SoLID simulation

Zhiwen Zhao
Uva

SoLID Collaboration Meeting

2011/6/2

GEMC
written by Maurizio Ungaro, used for CLAS12

GEMC (GEant4 MonteCarlo)

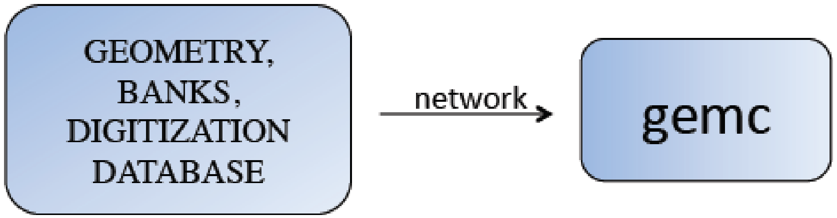
gemc is a C++ program that simulates particles through matter using the geant4 libraries.

GEMC

> Detectors Information are stored at the JLAB mysql server. Configuration changes are immediately available to the users without need to recompile the code

> Hit Process Factory: associate detectors with external digitization routines at run time

> Developers interact with database, do not need to know C++ or Geant4 to build detector and run the simulation

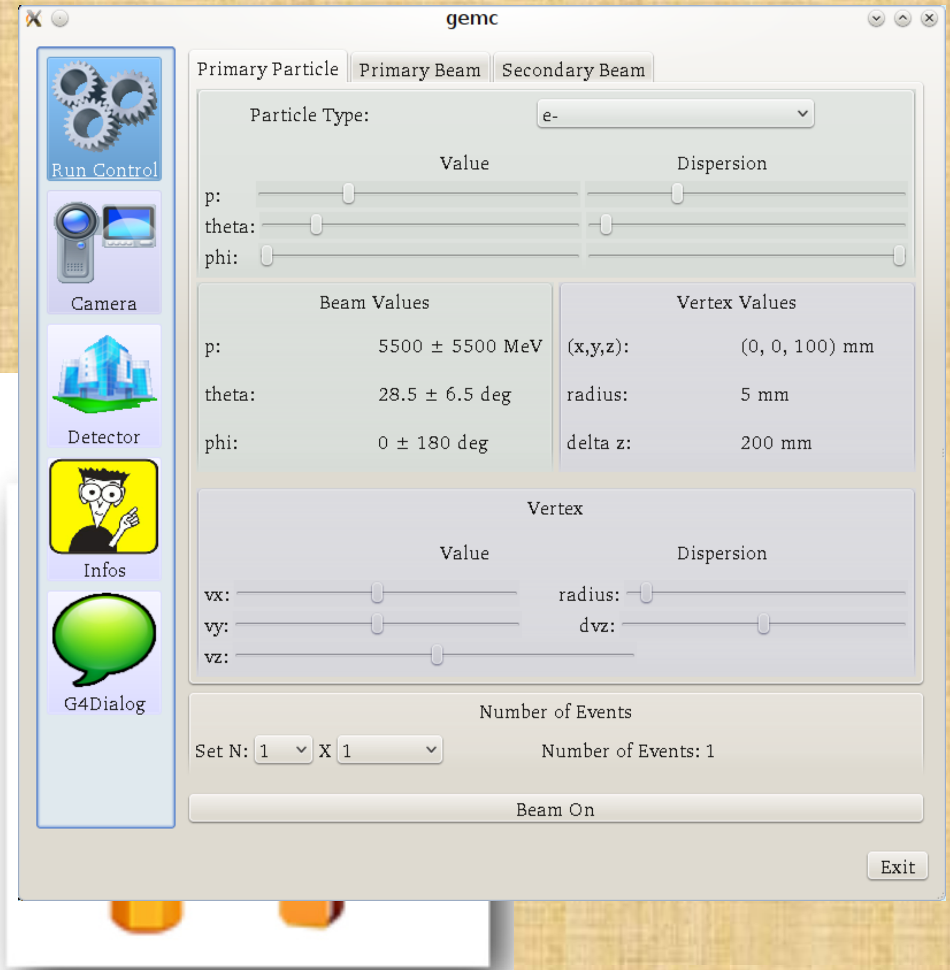


GUI (Run control)

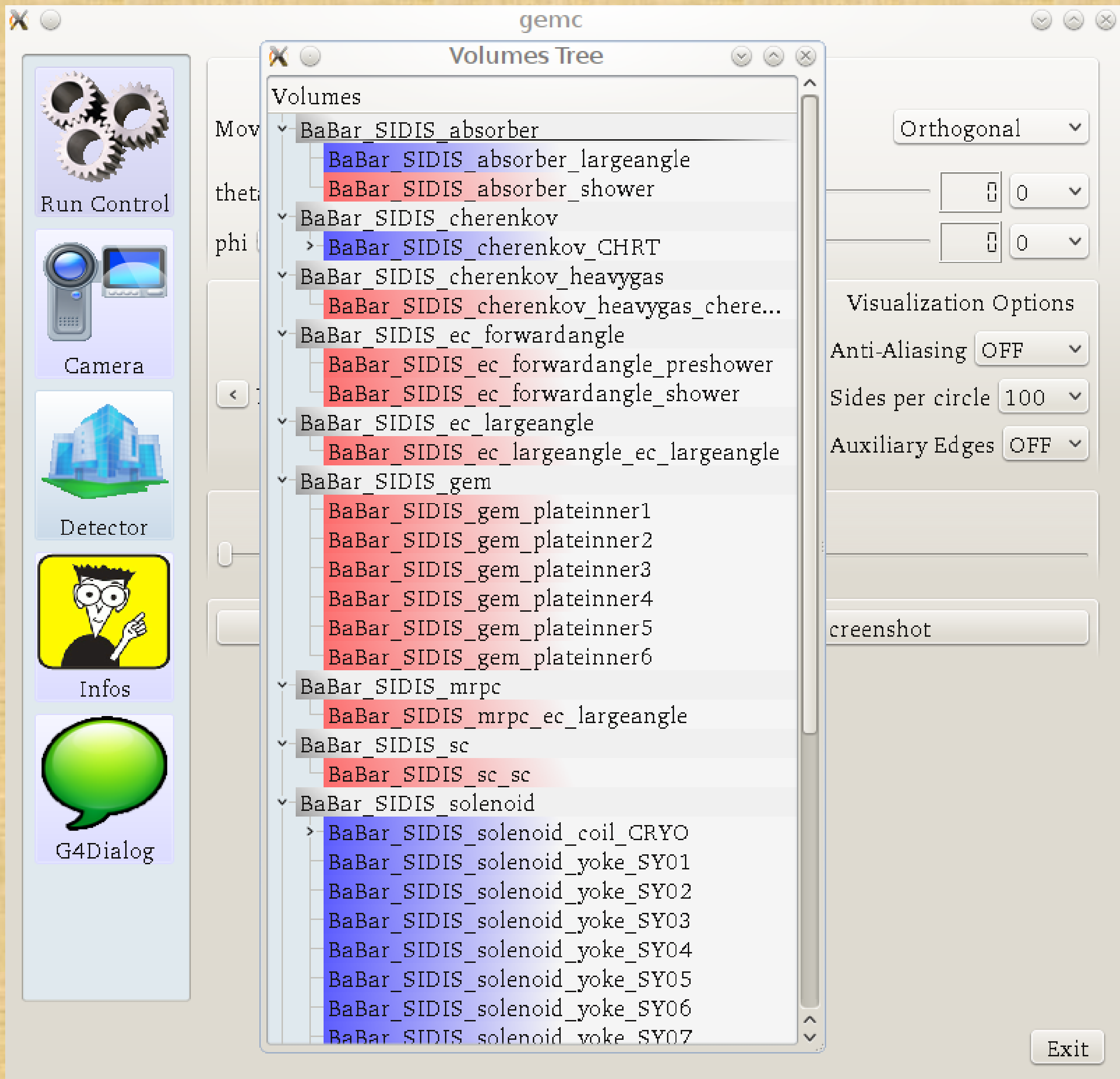
- Command Line Options

Various GEMC Options:

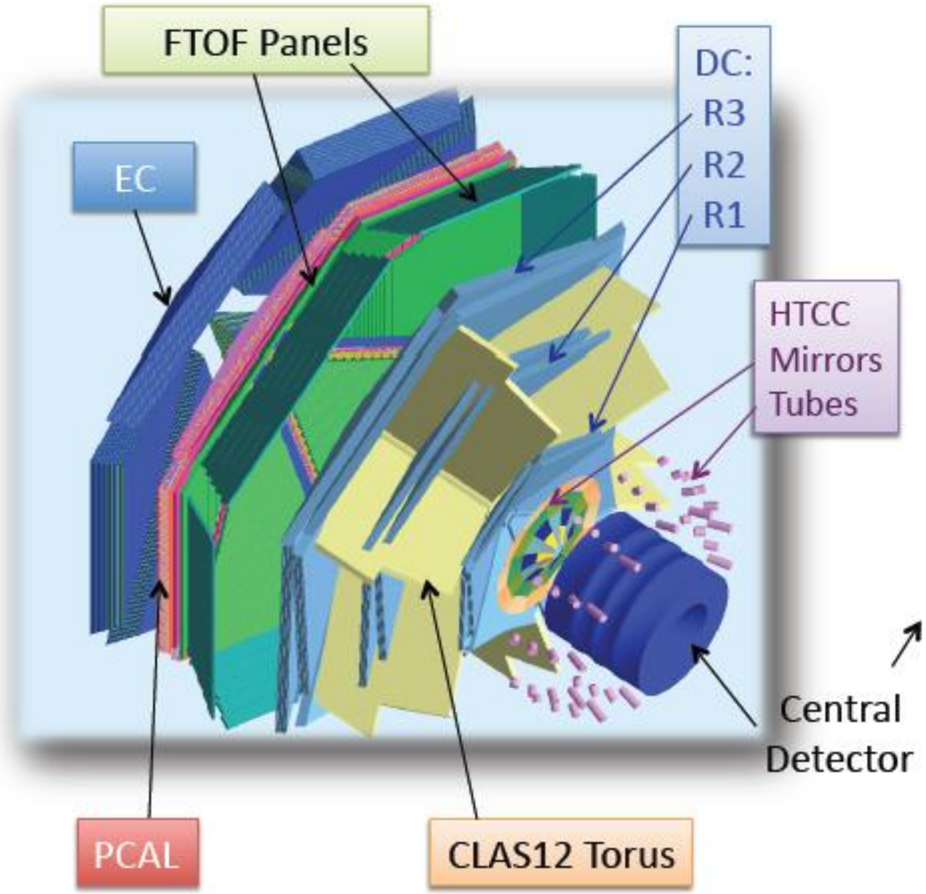
- ✦ Control
- ✦ General
- ✦ Generator
- ✦ Luminosity
- ✦ Mysql
- ✦ Output
- ✦ Physics
- ✦ Verbosity

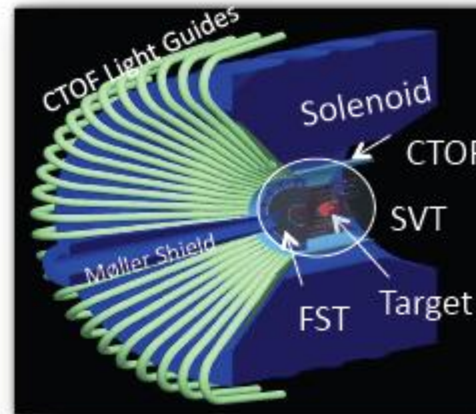


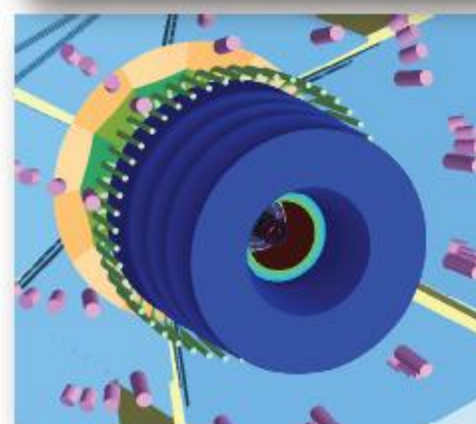
GUI (Detector)



Current Status for CLAS12







How To: new detector, hits

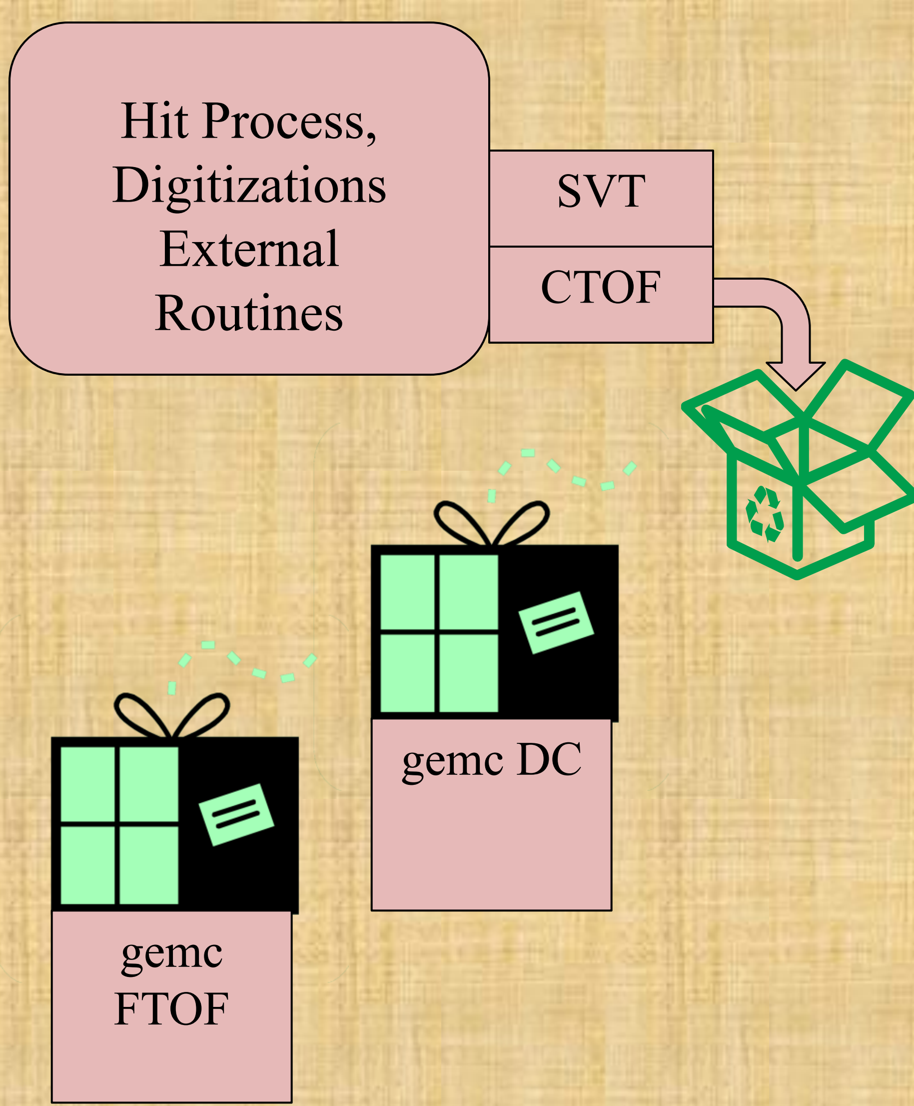
```
$detector{"pos"}          = ″10*cm 20*cm 305*mm";
$detector{"rotation"}     = "90*deg 25*deg 0*deg";
$detector{"color"}        = "66bbff";
$detector{"type"}         = "Trd";
$detector{"dimensions"}   = ″1*cm 2*cm 3*cm 4*cm 5*cm";
$detector{"material"}     = "Scintillator";
$detector{"mfield"}       = "no";
$detector{"ncopy"}        = 12;
$detector{"pMany"}        = 1;
$detector{"exist"}        = 1;
$detector{"visible"}      = 1;
$detector{"style"}        = 1;
$detector{"sensitivity"} = "CTOF";
$detector{"hit_type"}     = "CTOF";
$detector{"identifiers"} = "paddle manual 2";
```

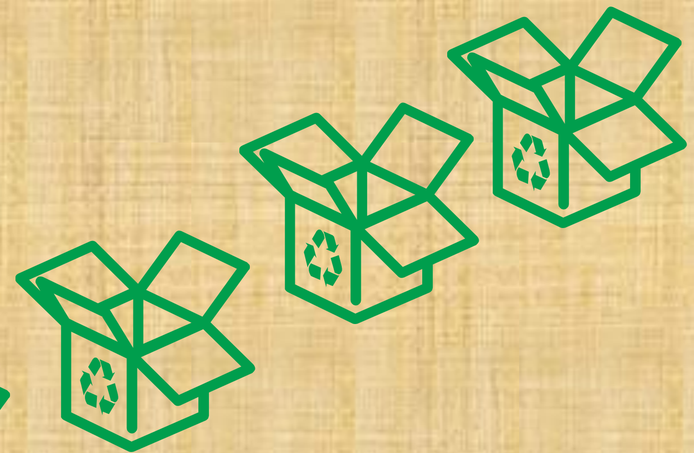
16th: Bank

17th: Digitization Routine

In general, 1 bank ←→ 1 digitization routine… but not necessary

Factory Method for Hit Processes





Automatic Process

Routines Still External

Easy to:
- add new routine
- debug
- modify

Digitization

Available For every G4 step	Hit Process Example
Hit Position →	Average (x,y,z)
Volume Local Hit Position →	Average (lx, ly, lz)
Deposited energy →	Total E
Time of the hit →	Average t
Momentum of the Track →	Average p (final p)
Energy of the track →	Energy
Primary Vertex of track →	Primary Vertex of track
Particle ID →	Particle ID
Identifier →	Strip, Layer, Sector
Mother Particle ID	
Mother Vertex	

Event Generation

1) Particle gun built in, two luminosity beams can be added
2) LUND Format (txt) for physics events

Data Output

1) evio, bank alike binary format by Jlab DAQ group
2) Root tree, convert from evio
3) text

Documentation

- **gemc.jlab.org**
- **https://hallaweb.jlab.org/wiki/index.php/Solid_sim_geant4**

Solid sim geant4

Contents [hide]

Advantage

- Central outside location of geometry/sensitivity/field/digitization
- Customized hit processing for various detectors
- ***Unified individual detector simulation and the whole SoLID simulation***

GEMC update

Progress

- Mirrors, done in the “identifiers” entry of the geometry, control optical property on fly.
- Right click to output geometry in GDML format.
- Mother particle tracking becoming optional to optimize speed.

Todo list

- Move material definition into database also.
- Move svn repository out of clas12svn and restructure.
- Improve database I/O.
- Adapt to Geant4.9.4.

SoLID GEMC update

Progress

- Add “solid” HIT_PROCESS_LIST
- More database added in soliddb.jlab.org to allow for the full SoLID, its subsystems simulation. Also database for individual developers.
- PVDIS and SIDIS yoke designs and field maps are unified
- More materials added for our setup.
- More instructions on wiki
- Rewrote many geometry to avoid overlap and added more
- EC simulation in GEMC is under work.
- Baffle redesign for various magnets
- Event generators updated for PVDIS and SIDIS
- Study configuration with ZEUS magnet.

Todo list

- Move subsystem simulation to GEMC
- Customize hit routine
- Direct root output

Compare geant4 to geant3 results

Progress

- SIDIS kinematics and angle distribution
- SIDIS and PVDIS low energy background rate.

Todo list

- Acceptance
- Detector resolution

CLAS12 SVT

Validation

	EM	Hadronic	Total
1a	57.68	2.588	60.27
1b	43.29	2.124	45.41
2a	50.82	3.685	54.51
2b	41.91	3.162	45.07
3a	44.59	4.813	49.4
3b	38.04	4.354	42.4

Geant4

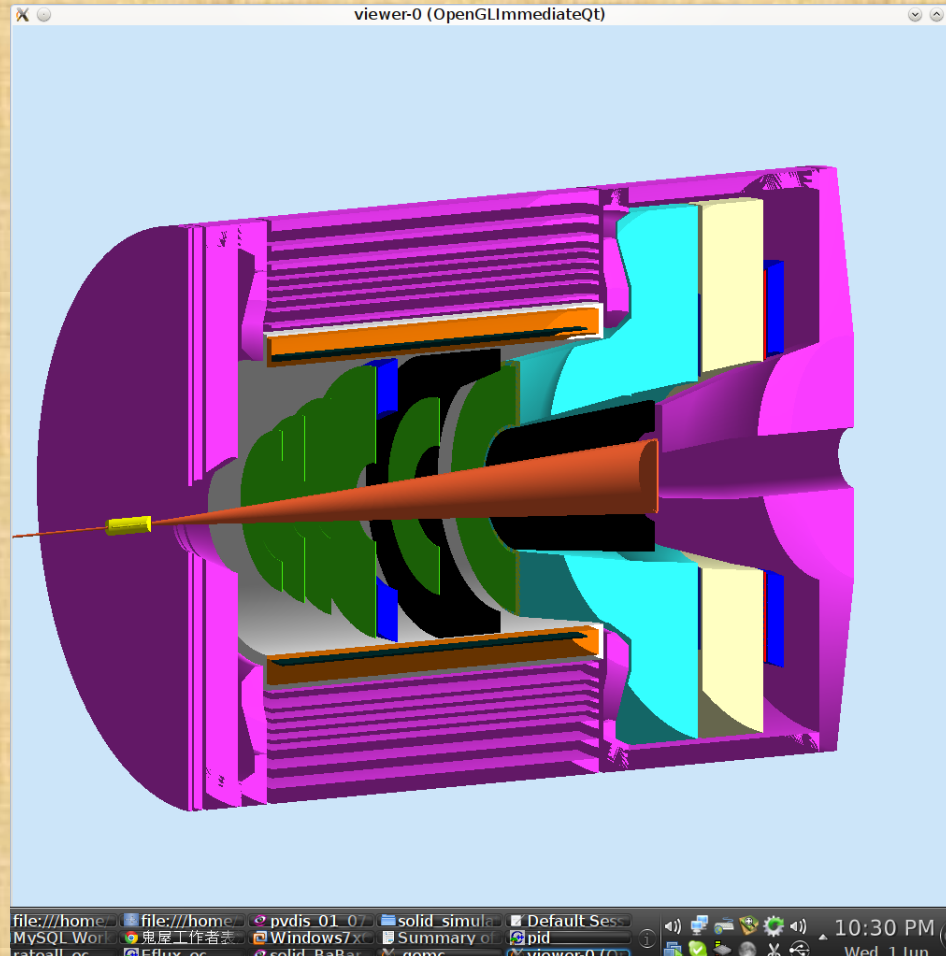
- Layer 1 - Total : 57.5 , hadrons : 3.4
- Layer 2 - Total : 51.1 , hadrons : 3.3
- Layer 3 - Total : 57.0 , hadrons : 4.3
- Layer 4 - Total : 51.3 , hadrons : 4.0
- Layer 5 - Total : 53.5 , hadrons : 4.3
- Layer 6 - Total : 49.4 , hadrons : 4.0

Geant3

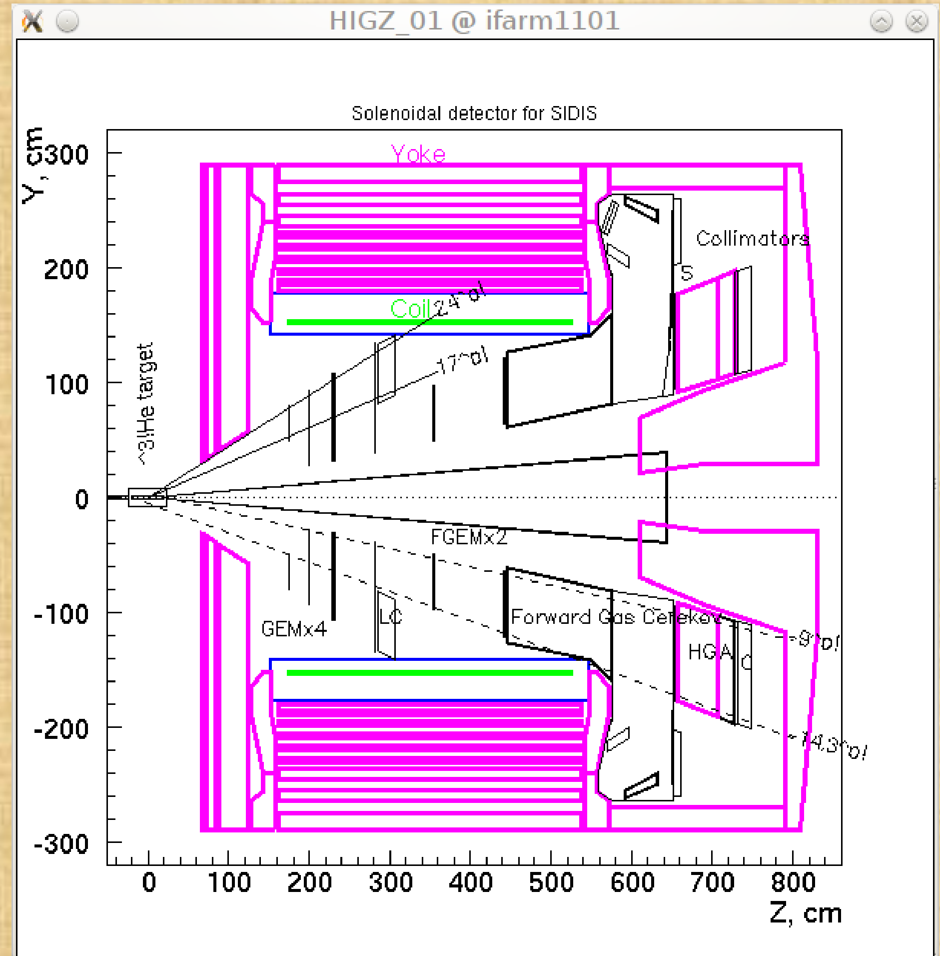
All rates in MHz

SIDIS with BaBar Magnet

geant4

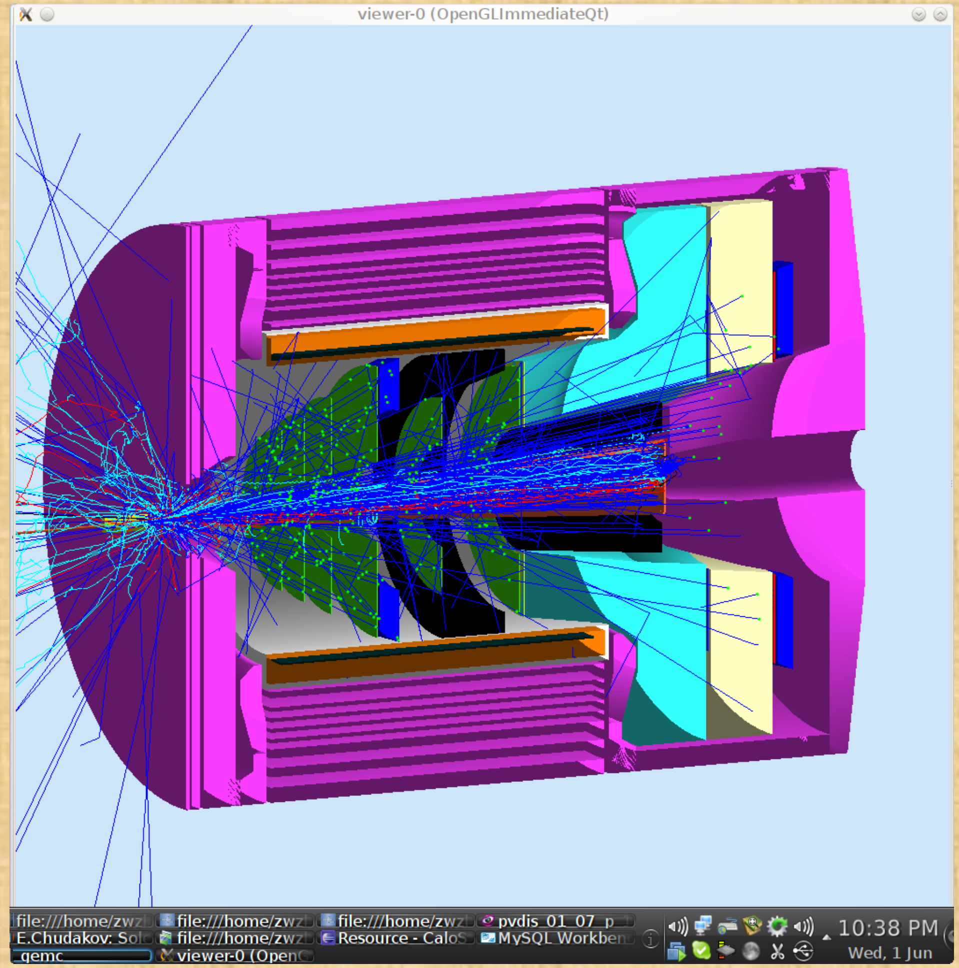


geant3

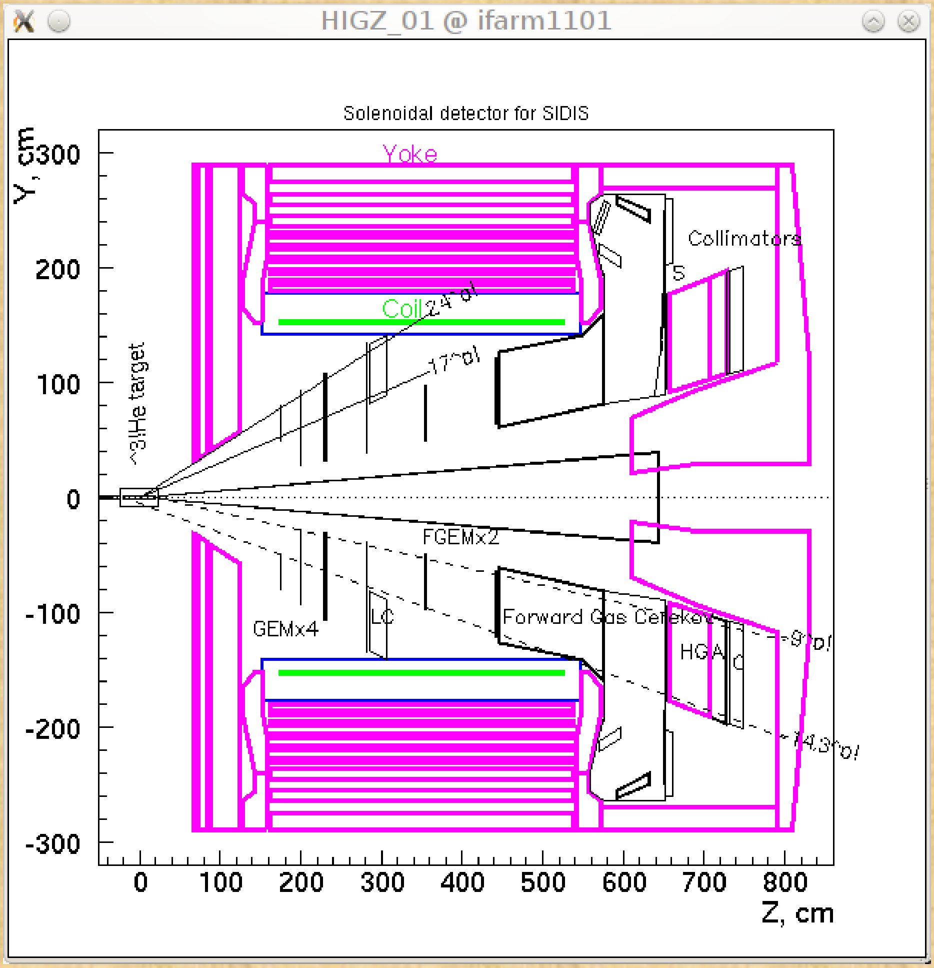


SIDIS with BaBar Magnet

geant4

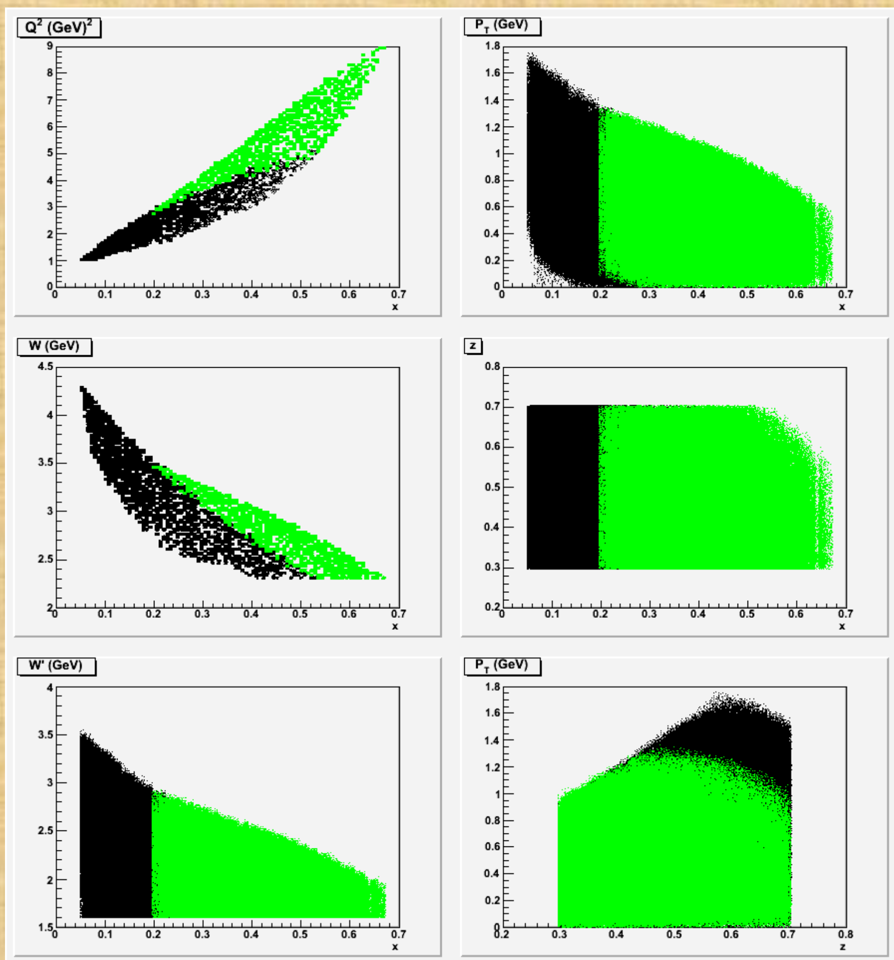


geant3



Kinematics for SIDIS with BaBar

geant4



geant3

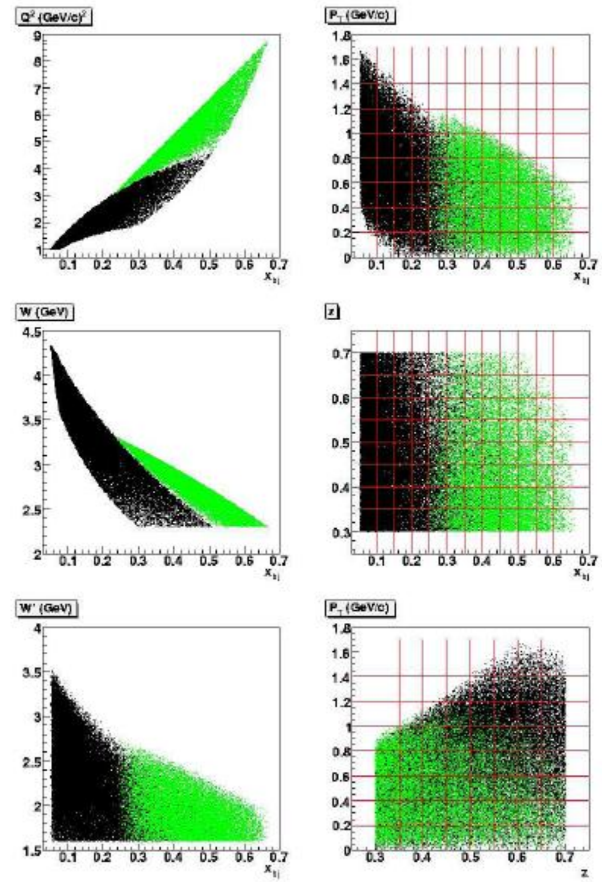
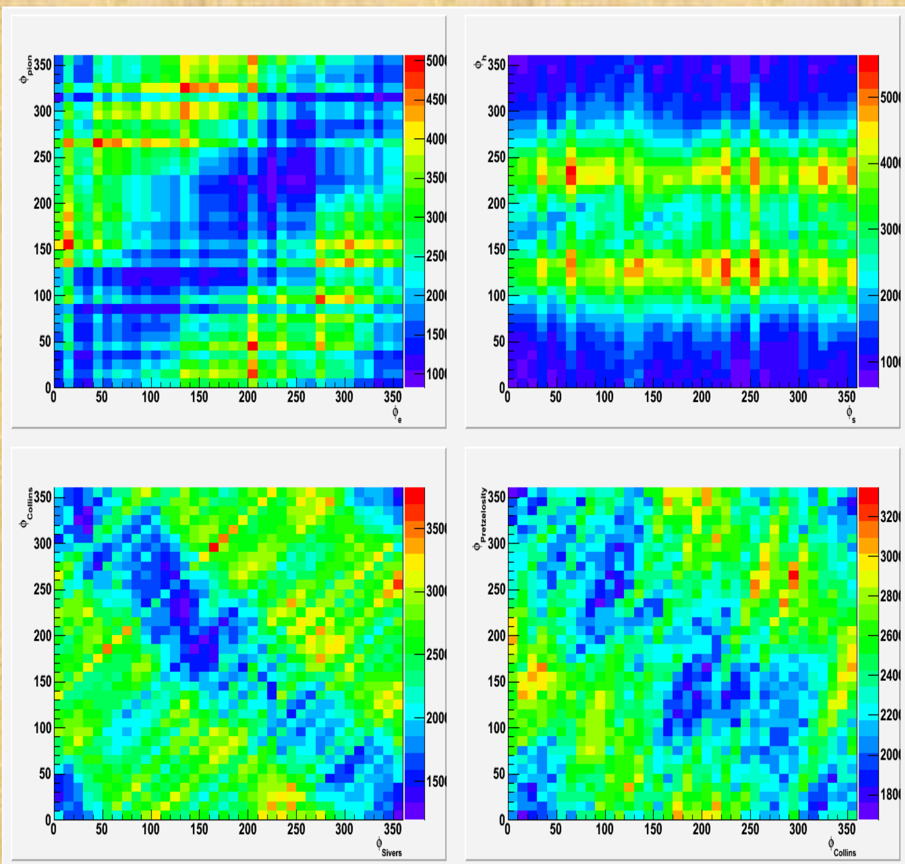


Figure 19: Kinematic coverage for the solenoid detector with a 11 GeV electron beam. The black points show the coverage for the forward angle detector and the green points show the coverage for the large angle detector.

40

Phase Space, Collins and Sivers Angle Coverage for SIDIS with BaBar

geant4



geant3

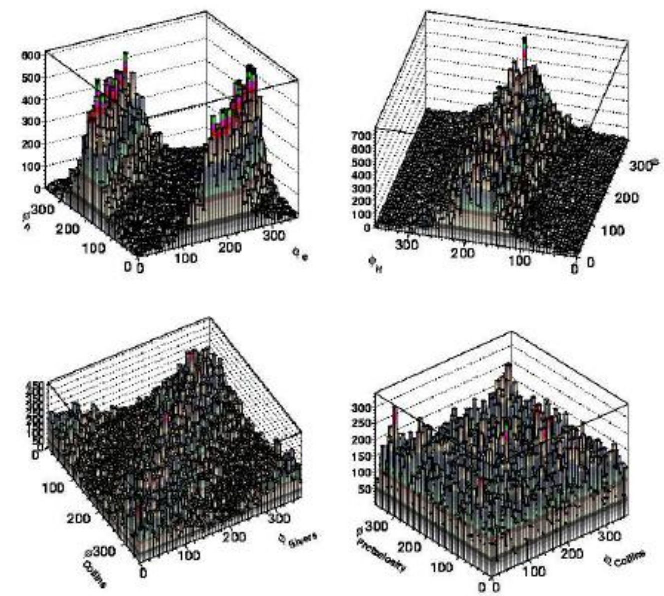
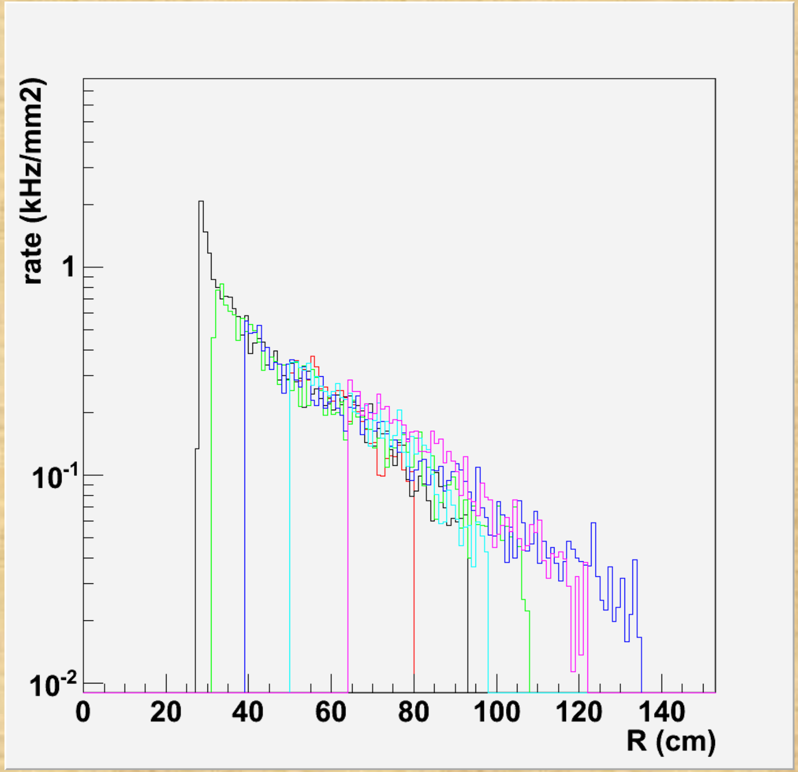


Figure 20: Angular coverage: The top left panel is for electron and hadron azimuthal angle. The top right panel is the ϕ_S and ϕ_h angle. The bottom left panel is the $\phi_{Collins}$ and ϕ_{Sivers} and the bottom right panel is the $\phi_{Collins}$ and $\phi_{Pretzelosity}$. The proposed experiment has the full 2π coverage in all azimuthal angular coverage.

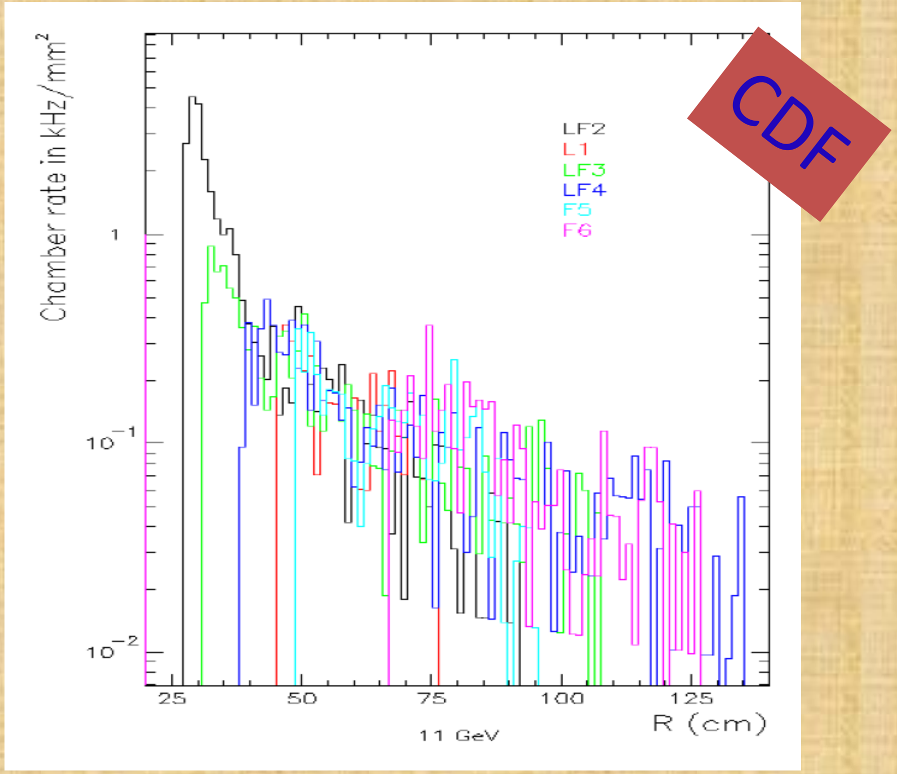
41

Background rate on GEM for SIDIS with BaBar

geant4



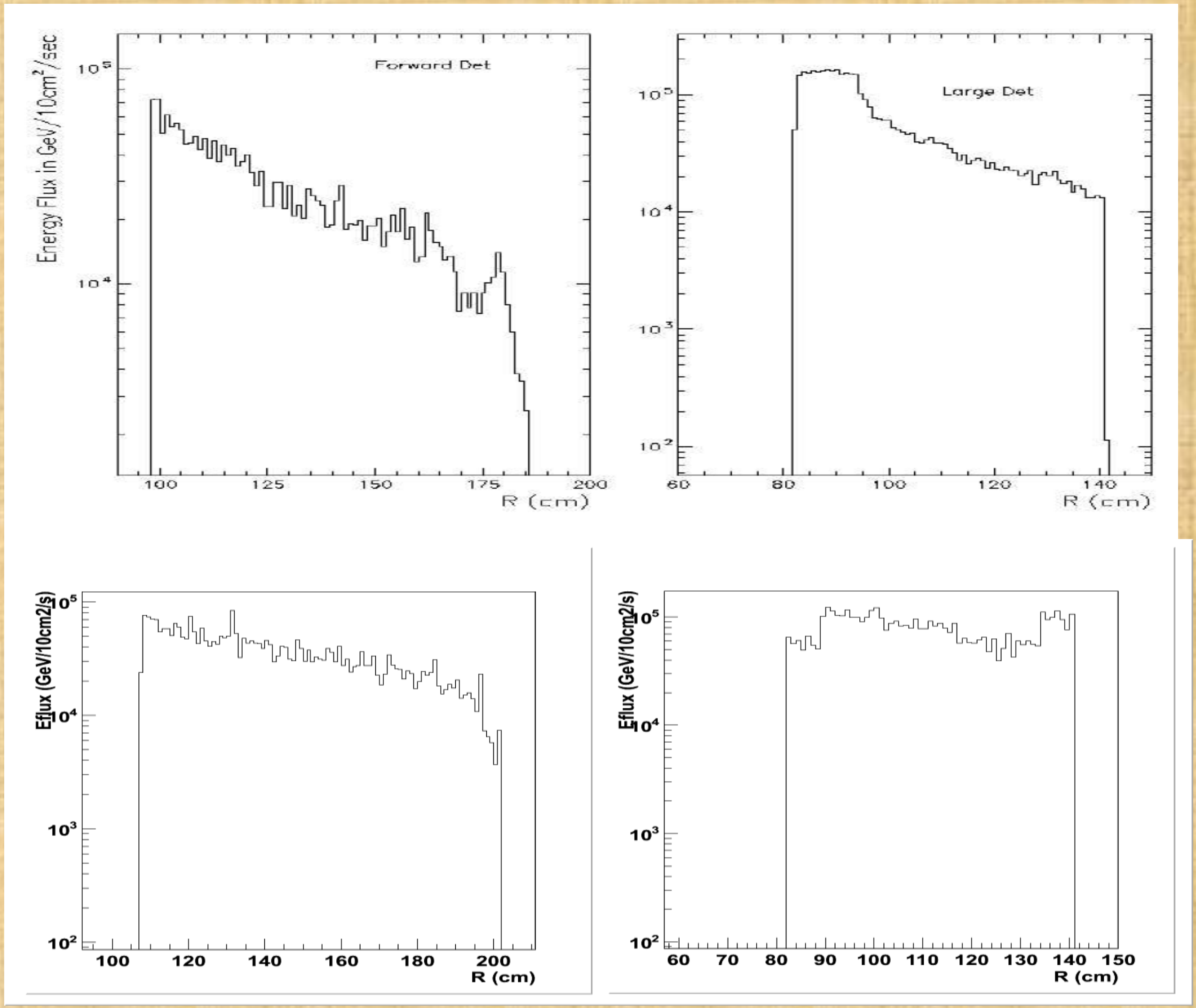
geant3



Condition: 15uA 11GeV e- beam, 40cm 3He 10amg gas target

Result: geant4 is about 1/2 of geant3 with a different magnet

Energy flux rate on EC for SIDIS with BaBar



geant3

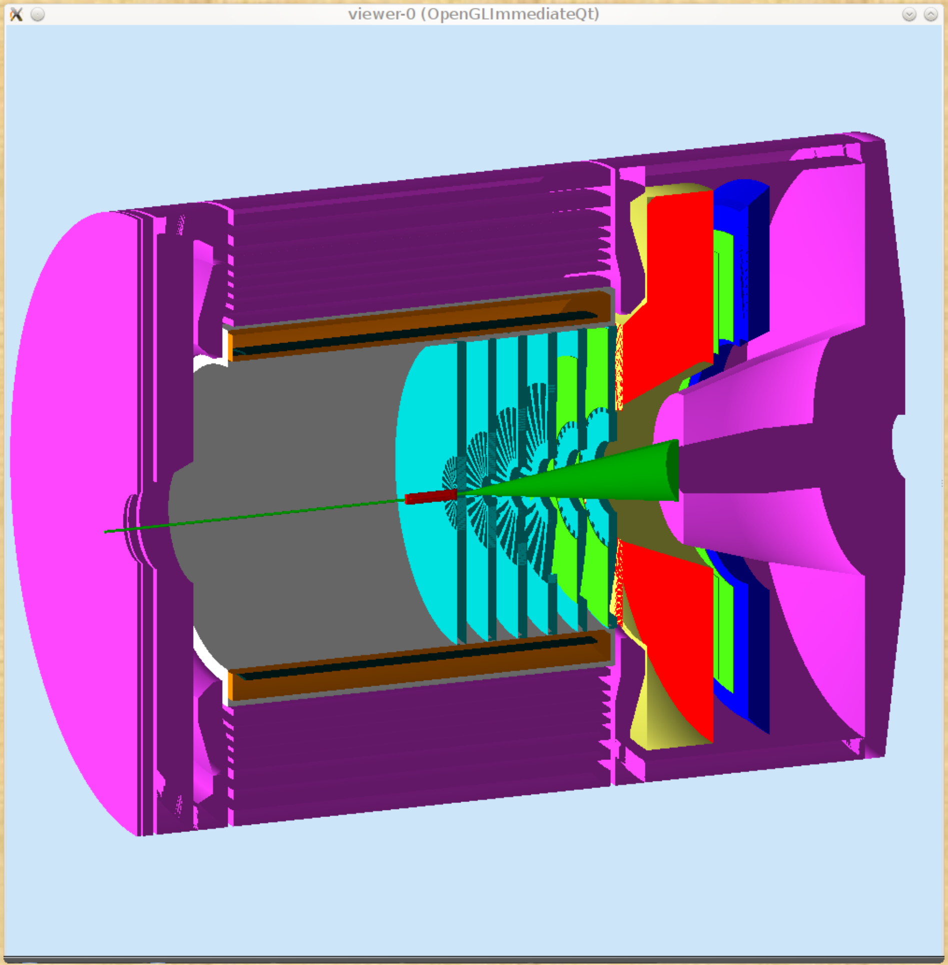
geant4

Condition: 15uA 11GeV e- beam, 40cm 3He 10amg gas target

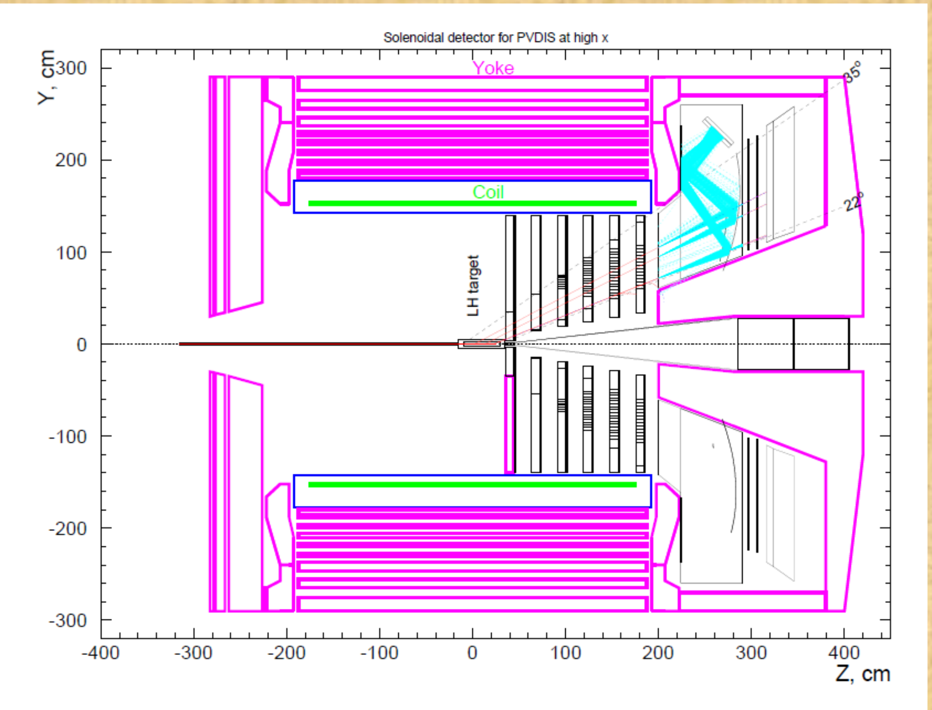
Result: geant4 is close to geant3 with the same magnet

PVDIS with BaBar Magnet

geant4

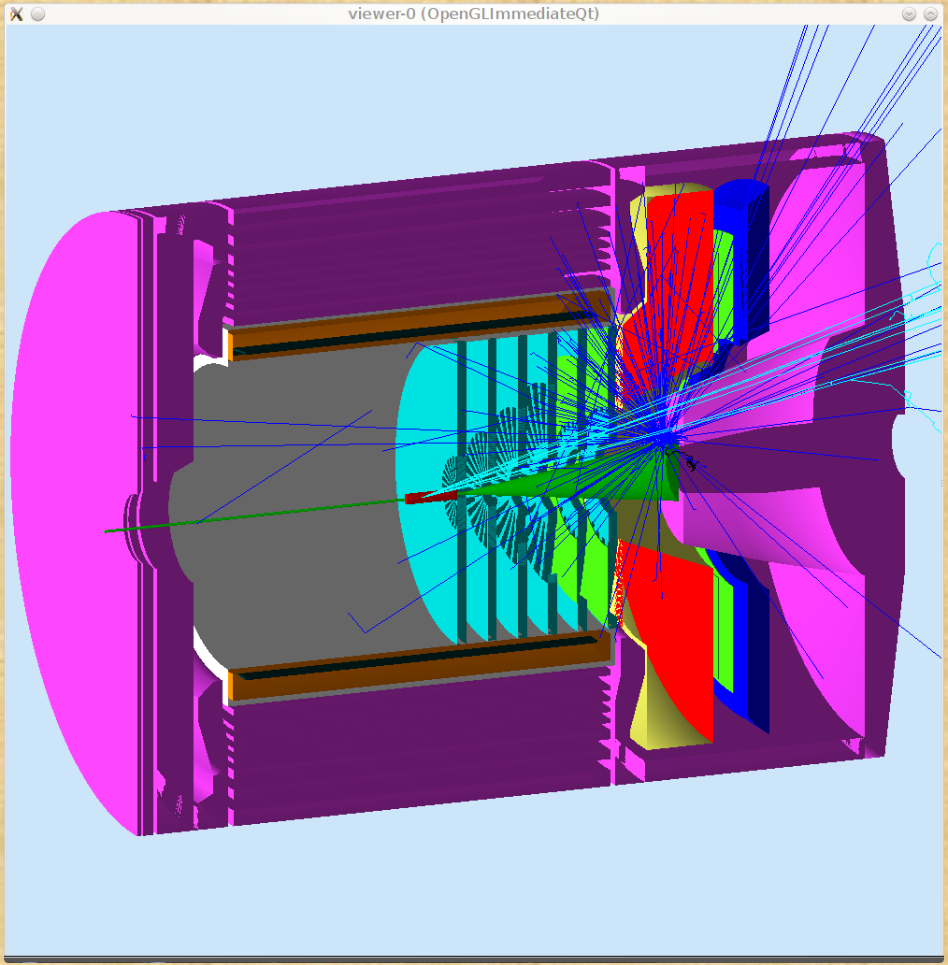


geant3

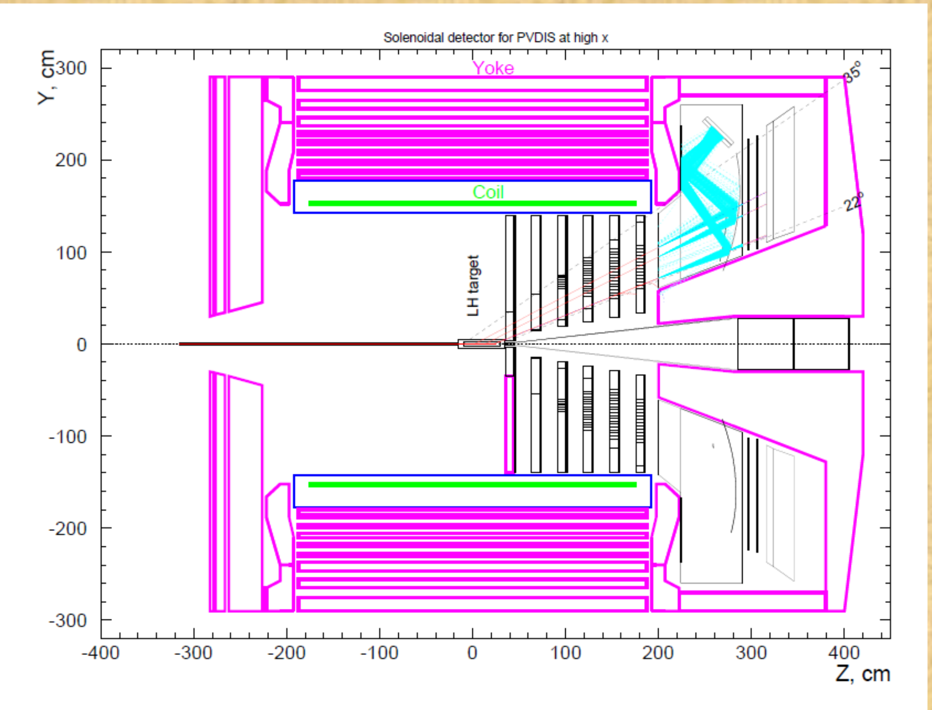


PVDIS with BaBar Magnet

geant4

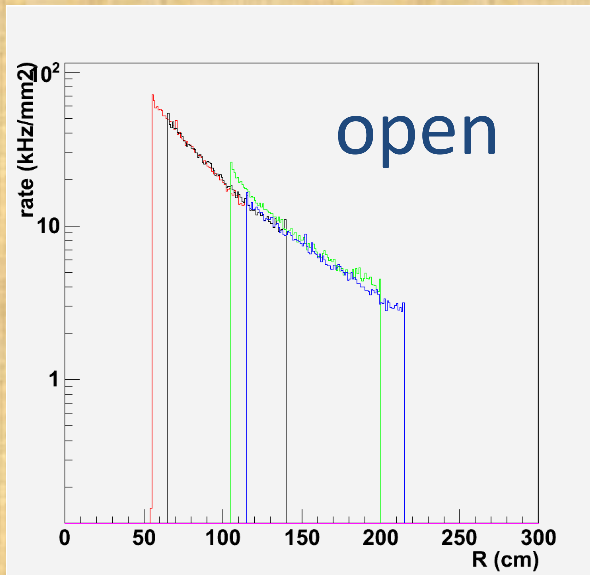


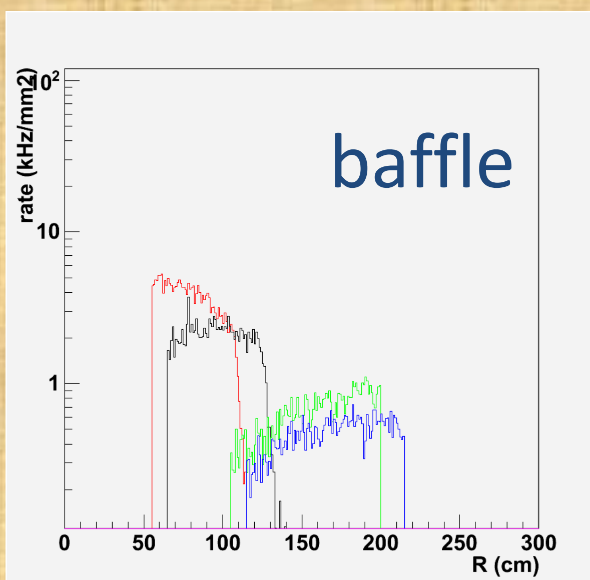
geant3



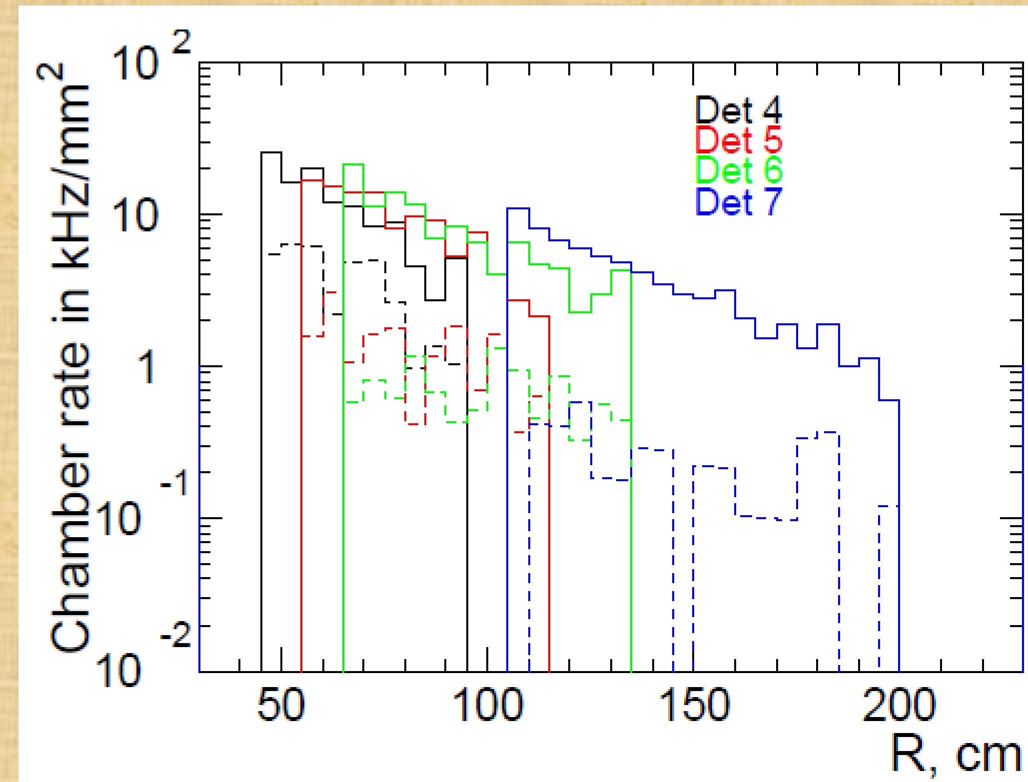
Background rate on GEM for PVDIS with BaBar

geant4





geant3

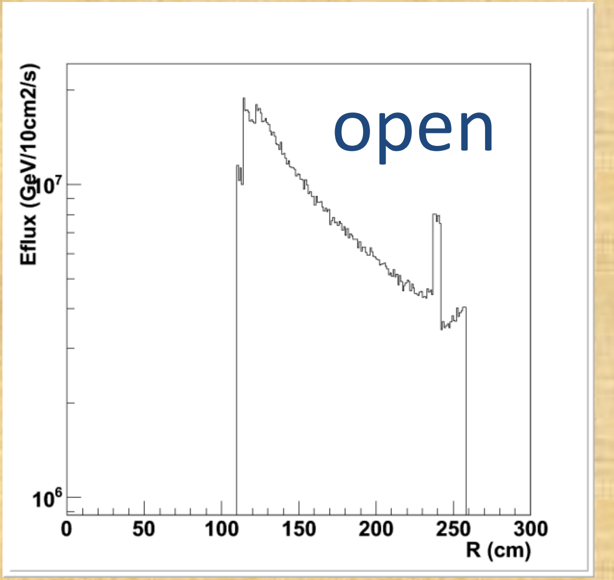


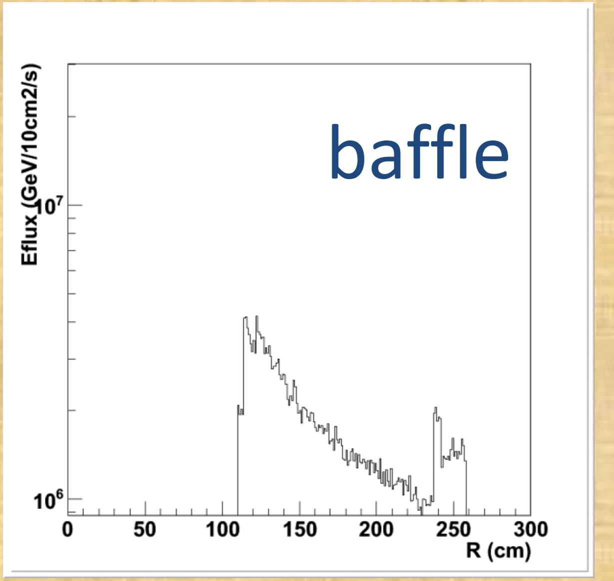
Condition: 50uA 11GeV e- beam, 40cm LD2 target

Result: geant4 is about 2 times of geant3 with LH2 target.

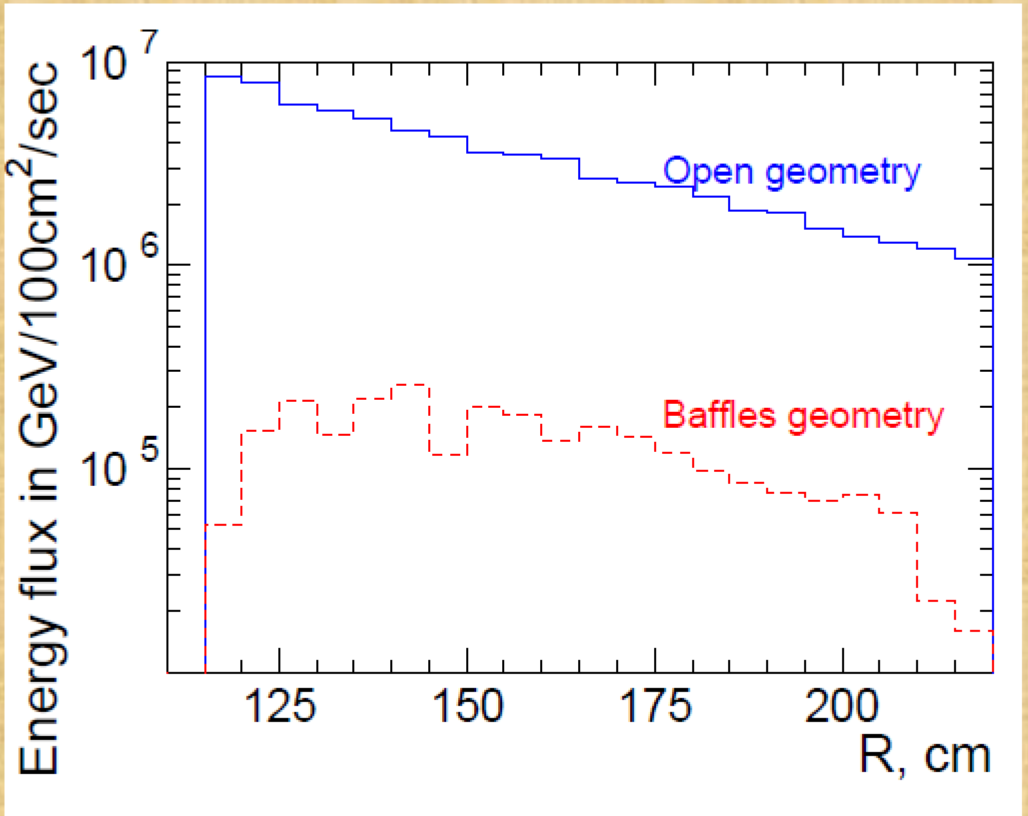
Energy flux rate on forward EC for PVDIS with BaBar

geant4





geant3



Condition: 50uA 11GeV e- beam, 40cm LD2 target

Result: geant4 is about 2 times of geant3 with LH2 target.

Summary

- Solid Simulation is making progress.
- Geant4 physics is under control.
- The program is ready to be used for various studies to help design.
- Subsystem simulation should take advantage of the framework.

Thanks

- Maurizio Ungaro
- Paul Reimer
- Seamus Riordan
- Lorenzo Zana
- Simona Malace
- Yang Zhang
- Eugene Chudakov
- Xin Qian
- Zhiwen Zhao