OASIS - Loral3 COOKBOOK

Prepared by Pierre Martin (10/25/00)

For: ____________________________________

A - Information for Visiting Astronomers

1) Accounts

- Pegasus Session : `Machine: neptune`

  `Login:`______________

  `Password:`______________

- Observer's Account : `Machine: makani`

  `Login:` ______________

  `Password:`______________

2) Support

- Resident Astronomer : `Pager: 925-7473`

  `Cellular Phone: 936-0885`

  `Office Phone: 885-3167 or 885-7944`

  `Residence: 885-8974`

  `Hale Pohaku: 935-9001`

  `Summit: 961-2630 or 961-2639`

  `E-mail: martin@cfht.hawaii.edu`

3) Others

- FAX at Summit: `808-935-4511`
- FAX in Waimea: `808-885-7288`
- CFHT Web Page: `http://www.cfht.hawaii.edu/`
- CFHT OASIS Web Page: `http://www.cfht.hawaii.edu/Instruments/Spectroscopy/OASIS/`
- CFHT Filters Web Page: `http://www.cfht.hawaii.edu/Instruments/Filters/`
- CFHT Detectors Web Page: `http://www.cfht.hawaii.edu/Instruments/Detectors/`
- Observing Assistants Page: `http://www.cfht.hawaii.edu/~oas/oaschedule.html`
- Astronomical Calendar: `http://www.cfht.hawaii.edu/Temporal/SkyCalendars/`
- Hawaii Weather Maps: `http://www.cfht.hawaii.edu/ObsInfo/Weather/`

B - Instrumental Configurations

Numerous optical configurations are possible with OASIS. These configurations can be selected through the **Observing Assistant** button in the Pegasus session. The standard OASIS configurations for both imaging and TIGER modes are given below **for a CCD with 15 μm pixel size** (i.e. Loral 3).

- **Imaging**

Spatial Resolution

F/20 AOB		F/8 Cassegrain	
Scale	*Field*	*Scale*	*Field*
$0.060''$/pixel	$90''$ diam.	$0.07''$/pixel	$143'' \times 143''$
$0.029''$/pixel	$45''$ diam.	—	—

- **TIGER**

Spatial resolution

F/20 AOB			F/8 Cassegrain		
Sky Sampling	*Field*	*CCD Sampling*	*Sky Sampling*	*Field*	*CCD Sampling*
$0.04''$/lens	$1.6'' \times 1.2''$	$0.000714''$/pixel	$0.27''$/lens	$10.4'' \times 8.3''$	$0.00482''$/pixel
$0.11''$/lens	$4.1'' \times 3.3''$	$0.00196''$/pixel	$0.41''$/lens	$15'' \times 12''$	$0.00732''$/pixel
$0.16''$/lens	$6.2'' \times 5.0''$	$0.00286''$/pixel	—	—	—
$0.30''$/lens	$11'' \times 9''$	$0.00536''$/pixel	—	—	—

Low Spectroscopy Resolution Configurations (F/20)

Name	Useful Wavelength Limits			Dispersion	Resolving Power	Beamsplitter
	Grism	λ_{inf} (Å)	λ_{sup} (Å)	Å/pixel		
LR2	R150	8650	10370	4.74	1000	I

Medium Spectral Resolution Configurations (F/20)

Name	Useful Wavelength Limits			Dispersion	Resolving Power	Beamsplitter
	Grism	λ_{inf} (Å)	λ_{sup} (Å)	Å/pixel		
MR0	O300	4150	4930	2.13	1059	50-50
MR1	O300	4760	5558	2.15	1210	V
MR2	R300	6210	7008	2.17	1525	R
MR3	R300	8346	9152	2.23	1965	I
MR4	O300	5502	6324	2.16	1375	R
MR5	R300	6940	7764	2.19	1710	R
MR6	R300	7685	8455	2.21	1880	I
MR7	R300	9150	9896	2.25	2220	I

High Spectral Resolution Configurations (F/20)

Name	Useful Wavelength Limits			Dispersion	Resolving Power	Beamsplitter
	Grism	λ_{inf} (Å)	λ_{sup} (Å)	Å/pixel		
HR1	B600	4852	5196	0.99	2530	V
HR2	B600	5118	5484	1.00	2650	V
HR3	O600	6209	6549	0.99	3215	R
HR4	O600	6492	6838	1.00	3335	R
HR5	R600	8435	8749	0.87	4295	I

C - CCD:

CCD Characteristics

Detector	Size	Pixel [μm]	Gain [e^-/ADU]	RON [e^-/pixel]	<Quantum Efficiency> [% for range in nm]					
					450-500	500-600	600-700	700-800	800-900	900-1000
LORAL3	2048^2	15	2.3	5.3	23	30	40	40	30	10

• Readout time: ~ 2.4 minutes for Loral3 (full CCD).
• Saturation level: ~ 32 000 ADUs for Loral3. Bias Level: ~ 510 ADUs
• **Orientation (f/20)**: North at the bottom; East at the right (with the NS axis at a position angle of about +9.5° from the vertical).
• **Orientation (f/8)**: North at the top; East at the right (with the NS axis at a position angle of about +22° from the vertical).

D - Calibrations

Calibration frames are crucial when observing with OASIS! It is very important that you keep track of the calibrations needed or done during your mission. The key is the following: **While observing, NEVER switch between two configurations on a same astronomical target without taking the necessary wavelength calibration frames**.

The following calibrations are imperative:

- For each imagery scenario :

    i) A flat-field exposure (At least 10 integrations of 15000 ADUs/frame taken with Gumball)
    ii) A flux calibration exposure

- For each TIGER scenario (this can be done during daytime and only ONCE for a given scenario) :

    i) A micro-pupil exposure (Gumball Halogen Imaging Lamp with about 10000-15000 ADUs/lens)
    ii) A flat-field continuum exposure with its associated wavelength calibration exposure (At least 10 continuum integrations of 15000 ADUs/frame taken with Gumball are recommended)
    iii) A twilight flat-field (2 frames of a few 1000s ADUS is a good number)

- For each science exposure :

    i) A wavelength calibration frame (MUST absolutely be done before switching configuration)

    ii) A flux calibration exposure of a standard star with its associated wavelength calibration (for each target).

E - Time and Overheads

• It takes ~ 1.5 hours for a full set of calibrations for one configuration. A set of 10 biases takes 30 minutes.

• Overheads are quite important while observing with OASIS. For example, if we include the wavelength calibrations, pointing, AO loop operation, field check acquisition, readout time of CCD and diverse software and hardware checkout procedures, two 30 minutes exposures on the sky will take a total of 95 minutes to be fully executed. That is, an efficiency of the order of 65% have to be taken into account for planning of your observing nights at f/20.

F - The Adaptive Optics Bonnette (AOB)

When OASIS is used in its f/20 mode, the observer has to become somewhat familiar with the operation of the AOB. A full description can be found, of course, in the AOB manual at the CFHT Web site. Here are a few important things to know while observing with AOB + OASIS:

• **APDs:** The avalanche photo-diodes of the wavefront sensor unit must be protected against excessive fluxes. The flux on the APDs should be < **8000** (linear up to 8000) and **never** > **15000**. The full correction is possible for flux > 80; guiding is possible with counts ∼ 20. *For OASIS, a lot of flux can be transmitted to the APDs during Gumball calibrations and skyflats (if necessary) or while guiding on a very bright object.* **Neutral density filters, available in the AO correction window, should always be used in these cases!**

• **Gain:** For a punctual object, the optimal gain value (128) should be used. For extended object, the gain should be reduced between 50 to 80.

• **ADC:** The Atmospheric Dispersion Corrector should in principle always be used with the OASIS + AOB configuration. *You can select "ADC in" in the AO control window before closing the AO loop.* However, beware that the flux going to the APDs will be diminished if the ADC is used.

• **Beamsplitters:** Several AOB beamsplitters are available: 50-50 (about 40% transmission to OASIS), and one for the "V", "R" and "I" bands (> 90% of the light in the filter bandpass is transmitted to OASIS). These beamsplitters can be changed during the night BUT about **15 minutes** will be lost on the sky during the operation. The recommended beamsplitter for each standard mode of OASIS is given in the tables of part B. **BEWARE: The beamsplitters are not perfectly aligned with each other so you have to redefine the AOB hotspot for each splitter change.**

• **WFS:** If guiding on a star nearby a very faint or extended object, this star has to be **within the physical limits of displacement for the wavefront sensor, that is, about 40″**.

• **AO Correction: After** confirmation by the Observing Assistant that the telescope is pointing at the target, the AO correction can be activated like this:

1. Click on **Go to Observe Configuration**. This bring the wavefront sensor on the "hotspot".
2. Check if the flux is increasing on the APDs. If yes, that means that the guiding object is well-positioned at the WFS; if not, you might have to move the telescope slightly around the "hotspot" until you see some flux.
3. Click on **Start AO correction** in the $\boxed{\text{AOB}}$ menu.
4. Select the appropriate neutral density filter, if necessary.
5. Try first with the gain set at 128. If the loop cannot be closed, try lower values.
6. Put the atmospheric dispersion corrector (ADC) in.
7. Click accept and look for the counts on the APDs and the tip-tilt values (must be < ±4 volts and very small (∼0.1 V) when the loop is closed). When the loop is closed, the message "guiding" will appear on the TV display next to the X-terminal.

• **Focus:** Telescope focus is done **manually** by looking at the numbers displayed in the AOB status window and applying the values with the focus handset. The status is updated every minute or so. Differences < 5 units are insignificant.

• **Offsets:** While using the AOB guiding, offsets can be applied using the **Offset** tool in the AOB control windows. The RA and DEC offsets can be entered and clicking the button "RA/DEC Offset with correction" will move the telescope while keeping the AO loop closed. It is also possible to apply offsets by giving a start and end position in X and Y pixels on the CCD.

G - Observing Procedures: A Summary

I - F/20 (AOB)

Here is a brief summary of the observing procedures for OASIS + AOB. Please, refer to the OASIS Web Page at the CFHT site for a much more complete description.

1) Open an OASIS Pegasus session on the observer's terminal in the control room using the login and password given on the first page. Open the AOB control windows by selecting the AOB button. Open also the **Special Functions** window for the AOB.

2) Select the Observing Assistant. First, if your name is not correctly implemented, do it by selecting the **Give the Observer Name** button. Open also the electronic logbook (**Display the Log Book**).

3) You can now define your scenarios. If scenarios are already present, you can have information or delete these scenarios with the **Display Scenario Info** and **Delete Scenario** buttons. By clicking on **Set-up a New Scenario**, you can now define an imaging or a TIGER scenario by selecting the instrumental characteristics needed for your observations.

4) If you want to take calibration frames (wavelength, flat-fields, pupil exposures) with one of your configured scenario, select this scenario from the **Take a Scenario Exposure** option then select the exposure type needed. You can then choose the light source (Gumball). It is possible to use different lamps with different exposure times for the same calibration frame. Note: It's a good practice to first determine the exposure times with a **Test Exposure** and a small CCD raster (e.g. 300×300)

5) If you want biases or darks, select the **Take a CCD Service Exposure** option, select the exposure type needed and enter the other parameters (number of exposures, CCD raster, name).

6) For each scenario, take the minimum set of calibrations listed in section D that can be obtained with the Gumball unit : pupil exposure, flat-field, wavelength calibration. DO NOT FORGET: *it is imperative to complete a set of calibration before switching to another configuration.*

7) Verify that the right AOB beamsplitter is mounted for your spectral range of interest. For the changing procedure, you need to use the **Move Beamsplitter Out** and **Move BeamSplitter in** buttons in the AOB "Setup Functions" window. *Only the Observing Assistant and the support astronomer are allowed to manipulate these expensive beamsplitters!*

8) After acquisition of the object with the AOB (see section E for a summary), it is now possible to take an field check exposure as defined in a scenario. We recommend that you always do that to verify the position of the object on the CCD (this is specially true when using a field of view of 1.5″ in diameter!). To be centered in a TIGER exposure, the image of your object should be located on a specific position on the CCD in the image. This reference position is determined by the CFHT staff and can vary slightly from a configuration to another:

OASIS Configuration	Reference Position on CCD
F/20 0.11″, 0.16″, 0.30″	
F/20 0.04″	
F/8 0.27″, 0.41″	

9) What should be done if your object is not located at the right location? The position of your object on the CCD depends of where the AOB hotspot has been defined. *It changes for each beamsplitter since they are not aligned perfectly well with each other (± 4″).* The observing method is first, to apply a small offset with the AOB (**Offset** button), then second take another field check exposure and repeat the offset until the object is at the right location. If you are planning to spend some time using this specific beamsplitter, it is better to redefine the hotspot by clicking on the **Record the instrument hotspot** in the "Setup" window for the AOB control. That means that each time you will acquire an object with the wfs, the object will be located at the reference position on the CCD and should then be centered for the TIGER exposure. Bingo!

10) Even if your object should be centered by now, it is a good practice to take a short exposure in TIGER mode before starting to integrate for a long time just to make sure that you are pointing where you want. Of course, this is only possible if your object is bright enough... You can use binning 4 × 4 to reduce the readout time. If your object it not perfectly centered, you can move it with the **Offse**t option for the AOB while taking the field orientation as given in section C into account.

11) Take at least one wavelength calibration with the scenario used for the science exposure.

12) You can edit the electronic log book to include real-time comments after data acquisition.

II - F/8 (No AOB)

Observing without the AOB (direct f/8) introduces a few important differences in the observing procedures, mainly affecting the telescope focusing and offsetting. **The importance of appropriate calibrations stays the same**. The operation of OASIS through the Observing Assistant is also exactly similar except, of course, that you have different configurations.

1) In the special functions of the AOB, you can move to the f/8 focus by clicking on the **Switch to the f/8 mode no AOB** button. If you were observing previously with AOB in f/20, take note of the telescope focus on the TV screen next to the terminals.

2) You can now define your scenarios as usual selecting the appropriate focus in the pull-down menus.

3) The telescope focus is different between the AOB and f/8 mode. It is also different between the imaging and TIGER configurations in f/8. That means that you must first do a focus sequence in the imaging mode and change manually the telescope focus by a certain offset when switching to spectroscopy. The focus sequence is done under the Focus button. You have to take first an image of your field (or a 10-11th mag. star close to your target) with a scenario (beware: the object HAS to be somewhere in the central 500 × 500 pixels). You can then enter the appropriate values for the focus procedure. For the imaging, the best telescope focus will be about 40 units higher that the one you had if you were observing with AOB before the mode switch. If not, a good guess is around 1970 units. For the automatic sequence, about 6 to 8 focus steps are necessary. You must move the telescope focus manually (ask the Observing Assistant for help) to the first value of the sequence. Steps of about 10 units should be fine. When the sequence is over, a plot will give you the best focus and you can then set the focus to this value. The OASIS Interface has been modified so that you will be warned when you should apply the appropriate offsets.

4) You can now move to your field and do an field acquisition if the object was not the one use for focussing. To do this, it is HIGHLY preferable to use the 0.29″/pixel sampling since the offset procedure was calibrated with this configuration. If your object is not at the reference position for this mode (given in the Table of page 5), you can select the **Offset** button in the Pegasus window (not the AOB one...) and give the coordinates X,Y for the offset. You are now ready for TIGER!

5) Before starting the exposure in TIGER mode, **you MUST apply an offset of -25 units to the telescope focus from the position found during the focus sequence in imaging mode**. There is a warning window popping up to reming you to apply this offset. You can then take a short exposure if your object is bright enough to verify centering in TIGER mode. You should not be more than 1.5″ from the center of the field. If it is a problem for you (i.e. you want your object very well centered), you must ask the telescope operator to move the telescope while keeping guiding on. The offsets can be calculated using the CCD pixels scale for TIGER modes given in page 2. Beware of the orientation! In f/8, the orientation is different from the f/20 mode (see section C).

6) Finally, do the appropriate calibrations!

H - Other Information

1) The data reduction package prepared by Lyon Observatory, XOasis, is available to reduce your data (which can be found in the /h/oasis directory) on **makani**. Ask your Support Astronomer for details.

2) The observers are responsible for copying their own data on exabyte or DAT tapes. Tapes are available in the control room at a nominal charge. The drives for **neptune and makani** are located in the computer room (next to the control room). You can use the Files button in the Pegasus session or your observer account to backup your data anytime during your mission.

3) The electronic logbook from the OASIS Pegasus session can be printed out and kept for reference. The file can also be saved in the /h/oasis directory by clicking on the "Export Logbook" button.

I - End of Mission

1) Report

• It is VERY IMPORTANT that you fill the form available on the CFHT Web page for your end-of-mission report (`http://www.cfht.hawaii.edu/ObsInfo/Forms/`). Please, let us know how your run went and what improvements you would like to see implemented in the future. Compliments are welcome too!

2) Results

• I would be extremely pleased if you keep me informed of your science results obtained with OASIS! If you have a publication available and you give me your permission, I would like a postscript copy to make it available on the OASIS Web page. Thanks!

GOOD LUCK !