Comments on Early Science Report Initial Draft

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ESR Initial Draft

- Early draft provided March 6th , 2025
  - Charge was to focus on main document, not the appendices
- Committee collected reviewer comments in Google Doc:
  - Full document provided for reference, included corrections for typos, etc.
  - https://docs.google.com/document/d/19CL3gSYcagsJZCs89Mq5eKgJXLS6BTXkog2Vq1Mx7as/edit?usp=sharing
- Committee met the evening of March 11th, 2025
  - Discussed comments, sorted areas of common concern and individual reviewer concerns
  - What follows is a synthesis of that discussion
  - In some cases, we suggest specific changes or approaches, in other cases we express a concern where the document seems to miss but we don't necessarily have a consensus recommendation.

Recognition of Effort

- The committee recognizes that the current draft is the results of a huge effort by the collaboration and especially the PWG's
- This draft is an excellent start on what is needed for the Early Science Whitepaper, and everyone involved should be proud of what they have accomplished.
- Everyone recognizes that there is a lot more to do, and the comments provided should in no way be construed as undermining the accomplishments made since we first received the charge for the Early Science Whitepaper.

Comments on Form

- Grammatical/Editorial:
  - In today's day and age there is no excuse for sending out a document full of typos and wording errors. Modern tools (from spell checkers to ChatGPT, etc., can at least remove the simple mistakes.
  - It is difficult to evaluate the content of a document when the presentation is lacking
- Voice:
  - One or two people should be assigned to go through the document and ensure that all sections have a similar style of writing. This is essential to delivering the message effectively.

Comments on Content

- The selection of topics in the physics sections seems somewhat haphazard, and selected for what we had studies for at hand and not in a way that might seem more logical to the reader.
  - For example, what are the easiest measurements to do (in terms of luminosity and detector maturity) and what are progressively more difficult.
  - There should be a clear and objective rationale for why a given measurement is selected and why others are not
- Declarative statements are made without references
- Current “state of the art” is not recognized or referenced.
  - A brief discussion of what is known from HERA, RHIC, JLab, LHC, etc. would help put the EIC measurements in context and underline their importance.
  - The NP Community is a key audience for this report! Not recognizing prior art will just create resentment.
- The overall *structure* of the document can be effective if the specific physics sections are organized logically.

Recommendation for Physics Sections

- The physics sections should follow a common format:
  - For this physics, what is the “state of the art” of current measurements. Reference extensively!
  - A discussion of the measurements that can be made during the Early Science era, starting from the simplest (in terms of luminosity and detector maturity) to the more complicated.
    - There should be a recognition that both the detector and the collider will ramp up their capabilities. (See next slide.)
  - An example measurement that demonstrates *impact*.
    - Physics impact plots have *impact*, cross sections or plots with error bars do NOT! The audience for the paper are not experts in EIC physics. The example should be able to be boiled down to something that demonstrates the science impact.
  - A brief statement on the ultimate capabilities of the EIC/ePIC for this science
    - Given the reader a glimpse of what the future holds beyond the Early Science period

Suggestion from EIC Whitepaper

- The physics sections of the EIC whitepaper used a common table format to provide a convenient summary:

Deliverables	Observables	What we learn
Sivers & unpolarized TMD quarks and gluon	SIDIS with Transverse polarization; di-hadron (di-jet)	Quantum Interference & Spin-Orbital correlations 3D Imaging of quark's motion: valence + sea 3D Imaging of gluon's motion QCD dynamics in a unprecedented Q^2 (P_{hT}) range
Chiral-odd functions: Transversity; Boer-Mulders	SIDIS with Transverse polarization	3^{rd} basic quark PDF: valence + sea, tensor charge Novel spin-dependent hadronization effect QCD dynamics in a chiral-odd sector with a wide Q^2 (P_{hT}) coverage

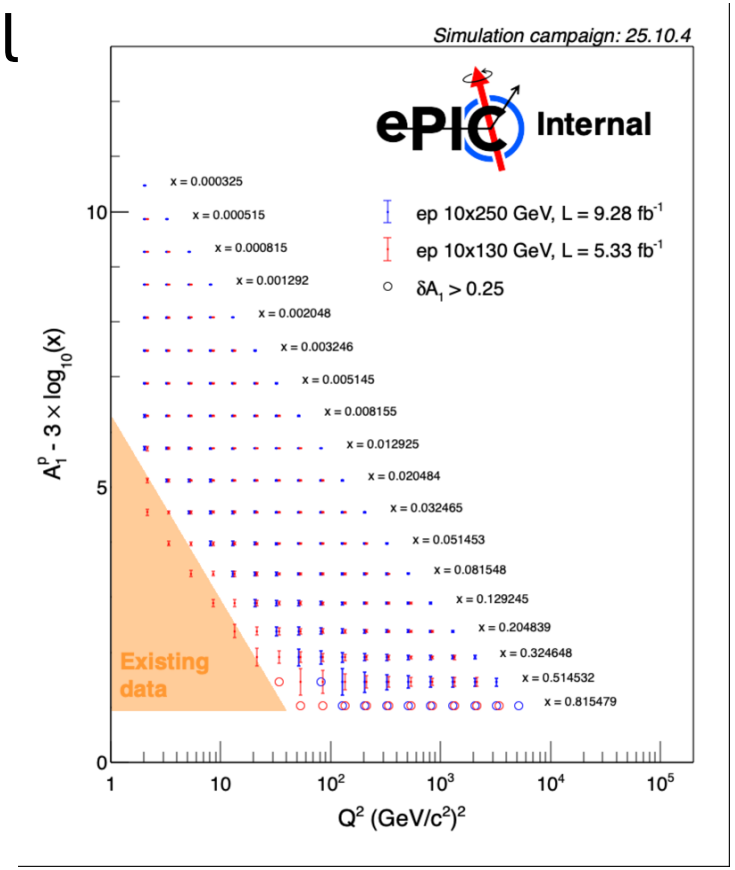
- Something similar could be adopted here for physics sections?
  - Can imagine separate columns for integrated luminosity required, etc.
  - Would help shorten some of the text
  - Could help sort measurements by feasibility and impact

Comments on Introduction/Pillars/Early Science

- Mention should be made of the Streaming Computing Model and the goal of the collaboration to provide calibrated data for analysis in *weeks*, not months or years.
  - It will take time to achieve this, but we should see the benefits within the Early Science period

Specific Comments on Inclusives

- Figure 2 (overlap w/HERA), 3 (PDF impact) – This is what we have in mind.
- Figure 4 (A_1^p) – Convert this to an impact pl structure function
- Underplays the importance of nPDF's – DIS on nuclei in a collider environment is new! This should feature prominently!



Specific Comments on SIDIS

- Figure 6 (Pion FF's/TMD PDF's) – A good example of what is needed.
- Figure 7 (Collins asymmetries) – Needs an impact plot!

- What happened to the discussion about pinning down the non-perturbative kernel in TMD evolution?

- Transition to gluon saturation section – needs impact study or remove it (could be in table). (seems disconnected)

Specific Comments on Exclusive, Diffraction and Tagging

- Figure 9 (DVCS σ and t distribution) – What is there now is an expert-level performance plot. Needs an impact study on GPD or CFF extraction
- Figure 10 (Exclusive Diffractive Phi Production) – Is this what we want to highlight? The level of the “dips” we can expect is still somewhat controversial. This is also a difficult measurement – concentrate on something simpler?
  - If you decide to keep it, can a theory band be put on the extracted gluon distribution?
- The DVCS discussion just begs for a brief discussion of the state of the art prior to the EIC.
- What about inclusive diffraction as for saturation studies? Again, emphasizes unique nature of the EIC!

Specific Comments on Jets/HF

- Figure 11 (R_{eAu} and Λ/D^0) shows two completely different physics quantities! These should be separate figures!

- Figure 12 (R_{eA} for D^0) – good, can theory or nPDF bands be put on the plot?

- Think about what we might be most likely to do in the first few runs. Will we go right to jet reconstruction, or will the first results be two-particle correlations?
  - Bias towards late in program
- Bias toward HI – inspired measurements

Conclusions

- The structure of this section can be quite effective as presented but will need to be updated as the physics sections are refined. Revise this *last*.

Final Comments

- Overall, this is a very good start!!
- Rework the physics sections to:
  - Take a more systematic approach to what will be measured in the first years
  - Use a table to measurements to make the sections more uniform
  - Recognize prior art
- The Appendices are really more like analysis notes. Should we keep them or wait for the NIMA papers?
- The Early Science Whitepaper is an important document to communicate to the NP community, as well as the wider scientific community, both the promise of EIC science and our excitement to pursue it.
- We hope our comments are useful and helpful in achieving this goal. We are also happy to answer questions or engage in further discussions.
  - There are many ways to pull this together in a reasonable fashion.