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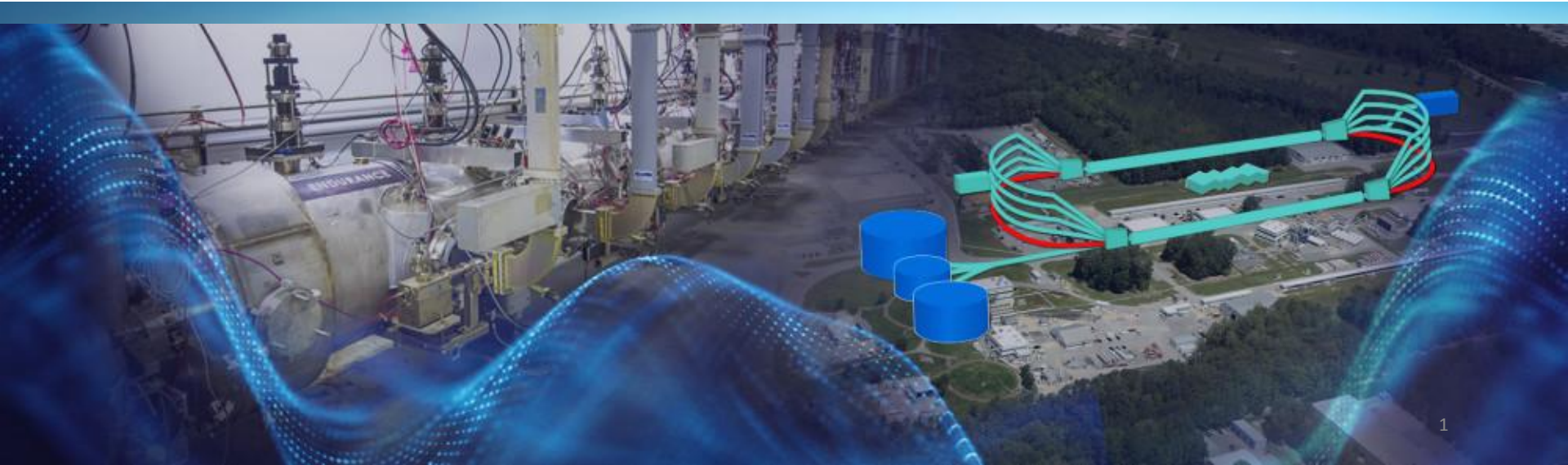
U.S. DEPARTMENT OF ENERGY
Office of Science

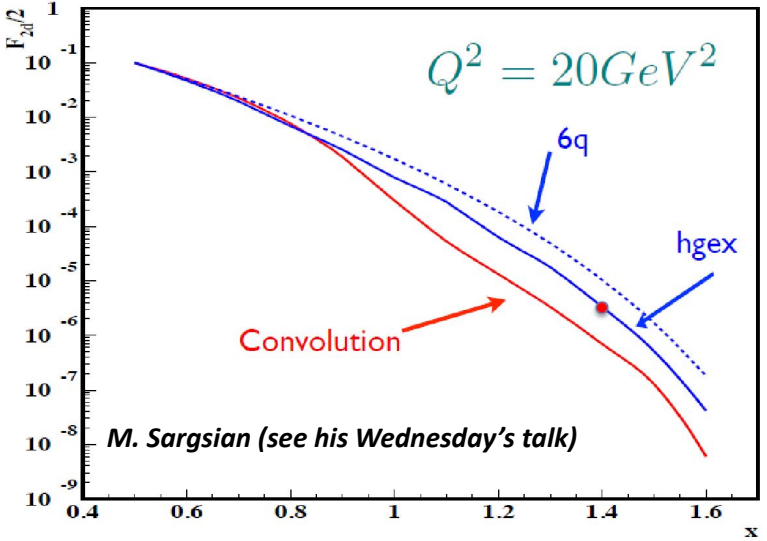
Super-fast quarks: experiment status

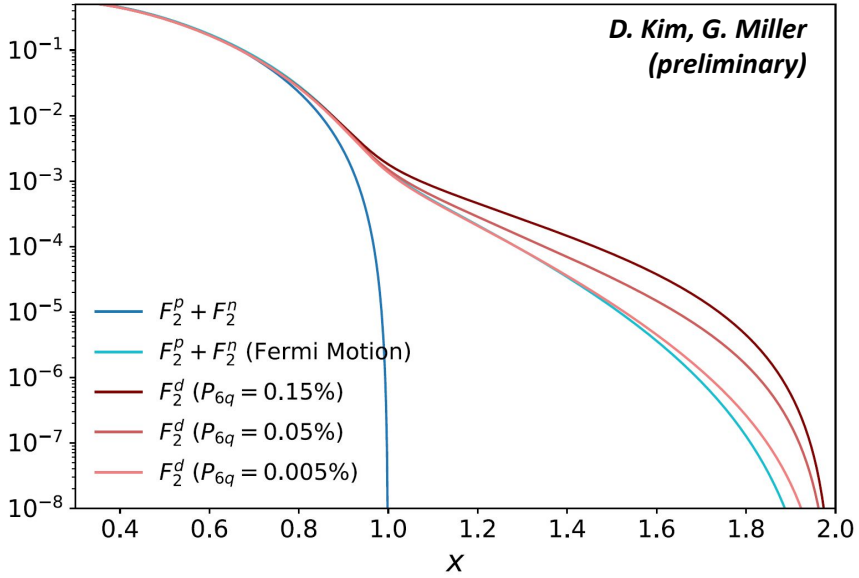
Shujie Li, John Arrington

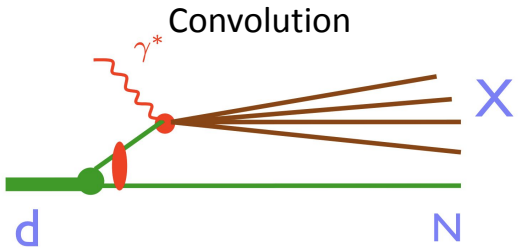
ECT* Workshop on short-distance nuclear structure and PDFs
Trento, July 19 2023

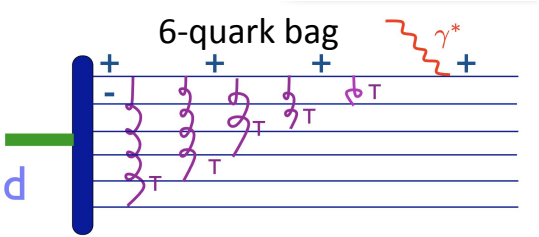


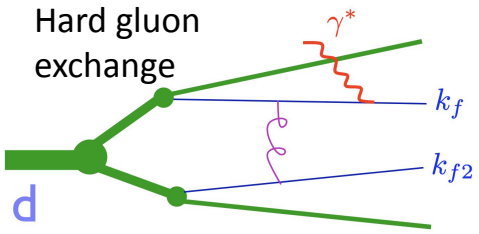
Super-fast quark in fast-moving nucleons





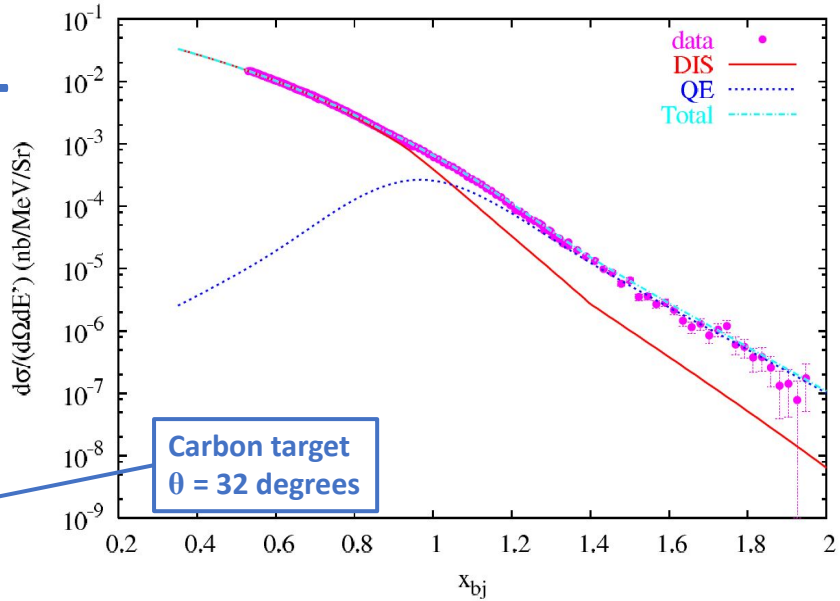


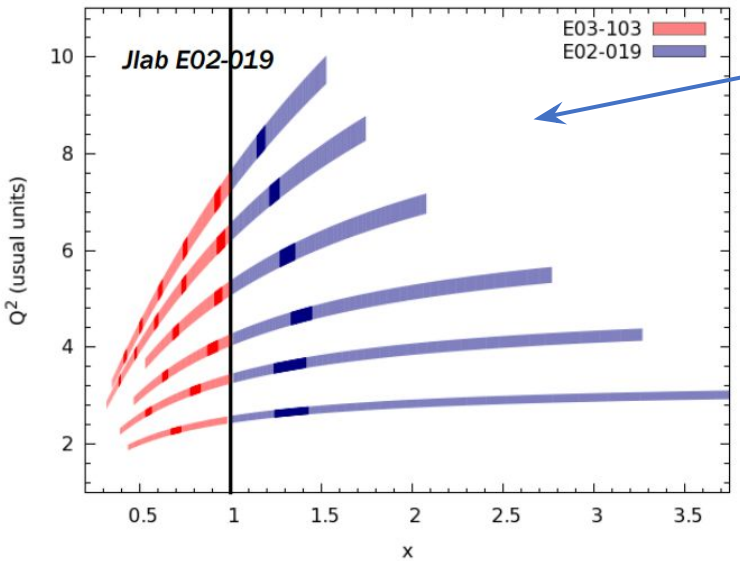




SFQ in experiments: DIS at x>1

- **High energies needed to isolate DIS at large x**
  - **6 GeV experiment limited to 8-9 GeV^2**
- Cross section very small (x>1, high Q^2)
- Need reliable calculations to use as 'baseline'





QE (blue) vs Inelastic (DIS + Resonance) (red)

QE dominated for x>1.1, and inelastic has significant resonance and DIS contributions

Not at all clear that structure function would provide access to pdfs or scale like DIS

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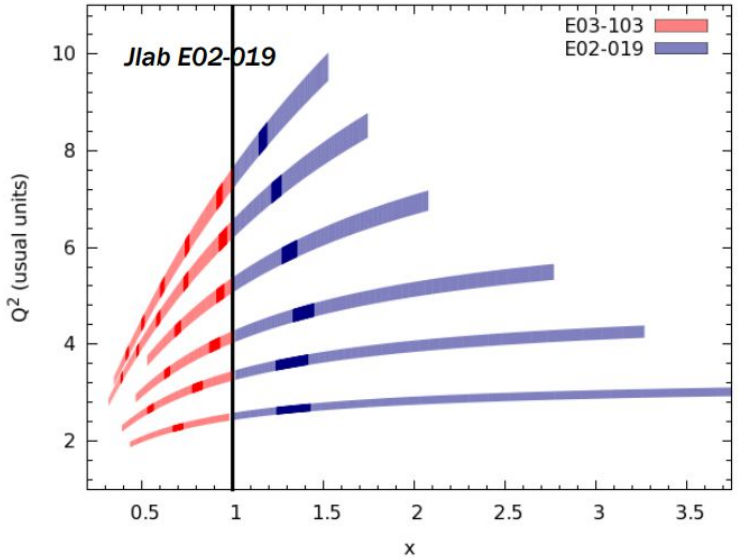
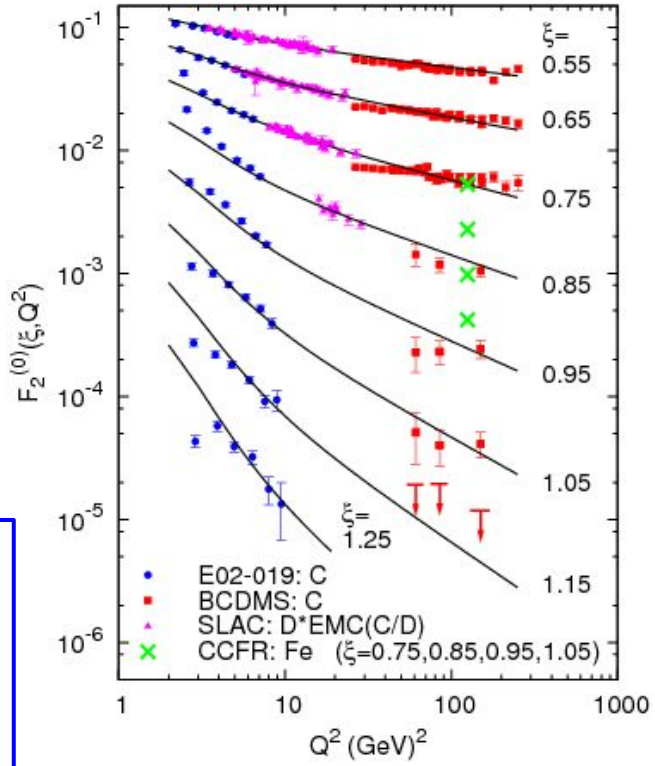


At 6 GeV, high Q^2 data consistent with DIS data up to x ≈ 0.8 and consistent with QCD scaling behavior for x>1

Consequence of *quark-hadron duality*

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

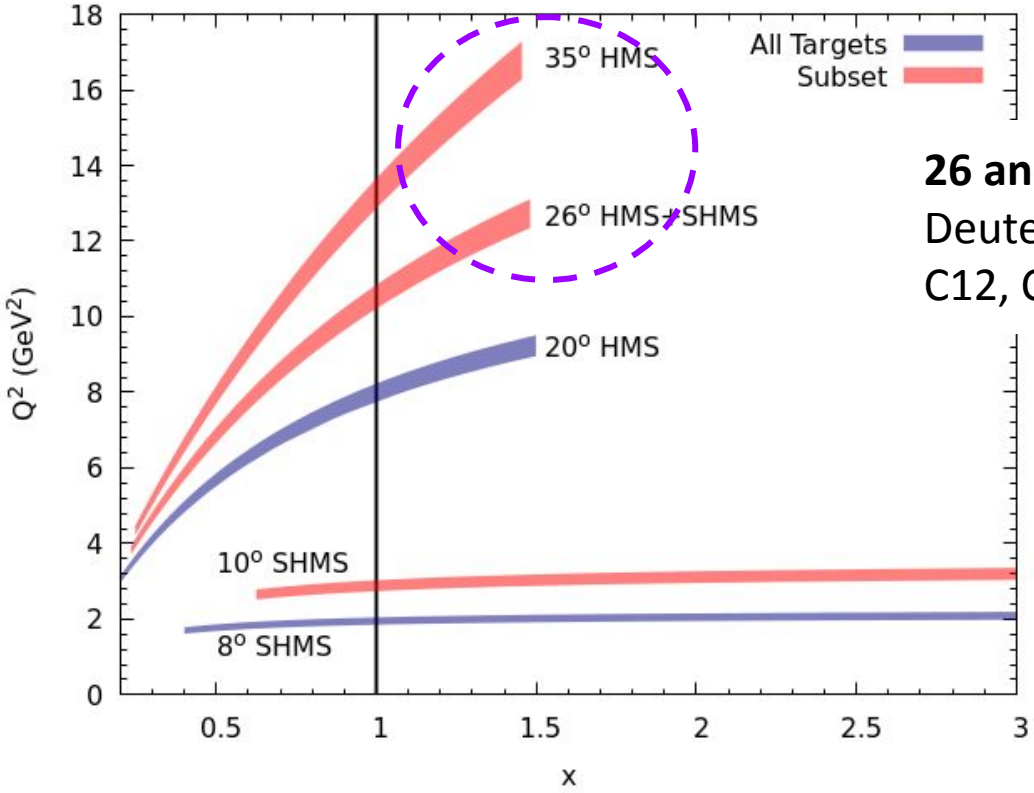


JA, et al, PRC 73 (2006) 035205

SFQs at 11 GeV: New kinematics

E12-06-105: SRCs at x>1 at 12 GeV[JA, D. Day, N. Fomin, P. Solvignon]

Part of the XEM2 experiment (Fall 2022 - Spring 2023 at Hall C, JLab)



26 and 35 degree:
Deuteron, Be9, Al (dummy), C12, Ca40

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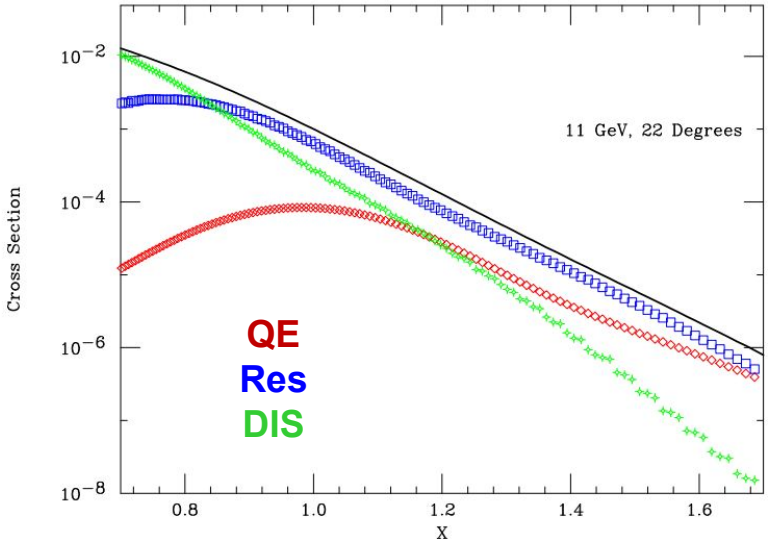
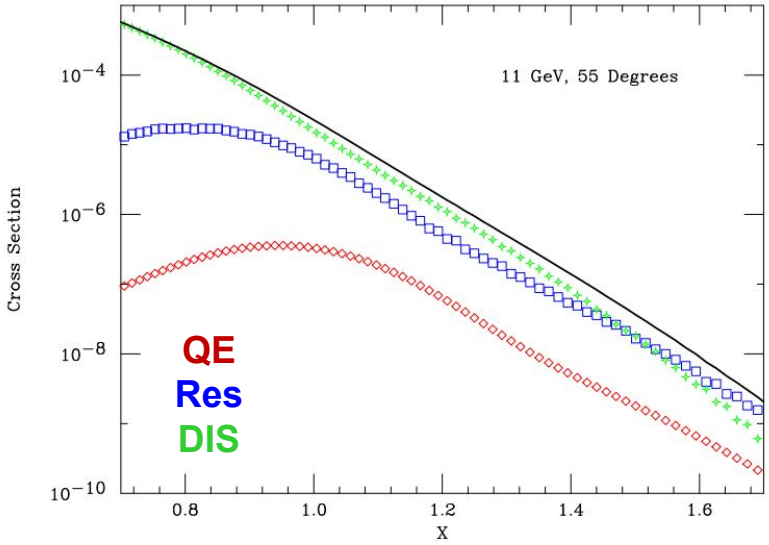
22 degrees: resonance dominated, QE & DIS small



55 degrees: DIS dominated x<1.4 resonance important, QE negligible



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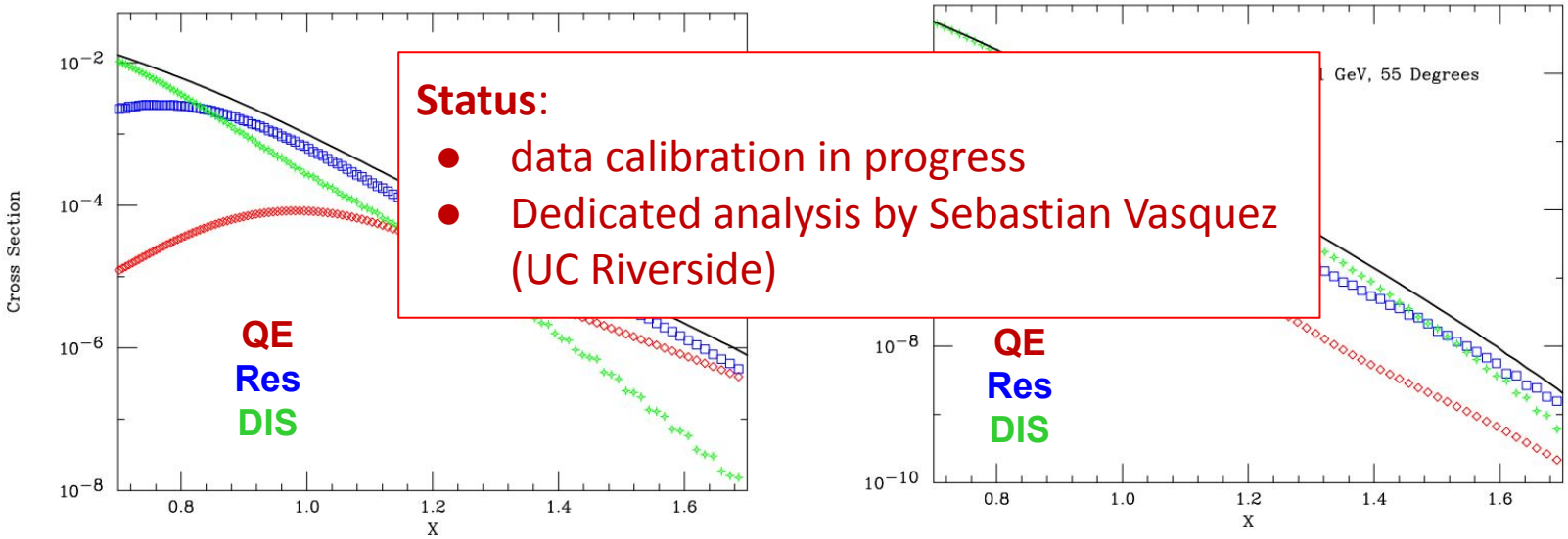
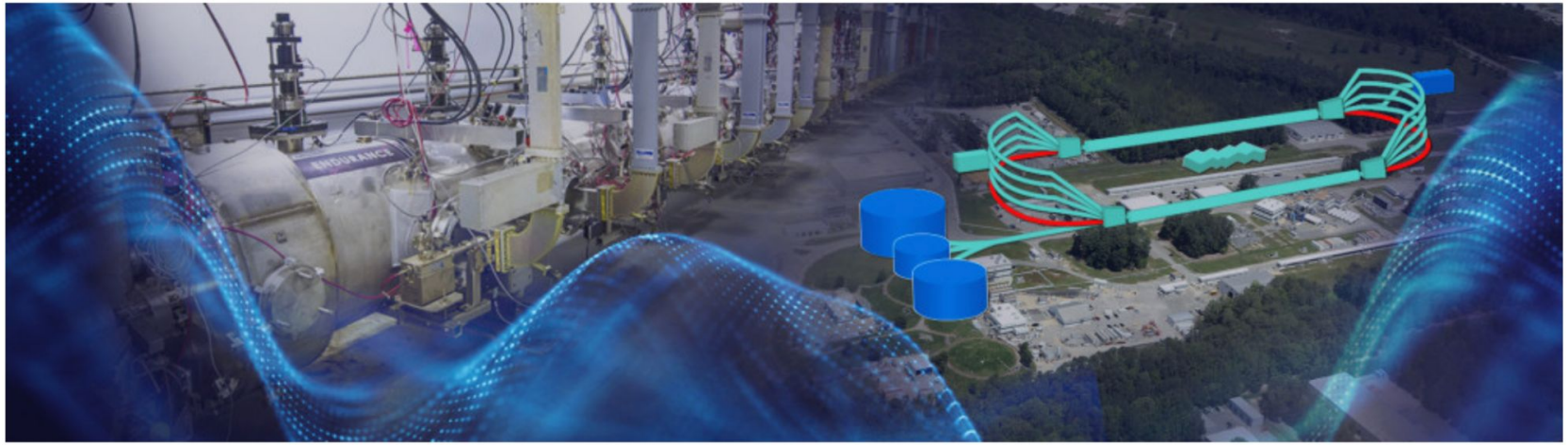


Status:

- data calibration in progress
- Dedicated analysis by Sebastian Vasquez (UC Riverside)

SFQs at 22 GeV: New Era

SCIENCE AT THE LUMINOSITY FRONTIER: JEFFERSON LAB AT 22 GEV

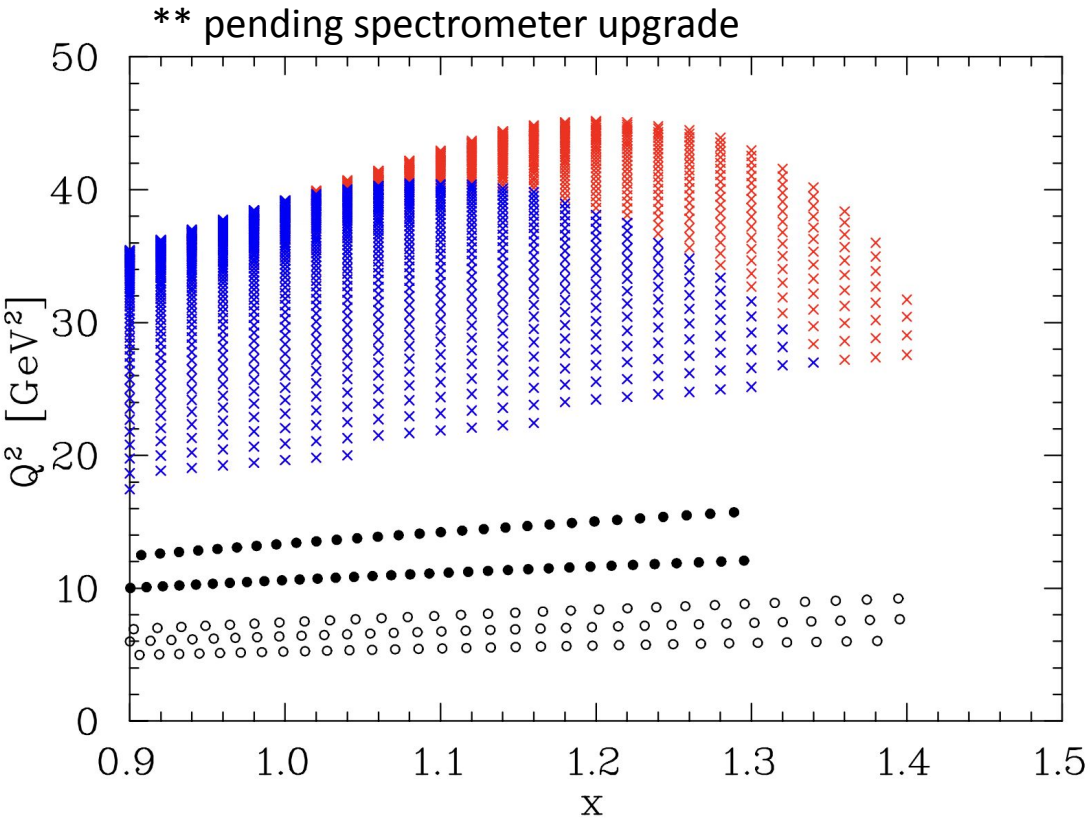


Conference Date

January 23, 2023 to January 25, 2023

22GeV white paper: Strong Interaction Physics at the Luminosity Frontier with 22 GeV Electrons at Jefferson Lab (arXiv:2306.09360)

SFQs at 22 GeV: Kinematic reach



Where do we go from here?

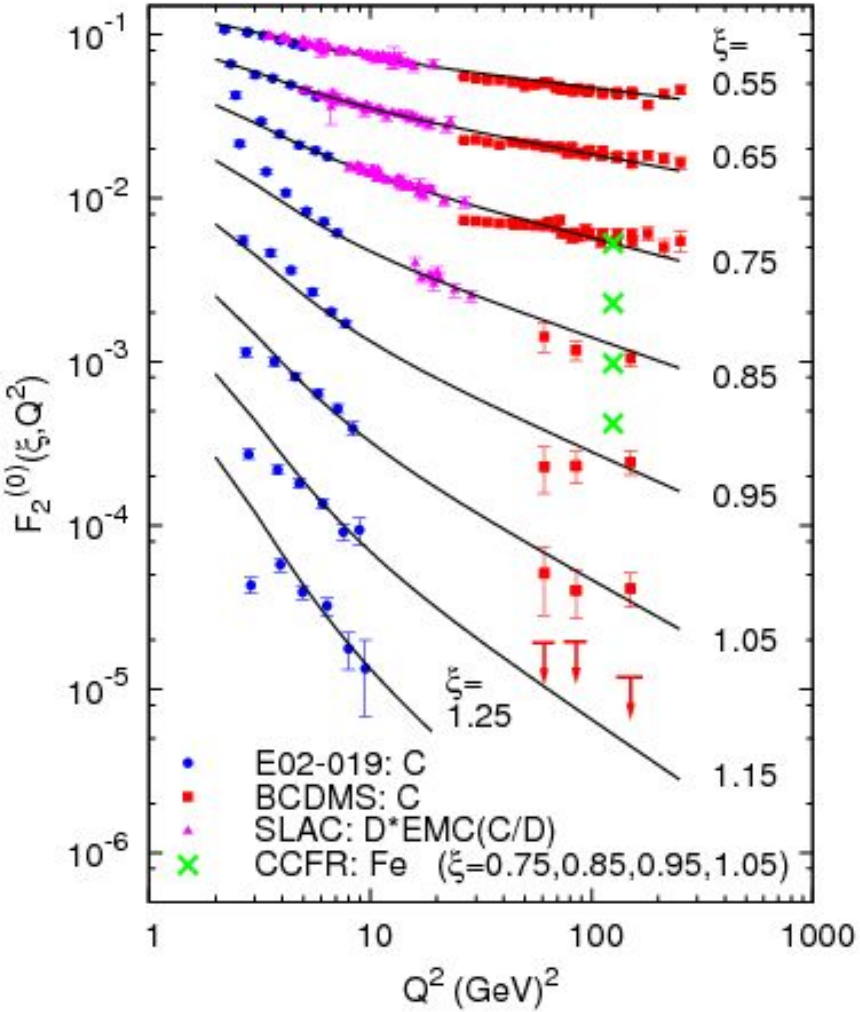
- Short-term:
  - Compare baseline convolution calculations, including TMC, HT effects
  - Extract the inclusive x>1 structure function from various models vs x, Q^2
  - Map out kinematic coverage, experimental needs for 22 GeV experiment

- 11 GeV: First test in compare of deuteron data to calculations
  - Try to quantify how well F_2 connects to pdfs at these kinematics
  - Look for potentially large increase (suppression) over baseline convolution
  - If observe large effect (relative to uncertainties associated with limit Q^2), look at A-dependence: 2H, 4He, 12C, 40Ca to see if it scales as predicted

- 22 GeV:
  - Cleaner measurement at much higher Q^2
  - Extend x range, where several models show rapid variation
  - Examine Q^2 dependence – test/constrain HT contributions

Thank you!

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



M. Sargsian, et al., JPG 29 (2003) R1-45