

# NSAC Long Range Plan Update

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July 26, 2023

# The Charge to the Nuclear Science Advisory Committee



U.S. Department of Energy  
and the  
National Science Foundation



July 11, 2022

Professor Gail Dodge  
Chair, DOE/NSF Nuclear Science Advisory Committee  
College of Sciences  
Old Dominion University  
4600 Elkhorn Avenue  
Norfolk, Virginia 23529

Dear Professor Dodge:

This letter requests that the Department of Energy (DOE)/National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) conduct a new study of the opportunities and priorities for United States nuclear physics research and recommend a long-range plan (LRP) that will provide a framework for coordinated advancement of the Nation's nuclear science research programs over the next decade.

The new NSAC LRP should articulate the scope and the scientific challenges of nuclear physics today, what progress has been made since the last LRP, and the impacts of these accomplishments both within and outside the field. It should identify and prioritize the most compelling scientific opportunities for the U.S. nuclear physics program to pursue over the next decade (fiscal year (FY) 2023-2032) and articulate its potential scientific impact. Further, a nationally coordinated strategy for the use of existing and planned capabilities, both domestic and international, and the rationale for new investments should be articulated. To be most helpful, the LRP should indicate what resources and funding levels would be required, including construction of new facilities, mid-scale instrumentation, and Major Items of Equipment, to maintain a world-leadership position in nuclear physics research. The LRP should also describe the potential impacts and priorities under constant level of effort budgets, 2 percent growth per year using the FY 2022 enacted funding level as a reference.

The extent, benefits, impacts, and opportunities of international coordination and collaborations afforded by current and planned major facilities and experiments in the United States (U.S.) and other countries, and of interagency coordination and collaboration in crosscutting scientific opportunities identified in studies involving different scientific disciplines should be specifically addressed and articulated in the report. Further, the scientific impacts of synergies with neighboring research disciplines and further opportunities for mutually beneficial interactions with outside disciplines should be discussed. The document should also articulate how efforts to promote and sustain a diverse, equitable, and inclusive nuclear science workforce will be fully integrated into every aspect of the vision for the future of U.S. nuclear science.

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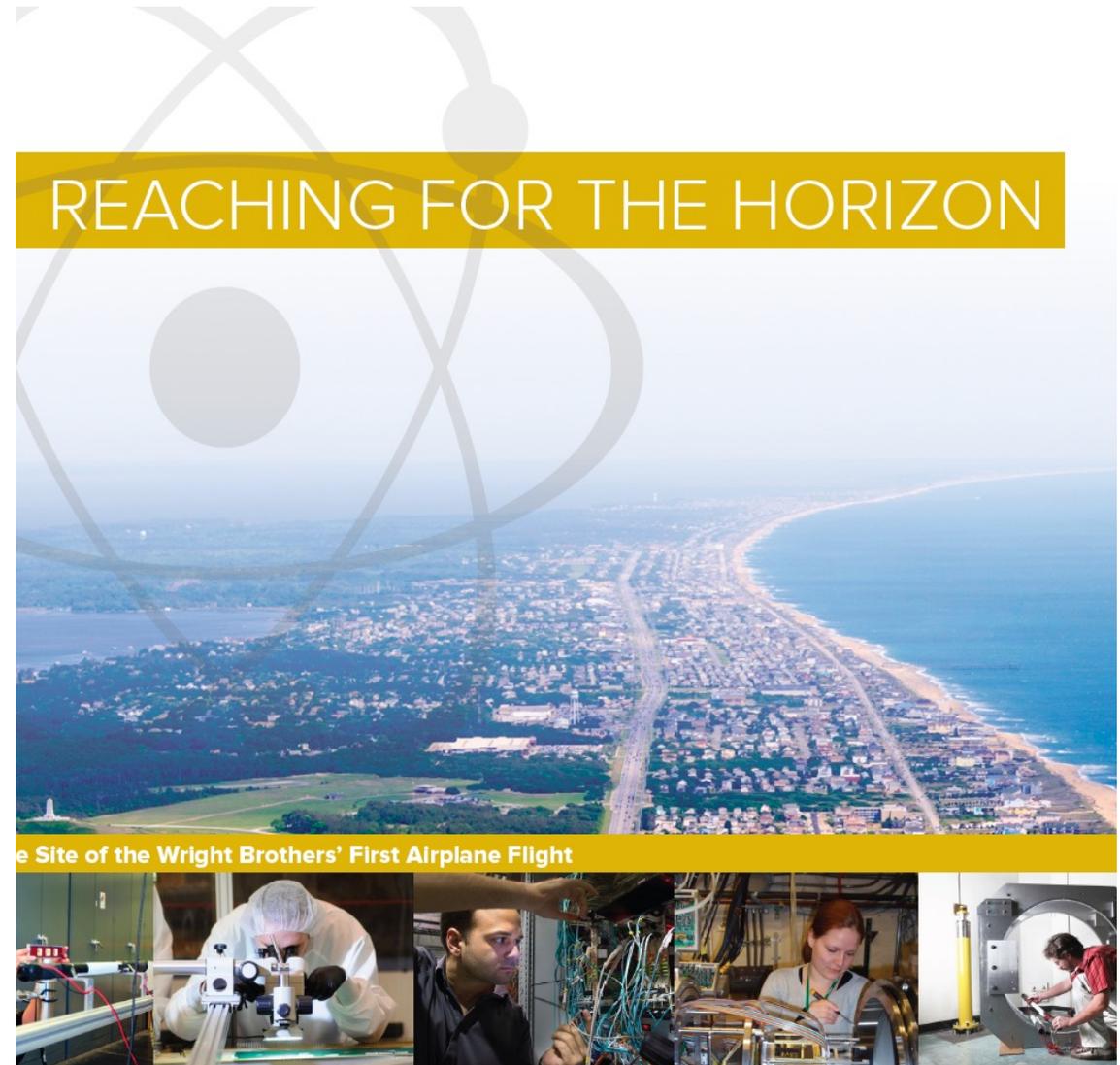
# The LRP Process

- This letter sets in motion a year long process that culminates in an in-person meeting of the NSAC LRP Working Group.
- At this meeting, the Working Group uses input from the community to formulate a prioritized list of recommendations.
- These recommendations serve as input to the Office of Nuclear Physics at the Department of Energy and the National Science Foundation.
- The last NSAC LRP took place in 2015.
- To orient ourselves let's look at the 2015 LRP recommendations.

# 2015 LRP Recommendations

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- 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.
- II. We recommend the timely development and deployment of a U.S. led ton scale neutrinoless double beta decay experiment.
- III. We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.
- IV. We recommend increasing investment in small-scale and mid-scale project and initiatives that enable forefront research at universities and laboratories.



# Before we get too far....

- I would love to use this meeting to discuss the 2023 recommendations from this process. However ...
- The chair of NSAC has asked us to embargo the discussions of the closed sessions and the final recommendations until they are officially released later this fall (date to be decided).
- Instead, I will try to explain a bit the process of the committee to give context to the recommendations when they are released.

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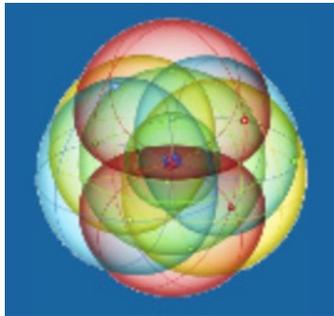


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# US Nuclear Physics Community

| SUB-FIELD   | SCIENTIFIC QUESTIONS  |
|---|---|
| Hot and Cold QCD                                      | <ul style="list-style-type: none"><li>• How do the properties of bound states, such as mass and spin, emerge from partonic DOF?</li><li>• What are the spin, spatial and momentum distributions of the quarks and gluons inside the nucleon?</li><li>• How do the fundamental interactions between quarks and gluons lead to the perfect fluid?</li><li>• What are the transport properties of the QCD fluid ?</li><li>• What is the correct phase diagram of nuclear matter?</li></ul> |
| Nuclear Structure, Reactions and Astrophysics (NSRA)  | <ul style="list-style-type: none"><li>• How does nuclear structure and reactions emerge from the nuclear force that binds nucleons into stable nuclei and rare isotopes?</li><li>• What are the limits of nuclear existence?</li><li>• What are the astrophysical origins of the elements and how did the chemical evolution proceed?</li><li>• What is the nature of neutron stars?</li></ul>  |
| Fundamental Symmetries, Neutrons and Neutrinos (FSNN) | <ul style="list-style-type: none"><li>• Why is there more matter than anti-matter?</li><li>• Is the neutrino its own anti-particle?</li><li>• What is the origin of neutrino mass?</li><li>• What is Dark Matter made of?</li><li>• Beyond-the-Standard Model physics that can be probed in precision experiments.</li></ul>  |

# Fall 2022 - Town Hall Meetings



- QCD Sept 23-25 @ MIT
  - <https://indico.mit.edu/event/538/>
  - 9 white papers submitted
- FSNN Dec 13-15 @ UNC Chapel-Hill
  - <https://indico.phy.ornl.gov/event/209/>
  - 20 white papers submitted
- NSRA Nov 14-16 2022 @ ANL
  - <https://indico.phy.anl.gov/event/22/>
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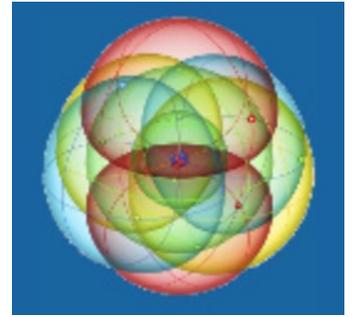
Town hall meetings were a forum for talks and discussions within the community. The conveners of each town hall then produced a summary white paper that included ranked priorities from each community (see links above).



# QCD Recommendations

- 1. Capitalizing on past investments.** (Town Hall votes 335/3/4)
  - Run the extensive 12 GeV program @ JLAB
  - Complete the RHIC science mission
  - Maintain leadership in the heavy ion program at the LHC
  - Expand base funding in nuclear theory
- 2. We recommend expedition completion of the EIC as the highest priority for facility construction.** (Town Hall votes 325/10/7)
  - Research workforce for ePIC
  - EIC Theory Alliance
- 3. Workforce and Conduct**
  - Increased investment in a robust and diverse STEM workforce, this includes our international collaborators.
- 4. Computing**
  - Increased investment in high input and high throughput computing for nuclear experiment and theory

# NSRA Recommendations



1. The highest priority for low-energy nuclear physics and nuclear astrophysics research is to maintain U.S. world leadership in nuclear science by capitalizing on recent investments.
  - Build robust and diverse workforce
  - Optimal operation of FRIB and ATLAS
  - Investments in university facilities
  - Support FRIB theory alliance
2. The science case for an energy upgrade of FRIB (*facility for Rare Isotope Beams*) to 400 MeV/u is compelling. We strongly endorse starting the upgrade during the upcoming LRP period to harness its significant discovery potential.
3. We strongly support enhancing opportunities in computational nuclear science to accelerate discoveries and maintain US leadership
4. Investments in interdisciplinary research centers
5. Support for compilation, evaluation, dissemination and preservation of nuclear structure and reactions data.

# FSNN Recommendations

1. We recommend the timely construction of ton-scale neutrinoless double beta decay experiments, each using a different isotope, and continued support of the broader research program.
2. We recommend a suite of targeted experiments aimed at challenging the Standard Model and uncovering new phenomena.
  - Neutron EDM, MOLLER@ JLAB, Project 8, PIONEER, SOLID@JLAB
3. We recommend new investments aimed at enlarging and supporting the nuclear theory efforts in FSNN.
4. We recommend enhanced investment in the growth and development of a diverse workforce to maximize our opportunities for scientific discovery and increase its impact in society.

# The 2023 LRP Process

- These sub-field priorities, along with with the white papers from the community are the input to the LRP working group.
- The process of developing the NSAC LRP priorities and language for the final recommendations is intense. The discussions are frank and open, but always thoughtful and collegial.
- Each WG member has dual loyalties – to their subfield(s) and to the entire NP community as a whole.
- At the end of the meeting the working group unanimously endorsed the process and the outcomes.
- The final recommendations and accompanying text will be documented and posted on the <https://science.osti.gov/np/nsac/Reports> this fall – date to be announced.

# Thoughts about the EIC in the LRP

The EIC project has made huge strides since the last LRP process.

This is in no small part due to :

1. Smart text and strong recommendations in the past LRP documents.
2. Strong and deft leadership at DOE, NSF and the partner labs.
3. A dedicated and united EIC community

I am very optimistic about our future!