Directorate for Mathematical and Physical Sciences
Advisory Committee Meeting Minutes
April 3-4, 2008

Thursday, April 3, 2008
Morning Session

Welcome and Introductions

Dr. Michael Witherell, Chair, called the meeting of the Directorate for Mathematics and Physical Sciences Advisory Committee (MPSAC) to order at 8:30 AM. After welcomes and introductions of members and other attendees, Witherell noted that the current state of the MPS budget allowed for an in-person meeting of the MPSAC this year, as opposed to last year's telecom. The subcommittee on major facilities had completed its report for this meeting. In reviewing the agenda for the meeting he noted that the MPSAC would be hearing from the chairs of the two Committee of Visitors subcommittees that had taken place in February 2008. The Director of the NSF, Dr. Arden Bement, Jr. would not be available to meet with the MPSAC, but the Deputy Director of NSF, Dr. Kathie Olsen, would meet with the group at lunch on Friday, April 4.

Remarks by MPS Assistant Director

Dr. Tony Chan, Assistant Director of MPS began his remarks by noting that the term of the current Chair of the MPSAC would end September 30, 2008. Dr. Robert Williams of the Space Telescope Science Institute (STScI) would become Chair of the MPSAC on October 1, 2008 and would serve for a period of two years. In the future, in order to ensure continuity, Chairs of the MPSAC would serve for 2-year periods.

Chan then discussed some personnel changes with MPS. The Head of the Office of Multidisciplinary Activities (OMA) is now Dr. Celeste Rohlfing. Prior to assuming this position she was a program director in the Division of Chemistry. Rohlfing was co-chair of the NSF-wide task force on broadening participation. The former Head of OMA, Dr. Henry Blount, is now in charge of EPSCOR in the Office of Integrative Activities (OIA). Lance Haworth, the former Acting Division Director of the Division of Materials Research (DMR) and Interim Head of OMA, is now head of OIA. A new Assistant Director has been announced for the Geosciences Directorate (GEO). He is the Dr. Tim Killeen, the Director of the National Center for Atmospheric Research in Boulder, Colorado. Dr. Dan Atkins, the Head of the Office of Cyberinfrastructure (OCI) is stepping down.

In describing the FY 2009 request, Chan noted that the physical sciences had been mentioned in the President's State of the Union address, and that the administration's American Competitiveness Initiative (ACI) had helped shaped the NSF FY 2009 budget request. He presented several tables showing NSF budget requests for the last several years, and noted that the 20.2% increase from the FY 2008 budget request for MPS reflected the increased emphasis by the administration on the ACI.

However, the bad news was that the FY 2008 budget increase for NSF had been lost in the Omnibus Bill associated with funding most Federal agencies for FY 2008. However, even within the restricted FY 2008 budget the Directorate planned new activities with respect to cyberdiscovery, the support of Centers for Chemical Innovation, an ACI Fellowship program, and, jointly with NASA, a Division of Astronomical Sciences (AST) virtual observatory solicitation. Activities that would be held level were the individual investigator programs and funding for the Materials Research Science and Engineering Centers (MRSEC). Activities that would be cancelled as a result of the budget included facilities upgrades, a fellowship program in the Division of Chemistry (CHE).

Chan then described the FY 2009 budget request. NSF-wide requests included support for activities involving Science and Engineering Beyond Moore's Law (SEBML), Cyber-enabled Discovery and Innovation (CDI), and Adaptive Systems Technology (AST). Within MPS there would be support for an MPS-Life Sciences Interface, and Quantum Information Sciences (QIS).

In his discussion of centers, institutes and facilities, Chan highlighted the Centers for Chemical Innovation (CCI) and the Physics Frontiers Centers (PFC). He presented tables showing the current MPS-supported facilities, and noted that reduced support would be provided for operations of the Cornell Electron Storage Ring (CESR) and the National Astronomy and Ionosphere Center (NAIC). The IceCube Project at the South Pole and the Atacama Large Millimeter Array (ALMA) were under construction, and support in the amount of $2.5 million for the Advanced Technology Solar Telescope (ATST) had been requested within the Major Research Equipment and Facilities Construction budget line item. Facilities in the planning and development stage included the Large Synoptic Survey Telescope (LSST), the Deep Underground Science and Engineering Laboratory (DUSEL), and the Giant Segmented Mirror Telescope (GSMT). Included within the latter project were the Thirty Meter Telescope (TMT) and the Giant Magellan Telescope (GMT).

Chan concluded his presentation with a summary of the MPS FY 2009 budget request. There would an increase in the number of individual principal investigator awards, there would be new starts on centers and institutes, there would be operation and construction of new facilities, and there would be expanded investment in the workforce.

During the questions that followed Chan's presentation, the issue was raised as to whether there would be a continuing resolution in FY 2009 because of the upcoming election, and Chan responded that this was possible, but hoped that it would last the entire year. Witherell noted that there may be supplemental bill for the science agencies for FY 2008.

Status Report from MPSAC Subcommittee on Major Facilities

Witherell, as Chair of the MPSAC Major Facilities subcommittee, presented its report. He began his report by noting that NSF pays great attention to facilities and the manner in which they are administered. The charge to subcommittee was whether DUSEL should enter the Readiness stage of the MREFC process. He noted that the Department of Energy (DOE) and NASA had more emphasis on facilities, and in the past NSF did not have a tradition of facilities like those of other agencies, and this had caused problems and cancellations of projects. He noted that facilities must be managed that that they don't take up the entire NSF budget, and this requires a close look at costs early on in the planning process. Also, entry of a project into the readiness stage did not imply that the project would be started.

The Subcommittee spent a fair amount of time discussing budgetary planning, including life-cycle costs of the DUSEL facility. The MREFC budget line item provides support for construction, but initial planning, preparation, and ultimate operation of a newly constructed facility must be funded by NSF divisions. This requirement means that planning must be done for the entire lifecycle of the facility, and must include taking account of maintenance and operations costs especially, which can mean, over the lifetime of the facility, investments by the divisions that exceed the initial construction cost of the facility.

The subcommittee asked MPS for its estimates of the lifecycle costs of DUSEL and for its strategy on supporting facility investments. MPS had provided a possible model for such investments. Chan commented that given MREFC modality for construction funding, global project management is difficult. The problem is not just the funding of operations for facilities, but consideration must also include long-term investments in other areas. Facilities are challenging because they are hard to roll back in tough years. The model that had been discussed involved maintaining balance across divisions and a requirement was that one project would not adversely effect other divisions. However, facilities represent a commitment by MPS and require stable budgets. At the directorate level, an MPS division proposing a facility would have to have a plan with the total lifecycle costs, showing how much the division is investing, redirecting, *etc*., and leading to a request for co-investment (~50/50) between the division and the MPS directorate. MPS has discussed caps for yearly percentage of total MPS budget going into facility design and development (D&D) and operations. The model considered involved a budget of about one percent of the MPS budget (between $10 million and $14 million annually). Also, there would be project cap over the lifetime of any particular project, and facilities would be competed within MPS.

The subcommittee also discussed the proposed oversight and management of DUSEL, and posed a number of questions to the Physics Division on this matter.

The findings of the subcommittee were that the experimental program had received excellent reviews. The development of project has been a straightforward process, including both the case for the science and the determination of the site.

The subcommittee encouraged NSF to have an independent cost review of the project, and was concerned that the present level of funding may not be sufficient. The subcommittee is also concerned about NSF oversight of DUSEL, whether the groups involved with DUSEL are large enough and strong enough to do proper oversight of the project, and this will tax the lean management structure of NSF.

The subcommittee's conclusion is that the DUSEL project was qualified to enter the Readiness Stage, but that the subcommittee has some concerns. The subcommittee recommends that MPS and DOE develop plans for close coordination of this project. In addition, the subcommittee recommends that there be very close oversight and management of the project and that MPS closely follow closely the planning process of the DOE/NSF High Energy Physics Advisory Panel (HEPAP) P5. The subcommittee recommends that MPS and DOE take responsibility for the long-term success of all aspects of DUSEL. If these conditions are met the subcommittee believes DUSEL will be a success.

Discussion of the subcommittee report was deferred to later in the afternoon.

Report of Division of Astronomical Sciences Committee of Visitors

Dr. John Carlstrom of the University of Chicago, a co-chair of the AST Committee of Visitors (COV) presented the report via phone.

The COV met in February 2008 for three days. The COV was impressed with the management, goals, and strategic plans for the future. They found that AST funds advanced science in every discipline from solar planets to dark energy. There were no suggestions for changes in the Division's strategic plans.

The COV noted that staffing for Division needs to be increased. More staff are needed to oversee major programs. Travel funds need to be doubled and strongly urges NSF to increase the budget for oversight needs. The COV noted that the astronomy community is seeking both public and private funding for their projects, and NSF should attempt to work with the private sector when such funds are obtained. Recommendations were made as to how NSF could carry out such partnerships. The review was highly supportive of the individual investigator grants, and was impressed with the program officers and their reaction to new sciences. However, there were some concerns with respect to diversity on the panels. At times the panel summaries provided to investigators are not very helpful and AST should try to create an analysis (using the program officer's review) that would provide more information to the principal investigator. Principal investigators should be encouraged to take advantage of the substantial amount of cyber infrastructure that now exists. The COV was impressed with AST's management of the national observatories. The COV had specific comments with respect to each of the facilities and these were presented by Carlstrom.

In the comments that followed the report, Gallagher asked if the COV had any concerns that cuts recommended by the COV would result in facility managers seeking congressional earmarks. Carlstrom responded that the Very Long Baseline Arry (VLBA) may be getting international partners, but with respect to NAIC there is pressure to obtain earmarks. Arnold asked if the COV had any discussion concerning the balance of funds between individual investigator grants and facilities. Carlstrom responded that the COV felt that the balance was in good shape. At present, the balance between funds going to facilities and to grants is out 55% to 45% respectively, and the COV felt this was about right.

Report of Division of Materials Research Committee of Visitors

Dr. Paul Peercy of the University of Wisconsin, Chair of the Division of Materials Research (DMR) COV presented the report via phone.

The COV finds DMR to be an exceptional division. It is a highly respected and supports excellent programs that address the nation's needs in health, environment, energy, and security. It is a leader in developing a quality science

and technology (S&T) workforce, important for the future economic success and viability of the nation. There is an excellent process for deciding which proposals to fund. Program Officers do an excellent job in ensuring participation of underrepresented groups. The staff is enormously valuable resource, but Program Officers are burdened with heavy and increasing workload.

He noted that the within DMR there was increased emphasis on the pipeline issues, DMR outreach activities have been quite effective but still have a long way to go. There is in place an excellent process of deciding upon the excellent proposals to fund. DMR has responded to all of recommendations of the previous COV.

DMR staff has educated reviewers about the NSF Merit Review Criterion involving broader through workshops and a Dear Colleague Letter, and this has resulted in more effective reviews.

The COV felt that it is important to protect individual investigators programs and that DMR had not received funding commensurate with its activities. It does an excellent job of funding transformative research and novel materials. DMR is seriously underfunded and this affects its impact on funding transformative research.

There is concern about the impact of major facilities on other programs when the division has a flat budget. With respect to the balance between grants, groups, centers and facilities the COV was not able to provide critical evaluation, but individual investigator grants should not decline below current levels. The COV suggested that NSF evaluate the balance between funding for research groups and facilities, and a concern is that a division that is a steward of major facilities has trouble because of inflation of costs that will drain resources from research side of house. DMR should examine the taxonomy for alignment with the changing materials community. Importance of theory has increased in all areas of materials research.

The COV felt that DMR was a pioneer in identifying what is viewed as high quality programs by the community, particularly in funding investigators early in their careers and funding high risk research. The COV particularly liked the post-award reverse site visits. The COV also commented on the fact that cyber activities were being given significant consideration in the current requested increase of 24%.

The COV noted that DMR has and continues to play a leadership role in many areas within NSF such as initiating the Partnerships for Research and Education in Materials (PREM), focusing on strategic planning, creating and managing interdisciplinary centers (the Materials Research Science and Engineering Centers [MRSEC] and the Nano Science and Engineering Centers [NSEC]), in developing international research collaborations such as the Materials World Network (MWN). The COV noted that DMR proactively moves into new research areas, it identifies transformative opportunities and creates effective programs to address them. It provides seed grants for young investigators and uses community workshops to guide the strategic directions of DMR.

In conclusion, the DMR COV commends NSF leadership for the large increase requested for DMR in the FY 2009 budget request, it commends DMR for its support of excellent programs, and the COV has complete confidence in DMR staff to make difficult decisions in tight budgets and to respond to new opportunities.

Status Report from MPSAC Light Source Subcommittee

Dr. Venkatesh Narayanamurti of Harvard University, Chair of the MPSAC Light Source Subcommittee, gave a progress report via phone. A final report will be completed later in the spring (May-June time frame). He discussed the panel charge, site visits made, and the wide spectrum of people on the panel. The Panel received a broad range of input from the community, federal agencies, and major laboratories. Panelists explored the role of the NSF, the science drivers, role of international activities, and interests of the private sector. A new frontier in coherent, time-resolved X-ray sources is seen that will have a broad impact on science. National laboratories visited included CHESS at Cornell University, the Synchrotron Radiation Center (SRC) at the University of Wisconsin-Madison, the Stanford Synchrotron Radiation Laboratory (SSRL) and the Stanford Linear Accelerator Center (SLAC) at Stanford University, and the Advanced Light Source (ALS), a division of Berkeley Laboratory. A broad spectrum of science was represented. Significant partnerships across NSF are seen as possible in this field. The Panel's next step is to complete the final report.

The discussion following this presentation brought out differences in researcher interactions at laboratories. Kafafi commented that NSF laboratories offer a fine opportunity for graduate students to have hands-on experience in the measurements. This approach to involve students is in keeping with NSF's educational goals, providing the students excellent opportunities to become versed in the design of the equipment and the measurements. Mathews pointed out that we need to develop more national talent in this field. Chan added that the NSF approach allows for such training to take place.

The View from the Office of Management and Budget

Dr. Joel Parriott of the Office of Management and Budget (OMB) gave an overview of OMB interactions with the NSF and basic research in general. He discussed the OMB charge in making budget recommendations in the government. He noted that in his position at OMB he has 20% of his budget responsibility in basic research, in marked contrast to his OMB counterparts where basic research is a much smaller part of the overall budget responsibilities. In the presentation Dr. Parriott commented that he is not in favor of a Department of Science, a subject that is brought up occasionally. He listed several issues of importance to MPS including portfolio management, integration of research and education, and transformational research that involves "high risk."

The ensuing discussion included questions on Dr. Parriott's views on (1) the Energy Recovery Linac (ERL) -- he views this as exciting technology; (2) K-12 education -- he sees it as state controlled and best accomplished through professional people in that field, although he added that NSF grantees had been successful in this area; (3) doubling of the NSF budget in the future -- he noted that OMB's goal is to spend less money in the future, therefore increases in the NSF budget would likely mean cuts elsewhere; (4) the contrasts among the NSF, DOE and NASA funding activities -- he thought the NSF culture is good at what it does, *i.e.*, the funding of basic research through grants; however, in his view large facility funding done at an arms-length distance does not work well because direct hands-on management is needed. He believes the culture at NASA and DOE is better suited to this type of management and NSF needs to improve in this regard.

Lunch Adjournment Followed by Divisional Breakout Sessions

MPSAC members had lunch with the MPS Divisions in the divisional breakout sessions. Topics discussed during these sessions included key long-range planning issues and FY 2010 budget ideas.

Thursday, November 8, 2007
Afternoon Session

The MPSAC reconvened in plenary session at 4:00 PM.

Reports from Divisional Breakout Groups

Membership within each breakout group can be found in Appendix II.

Division of Astronomical Sciences (AST)

Claude Canizares provided the AST report, which included a report from the Chair of the 2008 COV, followed by six topics from the breakout session.

COV Report – Dr. John Carlstrom gave a brief, positive report of the COV visit earlier this year. He said the top line observation was that the COV was very pleased with all they saw in the AST COV visit. They recommended no fundamental changes, with only minor higher order adjustments recommended. The major topic was the implementation of the Senior Review, which is going well. Carlstrom submitted the report for consideration by the MPSAC and recommended acceptance and transmittal to MPS.

Comments from AST Breakout Group
1) Staffing – AST has a portfolio that involves 55% of its funding going to facilities and this is a unique situation at NSF. Strong oversight of these facilities is important to AST, MPS, NSF, and the United States. The number of grants was not the sole metric to consider when deciding staffing levels; and the breakout group encouraged NSF to

take a look at the staffing levels used for oversight of its facilities.
2) Senior Review Process – The AST breakout group noted that the Senior Review process was an exemplary effort by AST and the community. Continuing strong support was needed to follow through to the goal of the process. The question of the relationship of the senior review to the National Academy of Sciences (NAS) Decadal Study was brought up, and it was suggested that in the future such reviews might follow the decadal study by a couple of years. The question was posed as to how this schedule would project onto NSF's budget cycle and process for new facility starts in the MREFC process. Canizares stressed that the senior review implementation had strong COV and MPSAC support and was community based.

3) FY 2008, FY 2009 Budget Situation – The breakout group had several observations: The FY 2008 operations plan is not approved, leaving decisions in limbo, *e.g.*, MREFC funds for the ATST. Small fluctuations can be problematic for AST, so getting the operations plan is important. The budget process is inelastic, which makes AST budgeting difficult. A continuing resolution could have a very bad impact in FY 2009. For FY 2010 and beyond, the relationship with ACI is important. Hopefully, investments will be driven by the NAS document *Rising Above the Gathering Storm*, but a change by a new administration can be expected. A significant driver of *Rising Above the Gathering Storm* was basic research in physical science and engineering, and MPS is a primary steward for science. Canizares stressed that it is important not to take too short term a focus on the types of basic research supported under ACI.

4) Co-investment Model – The breakout group thought it seemed like a very good idea to consider strategic investment. DUSEL is the present example, but the concept should be broader than major equipment, e.g., including the university base programs and making a wedge for initiatives. It makes more sense in a rising rather than a declining budget. It is a work in progress, but the basic idea seems a good one to the AST breakout group.

5) **LSST** – LSST is somewhat of a paradox. It is early in getting private funding; but not early in establishing an interagency agreement, a critical component. It is currently being considered by HEPAP P5; and we need to wait and see what they say.

6) Decadal Survey – The Decadal Survey is close to a kickoff. NSF-DOE-NASA are interacting with NRC and OSTP and are reviewing the last survey. The issue of independent costing has come up. Funding should be in place in a month or so.

Discussion by the MPSAC:

Witherell noted that the MPSAC had an action to consider for the AST COV report. The MPSAC must determine whether to accept the AST COV report and transmit it to NSF. Williams felt that it was a good report, and Gallagher noted that the report relied heavily on the senior review. He questioned setting funding levels below the viable level. Such an action sends mixed signals. It's a fundamental change in operating mode. AST should have a decision process in place. Van Citters responded that the Senior Review did recommend how the new operating level should be met. However, in its recommendation it did not make the target of $30,000,000 in savings by 2011, indicating it while its recommendations sought to reduce costs, these reductions did not cut to the bone.

Witherell stated that he heard nothing to indicate not acting to accept and transmit the AST COV report. One possible general MPSAC comment in the cover letter could be that it is important to provide oversight and management for facilities at NSF. There was no disagreement with this comment.

Dalton said that he had a concern with respect to the Major Facilities subcommittee recommendation concerning DUSEL. While it is stated that the DUSEL recommendation is not to be a funding recommendation, how is it to be read? The Major Facilities subcommittee report on DUSEL was more enthusiastic than the telecons the subcommittee had. He was concerned that when you decouple a recommendation from the funding level, what are you saying? Witherell responded that the DUSEL recommendation was not a recommendation for MREFC funding, rather for proceeding with planning. Canizares noted that NSF calls for life cycle costs and NSF staffing is part of the lifecycle picture, particularly for new programs. Dalton stated that we need the real cost of lifecycle planning and it is important to budget for lifecycle costs. Arnold added that it is important to understand the cost of oversight. Gallagher stated that he liked the way this was coming out as part of the AST COV, but with general applicability. This should be included as a point in the cover letter accepting the AST COV report.

Division of Materials Research (DMR)

Dr. Monica Olvera de la Cruz presented the report of the DMR breakout group and it was followed by the report of the COV and discussion.

The breakout group had discussed the staffing shortage in DMR and suggested that this be elevated to the level of the Office of the Director. She briefly touched upon the balance issue, and, in particular, the balance between centers compared to principal investigator support. It was noted that the centers have significant education and outreach activities. With respect to instrumentation, the breakout group noted that DMR supports 90% of National High Magnetic Field Laboratory (NHMFL). Other agency support should be considered. Support for instrumentation has not kept up with need. The breakout group liked the menu of topics for the FY 2010 budget exercise. Sustainability was considered an important driver for DMR. Matter by Design has a strong interdisciplinary aspect. Diversity is another important item, and the IGERT Fellow program was cited as a good example of a successful program. The International Materials Network was found to facilitate international interactions, including Africa. Quantum Science and Engineering (QSE) is a new phenomenon that bridges quantum mechanics and the classical world. Emergence is a good theme for complex interacting systems, and time was spent discussing the meaning of this theme. Finally, the Observation/Imaging theme was considered good for DMR. In general, the DMR breakout group was glad to see all of these activities under consideration.

Peercy gave a brief discussion of the COV report, indicating that the breakout group also discussed many of the topics discussed by the COV. He pointed out that the track record can be used to place the discussion in context; and the COV concurs with the very successful track record of DMR. Soboyejo was on the COV and pointed out that biomaterials were discussed. He suggested that there should be stronger interactions with other organizations and organization of biomaterials on different scales need to be recognized. Another topic discussed by Peercy was transformational research and that new ideas are often not recognized. How does one encourage high risk in a viable way? One could use track record. Recommended thinking this through before any new funding opportunity is initiated. In summary, the COV was happy with the review and found the responses very useful.

Gallagher commented that at there had been a brief discussion of the COV, but that basically the report was positive. The COV raised the question of the NHNFL and its funding, with 95% being supported by DMR and that significant benefit accrued to other disciplines. However magnet technology is a core responsibility of DMR.

Witherell suggested that the MPSAC accept and transmit the AST COV and the DMR COV reports.
Arnold expressed concern that two parts, integrity and scientific advances, were not covered in the Executive Summary. Both COV reports gave all positive marks and expressed advocacy, but with too little emphasis on peer review. Kafafi felt that the topic was covered and reported clearly. Arnold replied that it was not included in the Executive Summary. Dalton agreed with Kafafi and was puzzled by the concern that the report had only positive findings, commenting the DMR was performing extremely well. Dalton agreed with Kafafi and questioned the concern with all positive findings, commenting that DMR was performing extremely well. Arnold felt that in the future better instruction in the charge would help resolve this. Witherell commented that this was not a basis for bouncing back the report, but that it could be put in the transmittal letter.

Witherell asked for a motion to accept or not accept the reports, with the understanding that the concerns that had been brought up be covered in the transmittal memo. Soboyejo commented that all of the issues had been dealt with in the COV, and that certain items had been selected to be stressed in the executive summary.

After a motion to accept each report, followed by a second, both the Division of Astronomical Sciences COV report and the Division of Materials Research COV report were accepted unanimously.

Division of Physics

Dr. Jose Onuchic summarized the finding of the Division of Physics (PHY) breakout group. He reported that the breakout group was very happy with the discussion they had with PHY.

Overview: The breakout group felt that there is a good balance in PHY between supporting the existing programs and pursuing new opportunities, *e.g*., Physics of Living Systems, Quantum Information Systems (QIS) and this is producing a good evolution and balance in the PHY programs. PHY deserves support on its strategic portfolio balance strategy. A real concern is the lack of funding for mid-scale instrumentation, which is planned but is not yet funded adequately. The overall facility plan is good. PHY interfaces well with NSF-wide programs. The breakout group was positive about interfaces, but feels that initiatives must come from the grass roots and not from the top. There is a need for proper balance between top-down and bottom-up drivers, including the core support as one of the drivers.

Facilities: PHY has a cap of ~35% on facilities. Discipline is needed to maintain strategic balance. Some facilities have to be sunset, and this is difficult. PHY has a comprehensive plan for everything. The strategic co-investment plan is a good one, involving shared investment. The 50:50 approach proposed for support of DUSEL is good. However, it is important to maintain commitments for support by future MPS Assistant Directors. These projects need stability and predictability in funding in order to be successful.

Broadening Participation: The breakout group was very happy about activities in this area and the increasing fund for broadening participation. They did not hear enough on follow-up to the diversity workshop, and look forward to a more complete discussion next meeting. The report is being finished up, and follow-up activities are occurring. The PHY activity in increasing Hispanic participation is very good. The breakout group encouraged doing more to sharing best practices and there is always need for new, good ideas, not just money.

Division of Chemistry (CHE)

Dr. Cynthia Burrows gave the report on the CHE breakout group

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FY 08 Budget: She characterized the discussion as good news – bad news discussion, reality versus expectations. CHE will deal with the reality of the FY 2008 budget and will delay programs. The Discovery Corps, URCs, and Chemical Innovation Centers (CIC) will continue, but there are no solicitations.

International Collaboration: CHE does this via discussions with program directors and management counterparts in Germany, Spain, and China

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ACI Fellows Program: CHE is offering a two-year postdoctoral program that can be potentially longer if Fellow is transitioning to faculty or if Fellow is associated with facilities or industry. Proposals to this program must include broadening participation component.

Centers: There is a large increase of 160% for the CICs, with one Phase II CIC and three Phase I CICs. These centers have a two-phase process, allowing for three years to look at promising/high-risk ideas. This allows a test of efficacy of the center before support for phase II and adds flexibility to the program. The breakout group was enthusiastic about the centers and noted increased support for this concept from the community. Dalton commented that the approach was good in identifying high-risk activities and maintaining flexible CHE management.

CDI: The breakout group found a good level of CHE content in the program.

Strategic Directions Document: This planning effort began in FY 2007 and involved the program directors, MPSAC members, and the community, resulting in the document provided at the meeting. There are 8 strategic directions: ACI competitiveness; Communicating value; Global engagement; Grand Challenges via centers; Broadening participation (workshops on gender, underrepresented groups); Funding needs at different stages of career, focusing on the young, but issues at all stages; Discussion of Criterion II, including broadening participation and doing outside assessments; and assessment of CHE structure, ensuring CHE is not neglecting the interfaces and new areas.

Discussion: A brief discussion of science drivers for FY 2010 followed. Involvement of energy research was raised. It was noted that CHE cannot ignore this area of research even though there is a great deal of activity at DOE. More basic research is needed. Another area – science at interfaces, including tissue-bone research and chemical physical properties of interfaces was discussed. Two brief discussions stressed the topics of importance of organic chemistry

for understanding the universe and chemistry as a universal translator of science.

Division of Mathematical Sciences (DMS)

Dr. Douglas Arnold gave the report of the DMS breakout group.

FY 2008 Budget Picture: The breakout group looked at the budget picture for FY 2008. DMS committed $10M to CDI, so nothing else grew. Tom Russell briefed them on ACI, and things seemed to be working well. Award size and funding rate have gown some since last year. The funding rate for young investigators was a priority. Within DMS 70% of the budget goes for principal investigator support, and this has been stable despite lack of growth.

FY 2010 Initiatives: The breakout group discussed FY 2010 initiatives. One of the initiatives appears particularly promising – sustainable development/climate/alternative energy. Another new area, mathematical networks grants, involves a new funding mechanism – funding edges and not nodes – focusing on connections by means such as shared postdocs, instrumentation, *etc*. This addresses interdisciplinary research.

ACI Fellows: The EMSI21 program anticipated the ACI Fellows program and includes involving undergraduates to attract and retain talent for the math workforce.

Decadal Report: DMS does not have decadal reports. There have been some influential reports, *e.g*. the Odom Report, but there is still a need for further reports. The DMS Division Director, Dr. Peter March, is considering a National Research Council (NRC) study on mathematics research.
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Strategic Coinvestment: This concept works when budgets are increasing at a rate of 7% or 5%, but not 1%. The group suggested a cap for any coinvestment at 15% of the increment to the MPS budget.

Discussion: Witherell agreed that DMS needed an NRC report and that this is probably the right time for such a report. Chan expressed encouragement for the idea.

Division of Astronomical Sciences (AST)

The group reported that AST was doing a good job communicating to their community and political and economic communities their activities concerning the assessment of facilities and priorities of the AST budget. An outside contractor has been hired in an effort to understand more clearly the cost of operating facilities. AST is preparing for the next decadal survey in which the Department of Energy (DOE) and NASA will participate. The Virtual Observatory activity, being done in collaboration with NASA, is moving forward.

The breakout group discussed the AST budget. In FY 2008 AST requested a 10% increase in funding for the grants program. The committee discussed but did not agree with what the appropriate level of funding for instrumentation needed for astronomy should be. The group felt that strategic thinking/planning needs to be established regarding budgets and expectations.

International collaborations could be considerably expanded, and it will be risky for AST and MPS if NSF takes too narrow of an interpretation of ACI. Furthermore, the distribution of ACI funding is not transparent to the outside community. The comment was made that the overall budget and that related to ACI depend on OMB and that AST suffers in this respect as it needs to make sure that marketable technology resulting from AST investments is made know to the public and to legislators.

Discussion by the MPSAC on DUSEL and the Proposed Strategic Co-investment Model

Witherell suggested that the group discuss DUSEL first and then discuss the proposed strategic co-investment model (SCI). He pointed out that Chan indicated this is still under development.

Dalton stressed that the report prepared by the Major Facilities subcommittee is a good idea but the concept in the report needs discussion. The subcommittee does not want to say this is a model they necessarily support. Witherell pointed out that this statement is contained in the third of the recommendations but that it could be boldfaced to

stress it. Arnold commented that the model had some interesting ideas but that MPS should explore these further and then come back to the full MPSAC.

Witherell pointed out that the charge to the subcommittee had been to prepare a report on whether DUSEL should enter the "Readiness" stage of the MREFC process. The subcommittee had enlarged this charge to address how to approach the issue of support of facilities. This led to a series of recommendations on what MPS should do about facilities. DUSEL just happens to be the first to be considered under the new process. The report concludes that DUSEL is ready to advance, but with some reservations. The reservations address the overall facilities question.

Dalton pointed out that the report had also brought up a question concerning safety. Witherell indicated that this is the role of NSF as part of its oversight. DoE looks at safety, but NSF does not have experience here, and issues abound. DUSEL would be a dangerous underground operating environment. However, Lightbody cited Antarctica as an example of working in a hostile environment, noting that there had been a detailed safety review following a construction accident. Currently there is day-to-day management oversight of safety, with a safety officer on site. NSF uses experts to evaluate safety. Chan pointed out that for the S3 DUSEL review there were safety experts on the panel. The S3 review panel consisted of a large, heterogeneous group that included mining experts, an OSHA person, an EPA person, and 4-5 safety experts. This group looked at all four sites within the context of safety, going well beyond normal mining conditions. A reviewed safety plan, acceptable to the NSF, is a condition of readiness.

Witherell felt that it was important to get on record that this was a concern. There was a similar issue with environment. Part of the technical design report should include plans for addressing safety and environmental issues with Agency, State, and Federal approval. Dalton felt there was a need to be proactive on safety and the environment and Maldonado asked if there is a plan in effect to look at the safety of the full integrated system. Witherell responded that these are not things that universities usually deal with except those institutions that have specialized systems, *e.g.* a nuclear reactor. These topics were discussed in a preliminary way but must be addressed in the management plan and will be critical to that plan.

It was pointed out that the model currently set funding caps, but how will MPS manage when there are overruns? Witherell responded that there needs to be an independent review of cost, schedule, and scope at the time of the readiness phase before the Director signs off. Chan pointed out that the cap on MPS support does not include items such as increasing commodity costs that are driving up construction costs. Witherell said that a construction project needs to either build to scope and have contingency funds or have plans to build to cost and plan to descope if necessary. Lightbody pointed out that part of risk management is to analyze contingency and Chan commented that For NSF it is difficult, as the organization only gets a budget on a yearly basis. Witherell felt that the setting of the MREFC level must deal with cost, schedule, and scope and include contingencies. The SCI refers to operations, which are not known until the design study is complete. At some point NSF must decide whether to cancel or to descope the project. Aizenman commented that a project is funded for construction through the MREFC budget line, and this is independent of the Directorate or Division. But it is important that the Directorate has taken management and operations (M&O) costs into account, as these funds must come from the Directorate. Chan added that the funding model is only one of the aspects. Has the science case been made for the project? This is critical, as M&O costs impact the rest of the Directorate.

Burrows asked a question about broader impacts. Women and minorities are under-represented in physics. What will the facility do for this? Dehmer noted that the question at this stage is whether or not there is sufficient support to continue planning for operations and for science. The project itself has given emphasis to broadening participation through work with local entities. A workshop coming up in April will devote a full day to this. It will be in the S4 solicitation. Witherell commented that the Deep Science report was equivalent to an NRC report. Dehmer commented that the whole point of the S1 solicitation was to define the science and scope of the project. The Geosciences (GEO) and Engineering (ENG) Directorates are interested, as is the Biological Sciences (BIO) Directorate. Parriott indicated that NSF made two mistakes in facilities. One was failure to develop a plan; the second was not to anticipate the cost of the science. One is currently in the stage of discussion and planning, the first step in trying to do DUSEL the right way. Witherell commented that Sanford had donated $70,000,000 to the project, and $20,000,000 will be used for the Sanford Center for Science and Education, although no one knows what this will be used for at the moment.

Abruna asked there the DUSEL project stood in the priority list for PHY. Witherell responded that there have been reports (NRC, NSAC, HEPAP) over time and they have been strongly supportive of the project reports that have been done over time are strongly supportive. The HEPAP P5 process is now underway and has a specific charge to prepare a roadmap for high energy physics. Dehmer commented that while the official P5 report is due out at the end of May; an unofficial version will be available within the next two weeks and Witherell said that the report will need to be taken into account. Abruna again asked about the priority of DUSEL compared to other physics projects. Dehmer responded and said that PHY had looked at the physics landscape and asked what do you need to do to answer the most important questions in physics -- five of these questions are in particle physics. Abruna felt this was "the choir speaking." Dehmer responded that a major question is where PHY fields are going. PHY wants to optimize the PHY portfolio for the community. Support flows into all fields. For example, atomic and molecular physics went through a revolution, an area where PHY has major support; and it is a field less expensive than others. Another trend is the study of gravity. PHY has made an enormous investment in gravity since 1992. The Division must balance AMO, QIS, Physics of Living Systems, *etc.*, against each other, on different time and cost scales. The Directorate must balance PHY against CHE, *etc*. DUSEL is the highest priority of PHY and DUSEL can answer five big questions whereas the Large Hadronic Collider (LHC) can answer three.

Abruna asked Dehmer to identify the other projects. Dehmer responded that they were the upgrade for LIGO and IceCube. PHY is phasing out CESR because it is no longer at the frontier. The others are still strong. Facilities in PHY are balanced against everything, not just other facilities, and especially against the core programs. The request here is to approve of planning and finding out exactly what the cost of DUSEL will be.

Hughes asked Witherell if he was asking to the MPSAC to accept/transmit the subcommittee report *and* recommend advancing the DUSEL project to the readiness stage. Witherell said that the MPSAC would be asked about this the next day. Hughes then asked about the rest of the process and what came after readiness. Lightbody responded that the output from the readiness stage would be the Preliminary Design Report (PDR). The PDR review goes to the NSB for consideration.

McDuff said that it appeared that if the MPSAC were signing on to this DMS would receive no benefit but would be contributing to operations costs. The MPSAC will not get to make another recommendation later on and what happens if costs increase significantly? Chan responded that by moving on to the Readiness stage MPS will be above to determine what DUSEL will actually cost, and this requires a PDR. Witherell added that there are off-ramps from the readiness phase – priority, overtaken by events, overruns, *etc*.

Gallagher pointed out that the Director wants MPSAC to look at the impacts of the project on MPS and the science case for the project. MPS does not yet know what the costs of DUSEL will be and the MPSAC is being asked if the DUSEL project, based on its priority and its scientific merit, should enter into a stage where the actual costs of the projects can be determined. is ready to enter into planning to determine costs. Arnold stated that there are really two questions here, and it is hard to be affirmative in either case. The subcommittee looked at what had taken place with the project to date and has indicated that due diligence had been done. But there is only so much the MPSAC can do, and this is not a new review of DUSEL. This should be clear. This is not a new review.

There was further discussion on this point, with concern on how to limit impact and the fact that some MPSAC members felt that DMS and CHE concerned because they had such large principal investigator programs. It was noted that support for the Chemical Innovation Centers and Math Institutes might have been supported in this way.

Arnold commented that mixing of the charges in the report is what has caused the trouble. The charge was to investigate whether DUSEL should enter the "Readiness" stage, not examine a co-investment model. Williams asked if the project could be recommended for "Readiness" without having a co-investment model. Chan responded that the Office of the Director had asked MPS how the management and operations would be supported, and Aizenman pointed out that the Directorate requesting construction support had to pay for management and operation. A "straw" model to do that had been proposed but how that would actually be done remained an open question.

Adjournment

The meeting was adjourned at 6:00 P.M.

Friday, April 4, 2008
Morning Session

The MPSAC convened at 8:30 A.M.

Strategic Planning for FY 2010 and Beyond

The meeting began with an overview by Witherell of the morning activities. The first item on the agenda would be a series of short presentations on MPS concepts on possibilities for the FY 2010 budget request. That would be followed by a presentation by Dr. Jim Collins, Assistant Director of the Directorate for Biological Sciences (BIO) concerning joint initiatives between MPS and BIO. There would a lunch discussion with the Deputy Director of NSF, Dr. Kathie Olsen. Two action items that had been discussed the previous day would again come up for discussion: the DUSEL report from the Major Facilities subcommittee and managing the budget for support of this and other facilities.

In introducing the Directorate presentations Chan noted that the initiatives to be discussed this morning came out of an MPS senior staff retreat. The retreat was quite recent and so the ideas might not be very polished. In the near future there would be an Assistant Director's retreat and the discussions of the committee will be useful to to have at that time.

The following is a summary of the Directorate presentations. The presentations were limited to 5 minutes each.

Diversity - Lynnette Madsen.

It is important to level the playing field for women and people from underrepresented groups. Some ways of doing this are: supplements for breadth, seed grants, partnership programs, workshops about empowering future generations, American Competitiveness and Innovation (ACI) Fellows, as well as outreach to K-12 and community colleges.

Education - Jack Lightbody.

MPS has a responsibility and opportunity to help STEM teachers, inspire young students, and train the next generation of scientists and engineers. Some budget doubling drivers in this area include: development of new technologies, addressing critical problems, attracting the best and brightest to STEM disciplines, and providing enhancement to STEM education. One could get leverage through elementary, middle and high school STEM education and teacher enhancement. Some specific initiatives would be the 5- to 10-fold expansion of the Research Experiences for Teachers (RET), doubling the Research Experiences for Undergraduates (REU) program and including 2-year schools, expanding K-12 to K-14 participation, developing NOVA-line video segments and teaching web-casts, supporting digital libraries and grid-enabled access to teaching and research tools at universities.

International - Adrian de Graaf

In recent times there has been more and more emphasis on international activities. NSF is in the process of developing long-range plan and has a working group concentrating on this issue. It will be on the agenda of the AD retreat. The way science is conducted has changed dramatically and is now global in character. The US is not likely to regain its former position. Broad global leadership is critical. We must increase global exposure of future US science leaders so that the US remains attractive for international talent. We should interact with the best science wherever it may be and engage in science diplomacy. MPS international strategies could include: broadening and building on current international activities, pursuing collaboration with funding agencies around the world, expanding involvement with international agencies, increasing support for education and training abroad, as well as developing science world networks and international science institutes.

CDI - Tom Russell

Part of the motivation for CDI is to increase American competitiveness. Projects have to be multidisciplinary and potentially transformative. About one-fifth of the CDI budget is from MPS. About one-quarter of proposals were tagged with a math label and about one-quarter were tagged with a label from other physical sciences. (Proposals can receive multiple labels.) The first awards are expected to be made in July of 2008. The procedure for FY 2009 is already set. For FY 2010 and beyond, a bottom-up approach is proposed. It is important for initiatives to have long term impact, continuing past the life of the grant, and for there to be a strong buy-in from the POs and from the directorates.

Sustainability - Zakya Kafafi

Sustainability is related to the economy, the environment, and society. It is urgent to address sustainability questions and to understand the problems at a fundamental level. We need to more than double energy production by 2050. It is important to invest in transformative research which will lead to as yet unimagined future technologies. NSF has a mandate through its mission statement to address sustainability issues.

Matter by Design - Andrew Lovinger

Matter by design refers to the ability to design and create any type of matter for applications. Why now? First of all, there have been recent, powerful breakthroughs. Also, this topic is one of the priority research areas for a number of other countries. Various types of designed matter include hierarchical matter, self-replicating matter, material for biomedicine, metamaterials, and biochemical machines.

Designed Emergence - Raima Larter

How does matter design itself? Answering this question is centered in the MPS sciences but also goes beyond to other disciplines. Why now? The principles of self-organization and self-assembly in complex systems are now better understood. The philosophy underlying such research is “Until we make it we won't truly understand it.”

Quantum Science and Engineering - Charles Conover

The study of quantum science and engineering is driven by a wish to understand the world more deeply and to find out what we can do with such phenomena. Why now? There are a number of motivating questions, such as the following. Is there physics beyond the known quantum theory? How will quantum behavior exhibit itself as we continue to miniaturize electronic systems? There are also a number of motivating tools including phase controlled optical fields, attoscience, and optical cooling. Why MPS and NSF? This area crosses MPS divisions and provides opportunities for basic research.

Science of Observation - Nigel Sharp

This initiative deals with extending human capabilities to go beyond the current horizons. Specific examples include atomic level imaging of impurities, multi-scale real time imaging, etc. This is a good area for creating new partnerships.

Plasma Science - Charles Conover

Plasma is involved in many areas and scales. Understanding plasma is a challenge. The big questions relate to the physics of the universe, basic science, and everyday life. Why MPS? This area crosses all five MPS divisions and connects with other directorates. Why now? There are many opportunities for basic research. There is also a partnership in place between NSF and DOE.

MPS-Life Sciences Interface - Denise Caldwell

This initiative evolved in response to the research community and is research driven. It spans all of the divisions in MPS and 3 of them have programs related to life-science (math, materials research and physics). Chemistry has

30% of its budget devoted to this interface and various centers have a component devoted to it. Why? Because work in life sciences stimulates the imagination concerning the fundamental question of what constitutes life. Why Now? The community is already working on such questions and NSF is playing catch-up. Why NSF? Because NSF can break down traditional disciplinary barriers.

Witherell thanked everyone for their presentations.

Continuation of Discussion of Major Facilities Subcommittee Report on DUSEL and the Proposed Co-investment Model

Witherell summarized the previous afternoon's discussion: A trial balloon was floated about the budget. Chan had proposed a budget line with increments that could be used to fund new projects such as facilities. Some people liked the idea and others didn't, with the split running roughly along the lines of divisions which have facilities and those which do not. It was suggested that Chan come back to the committee with a more fully developed model for this budget tool so as to make a more convincing case.

Chan agreed with the summary. He expressed disappointment that he had not been able to explain the concept more clearly. The tool was intended to make things more transparent and not just as a way of funding facilities. Abruna remarked that the committee needed to decouple the specific case of DUSEL from the general model.

Witherell remarked that the MPSAC should also discuss DUSEL. He reminded the MPSAC that they are solely in an advisory capacity. Witherell also wanted the MPSAC to discuss the Major Facilities subcommittee report. He will go back and rewrite parts of the report so as not to offend certain communities. But the conclusions would not be altered. Some of the questions to be answered were: Should the report be made public now or should it be sent back to the subcommittee? Should DUSEL go into the readiness stage? How should Management and Operations be budgeted?

Dalton said it should be emphasized that NSF is taking a leadership role in safety and other areas. Witherell suggested that after he makes the changes the Major Facilities subcommittee report should go public. Aizenman pointed out that if the committee accepts the report then there is a subcommittee recommendation that needs to be addressed as to whether DUSEL should go into the readiness stage. Does the MPSAC agree with the subcommittee's recommendation? Chan pointed out that the MPSAC recommendation become official advice to the Assistant Director of MPS.

Witherell said he wanted to find out how the members of the Major Facilities subcommittee currently think. Speaking as a member of the subcommittee, he thinks that DUSEL should move on to the "Readiness" phase with certain concerns expressed such as, for example, how it will be funded. He suggested that each member of the Major Facilities subcommittee state what they thought.

Soboyejo said that the information presented yesterday was not sufficient for him to understand the potential impact on NSF. He suggested a strategic analysis that would address this issue. He said that MPSAC members were nervous because they do not fully understand what the proposed budget process for this project would be. Witherell pointed out that one can not know what the budget will be in the future. This model could set a pattern for all facilities of a certain scale.

Chan said that he was not asking the MPSAC for a proposed budget. But the committee could give advice about what MPS should do with the budget when it is known, for example, in order to protect a certain program or facility.

Abruna suggested making several different plans for various budget scenarios. Gallagher pointed out that PHY is saying this is their number one priority. Managing this program will change PHY and it should go ahead.

Keyes asked about involvement of other parts of NSF in DUSEL. Witherell answered that MPS and Physics are leading the way but other disciplines will be involved. Chan said that MPS is taking responsibility for the budget and costs for management and operations. GEO and ENG are also explicitly involved. BIO is not giving the project high priority. Dehmer said that other NSF Directorates will be involved but MPS will be the steward for the project.

Witherell suggested the committee consider an action item to accept and transmit the report with mixed reaction to the investment strategy as well as the need for more information about the funding impacts on MPS. Hughes asked whether this meant the MPSAC was recommending that DUSEL moves forward to readiness. Witherell clarified that no, this is not a recommendation on readiness.

Aizenman added that this is only the MPSAC committee accepting the Major Fcilitiy subcommittee's report. An alternative would be to send the report back to the subcommittee for revision. Gallagher asked when the MPSAC would make the DUSEL recommendation. Witherell suggested it could be done at the next meeting. Chan said that to take DUSEL forward he would need some sort of recommendation, but he could always go against the recommendation. Gallagher said he would prefer to accept the report at same time as recommending that DUSEL go forward.

Canizares said he had two questions he wanted answered: Is the project in shape to advance to readiness? And is MPS ready to go ahead with it? Dehmer pointed out that "readiness phase" is not a good term since the next phase is really a design phase. He also said that NSF can't seek a partnership with DOE until the project goes to readiness. Lightbody suggested that the committee could make a recommendation which included the concerns that have been expressed. Arnold proposed that the committee could endorse just going into readiness, but no further for right now.

Witherell called for a vote about whether to recommend going into the readiness phase even though budgetary planning needs to be worked out. Of the committee members, 8 felt comfortable with this suggestion, 5 were not comfortable, and the rest abstained.

Perspective from the Directorate for Biological Sciences: The Intersection of the Life and the Physical Sciences

Dr. James Collins, Assistant Director of the Directorate for Biological Sciences (BIO) introduced his talk by noting that there is frequent mention of the mathematical and physical sciences turning increasing attention to the biological sciences and he commented that MPS has interacted with BIO on several levels, including co-funding of projects of mutual interest, *etc*. and that BIO is interested in areas of research that involve theory.

He noted that the interface between life and the physical sciences is getting richer and that the interface for BIO between physical sciences is becoming transitive. Furthermore, seven of the 23 mathematical challenges are BIO problems. In the area of prebiotic chemistry one wants to see how chemistry moves to organic chemistry and then to biochemistry. The conceptual areas that are a focus are complexity, emergence, string theory (of interest to physics), and energy as the basis of life. He noted that the physics of light harvesting in plants has had some great theoretical breakthroughs. Chemistry is needed to understand the question of the transition to life and one needed to understand the interfaces between the biological, geological, and atmospheric sciences and how they interact to affect climate change. This information is needed in order to understand what to expect in the future in the environment and biological systems. On the other hand, there is no question but that biological systems affect the atmosphere, and one needs the physical sciences to understand these phenomena. The field of complexity needs to deal with biology, the physical sciences, engineering, and the social sciences to begin making predictions. We now see machines that are mimicking nature, and as we begin to look at living tissues we begin to see involvement of the materials research community and the science of biomimetics.

Collins sees a need and a problem in encouraging support for this growing cross disciplinary area and a need to educate future biologists. One has to ask what the curriculum for biologists of the future will be and determine the educational, institutional and cultural barriers that will affect this transition. Finally, are there funding models that can serve this growing science? He noted that there is now a program director that has a joint appointment between the Chemistry Division in MPS and BIO.

In the discussion that followed Collins' presentation it was noted that Arizona State University is developing new schools that work at the interfaces of these sciences and that one of the frequent questions that come up is how to deal with the undergrads who want to become involved in these areas. The two sciences need to meet in the middle for training. There are many different interests. It was noted that at the Mellon Foundation there is a vertically integrated program that brings primarily undergraduate students in mathematics and biology together. Finally, there

is interest and enthusiasm in this area from the mathematical, physical, and life sciences and the question is now how to develop that interest.

Discussion with NSF Deputy Director Kathie Olsen

Witherell welcomed Dr. Kathie Olsen, Deputy Director of NSF to the meeting. He gave an outline of a number of areas that he and the MPSAC wanted to bring to her attention including the current budget situation facing NSF.

Olsen responded by saying that this is an unusual year as it is a transition year because of the presidential elections that will take place in November. The large budgetary increase expected by NSF for FY 2008 was, to a large extent, directly tied to the American Competitive Initiative or the America Competes Act. The increase has not materialized. NSF had received a small increase just above one percent of its FY 2007 budget. There was a slight hope for increased funds in the form of a supplemental funding bill now being considered by Congress, but the chance for this being passed with additional funds for NSF was very uncertain.

The outlook for FY 2009 budget request is that there is a strong likelihood of a continuing resolution in the early months of FY 2009. The FY 2010 budget will face the scrutiny of a new administration and NSF is preparing for various possible scenarios. Dr. Olsen stated that NSF needs to be ready to justify key investment areas and that climate change and the economy will likely be very important.

In response to a question by Witherell chair regarding the MREFC process, Dr. Olsen responded that a working group has been formed to study the current process and to make recommendations for the future. No final decisions have been made, but it is already apparent that input regarding lifecycle costs, management and oversight, as well as education impact will need to be available earlier in the decision process than is currently the practice. In a related matter, Dr. Olsen commented on the new NSF-wide policy of data sharing. For example, the data generated by a large facility would be expected to be shared with the wider scientific community.

Witherell summarized the role that the MPSAC is playing in providing guidance to the Directorate on various issues including ACI, facilities, and various research opportunities. The current process is for the MPSAC to select a subcommittee to work on these topics between the two annual meetings and then report back with a white paper to the entire AC. Chan had previously indicated that this process is working very well and that the recommendations from the AC developed in this manner have been very helpful to the Directorate.

In response to a question on what mechanisms exist at higher levels within NSF to support “interfacial” or multidisciplinary research Olsen said that the Office of the Director strongly supports and encourages such research but that it leaves the awarding of grants to the Directorates. Some very modest amounts (a few millions) are available for the Director to invest in particularly worthwhile and potentially transformative activities at the boundaries between different disciplines.

Another question dealt with the role of initiatives versus unsolicited proposals as budget drivers. Olsen responded that OMB does not find the argument that the average NSF success rate is too low and should be raised to 30% convincing. NSF needs some focus in its research objectives. After an initiative has run its course the funds return to the program base.

Olsen described the annual budget process and the interaction with OMB. She then discussed possible partnerships with special focus on the National Institutes of Health (NIH). NSF carries out a number of joint activities with NIH and more collaboration is needed. A recommendation has been made by NSF that NIH set up a panel to set priorities for the interface between the Physical and Biological Sciences.

Witherell thanked Olsen for taking the time to meet with the MPSAC.

Other Business

Witherell made several comments concerning planning the work of the MPSAC that would be done over the next few months, and then the rest of the discussion could be devoted to facilities issues. If needed, he will put together a Research Opportunities Subcommittee with the chairs of the breakout sessions to be members of this subcommittee.

He noted that the NSF Assistant Directors have two retreats concerning preparations for the FY 2010 budget, and between these retreats Chan would let the subcommittee members know what issues it would be important for them to address.

With regards to the Major Facilities subcommittee, Witherell had the impression that the DUSEL project is ready to move forward into the readiness stage subject to the qualifications in the report, but that the committee as a whole is not yet satisfied with the budgetary planning and impacts on the rest of the division of the project. He asked what should be done with the subcommittee report. He recognized that it would be important to endorse the subcommittee report in a way which implies it is not necessarily the recommendation of the whole committee. He asked if the fulcrum of the committee (meaning its center) was comfortable with what he had outlined. Hearing no negative response, he said that he would craft precise wording for the endorsement.

Chan said that he needed advice about what information the committee needed to make their recommendation. He is already aware that people want quantification of the budget scenario. Witherell pointed out that great budgetary detail might be difficult to decode, but the committee needed some idea of the guiding principles for the budget. McDuff said that she was unconvinced by Chan's statement that the impact would equal across the divisions. She would like to have mechanisms in place which would make sure that the impact would balance out. Arnold concurred with McDuff. In the discussion on this matter it was pointed out that a committee can only give advice. Soboyejo said that while he didn't need to know the whole budget he did need to know what implications DUSEL would have, and Burrows wanted more information on the scientific and workforce impact of the project.

Witherell concurred and asked that this conclude the discussion of the budget. He asked that the last few minutes of the session be used to go around the room so that the outgoing members could make some parting remarks.

Arnold said that he had served under two MPS Assistant Directors and there was a big difference. Under the first, he felt the MPSAC advice was ignored. Under Chan, he felt the opposite. He also praised Witherell's institution of subcommittees. Arnold was not happy about having to work with white papers containing buzz words, considering budget drivers, and so forth. He found it useful to talk about initiatives coming from the bottom up.

Burrows commented on Witherell's “fulcrum,” or center of the MPSAC. She does not want people to forget the fringes as well. She said that one can build useful interfaces there.

Canizares said that diversity of the MPSAC is a great strength as is diversity in the directorate. He commended Chan for his involvement and frank interchanges with the MPSAC.

Dalton said that the greatest single issue which NSF could address would be giving a sense of confidence about continuity of the budget. He has had students tell him that they did not want to go into science because of the budgetary uncertainties. He feels that one of greatest obstacles is the perception of science as a difficult way to make a living. It is important to convince the public that science is worth funding. Scientists have to learn to play the initiative game effectively to bring in more money.

Hughes thanked the person (she does not know whom) who suggested she be on the MPSAC. She also thanked the MPS people for their work for the good of the community. She agreed with Dalton that it was important to attract young people to the field.

Onuchic said that he had enjoyed being on the MPSAC. He liked the fact that members of the MPSAC considered broad issues and did not restrict themselves to their own particular disciplines. He also enjoyed learning about new and exciting science. He agreed with Arnold that Chan made the MPSAC process much more open.

De la Cruz had to leave the meeting earlier and was not available to comment.

Witherell said he become a member of the MPSAC after being the Director of a national laboratory. When Chan asked him to be Chair of the MPSAC, he responded “Does the committee want to work more?” He based his style of chairmanship on the model he had developed in at the laboratory and which seemed to work well.

Chan said that it had been a pleasure to work with the MPSAC for the last year and a half. He commented that Witherell had really taken his responsibility as Chair seriously despite his other commitments. Chan also thanked all the MPSAC members.

Hughes pointed out that the committee should also thank Aizenman for taking care of arrangements for the meeting.

Adjournment

The meeting was adjourned at 2:00 PM.

APPENDIX I

ATTENDEES

MPSAC Members Present at NSF
Hector D. Abruna, Cornell University
Douglas Arnold, University of Minnesota
Cynthia Burrows, University of Utah
Claude R. Canizares, Massachusetts Institute of Technology
Larry R. Dalton, University of Washington
Patrick D. Gallagher, NIST Center for Neutron Research
Rhonda Hughes, Bryn Mawr College
David E. Keyes, Columbia University
Theresa A. Maldonado, Texas A&M University
Dusa M. McDuff,, SUNY-Stony Brook
Monica Olvera de la Cruz, Northwestern University
Jose N. Onuchic, University of California, San Diego
Winston Soboyejo, Princeton University
Joel E. Tohline, Louisiana State University
Robert Williams, Space Telescope Science Institute
Michael Witherell, University of California, Santa Barbara

MPSAC Members Absent
Dennis L. Matthews, University of California, Davis
Eric A. Cornell, University of Colorado
Iain M. Johnstone, Stanford University
William L. Jorgensen, Yale University
Ian M. Robertson, University of Illinois at Urbana-Champaign

MPS Staff
Morris Aizenman, Senior Science Associate, MPS
Tony Chan, Assistant Director, MPS
Adriaan de Graaf, Senior Advisor, MPS
Joseph Dehmer, Director Division of Physics
Luis Echegoyen, Director, Division of Chemistry
Eileen Friel, Executive Officer, Division of Astronomical Sciences (present via phone)
Zakia Kafafi, Director, Division of Materials Research
Jack W. Lightbody, Executive Officer, MPS
Deborah Lockhart, Executive Officer, Division of Mathematical Sciences
Celeste Rohlfing, Head, Office of Integrative Activities
Ulrich Strom, Acting Executive Officer, Division of Materials Research
G. Wayne van Citters, Jr., Director, Division of Astronomical Sciences (present via phone)

Visitors
John Henry Scott, Office of Science and Technology Planning (OSTP)
John Carlstrom, University of Chicago (presentation of AST COV via telephone)
Lance Haworth, Director, Office of Integrative Activities
Kathie Olsen, Deputy Director, NSF
Joel Parriott, Office of Management and Budget
Paul Peercy, University of Wisconsin (presentation of DMR COV via telephone)
Venkatesh Narayanamurti, Harvard University (presentation of status Light Source subcommittee via telephone)

APPENDIX II
BREAKOUT SESSION ROOMS
MPS Advisory Committee Meeting
April 3, 2008

		DIVISIONAL ASSIGNMENTS FOR MPSAC MEMBERS					
		AST	**PHY**	**CHE**	**DMR**	**DMS**	
		Room	**Room**	**Room**	**Room**	**Room**	
		880	**970**	**730**	**770**	**580**	
Term Ends 09/30/08							
	ARNOLD					R	
	BURROWS			R			
	CANIZARES	R					
	DALTON			X			
	HUGHES					X	
	OLVERA				R		
	ONUCHIC		R				
	WITHERELL		X				
Term Ends 09/30/09							
	JOHNSTONE					A	
	JORGENSEN			A			
	KEYES					X	
	MALDONADO		X				
	MCDUFF					X	
	ROBERTSON				A		
	SOBOYEJO				X		
	WILLIAMS	X					
Term Ends 09/30/10							
	ABRUNA			X			
	CORNELL		A				
	MATTHEWS		X				
	TOHLINE	X					
Term Ends 09/30/11							
	GALLAGHER				X		
A	Absent						
R	Breakout CHAIR, MPSAC member who will summarize Divisional meetings activities to MPSAC						

APPENDIX III
BREAKOUT REPORTS

Division of Astronomical Sciences Breakout Session Report

C. Canizares (*Rapporteur*), J. Tohline, R. Williams

1. COV report

AST is justifiably pleased with report, which is very supportive of the Division. The AST members of MPSAC (one of whom also served as a member of COV) strongly endorse the report and recommend approval and transmission by the MPSAC. Several of the items discussed by the COV were reviewed by our subgroup, and are addressed here.

We spent some of our time on the question of AST staffing, which is a major issue for AST. AST is particularly affected by this because it is the one division that has more than half of its funding devoted to the oversight of facilities, both under construction and in operations. FTE per proposal is not the only metric that should be used for determining staffing levels. We also discussed whether the MREFC process should include an internal NSF staffing and management plan, in addition to the construction and operations life-cycle cost plan.

We also endorse the COV recommendation that the Senior Review process be "institutionalized" as a sensible way to involve the community in the process of setting on-going priorities. We suggest that the timing be such that a Senior Review should follow each decadal study by a few years, in order to determine NSF's implementation plan for achieving the objective of the decadal report.

2. Senior Review Implementation

As we did at the last MPSAC meeting, we endorse the actions of AST in carrying out the recommendations of the last Senior Review. We understand and appreciate the fact that AST is receiving strong support within NSF, from COV, and from MPSAC. This is a very difficult and painful process, and we commend AST for dealing with the affected communities firmly but also fairly and with sensitivity. We were pleased to learn that several of the affected observatories are likely secure outside funding, allowing them to continue operations, albeit at a reduced level.

3. Budgets

AST is trying to cope with the uncertainties in the 2008 budget, pending final approval of the operating plan by Congress. The ongoing costs of facilities, major construction (ALMA), and facility design activities (ATST) create a serious "inelasticity" in the AST budget. This would be even more problematic in the likely case that the 2009 budget is delayed until past the election or even the inauguration (even more draconian national budget scenarios are also possible). AST is wise to try formulating contingency plans.

We also discussed the future of "ACI" budget increases under a new administration. ACI was this administrations response to the NRC report "Rising Above the Gathering Storm." That report stressed the importance of basic research as well as the "competitive" aspects of research that has more immediate commercial applications. NSF is charged by the federal government to be the steward of basic research and of the core communities in the scientific disciplines. Within NSF, MPS should be the prime advocate for this stewardship role. Support for this component should be elevated by MPS and NSF, not submerged.

4. MPS Co-Investment model

Our subgroup was strongly supportive of this concept and encourages MPSAC and MPS leadership to keep working on and refining the model. The idea of creating a possible funding wedge for strategic initiatives (including but not

limited to MREFC projects) is extremely attractive. Of course, this will be much easier to implement if the promised budget increases materialize.

5. LSST readiness

We received a brief report on the significant progress that has been made, in part thanks to some significant private funding that has been secured to advance the design and pursue casting of the 8.4m primary/tertiary mirror. The project underwent a very successful conceptual design review late last year. A key factor going forward will be securing the participation of DOE as a major partner, and the timing of this relative to NSF's MREFC process needs to be worked through. DOE's HEPAP and its subcommittee P5 are reviewing the project at this moment.

6. Decadal survey

Planning is underway, and NSF is in active and productive discussions with its partner agencies, NASA and DOE, along with OSTP and NRC. Final funding decisions are expected within the next month. The group is looking hard at "lessons learned" from the last survey. The charge will likely include reconsideration of all projects not already underway, independent costing, and broad community interactions.

Division of Chemistry Breakout Session Report

Cynthia Burrows, *Rapporteur*
Other MPSAC attendees: Hector Abruna, Larry Dalton

The CHE break-out session focused on (1) the budget, (2) activities resulting from last year's COV, (3) scientific drivers for the FY2009 budget request, and (4) various administrative topics including the strategic co-investment model (SCI).

The session began with a discussion of the FY 2008 budget expectations vs. realities, the even higher expectations of FY2009, and the likelihood of significant budget increases. CHE has done an excellent job of balancing the portfolio in the past year. It was noted that there was a significant increase in the number of proposals received this year, although the success rate did not diminish too dramatically. A significant portion of the next year's budget is driven by ACI-related activities, notably the Centers for Chemical Innovation. The current budget likely will permit funding of only one new Phase II center in the present competition. Another point of discussion was the large number of graduate students (and postdocs and undergrads) trained by CHE grants, which is part of the major impact of CHE.

Budget constraints have caused certain programs to be "paused" for assessment and possible re-inaugeration. These include the Discovery Corps Fellowships and the URC (early undergraduate research) program. The CRC program (collaborative research in chemistry) will continue, but applications will not be specifically solicited. There has also been some reorganization and optimization of how the proposals are handled within CHE.

International collaborations in chemistry were discussed. Current programs exist cooperatively with Germany and China, and the division is building programs with France, Spain, Brazil, India, and Argentina. This is done through direct discussions of chemistry program staff with their chemistry counterparts in other countries, not through an administrative superstructure. International expansion of the REU program is also underway.

As part of ACI-driven activities, CHE has developed an ACC fellows program. These are awards at the postdoctoral level for those within 2 years of PhD at the level of $200K/yr. These involve partnering with "big science" at a national lab or industry or Center 9CCI). The first deadline is May 1, 2008, and 5 awards are expected. These plans received strong endorsement from AC members.

The current status of the Centers for Chemical Innovations was discussed. These are ACI-driven, major research investments in multi-investigator, grand challenges. They have a novel funding scheme compared other MPS centers that involve a 3-year phase I award before competing for funding as a full-fledged Center (phase II). This scheme allows the division to take major risks in funding new and innovative projects while containing risks to a

lower, shorter-term budget. CHE is in the midst of reviewing 3 phase I centers for transition to phase II transitions. During this process, CHE is continually evaluating the parameters of the program: Is the 3-year period of phase I the appropriate length? 4 years? What are the mechanisms for reapplication?

Cyber-Enabled Discovery and Innovation was discussed; in a recent set of NSF-wide applications, a respectable number (18 of 204) of full proposals were of interest to CHE.

A significant portion of our discussion centered on the recently released report on Strategic Directions for CHE, 2008-2012. This self-study was suggested by the 2007 COV, and a significant effort was made in fall 2007 to develop a plan. Many CHE staff members participated and input was solicited from the chemistry community, in part through the Town Hall Meeting of the Fall 2007 American Chemical Society National Meeting. The NSF-CHE committee identified 8 critical issues, generated goals in each of these areas and strategies for achieving them. They also discussed strengths, weaknesses, opportunities and barriers to achieving these goals.

The 8 Critical Issues:

1. Advancing ACI: Chemistry has continued to sponsor workshops on emerging areas of research and interdisciplinary topics, particularly relevant to ACI. Continued expansion of the CCI program.
2. Communicating the value of chemistry to the public: Discovery corps fellowships might be aligned in this way.
3. Increasing Global Engagement (discussed above).
4. Increasing Grand Challenge Research through Centers (discussed above).
5. Broadening Participation: the workshop on URM faculty in September 2007 generated a great deal of positive feedback from the participants. For example, MIT has plans for a mentoring workshop for URM faculty that will be presented at the Town Hall meeting at the National ACS meeting next week.
6. Funding needs of investigators at different career stages—somewhat surprisingly, mid-career PIs are having issues. CHE will look into this and try to understand comments coming into the division.
7. Assessing the broader impacts review criterion: CHE is taking a leadership role in planning an outside assessment to see what the impact of this review criterion has been. It would be helpful to have a clearer definition of broader impacts and a set of best practices.
8. Updating the division of chemistry structure. After lengthy discussion within the CHE staff, no major realignment or renaming of programs is recommended at this time. However, the AC members thought that is important to continue to have this discussion and to revisit this issue from time to time.

Pertaining to staffing, there were positive points discussed including approval for hiring an additional senior administrator and the recent appointment of a shared program officer with MCB. Additional ones are needed for example with DMR.

Also in the business plan was a new use of PO comments to PIs, particularly following declined applications. The pilot plan is to include PO comments about how the final decision was made. This came in response to the COV.

There was substantial discussion about Science Drivers that might go forward to assist the next budget request process. Some thoughts that emerged:

- Sustainability must be a major focus. Fundamental research that underlies basic principles that will aid the development of alternative energy. Electron transfer, photochemistry—the interaction of light with molecules, energy storage and conversion, and di- and tri-atomics research. DOE does an exceptional job, but CHE must also participate. Fundamental breakthroughs are needed rather than tweaking existing systems in order to have real impact. This is the role of basic research.
- Science of interfaces: soft tissue to bone—how do these molecules connect? Natural environmental interfaces—biofilms on water or rock, biogeochemistry, air/water interfaces. Chemistry and physics of interfaces, materials and composites. These issues are fundamental to energy storage and information technology, molecular electronics, emergent phenomena and complexity, biomolecules in membranes and aggregates.
- Understanding the Universe: organic chemistry of distant planets plays a role in the origins of life.

We concluded the discussion on science drivers by noting that in multidisciplinary collaborations (among chemists,

biologists, physicists and engineers) the language of Chemistry serves as the universal translator.

Finally, there was a discussion of the strategic co-investment model (SCI) that was proposed to handle continuing costs of major facilities. This was part of the ongoing discussion of the DUSEL project. AC members expressed strong opposition to an across-the-board cut, or flat tax, that would decrease the budget in every division equally. In particular, there was significant concern about the message this would send to the Chemistry community. However, AC members could support a model that protected the individual investigator portions of divisions' budgets, and instead used a portion of each division's facilities/centers funds to create the co-investment funds needed in the future. AC members recommend that MPS proceed with extreme caution in this area.

Division of Physics Breakout Session Report

Participants: Michael Witherell, Theresa Maldonado, Dennis Matthews and José Onuchic

We were well impressed by the Joe Dehmer's presentation about the current status of the physics division and its future plans. The promotion of Denise Caldwell as the new Deputy Division Director has been a positive development. Denise and Joe form a great team.

The physics division in recent years has been able to keep an appropriate balance supporting the "core" programs while at the same time making sure to broaden the division towards new and exciting scientific programs. As Joe took over as division director, he created the physics of the universe program, one of the currently exciting research areas in physics. Later new exciting programs were implemented such as biological physics (now physics of the living systems), physics of the information frontier, and special emphasis to atomic and molecular physics during its rebirth period, etc. The creation of the physics frontier centers, integrating all the physics centers, created a center mechanism to make sure that the division is actively supporting the frontiers of the physics while at the same time is sufficiently flexible to adapt to the new frontiers as they move over time. There is no question about the great impact of these centers, both on great science and training as well as education and broadening participation. We agree with the division that the instrumentation initiative is still needed, but given funding constraints could be delayed. We do not disagree with delaying the start of this program but we would not like to see it disappear.

We were happy to see that the division has maintained its overall plan where at least 50% of the budget (normally more) is devoted to the core programs that fund single or few investigators award. This commitment is viewed as essential for the health of the division. They have also kept caps of 10% for the physics frontier centers and 35% for facilities.

How to fund facilities has been one of the major topics addressed by this subgroup. We had an extensive discussion about the future plans of the division on how to fund new initiatives and keep support to the current ones. The division fully understands the need to close some facilities when new ones are created. This is a painful but much needed process. The division during the last year has worked very close to the MPSAC subcommittee on facilities. We view very favorably the new proposed mechanism of co-support with the MPS directorate for operational costs. Also, the new mechanism in place of "not going into readiness unless the plan makes sense" was a much-needed operational plan. DUSEL appears to be a very exciting scientific opportunity but much care and attention is needed as the division moves towards this major scientific enterprise.

The division has also capitalized on some exciting new scientific opportunities that involved foundation-wide participation. The 2010 planning research topics are a very exciting list. The new MPS-Bio initiative and cyber infrastructure are good examples of some these opportunities that are currently being carefully discussed. Although we are very supportive of this programs we believe that a broad participation of interested parties in the foundation need to be involved in those discussions in order for them to be fully successful.

The energetic move by the division towards broadening participation has been viewed as essential for the health of the division. The current effort of using supplemental funding to support this effort in many different ways is a smart adaptive program. We were disappointed, however, with lack of information about activity following up on the workshop on diversity. The meeting had the participation of more than 50 chairs and deans, which have shared their success and frustrations in dealing with this major challenge. We would like to see if some actions coming from this

experience. This subgroup feels that one of the ways that the division can have impact on broadening participation is by translating best practices. To be successful in broadening participation efforts takes more than commitment, actually new and creative good ideas are much needed!

To conclude, we want to reinforce one more time the importance of international collaboration. We discussed this topic at length in our previous report but we want to make sure that special attention to this topic keep being devoted by the physics division.

APPENDIX IV

REPORT OF THE MAJOR FACILITIES SUBCOMMITTEE ON DUSEL

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May 22, 2008

Dr. Tony F. Chan
Assistant Director
Mathematical and Physical Sciences
National Science Foundation

Dear Tony,

At the April meeting of the MPS Advisory Committee we discussed the report of the Facilities Subcommittee on the Deep Underground Science and Engineering Laboratory (DUSEL). The Subcommittee, which I chaired, prepared that report in response to your charge letter of September 7, 2007. In this letter I am writing to communicate the consensus position of the full Advisory Committee that came out of our discussion.

At the end of the MPS Advisory Committee meeting, the full Committee endorsed the recommendation that as a project DUSEL was ready to advance from the Conceptual Design Stage to the Preliminary Design/ Readiness Stage, with the qualifying recommendations spelled out in the Subcommittee report. We did not feel that we could endorse the Strategic Co-Investment model of funding facilities and other strategic initiatives, however, since it has not been developed in enough detail to assess the impact of this funding model across MPS.

You heard the wide range of viewpoints from members of the committee on the issue of how operating costs for large facilities should be dealt with. You expressed an intention to make a presentation about your approach to strategic budget planning at the November MPSAC meeting, after you have had a chance to develop the ideas further with the MPS staff. We believe this will help promote a better understanding by the committee and allow us to provide better advice.

I am attaching the Report of the Facilities Subcommittee, which includes detailed recommendations on how MPS should deal with the DUSEL project and program, in addition to the findings and concerns that underlie those recommendations.

Sincerely,

Michael Witherell

Michael Witherell
Chair, Mathematical and Physical Science Advisory Committee

Report of the Facilities Subcommittee of the MPS Advisory Committee on the Deep Underground Science and Engineering Laboratory

Introduction

On September 5, 2007, Assistant Director Tony Chan wrote a letter charging the Facilities Subcommittee of the MPS Advisory Committee to look at the Deep Underground Science and Engineering Laboratory (DUSEL). He attached to this letter a general charge for the MPSAC Facilities subcommittee:

"The MPSAC Facilities Subcommittee is charged with:

- Assessing the potential contribution of new proposed facility projects to the scientific program of MPS, the role of such projects within the existing MPS facilities portfolio, and the impact of such facilities on future plans and budgets of MPS and its divisions; and
- Providing a recommendation to the MPSAC for the MPSAC statement to the MPS Assistant Director concerning an MPS request for entry of an MPS large facility project into the MREFC defined "Readiness Stage."
- Providing advice on elements of the MPS facilities portfolio at the request of the MPS Assistant Director."

He also gave the specific charge for DUSEL:
"I am asking the Subcommittee to prepare a recommendation to the full MPSAC as to whether DUSEL should enter the 'Readiness Stage' of the MREFC process."

Since that time the Facilities Subcommittee has worked to establish a framework for carrying out its role in giving advice on facilities in general, while addressing specifically the issues relating to DUSEL. We sent to MPS a set of questions about the oversight of facilities at NSF and within MPS in addition to detailed questions about the history and status of DUSEL. MPS sent us extensive responses to those questions, and we followed up with a series of discussions with MPS leadership. The overall result has been an extended discussion between the subcommittee and MPS about facilities, their role in the MPS research program, and about DUSEL.

In this report we summarize what we have learned about the process for designing, building, and operating facilities at NSF and specifically within MPS. In addition, we present our understanding of the status of the DUSEL project, and make some recommendations.

Large Facilities at NSF

"Facilities are an essential part of the science and engineering enterprise, and supporting them is one major responsibility of the National Science Foundation (NSF)."

The above quotation is the first sentence of the NSF Large Facilities Manual. In that manual, published in May 2007, the Foundation describes its plan for planning and managing large facility projects. Each such project goes through four stages: Conceptual Design, Readiness, (National Science) Board-Approved, and Construction.

For MPS projects, the first three of these stages are funded from the Research and Related Activities Account (R&RA). The construction stage for large facilities is funded from the Major Research Equipment and Facility Construction (MREFC) appropriation. At the end of construction, responsibility for operating the new facility reverts to MPS and the R&RA account. The transitions in funding type and in the responsible organization within NSF require particularly careful planning.

The NSF has established the Large Project Office (LPO) within the Office of Budget, Finance, and Award Management. The head of the LPO is Mark Coles, the Large Facilities Project Deputy. The LPO oversees all large facilities projects, of which there are currently 11 in development or construction. They are responsible for implementing the policies and practices in the Large Facilities Manual, working with the cognizant research directorate.

The Readiness Stage

Because of our charge, the Readiness Stage is particularly important to understand. We therefore include here the most important sections of the Large Facilities Manual relevant to this topic. The section of the Manual about the Readiness Stage begins with the following paragraph:

"The Preliminary Design/Readiness Stage further develops concepts to a level of maturity in which there are: a fully elaborated definition of the motivating research questions; a clearly defined site-specific scope; a PDP (Project Development Plan) that addresses major anticipated risks in the completion of design and development activities and in the undertaking of construction; and an accurate budget estimate that can be presented with high confidence to the NSF Director, NSB (National Science Board), the Office of Management and Budget (OMB), and Congress for consideration for inclusion in a future NSF budget request."

To enter the Readiness Stage, the project needs the following:

- a completed Conceptual Design proposal that has been reviewed and approved for funding, including a Project Execution Plan;
- approval by the Assistant Director, taking into consideration scientific merit and relative importance compared to other opportunities and demands for resources, with input from scientific community, disciplinary studies, advisory committee recommendations, and internal NSF considerations; and
- recommendation by the MREFC Panel to the NSF Director, who approves entry to readiness, and the concurrence of the NSB, as recorded by inclusion in the annual NSF Facility Plan.

A great deal needs to be accomplished in the Readiness Stage, as described in the Manual: "A candidate project exits from this stage and enters the Final Design/Board Approval stage after successful review by the MREFC Panel, and after the NSF Director recommends the proposed project to the NSB for approval to include in a future year budget request.

The MREFC Panel and the Director should first be satisfied that the following conditions have been met:

- the AD or office head of the sponsoring directorate or office (the originating organization) continues to assert the high scientific merit and importance of the project and has a sound financial plan for supporting the remaining pre-construction planning activities and the future operations and use of the facility;
- the Preliminary Design has been successfully reviewed internally and by an external panel of experts in order to obtain the best possible objective advice from authorities in the fields and disciplines utilized by the project;
- the DDLFP concurs that the Preliminary Design is reasonable and poses an acceptable level of risk, and that anticipated costs for construction and operation are sufficiently well known;
- the NSF Chief Financial Officer (CFO) certifies that the Preliminary Design budget has been satisfactorily defined;
- the NSF Director is satisfied that external participation in all phases of the project (other agencies, international and/or private sector entities, etc.) is well planned;
- updated Internal Management Plan and Project Development Plan documents have been reviewed and approved by the Facilities Panel (IMP only), the MREFC Panel, and the Director;
- an appropriate Project Leadership/Management team is in place; and
- the MREFC Panel asserts that the proposed MREFC project, when compared to other proposed projects – whether within the same field, across related fields, or across different fields – is among the very highest priorities for potential new facilities."

Advancement to Readiness Stage does not assure that a project will be started. The Large Facilities Manual describes the level of commitment to the project increasing as the project moves through the sequence of stages. It describes the following off-ramps from Readiness Stage:
" Projects may be removed from the Preliminary Design/Readiness stage by the NSF Director due to:

- insufficient priority over the long term;
- failure to satisfy milestones or other criteria defined in the IMP/PDP;
- eclipse by other projects;
- collapse of major external agreements;
- extensive estimated or actual cost overruns;
- significant changes in schedule for development;
- unexpected technical challenges;
- changes in the research community that indicate eroding support for the project; or
- any other reason that the Director deems sufficiently well-founded."

Budgetary Planning and Life-Cycle Costs

As facilities have become larger and more important to the national research enterprise, it has become more important to consider the costs of a facility over its entire life-cycle, including operation of the facility after construction. It is not uncommon for the operations costs to exceed the construction costs. Such operations costs are usually not reducible below a certain minimum level if the facility is to operate reliably and safely. Failure to account for these costs in budgets can cause problems for the entire research portfolio, as other programs are taxed to make up for unanticipated needs in facility operations.

We asked the MPS Directorate to provide us with their thoughts about how they are planning for the life-cycle costs, in particular the operations costs. They replied that they have been considering a "Strategic Co-investment" (SCI) model for major strategic investments, including but not limited to large facilities. In this model, a small fraction (of order 1%) of the MPS budget would be set aside each year for a special category of such co-investments, of which there would be a few across the directorate at any one time. This amount, about $15 million each year, would be given as in increment to the Divisions responsible for these strategic initiatives. This funding would be matched investments from the Division. For a construction project, MPS and the Division would reach agreement on the investment schedule at the time of approval for a construction start.

Overview of DUSEL and its Experimental Program

DUSEL is a "large scale, multi-purpose national facility that will exploit the considerable multi- and interdisciplinary discovery potential in science and engineering afforded by the deep underground environment." The primary scientific motivation for the project is a set of experiments in the areas of elementary particle physics, nuclear physics, and particle and nuclear astrophysics, and the Physics Division has taken the lead role in developing the project. MPS is therefore the lead NSF Directorate managing the process, although there is interest from Engineering and Geosciences in making use of the facility.

The first systematic look at a dedicated underground laboratory took place in 2001, when DOE and NSF cosponsored an ad hoc committee chaired by John Bahcall to look at opportunities in underground science. Since that time, a series of committees and panels have issued reports that have given support for an underground laboratory:

1. DOE-NSF Nuclear Science Advisory Committee Long-Range Plan (2002).
2. NSF-sponsored International Workshop on Neutrinos and Subterranean Science (NESS 2002) Final Report.
3. Connecting Quarks to the Cosmos (2003), National Research Council report.
4. DOE-NSF High Energy Physics Advisory Panel Long-Range Plan (2003).
5. Neutrinos and Beyond (2003), National Research Council report.
6. EarthLab (2003), NSF-sponsored report of underground opportunities in GeoSciences and GeoEngineering:
7. Report by the Interagency Working Group on Physics of the Universe (2004), National Science and Technology Council report.
8. Quantum Universe (2004), NSF-DOE High Energy Physics Advisory Panel Sub-Panel report.
9. Frontiers of Nuclear Science (2007), the Long Range Plan by the Nuclear Science Advisory Committee
10. Revealing the Hidden Nature of Space and Time (EPP2010, 2006), National Research Council report.

Partly in response to these reports, the Physics Division issued a DUSEL solicitation S-1, calling for a definition of the scientific program at such a laboratory. This led to the 2006 report *Deep Science,* written by a team led by six principal investigators from the fields of astrophysics, physics(2), civil engineering/ rock mechanics, geomicrobiology, and microbiology. (The report is available at http://www.deepscience.org .) This document gives the scientific justification for the project and recommends "a flagship world-class underground laboratory providing access to very great depth (approximately 2200 meters or 6000 meters water equivalent) and ample facilities at intermediate depths."

The initial physics program at DUSEL will be driven by two scientific campaigns. One is the attempt to detect directly the dark matter halo that envelops us. The astronomical evidence for dark matter is compelling and consistent. But to understand the nature of the dark matter, scientists are hoping both to observe its interactions in the laboratory and to produce dark matter particles at the Large Hadron Collider. The most recent review of the status of dark matter was the Dark Matter Scientific Assessment Group, which was a joint subpanel of the High Energy Physics Advisory Panel (HEPAP) and the Astronomy and Astrophysics Advisory Committee (AAAC). The report is available on the MPS website at http://www.nsf.gov/mps/ast/dmsag.jsp . They gave very high priority to a group of proposed experiments trying to extend the sensitivity to dark matter interactions into the range expected for supersymmetric particles.

The other scientific campaign is the search for neutrinoless double beta decay(DBD), which is being carried out by scientists from both the particle physics and nuclear physics communities. If neutrinoless DBD is discovered, it will both prove that neutrinos are their own antiparticles and measure the mass of the electron neutrino. The most recent review of the neutrino program was done by the Neutrino Science Assessment Group (NUSAG), a joint subpanel of HEPAP and the Nuclear Science Advisory Committee (NSAC). Its report on neutrinoless double beta decay is available at http://www.science.doe.gov/hep/NuSAGReport1final.pdf . They gave very high priority to an experimental program designed to increase the sensitivity in neutrino mass by one order of magnitude beyond present experiments.

Both of these reports were used as input to the "Particle Physics Roadmap," written by P5, the Particle Physics Project Prioritization Panel, in October 2006:
http://www.science.doe.gov/hep/P5RoadmapfinalOctober2006.pdf
That roadmap reserved the first group in its recommendation for the multibillion-dollar international collider projects needed to explore the energy frontier: the Large Hadron Collider now and the International Linear Collider in a decade's time.

The second group includes projects that are national in scope and significantly less expensive than the largest colliders. The three experimental programs given highest priority are dark matter, dark energy, and the exploration of neutrino mass. They said: "This grouping includes three small experiments: the 25 kg Cryogenic Dark Matter Search experiment, the Dark Energy Survey, and the Daya Bay reactor experiment. Also in this group is the support to develop the Stage IV dark energy experiments, the LSST and SNAP, to bring these to the 'Preliminary Design Review Stage' in the case of the NSF and 'CD2 Stage' in the case of the DOE over a two to three year time frame… The final item in this group is the R&D funding for DUSEL, along with support by the NSF and the DOE for R&D for both a large dark matter and neutrino-less double beta decay experiment. "

The P5 panel is now working on a new charge from Dennis Kovar of the DOE High Energy Physics program and Tony Chan of MPS. They have asked P5 to assess the current plans for the field of particle physics in the U.S. under four different budget scenarios. "The report should

also provide a detailed perspective on how the pursuit of possible major initiatives (such as DUSEL, ILC, Project X, etc.) would fit (or not) into the program you recommend in each of the scenarios." The panel is operating on a very compressed schedule. "We would appreciate the committee's preliminary comments by March 1, 2008 and a final report by April 15, 2008."

For the present purposes, we assume that the two experimental programs that comprise the flagships of the initial DUSEL physics program, double beta decay and the dark matter search, will keep their high priority in the new report. It is also important to follow the development of plans for additional major experiments for DUSEL. P5 is discussing the evolution of the accelerator-based program of particle physics in the U.S. over the next decade or two. They are considering the possibility of using the Fermilab accelerator complex as the base for the world's leading program of neutrino physics. This could involve the construction of a massive neutrino detector at DUSEL, serving as the target of a new, intensive neutrino source at Fermilab. This would extend the scope of the DUSEL experimental program beyond that planned for the initial round of experiments. It would involve large participation from the DOE High Energy Physics program. More information about those plans will be emerging from P5 and HEPAP in the months ahead.

The DUSEL Process

The NSF has conducted three program solicitations in association with DUSEL. The S-1 solicitation was for the development of the science case, and resulted in the "Deep Science" report. The S-2 solicitation was for statements of interest from candidate sites. The S-3 solicitation in the second half of 2006 was for a Deep Underground Science and Engineering Laboratory (DUSEL) Site Selection and Technical Design Development. In July 2007 NSF announced funding for a single proposal to develop advanced plans for DUSEL at the Homestake site, out of four proposals that were received. The team is led by Kevin Lesko of University of California, Berkeley and Lawrence Berkeley National Laboratory. The Conceptual Design Report associated with effort is available here: http://www.lbl.gov/nsd/homestake/conceptualdesign.html . The summary and conclusions section of this report includes the following: "The preliminary cost estimate ($FY07 without contingency) for the MREFC application is $410 M (including $225 M in experiments and $9 1M in design and outfitting for underground laboratories). Other funding totaling $180 M, including the Authority-controlled funds, will provide nine years of pre-operations support and underground lab preparation."

The commitment by the NSF is to the site and the proposing team for development of a technical design for the facility and is governed by a Cooperative Agreement (CA) with the submitting organization for the Homestake proposal -- the University of California, Berkeley. The CA is now in place and the first year funding of the three year award has been awarded. UC Berkeley is accountable for the success of the technical design phase of the facility. There is no commitment by NSF for the funding of DUSEL beyond the design phase, nor is there any implied commitment beyond the design phase to the project management organization.

With respect to the technical design of the experiments for DUSEL, it will be governed via a fourth solicitation (S4) that is in preparation. Institutional management, oversight, and accountability of the project beyond the design phase would be identified at the appropriate time in the project life cycle.

Oversight and Program Management of DUSEL

Assuming that the DUSEL project advances, MPS will take the lead in the development of the facility infrastructure, including large-scale physics instrumentation, in support of DUSEL maintenance and operations, and in support of the physics experiments and groups that would participate in DUSEL. The oversight will be done in consultation with Program Directors (PDs) from the three Directorates (MPS, ENG, and GEO), with a PD representing the Biological Sciences serving in a advisory capacity. All programmatic decisions and their implementation regarding DUSEL are and will be made in a collaborative fashion. Each Directorate is expected to support the research programs in its own disciplines.

DUSEL is currently overseen by one full-time Program Director (PD) in the Physics Division. Other PDs in Physics provide additional help during times of peak oversight activity. A search is under way for a second PD dedicated to DUSEL. The Program Director will conduct the project reviews, using external experts for both the technical and project (cost and schedule) aspects.

Budgetary Planning

It will be critically important to know both the construction costs and the management and operation (M&O) costs at the time of project approval. The present budgetary planning for the M&O phase of DUSEL has been done using a rough estimate that NSF will need to provide $50 M per year, or 10% of the construction cost. The ongoing technical design process should produce detailed cost estimates for both the construction process and the M&O phase.

MPS will need to provide funding for the parts of DUSEL not included in the MREFC appropriation, including planning, R&D, preoperations, and M&O. It is presently assumed that the integrated cost for these items will ramp up linearly from the level of $7 million per year in FY 2007 to an amount of about $50 million per year at the time construction ends. PHY is requesting co-investment from MPS for a base budget build-up of PHY by an amount of 3M$/year/year over the 7 years of construction. For reference, the requested PHY and MPS budgets in FY 2009 are $298 M and $1.403 B, respectively. About $250 M of the MPS budget is used to support the operation of facilities every year.

Prompted by the DUSEL discussion, MPS has been thinking more broadly about a “Strategic Co-Investment (SCI)” model in order to build up needed funding for important scientific initiatives, whether facilities or other large initiatives. The developing idea is for MPS to set aside up to 1% of its budget to set aside each year for increments in a small number of initiatives, to be matched equally by the relevant division. The integrated increment to a division budget for a specific initiative would be subject to a cap of 1.5% of the MPS budget. The set-aside of 1% of

the MPS budget for SCI increments would probably be sustainable only in a period where the MPS budget was growing faster than inflation, at least slightly.

Applying this general model to the specific case of DUSEL, there would be $3 M annual increment from MPS, which would represent about 20% of the 1% SCI investment fund for MPS each year of this period. By the end of the construction period, the total MPS contribution to the PHY annual base budget would be then about 1.5% of the total MPS budget, or $23 M. PHY would be expected to contribute the remainder, about $27 M, to meet the estimated operating costs of $50 M for DUSEL operations. This simple model will need to be refined after a detailed budget for DUSEL M&O validated by review as part of the ongoing Readiness Stage.

The DUSEL project is the only new facility now in planning stages by the PHY division. Advanced LIGO and Ice Cube are now in construction, with planned operations costs to MPS of $12 M and $4 M annually. The Large Hadron Collider (LHC) is in the operations phase now, with an annual budget of about $18 M. A planned upgrade to LHC instrumentation is in early stages of discussion, with a roughly estimated construction cost of $100 m, with the schedule still uncertain.

Findings

The experimental program for DUSEL has been given excellent reviews by several national panels. The flagship experiments of the initial program, double beta decay and dark matter search, have been given high priority within the national particle physics program by the P5 panel. The particle physics community is also discussing the possible need for a very-long-baseline accelerator experiment to advance neutrino science. The only suitable underground laboratory in the world for this may be DUSEL, which would greatly expand its scientific scope.

The MPS Advisory Committee is not constituted to conduct a new evaluation of the scientific promise of DUSEL that is independent of the evaluations given by the reports already published. DUSEL has emerged as the only new project in the planning pipeline for the Physics Division, which is consistent with the high priority given by several panels to the experiments it will enable. However, the MPS Advisory Committee is not in a position to evaluate the decision to give DUSEL top priority in Physics or across MPS. The HEPAP subpanel P5 will be issuing a revised roadmap over the next several months, and will provide important additional input on scientific priorities.

NSF reorganized the DUSEL process in 2004. Since that time, the development of the project through the S-1, S-2, and S-3 phases has gone according to plan. The two most important milestones in this process were the completion of the Deep Science report in December 2006 and the announcement of the selected site in July 2007. The next stage in this process is advancement to Readiness Stage.

Concerns

At the end of the Readiness Stage, NSF will review the bottoms-up cost and contingency estimates, the expected operations costs, the risk analysis, and the detailed project schedule. It

is not uncommon for one or more of these items to present a significant change from the present level of understanding. We believe that it is very important for a set of independent experts to review all of this information in great depth so that the NSF Director can bring the project to the Science Board with as much confidence as possible for such a complex project.

To be ready to start construction on DUSEL in as little as three years will take three large, well-organized efforts: one from the group that has already received the S-3 award, one from the organization that will receive the S-4 award, and one at the NSF. By the time this project goes to the National Science Board, the program goals and scientific requirements must be sharply defined and adequately compelling for the project cost. The organization capable of managing a very complex $500 million project must be in place and functioning well, and NSF must have developed a DUSEL program office capable of overseeing that organization. All of this would represent ambitious goals for the next three years, even if this project were being managed by an existing laboratory with expert teams and management all in place. In the case of DUSEL, however, one is forming the laboratory from scratch while developing the project.

The construction and operation of a deep underground laboratory present additional challenges in the management of the environment, safety, and health. This is a very different environment from a typical university laboratory, and it is important to build into the institution a high level of attention to issues of from the beginning. In its Antarctic research program, NSF has established its ability to manage a laboratory in the most difficult location on earth. The DUSEL will not be as unusual an environment as that, but it will need additional focus on the environment, safety, and health.

We are concerned that the present level of funding, starting with no preexisting laboratory, may not be sufficient to develop the facility and experimental designs and to build up the strong management teams by the end of the S-3 and S-4 award periods. It will require establishing a laboratory organization with key management and scientific personnel that is capable of functioning efficiently while growing into a laboratory of a few hundred people by the time construction is complete. It remains to be seen whether the commitment of NSF involved in the Readiness Stage is sufficient to convince key leaders to commit their careers to DUSEL. The NSF will have to develop a DUSEL program office capable of overseeing this period of facility construction and laboratory formation. The experience and best practices of deep underground laboratories around the world should be called on for advice.

The NSF oversight of DUSEL, both the construction project and the laboratory, must be clearly of such strength as to instill confidence that the project and scientific goals will be met. It is important that the executive and legislative branches see this as a model of management for large scientific facilities and that the scientific communities judge the scientific management of DUSEL to be comparable to the best-run national laboratories. We want to make sure that the best practices of program review and oversight are applied to DUSEL, including:

- regular cost, schedule, safety, and management reviews of the DUSEL construction project by an expert team that continues for the life of the project;

- regular reviews of the DUSEL laboratory organization, especially during the period of rapid growth from the present skeleton organization to full strength; and
- regular reviews of the laboratory operations budget as it takes shape, making sure to capture all costs that will be transferred from the construction budget at the end of the construction project.

The oversight and program management of DUSEL will tax the lean management structure of NSF. The Large Facilities Manual is a good document to guide the management of large facilities projects, but full implementation of it requires a large effort by several people experienced in oversight of large science facilities. Two dedicated Program Directors in the Physics Division may not be sufficient to supervise a project of this size. In addition, we note that the Large Projects Office is presently overseeing 11 large projects in various stages, with a smaller staff than other science agencies with similar levels of construction activity.

Conclusions

We conclude that the DUSEL project is ready to advance to the Readiness Stage, but with some qualifying recommendations spelled out below. The scientific program has been reviewed by the appropriate scientific communities and has been given strong support and high priority. The site selection process has been carried out successfully and is accepted by the involved communities. The Conceptual Design is at the appropriate level for this stage of the project. We are impressed with the progress made by a relatively small number of people over the last year.

Because of the importance of the scientific opportunities made available by the DUSEL project, we have taken a broad view of what will give it the best chance of success. This has led to a very productive discussion with MPS and PHY going beyond science to issues such as budget, management, organization, and oversight. The rest of this section summarizes our conclusions on these issues.

We recommend that MPS continue to develop the Strategic Co-Investment (SCI) model in more detail, in consultation with the divisions, the NSF directorate, and the MPSAC. The SCI model is an interesting framework for institutionalizing the process of building up funding for strategic initiatives. This model could be used for any strategic initiative that requires building up a large funding base over several years, not just large facilities. But it is important that SCI funding be reserved for initiatives with scientific opportunities that justify the level of investment and commitment by MPS and the division.

We recommend that MPS and the DOE High Energy Physics program develop a formal arrangement for close interagency coordination in the DUSEL scientific program. The scientific program will be supported by both agencies over decades, and the relevant scientific panels report to both. We expect rapid advance in our understanding of dark matter an neutrinos over the next decade, and optimizing the scientific program will require such close cooperation. We note that the agencies worked closely together on the U.S. LHC project, with great success, and this can be the basis for similar cooperation on DUSEL.

We recommend very close review and oversight of the DUSEL program from now until the laboratory starts operation. It is natural to consider a strong role for the DOE Office of Project Assessment in the review process for DUSEL. If this is not considered feasible, a review process equally comprehensive and detailed to that used for the LHC project must replace it.

We recommend that MPS follow closely the planning process being carried out by the HEPAP subpanel P5, which receives its charge from MPS and the DOE Office of High Energy Physics. When the P5 report becomes public, MPS and PHY should receive a briefing from the panel chair and take into account any additional statements they make about the priority and role of DUSEL.

We recommend that NSF and MPS look at DUSEL as an integrated and continuous long-term program, and take responsibility for the success of that program. This program includes the design and construction of the facility and experiments, establishment of the laboratory, preoperations and operations. For parties to commit their careers to DUSEL, the NSF will have to communicate that it is committed to the success of the project, assuming that all of the goals of the Readiness Stage are met. The sharing of responsibility among the Large Facilities Office, MPS and PHY must be done in a seamless matter, with all parties taking ownership of the entire process. It is possible to predict and avoid many possible problems by comparing closely with the large number of similar facilities project already done, but only if there are enough experienced eyes looking hard at every aspect.

We believe that the Deep Underground Science and Engineering Laboratory could be host to great science if these conditions for success are met.

Appendix 1

Membership of the MPS Facilities Subcommittee
Michael Witherell, Chair
Douglas Arnold
Larry Dalton
Sol Gruner
Robert Williams
James Yeck

APPENDIX V

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September 22, 2008
Dr. Tony F. Chan,
Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Chan:

I have reviewed the final version of the minutes of the Directorate for Mathematical and Physical Sciences Advisory Committee meeting that was held April 3-4, 2008 (attached), and am pleased to certify the accuracy of these minutes. Morris Aizenman has done an excellent job in recording the most significant parts of the discussion.

Sincerely,

Michael Witherell

Michael Witherell
Chair, Mathematical and Physical Sciences Advisory Committee