Synchrotron Radiation Application Roadshow

คลินิกวิจัยสัญจร 2018

25 ก.ค. 2561 มหาวิทยาลัยขอนแก่น

SYNCHROTRON THAILAND CENTRAL LAB

Synchrotron Radiation Microtomography

For Life science reseach

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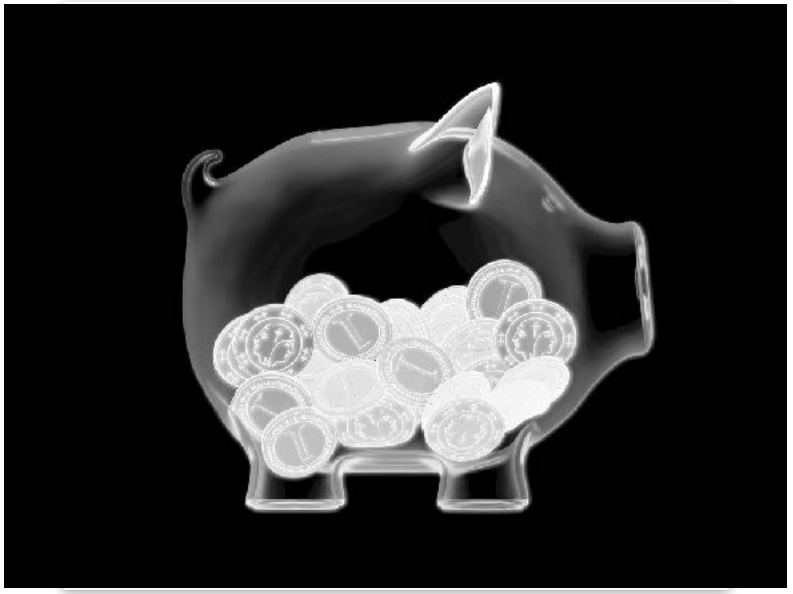
Beamline manager for XTM beamline

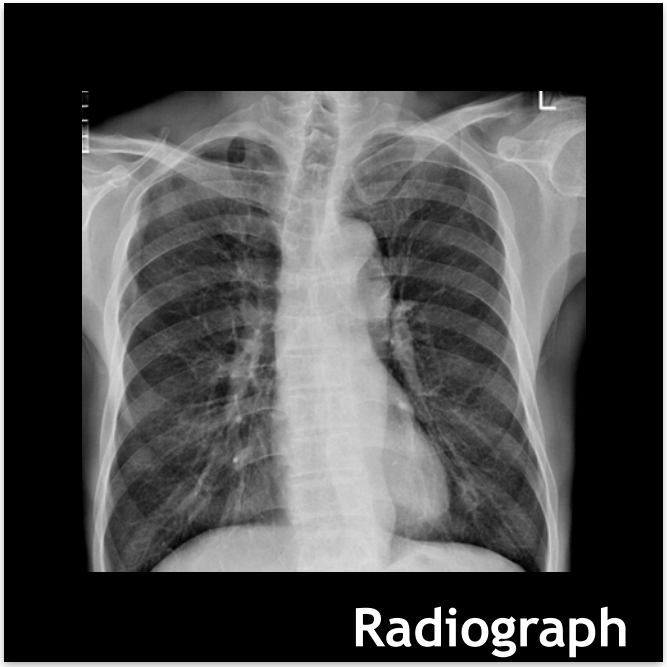
SLRI, Thailand



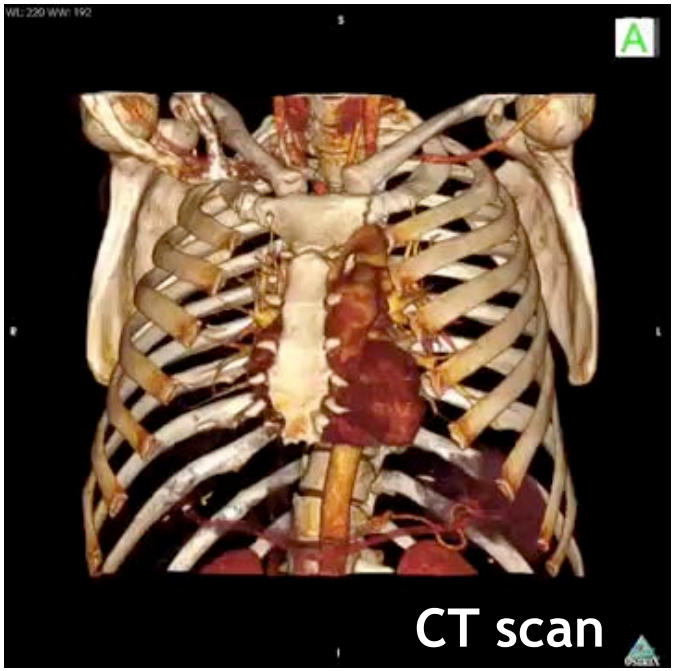
Computed Tomography (CT)

The 3D Visualization of internal matter without cutting open.

X-ray Radiography >>>> 3D CT scan



- Internal structure details
- Non-destructive method
- Only 2D representation



- Internal structure details
- Non-destructive method
- 3D representation
- Segmentation

Differential Absorption

Lambert Beer's law

$$I = I_0 e^{-\mu \rho t}$$

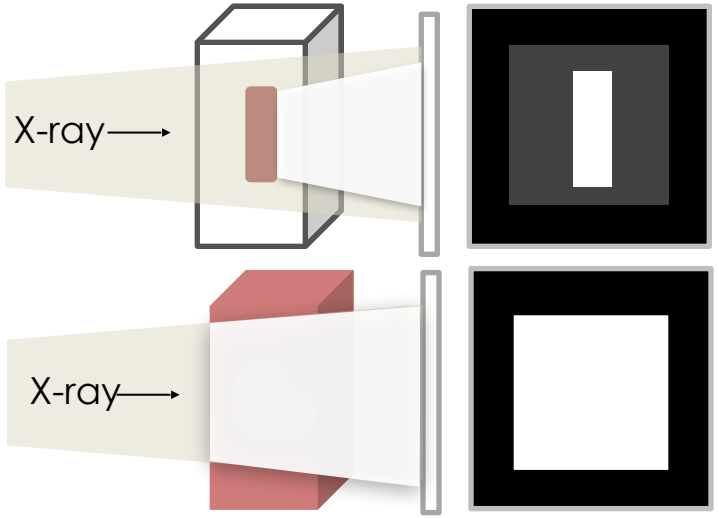
I_0 = initial intensity,

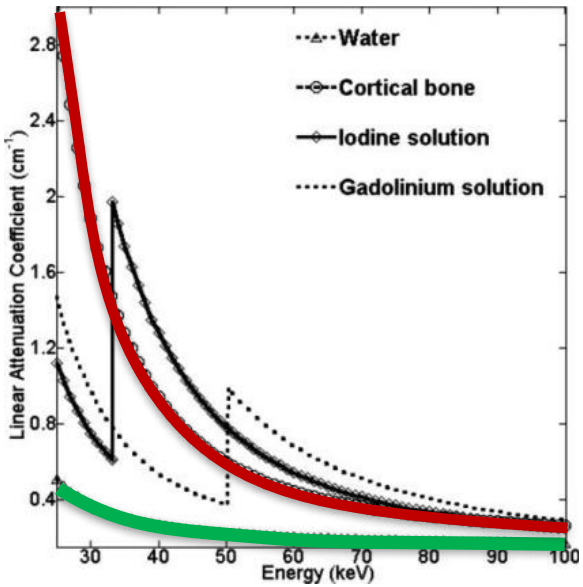
I = final intensity,

μ = mass absorption coefficient (cm^2/g)

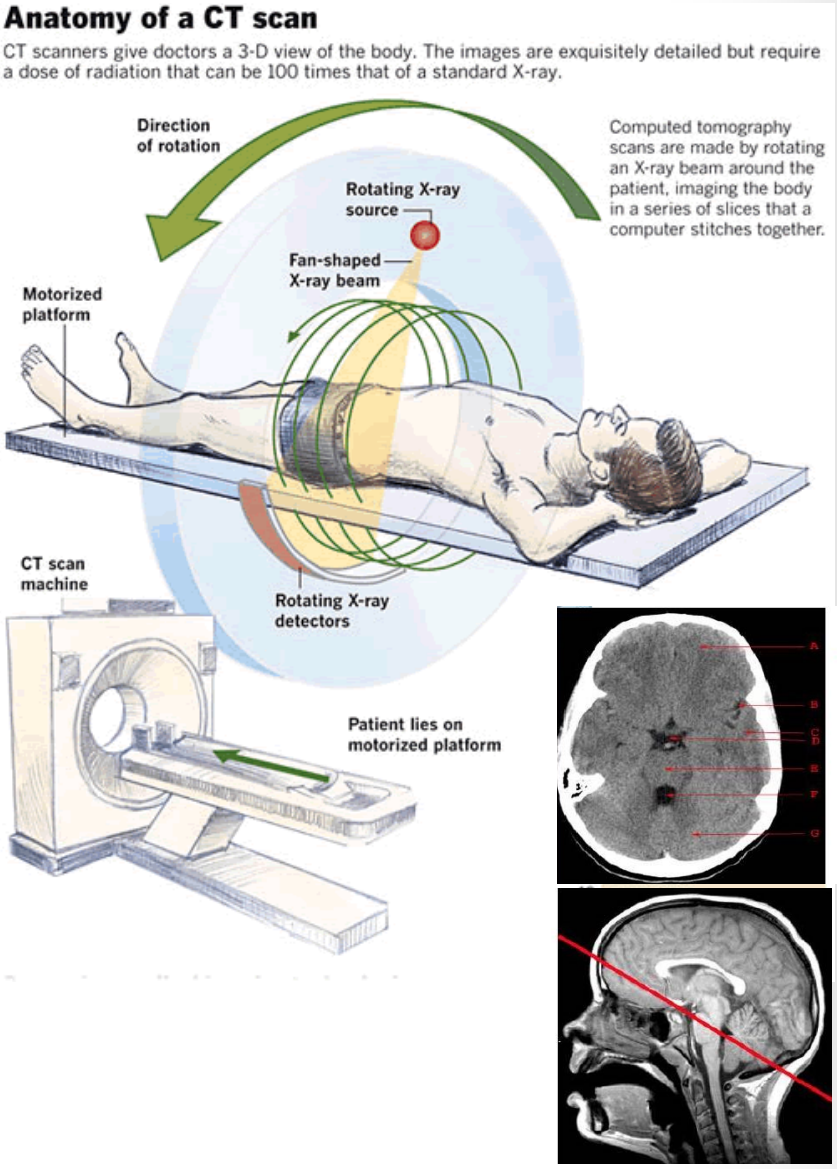
ρ = density (g/cm^3)

t = thickness (cm)

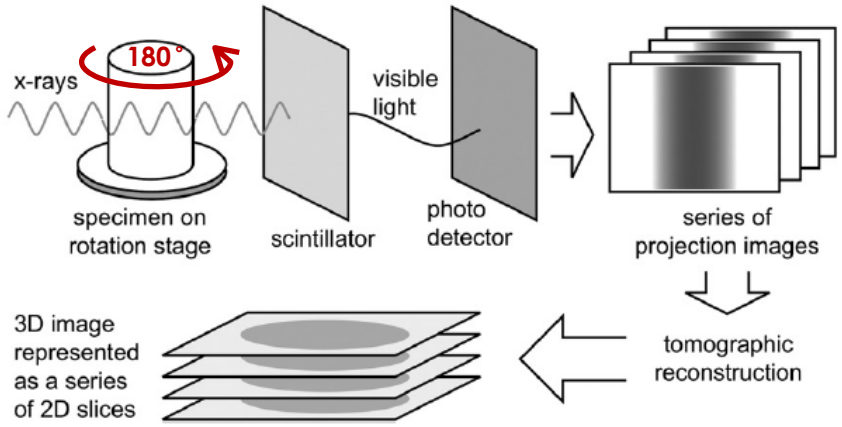


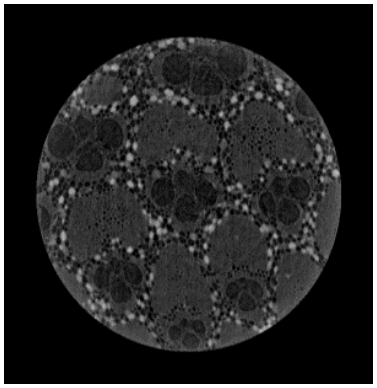


Clinical CT scan "*CAT scan*"

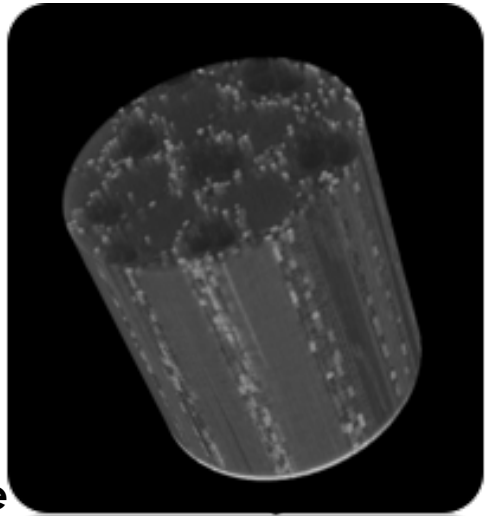


Research CT - "Micro-CT"





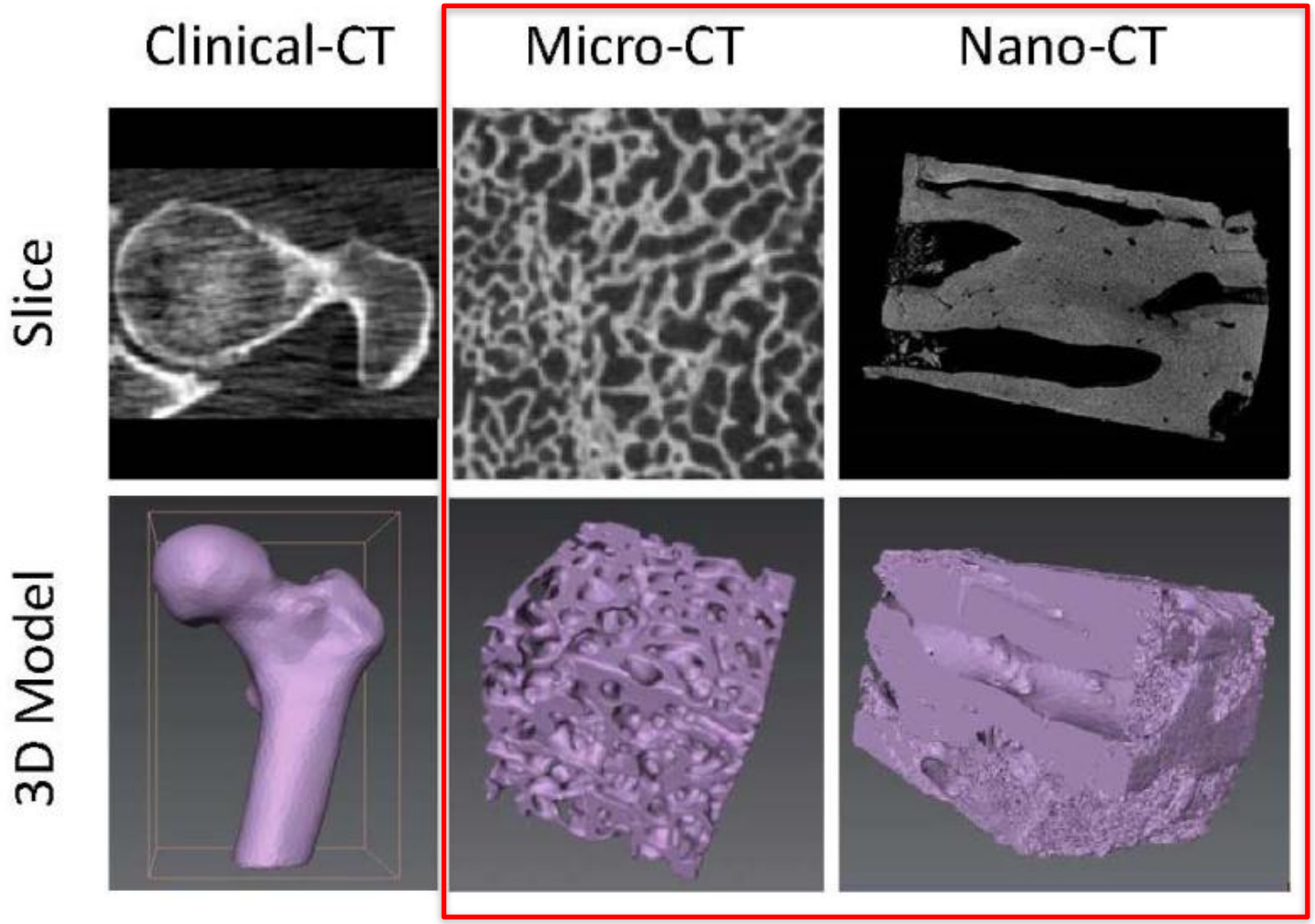
Reconstructed image (CT slice)



Stacking CT slices

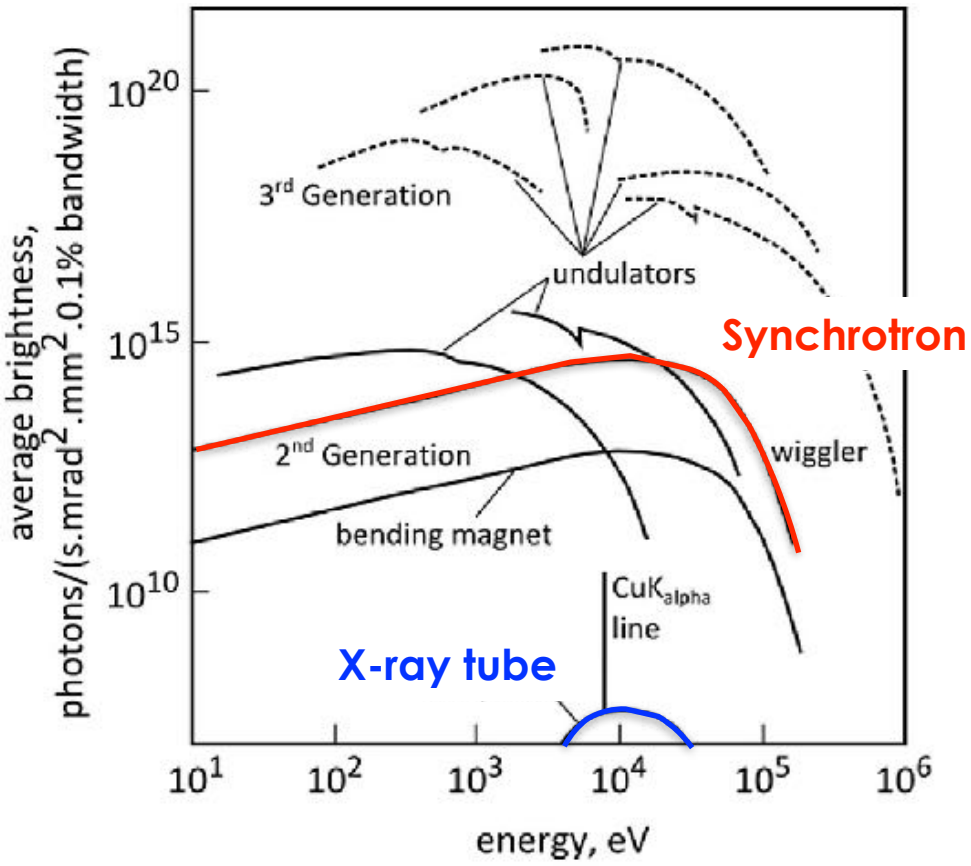
Landis, E.N. and Keane, D.T.(2010) **Materials Characterization** 61 1305 – 1316.

Research CT scan *"Micro-CT scan"*

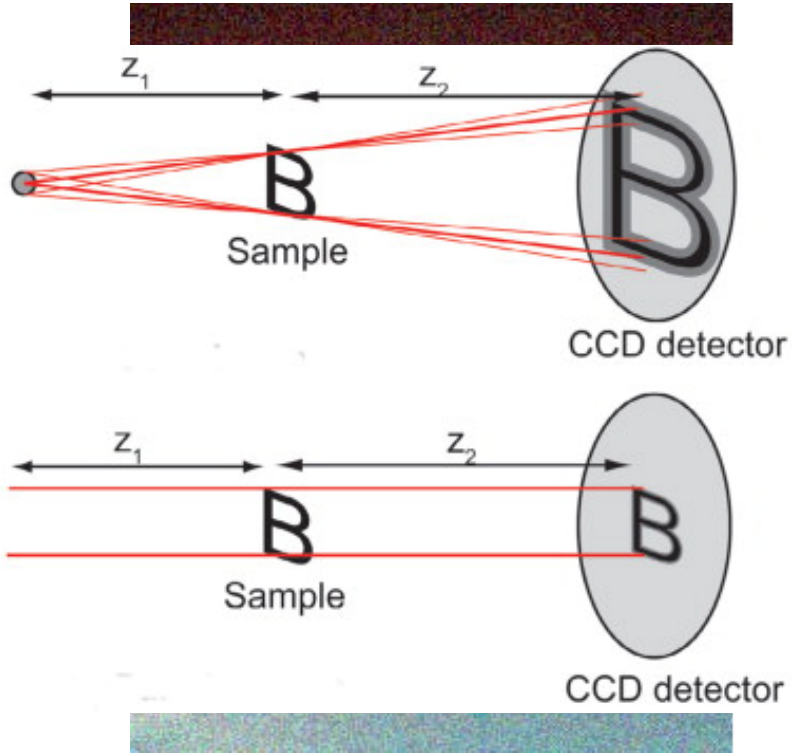


Why do you need synchrotron?

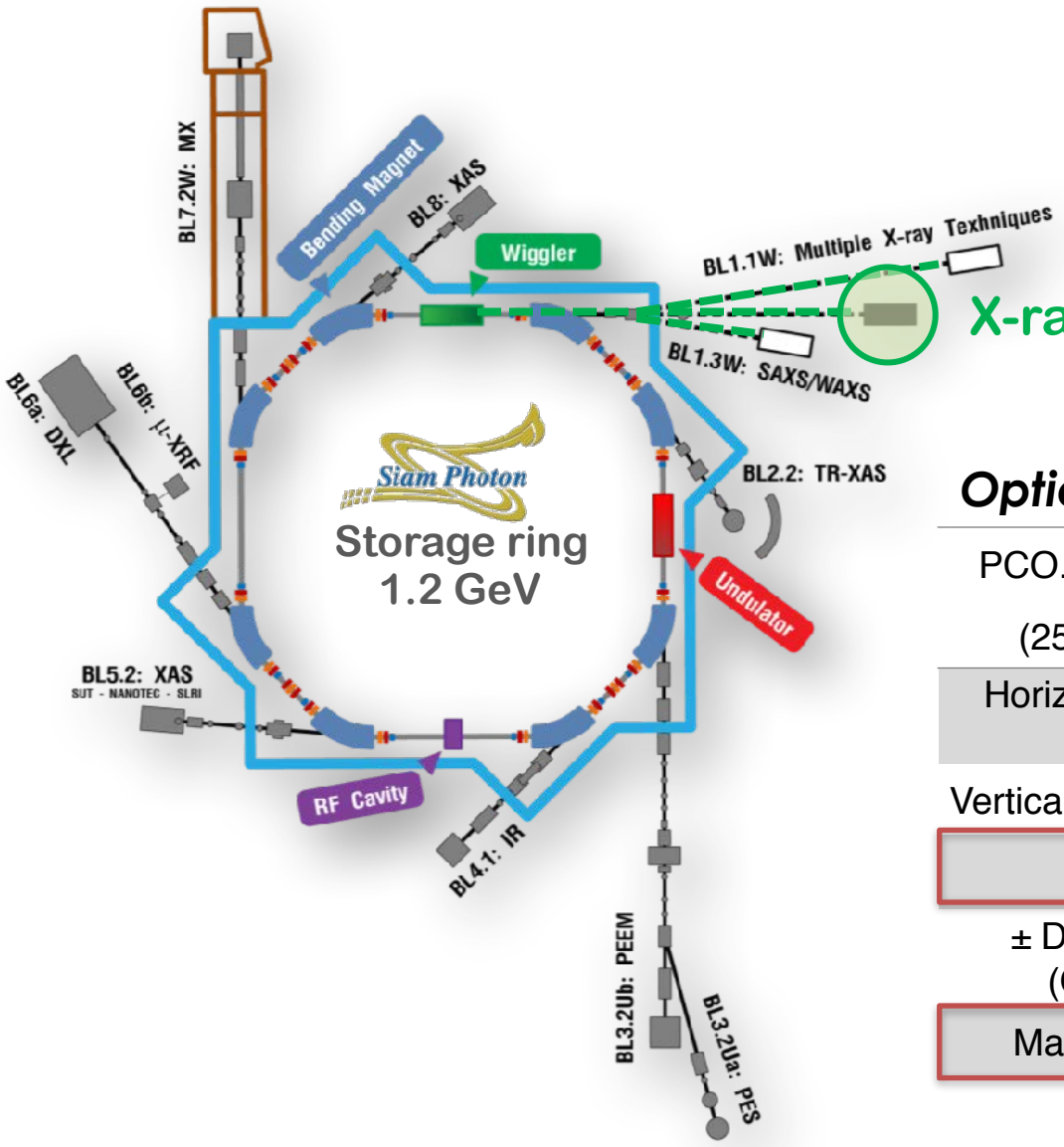
10^6 X Brightness



Parallel beam



Low light noise



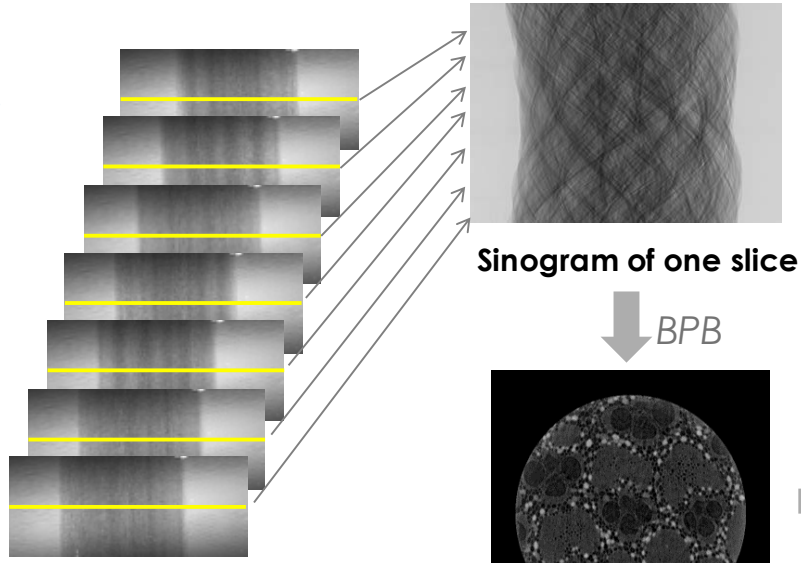
BL1.2W: X-ray Imaging & X-ray Tomographic Microscopy (BL1.2: XTM)

Optical performance:

PCO.Edge (sCMOS chip)	Magnification		
(2560 X 2160 pixels)	x2	x5	x10
Horizontal Objective field (mm)	9.24	2.47	1.85
Vertical Objective field (mm)	7.80	2.08	1.56
Pixel size (μm)	3.61	0.96	0.72
± Depth of focus (μm) (Optic + Camera)	146	8.5	4.8
Max. Resolution (μm)	5	3	1.5

APPLICATIONS of Micro-CT

- 3D visualization
- Phase distribution



Medical science

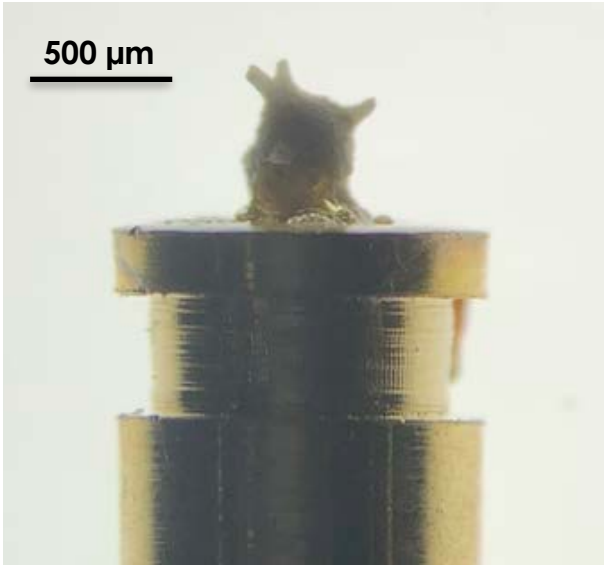
Agricultural science

Earth science

Microstructure of living organisms and microfossils

Bag worm

Beetle



Star sand

Marine fungal fruiting body submerges in decaying wood

Microfossils (<500 um)

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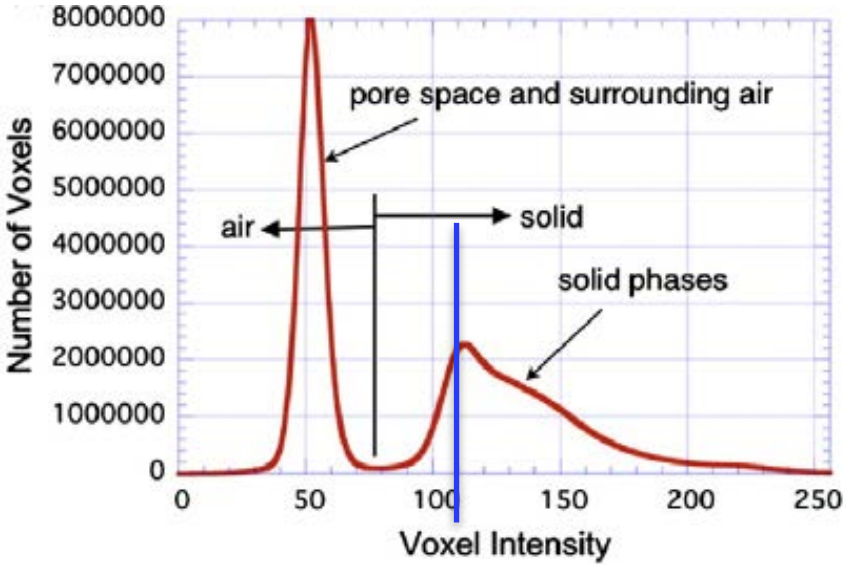
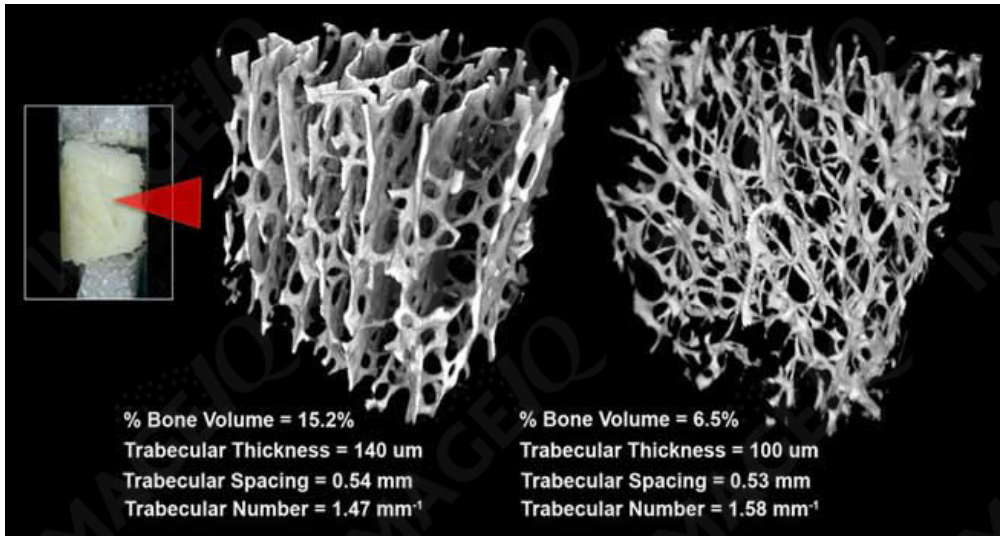
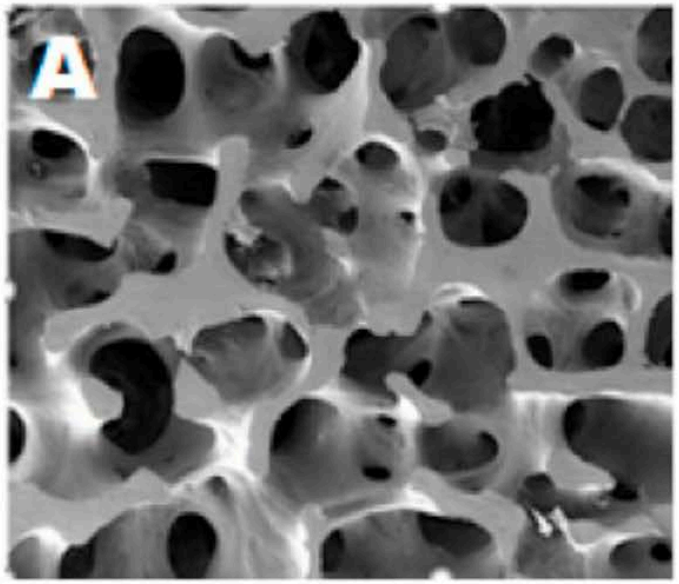
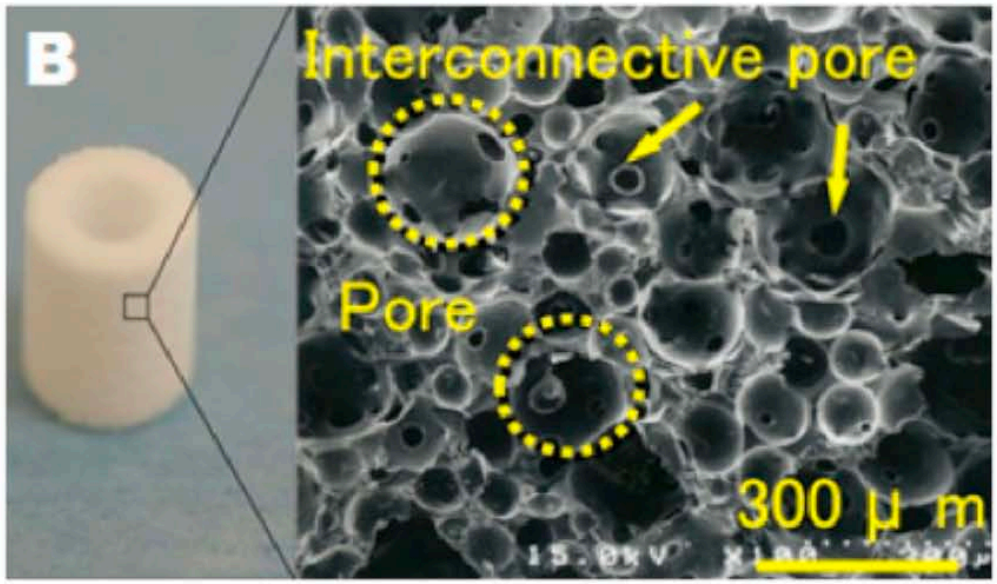
Analysis of Porosity in Bone (Osteoporosis)



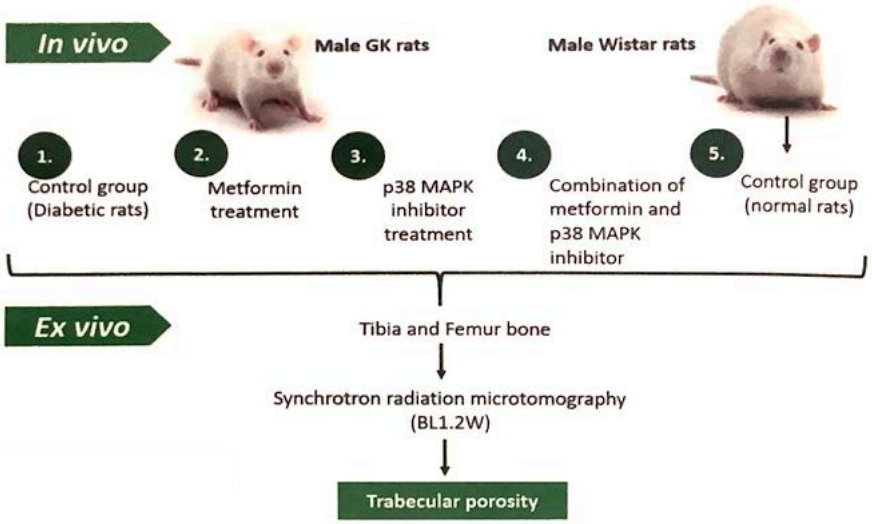






Metformin and MAPK inhibitor reduced bone porosity in lean type II diabetic rats

Assist. Prof. Sarawut Kumphune. (manuscript in preparation)



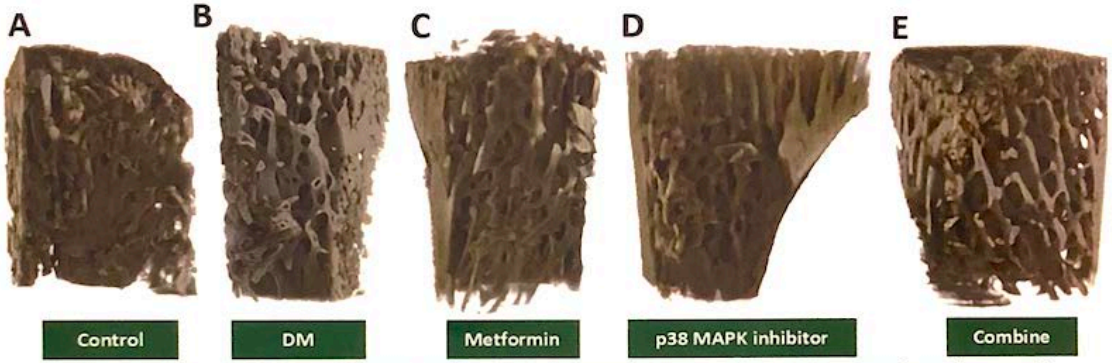
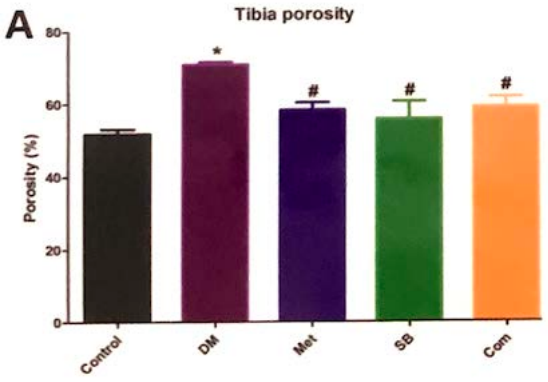
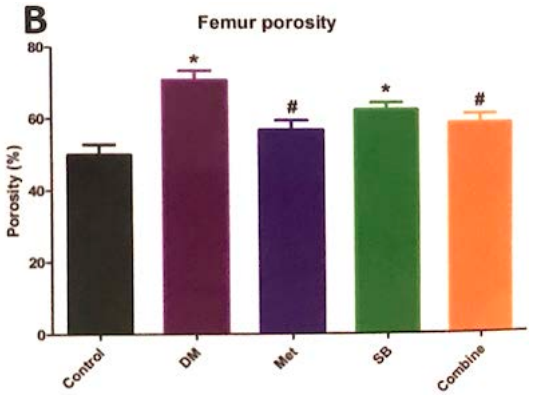


Figure1 3D render of synchrotron radiation microtomography data of tibia trabecular bone.

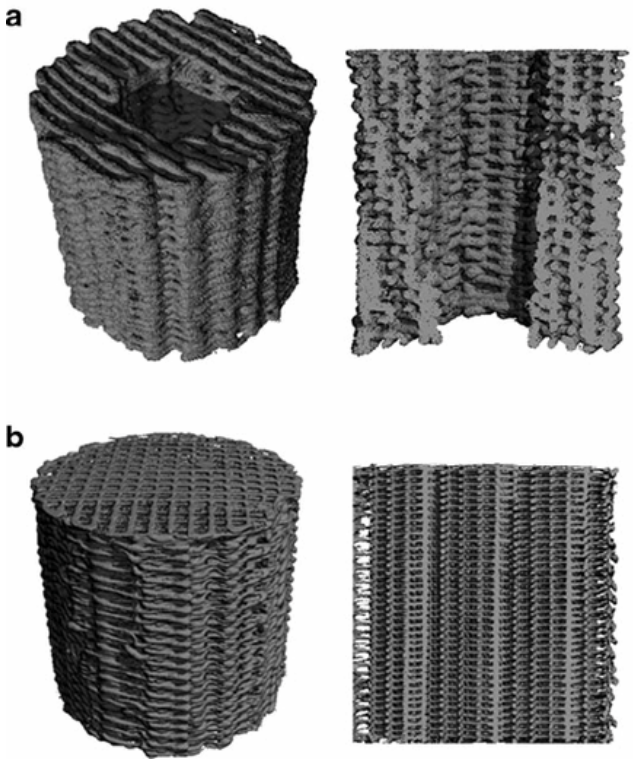


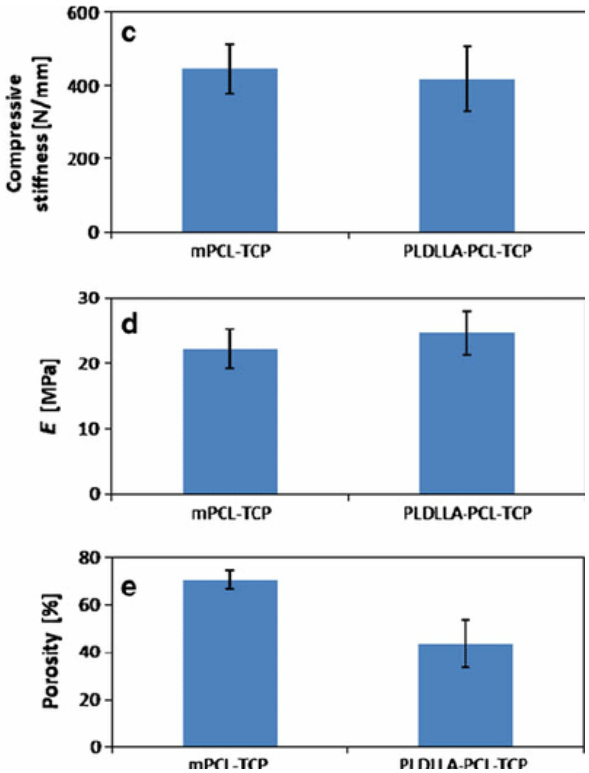


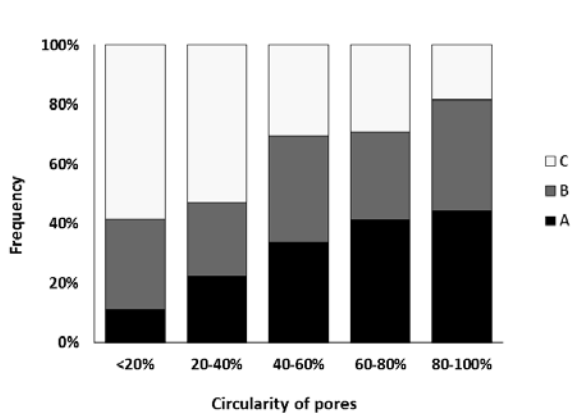
Custom-made composite scaffolds for segmental defect repair in long bones

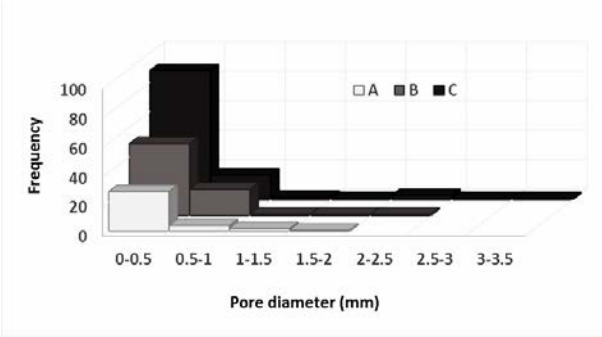
Reichert JC, et. al. (2011) ***Int Orthop.*** Aug;35(8):1229-36

3D reconstructions of a PDLLA-TCP-PCL (a) and mPCL-TCP scaffold (b)









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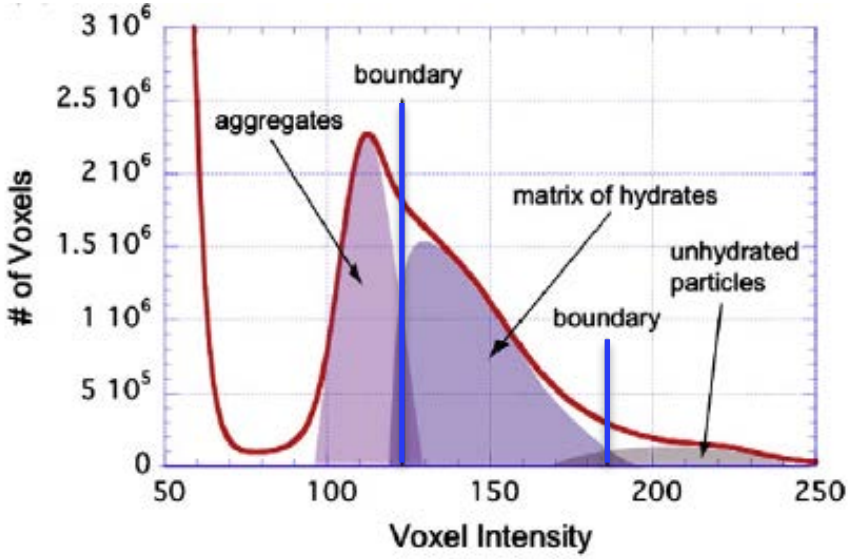
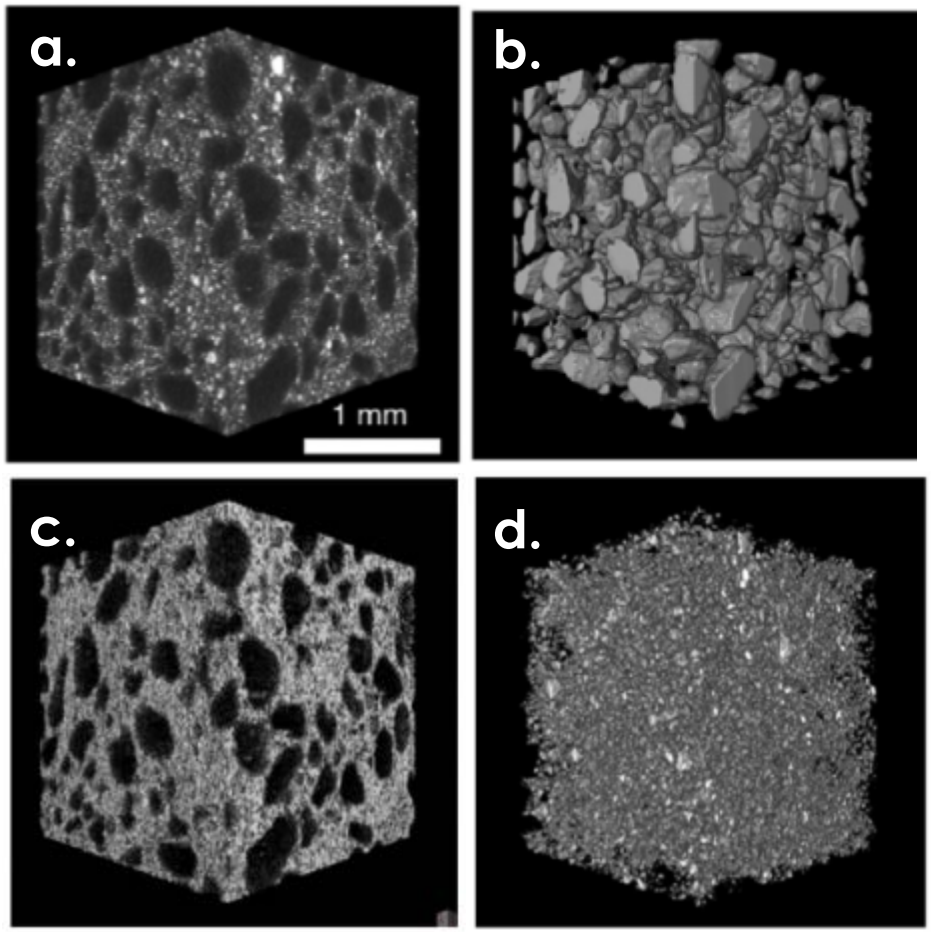
Phase distribution in Cement

Landis, E.N. and Keane, D.T.(2010) **Materials Characterization** 61 1305 – 1316.





Segmentation of solid phases

a. 3D render in grayscale volume
b. Aggregates
c. Cement hydrates
d. Unhydrated particles

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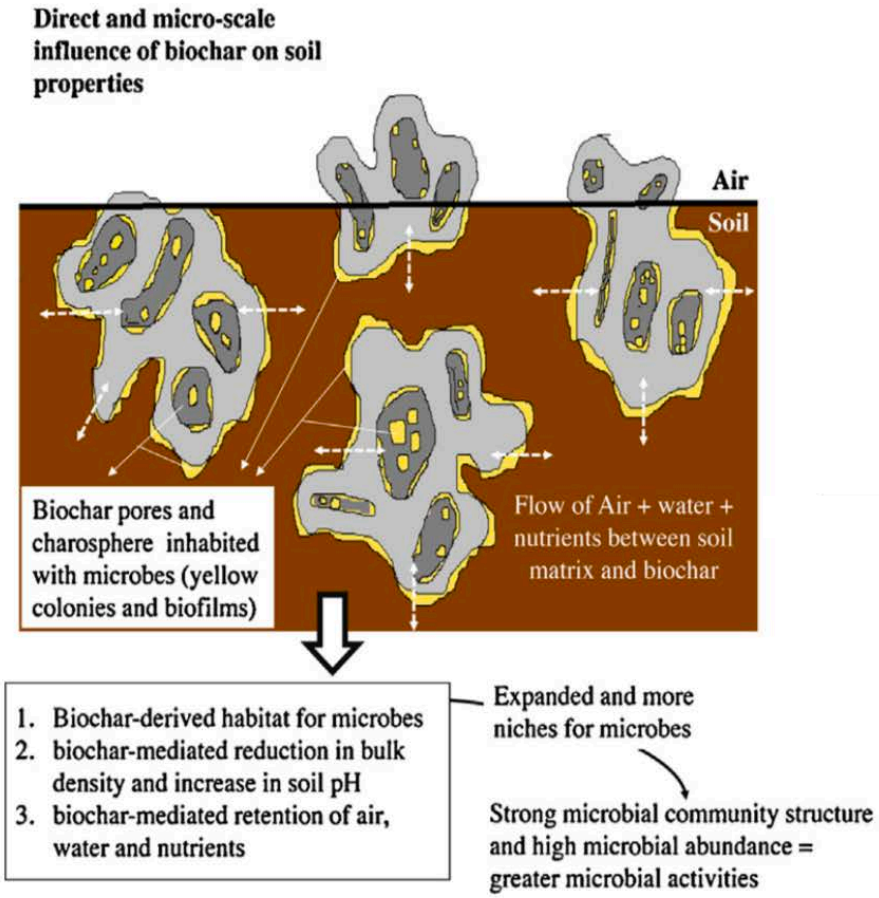
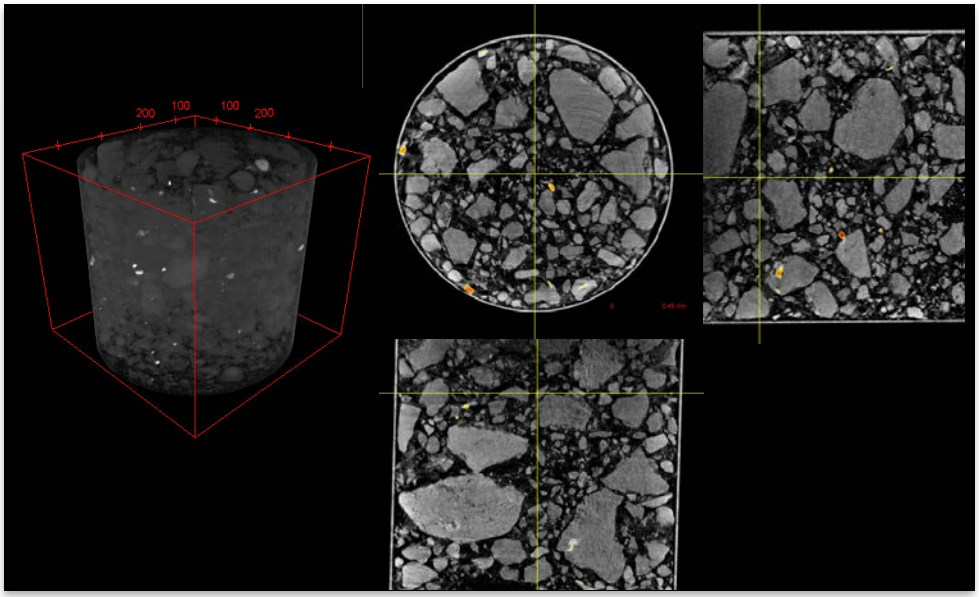
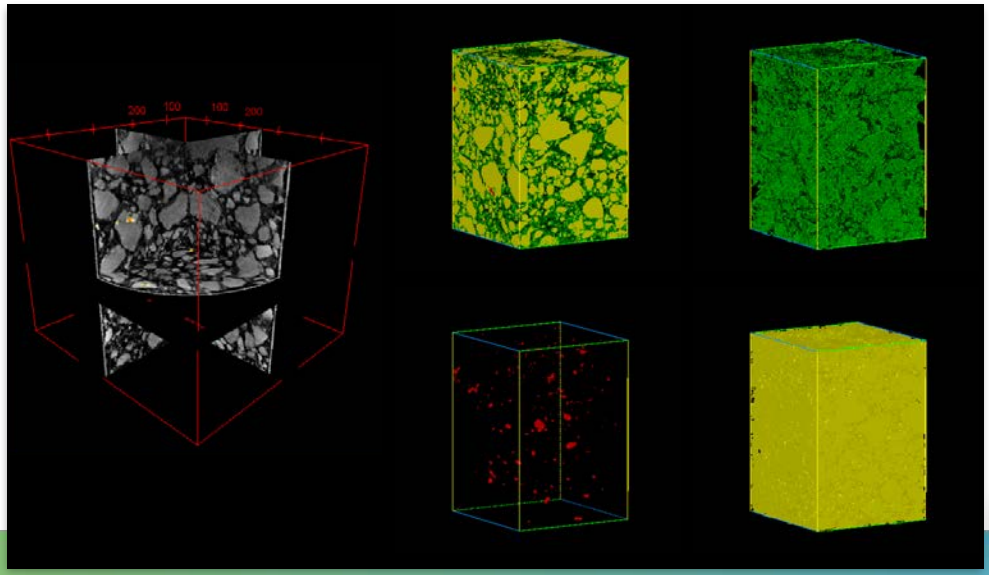
Biochar amended soil

Biochar amended soil

Dr. Ramida Rattanakam



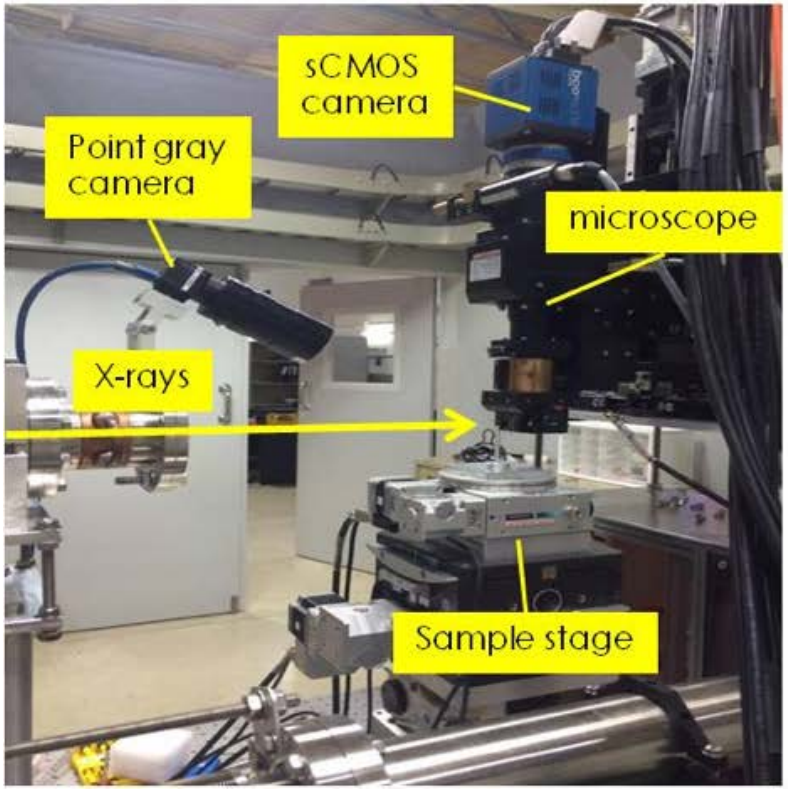


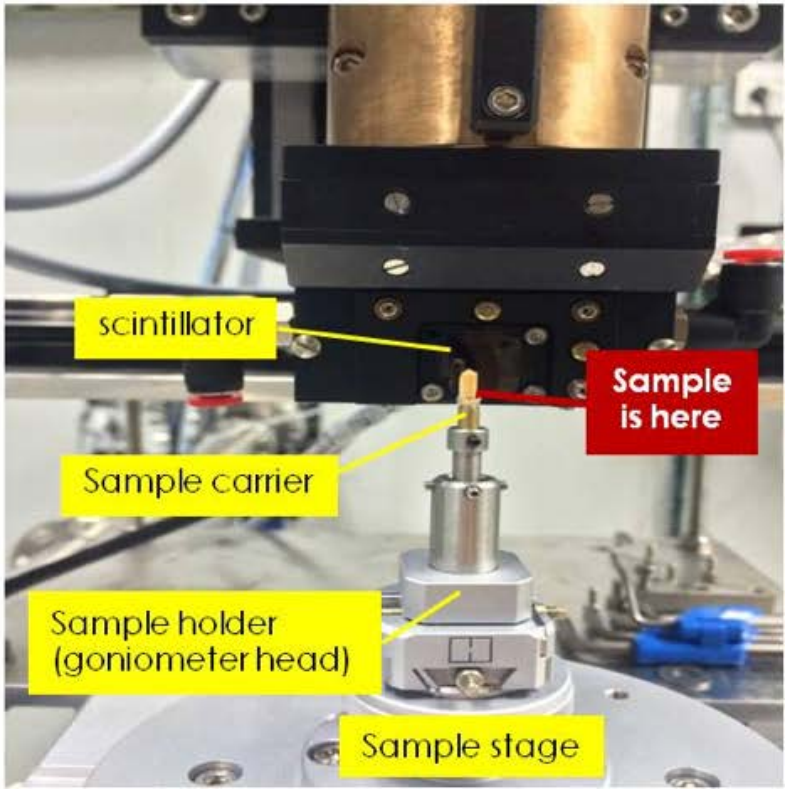


Experimental hutch of XTM Beamline

Experimental setup & Sample preparation

Preferable sample size
- **High z, diameter < 0.2 cm**
- **Low z, diameter < 1 cm**





BL1.2W: X-ray Imaging & X-ray Tomographic Microscopy (BL1.2: XTM)

Specification:

Source	Multi-pole wiggler, 2.2 T
Radiation type	Polychromatic beam
Energy range	5 – 20 keV
Imaging efficiency	100 frames/s
Beam size	10 X 4 mm (H x V)
Spatial resolution	1.5 μm (pixel size 0.72 μm)
Projection	Optique Peter WB microscope 2X, 5X,10X
Data acquisition/ Analysis	LABView-based :XIMaq, XIMove, Octopus
Detector	YAG-Ce scintillation sCMOS camera (PCO.edge 5.5)

Techical consultant:

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2. Pakkananan Pakawanit
3. Chalermluck Phusawat

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Thank you
for your attention