Req 5.6.9

Title:

Secondary Standards

Objective:

Build catalogs of secondary photometric standards by observing Landolt fields, centered on each individual CCD.

A fundamental concept in the calibration of **OmegaCAM** data is the photometric calibration for each separate CCD. To obtain this calibration with a single observation requires photometric standards covering the entire FoV of the instrument. There are currently no catalogs of photometric standard stars satisfying this requirement. Hence, obtaining such catalogs of **secondary standards** for the equatorial fields and the polar field will be part of the calibration observations to be performed during operations.

Obtaining the necessary observations of secondary standards is a time-consuming operation (see below). Moreover, because these observations should cover all 8 equatorial fields (ref **seq.– 563),**approximately two (bright) nights each month will have to be reserved for these observations, at least in the first year of operations.

The set of secondary standards observations will also be used to determine the illumination correction (**req.**548). Note, that this constitutes a bootstrap problem, because determining accurate zeropoints of the secondary standards requires that the illumination correction is already known.

Because of this bootstrap problem, a straightforward determination of the zeropoint requires that for each CCD the zeropoint and illumination correction are determined simultaneously using primary standards. Therefore, obtaining measurements of secondary standards requires a sequence of observations that positions the primary standards in each CCD, i.e. 32 pointings per field, per filter.

An initial determination of the illumination correction will serve as a check on the magnitude of the effects of stray light. To do this in a quick and efficient way, a preliminary catalog of standard stars that cover the FoV of **OmegaCAM** is required. The data for constructing such a catalog (**CalFile– 569E**) has been obtained. In case the effects of stray light turn out not to be negligible, the illumination correction will have to be characterized (see **req.** 548).

The order of priority of determining standards is first the **key bands** followed by the composite filter.

Fulfilling or fulfilled by:

Selfstanding.
Initial determination of the illumination correction is used to verify presence/absence of this effect (see **req.**548).

When performed/frequency:

Commissioning, 2 nights of bright time, each month in the first year.

Sources, observations, instrument configurations:

Strategy– freq Mode– Stare N=1 **OmegaCAM** equatorial fields and polar field.

Inputs:

CalFile– 569E *Primary Standard stars*

Outputs:

CalFile– 569 *Secondary Standard Catalog*
CalFile– 548 *Illumination Correction*

Required accuracy, constraints:

0.02 mag in individual secondary standard stars. The sources in **CalFile– 569** cover a FoV of approximately 1.2 square degree for every standard field. The density of the standard stars in a given field is such that the number of standard stars per chip is typically a few hundred.

Estimated time needed:

Two standard fields are observed each month, with an observing time of 5.8h each. Each standard field is observed with 32 pointings, in each of the **key bands**. Using an observing strategy in which the filter is changed after every set of 32 pointings, the total observing time T_{obs} for one field is estimated by:

$$T_{obs} = \sum_{i=1}^{N_{filter}} [(T_{int}(X_i) + T_{read} + T_{mov}) \times 32 + T_{filter}],$$

with $T_{int}(X_i)$ the integration time in band X_i, T_{read} the readout time of the full detector block, T_{mov} the movement time of the telescope, and T_{filter} the filter exchange time.
With a T_{read}=25s, a T_{mov}=40s, and a T_{filter}=75s, the total integration time for the four **key bands** and one field will be $\approx$ 21000s (5.8h). The integration times for each of the four **key bands** are: $T_{int}(u')$=110s, $T_{int}(g')$=60s, $T_{int}(r')$=75s, $T_{int}(i')$=115s. The reduction time of the data taken for one field is 2 hours per CCD/filter.

Priority:

essential

TSF:

Strategy– mosaic
Mode– Stare N=1
TSF– OCAM_img_obs_stare

Needed functionality:

In addition to standard processing functionality
catalog - source extraction (Sextractor)
catalog - select stars (LDAC filter)
catalog - associate (LDAC associate)
catalog - merge

CA:

Process those chips from the total set of standard field data that contain the Landolt stars. The following steps are performed on every separate chip in this subset (step 1):
1. De-bias, flatfield and astrometrically calibrate the input chip.
2. Derive a source catalog from the input chip (Sextractor).
3. Remove saturated sources from the source catalog.
4. Associate the source catalog with the standard star catalog.
5. Remove all the sources from the source catalog that have not been associated with a source from the standard star catalog.
6. Subtract the measured magnitude of the identified standard stars from their magnitude as known from the standard star catalog. The resultant numbers will further be referred to as raw zeropoints.
7. Derive a zeropoint for the input chip from the list of raw zeropoints by deriving the weighted average, and store this zeropoint.

This procedure will result in 32 values for the zeropoint, one for every chip. The remaining standard field data that does not contain Landolt start must only be de-biased, flatfielded, and astrometrically calibrated.

Obtain catalogs (step 2). The following steps are performed on every separate input chip of the previously de-biased, flatfielded and astrometrically calibrated standard field data :
1. Derive a source catalog from the input chip (Sextractor).
2. Remove the sources from the catalog with an error in the magnitude equal

to or larger than 0.03 magnitudes.
3. For the remaining sources, subtract their measured magnitudes from the zeropoint of the input chip as it has been derived in step 1.
4. Store in a catalog : the zeropoint corrected magnitudes of the sources together with their positional information.

Obtain secondary standards (step 3):
1. Associate the source catalogs derived in processing step 2.
2. Select from the association result those sources which have been observed at least 7 times. For every source in the resulting list, average the magnitude.
3. Select the sources with an averaged magnitude accurate within 0.02 mags.

Note that the procedures above only describe the most straightforward way of deriving a standard star catalog. In a more refined procedure with relative photometry, the non-standard stars can also be used. This will lead to more accurate results.