LD1601 Project Meeting 15-June-16

C. Weiss, LDRD Project "Nuclear gluons with charm at EIC," Meeting 15-Jun-16

1) Charm and DIS cross sections at large x and high Q^2

   Estimates using LO QCD formulas and numerical phase space integration

   Comparison with PYTHIA (?)

2) Charge/flavor separation of nuclear quarks at $x \sim 0.1$

   Physics motivation; NN interaction

   Simulation setup

3) Interfacing with GEMC simulations

   Reply to reviewers' questions

Charm and DIS cross sections I

- Calculate differential cross sections using LO QCD formulas

$$d\sigma(e + N \to e' + X) = \mathrm{Flux}(x, y, Q^2)\, F_2(x, Q^2)\, dx\, dQ^2 \quad (1)$$

$$d\sigma(e + N \to e' + c\bar{c} + X') = \mathrm{Flux}(x, y, Q^2)\, F_2^{c\bar{c}}(x, Q^2)\, dx\, dQ^2 \quad (2)$$

- Integrate cross section over finite x and Q^2 bins

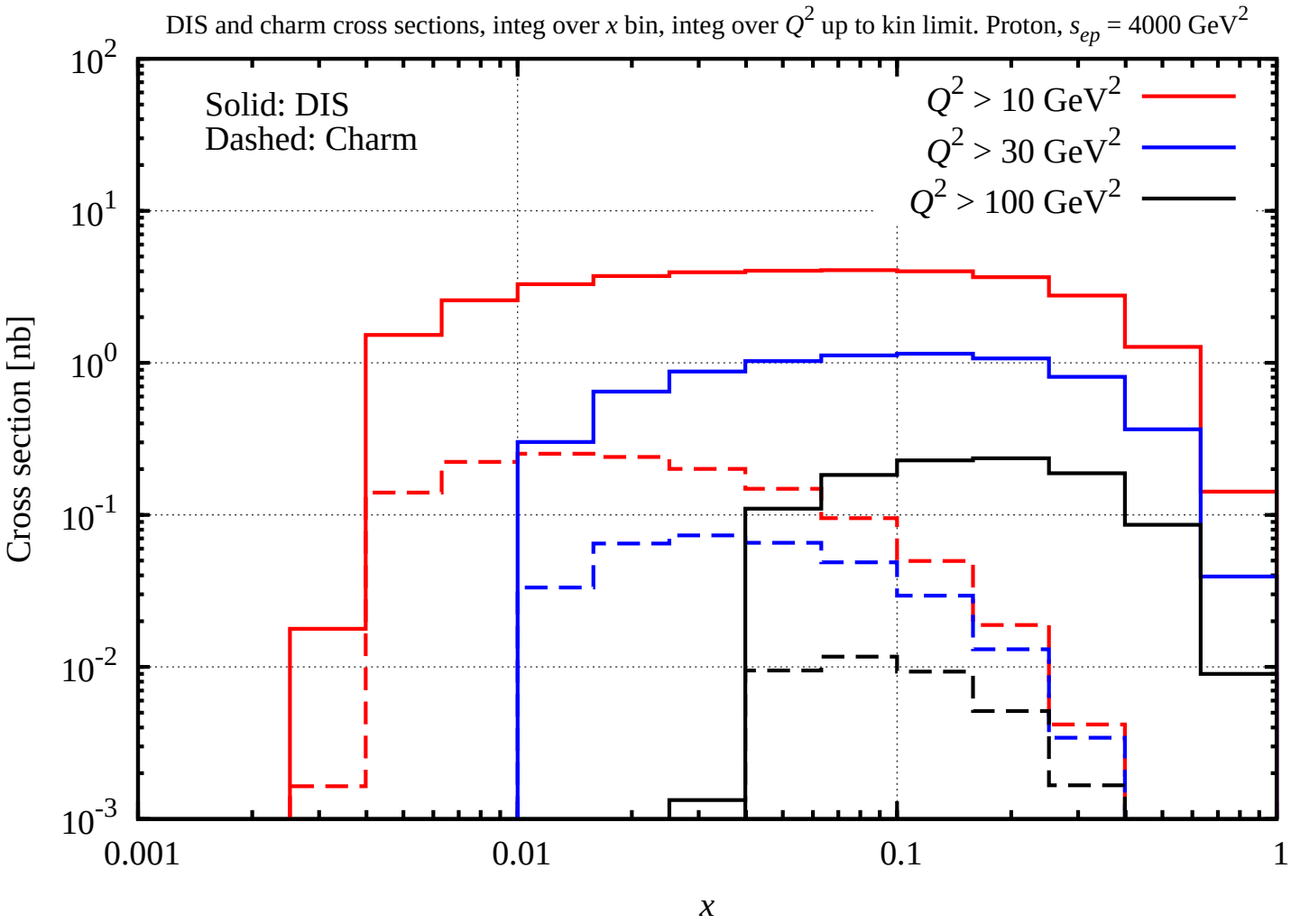
  x from $[x_1, x_2]$

  Q^2 from Q_2^1 to kinematic limit $Q_2^2 = x s_{eN}$ (corresponding to y = 1)

- Here $s_{eN} = 4000$ GeV^2, corresponding to 10 on 100 GeV

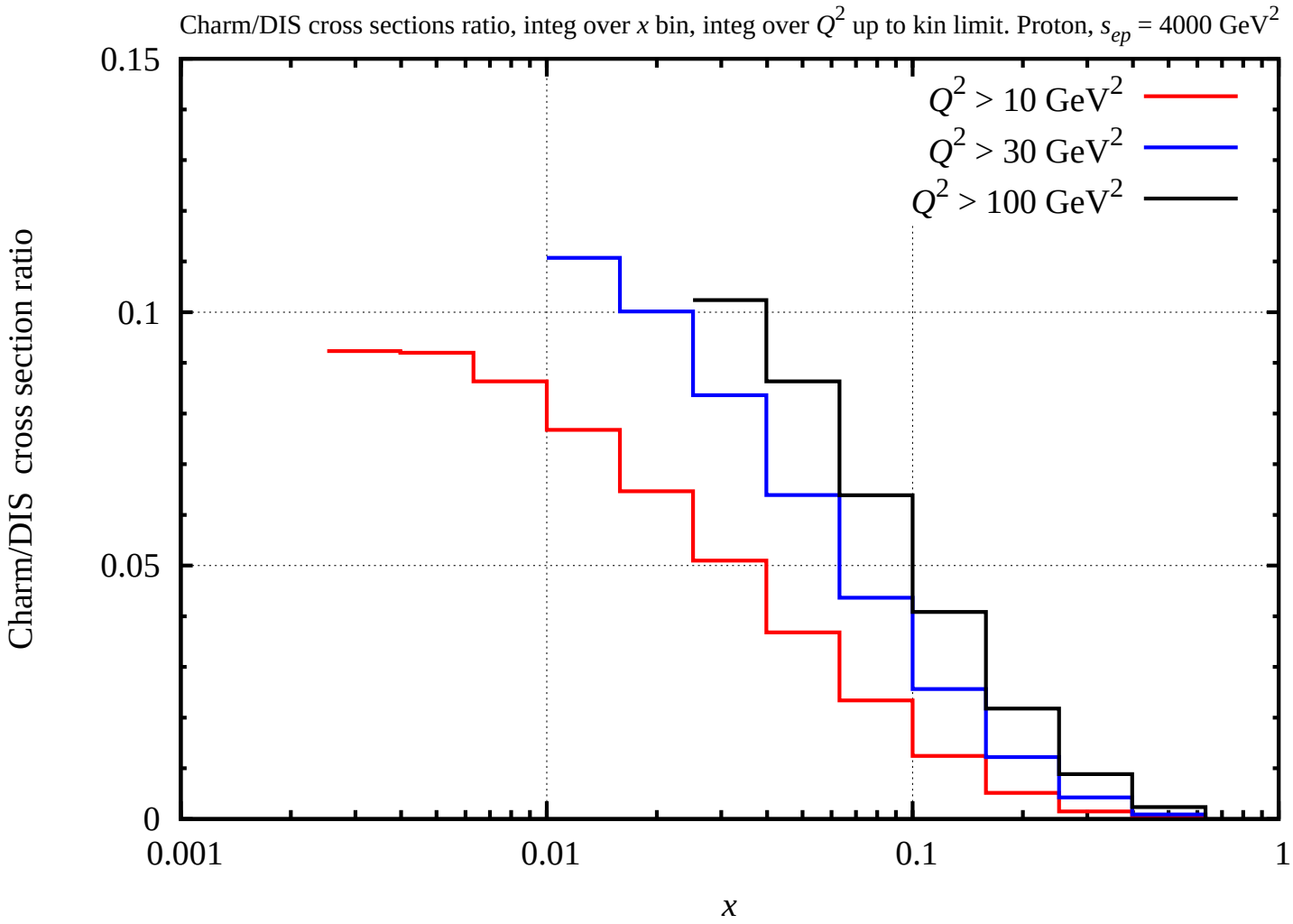
- From cross section to rates: Multiply with integ. lumi 1 fb^{-1} $= 10^6$ nb^{-1}

Charm and DIS cross sections II



- DIS cross section: Bjorken scaling implies $\sigma(\text{integrated}) \sim 1/Q_1^2$ ✓
- Charm cross section: Non-trivial Q_1^2 dependence through partonic kinematics

Charm and DIS cross sections III

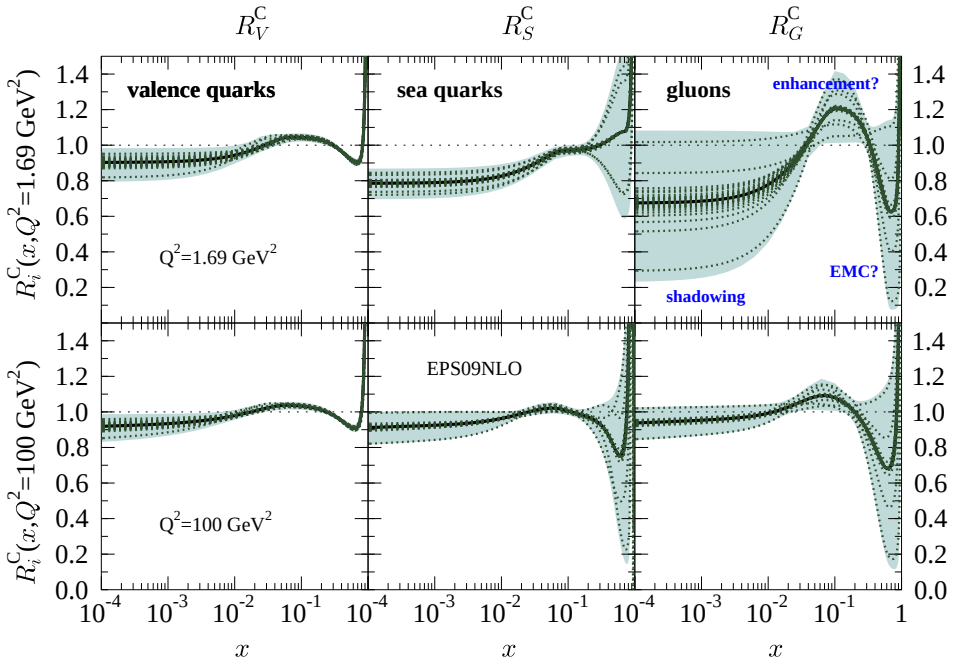


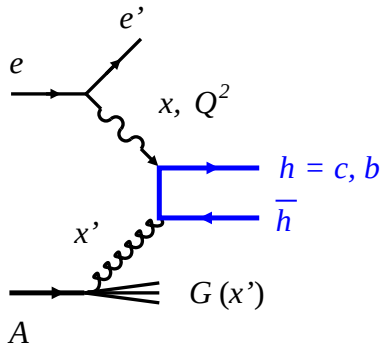
- Charm/DIS ratio grows linearly with $\log 1/x$, grows with Q^2
- Charm/DIS ratio $\sim$ 5–7% at $x \sim 0.1$ and $Q_1^2 \sim 100$ GeV^2

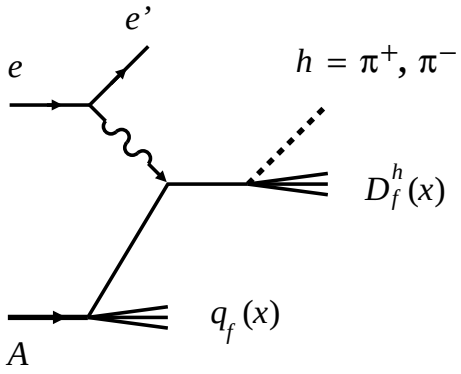
Charm and DIS cross sections IV

- Cut on large Q^2 improves charm/DIS ratio significantly
- Charm rates still acceptable at $Q^2 \gtrsim 100$ GeV^2, decrease only slowly with Q^2
- Cross section & integration codes checked against HVQDIS
- PYTHIA results should be verified with these estimates

Charge-flavor separation of nuclear quarks





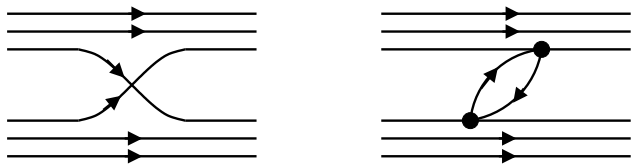


- EMC effect at $x > 0.3$?

  Modified nucleon structure $\leftrightarrow$ non-nucleonic DOF in nucleus

- Quark and gluon enhancement at $x \sim 0.1$ — antishadowing?

  QCD structure of NN interaction: Quark or antiquark enhancement?

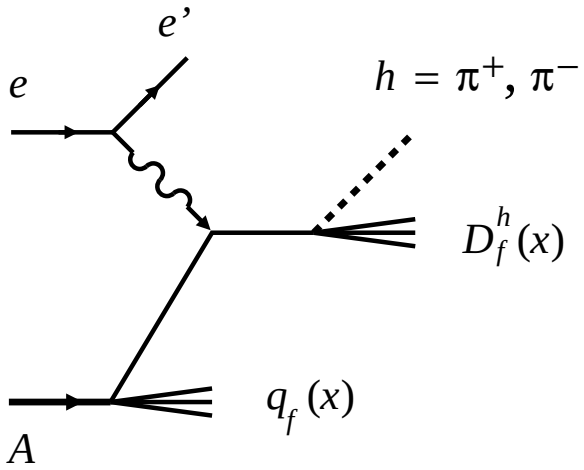


quark exchange meson exchange

  Gluon enhancement?

- Direct probes: Charm for gluon, semi-inclusive π, K for quark charge-flavor separation

Charge-flavor separation of nuclear quarks



- Semi-inclusive hadron production

  Standard method for charge/flavor separation
  HERMES, COMPASS, JLab 6 + 12 GeV

  LO, NLO implementation available

  Simulation tools available:
  HERMES, JLab CLAS/Hall C, SOLID

- Adapt to eA at EIC

  Nuclear effects contained in PDF – no explicit modeling (Fermi motion)!

- Apply to nuclear ratios at $x \sim 0.1$

  Separate charge/isospin combinations with $N(\pi^+ \pm \pi^-)$

  Fragmentation functions cancel in nuclear ratio. NLO effect?

  Estimate final-state interactions by measuring on different nuclei and using A–dependence

Verification of detector simulations

Reviewers' question: How will the parameterized detector simulation be validated? Is it based on an existing program? Has it been investigated to use GEMC, for example, to build a geometry for the JLEIC toy detector concept that could be used with G4 for simple benchmarking studies?