

# X3D WebGL based Volume Rendering

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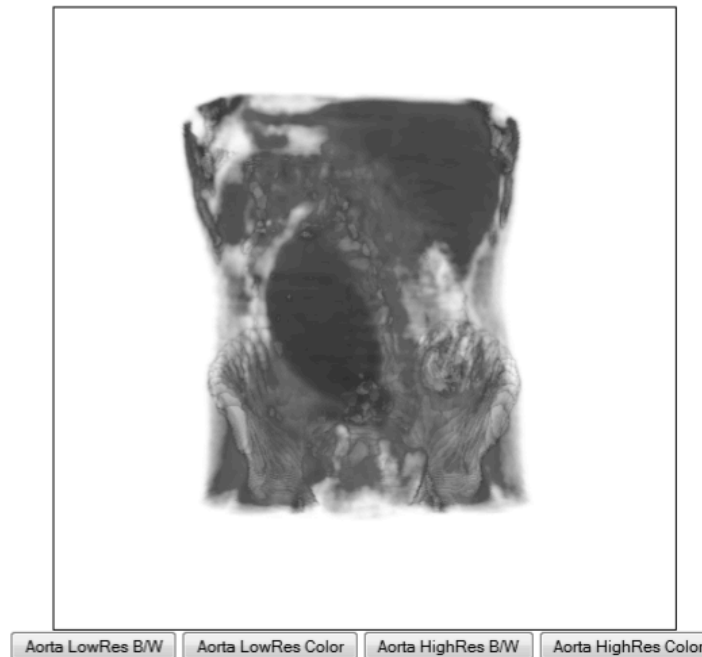
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# Volume Visualization 2011

**Real-Time Interactive Visualization of Volumetric Data with WebGL**



Rotation with the mouse, and Alt+Mouse to Zoom

<http://demos.vicomtech.org/volren/index.html>



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# 2012

- Implementation to support advanced medical visualization on the Web without plugins using existing standards ...



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# MEDX3D

Extension of the X3D ISO standard to support advanced medical visualization functionality

```
<?xml version="1.0" encoding="utf-8"?>
<X3D version="3.2" profile="MedicalInterchange">
<Scene>
<Group>
<NavigationInfo type="'EXAMINE' 'WALK'"/>
<Viewpoint description="first" position="0 0 0.6"/>
<Background skyColor="1 1 1"/>
<Transform scale=".001 .001 .001">
<!-- The volume -->
<VolumeData DEF="volume" rayStep="0.01" useSlicing="false"
  dimensions="250 250 156">
<Image3DTexture containerField="voxels" url="'data/S76280/
  IM00010">
</VolumeData>
</Transform>
</Group>
</Scene>
</X3D>
```



# X3DOM (Simple Example)

Framework for integrating and manipulating X3D scenes as HTML5/DOM elements

```

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <meta http-equiv="X-UA-Compatible" content="chrome=1" />
    <meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
    <title>Hello World</title>
    <link rel="stylesheet" type="text/css" href="x3dom.css" />
    <script type="text/javascript" src="x3dom.js"></script>
  </head>
  <body>
    <h1>XHTML Hello World</h1>
    <p>With X3D-namespace and case sensitive element/node names. Works with self-closing tags (e.g. Viewpoint and Material)</p>
    <X3D xmlns="http://www.web3d.org/specifications/x3d-namespace" showStat="false" showLog="false" x="0px" y="0px" width="400px" height="400px" altImg="helloX3D-alt.png">
      <Scene>
        <Viewpoint position='0 0 10' />
        <Shape>
          <Appearance>
            <Material diffuseColor='0.603 0.894 0.909' />
          </Appearance>
          <Box DEF='box' />
        </Shape>
      </Scene>
    </X3D>
  </body>
</html>

```



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# MEDX3DOM (Work in progress)

```

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="X-UA-Compatible" content="chrome=1" />
<meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
<title>Hello World</title>
<link rel="stylesheet" type="text/css" href="x3dom.css" />
<script type="text/javascript" src="x3dom.js"></script>
</head>
<body>
  <X3D xmlns='http://www.web3d.org/specifications/x3d-namespace'
    showStat='true' showLog='true' width='500px' height='500px'>
    <Scene>
      <Background skyColor='0.0 0.3 0.65' />
      <Viewpoint description='Default' zNear='0.0001' zFar='100' />
      <Transform>
        <VolumeData id='volume' dimensions='4.0 4.0 4.0'>
          <ImageTextureAtlas containerField='voxels' url='media/volume/aorta4096.png'
            numberOfSlices='96' slicesOverX='10' slicesOverY='10' />
          <OpacityMapVolumeStyle lightFactor='0.01'>
            <ImageTexture containerField='transferFunction' url='transfer.png' />
          </OpacityMapVolumeStyle>
        </VolumeData>
      </Transform>
    </Scene>
  </X3D>
</body>
</html>

```



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# Our contribution in MedX3DOM

## Generation of nodes for two components

### • Texturing3D

- X3DTexture3DNode
- ComposedTexture3D
- ImageTexture3D
- PixelTexture3D
- TextureCoordinate3D
- TextureCoordinate4D
- TextureTransformMatrix3D
- TextureTransform3D
- ImageTextureAtlas

### • VolumeRendering

- X3DComposableVolumeRenderStyleNode
- X3DVolumeDataNode
- X3DVolumeRenderStyleNode
- BlendedVolumeStyle
- BoundaryEnhancementVolumeStyle
- CartoonVolumeStyle
- ComposedVolumeStyle
- EdgeEnhancementVolumeStyle
- IsoSurfaceVolumeData
- OpacityMapVolumeStyle
- ProjectionVolumeStyle
- SegmentedVolumeData
- ShadedVolumeStyle
- SilhouetteEnhancementVolumeStyle
- ToneMappedVolumeStyle
- VolumeData

Implemented

Defined

Not implemented

Abstract

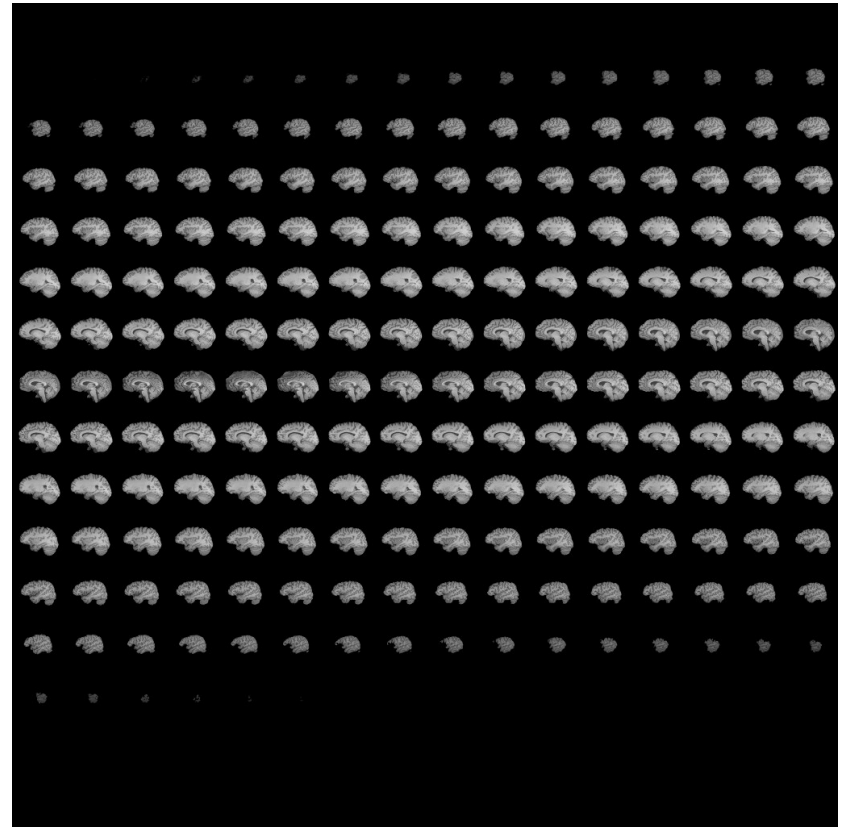


# ImageTextureAtlas for an Atlas Image Type

- Atlas
  - Composed image
  - Parameters
    - Number of slices
    - Number of rows
    - Number of columns

*The texture atlas is the mosaic of all the slices of a volume in one image, the order of the images is given by the rows and columns.*

- Brain Atlas Image





# New Node ImageTextureAtlas

```
ImageTextureAtlas: ImageTexture {  
    SFInt32    [in]    numberOfSlices    0  
    SFInt32    [in]    slicesOverX      0  
    SFInt32    [in]    slicesOverY      0  
}
```

ImageTextureAtlas node defines a texture map by specifying a single image file that contains slides of complete 3D data. Parameters indicate the information necessary for mapping voxels to the geometry.



# Modified OpacityMapVolumeStyle

```

OpacityMapVolumeStyle : X3DComposableVolumeRenderStyleNode {
  SFBool [in,out] enabled          TRUE
  SFNode [in,out] metadata         NULL  [X3DMetadataObject]
  SFNode [in,out] transferFunction NULL  [X3DTexture2DNode,X3DTexture3DNode]
  SFFloat [in,out] opacityFactor   0.01  [0,1]
  SFFloat [in,out] lightFactor     0.3    [0,1]
}

```

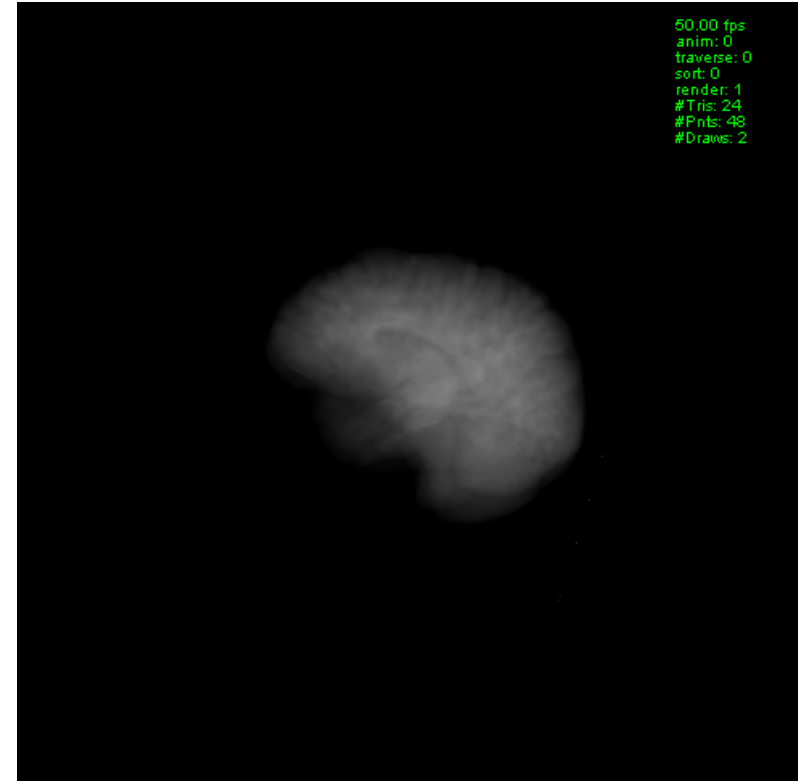
**OpacityFactor:** Value of contrast in each voxel of the volume

**LightFactor:** Value of radiance of light in each voxel of the volume



# Brain Example

```
<X3D xmlns='http://www.web3d.org/specifications/x3d-
  namespace'
  showStat='true' showLog='true' width='500px'
  height='500px'>
  <Scene>
    <Background skyColor='0.0 0.0 0.0'/>
    <Viewpoint description='Default' zNear='0.0001'
      zFar='100'/>
    <Transform>
      <VolumeData id='volume' dimensions='4.0 4.0 4.0'>
        <ImageTextureAtlas containerField='voxels'
          url='media/volume/brain-at_4096.jpg'
          numberOfSlices='226' slicesOverX='16'
          slicesOverY='16'/>
        <OpacityMapVolumeStyle>
        </OpacityMapVolumeStyle>
      </VolumeData>
    </Transform>
  </Scene>
</X3D>
```



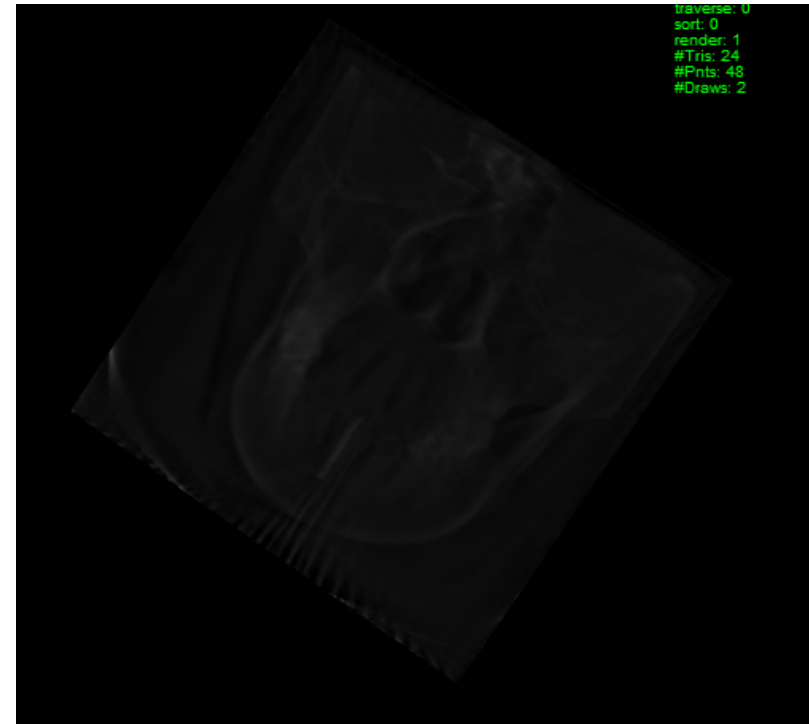
[http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest\\_brain.xhtml](http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest_brain.xhtml)



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# Skull Example

```
<X3D xmlns='http://www.web3d.org/specifications/x3d-
namespace'
showStat='true' showLog='true' width='500px'
height='500px'>
<Scene>
  <Background skyColor='0.0 0.0 0.0'/>
  <Viewpoint description='Default' zNear='0.0001'
zFar='100'/>
  <Transform>
    <VolumeData id='volume' dimensions='4.0 4.0
4.0'>
      <ImageTextureAtlas containerField='voxels'
url='media/volume/skull-at.png'
numberOfSlices='256' slicesOverX='16'
slicesOverY='16'/>
      <OpacityMapVolumeStyle>
      </OpacityMapVolumeStyle>
    </VolumeData>
  </Transform>
</Scene>
</X3D>
```



[http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest\\_skull.xhtml](http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest_skull.xhtml)



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# Aorta Example

```
<X3D xmlns='http://www.web3d.org/specifications/x3d-
namespace'
  showStat='true' showLog='true' width='500px'
  height='500px'>
  <Scene>
    <Background skyColor='0.0 0.0 0.0'/>
    <Viewpoint description='Default' zNear='0.0001'
zFar='100'/>
    <Transform>
      <VolumeData id='volume' dimensions='4.0 4.0
4.0'>
        <ImageTextureAtlas containerField='voxels'
url='media/volume/aorta4096.png'
numberOfSlices='96' slicesOverX='10'
slicesOverY='10'/>
        <OpacityMapVolumeStyle>
        </OpacityMapVolumeStyle>
      </VolumeData>
    </Transform>
  </Scene>
</X3D>
```



[http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest\\_aorta.xhtml](http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTest_aorta.xhtml)

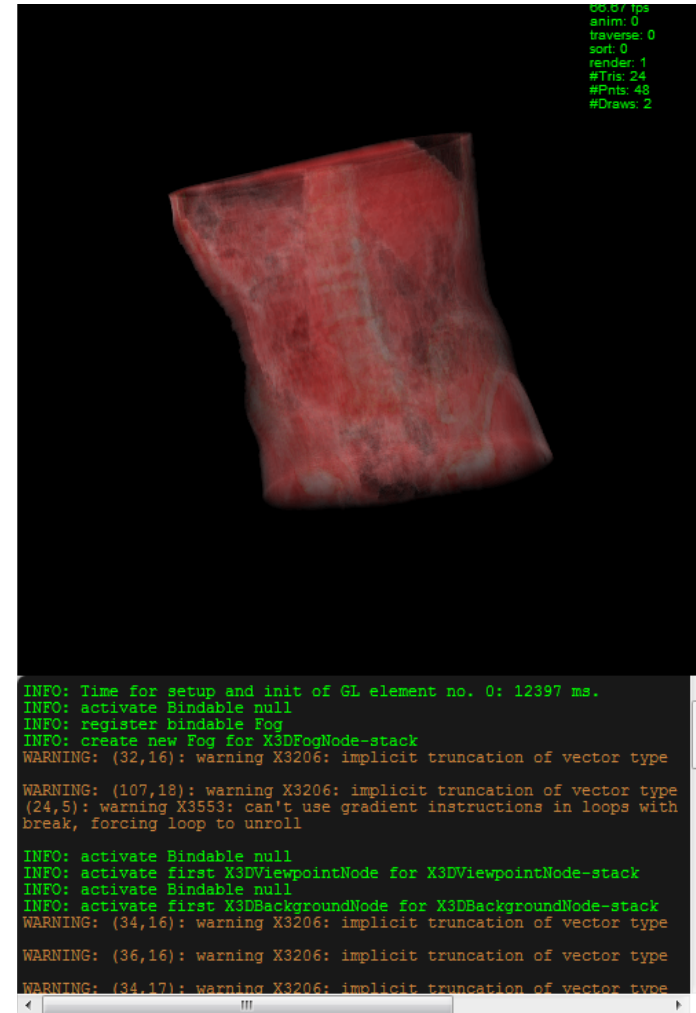


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# Aorta with color transfer function example

<http://demos.vicomtech.org> click on "Aorta with Transfer Function" in MEDX3DOM Section

[http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTestTF\\_aorta.xhtml](http://demos.vicomtech.org/x3dom/test/functional/volrenOpacityTestTF_aorta.xhtml)



# DICOM, NRRD, RAW Format??

- Javascript is very slow to process binary data
- The loaders of this kind of volume data are based in C and the conversion or reimplementaion is not straightforward
- Other types of volume formats exists, like MHD, NetCDF, ....., imposible to implement all
- **MEDX3DOM** is for the web, using web formats



# MEDICAL IMAGING

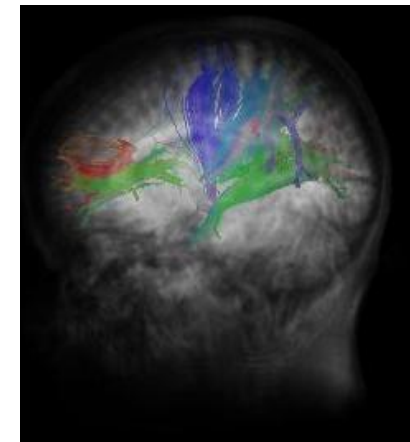
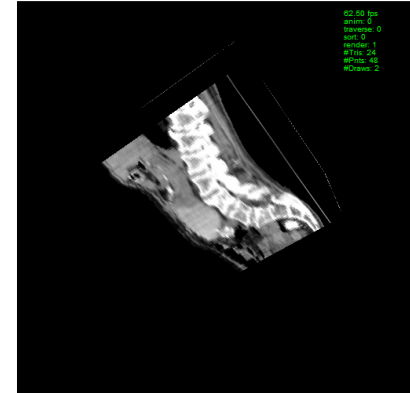
- DICOM format is the facto standard for medical imaging, but internally is a container of several kind of data, sound, 2D images, 3D images, metadata, etc
  - <http://demos.vicomtech.org/medica/WtMetalImageSimpleViewer2D.wt>
  - <http://demos.vicomtech.org/medica/WtWebGLSimpleImageViewer.wt>
- WADO: It is a webservice which provides medical images through the web retrieving from a PACS server
- MEDX3DOM: Will support WADO (Web Access to DICOM Objects)





# MEDX3DOM Future

- Work in progress
  - MPR Style
    - [http://localhost/x3domMPR/test/functional/volrenMPR\\_aorta.xhtml](http://localhost/x3domMPR/test/functional/volrenMPR_aorta.xhtml)
  - Combination with mesh models
    - [http://volumerc.org/demos/brainviewer/webgl/brain\\_viewer/brain\\_viewer.html](http://volumerc.org/demos/brainviewer/webgl/brain_viewer/brain_viewer.html)



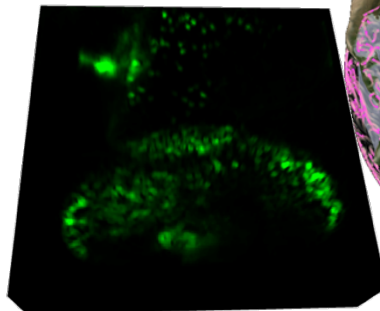
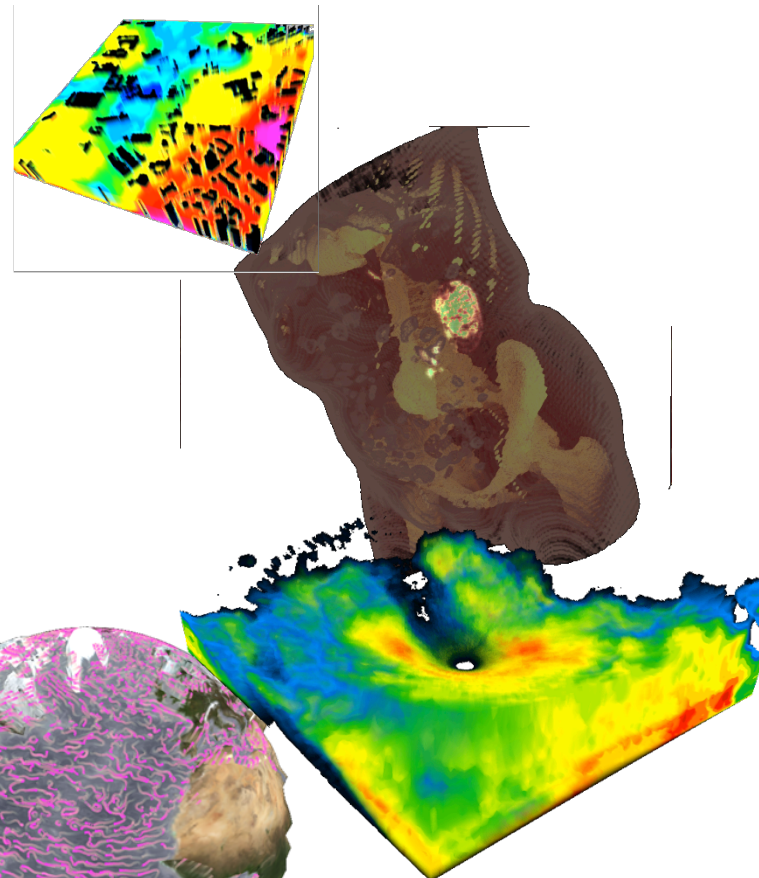
# MEDX3DOM Future

- Next steps
  - Different composition styles (MIP, X-Ray, Composed ...)
  - Lighting (Phong, Global illumination ...)
  - Animation (4D timesteps, video, flow animation ...)
    - <http://localhost/MedX3DOMGit2/test/functional/volrenTest.xhtml>
  - Data transfer optimization (streaming, compression,...)



# Beyond medical imaging

- Geovisualization
- Volume Attention Maps
- Meteorology
- FlowVisualization
- Confocal microscopy
- ....



# Keep updated!

- Our work:
  - <http://demos.vicomtech.org>
  - <http://www.volumerc.org>
- The technologies:
  - <http://www.khronos.org/webgl/>
  - <http://www.x3dom.org/>

Thank you! Questions?



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