SDSS Spectroscopic Systems Requirements on Survey Operations

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Introduction

The requirements for the spectroscopic data systems should be based on the science goals of the SDSS as stated in the Principles of Operation, explained in the SDSS Project Book, and distilled in the Science Requirements document of Michael Strauss. The goal is to have a set of testable requirements on the hardware, observing procedures, and analysis software that, if met, ensure the primary science goals of the SDSS will be achieved.

We follow the Crocker convention: each requirement is of the form:

- The quantitative requirement.
- The scientific justification for the requirement.
- The consequences of not meeting the requirement; that is, what scientific goals we sacrifice if we do not meet the requirement, and what the fall back position should be.
- Concrete tests of the requirement, including the analysis to be done on the data, and any special data or analysis that need to be obtained.
- The timescale within which these tasks will be done.
- Who has been given the authority to carry out these tests, and who has been given authority to sign off on them.
- The resources required to carry out these tasks.

We note explicitly that the science justification is to be a **science justification**. We further note that one of the main science goals of the survey is a uniform and homogeneous data set of high quality.

We assume that the Connolly/Strauss requirements were tested during commissioning, while here we address the needs of an ongoing production survey. This assumption is equivalent to the statement that over the last year we achieved high quality spectra and ongoing we aim to maintain that high quality.

Lastly, we will draw the distinction between a plate acceptance requirement and a survey systems requirement. The former are a formal basis of acceptance of data; the latter are aimed at keeping the system at the high state of performance achieved in 2002.

1 Requirements Per Plate

1.1 Data Sanity

The data obtained at the mountain should make sense to an experienced observer in a one minute visual inspection of the image.

- **Science Case-** The data must make sense in order to derive our science.
- **Consequences-** We waste time and effort taking data that are not of survey quality.
- **Responsible-** Kleinman, SubbaRao
- **Resources Needed-** Ten minutes of observer time per plate at the mountain. Mark SubbaRao's inspection program post-factory. A database of variable quality spectro data.

Notes-

Guidelines for the correctness of the spectro report are given in Declaring Plates Bad (see lineage section).

Tests-

An experienced observer should be able to judge in one minute's time whether the data make sense. We plan on implementing this via a 10% sampling of the data.

At the mountaintop and during data taking the steps are:

- a visual check of the nightly bias frames
- a visual check of one set of flats
- a visual check of one set of arcs
- a visual check of one exposure from each plate
- examination of 5% of the spectra themselves
- a check of the correctness of the spectro report

The astronomers at the factory check that the observers had time to make this check and if not, perform it themselves. This provides a level of redundancy.

As the final stage in the factory, a human inspection of the spectro1d output is performed on $\sim$ 10% of the fibers of a plate. This inspection is required for data acceptance.

Procedure on Fail-

File a PR. At the mountain, take steps if one knows what to do, else call in the instrument scientist and Survey Operations. At the inspection stage, if data problems are noted bring them to the Survey Quality phone cons.

Status-

A set of guidelines as to what "makes sense" are to be prepared for the observers; Kleinman and Annis are tasked with this.

Already implemented is the astronomer inspection of the final merged spectra, performed by Mark SubbaRao at Chicago. This is an examination of 5-10% of all spectra, typically the worst cases.

1.2 CCD Performance

The spectrograph CCDs should behave as photometric instruments.

- **Science Case-** This, like the sanity requirement, is one of the base assumptions of all the other requirements.
- **Consequences-** If it is not met, it is very unlikely we can meet our science goals.
- **Responsible-** Brinkmann
- **Resources Needed-** Code to perform the tests. IOP can provide the bad column map, the others are straightforward. A web page as a baseline/database of prior CCD status.

Tests-

An experienced instrument scientist can look at 4 numbers per CCD and judge whether the CCD is performing well. Further, the appearance of new bad columns may foretell a CCD changing condition.

At monthly checkout the instrument scientist will

- Bias: take 25 frames
  - measure bias
  - measure gain
  - measure read noise
  - measure bad columns
- Dark: take 3 900 second frames
  - measure dark current

A web page containing the results as a table will provide the baseline for changing instrument performance. We propose this page to be hosted at APO and maintained by the instrument scientist.

The current procedure to test these is laid out in the monthly checkout.

Procedure on Fail-

File a PR. If the instrument is behaving unexpectedly, the instrument scientist can fix what is obvious. If not, raise to survey operations those problems that are not.

Status-

Currently the data are taken and automated tests are performed; they do not report most of what is requested here.

1.3 S/N Threshold

The S/N threshold for data acceptance will be that the mean $(S/N)^2_{gri} \geq 15$ and that the minimum $(S/N)^2_{g,i} \geq 15$. At the mountain, the threshold number is 13. The minimum S/N for inclusion in a combined spectra will be $(S/N)^2_{g,i} \geq 2$, the range of exposure times included in a combination will be $\leq 100\%$, and the number of observations in a finished plate will be ≥ 3.

- **Science Case-** This S/N is required to meet the downstream requirements, and since we observe through clouds this cannot be an exposure time limit. The inclusion requirements have been set by spectro2d.
- **Consequences-** Many or most of the down stream requirements cannot be met. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Kleinman and Annis
- **Resources Needed-** SOS and spectro2d

Notes-

We take the spectro2d definition of $(S/N)^2$. The mountain top uses the SOS definition, which is more robust. The spectro2d definition is approximately 1.5 times that of SOS so the bias is towards conservative mountain top acceptance.

Tests-

At the mountain top the observers judge the state of a plate using the SOS outputs. When the cumulative $(S/N)^2$ rises above 13-15 the plate is declared done in the plate database and is unplugged.

At the factory, a plate is eligible for being accepted if the mean of the 6 spectro2d measurements sp1,sp2, g,r,i $(S/N)^2$ is above the threshold of 15, and if the minimum of the 4 spectro2d measurements sp1,sp2, g,i $(S/N)^2$ is above the threshold of 15. An exposure will only be considered for inclusion in the spectro2d analysis if all 4 sp1,sp2, g,i $(S/N)^2$ are above the threshold of ≥ 2.

Procedure on Fail-

At the mountain, take another exposure.

At the factory, if the reduced spectra do not meet survey requirements, this one and all others, the plate will be declared "not done" in the plate database, which places the tile back into the observing queue.

Status-

Already implemented, although the loop back to the plate database has yet to be demonstrated.

1.4 Redshift Success

The success of measuring redshifts on a main survey plate should be $\geq 95\%$.

- **Science Case-** For normal survey plate this is a requirement both of homogeneity and of time to survey completion.
- **Consequences-** We take less spectra over the lifetime of the survey, and systematic redshift incompleteness. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Annis
- **Resources Needed-** spectro1d

Notes-

This test is defined for objects with holetype == OBJECT. We do not plate an additional requirement on classification because we not that is not what we need to meet, despite the fact that the classification will have to be accurate for redshift success to be high.

Tests-

At the factory, a plate is eligible for being accepted if the spectro1d measurement of the redshifts of the spectra have success rate of $\geq 95\%$. In detail, this is whether zstatus != FAILED. (zstatus is a flag set by the spectro1d team at an appropriate threshold, currently set at z_confidence = 0.45.

Procedure on Fail-

Check why this occurred. Likely outcomes will be to (a) raise to Survey Operations (if the cause is instrumental), and (b) raise to Science Pipelines if the cause looks target selection related.

Status-

Already implemented.

1.5 Image Centering

The two spectro graphs should have continuous wavelength coverage of 3900-9100Åand the entire traces of all fibers should appear on the image.

- **Science Case-** We require the ability to see 3727Å at modest redshift (hence 3900Å) and Ly-α at high-z (hence 9100Å). The trace requirement is one of homogeneity and uniformity.
- **Consequences-** Our spectral database is less uniform, hence our spectral samples are less uniform. Our complete samples are less complete. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Lampeitl
- **Resources Needed-** SOS

Notes-

The procedure to test this is laid out in the monthly checkout.

This requirement requires at least one arc per plate per night.

Tests-

SOS already measures the extent of the spectra in wavelength and the minimum and maximum fiber placement in space. The test is to:

- Check wavemin $\leq$ 3794, 5791 for b,r cameras
- Check wavemax $\geq$ 6150, 9225 for b,r cameras
- Check that xmin $\geq$ 0 for both spectrographs
- Check that xmax $\leq$ 2047 for both spectrographs

We then plan to monitor this at the mountain, and to use this at the factory as a plate acceptance criteria.

Procedure on Fail-

Generally a collimation will fix this. Since our real time instrumentation is good at finding this, the collimation step occurs as soon as we see it go out of bounds.

Status-

Already implemented at the mountain top, but not at the factory.

1.6 Focus/Collimation

The image of the fibers delivered at the CCD should be in focus: the spatial,λ Gaussian width of the fibers in a flat,arc should be ≤ 1.5 pixels.

- **Science Case-** Resolution affects our ability to do sky subtraction, and our ability to work fine scale problems like Ly-α forest measurements are diminished.
- **Consequences-** Failing this requirement in particular hurts our survey homogeneity and uniformity. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Lampeitl
- **Resources Needed-** SOS

Tests-

This requirement is tested closely at the mountain:

- Check wsigma ≤ 1.05
- Check xsigma ≤ 1.05

We will perform the same check at the factory,

Procedure on Fail-

Part 1: perform a collimation immediately on fail, rejecting exposures take prior to the collimation Part 2: at the factory, reject the plate, entering the plate as "not done" in the plate database thus opening up the tile for reobservation.

Status-

SOS already produces the data products needed but the test itself does not seem to be in place.

1.7 Stability of the Spectral Resolution

The FWHM of unblended sky lines in all science spectra will be less than 1.05 times that of the arc lines in the same part of the spectrum.

- **Science Case-** The primary consequence is that the rms redhift measurements on galaxies be ≤ 30 km/s.
- **Consequences-** We lose precision on large scale structure measurements, amongst many other implications. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Lampeitl/Annis
- **Resources Needed-** Modified SOS

Notes-

This is a requirement on flexure and our ability to correct for it.

Combined with the focus/collimation requirement above, this fulfills the science requirement that the minimum spectral resolution in a 15 minute exposure at any wavelength in any fiber is 1800.

All spectra are extracted from ~ 15 min exposure before coadding. Flexure in a 15 min exposure amounts to approximately 1/4 pixel. This is approximately a factor of 4 below that required to produce a 5% effect in the FWHM of sky lines.

Some amount of flexure is actually a help. Since the instrument is slightly undersampled both in wavelength and X, some amount of flexure and modest defocus helps with the undersampling. In the case of flexure, this amounts to drizzling the wavelength coverage and is reported to be a big help.

Tests-

At the mountain, SOS checks for changes between the flats and the science sky lines. If the difference is above some limit, SOS requests "post-calib" calibration data.

At the factory we will test the requirement directly.

Procedure on Fail-

At the mountain, take post calibrations. At the factory, reject the plate and enter the plate as "not done" in the plate database thus opening up the tile for reobservation. If endemic, file a PR and raise to Survey Operations.

Status-

At the mountain, already implemented. At the factory work needs to be done.

1.8 Accuracy of the Wavelength Solution

The RMS deviation between the wavelength solution derived from the arc lines and the measured positions of the individual arc and sky lines should be less than 0.1/0.2Å in the blue/red camera for all fibers over the full spectral range.

- **Science Case-** Large scale structure demands accurate redshifts: 1Å at 4000Å corresponds to a noise of 75 km/s, which corresponds to $\approx 1Mpc$.
- **Consequences-** Within limits, this just adds noise to the large scale structure measurements, and to the extent that sky subtraction goes bad classification suffers. *A data acceptance criteria: data will be rejected.*
- **Responsible-** Lampeitl
- **Resources Needed-** Modified SOS (?)

Tests-

At the mountain the first check on this is to watch the SOS measurement of arc bestcorr, demanding that it be ≥ 0.7.

At the factory the actual requirement will be tested.

Procedure on Fail-

At the mountain, take another arc, re-check solution. If continued failure, file a PR and raise to Survey Operations and/or Science Pipelines.

At the factory, reject the plate and enter the plate as "not done" in the plate database thus opening up the tile for reobservation.

Status-

Mostly implemented at the mountain top, no implementation at the factory. SOS already produces the data products needed, I believe, but the test itself does not seem to be in place.

The state of the current reductions in regards to this is unknown.

1.9 Spectrophotometry and Fluxing

The synthetic unsmeared Spectro magnitudes and the measured Photo g,r,i fiber magnitudes should agree to a mean offset of 0.1 mag and a RMS dispersion of $\leq$ 0.1 mag for stars; the synthetic unsmeared Spectro magnitudes and the measured Photo r fiber magnitudes should agree to a mean offset of 0.1 mag and a RMS dispersion of $\leq$ 0.1 mag for galaxies.

- **Science Case-** Accurately fluxed spectra yields interesting galaxy science; correctly shaped continua aids in redshifts, classification, and line flux/luminosity measurements.
- **Consequences-** A large set of non-core science is impacted, including our ability to directly use spectral synthesis models to interpret our galaxy spectra.
- **Responsible-** Annis
- **Resources Needed-** spObj files

Notes-

It is pointed out that plates designed high airmass, such as is required for either extreme North or South survey limits, present great problems for spectrophotometry over the entire wavelength coverage of the SDSS spectra.

Tests-

Since both SOS and spectro2d measures synthetic magnitudes, this is just a catalog matching and subtraction.

This will be used at the factory as a plate acceptance criteria.

Procedure on Fail-

File a PR, and try to understand why it failed. Raise to survey operations.

Status-

2 Requirements Per Dark Run

2.1 Spectroscopic System Throughput

The spectroscopic system must be capable of achieving $(S/N)^2_{g,i} = 20$ in three 15 minute exposures on clear nights in reasonable seeing (≤ 2").

- **Science Case-** Below this limit our LRG redshift success rate falls.
- **Consequences-** We must expose longer, and over the lifetime of the survey we obtain less spectra.
- **Responsible-** Annis
- **Resources Needed-** N/A

Notes-

We take the SOS/spectro2d definition of $(S/N)^2$.

Operationally this is what one wants to know: is the throughput of the system high enough to achieve the science goals.

One might also put a requirement on the mean time for spectro graphic setup, the time allocated to a plate not spent in science exposures or calibrations.

Tests-

For those nights reported clear and with reasonable seeing, plot $(S/N)^2_{g,i}$ versus exposure time.

Procedure on Fail-

Raise to Survey Operations, who will schedule sub-system tests of throughput.

Status-

2.2 Galaxy Redshift Reproducibility

For galaxies selected by the main galaxy target selection, classified by spectro1d as galaxies, and with successful redshift measurements, the redshifts will be reproducible to an RMS of 30 km/s. The maximum rate of redshift error, defined as $\Delta z > 300$ km s^{-1} with both z declared of high confidence, cannot exceed 1% of the main galaxy sample.

This is single most important requirement in this document.

- **Science Case-** This stringent constraint is necessary for large-scale structure studies; more than 1% error rate in galaxy redshifts will certainly cause problems with measuring the density of galaxies on large scales.
- **Consequences-** We fail to meet our stated primary goal.
- **Responsible-** SubbaRao
- **Resources Needed-** Repeated observations: a pair of tiles that between them may be observed throughout the year will be defined as repeatability tiles. At shake time one or both plates will be observed as part of the normal shake procedures.

Notes-

There are two distinct items being tested here, but they are logically a unit.

We also do not understand the state of systematic redshift error checking: emission vs. cross correlation redshifts, differing templates and dependence on z, type.

Tests-

This test will be performed using the repeat shake observations. It amounts to the a catalog comparison. The RMS velocity error will be defined over the magnitude range $19.0 < r'_{fiber} < 19.5$ and will be based on those galaxies within the 99th percentile of the distribution of redshift differences.

Look at the shape of the rms distribution, including the QA fibers.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

2.3 LRG Redshift Reproducibility

For galaxies selected by the LRG target selection, classified by spectro1d as galaxies, and with successful redshift measurements, the redshifts will be reproducible to an RMS of 100 km/s.

- **Science Case-** This constraint is necessary for large-scale structure studies.
- **Consequences-** We fail to meet our stated goal of LRG LSS.
- **Responsible-** SubbaRao
- **Resources Needed-** Repeated observations: observations of the repeatability tiles.

Notes-

We drop the redshift error rate requirement (The maximum rate of redshift error, defined as $\Delta z > 1000$ km s^{-1} with both z declared of high confidence, cannot exceed 1% of the sample) as being untestable on the ~ 50 LRG expected on a single plate.

Tests-

This test will be performed using the repeat shake observations. It amounts to the a catalog comparison. The RMS velocity error will be defined over the magnitude range $19.0 < r'_{fiber} < 19.5$ and will be based on those galaxies within the 90th percentile of the distribution of redshift differences (i.e. allowing for up to 10% of the redshifts to be excluded from analysis). 90% of confirmed LRG must result in a repeatable measure of their redshift.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

2.4 Quasar Redshift Reproducibility

For QSOs selected by the main QSO target selection module, classified as qsos by classified by spectro1d as qsos, and with successful redshift measurements, the redshifts of non-BAL QSOs (BAL QSOs) will be reproducible to an RMS of 0.005 (0.02).

- **Science Case-** Small scale structure in quasar-galaxy cross correlation analysis. Beyond that, there is the survey uniformity and homogeneity goal.
- **Consequences-** If the RMS increases to 0.05, we lose the science in the justification. Above that, the main quasar sample science goals are likely to be affected.
- **Responsible-** SubbaRao
- **Resources Needed-** Repeated observations: observations of the repeatability tiles.

Notes-

An RMS of 0.005 corresponds to 1500 km/s. We likely do much better on repeat observations for the same

The QSOs used in this calculation will lie in the magnitude range $18.7 < g' < 19.2$ or $18.4 < i' < 18.9$ for the main QSO sample and $19.5 < i' < 20.5$ for the high redshift QSO sample (measured from dereddened fiber magnitudes) and will have been identified as having high confidence redshifts by the 1D spectroscopic pipeline. The RMS redshift measurement for non-BAL QSO's will be based on QSOs within the 98th percentiles (i.e. allowing for up to 2% of the redshifts to be excluded from analysis).

Tests-

On repeated plates, measure RMS of redshift differences.

This should probably be done on reruns as well, against the quasar working group provided truth catalog.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

2.5 Star Redshift Reproducibility

The repeatable RMS dispersion of the radial velocity measurement of stars (where repeatable refers to a plate that has been replugged prior to reobservation) will be < 30 km/s over the magnitude interval $19.0 < r'_{fiber} < 19.5$.

- **Science Case-** Required for studies of galactic structure.
- **Consequences-** We lose the ability to see the halo star streams.
- **Responsible-** Annis
- **Resources Needed-** Repeated observations: observations of the repeatability tiles.

Notes-

The velocity zeropoints were checked during commissioning with observations of M67.

Tests-

On repeated plates, measure RMS of redshift differences.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

3 Requirements Per Spectroscopic Rerun

3.1 Galaxy Classification Accuracy

For galaxies selected by the main galaxy target selection 99% of all spectroscopically confirmed galaxies must be classified as such by the spectroscopic pipeline.

- **Science Case-** Required for the homogeneity of the main galaxy sample. Truly random subsampling would be fine, but the likely failure modes here are systematic and hence would hurt large scale structure measurements.
- **Consequences-** Our sample is less homogeneous, and much more care would be needed to sub-divide the galaxy sample for large scale structure measurements.
- **Responsible-** SubbaRao
- **Resources Needed-** Spectroscopic plate testbed

Tests-

On testbed of known spectroscopic types, check accuracy of classification. This testbed should be of a size of $\sim 1\%$ of the full survey.

The galaxy working group is encouraged to produce a galaxy catalog that would be useful as a testbed.

We plan to run this test prior to turning any spectroscopic rerun into a live rerun reducing data from the mountain.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

3.2 Quasar Classification Accuracy: False Negatives

For a spectroscopically confirmed sample of QSOs a minimum of 98% of QSOs will be correctly classified as such by the spectroscopic pipeline, with a misclassification into a category other then "unknown" not to exceed 1%.

- **Science Case-** The strongest justification here is uniformity and homogeneity of the survey data.
- **Consequences-** The sample will be more incomplete, harder to use.
- **Responsible-** SubbaRao
- **Resources Needed-** Quasar Working Group quasar catalog

Notes-

Actual requirements beyond homogeneity would require a demonstration of the consequences of incompleteness on, say, the luminosity function as a function of type and redshift.

Tests-

On a testbed of known spectroscopic types encompassing the main survey quasars and high-z quasars check the accuracy of classification.

The quasar working group has produced a quasar catalog for the EDR and is in the process of preparing the same for DR1. Encompassing as these do the combined effort of the collaboration, these catalogs would form the ideal testbed. The minimum testbed would be a sample of $\sim 1\%$ of the full survey.

We plan to run this test prior to turning any spectroscopic rerun into a live rerun reducing data from the mountain.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

3.3 Quasar Classification Accuracy: False Positives

Of sources selected by the QSO target selection module but which are not spectroscopically confirmed as QSOs (i.e., stars) no more than 1% will be classified with high confidence as QSOs.

- **Science Case-** The strongest justification here is uniformity and homogeneity of the survey data.
- **Consequences-** The sample will be more incomplete, harder to use.
- **Responsible-** SubbaRao
- **Resources Needed-** Quasar Working Group quasar catalog

Tests-

On a testbed of known spectroscopic types encompassing the main survey quasars and high-z quasars check the accuracy of classification.

The quasar working group has produced a quasar catalog for the EDR and is in the process of preparing the same for DR1. Encompassing as these do the combined effort of the collaboration, these catalogs would form the ideal testbed. The minimum testbed would be a sample of $\sim 1\%$ of the full survey.

We plan to run this test prior to turning any spectroscopic rerun into a live rerun reducing data from the mountain.

Procedure on Fail-

File a PR. Investigate and raise to Science Pipelines.

Status-

Already implemented as a test during commissioning.

4 Lineage

The requirements laid out here are from a long line of requirements documents, starting with instrument design and proceeding through commissioning. The emphasis here is on normal operations.

Requirements documents, with those accepted by survey management noted by *.

- Strauss 1995
  I saw this in 2003, but can't relocate it
- Connolly 1998,
  Requirements and Status of the SDSS Spectroscopic Systems,
  http://tdserver1.fnal.gov/project/sdss/dp-review-700/dp-review-docs/spectro-req-review.pdf
- *Kent 1999,
  Data Processing Requirements for SDSS Offline Software
  http://www-sdss.fnal.gov:8000/edoc/requirements/softreq/softreq.html
- *Strauss 1999,
  Scientific Requirements and Scientific Commissioning for the SDSS
  http://www-sdss.fnal.gov:8000/edoc/requirements/scireq/scireq.html
- Strauss 2000
  Requirements and Status of the SDSS Spectroscopic Systems,
  I saw this in 2003, but can't relocate it. I have a copy of this one, at least.

Documents related to requirement, those giving standard operating procedures noted by *.

- Nichol 1999, Discussion of Spectrophotometry,
  http://astro.princeton.edu:81/requirements/spectrophoto.ps
- *Newman 2003, SDSS Spectrographic Observing Procedures,
  http://sdsshost.apo.nmsu.edu/sdssProcedures/specObs.html
- *Kleinman 2003 Spectroscopic Monthly Checklist,
  http://sdsshost.apo.nmsu.edu/sdssProcedures/sopMonthly.html
- *Schlegel 2002, Proposal for Declaring Spectro Data "Bad",
  sdss-obs#3084, http://astro.princeton.edu:81/sdss-obs/msg.3084.html
- Tremonti 2002, Spectrophotometry,
  http://zephyr.pha.jhu.edu/ cat/phonecon/fluxcor.ps

Fate of Other Requirements

Connolly 6 removed as not stringent enough to test, nor a problem for the reduction. "FWHM of unblended arc lines, in pixels, in a given fiber will have an rms dispersion of less than 5% of the mean FWHM"
Connolly 7 removed in Strauss version. "FWHM of unblended arc lines, in pixels, at a given wavelength will have an rms dispersion of less than 5% of the mean FWHM"
Connolly 11/Strauss 4 removed because there is essentially nothing we can do about this if we find we are failing. "Cross talk between adjacent fibers..."
Connolly 17/Strauss 18 is a requirement on the target selection, not the spectroscopy system. "At least 3 bright calibration standards with smooth spectroenergy distributions must be spectroscopically observed per plate."
Strauss 12, 13, 14: Robustness of code, documentation of code, version control of code. Assumed met.
Strauss 15: Flagging of data reduction problems. Assumed met.
Strauss 16: Process should not introduce artifacts. Not testable.

4.1 Positioning of the Fibers: Connolly 18/Strauss 17

The position of each fiber, relative to the center of its target, must be determined with an accuracy of < 0.3" for over 85% of fibers.

- **Science Case-** Above this limit we must expose longer to achieve uniform redshift success.
- **Consequences-** We must expose longer, and over the lifetime of the survey we obtain less spectra.
- **Responsible-**
- **Resources Needed-**

Notes-

This is a requirement on the positioning of the fibers, and is a test of the total system from Astrom and Photo through Plate and the plate drilling.

The positional accuracy will be defined relative to the r' band images and will include a positional correction for the effects of atmospheric refraction at the hour angle for which the plate was drilled.

Tests-

I am leery of this requirement because I do not know a test any less brute force than a plate mapping.

This requirement will probably be dropped. Recall that the overall system was tested during commissioning, and dropping this test would be equivalent to the statement that we believe the internal QA of Astrom and plate drilling sufficient for the remainder of the survey.

4.2 Throughput variation of fibers: Connolly 3/Strauss 3

The RMS fiber-to-fiber throughput variation of all fibers should not exceed 10% at any wavelength.

- **Science Case-** Above this limit we must expose longer to achieve uniform redshift success.
- **Consequences-** We must expose longer, and over the lifetime of the survey we obtain less spectra.
- **Responsible-** Lampeitl/Annis
- **Resources Needed-** Modified SOS

Tests-

The test is to measure standard deviation of extracted flat field spectra. SOS creates the extracted flat field fibers. We plan to modify SOS to perform the actual test.

We note here that this requires at least one flat per plate per night.

We plan to monitor this at the mountain, and to use this at the factory as a plate acceptance criteria.

Procedure on Fail-

Clean fibers. File a PR and raise to Survey Operations if problems persist.

Status-

We finally dropped this requirement as we could find no one who thought that once met in commissioning it was plausible to thereafter cause operational impact.