



# X-ray Nano-Computed Tomography

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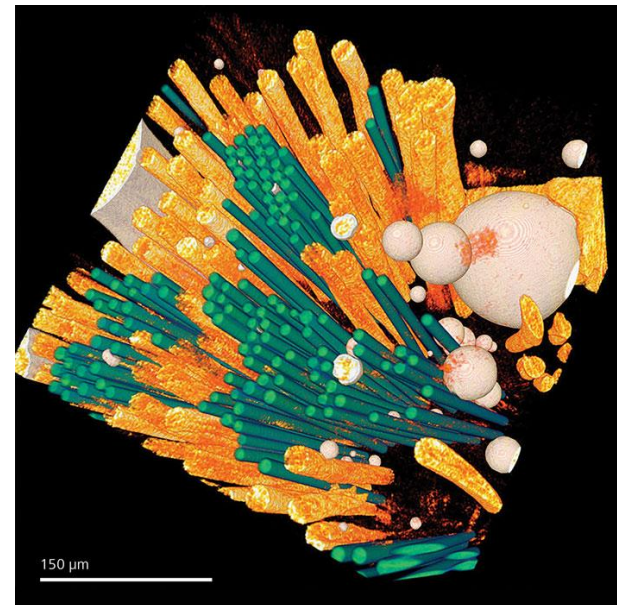
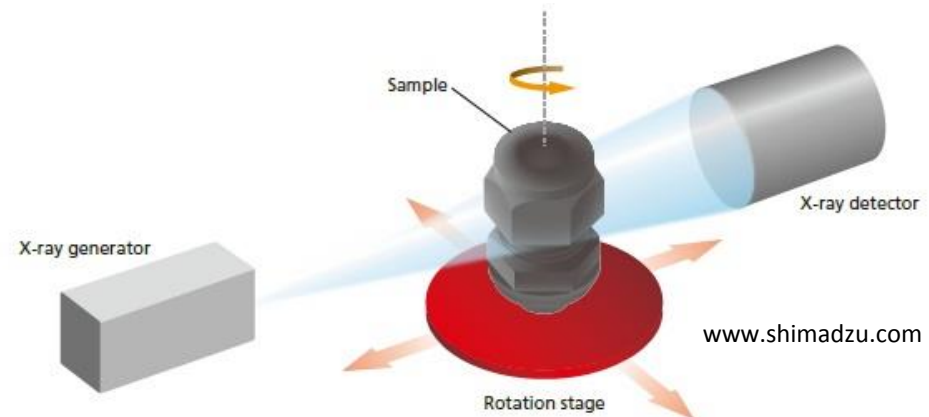
<http://composites.mech.utah.edu>



# What is X-ray computed tomography?

## X-ray CT:

- 3D non-destructive imaging technique based on X-ray attenuation
- Sample placed between source of X-rays and the X-ray detector
- Sample rotated between  $180^\circ$  and  $360^\circ$ , while 2D attenuation images are acquired
- 2D attenuation data is reconstructed (e.g. using filtered back projection) to obtain a 3D tomographic stack of images



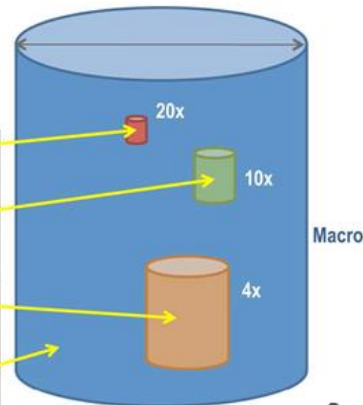
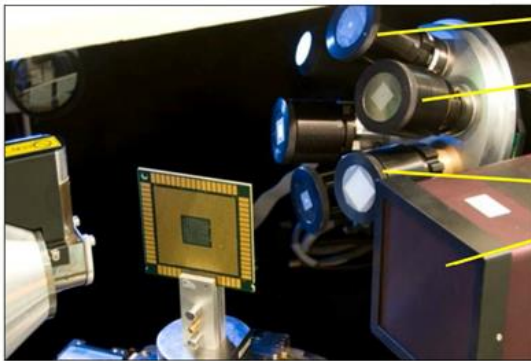
Images provided by Carl Zeiss X-ray Microscopy, Inc.



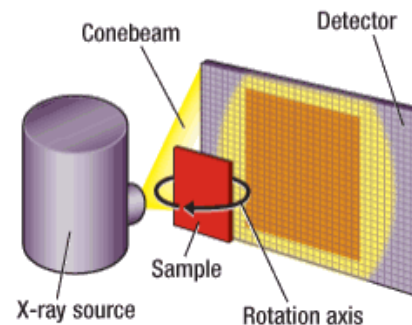
# X-ray CT 3D microscope

## Xradia 520 Versa by Carl Zeiss:

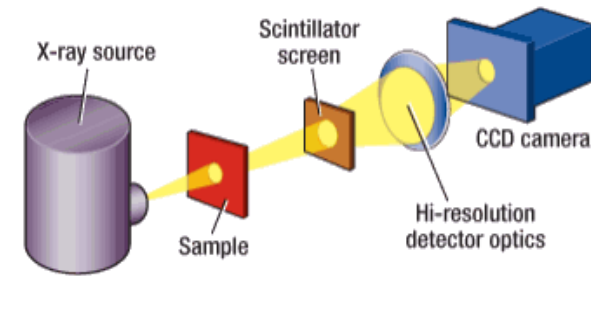
- 450nm – 50 $\mu$ m resolution range
- 1 mm to 10's of cm working distance
- Long scan time (8 – 48h)



Conventional Micro CT design



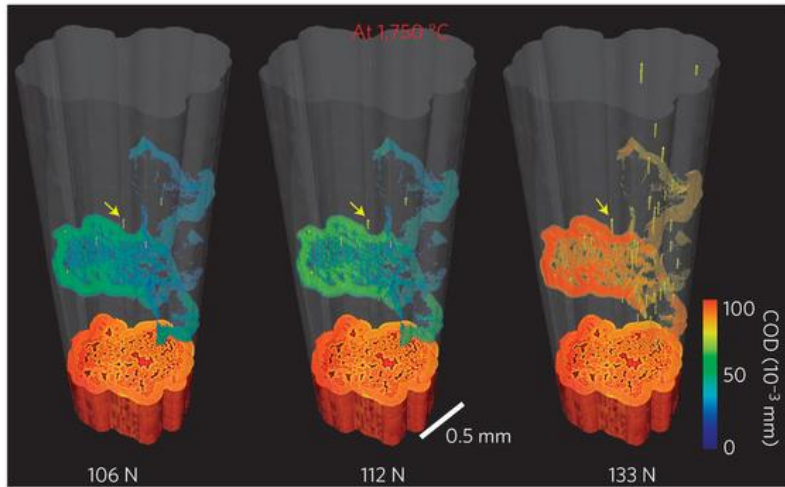
Xradia microscope design





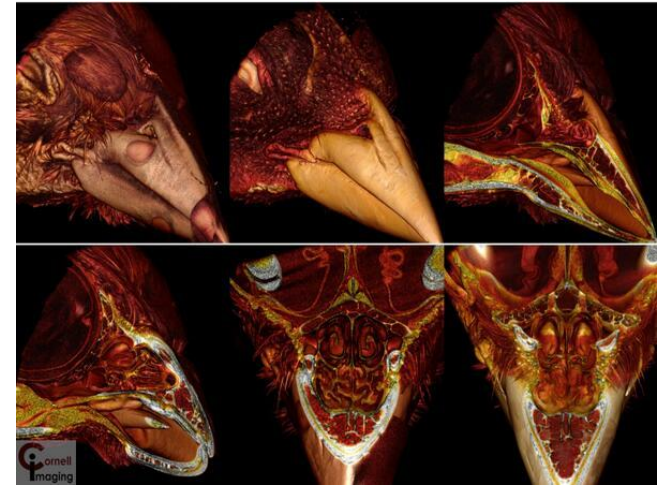
# Application and example data

## Engineered materials - ceramics



Bale et al, Nature Materials, 12, 40-46 (2013)

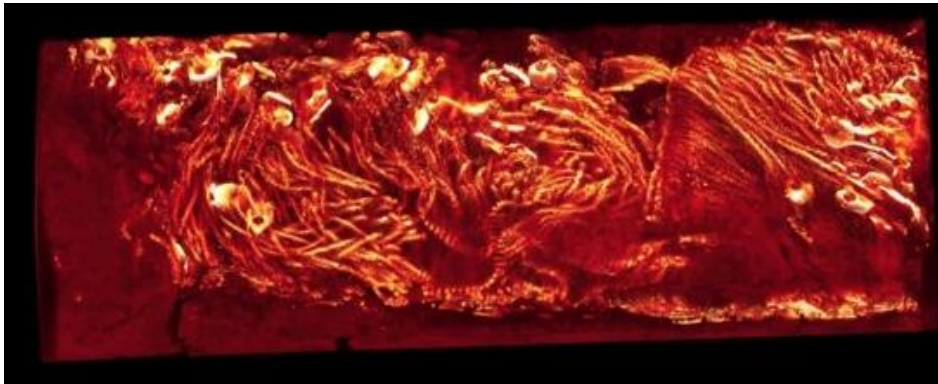
## Biology - Sparrow



Images provided by Cornell Imaging

## Historical artifacts -

## Captain William West's silk and silver sash



Images provided by Cornell Imaging

## Soft tissue - heart

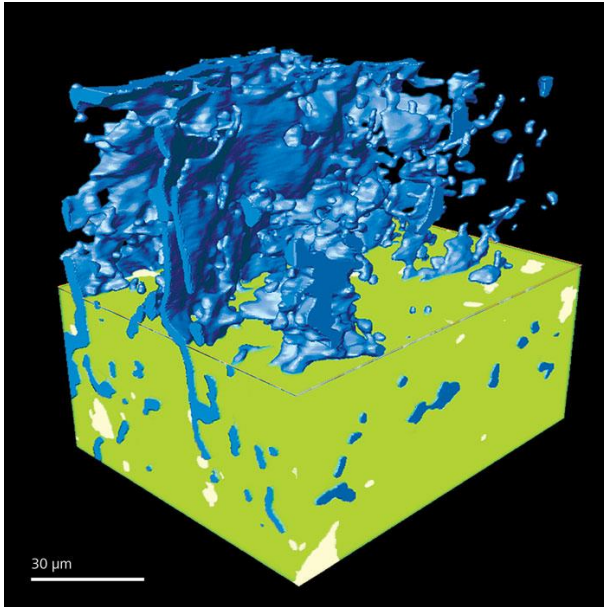


Images provided by Cornell Imaging



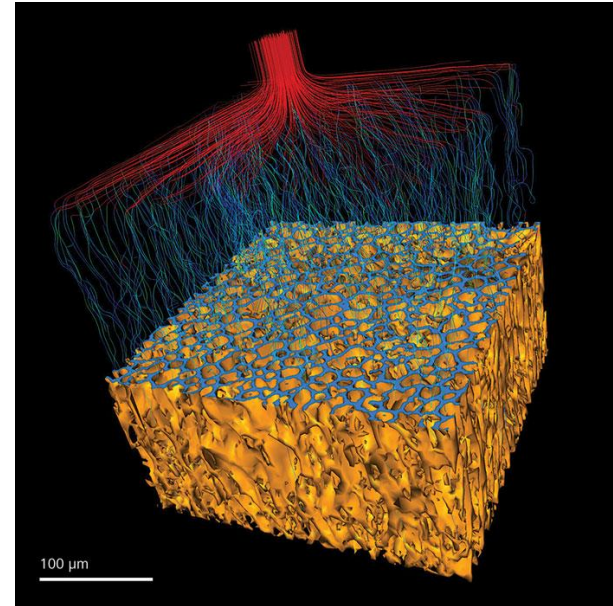
# Application and example data

## Natural materials - shale



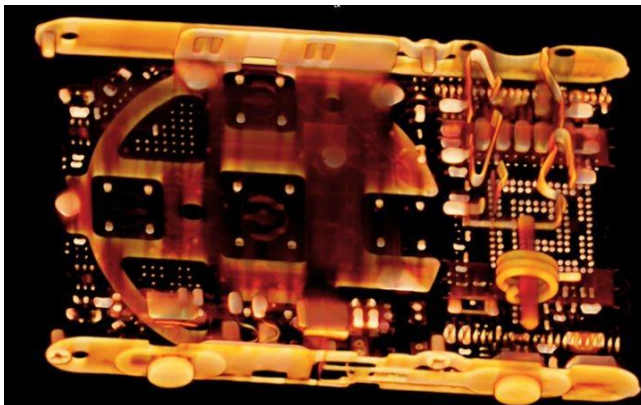
Images provided by Carl Zeiss X-ray Microscopy, Inc.

## Porous polymer (with fluid flow sim.)



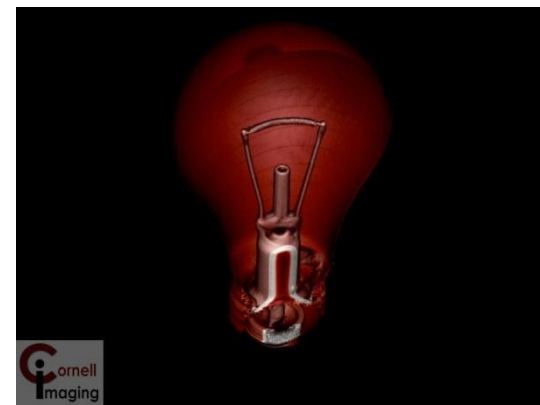
Images provided by Carl Zeiss X-ray Microscopy, Inc.

## Electronics – Ipod Shuffle



Images provided by Cornell Imaging

## Engineered structures - lightbulb

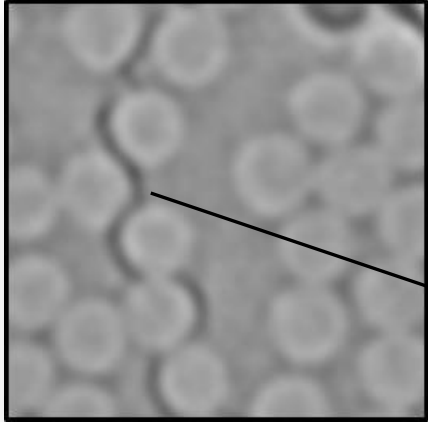


Images provided by Cornell Imaging

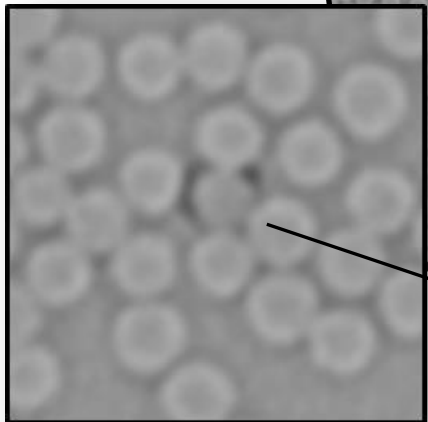
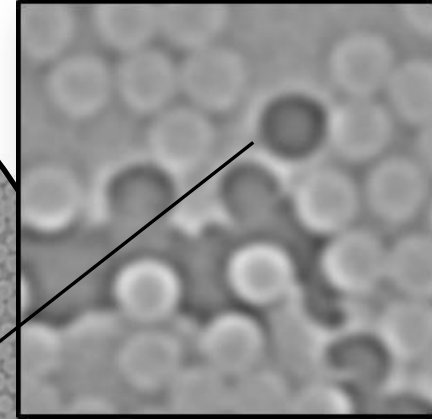


# Application for composites

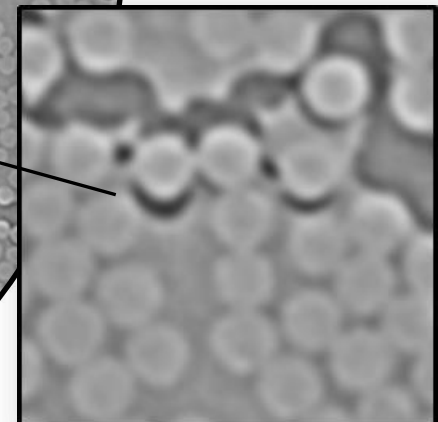
resin fracture



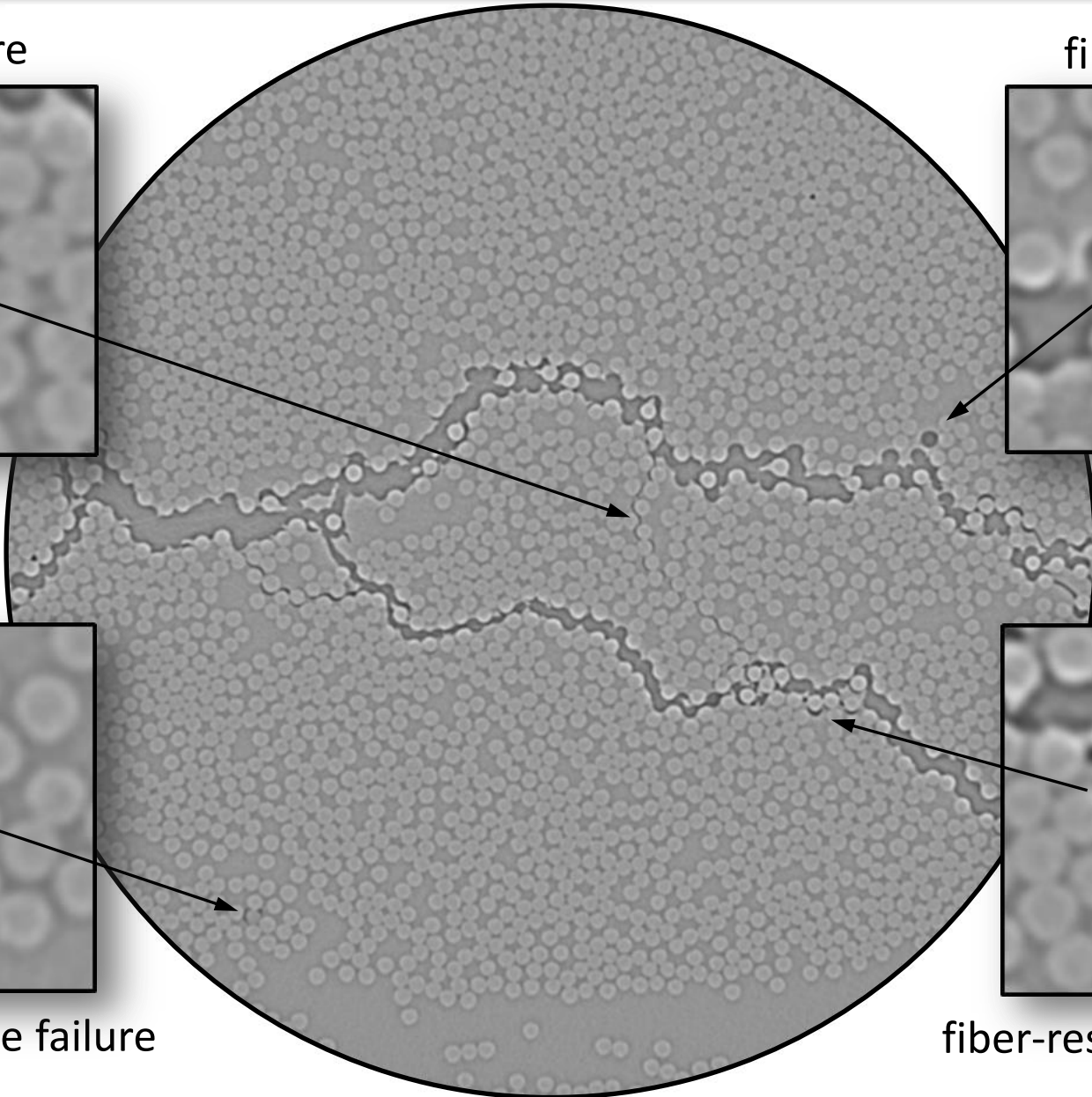
fiber pullout



fiber tensile failure



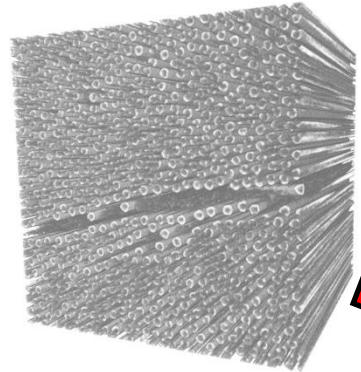
fiber-resin decohesion



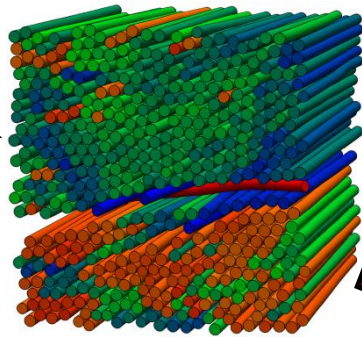


# Application for composites

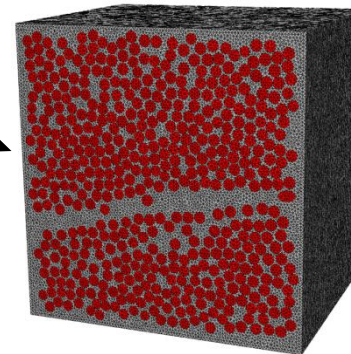
X-ray CT imaging



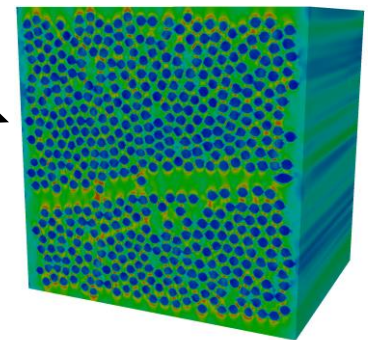
Segmentation  
and statistical  
analysis



FE meshing



FE simulation





# How do we get it and keep it at U of U?

## Potential funding sources:

- NSF Major Research Instrumentation Program (MRI)
- Academia/Industry partnership(s)
- Multi-PI grants from DOD, DOE, DOC focused on accelerating discovery of new materials by leveraging new experimental tools (i.e. hi-res X-ray CT) and supercomputer based simulations

## Business plan:

- Follow the Cornell Imaging Facility model
- U of U user (first scan free, \$100/h), external academic user (\$220/h), commercial user (\$350/h)
- Engage local industry, universities, and government labs/facilities to garner clients
- Publicize!