Sloan Digital Sky Survey
Quarterly Progress Report
Fourth Quarter 2001

March 6, 2002

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1. OBSERVATION STATISTICS

1.1 Summary

In Q4, observing focused on the Northern Galactic Cap and on repeated scans of the Southern Equatorial Stripe. We obtained 329 square degrees of imaging data on the Northern Galactic Cap, or 71% of the baseline goal of 461 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. We obtained 518 square degrees of "Good minus Unique" imaging area on the Southern Equatorial Stripe, or 96% of the baseline goal for total imaging area on the southern stripes. When all imaging is combined, we obtained 847 square degrees, or 85% of the total baseline goal for the quarter.

Spectroscopy focused on observations of the Northern Galactic Cap and the three Southern stripes. We completed 27 plates on the Northern Galactic Cap, or 47% of the baseline goal of 58 plates. We also completed 62 plates on the three Southern stripes, or 70% of the baseline goal of 88 plates. Combining the number of plates observed, we completed 89 plates, or 61% of the total baseline goal for the quarter.

Repeated imaging scans is the primary goal of the survey of the Southern Equatorial Stripe. Accordingly, progress on the Southern Equatorial Stripe is measured by the mean number of times the stripe is imaged. We have obtained 884 square degrees in cumulative imaging to date. Given the Southern Equatorial Stripe footprint of 270 square degrees, we have already imaged an average area in the stripe more than three times, and in fact have covered a few small overlap areas as many as nine times.

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 system problems associated with scheduled downtime, and poor weather. The October dark run was shortened by four days to accommodate the annual re-aluminization of the 2.5-meter telescope primary mirror at Kitt Peak. Although the baseline plan took into account the shortened observing period due to mirror re-aluminization, a number of problems encountered when the telescope was brought back online hampered observing progress. In addition, we lost a significant amount of observing time due to poor weather. In October, there were only three scheduled observing nights in which the weather was suitable to observe throughout the entire night. On those three nights, we did very well, completing seven plates on two of the nights, and six plates on the third. Weather also hampered our progress in November and December. Poor weather prevented us from even opening the enclosure on 15 of the 39 scheduled observing nights in the November and December observing periods.

1.2 Q4 Imaging

We obtained 847 square degrees of new imaging data, corresponding to 85% of our incremental baseline goal for imaging in Q4-2001. Table 1.1 compares our quarterly and cumulative imaging survey progress against the baseline.

Table 1.1 Imaging Survey Progress in Q4-2001

	Imaging Area Obtained (in Square Degrees)			
	Q4-2001		Cumulative through Q4	
	Baseline	Actual	Baseline	Actual
Northern Survey[1]	461	329	2845	2448
Southern Survey[1]	110	0	745	738
Southern Equatorial Stripe[2]	430	518	675	884

1. “Unique” area
2. “Good minus Unique” area

The baseline plan showed that we would complete the imaging portion of the Southern Survey in Q4 if we obtained 110 square degrees. However, we essentially finished the imaging portion of the Southern Survey in Q3 2001 and so we no longer book new imaging area against the Southern Survey. Instead, new imaging area is credited towards the Survey of the Southern Equatorial Stripe, since we are now doing repeat scans on this stripe.

With regard to the Southern Equatorial Stripe, it is misleading to measure performance by comparing the 518 square degrees of imaging data obtained to a baseline goal of 430 square degrees. To more accurately measure imaging performance on the southern stripes in Q4, one should compare the actual area obtained (518 square degrees) to the total area specified in the baseline plan for the three stripes combined (110 square degrees plus 430 square degrees). By this accounting, we obtained 96% of the baseline goal for imaging on the southern stripes in Q4.

We only obtained 71% of the Q4 baseline goal for imaging data for the Northern Survey. As noted earlier, weather was a key limiting factor. During the October run, conditions were suitable for imaging on only two of the 14 scheduled observing nights and on those nights, we imaged on the Southern Equatorial Stripe. In November, only four nights had partial periods when weather was suitable for imaging and on those, we obtained 75 square degrees on northern stripes. December was slightly better. On the four nights with partial periods suitable for imaging, we obtained 253 square degrees on northern stripes.

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

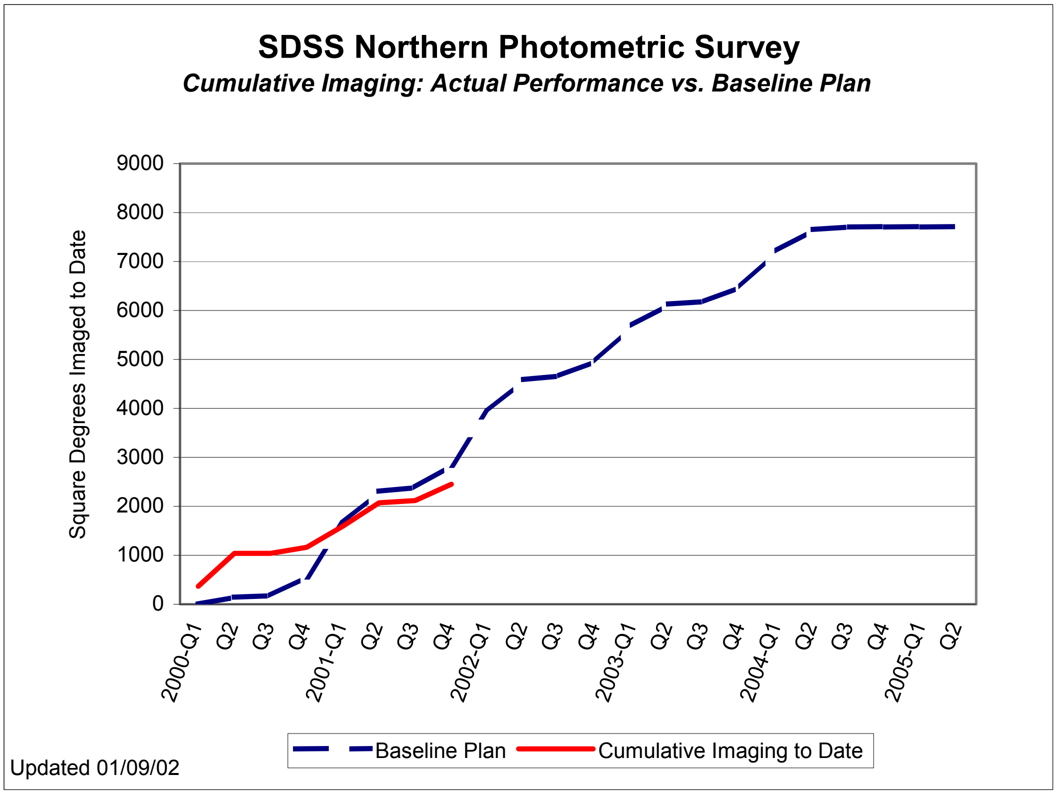

Figure 1.1. Imaging Progress against the Baseline Plan – Northern Survey

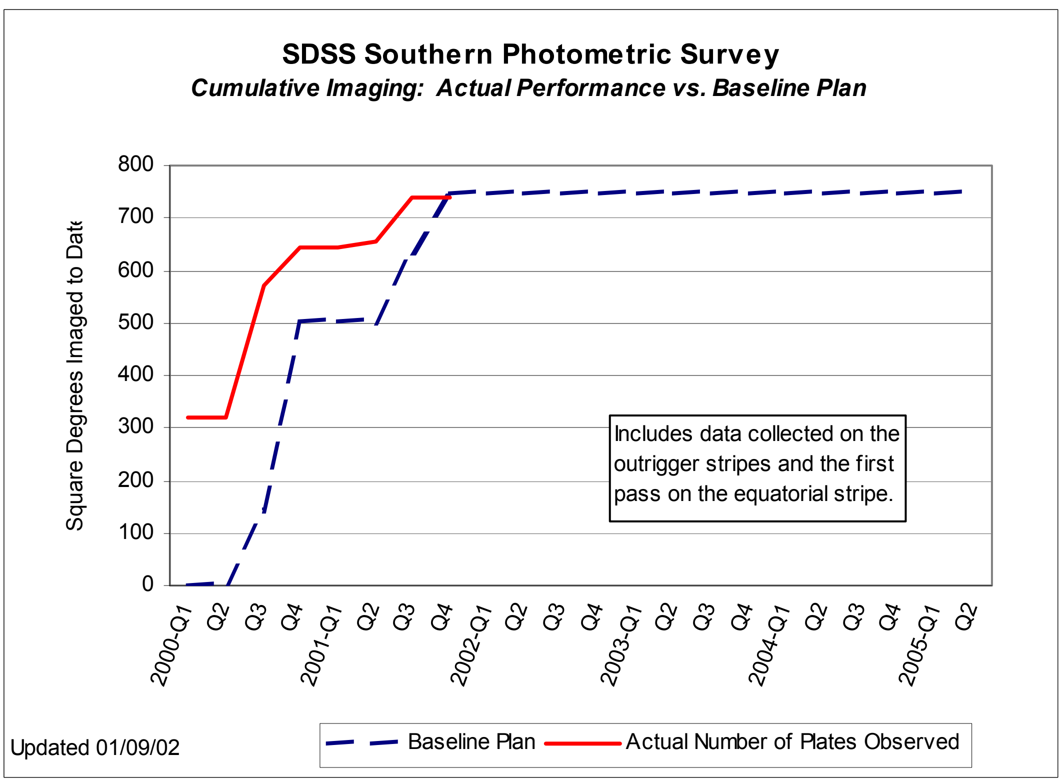

Figure 1.2. Imaging Progress against the Baseline Plan – Southern Survey

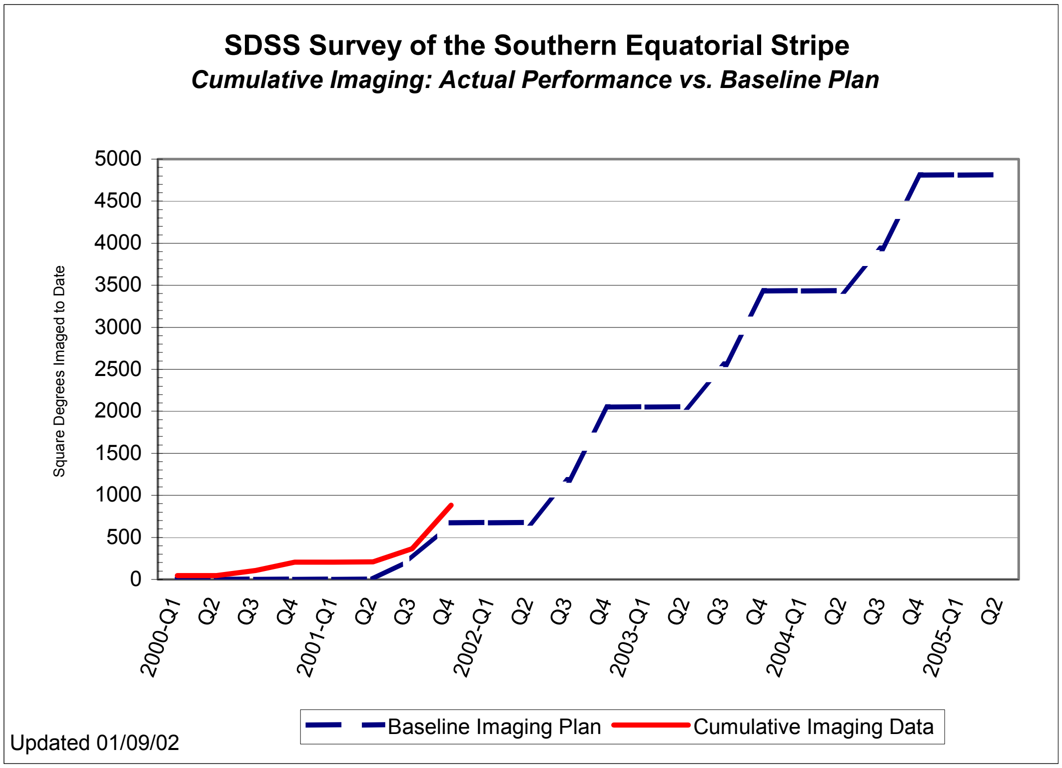

Figure 1.3. Imaging Progress against the Baseline Plan – Southern Equatorial Survey

1.3 Q4 Spectroscopy

We observed a total of 89 plates during Q4, which corresponds to about 57,000 spectra and 61% of our baseline goal for Q4. Table 1.2 compares the spectroscopic data obtained during Q4 against the baseline projection. We report progress on spectroscopy in terms of the number of plates that were observed and declared done during the quarter. The successful observation of a plate will typically yield 640 unique spectra.

Table 1.2. Spectroscopic Survey Progress in Q4-2001

	Number of Plates Observed			
	Q4-2001		Cumulative through Q4	
	Baseline	Actual	Baseline	Actual
North	58	27	263	233
South	53	31	148	131
Southern Equatorial	35	31	54	36
Total plates	146	89	465	400

Simply stated, we fell far short of our Q4 goal. As noted earlier, when conditions are clear, we are routinely able to complete six or seven plates a night. Unfortunately, in Q4, there were many nights when we could not open at all. Of the remaining nights, weather conditions either forced opening late or closing early, or required us to observe through clouds or in moonlight, or both. Table 1.3 illustrates the number of nights in Q4 when weather significantly affected our ability to observe.

Table 1.3. Breakdown of Weather Conditions in Q4 2001

Period	Scheduled observing nights	Nights when weather prevented opening	Nights when weather limited observing hours
October	14	0	8
November	19	7	7
December	20	8	5

In addition to weather, our overall yield was impacted by a shortage of standard survey plates in Q4. Since we did not have an adequate supply of standard plates to observe during certain times during the quarter, we made productive use of these times by observing specially designed plates. However, since some of these special plates require longer observing times and special observing procedures, they take longer to complete. Hence, they have a negative effect on overall yield. Additional detail on these special plates is provided in Section 5.2.

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

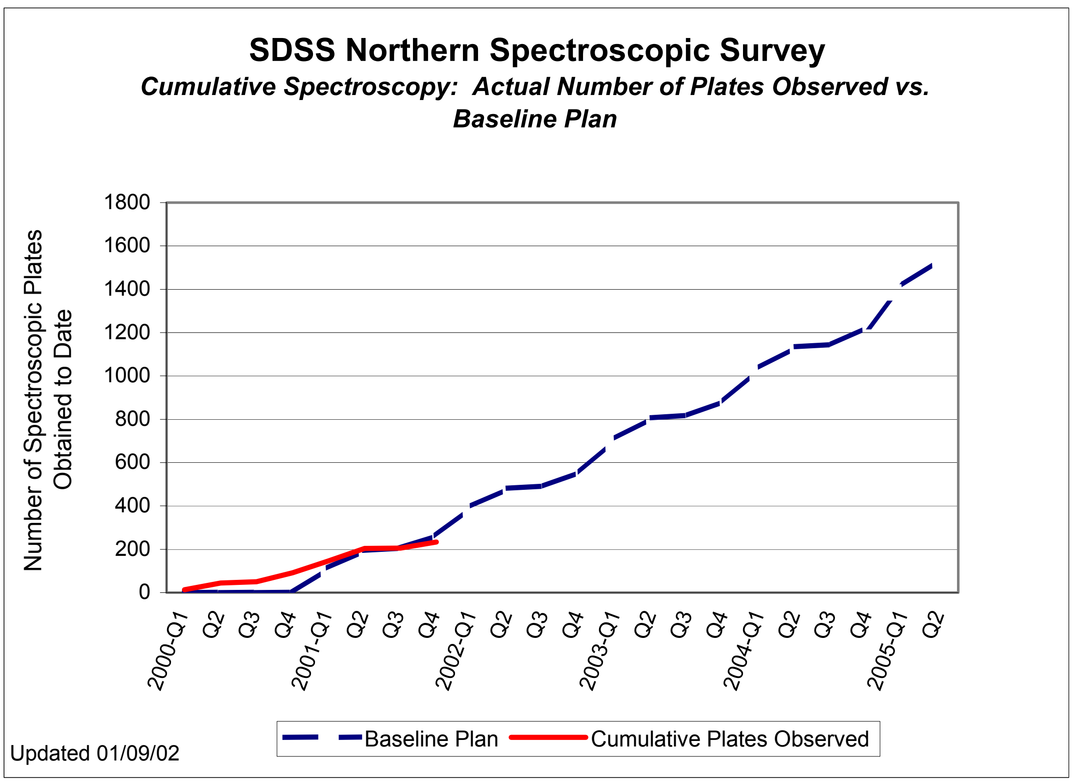

Figure 1.4. Spectroscopic Progress against the Baseline Plan – Northern Survey

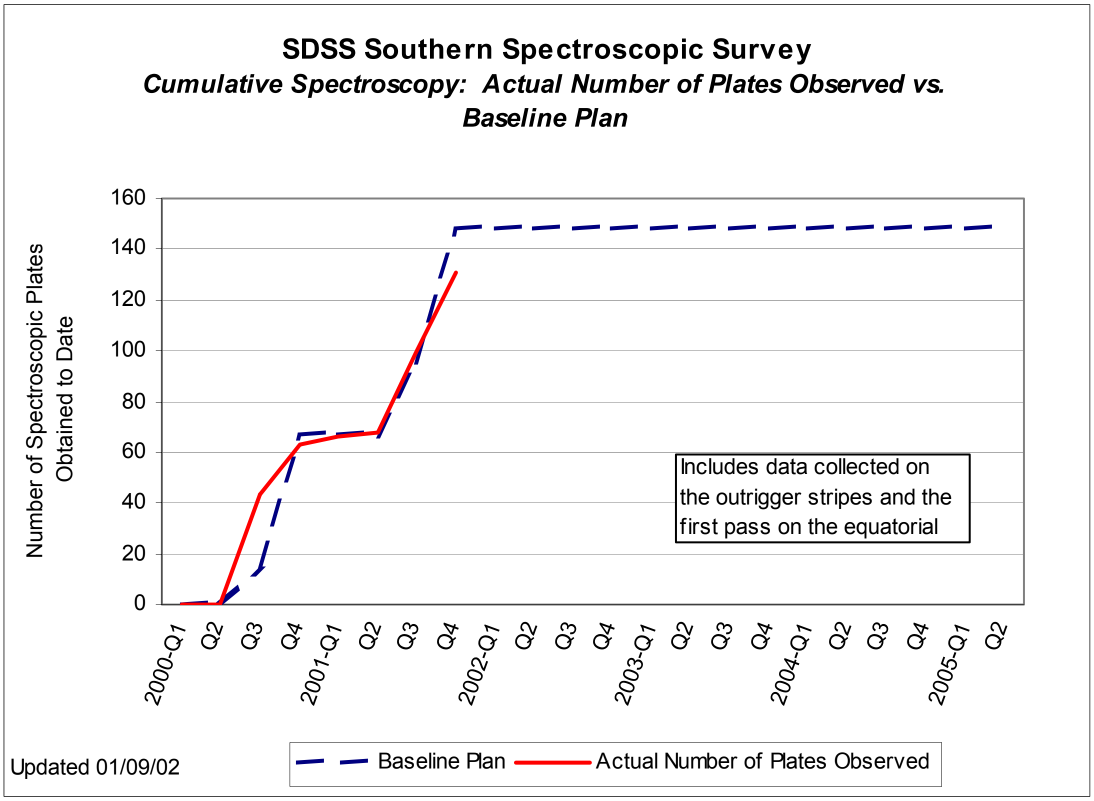

Figure 1.5. Spectroscopic Progress against the Baseline Plan – Southern Survey

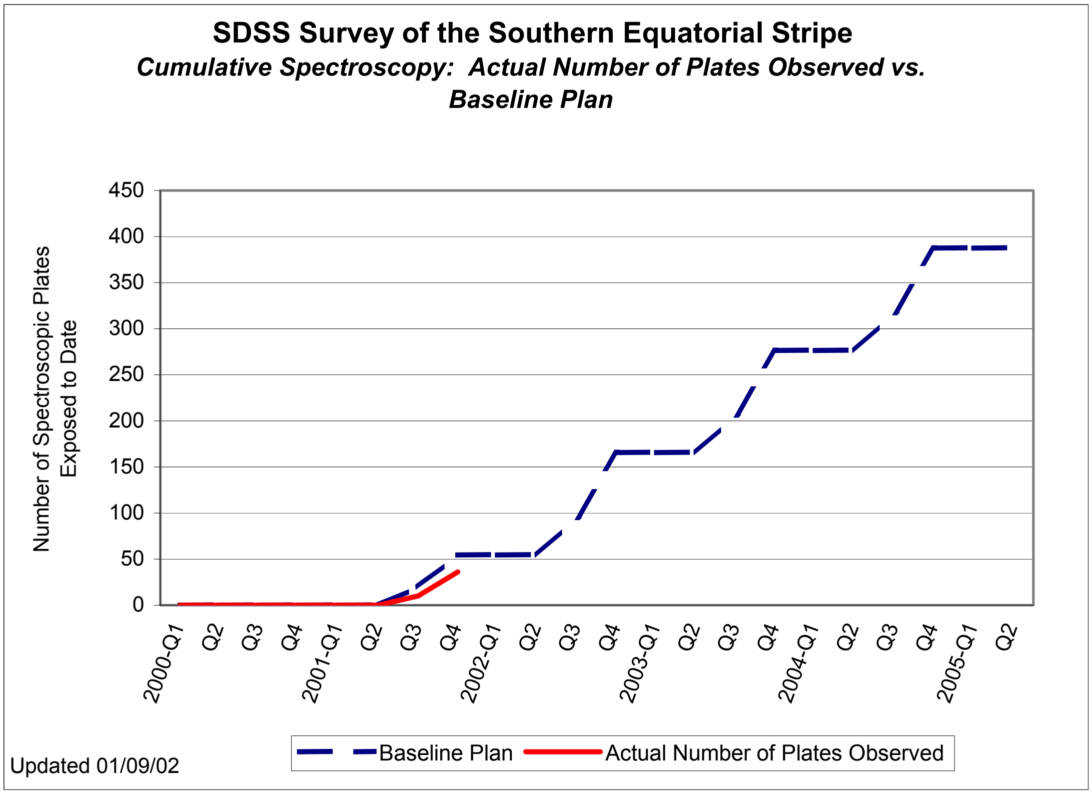

Figure 1.6. Spectroscopic Progress against the Baseline Plan – Southern Equatorial Survey

1.4 Status of Photometric Telescope Secondary Patches

In Q4, we completed 776 secondary patches for the Northern Survey and 89 secondary patches for the Southern Survey. While all of the secondary patches for the Southern Survey had already been obtained before Q4 began, the time that was photometric was also used to make repeat observations of some of the patches for the Southern Survey. 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 Q4-2001

	Cumulative through Q4
Unique Patches	
“Done, verified”	865
“Done, not verified”	0
Old patches available	39
Total Patches Done	904
Total number required	1558
Percent observed (exclusive of old patches)	56%

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 Q4 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 Q4

We continued to monitor our efficiency in Q4 using the semi-automated time tracking tools we developed. Table 2.1 summarizes the breakdown of observing time in Q4-2001 according to the categories used to prepare the baseline projection. For reasons discussed below, care is needed in interpreting some of the categories.

Table 2.1. Comparison of Q4-2001 Efficiency Measures to the Baseline

		October		November		December	
Category	Baseline	Dark	Dark+gray	Dark	Dark+gray	Dark	Dark+gray
Total time (hrs)	Oct: 98:22 Nov: 148:47 Dec: 157:20	98:22	130:34	148:47	214:11	157:20	221:09
Imaging fraction	0.27	0.13	0.12	0.44	0.34	0.38	0.31
Spectro fraction	0.63	0.81	0.84	0.50	0.64	0.56	0.64
Weather	0.60	0.88	0.82	0.50	0.49	0.52	0.49
Uptime	0.90	0.93	0.94	0.89	0.89	0.92	0.92
Imaging efficiency	0.86	0.63	0.63	0.82	0.82	0.83	0.83
Spectro efficiency	0.65	0.57	0.61	0.60	0.60	0.66	0.67
Operations	0.90	0.96	0.96	0.96	0.96	0.94	0.93

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. The amount of time spent observing in one mode or the other is straightforward to measure. Assigning the time considered overhead to one mode or the other is much more difficult. The 5-year Baseline Plan distinctly divides operations overhead between imaging and spectroscopy. In practice, assigning overhead between imaging and spectroscopy is somewhat arbitrary given the manner in which observing activities occur, and 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 reported here actually represent 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.

In October, our imaging fraction fell well below the baseline, while the November and December imaging fractions were significantly above the baseline. The low imaging fraction in October was caused by weather.

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 good weather fraction is an upper limit on the number that should be compared to the baseline, and is an overestimate of 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 October, November, and December becomes 0.67, 0.45, and 0.42 respectively.

Overall, there were 19 fewer hours of useful weather in Q4 than specified by the baseline. Moreover, the weather was favorable for spectroscopy in October, but not so favorable in November and December due to moonlight and many cloudy nights. In the 123 hours of science exposures taken, we completed 89 plates. Had these exposures been taken under good weather conditions and no moon (as assumed in the baseline), we would have completed them in 67 hours of exposure time. Thus, an additional 56 hours of exposure time were needed because of difficult weather or moonlight conditions.

2.4. System Uptime

System uptime is a measure of equipment availability when conditions are suitable for observing. The number measured by the time-tracker is directly comparable to the number specified in the baseline. The baseline uptime was comfortably exceeded in October and December, and we fell just short of the baseline in November. We should be able to comfortably exceed it routinely and are working toward this goal.

2.5. Imaging Efficiency

In the Q3 report, we described two simple statistics from our time tracking data that can be used to measure imaging efficiency. 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 Q3, our measured efficiency ratio was 0.67. For Q4, the ratio of science imaging time (55.1 hours) to the sum of imaging and imaging setup time (69.5 hours) was 0.79. More encouraging, however, is to look at this ratio on month-by-month basis in Q4. The monthly imaging efficiency ratios for Q4 are shown in Table 2.2.

Table 2.2. Imaging Efficiency Ratios for Q4-2001

	October	November	December	Aggregate
Imaging efficiency ratio	0.63	0.82	0.83	0.79
Baseline	0.86	0.86	0.86	0.86
Efficiency relative to baseline	73%	95%	95%	92%

In the Q3 report, we described a number of planned changes in observing procedures that were identified as ways to improve imaging efficiency. In Q4, we implemented procedural changes to reduce the setup and ramp time prior to the start of imaging scans. Telescope pointing was improved as a result of a correct instrument block (described in the Q3 report) and the improved pointing allowed the observers to begin imaging scans closer to the desired start point. This resulted in less overlap of previously imaged areas, which in turn led to a greater yield of “unique” data. Secondly, we improved the algorithm to compute the starting focus point for the telescope as a function of temperature. This now allows the observers to predict initial telescope focus more accurately, which in turn reduces the amount of time necessary to focus during setup.

In addition to reporting an improvement in the efficiency ratio, we are also able to report an improvement in the imaging effectiveness ratio. In Q3, our measured effectiveness ratio was 12.7 square degrees/hour. In Q4, the sum of the imaging area obtained in Q4 (847 square degrees) divided by the time expended on science imaging (55.1 hours) was 15.4 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). The ratio of these two rates is 83%, as compared to a ratio of 68% for Q3.

The product of the two ratios is 76% and is significantly higher than the 53% ratio reported for Q3. We are encouraged by the improvements realized in Q4, especially given the fact that October pulled the whole quarter down and that November and December imaging efficiencies were within a few percent of the baseline goal.

2.6. Spectroscopic Efficiency

During Q4, the total time spent making spectroscopic observations, after excluding the time for cartridge changes, setup, and calibration, was 123 hours, compared to the baseline expectation of 109 hours. The difference is due partly to spectroscopic observing in less than ideal weather conditions and partly to the use of gray time for spectroscopy. Gray time was not included in the baseline plan because we were not certain that such observations would produce survey quality data. Gray time has also proven useful for producing survey quality data and for performing critical engineering and calibration tests. The mean time in Q4 expended to obtain survey quality spectra for a plate was 83 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 Q4, this results in an achieved efficiency of 0.57, which is close to the efficiency of 0.56 derived for Q3 and significantly short of the baseline goal of 0.65. The Q4 inefficiency cost us just under 6 hours of observing time, which given the marginal conditions under which spectroscopic data was collected, cost us roughly 3 plates over the quarter.

An additional performance indicator is to compare the median time spent on the various components of 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. In reality, this turns out to be only a small fraction of the total number of plate mountings, since under ideal weather conditions we will always be imaging. Notwithstanding, it does allow us to measure performance and identify areas requiring improvement.

Table 2.3 provides the median time, by month, for the various elements of spectroscopic time since the new time-tracking tools were implemented in early August 2001. 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

Category	Baseline	Aug	Sep	Oct	Nov	Dec
Cartridge change	10	7	7	6	6	6
Setup	10	14	14	14	15	13
Calibration	5	12	12	12	12	12
CCD readout	0	3	3	3	3	3
Total overhead	25	36	36	35	36	34
Science exposure (assumed)	45	45	45	45	45	45
Total time per plate	70	81	81	80	81	79
Efficiency	0.64	0.56	0.56	0.56	0.56	0.57

It is important to note that the observers typically change cartridges in less time than the baseline plan allows for this step. It is unlikely that instrument change time can be further reduced without compromising personnel safety or equipment protection.

The CCD readout time of 3 minutes is not based on what we actually did, which is affected by weather, but rather on the total readout time for a 3-exposure sequence on a plate (any additional readout time is more appropriately classified as weather).

Since we can do little to improve instrument change and CCD readout time, we are evaluating ways to reduce setup and calibration time. Setup includes field acquisition and focus. Improved and consistent telescope pointing will reduce field acquisition time, and improved initial focus estimates will minimize the need for time-consuming focus sweeps. Current efforts include understanding scale factor changes as a function of temperature and improving algorithms to compute initial focus for spectroscopy, based on temperature. We have a functional algorithm for computing focus at the start of an imaging scan, but a comparable algorithm for spectroscopy is not working nearly as well.

Regarding calibrations, the baseline allows 5 minutes to do calibrations, which is roughly the time it takes to complete flat fields and arcs. There was no provision in the baseline for spectrophotometric calibration. We are evaluating the various calibration operations, and their sequence, in order to identify areas where we can shave time and come closer to the baseline.

2.6 Summary of Efficiency Observations

Weather was better than predicted in October and worse in November and December. Equipment availability in general exceeded baseline goals. Nevertheless, we continually strive to improve uptime to maximize the use of available science time. Significant improvements have been realized in imaging efficiency as a result of the improved observing procedures implemented during Q4. Improvements are still needed to bring the efficiency of spectroscopic operations in line with the baseline.

3. OBSERVING SYSTEMS

In October, the annual re-aluminizing of the primary mirror was completed. Throughout the quarter, the instruments worked well, we continued work to improve the thermal environment around the telescope, and we identified and implemented procedural changes to improve observing efficiency.

3.1. The Instruments

The instruments performed reasonably well throughout the quarter. In November, we had a problem on one night with a failing filter in one of the imaging camera power supplies. The faulty filter was quickly replaced with an on-site spare. We also had two spectrograph problems, both of which occurred once. The first involved problems with the LN2 autofill system not shutting off properly; we were unable to reproduce the problem the next day and the problem has not re-occurred since October. The second involved a software bug that wrote an incorrect exposure time to a file header used by subsequent data processing code. This resulted in the loss of a 25-minute science exposure on November 25. Subsequent attempts to reproduce the problem have been unsuccessful, so diagnostic code was added to help debug the problem should it recur. Fortunately, we have not seen the problem since its first occurrence.

A potentially serious situation was discovered in the liquid cooling loop that cools the spectrograph electronics. During a preventive maintenance inspection, a fine silt was found in the cooling loop. Analysis of the silt indicated that the laboratory-grade glycol used in the cooling loop was corroding the aluminum heat exchangers used on the spectrographs.

Replacement radiators, with copper tubing, were ordered and scheduled for installation during the late January 2002 bright period.

3.2. Thermal Work

We continued our work to improve the thermal environment around the telescope. The following activities occurred during the fourth quarter:

1. In Q3, we installed the refrigeration unit designed to cool the enclosure to temperatures around 20 degrees F. In Q4, testing revealed that the unit was not working properly. Service technicians came to the site and found that a seal had dried out, thereby allowing the refrigerant gas to escape. The seal was replaced, the gas recharged, and the unit returned to normal operation. We have modified our monthly maintenance program to include briefly running the refrigerator to prevent dried-out seals in the future.

2. Although we have removed a significant number of heat sources from the lower enclosure, it is still several degrees above the temperature of the outside air. In 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. The conceptual design work is underway and we anticipate completing the installation work early in Q2 2002.

We have been reporting that the largest remaining thermal project has been the replacement of the inefficient Glentec power servo amplifiers that run the telescope. We made no progress during Q4; however, we did carefully review the need for this work given the proposal to improve cooling flow through the lower enclosure. Given the demonstrated reliability of the Glentec amplifiers and the availability of suitable spares, it is more cost-effective at this point to proceed with the louver installation and then re-assess the temperature levels in the enclosure and the need to replace the amplifiers. We have suspended all plans for work on a potential amplifier replacement until the need can be evaluated upon completion of the louver installation.

3.3. The Photometric Telescope

There were no significant problems with the Photometric Telescope (PT) during Q4. The PT Cryotiger closed cycle refrigerator required recharging once during the quarter, which is a maintenance item and consistent with past operating experience.

3.4. Operations Software

During Q4, we were 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.

In Q4, a long-standing bug in the Motion Control Processor (MCP) code was fixed that prevented the fiducial system from initializing encoder values properly. It was discovered that the MCP was incorrectly updating the encoders on all three axes when only one was known to be at rest. In addition, we have made progress in understanding the source of 1-second offsets in the timing between the Telescope Control Computer (TCC) and the MCP. These are reported as axisDTime errors in the observing logs and have the potential to affect telescope position. Late in Q4, diagnostics added to the observing software helped isolate the problem to the TCC. Testing and analysis is still underway, as the exact source of the problem within the TCC has yet to be found.

In addition, we are actively pursuing several problems associated with the data acquisition software. The ptVME link, a controller on the mainframe computer at APO that is central to observing operations, has caused a number of problems in the past six months. The ptVME link serves to connect the various computer cards on the mainframe bus. One significant problem is that we are unable to take binned data on the sky; the ptVME link goes down almost immediately after the drift scan is started. A suspect for the problem is that astroline, an on-line data processing pipeline, is not being disabled properly. The problem on the sky occurs when astroline (or some part of the DA system) fails to deal with very large gang files, which result from the larger area/frame that was required to solve an earlier problem. In addition, the ptVME link is occasionally lost for no reason. There is often great difficulty in re-establishing it via rebooting the data acquisition computer (DA), and this is possibly associated with a software process trying to fetch gang files during a reboot, or other attempts by the observers' programs (the "xOPs") to talk to the DA during a reboot. It has recently been shown that a ptVME reset will cure the problem without the reboot, which goes a long way to solving the above problem. There is one incident where the link failed during a normal imaging scan, and we think that the run continued while the crates were rebooted such that we didn't lose any data or time. If this is true then this problem is only a nuisance at its current frequency, but it will make a noticeable impact if it begins to happen more often, especially during the night. There is also concern that it is the early warning of a serious hardware problem. We believe we may have found a way to exercise this failure mode to gain a better understanding of what is happening and how to fix it.

In addition to solving the ptVME link problem, we are making improvements to the DA code to find sky levels more quickly in order to decrease setup time for imaging scans. A version that addressed this problem was delivered and tested in Q4, and found to have many more bad (failed) quartiles than in a previous version, so we rolled back and are awaiting a new version to test.

Finally, the process that we implemented in Q3 to control software changes and focus effort of addressing critical needs worked well in Q4. To date, the process has been used to address mostly short-term fixes and needed improvements. To review long-term needs and develop an achievable work plan and schedule, a planning meeting of the observers, developers, and SDSS management is planned for early Q2 2002.

3.5. Status of Engineering Tasks Scheduled for Q4

Table 3.1 reports the status of the more significant engineering tasks that were scheduled for completion in Q4-2001. Tasks marked with asterisks were carry-over tasks from Q3.

Table 3.1. Status of Engineering Tasks Scheduled for Q4-2001

Task	Responsible	Driver	Priority	Status
Complete cartridge concentricity questions*	Leger	Efficiency	High	50%
Develop PM program for telescope systems*	Leger	Reliability	High	50%
Procure / install emergency closing generator*	Leger	Equip prot.	High	25%
Fabricate secondary latch improvements*	Gunn	Equip prot.	High	75%
Develop/implement inst. change interlocks*	Anderson	Equip prot.	High	90%
Design enclosure stair upgrade	Carey	Safety	High	5%
Aluminize 2.5m primary mirror	Leger	Data quality	High	100%
Develop method to remove set in science fibers	Owen	Reliability	High	0%
Assess Holloman scattered light sensitivity	Rockosi	Data quality	High	0%
Procure & install humidity sensor near enclosure	Gillespie	Equip prot.	Medium	25%
Finish implementation of slip detection system*	Czarapata	Equip prot.	Medium	95%
Develop requirements for cloud camera upgrade	Gunn	Reliability	Medium	50%

In general, we did not do very well in completing the projects planned for Q4. In some cases, resources were redeployed to address hardware problems affecting telescope operations. Two of these problems are worth noting. We had problems with one of the positioning actuators on the secondary mirror that affected telescope focus. The actuator was failing when temperatures dropped below 0C. We eventually traced the problem to a defective thrust bearing on the actuator lead-screw assembly, which has since been replaced. We have plans to replace all remaining lead-screw assemblies in Q1 2002 to prevent similar problems in the future. We also had troubles with the azimuth fiducial system working properly under very cold temperatures, which turned out to be an adverse affect of our thermal improvement work. The telescope cone fans now cause the telescope structure to cool much more rapidly than the concrete pier supporting the telescope, and this rapid differential in temperature affects the gap between the azimuth fiducial read head and the fiducial tape system. A cam follower mechanism was fitted to the read head holder to fix the read head gap, and this upgrade seems to have solved the problem.

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

- We decided in Q4 to suspend the cartridge concentricity measurements indefinitely. The purpose of the concentricity measurements was to help us understand the source of occasional plate misalignment. Through testing, we learned that by increasing the force on the instrument lift that raises and engages the spectroscopic cartridges with the kinematic mounts on the telescope, we increased the consistency of plate alignment with the telescope through better engagement with the kinematic mounts.
- We continued slip detection system testing throughout Q4, but persistent concerns over false trips kept us from fully implementing the system during normal operations. There are timing problems between the output of the slip detection module and the computer that reads these signals. Through testing, we have learned that an additional latching circuit that will latch and hold the slip detection output values will solve this problem. A conceptual design is complete, and we anticipate fabricating, installing, and testing this circuit in Q1 2002.
- The preventive maintenance program for the telescopes remains under development. A detailed list of systems requiring periodic inspection/maintenance has been posted on the web and is being followed, and we continue to develop and post maintenance procedures. As maintenance needs arise, they are added to the list, but we have been operating in reactive mode. The task remains open because we have yet to complete a comprehensive

review of the various telescope systems to identify and address all areas requiring preventive maintenance. We will strive to complete this in Q1 2002.

- Work on the enclosure stair upgrade was interrupted by the secondary mirror actuator problem. We did identify a source for replacement stairs and some conceptual design options have been considered. This work will recommence in Q1 2002.
- A detailed design, work scope, and cost estimate was prepared for the Emergency Closing Generator late in Q4, but was not reviewed in time to proceed with the project prior to the December shutdown. Work will commence in Q1 2002 and is scheduled for completion in Q2.
- The components to improve the camera secondary latches were completed, but we chose to postpone the installation onto the camera until the January 2002 bright time. We had decided early in the quarter to shut down operations between the Christmas and New Year holidays, given the way the dark runs coincided with the holiday schedule. We also decided not to work on any systems during this break, in an attempt to see how well we could come up from a shutdown when nothing had changed. As a result of this decision, the secondary latch improvements were not installed in December as had been planned.
- The PLC code for the interlock instrument change system was completed and installed in December. Initial tests showed the system to work properly in all areas except for instrument lift control. The manner in which instrument lift force limit protection was implemented caused the lift to begin oscillating while lifting the imaging camera. The PLC code was modified in late December to eliminate this oscillation, but due to the holiday shutdown, we decided not to install the modified version until the January 2002 bright time. It should be noted that this decision does not jeopardize the safety of the imaging camera. The instrument change interlock system has two modes of operation: manual and automatic. In manual mode, the instrument change interlocks are not active. In automatic mode, they are. With the system in manual mode (which is the configuration we have been operating with for several years), the instrument lift does not oscillate when lifting the imaging camera.
- The work plan and cost estimate for the humidity sensor project was completed and the humidity sensor purchased. Installation work will be finished in Q1 2002.
- Work on the improved plug-plate drilling fixture has been postponed until mid-2002, since this project is of lower priority than many other tasks.

3.6 Engineering Tasks Scheduled for Q1-2002

An engineering planning meeting was held in mid-December to review our performance against the work plan we developed at the June planning meeting and to develop the work plan for 2002. Tasks were reviewed against need and budget impact, and priorities and work allocations set accordingly. Table 3.2 lists the more significant engineering tasks scheduled for completion in the first quarter of 2002. It should be noted that the list does not include the monthly plug plate drill runs or numerous documentation tasks. Tasks marked with asterisks are carry-over tasks from 2001.

Table 3.2. Engineering Tasks Scheduled for Q1-2002

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

In re-prioritizing our work to focus on efficiency and reliability, we have postponed several lower priority projects that were scheduled for completion in 2001. Because of the number of high priority tasks that have been moved into Q1 2002, several lower priority tasks are now scheduled later in the year.

4. DATA PROCESSING AND DISTRIBUTION

4.1. Data Processing

Six Terabyte disk servers were installed at Fermilab, along with a pair of machines to hold the SDSS software product disks, to enhance data processing operations. All imaging and spectroscopic data collected to date are processed, and all plug-plate drilling deadlines were met. The status of Q4 data processing goals is as follows:

1. Keep current with all imaging, spectroscopic, and photometric telescope data.
   - All data collected to date have been processed.

2. Produce files for the October, November, and December drilling runs.
   - A total of 109 plates were designed in Q4. The breakdown by chunk is as follows:
     - Chunk23 11 plates
     - Chunk24 27 plates
     - Chunk25 16 plates
     - Chunk26 4 plates
     - Chunk27 23 plates
     - Chunk28 13 plates
     - Chunk29 15 plates, special design for efficiency and science studies.

3. Implement and validate photo v5_3 changes to the pipelines, opdb, and sx.
   - Substantial development work was done on photo v5_3 at Princeton and a test operational database was used at Fermilab to store results. Testing and validating

outputs from the new pipeline will continue into the first quarter of 2002, in preparation for the initial round of data processing for Data Release 1.
- Minor changes to the spectro pipelines were implemented, with the changes to be validated in January 2002.
- Finally, we decided not to implement changes to the Objectivity version of the sx, but rather to implement all changes in SQLServer.

4. Implement the opdb on a Linux machine, complete reliability testing, and make it operational.
   - The opdb was installed and is now operational on a Linux machine. It performs twice as fast as on the previous platform.

5. Implement automation of database updates, including loading chunks after target selection/tile creation, loading spectra into chunk databases, and loading imaging into staging database.
   - This work was begun in Q4, and will be finished in January 2002.

6. Launch the reorganized "collaboration" web pages (from www-sdss.fnal.gov:8000)
   - The pages have been moved to a reorganized site, but the launch has been delayed. We planned to implement these on web servers administered by the Fermilab Computing Division, but resources in the department that supports these servers were not available. We will launch these web pages on a server managed by the Fermilab Experimental Astrophysics Group (EAG) in Q1 2002.

7. Change the photometric calibration procedures to take explicit account of the fact that the calibrating telescope (the USNO 1-m) is on a slightly but significantly different system from the native system of the survey telescope. This involves several steps:

   - Characterize the transformations between the APO photometric telescope and the USNO system. This is rendered more difficult because of photometric instabilities in the APO telescope before the summer of 2001. - This work is essentially finished.

   - Set mean colors and mean airmasses in such a way that the *mean* behavior of the new system is the same as that for the old, so that target selection is unchanged in the mean. - This work is done.

   - Characterize the transformations between the USNO system and the native survey system and implement code that will pass secondary standards to the survey reductions on that native system. All photometry will henceforth be published on that system. - This work will be finished in the first quarter of 2002.

   - Test the above steps end-to-end from calibration through target selection.

   - Develop a global scheme, using cross scans or a similar technique, which can be used to tie the local calibrations together into a survey-wide accurate calibration. - Tests will begin during the second quarter of 2002.

A number of other photometric improvements involving the detailed handling of the relation of PSF magnitudes to large-aperture magnitudes (the so-called `aperture corrections'), the use of the sky background to help local column-to-column calibrations, much improved flat-fielding techniques, either have been finished and incorporated into Photo v5_3 or will be incorporated into downstream calibration software (NFCALIB) for Data Release 1 during the first quarter of 2002.

8. Implement strong authentication at FNAL. - Done

4.2. Data Distribution

The status of Q4 data distribution goals is as follows:

1. Implement the sx v2_4 improvements:
   - best/target/all rerun selection
   - mask objects
   - tiling information
   - ProxList integration
   - upgrade segment class to include start,end mu
   - implement target and tile chunk
   - reintroduce java query tool
   - implement photo v5_3 parameters
   - implement 64-bit flag fix, to include constants
   - fix MACROs in the parser (rerun, fieldID, etc.)
   - add photo z

   Working in the Objectivity framework to implement these changes proved to be very difficult. We made a strategic decision to implement these new features in SQLServer. However, substantial design work on these items will be used in the SQLServer solution.

2. Make the six new disk servers and the products/NIS servers operational and load all corrected frames. – All are operational and 50% of the corrected frames have been loaded.

3. Load and operate the following data servers for the collaboration:
   - o chunk data archive server
   - o staging catalog archive server
   - o staging data archive server
   - The chunk catalog archive server has suffered from several corruptions. The staging servers are approx. 7 weeks out of date; we expect to be current by the end of Q1 2002.

4. Implement all schema in SQLServer, load "chunk" data for testing, and automate the documentation of classes. – This work is in progress.

5. Design and implement archive usage reports. - This work is done, with reports available online at: http://www-sdss.fnal.gov:8000/~sdssdp/sxstats

6. Distribute tapes of EDR and Chunk data to collaborators in Japan and Germany.
   - Tapes have been distributed and successfully read.

4.3. Data Processing and Distribution Goals

The following set of goals have been established for Q1-2002:

- Keep current with all imaging, mt, and spectro data.
- Produce files for monthly drilling runs, as requested.
- Implement and validate photo v5_3 changes to the science pipelines.
- Implement and validate idlSpec2D v4_9 changes in preparation for DR1 reprocessing.
- Run the Data Release One “test suite” with these pipelines; analyze results; implement final fixes; begin processing for Data Release One.
- Implement the SQLServer science database, loaded with SIRTF data, for demonstration to the collaboration at the March 2002 meeting.

5. SURVEY PLANNING

5.1 Observing Aids

Several programs used to aid in observing were updated.

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. The program has been updated to use new photometric equations proposed for the final survey reductions, and many small issues were addressed, including the use of nonlinearity corrections that will improve the accuracy of bright stars.

2. Son-of-Spectro is a program that analyzes spectroscopic exposures in near-real time and determines if they have adequate signal/noise. Several features have been added. There are tools for plotting the reduced spectra. There is a mechanism for declaring exposures bad-useful to override the otherwise fully automated reduction program. It is now possible to reduce exposures taken before the calibrations, useful in cases when preliminary calibrations were not obtained for one reason or another.

3. The plate inventory database tracks which plates have been observed. The database now shows the optimal time for a plate to be observed during the night. This should help maintain a uniform availability of plates throughout a night. There are now a significant number of plates for observing with lower priority than the main survey, and several plates have special observing requirements. These are now flagged as such for the convenience of the observers. For plates that are observed on multiple nights, the cumulative exposure is now displayed, making it easier for the observers to collate the information across nights.

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. Only small feature enhancements 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. A bug in the algorithm for allocating plates during the night was fixed. The program can now query the plate inventory database for plates of differing priorities.

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. The same bug in the plate layout program was also fixed here.

3. The plate design program has had a new test added that checks if a plate is "pluggable." A pluggable plate is one in which all of the holes in the plate can be easily plugged by the optical fibers without subjecting any of the fibers to undue stress. In the past, some "unpluggable" plates were drilled and shipped to APO.

5.2. Target Selection

Several special plates were designed and drilled to fill in a gap in the observing schedule that occurred in the middle of the night in December. All main survey plates and southern survey plates available at this time of night had already been observed. Observing programs were solicited for targets of high scientific interest, including faint galaxies for photometric redshifts, faint stars in the halo of the Milky Way, stars in Galactic clusters needed for spectrum synthesis, and galaxies in distant galaxy clusters. These programs were selected according to procedures defined in the Principles of Operation. Most of the plates made use of existing plug plate designs, retaining the guide star layout and replacing science objects with new targets.

6. COST REPORT

The operating budget that the Advisory Council approved in November 2000 for the year 2001 consisted of $1,938K of in-kind contributions from Fermilab, US Naval Observatory (USNO), Los Alamos National Laboratory (LANL), and the Japan Participation Group (JPG); and $4,000K for ARC funded expenses. In November of 2001 we confirmed our earlier tentative conjecture that we could contain the cash funded expenses to $3,400K, well below the planned level. The SDSS Management requested that the ARC funded budget for 2001 be reduced to $3,400K and that the 2001 budget for in-kind contributions be increased to reflect the actual contributions.

The initial ARC-funded cash budget of $4,000K included $447K for management reserve. Since a review of cost performance through October 2001 showed that the estimated expenses for 2001 would be $3,230K, the management reserve was reduced to $170 K and $600K of the unused funds from the original 2001 budget were allocated to the management reserve in calendar years 2003 and beyond. In January 2002, the actual cash-funded expenses for all of 2001 were reviewed again and found to be slightly lower than had been forecast in November.

Table 6.1 shows the actual cost performance by project area for ARC-funded cash expenses in 2001. A more complete table comparing actual to baseline performance is included as an attachment to this report. As noted in previous reports, final fourth quarter expenses were not available for all of the institutional budgets at the time this report was prepared, due to variations in the timeliness of the accounting systems for the various institutions performing work for the SDSS. In these instances, fourth quarter expenses have been estimated to the best of our ability. The reported expenses will be revised as final invoices are received from the supported institutions. After the final books are closed, any remaining unspent management reserve funds will be placed in the management reserve for 2002.

Table 6.1. ARC-Funded 4th Quarter Expenses and Forecast for 2001 ($K)

	2001 – 4th Quarter		2001 – Total		
Category	Baseline Budget	Actual Expenses	Baseline Budget (Nov 2000)	Revised Budget (Nov 2001)	Current Forecast
1.1. Survey Management	55	36	274	220	218
1.2. Collaboration Affairs	0	0	0	0	0
1.3. Survey Operations					
1.3.1. Observing Systems	233	229	1,095	956	967
1.3.2. Data Processing & Dist.	159	162	696	648	641
1.3.3. Survey Coordination	0	0	0	0	0
1.3.4. Observatory Support	330	383	1,320	1,318	1,336
1.4. ARC Corporate Support	37	18	167	88	82
Sub-total	815	828	3,553	3,230	3,243
1.5. Management Reserve	113	0	447	170	0
Total	928	828	4,000	3,400	3,243

6.1. First, Second, and Third Quarter Adjustments

ARC-funded 2001-Q1, Q2, and Q3 expenses have been adjusted from that reported in the Q3 progress report to reflect revised costs reported by several institutions. Actual Q1 expenses increased by $12K, Q2 expenses decreased by $3K, and Q3 expenses decreased by $37K. The net change is a decrease of $28K from that reported in the 2001-Q3 report.

Slight adjustments have also been made in the value of in-kind contributions for this same period. The reported in-kind contribution increased by $6K in Q1, increased by $10K in Q2, and increased by $7K in Q3. The net change in reported in-kind contributions is a increase of $23K from that reported in the Q3-2001 report and is largely due to the inclusion of JPG contributions that were not properly included in previous reports.

6.2 Fourth Quarter Performance - In-kind Contributions

The sum of in-kind contributions for the fourth quarter was $589K against the baseline forecast of $434K, 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 in-kind contribution for Observing Systems Support exceeded the baseline for the reasons noted in the 2001-Q3 report. Most notably, additional effort was required on the slip detection and interlock systems and to provide engineers with drafting support to bring systems documentation into better shape, and Fermilab was required to change the manner in which vacation and sick leave are accounted for. Previously, these costs had been included in overhead, which was not included in the in-kind costs.

Los Alamos provided programming support for the Telescope Performance Monitor as required When the 2001 budget was prepared in November 2000, the level of support that Los Alamos planned to provide in Q4-2001 was undefined. Accordingly, the baseline forecast for Los Alamos support in Q4 was zero. The value of actual in-kind support provided by Los Alamos in Q4 was $102K, which is comparable to previous quarters but which also makes up a significant portion of the $155K increase in reported Q4 costs against the baseline.

USNO provided support as required for the software systems they provided and now maintain, but as previously reported, these systems are mature and stable and so the required level of support is less than was anticipated when the baseline was prepared; USNO activity continues to focus on quality assurance testing.

JPG provided the anticipated level of in-kind support for the imaging camera; however, the estimated value of this in-kind contribution was inadvertently left out of the baseline budget when it was prepared. The value of the JPG in-kind contribution is now being reported. For the year 2001, the total JPG in-kind contribution was approximately $40K.

6.3. Fourth Quarter Performance – ARC Funded Expenses

The sum of ARC-funded expenses for the fourth quarter was $828K, which is $13K above the fourth-quarter budget of $815K.

Survey management costs as a whole were $19K below the Q4 baseline. Expenses related to the Project Spokesperson and to the Office of the Project Scientist were lower than anticipated. JHU was unable to provide the level of pipeline testing and validation support anticipated in Q4, as forecast in the Q3 report, so no funds were expended on this effort. Support for Survey Management at Fermilab exceeded the baseline by a very small amount. For the year, final survey management costs are forecast to be $56K (20%) below the baseline budget.

Observing Systems costs were below the fourth quarter budget by $4K. The Fermilab budget for Observing Systems support was overspent because ARC-funded salary costs for an additional mechanical technician at APO were not included in the baseline plan. The need for this additional support was determined after the baseline budget was prepared. UW and Princeton expenses for Observing Systems support were in close agreement with the budget. The UC budget for Observing Systems was underspent because expenses for thesis publication charges were not realized in 2001. These costs are now expected in Q1-2002. Finally, the JHU budget for Observing Systems support appears overspent in Q4 because the funds for this effort were not fully allocated when the baseline budget was prepared. In fact, Q4 expenses are in line with the revised budget for this work. For the year, the Observing Systems budget will be under spent by approximately $128K (12%), in part because several planned projects, including the Cloud Camera upgrade and the DIMM mounting, were not completed during the year as planned.

Data Processing and Distribution costs were $3K above the third quarter budget. Travel costs for Fermilab personnel and support costs for UC and JHU personnel were both below baseline estimates. The Princeton budget for software and data processing support was overspent because of a slight increase in Princeton personnel and travel expenses, and departmental computing support charges that had previously been waived as overhead, but that are now charged to the ARC-funded budget. For the year, the Data Processing and Distribution budget will be under spent by $55K (8%).

Observatory Support costs were $53K above the baseline budget for Q4. The Observatory Support budget appears overspent in Q4 because in addition to planned Q4 expenses, it includes hardware procurements, miscellaneous operations costs, and travel expenses that were encumbered in Q3 but not booked until Q4. Actual Q3 expenses have been adjusted downward from the previous report to reflect this shift in expense timing. With regard to Q4 expenses, salary costs were higher than average due to increased overtime to cover the longer observing nights. For the year, travel costs were only slightly under budget, even with several late-year trips to Seattle, Japan, and Fermilab by several APO staff. In the Supplies, Repairs/Maintenance, and Services categories, there is an $18K overrun that has been attributed mainly to relocation expenses for new employees in Q2. Utilities overran by about $17K (more LN2 use than budgeted, increased electric costs for 2.5-m enclosure HVAC, higher FedEx costs for shipping tapes, and a significant water leak on the site which is now fixed). Equipment was overspent by $5K to buy workstations for two newly hired Observers. Housekeeping was overspent because the replacement cleaning contractors services are more expensive than budgeted. In addition, $15K was spent to replace the LN2 umbilicus to the imager; site funds were used to expedite the work. Site funds were also used to replace/upgrade surge suppression systems, various h/w for the DA system, furniture for the SDSS engineering group, and cold-weather work clothes and safety items for the staff. For the year, the Observatory Support budget is forecast to overrun the baseline budget by $16K (1%).

ARC Corporate Support costs were $19K below the fourth quarter budget. Funds are held in the ARC Corporate account and distributed evenly throughout the year to support personnel replacement costs. In addition, funds are held in the ARC Corporate Support budget under the category “Additional Scientific Support” to provide for additional scientific support when needed to work on specific problems or areas of concern. This budget is also spread evenly throughout the year in the baseline plan. These funds were not needed in the fourth quarter; therefore, we have removed them from the forecast. Q4 expenses included costs associated with the Operations Efficiency Review held at Fermilab in November 2001, the November Advisory Council meeting, technical paper publication charges, and various petty cash items. For the year, the ARC Corporate Support budget will be under spent by $85K (51%).

No management reserve funds were distributed in the fourth quarter or during the year. Once all final costs are known and the books for 2001 are closed, all remaining unspent management reserve will be placed in the management reserve for 2002.

7. PUBLICATIONS

LOTUS, Super-LOTIS, SDSS, and Tautenburg Observations of GRB 010921
Don Q. Lamb, et al. - ApJL submitted

VLT optical and near-IR observations of the z=6.28 quasar 1030+0524
Laura Pentericci, et al. - AJ submitted

Unusual Broad Absorption Line Quasars from the Sloan Digital Sky Survey
Patrick B. Hall, et al. - ApJ submitted

Dynamical Confirmation of SDSS Weak Lensing Scaling Laws
Tim McKay, et al. - ApJ submitted

SDSSp J124602.54+011318.8: A Highly Luminous Optical Transient at a Redshift of 0.385
Daniel E. Vanden Berk, et al. - ApJ submitted

A Matched-Filter Analysis of the Tidal Tails Around the Globular Cluster Palomar 5
Connie Rockosi - AJ submitted

Higher Order Moments of the Angular Distribution of Galaxies
Istvan Szapudi, et al. - AJ accepted

Early-type galaxies in the SDSS
M. Bernardi, et al. -AJ submitted

The Sloan Digital Sky Survey Quasar Catalog I. Early Data Release
D.P. Schneider, et al. - AJ accepted