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Volume Rendering

A walk-through

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Data Visualization

Is to synthesize (generate) an image that describes numerical data.

In the medical field, advanced computer graphics techniques are used to generating realistic images of the medical data.

Data Visualization

- 2D Scalar-field (image)
- 3D Scalar-field (Volume)
- Vector-fields

- Given some data captured by a capturing device, how can we see this data in a meaningful way?
  - There is no best way

Data Visualization cont'd

- There are two aspects here
  - What parts of the data do we want to see?
    - Multi planner reconstruction (MPR)
    - Volumetric
  - How do we want to see this data? In what colors?
    - Transfer function
    - Lookup table

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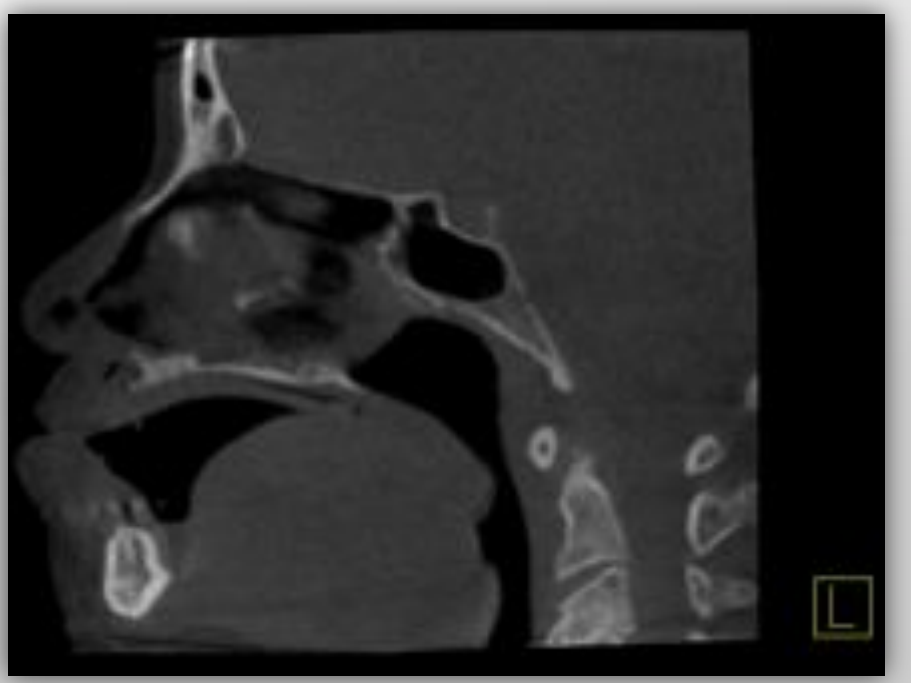
What do we want to see?

IMAGE RECONSTRUCTION

MPRs

- Reconstruction of 2D Images from a 3D scalar-field along a plane.



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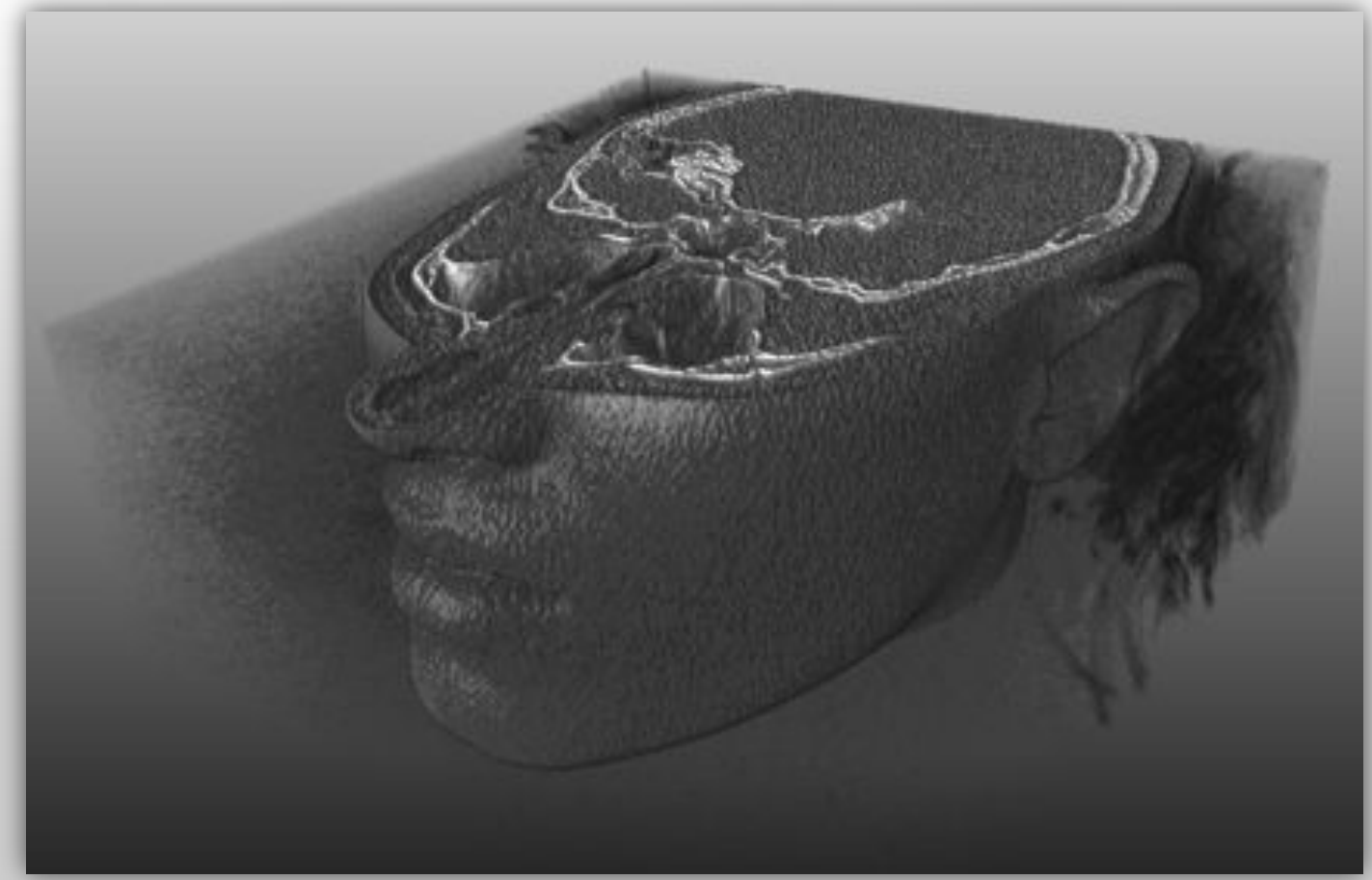
Volume Rendering

- Rendering the whole 3D scalar-field in volumetric 3D space.



We will consider two techniques

- Texture based volume rendering
- Ray-casting volume rendering

VOLUME RENDERING

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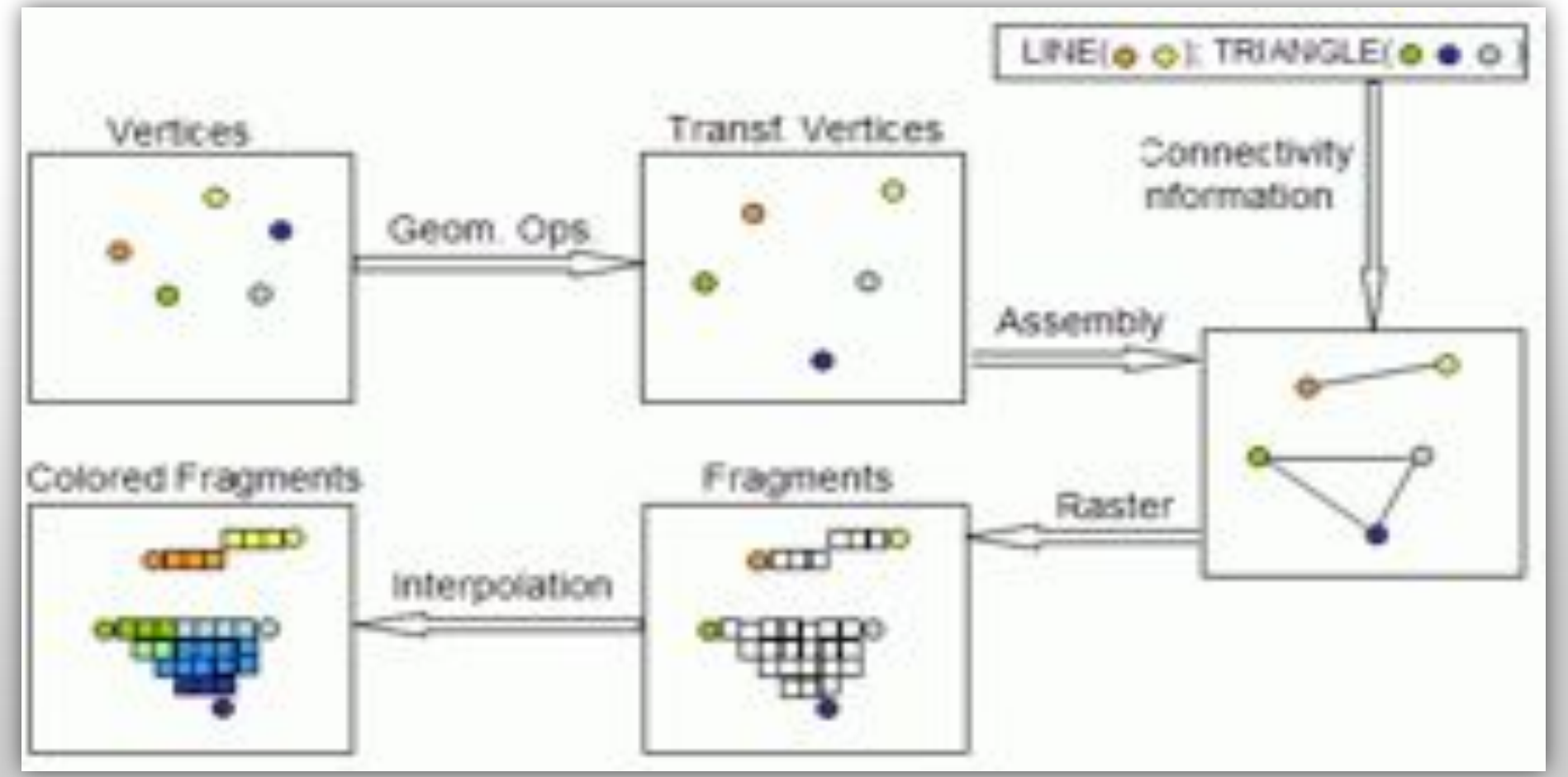
Graphics pipeline simple view



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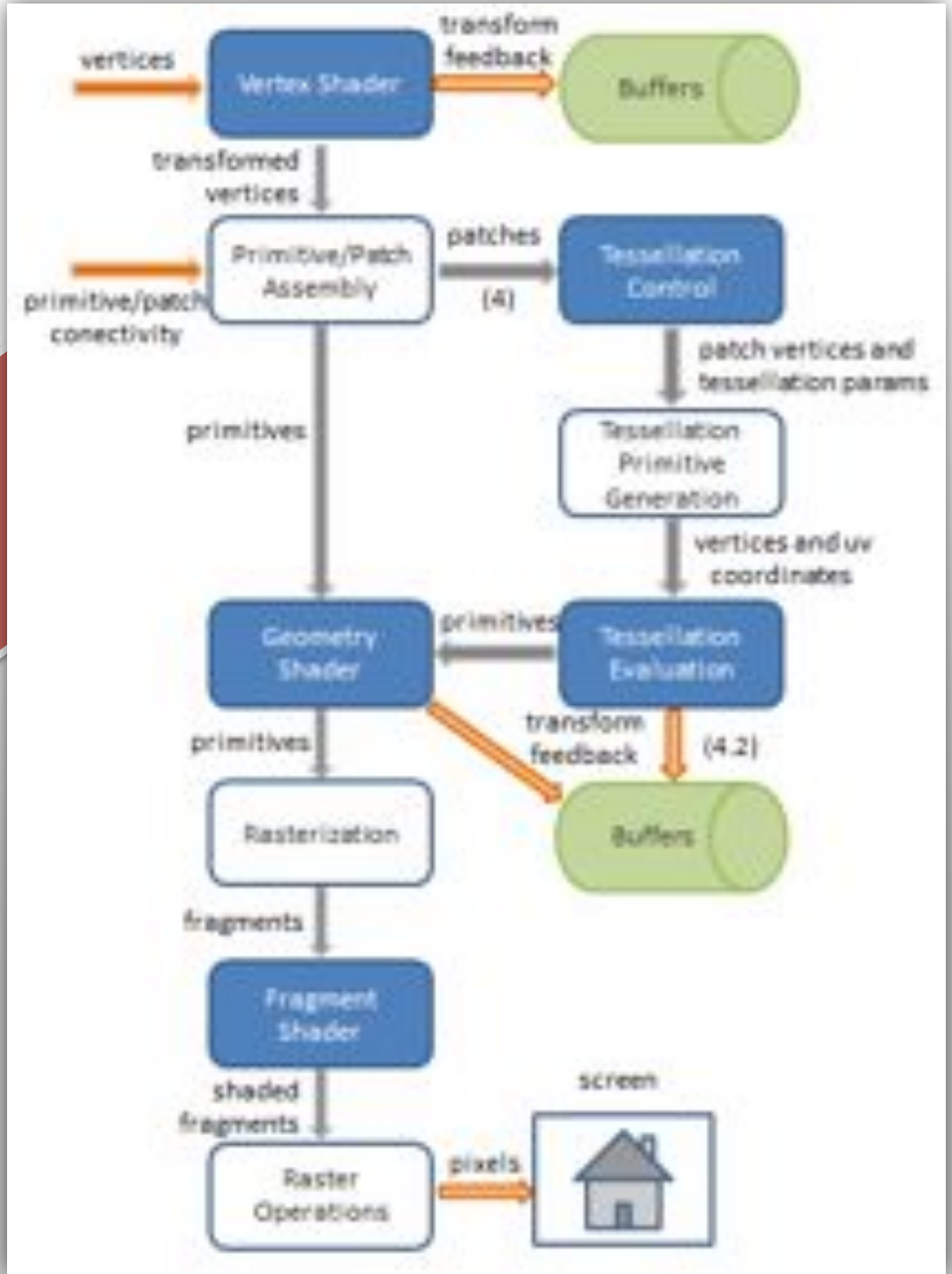
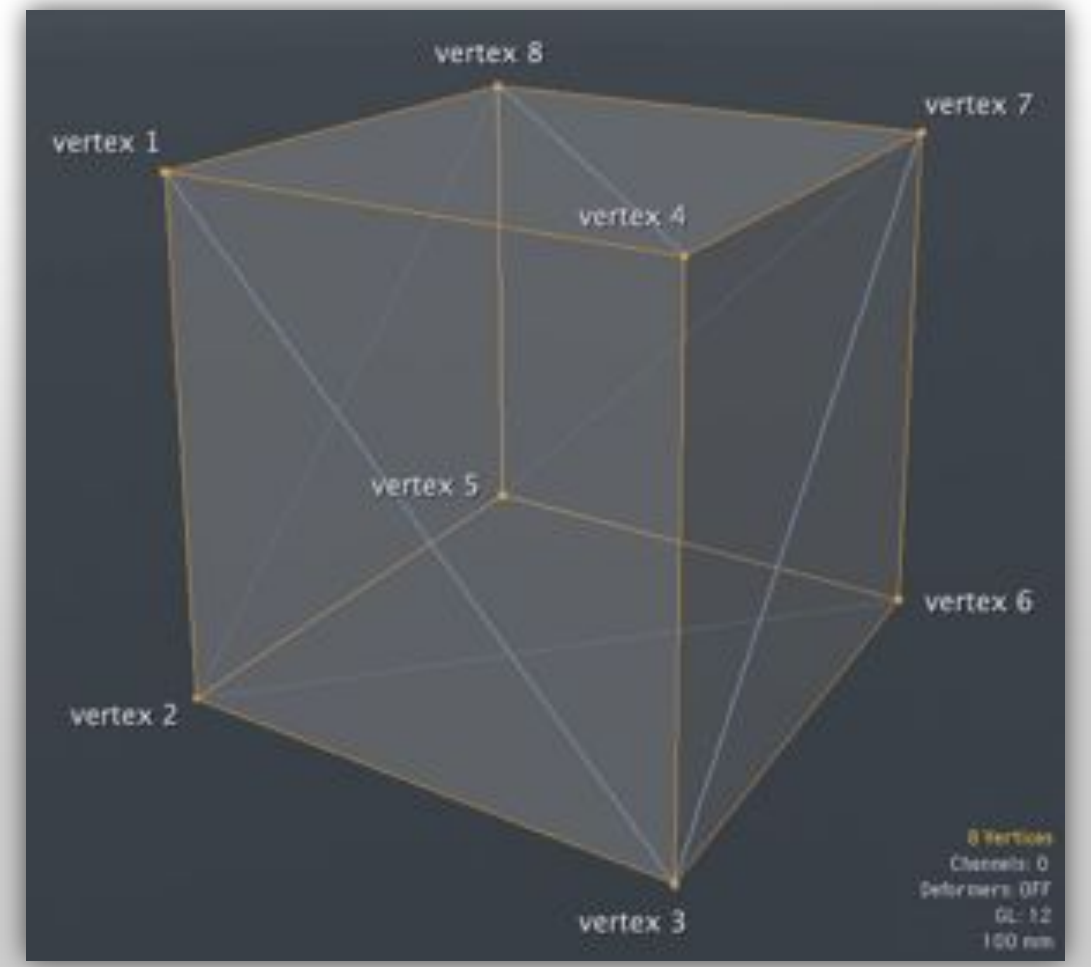
Modern Graphics Pipeline

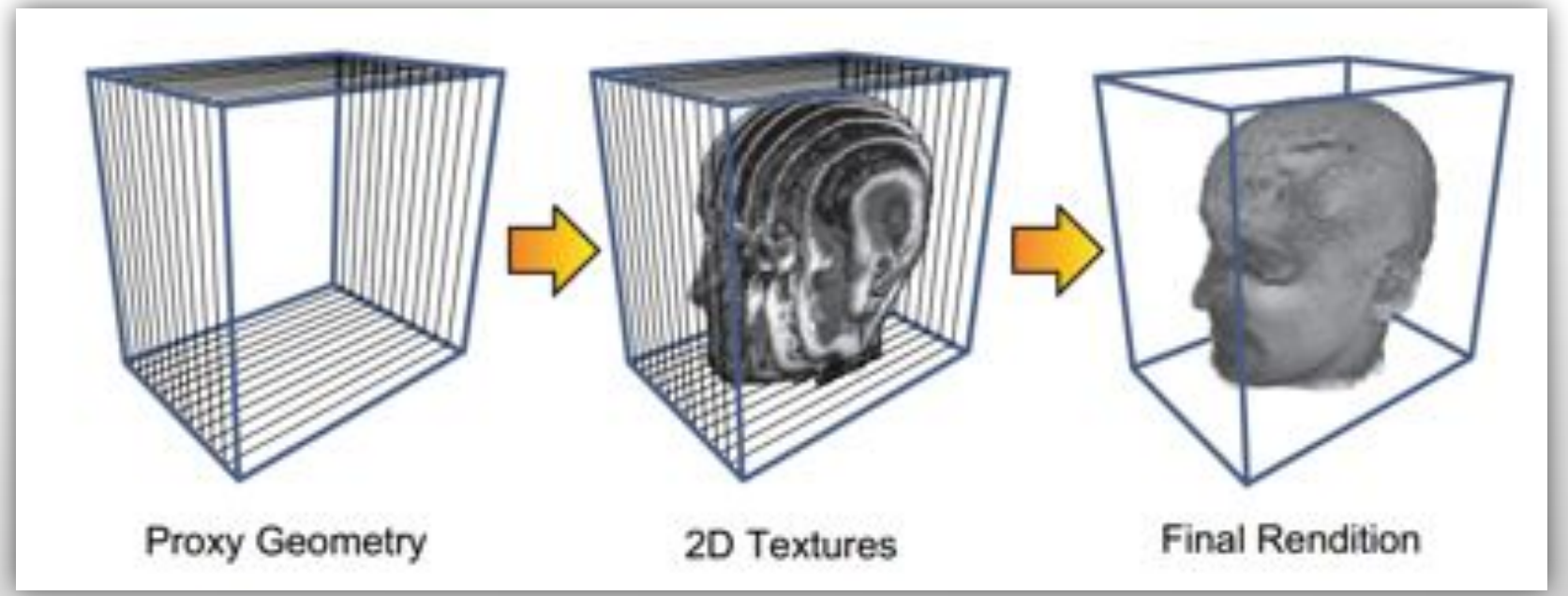


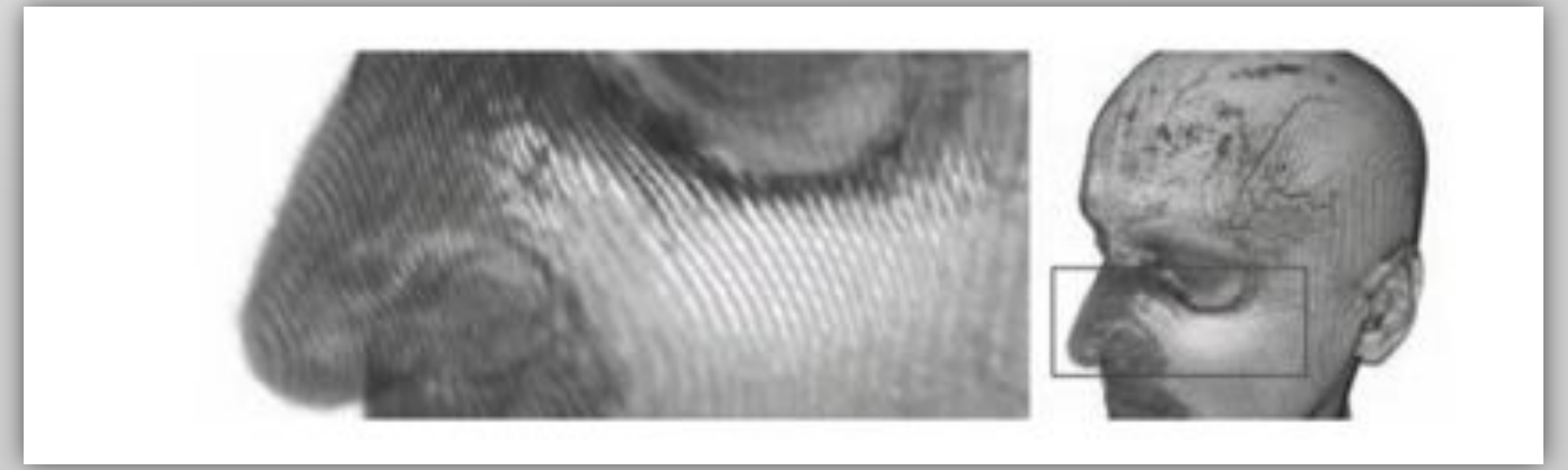
Proxy Geometry

- Graphics pipe-line only see polygons



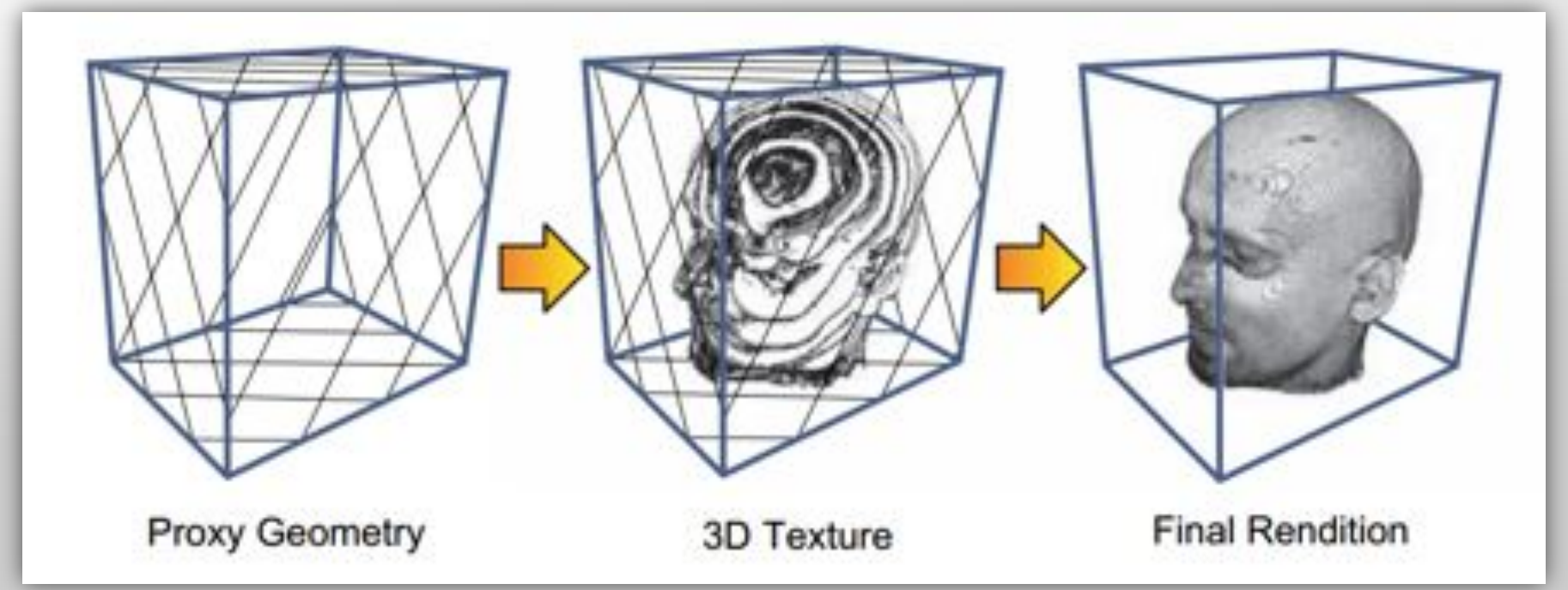
Object space volume rendering





Eye-space volume rendering

- Requires 3D texture and dynamic slicing of the proxy geometry.



RAY CASTING

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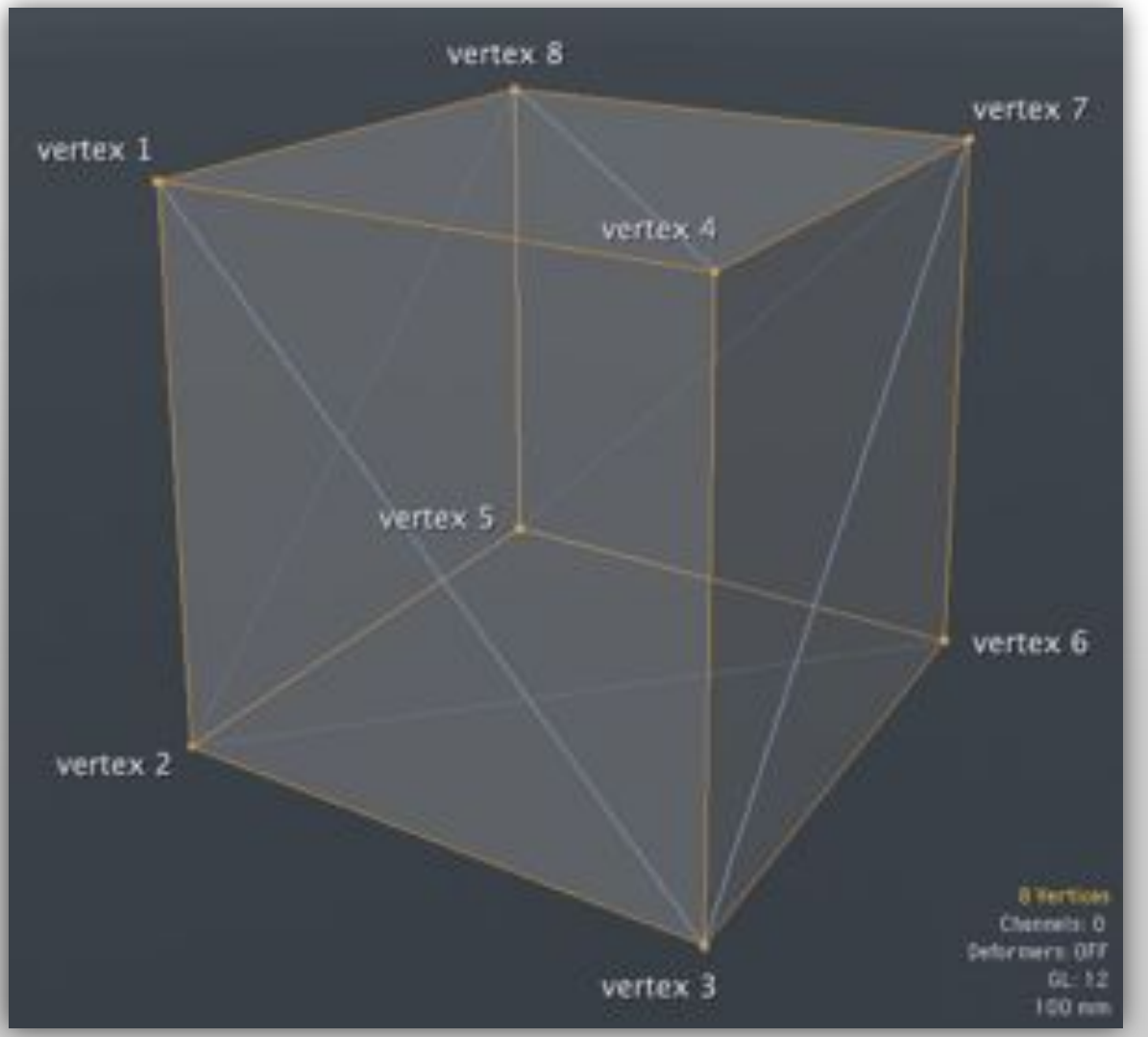
Proxy Geometry



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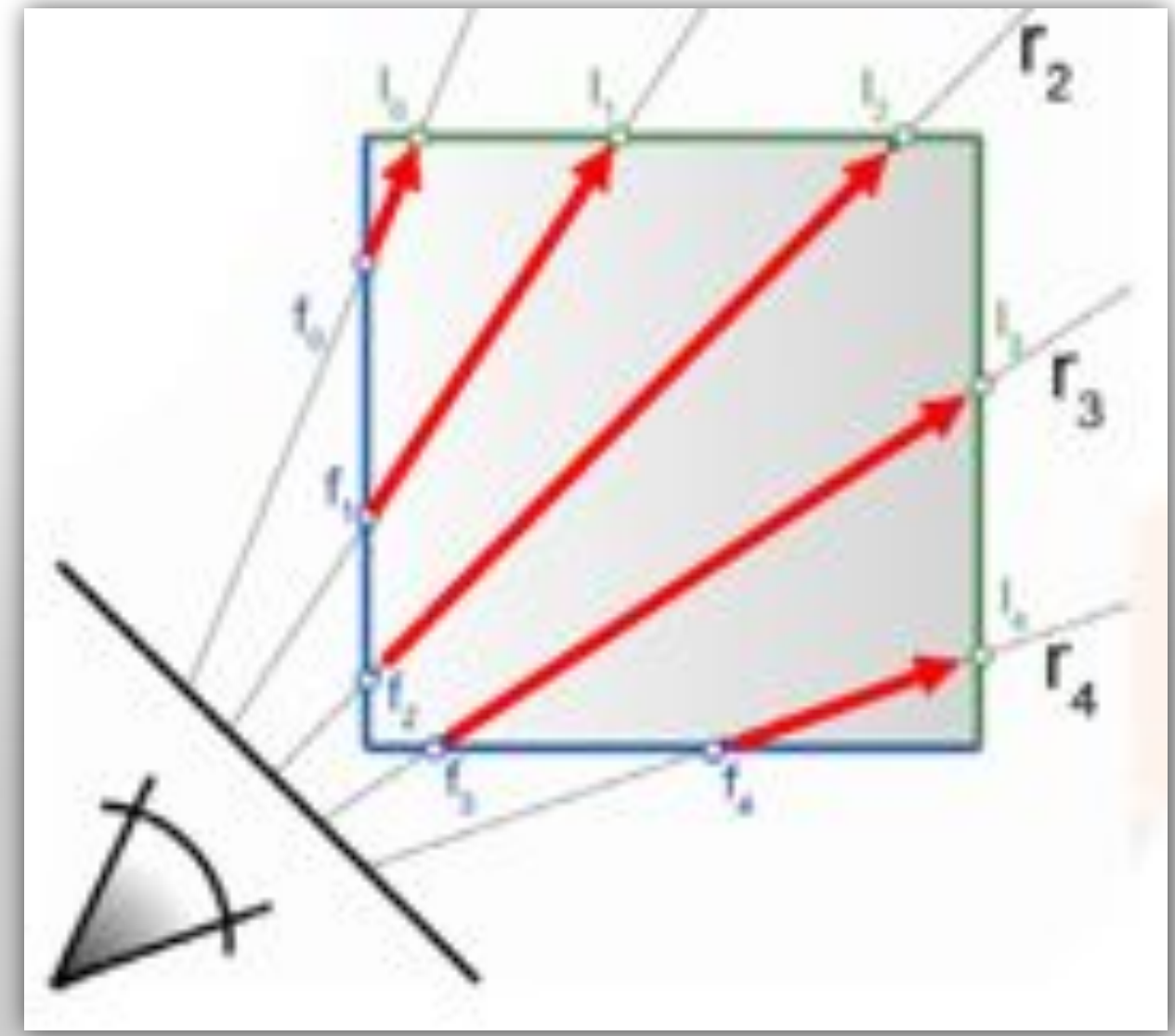
Intersection of eye rays



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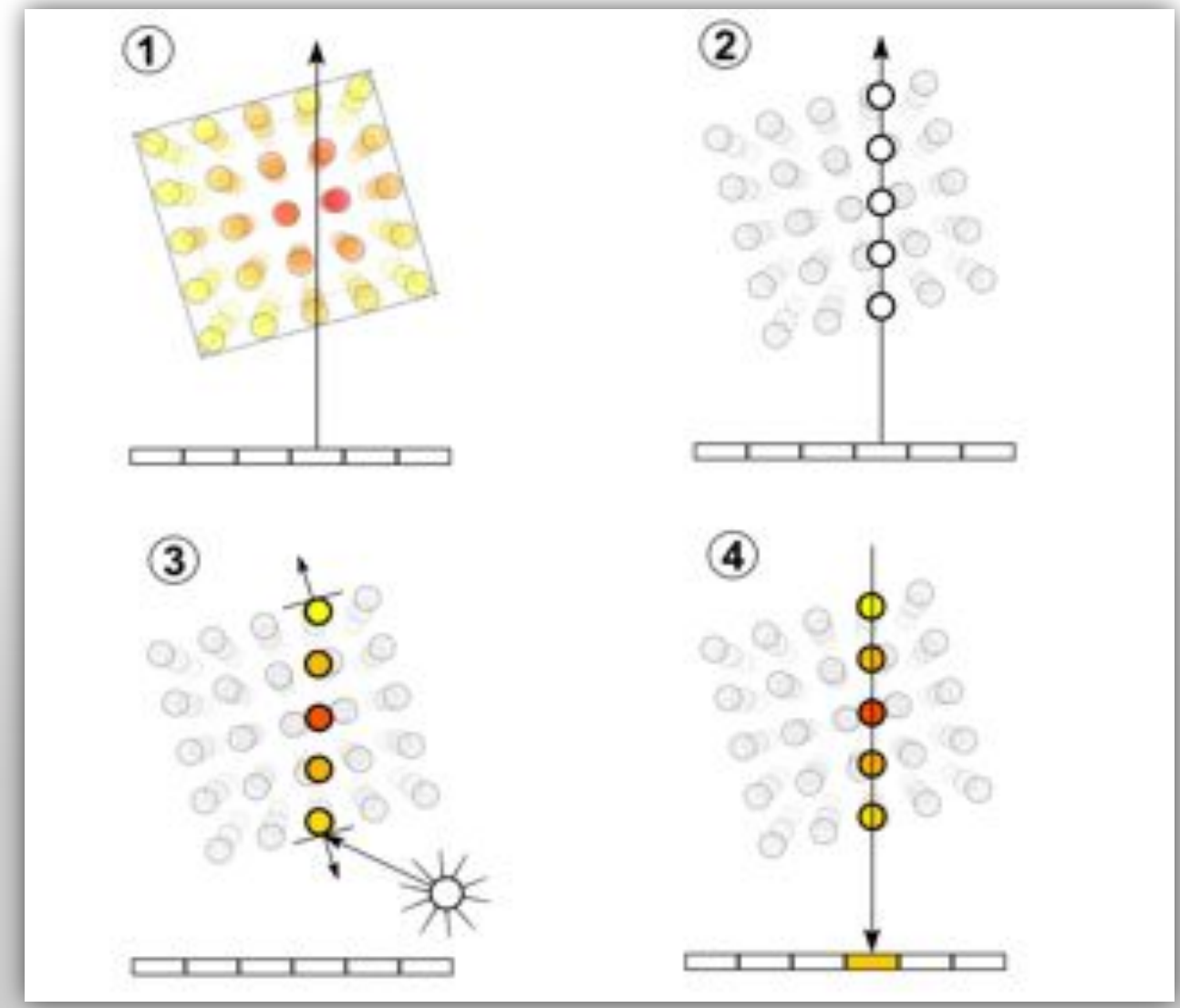
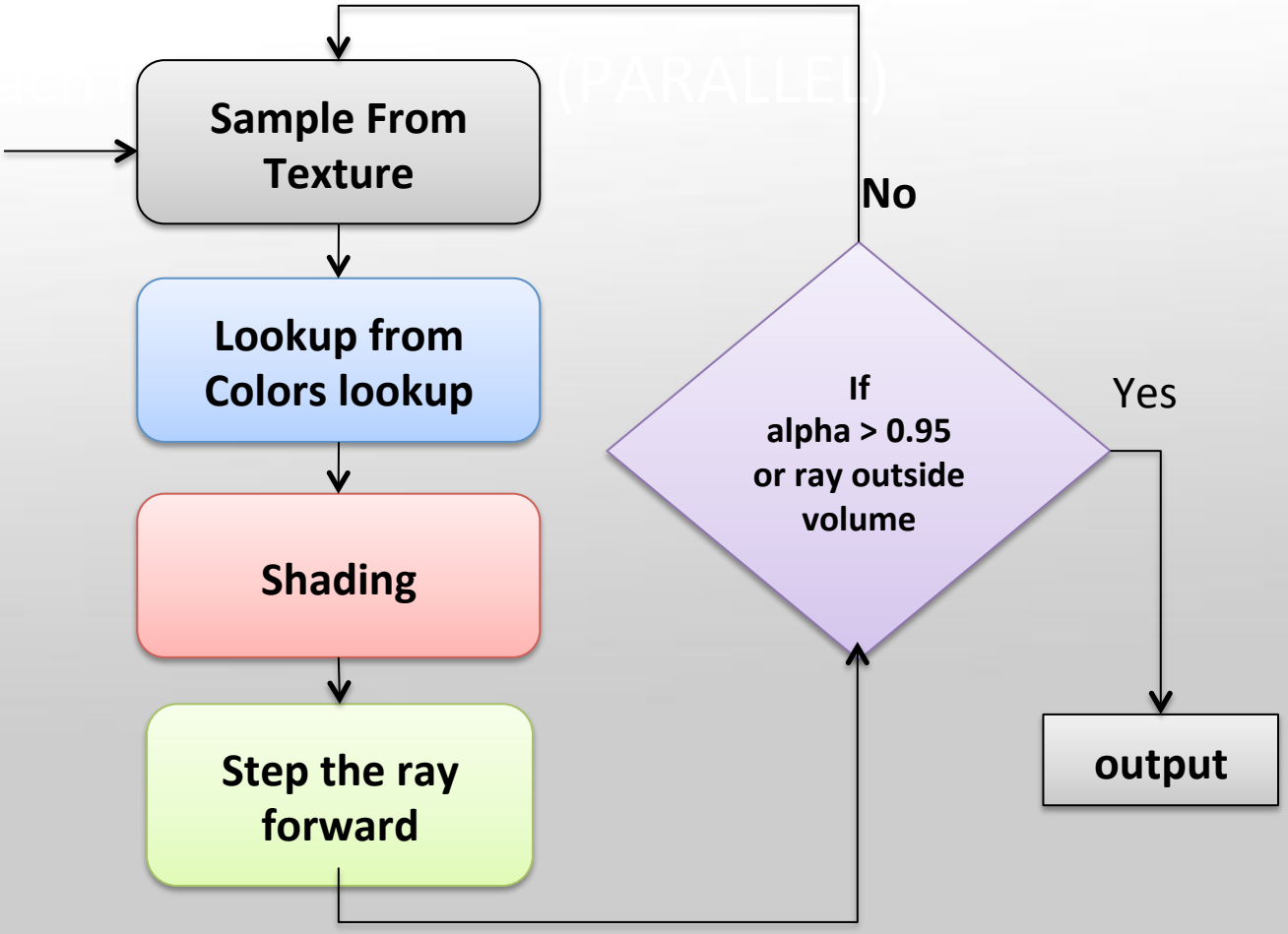
Sampling From Volume



Fragment shader ray casting



Fragment shader ray casting

```
for(int i = 0; i < Iterations; i++)
{
        value = tex3Dlod(VolumeS, pos).r;
        src = (float4)value;
        src.a *= .5f; //reduce the alpha to have a more transparent result
        src.rgb *= src.a; //Front to back blending
        dst = (1.0f - dst.a)*src + dst;
        //break from the loop when alpha gets high enough
        if(dst.a >= .95f)
            break;
        //advance the current position
        pos.xyz += Step;
        //break if the position is greater than <1, 1, 1>
        if(pos.x > 1.0f pos.y > 1.0f pos.z > 1.0f)
            break;
}
```

How do we want to see every value of the data

TRANSFER FUNCTION

Transfer function

- Is a transformation that maps scalar-data to a pixel color that reflects a specific meaning.
- Pixel color could be composed of
  - Opacity
  - Color
  - Light (including Material)
  - Index of refraction

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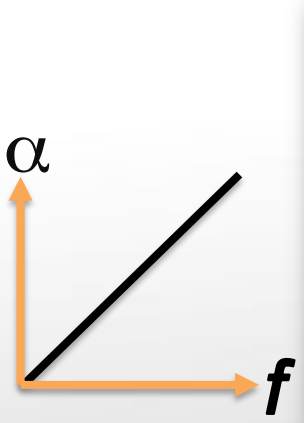
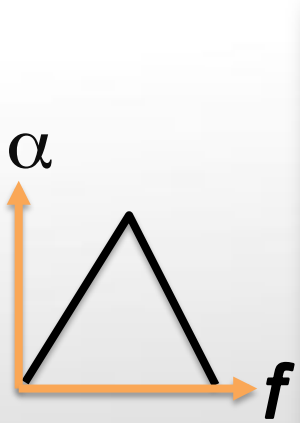
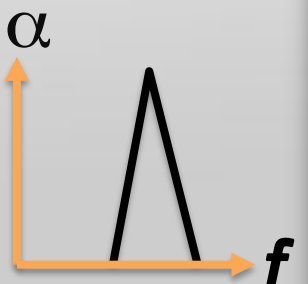
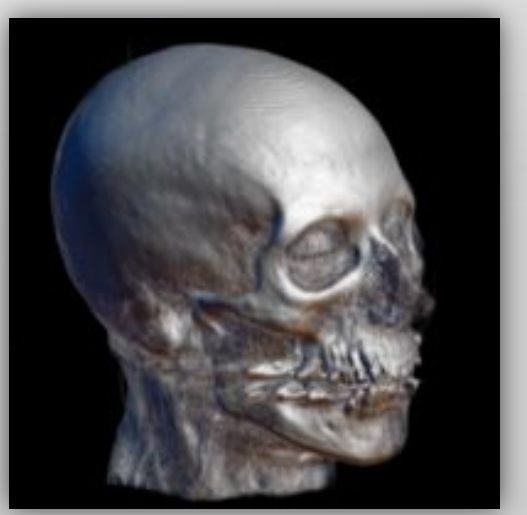
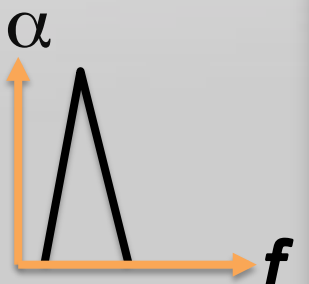
Transfer function



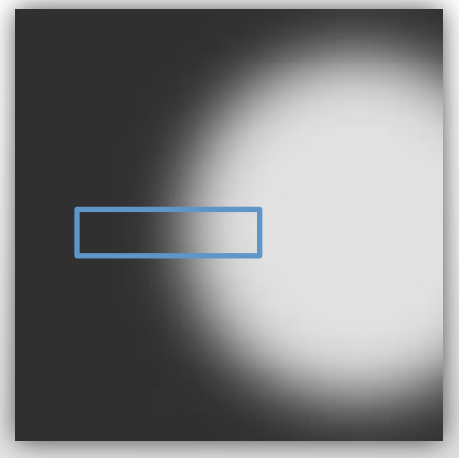


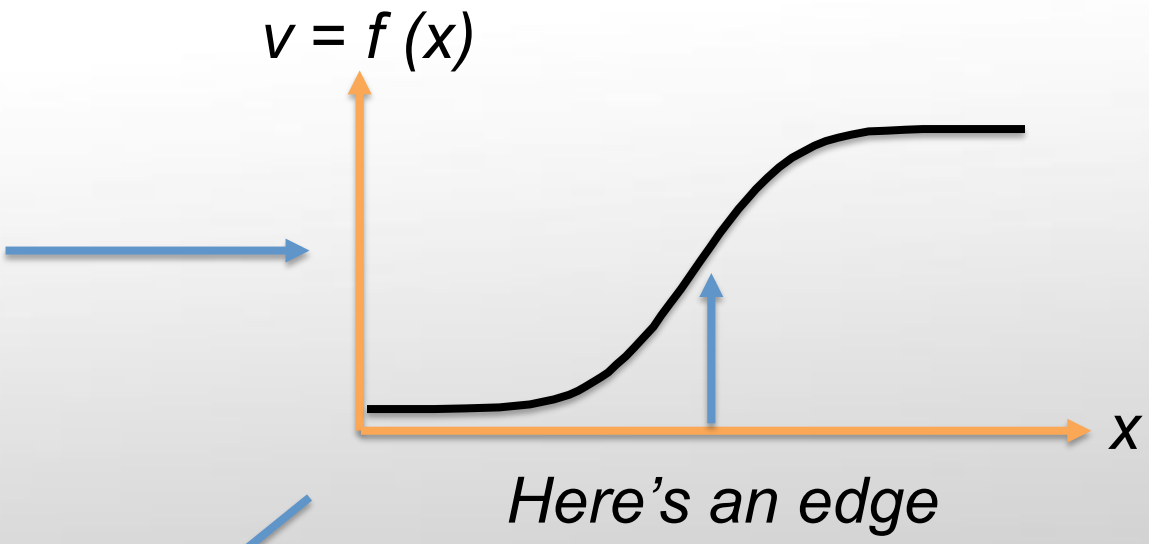




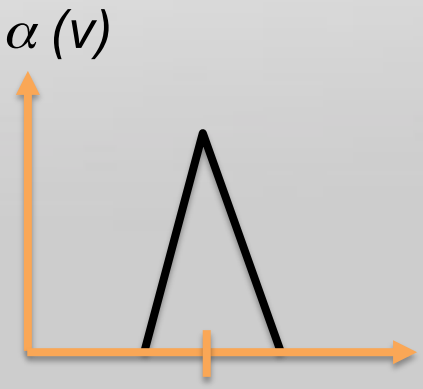


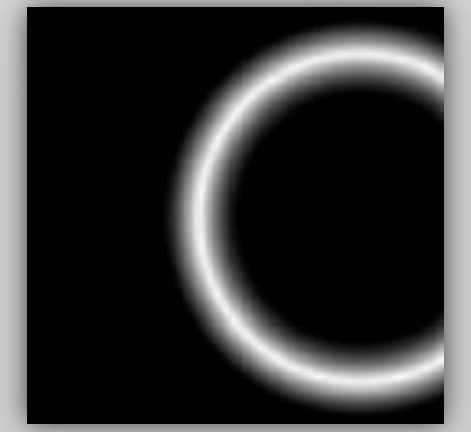
TFs as feature detection



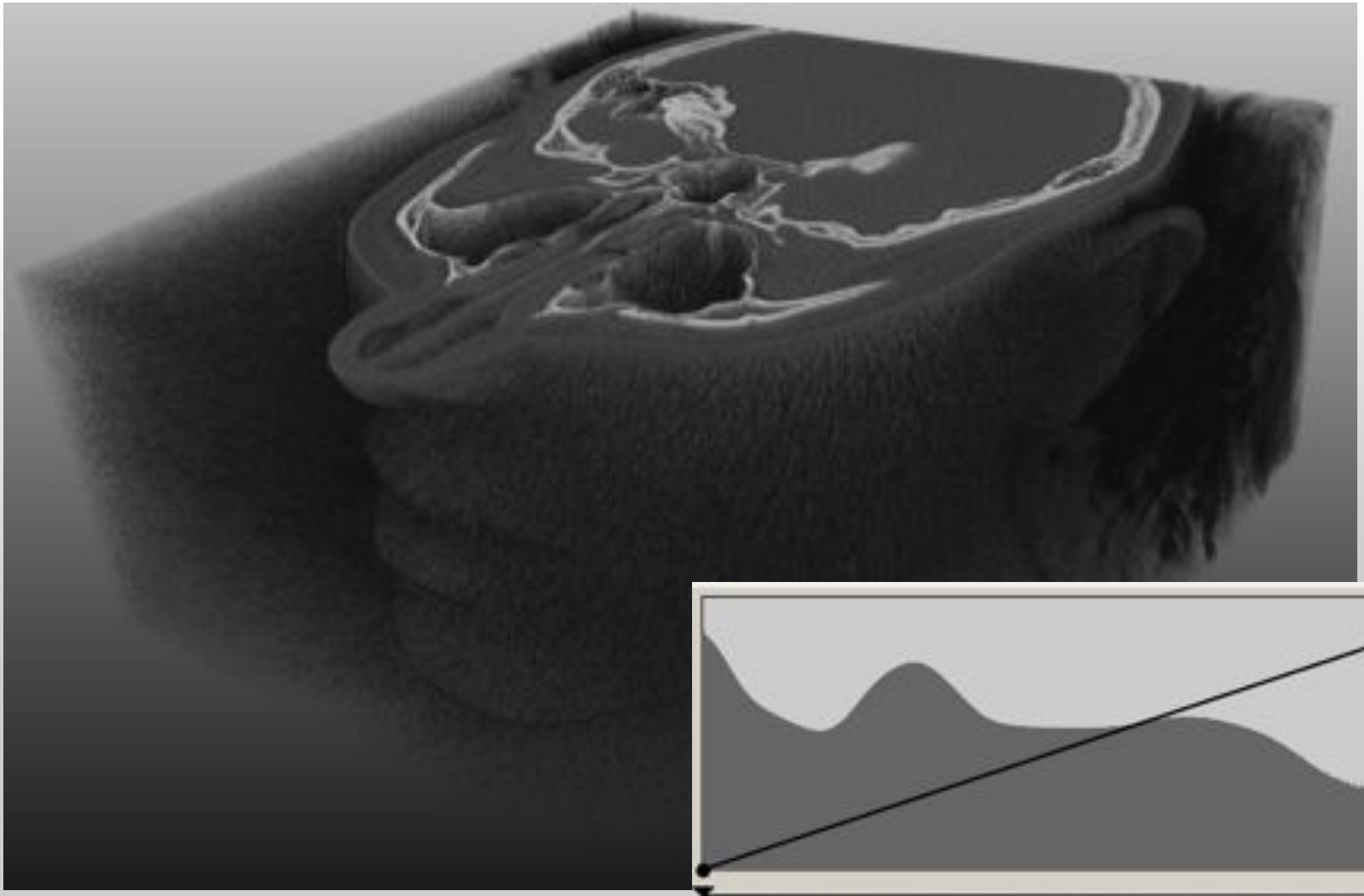


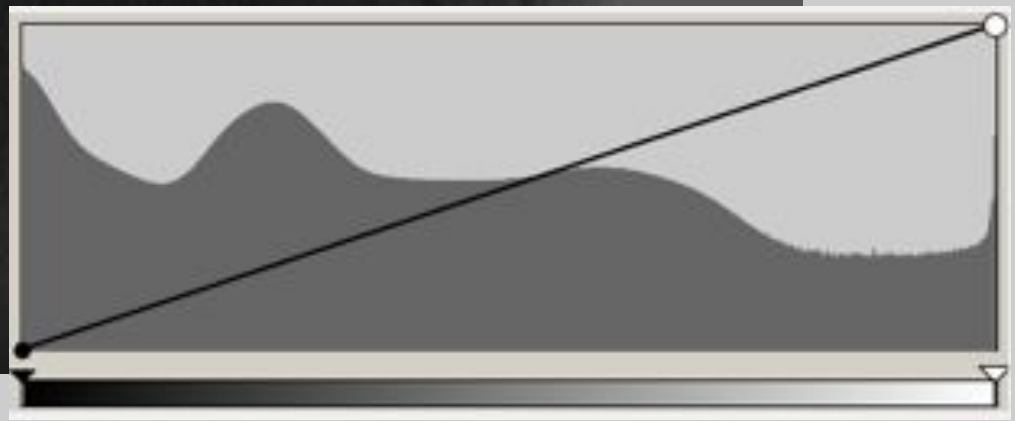
Here's an edge





Transfer function Cont'd





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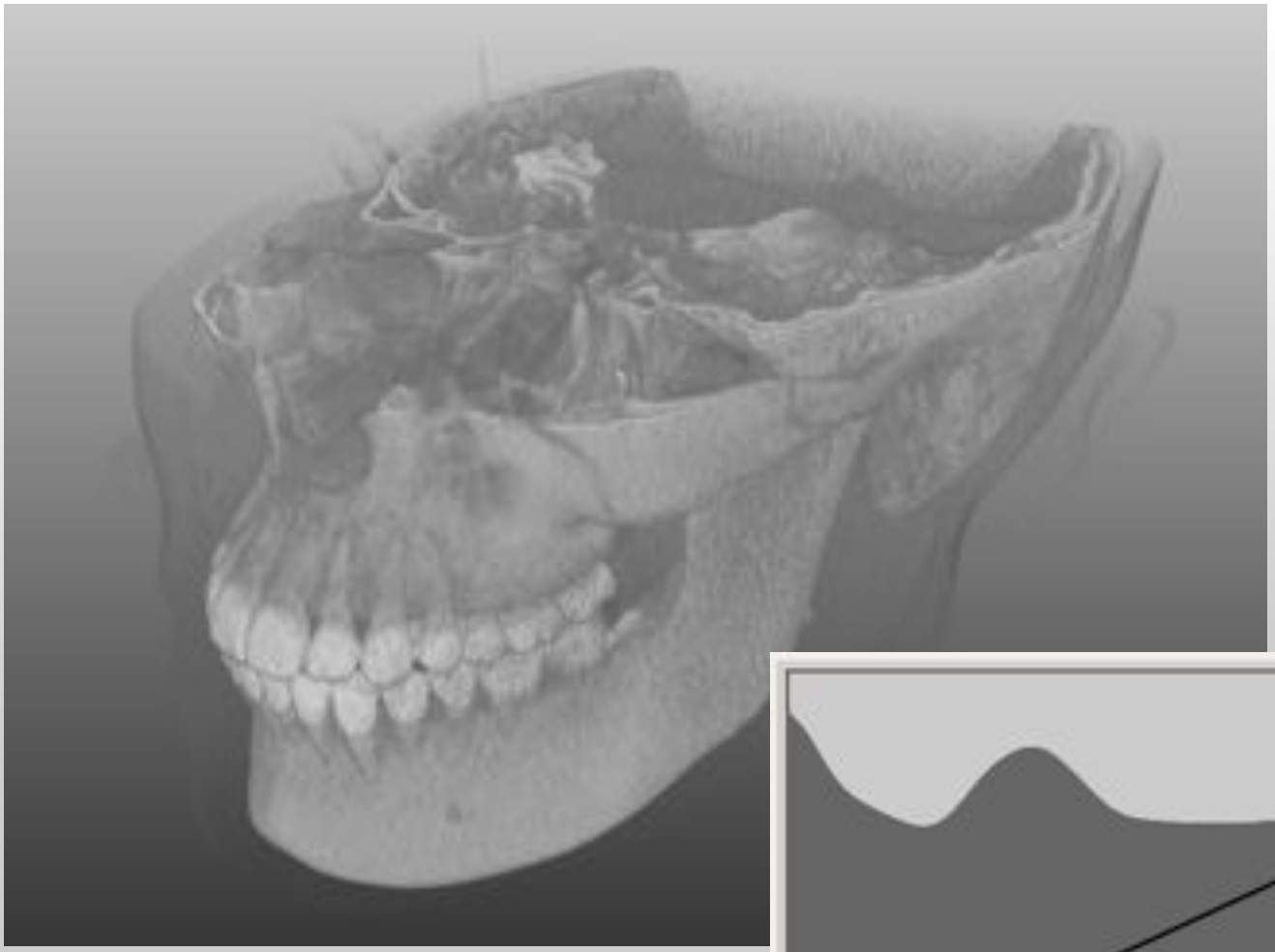
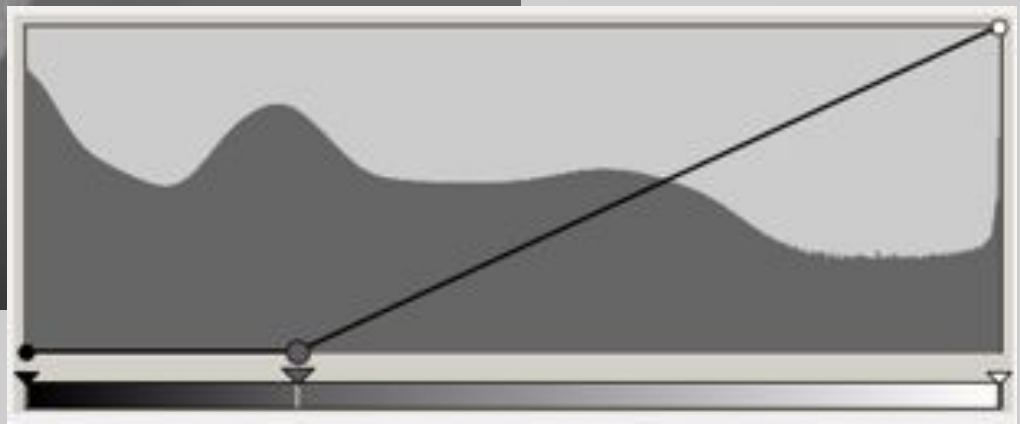
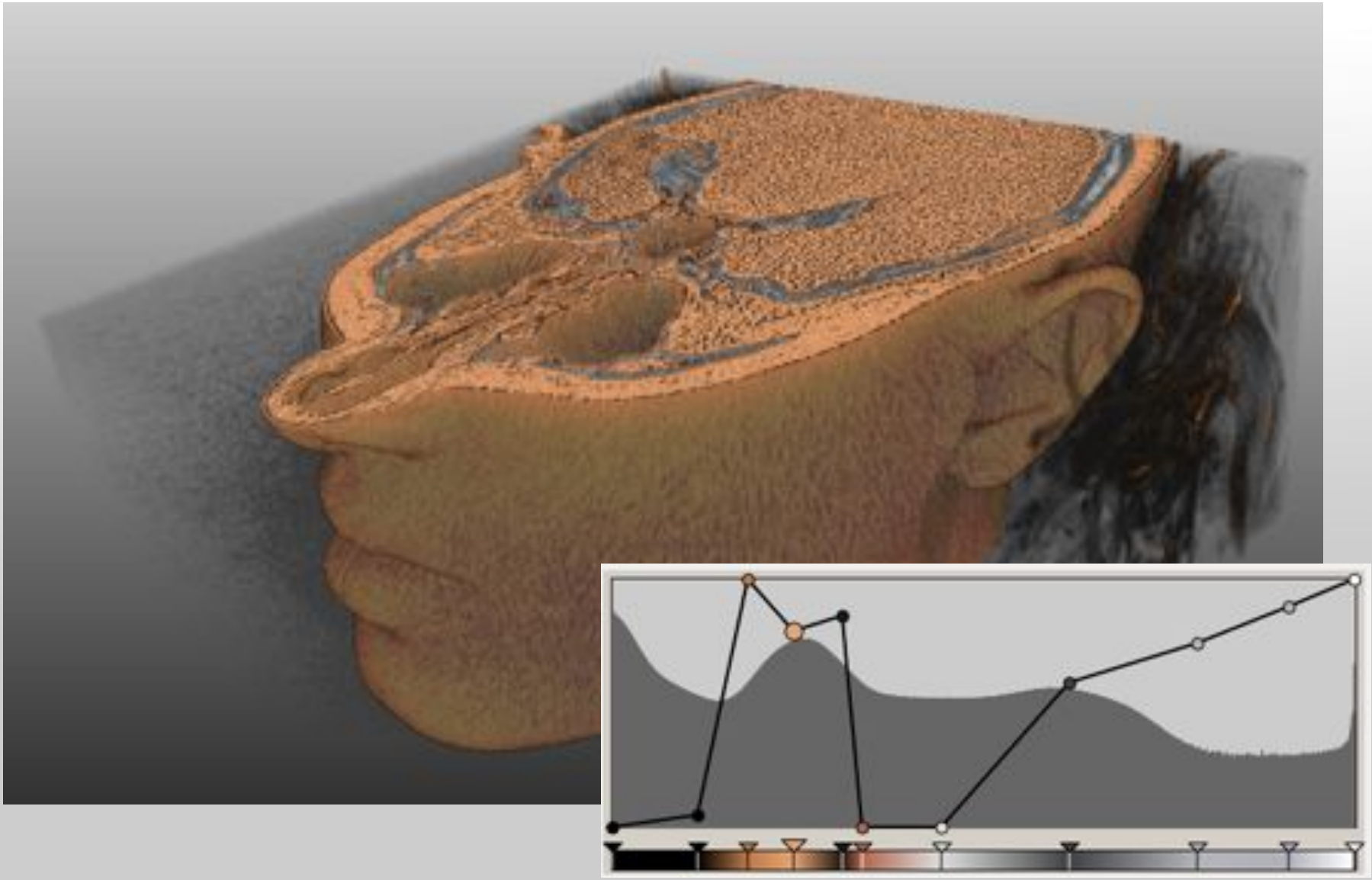
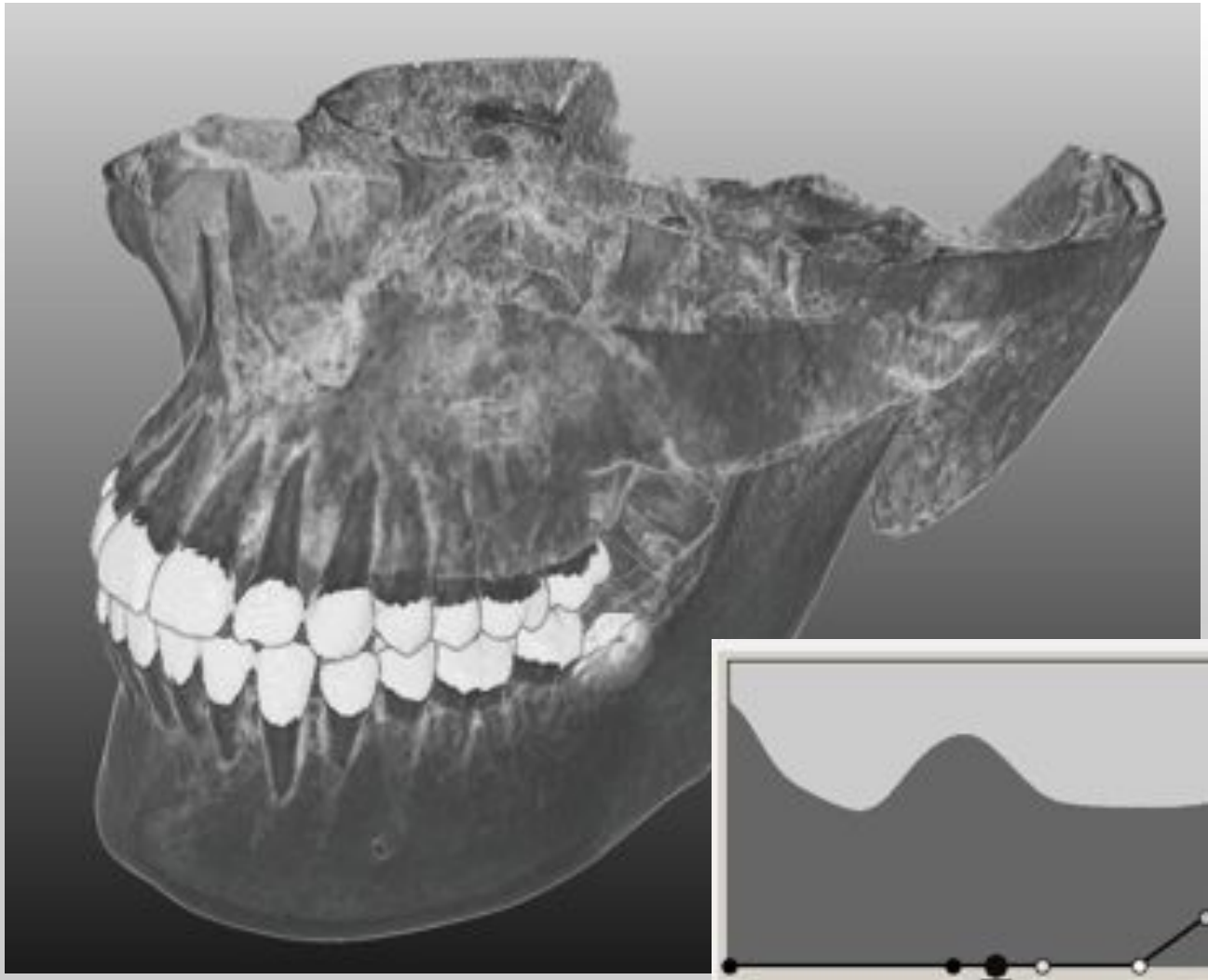


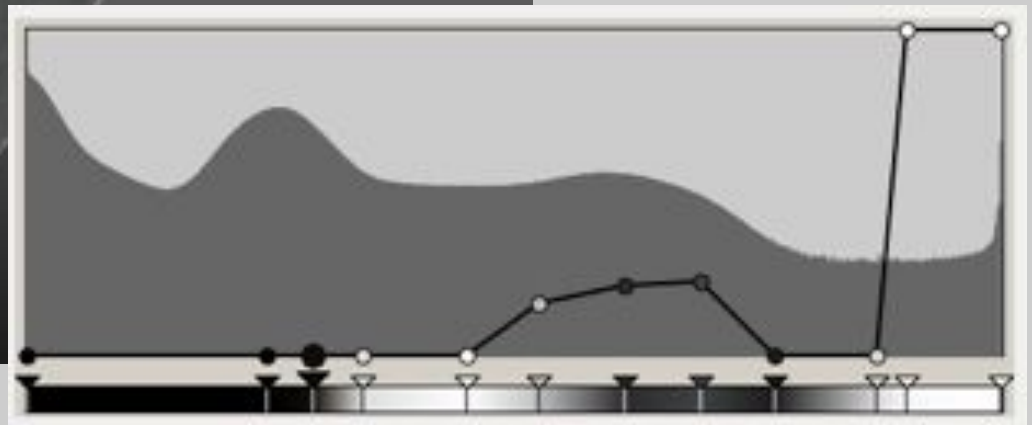


Transfer function Cont'd

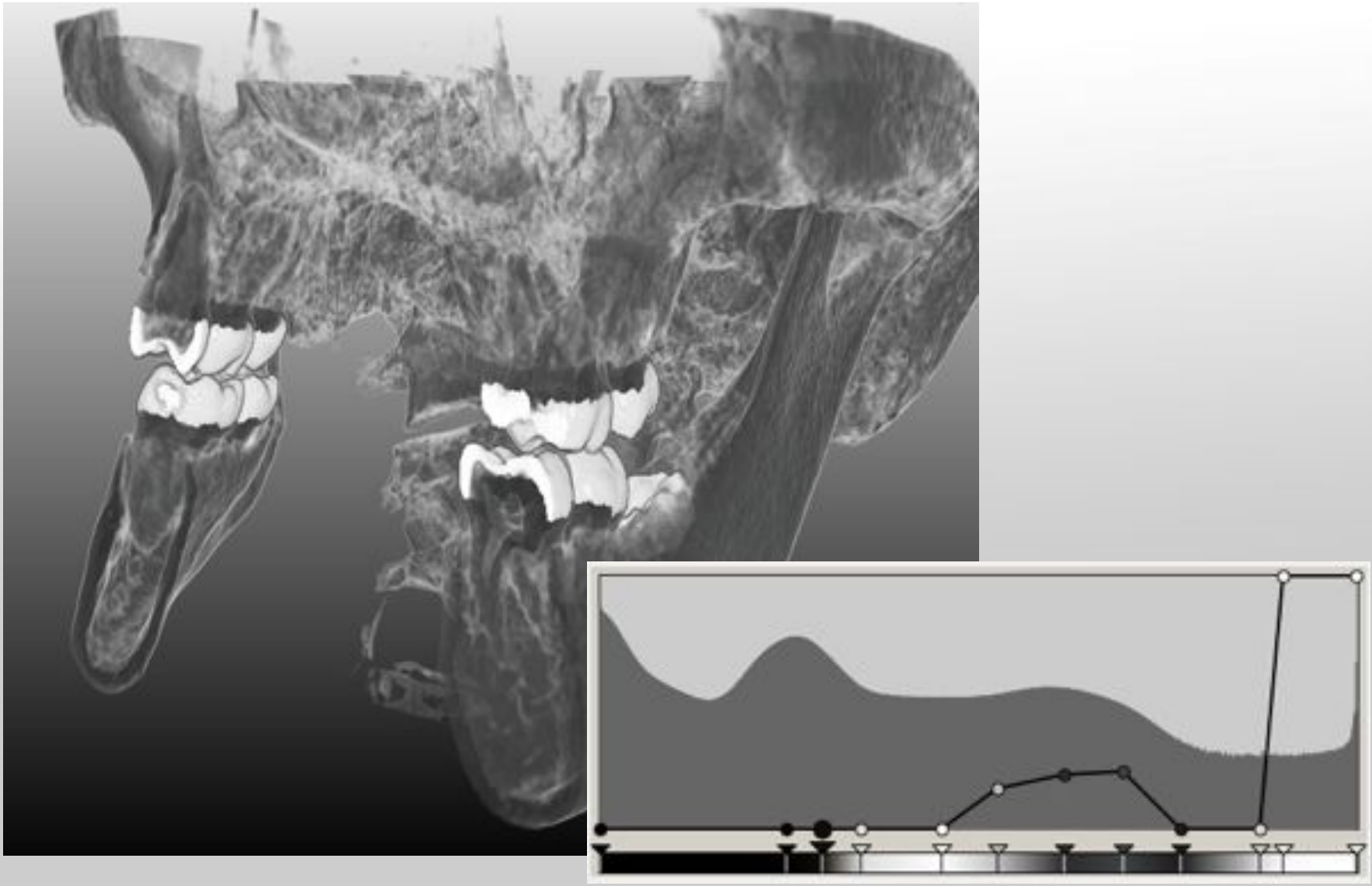


Transfer function Cont'd





Transfer function Cont'd



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