Geant4 Visualization Status

HepRep/WIRED

OpenGL

DAWN

So many options, it needs two title pages
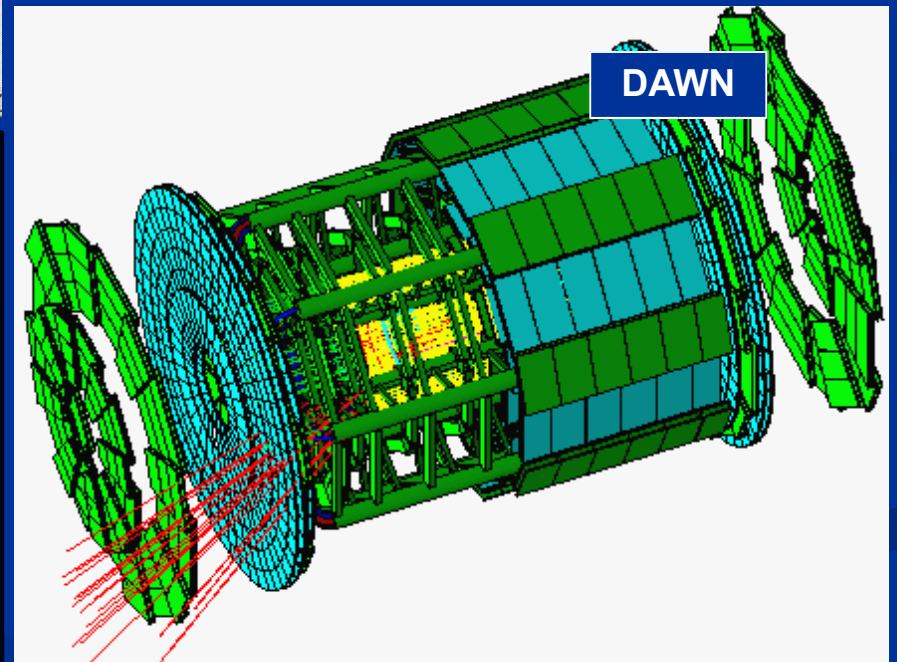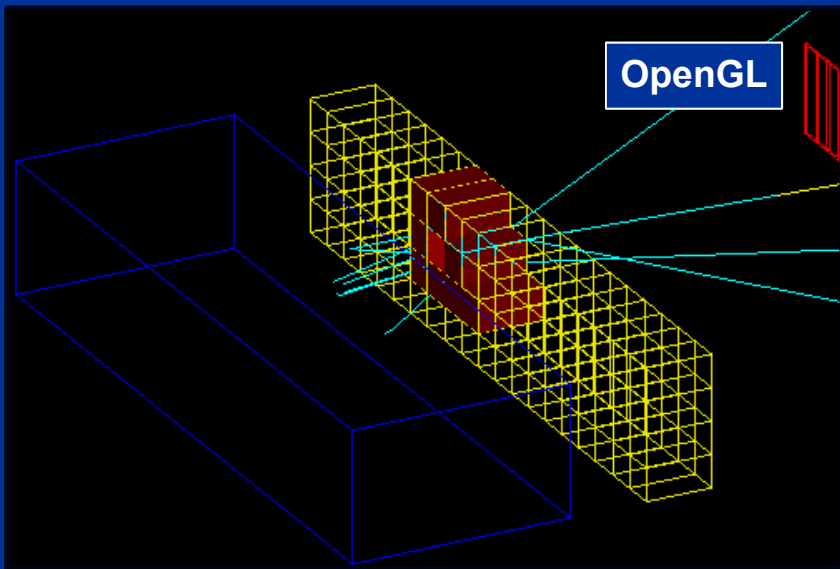
Geant4 Visualization Status
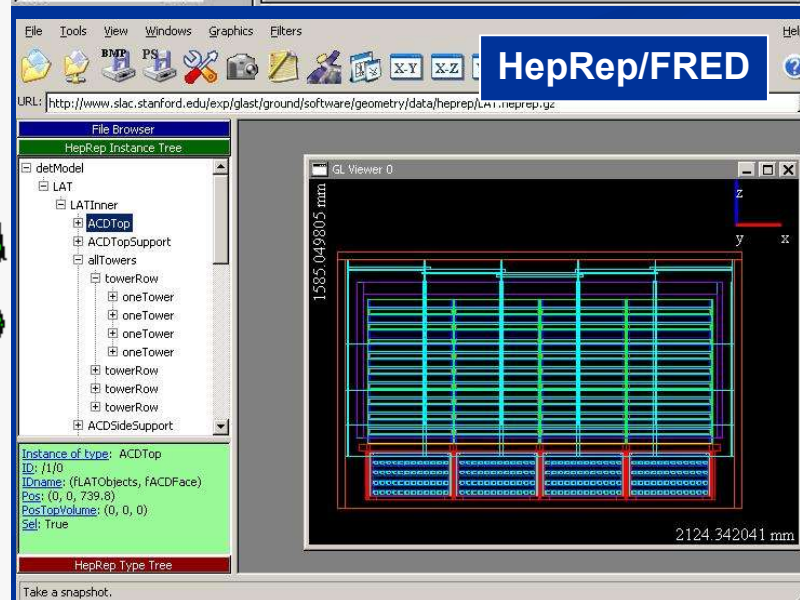
Status of the Visualization Drivers

- Seven Visualization Drivers
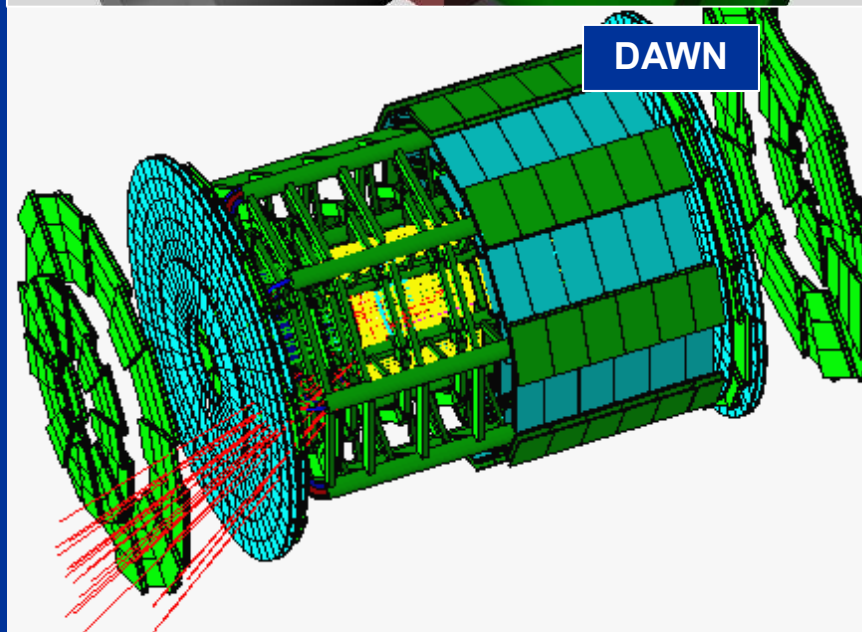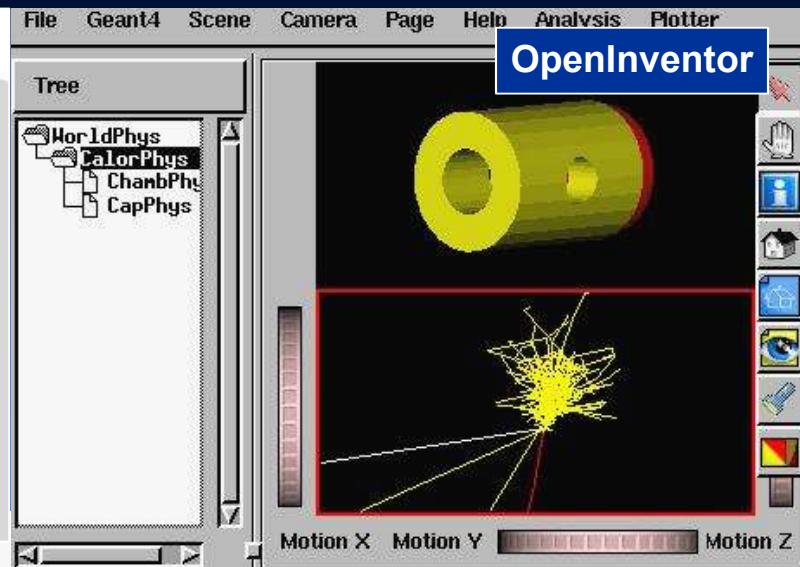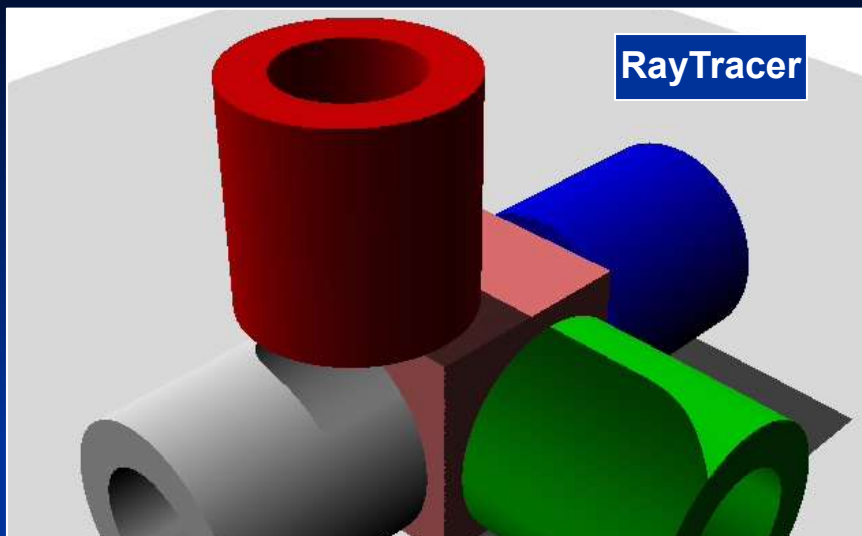 - OpenGL
  - OpenInventor
  - HepRep/WIRED (and FRED)
  - DAWN
  - VRML
  - RayTracer
  - ASCIITree

OpenGL

- /vis/open OGLIX

- Features
  - Control directly from Geant4
  - Uses GL libraries that are already included on most Linux and Windows systems
  - Rendered, photorealistic image with some interactive features
    - zoom, rotate, translate
  - Fast response (can usually exploit full potential of graphics hardware)
  - Limited printing ability (pixel graphics, not vector graphics)

- Supported by John Allison with Guy Barrand

Run with or without Motif Control

- If you don't have Motif, all control is done from Geant4 commands:
  - /vis/open OGLIX
  - /vis/viewer/set/viewpointThetaPhi 70 20
  - /vis/viewer/zoom 2
  - etc.
- But if you have Motif libraries, you can control Geant4 from Motif widgets:
  - /vis/open OGLIXm
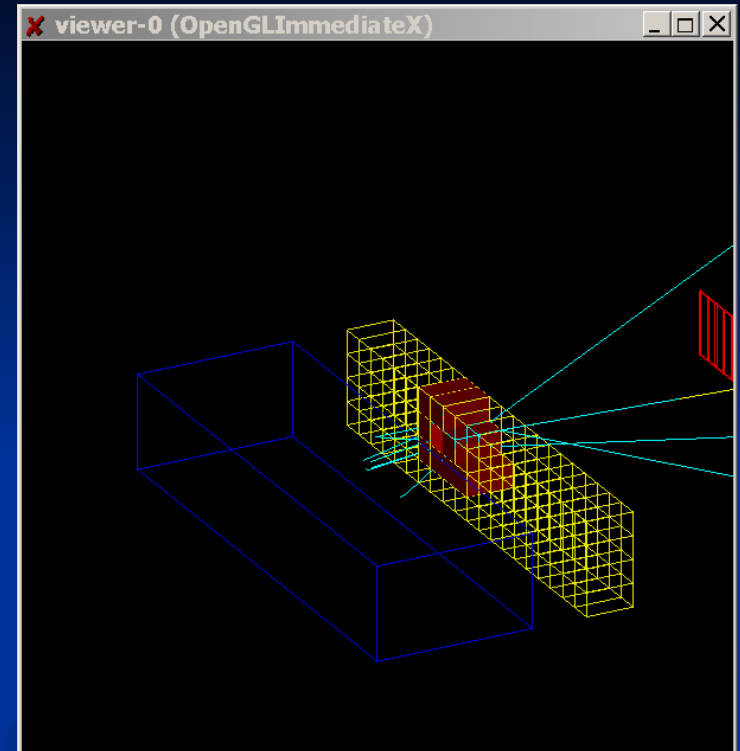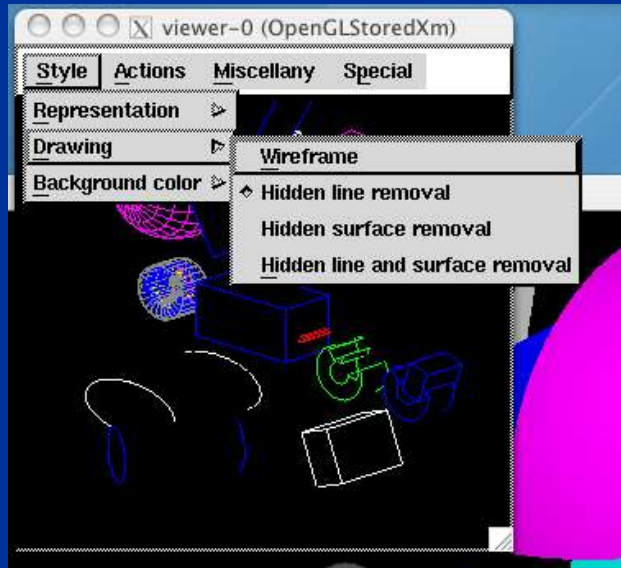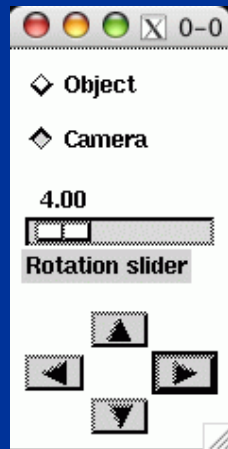
OpenGL Additional Modes

- There are actually 6 OpenGL drivers - OGLxy:
  - x = I (Immediate) or S (Stored)
  - y = X, Xm (Motif) or Win32

- Immediate mode: draws only to screen, no "memory"; detector can be redrawn after view changes but event data is lost.
- Stored mode: creates graphical database (display lists); nothing is lost on simple operations like change of viewing angle

- Also note: Smooth shading and Transparency are coming in the next Geant4 release (Geant4.8.0)

Hidden Line Removal

- By default, hidden line removal is disabled
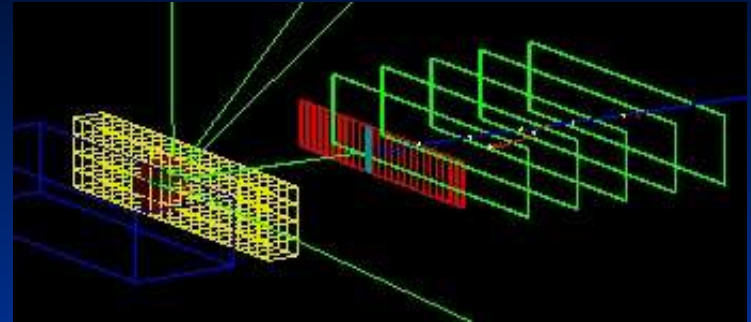
- To turn on hidden line removal
  - /vis/viewer/set/hiddenEdge 1
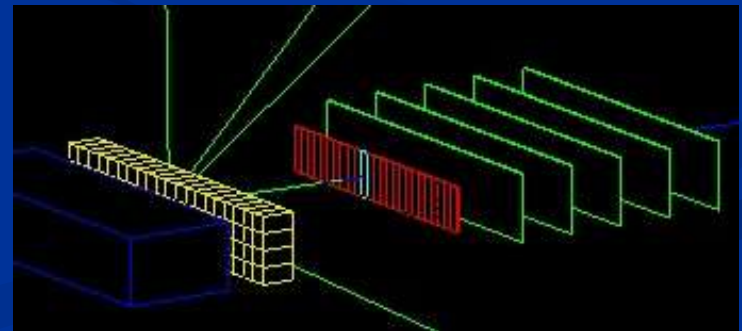 - Hides edges of geometry,
    but lets trajectories through
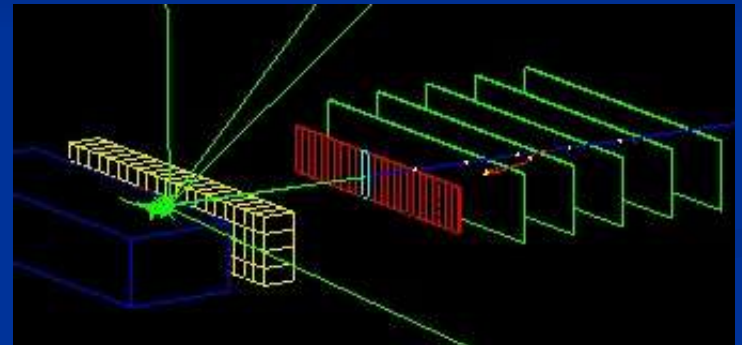
- To hide trajectories and hits as well
  - /vis/viewer/set/hiddenMarker 1

OpenInventor

- /vis/open OIX

- Features
    - Control from the OpenInventor GUI
    - Requires addition of OpenInventor libraries (freely available for most Linux systems and Windows).
    - Rendered, photorealistic image
    - Many interactive features
        - zoom, rotate, translate
        - click to "see inside" opaque volumes
    - Fast response (can usually exploit full potential of graphics hardware)
    - Expanded printing ability (vector and pixel graphics)

- Supported by Guy Barrand

OpenInventor: Start from Geant4

- With OpenInventor, start from Geant4, but then some control from OpenInventor GUI
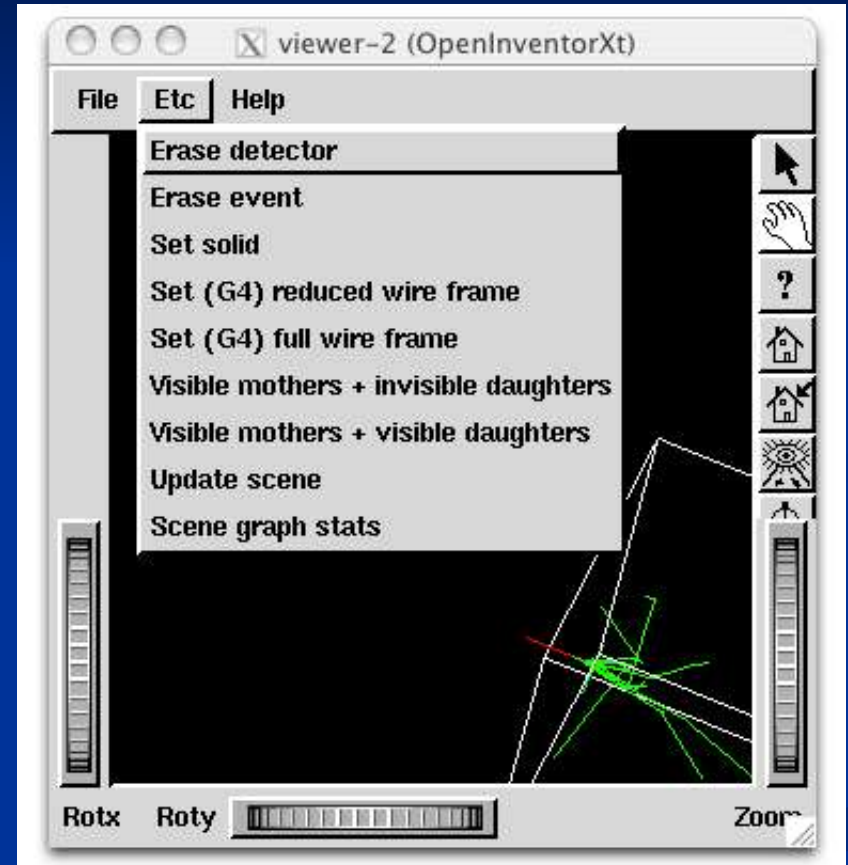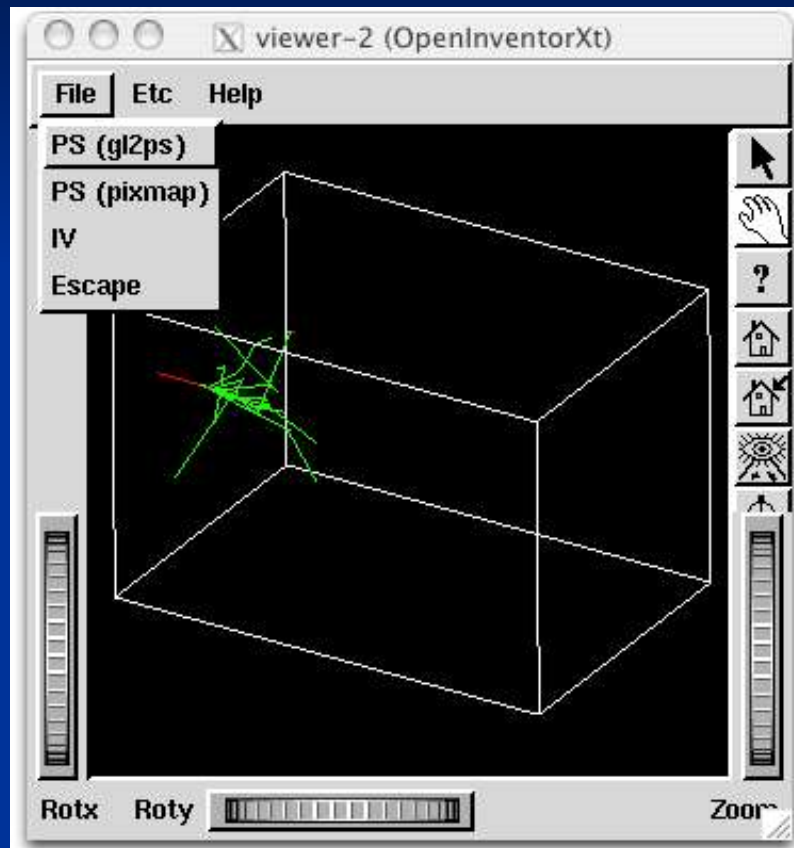
OpenInventor: More GUI Control

- You can also choose to control the Geant4 run from OpenInventor.

OpenInventor Details
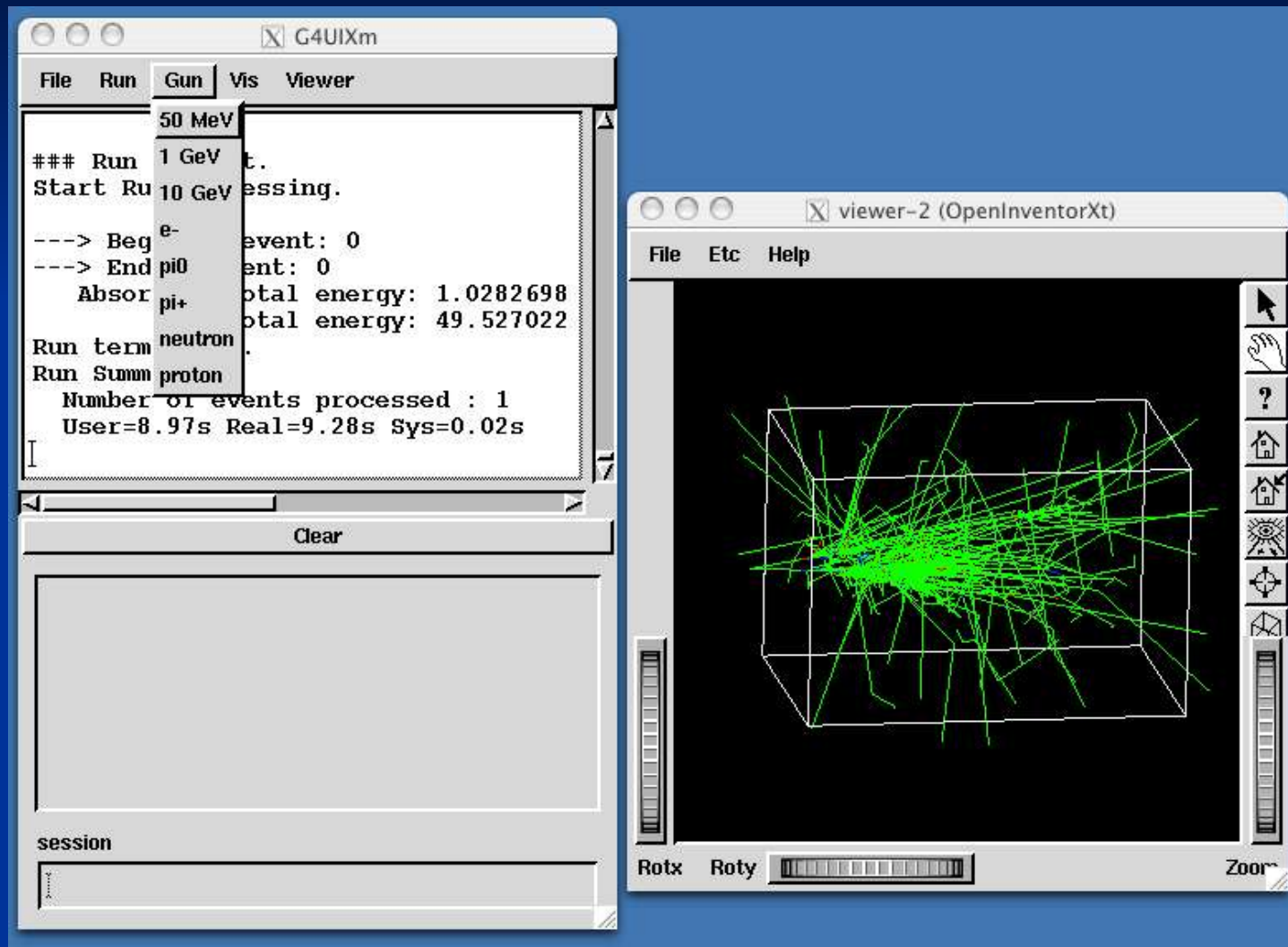
- Connected directly to the Geant4 kernel, using same language as that kernel (C++):
    - Can have direct access to Geant4 data (geometry, trajectories, etc.).
- Use of OpenGL for rendering:
    - Supports lighting and transparency
- Thumbwheel control to rotate an zoom
- Picking to ask about data
- "Control Clicking" on a volume turns on rendering of that volume's daughters. "Shift Clicking" a daughter turns that rendering off:
    - If modeling opaque solid, effect is like opening a box to look inside
- OpenScientist Home Page http://openscientist.lal.in2p3.fr
    - Follow the "Geant4 and Inventor" link at the left hand side of that page for details.

HepRep

- /vis/open HepRepFile

- Features
  - Create a file to view in the WIRED3, WIRED4 and FRED HepRep Browsers
  - Requires WIRED browser (a Java application easily to install on all operating systems)
  - Wireframe or simple area fills (not photorealistic)
  - Many interactive features
    - zoom, rotate, translate
    - click to show attributes (momentum, etc.)
    - special projections (FishEye, etc.)
    - control visibility from hierarchical (tree) view of data
  - Hierarchical view of the geometry
  - Export to many vector graphic formats (PostScript, PDF, etc.)

- Supported by Joseph Perl and Mark Donszelmann
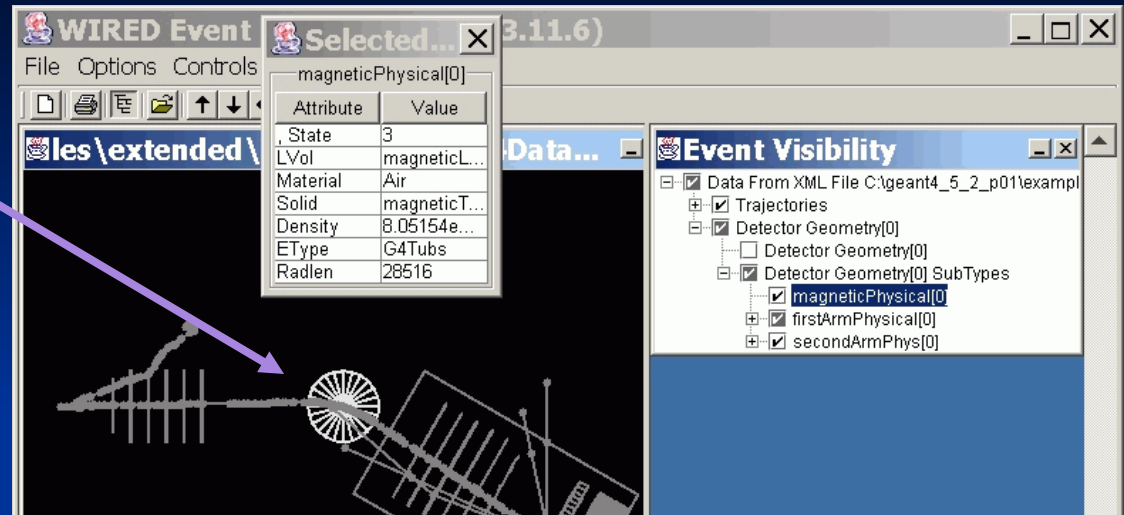
WIRED3: Shows Geometry Hierarchy

Turn visibility on and off from hierarchical control
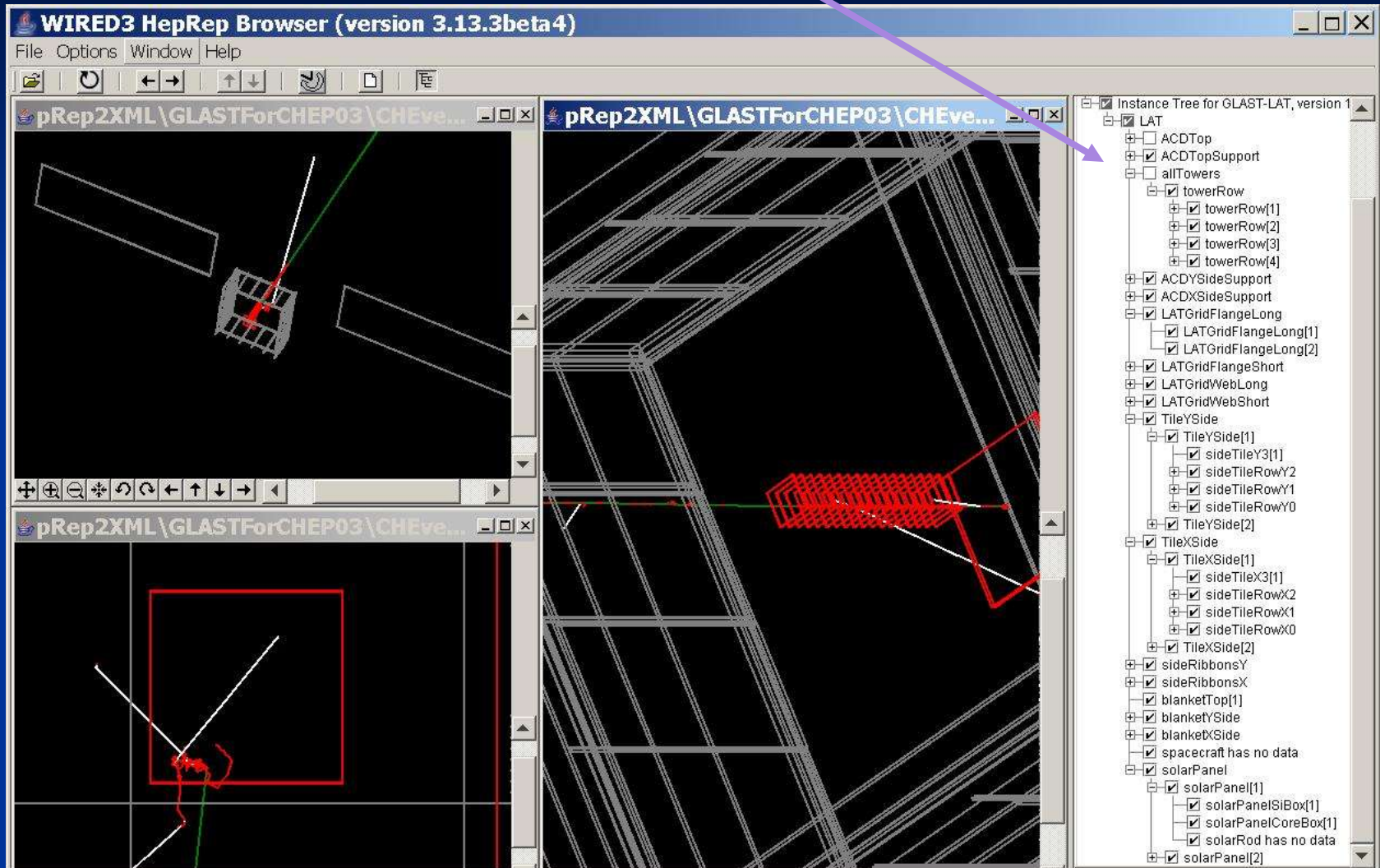
WIRED3: Pick to Show Physics Attributes

Picked on this volume to show
- **Material**
- **Density**
- **Radlen**
- **etc**

Picked on this trajectory to show
- **Particle ID**
- **Charge**
- **Momentum**
- **etc.**
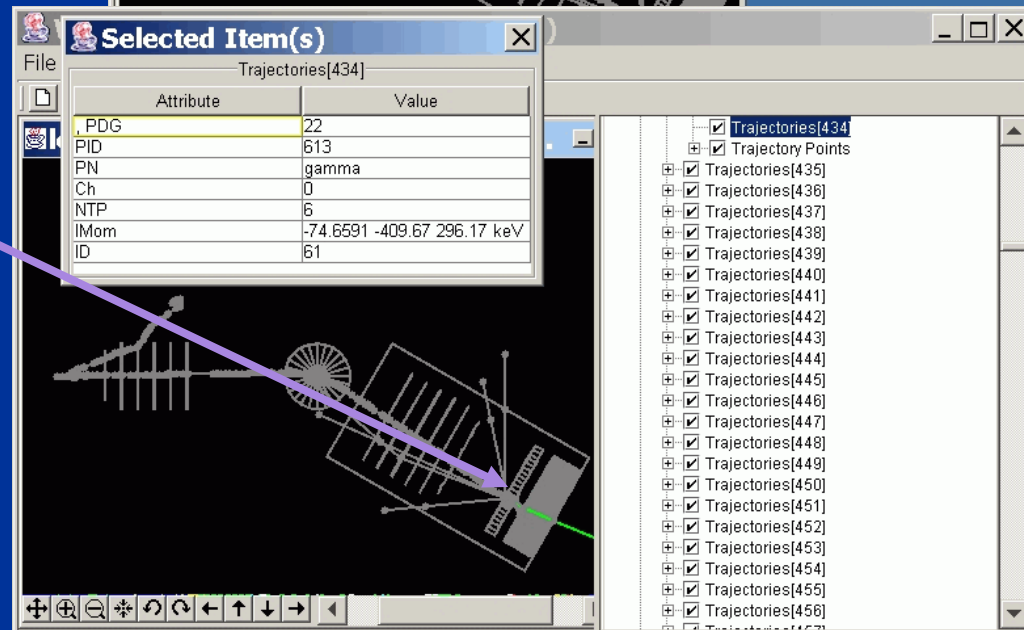
WIRED3: Labeling by Any Attribute

Geant4 Visualization Status   J. Perl
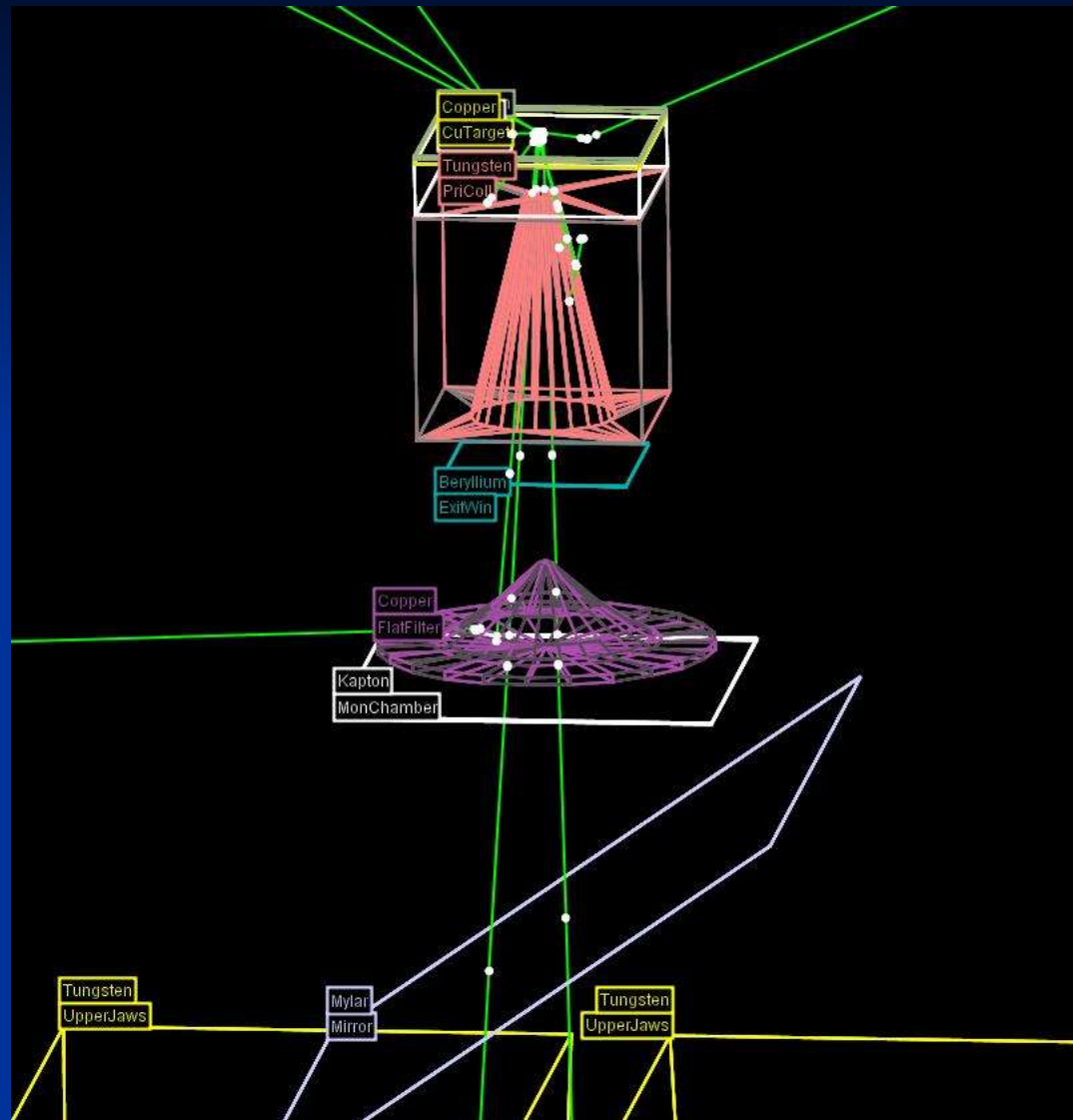
WIRED3: Cut by Any Attribute

WIRED4: Part of JAS

- Install JAS (Java Analysis Studio)
- Then download WIRED4 Plug-in
- http://wired.freehep.org/index.html
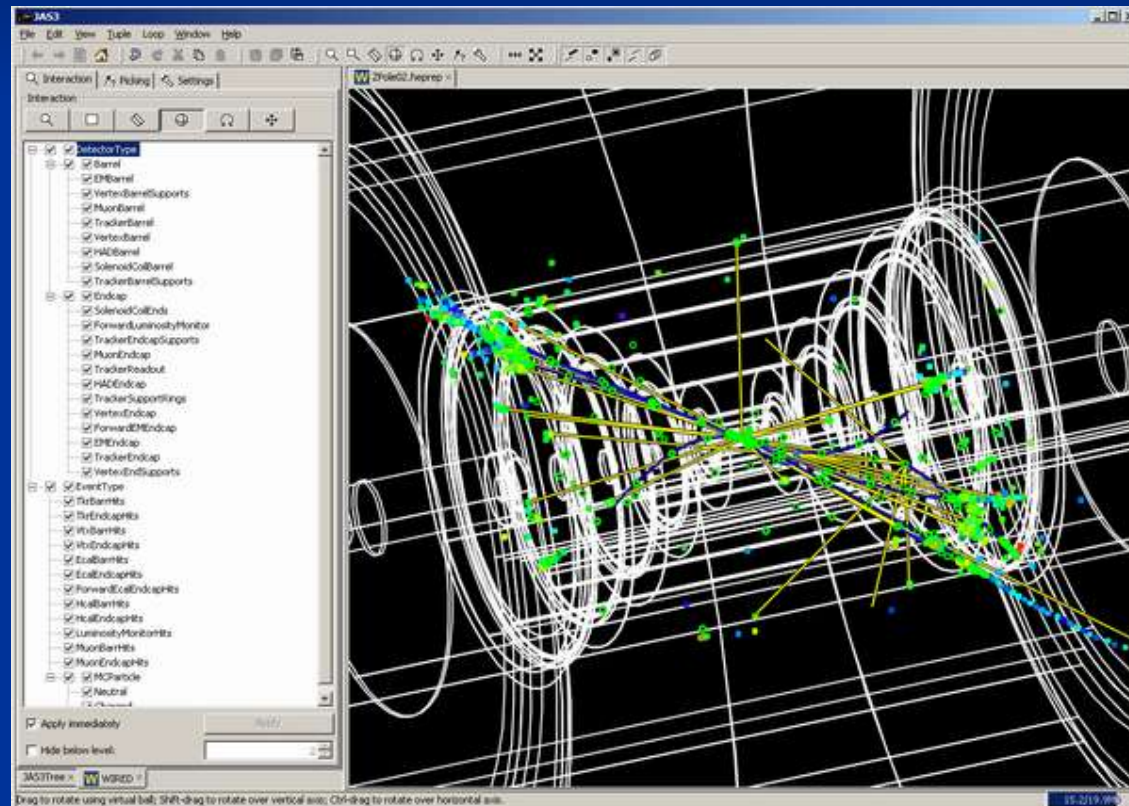
FRED: Fox Ruby Event Display

- An additional HepRep-compatible browser developed by members of the GLAST space telescope collaboration.

- Includes the fast rotations and beautiful rendering of GL plus HepRep interactivity

- Allows scripting to change any attribute based on logic involving other attributes, hence things like "color by momentum" are scriptable.
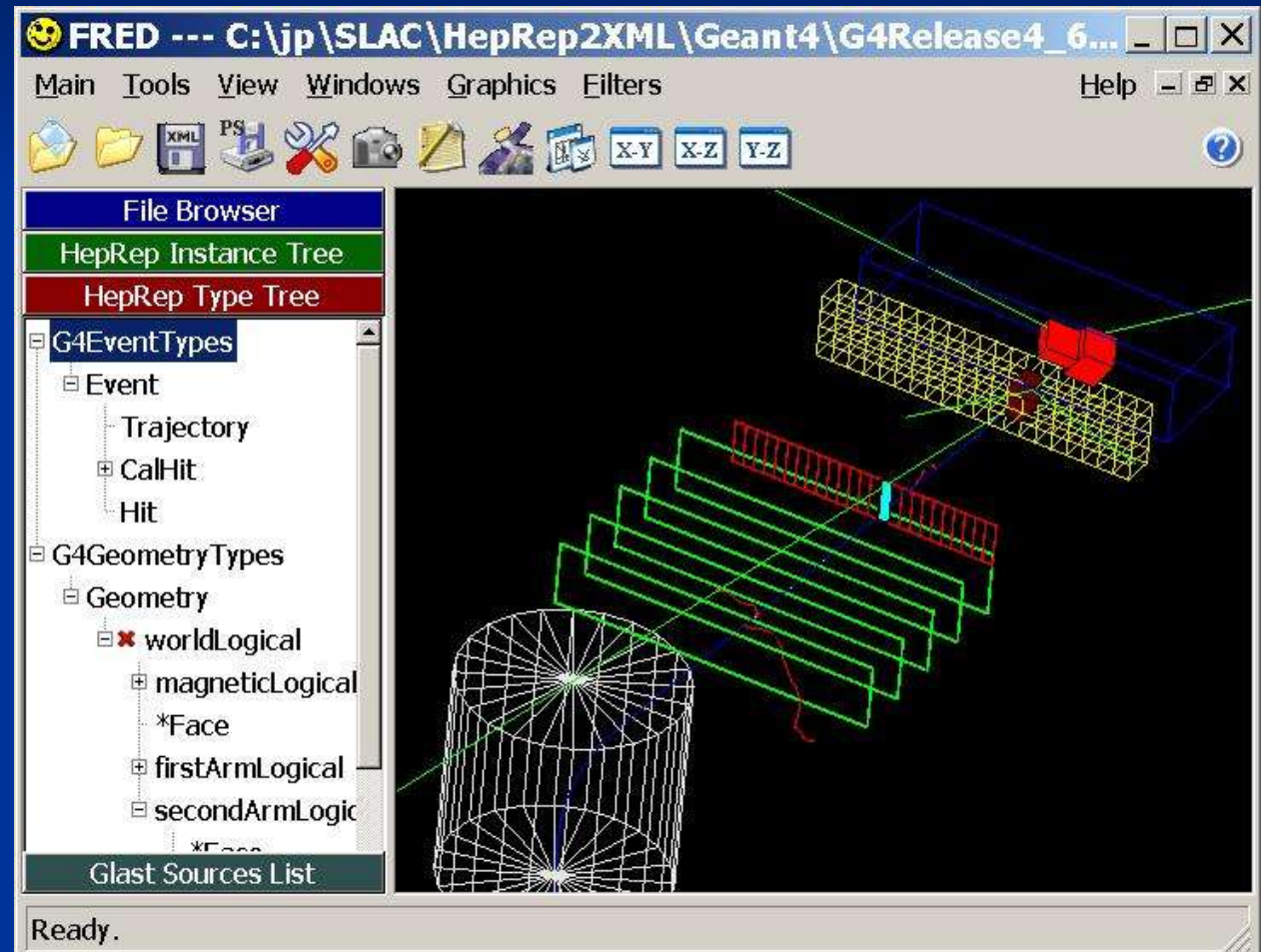
DAWN

- /vis/open DAWNFILE

- Features
  - Create a .prim file
  - Requires DAWN, available for all Linux and Windows systems
  - DAWN creates a rendered, photorealistic PostScript image
  - No interactive features
  - Highest quality technical rendering - vector PostScript

- Supported by Satoshi Tanaka
  - Recently ported DAWN, DAWNCUT and DAVID to FedoraCore 4.0 (g++ 4.0)

DAWN Examples

- From a repository of beautiful images at
  - http://geant4.kek.jp/~tanaka/GEANT4/ATLAS_G4_GIFFIG/
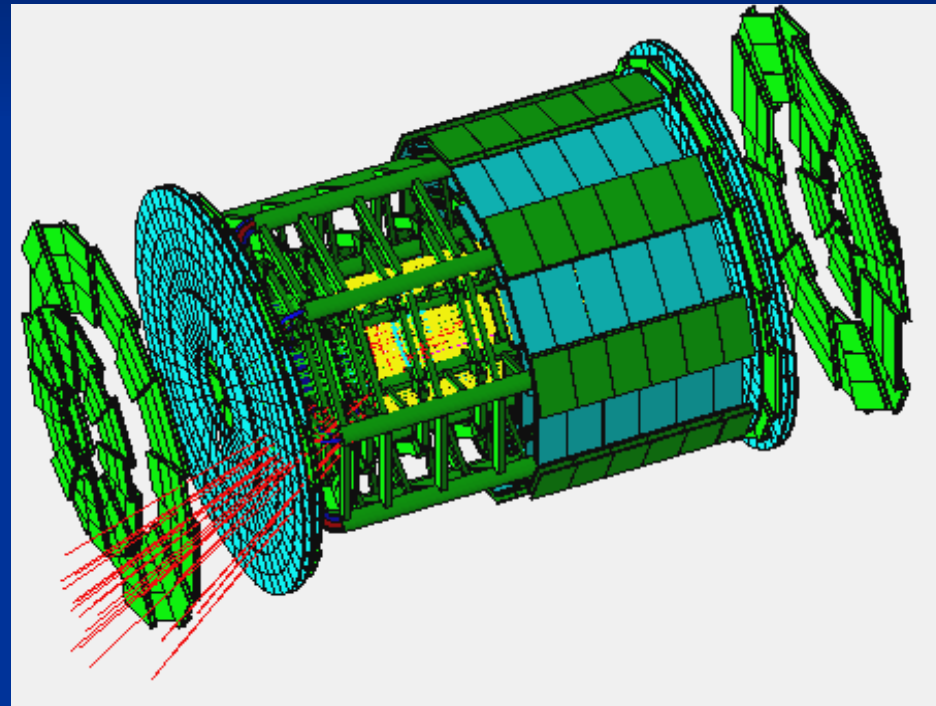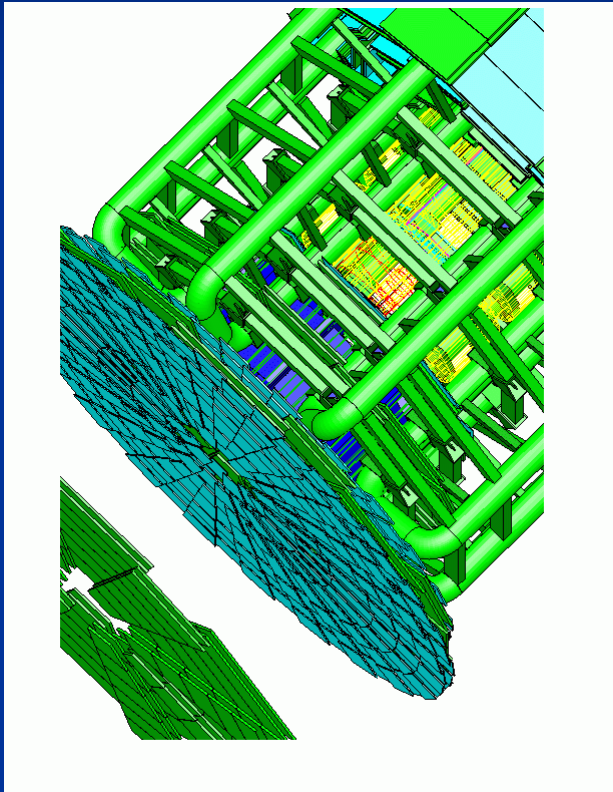
DAWN makes True Vector PostScript

- So when you zoom in with your PostScript browser, the images retain high resolution
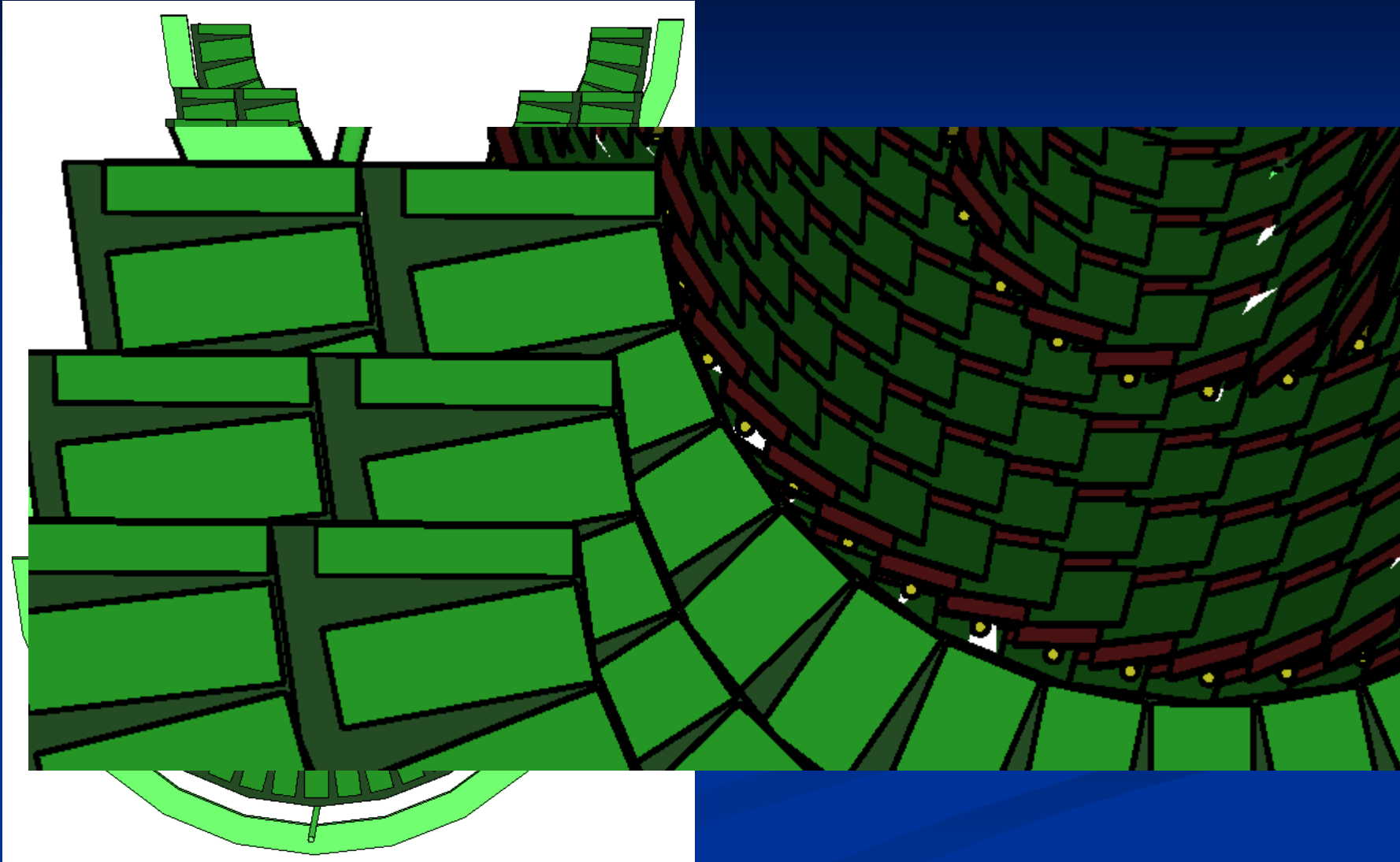
DAWNCUT and DAVID

- A standalone program, DAWNCUT, can perform a planar cut on a DAWN image.
  - DAWNCUT takes as input a .prim file and some cut parameters. Its output is a new .prim file to which the cut has been applied.

- Another standalone program, DAVID, can show you any volume overlap errors in your geometry.
  - DAVID takes as input a .prim file and outputs a new .prim file in which overlapping volumes have been highlighted.

- Details at http://geant4.kek.jp/~tanaka/

DAWN Immediate Mode

- Remember that DAWN also has an immediate mode.
    - /vis/open DAWN
    - rather than
    - /vis/open DAWNFILE

VRML

- /vis/open VRMLFILE1 or /vis/open VRMLFILE2

- Features
  - Create a file to view in any VRML browser (some as web browser plug-ins).
  - Requires VRML browser (many different choices for different operating systems).
  - Rendered, photorealistic image with some interactive features
    - zoom, rotate, translate
  - Limited printing ability (pixel graphics, not vector graphics)

- Supported by Satoshi Tanaka

VRML

- View file in a VRML Browser
  - Many free options, for example, here is one from octaga.com
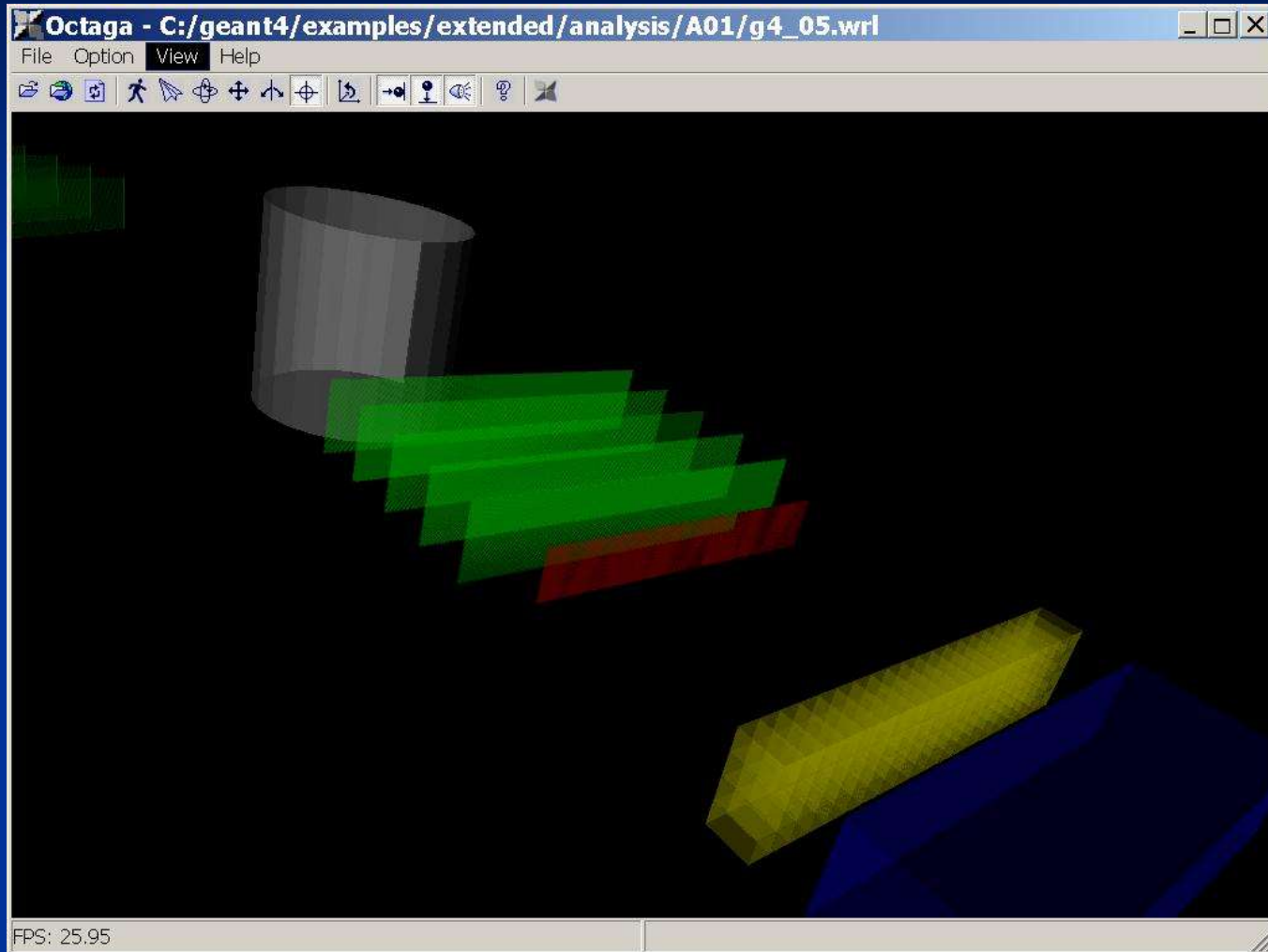
VRML Immediate Mode

- Remember that VRML also has an immediate mode.
    - /vis/open VRML
    - rather than
    - /vis/open VRMLFILE

RayTracer

- /vis/open RayTracer

- Features
  - Create a jpeg file
  - Forms image by using Geant4's own tracking to follow photons through the detector
  - Can show geometry but not trajectories
  - Can render any geometry that Geant4 can handle (such as Boolean solids) - no other Vis driver can handle every case
  - Supports shadows, transparency and mirrored surfaces

- Supported by Makoto Asai and John Allison

RayTracer Shows Shadows

Geant4 Visualization Status   J. Perl
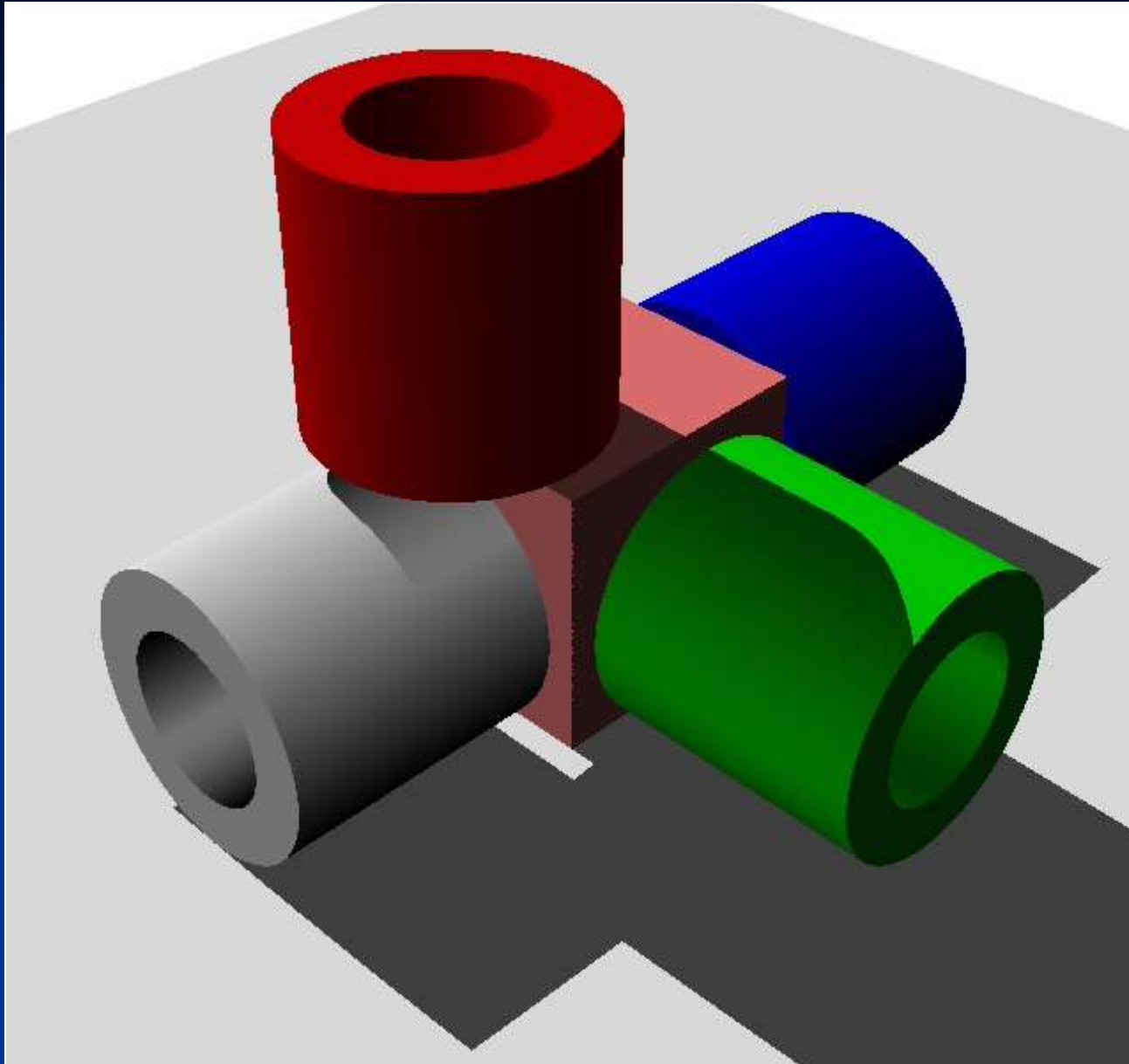
RayTracer Supports Transparency
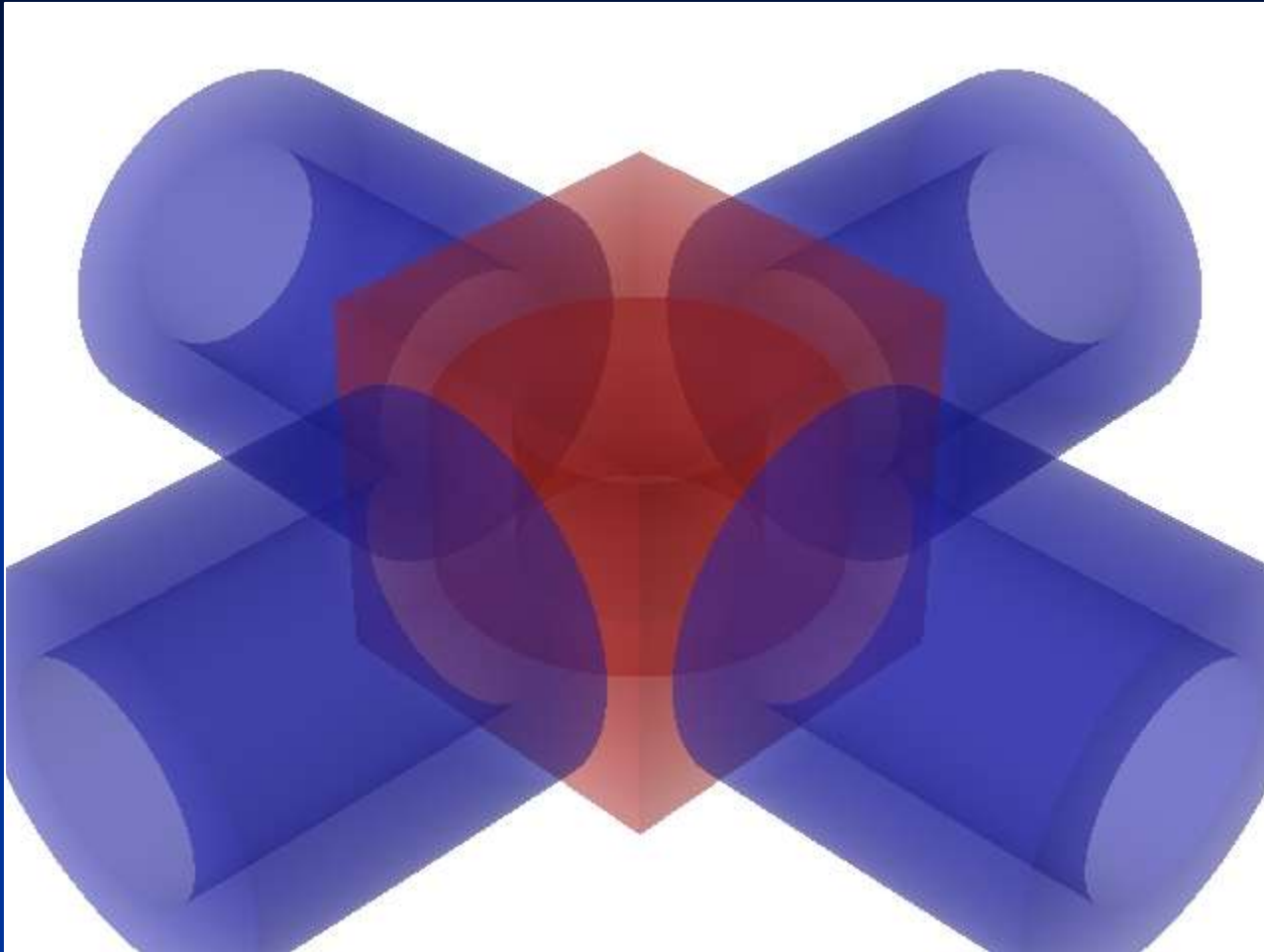
RayTracer Handles Mirrored Surfaces

Mirrored
Surfaces
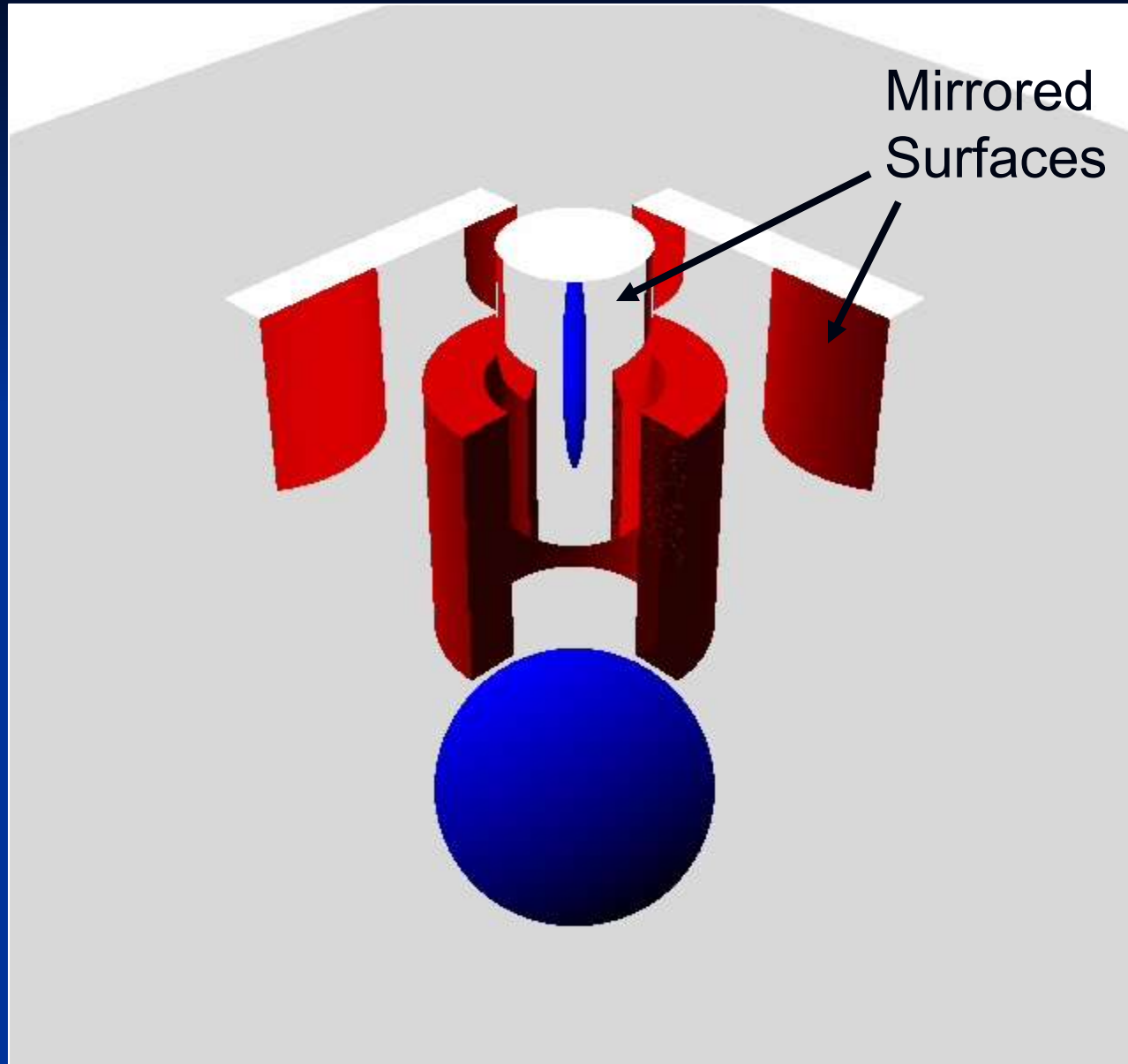
RayTracer Handles Boolean Solids

Geant4 Visualization Status   J. Perl
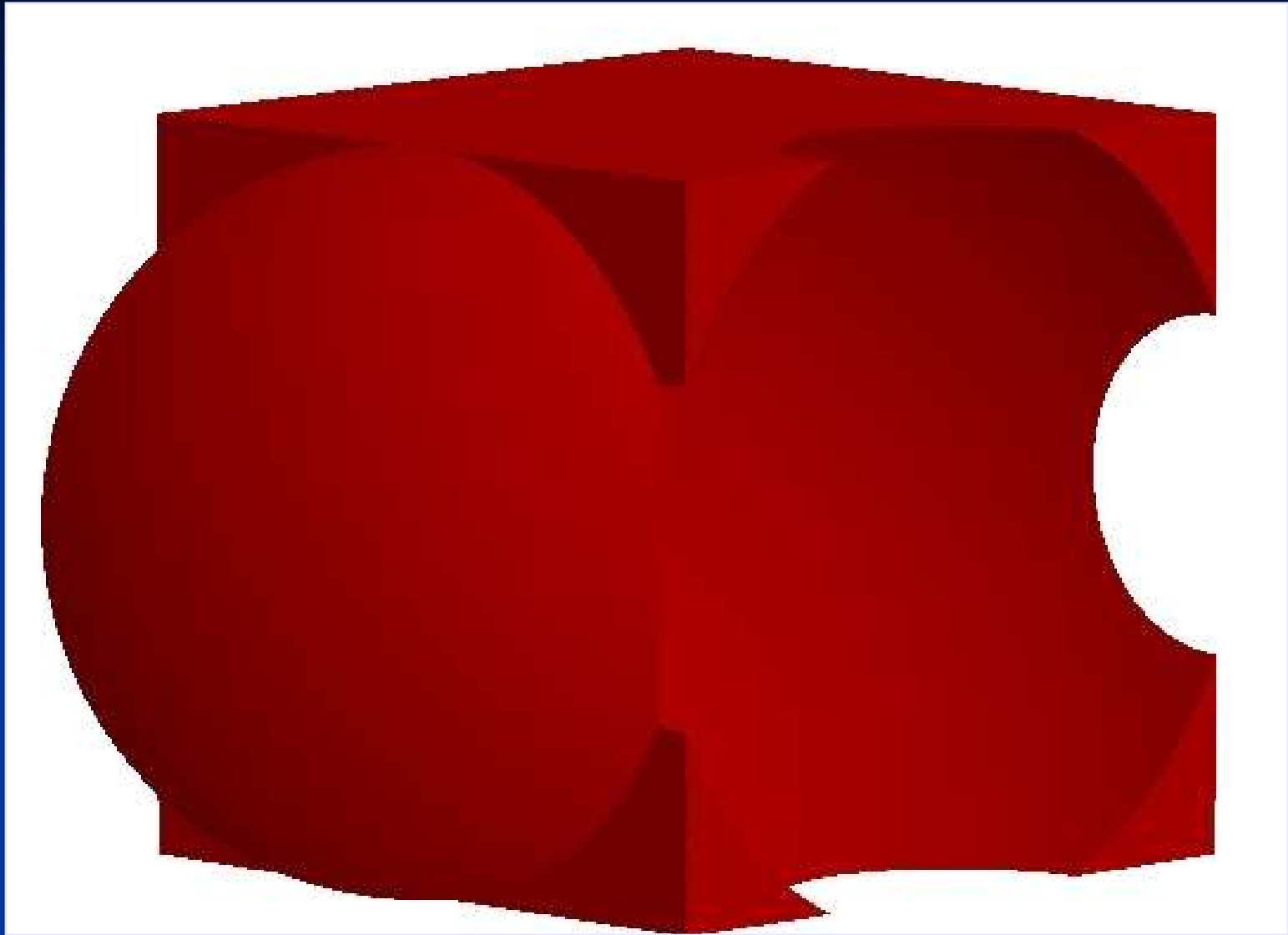
RayTracerX

- Coming in next release (Geant4.8.0)
- In addition to
  - /vis/open RayTracer
- You will have the option of
  - /vis/open RayTracerX

- Builds same jpeg file as RayTracer, but simultaneously renders to screen so you can watch as rendering grows progressively smoother.
- Means you can abort and retry the rendering with different view parameters without having to wait for the complete refinement of the image.
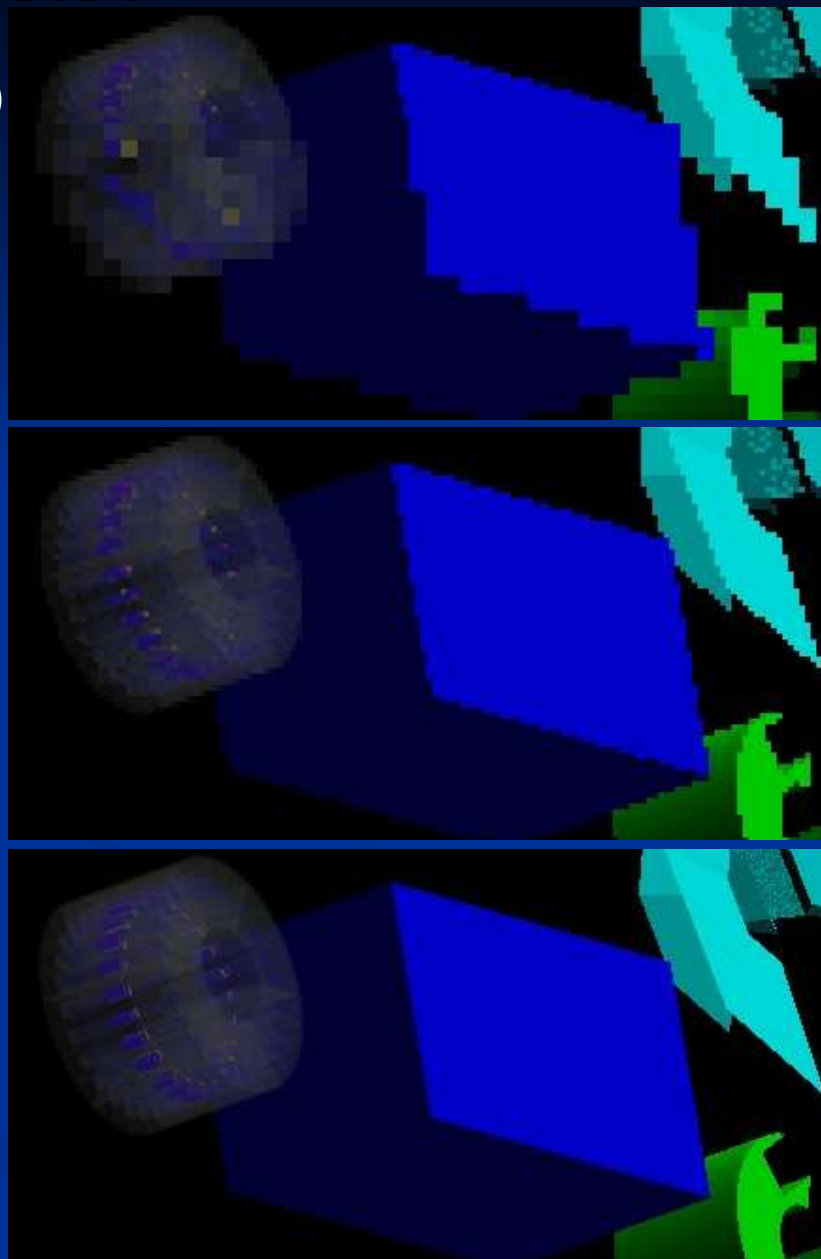
ASCIITree

- /vis/open ATree

- Features
  - Text dump of the geometry hierarchy
  - Not graphical
  - Control over level of detail to be dumped
  - Can calculate mass and volume of any hierarchy of volumes

- Supported by John Allison

ASCIITree

- ASCIITREE is a visualization driver that is not actually graphical, but that dumps the hierarchy as a simple text tree.
    - /vis/open ATree

- /vis/viewer/flush
    - "worldPhysical":0
    - "magneticPhysical":0
    - "firstArmPhysical":0
    - "hodoscope1Physical":0
    - "hodoscope1Physical":1 (repeated placement)
    - "hodoscope1Physical":2 (repeated placement)
    - "hodoscope1Physical":3 (repeated placement)
    - "hodoscope1Physical":4 (repeated placement)

- Can be set to various levels of detail
    - /vis/ASCIITree/verbose <verbosity>
    - 0: prints physical volume name.
    - 1: prints logical volume name.
    - 2: prints solid name and type.
    - 3: prints volume and density of solid.
    - 4: calculates and prints mass(es) of volume(s) in scene.
    - By default, shows only daughters of first placement and not repeat replicas.
    - Add 10 to the above to also show repeated placements and replicas.

ASCIITree: Calculate Volume and Mass

- At verbosity level 4, ASCIITree calculates the mass of the complete geometry tree taking into account daughters up to the depth specified for each physical volume.

- The calculation involves subtracting the mass of that part of the mother that is occupied by each daughter and then adding the mass of the daughter, and so on down the hierarchy.

- /vis/ASCIITree/Verbose 4
- /vis/viewer/flush
- "HadCalorimeterPhysical":0 / "HadCalorimeterLogical" / "HadCalorimeterBox"(G4Box), 1.8 m3 , 11.35 g/cm3
  - "HadCalColumnPhysical":-1 (10 replicas) / "HadCalColumnLogical" / "HadCalColumnBox"(G4Box), 180000 cm3, 11.35 g/cm3
    - "HadCalCellPhysical":-1 (2 replicas) / "HadCalCellLogical" / "HadCalCellBox"(G4Box), 90000 cm3, 11.35 g/cm3
      - "HadCalLayerPhysical":-1 (20 replicas) / "HadCalLayerLogical" / "HadCalLayerBox"(G4Box), 4500 cm3, 11.35 g/cm3
        - "HadCalScintiPhysical":0 / "HadCalScintiLogical" / "HadCalScintiBox"(G4Box), 900 cm3, 1.032 g/cm3

- Calculating mass(es)...
  - Overall volume of "worldPhysical":0, is 2400 m3
  - Mass of tree to unlimited depth is 22260.5 kg

New in Geant4 Visualization Since 4.7.0

- Control accumulation of hits and trajectories
    - /vis/scene/endOfEventAction
    - /vis/scene/endOfRunAction
- OpenInventor: Well supported again
    - both Linux and Windows
- OpenGL: Hidden line removal
    - /vis/viewer/set/hiddenEdge 1
        - Hide edges of geometry but trajectories show through
    - /vis/viewer/set/hiddenMarker 1
        - Hide trajectories too
- ASCITree: verbose mode prints volume and mass
- Geant4 Trajectories and Hits can be assigned additional arbitrary attributes
    - WIRED or FRED HepRep browsers can display those attributes when you click on the relevant object
    - WIRED lets you label objects by any of these attributes or cut visibility based on these attributes
    - See Examples A01 or RE01
        - Look for G4AttDef and G4AttValue

New in Geant4 Visualization Since 4.7.1

- G4VisExecutive: Simplifies selection of drivers, replaces vis managers
- Control visibility of Boolean components, voxels and readout geometry
    - /vis/specify and /vis/scene/add/logicalVolume
- Added clipping volume
    - additional parameters to /vis/scene/add/volume
- Improved command guidance
    - THE resource for complete and current information
    - README's have been removed.
- Support G4 Logo
    - /vis/scene/add/logo
- Standalone mode: the visualization system can be used on its own - without the rest of Geant4.
    - Build something "by hand" from the Geant4 geometry primitives and placement apparatus, but without any of the main parts of Geant4 such as detector construction, run manager or physics list
    - Still preserves all of the interactive apparatus of the visualization system
    - Example coming in release 4.8.0 - /examples/extended/visualization/standalone
- HepRep: more efficient representation of solids cuts file size in half

Coming in Geant4 Visualization for 4.8.0

- OpenGL: Smooth shading and Transparency

- RayTracerX - Builds same jpeg file as RayTracer, but simultaneously renders to screen so you can watch as rendering grows progressively smoother

- "/tracking/storeTrajectory 1" issued automatically for you when you do /vis/scene/add/trajectories

- /vis/viewer/scale <3 vector of scale factors>
  - Like Zoom but provides different scale factor in different directions
  - Initially will be supported by OpenGL and OpenInventor

- "Enhanced trajectory drawing" to interactively change how trajectories are modeled
  - Initial options will let you select to either color by charge, or by particle ID
    - /vis/model/trajectories/drawByCharge
    - /vis/model/trajectories/drawByParticleID
    - And then additional commands to set specific colors
  - Soon thereafter, drawByMomentum, drawByOriginLogicalVolume, etc
  - Also mechanism to let you define your own "drawBy…" class and then invoke it from the command line
  - Moved some interfaces from intercoms to graphics_reps

Tutorials - Have 3, Want More

Summary

- 7 Drivers Well Supported

- Incremental addition of new features

- No changes required in user code for 8.0

- You gotta love those new twisted solids that Oliver showed yesterday.
  - Oliver will implement DescribeYourself methods. Visualization should then be able to handle them.

- Need to explore ways to integrate at least some minimal visualization for DICOM.
  - Takashi's group have an external tool for this, but it is not something we can absorb into the Geant4 distribution itself