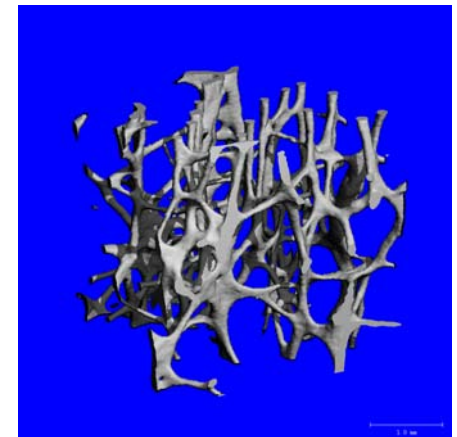
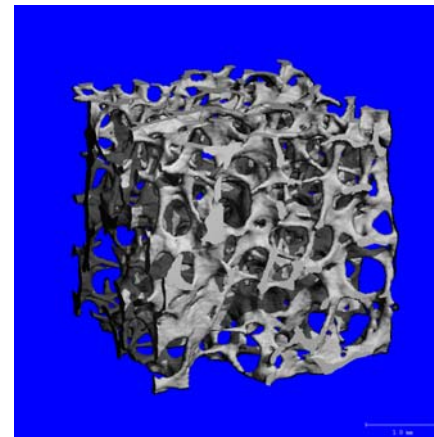
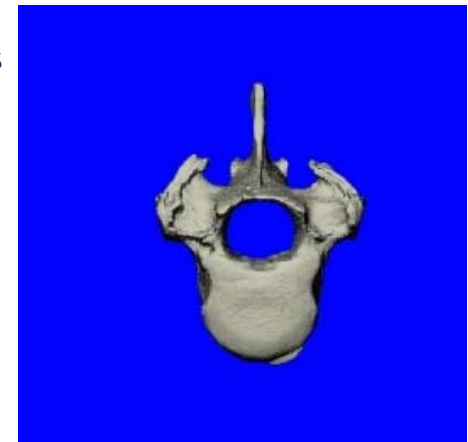


Bone microarchitecture scanners MicroCT - XtremeCT

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- ❖ **MEDES- French institute for Space Physiology and Medicine**
 - ❖ **In space**
 - Bone loss of astronauts
 - Supporting research - Effects of mechanical constraints on bone remodeling
 - ❖ **Context for studies on bone**
 - DEXA: information on density only - idea on bone quantity
 - Bone markers
 - Bone biopsies / histomorphometry
 - ➔ Need for an imaging tool for:
 - Information on **bone quality**
 - « Virtual biopsies »
 - Longitudinal studies on **bone microarchitecture changes** (trabecular bone)
 - Estimation of fracture risk
 - In vitro / in-vivo / clinical device
- ⇒ **SCANCO products: μ CTs, vivaCT, XtremeCT**



Added value of microCT scans

❖ Bone microarchitecture imaging

- Bone geometry
- Information on bone structure -> Contribution to the bone quality

❖ High resolution

- From 10 μ m (μ CT) to about 100 μ m depending on size of sample/image area, device and use.

❖ Quantitative structural information on cancellous and cortical bone

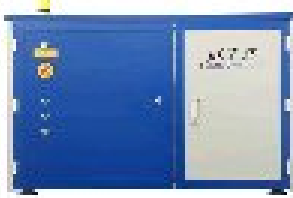
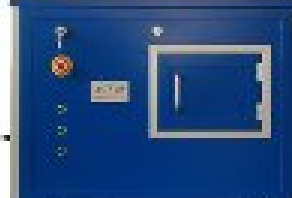
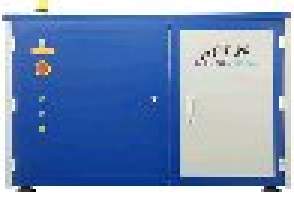
❖ Analysis of the true 3D structure of trabecular bone + morphological properties

❖ Allows further data processing

- FEA
- Other image analyses



Big size of data (several GBs), need very good computers + storage capacities for further processing

Feature	<i>μCT 35</i> SCANCO MEDICAL	<i>μCT 40</i> SCANCO MEDICAL	<i>μCT 80</i> SCANCO MEDICAL
			
<i>Peak/Mean Energy</i>	30-70 kVp / 20-50 keV	30-70 kVp / 20-50 keV	30-70 kVp / 20-50 keV
<i>Max. Scan Diam. / Len.</i>	36.9 mm / 120 mm	36.9 mm / 80 mm	75.8 mm / 120 mm
<i>Resolution (Nominal, 10% MTF)</i>	1.75-72 μm / <5 μm	6-72 μm / 9 μm 9 μm at 10mm object size - 20μm at 36 mm diameter, 8 cm length	10-74 μm / 15-90 μm
<i>Minimal Scan Time per Slice</i>	3 s	2 s	3 s
<i>Image Matrix</i>	512 × 512 1024 × 1024 2048 × 2048	512 × 512 1024 × 1024 2048 × 2048	512 × 512 1024 × 1024 2048 × 2048

Highest resolution - less than 5 μm

High resolution for large samples
78mm scan diameter - possibility to evaluate complete human bones

➔ Compromise between sample size and resolution

VivaCT - XtremeCT

Feature	<i>vivaCT 40</i> SCANCO MEDICAL	<i>vivaCT 75</i> SCANCO MEDICAL	 XtremeCT
			
Type	in vivo (animal)	in vivo (animal)	in vivo (human)
Geometry	Cone-Beam	Cone-Beam	Cone-Beam
Peak/Mean Energy	30-70 kVp / 20-50 keV	30-70 kVp / 20-50 keV	60 kVp / 40 keV
Max. Scan Diameter	20-38 mm	40-78 mm	125 mm
Max. Scan Length	145 mm	145 mm	150 mm
Nominal Resolution	10 μ m	20 μ m	42 μ m
Resolution (10% MTF)	20 mm \emptyset : 16 μ m	40 mm \emptyset : 32 μ m	125 mm \emptyset : 100 μ m
Slice Thickness	10-38 μ m	20-79 μ m	41-246 μ m
# of Slices	< 10000	< 10000	< 10000
Minimal Scan Time per Slice	3 s	2 s	1 s
2D-Image Matrix	512 x 512 1024 x 1024 2048 x 2048	512 x 512 1024 x 1024 2048 x 2048	512 x 512 up to 3072 x 3072

- ❖ **In vivo system for human extremities (Radius and Tibia)**
- ❖ **Interesting for analysing « big » samples**
- ❖ **Measures both density and structure**
- ❖ **Isotropic Resolution:**
 - ~100 µm
- ❖ **Scan time:**
 - 2-3 min for 110 sections (clinical use) (9 mm, 1536 x 1536)
 - For bigger samples - (ex mandibles Pr. Braga)
 - 2834 slices - 5 hours 1/2 - reconstruction
 - time - 80 hours
- ❖ **FOV: 128 mm**
- ❖ **Scan Length: 150 mm**



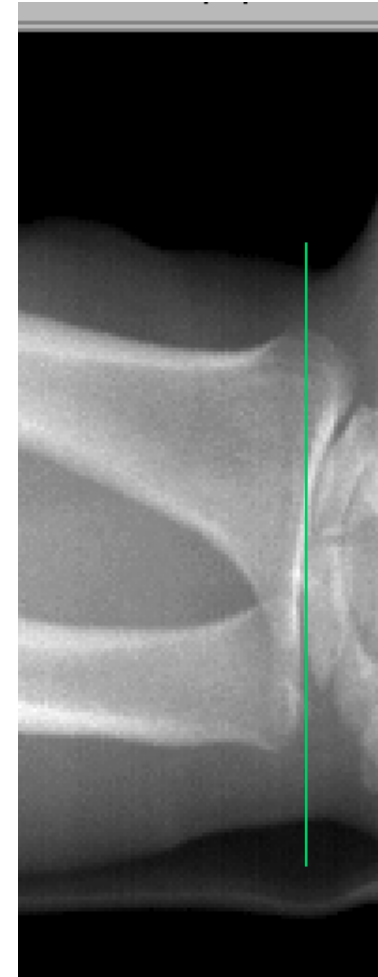
- ❖ **Image Matrix:**
 - 1536x1536 (default), possible up to 3072x3072
- ❖ **Transfer to DICOM files**

- ❖ 82 μm pixel size allows to image the three-dimensional trabecular network in the human forearm and lower leg
- ❖ Isotropic 3D resolution

Radius of 65 year old male volunteer

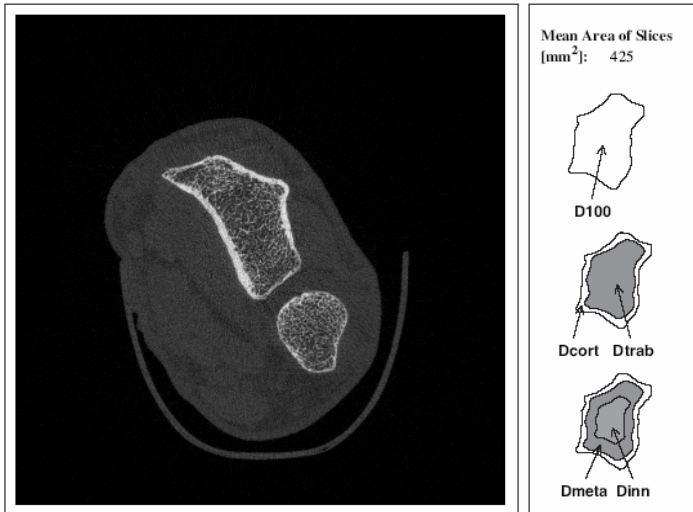


- ❖ **Warmup incl. QC (~ 30 min)**
- ❖ **Calibration Scan**
- ❖ **Positioning**
 - Scout-View (Radiograph)
 - Laser Positioning
- ❖ **Scan**
- ❖ **Automatic Launch of reconstruction**
- ❖ **Evaluation**
 - Drawing outline of first slice
 - Automatic Calculation of Parameters offline



Automatic standard evaluations

Site: Radius
 Pat-No.: 10 Filename: C0000300
 M-No.: 310 Date: 12-MAR-2003 02:51
 Born: 1.1.1949 Age: 54



Densities			Structure		
D100	[mg HA/ccm]	283	BV/TV	[1]	0.177
Dtrab	[mg HA/ccm]	212	Tb.N	[1/mm]	2.42
Dmeta	[mg HA/ccm]	345	Tb.Th	[mm]	0.073
Dinn	[mg HA/ccm]	122	Tb.Sp	[mm]	0.340
Ratio: Meta/Inn	[1]	2.83			
Dcort	[mg HA/ccm]	729	C.Th	[mm]	0.27

D100	Average Bone Density	BV/TV	Trab. Bone Volume to Tissue Volume
Dtrab	Trabecular Bone Density	Tb.N	Number of Trabeculae
Dmeta	Meta Trab. Bone Density	Tb.Th	Trabecular Thickness
Dinn	Inner Trab. Bone Density	Tb.Sp	Trabecular Separation
Meta/Inn	Ratio Meta to Inner Density		
Dcort	Cortical Bone Density	C.Th	Cortical Thickness

- ❖ Trabecular and cortical evaluation of radius
- ❖ Density as well as structural indices such as Tb.N, Tb.Th_(derived), Tb.Sp_(derived) and C.Th
- ❖ Matching of Region of Interest between scans

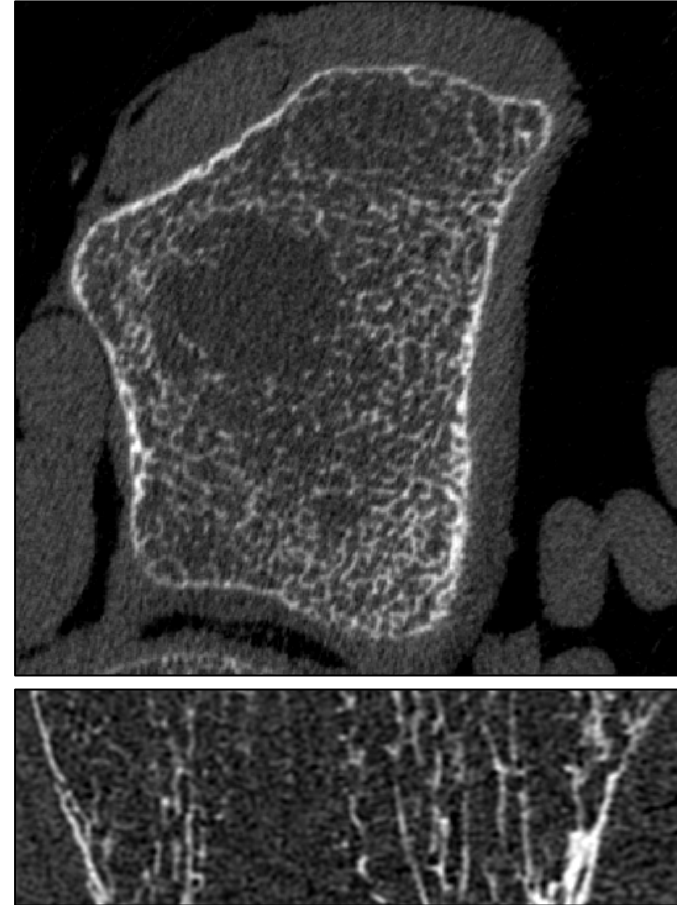
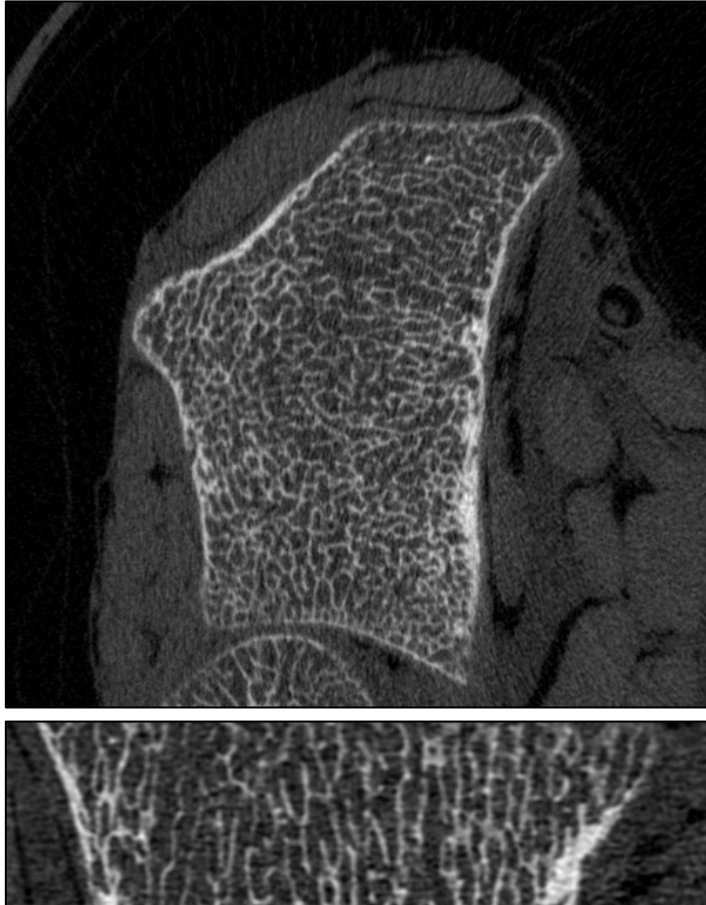
3D Density and Structure Analysis

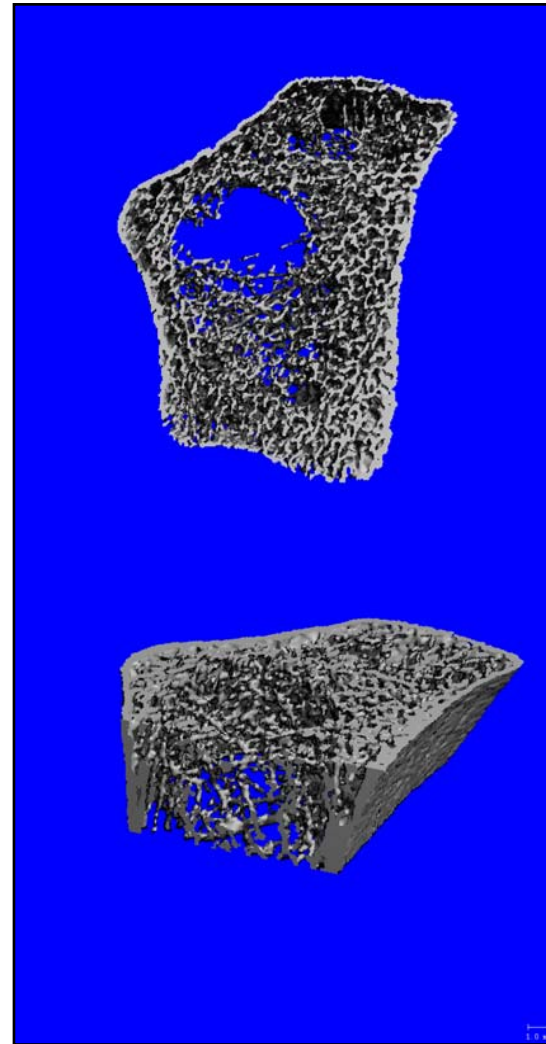
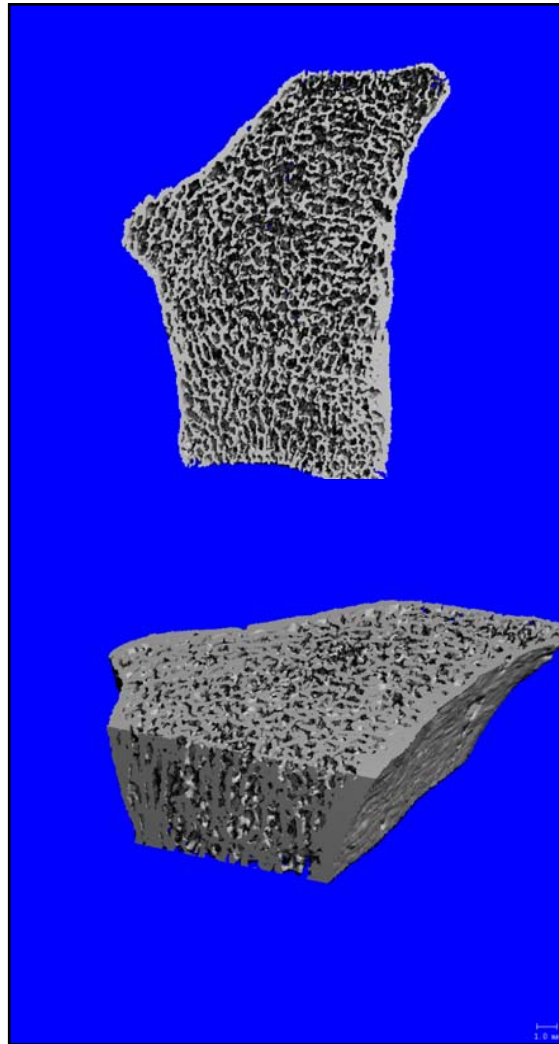
Automatic standard evaluations

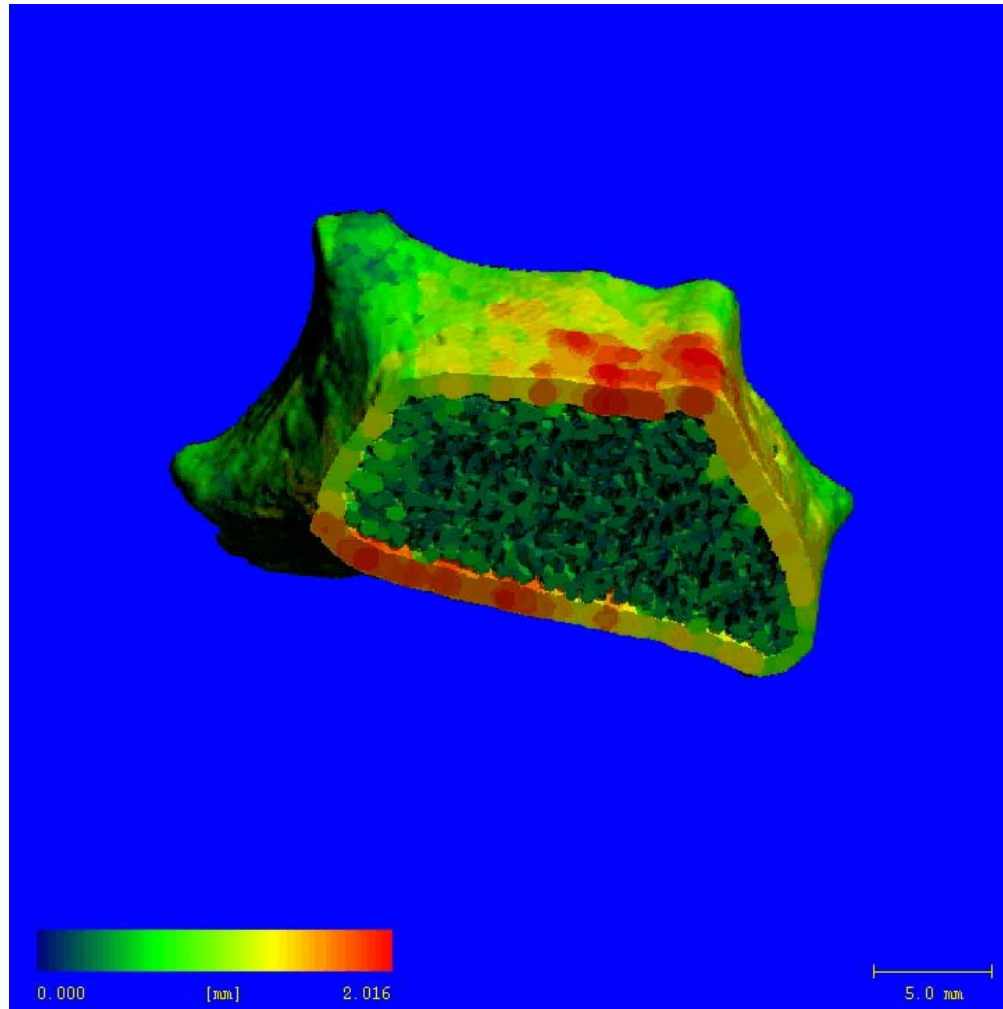
Densities			Structure		
D100	[mg HA/ccm]	283	BV/TV	[1]	0.177
Dtrab	[mg HA/ccm]	212	Tb.N	[1/mm]	2.42
Dmeta	[mg HA/ccm]	345	Tb.Th	[mm]	0.073
Dinn	[mg HA/ccm]	122	Tb.Sp	[mm]	0.340
Ratio: Meta/Inn	[1]	2.83			
Dcort	[mg HA/ccm]	729	C.Th	[mm]	0.27

D100 Average Bone Density
 Dtrab Trabecular Bone Density
 Dmeta Meta Trab. Bone Density
 Dinn Inner Trab. Bone Density
 Meta/Inn Ratio Meta to Inner Density
 Dcort Cortical Bone Density

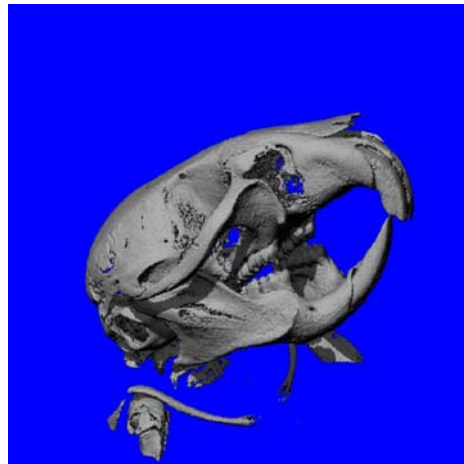
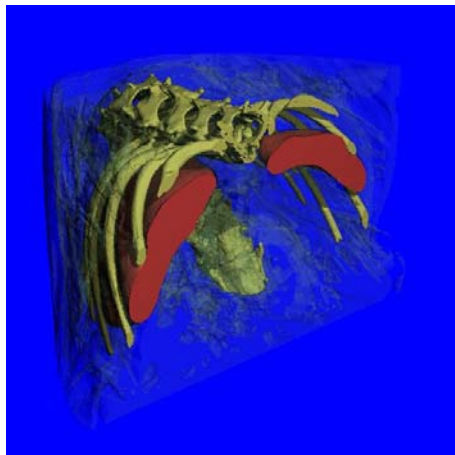
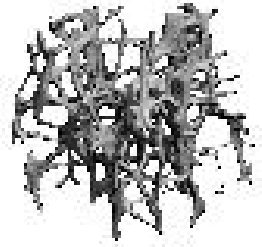
BV/TV Trab. Bone Volume to Tissue Volume
 Tb.N Number of Trabeculae
 Tb.Th Trabecular Thickness
 Tb.Sp Trabecular Separation
 C.Th Cortical Thickness







Other examples of images (μ CT, vivaCT)



Potential issues for labs...

❖ Computer « power » for scanning (at XtremeCT computer level)

- Sized for clinical samples
- For anthropology
 - Much longer scanning time
 - Much longer duration for reconstruction
 - Need for high storage capacity

❖ For further processing by labs:

- No problem to export data into DICOM files
- Definition of ways to retrieve data from XtremeCT location to the lab.
- Need for high storage capacity (scans of several GB)
- Need for high processing capacity
 - To read data
 - To process data
 - Image analysis
 - FEA
 - ...

❖ For exchanges between lab?

- Further exploitation of data
- On-line databases?

- ❖ Possible evolution of the devices that would be interested for your field?
- ❖ Type of parameters of interest for you?
- ❖ Further processing?
- ❖ Databases
- ❖ ...

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