Prospects of charm measurements at EIC

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(For BNL eA Group)
Why Heavy Flavor?

- Massive quarks
- Probe Gluon density
- pQCD calculable

B. Mueller, nucl-th/0404015

Boson-Gluon fusion
Results from ep at HERA
eA (enrich gluons)

EIC
- eRHIC e+Au, (20 GeV + 100 GeV/n)
- eRHIC e+Au, (10 GeV + 100 GeV/n)
- ELIC e+Ca, (7 GeV + 75 GeV/n)

\[ Q_s^2, Q_{s,q}^2, Q_s^2 \text{ Au (} b = 0 \text{ fm)} \]

\[ Q_s^2 \text{ Ca (} b = 0 \text{ fm)} \]

\[ Q_s^2 \text{ proton} \]

CGC: high density gluons

Dilute gas

momentum
Model used for rate estimates

HVQDIS: different schemes
A. Chuvakin, J. Smith and B.W. Harris, hep-ph/0010350; PRD 57(98)2806
Estimated charm production

\[ J/\psi \approx 1/100 \text{ (300) } cc\bar{b} \]
Detect heavy Flavors

- D, D*, D+μ
- J/Ψ→μμ

H1, hep-ex/0503038

<table>
<thead>
<tr>
<th></th>
<th>ΔΦ &lt; 90°</th>
<th>ΔΦ &gt; 90°</th>
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<tbody>
<tr>
<td>Q(D^*) = Q(μ)</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>charm (%)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>beauty (%)</td>
<td>3.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Q(D^*) ≠ Q(μ)</td>
<td>III</td>
<td>IV</td>
</tr>
<tr>
<td>charm (%)</td>
<td>6.0</td>
<td>93.8</td>
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<tr>
<td>beauty (%)</td>
<td>50.0</td>
<td>25.9</td>
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</tbody>
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Possible Compact Muon Detector

• Novel and Compact:
  Timing, Position ↔ Track Segments+FastHits
  One Layer/Detector ↔ Many Detector Systems
  MRPC ↔ RPC+MWPC

• QCDLab:
  Momentum: few GeV/c ↔ 10—1000 GeV/c
  Background tracks: 1000 ↔ 10

• R&D:
  Simulation, MRPC Detector, Online Trigger, Background

• Couple with vertex detector for heavy flavor physics in EIC
Hadron Rejection and Trigger at (e)RHIC

<table>
<thead>
<tr>
<th>Cuts</th>
<th>Nhit/event</th>
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</thead>
<tbody>
<tr>
<td>No cut</td>
<td>70</td>
</tr>
<tr>
<td>TOF (&lt;20ns)</td>
<td>1.6</td>
</tr>
<tr>
<td>Eloss</td>
<td>7.6</td>
</tr>
<tr>
<td>TOF&amp;Eloss</td>
<td>0.72</td>
</tr>
<tr>
<td>TOF (-400ps,100ps)</td>
<td>0.23</td>
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</tbody>
</table>
Muon Efficiency

Single particle GEANT simulation.

Particles are generated with flat \( p_T \), \( \eta \) and \( \phi \) distribution. 0<\( p_T <20 \)GeV, 0<\( \eta <0.8 \), 0<\( \phi <2\pi \).

Cuts used for muon ID:

- Time of flight (TOF) difference between hits and tracks.
- Distance of closest approach (DCA) between hits and tracks.

MTD effective azimuthal coverage is 56.6%: ~80% of the muons within MTD coverage can be reconstructed.

Hadron Rejection: ~100
2. LMRPC -- design and construction

TOP View

Size: 95 x 25.6 cm²
Read out strip: 25 mm wide, 4 mm gaps
Active area: 87 x 20 cm²
The first LMRPC
The signal propagation velocity: \( 56.4 \pm 0.7 \, \text{ps/cm} \)

Time Resolution: 59ps
Test Trays at STAR and FNAL MT6

- Test muon/hadron identification at STAR and FNAL test beam
- LMRPC (fast trigger, hadron rejection)
- GEM tracking for improvement of momentum resolution (future)
Conclusions and Prospects

- Future eA with high luminosity
- High statistics with wide kinematics coverage for heavy flavor
- Probe gluon structure in heavy nuclei
- Simulations and detector R&D
MTD is able to reject hadrons by a large factor (50-100) up to high $p_T$. 