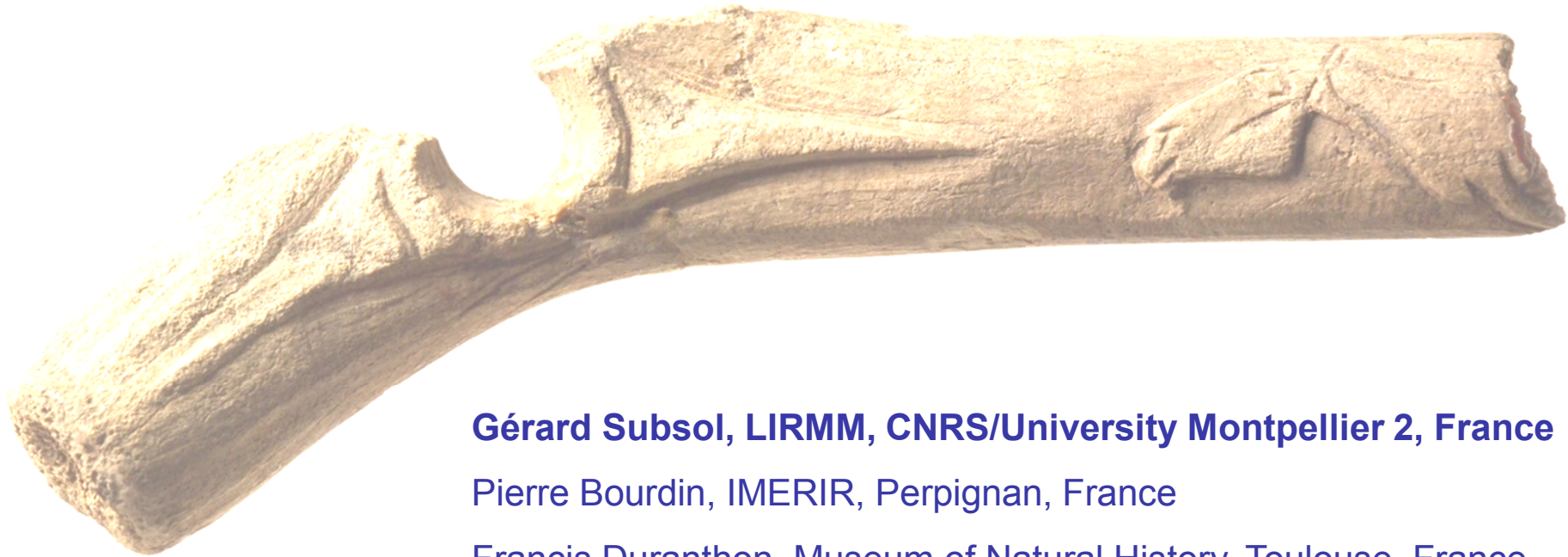# 3D digitizing and visualizing a prehistoric portable art object: a 12,000 years old "bâton percé"

Gérard Subsol, LIRMM, CNRS/University Montpellier 2, France

Pierre Bourdin, IMERIR, Perpignan, France

Francis Duranthon, Museum of Natural History, Toulouse, France

José Braga, AMIS Laboratory, CNRS/University Toulouse, France

Description of the "bâton percé"

- Prehistoric item made by Man (mobile art)
- ~ 10 cm long stick (="bâton")
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IMERIR

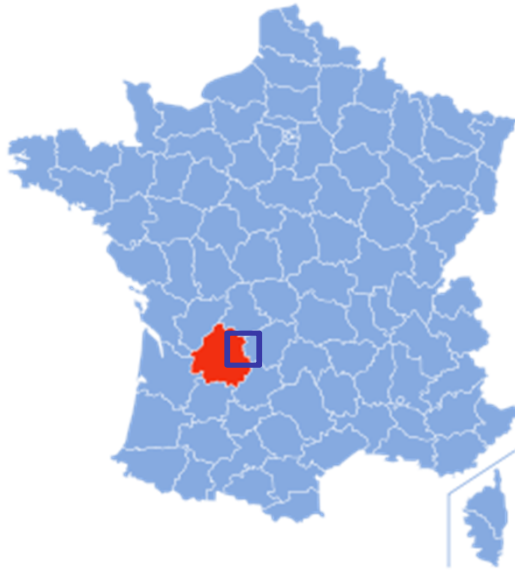LIRMM

MUSÉUM TOULOUSE

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- Fine engravings
- Broken into 2 parts: Museum of Toulouse / MAN, St Germain en Laye

Time and spatial context

Estimated age: ~ 12,000 BP   Found in la Madeleine shelter
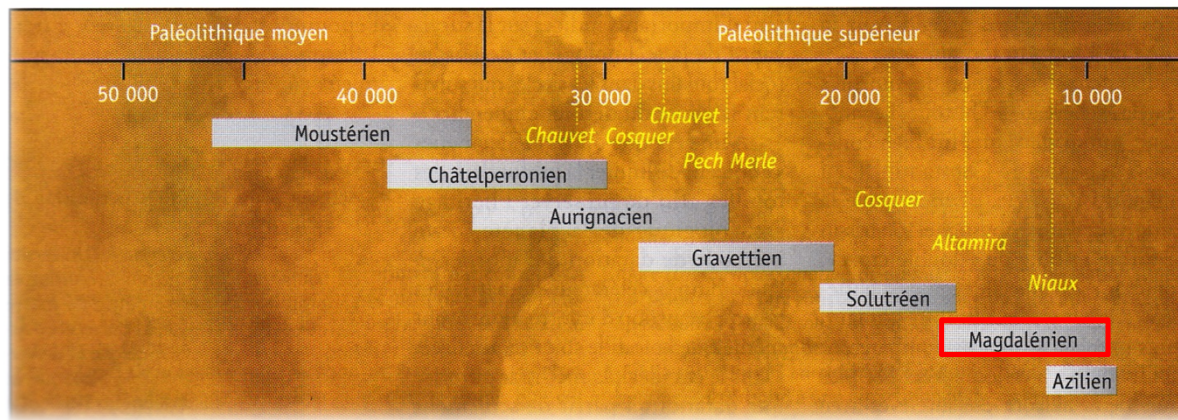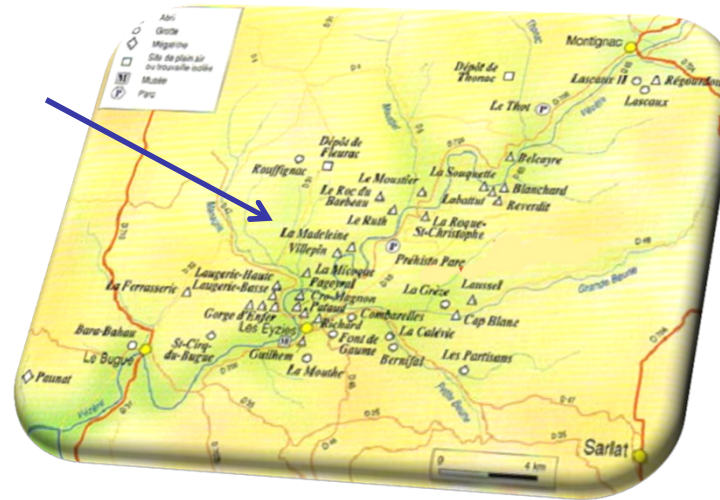
Magdalenian period
(17,000 to 9,000 BP)
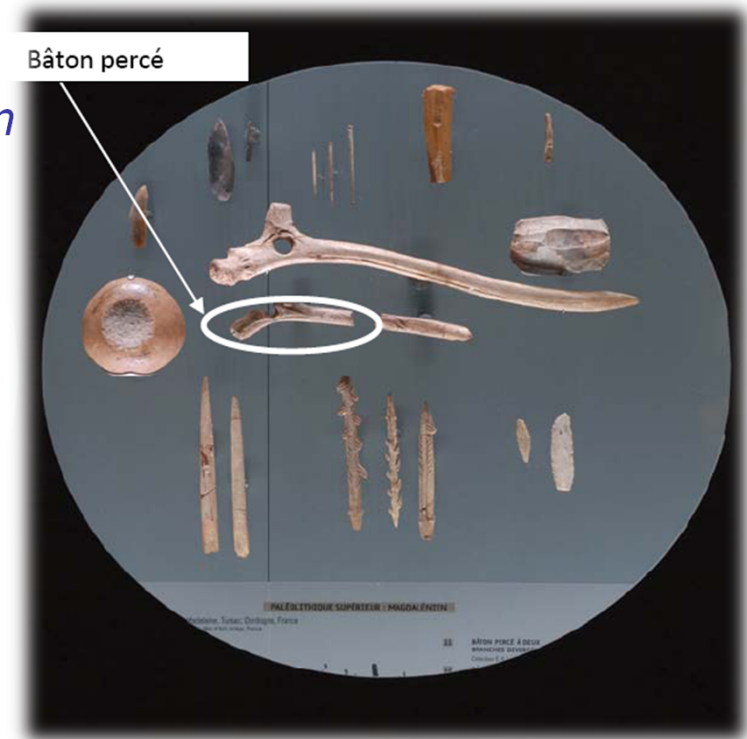**= period of a symbol and
cultural revolution**

Many interrogations…

► How the "bâton percé" was designed and built?
► What was its purpose (symbol of power, arrow straightener, spear thrower, etc.)?

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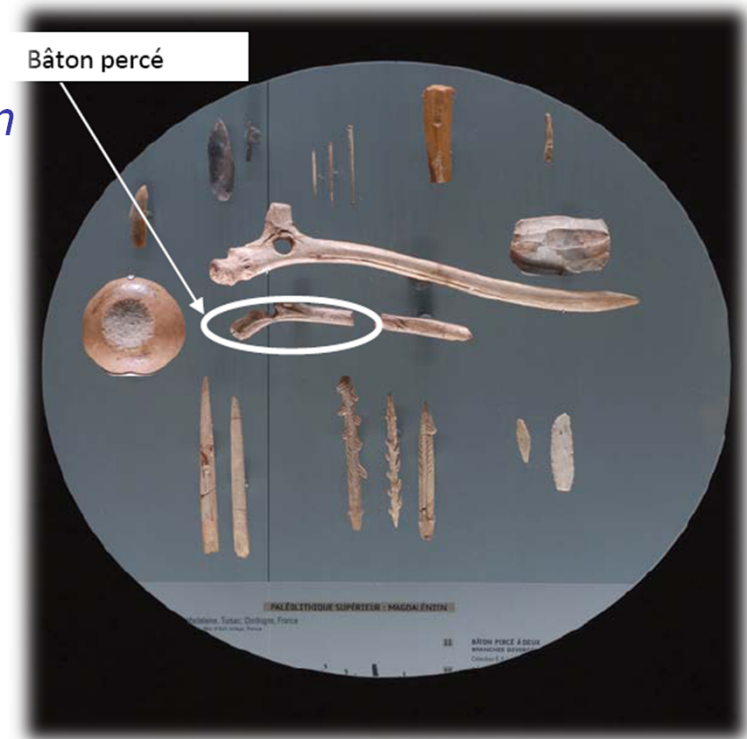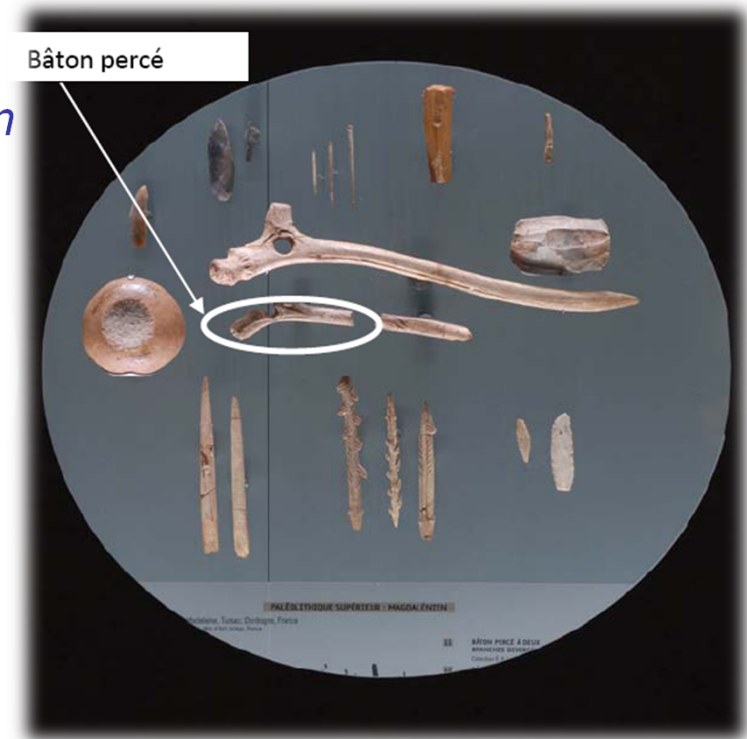► What was its purpose (symbol of power, arrow straightener, spear thrower, etc.)?

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→ *analysis of the material (species, age…)*

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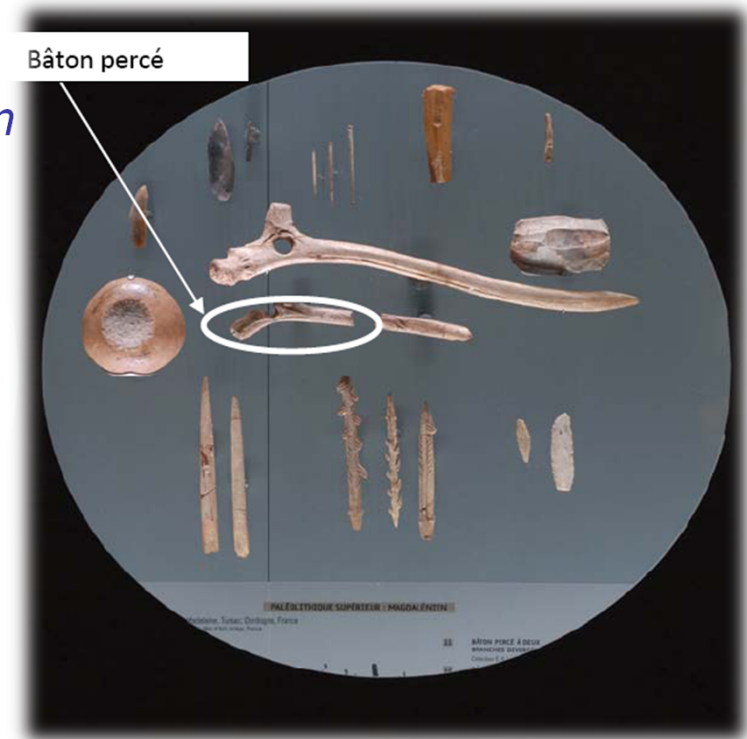► What was its purpose (symbol of power, arrow straightener, spear thrower, etc.)?

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Bâton percé

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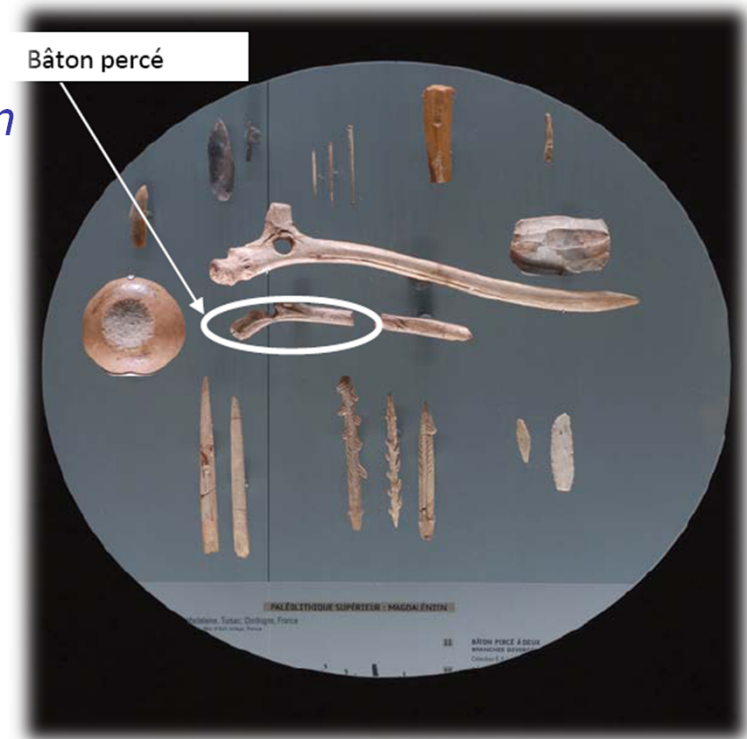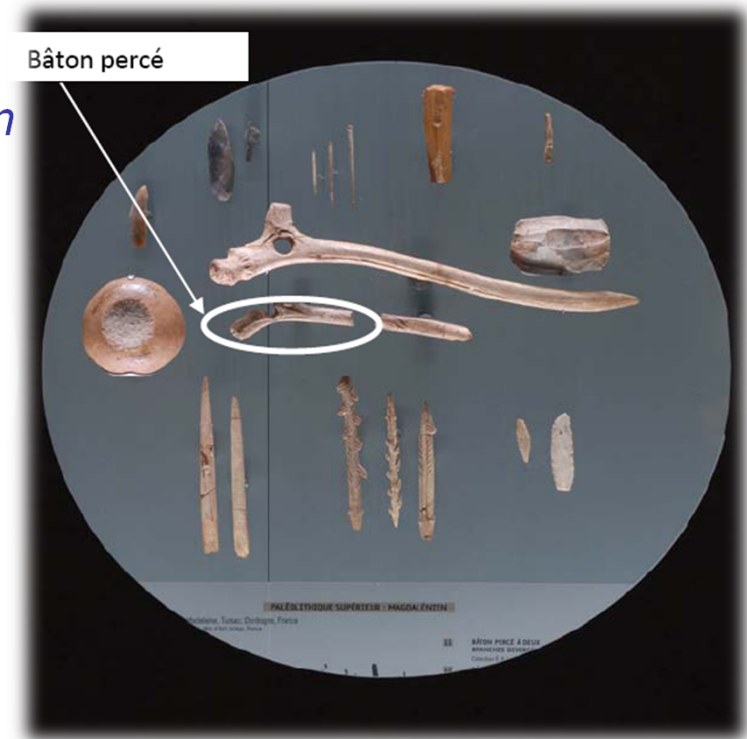► What was its purpose (symbol of power, arrow straightener, spear thrower, etc.)?

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    → *reassemble it*

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Bâton percé

► Build a "virtual" representation   → *test surface and volume scanning devices*
► Propose specific analysis tools   → *develop 3D visualization/interaction techniques*

Surface scanning
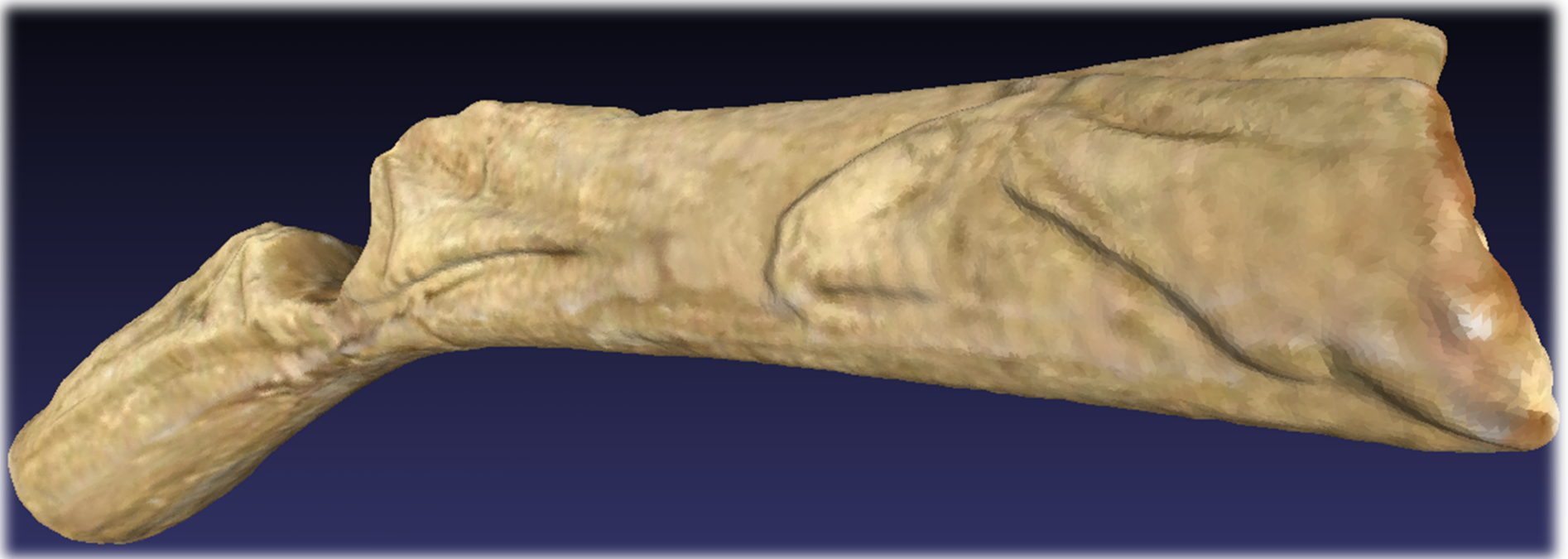
- Hand-held scanner (prototype) developed by a start-up (Noomeo©)

- Structured light projection (claimed resolution up to 50-100 μm)

- + high resolution photographs

- Heavy manual process (manipulation, registration, mapping)

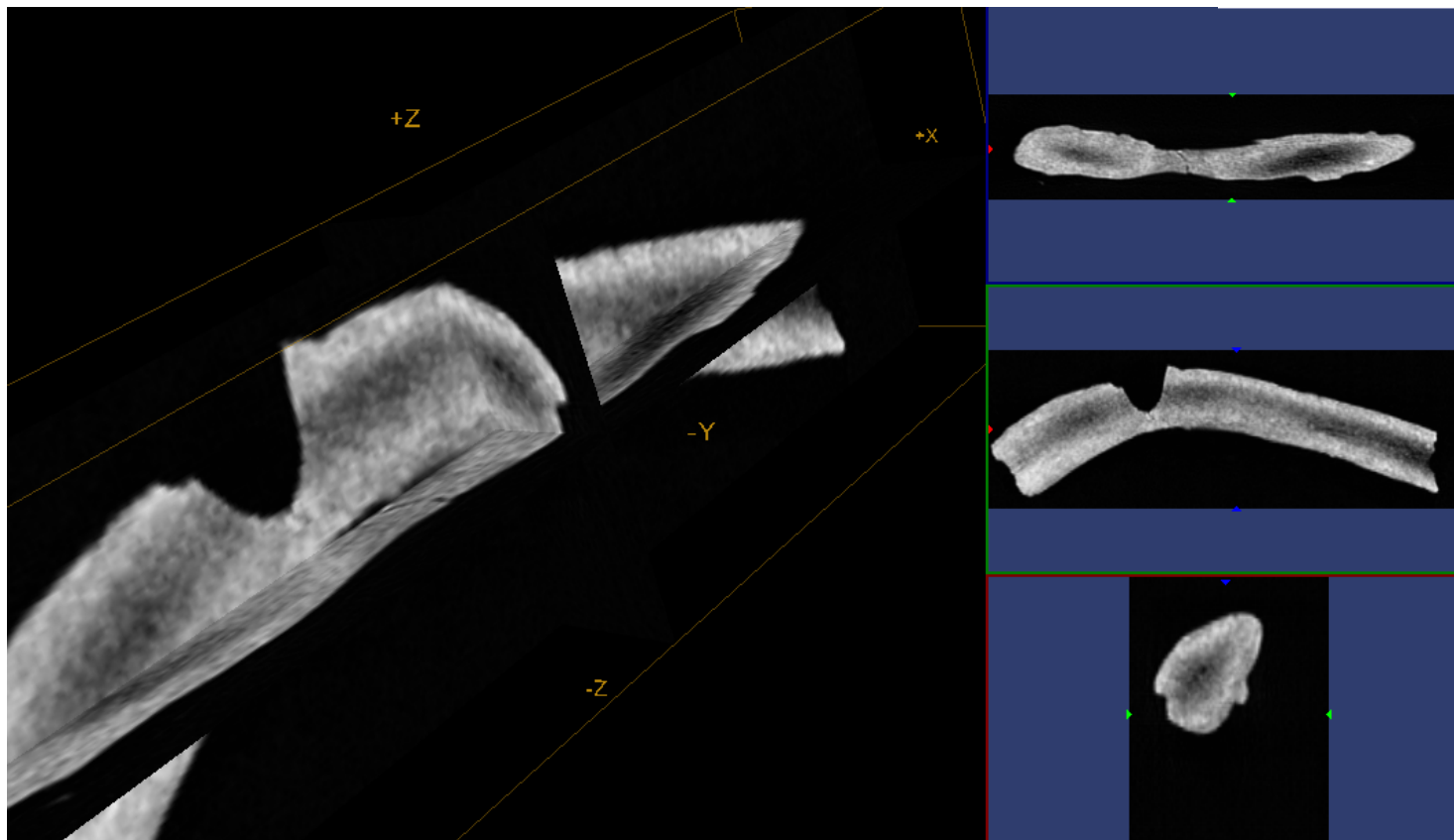*347,277 vertices / 329,210 faces + texture!*

Volume scanning: CT-Scan

Data file:

78 Mb

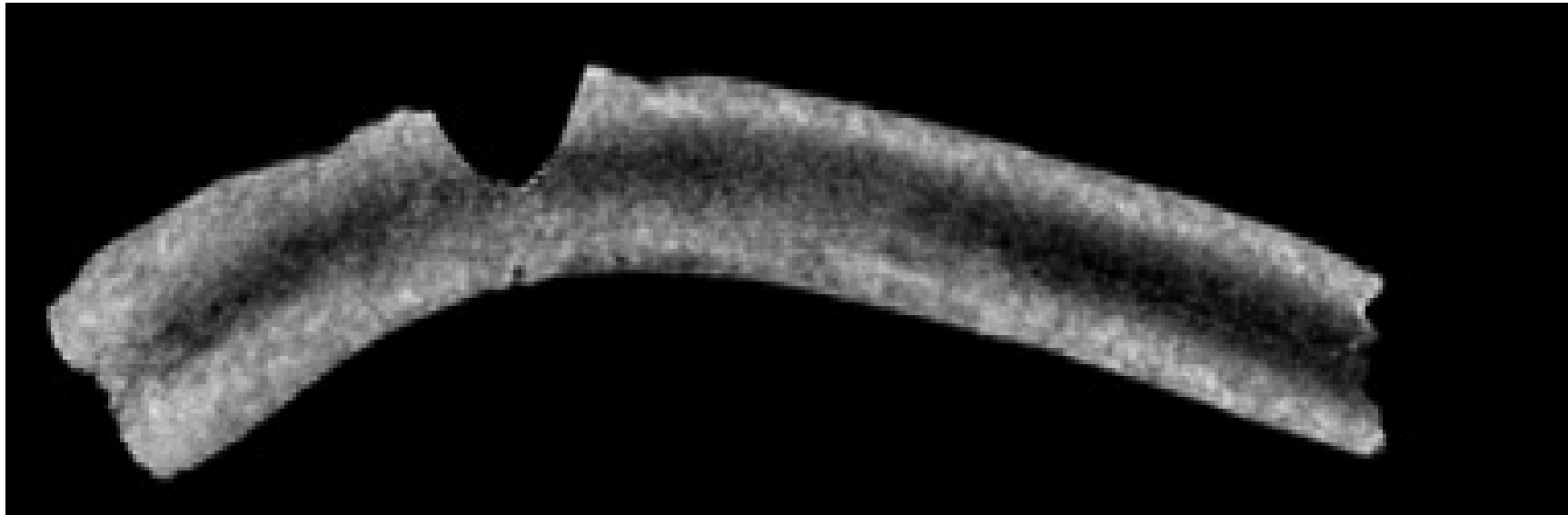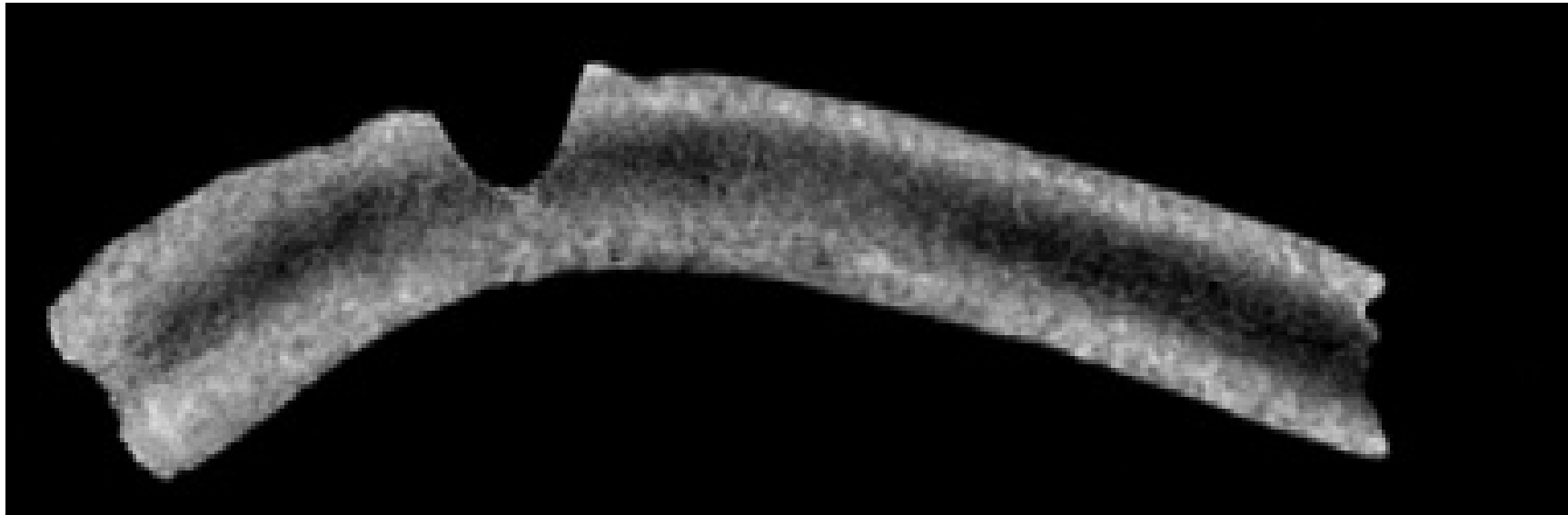512 x 512 x 154 slices

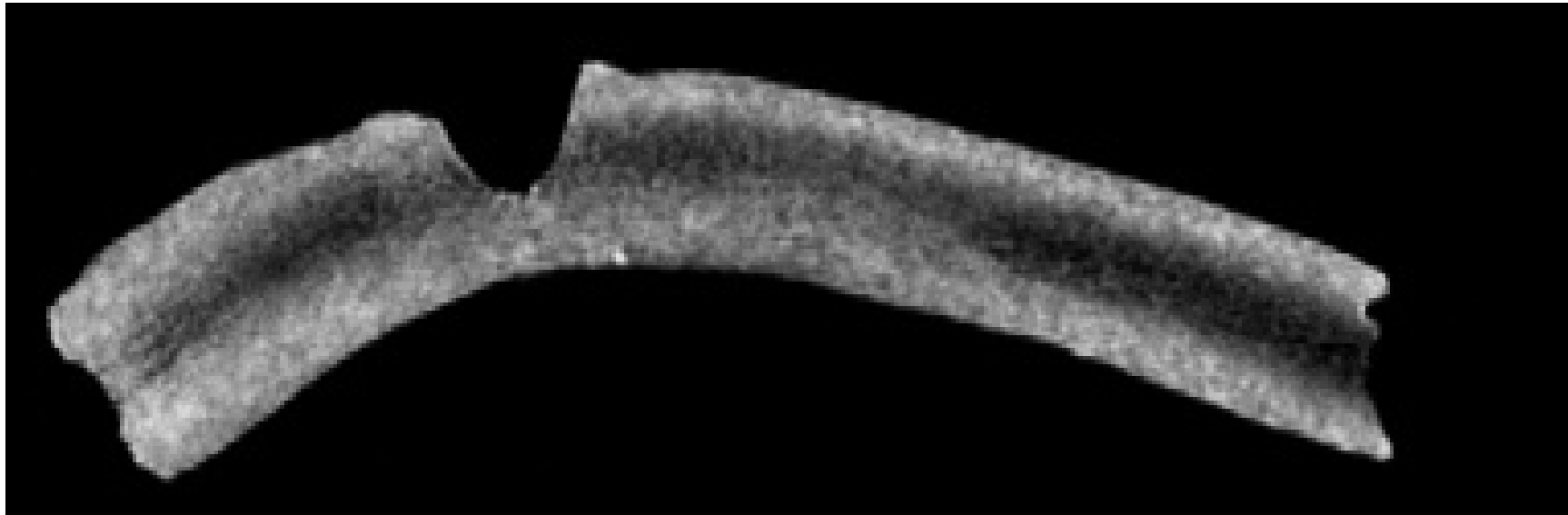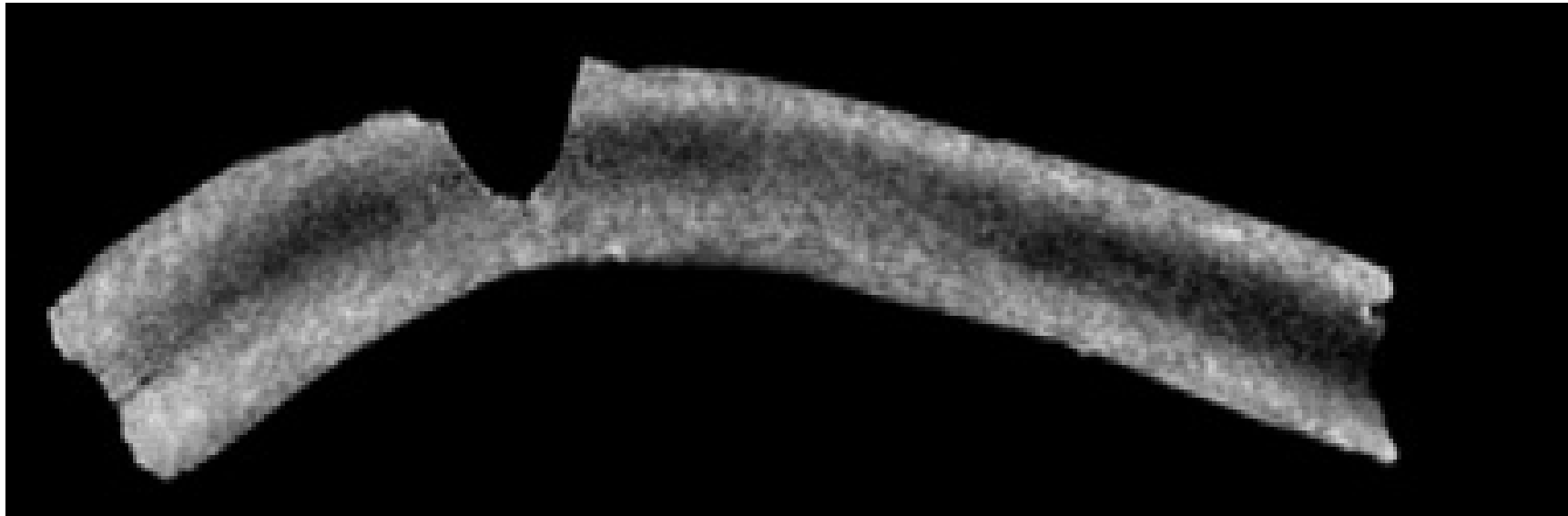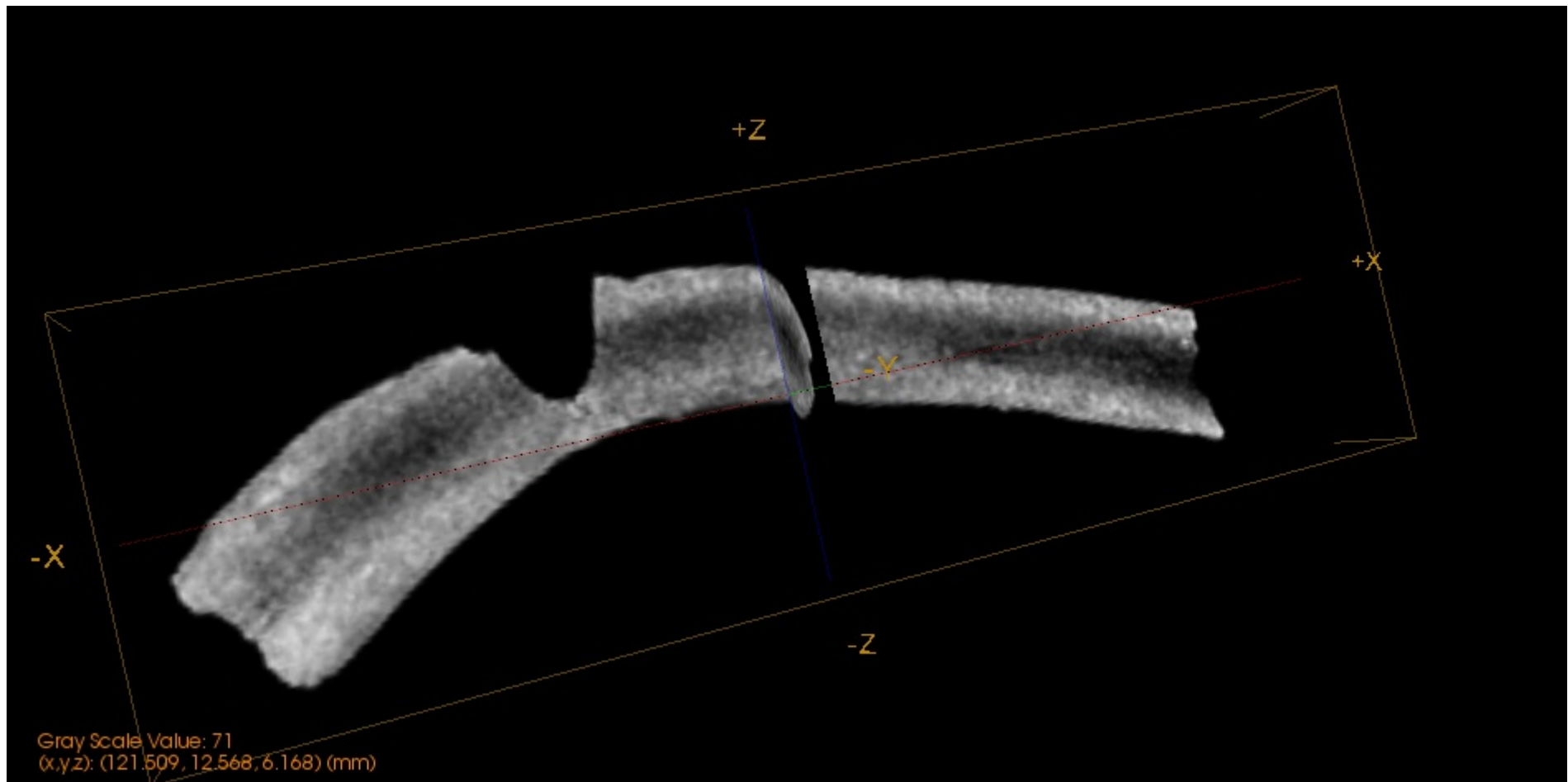0.322 mm x 0.322 mm x 0.300 mm

Volume scanning: CT-Scan

Data file:

78 Mb
512 x 512 x 154 slices
0.322 mm x 0.322 mm x 0.300 mm

Slice 130

Volume scanning: CT-Scan

Data file:

78 Mb
512 x 512 x 154 slices
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Slice 131

Volume scanning: CT-Scan

Data file:

    78 Mb

    512 x 512 x 154 slices

    0.322 mm x 0.322 mm x 0.300 mm

Slice 132

Volume scanning: CT-Scan

Data file:

        78 Mb
        512 x 512 x 154 slices
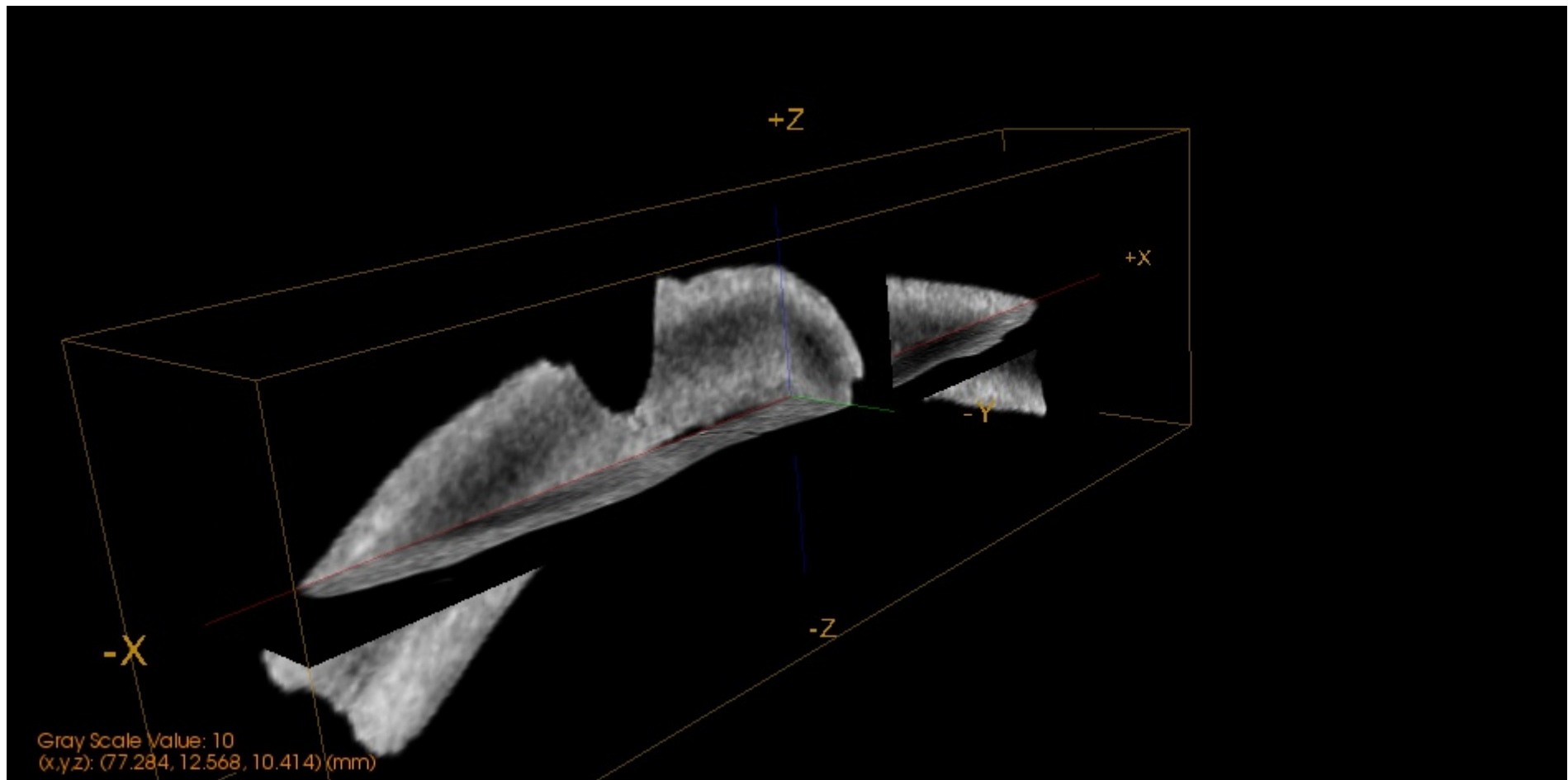   0.322 mm x 0.322 mm x 0.300 mm

Slice 133

Volume scanning: CT-Scan

Data file:

78 Mb
512 x 512 x 154 slices
0.322 mm x 0.322 mm x 0.300 mm

Volume scanning: CT-Scan

Data file:

    78 Mb
    512 x 512 x 154 slices
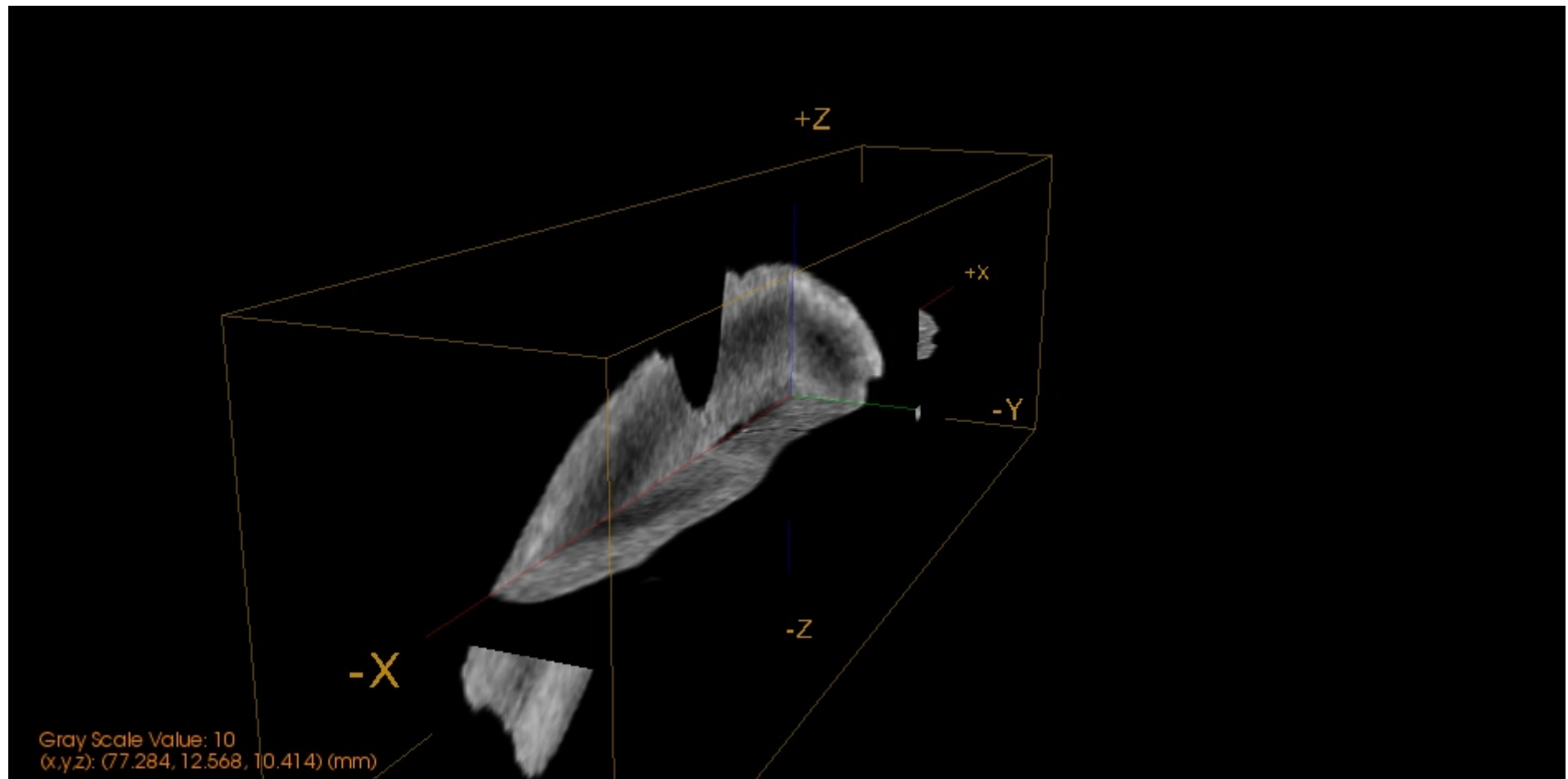   0.322 mm x 0.322 mm x 0.300 mm

3D digitizing and visualizing a prehistoric portable art object: a 12,000 years old "bâton percé"

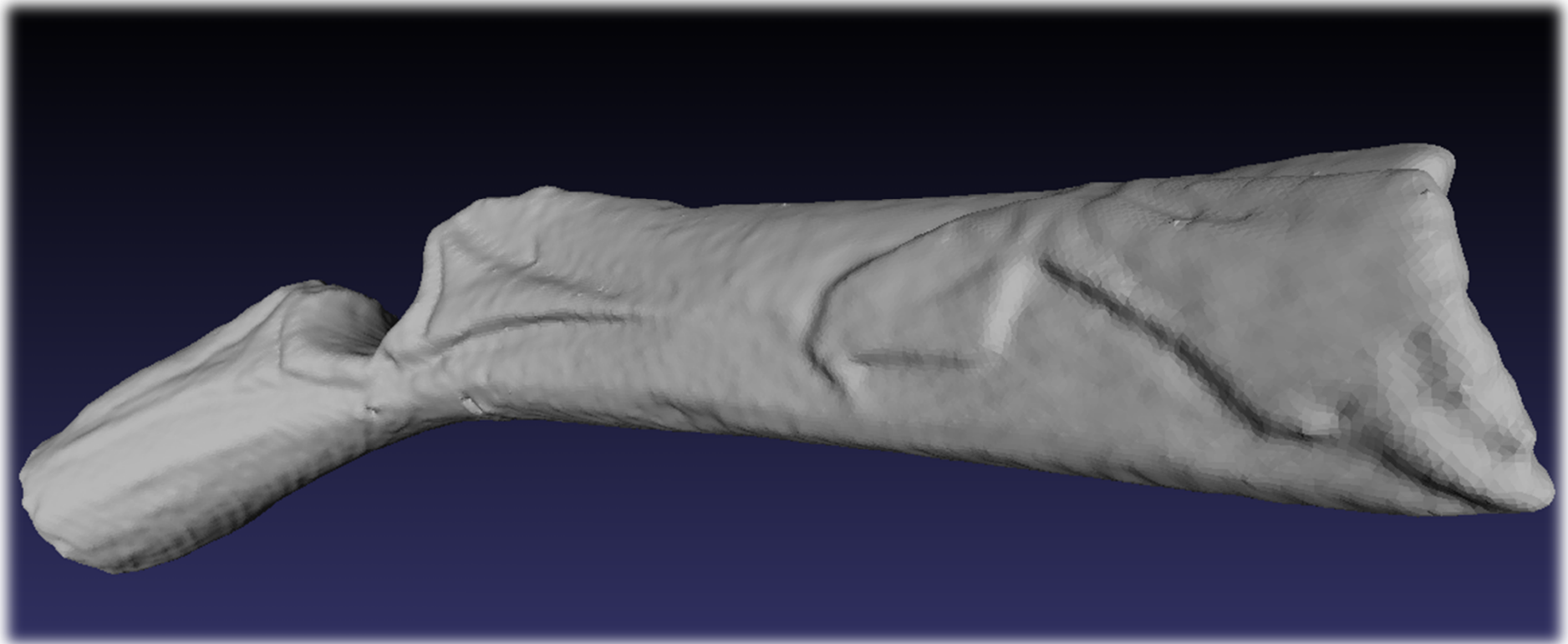# Volume scanning: CT-Scan

Data file:

    78 Mb

    512 x 512 x 154 slices

    0.322 mm x 0.322 mm x 0.300 mm

Volume scanning: CT-Scan

- Information in the volume: internal structure of the bone

- Processing: isosurface computation + surface smoothing

102,173 vertices / 197,214 faces
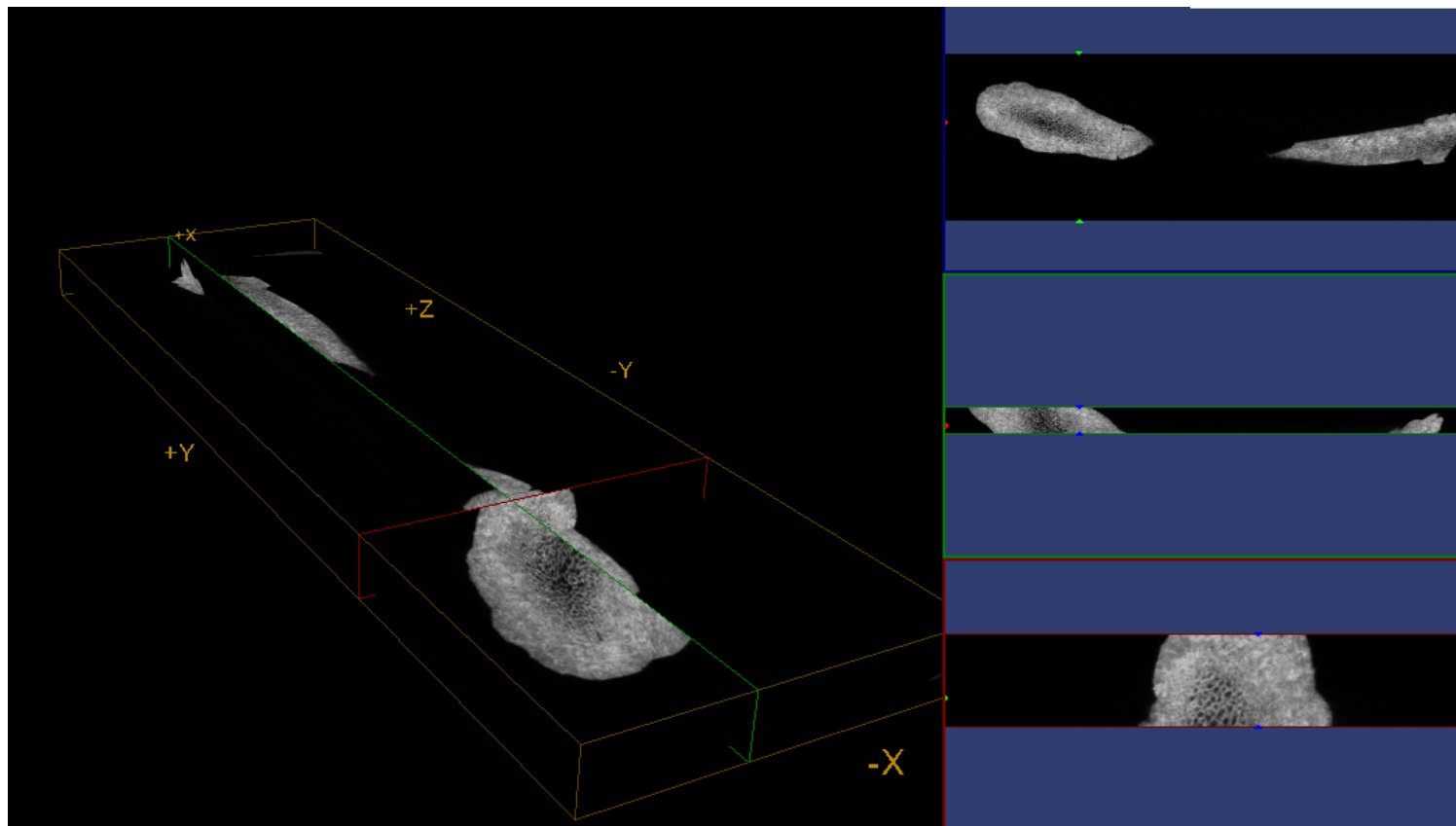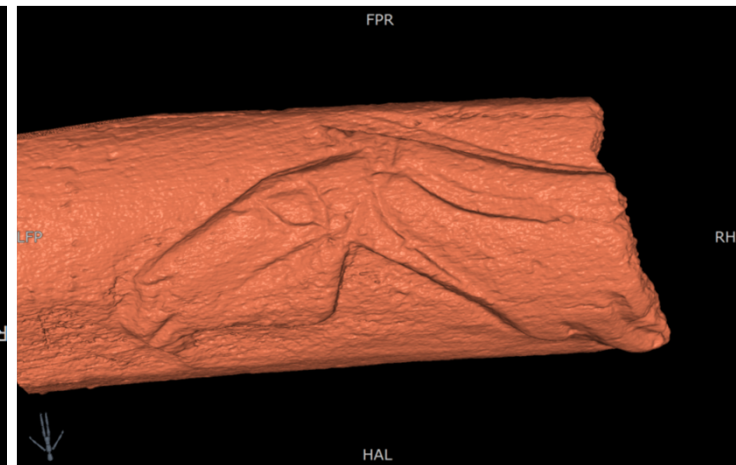
Volume scanning: µCT-Scan
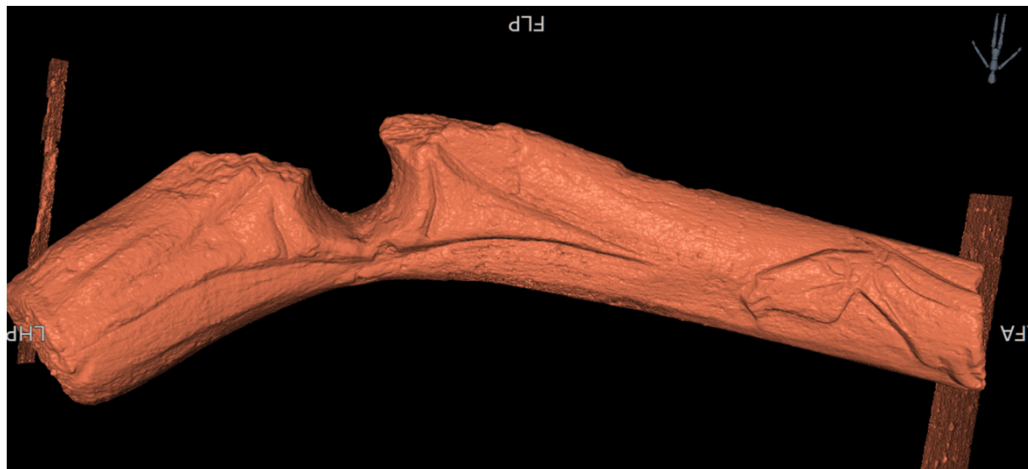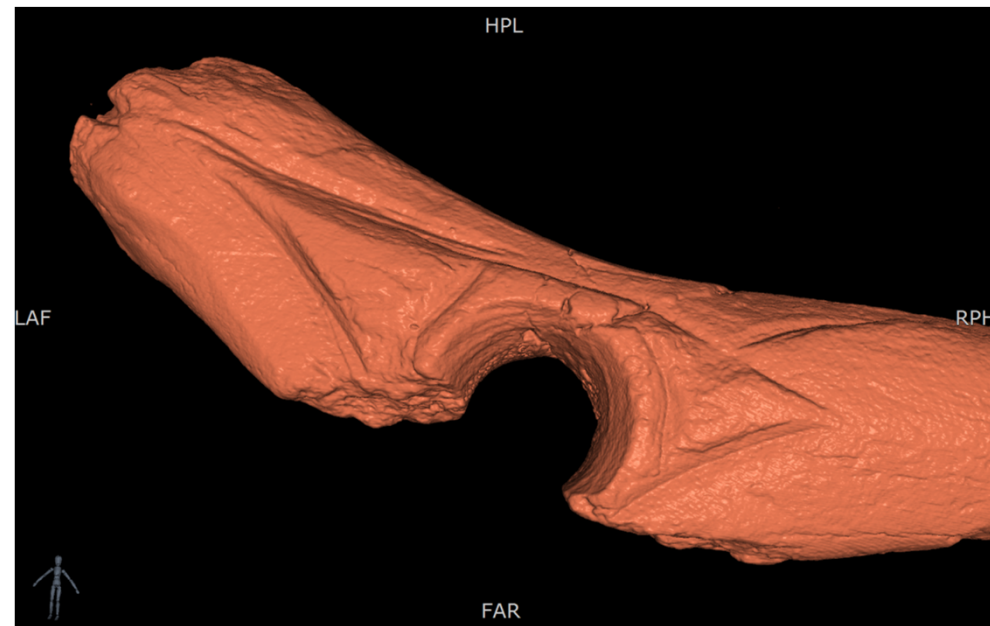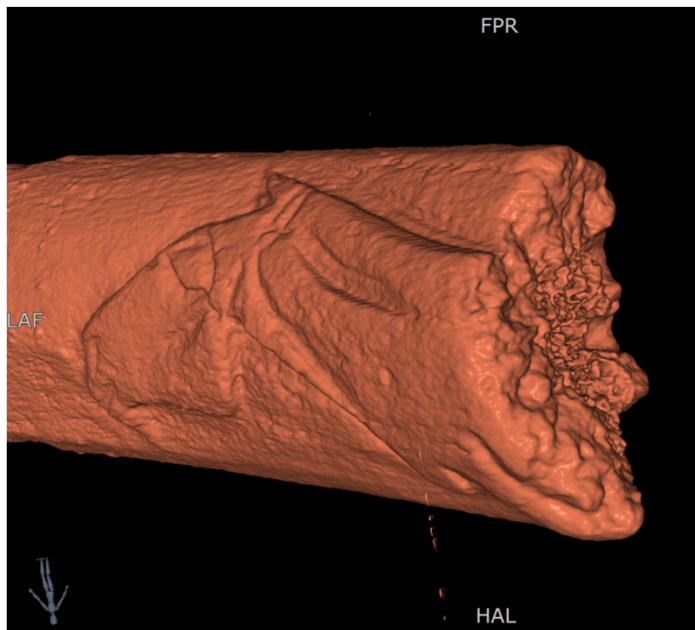
XtremeCT

Data file:

4.761 Gb
2780 x 836 x 908 slices
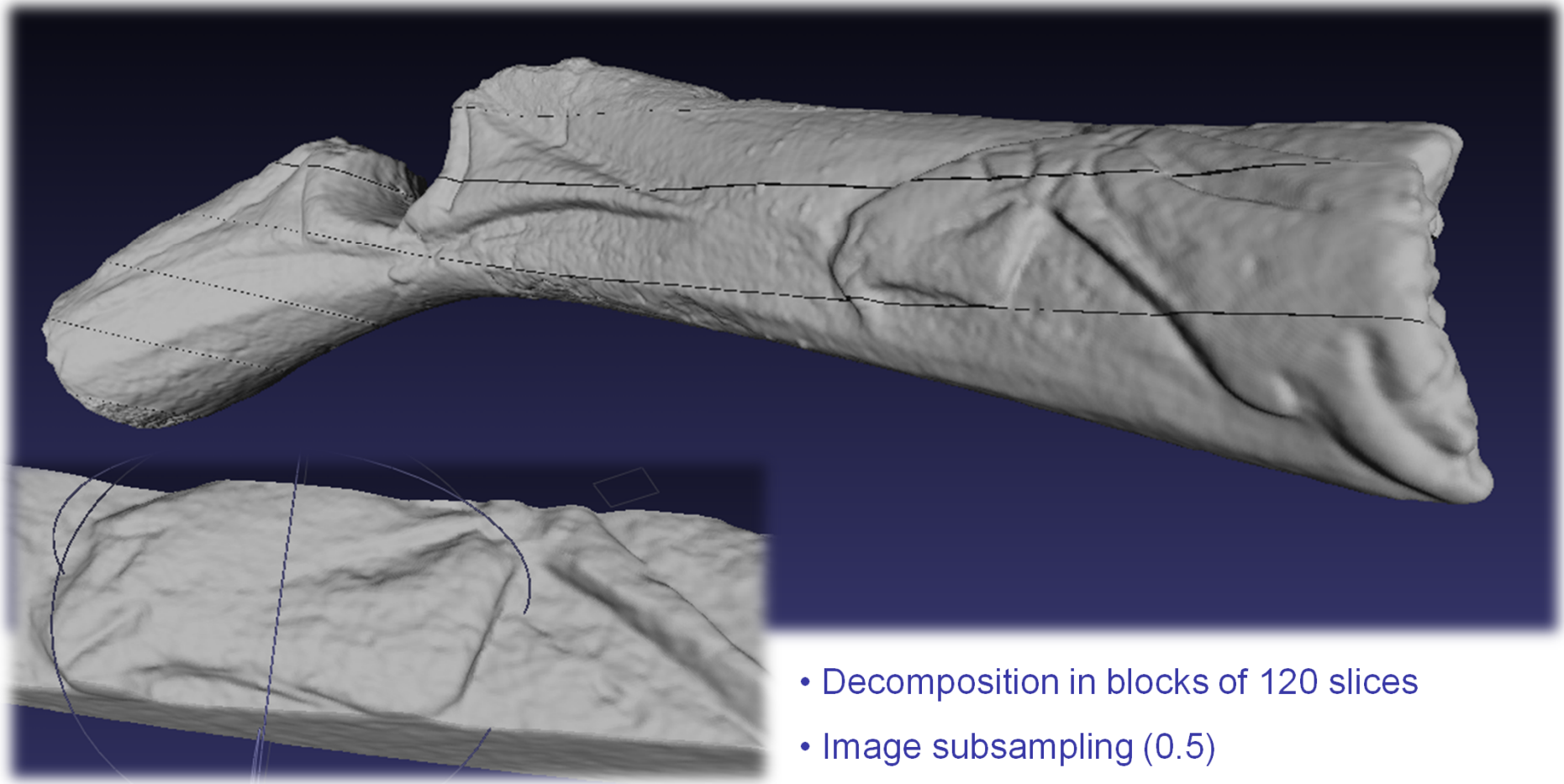0.041 mm x 0.041 mm x 0.041 mm

Volume scanning: µCT-Scan

- Volume rendering performed with Myrian© at full resolution
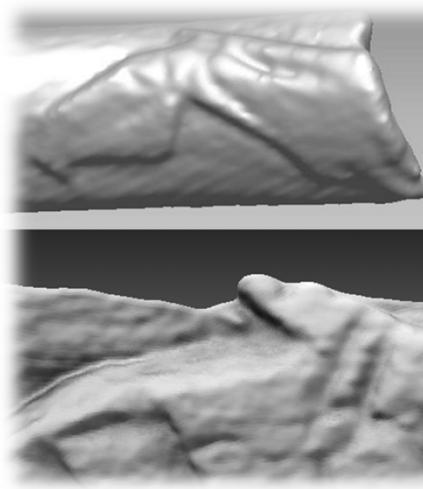
Volume scanning: µCT-Scan

1,503,555 vertices / 2,614,750 faces

- Decomposition in blocks of 120 slices
- Image subsampling (0.5)
- Smoothing + isosurface computation +
- Fusion of blocks

3D digitization: assessment

	Advantages	Disadvantages		Accuracy
Surface scanning	• Texture • Good precision • Low cost (e.g. NextEngine©) • Portable	• No inside information • Hidden regions • Surface artifacts • Manual interaction (e.g. positioning)		~1-100 µ
Volume scanning	• Inside information • Good precision • Automatic process (→ fast) • No surface artifact (but beware to metallic inlays)	• No texture (but HR photographs could be mapped) • Huge data • Not portable • Limited acquisition space	*CT*	~ 100-300 µ
			µCT	~1-50 µ

Surface scanning

Volume scanning (CT)
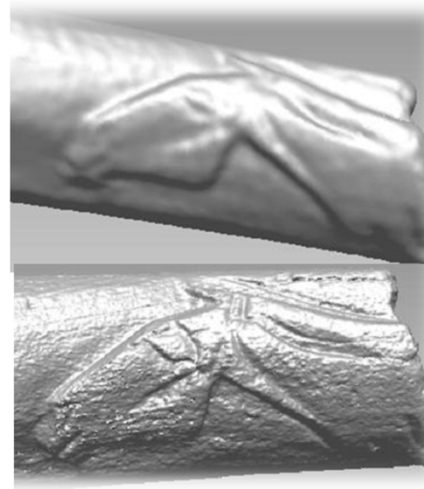
Volume scanning (µCT)

3D visualization

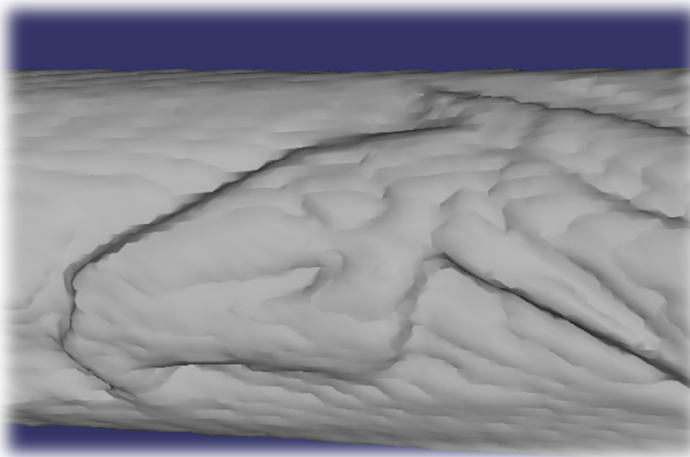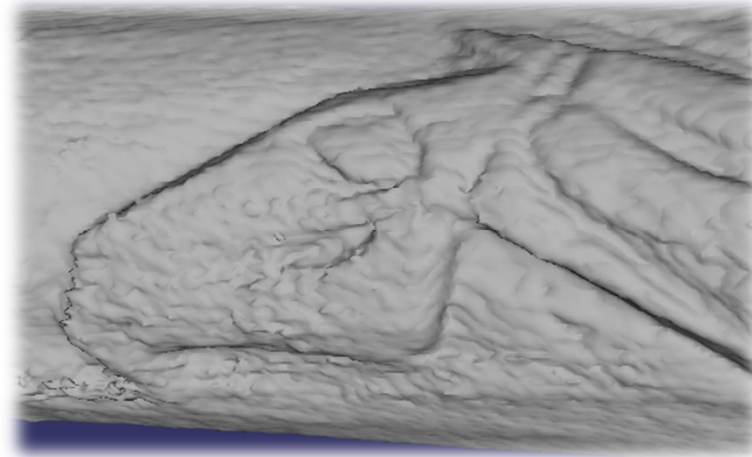►Managing large datasets

→ Level Of Detail structure

- *Full resolution*: 652 Mb
- *Mid-resolution*: 60 Mb (1/4)
- *Low-resolution*: 5,4 Mb (1/8)

Implemented as a LOD group node in Open Scene Graph which allows switching between children depending on distance from eye point

Mid

Full

3D visualization

► Displaying the scene in 3D

1. *DepthQ 3D projector for active stereoscopic projection*
2. *NuVision 60 GX stereoscopic wireless glasses*
3. *Infra-red emitter for synchronization with the glasses*

3D interaction

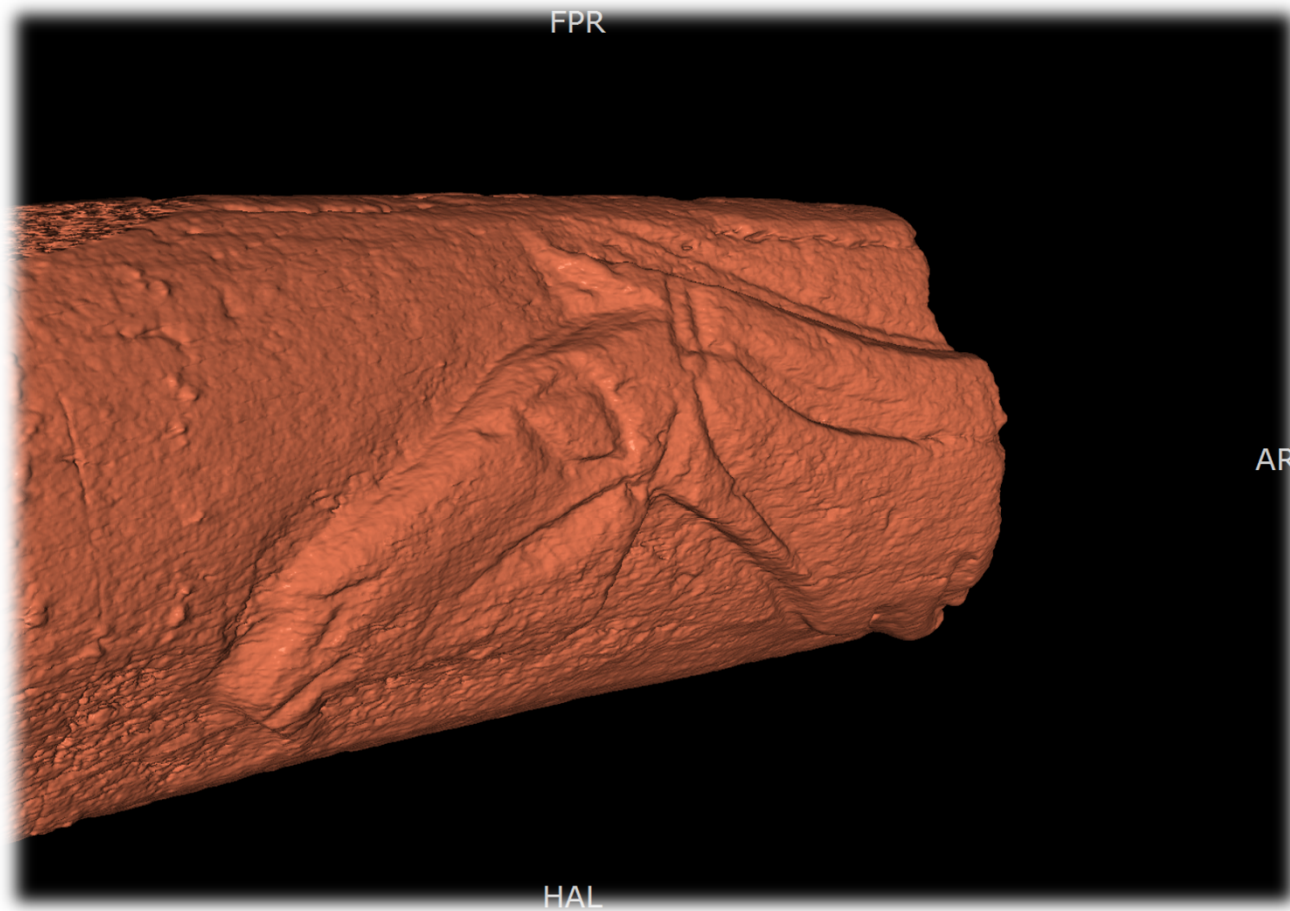► Using a tangible (and low-cost) interface: Wiimote + MotionPlus

• Rotation angles along (X,Y,Z).
• + trigger to freeze the position in order to reposition the interface or visualize a detail.

• Use of Wiiuse and WiiYourself libraries

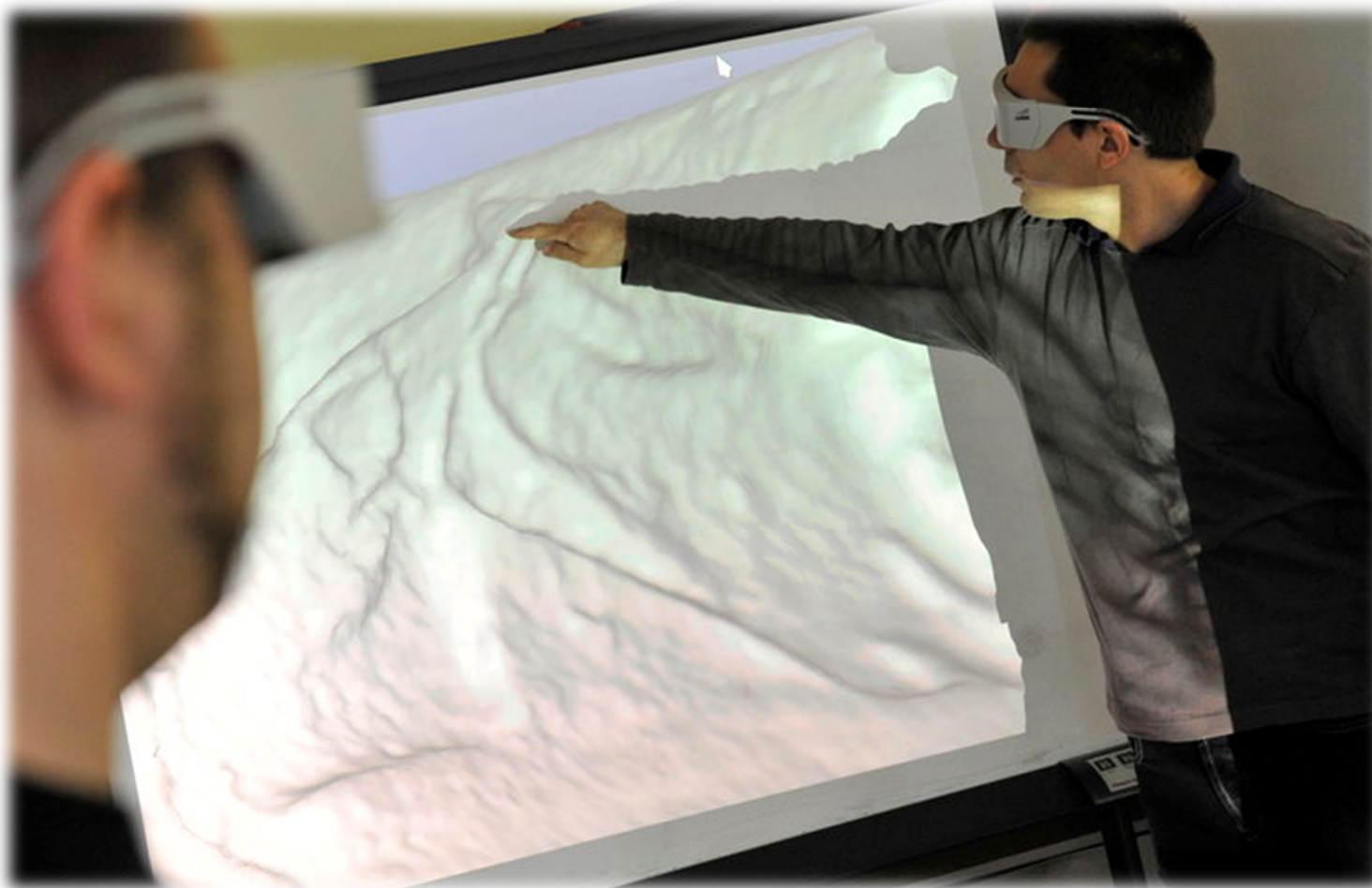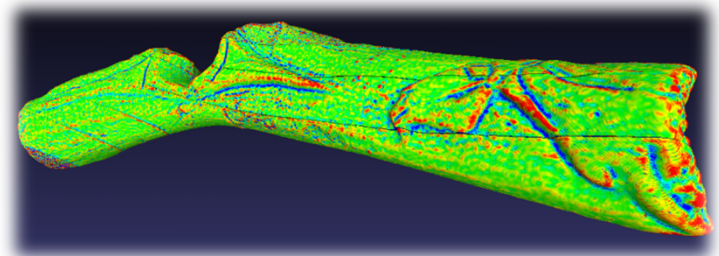→ Very intuitive even if a position drift occurs very quickly.

Future work

- Volume scanning with a higher resolution (9 µ)

Future work

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- Visualizing engravings and analyzing their profiles

Future work

- Volume scanning with a higher resolution (9 μ)
- Visualizing engravings and analyzing their profiles
- Using 2 Wiimote to reassemble the two parts

Fragment du MHNT   Fragment du MAN

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Thank you for your attention