DIGITALISATION - NOVEL DAMAGE AND MATERIAL ANALYSIS IN 3D AND BEYOND

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Zeus from Dresden, SKD

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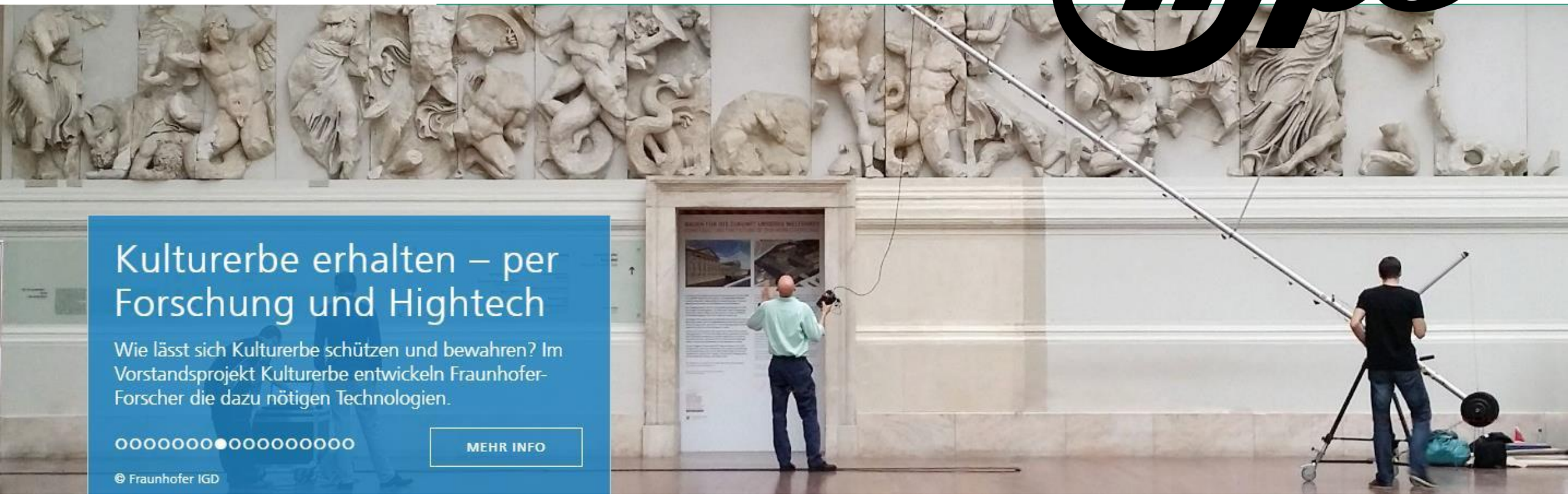
Fraunhofer-Gesellschaft for the advancement of applied research

Fraunhofer

- Established 1949, 73 institutes, 28 000 staff
- Fraunhofer researches for the future to support industry and society
- Greatest success – mp3 music algorithm - digitalisation of music

mp3



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Fraunhofer – a strong partner for innovation, technology and creativity in cultural heritage

- Partner in many national and international networks in the field of cultural heritage protection
- Development of cutting edge technologies and materials and methodologies
- Active in vocational training and education
- Support and create opportunities for young researchers
- Enhance transfer from research into market opportunities

European Cultural Heritage Year 2018 – the contribution of Fraunhofer-Gesellschaft

a research project of Fraunhofer with State Collections Dresden and the University Library

Digitalisation, materials research and socio-economic study

1 June 2015 – 31 December 2018

Financial support: 1.5 Mio €

Dresdner Zeus, SKD

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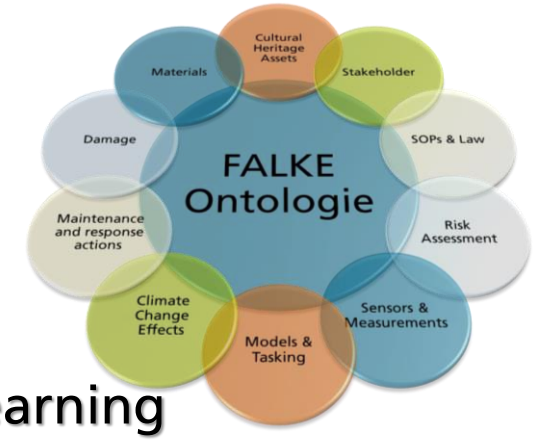
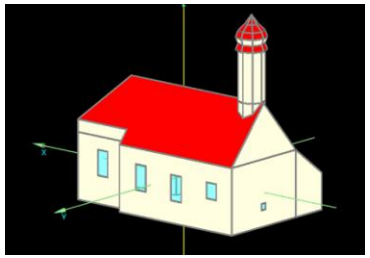
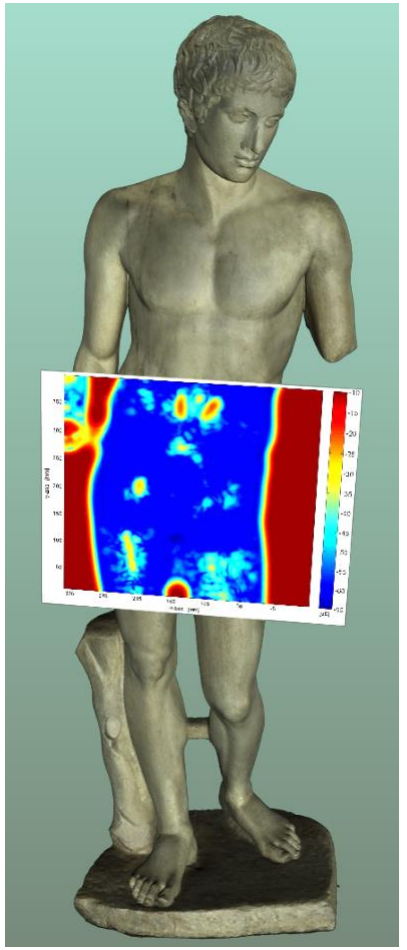
Digitalisation is more than only scanning objects

Examples from Fraunhofer

- automated contactless 3 D scanning
- working with digital twins
- interactive data platforms
- application of artificial intelligence and machine learning
- digital building management and smart museums
- virtual and augmented reality
- volumetric capture
- data formats and data security
- simulation models of historic buildings
- sustainability – **green digitalisation**







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What did we do?

- For the first time fusion of different contactless, digital techniques
- Applied to sculptures of the State Collections Dresden and Minster Freiburg
- Development of webbased consolidated 3D-Models
- Knowledge Transfer
  - Layer concept for visualisation of different data sources
  - 3D centered annotation
- Development of a 2D/3D work station with floating image display
  - Emergence of 3 D-contents in front of monitor
  - Connection to 3D-annotation system (hybrid visualisation)

Situation of today

State of the art

- high resolution 3D-models
- digital data from
  - optical
  - acoustic
  - elektromagnetic methods

in the beginning

- consolidated 3D-Models
- providing information
  - from inside the object
  - about material compostion
  - about existing damages
- no standardised data
- limited access to original data

Consolidated 3D-visualisation for presentation and interaction

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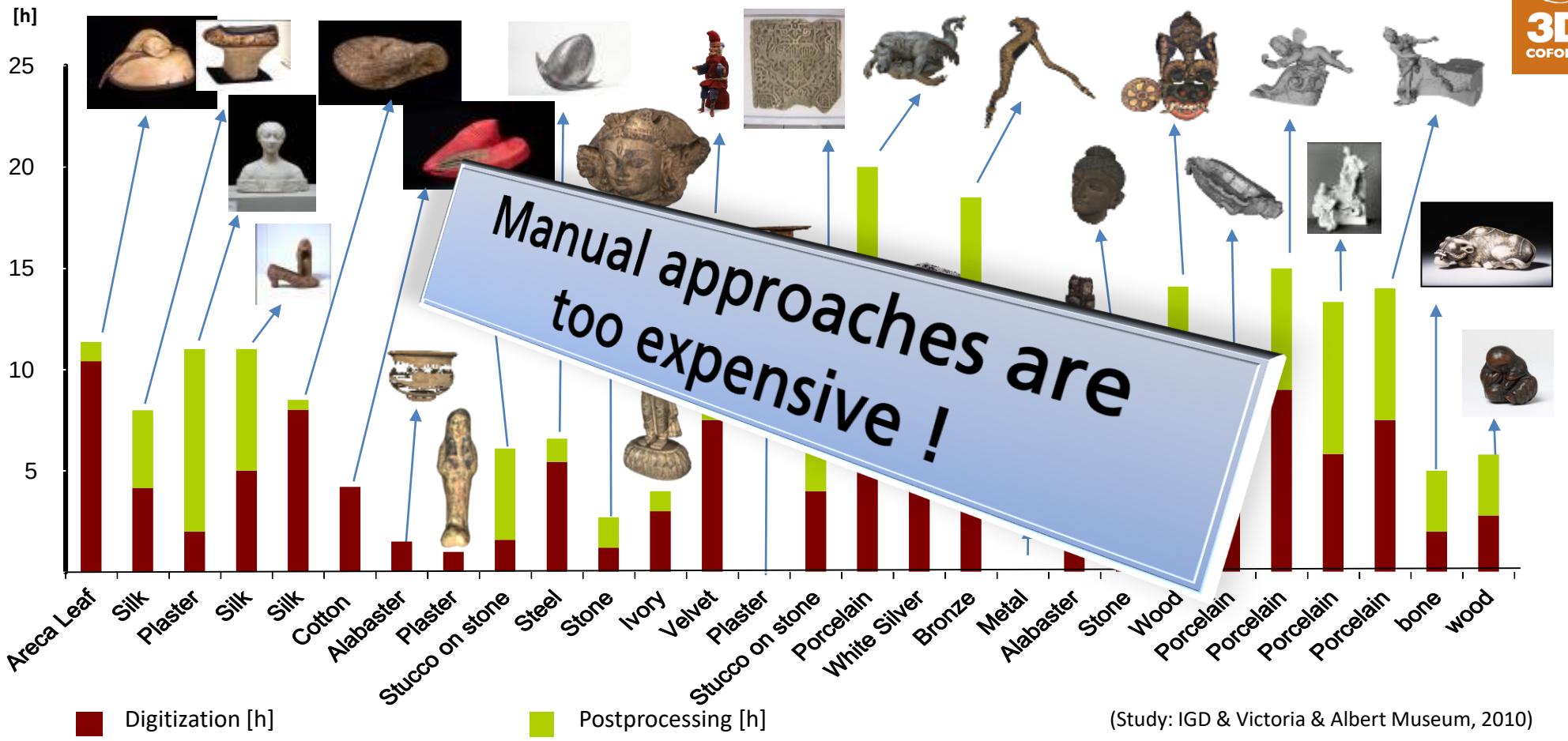
Which digital methods have been applied and have been coupled?

- 3D-Digitalisation – automatically and manually
  (surface, geometry, texture and reflection behaviour)
- confocal, high resolution microscopy (nm resolution for detection of paint residues)
- Tera-Hertz-Technology (Wooden sculptures, humidity content inside)
- mobile ultrasonic tomography (shortening the recording time form days to minutes)
- and materials research

Challenges in 3 D digitalisation



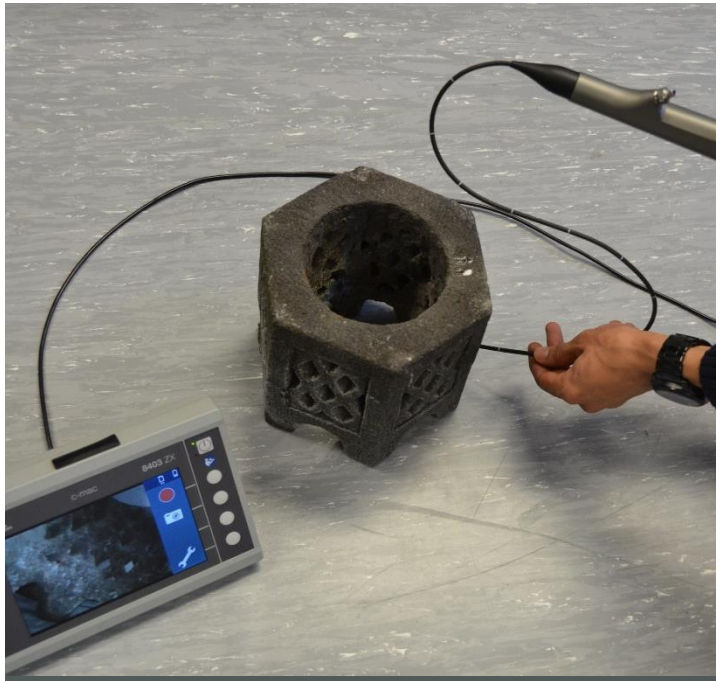
(Study: IGD & Victoria & Albert Museum, 2010)

CultLab 3 D – automated 3D scanning of objects

- CultLab3D fastest, contactless mass digitalisation conveyor belt in the world
- Accuracy in sub mm range
- reflecting surfaces also possible

Optical, contactless recording of big objects

Coupling of information from positions und images results in 3D-image of an object

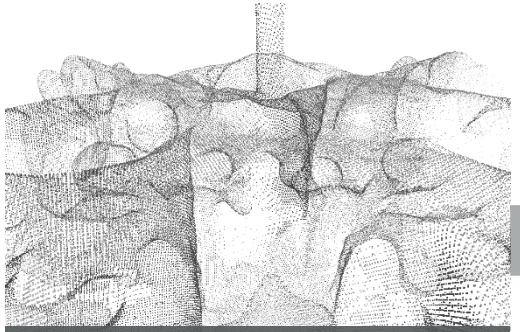


Recording of surface with scanner; voids with endoscope

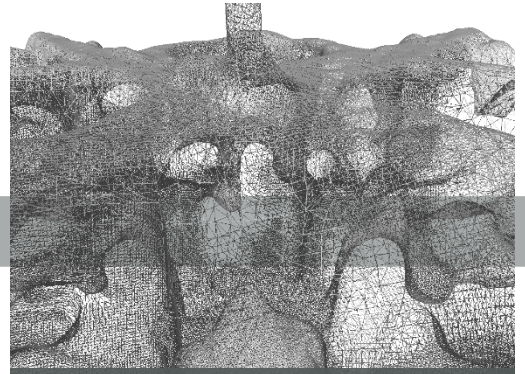
Recording of surface with digital reflex camera

From digital model to 3D copy

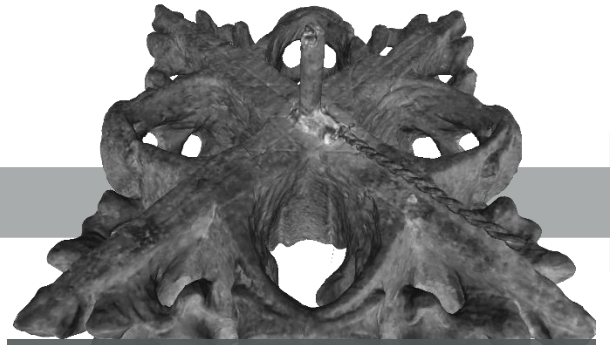
Sculpture *Dresdner Knabe* und finial from Minster in Freiburg



Point cloud – several tera bytes of data



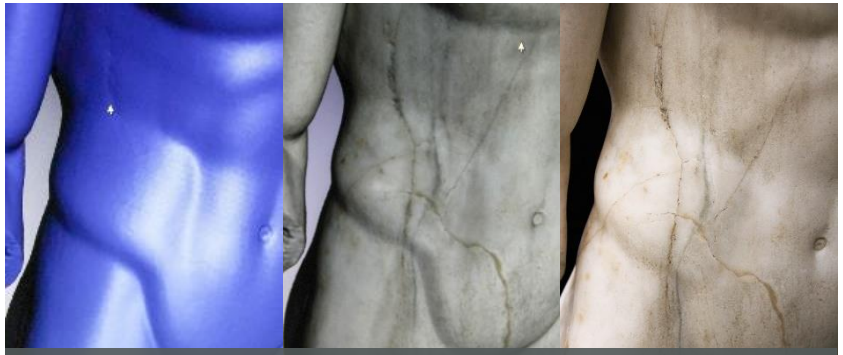
Interpolated mesh



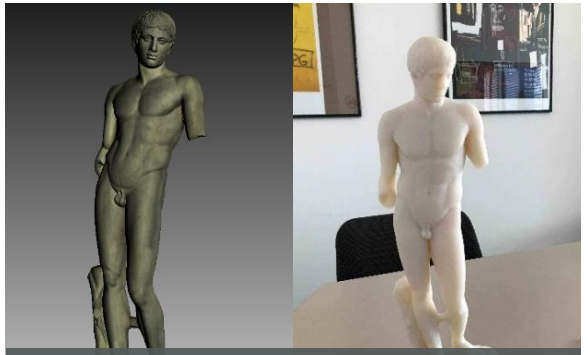
3D-model

3D-replica

Point cloud and resulting model



Model, textured model, original



3D-model + 3D replica

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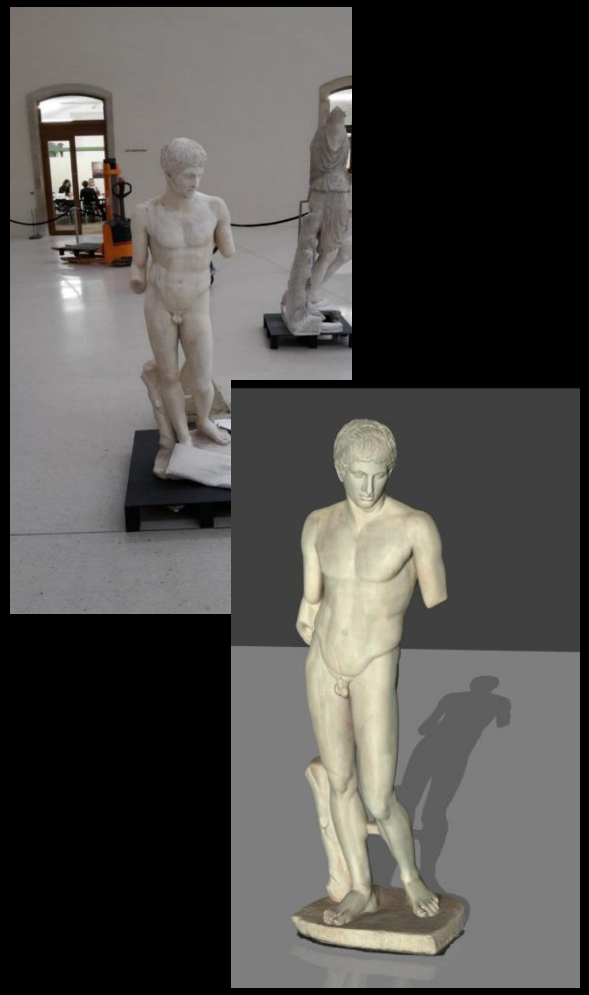
Sculptures from Dresden and their digital twins of 4 different materials



Dresdner Knabe (500 BC)

(157 x 53 x 51 cm), marble

Surface texture, defects in material

Amazone Mattei (modern copy)

(204 x 75,5 x 88 cm), plaster

Different materials inside, wall thickness of casts

Egyptian relief (2500 v. Chr)

(87 x 45 x 17 cm), lime stone

Original paint beneath surface

Pieta from Mohorn (unk.)

(101,5 x 75 x 41 cm), wood

Worm damage, compostion, individual fragments

Tera-Hertz technology makes the invisible visible – example Egyptian relief fragments

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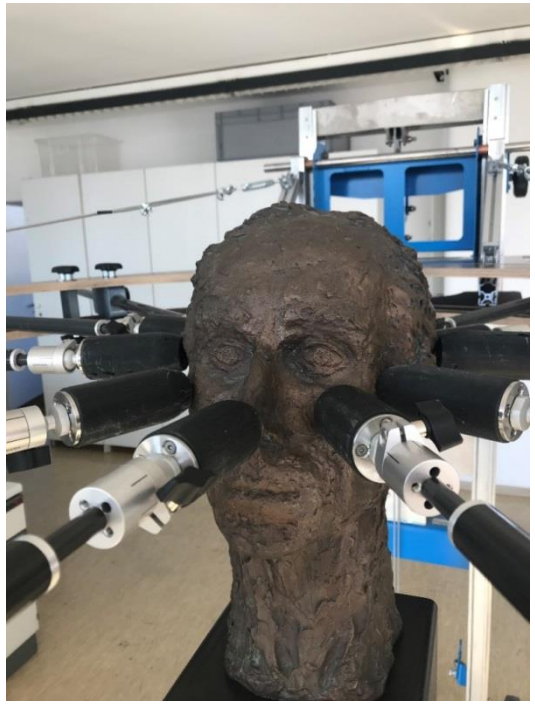
The first prototype – mobile ultrasonic tomography

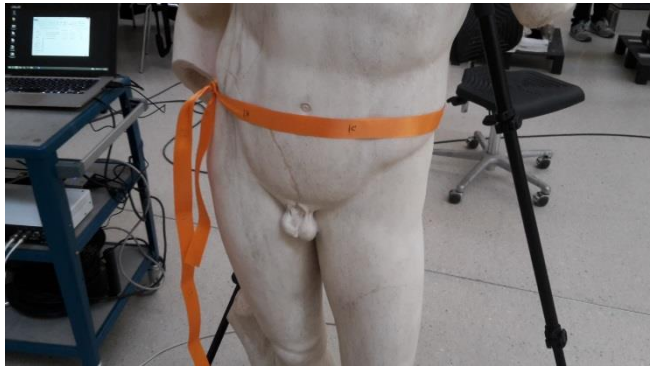


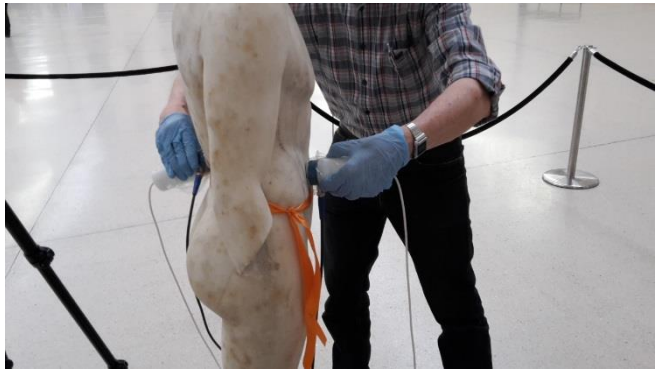
Scan ring with maximum 24 transducers and atomatic position acquisition

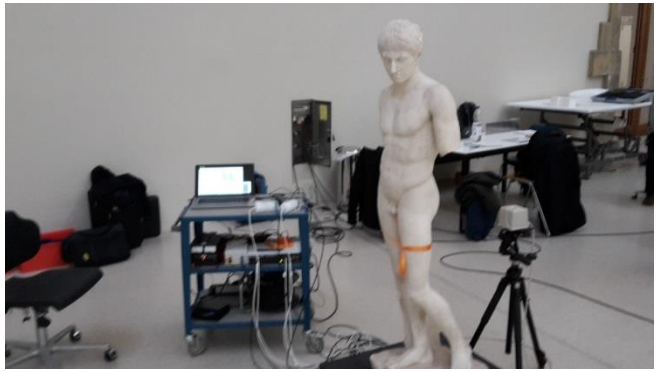
Disadvantage - too rigid for most applications

The second prototype – with flexible scan belt

Scan belt with maximum 64 transducers and fast wireless position acquisition







Ultrasonic tomography at *Dresdner Knaben* (still manually done)

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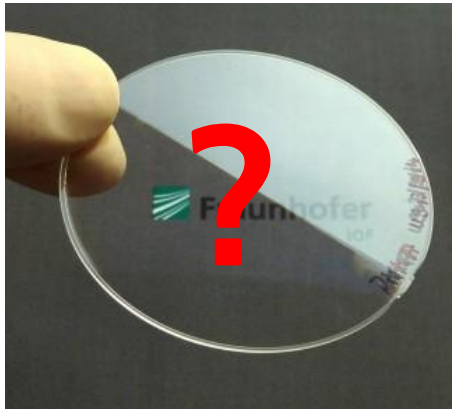
Dry coupling of ultrasonic transducer for cultural heritage materials with high acoustic impedance

Ultrasonic gel for medical diagnostics and anti reflective coating



For heritage materials?

https://www.praxisdienst.de/Diagnostik/Fachspezifische+Diagnostik/Ultraschall/Ultraschallgel+Zubehoer/?ldtype=grid&_artperpage=20

https://www.iof.fraunhofer.de/de/presse-medien/pressemitteilungen/2012/ausgezeichnete_forschungaufderoptatec.html

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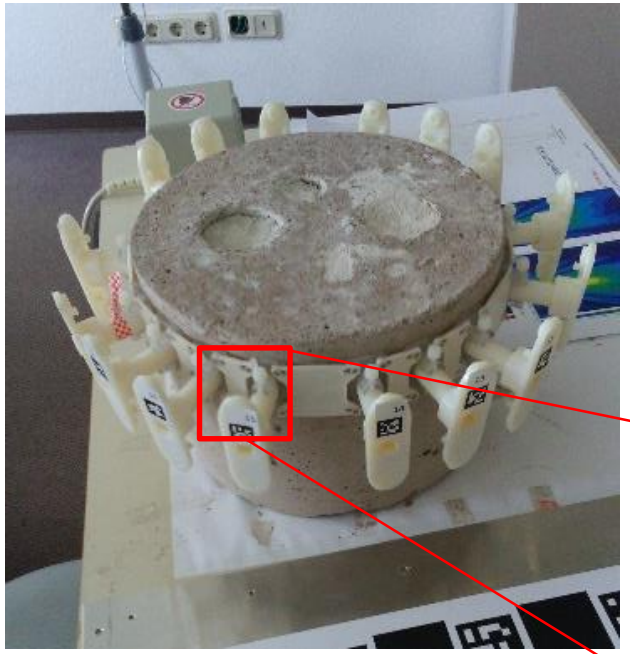
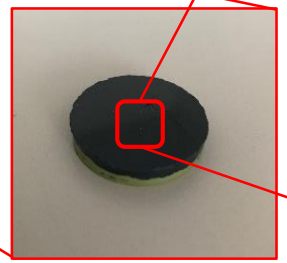
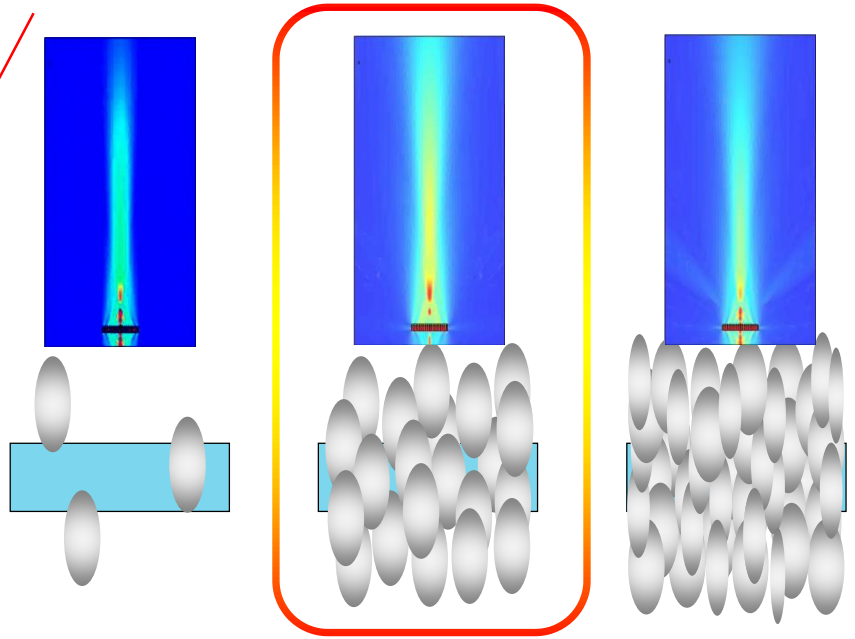
Development of a dry coupling transducer component based on nanotechnology suitable for cultural heritage







Tailor made coupling based on speciality polymer allows optimal ultrasonic intensity and residue free removal

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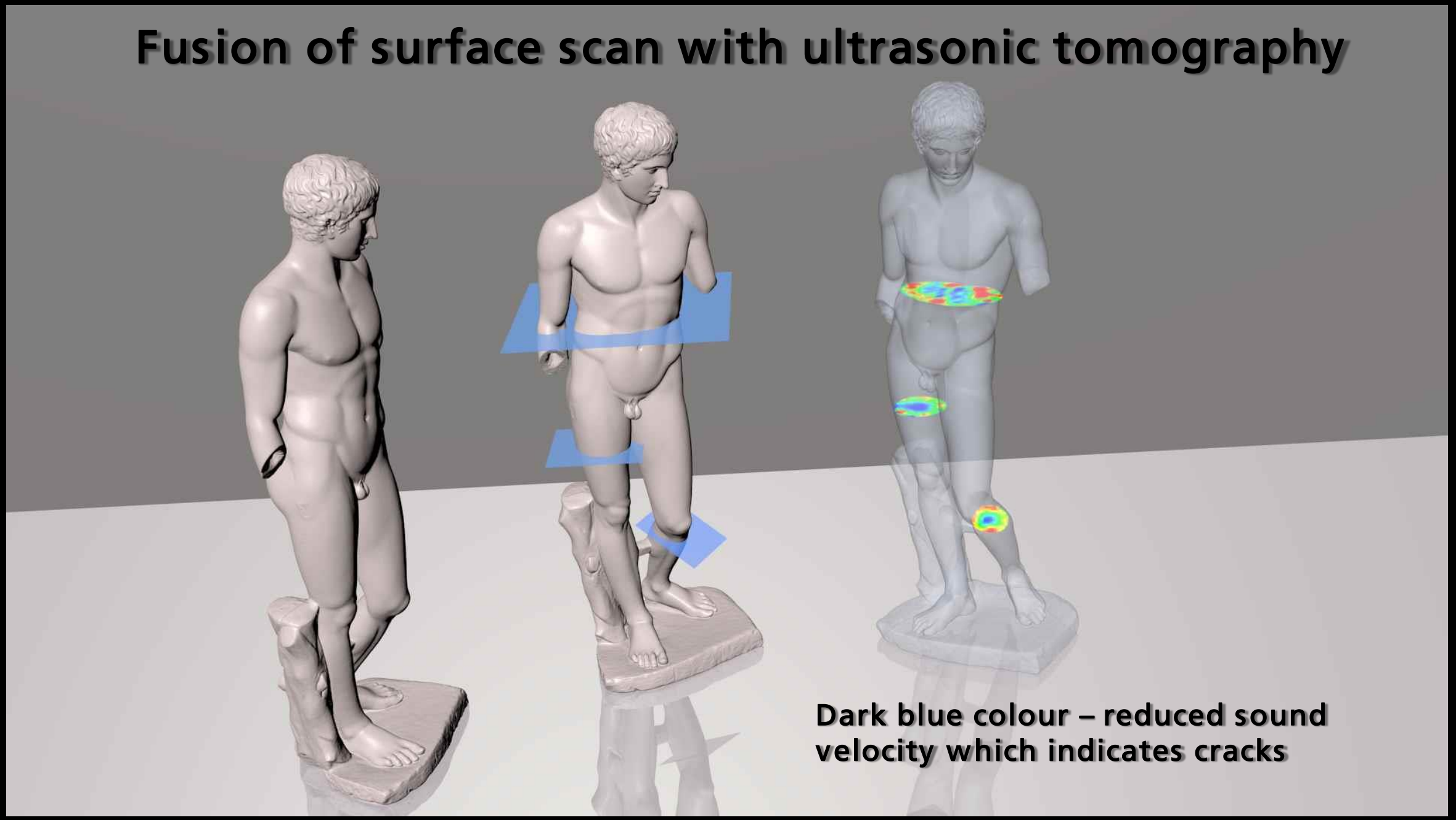
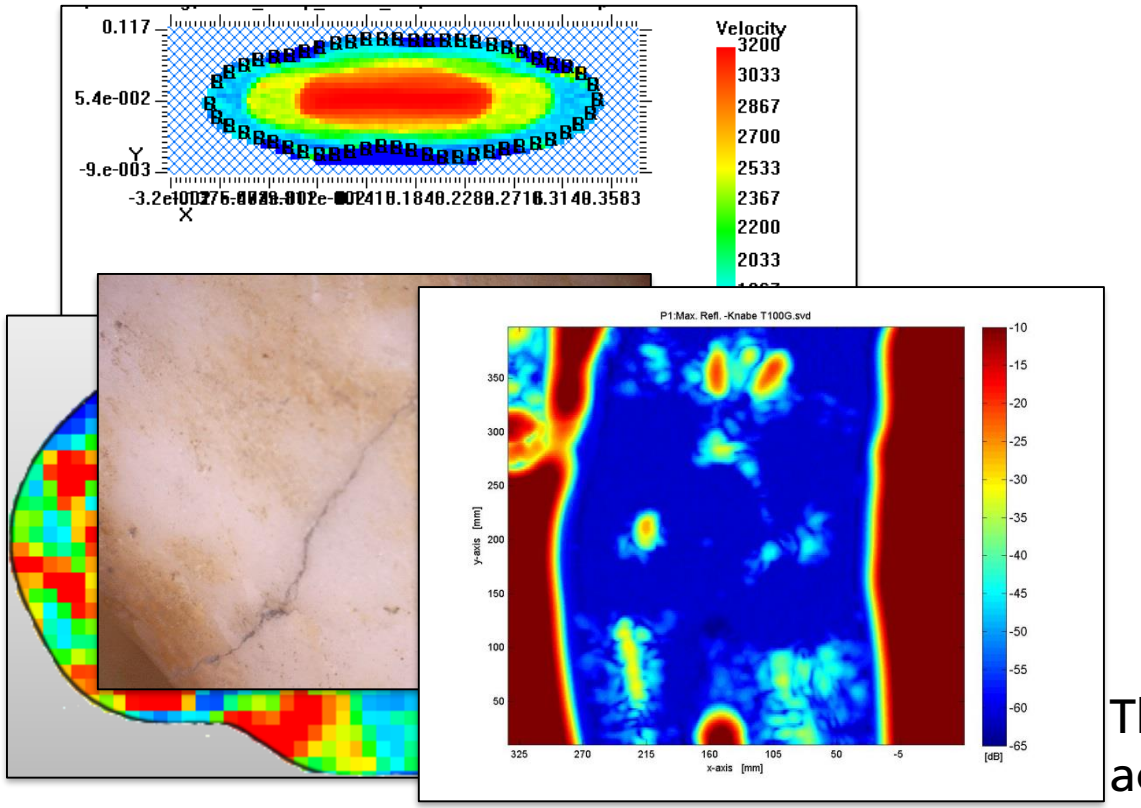
Fusion of surface scan with ultrasonic tomography



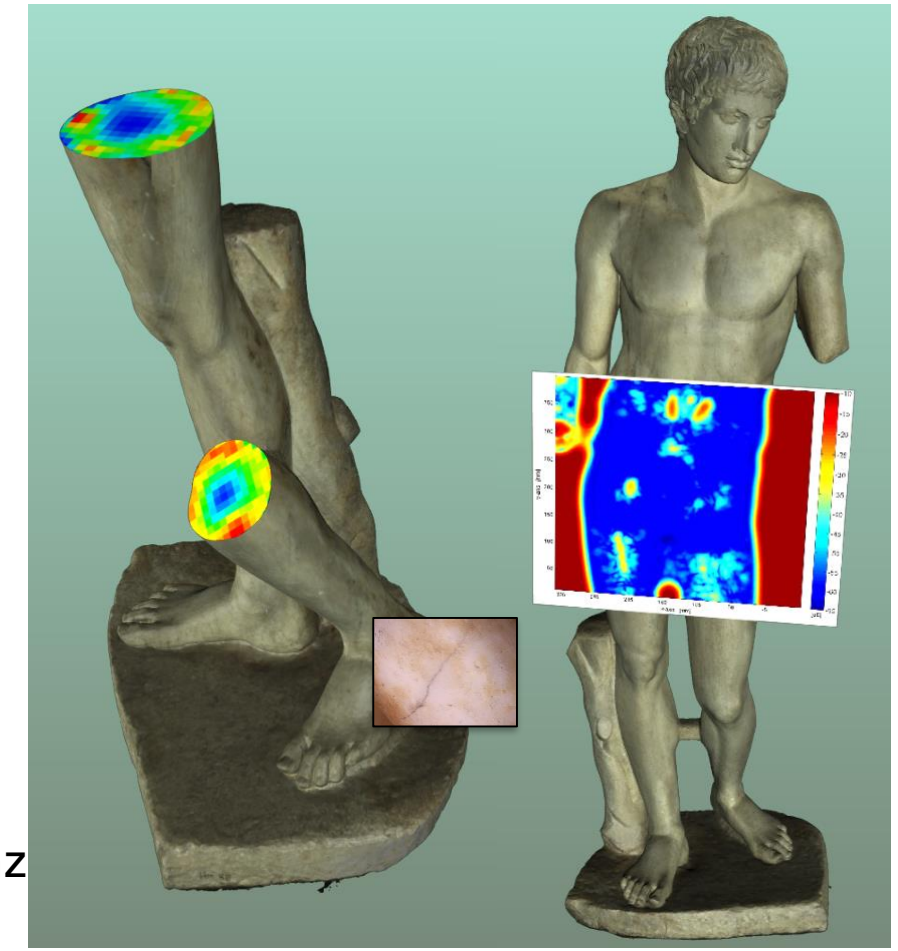
Dark blue colour – reduced sound velocity which indicates cracks

How does the information reach the objects?

- Web-based display of consolidated 3D-models
- Merging of different sources



Thz - 100 Ghz acquisition



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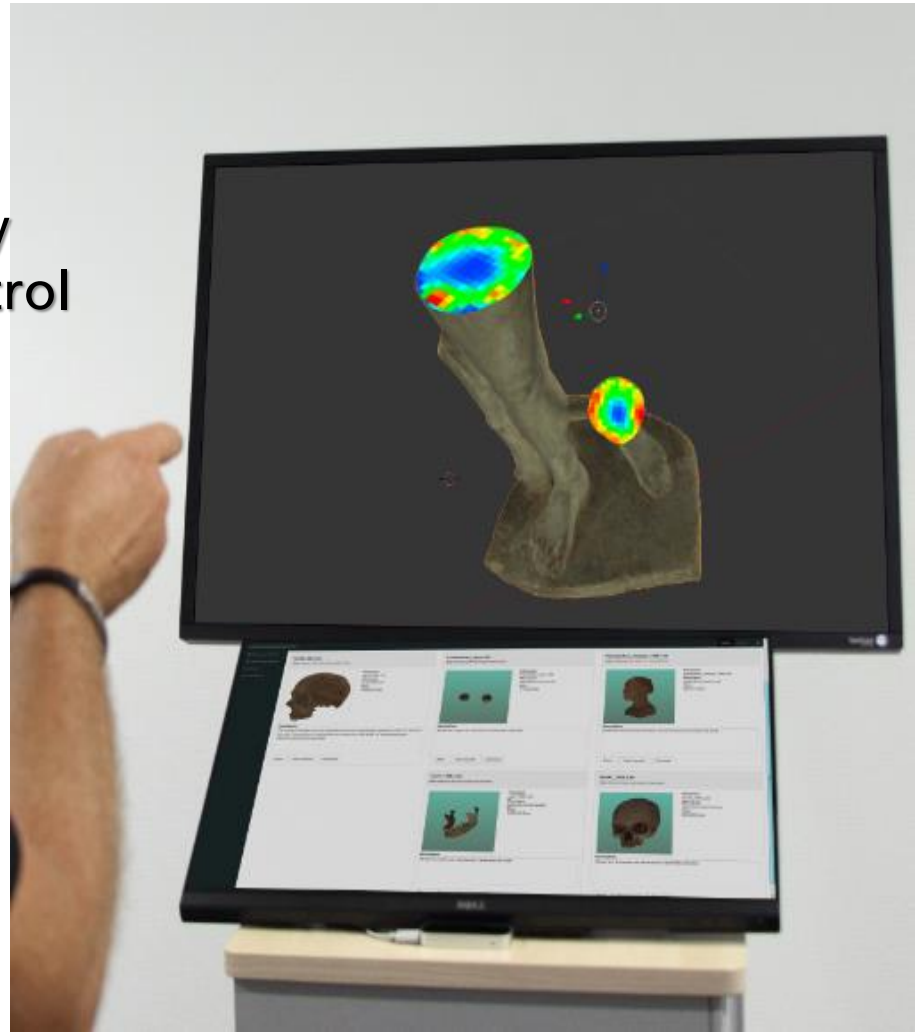
Prototype of a 3D web-based work station

A combined 2D/3D display
with gesture and touch control



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Outlook

Future of 3D digitization:

- Autonomous, fast and economic 3D scanning of entire collections
- Color-calibrated pipline from capture to simulation, visualization and replica
- Fusion of results from a variety of tactile, optical or electromagnetic scanning or measurement technologies into consolidated 3D models, combining surface and volumetric scanning as well as physical material properties
- Web-based, concurrent scientific work on digital replicas to protect originals from deterioration
- Extension to industrial applications, e.g.:
  - Next dimension of product photography supporting 3D-AR-applications in web-shops
  - Economic and highly customized mass production

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Many thanks to
All of you and to
My colleagues

Stay safe

The Fraunhofer Virtual Heritage Expo