ALFOSC Multi Object Spectroscopy User Manual

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Contents

1 List of changes

- 14/5 2002: Added description of how to make the mask image.
- 14/5 2002: Added description of fiducial holes in .ap files.
- 14/5 2002: Added note on relaxed autoguiding after alignment.
- 20/1 2003: Changed paths in the aquisition description for new florence.
- 28/5 2003: Added posibility of loading images directly from source directory.
- 29/10 2003: Added note on the fact that the .ap filed need to have 8 header lines.
- 6/4 2005: Changed the image path in the description.

2 Introduction

This manual describes all steps involved in making MOS plates for ALFOSC. Sections 1-4 gives the necessary instructions for observers while sections 5-8 gives operational procedures for staff. In addition to this manual, the NOT web-page gives information on how and where to run the related software.
To make a MOS plate, a `template image` of the field, obtained with ALFOSC, is required, because ALFOSC has some field distortion. When the template image is acquired, the observer or a staff member must produce a plate layout, which is written to a CNC file, using the `mosplate` program. After this has been completed, the MOS machine operator (a staff member) produces the MOS plate after having initialised the MOS machine. The manufacturing of a MOS plate can usually be completed within a couple of hours, but will have to be done during day time.

3 The template image:

The template exposure is used for defining the size and the positions of the slits. The template exposure should be obtained with ALFOSC through a broad band filter, approximately centered on the wavelength region corresponding to the grism which is going to be used for the MOS exposure. As a rule of thumb the exposure time should be of the order of 1-5% of the exposure time required to obtain the spectra, unless emission lines are studied. To avoid large slit losses due to differential atmospheric refraction it is desirable to obtain the template image at the parallactic angle. This requires careful planning of the MOS observations.
To optimise the use of observing time, the template images should, if at all possible, be obtained prior to the run. As the observing time required for doing this is limited, they may either be taken during a previous MOS observers observing run or by staff during technical/staff time. The `mosplate` program allows for (X,Y) pixel coordinate input from a file. For very faint objects or emission line objects, it is therefore possible to use a short template exposure to transform (Ra,Dec) or other coordinates to ALFOSC CCD coordinates. It is the task of the observer to provide this transformation, once the template image has been acquired.

4 Making the instruction file for the MOS milling machine

The program `mosplate` is used to define the layout of the MOS plate. It is running under IDL. Because the NOT wants to retain a full record of all MOS plates manufactured, it can only be run at the telescope. In addition to displaying the loaded template image, it can also calculate and display the layout of the spectra on the CCD, given the specified aperture layout. New apertures may either be added individually with the cursor or read from a simple ASCII file.
The `mosplate` program is fully controlled via a graphical user interface and is largely self explanatory. The user interface allows the user to control and adjust all relevant parameters for each slit. A few things are worth mentioning here. The program can be in two states, one state where no aperture is selected and another where an aperture is selected. When no aperture is selected, a click with the mouse in the un-zoomed image creates a new aperture. The positioning of the new aperture can be selected by the user to be either `centroid` of nearest point source or `cursor`. However, if there is an existing aperture within $5''$of the cursor position and the positioning mode is `centroid`, this aperture will be (re)selected rather than defining a new aperture. This allows the user to modify apertures previously defined. When a new aperture is defined, the state changes to `aperture selected mode`. In this mode, the complete definition of the selected aperture is displayed in the text area near the upper right corner of the `mosplate` window. The user may

now move, resize or delete this aperture. To return to the `no aperture selected` mode, press the cursor in the un-zoomed image, or if desired, delete the selected aperture.

```
# Template input file for mosplate
#
# The file must comply with the following rules:
#
# The first up to 100 lines may be a header with comments.
# Each comment line must contain at least one ‘#’ character.
# All lines preceding the header defines the center of a slit (no empty lines!).
# Each slit definition line must give the number, X and Y center of a slit.
# Number, X and Y goes in first three white space separated columns.
# Only digits, decimal comma and white spaces are accepted.
# Additional data colums with (numerical) user relevant information are allowed.
#
# It is desirable but not required that users document the input file
# with a header, giving the date of writing, target, template image,
# content of columns etc.
#
# FIELD: M13
# WRITTEN: 99.07.08
# AUTHOR: Michael I. Andersen
# TEMPLATE: if230115
#
# ID      XCEN      YCEN     MAG
   1       90.52    848.96   15.83
   2      164.28    872.68   16.11
   3      494.23    783.02   18.91
   4      538.42    961.27   17.44
   5      625.91   1018.23   13.47
   6      931.18    913.91   19.02
   7      960.01    945.87   17.82
   8     1031.62    937.19   17.10
   9     1490.46    636.65   18.01
  10     1953.57   1024.74   15.33
  11     1906.53   1079.42   16.01
  12      228.98    868.92   16.90
  13      996.74    810.48   17.48
  14     1632.23    878.82   17.40
  15     2027.20    741.66   18.12
  16     1794.68    731.65   18.01
```

A sample ASCII coordinate input file for the `mosplate` program.

If a template image has been obtained well in advance of the observing run, the observer should before traveling to the NOT prepare an ASCII input file. The NOT staff does then have the possibility to manufacture the MOS plate before the observer arrives at the telescope, thereby saving travel days for the observer.
To get the plate aligned with the targets on the sky, at least three relatively bright acquisition stars should be selected. Make square apertures for these stars, $4''$ wide.

The template image must be in FITS format and have the extension '.fits'. ASCII input files must have the extension '.coo'. Below is given information on how to run `mosplate` and where to put the template images and input files. This information is also available on the NOT web pages.

4.1 How to start the `mosplate` program

- Log on to 'sandra' as user 'mos' with the password provided by the staff.
- type `bin/mosplate` to start the program.

4.2 Where to place template images for use in `mosplate`

Template images to be used for layout of MOS plates using the `mosplate` program must be copied to `sandra: mos/templates` and have extension `.fits` as stated above.

4.3 Where to place ASCII input coordinate files

The ASCII coordinate input files must be placed in `sandra:~mos/input_coords` and must have extension `.coo` as stated above.

4.4 The products of the `mosplate` program

When the layout of all the slits on the mosplate is done, the NC instruction file has to be produced. This is done by pressing the button labled *Write NC file* in the `mosplate` program. Pressing this button will produce the following products (files)

- The NC instruction file.
  The file will be in the directory `~mos/mosplate/nc`.
- An ASCII file listing the slits and their properties.
  The file will be in the directory `~mos/mosplate/ap`.
- A Postscript file containing a graphical representation of the layout of the MOS plate.
  The file will be in the directory `~mos/mosplate/ps`.

5 Target acquisition

The target aquisition is done using two IRAF tasks. The first task uses two images as input - one of the MOS mask illuminated by a calibration lamp and one of the astronomical object field. The image of the MOS mask should be made with the halogen calibration lamp, the calibration lens and a B filter. A one second exposure is sufficient.
The aperture files (.ap) *has* to contain the dimentions 4.0 as WIDTH and LENGTH. This is the only way for the task to identify a fiducial hole. And example of a correct ".ap" file:

```
Aperture   XCEN      YCEN     WIDTH    LENGTH
   #       [pix]     [pix]    [ " ]     [ " ]
   1      100.97    886.25     4.0       4.0
   2      570.46   1880.12     4.0       4.0
   3     1867.09   1811.33     4.0       4.0
   4      961.70    354.91     4.0       4.0
   5      292.55   1211.12     2.0      10.0
   6      786.51   1343.49     2.0      10.0
```

An example of a wrong ".ap" file:

```
Aperture   XCEN      YCEN     WIDTH    LENGTH
   #       [pix]     [pix]    [ " ]     [ " ]
   1      162.52    715.39     3.0       0.1
   2      332.91   1270.09     3.0       0.1
   3     1928.18   1701.38     3.0       0.1
   4      893.50    488.20     3.0       0.1
   5     1490.34    855.28     1.8      12.0
   6     1363.45    740.50     1.8      12.0
```

Edit the ".ap" file be hand to comply to this restriction.

The ".ap" files also needs to have 8 header lines. They will have this by default when produced by the `mosplate` program.

The task then calculates the amount to offset and rotate the telescope in order to make the MOS mask coincide with the objects in the field. These two images and the aperture file must exist in the directory `florence:/var/guest/mosimages` in order to be found by the IRAF tasks described below (it has been tested that images also can be loaded directly from the mounted directory, which is `/data/alfosc`. If you do this there is no need to copy the images).
The second IRAF task moves the telescope based on the results found by the first IRAF task.
As with all IRAF tasks, the parameters can be given in different ways. They can all be written on the IRAF command line after the command. The command can be typed and the parameters can be given when IRAF prompts for them. Finally, the parameters can be edited using the `epar` IRAF command. This manual assumes a basic knowledge of IRAF.
The following is a complete description on how to do the target aquisition.

- Log in on the computer *florence* as user *guest*.
- Type '`cd iraf`'.
- Type '`ds9 &`' to start your favorite image display program.
- Type '`xgterm &`' to start a graphics capable xterm.
- In the *xgterm* type '`cl`' in order to start IRAF.
- Type '`cd ../mosimages`'.
- Make sure that the aperture definition file for the MOS mask in use is in this directory (`/var/guest/mosimages`). The name will be MOS00??.nc.ap, where ?? is a sequence number.
- Type `alfosc` to load the IRAF alfosc package.
- Type

  ```
  mostweak <mask-image> <objectfield-image> <aperturefile> 4.0
  ```

  ,where `<aperturefile>` is the file `MOS0020.nc.ap` if MOS mask 20 is in use. Please see the IRAF manual page of the `mostweak` task for a complete description.
- The mask image will be displayed and the slits marked with green circles.

- Position the cursor over the slit that is marked with a yellow circle. Press '`a`'. When the statistics appear in the xgterm window press '`q`' to move on to the next slit that will be marked with a yellow circle. Be aware that the circle and the slit in question will not always coincide completely, but it should be obvious which slit it is. The position found by the program will be marked by a small red circle.
- When all usefull slits are marked, the image of the object field is displayed and the first alignment star will be marked with a yellow circle. Position the cursor on that star and press '`a`'. Press '`q`' after the statistics appear in order to move on to the next usefull star. The position of the star found by the program will be marked with a small red circle. Also in this case the circles will not coincide complely with the stars so take care when identifying them.
- After the last star has been marked, the program displays the amount to offset the telescope in the pixel X and Y direction and how much to rotate the field.
- Apply these changes using the IRAF task `mosmove` in the following way. Type

  ```
  mosmove
  ```

  and the task will prompt you for the current TCS access code. The value of the access code has the default value from the last time the task was run, so if the access code has not changed you can just press enter. Please see the IRAF manual page of the `mosmove` task for a complete description.
- Turn on autoguiding as fast as possible using relaxed autoguiding (TCS command: ag-re-on).
- Make an image of the field through the MOS mask and check the alignment of the slits and corresponding objects.

This procedure will probably have to be iterated two times for the objects to be correctly aligned with the mask.

A Online help for IRAF package alfosc

A.1 The mostweak task

```
MOSTWEAK (December2000)            NOT           MOSTWEAK (December2000)



NAME
    mostweak -- find telescope tweak parameters from  two  images  taken
    with a mask and of the object field.


USAGE
    mostweak maskimage objectimage maskdefinitionfile holesize


PARAMETERS

    maskimage
        Name of the image taken WITH a mask of a calibration lamp.

    objectimage
        Name of the image taken WITHOUT a mask of the target field.

    maskdefinitionfile
        Name of the MOS mask definition file (.ap file).

    holesize
        The  diameter  of  the  fiducial holes in arcsec.  In this task,
        this parameter affects the centroid algorithm.


DESCRIPTION
    This task determines the centroid positions of  the  fiducial  stars
    and  the  fiducial holes on an image of the mask and an image of the
    target object field. To measure the pixel coordinates on  the  image
    the interactive task imexamine is used.

    The differences in the measured positions of the stars and the holes
    are then transformed into telescope tweak  parameters:  offsets  and
    rotation.  Ask somebody who knows about it (maybe yourself) to apply
    this tweak, which should bring the  fiducial  stars  closer  to  the
    centre of the fiducial holes of the mask.


EXAMPLES
    Take  an  image  of a calibration lamp (i.e. halogen) with the mask,
    at the required telescope position and rotator angle, and  an  image
    of the target astronomical field, and do
```

```
mostweak jc240011 jc240012 MOS0006.ap
```

Apply the recommended tweak (first the offset, then the rotation). This tweak should bring your fiducial stars closer to the centre of the mask holes.

THE INTERACTIVE PART OF THE TASK

This task will display the section of the mask image which contains the fiducial star slits; the slits are marked by a circle. The user is advised to adjust the colour scale of the image display tool such that the fiducial stars AND the fiducial holes are clearly visible. The object field image will be displayed in full size and the fiducial stars will be marked as described above.

The user has to point the cursor at the fiducial stars (slits) marked by a YELLOW circle, and has to press key -a- to activate the centroid algorithm. If key -a- is pressed more than once, the final press will be evaluated. Each press will be acknowledged by statistics appearing on the terminal that runs IRAF. To advance to the next star (slit), press -q-. To avoid a particular star (slit) to take part in the tweak fit, press -q- WITHOUT pressing -a- first.

On the image display the centroid positions of the slits and stars will be marked by a RED circle.

When all fiducial slits and fiducial stars have been marked by the user, the tweak will be computed.

If one of the centroid positions of the stars or holes seems wrong (judging from the RED circles), the task can be run again with the user discarding the star in the way described above.

A good tweak fit needs no less than 3 stars. Nevertheless, a tweak can be computed on only 2 stars.

TIME REQUIREMENTS

A lot less than doing it by hand.

BUGS

email Jacob W. Clasen (jclasen@not.iac.es),
for bug reports and constructive remarks

SEE ALSO

mosmove

A.2 The `mosmove` task

```
MOSMOVE (December2000)           NOT           MOSMOVE (December2000)



NAME
    mosmove -- Perform the move of the telescope in order to  align  the
    MOS mask with the object field.


USAGE
    mosmove [TCS access code]


PARAMETERS

    TCS accesscode
        The  access  code for the TCS. This parameter is learned and the
        user is prompted for it if it is absent.

    Verbose
        Verbose yes/no. If set to 'no' no text output is generated.  The
        parameter is hidden.

    Inputfile
        The  absolute  path of the file containing the values written by
        the mostweak task.  This  file  will  be  written  in  the  same
        directory  as  the  'ldsstweak'  FORTRAN  program  used  by  the
        mostweak        task.        This          is            currently
'result.out'. The parameter is hidden.

    Offset program
        The absolute path to the program 'teloffset'. Normally found  in
        '/usr/local/bin'. The parameter is hidden.

    Rotation program
        The  absolute path to the program 'MOS-rotation'. Normally found
        in '/usr/local/bin'. The parameter is hidden.

    IP address
        The IP address of the TCS  computer.  Normally  161.72.5.7.  The
        parameter is hidden.


DESCRIPTION
    This  task  moves  the telescope in RA and DEC and changes the field
    rotation. The amount of these movements are the ones  found  by  the
    last  run of the mostweak task.  It is not necesary to to supply any
```

information apart from the access code to this task. All the telescope movement values are stored in a file by the mostweak task and then read by this task. The task uses the UNIX command line programs 'teloffset' and 'MOS-rotation'. These programes must be present and the path to them set (see parameters).

EXAMPLES

Simply type the task name and press enter

```
mosmove
```

The task will prompt you for the TCS access code. If is has not changed just press enter.

TIME REQUIREMENTS

A lot less than doing it by hand.

BUGS

email Jacob W. Clasen (jclasen@not.iac.es), for bug reports and constructive remarks

SEE ALSO

mostweak