Southern African Large Telescope

Title: **Automatic gain correction algorithm for the RSS mosaic CCD**

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ABSTRACT

In this report I present my very simple automatic algorithm to correct gains for different amplifiers of RSS CCD mosaic. This algorithm was implemented with MIDAS and used by me for RSS data reduction during last 12 years and showed very stable result. Generally, RSS CCD gains could be corrected easily using FLATs taken immediately after/before science spectra. Using science frames themself looks not very easy task in terms of automatic algorithm.

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1 Introduction

RSS CCD mosaic consist of six different CCD amplifiers. Generally, we know that some problems exist related to the stability of work all these amplifies together. These problems appeared as different amount of effects during all years of work with this mosaic. Some of these problems were fixed and never appeared again, where others exist up to now. One of the very important is an effect of gain variations with time for each amplifier, which results to the difference of background levels of amplifiers for RSS CCD mosaic after the standard gain correction procedure. It is well known that for RSS CCD mosaic gain variates sometime during some hours, so the standard procedure of gain re-calibration does not help, generally say. Fortunately, since the absolute flux calibration is not feasible with SALT, someone can try to correct the level of each amplifier multiplying it to some coefficient to make background level uniform for all amplifiers.

In this report I will describe my implementation of this simple idea and show some examples of its work.

2 The Algorithm for calculation of Gain-correction coefficients using FLATs

The general idea is based on the BASIC suggestion that **the distribution of spectral continuum could be well enough approximated by linear polynomial function inside of small regions, which are located very close to the edges of amplifiers**. Since the most uniform spectral continuum is the spectral distribution of the QTH lamps, the algorithm was developed and tested on this type of spectral data.

The algorithm I am going to present is based on some suggestions:

1. I suggest that all Gain-correction coefficients between different amplifiers are NOT DEPEND on Y-direction (along columns)

2. I suggest that the gain for the **THIRD** amplifier is correct. All others gains needs to be corrected to this one.

The algorithm could be presented with the next amount of steps:

1. All flats, obtained after/before the same science observations are combined with median to remove cosmic. Gaps between CCDs should NOT BE touched.

2. The combined flat is averaged in Y-direction (along columns) to produce one-dimensional spectrum of very high Signal-to-Noise ratio. In this case the gain problems even at the level of $\sim$1% are obviously visible after that. See Figure 1 for more details;

3. Select some amount of pixels around of border between Amplifier1 and Amplifier2, fit their distributions with linear functions and calculate their level difference at the pixel of border. See Figure 2 for more details;

4. Select some amount of pixels around of border between Amplifier2 and Amplifier3, fit their distributions with linear functions and calculate their level difference at the middle of gap between CCDs. See Figure 3 for more details. Finally, the calculated Gain-correction coefficient will be applied to both pixel distribution for Amplifier1 and Amplifier2;
5. The same procedure should be applied to all other Amplifiers. The final corrected distribution is shown in Figure 4;
6. The calculated Gain-correction coefficients have to be applied to the Science spectra.

3 The Algorithm for calculation of Gain-correction coefficients using Science spectra them-self

The above algorithm could be applied to Science spectra directly, but some obvious additions have to be taken into account:

1. Since spectral distribution of objects could be NOT linear at the edges of amplifiers the procedure of average in Y-direction has to exclude object spectra from this average;
2. Of course, data has to be cleaned out of cosmic previously;
3. Since at the edges of amplifiers strong emission sky-lines could exist, fitting algorithm should be clever enough to exclude such lines from the fitting;
4. Since level of sky background could be very low during dark time or for the reason of short exposures, the final result could be not acceptable anyway, unfortunately.

For all above reasons, calculation of Gain-correction coefficients using Science spectra them-self is much harder problem. The final automatic procedure appears to be not very simple in this case.

4 Conclusions

I have presented very simple, but efficient algorithm for calculation of Gain-correction coefficients. To use this algorithm by automatic pipeline easily the observational block has to contain FLATs.

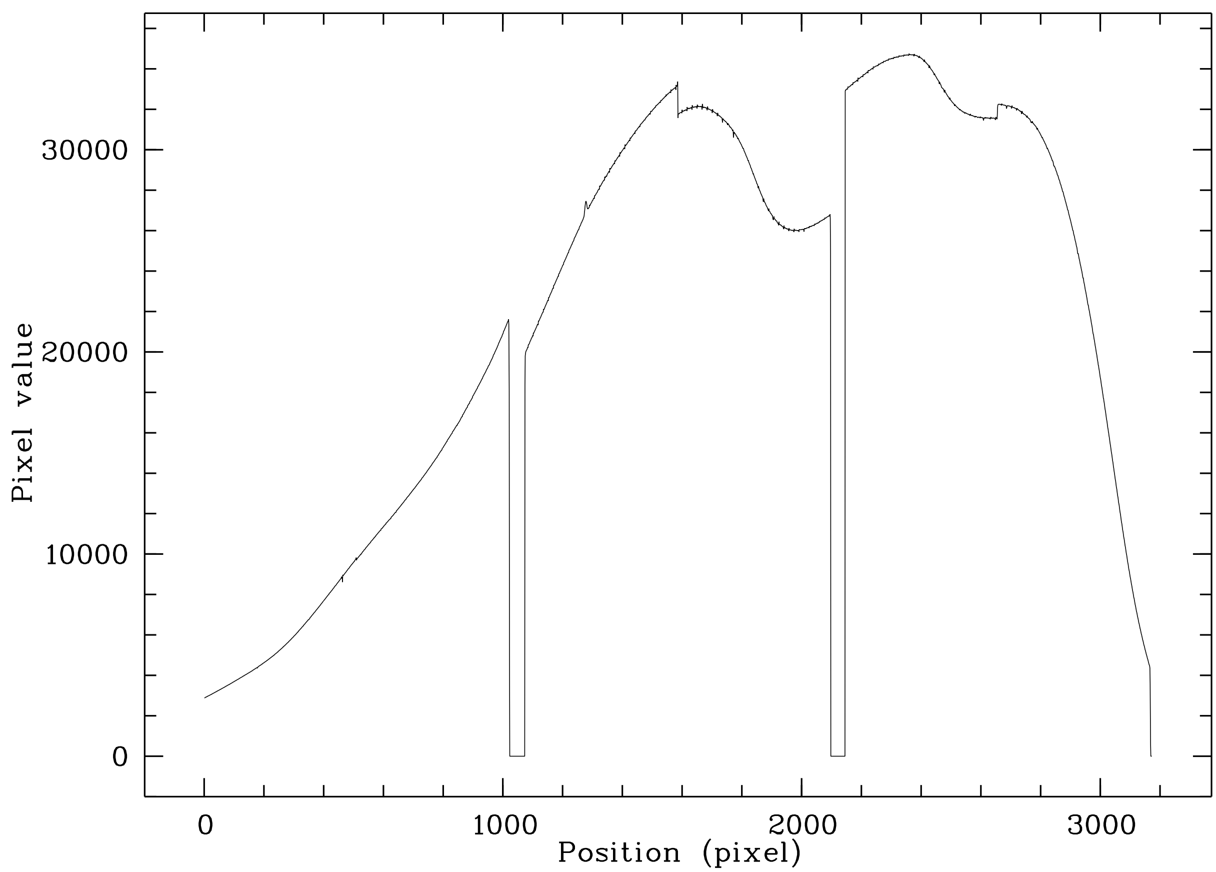

Figure 1: An example of spectral continuum distribution for QTH lamp before any gain corrections. The number of CCD amplifiers counted from the left to right. There is no obvious jump between Amplifier1 and Amplifier2, where jumps between all others are obvious.

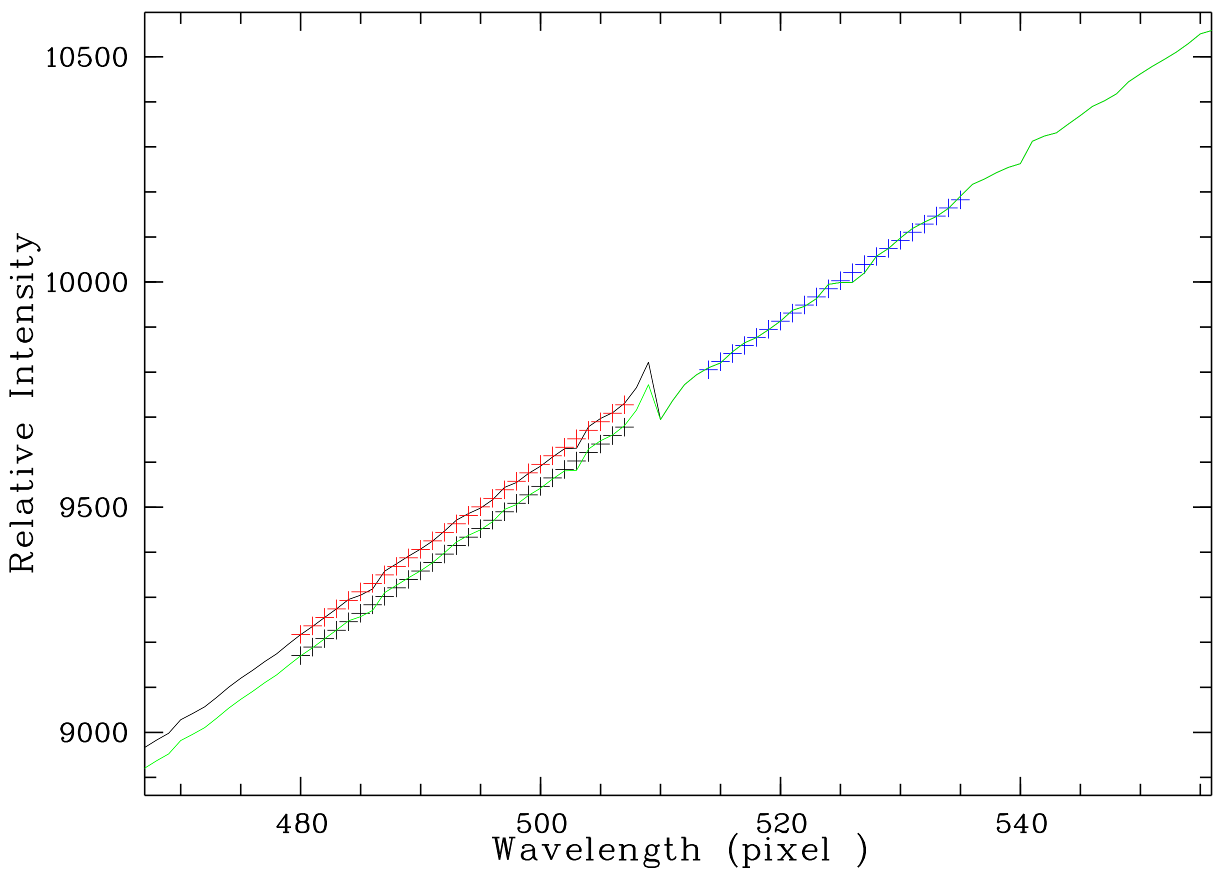

Figure 2: Calculation of the Gain-correction coefficient for the Amplifier1. The distribution of the pixel intensities before correction is shown with black line. Their fit is shown with red crosses. The distribution of the pixel intensities for Amplifier2 is shown with green line. Their fit is shown with blue crosses. The level of the Amplifier1 after correction is shown with green line as well. The black crosses show the same distribution as red ones, but after correction. The Gain-correction coefficient is 0.5% for the Amplifier1. Another problem for RSS CCD electronics is obvious with this figure – there is some additional jump between last pixels of each amplifiers, which has to be ignored, because it is exception.

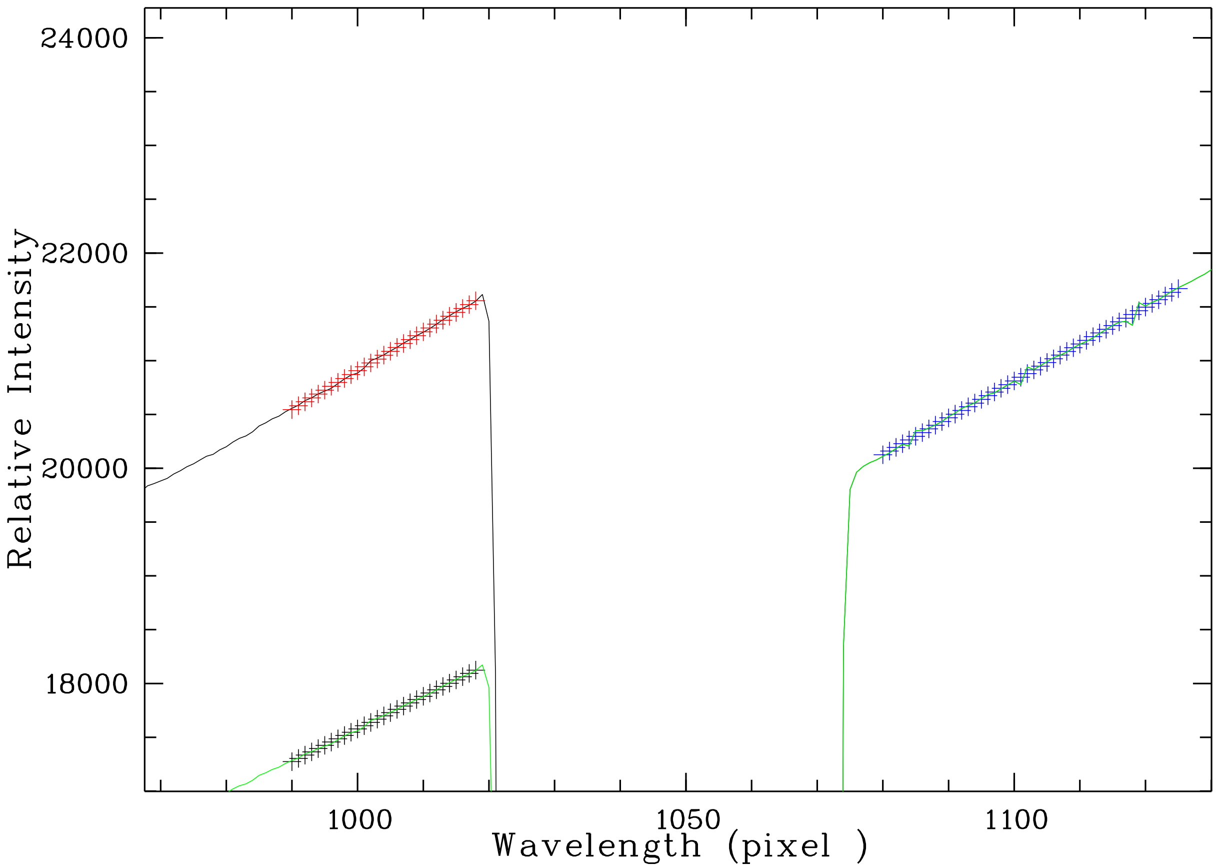

Figure 3: Calculation of the Gain-correction coefficient for the Amplifier2. The distribution of the pixel intensities before correction is shown with black line. Their fit is shown with red crosses. The distribution of the pixel intensities for Amplifier3 is shown with green line. Their fit is shown with blue crosses. The level of the Amplifier2 after correction is shown with green line as well. The black crosses show the same distribution as red ones, but after correction. The Gain-correction coefficient is 16% for the Amplifiers 1 and 2.

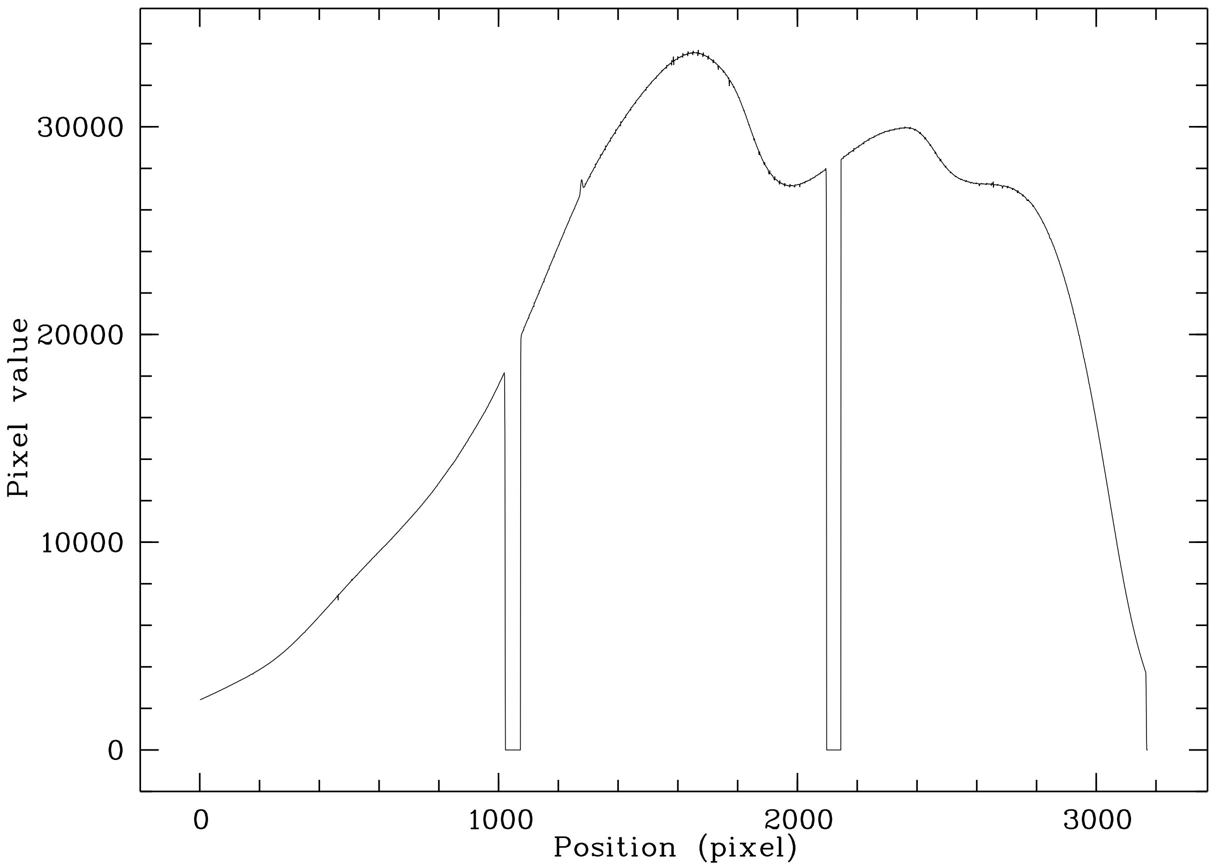

Figure 4: An example of spectral continuum distribution for QTH lamp after my automatic gain corrections procedure. Please, compare with initial distribution from Figure 1.