KBSI 한국기초과학지원연구원
KOREA BASIC SCIENCE INSTITUTE

Biological applications of Computed Micro- and Nano-Tomography

μ-CT('15) DXA('18) 3D X-ray Microscope('20)

Utilization of 3D image from centi to nano

imAGE 3DX-RAY

2022. 08. 19.
Gwangju Center Jae-Il Park

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Korea Basic Science Institute, KBSI

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I. Korea Basic Science Institute

1. Vision & Goals

Mission

Conducting R&D on research facilities & equipment and analytical S&T, and joint research and support for promoting basic science

Vision

World-class open research platform creating the advance in science and technology and people's happiness

Main Functions

- Leading the comprehensive development of research infrastructure that drives national innovative growth
- Analytical science research maximizing the capabilities of national research infrastructure
- Sharing & spreading of analytical science for national R&D competitiveness improvement

Promotion Strategies

- Basic research promotion — *Key roles*
- Customer value realization — *Benefit to customer*
- Outstanding performance achievement — *Superexellence*
- Research foundation innovaiton — *Innovation*

2. Leading-edge Equipment

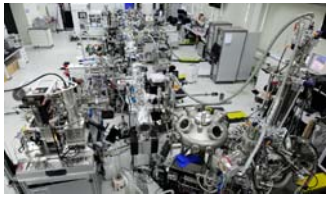
High Voltage Electron Microscope

15 T Fourier-Transform Ion Cyclotron Resonance Mass Spectrometer

900 MHz Nuclear Magnetic Resonance Spectrometer

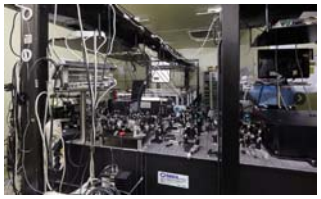
Sensitive High Resolution Ion MicroProbe

Advanced in situ Surface Analysis System



Nano Secondary Ion Mass Spectrometer

Femtosecond Multi-Dimensional Laser Spectroscopic System



Bio-High Voltage Electron Microscope

7 T Human Magnetic Resonance Imaging Scanner

Cryo-Electron Microscope System

Atomic Resolution Electronic Structure Scanning Transmission Electron Microscope

Ultra High-Resolution Isotope Microscope System

3. Locations

/ Daedeok Headquarters /

· Bioconvergence Analysis	Biological Disaster Research
· Environmental & Material Sciences	Electron Microscopy Research, Advanced In situ Nanosurface Research
· Scientific Instrumentation	Optical Instrumentation Development, Scientific Instrument Reliability Assessment, Instrumentation Development Support, Spin Engineering Physics Research, Mass Spectrometry and Advanced Instrumentation Research

/ Ochang Center /

· Bioconvergence Analysis	Biomedical Omics Research, Drug & Disease Target Research, Protein Structure Research, Bioimaging Research
· Environmental & Material Sciences	Electron Microscopy Research, Geochronology Research, Environmental Monitoring and Research
· Scientific Instrumentation	Spin Engineering Physics Research, Mass Spectrometry and Advanced Instrumentation Research

/ Seoul Center /

Environmental Risk Analysis and Research, Space–Time Resolved Molecular Imaging Research

/ Gwangju Center /

Advanced Aging Science Research

/ Western Seoul Center /

Omics System Research, Functional Interface Science

/ Busan Center /

Advanced Materials Research Based on Surface Modification / Analysis

/ Jeonju Center /

Nano & Carbon-based Materials Research

/ Daegu Center /

Functional Materials Research

/ Chuncheon Center /

Disease-Specific Optical Imaging Research

4. KBSI-Gwangju Center

Introduction | Detailed research information

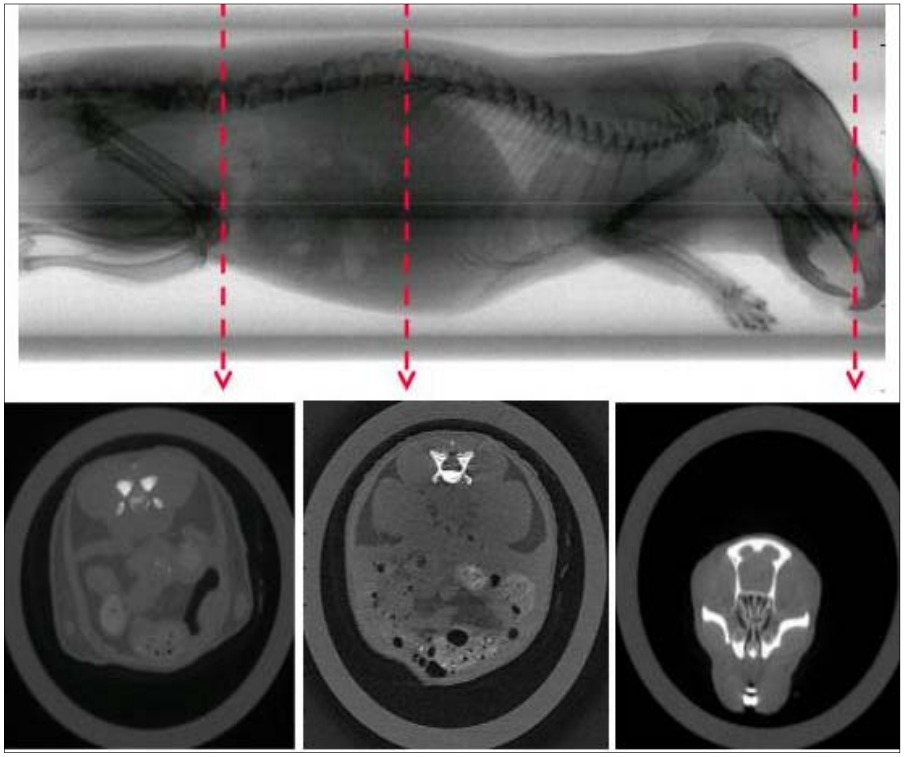
At Gwangju Center we provide analytical services in the material structure analysis and the aging science by operating the state-of-the-art analytical instruments, contributing to the advancement of the science and technology. We support local industries in broader Gwangju City by actively participating in the industry-university joint researches.

The aging research facility plays various roles in, such as supplying and developing aged animal models for the researchers in Korea, preclinical researches using experimental animals, and joint-researches associated with aging related bio-imaging. We also provide technical support for related companies.

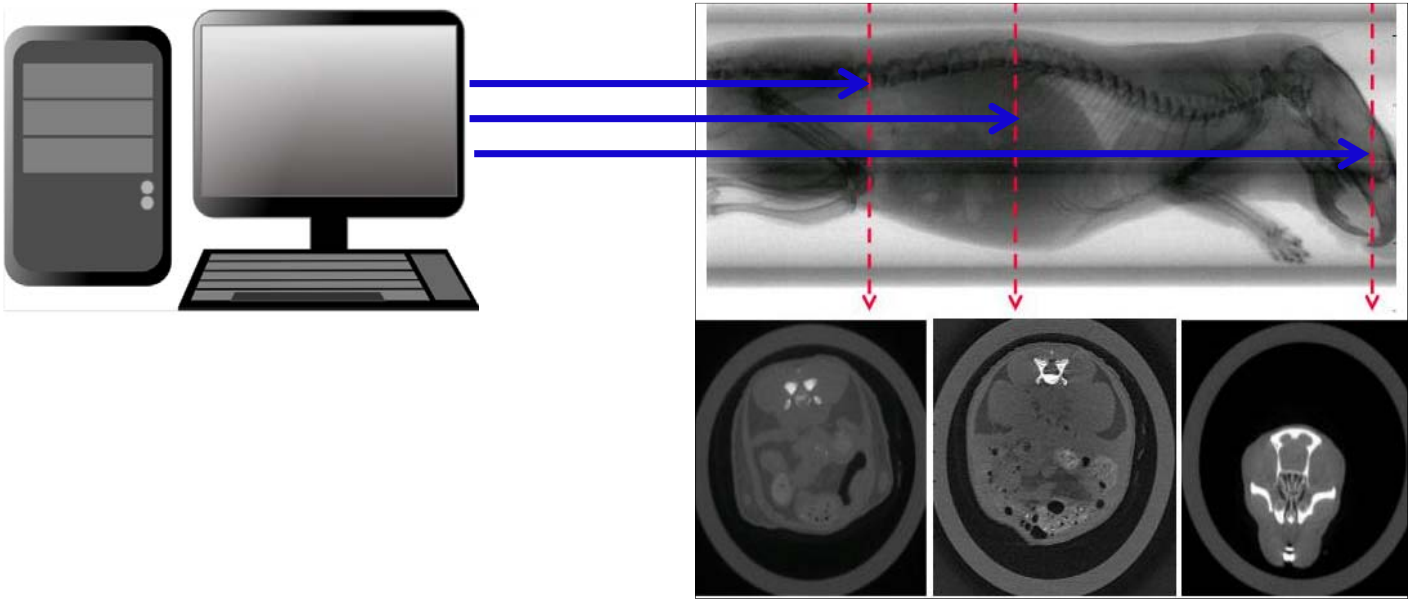
II. *In vivo* CT *vs In vitro* CT

CT : Computed Tomography

Tomography; Tom + graphy

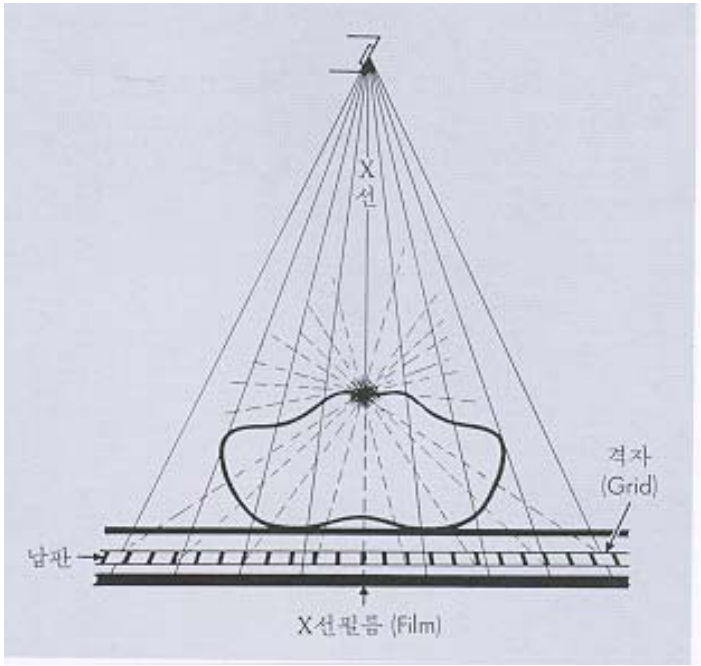


CT : Computed Tomography;



X-ray primary radiation

The degree of X-ray absorption differs depending on the material

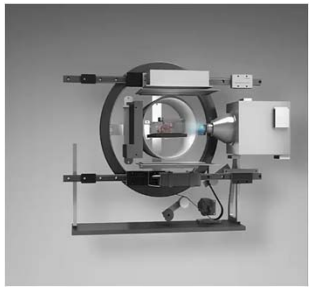


The more absorbed X-ray images appear brighter

High Resolution more & more!

In Vivo

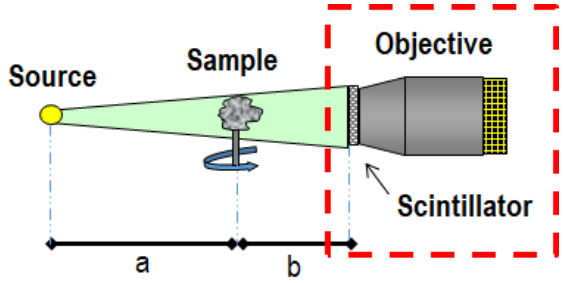
Quantum GX



In Vitro

Xradia Versa

Xradia Ultra



Resolution (X-ray spatial resolution)

mm ⟶ 9 μm ⟶ 0.5 μm ⟶ 50 nm

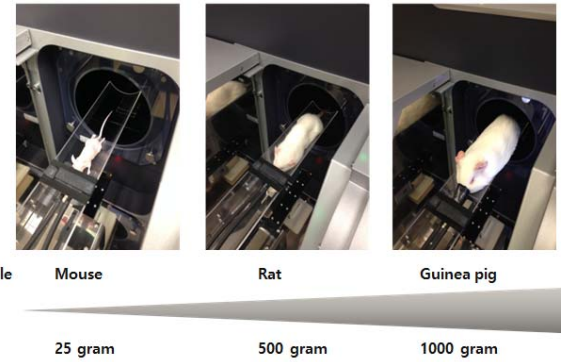
Detector 3D Voxel size (2D pixel size)

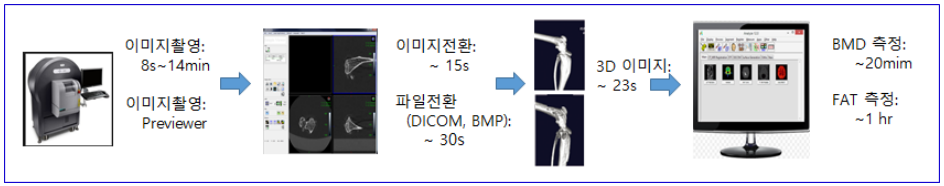
144 μm ⟶ 4.5 μm ⟶ 0.04 μm ⟶ 16 nm

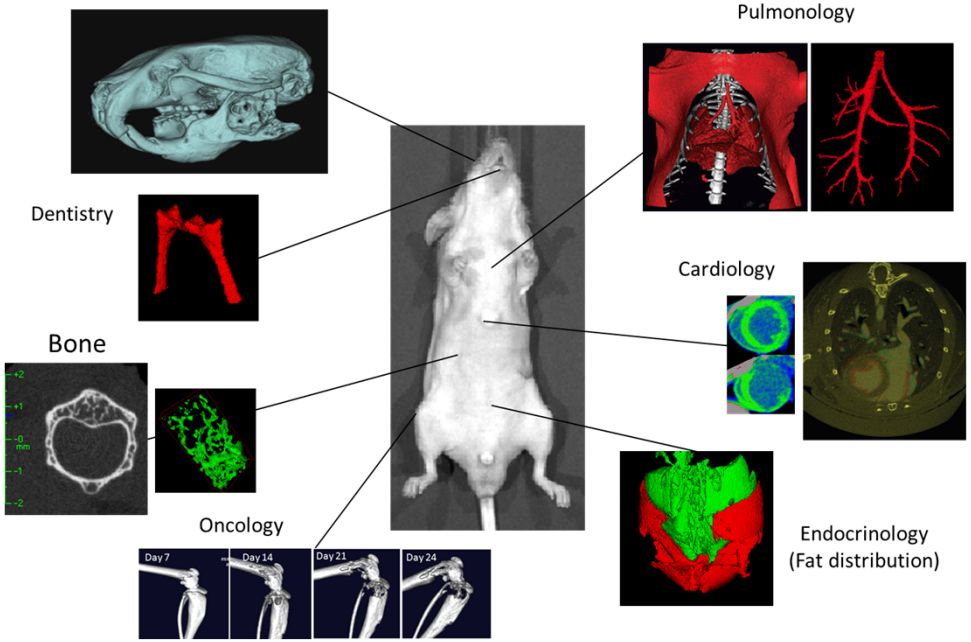
Broad micro-CT application

In Vivo

Quantum GX







Technical and Application:

☞ high Resolution Imaging at a 4.5 μm Voxel Size

- FOV 72 mm : 9 μm
- FOV 36 mm : 4.5 μm

Broad sub-micro-CT application

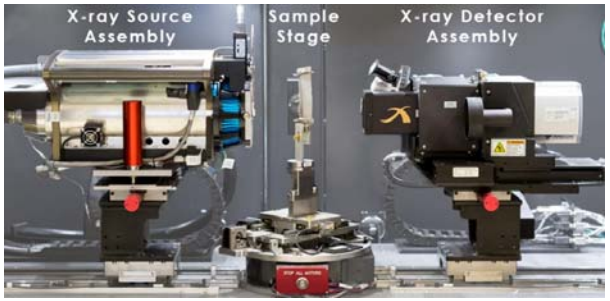
In Vitro

Xradia Versa 620

(Main specifications) 3D structural analysis from macro to nano scale

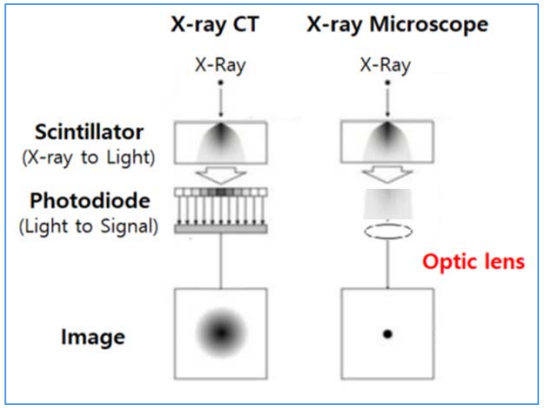
- Spatial resolution: 500 nm or less
- Minimum achievable voxel size: 40 nm or less
- Scintillated detectors with microscope objective lens
  - 0.4X / 4X / 20X / 40X and FPX(Flat panel extension)
- Imaging system
  - HART(High aspect ratio tomography)
  - Dual scan contrast visualizer(Dual energy)

(Core function) Sealed X-ray tube + Scintillated detector + Microscope objective lens

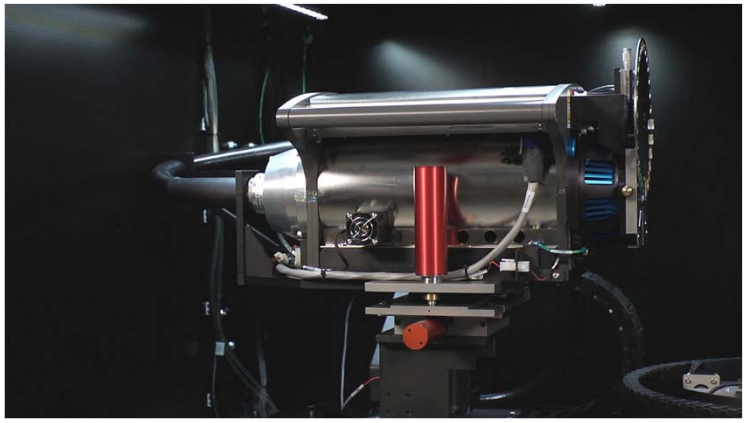


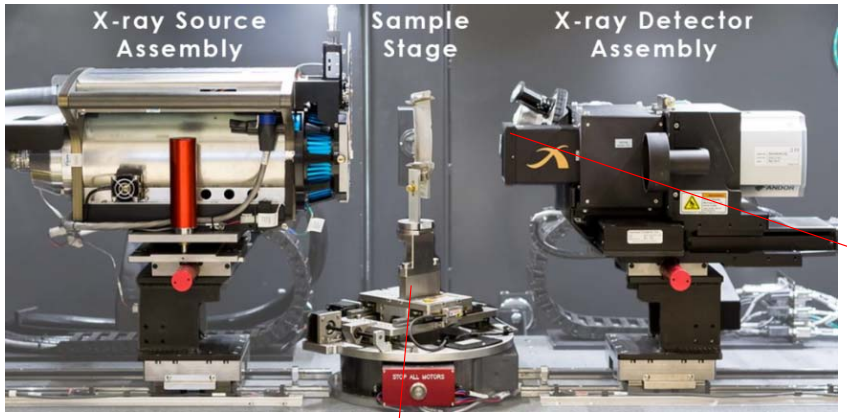
X-ray Architecture:
Sealed X-Ray Tube:

Scintillator + Optical lens
Low pass X-Ray scintillator



Broad sub-micro-CT application

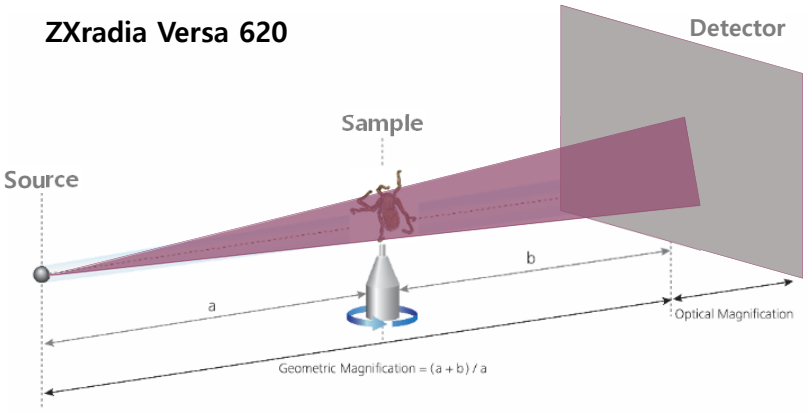




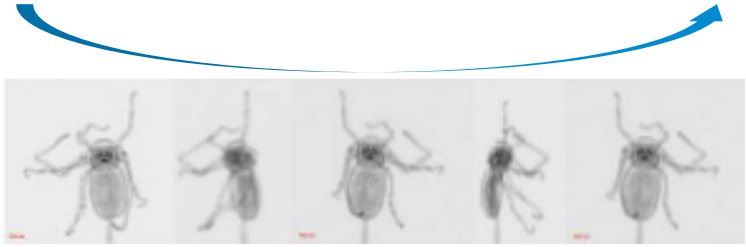
Auto loader

Xradia Versa 620
Optics for various magnifications

Broad sub-micro-CT application



X-ray
(Projections)



Reconstruction

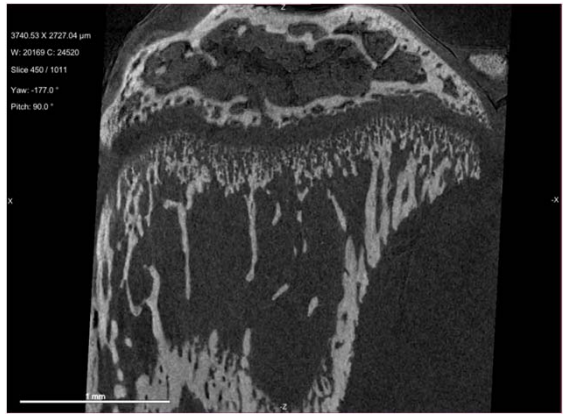
Virtual slices

III. Biological applications by CT

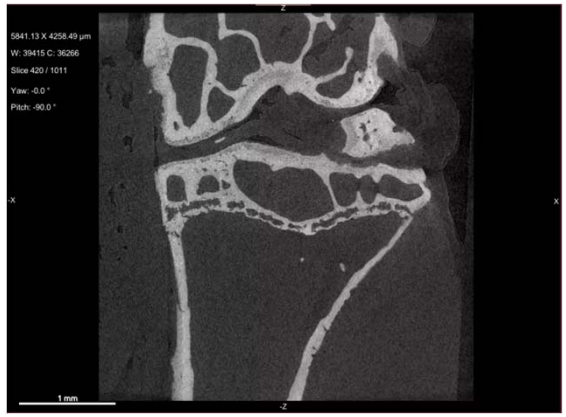
Broad CT application : Bone

X-ray CT (20uM) *vs* 3D X-ray Microscope (10uM)

2 Months



20 Months



Implementation of non-invasive 3D images

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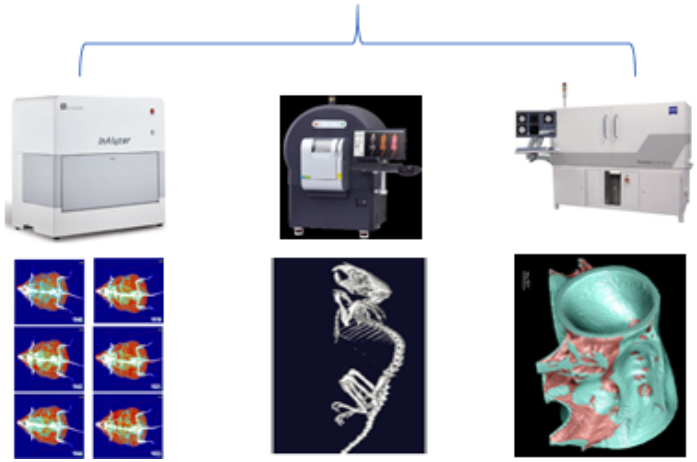
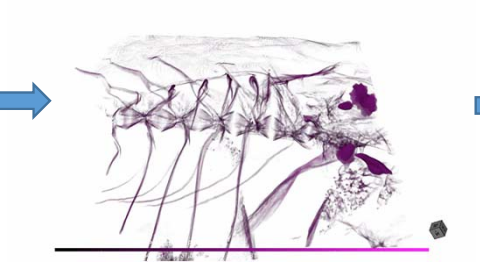


DXA	Micro CT	Sub-micron XRM	Widefield LM	Confocal LM	Super resolution LM	Nanoscale XRM	C-SEM	FE-SEM	FIB-SEM	Helium Ion Microscope
>1 mm	10 μm	700 nm	250 nm	200 nm	20 nm	< 50 nm	< 2 nm	< 1 nm	< 1 nm	< 0.5 nm

30 um

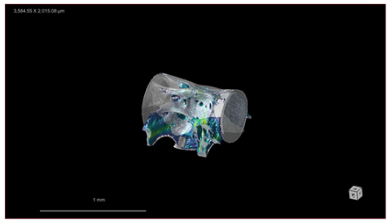
Zebrafish's Whole body

5 um



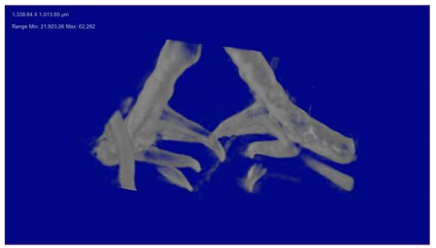
Zebrafish's abdormal vertebrae

1.0 um



Zebrafish's First Caudal vertebrae

0.4 um



Zebrafish's Teeth

한국기초과학지원연구원은
'분석과학을 선도하여 과학기술의 발전과 국민행복을 창출하는
글로벌 연구 인프라 혁신 기관' 으로 나아갑니다.

감사합니다.

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