MOS/FP COOKBOOK

Prepared by Pierre Martin (02/12/01)

For: ______________________________

A - Information for Visiting Astronomers

1) Accounts

• Pegasus Session :

`Machine: neptune`

`Login: mosfpeev`

`Password:`______________

• Observer's Account :

`Machine: makani`

`Login:` ______________

`Password:`______________

2) Support

• Resident Astronomer :

`Cellular Phone: 936-0885`

`Pager: 925-7473`

`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 FP Web Page: `http://www.cfht.hawaii.edu/Instruments/Spectroscopy/Fabry-Perot/`
• 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/1999/`
• Hawaii Weather Maps: `http://www.cfht.hawaii.edu/ObsInfo/Weather/`

B - Instrumentation

1) CFHT Etalons:

CFHT#1 Etalon Characteristics (ET50-822)

Wavelength	**Interference Order**	**Expected Finesse**
Hβ 4861 Å	1569	7 - 8
[OIII] 5007 Å	1523	11 - 12
Hα 6563 Å	1162	12 - 13
[NII] 6584 Å	1158	12 - 13
Neon 6599 Å	1156	12 - 13
[SII] 6717-6731 Å	1134	14 - 15

Parameter	**Value**
Wavelength Ranges	4700 - 5400 Å; 6200 - 7500 Å
Scanning Constant	$\sim$2.71
BCV (free spectral range at 6598 Å)	$\sim$2435 units

CFHT#3 Etalon Characteristics (ET50-839)

Wavelength	**Interference Order**	**Expected Finesse**
Hα 6563 Å	72	60 - 62
[NII] 6584 Å	72	60 - 62
Neon 6599 Å	72	58 - 60
[SII] 6717-6731 Å	70	55 - 60

Parameter	**Value**
Wavelength Range	5600 - 7500 Å
Scanning Constant	$\sim$2.44
ΔBCV (full order scan at 6599 Å)	$\sim$2690

Laval Etalon Characteristics (ET50-832)

Wavelength	**Interference Order**	**Expected Finesse**
[OIII] 5007 Å	1005	15-16
HeI 5015 Å	1003	15 -16
Hα 6563 Å	768	25
[NII] 6584 Å	766	25
Neon 6599 Å	764	25
[SII] 6717-6731 Å	747	20

Parameter	**Value**
Wavelength Range	Å
Scanning Constant	$\sim$2.43
ΔBCV (full order scan at 6599 Å)	$\sim$2716

2) CS100 Controller (usual settings in **bold**)

CFHT#1

Axis	**Fine Setting**	**Coarse Setting**	**R balance**	**Gain**	**Time**
X	2.48	0.2	0.46	64	25
Actual in X					
Y	6.60	0.2	4.06	64	25
Actual in Y					
Z	5.22	0.0	4.12	64	25
Actual in Z					

CFHT#3

Axis	**Fine Setting**	**Coarse Setting**	**R balance**	**Gain**	**Time**
X	5.28	0.3	4.08	64	25
Actual in X					
Y	0.28	0.0	3.85	64	25
Actual in Y					
Z	2.75	−1.0	4.11	64	25
Actual in Z					

Laval

Axis	**Fine Setting**	**Coarse Setting**	**R balance**	**Gain**	**Time**
X					
Actual in X					
Y					
Actual in Y					
Z					
Actual in Z					

3) MOS + CCDs:

MOS-FP + CCDs

Detector	Size	Pixel Size [μm]	Scale [″/pixel]	Gain [e^-/ADU]	RON [e^-/pixel]	<Quantum Efficiency> [%]			
						450-500	500-600	600-700	700-750
LORAL3	2048^2	15	0.31	2.3	5.3	23	30	40	40
EEV1	2k×4.5k	13.5	0.28	1.89	∼3	81	76	72	65

- Optimal field of view: ∼ `8.7 × 8.7 arcmin`
- Usual CCD raster for MOS-FP (full field): $X_c = 1024$, $Y_c = 1024$, $X_s = 2048$, $Y_s = 2300$ (EEV1).
- Readout time: ∼ `90 seconds (full CCD); ∼48 seconds (2048 × 2300 raster) (STIS2)`
- Saturation level: ∼ `32 000 ADUs`
- Central wavelength of interference filters:

$$\lambda_{central} = \lambda_0 \left[1 - (N_{air}/N_{filter})^2 \sin^2 \alpha\right]^{1/2} + 0.18(T - 20) \qquad (1)$$

where λ_0 is the central wavelength at normal incidence and reference temperature for filter (20C for MOS filters); N_{air} and N_{filter} are the index of refraction of air (= 1.0) and the filter, (∼ 1.7), respectively; α is the inclination of the filter and, T is the ambient temperature.

4) Useful Fabry-Perot Formulae

- Reflective Finesse:

$$F = \frac{4f^2}{pDg^2(\Delta x_1 + \Delta x_2)} = \pi\frac{\sqrt{R}}{(1-R)} \tag{2}$$

with f= 128mm; p = interference order; D = diameter of the interference ring; g = pixel size in mm; Δx_n = FWHM of the ring in pixels; R = reflectivity.

- ΔBCV (i.e. "BCV fsr"):

$$\Delta BCV = \frac{\lambda}{Scanning\ \ Constant} \tag{3}$$

- Free Spectral Range:

$$FSR = \frac{\lambda}{N} \tag{4}$$

with N = interference order.

- Resolving Power:

$$RP = NF = \frac{\lambda}{\delta\lambda} \tag{5}$$

with N = interference order and F is the reflective finesse.

C - Observing Procedures: A Summary

Here is a brief description of the observing procedures for MOS-FP. Please, refer to the User's Manual on the CFHT Web page for a much more complete description.

1) From the Pegasus session for MOS-FP, verify that the observing run ID and PI name are correctly stated below the main menu bar. If not, ask your support astronomer to change it. Also, verify that there is enough disk space left (less than 70% full) for your run. If not, you can clean the directory using the FILES form. Ask also for logsheets since it is important to keep track of all your exposures in FP spectroscopy.

2) Open the MOS-FP window and verify that all your filters have been installed. If not, go on the 5th floor and install them in the mask slide in the three positions available (position 1 is always open) with the help of your support astronomer. When done, update the form MOS-FP in the Pegasus session.

3) Click the Fabry-Perot button and take note of the following parameters as stated in the Pegasus window:

Parameter	Value
Etalon	
Setting Wavelength	
Scanning Constant	
BCV fsr	

Parameter	Value
Etalon	
Setting Wavelength	
Scanning Constant	
BCV fsr	

Parameter	Value
Etalon	
Setting Wavelength	
Scanning Constant	
BCV fsr	

4) Ask the support astronomer for the value of the finesse measured during the set-up **for the correct wavelength**. You can verify this value using the technique described in the User's Manual and the formula (2). If a full scan is desired for your observations, calculate the number of channels ($N_{channels}$) necessary using the Nyquist criteria: $N_{channels} = 2.2 \times Finesse$

Parameter	Value
Wavelength	
Finesse	
$N_{channels}$	

Parameter	Value
Wavelength	
Finesse	
$N_{channels}$	

Parameter	Value
Wavelength	
Finesse	
$N_{channels}$	

5) There are three scanning methods for MOS-FP (see manual for more details):

i) Full Scan: The only parameters to set in the Fabry-Perot window are $N_{channels}$ (calculated above) and the wavelength. Monotonic or interlaced scannings with or without overlapping can be selected.

ii) Partial Scan: In this mode, only a few channels are scanned. To accomplish this, a BCV value that brings an interference ring in spatial correspondence with the object must be found. In the Fabry-Perot form, you must then enter the precise wavelength range to be scanned as well as the interference order and the exact calibration wavelength. The BCV value must be calibrated before the night and the Z channel voltage has to be set to zero.

iii) Manual Scan: The scanning is done by entering manually values for BCV in the $\boxed{\text{Fabry-Perot}}$ form. The BCV values range from -2048 to $+2047$ which cover ~ 1.7 interference order at Hα.

6) Phase map and flat-fields can be obtained from the internal calibration lamp system ("Gumball") and the dome flat-field screen. For the phase map, the $\boxed{\text{LAMPS}}$ form offers a Neon lamp with a filter isolating a line at 6598.9 Å for Hα work. A line at 6717 Å is also available from the other Neon lamp for [SII] work (you must then use a filter in the mask slide). For [OIII] 5007 Å, there is a line at 5015 Å from the Helium lamp. For the flat-fields, ask your OA to position the telescope on the dome screen and control the lamps from the control room using the panel next to the terminals. Use the same scanning procedure and CCD raster as for the science observations.

7) Before starting an exposure on your object, you must focus the telescope (not MOS!). Ask the Observing Assistant (OA) to point a 7th or 8th magnitude star near your target. Using the handset, move the telescope focus around 1950. Take a normal exposure **with** the right filter and etalon (no binning!) with the $\boxed{\text{EXPOSE}}$ form. Localize the star on the CCD (verify that it is not overexposed) and select an appropriate (100×100) focus raster with the button $\boxed{\text{FRASTER}}$. In the $\boxed{\text{FOCUS}}$ window, select "analytical" and use the $\boxed{\text{IQE}}$ button to get the statistics. Repeat the procedure by moving the telescope focus for a rough estimate (15-20 focus units) and then use $\boxed{\text{CAF}}$ or you can manually do a fine focus (step of 5 units). **IMPORTANT:** Focussing should be repeated for each filter change or for large telescope motions ($> 30°$).

8) Before starting, verify with your OA that the filter selected for the Cassegrain guider corresponds to your wavelength of interest to minimize atmospheric refraction effects (for example, filter RG610 should be used for Hα work). You are now ready for science observations!

9) To run a science exposure, *i)* verify that you have the right filter in the beam; *ii)* select the correct CCD raster; *iii)* open the $\boxed{\text{Fabry-Perot}}$ window, select the appropriate scanning procedures and the parameters and click on "accept". This brings automatically the $\boxed{\text{EXPOSE}}$ form. Select the exposure type ("object"), specify the exposure time in seconds *for one individual channel*, fill up the other entries and click on "accept".

10) Important: During the observations, you should routinely check on the 5th floor that the CS100 loop remains close since no error message will appear if the loop opens.

11) Both IRAF (version 2.11) and IDL (cersion 5.0) are available on **makani** for data reduction.

12) 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 $\boxed{\text{FILES}}$ button in the Pegasus session or your observer account to backup your data anytime during your mission.

13) Important: The EEV1 detector is affected by hot pixels. Darks of the same exposure times as your science frames must be taken during your run to ensure that these hot pixels can be subtracted.

D - End of Mission

1) Data Archiving

• During your run, your data were automatically saved in Waimea for subsequent archiving at CADC. If needed, you can retrieve your data by contacting: `http://cadcwww.dao.nrc.ca/`

2) 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/ obsrpt_e.html`). Please, let us know how your run went and what improvements you would like to see implemented in the future. Compliments are welcome too!

E - APPENDIX: SCANNING RECOVERY PROCEDURE for Loral 3

During a full scan, it might happen that the CCD controller will hang out and the scanning will be stopped. This is due to the internal architecture of the controller and this problem can occur once or twice during your run. Here's some information to minimize the occurrence of this problem and how to recover from it.

- **Never** click on "abort" or "stop" the exposure during reading out. As much as possible, leave these buttons alone!
- Keep an eye on your scanning because the controller problem can occur at any time. It is strongly recommended to take note of all the positions (BCV) for the individual channels during the scan by using the tables attached to this document. These values are updated in the Fabry-Perot status window and can be used later to finish the scan.
- If the CCD hangs up, click in the background of your terminal and find "OCS Configuration" This will open a window displaying all the servers. For the detector server, click on "exit". When done, click on "start" and wait until completed. Try a few biases to see if the CCD is now working properly. If not, contact your support astronomer.
- If the CCD is back to normal, you can continue your scan but you have to do it manually. Go in the "Fabry-Perot" window and select manual. You must now enter the BCV value for the channel you were doing during the crash and click "accept". All the remaining channels can also be done by entering their BCV value so it is important to note them during a successful scan. If the actual scan is the first one and you do not have all the BCV value for all the channels, you can still calculate them with the interval between the channels: BCV (fsr)/Number of channels. Verify that this number is consistent with the difference of BCV seen for the first channels already scanned.