MOSFIRE PDR Report
11-12 April 2006

Review Committee:
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General Comments

The Preliminary Design Review (PDR) for MOSFIRE was held in Pasadena on 11-12 April 2006. The Review Committee presented their overall evaluation of the instrument design and made specific comments and recommendations to the instrument team after a series of presentations covering all aspects of the instrument goals, requirements, and design. This report describes these comments in more detail and represents the consensus opinion of the committee on the state of the MOSFIRE approach and design. Answers to the specific questions charged to the committee are given at the end of the report.

Overall the committee agreed unanimously that the instrument passed the PDR and should proceed immediately with the detailed design and initial construction of the instrument. The team assembled to build the instrument is strong and motivated and has an excellent heritage. The instrument science goals are extensive and very exciting and there should be ample enthusiasm to use the instrument. The preliminary design is strong and was presented in a timely, organized, and coherent manner. The design is sound and practical and incorporates designs from previous instruments that are known to work. The amount of work done seemed impressive for the apparently short time spent developing the design to the level presented at the PDR.

Specific Comments and Recommendations

Although the design seemed generally sound and without serious limitations, the committee nonetheless did note several issues that the team should address. The motivation and philosophy of the committee as issues arose is drawn from the orientation that MOSFIRE should ultimately be an exciting and productive scientific instrument. In particular, the committee felt that four precepts should govern the evaluation of any design or implementation decision:

- MOSFIRE should have the highest possible throughput to maximize sensitivity
- The instrument should have the lowest possible background between OH lines to maximize sensitivity to faint sources
- The instrument should maximize observing efficiency to make optimal use of scarce observing resources
- The instrument should allow for tight control of systematic errors to allow for the

greatest possible range of scientific applications

The committee noted in particular that the project should develop a range of specific observing scenarios with particular goals for S/N, resolution, etc. and validate the existing specifications for the instrument. A few other concerns were also noted. The remainder of this report describes these concerns and gives particular comments and recommendations.

Optical Design

The committee judged the design of the optics for MOSFIRE to be generally excellent. Although the committee has no specific optical design expertise, we felt that additional study may lead to some simplification that could increase throughput, lower cost, and lead to a better balance of throughput and image quality. In particular, the collimator lens set seemed to perform better than was justified by the presentation, for example, and could perhaps be simplified.

The committee urged that the performance of the optical system be analyzed under conditions that simulate the observing conditions MOSFIRE is likely to encounter. In particular, the near infrared sky spectrum is dominated by extremely bright emission lines throughout the J and H bands. The optical design should be analyzed to investigate if the expected aberrations will lead to serious contamination of the relatively dark sky between the lines. A general analysis of the stray/scattered light performance should also be performed as soon as possible.

Mechanical Design

The overall design and plan presented for the mechanical systems was excellent. The approach seemed generally sound and based on previous successful components and prototypes. Furthermore, the MOSFIRE design team seems aware that the dominant flexure in the grating system needs to be reduced. However, the committee did note with concern that the flexure compensation plan relies heavily on low hysteresis and smooth elastic behavior, but that the design philosophy did not reflect this reliance. We urge the team to consider kinematic connections between the instrument and telescope and between the inner and outer structure, for example. In general, the design should focus on repeatable deflections as much as possible so as to mitigate the risk of not meeting the flexure (or, more precisely, image motion of any type) specification at the focal plane.

Guide Camera Layout

The guide camera optical elements are mounted on the dewar such that pressure-induced flexure of the vacuum vessel may translate or misalign the optical system. The committee also believed that a calibration system would be a high-priority addition in the future. We suggest that both of these features might be facilitated by providing an annular optical bench in front of the instrument entrance window. On this bench, the guide optics could be folded such that the optical path remains in a single plane, perpendicular to the telescope optical axis. If the space is provided now, a calibration projector system could conceivably added later and mounted on the same optical bench, such that it illuminates the back surface of the dust cover or similar instrumental feature. A kinematic (hexapod arrangement) connection between the bench and the outer diameter of the vacuum vessel would provide stiff and repeatable support for the bench.

Configurable Slit Unit

The plan to use a commercial vendor to provide a configurable slit unit seemed an excellent approach to a difficult problem for infrared spectrometers. The preliminary performance presented by CSEM representatives was impressive. Additional testing and development of the unit obviously is required (as plans presented at the PDR indicated). The committee urges a measurement of the light leaks through the bars under simulated observing conditions (near infrared light, appropriate beam and illumination pattern, etc.) and confirmation that these will not compromise science observations. Analysis of the thermal effects on the positioning of the bars should also be completed. Further, optical design and analysis of the tip/bar profiles should be done with the goal of understanding the vignetting caused by out-of-focus slit ends and general impact on potential observations. The committee also noted that the re-configuration of the bars seemed a significant cost to observing efficiency and urges any attempt at reducing that time, assuming this can be accomplished without compromising the positioning accuracy.

Electronics and Detectors

The designs for the electronics and detector systems for MOSFIRE are strong and based on a working heritage. The only area of concern is the Hawaii-2RG ASIC development, which is a development risk for the project. The committee urges close and frequent evaluation of the progress of the ASIC development.

Software

The software plans are generally excellent and present a practical re-use of existing architectures, although specific use cases are recommended to help refine the MOSFIRE desktop.

To support integration testing of the CSU interface and to facilitate subsequent troubleshooting by the MOSFIRE team, the committee strongly recommends a handover and re-use of any test software that CSEM uses to externally exercise and validate this interface across the serial link. It is also suggested that the MOSFIRE software team explore the possibilities for collaboration with the MAGIQ software team (developing the guider camera software for MOSFIRE and other Keck instruments) on common camera abstractions or other design concepts that could be shared across both efforts. The bridge software to the detector target computer combines a few different technologies, seemed challenging and not without risk, so the committee suggests some follow-up discussions and information exchange with WMKO software engineers on the proposed technical approach and possible alternatives.

Management and Budget

The project clearly has experienced leadership and strong cross-institutional communications. The groups have successfully completed previous infrared instruments and seem to have formed a coherent team to build MOSFIRE. The committee did see a need for a specific and focused System Engineer, since that effort seems to be generally distributed over many project personnel and a single person may be more efficient and effective. Further, there is a need for the project to develop additional error budgets and test plans and to connect instrument performance objectives to observing scenarios; a designated System Engineer perhaps could do these.

The committee recognizes that MOSFIRE has limited descope options and contingency plans. Nonetheless, more effort could be made to develop possible plans, particularly since any descope options must be implemented early for meaningful cost savings. Also, the committee strongly urges the project to consider hooks for future upgrades now, since later additions could be impossible without this initial planning. There was particular interest in a tiltable or second grating option and a calibration unit as possible future upgrades.

We saw no particular concerns with the budget projections. The project should be congratulated for developing a munificent private donor.

Conclusions

The PDR Committee feels that MOSFIRE has a strong and impressive preliminary design. The excellent and capable team can execute the project within budget and schedule. The committee has very few concerns and wishes the project good luck!

Answers to PDR Questions

- Do the preliminary specifications given in the report meet the science requirements?
  - Yes
  - Science Advisory Panel should develop a range of specific observing scenarios with particular goals for S/N, resolution, etc. and validate the existing specifications
- Does the performance predicted for the preliminary design meet the preliminary specifications given in the report?
  - Generally yes, but some issues need further study
- Are the technical requirements for the instrument clear, complete, and well defined?
  - Generally yes
- Are the preliminary designs complete enough to establish the feasibility of the proposed design?
  - Yes
- Based on the reviewer's knowledge and experience are the proposed designs feasible?
  - Yes
- Based on the reviewer's knowledge and experience are the proposed designs based on sound scientific principles and best engineering practices?
  - Yes
- Are all of the interfaces to the instrument well defined?
  - Yes
- Are all of the interfaces between subsystems internal to the instrument well defined?
  - Yes
- Are the preliminary plans for integration and test clear and well thought out?
  - Appropriate for PDR stage
- Is the risk identification complete and, if not, what additional risks should be considered?
  - Generally yes
- Are the risk mitigation efforts and future plans for risk mitigation likely to result in retirement of all critical risks?
  - Generally yes
- Does the preliminary design report provide adequate detail on the preliminary design activities?
  - Yes
- Are the interface design documents clear and sufficiently detailed?
  - Yes
- Is clear flow down established from the science requirements to the technical requirements?
  - Yes (see previous answer)
- If the predicted performance for the designs does not meet the science requirements or the preliminary specifications are the plans for addressing this sufficient?
  - N/A
- Are the plans for completion of the project, including schedule and budget, sufficiently

detailed and complete?
  - Yes
- Based on the reviewer's knowledge and experience is the proposed schedule and budget to completion realistic?
  - Yes