Calibration plan at NOT
DRAFT

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1 Introduction

The Monitoring Plan aims to provide the data to quantify instrument and telescope behaviour for the information for the maintenance of the telescope and instruments. It is not aimed to supply calibrations for visiting astronomers. However occasionally this data might be useful when reducing the data. The visiting astronomer is solely responsible for to obtaining all the needed calibration frames (dark, bias, flatfields, standard star observations etc.) for their science images.

The optical imaging monitoring plan consists of frequent "health" checks of the detectors, regular zeropoint measurements and less frequently tested, presumably constant characteristics of the instrument or telescope.

2 Detector health checks

The definition of a health check of the detector is to measure the read out noise, gain and bias level. Ideally the "health check" should be done every day for the Cassegrain instrument (ALFOSC, NOTCam, MOSCA) and in a regular interval for the StanCam and FIES (once a week/every other week/once a month), however in reality dailys check might not be necessary.

2.1 The testing interval

In order to estimate the amount of time needed for the health check, the number of observing runs and instrument changes were calculated for the years 2002 and 2003. During these years there were 95 observing runs and 26 instrument changes per year on average (ALFOSC 16, NOTCam 7 and MOSCA 3 times) with the typical time instrument being mounted two weeks for ALFOSC and one week each for NOTCam and MOSCA. However the longest time was almost six weeks (ALFOSC). If the detectors are tested in some other interval there will be extra administration work. Table 1 summarises the total time needed for the health check per year with three different scenarios, test every day, beginning of each run and after instrument change. It is assumed that the test takes about twelve minutes and that StanCam is tested once a month.

So far the detectors have been reliable and so daily testing would be an over the top starting point. Also, less frequent testing would not increase the work load

Table 1: The estimated time per year for the health checks of the ALFOSC, MOSCA and StanCam detectors. It has been assumed that StanCam is tested 12 times per year and estimated that one test takes 12 minutes on average.

	every day	every run	instrument change
number of test	365+12	95+12	26+12
time (hours)	76	22	8

of the staff too much. Testing the detector at the beginning of every run would give very good sampling. In this case the support astronomer on duty would test the detector after changing the set-up for the visiting observer, however at the moment maybe even less frequent testing would be sufficient. It is suggested that, as a starting point, testing of the detectors after mounting the telescope should be enough. The support astronomer on duty would be responsible for testing the detector. StanCam and FIES should be tested, say once a month, and the instrument scientist would be responsible for performing the test.

2.2 The tests and results

Arto and Silva Järvinen have written IDL-scripts for testing ALFOSC, StanCam and NOTCam. These scripts are easy to use and are (will be?) well documented. The ALFOSC (StanCam) script can be modified for MOSCA and possible future detectors as well. The "raw" data will have the standard NOT filenames, hence all this data will be archived in the normal way. The results will be stored in a database and displayed in a www-page (http://www.not.iac.es/instruments/qc/). There will be a warning message if the new values deviate more than three sigma from the average. For ALFOSC and StanCam plots of gain, read out noise, number of counts and the bias level are displayed. The NOTCam page shows plots of gain, read-out noise and linearity of each quadrant, the amount of dead, hot and cold pixels and the temperature during the test.

Both ALFOSC and MOSCA tests use β-light for illuminating the detector. The β-light has a half-life of 12.3 years, so in reality the light level of two consecutive tests should have similar count levels. A sudden dip in the light level will imply that an optical element is in the beam, or something is wrong with the camera optics or with the CCD.

2.3 The future plan

At the moment the tools (scripts and light sources) for regular "health checks" of the detectors are available. The only "problems" are that one can not have constant illumination at full FIES detector, however using the same small area one can carry out the "health check". Also StanCam is tested using the dome lights, hence the absolute light level is not known. The new adapter could have the possibility of installing a β-light, which would be available for all the detectors.

After a year or so the test interval should be revised in order to decide whether less or more frequent testing is desired.

2.4 A brief overview to the "health checks"

• ALFOSC: The health check for ALFOSC is done using β-light without any filters in the beam. The light source is installed in FASU-B slot 6 and the script takes two bias frames and two 15 seconds exposures and sends the results to a database. The time needed from the start to end is about ten–fifteen minutes.
• MOSCA: Similar procedure to the ALFOSC test, however the time needed will be different (to be tested).
• NOTCam: One needs to open the telescope mirror cover, adjust the tungsten lights of the dome and run a script. The script will automatically send the results to a database and update the www-page.
•StanCam: One needs to open the telescope mirror cover, switch on the TV-camera light and run the script. The light level can not be used in monitoring purposes. The test takes about ten minutes and the results will be sent to a database and the www-page will be updated.
•FIES: Using the internal flats and bias frames one can estimate the read out noise and the gain. However the useful area is very small. This test is just to check the stability of the instrument, and the real values might be quite different to the test results.

3 Zero point monitoring

In order to monitor the throughput of the telescope, instrument optics and detector photometric standard stars need to be observed. In fact this is mostly monitoring of the reflectivity of the main mirror, because one can assume that the reflectivity of the secondary mirror, throughput of the instrument optics and the sensitivity of the detector are much more stable than the reflectivity of the main mirror.

Zero point monitoring should be carried out basically every technical night using the Cassegrain instrument with "standard" UBVRI (JHK) filters and blue+red grism and less frequently StanCam (and FIES). During the semester P28 there has been a technical night every fortnight, on average. At ESO/VLT they have found in U-band the zeropoint decrease rate is as high as 0.13 mag/year (http://www.eso.org/observing/dfo/quality/ALL/daily_qc1.html). This suggests that zero point measurement once a month should give sufficient sampling. However, accurate conversion factors between ALFOSC, StanCam and MOSCA are needed in order to have a "master" zeropoint curve, which would include all the zeropoint measurments.

3.1 Monitoring procedure

The idea is to monitor the photometric zeropoints with permanent set of broad band filters, using a standard procedure and reducing the data and presenting the results in an uniform way.

The filters for the instruments are follows:
ALFOSC: U#7, B#74, V#75, R#76, i#12
StanCam: U#6, B#8, V#9, R#10, I#13
MOSCA: U#104, B#105, V#106, R#107, I#108

When the relative sensitivity of ALFOSC/StanCam and StanCam/MOSCA is determined accurately, a master zeropoint curve including all the data can be created.

Standard stars: Selected Landolt (AJ 104, 340, 1992) fields will be used for the zp-monitoring. Altogether about ten fields evenly distributed in RA are needed in order to have a field available at any given time.
The selection criteria of these fields are:

1. More than three "Landolt" stars in the FOV of ALFOSC
2. Has been observed more than three times and for at least two nights.
3. A published photometric error smaller than 0.03 magnitudes.

All these fields will be imaged using ALFOSC, in order to have user friendly finding charts in the www-page. In addition, the www-page will have the

U-B, B-V, V-I colour and UBVRI-magnitude range of the stars in each field and estimated maximum exposure times for a given seeing. The catalogue will be available from the TCS.

Observations: The observing procedure during the night will be as follows:

1. Choose a standard star field close to the meridian (+-1 hour).
2. Check the seeing, choose the filter and exposure time.
3. Do all five filters (e.g. U#7 ,B#74 , V#75 , R#76 , i#12).

NOTE Don't offset the telescope between the images!
In principle, no bias nor flat images are needed.

Table 2: Selected standard star fields (Landolt, A. AJ 104, 320 192)

field name	RA	decl	stars	U-B	B-V	V-I
SA92_252	00:54:43	+00:40:15	4	-0.14 – 0.96	0.52 – 1.13	0.67 – 1.34
PG0231+051	02:33:38	+05:18:40	3	-1.19 – 1.34	-0.33 – 1.45	-0.53 – 1.95
RA95_275	03:54:38	+00:27:20	3	1.22 – 2.23	1.23 – 1.99	1.40 – 2.27
SA98_670	06:52:12	-00:20:56	9	0.10 – 1.94	0.16 – 1.91	0.17 – 2.09
RU_149	07:24:16	-00:32:38	8	-0.78 – 1.03	-0.13 – 0.66	-0.11 – 1.13
RU_152	07:29:56	-02:05:39	7	-1.07 – 0.49	-0.19 – 0.88	-0.14 – 0.92
PG0918+029	09:21:34	+02:46:39	5	-1.08 – 0.82	-0.27 – 1.04	-0.29 – 1.11
PG1047+003	10:50:09	-00:01:08	4	-1.12 – 0.17	-0.29 – 0.69	-0.30 – 0.84
PG1323-086	13:25:44	-08:50:00	4	-0.68 – 0.26	-0.14 – 0.76	-0.13 – 0.83
SA107_602	15:39:14	-00:13:28	4	0.05 – 1.27	0.50 – 1.41	0.70 – 1.76
PG1633+099	16:35:34	+09:47:08	5	-0.97 – 1.14	-0.19 – 1.13	-0.21 – 1.14
L110_230	18:40:49	+00:01:37	4	0.15 – 1.39	0.73 – 1.91	0.89 – 2.36
SA111_1925	19:37:37	+00:25:48	3	0.26 – 2.31	0.40 – 1.96	0.47 – 2.40
Mark A	20:43:59	-10:46:37	4	-1.16 – 0.65	-0.24 – 0.94	-0.24 – 1.10
PG2213-006	22:16:24	-00:21:27	4	-1.12 – 0.30	-0.22 – 0.75	-0.20 – 0.83

For zp-monitoring purposes the standard star field is needed to be observed close to the meridian, in order to have as small airmass as possible. Also if all the data has about the same airmass the uncertainty of the extinction will less affect to the results. The time needed for the zeropoint measurement is about ten minutes, including slewing and reading out time.

Data reduction: The data will be reduced using an IRAF script (alfosc_qc.cl, originally from the ING), which subtracts the overscan region, but don't do any flat field correction. For monitoring purposes this approach is accurate enough, because the stars are relatively bright and the long term changes are to be studied using this data. In the case of a dramatic dip or something else alarming, then the data will be studied more carefully.
The user needs to give an estimate of the seeing of the images. This value is used for the photometry namely as the aperture radius, which is four times FWHM. The sky background will be an annulus of one pixel nine times FWHM from the centre of the star.
After the user has identified the Landolt stars, the script will perform aperture photometry (APPHOT) and use task FITPARAMS to find the zeropoints and colour terms. All the zero points are calculated at zenith using the "standard" extinction (U=0.46, B=0.22, V=0.12, R=0.08, I=0.04) and with free and fixed colour terms. All zeropoint values will be stored in a database, but the final results in the www-page will be given using colours: U-B=0.5, B-V=0.5, V-R=0.5, R-I=0.5.

Relative sensitivity between ALFOSC/StanCam and StanCam/MOSCA will be determined using quasi simultaneous observations of an open cluster in a photometric night.

The zeropoint measurement should show gradual decrease of the sensitivity. It is expected that in the blue the slope is steeper than in red. When combining this information with the CO_2 and wet cleaning of the mirrors, one can estimate the effect of the mirror cleaning. This data will help to estimate the time for realuminising the main mirror.

4 Other tests

Some of these tests are more commission tests and not really part of the calibration plan. The reason to include less relevant tests is that the information is not available from our www-pages.

4.1 Performance tests

These tests should be carried out, say, once a year.

Linearity and the shutter delay Linearity of ALFOSC, StanCAm, FIES and MOSCA should be tested regularly. As a secondary result e.g. shutter delay will be checked as well. For reducing the data, there is only MIDAS script available.

Image quality This is to test that the TCS Zernikes are set correctly, i.e. that the optimum focus will give roundest and the sharpest image. This test should be carried out using MOSCA or StanCam under good seeing conditions. Procedure: Focus sequences with different TCS Zernike amplitude and angle. Analyse the image using e.g. IRAF.

Focus pyramid This test is to check that the focus pyramid gives the best focus value and also to verify that the TCS focus correction for the zenith distance is correct. This test test should be carried out at the same time as image quality test above, comparing the best focus sequence TCS focus value to the one given by the focus pyramid.

Flat fields This is to monitor the flatfields using the "standard" filters ALFOSC, MOSCA, StanCam. The results should be in a www-page.

Cosmetic and bad pixels In order to monitor the amount of bad pixels and cosmetics of the detectors ALFOSC, MOSCA, StanCam. The results should be in a www-page.

Scattered light In order to verify the amount of scattered light, i.e. no new sources.

Filters The quality of the filters should be checked occasionally. Things to be checked are the cleanness of the filters, "pinholes" and spatial variations.

4.2 Commissioning type tests

These tests are somewhat lower priority and performed only once, unless there are strong reasons for redoing.

Light leak Should be done once and put the results in the www-page StanCam, ALFOSC, MOSCA.

Filters Measure the transmission curves, if needed, and for the narrow band filters the throughput relative to a nearby UBVRI filter. (is this needed???)

Ghost images A comment on ghost images of StanCam ALFOSC, MOSCA should in the www-page

Bias levels The "health check" will tabulate the bias level of StanCam, ALFOSC and MOSCA using the "standard" setup. In addition, the low/high gain and different binning bias level should be available from the web.

Dark current A comment on dark current of ALFOSC, StanCam and MOSCA should be added in our www-pages.

Timings The overhead times of moving ALFOSC calibration mirror in/out, FAPO in/out, moving CCD-probe in/out, changing StanCam filter, rotating FAPO, filter-, grism-, aperture and FASU-wheels.

Rotation centre StanCam, ALFOSC, MOSCA. This should be measured at least three times for MOSCA and ALFOSC in order to have an idea of the repeatability when mounting the instrument

Pixel scale Detailed results of determining the pixel scale and distortion of StanCam, ALFOSC and MOSCA.

Focus depth Under good seeing conditions measure how many TCS focus units change the measured seeing one pixel wider: ALFOSC, StanCam, MOSCA, NOTCam.

Focus offsets Under good seeing conditions measure the focus offsets relative to, say, V-filter. Check all the filters and measure also the the thickness of the filter.

FAPO Test the flat-fielding with different half wave plate positions. If the flat fields independent of the FAPO-angle, one can use one (instead of four in linear polarimetry) position in the reductions.

Test if the object position in the field makes any difference when measuring the fluxes of the images.

Test the UBVRI instrumental polarisation.

Coronagrapich mode Measure the transmission of the “dots” using dome flats and during the night test the PSF.