

Semi-inclusive reactions working group: summary

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Anselm Vossen (Duke& JLab), Bowen Xiao (Central Normal University)

March 21, 2020



7 presentation + joint session with Jet/Heavy flavor WG

19'th march

Spectroscopy overview/theory	<i>Alessandro Pilloni</i>	
Online	21:30 - 22:00	
Spectroscopy experiment	<i>Justin Stevens</i>	
Online	22:00 - 22:30	
Di-hadron fragmentation update	<i>Anselm Vossen</i>	
Online	22:30 - 23:00	

20'th march

Lambda fragmentation related measurements	<i>Jinlong Zhang</i>	
Online	13:30 - 14:00	
(nuclear) Fragmentation function related measurements	<i>Charlotte Van Hulse et al.</i>	
Online	14:00 - 14:30	
Quark Sivers/TMD related measurements	<i>Alexei Prokudin</i>	
Online	14:30 - 15:00	
Parton helicity related measurements	<i>E. C. Aschenauer</i>	
Online	15:00 - 15:30	

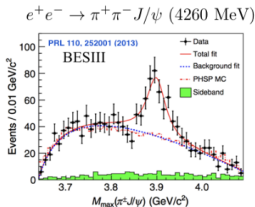
20'th march

Gluon Sivers Related Measurements	<i>Liang Zheng</i>	
Online	16:00 - 16:25	
TMD measurements in jets	<i>Felix Ringer</i>	
Online	16:25 - 16:50	
Modification of heavy flavor in e+A collisions at the EIC	<i>Zelong Liu</i>	
Hadrons in jets	<i>Yiannis Makris</i>	
Online	17:15 - 17:40	
Discussion		
Online	17:40 - 18:00	

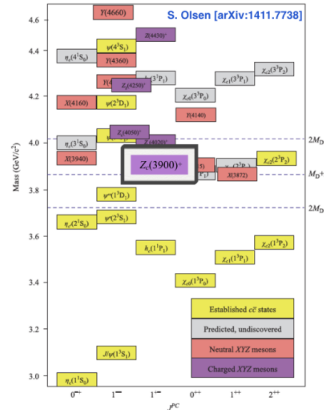
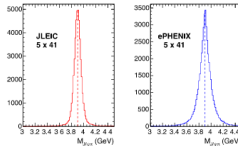


Spectroscopy: XYZ, P_c

- Many new states observed in the last ~decade
 - Many beyond minimal quark content
- Some existing models for photoproduction; new predictions from Joint Physics Analysis Center (JPAC)
- Initial fast-smearing simulations underway (eic-smear)
 - Requirements on Particle ID and vertex detectors



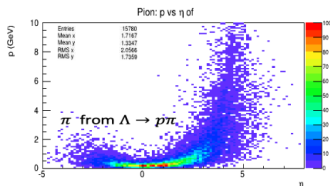
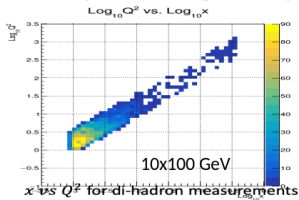
New eic-smear simu:
 $\gamma p \rightarrow Z_c^+(3900)n$



Stevens, Piloni (Thursday PM)

Di-hadron and Λ

-  polarized final states
-  di-hadron correlations
- Explore spin-orbit correlations in hadronization
- Additional degrees of freedom in final state make targeted extraction of nucleon structure possible
 -  Highlight channels
 - Transversity in di-hadrons
 - Boer-Mulders in di-hadrons
 - Lambda polarizing FFs, spin transfer
- Status:
 - First simulation work started
 - Implementation on general analysis modules started



Quark pol.

	U	L	T
U	D_1		H_1^1
L		G_{1L}	H_{1L}^1
T	D_{1T}^1	G_{1T}	H_{1T}^1

Hadron pol.

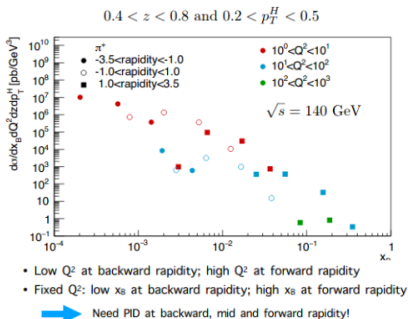
TMD FFs

} Lambda

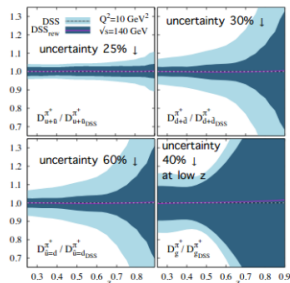


Fragmentation functions and nuclear fragmentation functions

Studies for an EIC of semi-inclusive lepton-nucleon DIS and collinear fragmentation
E. C. Aschenauer, I. Borsa, R. Sassot, C. Van Hulse, PRD 99 (2019) 094004



Essential reduction of uncertainties for FF's



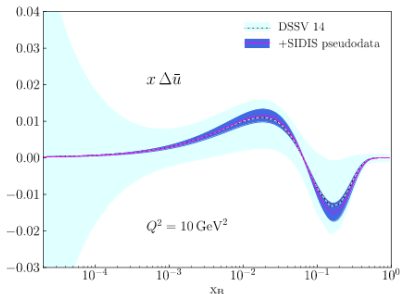
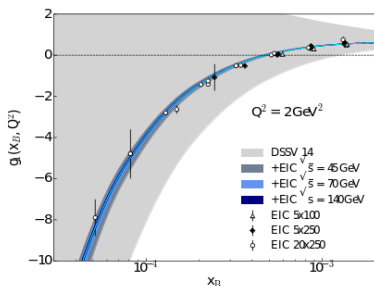
- Large (PID) detector coverage in rapidity necessary:
 - complementarity of rapidity regions in kinematic coverage
 - disentanglement current and target fragmentation
- Impact of limited detector resolution needs to be studied
- Measurements on nuclear targets allow to study hadronisation process: studies for EIC needed



Helicity PDFs and Gluon/Sea contribution to spin

Current progress:

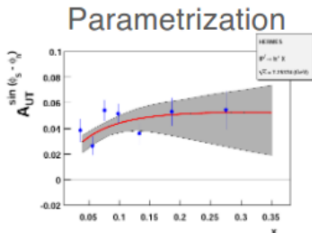
- Polarized generators: PEPSI & Djangoh
- The pseudo data for variety of targets at different set of energies (at 10fb^{-1} , with 100 % polarizaton)



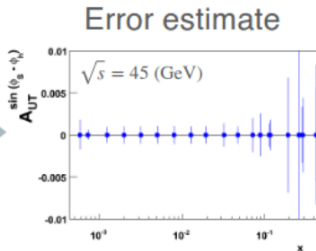
- Need to study detector effects, can be done using the smearing generator
 - but need consistent parametrization for tracking and PID

TMD at EIC

- Unpolarized cross sections are reliably simulated using Pythia
- There is **no** polarized SIDIS event generator that includes all correlations
- Current way is **reweighing** unpolarized events based of extracted parametrizations



Anselmino et al (2009)



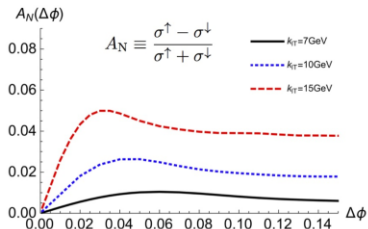
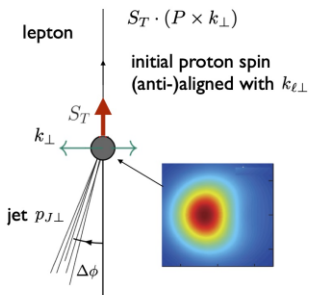
EIC estimate @ 10 fb⁻¹

- Database of both parametrizations and error estimates is highly needed
- Expertise exists in our and HEP community and other groups, cooperation is needed

TMD Measurements with Jets

- Jet Correlations

- Direct probe of quark Sivers effect via electron-jet correlations
- Proton-jet correlations (Reduction of hadronization effects)

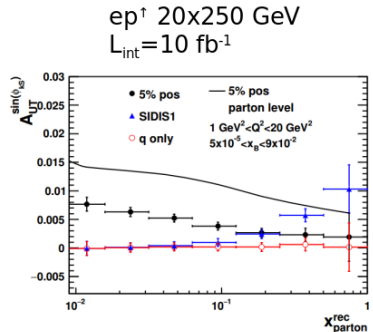


- Jet Substructures (probe different TMD in-jet distributions)
- Recent significant progress of TMD-jet observables
- Important observables at the EIC



Gluon Sivers related measurements

- Open charm measurement
 - Clean probe to gluon distribution
 - Experimentally challenging
- Dihadron measurement
 - Straightforward to do
 - Statistically favored
 - May suffer stronger dilution
- Dijet measurement (Most promising)
 - Strong correlation to parton kinematics
 - Enough statistics to do multi-dimensional binning
 - Large quark Sivers background



Money plot

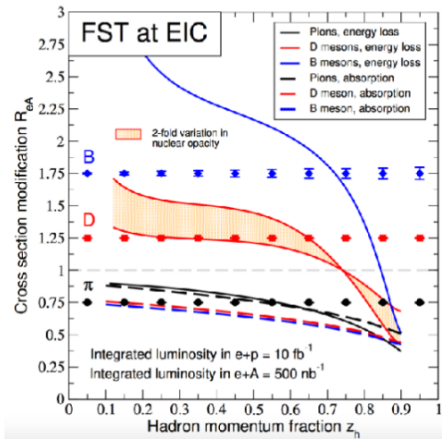
Detector effect within eic-smear and new jet axis effect studies are on the way!



Medium modification in nuclei

2002.05880

- To understand models of nuclear modification in DIS reactions with nuclei (HERMES can not do)
- To see the differences of the fragmentation functions and formation times for different heavy mesons.



- Hadron (π^0 , D , B mesons) productions at EIC are studied by using the FFs in Au medium

Summary

- ▶ Semi-inclusive WG deals with a wide spectrum of physics topics
 - ▶ TMD distributions
 - ▶ Collinear distributions
 - ▶ Di-hadron, and Λ
 - ▶ Spectroscopy
- ▶ Intersection with other groups
 - ▶ TMD distributions, Di-hadron, and $\Lambda \rightarrow$ Jet/Heavy flavor WG
 - ▶ Collinear distributions \rightarrow inclusive WG
 - ▶ Spectroscopy \rightarrow exclusive/tagging WG
- ▶ **Work in progress!**
 - ▶ A lot of studies already done by BNL group (collinear physics, unpolarized TMD measurements)
 - ▶ Polarized TMD-related studies currently await the theory input to reweight MCEG
 - ▶ Spectroscopy, Di-hadron, and Λ studies are already in the working loop

