

# Status of PYTHIA6 study, MEIC version

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- File Download from  
> `svn co https://jlabsvn.jlab.org/svnroot/eic/evgen/pythiaRHIC`
- “1.0.0/README or HOW-TO-CONFIG” provides :
  - a brief introduction/compile/install
  - additional info and some troubleshooting
  - typical installation time is about an hour
- Code's distributed to and tested by
  - ODU, GSU, CUA, JLAB, DUKE, ...

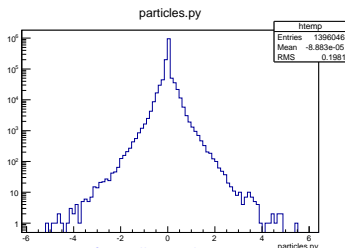
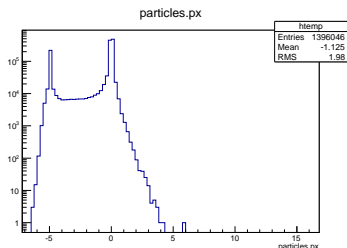
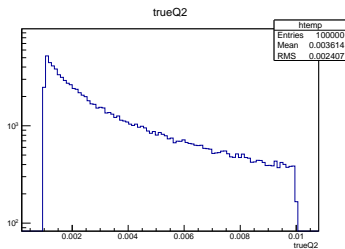
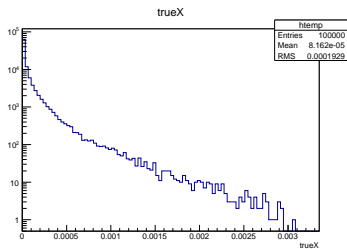
- A slight modification from eRHIC PYTHIA6
- Crossing angle: 50mrad for MEIC config.
- Particles list in the PYTHIA6.155
- Output format matches with GEMC
- Add flag for intermediate particle/unphysical particle/(anti)quark/gluon for GEMC

You can find more examples (current studies) under:

[https://eic.jlab.org/internal/index.php/Detector\\_Working\\_Group\\_Meetings](https://eic.jlab.org/internal/index.php/Detector_Working_Group_Meetings)

# Snapshot of PYTHIA6 kinematics: $(e, p) = (5, 100)$ GeV

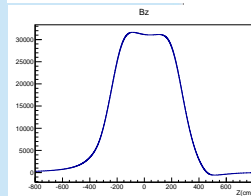
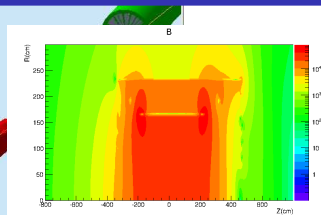
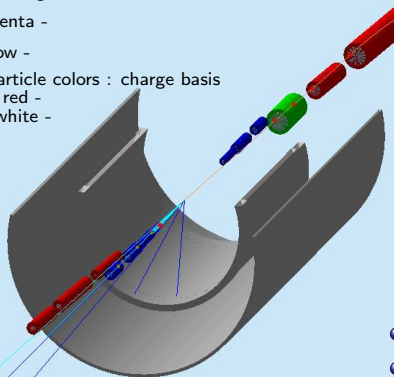
- $[x_{BJ}^{min}:x_{BJ}^{max}] = [10^{-4} : 10^{-3}]$ ,  $[Q_{min}^2:Q_{max}^2] = [10^{-3} : 10^{-2}]$



\*\* momentum from all particles

# Snapshot of GEMC with PYTHIA6 event

- neutrons: - black -
- photons: - blue -
- $e^-$ : - cyan -
- protons: - orange -
- $\pi^+$ : - magenta -
- $\pi^-$ : - yellow -
- all other particle colors : charge basis
  - $q=+1$ : - red -
  - $q=-1$ : - white -

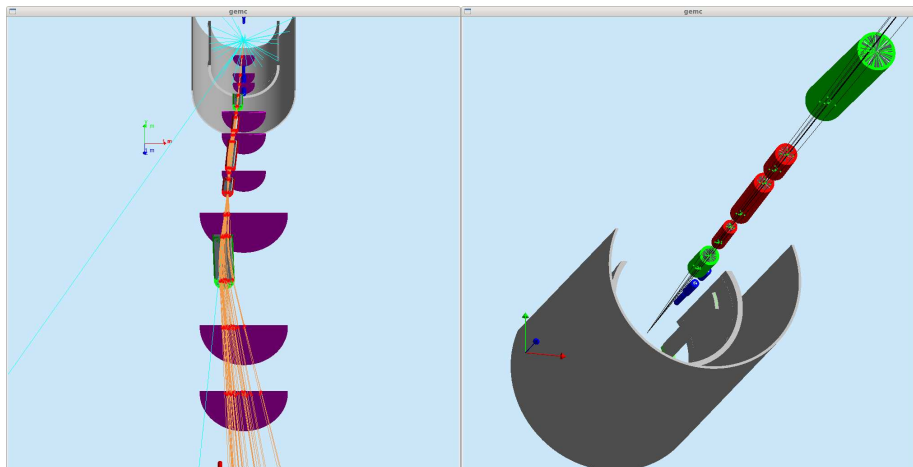


- $(e, p) = (5, 100)$  GeV
- HALL\_MATERIAL=Vacuum
- Dual solenoid coils:  $\vec{B}=3.0T$
- 10 events

\*\* [https://gemc.jlab.org/gemc/Documentation/Entries/2011/1/26\\_Particle\\_Color\\_Codes.html](https://gemc.jlab.org/gemc/Documentation/Entries/2011/1/26_Particle_Color_Codes.html)

# Spectator protons and Neutrons

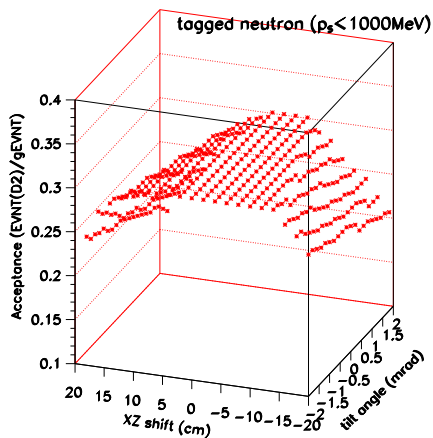
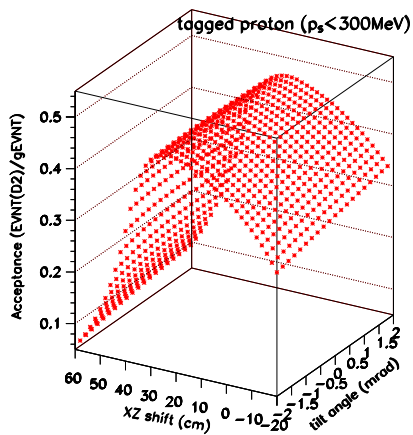
- Optimization of  $D2$  position ( $X', Z'$  by shift-parameter ( $b_{xz}$ ), tilt angle ( $\theta$ ))



(left) spectator proton (STEGs, 50GeV), (right) neutron (PYTHIA)

# Acc = #.Evtnt passed Dipole2 / #.Evtnt of GEN

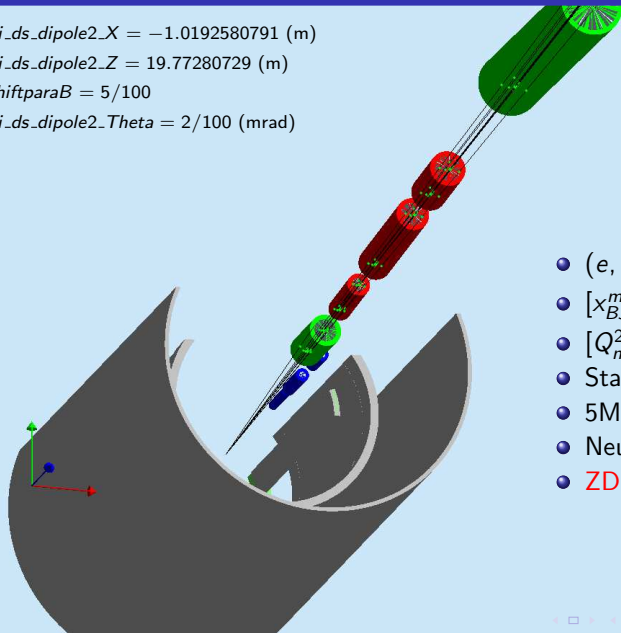
- event passes all beam line magnets (D1/Q1/Q2/Q3/D2)



\*\* Note that shift parameter and tilt angle  $\times 1/100$

# Example [1]: ZDC study - display only 50 events -

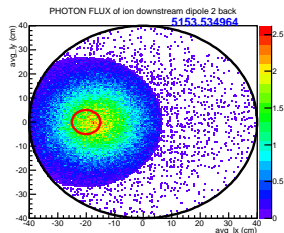
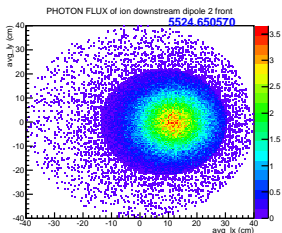
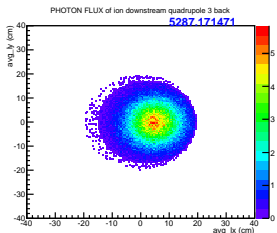
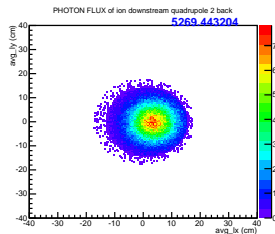
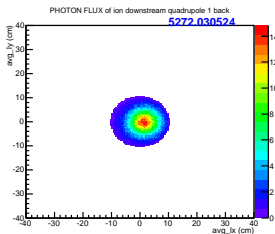
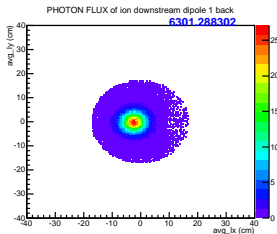
- $i\_ds\_dipole2\_X = -1.0192580791$  (m)
- $i\_ds\_dipole2\_Z = 19.77280729$  (m)
- $shiftparaB = 5/100$
- $i\_ds\_dipole2\_Theta = 2/100$  (mrad)



- $(e, p) = (5, 100)$  GeV
- $[x_{BJ}^{min}:x_{BJ}^{max}] = [10^{-4} : 10^{-3}]$
- $[Q_{min}^2:Q_{max}^2] = [10^{-3} : 10^{-2}]$
- Standard GVMD model
- 5M generated
- Neutron selected only (flag)
- ZDC detector geometry ???



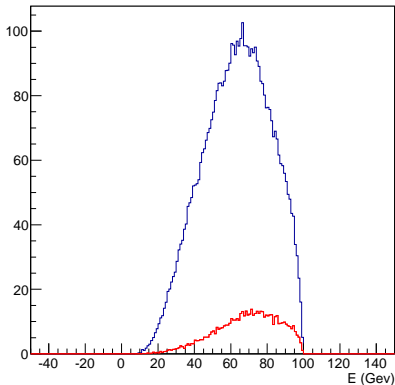
# Neutron distribution at each magnet with $paraB = 0.05$ & $\theta_{tilt} = 0.02$



\*\* photon flux = VINT(319) in PYGAGA

# Neutron distribution → radiation dose

Energy at Ion Dipole2back with avg\_local\_coord



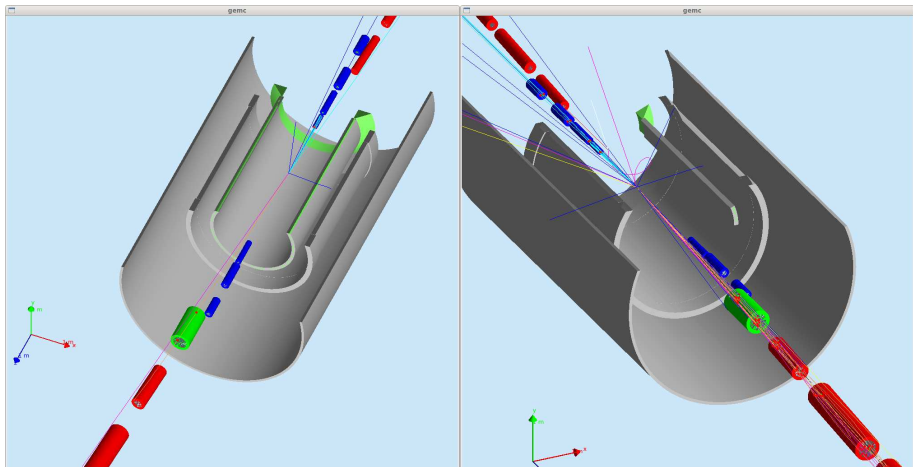
\*\* Wighted by virtual photon flux

\*\* blue : full dipole area, red : 10cm circle area

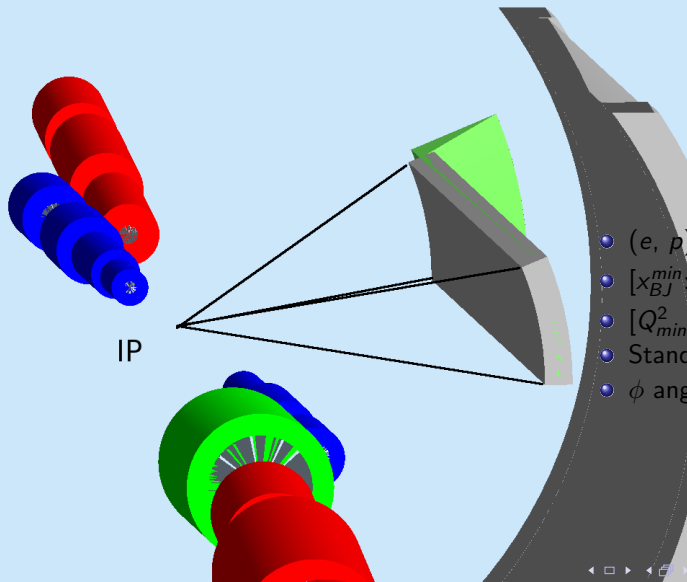
- Neutron energy distribution after 2nd Dipole
- Estimation irradiation dose around center  
- approx. 230 neutron count/cm<sup>2</sup>
- PYTHIA luminosity ...dose...total energy
- acceptance/efficiency plots

# Example [2]: Multiplicity study with DIRC bar

- $(e, p) = (5, 100)$  GeV
- DIRC detector (particle color code same as previous slide)
  - Whole (left) vs. One of 16 segments (right)



# Snapshot of DIRC in GEMC

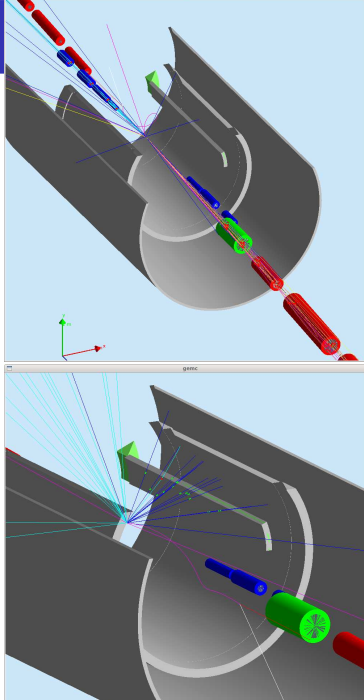


IP

- $(e, p) = (5, 100)$  GeV
- $[x_{BJ}^{min}, x_{BJ}^{max}] = [10^{-3} : 10^{-1}]$
- $[Q_{min}^2, Q_{max}^2] = [1 : 10^2]$
- Standard GVMD model
- $\phi$  angle =  $(0:22.5)$  (deg)

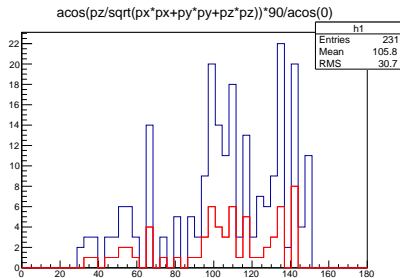
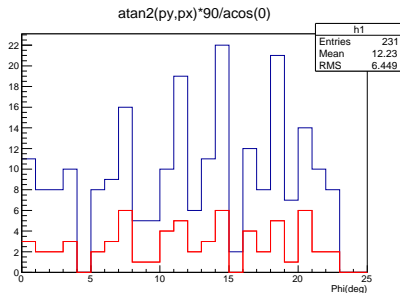
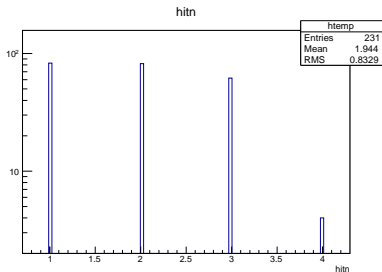
# Snapshot of DIRC in GEMC

- $(e, p) = (5, 100)$  GeV
- DIRC detector (few tens of events)
  - No kinematic restriction (top)
  - Event filtered out with specific  $\phi_h$  angle (bottom)
  - Active detector area
  - `$detector" sensitivity" = "flux"`;
  - `$detector" hit_type" = "flux"`;



# Event distribution on DIRC bar

- A single DIRC segment
- Num. of Event vs. angular distribution  $\phi$ (right-top),  $\theta$ (right-bottom)
- Number of hit (*hitn*)
- Nominal(blue) vs. *hitn* > 2(red)

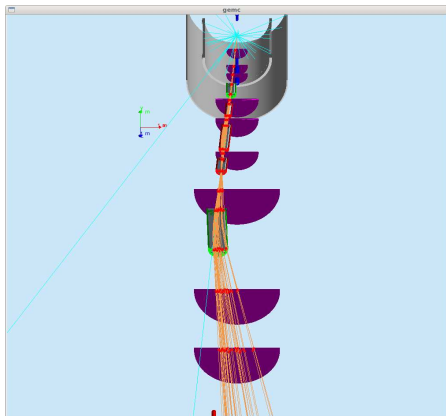


- On going work PYTHIA6 and (8) as initial project for MEIC
- Increasing interest from various institutions/groups
- Incorporation with GEMC for full chain of simulation
- Certainly it is crucial for more realistic/sophisticate simulation
  - physics event distribution
  - detector efficiency
  - particle multiplicity
  - physics background
  - etc...

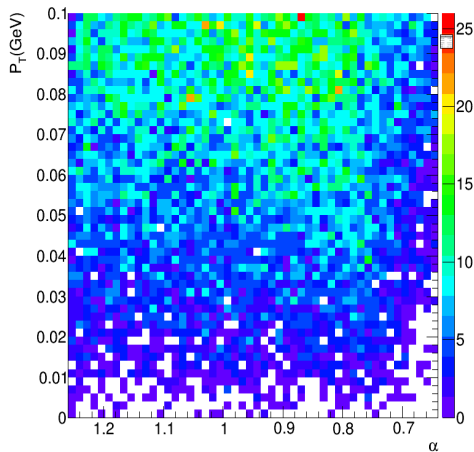
# BACKUP



# MEIC Beam line / Spectator Tagging $eD \rightarrow e'p_s X$

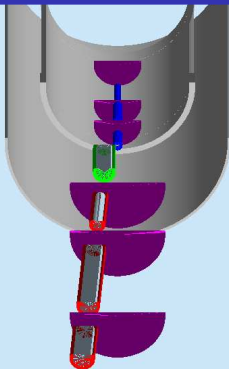


low  $\alpha_R \rightarrow$

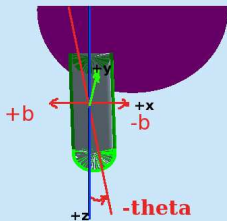


- Left: MEIC beam-line with spectator proton (red rays) and scattered electrons (blue rays), Right: Acceptance as function of  $p_T$ ,  $\alpha_R$  at the exit of the second dipole. Acceptance drops at smaller  $\alpha_R$  due to the second dipole geometry. Note that  $\alpha_R$  goes the same way with bending spectator proton at the second dipole.

# D2 adjust coordinate in GEMC — [backup] —



- purple half disk: virtual detectors
- local magnet coordinate
- $\pm b$ : shift parameter B
- $theta(\theta)$ : tilt angle  
- sign: direction



## D2 adjust coordinate in GEMC — [backup] –

- Magnet parameters: "meic\_det1\_parameters\_Original.txt"
- Magnet thickness electron line(4cm), ion line(7cm)
- All Dipoles and Quads are circle shape
- Dipole1 is parallel to electron beam line
- Only Dipole2 position change  
**NEW PERL Script**
  - meic\_det1\_dual\_barrel.variable.pl
  - meic\_det1\_magnet\_ion\_dipole.variable.pl
- Dipole2 tilt angle ( $\theta$ ) and shift ( $b_{xz}$ )
- Tilt Range:  $\theta = -2.0 \dots +2.0$  mrad,  $\delta\theta = 0.2$  mrad
- Shift Range:  $b_{xz} = -20/100 \dots +20/100$ ,  $\delta b_{xz} = 2/100$
- Test with Spectator Proton, Neutron ( $p_S = 300$ , 1000GeV)