Sloan Digital Sky Survey II

2006 FIRST QUARTER REPORT

January 1, 2006 – March 31, 2006

Table of Contents

Q1 PERFORMANCE HIGHLIGHTS

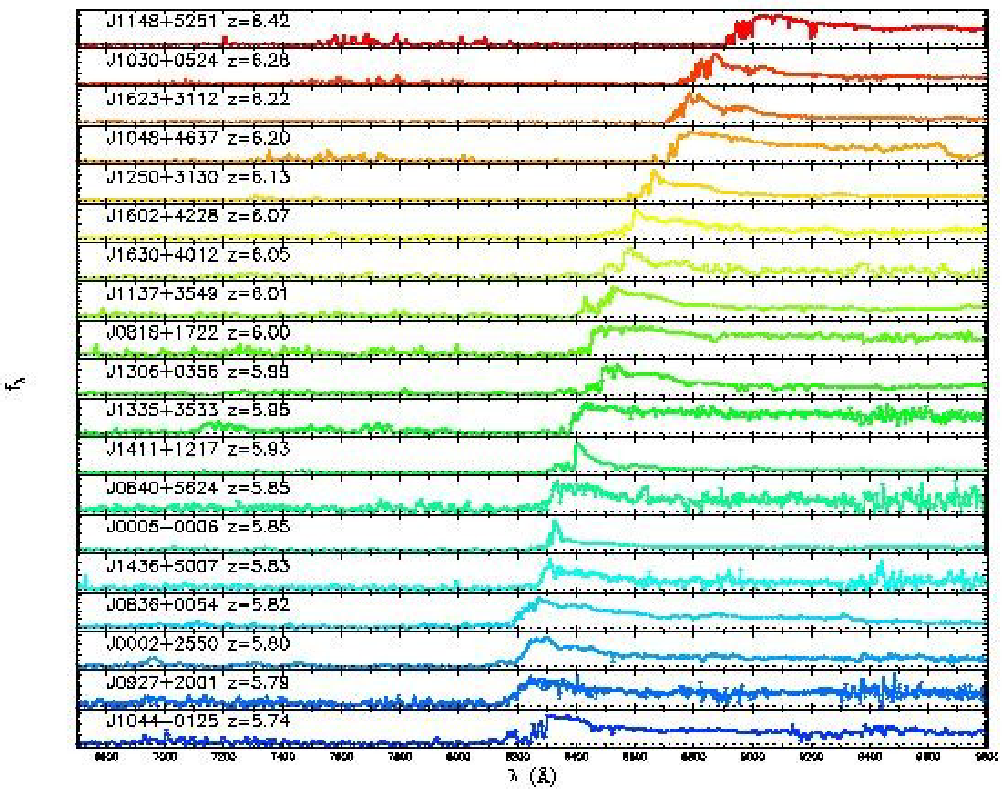
- The Legacy imaging survey is essentially complete. We obtained 50 square degrees of new imaging data, which closed the gap in the imaging footprint that was present at the start of SDSS-II operations.
- We completed 128 Legacy spectroscopic plates against a goal of 106 plates. Through Q1, we are slightly ahead of our goal for the Legacy spectroscopic survey. We have completed 1289 Legacy plates against the baseline goal of 1264 plates.
- We obtained 189 square degrees of new imaging data for the SEGUE Survey, against a baseline goal of 460 square degrees. Weather conditions in the last two quarters have been more suitable for spectroscopy than imaging, which has drastically limited our SEGUE imaging progress.
- We completed 42 SEGUE plates (21 bright and 21 faint). The combination is roughly equivalent to completing 21 SEGUE tiles, against a baseline goal of 15 tiles.
- Worked continued on the final version of Data Release 5. The final version will be released to the collaboration in mid-May and to the public on June 26, 2006.
- We recorded over 16.3 million hits on our SkyServer interfaces and processed approximately 948,000 SQL queries. We also transferred at least 4.23 terabytes of data through the various Data Archive Server (DAS) interfaces.
- Q1 cash operating expenses were $979K against a baseline budget of $1,114K, excluding management reserve. In-kind contributions were $179K against anticipated contributions of $163K. No management reserve funds were expended in Q1.
- An SDSS-II collaboration meeting was held March 23-25 in Santa Fe, New Mexico. The meeting was hosted by Los Alamos National Laboratory and well attended by collaboration members from around the world. The meeting included science talks, working group sessions, a discussion of

Education and Public Outreach activities, and a discussion of possible uses of the SDSS facilities post 2008. Immediately following the collaboration meeting, the SEGUE team conducted their own 3-day meeting focused around SEGUE science, observing strategy, and software development.

1. SOME RECENT SCIENCE RESULTS

The following descriptions, with graphics, briefly highlight some of the scientific work accomplished during the reporting interval (bearing in mind that efforts often spill over into other quarters). Unlike the list of publications given in Exhibits 3 and 4, the topics selected here are by no means comprehensive, nor even representative, of the science being undertaken by the SDSS collaboration. These short science descriptions nevertheless augment our reporting of activities in SDSS-II.

The Universe Goes Black in the Ultraviolet

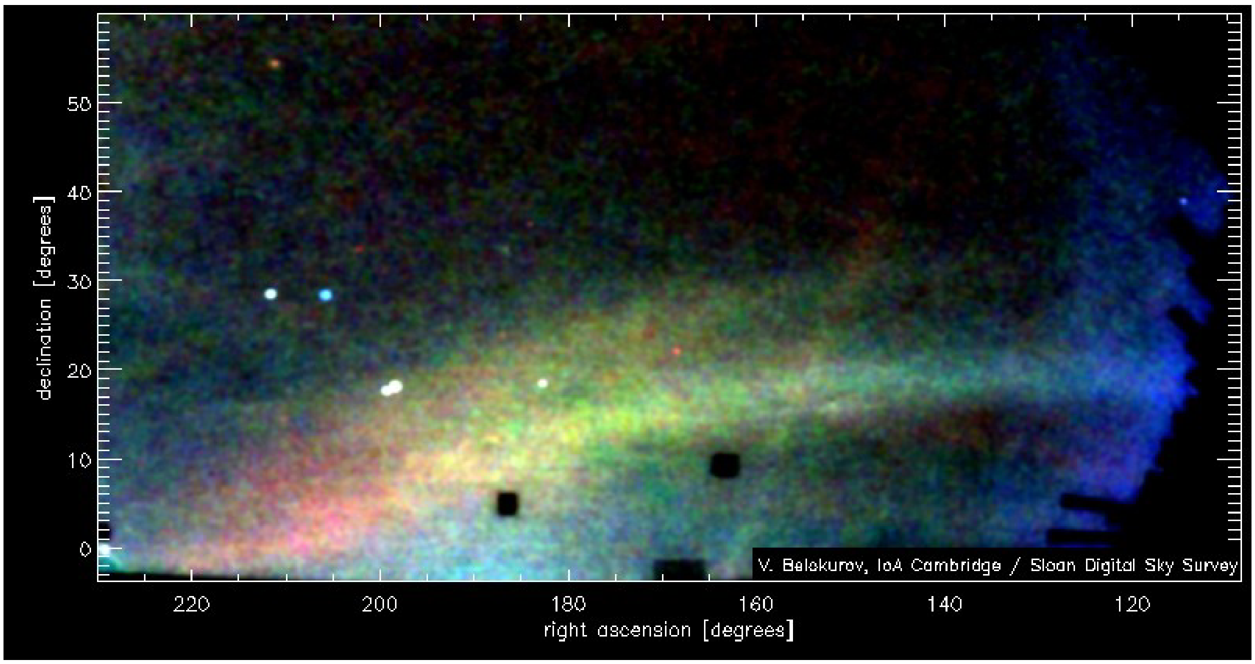


Some 300,000 years after the Big Bang, the Universe cooled enough to allow electrons and protons to combine into neutral hydrogen atoms. Some time in the next billion years, the Universe underwent another great phase transition, in which light from stars and accreting black holes re-ionized nearly all of the atoms in low density, intergalactic gas. Neutral hydrogen atoms absorb ultraviolet light from background sources, and even the small residual fraction of neutral atoms produces significant absorption. The above picture shows the spectra (energy flux vs. light wavelength) of 19 of the most distant known quasars, all discovered by the SDSS, in order of increasing distance from bottom to top. Light from these quasars has been stretched by the expansion of the Universe from the ultraviolet wavelengths where it was emitted to the optical and near-infrared wavelengths where it is observed. In each spectrum, we see the signature of intergalactic hydrogen absorption at the shorter, bluer wavelengths. However, for the closer quasars, some light is still getting through. For the most distant quasars, however, there is a portion of the spectrum that is, within the measurement errors, perfectly black. Measurements from these spectra show a rapid increase in opacity to ultraviolet light, which in turn suggests that these sources are probing the tail end of the epoch of reionization."

References

1. Constraining the Evolution of the Ionizing Background and the Epoch of Reionization with z _ 6 Quasars II: A Sample of 19 Quasars, by X. Fan et al., Astronomical Journal, in press, preprint astro-ph/0512082.

The Field of Streams



This image shows a map of the distribution of stars in the outer Milky Way, covering nearly a quarter of the sky. The map is color-coded by distance, increasing from blue to green to red. It is built using only the bluest stars measured by the SDSS, eliminating the far more numerous, redder, nearby stars that would otherwise swamp these background structures. Satellite galaxies orbiting the Milky Way are literally ripped apart by the tidal forces of our galaxy. As they sink in gravitational quicksand, their stars are torn from them in giant streams that trace their orbital paths - just like meteor streams lie along the paths of defunct comets in the Solar system. The dramatic double arch that dominates this image is a stream torn from the Sagittarius Dwarf Galaxy, which has wrapped around the Galaxy multiple times so that we see a bifurcated trail in this region of the sky. (One of these trails actually shows two wraps of the stream at different distances, superposed on each other.) Other prominent features in the map include the Monoceros ring (right hand side, dark blue) and the Virgo Overdensity (lower edge, light blue) discovered in earlier SDSS studies, and a sharp trail streaking diagonally across the middle whose “parent" has not been identified. The wealth of structure supports a picture in which the outer parts of the Milky Way have been built largely by the accretion and tidal destruction of satellite systems. Further discovery and mapping of these structures is one of the major goals of the SEGUE component of SDSS-II.

References:

1. The Field of Streams: Sagittarius and its Siblings, by V. Belokurov et al., The Astrophysical Journal (Letters), Vol. 642, L137 (2006)

2. SURVEY PROGESS

As we have noted in past reports, it is more practical and convenient to report progress and performance metrics in terms of complete observing runs as opposed to partial runs. The period of accounting for this report includes four observing runs spanning the period from December 16, 2005 through April 4, 2006.

2.1. Legacy Survey

Weather favored spectroscopic operations, which allowed us to complete 128 Legacy spectroscopic plates against the baseline goal of 106 plates. We also obtained 50 square degrees of new imaging data, which essentially "filled in the gap" in the imaging footprint. Figure 2.1 shows progress in terms of the imaging survey footprint, as of April 8, 2006. With the exception of a few small areas that have not been imaged (near the ends of stripes 23 and 33, for example), the imaging survey of the Northern Galactic Cap is essentially complete. We may try to obtain these missing areas as time permits, but at this point, SEGUE imaging is being given higher priority.

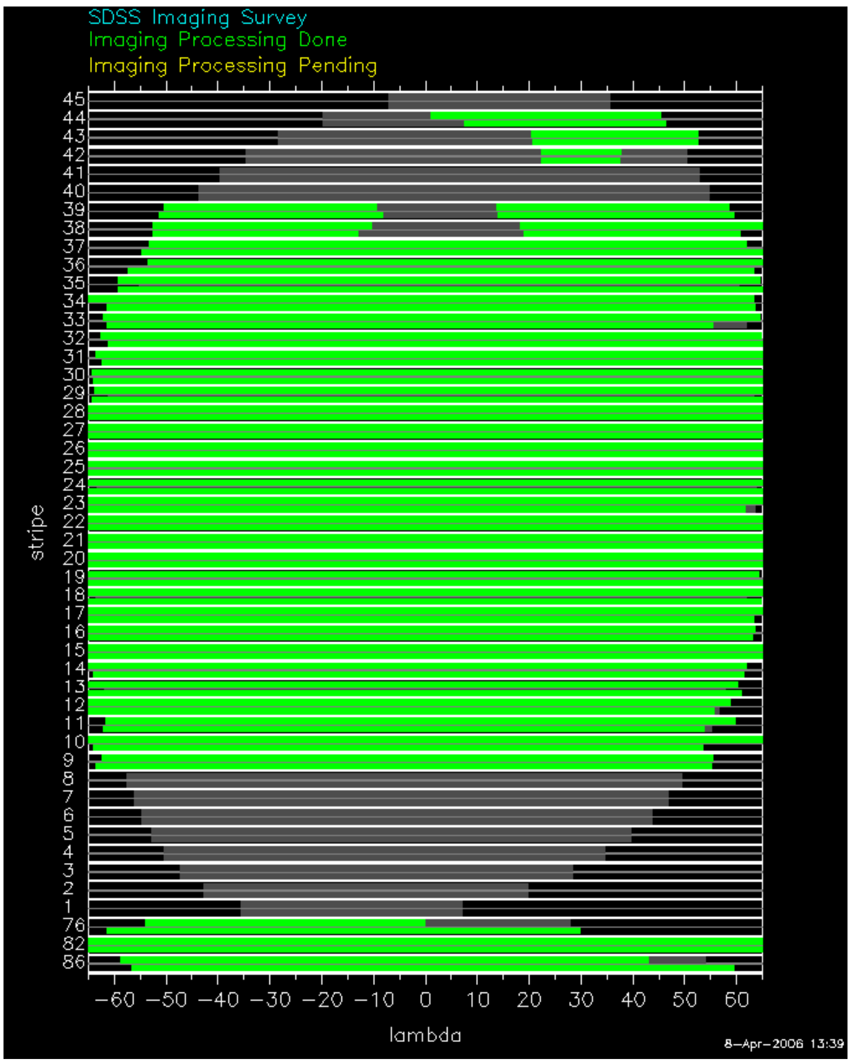


Figure 2.1. Survey Footprint as of April 8, 2006

Table 2.1 compares the imaging and spectroscopic data obtained against the Legacy baseline plan. When the baseline plan for SDSS-II was prepared, we estimated that the total area to be imaged was 7808 "footprint" square degrees. In reality, with the gap closed, the actual area imaged is 7561 "footprint" square degrees. If over time we fill in the missing areas on stripes 23 and 33, for example, the total area obtained in the North will come closer to the baseline forecast. For now, however, we are declaring the Legacy imaging survey to be complete.

Table 2.1. Legacy Survey Progress in 2006-Q1

	2006-Q1		Cumulative through Q1	
	Baseline	Actual	Baseline	Actual
Legacy Imaging (sq. deg)	0	50	7808	7561
Legacy Spectroscopy (tiles)	106	128	1264	1289

The following graphs show progress against the baseline plan. For the Legacy Survey, we have chosen to extend the progress charts from SDSS to include the three-year time extension. For the imaging survey, the baseline has been left unchanged. For the spectroscopic survey, we have set the baseline plan for SDSS-II equal to actual progress prior to July 2005. In addition to showing the rate at which we need to complete plates to finish the Survey, this shows the rate at which we completed plates in the past.

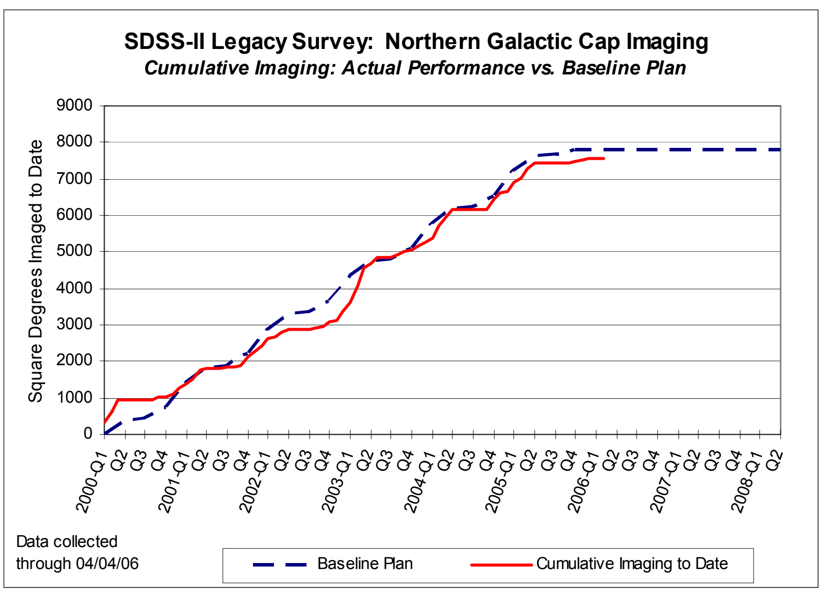


Figure 2.1. Imaging Progress against the Baseline Plan – Legacy Survey

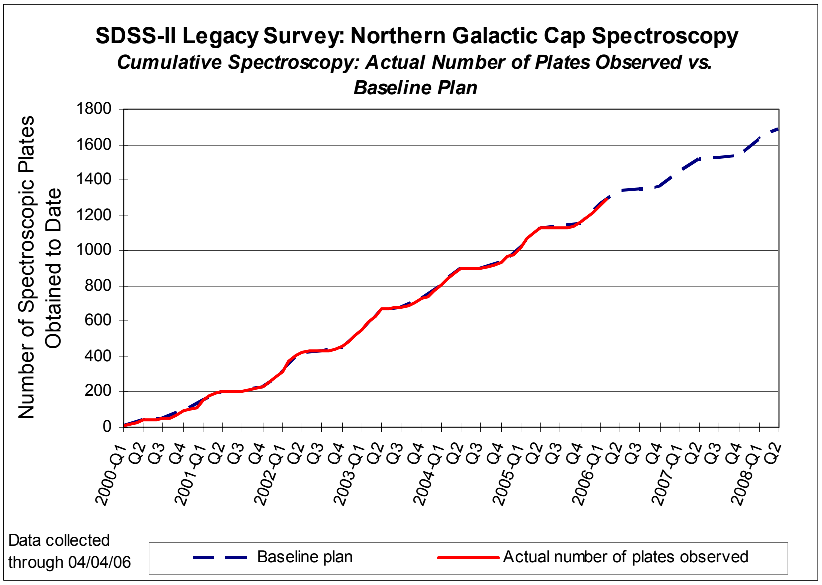


Figure 2.2. Spectroscopic Progress against the Baseline Plan – Legacy Survey

2.2. SEGUE Survey

Table 2.2 compares SEGUE progress against the baseline plan. The SEGUE Survey is ahead of the baseline in both imaging and spectroscopy due to the acquisition of SEGUE data in previous quarters, when commissioning and proof-of-concept observations were made.

Table 2.2. SEGUE Survey Progress in 2006-Q1

	2006-Q1		Cumulative through Q1	
	Baseline	Actual	Baseline	Actual
SEGUE Imaging (sq. deg)	460	189	967	1838
SEGUE Spectroscopy (bright plates)	15	21	44	76
SEGUE Spectroscopy (faint plates)	15	21	44	65

We obtained a total of 189 square degrees of new SEGUE imaging data against a baseline goal of 460 square degrees. Data were taken on stripes 1260, 1356, 1540, and 1600. Weather conditions in the last two quarters have seldom been suitable for imaging, which has significantly slowed our progress on the SEGUE imaging survey. The last two months were especially bad; unsuitable conditions prevented us from obtaining any new imaging data in February or March.

SEGUE spectroscopic observing was obtained mostly in December and January. The Legacy spectroscopic program took priority in February and March. A total of 42 SEGUE plates (21 bright and 21 faint) were completed. This is roughly equivalent to completing 21 SEGUE tiles, as a SEGUE tile is considered complete when the faint and bright plate combination for a field is observed. Our observing strategy is arranged to complete plate pairs in roughly the same time frame, in order to maximize the scientific usefulness of each plate pair. However, given the many factors that affect observing operations (atmospheric conditions, available time, etc.), it is not always efficient to complete plates in "pair combinations." Therefore, we have elected to separately report progress in terms of the number of bright and faint plates completed, as opposed to combined bright/faint plate pairs (i.e., SEGUE tiles).

The following graphs illustrate SEGUE progress against the baseline plan. The imaging graph presents a straightforward comparison of imaging progress against plan. The spectroscopy graph shows the rate at which we have completed bright and faint plates separately.

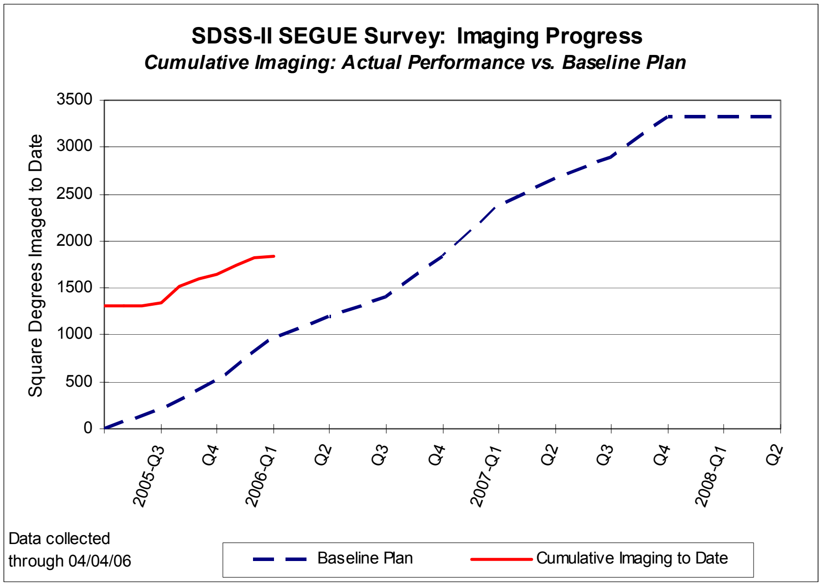


Figure 2.3. Imaging Progress against the Baseline Plan – SEGUE Survey

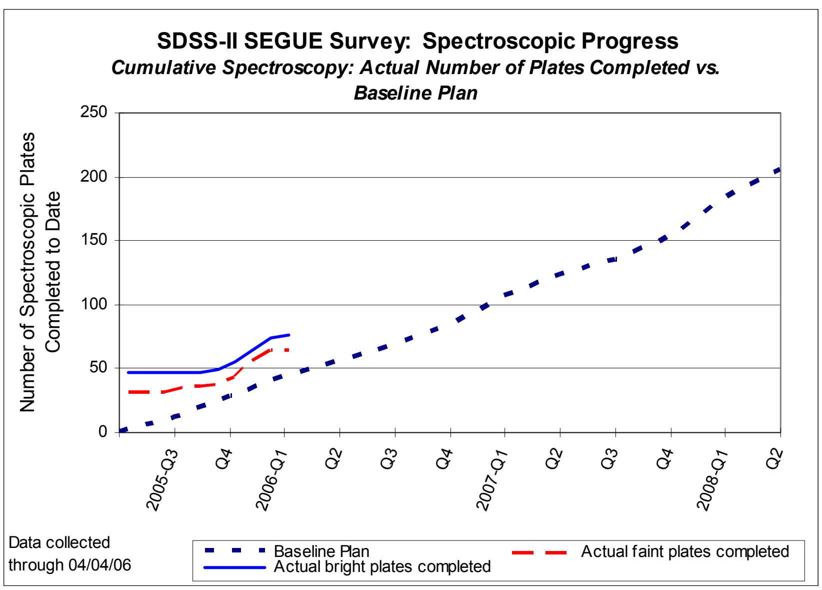


Figure 2.4. Spectroscopic Progress against the Baseline Plan – SEGUE Survey

In addition to observing at APO, the SEGUE team continued observations with the USNO 1-m telescope in Flagstaff during dark time to obtain images of bright stars and cluster with the u'g'r'i'z' system, which will be used to refine the calibration of the SEGUE photometry and spectroscopy.

2.3. Supernova Survey

No observing time was allocated to the Supernova Survey in Q1, in accordance with the SDSS-II observing plan.

3.0 OBSERVING EFFICIENCY

Observing efficiency is summarized according to the categories used to prepare the baseline projection.

3.1. Weather

The weather category reports the fraction of scheduled observing time that weather conditions are suitable for observing. Table 3.1 summarizes the amount of time lost to weather and Figure 3.1 plots the fraction of suitable observing time against the baseline forecast. Averaged over the quarter, the fraction of available observing time was close to that predicted in the baseline plan. However, as seen in the graph, weather conditions in December and January were much more favorable than in February and March. Moreover, for much of the reporting period, weather conditions favored spectroscopy over imaging. This was particularly true for February and March, during which we did not obtain any new imaging data.

Table 3.1. Potential Observing Hours Lost to Weather in Q1

Observing Condition	Total hours potentially available for observing	Total hours lost to weather	Fraction of time suitable for observing	Baseline Forecast
Dark Time	538	214	60%	60%
Dark & Gray Time	781	332	58%	60%

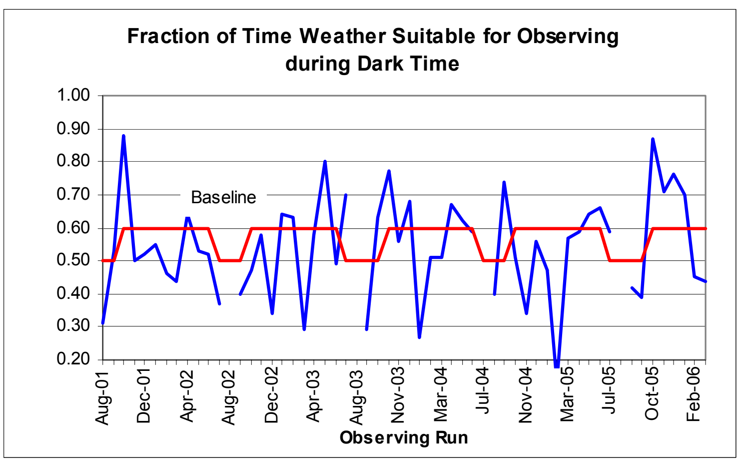


Figure 3.1. Percentage of Time Weather Suitable for Observing

3.2. System Uptime

System uptime measures the availability of equipment when conditions are suitable for observing. We averaged 98% uptime against a baseline goal of 90%. Table 3.2 summarizes the total amount of time lost to equipment or system problems and Figure 3.2 plots uptime against the baseline goal.

Table 3.2. Potential Observing Hours Lost to Problems in Q1

Observing Condition	Total hours potentially available for observing	Total hours lost to problems	System Uptime	Baseline Forecast
Dark Time	538	11	98%	90%
Dark & Gray Time	781	25	97%	90%

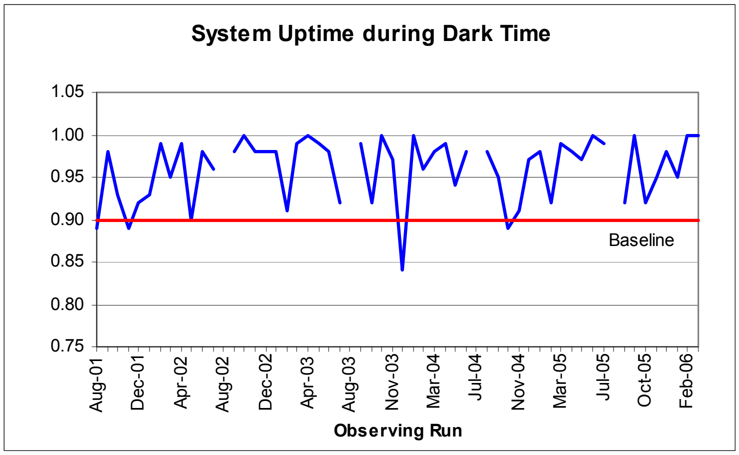


Figure 3.2. System Uptime

The uptime measurement for Q1 is a bit misleading in that the five scheduled observing nights in which the imaging camera was unavailable do not count against the uptime metric, because weather conditions during the downtime were unsuitable for imaging. We did not lose science time due to the imager problems because we operated in spectroscopic mode. However, had conditions been photometric, the amount of lost imaging time could have been substantial.

3.3. Imaging Efficiency

Imaging efficiency in December and January averaged 84% against a baseline goal of 86%. Imaging efficiency was unmeasured in February and March because weather prevented imaging operations.

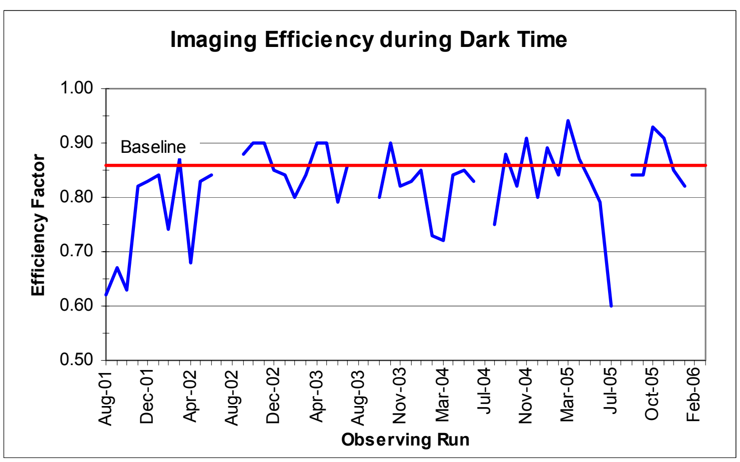


Figure 3.3. Imaging Efficiency

3.4. Spectroscopic Efficiency

Spectroscopic efficiency is derived by assessing the time spent performing various activities associated with spectroscopic operations. Table 3.3 provides the median time, by dark run, for various overhead activities associated with spectroscopic operations. Units for all categories are minutes except for efficiency, which is given as the ratio of baseline science exposure time (45 minutes) to total time required per plate. Using these measures, spectroscopic efficiency exceeded baseline goals; average efficiency in Q1 was 67% against the baseline goal of 64%.

Table 3.3. Median Time for Spectroscopic Observing Activities

Category	*Baseline*	*Run starting Dec 20*	*Run starting Jan 19*	*Run starting Feb 17*	*Run starting Mar 19*
Instrument change	10	5	5	5	5
Setup	10	10	10	8	9
Calibration	5	5	5	5	5
CCD readout	0	3	3	3	3
Total overhead	25	23	23	21	22
Science exposure (assumed)	45	45	45	45	45
Total time per plate	70	68	68	66	67
Efficiency	0.64	0.66	0.66	0.68	0.67

Figure 3.4 shows that efficiency is trending upward in recent months due to a slight reduction in the amount of time spent in setup.

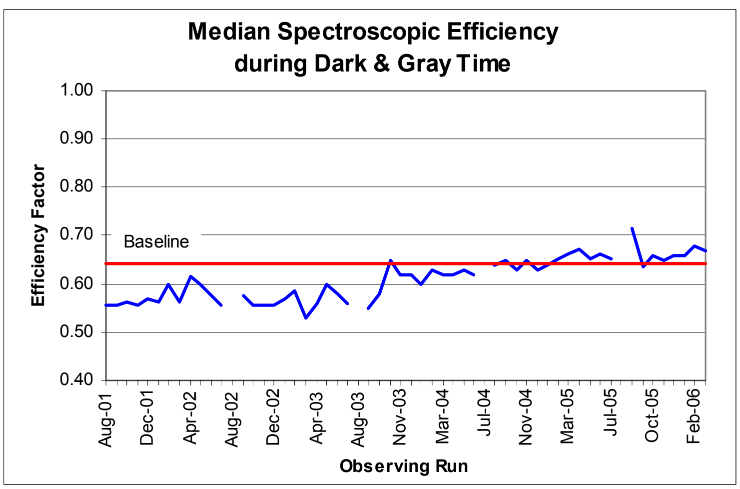


Figure 3.4. Spectroscopic Efficiency

4. OBSERVING SYSTEMS

Observing systems includes the instruments, telescopes, computers and various sub-systems that support observing operations at APO.

4.1. The Instruments

We had a serious problem with the imaging camera in March that took the camera out of service for several days. Fortunately, the fault occurred during a period in which conditions were unsuitable for imaging, so no imaging science time was lost while the camera was diagnosed and repaired.

On March 8, we lost communication with the camera. At the same time, the camera LN2 autofill system started misbehaving badly. While site staff started checking out communication channels and manually attending to LN2 fills to keep the camera cold, Jim Gunn and Connie Rockosi traveled to APO to diagnose the source of the problem.

After warming up the camera and waiting for the vacuum to clean up, the camera was opened up. Troubleshooting indicated that the problem was on the board from Triangle Digital Systems that holds the executive microprocessor. This microprocessor handles all of the commands and telemetry for the camera. All evidence pointed to the failure of a crystal oscillator. Everything else in the camera seemed to be fine.

Early on March 13, the crystal was replaced with a spare and the camera started behaving normally, with the exception of the u3 chip. By evening, the u3 chip was also working normally, showing nominal values for bias and read-noise for both amplifiers, cosmic rays, the usual bad columns, etc. Looking ahead, we plan to do additional testing during the summer, as well as test some schemes to bypass these parts in the camera.

In late-March, the observers started reporting voltage glitches on two of the imager CCDs. Suspecting a faulty power supply, we replaced the supply with one from the spares pool. The glitches continued occurring sporadically for several more days and then abruptly stopped. We have not seen the glitches since, nor have we been able to conclusively determine their cause.

The spectrographs worked well during the quarter. We had a single instance of a problem with the collimator actuator on Spectrograph #2 in early March. The actuator failed to move properly during the first attempt to acquire dithered flats as part of the monthly spectrograph check-out procedure. The actuator moved as expected on the second attempt and has worked fine since.

4.2. The 2.5m Telescope

In addition to responding to instrument problems and performing scheduled preventive maintenance, the on-site engineering team was engaged in a number of planned engineering activities. The following list highlights some of the more notable engineering work performed during the quarter.

1) We continued our effort to qualify a replacement supplier for the neon/argon lamps used in spectrograph calibration. We identified a vendor capable of producing lamps with neon and argon spectral lines and evaluated several lamp configurations and designs. Unfortunately, output intensity remains too low to be useful. In the coming weeks, we plan to test one additional lamp configuration from this vendor. If unsuccessful, we will begin looking for another vendor.

2) We initiated axis drive evaluations in an effort to baseline the system, which will aid in troubleshooting and diagnostic work in the future.

3) The PID values in the rotator drive servo loop were adjusted to eliminate motor "ringing" at slew speeds. Initial tests indicate that the new values provide proper servo performance at both slew

and tracking speeds. However, we plan to monitor system performance over time to ensure performance requirements are being met under all operating conditions.

4) An electrical relay on the Motion Control Processor (MCP) failed in February, which inhibited operation of the telescope control system. The relay serves as a watchdog for the MCP; if the MCP fails, the relay inhibits telescope motion, which prevents a potential run-away condition. In this case, the MCP itself didn't fail; the add-on module containing the relay failed. Unfortunately, the fault condition was difficult to diagnose as the relay was added after the control system was commissioned. Drawings and schematics had not been updated to include the relay and control logic, and the lack of sufficient documentation added a day to the troubleshooting exercise. Once the problem source was identified, we replaced the failed module with a unit from the spares pool, which returned the telescope to full operation. In addition to replacing the failed relay, we also updated schematics, logic diagrams, and the online graphical interlocks display to include the relay. We also installed a bypass switch in the interlock system splitter chassis and incorporated a status bit into the interlock system programmable logic controller (PLC).

5) In the course of daily activities, the on-site engineering team found damage to the imager umbilicus close to the point of contact with the imager saddle. Emergency repairs were made that should allow operations to continue until summer shutdown, when we can implement a more permanent repair.

6) We encountered a fiber mapping problem on spectroscopic cartridge #1, which was caused by a broken fiber near one end of the fiber bundle terminal block. It turns out that a broken fiber at either end of a terminal block (i.e., fiber #1 or #20 of a given 20-fiber bundle) would cause the mapping system to become confused; the mapper would incorrectly map the remaining fibers in the bundle. Once the nature of the problem was understood, modifying the fiber mapper software to eliminate the confusion was straightforward and quickly implemented.

7) During routine inspections, we discovered throughput problems with two of the four spare optical fibers in the rotator wrap. We attempted to repair the damaged fibers by re-terminating the fibers, but it appears that the damage is located at some point along the fiber length internal to the rotator cable wrap, as opposed to near the terminal ends. Rather than disassemble the rotator wrap at this time, we will wait until summer shutdown to replace the damaged spare fibers.

8) One of the flat field screen motors failed during the quarter. We promptly replaced it with a unit from the spares pool. We also purchased two new motors to replenish the spares pool. All necessary modifications were made to the new spares, such that the new units are ready for installation if and when needed.

9) A high-precision bubble level was installed on the altitude axis drive disk. This will be used to determine the 90-degree altitude position should we lose the electronic transducer currently providing position information to the motion control system.

10) To improve the reliability of the oxygen monitoring system in place near the 2.5-meter telescope, we began evaluating a new type of oxygen sensor. The calibration of the existing sensors drifts with time, which affects system reliability. A new type of sensor was identified, purchased and installed adjacent to an existing oxygen sensor in the cone pit. We are monitoring and comparing the output and calibration stability of the two sensors in order to determine whether the new sensor is indeed more stable and reliable under our ambient operating conditions.

11) During the quarter we discovered interference between the "Holloman light baffles" and the telescope fork tines, which required us to move the position of the lower motion limit on the altitude axis. The original limit was 0.5 degrees from horizontal; the new limit is set at 3.5 degrees. The change was implemented through changes in the interlock PLC ladder-logic code and MCP software. A bypass exists that allows us to still reach the 0.5 degree position when needed for telescope maintenance work.

12) After several unsuccessful attempts to effectively repair the altitude drive on our DIMM telescope, we decided to purchase a new replacement telescope. The new telescope, a 10-inch Meade LX200GPS, was purchased in February and installed in the existing dome. Due to minor size differences between the old and new telescopes, it was necessary to modify the dome tub slightly to fit the new telescope. Minor modifications were also required to our existing control software. Since installed, the new DIMM has been working well.

13) We conducted an evaluation of the telescope temperature monitoring system and determined that overall the system was functioning fairly well. The area of most concern was the robustness of the connectors and wiring to connect the thermal sensors to the system. We are in the process of prototyping an improved connector design for installation during the summer shutdown. The electronics have been reliable to the extent that no upgrades or improvements are necessary.

14) Cables, hoses and other supply lines run between the telescope forks and the primary support structure (PSS) through large plastic conduits affectionately called "elephant trunks." Over time, the effects of elevation and temperature have taken their toll on the plastic to the extent that the elephant trunks have begun to crack and break, especially during cold weather. To date, the cracking has occurred near the ends of the trunks and we have been able to cut away the broken section and re-attach the conduit to the end fittings. However, with each break and repair, the trunks become shorter in length, which reduces flexibility. Thus, cutting away broken sections is a short-term fix at best. With the advent of warmer weather, we do not anticipate further problems until next fall. In the interim, we are looking at alternate designs or components. To date, we have found a possible off-the-shelf replacement conduit and have received samples from the vendor for evaluation. We are also prototyping our own design for testing and evaluation. Our goal is to have a replacement system ready for installation in fall 2006.

In addition to supporting SDSS-II operations, the engineering team provided support for Phase II observations for the Exoplanet Tracker project. The plug-plate lab was re-arranged to accommodate a temporary instrument enclosure used to house the ET instruments. The fiber mapper and some of the plate storage shelves were relocated and an 8' x 10' instrument enclosure installed in the southwest corner of the lab. A new optical bench was installed in the enclosure and optical fibers run between the enclosure and telescope.

4.3. The Photometric Telescope

The Photometric Telescope (PT) worked reasonably well throughout the quarter. In our last report, we described plans to replace the Telescope Control System (TCS) computer with a spare in an attempt to resolve network communication problems that were affecting observing operations. Swapping the computer turned out to have little effect. However, increasing a timeout in MOP improved performance by reducing the frequency of system delays. MOP was modified to increase the length of time it waits for the TCS to respond to a request for telescope position information. For unknown reasons, TCS is often slow in responding to this request. Although the change did not fully solve the problem, it significantly reduced the impact on operations.

We have identified several fully functional computers on site that will serve as space computers for the TCS, as it requires an older 80486-class machine. We intend to inventory and add these machines to the PT spares pool.

We installed a new set of drive belts on the PT axes drives. The replacement was made because of the axis jam we experienced in December, as reported in the Q4 report. The drive belts are cogged timing belts and since they had experienced some cog jumps, we thought it prudent to replace them as a preventive measure

4.4. Operations Software and the Data Acquisition System

Work completed on the data acquisition system (DA) included building and deploying a monitoring system for the DA VxWorks boards, removing the remaining DA dependence on the Silicon Graphics host system (*sdsshost*), and fixing the bad video interface card sent back from APO.

Features provided by the new monitoring system include ensuring that all critical processes on the boards are running, verifying that photo frames are being archived in a timely fashion, and producing logs of various system parameters to aid in debugging of any problems on the boards.

The remaining dependence on the SGI host consisted of two systems that were still using software compiled on that host. These were the simulator processor board and the MVME2302 card with a Peritek VCQ-M daughter board that is used as a replacement for the Vigra cards in driving the scrolling displays. In the simulator system, the processor board was upgraded from an MVME167 to an MVME5500 and the necessary code changes made to support the operation of the simulator system from a Linux host. For the video card, the VxWorks kernel was upgraded from 5.3 to 5.5 (to match the other DA boards) and the necessary code changes were made to compile and load the software for this board from Linux. In both cases, the changes have been installed at the Fermilab test stand but have not yet been installed at the observatory. For the broken VCQ-M daughter card, a replacement card purchased from Rastergraf, Inc. fixed the problem.

Work planned for Q2 includes deploying the changes for booting all of the DA boards from Linux to the production system, investigating whether recent bug fixes might help eliminate the missed VCI+ interrupt messages that we see several times per exposure in the spectro system, updating the online DA documentation, investigating improved sky subtraction for astro chips, and making any changes necessary to make binned scanning work.

The only outstanding issue on the DA is whether to order more replacement VCQ-M boards from Rastergraf at this time. The boards are rather costly and we are considering whether current sparing levels are adequate. At present, we have three working boards (one at FNAL, one in the spectro crate at APO, and one spare at APO) and two broken boards at APO.

The database containing position and exposure information on PT patches, *mopdb*, was successfully ported to Linux on the new host computer, *sdsshost2*. Remaining work before decommissioning the old host computer, *sdsshost,* involves porting the VxWorks development environment to *galileo.apo.nmsu.edu*. *Galileo* is a very old Sun workstation and we have concerns over its long-term reliability. In the short-term, we plan to complete the port to *galileo* in Q2, at which time we will be prepared to decommission *sdsshost*. In the longer-term, we plan to replace *galileo* with a new Sun SPARC workstation to improve reliability. We need to procure a Sun workstation as VxWorks 5 does not run on Linux.

5. DATA PROCESSING AND DISTRIBUTION

5.1. Data Processing

5.1.1. Software Development and Testing

No changes were made to the production Legacy photometric or spectroscopic pipelines in Q1.

Development work continues at Princeton on the spectroscopic pipeline, the photometric pipeline, and photometric calibration. With regard to the spectroscopic pipeline, all existing data have been run through idlspec2d v5_1_3 and comparison testing of the outputs with v4_10_9 reductions has begun. However, several major issues have arisen with the SEGUE bright plates. These have large numbers of stars as bright as 14-15 magnitudes, which produce scattered light especially in the blue camera (b1) on Spectrograph #1 and negatively impact the skies. As a result, skies are rejected by the bright starts (BS) code, standards are rejected, and plates "won't reduce." Rejection thresholds have been adjusted in order to reduce the data from these plates, and scattered light data taken at APO have been examined. The extraction code is currently being rewritten and we think this is a soluble problem. Although this has held up formal testing, some testing work is nonetheless underway to gain some feeling for what has to be done. Finally, the data model changes for idlspec2d v5 have been documented and new disk has been purchased to support the development and testing process.

On the photometry front, work is underway to handle crowded-field photometry on low latitude scans. Crowded-field code that works well on single-band data at low latitudes now exists. Future work will involve adapting the code to handle multiple bands. We anticipate completing this work in Q2.

On the calibration front, an updated list of photometric Apache Wheel scans has been assembled and all Apache Wheel (AW) data have been run through the Apache Wheel pipeline. A significant amount of effort has gone into running ubercal, including developing 1) working code that can incorporate Apache Wheel data; and 2) a full survey simulator to test the calibrations. The simulations suggest that one can get to magnitude errors (in the zero-points) of 4 mmag. However, after running bluetip, it was discovered that striping was still present. Bright stellar data were downloaded from the CAS for comparison and it was found that the Fermilab and Princeton data processing reductions, ostensibly running the same version of Photo, give very different results in regions of poor and variable seeing. The problem has been traced to the Postage Stamp Pipeline (PSP) - Princeton is running a version which rejects most stars in regions of poor seeing. Work is underway to fix this.

Work continues by the JINA-MSU team on the development of the stellar atmosphere pipeline that will be used for SEGUE observations in order to estimate atmospheric parameters (Teff, log g, [Fe/H]) based on R = 2000 spectroscopy and ugriz photometry.

The stellar atmosphere pipeline in use is presently based on a number of independent methods (obtained from different calibrations) for each parameter, which are then suitably averaged in the final estimation process. Estimates of the internal scatter in the determination of a given parameter are also kept track of. The pieces of this pipeline are (for now) run as separate procedures. Steps are being taken in order to put all of these pieces into an IDL procedure so that they can be run in standalone mode. Several of the calibrations rely on input B-V colors, which have to be derived from observed g-r colors via an approximate transformation. This step will be eliminated soon, as new calibrations tied directly to ugriz colors are obtained. Highlights of Q1 progress are as follows:

- First implementation of a "full" pipeline, which now comprises the procedures of Beers, Wilhelm, Allende Prieto, and Norris, in order to obtain best estimates of stellar parameters. Thus, we are quite close to obtaining v1_0 of the SEGUE pipeline IDL code for generation of stellar parameters.

- Continued obtaining high-resolution spectroscopy of SEGUE stars with predicted parameters from the present pipeline, so that calibration and refinement of these estimates can be carried out. To date, some 20 stars have available Keck spectroscopy, and of greatest importance, over 60 HET spectra have been obtained in the first and second (of three) trimesters anticipated to be obtained over the course of the coming half year. The parameters derived from these spectra will be used to evaluate the predictions of the SEGUE pipeline, and to derive corrections (if needed). These same spectra will be of use for establishing the actual velocity errors in SEGUE spectra, since the high-resolution data have errors on the order of 1 km/s.

- Production of a set of stars for the extended calibration that have preliminary pipeline determinations of atmospheric parameters, ordered by "boxes" within the SEGUE parameter space, so that others within the collaboration can more easily assist with the acquisition of suitable calibration observations at high resolution. This list has been provided to Yanny and Rockosi, and will be supplemented shortly with lists of the parameters derived from the existing high-resolution data, and circulated to the collaboration, in hopes that others with access to high-resolution spectrographs on suitable-sized telescopes will be motivated to assist with the calibration effort.

In the coming quarter, our primary goal is to have a reasonable (IDL based) spectroscopic pipeline up and running. Anticipated delivery is now by the end of May 2006. This will represent v1_0 of the pipeline. Once this goal is accomplished we will seek to refine and improve the pipeline based on empirical comparison of the estimated atmospheric parameters with those obtained from high-resolution spectroscopic observations that we either have already, or are presently obtaining. This effort will also provide an external measure of the expected errors in the parameter determinations.

We are also looking to implement a neural-network-based estimation procedure, based on work that is being carried out at MPIA. This should be available to us within the next month, and will be put into the current pipeline.

We plan to run v1_0 of the pipeline through all available SEGUE data as of mid-May, in order to verify that it is working properly (i.e., that it reproduces what we obtain from the "individual components" of the pipeline mentioned above). A catalog of the derived parameters will be circulated to the SDSS-II/SEGUE collaboration once this is done.

5.1.2. Data Processing Operations at APO

No data were processed at APO during Q1 as we were not collecting new supernova data.

5.1.3. Data Processing Operations at Fermilab

Data for the Legacy and SEGUE Surveys were processed at Fermilab. All spectro data were processed using existing Legacy versions of the spectroscopic pipelines (idlspec2d v4_10_4 and spectro 1D v5_9_4) and flat fields from 2004-2005 observing season. All imaging data were processed with the Legacy version of the photometric pipeline (photo v5_4_28). In Q1, the DP team kept up to date on all imaging and spectroscopy data and recovered data lost as the result of two RAID disk array failures.

5.1.4. Data Processing Operations at Princeton

Legacy and SEGUE data are also being processed at Princeton. The reduction environment for imaging data is being used to support work on ubercalibration and the photometric pipeline, Photo. The reduction environment for spectroscopic data is being used to process spectroscopic data from the Legacy and SEGUE Surveys through idlspec2d v4_10_9 and v5_1_3, as pipeline development work continues.

5.2. Data Distribution

5.2.1. Data Usage Statistics

To date, the general public and astronomy community have access to the EDR, DR1, DR2, DR3, and DR4 through the DAS and SkyServer interfaces. In addition, the collaboration has access to the Runs DB and the preliminary version of DR5. A helpdesk has been established at Fermilab to respond to user questions, or to system problems reported by users. In Q1, the helpdesk responded to an average of 1 request per day for help or information.

Figure 5.1 plots the number of web hits we receive per month through the various SkyServer interfaces. In Q1 we recorded 16.3 million hits, compared to 16.4 million hits in Q4 and 15.6 million hits in Q3.

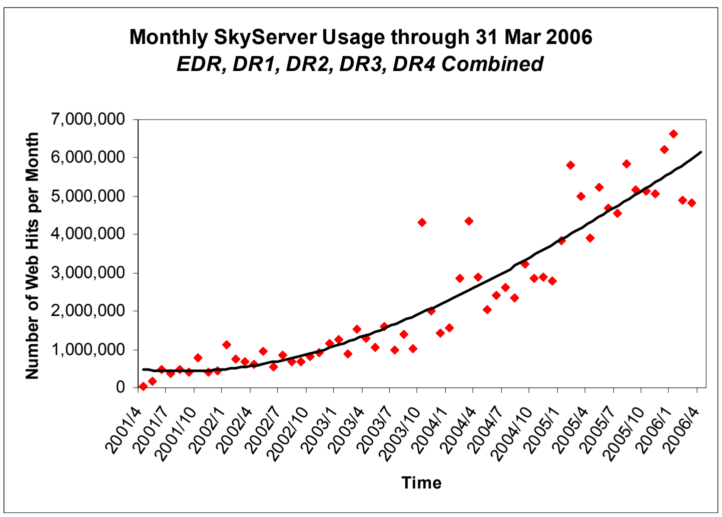


Figure 5.1. SkyServer usage per month, for all public releases combined.

Figure 5.2 shows the total number of SQL queries executed per month. We executed 0.9 million queries in Q1, compared to 1.7 million queries in 2005-Q4 and 0.7 million queries in Q3.

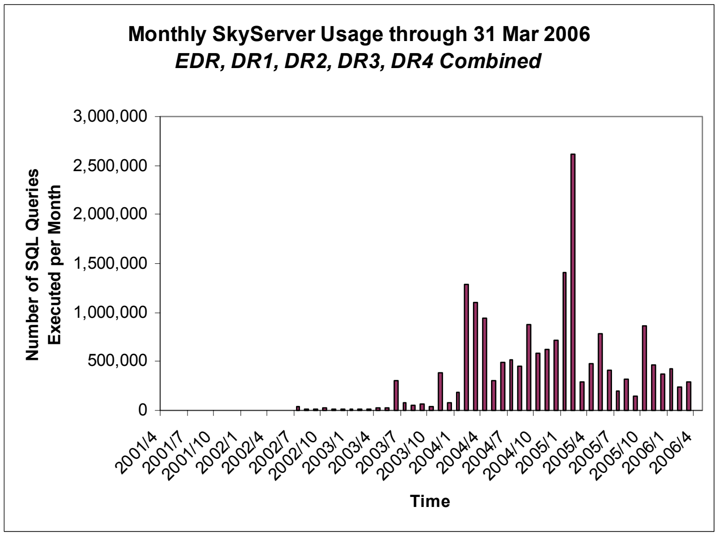


Figure 5.2. SkyServer usage, measured by the number of SQL queries submitted per month.

Through March 31, 2006, the SkyServer interfaces have received a total of 142 million web hits and processed over 18.6 million SQL queries. On average, the SkyServer sites are receiving 5.4 million hits and processing 316,000 SQL queries per month.

In the 2005-Q4 report, we described problems with our DAS machines that affected our usage harvesting systems. These problems were addressed and harvesting restored in Q1. Figure 5.3 shows the volume of data transferred monthly from the DAS through the rsync server. The rsync server was brought back into service near the end of January, so usage statistics for Q1 only include the months of February and March. During these months, users transferred a total of 1.78 TB of data via rsync.

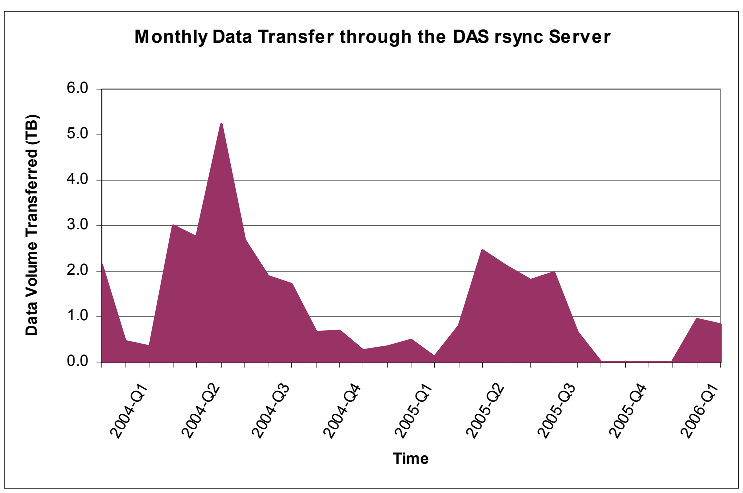


Figure 5.3. Monthly volume of data transferred via the DAS rsync Server.

Figure 5.4 shows the volume of data transferred monthly through the DAS web interface. Usage harvesting for web-based transfers was restored in January, so usage statistics for Q1 cover the months of January, February and March. During these months, users transferred a total of 2.44 TB of data.

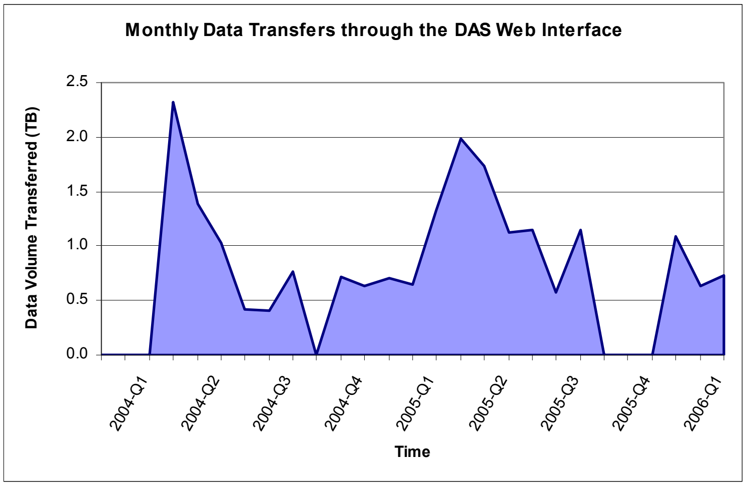


Figure 5.4. Monthly volume of data transferred via the DAS web interface.

Although providing two access portals to the DAS moderately increases the complexity of our data distribution system, providing access to the data through the two portals more effectively meets the needs of our user community. Each access method has advantages and disadvantages that affect users differently, depending on their data needs, connections, etc. Figure 5.5 shows the total volume of data transferred from the DAS through the two access portals combined. In addition to showing total volume transferred, the stacked-area chart shows the fraction transferred via each method (rsync vs. web interface). Historically, the majority of data transfers have been made using rsync, suggesting that rsync is the preferred transfer method for large data transfers. In the last two months, the volume of data transferred via each method is comparable (0.9 TB vs. 0. 7 TB for rsync and web, respectively). We will continue to monitor this going forward and will re-assess the decision to offer two access portals if it becomes clear that one method is clearly preferred. In the meantime, we will continue offering both access methods, as it appears that offering both more effectively satisfies the access needs of our users.

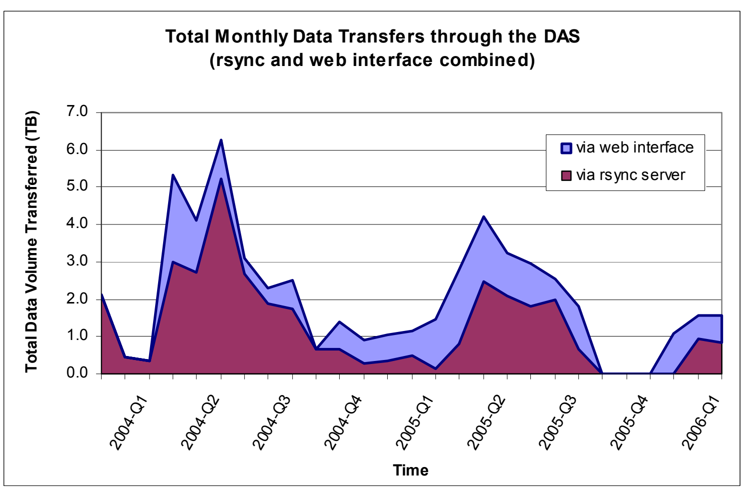


Figure 5.5. Total monthly volume of data transferred via the DAS (rsync and web interface combined).

5.2.2. Data Release 5

DR5 contains all survey quality imaging data collected through June 30, 2005, and the corresponding spectra. Thus, DR5 comprises the final Science Archive of the SDSS-I. Table 5.1 summarizes the contents of DR5 and provides a comparison with the DR4 release. The table and following summary of DR5 contents is reiterated for convenience from the 2005-Q4 report.

Table 5.1. DR5 Contents

	DR4	*DR5*	*Increment*
Imaging			
Footprint Area	6,670 sq. deg.	8,000 sq. deg	1,330 sq. deg.
Imaging Catalog	180 million objects	215 million objects	39 million
Data volume			
Images	7.5 TB	9.0 TB	1.5 TB
Catalogs (DAS, fits format)	1.5 TB	1.8 TB	0.3 TB
Catalogs (CAS, SQL database)	3.0 TB	3.6 TB	0.6 TB
Spectroscopy			
Spectroscopic Area	5,320 sq. deg	5,740 sq. deg.	420 sq. deg.
Total Number of Spectra	849,920	1,048,960	199,040
Galaxies	565,715	674,749	109,034
Quasars (redshift < 2.3)	67,382	79,934	12,552
Quasars (redshift > 2.3)	9,101	11,217	2,116
Stars	102,714	154,925	52,211
M Stars and later	50,373	60,808	10,435
Sky Spectra	44,363	55,555	11,192
Unknown	10,272	12,312	2,040

In addition to standard survey data, DR5 contains spectroscopic data from 361 "extra" and "special" plates (compared to 276 for DR4; Δ = 85 plates). The bonus data come from the following plate observations:

- 62 "extra" plate/MJD combinations which are repeat observations of 53 distinct main survey plates (*increment of one plate above that released with DR4*).
- 289 distinct "special" plates, which are observations of spectroscopic targets, mostly in the southern galactic cap, which were selected by the collaboration for a series of specialized science programs. Some of these plates are outside of the DR5 imaging area (*increment of 83 plates above that released with DR4*).
- 10 "extra-special" plates, which were repeat observations of "special" plates (*increment of 1 plate above that released with DR4*).

DR5 efforts in Q1 focused on finishing the enhanced version of DR5 for collaboration release. Details are provided in the following sections (5.2.3 and 5.2.4). As of this writing, we anticipate releasing the "enhanced" and final version of DR5 to the collaboration in mid-May and to the public on June 26, 2006, in accordance with the approved data distribution plan.

5.2.3. Data Archive Server

Work on the Data Archive Server (DAS) included building the complete data set for the DR5 DAS and chasing down missing or incomplete files for that data set.

5.2.4. Catalog Archive Server

Work on the Catalog Archive Server (CAS) included addressing problem reports, finishing the enhanced version of the DR5-CAS for collaboration release, preparing for the DR6 data load, and providing general support for data distribution operations.

In Q1, 26 problem reports filed through the SDSS Problem-Reporting Database were fixed and closed, including nine that were classified as serious/high and one filed against CasJobs that was classified as critical/medium.

Several enhancements were made to the version of the DR5-CAS that will be released to the collaboration in early May and to the public on June 26, 2006. These include the following:

1. All of all the DR5 JPEG images were regenerated to fix a clipping error. The new images were re-loaded into the CAS using a script that took 1-1/2 days to run. An additional half-day was spent fixing JPEGs that didn't get copied properly the first time. Subsequent inspections of the reloaded images have determined that the fix was successful.

2. RunQA data, generated during data processing, were added to tables in the BestDR5 and TargDR5 databases.

3. Photometric redshifts (photo-z's) and estimated errors, computed by two separate groups within the collaboration using different algorithms, were loaded into tables in BestDR5. Online documentation was created that describes the algorithms used to compute the photo-z's.

4. Sample queries were added to the online documentation to help users learn how to generate large scale structure galaxy sample catalogs, including mask and selection function information, directly from the database.

5. The DR5 Quasar Catalog was constructed and added to the database. The catalog is constructed of all quasar candidates contained within the DR5 dataset, with their "vital signs" gathered from the many different SDSS data sources (i.e., the FIRST, ROSAT, Stetson, USNO and USNO-B catalogs) into one Quasar Concordance table. The tables and views created by the quasar concordance algorithm on the Best, Target and Spectro datasets are part of the Best database. The following table summarizes these tables and views. A more complete description of the quasar catalog can be found in the online documentation for DR5.

Table 5.2. QSO Table/View Descriptions

Name	*Type*	*Description*
QsoCatalog	View	A view of QsoCatalogAll limited to only the best QSO from each bunch
QsoConcordance	View	A view of QsoConcordanceAll limited to only the best QSO from each bunch
QsoCatalogAll	Table	The superset of all QSO candidates identified by the algorithm described below
QsoConcordanceAll	Table	Combines the Best, Spec and Target fields for each QSO candidate
QsoBunch	Table	The QSO neighbors organized into neighborhood bunches with a *head* QSO associated with each bunch
QsoBest	Table	The fields from the Best PhotoObjAll table associated with each QSO candidate
QsoSpec	Table	The fields from the Best SpecObjAll table associated with each QSO candidate
QsoTarget	Table	The fields from the Target PhotoObjAll table associated with each QSO candidate

6. Definitions for the tables listed above were added to SpectroTables.sql and Views.sql, and indices added to IndexMap.sql. The changes were made in sqlLoader v5_1_3.

7. Documentation updates were made, including adapting the file generated to document the creation of the quasar catalog (QsoConcordanceV22.doc) into the SkyServer Algorithm table as the entry "Building the QSO Catalog Tables"; and adding the table descriptions to the TableDesc table.

8. Rerunning the metadata (Algorithm, TableDesc, DBColumns and DBObjects) and replacing these tables in the DB, so that the Schema Browser shows all QSO table entries.

9. Running spSetVersion to run the diagnostics, compute the checksum, and set the version to v5_3.

Upgrades were made to the CasJobs web service in Q1. New features implemented in v2_8_7 include allowing query outputs to be directed into variables and temp tables; and allowing query plans to be obtained without having to log in. All changes were checked into the CVS code repository. Additional features being added to version v2_9, which is still under test, include bug fixes to address active problem reports, parser and GO syntax upgrades, updated queue handling, and upgrading to ASP.NET.2.0.

In preparation for DR6, we began assembling and vetting the list of proposed data model changes. Data model changes are necessary to incorporate among other things, new SEGUE data parameters into the database. We anticipate finalizing the list of approved changes in Q2 and starting the process of upgrading the sqlLoader to accommodate the changes. We also initiated the procurement of three new file servers to support DR6 loading and hosting operations.

5.2.5. Runs Database

We continued incrementally loading imaging data into the runs database, RunsDB. This database, which is available for CAS-style SQL queries and CasJobs batch queries, will eventually contain the data from all imaging scans obtained with the 2.5-meter telescope, regardless of data quality. On February 9, we released to the collaboration an updated version of the runsDB that contained the repeat Stripe 82 scans as well as 31 of the SEGUE imaging scans.

We then continued loading additional runs into the master copy of the database. An additional 20 SEGUE scans and 32 Legacy scans were added to the database, a copy of the database was made, and the “Finish” step of the loading process was started. We anticipate releasing this updated version to the collaboration in mid-May.

In parallel with running the Finish step on the copy of the RunsDB, we continued loading new scans into the master copy. In all, 94 imaging scans were loaded into the RunsDB in Q1. We plan to continue this incremental loading and release process until all imaging data is loaded and available to the collaboration.

5.2.6. Supernova Survey Data Release 1

The first public release of data from the Supernova Survey occurred in January 2006. The release makes available data obtained on Stripe 82 during the 2005 observing campaign. Access to the data is through the following URL: http://www.sdss.org/drsn1/DRSN1_data_release.html.

The SN data release web page provides access to the corrected frames and uncalibrated catalogs via a pared-down DAS script, along with a list of the runs available and some information regarding their quality. Sixty-six of imaging runs obtained in the fall campaign are currently available. An additional seven runs will be added once they have been successfully run through the photometric pipeline.

6. SURVEY PLANNING

6.1. Observing Aids

Several programs are used to aid in planning and carrying out observations. The patch database, which is used by the PT control program to track which patches have been observed, was installed on the new *sdsshost2* computer, preparatory to decommissioning of the Silicon Graphics computer, *sdssmth*.

6.2. Target Selection

For this quarter, 112 plates were designed and drilled in three drilling runs. Of these, 23 were for the Northern survey area, 37 were for the normal exposure SEGUE plates, 37 were for double length exposure SEGUE plates, 3 were special SEGUE cluster plates, and 12 were for the ET program.

6.3. Survey Planning

The software that is used to track survey progress that is contained in this report is also used to prepared monthly observing plans. Some small bugs in the code were fixed.

Agreement was reached on modifying the observing strategy next autumn to increase the likelihood that the SEGUE program will obtain important imaging data during time that overlaps the supernova program while ensuring that the supernova program still obtains data with the proper cadence for its program.

7. COST REPORT

The operating budget that the Advisory Council accepted and the Board of Governors approved for SDSS-II activities during the period January 1 through December 31, 2006 consists of $640K of anticipated in-kind contributions from Fermilab, the US Naval Observatory (USNO), the University of Chicago (UC), the Johns Hopkins University (JHU), the University of Washington (UW), and the Joint Institute for Nuclear Astrophysics (JINA); and $4,620K for ARC-funded cash expenses.

Table 7.1 shows actual cost performance for ARC-funded cash expenses in Q1. More complete tables comparing actual to baseline performance are included in the appendices of this report. Appendix 1 compares Q1 cash expenses to the budget and presents the revised cash forecast for 2006. Appendix 2 compares actual in-kind contributions to the budget and presents the revised in-kind forecast for 2006.

7.1. Q1 Performance - In-kind Contributions

The sum of in-kind contributions in Q1 was $179K against the baseline forecast of $163K and was provided by Fermilab, JHU, UC, UW, and Michigan State University (MSU) for JINA, as follows:

- Fermilab provided support for survey management, data processing and data distribution activities. Effort was also provided to support oversight and planning, and development work for the SEGUE and Supernova projects. The level of effort provided to support development, data processing and data distribution was greater than anticipated, as were the salary costs of the individuals performing this work.
- JHU provided support for the development, loading and hosting of the databases associated with the CAS, CasJobs, and SkyServer, at the anticipated level.
- No in-kind support was provided by UC in Q1; instead, this effort will be concentrated in Q2-3 in preparation for, and support of, the fall SN observing season. For the year, the total anticipated level of in-kind support is in agreement with the baseline budget.

- No support was provided by USNO in Q1; no support was required.
- UW contributed the overhead associated with the plate drilling operation as anticipated.
- MSU provided support for the development of the spectroscopic pipelines that will be used for SEGUE observations in order to estimate atmospheric parameters. The level of effort provided was as anticipated.

Table 7.1. Q1 Cash Expenses and Forecast for 2006 ($K)

Category	2006 – 1st Quarter Baseline Budget	2006 – 1st Quarter Actual Expenses	2006 Operations Budget Total *(for the period Jan-Dec 2006)* Baseline Budget	2006 Operations Budget Total *(for the period Jan-Dec 2006)* Current Forecast
1. Survey Management	91	69	460	455
2. Survey Operations				
2.1. Observing Systems	166	162	725	729
2.2. Observatory Operations	418	373	1,670	1,627
2.3. Data Processing	243	220	775	738
2.4. Data Distribution	103	98	305	320
2.5. ARC Support for Survey Ops	33	3	95	68
3. New Development				
3.1. SEGUE Development	27	14	102	102
3.2. Supernova Development	0	0	0	0
3.3. DA Upgrade	0	11	0	11
3.4. Photometric Calibration	13	14	53	63
4. ARC Corporate Support	19	15	45	52
Sub-total	1,114	979	4,230	4,167
5. Management Reserve	98	0	390	390
Total	1,211	979	4,620	4,557

7.2. Q1 Performance – ARC Funded Cash Expenses

ARC-funded expenses were $979K, or $135K (12%) below the budget of $1,114K, before management reserve.

Survey management costs were $69K against a budget of $91K. Actual support costs for the Director, Project Scientist, EPO Coordinator, Public Information Officer, project management support staff, and Collaboration Affairs were less than anticipated. Expenses for the ARC Business Manager, ARC Office of the Secretary/Treasurer, and Public Affairs (mainly AAS meeting costs) were as anticipated. For the year, the revised forecast for Survey Management expenses is $455K, or $5K (1%) below the baseline budget.

Observing Systems costs were $162K against a budget of $166K. UW costs were less than budgeted, as the amount of UW engineering and technical effort required to support on-going operations was less than anticipated. Other accounts varied by +/- a few $K. We drew down the ARC account holding funds for additional engineering support by a very small amount. Other expenses charged against the ARC account included the purchase of the new DIMM telescope, the deposit for aluminizing the 2.5-meter primary mirror, and the purchase of fire protection equipment for the observatory, to mitigate risks associated with forest fires. For the year, the revised forecast for Observing Systems expenses is $729K, or $4K (1%) above the baseline budget of $725K.

Observatory Support costs were $373K against a budget of $418K. Salaries were below the budget forecast for the quarter, partly because of flux in filling open personnel positions and an administrative mismatch between budgeted and actual salaries; the latter will be corrected in the upcoming Q2 report. Travel expenses also ended up below budget, but should show a larger burn rate in Q2 due to relocation expenses and collaboration meeting travel. Other cost categories showed under-runs, which can be attributed to year-long encumbrances that are not yet registering in these accounts, but will appear in upcoming reports. For the year, the revised forecast for Observatory Support expenses is $1,627K, or $45K (3%) below the baseline budget of $1,672K.

Data Processing costs were $220K against a budget of $243K. Fermilab expenses exceeded the Q1 forecast slightly due to higher than anticipated salary costs, which were partly offset by lower than anticipated material and supply costs. Actual expenses at Princeton and Chicago were lower than anticipated, due to the availability of software development resources at Princeton and the amount of work required from Chicago. For the year, the revised cost forecast for Data Processing is $738K, or $39K (5%) below the baseline budget of $777K.

Data distribution costs were $98K against a budget of $103K. Fermilab expenses were slightly less than anticipated because computer hardware purchases anticipated in Q1 will actually occur in Q2. JHU expenses were in line with expectations. For the year, the cost forecast for Data Distribution is $320K or $14K (5%) above the baseline budget of $306K. The increase is related to additional computer hardware purchases needed to support the JHU mirror site for public data distribution.

Minimal expenses were incurred against the ARC accounts holding funds for additional Survey Operations support (specifically, Additional Scientific Support and Observers' Research Support). Unspent funds from the Observers' Research Support budget have been carried forward into the forecast for Q2-4. The Q2-4 forecast for Additional Scientific Support remains unchanged from the baseline, resulting in a forecasted cost savings given the small level of expenses in Q1. Overall, the revised forecast for Survey Operations support is $68K, or $28K (29%) below the baseline budget of $96K.

Expenses associated with development work for the SEGUE Survey were $14K against a budget of $27K. Expenses to support development work at Princeton were in close agreement with the budget. Funds had been budgeted for development work at Fermilab related to SEGUE data distribution; no costs were charged against this account in Q1 as Fermilab data distribution efforts were focused on DR5 preparations. For the year, the revised forecast for SEGUE development work remains unchanged at $102K. The Fermilab forecast has been revised downward, as experience is indicating that the amount of effort to incorporate SEGUE data into the CAS will be less than earlier predicted. The Princeton forecast has been revised upward as we anticipate adding an additional post-doc in the latter half of the year to augment the level of effort going into software development.

Expenses associated with the DA upgrade were $11K. We had not budgeted funds for development work in 2006. When the budget was prepared in October, it appeared that system commissioning and integration would be complete by the end of 2005 and that ongoing work would be of maintenance and support nature. In fact, some development work carried over into the early part of 2006, as discussed in Section 4.4. As of this writing, all development work is complete and the cost account for these expenses has been closed.

Expenses associated with photometric calibration efforts at Princeton were in close agreement with the budget. For the year, the revised forecast is $63K, or $10K (19%) above the baseline budget of $53K. In the latter half of the year, we anticipate adding an additional post-doc at Princeton to support the calibration effort.

Miscellaneous ARC corporate expenses (i.e., audit fees, bank fees, petty cash, and APO trailer rentals) were slightly lower than anticipated. The budget anticipated audit expenses in Q1, but these will actually be accrued in Q2. For the year, the revised forecast is $52K against the baseline budget of $46K. The forecast has been revised upward to reflect the present outlook for corporate expenses.

7.3. Q1 Performance - Management Reserve

No management reserve funds were expended in Q1. Unspent management reserve has been carried forward into Q2-4.

8. PUBLICATIONS

In Q1, there were 13 papers based on SDSS data that were published by members of the SDSS collaboration. There were also 32 papers published by individuals outside of the collaboration, using publicly available data. Exhibit 3 lists papers published by members of the SDSS Collaboration; Exhibit 4 lists papers published by individuals outside of the SDSS collaboration.

At the time of this writing, there are 1058 published refereed papers that include 'SDSS' or 'Sloan' in their title and/or abstract. These papers have been cited a total of 30,305 times, including 57 papers cited more than 100 times.

Exhibit 1. CY2006 Cash Budget Forecast

SDSS-II CY2006 Budget Forecast as of April 30, 2006

Code	Item	Inst	Qtr 1 Jan-Mar Approved Baseline Budget	Qtr 1 Jan-Mar Actual Expenses	Qtr 1 Jan-Mar Variance (%)	Qtrs 2-4 Apr-Dec Approved Baseline Budget	Qtrs 2-4 Apr-Dec Apr-2006 Forecast	Qtrs 2-4 Apr-Dec Variance (%)	CY2006 Total Approved Baseline Budget	CY2006 Total Apr-2006 Forecast	CY2006 Total Variance (%)
OPERATIONS BUDGET - CASH EXPENSES											
1.0 Survey Management											
SSP-221	ARC Secretary/Treasurer	ARC	2	2	-6%	9	9	-1%	12	11	-2%
SSP-234	ARC Business Manager	ARC	16	17	3%	49	50	2%	65	67	2%
SSP-246	PU Office of the Project Scientist	PU	4		-94%	69	72	4%	73	72	-1%
SSP-248	FNAL Support for Survey Management	FNAL	15	12	-23%	45	45	0%	60	57	-6%
SSP-267	UC Support for Survey Management	UC	14	11	-19%	65	65	0%	79	76	-3%
SSP-270	UW Support for EPO Coordinator	UW	9	4	-56%	26	45	71%	35	49	39%
SSP-291a	ARC Support for Public Affairs	ARC	8	9	14%	8	4	-44%	16	13	-16%
SSP-291b	ARC Support for Spokesperson	ARC	4	1	-77%	11	11	0%	14	11	-19%
SSP-291c	ARC Support for Collaboration Affairs	ARC	11	4	-66%	33	33	0%	44	37	-16%
SSP-291i	ARC Support for Public Information Officer	ARC	7	10	34%	22	20	-11%	30	30	0%
SSP-291L	ARC Support for EPO Webmaster and Teacher	ARC	2	0	-100%	31	32	1%	33	32	-4%
	Survey Management Sub-total		**91**	**69**	**-24%**	**369**	**386**	**4%**	**460**	**455**	**-1%**
2.0 Survey Operations											
2.1 Observing Systems											
SSP-231	UW Observing Systems Support	UW	44	36	-17%	191	198	4%	235	234	0%
SSP-232	PU Observing Systems Support	PU	11	11	1%	36	37	3%	46	48	2%
SSP-242	FNAL Observing Systems Support	FNAL	85	91	8%	260	260	0%	345	351	2%
SSP-261	FNAL Data Acquisition System Support	FNAL	4	10	135%	11	11	0%	16	22	38%
SSP-291d	ARC Observing Systems Support	ARC	23	13	-41%	61	61	0%	84	74	-11%
	Observing Systems Sub-total		166	162	-2%	559	567		725	729	1%
2.2 Observatory Support											
SSP-235	NMSU Site Support	NMSU	418	373	-11%	1,254	1,254	0%	1,672	1,627	-3%
2.3 Data Processing											
SSP-240	FNAL Software and Data Processing Support	FNAL	183	187	2%	336	330	-2%	519	517	0%
SSP-238	PU Software and Data Processing Support	PU	46	22	-53%	166	157	-5%	212	179	-16%
SSP-239	UC Software and Data Processing Support	UC	14	11	-24%	32	32	0%	46	43	-7%
	Data Processing Sub-total		243	220	-10%	534	519	-3%	777	738	-5%
2.4 Data Distribution											
SSP-268	FNAL Data Distribution Support	FNAL	90	84	-6%	167	167	0%	257	252	-2%
SSP-237	JHU Data Archive Development and Support	JHU	13	14	2%	36	55	54%	49	69	40%
	Data Distribution Sub-total		103	98	-5%	203	222	9%	306	320	5%
2.5 ARC Support for Survey Operations											
SSP91f	ARC Additional Scientific Support	ARC	30	2	-93%	53	53	0%	82	54	-34%
SSP91h	ARC Observers' Research Support	ARC	4	1	-82%	11	13	27%	14	14	0%
	Data Distribution Sub-total		33	3	-92%	63	66	5%	96	68	-29%
	Survey Operations Sub-total		**963**	**855**	**-11%**	**2,614**	**2,629**	**1%**	**3,577**	**3,484**	**-3%**

Exhibit 1. CY2006 Cash Budget Forecast (continued)

SDSS-II CY2006 Budget Forecast as of April 30, 2006

		Inst	Qtr 1 Jan-Mar: Approved Baseline Budget	Qtr 1 Jan-Mar: Actual Expenses	Qtr 1 Jan-Mar: Variance (%)	Qtrs 2-4 Apr-Dec: Approved Baseline Budget	Qtrs 2-4 Apr-Dec: Apr-2006 Forecast	Qtrs 2-4 Apr-Dec: Variance (%)	CY2006 Total: Approved Baseline Budget	CY2006 Total: Apr-2006 Forecast	CY2006 Total: Variance (%)
OPERATIONS BUDGET - CASH EXPENSES											
3.0 New Development											
3.1 SEGUE Survey Development											
SSP-138	PU Software and Data Processing Support	PU	13	14	7%	40	53	33%	53	67	27%
SSP-268	FNAL Data Distribution Support	FNAL	14	0	-100%	35	35	0%	49	35	-29%
	SEGUE Development Sub-total		27	14	-48%	75	88	18%	102	102	0%
3.2 Supernova Survey Development									0	0	
	No allocation		0	0	---	0	0	---	0	0	---
	Supernova Development Sub-total		0	0	---	0	0	---	0	0	---
3.3 Data Acquisition System Upgrade											
SSP-161	FNAL DA Upgrade		0	11	---	0	0	---	0	11	---
	DA Upgrade Sub-total		0	11	---	0	0	---	0	11	---
3.4. Photometric Calibration Development											
SSP-138	PU Software and Data Processing Support	PU	13	14	7%	40	49	23%	53	63	19%
	Photometric Calibration Sub-total		13	14	7%	40	49	23%	53	63	19%
	New Development Sub-total		**41**	**39**	**-3%**	**115**	**137**	**19%**	**155**	**176**	**13%**
4.0 ARC Corporate Support											
SSP91e	ARC Corporate Support	ARC	19	15	-19%	27	37	36%	46	52	13%
	ARC Corporate Support Sub-total		**19**	**15**	**-19%**	**27**	**37**	**36%**	**46**	**52**	**13%**
Cash Budget Sub-total			**1,114**	**979**	**-12%**	**3,125**	**3,188**	**2%**	**4,238**	**4,167**	**-2%**
5.0 Management Reserve		ARC	98	0	-100%	293	390	33%	390	390	0%
TOTAL CASH BUDGET			**1,211**	**979**	**-19%**	**3,417**	**3,578**	**5%**	**4,628**	**4,557**	**-2%**

Exhibit 2. CY2006 In-Kind Contribution Forecast

SDSS-II CY2006 Budget Forecast as of April 30, 2006

			Qtr 1 Jan-Mar			Qtrs 2-4 Apr-Dec			CY2006 Total		
		Inst	Approved Baseline Budget	Actual Expenses	Variance (%)	Approved Baseline Budget	Apr-2006 Forecast	Variance (%)	Approved Baseline Budget	Apr-2006 Forecast	Variance (%)
OPERATIONS BUDGET: IN-KIND											
1.0 Survey Management											
SSP-248	FNAL Support for Survey Management	FNAL	33	35	8%	101	101	0%	133	136	2%
	Survey Management Sub-total		**33**	**35**	**8%**	**101**	**101**	**0%**	**133**	**136**	**2%**
2.0 Survey Operations											
2.1 Observing Systems											
SSP-231	UW Observing Systems Support	UW	15	15	0%	45	45	0%	60	60	0%
	Observing Systems Sub-total		15	15	0%	45	45	0%	60	60	0%
2.3 Data Processing											
SSP-239	UC Software and Data Processing Support	UC	5	0	-100%	14	14	0%	19	14	-25%
SSP-240	FNAL Software and Data Processing Support	FNAL	46	79	71%	139	139	0%	185	218	18%
SSP-257	USNO Software and Data Processing Support	USNO	11	0	-100%	32	32	0%	42	32	-26%
SSP-269	MSU SEGUE Software Development and Support	MSU	0	0	---	31	31	0%	31	31	0%
	Data Processing Sub-total		62	79	28%	216	216	0%	278	295	6%
2.4 Data Distribution											
SSP-237	JHU Data Archive Development and Support	JHU	26	26	0%	57	66	16%	82	91	11%
SSP-240	FNAL Software and Data Processing Support	FNAL	7	9	32%	20	20	0%	26	29	8%
	Data Distribution Sub-total		32	34	7%	77	85	11%	109	120	10%
	Survey Operations Sub-total		**109**	**129**	**18%**	**338**	**347**	**3%**	**447**	**475**	**6%**
3.0 New Development											
3.1 SEGUE Survey Development											
SSP-237	JHU Data Archive Development and Support	JHU	6	0	-100%	18	16	-6%	23	16	-30%
SSP-269	MSU SEGUE Software Development and Support	MSU	16	16	0%	16	16	0%	31	31	0%
	SEGUE Development Sub-total		21	16	-27%	33	32	-3%	55	48	-13%
	New Development Sub-total		**21**	**16**	**-27%**	**33**	**32**	**-3%**	**55**	**48**	**-13%**
TOTAL IN-KIND CONTRIBUTIONS			**163**	**179**	**10%**	**472**	**479**	**2%**	**635**	**659**	**4%**
TOTAL OPERATING BUDGET (Cash and In-kind)			**1,374**	**1,158**	**-16%**	**3,889**	**4,057**	**4%**	**5,263**	**5,215**	**-1%**

Exhibit 3. Papers from within the SDSS Collaboration

1. A New Milky Way Dwarf Satellite in Canes Venatici. ApJ L submitted - D. B. Zucker, et. al.

2. The Sloan Digital Sky Survey Quasar Lens Search. I. Candidate Selection Algorithm. AJ submitted – M. Oguri, et. al.

3. Quasars Probing Quasars I: Optically Thick Absorbers Near Luminous Ionizing Sources. ApJ submitted – J.F. Hennawi, et. al.

4. Type II Quasars from the Sloan Digital Sky Survey: V. Imaging host galaxies with HST. AJ submitted – N. Zakamska, et al

5. SDSS Pre-Burst Observations of Recent Gamma-Ray Bursts. PASP accepted – R. Cool, et al.

6. Chandra Observations of the Highest Redshift Quasars from the Sloan Digital Sky Survey. ApJ accepted – O. Shemmer, et al.

7. A 110 MG cyclotron harmonic in the optical spectrum of RX J1554.2+2721. A&A accepted - A. Schwope, et al.

8. A Spectroscopic Survey of Faint Quasars in the SDSS Deep Stripe: I. Preliminary Results from the Co-added Catalog. AJ accepted – L. Jiang, et al

9. A Catalog of Broad Absorption Line Quasars from the Sloan Digital Sky Survey Third Data Release. ApJS accepted – J. Trump, et al.

10. Percolation Galaxy Groups and Clusters in the SDSS Redshift Survey: Identification, Catalog, and the Multiplicity Function. ApJ submitted – A.A. Berlind, et al.

11. The Effect of Large-Scale Structure on the SDSS Galaxy Three-Point Correlation Function. MNRAS accepted – R. Nichol, et al.

12. Andromeda X, A New Dwarf Spheroidal Satellite of M31: Photometry. ApJL submitted – D.B. Zucker, et al.

13. Average Extinction Curves and Relative Abundances for QSO Absorption Line Systems at 1<Z(ABS)<2. MNRAS accepted – D.G. York, et al.

Exhibit 4. Publications Based on Public Data

1. GalICS V : Low and high order clustering in mock SDSS's MNRAS in press - J. Blaizot, et al.

2. A Comprehensive Study of 2 000 Narrow Line Seyfert 1 Galaxies from the Sloan Digital Sky Survey: I. The Sample. ApJS accepted – H. Zhou**,** et al.

3. The star formation history of early-type galaxies as a function of mass and environment. MNRAS submitted - M.S. Clemens, et al.

4. Cross-correlation of WMAP 3rd year and the SDSS DR4 galaxy survey: new evidence for Dark Energy. MNRAS submitted - A.Cabre, et al.

5. The structure of galactic disks: Studying late-type spiral galaxies using SDSS. A&A submitted - M. Pohlen, et al.

6. Gas metallicity diagnostics in star-forming galaxies. A&A submitted – T. Nagao, et al.

7. Morphology of Luminous Infrared Galaxies in the Local Universe. ApJ submitted - J. L. Wang, et al.

8. Modelling galaxy clustering in a high resolution simulation of structure formation. MNRAS submitted – L. Wang, et al.

9. The OLS-lens survey: The discovery of five new galaxy-galaxy strong lenses from the SDSS. MNRAS accepted - J.P. Willis, et al.

10. Oxygen abundance in the Sloan Digital Sky Survey. A&A accepted - F. Shi, et al.

11. Six Peaks Visible in the Redshift Distribution of 46,400 SDSS Quasars Agree with the Preferred Redshifts Predicted by the Decreasing Intrinsic Redshift Model. ApJ accepted - M.B. Bell, et al.

12. The 3D skeleton of the SDSS. ApJ Letters submitted –T. Sousbie, et al.

13. The asymmetric structure of the Galactic halo. MNRAS accepted - Y. Xu, et al.

14. On the luminosity function of galaxies in groups in the Sloan Digital Sky Survey. ApJ submitted – A. Zandivarez, et al.

15. A new bound on the neutrino mass from the SDSS baryon acoustic peak. JCAP submitted – A. Goobar, et al.

16. Abell 2111: An Optical and Radio Study of the Richest Butcher-Oemler Cluster. AJ accepted – N.A. Miller, et al.

17. CIRS: Cluster Infall Regions in the Sloan Digital Sky Survey I. Infall Patterns and Mass Profiles. AJ submitted – K. Rines, et al.

18. The Spatial Clustering of Low Luminosity AGN. ApJ submitted – A. Constantin, et al.

19. The Mid-Infrared/Optical Properties of Type 1 Quasars. ApJS submitted – G. Richards, et al.

20. The Small-Scale Environment of Quasars. ApJ submitted – W. Serber, et al.

21. Abell 2111: An Optical and Radio Study of the Richest Butcher-Oemler Cluster. AJ accepted – N.A. Miller, et al.

22. SDSS J143030.22-001115.1: A misclassified narrow-line Seyfert 1 galaxy with flat X-ray spectrum. ChJAA accepted – W. Bian, et al.

23. Probing the Sagittarius stream with blue horizontal branch stars. MNRAS accepted – L. Clewley, et al.

24. Color, Structure, and Star Formation History of Dwarf Galaxies over the last ~3 Gyr with GEMS and SDSS. ApJ accepted – F.D. Barazza.

25. Spectroscopic Identification of Cool White Dwarfs in the Solar Neighbourhood. ApJ accepted – A. Kawka, et al.

26. The environmental dependence of galaxy clustering in the Sloan Digital Sky Survey. MNRAS submitted – U. Abbas, et al.

27. The Environment of Active Galaxies in the SDSS-DR4. A&A accepted - G. Sorrentino, et al.

28. The Blueshift of the [O III] Emission Line in NLS1s. MNRAS accepted – W. Bian, et al.

29. MT Survey for Intervening MgII Absorption. ApJ accepted – D.B. Nestor, et al.

30. SDSS Pre-Burst Observations of Recent Gamma-Ray Burst Fields. PASP Submitted – R.J. Cool, et al.

31. The Luminosity, Colour and Morphology dependence of galaxy filaments in the Sloan Digital Sky Survey Data Release Four. Submitted to MNRAS – B. Pandey, et al.

32. UV-Optical Colours as Probes of Early-Type Galaxy Evolution. ApJ Submitted – S. Kaviraj, et al.