

Microfocus computed tomography and other X-Ray techniques for scientific applications

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1. Historical review
2. Conventional and Microfocus X-Ray Technology
3. Computed Tomography - CT
4. Automated Defect Recognition - ADR
5. FEM Analysis based on CT - Data
6. On-line process radioscopy

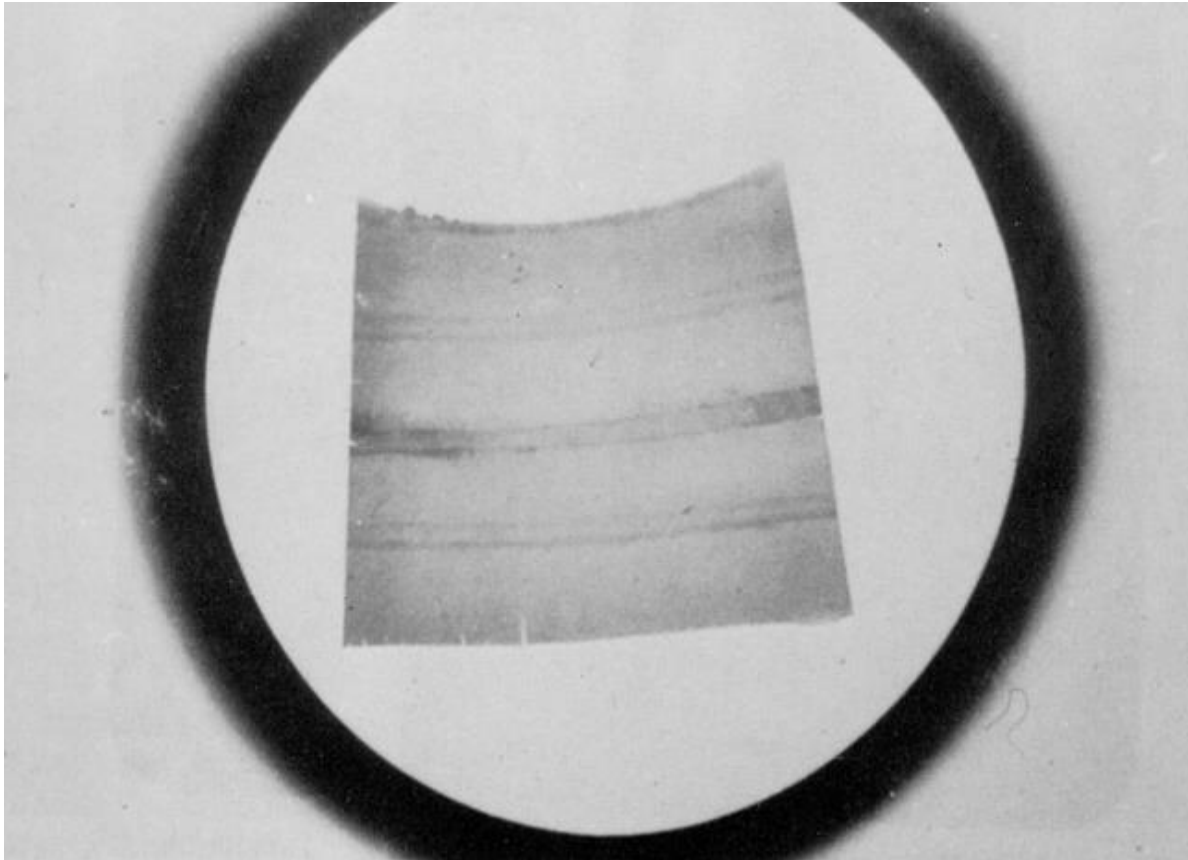
Historical review



*Historical X-Ray System
(Deutsches Röntgen-
Museum, Remscheid)*

Historical review

Radiografic techniques



*Four soldered and
afterwards rolled
zinc stripes*

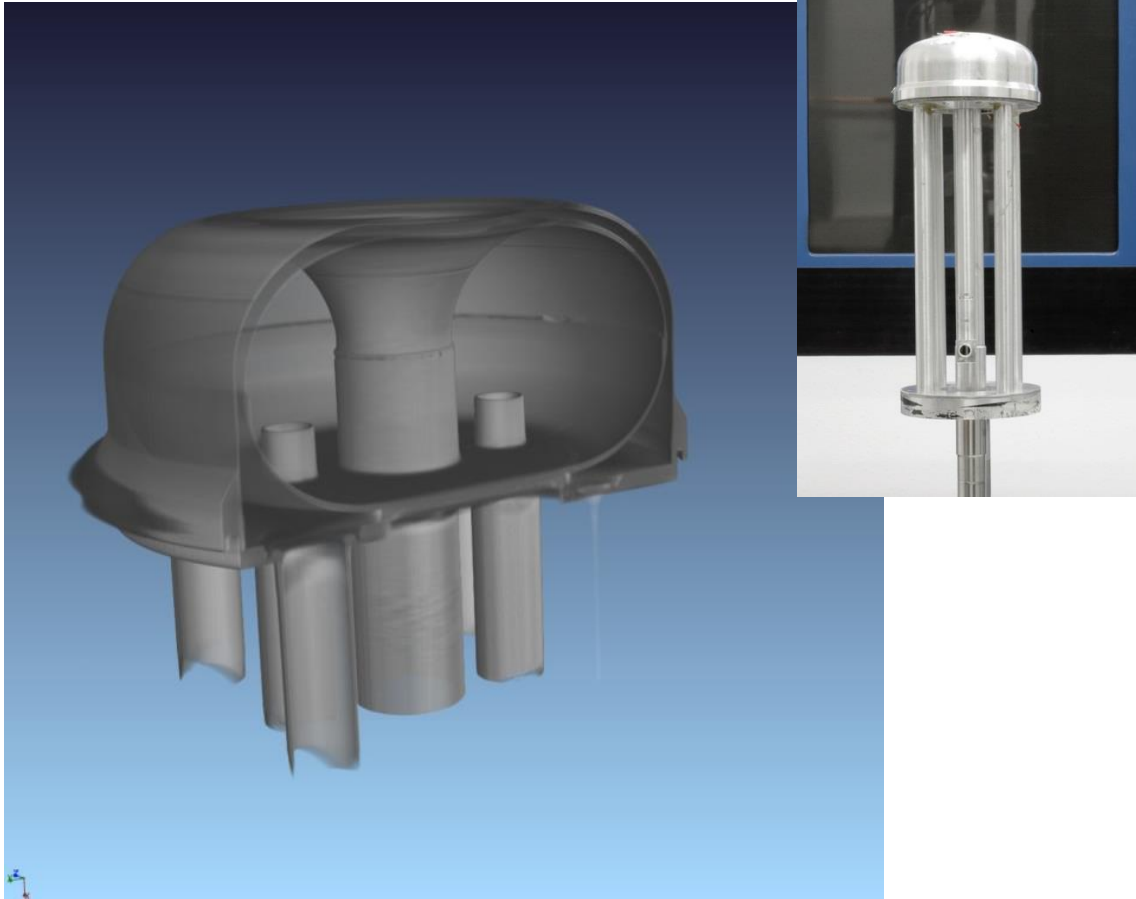
*produced by
W. C. Röntgen
in 1896*

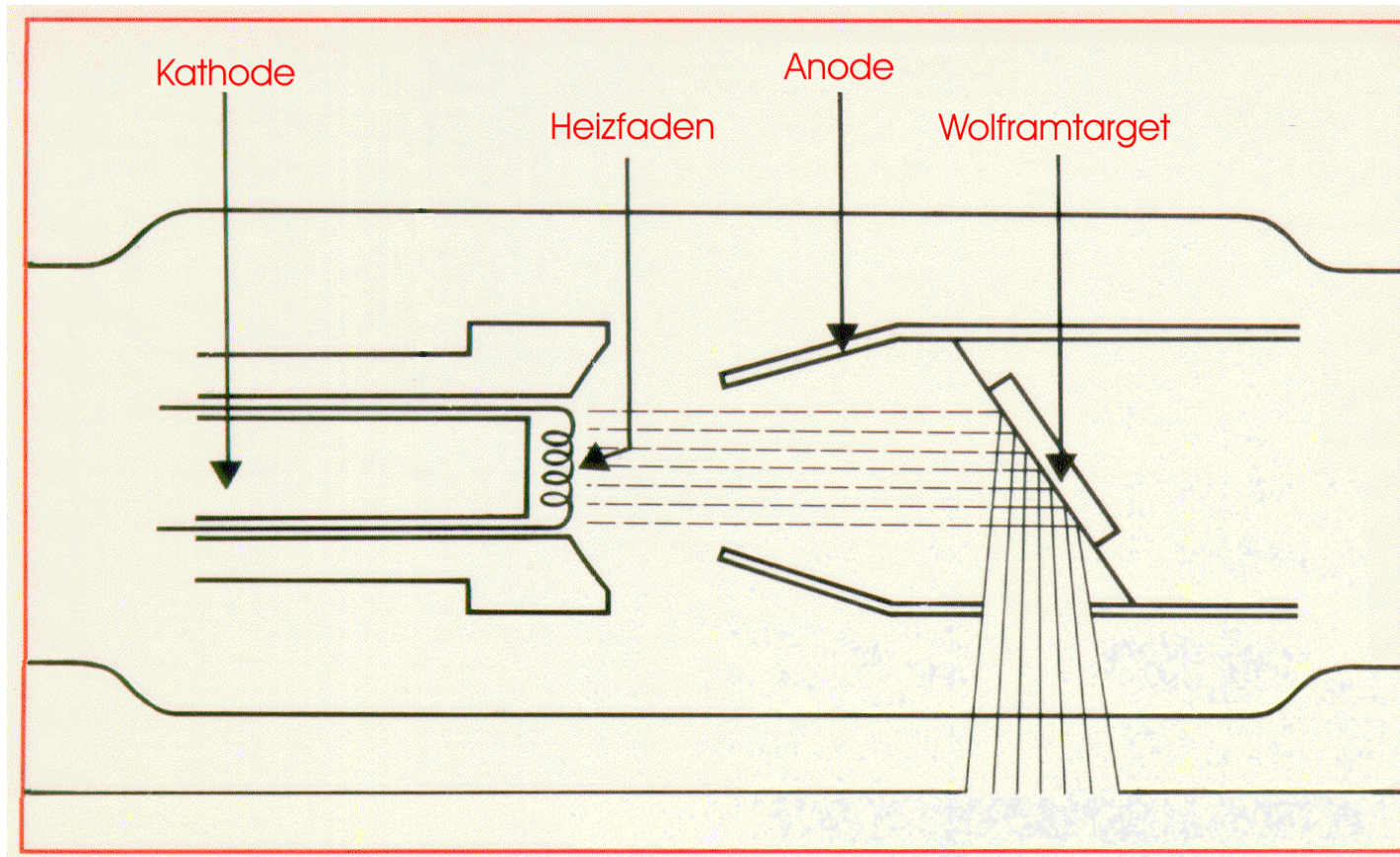
*First radiography
of a technical joint*

The micro focus-CT-system at ZEA-1

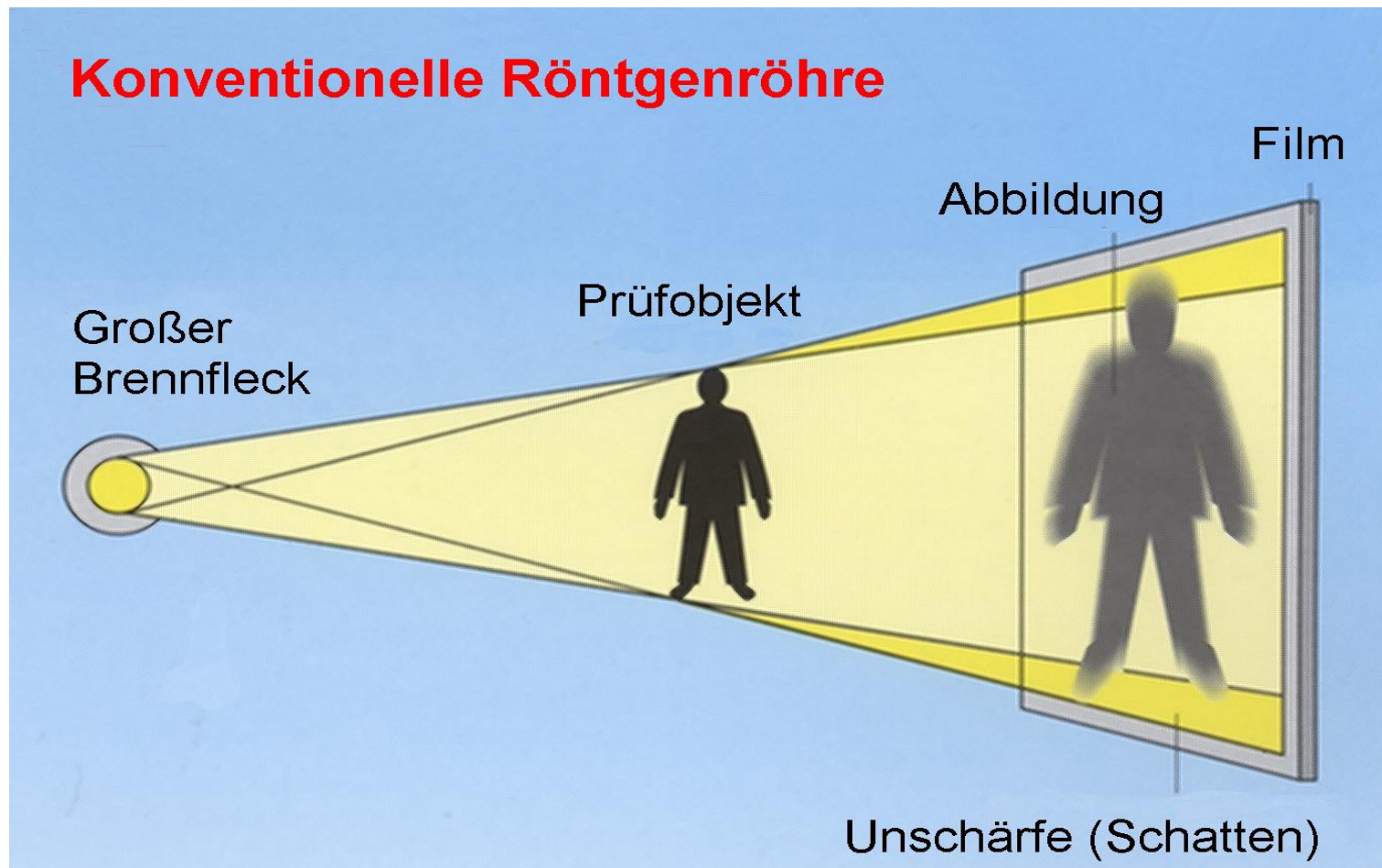


Computed Tomography - CT

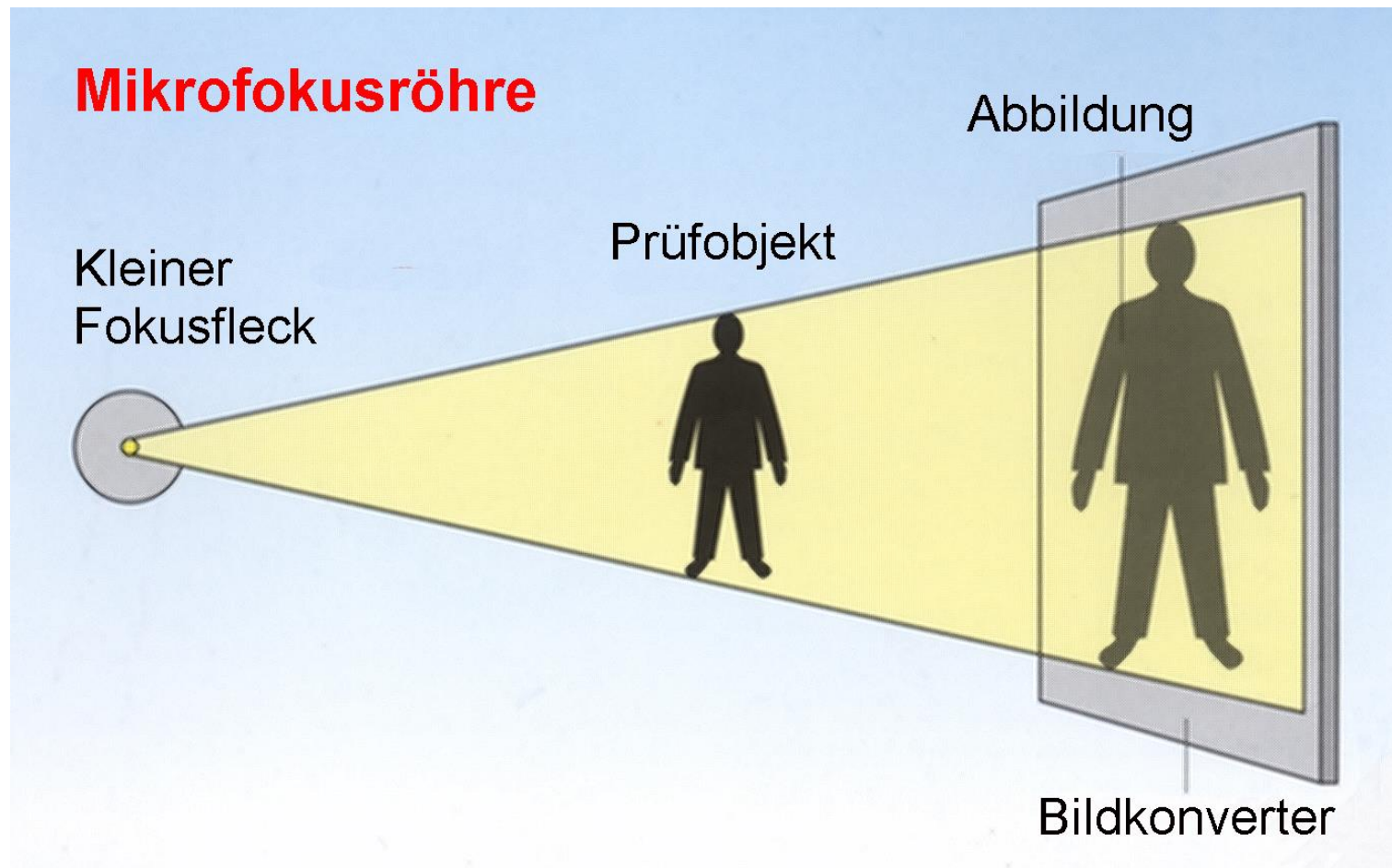


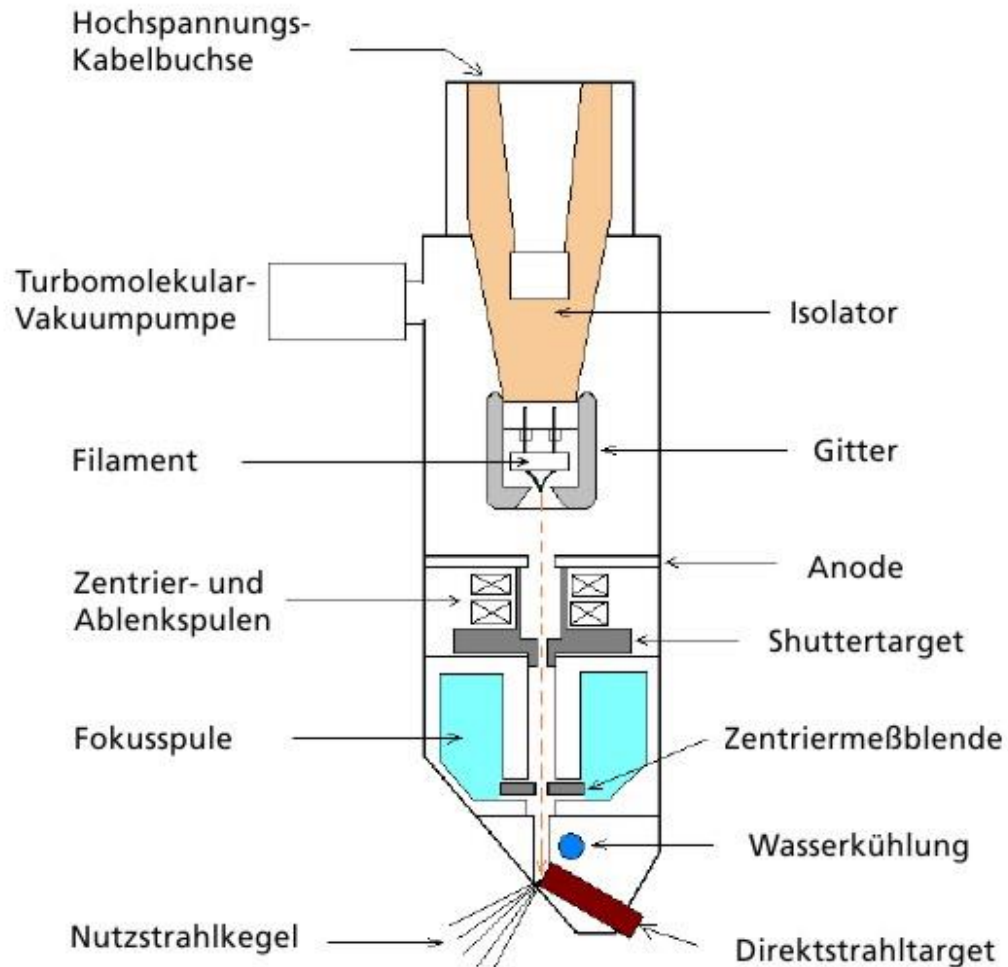


Basic structure of a conventional X-Ray tube



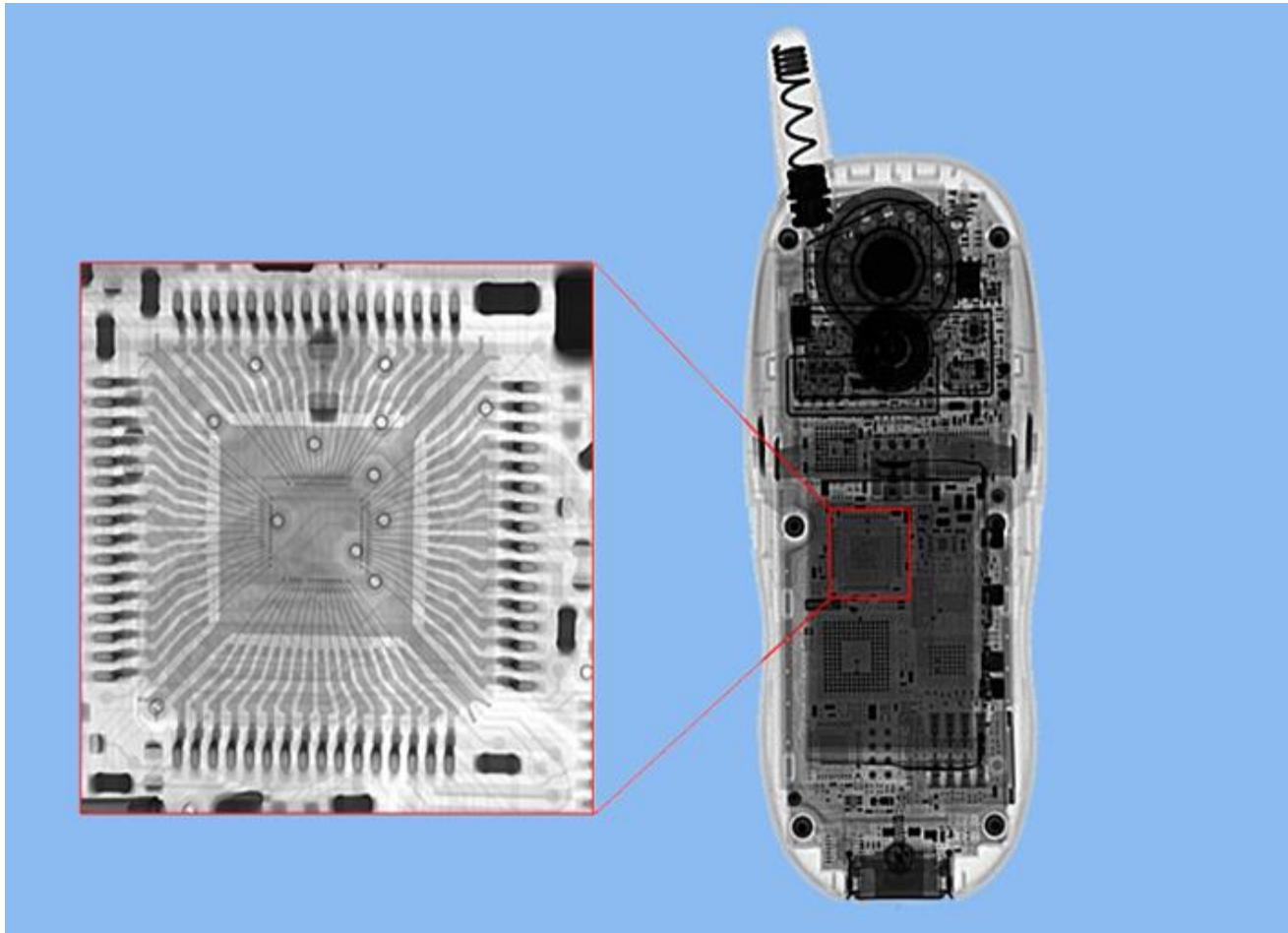
Quelle: [13]



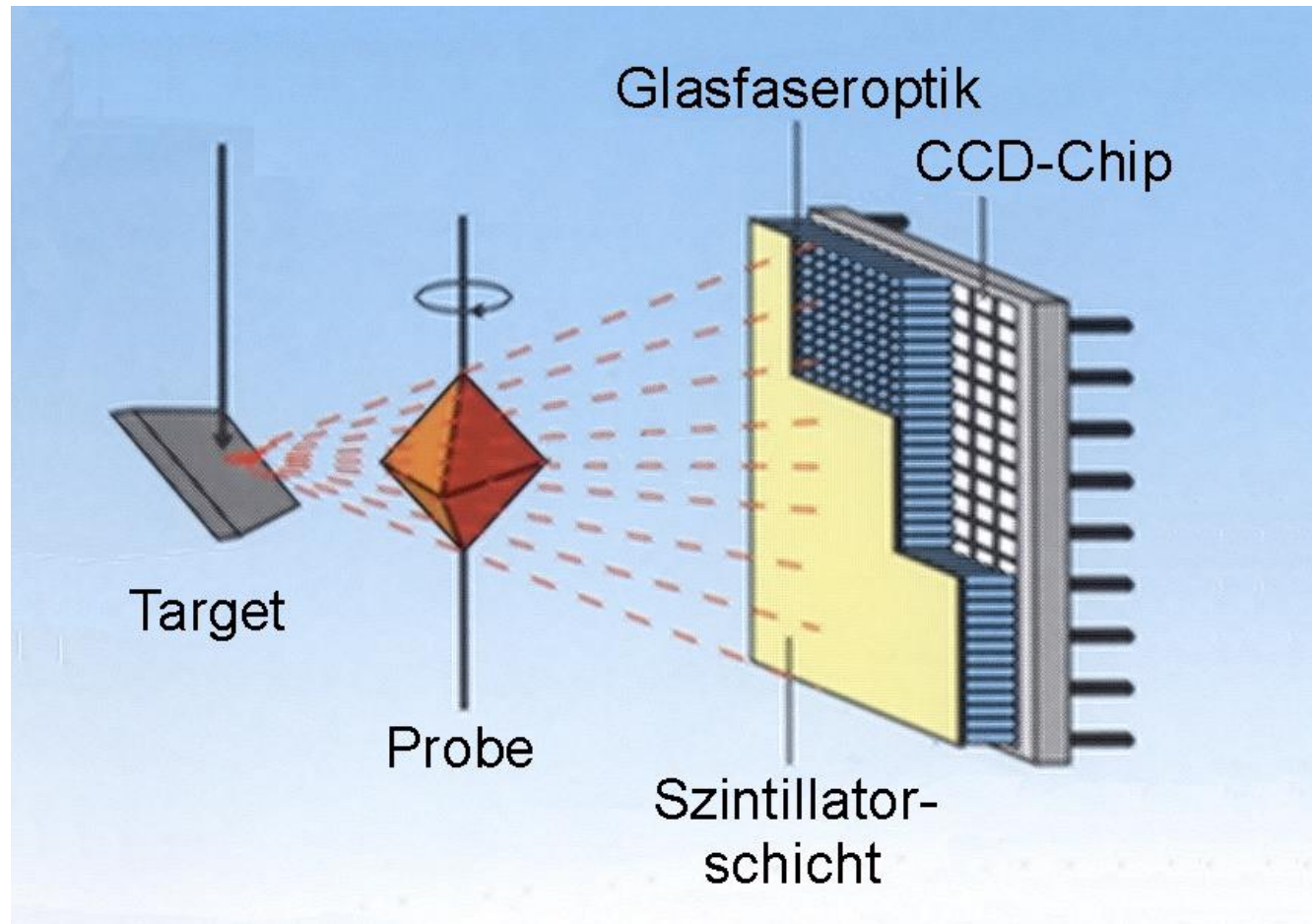


Basic structure of a mikrofocus X-Ray tube

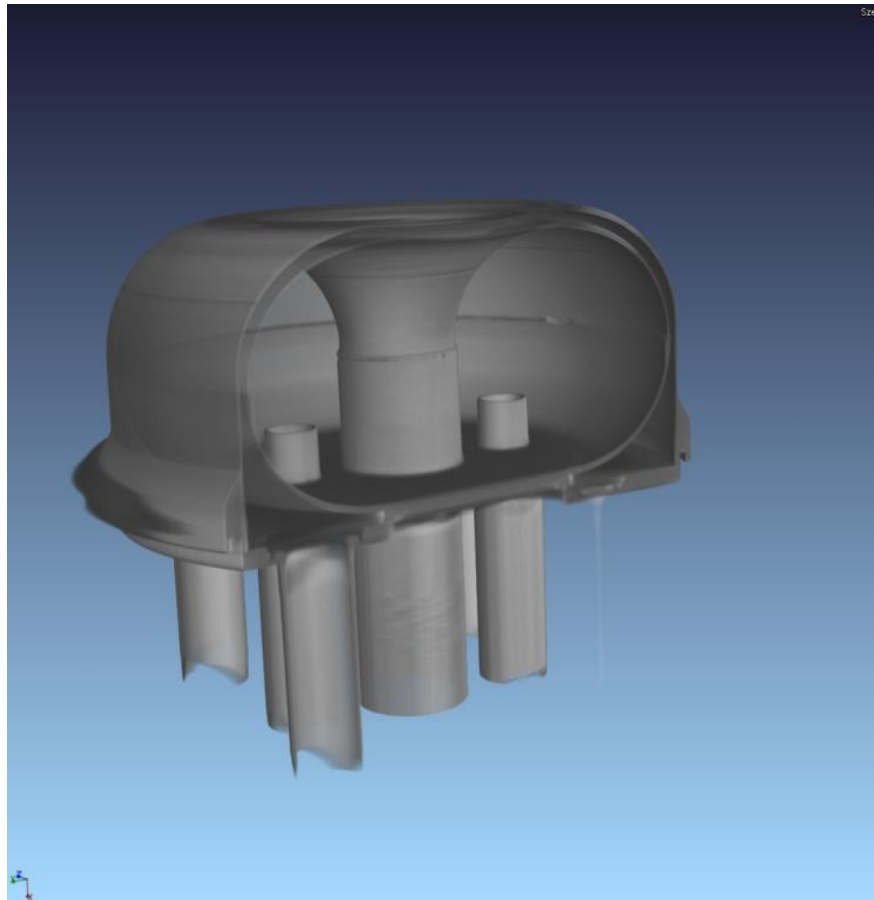
Microfocus Radioscopy



Draft of a Cone-Beam-CT



Computed Tomography - CT



Computed Tomography - CT

The micro focus-CT-system at ZEA-1

- *Micro- and Submicro(nano)focus systems up to 225 kV, 3 mA*
- *Minifocus- und conventionally systems up to 320 kV, 13 mA*
- *Digital Flat-Panel-Detectors, active Area up to 410 x 410 mm, 2048 x 2048 Pixels, Res. 100 μ m*
- *Ultra-precise manipulation system, precision < 1 μ m*
- *Qualified und certificated personal regarding DIN EN ISO 9712 up to Level RT/DR 3*

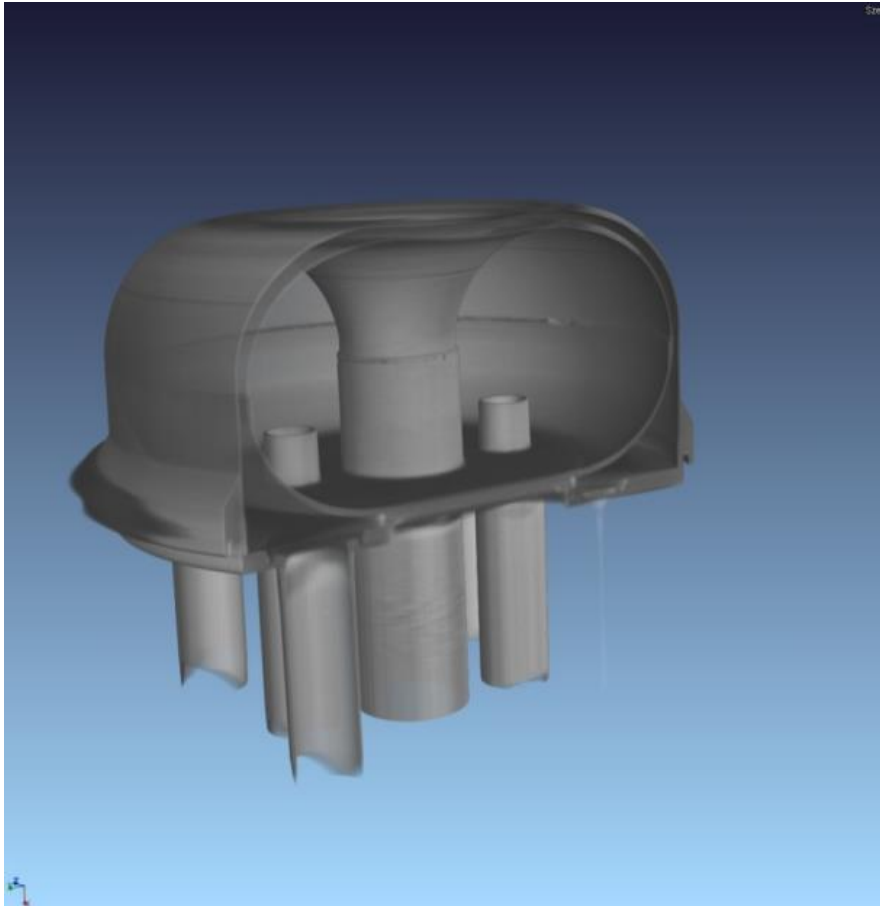
Computed Tomography - CT

The micro focus-CT-system at ZEA-1

- *High resolution Material analysis, joining technology processes and structures*
- *3-D image reconstruction and visualisation*
- *Automatic defect detection segmentation and surface reconstruction*
- *high resolution and failure detection through direct magnification*
- *real time x ray imaging of joining processes with direct defect detection and correction*

Computed Tomography – CT

Examples / Results

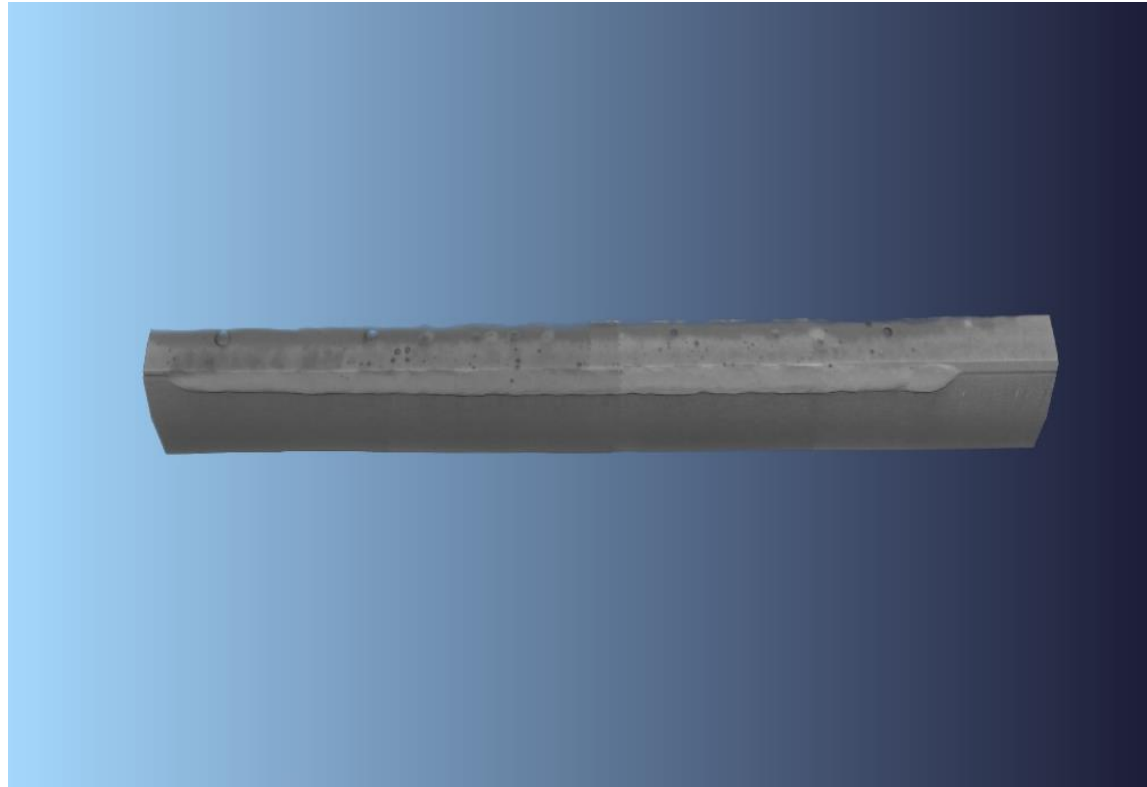


Cryo System for Ultra Cold Neutrons for neutron scattering experiments at FRM II- Jülich center for neutron research

CT-inspection of Cryo-head, complex welding structure non destructive inspection

Computed Tomography – CT

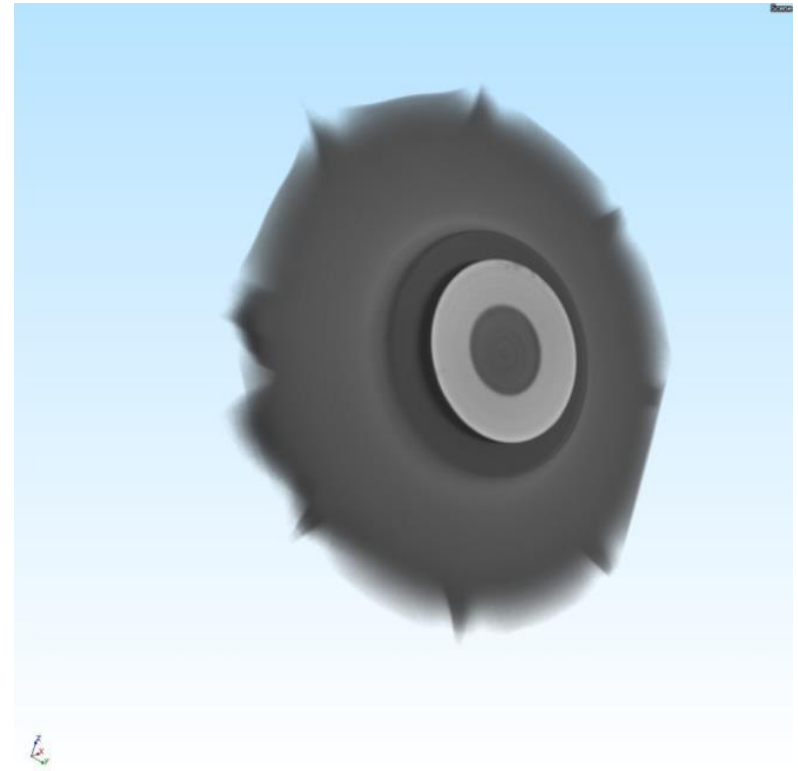
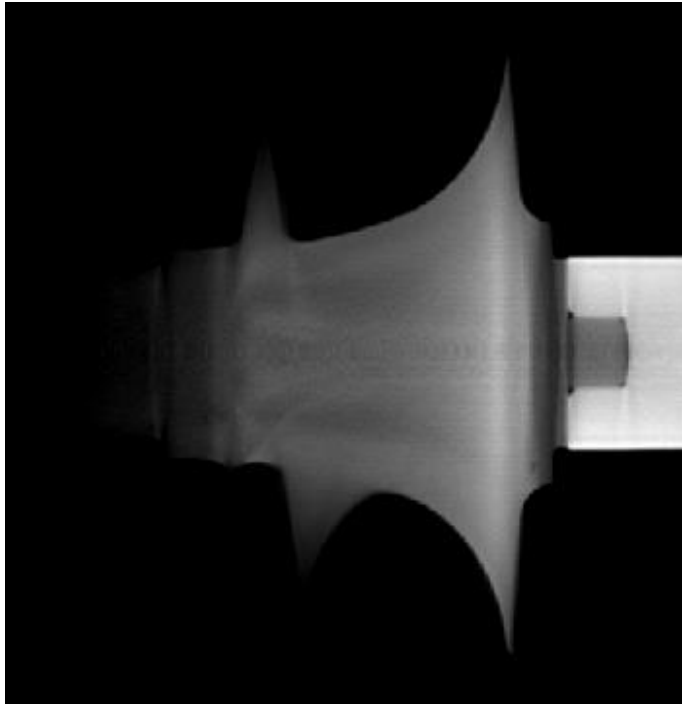
Examples / Results



Welding probe / CT-inspection / virtual cut
3 dimensional structure of welding surface

Computed Tomography – CT

Examples / Results

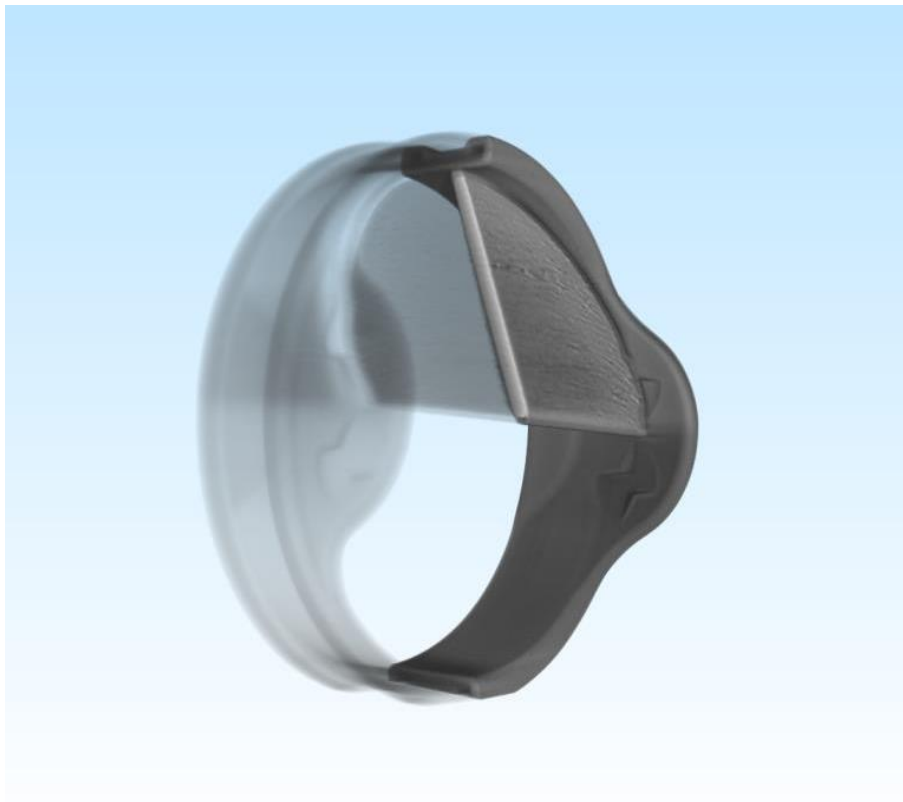


EB-welded shaft of a turbocharger
CT-inspection / virtual cut

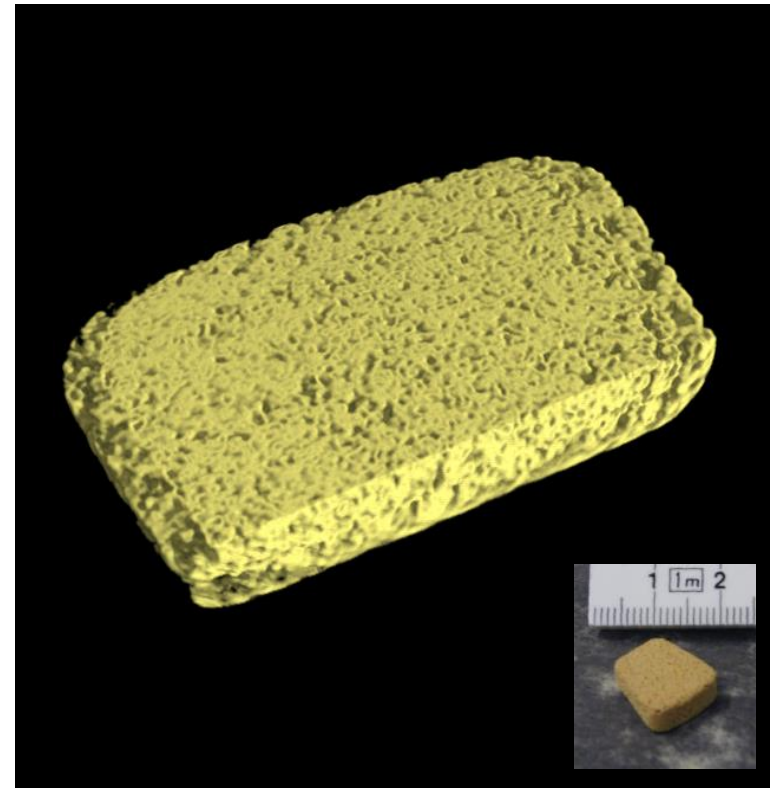
Computed Tomography – CT

Examples / Results

artificial heart valve



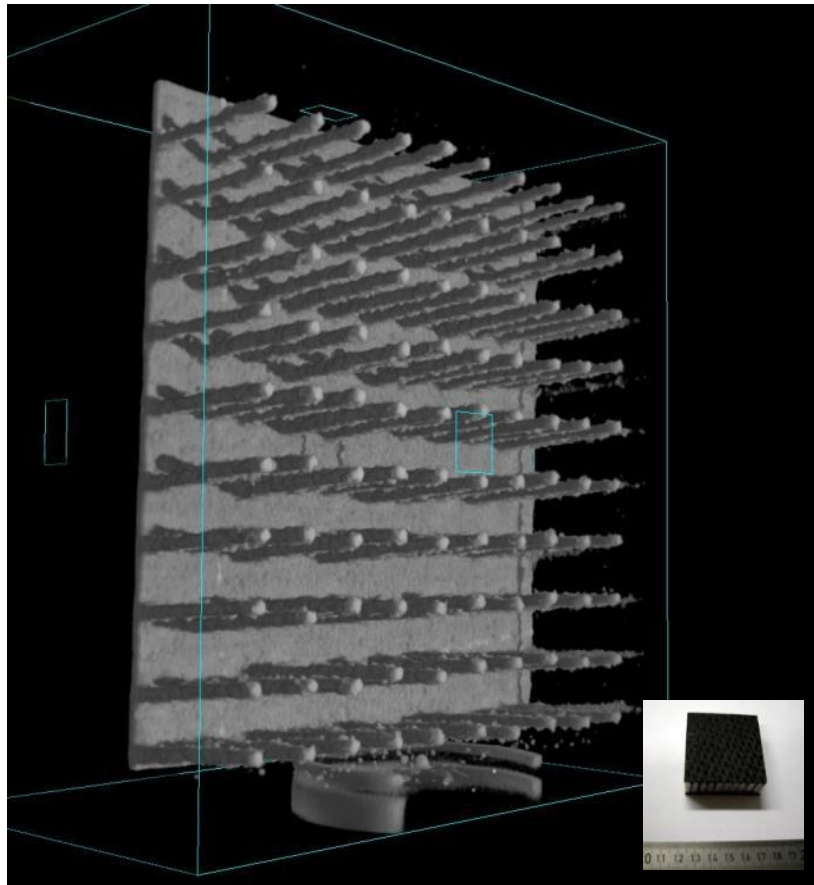
medical ceramics



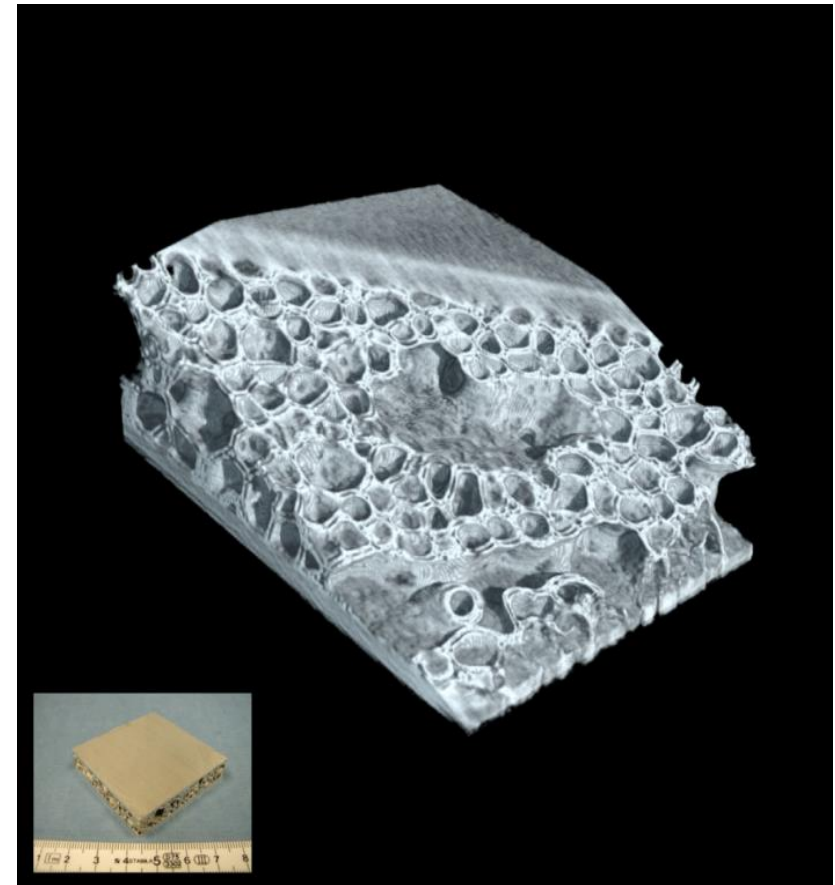
Computed Tomography – CT

Examples / Results

foamed CFC / reinforced



foamed aluminum



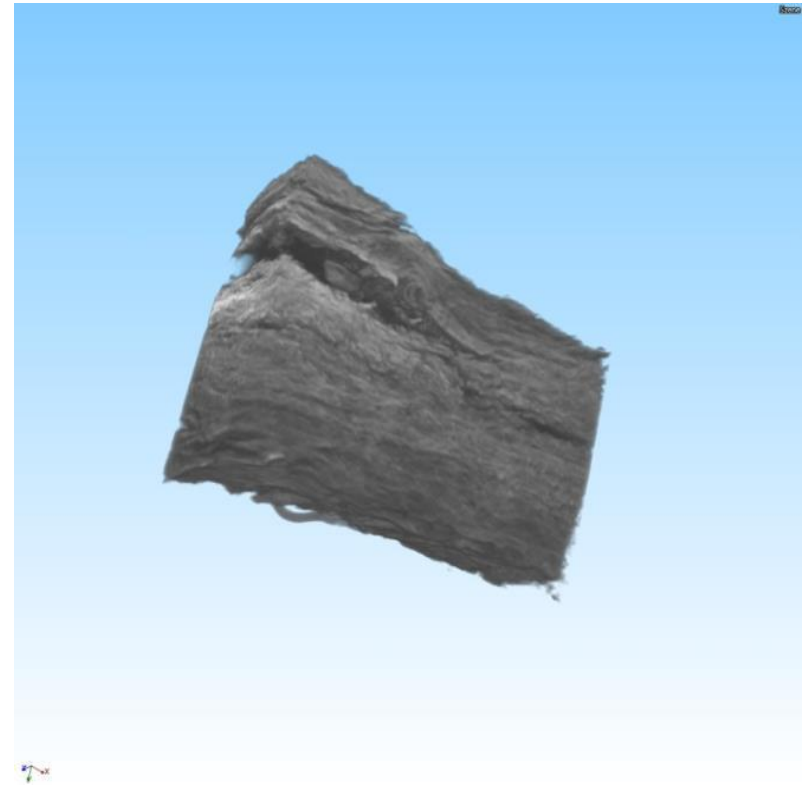
Computed Tomography – CT

Examples / Results

leafs of rape



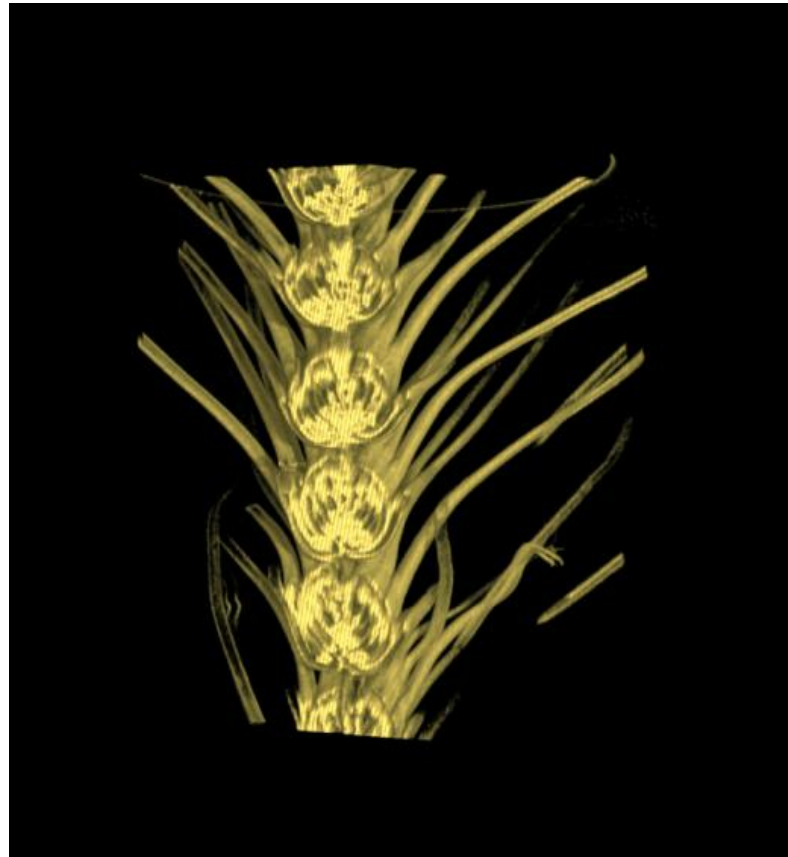
peat of turf



Computed Tomography – CT

Examples / Results

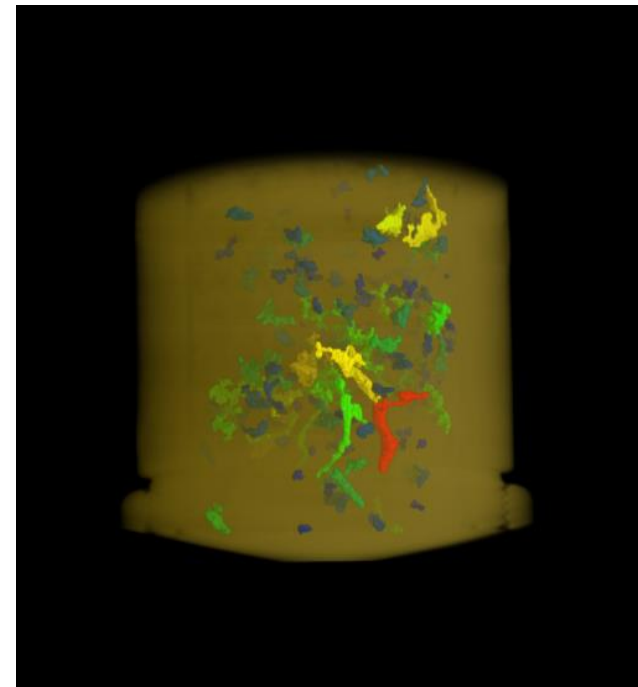
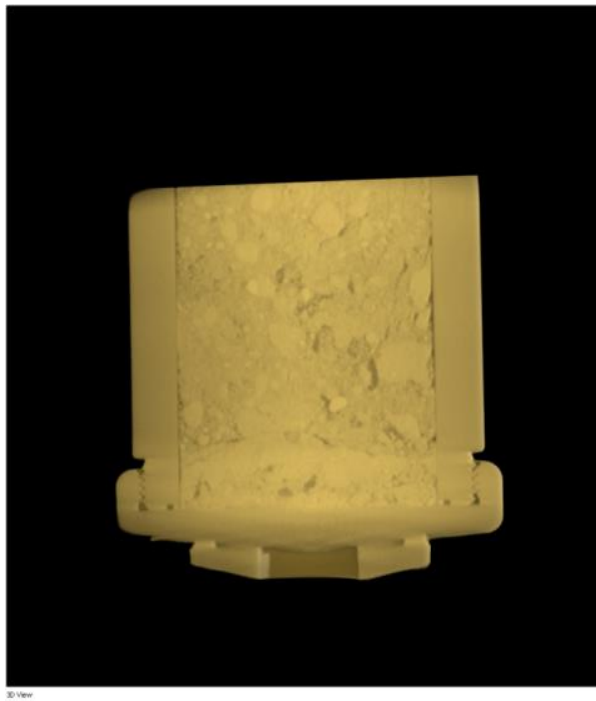
Ear of rye



Computed Tomography – CT

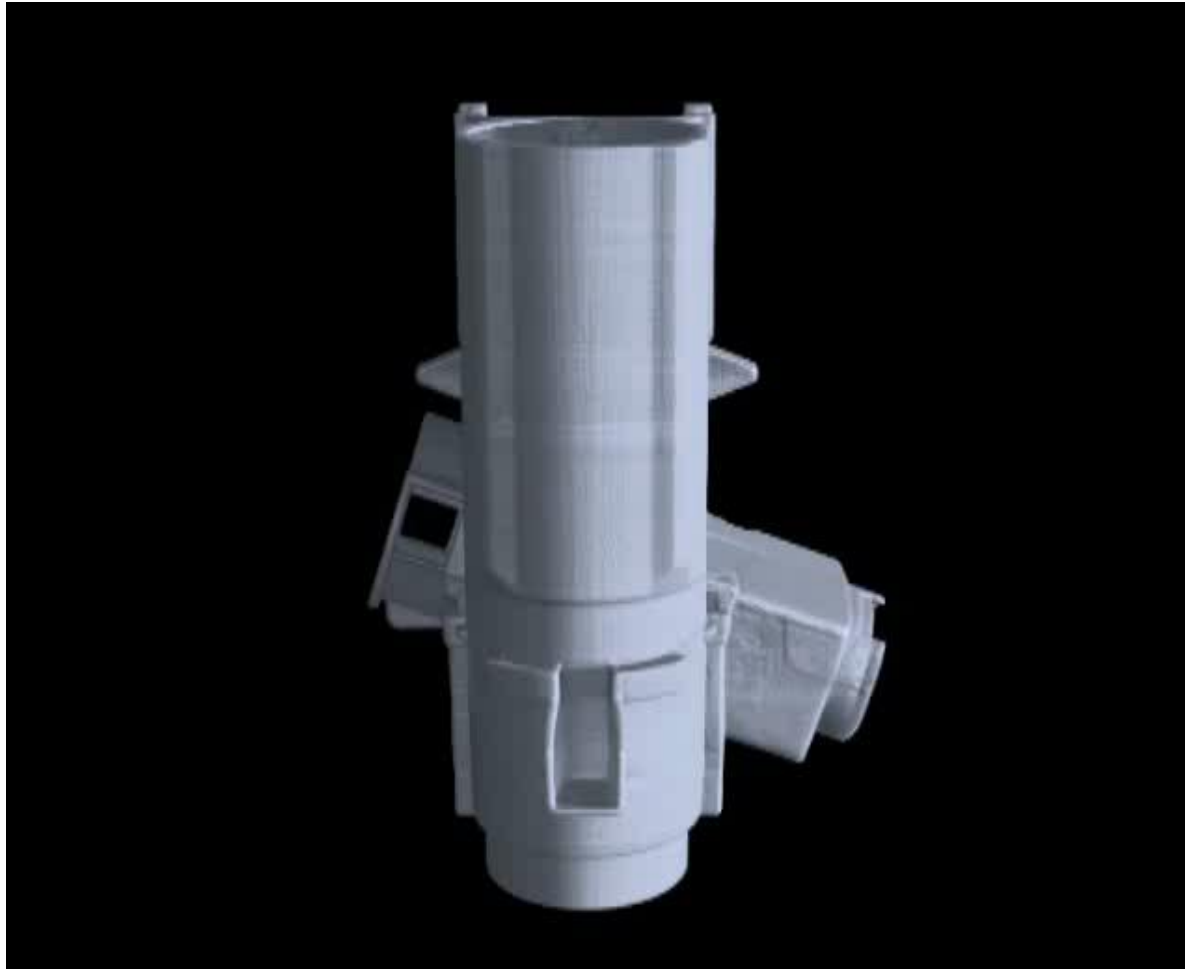
Examples / Results

*Drill core for investigation of soil probes
(density and root distribution)*



Computed Tomography – CT

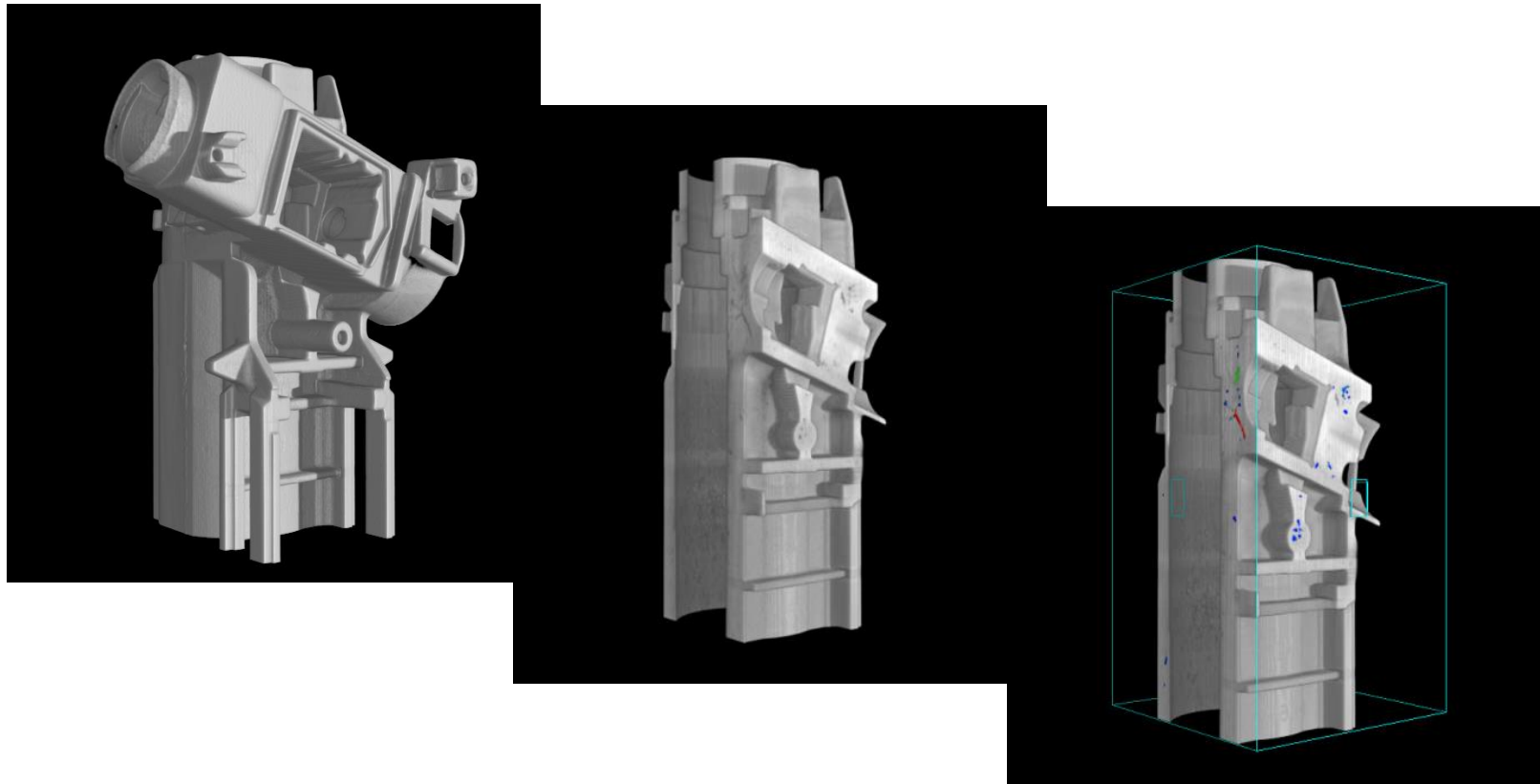
Examples / Results



Computed Tomography – CT

Examples / Results

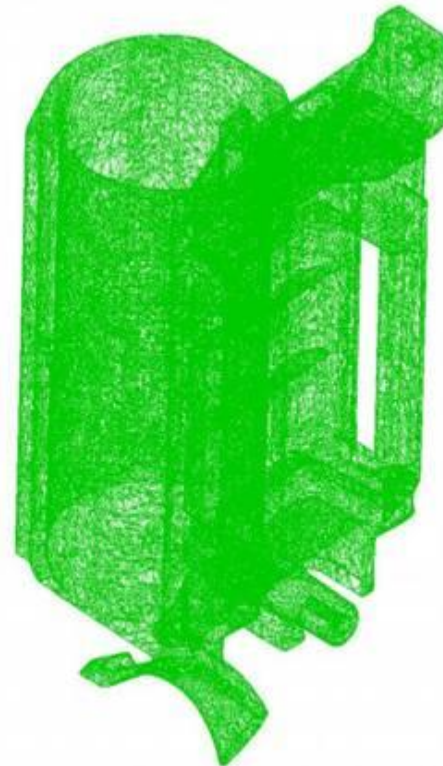
Mg-die-casting automotive part / CT and ADR



Computed Tomography – CT

Examples / Results

FEM Analysis based on CT – Data



Computed Tomography – CT

Examples / Results

Aluminum die-casting automotive part

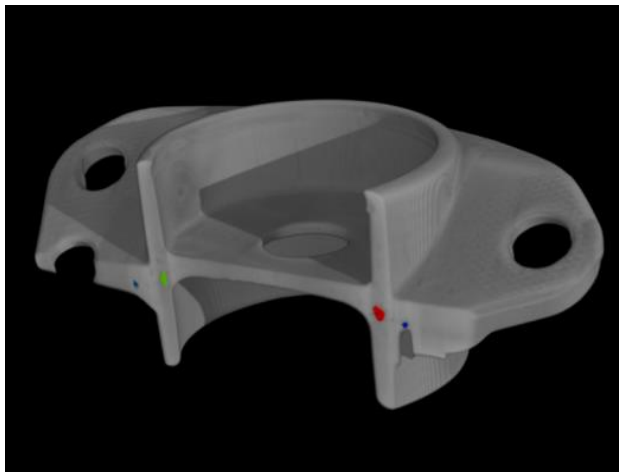
*Original
Photo*



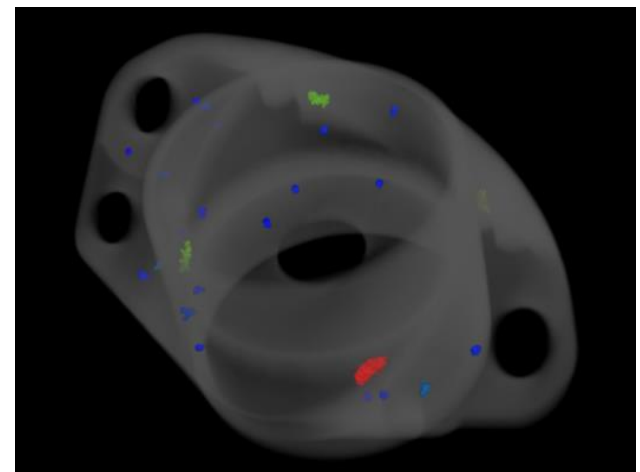
*CT
Reconstr.*



ADR



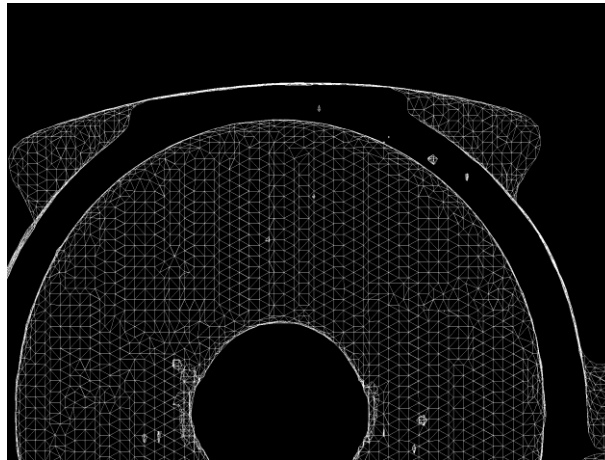
*ADR
transparent*



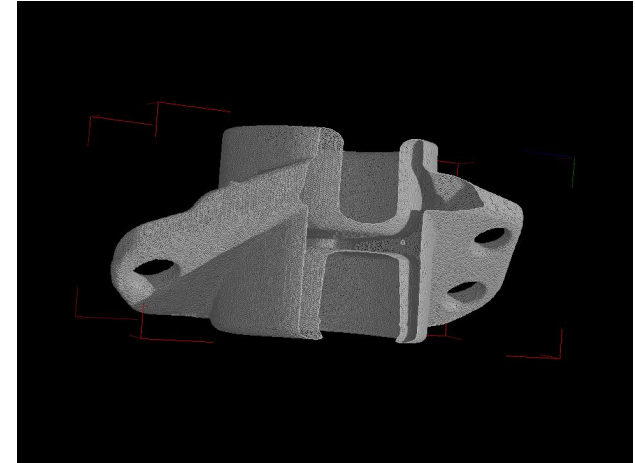
Computed Tomography – CT

Examples / Results

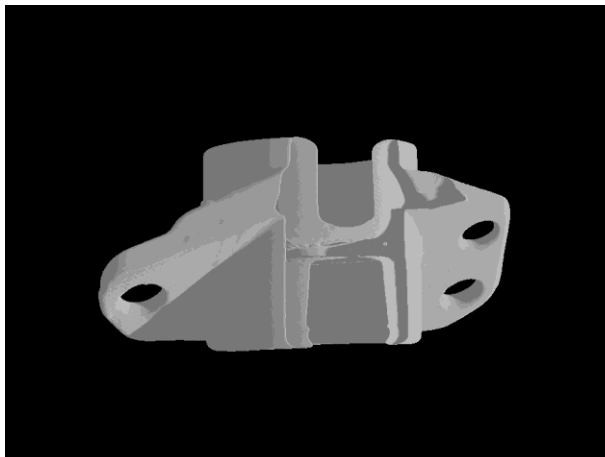
*Generate
wireframe
with
defect
(slice)*



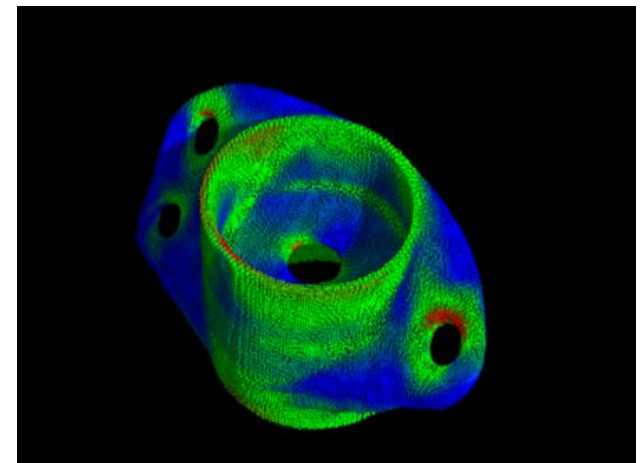
*Generated
wireframe
with
defect*



*Surface
reconstr.
with
defect*

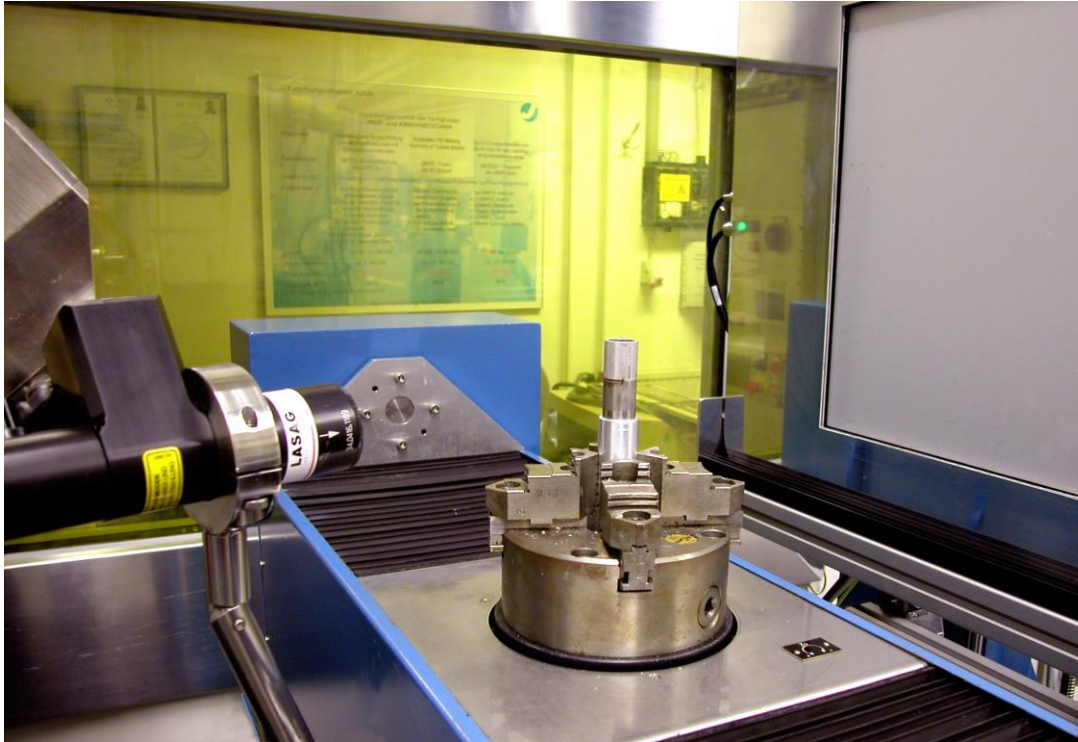


*FEM
Analysis*



On-line process radioscopy

Examples / Results



*Laserwelding of an
Aluminium and Steel tube*

*original measures:
app. 60 mm x 20 mm diam.*

On-line process radioscopy

Examples / Results



*Laserwelding of an
Aluminium and Steel
tube*

*original measures:
app. 60 mm x 20 mm
diam.*



Outlook

The development of Radiographic Techniques continues....

e.g. - Nanofocus-Systems

(focusgeometry < 1 μm)

- Flatpanel-Detektors

*(higher resolution, sensitivity und read-out frequency
higher dimensions of active area)*

*- Processes in on-line process radioscopy
and automated defect recognition*

- Developements in realtime computed tomografie

*Thank you very much for
your interest and attention !*