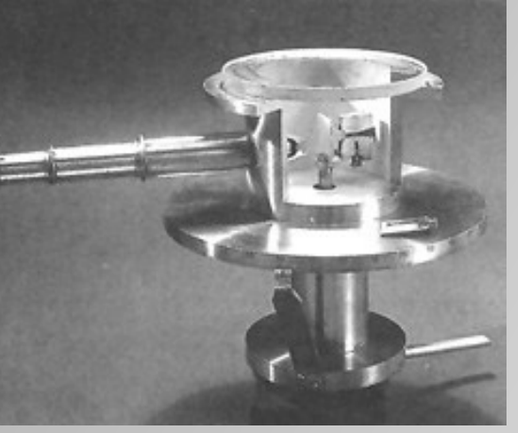

Office of Science
U.S. Department of Energy

~10^{-10} m
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~10^{-14} m
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< 10^{-18} m

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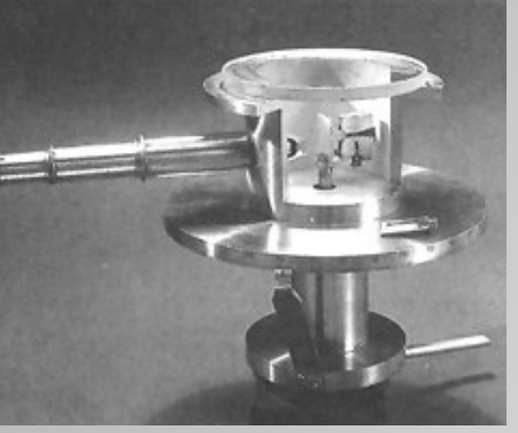
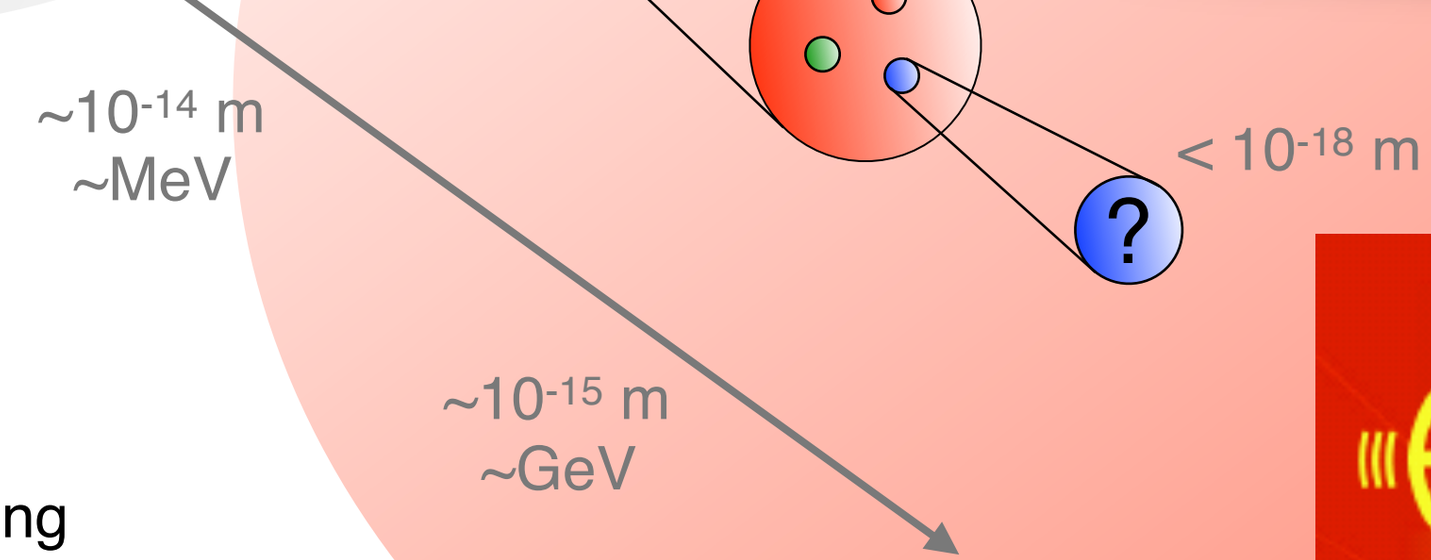
RHIC and AGS Users' Meeting
BNL, Upton, NY - June 15, 2018



U.S.-Based Electron Ion Collider Science Assessment
an ongoing study by the National Academies

Ernst Sichtermann (Lawrence Berkeley National Laboratory)



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The short version

"Until the report is publicly released…" **its contents are confidential.**

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The content, findings, recommendations etc. are thus for another day.

The short version and an outline for the next 18 slides

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The content, findings, recommendations etc. are thus for another day.

The remainder of this talk is based only on *publicly available* materials:

- Path to the NAS EIC Science Assessment (abbreviated version)
- NAS studies, process and stages

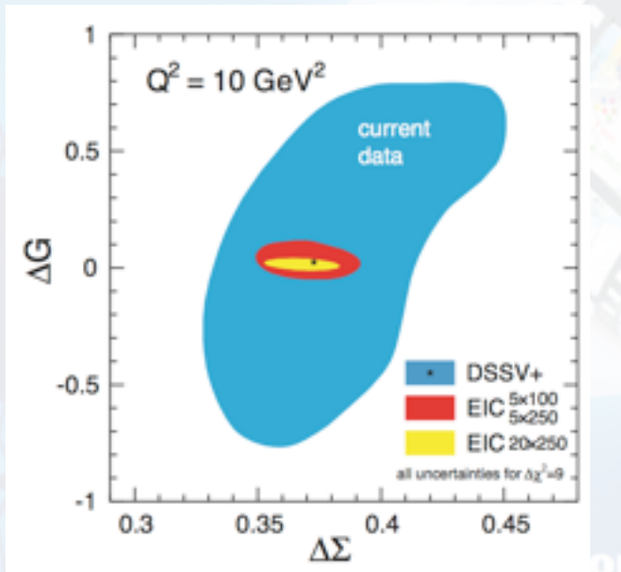
  EIC Science Assessment specifics
- Closing comments

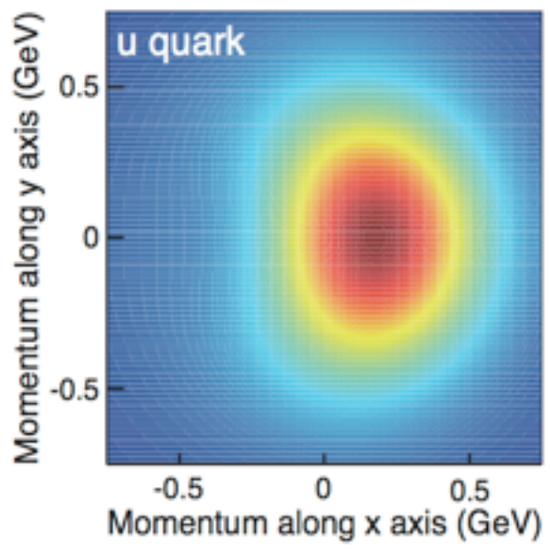
The EIC White Paper - Three Key Questions

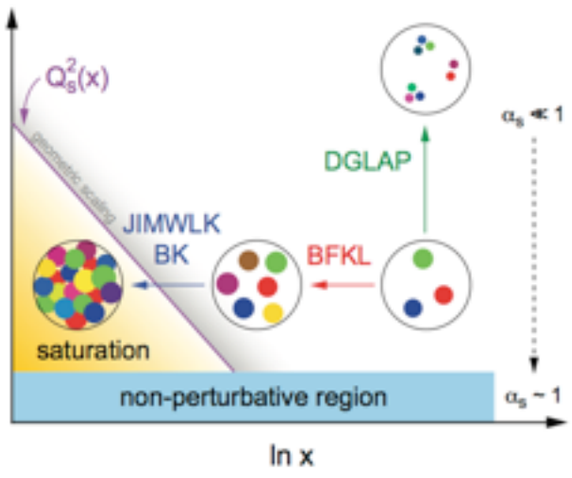
Eur. Phys. J. A52 (2016) no.9, 268

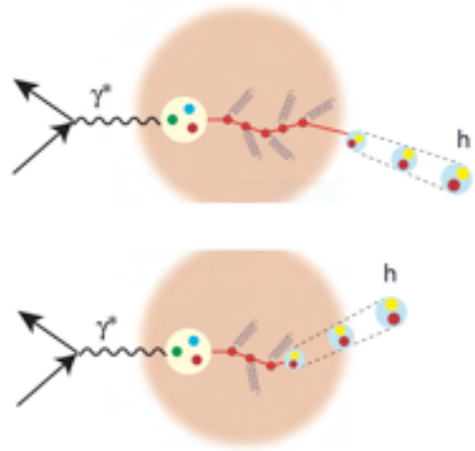
- *How are the sea quarks and gluons, and their spins, distributed in space and momentum inside the nucleus?*
- *Where does the saturation of gluon densities set in?*
- *How does the nuclear environment affect the distribution of quarks and gluons and their interactions in nuclei?*

The EIC White Paper - Four Key Science Figures







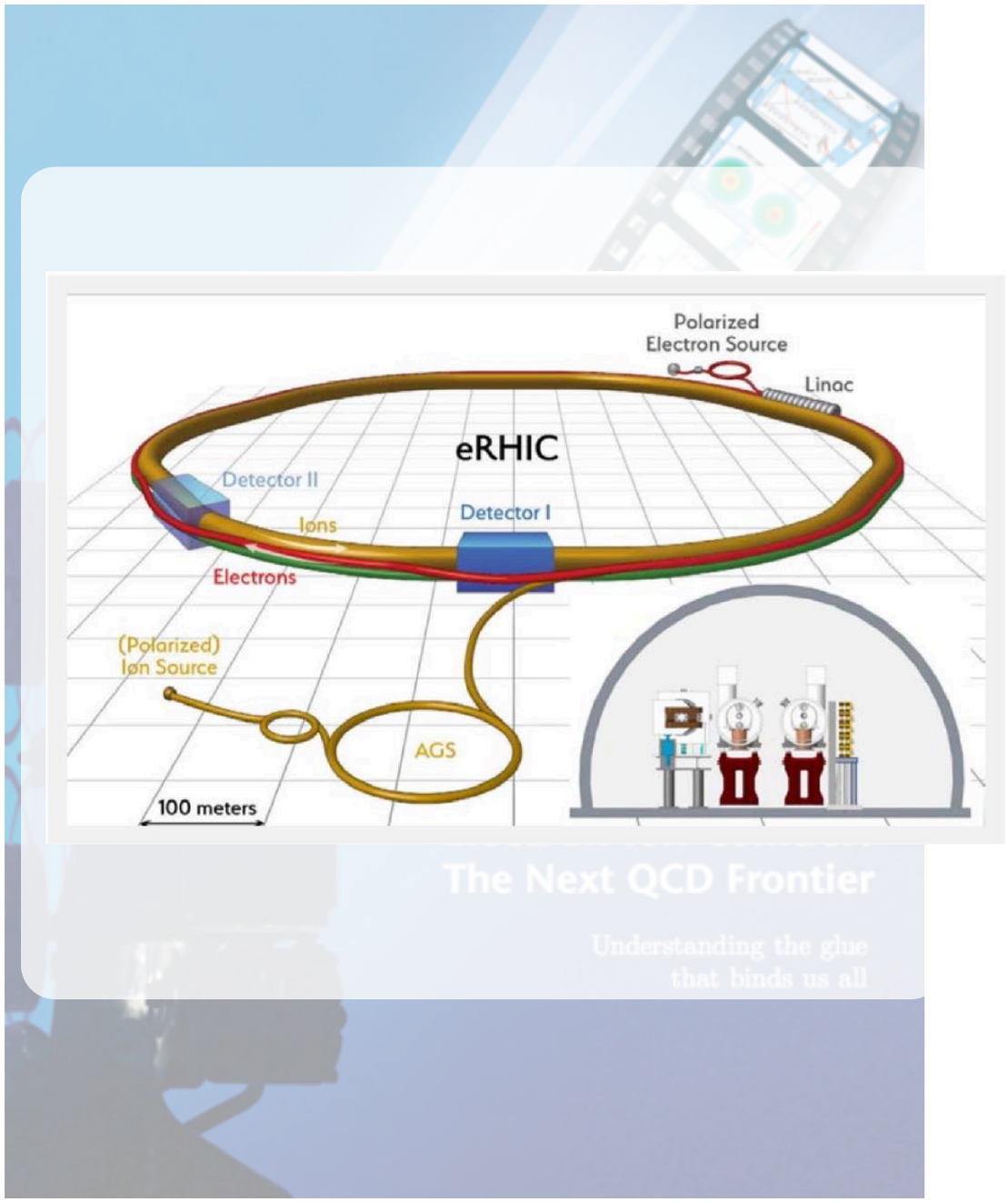


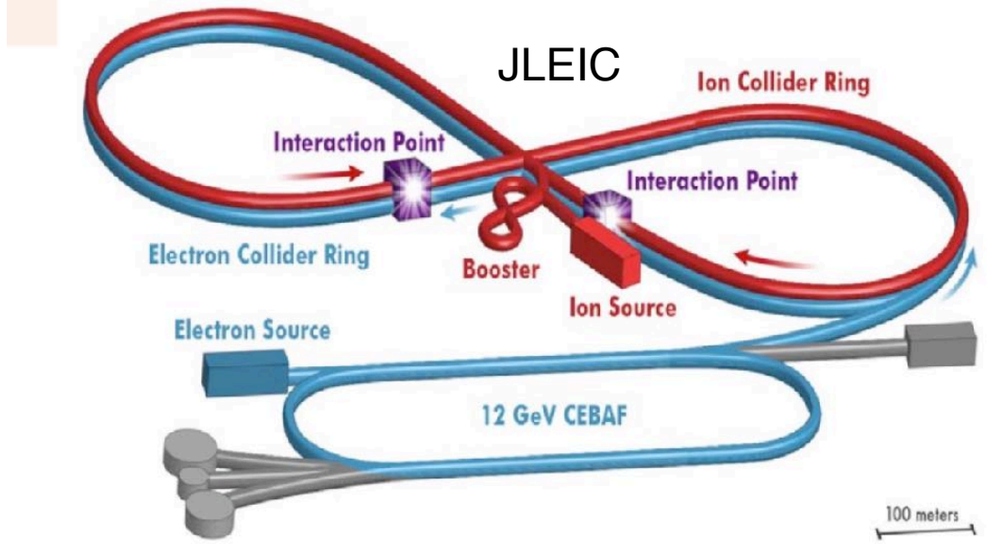
Nuclear Physics enabled by EIC **beam** energy, intensity, polarization, and species,

detector capabilities,

theory

The EIC White Paper - Two Facility Options





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

theory

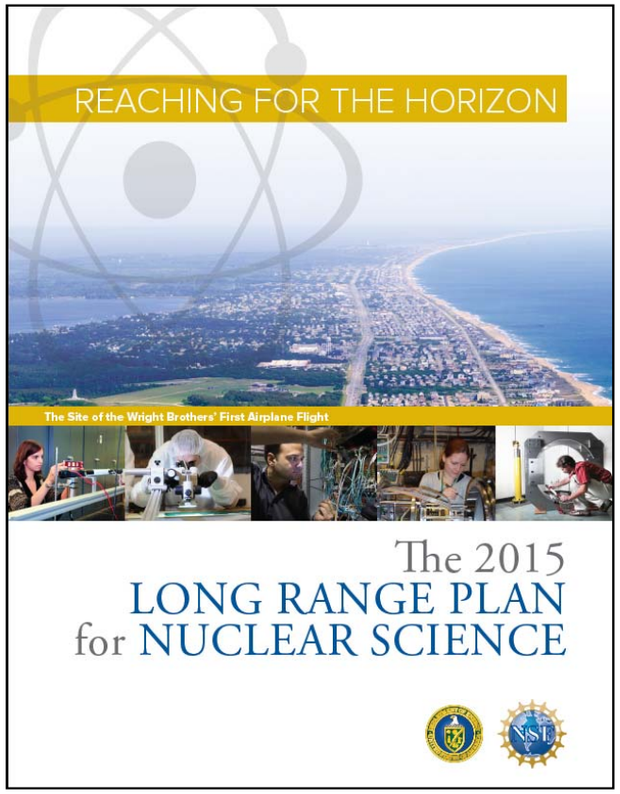
From: *DOE Office of Nuclear Physics Overview,* Dr. Tim Hallman, NSAC, March 2016

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/

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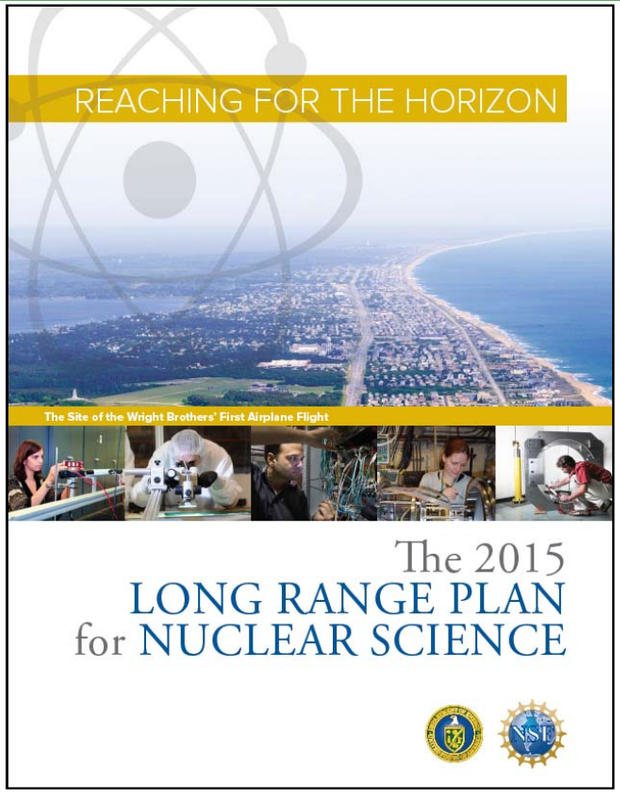

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Next Formal Step on the EIC Science Case

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.

Mail reviews received; proposal approved for funding in PAMS; PR package in PAMS being processed.

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

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"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 and Medicine

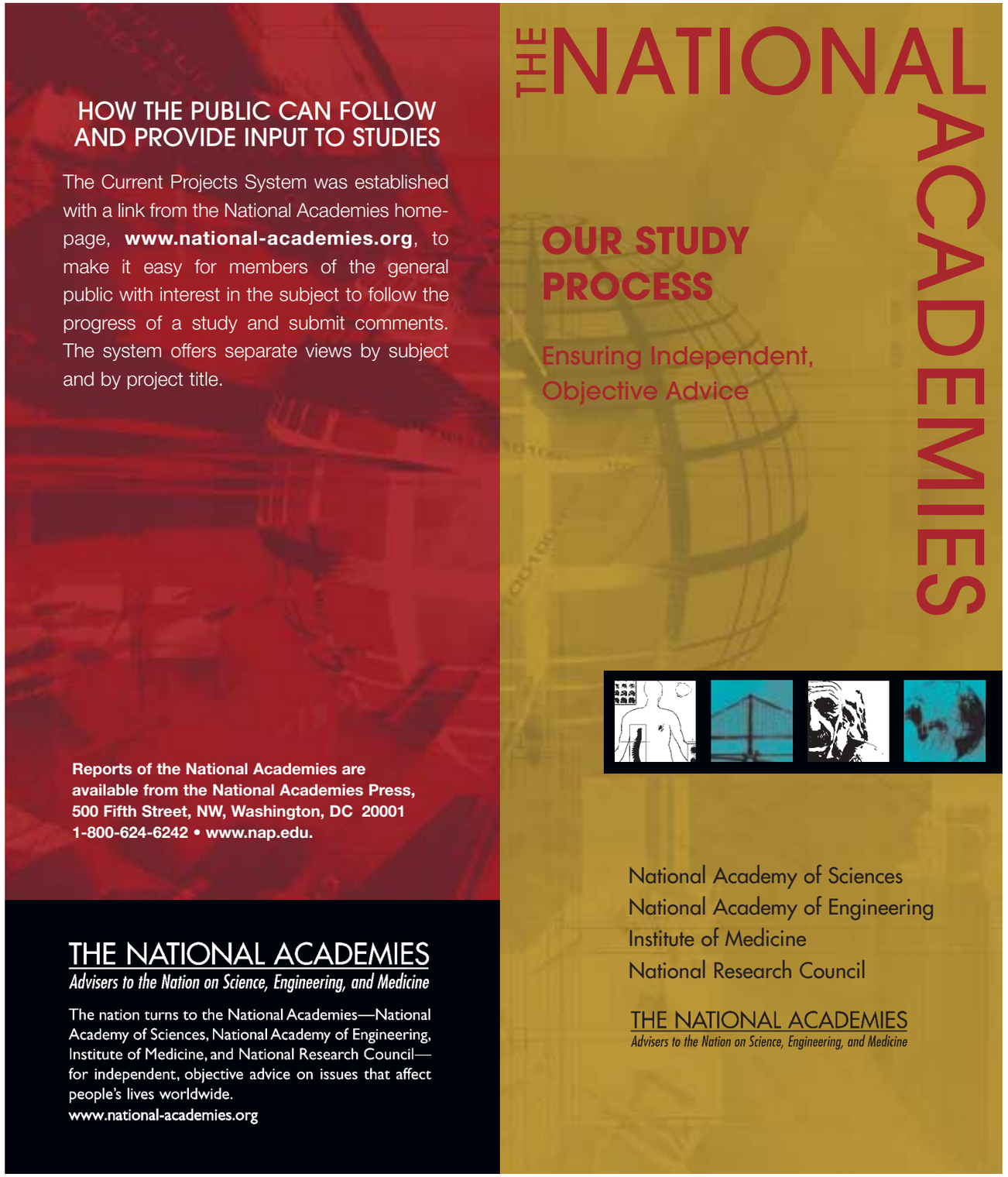
The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

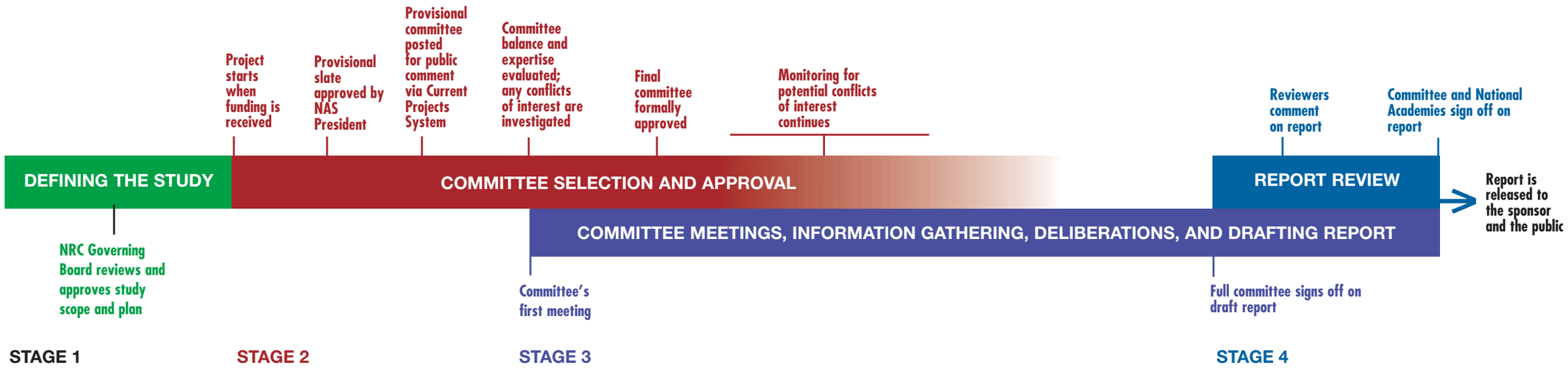
The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

The National Academies - Studies



http://www.nationalacademies.org

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.

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

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?*

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

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, associate chief scientist for Laboratory Directed R&D 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

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

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 two committee teleconferences

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
	9:15	National Academies basics	Andrea Peterson, BPA program officer
	9:30	Bias and conflict	David Lang, Study Director
	10:30	Discussion: statement of task	
open	11:30	European perspectives on an EIC facility	Peter Braun-Munzinger, GSI, committee member
	13:00	The 2015 NSAC Long Range Plan	Donald Geesaman, Argonne National Laboratory
	13:45	EIC R&D Community Review Summary	Kevin Jones, Oak Ridge National Laboratory
	14:30	Discussion with Congressional Staff	Adam Rosenberg, House S&T Comm., Energy Subcomm.
	15:00	Discussion with NSF Physics	Denise Caldwell, NSF PHY
	15:30	RHIC Cold QCD Plan for 2017 to 2023	Christine Aidala, U. of Michigan, committee member
	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
	10:00	Continued discussion with DOE	
	11:00	Discussion with DOE Office of Science	Steve Binkley, DOE Office of Science
	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	
	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
	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.
	11:15	EIC accelerator technology development	Lia Merminga, SLAC, committee member
	13:00	EIC computing challenges and opportunities	Ernst Sichtermann, LBNL, committee member
	13:45	Open discussion of EIC physics: energies, crucial experiments, etc.	
closed	15:00	Review of chapters 3, 4, and 5	
	17:00	Initial discussion of findings and recommendations	

September 12, 2017

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

Closing Comments - U.S.-Based EIC Science Assessment

"Until the report is publicly released…" **its contents are confidential.**

This said, I hope to have given you a flavor of the process and the study status from publicly available resources.

With deep gratitude to:

Many colleagues who developed the case for the EIC over many years,

The DOE, sponsor of this study,

Speakers and participants in our open meeting sessions,

Reviewers for their thoughtful comments,

NAS staff, in particular James Lancaster, David Lang, Christopher Jones, Henry Ko, Andrea Peterson, and Linda Walker,

Committee co-chairs and fellow members.

Thank You and Stay Tuned!