

Southern African Large Telescope



Title: **Suggestions to make MOS working**

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ABSTRACT

This document attempts to analyze the current MOS status and to make some suggestions to make it work.



Contents

1	Introduction	3
2	The current implementation using the Pellicle	3
2.1	Basic definitions	3
2.2	Current Problems	3
2.3	The current scheme (as of mid-September 2011)	4
3	Why is it still so very slow	6
4	What should be done	7
5	Final scheme	8
6	To do list for programming	8

List of Figures

1	PCON screen with the current MOS implementation.	5
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1 Introduction

We have two different schemes of MOS implementation. One is a design philosophy which requires SCAM + Fold_mirror + PCON_PDET + guiding. Another one requires Pellicle + PCON_PDET + guiding. We prefer the second one. It has the potential of being quicker, it does not need the additional mappings of ref.star info to salticam view, and most importantly, we think, it avoids any concerns of fold-mirror behaviour at any given time. Alexei was involved in the initial implementation of this second scheme at the telescope, and we will try to summarize below how it works currently and the crucial additional steps which have to be done to make this scheme work properly.

Note also that both the above schemes assume we are sticking with the small-reference holes method of alignment, without real through-slit images to check it. It still remains to be verified that this is a reliable enough method.

2 The current implementation using the Pellicle

2.1 Basic definitions

MOS has three systems of coordinates:

- System **A** – describes where centres of reference stars are located after making of mask image. This is an immovable system of coordinates.
- System **B** – describes where the predicted centres of reference stars are located based on database information, after transformation of their positions to the PDET screen. This is a movable system of coordinates, where all positions may be systematically shifted for various reasons.
- System **C** – describes where the centers of reference stars are located on the PDET image of the field. This is a movable system of coordinates, where all positions may be systematically shifted/rotated because of pointing accuracy.

After all three systems coincide within acceptable accuracy, the MOS acquisition procedure is “finished”, the spectrograph has to be configured and spectral observations can be started.

2.2 Current Problems

Ideally, systems **A** and **B** have to coincide by definition. But in reality we have a situation where they sometimes are close to each other, but often are shifted relative to each other by a large distance (half of the screen). Since system **A** is NOT movable, the problem is with system **B**. This is probably not only a current problem, but there will always be a non-zero probability to have such a shift for various reasons. (??) It means that we always have to be ready/able to shift system **B**.



In addition, there are severe efficiency issues, which will be pointed out in the following sections.

2.3 The current scheme (as of mid-September 2011)

The current PCON implementation is shown in Figure 1. We have the following procedure:

1. Point the telescope to the next MOS field with the correct PA:
 - Light has to be redirected to RSS.
 - Pellicle is in position “IN”.
 - RSS is configured for the imaging mode.
 - Requested MOS mask has to be inserted in the beam.
2. Modified “MOS Cal” procedure, “Markers setup”, was designed to measure accurate positions for system **A** under the assumption that they will be close to the positions of system **B**. But since system **B** could be shifted, the observer now needs to:
 - (a) Press button “MOS Cal procedure” after setup of exposure time – an image (using just background night sky light) will be produced (recommended exposure about 10–20s) for the inserted mask. Binning HAS TO BE 1×1, otherwise size of markers are too large and do not relate to useful reality.
 - (b) Move markers of system **B** using the pixel positions of the reference star holes and markers. These have to be determined manually and entered manually on the PCON MMI. Repeat the read-out. If systems **A** and **B** are close enough, centers of **A** will be calculated.
 - (c) When the SA thinks the centers of **A** are calculated correctly she/he can finish “MOS Cal”, move out the mask and go to the next step – “Coarse alignment” .

*If case (c) is not true, the whole iteration (a-c) has to be repeated, where the size of the boxes for **B** could be changed, some positions from the **B** could be forbidden. EACH time a new frame HAS TO BE read-out to see changes.*
3. Modified “MOS Peak-up” procedure – coarse alignment – was designed to measure accurate positions for system **C** under the assumption that they will be close to system **B**. Since after pointing the telescope the difference could be large, we first need a coarse and after that a fine alignment.
 - (a) Press button “MOS Peak-up procedure” after setting up the exposure time – an image (use clear or cut-off filters) will be produced (recommended exposure about 5–15s). Binning HAS TO BE 1×1, otherwise the size of markers is too large and are not useful.
 - (b) Markers of the system **B** will be shown. Identify field using finding chart (very often you do not need it to identify pattern). Move reference stars to markers of the system **B**

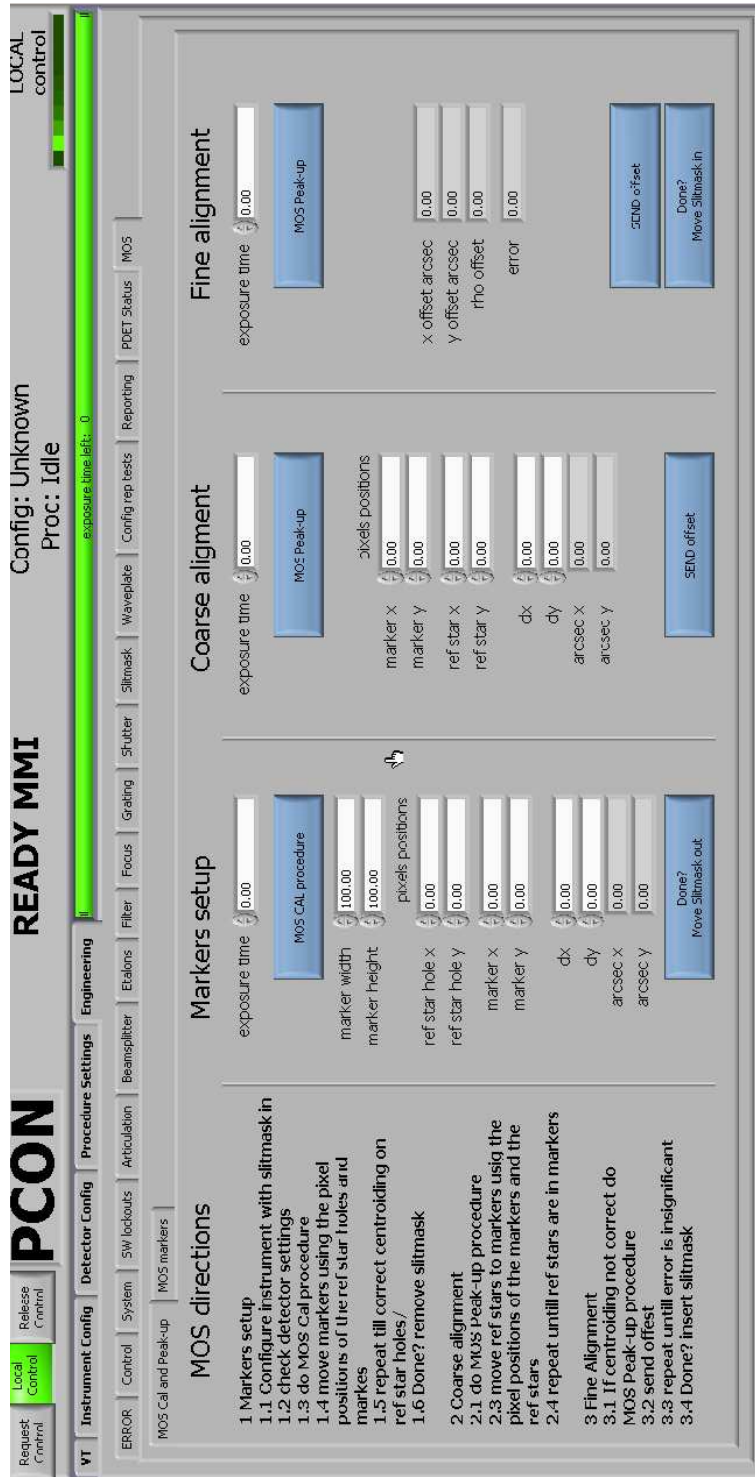


Figure 1: PCON screen with the current MOS implementation.



using the pixel positions of one marker (approximate center) and the related reference star (approximate center). These have to be determined manually and entered manually on the PCON MMI. System will calculate difference. Press “SEND offset” to send the offsets to the telescope.

- (c) Repeat (a) and (b) until reference stars on the image (system C) appear close (how close?) to the position of markers from system B. The centers of C (the actual ref.stars) will be calculated automatically when this point is reached. Move to the fine alignment after that.

4. Modified “MOS Peak-up” procedure – fine alignment:

- (a) Press button “MOS Peak-up procedure” after setting up exposure time – an image will be produced (recommended exposure about 5–15s). Binning HAS TO BE 1×1 , otherwise size of markers are too large to be useful.
- (b) Markers of the system B will be shown. Centers for the reference stars (system C) will be calculated and shown as crosses. Since system has centers for two systems (systems A and C) somewhere, it can calculate accurate offsets (X, Y, Rho).
- (c) Look at the centers. Do you agree with the offsets? If you agree that all of them were defined more or less properly, press “SEND offset” to send these offsets to the telescope. If you do not agree, go to step (a) and repeat it.

If the suggested X and Y offsets are smaller of 3 arcsec each, start guiding with previously selected guiding star and press “SEND offset” ONLY AFTER the guidance was started.

If suggested X and Y offsets are smaller of 0.5-1 arcsec each, you are finished. Press “Move Slitmask in” button.

5. Setup spectrograph.
6. Start exposure.
7. Move pellicle OUT.
8. Drink tee/coffee. You are hero.

3 Why is it still so very slow

The simple scheme, that is shown in Figure 1 and was described in the previous section, currently is VERY slow. There are obvious reasons for that:

1. You have to use 1×1 binning which is the slowest one.
2. Any modifications at all during these iterations need additional read-outs, that together with 1×1 binning make you crazy.



3. There are no interactive modifications anyone can do with PDET, only the possibility to manually enter numerical values on PCON and make additional read-outs to see the result.
4. During “Markers setup” procedure the final shift is the integral one relative to the first position. This makes the observer crazy immediately.
5. The current version of the centering algorithm is very unstable.

4 What should be done

1. The whole current “MOS CAL” procedure of iteratively moving markers to ref.star positions is a total waste of time. All you need to do is take one image of the sky with the mask in – you now have the ref.star slit positions (system A). The system plots on PDET where it *thinks* the database ref.stars are (system B). The user assigns just one B-marker to an A-ref.slit position, using a clicky-click on PDET. System plots modified B-markers on PDET with *no* new readouts necessary. System is ready to move to coarse-alignment.

You also have to be able to de-select and/or re-center individual ref.star positions if they fall in gaps/edges or automatic centering does not work.

If this step takes more than 60 seconds including a 2x2 frame exposure and readout, it will be a failure of implementation. Alexei says it currently took anywhere from few minutes to most of the track.

2. “Coarse alignment, MOS-PEAKUP” has to be done in the clicky-click mode, using PDET, rather than manually input numbers. After the SA identifies the ref.star vs. ref.slit pattern, a clicky-click of only *one* pair of them should move the telescope to close enough alignment for the ref.stars to be automatically calculated in the next step. Again, you must be able to de-select stars from further consideration without the need of redoing your steps. And of course markers should take into account if you use 2x2 or 4x4 modes. Most often this should also be just a single iteration. 1-2 minutes is the goal.
3. “Fine alignment, MOS-PEAKUP”. 3-5 minutes should be the goal here, including 2-3 exposures and readouts, and setting up guiding during this time using the pellicle view. The crucial things remaining are:
 - a) we absolutely have to be able to select which reference stars to use in the peak-up calculation, *and* this has to be done *without* the need of taking extra readouts, or going back all the way to the “MOS-CAL” step as currently appears to be the case. Aren’t the positions sent from PDET to PCON saved? Why does the PCON need a new readout every time a new calculation is made?
 - b) the centering algorithm on stars needs to be checked. Users report unreliable behaviour. This is obviously crucial for the whole acquisition to work accurately.



- c) and once again the markers have to be able to handle 2x2 or 4x4 readouts.
4. Programmers for both PCON and PDET have to be physically at the telescope during nights of any proper MOS commissioning.

5 Final scheme

[To be written up after discussion of the above points.]

6 To do list for programming

- Must be able to de-select ref.star boxes on PDET in the initial MOS-CAL procedure.
- Must be able to re-center interactively ref.star positions on PDET in the MOS-CAL procedure (in case of e.g. wrong centering due to cosmics). This is not allowed to require a new frame to be exposed.
- Marker sizes must automatically adjust to the used detector binning.
- Coarse alignment, MOS-PEAKUP, has to be done in the clicky-click mode using PDET, rather than manually input numbers. So, telescope offsets have to be determined from PDET clicks.
- Must be able to de-select ref.stars on PDET during the MOS-PEAKUP procedure.
- Must be able to re-center interactively ref.stars on PDET during the MOS-PEAKUP procedure. This is not allowed to require a new frame to be exposed (new frames are needed only when you move the telescope).