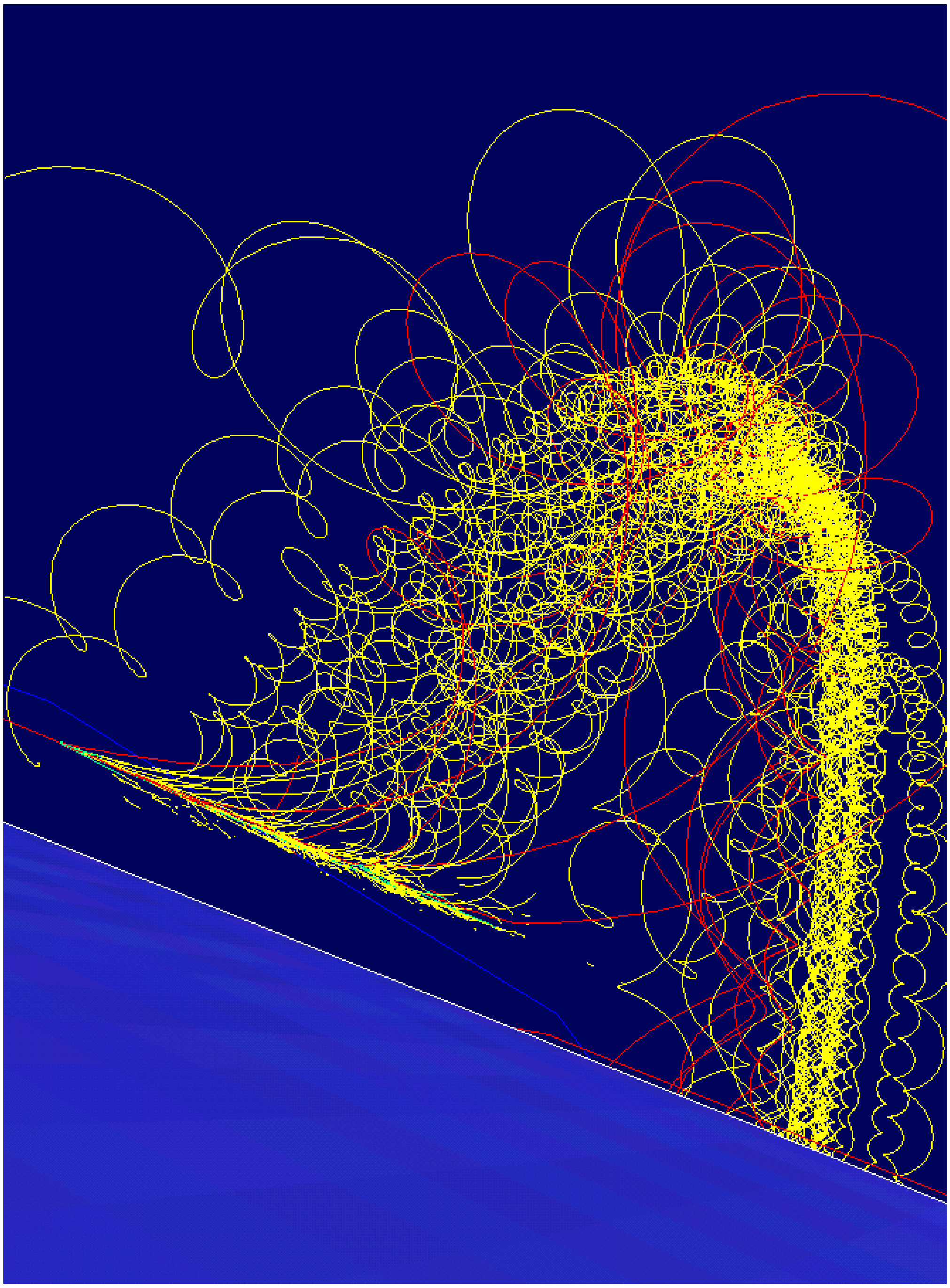
Geomview Interface for Cosmos



1 What is Geomview ?

Geomview is an object-oriented 3-D object viewer developed at the Geometry Center of Univ. of Minnesota (http://www.geom.umn.edu/). The Center was already closed. The last version developed there was 1.6.1. However, it's development has been continued at http://www.geomview.org/ which releases the latest version of 1.8.1-2. Geomview is a freely available powerful software and can be used on many unix systems; precompiled binaries of 1.6.1 are still obtainable from the

Geometry Center and other places. Geomview assumes Motif GUI (on X-window), and openGL. One exception that dose not use these is the NEXTSTEP; however, versions newer than 1.6.1 is not available for it. Version 1.6.1 is enough for most of Cosmos requirement so that you may use that version if you cannot find a newer version for your system.

The binary executable for Version 1.8.1-2 is obtainable for the Intel PC Linux (rpm file). As compared with 1.6.1, some new features have been added. Among them, texture mapping and semi-transparent coloring are to be mentioned.

Geomview has the external module function (or we may say 'plug-in') to extend it's functionality. A number of such external modules are available.

Although I haven't seen binaries of the latest versions for O.S's other than PC Linux, we would be able to compile Geomview from the source since openGL can be replaced by Messa, and Motif by open Motif or Lesser Tif. Try it !

2 How to use Geomview within Cosmos

2.1 Preperation

Of course Geomview must be installed.

- You have to setup an environmental variable GEOMVIEW to be the path to the Geomview executable. For example, if you use csh,

  setenv GEOMVIEW /usr/bin/geomview (probably, for Linux)

  or

  setenv GEOMVIEW /usr/local/Apps/Geomview.app/Geomview (probably for NEXTSTEP)

- Geomview should normally be used in the *Cosmos*/Util/Geomview directory. If you are a NEXTSTEP user, you have to copy '.geomview' in this directory to your home directory. On other systems, having '.geomview' in the home directory is also not a bad idea.

- The scripts in *Cosmos*/Util/Geomview assumes 'tcsh' in /usr/local/bin/. (On some systems, 'csh' would not run correctly). You might have to modify `#!/usr/local/bin/tcsh` in the top of the scripts or you might have to establish the link of 'tcsh' to /usr/local/bin/tcsh.

- Geomview is used to display particle tracks generated by Cosmos execution. You have to establish the working directory by editing 'disptracebygeomv' file where you will see 'vdir' at the top part. The default place is /tmp/$USER. The system stores particle track data for Geomview in that directory as 'ptcl2p1.vect' etc. You would also like to adjust the particle type to be displayed. The default setting is seen in 'ptcls' below 'vdir'; it dose not include neutrinos (code 7 and 8).

It may be worthwhile to remember that
$GEOMVIEW object1 object2 ...
invokes Geomview to display Geomview objects specified by object1, object2,...

3 Displaying particle tracks

Particle track information can be obtained by specifying Trace > 0 in the parameter file at Cosmos execution time. The trace data can be displayed by Geomview as vector data. There are several display style to show these data. You have to remember that you will not see any tracks even after successful invocation of Geomview; you have to push 'Look' button in that case.

In what follows, you have to give an explicit data for an italicized parameter, and block letters must be given as it is. *tracedata* means the path to the trace data, say, /tmp/foo/trace1.

1. Only trace data is displayed. Trace data type is arbitrary (.i.e, any value of 'Trace> 0"). The usage is:

   ./disptracebygeomv `[-c|z|b]` *tracedata*

   You may add an optional parameter -c, -z or -b. The -c (default) is to show only charged particles. That is

   ./disptracebygeomv *tracedata*

   and

   ./disptracebygeomv -c *tracedata*

   are equivalent. The -z is to show only neutral (zero charge) particles. The -b for showing both charged and neutral particles. Therefore, if 'ptcls' defined in 'disptracebygeomv' contains 1 (code for gamma ray), the default invocation of disptracebygeomv will not show gamma rays.

2. Trace data + air shower array are displayed.

   (a) The trace data is in detector system (Trace = 21 or 23)

   ./disptracebygeomv `[-c|z|b]` *tracedata* array *sx sy zmax*

   sx is to shift the trace data by *sx* (m) in the x direction. *sy* for the y axis. *zmax* is to select only those data with $z < zmax$ (m).

   (b) The trace data is in the E-xyz system (Trace = 41 or 43).

   ./disptracebygeomv *tracedata* array

   You can setup your desired air shower array (see next section). The default array is Tibet-III array at Yangbajin, China.

3. Trace data + Earth are displayed. The trace data is in the E-xyz system(Trace=41 or 43)

   ./disptracebygeomv `[-c|z|b]` *tracedata* earth

4. Trace data + Earth + array are displayed. The trace data is in the E-xyz system (Trace=41 or 43).

   ./disptracebygemov `[-c|z|b]` *tracedata* earth array

If you issue
./disptracebygeomv
a brief summary of the command usage is displayed.

Caution: If you use the E-xyz coordinate system for trace data, don't try to enlarge the view so that you can see the detector box (order of $\sim$ 1 m) clearly (magnification more than 10^6 times); Geomview uses single precision calculation and such a large magnification factor might result in bizzare. You should use 2.-(a) for such a purpose.

3.1 Some further details

- The disptracebygeomv command creates ptcl1z1.vect, ptcl2p1.vect, ptcl2n1.vect etc in the working directory. The number after 'ptcl' is the particle code; 1 means gamma rays, 2 electrons etc. Then, 'z', 'p', or 'n' comes;. 'z' is for zero charge, 'p' for positive and 'n' for negative charge. The number that comes after this is normally 1. However, if there is a very long consecutive track, we may see ptcl2p1.vect, ptcl2p2.vect etc. This is due to the Geomview limitation that it cannot treats 32k vectors at once and we have to divide the data into more than two files. Such a long track may be produced when we trace charged particles at very high altitudes.

  Be careful that these vector data can grow very large and is left in the working directory.

- The Earth globe is displayed with texture mapping of a world atlas on a sphere. Geomview version 1.8.1-2 supports texture mapping but the older versions may not support it. In that case, you will see a "bare' globe without error. (See Fig.1). Texture mapping itself is somewhat capriccio; depending on some unknown feature of texture, mapping is automatically performed in some case and is not in other case until we push the texture buttons.

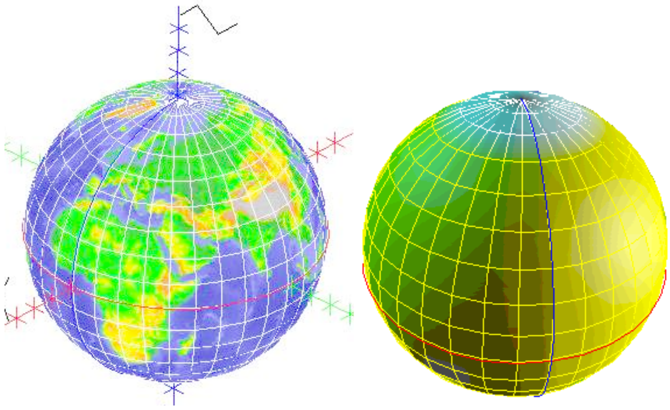


Figure 1: Left: A texture mapped globe (Axes are not attached in normal cases). Right: If texture mapping is not supported, the globe will look like this. The north pole region is colored white. In both view, the blue line shows meridian at longitude 0°, and the red the equator. The lines showing the longitude and latitude are drawn with 10° steps. They can be erased if the edge display is disabled.

- You can map a different world atlas by preparing a 'pnm' file. The atlas must be in the Mercator system (size is arbitrary). Normally, such an atlas spans from $-180°$ to $180°$ in longitude. However, if we use such an atlas, we encounter the texture mapping capriccio as mentioned earlier. So you have to prepare an atlas which spans from 0° to 360° in longitude. The file name must be specified in Globe/globe.mesh like (it can be gzipped)

```
texture {
        file WorldA0+360.pnm.gz
        apply decal
}
```

  If you still want to use an atlas spanning from $-180°$ to $180°$ in longitude in spite of the 'capriccio', Globe/globe-180+180.mesh may be employed.

- The 'ground' on which the air shower array is located is also a texture map. The size is adjusted to be 10 km $\times$ 10 km.

- You may use your own air shower array. The default array consists of 1 m cubic boxes which is defined in Array/unitbox.inst (Fig.2). You may modify the size and color here.

  The number of unit boxes and the locations (air shower array) are specified by Array/array.inst.

  To make an array.inst newly, you may go to the Array directory and issue

```
cat arrayheader > array.inst
awk -f array.awk xyzdata >> array.inst
```

where each raw of 'xyzdata' must contain 'x, y, z' of individual detector location in unit of m. In the case of the Tibet array, the basic array data ('array') consists of a number of columns. To extract 'x, y, z' from that, extractXYZ.awk may be used.

Hence

```
cat arrayheader > array.inst
awk -f extractXYZ.awk array | awk  -f array.awk >> array.inst
```

will work.

To place the air shower array on a given position of the Earth, 'Array/matrix' must be prepared. The matrix can be computed by going to *Cosmos*/Util directory and

```
make -f det2Exyz.mk
a.out < param
```

You have, of course, give the longitude and latitude of the observation place in 'param'. The height is taken from the deepest observation level.

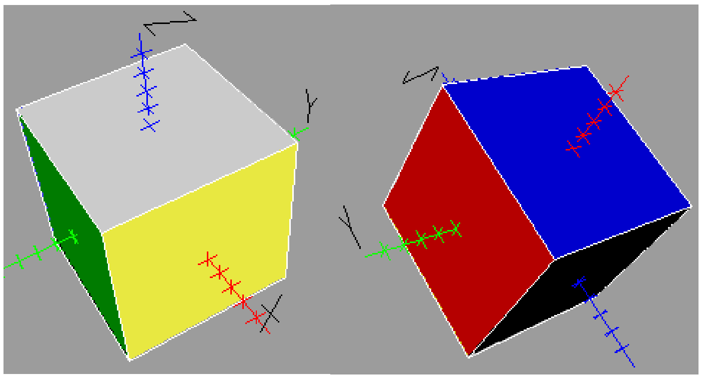


Figure 2: The default unit detector shape; orientation and face color

You could use more realistic array which can be an input to Epics for detector simulation. However, the data configuration becomes more complex resulting in slower display speed.

- Particle track color is specified in the 'colortab' file. You may adjust it. (The color can also be changed within the Geomview window).

4 Creating animation and taking still pictures

Among the external modules available for Geomview, StageTools would be one of the most useful ones. One module from that, StageManager, enables us to make mpeg animation, and StageStill to take a snapshot in various formats (eps, pnm etc).

To make these work, mpeg_encode and tcl/tk must be availble for use. The Linux environment is ready for it.

To be able to use these for texture mapped image, one has to enable 'hardware shading' (though shading is actually performed by software).

Again, texture mapping is capriccio and in some case you cannot make a desired movie from such a image. In that case, you may use StageManager only for preview, and capture the image by the 'mkmovie' command (in *Cosmos*/Scrpt; the import command for capturing must be available). You have to increase the number of frames specified in StageManager by about 10 times (since capture rate is slow).

5 Examining how particles fall on the array

Adding to the demonstration purpose, you may want to see how electrons/gamma rays etc fall on the air shower array; you may debug your simulation by this or get a hint for better array configuration.

For such a purpose, taking trace information from tens of km above the array simply results in too much trace data size and too slow display speed. You may limit the tracks for display by choosing a small vale for *zmax*. This will reduce the vector data size remarkably, but dose not lead to shrink the track data size itself. There is another problem by this method. Since *zmax* is applied only for nodal points, and for gamma rays (in general for neutral particles), we might not be able to find nodal points below *zmax* because they can run long distances.

To resolve these problems, we may use Trace=23. This setting will force to take trace information only if the track is below the highest observation level. Therefore, we may set, for example,

```
DepthList = -1,-2, 0
HeightList = 4273.4, 4271.4,
Trace = 23,
...
BorderHeightL = 4270.4
```

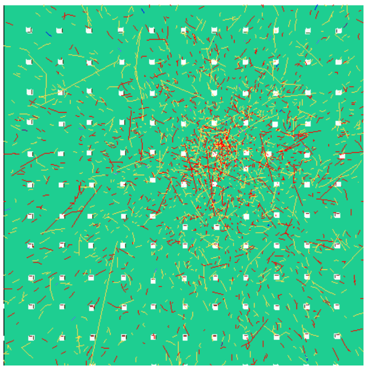


Figure 3: 10 TeV proton shower falls on near the center of the aray; only charged particles are shown

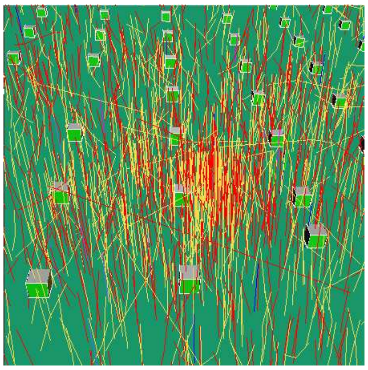


Figure 4: The central part from a different angle

Then, trace information is taken only between 4273.4 m to 4270.4 m and there are surely nodal points at least at these 3 heights. The base detector system is at 4271.4 m in this case. Examples are shown in the next figures.

You could have a similar display without taking trace. You may record each particle information at an observation level (x,y,z and direction cosines). From these you can create a pseudo track information, too.

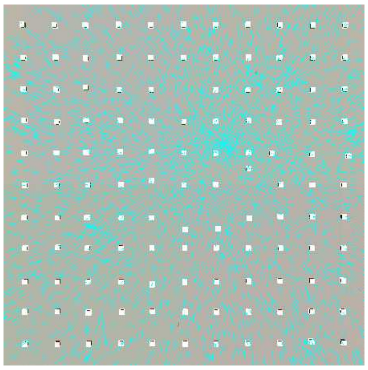


Figure 5: The same event as the previous figure but only neutral particles (mostly gamma) are shown

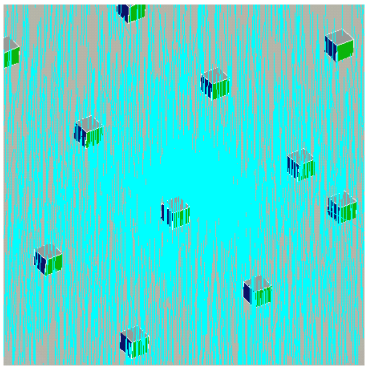


Figure 6: The central part from a different angle