Observations with SOFIN at the NOT

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Contents

1 Before the run

- Prepare your catalog in `sandra.not.iac.es` in the `/home/catalogue` directory [1]. Login as `guest` with the password provided by the stuff. Load the catalog to the TCS (Telescope Control System) via `MainMenu/Catalog`.

  In case of having problems with the write permission of the catalog file, check that you are user `guest` (by using the command `whoami`), and if not, then login with `su guest`, enter the above password, and change to the catalog directory.

- Change the balance of the telescope by `count-hei 0.95`. The telescope should be in idle mode. Change the altitude by `alt 45` and check the balance by displaying a status page and inspecting the current of the two motors by `show 42` or `show 18`.

- Change the default settings for the telescope:
  - Focus of the telescope by `foc-pos 23400`.
  - Focus of the guide TV by `tv-foc 480`.
  - Telescope offset step size in arcsec by `o-s 0.2 0.2`.
  - Guide probe step size by `p-s-s 30 30`.

Note that if the TCS is re-booted then the default settings should be reset again.

2 During observations

2.1 Opening the telescope

- Reset the security system, type `power-on` and confirm with `Y`.
- Open upper hatch by `o-u-h`. Wait while it is opened to proceed. Open side ports meanwhile.
- Open mirror cover by `o-m-c`.
- Open lower hatch by `o-l-h`.
- Switch guide TV on by `tv-on`.
- Set rotator to automatic mode by `rot-auto`.

[1] it can also be submitted through the web program under `http://www.not.iac.es/new/observing/RunPreparation.html`

2.2 Making exposure

- Select object in the catalog `MainMenu/Catalog` by pressing $\boxed{5}$ or $\boxed{6}$ on the keypad (it is also a way to refresh the catalog screen).
- Set the rotator angle depending on the optical camera used, the declination δ of the object, and the latitude ($28°45'$) of the site in order to minimize flexure of the spectrograph:

Camera 2:	$\delta > 28°45'$	`d-p -70.`
	$\delta \leq 28°45'$	`d-p -30.`
Camera 1 or 3:	$\delta \geq 28°45'$	`d-p +30.`
	$\delta < 28°45'$	`d-p +70.`

- Preset to the object with the $\boxed{7}$ key.

  This combined command will point the telescope to the star, set the rotator angle chosen, select the appropriate guide star, and the TV filter according to its brightness.
- Optionally change the TV filter with `tv-fil g`, `r`, `y`, or `o` depending on the brightness of the guide star. Filter letters stand for gray, red, yellow, and open.
- Set the object on to the slit by moving the telescope with arrow buttons.
- Check the telescope focus and if necessary change it with `foc-del` followed by the relative increment, say, +100, or −200 with respect to the default focus value. The command `foc-del 0` resets the focus to the default value. Changing the telescope focus requires correction of the guide TV camera with `tv-foc` followed by the absolute value of the new focus.
- Click the middle button (`star`) of the TCS mouse on to the guide star. If the sky is bright, change the position of the background box closer to the guide star with the left mouse button (`sky`). Initiate autoguider by `rel`.
- Start the exposure. If during a long sequence of exposures, the rotator angle is out of the working range ($-30°$ to $-70°$ for camera 2 and $+30°$ to $+70°$ for camera 1 and 3), then stop the sequence, make an optional ThAr exposure, and de-rotate the rotator back to the original angle: stop autoguider `a-s`, preset to the star with $\boxed{7}$, click on the guide star, and initiate autoguider `rel`. Make additional ThAr exposure, and continue the sequence of object exposures. *Note that nor rotator or telescope should be moved while the exposure is going.*
- Make a fine correction of the star on the slit via `MainMenu/GuideProbe/Others`. Use $\boxed{1}$ and $\boxed{3}$ buttons to move in x-direction and $\boxed{2}$ and $\boxed{5}$ in y (see Fig.1). Press the button and wait a few seconds till the star is centered in the guide probe box.

  In case the star cannot be set onto the slit due to slow motion or if it went too far, then stop autoguider with `a-s`, correct position with arrow buttons, click middle mouse button on the guide star, and initiate autoguider with `rel`.
- Stop autoguider by `a-s` once the object exposure is finished followed by comparison spectrum and flat field exposures. To change to a new object start over at the beginning of this section.

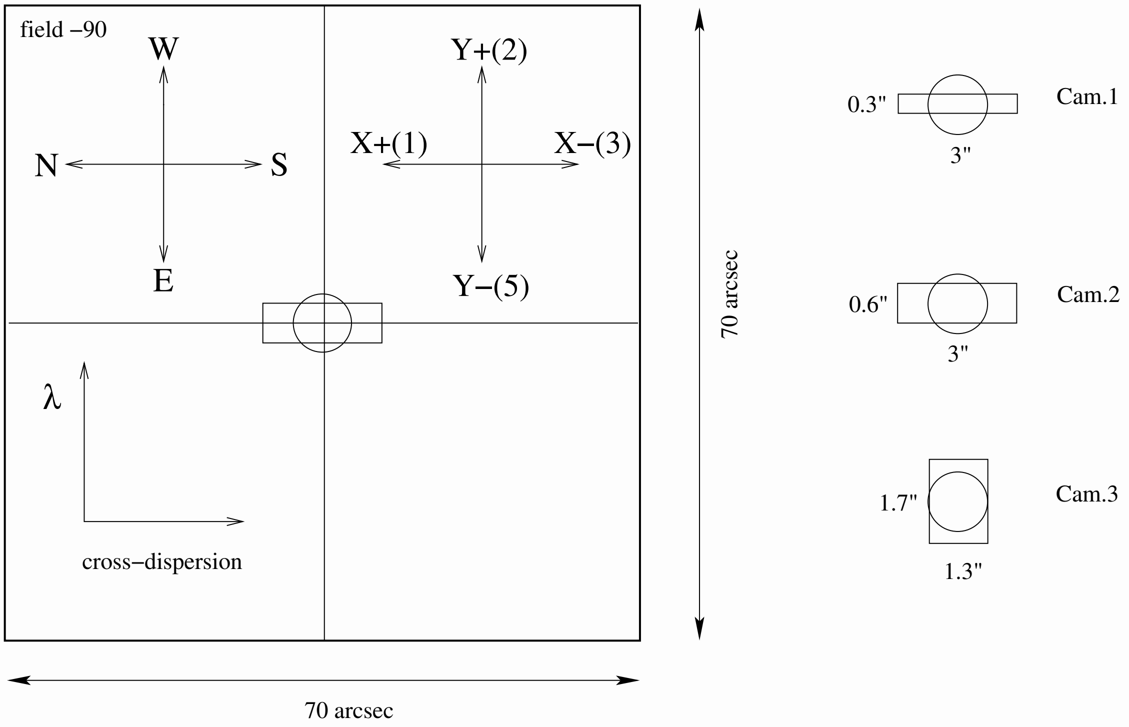

Figure 1: The slit as seen on the SOFIN guiding TV camera screen. Shown the directions of the guide probe motion with the corresponding TCS buttons from `MainMenu/GuideProbe/Others`, and the telescope motions in α and δ with arrow buttons when the paralactic angle is $-90°$.The relative dimensions of the slit for different cameras are at the right.

2.3 Summary of the commands to make exposure

1. Select object in catalog menu `main-3` with `5` and `6`
2. `d-p -70 -30 +30 +70`
3. Preset with `7`
4. Wait to see the star at the slit
5. `tv-fil g r y o` optionally
6. Set the star on to the slit with arrow keys
7. Click on the guide star
8. `rel`
9. Start exposure
10. Correct position of the star on the slit from `main-4-0`
11. `a-s`

2.4 Closing the telescope

- Switch the SOFIN guiding TV camera off (upper button on the power supply).
- Switch the telescope guiding TV off by typing `tv-off`.
- Put telescope to zenith position by typing `zenith`.
- Close lower hatch by `c-l-h`.
- Close mirror cover by `c-m-c`.
- Park the building by `MainMenu/StartStop/ParkBuilding`.
- Close upper hatch by `c-u-h`. Wait while it is closed to proceed. Close side ports meanwhile.
- Type `power-off`.
- And submit End-of-Night (or End-of-Run) report at the NOT home page.

3 Other modes and notes

3.1 Observations with the Stokesmeter

- Stokesmeter is on-axis
  - Focus of the telescope `foc-del 500`.
  - Focus of the guide TV `tv-foc 570`.
  - Set the paralactic angle to $-90°$ typing `field -90`, so that the two beams are oriented to the north pole, i.e. by pressing arrow buttons `Up` and `Down` the two beams move in declination along the slit height.
  - Use the Loral CCD binning factor 1 in columns, in order to the two closely spaced beams are well sampled in cross-dispersion direction.
- Stokesmeter is off-axis
  - Focus of the telescope `foc-del 0`.
  - Focus of the guide TV `tv-foc 480`.

3.2 Scaling factors of the spectrograph

The scaling factors of the CCD pixels in cross-dispersion direction are:

Camera	CCD	pixel, μm	M	arcsec/pixel
1	EEV3	22.5	1.489	0.110
2	EEV7	22.5	0.716	0.230
2	Loral	15.0	0.716	0.153
3	EEV3	22.5	0.249	0.662

These numbers can be used for measurement of seeing by estimating the width of cross-dispersion profile of an échelle order.

In the cross-dispersion direction the magnification factor is $M = f_{\rm cam}/f_{\rm col}$ and the projected slit height p related to the entrance slit height w as $p = M\,w$. The scaling factor ($F/206265$) of the telescope is $1'' = 136.5\,\mu$m for the focal length $F = 28160$ mm.

The magnification factor M_λ in the dispersion direction is $M_\lambda = f_{\rm cam}/f_{\rm col} \cdot \cos\alpha/\cos\beta$. where $f_{\rm cam}$ and $f_{\rm col}$ are the focal length of the camera and collimator, α and β are the incident and diffracted angles on the échelle. The later ratio is the échelle magnification factor equals to 0.7546 at blaze.

The following table gives approximate slit heights for optical cameras. The slit height is set by the mark on the handle in hour minutes ($15^{\rm m}$ is $90°$). The height in pixels depends also on the CCD used.

Camera	Handle	Pixels	Arcsec	CCD
1	$15^{\rm m}$	??		EEV3
2	$15^{\rm m}$	25	$3.8''$	Loral
2 + Stokesmeter	$40^{\rm m}$	44	$6.7''$	Loral
3	$5^{\rm m}$	3	$2.0''$	EEV3

3.3 Focus of the optical cameras

Positions of the best focus for optical cameras obtained at different air temperatures:

Camera	CCD	Filter	Temp, C	Focus
1	EEV3	yes	12	
1	EEV3	no	12	22
2	EEV7	yes	8	40
2	EEV7	no	19	35
2	Loral	yes	12	51
2	Loral	no	12	46
3	EEV3	yes	8	13

With the increase of air temperature by 4C, the focus of the camera 2 should be decreased by 1 large division of the focussing ring.

4 Manual adjustment of the image

The step size of the échelle and prism stepping motors in CCD pixels. The shift in rows corresponds to the turn of the échelle, the shift in columns - to the cross-dispersion prism.

Camera	CCD	100 rows	100 columns
2	Loral	147	112
3	Loral	430	
1	Loral		534

5 Solution to the problems

5.1 No star is seen on the SOFIN guide TV

- It is cloudy: check outside.
- Upper hatch is closed: open it with `o-u-h`. It may happened if the zenith distance of the star is more than 55°.
- Lower hatch is closed and the zenith distance of the target is more than 55°: open it with `o-l-h`.
- Mirror cover is closed: open it with `o-m-c`.
- TV camera power supply is off: switch the upper button on the power supply. *Do not change any settings on the power supply: it may damage the camera.* The gauge should show the voltage of 12V.
- TV camera shutter is closed: set gray filter or open it from `Observations/Setup/Instrument/ICCD`.
- The star is too faint: increase the gain of the camera with the knob atop of the power supply. Decrease the gain clockwise, increase the gain anti-clockwise. *Do not overturn the gain regulator: it has the soft stopper ends.*
- Check the coordinates.
- Check that the CCD probe or the guide probe are not obscuring the beam. Otherwise, park the CCD probe with `c-p-p` or the guide probe with `g-p-p`.
- Check that the brightness and contrast knobs of the TV monitor is at maximum.
- The star is out of the TV screen (the field of view is 70″): preset to the star once more.

  If there is still no star, try `g-p-c` to move the guide probe to the center to view the star on the telescope guide TV (field of view is 100″). Move the star to the screen center and park the guide probe with `g-p-p`. This may be due to error in the pointing model of the telescope at specific locations: to store the offsets use `pr-po-ad`, to reset the offsets at some other telescope positions use `pr-po-re`.
- Possible malfunction of the pentaprism in spectrograph: initialize the unit by typing from the DOS prompt

```
\4a\sofin\beam init
```

- The Stokesmeter is moving and obscures the beam: check that one of the two LEDs named `KV1` and `KV2` on the CAMAC module called `shifter` is on, which indicates that the Stokesmeter is on or off axis.
- Something was forgotten to be removed on the front flange of the spectrograph during installation to the telescope.

5.2 No guide star is seen on the telescope guiding TV

- Check that the TV is on by typing `tv-on`.
- Change to the appropriate filter `tv-fil g r y o`.
- Try to pickup a guide star once again without changing the telescope position: type `field` and press `Help` button to display it. Type the displayed field angle and press `Enter`.

6 Handling the SOFIN spectrograph

This section is to be done by a qualified support person.

6.1 Before the run

6.1.1 At the telescope floor

- Check that the battery of the spectrograph lifter are charged. Ask staff to recharge the batteries otherwise.
- Start to pump the CCD cameras. Use the dedicated power supply (named Mascot) at 24V to heat the absorb pump of the Astromed cameras. Plug it to the camera once the pumping starts and unplug it when the pumping is over.
- Open the spectrograph, take away plastic bags covering optical cameras and electronics. Remove the **heavy** yellow disk which covers the spectrograph flange and secure it to the wall barriers with a plastic tie.
- Carefully open the échelle unit cover by removing two bolts with handles and then pull out the grating plastic cover. Close the cover, put the plastic cover in envelope, and store it in the control room.
- Stop pumping the CCD after 2-4 hours. The nominal dewar pressure is 10^{-6} mbar. Fill the dewar with the liquid nitrogen.
- Turn the telescope power on and put the rotator angle to zero position. Install the spectrograph on the telescope. The spectrograph is oriented so that the CCDs are faced to the entrance door and their electronics to the crane. *Watch the cables while operating with the fork lift.* Put the fork lift all the the way against the spectrograph yellow holder. Insert a wooden plate between the fork ends and the bottom of the spectrograph yellow holder. Lift the spectrograph, adjust the holes, and use the blue bolts and washers to mount.

- Plug in the power cable of the spectrograph to the telescope power splitter.
- Install CCDs to the spectrograph. Remove the red covers from the bayonet connector of the optical cameras: turn out a half way the slanted stopper screw with the handle, turn the red cover anti-clockwise, and pull it out. Put the CCD into the bayonet connector slots and turn it clock-wise before the rim with the cut edges touches the stopper screw (with flat handle). Tight the four screw with handles in the CCD bayonet connector and screw the stopper with handle. *Do not use screwdriver for this operation: everything should be done by hand. Do not turn the stopper screw with the flat handle, since it will change the CCD adjustment.*
- Check that the Astromed CCD electronics power is off and check that its cooling fan is resting. *Only after that* connect the cable between the electronics and the CCD dewar: detach the connector cap, *DO NOT touch the connector pins: any static charge will irreparably destroy the CCD chip*, ground the cable connector against the dewar connector and plug it in by turning clockwise. Plug in the power of the CCD electronics.
- Switch the power of the Loral CCD electronics off. Connect the respective cables to the CCD dewar. Connect the yellow fiber cable to the electronics which connects it with the control computer. Only after that plug the power of the electronics on.

6.1.2 In the control room

- Boot DOS from Linux at the spectrograph control computer.
- Remove the top metal cover from the CAMAC crate.
- Switch on the High Voltage Power Supply for the photon counter at the rear of the CAMAC crate. It takes several hours to get it into the working regime.
- Check that the black coaxial cable connected to the slit guiding camera is plugged to the TV monitor input connector. The monitor is situated to the left of the TCS console.
- Start the control program by typing `s` from the DOS prompt being in the `C:SOFIN` working directory.
- Put the power of the CAMAC crate on with the switch at the left lower part of its front panel. Just after that initialize the spectrograph devices from `Observations/Setup/Instrument` menu.
- Initialize the Astromed CCD in order to set the CCD working temperature from the `Observations/Detector` menu. The CCD identifier should be properly chosen according to which electronics the cable is currently connected. Initialize the second Astromed CCD (if it is installed) after switching the black computer cable from one electronics to the other. In any other instances, once the Astromed camera power is switched off and then on again, it should be be initialized again. The Loral CCD camera does not to be initialized. It can take up to 30 minutes to get the CCD to the working temperature regime. The current CCD temperature can be checked from the `Observations/Setup/Detector` menu against the reference preset temperature.
- Check and correct the computer time settings in the `Setup` menu of the database of objects by displaying the current position of any object from database. Change if necessary the time zone in the database of sites, so that the UT and LST displayed correspond to the telescope clocks. The database of objects can be invoked either from `Shell/Objects/DisplaySelected` menu commands, or from `Observations/Object/SelectObject`.

6.2 During the run

- Switch the power supply for the intensified TV camera. Change the filter settings in the `Observations/Setup/Instrument/TV camera` depending on the brightness of the object. Too bright star can permanently damage a very expensive intensified CCD: in this case immediately switch off the power supply for the power supply of the camera (the upper button), then change to the gray filter, and power on again. Do not change brightness or contrast of the viewing TV monitor: it is a potential risk that too bright object cannot be seen on the screen and the immediate action be taken.
- The CCD cameras should be re-filled with liquid nitrogen before, at the middle, and at the end of each the night. Check periodically during the night, that the sink sensor of the dewar is below 100–110K. Once it is higher, the CCD temperature will start to rise. The CCD should never be re-filled while it is exposed: this will lead to a significant drift of the spectral lines. The CCD of the other optical camera which is not under exposure can be re-filled without any problems.
- To switch between two optical cameras currently installed, four things to be done:
  1. Flip the cross-dispersion prism by rotating the handle at the prism to the direction indicated by the labels above it.
  2. Switch the Astromed CCD black computer cable from one electronics to the other. In case the Loral CCD is installed, no cable switch is necessary.
  3. Adjust the slit height: open the slit hatch and turn the handle clockwise to make slit decker taller. Since there is no gage on the slit decker, a rule of thumb says that for camera 2 and 1 it is 90° from the closed position, for camera 3 it is about 10°. Make the final check by making the flat field image and inspecting the interorder distance in the red orders. The minimal interorder separation should be at least 3 pixels.
  4. Change the CCD software setup in `Observations/Setup/Detector/Configuration` according to the CCD camera connected.

6.3 After the run

- Switch power of the CCD electronics off. Check that the cooling fan is at rest. Unplug the Astromed CCD dewar cable and immediately close it with the connector protective cap. *Do NOT touch the connector pins.* Disconnect the cables of the Loral CCD if installed. Secure the CCD cables to the electronics plate with a plastic tie.
- Dismount the CCD cameras and store them into the control room. Cover the optical cameras with the red blanks.
- Cover the échelle with the plastic plate.
- Unplug the spectrograph power cable. Dismount the spectrograph.
- Close the spectrograph top with the heavy yellow cover and bolt it with the four screws.
- Cover the optical cameras and the round electronics box with plastic bags.
- Cover the spectrograph with the black hood. Hide the cables below the spectrograph.
- Switch off and unplug the power supply for the intensified TV camera.
- Switch off the High Voltage Power Supply for the photon counter at the rear of the CAMAC crate.

- Switch off the CAMAC crate, cover it with the metal plate, and secure it with the tape.
- Transfer the data with `ftp` to `miriam.not.iac.es` to `/home/data1` or `/home/data2` directory. Login as `guest` with the password provided by the stuff.