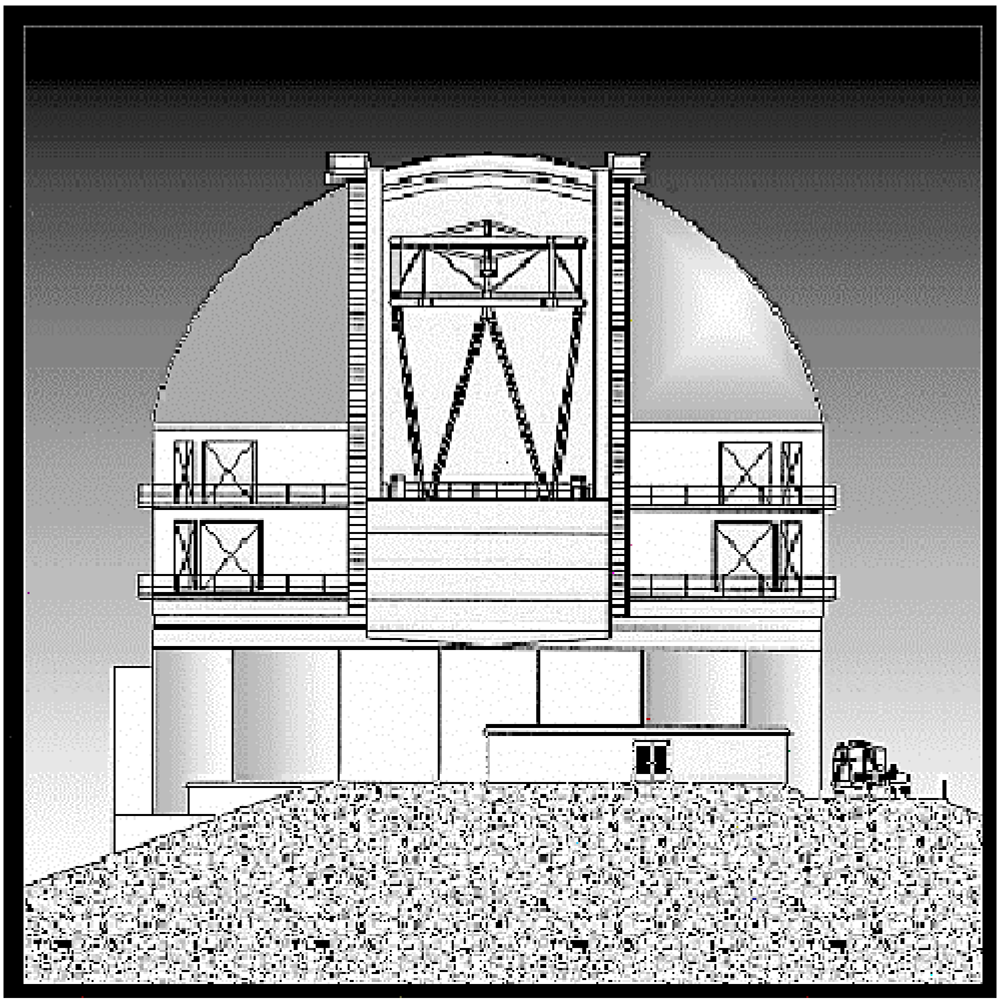
GEMINI
8-M Telescopes
Project

REV-O-G0077

Gemini M2 CDR Meeting Report



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July 11, 1996

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Gemini M2 CDR Meeting report

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Introduction

The report is divided into the various subassemblies and then the overall assembly. The responsible organizations are noted while some overlap is always required.

Overall comments

The system is looking very good and the three separate teams are doing a very good job. Unfortunately, this report emphasizes the 10% of the areas with problems rather than the 90% of satisfactory designs.

There is one area of WARNING to the project. This concerns the lack of adequate handling/maintenance planning for the final system. This is important NOW because it could affect the subsystem designs going on at the separate organizations. Some designs should be changed before they present a future problem with a more costly change required. Below is a sample:

> *"-the handling has not been thought out sufficiently to proceed to fabrication of the assembly. The ability to mount/dismount the assembly may prove of more importance to its final performance than a lot of the items presented. They must address this before continuing"*

I. Secondary (M2) mirror (Zeiss-Morton)

<u>A. Blank structure/design</u>

1. Gravity surface deformations.

The secondary mirror design appears to be consistent with the design requirements with the exception of the zenith-horizon gravity deflection. In this case, given that the scientific utilization will be limited to zenith angles of less than 75 deg, and that at 75 deg zenith angle there is considerable margin in overall imaging performance and that the requirement is exceeded by only about 10%, I feel this design provides acceptable performance.

2. Edge bevel

A 1/2 mm radius on OD and ID of M2 mirror (rather than a bevel; Mike Pickering's strong recommendation) is consistent with the design requirements and is acceptable, however consideration of any larger radius will require discussion of scientific/risk tradeoff including both effects on the emissivity and stray light performance of the telescope.

Morton recommends 1 mm radius on edge even though this does not meet our requirements. Thus the 0.5mm vs 1.0mm secondary mirror bevel/radius needs further investigation. Only after a definitive report on the risk-tradeoffs should the project use the recommended 1 mm.

3. Flexure design/attachment

The flexures should be redesigned for a reduced maximum range in order to increase stiffness and thus lowest natural frequency of M2 system, and to increase survivability of flexures due to inadvertent damage. Considering the operational difficulties (and potential downtime) of replacing flexures, a factor of safety of 2.2 seems too small. A FOS of 3-4 would be more appropriate. Increasing the lowest natural resonant frequency of this system will also allow somewhat higher bandwidth for the tip/tilt system.

The redesign should also provide for easier removal/replacement of damaged flexures, with the goal that the replacement can be done by project staff at or near the telescope sites (in the "field') The key point here is that the Gemini telescopes will initially have only one M2 each, thus if a flexure is damaged, the telescope is out of use until is can be replaced. Any special alignment fixture or locating "features" should be provided to the project so they could be made more readily removable without sacrificing repeatability.

4. Test to 8 g acceleration

The acceleration testing level for (a) finding cracks and (b) earthquake failure should be re-evaluate to decide exactly what information is required and to be obtained at this stage in the test procedure. Several reviewers worried about testing the actual blank to 8 G's+. It was pointed out that we are not testing anything else to this level. Is this a high risk test that is too extreme?

What course of action would the project take if this test fails?

One suggestion made was to test the Cerro Pachon secondary mirror to 8g, while the first mirror was tested to less (equivalent to R6).

5. General

Morton/Zeiss to supply mass/moment values to Lockheed ASAP (with tolerances).

B. Surface quality (polishing)

The surface accuracy requirements are extremely important for the long term scientific value of the Gemini telescopes. Since the secondary mirror is the pupil stop for the Gemini telescopes, the surface quality right out to the edge contributes to the imaging performance. Testing right out to the edge is thus a key to achieving the required surface accuracy. The polisher should continue to be encouraged to achieve a surface finish that is smoother than the requirement of 20 A rms roughness.

The major concern revolves around the edges where the original plan of excess material to be subsequently removed has changed. Zeiss should strongly consider increasing their interferometric spatial resolution for part of the M2 surface testing so as to be able to measure the edge finish (and perhaps other small areas) with better than the nominal spatial resolution to be used to sample the whole mirror. This may require a sub aperture test to confirm edge quality (inner and outer) It was also noted that the sharp bevel edge was easier to verify than the radius (more difficult to "see" the edge interferometrically).

The project should ask to review the testing approach to ensure its adequacy to evaluate the surface quality to the edge.

<u>C. General</u>

The schedule appears to not have any slack in it for failures. If they get a failure at the beginning, during the riskiest part, what is impact on project schedule? The project should build in to the schedule the assumption that they will drop 2-3 months due to problems.

II. Tip Tilt subsystem (Lockheed Martin)

<u>A. Hardware</u>

The design presented appears to be consistent with all the design requirements. It was suggested that Lockheed look at the issue of trapping photons from the micro-E optical encoder. A very low photon flux leakage either to the ID of M2 or out to the inner surface of the deployed baffle could result in a significant photon background at the science detector. Not everyone was convinced that the analysis showed that the vibration cancellation specification was met.

<u>B. Software</u>

There was no mention of the software required to control the system nor a functional description of what is being provided. It is essential to describe this in writing to get both sides to understand the other. The toughest spec to meet is the reduction of the tip/tilt power using a 25 Hz servo-bandwidth. The project should expect to see more information on how they plan to do this. Most of the work to date has been very idealized with little analysis of how the top level error budget was divided amongst the subsystems. For instance, we were told that the resolution of 0.005 arcsec was sufficient without anything to back this up.

C. General

The ICD is in process and should be finished as a top priority.

It is imperative that the system be shown to meet spec in the same orientation as it will be operated. If the Lockheed vibration cancellation system works to spec then the support rig should be possible.

III. Positioning subsystem (Gemini)

A. Hardware

The design presented appears to be consistent with all the design requirements. The normal motions of the bearings will be only of very limited extent - a small fraction of a ball circumference. Under these conditions, a variety of effects may eventually lead to an "indexing" stiction and/or increased or other non-linear effects. The project should assess the potential for such effects and consider options for exercising the positioning system bearing, e.g. by a complete rotation of the bearings at the start of each night of observations.

Look into positioning system steppers to see if they can use the same motors & drives as in Lockheed's tilt control box. If The Lockheed box needs to be larger to do this, we need to re-size it immediately.

B. Software/Analyses

There appears to be a good stiffness margin for positioning system (89 Hz vs 60 Hz).

No servo analysis of the positioning system was presented at all. It is common practice (at a CDR) to show that the servo requirements can be met. Also, there were indications that the positioning analysis had changed without a new presentation.

Decisions connected with software control for the positioning system were not yet well defined, e.g. when does a position change request get acted upon?

C. General

Good to have controls combined into one. The controls interface needs to be clarified.

One potential problem with the positioning system is that it was originally a project responsibility which changed hands internally before going out to Lockheed. Do we have confidence that nothing has fallen between the cracks?

IV. Deployable Baffle subsystem. (Gemini)

A. Stray light

It was not clear that at the deployed optical position, the baffle would be sufficiently light tight to achieve adequate baffling of the focal plane. The project should consider providing light seals between the vanes of the deployable baffle that could provide an effective light seal and also act as a cushion to eliminate rattling between adjacent leaves. Note that it is still necessary for the baffle to retract to a position behind the secondary mirror such that it cannot be seen form the focal plane of the telescope. It appears that at the optical position (which is probably the critical one in this regard) the overlap was only 5-10mm and with a 5mm gap between veins which is probably not sufficient.

Similarly the project should consider adding a rubber-like seat/recess for the central baffle to provide a light seal and shock absorbing capability. A very low photon flux leakage either to the ID of M2 or out to the inner surface of the deployed baffle could result in a significant photon background at the science detector.

B. Thermal analysis

Given the strong super-cooling of the baffle vanes, the project should consider a lower emissivity backing than Lo-mit, e.g. aluminum tape, chemical gold?

The modeling of sub-cooling of the baffle should indicate the seeing effect. It should also include some indication of the winds effect (40m/sec wind speed is a realistic number for the maximum wind speed the baffle could see during operation if observing facing into the wind at low altitude angles)

C. General

It appears that there is a real opportunity for commonality of stepper motors between the positioning system/deployable baffle and the tip/tilt system. The project is encouraged to adopt the common stepper motors types where it makes sense.

The position sensor rather than microswitches should be used for defining the intermediate (optical and near-IR) positions of the outer baffle (in case on-telescope testing reveals that a slightly different effective radius as seen from the instrument is required). Microswitches should still be used for the limits positions (one of which is the thermal IR position).

V. Overall System (Gemini)

A. Handling/maintenance

The most significant issue is that of handling of the M2 assembly. The project should establish a finite time scale for firmly establishing the processes, procedures, and necessary equipment for all steps of integration, installation and removal of the M2 assembly on the telescope, taking into account viability during integration and operations phases, personnel safety and providing adequate protection for the secondary mirror itself as well as the rest of the assembly.

Safe and reliable disconnect and connection of the necessary cables is a must.

The M2 group should specify their requirements for routine maintenance facilities (as is being done by the various instrument groups).

Consider using the instrument handling cart rather than a separate cart for fine control of position whilst attaching to the top-end structure.

Access to connectors for removal/connection of secondary module needs more design thought. Re-consider the routing of the wiring and whether it could be made easier to connect when installing the M2 assembly on the telescope.

<u>B. Safety</u>

Access platform should be carefully designed to meet safety codes and to ensure good maintenance access.

In the advent of a mirror substrate failure (quickly propagating crack that splits the mirror into two or more pieces) what protection to the telescope and personnel would there be?

<u>C. System analysis</u>

It would be nice to see requirements/performance at M2 assembly level to summarize

- Zeiss blank
- Lockheed tilt system
- Positioning/baffle

Project should provide an overall assessment of how the M2 assembly will perform compared to the top level requirements, imaging, emissivity, tracking.

Project should use nominal prescriptions for M1 and M2, including nominal dimensions and offsets between optical and mechanical axes of the mirrors, and calculate footprint of center of focal plane on the primary mirror for the secondary mirror centered and tilted as per 15 arc sec chop on the sky. There is concern that the allowed 1/2mm displacement between optical and mechanical centers for M2 will significantly displace the footprint of the science beam on M1 and limit the available chop angles if the footprint is not to move off M1 during chopping. The same concern holds for the allowed decenter of the optical and mechanical axes of M1.

Assumptions made on telescope dynamics and related properties (main truss eigenfrequencies, module mass, relative displacements between primary and secondary mirrors) are consistent with the latest analysis from TELAS.

Make sure James has updated mass estimates including cables, the M2 assembly module and the outer ring electronics

Clarify operational/performance environments for sub-assemblies.

The ICD to enclosure crane is needed. Move the connectors on the control electronics enclosure to the side location for better accessibility.

Some of the ICDs are out of date. Specifically those which refer to the DRD as the source of info about the ROE system to Lockheed system interface.

Controls/Interface - get ROE/Lockheed/John/Andy together to work out details.