Req 5.6.1

Title:

Shutter Timing

Objective:

Verify the actual timing of the shutter, monitor position dependent delays of the shutter motion in both directions.

Exposure timing has to be accurate to $\pm 0.2\%$ at 1 sec exposure time at any position of the focal plane (**OmegaCAM** Technical Specifications). The exposure timing signal is provided by PULPO. For the following considerations we assume that the PULPO timing signal is accurate to better than 0.1 msec (i.e. it is not the dominating source of inaccuracy).

The shutter mechanism consists of a pair of chasing carbon fibre blades. Their movement is controlled by the Shutter Control Unit (Shutter CU) such that it results in an identical effective exposure time all over the frame. These two movements may or may not overlap in time depending on the exposure time and the blade traveling time.

The opening blade starts moving immediately (μsec's) after the falling edge of the TTL signal (provided by PULPO). This is the beginning of the exposure procedure. The closing blade starts moving immediately (μsec's) after the rising edge signal was detected and ends (about 1 sec later) when the closing blade completely covers the aperture, which marks the end of the exposure procedure. Therefore, the duration of an exposure procedure is always:

```
exposure time + blade travel time (ca.  1 sec)
```

Two types of delays affect the effective exposure time: The delays of the start of the blade movements after the opening/closing TTL signal edge (i.e. absolute exposure time) and position dependent delays during blade movement (i.e. exposure homogeneity).

The open/close delays are up to 0.05 msecs due to signal polling of the Shutter Control Unit software. These values are well within the requirements (shutter open time error: $\pm 0.2\%$ at 1 sec corresponding to ± 2 msecs). Deviations from this occur only in case of a severe shutter failure which is detected by the Shutter CU and PULPO independently followed by operator actions.

Position dependent delays (requirement: 0.2% at 1 sec exposure time) will be monitored in regular intervals of 3 months. This will be done for both shutter movement directions.

Dome flatfields of 10 sec and 0.1 sec exposure time will be taken for both

shutter blade movement directions. Illumination level shall be such that the CCD's are at about 60% to 80% full well for the 10 sec exposure. Exposure times will have to be evaluated during Commissioning.

Fulfilling or fulfilled by:

selfstanding

When performed/frequency:

Commissioning, once per 3 month, further to determined by experience. Daytime

Sources, observations, instrument configurations:

Dome flat field with a level of about 40,000 - 50,000 ADU's

Inputs:

Raw dome flatfields
CalFile– 541 *Master Bias frame*

Required accuracy, constraints:

Timing error less than 0.2%.

Estimated time needed:

1 hour

Priority:

desirable

TSF:

Mode– Stare N=4
(**TSF– OCAM_img_cal_domeflat,** $N = 4$, $t_{exp} = 10.0, 0.1, 0.1, 10.0$)
= **TSF– OCAM_img_cal_shutter**

Recipe:

Recipe– Shutter_Delay

Needed functionality:

image – collapse;

CA:

Interactive analysis with Eclipse After bias correction divide (0.1 sec exp.) / (10 sec exp.) for each shutter direction and average columns (or rows, which is appropriate) to improve S/N (the effect is 1-dimensional).

The result will be inspected for deviations from homogeneity ($\pm 2\%$ at 0.1 sec, i.e. $\pm 0.2\%$ at 1 sec) for both shutter directions. Shutter direction is indicated

in header.

CAP:

```
input bias, low_level_flat, high_level_flat
for ShutterDirection up,down
tmp = (low_level_flat-bias)/(high_level_flat-bias)

line = tmp.colapse()

output ShutterDirection,line
```