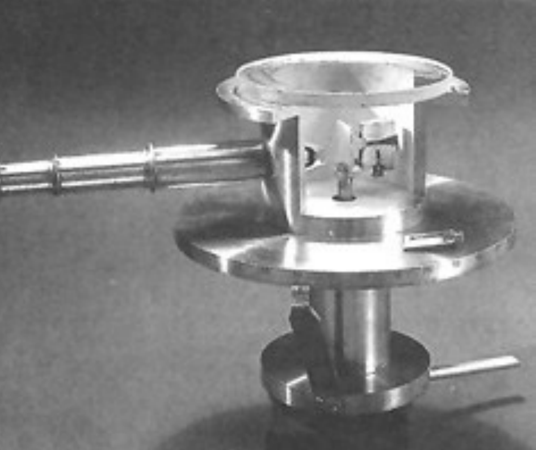
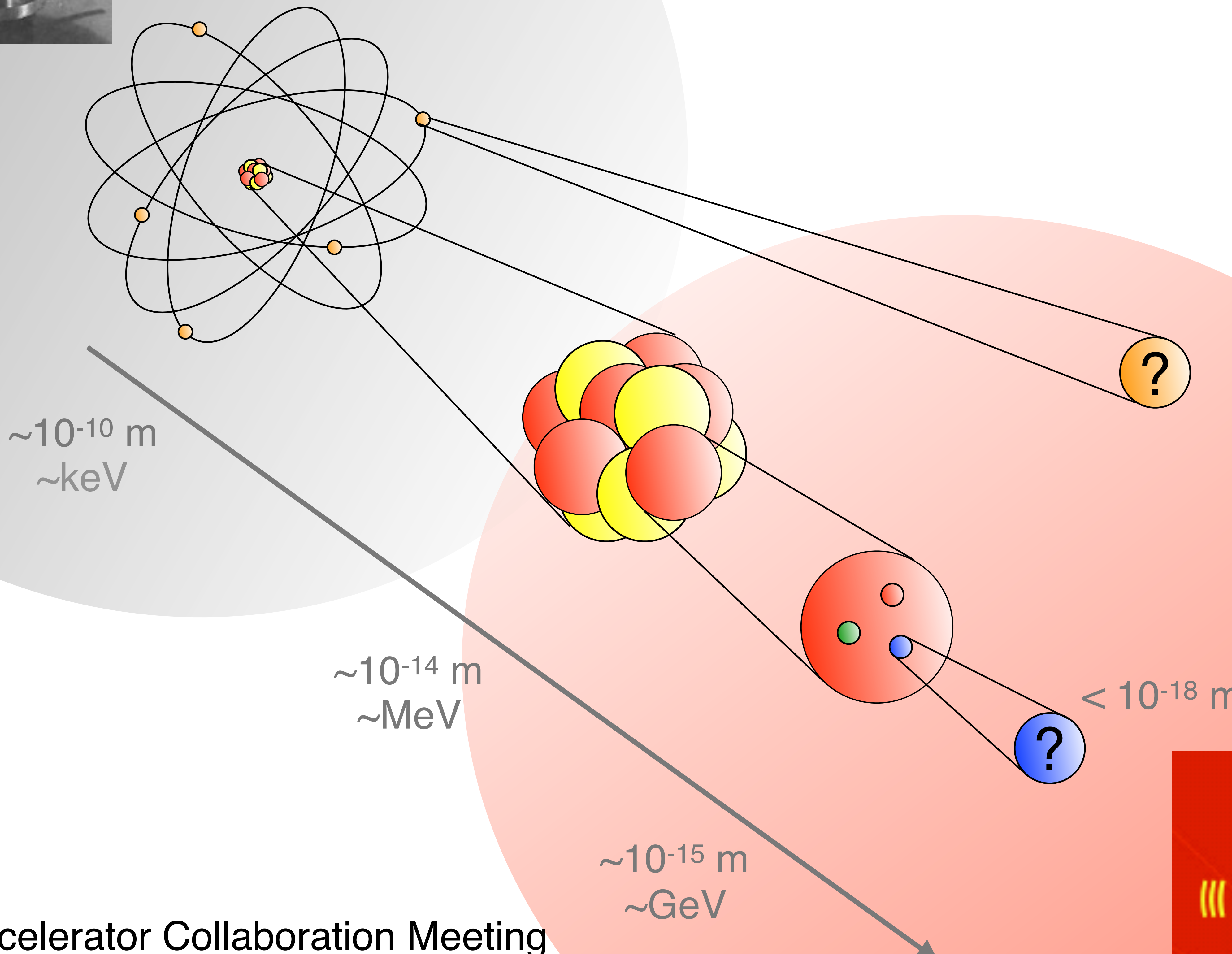
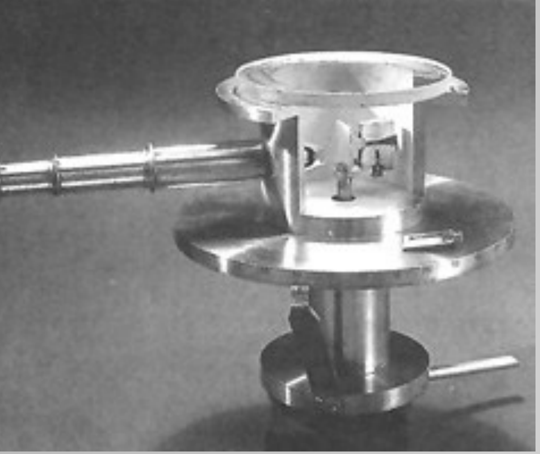


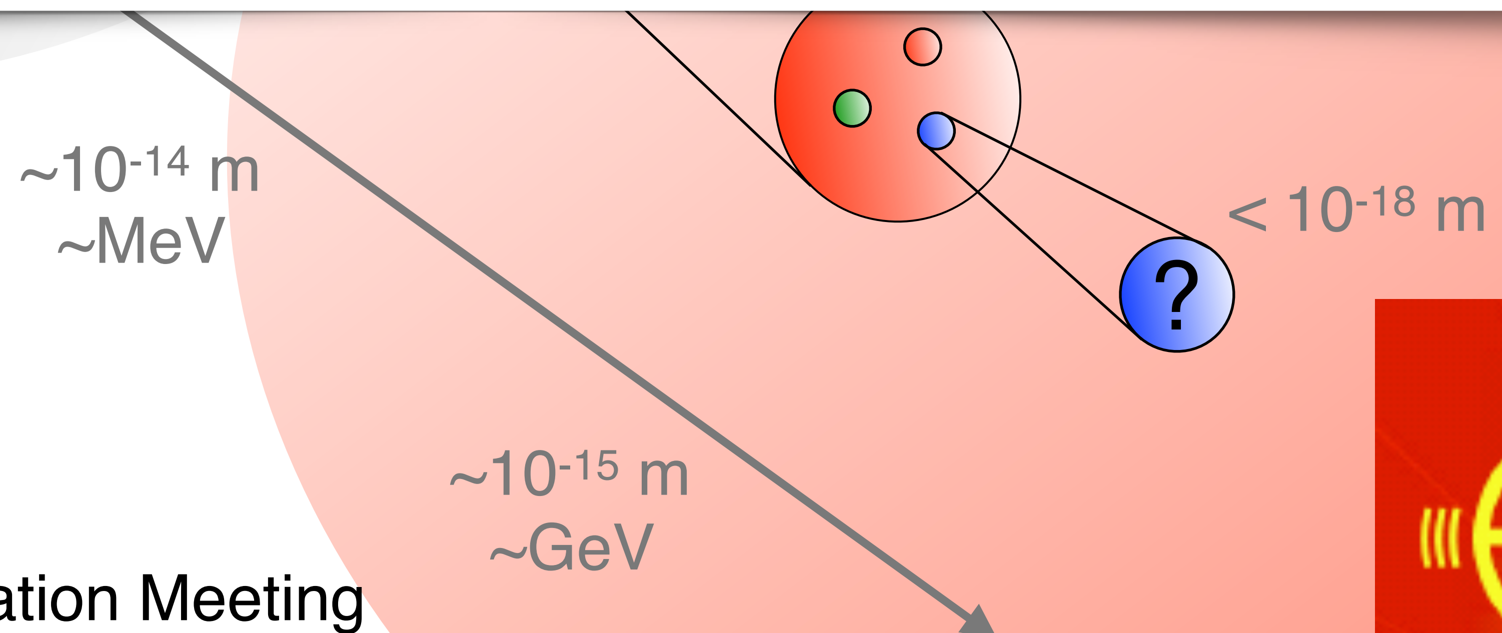


2nd EIC Accelerator Collaboration Meeting
JLab, Newport News - October 29, 2018

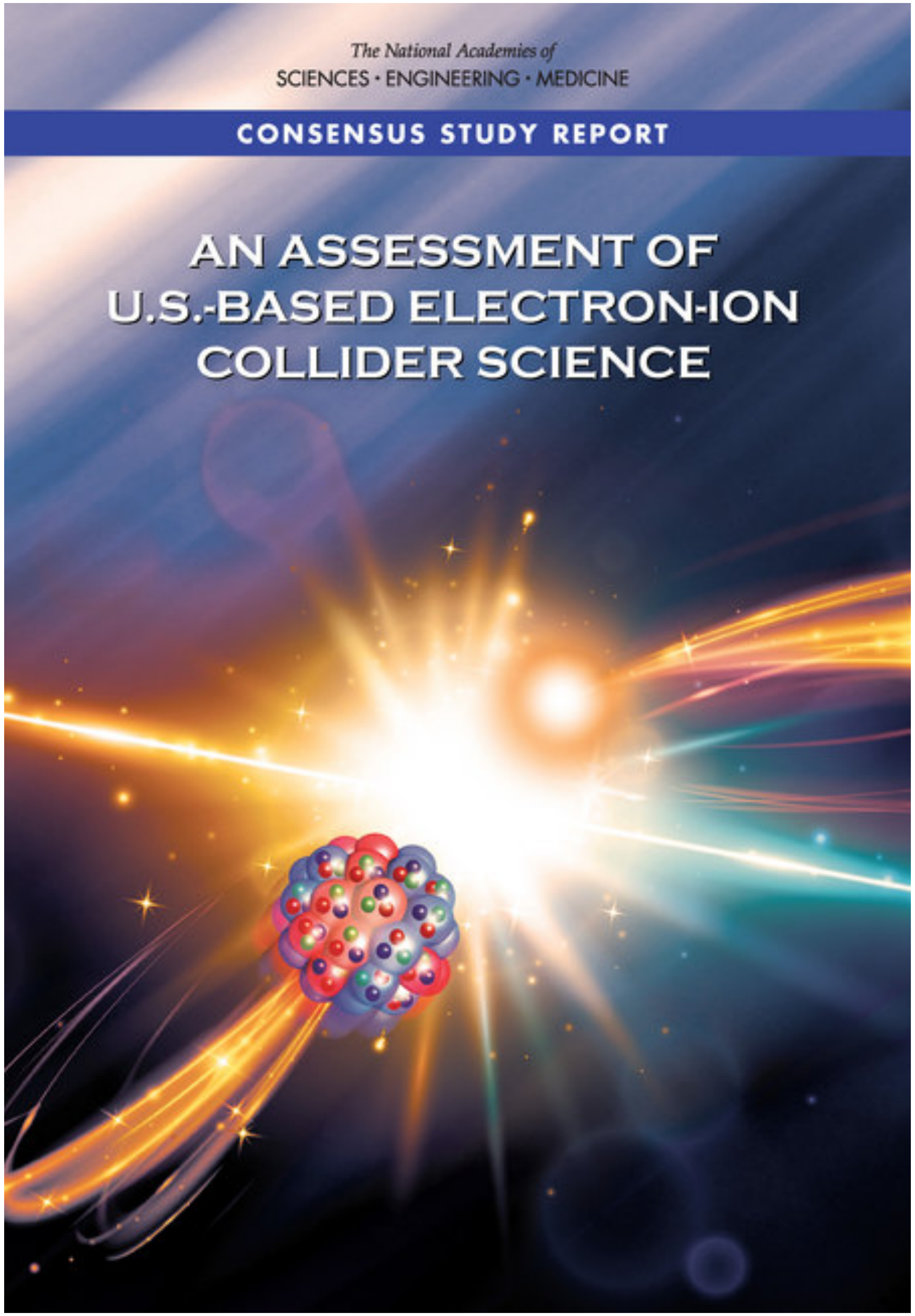


U.S.-Based Electron Ion Collider Science Assessment
a recent study by the National Academies

Ernst Sichtermann (Lawrence Berkeley National Laboratory)



2nd EIC Accelerator Collaboration Meeting
JLab, Newport News - October 29, 2018



The short version:

The National Academies of Sciences, Engineering, and Medicine was asked by the U.S. Department of Energy to assess the scientific justification for building an Electron-Ion Collider (EIC) facility.

The *unanimous* conclusion of the Committee is that an EIC, as envisioned in this report, would be…

… a unique facility in the world that would answer science questions that are compelling, fundamental, and timely, and help maintain U.S. scientific leadership in nuclear physics.

Before this NAS study - 2007 Long Range Plan

An Electron-Ion Collider (EIC) with polarized beams has been embraced by the U.S. Nuclear Science Community as embodying the vision for reaching the next QCD frontier.

EIC would provide unique capabilities for the study of QCD well beyond those available at existing facilities worldwide and complementary to those planned for the next generation of accelerators in Europe and Asia.

Before this NAS study - NRC Report on Nuclear Physics

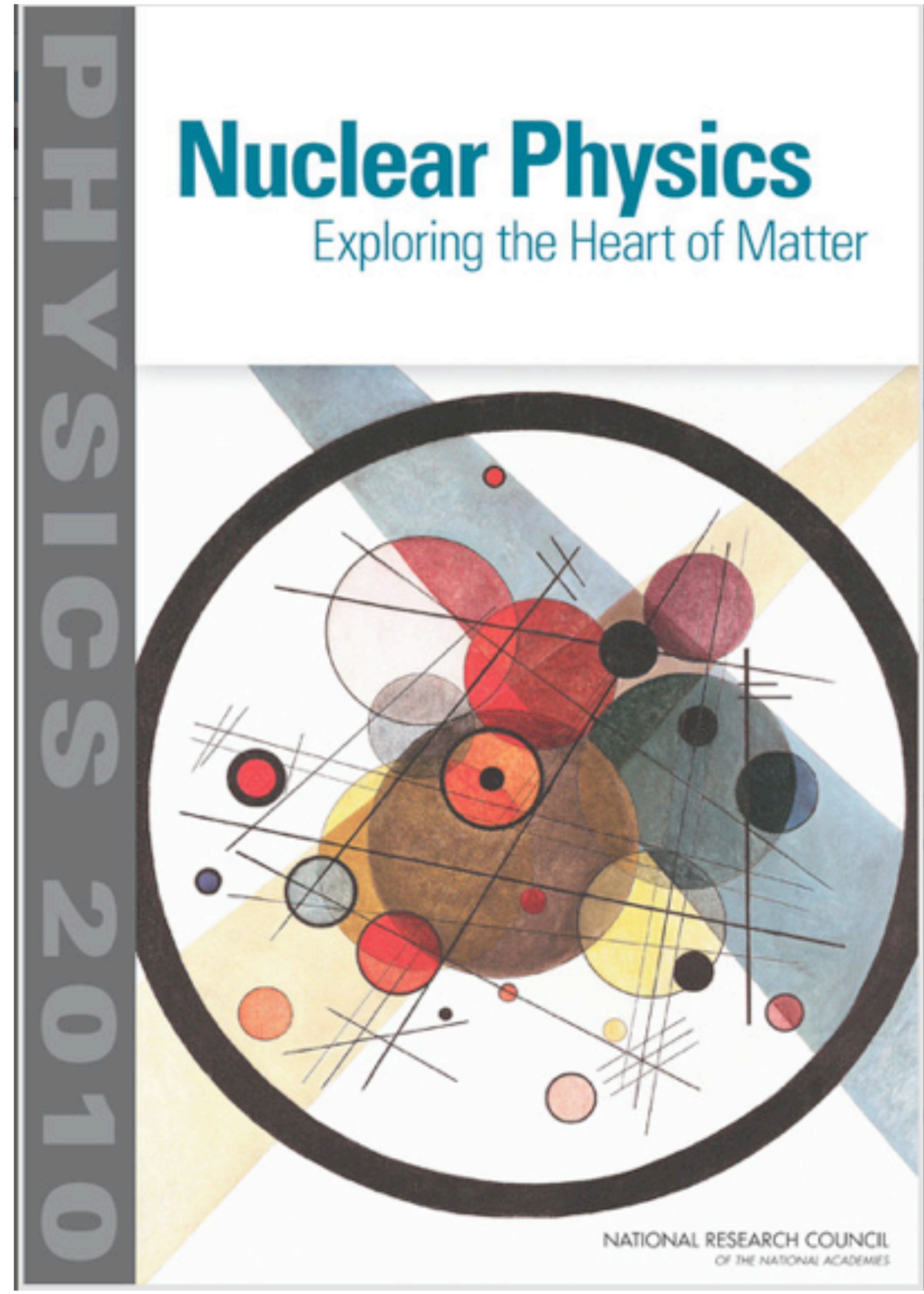
Page 236 - Recommendations,
Building a Foundation for the Future:

Without gluons, there would be no neutrons or protons and no atomic nuclei. Gluon properties in matter remain largely unexplored and mysterious.

Finding: An upgrade to an existing accelerator facility that enables the colliding of nuclei and electrons at forefront energies would be unique for studying new aspects of quantum chromodynamics. In particular, such an upgrade would yield new information on the role of gluons in protons and nuclei. An electron-ion collider is currently under scrutiny as a possible future facility.

Recommendation: Investment in accelerator and detector research and development for an electron-ion collider should continue. The science opportunities and the requirements for such a facility should be carefully evaluated in the next Nuclear Science Long Range Plan.

No other facility finding or recommendation.



National Research Council. *Nuclear Physics: Exploring the Heart of Matter.* Washington, DC: The National Academies Press, 2013.

Before this NAS study - NSAC Facilities Subcommittee

NSAC Facilities Subcommittee (2013):

"*The EIC would be a unique and powerful microscope to provide a dynamical mapping of gluons in the nucleon and in nuclei. It is an ideal tool to investigate the mechanism of how quarks and gluons propagate in nuclear matter and join together to form hadrons. The EIC is our portal to an in-depth and fundamental understanding of gluonic matter and of QCD."*

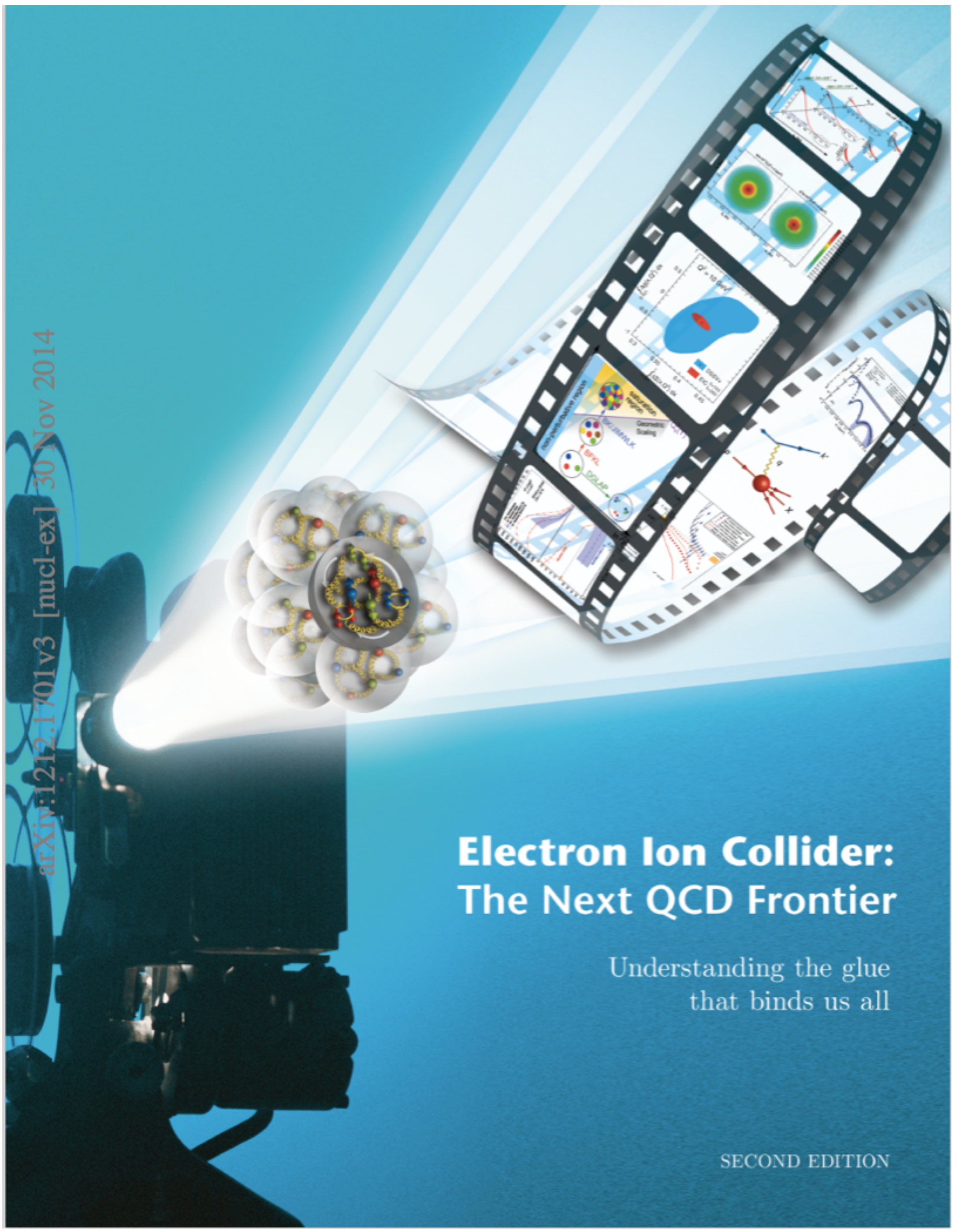
As stated in the 2007 Long Range Plan, "*An EIC with polarized beams has been embraced by the U.S. nuclear science community as embodying the vision for reaching the next QCD frontier.*"

The Subcommittee ranks an EIC as **Absolutely Central** in its ability to contribute to world-leading science in the next decade."

...

Concerning readiness of the facility for construction, we rank this facility in the category **(b) significant scientific/engineering challenges to resolve before initiating construction**."

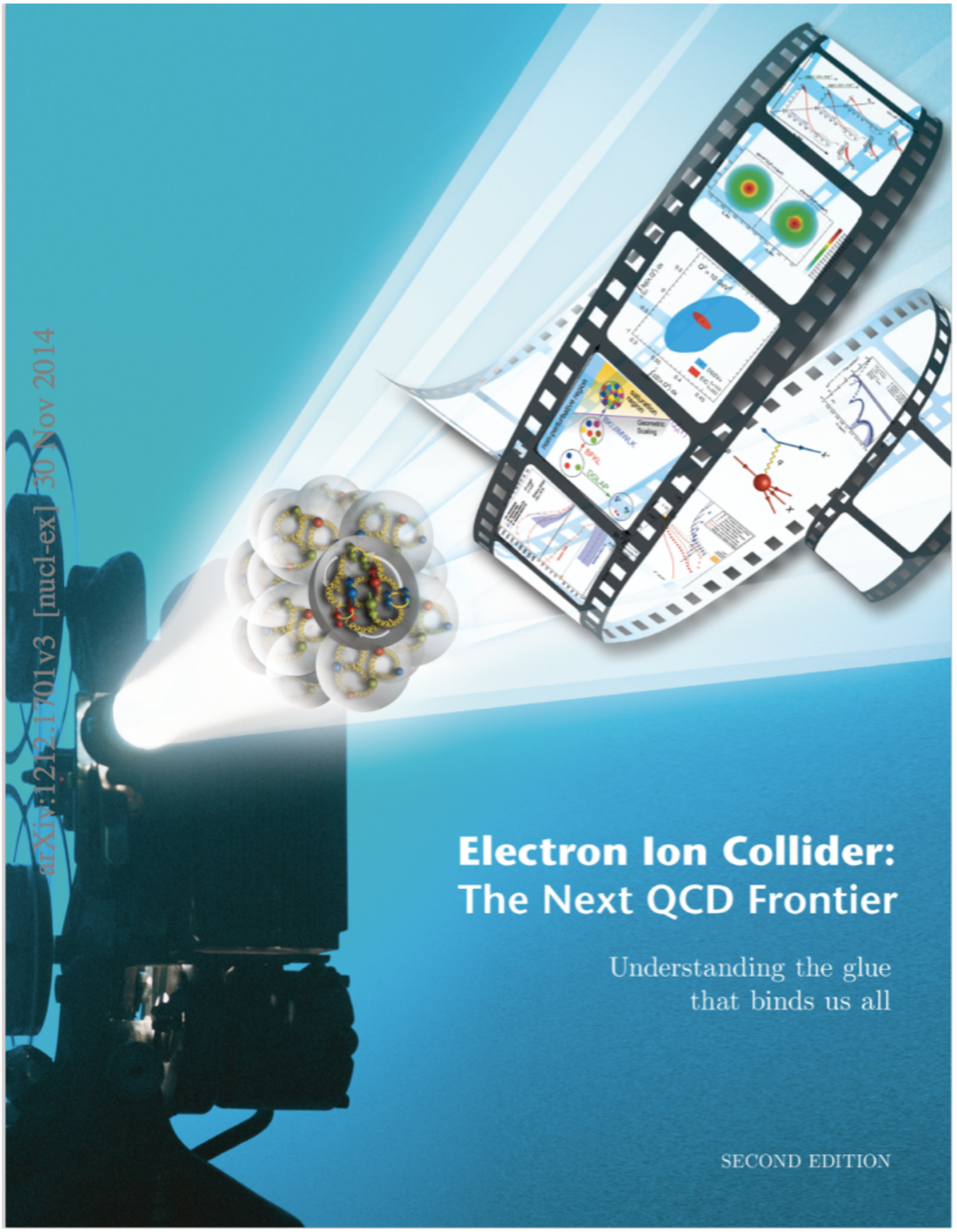
The EIC White Paper - Three Science Questions



Eur. Phys. J. A52 (2016) no.9, 268

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

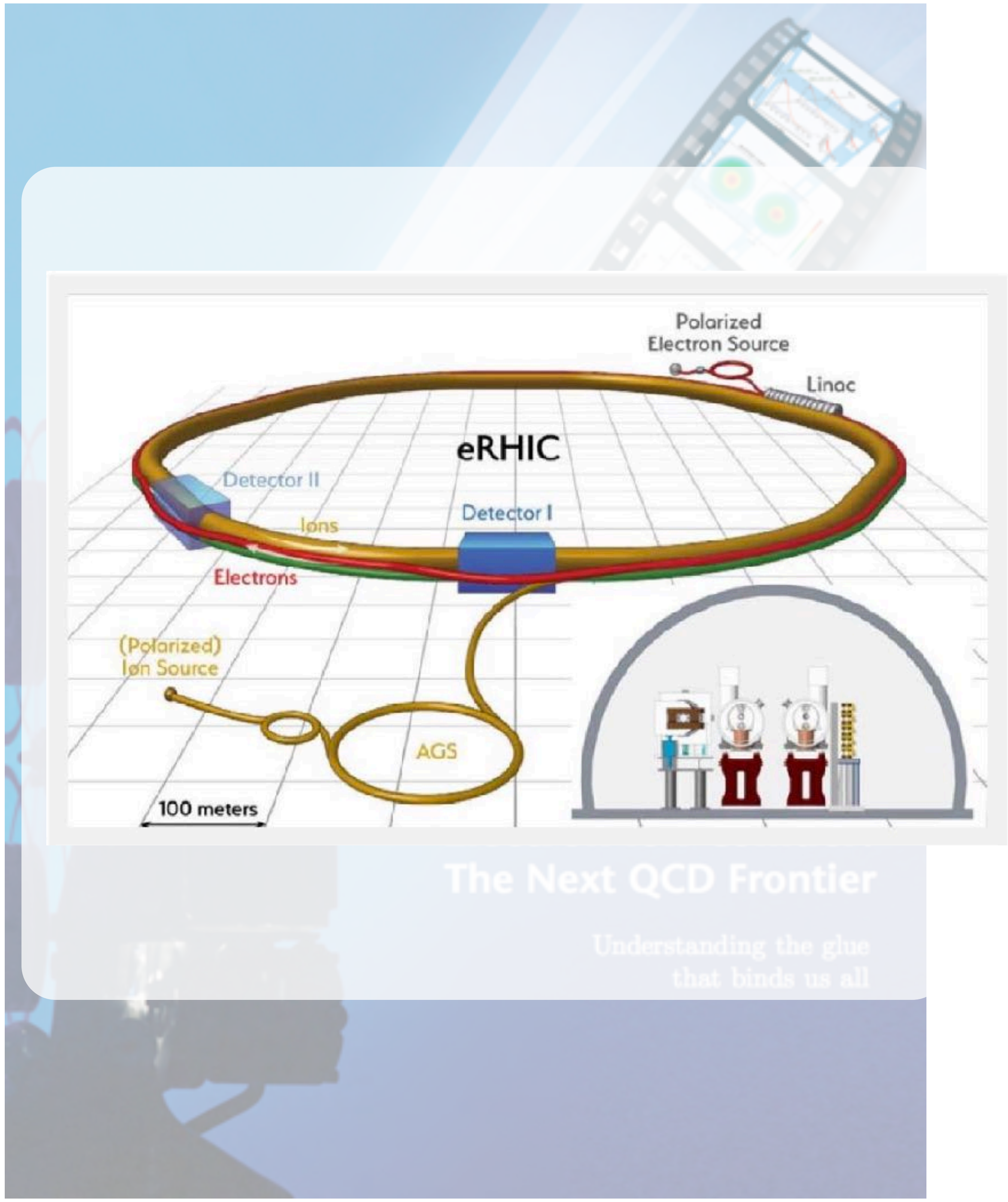
The EIC White Paper - Machine Rationale

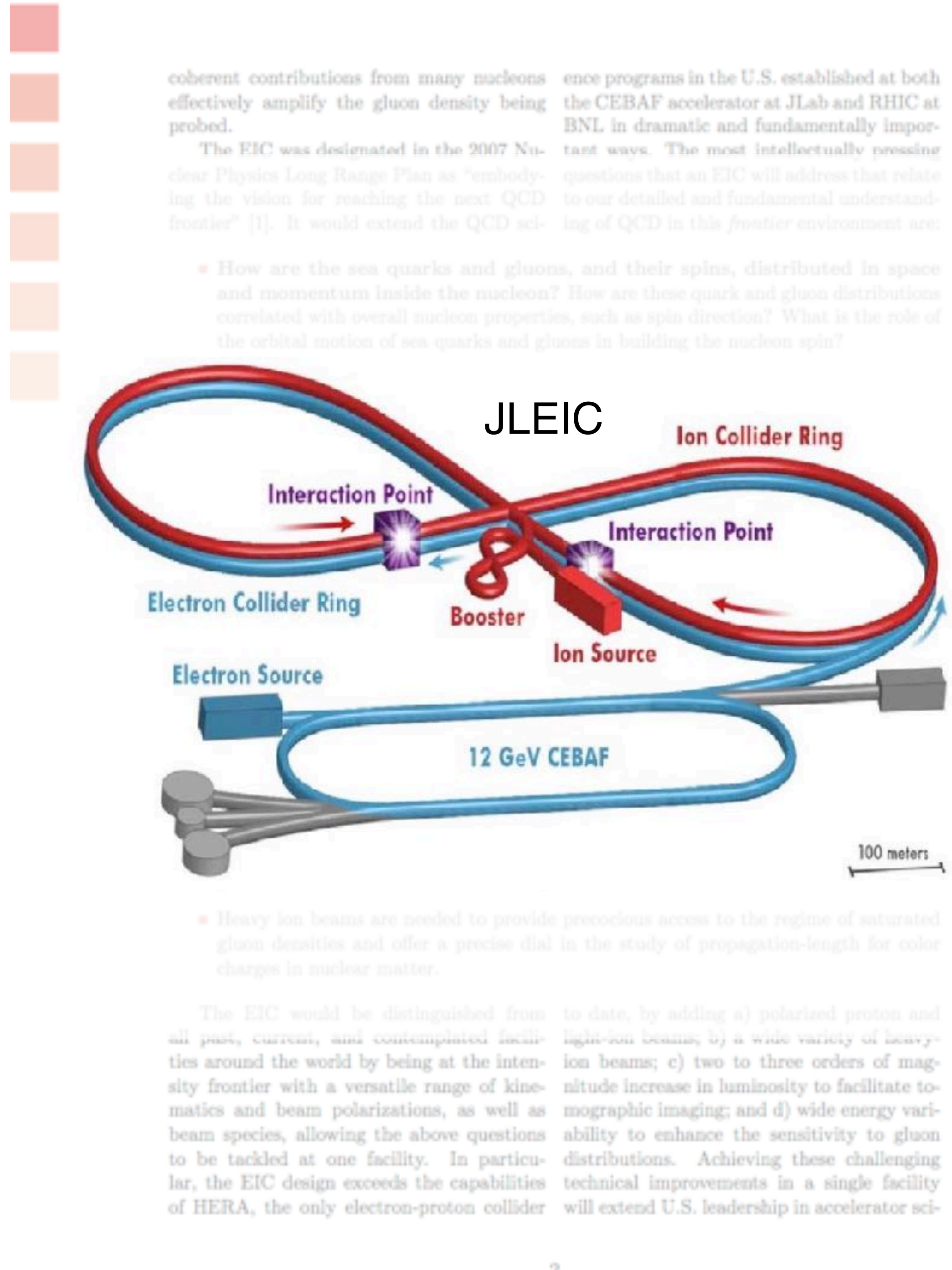


Eur. Phys. J. A52 (2016) no.9, 268

- *A collider is needed to provide kinematic reach well into the gluon-dominated regime;*
- *Electron beams are needed to bring to bear the unmatched precision of the electromagnetic interaction as a probe;*
- *Polarized nucleon beams are needed to determine the correlations of sea quark and gluon distributions with the nucleon spin;*
- *Heavy ion beams are needed to provide precocious access to the regime of saturated gluon densities and offer a precise dial in the study of propagation-length for color charges in nuclear matter.*

The EIC White Paper - Two Facility Options





coherent contributions from many nucleons effectively amplify the gluon density being probed.

The EIC was designated in the 2007 Nuclear Physics Long Range Plan as "embodying the vision for reaching the next QCD frontier" [1]. It would extend the QCD science programs in the U.S. established at both the CEBAF accelerator at JLab and RHIC at BNL in dramatic and fundamentally important ways. The most intellectually pressing questions that an EIC will address that relate to our detailed and fundamental understanding of QCD in this *frontier* environment are:

- How are the sea quarks and gluons, and their spins, distributed in space and momentum inside the nucleon? How are these quark and gluon distributions correlated with overall nucleon properties, such as spin direction? What is the role of the orbital motion of sea quarks and gluons in building the nucleon spin?

- Heavy ion beams are needed to provide precocious access to the regime of saturated gluon densities and offer a precise dial in the study of propagation-length for color charges in nuclear matter.

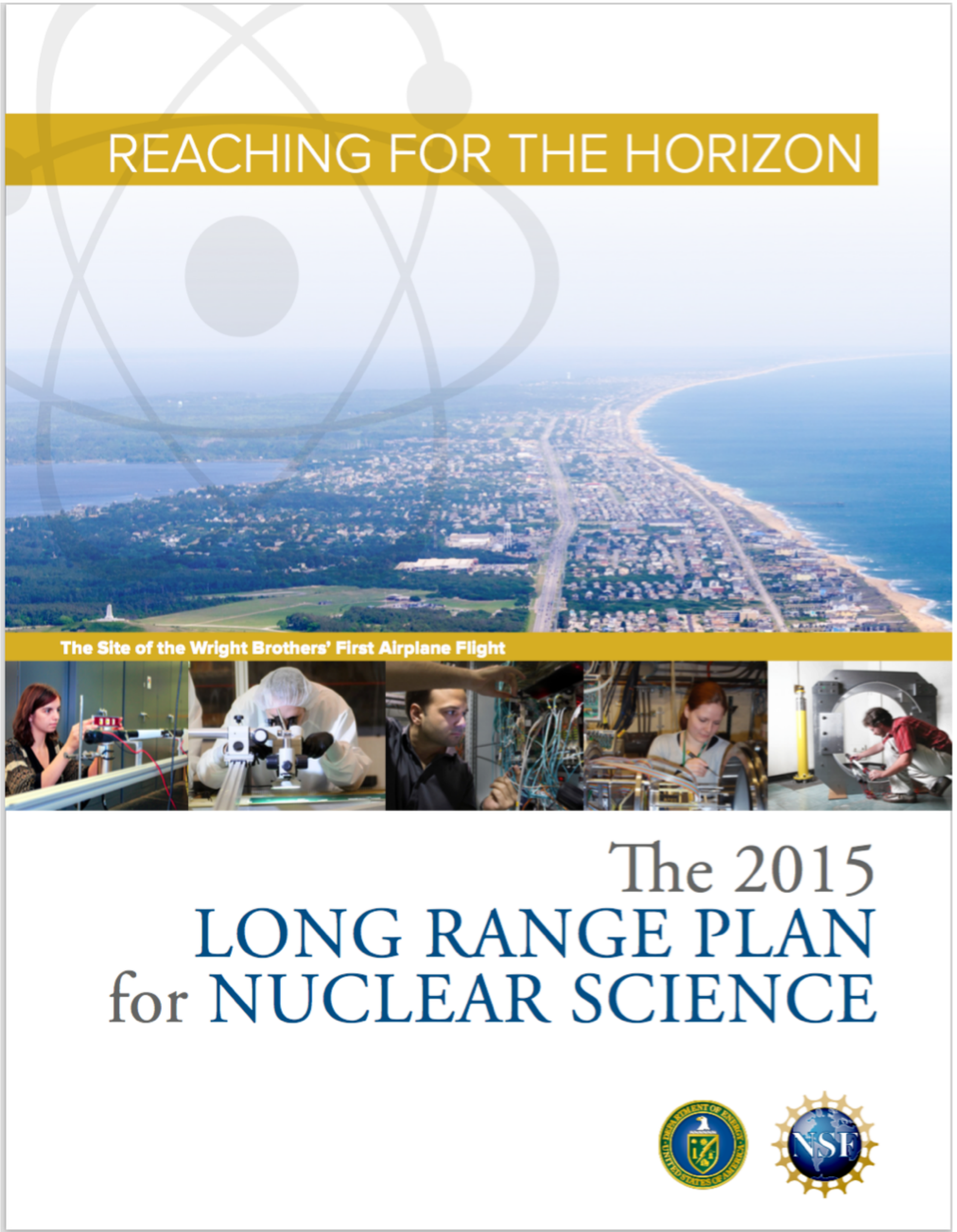
The EIC would be distinguished from all past, current, and contemplated facilities around the world by being at the intensity frontier with a versatile range of kinematics and beam polarizations, as well as beam species, allowing the above questions to be tackled at one facility. In particular, the EIC design exceeds the capabilities of HERA, the only electron-proton collider to date, by adding a) polarized proton and light-ion beams; b) a wide variety of heavy-ion beams; c) two to three orders of magnitude increase in luminosity to facilitate tomographic imaging; and d) wide energy variability to enhance the sensitivity to gluon distributions. Achieving these challenging technical improvements in a single facility will extend U.S. leadership in accelerator sci-

2

Nuclear Physics enabled by EIC **beam** energy, intensity, polarization, and species,
detector capabilities,

theory

Before this NAS study - 2015 Long Range Plan



RECOMMENDATION I

The progress achieved under the guidance of the 2007 Long Range Plan has reinforced U.S. world leadership in nuclear science. The highest priority in this 2015 Plan is to capitalize on the investments made.

RECOMMENDATION II

We recommend the timely development and deployment of a U.S.-led ton-scale neutrinoless double beta decay experiment.

RECOMMENDATION III

We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB. [Q3 FY22]

RECOMMENDATION IV

We recommend increasing investment in small-scale and mid-scale projects and initiatives that enable forefront research at universities and laboratories.

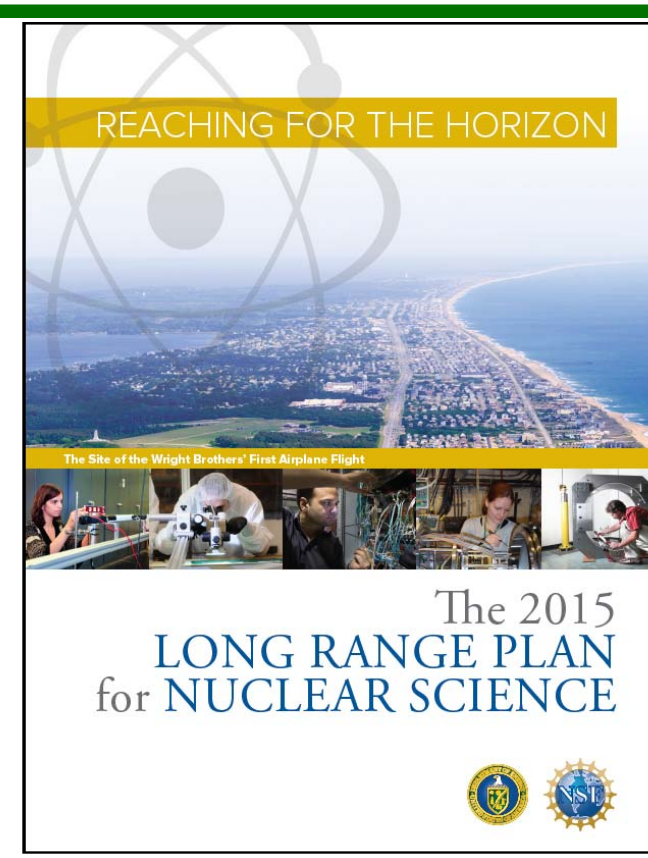
From: *DOE Office of Nuclear Physics Overview,* Dr. Tim Hallman, NSAC, March 2016

The 2015 Long Range Plan for Nuclear Science

NSAC and APS DNP partnered to tap the full intellectual capital of the U.S. nuclear science community in identifying exciting, compelling, science opportunities

Recommendations:

- The progress achieved under the guidance of the 2007 Long Range Plan has reinforced U.S. world leadership in nuclear science. ***The highest priority in this 2015 Plan is to capitalize on the investments made.***
- The observation of neutrinoless double beta decay in nuclei would…have profound implications.. ***We recommend the timely development and deployment of a U.S.-led ton-scale neutrinoless double beta decay experiment.***
- Gluons…generate nearly all of the visible mass in the universe. Despite their importance, fundamental questions remain…. These can only be answered with a powerful new electron ion collider (EIC). ***We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.***
- ***We recommend increasing investment in small-scale and mid-scale projects and initiatives that enable forefront research at universities and laboratories.***



NP is implementing these recommendations which are supported in the President's FY 2017 request

https://science.energy.gov/np/nsac/

From: *DOE Office of Nuclear Physics Overview,* Dr. Tim Hallman, NSAC, March 2016

Next Formal Step on the EIC Science Case

THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE
Division on Engineering and Physical Science
Board on Physics and Astronomy
U.S.-Based Electron Ion Collider Science Assessment

Summary

The National Academies of Sciences, Engineering, and Medicine ("National Academies") will form a committee to carry out a thorough, independent assessment of the scientific justification for a U.S. domestic electron ion collider facility. In preparing its report, the committee will address the role that such a facility would play in the future of nuclear science, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics. The need for such an accelerator will be addressed in the context of international efforts in this area. Support for the 18-month project in the amount of $540,000 is requested from the Department of Energy.

<u>Mail reviews received; proposal approved for funding in PAMS; PR package in PAMS being processed.</u>

Progress is also being made on a second Joint NAS study on Space Radiation Effects Testing

https://science.energy.gov/np/nsac/

From: *DOE Office of Nuclear Physics Overview,* Dr. Tim Hallman, NSAC, October 2016

Next Formal Step on the EIC Science Case

THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE
Division on Engineering and Physical Science
Board on Physics and Astronomy
U.S.-Based Electron Ion Collider Science Assessment

Summary

The National Academies of Sciences, Engineering, and Medicine ("National Academies") will form a committee to carry out a thorough, independent assessment of the scientific justification for a U.S. domestic electron ion collider facility. In preparing its report, the committee will address the role that such a facility would play in the future of nuclear science, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics. The need for such an accelerator will be addressed in the context of international efforts in this area. Support for the 18-month project in the amount of $540,000 is requested from the Department of Energy.

"U.S.-Based Electron Ion Collider Science Assessment" is now getting underway. The Chair will be Gordon Baym. The rest of the committee, including a co-chair, will be appointed in the next couple of weeks. The first meeting is being planned for January, 2017

https://science.energy.gov/np/nsac/

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

BOARD ON PHYSICS AND ASTRONOMY (BPA)

An Assessment of U.S.-Based Electron-Ion Collider Science

A study under the auspices of the U.S. National Academies of Sciences, Engineering, and Medicine

Gordon Baym and Ani Aprahamian, Co-Chairs

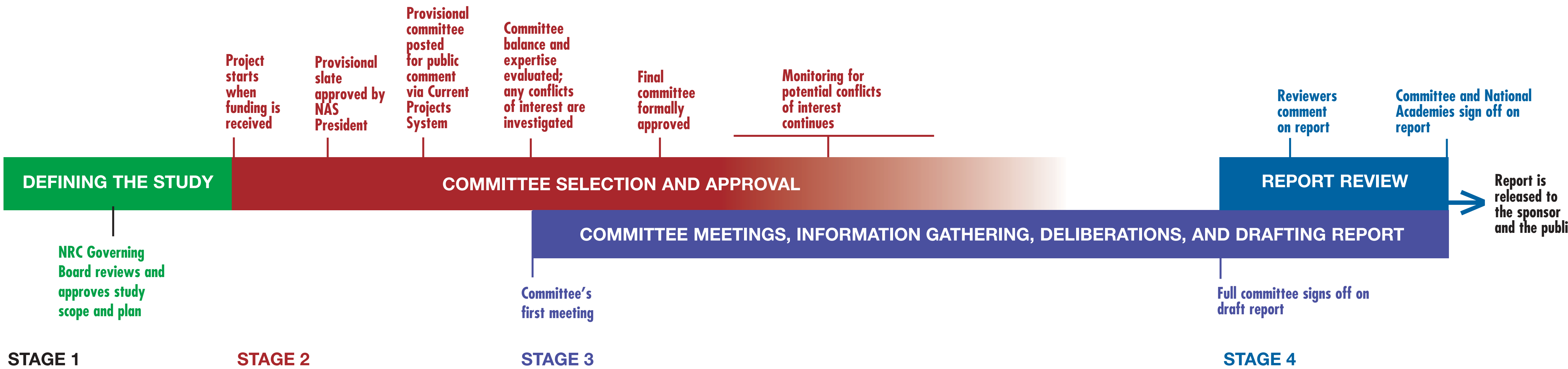
The study is supported by funding from the DOE Office of Science.

(Further information can be found at: https://www.nap.edu/25171)

The National Academies produce reports that shape policies, inform public opinion, and advance the pursuit of science, engineering, and medicine.

The present report is carried out under the leadership of the Board on Physics and Astronomy (James Lancaster, Director). The BPA seeks to inform the government and the public about what is needed to continue the advancement of physics and astronomy and why doing so is important.

The National Academies - Studies



Stage 1: Defining the Study

Stage 2: Committee Selection and Approval

- An appropriate range of expertise for the task
- A balance of perspectives
- Screened for conflicts of interest

Stage 3: Committee Meetings, Information Gathering, Deliberations, and Drafting the Report

Stage 4: Report Review

Release to the sponsor and (shortly thereafter) to the public

Study - U.S.-Based Electron Ion Collider Science Assessment

Project Scope / Statement of Task:

The committee will assess the scientific justification for a U.S. domestic electron ion collider facility, taking into account current international plans and existing domestic facility infrastructure.

In preparing its report, the committee will address the role that such a facility could play in the future of nuclear physics, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics.

Study - U.S.-Based Electron Ion Collider Science Assessment

Project Scope / Statement of Task (continued):

In particular, the committee will address the following questions:

- *What is the merit and significance of the science that could be addressed by an electron ion collider facility and what is its importance in the overall context of research in nuclear physics and the physical sciences in general?*
- *What are the capabilities of other facilities, existing and planned, domestic and abroad, to address the science opportunities afforded by an electron-ion collider? What unique scientific role could be played by a domestic electron ion collider facility that is complementary to existing and planned facilities at home and elsewhere?*
- *What are the benefits to U.S. leadership in nuclear physics if a domestic electron ion collider were constructed?*
- *What are the benefits to other fields of science and to society of establishing such a facility in the United States?*

Committee - U.S.-Based Electron Ion Collider Science Assessment

courtesy John Jowett

Committee - U.S.-Based Electron Ion Collider Science Assessment

courtesy John Jowett

Committee - U.S.-Based Electron Ion Collider Science Assessment

Co-Chairs:

Dr. Ani Aprahamian, professor of experimental nuclear physics at the University of Notre Dame

Dr. Gordon A. Baym (NAS), professor emeritus at the University of Illinois at Champaign-Urbana

Members:

Dr. Christine Aidala, associate professor of physics at the University of Michigan

Dr. Peter Braun-Munzinger, scientific director of the ExtreMe Matter Institute (EMMI) at GSI

Dr. Haiyan Gao, professor of physics and Vice Chancellor for academic affairs at Duke University

Dr. Kawtar Hafidi, director of the Physics Division at Argonne National Laboratory

Dr. Wick C. Haxton (NAS), professor of physics at the University of California, Berkeley

Dr. John Jowett, senior accelerator physicist at CERN.

Dr. Larry McLerran, Director of the Institute for Nuclear Theory at the University of Washington

Dr. Lia Merminga, Associate Laboratory Director, Accelerator Directorate, SLAC

Dr. Zein-Eddine Meziani, professor of physics at Temple University

Dr. Richard G. Milner, professor of physics at MIT and director of MIT's LNS

Dr. Thomas Schaefer, professor of physics at North Carolina State University

Dr. Ernst Sichtermann, senior scientist at Lawrence Berkeley National Laboratory

Dr. Michael Turner (NAS), Bruce V. Rauner Distinguished Service Professor at the University of Chicago and director of the Physics Frontier Center and the Kavli Institute for Cosmological Physics

Information Gathering - U.S.-Based EIC Science Assessment

NAS Study Process:

"Study committees gather information from many sources in public meetings but they carry out their deliberations in private in order to avoid political, special interest, and sponsor influence"

U.S.-Based EIC Science Assessment:

Publications and reports, e.g. the EIC White-Paper, 2015 LRP, and *many* others

Presentations and discussions,

Four in-person committee meetings and three committee-wide teleconferences, …

1. Feb. 1-2, 2017 in Washington, DC: Funding agencies, House Science and Technology Committee, NSAC, EIC collider physics, European perspective, RHIC plans
2. April 19-20, 2017 in Irvine, CA: JLab plans, EIC User Group, EIC in China, CERN, gluon and deep inelastic scattering physics
3. Sept. 11-12, 2017 in Woods Hole, MA: EIC accelerator technology, EIC computing, gluon saturation
4. Nov. 27-28, 2017 in Washington, DC

http://www.nationalacademies.org/cp/

Committee Meetings - U.S.-Based EIC Science Assessment

February 1, 2017 - Washington, DC

closed	9:00	Welcome and meeting overview	Ani Aprahamian and Gordon Baym, co-chairs
closed	9:15	National Academies basics	Andrea Peterson, BPA program officer
closed	9:30	Bias and conflict	David Lang, Study Director
closed	10:30	Discussion: statement of task	
open	11:30	European perspectives on an EIC facility	Peter Braun-Munzinger, GSI, committee member
open	13:00	The 2015 NSAC Long Range Plan	Donald Geesaman, Argonne National Laboratory
open	13:45	EIC R&D Community Review Summary	Kevin Jones, Oak Ridge National Laboratory
open	14:30	Discussion with Congressional Staff	Adam Rosenberg, House S&T Comm., Energy Subcomm.
open	15:00	Discussion with NSF Physics	Denise Caldwell, NSF PHY
open	15:30	RHIC Cold QCD Plan for 2017 to 2023	Christine Aidala, U. of Michigan, committee member
open	16:15	Electron-Ion Collider: The next QCD frontier	Richard Milner, MIT, committee member

February 2, 2017

open	9:00	Discussion with DOE Nuclear Physics	Tim Hallman, DOE NP
open	10:00	Continued discussion with DOE	
open	11:00	Discussion with DOE Office of Science	Steve Binkley, DOE Office of Science
open	11:30	Continued discussion with DOE	
closed	13:00	Discussion: Next Steps Statement of Task Report Outline Information gathering Future meetings, work plan and schedule	
closed	14:00	Adjourn	

http://www.nationalacademies.org/cp/

Committee Meetings - U.S.-Based EIC Science Assessment

April 19, 2017 - Irvine, CA

closed	9:00	Welcome	Gordon Baym, co-chair
	9:10	General Discussion and review of previous meeting	
open	10:00	Physics of gluon saturation	Jean-Paul Blaizot, IPhT CEA-Saclay
	11:00	Heavy Ion Physics at CERN	Peter Braun-Munzinger, GSI, committee member
	12:45	Deep-inelastic scattering	Amanda Cooper-Sarkar, Oxford University
	13:30	Theoretical Perspectives on EIC Science	Xiandong Ji, U. of Maryland/Shanghai Jiao Tong U.
	14:30	JLab 5-year physics agenda	Zein-Eddine Meziani, Temple U., committee member
	15:15	Science potential of a U.S.-based EIC	Abhay Deshpande, Stony Brook University
	16:00	Discussion	

April 20, 2017

closed

9:00 Discussion: Preliminary conclusions and recommendations
- Report outline
- Writing responsibilities
- Further information gathering

11:00 Discussion, continued

13:00 Discussion: Future meetings
- Assignments
- Schedule

14:00 Adjourn

http://www.nationalacademies.org/cp/

Committee Meetings - U.S.-Based EIC Science Assessment

September 11, 2017 - Woods Hole, MA

closed	8:30	Welcome	Gordon Baym, co-chair
closed	8:45	Review of chapters 1 and 2	
open	10:30	Dipole cross-section measurements and the physics of gluon saturation	Al Mueller, Columbia U.
open	11:15	EIC accelerator technology development	Lia Merminga, FNAL, committee member
open	13:00	EIC computing challenges and opportunities	Ernst Sichtermann, LBNL, committee member
open	13:45	Open discussion of EIC physics: energies, crucial experiments, etc.	
closed	15:00	Review of chapters 3, 4, and 5	
closed	17:00	Initial discussion of findings and recommendations	

September 12, 2017

closed	8:30	Discussion of findings and recommendations; work on drafts
closed	11:00	Work on drafts, continued
closed	13:00	Discussion: Future meetings Further assignments Schedule
closed	14:00	Adjourn

http://www.nationalacademies.org/cp/

Committee Meetings - U.S.-Based EIC Science Assessment

November 27, 2017 - Washington, DC

closed

9:00 Brief introduction by co-chairs — Ani Aprahamian and Gordon Baym, co-chairs
9:15 Discussion of findings and recommendations
10:30 High level discussion: does the draft reflect our findings and recommendations?
13:00 Review of chapters 1 and 2
14:45 Review of chapters 3 and 4
16:15 Review of chapters 4 and 5

November 28, 2017

closed

9:00 Further discussion of findings and recommendations
11:00 Discussion: Further assignments
Schedule
13:00 Wrap up / continued discussion of next steps
14:00 Adjourn

http://www.nationalacademies.org/cp/

Bottom Line

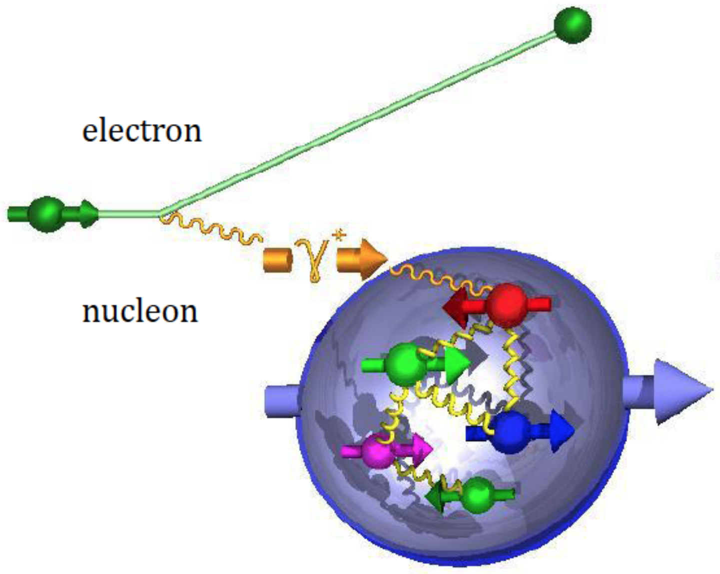
The committee unanimously finds that the science that can be addressed by an EIC is compelling, fundamental, and timely.

The unanimous conclusion of the Committee is that an EIC, as envisioned in this report, would be a unique facility in the world that would boost the U.S. STEM workforce and help maintain U.S. scientific leadership in nuclear physics.

The project is strongly supported by the nuclear physics community.

The technological benefits of meeting the accelerator challenges are enormous, both for basic science and for applied areas that use accelerators, including material science and medicine.

Outline of the Report



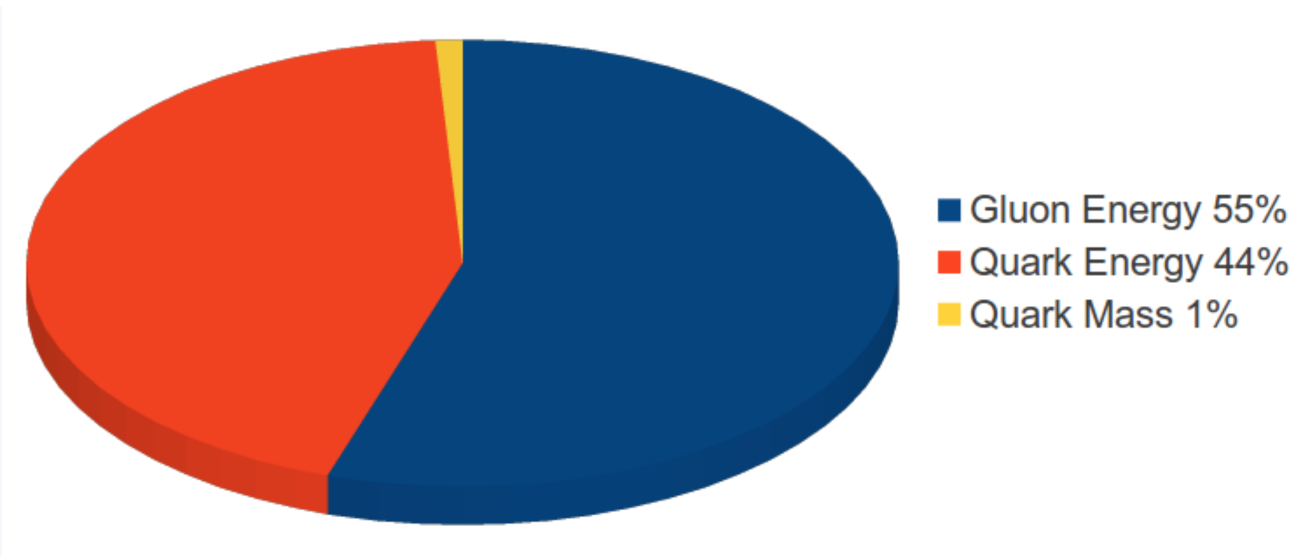
Front Matter
Preface
Summary

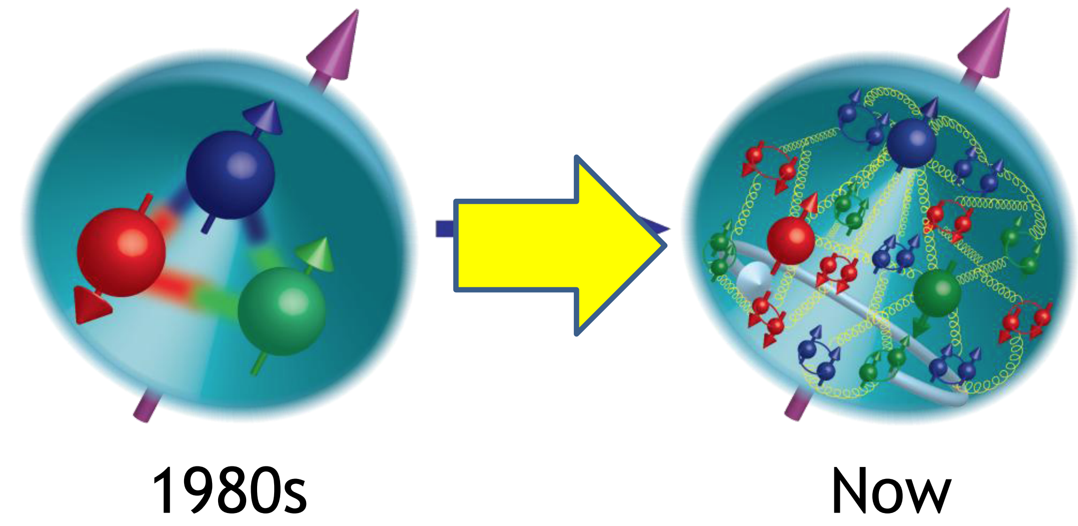
- ❖ Ch 1: Introduction (overview)
- ❖ Ch 2: The scientific case for an electron-ion collider (and how an EIC would do the science)
- ❖ Ch 3: The role of an EIC within the context of nuclear physics in the U.S. and internationally
- ❖ Ch 4: Accelerator science, technology, and detectors needed for a U.S.-based EIC
- ❖ Ch. 5: Comparison of a U.S.-based EIC to current and future facilities
- ❖ Ch. 6: Impact of an EIC on other fields
- ❖ Ch 7: Conclusion and findings

Appendixes: Statement of Task; Bios; Acronyms

Ch. 2: Basic science to be explored

How does a nucleon acquire mass? -- almost 100 times greater than the sum of its valence quark masses. Cannot be understood via Higgs mechanism

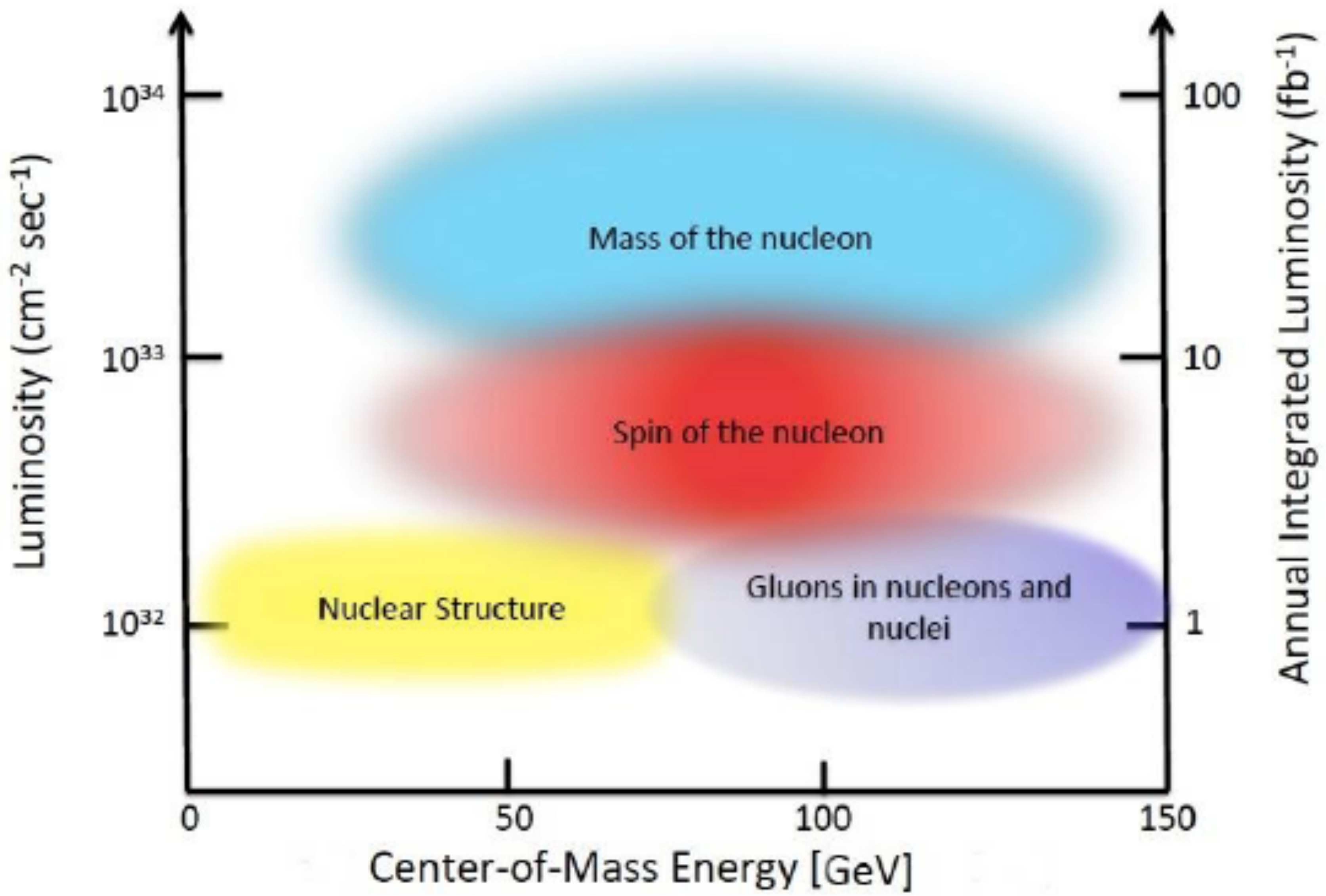


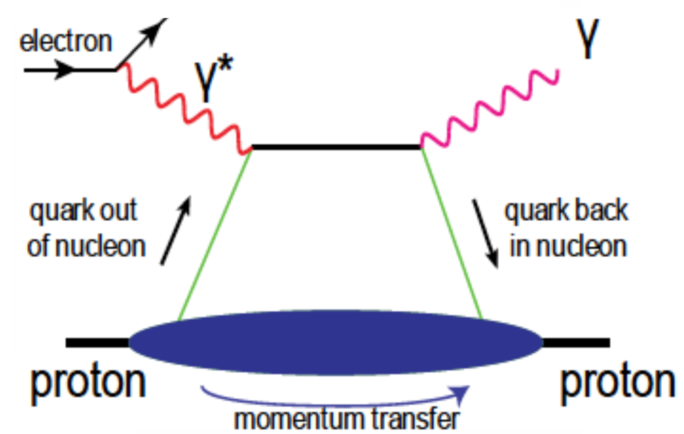


How does the spin (internal angular momentum) of the nucleon arise from its elementary quark and gluon constituents? Proton spin is the basis of MRI imaging.

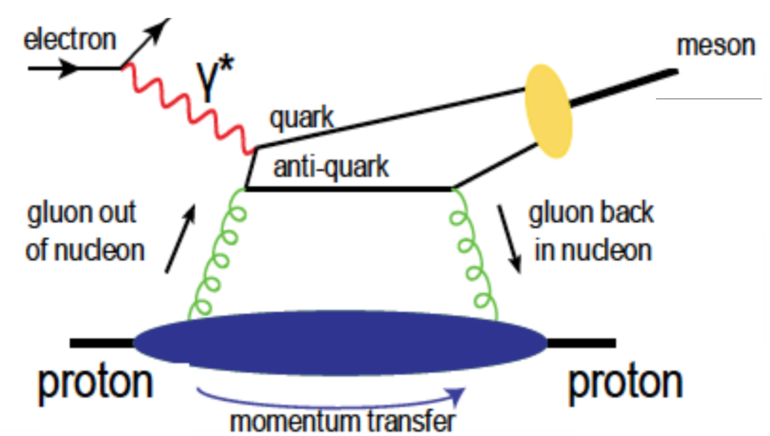
What are the emergent properties of dense systems of gluons? How are they distributed in both position and momentum in nucleons and nuclei, and how are they correlated among themselves and with the quarks and antiquarks present? *What are their quantum states?* Are there new forms of matter made of dense gluons?

Basic experiments in c.m. energy - luminosity landscape



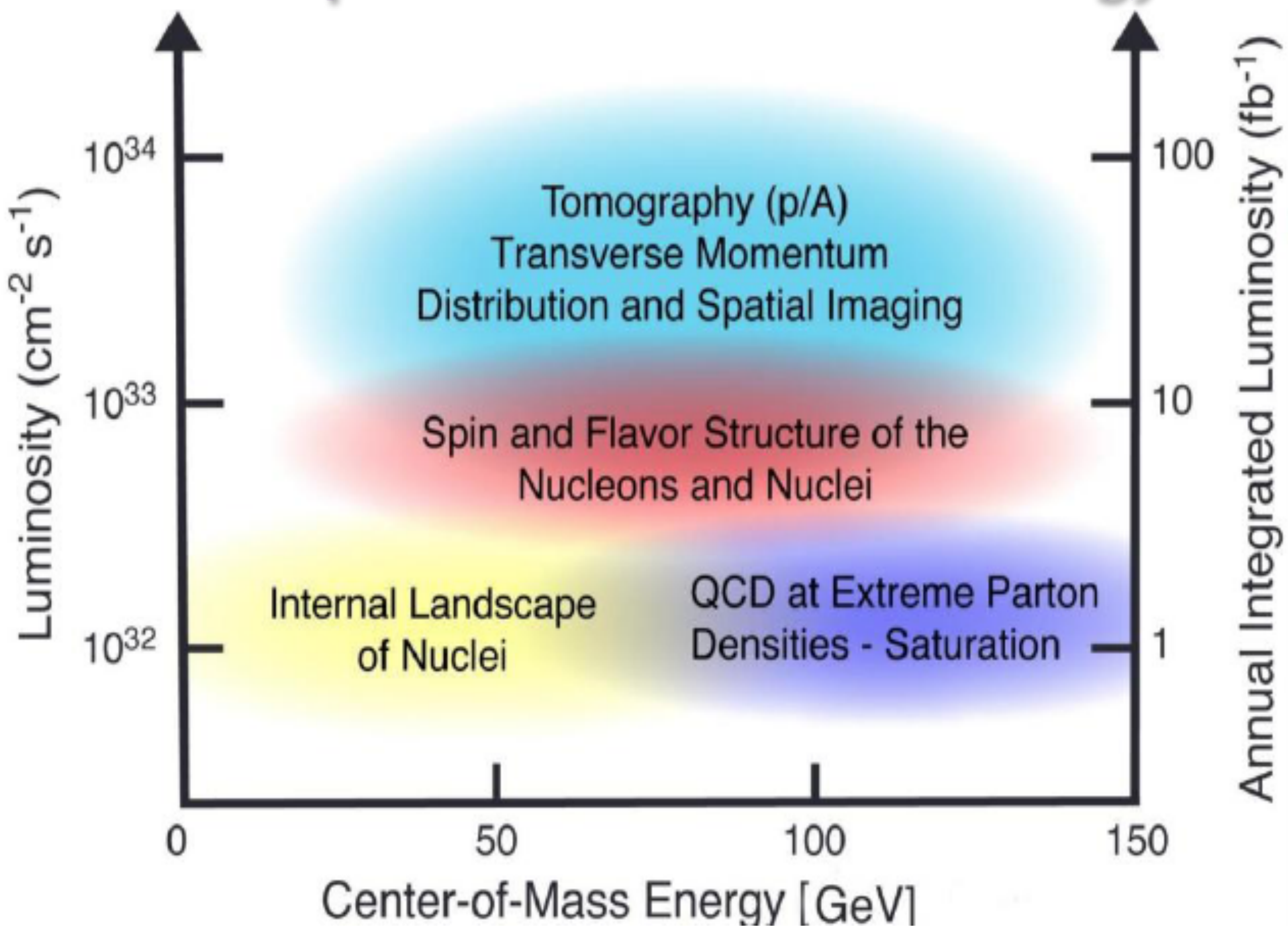


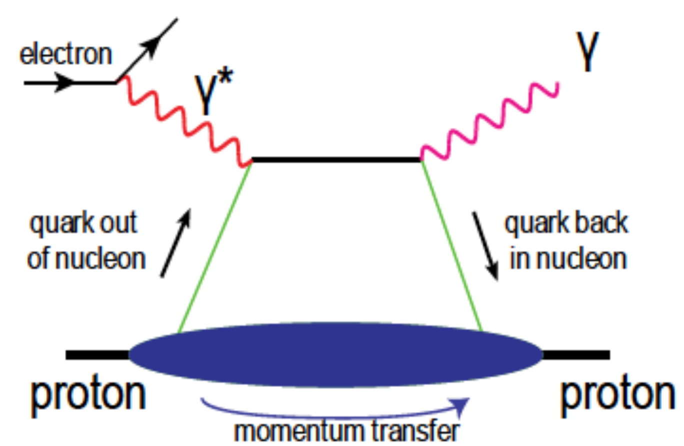
Deeply virtual Compton scattering

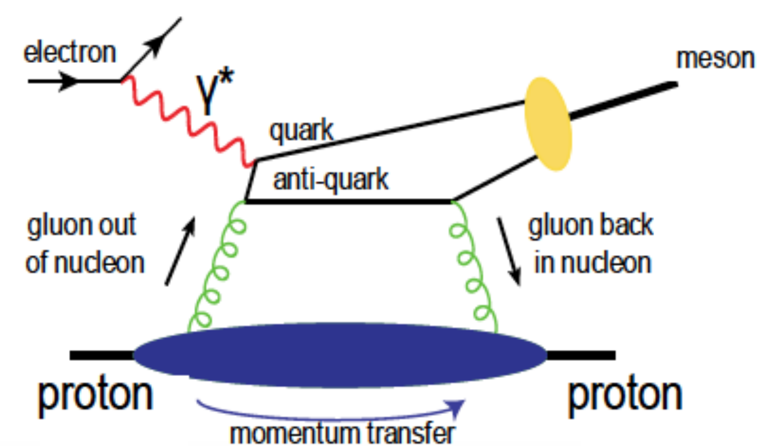


Deeply virtual meson production

Basic experiments in c.m. energy - luminosity landscape







Deeply virtual Compton scattering

Deeply virtual meson production

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Ch. 3: The role of an EIC within the context of nuclear physics in the U.S. and internationally

"Nuclear physics today is a diverse field, encompassing research that spans dimensions from a tiny fraction of the volume of the individual particles (neutrons and protons) in the atomic nucleus to the enormous scales of astrophysical objects in the cosmos."

FRIB in construction at MSU will keep us at a leadership position in the world in understanding the behavior of hadrons inside the atomic nucleus

Inside hadrons, the interactions of gluons and quarks address the fundamental questions on the origin of mass, spin, and saturation. Quantum Chromodynamics (QCD) physics

U.S. Nuclear Science Context for an **Electron-Ion Collider**

U.S. Leadership in Nuclear Science

Ch. 4: Accelerator science, technology, and detectors needed for a U.S.-based EIC

(Choice of design/site for am EIC was not in our statement of task)

Major challenges in accelerator design:
- High energy, spin-polarized beams colliding with high luminosity

BNL eRHIC and JLab JLEIC Conceptual Designs
- build on existing accelerators in different ways
- both require extensive R&D to fully address the science

Enabling Accelerator Technologies
- Interaction region design, magnet technology
- Strong hadron beam cooling (innovative concepts)
- Energy Recovery Linacs
- Crab Cavity operation in hadron ring
- Polarized e,p and ^3He Sources, preservation in accelerators
- Simulations of beams in novel EIC operating modes

Detector Technologies

Ch. 5: Comparison of a U.S.-based EIC to current and future facilities

HERA at DESY... A (former) collider of electrons with protons

CEBAF at JLab….Electron accelerator to 12 GeV

Compass experiment at CERN…muons and protons in collisions

RHIC…Heavy Ion and polarized proton collider

LHC at CERN…Large Hadron Collider: protons and heavy ions

Other Future Electron-Hadron Collider Proposals
- LHeC
- FCC-he …Future Circular Collider
- China: possible low energy EIC at HIAF
  (High Intensity Heavy-Ion Accelerator Facility)

Opportunities for future collaborations!!

Ch. 6: Impact of an EIC on other fields

EIC will sustain a healthy U.S. accelerator science enterprise
- Maintain leadership in collider accelerator technology
- Enable new technology essential for future particle accelerators
- EIC R&D targeted at developing cutting-edge capabilities

Workforce
- Nuclear physicists essential to U.S. security, health & economic vitality
- About one half of U.S. PhDs in nuclear physics are in QCD

Advanced scientific computing
- Maintaining a competitive high performance computing capability is essential to U.S. scientific leadership
- Lattice QCD uses the worlds most advanced computers to provide *ab initio* QCD calculations essential to interpret EIC data

Connections to:
- Condensed matter and atomic-molecular physics
- High-energy physics
- Astrophysics

Findings

The science

Finding 1: An EIC can uniquely address three profound questions about nucleons—neutrons and protons—and how they are assembled to form the nuclei of atoms:

- *How does the mass of the nucleon arise?*
- *How does the spin of the nucleon arise?*
- *What are the emergent properties of dense systems of gluons?*

Accelerator

Finding 2: These three high-priority science questions can be answered by an EIC with highly polarized beams of electrons and ions, with sufficiently high luminosity and sufficient, and variable, center-of-mass energy.

Findings

Finding 3: An EIC would be a unique facility in the world, and would maintain U.S. leadership in nuclear physics.

Finding 4: An EIC would maintain U.S. leadership in the accelerator science and technology of colliders, and help to maintain scientific leadership more broadly.

Finding 5: Taking advantage of existing accelerator infrastructure and accelerator expertise would make development of an EIC cost effective and would potentially reduce risk.

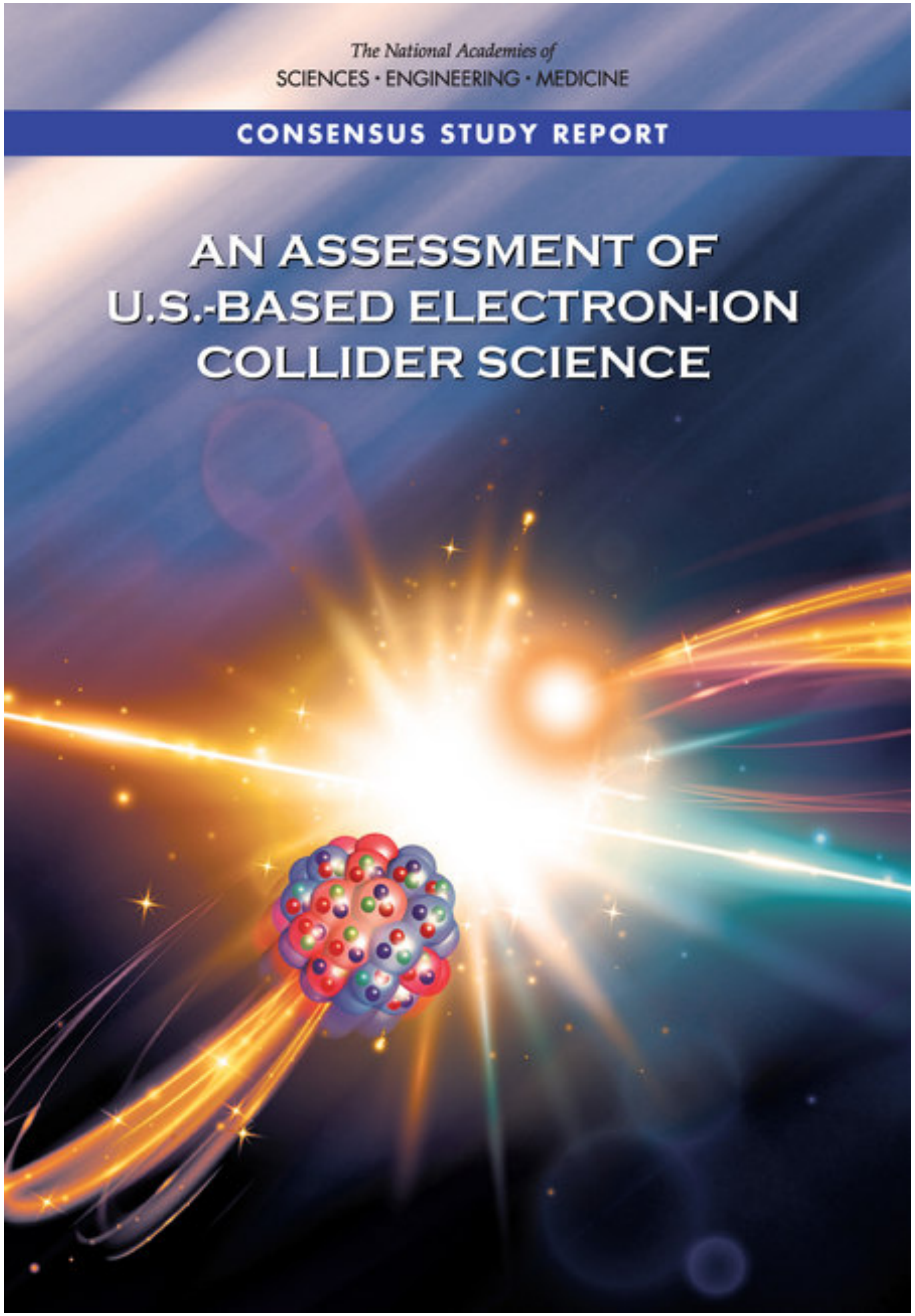
Finding 6: The current accelerator R&D program supported by the Department of Energy is crucial to addressing outstanding design challenges.

Findings

Finding 7: To realize fully the scientific opportunities an EIC would enable, a theory program will be required to predict and interpret the experimental results within the context of QCD, and further, to glean the fundamental insights into QCD that an EIC can reveal.

Finding 8: The U.S. nuclear science community has been thorough and thoughtful in its planning for the future, taking into account both science priorities and budgetary realities. Its 2015 Long Range Plan identifies the construction of a high luminosity polarized Electron Ion Collider (EIC) as the highest priority for new facility construction following the completion of the Facility for Rare Isotope Beams (FRIB) at Michigan State University.

Finding 9: The broader impacts of building an EIC in the U.S. are significant in related fields of science, including in particular the accelerator science and technology of colliders and workforce development.

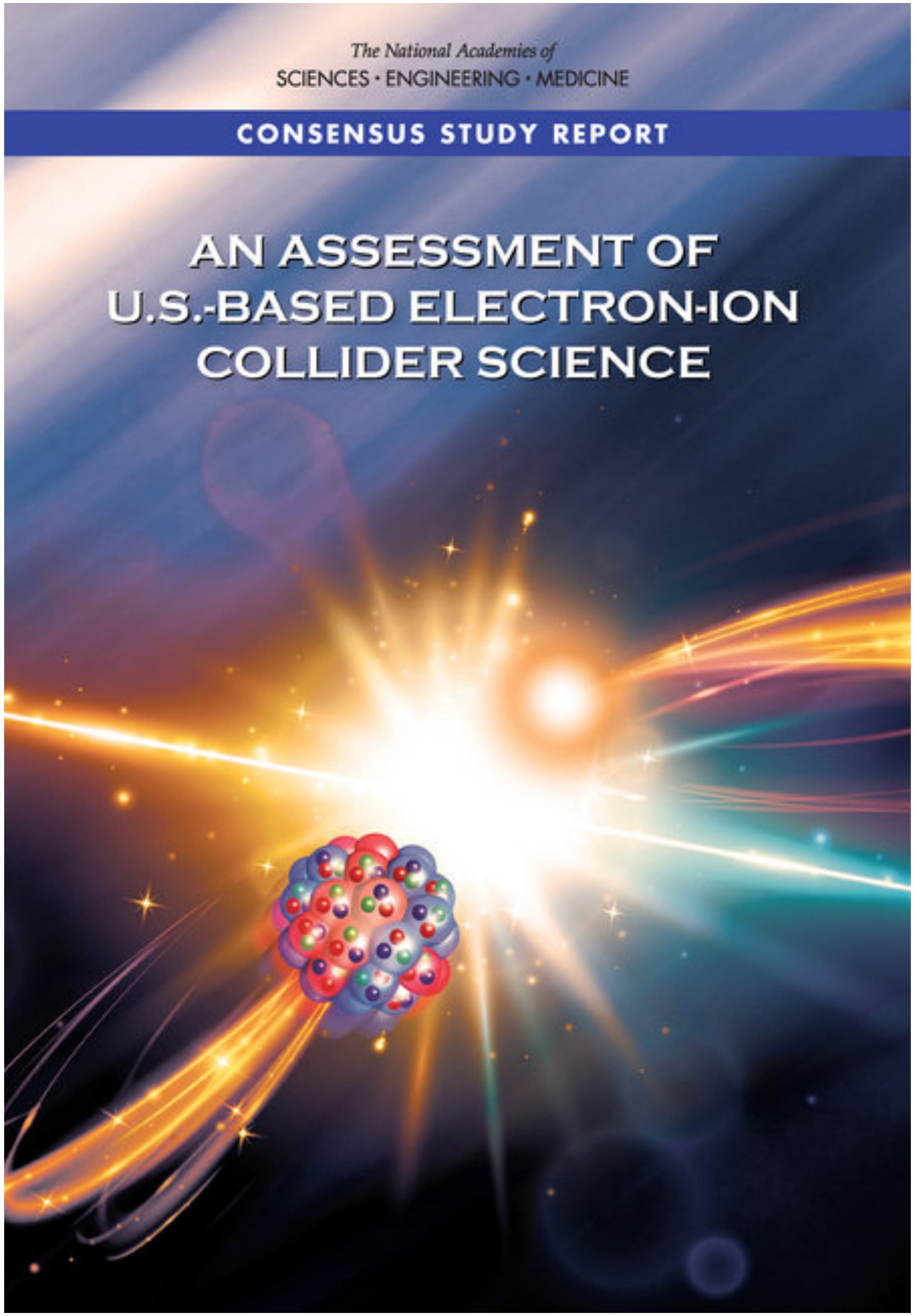


The committee *unanimously* finds that the science that can be addressed by an EIC is *compelling, fundamental, and timely.*

The *unanimous* conclusion of the Committee is that an EIC, as envisioned in this report, would be a *unique facility in the world that would boost the U.S. STEM workforce and help maintain U.S. scientific leadership in nuclear physics.*

The project is strongly supported by the nuclear physics community.

The technological benefits of meeting the accelerator challenges are enormous, both for basic science and for applied areas that use accelerators, including material science and medicine.



The committee *unanimously* finds that the science that can be addressed by an EIC is *compelling, fundamental, and timely.*

The *unanimous* conclusion of the Committee is that an EIC, as envisioned in this report, would be a *unique facility in the world that would boost the U.S. STEM workforce and help maintain U.S. scientific leadership in nuclear physics.*

The project is strongly supported by the nuclear physics community.

The technological benefits of meeting the accelerator challenges are enormous, both for basic science and for applied areas that use accelerators, including material science and medicine.

Thank you for your attention