AiC Report to NOT Council.
NOTCam Commissioning Oct-01 to Apr-02.

Version for distribution to Council

Anlaug Amanda Kaas, acting AiC,
La Palma

April 8, 2002

Contents

1 Introduction

NOTCam was offered to astronomers in visitor mode on April 1st 2002. The instrument works well and no observing time has been lost to problems so far. The observers gather huge amounts of data (26 CDs are burned per night), and the data look good on the preliminary analysis.

For background information I refer to the report on *NOTCam commissioning during the summer 2001* by Tim Abbott.

2 Short summary of the last commissioning runs

The 4th NOTCam commissioning run in October (two nights) was lost to useless weather and an irremediably stuck filterwheel. Subsequently NOTCam was warmed up and opened. The cause of the stuck filterwheel was the nut of a screw in the motor gear.

During the 5th NOTCam commissioning run in November (two nights) it was realized that the shutter was more unreliable than ever. Observations were repeatedly interrupted during the first night. For the second night we decided to run without the shutter and disabled it. Some of the NOTCam commissioning proposal targets were done.

The 6th NOTCam commissioning run around Christmas (5 nights) was practically all lost to bad weather. The good news is that the instrument behaved perfectly: no timouts on any wheels (neither the focus mechanism) and no shutter problems! In fact, we haven't seen the shutter fail since. Domeflats and darks obtained. First reliable noise and linearity test data.

The 7th commissioning run in early January (2 nights) lost 1 night to weather. The second night was not photometric but photometric standards were observed, as well as psf testing across the FOV, and testing for ghosts.

The 8th commissioning run in late January (3 nights) lost 70 % to thick clouds, but some narrowband filter commissioning was started through thinner clouds.

The 9th commissioning run in late March (3 nights) was totally lost to rain.

3 NOTCam cold shutter - problem solved

The shutter problem was not fully realized during the first commissioning run as it was difficult to separate this effect from other features because of the preliminary state of the data acquisition system. The first time the shutter hung completely open we believed it was due to a bug in the dark command. It is now evident that the problem was there all the time. First investigations in August showed that the spring holding the microswitch down was sufficiently strong to push the shutter back a short distance after initialising. The effect this would have on the observations could clearly explain the obtained images. The microswitch spring was weakened in an effort to cure the problem. Also, a "LED box" diagnostic device was connected to the control circuit to monitor the shutter behaviour. The next time NOTCam was cold (September) we found that the shutter still lost syncronization with the controller on several occasions, but less frequently. Upon the next warm-up and opening of NOTCam, the spring was weakened a bit more and the shutter was thoroughly excercised without ever failing once (while warm). During the 5th commissioning run, however, it was realized that the cold shutter was more problematic than ever. Repeated interruptions and aborts of the observations during the first night prompted us to continue the second night's observations with the shutter disabled. To avoid another thermal cycle a software solution was first sought. The speed of the rotating shutter was modified. Increasing the time it takes to rotate the shutter 90 degrees from 100 to 150ms seems to have solved the problem. We have not seen the shutter fail since this modification. A closed loop solution is now being looked into where the shutter position verification is done automatically.

4 NOTCam cooling: PTR & LN2

In its storage position on the dome floor NOTCam can be kept cold by the PTR only, which is gratifyingly keeping it stable at around -185 to -190 degrees. NOTCam has now been kept cold since the end of November. A back-up solution with Peltier coolers in the case of power cuts is being looked into. The PTR itself is on the no-break, but the required water cooling isn't and that system will shut down. The situation is only critical if power is lost for a longer time or if it is impossible to get to the telescope (weather).

Pending the arrival of the long hoses for the PTR, the PTR is currently disconnected whenever NOTCam goes on the telescope, and LN2 must then be filled every day to keep the instrument cold. During observations some action must currently be taken against spilling of LN2 at given orientations of the rotator and telescope altitudes. This limits observations to airmass smaller than ~ 2. Extended vacuum jacketed hoses will be mounted to each of the fill and vent tubes, oriented to minimize this problem, as soon as the ordered hoses are in hand.

5 NOTCam BIAS

The last reminaing fixes to the BIAS data aquisition software was made by Jens K-lougart when visiting the NOT during mid-March. At the time of writing there is only small fine-tuning left to be done in the software, such as making an "abort" command work.

6 NOTCam observing modes

So far broad-band imaging through both the wide field (WF) camera (3.9'x3.9') and the high resolution (HR) camera (80" x 80") have been commissioned with the engineering grade array installed. The science grade array will be installed when we have a stable system and the need for thermal cycles can be minimized. Switching between the WF and HR cameras is done in less than two minutes. Turning the filter wheels one full turn takes 30 seconds. All wheels can be turned simultanously.

There are two read-out modes available. The first is a standard *reset-read-read* mode (also called Fowler sampling) which resets the capacitor, makes a non-destructive read immediately after, then integrates for as long as wanted and reads again after end of integration. Subtracting the first readout (the reset frame) from the end-of-integration frame provides the final image. The second is a *sample-up-the-ramp* mode which reduces the noise by multiple non-destructive readouts during the exposure upon which a linear regression analysis applied to the data points provides a mean flux rate. The first mode is needed for brighter targets observed with broad band filters, but the shorter the individual integration time, the larger the overhead factor (total time/integration time). For a series of 1s integration the overhead factor is 10, while for 5s exposures it is 3. For the *sample-up-the-ramp* mode the overhead factor is around 1.3 only, but this mode can be used only for longer exposures. The separation between the N non-destructive read-outs can not be smaller than the read-out time which is currently 3.6s. A maximum of $N = 14$ readouts is now allowed.

Note that overhead to dithering is not included in the above overheads. All data must be obtained by dithering to provide proper sky subtraction, the dithering step size being determined by the type of target. Extended or crowded fields demand off fields (or beam-switch observing) to estimate sky, which means an overhead factor of 2 times that of sparsely populated stellar fields. To accomodate a best combination of dithering, type of readout, individual exposure times and number of repetitions, observing macros are being made for each target. Large mosaics must be done without autoguiding to avoid the risk of having the guide probe entering the field of view.

A preliminary NOTCam User's guide is already made available to the observers on our web pages. A commissioning report is under development, a bit delayed because of the bad weather during commissioning, but we hope to have the first version made public soon. We are also working on some quick-look reduction tools to be used off-line while observing. So far - the data verification for each project has been made by the support astronomer during the first night.

7 NOTCam engineering grade array

- Bad pixel level (hot and cold) about 2%. A small increase has been noted from June to December.
- Gain is 3 e^- per ADU.
- Readout noise is 24 e^- for the *reset-read-read* mode and 14e^- for the *sample-up-the-ramp* mode.
- Dark current is less than 1 e^-/s.
- Linearity good to 99% up to 20000 ADUs.
- Saturation effects start at 40000 ADUs.
- The memory effect in terms of positive and negative ghost images of a close to saturation target is not properly quantified yet. Normally the array recovers after a couple of readouts.
- No cross talk between the four quadrants has been seen.

8 NOTCam optical performance

- WF camera platescale and optical distortion is currently being investigated.
- WF camera lateral color distortion between J (1.25 μm) and K (2.2 μ) is centrosymmetric and amounts to 1 pixel in the edges.
- HR camera platescale, optical distortion and lateral colour distortion to be tested.
- PSF stability across the field to be analyzed both for WF and HR camera. Data in hand.
- Focus travel with wavelength measured for both cameras. Less than expected from the optical design.
- Ghosts are expected to be minimized by tilting the filters. Quantitative test data to be analysed.

9 NOTCam sensitivity and throughput

- Preliminary zero-point magnitudes (J=22.3, H=22.3, K=21.5) to be confirmed when photometric weather allows (hopefully in May). Note! Preliminary results obtained with the "unreliable" shutter.
- Photometric scatter over the WF camera field $< 3\%$.
- The sky backgrounds are around J=15, H=14, and K=12 mag/arcsec^2, but variable.

10 NOTCam upgrades for the future

- Allow for binning and windowing readout commands
- Faster controller needed to beat the long readout time (3.6s)
- Grisms for the spectroscopic mode