

**Report of the 2016 Committee of Visitors
NSF Major Research Instrumentation
Program
9/24/2016**

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For the Major Research Instrumentation Program
Office of Integrative Activities
National Science Foundation**

I. Overview

The 2016 Committee of Visitors (COV) for the Major Research Instrumentation (MRI) Program met on September 22 and 23, 2016 at the National Science Foundation. This COV evaluated the time period for program actions from FY 2010 to FY 2015. The committee membership is listed in Appendix I. The meeting agenda and charge to the committee is attached in Appendices II and III. The Head of the Office of Integrative Activities, Dr. Suzanne Iacono, gave the charge to the committee. The coordinator for the MRI program, Dr. Randy Phelps, helped facilitate the review by the committee.

Prior to the meeting at NSF, Dr. Phelps held a virtual overview and COI briefing remotely. The committee reviewed a sampling of MRI actions over the last five years identified by NSF staff utilizing a stratified random sampling technique to collect the jackets of actions over this period. Care was given to capture a representative sampling of proposals evaluated over that time period considering proposal size, institution type or size, area of research as well as geographical location. Because of the remote briefing prior to the meeting, NSF allowed the COV members access to eJackets online, which helped in preparation for the meeting. This allowed the COV panel members to familiarize themselves with the information in the jackets and to not be rushed in evaluating these proposals while at the meeting. Without prior online access, the eJacket review has been more difficult for previous MRI COV panels. Having access to a view of the process and effort necessary for each proposal illustrated NSF's strong standing in evaluating and promoting science. Indeed, the committee appreciated the great complexity at which the MRI operates and is impressed with the level of success and effectiveness of upholding the strong scientific merit criteria in the presence of such large numbers of proposals.

The approach of this report is to first capture the details of the review process in the MRI program. This involves an analysis of the methods used for review as well as the types of documentations available to the program officer and later to the PI to rationalize a decision to fund or not fund a proposal. The committee also reviewed the expertise of the reviewers as well as the diversity of the reviewers. The COV also examined the management at NSF of the MRI program and the funding structure of the program. In addition to these items, the committee discussed the response of the NSF MRI program to the previous COV report. Finally, with data provided by the NSF, the committee investigated particular questions related to gender representation, the flexibility of the MRI program and the research instrumentation needs of the future, the administration of unexpected grant support through an ARRA--like event, as well as the maximum cap of MRI proposals. The committee found the quality of information provided for the purposes of an open evaluation of the strengths and weaknesses of the MRI program to be impressive.

II. Findings of the 2016 COV MRI Committee

- The NSF MRI program's review of the scientific merit of proposals submitted was found to be excellent and to be a major strength of the MRI program.
- The breadth of the NSF--MRI program to fund instrumentation for all fields is excellent.
- The diversity of PIs awarded grants as part of the MRI program appears to be proportional to the diversity of PIs who submitted proposals.
- The proposals that NSF receives from the various institutions appears to not be proportional to the diversity of the professional community from which they come.
- The proportion of MRI submissions from women is smaller than the proportion of submissions by women NSF--wide. The overall number of submissions to the MRI program by women is still very small. Similarly, the overall number of submissions to the MRI program by underrepresented groups is very small.
- The NSF MRI program does not make priorities to support areas of interest at the agency;; instead the priorities are driven by the US scientific community through the rigorous and diverse proposal submission and evaluation process.
- The MRI program continues to have a transformational impact on the nation's scientific enterprise.
- The decline of available funds committed to the MRI program prevents a number of highly recommended proposals from being funded.
- There is a gap in the funding between instrumentation acquisition and developmental awards. This appears to be particularly true of instrumentation developmental awards for instruments still in their early prototype stage.
- The number of staff devoted to the MRI program alone is too small.

III. Recommendations of the 2016 COV MRI Committee

- For proposals submitted to the MRI program, a one page document should be added to each proposal that describes the faculty demographics of the University in STEM as well as the demographics of the institution's MRI submissions for the last 5 years (specifically the PIs of those proposals).
- NSF should collect these demographic data over the next five years, analyze these data, and provide this information to the next COV.
- The NSF MRI program should provide panel reviewers with clear guidelines regarding how to weigh the contributions of research excellence and training excellence during the review process.
- The NSF MRI program should allow for temporary (one or two month) support for graduate student, postdocs, or PI training on the use of a particular instrument funded by the MRI program.
- Provide more support staff for the MRI program at critical times of submissions and awards.
- Institute an EAGER--like mechanism within the MRI program to support very early stage instrumentation development.
- The COV recommends that the RAPID mechanism is not appropriate for the MRI program.

- In the absence of additional funding, the committee recommends not to increase the funding cap for MRI proposals.
- The NSF should have clear and consistent practices for describing the information in Form 7 such that outside reviewers can more easily understand it.
- For evaluating the eJackets, the sampling of both awarded and declined as well as acquisition and development proposals (if possible) would give COV members a better grasp of the kinds of responses that are obtained.
- Having more time to evaluate the eJackets prior to the meeting would allow more time for COV members to discuss trends.

IV. The Review Process at MRI

A. The methods of the review process for the MRI program

The COV found:

Within NSF, divisions may use ad hoc (mail) reviews, panels, or both to review MRI proposals. The methodology used is driven both by division history and by the number of MRI proposals the division receives. Some divisions typically use only panel reviews, but if the division receives only a few MRI proposals, it is not effective to convene a panel and mail review is used. We emphasize that, overall, the NSF review process is admirable and provides excellent constructive detail to proposers and program officers. However, the variability in methodology presents additional work for the COV to understand and assess the suitability of the MRI review process.

The COV Recommends:

To streamline efforts of future COVs, we suggest that details be provided on the review process within each division, which would allow better interpretation of the information provided by the existing "Form 7." Specifically, it is important that the COV can determine whether: (1) a reviewer was invited as an ad hoc (mail) reviewer, or a panel reviewer;; (2) within a panel, if a panelist has been asked to provide a written review;; and (3) what the response is (review provided, panel discussion only, conflict of interest, or no response).

It is possible that some uncertainty stems from "Form 7" being filled out inconsistently between different divisions, and that more careful attention to uniformity across the agency would assist the next COV.

The COV recognizes the value of panels to clarify prioritization or broaden input especially when many proposals across a wide range of specialties are under consideration. For divisions with large MRI involvement, either in number of proposals or dollar amount, that currently use only mail review, we recommend that a panel be added.

B. Merit Review Criteria for the MRI program

The COV found:

The MRI merit review process is generally a well--documented procedure that works extremely well. The two criteria reviewed are Intellectual Merit and Broader Impacts. The three components of the merit review – individual reviews, panel summaries and program officer Review Analysis – all address both criteria. The reviewers, on average, appear to place greater weight on intellectual merit and typically provide excellent and extremely thoughtful reviews of the research. The same careful review of the broader impacts was more mixed. The purpose of the MRI program is to provide "organizations with opportunities to acquire major instrumentation that supports the research and research training goals of the organization." Therefore, both research and training are important features of the proposal. Given the focus on research training at primarily undergraduate institutions (PUIs) they may be disadvantaged in the review process without the appropriate guidance to reviewers regarding how to weigh research and training. This disadvantage for PUIs in the review process was illustrated in the reviews, with some proposals from PUIs being severely criticized for their intellectual merit and the PI's publication records.

The COV recommends:

The committee recommends that there be clear guidelines regarding how to weigh research and training during the review process. These guidelines may vary as a function of the type of university or other factors.

C. Individual reviews used in the MRI proposal evaluation process

The COV found:

Proposals submitted to the MRI program are evaluated in an ad hoc and/or panel review process according to the needs of each specific disciplinary division. This approach is suitable and supports broad participation of disciplines within the program. Like other NSF programs, MRI proposals are evaluated based on established Intellectual Merit and Broader Impact criteria. Additionally, consideration is given to the Management Plan to ensure maintenance, institutional commitment and access to a wide range of users beyond the proposal duration. Each proposal with a budget below one million dollars is reviewed by at least three experts and five experts for proposals with a funding size above one million dollars. The review process is documented in individual expert review reports, the panel summary, and review analysis which summarizes the review process and is given by the responsible program officer to ensure that funding decisions are transparent and sound.

The COV was impressed by the detail and depth of the technical content of the individual reviews, which demonstrated a high quality standard for both regular and large scale proposals and give valuable feedback to the PIs about the strengths and weaknesses of their proposals. The MRI program funds two types of proposals, acquisition and

developmental, where developmental proposals are seen to be a vital part of the MRI portfolio to enable next generation instrumentation for future discovery and exploration. Developmental proposals as well as large scale proposals may have a higher risk potential, which NSF considers in more rigorous individual review and oversight processes. It was found that enabling transformative research is one of the main goals of the MRI program, however, student training and facility management are also considered when funding decisions are made. Individual reviews as used by MRI are highly appropriate for the evaluation of the quality and the potentially transformative character of submitted proposals. Overall, the COV was enthusiastically positive about the amount of care, detail and consideration which is given by NSF to the technical part of the review process.

The COV recommends:

Although proposal reviews are performed in many different ways (large panels, small panels, ad-hoc), the COV recommends to use a common format for the Review Analysis which should uniformly address details about the composition of panels, number of proposals under review, institutions involved (MSI, PhD, PUI etc.), a brief summary about the panel discussion and final proposal rankings, and a detailed rationale about the funding decision.

The COV further recommends that NSF tracks the scientific and student teaching outcomes from funded proposals beyond the proposed project's duration to ensure long term impact of the investment.

D. Panel Summaries and Panel Recommendations used in the MRI proposal evaluation

The COV found:

In addition to the reviews, the panel summaries also provide valuable information to the PI about the review process, the rationale for the decision, as well as potential feedback on how to improve the proposal in some cases. In its review of MRI eJackets, the COV concluded that MRI review panels are generally functioning as they should be, and they provide a sufficient level of detail to give an impression of the overall discussion of a proposal. In the selection of eJackets the COV reviewed, it appeared that proposals with stronger reviews received more thorough and detailed panel summaries and were often prefaced with comments on the strength of the proposal. The COV observed that an additional function of the panel is to weigh in when there are divergent reviews of a proposal, and in these cases the summary should capture the essence of the discussion and recommendations of the panel.

The COV recommends:

The COV discussed the role of the panel in taking a more active role in encouraging resubmission of promising proposals, and debated the merits of this as another piece of feedback for PIs. Such feedback could be used by PIs to gain needed support from their

institutions. This could be one way to promote successful proposals submitted by PIs from underrepresented groups. However, the COV did not reach consensus on this issue.

Because the entire panel must sign-off saying the panel summary reflects the view and recommendation of the panel, the COV recommends that program officers remind panels to ensure their summaries fully reflect all aspects of the discussion and include all views from the panel discussion

E. Evaluation of the Documentation in the eJackets provided to the COV

The COV found:

The Documentation contains the following: a context statement, individual reviews, panel summary, site visits (not applicable for the MRI), program officer Review Analysis and staff diary notes.

The COV was generally impressed with the package documentation. The eJackets we reviewed provided information about the submitted proposal, the feedback made available to the proposer in the form of context statement, individual reviews and panel summary. The package documentation also provided internal documentation of the Review Analysis that is written by the program officer and an overview of the panel members. Communications between the program officer and PI through correspondences, diary notes, and PO comments were also available.

The panel reviews were thorough and consistent between the different programs over the 2010--2015 period. Each proposal received 3--5 reviews even though the number of reviewers declined from 4--5 per proposal to 3--4 per proposal midway due to travel budget reduction requirements by the Agency. Panel summaries were available for each proposal as well. Each proposal also had a context statement made available for review.

The program officer Review Analysis documentation was mutually agreed to be the most informative in providing an overview of the review process of a particular proposal in terms of reviewer scores, panel summary, and program officer recommendation. The level of detail was clear and varied from one to five pages depending on the program officer. A few COV members noted that providing the PIs with access to the contents of this document minus the confidential parts would be deemed helpful for transparency. Staff notes, though not available in all projects, were also extremely helpful in providing additional context to interactions between NSF and the PIs of awarded grants and on decisions.

The Form 7 was viewed as an important document that conveyed the review committee makeup for the different programs. This make--up consisted of names of all involved reviewers as well as documented the role they played in each proposal. It was unclear in some cases to the COV how the review process was structured -- by mail, adhoc, or panel -- based on the published format. The word panel was listed in the template. As a result, during discussions COV members have different interpretations of how the review was convened (i.e. by mail, ad hoc, or panel) across the different divisions. This ambiguity was confusing without interpretation from the program representatives at the meeting.

The COV recommends:

Overall, the COV was impressed with the documentation format and process. To alleviate future confusion of Form 7, we recommend constructing a summary sheet that describes how the different divisions or programs convened their reviews or panel. We also recommend providing future COVs with a list of keywords and definitions related to the Form 7.

F. Review of documentation to the PI in the MRI program

The COV found:

In the cases where the panel recommendation and the program recommendation are the same (e.g., both are decline, or both are award) then the rationale is clear to the PI through the provided documentation. For example, the reviews for the most part provide a detailed discussion of the strengths and weaknesses of the proposal in both Intellectual Merit and Broader Impacts. Even in cases where a particular review is brief, it is complemented by other reviews that provide more detailed feedback. The panel summaries capture the discussion and recommendation of the panel.

In a few cases, a proposal was rated “Competitive” or “Recommended for Funding”, but the program officer did not recommend the proposal for funding and thus it was declined. The Review Analysis explained this decision, but it is not clear how PIs receive feedback. In most cases, additional feedback would be useful to the PI in developing a strategy for the competition for MRI slots and future re--submissions. For example, the reason for decline in some cases is that the PI has not made sufficient progress on a currently funded MRI award, or the preliminary results have not been incorporated into the new proposal. This information was in the Review Analysis, but was not considered strongly by the panel in its recommendation. In this situation, telling the PI that the currently funded project’s status was a significant factor in the decline of the new proposal would encourage the PI to make progress on an existing award before a new proposal is submitted.

The COV recommends:

It may be possible to develop a more formal process for feedback in the case that the panel recommendation and the program officer recommendation differ. The process should be documented for the benefit of the program management. The COV does not wish to prescribe a specific format for this feedback. It may be sufficient, for example, to provide a PO Comment or Diary Note about a phone call or an email to the PI about how additional information derived from the Review Analysis was conveyed to the PI, and other processes may be developed.

V. Evaluation of the Selection of Reviewers in the MRI Program

A. Reviewer Expertise and/or Qualifications of the MRI program

The COV found:

Typically, proposals were reviewed by 3--5 referees who have been selected to have specific knowledge for the particular topic area of the proposal. As the MRI program mostly involves very specific instrumentation challenges, especially the "build" proposals, having referees with deep knowledge is much more important than for the general science panels, where often a broader knowledge of the topic area and context is preferable. When it comes to judging the construction of a new instrument, typically with unique, previously non--existent properties, it is essential to have a set of reviews which are able to pinpoint some of the potential risk factors and weaknesses, and assess the overall feasibility of the instrument.

The information in the eJackets have demonstrated that the referees selected by the program possessed a remarkable depth and competence in sometimes extremely specific, very narrow topic areas. This reflects well on the selection process of the referees/panelists. Obviously the program has gone to extreme lengths to ensure the participation of the best domain experts.

The COV recommends:

The COV commends the MRI program of finding excellent reviews and enthusiastically urges the program to continue this great practice.

B. The MRI program's handling of Conflicts of Interest

The COV found:

Avoidance of COI was clearly a high priority in the review process for the MRI competitions. When reviewers or panelists had a conflict they did not take part in the review of the proposals and this was noted in the Review Analysis portion of the eJacket. COV did not find any evidence of issues with the identification of conflicts among the proposals reviewed. Given the fact that the proposals are often very specific with few specialists focusing on these areas, the program officers should be commended on their extensive work in ensuring that the potential conflicts have been avoided.

It was also stressed that avoidance of conflicts of interest is essential to the integrity of the Committee of Visitors process. COV members only had access to eJackets that were previously vetted for any potential conflicts;; in addition, COV members were instructed to check for issues and discuss with program officers before proceeding with their analysis of the materials.

The COV recommends:

The COV commends the efforts of the MRI program to avoid any conflicts of interests and urges the program to continue in this practice.

C. Inclusivity and Diversity of the Review Process

The COV found:

The MRI program continues to work hard to make sure the review process is inclusionary and that URM, women, and faculty from different types of institutions are appropriately represented. The COV reviewed MRI submission and funding data since the last COV, and concluded that reviewer representation of these groups is comparable with the percent awarded by MRI proposal submissions from within these groups. However, it is of note that URM reviewers were overrepresented relative to the number of URM proposal submissions. COV analysis of eJackets did show some review panels with less than optimal representation. The COV understands that some of this is likely due to overall underrepresentation of URM and women in these disciplines. However, the COV also recognizes that proposals in a panel with low representation could easily have individual reviews with no representation that might not ever make it to further panel discussion. For example, in a panel of eight reviewers with only one female member, it is likely that there will be proposals receiving initial individual reviews by three male reviewers. If those reviews resulted in low ranking of the proposal, then that proposal may not be discussed by the more diverse panel as a whole.

The COV recommends:

Based on these analyses, the COV commends the efforts of the NSF in working towards diverse staffing of review panels. We also encourage sensitivity towards possible over--prescription of reviewers from underrepresented groups, not by decreasing diversity on review panels, but by continuing to work towards increasing submissions from these groups as described in other areas of this report and continuing to broaden the reviewer pool.

VI. Management of the MRI program

A. The management of proposal submissions and awards of the MRI program

The COV found:

The committee examined the management format for the MRI program. The program has established a bottom up approach. The MRI proposals are initially submitted through Fastlane and then evaluated for compliance by the MRI staff. The large number of proposals is distributed by the MRI staff to the divisions. The committee noted that this is a relatively large task for just a single NSF MRI staff member.

Once the proposal is at the division level, the review process is handled by that division program officer. The committee discussed the method by which the MRI program allocates its funds for the program for a given year. The allocation is largely based on the total dollar amount proposed in each division. The committee noted in some cases this might influence the division of funds toward particular areas of research. However, the process seems to have been representative of the needs of the scientific community. Part of the funds initially given to the MRI program is used solely for larger (greater than 1 million dollars) proposals. The committee agreed that by having this method of funding

larger dollar amount proposals was a useful process to not penalize those proposals and at the same time not limit the number of potential smaller dollar amount awards. The decision to use the set--aside larger dollar amount proposal funds was made at the directorate level and is correlated with the dollar amount proposed by each directorate. The committee found that MPS was a major recipient of these larger dollar amount proposals. The MRI program also keeps a smaller 5% of the allocated budget to finally normalize the portfolio of the MRI program. The complex dynamics of how this process works was clearly explained to the committee.

The COV recommends:

Due to the very large work load, the COV recommends that there be more support staff for the MRI program. The COV also recommends that updated data regarding the statistics of MRI support allotted to different divisions be obtained on a yearly basis. The acquisition vs development instrumentation data as well as data regarding demographics of allotted funds could be more efficiently obtained with additional support staff.

B. Emerging Research and Education opportunities

The COV found:

The MRI program provides funds for the purchase of research instrumentation and a portion of these funds must go to support the acquisition of critical, but routine equipment in order to maintain the instrumentation infrastructure of the nation's research and teaching institutions. However, as the MRI program is currently managed and implemented, it does have the potential to be responsive to emerging and evolving technologies. The program does not have targeted areas for instrument funding and this provides flexibility in what is being requested and therefore allows those with the most knowledge in specific areas – the researchers – to request funds for what they believe they need. The use of expert review panels serves to further direct funding to new areas. The development of new instruments for emerging research areas is clearly addressed by the MRI Development grant mechanism;; however, there is evidence from some of the reviewed eJackets that the MRI Acquisition program also funds commercial instruments or instrument upgrades that provide access to the newest technologies required for emerging research. For this reason, the Acquisition program has aspects that we consider to be responsive to emerging research needs.

The COV recommends:

Recommendations in this area are to continue to encourage the submission of instrumentation requests for newly released commercial technologies and for instrument “add--on’s” that will provide the enhanced capabilities needed to allow researchers to move into the emerging research areas of the future. A more ambitious recommendation is to consider a new investment area within the MRI program portfolio similar to the NSF Early--concept Grants for Exploratory Research (EAGER) to provide a mechanism for the early stage development of new instruments for emerging technologies from the ground up. This would differ from the current MRI Development mechanism in that less

preliminary data would be required and less emphasis on making the instrument a shared instrument. Perhaps it could be integrated into the current MRI development program in a way similar to the NIH's R21/R33 program where the R21 is considered an exploratory project and the R33 is for instrument optimization and validation.

In terms of educational opportunities, the primary goal of the program is to provide cutting--edge instrumentation for research, and therefore the educational component might not be seen as important by reviewers as it is in a standard research proposal. However, as new technologies are adopted by researchers and new instruments acquired, there is a need to educate students and postdoctoral researchers on these new technologies and the operational methodologies involved. The quality of data produced is directly tied to the level of understanding the user has on the operation and capabilities of the instrument. In this sense, a critical limitation in the MRI instrument acquisition program is the lack of funds for training specific to the instrument acquired. (We note that this is not the case for MRI Development proposals since funds can be requested for training of PhD students that work on the instrument development.) This is not a recommendation for full GRA or postdoctoral support, but an example might be allowing funds to be used to send a student for training on advanced imaging technologies. This type of educational experience has a modest cost and would enhance the education opportunities provided by the program, as well as ensure that the required knowledge base for optimal instrument operation is available at the funded institution.

C. Program planning/prioritization process for portfolio development

The COV found:

The COV views the MRI program as a critical part of maintaining a healthy and excellent science and engineering infrastructure in the US, facilitating capacity--building to build research capabilities across diverse institutions. This is more critical than ever in the 21st century, in view of increasing competition from abroad. The MRI program is unique because it is responsive to the research vision of a diverse and excellent cadre of STEM scientists in the US, as well as their institutions, who are part of the internal selection process of the proposals submitted to NSF. This distinguishes the NSF MRI program from most other agency infrastructure investments, which often fund shorter--term investments in narrower targeted areas of research. As such, the MRI program is critical for US competitiveness in science and engineering research, allowing teams of faculty to sustain internationally competitive research programs.

The COV recommends:

The COV believes the current planning and prioritization of the MRI program are well suited to achieving the critical goals in sustaining an internationally competitive research program by allocating funds based on MRI proposals, thus staying at the leading edge of science and engineering innovation in the US.

D. Responsiveness of the MRI program to previous COV recommendations:

The COV found:

Overall, the COV agrees that some comments and recommendations from the previous COV have been implemented but there are several major ones that need to be addressed. The MRI program has implemented protocols and procedures to reasonably address the transparency and variability of the review process across disciplines, the handling of larger dollar amount proposals, the data specific to the participation of women and underrepresented minorities, and cost sharing guidelines as mandated by Congress.

The COV recommends:

Although the MRI staff has done a tremendous job under heavy work load, there is no clear indication that NSF is committed to increase the MRI staff that will decrease the extreme work load while increasing MRI program efficiency, uniformity, and effectiveness. As stated in the 2010 COV report, this COV urges that NSF explore mechanisms to maintain the higher staffing level that was available to the MRI program in 2009.

Delineation is needed to clarify the efforts to increase and encourage development proposal submissions. It is not clear whether these efforts have evolved into the broader program or related to a specific call.

Although general COI protocols are effectively implemented, the COV agrees that specific protocols are needed to limit access to proposals and eJackets for panel reviewers with COIs.

VII. Additional Questions Requested for the COV to consider

- A. Based on the data we have provided, what if any issues relating to MRI PI/co-PI gender representation should the MRI Program address, and is there an incentive structure that MRI might implement to better achieve balanced gender representation?**

The COV found:

After review of the MRI funding history the COV determined that the program funds women at a similar rate as men based on the number of applications submitted by each gender. However, the proportion of submissions from women to the MRI program is smaller than the NSF--wide average. This suggests that the bottleneck to a more diverse group of PIs might be at the university level, since each institution selects three proposals to move forward for consideration. This bias may arise in part from that fact that there are a higher proportion of senior male investigators in STEM, and even when a junior female (or male) investigator is more technically qualified, the internal selection committee recommends that a more senior faculty member serve as PI. The committee also would like to stress that the issues surrounding gender equity extends more broadly to underrepresented minorities.

The COV recommends:

The COV considered potential measures to address the gender gap observed, as follows:

1. We recommend that NSF require institutions to submit a one page summary of the demographics of its STEM faculty along with the demographics of the PIs who submitted an MRI from their institution over the previous five years. This report will provide information on the culture of the institution with regard to diversity and gender equity as well as document the internal selection process. NSF would then be able to collect and analyze these data and report the results to the next COV. There was consensus among the COV regarding this approach.
2. We discussed a process of including the one page demographic data in (1) in the supplemental data of each proposal to allow reviewers to have access to these data. This option did not receive uniform support by the committee. However, some members of the COV felt that a strong statement regarding institutional culture and diversity should be made.
3. We discussed a proposal to allow institutions to submit an additional fourth application when at least two of the four submissions have a female PI. The strengths (e.g., it increases the number of applications from women) and weaknesses (e.g., institutions can 'game' the system by having a woman as PI in name only) of this option were discussed. There was no consensus regarding this approach.
4. The NSF guidelines to the institutional internal MRI selection committee should indicate that the submitting PI's technical expertise related to the requested instrument is more important than the PI seniority or status.

B. Is MRI sufficiently flexible enough to respond to the evolving needs of the research community and what suggestions do you have to ensure that the Program responds to research needs into the future?

The COV found:

As it is currently implemented, the MRI program offers flexibility to the community. The agency's decision against targeted programs for specific types or classes of instrumentation offers many advantages and allows the community to create its own direction. However, it is unclear how the MRI program can ensure that proposals submitted for funding truly reflect the diversity of activities defined by the research community. Universities are allowed to submit a total of three proposals per submission window and therefore decide which ones to move forward. Universities may make their decisions based on different standards than NSF, which may become a constraint on the overall flexibility of the MRI program. We see this challenge, which NSF has little control over, as a possible limiting factor on how effectively the MRI can actually respond to the evolving needs for providing cutting edge research infrastructure.

The COV recommends:

1. A need exists to understand how currently funded projects are effectively transferred into the science community and into industries supported by these research activities. Inherent to the MRI program is a limitation of funds available to train the next generation of immediate users and to develop training methods that can be shared with the broader community. As scientific instrumentation and the associated methodologies become more complex, the need for technical training will be more important. We recommend that NSF provides mechanisms for acquisition of supplemental funds to select MRI grants that allow broader access to equipment use.

2. A need also exists to understand how to broaden the diversity of research opportunities and participation in the MRI program. Currently, the NSF program has limited control over who submits to the program given that institutions make that decision. We propose that NSF considers a tiered funding structure between low, mid, and high range projects with the current options of 1 development and/or 1--2 acquisition projects. For at least one acquisition project, we would recommend that NSF considers defining bands for low (up to \$300k), mid (up to \$1M) and large (more than \$1M) scale equipment. This method may stimulate different types of research, and perhaps allows a broader range of researchers to participate in MRI which we think is currently limited by the university pre--selection process.

C. The ARRA and Gulf Oil Spill RAPID competitions represented “unexpected events” for the MRI Program. Using these competitions as examples, can the COV recommend general principles/procedures that MRI might employ if similar, yet likely unique, situations arise in the future?

The COV found:

RAPID. In 2010, following the Gulf oil spill, MRI set aside a portion of their funding to support spill--related research. A dear colleague letter was released to the scientific community (<http://www.nsf.gov/pubs/2010/nsf10064/nsf10064.jsp>), noting that the Rapid Response Research (RAPID) mechanism was available for MRI proposals. RAPIDs have a low upper limit of \$200K, are limited to 1 year with no cost extensions, are short (3--5 pages), and have an internal review process only, by the division program officers. The usual MRI program cost sharing was required. For this single MRI--specific submission, the limit on the number of proposals per institution was waived. Proposers were instructed to communicate individually with the MRI and division program officers before submitting proposals. After discussion between PIs and program officers, approximately 40 proposals were submitted.

MRI--R2. In response to the funding available following the American Recovery and Reinvestment Act (ARRA), the MRI program offered an additional program solicitation (<https://www.nsf.gov/pubs/2009/nsf09561/nsf09561.htm>). New submissions were in addition to the institutional limit for the regular MRI submissions. The upper cap was increased to \$6 million, and cost sharing was waived for institutions of higher education not ranked in the top 100 institutions receiving federal research and development funding, but required “certification from the institution's President or Provost that the project would: (1) make a substantial improvement in the institution's capabilities to conduct leading--edge research;; (2) provide research experiences for undergraduate students using

leading-edge facilities;; and (3) broaden the participation in science and engineering research by women, underrepresented minorities and persons with disabilities.”

In response to this call, MRI received approximately 1200 proposals, with the average budget over \$1 million. This was a significant stress on the NSF MRI office.

Utilization of the RAPID process for distribution of MRI funds generated some concern on the COV that the proposed large single item purchases were well-considered and fit effectively into long-range, institutional plans. However, we recognize that some immediate and transitory phenomena may require quick responses (e.g. there is not time for proposals to go out for the external reviews required by other funding protocols). The COV suggests that if the RAPID process is used again, proposals be required to specifically address how the institution/investigators will continue to use the equipment following the RAPID time frame. This can then be considered in review by the program officers, and their analysis can include an assessment of how the instrumentation will impact research long term. To assist future COVs in their charge, we also suggest that comparative scores of RAPID proposals be included in the reviews provided by program officers. The COV was also concerned that only a single reviewer assessed each proposal, and suggest that at a minimum two program officers (e.g., MRI and relevant division) review each proposal. To aid this review process and the general expertise of the program officers, we suggest that proposers be required to include a short section directed to a broad scientific audience, in addition to technical details. We note that this is not the only alternative method for obtaining multiple reviews for proposals on a short time frame, and other options should be considered.

The COV feels that the MRI program responded appropriately and creatively to the unexpected ARRA funding opportunity. We suggest a general approach for utilizing possible future “windfall” funding, as follows, recognizing that there will likely be additional constraints that may necessitate adaptation.

The COV recommends:

1. If the timing is correct, the funding can be folded in to the regular MRI proposal process, as was done for part of the ARRA funding. If timing dictates, a special solicitation may be necessary as funds will likely need to be distributed within one fiscal year.
2. Though funding constraints may limit projects to one year, a no-cost extension of up to 12 months should be available. For development and even for simple equipment purchases it may take several months to complete delivery, and sufficient time should be available for set-up and for some data collection.
3. The upper limit to budget requests should be set at a level that allows funding of a suitable number of grants;; though the number may depend in part on the overall amount of funding available, we suggest targeting a minimum of 50, if possible. The intent is to ensure that the funding is spread between many divisions, rather than supporting a few large awards in a limited number of divisions.
4. Standard MRI institutional cost-sharing should be required to encourage long-term commitment from the universities.

5. The RAPID mechanism is not appropriate with the goals of the MRI program.

D. The competition related to the American Recovery and Reinvestment Act (ARRA) was the only time MRI has accepted proposals requesting up to \$6 million. Based on your review of all MRI actions, can the COV comment about the appropriateness of a higher cap and recommend principles/procedure that may be needed should the cap for MRI be raised above its current \$4 million in the future.

The COV found:

The COV committee does not think that a higher funding cap for MRI, in general, would serve the scientific community better than the current cap, though a higher cap may be helpful if some special processes were to be put in place. We think that in some aspects, the current \$4M upper limit may already be too high. A smaller cap may increase the broader impacts of the MRI program to all types of institutions, and in that way raise the scientific capability of the country. That is, without additional funds to the MRI program we do not recommend that the MRI cap be raised.

There are a few concerns about a higher cap for the general MRI call. One concern is that a higher cap may skew awards towards development grants, which would favor awards to highly ranked research intensive institutions. A higher cap might also reduce funding to smaller institutions and reduce the reach of the MRI program to these institutions. With a higher cap, PIs may target larger awards, but these are less likely to be funded. The effect to the country may be a significant, but ineffective, proposal development effort by a large number of potential PIs. Another consideration is that the University selection process typically gives preference to a higher budget, since universities want to maximize the impact of the limited number of MRI slots. This is an artificial selection criterion that is not based on scientific merit. For these reasons, we believe that allowing a higher cap in general on the MRI budget may not serve the scientific community well.

However, the COV recognizes that there is a gap between the MRI and the MREFC program for scientific instrumentation. To fill this gap, there may be a way to support a higher cap in order to fund larger--scale instrumentation needs through special calls and a different review process. This could be modeled, say, after the Mid--Scale Innovations Program in Astronomy (NSF #15--580), that has a cap of \$30M. In this program there are two proposals allowed per university, and a pre--proposal is required.

The COV recommends:

Although overall, the COV does not recommend a funding cap increase, MRI requests for well justified instruments whose cost exceeds the current cap could be accommodated depending on available funds through a special funding opportunity every three to four years. We expect that these more expensive instruments would have an extended lifespan and a larger community of users than the average, and therefore annual special calls of this mechanism would not be required. The evaluation process would require a Letter of Intent and/or pre--preproposal. A preliminary selection process should permit only

credible proposals to be submitted. This special call should be supported through additional funds to the MRI program, just as special ARRA funds allowed a higher \$6M cap on the MRI budget.

Appendix I.

2016 MRI COV Members

Amy Apon	Clemson University	CISE
Alan Foley	Syracuse University	EHR
Rhonda Franklin	University of Minnesota	ENG
Ted Goodson (Chair)	University of Michigan	MPS
Stacy Kim	Moss Landing Marine Labs	GEO
Margaret Murnane	University of Colorado	MPS
Sharlene Newman	Indiana University	SBE
Willie Rockward	Morehouse College	MPS
Eva Schubert	University of Nebraska	ENG
Alex Szalay	Johns Hopkins University	CISE
Jennifer Whiles--Lillig	Sonoma State University	MPS
Jason Williams	Hofstra University	BIO
Warren Zipfel	Cornell University	BIO

Appendix II.

AGENDA Committee of Visitors Major Research Instrumentation (MRI) Program September 22-23, 2016

Thursday, September 15 **Telecon w/ COV Chair Ted Goodson (1pm Eastern)**
Friday, September 16 **WebEx briefing w/ COV Members**

Wednesday, September 21 **COV Member Arrival in DC Area**

Thursday, September 22 **8:30am-6:15pm, Stafford II, Room 575**
Program Review

8:30-8:45	Greeting by Dr. C. Suzanne Iacono, Head OIA
8:45-9:00	Greetings by Dr. Randy Phelps (OIA) & COV Chair
9:00-9:15	Review of COI and Confidentiality ¹
9:15-9:30	Overview of eJ and <u>Member Review Assignments</u> ¹
9:30-12:00	Review of MRI Actions
12:00-1:00	Working Lunch
1:00-2:45	Continue Review of MRI Actions
2:45-3:30	Discussions with Directorate/Division MRI Program Officers
3:30-3:45	Break
3:45-4:45	Committee Discussion (OIA staff available for questions)
4:45-5:30	Continue Review of MRI Actions
5:30-6:00	Discussion on Final Report Writing

Friday, September 23 **8:30am-5:00pm, Stafford II, Room 575**
Program Review and Report Writing

8:30-9:00	Committee Discussion
9:00-12:00	Program Review & Report Writing
12:00-1:00	Working Lunch
1:00-3:00	Continue Discussion & Report Writing
3:00-4:00	Report-out to OIA and NSF Staff
4:00-5:00	Finalize Final Report

Appendix III.

National Science Foundation

CHARGE TO THE COMMITTEE OF VISITORS

For the Major Research Instrumentation Program - a cross-Foundation program coordinated by the Office of Integrative Activities

September 22-23, 2016

A. CHARGE TO THE COMMITTEE

In accordance with National Science Foundation (NSF) policy, the Committee of Visitors (COV) for the Major Research Instrumentation (MRI) program shall review the proposal actions and project outcomes of the program to provide NSF with an independent evaluation that:

- a) Assesses the quality, integrity, and transparency of program operations and program-level technical and managerial matters pertaining to proposal decisions, and
- b) Comments on how the resulting portfolio of awards has contributed to NSF's mission, the attainment of NSF strategic goals, and MRI program objectives.

The COV for the Major Research Instrumentation (MRI) program is further charged to provide its findings and recommendations in these matters in a written report to NSF.

B. SPECIFIC DUTIES

The COV review of program management is to consider Major Research Instrumentation (MRI) proposal actions that were completed during six fiscal years: FY 2010, FY 2011, FY 2012, FY 2013, and FY 2014 and FY 2015. The portfolio of awards to be assessed includes MRI projects that are currently active or have been closed out during the previous five fiscal years. The COV review may also include consideration of significant impacts and advances that have developed since the previous COV review in 2010, including incremental progress made on results reported in prior fiscal years. Specific aspects of the MRI program to be addressed are:

1. Relative to the quality, integrity, and transparency of processes used to solicit, review, recommend, and document proposal actions:

- (a) Selection of an adequate number of highly qualified reviewers who are free from bias and/or conflicts of interest;
- (b) Appropriate use of NSF merit review criteria;
- (c) Documentation related to program officer decisions regarding awards and declines, and the scope, duration, and size of projects;
- (d) Balance of awards in terms of subject matter; emerging opportunities; high risk and innovation; size versus number of awards; new investigators; diversity of underrepresented groups; geographic distribution of principal investigators;
- (e) Overall technical management of the program; and,
- (f) Response of the program under review to recommendations of the previous COV

review.

2. Relative to the contributions of the results generated by awardees to the attainment of program objectives and NSF's strategic outcome goals:

- (a) The relationships among award decisions, program goals, and Foundation-wide programs and goals;
- (b) Results, in the forms of outputs and outcomes of MRI investments for the relevant fiscal years, as they relate to the Foundation's current strategic goals and annual performance goals;
- (c) The significant impacts and advances that have developed since the previous COV review; and
- (d) Examples of new products or processes, or new fields of research whose creation can be traced to the outputs and outcomes of MRI-supported projects over an extended period of time.

C. REPORTING RESPONSIBILITIES

The COV Core Questions and Reporting Template for 2016 will be used to guide the assessment process and provide structure to the written assessment by the COV. The Core Questions in Section B of the template are to be addressed in light of the NSF goals in the four strategic areas: Discovery, Learning, Research Infrastructure, and Stewardship.

1. For the strategic areas of Discovery, Learning, and Research Infrastructure, the COV should look carefully at the outcomes of the MRI award portfolio over time and report on:
 - (a) Noteworthy achievements of the year based on MRI awards in each area;
 - (b) The ways in which funded projects have collectively affected progress toward NSF's goals in each area; and
 - (c) Expectations for future performance based on the current set of awards.
2. For the response to the strategic goal for Stewardship, the COV should comment, where appropriate, on NSF providing an agile, innovative organization capable of supporting excellence in scientific and engineering research and education, including:
 - (a) Improving the quality and transparency of the merit review system;
 - (b) Utilizing emerging technologies for business application and customer service to improve access to critical program information; and
 - (c) Expanding efforts to increase participation in the MRI program by underrepresented groups and diverse institutions throughout the United States, its territories, and possessions.



C. Suzanne Iacono, Head
Office of Integrative Activities

For the Major Research Instrumentation Program 2016 COV,

T. Goodson III, Chair