



## YALE UNIVERSITY

A. W. WRIGHT NUCLEAR STRUCTURE LABORATORY

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OFFICE OF THE DIRECTOR

October 20, 2004

Dr. Raymond Orbach  
Director  
Office of Science  
US Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585

Dr. Michael S. Turner  
Assistant Director  
Directorate for Mathematical & Physical Sciences  
National Science Foundation  
4201 Wilson Boulevard  
Arlington, VA 22230

Dear Drs. Orbach and Turner:

Your letter of February 18, 2004 charged NSAC to provide guidance beyond the recommendations of the Long Range Plan in the area of relativistic heavy ions (RHI). NSAC was asked to examine current and proposed US efforts in this field, especially in light of new results at RHIC, and to identify the optimal scientific opportunities, taking into account both national and international resources and research supported by the NSF. Your charge specifically asked NSAC to identify scientific opportunities, as well as facility and instrumentation capabilities, to sustain a strong on-going program, both in a constant level of effort scenario and with additional funding. The charge asked NSAC to focus on the 2006-2010 time period and to look at both the impact of prioritized efforts and of those that could not be done at these funding levels. Consistency with recent research milestones validated by NSAC was also to be an important consideration.

NSAC formed a sub-committee, chaired by Peter Barnes of Los Alamos National Laboratory, to prepare a response to this charge. This sub-committee has completed its work and presented its Report to NSAC at a meeting on October 7, 2004. NSAC unanimously accepts the Report and concurs with its conclusions. A copy of the Report is enclosed with this letter.

RHI research has three important components: heavy-ion research at RHIC, nucleon structure research at RHIC, and a new heavy-ion research opportunity at the LHC facility. NSAC agrees wholeheartedly with the Subcommittee that the future scientific impact of this research will be outstanding. This field constitutes one of the forefront areas of modern science and is nuclear physics' connection to high energy-density physics in the universe.

The report outlines the accomplishments and possibilities in the three components of RHI research. It points out that a new form of QCD matter has already been discovered at RHIC. Machine and detector upgrades that provide access to rare probes at RHIC will preserve its unique discovery potential for the decade to come. In addition, the tools required at RHIC for studying the spin structure of the nucleon, through polarized p+p collisions at the highest energies, are now in place. The continued development of the polarized proton program will establish RHIC as a premiere facility, complementary to JLab, for the study of hadronic matter.

The report recommends that the US participate in the new heavy-ion program at the LHC, where the center of mass energy is 30 times that of RHIC. The LHC research program complements that at RHIC and significantly enhances our understanding of this new form of matter. US participation at the LHC is highly leveraged by existing large US and international contributions and benefits from U.S. leadership in the heavy-ion field.

Within a constant level of effort budget (at \$158.9 M, FY05), all these opportunities cannot be pursued, and the Subcommittee analyzed the difficult choices of priorities that would need to be made. Optimal allocations that will result in a scientifically productive, sustained, program were judged to include new investments that will extend the scientific reach of the RHIC facility, and participation in the new program at the LHC, even with consequent reductions in running weeks at RHIC. However, the impact will be a severe under-utilization of the RHIC facility during a critical period in its physics program, and the inability to invest sufficient resources to capitalize on an opportunity for the US to have a larger scientific impact at the LHC. Additional funds of about 10% will significantly enhance the scientific opportunities and discovery potential made possible by past investments and allow more optimal operation of the RHIC facility.

Relativistic Heavy Ion research provides superb and unique scientific opportunities for the nation that are essential and central to understanding the fundamental constituents of nature and their interactions. NSAC enthusiastically endorses strong pursuit of this research. The recommendations of this Report are realistic, given budgeting guidelines, and will optimize the scientific output of RHI research.

Sincerely,



Richard F. Casten  
Chair, NSAC

cc: Kovar  
Schroeder  
Dehmer  
Keister  
NSAC members