Req 5.4.8

Title:

Characterize the illumination correction.

Objective:

Characterize the illumination correction.

The zeropoint is determined individually for each CCD in **req.** 563. The gain variation over individual chips is characterized by the twilight and sky flatfields (**req.** 543 and **req.** 544) under the assumption of an ideal flat illumination over the field of view. In practice this ideal flat illumination can be affected by stray light (sky concentration) and a correction for this effect has to be made.

An initial verification during commissioning whether this effect is indeed present will be obtained by quickly deriving many zeropoints for individual stars in a standard field (eg from the INT-La Palma preparatory programme). This technique, which is fully automatic, could also be used to quickly verify the effect during RP.

In case the effect is found to have an amplitude over a single chip larger than 1% , it has to be characterized using series of measurements of a standard field with 32 pointings, such as done in **req. 569** *Secondary Standards*.

The map that results from the (interactive) characterization of the illumination correction is used to make an illumination correction frame for every individual chip (**CalFile– 548**).

Fulfilling or fulfilled by:

Initial verification of effect during Commissioning : selfstanding
Characterization of the effect : additional data reduction of **req. 569** *Secondary Standards*

When performed/frequency:

First verification of effect during early commissioning. Characterization at end of Commissioning. During RP, once/month to be determined by experience.

Sources, observations, instrument configurations:

Standard equatorial field

Inputs:

The inputs for deriving the illumination correction frame:
CalFile– 548F *Illumination correction fit coefficients*
The name of the chip for which to derive the frame

The inputs for deriving a quick-fit to the effects of stray light (Category III recipe):
Fully calibrated image of a equatorial standard field
CalFile– 569E *Primary Standard stars*

Outputs:
The output from deriving the illumination correction frame:
CalFile– 548 *Illumination correction*
The output from a full, interactive characterization of the effects of stray light:
CalFile– 548F *Illumination correction fit coefficients*

Required accuracy, constraints:
better than 1% for the amplitude over a single CCD.
Estimated time needed:
Verification of effect during Commissioning : 0.5 hour.
Priority:
essential
Recipe:
For deriving an illumination correction frame (**CalFile– 548** *Illumination correction*) out of fit coefficients:

```
  Illumination_Correction -i illumination_correction_fit -c chip_name

  illumination_correction_fit : the map containing the fit made
to the
                                illumination variation.
  chip_name                   : the name of the chip for which the
frame
                                must be derived.
```

For a quick evaluation of the effects of stray light - CATIII :

```
  Illumination_Correction_Verify -i <science_frames> -s standard_catalog

  science_frames   : list of de-biased, flatfielded, and astro-
metrically
```

```
                        calibrated frames of a standard field.
  standard_catalog : standard star catalog.
```

Needed functionality:

catalog - source extraction (Sextractor)
catalog - associate (LDAC prephotom)
catalog - select stars (LDAC filter)
image - generation (eclipse.image_generator)
misc - regression (nonlinear least-squares fit)

CA:

The description given in the following paragraph refers to the procedure used in the creation of the illumination correction frame (**CalFile– 548**). The steps followed are:
1. Retrieve fit parameters from the illumination correction map.
2. Generate a frame with pixel values determined from these fit parameters.

The description given in the following paragraphs refers to the procedure used in deriving a quick-fit to the effects of stray light. This check is done as an initial verification of the effect during Commissioning (see **req.** 569). The steps to follow are:

1. De-bias, flatfield and astrometrically calibrate the input chips.

The following steps are performed on every separate input chip as reduced in step 1:
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 numbers resulting from the subtraction will further be referred to as zeropoints. Store for every standard star its zeropoint together with its x-y pixel position on the chip in a list.
7. Visualise the variation of the zeropoint as a function of the position on the

chip.

The full characterization of the illumination correction needs a preliminary reduction of the data for **req.** 569 that preceeds the data reduction for **req.** 569 that is used to derive **CalFile– 569** *Secondary Standards*. For the purpose of characterization, the data must be de-biased, flatfielded and astrometrically calibrated. The full characterization of the illumination correction is done in an interactive analysis. Note that the characterization of the illumination correction and the derivation of **CalFile– 569** *Secondary Standards* are caught in a bootstrap. This analysis must be performed for every filter separately. Obtaining the full characterization of the effects of stray light involves the following steps:

1. Extract catalogs from processed data. Note that many sources in these catalogs will have been observed multiple times.
2. Remove the saturated sources from the catalogs.
3. Associate the catalogs with the standard star catalog.
4. For every source that has been observed more than once, collect its different positions in the focal plane and combine these with its different measurements of the zeropoint. This produces for every such source a set of differential zeropoints as a function of its position in the focal plane. This information combined for all sources traces the variation of the zeropoint (note that in the end, the illumination correction is charaterized using relative photometry of the stars, since we are determining the variation of the zeropoint over the FoV).
5. From the variation of the zeropoints over the FoV, derive a map of the illumination correction as a function of the position in the focal plane (**CalFile– 548F**).

CAP:

```
The description given in this section refers to the procedure used
in the
creation of the illumination correction frame.

fit_coeffs = retrieve_fit_coefficients_from(map)
image_generator = eclipse.image_generator.image_generator(xsize,
ysize)
illum = image_generator.generate_poly2d(fit_coeffs)
```