

2007 Nuclear Physics Long Range Plan and DUSEL

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on behalf of NSAC
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2007 Nuclear Physics Long Range Plan

The Nuclear Science Advisory Committee (NSAC) with participation by the APS Division of Nuclear Physics (DNP) develops a long range plan every ~5 years.

(http://www.sc.doe.gov/np/nsac/docs/NSAC%20Charge_LRP.pdf)

- **Process:**

- DNP organized town meetings, culminating in white papers
 - Nuclear Structure and Astrophysics
 - Neutrinos and Symmetries
 - Phases of QCD matter
 - QCD and Hadron Physics
- NSAC Role:
 - Establish Working Group, obtain town meeting white papers
 - Working Group develops recommendations
 - Produces Report (Final report by end of 2007)

LRP Recommendation I

We recommend completion of the 12 GeV Upgrade at Jefferson Lab. The Upgrade will enable new insights into the structure of the nucleon, the transition between the hadronic and quark/gluon descriptions of nuclei, and the nature of confinement.

LRP Recommendation II

We recommend construction of the Facility for Rare Isotope Beams, FRIB, a world-leading facility for the study of nuclear structure, reactions and astrophysics. Experiments with the new isotopes produced at FRIB will lead to a comprehensive description of nuclei, elucidate the origin of the elements in the cosmos, provide an understanding of matter in the crust of neutron stars, and establish the scientific foundation for innovative applications of nuclear science to society.

LRP Recommendation III

We recommend a targeted program of experiments to investigate neutrino properties and fundamental symmetries. These experiments aim to discover the nature of the neutrino, yet unseen violations of time-reversal symmetry, and other key ingredients of the new standard model of fundamental interactions. Construction of a Deep Underground Science and Engineering Laboratory is vital to US leadership in core aspects of this initiative.

LRP Recommendation IV

The experiments at the Relativistic Heavy Ion Collider have discovered a new state of matter at extreme temperature and density—a quark-gluon plasma that exhibits unexpected, almost perfect liquid dynamical behavior. We recommend implementation of the RHIC II luminosity upgrade, together with detector improvements, to determine the properties of this new state of matter.

2007 LRP and DUSEL

- **Fundamental Symmetries and Neutrinos**

A “New Standard Model Initiative” that represents one of the major thrusts in nuclear science for the next decade seeks to address three key science questions:

- What is the nature of the neutrinos, what are their masses, and how have they shaped the evolution of the universe?
- Why is there now more matter than antimatter in the universe?
- What are the unseen forces that were present at the dawn of the universe but disappeared from view as it evolved?

“A vital component of U.S. leadership in this field will be the construction of a Deep Underground Science and Engineering Laboratory in the United States, together with the suite of low-background experiments.”

2007 LRP & Experiments at DUSEL

- As part of the “New Standard Model Initiative”
 - A program to the search for neutrinoless double beta decay in atomic nuclei
 - Experiments aimed at studying solar neutrinos, supernovae neutrinos, geoneutrinos,
 - Nuclear physicists involved in dark matter experiments
- As part of the Physics of Nuclei and Nuclear Astrophysics
 - a low-energy accelerator to study rare processes and cross-sections

Spare slides

The Science – Fundamental Symmetries and Neutrinos

- What is the nature of the neutrinos, what are their masses, and how have they shaped the evolution of the universe? $0\nu\beta\beta$ decay, θ_{13} , β decay, ...
- Why is there now more matter than antimatter in the universe? *EDM, DM, LFV, $0\nu\beta\beta$, θ_{13} ...*
- What are the unseen forces that were present at the dawn of the universe but disappeared from view as it evolved? *Weak decays, PVES, g_{μ}^{-2} , ...*

The Science – Physics of Nuclei and Nuclear Astrophysics

- **What is the nature of the nuclear force that binds protons and neutrons into stable nuclei and rare isotopes?**
- **What is the origin of simple patterns in complex nuclei?**
- **What is the nature of neutron stars and dense nuclear matter?**
- **What is the origin of the elements in the cosmos?**
- **What are the nuclear reactions that drive stars and stellar explosions?**

LRP Working Group members:

Elizabeth Beise	Edward Hartouni	Lia Meringa	Susan Seestrom
Douglas Bryman	Ulrich Heinz	Curtis Meyer	Bradley Sherrill
Adam Burrows	David Hertzog	Zein-Eddine Meziani	James Symons
Lawrence Cardman	Roy Holt	Richard Milner	Tony Thomas
Richard Casten	Calvin Howell	Berndt Mueller	Robert Tribble
Gordon Cates	Barbara Jacak	Witold Nazarewicz	Thomas Ullrich
Jolie Cizeweski	Peter Jacobs	Heino Nitsche	Ubirajara van Kolck
David Dean	Robert Janssens	Margaret Norris	Steven Vigdor
Abhay Deshpande	Xiandong Ji	Michael Ramsey-Musolf	Michael Wiescher
Charlotte Elster	David Kaplan	Winston Roberts	John Wilkerson
Rolf Ent	Dmitri Kharzeev	David Robertson	Boleslaw Wyslouch
Bradley Filippone	Roy Lacey	Hamish Robertson	Sherry Yennello
Stuart Freedman	David Lee	Thomas Roser	Glenn Young
Thomas Glasmacher	I-Yang Lee	Guy Savard	William Zajc
Timothy Hallman	Naomi Makins	Hendrik Schatz	

LRP Sections

- Overview (R. Tribble)
- Science
 - QCD and Phases of Matter (R. Lacey)
 - QCD and Hadron Structure (R. Ent)
 - Emerging QCD Frontier (T. Ulrich)
 - Nuclei: From structure to Exploding Stars (D. Dean)
 - In Search of the New Standard Model (M. Ramsey-Musolf)
- International Facilities/Collaborations (X. Ji)
- Facilities and Equipment (I.-Y. Lee)
- Education (P. McMahan)
- Connections to other Fields (W. Nazarewicz)
- Applications (S. Seestrom)
- Recommendations (R. Tribble)
- Resources (R. Tribble)

Assumptions in the Plan

[priorities set]

- DOE NP Budget doubles in 10 years
- 1% over C.E. in research budgets
- C.E. for operations
- No major Low Energy upgrades
- DUSEL + major equipment funding – NSF
- GRETA not fully funded
- RHIC II partial support from RHIC ops.