

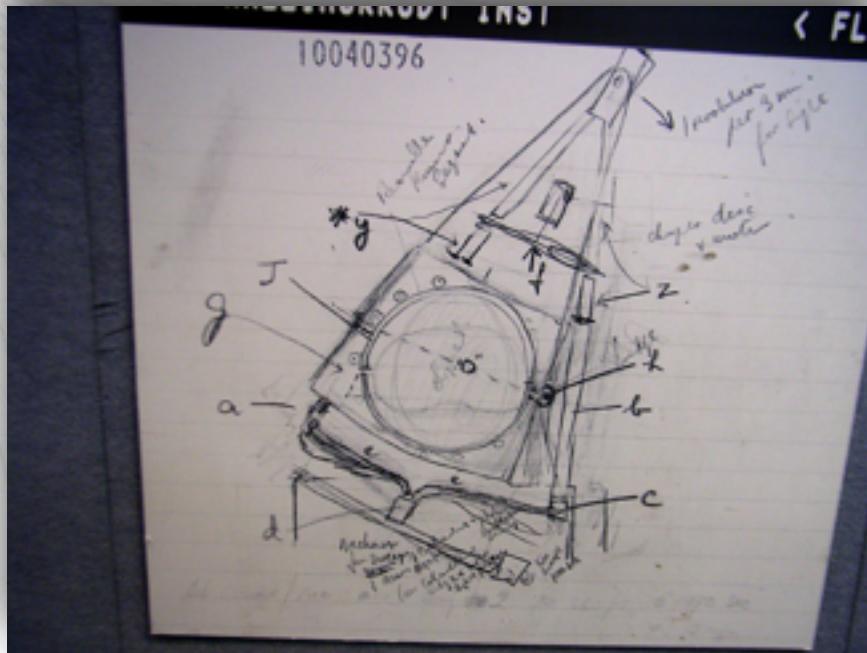
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Interactive Visualization of Whole-Body Medical Volume Data

Anders Ynnerman
Norrköping Visualization Center
Linköping University
Sweden



CT Scanning Technology



1972



1979



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The Scanning Facility at CMIV



Siemens Somatom Definition Flash



Latest Scanner - Sept 2014

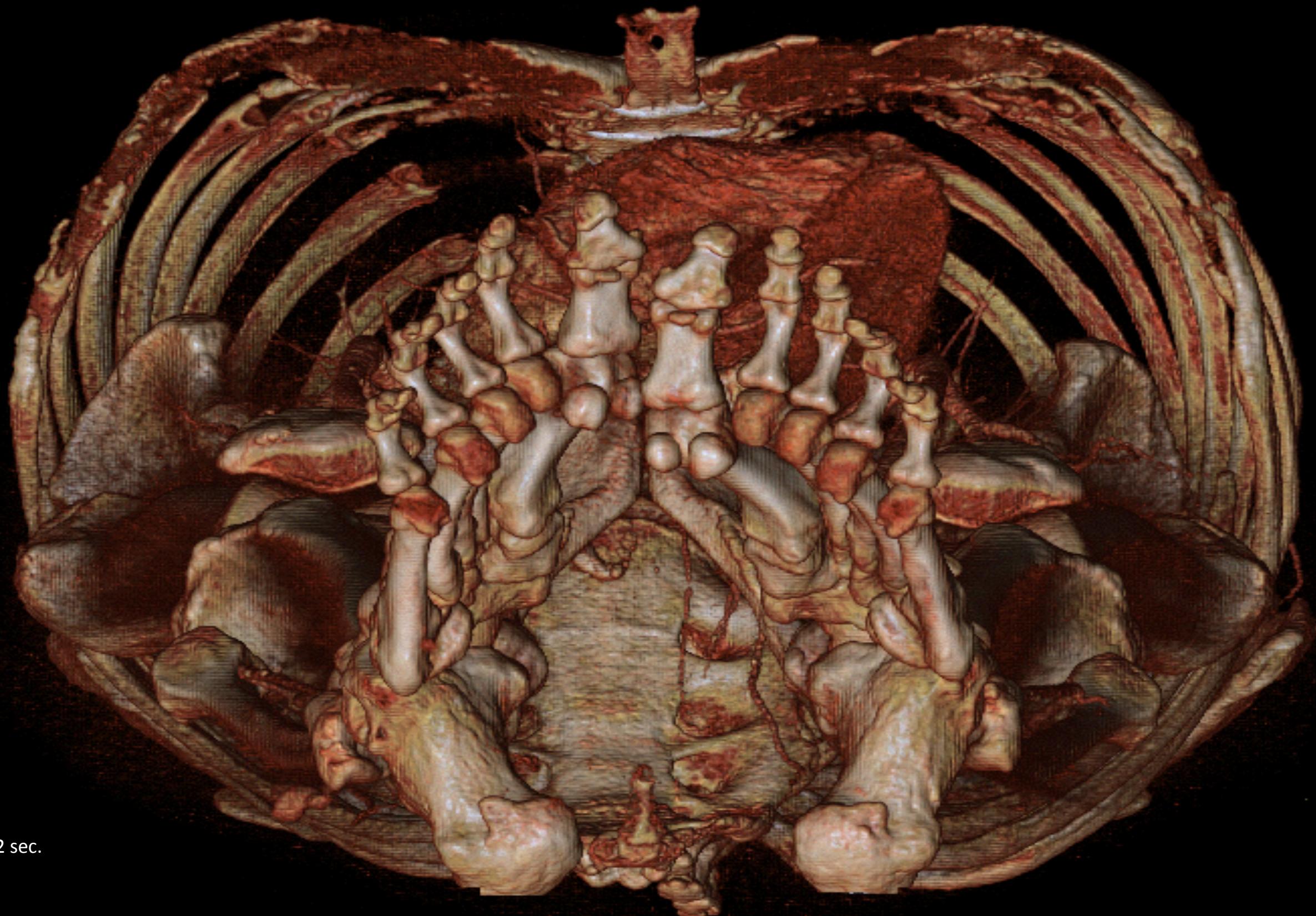
- Dual Energy
- Number of acquired slices 384
- Rotation time 0.25 s
- Temporal resolution 66 ms
- Spatial resolution 0.24 mm
- Max. scan speed 737 mm/s¹
- Full body scan ~ 20 Gb
- Time resolved scan ~ 5 Gb/s



Siemens Force

CMIIV

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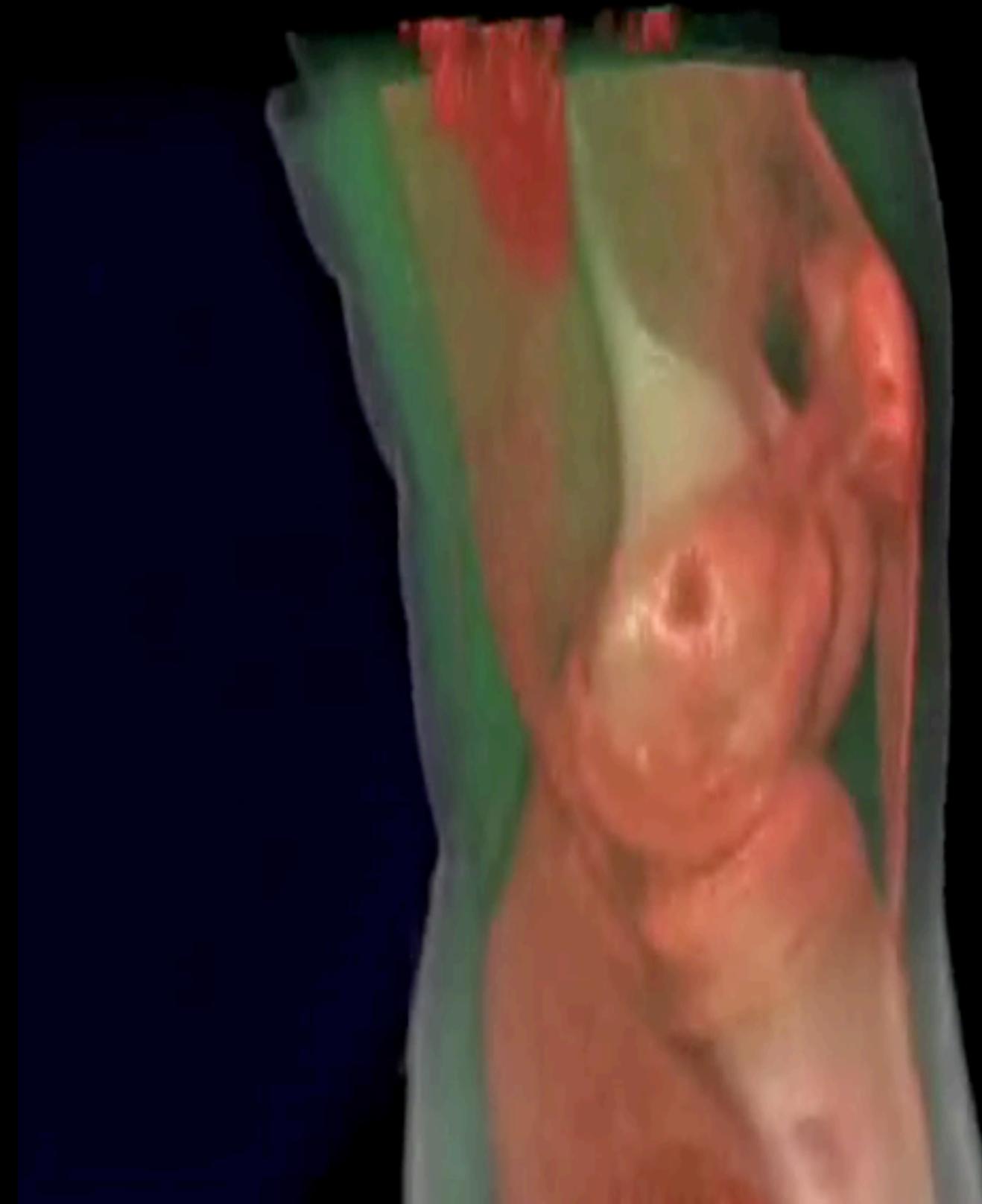


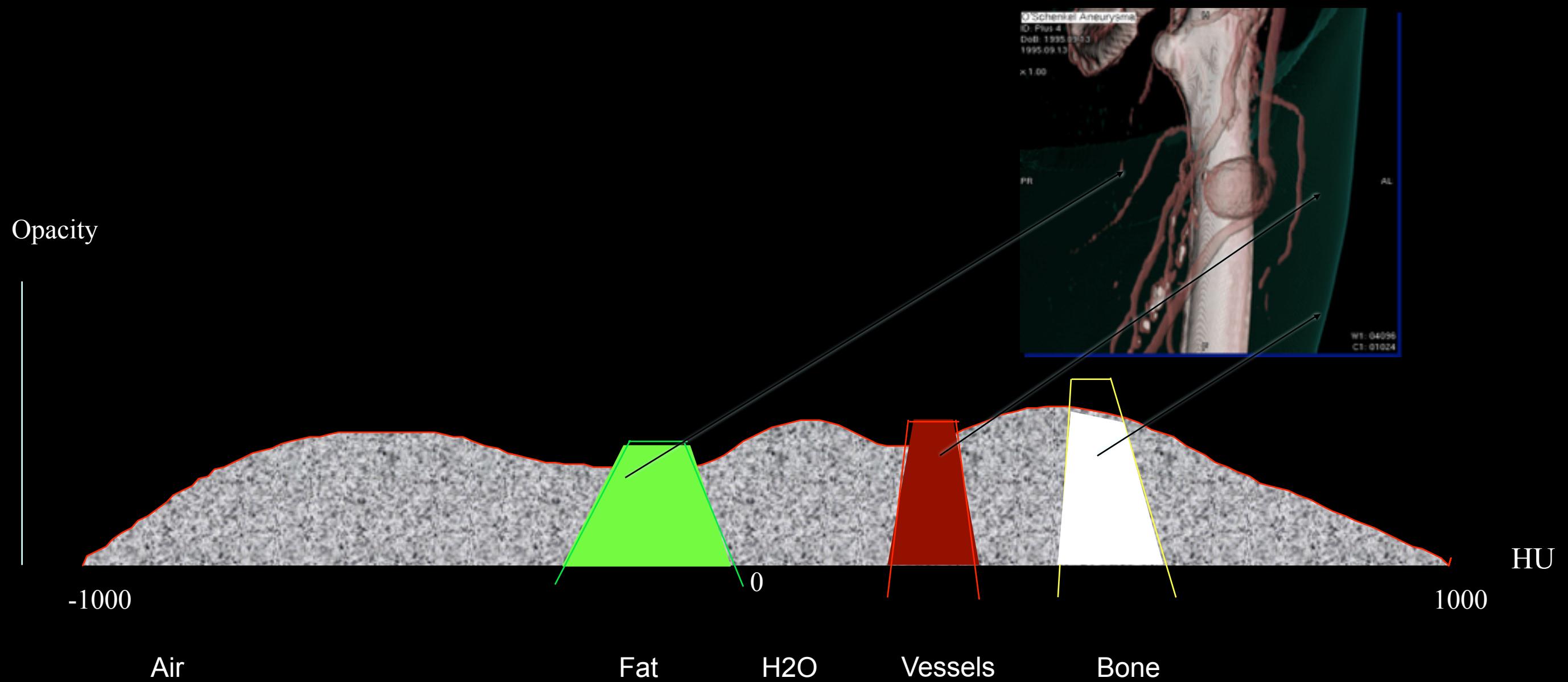


A 3D surface reconstruction of a biological specimen, likely a mollusk shell or a similar organic structure. The model is colored with a gradient from red at the top to green and blue at the bottom. A vertical scale bar is positioned on the left side of the image, showing a height of 0.67mm. The structure features a prominent siphonal canal opening on the right side and a thickened apertural margin. The overall shape is roughly triangular with rounded lobes.

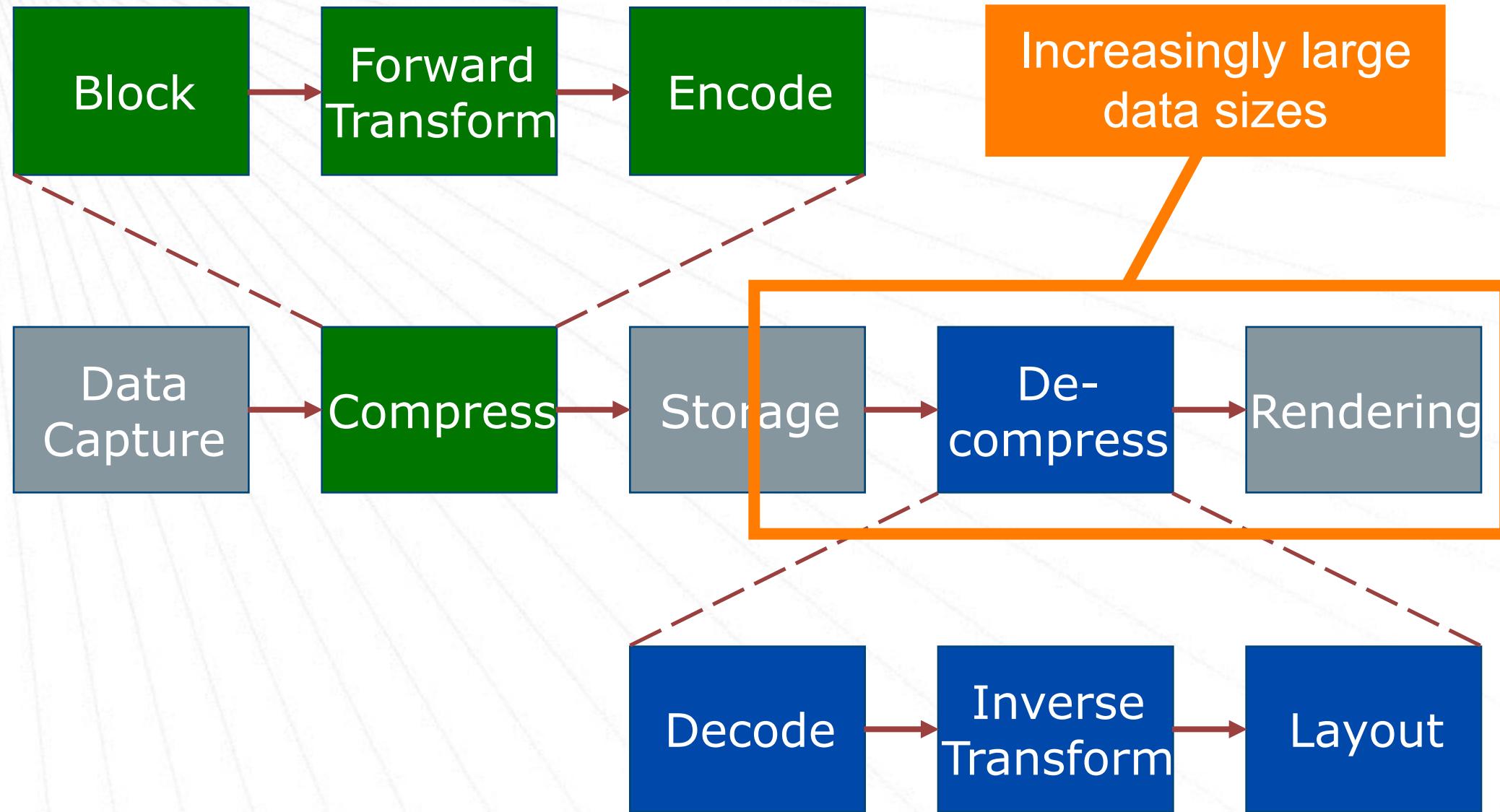
0.67mm



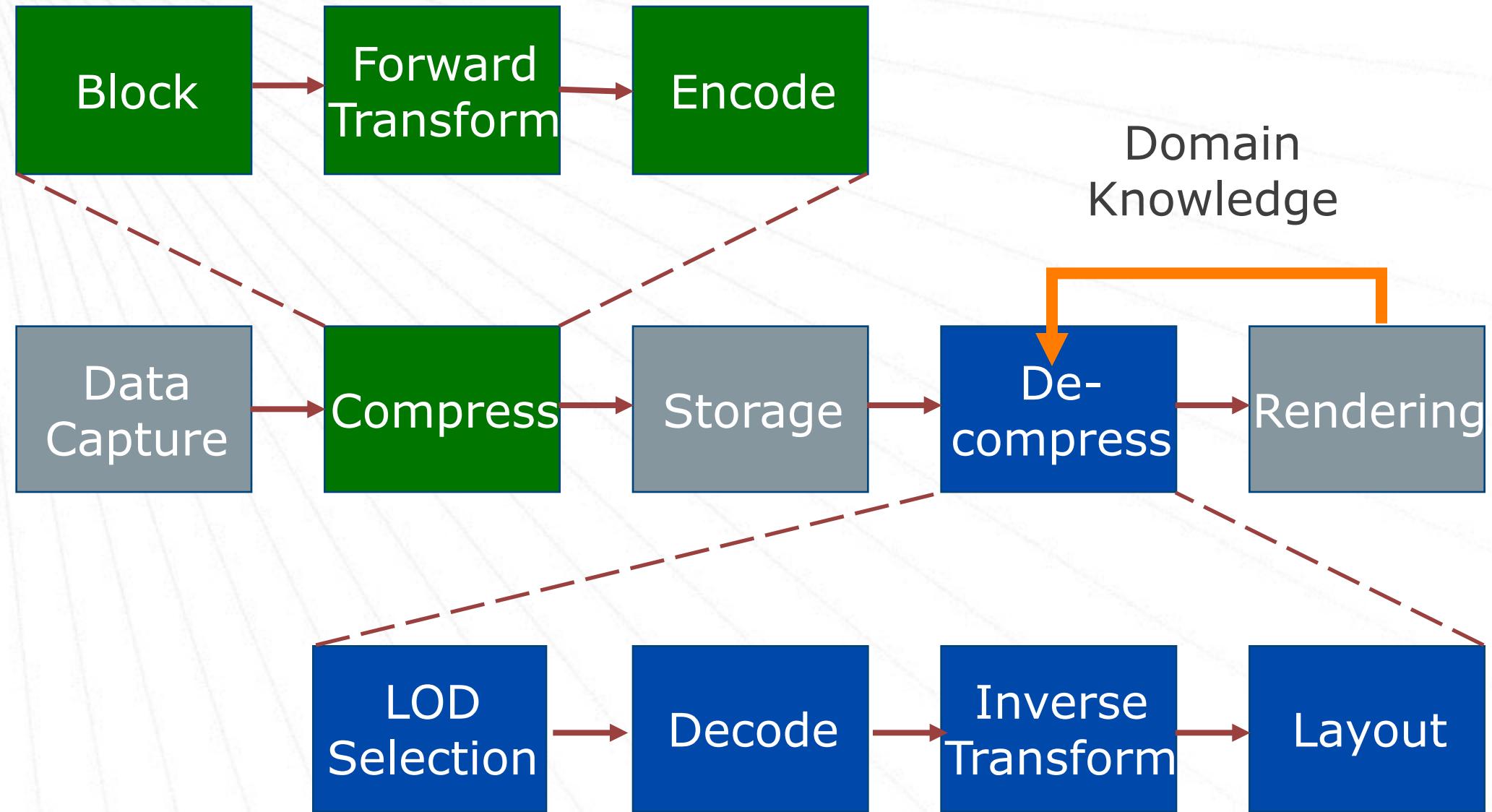




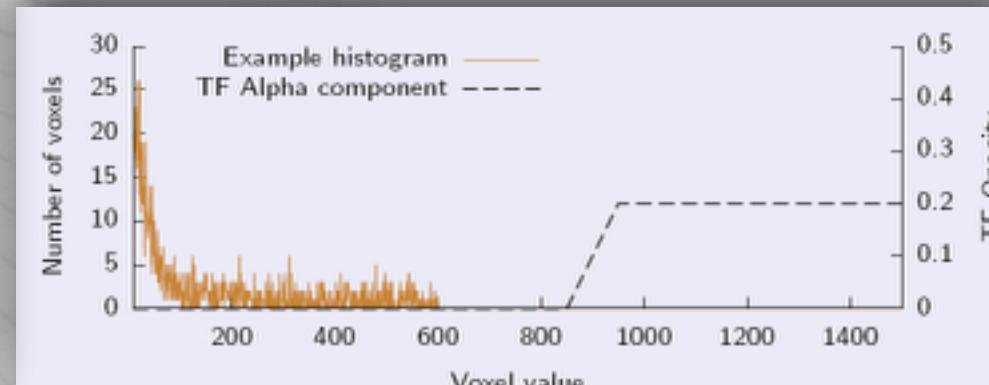
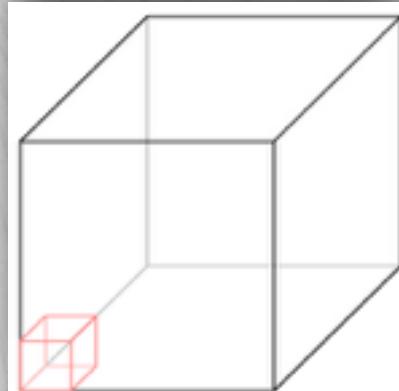
Direct Volume Rendering Challenges



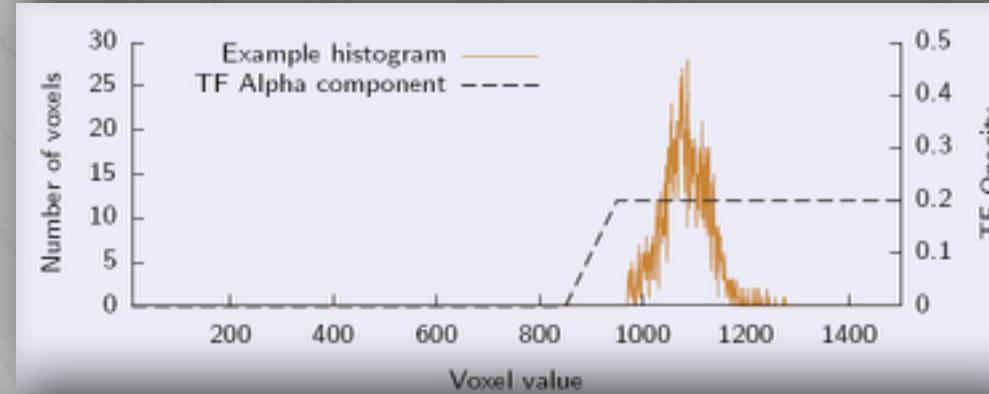
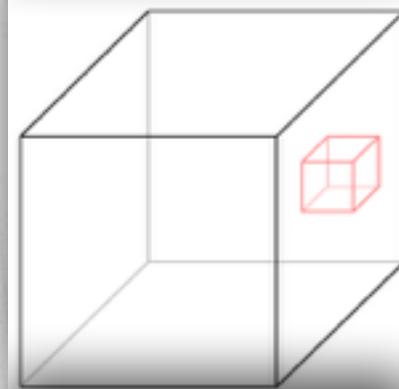
Reducing Required Size



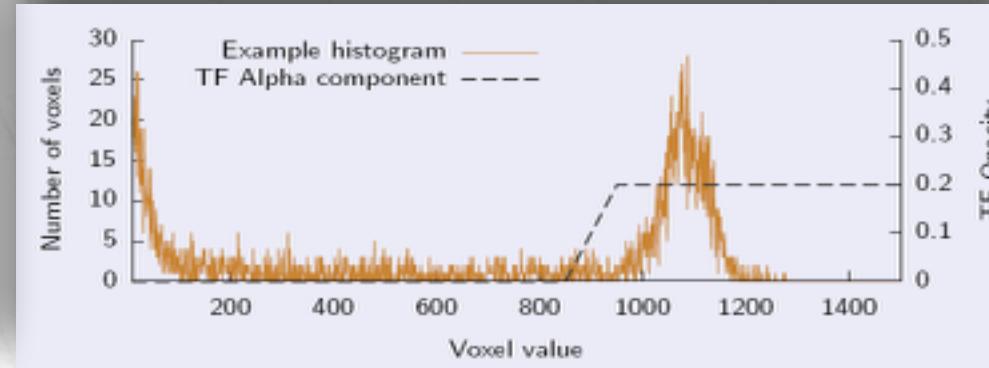
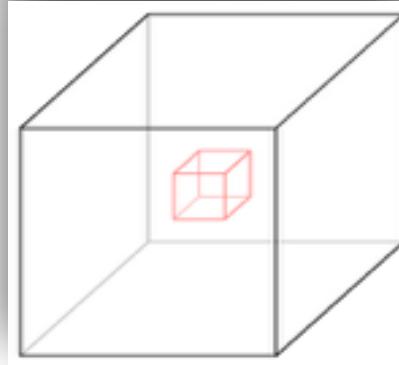
Block Analysis



No TF Content
All voxels in a block become completely transparent



Constant TF Content
All voxels become homogeneously transparent of the same color in a block



Varying TF Content
Voxel colors and opacities vary substantially in a block



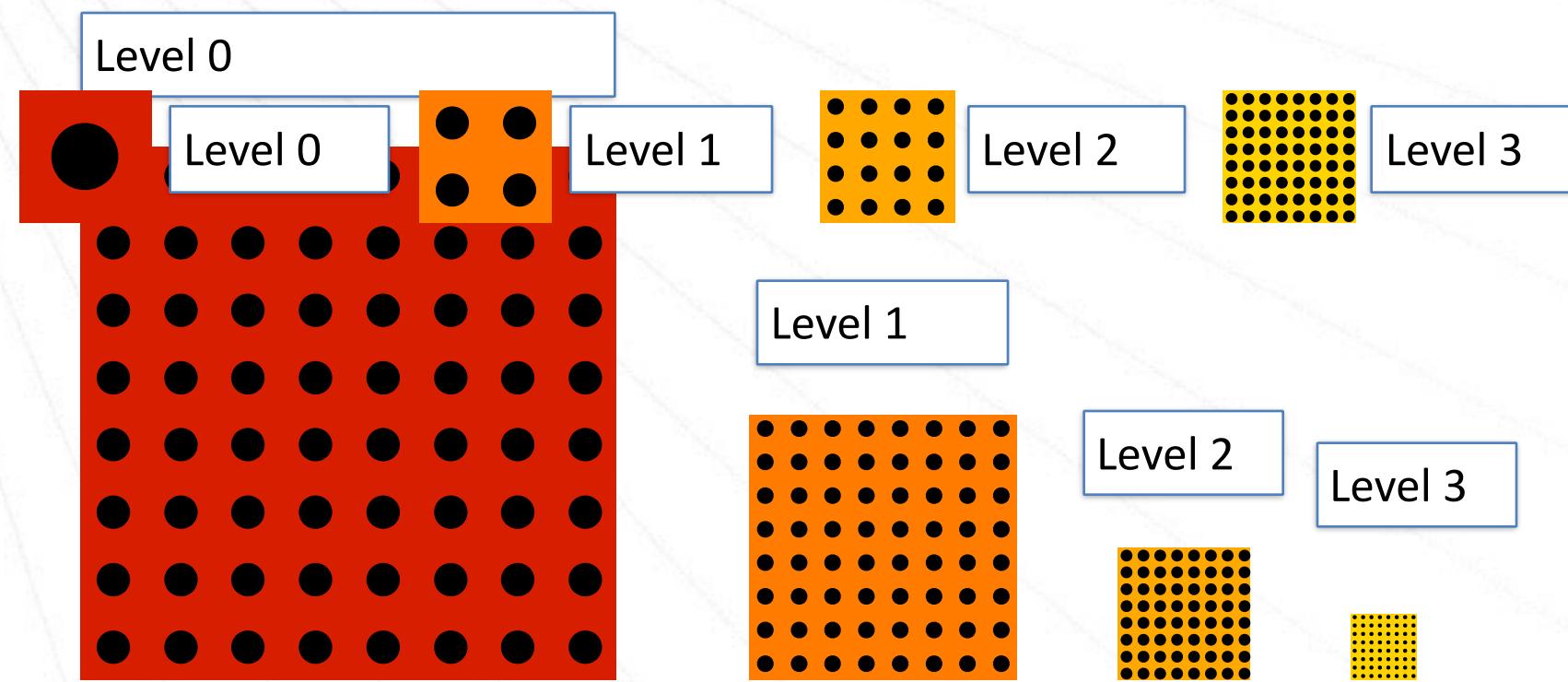
Multiresolution Volumes

Volume is divided into blocks

Hierarchical or flat structure

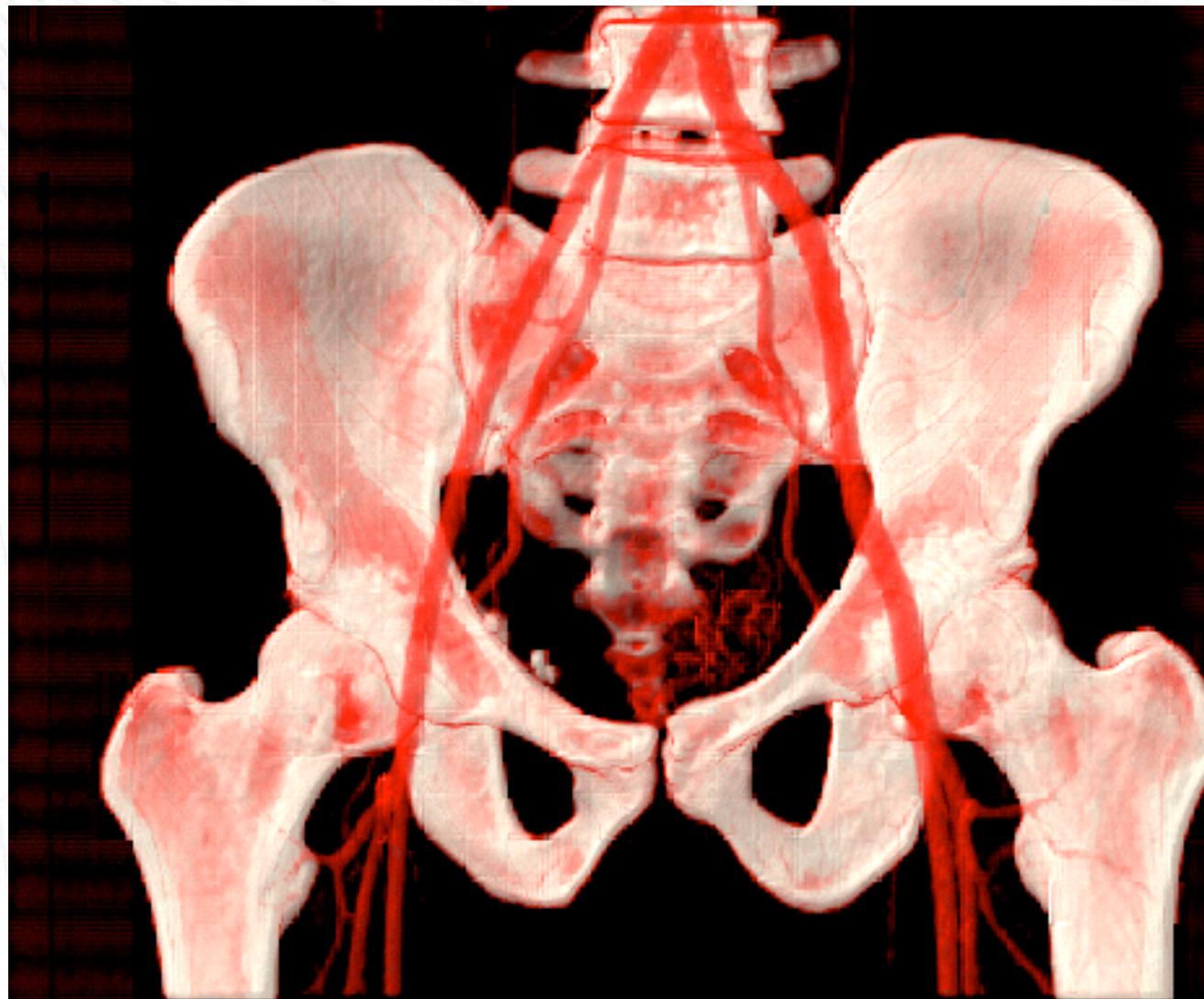
Hierarchical structure (octree)

Flat blocking structure



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TF Based LOD Data Reduction



CIE L^{*}u^{*}v^{*} ΔE error

Data Reduction:

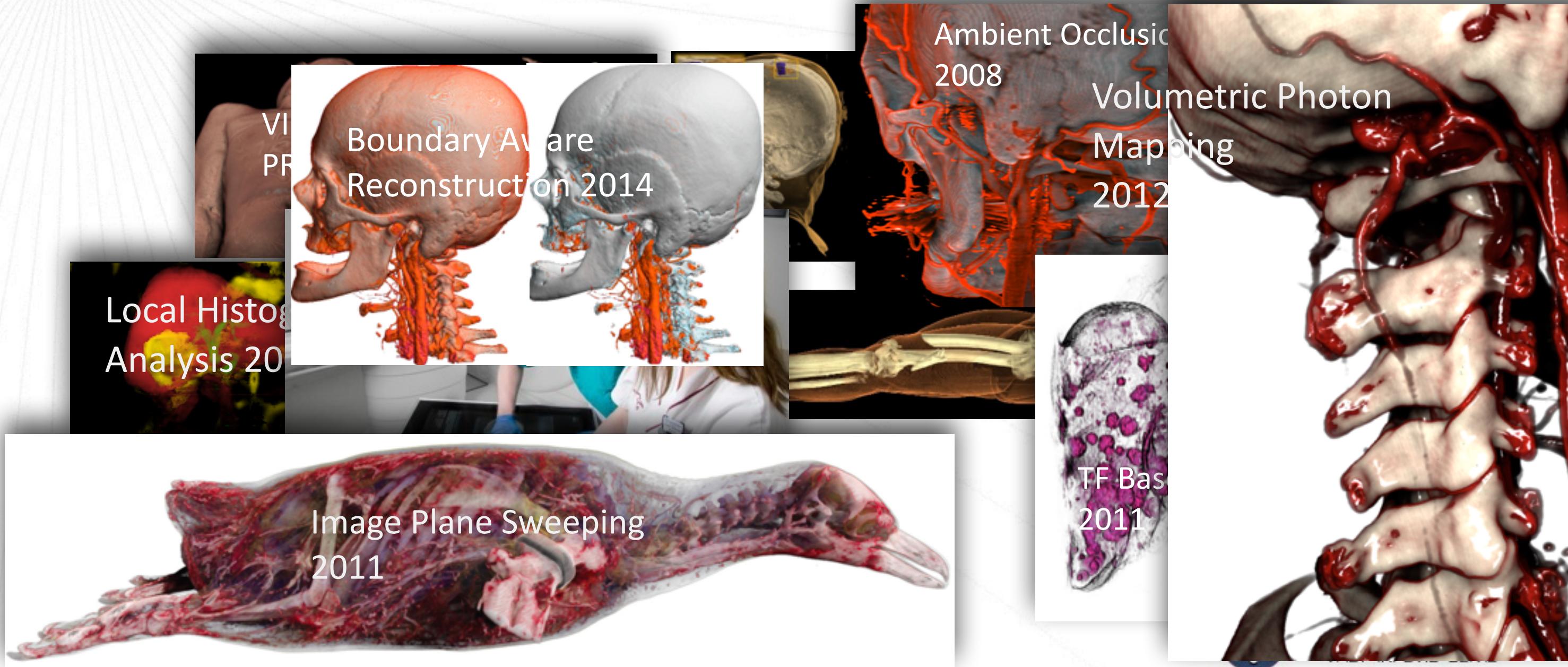
800:1

0.25%



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Steps on the way - a few stamps



Forensic Pathology

- Exploration without guidance
- Need for improvement of workflow
- Need for documentation tools
- Fast uptake of new technologies
- Media hype ...



Virtual Autopsies

From body bag to bones in a minute
Real-time full body rendering (10 GB volume)

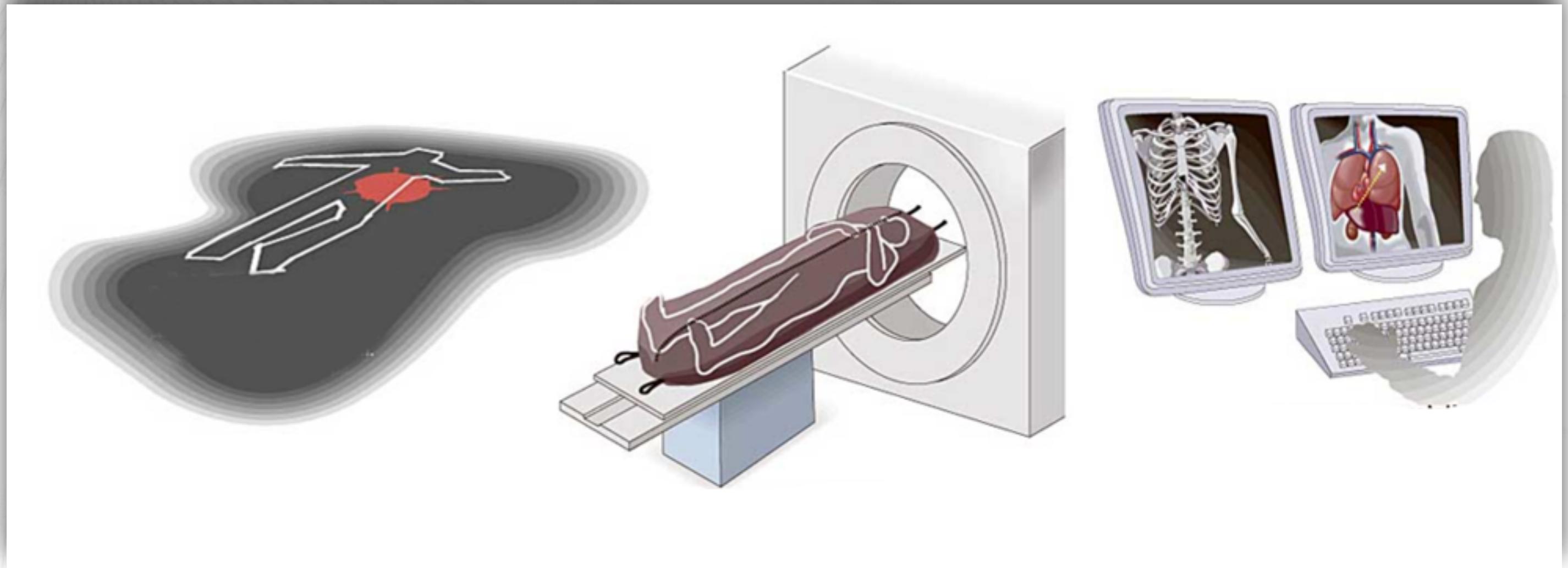


Multiresolution at Work

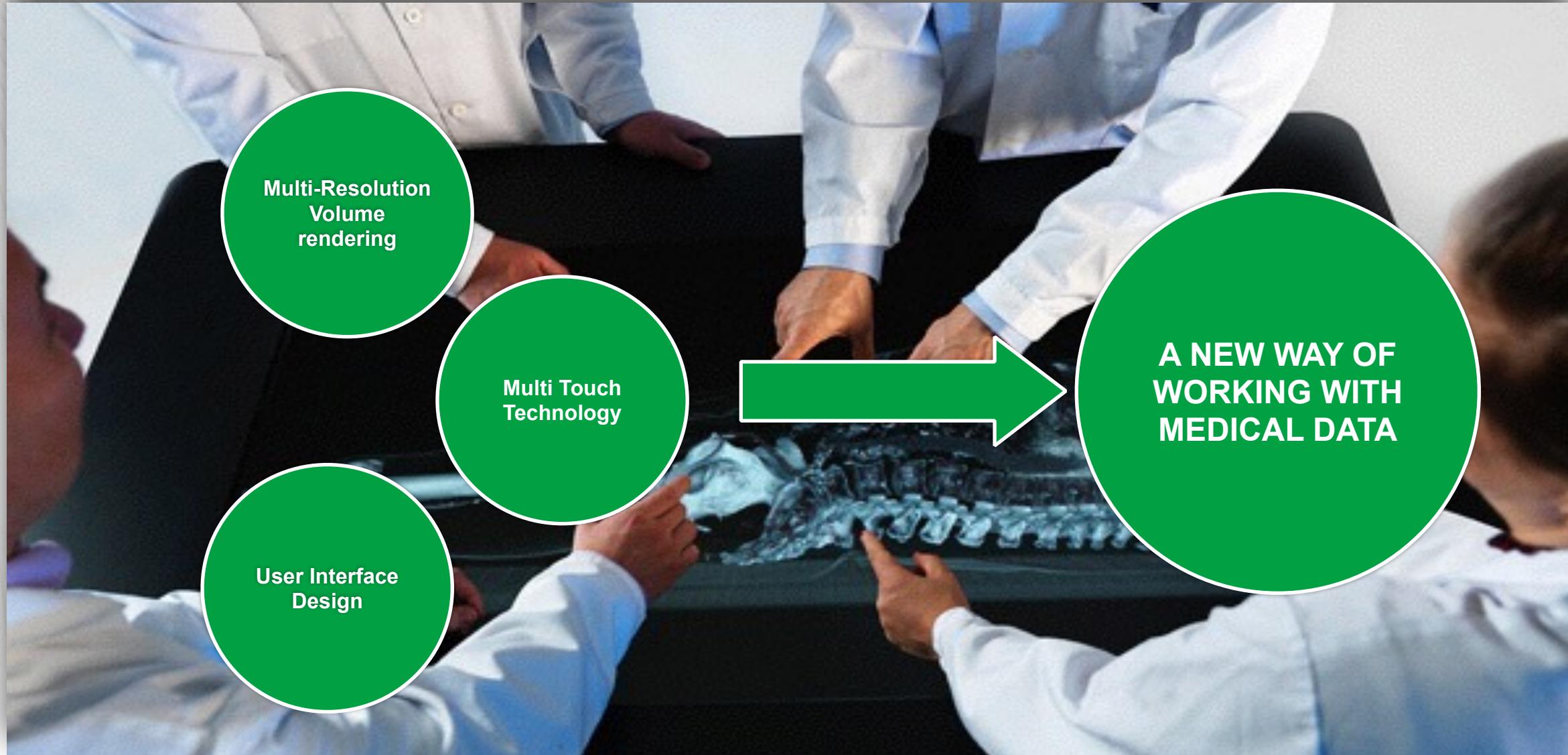


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Virtual Autopsies - Workflow



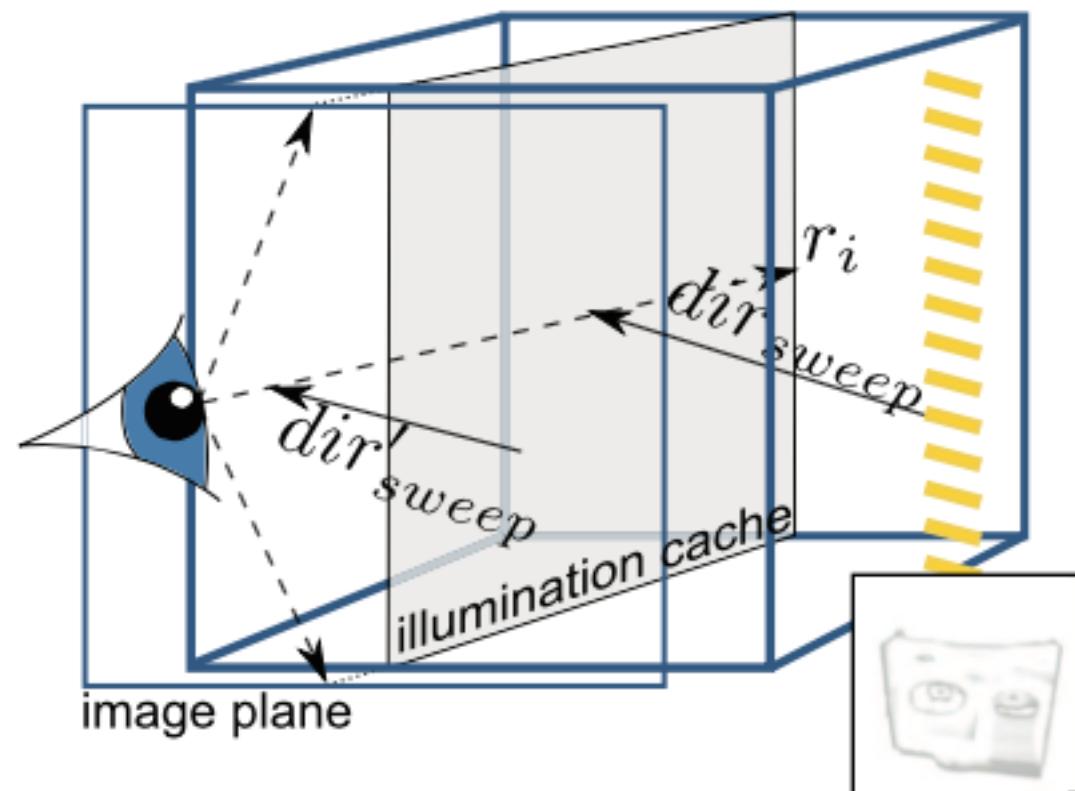
Touch Interfaces



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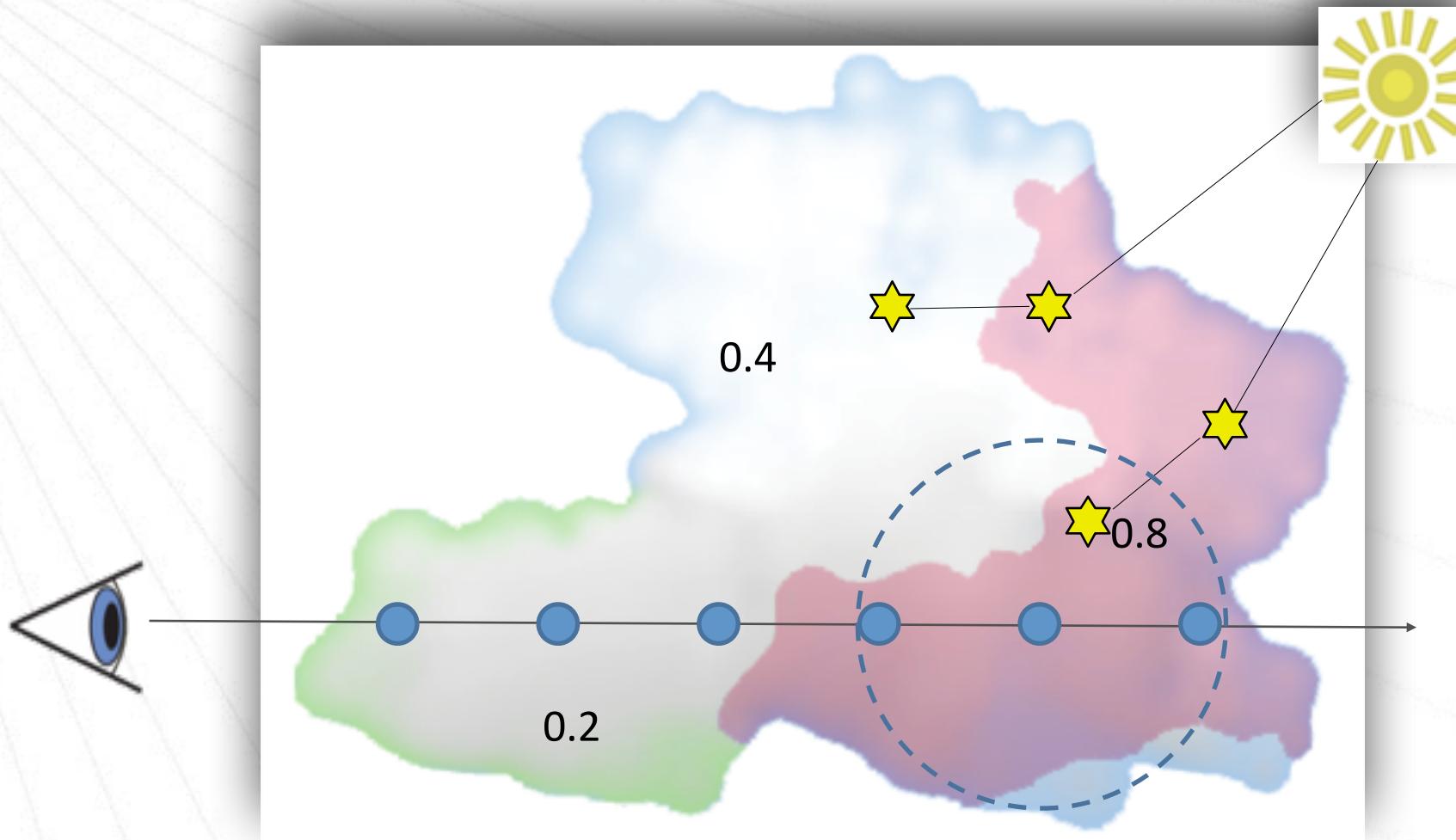
Virtual Autopsy^{DEMO}

Image Plane Sweeping



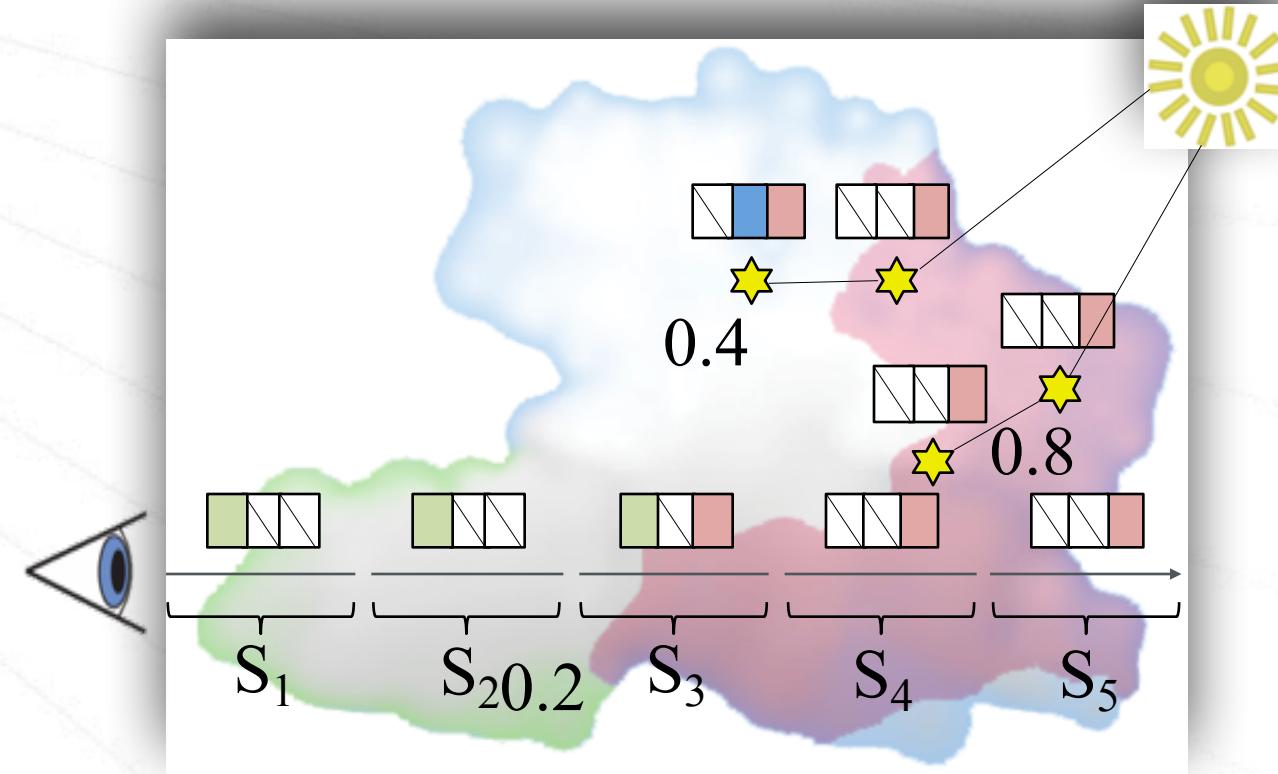
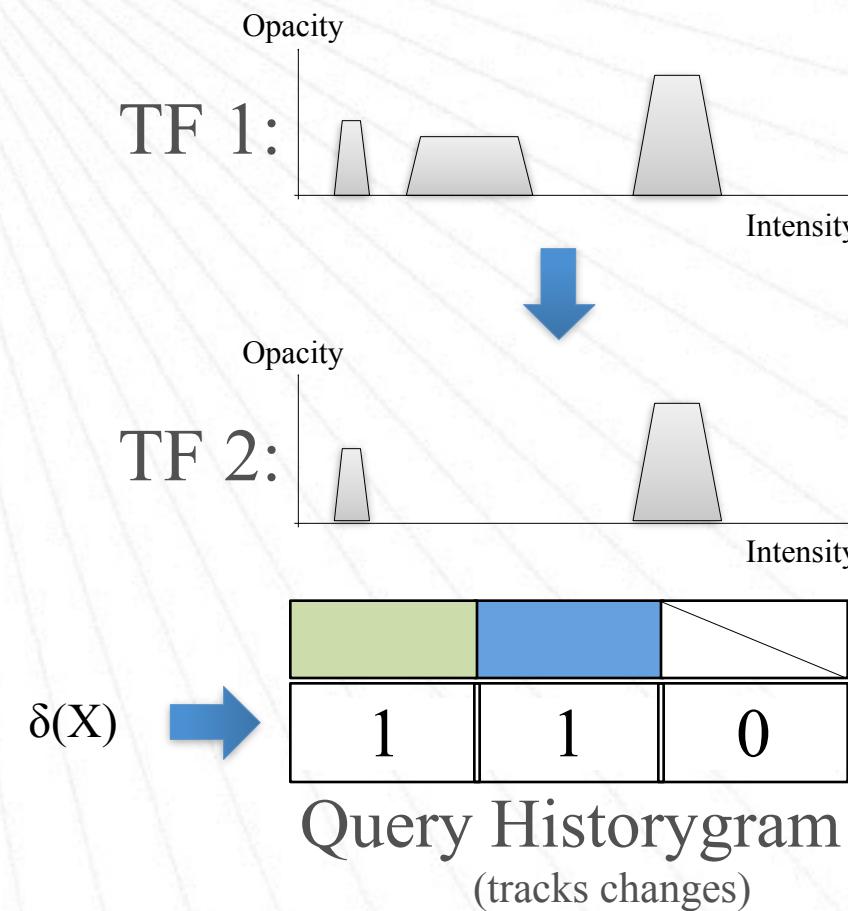
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Photon Mapping



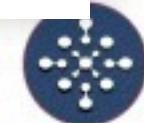
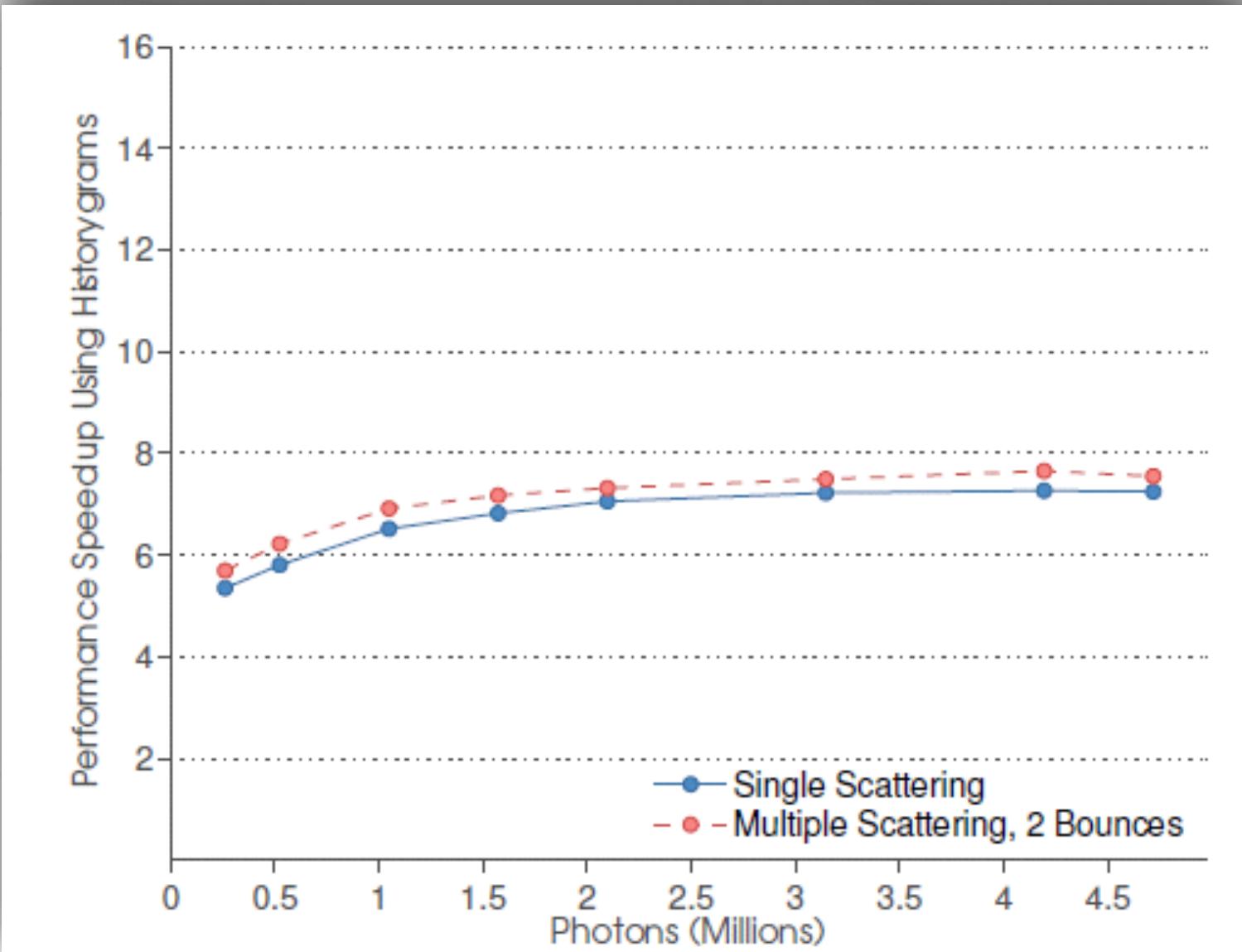
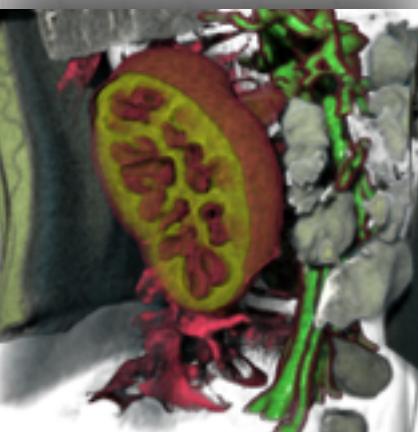
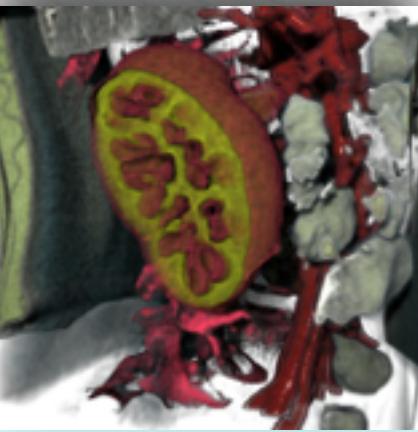
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Historygrams for Photon Mapping



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Performance



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Volumetric Photon Mapping



PHOTON MAPPING GEBELEIN MAN



Medical Visualization Table



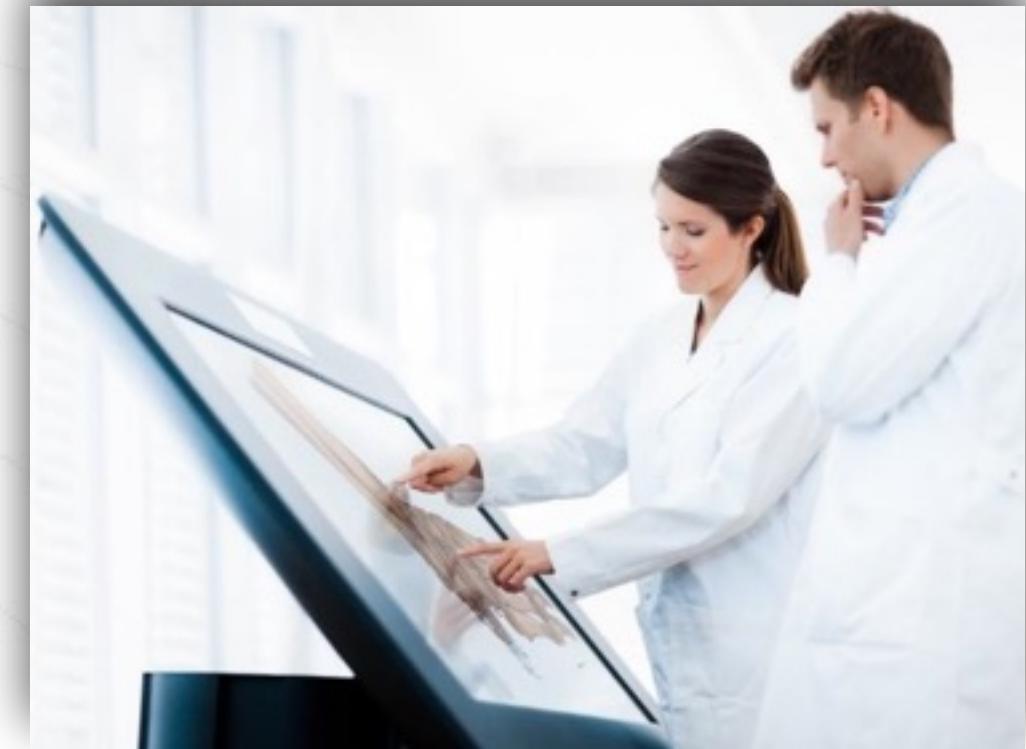
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Modes of Operation



TABLE Mode
Allows group interaction
Same position as a dissection table

BOARD Mode
Can be attached to a projector or second screen



Latest Design



Interface - Interaction

- Intuitive gestures
 - Swipe, scroll, zoom, cut with the fingers, dissect, navigate inside structures
 - Reduces learning curve and helps the user get more comfortable with the software



Interface - Tools

- Complete 2D and 3D tools
 - Cut
 - Slice
 - Measurements
 - Labeling
 - Segmentation of bones
 - CT and MRI stack review



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Interface - Labels

- Dynamically label all the structures
- Hide for quizzing



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Clinical Use and Medical Education



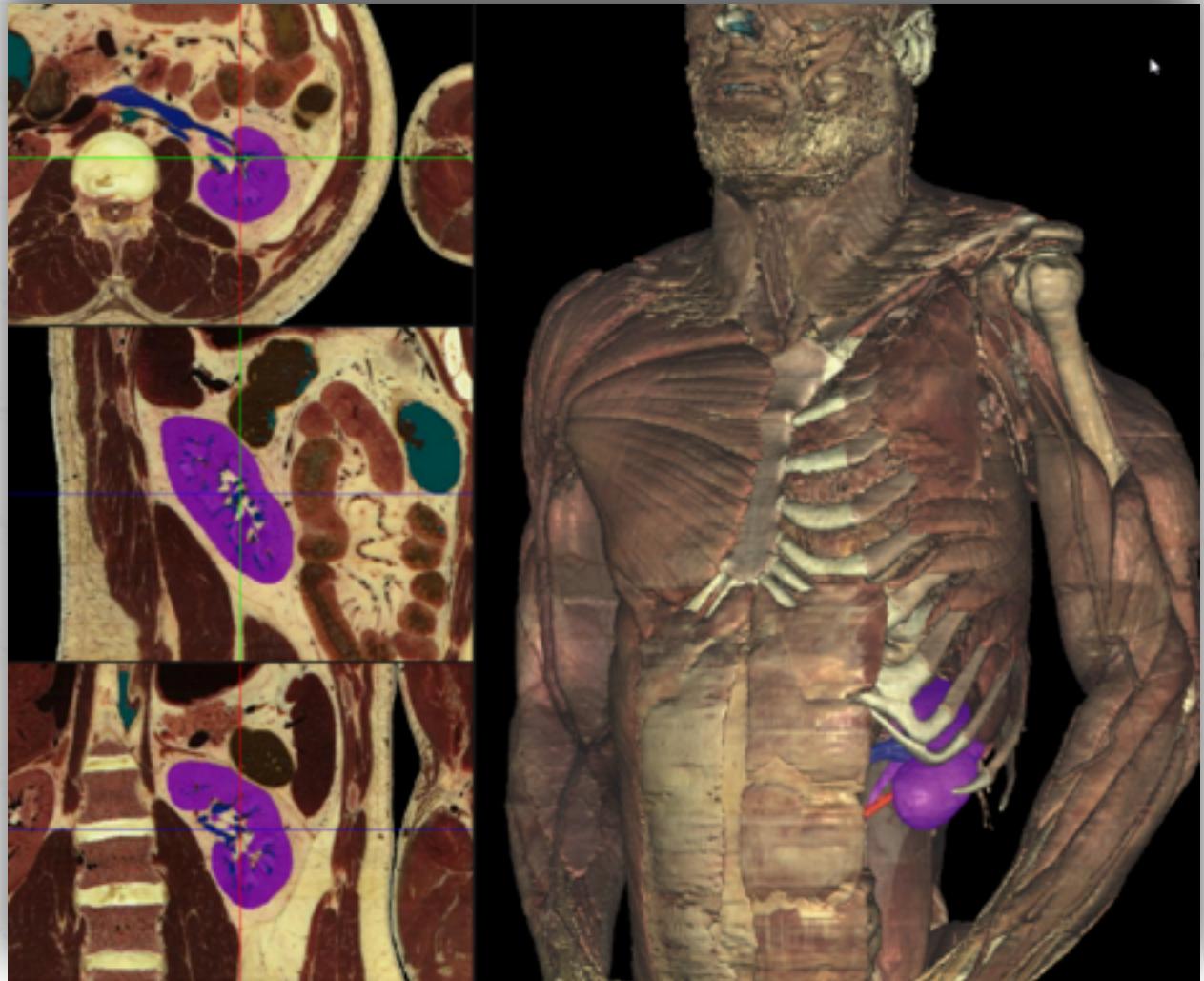
Anatomy Lab

- Virtual dissection:
 - Allows dissection at the same time with a cadaver or to repeat a dissection from a case in the table
 - Interaction with real bodies and anatomical variations
- Problem based learning (PBL) method
 - Improves learning in students
 - Develops critical thinking, group and team work skills



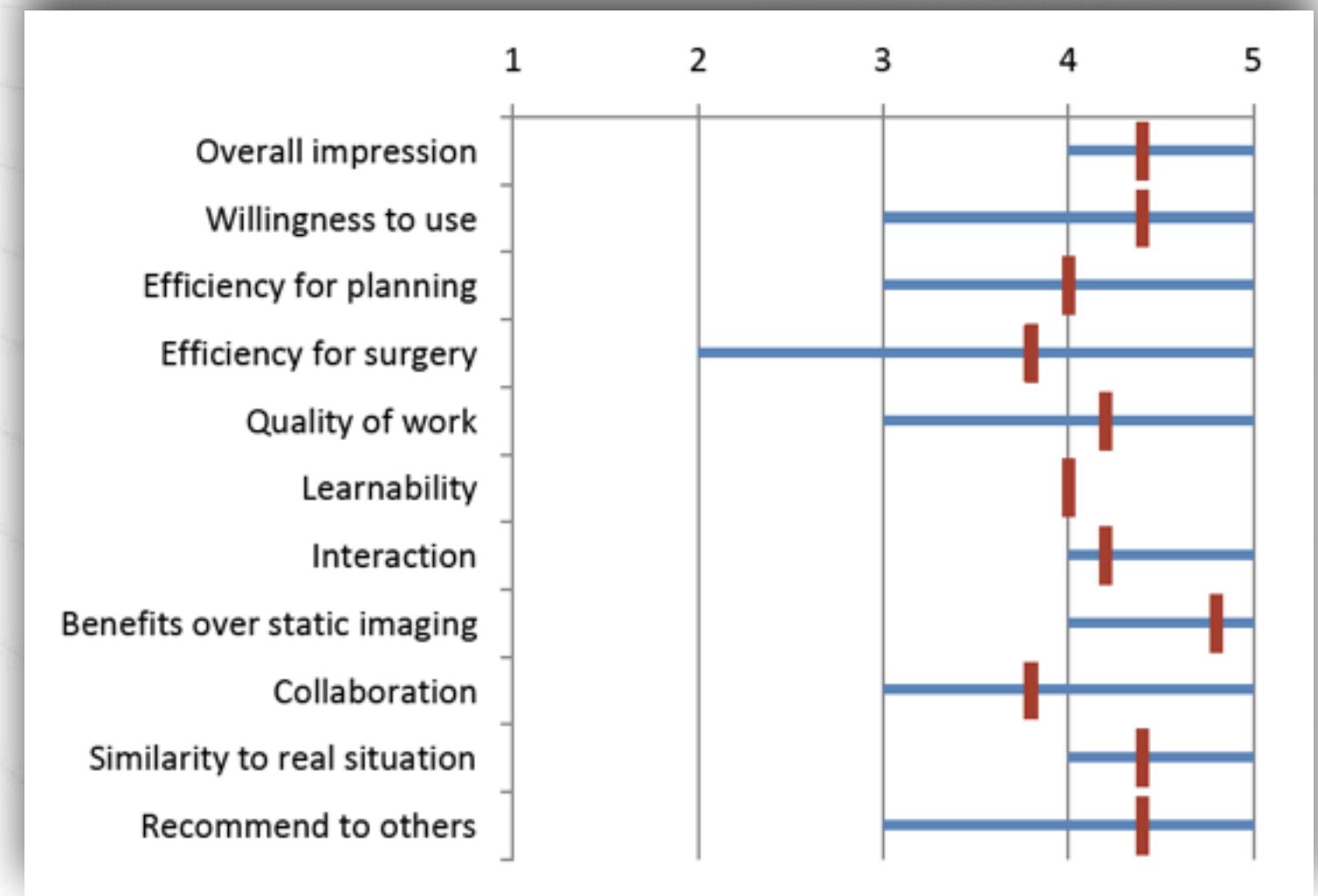
Clinical Training

- Different cases
 - Real dimensions, real pathologies
 - real patients
 - simulated surgery
- Different training programs
 - radiology
 - surgery
 - general medicine
 - residency



Surgical Planning

- Evaluation with 5 orthopedic surgeons
- Scale
 - 1 Strongly unfavorable
 - 3 Unsure
 - 5 Strongly favorable



NESWAIU (Priest, Thebes, 300 bc)



CT Scanning



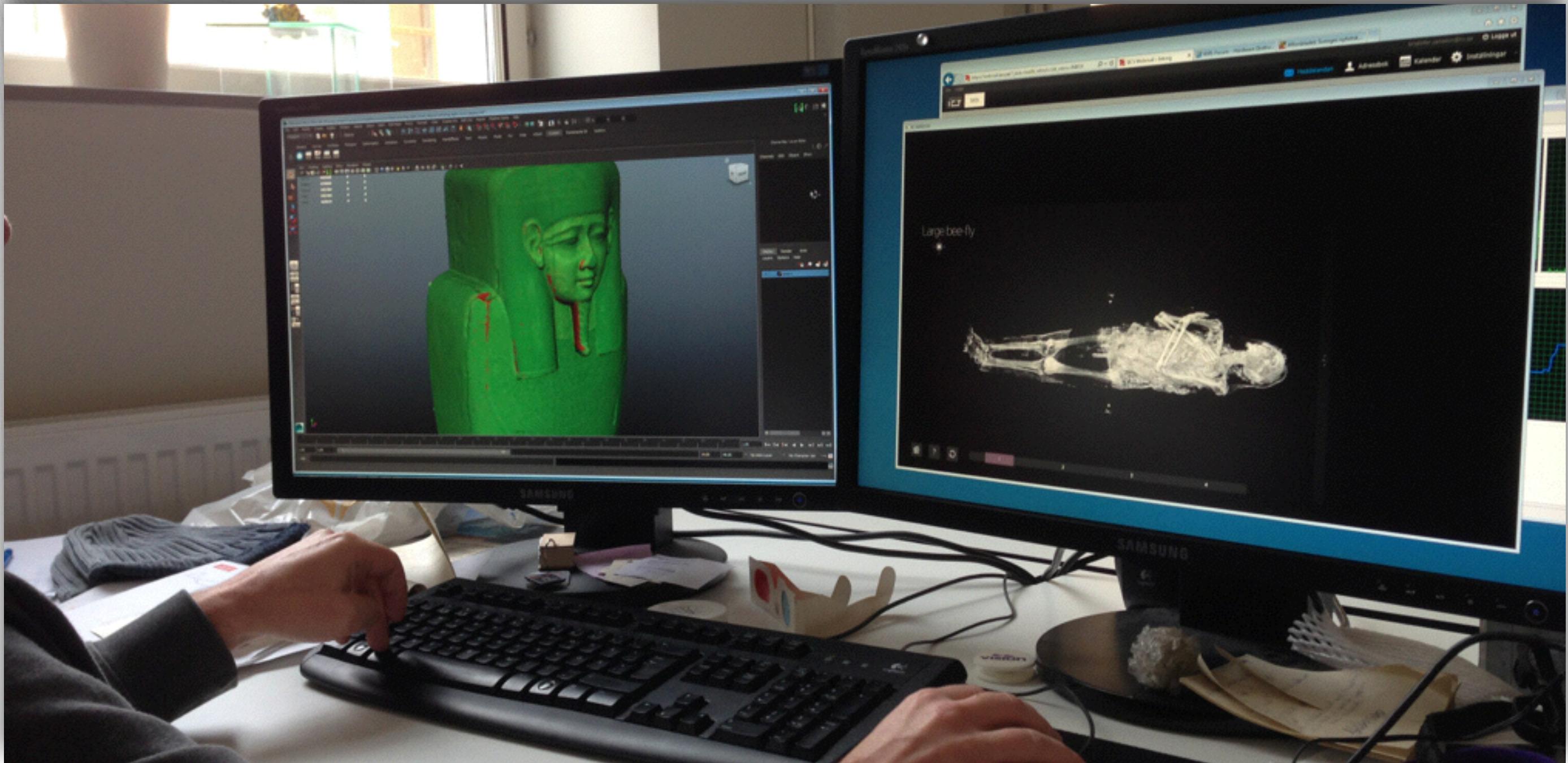
Laser Scanning



Photogrammetry



Data Fusion



3D PRINTING



ZCORP / Z650





3D PRINTING



EXHIBITION

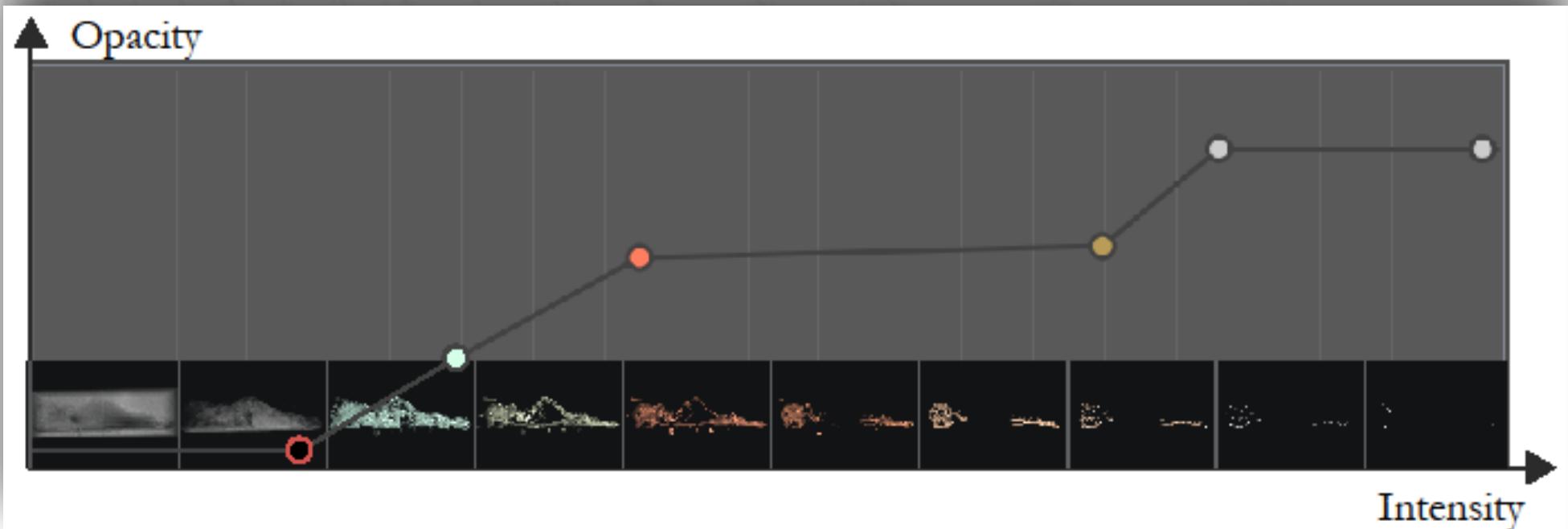
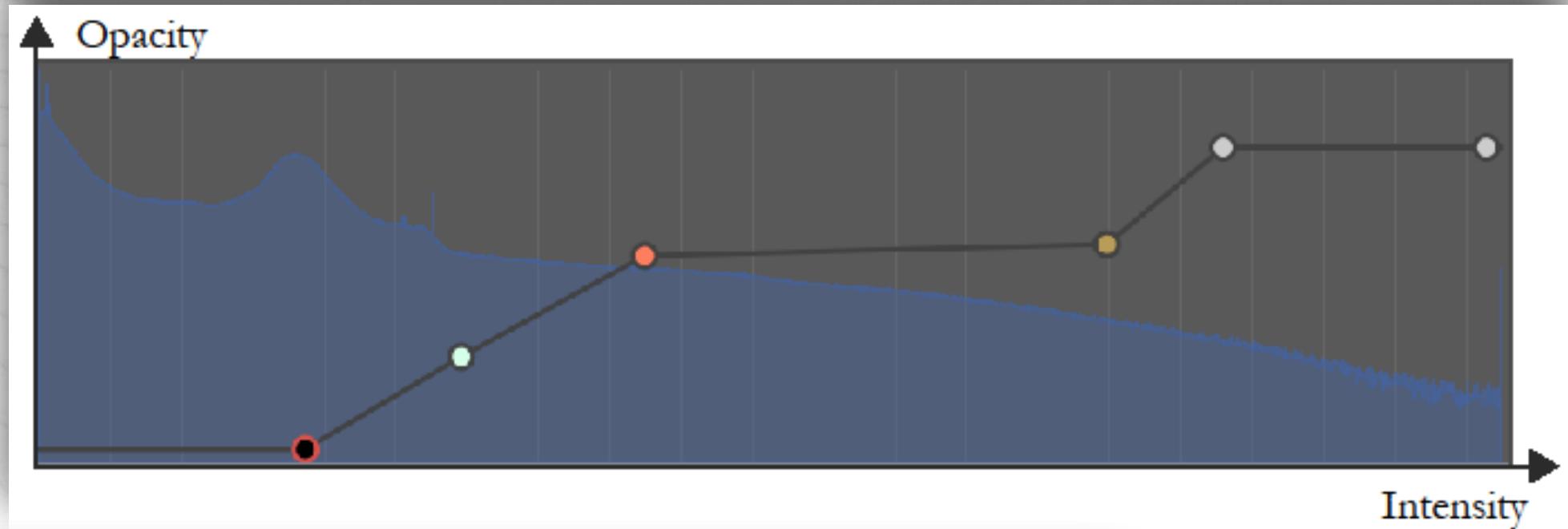


Intuitive Interface for Volume Exploration

- Volume exploration for users with no experience of transfer functions



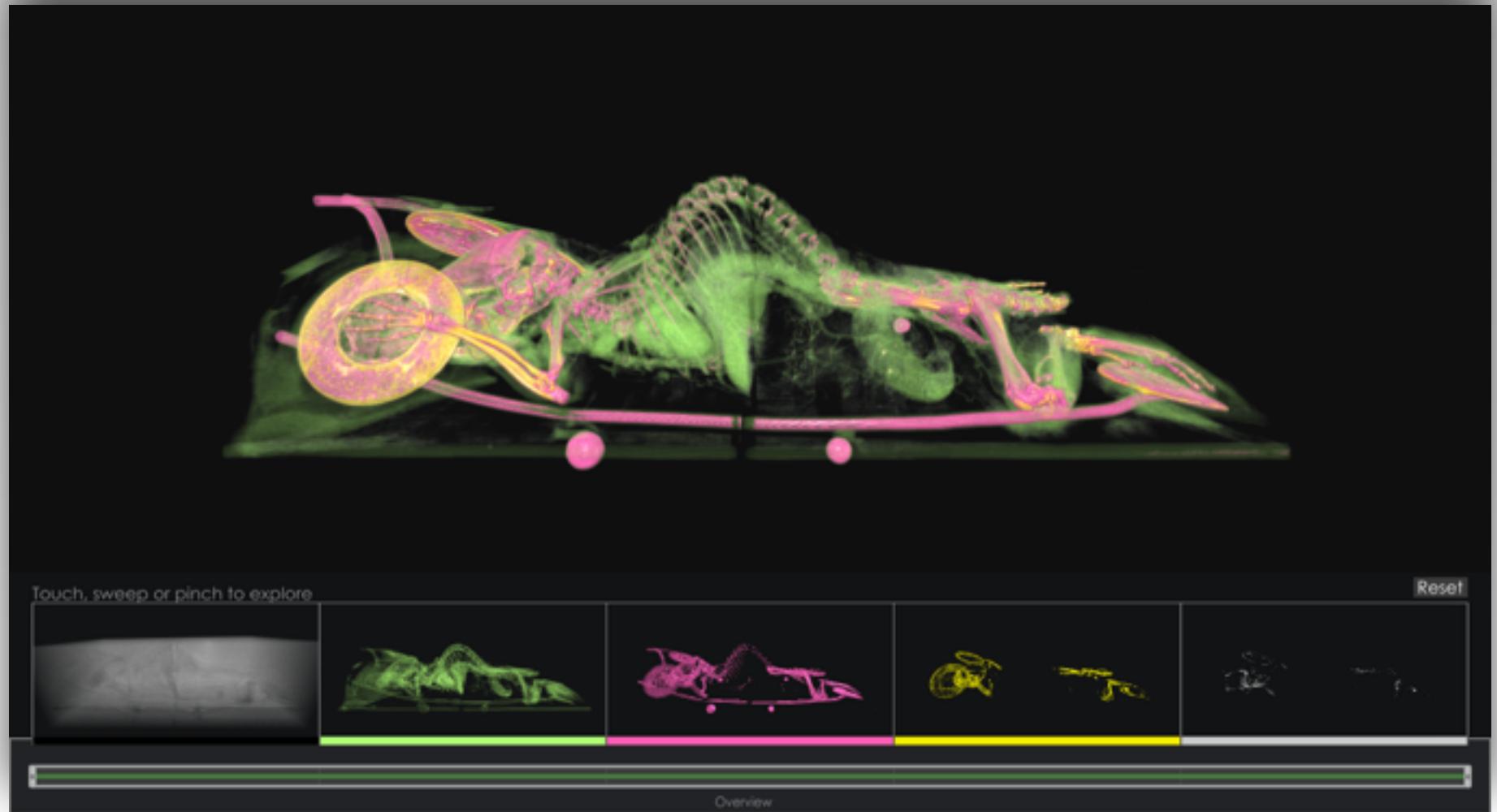
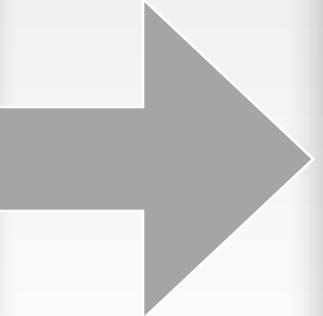
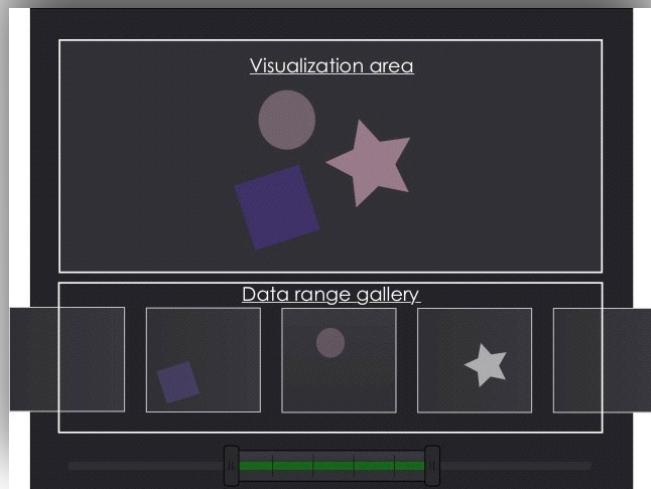
Idea

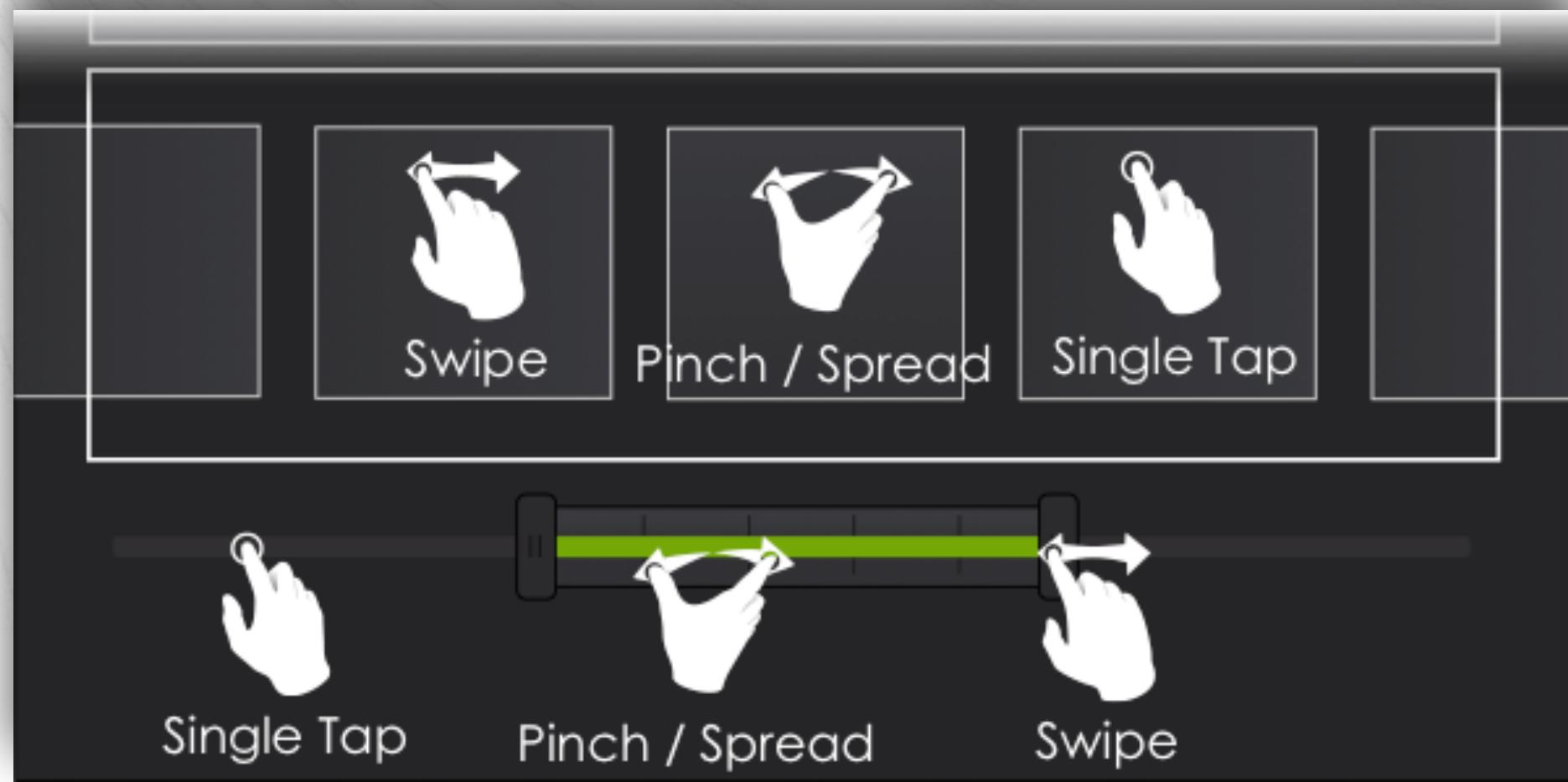
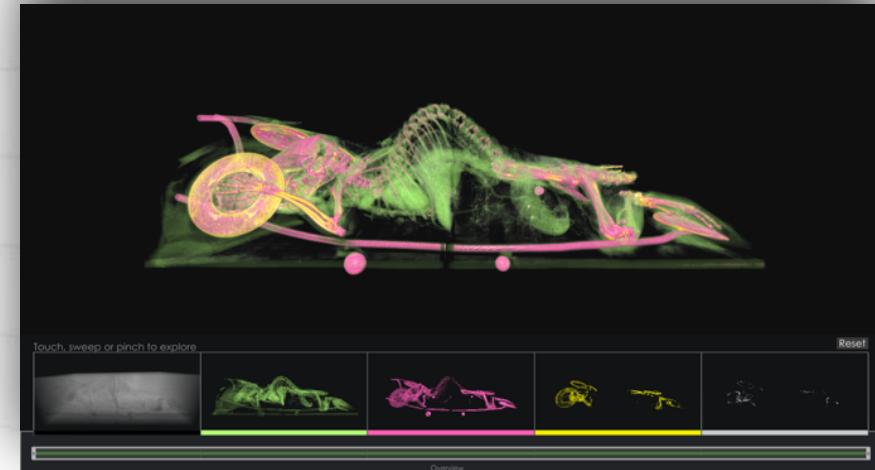
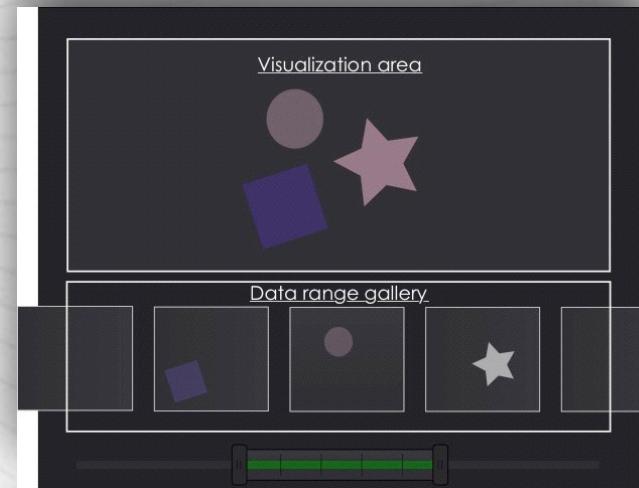


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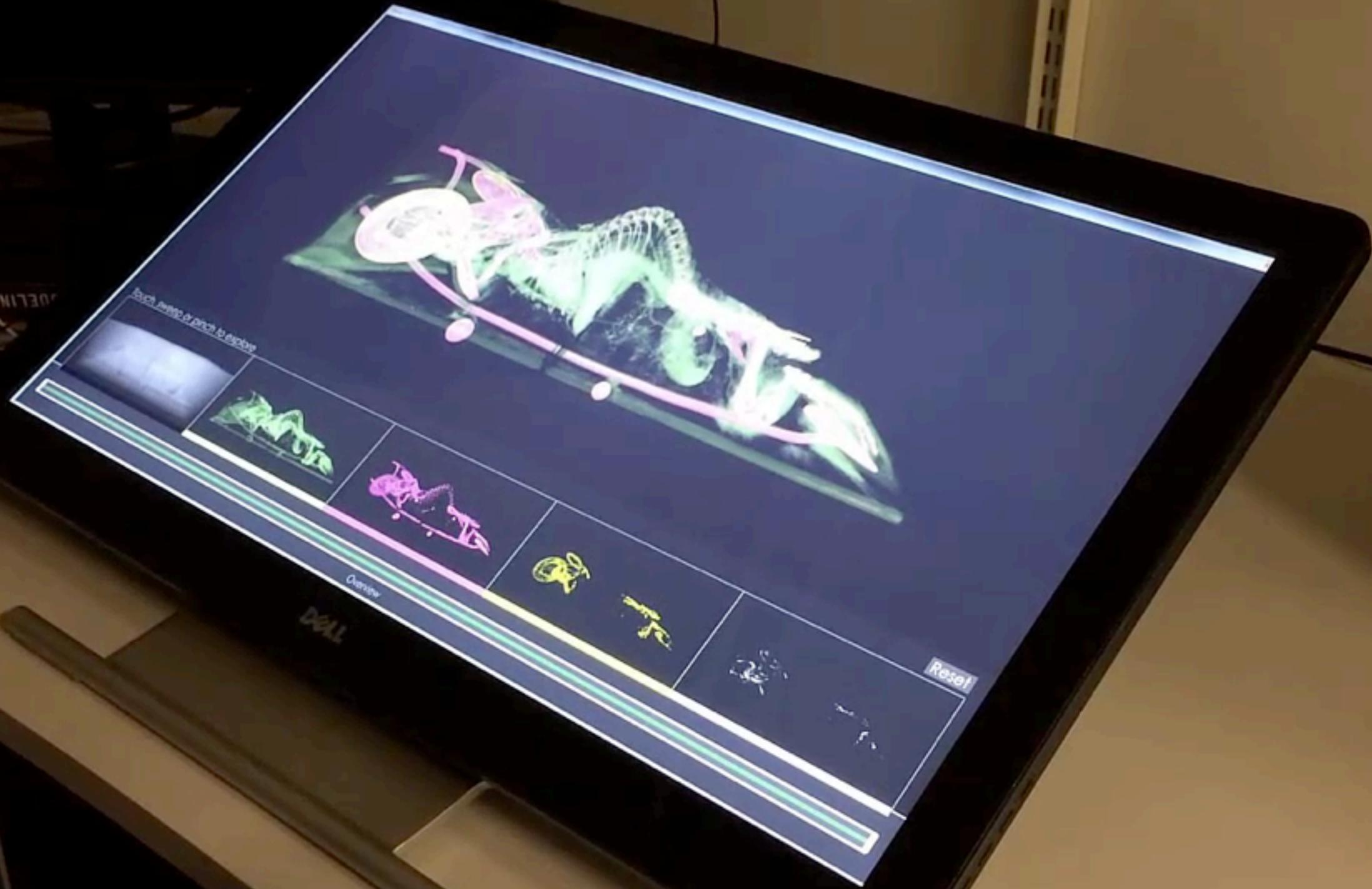


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