

# The Electron Ion Collider: A Next QCD Frontier

*Understanding the glue that binds us all*

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Physics Opportunities @ An Electron Ion Collider

Bloomington Indiana

August 20, 2012

A. Deshpande, Z.-E. Meziani, J. Qiu for the EIC WP Writing Group

- A brief background on the White Paper (WP)
- An overview of the current WP draft
- The executive summary (ES) and its time lines: Tribble-II subcommittee deliberations (Sept. 7)
- WP and its time lines: Broader NP community's townhall meetings at the DNP'12 and Tribble-II final report (December'12)

Dear Zein-Eddine,

May 2011

It is important in preparing for the next Nuclear Physics Long Range Plan to produce a community-wide science White Paper for a non-site-specific EIC by the end of calendar year 2011. This schedule would give us time to get further community and funding agency input, and **to iterate to a final version by Fall of 2012, when Town Meetings for the next LRP might start.**

I am writing to see if you would be willing to serve with Abhay Deshpande and Jianwei Qiu as overall editors and overseers of the White Paper. I lay out the organization of the Steering Committee you would lead below. The committee membership has been endorsed by Tom Ludlam, Bob McKeown and Hugh Montgomery, and at this point all the individuals listed below have agreed to serve.

I think the “Yellow Book” that **will soon result** from the Fall 2010 INT program should serve as a resource for the White Paper, but it will be far too long and detailed for a non-expert audience. I think **the White Paper should be no more than ~100 pages, and should be aimed at non-experts, including our potential “champions” within DOE (e.g., Tim Hallman) and the rest of the Nuclear Physics community** that will be asked to endorse this vision. It should start with an ~5-page Introduction – basically the “elevator speech” we have discussed, slightly amplified – **laying out the goals, importance and uniqueness of the facility, and answering the basic questions raised about EIC at the last LRP meeting in Galveston in 2007, all in clear, concise, compelling, jargon-free language. The Introduction should also indicate the features of the science goals that could be accomplished with a first-stage machine and detectors, and should include a few of the most compelling “money plots” envisioned.** I expect writing of the Introduction would fall mostly to the three overall editors in the organization outlined below.

**There should then be ~10-page sections on specific science areas, laying out and fleshing out “golden experiment matrices” with simulated money plots.** It is very important that these sections build on the excellent progress made at the INT workshop in selecting golden experiments to emphasize – the White Paper should not try to present all science that would be done at an EIC, but should concentrate on the measurement program that most compellingly illustrates the intellectual goals and performance requirements of the facility. **These sections should get across the fundamental goals of the research and enough technical discussion to convince a reader of the basic feasibility and interpretability of the results, but should otherwise be relatively light on technical experimental and theoretical detail.** There should be a section of **~10-15 pages on basic machine parameters**, design options, technical challenges and ongoing R&D, which covers both design approaches (again without gory technical detail). A similar section of **~10 pages on detector design** features and challenges would round out the document as I see it. I don't think this White Paper needs to get into cost estimates, although we will clearly need that as well by the time of the LRP.

We have tried to assemble a Steering Committee comprising experimentalist/theorist pairs, broadly representative of the interested institutions (and not too heavily BNL- and JLab-laden), aligned with an envisioned breakdown of the science and technical sections, as follows:

**Overall editors:** A. Deshpande (Stony Brook), J. Qiu (BNL) and Z.-E. Meziani (Temple U.)

**Gluon saturation in e+A:** T. Ullrich (BNL) and Y. Kovchegov (Ohio State U.)

**Nucleon spin structure (mostly inclusive e+N):** E. Sichtermann (LBNL) and W. Vogelsang (Tubingen)

**GPD's and exclusive reactions:** F. Sabatie (Saclay) and M. Diehl (DESY)

**TMD's, hadronization and SIDIS:** H. Gao (Duke) and F. Yuan (LBNL)

**Electroweak physics:** K. Kumar (U. Mass.) and M. Ramsey-Musolf (Wisconsin)

**Accelerator designs and challenges:** T. Roser (BNL) and A. Hutton (JLab)

**Detector design and challenges:** E. Aschenauer (BNL) and T. Horn (CUA)

**Senior advisors:** R. Holt (ANL) and A. Mueller (Columbia)

If you are willing to serve as one of the overall editors, please let me know soon, and then get in touch with Abhay and Jianwei to discuss how to launch the efforts. I am hoping that considerable progress can be made on the White Paper over the coming summer.

Cheers, and thanks for a reasonably prompt response,  
Steve

# Final committee:

## Overall editors:

A. Deshpande (Stony Brook), J. Qiu (BNL) and Z.-E. Meziani (Temple U.)

## Gluon saturation in $e+A$ :

T. Ullrich (BNL) and Y. Kovchegov (Ohio State U.)

## Parton propagation and energy loss in nuclei: (added)

W. Brooks (UTF, Santa Maria) & J. Qiu (BNL)

## Nucleon spin structure (mostly inclusive $e+N$ ):

E. Sichteremann (LBNL) and W. Vogelsang (Tübingen)

## GPD's and exclusive reactions:

F. Sabatiè (Saclay) and M. Diehl (DESY)

## TMD's, hadronization and SIDIS:

H. Gao (Duke) and F. Yuan (LBNL)

## Electroweak physics:

K. Kumar (U. Mass.) and M. Ramsey-Musolf (Wisconsin)

## Accelerator designs and challenges:

T. Roser (BNL) and A. Hutton (JLab)

## Detector design and challenges:

E. Aschenauer (BNL) and T. Horn (CUA)

## Senior advisors:

R. Holt (ANL) and A. Mueller (Columbia)

# The White Paper as of today: 146 pages

- Executive Summary (ES) → **12 pages to Tribble-II**
- Spin and 3D structure of the nucleon:
  - **Introduction (9 pages)**
  - *Longitudinal Spin: (11 pages)*
  - *Confined Motion of Partons in Nucleons (TMDs) (9 pages)*
  - *Generalized Parton Distributions (14 pages)*
- The Nucleus: A QCD Laboratory
  - **Introduction (5 pages)**
  - *Physics of extreme gluon density (23 pages)*
  - *Quarks and gluons in nuclei (8 pages)*
  - *Connections to A-A, p-A and Cosmic Rays (11 pages)*
- Opportunities at the extreme luminosity **(6 pages)**
- Accelerator design **(12 pages)**
- Detector design **(12 pages)**
- **Acknowledgment (1 page → will certainly grow....)**
- References **(9 pages)**

# Comment on EIC WP Draft

146 page EIC White Paper (draft)

Too long: not appropriate for Tribble-II deliberations. **Submit the 12 Page Executive Summary to Tribble-II.**

The WP was and is intended for the broader NP community for the Long Range Planning discussions, and town-hall meetings.

Long Range Plan (When?)

Town meetings being organized in DNP'12 (October 2012)

**Need to open the EIC White Paper for Comments from BNL & Jlab User communities: More on this later.**

Aim to prepare an almost final draft of the White Paper by October Town hall meetings, and submit the final White Paper to NSAC (and its subcommittees in November after input/comment from the DNP)

# LETS FOCUS ON THE EXECUTIVE SUMMARY:

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We would appreciate comments from the POETIC participants!



(Adapted from Steve V.'s recent discussion on RHIC WP)

# Feedback needed: *Executive Summary*

- Written for a non-expert nuclear (+1 CM) physicists
- Emphasis on complete but concise
- August 28 submission aimed at Tribble-II 1<sup>st</sup> meeting: Sept. 7
- Currently, 12 pages: approximately correct length
- The rest of the WP DRAFT will serve as a back-up document

## Feedback needed by **August 24<sup>th</sup>**:

- What is **absolutely** needed to strengthen the case?
- Are there statements made that are detrimental to the case?
- Relative emphases amongst different components correct?
- Any mistakes in the physics? (in the process of simplification)
- Is there anything crucial that is missing?
- Are there better figures? Could one improve cartoons?
  - **Only YES does not help: suggest/contribute alternatives!**

# Method to convey your comments on the Executive Summary (by August 24):

Please Email:

**Subject: “Comments on EIC Executive Summary”**

- Abhay Deshpande ([abhay.deshpande@stonybrook.edu](mailto:abhay.deshpande@stonybrook.edu))
- Zein-Eddine Meziani ([meziani@temple.edu](mailto:meziani@temple.edu))
- Jianwei Qiu ([jqiu@bnl.gov](mailto:jqiu@bnl.gov))

We will convey the comments to the entire WP writing group.

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12 PAGES

Request your input by August 24.  
Will go to Tribble-II panel by August 27/28

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**Introduction:** Relevance of studying the properties of fundamental structure of matter to nuclear science. What are the big questions? Why is EIC the ONLY appropriate facility to address them? What would be the deliverables for the 1<sup>st</sup> Stage?

How would EIC position US towards continued leadership in nuclear physics (including accelerator science)

## 1.1 INTRODUCTION

### Three big questions in QCD:

- How are the sea quarks and gluons inside the nucleon distributed in space, momentum, spin and flavor?
- Where does the saturation of gluon densities set in?
- How does the nuclear environment affect the distribution of gluons and interactions of quarks in nuclei?

### Why EIC?

Why a collider is the right tool?

Why is electron the right tool?

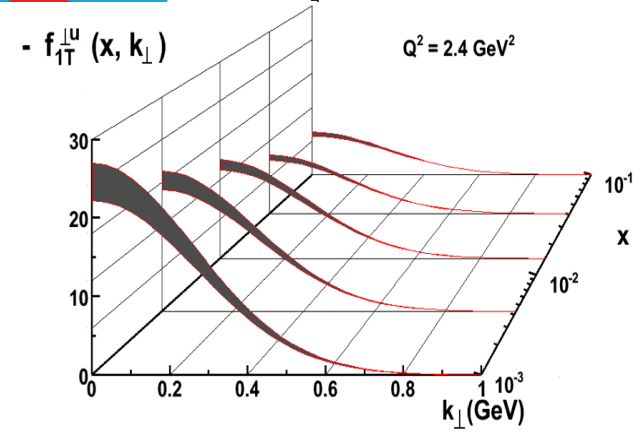
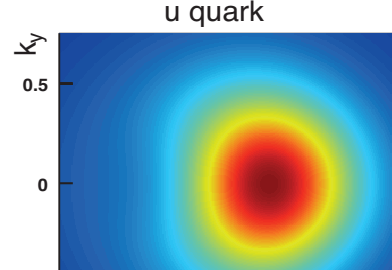
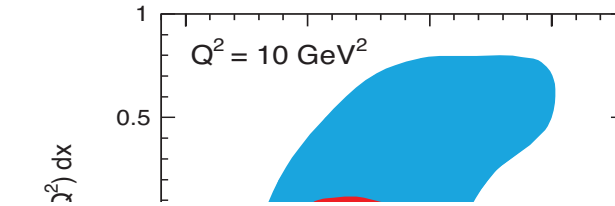
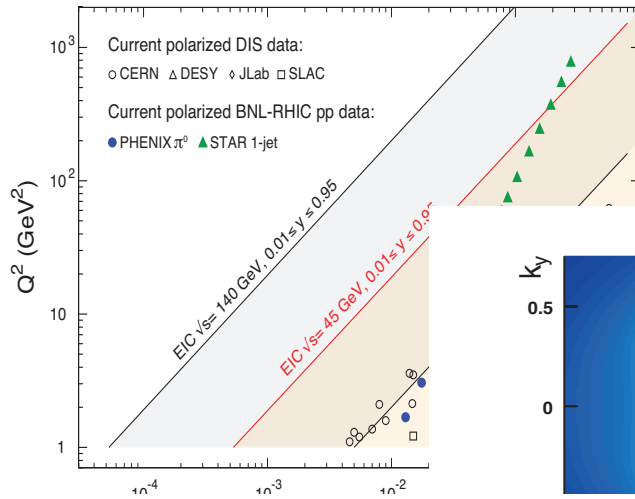
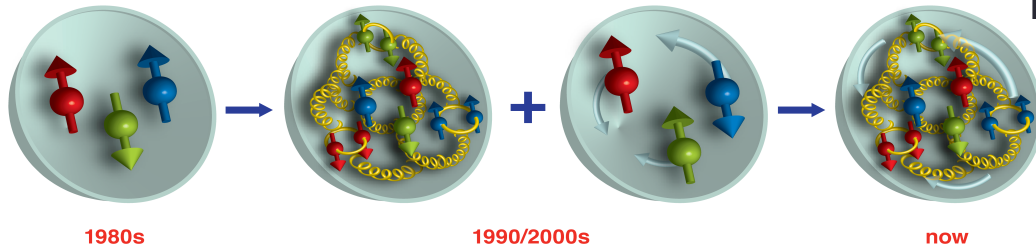
Why is polarization of beams needed?

How would nuclei help in addressing the gluon related questions?

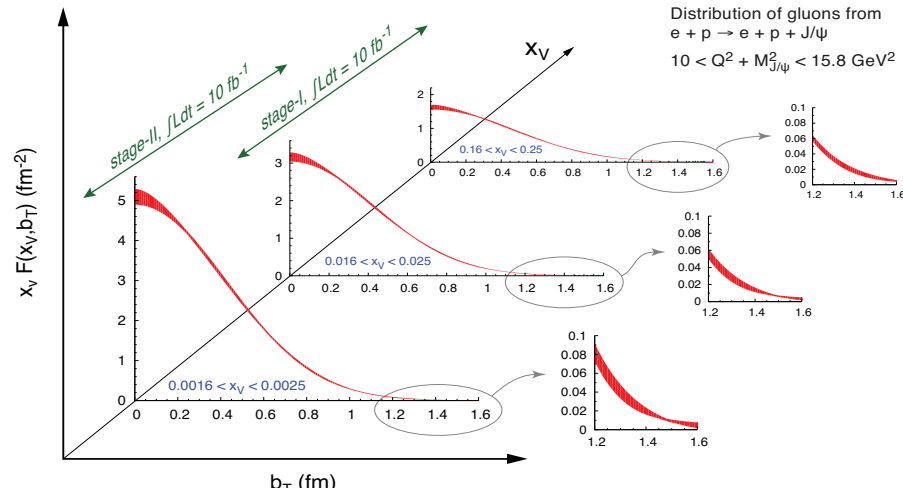
Why should heavy ion physicists care?

# Executive Summary: Cartoons and Figures

## Physics with polarized nucleon

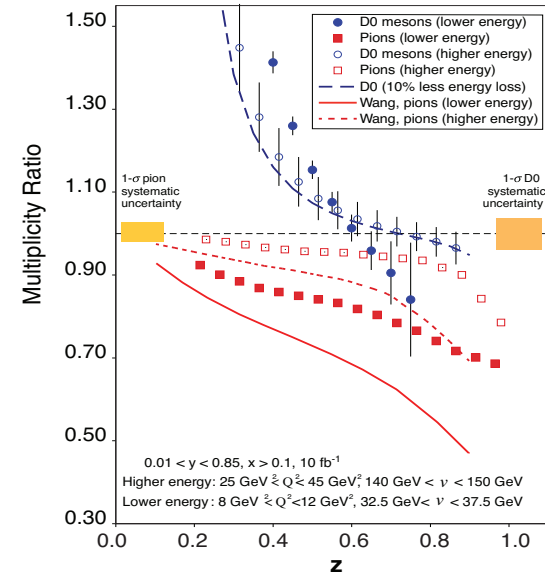
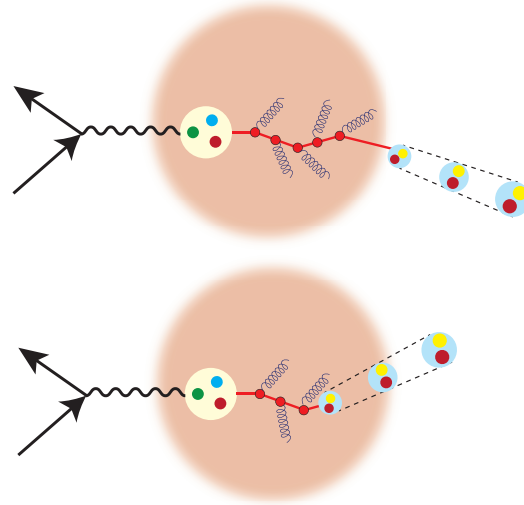
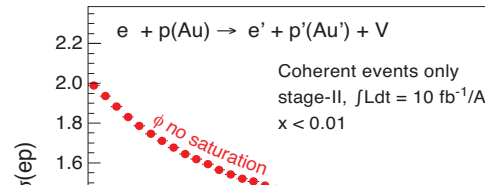
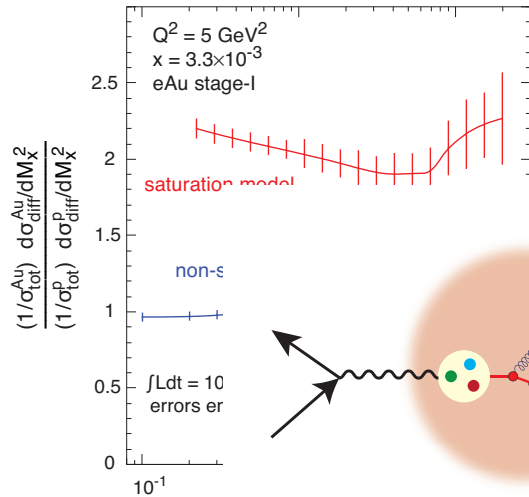
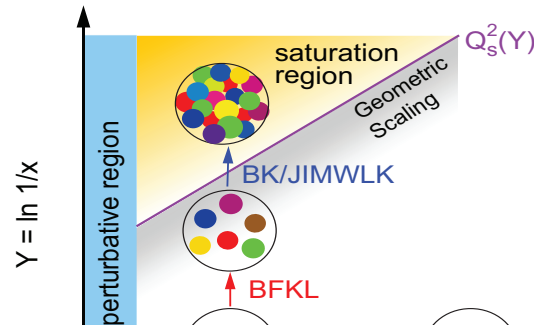
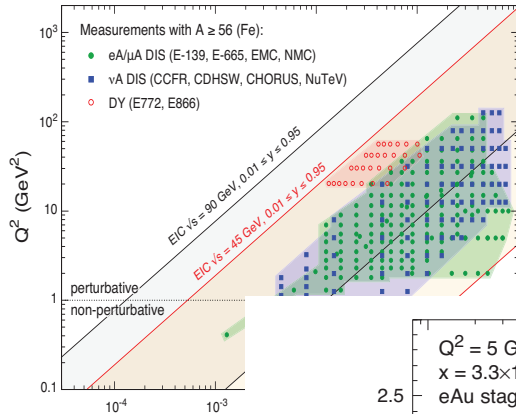


Distribution of gluons from  $e + p \rightarrow e + p + J/\psi$   
 $10 < Q^2 + M_{J/\psi}^2 < 15.8 \text{ GeV}^2$

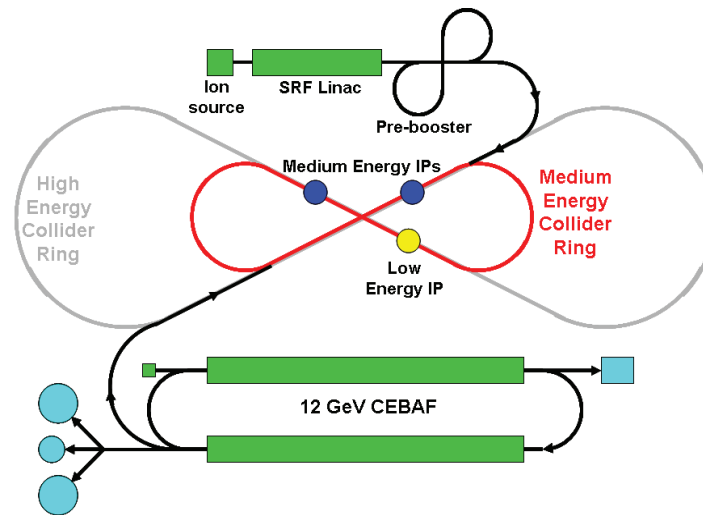
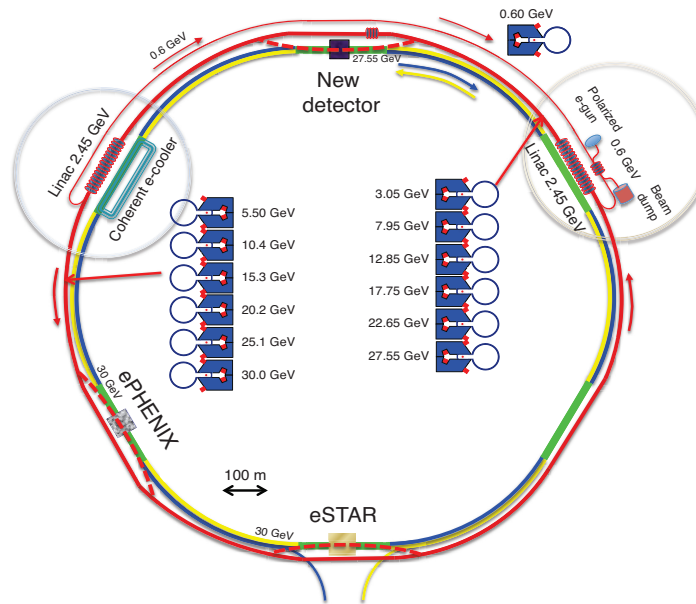


Figures from the ES

# Physics with Nuclei



Figures from the ES



Figures from the ES

# BEYOND AUGUST 24<sup>TH</sup>: FINALIZING THE WP

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Aim at a time line which prepares the final WP around the DNP Townhall meetings (last week of October)



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# White Paper path forward:

- After ES is finalized and sent to the Tribble-II (end of August)
- Present the WP (distribute the link of the WP draft) to the BNL and Jlab User communities, EIC collaboration lists
- Comments gathered by a web based system that was used recently by Jefferson Laboratory for its 12-GeV White Paper.
- Identical systems will be setup both at BNL and JLab
- Approximately 2 weeks for the comments period
- Approximately 2 week for the conveners of sections to accommodate them
- 1 week for (JQ, Z-EM & AD) to finalize the WP beyond that
- Aim for a final WP in the last week of October. To the BNL/Jlab managements in November

# Feedback on the *White Paper*

Keeping in mind the following things:

Intended for the broader Nuclear Physics audience [High energy NP: Jlab, RHIC, but also, FRIB-community, symmetry violation seekers, theorists] who would influence the decision on EIC in the next Long Range Plan.

Comprehensiveness less important than being concise and articulating the case most effectively.

Length can not increase, can we reduce it to about 100 pages?

# Feedback on the *White Paper*

*(Method and Dates on when, will be conveyed to you soon)*

- What other things absolutely needed to strengthen the case for the EIC?
- Are there parts of current draft which are detrimental to making the case for the EIC?
- Are relative emphases and lengths amongst chapters & within chapters correct?
- Are there mistakes in the physics?
- Can the presentation/articulation improve by simple changes to the structure of the sections, inclusion of new things (replacing current parts)
- Are there better figures/cartoons which could be used?

# Summary:

- A good draft of the EIC White Paper is now ready, and was released (for the first time) to THIS audience
- We anticipate your comments and suggestions on the Executive Summary (12 Pages) by August 24. We hope to send the improved draft to the Tribble-II panel by August 28.
  - Comments by email to Abhay, Jianwei and Zein-Eddine
- The comments on the rest of the White Paper: welcome but at a later date. We aim to finalize the WP by the end of October, November. Method of making the comments and the timelines will be distributed soon.