EIC Project Status: A Personal View

- Introduction
- Review of science program
- Overall status and plans
- Future steps towards developing the CDR
- Summary and my conclusions

Introduction

- DISCLAIMER: These are my own views and opinions, not necessarily those of the EIC Collaboration, Jefferson Lab, or BNL scientific management!
- See Thomas Ullrich's talk from Monday for much more on the physics case
- Numerous references available; most recent is 2007 white paper "White Paper" written for 2007 Long Range Planning (LRP) exercise by the Nuclear Science Advisory Committee (NSAC). The best place to find all of these is the EIC site: http://web.mit.edu/eicc/index.html
- Apologies in advance for omissions and errors!

What is the EIC?

- A high luminosity (> 10^{33}) electron-ion collider with center-of-mass energies ranging from 30 - 100+ GeV
- Two existing US labs are developing accelerator designs
  - ➡ eRHIC: add an electron accelerator to existing ion machine at BNL
  - ➡ ELIC: add an ion accelerator to existing electron machine at Jefferson Lab
  - ➡ Both labs have high priority programs (with substantial accelerator upgrades) planned for the next 10+ years
  - ➡ Both see EIC as a long term goal for their facilities
- Active development - See the following talk from Richard!

Why build the EIC?

- Unlike almost all other fundamental forces, the QCD lagrangian precedes our knowledge of phenomena
  - ➡ HERA discovers the explosion of “wee partons” at low x and the ability of the photon to exchange large momentum and energy transfer with the nucleon without disintegrating
  - ➡ EMC discovers that the nucleon spin is not dominated by the contributions from the quark spins
  - ➡ Relativistic heavy ion collisions reveal a new world of QCD in a truly new regime
- Many fundamental questions about the nature of quark-gluon bound states and dynamics remain open, especially if we look for a precise quantitative understanding
- To advance we must continue to explore the new and scrutinize the “known”

Precision Studies of Nucleon Structure

- Main objectives are to measure
  - ➡ Gluon distribution and polarization (and test Bjorken Sum)
    - ❖ F_L and g_1 measurements
  - ➡ Sea quark distributions and polarization
    - ❖ Semi-inclusive DIS and g_5 measurements
  - ➡ Generalized parton distributions (GPDs) at high Q^2
    - ❖ DVCS and Exclusive Meson Production
  - ➡ Transversity distribution and Transverse momentum distributions (TMDs)
    - ❖ Azimuthal asymmetries from transversely polarized targets

Studies of "Dense" Gluonic Fields

- Investigate nuclear fields at low Bjorken x and high Q^2
  - ➡ Use nuclear "oomph" to observe the onset of saturation
    - ❖ F_2, F_2^C and F_L, F_L^C measurements on heavy ions
    - ❖ Di-jet production
  - ➡ Dedicated measurements of "diffractive" processes
    - ❖ Exclusive vector meson (especially J/Ψ) production
    - ❖ Nuclear DVCS

Dynamics of Confinement: From quark to hadron...

- Explore in detail the process by which fast quarks produce hadrons (and target remnants resolve themselves)
  - ➡ Move beyond identified hadron multiplicities
    - ❖ Fracture function studies
    - ❖ New observables sensitive to hadronization models
- Explore how this process is altered in the nuclear medium
  - ➡ Nuclear attenuation and p_T broadening

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Long Range Plan for Nuclear Science by NSAC, 2002

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A high luminosity Electron Ion Collider (EIC) is the highest priority of the QCD community for new construction after the Jlab12 GeV and RHIC II upgrades. EIC will address compelling physics questions essential for understanding the fundamental structure of matter:

- ***Precision imaging of the sea-quark and gluons to determine the spin, flavor and spatial structure of the nucleon***
- ***Definitive study of the universal nature of strong gluon fields in nuclei***

The collider and the detector designs must be developed expeditiously.

Unanimous recommendation of the Quantum Chromodynamics Town Meeting, at Rutgers University, New Jersey, January, 2007

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We recommend the allocation of resources to develop accelerator and detector technology necessary to lay the foundation for a polarized Electron-Ion Collider. The EIC would explore new QCD frontier of strong color fields in nuclei and precisely image the gluons in the proton.

Long Range Plan for Nuclear Science by NSAC, 2007

The next stage of development

- Accelerator/Detector needs for the different physics measurements have to be solidified
  - ➡ ep DIS can build on the HERA experience
  - ➡ eA and exclusive measurements will be a new frontier
- Assessment of critical systematic uncertainties, and how to minimize/control them
- Broad program will be hard to fit under one “roof”
  - ➡ Can we develop a “standard” detector given not only the variety of final states but the large range in center-of-mass energy?
  - ➡ Can a “standard” detector be developed which works for both ELIC and eRHIC designs, especially given integration issues?

Too many options!

- At present, we probably have too many options on the table
  - ➡ positrons? polarized positrons?
  - ➡ inclusive measurements vs semi-inclusive?
  - ➡ Exclusivity requirements?
  - ➡ Which energies are optimal?
  - ➡ High vs low repetition rate?
  - ➡ What are luminosity requirements and what is “too much?
  - ➡ How much money is too much?
- Guidelines need to be agreed upon
- How will we make the hard decisions?

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- Are there other ways to develop a national appreciation of QCD physics among the general public? (are we doing enough in other words)

Moving to Realization of the EIC

- At the December 2007 EIC meeting at Stonybrook, a general timeline was proposed:

➡ Finalize Detector Requirements from Physics	2008
➡ Revised/Initial Cost Estimates for eRHIC/ELIC	2008
➡ Investigate Potential Cost Reductions	2009
➡ Establish process for EIC design decision	2010
➡ Conceptual detector designs	2010
➡ R&D to guide EIC design decision	2011
➡ EIC design decision	2011
➡ MOU's with foreign countries?	2012

Some thoughts on this plan...

- Preparation for CD0 needs to be “coincident” with next LRP, presumably in 2012
  - ➡ Significant effort but it’s hard find/assign resources for a program which will not occur until approximately 2020
  - ➡ 20 people spending 0.05 FTE/year is only 1 FTE/year plus there is typically inefficiency working on anything 5% of your time
  - ➡ Need to develop agreement in community we need these studies NOW!
  - ➡ ELIC/eRHIC decision is late in process, but do we really have the manpower to fully develop two different spectrometers to a meaningful level?
- Physics/detector needs are on the critical path!

Some suggestions!

- Need to revitalize (ASAP) small (real) workshops to drive progress
- Try to develop standardized center-of-mass energies at appropriate time
- Regular communication among convenors/organizers (yes, another phone conference...)
- Need much more explicit/detailed milestone/deadlines
- Push decision process earlier to allow the spectrometer to be more fully developed by 2012

Summary and Conclusions

- The community agrees this is an exciting and worthwhile program, but we must do our homework and wait our turn...
- Physics simulation tools are mostly in place for the proposed program, now they need to be used to solidify physics impact and detector requirements
  - ➡ Major focus of parallel sessions in this meeting!
  - ➡ Development of decision process needed sooner, rather than later
- Goal to be ready for CD0 at next LRP will be difficult; requires commitment and progress now
- We must broaden our outreach!