Report of the NSAC Subcommittee on Scientific Facilities

R. P. Redwine, Chair

Gaithersburg, Maryland

March 8, 2013

Charge to NSAC

Please provide me with a short letter report that assigns each of the facilities to a category and provides a short justification for that categorization in the following two areas, but do not rank order the facilities:

1. The ability of the facility to contribute to world-leading science in the next decade (2014-2024). Please include both existing and proposed facilities/upgrades and consider, for example, the extent to which the proposed or existing facility or upgrade would answer the most important scientific questions; whether there are other ways or other facilities that would be able to answer these questions; whether the facility would contribute to many or few areas of research and especially whether the facility will address needs of the broad community of users including those supported by other Federal agencies; whether construction of the facility will create new synergies within a field or among fields of research; and what level of demand exists within the (sometimes many) scientific communities that use the facility. Please place each facility or upgrade in one of four categories: (a) absolutely central; (b) important; (c) lower priority; and (d) don't know enough yet.

2. The readiness of the facility for construction. For proposed facilities and major upgrades, please consider, for example, whether the concept of the facility has been formally studied; the level of confidence that the technical challenges involved in building the facility can be met; the sufficiency of R&D performed to date to assure technical feasibility of the facility; and the extent to which the cost to build and operate the facility is understood. Please place each facility in one of three categories: (a) ready to initiate construction; (b) significant scientific/engineering challenges to resolve before initiating construction; and (c) mission and technical requirement not yet fully defined.

Each SC program Associate Director will contact the Chair of his or her Federal Advisory Committee to discuss and coordinate the logistics of executing this change. We realize that the six SC programs will require somewhat different approaches, in part based on recent and future community planning activities. In addition, if you would like to discuss the charge further, please feel free to contact Pat Dehmer. (patricia.dehmer@science.doe.gov). Thank you for your help with this important task.

NSAC Subcommittee on Scientific Facilities Membership

Doug Beck, U. Illinois
Jim Beene, ORNL
Brian Cole, Columbia U.
Carl Gagliardi, TAMU
Don Geesaman, ANL (*ex officio*)
Rod Gerig, ANL
Keith Griffioen, William and Mary
Kim Lister, U. Mass. Lowell
Zein-Eddine Meziani, Temple U.
Bob Redwine, MIT (Chair)
Don Rej, LANL
Hamish Robertson, U. Washington
James Symons, LBNL

Timeline

Charge to NSAC - December 20, 2012

NSAC charge to Subcommittee and formulation of Subcommittee membership - January 2013

Meeting in Bethesda, MD - February 15-16, 2013

Draft report to NSAC - March 2, 2013

Final report to NSAC - March 8, 2013

Ground Rules

DOE NP provided their lists of current and anticipated facilities and upgrades, including comments.

The Subcommittee had the right to add or subtract facilities or upgrades.

The estimated cost of the facilities or upgrades must be $100M or above.

Important Resources

2007 Long Range Plan

2012 National Research Council report
Nuclear Physics: Exploring the Heart of Matter

2013 NSAC Subcommittee Report
Implementing the 2007 Long Range Plan

Subcommittee Actions

We advertised the request from the DOE Office of Science to the NP community and solicited input concerning facilities and upgrades that should be on the lists.

We received very few responses to this solicitation, but considered the responses received carefully.

The Subcommittee decided that the lists of present and proposed facilities and upgrades provided by DOE NP were the correct lists.

We invited spokespersons for the projects under consideration to present at the meeting on February 15 and 16 in Bethesda, MD.

Following this meeting, we formulated our recommendations in response to the charge and are submitting these recommendations to NSAC.

Current User Facilities

- Argonne Tandem Linear Accelerator System (ATLAS)
- Continuous Electron Beam Accelerator Facility (CEBAF)
- Relativistic Heavy Ion Collider (RHIC)

Proposed Facilities and Upgrades

- Electron-Ion Collider (EIC)
- Facility for Rare Isotope Beams (FRIB)
- Ton-scale Neutrino-less Double Beta Decay Experiment(s) (NLDBD)

Reminder: Rankings

"The ability of the facility to contribute to world-leading science in the next decade"

(a) absolutely central; (b) important; (c) lower priority; (d) don't know enough yet

"The readiness of the facility for construction"

(a) ready to initiate construction; (b) significant scientific/engineering challenges to resolve before initiating construction; (c) mission and technical requirements not yet fully defined

ATLAS

Physics goal is a description of all bound nuclear systems that has real predictive power and is based on models that use realistic nucleon-nucleon forces.

Data needed include precise measurements from near stability and results from both near the drip lines and in heavy nuclei.

ATLAS has the following key capabilities:

Intense stable beams

Light radioactive beams produced by “in-flight” methods

Neutron-rich beams of fission fragments

ATLAS is in great demand. About 400 users are actively involved this year.

We rank the Physics importance of ATLAS as “absolutely central”.

CEBAF

Physics goals include studies of nuclear structure, the structure of hadrons, quark confinement, quark hadronization, fundamental forces and symmetries, theory and computation, superconducting accelerator science, and related subjects such as medical imaging.

CEBAF uses parity-violating electron scattering to address a variety of important questions.

With upgrade in progress, the facility will operate with 4 experimental halls, each with unique capabilities.

12-GeV upgrade is 73% complete; first beam to Hall A in 2nd quarter of FY14.

Additional detector systems that are needed to fully exploit the physics potential include MOLLER (parity violation) and SoLID (high luminosity and acceptance).

A large user group has proposed and had approved 7 years worth of high-priority physics experiments using CEBAF.

We rank the Physics importance of CEBAF as “absolutely central”.

RHIC

Physics goals include study of the QCD phase transition in nuclear collisions over a wide range of initial temperature and baryon densities, and study of the spin content of the proton.

RHIC can collide a wide variety of ions from protons up to Uranium over a range of nucleon-nucleon center of mass energies from 7 to 200 GeV. RHIC is the only polarized hadron collider in the world.

RHIC is uniquely positioned to study the onset of deconfinement.

RHIC has a user community of more that 1000 physicists, including significant international representation.

Japan has made a substantial investment in RHIC, especially in the RHIC Spin program.

We rank the Physics importance of RHIC as “absolutely central”.

EIC

Physics goals include investigation of how quarks and gluons propagate in nuclear matter and join together to form hadrons. The EIC would be a unique and powerful microscope to provide a dynamical mapping of gluons in the nucleon and in nuclei. It would be a portal to an in-depth and fundamental understanding of gluonic matter and of QCD.

Two laboratories (Brookhaven National Laboratory and Jefferson Laboratory) are considering how to build an EIC, building on existing investments. The laboratories are working together and have made progress in exploring pre-conceptual design options and in defining the technical challenges.

Both designs are in very early stages relative to the Office of Science project review process.

We rank the Physics importance of an EIC as “absolutely central”.

We rank the Readiness of an EIC as “significant scientific/engineering challenges to resolve before initiating construction”.

FRIB

Physics goals focus on the study of exotic nuclei at the limits of nuclear stability. FRIB will address longstanding questions about the astrophysics origin of the elements and the fundamental symmetries of nature. It will provide new isotopes for research related to societal applications.

Rare isotope beams will be available over a range of energies, from isotopically separated stopped beams through beams near the Coulomb barrier up to full fragmentation energies.

More than 1300 users are involved in refining science goals and in designing novel detectors.

The technical feasibility and cost to build FRIB have been thoroughly reviewed; the project underwent a readiness for CD-2/3A review in April 2012.

We rank the Physics importance of FRIB as “absolutely central”.

We rank the Readiness of FRIB as “ready to initiate construction”.

NLDBD

Physics goal is to look for evidence of non-conservation of lepton number, which is required if NLDBD occurs. The lightness of neutrinos may be related to a very heavy mass scale beyond the reach of accelerators. This implies that neutrinos are "Majorana" particles, one and the same with their antiparticles. Lepton number would then not be conserved.

Experiments using several different isotopes are operating at the 100 kg scale. Going to the ton scale involves technical challenges, some of which have been resolved. R&D with respect to achievable backgrounds is still needed in most cases.

Projected costs cover a wide range, scattered about the $100M level.

We rank the Physics importance of at least one NLDBD experiment at the ton scale as "absolutely central".

We rank the Readiness of NLDBD experiments at the ton scale as "significant scientific/engineering challenges to resolve before initiating construction".

Summary of Rankings

Facility	Science	Readiness
ATLAS	a	
CEBAF	a	
RHIC	a	
EIC	a	b
FRIB	a	a
NLDBD	a	b

Comments

The fact that the relatively small number of major facilities that remain or are planned in Nuclear Physics are “absolutely central” in scientific importance should not be a surprise.

Our community has had for a long time a rigorous system of setting priorities and making hard choices, including closing facilities that no longer address issues of high scientific importance.

The results of our Subcommittee work strongly support the “Modest Growth” scenario discussed in the report of the NSAC Subcommittee on Implementing the 2007 Long Range Plan.