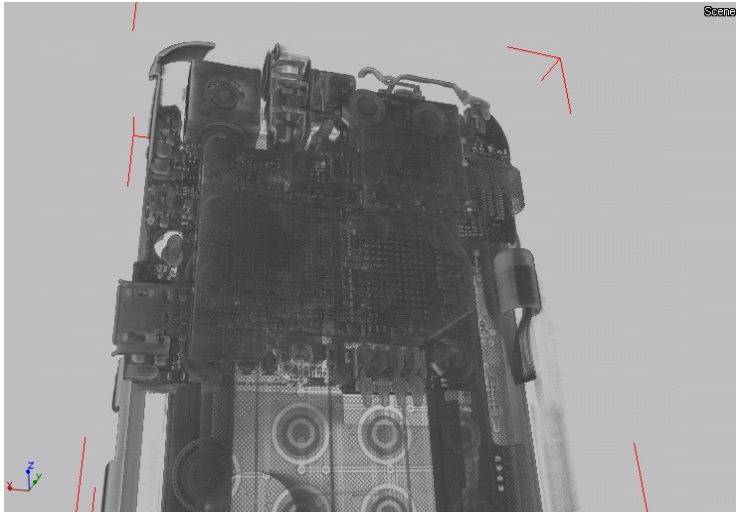
SP / nanotom

Stig Larsen 2013-05-02



SP Technical Research Institute of Sweden

SP Technical Research Institute of Sweden is a leading international research institute. We work closely with our customers to create value, delivering high-quality input in all parts of the innovation chain, and thus playing an important part in assisting the competitiveness of industry and its evolution towards sustainable development.

SP Technical Research Institute of Sweden

ABOUT SP

The SP Group	is wholly owned by RISE
Subsidiaries	6
Employees	1 100
Revenues	Euro 120 million
Customers	> 10 000
Ph.D. and Lic. Eng.	approx. 300
Ph.D. students	approx. 80
Degree projects	approx. 70
Adjunct professors	26

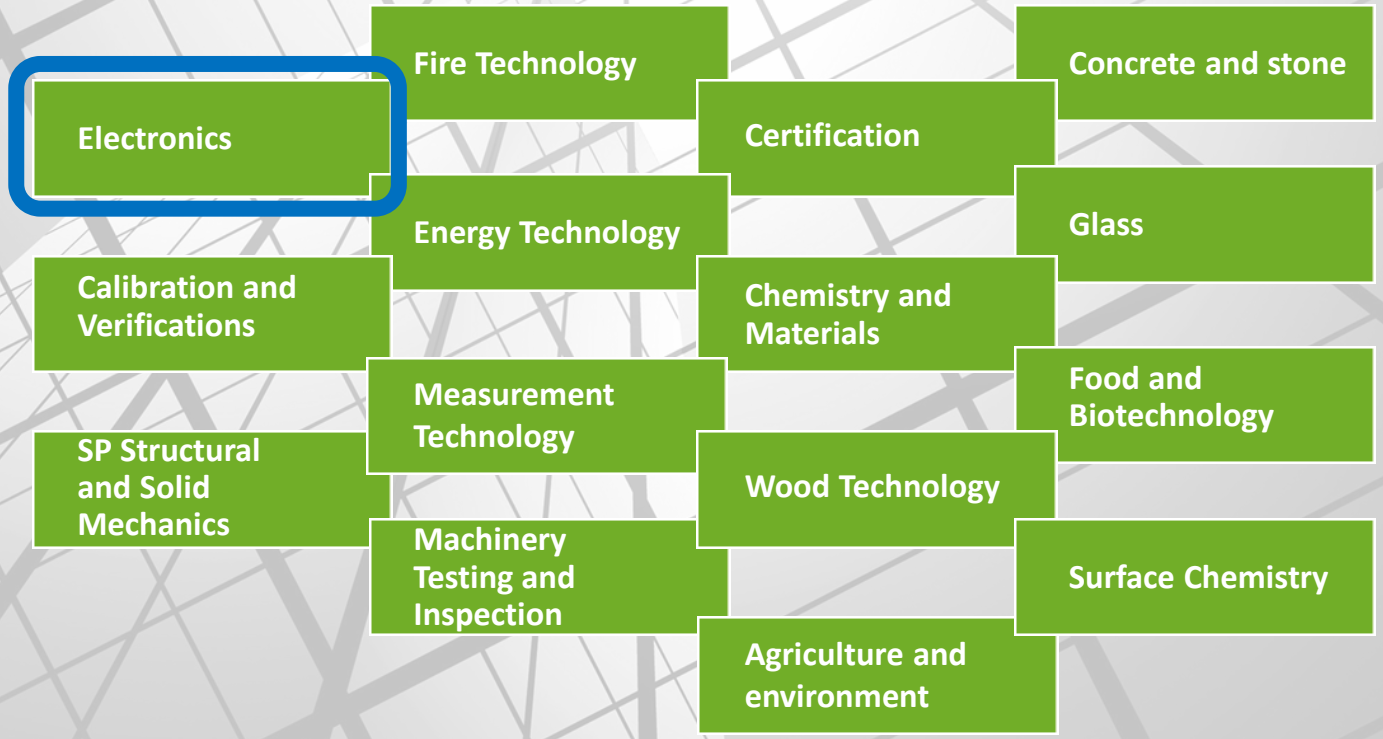
SP Technical Research Institute of Sweden

WE CREATE VALUE IN COLLABORATION

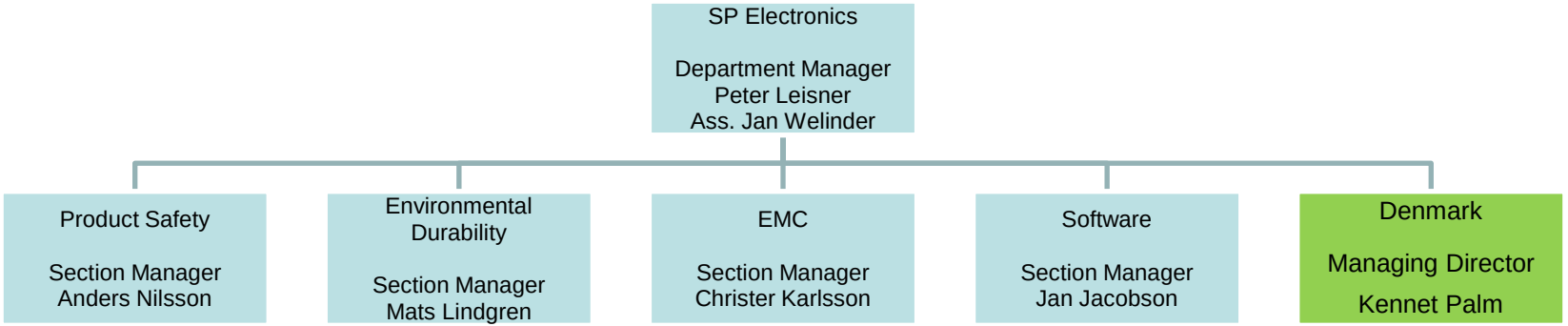
THE INNOVATION PROCESS – WITH YOU EVERY STEP OF THE WAY

- > 10 000 customers
- Leading edge expertise
- Experimental resources
- Technical scope
- Interdisciplinary working method

Technical Areas



SP Denmark – Part of SP Electronics



SP Denmark – some facts:

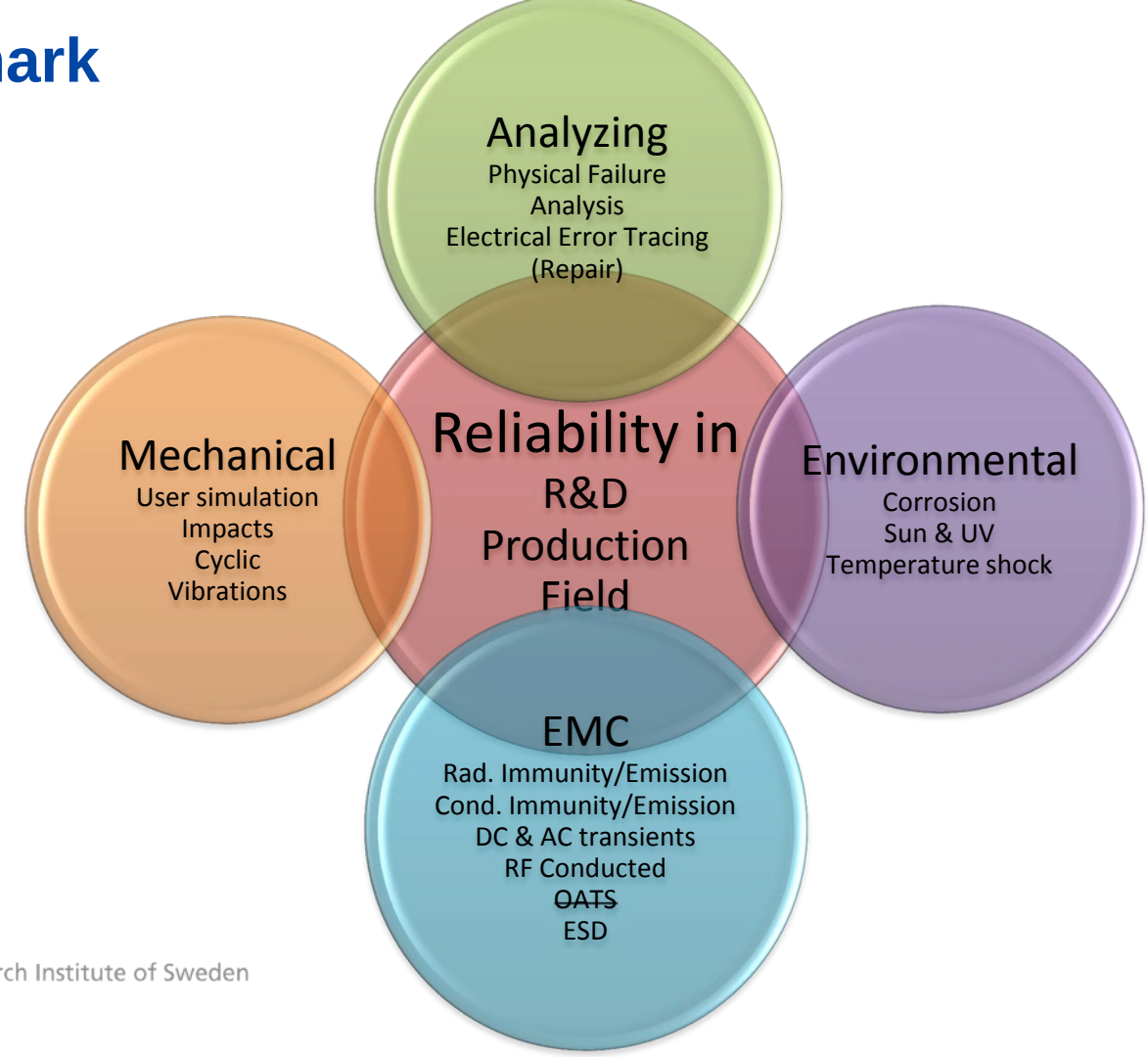
Established February 2012

Located at A. C. Meyers Vænge, Copenhagen SV,
together with Aalborg University Copenhagen

We are 8 employees and 600 pieces of equipment on 800 m²

SP Denmark

2013

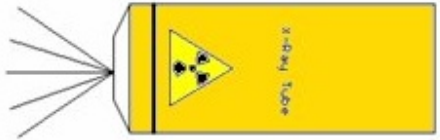


SP Technical Research Institute of Sweden

Nanotom in SP Denmark

Phoenix Nanotom from 2008

X-ray source: 180 kV, 15 W
”high-power nanofocus tube”



Detector: Hamamatsu
2300 * 2300pixels, 12bit, 50 x 50 µm pixels
Virtual detector mode: up to ~ 6600 * 2300pixels

Reconstruction:
10 server PCs,
16 GB RAM each

Analysis &
Visualization:
2xQuadcore,
128GB RAM

Volume file size created from full resolution of detector: 20 GB ($2300^2 * 2300 * 2 / 1024^3$)
When 3-fold detector size is used, volume file size is up to: ~200 GB

Conclusion: The computer is not able to handle the largest volume that can be produced from one scan in the nanotom

The full potential of the nanotom has not been unleashed…

Rekonstruktion

- I SP Danmark har vi phoenix datos-x version 1.5, og det kører på den samme hardware som vi har haft siden 2008
- Ved opgradering af computer hardware vil der forskellige veje at gå:
  - fortsat anvendelse af version datos-x version 1.5 og Windows XP til rekonstruktion
  - rekonstruktion med VG StudioMax rekonstruktionsmodul på ny hardware og Windows 7
  - eventuelt indkøb af ny software til rekonstruktion

Software – analyse af 3D data

Forslag til opgavefordeling for at udnytte nanotom'en bedst muligt i SP

- Scanning og rekonstruktion udføres af SP Danmark
- Videre behandling af 3D data foretages af afdelingerne der kender emnet

Men så simpelt er det selvfølgelig ikke!

- Optimering af scanning og rekonstruktion kræver et kendskab til opgaven der skal løses
- Behandling af 3D data kræver at man har den rette software, og at man forstår at anvende denne software

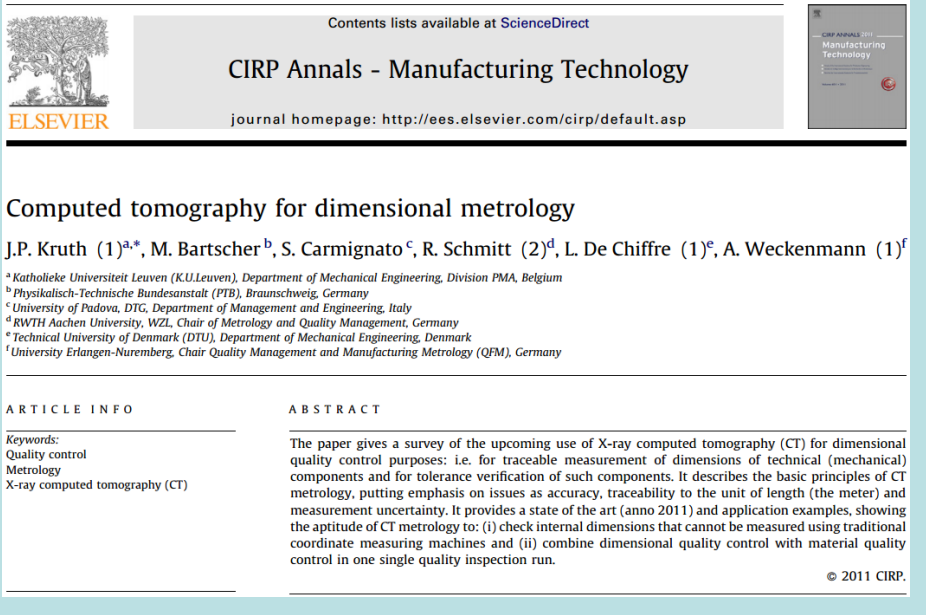
"Jævnlig anvendelse af VG StudioMax igennem 5 år betyder ikke nødvendigvis at man er ekspert"

Udbredelse af kendskab til industrial CT i SP koncernen

- Ingen praktisk erfaring med CT i SP i Sverige
- Men mange gode ideer, og ønsker om at prøve det

Et godt sted at starte kunne være at henvise til denne →

http://www.dtu.dk/upload/subsites/cia-ct/publications/kruth_cirp2011.pdf



Contents lists available at ScienceDirect

CIRP Annals - Manufacturing Technology

journal homepage: http://ees.elsevier.com/cirp/default.asp

Computed tomography for dimensional metrology

J.P. Kruth (1)[a,*], M. Bartscher[b], S. Carmignato[c], R. Schmitt (2)[d], L. De Chiffre (1)[e], A. Weckenmann (1)[f]

[a] Katholieke Universiteit Leuven (K.U.Leuven), Department of Mechanical Engineering, Division PMA, Belgium
[b] Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany
[c] University of Padova, DTG, Department of Management and Engineering, Italy
[d] RWTH Aachen University, WZL, Chair of Metrology and Quality Management, Germany
[e] Technical University of Denmark (DTU), Department of Mechanical Engineering, Denmark
[f] University Erlangen-Nuremberg, Chair Quality Management and Manufacturing Metrology (QFM), Germany

ARTICLE INFO

Keywords:
Quality control
Metrology
X-ray computed tomography (CT)

ABSTRACT

The paper gives a survey of the upcoming use of X-ray computed tomography (CT) for dimensional quality control purposes: i.e. for traceable measurement of dimensions of technical (mechanical) components and for tolerance verification of such components. It describes the basic principles of CT metrology, putting emphasis on issues as accuracy, traceability to the unit of length (the meter) and measurement uncertainty. It provides a state of the art (anno 2011) and application examples, showing the aptitude of CT metrology to: (i) check internal dimensions that cannot be measured using traditional coordinate measuring machines and (ii) combine dimensional quality control with material quality control in one single quality inspection run.

Hvor kommer ideerne fra?

…utallige videnskabelige artikler om industrial CT.

X-ray micro-tomography an attractive characterisation technique in materials science

L. Salvo [a,*], P. Cloetens [b], E. Maire [c], S. Zabler [b], J.J. Blandin [a], J.Y. Buffière [c], W. Ludwig [b], E. Boller [b], D. Bellet [a], C. Josserond [a]

[a] INPG Grenoble, GPM2, ENSPG, FR 2145, BP 46 38402 St. Martin d'hères Cédex, France
[b] ESRF, BP 220 38043 Grenoble Cédex, France
[c] GEMPPM, INSA-Lyon, 69621 Villerbanne Cédex, France

Abstract
X-ray tomography is a non-destructive technique which provides 3D information of materials. It is consequently very attractive in Materials Science since the relation between macroscopic properties and the micro-structure of a material is very frequently required. The aim of this paper is to present selected results obtained in various investigations of metallic materials such as superplastic deformation, materials in the semi-solid state and metallic foams. Depending on the studied features, several tomography analysis modes were used: conventional absorption mode, phase contrast and holotomography, a new technique, which provides the 3D distribution of the electron density in the bulk of the material. Furthermore micro-tomography enables one to perform in situ experiments either by using a

A comparative study of high resolution cone beam X-ray tomography and synchrotron tomography applied to Fe- and Al-alloys

Johann Kastner [a,*], Bernhard Harrer [a], Guillermo Requena [b], Oliver Brunke [c]

[a] Upper Austria University of Applied Sciences, Stelzhamerstrasse 23, 4600 Wels, Austria
[b] Vienna University of Technology, Institute of Materials Science and Technology, Karlsplatz 13/E308, 1040 Vienna, Austria
[c] GE Sensing & Inspection Technologies GmbH, Niels-Bohr-Straße 7, 31515 Wunstorf, Germany

Abstract
X-ray computed tomography(XCT) has become a very important method for non-destructive 3D-characterization and evaluation of materials. Due to measurement speed and quality, XCT systems with cone beam geometry and matrix detectors have gained general acceptance. Continuous improvements in the quality and performance of X-ray tubes and XCT devices have led to cone beam CT systems that can now achieve spatial resolutions down to 1 mm and even below. However, the polychromatic nature of the source, limited photon flux and cone beam artefacts mean that there are limits to the quality of the CT-data achievable; these limits are particularly pronounced with materials of higher density like metals. ….

Etude expérimentale du comportement de polymères thermoplastiques renforcés : Polypropylène chargé de fibres de chanvre

F. GEHRING, V. BOUCHART, F. DINZART, P. CHEVRIER

Laboratoire de mécanique Biomécanique Polymère Structures (LaBPS), ENIM, 1 route d'Ars Laquenexy CS 65820 57078 Metz Cedex 3

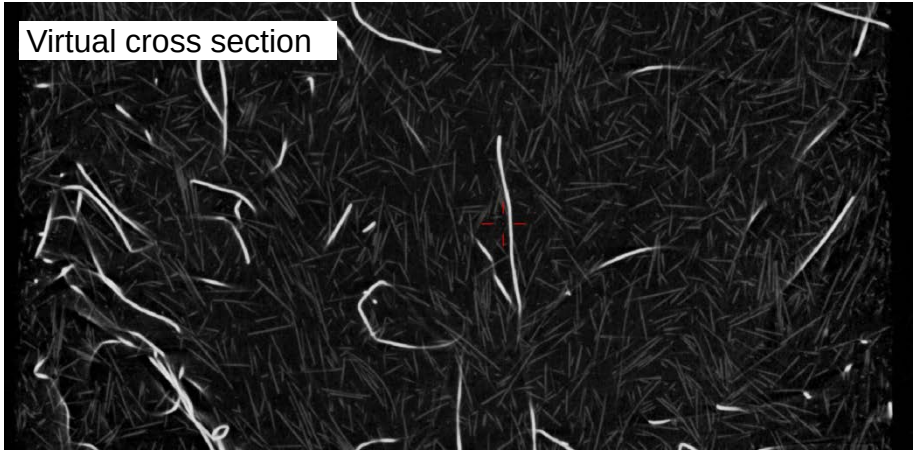
Abstract :

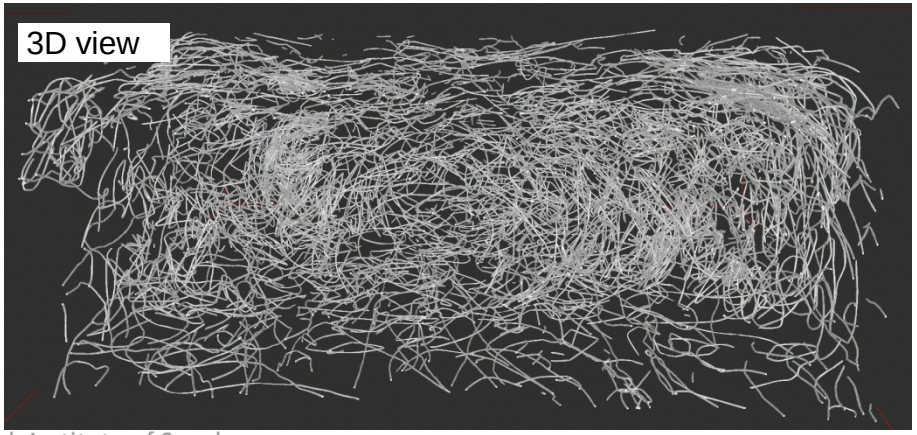
We investigated the thermo-mechanical behavior of short hemp fibers reinforced polypropylene. Tensile tests were conducted at various strain rates (10^{-4} to $10^{-2}s^{-1}$), temperatures (between 0°C and 60°C) and fiber content (5%w/w to 20%w/w). Dynamic thermo-mechanical behavior was investigated via DMA analysis. We observed damage mechanisms with environmental SEM. The mechanical behavior and the damage evolution will be described by a 3D finite element model based on the microstructure obtained by RX tomography.

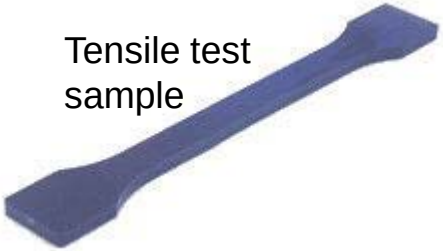
SP Technical Research Institute of Sweden

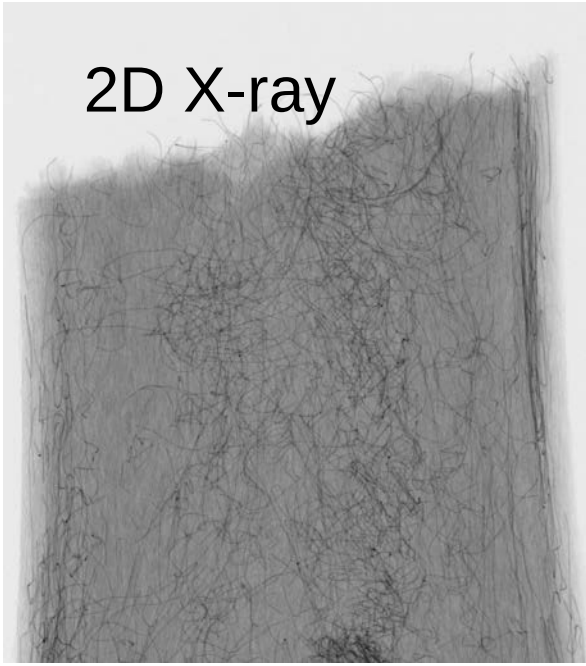
Glas- og stålfiber forstærket plastemne

- Forskellen mellem glasfibre og stålfibre illustreres
- Hver enkelt glasfiber har en ret klar orientering og længde
- Stålfibrene krøller sammen og klumper sammen
- VG StudioMax har et modul til at analysere fibre, men kan man analysere på stålfibre som de ser ud her?









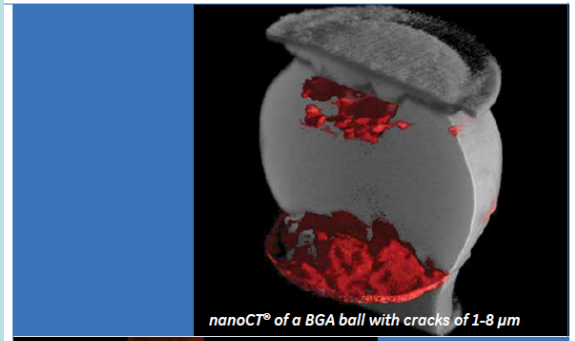
Elektronik

- Det kunne være interessant at se faser i lodning
- GE Inspection Technologies har demonstreret at det er muligt på en nanotom

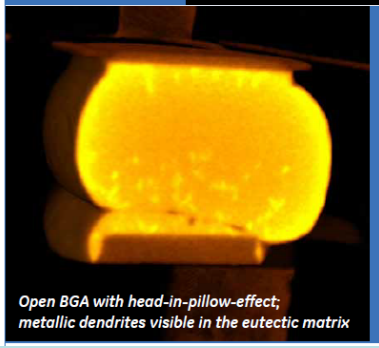
From GE Inspection Technologies brochure
"Solder joint inspection and analysis"

nanoCT®

The combination of phoenix|x-ray's high-power nanofocus X-ray tube and optimized reconstruction software enables unprecedented nanoCT® image resolution and quality. This technology allows the inspection and 3-dimensional visualization of the internal details of smaller specimens with submicrometer voxel resolution.



nanoCT® of a BGA ball with cracks of 1-8 µm



Open BGA with head-in-pillow-effect; metallic dendrites visible in the eutectic matrix

Beton

Eksempel på anvendelse af CT indenfor analyse af skademekanismer for beton:

En sample scannes imellem en række af miljøpåvirkninger, således at man kan følge udviklingen af skader (revner; opløsning af materiale; …)

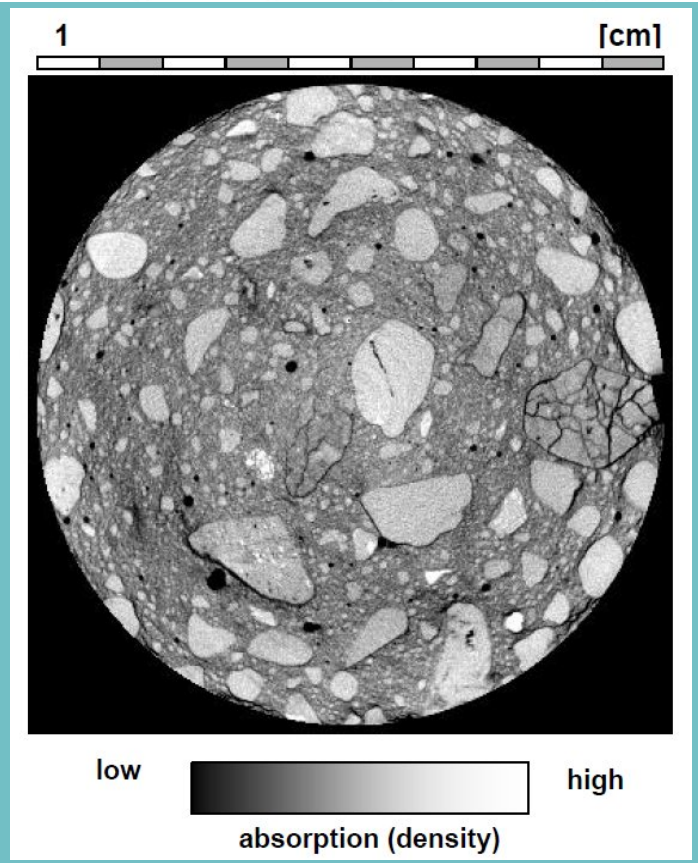
I nanotom'en regner vi med at kunne klare en beton sample på omkring 50 mm i diameter.
Til forsøgene beskrevet i artiklen er anvendt 320 kV og 2 mA.

"Increasing damages at concrete structures and the application of innovative cementitious building materials need worldwide heightened research activities in finding the damage mechanisms due to physical, chemical and mechanical exposure."

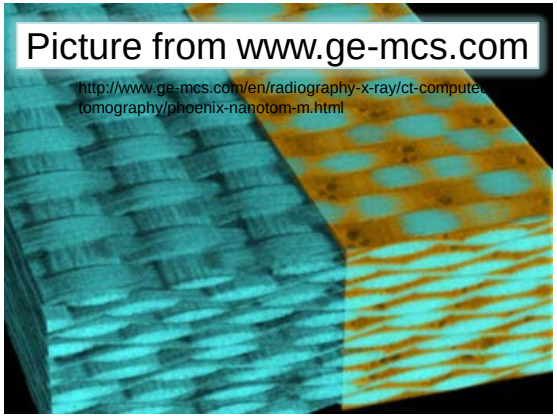
SP Technical Research Institute of Sweden

APPLICATION OF X-RAY TOMOGRAPHY FOR THE VERIFICATION OF DAMAGE MECHANISMS IN CONCRETE

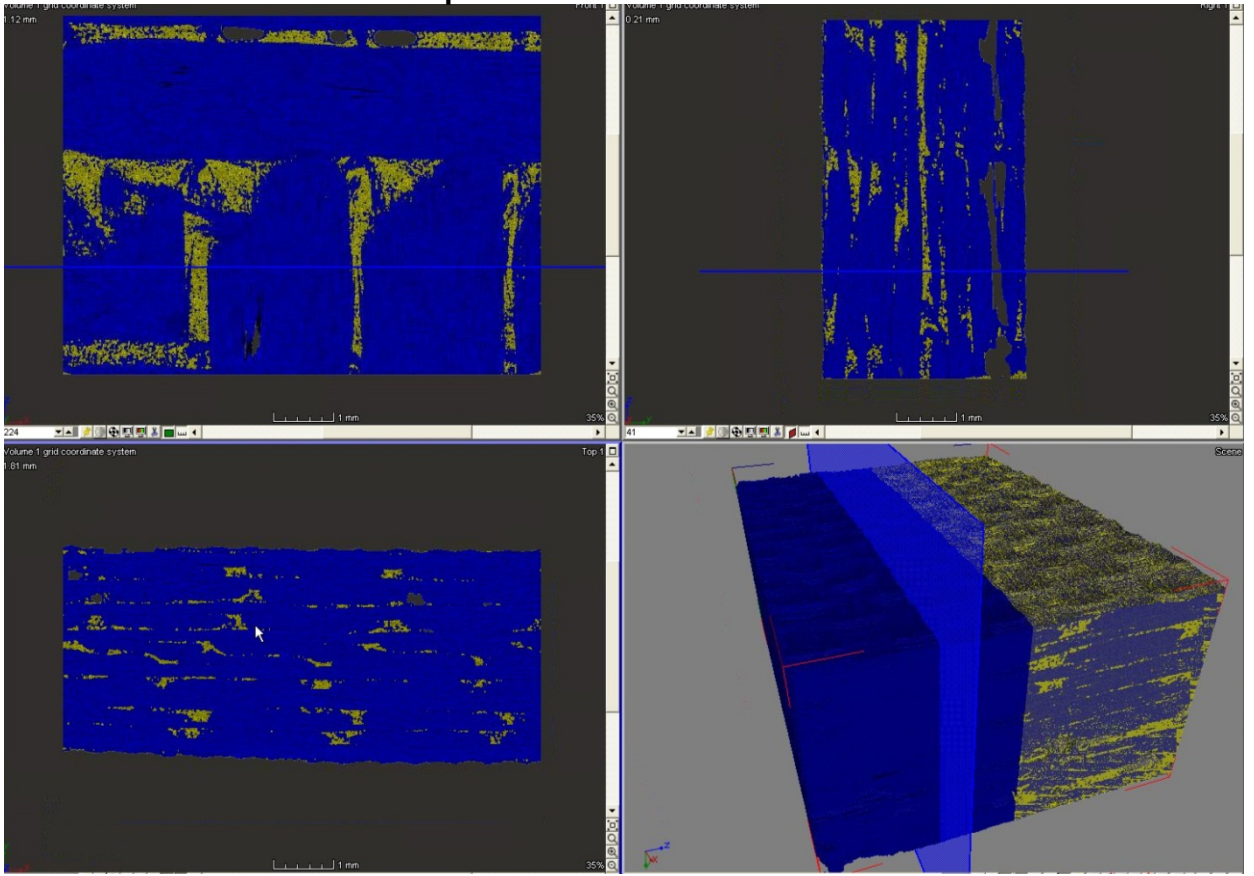
Dr.-Ing. F. Weise & Dr. rer. nat. J. Goebbels & Dipl.-Ing. Bärbel Maier
Federal Institute for Material Research and Testing
12205 Berlin
Germany
Frank.Weise@bam.de & Juergen.Goebbels@bam.de & Baerbel.Maier@bam.de



Fiber composite material



carbon fibre composite scanned on nanotom in SP



Possible application:
Analyze for distribution of resin, amount of voids, warping of fiber mats, etc.

SP Technical Research Institute of Sweden

Ofte stillet spørgsmål: Hvad kan vi se igennem?

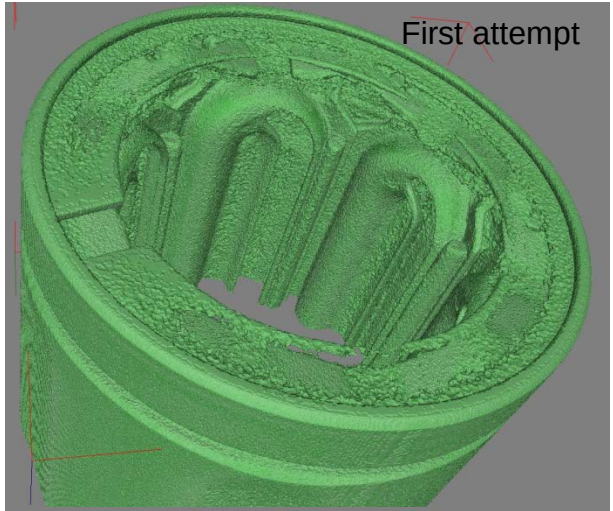
Vi snakker ofte om begrænsningerne for X-ray / CT

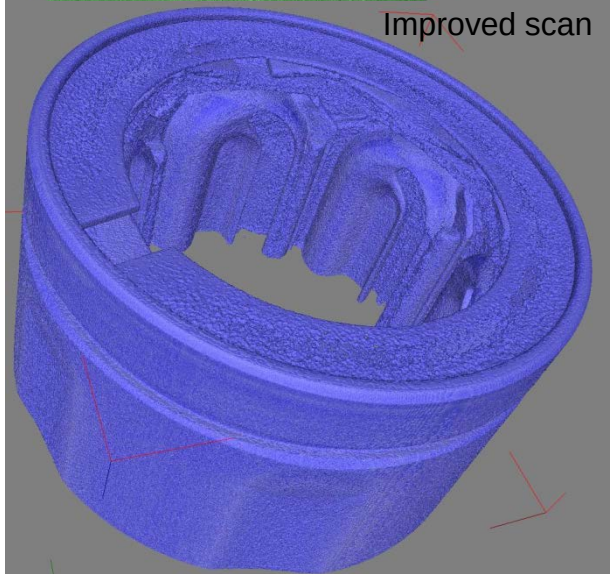
- Størrelsen af emnet kan sætte en grænse for opløsning
- Svært at se lette materialer sammen med tunge materialer
- Emnet må ikke være så stort at vi 'ikke kan skyde igennem det'
- …

Men en mulig kunde vil gerne have et meget mere præcist svar på hvad der kan lade sig gøre!

Vi har f.eks. udført et par eksperimenter for at se hvor meget stål vi kan se igennem. Men vi er stadig nødt til at spørge om hvilke detaljer vi skal kunne se for at scanningen er 'god nok'

Bearing outer diameter: 76 mm

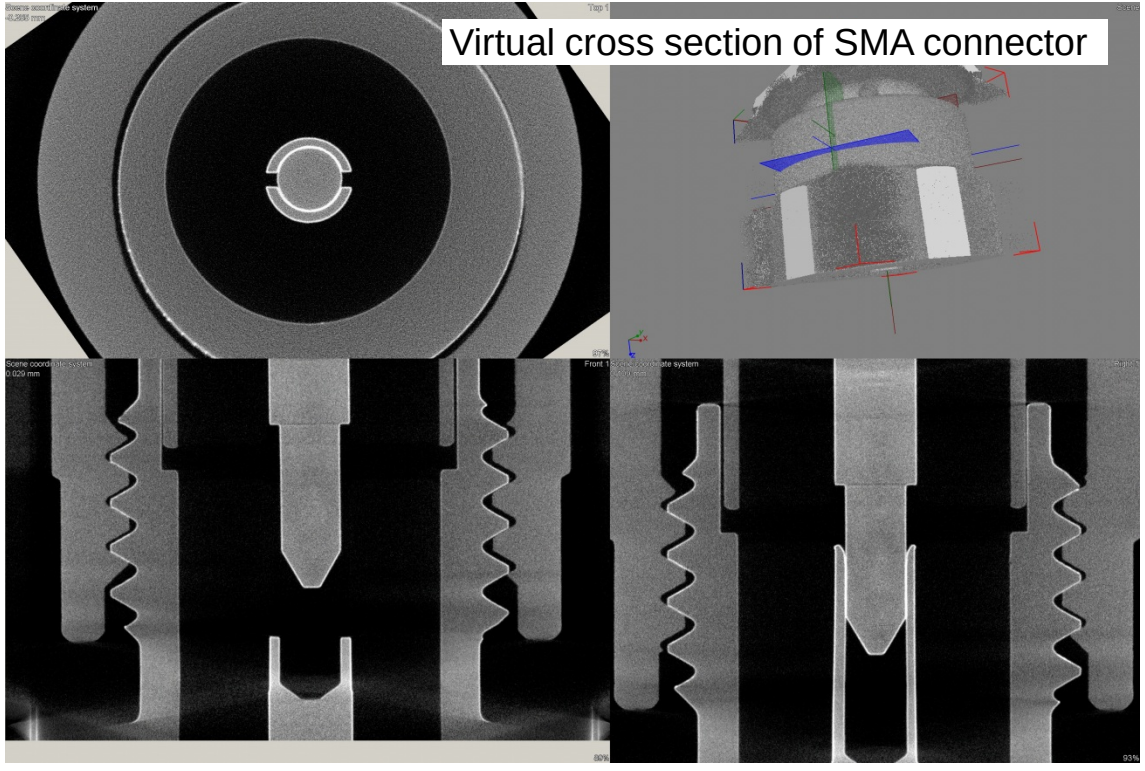




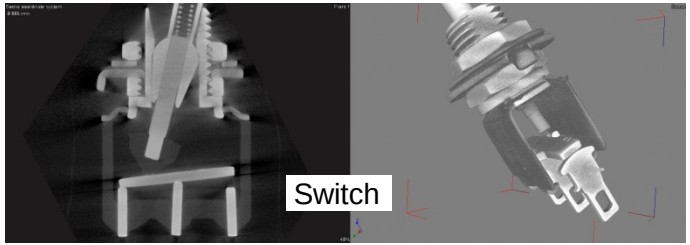
Hvorfor CT? Kan vi løse opgaven med 2D X-ray?

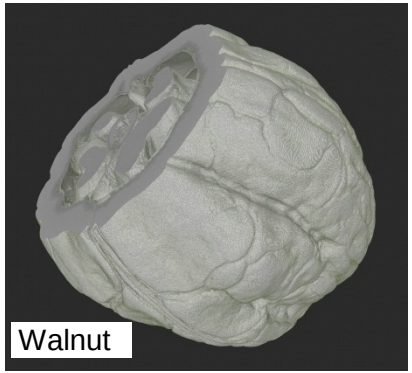
- Hvor perfekt er forbindelserne i en SMA connector centreret, og hvor meget geometrisk afvigelse skal der til før det påvirker signalet der føres igennem?

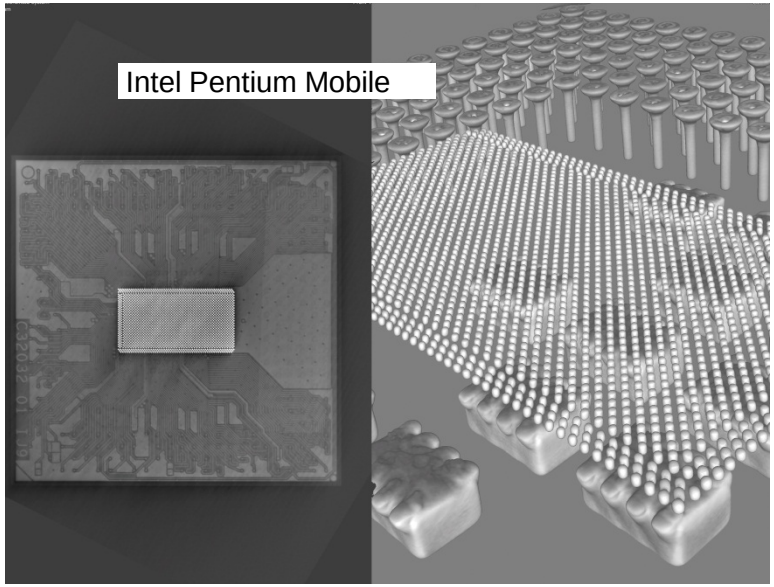
- Med CT scan kan man måske få en overbevisende dokumentation, men et trænet øje kan ofte se rigtigt meget med 2D X-ray udstyr.

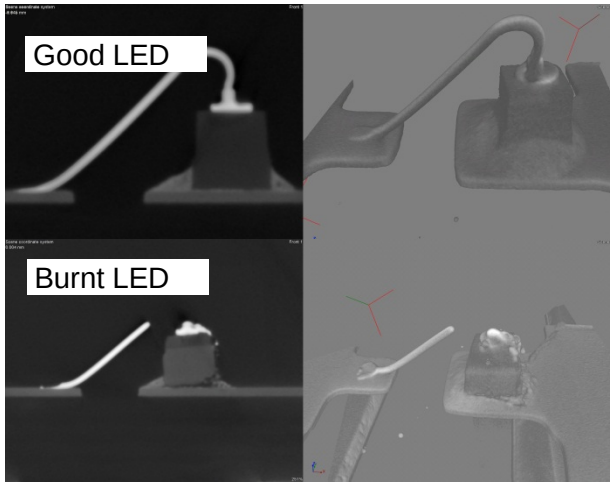


Some examples

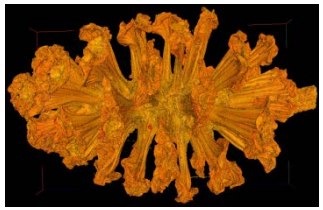

Switch

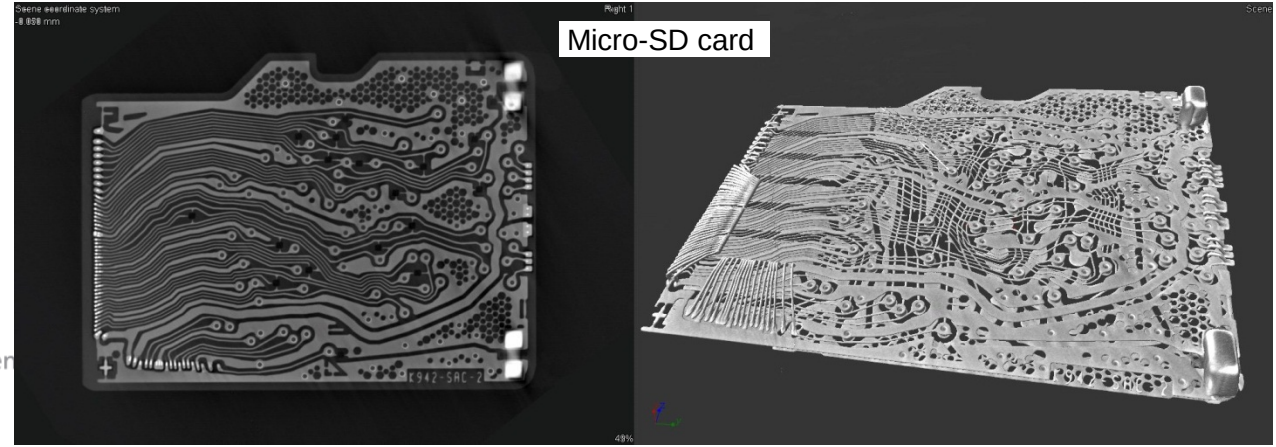

Walnut


Intel Pentium Mobile


Good LED

Burnt LED




Micro-SD card

SP Technical Research Institute of Sweden

WE CREATE VALUE IN COLLABORATION