SoLID Simulation

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SoLID Jlab Physics Division
Brainstorming Session
2012/01/06

Jefferson Lab

Outline

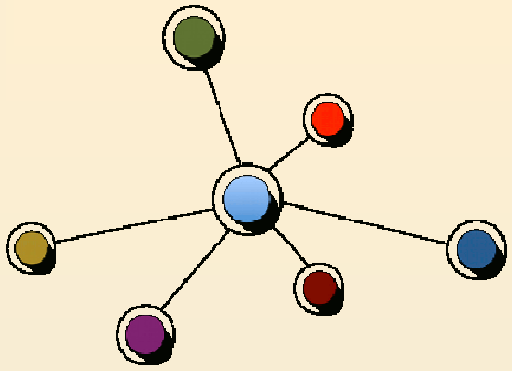
- History
- SoLID GEMC simulation framework
- Simulation study
  - Choosing Magnet
  - PVDIS Baffle Design
  - EM background
  - Neutron background
- Summary

History

- Comgeant, Geant3 based simulation program.
- geometry/sensitivity/digitization/field as input files and detached from main code, run different settings without recompilation.
- Successfully used for PVDIS and SIDIS proposals.

- As Geant3 development has stopped, we want to move on from Geant3, Fortran based framework to Geant4, C++ based framework for the next 10 years of design, running and analysis.

GEMC (GEant4 MonteCarlo)



Used by CLAS12

- C++ program that simulates particles through matter using the Geant4
- Detector information are stored in mysql database. configuration changes are immediately available to users without need of recompiling the code.
- Hit process factory: associate detectors with external digitization routines at run time.
- perl script I/O to database, no need to know C++ or Geant4 to build detector and run the simulation.

GEOMETRY, BANKS, DIGITIZATION DATABASE → network → GEMC

GEMC interface

Batch mode

Various GEMC Options:

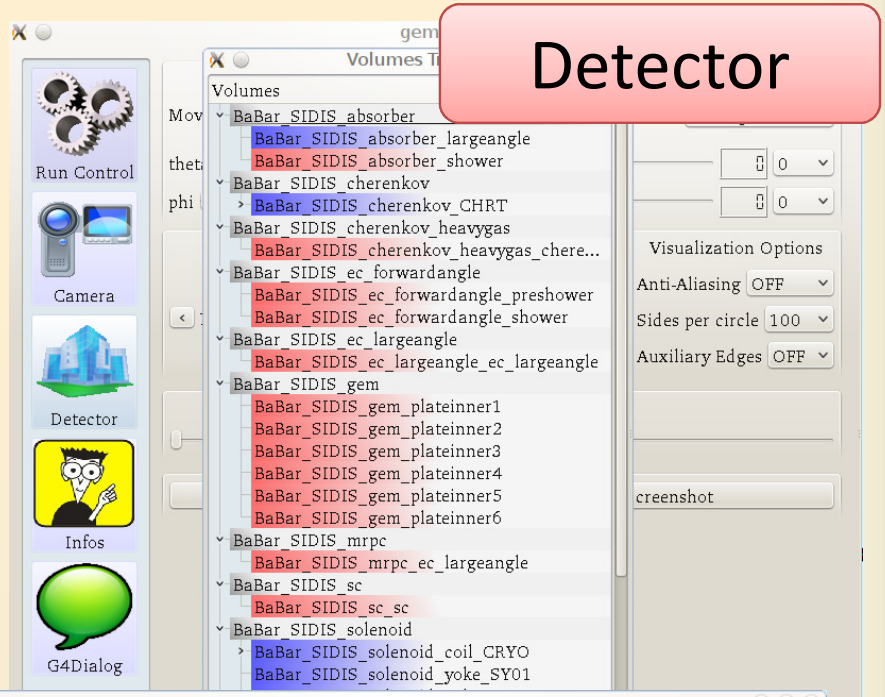
- Control
- General
- Generator
- Luminosity
- Mysql
- Output
- Physics
- Verbosity

GEMC interface

Interactive mode

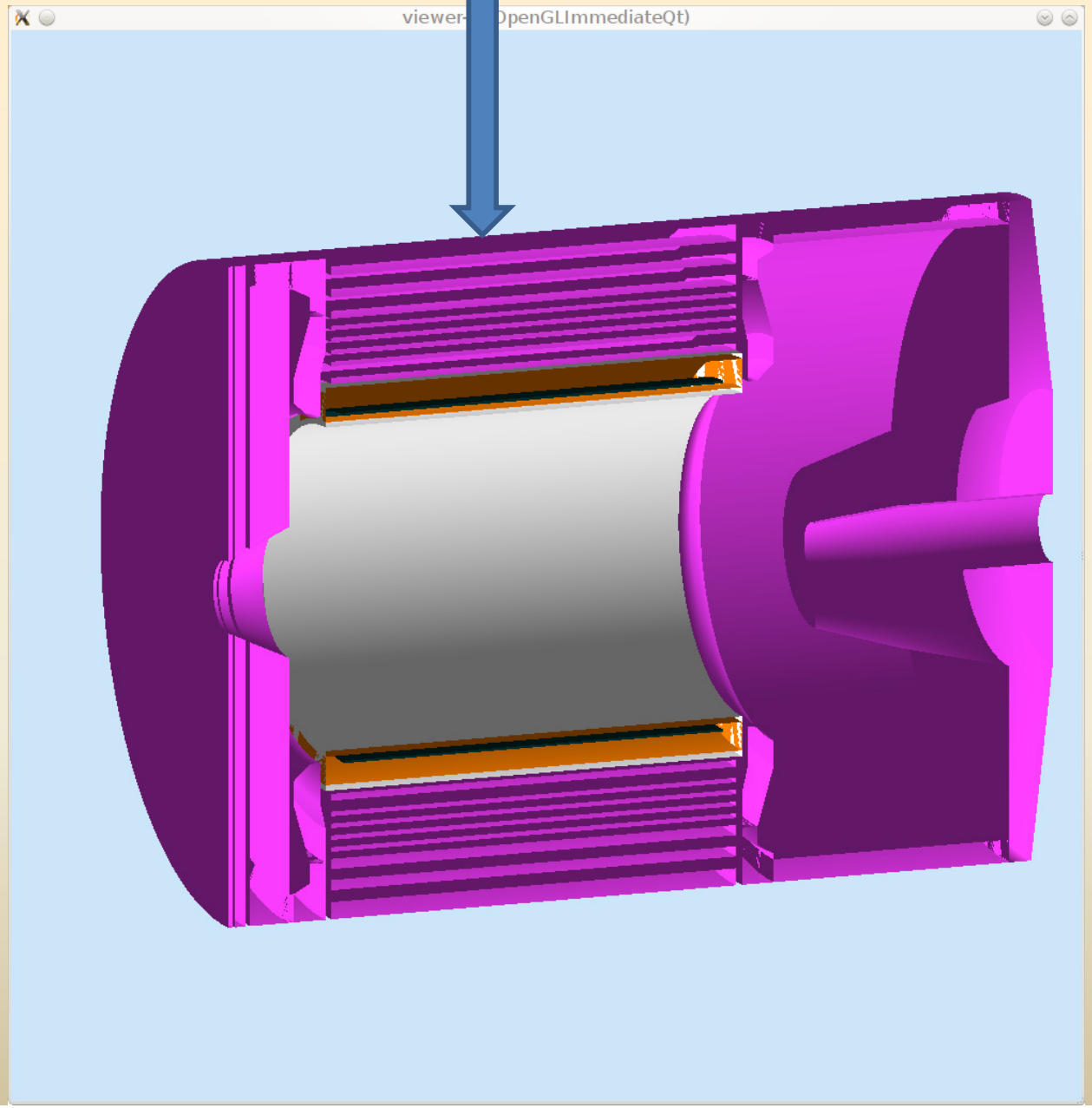
Run Control

Detector

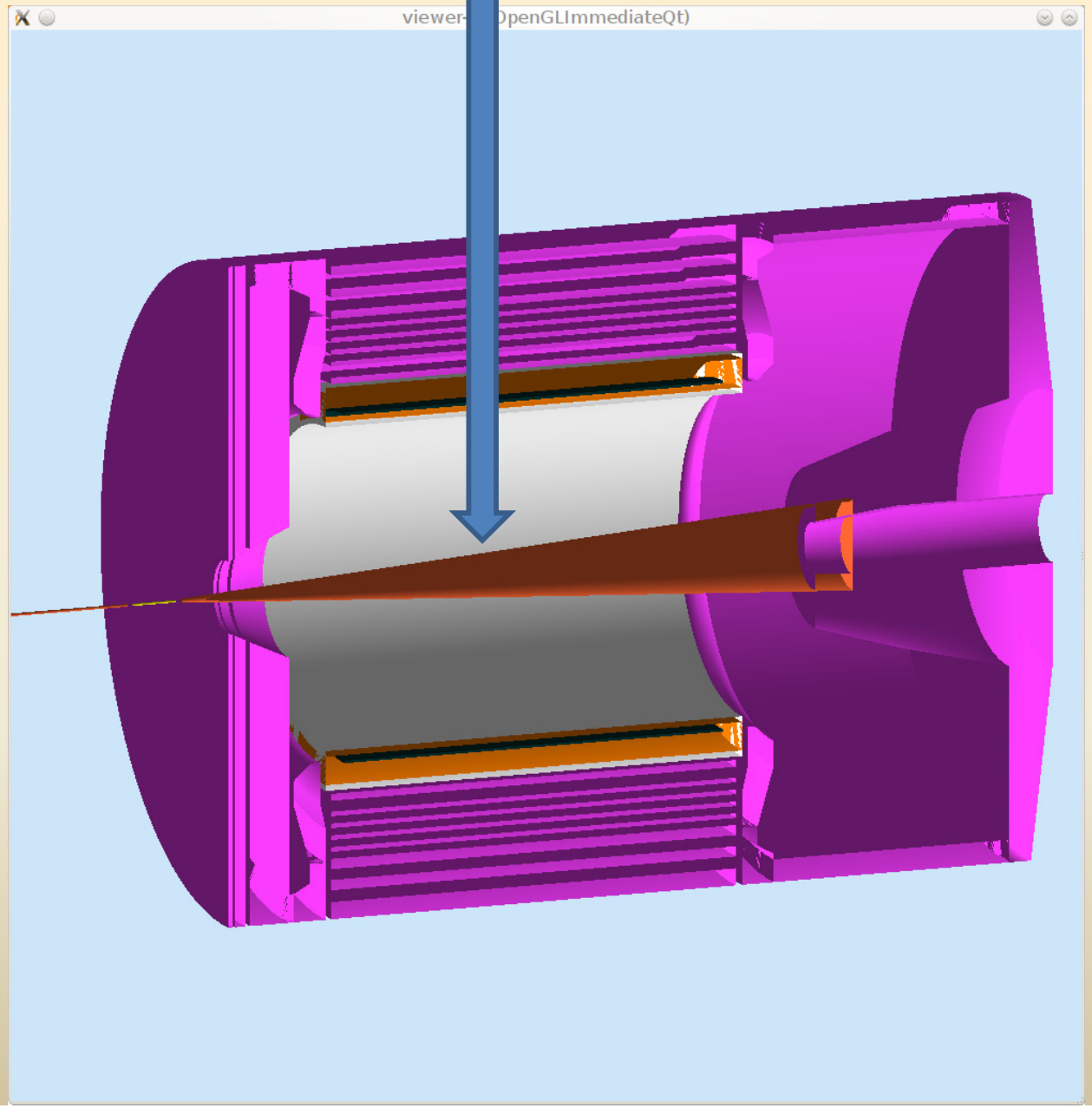


Camera

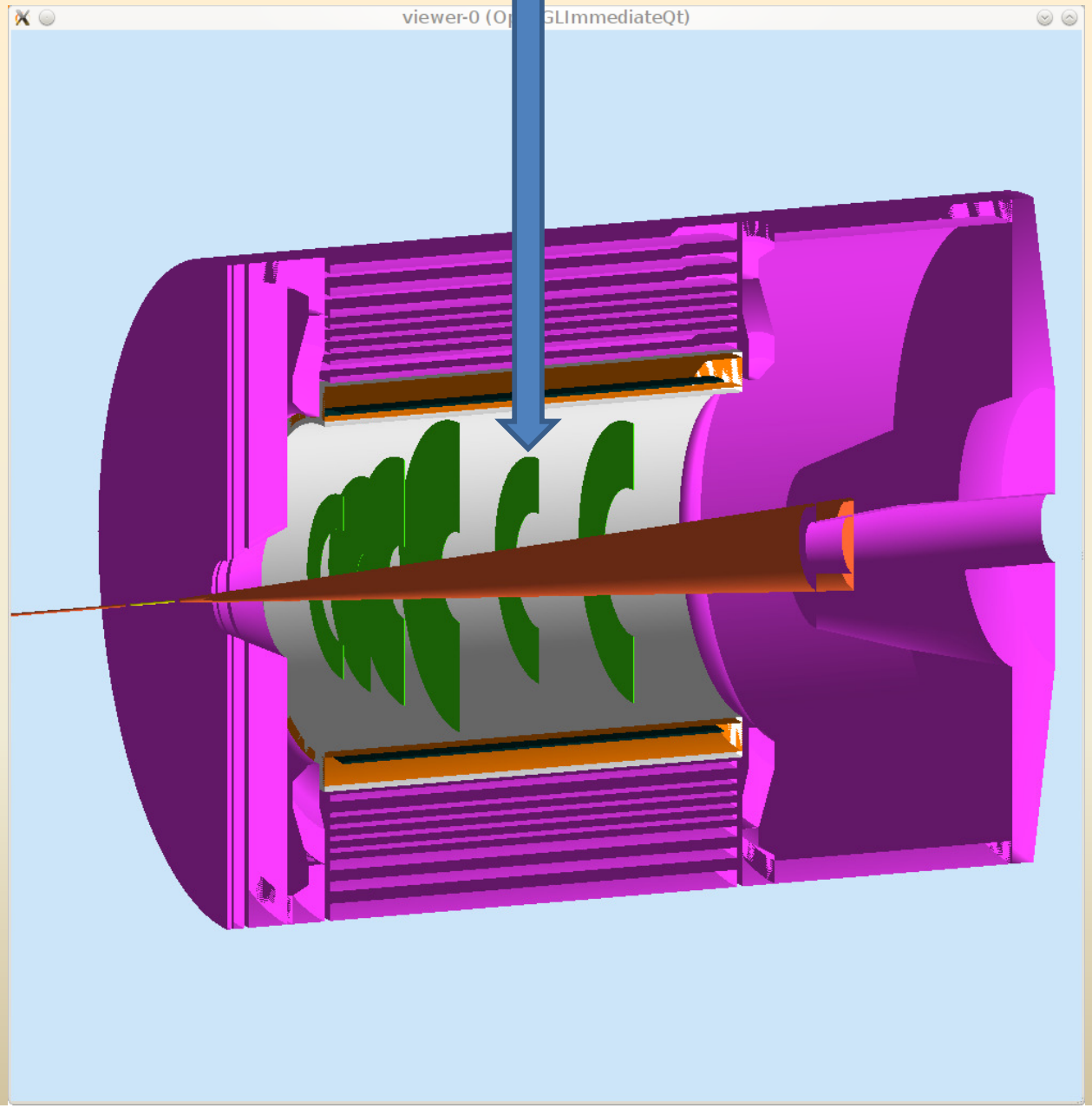
Magnet/coil/yoke



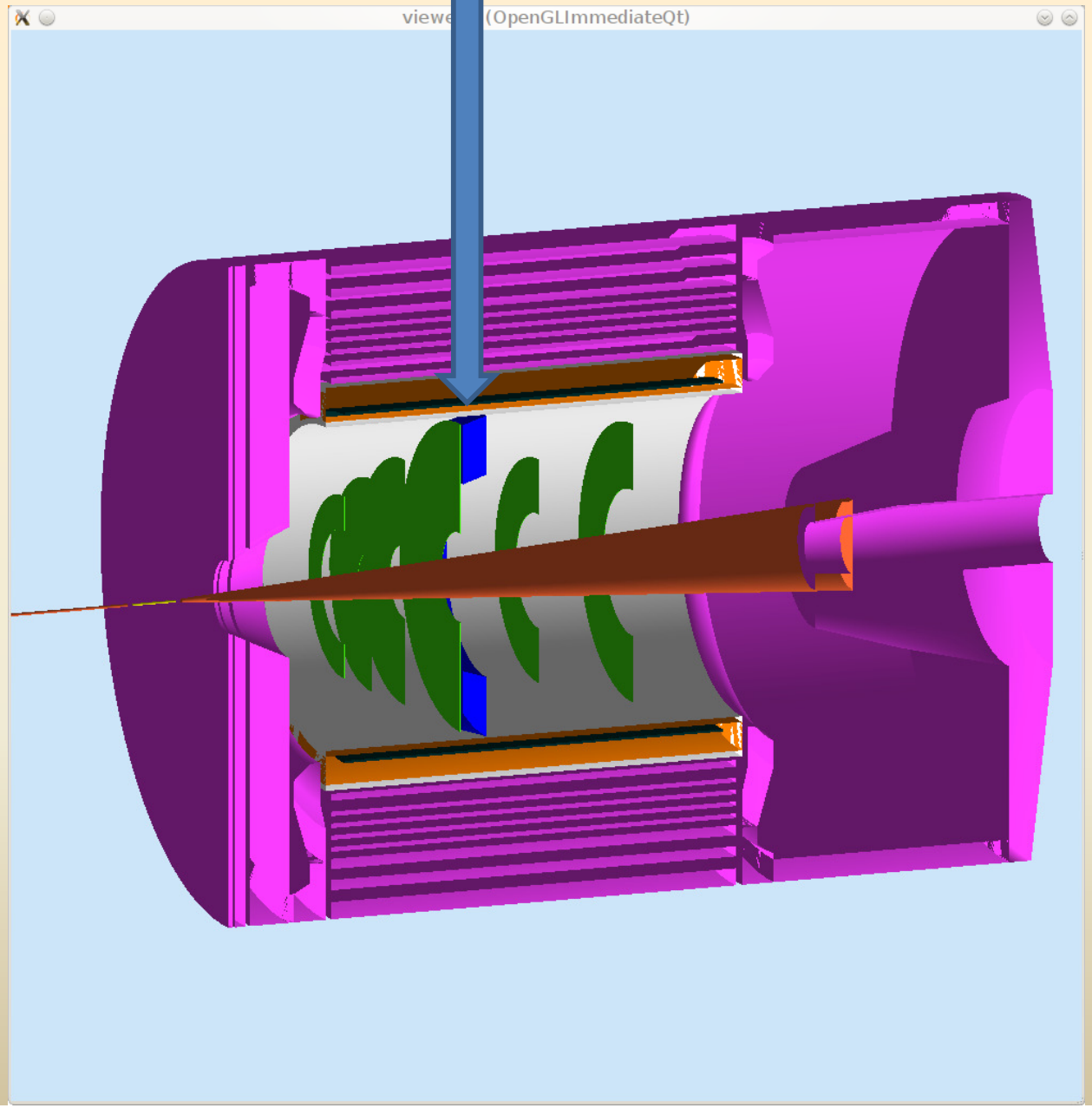
Target/Beam line



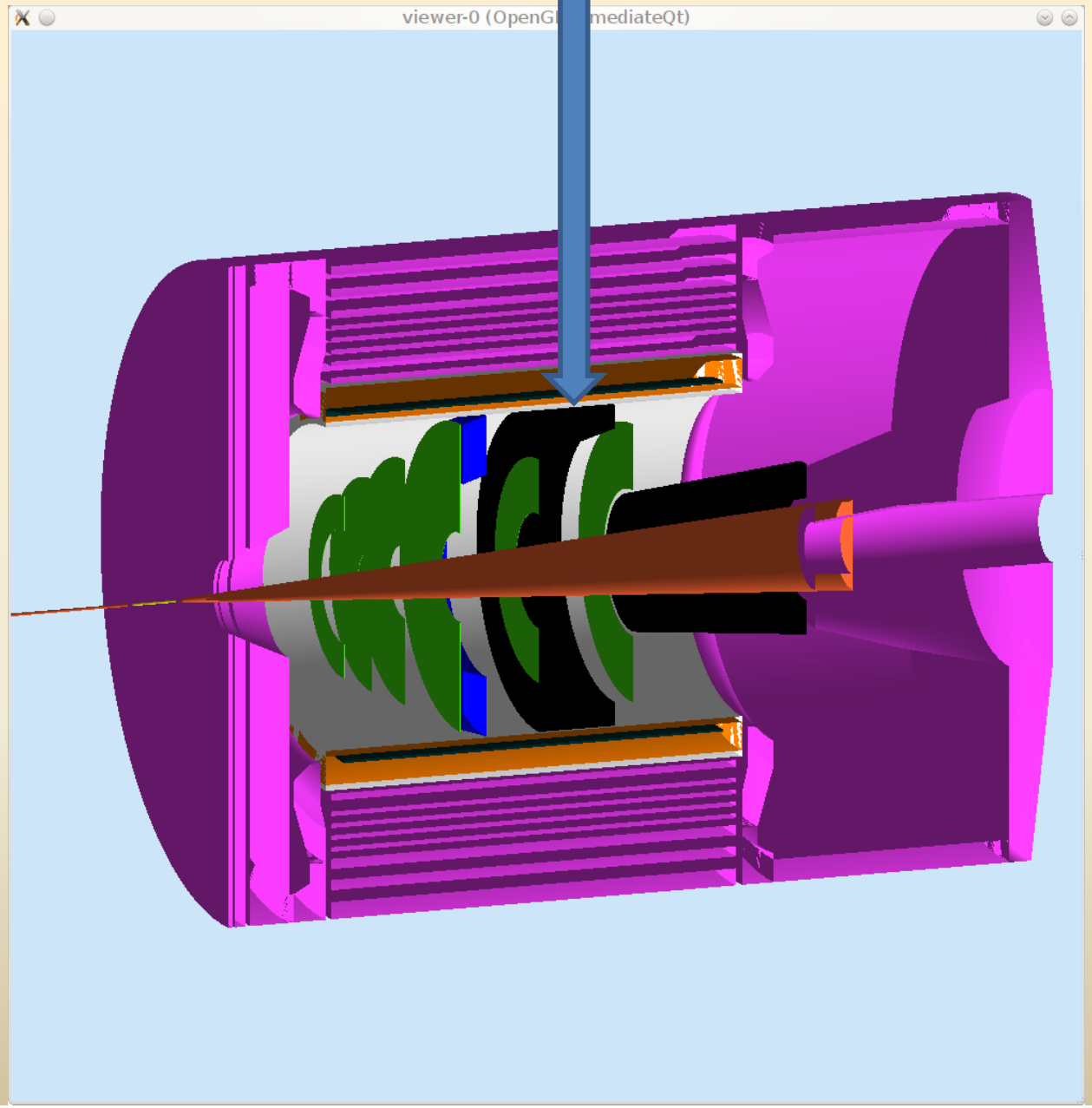
GEM



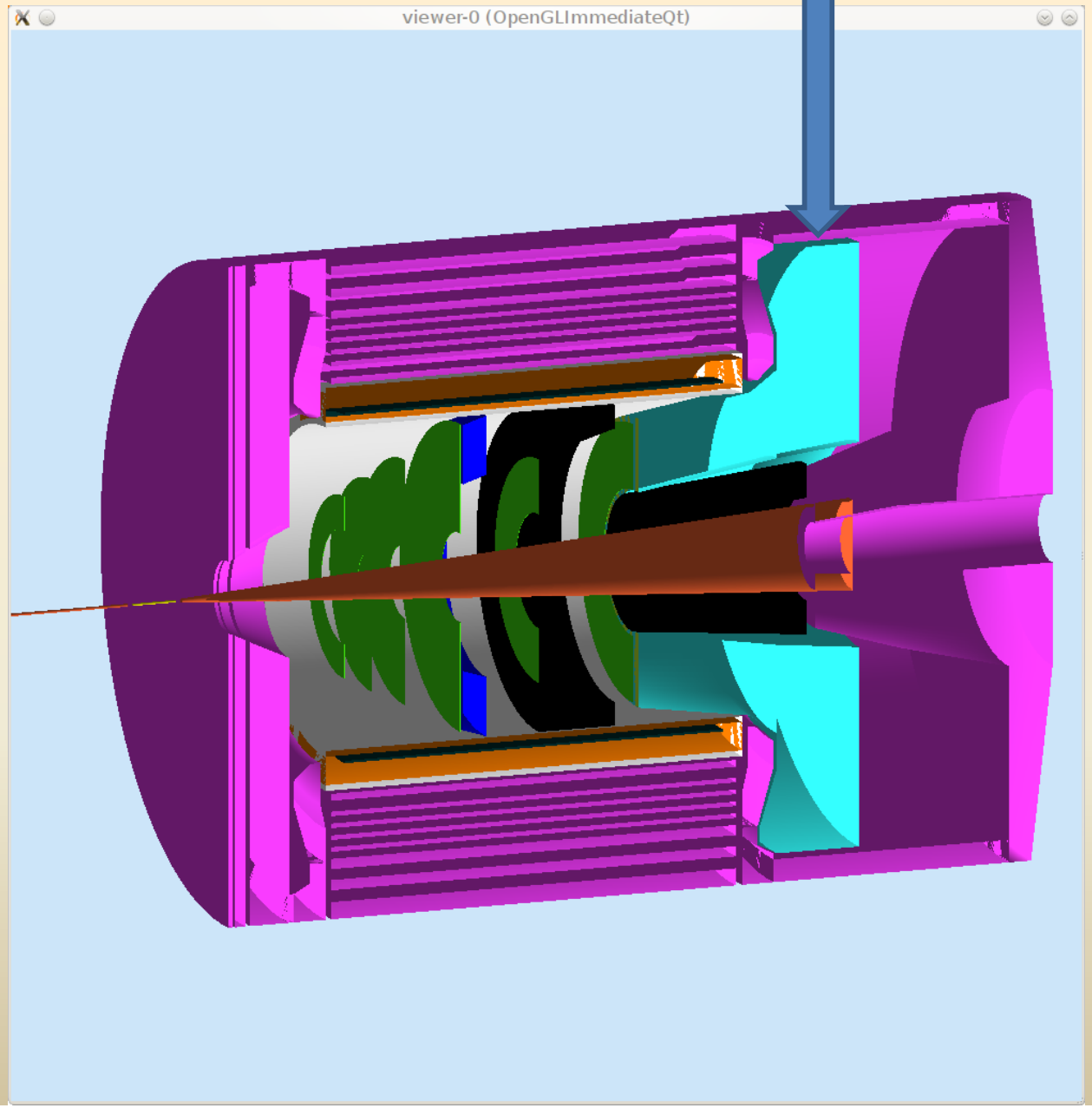
EC, large angle



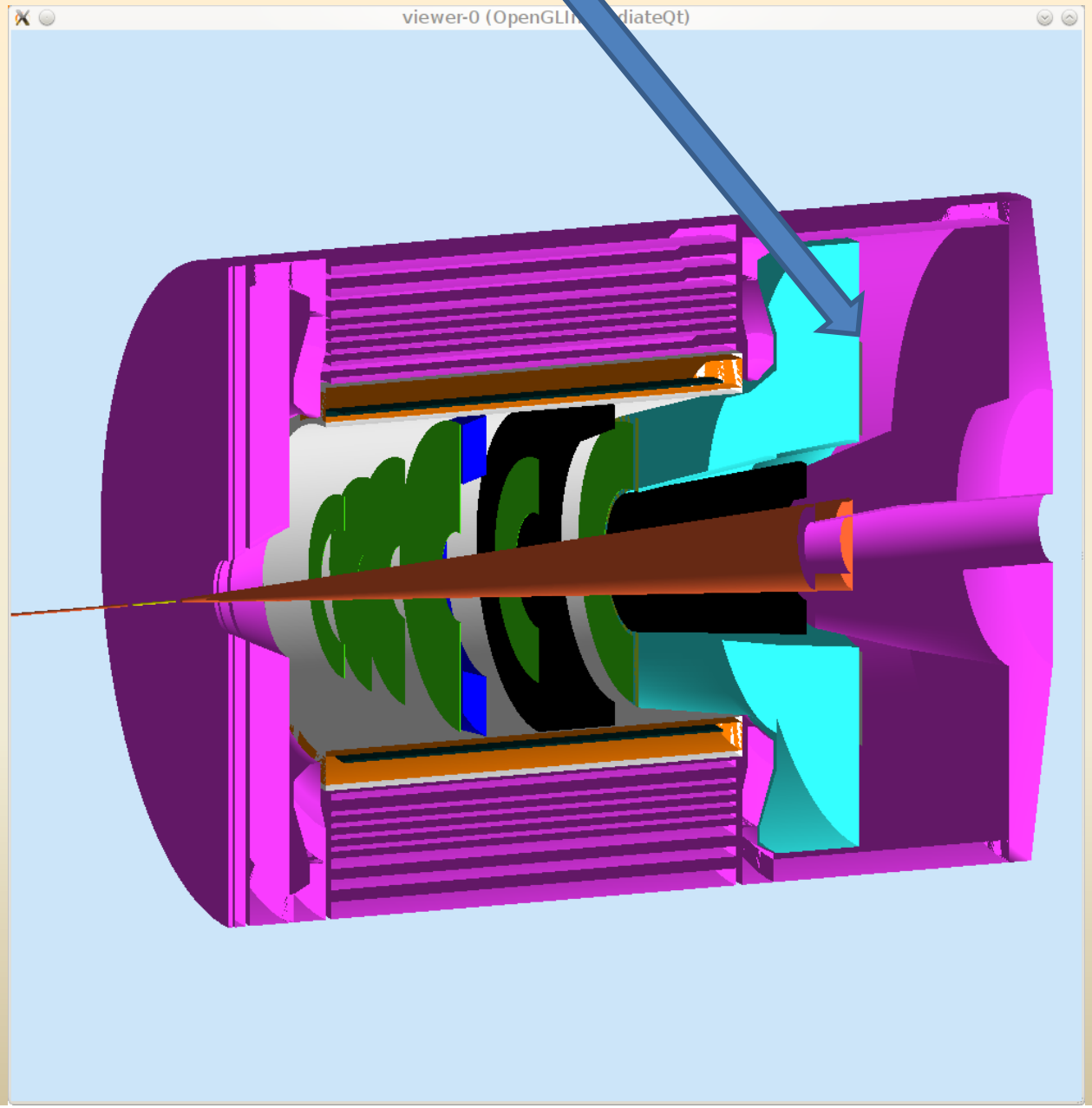
Collimator



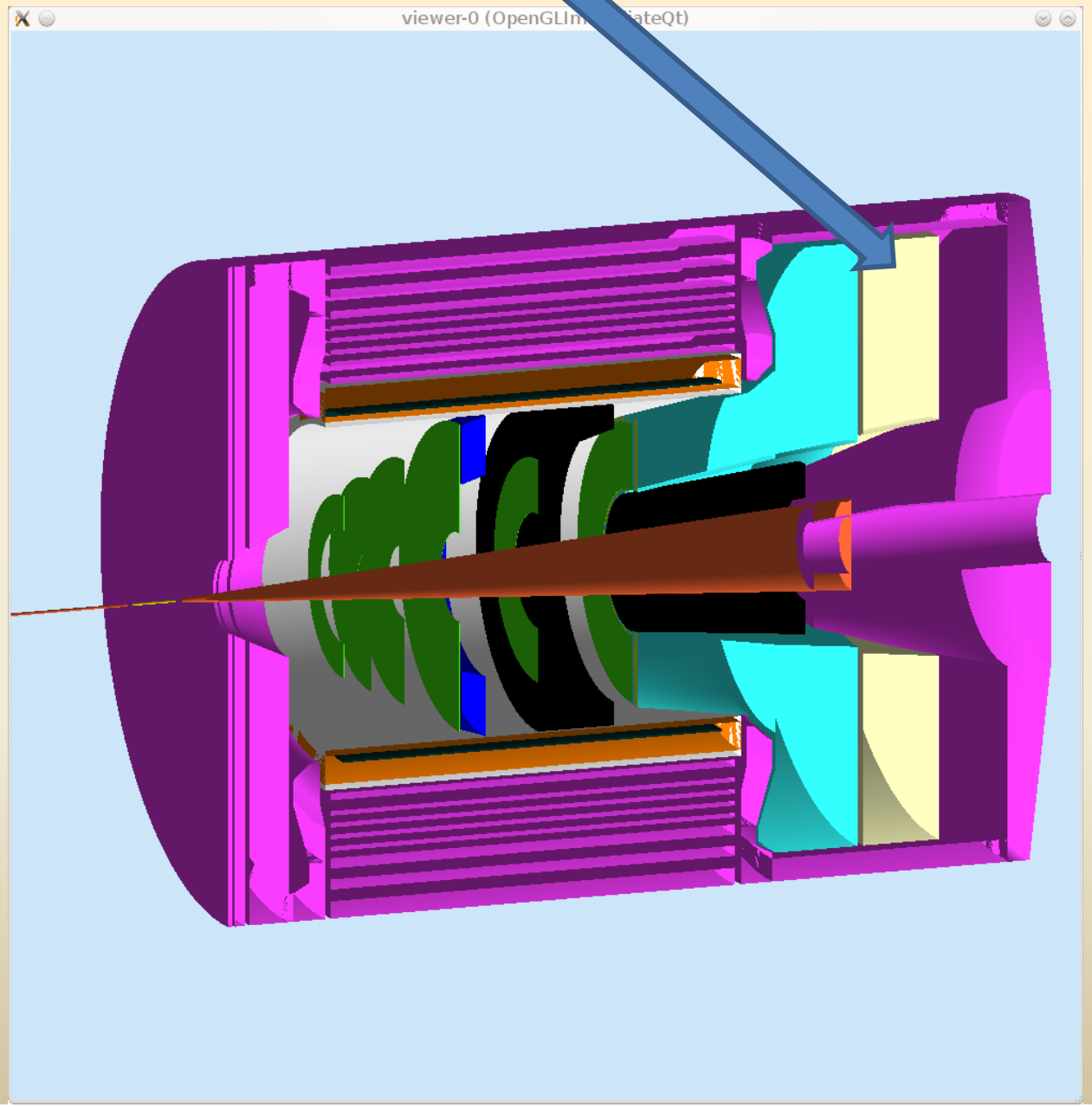
Cherenkov, light gas



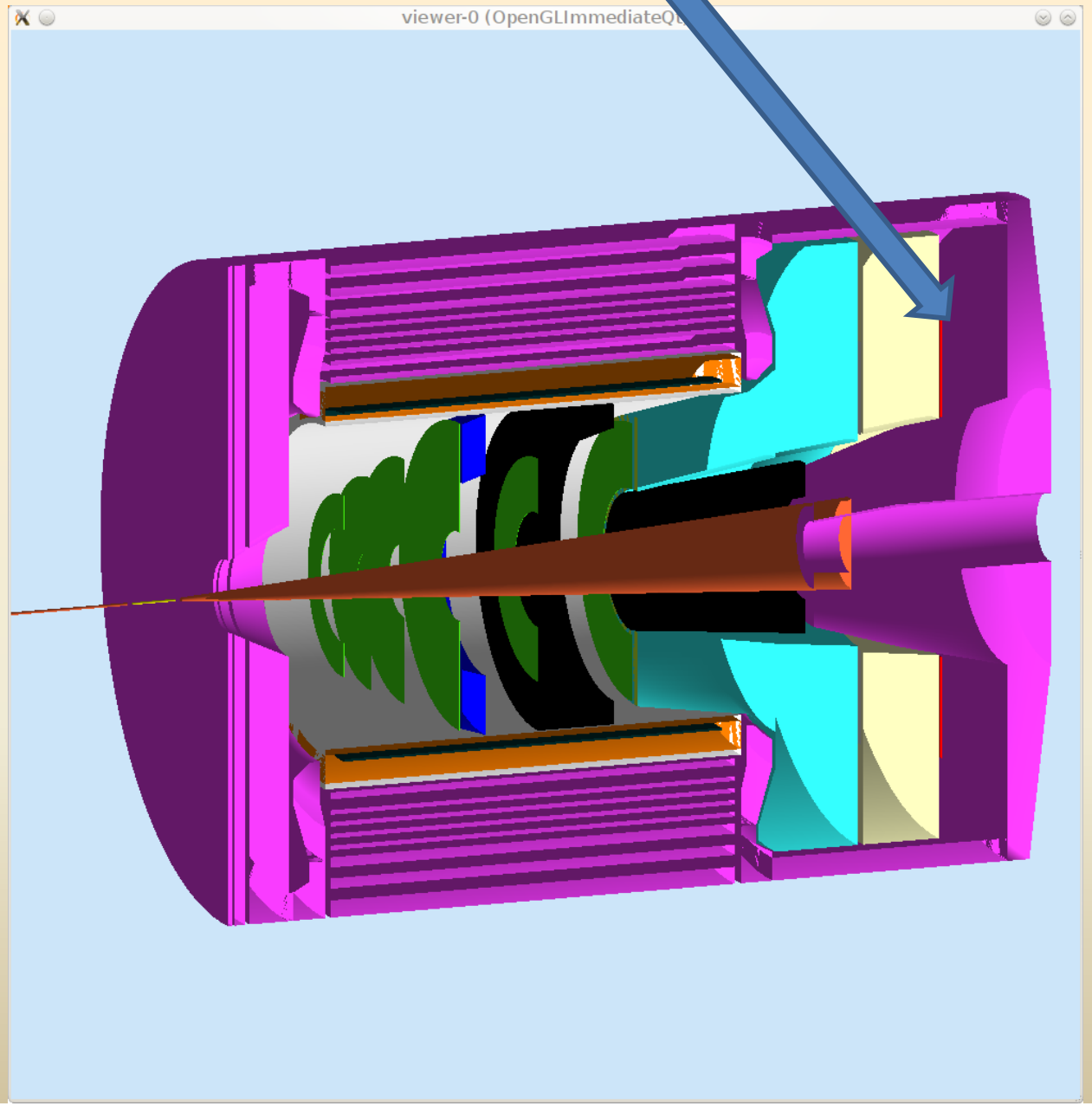
Scintillator



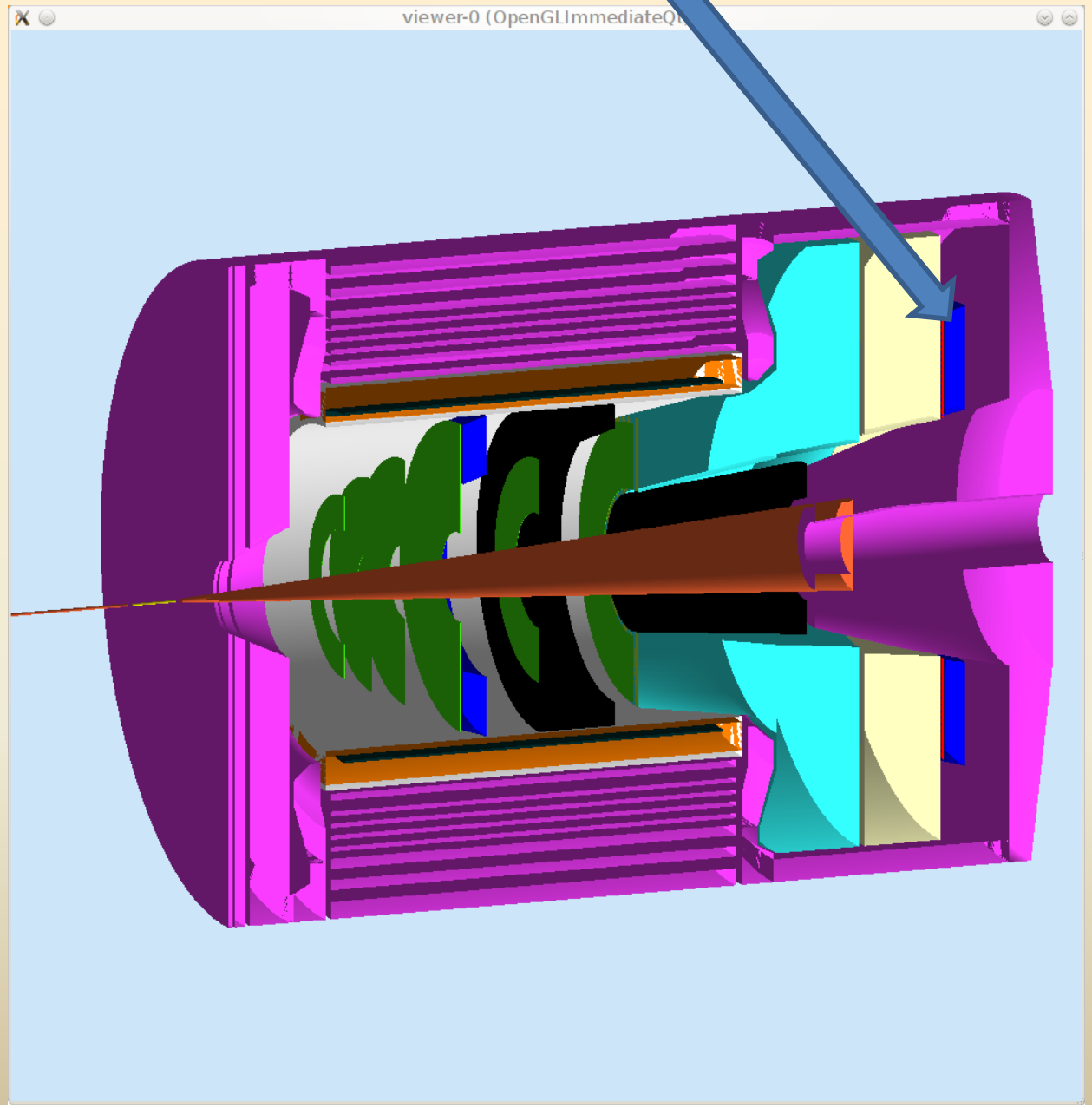
Cherenkov, heavy gas



MRPC (Multigap Resistive Plate Chambers)

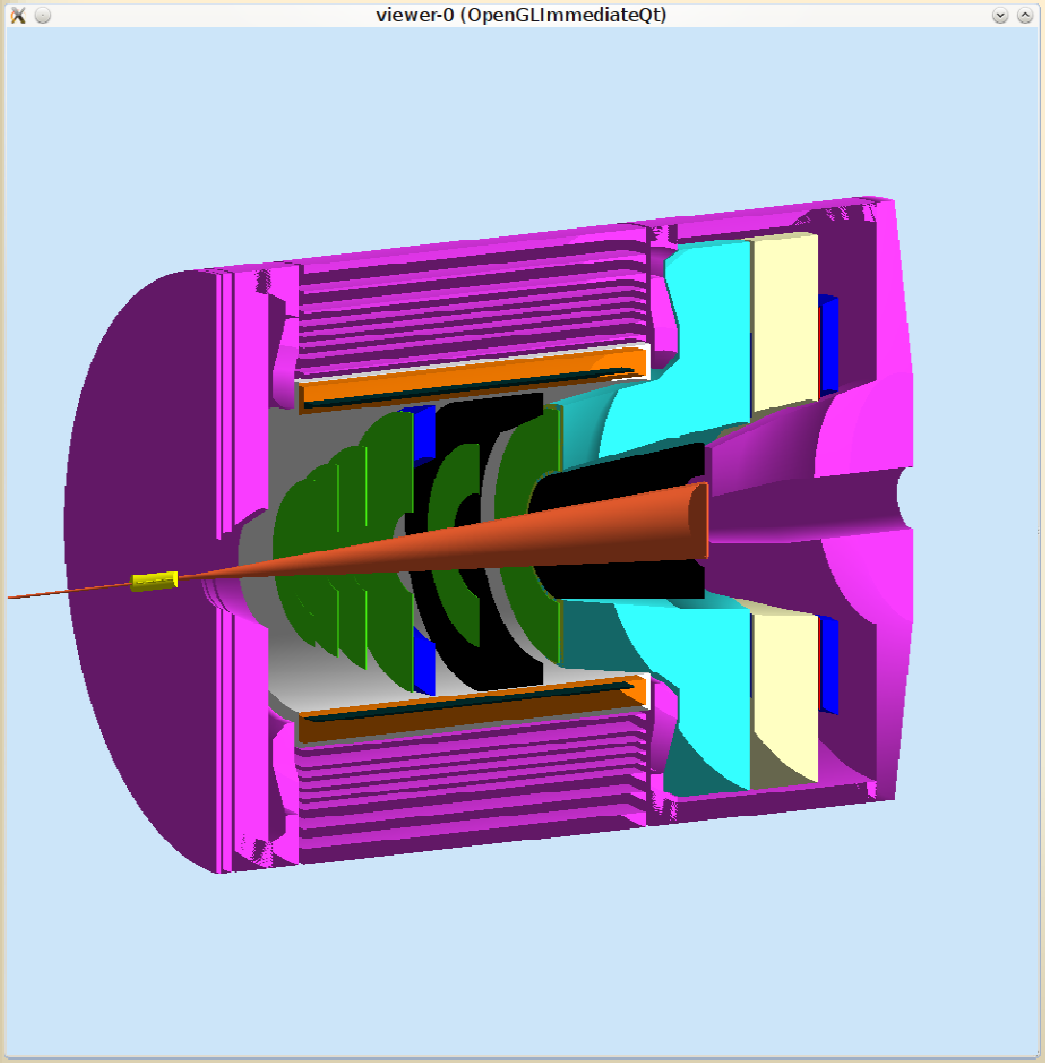


EC, forward angle

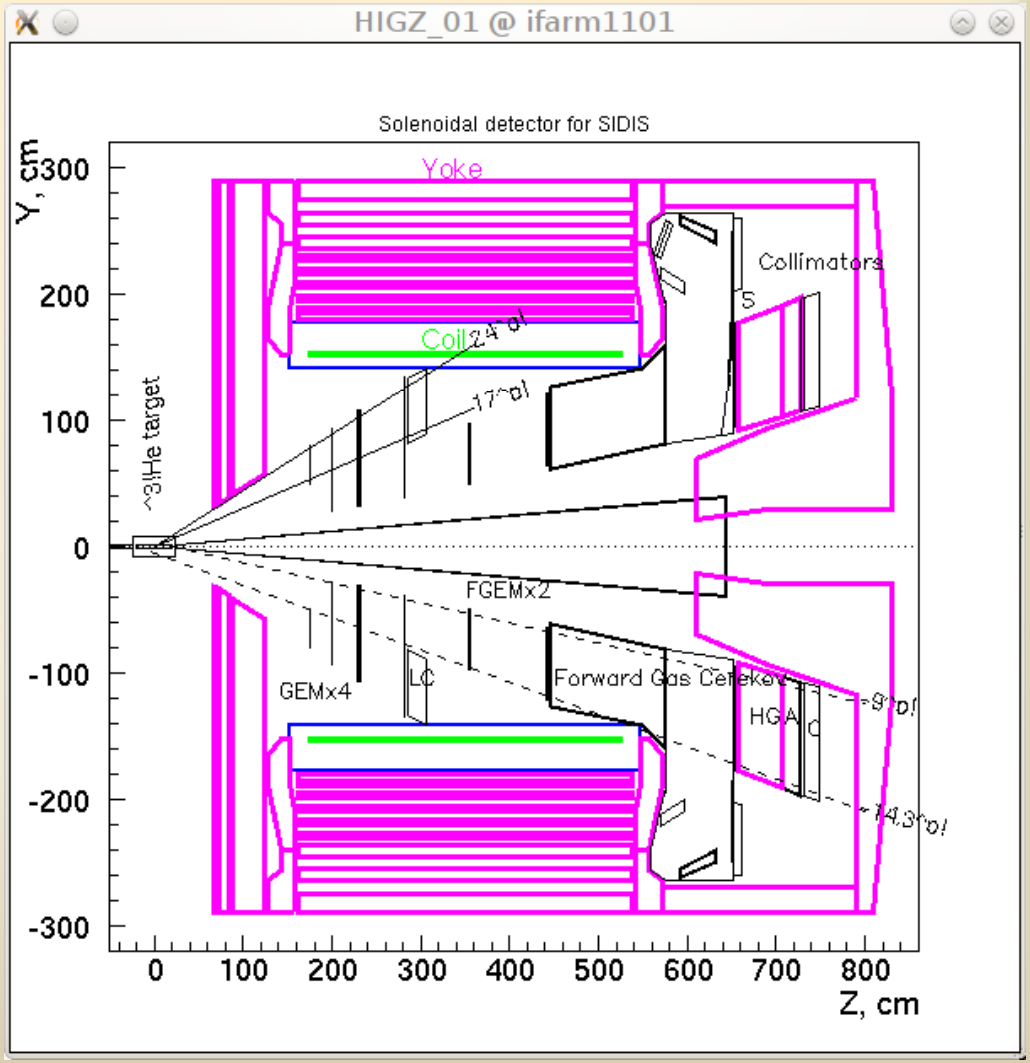


SIDIS with BaBar Magnet

3D Geant4

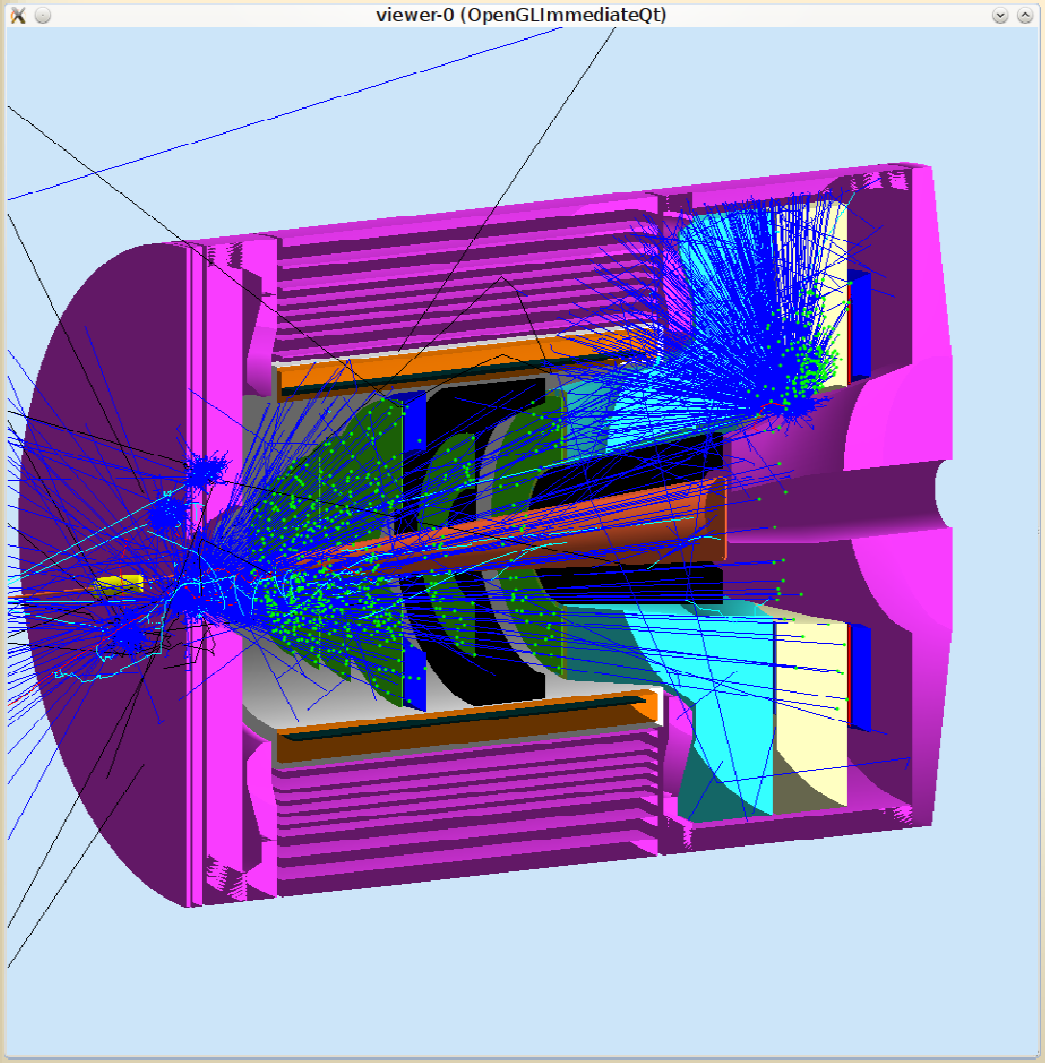


2D Geant3

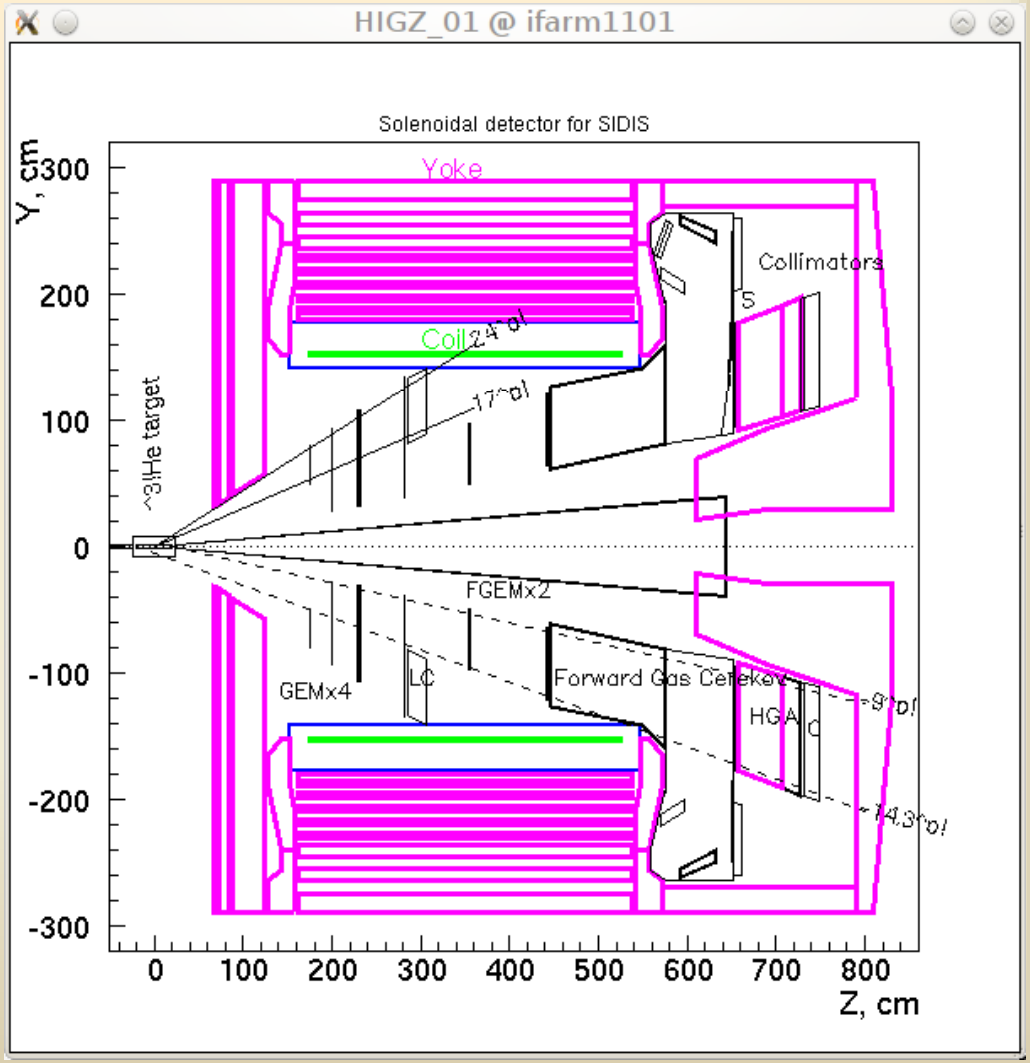


SIDIS with BaBar Magnet

3D Geant4

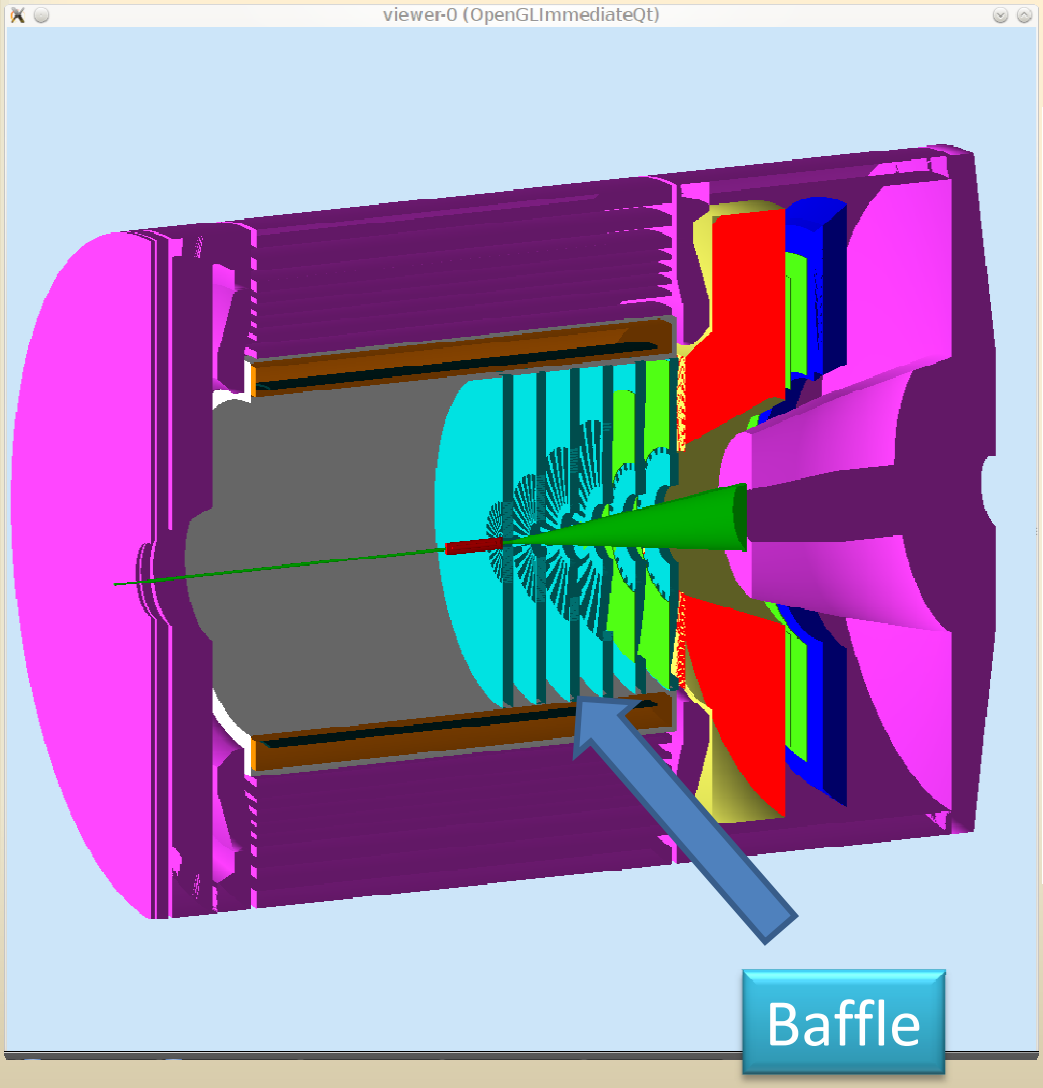


2D Geant3

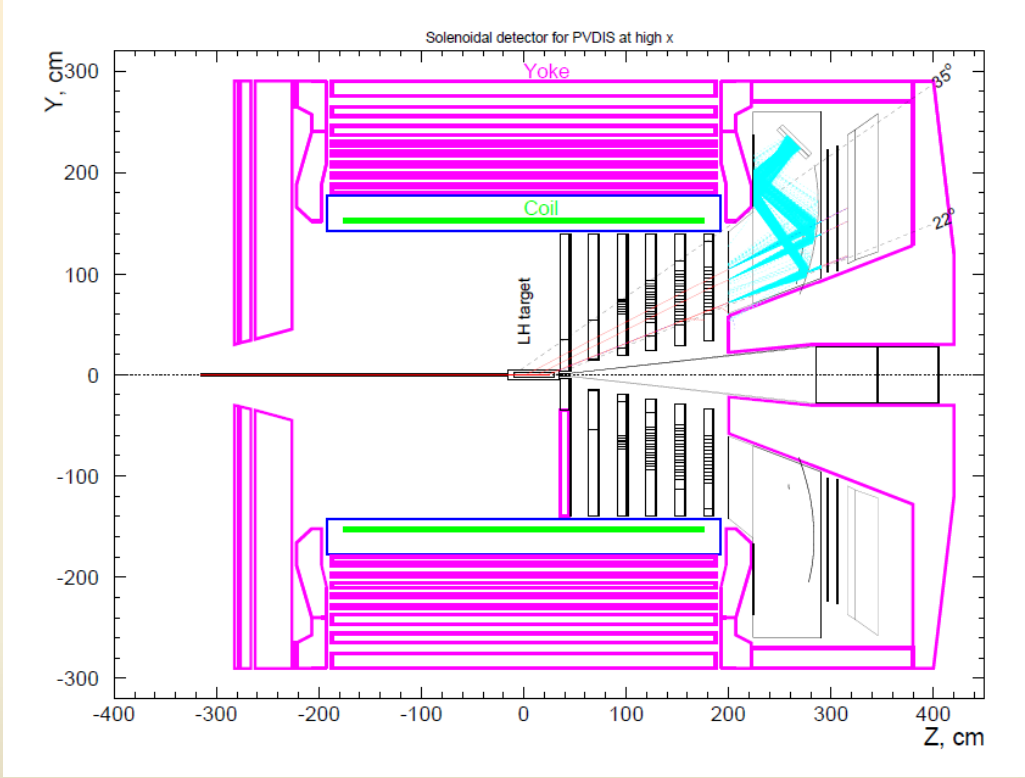


PVDIS with BaBar Magnet

3D Geant4

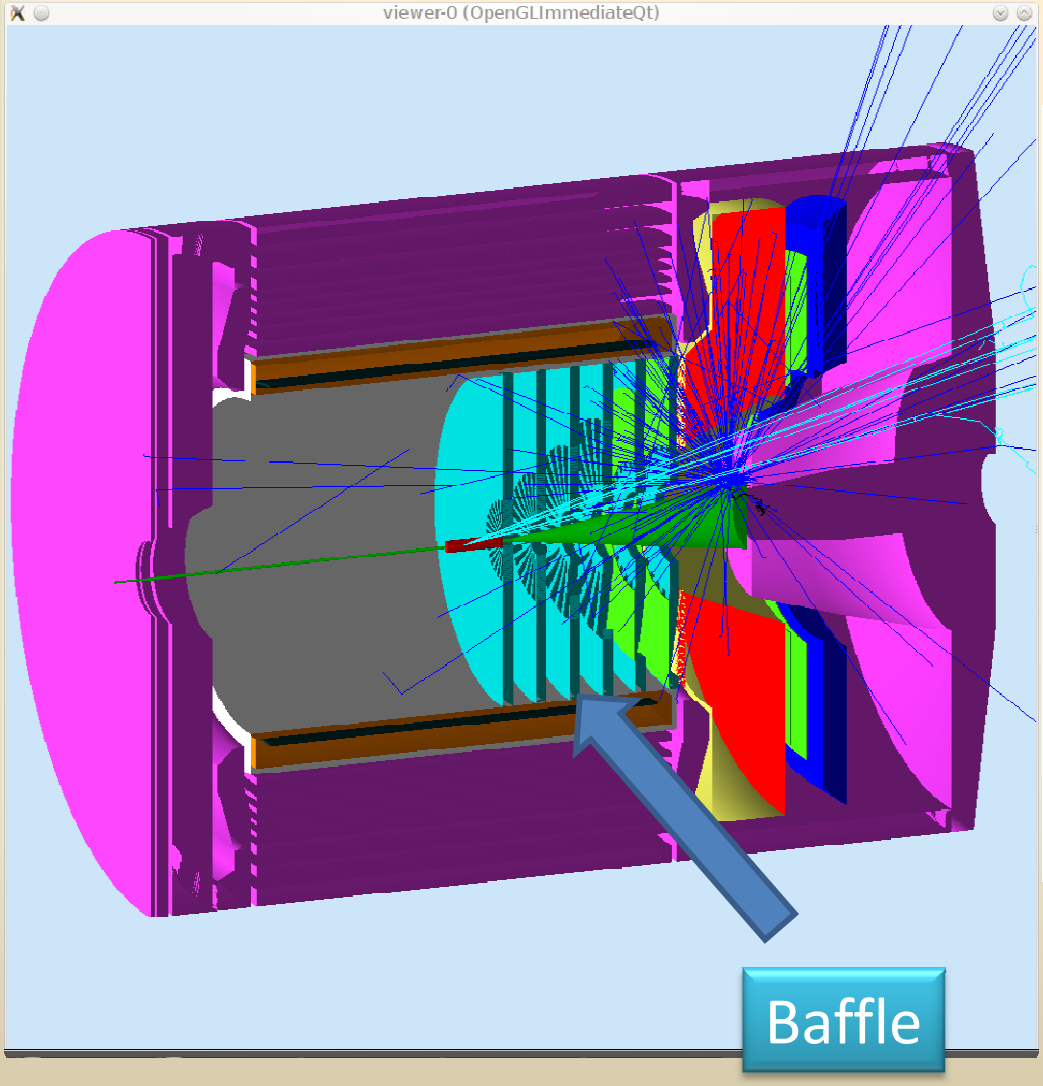


2D Geant3

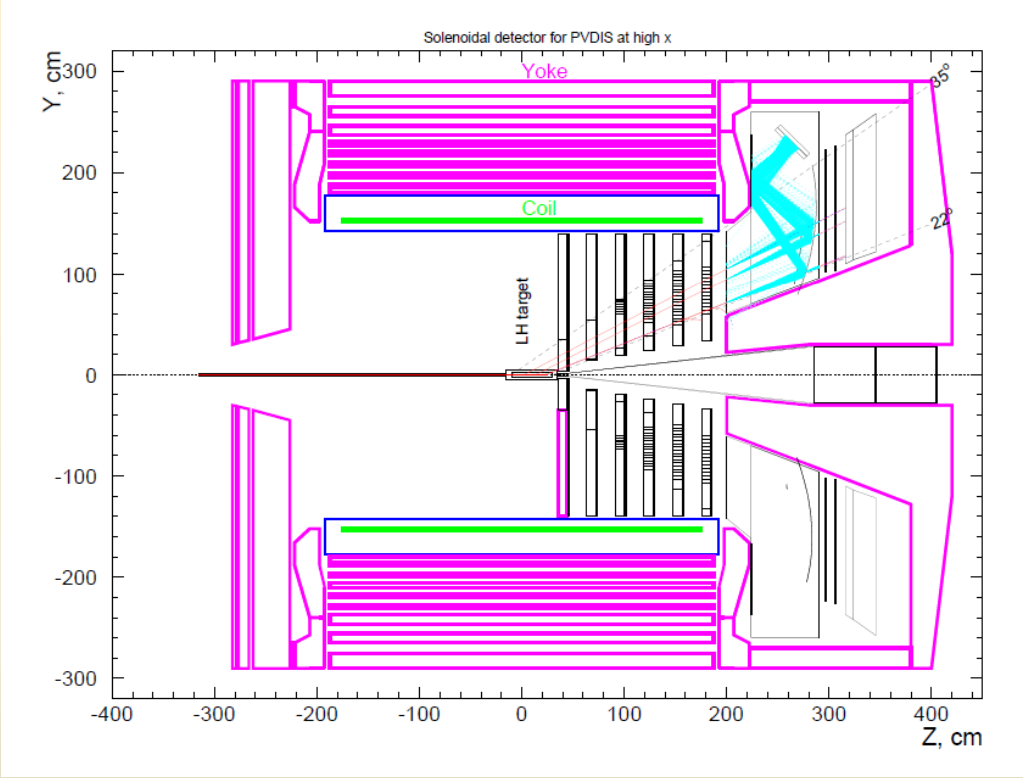


PVDIS with BaBar Magnet

3D Geant4



2D Geant3



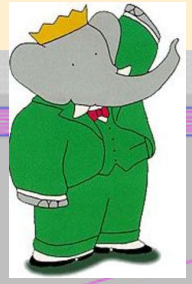
SoLID Simulation Framework (GEMC)

- gemc.jlab.org
- Geant4, C++, Qt, OpenGL
- geometry/sensitivity/digitization/field in mysql databases (soliddb.jlab.org)
- Customized hit processing for various detectors.
- ***Unified individual detector simulation and the whole SoLID simulation.***
- ***It can be used for other projects.***

Magnet Option

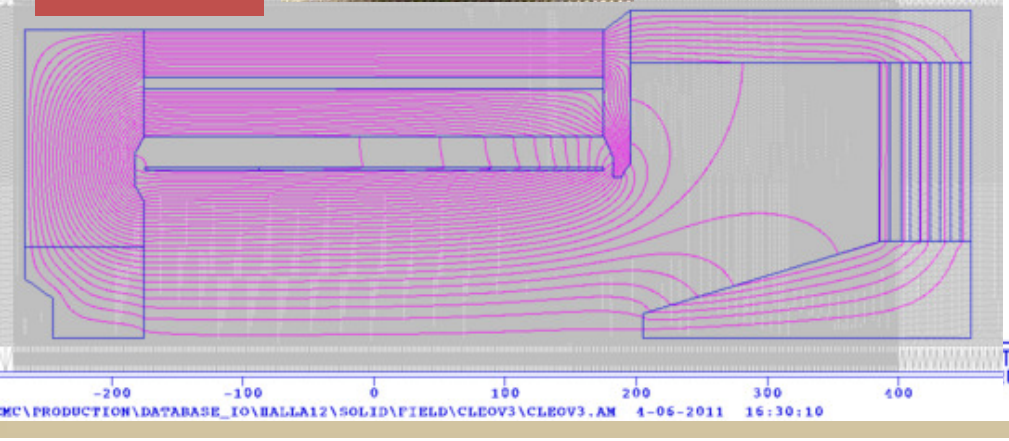
Poisson 2D

BaBar

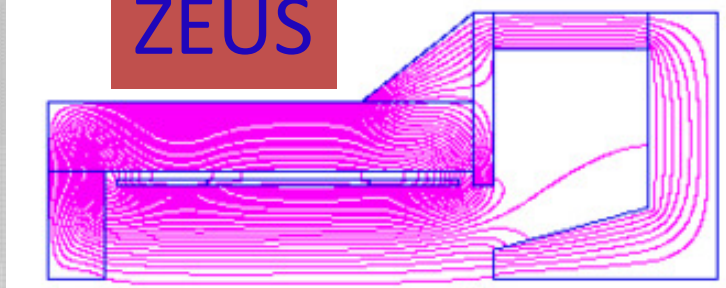


CDF

CLEO



ZEUS

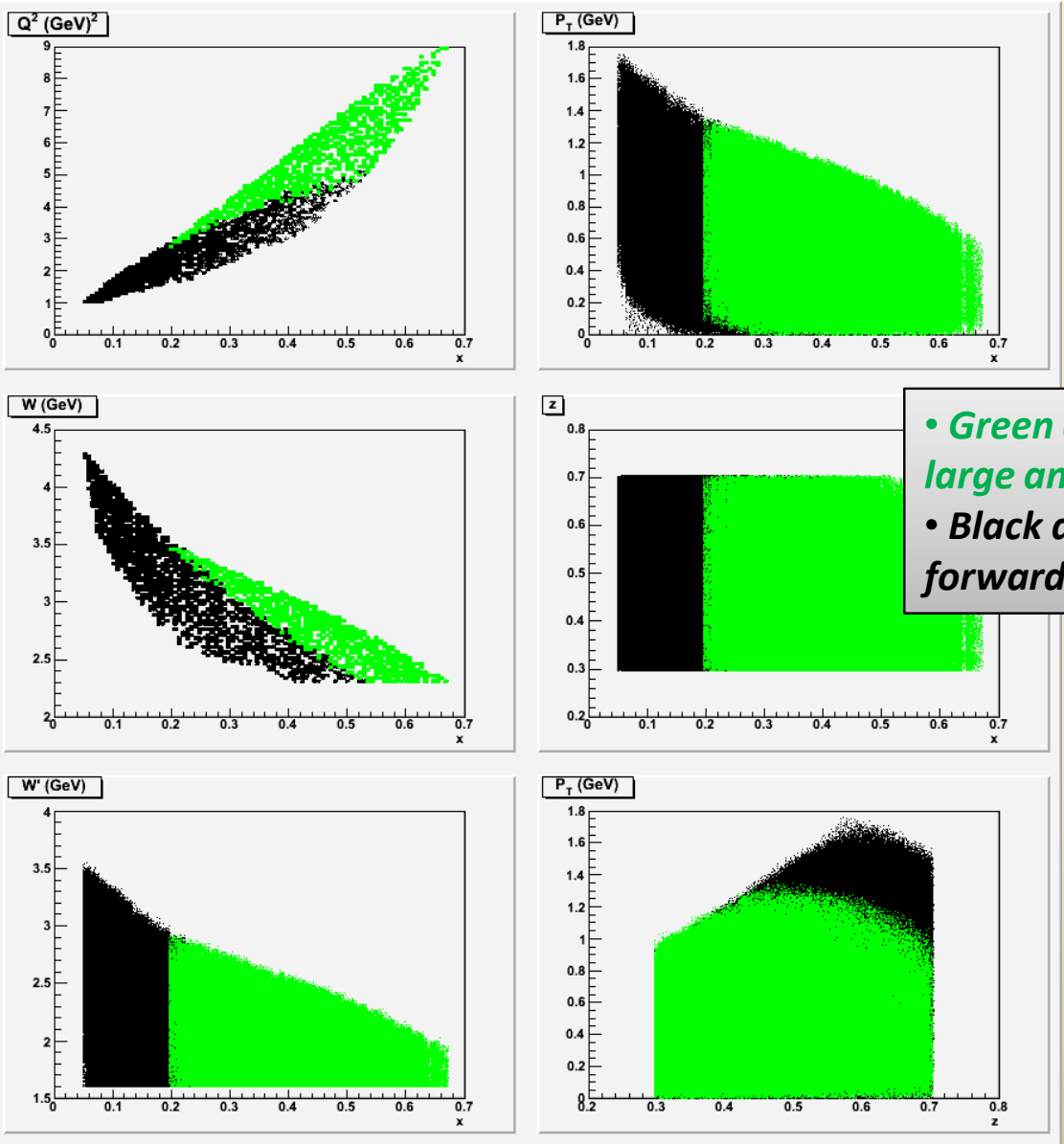


Magnet Comparison

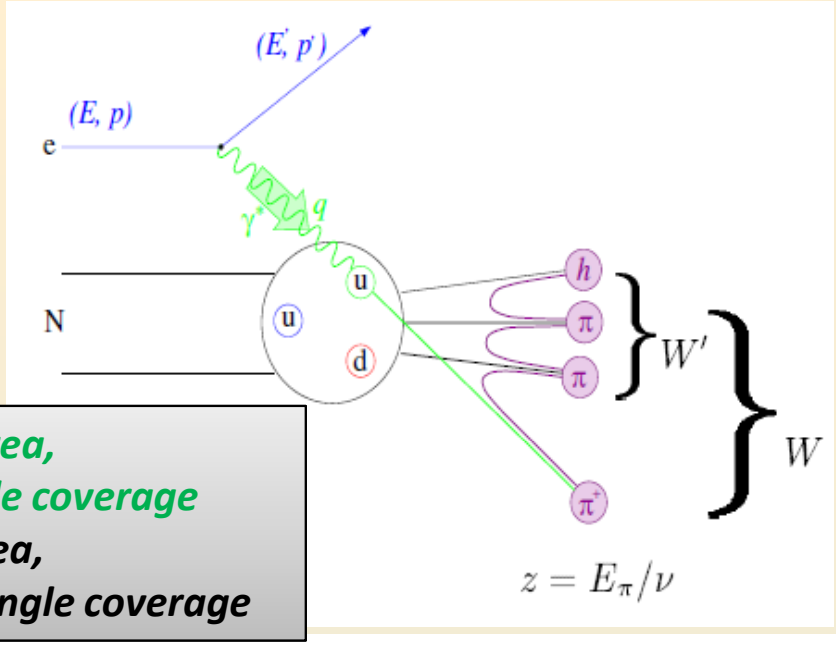
	BaBar	CLEO	ZEUS	CDF	Glue-X		Ideal
					Old SLAC	New	
Cryostat Inner Radius	150 cm	150 cm	86 cm	150 cm	90 cm		100 cm
Length	345 cm	350cm	245cm	500 cm	350 cm		250 cm
Central Field	1.49T	1.5T	1.8T	1.47T	2 T		1.5T
Flux Return Iron	Yes	Yes	No	No	No		
Cool Icon	Yes	Yes	Yes	No	No		
Variation in Current density with z?	2x more in end than central	4.2% more in end than central	40% more in end than central	No	Yes	Yes	
Available	Probably Not??	Probably	Probably	Probably	One will be available		

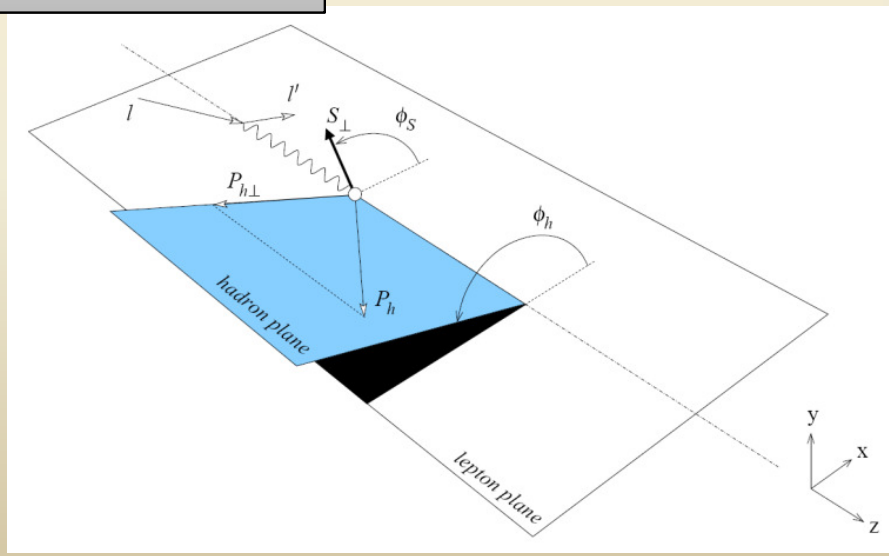
SIDIS Kinematic Coverage@11GeV

BaBar



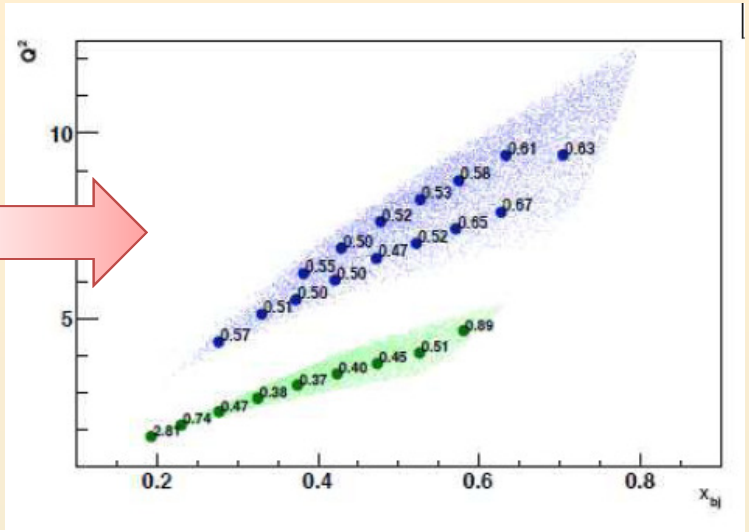
- ***Green area, large angle coverage***
- ***Black area, forward angle coverage***





Magnet Choice

PVDIS FOM is not sensitive to different magnet option.



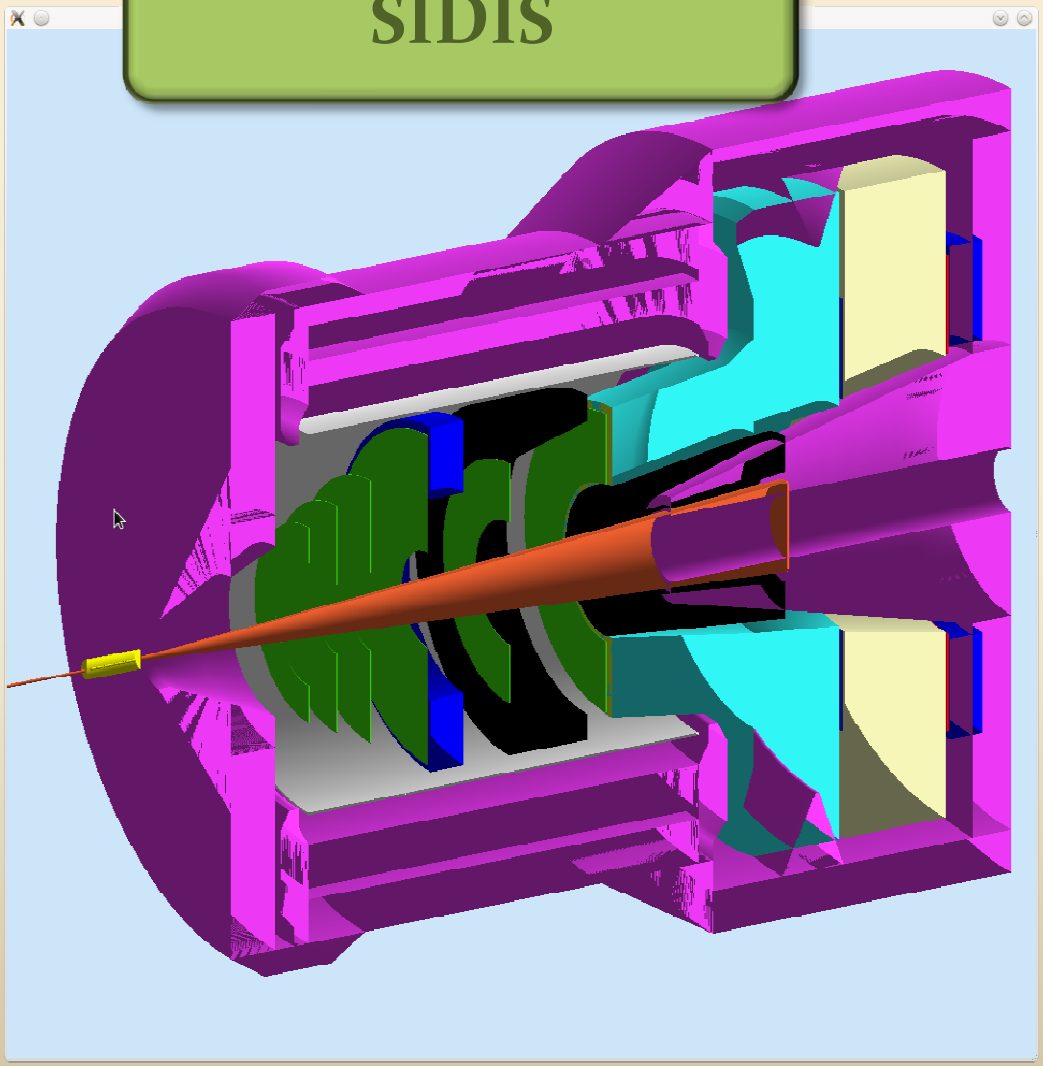
SIDIS Kinematic Coverage@11GeV favors BaBar/CLEO.

	ZEUS	BaBar/CLEO	CDF	Glue-X	Ideal
x	0.05-0.58	0.05-0.65	0.05-0.64	0.05-0.64	0.05-0.65
z	0.3-0.7	0.3-0.7	0.3-0.7	0.3-0.7	0.3-0.7
Q^2	1-6	1-9	1-7.2	1-8	1-9
W	2.3-4.2	2.3-4.4	2.3-4.2	2.3-4.2	2.3-4.3
W′	1.6-3.4	1.6-3.5	1.6-3.4	1.6-3.4	1.7-3.5
P_T	0-1.45	0-1.7	0-1.45	0-1.45	0-1.6

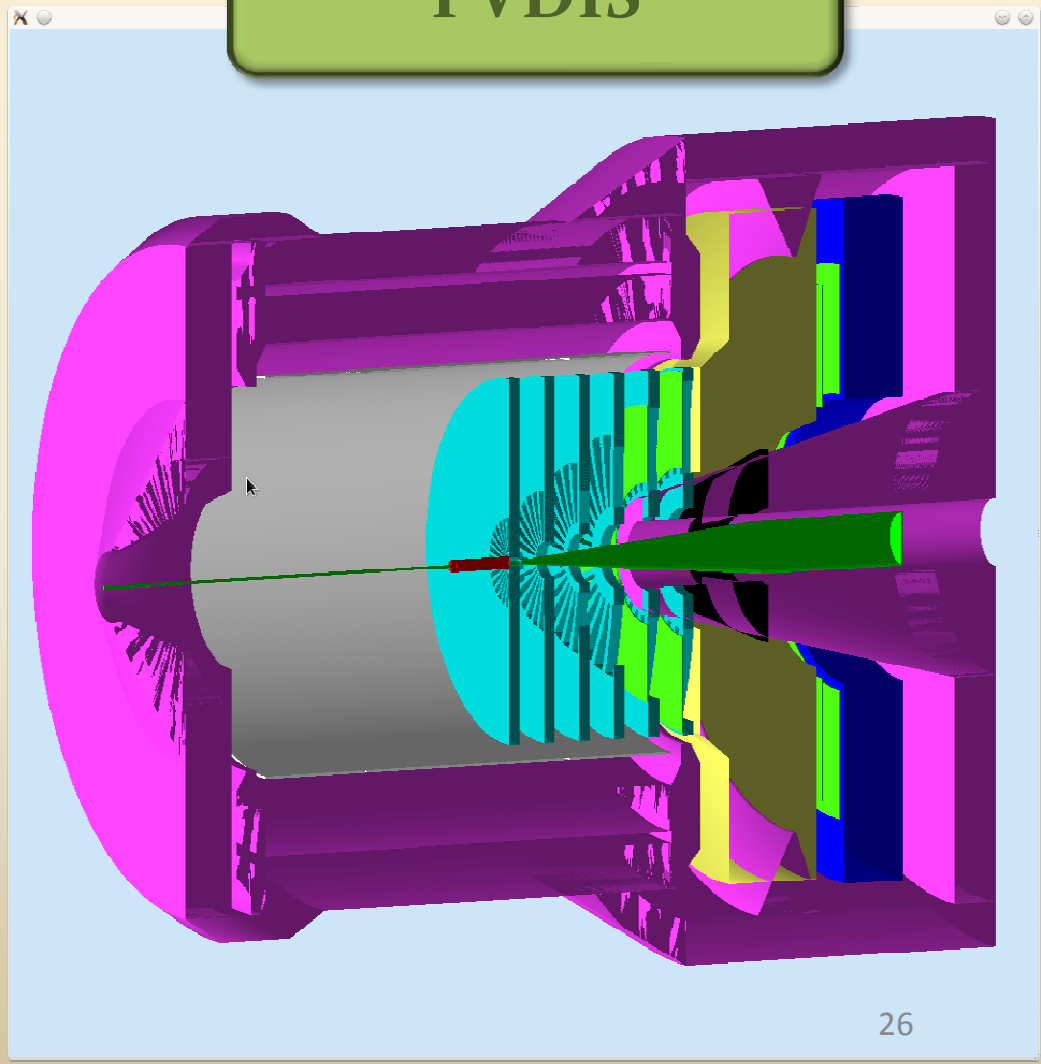
CLEO magnet and yoke

design in progress

SIDIS

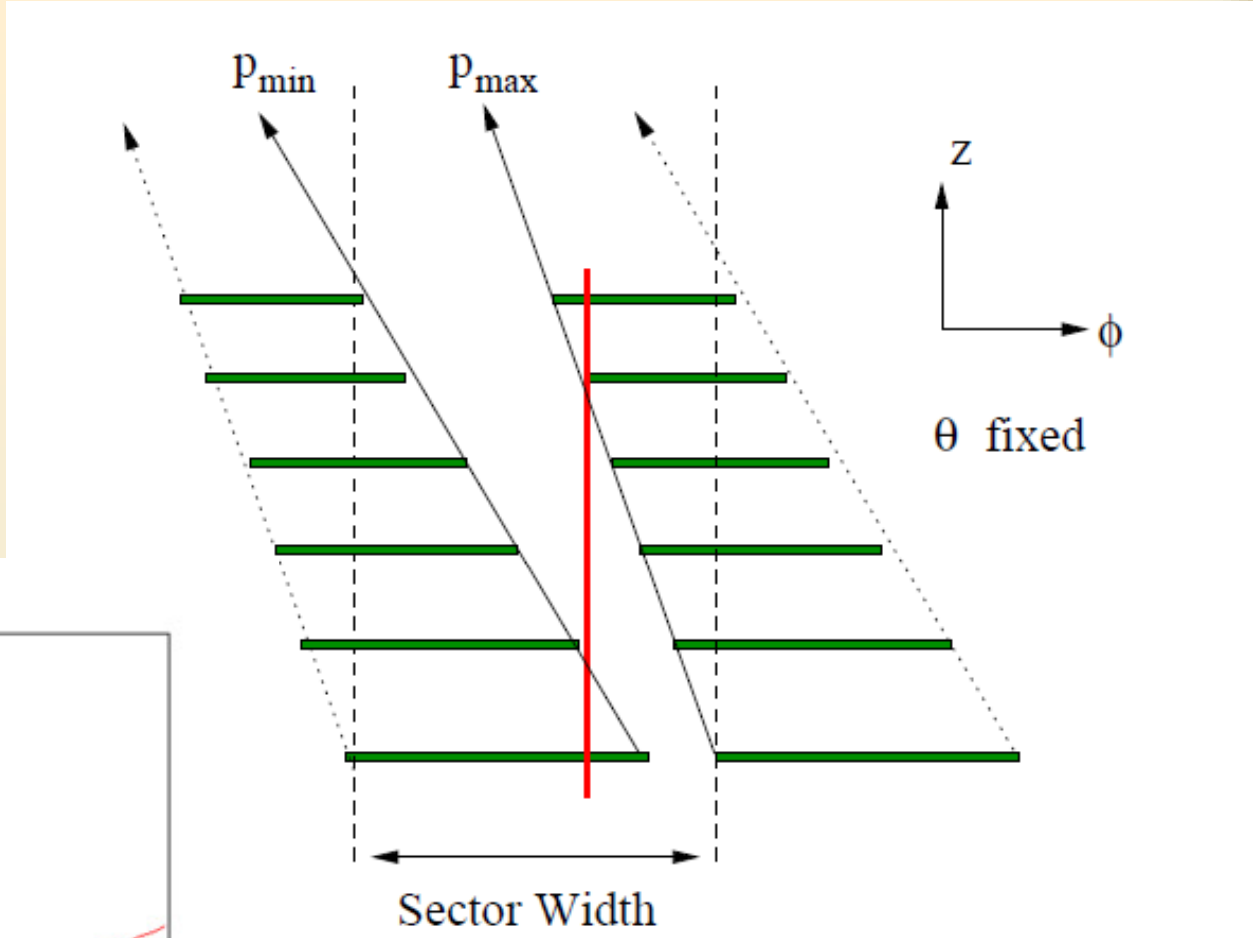


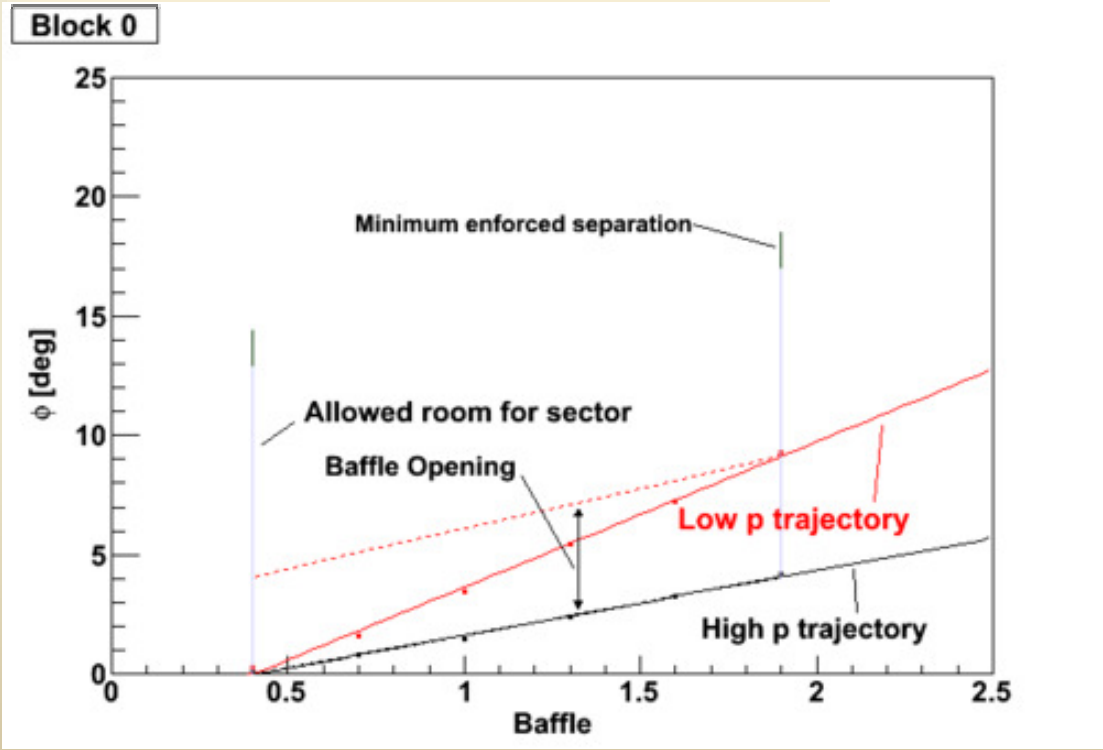
PVDIS



PVDIS Baffle Design

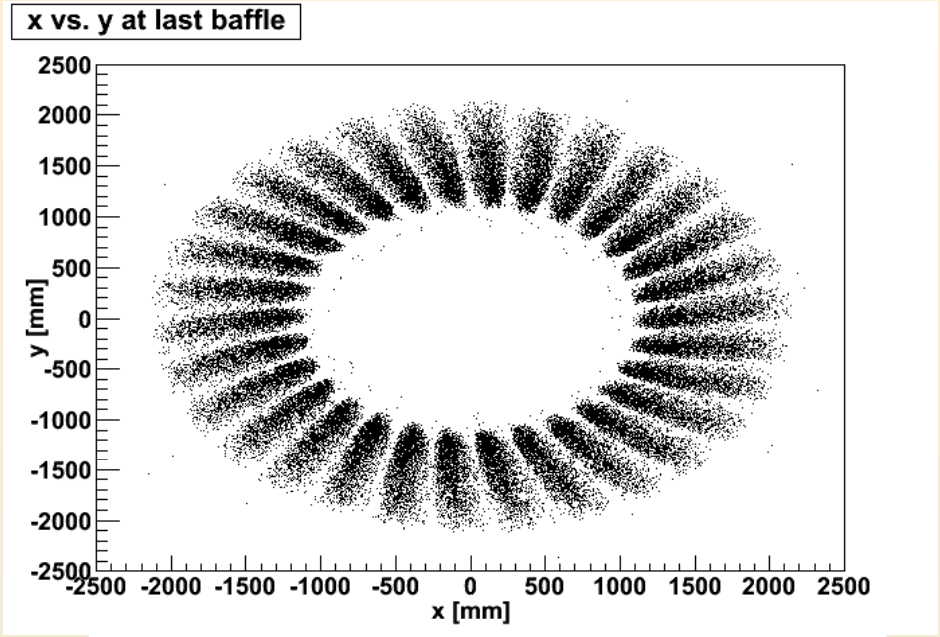
Luminosity $10^{39}/s/cm^2$

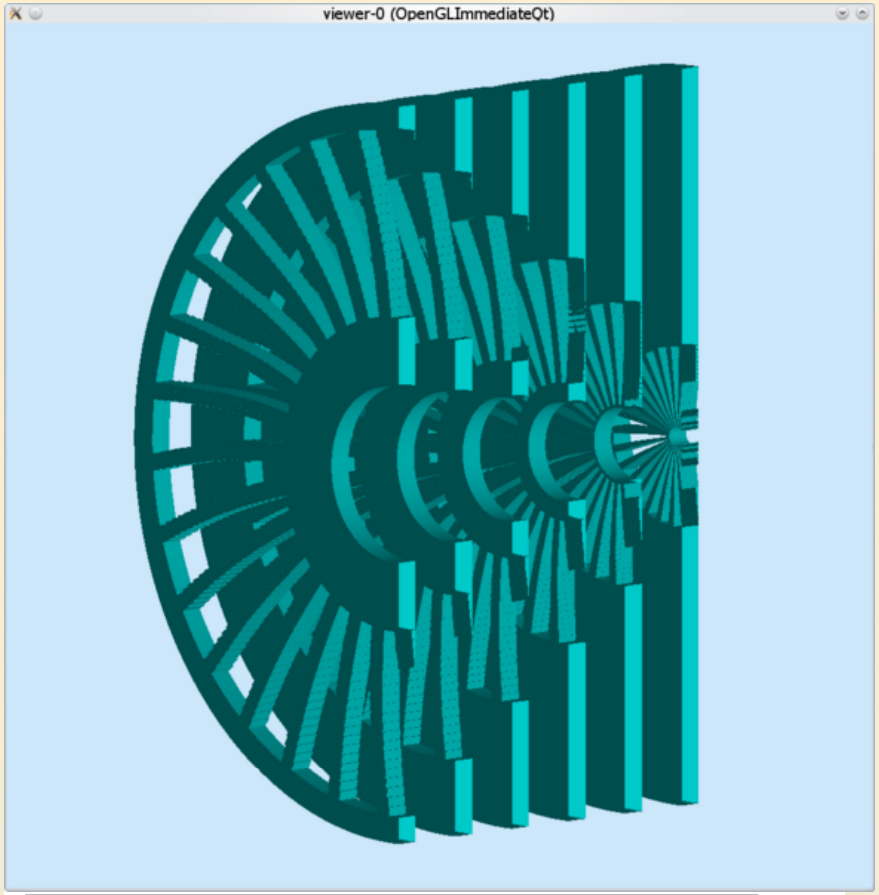


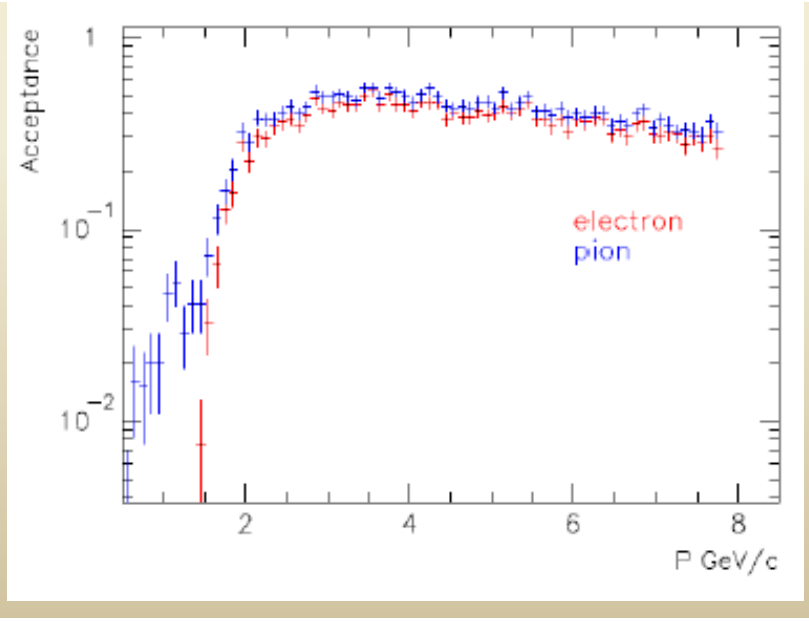


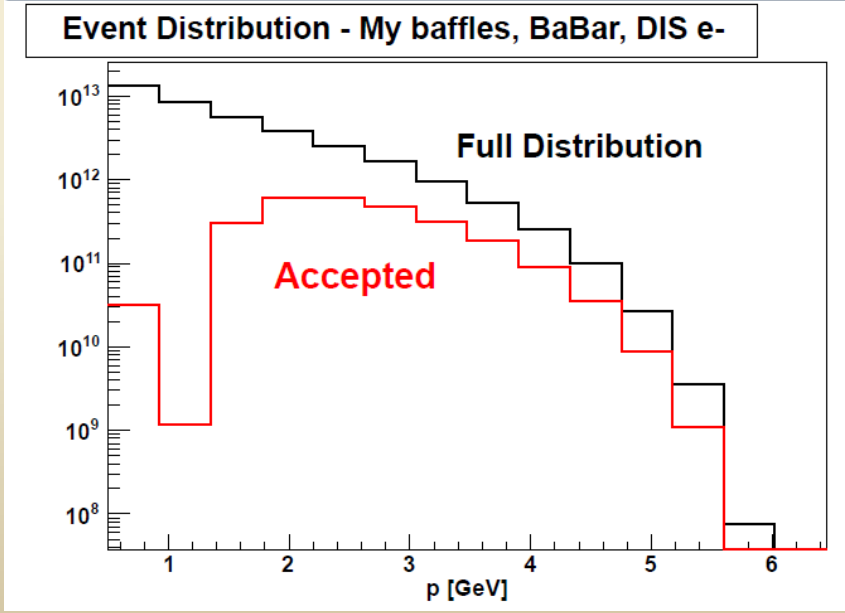
PVDIS Baffle

Reduce background by 50





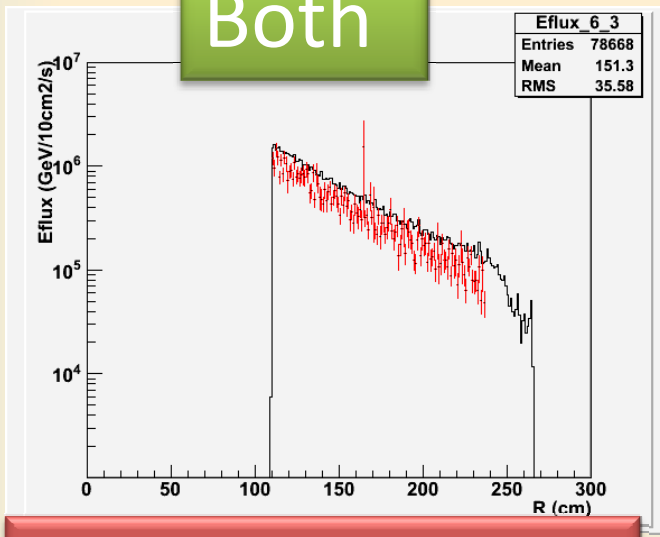




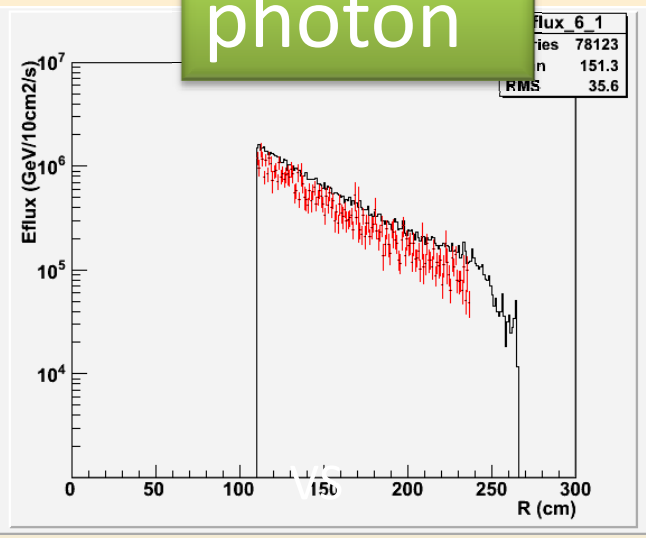
PVDIS EM Background (on EC, no baffle)

red Geant3, black Geant4

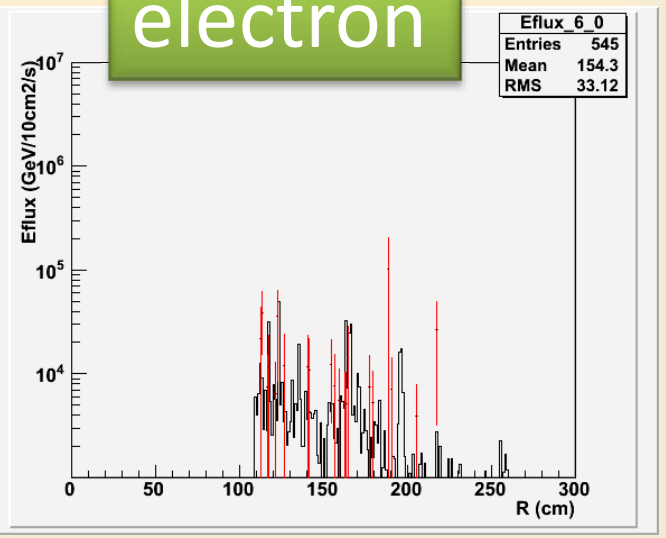
Both



photon



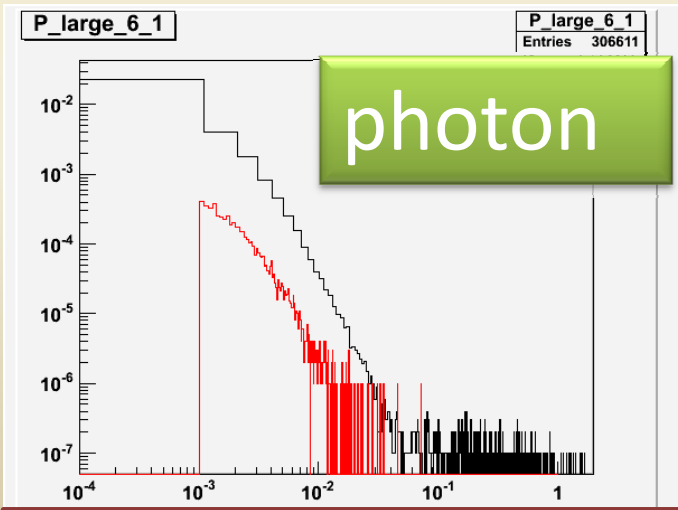
electron



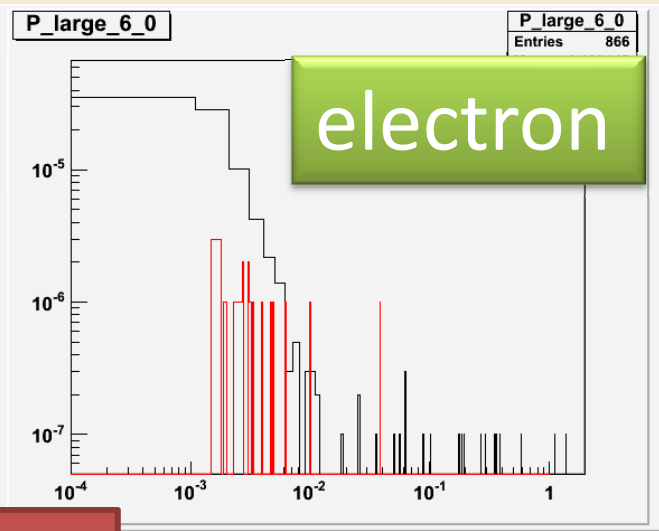
Energy Flux VS R

For Energy Flux, Geant4 shows ~30% larger than Geant3

photon



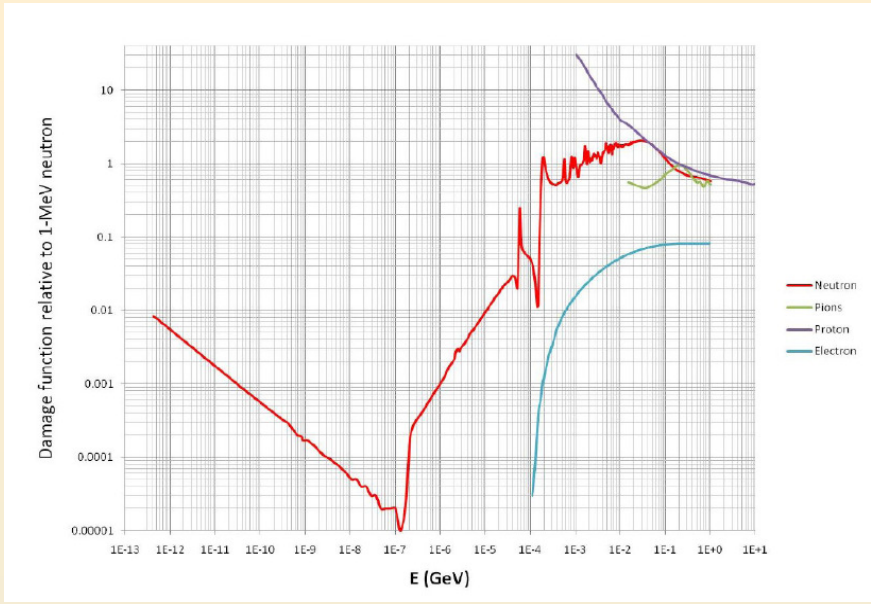
electron

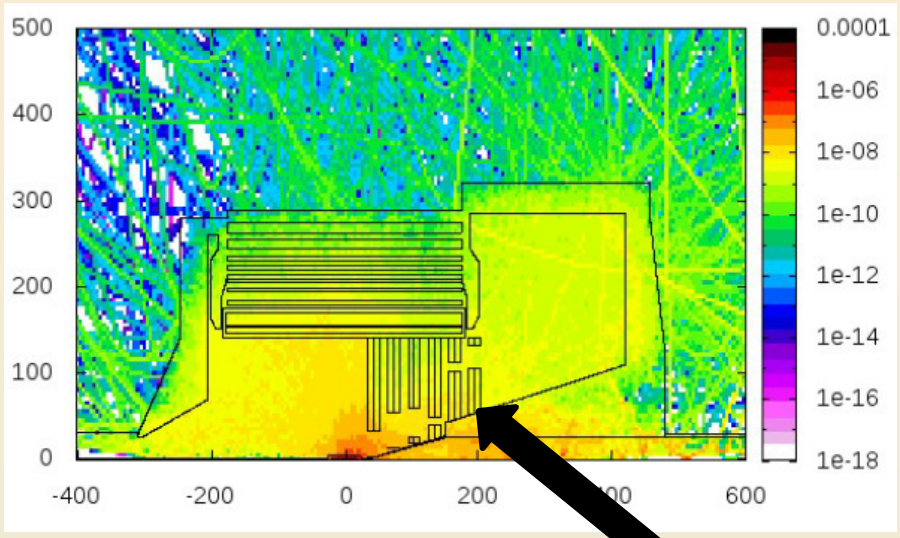


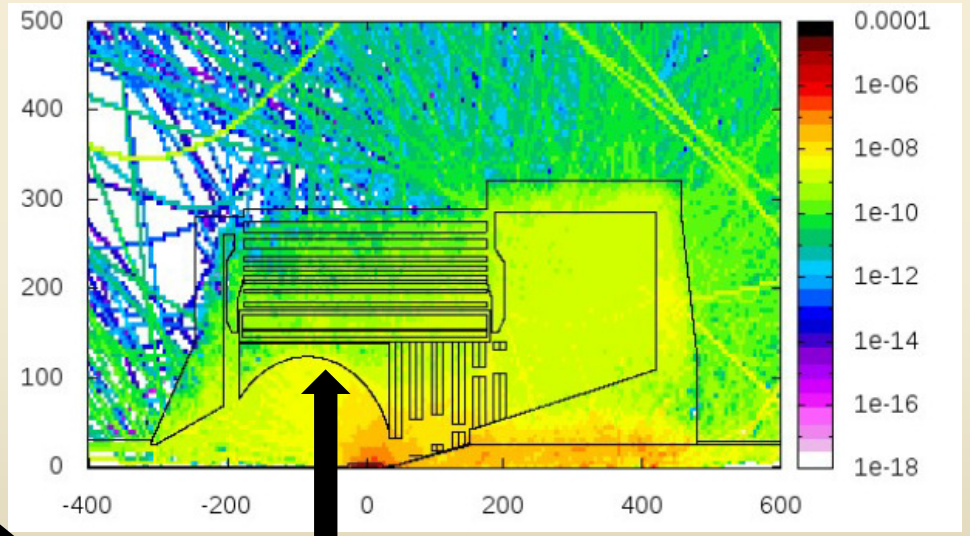
Momentum Distribution

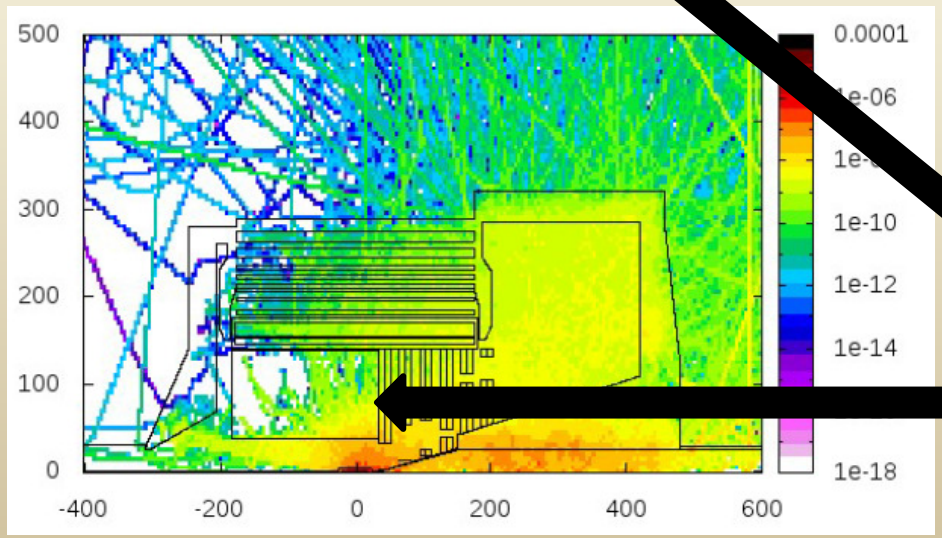
Neutron Shielding

Use FLUKA for study









boron polyethylene shielding

Summary

- SoLID simulation framework is successfully built base on GEMC with Geant4 and C++.
- A lot of subsystem design and simulation progresses have been made. More studies are under way.
- In preparation for the director review.

Thanks

- Maurizio Ungaro
- Paul Reimer
- Seamus Riordan
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- Xin Qian