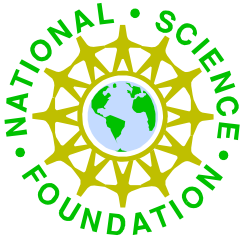
Update from NSAC

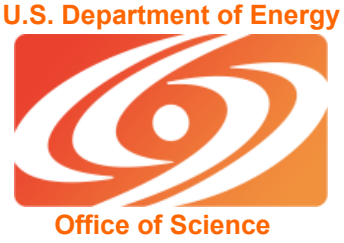
IUPAP D9

July, 2011

Susan J. Seestrom

NSAC Chair





2011 NSAC Members

Jeffrey Binder *(ORNL)*
Jeffery Blackmon *(LSU)*
Gail Dodge *(ODU)*
Richard Furnstahl *(Ohio)*
Alexandra Gade *(MSU)*
Carl Gagliardi *(TAMU)*
Susan Gardner *(Kentucky)*
Peter Jacobs *(LBNL)*
David Kaplan *(INT/UW)*
Dimitri Kharzeev *(BNL)*
Josh Klein *(Penn)*
Karlheniz Langanke *(GSI)*
Zheng-Tian Lu *(ANL)*

Allison Lung *(TJNAF)*
Curtis Meyer *(CMU)*
Julie Velkovska *(Vanderbilt)*
Susan Seestrom *(LANL)*

Bob Tribble (DNP)
Michael Bronikowski *(ACS)*
Robert Atcher (SNM)

NSAC has had two active Charges this year

- Public Access to Research Results – sub-committee **Chair Allena Opper** *(George Washington) – recently completed*

- Neutron Charge – sub-committee **Chair Krishna Kumar** *(U. Mass.)* *(acting NSAC Chair Peter Jacobs)*

Public Access to Research Results

- America COMPETES Reauthorization Act of 2010 addresses public access to research results, particularly in the forms of scholarly publications and digital data.

- Charge from DOE Office of Science: "Identify and assess current practices, policies and procedures to research results with report by 1-jul-2011."

(Public = general public AND scientists outside the group producing the research)

PARR Subcommittee organized around research areas

- Jlab: Curtis Meyer *(CNU)*
- LHC: Julia Velkovska (Vanderbilt)
- Neutrinos: Josh Klein *(U Penn)*
- Neutron Physics: Fred Wietfeldt *(Tulane)*
- Low Energy User Facilities: Michael Thoennessen *(MSU/NSCL)*
- Small groups and single investigators: Mark Riley *(FSU)* and Carl Brune *(OU)*
- RHIC: Helen Caines *(Yale)*
- Theory: Paul Mackenzie *(FNAL)* and Scott Pratt *(MSU)*
- **Chair: Allena Opper** *(George Washington)*

PARR - Status

- Report was developed based on information obtained from the broader nuclear physics community
- Report delivered to NSAC prior to Jun 30-July 1 meeting
- Approved July 20 after minor modifications by email vote

PARR Findings

- The field of nuclear physics publishes in scholarly journals and uses the publication policies of those journals as well as archives and databases to make its research results available to the public
- Pre-final data in the form of preliminary data, theses, conference presentations, and reports are generally publicly available on pre-print servers (e.g. arXiv and CERN Document Server), conferencewebsites, and published proceedings, and, in some cases, in collaboration talk data-bases.
- Requests for digitized detector signals, processed detector signals, and associated computer codes by others not involved in producing them are in general rare, and because of the complexities in using these data, usually not fulfilled.
- Small focused workshops (such as those at the Institute for Nuclear Theory), summer schools, collaboration meetings, and conferences play a crucial role in disseminating and extending research results.

Neutron Charge

- Background
  - 2003 subcommittee recommended launching of nEDM and FNPB
  - 2007 LRP: Neutron physics part of FS Initiative
- Evaluate current and proposed research program
  - physics potential in the context of the larger fundamental symmetries subfield
  - scientific capabilities and specific opportunities
  - international context

Neutron Charge, continued

- Recommendations of priorities in context of
  - projected resources; constant level of effort at FY2011 levels
  - identify most compelling opportunities
  - spell out infrastructure and effort required
  - both US and international capabilities as backdrop
  - priorities for incremental investments beyond constant level
  - assessment of current scientific and technical workforce

Neutron Subcommittee Membership

Professor Hartmut Abele
Technische Universität Wien (Vienna)
Atominstitut der Österreichischen Universitäten

Professor Alejandro Garcia
Department of Physics
University of Washington

Professor John Hardy
Department of Physics & Astronomy
Texas A&M University

Professor Wick Haxton
Department of Physics
University of California, Berkeley

Professor David Hertzog
Department of Physics
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Dr. Peter Jacobs
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Professor Krishna S. Kumar, Chair
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University of Massachusetts, Amherst

Dr. Zheng-Tian Lu
Physics Division
Argonne National Laboratory

Professor Michael Ramsey-Musolf
Department of Physics
University of Wisconsin

Professor Michael Romalis
Department of Physics
Princeton University

Neutron Physics Themes

- nEDM experiment
  - compelling physics case in larger context
  - large fraction of funding and effort
- Weak Interactions with Neutrons
  - semi-leptonic weak interactions
    - lifetime is a fundamental parameter; current results inconsistent
    - correlations comprehensively probe neutron charged weak current: evaluate in larger context based on sensitivity to BSM physics
  - hadronic parity violation
    - fundamental description of non-leptonic weak interactions
    - connections to other important puzzles in nuclear physics

Overall experimental program, evaluate recent progress: degree of difficulty vs physics payoff

Activities to Date

- January to March: Preparations
  - Peter Jacobs (acting NSAC Chair) & Krishna Kumar (subcommittee Chair) assembled 10 member subcommittee
  - Subcommittee mapped out strategy
    - center work around 3 meetings
    - have regular teleconferences to discuss physics and priorities
    - First two meetings are "fact-finding": 1) nEDM 2) rest of program
    - the third meeting will be the resolution meeting: early June
- April 1 and 2: nEDM meeting
  - receive complete briefing from agencies on neutron program
  - 1.5 days of talks by nEDM collaboration describing physics, technical status and future plans
- April 15 and 16: Electroweak physics with neutron beams
  - US initiatives on lifetime, decay correlations, hadronic PV, interferometry
  - facilities perspectives from LANL, ORNL and NIST

Neutron EDM Overview

- **Physics Motivation for a neutron EDM**
  - *Search for a non-zero EDM: signature of T-violation*
  - *Search for new physics in early universe; explore baryogenesis scenarios*
  - *Fundamental test of the symmetries of the Standard Model*
- **Community Endorsement**
  - *2002 LRP and 2003 Neutron Subcommittee's strong support*
  - *Significant investments in R&D for next generation experiment*
  - *New beamline: FNPB at ORNL*
  - *Recommendation 3 in 2007 LRP singled out T-violation searches*
- **We find the motivation for sensitive EDM searches, including neutron EDM, to be as compelling as ever**

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Neutron EDM Priority

The successful completion of an nEDM experiment, the initiative with the highest scientific priority in US neutron science, would represent an impressive scientific and technical achievement for all of nuclear physics, with ramifications well beyond the field

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nEDM Overview

Findings

- **nEDM conceptual design is novel**
  - *large active volume: gain statistical sensitivity to 1-10x10^{-28} e-cm*
  - *several novel techniques to explore unknown new systematics*
  - *only concept aimed directly at exploring a new regime of sensitivity*
- **nEDM reach is nominally estimated at 4x10^{-28} e-cm**
  - *such reach would have profound impact beyond subfield even if negative*
  - *even if reach is ~10x10^{-28} e-cm, still worth doing at current scope so long as final results and publications are produced before 2025*
- **Design has progressed over last few years**
  - *Feasibility studies of physics concepts driving experimental design*
  - *several technical challenges have been resolved*
  - *First-pass engineering design*
- **International competition (ILL, PSI)**
  - *intermediate steps about an order of magnitude less sensitive (50x10^{-28})*
  - *however, estimated to have faster turnaround time (5 years)*
  - *in the 10 year time frame, they expect to compete at the same level*

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Current Status of nEDM

Findings

- **Significant further R&D is required**
  - *Fundamental physics concepts related to measurement techniques validated, but important details still being worked out*
  - *Several key aspects of the measurement technique remain unproven under true experimental conditions: HV breakdown limit, electric field monitoring, electrode coating, and total photoelectron yield per signal event*
- **The subcommittee feels that the collaboration needs:**
  - *A singular focus on outstanding R&D issues*
  - *Better coordination and communication across various teams*
  - *Improved support for large scale cryo-engineering*
  - *Improved communication and support from ORNL and LANL*

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After extensive deliberation of the progress and needs, the subcommittee formulated 6 recommendations to define a path forward

Recommendation 7

- **The neutron lifetime is a fundamental parameter**
  - *Impacts many areas of nuclear & particle physics and cosmology*
  - *Current thrust is to improve consistency to a precision of 1s*
  - *Well-motivated long term goal is to achieve a precision of 0.1 s*

7) We recommend that high priority be given to acquiring new data with the cold beam based lifetime measurement at NIST, following its planned improvements.

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- **Primary findings**
  - *A robust beam-based lifetime measurement at 1s precision is very timely*
  - *A magneto-gravitational trap using UCNs aims to reach 0.1s in the long term*
    - ***substantially more R&D would be required to demonstrate viability***
  - *The NIST effort using magnetically trapped UCNs is not competitive*
  - *The research groups would benefit from better communication & collaboration*
    - ***work together to chart out the most effective future R&D strategies***

Recommendation 8

- Neutron beta decay correlation coefficients fundamentally important

8) We recommend continued support for the UCNA experiment at LANL to improve the measurement precision of the A-coefficient by exploring a cost-effective and expeditious path to the original design sensitivity of 0.2%. We further recommend parallel R&D to develop the experiment to measure the a-coefficient with the Nab spectrometer, with a sensitivity of 0.1%.

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- Primary findings
  - *A- and a-coefficients measure g_A/g_V; impacts many subfields*
    - *strong motivation to pursue fractional accuracy of 0.1% in the long term*
    - *aCORN at NIST will provide an intermediate step (~ 1%)*
    - *Nab should provide an order of magnitude improvement in the long term*
  - *B- and b-coefficients have interesting sensitivity to BSM physics*
    - *R&D for future measurements could be explored; long term goal of 10^{-4}*
    - *Full-scale UCNB and abBA/Panda projects should be revisited in few years*

Recommendation 9

- **Hadronic Parity Violation: study strangeness-conserving hadronic weak interactions**
  - *Nuclear decay: dynamical suppression of long-range N-N weak interactions*
  - *NPDGamma at SNS seeks to confirm this interpretation*
    - ***fundamental strong-weak interaction interplay vs many-body dynamics***

9) We recommend strong support for the NPDGamma experiment as the highest priority measurement in hadronic parity-violation, and urge that every effort be made to reach the design goal, an asymmetry determination of one part in 10^8.

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- **Additional Findings**
  - *Other significant investments: await the success and outcome of NPDGamma*
    - ***n-^{3}He: development could continue as R&D; further technical review warranted***
    - ***n-^{4}He motivation and technical feasibility should be reviewed in a few years***

Completing the Charge

- Executive summary and draft findings and recommendations presented to NSAC June 30-July 1
- Final report due to NSAC in September

Long Range Plan?
(1983,1989, 1996, 2002, 2007)

Long range plans have been issued every ~6 years; preparation extends over about 2 years, so hypothetically: