

Geant4 Visualization Tutorial using the DAWN Event Display

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Introduction

This tutorial is designed for anyone who wants to learn DAWN Visualization for Geant4.

This tutorial can be used on its own, but gives the most comprehensive introduction to Geant4 visualization when used as part of the following full set of documents:

- [Geant4 Installation Guides](#)
- Introduction to Geant4 Visualization ([ppt](#), [pdf](#))
- [Geant4 Visualization Tutorial using the HepRApp HepRep Browser](#)
- [Geant4 Visualization Tutorial using the DAWN Event Display](#)
- [Geant4 Visualization Tutorial using the OpenGL Event Display](#)
- Geant4 Visualization Commands ([ppt](#), [pdf](#))
- Geant4 Advanced Visualization ([ppt](#), [pdf](#))

When you run Geant4 visualization using

```
/vis/open DAWNFILE
```

Your output comes in a graphics file in a format called .prim suitable for viewing with the DAWN Event Display. This visualization tutorial will show you how to use the DAWN Event Display to view that file (or an equivalent file included with this tutorial - see details later).

DAWN's full name is "Fukui Renderer DAWN (Drawer for Academic WritiNgs)". It was created by Satoshi Tanaka as a vectorized 3D PostScript processor with analytical hidden line/surface removal intended for precise technical drawing of complicated objects. Designed specifically for Geant4, DAWN calculates all visible parts of the 3D data before drawing and then produces device-independent vectorized graphics for high quality technical applications.

DAWN is a C++ application that in turn relies on the Tcl/Tk control language and gui toolkit. DAWN sends output for viewing either to a PostScript file, or directly to a PostScript viewer, or to an OpenGL viewer. Since the purpose of this tutorial is just to give you a quick feel for the power of DAWN, this tutorial will focus on just one of those modes, the easiest one to set up, sending output to a PostScript file. For information on the other modes, and for more complete and up to date information on other DAWN topics, see the DAWN Home Page at: http://geant4.kek.jp/~tanaka/DAWN/About_DAWN.html

The .prim File

DAWN's input is something called a .prim file. The .prim file is a plain text file format that contains a full 3D description of what is to be drawn (geometry, trajectories, hits, markers - depending on what you chose to add from Geant4) plus visualization attributes (such as color and linestyle).

You don't really need to understand the details of the .prim file format to use DAWN, but in case you are interested:

- The .prim file is a simple, flat file format (no hierarchy of objects).
- Because the .prim file format was created specifically for Geant4, it has the same set of graphics primitives as Geant4.
- The .prim format is further described at: [The DAWN Format Manual](#)

The .prim file format is fairly easy to understand just by looking at it. Here are some lines from one

example:

```
##G4.PRIM-FORMAT-2.4

##### List of primitives 1 #####
/BoundingBox -1.0 -1.0 -5.0 8.0 4.0 6.0
!SetCamera
!OpenDevice
!BeginModeling

# Box
/Origin 0.0 0.0 0.0
/ColorRGB 1.0 0.0 0.0
/Box 0.5 2.0 4.5

# Column
/Origin 4.0 0.0 0.0
/ColorRGB 0.0 1.0 0.0
/Ndiv 50
/Column 1.5 2.0

# Trd
/Origin 0.0 0.0 0.0
/ColorRGB 0.0 1.0 1.0
/Origin 7.0 0.0 0.0
/Trd 1 0.5 1 0.5 4

# Cone segment
/Origin 1.0 5.0 0.0
/ColorRGB 0.0 1.0 1.0
```

If you have not yet produced your own .prim file, this might be a good time to do so.

You can also skip running Geant4 for now and instead find a copy of this file [here](#).

The commands to generate a .prim file from a typical example such as example A01 are:

```
$G4BIN/A01app
/vis/open DAWNFILE
/vis/drawVolume
/vis/viewer/flush
/vis/scene/add/trajectories
/vis/scene/add/hits
/run/beamOn 1
```

At the first "/vis/viewer/flush", a .prim file is produced that contains only detector geometry.

At the "/run/beamOn 1", a second .prim file is produced that contains geometry plus trajectories and hits. This file is produced because the "/run/beamOn" automatically does a "/vis/viewer/flush".

Other commands that might be useful are discussed in this document's section called [Further Resources](#). Ignore any commands related to setting camera views, lighting or surface style. Those commands are only relevant to an immediate visualization driver such as OpenGL. When you work with a driver such as DAWN that has a 3D file format, you set these things later, from the visualization application, DAWN.

Installation

This tutorial assumes you have already done a basic Geant4 installation. If you need help with that, see the [Geant4 Installation Guides](#).

Before continuing with this DAWN tutorial, make sure you have the following underlying software:

- Linux/UNIX/Mac with X-Windows or Windows XP/2000/NT/98
- The Tcl/Tk Command Language and GUI Toolkit
- A PostScript viewer such as gsvie

Free versions of Tcl/Tk and gsvie are available.

Installing Tcl/Tk on Mac

Use the Tcl/Tk prebuild disk image from:

- <http://www.activestate.com/Products/Download/Download.plex?id=ActiveTcl>

Select Mac OS X (Universal) and follow the prompts for standard Mac DMG installation.

Installing Tcl/Tk on Linux/Unix

Use the Tcl/Tk source code from:

- <http://www.activestate.com/Products/Download/Download.plex?id=ActiveTcl>

The download is a tar-gzipped archive. Unzip and Untar it as follows;

```
gtar zxf /path/to/ActiveTcl-download.tar.gz
```

Run ActiveTcl-linux/install.sh, which will select between a GUI or text-based installer. It uses the GUI version when it can connect to a display (requires local X installation).

After installation, make sure that the path to the installed executables is placed on your path. (Thanks to the [ActiveState](#) company for these instructions.)

Installing Tcl/Tk on Windows

Use the Tcl/Tk source code from:

- <http://www.activestate.com/Products/Download/Download.plex?id=ActiveTcl>

The download is a self-extracting and installing executable. It is also a ZIP file should you choose to unzip it.

Run the install.bat to install ActiveTcl. On Windows 95/98/ME, ActiveTcl will not place the tclsh and wish on your path, although it will associate .tcl files to wish.

If the ActiveTcl installer complains that it cannot find the ActiveTcl package when trying to run, it is likely that the TCL_LIBRARY variable is set in your environment (the Ruby language does this, for example). This is an unnecessary setting, and should be removed. Windows 9* users can remove the entry from their 'autoexec.bat' file, and Windows NT/2000/XP users can remove it from the Environment Settings (right click on "My Computer"; select "Properties", go to the "Advanced" tab and select "Environment Variables..."). Windows 9* users may have to reboot to force the system to recognize the change in settings. Otherwise, just restart the Explorer or DOS shell and run the self-extracting executable again. (Thanks to the [ActiveState](#) company for these instructions.)

Installing gsview and ghostscript on Mac

This step is not necessary on the Mac. Appropriate tools are already included in the X11 part of XCode.

Installing gsview and ghostscript on Linux/Unix

Use the gstools source code from:

- <http://www.cs.wisc.edu/~ghost>

The download is a tar-gzipped archive. Unzip and Untar it as follows;

```
gtar zxf /path/to/ghostscript-8.54-gpl.tar.gz
```

You will also need gsview-4.8-1.i386.rpm (obtain and unpack the same way)

Installing gsview and ghostscript on Windows

Use the gstools source code from:

- <http://www.cs.wisc.edu/~ghost>

Obtain and run the self-extracting gs854w32-gpls.exe

Obtain and run the self-extracting gsv48w32.exe

Installing DAWN on Linux/Unix/Mac

You will need a C++ compiler and a make utility to proceed on this platform.

Use the DAWN source code from the main DAWN repository:

- http://geant4.kek.jp/~tanaka/src/dawn_3_88a.taz

Unzip and Untar the file:

```
tar -zxvf dawn_3_88a.taz
```

You should then have a directory called dawn_3_88a.

- For Mac OSX 10.5, replace the file named "Makefile" in that directory with the version you can find [here](#)
- For Ubuntu, replace the file named "Makefile" in that directory with the version you can find [here](#)
- For other Unix/Linux/Mac versions, the existing Makefile should be OK

Proceed as follows:

```
cd dawn_3_88a
make clean
make guiclean
make
```

You should then see a file called simply "dawn".

Last step is to put the DAWN directory into your command path, using something like:

```
export PATH=<my_dawn_directory>:$PATH$
```

DAWN is ready to run.

Installing DAWN on Windows

DAWN is available for Windows as a precompiled binary. There is no need to compile.

Use the DAWN Windows binary from:

- <http://geant4.kek.jp/~tanaka/src/WinDAWN385cBin.taz>

Unzip and untar the file:

```
tar -zxvf WinDAWN385cBin.taz
```

You should then have a directory called WinDAWN385cBin. This contains the executable, dawn.exe, and some related files.

Windows users need to add one more file to that directory (already included in the Linux/Unix/Mac version). Get the file prim1.prim from [here](#).

Finally, add some more example prim files into your WinDAWN385cBin directory as follows. Take the file primdata.taz from [here](#) and insert it into your WinDAWN385cBin directory. Then unzip and untar the file:

```
tar -zxvf primdata.taz
```

You will now have a subdirectory called PRIM_DATA.

Last step is to put the DAWN directory into your command path, using something like:

```
set PATH=<my_dawn_directory>;$PATH$
```

DAWN is ready to run.

If you have any problems running DAWN on Windows, it may be that your pre-existing command path contains some conflicting code. Try simplifying your path to something like:

```
set PATH=C:\program files\gstools\gsview;C:\Tcl\bin;C:\WINNT\system32;C:\WINNT;C:\WINNT\System32\Wbem;c:\program files\dawn;
```

Running DAWN

The executable is in the directory "dawn_3_88a" (Linux/Unix/Mac) or "WinDAWN385cBin" (Windows).

Set a command window to that directory and then run DAWN on a simple prim file example by typing:

```
dawn prim1.prim
```

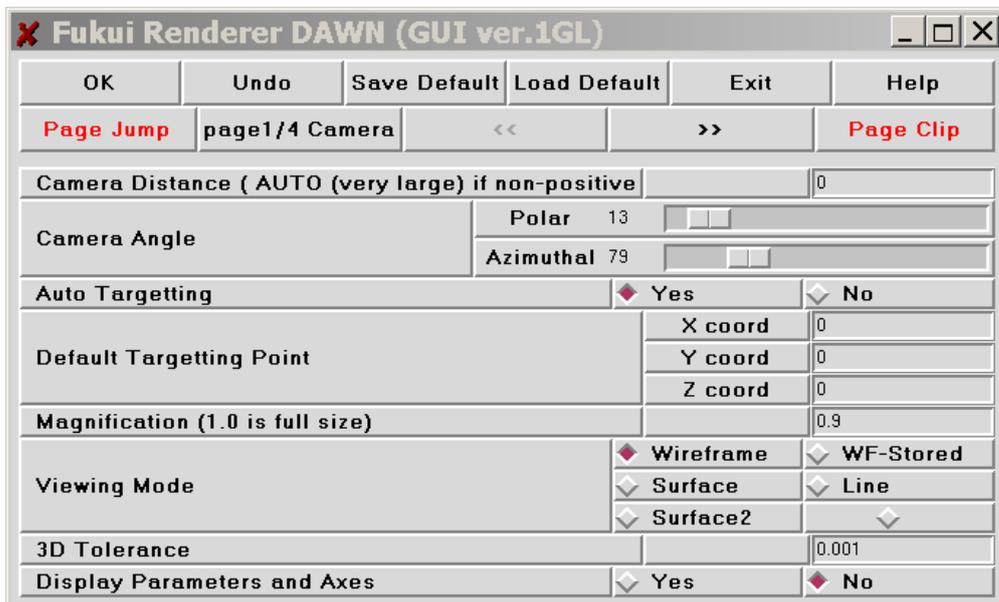
The console should respond with:

```
perl@noric10 $ dawn prim1.prim
```

```
*****
      Fukui  Renderer
          DAWN
(Drawer for Academic Writings)
ver 3.85...
*****
```

```
**** g4.prim viewer mode (default)
**** ("dawn -h" for help)
```

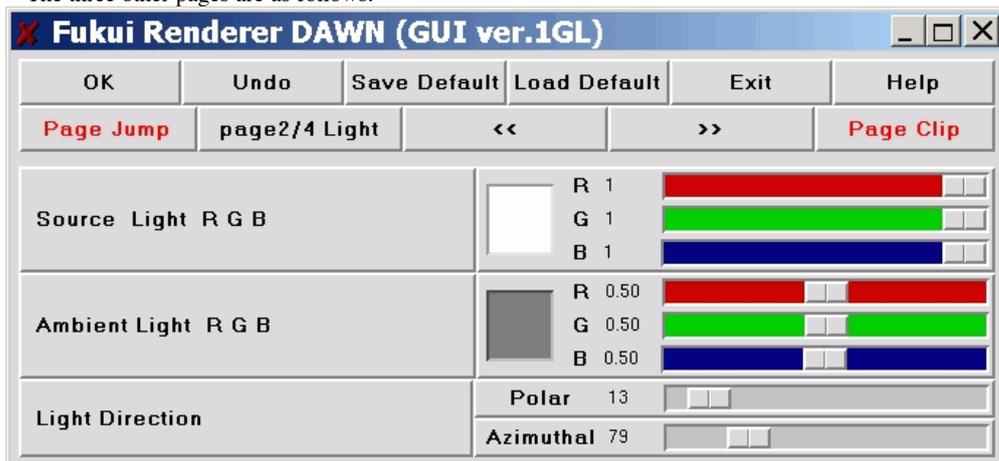
and the DAWN window should appear:

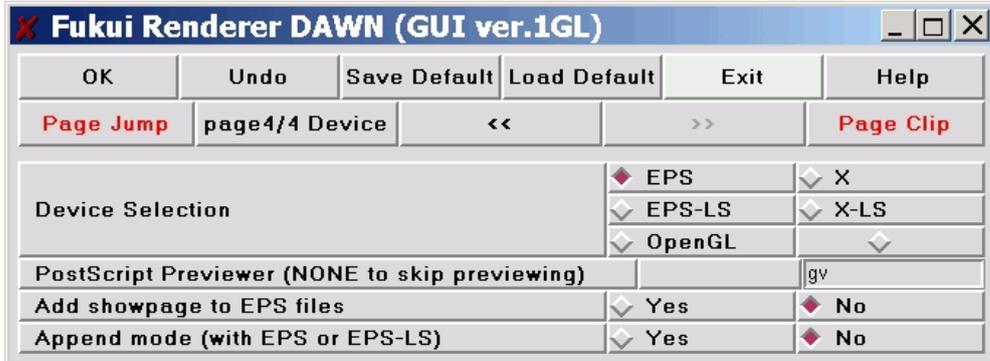
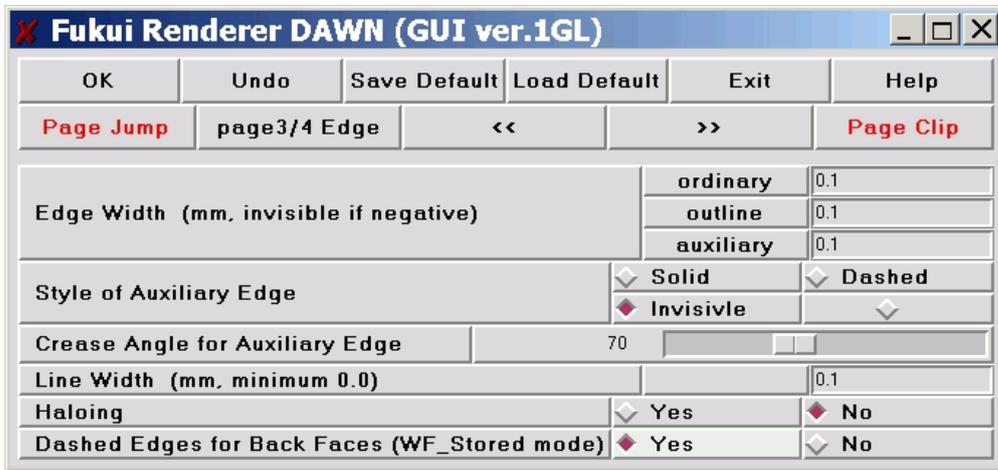


- The DAWN GUI has problems on recent Windows versions. It crashes on startup. We are currently waiting for a fixed version, but for now there is no workaround.
 - Though the GUI doesn't work, DAWN will still create a PostScript file.
 - What you lose is the ability to manipulate the camera, lighting and other settings from the DAWN GUI.
 - You can still manipulate these settings, but must do it directly in Geant4 (from commands such as `/vis/viewer/set/viewPointThetaPhi`) before you generate the PRIM file.
- Note that DAWN remembers parameter settings and GUI settings from one session to the next, so the next time you start DAWN, the GUI may look a little different from what you see above (depending on how you had things when you last exited DAWN).
- The DAWN GUI has several different "pages". To change from one page to another, use the arrow buttons from the second line of the GUI:



- The three other pages are as follows:

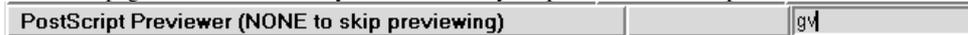




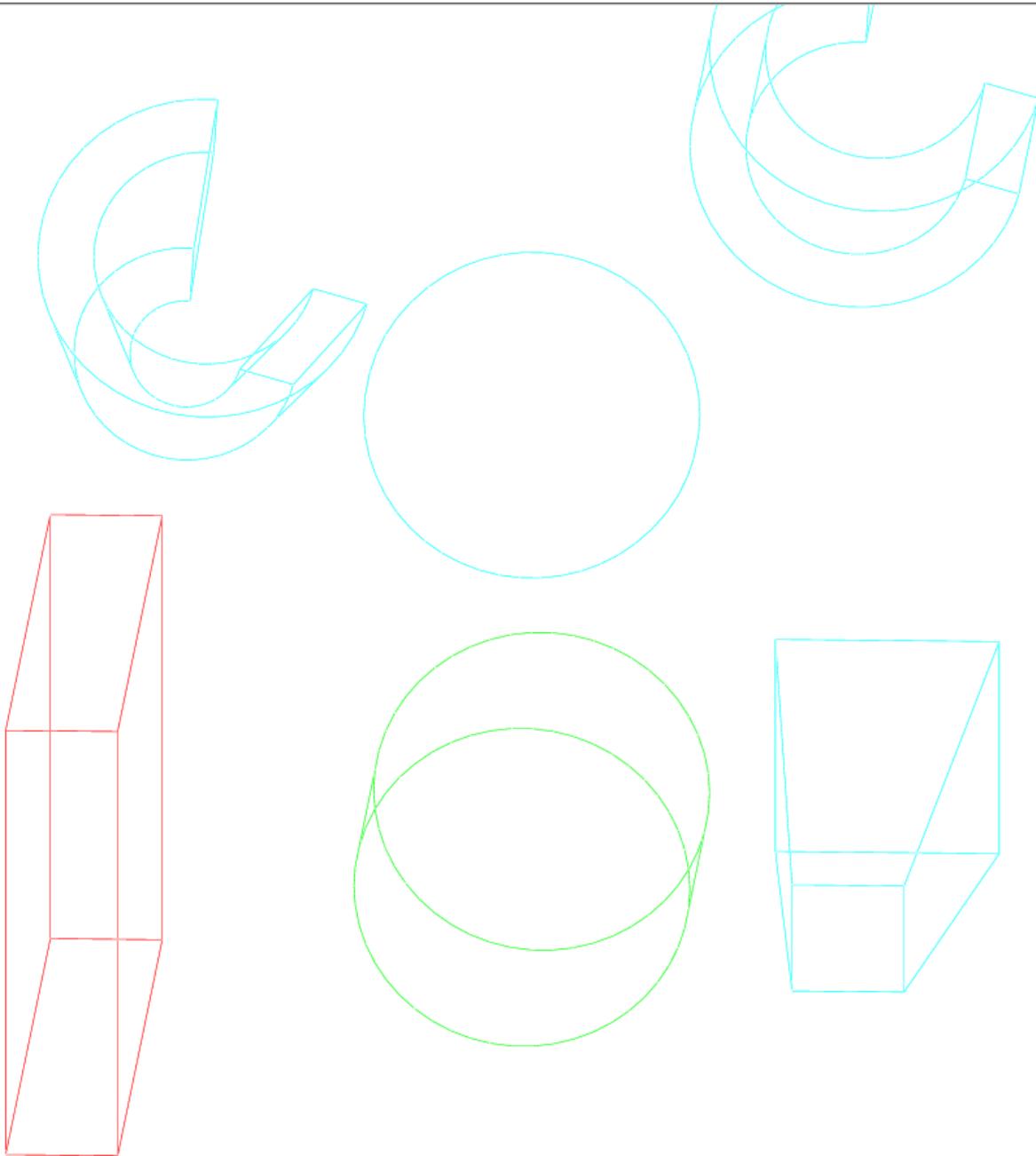
- For a first example, just go to page 4 and change "Device Selection" to "Eps":



- Also on page 4 is an area where you can indicate your preferred "PostScript Previewer".



- DAWN will know how to automatically bring up new images in your PostScript viewer if you fill this in with the name of the command that you use to view PostScript, such as "gv".
- Mac users, specify the version of gs already included in your X11 installation: /usr/local/bin/gs
- If you instead leave this blank, then DAWN will still generate PostScript output, but you will have to run the PostScript viewer by hand to actually view that file.
- Then from the top left corner of any page, select "OK".
- A file should be created with the name "prim1.eps".
- If you specified a valid "PostScript Previewer" on page 4, your PostScript viewer will automatically run. Otherwise, just start it by hand, typing something like:
gv prim1.eps
- You should then see the DAWN image:



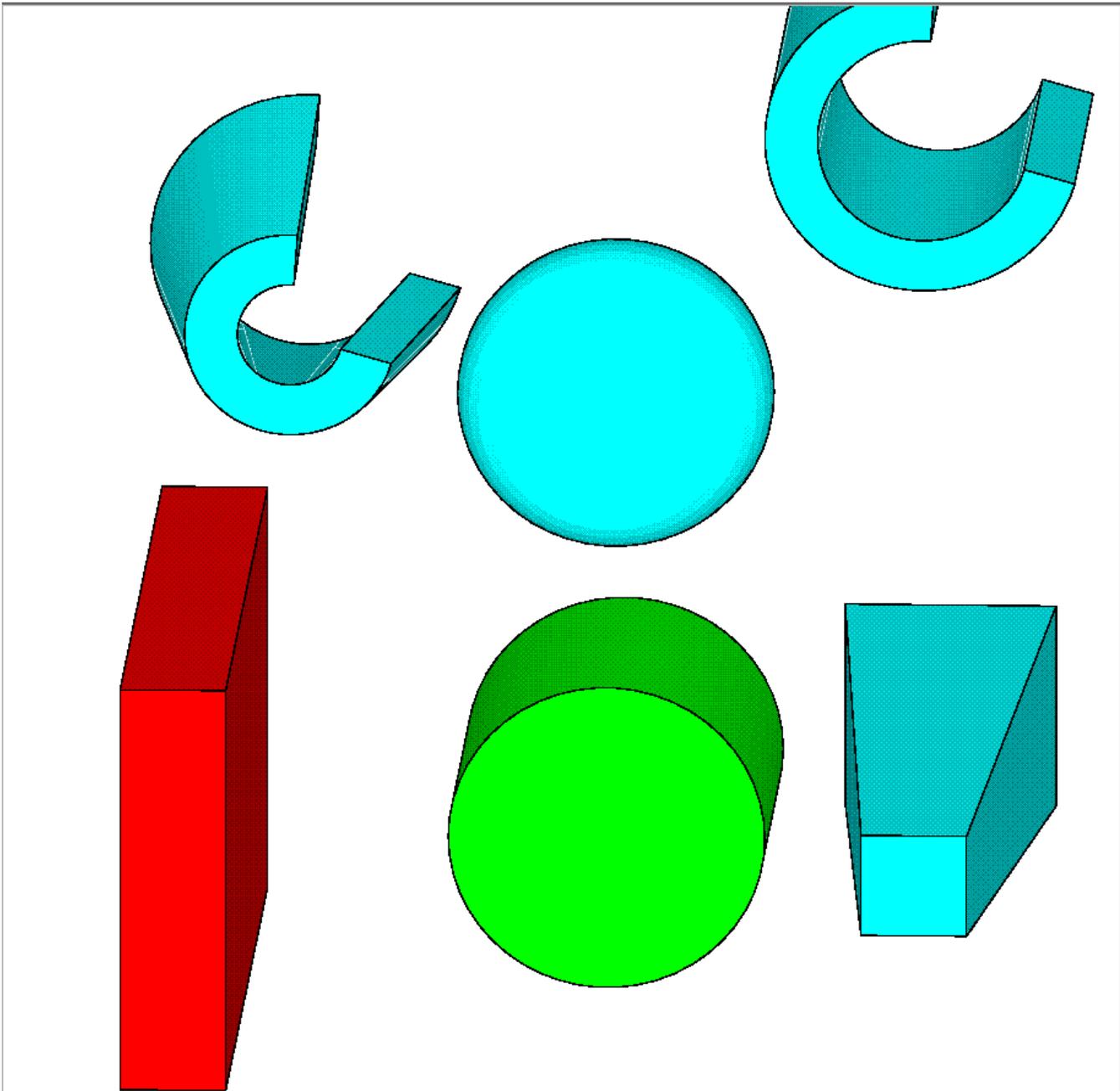
- Remember that DAWN remembers your settings from one session to the next. This means that until you tell it otherwise, it will continue come up showing page 4 and will continue to use the "Device Selection" of "Eps".
- Start DAWN again:

```
dawn prim1.prim
```

- Go to the DAWN GUI's page 1 and change the "Viewing Mode" to "Surface":



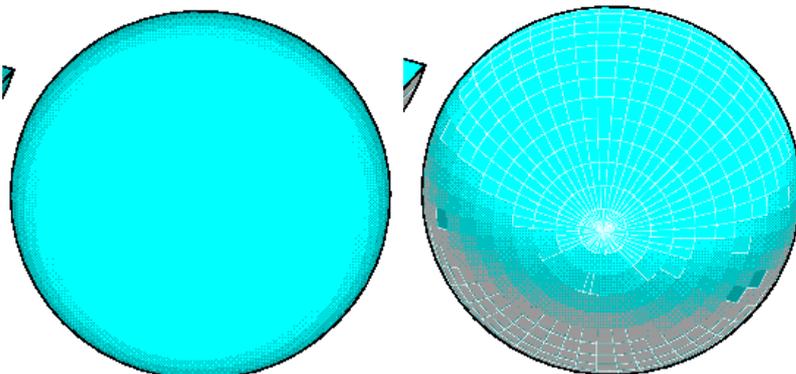
- Then from the top left corner of any page, select "OK".
- A new file should be created with the same name as before, "prim1.eps".
- If you specified a valid "PostScript Previewer" on page 4, your PostScript viewer will automatically run. Otherwise, just start it by hand, typing something like:
gv prim1.eps
- You should then see the previous DAWN image as surfaces rather than wireframe:



- Start DAWN again, and this time try making a change on the lighting control page, page 2. Specifically, change the "Light Direction" "Polar" angle from its previous value of 13 to a new value of 54.5.

Light Direction	Polar	54.5	<input type="text"/>
	Azimuthal	79	<input type="text"/>

- The light that previous shone from the front will now shine from the top. We show here just how the sphere part of the picture looks in the two different lighting setups:



- This first prim file we've been using is really too simple to showcase DAWN's powerful drawing abilities. Many more prim data examples are in the PRIM_DATA subdirectory.
- For example, try:

```
dawn PRIMDATA/pixel_cut0100.prim
```

Let the "Lighting Direction" "Polar" angle back to 13, and hit "OK".

Because this is a large prim file, DAWN will take a few minutes to process during which you will see console messages such as:

```
***** 250 primitive are processed
***** 500 primitive are processed
***** 750 primitive are processed
***** 1000 primitive are processed
***** 1250 primitive are processed
```

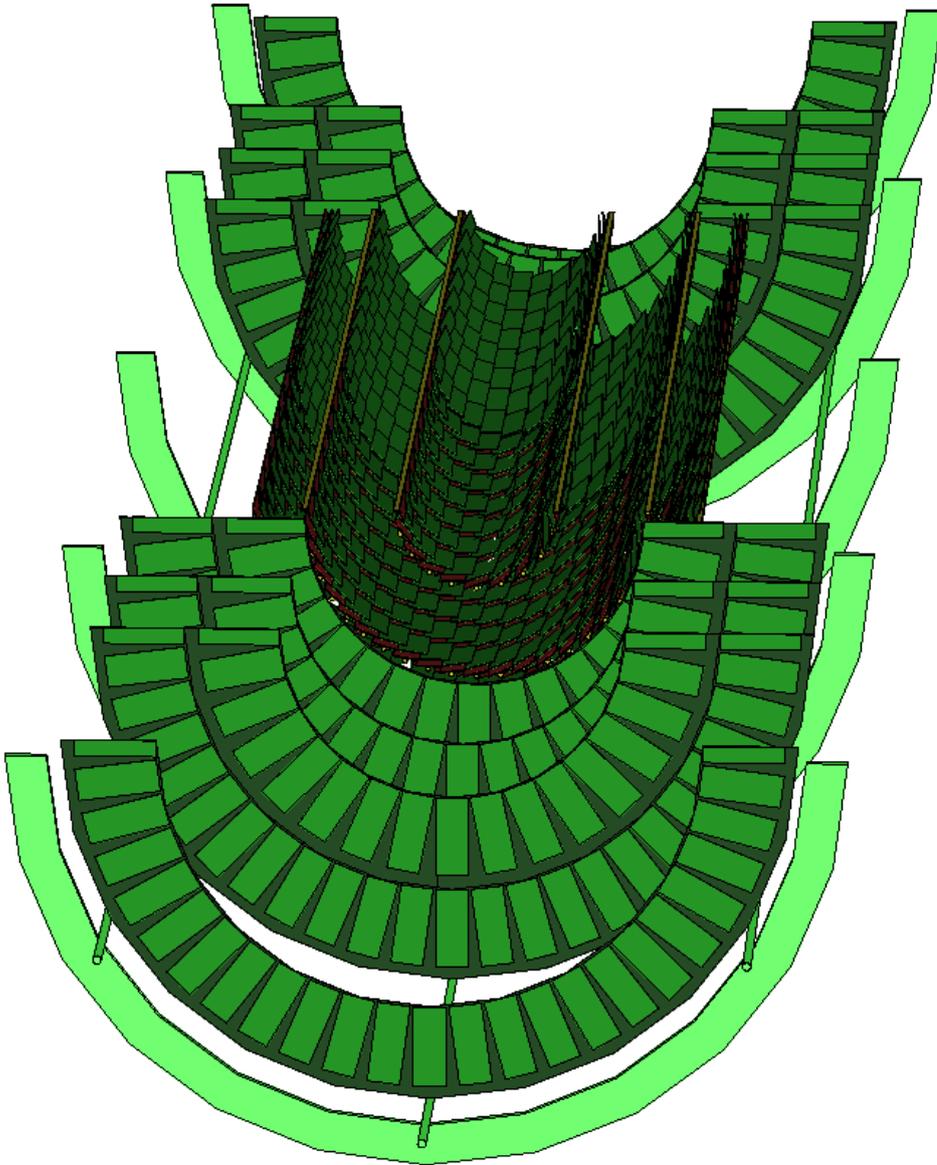
```
-----
upto OBJECT 1414 "POLYHEDRON": Eliminating hidden parts of facets ...
-----
```

```
***** upto OBJECT 1414: 500 polygons are processed ( 9 % )
***** upto OBJECT 1414: 1000 polygons are processed ( 19 % )
***** upto OBJECT 1414: 1500 polygons are processed ( 29 % )
***** upto OBJECT 1414: 2000 polygons are processed ( 39 % )
***** upto OBJECT 1414: 2500 polygons are processed ( 49 % )
***** upto OBJECT 1414: 3000 polygons are processed ( 59 % )
***** upto OBJECT 1414: 3500 polygons are processed ( 69 % )
```

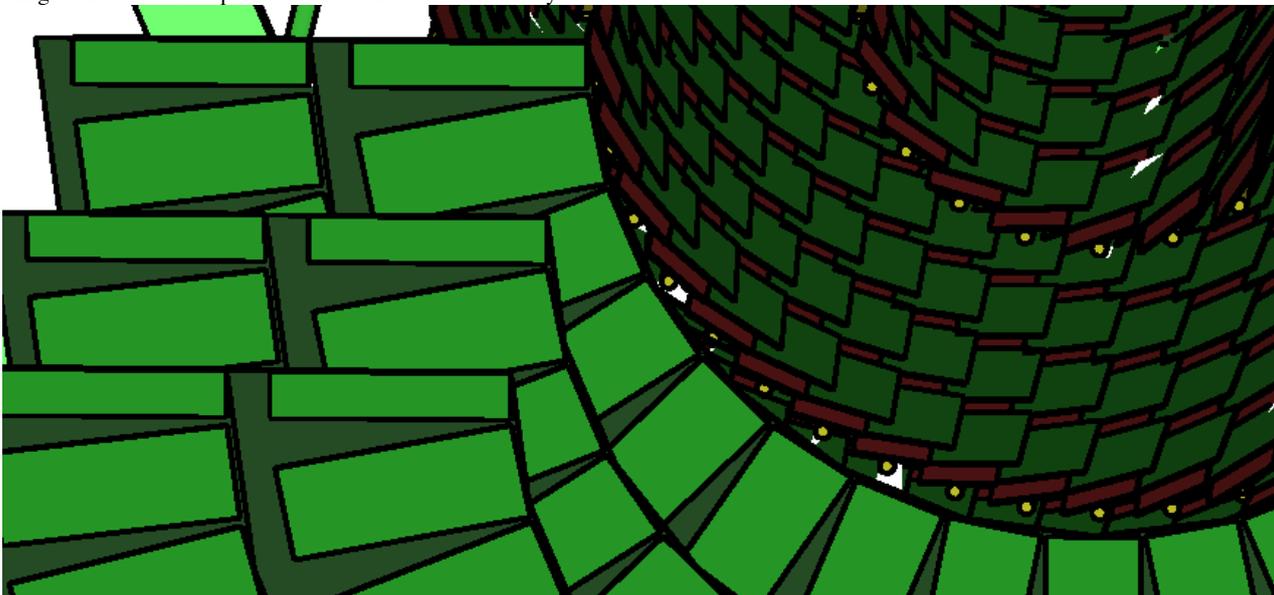
- Eventually, you will see the message:

```
***** PostScript file "PRIM_DATA/pixel_cut0100.eps" is created.
```

- The resulting EPS file looks like:



- And here is a good time to discuss the important fact that this DAWN image is Vector graphics (not bitmapped graphics). As a result, you will find that if you use your PostScript viewer's zoom feature, the image will remain sharp and full of detail no matter how you zoom:



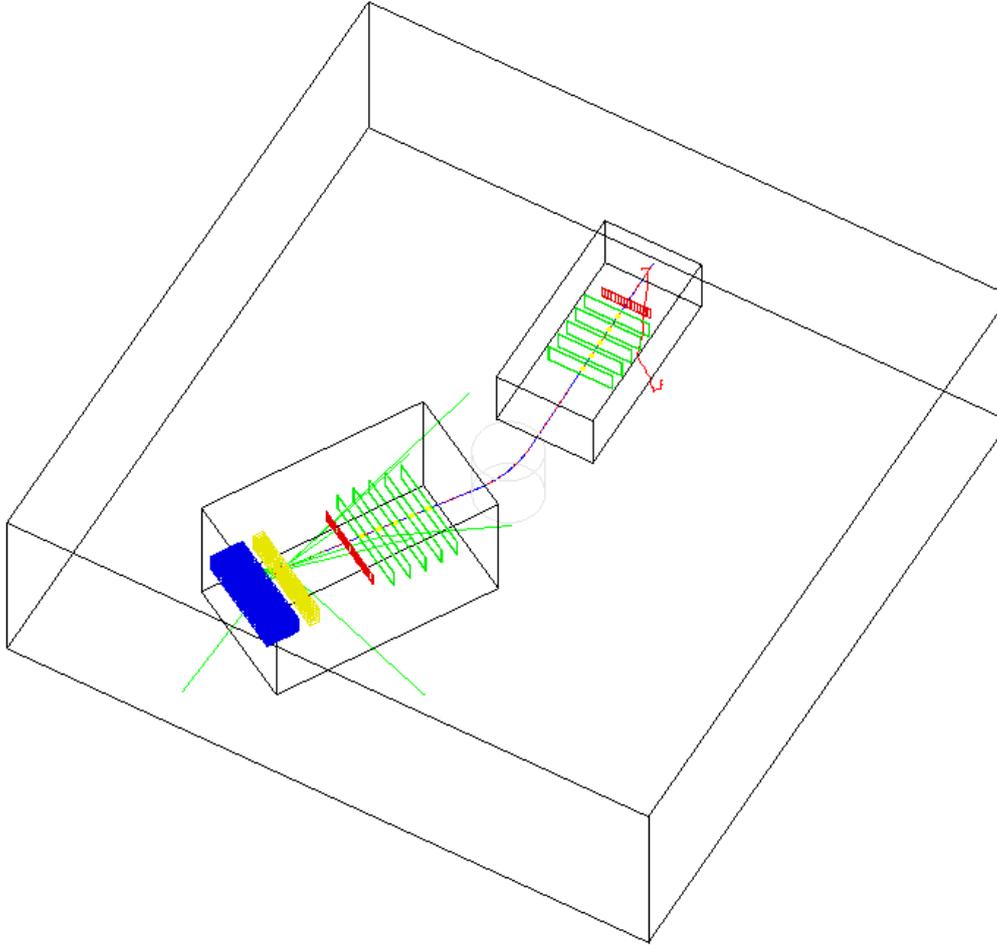
- Now that you have some basic familiarity with DAWN, use it to view the prim file that you created during the previous tutorial when you ran Geant4's A01 example. You should have a file called: `geant4\examples\extended\analysis\A01\g4_01.prim`

Or, if you skipped running Geant4 for now, you can instead find a copy of this file [here](#).

- Run DAWN on this file:

```
dawn g4_01.prim
```

- Go to the DAWN GUI's page 1 and select "Load Default".
- On the same page, change "Camera Angle"..."Polar" to 60 (the slider will get you close, or you can type in a specific number to clicking on the existing polar angle and then typing your new value).
- You should end up with an image as follows:



- DAWN has many more options that you can best learn by playing around. If you get into trouble (for example, bad values for "Camera Distance" can cause a crash), use the DAWN GUI's page 1 button "Load Default" to get back to a stable configuration.
- This tutorial has only scratched the surface of DAWN. Its purpose was to give you a brief, hands on introduction to this powerful tool and to encourage you to further explore its abilities. Not only have we neglected many of the features in the DAWN GUI, but we have also neglected the many other modes in which it can be run (direct to XWindows, receiving prim files via sockets from other running applications, etc). A large range of problems involving very high quality technical rendering can be solved by DAWN.

Speeding Up DAWN for Very Complex PRIM Files

If your prim file is very complex, you may find that DAWN's performance is distressingly slow. This can make it very time consuming to find the best view angle.

- One trick that can help is to turn off surface rendering, using wireframe mode instead, until you have found the right view angle.
- Then only turn surface rendering back on when you are ready to do the final rendering.

Recap of Geant4 Commands Used in this Tutorial

If you need to quickly repeat the commands to generate the .prim file, it may be helpful to cut and paste a set of commands from this list:

```
$G4BIN/A01app
```

```
/vis/open DAWNFILE
/vis/drawVolume
/vis/viewer/flush
/vis/scene/add/trajectories
/vis/scene/add/hits
/run/beamOn 1
```

Further Resources

Documents in this Visualization Tutorial Set:

- [Geant4 Installation Guides](#)
- Introduction to Geant4 Visualization ([ppt](#), [pdf](#))
- [Geant4 Visualization Tutorial using the HepRApp HepRep Browser](#)
- [Geant4 Visualization Tutorial using the DAWN Event Display](#)
- [Geant4 Visualization Tutorial using the OpenGL Event Display](#)
- Geant4 Visualization Commands ([ppt](#), [pdf](#))
- Geant4 Advanced Visualization ([ppt](#), [pdf](#))

Other Resources:

- For the most complete information on DAWN, plus repositories of sample prim files, output files and related applications:
<http://geant4.kek.jp/~tanaka/>
- On-line documentation on Geant4 visualisation:
<http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/Visualization>
- List of visualization commands:
http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/Control/UIcommands/_vis_.html
- Questions, comments about Geant4 Visualization - Contact us through the Geant4 Visualization online forum:
<http://geant4-hn.slac.stanford.edu:5090/HyperNews/public/get/visualization.html>

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