



中国科学院水生生物研究所  
INSTITUTE OF HYDROBIOLOGY, CHINESE ACADEMY OF SCIENCES

中科院水生所

# 活体及离体样本扫描及应用

水生所分测中心 王鑫

2020年8月14日

# 汇报内容

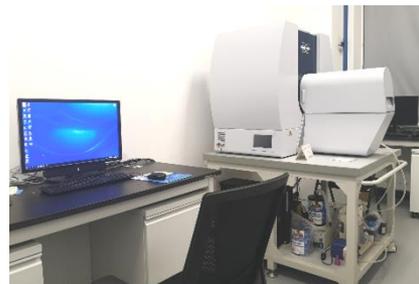
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- 一、光学平台介绍
- 二、实验动物影像介绍
- 三、实验流程介绍
- 四、成像应用

# 一、光学平台介绍



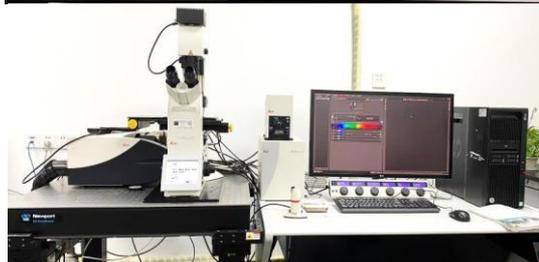
Leica SP8



Skyscan 1276



AL-WJ9



Leica DLS



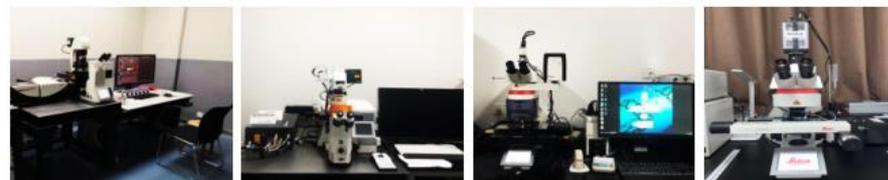
Amersham  
Typhoon RGB



Leica STED



Zeiss LSM  
710 NLO

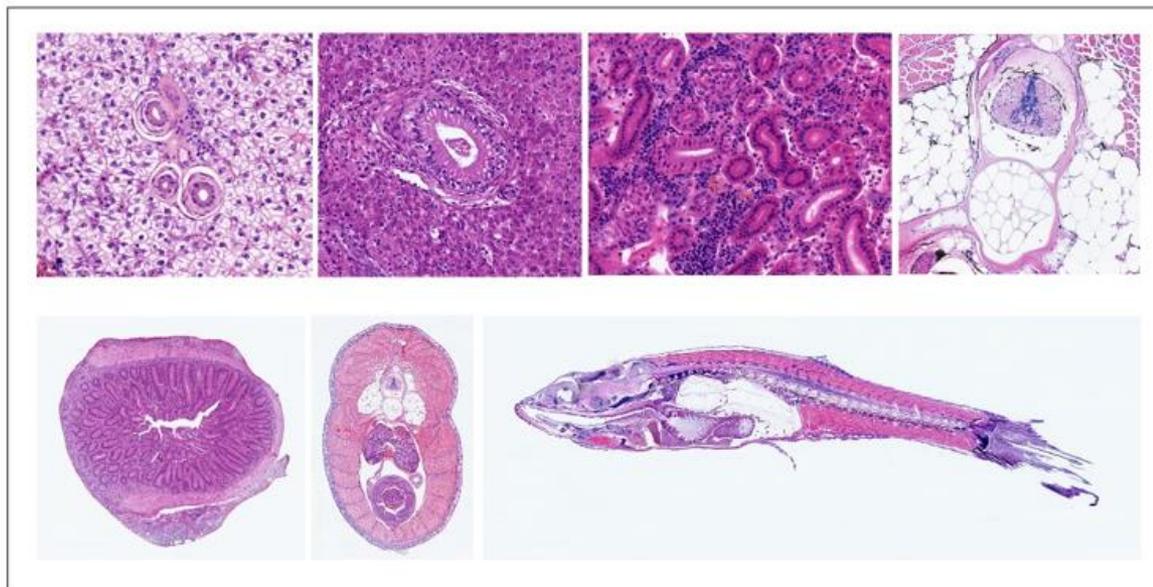


荧光显微镜

# 一、光学平台介绍-组织切片制样



全自动脱水机



全自动包埋机



切片机



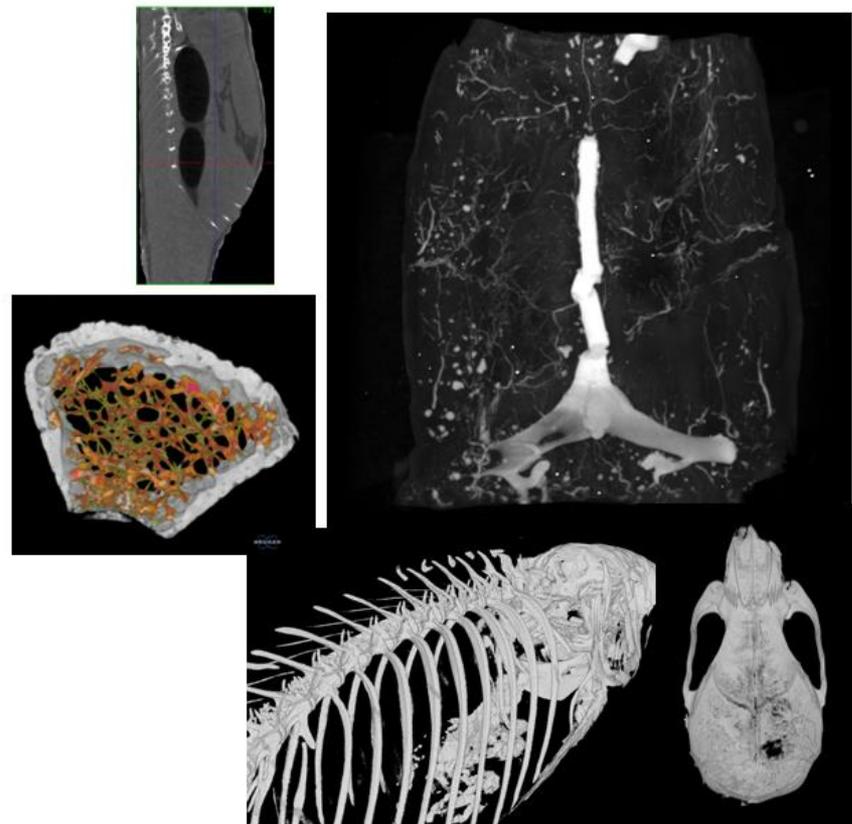
漂烘仪



全自动染色机

## 二、实验动物影像

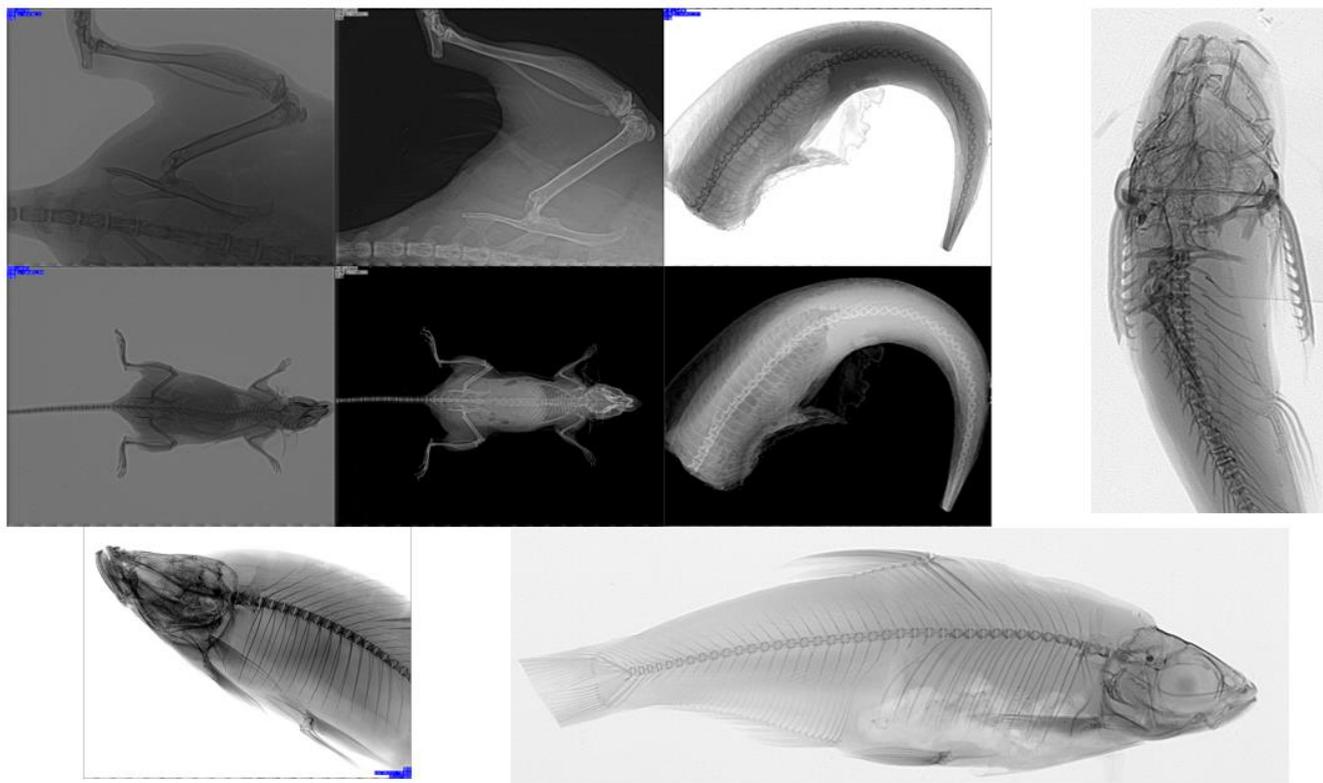
	活体检测	离体检测
X光机	全身成像、快速初筛	局部成像
Micro-CT	高分辨率成像、三维、脂肪、骨参数定量	骨骼精细扫描、骨密度、骨参数、三维、材料



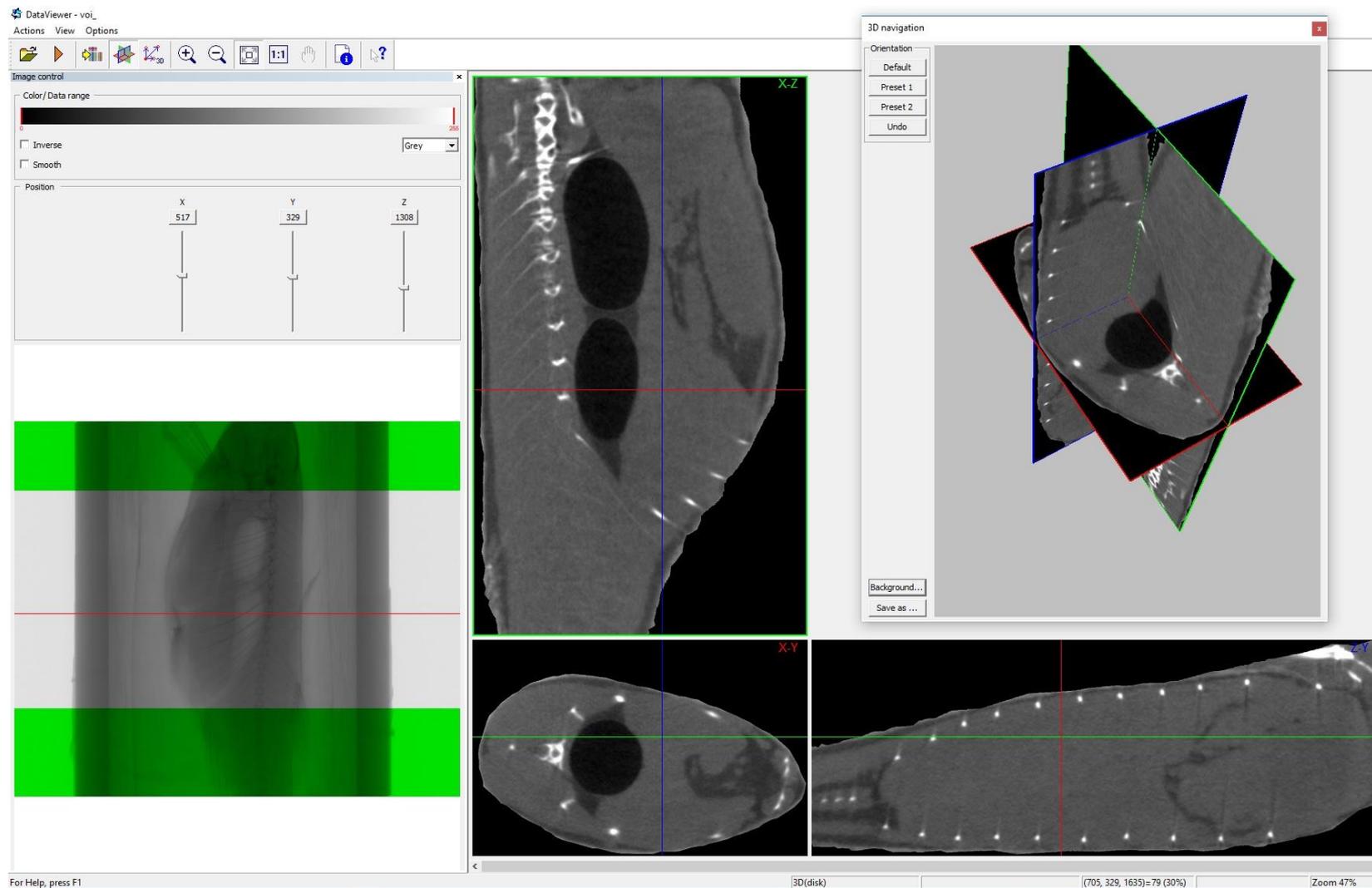
## 二、实验动物影像介绍-X光成像仪



便携式X光成像仪  
型号：AL-WJ9  
厂家：奥龙

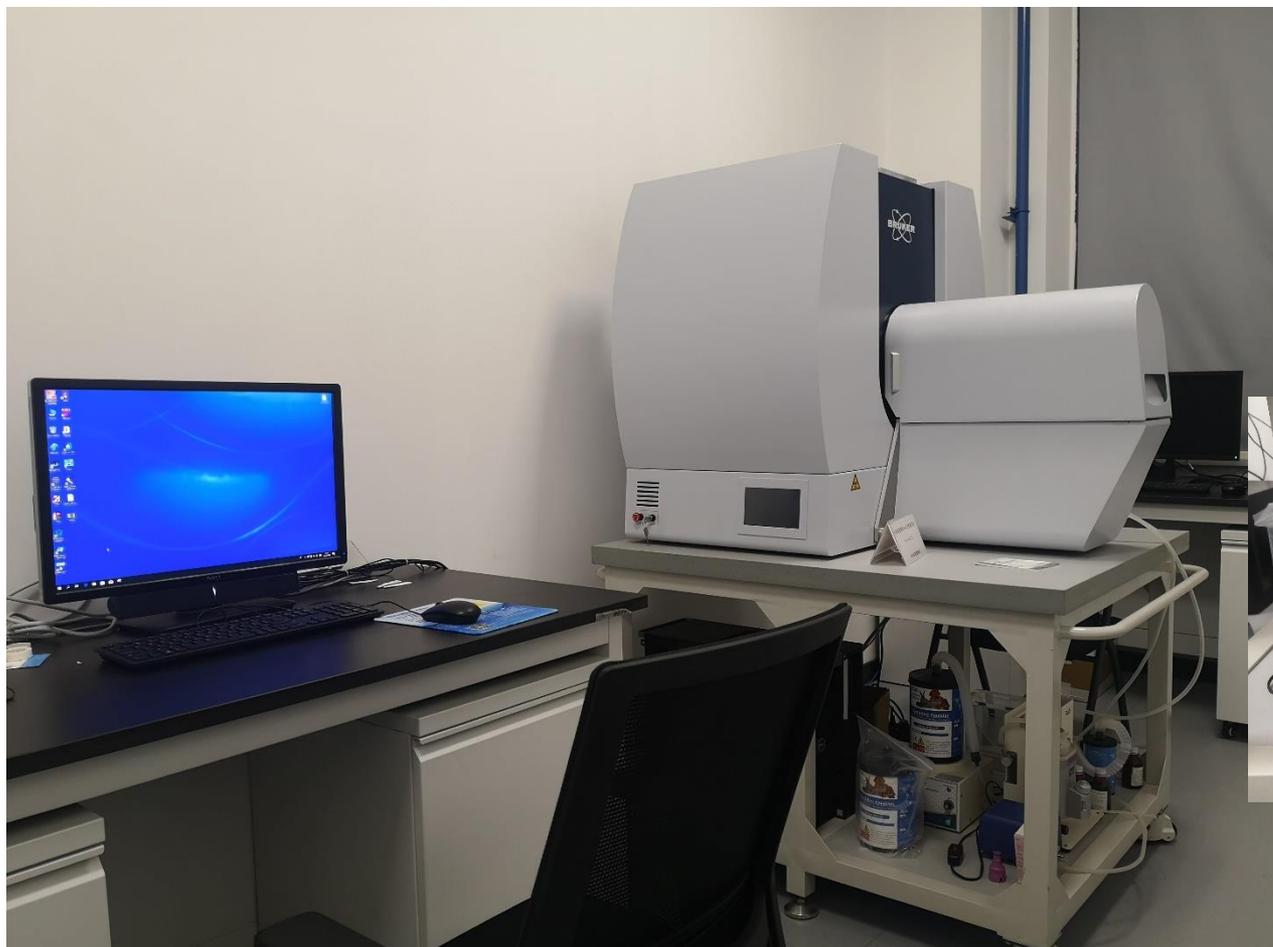


## 二、实验动物影像-计算机重建三维断层



## 二、实验动物影像

## Skyscan high resolution in vivo microCT

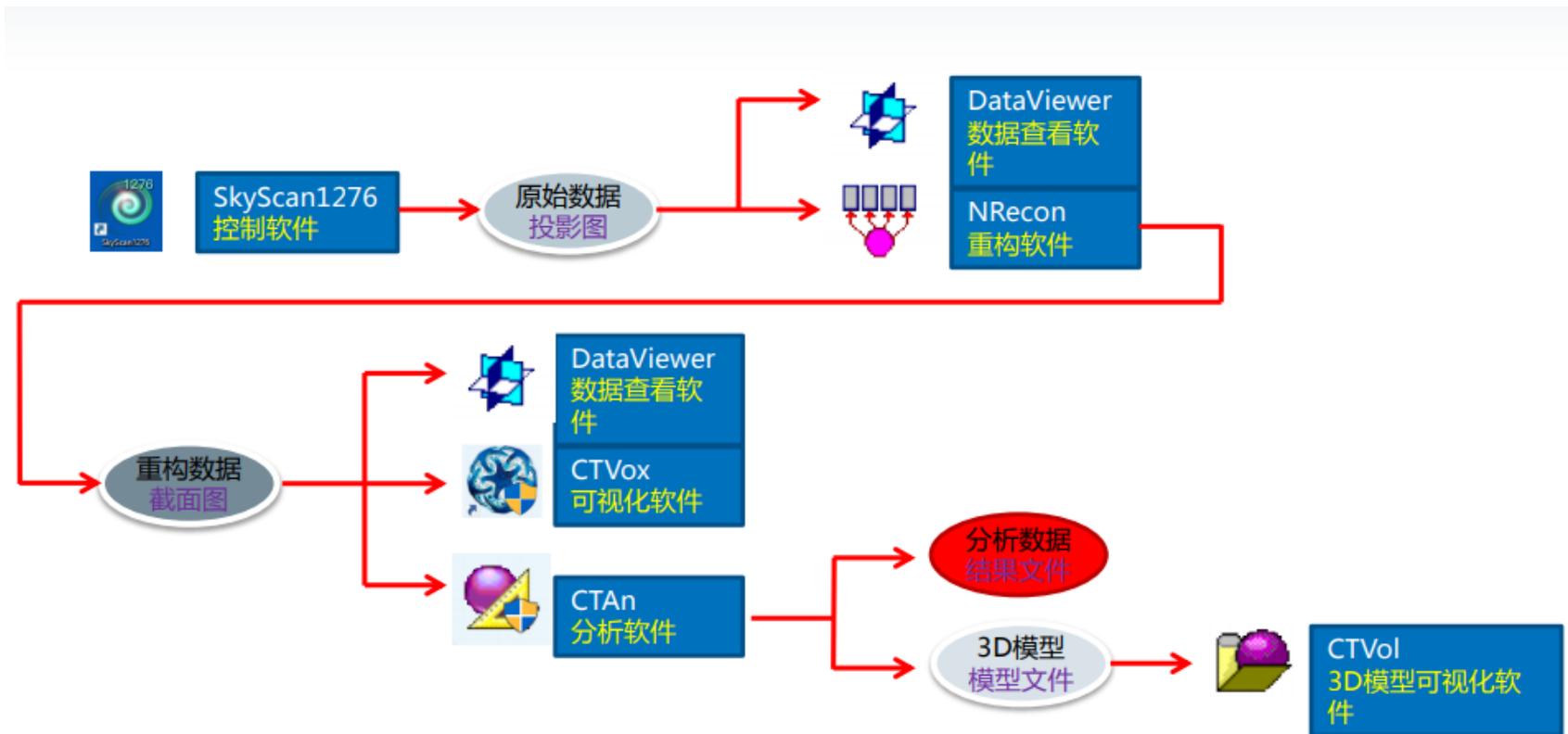


Skyscan 1276



气麻系统

### 三、实验流程介绍



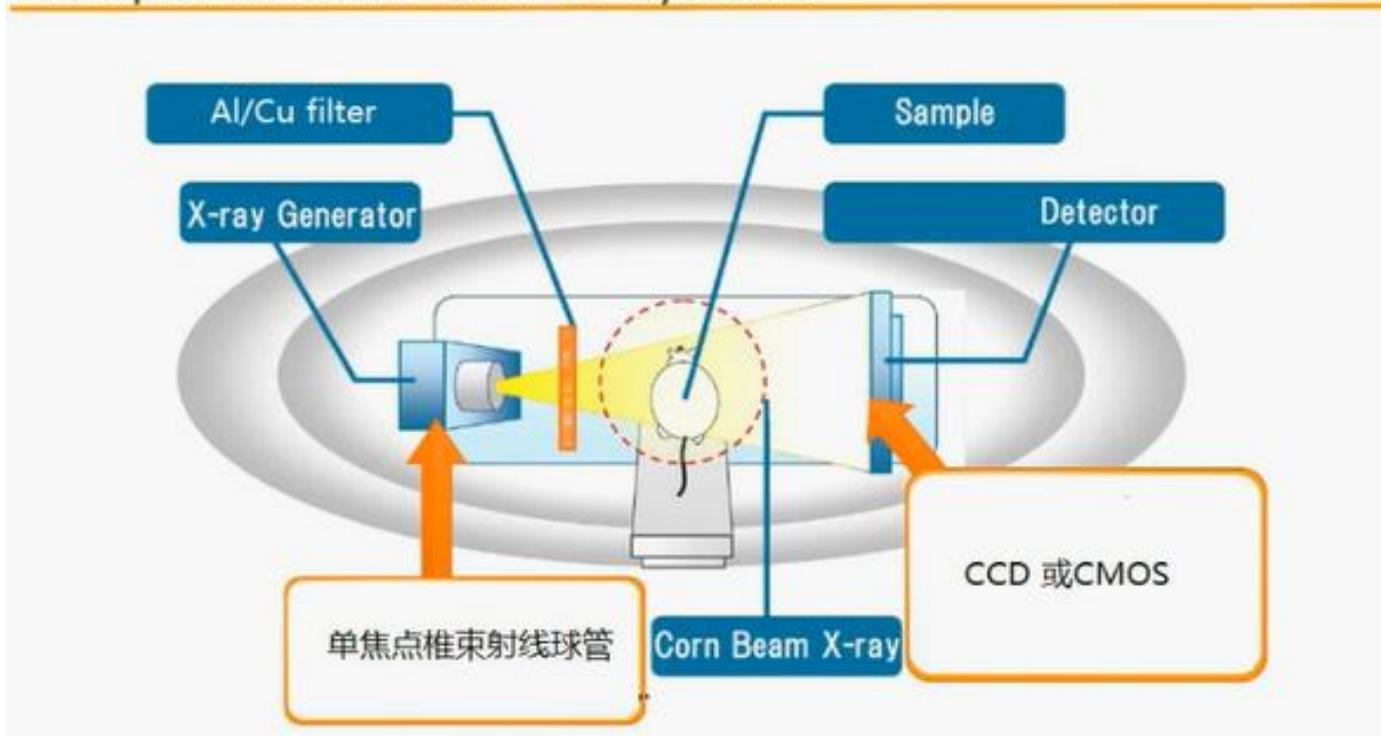
### 三、实验流程介绍-动物麻醉

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- 吸入式麻醉系统（大鼠、小鼠）：  
异氟烷+氧气/空气
- 流量：大鼠0.8-1；小鼠0.6-0.8
- 预麻：3-4%异氟烷
- 维持：1-2%异氟烷
- 浸泡式麻醉（鱼类）：  
MS-222

### 三、实验流程介绍-样本摆放

#### Principles of Corn Beam CT Systems



In vivo CT: 射线球管和CCD旋转，样本固定不动  
扫描空间是圆柱形，越靠近圆柱体中轴线，效果越好

### 三、实验流程介绍-动物床

样品最大尺寸30CM× 8CM

70mm

40mm

30mm

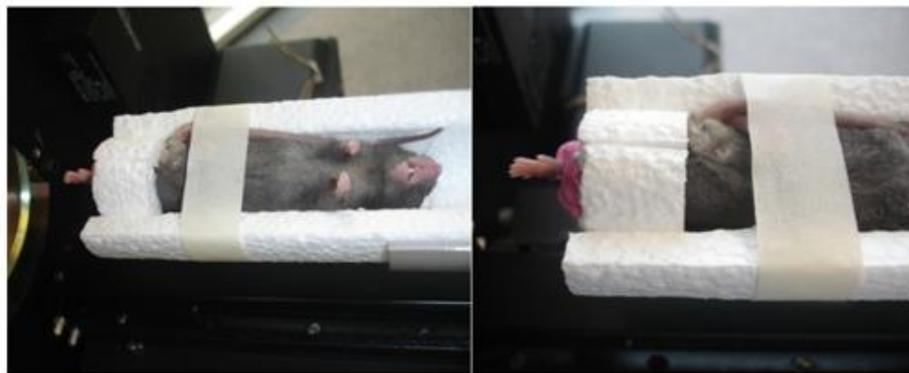
20mm

12mm

76mm



动物床



样品固定

## 三、实验流程介绍-离体样品取样

---

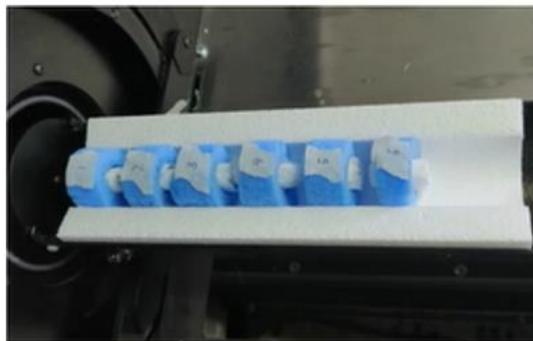
### 样本处理

- 动物处死之后尽快取样，必要时加辅助的形态固定措施
- 剥除非必要的软组织
- 尽量取出额外的造模材料等

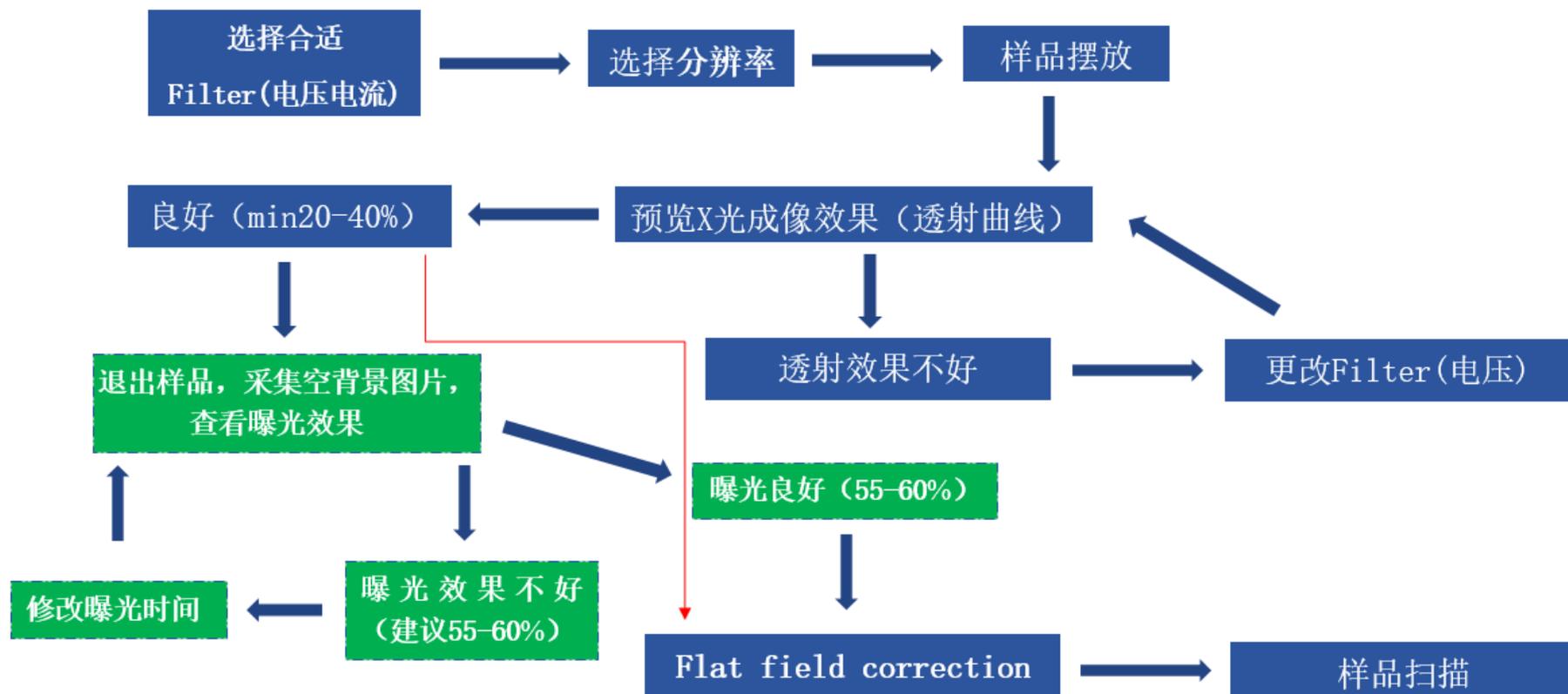
### 固定

- 中性甲醛
- 乙醇
- 冷冻保存——完全解冻再扫描

### 三、实验流程介绍-样品准备



### 三、实验流程介绍-扫描参数设定



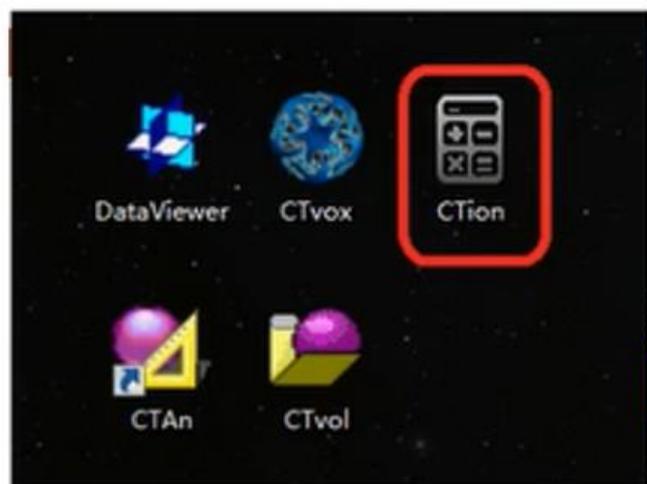
### 三、实验流程介绍-数据重构

The screenshot displays a software interface for X-ray data reconstruction, featuring several overlapping windows:

- Reconstruction (Top):** A window with tabs for Start, Settings, Advanced, Output, and Summary. It contains a plot showing a sharp peak on a baseline.
- Reconstruction (Right):** A smaller window showing the 'Advanced' settings tab, including a 'Position' field set to 1263, a 'fastest' field set to 1263, and a 'Top' field set to 2591.
- Reconstruction (Bottom Right):** A window showing the 'Advanced' settings tab with various options checked:
  - Smoothing (3)
  - Misalignment compensation:
    - Show -11.5
  - Object larger than field of view
  - Ring artifacts reduction (22)
  - Beam-hardening correction (30%) (prev: 30%)
  - CS rotation (deg) 0.00

- Batch manager (Bottom Left):** A window with buttons for Start batch, Submit again, Move up, Remove, and Remove all, along with a table for Batch job, Status, and Message.
- Color (Bottom Right):** A window with an 'Inverse' checkbox and a color gradient bar.
- Background:** A dark image showing a circular object, possibly a slice of a specimen, with a green circle overlaid.


### 三、实验流程介绍-扫描剂量



50  
455

```
image crop origin X=0  
Image crop origin Y=0  
Camera binning=2x2  
Image Rotation=0.2390  
Gantry direction=CW  
Number of connected scans=1  
Image Pixel Size (um)= 17.76  
Object to Source (mm)=120.625  
Camera to Source (mm)=171.118  
System Matrix Calibration=NO  
Vertical Object Position (mm)=60.869  
Optical Axis (line)= 653  
Filter=Al 0.5mm  
Image Format=TIFF  
Data Offset (bytes)= 264  
Horizontal overlap (pixel)=64
```

CTion

Ionizing xray dose calculator

Xray filter: 0.5mm Al

Applied voltage: 50  
Available range: 40 - 80 kV

Source current (μA): 455

Source-object distance (mm): 120.625

Dose Rate (mGy/min)

**BRUKER**

Air: 333.09  
Mouse (25mm diam.): 153.37  
Rat (75mm diam.): 57.22

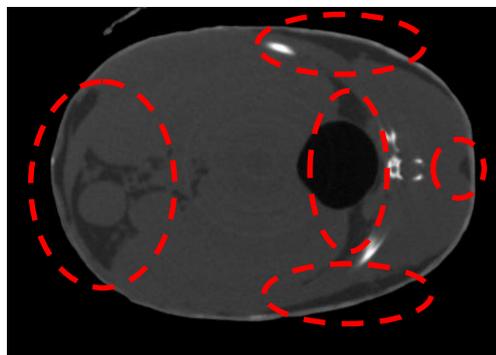
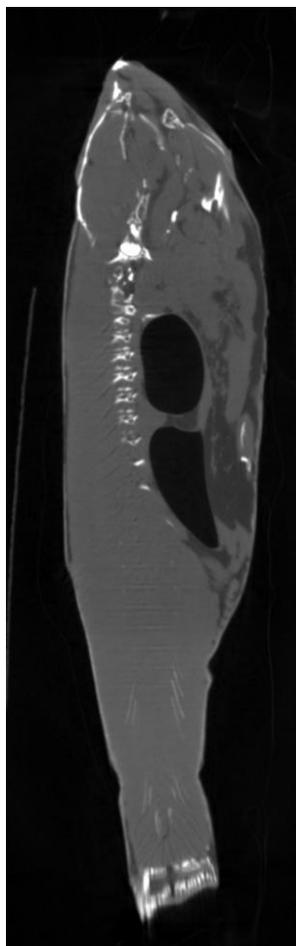
Press F1 to open help info

Calculate Save

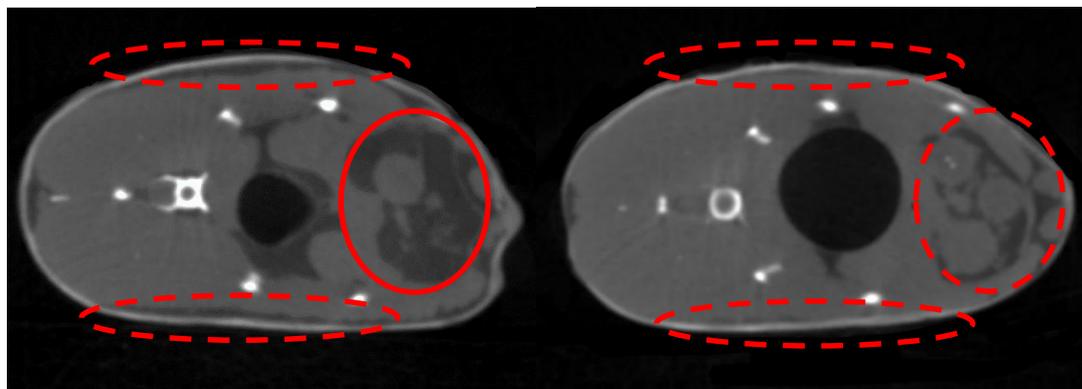
Type Of Motion=STEP AND SHOOT  
Source Temperature=24.80 °C  
Study Date and Time=Oct 10, 2019 10:30:54  
Scan duration=00:04:45  
[Reconstruction]  
Reconstruction Program=NRecon

## 四、成像应用-脂肪扫描及定量计算

斑马鱼脂肪分布



双侧皮下  
背部  
鱼鳔两侧  
腹部



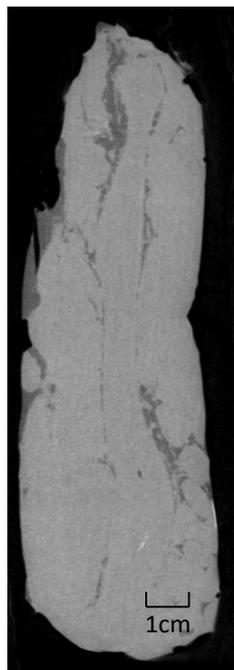
实验组

对照组

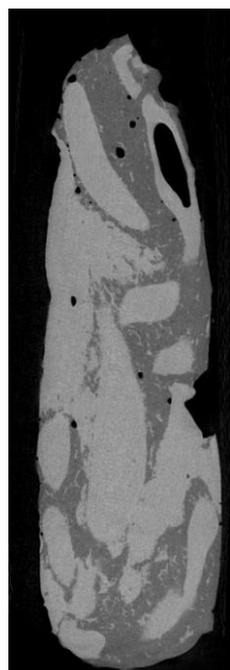
## 四、成像应用-脂肪扫描及定量计算

鲤鱼肝脏断层像

Image pixel size 10 $\mu$ m



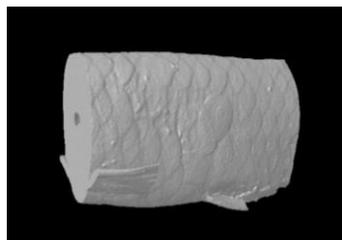
对照组



实验组

TV(总体积)	219.2409mm <sup>3</sup>
Obj.V(脂肪体积)	15.37061mm <sup>3</sup>
Obj.V/TV(体脂比)	7.01083%

CTVol 3D效果图



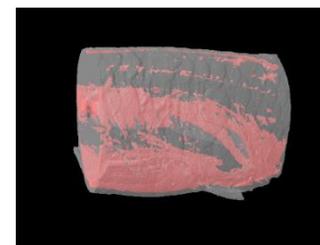
斑马鱼3D图

+



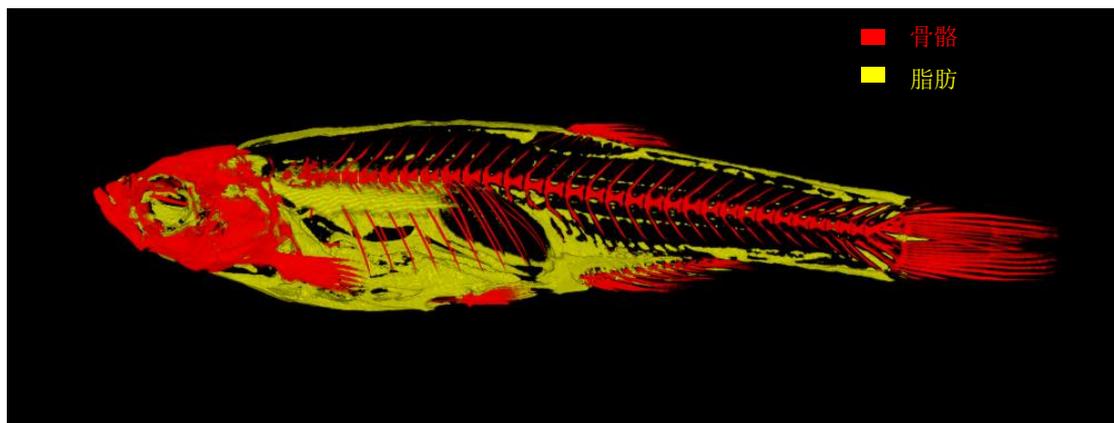
脂肪3D图

=



鱼体脂肪3D图

CTVox 斑马鱼脂肪3D效果图

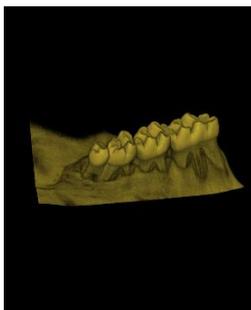


## 四、成像应用-骨骼扫描及定量计算

骨骼3D成像



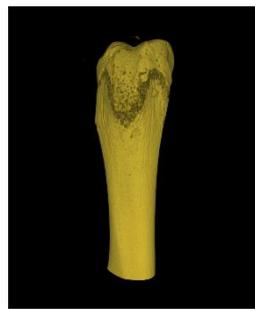
大鼠骨骼



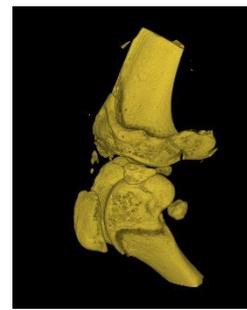
牙齿



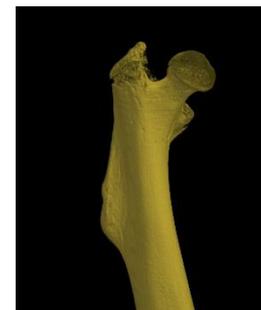
脊椎



股骨



膝盖

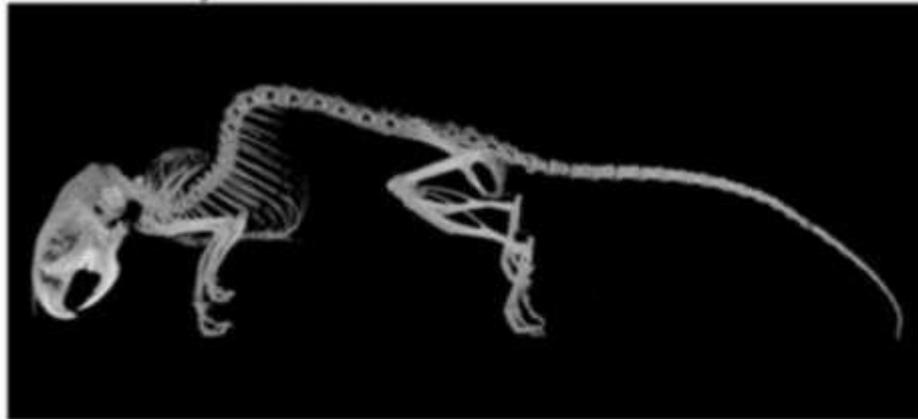


胫骨

## 四、成像应用-骨骼扫描及定量计算

大鼠骨骼 Image pixel size 35 $\mu$ m

*P4ha1<sup>+/-</sup>;P4ha2<sup>+/-</sup>*

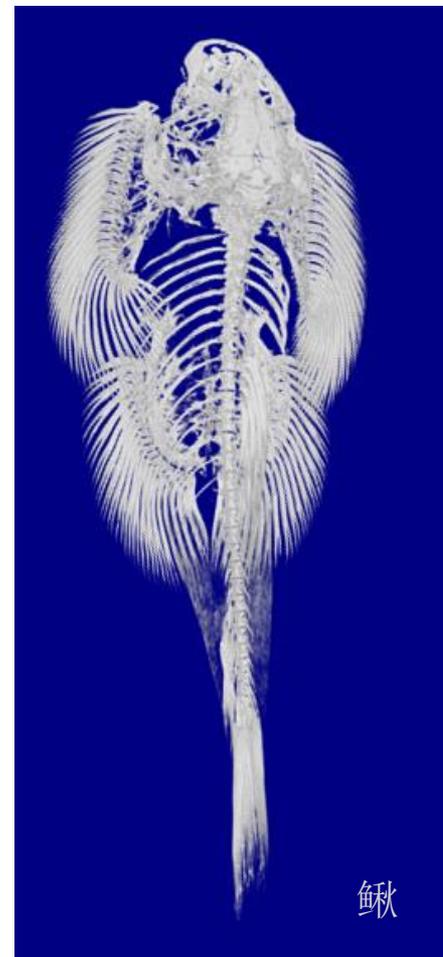
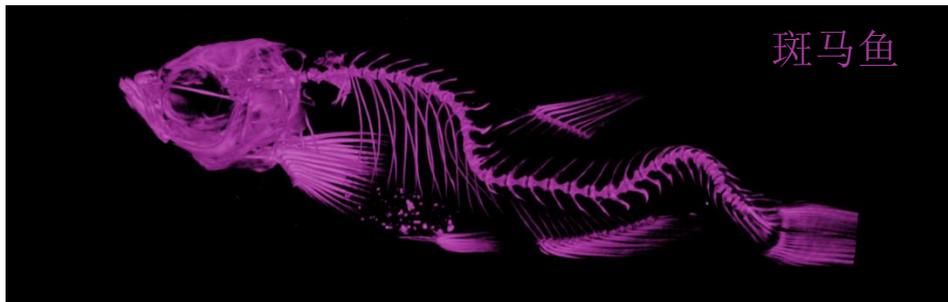
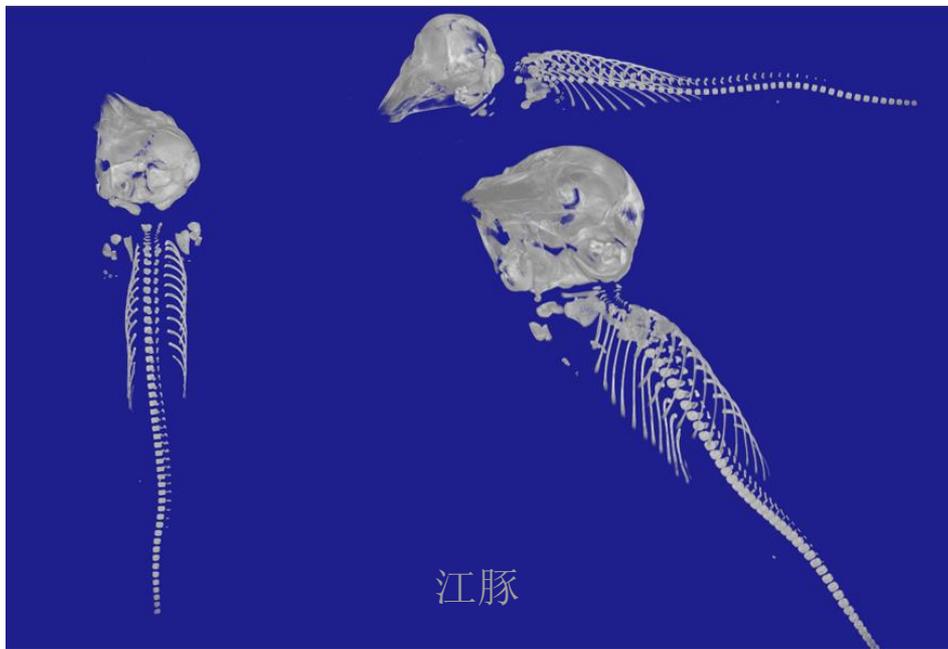


*P4ha1<sup>+/-</sup>;P4ha2<sup>-/-</sup>*



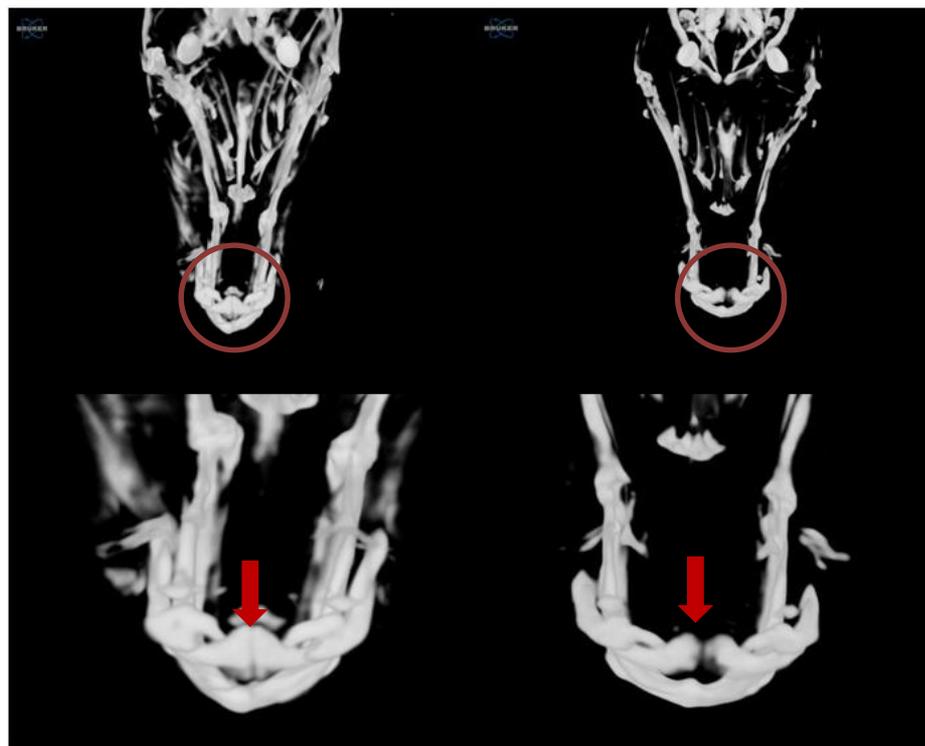
## 四、成像应用-骨骼扫描及定量计算

### 骨骼3D成像



## 四、成像应用-骨骼扫描及定量计算

斑马鱼头骨 Image pixel size 2.8 $\mu\text{m}$



对照组

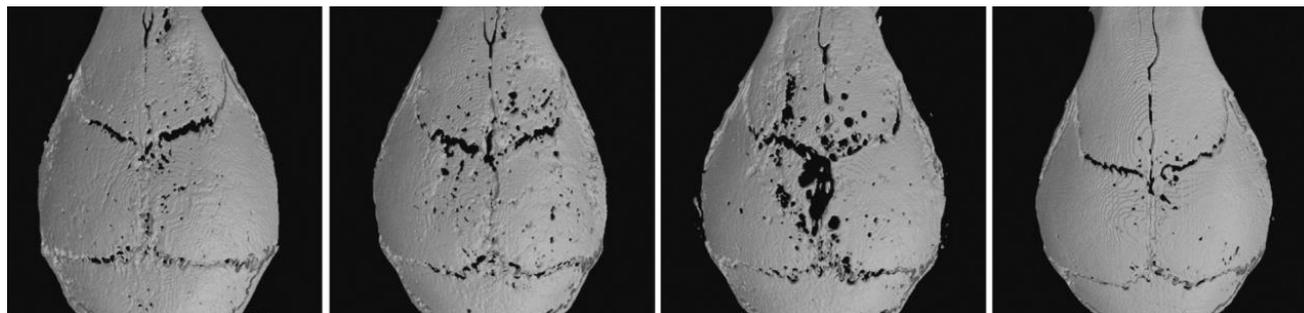
处理组

## 四、成像应用-骨骼扫描及定量计算

### 颅骨3D成像



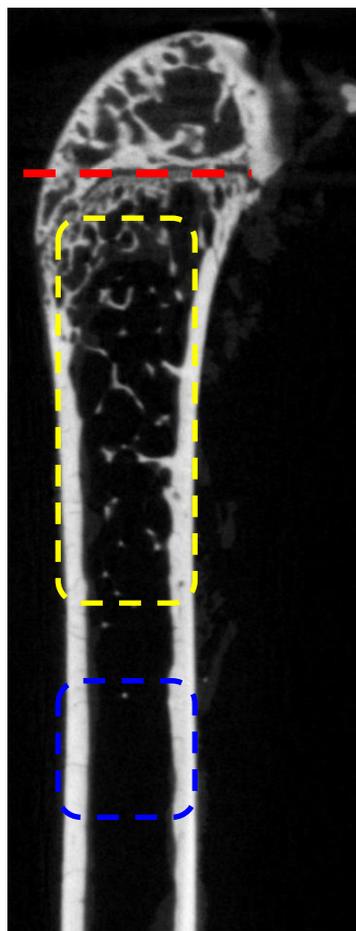
骨修复  
骨量计算



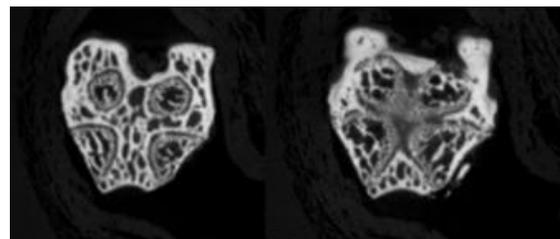
骨损伤

## 四、成像应用-骨骼扫描及定量计算

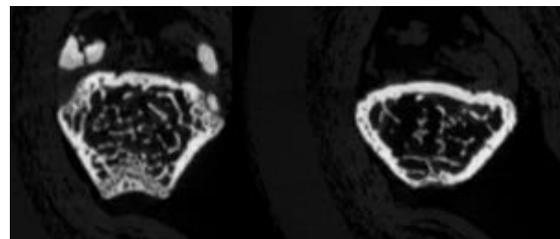
小鼠股骨断层像 Image pixel size  $4\mu\text{m}$



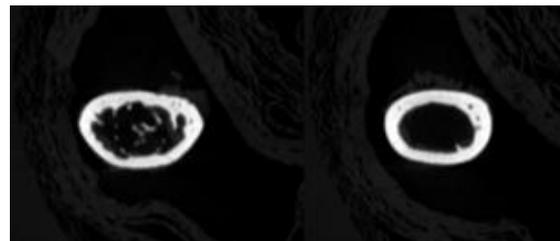
生长版



骨小梁

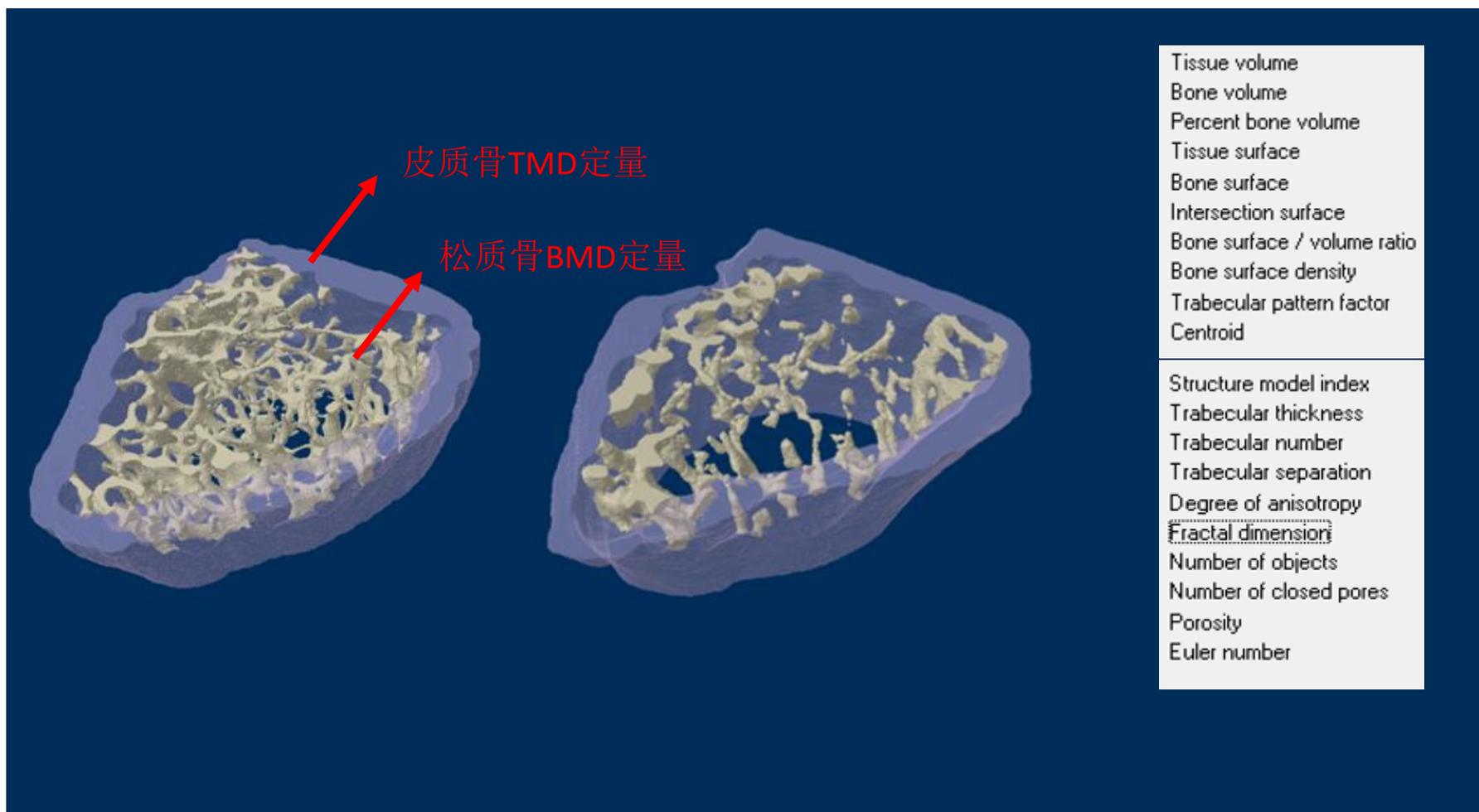


骨皮质



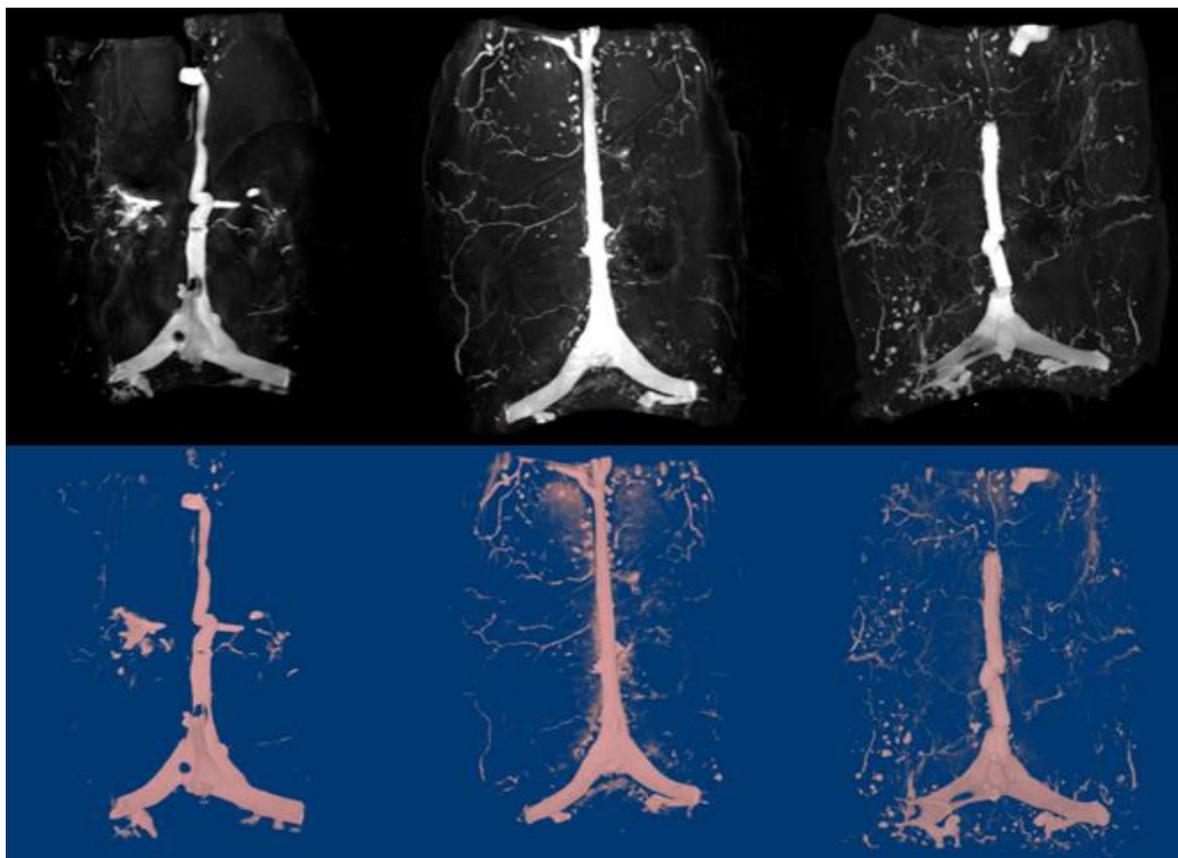
## 四、成像应用-骨骼扫描及定量计算

小鼠股骨3D成像、骨密度、骨参数定量计算



## 四、成像应用-造影成像

小鼠颅骨血管造影 Image pixel size 6.5 $\mu$ m

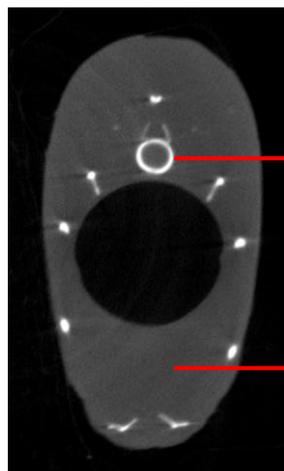


Ctvox 最大投影像

Ctan 处理后3D成像

## 四、成像应用-造影成像

斑马鱼造影 Image pixel size 4 $\mu$ m



骨骼

内脏、肌肉

造影前



肌肉

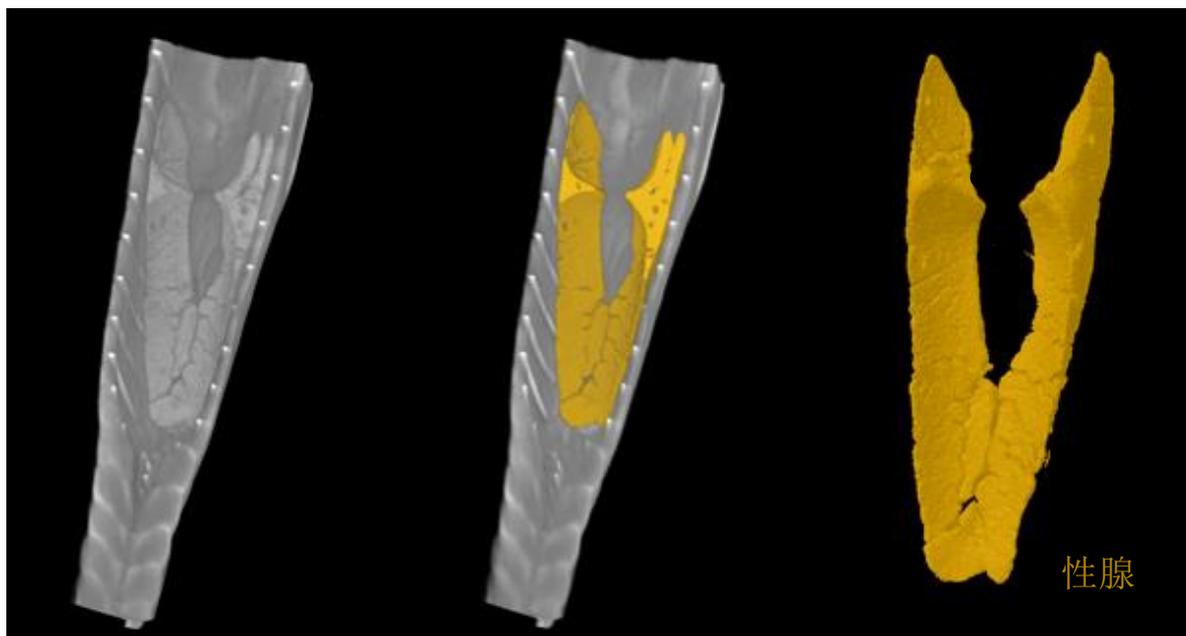
骨骼

腹腔

性腺

肠道

造影后



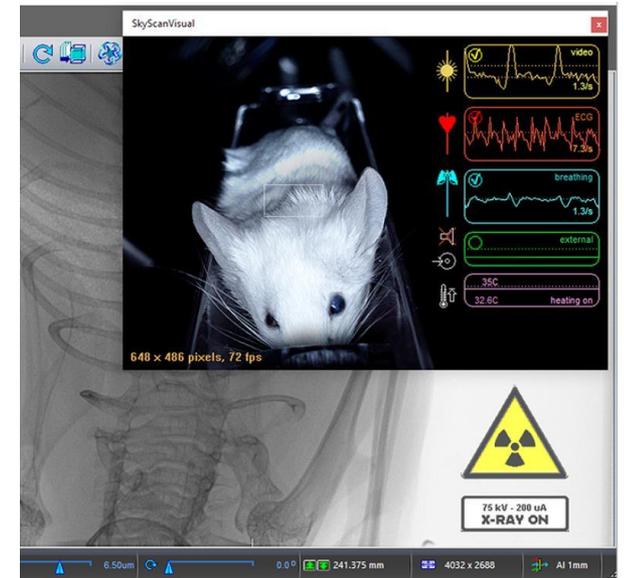
性腺

斑马鱼性腺3D成像

## 四、成像应用-肺部扫描



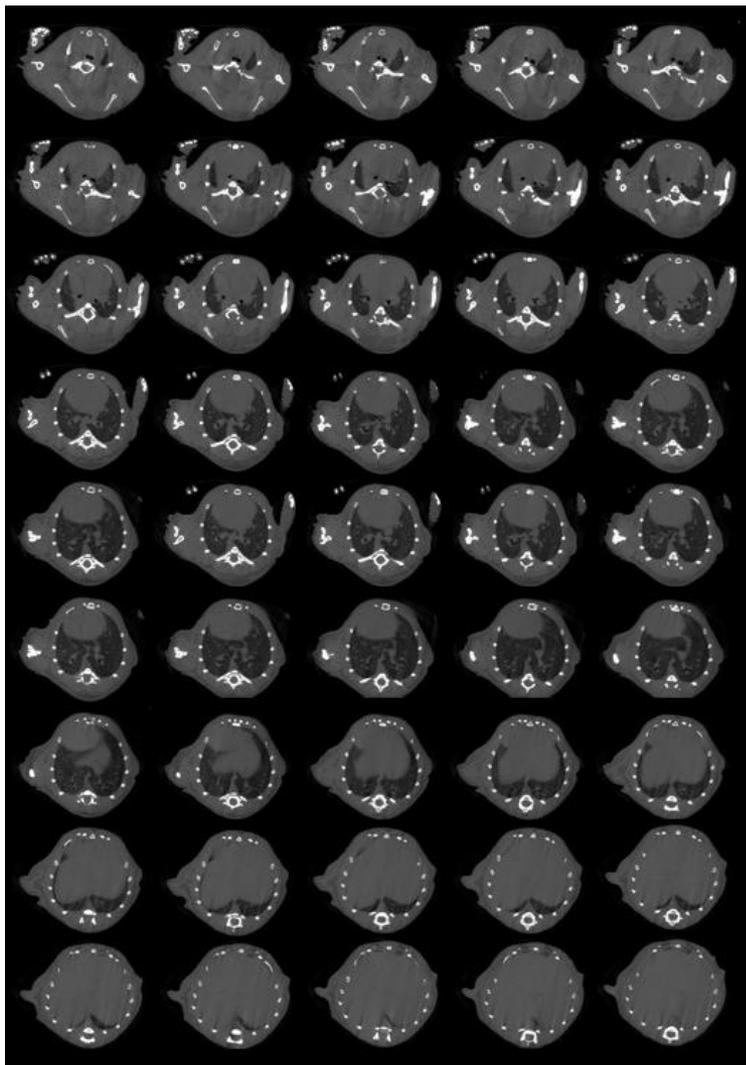
呼吸门控成像



扫描心电监测

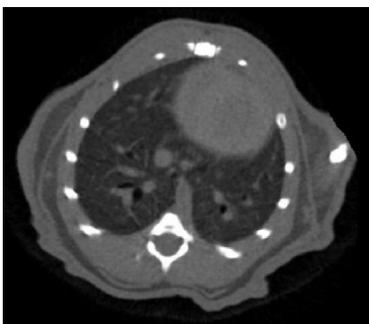
## 四、成像应用-肺部扫描

小鼠肺断层像 Image pixel size 35 $\mu$ m



# 四、成像应用-肺部扫描

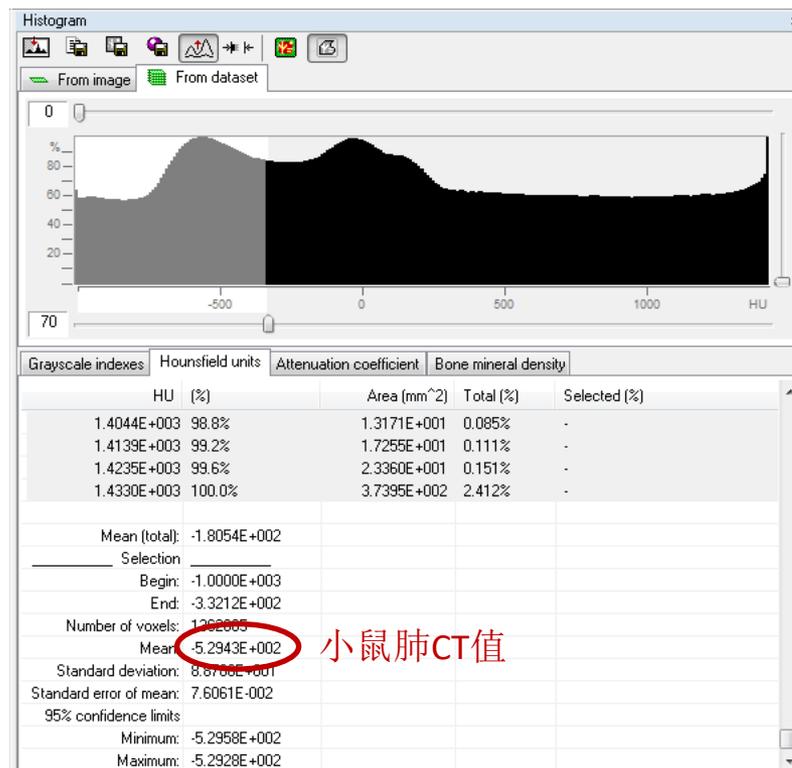
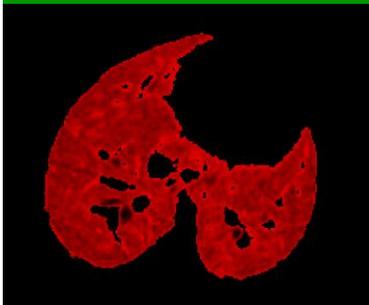
肺部断层像



肺部ROI选择



肺部ROI



## 四、成像应用-材料

### Hounsfield units (HU)



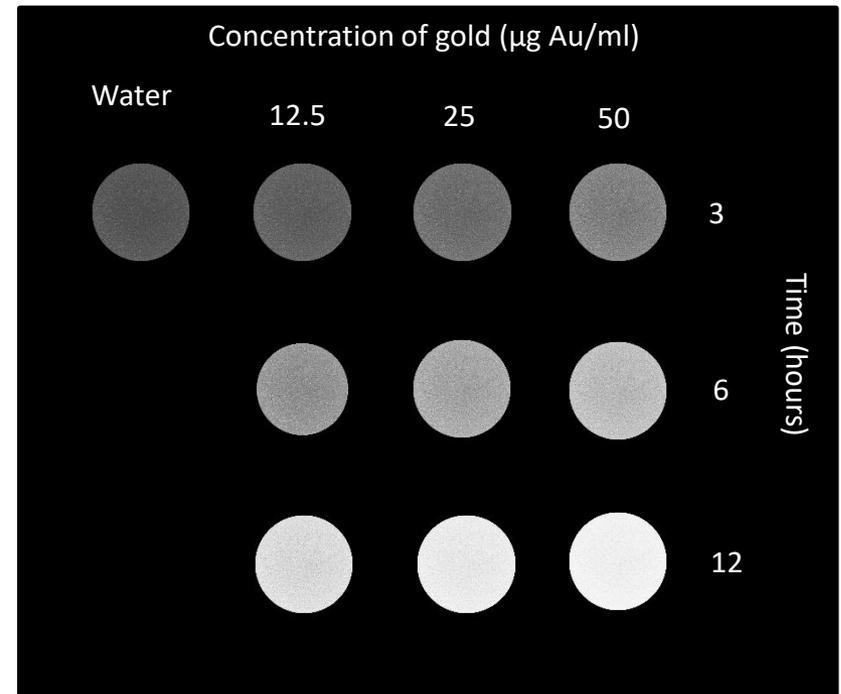
Density range calibration

Calibration unit	Min value	Max value
Index	0	255
HU	-1000	1433

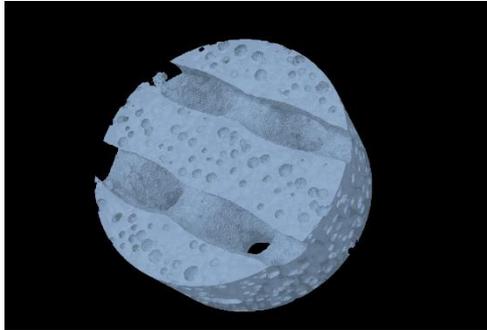
G279 : X ✓ fx

Evaluate

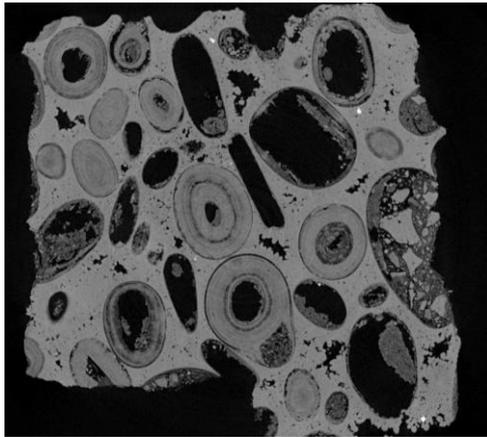
	A	B	C
274	Number of	2.31E+08	
275	Mean:	-5.86241	
276	Standard	39.46641	
277	Standard	0.0026	
278	95% confidence limits		
279	Minimum:	-5.8676	
280	Maximum:	-5.85722	
281			



## 四、成像应用-材料



生物材料



矿石

3D Analysis Results

Dataset: subsea\_ir\_rec\_voi\_  
Number of layers: 118  
Computation time: 00:00:09

Description	Abbreviation	Value	Unit
Centroid (z)	Crd.Z	2894.46763	um
Number of objects	Obj.N	815	
Number of closed pores	Po.N(cl)	21702	
Volume of closed pores	Po.V(cl)	602945164.03227	um <sup>3</sup>
Surface of closed pores	Po.S(cl)	84833811.75217	um <sup>2</sup>
Closed porosity (percent)	Po(cl)	2.80829	%
Volume of open pore space	Po.V(op)	3683581867.50...	um <sup>3</sup>
Open porosity (percent)	Po(op)	14.64423	%
Total volume of pore space	Po.V(tot)	4286527031.53...	um <sup>3</sup>
Total porosity (percent)	Po(tot)	17.04127	%
Euler number	Eu.N	21672	
Connectivity	Conn	845	
Connectivity density	Conn.Dn	0.00000	1/um <sup>3</sup>

The auto saving of results is done in subsea\_ir\_rec\_voi\_3d.csv

定量计算

# 谢谢!



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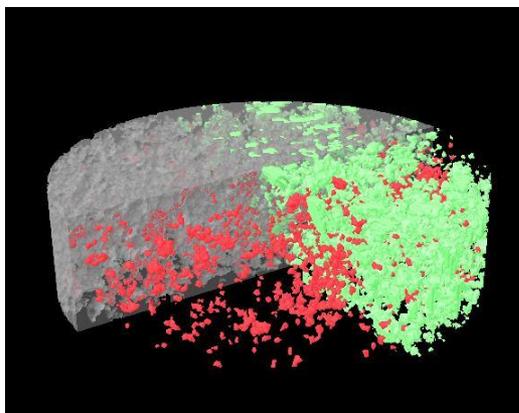
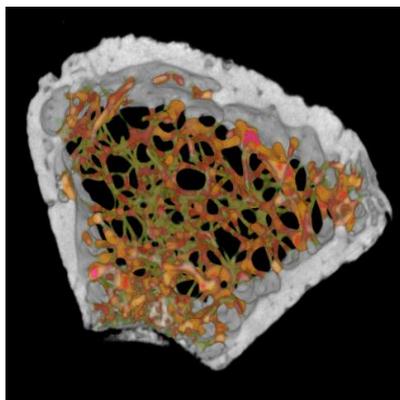


## 样品接收

方式	模型	部位
离体	鼠/兔	单腿骨
		双腿骨
		颅骨
		尾骨
		椎骨
	植物	根
		茎
		叶
	鱼类	骨骼
		脂肪
内脏造影		
其它	生物材料	
	化石	
	软组织	
活体	鼠	局部
		全身
		心、肺门控

送样方式：固定后寄送  
冷冻寄送

# 检测项目



## 骨科学研究

指标名称	简写
骨表面积	BS
组织体积	TV
骨体积	BV
骨表面积骨体积比	BS/BV
骨表面积组织体积比	BS/TV
骨体积分数	BV/TV
骨矿物质密度	TMD
骨密度	BMD
骨小梁数	Tb.N
骨小梁厚度	Tb.Th
骨小梁分离度	Tb.Sp
骨小梁模式因子	Tb.Pf
结构模式指数	SMI
各向异性程度	DA
分形维度	FD
骨小梁连接密度	Conn.D
皮质骨总面积	Tt.Ar
皮质骨面积	Ct.Ar
皮质骨厚度	Ct.Th

## 材料学研究

指标名称	简写
封闭孔数	Po.N(cl)
封闭孔体积	Po.V(cl)
封闭孔表面积	Po.S(cl)
封闭孔隙率	Po(cl)
开放孔体积	Po.V(op)
开放孔隙率	Po(op)
孔隙总体积	Po.V(tot)
总孔隙率	Po(tot)

## 脂肪代谢研究

指标名称	简写
组织体积	TV
脂肪体积	FV
脂肪积分数	FV/TV