Southern African Large Telescope

Title: **Proposed plan for RSS spectral focus tests**

Author(s): **Alexei Y. Kniazev**

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Approved: **David Buckley (Ast Ops Manager)**

Signature:_____ Date:_____

ABSTRACT

In this document I summarized our knowledge about previous RSS spectral focus situation and procedure we used to characterize it. I proposed also the plan for spectral focus tests after RSS update.

South African Astronomical Observatory, Cape Town 7925, South Africa

Contents

List of Figures

1 Introduction

The Prime Focus Imaging Spectrograph (currently – the Robert Stobie Spectrograph or RSS) was designed and built for SALT by the University of Wisconsin-Madison and Rutgers University. This instrument is the priority first-light instrument of SALT. RSS exploits the improved blue/UV throughput of SALT as well as its access to a science field of 8 arcmin diameter. It has many different modes of observations like long-slit, multi-object (slitlets and Fabry-Perot option) spectroscopy (MOS) and narrow-band imaging, as well as having a polarimetric capability.

2 Pre-history

It is well known fact that during first mounting at the telescope (2005–2006) RSS showed large focus gradient along the spectrum. The most interesting facts of this situation were, from my point of view:

1. such detected gradient was about 10 times larger compare to estimations
2. its range **DID NOT DEPEND** on used grating.

For example, look into Figure 1. It is easy to see that using of grating that gives ∼1.5 better spectral resolution (covers less spectral area) did not produce less focus gradient range. In both cases total range was about 600–700 microns. These facts reflect the external problem of CCD mounting that was realized finally.

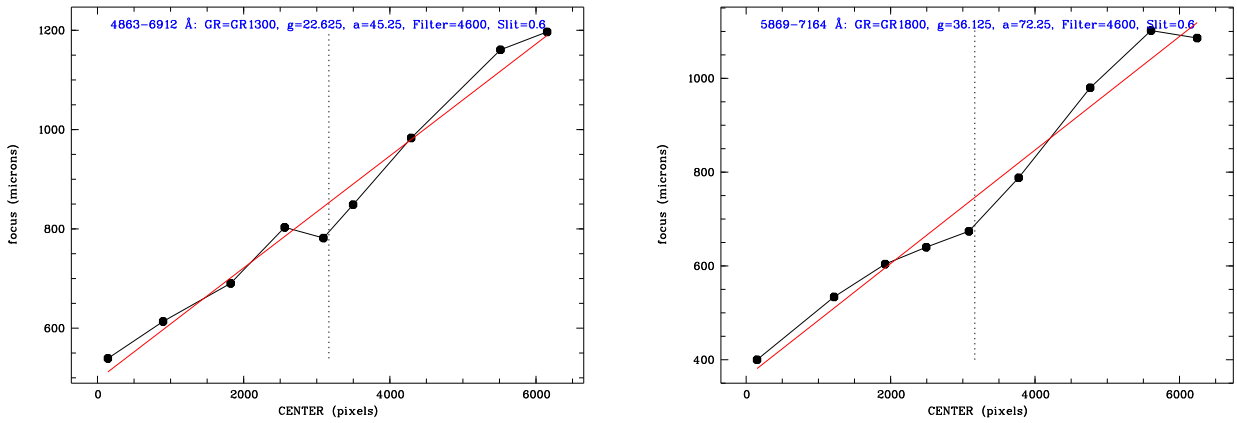

Figure 1: Examples of measured the best camera focus values depending on RSS field position for two different RSS spectral configurations. Black dots are the best camera focus values calculated for the different field positions. Red line shows the result of linear polinomial fit. Dashed line shows the central field position.

2.1 The procedure of finding the best focus value

To find the best focus value for the current RSS spectral setup and to characterize the value of focus gradient for such setup I fitted to SALT data in December 2005 the procedure that was implemented into MIDAS in 1995 (Kniazev & Shergin , 1995). This procedure is described in Section 4 and was actively used during 2006 to compile data for the best internal focus values of different RSS setups (See http://www.saao/telescopes/salt/astronomy-operations/astronomers/calibration/rss-internal-focus/).

Unfortunately, this work was never finished since RSS was removed from the telescope, but gave us the possibility to conclude that:

1. The best focus value looks similar for different slits;
2. There is some shift for the best internal focus values for the certain spectral setup between slits and slitlets.

3 The current plan for RSS spectral focus tests

To characterize the current situation with RSS best focus values (after RSS upfate) I suggest to divide this process in some steps, where the next one has to be done only after finishing of the previous step:

1. To characterize the best focus values and the total region for one-two selected setups just to check, that the situation is not the same as in 2005–2006;

   Suggested Slit: 0.6 arcsec that was used previously.

   Suggested CCD setup: 1x1 binning, bright, fast.

   Suggested Grating name: GR2300. It is one of the highest resolution gratings, where five grating angles were measured in 2006. I am suggesting two setups: **ga=31.625, aa=63.25, filter=3400** for the blue spectral area (4000–5000) and **ga=44.0, aa=88.0, filter=4600** for the green (5560–6460).

   Suggested procedure: Take 12 spectra to cover focus range 400–1500 microns with step 100 microns per each spectral setup (**spectral set** afterwhile);

2. To characterize the stability of these selected setups depending on different factors: time, angles, etc ...;

   Suggested Slit: 0.6 arcsec.

   Suggested CCD setup: 1x1 binning, bright, fast.

   Suggested Grating name: GR2300, by definitions, with the same setups which were used for the previous tests: `ga=31.625, aa=63.25, filter=pc3400` for the blue spectral area (4000–5000) and `ga=44.0, aa=88.0, filter=pc4600` for the green (5560–6460).

   Suggested procedure:

(a) *To check stability after changing of gratings:* Change GR2300 to any other. Back to GR2300. Spectral sets for both setups.

(b) *Flexure stability:* Change tip-tilt angle of spectrograph. Back to G2300. Spectral sets for both setups.

(c) *Time stability:* Spectral sets for both setups for the next day.

3. To characterize the best focus values for the central wavelenghts of different setups of one graiting;

   Suggested Slit: 0.6 arcsec.

   Suggested CCD setup: 1x1 binning, bright, fast.

   Suggested Grating name: GR2300

   Suggested procedure: There are about 55 setups for GR2300 from ga=30.125,aa=60.25 to ga=50.0,aa=100.0, very few for blocking filters `pc03200` and `pc03400`, and a lot for `pc3850` and `pc4600`. I suggest for the beginning 4 setups for `pc3850` and 4 setups for `pc4600` to cover the total range of aas and gas to try to find analytic equation finally:

```
ga=32.375, aa=64.75, filter=pc3850
ga=34.630, aa=69.25, filter=pc3850
ga=36.125, aa=72.25, filter=pc3850
ga=37.625, aa=75.25, filter=pc3850

ga=38.000, aa=76.00, filter=pc4600
ga=41.000, aa=82.00, filter=pc4600
ga=44.000, aa=88.00, filter=pc4600
ga=50.000, aa=100.0, filter=pc4600
```

4. To chech possible shift between slits and slitlets;

   Suggested Slit: long-slit 0.6 arcsec and fiber-mask with slit 0.6 arcsec.

   Suggested CCD setup: 1x1 binning, bright, fast.

   Suggested Grating name: GR2300, the same two setups which were used for the first test.

   Suggested procedure: Spectral sets for fiber-mask to compare.

5. To chech dependence of the best focus values with different slits;

   Suggested Long-Slits: 0.6, 1.0, 1.5 arcsec.

   Suggested CCD setup: 1x1 binning, bright, fast.

   Suggested Grating name: GR2300, the same two setups which were used for the first test.

   Suggested procedure: Spectral sets for different slits to compare.

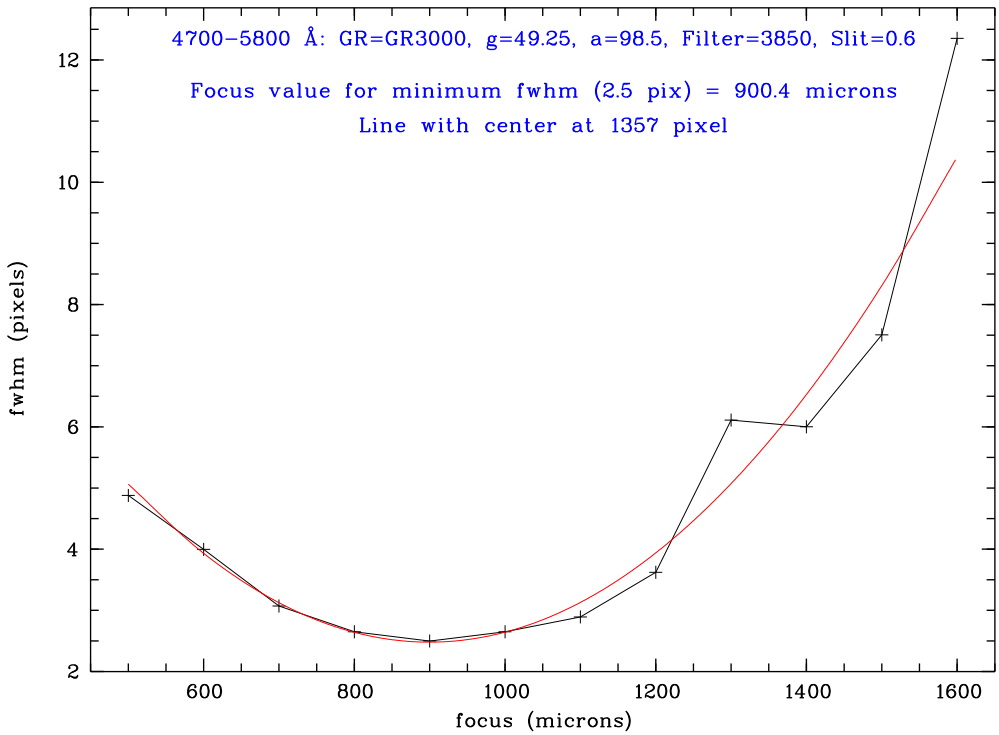

Figure 2: An example how the arc line FWHM behave as a function of dispersion co-ordinate for each focal station. Fitting result of the second order polinomial is shown as red line.

6. To systematicaly characterize all setups of all graitings.

   Will be properly planned on the base of previous tests

4 The procedure

4.1 The algorithm

1. For the current RSS spectral setup and narrowest slit (currently 0.6″) set of spectra has to be observed covers range of values for focus of the camera. The focus value in which the best focus for the middle of the field is reached has to be somewhere in the middle of the range.

2. After all spectra are taken the number of spectral lines has to be selected covering maximal range of X-coordinates (columns). Selected lines have to be single. Of course, selection process have to be done using spectrum observed nearby to the best focus for the middle of the field.

3. To increase S/N ratio for the above selection relatively narrow range of Y-coordinates

(rows) could be averaged in the middle of the field where the curvature of the field is minimal.

4. Gaussian fitting has to be done for all selected lines in all observed frames. As a result of such fitting procedures FWHMs values depending on focus value have to be collected. Only one gaussian has to be fitted in each selected line. The last is very important because spectral lines that were observed far away from the best focus value have very complex shape.

5. For each line dependence FWHM versus focus has to be fitted with polinimial of the second (or higher) order. The minimum of such fitting gives the best focus value for this line (X-coordinate of the field). See Figure 2 as an example of such dependence.

6. The summary of such best focus values for the different lines gives picture is shown in Figure 1.

References

Kniazev, A.Y., & Shergin, V.S., 1995, "CCD observations with MIDAS at 6m telescope. NICE package", Internal report of SAO RAS, 239, 1–24