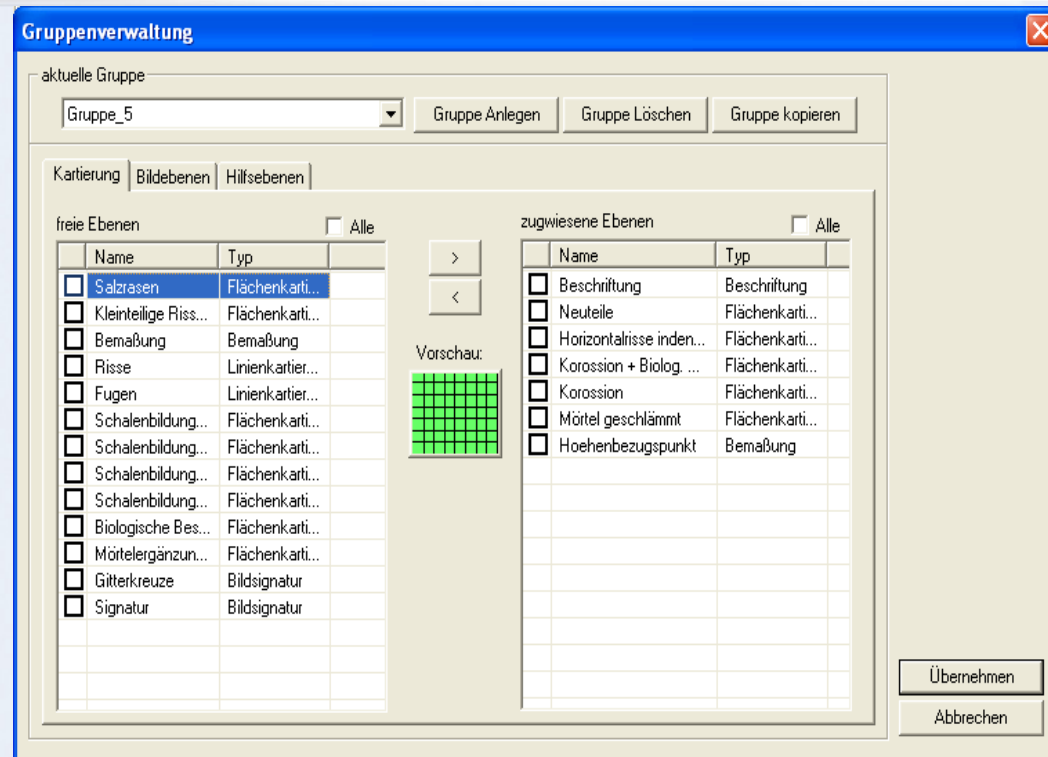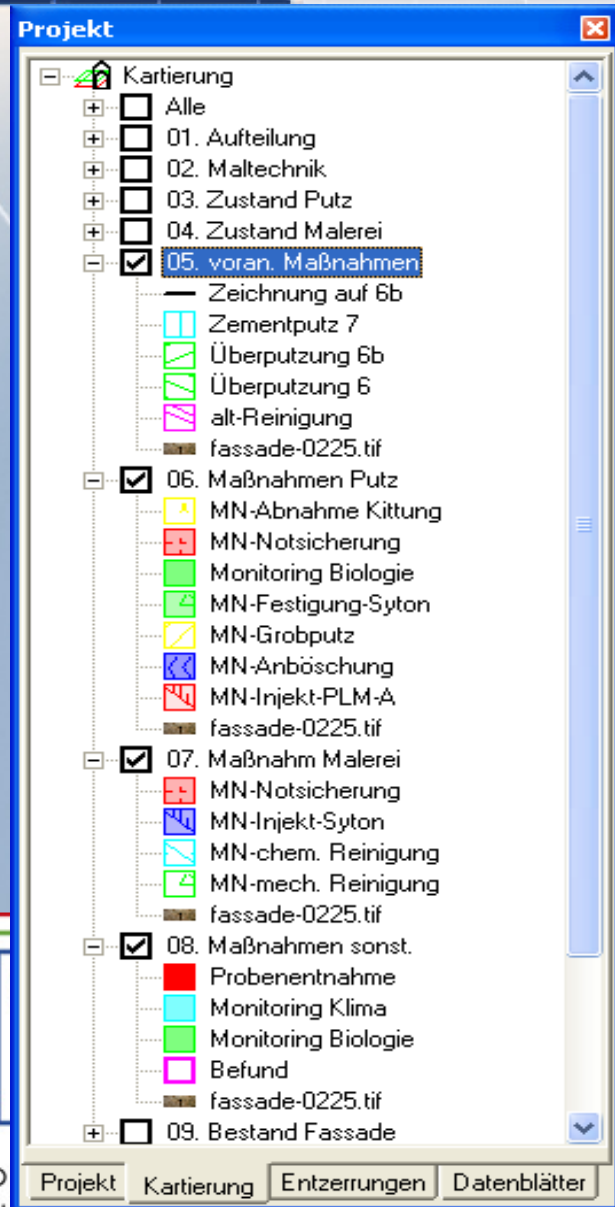
metigo *MAP* – Mapping classes (layer)
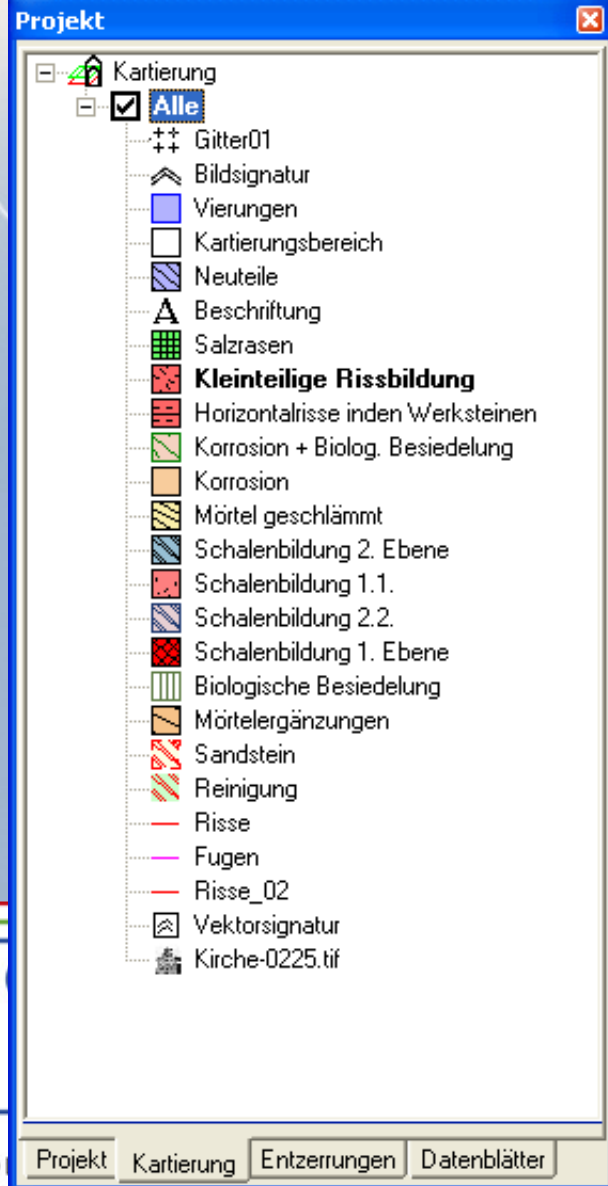
- individual creation of mapping classes for each topic (damages, materials, planed conservation measures…)

- class types for area and line mapping, signatures, detail photos, measurements and annotations

- large library of mapping signatures
  - Hatchings and transparent area
  - Linetypes
  - Vector signatures
  - colour libraries

- for each layer individual assignment of:
  - size classes,
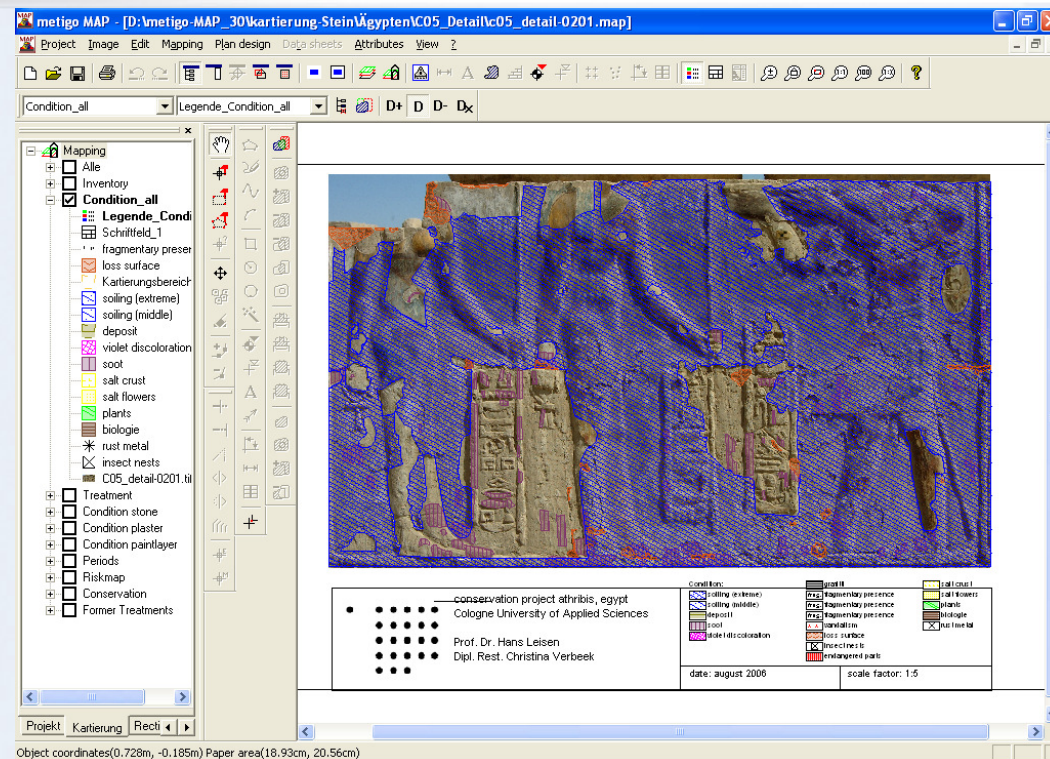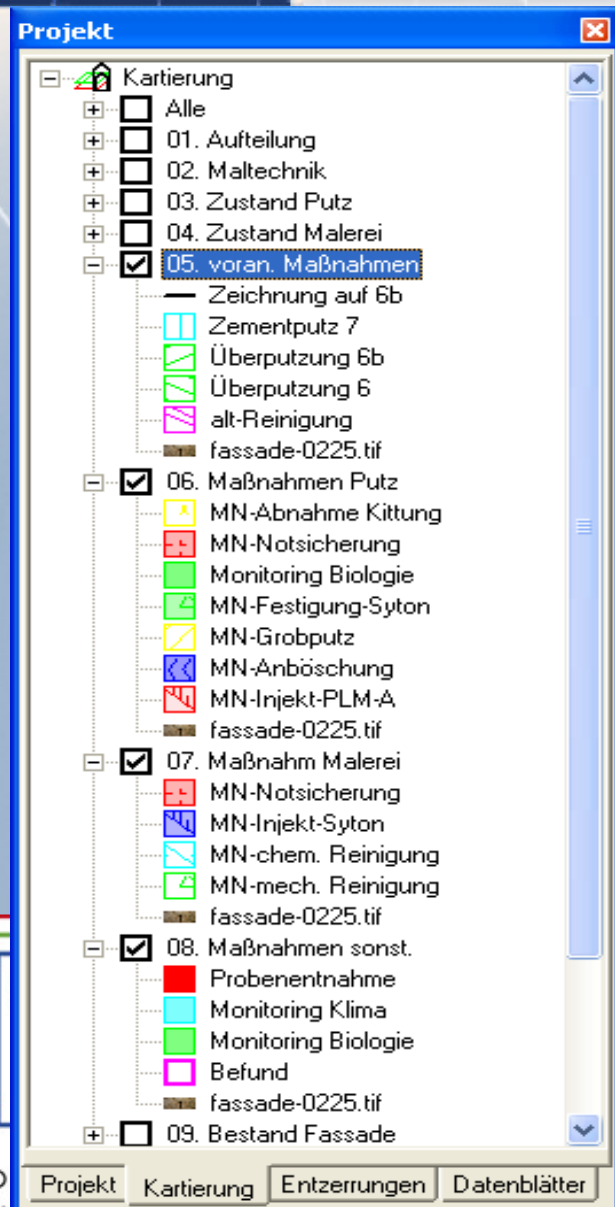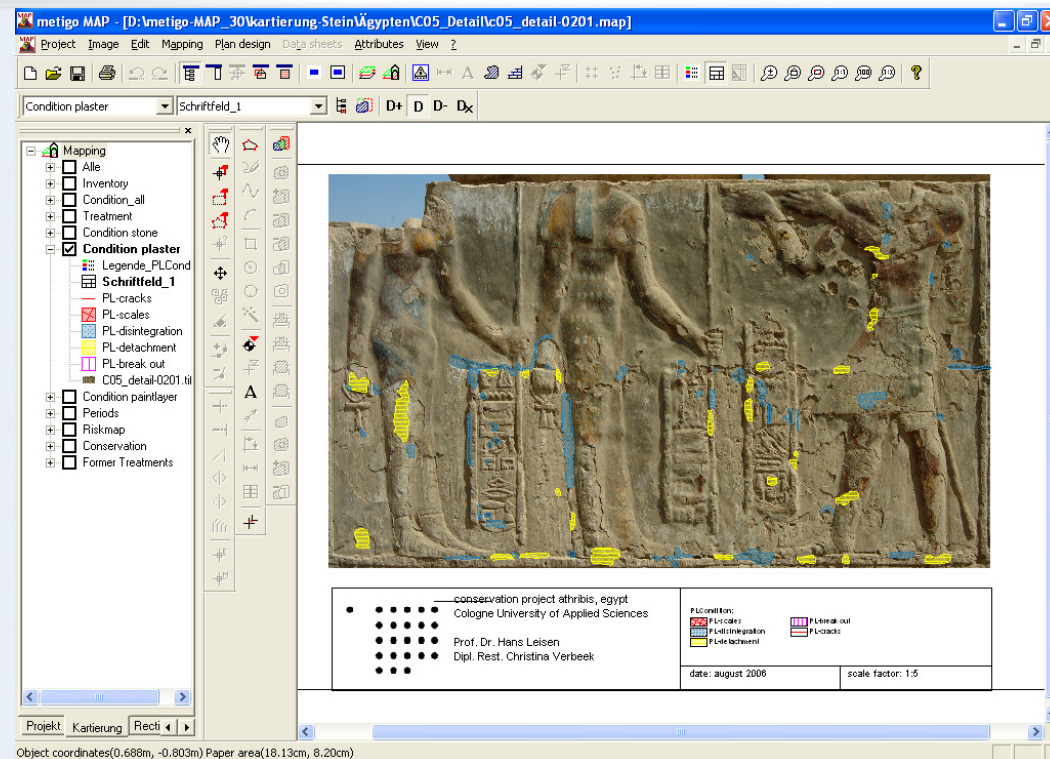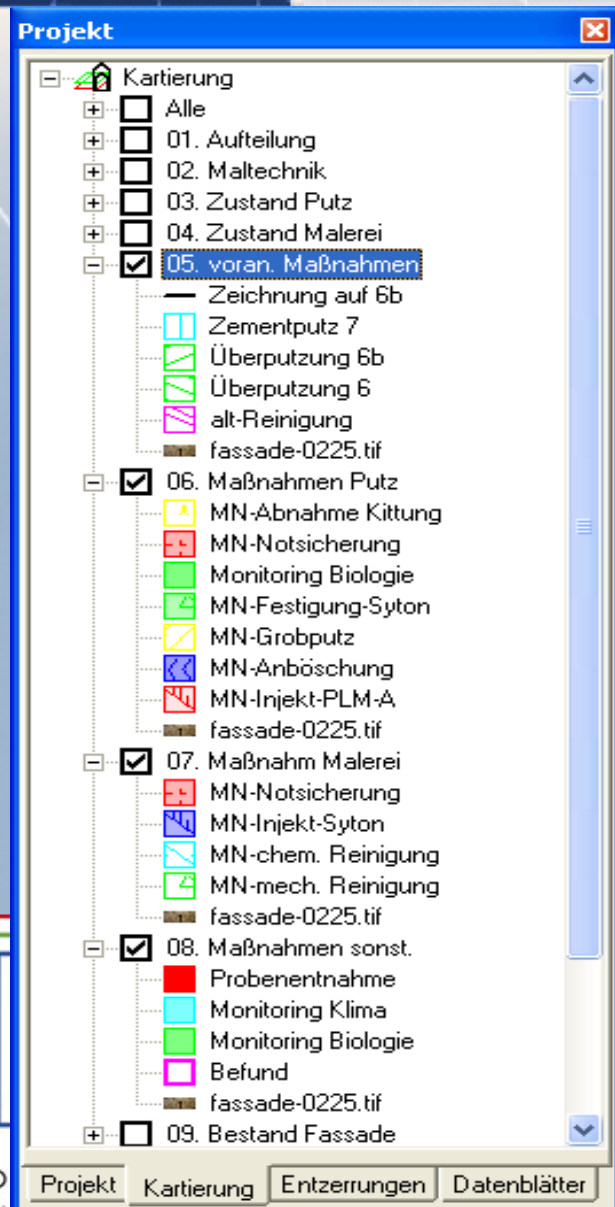 - data fields,
  - units, fractional digits

metigo *MAP* – Mapping groups

(Eqypt, Athribis Project, FH Köln, FB Restoration, Neverhotep e.V.)

- variable combination of:
  - mapping classes
  - image layers (UV-light, Infrared, historical…)
  - Helping planes, legends and title blocks

- display control / arrangement:
  - mapping phases,
  - conservations measures,
  - printing layouts

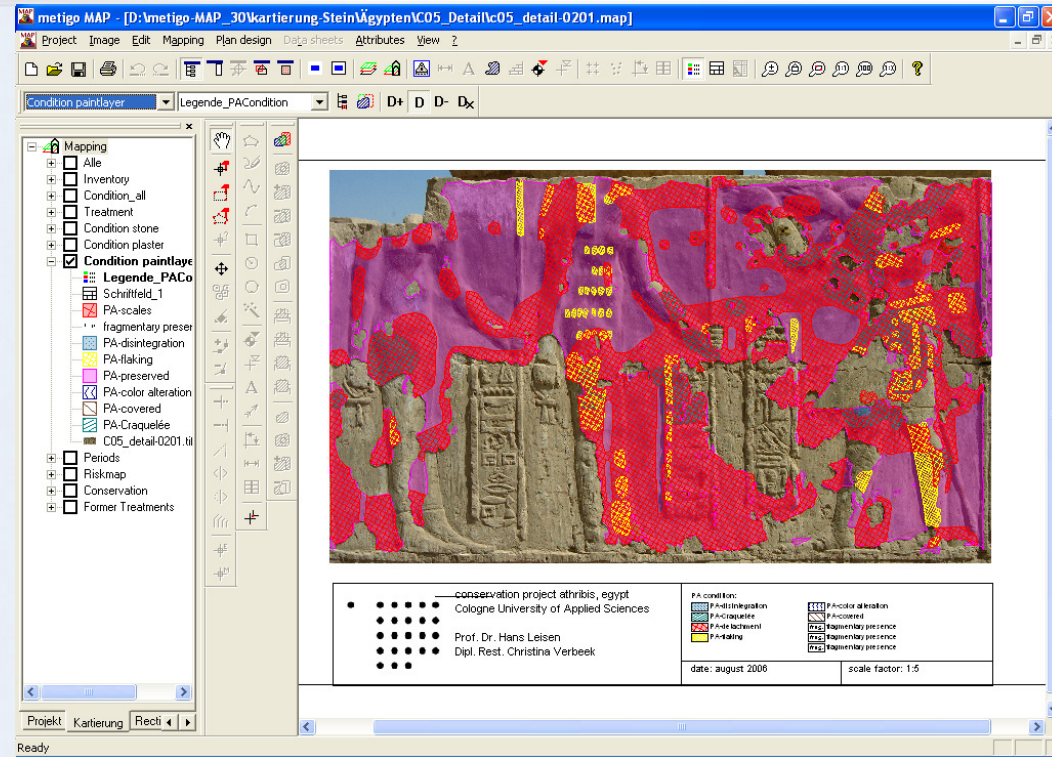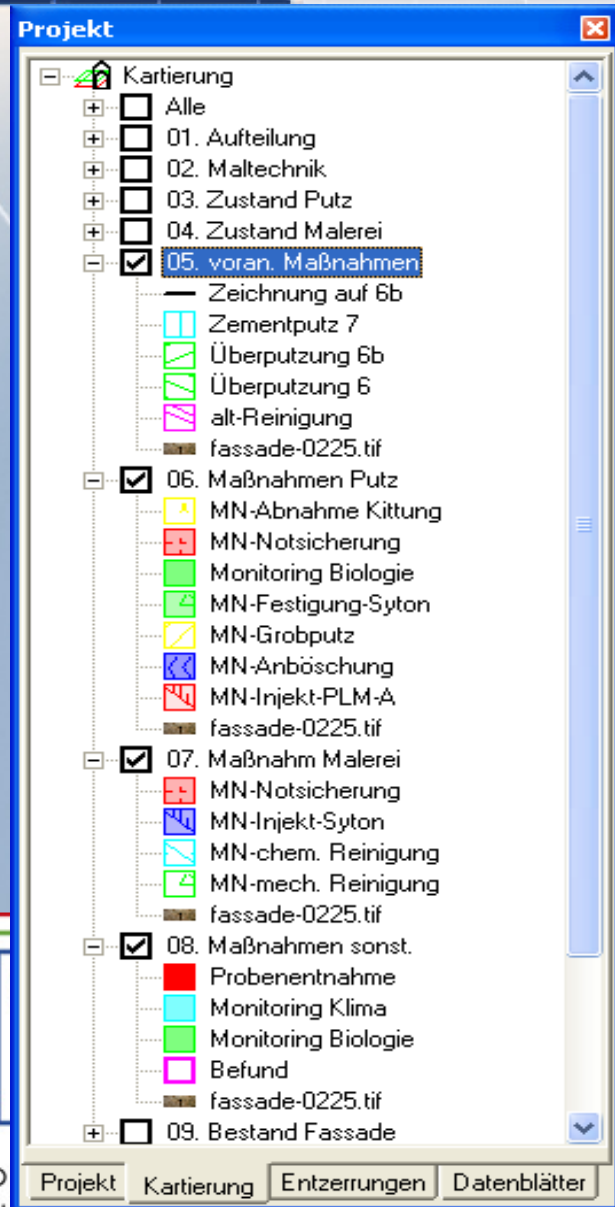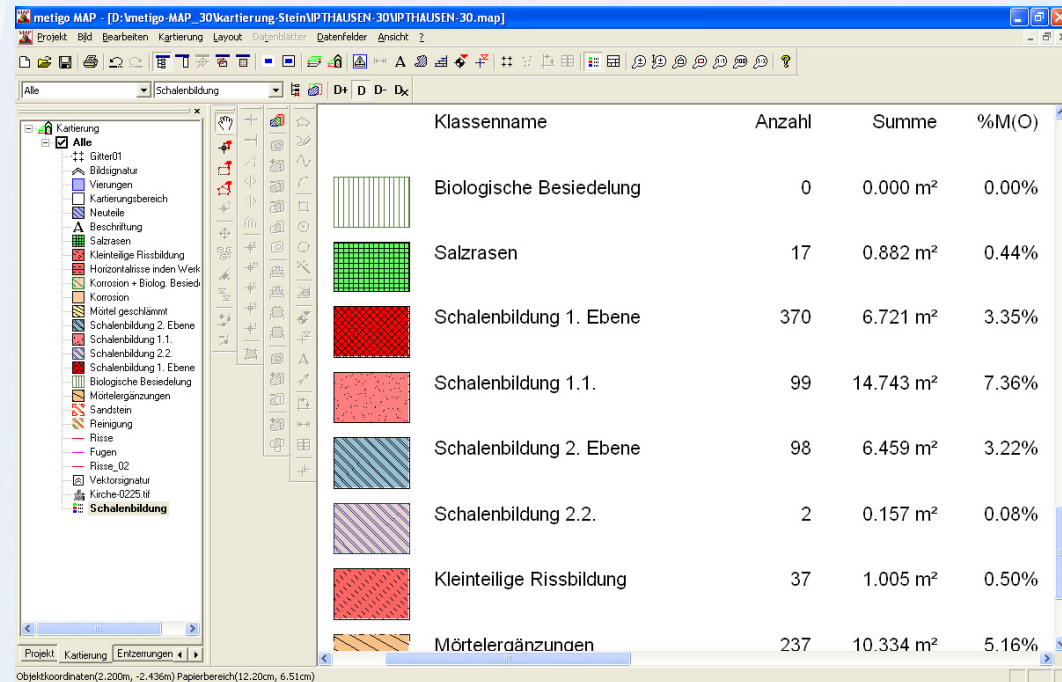# metigo *MAP* – Mapping groups

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metigo *MAP* – Mapping legends

- automatic connection of Legend with class management,
- Legend allows display of: - quantity survey,
                                           - percent calculation,
                                           - size classes...

- group legend for display of group content,
- templates for legends

metigo *MAP* – Rectification by geometry

Rectification by rectangle
• A rectangle is defined at the object and the width and heigh are measured.

Rectification by parallel lines
• Horizontal and vertical lines are defined at the object and one measuring section is taken per horizontal and vertical way.

Rectification by net of distances
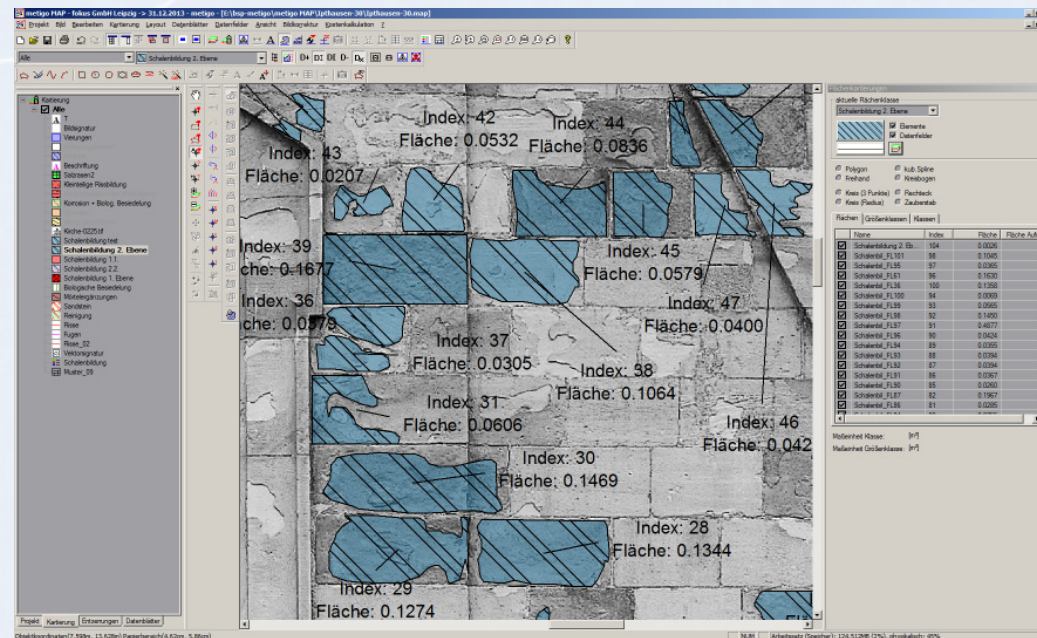• Before photograph 4 points are marked and 6 distances (the 4 border and the 2 diagonals) are measured at the object.

Scaling function
• Scanned paper plans can be scaled by one object extent or the distance between grid crosses or the scalebar.
• Plastics or bent surfaces can be scaled to one idealized reference extend.

metigo *MAP* - Digital mapping

Drawing tools

• Polygons, splines, free hand line, circle and 3-point arc,
• combined element: Polygon, free hand line, 3-point arc and spline
• CAD- and cutting tools for processing contures of bordering areas and enclosures
• all elements are vector based → offers editing and high quality for output

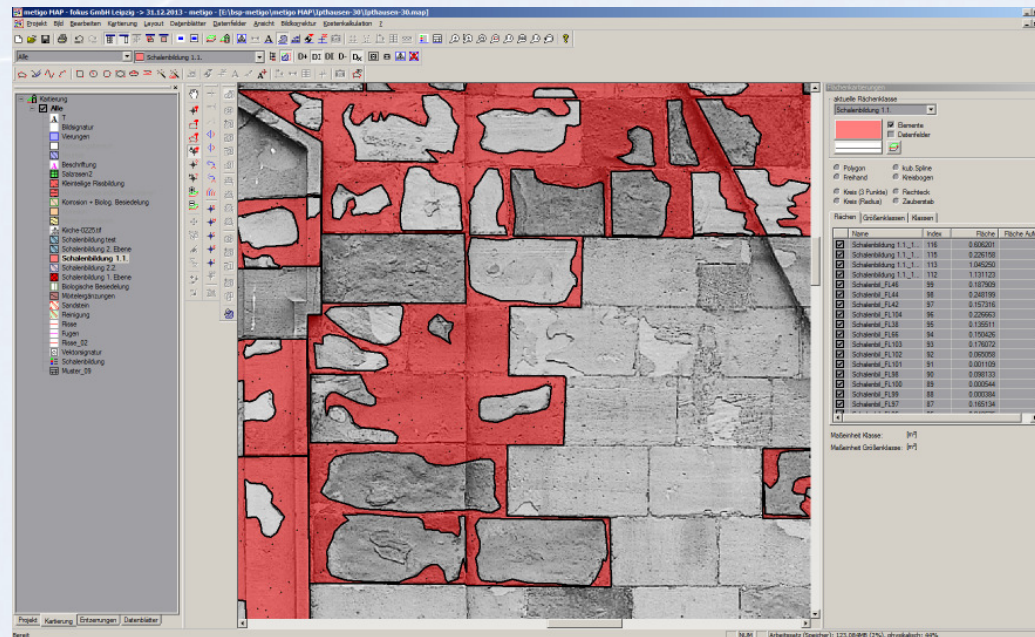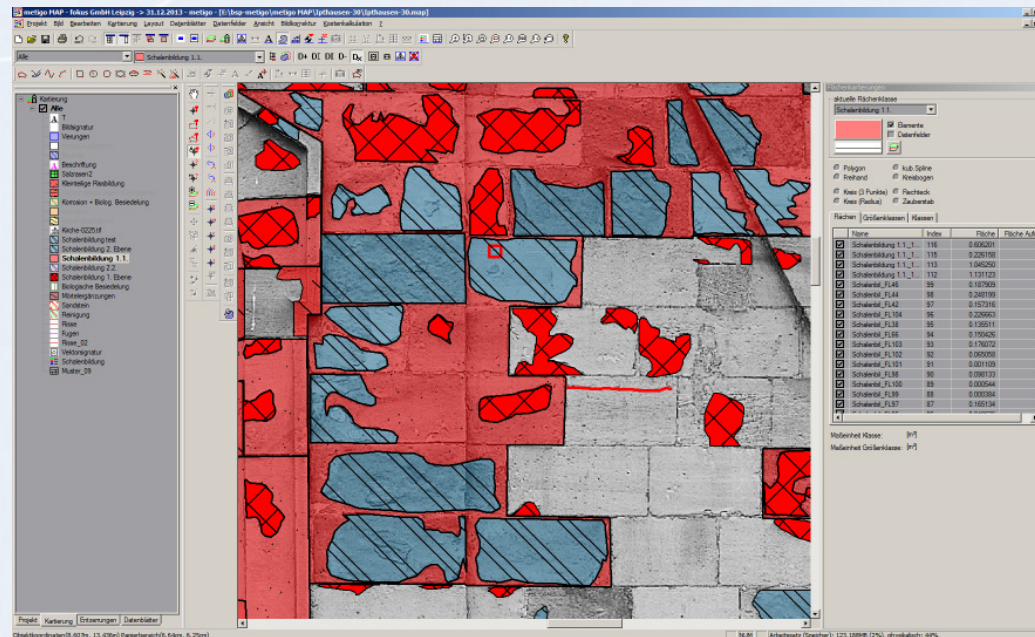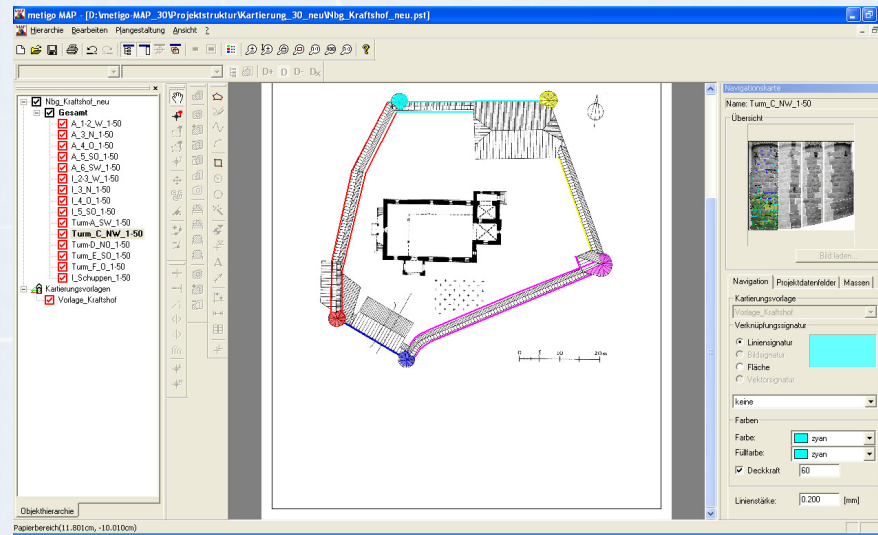Wallfahrtskirche Ipthausen, mapping:
Hendrik Romstedt, Kircheim/Thür.

Quantity survey

• based on true to scale mapping basis (image or CAD-drawing),
• calculate immediately to mapping for each drawed or edited element,
• layer specified assignment of mass calculation
 (length, area, circumference, depth, volume, sorting in size classes...)

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metigo *MAP* - Digital mapping

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metigo *MAP* – Object hierachy

Mapping template
- Processing of mapping templates,
- adaption of project changes over object hierarchy

Project organisation
- Projects are saved on harddisk like displayed in object tree
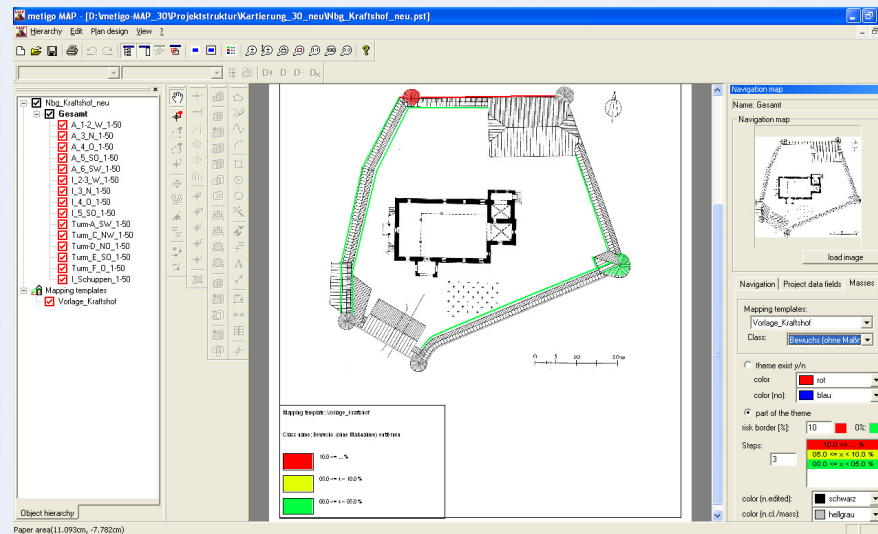
Projekt navigation
- simple with structure tree
- navigation map with link areas for better navigation in large projects

Quantity survey
- request of mass protocolls,
- visual analyis of damage in navigation map

metigo *MAP* – Object hierarchy

• Wiesbaden, Kurhaus – Mapping: Jens Kaminsky, Plauen

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New in Version 4.0

- Correction of image defects
- rectification by coordinates
- automated rectification
- evaluation of image stacks

- user management
- Object-orientated mapping
- Module for cost calculation
- 3D mapping

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metigo *MAP 4.0* – Correction of image defects
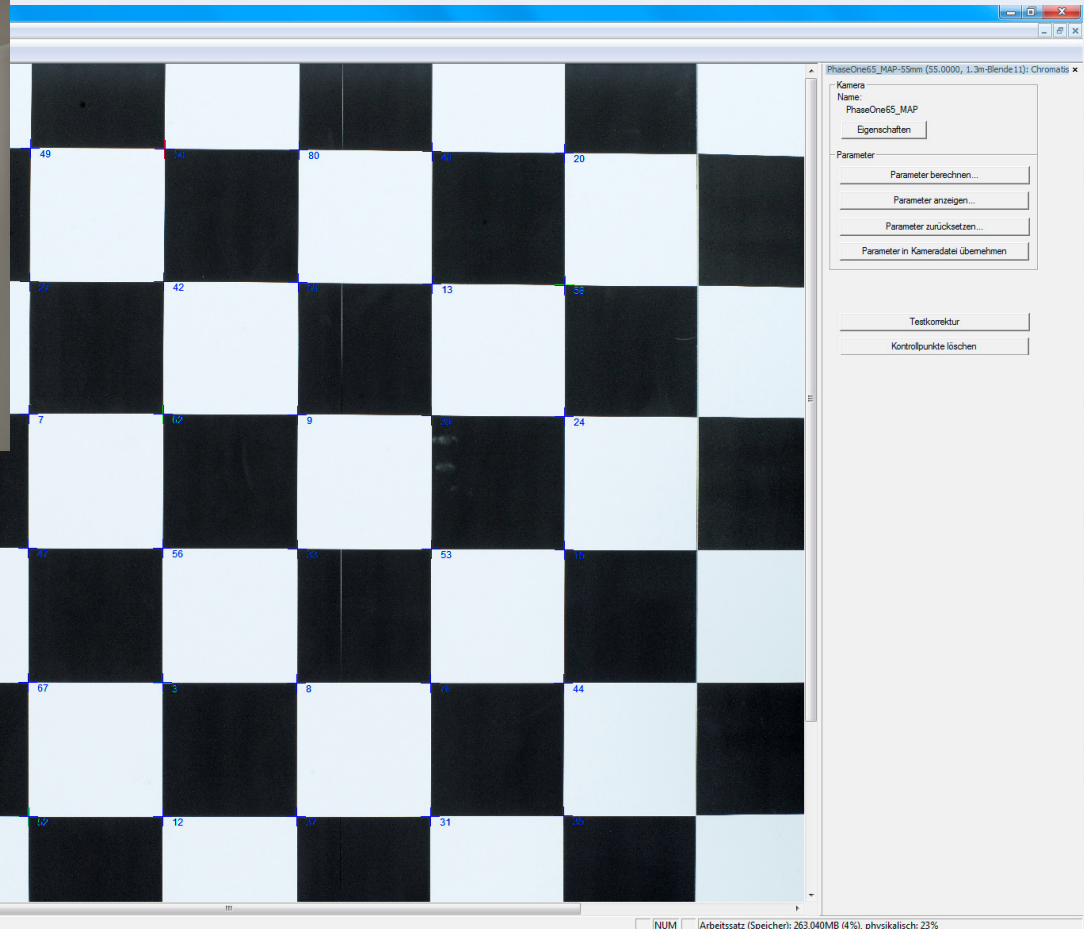
- recording of chessboard
- automated calculation of correction parameters by polynom
  → correction chromatic aberration and distortion
- distortion correction is also possible by photogrammetric calibration

metigo *MAP 4.0* – Rectification by coordinates
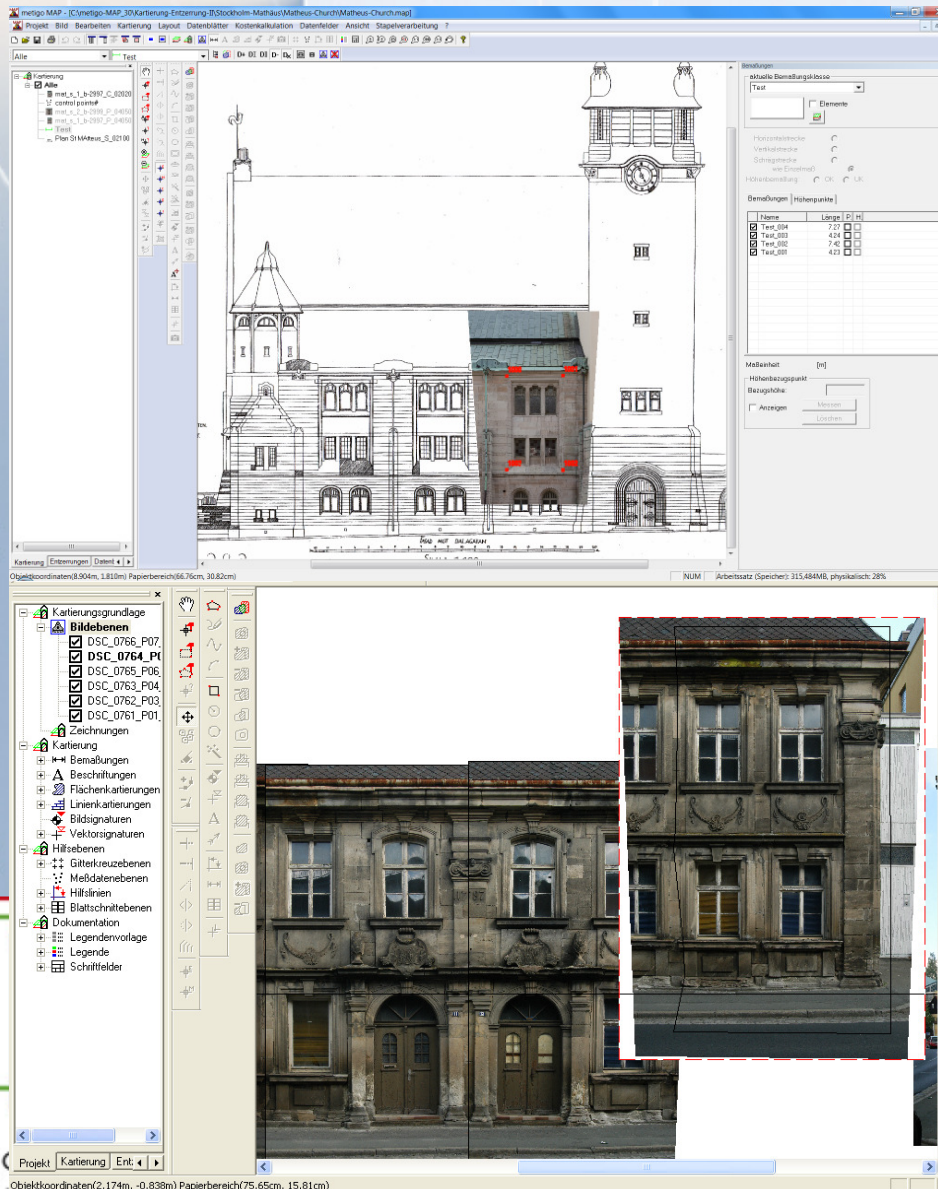
Image rectification by coordinates
- Measurement of coordinaten on the basis of a CAD-drawing or scaled plan
- interface for import of 3D coordinates, that are measured with total station.

Image montage
- Montage of image plans with different images scales and qualities (resolution, colour, grey scaled)
- Montage- and image processing functions,
- export multi layer TIFF for additional processing in Adobe photoshop

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metigo *MAP 4.0* – automated Image rectification
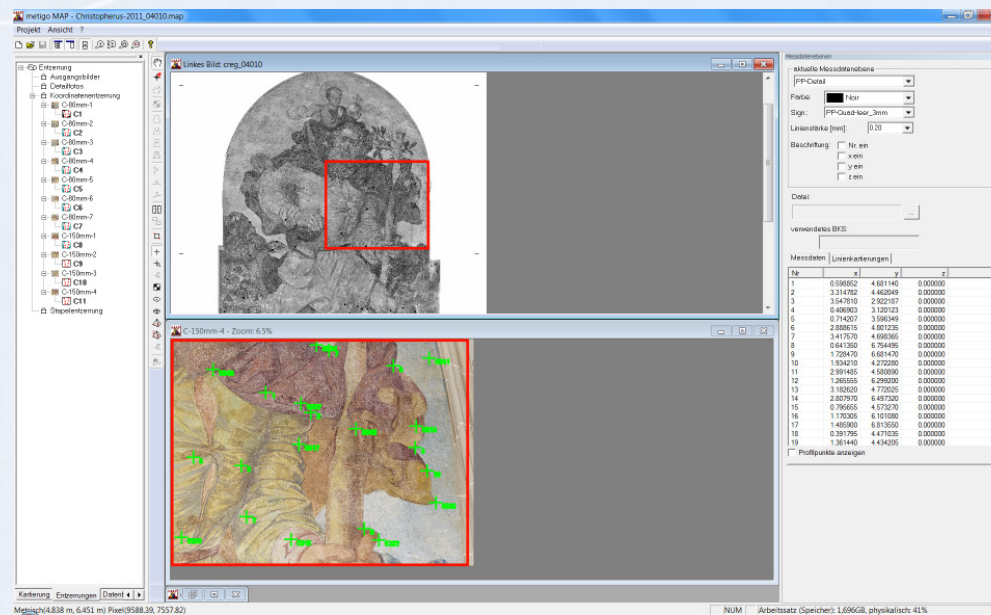
Automated image rectification with Matching

• image rectification of only one total view image

    → result is used as reference for matching

• for each of the other images user only has to define approximate rectangle on reference
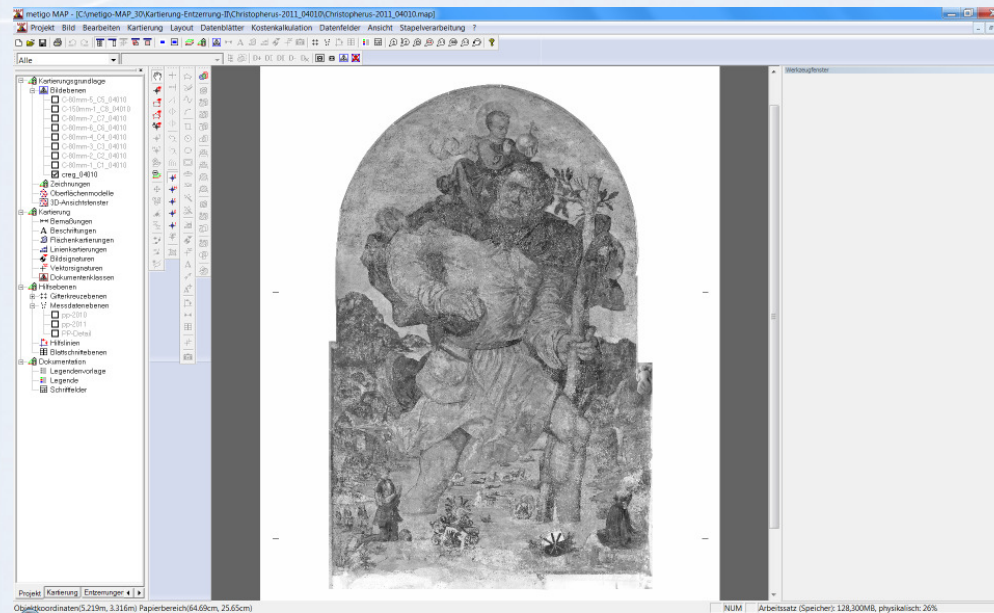
metigo *MAP 4.0* – automated Image rectification

Automated image rectification with Matching

- substantial similarity in images of same object allow measurment of subpixel precision for corresponding image points
- congruent rectification on the base of identical points
- higher accuracy for image montage because of of subpixel precision

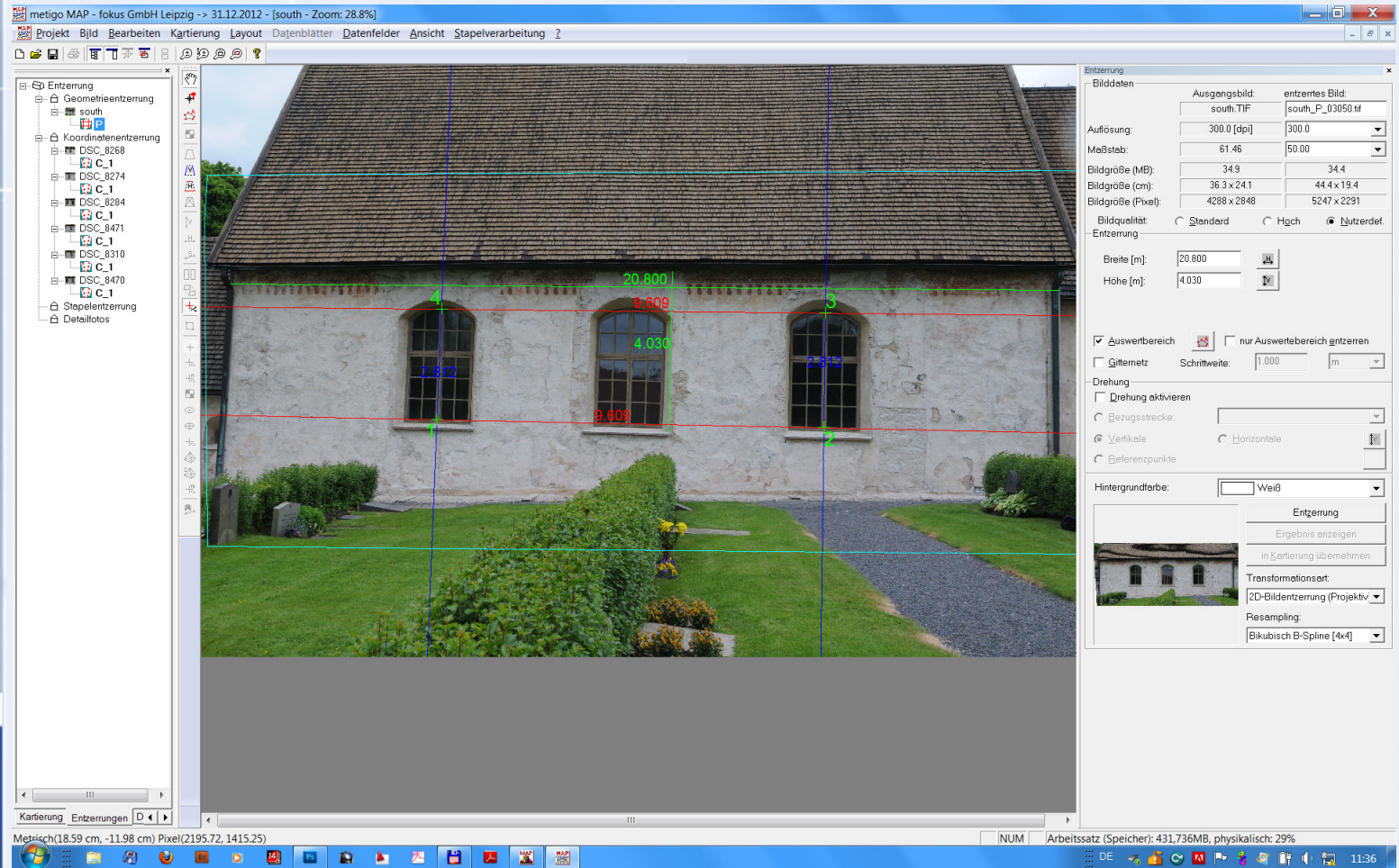# metigo *MAP 4.0* – automated Image rectification

Examples

• additional documentations of preliminary results can be made during conservation process
 and can be transformed to the first image / existing documentation
• transform detail image with high resolution on exsiting image plan
 → only for selected detail or whole image plan in higher resolution
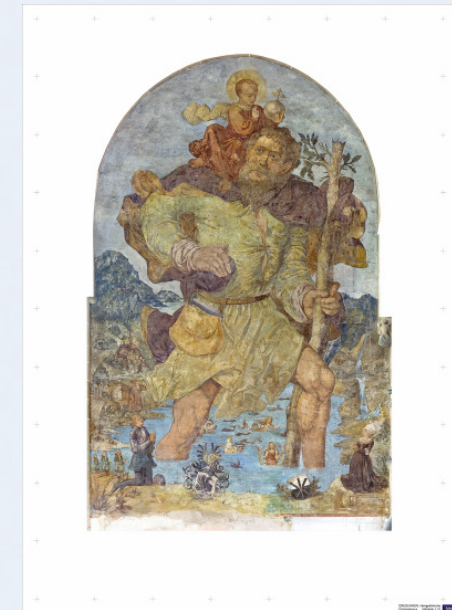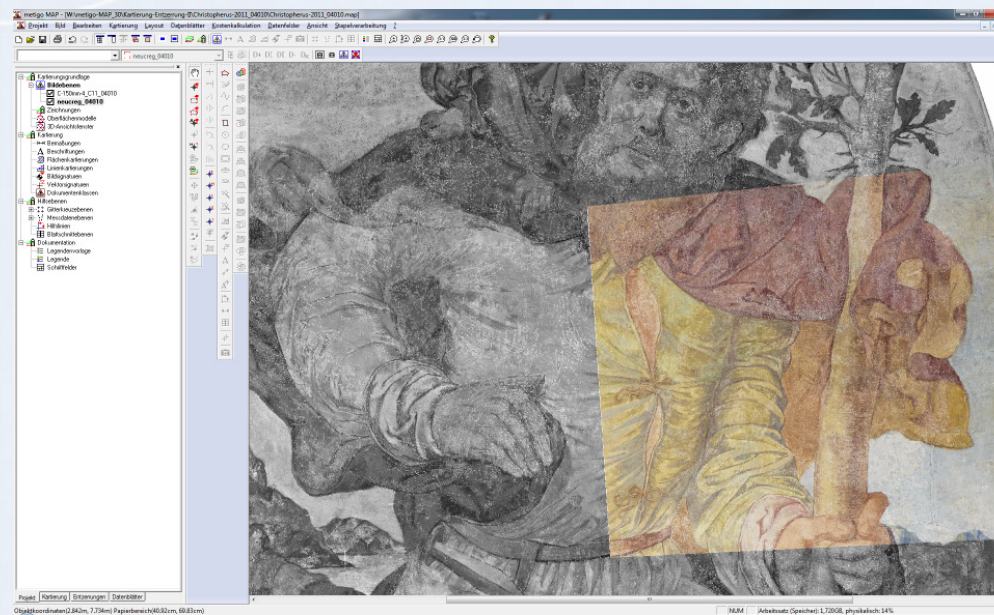
• Creglingen, church Herrgottskirche, Christopherus Fresco, 2012
 Image plan in scale 1:10

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metigo *MAP 4.0* – automated Image rectification

- Alvesta, Sweden, 2012

- overview image rectified by geometry (parallel lines)
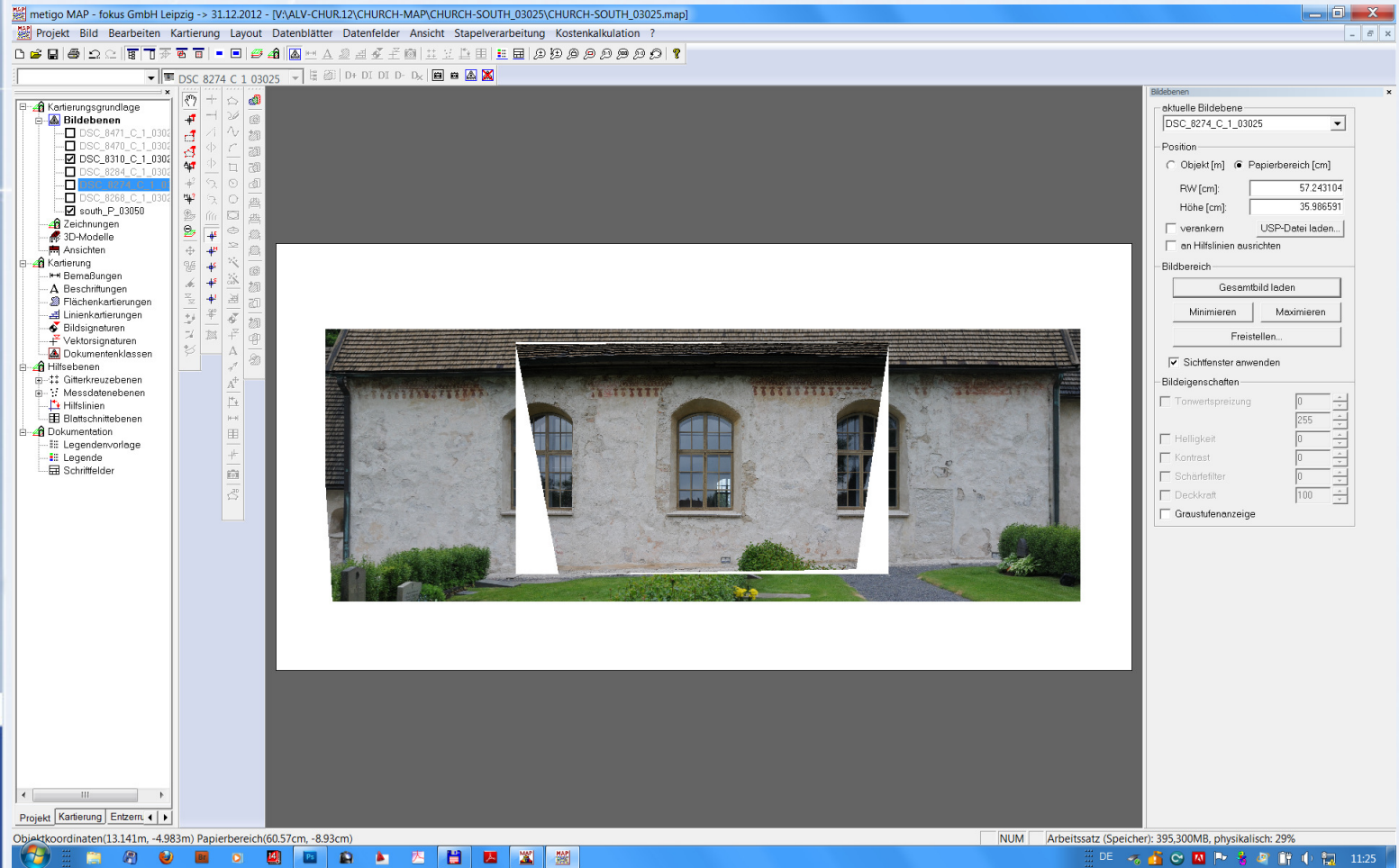
metigo *MAP 4.0* – automated Image rectification

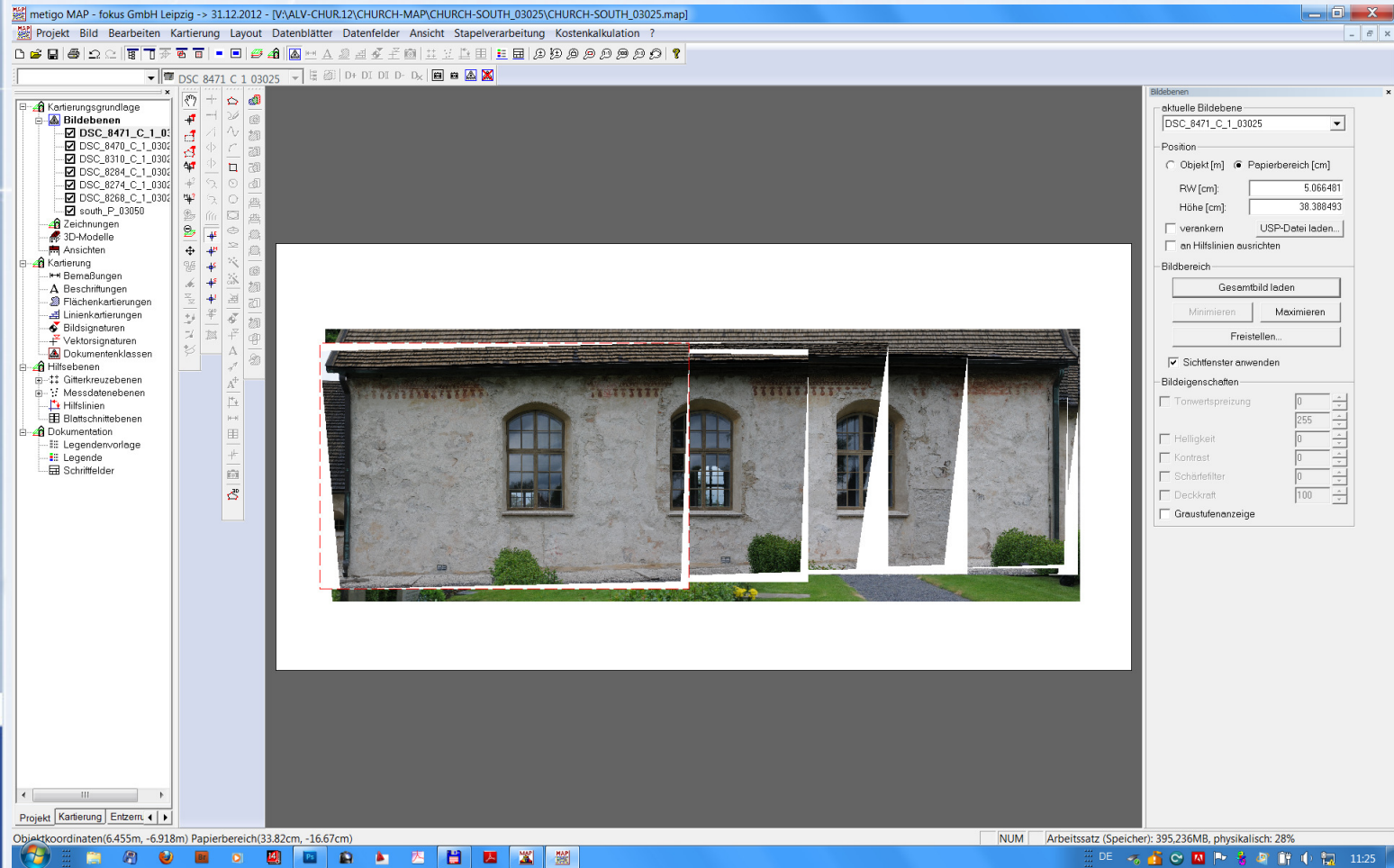- automated detection of identical points in search area of details

metigo *MAP 4.0* – automated Image rectification

• overlay of one detail rectification on rectified overview image

metigo *MAP 4.0* – automated Image rectification

• overlay of all detail rectifications

Abstand Gitterkreuze: 1.00m

CHURCH-SOUTH_04050
Maßstab 1:50

• Digital image plan after image processing, scale 1:50, 400dpi
  Alvesta, Sweden, 2012

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metigo *MAP 4.0* – Image stacks

Automated rectification of thermografic image sequences
(Kühren, church , 2012 - development project with IDK Dresden, Dr. rer. nat. C. Franzen)

- nondestructive detection of local separations of mural paintings
- heating of wall area in small steps
- documentation of heat up and cool down phase in fixed time steps by infrared camera

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metigo *MAP 4.0* – Image stacks

## Automated rectification of thermografic image sequences
(Kühren, church , 2012 - development project with IDK Dresden, Dr. rer. nat. C. Franzen)

- varying heat conduction to underlaying brickwork allows conclusions about detachment of plasters from the wall
- thermografic reference points for automated rectification
- automated rectification of image sequence and Integration in structure of a mapping project

- 5 images of one sequence of 58 images shown temperatue
  blue: -0,6 °C until magenta: +2,8 °C

metigo *MAP 4.0* – Image stacks
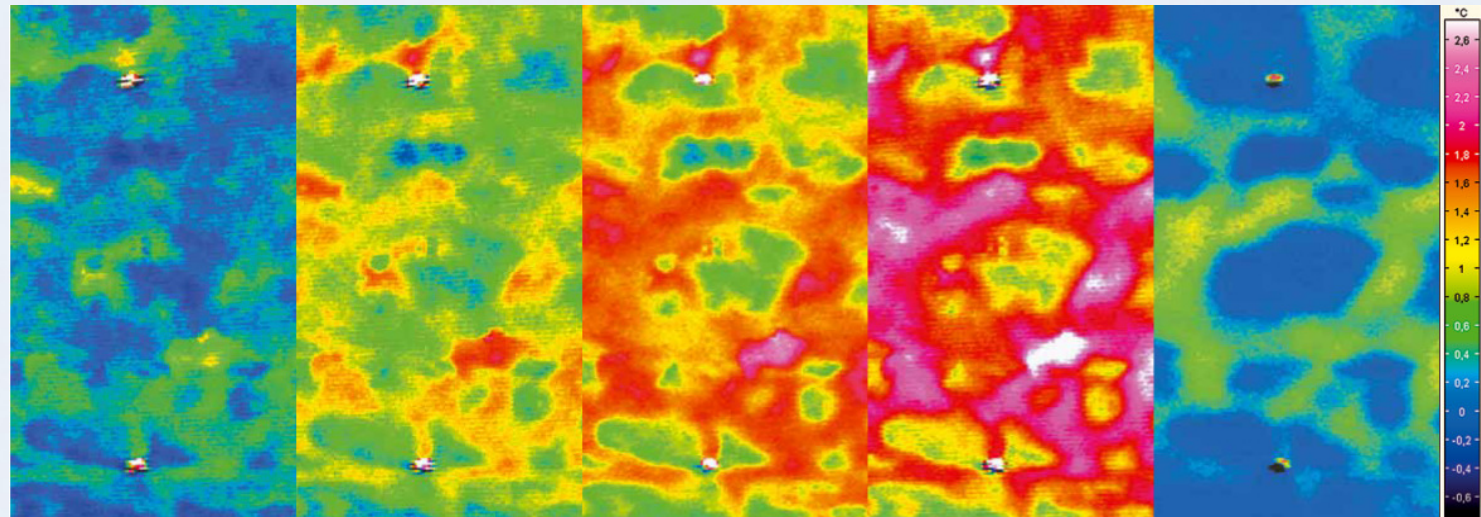
Automated rectification of image stack
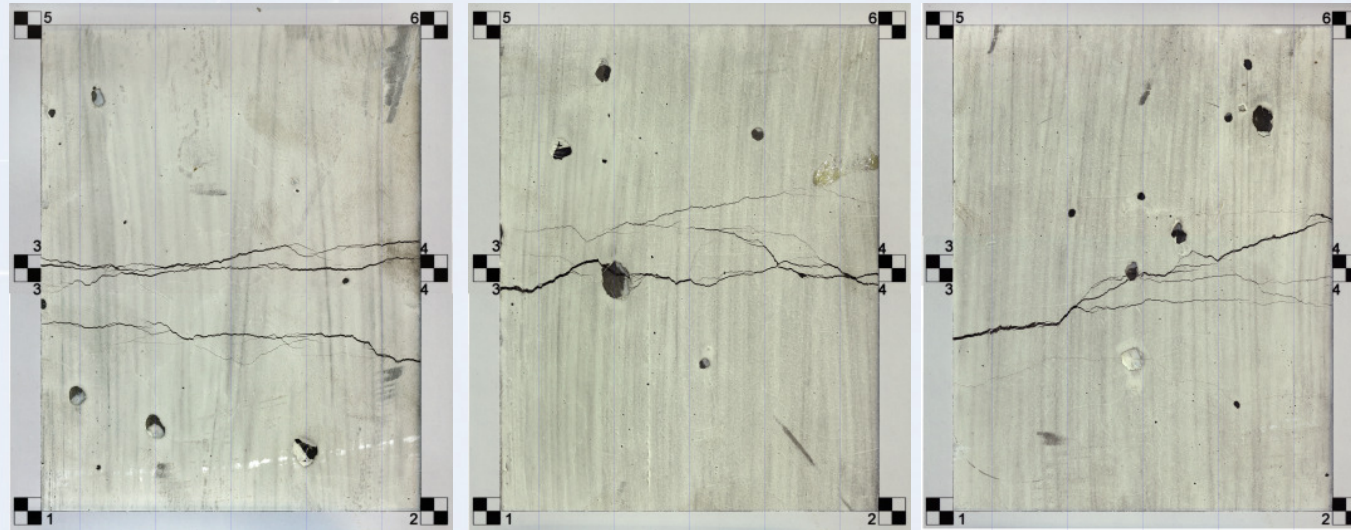
Tensile tests on SHCC-concretes (fibrated concrete)
Evaluation of width, number, arrangement of cracks, HTWK Leipzig, faculti buildings
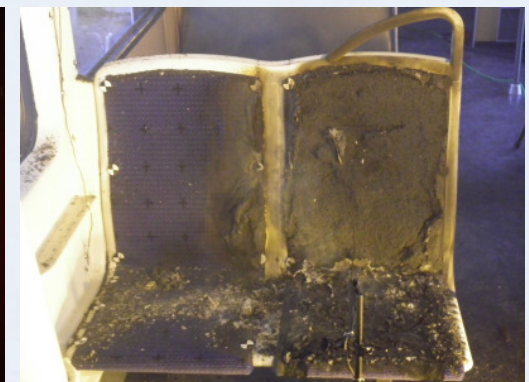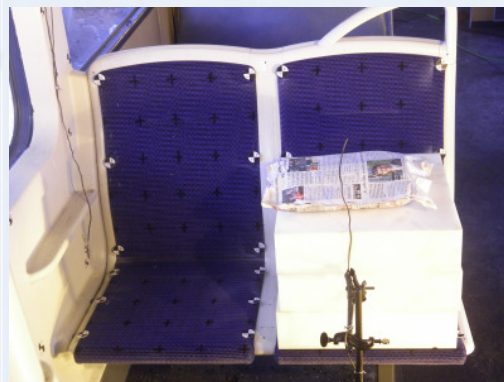
Fire tests for city trains (Nuremberg),
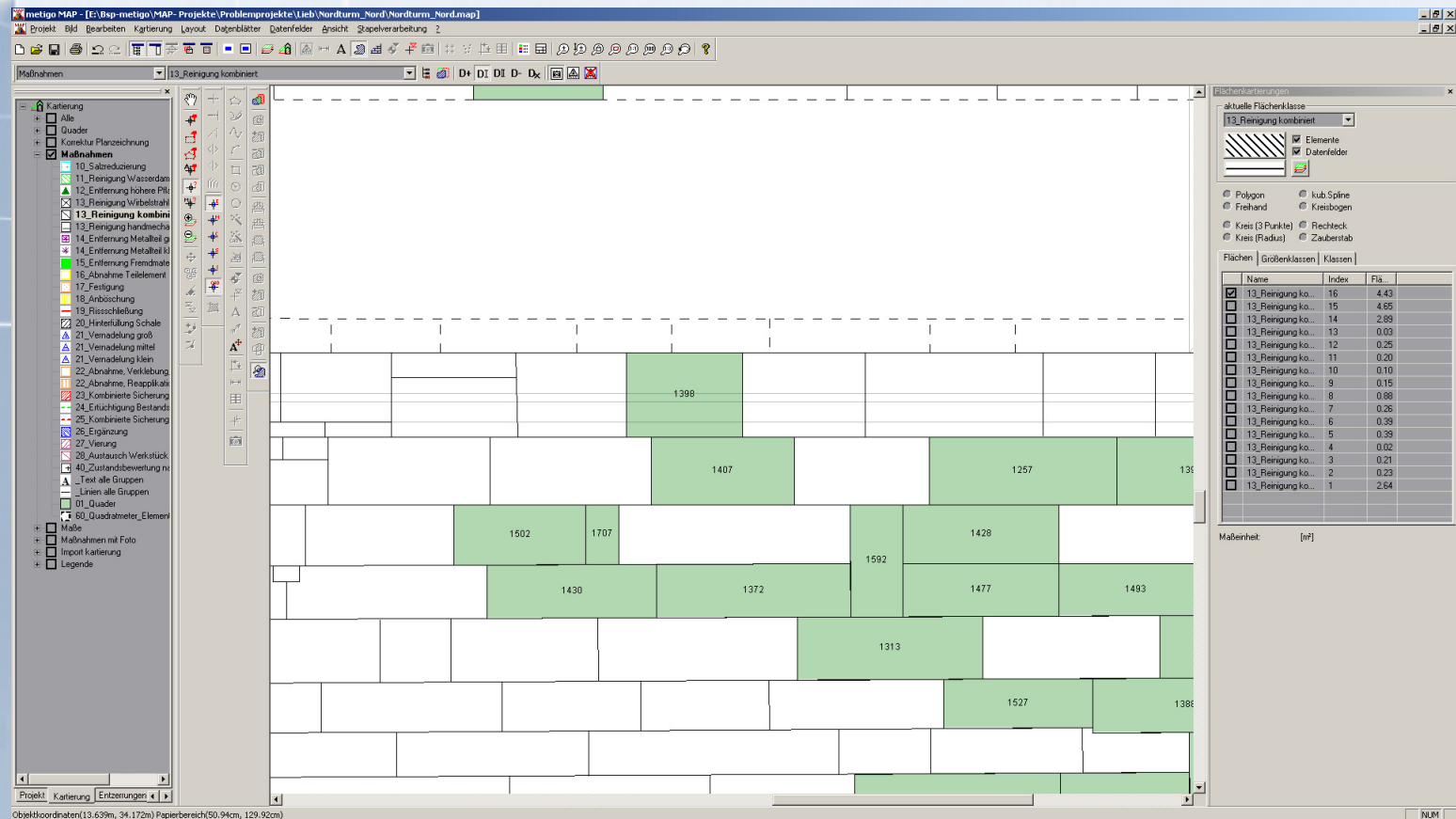Brandschutz Consult Ingenieurgesellschaft mbH Leipzig

metigo *MAP 4.0* – Object orientated analysis

- digital mapping (areas, lines, symbols...) and graphic evaluation of stone contures (area)
- area analysis of mapping by drawn stone contures

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metigo *MAP 4.0* – Object orientated analysis

- display of filtered stones (green), with or without mapping content
- output with the help of data sheets

- area analysis usable for any area classes
  (lines of scaffold, wall sections, …)

metigo *MAP 4.0* – Object orientated analysis
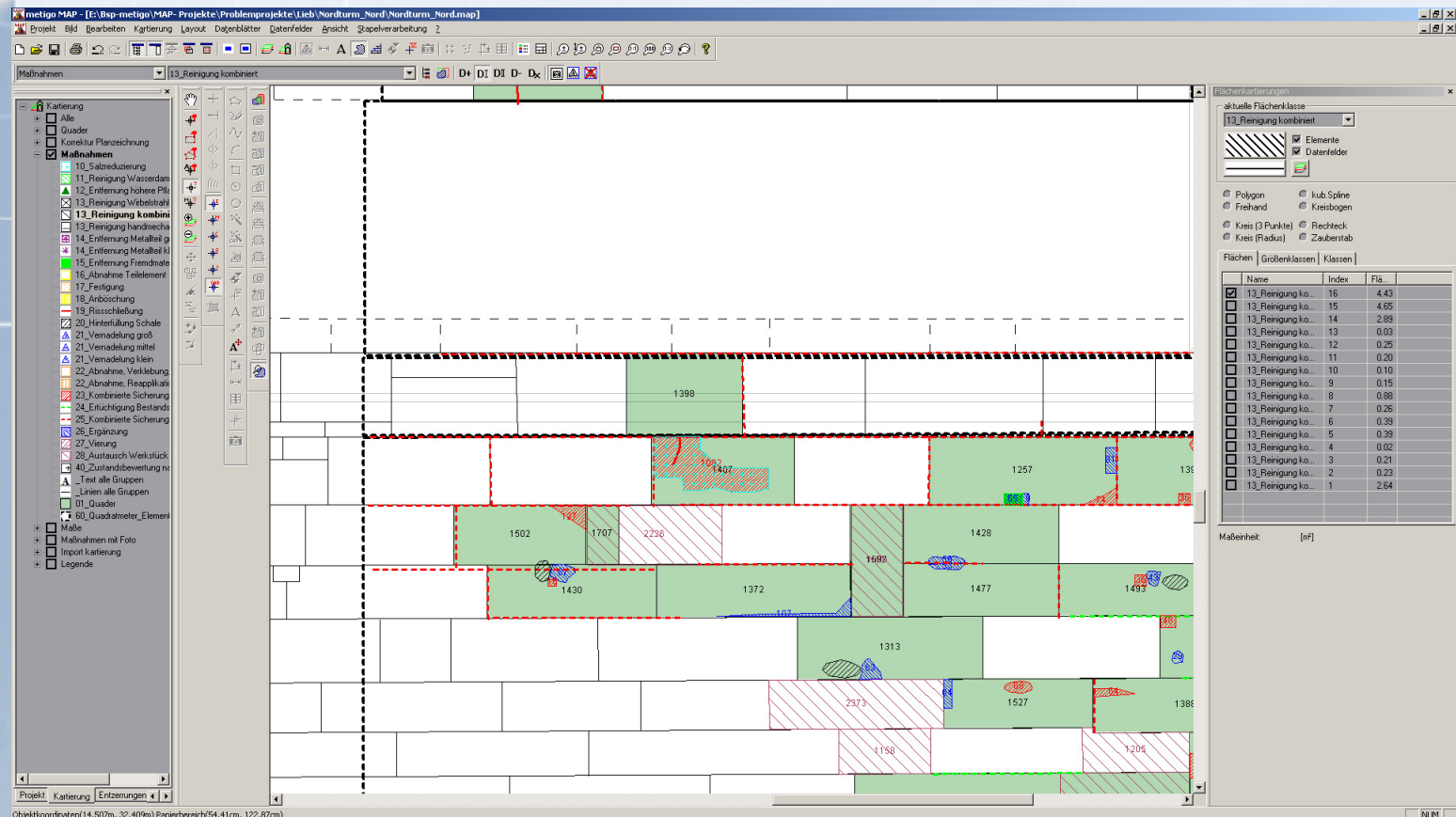
- display of filtered stones (green), with or without mapping content
- output with the help of data sheets

- area analysis usable for any area classes
  (lines of scaffold, wall sections, …)

metigo *MAP 4.0* – User management

- define user with individual rights
- Analysis of mapping processes:
  - WHAT was mapped by WHOM in wich time (for billing) ?
  - differential quantity export
- merge of partial mappings to one mapping project

metigo *MAP 4.0* – Cost calculation

- till now: quantity export to chart calculation for further calculation
- Why integration of cost calculation in metigo *MAP* ?
  - Data in mapping project are already well structured
  - complexity of process can be supported by input of additional data during mapping

metigo *MAP 4.0* - Cost calculation

- additional cost factors for material & work for each class
- workload can be described in several worksteps and persons with different skills
- different prices for material and working time → several variants for comparison
→ better planning, preparation and control of conservation
- *separat modul, can be purchased in addition to metigoMAP*

3D mapping

- import of 3D surface models (STL, SHP) as mapping base
- 3D models by scanner or photogrammetric systems with image matching (metigo*3D*)
- orthogonal projected views for 2D true to scale output

- mapping in 2D window or 3D window
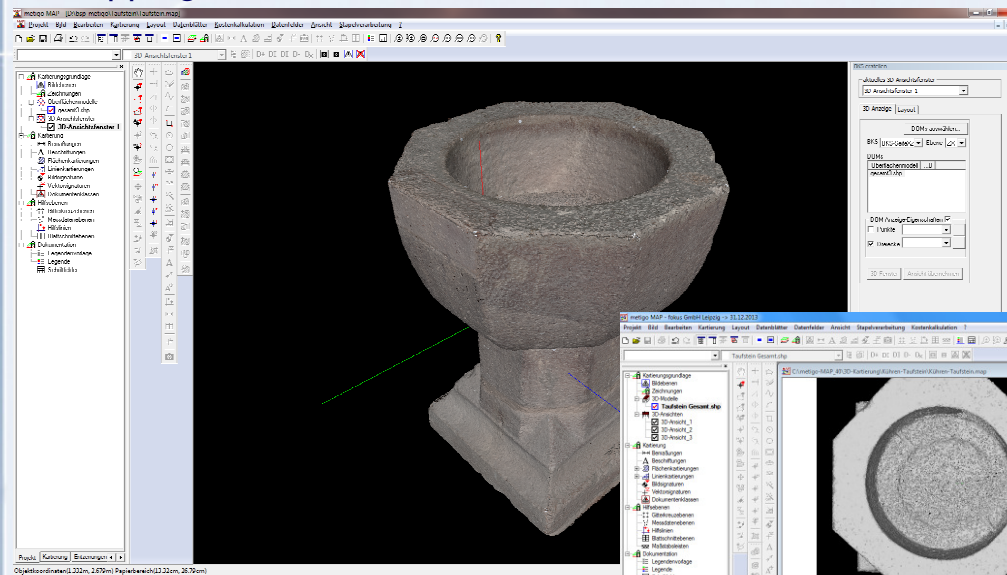
Kühren church,
Medival font, 2012
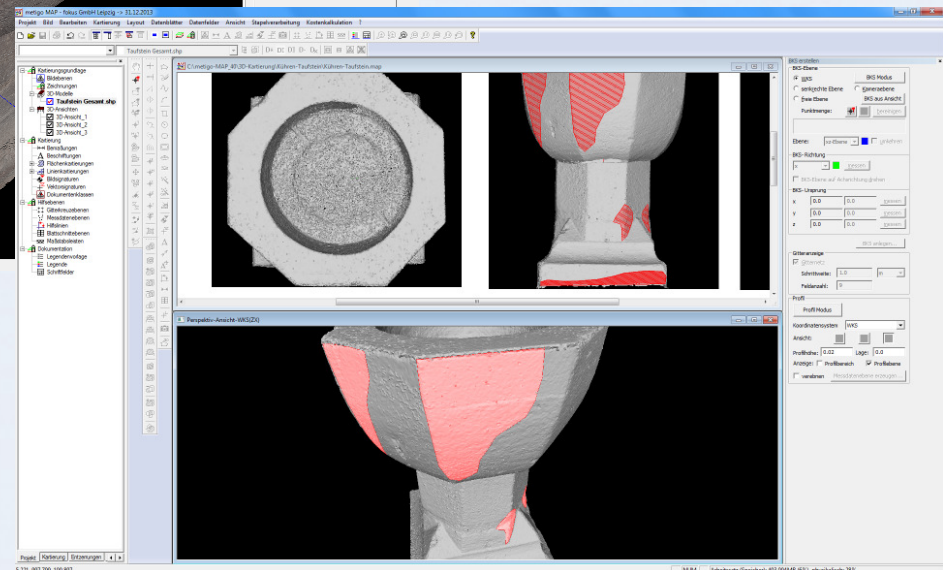
- top: 3D evaualtion window
- right: 2D views within mapping project

metigo *MAP* - Customer topology
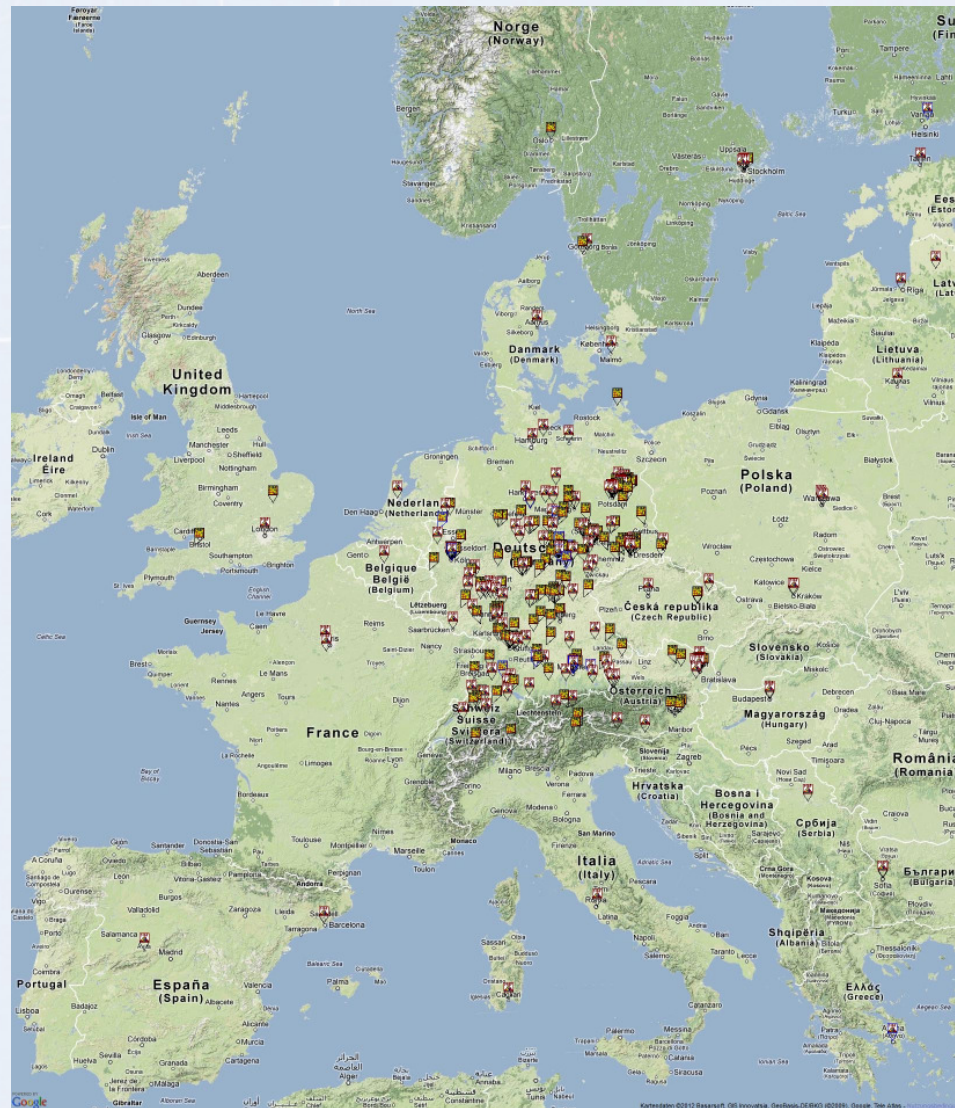
- development since 2000
  (more than 600 Licences)

- ca. 80% of customer are free
  conservators and restauration
  companies

- usage in departments:
  - 70% stone
  - 20% wall
  - 10% wood, paintings, paper,
    textile and glas

- languages:
  english version since 2005
  polish version since 2009
  spanish and french
  version since 2012

metigo*3D* - Software for 3D Object documentation

I. Image recording & orientation

II. Generation of point clouds
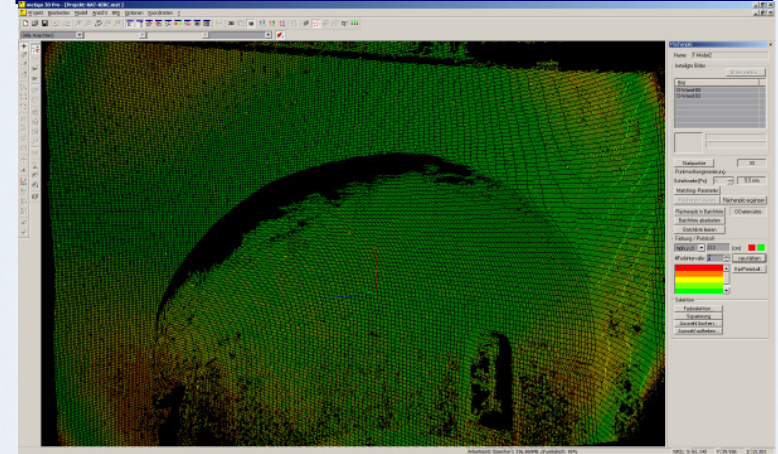
IV. True to scale image plan

III. 3D surface model (DSM)
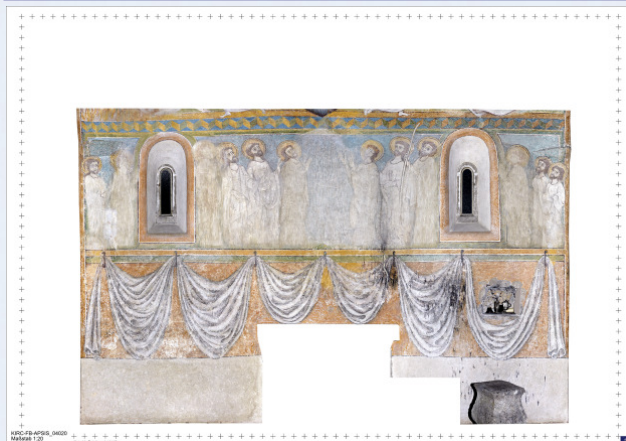
metigo*3D* – Image recording
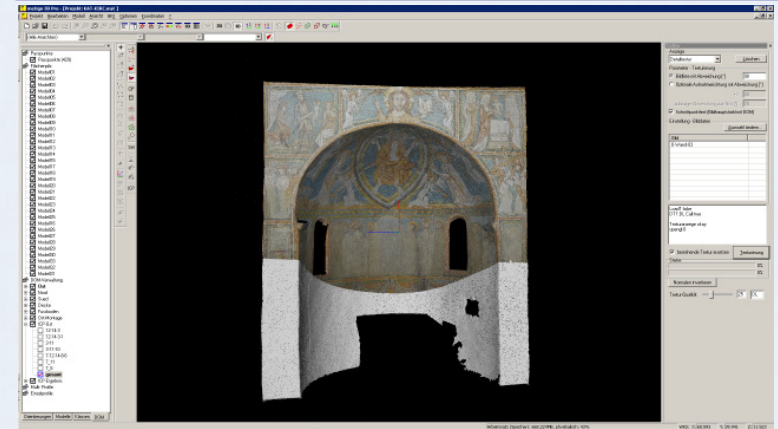
Stereo models (image pairs):
- Digital SLR camera (full frame sensor), photogrammetric calibration is needed!
- image recording by hand or from recording rail (on tripot)
- ratio of basis to recording distance in the field of 1:5 until 1:10
   (e.g. recording distance 7m ➔ camera basis ~1m)

Reference measures at the object:
- distance at object
- distance between 2 cameras
- tacheometer for measuring of reference points

Recording rail for 2 SLR- cameras

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metigo*3D* - model orientation

Image analysis:
• automated detection of identical points in set of image
• automated detection of Stereo models

Orientation:
• orientation for images is calculated on base of known control points and
• 3D-Reference measures
→ 3D reference points measured by tacheometer
→ distance at object or between cameras
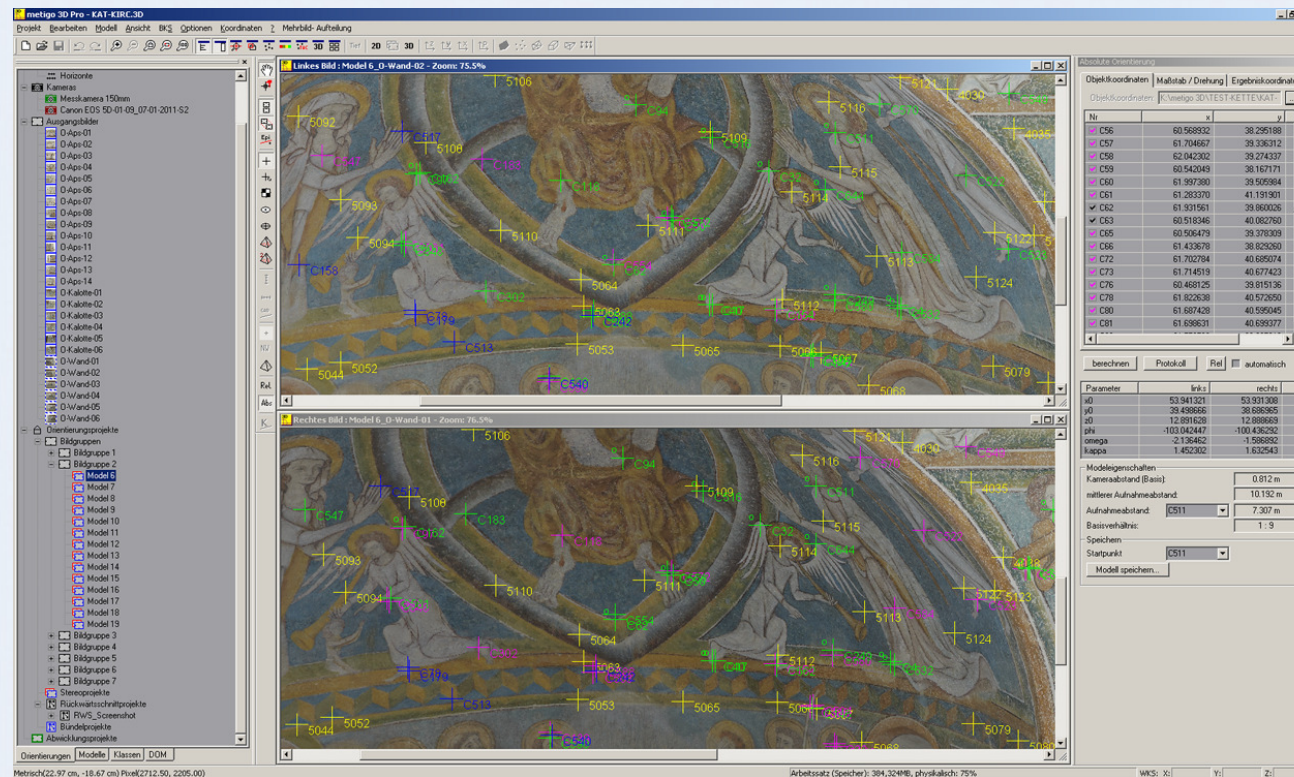
Orientated stereo model with image coordinates

metigo*3D* - point cloud generation

Point matching:
• surface of object is „scanned" by expansion algorithm

Parameter:
• point distance at the object
• accuracy of evaluation (point colours, automated filtering)

Batch process:
• point cloud per model with ca. 500.000 points in ca. 1 minutes

Generation of point cloud

metigo*3D* - point cloud generation

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Generation of point cloud

metigo*3D* – Triangulation and Texturing

Digitale 3D surface model (DSM):
• connecting of neighboured points to triangles

Texturing:
• with images, that were used for Matching
→ higher image resolution than with coloured point clouds is possible
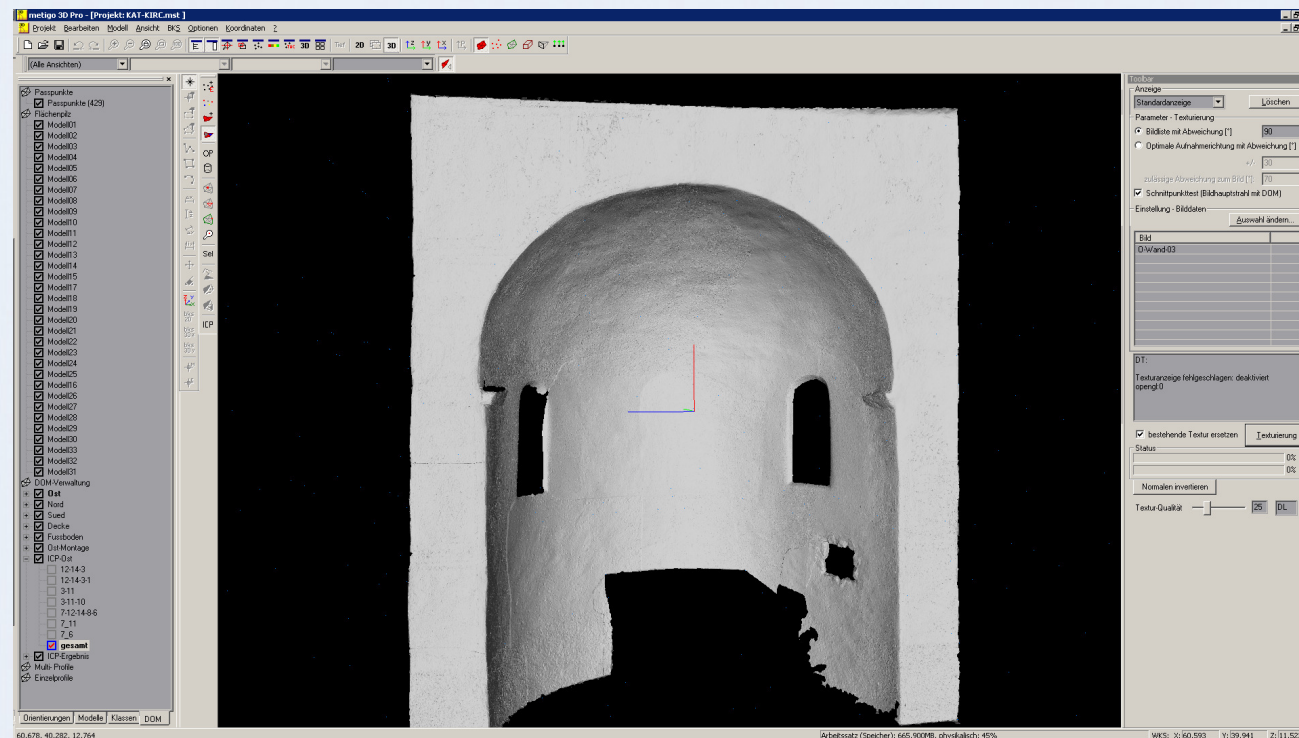
Digital surface model

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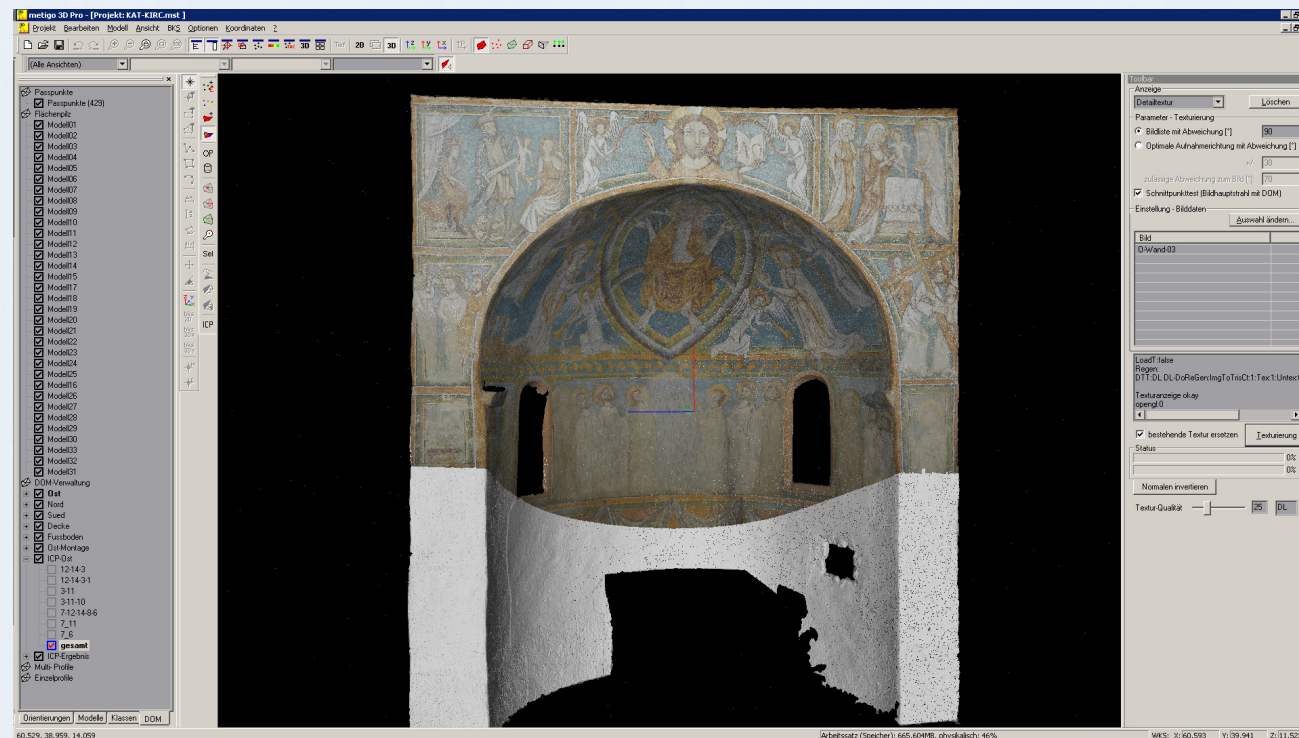
Digital surface model textured with one image

Projection geometry:
• Definition of plane or cylinder with user coordinate system

Calculation of true to scale image plans:
• Projection geometry (plane, cylinder)
• corretion by 3D surface model
• user defined scale and resolution

Projection plane in user coordinaten system

metigo*3D* - Orthophoto / Unwrapping I

Projection geometry:
• Definition of plane or cylinder with user coordinate system

Calculation of true to scale image plans:
• Projection geometry (plane, cylinder)
• corretion by 3D surface model
• user defined scale and resolution

Projection plane in user coordinaten system; image plan as orthogonal projection

metigo*3D* - Orthophoto / Unwrapping II

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**Orientated image
with Projection
of cylinders**
Castle Katzenstein

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Orientated image with Projection of cylinders
Castle Katzenstein

Unwrapping with Orthoprojection
Coloured images
Original 1:5, 300dpi

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metigo3D - Orthophoto / Unwrapping III

UV light images:
• orientated by spatial resection
• orientated UV-images projected on the same geometry like colour images

Orientated image UV-light
castle Katzenstein

metigo3D - Orthophoto / Unwrapping III
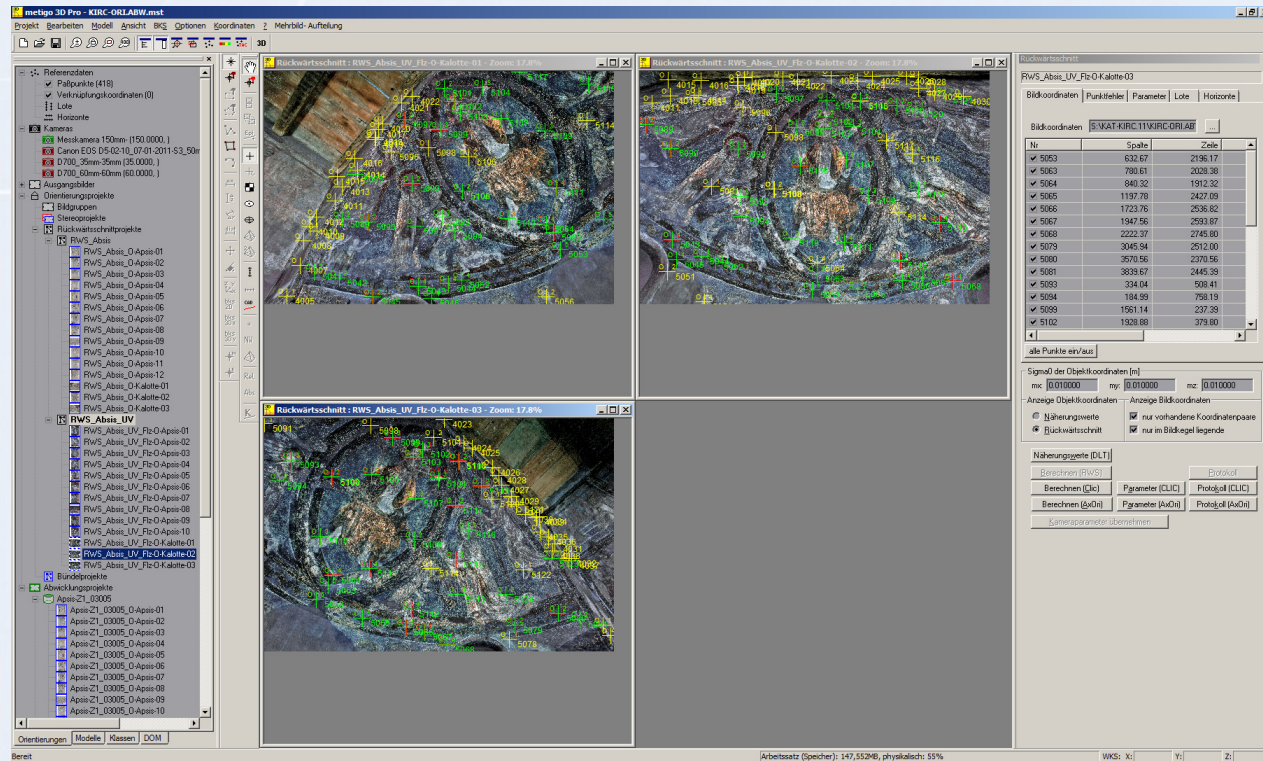
UV light images:
- orientated by spatial resection
- orientated UV-images projected on the same geometry like colour images

Orientated image UV-light
castle Katzenstein
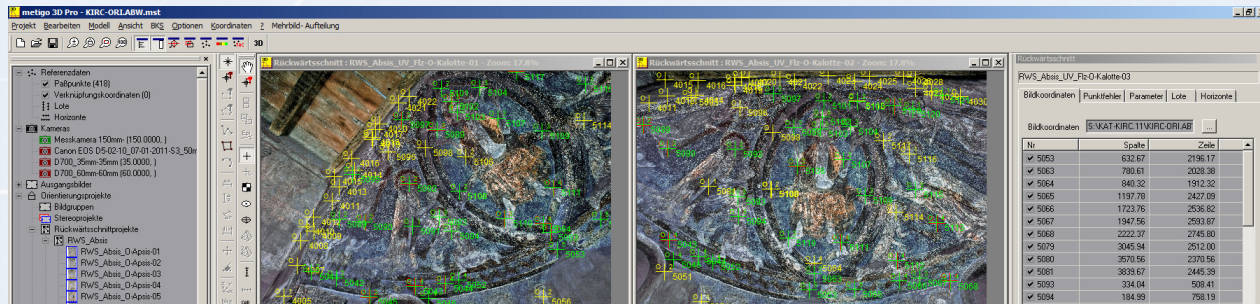
unwrapping with Orthoprocektion
UV light images
Original 1:5, 300dpi

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Image plan of Apse
im Original 1:5
Colour images
Castle Katzenstein

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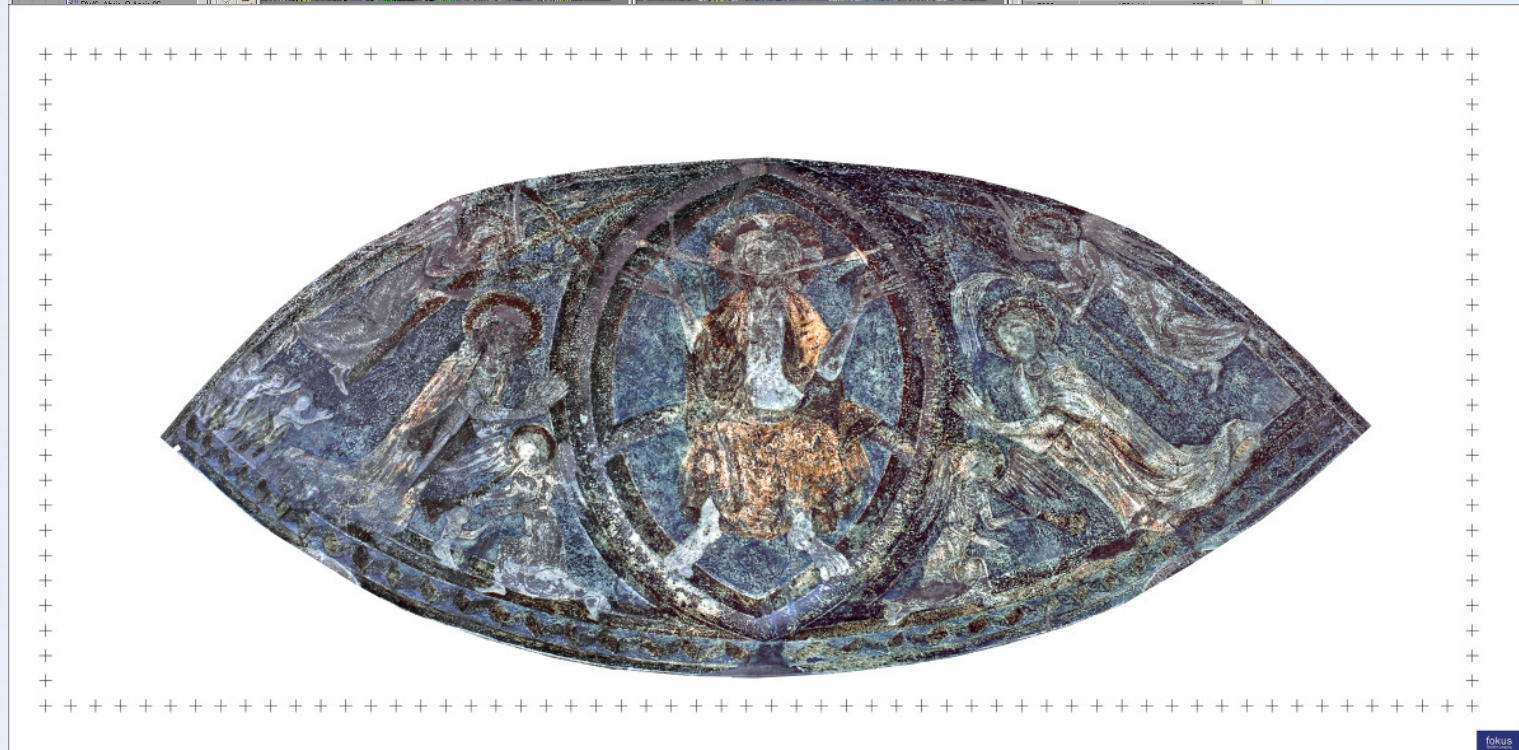
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Image plan of Apse
im Original 1:5
Colour images
 Castle Katzenstein

Image plan of Apse
in Original 1:5
UV light images

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metigo*3D* – Orthogonal projection

Combination of Laserscandata with high resoluted images:
- Rottweil, church Heilig-Kreuz-Münster, south aisle, 2012
- Digital unwrapping with Orthogonal projection

(Laserscan: Scan 3D GmbH, Berlin)

photogrammetric orientated image
(1 of 17 images)
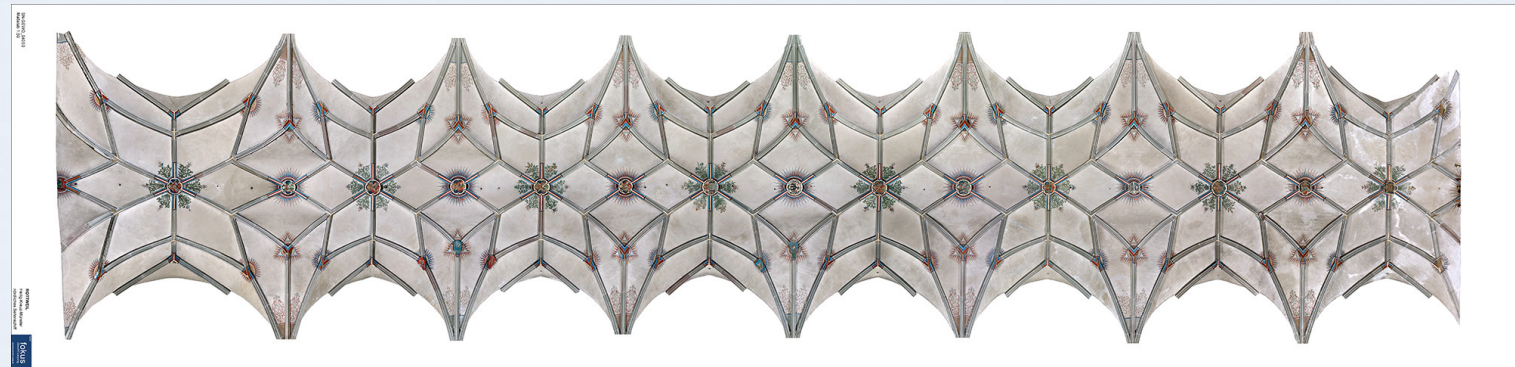
Digital unwrapping with orthogonal projection in scale 1:25

metigo3D - Orthogonal projection

Combination of Laserscandata with high resoluted images:
• Rottweil, church Heilig-Kreuz-Münster, 2012
• Digital unwrapping with Orthogonal projection, Detail in image plan in scale 1:25

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metigo*3D* – Deformation analysis

Calculation of true to scale image plane:
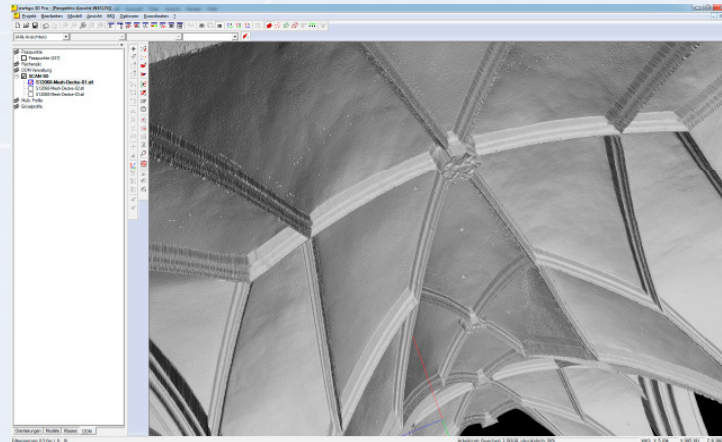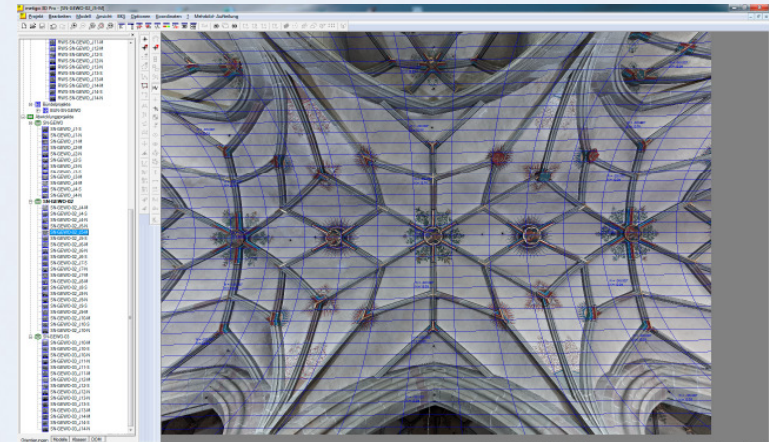- coordinate plane for Deformation analysis is defined
- DSM is coloured in dependece of distance to plane
- image export with user defined scale and resolution
- Integration in mapping project
- shown deformation: green: +4cm until red: -2cm

Image plan of stone floor
(rectification & montage)
1:10, 400dpi
 monastery Raitenhaslach, Steinerner Saal

Raitenhaslach, monastery, Steinerner Saal, 2012 - Digital image plan of floor; scale 1:10
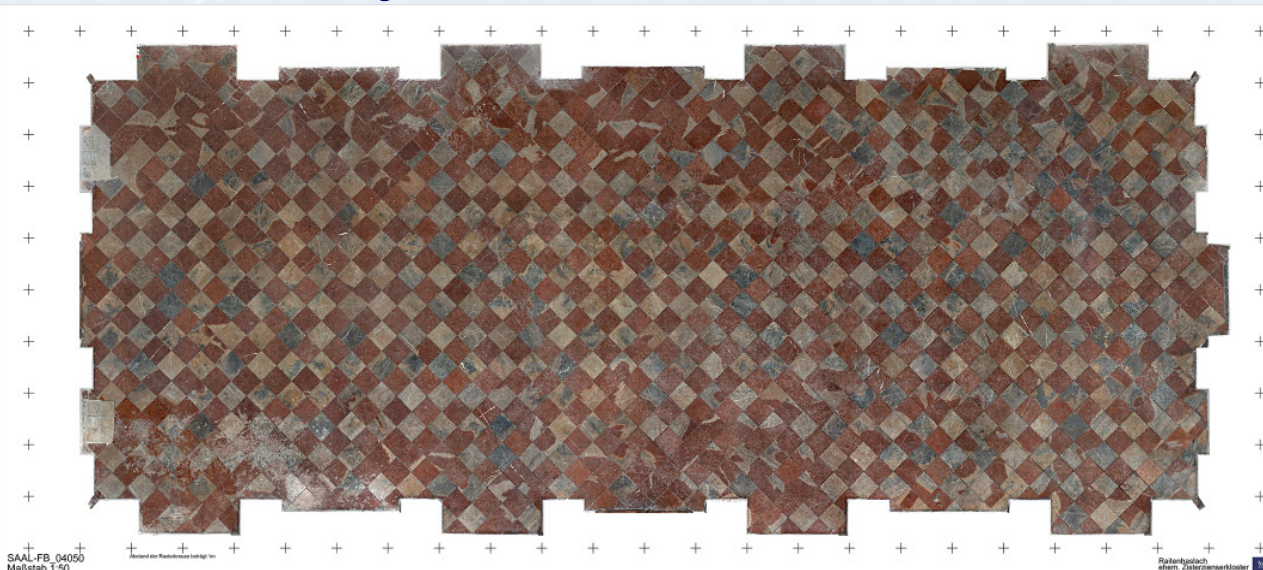
metigo*3D* – Deformation analysis

Calculation of true to scale image plane:
- coordinate plane for Deformation analysis is defined
- DSM is coloured in dependece of distance to plane
- image export with user defined scale and resolution
- Integration in mapping project
- shown deformation: green: +4cm until red: -2cm

Image plan of stone floor
(rectification & montage)
1:10, 400dpi
 monastery Raitenhaslach, Steinerner Saal

Deformations analysis
Point cloud of Laser scanner
1:25, 400dpi

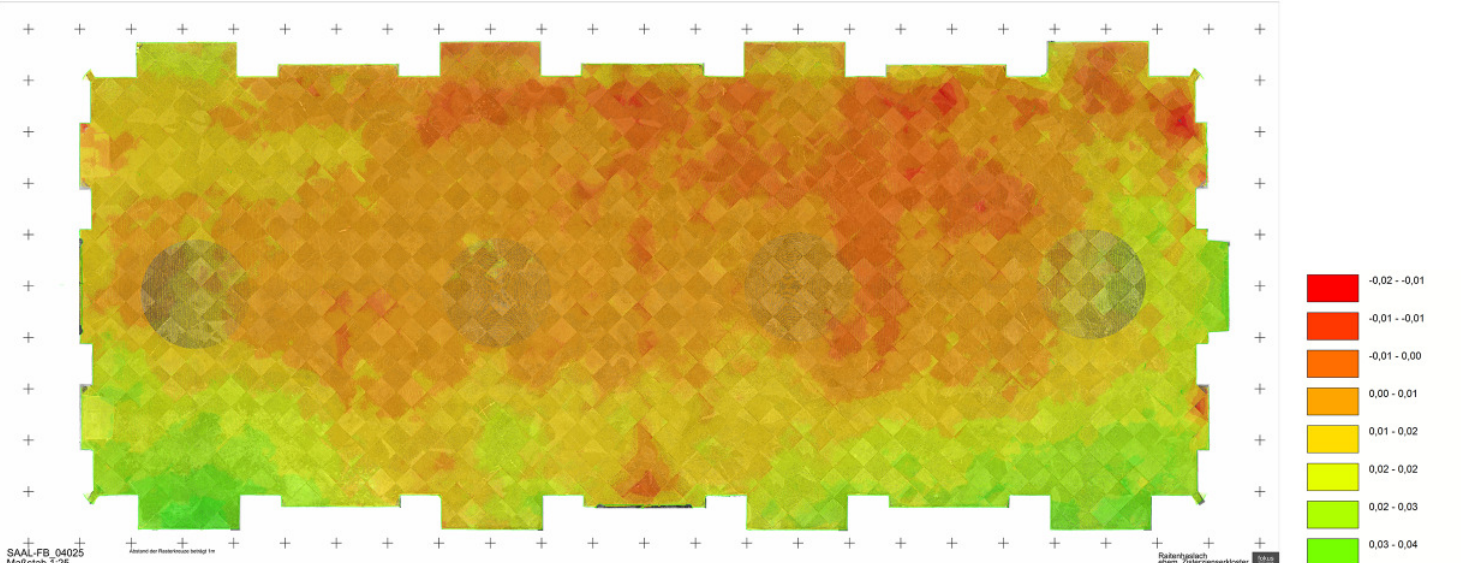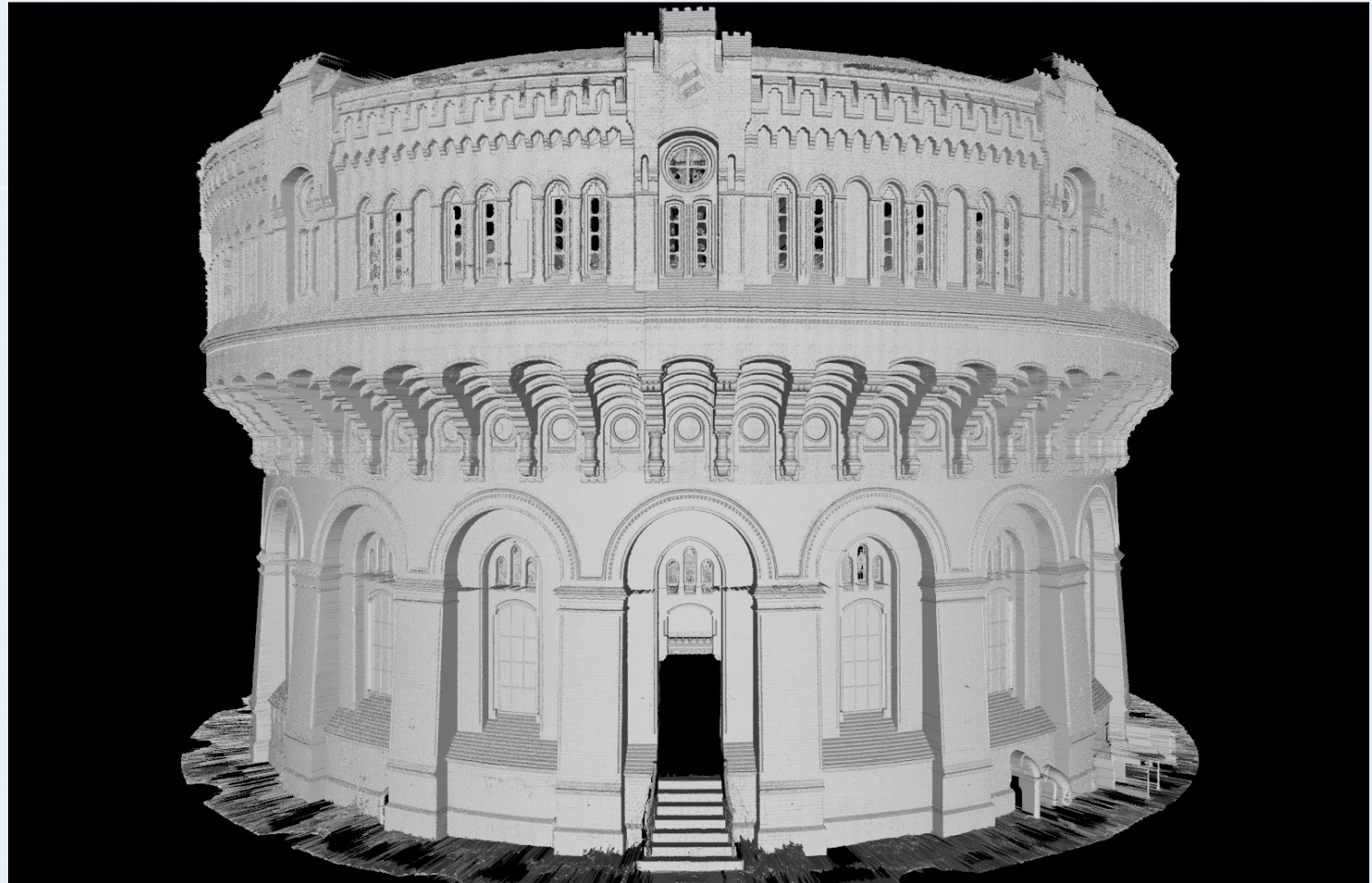|	
■	-0,02 - -0,01
■	-0,01 - -0,01
■	-0,01 - 0,00
■	0,00 - 0,01
■	0,01 - 0,02
■	0,02 - 0,02
■	0,02 - 0,03
■	0,03 - 0,04

Raitenhaslach, monastery, Steinerner Saal, 2012 - Digital image plan of floor; scale 1:10

metigo3D - Orthogonal projection

Combination of Laserscandata with high resoluted images:
• Kiel, water tower, 2012, Digital unwrapping with orthogonal projection

(Laserscan: Scan 3D GmbH, Berlin)
Image texture by photogrammetric orientated image (24 images)

Combination of Laserscandata with high resoluted images:
• Kiel, water tower, 2012, Digital unwrapping with orthogonal projection, 1:25

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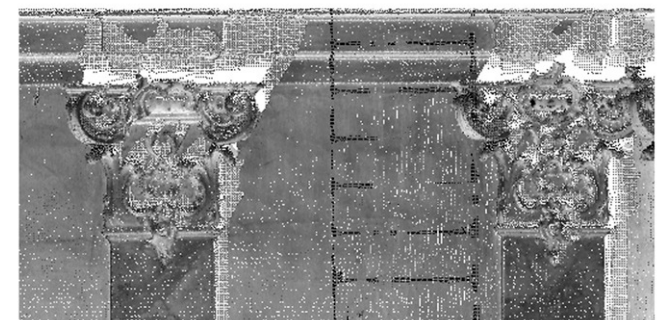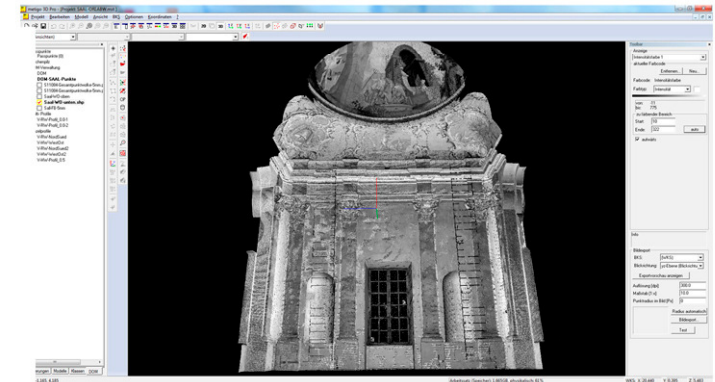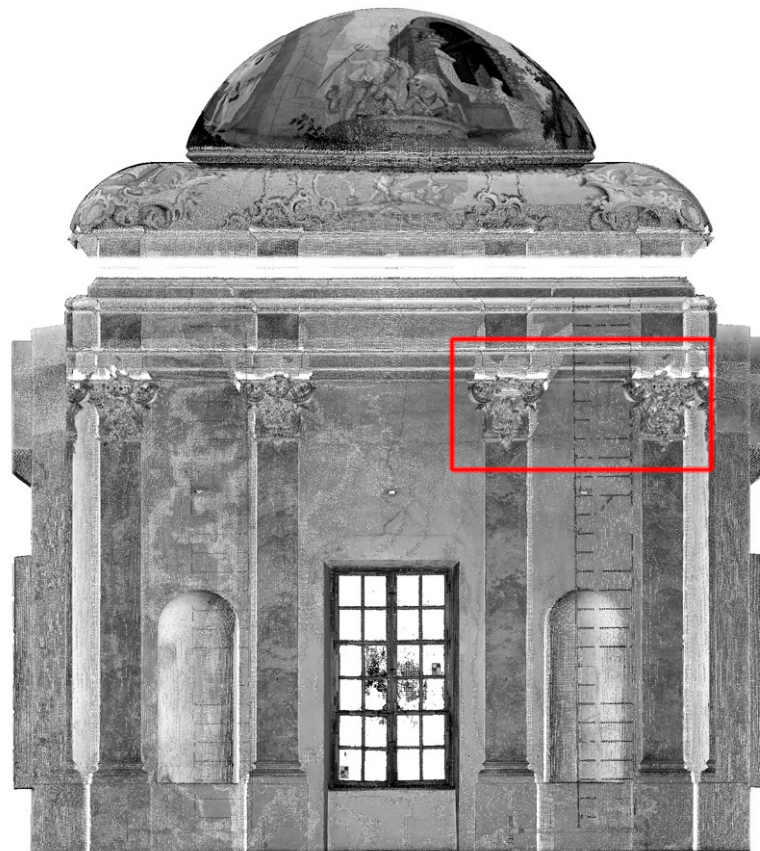www.fokus-GmbH-Leipzig.de

metigo3D - Orthogonal projection

Combination of Laserscandata with high resoluted images:
• Raitenhaslach, monastery, Steinerner Saal, 2012,
• Photogrammetric documentation 1:20

• Orthoprojection with Intensity colours 1:50
• Laserscan 5mm point distance
  (Scan 3D GmbH, Berlin)

• detail 1:20

metigo3D - Orthogonal projection

Combination of Laserscandata with high resoluted images:
• Raitenhaslach, monastery, Steinerner Saal, 2012,
• Photogrammetric documentation 1:20

• Digital image plan 1:50
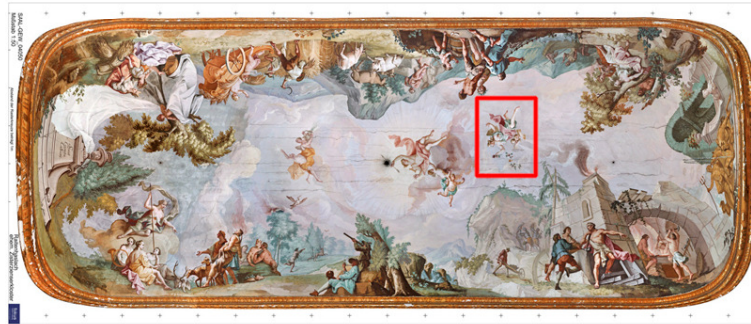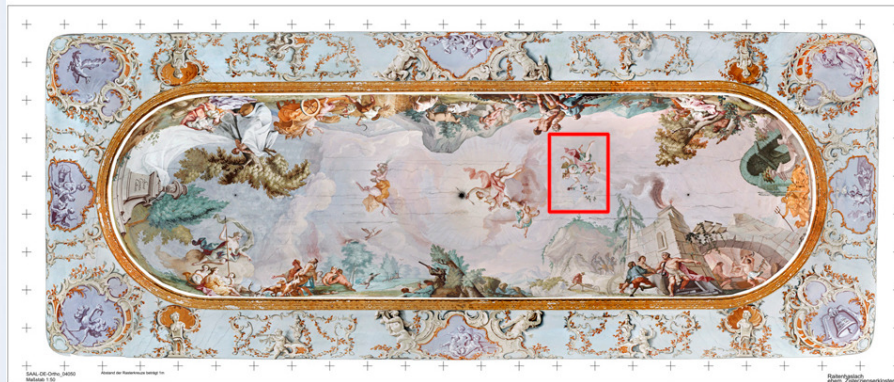(projective rectification)

• detail 1:20

metigo3D - Orthogonal projection

Combination of Laserscandata with high resoluted images:
- Raitenhaslach, monastery, Steinerner Saal, 2012,
- Photogrammetric documentation 1:20

- unwrapping with Orthoprojection

- Orthoprojection
  (Means ton and vault, each with 12 images,

- Detail 1:10

metigo3D - Orthogonal projection