Req 5.2.1

Title:

CCD read noise

Objective:

Measure the CCD read noise (in ADU's) as a standard health check.

The read noise is measured from pairs of bias exposures. The rms scatter of the differences between two exposures is computed and divided by $\sqrt{2}$. Monitor variations. This is the first order daily health check.

Fulfilling or fulfilled by:

Selfstanding

When performed/frequency:

daytime- Commissioning, during all operations: daily health check.

Inputs:

2 raw bias frames **CalFile– 521** $Readout\ noise$ older versions

Outputs:

CalFile– 521 $Readout\ noise$ in ADU's
The **CalFile** correponds to QC parameter read_noise (a single number).

Required accuracy, constraints:

Readout noise less than $5e^-$.
Variation in readout noise w.r.t. reference value less than $0.5e^-$.
These are lab values. The corresponding limits in ADU can be calculated using the e^-/ADU conversion factor from **req.**523.

Estimated time needed:

Observation: 5 min. Reduction: 5 sec/CCD.

Priority:

essential

TSF:

Mode– Stare N=2
(**TSF– OCAM_img_cal_bias,** N=2)
= **TSF– OCAM_img_cal_readnoise**

Recipe:

```
Read_Noise -i bias1 bias2 [-max MAXIMUM_ITERATIONS]
                          [-rej REJECTION_THRESHOLD]
```

```
bias1, bias2          : the two raw bias images
MAXIMUM_ITERATIONS    : maximum number of iterations for statistics
                        measurement (integer).
                        Range of allowed values: 2 - 10. Default:
5
REJECTION_THRESHOLD : rejection threshold for bad pixels in sigma
(float).
                        Range of allowed values: 1.0 - 10.0. Default:
5.0
```

Before applying this recipe, use **Recipe– Split**—which is documented in **seq.–631**—with the `-t bias` option to split the raw multi-extension FITS input files.

```
  previous      : previous measurements
```

Needed functionality:

image arithmetic (eclipse.image_sub)
image statistics (eclipse.iter_stat)

CA:

Process (make):
1. Subtract the two bias frames to produce a difference image.
2. Iteratively reject outliers in the difference image.
3. Compute the mean, median and rms of the remaining pixels of the difference image.
4. The readout noise is the rms divided by $\sqrt{2}$.

Verification (verify):
1. The read noise should be less than the equivalent of $5e^-$ in ADUs
2. The mean of difference image should be less than the equivalent of $1e^-$ in ADUs

Trend Analysis (compare):
1. The difference between consecutive read noise measurements should be less than $0.5e^-$

CAP:

```
  MAXIMUM_READNOISE              : Quality Control (default 5.0)
```

```
  MAXIMUM_BIAS_DIFFERENCE       : Quality Control (default 1.0)
  MAXIMUM_READNOISE_DIFFERENCE  : Quality Control (default 0.5)

QC Flags:
  READNOISE_TOO_HIGH
  BIAS_DIFFERENCE_TOO_HIGH
  READNOISE_DIFFERENCE_TOO_HIGH

diff_image = eclipse.image_sub(bias1, bias2)
stats = eclipse.iter_stat(diff_image,
                          MAXIMUM_ITERATIONS,
                          REJECTION_THRESHOLD)
read_noise  = stats.stdev / sqrt(2)
mean_diff   = stats.avg_pix
median_diff = stats.median
```

if $\mathsf{read}_noise > MAXIMUM_READNOISE : READ_NOISE_TOO_HIGH =$
$1 if mean_diff > MAXIMUM_BIAS_DIFFERENCE : BIAS_DIFFERENCE_TOO_H$
$1 if abs(read_noise - previous.read_noise) > MAXIMUM_READNOISE_DIFFEREN$
$READNOISE_DIFFERENCE_TOO_HIGH = 1 ? endverbatim$