Update on the x>1 Analysis and the Upcoming Experiment E12-06-105





2/17/2022 Hall C Collaboration Meeting Casey Morean

E12-06-105 Physics Goals

- Make precision measurements of 2N SRCs
 - A-dependence in light nuclei
 - Variation with neutron excess
 - Connect the EMC effect and SRCs
- Aim to make first observations of 3N SRCs
- Look for superfast quarks
 - Nuclear PDFs at X>1

Physics goals rely upon full understanding the Hall C hardware and software





Previous Hall C 2N SRC Results



N Fomin et al. PRL 105, 212502 (2010)



Previous Hall C SRC Results





3N SRCs at High Q²

- α_{3N} allows for more precise determination of SRC onset
- Current work suggests 3N SRCs do not become dominate until higher Q²
 - α_{3N} of around 1.6-1.8; Q² >3 GeV²
- Proposed subset of nuclei reaches highest Q² in the minimal amount of time





Superfast Quarks

- Higher beam energy allows us to use deep inelastic scattering to probe PDFs at x>1
- Q² in the 7-9GeV² range



L. W. Whitlow et al. Phys. Lett. B282, 475 (1992)



Commissioning x>1 Data

- 2N SRC data taken in 2018 during F2 experiment
- 2N SRC data taken in 2019 during J/ψ run period (while HMS was offline)







Analysis Status

Luminosity StudiesDetector Efficiencies

- Detector Calibrations
- ✓ Optics Studies
- ✓ Live-time Studies
- × Background Events





SHMS Optics

- Momentum saturation factor erroneously added to optics model based on field probe measurements
 - Early (e,e'p) experiment showed correlation between the spectrometer arms
- Mis-set optics model of Monte Carlo to replicate data
 - Use this information to correct the matrix elements in hcana
- Many small improvements over time
 - Not an issue for 2019 dataset

Plots courtesy of Aruni Nadeeshani





Electronic Dead-Time

- 100ns gates used during commissioning experiments
- STOF trigger leg removed in 2019
- Improper use of EDTM system for the higher rate running (Didn't account for ps)
 - Total live-times greater than 100%
- Using Dave Mack's model of electronic live-time
 - The results are much better with this model, but may still need full MC.





Background of Bad Events

- Dummy subtraction in Deuterium does not cancel in the kinematically forbidden zone:
 - Finite spectrometer acceptance \rightarrow Kinematically forbidden region is X>2.14
- Looked into using Mark's improved tracking algorithm
 - More events! Same shape and same issues. (Was using chisq method instead of pruning method)
- Now attempting to use MC and XEM_model to make cut on FP quantities.





Data Taken Spring 2018/2019

2018	
Central Momentum	9.8 GeV
Q ²	2.08
Angles	8.02
Elements	H, D, C, Al, ⁹ Be, ¹⁰ B, ¹¹ B

• EMC data also taken in 2018

2019	
Central Momentum	9.8 GeV
Q ²	4.46
Angle	13.10
Elements	H, D, C, Al, ¹⁰ B, ¹¹ B

*Boron targets are boron carbide B_4C



Data Quality Spring 2018 Born Cross-Section



Nominal Acceptance





Statistics Projection for Ratios

Spring 2019 Born Cross-Section Ratio

Spring 2018 Born Cross-Section Ratio

Nominal Acceptance



Upcoming Experiment

- Optimizing the Runplan
- New High-Pressure Target Cell
- Work on hallc_replay_XEM
 - ✓ Online estimate of good electron rates
 - Expert tools (timing window / ref-time plots, BCM checks)
 - ✓ Online replay diagnostic plots
- Progress on XEM model for new targets



Beam Time Allocation

- 25 days of SRC production running
- 21 days for the EMC production running
- Multiple run periods







Run Planning Data vs. Sim. Rates

- XEM model weighted single_arm_mc
- DAQ rate is the total rate, not just within the acceptance
 - Pions, events without tracks, etc.
- DAQ in buffered mode now, ~2X event rate of 2018
- Further from the beamline, less background events



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New High-Pressure Target

- The target group is fabricating a never-before used target cell made to handle high pressure and cryogenic temperatures
- Engineering DWGs:

-Dave Meekins



Model Work

- Need proper model weighting of MC
- Update XEM model to use Eric Christy's F1F221 nucleon structure functions
- Smooth connection between EMC and x>1 region
- Parameterize the EMC effect
- Add starting points for new targets parameterized by world data





Summary & Outlook

- Calibrations and data quality check
 done
 - Utilize the 2018 EMC and SRC data to examine the EMC-SRC correlation
- Data taking for full experiment begins this June!
- Interesting Physics is waiting
 - 2N SRCs, 3N SRC signature, superfast quarks at x>1
- Well equipped for the upcoming experiment.
- Finalizing the order of our running



Thank You!

- Nadia Fomin, Dave Gaskell, John Arrington
- Bill Henry, Mark Jones, Dave Mack, Simona Malace, Eric Christy
- Graduate Students

Questions?



Office of Science



Event Distributions Across X

 Quick changes in diagnostic plots

Extra 1

 We can simulate what is expected to inform the shift takers





Carbon at 8°, $P_{central} = 9.7 \text{GeV/c}$





Update to HCANA

- Include events where PulseIntRaw==0
- Use only events with a scintillator hit at both ends of a bar
- Exclude random events when running at high rates by using time-of-flight
 - Requires beta calibration
- If the TDC fires, and there is any pulse in the ADC, it could be an event



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