GEMINI PROJECT
NEWSLETTER

THE GEMINI 8-METER TELESCOPES PROJECT works in conjunction with the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation.

October 1992 / Number 3

GEMINI WELCOMES PROJECT SCIENTIST

Dr. **Matt Mountain** has been selected for the position of Gemini Project Scientist and will assume the post in mid-November, 1992. He will work with the Gemini engineering team throughout the lifetime of the project to provide advice about scientific priorities, evaluate project plans to ensure consistency with scientific priorities, and serve as the interface between the project and representatives of the science communities in the partner countries.

He will chair the Science Advisory Committee for the Gemini Project, which includes leading astronomers from the partner countries.

Dr. Mountain received his B.Sc. in physics in 1978 and his Ph.D. in 1983, both from the Imperial College of Science and Technology, London University. He then held a Research Fellowship, also at Imperial College, from the Science and Engineering Research Council before joining the staff at the Royal Observatory, Edinburgh. In 1985 he became project scientist for CGS4, an infrared spectrometer that he constructed and commissioned for UKIRT, where it is now scheduled for over half the observing time. Recently, Dr. Mountain began work on a plan for implementing active and adaptive optics at the UKIRT telescope.

During the definition phase of the Gemini project, Dr. Patrick Osmer, Deputy Director of the National Optical Astronomy Observatories (NOAO), served as interim project scientist. Dr. Osmer was initially project scientist for the US efforts to build 8-m class telescopes at their national observatories. He led the preparation of a proposal to build two 8-m telescopes, which was submitted in 1989 to the National Science Foundation by NOAO. When the United Kingdom and Canada joined the project, forming an international collaboration, Dr. Osmer was assigned the task of working closely with the astronomical communities in all three countries to define the science requirements for the project. The Board of Directors of the Gemini Project will approve the science requirements and a detailed project plan in November, 1992. Dr. Osmer had earlier indicated his desire to return to NOAO following the completion of the definition phase of the project to continue his research. He is involved in a major program to identify quasars at large redshifts with the goal of determining how their space density evolves over the lifetime of the universe.

– Sidney Wolff
Project Director

TABLE OF CONTENTS

Perspective of the Project Manager

It seems only a week ago that we were doing our last newsletter. I hope everyone found a few days for vacation, because if you wait for things to quiet down in the project—*it never happens.* The Tucson staff have been involved in cost estimating for every conceivable option our science communities have asked for. This is not the fun part of the job, but we have presented the information to so many different groups we now have a good understanding of the areas where we are comfortable with the estimates and where we need to recheck the numbers being used.

In spite of the time drain required by the repeated reviews of the cost estimates, the Group Managers continue to guide the engineering staff involved in the concept designs, and the variation on those designs to optimize the telescopes. We see now that work done in the spring of this year to design and analyze a telescope optical support structure that would meet the very stringent criteria set forth by Frank Low (University of Arizona) has paid big dividends in improving predicted imaging and IR performance.

In August, Building and Enclosure Manager, Henry Blair, left the project rather suddenly. As a result, we have made a permanent organizational change and combined the Telescope and Building Enclosure Groups into one group managed by Keith Raybould — The Telescope Structure, Building/Enclosure Group. I feel the combined group is stronger and more capable than ever. They reflect the breadth of experience, flexibility and commitment that the project has benefited from by being able to form a dedicated project group, and by bringing to Tucson some of the best talent from our partner countries.

A good part of the design staff has now been in Tucson close to a year, and we are all looking forward to seeing the design fixed. The first of the Provisional Design Reviews (for the Telescope) takes place in December.

A small group of individuals has been closeted away days—no, that should be weeks, nights and weekends—to see that the project gets the best Primary Mirror blanks possible given constrains of performance, budget, schedule, and risk to the project. I want all those individuals involved to know that their efforts are greatly appreciated, and I would be sure to miss someone if I were to try and name them all. The senior staff of the Optics and Administrative Groups are noteworthy as they have been at the core of the effort to make sure every step was carried out properly.

– L. K. Randall
Project Manager

VENDOR SELECTED FOR PRIMARY MIRRORS

The Gemini project has selected **Corning, Inc.** to supply the primary mirrors for the Gemini 8-m telescopes.

The process of selecting a primary mirror blank was begun by the Gemini project in June of 1991 with the formation of the Gemini Mirror Review Committee. This committee was composed of an international group of scientists and technical experts from outside the project. Their work resulted in a recommendation that the University of Arizona Mirror Lab, Corning Inc., and Schott Glaswerke are each capable of producing mirror blanks that could meet the scientific requirements of the Gemini 8-M Telescopes.

A Selection Plan Document of some 150 pages was prepared by the project and approved by the Interim Gemini Board. That document described the nature and scope of the acquisition, the schedule for the process, and the request for proposal. All bidders were required to provide a fixed price proposal and to meet certain other mandatory requirements with respect to specifications. In addition, each bidder was given the opportunity to present alternate proposals that might provide cost, technical, or other advantages. The selection plan also called for the formation of the Source Selection Evaluation Board (SSEB), which included a scientist, several engineers and contracting experts. The evaluation board developed the evaluation criteria and their associated weighting factors as part of the final Selection Plan Document. The criteria were included in the Request for Proposal (RFP).

The Source Selection Advisory Committee (SSAC), which included scientists from the partner countries and one contract specialist, was formed to advise the project manager on the selection plan and on how the evaluation process was conducted. The advisory committee was also required to make a recommendation on proposal selection.

The Request for Proposal was reviewed by the National Science Foundation in late April, and a review of the selection process was conducted by the Interim Gemini Board in May. The RFP was issued to the three potential contractors on May 6, 1992. The contractors responded in June with fixed price proposals meeting the project's requirements, as well as offering alternative proposals for mirror blanks. The evaluation board then proceeded with the evaluation of the scientific, technical and management factors, which had been established prior to the issuance of the RFP. Cost information was not available to the evaluation board until the completion of the evaluation scoring.

After completing its initial deliberations, the evaluation board determined that no additional information was required from the respondents and the Final Evaluation Report (FER) could be prepared. The Final Evaluation Report, containing a recommendation for mirror selection, was sent to the SSAC, and after meeting in Tucson this committee produced a report and consensus recommendation.

We believe that every effort has been made to make the mirror and manufacturer selection process as impartial and fair as possible. The recommendations are the result of an intensive examination of the scientific and technical requirements of the project. We were gratified by the quality of the proposals; it was obvious that all three respondents had put much thought and effort into their responses.

Given the proposals actually received from the three vendors, the case for the selection of Corning is compelling. Recommendations in favor of the Corning option were made by the SSEB, the SSAC, the Gemini project manager and director, and endorsed by the AURA Executive Committee and by the Gemini Board.

– Sidney Wolff
Project Director

Technical Efforts for Primary Mirrors

During the interval before the proposals were received from potential vendors for the primary mirror blanks, Myung Cho, Eugene Huang and Larry Stepp of the Optics Group, Gemini Chief Engineer Earl Pearson, and others were involved in extensive modeling (and some debate) to predict the scientific performance of each mirror option.

Proposed mirror support systems for each mirror were developed by Eugene and Myung. They used finite-element analysis to: (1) predict the performance of these systems at different zenith angles; (2) evaluate the response of each type of mirror to anticipated support force errors, and (3) evaluate their responses to uniform and non-uniform wind loading.

In the course of this effort, Myung Cho developed several analysis tools that will be useful throughout the project. One of these was a program to create surface displacement grid files from I-DEAS finite-element results. These grid files have been made compatible with several optical analysis programs, including PC-Fringe and Code V. This allows extensive optical performance analysis based on calculated mirror surface deformations. Myung also developed a program to calculate the structure function of a distorted mirror surface modeled by finite-element analysis.

As part of the primary mirror scientific performance evaluation, the Royal Observatory at Edinburgh has analyzed the image quality effects of print-through of support locations for each type of mirror as well as the honeycomb structure print-through on the borosilicate mirrors caused by polishing pressures. Myung and Eugene calculated the effects of support print-through using a combination of local and global finite-element models. They were able to provide ROE with Code V interferogram files of the distorted mirror surfaces. The ROE study has quantified the changes to the point spread functions caused by these print-through bumps, and has allowed the project to determine allowable bump amplitudes. ROE is currently writing the final report for this study, which is an extension of a study they did for Gemini last winter. Our thanks to them, and also to Paul Hickson and Gordon Walker of the University of British Columbia for defining an appropriate image quality specification relating to these print-through effects.

– Larry Stepp
Optics Manager

GEMINI SCIENCE ACTIVITIES

Gemini Science Committee Meeting

The Gemini Science Committee met in Tucson on June 16-17, 1992. The committee heard a presentation on the IR science capabilities of Gemini by C. Beichman and F. Gillett (*see the following article*). Gillett reported on the latest calculations of the telescope emissivity done by A. Dinger with the APART program. They show, for example, that the system emissivity is predicted to be 3.05% at 2.2 microns with an aluminum coating on the primary, compared to 1.55% with a protected silver coating. The project has commissioned a study by Optical Data Associates regarding the feasibility of protected silver coatings for the primary mirror, and a report on a literature search and computer simulations has been received. It indicates that a promising path for silver is to use an undercoat of copper and an overcoat of hafnium oxide to achieve a durable surface.

The Project is charged with delivering to the Gemini Board prior to its November meeting a plan for constructing the telescopes and initial instrumentation that is consistent with a $176M funding level. Discussion of how to formulate the plan was a main activity of the Science Committee during the meeting. The Committee heard presentations by the project staff on current concepts and budget estimates for the different areas of the project and discussed how to achieve the greatest scientific capabilities in the capital phase. It is clear that the cost of the three configurations and eight instruments for each telescope that have been discussed in preliminary form exceeds the funding limit. In addition, there is no practical way to put into service all such capabilities in the one year after first light that is allotted to the commissioning phase.

The Committee asked that a committee of outside experts be established to review the project approach and cost estimates and to explore options for meeting the funding target. It was agreed that the Project Scientists would then meet in Tucson at the end of August to consider the recommendations of the expert committee, cost drivers identified by the Project staff, and the results of further studies by the Project staff. The Project Scientists would then prepare a prioritized set of recommendations for consideration at the September meeting of the Science Committee. The recommendations would provide a path for the initial implementation as well as the subsequent development of the Gemini Project.

Expert Committee

Based on nominations by the Project Scientists from each country, the committee of A. Boksenberg, Chair, F. Chaffee, and J. B. Oke was formed. It met with the Project staff in Tucson during the week of July 13 to review the scope of the project, its plans, and the cost estimates. The committee subsequently prepared its report and recommendations prior to the meeting of the Project Scientists August 24-28. The Project is very grateful to the committee members for agreeing to take on an intensive task on such short notice.

Project Scientists Meeting

During the week of August 24-28, P. Osmer, R. Davies, F. Gillett, R. Green, M. Mountain, and G. Walker met in Tucson to consider the report of the Expert Committee, the cost drivers identified by the Project staff, and the latest cost estimates from the Project. By the end of the week they prepared a package of recommendations and priorities consistent with the science requirements of the communities in the partner countries for different funding levels, including the $176M target. The package formed the basis of the discussion for the Gemini Science Committee when it met in Tucson September 14-16. The Committee is to recommend the definitive Science Requirements and implementation plan that is to be forwarded to the Gemini Board.

*– **Patrick S. Osmer***
Interim Project Scientist

Science Drivers for an Infrared Optimized 8-m Telescope

Four fundamental physical effects make infrared wavelengths critical to modern astrophysics: (1) the expansion of the Universe redshifts key diagnostics of the early Universe into the infrared; (2) the interstellar dust that absorbs so strongly in the UV/optical becomes only weakly absorbing in the near-IR and emits in the thermal IR; (3) the peak emission of the stars that provide most of the (baryonic) mass of galaxies falls around 1.6(1+z) μm; and (4) the infrared contains a rich suite of atomic, ionic, molecular, and dust spectral features that can be used to determine physical conditions and abundances in most phases of the interstellar medium. An 8-m telescope on Mauna Kea optimized for imaging quality and low emissivity will enable a broad suite of new scientific investigations, from the formation of stars and planets to the origins of galaxies. The rest of this article draws on current research topics in the near and thermal infrared that an infrared-optimized Gemini might be used for if it were available today.

Star Formation

The Gemini spatial resolution of 0.1 arcsecond at 2-3μm will enable observers to study the formation of multiple stellar systems and the evolution of protoplanetary disks, to search for luminous sub-stellar objects (brown dwarfs), and to investigate the initial mass function in a wide variety of star-forming environments.

The observed 1 μm to 1000 μm spectral energy distributions of young stellar objects requires the presence of disks around many of these objects. In the near-IR, Gemini will be able to study scattered light from the disks with 10 AU resolution in the nearest star-forming regions. In the thermal infrared, 3-30 μm, Gemini will be able to study the disk emission with 10-100 AU resolution. Models indicate that the presence or absence of disks on size scales of ~ 10AU should be detectable in the 1-10 μm wavelength region (Lada and Adams 1992). Observations in a variety of broad and narrow-band filters will help determine the structure and composition of the disks. Imaging spectroscopy in the 2.3 and 4.6 μm CO bands will be able to resolve orbital motions of the gas in these disks.

Gemini's sensitivity and spatial resolution will be needed to study the low end of the mass spectrum. Near-infrared imaging can identify sub-stellar masses in their earliest phases where theory indicates they will be the brightest. A giant Jupiter with 20M(Jupiter) will have a luminosity of 10^{-2} to 10^{-3} L(sun) in its first 10^{5-6} years, and might be detectable as a companion of another star, or as a field object in a young stellar cluster. At the distance of Taurus, such an object might have an effective temperature of 2700K and a flux density of 5 mJy at 2.2 μm (Nelson, et al., 1992). Identification and characterization of these objects would help determine how much mass is locked up in the low end of the stellar mass function.

Gemini's superb imaging qualities will also be needed to determine the high mass end of the luminosity function in molecular clouds. In some clouds, the density of young stellar objects approaches 20,000 objects per cubic parsec with projected separations of less than an arcsecond. Gemini's imaging qualities will be able to determine the location of young stellar objects in the HR diagram, to help us understand what kinds of stars form in large clouds as opposed to small cores, and how bound and unbound clusters form.

Imaging, speckle imaging and lunar occultations have identified companion objects to previously known infrared sources with separations in the range 10-1500 AU, with a frequency consistent with the multiplicity statistics of field stars (Gehz, et al. 1992; Simon, et al. 1991). Some of the proposals for Gemini might include imaging and spectroscopic investigations concentrating on systematic searches for and study of multiple systems and the determination of the masses of component objects. These investigations would lead to a better understanding of whether binary systems form due to the presence of multiple condensations within a cloud, or to the fragmentation of a protostellar disk.

Planetary Debris Disks

The biggest surprise of the IRAS mission was the discovery of disks of material in orbit around nearby stars such as Vega and Beta Pictoris. While ground based work is limited by the low surface brightness of the emission from these disks, Gemini will be able to make a number of important contributions because of its low emissivity optics. Maps and narrow-band spectra have recently been obtained of dust in the disk surrounding Beta Pictoris. These data (Telesco, et al., 1988, 1991; Skinner et at., 1992; and Backman, et al., 1991) have shown that: (1) dust in the Beta Pic shell contains silicate grains with emission properties much like comets seen in the solar system *(Figure 1)*; and (2) that the central tens of AU surrounding

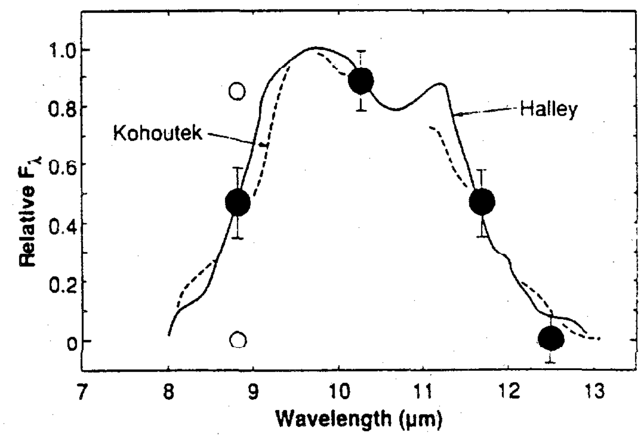


Figure 1(a).

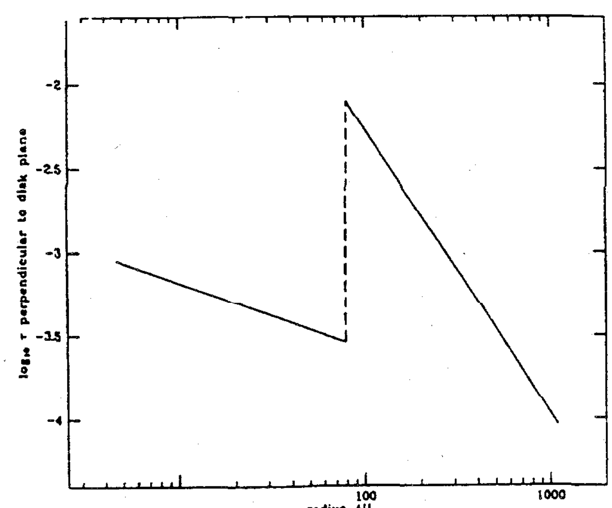


Figure 1(b).

Figure 1(a). 10μm spectra of Beta Pictoris (Telesco and Knacke, 1991) shows the presence of silicates in the emission from the disks surrounding these stars. **1(b).** Observations with 4 and 8 arcseconds resolution (Backman, et al., 1991) constrain the spatial distribution of the circumstellar material, suggesting the presence of an inner gap that might be due to the presence of planets.

Beta Pic may be devoid of large amounts of dust, perhaps because of the presence of planets. Observations with high sensitivity in the thermal infrared and high spatial resolution will be critical for mapping the distribution and composition of the emitting material in these disks. These observations will take advantage of the fact that Gemini's diffraction limit at 10 μm of 0.3 arcsecond corresponds to 3 AU at nearby stars like beta Pic. Gemini's primary mirror will have to be kept very clean to keep its emissivity low. A side benefit of this cleanliness will be the ability to carry out coronographic studies of Beta Pic-like stars looking for near-IR and optical evidence for disks.

The Galactic Center

Do the centers of the Milky Way and other active galaxies harbor black holes? In many cases high spatial and spectral resolution observations in the infrared are critical to advancing our understanding, since the centers of active galaxies are obscured from view at optical wavelengths by dust. Recent near-IR speckle results with 0.25 arcsec resolution (Eckart, et al., 1992) suggest that the Galactic Center contains an active nucleus surrounded by a wind-blown bubble *(Figure 2)*. A velocity resolved map of the Galactic Center in the 12.8 μm line of [NeII] (Lacy et al., 1991) implies the presence of a 2 million M(sun) black hole within the central 0.1 parsec. Imaging spectroscopy of the Galactic Center will clarify the spatial-velocity structure of the region. Gemini will be able to search the centers of nearby galaxies for 10^7M(sun) black holes in the same way.

Infrared Luminous Galaxies and Proto(?)-galaxies

Perhaps the most luminous object in the universe is the IRAS source F10214 *(Figure 3)*, first detected at 60 μm in the IRAS Faint Source Survey (Rowan-Robinson, et al., 1991), and determined from subsequent optical and near-IR observations to have a redshift of z = 2.28. The detection of the redshifted millimeter line of CO(3-2) indicating the presence of enough material to make a galaxy the size of the Milky Way, $2x10^{11}$ M(sun), makes this object the best candidate for a forming spiral galaxy yet found. Near infrared spectroscopy and imaging will be important tools for a detailed study of objects like this, which may be found by deep IR surveys (by Gemini itself), or by IRAS, ISO, or SIRTF, and which may have none, or only very faint optical counterparts. High sensitivity and superb imaging will make it possible to study the morphology and dynamics of these objects and to detect the individual supernovae that

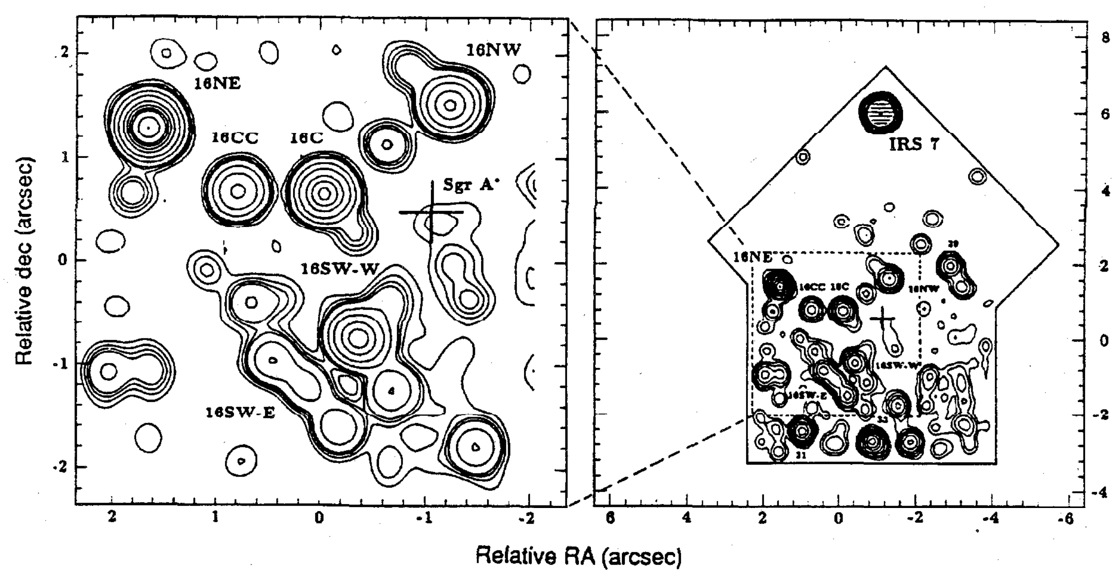


Figure 2. A near-IR image of the Galactic Center with 0.25 arcsecond resolution (Eckart et al., 1992) suggests the presence of a wind blown bubble of gas at the center of the Milky Way. Gemini will be able to make high spatial and spectral resolution images of the region to constrain the properties of a central massive object at the center.

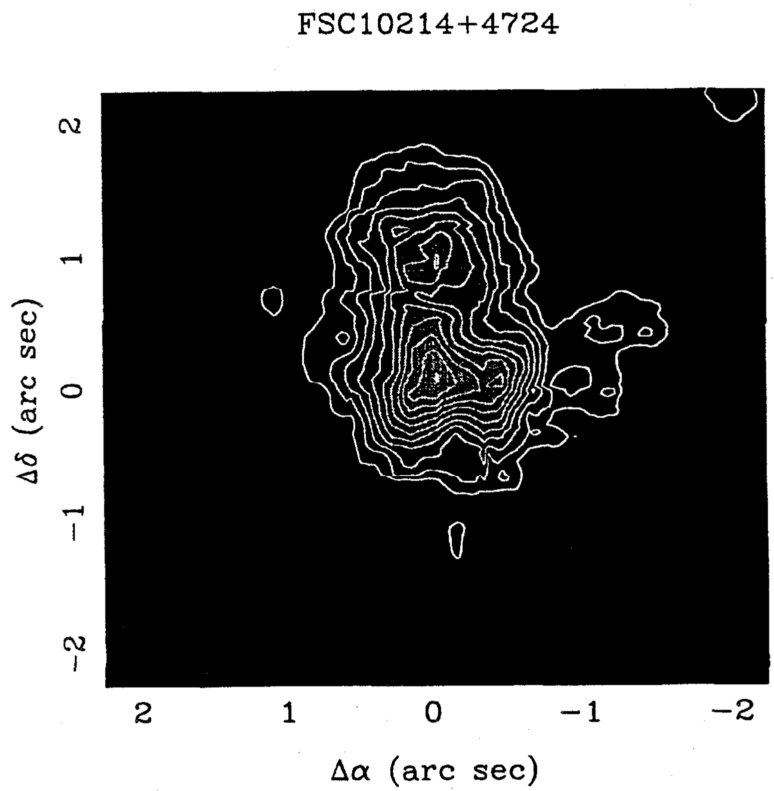


Figure 3. An image of F10214 in a narrow band near Halpha (observed at 2.1μm) from the 5-m telescope (Soifer et al., 1992, in press) suggests that a merger system maybe responsible for the $5x10^{14}$ L(sun) emitted by this faint IRAS source.

must be present in these galaxies if the starburst model for the energy source of these galaxies is correct. Finally, the high sensitivity of an 8-m telescope for IR imaging and spectroscopy will make it possible to find and study L* galaxies at high redshift to determine their morphologies, elemental abundances, and evolutionary stage.

References:

Backman, Gillett, F. C., and Witteborn, F. C., 1991, *Ap.J,* 385, 670

Eckart, et al., 1992, *Nature,* 355 1

Gehz, A., et al., *AJ in press*

Lacy, J., et al., 1992, *ApJ,* 380, L71

Lada, C. and Adams, F., 1992, *preprint*

Nelson, L., Rappaport, S. and Joss, P.C., 1992, *preprint*

Rowan-Robinson, et al., 1991, *Nature,* 351, 719

Simon, M., et al., 1991, *Ap.J,* 348, 212

Simon, M., et al., 1991, *Ap.J,* 347, L12

Skinner, C. J., Barlow, M. J., Justtanony, K., 1992, MNRAS, 255, 31 p.

Soifer, B. T., et al., 1991, *Ap.J.,* 381, L55

Soifer, B. T., et al., 1991, *Ap.J.,* 381, L55

Telesco, C. M., et al., 1991, *Ap.J.,* 372, L29

Telesco, C. M., et al., 1988, *Nature,* 335 51

– C. Beichman and F. Gillett

Notes from the U.S. Project Office

The U.S. Project office resides at NOAO and consists of Richard Green and Larry Daggert, manager of NOAO Engineering and Technical Services. To date, this office has primarily supported the participation of U.S. astronomers in Gemini advisory committees, particularly the National Science Advisory Committee, the Gemini Science Committee, and the instrument working groups. The office will also play an increasing role in the discussion and distribution of work packages as that plan is developed.

The U.S. Gemini Science Advisory Committees met in Tucson last February and again on August 13th and 14th. Their charge was to consider the budget figures provided by the Project, and to develop a choice for first-light configurations of the two telescopes that reflected national scientific priorities. Recommendations were developed by two subgroups, an IR and an Optical/UV subcommittee, then merged by a joint committee into a unified set of priorities. The Project engineering team also presented a technical overview of design progress for discussion.

The U.S. astronomy community owes a debt of gratitude to the members of the national SAC. They devoted time and energy to understanding the technical and budgetary issues of the Gemini Project, and developed a unified recommendation that serves the scientific needs of the users and meets the priority goals defined in the NAS decade survey report. The members of the **IR subcommittee** are:

Chas Beichman (IPAC)
Jay Elias (CTIO/NOAO)
Ian Gatley (NOAO)
Bob Gehrz (U. of Minnesota)
Fred Gillett (NOAO)
John Lacy (U. of Texas)
Frank Low (U. of Arizona)
Mike Simon (S.U.N.Y.)
Charles Telesco (NASA/Marshall), and
Mike Werner (J.P.L.).

The **Optical/UV subcommittee** consists of:

Sam Barden (NOAO)
Todd Boroson (NOAO)
Alan Dressler (O.C.I.W.)
Jay Gallagher (U. of Wisconsin)
John Huchra (CfA)
Paul Schechter (M.I.T.)
Bob Schommer (CTIO/NOAO)
Steve Strom (U.Mass.)
Tony Tyson (Bell Labs), and
Don York (U. of Chicago).

Fred Gillett chaired the IR subcommittee; Richard Green chaired the Optical/UV subcommittee. The merging of recommendations was accomplished by the IR/Optical Committee composed of: Beichman, Dressler, Gehrz, Gillett, Low, Schechter, and Strom, with Pat Osmer and Sidney Wolff attending ex officio. The U.S. SAC process had been organized and chaired by Pat Osmer as Interim U.S. Project Scientist; for the August meeting, the chair was Richard Green.

Four of these astronomers serve as the U.S. representatives to the Gemini Science Committee, putting in additional time and travel in support of the project; they are: Chas Beichman, Alan Dressler, Fred Gillett and Richard Green. For the September meeting in Tucson, Mike Werner replaced Chas Beichman. The contributions of three people deserve special mention. Frank Low's commitment to the imaging and IR performance of the telescope is reflected in the current mount design. Steve Ridgway chairs the Adaptive Optics Subcommittee and continues his work to identify the implementation of higher-order correction to achieve the full aperture gains of the telescopes. Fred Gillett does not carry an official project title, but he has translated his concern for the highest imaging quality and best thermal properties into daily interaction with the project team, and he is among the most visible and best known of the community's scientists to the Gemini staff. It is through the voluntary participation and continuing involvement of the partner country scientists that we will achieve the unique performance goals of the Gemini telescopes.

– Richard Green
U.S. Project Scientist

UK Project Team

As activity in the Project expands, the UK Project Team is re-organising. I am taking up a post at Oxford University. I will continue as UK Project Scientist, but from 1st October my duties as Project Manager will be taken over by Terry Lee at the Royal Observatory Edinburgh. Terry is Head of the Technology and Computing Division at ROE and was Director of the UKIRT for its first six years. He has been responsible for instrument building and telescope engineering at the Royal Observatory, Edinburgh since 1985. I will continue to be the principal UK scientific contact for the Gemini Project, but Terry will take over responsibility for the overall management of the UK technical programme and for the technical and management interface with the Tucson Project Team. Justin Greenhalgh will continue in his role providing day-to-day management of the UK programme based at Oxford and RAL.

Jeremy Allington-Smith is joining the UK Team from Durham to take up the post of Deputy Project Scientist. Jeremy has played a large role in the development and commissioning of the series of focal reducing spectrographs that have been built in Durham. Most recently he was in La Palma commissioning the Low Dispersion Survey Spectrograph (LDSS-II) on the William Herschel Telescope. We look forward to having him on board; he will arrive in Oxford Oct 1st 1992.

– Roger Davies
UK Project Scientist

Canadian Activities

A Canadian Project Office has been established at the Dominion Astrophysical Observatory in Victoria. Andy Woodsworth has been appointed as the Canadian Project Manager, reporting to Don Morton, Director General of NRC's Herzberg Institute of Astrophysics. Tim Davidge has been appointed as Canadian Project Astronomer, and his primary responsibility is Gemini instrumentation. Tim reports to Gordon Walker, who is the Canadian Project Scientist, and a professor at the University of British Columbia in Vancouver. Don Morton and Gordon Walker are the two Canadian members of the Gemini Board. We are also trying to recruit a Canadian Project Engineer for the office at DAO.

The Canadian Scientific Steering Committee met on August 16-18 at the Dominion Astrophysical Observatory to discuss current scientific issues. Conclusions reached by the committee were that:

1. image quality is of paramount importance, and that the goal of 0.1 arcsec optics should be maintained;
2. an effort should be made to preserve near-ultraviolet capabilities; and
3. the ability to monitor observing sessions remotely should be retained.

Instrumentation priorities were also reviewed, and the highest priority instruments for the Canadian community are:

1. a high-order adaptive optics system;
2. an imaging multi-object spectrograph, which will operate in multi-slit mode;
3. a cooled-grating spectrograph to operate in the 1-5 micron region; and
4. a high-resolution optical spectrograph.

– Andy Woodsworth
Canadian Project Manager

GEMINI GROUP UPDATES

Administrative Management Group

The Gemini Administrative Group staffing is now up to four regular employees and one temporary employee. Since the last newsletter, we have added a Financial Administrator, Mr. Don Ferris. We have also hired a temporary Project Scheduler, Mr. Dan Eklund. If this position becomes a regular position, the partner countries will be asked to make inputs as to possible persons that might be interested in the position.

The Financial Administrator has been working diligently to prepare the Gemini budget and spending profiles for the total project. He is currently completing the projected budget for CY 1993 based on projections from the Project Manager and the Group Managers. In addition to the financial projections, the Financial Administrator has also been compiling the Work Breakdown Structure (WBS) for the complete project and is now being assisted by the Project Scheduler in that task. The WBS information will be utilized to develop the overall project schedule, account codes, and the designation of the various Work Packages, which will eventually be allocated among the partner countries and the University of Hawaii.

The Administrative Management Group, along with the Optics Group Manager, have been heavily involved in the 8-m Mirror Solicitation Process. This process which was begun in February 1992 was concluded in mid-September 1992. It has been a long process, beginning with pre-solicitation, and proceeding through the total selection process. The 8-m Mirror acquisition is an important milestone not only for the Administrative Management Group, but for the project as a whole.

Although the Mirror solicitation has been an important one, it is not the only solicitation with which Gemini and the Administrative Management Group have been involved. To date, in 1992, The Administrative Management Group has written 48 contracts for the Gemini Project. As the project progresses, contracts of various types will be written in support of the Group Managers and the project in general. As part of the contracts process, the partner countries are asked to state their interest in either doing the work or recommending agencies within their countries for doing the work. The contracts process, however, is normally a competitive one.

The Administrative Management Group has moved into a portion of the new Gemini building addition. The work on the new addition was completed in late July, and freed up space for the Controls and Software Group personnel.

One of the primary goals of the Administrative Management Group for the remainder of CY 1992 is to complete agreements with the partner countries. Work has begun on the agreement between the Gemini Project Office and the United Kingdom Science and Engineering Research Council (SERC). This agreement is currently being written in draft for review by Gemini Group Managers and the Project Manager. After the final Gemini review, the agreement will be forwarded to SERC for their comments. The Administrative Manager and the Contracts Administrator are scheduled to go to Canada in October to initiate discussions with the Canadian Commercial Corporation, a Canadian government agency, for the purpose of developing an agreement for placing contracts in Canada. The Canadian Project Manager will also attend that meeting, representing the National Research Council of Canada.

– Jack Morton
Administrative Manager

GEMINI GROUP UPDATES

Controls Group

The Controls Group has a new member. Peregrine McGehee has accepted the position of Instrument Control Software Engineer with the group and started as of July, 1992. Peregrine comes to Gemini from the California Submillimeter Observatory and so is quite familiar with the Mauna Kea site and Hilo.

Current Work

The work of the Controls Group has been concentrated in the following areas since the last newsletter:

- continuing evaluation of telescope performance
- monitoring initial servo design contract
- creation of initial planning documents
- contracting out servo analysis
- analysis of real time operating systems
- review of commercial visualization products
- review of commercial real time database

Telescope Performance

An interim study of the open loop (no guide star) telescope performance in the presence of wind shows that, in order to meet the tracking specification, the enclosure must provide an effective reduction in wind speed of 5 (maximum wind speed impacting telescope of 2 m/s) if neither a focal plane star nor upper end gyroscopic stabilization is used. If gyroscopic stabilization is used then the wind reduction required is a factor of 2.5. This study has been published as a technical report and is available on request (rmcgonegal@noao.edu).

Subsequent to this the project scientists have proposed to drop the open loop tracking requirement completely and to focus the project on the closed loop and tip/tilt tracking modes. We must still set limits on the open loop tracking performance - it must be sufficient for field identification and acquisition of guide stars.

Initial Servo Design

ASA Automation, in collaboration with M.Davies and S.Hutton of the University of British Columbia, will be presenting the results of this design study to the project at the end of September. A draft of the literature study has been submitted to the project. One of the main points made in the literature study is that, although the tracking and pointing requirements for modern telescopes are approaching those of space instruments, there has been little use made of the large amount of work done on smart structures and optimal control in the space fields.

Initial Planning Documents

In order to provide a common base for the Gemini Software and Controls efforts the group has been concentrating on the creation of the following documents:

- Software Management Plan
- Software Concept Specification
- Software Programming Standards
- Control System Design Requirements

These documents will each undergo a number of drafts before coming under change control. At a minimum these documents will be reviewed by the project, the Controls Working Group, and the community before undergoing formal review.

Servo Analysis Contract

The group has been disappointed in the lack of response to its advertisements for a servo engineer to join the project. At this point in time we have decided to create a consulting contract with an outside firm in order to make progress in this area. Towards the end of 1993 we will decide whether to continue with a consulting contract or to attempt to hire.

The response from the commercial community has been somewhat overwhelming. Nine companies, ranging from major Aerospace to small consulting firms, have responded from Canada and the United States. The breadth and depth of experience in creating complete telescope systems assures us of getting good help with the project.

GEMINI GROUP UPDATES

Real Time Operating Systems

The group has decided that, if it is to adopt a common real time operating system across the project (which it will), it must review the field at this time in order to make a long term decision that is most beneficial to the project. At the current time the field has been narrowed to two contenders; VxWorks from Wind River Systems and Lynx OS from Lynx Real-Time Systems.

We realize that a majority of the astronomical community has decided on VxWorks as the system of choice and this is a powerful argument for adopting it. However Lynx OS has been adopted by both Sun and Hewlett Packard, is considerably less expensive, and runs on a number of platforms (386/486, 68000, and Sparc/HP9000 soon). This gives Lynx users access to a wider variety of target architectures and bus systems. Although VxWorks provides a richer set of programming tools this is not necessarily a benefit in a project that is trying for standardization.

P.McGehee is currently studying the different options and, after a community discussion, we hope to reach a decision by the end of this year.

Visualization Products

The need to provide image/spectra visualization and manipulation at the telescope is a given for this project. Although the different processing systems (ADAM, IDL, IRAF, MIDAS) provide excellent capabilities it is not clear that these are the answer for real time use during observing. In order to make an informed decision we are examining the product PV Wave from Precision Visuals as a candidate for real time imaging at the telescope. It is, of course, our intent to provide a number of processing packages off line for use by observers.

Real Time Database

There are a number of ways to connect together the various software parts (like instrument control, telescope control, subsystems control, user interface) into a coordinated whole. Two of the most popular are message passing and a real time database. The software product RTAP (Real-Time Applications Platform) from Hewlett Packard is being evaluated as a candidate. This package has a number of features which are attractive to the project:

- it is a commercial package from a major vendor
- it provides a real time database capability that can be distributed
- it provides a complete user interface
- it allows staff to easily monitor, log, and view contents of database over time

Future Work

The group intends to continue laying the base needed for successful subcontracting of the work packages. We expect to have this base in place by the end of the year so that packages can be placed with community groups and commercial firms starting early next year.

– Richard McGonegal
Controls Manager

GEMINI GROUP UPDATES

Instrumentation Group

The Gemini Instrumentation Group continues to work on some of the telescope/instrument facility issues such as instrument mounting, acquisition, guiding and wavefront sensing for active control of the telescope optics.

Basic layout concepts have been developed for instrument mounting which will be developed in more detail after the telescope focal ratios have been finalized. The present arrangement allows for the mounting of two instruments, one looking upward and one looking sideways. In addition, there is a feed provided for an adaptive optics unit as well as a calibration unit position. There is also provision for permanently mounting an optical imager on the support unit. The imager will be used for field acquisition in addition to science functions.

A design study contract for the guiding and active wavefront sensing facility will soon be placed.

A draft instrumentation plan has been developed. Subsequent to decisions being made on instrument priorities (expected after the GSC meeting in mid-September), a final draft plan will be prepared and distributed for comments and feedback.

The group is presently drafting procedures for the allocation of instrumentation workpackages to the partner countries. Individual workpackage definitions are being prepared for the first workpackage allocation meeting, which will be held late this year or early next year.

– David J. Robertson
Instrumentation Manager

Optics Group

As reported above, the primary mirror selection process has occupied much of the effort of the Optics Group over the last few months. Part of this effort was the preparation of preliminary specifications and a Request for Quotation for primary mirror polishing. This RFQ was sent to several large mirror polishers, asking for cost estimates for polishing each type of 8-meter primary mirror. We received a number of good responses.

We also sent potential vendors preliminary specifications and RFQs asking for cost estimates for wide field secondary mirror blank fabrication and polishing and (silicon carbide) IR secondary mirror blank fabrication and polishing. These vendor estimates have been used to update and refine our plans and budgets for the optical assemblies.

Eugene Huang has prepared a report on line-of-sight sensitivity equations for calculating the effect of tilts and translations of the telescope optical elements on telescope pointing. Eric Hansen and John Roberts have evaluated the effects of the same type of optical element motions on image encircled energy.

Technical studies and cost estimates have been prepared in response to several suggested telescope configuration changes including: changing the wide field f/ratio to f/9, changing the IR mode f/ratio to f/20, reoptimizing the wide field for 30 arc minutes instead of 45, inserting relay optics to transfer the f/16 beam to the Nasmyth focus, and developing a 10 arc minute field corrector for the f/16 Cassegrain focus. Our thanks to Charles Harmer of NOAO for his optical design support in these studies.

We have also continued our collaboration with the WIYN Project, consulting with them on null lens design, active mirror support design, and optical specifications for primary mirror figuring. They have been very cooperative in helping us with cost estimates, based on their procurement experiences, and keeping us informed about progress on their primary, secondary and tertiary mirrors. It is valuable to actually get to see their hardware, including their lightweight mirror blanks.

– Larry Stepp
Optics Manager

GEMINI GROUP UPDATES

Telescope Structure, Building/Enclosure Group

Building/Enclosure Design and Early Construction Plans

Group Priorities

During the past few weeks, the combined Telescope Structure, Building/Enclosure Group has been re-organizing and defining future plans. Priorities for the building and enclosure work are as follows:

- Determine the critical tasks that must be started immediately to enable the work planned for the summer of 1993 on Mauna Kea to proceed. A high priority has been to ensure that we do not lose a year of construction on Mauna Kea. The earliest we envisage start-up of construction on Mauna Kea is April 1993, which corresponds to the earliest we can expect to get the Conservation District Use Permit (CDUP) for construction on Mauna Kea.

- Place contracts with ASTeR, INC. and the San Diego Supercomputer Center to allow the flow characteristics over the summit to be evaluated with numerical modeling. Dave De Young will be involved in the latter work. The results of these studies will aid selection of the height of the telescope altitude axis above the ground level.

- Reduce the number of enclosures under review to two candidate enclosure designs. This has simplified the design process and will make model testing in water/wind tunnels more efficient.

- Start an intensive program of analysis, design evaluation and review to ensure we understand and control the "dome seeing".

- Generate a schedule and budget.

Critical Tasks

The critical tasks identified to allow construction to proceed on Mauna Kea include:

- Completing the design of the Hale Pohaku construction cabins and formulating an agreement with the Institute for Astronomy (IFA) and Subaru for sharing the cost of common infrastructure.

- Analyzing the soil samples taken on Mauna Kea. A contract has been placed with Harding Lawson Assoc. (HLA) to analyze core samples taken on our site on Mauna Kea and to deliver a geotechnical report by mid-October.

- Completing the Conservation District Use Application (CDUA). The CDUA is being reviewed by IFA prior to submittal to the Department of Land and Natural Resources (DLNR).

  After obtaining the CDUP, relocate the 24-inch telescope, power lines and utilities that cross the site, and building the access road on Mauna Kea in 1993. In addition, the Hale Pohaku construction cabins will be built. Site preparation for the building and enclosure on Mauna Kea will start in the summer of 1994.

Other critical tasks are as follows:

- Establishing requirements and costs for facilities in La Serena and the support buildings on Cerro Pachon.

- Establishing enclosure costs.

- Establishing requirements and developing design layouts for the subterranean facility on Mauna Kea and Cerro Pachon.

- Defining numerical modeling methods for predicting the air flow over the Mauna Kea telescope site. Information from this design study will be used to determine the height of the site boundary layer, and subsequently, the height to the telescope altitude axis above the ground level. ASTeR, Inc. are simulating the overall flow over the mountain, and

GEMINI GROUP UPDATES

Dave De Young, using the ASTeR, Inc. results as boundary conditions, will model the air flow over the telescope site in more detail. Results will be correlated with site wind data taken by Ruth Kneale on the site this year.

- Steve Hardash and Peter Hatton are developing design layouts of the enclosure and the subterranean facility.

Enclosure Design Options

We have narrowed our design options to: (1) a ventilated hemispherical dome with opening vents; and (2) a co-rotating compact enclosure (also with opening vents).

Both enclosure designs will be taken through the Provisional (PDR) and possibly the Critical Design Reviews (CDR) to production of construction documents and bidding. Selection of the enclosure will then be based on construction costs and in-house performance evaluation.

Current design work includes:

- Bob Ford is investigating suitable mechanics for the ventilation system. Seven mechanical systems have been identified for further evaluation and costing. Performance criteria have been established, and after approximately three months of engineering, a system will be selected.

- Thermal modeling of the enclosure. Bob Ford is modeling the enclosure skin and structural member response during the daytime and during observing. This work will establish requirements for the skin surface properties, solar absorptivity and thermal emissivity, and other thermal control features such as insulation, air flow in cavities and daytime air conditioning.

- Future work will include wind or water tunnel tests or further numerical modeling.

Design Reviews

Two advisory group(s) with more targeted aims will replace the current building and enclosure working group. The first group consists of scientists who will work closely with the Gemini project to advise on the overall design approach for the enclosure. Emphasis will be on thermal considerations, air flow management and control of "dome seeing". We hope to involve scientists with a background of experience in these areas. This group will review the design approach and results obtained to date at an informal meeting in early October. The second advisory group will be principally technical, and will be involved at the design reviews.

We will be moving some of the building and enclosure design reviews to coincide with the telescope design reviews. This will achieve two aims: (1) if some individuals are on both design reviews, there will be continuity of evaluation between the telescope and enclosure designs; (2) it will be more efficient and cost effective for both the reviewing personnel and the Gemini group to hold the two meetings at the same time.

The dates for the building and enclosure PDR remains the same—April 1993. We will move the building and enclosure CDR to September 1993 to coincide with the telescope CDR. In addition, we will hold an informal building and enclosure design review before the PDR, to coincide with the telescope PDR at the beginning of December 1992.

Telescope Design

The telescope design has evolved considerably since the last newsletter. Since the con-focal Cassegrain and Nasmyth requirement was relaxed, the single azimuth track telescope configuration has become viable. After developing design layouts and performance evaluation, we have selected the single azimuth track design as the baseline option. Although the mount is significantly heavier—95 tons compared to 40 tons—the concrete pier is simpler and lighter. The azimuth track diameter for the new mount is the same diameter, 9.5m, as the inner track of the double azimuth track design. Within the constraint of machining critical surfaces in one machining operation (i.e., to avoid resorting to segmented tracks) the track diameter has been maximized to improve the dynamic performance of the structure and to provide a large diameter for the drive system and encoder surfaces.

GEMINI GROUP UPDATES

We have also placed a commercial contract to undertake manufacturing feasibility and design trade-off studies to ensure that we develop a cost-effective mount structure with high performance.

The telescope will still accommodate interchangeable top-end rings. Currently we envisage two rings, an f/6 and an f/16 *(see drawings on page 18)*. The f/6 secondary has a dedicated top-end ring, and feeds only the Cassegrain focus. The f/16 top-end ring has an interchangeable undersized silver coated f/16 secondary for IR at the Cassegrain focus, and an f/19.6 optical aluminum coated secondary to reach the Nasmyth foci. The telescope can accommodate instruments on two Nasmyth platforms. The Nasmyth instruments are supported in a bearing with a vertical axis. Rotation of the instrument in this bearing de-rotates the field without the requirement for de-rotation optics. In addition, rotation about this axis avoids the instrument components changing orientation relative to gravity—important for excellent performance of high resolution instruments.

All secondary mirror and top-end changes are accomplished during the daytime using specialized handling equipment.

The primary mirror has been located to allow a tertiary mirror to reflect a 3 arc minute field to the Nasmyth foci.

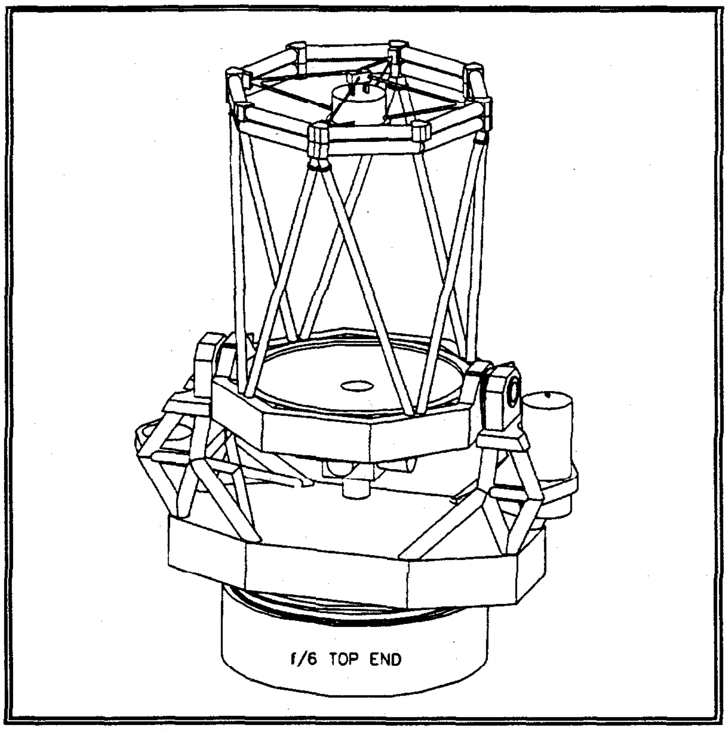
Mike Sheehan is currently evaluating the requirement for composites in the upper telescope tube structure. Composites provide a potentially higher specific stiffness with higher passive damping—desirable characteristics for the telescope structure. He is evaluating the performance under wind, fast guiding and chopping loads with different combinations of composite and steel. A significant performance enhancement has recently been achieved by using high modulus composites for the vanes that support the secondary mirror modules from the top-end rings. By careful selection, he has reduced—by a factor of three—the image degradation caused by piston of the secondary relative to the primary mirror. We have also placed a commercial contract to test the composite mechanical properties, in particular, the hysteresis and damping characteristics.

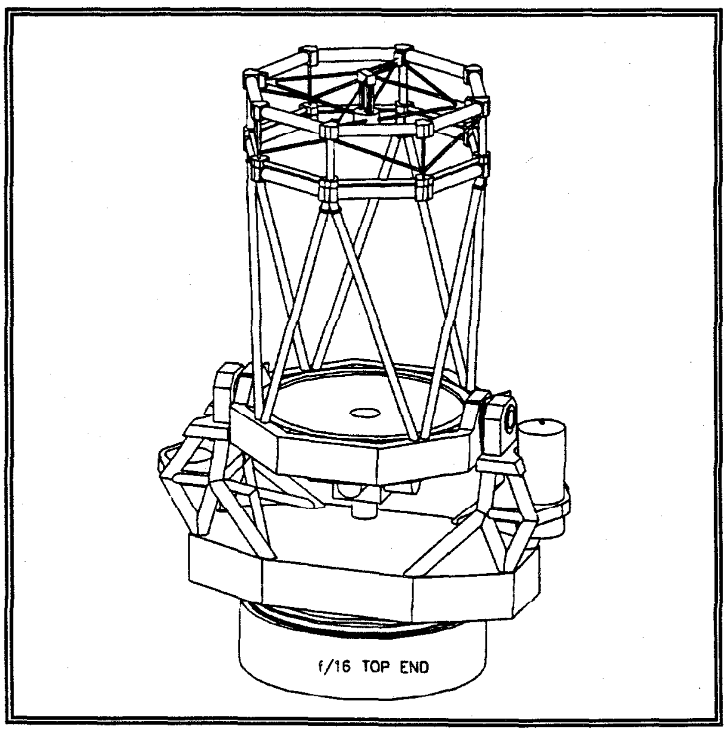
The friction driven test rig, designed by Mark Warner to test two designs of encoder mounts, has been completed and commissioned. The project is involved in a collaboration with the WIYN, Magellan and the MMTO to test friction driven encoder mounts. Next week the WIYN encoder mount will be delivered for testing. Gordon Pentland has completed the design of the alternative encoder mount, and manufacture will start soon.

Turning to coating development and mirror cleaning, the literature search and computer simulations of protected silver coatings by Optical Data Associates has been completed and a report submitted. Sputtered and evaporated protected silver coatings deposited by proprietary processes by OCA Applied Optics will be delivered to Gemini by the end of the month for emissivity measurements.

We will be evaluating two methods for cleaning the primary mirror in-situ. A contract has been placed with STI optronics to evaluate the Excimer laser cleaning process. We will be sending aluminium-coated samples to an observatory on Mauna Kea for contamination. The samples will be exposed for different time periods, and then returned to Gemini for emissivity measurements. Some of the samples will then be cleaned with CO_2 snow, and others using the Excimer lasers, after which their emissivity will be remeasured. Information from these tests will enable us to determine the relative efficiency of the two cleaning methods and to gain an understanding of the optimal period between in-situ mirror cleaning operations. Ruth Kneale is coordinating coating activities.

– Keith Raybould
Telescope Structure, Building/Enclosure Manager


f/6 TOP END


f/16 TOP END

Upcoming Gemini Project Meetings

Date(s)	Meeting	Location
Nov. 9-11, 1992	Gemini Interim Board Meeting	Tucson, AZ
Jan. 25-26, 1993	Gemini Oversight Committee	Tucson, AZ

GEMINI
8-M Telescopes Project

950 N. Cherry Ave.
P.O. Box 26732
Tucson, Arizona 85726-6732