GEMINI

NEWSLETTER

Issue 13 December 1996

GEMINI
8-Meter Telescopes Project

Both Gemini Sites Start to Take Shape

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United States • United Kingdom • Canada • Chile • Brazil • Argentina

Introduction

There has been considerable progess both at Mauna Kea, Hawaii and at Cerro Pachon, Chile as can be seen from our front cover, "*Both Gemini Sites Start to Take Shape*". The steel work for both enclosures has now reached to the top of the telescope pier, some 44 feet (13.4 meters) above the ground. Work on putting up the rotating enclosure carousel on Mauna Kea started in October, with Cerro Pachon following in March of next year. Another milestone, shown on our back cover, is the start of the inital polishing (more accurately, grinding at this point) of our first Gemini primary mirror at REOSC. Having successfully polished two VLT mirrors, with the third underway, REOSC is all set to repeat these successes on the two Gemini mirrors.

In this newsletter we begin looking forward to the science operations of the Gemini Observatory. We have an article describing the work that is being done on simulations of our proposed queue scheduling system and a description of the Gemini Data Handling System, the system that will provide astronomers with their first look at data collected by the Gemini telescopes and their instruments. In addition, we are starting a series of detailed descriptions of the Gemini instruments. In this issue we start with GMOS, the two Gemini Multi-Object Spectrographs that are being built for Gemini North and South.

Also, please have a look at our Web site (*http://www.gemini.edu/*), which is more than just a place to see the latest pictures from the Gemini project. We also use it to coordinate all our documentation and information between our international partners. It now contains all of our recent pre-prints, which should have started appearing in your libraries; announcements of meetings; and forthcoming job opportunities with the Gemini Operations.

-Matt Mountain
Director

Project Update - December 1996

Construction activity for both Gemini telescopes continued at a rapid pace through 1996, as evidenced by the fact that construction project spending peaks in 1996 and 1997 at $40 million per year.

The enclosure base and support facility steel structures were completed at both sites during the past six months. Exterior cladding of the structure is underway at Mauna Kea. As soon as the cladding of the support facility was complete, San Juan Construction started work under their contract to complete the site construction at Mauna Kea. This work is scheduled to be finished in mid-1997. Work at Cerro Pachon is pausing until award of the contract to complete the site construction. In the meantime, most of the plant equipment to be installed at the Cerro Pachon facility is being procured in the U.S. and shipped to Chile.

Coast Steel started erection of the Mauna Kea enclosure carousel in October 1996 and is scheduled to complete by early July 1997. Plans are being made to move up the start of erecting the Cerro Pachon enclosure to March 1997 to take advantage of the early completion of the steel structures by Con-Pax.

Preassembly of the first telescope structure at the Telas/NFM factory in Le Creusot, France, started in September 1996. Preassembly and testing work at Le Creusot should be completed in February 1997, at which time the structure will be disassembled and shipped to Hawaii.

Work Package	System Design Review	Preliminary Design Review	Critical Design Review	Alpha Release	Beta Release	Final Release
Principal Systems						
Observatory Control System	▨	▨	▨	Feb-97		
- VUI Simulator	▨	▨	▨	▨	▨	▨
- Control Simulator	▨	▨	▨	▨	▨	▨
Telescope Control System	▨	▨	▨	Mar-97		
Data Handling System	▨	▨	Jan-97			
Core Instrument Controller	▨	▨	▨	▨		
Interlock Safety System	▨	Dec-96				
Real-Time Systems						
Standard Controller	▨	▨	▨	▨	▨	▨
Mount Control System	▨	▨	Dec-96			
Primary Control System	▨	▨	▨	Mar-97		
Secondary Control System	▨	▨	▨	▨		
Enclosure Control System	▨	▨	Feb-97			
Hydrostatic Bearing System	Dec-96					

Figure 1. Controls and software work package status.

Similarly, the Mauna Kea coating plant will be preassembled and tested at the vacuum vessel fabricator's factory in Seattle before being shipped to Hawaii. This work will start in December 1996 and finish in May 1997.

Grinding on the first primary mirror has been underway at REOSC since July of this year. Grinding should be finished in February and polishing will start in April 1997. The second primary mirror blank was slumped by Corning in July. Corning completed generation of the back (convex) surface of the blank in October. Acid etching of the back surface will be completed and the blank turned over in preparation for generation of the front surface by the beginning of 1997.

Work on the primary mirror cell structure at Telas/NFM is progressing well. The structure pieces were tack welded into place in early November. The cell structure should be ready to start installation of the primary mirror support system at the Telas /NFM factory in May 1997. Fabrication, assembly, and testing of the mirror support system components at Royal Greenwich Observatory (RGO) will be completed in February 1997, well in advance of when they are needed for installation in the mirror cell.

The Critical Design Review of the secondary mirror assembly (mirror, fast tip/tilt/focus/ chopping mechanism, positioning system, and deployable baffle) was successfully completed in late June 1996. Morton delivered a small flat silicon carbide blank to Zeiss for polishing and ion figuring tests. They are currently working on the first 1-meter secondary blank, which is due to be delivered to Zeiss in April 1997.

In the controls and software area, work is moving forward on the multiple work packages as summarized in Figure 1. Effort was on hold in work packages involving Alan-Bradley programmable logic control hardware (e.g., Interlock Safety System and Hydrostatic Bearing System) while we recruited an experienced PLC programmer.

All of the remaining major contracts in facility instrumentation were placed during the past six months. RGO awarded the contract for fabrication of the acquisition and guiding opto-mechanical assemblies to Carl Zeiss in September. This work is being performed in Jena, Germany. We awarded contracts for the instrument support structures (ISS) as well as the Cassegrain rotators and cable wraps in the fall of 1996. The ISS work is being done by Advanced Mechanical Optical Systems near Liege, Belgium. With a positive result from the assessment of the scientific viability of a low order natural guide star adaptive optics system for the Gemini North telescope, work has resumed in Canada on preliminary design of the Gemini adaptive optics system.

Both near-infrared instruments completed Preliminary Design Reviews during the past six months. The imager PDR was held at the University of Hawaii in June and the spectrograph PDR was held at NOAO in October. Teams from the University of California at Irvine and the University of Arizona were selected to perform conceptual design studies of a mid-infrared imager for Gemini. Conceptual Design Reviews will be held in January 1997. Detailed design of the Gemini multi-object spectrograph in Canada and the UK is progressing towards Critical Design Review in January 1997. Finally, proof of the immersed echelle grating concept for the high resolution optical spectrograph was successfully completed in August. The Conceptual Design Review for the complete instrument was held at University College London in November.

-Richard Kurz
Project Manager

Classical and Queue Scheduling of the Gemini Telescopes[1]

1. INTRODUCTION : THE CASE FOR QUEUE SCHEDULING

Spectacular images from the Hubble Space Telescope over the past several years have demonstrated the need for optical and infrared observations at sub-arcsecond spatial resolution in order to study and understand the physical processes occurring in resolved structures throughout the universe. Together with the direct increase in point source sensitivity with decreasing image size for a background noise limited telescope, this has led to the adoption of superb image quality as the key scientific requirement of the Gemini telescopes.

The distribution of natural seeing at the Gemini northern (Mauna Kea, Hawaii) and southern (Cerro Pachon, Chile) sites is superb with a median of 0.4 arcsec FWHM. Nevertheless, the very best conditions, be they an image quality of better than 0.25 arcsec or a low IR background, will by definition always be rare. It will be one of the central challenges in scheduling and operating the Gemini 8m telescope to take full advantage of such conditions as and when they arise.

To facilitate the matching of observations to conditions, at least one half of the time on the Gemini telescopes will be operated in a so-called "queue-scheduled" mode. These observations will be pre-planned by the principal applicants and executed by Gemini staff astronomers according to well-defined criteria including matching required observing conditions, instrumental availability, program status and timeliness. The remainder of the time will be operated in the classical fashion with specific nights allocated in advance to particular projects, typically carried out by the applicant(s).

In this article we present an overview of the Gemini allocation and scheduling process with an emphasis on queue scheduling and simulations that have been carried out in order to demonstrate its fairness and efficiency. The goals of the process are described in section 2 and key features of the scheduling of classical and queue programs are given in sections 3 and 4, together with a worked example. The execution of queue-scheduled programs is discussed in section 5 and the philosophy of how the various types of time are distributed and charged amongst the partners is in section 6. Finally, section 7 describes the results from a number of simulations of the scheduling process.

2. GOALS OF THE ALLOCATION AND SCHEDULING PROCESS

The goals of the Gemini allocation and scheduling process are simply stated: fairness and efficiency. The former means that time must be divided fairly amongst the Gemini partners with each feeling that they have received an appropriate share of the "desirable" time. (The different types of time are discussed further in sections 6 and 7; note that time which is desirable for one partner might not be desired by others). It is expected that this balance will not be achieved accurately over one semester but only over two or three semesters (1-1.5yr). The second goal is that the allocation and scheduling process should permit partners to exploit the unique capabilities of the Gemini facility (e.g. image quality of IR background) but that the telescope should be used efficiently and never be sitting idle when it could be executing a program of interest to one of the partners. The success of this process should be measured in executing the maximum number of highly ranked scientific programs within these constraints.

3. SCHEDULING OF CLASSICAL PROGRAMS

Telescope proposals on Gemini will be solicited, reviewed and given a scientific priority independently by each of the Gemini partners. One important concept in bringing together these ranked

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[1] Based on a paper presented at the SPIE meeting on Large Telescopes, Landskrona, Sweden 1996.

1. US
2. UK
3. US
4. Canada
5. Host
6. US
7. UK
8. US
9. US
10. Chile
11. UK
12. Canada
13. US
14. US
15. UK
16. Host
17. US
18. Canada
19. US
20. UK
21. Brazil
22. Argentina
23. US
24. UK
25. US
26. Canada
27. US
28. Host
29. UK
30. US
31. US
32. Canada
33. UK
34. Chile
35. US
36. US
37. UK
38. US
39. Host
40. Canada
41. US
42. UK
43. US

Figure 2 : The merging sequence of Gemini partners.

lists of proposals, prior to scheduling both classical and queue time, is that of the "merging sequence". The merging sequence, illustrated in Figure 2, is a sequential list of the six Gemini partner countries as well as the host site (University of Hawaii or Chile). The frequency with which each partner occurs in the 43-entry sequence is roughly proportional to their involvement in the project and ensures approximately correct balance in access to the desirable time.

Each entry in the sequence corresponds to a specific amount of time. In the case of classical proposals this is nominally 0.5 nights, for queue proposals it is 4 hours. This nominal duration may be modified by the individual partners electing for a different classical/queue balance (e.g. Canada might choose for all of its time to be allocated in the queue mode in which case each entry in the classical merging sequence would fall to zero and in the queue sequence increase to 8 hours) or as a result of imbalances in the scheduling or usage of time in previous semesters.

The merging sequence describes the order in which proposals from the partners are selected. Classical programs are placed in the schedule in the quanta defined above; if a program cannot be scheduled it is skipped. Any minor advantage in being the partner with 'first pick' (the US in Fig. 2) is reduced by rotating the starting point amongst the partners in subsequent semesters e.g. the top-ranked UK classical program would be the first scheduled in the 2nd semester, the top Canadian program in the 3rd, and so forth.

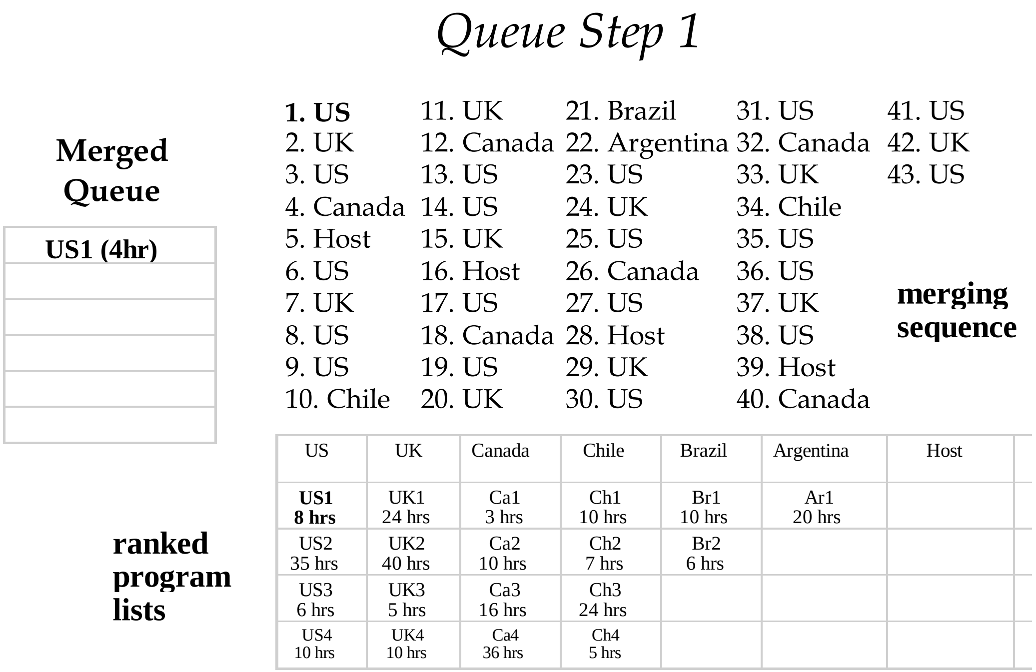
4. HOW THE QUEUE IS LOADED

The queue is assembled from the individual partner ranked lists in much the same way as for the classical schedule described in section 3 using the merging sequence. In this case each entry is nominally equivalent to 4 hours of integration time but adjusted after the classical schedule is constructed. A simulation prevents overloading of the semester by more than a certain fraction for any particular type of time compared with statistical expectations. This check prevents the queue being populated entirely by proposals requiring 20%-ile seeing with dark, photometric conditions, for example. The overloading adopted as a baseline is 30% although this will be adjusted as a history of the variance in observing conditions is built up. Note that this overloading means that although a program may be entered in the queue, it may not get to be executed. The queue will be erased periodically but individual partners may award "long-term" status to meritorious programs if desired, guaranteeing a position within that partners queue input to the next semesters merger. As in the classical case, programs which cannot be put into the queue because they exceed the overloading are skipped. Once a program has been loaded into the queue, the principal applicant will be contacted for the second phase of the application process which involves definition of the pre-planned observing and data reduction script(s).

4.1 A worked example

A worked example showing the first steps in the construction of the queue is shown in Figure 3. The first frame (queue step 1) shows the separate national lists ranked in order of scientific priority and the merging sequence with the first entry (US) highlighted. In this example, the top-ranked US program has requested 8 hrs of time, the first 4 of which (corresponding to one entry in the merging sequence) have been loaded into the merged queue. At step 2, the top-ranked proposal from the next entry in the merging sequence (UK) would be selected and the corresponding 4 hrs loaded into the queue. This process continues until all of the time has been allocated.

At each step in the queue assembly the requested observing conditions are tested against those



US	UK	Canada	Chile	Brazil	Argentina	Host
US1 **8 hrs**	UK1 24 hrs	Ca1 3 hrs	Ch1 10 hrs	Br1 10 hrs	Ar1 20 hrs	
US2 35 hrs	UK2 40 hrs	Ca2 10 hrs	Ch2 7 hrs	Br2 6 hrs		
US3 6 hrs	UK3 5 hrs	Ca3 16 hrs	Ch3 24 hrs			
US4 10 hrs	UK4 10 hrs	Ca4 36 hrs	Ch4 5 hrs			

Figure 3 : The first step in assembling the queue.

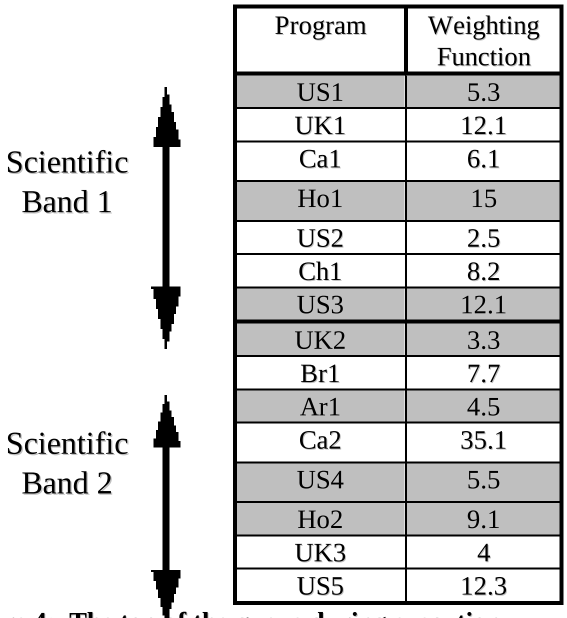
available based on a statistical expectation for the semester. Suppose program US1 has requested bright, photometric conditions with the best image quality but no constraint on IR background (it is a near-IR H-band imaging experiment, say). Of the 10 hrs expected to be available, 4 hrs are 'assigned' to this program. If the request had exceeded the time available, and if no time under better conditions (e.g. 50%-ile IR background) were available, then the program would have been skipped and not entered into the queue. It is sobering to note how little of the very best quality time is likely to be available (only 4 hr of 20%-ile image quality, IR background, dark, photometric time in a typical 2 month period!).

5. EXECUTION OF QUEUE OBSERVATIONS

As described in section 4, the queue is loaded on the basis of scientific rank and nationality, thus determining *whether* a program is likely to be executed. The specific requirements of an observation such as image quality, lunar phase, hour angle, program status, instrumentation etc., should determine *when* an observation is executed. The goal of the execution process is that, at the end of the semester, all of the programs in the queue above a line (near the bottom) will have been completed and none below it started.

In practice there are a number of ways in which we can draw an observation from the queue. First let us sub-divide the queue into bands of equal scientific quality containing some number of proposals and match the observations to the current conditions. Figure 4 shows the first 15 entries in the merged queue. Only those with light backgrounds (UK1, Ca1 etc.) have requirements consistent with the conditions.

In the extreme example that the length of a scientific band is only one proposal, then the execution would proceed from the top of the list



Program	Weighting Function
US1	5.3
UK1	12.1
Ca1	6.1
Ho1	15
US2	2.5
Ch1	8.2
US3	12.1
UK2	3.3
Br1	7.7
Ar1	4.5
Ca2	35.1
US4	5.5
Ho2	9.1
UK3	4
US5	12.3

Figure 4: The top of the queue during execution.

down and there would be limited optimisation and matching to the conditions. In the other extreme of the length of a band being the entire queue then although there would be excellent matching to conditions, the scientific quality ranking from the national partners would have been ignored.

To preserve the scientific ranking whilst ensuring that observations are executed under appropriate conditions a weighting function has been adopted. For each program whose requirements match the conditions, a weighting function is computed for each observation from parameters including the degree of match to the observing conditions, the hour angle, and the program status (i.e. whether observations from the program have already been executed). Then within the highest scientific quality band the observation with the largest weight is selected for execution (UK1 in the example in Fig. 4). If two observations have the same weight then that which is closest to the top is chosen. If no program in the top band can be executed because better conditions are required, then the search for a suitable program proceeds to the next band down.

The choice of the optimum band length and the full list of parameters in the weighting function are yet to be determined and will result from a simulation of the queue execution.

6. HOW TIME IS TO BE CHARGED

The intent in counting usage of Gemini telescope time is for parity between queue and classically scheduled time. Therefore classical time will be counted as hours allocated, starting and ending at astronomical twilight for nighttime observing. Classical observers will be encouraged to obtain the nominal calibration exposures in order to ensure the long term usefulness of the data archive.

Queue time will be counted as the fraction of hours used. The clock for a queue exposure begins at the start of the slew for that observation and ends at the start of the slew for the next observation. Thus the time to slew to the object, acquire it, configure the instrument and the telescope, read out the detector and confirm that the data are satisfactory are all included. The nominal calibrations will be provided (with charges split among all those programs which can use a given calibration) to queue scheduled programs. Any additional calibrations required for a queue scheduled program will be explicitly charged to that program.

The Gemini queue observer will have some discretion over the integration time for a given observation. Proposers will have to give an estimated integration time for the nominal conditions they require, but if an observation is done under better conditions, it would be inefficient (and not what a classical observer would do) to insist on the same integration time. During the early use of the facility when the instrument and telescope characteristics are still being refined, this criteria will simply be integration time, but it is expected to evolve into a signal-to-noise ratio criterion.

At intervals throughout the semester, the time accounting will be reviewed. Imbalances in the usage of time (calculated relative to the nominal availability or actual request and normalized by the total usage amongst the partners) may be used as a feedback by adjusting the weighting factors determining queue execution and by adjusting the duration of each partners merging sequence entry prior to the time allocation and scheduling meeting.

7. CLASSICAL SCHEDULING AND QUEUE LOADING SIMULATIONS

To study the scheduling process in more detail and understand the potential areas of difficulty, a (manual) simulation of both classical and queue scheduling (but not, yet, queue execution) has been carried out.

7.1 Input to the simulations

As input to this exercise, lists of dummy proposals simulating the output from the national time allocation committees were produced by the Gemini project scientist team and national project scientists (the latter incorporating any national biases in instrument or observing condition usage). A total of 41 classical and 78 queue proposals distributed amongst observing conditions and instruments was produced. Scientific priority rankings were assigned at random. Relevant information for the queue applications, supplementary to the instrument (choice of 4), target list and schedule timing (dark/bright; acceptable dates) required for a classical proposal, were the image quality (specified as better than 20%-ile, better than 50%-ile or unconstrained), IR background (same three categories as image quality) and cloud cover (photometric or spectroscopic).

In addition a blocked out schedule giving an example of the likely distribution of classical, queue and Directors/engineering time, instrument availability and lunar phase was produced. (In practice this would be provided ahead of the Gemini call for proposals for potential proposers to assess the availability of facilities as well as for Gemini staff planning). As an illustration of the level of realism incorporated, the classical and queue periods are both scheduled in 5 nominal 18 night blocks, interleaved with 3 nights Directors/engineering time for instrument and facility checks, with both dark and bright time accessible, but out of phase, to each classical/queue period. Time for instrument changeovers is included (three of the four nominally available instruments can be mounted at any one time on the Cassegrain instrument support structure).

Full details of the simulations are given in Puxley *et al* (Gemini Preprint #13).

7.2 Queue Loading Results and Simulations

Figure 5 summarizes the queue loading results for a second trial analyzed in terms of the observing conditions, subdivided into the best conditions (the sum of time allocated in 20%-ile image quality or IR background), average conditions (likewise for 50%-ile conditions) and the total allocations. The top-left box shows the nominal queue loading (after adjustment for the classical scheduling results) in hours and their distribution amongst the partners. For each of the three observing condition categories the other boxes show for each partner the actual 'allocation' (i.e. program time loaded into the queue), the request, the allocation as a fraction of the request, the allocation as a fraction of the total over all partners and the actual allocation as a fraction of the nominal allocation. (Note that the total queue allocation was only about 75% of that available due to the input proposals undersubscribing the poorest conditions).

nominal queue availability
(adjusted for classical schedule)

	hrs	frac
US	392	**47%**
UK	173	**21%**
Ca	130	**16%**
Ch	70	**8%**
Ar	35	**4%**
Br	35	**4%**
sum	835	

total queue time (sum of all conditions)

	loaded hrs	request hrs	frac of request	frac of total alloc	frac of nominal avail	frac wrt nom'l
US	334.2	445	75%	**51%**	85%	109%
UK	146	217	67%	**22%**	84%	108%
Ca	70.9	247	29%	**11%**	55%	70%
Ch	49	80	61%	**8%**	70%	90%
Ar	26	40	65%	**4%**	74%	95%
Br	25	40	63%	**4%**	71%	92%
sum	651.1	1069			**78%**	

average conditions (sum of avg im and avg IR)

	loaded hrs	request hrs	frac of request	frac of total alloc	frac wrt nominal
US	183.9	183.5	100%	52%	111%
UK	73.7	126	58%	21%	101%
Ca	35.8	180	20%	10%	65%
Ch	30	25	120%	8%	101%
Ar	24	30	80%	7%	162%
Br	6	20	30%	2%	41%
sum	353.4	564.5			

best conditions (sum of best im and best IR)

	loaded hrs	request hrs	frac of request	frac of total alloc	frac wrt nominal
US	110.3	114.5	96%	**42%**	90%
UK	70.6	84	84%	**27%**	130%
Ca	56.9	67	85%	**22%**	140%
Ch	9	30	30%	**3%**	41%
Ar	4.9	10	49%	**2%**	45%
Br	10	25	40%	**4%**	91%
sum	261.7	330.5			

Figure 5 : Results of the 2nd queue loading trial

			1st trial		2nd trial	
	no. of props.	request (hrs)	loaded hrs	fraction alloc.	loaded hrs	fraction alloc.
US	8	105	86.9	**83%**	105	**100%**
UK	6	84	64.4	**77%**	77	**92%**
Ca	2	36	28.2	**78%**	27	**75%**
Ch	2	30	20	**67%**	24	**80%**
Ar	1	20	20	**100%**	16	**80%**
Br	1	10	0	**0%**	10	**100%**

Figure 6 : Queue loading results for the scientifically top-ranked quarter of proposals.

The queue loading results were also analyzed in terms of the distribution of time amongst the partners for their top-quarter and top-half scientifically ranked proposals. Figure 6 shows for each partner the number of proposals in the fomer category, the request, and the allocation resulting from the two trials. Bearing in mind that the small number of proposals from the smaller partners can influence the statistics in this analysis, the second trial succeeds significantly better than the first in ensuring that the top ranked proposals are loaded into the queue.

7.3 Overall simulation conclusions

From both the classical and queue scheduling simulations it can be seen that the use of the merging sequence with its inherent balanced distribution to allocate time on the Gemini telescopes results in the partners having fair and equal access to the desirable observing conditions. A simulation of the queue execution, describing how observations are drawn from the queue, is presently being carried out. The loading of the queue using a statistical distribution of the expected observing conditions and intrinsic balance imposed by the merging sequence suggests that this too will be successful and that, through the possibility of adjustment to the weighting function to correct minor imbalances in the time actually charged, will result in fair usage of the conditions.

Importantly, the queue scheduling simulation shows that, on average, the top scientifically ranked proposals from each partner will get scheduled.

-Phil Puxley
Assoc. Project Scientist for Operations

The Gemini Multiobject Spectrographs

Both GEMINI telescopes will be equipped with a multiobject spectrograph (GMOS)[1,2] designed to fully exploit the excellent images that the telescopes will produce. The main parameters are summarised below.

- Field of view: 5.5 x 5.5 arcmin^2
- Spectral resolution: $\lambda/\Delta\lambda < 10.000$ (0.25 arcsec slit)
- Wavelength range: 0.36-1.1μm (design capability to 1.8μm)
- Image scale: 0.08 arcsec/pixel
- Detector: 3x (4096x2048) CCD mosaic with 15μm pixels
- Fore-optics: Atmospheric Dispersion Corrector integrated with field corrector
- Main modes:
  - Multiaperture spectroscopy via masks
  - Longslit spectroscopy via masks
  - Integral field spectroscopy
  - Direct imaging

Since this is a facility instrument, there are many scientific drivers, for example:

- Surveys of faint galaxies which require not only high efficiency but also the ability to arrange slits in multiple tiers to increase the multiplex gain.

- Surveys of dark matter in low mass galactic systems which require the ability to measure radial velocities to 1-2 km/s and a multiobject capability so that complete stellar systems can be surveyed in one observation.
- Two-dimensional (integral field) spectroscopy of intermediate-redshift objects on scales similar to that of the Hubble Space Telescope to study kinematics, star formation and to obtain accurate distant estimates.

Optics

One of the remarkable features of the instrument is the fine image scale, which is required to exploit the excellent images provided by the telescopes. GMOS includes an integrated on-instrument wavefront sensor to provide the necessary correction signals for the articulated tip-tilt secondary mirror.

The optical design (Figure 7) uses refractive optics and reflection gratings. The image quality is such that 50% of the light is enclosed within a diameter of ~0.1 arcsec over a field ~7 arcmin in diameter. The use of very broad-band antireflection coatings such as Sol-Gel is being studied.

The optical system includes an integrated atmospheric dispersion compensator and a corrector to improve the image quality in both imaging and spectroscopic modes.

Aperture masks

Remotely deployable masks will be used for both multiple aperture and single aperture spectroscopy. Because of the great accuracy required in the location of the slits, it is likely that all masks will be designed with the aid of direct images taken with GMOS. Because the telescope will be largely queue-scheduled, it will be possible to take these images some time ahead of the spectroscopy to give the investigators enough time to design the masks and for them to be made at the telescope[3].

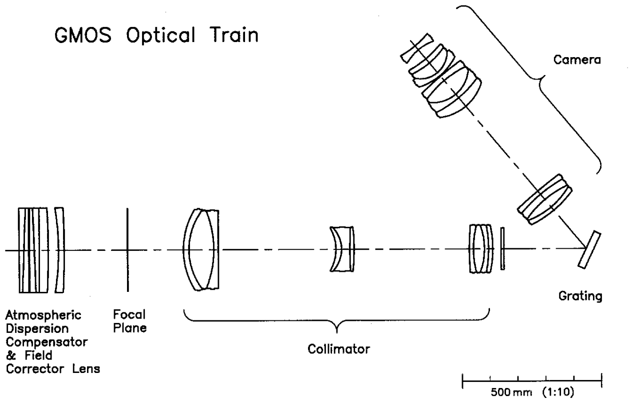


Figure 7. The layout of the main optics including the ADC and corrector (PDR).

It will be possible to make accurate slits as narrow as 0.25 arcsec in order to exploit the best seeing conditions and to achieve the highest spectral resolution. The combination of large field. excellent image quality and the ability to arrange the slits in multiple tiers implies a maximum multiplex gain of several hundred.

Accurate target acquisition is also critical to the instrumental performance. The simplest and most reliable method is to image the sky through masks which include small holes through which reference stars can be viewed. The mask-sky displacement is then used to offset the telescope to ensure accurate registration.

Integral field unit

The integral field unit[4] (IFU) will provide two-dimensional spectroscopy over a contiguous field of ~50 arcsec^2 with 0.2 arcsec sampling. A small *background* field will be available at fixed separation (≥1 arcmin) from the main *object* field for accurate background subtraction in cases where the object completely fills the IFU object field or where beam-switching is required for maximum accuracy.

Applications include studies of the velocity fields of galaxies imaged by the Hubble Space Telescope (Figure 8) and determination of the ionisation source in active galaxies by examining the spatial variation of emission line ratios. This can be done far more efficiently than with either stepped longslit spectroscopy or Fabry-Perot scanning. Even in poor seeing, the system will act as an efficient image slicer to enhance the product of spectral resolution and throughput.

The use of microlenses and fibres will enhance the throughput of the IFU by optimising the coupling between the fibres and both telescope and

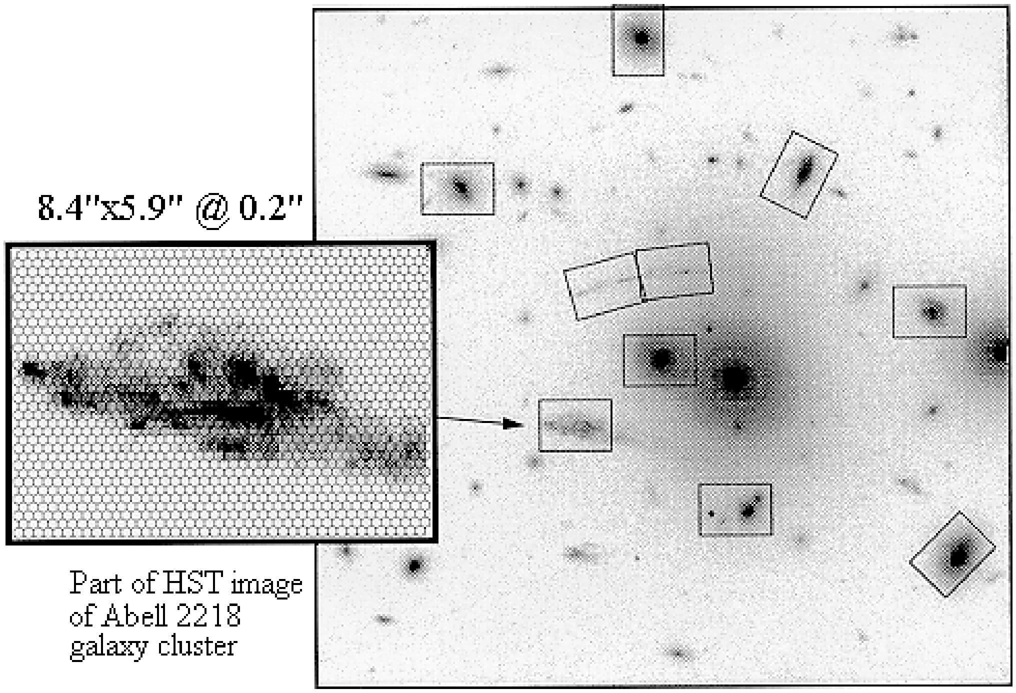


Figure 8. A simulation of the sampling pattern of an Integral Field Unit covering an area of 50 arcsec2 in a format of 42x37 (8.4x5.9 arcsec) where the horizontal distance between adjacent hexagonal microlenses is 0.2 arcsec. This is compared with an HST image of part of the galaxy cluster Abell 2218 (Sharples, private communication) containing gravitationally-lensed objects to show how the field is matched to the scale of many objects of interest.

spectrograph and by eliminating deadspace between the fibre cores. The effective slit width is ~0.27 arcsec and each spectrum can be up to 3000 pixels long, yielding up to 900 spectral resolution elements per spatial sample. GMOS will convert to integral field mode simply by deploying an IFU in the focal plane in the same way as a mask. Other IFUs, with different field geometries or sampling, can also be used.

Dispersion system and flexure control

The spectrographs will provide a large range of dispersion options via a 4-position grating turret which includes a plane mirror for imaging.

It is a key requirement that the tilt of each grating be maintained precisely even when moved out of the light path so that the spectroscopic setup is not disturbed during target acquisition. Instrument flexure will be minimised to permit measurement of radial velocities to an accuracy of 1-2 km/s with hourly on-target wavelength calibration. This requires resolving powers up to 10,000 which will be provided either with a 0.25 arcsec slit with normal gratings or with a 0.5 arcsec slit via an upgrade to immersed gratings.

The mechanical system (Figure 9) has been designed to eliminate tilts between optical components so that the only effect of flexure is a slow motion of the image of the slit on the detector. This means that flexure can be compensated simply by moving the detector. A novel cryogenic translation and focus stage has been designed for this purpose[5].

Guiding and wavefront sensing

The telescope tip-tilt system requires signals from a wavefront sensor. This must be tightly integrated with the slit area to eliminate guiding errors due to differential flexure. The sensor is fed via an angled pick-off mirror which can be deployed within a patrol field sufficient to provide at least a 90% probability of finding a suitable reference star even at the galactic poles.

Current status

GMOS has passed successfully through a Preliminary Design Review. The next stage is the Critical Design Review in Jan 1997. Once the detailed design is complete. the team will start to build and test the instruments. The northern

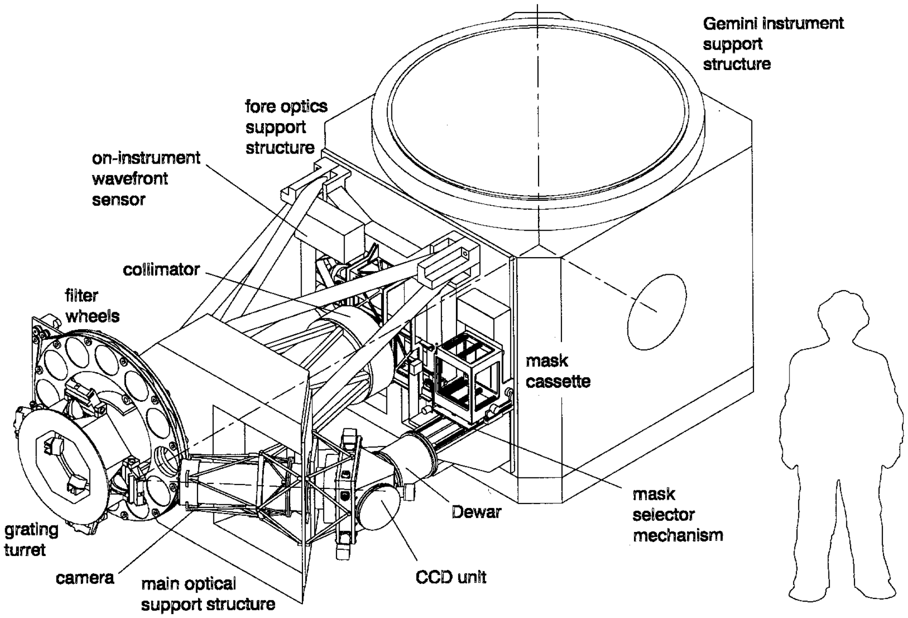


Figure 9: The layout of the major parts of the mechanical structure excluding the enclosure (PDR). GMOS is roughly 2m on a side.

instrument is scheduled for delivery in 1999 and the southern instrument one year later.

We are considering various upgrades to GMOS:

- Operation in the non-thermal infrared via a new 2Kx2K detector and revised antireflection coatings.
- Higher resolution IFUs (0.05-0.1 arcsec sampling).
- High-order on-instrument wavefront sensor for use with the GEMINI AO system.
- Polarisation capability via beam-splitting prisms installed in GMOS and a waveplate installed in the ISS.
- Immersed gratings to allow R =10,000 to be obtained with a 0.5 arcsec slit.

The GMOS team would appreciate comments on these options.

Acknowledgements

We gratefully acknowledge the help of the other members of the Canada-UK GMOS team in preparing this article: T. Bond, M. Fletcher, B. Leckie, C. Morbey, S. Roberts, L. Saddlemyer, J. Sebesta, J. Stilburn, K. Szeto, P. Bettess, E. Chadwick, R. Content, G. Dodsworth, R. Haynes, D. Lee, I. Lewis, J. Webster, E. Atad, S. Beard, M. Ellis, and P. Hastings.

Further details

Please consult *http:llstar-www.dur.ac.ukl~jral gmos.html* where copies of the references and additional information may be found.

References

1. Allington-Smith J.R., *et al*., Proceedings of the *Wide field spectroscopy* conference held in Athens. Greece. 20-24 May 1996 (Kluwer).
2. Davies R.L. *et al*., To appear in SPIE Vol 2871.
3. Szeto, K., To appear in SPIE Vol 2871.
4. Allington-Smith J.R. *et al*., To appear in SPIE Vol 2871.
5. Hastings, P.R., To appear in SPIE Vol 2871.

- Jeremy Allington-Smith, Roger Davies, David Crampton, Rick Murowinski, Tim Davidge, and Phil Williams

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The Gemini Data Handling System

After a successful Preliminary Design Review on September 17, 1996, the Gemini 8 Metre Telescopes' Data Handling System (DHS) is well on the way to the detailed design stage. The DHS's requirements are now fully defined and its high level design is complete. All this considered, now seems like an ideal time to tell a wider audience about the DHS.

What is the DHS' job in the context of the Gemini 8 Metre Telescopes?

The main purpose of the DHS software is to provide a data handling infrastructure for the other Gemini principal systems, which are the Telescope Control System, the Observatory Control System and the Instrument Control Systems. The idea being that, by concentrating all data management in one part of the Gemini system, other systems would be freed as much as possible from the details of how and where the data are stored. In addition, the DHS provides an infrastructure for data quality assessment, which includes processing data to remove telescope and instrument signatures and displaying data.

In practical terms, this broad definition translates to the following. The DHS:

- stores and retrieves data files to and from magnetic store and permanent store
- creates user transportable media (e.g., tapes)
- displays images and other data (error, bad pixel) using a Quick Look Display
- uses recipes to do synchronous data processing
- uses recipes to do on-line data processing for quality assessment
- logs events from all Gemini principal systems

To accomplish these tasks the DHS has been broken down into a set of component parts. The components consist of three main types: subsystems, libraries and graphical user interfaces (GUIs). These components will be revisited further on in the discussion.

First. an overview of the design approach. The DHS is being designed using the Booch object-oriented (OO) methodology[1]. "OO" is a buzzword these days in the world of software engineering. It puts a twist on traditional software design. Traditionally, each module in the system denotes a major step in some overall process. By contrast, in object-oriented methodology, entities (classes) are chosen which serve as agents that work together to carry out the tasks that continue the process. Here, an analogy is useful. Consider that the *classes* resemble *actors* and that the *tasks* which the classes perform, resemble *roles*. Then, the system can be viewed as a group of actors each with assigned roles. Together these actors provide the system functionality.

The DHS team selected the OO approach because of its popularity and the belief that OO is not a fad, but rather the way of the future. Taking this approach will allow the DHS to be extensible; i.e., it will be easy to add new functionality to the classes as the system configuration evolves. OO also ensures that the DHS will be flexible. This means that the DHS will be set up to be able to replace the data processing systems it uses with new tools, as they become available. Also a factor in the decision was the commitment made by the Observatory Control System team to develop software using OO.

Given this *brief* introduction to OO philosophy, it is possible now to examine in more detail the design of the DHS. For design implementation, an object-oriented design tool called Rose[2] is being used. As the first step of the software design, classes are defined. To define these classes, there are no hard rules. To quote Stroustrup when asked about the rules of classification, he replied, “It’s a Holy Grail. There is no panacea.”[3] For the case of the DHS, the rules of classification are defined as follows: a *class* is assigned to each part of the system where there appears an independent set of tasks to be done.

The classes that are defined for DHS software have been generated based on identifying the actors in the DHS system and are shown in Figure 10. As mentioned earlier, the main types of component parts are: subsystems, libraries and GUIs. In Figure 10, these are shown by the classes *dhsSubsystem, dhsLibrary* and *OcsWish.* Classes that are based on one of the three main types use arrows to point towards the main class from which they are derived. This means that the class *statusServer* is based on the *dhsSubsystem* class. One can say that the statusServer *is a kind of* dhsSubsystem.

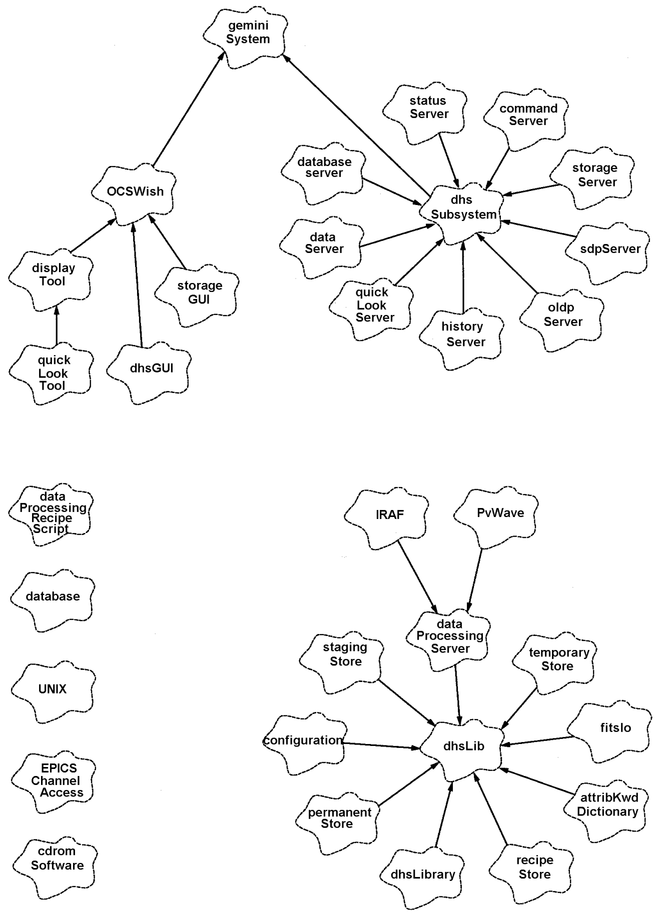


Figure 10. The DHS classes.

Listed in Table 1 are brief descriptions of all the dhsSubsystem classes, Table 2 lists the OcsWish classes and Table 3 lists the dhsLib classes. Remaining classes are used to describe components external to the DHS. Shown in Figure 10, these are the cdromSoftware, database, dataProcessingRecipe Script, EPICS Channel Access and UNIX classes.

The detailed design of the DHS classes is currently under way, proceeding on a track by track basis (not shown in Figure 6) to provide incremental software deliveries to other Gemini systems in order to facilitate their development process.

References

1. Object-Oriented Analysis and Design, Grady Booch, Addison-Wesley, 1994.
2. Rational Rose/C++ User's Guide, Revision 2.7 (Software Release 2.7), Rational Software Corporation, 1995.
3. The C++ Programming Language, 2nd Edition, Bjarne Stroustrup, Addison-Wesley, 1991.
4. Definition of the Flexible Image Transport System (FITS), Proposed Standard, NOST 100-1.0, March 8, 1993, NASA Science Office of Standards and Technology
5. Self-defining Data System (SDS), AAO/SDS_07, Jeremy Bailey, Anglo-Australian Observatory, Version 1.2, 9 September 1992.

TABLE 1. Summary of DHS subsystem classes.

dhsSubsytem Class	Description
commandServer	Server responsible for the interface between the DHS and the outside world.
dataServer	Server responsible for transferring data to and from other Gemini systems.
databaseServer	Server responsible for interfacing to the DHS database.
historyServer	Server responsible for receiving and logging history information from all Gemini systems.
oldpServer	Server responsible for on-line data processing.
quickLookServer	Server responsible for distributing data to Quick Look Tools.
sdpServer	Server responsible for synchronous data processing.
statusServer	Server responsible for reporting DHS internal status.
storageServer	Server responsible for creating permanent store media and user transport media.

TABLE 2. Summary of OcsWish classes.

OcsWish Class	Description
displayTool	User interface for image display.
dhsGUI	General user interface to the DHS system.
oldpGUI	User interface to the on-line data processing server.
quickLookTool	User interface to display Quick Look data.
storageGUI	User interface to the storage server.

TABLE 3. Summary of DHS library classes.

dhsLib Class	Description
attribKwd Dictionary	Converts Gemini system attributes to FITS[4] keywords.
configuration	Reads configuration files.
dataProcessing Server	Common interface to the data processing systems used by the DHS.
dhsLibrary	Provides the public command interface and bulk data interface to the DHS.
fitsIo	Converts data between SDS[5] format and FITS format.
permanentStore	Manages the DHS permanent store.
recipeStore	Provides access to the DHS data processing recipe store.
stagingStore	Manages the DHS staging store.
temporaryStore	Manages to the DHS temporary store.

-Dayle Kotturi
Herzberg Institute of Astrophysics

Reports from the National Project Offices

US Gemini Project Office

The US Gemini Project Office has been busy with management of the US-allocated instruments, but we have found time to focus on planning for the future - the role of our national project office in the era of an operating Gemini Observatory, priorities for future instruments, and educational outreach activities.

Progress towards definition of a **Gemini Mid-Infrared Imager (MIRI)** began in October when Ron Garden at the University of California, Irvine and George Rieke at University of Arizona, Steward Observatory, were each funded to perform a conceptual design/feasibility study. They and other unfunded groups will present their reports in January 1997. The scientific requirements of the MIRI will then be re-evaluated, with respect to the technical and cost trade-offs presented in the reports, before proceeding to the main competition - that of the complete design and instrument fabrication. The competition is open to anyone in the US community and those interested are strongly encouraged to contact the USGP (wood@noao.edu) for more information.

Two other competitions are in progress to purchase the **CCDs** and, separately, **CCD Controllers** to use in the optical instruments, GMOS and HROS. NOAO will integrate and test the delivered CCDs and Controllers as a subsystem and subsequently integrate that subsystem with the instruments.

The **Near-Infrared Imager (NIRI) and Spectrograph (GNIRS)** are well underway in their design efforts. The NIRI team at University of Hawaii passed its Preliminary Design Review in late June and is working towards a Critical Design Review scheduled for April 1997. All of the science requirements and goals are expected to be met with the exception of a goal that the instrument be designed to accommodate arrays of twice the size of the baseline 1024x1024 Aladdin InSb arrays. The University of Hawaii is working hard to assure delivery of NIRI in time for telescope commissioning.

The GNIRS team at NOAO successfully passed its Preliminary Design Review in mid-October. GNIRS is also expected to accomplish all of the science requirements.

A goal of multi-slit capability is not achievable in the NOAO design. Recent headway was made with the **IR detectors** for NIRI and GNIRS as an order was placed with Hughes Santa Barbara Research Center for a foundry run of Aladdin 1024x1024 InSb arrays.

USGP convened a workshop in August to identify the interests and priorities of the US community for **future Gemini instrumentation**. About 25 astronomers, including representatives from other large US telescopes, attended the workshop and discussed the science drivers for Gemini capabilities. A summary of the workshop results appears in the December 1996 NOAO Newsletter and a report of the workshop is available from USGP.

Finally, on a personal note, the USGP welcomes **Dave Silva** to its scientific staff. As most of you know, Dave has been a member of the Kitt Peak Scientific Staff and was responsible for the commissioning of the WIYN telescope. His experience with telescope operations and alternate observing modes will be most valuable as we approach the operations phase of Gemini. We have also been fortunate to gain the part-time support of Kitt Peak scientists **Sam Barden** and **Dick Joyce,** who will be responsible for representing USGP and US community scientific interests associated with all Gemini instruments.

-Kathy Wood

UK Gemini Project Office

Progress on the Gemini instruments underway in the UK has been steady with a number of significant milestones reached since the last newsletter was published. GMOS (a collaboration between Canada and the UK) is preparing for its CDR in January 1997, HROS for its CoDR in November 1996, while MICHELLE had its mechanical and cryogenic CDR in October.

An international Gemini science workshop is planned for January 1997. This workshop will provide a forum for about 30 astronomers from the partner countries and the international project office, to consider the key scientific programmes the Gemini telescopes should be able to address. Apart from promoting better interaction between the Gemini partners, the workshop will also focus on the instrumentation to be provided in the first few years of the operations phase of the telescopes. The meeting will be held in the Cosener's House near Abingdon in Oxfordshire immediately after the GMOS CDR.

The end of September witnessed a major change in the project in the UK. Roger Davies, who has guided the UK involvement in Gemini, decided earlier in the year to step down from his role as UK Project Scientist to devote more time to his other tasks including his duties as Professor of Astronomy at the University of Durham, his role as GMOS project scientist, and his research projects. Roger returned to the UK from Tucson in 1988, to lead the UK team that investigated the requirements and options for collaboration in large telescope projects as the UK Large Telescope Project Scientist based in Oxford. In this role he overcame many difficult periods and guided the UK towards commitment to the collaboration that became the Gemini project. Roger's leadership, energy, and vision carried the UK community and it is now difficult to imagine the future that we would face, if we had not joined with our partners in Gemini. Roger took on the mantle of UK Gemini Project Scientist and continued in this role when he accepted the Chair at Durham. He has seen the UK move to a position where Gemini is universally regarded as the highest priority project in the ground-based area of astronomy. His stewardship means that we are well poised to take advantage of the capabilities that Gemini has to offer when the telescopes are opened up for general observing in 2000 and 2001. Roger will continue to be involved in the UK Gemini Programme as Chairman of the UK Gemini Steering Committee and we expect to rely on his advice and knowledge for a long time to come. We would like to record our thanks on behalf of the UK and the wider communities to Roger for all that he has contributed to making Gemini the successful project that it is.

Roger has been replaced by Patrick Roche, who has also had a long involvement initially with the UK Large Telescope Project and then with Gemini. Pat is based at Oxford University and has a background in studies of the interstellar medium through infrared astronomy and the development of infrared instrumentation. He can be contacted at telephone 44-1865 273338, fax 44-1865 273390, or at *p.roche@physics.oxford.ac.uk*.

-Adrian Russell

Canadian Gemini Project Office

The "biggest" news from Canada was the partial erection of the Mauna Kea enclosure at Coast Steel Fabricators, in Port Coquitlam. Even though the girders of the "dome" or rotating part were based at ground level instead of on top of the enclosure base, it was visible from several blocks away from Coast's plant. In fact, that is how my taxi driver found Coast's plant -- by homing in on the enclosure looming in the distance!

Most of the CGPO attention has been on our Gemini work packages. The Data Handling System (DHS) and Multi-Object Spectrograph (GMOS) - a collaboration with the UK - are reported on elsewhere in this Newsletter. At a personal level, work on the Enclosure Control System came to an abrupt standstill when Bob Wooff, who is doing almost all the work on ECS, was hit by a car while cycling. Bob was injured quite badly and was off work for a few months, but he is now back with us, much to our relief. His good recovery was no doubt helped by his superb physical shape: he is Canadian champion, in his age group, in the triathlon.

We are also collaborating with the UK on the wavefront sensors, and here Brian Leckie, Tim Hardy, and Rick Murowinski are the ones doing the work. With the WFS work now past CDR, we expect delivery of the first controller from San Diego State University and an engineering version of a CCD from EEV during November.

Finally, the DAO Instrument Group has been very excited by the very successful commissioning and science observing runs with the Adaptive Optics Bonnette that we and our partners built for CFHT. AOB gives diffraction limited images on a routine basis and has had no problems since installation in the Spring. David Crampton, Simon Morris, and Tim Davidge are all involved in the science commissioning of AOB and we have been treated to much excitement around the coffee table. Preliminary results indicate the discovery of an optical counterpart to the radio source Sagittarius A, though this remains to be confirmed. M31 was imaged at K band, and photometry was obtained on over 1,000 stars in the inner field, including in the nucleii.

We are all eager to move forward quickly with the Gemini AO system. We have already started revising the optical design, done by Harvey Richardson, and we expect to restart other elements of the work during November. Glen Herriot, who is managing this project, has been working on the schedule to try to reach Gemini's goal of completion by the end of 1999.

As a last note, the area code for Victoria has changed from 604 to 250. This includes the CGPO, DAO, and Don Morton; however, Gordon Walker will retain the 604 area code.

-Andrew Woodsworth

Chilean Gemini Project Office

Recent news from the Chilean Gemini Project Office is encouraging. Oscar Riveros has been named as the new Chilean Project Manager; he is located at CONICYT in Santiago. The General Astronomy Law has finally been approved in the House of Representatives and is now at the Senate. Final approval is expected by December-January. Also, the Gemini Law has been presented at the House of Representatives the week of October 14th. A fast passage is expected through the House.

The Gemini Finance Committee meeting took place the week of October 14th in La Serena.

- Oscar Riveros

Argentine Gemini Project Office

In the Argentine report that appeared in the previous issue of the Newsletter, we omitted the name of Hugo Levato, from the CASLEO from the list of members of the Scientific Advisory Committee. This time we would also like to add the names of Hugo Marraco, from CONAE, the Argentine Space Agency, who is an authority on communication through computers; and of Roberto Aquilano, who represents the Astronomy group in the Physics Institute at Rosario (IFIR).

At the last meeting of the Committee the decision was taken to invite the following engineers to join the Committee as Associates:

- Arnaldo Rosendo Casagrande, from CASLEO, an expert on telescopes;
- Juan José Larrarte, from IAR, an expert on electronics;
- Pablo Florencio Pereyra, from CASLEO, an expert on programming; and
- Adolfo Héctor Marun, from CASLEO, an expert on CCD's and controllers.

At the last meeting of the Argentine Astronomical Association, in September, an invited talk on the Gemini Project was given, and updates are being offered at each Argentine astronomical institution by the respective member of the Advisory Committee.

For the time being the telephone numbers of the Prokect Office are (voice) +54-(0)21-38810 / 217308; fax +54-(0)21-211761; and the e-mail address is *sahade@fcaglp.fcaglp.unlp.edu.ar*. In November, 1996, the 38810 number will change into 838810.

-Jorge Sahade

Brazilian Gemini Project Office

The Brazilian astronomical community formally joined the SOAR Project on October 16th, with a letter from the President of CNPq to the partners, the University of North Carolina, Michigan State University and the National Optical Astronomy Observatories (NOAO). Dr. Tundisi says "It is with great satisfaction that I communicate to our partners that Brazil has decided to become a full member of the SOAR Project within the guidelines delineated in the Memorandum of Understanding and in the discussions at Chapel Hill, last August. I am sure that this partnership will last for very long time and will benefit all of us." After a joint press release issued on October 18th, the SOAR project has officially begun.

The SOAR telescope will be neighbor to Gemini South in the Chilean Andes. The baseline design is a 4-m telescope with two Nasmyth ports, one of which will be ~f/15, to allow instrument sharing with Gemini. One of the top priorities of SOAR is image quality. The project seeks to fully exploit the capabilities of a tip/tilt secondary and optimum operation in the NIR. Brazilian industry sees an opportunity to participate in the construction of certain parts of the telescope, such as the bulk structure. The Brazilian astronomical community is proposing to build an optical spectrograph under the guidance of NOAO.

SOAR represents a natural step between the successful operation of a 1.6-m telescope at the Brazilian Astrophysical Laboratory (LNA) for the last 15 years and the use of the Gemini 8-m telescopes. It is anticipated that SOAR will be the workhorse of astronomical research in the country, producing first rank data for the groups already established and encouraging the formation of new groups.

- Francisco Jablonski

Staff Changes at Gemini

Figure 11 shows the current Gemini project organization. Staffing has changed in the Controls & Instrumentation Group. Mike Burns and Susan Wieland have left the project. Jim Wright and Steven Smith have been hired as software engineers

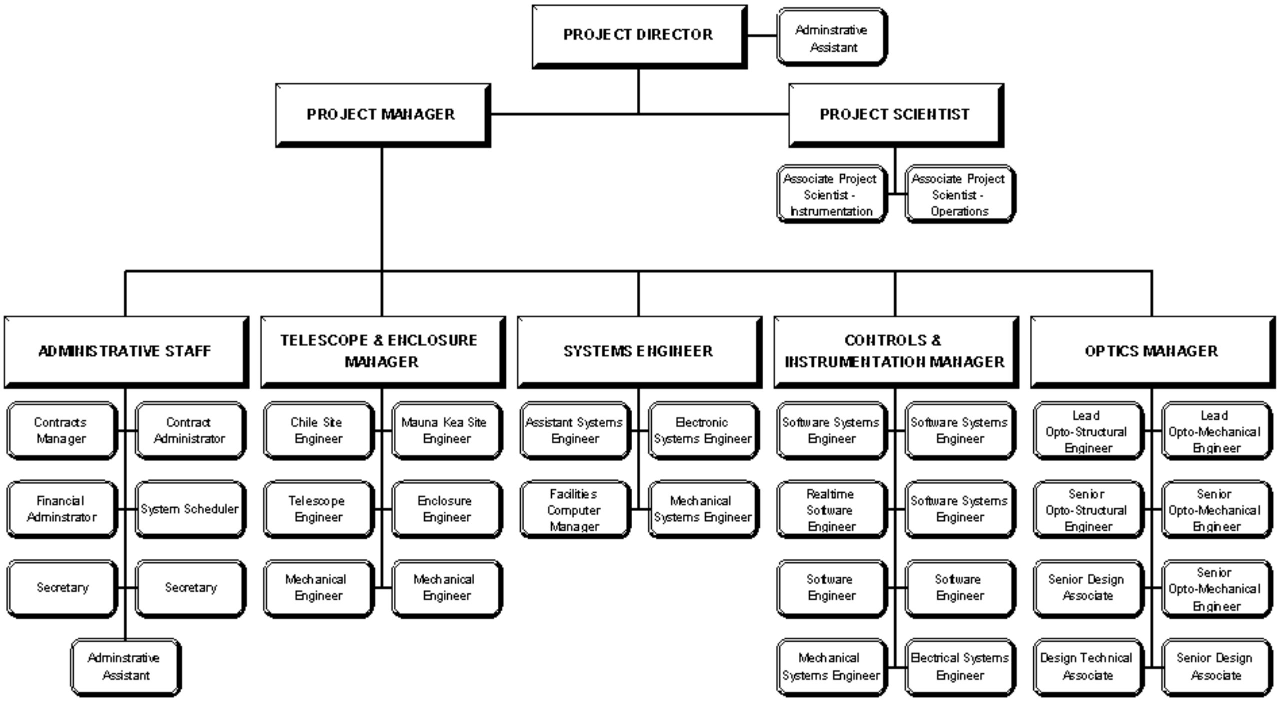


Figure 11. International Gemini Project Organization, October 1996.

in the Controls area, and Mark Hunten has been hired as an electrical systems engineer in the Instrumentation area. In addition, Kim Gillies and Shane Walker, two software systems engineers, have transferred from NOAO to Gemini.

Released Documentation

The following documents have been released by the Gemini Project since the last edition of the Gemini Newsletter (June 1996). Copies of these and other publications are available on request by contacting the Gemini Project systems librarian at the project address, or by emailing *rkneale@gemini.edu*. Document numbers are listed in parentheses. **Please note:** This list does not include any Interface Control Documents. For current ICDs, please see the Gemini ICD Database Tool at *http://www.gemini.edu/systems/ icd_main.html*.

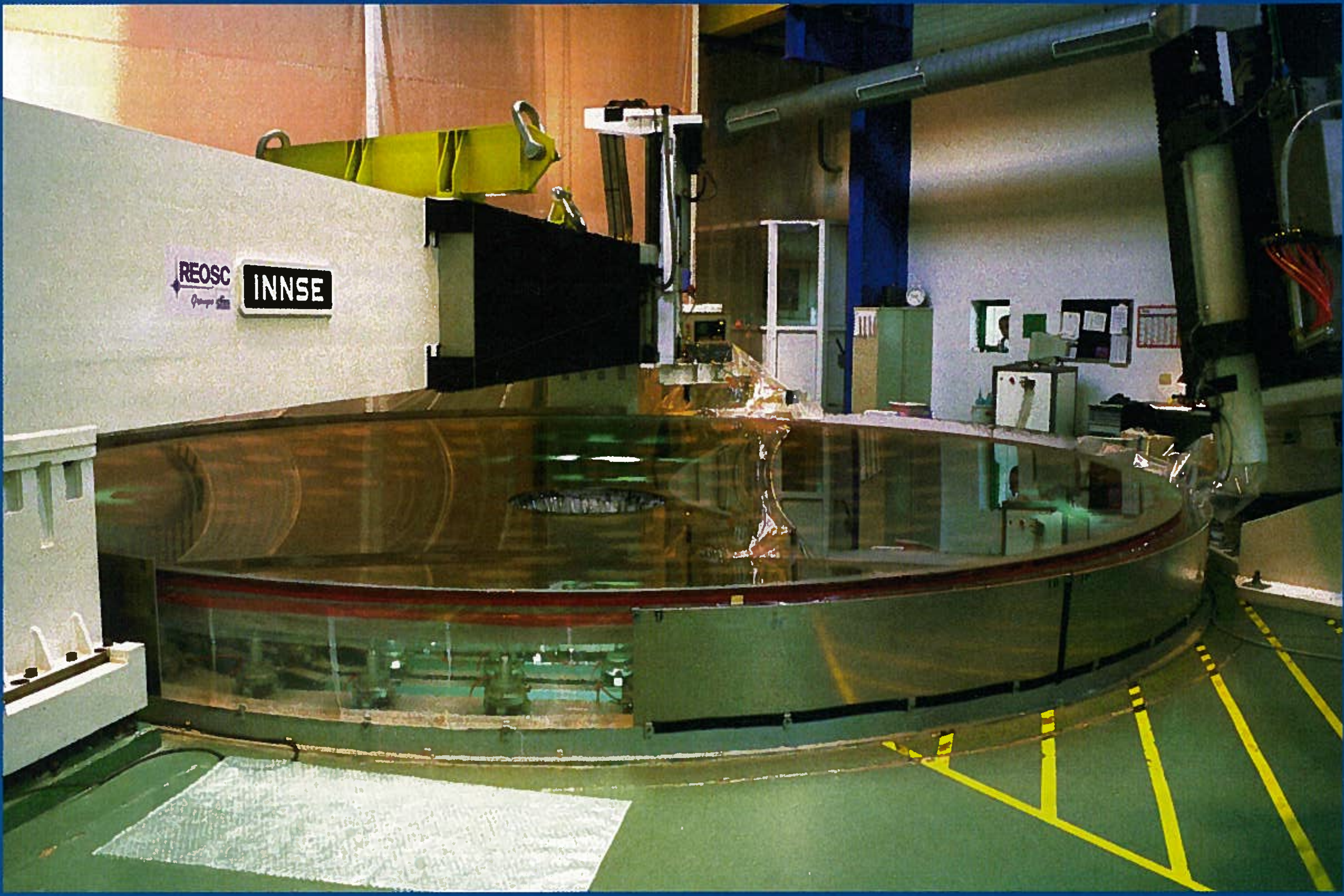
- The Gemini 8-M Telescopes Project. Mountain, June 1996. (Gemini Preprint #5)
- Gemini 8 Meter Telescopes Performance Estimates Update. Oschmann, June 1996. (Gemini Preprint #6)
- Management of the Gemini 8-m Telescopes Project. Kurz, June 1996. (Gemini Preprint #7)
- Managing an Internationally Distributed Instrumentation & Controls Project. McGonegal, June 1996. (Gemini Preprint #8)
- Active Optics Performance Study of the Primary Mirror of the Gemini Telescopes. Cho, June 1996. (Gemini Preprint #9)
- Gemini Primary Mirror Cell Design. Huang, June 1996. (Gemini Preprint #10)
- What is beyond 8m-10m Class Telescopes and the VLT-I: A Very Large Imaging Array for Groundbased Infrared and Optical Astronomy. Mountain, June 1996. (Gemini Preprint #11)
- Prototype Testing of a Surface Heating System for the Gemini 8-m Telescopes. Hansen, June 1996. (Gemini Preprint #12)
- Observing with a 21st Century Groundbased Telescope. Puxley, June 1996. (Gemini Preprint #13)
- The Software Design of the Gemini 8m Telescopes. Wampler, June 1996. (Gemini Preprint #14)
- Gemini Instrumentation Program Overview. Simons, June 1996. (Gemini Preprint #15)
- Thermal Analysis on Hex Placement Patterns of the Gemini Primary Cho, July 1996. (Gemini Preprint #16)
- Description of Algorithms to Control Primary Mirror Position. Stepp, July 1996. (SPE-O-G0063)
- Cryomotor Standards. McGonegal, July 1996. (SPE-C-G0066)
- Gemini SPIE papers, Landskrona conference. July 1996. (RPT-PM-G0070). ***Note:*** *Contains bound copies of all papers relating to Gemini, including Gemini preprints #5-15.*
- Prediction of Servo Error Using Simulink Model, Rev 3.0. Wilkes, July 1996. (TN-C-G0040)
- Report of the Proof of Concept Review Committee for the HROS Immersed Echelle. Simons et. al., August 1996. (REV-I-G0078)
- Near-Infrared Filter Manufacturing Specifications for Gemini Instruments. Simons, August 1996. (TN-PS-G0042)
- Numerical Simulations of Airflow in Telescope Enclosures. DeYoung, September 1996. (Gemini Preprint #17)
- Operations Science Use Scenario. Puxley, September 1996. (TN-PS-G0043)
- Wavefront Sensing CDR Documentation. September, 1996. (REV-I-G0084)
- Data Handling System PDR Documentation. October, 1996. (REV-C-G0082)
- Gemini Near-IR Spectrograph PDR Documentation. USGPO, October 1996. (REV-I-G0086)

AURA Corporate Office Moves to New AAAS Building

The Corporate Office recently relocated to the new office building of the American Association for the Advancement of Science (AAAS) at 1200 New York Avenue, N.W., Washington, DC 20005. AURA is located in Suite 350. Phone and fax numbers remain unchanged (phone: (202) 483-2101; fax: (202) 483-2106).

If you happen to be in this part of town or visiting the AAAS, feel free to visit our new offices!

- Lorraine Reams



GEMINI

8-Meter Telescope Project

THE GEMINI 8-METER TELESCOPES PROJECT is an international partnership managed by the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation.

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