Towards Quantifying the Impact of Future SPD Asymmetry Measurements

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March 03, 2021

- Updates from various correspondence (partially mentioned in an email a couple of weeks ago)
- Early look at distributions of some kinematic variables and underlying partonic processes in pythia simulations of charmonium and open charm productions

Gluon Sivers Distributions $f_{1T}^{\perp g}$

- Contacted multiple groups that worked on Gluon Sivers function (often with RHIC data)
- Have not heard back from Zhongbo Kang (UCLA), Cristian Pisano (U. Cagliari) even after multiple emails
- Xiaojun Yao and Yoshitaka Hatta (Phys. Lett. B, vol 790, p361-366) have both replied
- Xiajun said D-meson A_N measurements probing intermediate-large x would be useful, but said his expertise/interest is in low-x region. Doubtful about charmonium (uncertainty due to prod. mechanism?)
- Yoshitaka said he is now focussed on e+p measurements (future EIC at BNL)
- He cautioned against using TMD approach for extract Gluon Sivers from SSA in p+p. Prefers using three-g correlators (more rigorous theoretical approach)

Gluon Sivers Distributions $f_{1T}^{\perp g}$

- No substantive suggestions yet to judge impact of future SPD measurements on Gluon Sivers function
- Yoshitaka pointed to work by a group at Niigata Univ. Yet to hear back from them
- Cagliari group (D'Alesio et al.) have done work very relevant to SPD. Anyone with their direct contact please let me know (Cristian Pisasno not responding, Alexey did not hear from Francesco Celiberto)

Unpolarized Gluon Distributions $f_1^g(x)$

- Maria Gazrelli from the PROSA group (that combined LHCb data with HERA data to update unpol. dist.) replied. She agrees with me that mock data from SPD can be included in their fitting (xFitter) to see impact on uncertainty band
- Differential distributions of D meson production theoretical estimates or MC data with stat. (and sys. - but we are far from that) errors can be used
- Andrey Sapronov and Oleksandr Zenaiev replied and can help if needed with xFitter techniques
- Samara group already presented LO D-meson cross-section predictions in last meeting

Gluon Helicity Distributions $g_1^g(x)$

- Werner Vogelsang (DSSV group) replied. He agrees that there are large uncertainties in high-x ranges and new A_{LL} data can be very useful
- They have an ingenious method of reweighting MC with asymmetry data to test its impact on $\Delta g(x)$ i.e. STAR di-jet results in their paper
- Rodolfo Sassot (DSSV) agreed to help us use mock SPD A_{LL} data with this technique
- Werner agreed to produce the prompt photons A_{LL}. I also notice our own colleagues from Samara will present A_{LL} calculations
- I'll contact both sides to use predictions for the fit to quantify impact of such measurements on global analysis of $\Delta g(x)$

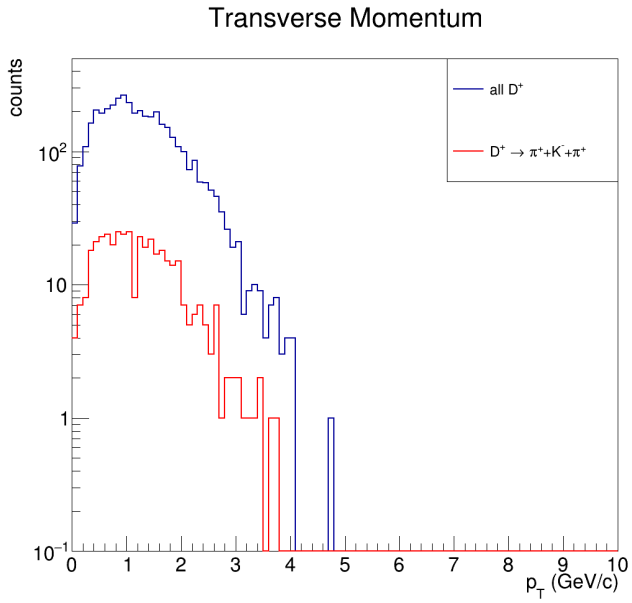
Pythia Simulations to Study Open Charm and and Charmonium

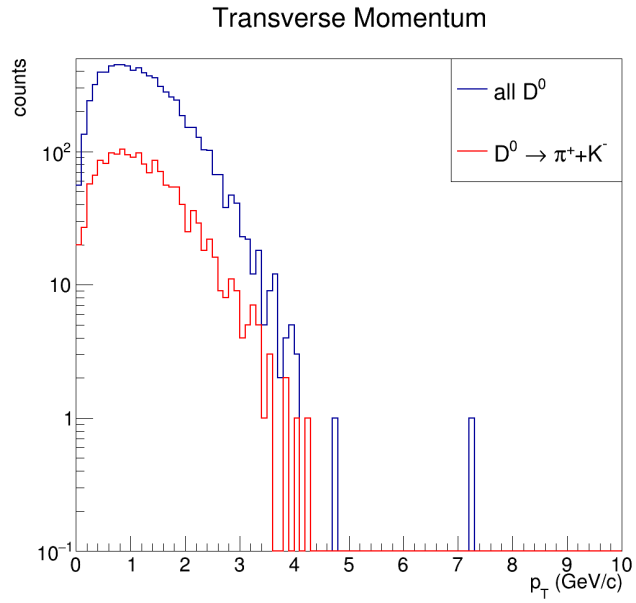
- Early study. Not large statistics yet. A few concerns to be cleared
- Pythia8 : $p + p$ at $\sqrt{s} = 27$ GeV. HardQCD:all, Charmonium:all
- Purpose : kinematic distributions of particles of interest and their decay products
- Purpose : Bjorken-x distributions of partons producing them (essential to see impact on various gluon dist.)
- Purpose : study variation with PDFs (especially gluon) as it is NOT known very precisely

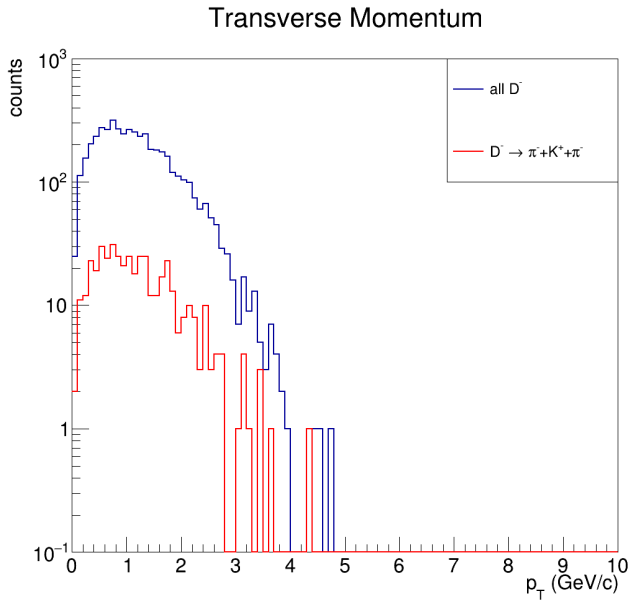
Some Numbers

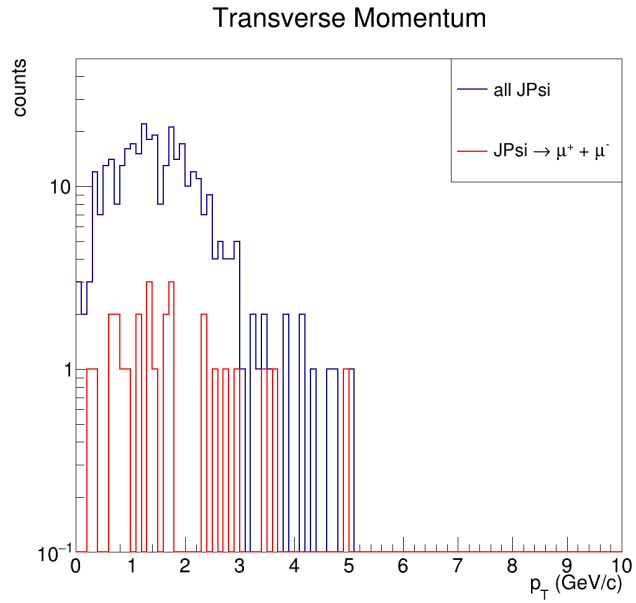
- 10 Million $p + p$ events. HardQCD:all, Charmonium:all, PDF:pSet=7 (CTEQ6L NLO)
- $J/\Psi = 343$, $J/\Psi \rightarrow \mu^+\mu^- = 27$ (7.8% PDG BR 5.96%)
- $D^+ = 4104$, $D^- = 4669$, events with $D^+ + D^- = 1286$
- $D^+ \rightarrow \pi^+ + K^- + \pi^+ = 404$ (9.8% PDG BR 9.2%)
- $D^0 = 7549$, $\bar{D}^0 = 9093$, events with $D^0 + \bar{D}^0 = 4458$
- $D^0 \rightarrow \pi^+ + K^- = 1637$ (22.3% ??!! PDG BR = 3.9%) I did ensure only 2 decay products
- Concerns : 1) D^0 decay branching ratio 2) use of certain PDF set (NNPDF_nlo_as_0118_nf_6) produce order of magnitude more particles

Transverse Momentum Distributions

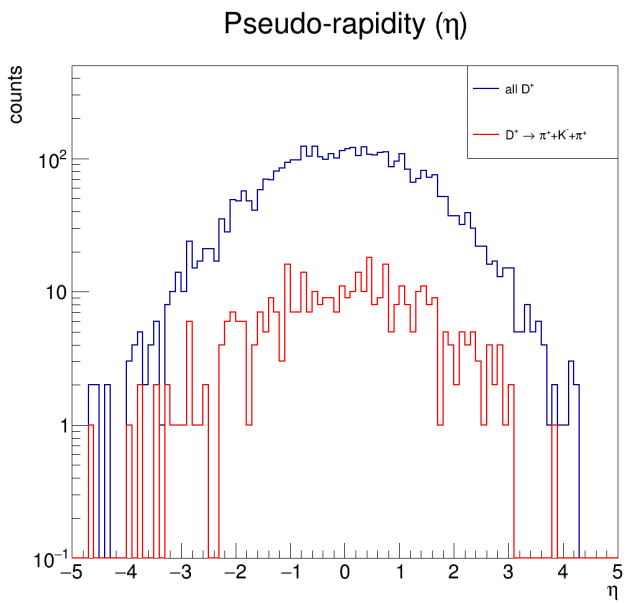


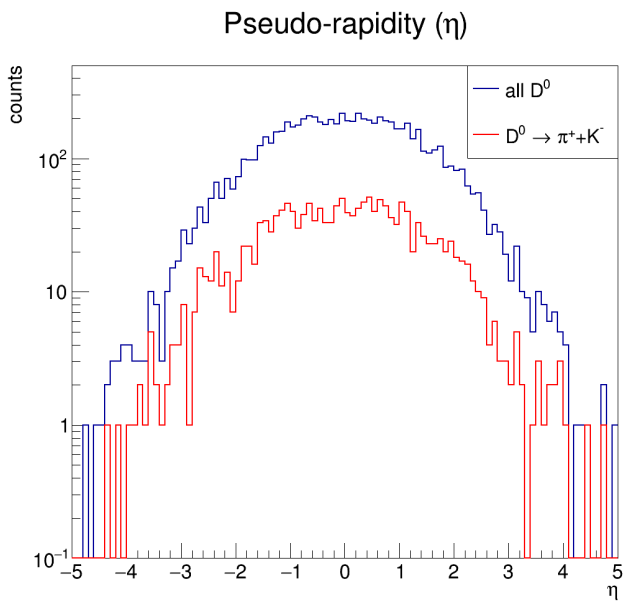


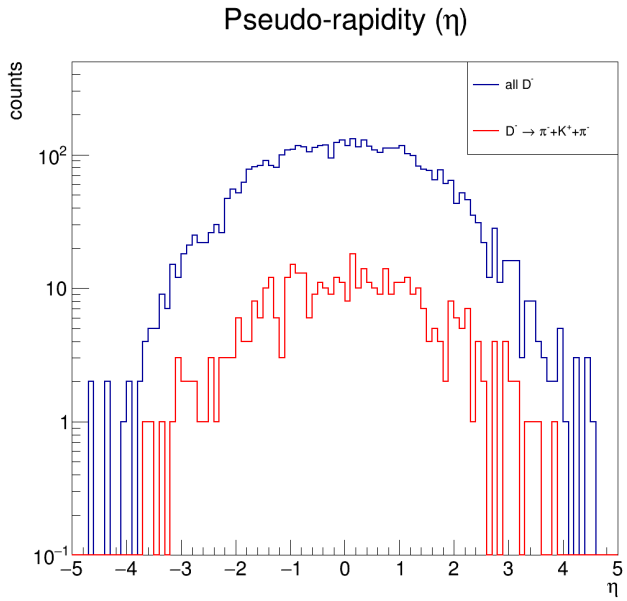


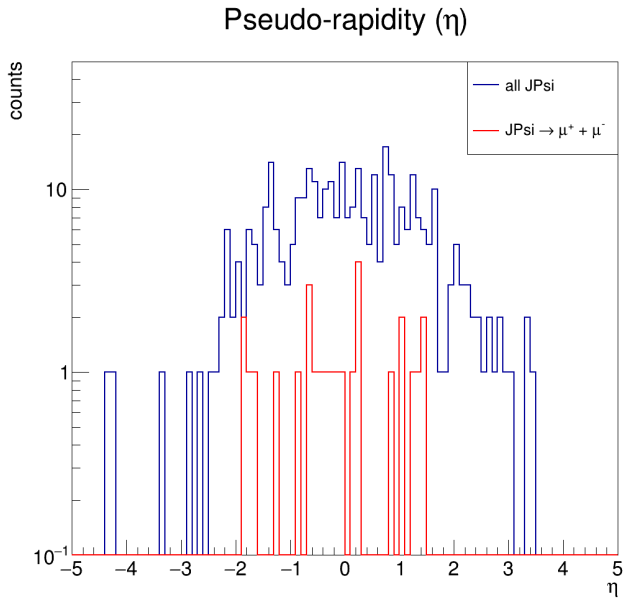


Pseudorapidity Distributions

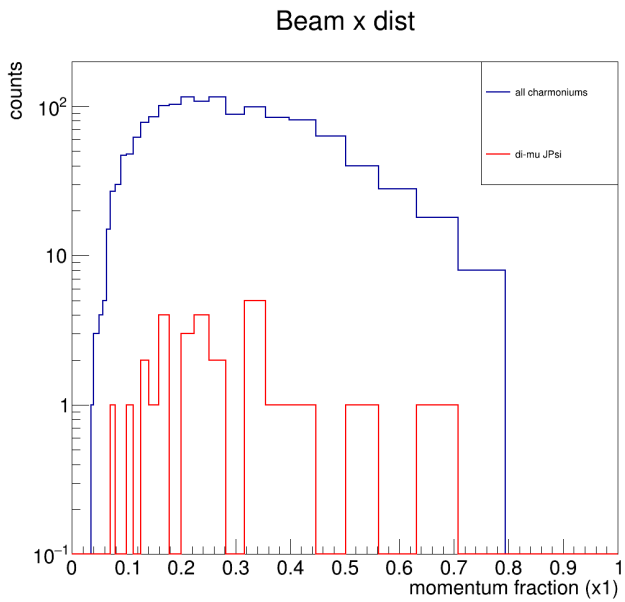


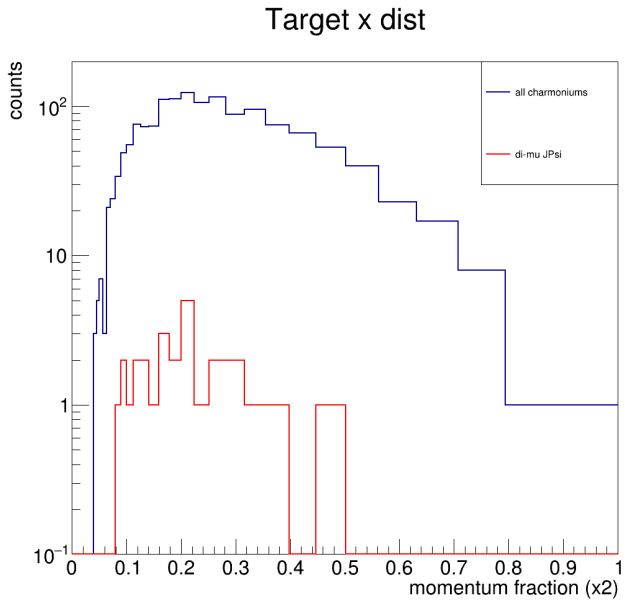


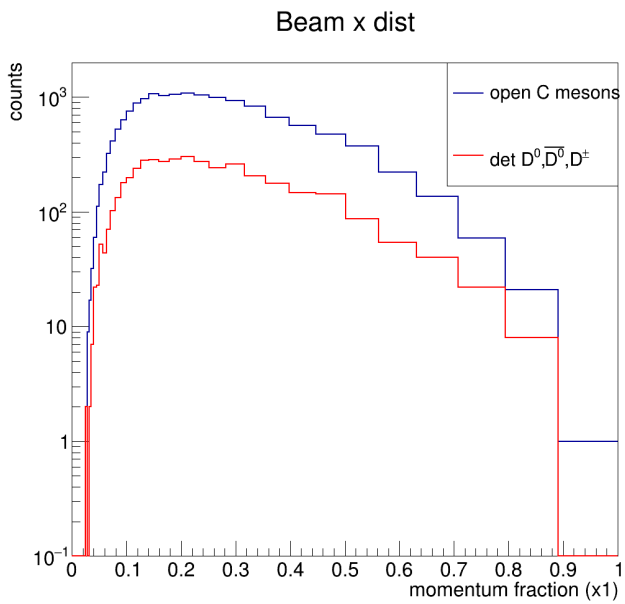


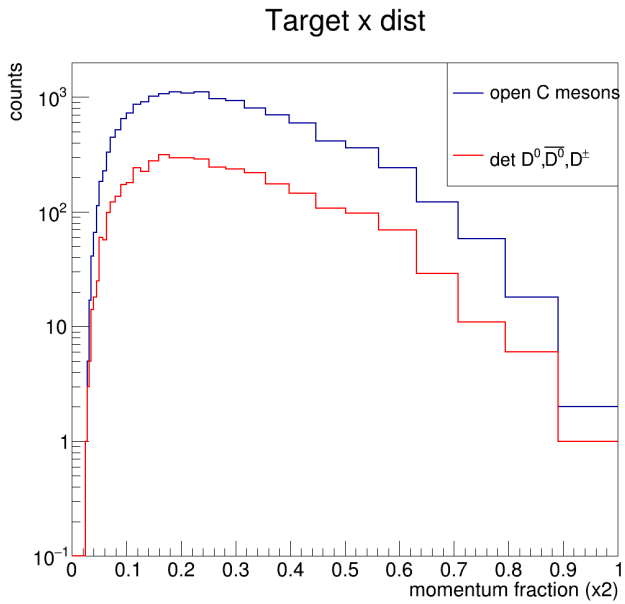


Partonic x Distributions









Next To Do

- Increase statistics so that uncertainties are smalles than from systematic differences from using different PDFs (Pythia internal + LHAPDF6 sets)
- Include and study prompt photon productions
- Scale with cross-sections properly to generate differential distributions in bins of p_T, x_F
- With proposed experimental luminosity, generate expected statistical uncertainties (keeping in mind unpol. dist. study)
- Look at partonic x for diff. p_T bins of observed particles
- Coordinate between groups to use A_{LL} predictions for SPD measurements
- Still need advice from group(s) expert in extracting Gluon Sivers using A_N measurements