Performance Measures for the Heavy Ion Program

Stephen Steadman
Division of Nuclear Physics
U.S. Department of Energy

19th Winter Workshop on Nuclear Dynamics
Breckenridge, CO
February 13, 2003

Outline

1. President's Management Agenda

2. R&D Investment Criteria

3. Program Strategic Performance Goals and Targets

4. Key Questions

5. Next Steps

6. Conclusions

Note: This is first presentation by DOE-NP using computer!

President's Management Agenda

"The President's Management Agenda, announced in the summer of 2001, is an aggressive strategy for improving the management of the Federal government. It focuses on five areas of management weakness across the government where improvements and the most progress can be made."

http://www.whitehouse.gov/omb/budget/fy2002/mgmt.pdf

GOVERNMENT-WIDE INITIATIVES

- **Strategic Management of Human Capital:** "The first priority of the President's management reform initiative is to make government citizen-centered. The number of layers in government must be compressed to reduce the distance between citizens and decision-makers, and agencies should redistribute their allotted staff from higher-level positions to front-line service-delivery…"
  - **The Office of Science is now undergoing a restructuring to accomplish this.**
- **Competitive Sourcing:** "To achieve efficient and effective competition between public and private sources, the Administration has committed itself to simplifying and improving the procedures for evaluating public and private sources…"
- **Improved Financial Performance:** "…OMB will work with agencies to establish goals to reduce erroneous payments for each program."
  - **Government is catching up to standard accounting practice.**

President's Management Agenda (continued)

- **Expanded Electronic Government:** "The Administration will advance E-government strategy by supporting projects that offer performance gains across agency boundaries, such as e-procurement, e-grants, e-regulation, and e-signatures…"
  - **The Office of Science now requires electronic submission of grant proposals; it is expected that Field Work Proposals from labs will also be electronically submitted.**

- **Budget and Performance Integration: "**To provide a greater focus on performance, the Administration plans to formally integrate performance review with budget decisions. This integration is designed to begin to produce performance-based budgets starting with the FY 2003 Budget submission… Over time, agencies will be expected to identify high quality outcome measures, accurately monitor the performance of programs, and begin integrating this presentation with associated cost. **Using this information, high performing programs will be reinforced and non-performing activities reformed or terminated."**
  - **Distinctions will be made between "high performing programs" and "non-performing activities."**
  - **The OMB FY2002 "scorecard" rated Office of Science program targets as "needing improvement."**

President's Management Agenda (continued)

9 SPECIFIC PROGRAM INITIATIVES:

- Better R&D Investment Criteria (Department of Energy)
  - **Initiative:** "The Administration is developing objective investment criteria for federal R&D projects. These criteria will also be used to assess the performance of research programs. A well directed R&D portfolio should demonstrate progress towards the portfolio's strategic goals, without necessarily expecting success from each and every project… OMB and the OSTP will also work with NASA, the NSF, DOD, NIH, and DOE to develop separate criteria, to be issued in Spring 2002, for evaluating basic research during formulation of the 2004 Budget."
  - **Expected Near-term Results:** "Application of the criteria will provide a benchmark for future assessments that will inform funding beyond 2003."
  - **Expected Long-term Results:** "The Administration expects that these investment criteria will better focus the government's research programs on performance. The effectiveness of the U.S. government's R&D investment will be measurably improved over a period ending three years from initial benchmarking… Basic research programs will better target improving the quality and relevance of their research. These investment criteria will promote our nation's leadership in important science and technology areas."

R&D Investment Criteria (Relevance)

"Programs must be able to articulate why this investment is important, relevant, and appropriate. Programs must have well-conceived plans that identify program goals and priorities and identify linkages to national and 'customer' needs."

Note: Who is the customer? IBM experience under Lou Gerstner

Retrospective:

- Impacts on other scientific fields (e.g., astrophysics and computational physics) and benefits to society (e.g., nuclear medicine, materials testing and modification, environmental applications, and national security) are indicated.
- Long Range Plans, developed every 5-6 years by the community, assess progress in the field, which areas have matured and which areas offer new opportunities.

Prospective:

- Long Range Plans identify most promising scientific opportunities, providing clear prioritized goals for scientific output; have developed five basic questions that define objectives.
- NSAC sub-panels provide periodic reviews of sub-fields, to evaluate opportunities and provide guidance for determining priorities among competing demands for resources.
- Program Advisory Committees of experts at user facilities evaluate merit and feasibility of research plans to ensure work best addresses scientific goals and its execution is well-conceived.
- Proposed projects must undergo review for mission need (CD0) to ensure relevance. Lehman-type reviews evaluate project management, cost, and schedules of construction and equipment fabrication projects, providing expert judgment and ensuring best practices before construction start.

R&D Investment Criteria (Quality)

"Programs must justify how funds will be allocated to ensure quality R&D. Programs allocating funds through means other than a competitive, merit-based process must justify these exceptions and document how quality is maintained."
Note: Must maintain quality of peer-review process

Retrospective:

- All renewal research grants to university groups are peer-reviewed for quality of research performed.
- Major user facilities have annual program reviews by panels of experts to evaluate quality of the science of the facility and of the research groups at the facilities, as well as the quality of facility management. Appropriate corrective action is taken, as necessary, to maintain quality.
- Laboratory research groups have annual program manager briefings.

Prospective:

- All new and renewal research grants to university groups and new research projects at laboratories are selected based on merit peer-review for quality and relevance to Program Goals. Laboratory research projects will be reviewed on 3-year cycle.
- NSAC sub-panels are charged periodically to evaluate all research within the four sub-programs to provide recommendations as to the highest quality work to pursue. An evaluation of the theory program is being planned.

R&D Investment Criteria (Performance)

"Programs must have the plans and management processes in place to monitor and document how well this investment is performing. Program managers must define appropriate outcome measures and milestones that can be used to track progress towards goals, and assess whether funding should be enhanced or redirected."

Retrospective:

- Program has specific targets regarding program management and facility performance (beam hours) that are tracked quarterly. Manpower statistics are reported annually with manpower survey.
- Each sub-program has specific targets to measure scientific progress, reported annually.
- Laboratory Field Work Proposals and Grant Progress Reports are monitored for satisfactory progress annually.
- Construction projects, major accelerator improvement projects and capital equipment fabrication projects are monitored quarterly and reviewed annually, with corrective action taken as necessary.

Prospective:

- Program and program elements have **Program Specific Performance Goals** and corresponding **Targets**.
- Construction projects, major accelerator improvement projects and capital equipment fabrication projects are baselined with schedule milestones and cost profiles, using Lehman-type reviews of experts.

NP Program Performance Elements (process oriented)

Strategic Performance Goal: Manage a productive and sustainable program that provides world-class research results in the scientific disciplines encompassed by the Nuclear Physics mission areas cognizant of DOE needs as well as the needs of the broad scientific community.

Performance Indicators: Validation of results by merit review with external peer evaluation; validation of program directions by Nuclear Science Advisory Committee.

FY 2004 Performance Targets:

- At least 80% of all new research projects will be peer reviewed and deemed excellent (of highest quality) and relevant, and annually 30% of all ongoing projects will be subject to peer review with merit evaluation. (quality)
- Respond to priorities and recommendations for the DOE Nuclear Physics program in the 2002 Nuclear Science Advisory Committee Long Range Plan: (relevance)
  - increase support for research and operations in order to exploit the opportunities made possible by recent investments at the new and upgraded facilities, for university research and infrastructure, and for nuclear theory;
  - maintain support of R&D activities to prepare for the future construction of the possible major new facility, the Rare Isotope Accelerator (RIA);
  - maintain R&D funding and prepare for the upgrade of the Continuous Electron Beam Accelerator Facility at Jefferson Lab to 12 GeV.

NP Program Performance Elements (facilities and projects)

Strategic Performance Goal: Manage all Nuclear Physics facility operations and construction to the highest standards of overall performance; using merit evaluation with independent peer review.

Performance Indicators: Percent on time/on budget; percent unscheduled downtime.

FY 2004 Performance Targets:

- Maintain and operate Nuclear Physics scientific user facilities so the unscheduled operational downtime will be kept to less than 20%, on average, of total scheduled operating time. (performance) (Same target as in FY 2003)
- Conduct annual reviews of the Thomas Jefferson National Accelerator Facility and the Relativistic Heavy Ion Collider facility; use results of reviews to identify areas where increased efficiency and scientific productivity can be obtained. (quality, performance)
- Fabrication of the STAR EMCAL Enhancement, the Fundamental Neutron Physics Beamline at the Spallation Neutron Source, and the Gamma-Ray Energy-Tracking In-beam Nuclear Array (GRETINA) (Major Items of Equipment) will not exceed 10% of cost and schedule baseline estimates. (performance) (Similar target to FY 2003)

Medium Energy Nuclear Physics Subprogram (research)

Subprogram Goal: Determine the structure of nucleons in terms of bound states of quarks and gluons; measure the effects of this structure on the properties of atomic nuclei.

Performance Indicators: Validation of results by merit review with external peer evaluation.

FY 2003 Performance Targets:

- As elements of the electron beam program, (a) collect first data with the BLAST detector at MIT/Bates, studying the structure of nucleons and few body nuclei, and (b) collect first data to map out the strange quark contribution to nucleon structure using the G0 detector, utilizing the high intensity polarized electron beam developed at Thomas Jefferson National Accelerator Facility.

Medium Energy Nuclear Physics Subprogram (2) (research)

FY 2004 Performance Targets:

- At MIT/Bates complete high-priority experiments with BLAST studying structure nucleons and few body nuclei.
- At Thomas Jefferson National Accelerator Facility perform experiments, analyze data, and/or publish results by carrying out a peer-reviewed and prioritized research program directed towards determining the structure of nucleons, including:
  - the first experiment to study new theoretical functions that describe the proton structure (Generalized Parton Distributions)
  - measurements of the form factor of the pion and of the charge distribution of the ^{4}He nucleus, and
  - measurements to complete the first phase of the study of the excited states of the nucleon.
- At the Brookhaven Relativistic Heavy Ion Collider, perform experiments, analyze data, and/or publish results by carrying out a peer-reviewed research program studying internal structure of the proton, including:
  - asymmetry measurements of pion production in collisions of polarized protons at high energy.

Low Energy Nuclear Physics Subprogram (research)

Subprogram Goal: Determine the low energy properties of nuclei, particularly at their limits of stability; use these properties to understand energy generation and the origin of the elements in stars, and the fundamental symmetries of the "Standard Model" of elementary particle physics.

Performance Indicators: Validation of results by merit review with external peer evaluation.

FY 2003 Performance Targets:

- Collect the first data from the Kamioka Large Anti-Neutrino Detector (KamLAND), a joint U.S.-Japan experiment measuring anti-neutrinos produced in nuclear reactors.
- Deliver the prototype high energy, high power gas catcher to the GSI facility in Germany and prepare it for testing. Complete tests of prototype targets for RIA. Complete prototype Electron Cyclotron Resonance ion source and fabricate prototypes of the high-beta superconducting radio-frequency (RF) cavities for RIA.

Low Energy Nuclear Physics Subprogram (2) (research)

FY 2004 Performance Targets:

- Perform experiments, analyze data, and/or publish results by carrying out a peer-reviewed and prioritized research program, including:
  - at the Argonne Tandem Linac Accelerator System (ATLAS) measure masses with high precision of nuclear astrophysically important radioactive nuclei, identify collective excitations in actinide nuclei, and develop new exotic beams for nuclear astrophysics and structure studies;
  - at the Holifield Radioactive Ion Beam Facility (HRIBF), use stable and radioactive ion beams (RIBs) to measure the properties of reactions that are important for understanding the synthesis of elements in stellar explosions and necessary for interpretation of solar neutrino experiments, and measure shapes of neutron-rich nuclei.

- With KamLAND, perform experiments, analyze data, and publish results, completing the first measurement of reactor-produced anti-neutrinos with this detector.

- As part of R&D for the possible RIA, complete test of the high-beta superconducting RF cavities.

Nuclear Theory and Nuclear Data Subprogram (research)

Subprogram Goal: Provide a theoretical program that supports the Medium Energy, Heavy Ion, and Low Energy strategic goals, by developing models, computational techniques, interpreting data, and finding new directions for profitable investigation; provide reliable nuclear data in formats that are useful for a wide range of activities in nuclear and astrophysics research, nuclear medicine, nuclear stockpile stewardship, national security and space exploration.

Performance Indicators: Validation of results by merit review with external peer evaluation.

FY 2003 Performance Targets: None were set for the FY 2003 Budget.

FY 2004 Performance Targets:

- Develop models, interpret data, and find new research directions relevant to the Nuclear Physics mission, and publish results.
- At the National Nuclear Data Center, complete database migration project, performing a generational step to a modern relational database management system.

Heavy Ion Nuclear Physics Subprogram (research)

Subprogram Goal: Determine the behavior and properties of hot, dense nuclear matter as a function of temperature and density; establish whether a quark-gluon plasma can be created in the laboratory and, if so, characterize its properties.

Performance Indicators: Validation of results by merit review with external peer evaluation.

FY 2003 Performance Targets:

- Initiate first round of experiments with collisions with other ions to compare to results of gold-gold collisions.

FY 2004 Performance Targets:

- At the Relativistic Heavy Ion Collider, perform experiments, analyze data, and/or publish results by carrying out a peer-reviewed and prioritized research program directed towards determining the behavior and properties of hot, dense nuclear matter, including:
  - Measurements of the thermodynamic and hydrodynamic properties of hot nuclear matter; and
  - Measurements of the yields of high transverse momentum particles through hot and cold nuclear matter.

Key Questions – A Framework for Setting Goals

- **Elucidate on the "Five Questions" in the Long Range Plan that broadly define nuclear physics thrusts:**
  - What is the structure of the nucleon? (Medium energy, Theory))
  - What is the structure of nucleonic matter? (Low and Medium energy, Theory)
  - What are the properties of hot nuclear matter? (Heavy ion, Theory))
  - What is the nuclear microphysics of the universe? (Low energy, Theory)
  - What is to be the new Standard Model? (Low energy, Theory)
- **Questions have been very effective in presenting the program to Office of Science and DOE management, OMB, and the public.**
- **Upside to key questions:**
  - Provides goals for sub-programs that can be easily discussed with OMB, etc.
  - Drives setting performance goals: specific, "quantifiable" results
- **Downside to key questions:**
  - Can no longer be inclusive: some topics that may be good physics are left out.
  - Can drive program to be more conservative, lower risk, less serendipity
- **What should the process be to establish such key questions?**
  - NSAC, Laboratories, NP Division of APS, …?

Key Questions (cont'd)

- **Possible key questions for Heavy Ion sub-program**
  - What is the equation of state of hadronic nuclear matter?
  - Where is the temperature/baryonic density phase boundary between hadronic matter and the quark gluon plasma?
  - What are the thermodynamical properties of hot nuclear matter?
  - What are the hydrodynamical properties of hot nuclear matter?
  - What is the energy loss of high transverse momentum particles in the hot and cold nuclear matter medium?
  - What is the size of the "fireball" in gold-gold collisions before freezeout; what is the energy density at freezeout?
  - What is the production rate for charm from hot and cold nuclear matter in heavy ion collisions?
  - What is the production rate for direct photons in heavy-ion collisions?
  - What is the production rate for upsilon in hot nuclear matter?
  - What is the production rate for bottom quarks in hot nuclear matter?
  - …?

Next steps

- Planned NSAC sub-committee review of theory sub-program will be used to help validate relevance of present theoretical portfolio to the goals of the theory sub-program.

- Sub-programs will be reviewed periodically by DOE panels to determine it there is the right balance of effort to achieve sub-program goals, with the heavy-ion program the first in line for such a review.

Conclusions

- We are trying to use this process for positive gain, avoid harming what is good. There is the danger of unintended consequences. There is some hope that the generally outstanding evaluation of basic science research will lead to increased funding: "high performing programs will be reinforced."

- We need to work together to construct performance targets that are high quality and meaningful, emphasize the science output, developing targets that can be measured, but are achievable.