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Improved Geometry Representations for Monte Carlo Radiation Transport

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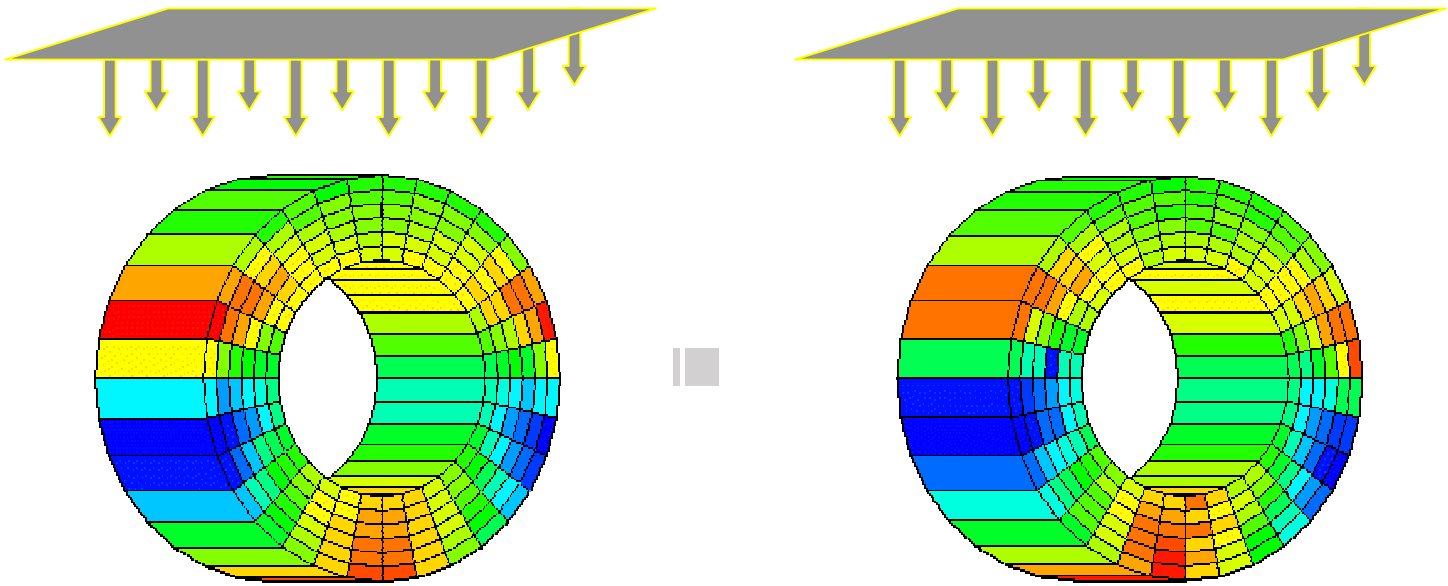
Integrated Tiger Series (ITS)

ITS (Integrated Tiger Series) permits a state-of-the-art Monte Carlo solution of linear time-integrated coupled electron/photon radiation transport problems with or without the presence of macroscopic electric and magnetic fields of arbitrary spatial dependence

What does ITS do?

ITS allows designers to predict product performance in radiation environments



Simulation (3M)

Measurement (Raychem)

Limitations of Modern Radiation Transport Software

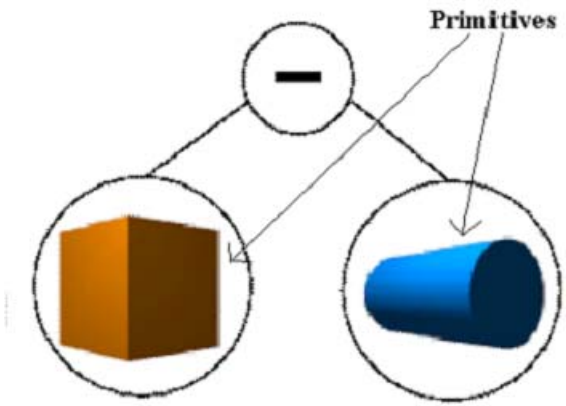
- **Requires combinatorial representation of input geometry**
- **Geometry engine is “hardwired” in to transport physics code**
  - **Requires large code modifications when:**
    - **geometry standard changes**
    - **new geometry representation is added to simulation**

Geometry Representations

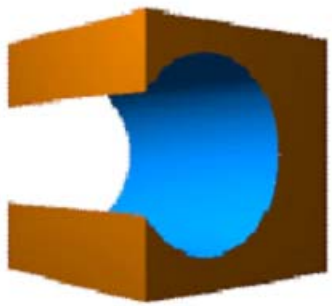
- Combinatorial Geometry
- Boundary Representations
- Hybrids

ITS Combinatorial Geometry (CG)

- In a CG representation, each model is built from Boolean combinations of primitives
- These combinations form a tree of primitives and set operations such as unions, intersections and subtractions

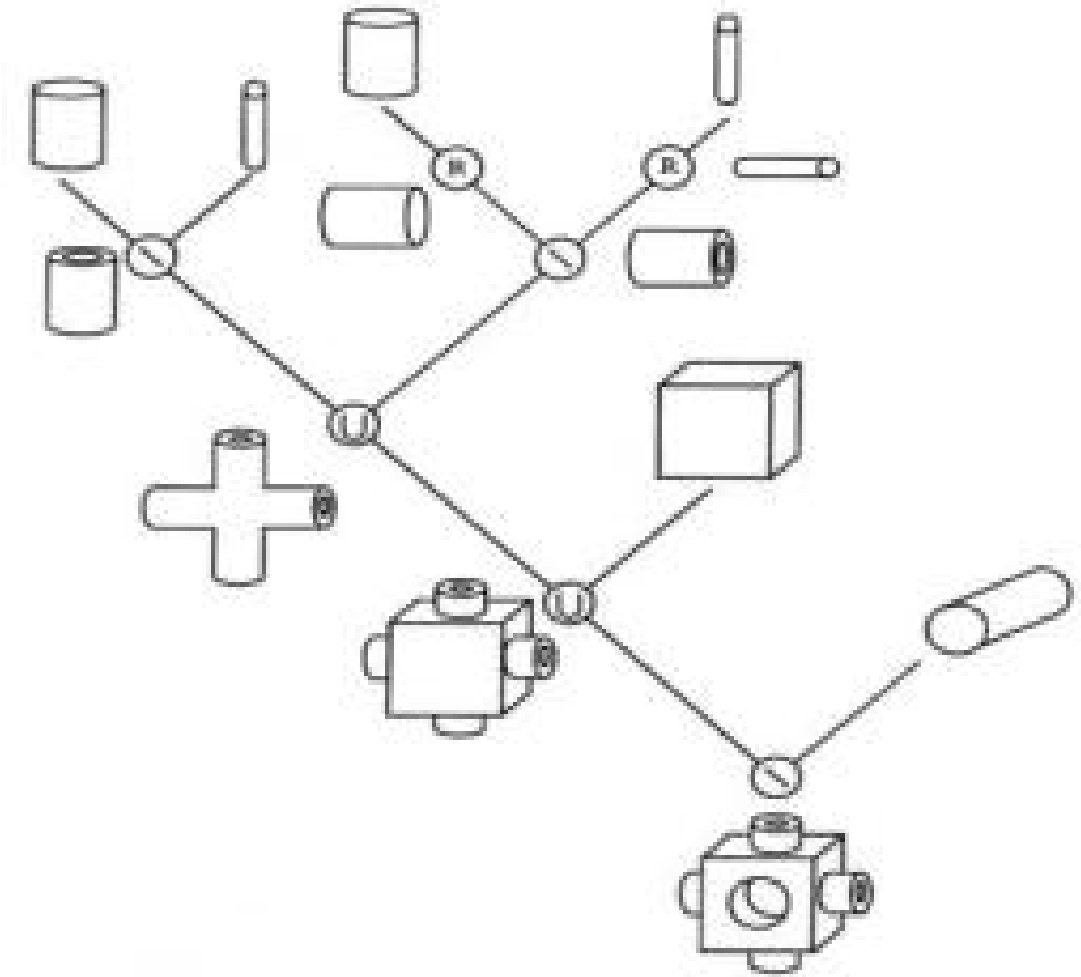


CG Subtraction

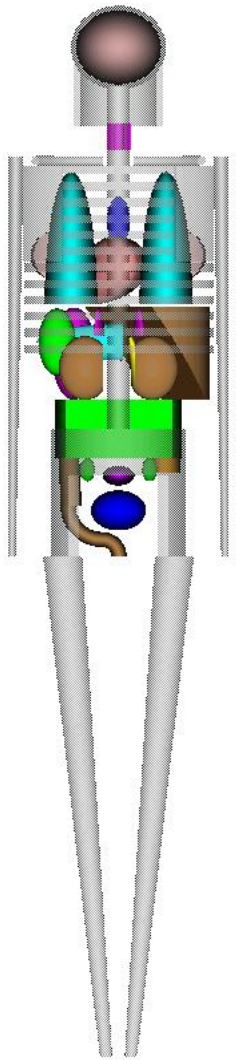


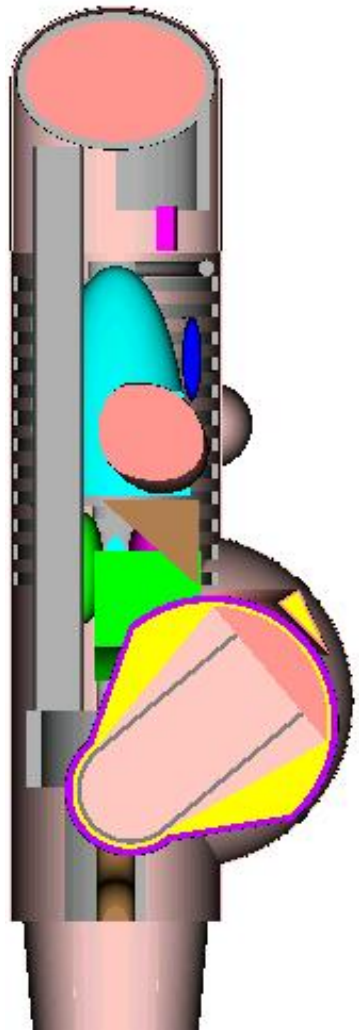
The Resulting Solid

CG-Tree



CG Input for Radiation Transport on Human





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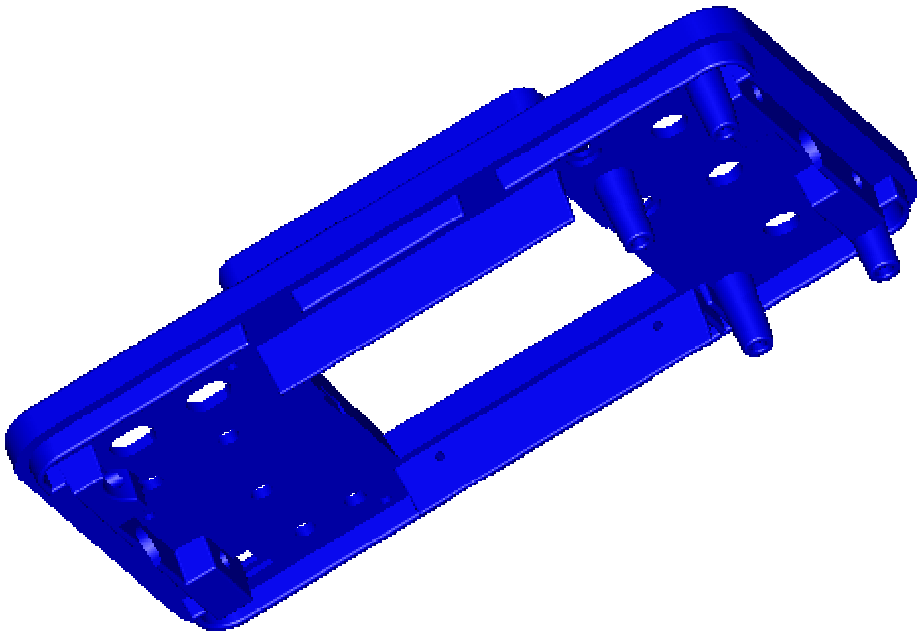
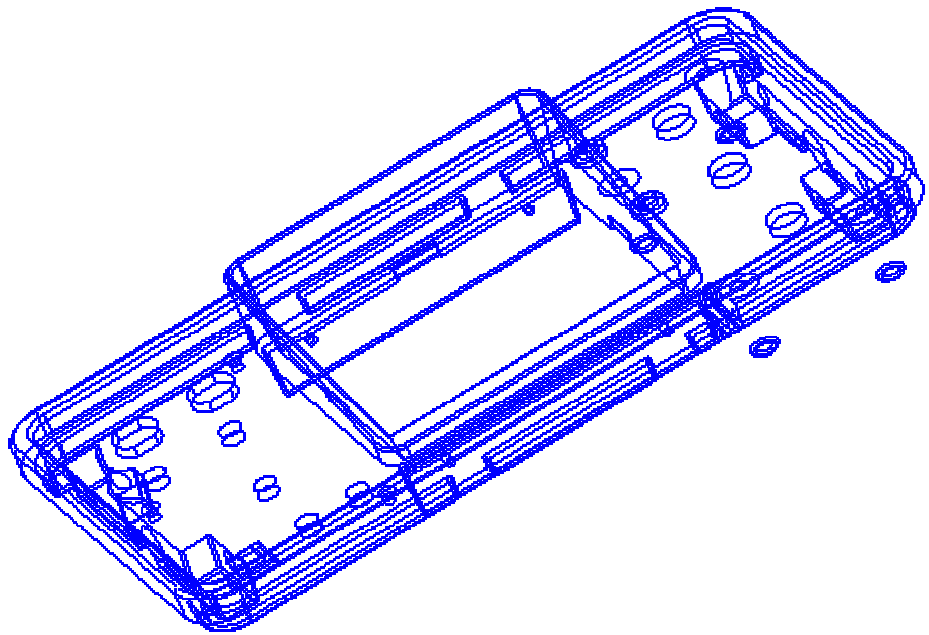
Boundary Representations

- Bound infinite surfaces with edges
- Based upon a topologic hierarchy
  - Body -> Lump -> Shell -> Face -> Edge - >Vertex
- Edges and vertices provide boundaries for faces
- Used by most modern CAD software (Pro/ENGINEER, 3-D Solid Works…)

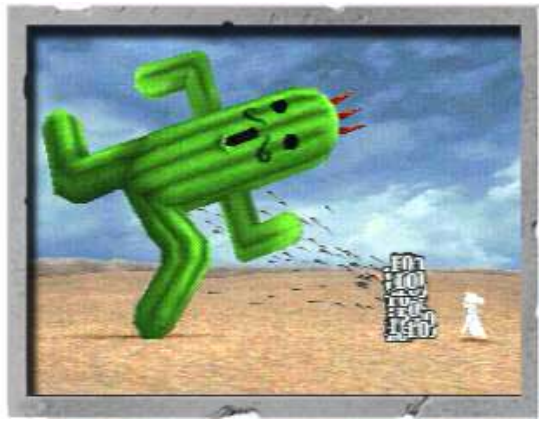
Boundary Representation Example

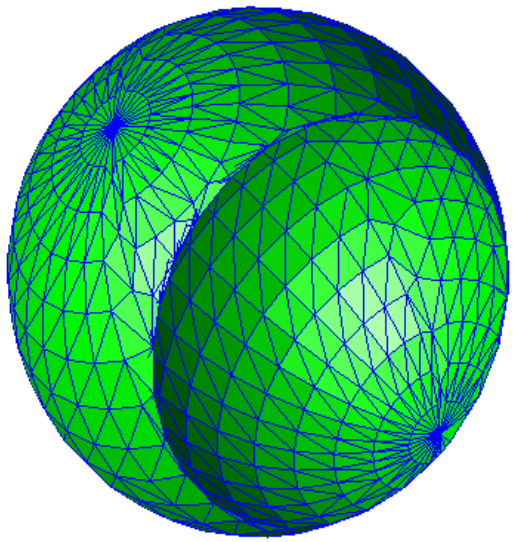




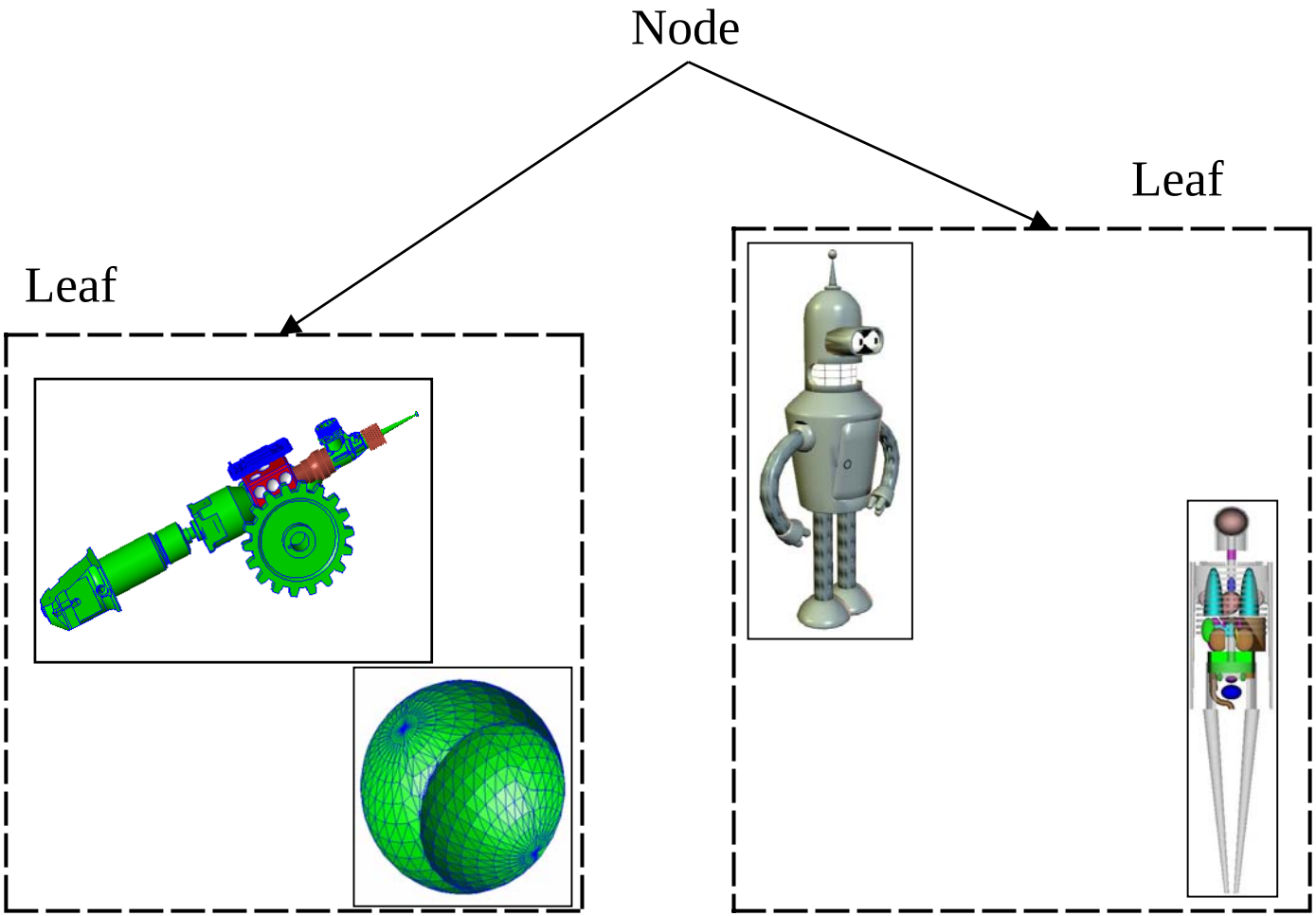
Facetted Representations (B-REP)

- **Planar patches tied together form surfaces**
- **Popular in 3D-games, rapid-prototyping, and real-time graphics**

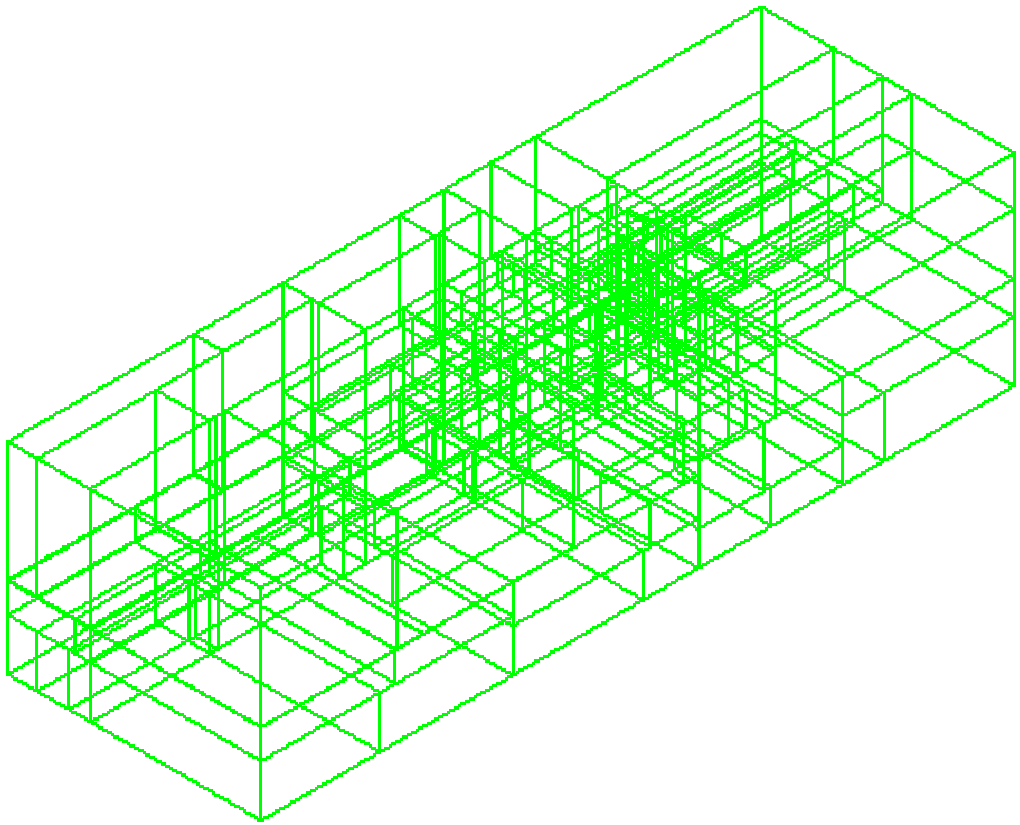


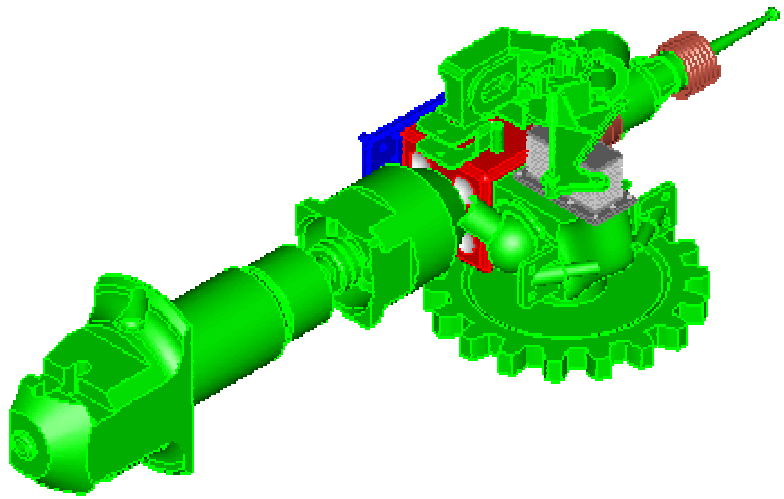


Generic Geometry Representation



KD-Tree





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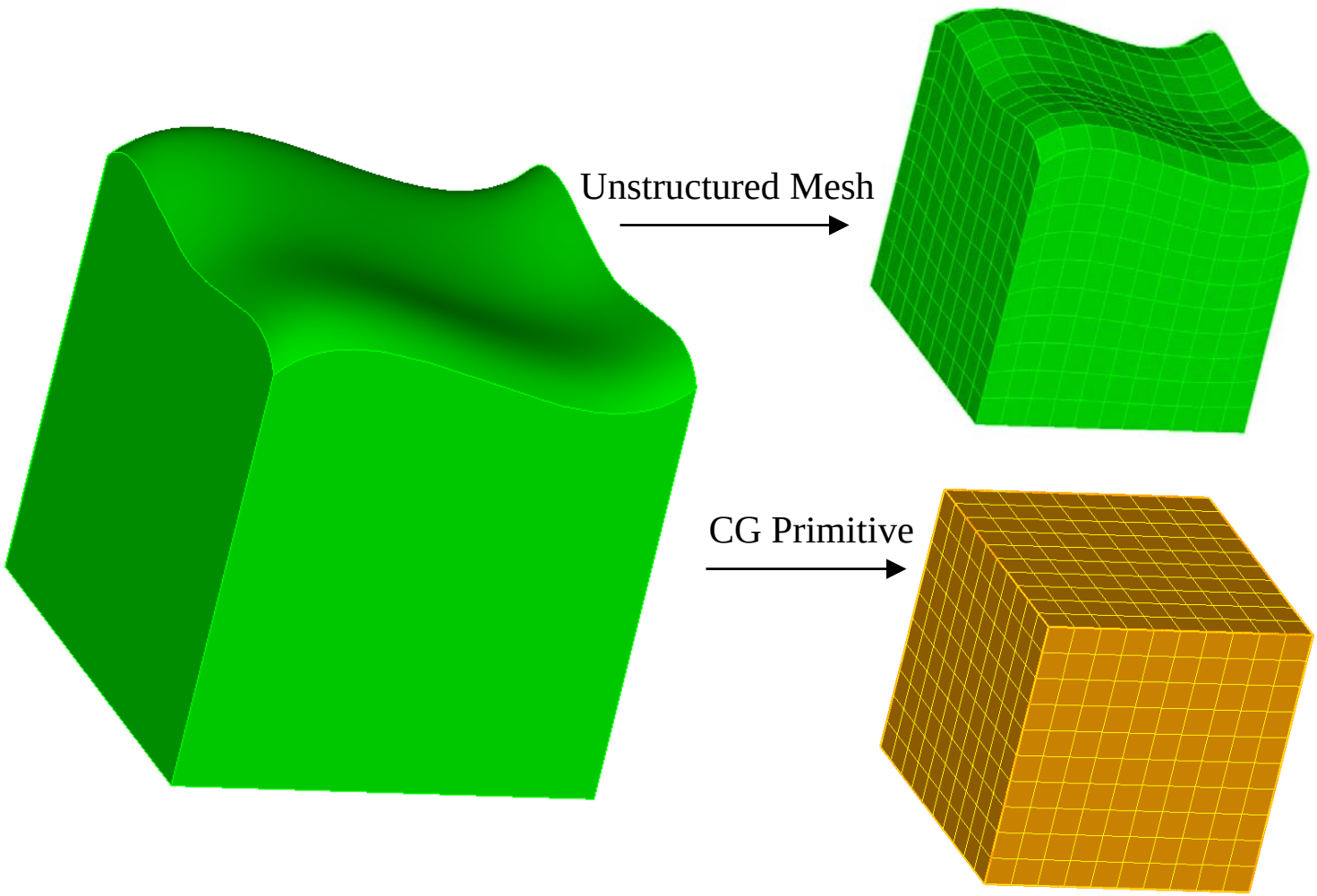
Applications

- **Can now track on any geometry which supports ray shooting operations!**

- **Explore two examples**
  - **Unstructured Meshes**
  - **Computed Tomography Data**

Finite Element Tracking



Visible Human Data

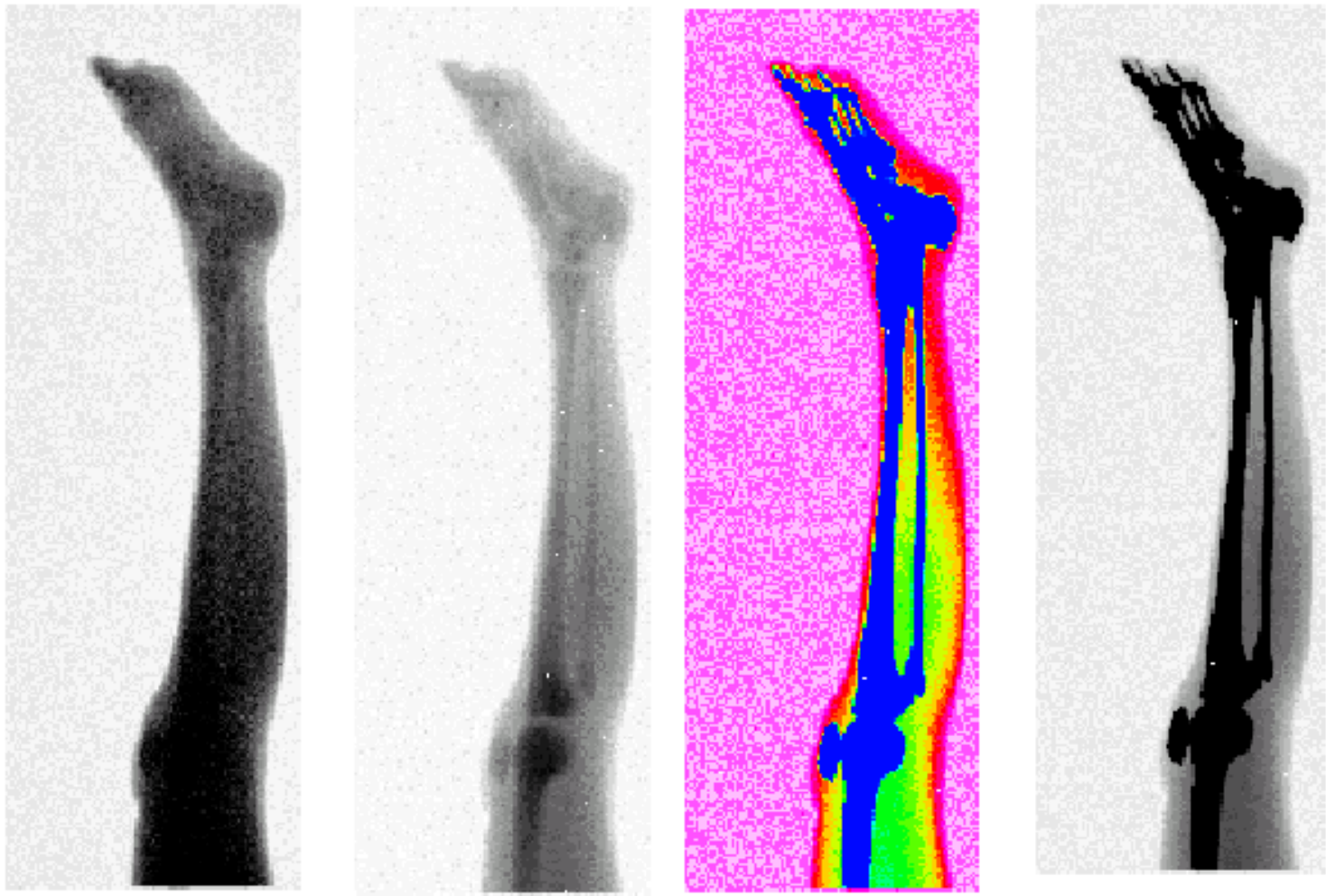
The National Library of Medicine's

Visible Human Project (TM)

Human-Computer Interaction Lab
Univ. of Maryland at College Park

Computed Tomography Isosurface

Transport Calculation on CT Data 25KV



CT Transport Images 75KV