

# Surface Mesh Modeling of System Geometry and Anatomy Phantom for GEANT4/GATE Simulations

Timothy Fromme<sup>1</sup>, Benjamin Auer<sup>2</sup>, Arda Könik<sup>2</sup>, and Michael A. King<sup>2</sup>

<sup>1</sup> Worcester Polytechnic Institute, Robotics Engineering, Worcester, MA, USA

<sup>2</sup> University of Massachusetts Medical School, Department of Radiology, Worcester, MA, USA



**GATE**

Simulations of Preclinical and Clinical Scans in Emission Tomography,  
Transmission Tomography and Radiation Therapy



**WPI**

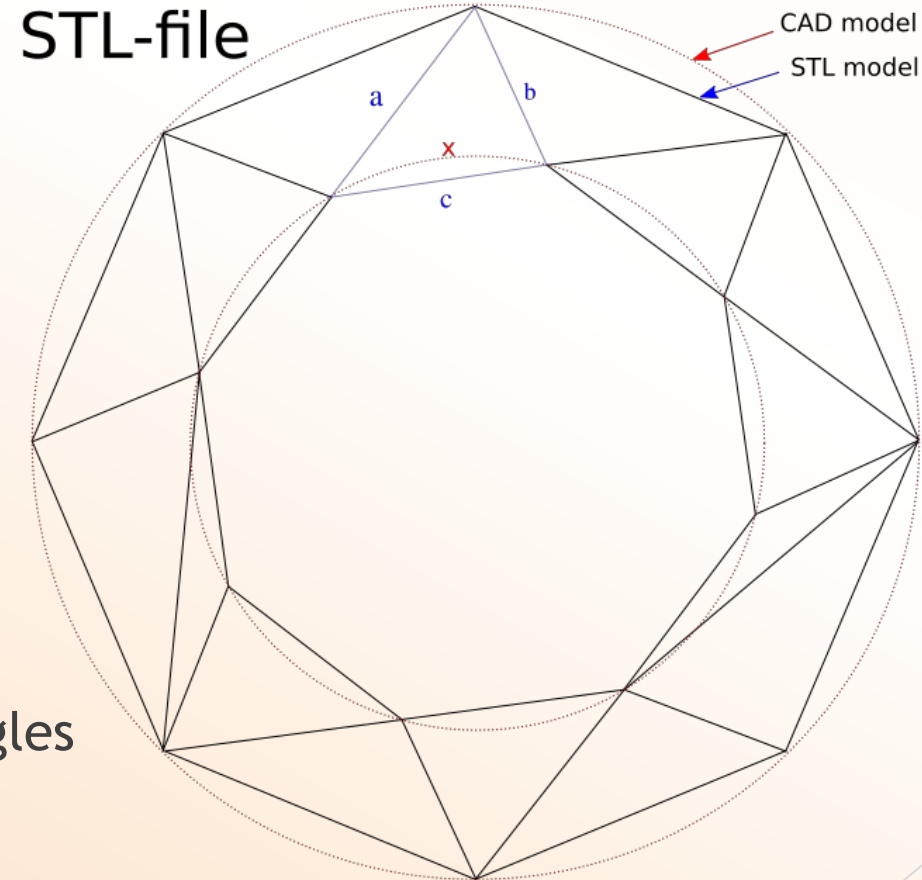


# Overview

- ▶ Key new feature in GATE V8: “tessellated” volume
  - ▶ STL file import
- ▶ We present two MPH collimator systems for  $^{123}\text{I}$  SPECT brain imaging using this feature
- ▶ STL approach allows for more complicated geometry, faster workflow
- ▶ SolidWorks Design → STL output → GATE tessellated volume

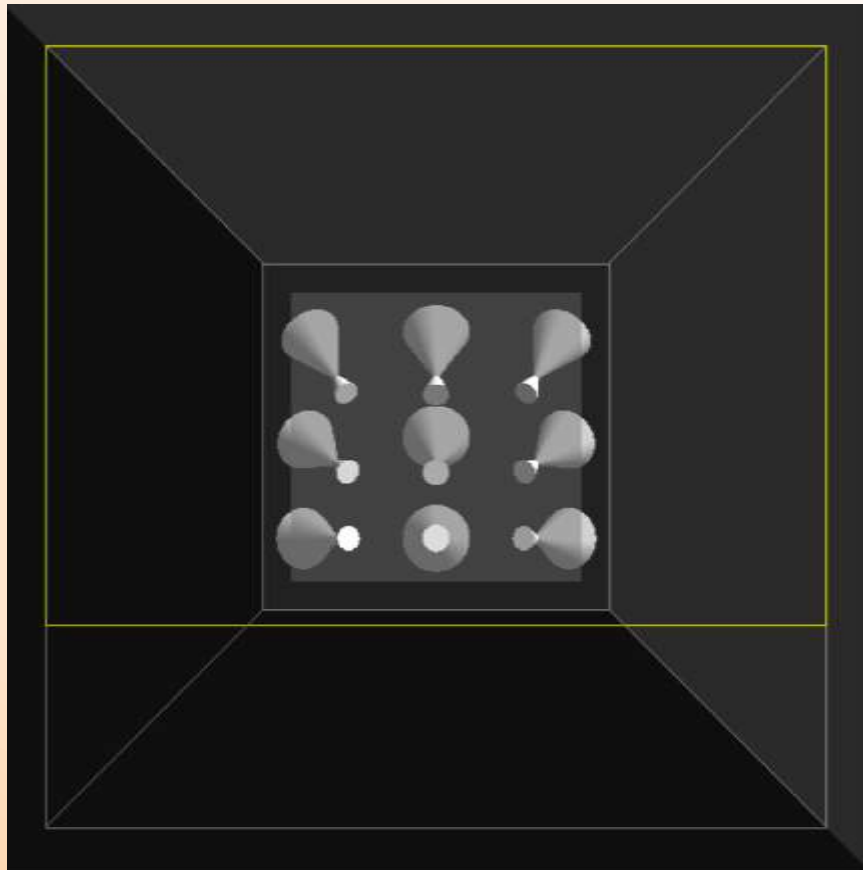
# What is an STL File?

- ▶ Triangulated mesh
- ▶ Perfectly matches flat features
- ▶ Approximates curved features
- ▶ Better approximation with more triangles

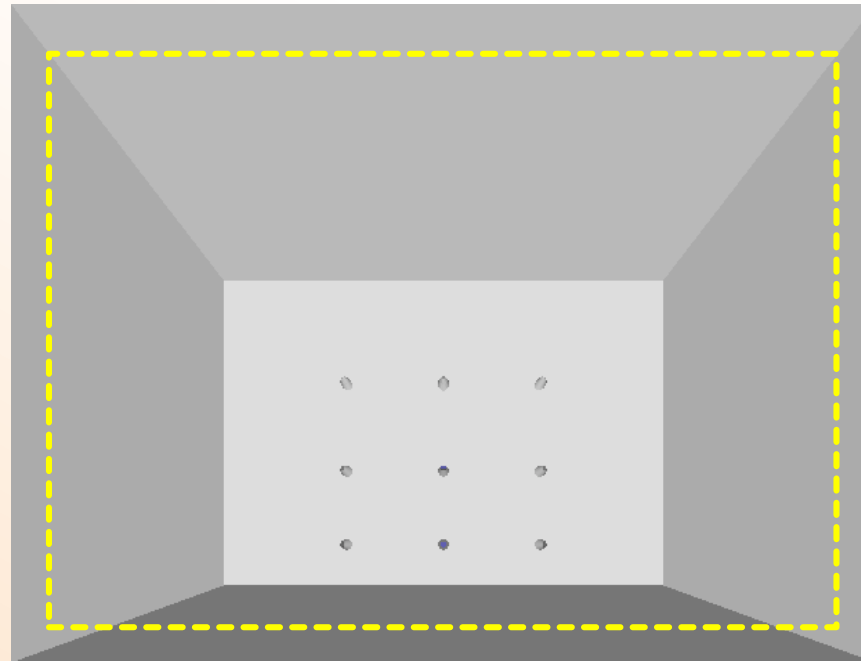


# 9 Pinhole Collimator Design

GATE Primitive

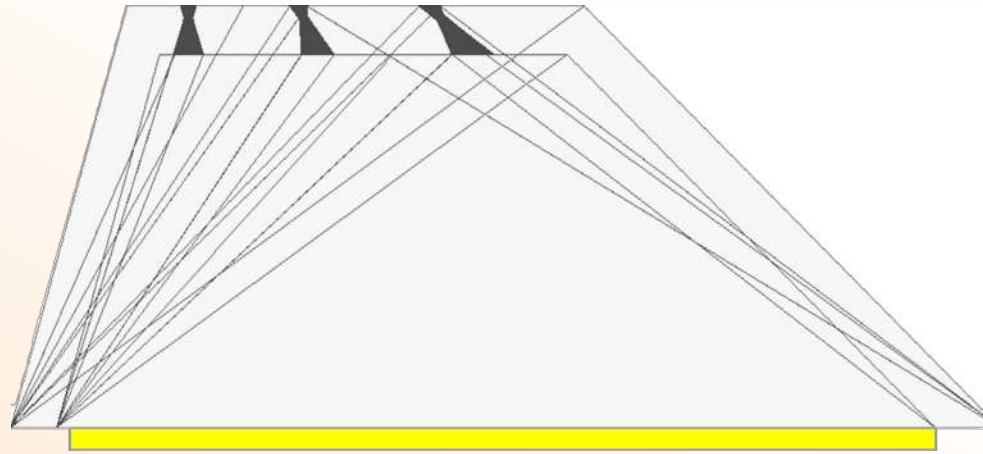


STL



# 9 Pinhole Collimator Design

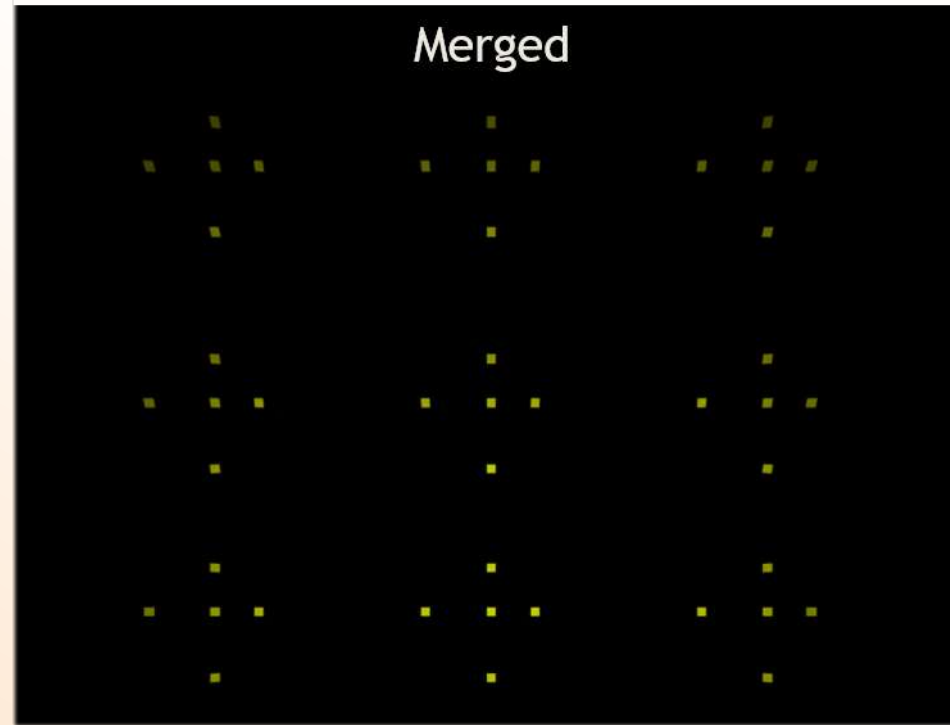
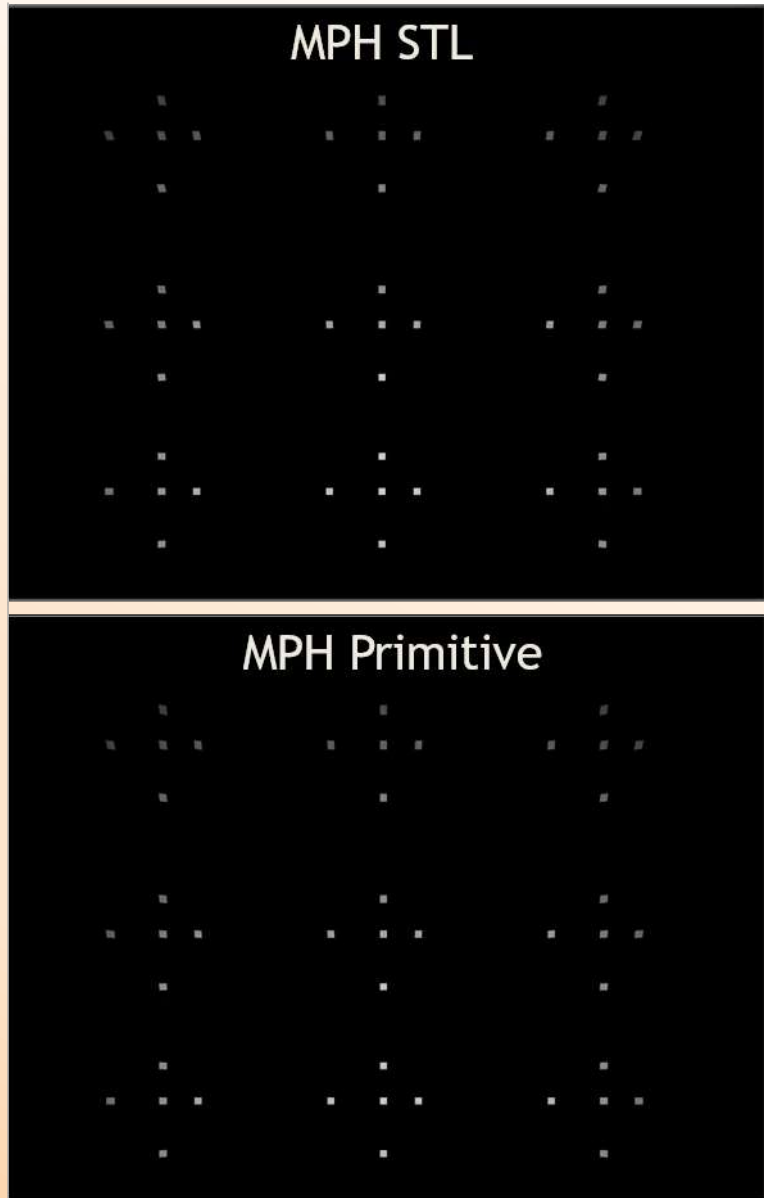
STL



GATE Primitive



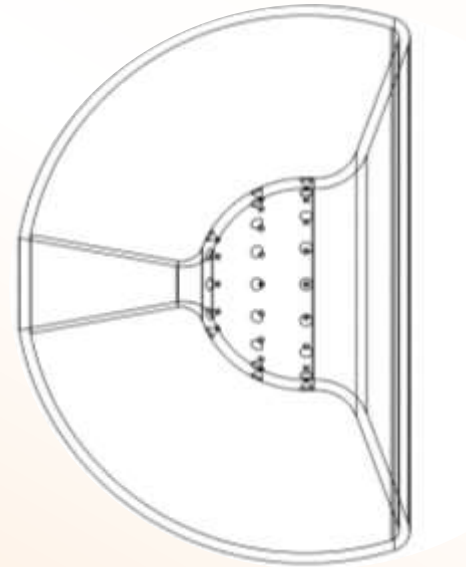
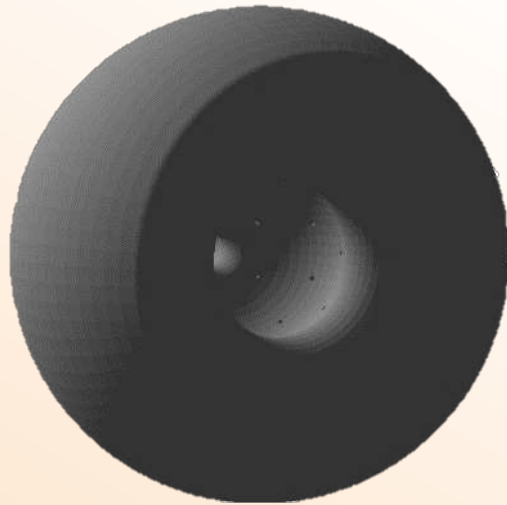
# Validation of our STL Approach



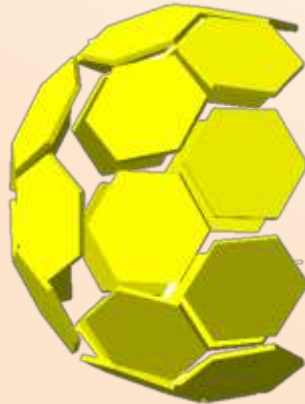
STL Counts Detected: 758 K  
Primitive Counts Detected: 757 K

# 23 Heads MPH System

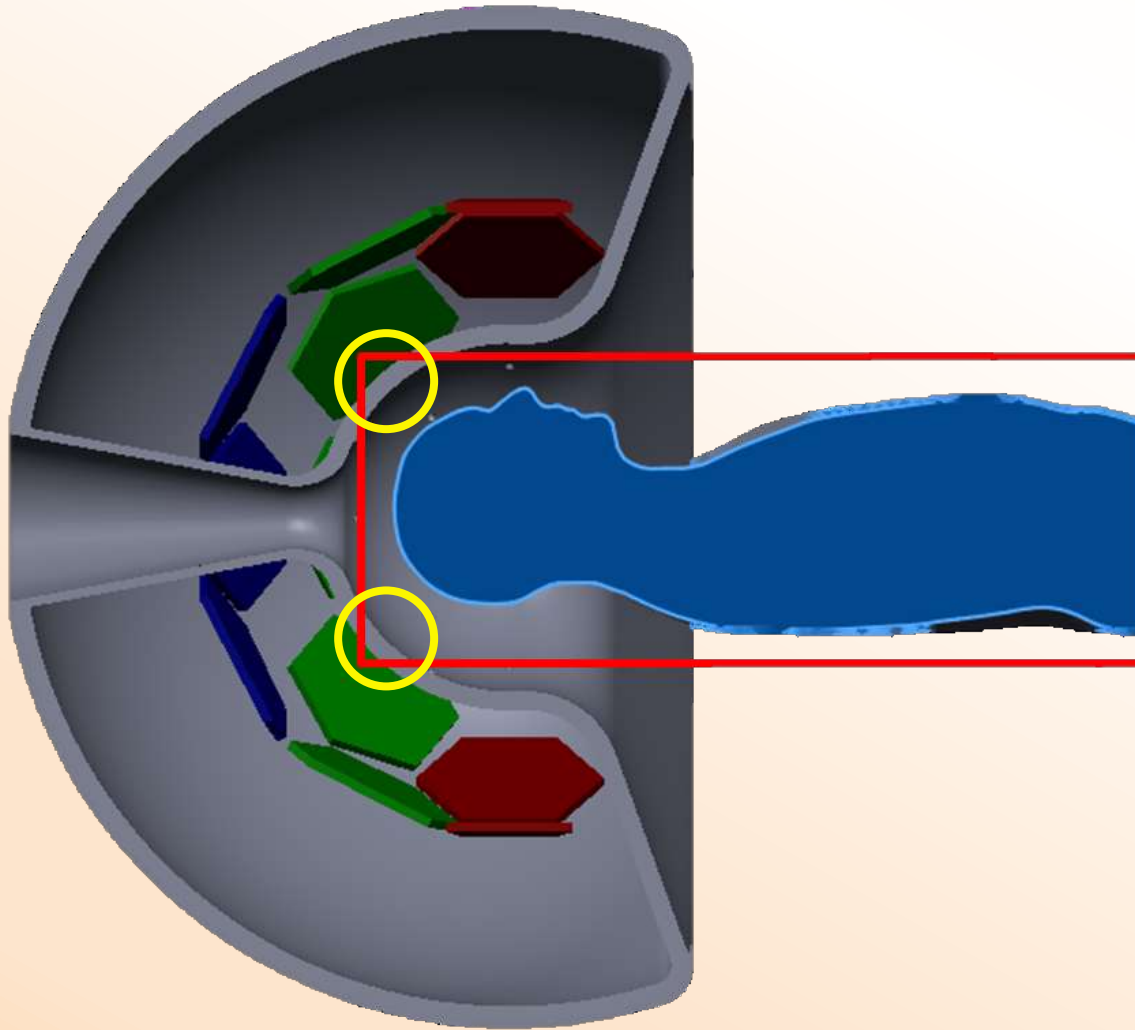
STL  
Collimator



STL  
NaI Detectors



# Voxelized Phantom Overlap Problem





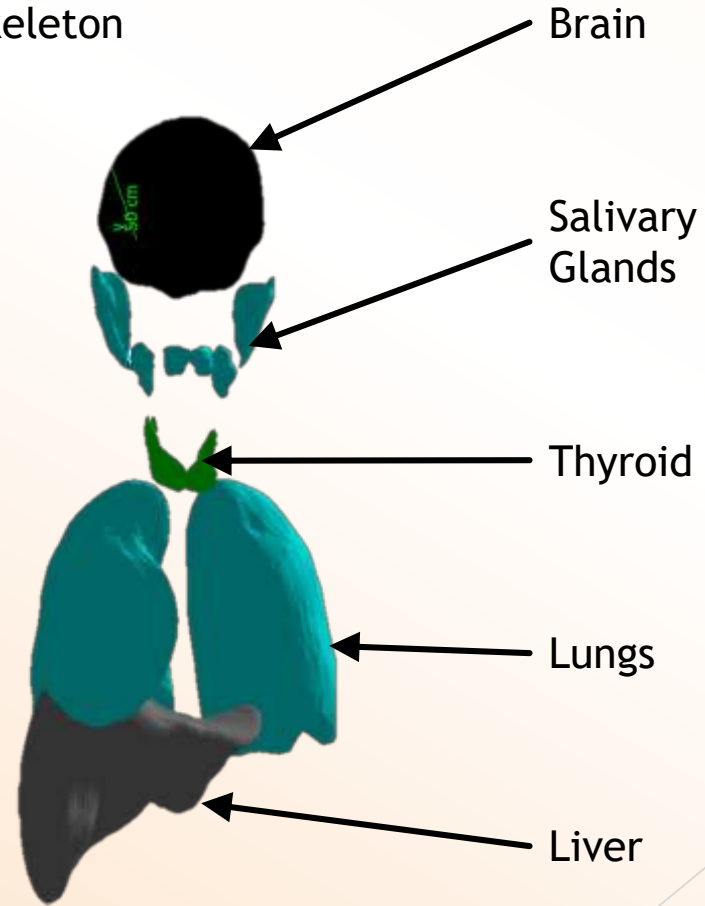
# STL Phantom Solution



Body



Skeleton



Brain

Salivary Glands

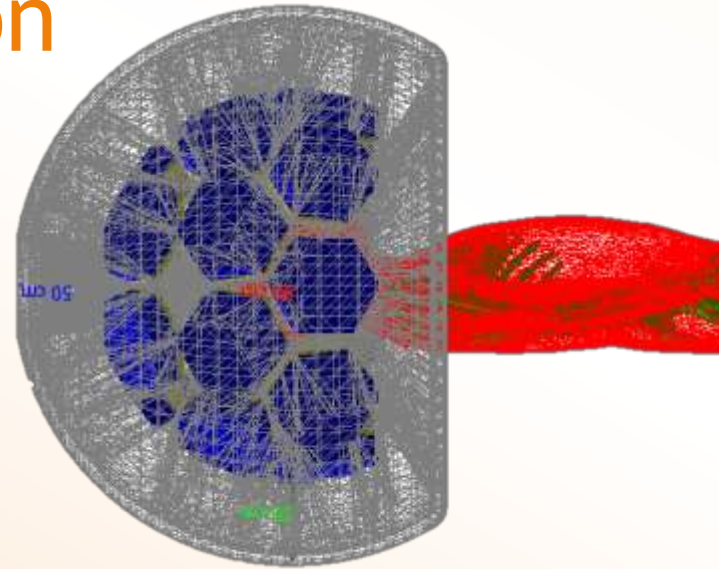
Thyroid

Lungs

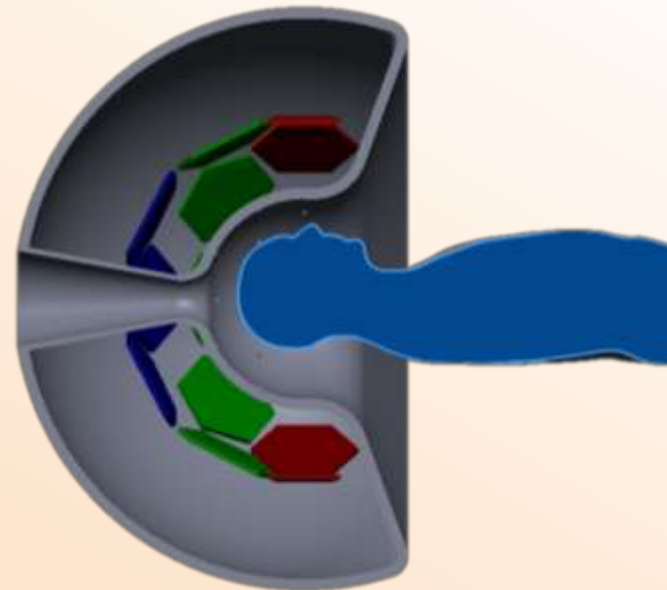
Liver

# STL Phantom Solution

- ▶ Allows phantom to fit inside current system
- ▶ No overlap between system and phantom



GATE  
Screenshot



SolidWorks  
Screenshot

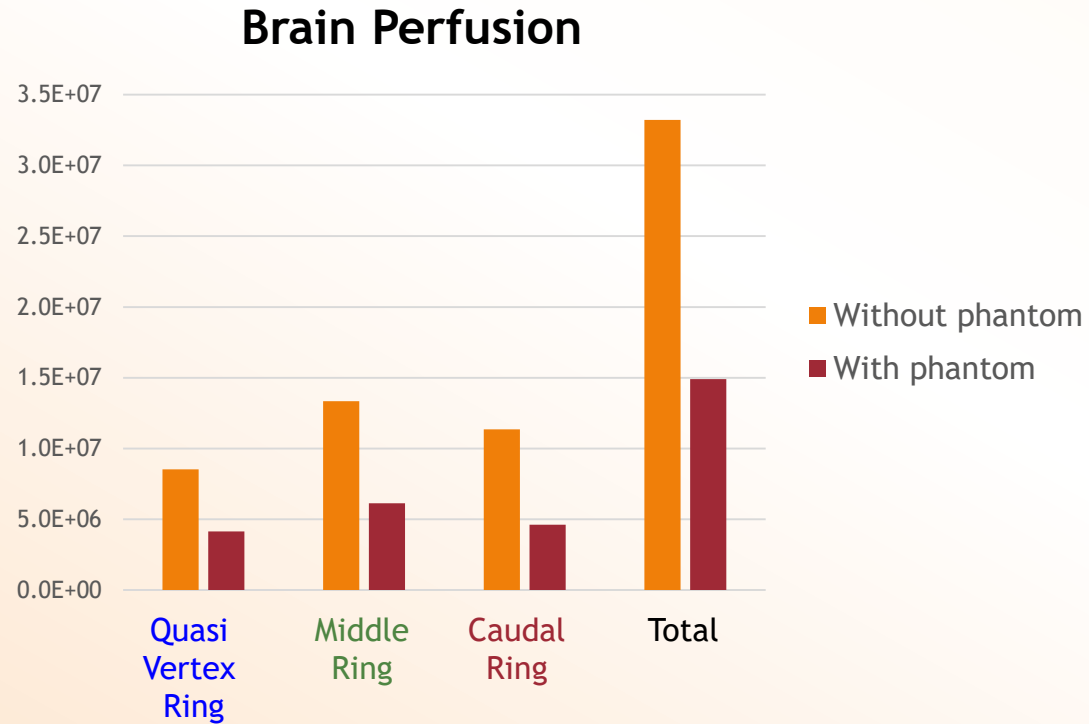
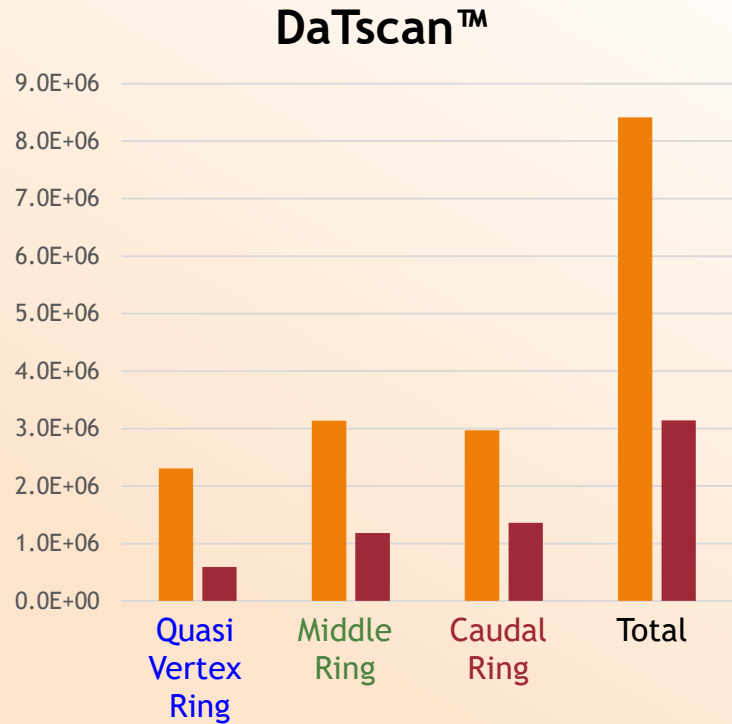
# STL Phantom Solution

- ▶ Used XCAT program to generate mesh output

<https://olv.duke.edu/industry-investors/available-technologies/xcat/>

- ▶ Cleaned up the output using SolidWorks and Meshlab
  - ▶ Holes in Mesh
  - ▶ Non-manifold edges/vertices
  - ▶ Intersecting triangles

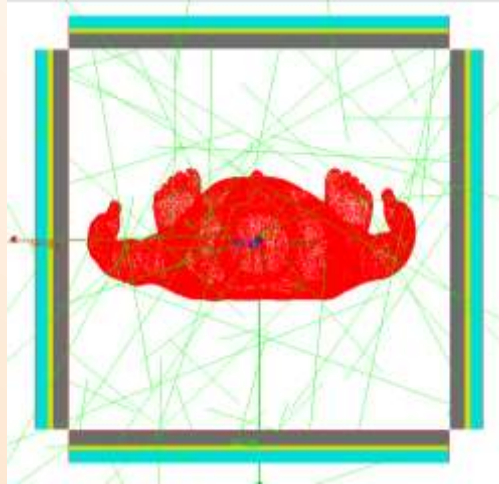
# Impact of Phantom on Count Levels



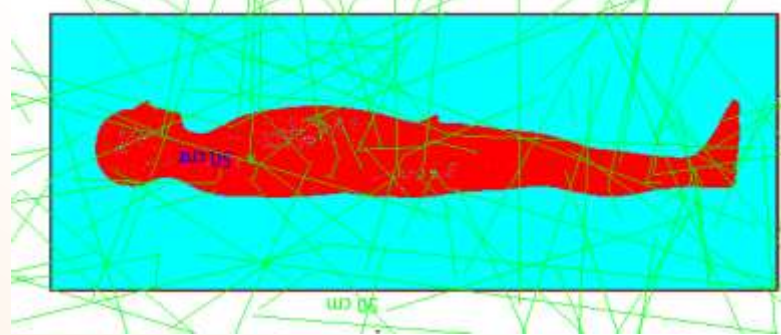
- ▶ Impact of the subject: Total counts observed on the projections divided by a factor of ~2.2

# Assessment of the Time Performance of our Approach

Parallel holes collimator  
4 detection heads around the subject



Whole body projections

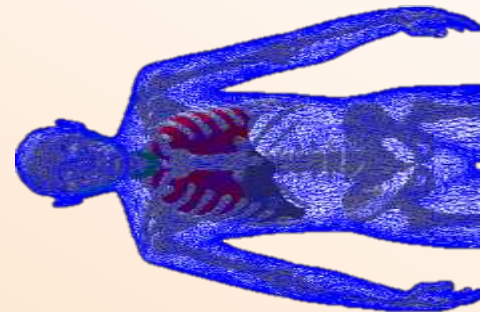


Subject composed of water



2-3 times faster than voxelized phantom

Adding all the Mesh based organs



Increases the computation time by 30% to 40%

# Future prospects

- ▶ Develop an STL based approach for emission
- ▶ Develop an automatic method to clean up the mesh files from the XCAT software
- ▶ Increase database of usable organs
- ▶ Assess the impact of mesh size on computation time and accuracy

# Questions?

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