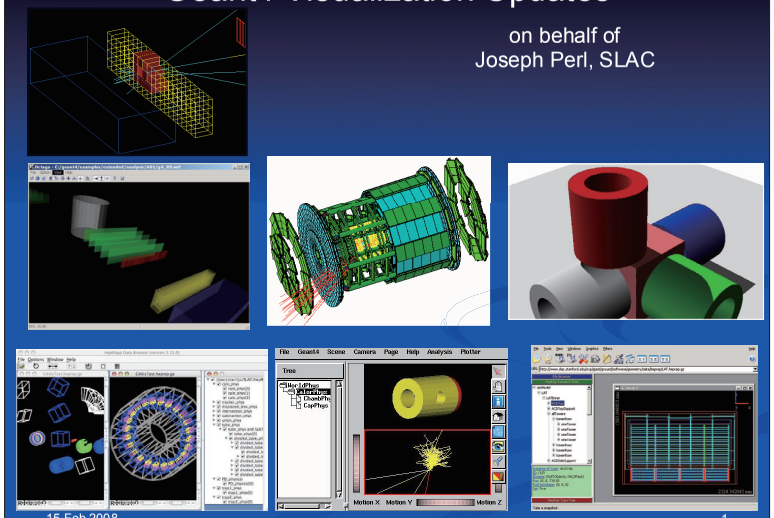
# Geant4 Visualization Updates

on behalf of
Joseph Perl, SLAC





## Contents

- Review of Visualization Drivers
- Enhanced Trajectory Drawing
  - DrawBy Models
  - Trajectory/Hit Filtering
  - Rich Trajectories
  - Smooth trajectories
- Event keeping
- Picking in OGLX
- Movies
- Volume Rendering
- Visualization of Fields



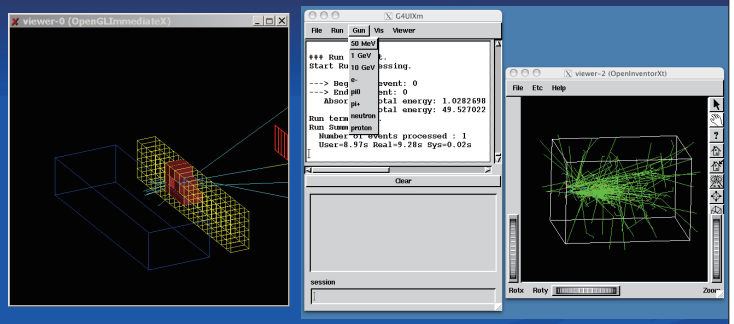
## Quick Overview of Visualization Driver Choices

- Geant4 comes with Seven families of visualization drivers:
  - OpenGL
  - OpenInventor
  - HepRep
  - DAWN
  - VRML
  - RayTracer
  - ASCIITree
- Just quick overview slides here.
  See references section for talks with more detail on individual drivers and commands.
- Different drivers are appropriate for different needs
- The set of commands the user sees are consistent regardless of the driver



## Quick response with flexible camera control to study geometries, trajectories and hits

- OpenGL and OpenInventor



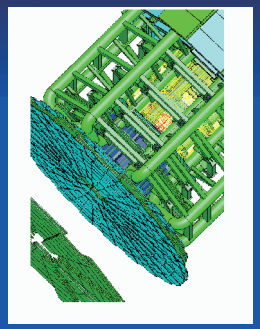
- Widely available world standards for fast, photo-realistic rendering.

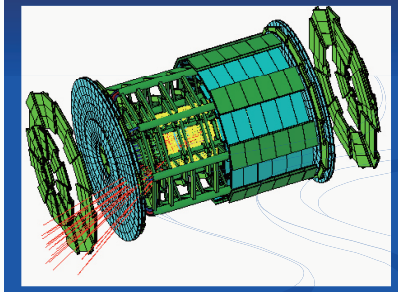


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## High-quality Output for Publications

- DAWN



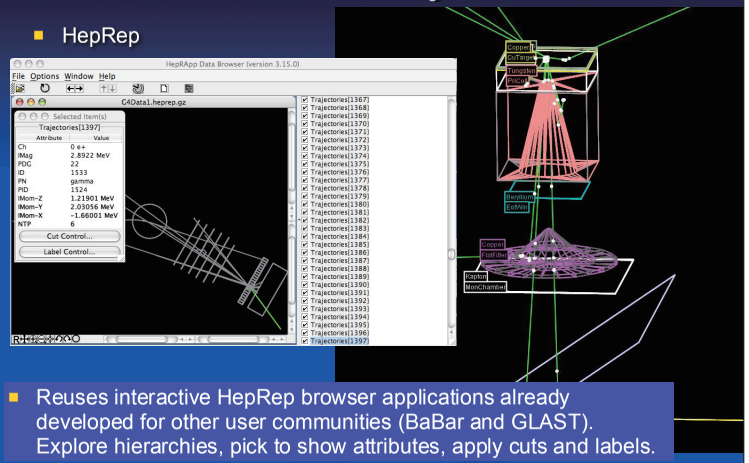


- Developed specifically for Geant4. Not fast, but the highest quality rendering available anywhere. Excellent for publications.



## Interactive Picking to Get More Information on Visualized Objects

- HepRep

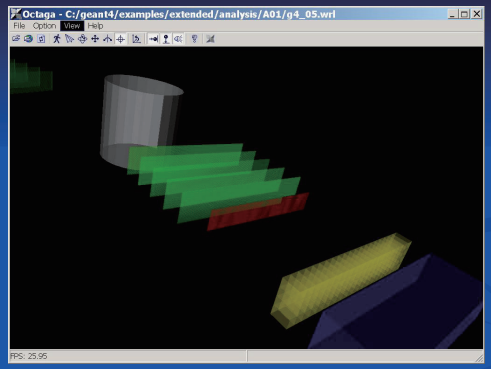


- Reuses interactive HepRep browser applications already developed for other user communities (BaBar and GLAST). Explore hierarchies, pick to show attributes, apply cuts and labels.



## 3D Format Suitable for Web Distribution

- VRML

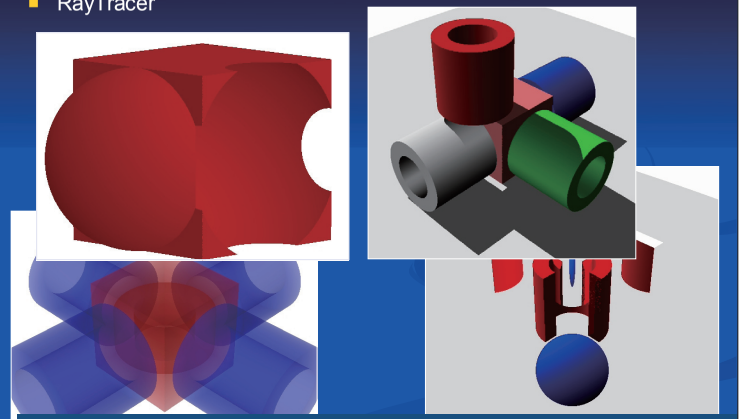



- Many VRML browsers available, some as web plug-ins



## Understand Complex Boolean Solids and Transparent or Reflective Surfaces

- RayTracer



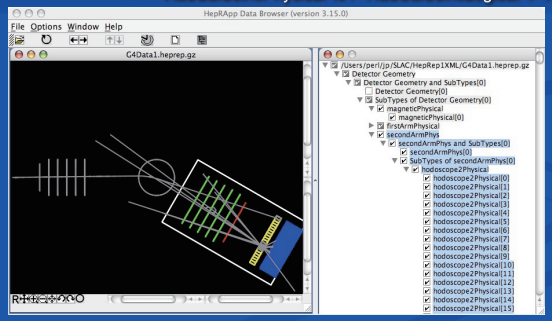
- Reuses Geant4's own tracking to shoot photons through the geometry



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## Tools to Understand Geometry Hierarchies

- ASCIITree, HepRep
  - /vis/ASCIITree/Verbose 4
  - /vis/viewer/flush
  - "HadCalorimeterPhysical":0 / "HadCalorimeterLogical" / "HadCalorimeterBox"(G4Box), 1.8 m3 ,
    - "HadCalColumnPhysical":-1 (10 replicas) / "HadCalColumnLogical" / "HadCalColumnBox"(
      - "HadCalCellPhysical":-1 (2 replicas) / "HadCalCellLogical" / "HadCalCellBox"(G4Box)
        - "HadCalLayerPhysical":-1 (20 replicas) / "HadCalLayerLogical" / "HadCalLayerB
          - "HadCalScintiPhysical":0 / "HadCalScintiLogical" / "HadCalScintiBox"(G4Bo

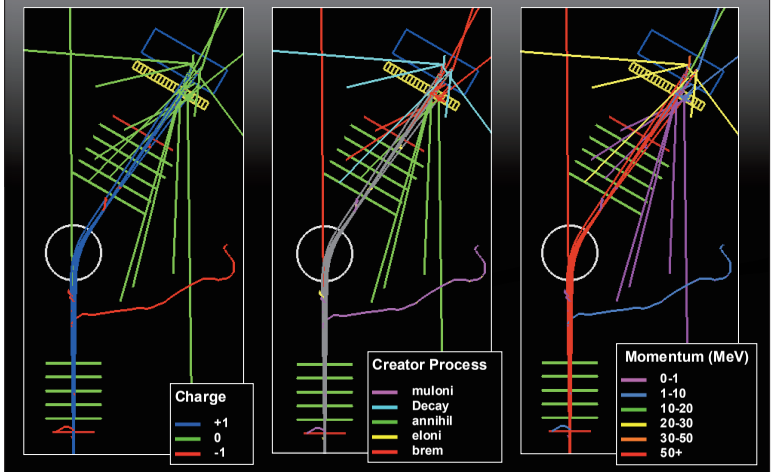





## RECENTLY UPDATED FEATURES

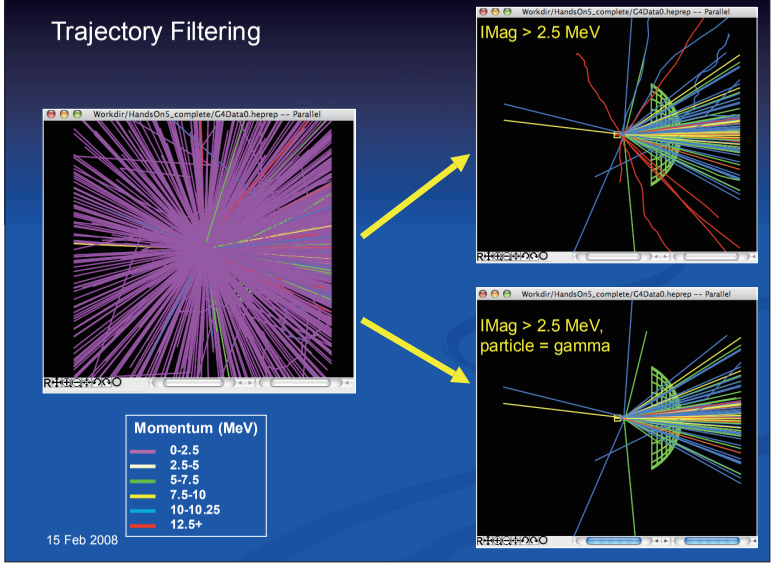


## Trajectory Drawing By Various Models






## Trajectory Filtering





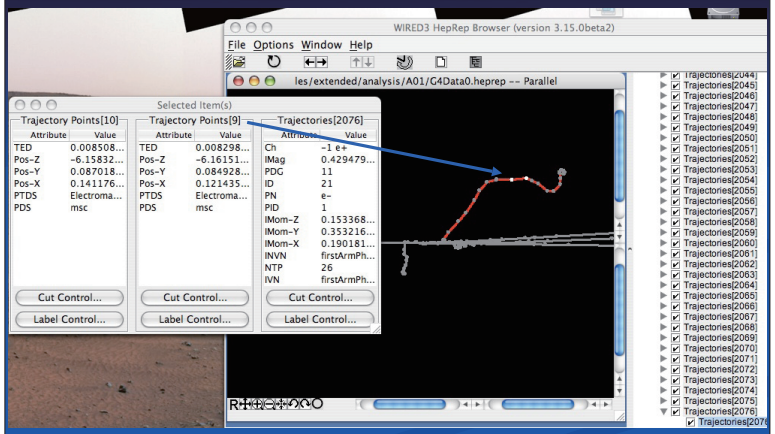

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## Extra Information Available from the Trajectory

- Most users use the standard G4Trajectory
  - Rich Trajectory encodes additional information at every step point
  - Smooth Trajectory adds auxiliary points to allow smoother line in visualization (not Geant4 Steps, no physics at auxiliary points)
    - Useful when trajectories are highly curved due to magnetic fields
- Control via:
  - /vis/scene/add/trajectories
  - /vis/scene/add/trajectories rich
  - /vis/scene/add/trajectories smooth
  - /vis/scene/add/trajectories smooth rich
- If you actually want to display the trajectory points, you need to issue the appropriate trajectory modeling commands, such as:
  - /vis/modeling/trajectories/create/generic
  - /vis/modeling/trajectories/generic-0/default/setDrawStepPts true
  - /vis/modeling/trajectories/generic-0/default/setStepPtsSize 16
  - /vis/modeling/trajectories/generic-0/default/setStepPtsColour red

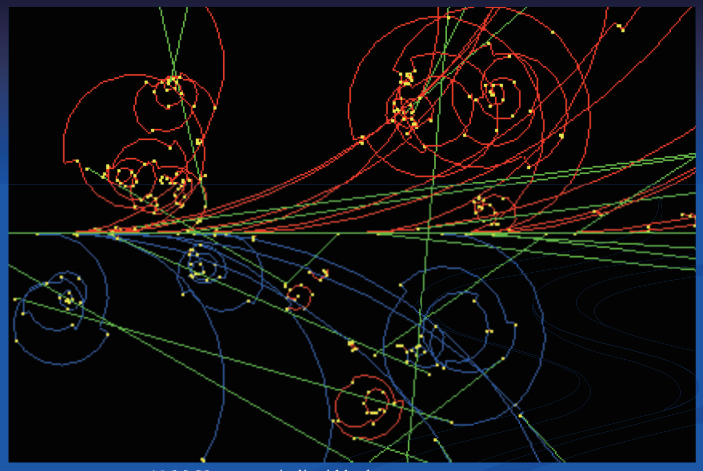


## Rich Trajectory Has Details on Every Step Point






## Smooth Trajectory



10 MeV gammas in liquid hydrogen



## Event keeping

Put something like this in EndOfEventAction:

```
if (energyDepositedThisEvent) {
   G4EventManager* em = G4EventManager::GetEventManager();
   em->KeepTheCurrentEvent();
}
```

At end of run, this is printed (`/vis/verbose confirmations`):

```
To see all events: "/vis/scene/endOfEventAction accumulate".
To see events individually: "/vis/reviewKeptEvents".

Idle> /vis/reviewKeptEvents
Drawing event : 0.  At EndOfEvent, enter any command, then "cont
[inue]"...
  Useful commands might be:
    "/vis/viewer/..." to change the view (zoom, set/viewpoint,...).
    "/vis/oglx/printEPS" to get hard copy.
    "/vis/open" to get alternative viewer.
    "/vis/abortReviewKeptEvents", then "cont[inue]", to abort.
```



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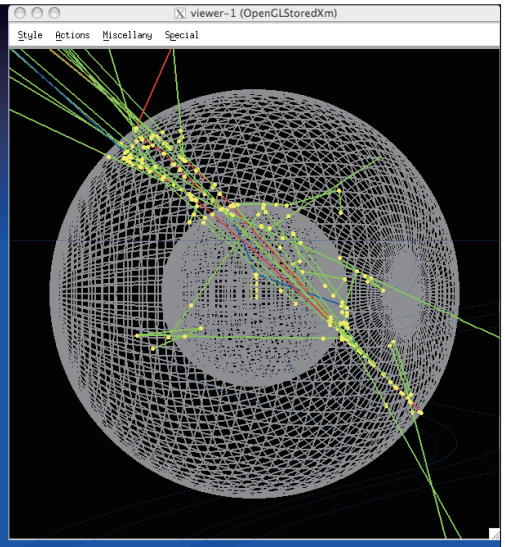
Hollow aluminium sphere

Silicon detector in centre (vertical yellow line)

A 500 MeV electron enters at 5 o'clock, showers

Positron (blue) produced near inner radius, scatters of detector

Event approx. 1 in 10,000 caught by event keeping




15 Feb 2008 17

# Picking in OGLX

- Picking has been available in Open Inventor for some time
- Information now augmented
- Extended to OpenGL X Windows (not Xm nor Win32 at present)

```
/vis/open OGLSX
/vis/viewer/set/picking
/run/beamOn
/vis/viewer/flush
Window activated for picking (left-mouse), exit
(middle-mouse).
```

15 Feb 2008 18

Picking a geometry item

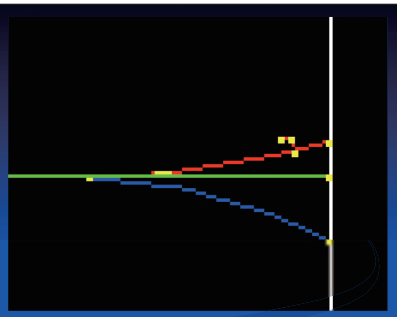
```
G4PhysicalVolumeModel:
Physical Volume Path (PVPath): World:0
Logical Volume (LVol): World
Solid Name (Solid): World
Entity Type (EType): G4Box
Dump of Solid properties (DmpSol):
-------------------------------------------------------------
    *** Dump for solid - World ***
    ===================================================
 Solid type: G4Box
 Parameters:
    half length X: 90 mm
    half length Y: 60 mm
    half length Z: 60 mm
-------------------------------------------------------------

Transformation of volume (Trans):
         1         0         0         0
         0         1         0         0
         0         0         1         0
= translation:
         0         0         0
* rotation:
         1         0         0
         0         1         0
         0         0         1
* scale:
         1         1         1
Transformed axes:
x': (1,0,0)
y': (0,1,0)
z': (0,0,1)

Material Name (Material): LigH
Material Density (Density): 70.8 mg/cm3 (G4BestUnit)
Material State (enum undefined,solid,liquid,gas) (State): 2
Material Radiation Length (Radlen): 8.92265 m    (G4BestUnit)
Cuts Region (Region): DefaultRegionForTheWorld
Root Region (0/1 = false/true) (RootRegion): 1
```

15 Feb 2008 19

Picking a trajectory



```
G4SmoothTrajectory:
Track ID (ID): 3
Parent ID (PID): 1
Particle Name (PN): e+
Charge (Ch): 1 (e+)
PDG Encoding (PDG): -11
Momentum of track at start of trajectory (IMom): 19.3297 -0.453169 -0.0373853 MeV (G4BestUnit)
Magnitude of momentum of track at start of trajectory (IMag): 19.3351 MeV (G4BestUnit)
No. of points (NTP): 4
G4SmoothTrajectoryPoint:
Step Position (Pos): 6.10648 0 0 cm  (G4BestUnit)
G4SmoothTrajectoryPoint:
Step Position (Pos): 6.10648 0 0 cm  (G4BestUnit)
G4SmoothTrajectoryPoint:
Auxiliary Point Position (Aux): 7.21394 -0.122231 -0.00215702 cm  (G4BestUnit)
Auxiliary Point Position (Aux): 8.30189 -0.440266 -0.00435151 cm  (G4BestUnit)
Auxiliary Point Position (Aux): 8.98888 -0.756201 -0.00581442 cm  (G4BestUnit)
Step Position (Pos): 8.98888 -0.756201 -0.00581442 cm  (G4BestUnit)
G4SmoothTrajectoryPoint:
Step Position (Pos): 9 -0.762237 -0.00590675 cm  (G4BestUnit)
```

15 Feb 2008 20

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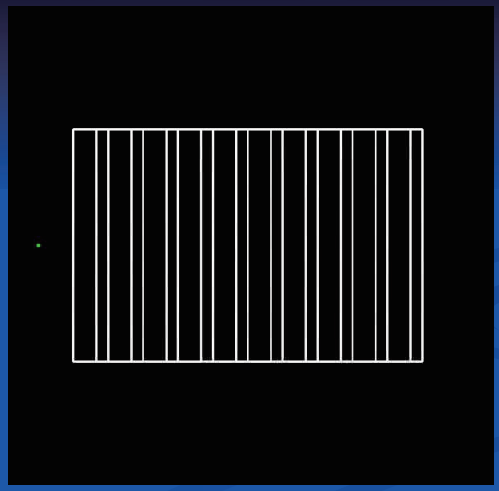
## Movies: Stitched Together from Multiple Stills



http://www.hep.man.ac.uk/u/johna/pub/Geant4/Movies/g4RayTracer.mpg



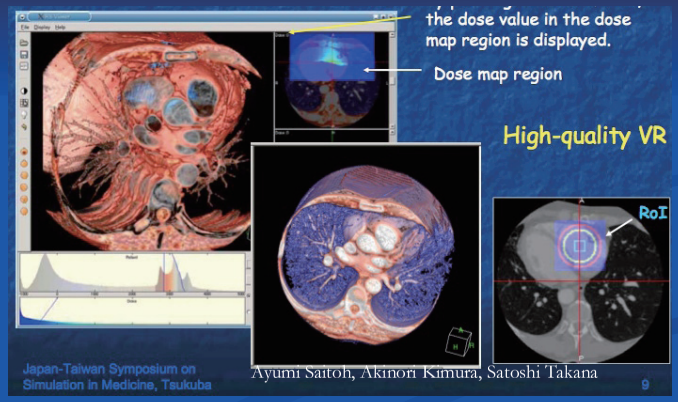
## Movies: Live from Geant4 OpenGL





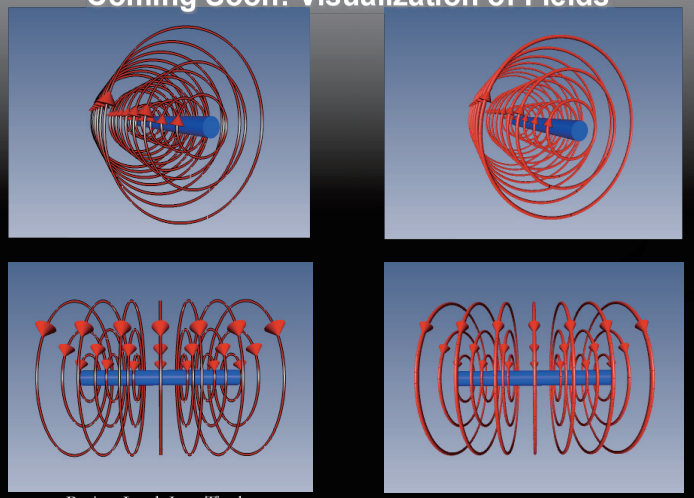
## gMocren - to Visualization Volume Data

- Geant4 has been interfaced to a commercial tool for visualization of voxel data.
- Free to all Geant4 users.
- Does not actually function as integral part of the Geant4 visualization system.
  - Implemented as a G4 example, outputs data in form appropriate for gMocren






## Coming Soon: Visualization of Fields



Project Lead: Jane Tinslay



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# References and Further Resources



# Geant4 Visualization Resources

Geant4 Installation Guides
- http://geant4.slac.stanford.edu/installation

Hands on HepRApp Tutorial
- http://geant4.slac.stanford.edu/Presentations/vis/G4HepRAppTutorial/G4HepRAppTutorial.html

Hands on DAWN Tutorial
- http://geant4.slac.stanford.edu/Presentations/vis/G4DAWNTutorial/G4DAWNTutorial.html

Hands on OpenGL Tutorial
- http://geant4.slac.stanford.edu/Presentations/vis/G4OpenGLTutorial/G4OpenGLTutorial.html

Introduction to Geant4 Visualization
- http://geant4.slac.stanford.edu/Presentations/vis/G4VisIntroduction.ppt (and .pdf)

Geant4 Visualization Commands
- http://geant4.slac.stanford.edu/Presentations/vis/G4VisCommands.ppt (and .pdf)

Geant4 Advanced Visualization
- http://geant4.slac.stanford.edu/Presentations/vis/G4VisAdvanced.ppt (and .pdf)

How to Make a Movie
- http://geant4.slac.stanford.edu/Presentations/vis/HowToMakeAMovie.ppt (and .pdf)

Visualization Chapter of the Geant4 User's Guide for Application Developers
- http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/

List of Visualization Commands:
- http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/AllResources/Control/UIcommands/_vis_.html

For Questions or Comments: Geant4 Visualization Online Forum:
- http://geant4-hn.slac.stanford.edu:5090/HyperNews/public/get/visualization.html



# References


- OpenScientist Home Page
  http://openscientist.lal.in2p3.fr
- HepRep: a generic interface definition for HEP event display representables
  http://www.slac.stanford.edu/~perl/heprep
- HepRApp HepRep Browser
  http://www.slac.stanford.edu/~perl/HepRApp
- Wired4 JAS Plug-In
  http://wired.freehep.org
- Fred: oh no, another event display (a HepRep client)
  http://www.fisica.uniud.it/~glast/FRED
- DAWN Home Page
  http://geant4.kek.jp/~tanaka/DAWN/About_DAWN.html
- DAWNCUT Home Page
  http://geant4.kek.jp/~tanaka/DAWN/About_DAWNCUT.html
- DAVID Home Page
  http://geant4.kek.jp/~tanaka/DAWN/About_DAVID.html
- Satoshi Tanaka's GEANT4 Ritsumeikan University Group Home Page (more information on DAWN, sample PRIM files, images, etc.)
  http://geant4.kek.jp/~tanaka/




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