Sloan Digital Sky Survey

Quarterly Progress Report
First Quarter 2002

May 1, 2002

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1. OBSERVATION STATISTICS

1.1 Summary

In Q1, observing focused on the Northern Galactic Cap and on repeated scans of the Southern Equatorial Stripe. We obtained 560 square degrees of imaging data on the Northern Galactic Cap, or 51% of the baseline goal of 1091 square degrees. Since the imaging portion of the Southern Survey is essentially finished, all imaging in the south focused on repeated scans of the Southern Equatorial Stripe. In Q1, we obtained 139 square degrees of "Good minus Unique" imaging area on the Southern Equatorial Stripe. When all imaging is combined, we obtained 699 square degrees in Q1, or 64% of the baseline goal for the quarter.

Since repeated imaging scans are the primary goal for the Southern Equatorial Stripe, progress can be measured by the mean number of times the stripe is imaged. To date, we have obtained 1026 square degrees in cumulative imaging on the Southern Equatorial Stripe. Given the stripe's footprint of 270 square degrees, this means we have already imaged an average area in the stripe nearly four times, and in fact have covered a few small overlap areas as many as nine times.

In Q1, spectroscopy focused on observations of the Northern Galactic Cap and the three Southern stripes. We completed 83 plates on the Northern Galactic Cap, or 61% of the baseline goal of 137 plates. We also completed 3 plates on the Southern stripes. Combining all areas, we completed 86 plates in Q1, or 63% of the total baseline goal for the quarter.

The cumulative areas imaged for the Southern Survey and Southern Equatorial Survey remain ahead of the baseline and the Northern Survey remains behind. Progress was hampered by a combination of poor weather and system problems. Poor weather prevented us from even opening the enclosure on 21 of the 60 scheduled observing nights in January, February, and March. Of the 39 nights when we were able to open, there were only 11 nights with no reference to poor weather conditions (clouds, dust, wind, snow, etc.) in the observing logs. The impact of weather is discussed in more detail in Section 2.3. System problems are discussed in Section 3.

1.2 Q1 Imaging

As noted, we obtained 699 square degrees of new imaging data in Q1, corresponding to 64% of our incremental baseline goal for the quarter. Table 1.1 compares the imaging data obtained in Q1 against the baseline projection.

Table 1.1. Imaging Survey Progress in Q1-2002

	Imaging Area Obtained (in Square Degrees)			
	Q1-2002		Cumulative through Q1	
	Baseline	Actual	Baseline	Actual
Northern Survey[1]	1091	560	3936	3022
Southern Survey[1]	0	0	745	738
Southern Equatorial Stripe[2]	0	139	675	1026

1. "Unique" area
2. "Good minus Unique" area

We obtained 51% of the Q1 baseline goal for imaging data for the Northern Survey, which is far short of our goal. As noted earlier, weather was a key limiting factor. We imaged whenever conditions were photometric and seeing appeared to meet, or would meet in short order, acceptability requirements based on the observing aids in use at APO. The observers worked aggressively to obtain imaging data whenever possible and made sound judgments based on weather forecasts and trends; the observing aids at their disposal; and their experience. However, aggressively pushing the limits through variable and sub-standard seeing conditions caused a significant amount of the collected data to be rejected during final data processing. In other words, although the fraction of time imaging in January exceeded the baseline, and the fraction of time spent imaging in March almost met the baseline, the overall yield in data that met survey quality requirements fell short of the baseline. This is an unfortunate but necessary strategy for us to adopt; we must be willing to pursue imaging whenever possible in order to catch up to our baseline goals.

The following charts plot cumulative imaging progress against the baseline for each of the three surveys. Imaging efficiency is discussed in Section 2.5.

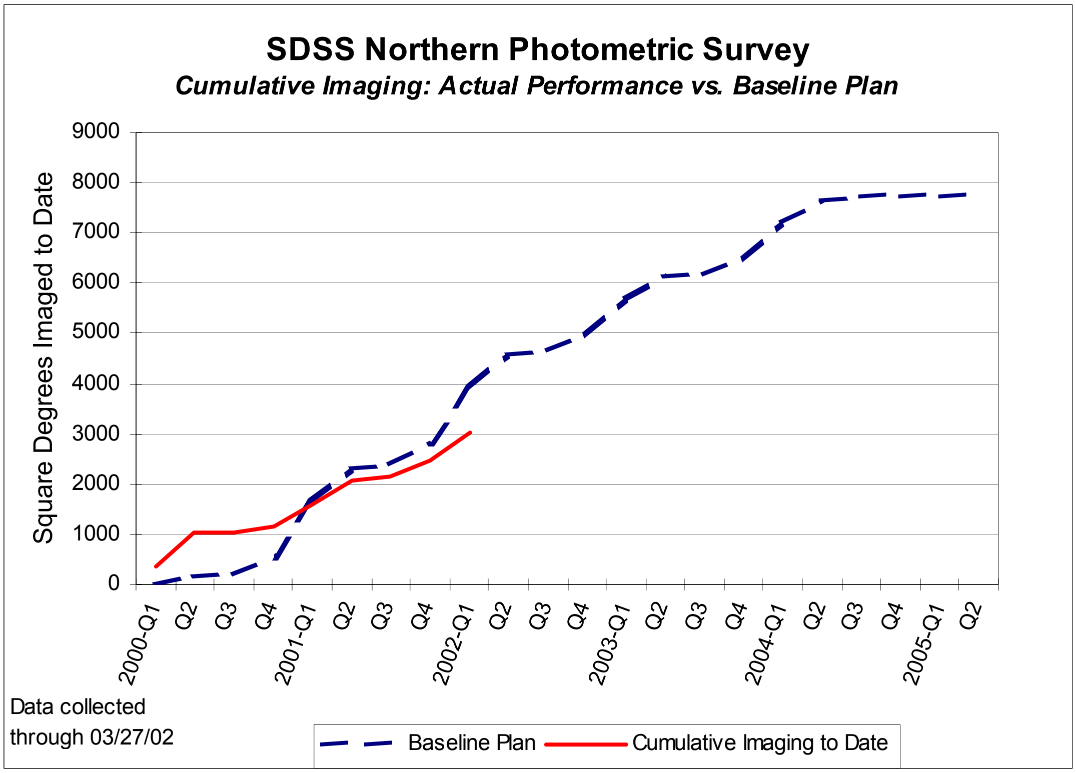

Figure 1.1. Imaging Progress against the Baseline Plan – Northern Survey

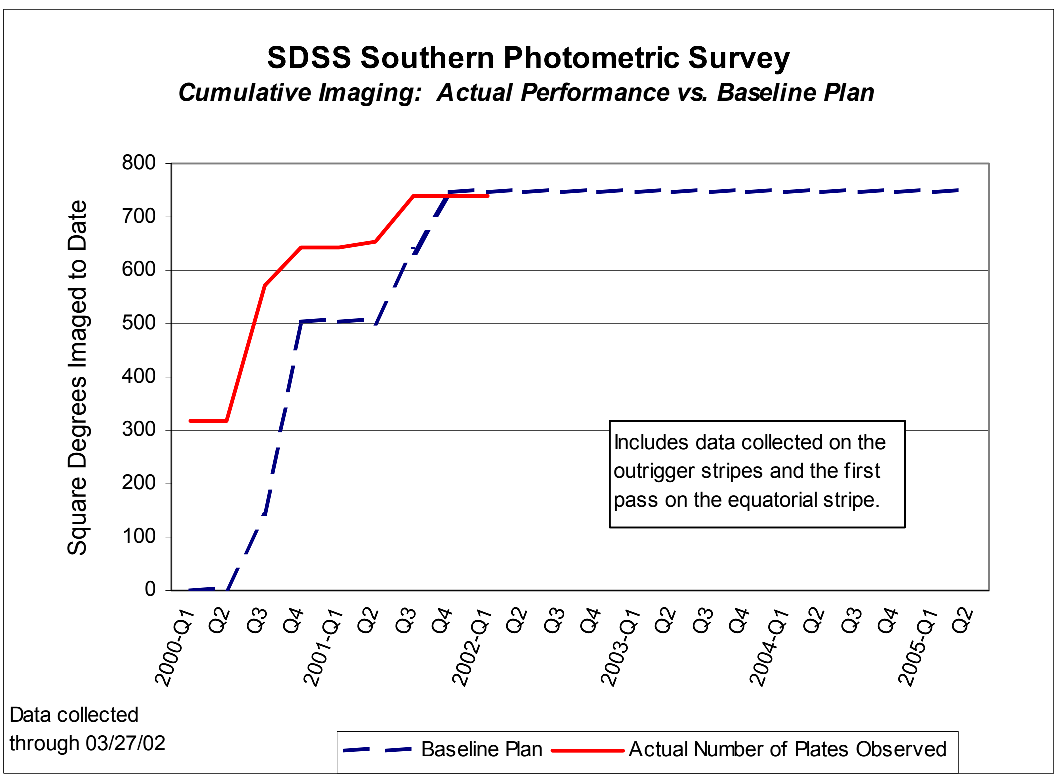

Figure 1.2. Imaging Progress against the Baseline Plan – Southern Survey

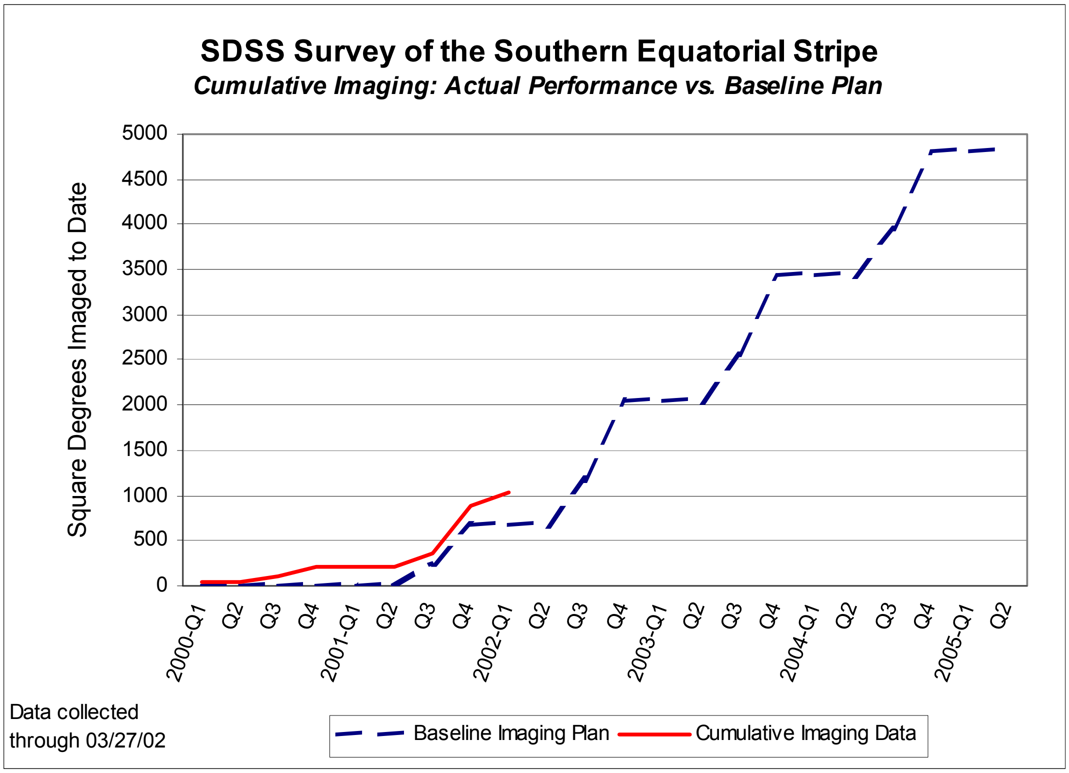

Figure 1.3. Imaging Progress against the Baseline Plan – Southern Equatorial Survey

1.3 Q1 Spectroscopy

We report progress on spectroscopy in terms of the number of plates observed and declared done during a quarter. The successful observation of a plate will typically yield 640 unique spectra. In Q1, we observed a total of 86 plates, which corresponds to about 55,000 spectra and 63% of the baseline goal for Q1. Table 1.2 compares the spectroscopic data obtained in Q1 against the baseline projection.

Table 1.2. Spectroscopic Survey Progress in Q1-2002

	Number of Plates Observed			
	Q1-2002		Cumulative through Q1	
	Baseline	Actual	Baseline	Actual
North	137	83	400	316
South	0	0	148	130
Southern Equatorial	0	3	54	46
Total plates	137	86	602	492

As with imaging, we fell short of our goal primarily because of weather. When conditions are clear, we routinely complete six or seven plates a night. Unfortunately, in Q1, there were many nights when we could not open at all. Of the remaining nights, weather conditions either forced us to open late or close early, or required us to observe through clouds, in moonlight, or both. Table 1.3 illustrates the number of nights in Q1 when weather significantly affected our ability to observe.

Table 1.3. Breakdown of Weather Conditions in Q1 2002

Period	Scheduled observing nights	Nights when weather prevented opening	Nights when weather limited observing hours
January	21	6	11
February	20	7	9
March	19	8	8

The following charts plot cumulative spectroscopic progress against the baseline for each of the survey areas. Spectroscopic efficiency is discussed in Section 2.6.

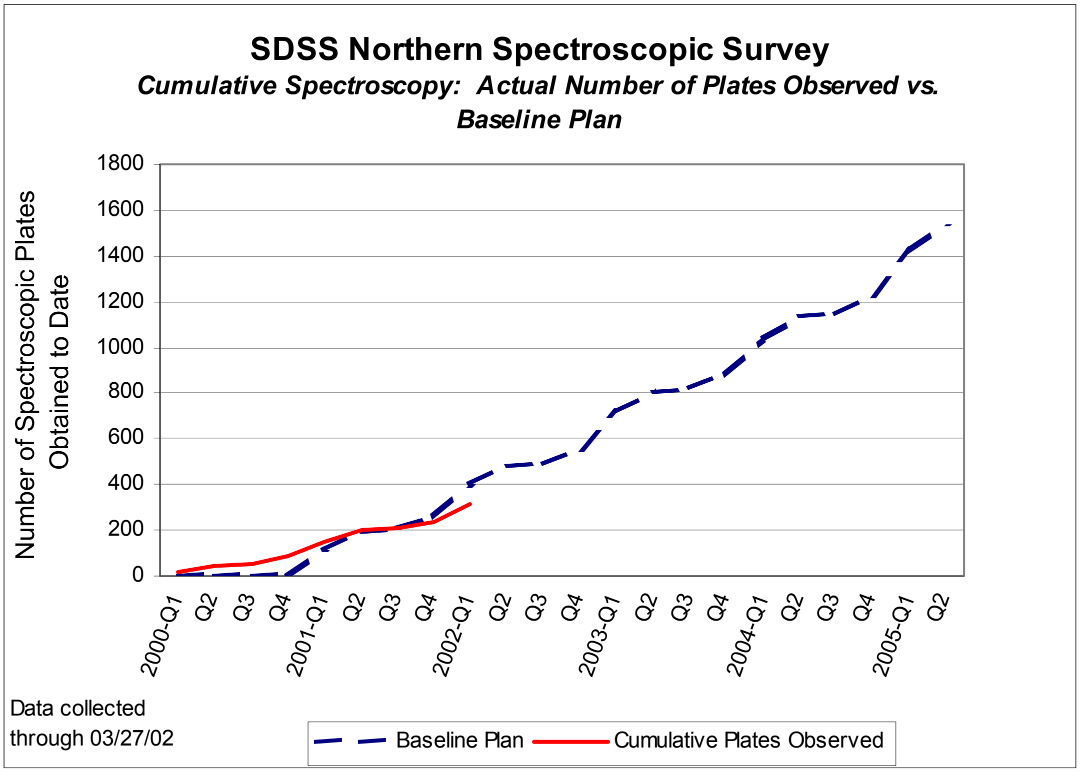

Figure 1.4. Spectroscopic Progress against the Baseline Plan – Northern Survey

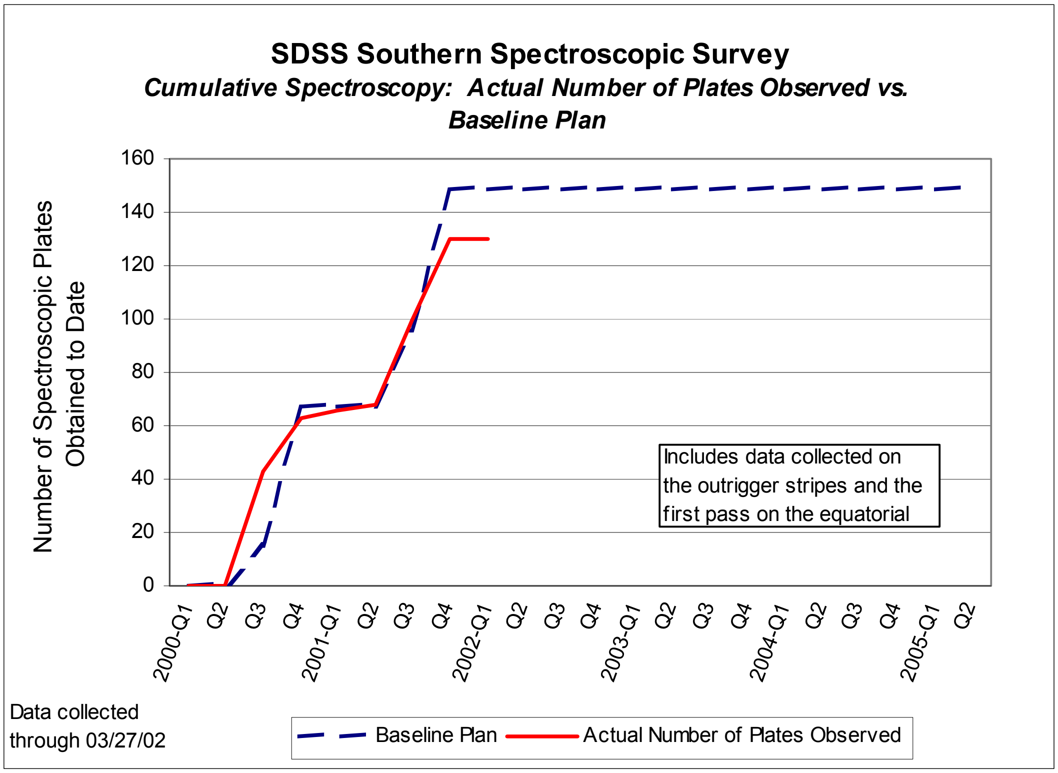

Figure 1.5. Spectroscopic Progress against the Baseline Plan – Southern Survey

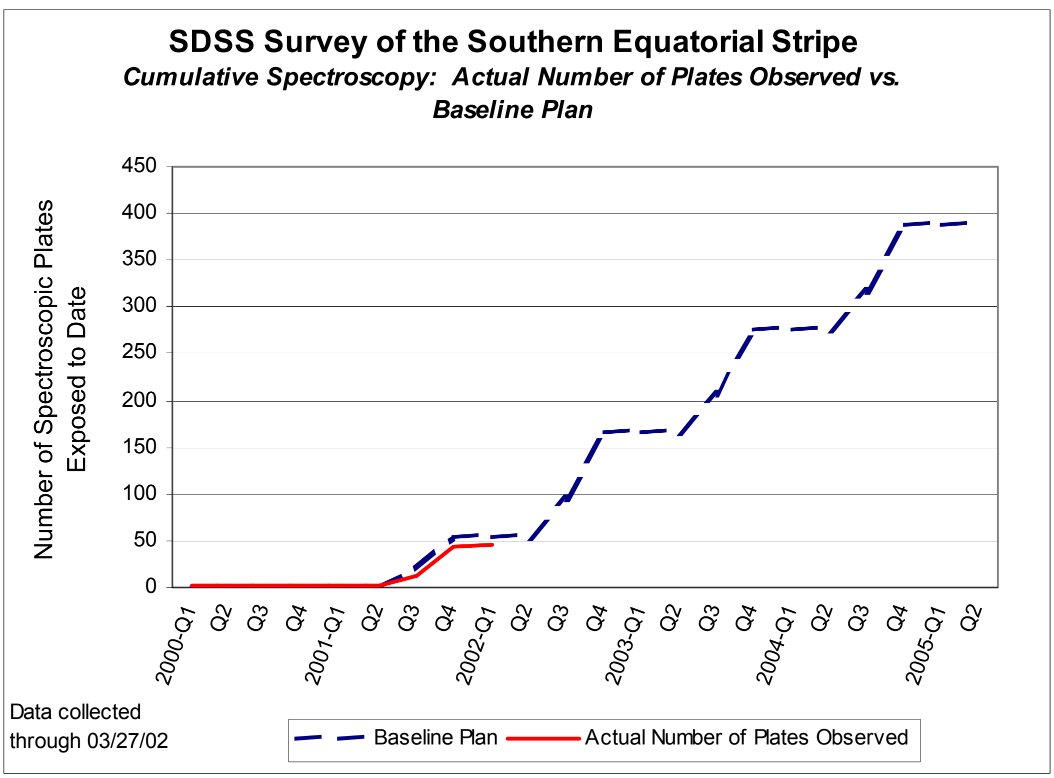

Figure 1.6. Spectroscopic Progress against the Baseline Plan – Southern Equatorial Survey

1.4 Status of Photometric Telescope Secondary Patches

In Q1, we completed 184 secondary patches for the Northern Survey and 5 secondary patches for the Southern Survey. While all of the secondary patches for the Southern Survey had been obtained before Q1 began, a small fraction of photometric time was used to make required repeat observations of some Southern Survey patches. A summary of the PT patches that have been observed and classified is shown in Table 1.4.

Table 1.4. Summary of Unique Secondary Patches Progress in Q1-2002

	Cumulative through Q1
Unique Patches	
“Done, verified”	1054
“Done, not verified”	0
Old patches available	39
Total Patches Done	1093
Total number required	1558
Percent observed (exclusive of old patches)	70%

The categories used in Table 1.4 are defined as follows. Unique Patches consist of the number of patches under the current patch layout system that have been successfully observed. This criterion is analogous to the “unique” criteria for imaging data. Patches classified as “Done, verified” have been successfully observed at APO and their quality verified after data processing at Fermilab. Patches classified as “Done, not verified” have been observed and declared “good” at APO, but they still require data processing confirmation. All patches observed in Q1 have been processed, so no patches are listed in this category. There are also 39 patches that were observed earlier, but that need to be re-observed under the current layout scheme. These patches are of sufficiently good quality, and their positions close enough to that in the current layout, that re-observing these patches has been given lower priority relative to observing new patches. These patches are classified as “Old patches available.” “Total Patches Done” is simply the sum of these three categories. It is also the total number of patches that have been observed since the PT baffling was improved and the PT CCD cleaned to remove a contaminating film from the CCD surface.

While the fraction of sky with good patches is greater than the fraction of sky that we have successfully imaged, some patches are still needed for parts of the Northern Galactic Cap that have been successfully imaged. It is important to note that patches can be observed whenever the sky is photometric, while imaging requires that the sky be photometric and the seeing be less than 1.5 arcseconds rms. Because this second requirement is very restrictive, the fraction of time that one can obtain good patches is much greater than the fraction of time that survey quality imaging data can be obtained. We expect to obtain all of the missing patches before the end of Q2-2002. Once we have reached that state, the acquisition of good patches should remain comfortably ahead of the imaging survey.

2. OBSERVING EFFICIENCY

2.1. Overview of Observing Efficiency in Q1

We continue to monitor our efficiency using the semi-automated time tracking tools we developed. Table 2.1 summarizes the breakdown of observing time in Q1-2002 according to the categories used to prepare the baseline projection.

Table 2.1. Comparison of Q1-2002 Efficiency Measures to the Baseline

		January		February		March	
Category	Baseline	Dark	Dark+gray	Dark	Dark+gray	Dark	Dark+gray
Total time (hrs)	Jan: 161:21 Feb: 152:40 Mar: 144:02	161:21	228:48	152:40	205:59	144:02	191:34
Imaging fraction	0.27	0.31	0.28	0.13	0.12	0.24	0.20
Spectro fraction	0.63	0.58	0.65	0.76	0.78	0.64	0.70
Weather	0.60	0.55	0.47	0.46	0.42	0.44	0.47
Uptime	0.90	0.93	0.95	0.99	0.99	0.95	0.92
Imaging efficiency	0.86	0.84	0.84	0.74	0.74	0.87	0.87
Spectro efficiency	0.65	0.60	0.61	0.66	0.64	0.58	0.61
Operations	0.90	0.93	0.92	0.93	0.92	0.89	0.90

2.2. Allocation of Time between Imaging and Spectroscopic Operations

The fraction of time spent on imaging and spectroscopic operations includes actual observing time and overhead. Actual observing time in one mode or the other is straightforward to measure. By contrast, measuring the overhead associated with one mode or the other is difficult. The 5-year Baseline Plan distinctly divides overhead between imaging and spectroscopy while in practice, assigning overhead between imaging and spectroscopy is somewhat arbitrary given the manner in which observing activities occur. Moreover, an arbitrary assignment of time does not lead to accurate performance measurements. Since we cannot accurately measure overhead performance in the same manner as defined in the Baseline Plan, we have derived, from the baseline goals, a set of time allocation metrics that are measurable. The derived measurable metrics are shown in the baseline column in Table 2.1.

In practice, weather actually drives the division of science time between imaging and spectroscopy; whenever the weather is suitable for imaging, we image. As a consequence, the numbers we report also represents the fraction of potential observing time that the weather was good enough to image. Potential observing time is defined as time when the weather is suitable for observing and equipment is working properly. In this sense, then, imaging fractions higher than the baseline (which lead to spectroscopic fractions below the baseline) are desirable at this point in the Survey.

For Q1, the fraction of time allocated to imaging was slightly higher than the baseline in January, slightly below the baseline in March, and far short of the baseline in February. Of 20 scheduled observing nights in February, conditions were suitable for imaging on only three nights. Moreover, on those three nights, there were only brief periods that were photometric with acceptable seeing.

2.3. Weather

The weather category represents the fraction of scheduled observing time that the weather is suitable for observing. The baseline plan assumed that when the weather was good enough to have the telescope on the sky, it was also good enough to complete a spectroscopic plate in 45 minutes of science exposure time. In reality, we are able to take useful spectroscopic data when the weather is much worse. The impact is simply that longer exposure times are necessary to achieve the required signal-to-noise ratio. However, since the time tracker considers all of the time that useful data can be taken as good weather, the weather fraction measured by the time tracker is not directly comparable to the baseline.

In effect, the weather fraction reported by the time-tracker is an upper limit on the number that should be compared to the baseline, since it overstates how good the weather was. If an estimated correction based on the number of plates completed is made, the weather fraction for dark + gray time for January, February, and March becomes 0.38, 0.35, and 0.44 respectively.

Overall, there were 48 fewer hours of useful weather during dark time in Q1 than specified by the baseline. We were able to offset this loss by picking up an additional 70 hours of spectroscopic observing during “gray” time. However, spectro efficiency during gray time, or through cloudy conditions, is significantly less than in “good” weather conditions. The impact in Q1 is illustrated as follows: In the 118 hours of science exposures taken, we completed 86 plates. Had these exposures been taken under good weather conditions and no moon (as assumed in the baseline), we would have completed them in 65 hours of exposure time. Thus, an additional 53 hours of exposure time were needed to complete these plates because we observed in difficult weather and/or moonlight conditions.

Over the past several quarters, we have reported that the weather has been a limiting factor in our ability to reach our baseline goals. The baseline goals were established on the assumption that on average, for any given year, the weather would be suitable for observing 50% of the time in Q3 and 60% of the time in the remaining three quarters. This assumption was based on historical weather information for Apache Point Observatory. Figure 2.1 compares the fraction of dark time that the weather was suitable for observing at APO since August 2001, against the baseline weather assumption. The trend chart begins in August 2001, when we implemented our new time tracking tools, and clearly illustrates the length of time that we have operated with sub-optimal weather conditions. As previously noted, we have been able to offset some of the lost time by conducting spectroscopic observations during gray time, but this does nothing to help us catch up on imaging data.

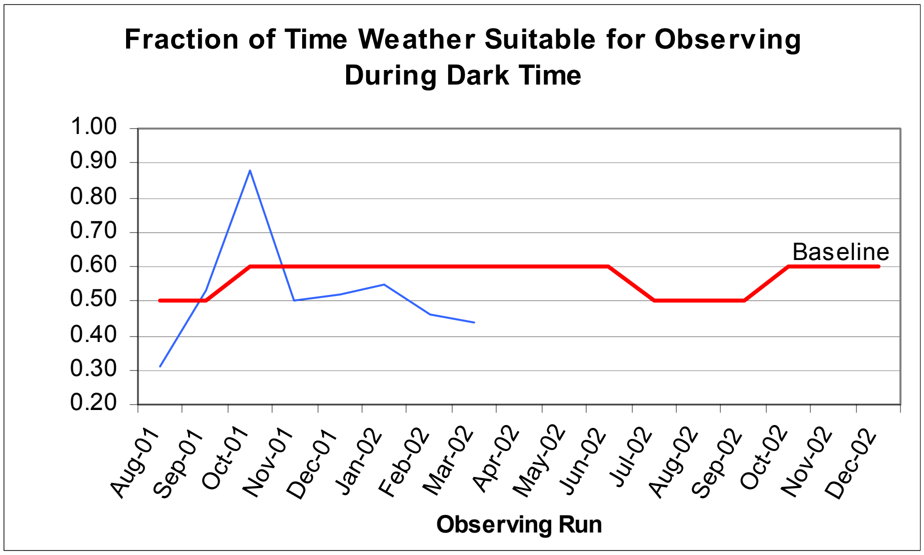

Figure 2.1. Comparison of the fraction of time that the weather was suitable for observing during dark time, compared to the 5-Year Baseline Plan.

2.4. System Uptime

System uptime is a measure of equipment availability when conditions are suitable for observing. Figure 2.2 shows system uptime for each observing run since August 2001. The number measured by the time-tracker is directly comparable to the number specified in the baseline. Although we experienced a number of equipment problems during Q1, which are discussed in Section 3, we still exceeded the uptime goal of 90% for each observing run of Q1. We were particularly encouraged by system performance in February, when we achieved system uptime of 99%, but the sharp drop in March performance tempered our enthusiasm. We still have work to do to improve system performance in order to maintain a consistently high performance rating.

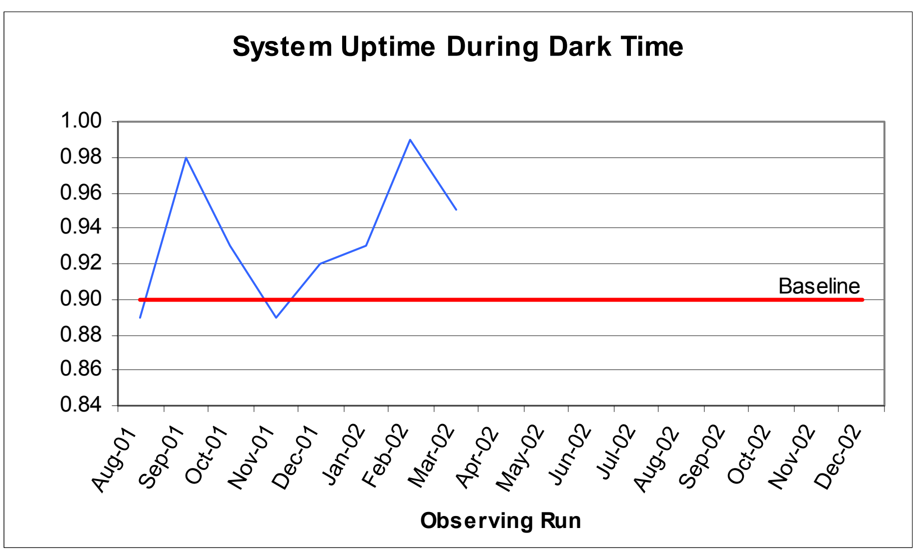

Figure 2.2. System Uptime During Observing Periods

2.5. Imaging Efficiency

We continue to use two simple statistics from our time tracking data to measure imaging efficiency: the imaging efficiency ratio and the imaging effectiveness ratio. The first, a measure of observing efficiency, is the ratio of science imaging time to the sum of science imaging time plus imaging setup time. The second, a measure of how effectively we use available imaging time to acquire new survey quality data, is the ratio of imaging area obtained to the science imaging time.

The baseline plan established the imaging efficiency ratio to be 0.86. In Q1, our measured efficiency ratio was 0.83, as compared to 0.79 for Q4. The monthly imaging efficiency ratios for Q1 are shown in Table 2.2.

Table 2.2. Imaging Efficiency Ratios for Q1-2002

	January	February	March	Aggregate
Imaging Efficiency Ratio	0.84	0.74	0.87	0.83
Baseline	0.86	0.86	0.86	0.86
Efficiency relative to baseline	98%	86%	101%	97%

Imaging efficiency was quite good in January and March, but suffered in February due to a large number of short imaging scans. In February, the mean setup time per scan was 23 minutes compared to the baseline of 24 minutes, but the mean science time per scan was 1:06 hours, compared to the baseline goal of 2:30 hours. The shorter scan time means more overhead per area imaged, which drives down efficiency.

In addition to an overall improvement in the efficiency ratio, we achieved an improvement in the imaging effectiveness ratio. In Q4, our measured effectiveness ratio was 15.4 square degrees/hour. In Q1, the sum of the imaging area obtained in Q1 (699 square degrees) divided by the time expended on science imaging (39.6 hours) was 17.6 square degrees/hour. The baseline goal is 18.6 square degrees per hour. The difference between the actual and the baseline consists of imaged area that did not meet survey requirements and imaged area that did not contribute to the survey goals (e.g., overlapped areas). Thus, the imaging effectiveness ratio was 95% for Q1, compared to 83% for Q4 and 68% for Q3.

The product of the efficiency and effectiveness ratios is 92%, which indicates a performance improvement for the second quarter in a row, since we achieved a 76% ratio in 2001-Q4 and a 53% ratio in Q3.

2.6. Spectroscopic Efficiency

During Q4, the total time spent making spectroscopic observations, after excluding the time for cartridge changes, setup, and calibration, was 118 hours, compared to the baseline expectation of 99 hours. The difference is due partly to spectroscopic observing in less than ideal weather conditions and partly to the use of gray time. Gray time was not included in the baseline plan because we were not certain that such observations would produce survey quality data.

The mean time expended in Q1 to obtain survey quality spectra for a plate was 82 minutes, whereas the baseline allocates only 45 minutes. However, comparing the mean time per plate to the baseline is not a practical performance indicator, because in addition to observing efficiency, the measured mean includes the effects of weather, moonlight, and the longer observing times required for special plates. A better method of determining our efficiency is to extract from the time-tracking records the median overhead per plate mounting, and then calculate the efficiency this overhead would correspond to under good weather conditions. In Q1, this results in an achieved efficiency of 0.57, which is similar to the efficiency achieved in Q4 but still significantly short of the baseline goal of 0.64.

An additional performance indicator is to compare the median time spent on spectroscopic observing against the baseline goals. By analyzing only those plate mountings in which there were no reported weather or equipment delays during the entire set of observations, we are able to measure operating performance and exclude the impact of factors beyond our control, such as weather and moonlight. Table 2.3 provides the median time, by month, for the various elements of spectroscopic time. Units for all categories are minutes except for efficiency, which is given as the ratio of science exposure time to total time required per plate.

Table 2.3. Median Time for Spectroscopic Observing Activities Over the Last Two Quarters

Category	Baseline	Oct	Nov	Dec	Jan	Feb	Mar
Cartridge change	10	6	6	6	6	5	5
Setup	10	14	15	13	12	10	12
Calibration	5	12	12	12	14	12	15
CCD readout	0	3	3	3	3	3	3
Total overhead	25	35	36	34	35	30	35
Science exposure (assumed)	45	45	45	45	45	45	45
Total time per plate	70	80	81	79	80	75	80
Efficiency	0.64	0.56	0.56	0.57	0.56	0.60	0.56

In Q1, we obtained reductions in cartridge change and setup times, but saw an increase in calibration times during the January and March dark runs. The increase in calibration time is due to an increase in the number of post-calibrations required during these months. During spectroscopic observations, calibrations taken before a plate is observed are called “pre-calibs”, and calibrations taken after the last exposure are called “post-calibs.” If a plate is completed in three relatively short exposures (e.g, 15-20 minutes per exposure), or if the site conditions are not changing, then pre-calibs are usually sufficient to calibrate the plate. However, if exposure times are long due to cloudy and/or moony conditions, or if a plate is started on one night and finished on another, then post-calibs are needed. Obviously, post-calibs significantly increase overall calibration time and the more post-calibs required, the larger the median calibration time. Due to the weather conditions in January and March, a larger number of post-calibs were required, which pushed up the median calibration time for these months.

To improve spectroscopic efficiency, we clearly need to evaluate and implement ways to reduce setup and calibration time. Setup includes field acquisition and focus, and we have identified that improved and consistent telescope pointing will reduce field acquisition time and improved initial focus estimates will minimize the need for time-consuming focus sweeps. We are still working on understanding scale factor changes as a function of temperature and on improving algorithms to compute initial focus for spectroscopy, based on temperature, but we did not make much progress in these areas during Q1. We also made little progress in reducing calibration time. We intend to evaluate the various calibration operations, and their sequence, in order to identify areas where we can reduce overhead time and come closer to the baseline, but we have no progress to report for Q1.

2.7 Summary of Efficiency Observations

Weather was worse than predicted throughout the quarter. Equipment availability exceeded baseline goals. Earlier improvements in imaging efficiency continue to pay dividends, as imaging efficiency in Q1 was consistently higher than in the past. Improvements are still needed to bring the efficiency of spectroscopic operations in line with the baseline.

3. OBSERVING SYSTEMS

Throughout Q1, the instruments worked well, we continued to improve the thermal environment around the telescope, and we completed a number of engineering tasks. Unfortunately, we also had a number of serious problems that affected operations.

3.1. System Problems in Q1

We encountered a number of system and equipment problems in Q1 that affected observing performance. In Q4, we reported a problem with one of the secondary mirror actuators. The actuator would move very slowly when temperatures dropped below approximately 5C. The slow movement affected observing efficiency until troubleshooting during the January observing run finally led to the replacement of the actuator lead screw and bearing assembly, which solved the problem. Since this was a mechanical wear failure, the lead screw assemblies on all three actuators have been replaced.

In the February run, a freak ice storm at APO froze the 2.5m telescope enclosure to the platform and caused damage to the enclosure power rails. The rails shorted, which prevented the opening and closing of the building. Spare rails were installed as a temporary fix and a roof assembly built and installed over the rails to prevent ice build-up in the future. Permanent rail replacements were ordered and arrived in late March. They are scheduled for installation during the April bright time.

At the beginning of the March dark run, APO experienced two days of unusually cold weather with nighttime temperature dropping to approximately –15C. The cold temperature caused a large number of problems with the instruments and mechanical systems, which eventually resulted in the termination of observing operations during those nights. We have a list of the systems that failed and we intend to systematically go through each to see if improvements can be made to ensure trouble-free operation at cold temperatures. If we cannot improve low-temperature performance, we may need to consider a low-temperature operating limit to avoid damage to critical systems or the instruments.

3.2. The Instruments

The instruments performed well throughout the quarter, except during the brief cold snap in early March. The extreme cold prevented the spectrograph slit head doors and camera shutters from functioning properly. The cold also affected the imaging camera, as problems were encountered with the imager t-bar latches and several of the imager CCDs, including the u3 chip that has caused problems in the past. Fortunately, we have not seen any lasting effects from the cold snap. All of the instruments recovered and began functioning properly once the temperature warmed back up.

In the 2002 Q4 report, we noted that fine silt had been found in the liquid cooling loop. Subsequent analysis indicated that the laboratory-grade glycol used in the cooling loop was corroding the aluminum heat exchangers used on the spectrographs. In January, we installed replacement heat exchangers in both spectrographs. The replacement heat exchangers use copper tubing, so we do not expect to have any further problems with corrosion in this system.

3.3. Thermal Work

In 2001 Q4, we began investigating a plan to install louvers in the lower enclosure to provide a flow of cool outside air through the enclosure, thereby reducing its temperature. In Q1, we finished the conceptual design work and finalized the plan for installing louvers in the lower level. A statement of work has been prepared and a Request for Quotation (RFQ) let. We anticipate this work will be completed in Q2.

One of the remaining heat sources on the telescope was the Flat Field lamps. Thermal imagery showed that the lamp bodies remained at elevated temperatures some thirty minutes after the lamps had been turned off. To prevent the “hot” lamp bodies from affecting telescope seeing, plumbing was installed to connect the lamp bodies to the liquid cooling loop used to extract heat away from the telescope. In Q1, the plumbing installation was finished and extensively leak-tested, and the system brought on line for the March observing run.

3.4. The Photometric Telescope

There were no significant problems with the Photometric Telescope (PT) during Q1. There were occasional problems with the PT filter-wheel controller that have been with us for some time. A replacement control board has been designed and fabricated, and is scheduled for installation during the summer 2002 shutdown.

3.5. Operations Software

During Q1, we were again hampered by a number of observing software problems that affected observing efficiency. Since operations began, we have fixed a number of bugs in the observing software and efficiency has improved as a result. As time progresses, the remaining problems become more subtle and difficult to troubleshoot and fix. Working closely with the developers, the observing staff has developed work-arounds while the developers continue to troubleshoot and fix the remaining bugs that interrupt observing operations and affect efficiency.

A software bug that caused sporadic telescope axis halts was found and fixed in Q1. A careful review of the MCP->TCC tap log showed a pause reminiscent of the AxisDTime pauses that were fixed last quarter. In this case, however, the pause lasted over 2 minutes, instead of the 1-second pause seen with AxisDTime errors. A bug was found in the TCC's output system, which used interrupts to output data and "blocking writes" to deliver the data. Normally this did not cause problems, but if a user interrupted output just as the user's process had the axes tied up, the axes would remain tied up until the user allowed TCC output again. The problem was solved by having the output interrupt use nonblocking (asynchronous) writes.

We continue to be discouraged by the frequency of errors in the PT-VME link hardware and software. This facility is used in all communications between the IRIX host computer and the VME crates. In Q1, efforts focused on narrowing the problems down to hardware or software causes. For the former, a program of daily testing of the links was started. PT-VME link boards were swapped in an effort to identify failing hardware. Results to date have been inconclusive. There are indications that many of the observed errors may instead be related to the driver software and interactions with client software (i.e., astroda).

Work was performed to resolve problems encountered during binned scanning, which is used in the "Apache Wheel" data acquisition runs. Successful use of binned scanning requires reconfiguration of the DAQ software to turn off the astroline code before starting a binned run, then re-enabling astroline prior to standard drift scanning. In Q1, procedures for this reconfiguration were developed, tested, and documented in coordination with the observing staff. Binned scanning was also found to provoke a higher rate of PT-VME link errors. These were found to be recoverable using existing utilities. Preliminary procedures have been developed and training of the observing staff in the use of these procedures has begun.

Work continued on improving the algorithms associated with quartiling in the astroline software. The intent was to reduce imaging setup time by improving the response of astroline to abrupt changes in ambient light level, such as near twilight, at the beginning of runs when the shutters are opened, and on "moony" nights. The original algorithm responded to these step function-like changes very slowly, with recovery of proper quartiling and establishment of sky values requiring five minutes or more. Prior to recovery, star finding and automated focusing cannot proceed. A new algorithm was introduced which recovers sky values within a few frames (one to two minutes). However, this new algorithm failed in response to very bright stars and extended bright objects. An improved version of astroline is currently undergoing testing.

During Q1, we modified all observing software as necessary to record all time stamps in UT format. Standardizing time formats was done to make troubleshooting and analysis easier.

A problem arose in Q1 related to "smears", which are taken as part of the spectrophotometric calibration process for a spectroscopic plate. Guider frames from smears would occasionally show stars as dots rather than streaks. Through troubleshooting, it was discovered that the TCC was sometimes being commanded to clear the velocity offsets too soon. A new version of the TCC was installed, but has only partially fixed the problem, since some of the problem stems from the manner in which SOP, the Spectroscopic Observers' Program, communicates with the TCC. SOP would send commands to the TCC without knowing whether they were ever executed, or even received. Implementing a proper handshake was very difficult at the time SOP was written because the TCC did not return useful identifiers for commands, but since this has been corrected, SOP can now check for proper completion. A quick and temporary modification was made in SOP to monitor the proper execution of commands by the TCC. A more robust improvement is under development and is scheduled for installation in May.

Finally, to review long-term needs and develop an achievable work plan and development schedule, an Observing Software planning meeting is planned for May 2002. A principal goal of this meeting is to identify the list of bug fixes and improvements that are absolutely necessary to improve data quality or observing efficiency, and develop a realistic, resource-loaded schedule for completing these improvements. All other observing software will be frozen, with no changes allowed unless necessary to fix new critical bugs that appear.

3.6. Status of Engineering Tasks Scheduled for Q1

Table 3.1 reports the status of the more significant engineering tasks that were scheduled for completion in Q1-2002. Tasks marked with asterisks were carry-over tasks from Q4.

Table 3.1. Status of Engineering Tasks Scheduled for Q1-2002

Task	Responsible	Driver	Priority	Status
Install PT enclosure platform	Leger	Safety	High	100%
Finish M2 actuator assembly upgrade	Carey	Reliability	High	100%
Finish spectrograph radiator upgrade	Leger	Reliability	High	100%
Install imager secondary latch upgrade*	Gunn	Equip prot.	High	100%
Finish instrument change interlocks*	Anderson	Equip prot.	High	95%
Procure / install emergency closing generator*	Leger	Equip prot.	High	90%
Finish PM program for telescope systems*	Leger	Reliability	High	60%
Design enclosure stair upgrade*	Carey	Safety	High	50%
Finish installation of SDSS humidity sensor*	Gillespie	Equip prot.	Medium	100%
Finish proof-of-concept work for Cloud Camera	Gunn	Reliability	Medium	100%
Finalize requirements for cloud camera upgrade*	Gunn	Reliability	Medium	100%
Finish implementation of slip detection system*	Czarapata	Equip prot.	Medium	95%
Implement imager LED calibration system	Gunn	Data quality	Medium	50%
Finish revised requirements for DIMM	Gunn	Efficiency	Medium	0%

Regarding the tasks listed in Table 3.1, the status of the incomplete tasks is as follows:

- The interlock instrument change PLC code was modified in Q1 to correct for an offset that had developed in the altitude clinometer, a transducer used to detect the altitude angle of the telescope. In Q1, the clinometer was recalibrated at different temperatures and the new scale factors added to the PLC code. The revised code has been installed and will be extensively tested in Q2. It should be noted that this bug prevented us from testing the instrument change interlocks, but it did not hamper observing operations.
- In Q1, the Emergency Closing Generator was received and installed, the generator enclosure fabricated and installed, and electrical work partially finished. We are awaiting the delivery of the knife switch that will connect the emergency generator to the enclosure power distribution system. We fully expect to have the emergency generator system in operation by the end of the April bright time.
- The preventive maintenance program for the telescopes remains under development. The list of periodic inspection/maintenance tasks is posted on the web and is being followed, and we added additional PM items to the list in Q1. The task remains open because we

have yet to complete a comprehensive review to identify and address all areas requiring preventive maintenance. We will strive to complete this during 2002.

- Significant progress was made on the design of a new stair system for the 2.5m telescope enclosure. During Q1, several design options were investigated and considered, including a new stairway external to the rolling enclosure and a new internal stair system with a modified hatch door. The former was rejected because it was very costly and there were questions about its practicality. A design review was held and the decision made to proceed with the internal stair system. Detailed design work is now underway, with installation scheduled for late Q2.
- We fabricated and bench-tested a circuit board for the slip detection system that will latch and hold slip detection readings until they can be read and logged by the Telescope Performance Monitor (TPM). Installation was scheduled for the March bright time but because of a heavy workload, this task was not completed. The new circuit board is now scheduled for installation during the April bright time.
- The conceptual design of the Imager LED Calibration System was finished, reviewed and approved during Q1. Parts have been ordered and components fabricated, and assembly is underway. This system will be finished and placed into operation in late Q2.
- No progress was made on revising the DIMM mounting requirements. However, a revised design for mounting the DIMM was finished and distributed for review. We expect to revise the mounting requirements in Q2, and review and approve a simpler installation scheme. DIMM installation should occur during the summer 2002 shutdown.

3.7 Engineering Tasks Scheduled for Q2-2002

Table 3.2 lists the more significant engineering tasks scheduled for completion in the second quarter of 2002. Tasks marked with asterisks are carry-over tasks from Q1-2002.

Table 3.2. Engineering Tasks Scheduled for Q1-2002

Task	Responsible	Driver	Priority
Finish PM program for telescope systems*	Leger	Reliability	High
Finish emergency closing generator system*	Leger	Equip prot.	High
Test and debug instrument change interlocks*	Anderson	Equip prot.	High
Design, fabricate, install encl. stair upgrade*	Carey	Safety	High
Finish M2 actuator bellows upgrade	Carey	Reliability	High
AZ fiducial read-head mount upgrade	Leger	Reliability	High
Enclosure lower-level louvers	Klaene	Data quality	High
Finish implementation of slip detection system*	Czarapata	Equip prot.	Medium
Finish imager LED calibration system	Gunn	Data quality	Medium
Fabrication/assembly of new Cloud Camera	Gunn	Reliability	Medium
Finish revised requirements for DIMM	Gunn	Efficiency	Medium
Finish detailed design work for DIMM mount	Gunn	Efficiency	Medium
Design and fabricate plug plate drilling fixture	Carey	Efficiency	Medium
Design and fabricate M2 aluminizing fixture	Carey	Data quality	Medium

An engineering planning meeting is scheduled in May 2002 to review performance against the plan developed in December 2001, revise the plan for the remainder of the year, and begin initial planning for 2003. The meeting will also provide an opportunity to review in detail the work planned for the Summer 2002 shutdown.

4. DATA PROCESSING AND DISTRIBUTION

4.1. Data Processing

4.1.1. Data Processing Operations in Q1

All imaging and spectroscopic data collected through the end of Q1 have been processed, and plate designs were delivered on schedule for the January, February, and March drilling runs. In addition, four Terabyte disk servers were installed at Fermilab and are being tested.

We continue to improve operational efficiency in the data processing factory at Fermilab. Typically we have a dozen imaging runs in progress. Runs may be in various stages of processing, waiting for calibration patches to be observed, or waiting for problem reports (PRs) to be addressed. Our status and reporting tool (monitorDP, similar to the "watcher" at APO) helps us monitor the runs. To continually improve data processing operations, we identify components of the factory that hinder efficiency and track them with the PR system.

The following items summarize our progress in achieving the data processing goals for Q1.

1. Keep current with all imaging, mt, and spectro data.
   - This has been accomplished. Data are available to the collaboration in the "chunk" and the "stage" databases. The contents of these are listed at:

Net Area	# Plates	Summary file for Spectro Data Loaded
2405.0	481	http://www-sdss.fnal.gov/sdssdp/status/weekly/Plate-Mjd-in-Chunk.html

Net Area	# Fields	Summary File for Imaging Data Loaded
3456.6	18435	http://www-sdss.fnal.gov/sdssdp/status/weekly/ImagingInChunk.html
4812.0	25664	http://www-sdss.fnal.gov/sdssdp/status/weekly/ImagingInStage.html
696.6	3715	http://www-sdss.fnal.gov/sdssdp/status/weekly/ImagingInStage2.html

2. Produce files for drilling runs, as requested.
   - We designed plates for the following drilling runs:
     - January: Chunks 30, 31, 32, and 33: total of 10+10+12+15=47 plates
     - February: Chunks 34, 35: total of 16+22 = 38 plates
     - March: Chunks 36, 37, 38, and 39: total of 17+18+8+8=51 plates

3. Implement and validate photo v5_3 changes to the science pipelines.
   - Final implementation and validation has been delayed due to the finding and fixing of bugs during the testing process.

4. Run the Data Release One "test suite" with these pipelines; analyze results; implement final fixes; begin processing for Data Release One.
   - Because item 3 had not been accomplished, we were unable to proceed with this step.

5. Implement the SQLServer science database, loaded with SIRTF data for demonstration to the collaboration.
   - The imaging and spectra data have been loaded for the SIRTF data set, but we have not been able to present it to the collaboration for demonstration.

4.1.2. Pipeline and QA Development in Q1

Development work continued on Photo 5_3 (SSC, PSP, and opdbQA), the code that will be used to process imaging data for Data Release 1. The largest change made was to regenerate data quartiles in the SSC, rather than use those from the DA, to avoid problems caused by missing quartile values in the DA outputs. Fourteen Problem Reports (PRs) were closed in the process of shaking out Photo 5_3.

New flats were generated from the so-called ”oblique scans.” A substantial amount of time was spent characterizing the flat field problems, and showed definitively that the flat fields do change with time, with transitions occurring at times when the camera was opened up for repairs.

Development work also continued on the Spectro1D pipeline, in preparation for Data Release 1. Work in Q1 included the following:

- Implemented code that outputs velocity dispersion measurements for early type galaxies;
- 1d now runs on monolithic spPlate input files output by idlspec2d;
- Improvements to continuum and line fitting, and fixed a bug in emission line width errors for weak lines;
- Line finding algorithm more robust;
- Set of stellar and QSO templates for cross-correlation has been completely overhauled with a new set of higher S/N templates with better coverage of the spectral types of stars and QSOs and more accurately calibrated;
- QSO line fitting allows for larger velocity shifts between lines;
- Improved handling of exotic QSOs in the manual inspection stage;
- Cross-checks implemented to ensure that only manually inspected plates are loaded into the science database;
- Implemented new set of eigentemplates for galaxy spectral classification via PCA, based on much larger sample of input galaxy spectra;
- Implemented additional warning flag triggered by large differences between photo and synthetic 2d fiber magnitudes.

4.2. Data Distribution

4.2.1. Use of the Early Data Release

A log of the maximum number of concurrent users each day is maintained on-line at: http://wwwsdss.fnal.gov/sdssdp/sxstats/EDR/2002_Max_Concurrent_Users_by_Day. During this quarter, we averaged a maximum of 8.9 concurrent users of the EDR Catalog Archive Server. For the collaboration Chunk Catalog Archive Server, the average was 5.4.

4.2.2. Q1 Activities in Preparation for Data Release 1

We are preparing for Data Release One (DR1), which is scheduled for January 2003. During Q1, we defined the specific imaging runs that will be released. This consists of all imaging data taken before June 2001 that was used to define spectroscopic plates, and all spectra data from the main survey sample that were collected by the end of 2001. We defined a project schedule and detailed plans for consistency testing and science testing for DR1. We also implemented a new Data Archive Server for use by the collaboration.

We are currently 8 weeks behind the baseline schedule for DR1. This is due largely to delays in validating the new version of the photo product, used for the PSP and frames pipelines. We are also late in meeting milestones for developing the SQLserver databases, and for the spectro pipelines. The plan called for the DR1 databases to be loaded by June, in order to give the collaboration ample time to analyze the data set, characterize its features in release notes, and shake down the database systems.

4.3. Data Processing and Distribution Goals for Q2

The following set of goals have been established for Q2-2002:

1. Have the DR1 versions of all pipelines delivered and tested;
2. Have all DR1 data processed with these pipelines;
3. Have SQLserver databases, with imaging, spectro, tiling, and mask schema loaded, available for collaboration testing;
4. Continue routine processing of data, especially to design plates for each tiling run;
5. Have data processing automated, and demonstrate that one FTE equivalent can run routine imaging and spectro processing, not including target/tile/plate and database stuffing operations

5. SURVEY PLANNING

5.1 Observing Aids

Several programs are used to aid observing operations at APO.

1. HoggPT is a program that processes the data from the Photometric Telescope in near real time and provides feedback on the photometric quality of a night. This program has remained essential unchanged.

2. Son of Spectro is a program that analyzes spectroscopic exposures in near-real time and determines if they have adequate signal/noise. This program is continuously upgraded as various problems with the spectroscopic data are uncovered. New features added this quarter include the ability to plot individual spectra, the ability to declare certain frames bad (including cases where incorrect header information is supplied), the ability to process data taken in a nonstandard sequence, and the ability to track the spectrograph focus. This latter capability was added after one dark run in which the spectrograph focus shifted by a large amount due large changes in temperature.

3. The plate inventory database tracks which plates have been observed. No major enhancements have been made.

4. The patch database tracks the Photometric Telescope observing program. The database code was restructured to make it more maintainable and a more robust backup procedure has been implemented. No changes were made.

Several programs are in various stages of development to aid in planning observations.

1. The plate layout program determines the exact parameters to be used for designing new plates. This program is relatively stable. No changes were made.

2. The plate planning program helps decide which areas of sky should be imaged next in order to maximize plate availability at all times during the night. No changes were made.

3. The plate design program was modified to output proper coordinates to be used when a plate is measured with a coordinate measuring machine as part of quality analysis. Previously, coordinates for the plate bent in the drilling fixture were used, which required removing a low-order polynomial in analyzing the residuals.

5.2 Target Selection

No changes were made to the target selection code or algorithms. All plates that were designed were for the main northern survey region.

136 plates were designed and drilled this quarter in three drilling runs.

6. COST REPORT

The operating budget that the Advisory Council approved in November 2001 for the year 2002 consists of $2,291K of in-kind contributions from Fermilab, US Naval Observatory (USNO), Los Alamos National Laboratory (LANL), and the Japan Participation Group (JPG); and $3,425K for ARC funded expenses.

Table 6.1 shows the actual cost performance by project area for ARC-funded cash expenses in Q1 2001. A more complete table comparing actual to baseline performance is included as an attachment to this report.

Table 6.1. ARC-Funded 1st Quarter Expenses and Forecast for 2002 ($K)

	2002 – 1st Quarter		2002 – Total	
Category	Baseline Budget	Actual Expenses	Baseline Budget (Nov 2001)	Current Forecast
1.1. Survey Management	60	43	249	242
1.2. Collaboration Affairs	4	1	16	16
1.3. Survey Operations				
1.3.1. Observing Systems	219	184	870	864
1.3.2. Data Processing & Dist.	165	143	641	620
1.3.3. Survey Coordination	0	0	0	0
1.3.4. Observatory Support	340	368	1,360	1,388
1.4. ARC Corporate Support	13	23	88	91
Sub-total	801	762	3,225	3,221
1.5. Management Reserve	50	0	200	200
Total	851	762	3,425	3,421

6.1 First Quarter Performance - In-kind Contributions

The sum of in-kind contributions for the first quarter was $541K against the baseline forecast of $576K, and was provided by Fermilab, Los Alamos, the U.S. Naval Observatory (USNO), and the Japan Participation Group (JPG).

Fermilab provided support for the data acquisition system at APO, the software programs used by the observers to operate the telescopes and instruments (the "Observers' Programs"), and the data processing systems at Fermilab as agreed. The Fermilab budget for Survey Management support exceeded the baseline due to a change in personnel in the project management office; higher in-kind salary costs associated with the new staff have increased the estimated value of the in-kind support. The level of effort, however, has not changed. The level of in-kind Observing Systems Support was less than predicted when the budget was prepared in November, because resources at Fermilab were not available to support SDSS at the level anticipated. The forecast for Q2-Q4 has been adjusted to more closely reflect the reduction in the level of effort anticipated through the end of 2002.

Los Alamos provided programming support for the Telescope Performance Monitor, and planning and testing support in preparation of Data Release 1. As a result of increased involvement in each of these areas, the level of in-kind support provided in Q1 exceeded the forecast prepared in November 2001.

USNO provided support as required for the astrometric pipeline and other software systems they maintain. The astrometric pipeline is mature and stable and no major changes have been made. Astrom team activities continue to focus on quality assurance testing. The level of in-kind support in Q1 was in line with the baseline forecast.

JPG provided support during the month of January to help analyze data collected to characterize the non-linearity of the imaging camera. For the quarter, the level of effort was lower than had been predicted. In fact, for the year, we estimate that the level of effort required will be substantially less than earlier forecast. As a result, we have reduced the forecast for in-kind JPG effort from $40K to $10K for the year. Since minimal costs were incurred in Q1, the $10K forecast has been distributed evenly across Q2-Q4.

6.2. First Quarter Performance – ARC Funded Expenses

The sum of ARC-funded expenses for the first quarter was $762K, which is $39K below the first-quarter budget of $801K.

Survey management costs as a whole were $17K below the Q1 baseline. Expenses related to the Office of the Project Scientist were lower than anticipated. The Project Spokesperson budget was underspent because some of the Spokesperson's travel was arranged and billed through the Fermilab survey management account, SSP48. Since these costs were incurred against SSP48, there was a corresponding overrun in the Fermilab survey management budget. There was not, however, an overall increase in Survey Management costs. Minimal costs were incurred at NYU for photometric system support in Q1; the budget provides for travel expenses and computing hardware and has been moved forward into Q2 while the need for continued support is reviewed. ARC Support for Public Affairs was underspent because some of the budgeted costs for AAS meetings were not expensed in Q1. These expenses will be costed in Q2 and so the budget has been moved forward accordingly. For the year, survey management costs are forecast to be within $7K (3%) of the baseline budget.

ARC Support for Collaboration Affairs holds the budget for Working Group travel and technical page charges. A modest amount of travel expenses were incurred in Q1, but no page charges, so the budget balance has been moved forward into the remaining three quarters.

Observing Systems costs were $6K below the first quarter budget. All institutional expenses were within a few thousand dollars of the allocated budgets. The largest variance appears in the budget for ARC Observing Systems Support. When the budget was prepared in November, the assignment of engineering projects to the various institutions was not finalized, so the budget for these projects was held in the ARC Corporate account. The distribution of engineering work was finalized in December and the funds reallocated to the institutions accordingly. In addition, funds were placed into the ARC Corporate account to address thermal improvement needs. None of these funds were expended in Q1 and so the budget for thermal improvements has been moved forward. For the year, the total Observing Systems forecast is within $6K, or 1% of the baseline budget.

Data Processing and Distribution costs were $22K below the Q1 budget. Fermilab and Princeton expenses were within a few thousand dollars of the allocated budgets. The UC budget was overspent for two reasons. First, salary costs for Q1 were underestimated when the budget was prepared in November; actual salary costs were in line with the current budget forecast. Second, a computer that had been budgeted for in Q2 was purchased in Q1. The Q2 forecast has been reduced to reflect this shift. JHU expenses associated with data archive development and support were $13K below the Q1 budget. Personnel costs were $3K lower than planned, and costs for hardware upgrades, software contracts, and miscellaneous support costs were not realized in Q1. The budget for the latter items has been moved forward in the year. For the year, the Data Processing and Distribution forecast is within $21K (3%) of the baseline budget.

Observatory Support costs were $28K above the baseline budget for Q1. The Observatory Support budget appears overspent because in addition to planned Q1 expenses, it includes hardware procurements, miscellaneous operations costs, and travel expenses that were encumbered in Q1 but have not been accrued. With regard to Q1 expenses, salary costs during the quarter were above average (27%) because of additional overtime paid during the longer winter nights. This is similar to the salary expensed in the 4th quarter of 2001, and the spend rate will abate somewhat in the 2nd and 3rd quarters due to shorter nights and the scheduled summer 2002 shutdown. Encumbrances incurred in Q1 include multi-quarter contracts for housekeeping, NSO services, maintenance contracts, etc. Most of the full-term values for these contracts are front-loaded as encumbrances, which end up being moved to later quarters as they are expensed. Also, the Observatory Support budget sustained a $2K hit for an unplanned emergency repair of the power rails to the SDSS enclosure, which had been damaged by ice and water. Public outreach, a small budget category, was expensed to 68% of the total year's budget to pay for a PR video about the site and for replenishing a year's worth of site brochures. The equipment category is spent/encumbered to the 42% level, mainly because of the purchase of a replacement copier for the site. For the year, the Observatory Support budget is forecast to be within 1% of the baseline budget.

ARC Corporate Support costs were $10K over the first quarter budget. The annual insurance expenses were approximately 25% ($1.3K) more than anticipated. In addition, APO petty cash expenses were greater than anticipated during Q1 because the temporary help at APO is being paid from petty cash instead of through SSP35 as anticipated. A transfer of budget from SSP35 to SSP91E will cover these expenses. For the year, and before the transfer of funds, the ARC Corporate Support budget is forecast to be within $3K, or 35% of the baseline budget.

No management reserve funds were distributed in Q1. In addition, we are in the process of collecting final 2001 costs in preparation for closing the books on the 2001 budget. Once final costs are known, we plan to place all remaining unspent management reserve from 2001 in the management reserve for 2002.

7. Publications Q1 2002

Stellar Masses and Star Formation Histories for 80,000 Galaxies from the Sloan Digital Sky Survey
MRNAS submitted – Guinevere Kauffmann, et al.

Composite Luminosity Functions of the Sloan Digital Sky Survey Cut & Enhance Galaxy Cluster Catalog
PASJ submitted – Tomo Goto, et al.

Exploratory Chandra Observations of the Three Highest Redshift Quasars
ApJL, 569, 5 (2002) – W.N. Brandt, et al.

Optical and Radio Properties of Extragalactic Sources Observed by the FIRST Survey and the SDSS
AJ submitted – Zeljko Ivezic, et al.

Characterization of M, L and T Dwarfs in the Sloan Digital Sky Survey
AJ accepted – Suzanne L. Hawley, et al.

Comparison of Asteroids Observed in the SDSS with a Catalog of Known Asteroids
AJ submitted – Mario Juric, et al.

Spectroscopic Target Selection in the Sloan Digital Sky Survey: The Main Galaxy Sample
AJ submitted – Michael Strauss, et al.

Spectroscopic Target Selection in the Sloan Digital Sky Survey: The Quasar Sample
AJ accepted – Gordon Richards, et al.