Simulation of the Scintillator Geometry in the Electromagnetic Calorimeter in the CLAS12 Detector

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Redefining the Scintillator Geometries

To simulate events in CLAS12 we use a program called gemc which is based on a package called G4. It was developed at Jlab for the purpose of simulating events in CLAS12. G4 simulates particle tracks and their interactions with materials as well as defining the geometries of CLAS12 components used in gemc. All the geometry parameters are stored in a MySQL database. To simulate the calorimeters as strips there were three files that had to be edited and a new table was created in the MySQL database.

e_conf - This file was edited so that the new strip geometries would be put in the correct database and table that was created for them.
e_build_strips.pl - This perl script was adapted from ec_build.pl which was used to create the slab geometries. It now runs a series of loops to create the parameters for a layer of scintillator strips before creating a lead layer. These geometries are then loaded into the database.
EC_hitprocess.cc - This is the new MySQL table that was created to hold the strip geometries. By allowing the strip geometries to have their own table it makes it very easy to switch between using the slab geometries and the strip geometries. This enables us to compare the performance of gemc with and without the new geometry.

Testing the Strip Geometries

We compared the difference in particle hit position between the two geometries. We ran simulations of both geometries using electrons aimed perpendicularly at the EC with no magnetic field and no other components of CLAS12. The graphs in Figure 5 show the number of hits in each strip of the U, V, and W layers in the left-hand column. There is little difference between the two geometries in the distribution of hits for each EC view. To make the comparison more rigorous we took the difference between the hit distribution as a function of strip number for each geometry. We took the number of events in a strip for the slab geometry and subtracted the equivalent value for the strip geometry. The right-hand column in Figure 5 shows the results for each view. We observe shifts between the two geometries consistent with the strips being located 200 microns radially closer to the beam line with no measurable difference in the azimuthal direction.

We performed a field test on the speed of the interactive graphics in gemc comparing the new strip geometry to the old slab geometry. We took frame rate measurements using glxgears (see figure 6). The program prints out the overall frames per second (FPS) of the window in 5 second intervals. We allowed it to run for 30 seconds to give us a base line frame rate. Next we ran gemc with the graphics and only the EC while interacting with the graphics for 30 seconds. The results are shown in the table below. We found that the new strip geometries were about 25% slower than the slab geometries.

<table>
<thead>
<tr>
<th>Energy (GeV)</th>
<th>Slab FPS</th>
<th>Strip FPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>(2.61 ± 0.09) x 10^8</td>
<td>(2.61 ± 0.09) x 10^8</td>
</tr>
<tr>
<td>6</td>
<td>(4.17 ± 0.02) x 10^8</td>
<td>(4.17 ± 0.02) x 10^8</td>
</tr>
<tr>
<td>12</td>
<td>(8.33 ± 0.08) x 10^8</td>
<td>(8.33 ± 0.08) x 10^8</td>
</tr>
</tbody>
</table>

Conclusion

We have modified the scintillator geometry of the simulation of the CLAS12 electromagnetic calorimeter to use individual strips in each layer. This change is closer to the physical geometry of the device. Our tests show this modified geometry is still close in position to the previous version within about 200 microns. The computational time is a few percent longer at high electron energies with the simulated strips and the graphics response is about 25% slower.

References