Author: Anton Dementyev (2023638)
CSCM37 Coursework 2: Volume Visualization

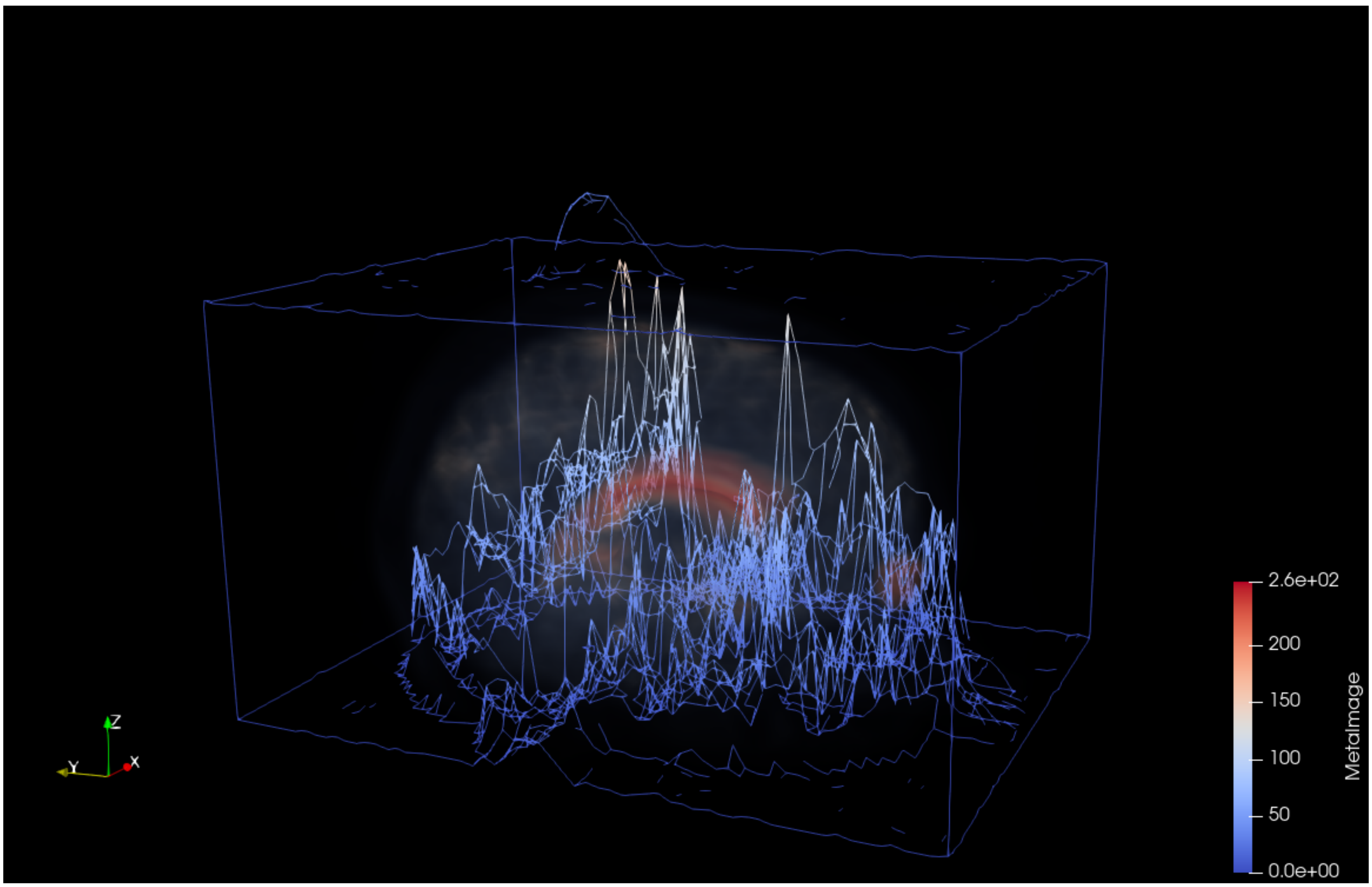
Head MRI Localized

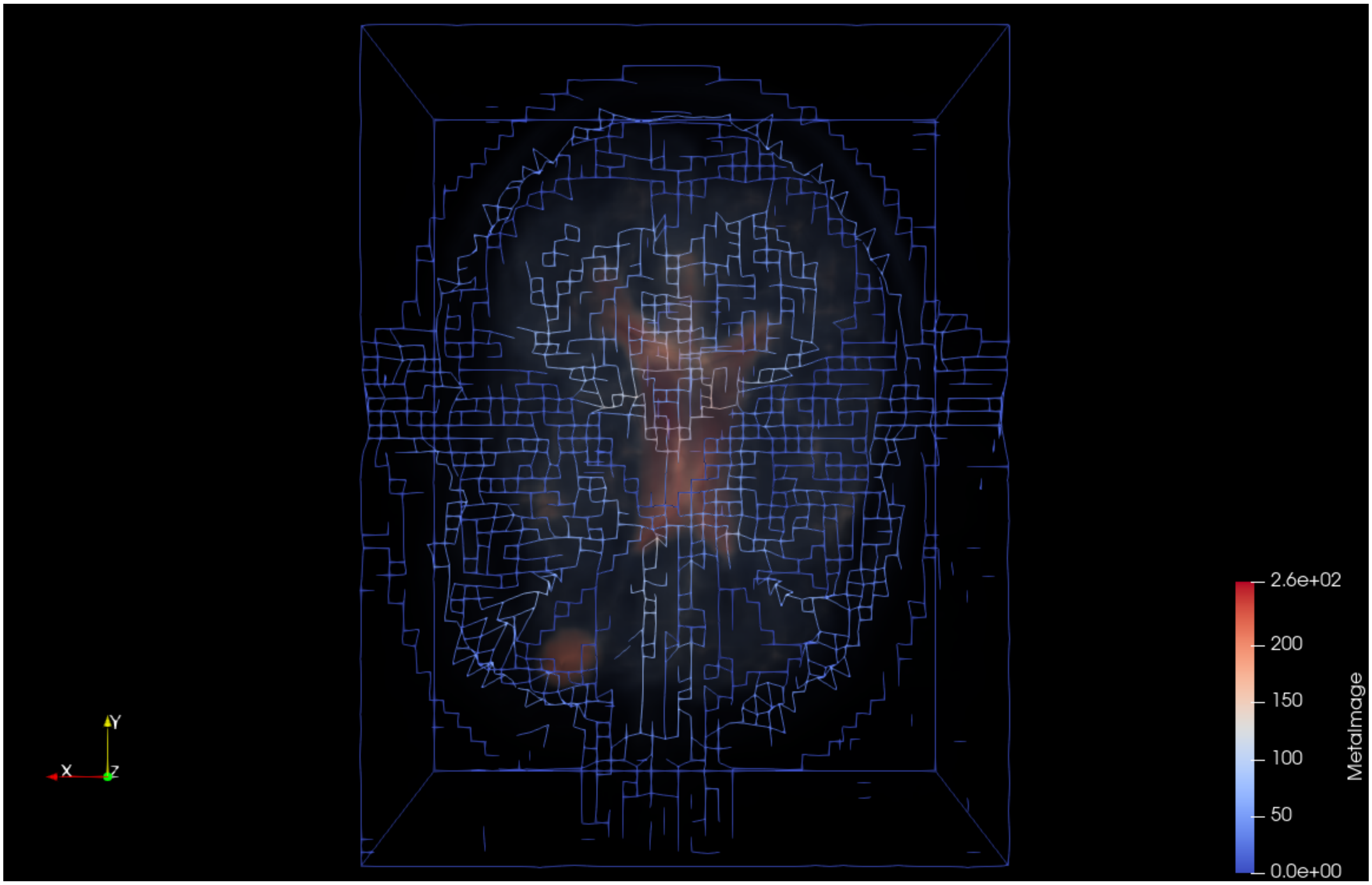
What can we learn from the visualization?

With the aid of this visualization diagnosts and oncologists can potentially detect, describe and evaluate geometric parameters of all possible kinds of tumor or hematomas in the brain of a patient, as well as chemical ones. It is important for the selection of a therapy, especially when speaking about highly precise methods (e.g., gamma knife), where determining the configuration is vital.

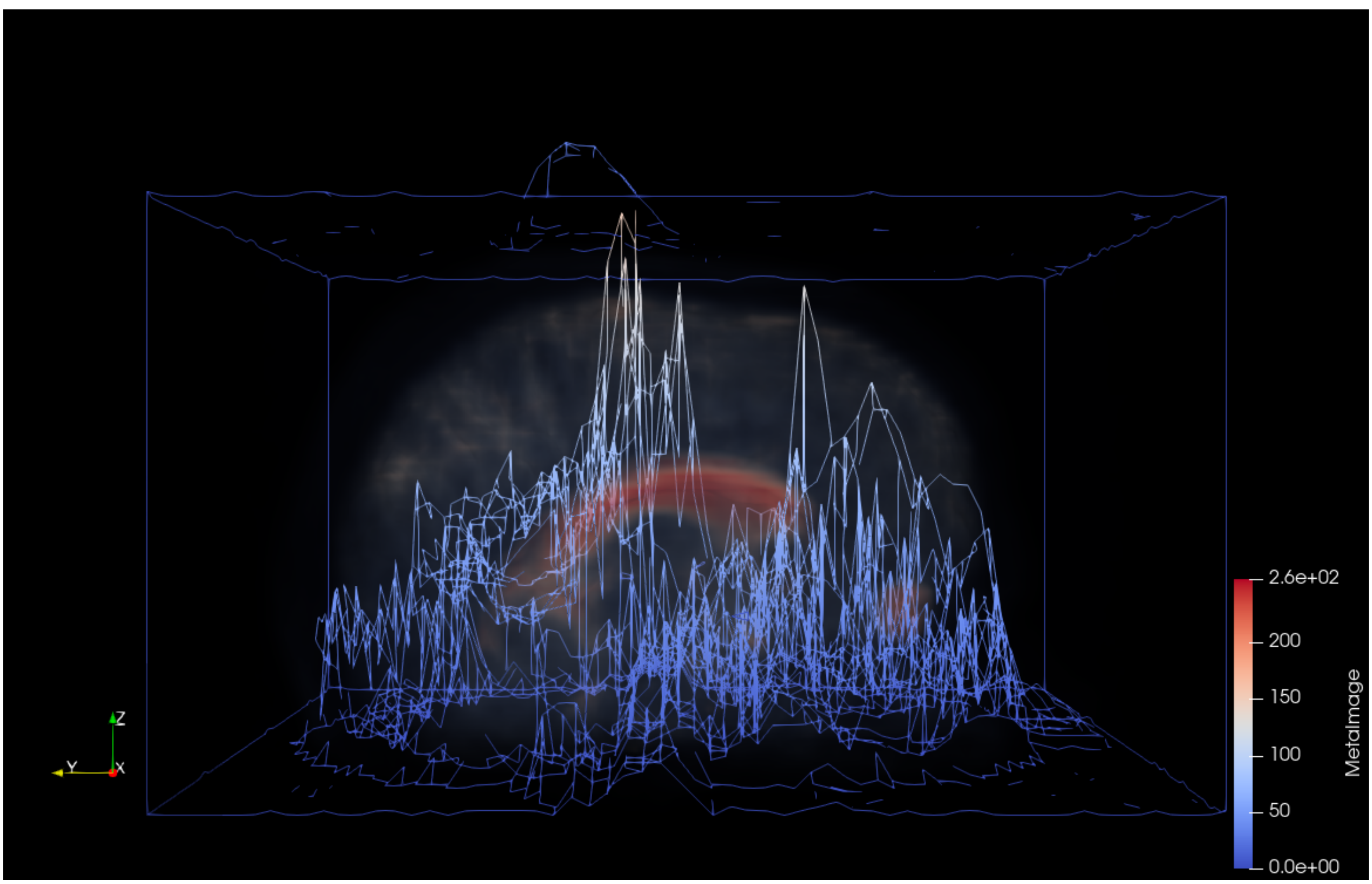
What is the name for the type of visualization(s) used?

Feature edges + direct volume





Y
X
Z
2.6e+02
200
150
100
50
0.0e+00
MetaImage



Z
Y
X
2.6e+02
200
150
100
50
0.0e+00
MetaImage

What are all visual mappings used?

Color mappings:

We have selected the default cool-to-warm palette as the basis the our color mappings. Data values = [0; 255].

- Cerebral cortex, spikes (bottom): blue, data values: ~[0; 50];
- Cerebral cortex (gaps), spikes (mid): white, data values: ~[50; 150];
- Corpus, eyes, spikes (top): red, data values ~ [150; 255];

Opacity mappings:

For the volume (head):

- Cerebral cortex: ~ [0; 0.03];
- Corpus, eyes: ~ [0.03; 0.25];

Was there any special data preparation done?

1. Subset extraction:
   Cutting to the nasal area:
   z-axis (0 - 41) -> (6 - 41)
2. Warping by scalar
   Scale factor - 1

What are the limitations of your design?

First, the magnitude of the volumetric spikes is very relative. In essense, it is amplfied in the selected way purely to make the comparison between them illustrative enough, but does not represent the actual depth. Also, we need to use an extra component (head) to make it clear where the spikes are. However, a possible improvement would be making a toggle for the head, as it can actually hinder the perception of the depth of the hills (spikes), especially when looked at from below (image 2). Alternatively, we can use an outline of the brain as a reference point, but this is quite debatable.

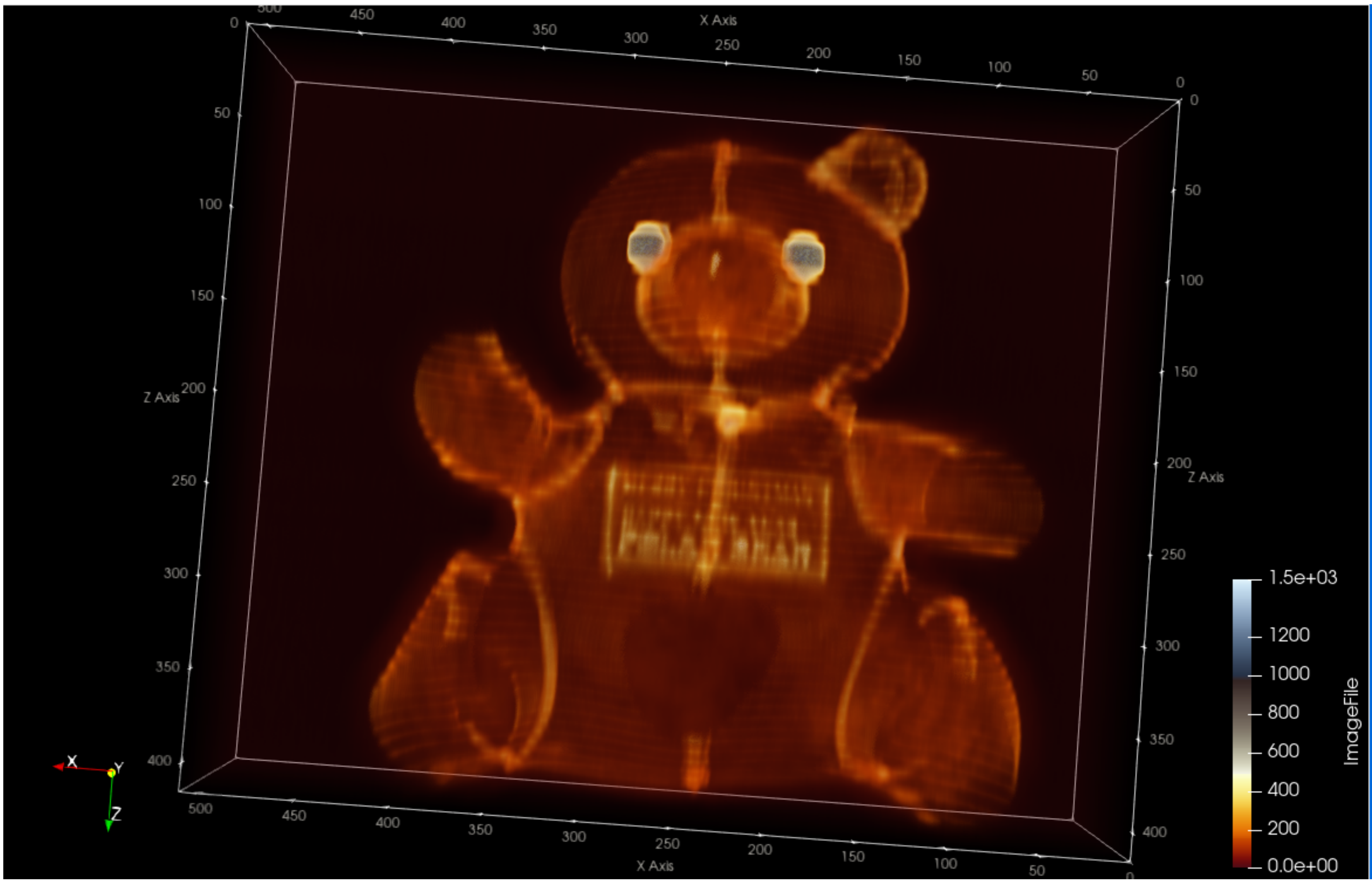
Bear Declassified

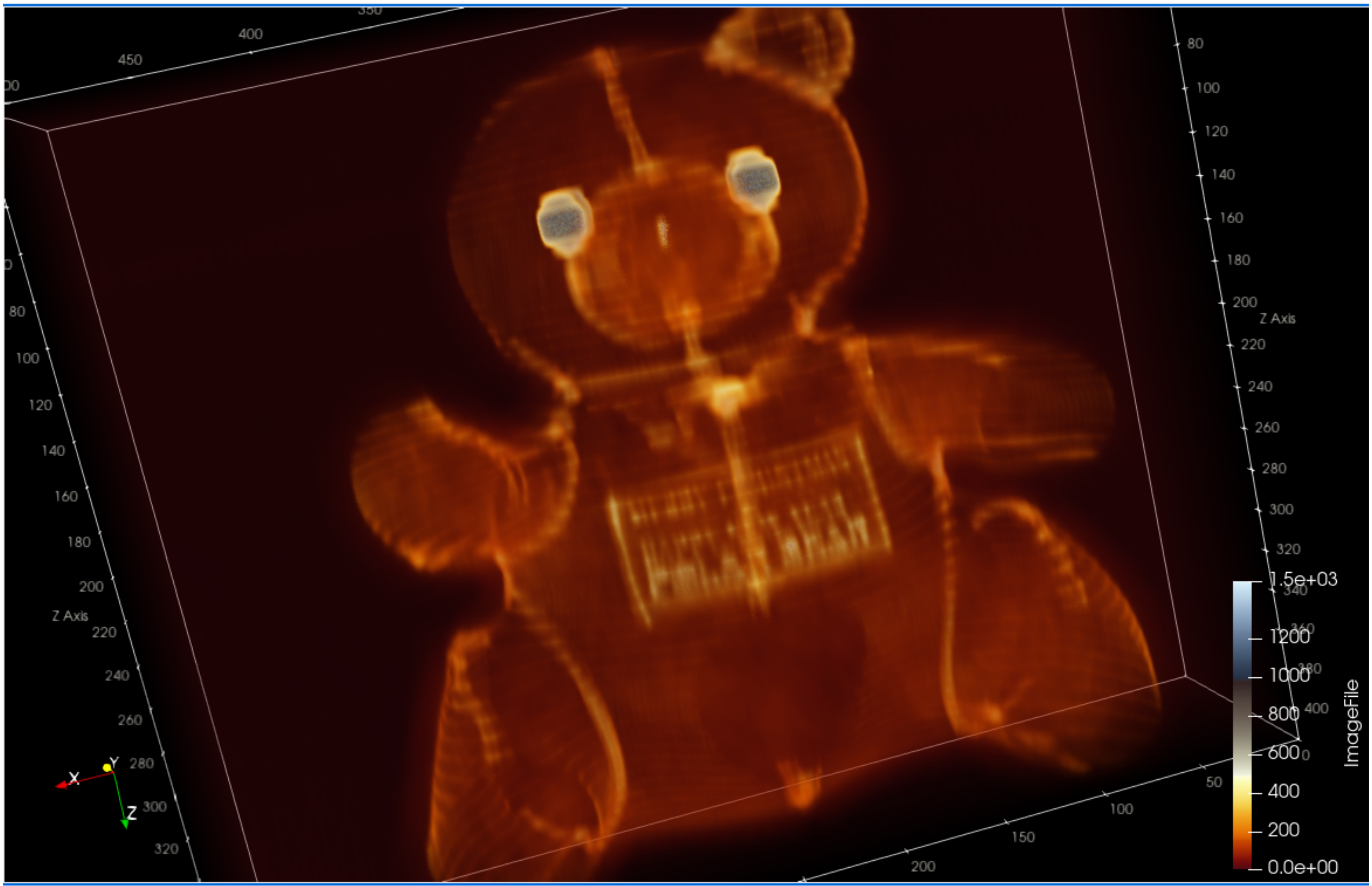
What can we learn from the visualization?

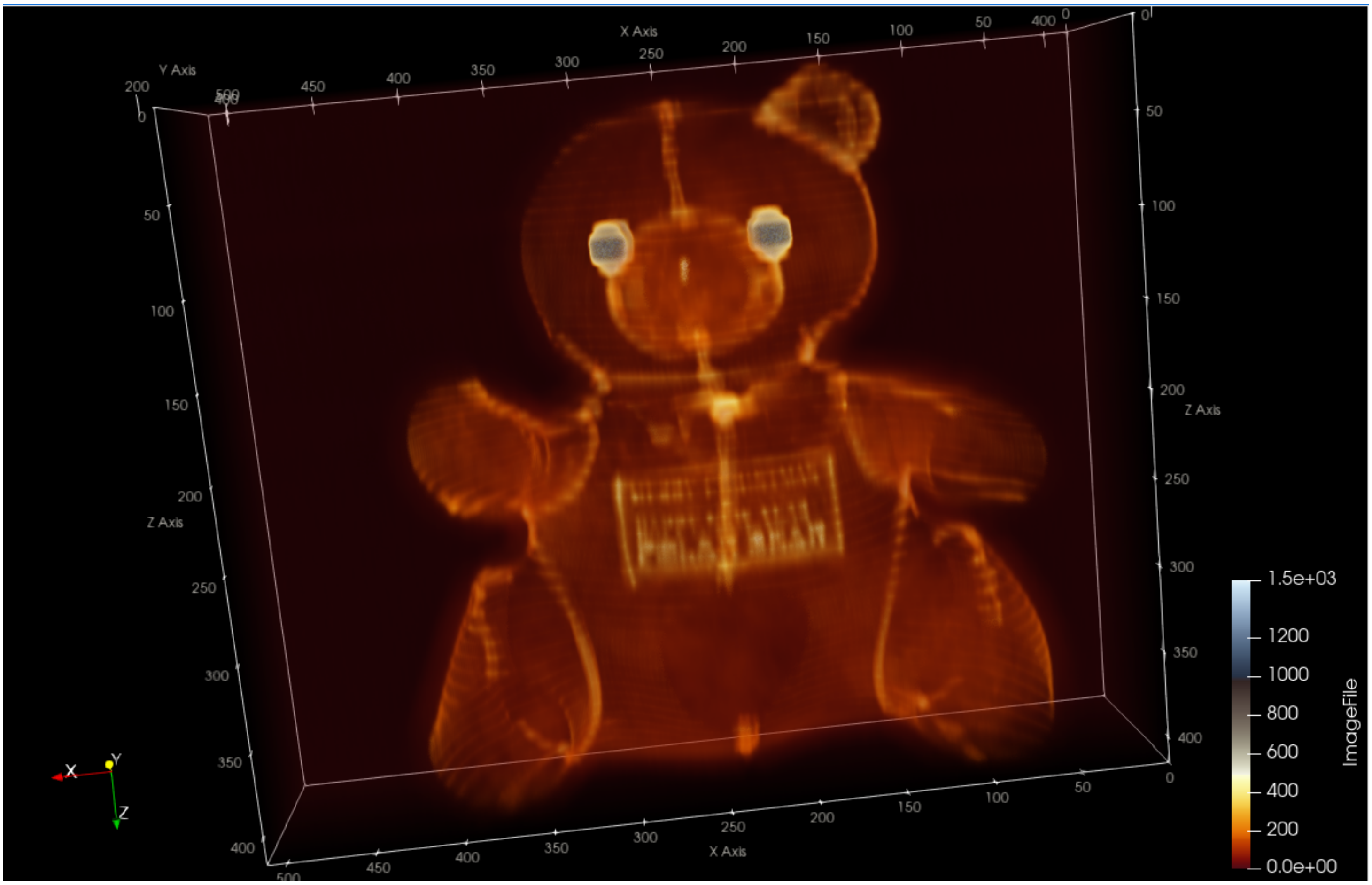
We can learn what is written on the belly of the teddy bear. Potentially, this can help us determine its origin (place of sale / manufacturing) or why it was acquired (e.g., a New Year / Christmas present).

What is the name for the type of visualization(s) used?

Volume Clip Visualization




Z Axis
Z Axis
ImageFile
1.5e+03
1200
1000
800
600
400
200
0.0e+00
X
Y
Z



What are all visual mappings used?

Color mapping:

We have selected the Yellow - gray - blue palette as the basis the our color mapping.

- Body (insides): red, data values: ~[0; 250];
- Space around the bear: red, data values ~ [0; 250];
- Seams (contours): yellow, data values: ~[250; 700];
- Eyes: black & blue, data values: ~[700; 1300].

Opacity mapping:

- Bear insides, space around the bear: ~ [0; 0.37];
- Seams, letters: ~ [0.37; 0.76];
- Eyes: ~ [0.76, 1].

Was there any special data preparation done?

1. Data Spacing -> z-axis x 6.7 times
2. Subset extraction:

   To remove the surface the bear is leaning (lying) on and the volume right before the sign, we extract the susbset within the y-axis: (0 — 511) -> (230 — 350)

What are the limitations of your design?

Unfortunately, even though the text is rather undestandable (presumably, "MERRY CHRISTMAS HAPPY NEW YEAR POLAR BEAR"), we cannot distinguish some letters (e.g., letter "R") and have to deduce the word through its context. However, we have not found other ways (e.g., switching opacity of the bear's insides to lower values) to amplify resolution of certain letters without sacrifising the resolution of the others. In addition, the luminance of the seam behind the sign on the bear's belly covers some letters of the sign, but is very difficult to remove. However, it can be thought of as a potential improvement. Finally, the color mappings used for enhancing the perception of the text may deviate from its viewer's cognitive bias and they may find the visualization daunting.

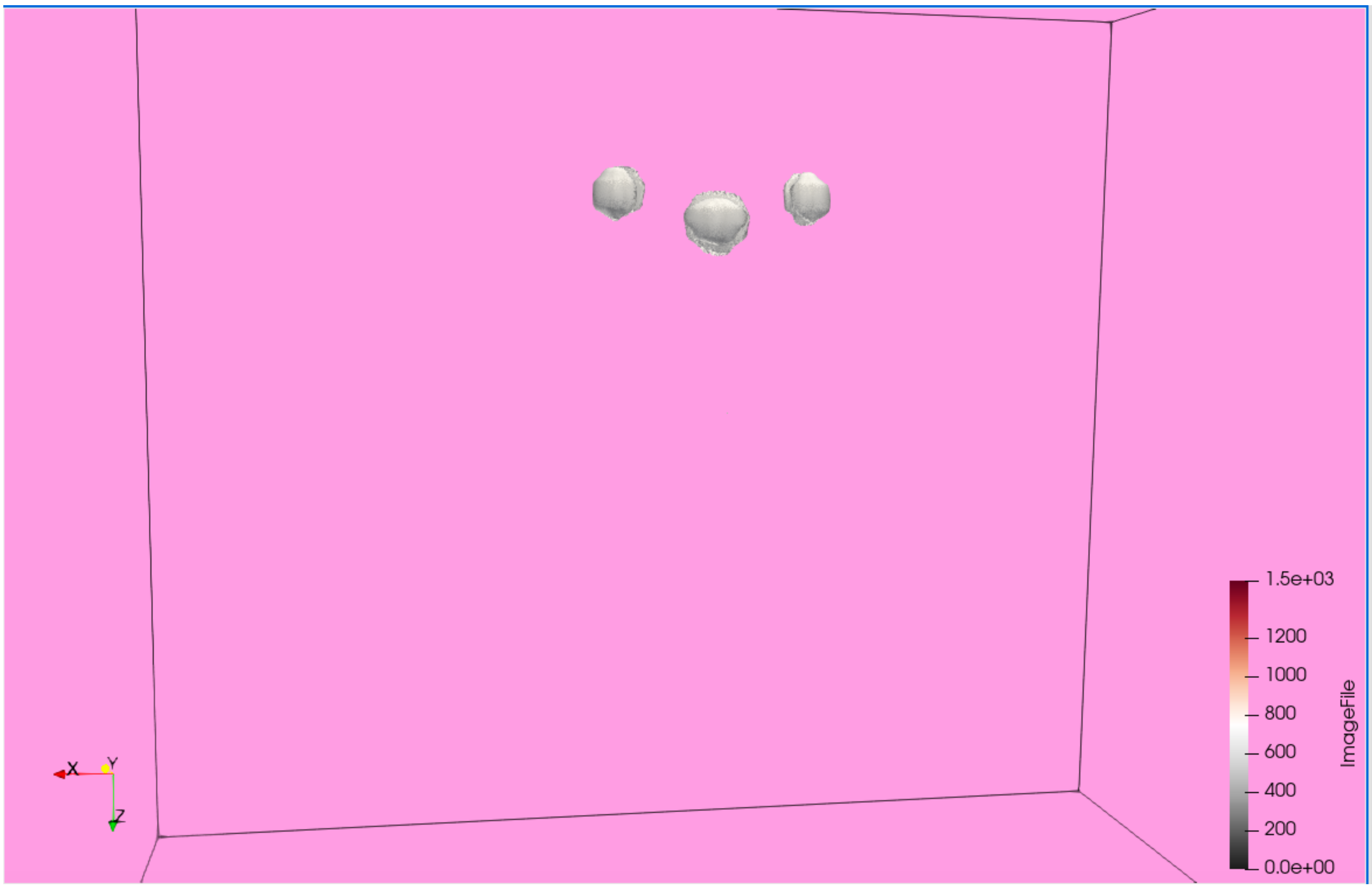
I'm in Love with the Shape of You (Buttons)

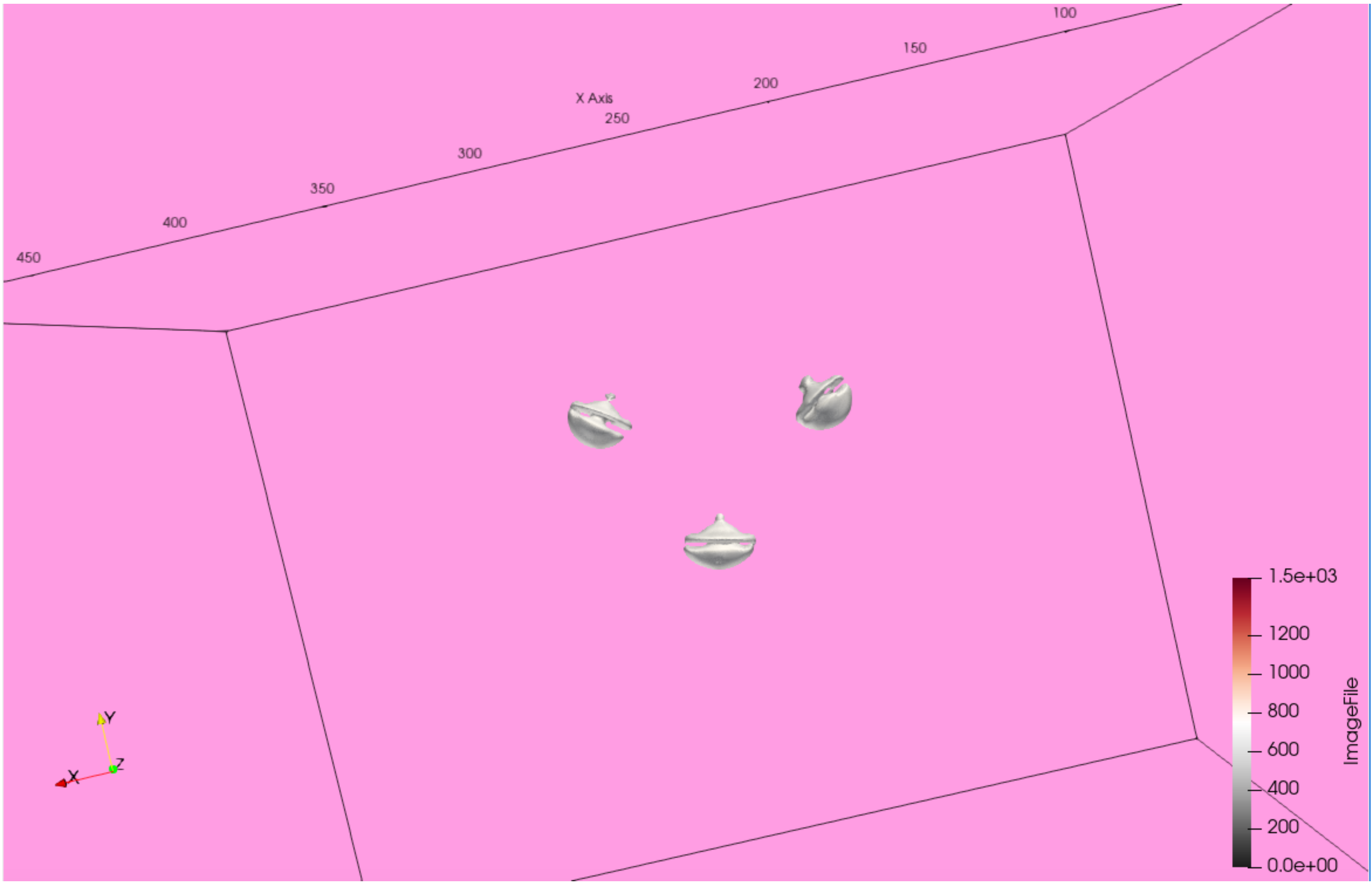
What can we learn from the visualization?

We can discover the physical structure of the buttons on the bear and understand how they are attached to the body. Also, we can learn if buttons on the nose and the eyes are anyhow different.

What is the name for the type of visualization(s) used?

Isosurface




X Axis
100
150
200
250
300
350
400
450
Y
Z
X
1.5e+03
1200
1000
800
600
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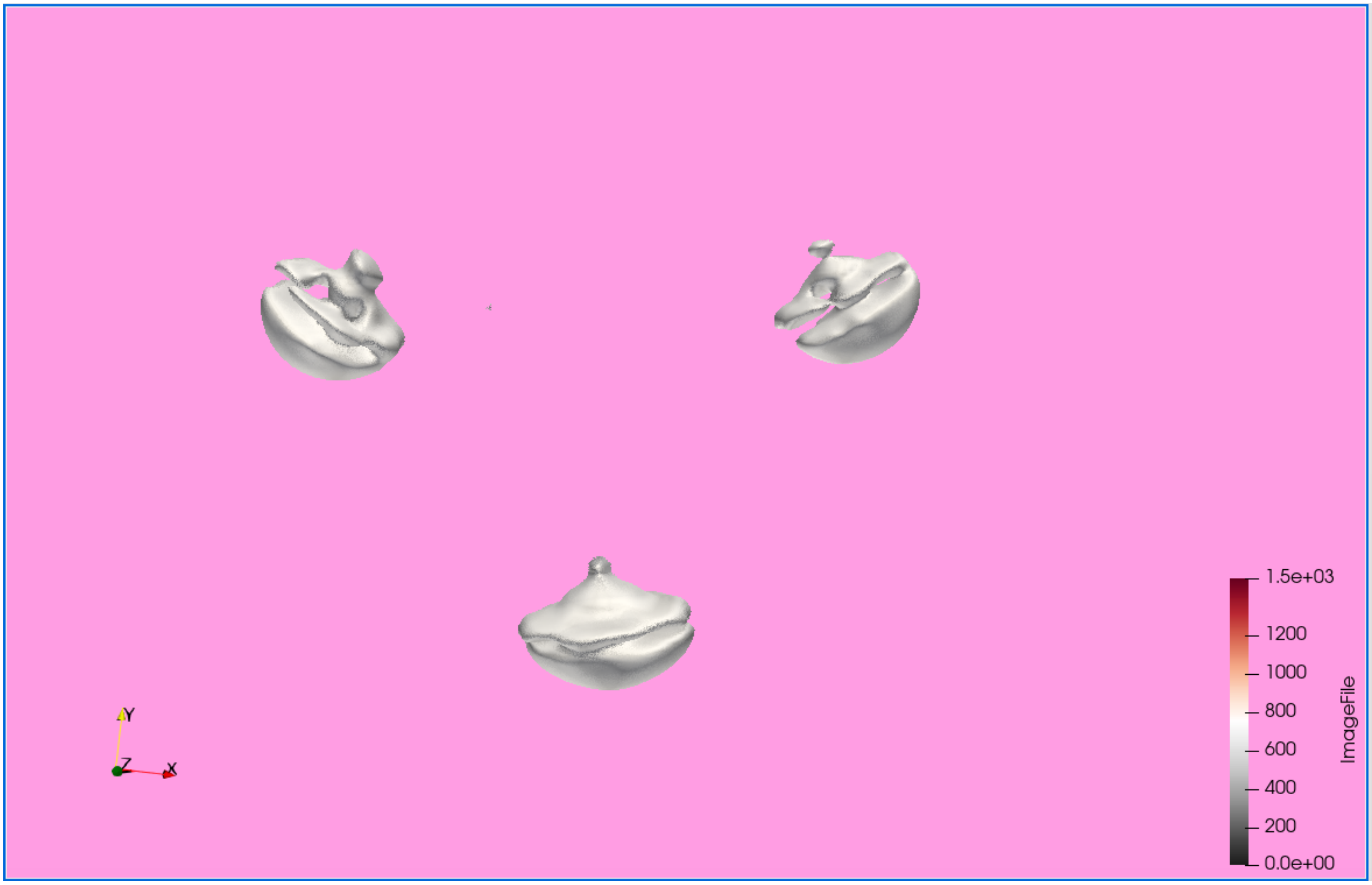
200
0.0e+00
ImageFile



What are all visual mappings used?

We have selected the Gray and red palette as the basis the our color mapping. Further we only mention the mappings for the buttons, as other elements do not get displayed after applying isosurface rendering.

Color mapping:

- Buttons: gray, data values: ~ [0; 750].

Opacity mapping:

- Buttons: ~ [0.6; 1].

Was there any special data preparation done?

1. Data Spacing -> z-axis x 6.7 times
2. Subset extraction:
   To remove the surface the bear is lying on, with extract the susbset within the y-axis: (0 — 511) -> (0 — 370)

Also, volume rendering blend mode is set to isosurfacing with shades enabled.

What are the limitations of your design?

Although we can get a sense of the overall shape of the buttons and some pecularities of each type of button, we cannot take away much upon a very close inspection of them as the isosurface becomes disintegrated. Also, it might be a bit difficult to determine the orientation of the visualization right away, since the buttons are fairly similar at first glance. Hence, we can add an outline of the bear's head to improve on this. Still, it becomes understandable quite quickly. Finally, a minor limitation is that it is a bit computationally expensive to run, even without the axes displayed.

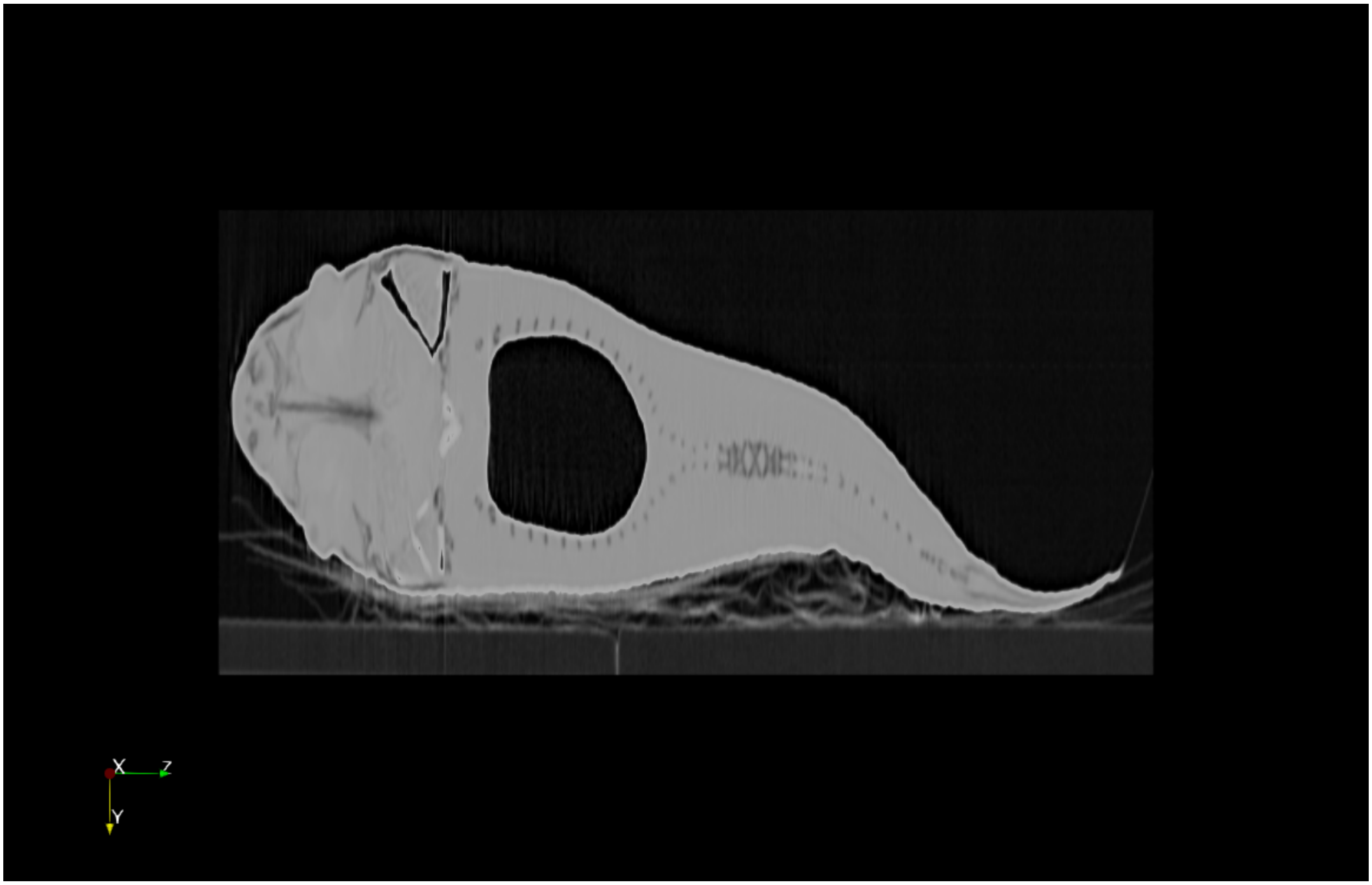
Swim Bladder Gives You Wings

What can we learn from the visualization?

We can learn what the structure, shape and possibly the volume of the fish's swim bladder is. All three can be useful for comparing various types of fish in ichthyological contexts.

What is the name for the type of visualization(s) used?

Slice



What are all visual mappings used?

We have selected the X-ray palette as the basis the our color mapping.

Color mapping:

- Body — {swim bladder, other gaps}: white / gray, data values: ~[0; 2501];
- Swim bladder: black, data values ~ [2501; 2871].

Opacity mapping:

- Body — {swim bladder, other gaps}: ~[0.77; 0.93];
- Swim bladder: ~[0.93; 1].

Was there any special data preparation done?

Slice extraction:

Property	X	Y	Z
Origin	127.5	127.5	255.5
Normal (image 1)	0	-1	0

Property	X	Y	Z
Normal (image 2)	1	0	0

What are the limitations of your design?

We cannot really see at which stage of inflation the swim bladder is, so we need to know the state of the fish prior to analysing the swim bladder's aforementioned properties. Also, as this is a slice, perhaps undestanding how smooth / homogeneous the surface of the swim bladder is, is a bit problematic. As an improvement, perhaps, we can suggest taking a lot more shapshots while rotating x and y axes within their plane — this will help get a grasp of the geometry of the swim bladder more precisely, as with our visualization we rely on the assumption the center always represents the biggest radius possible, which is obviously not true.

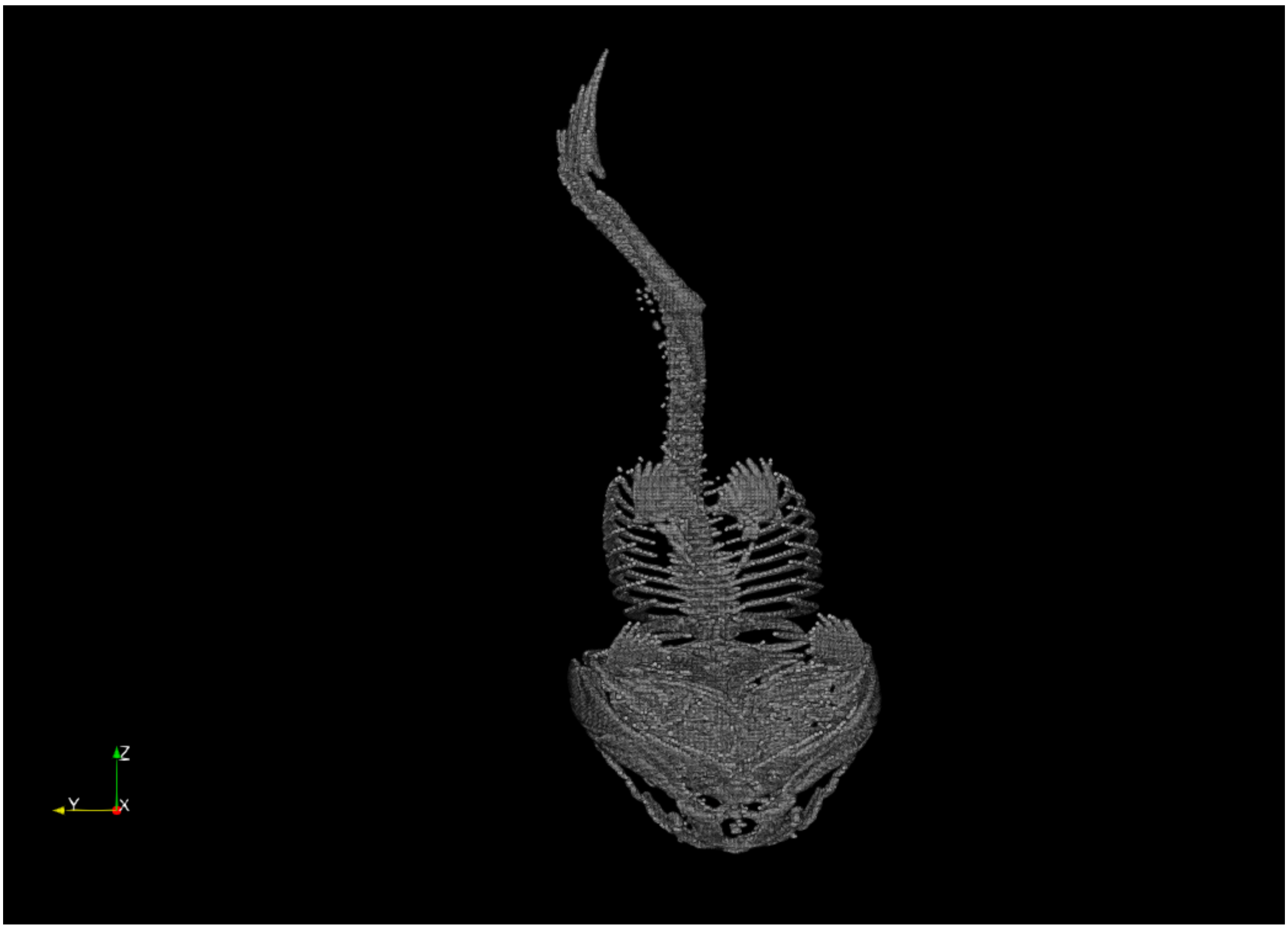
Fish Skeleton

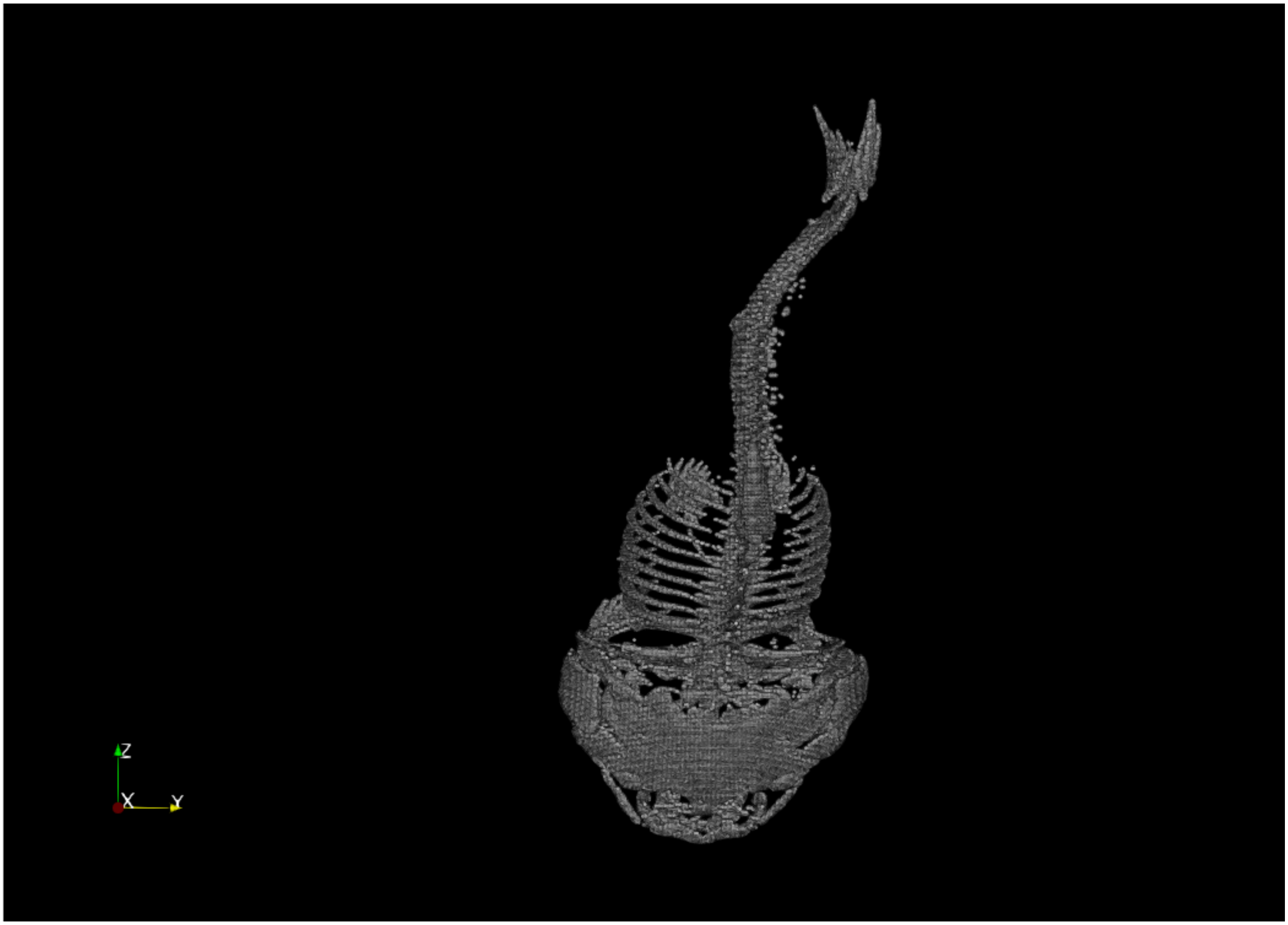
What can we learn from the visualization?

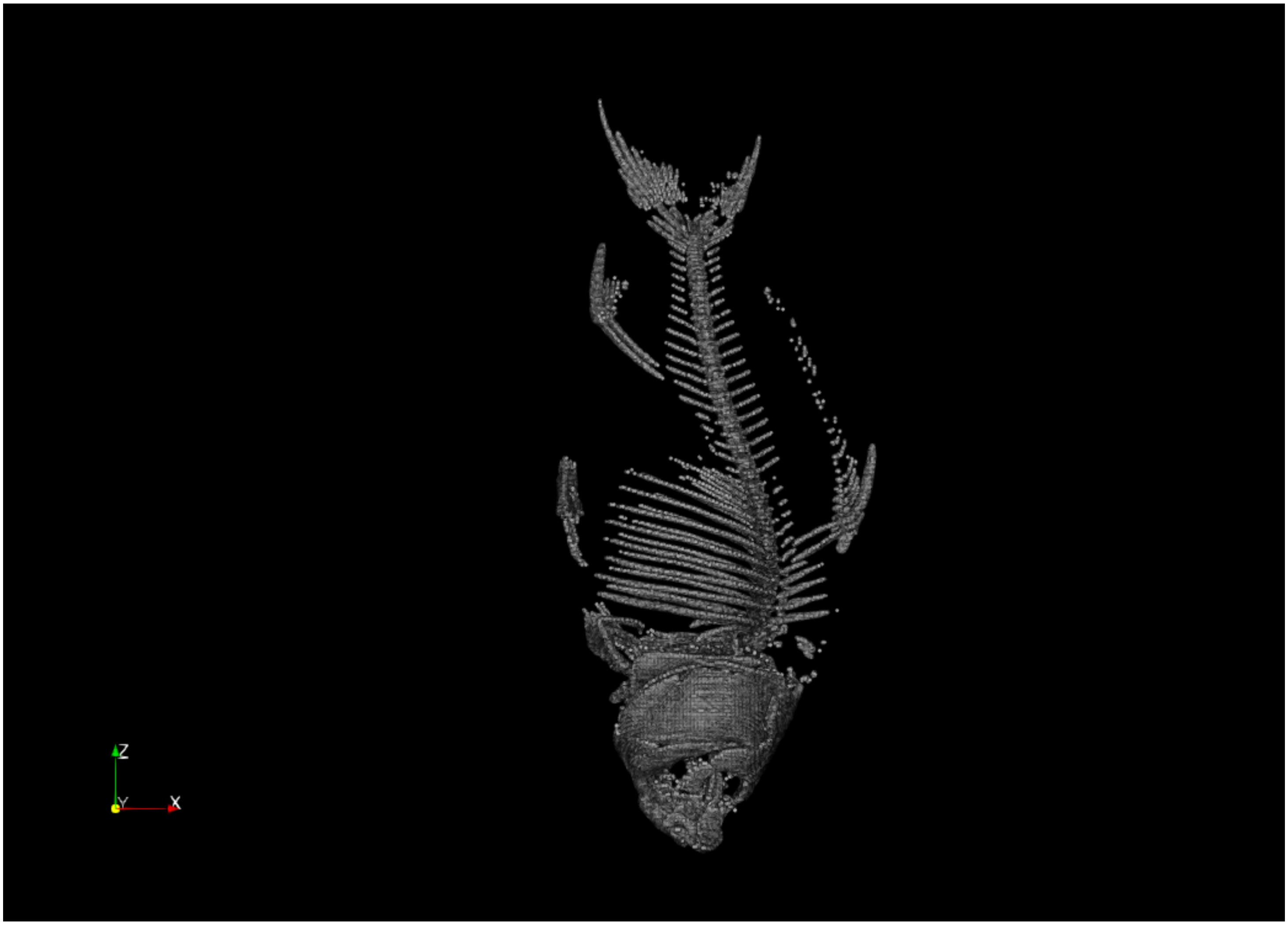
We can understand the bones' structure of a fish usign this visualization. However, its lower-level purpose is displaying the spinal region of the fish, with an emphasis on how it can flex during movement. The latter can be useful, for instance, when studying factors impacting the speed of certain fish.

What is the name for the type of visualization(s) used?

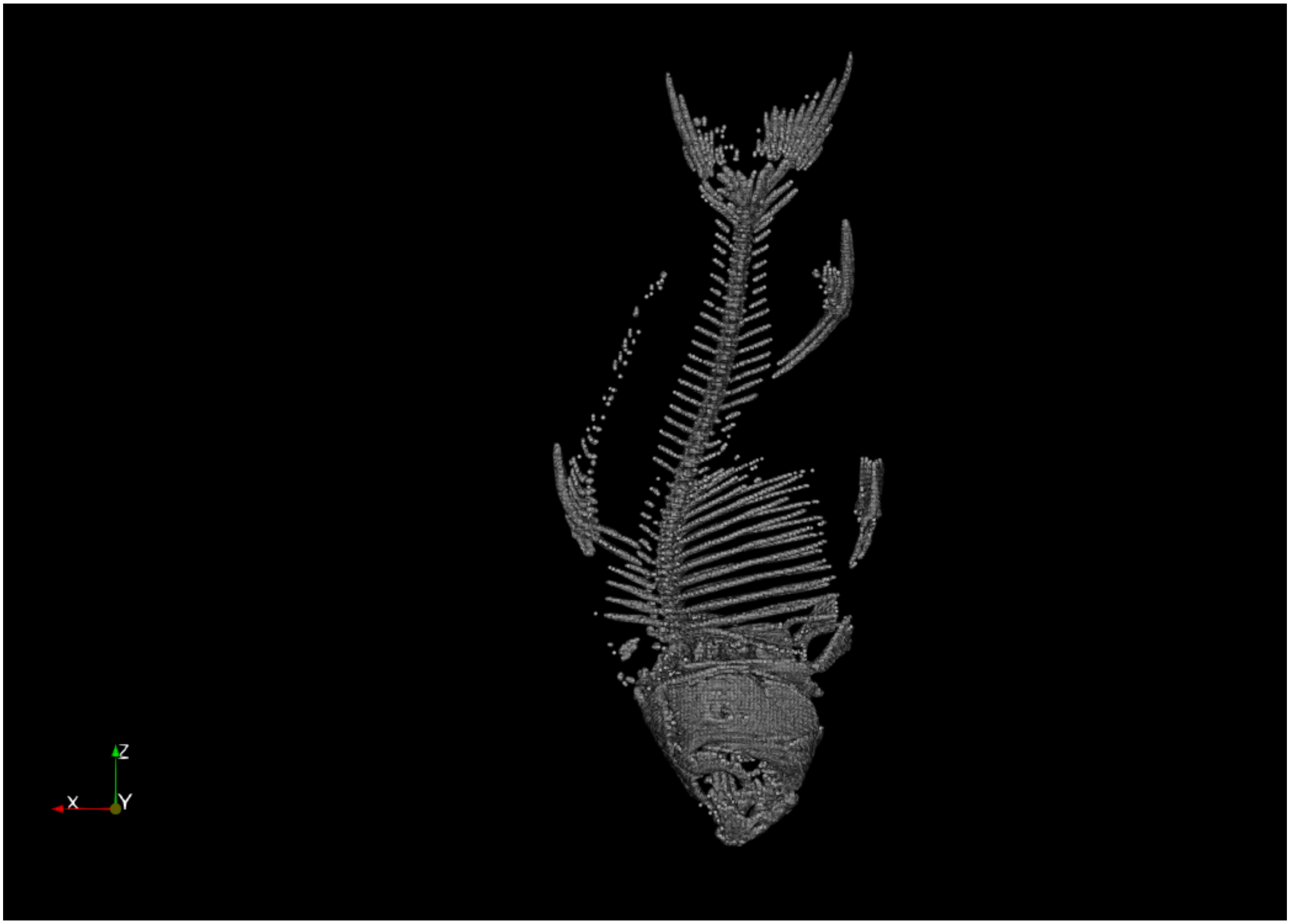
Gaussian Points (Isosurface)

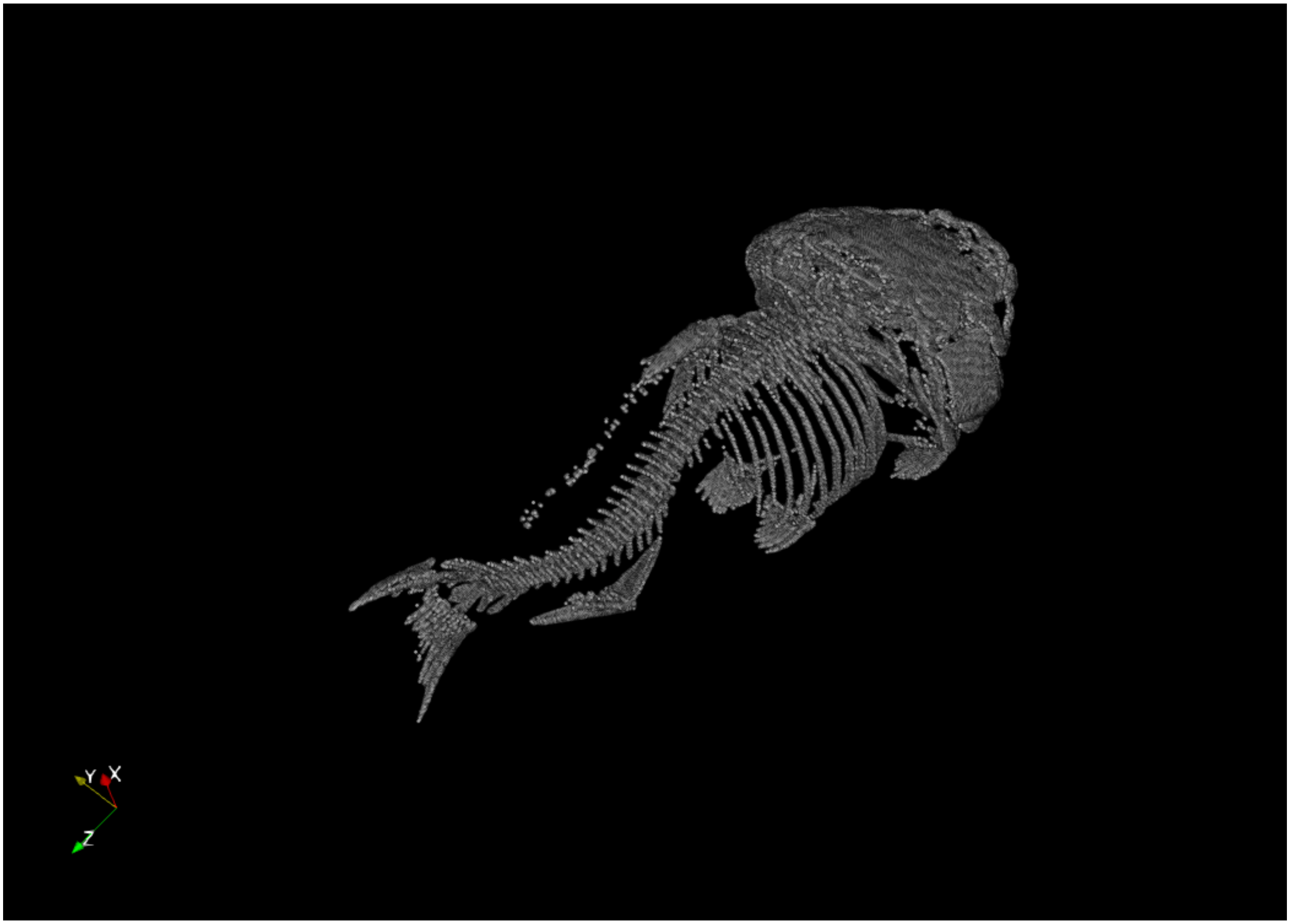


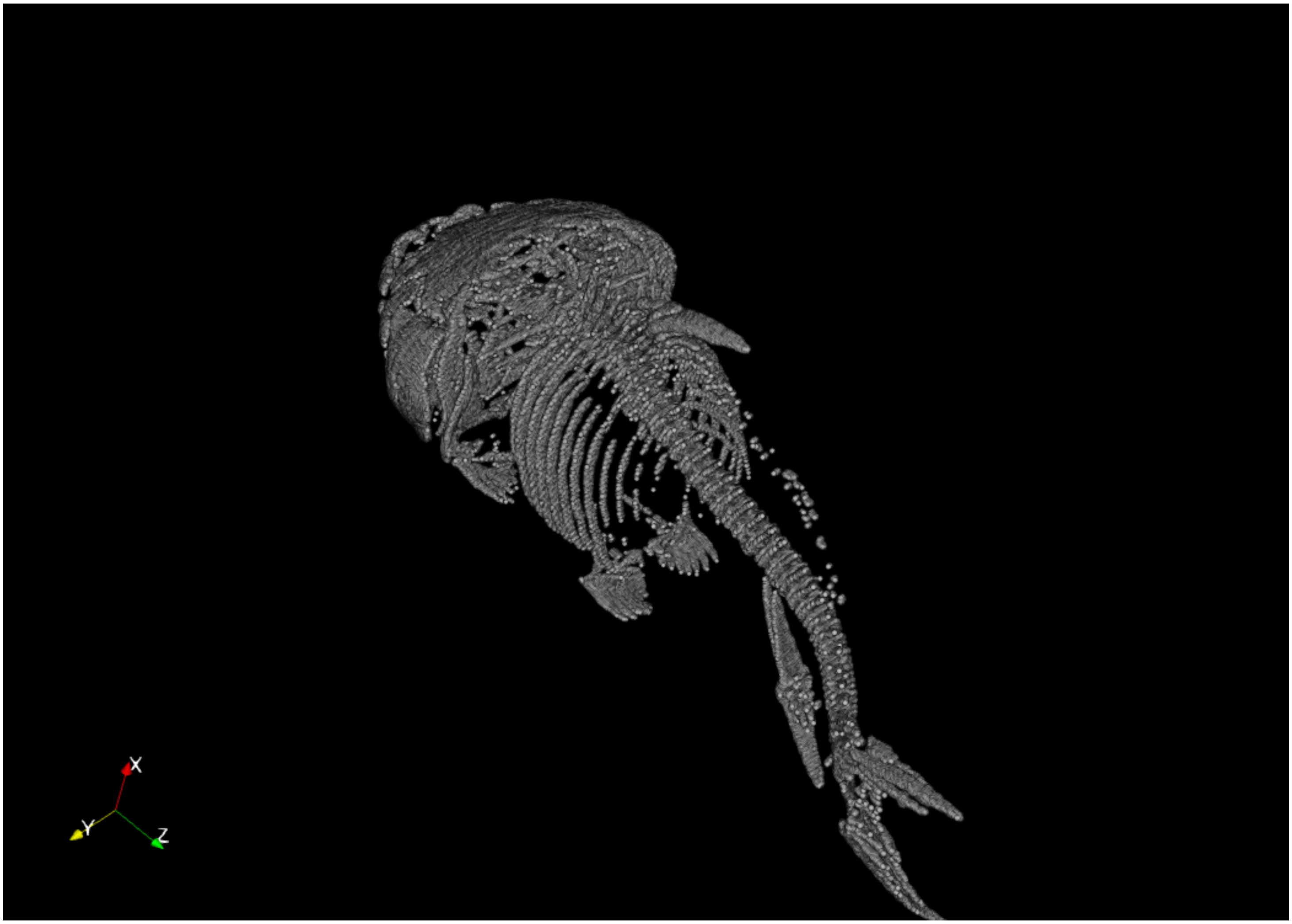

Z
X
Y



Z
Y
X


Z
X
Y


Y
X
Z



What are all visual mappings used?

Not part of the transfer function (it was not used for this visualization):

- Skeleton (point) opacity -> 0.3;
- Sketelon point radius -> 1.49.

Was there any special data preparation done?

Contour extraction.

What are the limitations of your design?

A minor limitation is that some parts of the head's bone structure are not fully distinguishable. Hence, as mentioned before, this visualization is more applicable for examining the spine of the fish. At the same time, the main advantage of gaussian points is displaying the connectity between voxels. Due to this notion, it is really effective when the fish is turned sideways, but is not so effective from above (e.g., with respect to making out each vertebra from a distance, like in the 1st image). For our outlined purpose, we do not think that the visualization has a lot of room for improvement. However, if we used an isosurface only, the visibility of the details of the smaller bones could be enhanced using ray tracing, but in fact gaussian points still provide a lot more information in that sense.