

Semi-parametric Monte Carlo of Photons in GlueX

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Motivation

- Provide means of doing a fast Monte Carlo simulation of the GlueX detector based on resolutions and efficiencies obtained from full reconstruction of *ab initio* GEANT simulation.
- Provides a stop-gap while charged particle tracking reconstruction code is developed.
 - Avoid track finding issues believed to be, ultimately, resolvable
 - Apply single track resolutions to multiple tracks while multiple track reconstruction is still somewhat immature.
- Semi-parametric photon reconstruction provided as well.

The *hdparsim* Project

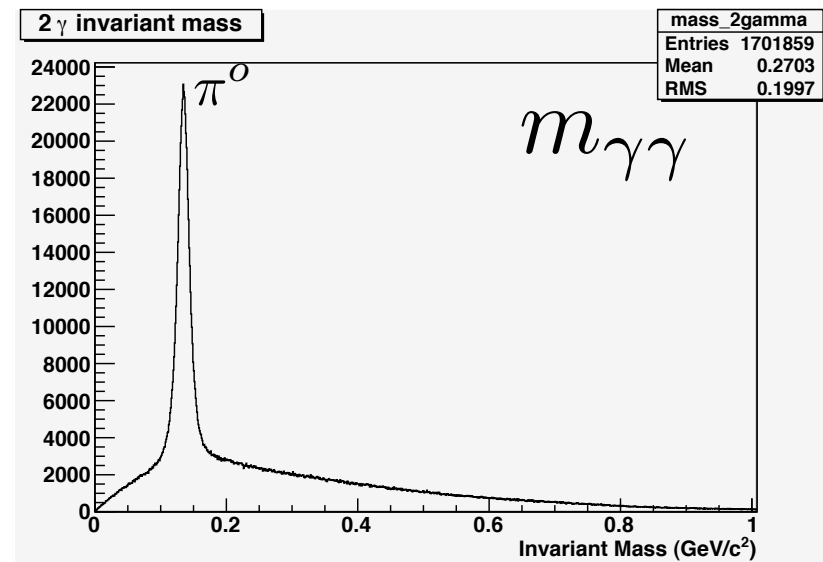
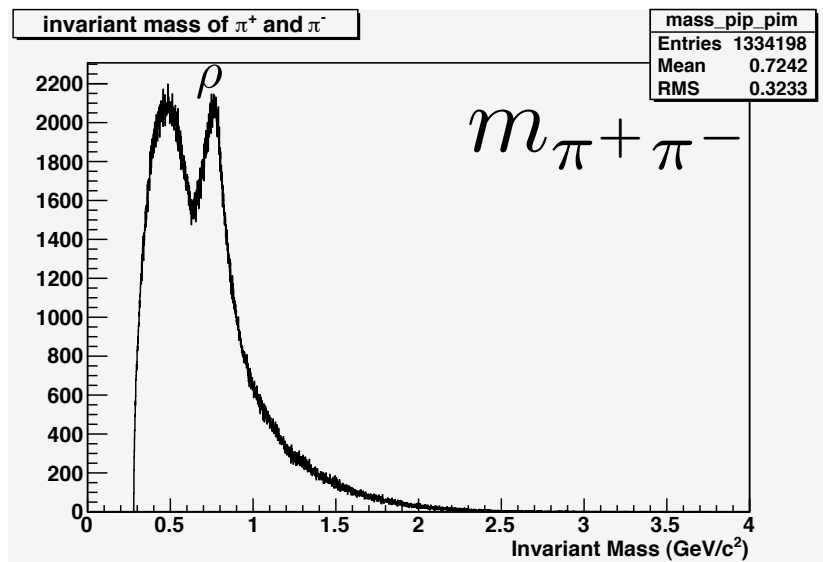
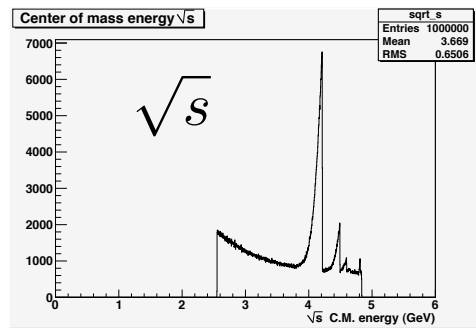
- The *hdparsim* plugin takes tables of energy resolution, angular resolutions, and efficiencies that are stored in ROOT files and uses them to smear generated values
- Source code is kept here:
<https://halldsvn.jlab.org/repos/trunk/src/programs/Simulation/plugins/hdparsim>
- Resolution tables are available on the web, and automatically downloaded when the plugin is used.

Using *hdparsim*

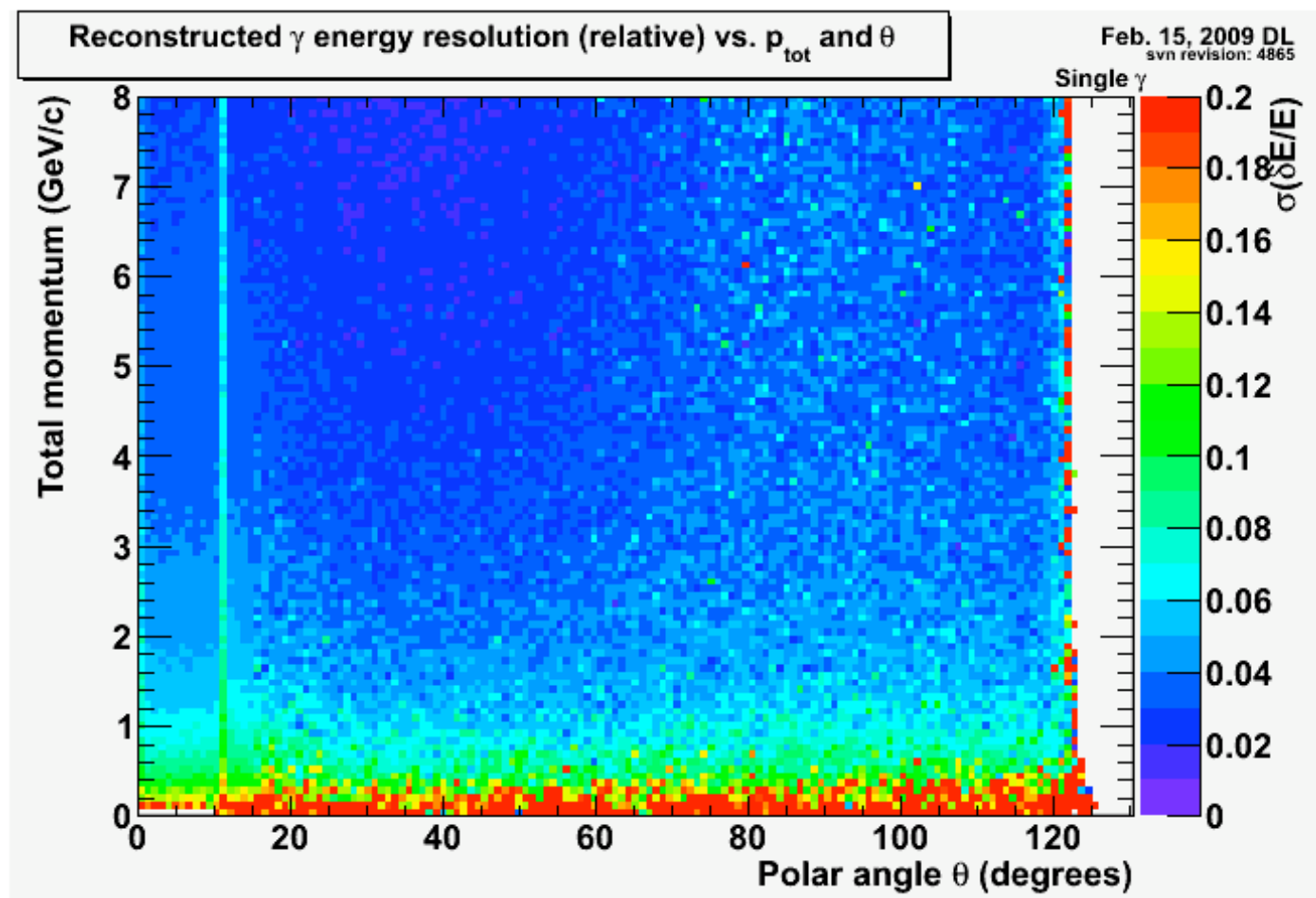
hd_root --config=jana.conf bggen.hddm

jana.conf

```
PLUGINS hdparsim,invariant_mass_hists
DEFTAG:DParticle HDParseSim
DEFTAG:DPhoton HDParseSim
```

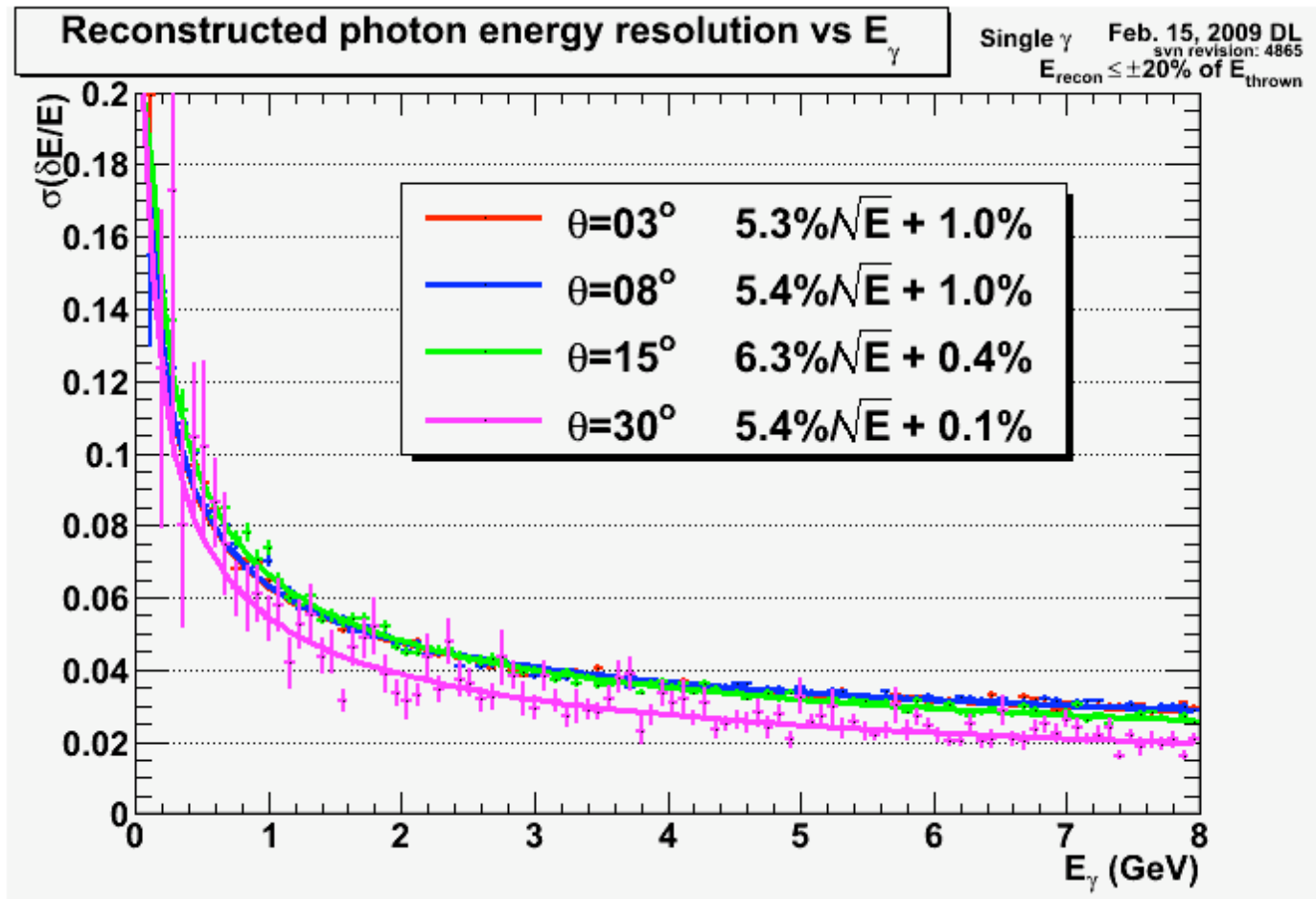


Reconstructed Photon Energy Resolution from *hdgeant* and *DPhoton*



3.2M single photon events were simulated with energies from 0 to 8 GeV and polar angles from 0° to 140°

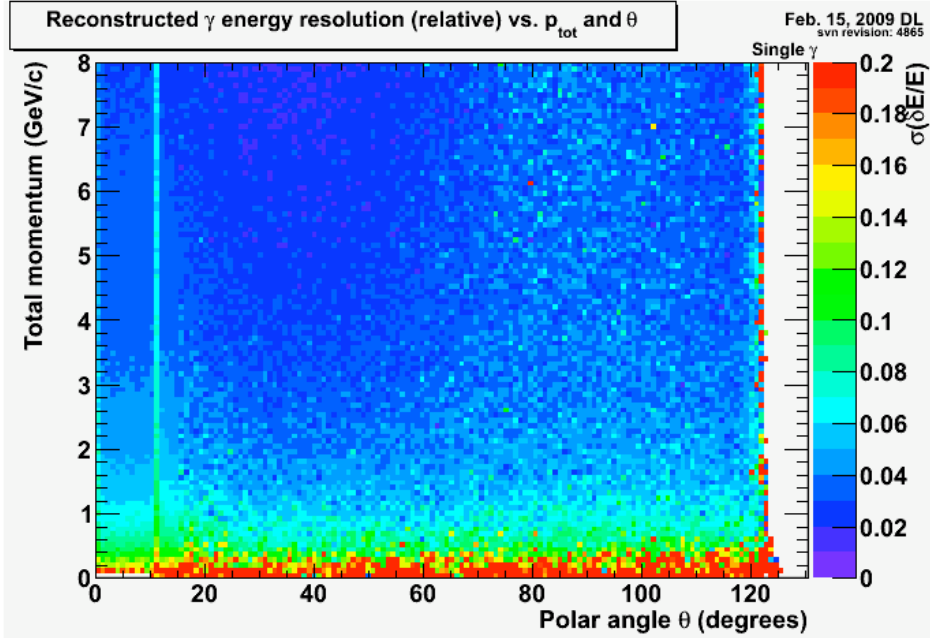
Energy resolution for few theta bins



Energy Resolution

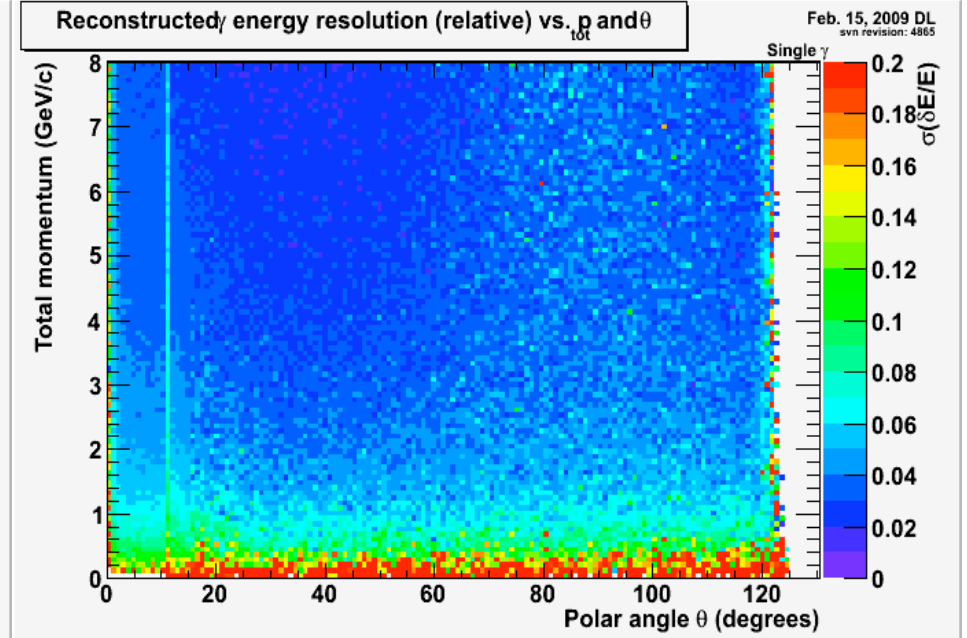
3.2M photons simulated
and reconstructed

hdgeant



100M photons parametrically
simulated using *hdgeant*
derived resolutions

hdparsim

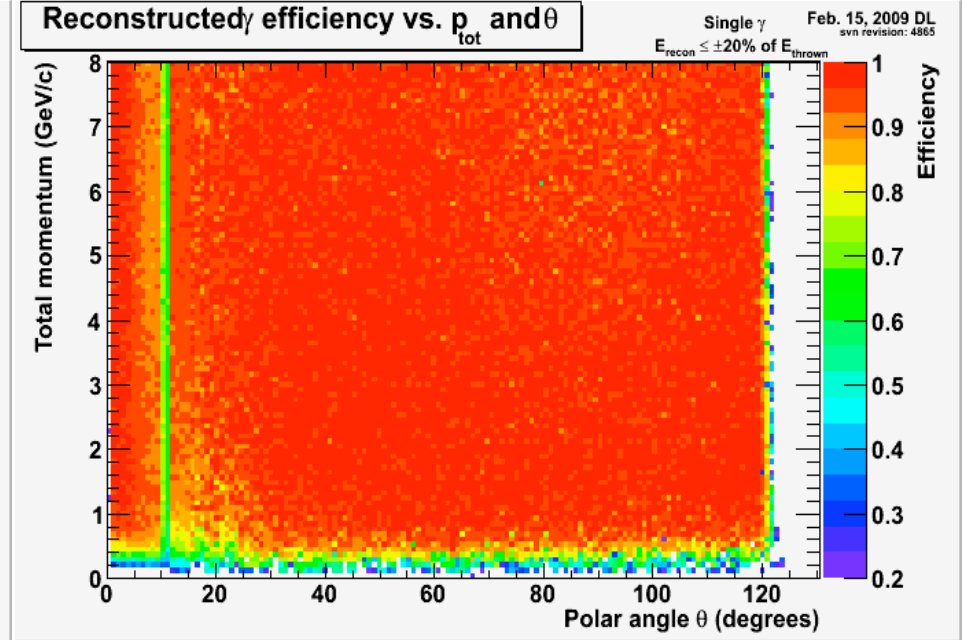
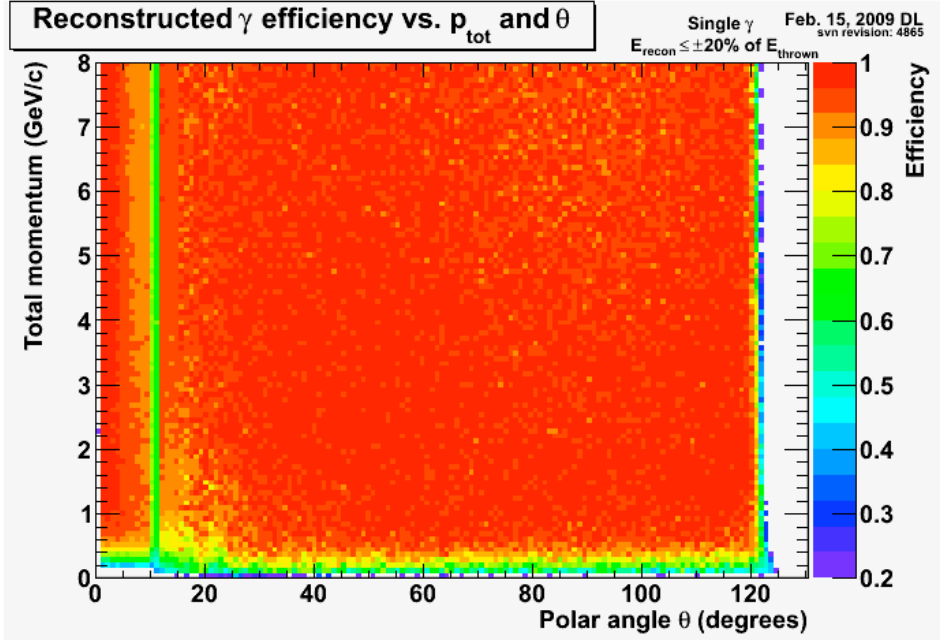


Reconstruction Efficiency

Photon considered found if reconstructed energy was within +/- 20% of thrown

hdgeant

hdparsim

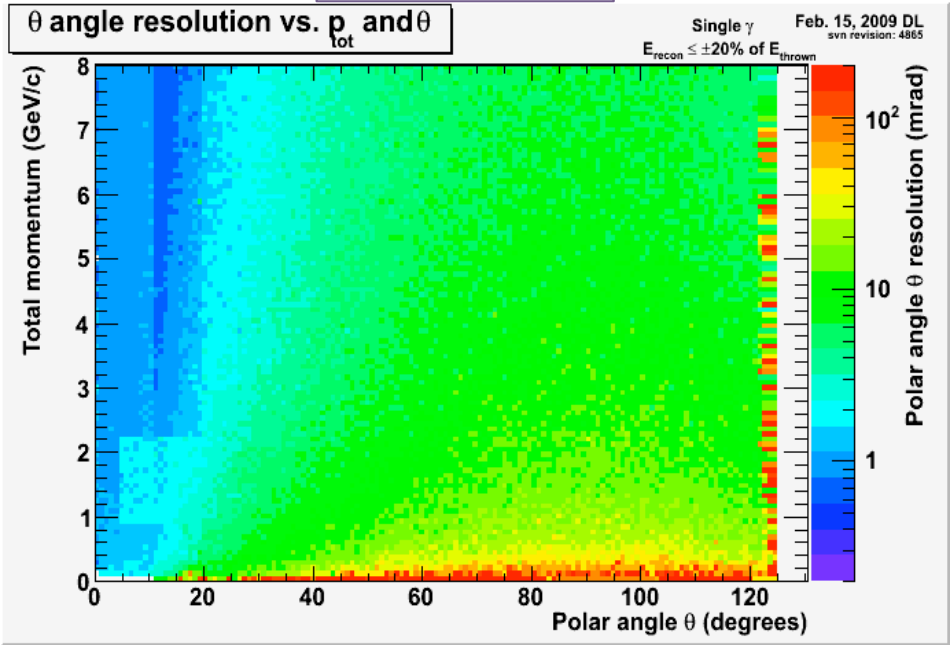
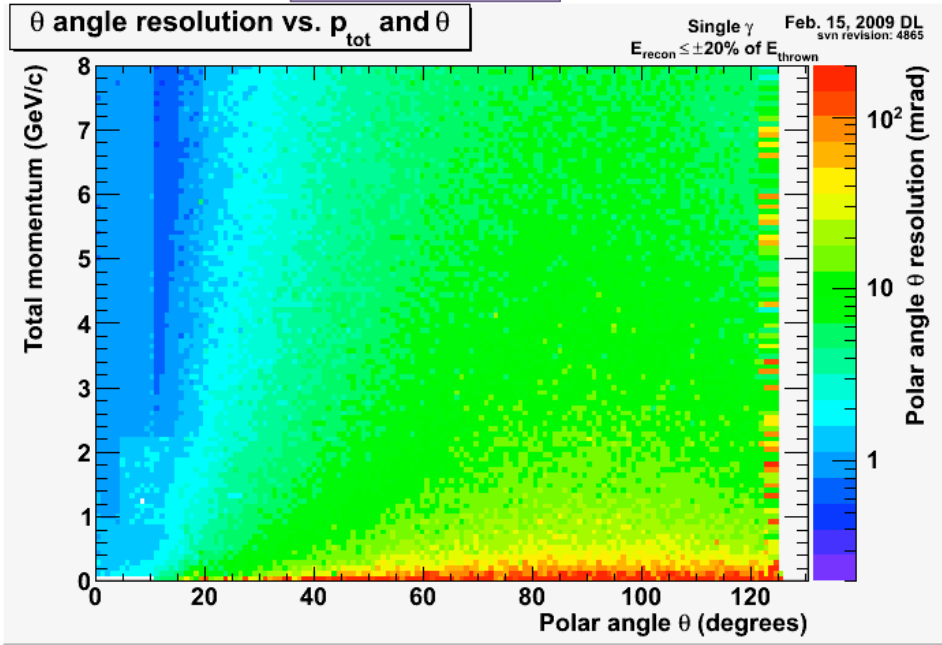


Polar Angle Resolution

hdgeant

Note the z-axis is a log scale in mrad

hdparsim

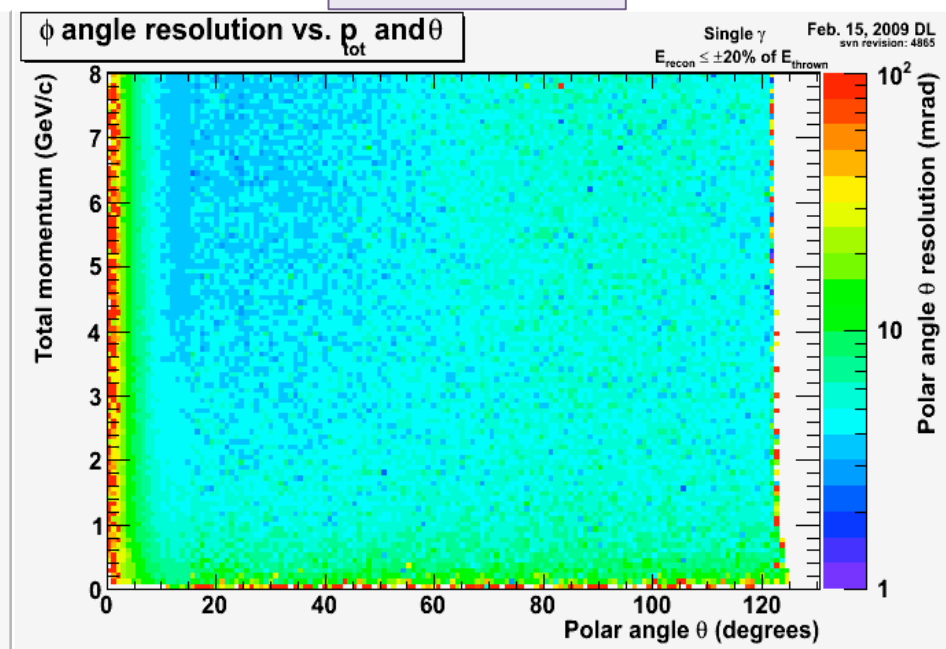
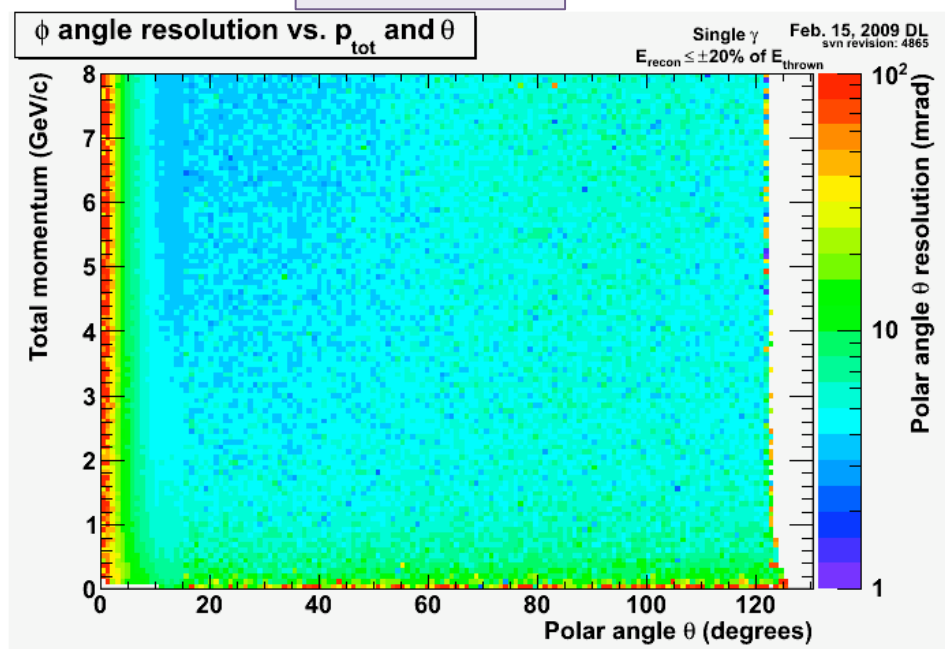


Azimuthal Angle Resolution

hdgeant

Note the z-axis is a
log scale in mrad

hdparsim



Performance

- It took about 35 minutes to produce a file of 100M generated events with 1 photon each on my laptop
- It took about 20 minutes to process all 100M events with *hdparsim*

```
264 Feb 15 09:42 run_test.csh
593454704 Feb 15 09:46 genphoton.ascii
1320005967 Feb 15 10:17 output.hddm
660854 Feb 15 10:17 hd_res_photon.root ← downloaded
646808612 Feb 15 10:38 hd_root.root
```

Performance

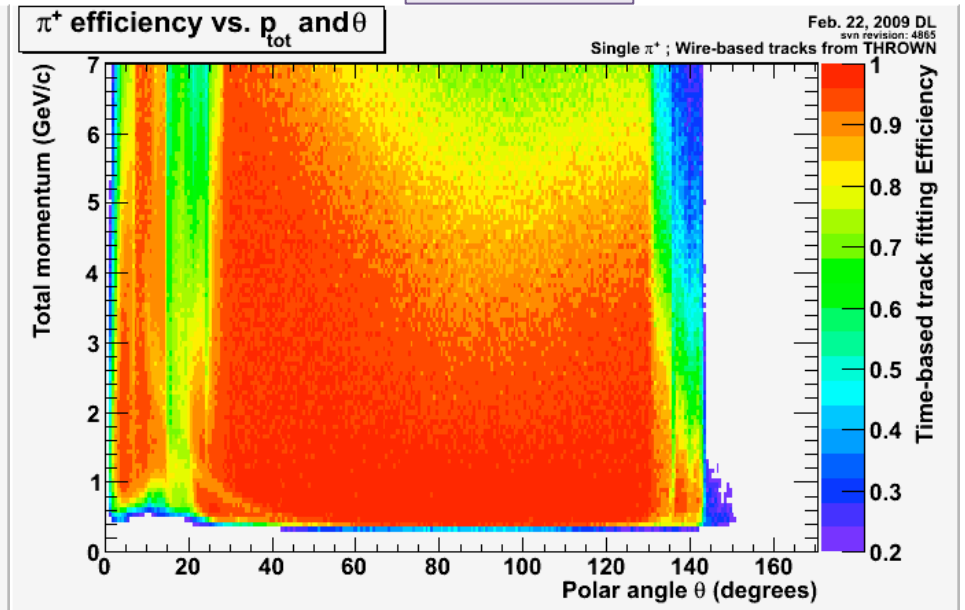
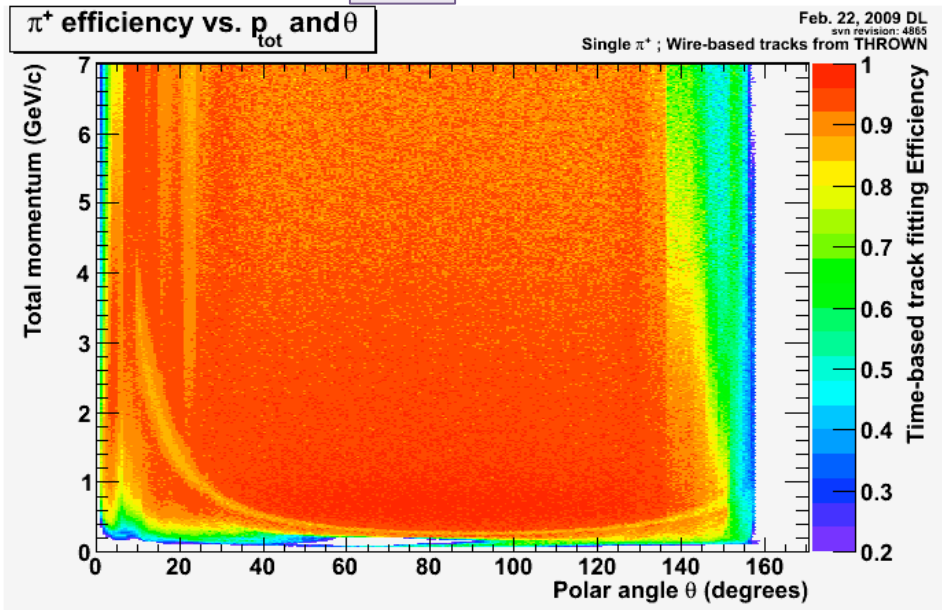
- Charged tracks will take the same amount of time as photons since they are indexed and smeared in exactly the same way.
- Charged track simulation reconstruction rates:
 - Simulation (hdgeant): ~ 44 Hz
 - Full reconstruction: ~ 2 - 10 Hz
 - Parametric: ~ 80 kHz

π^+ , proton efficiencies

π^+

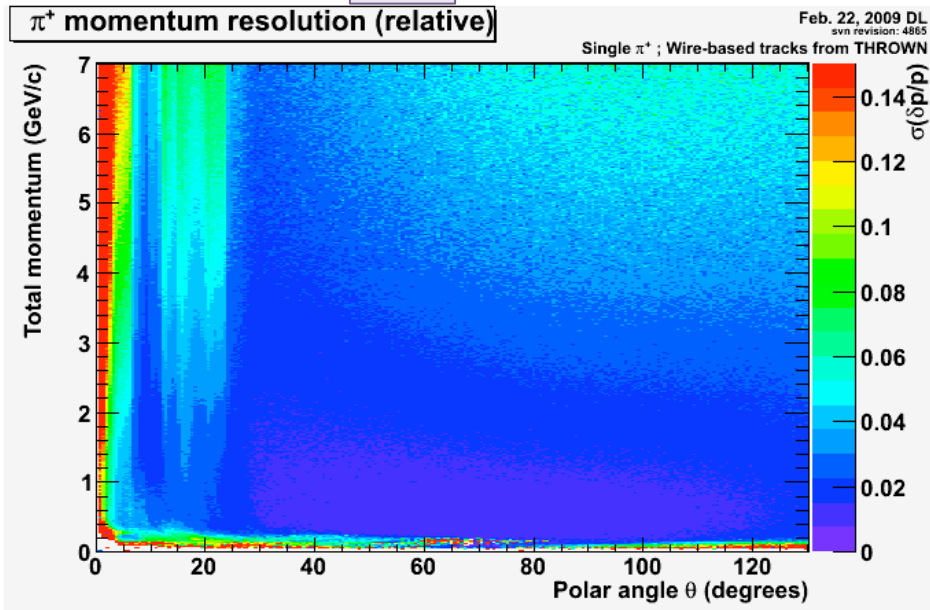
Tracking $\chi^2/N_{\text{dof}} < 1000$ and reconstructed total momentum within 20% of thrown

proton

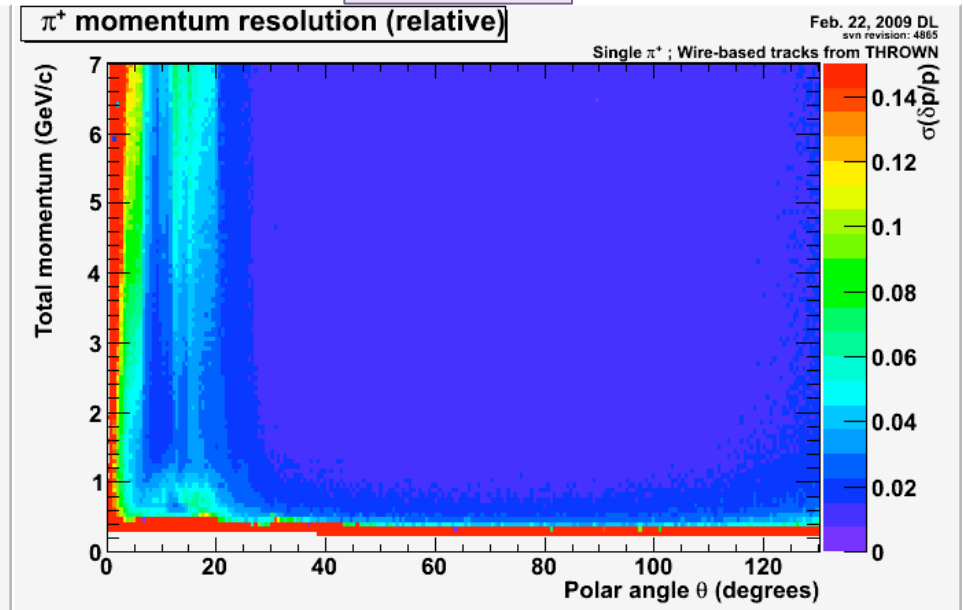


π^+ , proton Momentum Resolutions

π^+



proton



Summary/Outlook

- *hdparsim* provides an integrated solution for doing fast Monte Carlo simulations of the GlueX detector. But some work is still needed to make it reliable:
 - *Charged track efficiency table needs to be updated with recent fix to hdgeant. Even with that, the efficiency of low momentum (~600MeV) low angle (~10 degrees) tracks is artificially low.*
 - *Proton (and Kaon?) tables should be generated and used. Currently, the pion tables are used for protons and separate tables are not used for Kaons.*
 - *Versioning scheme should be imposed on data tables. (Maybe just an object in the ROOT file plus a naming scheme with links to the latest)*

HOWTO Documentation on Wiki

- http://www.jlab.org/Hall-D/software/wiki/index.php/HOWTO_run_the_semi-parametric_Monte_Carlo