CAT+CES

Operating Manual

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Chapter 1

Introduction

This manual describes the Coudé Echelle Spectrometer (CES) as well as the operation of the Coudé Auxiliary Telescope (CAT). It is a new version of the Operating Manual No. 8 (March 1989) prepared by H. Lindgren and A. Gilliotte. The update by G. Mathys (April 1994) has been integrated in the present version.

The manual is intended to serve as a guide during both the preparation and execution of an observing program. A detailed description of the CES and CAT operations is given, in order to enable the observer to perform a complete observing program. The most relevant IHAP (and MIDAS) commands, to be used during a typical observing run, are explained. A significant number of programmes scheduled for the CAT/CES are performed in remote mode from Garching; for this purpose, remote control operations are also described.

In principle, the CES can also be used together with the 3.6 m telescope via a fiber optics link. At present, however, this option is not offered. A 3.6m-CES stable fiber link is under development.

The first part of the manual is intended to help for proposal preparation, in the second part operational aspects are considered, including a section "Trouble-shooting".

We strongly encourage users to make comments and suggestions concerning this manual. Please do so by writing in your observing report and/or sending your comments to the 3.6m and CAT instrument support account 360cats@eso.org.

Chapter 2

System description

2.1 General description

The CES was designed by D. Enard and M. Le Luyer [1] and was installed at La Silla in 1980. It began operation in a scanner mode. Shortly thereafter observations started with the Maksutov Long Camera and an 1872 pixel reticon array. In 1982 the first tests were made using a fiber optics link from the 3.6 m telescope's prime focus to the CES in its double pass scanner mode [2]. A major step towards fainter magnitudes was taken in 1986 with the arrival of the Short Camera, designed by B. Delabre [3] and equipped with a high resolution CCD as detector. Finally, in 1987 a CCD was also installed in the Long Camera allowing high-resolution observations of fainter stars. The reticon array and scanner mode are not used anymore. The installation of a low noise, high quantum efficiency CCD in the Long Camera in 1995 has resulted in the decommissioning of the Short Camera. Since 1987, the CES has been offered on a regular basis as a remotely controlled facility from ESO headquarters in Garching.

The CES employs a classical Czerny-Turner grating mount with a 204×408 mm echelle grating of 79 gr/mm as the dispersive element. The order separation is made by a prism pre-monochromator also mounted in a Czerny-Turner configuration. For maximum efficiency from the UV to the near IR, two optimized light-paths are available: one for the red and one for the blue. The spectrograph is highly automated; only the initial set-up, instrument focus, and path selection have to be made manually.

2.2 The CAT

The CES was originally designed to be fed either from the Coudé focus of the 3.6 m or from a 1.4 m Coudé Auxiliary Telescope (CAT) located in a separate building. The CAT is an Alt-Alt telescope with a Nasmyth focus (Fig. 2.1). Four secondary mirrors with different coatings are mounted in a turret. Two coatings are dielectric and partly overlapping in their useful wavelength range; the blue should be used below 5500 Å, the red above 4500 Å.

Quantity	Value	Comments
	CAT Telescope	
Pointing Limitations	See Figure 2.2	Slightly changing with time
Large Field FOV	3.2×2.3 arcmin	
Small Field FOV	62×46 arcsec	Reversed orientation
	CES Spectrograph	
Switch wavelength Blue/Red	5200 Å	
Slit orientation	See Figure 2.3	
Scale at the slit	0.226 mm/arcsec	0.442 arcsec/mm
Max Slit height	30 mm (20 arcsec)	
Slit width α	50 μm $\leq \alpha \leq$ 5 mm	
R×α	124600	Roughly constant with λ
Max. resolv. power CCD#34	110000	2 pixels sampling
Max. resolv. power CCD#38	75000	See table
Dispersion (Å/pixel)	λ/228000	
	CCD Detector	
Scale $\parallel$ dispersion	0.56 arcsec/pixel	15μm pixel
Scale $\perp$ dispersion	0.45 arcsec/pixel	
Slit - CCD orientation	Up-Right[1]	CCD#34
	Up-Down[2]	CCD#38
	CAT+CES efficiency	
CCD#38		See table
Blue (4035 Å)	4.4%	S/N ~ 100 for V=6 in 6 min.
Red (6450 Å)	8.5%	S/N ~ 100 for V=6 in 3 min.
CCD#34		See table
Blue (4035 Å)	1.2%	S/N ~ 100 for V=6 in 20 min.
Red (6450 Å)	4.3%	S/N ~ 100 for V=6 in 6 min.

Table 2.1: CAT + CES characteristics summary; Notes: (1) Moving upwards along the slit corresponds to moving towards larger x-values (to the right) on the detector; (2) Moving upwards along the slit corresponds to moving towards smaller y-values (downwards) on the detector

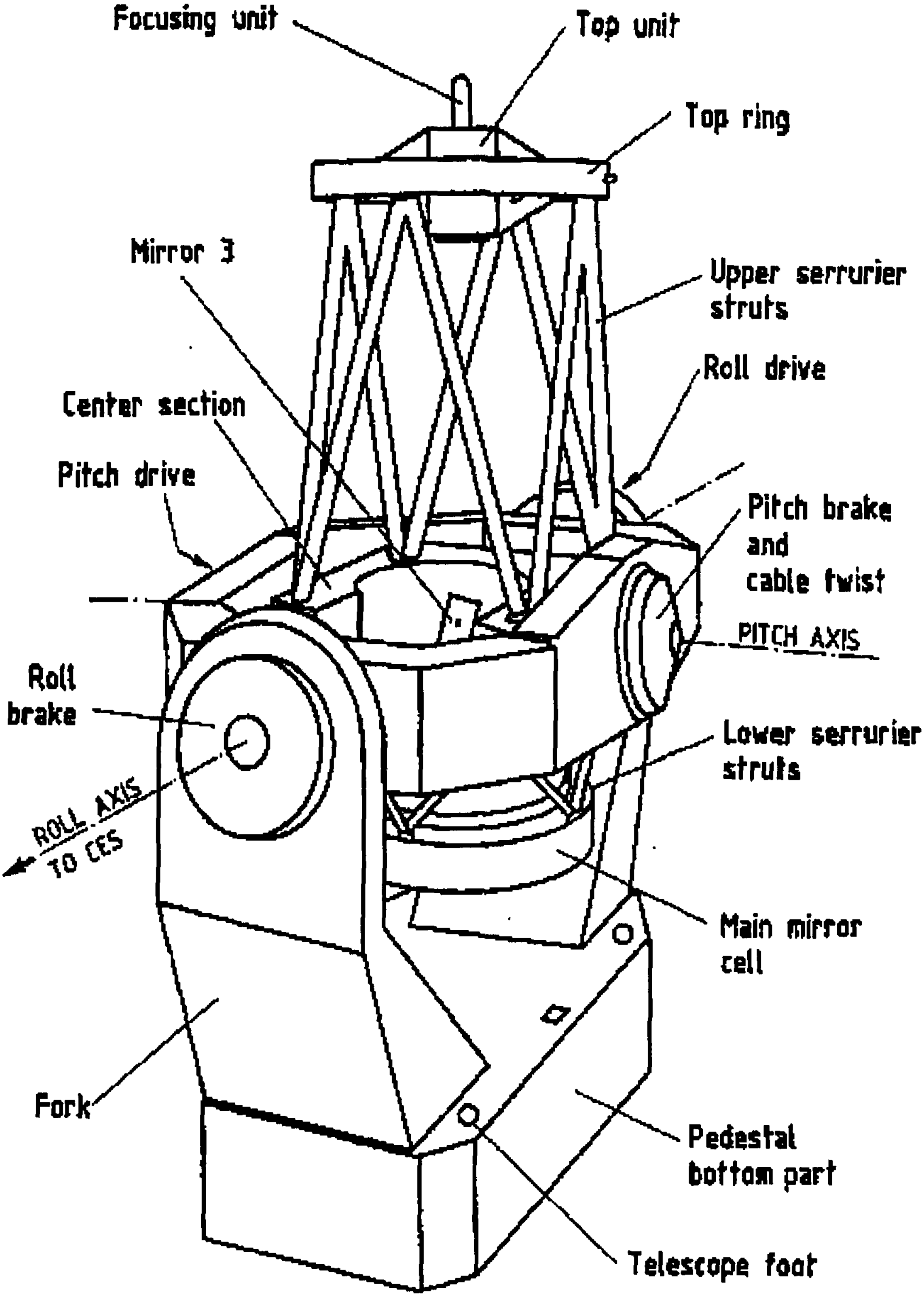


Figure 2.1: Mechanics of the CAT

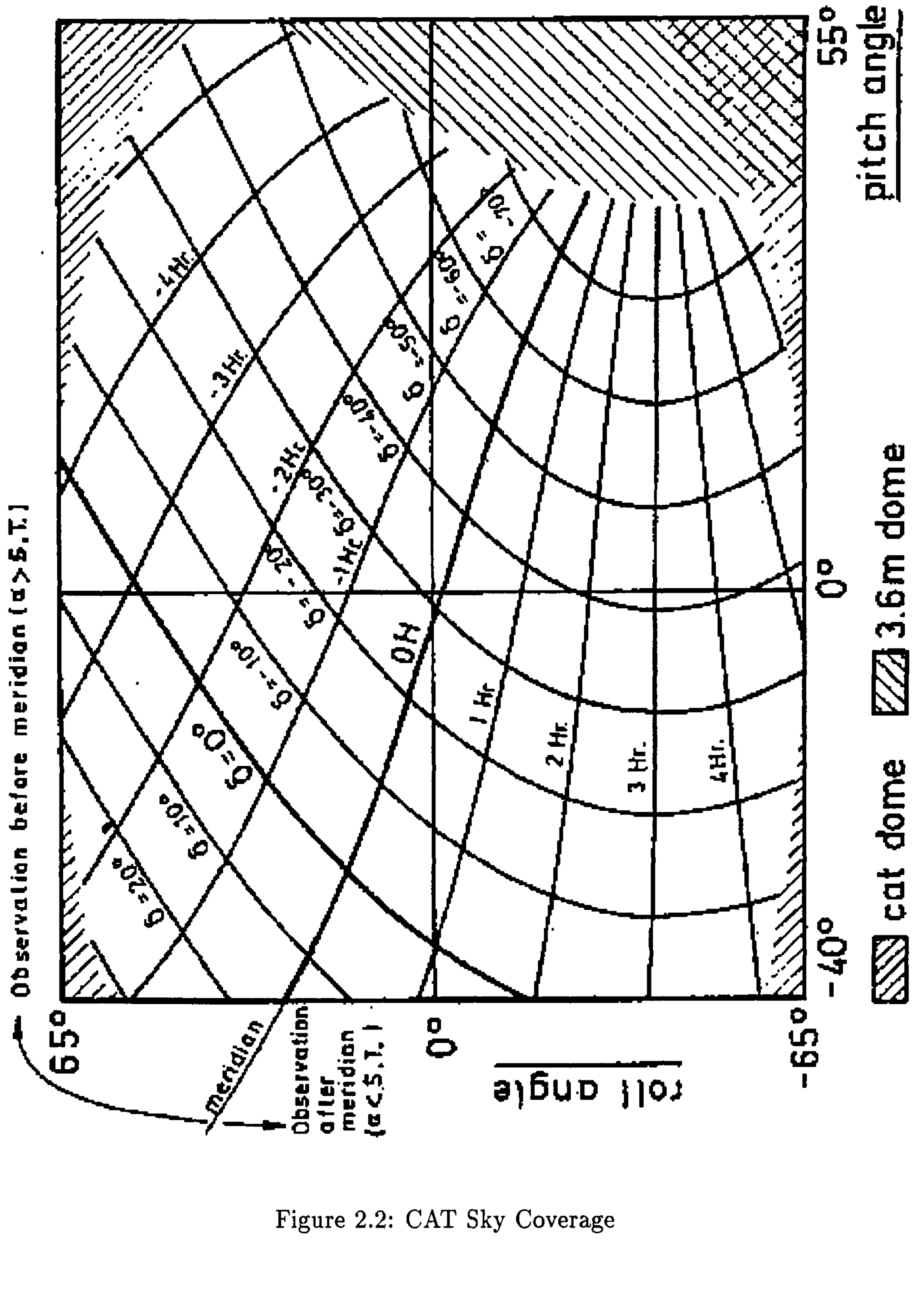


Figure 2.2: CAT Sky Coverage

A third secondary has a normal aluminium coating suitable for a wide wavelength range, a fourth is free. The mirror selection is made from the CAT/CES control room. The flat moveable third mirror sends a f/120 beam towards the focal reducer. The beam is inclined $2^\circ 3'$ from the horizontal.

A finder telescope mounted on the CAT shows a large field of 20×26.5 arcmin on a TV monitor in the control room. Restrictions on the CAT pointing coverage are imposed by the short distance between the CAT tower and the 3.6 m building. Objects outside the frame of Fig. 2.2 or inside the hatched areas cannot be reached. Furthermore, when the telescope is pointing towards higher northern declinations, additional limitations are created by the grazing reflection of the beam off mirror M3. Since the CAT roll axis is not strictly oriented in the north-south direction, a meridional asymmetry is present in Fig. 2.2. This is important for objects north of $+10^\circ$ which should be observed before the meridian. Note that the pointing limits (Fig. 2.2) are only approximate, and that they can vary slightly with time, depending in particular on the exact optical alignment of the telescope. One is advised against letting the CAT approach these limits too close, as the third (flat) mirror (M3) may get stuck and a significant amount of time may be lost in attempts to bring it back into regular operation.

Please take into account the CAT pointing limitations when preparing your proposal and observing run.

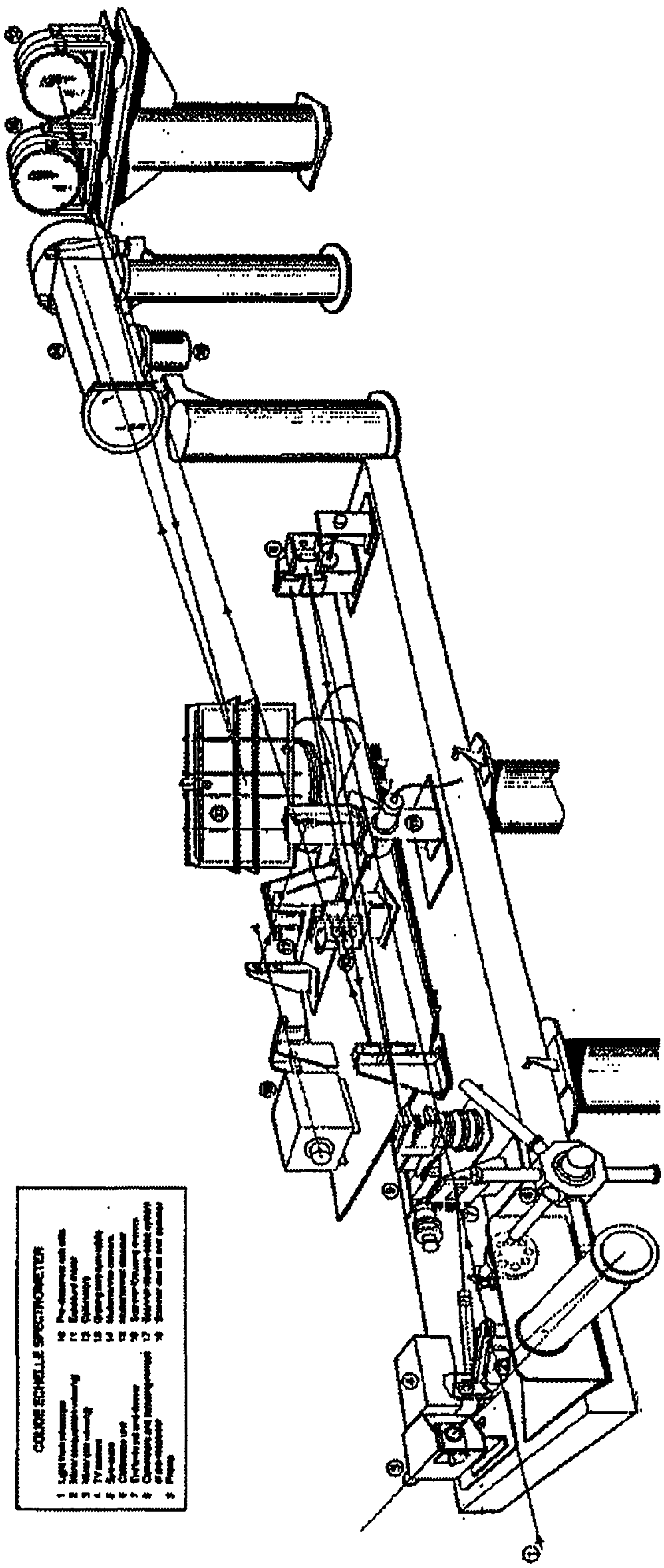
2.3 The CES

Figs. 2.3 shows the general layout of the CES. Additional information can be found in reference [1].

The f/120 beam from the CAT is changed to the CES f/32.3 aperture by a two-element focal reducer. The focal reducer is located in front of the slit area and uses four specially coated lenses, two for the blue path and two for the red. The lenses are mounted on two turrets which must be manually rotated to bring the selected lens into the light-path.

Fig. 2.5 shows the slit area and the focal reducer. The slit is continuously adjustable in width (50 μm to 5 mm) and height (max. 30 mm or 20 arcsec). The scale is 0.226 mm/arcsec. To facilitate guiding the slit unit is slightly tilted with respect to the optical axis. The stellar image reflected off the slit jaws can be seen from the control room with the help of a TV system. A flat mirror may be switched into the light-path after the focal reducer to give a view of the sky through the CAT telescope (Large Field). This mode is used to find and center the star on the TV monitor. Moving the mirror out of the light-path allows the star to be centered on the slit (Small Field). The large field has a size of $3.2' \times 2.3'$ with a direct field orientation; the small field covers $62'' \times 46''$ in reversed orientation. Field rotation is clockwise in the large field and anticlockwise in the small field.

An eyepiece mounted close to the TV camera in the slit room may be used to view the slit or the large field visually. This may be useful, for example, to locate bright stars during daytime. The lever situated to the right of the eyepiece has to be in its outer position. A


COUDE ECHELLE SPECTROMETER

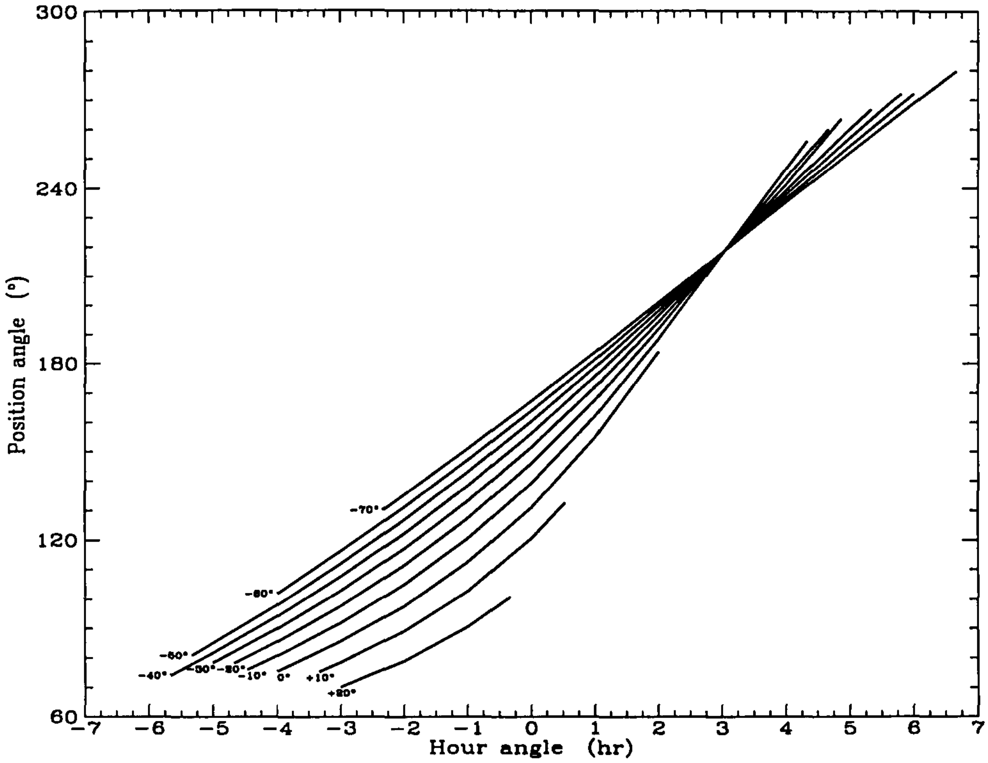


Figure 2.4: Position angle of the CES slit as a function of hour angle, for various declinations

wheel in front of the TV camera holds three filters, "blue", "green" and "red". A fourth position, "white", is open, and a fifth, "black", is closed. Normally the open position may be used for autoguiding at all wavelengths. If observations are made at large zenith distances, the colored filters corresponding to the wavelength range under investigation should be used to minimize problems with atmospheric differential dispersion. The filters may also be useful to identify blue or red stars (see Fig. 2.6).

Due to the Alt-Alt mount of the CAT and the use of the Nasmyth focus, field rotation is present at the focal plane. Fig. 2.4 shows the position angle of the CES slit as a function of the hour angle of the observed target, for a series of declinations; it approximately covers the portion of the sky to which the CAT can be pointed.

The relative orientation of the slit on the guiding TV monitor and on the CCD is such that the upper end of the slit image on the monitor (in small field) corresponds to the right (large x) side of the CCD (with CCD#34). With CCD#38 the upper end of the slit image corresponds to the bottom (small y) side of the CCD.

Seven calibration lamps are available. The two most commonly used are the Thorium hollow cathode lamp (No. 2) for wavelength calibration and the Quartz Iodine lamp (No. 6) for flat field correction. The selection between the lamps is made by a small rotating prism mounted at the center of the lamp turret assembly. This prism sends the light to a 45° mirror which can be inserted into the main light-path to illuminate the slit. A wheel between the prism and the 45° mirror holds 8 neutral filters ranging in density from 0 to 4. The lamp assembly is automatically set and controlled by the MULTI program when a calibration exposure is defined. A laser can be used to accurately determine the instrumental profile, at two wavelengths: $\lambda_1 = 4880$ Å in the blue and $\lambda_2 = 6328$ Å in the red.

2.3.1 Predisperser area

The predisperser is a prism monochromator mounted in a quasi Czerny-Turner configuration used to isolate the correct echelle grating order. Fig. 2.7 shows the optical elements. The f/32.3 beam from the slit is reflected by the collimator mirror and then refracted by the 22° Littrow prism towards the predisperser camera mirror. A spherical field mirror with a large radius of curvature (R = 10.6 m) sends the light toward the predisperser exit slit, the collimator, and the echelle grating. It images the telescope pupil on the echelle grating and changes the aperture of the beam to f/29.

The width of the predisperser exit slit is calculated and set by the control program to minimize the contaminating light from neighbouring echelle orders. This range is a function of wavelength and set-up configuration (see also section 5.2). The result is that the level of scattered light is extremely low which in turn means a cleaner instrumental profile.

The part of the spectrum which falls outside the wavelength range under study is deflected at the exit slit towards a photomultiplier which serves as an exposure meter. Obviously, the reading from this ratemeter depends strongly on the central working wavelength, and also on the spectral type of the stars observed.

The blue and red predisperser collimator mirrors are mounted on a rotatable turret. When in use, these two mirrors are slightly differently inclined to allow the light to be reflected to the appropriate red or blue prism. All optical elements in the predisperser are duplicated: there are two prisms, two camera mirrors, two field mirrors, two deflecting mirrors, and two exit slits. All mirrors are coated; the wavelength limit between the two paths falls around 5200 Å. The two field mirrors are oriented in such a way that the red and blue beams converge at the same place on the echelle collimator mirror.

2.3.2 The Long Camera

The Long Camera (Fig. 2.8) is a Maksutov system with a Newtonian focus. It has an aperture of f/4.7, a focal length of 942 mm and a reciprocal linear dispersion of 1.45 Å/mm at 5000 Å. Two pillars located between the grating and the scanner camera mirror carry the camera (Fig. 2.3). It is held in a fixed position by three isostatic supports. The detector with its dewar and controlling electronics is mounted below the camera.

Resolving powers used with the Long Camera lie normally between 50.000 and 110.000. In an Echelle configuration the resolving power times slit width product $R\alpha$ is, in first approximation, constant. This property can be used to easily estimate the dispersion at

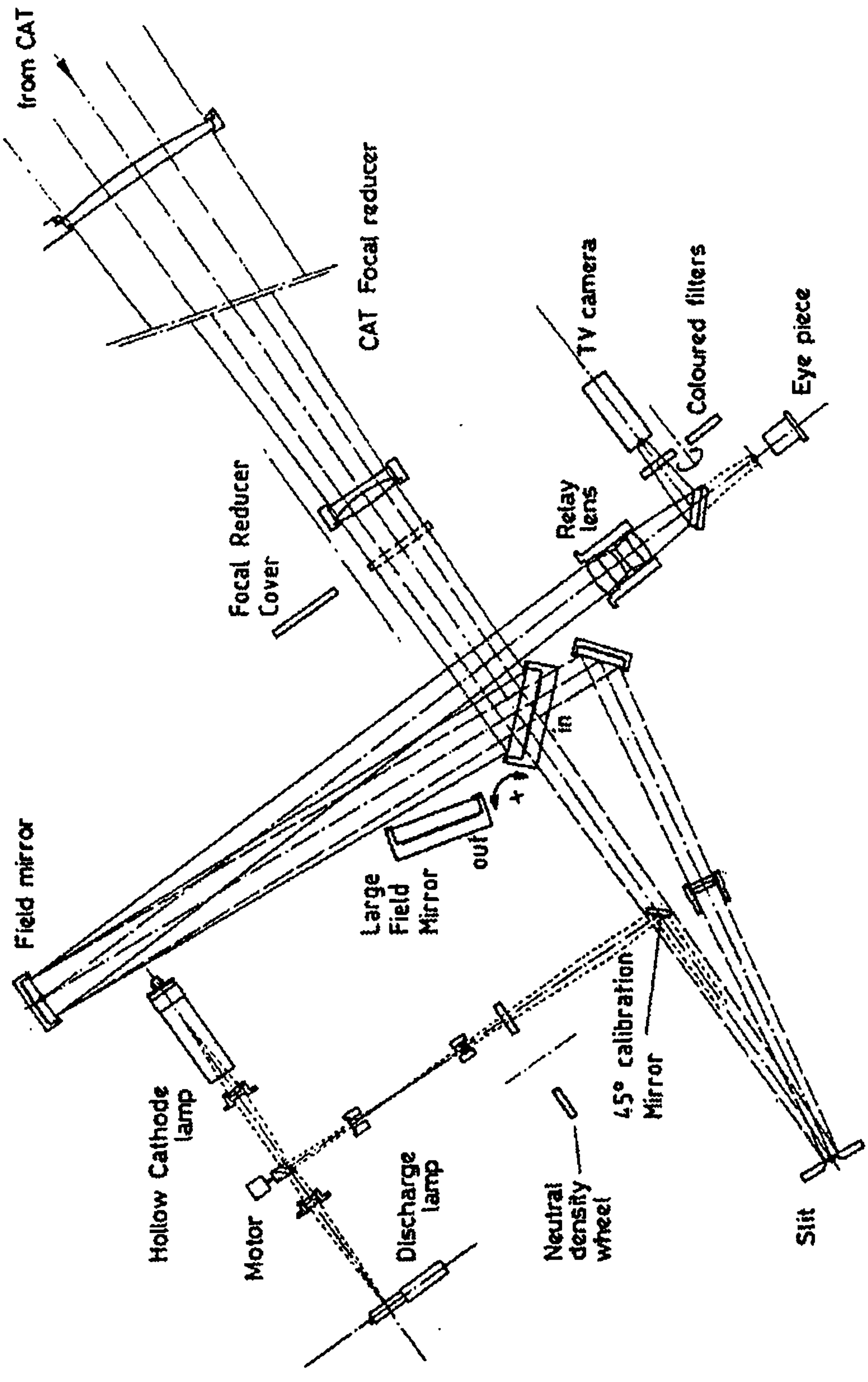


Figure 2.5: Optical Schematic of the Slit Environment

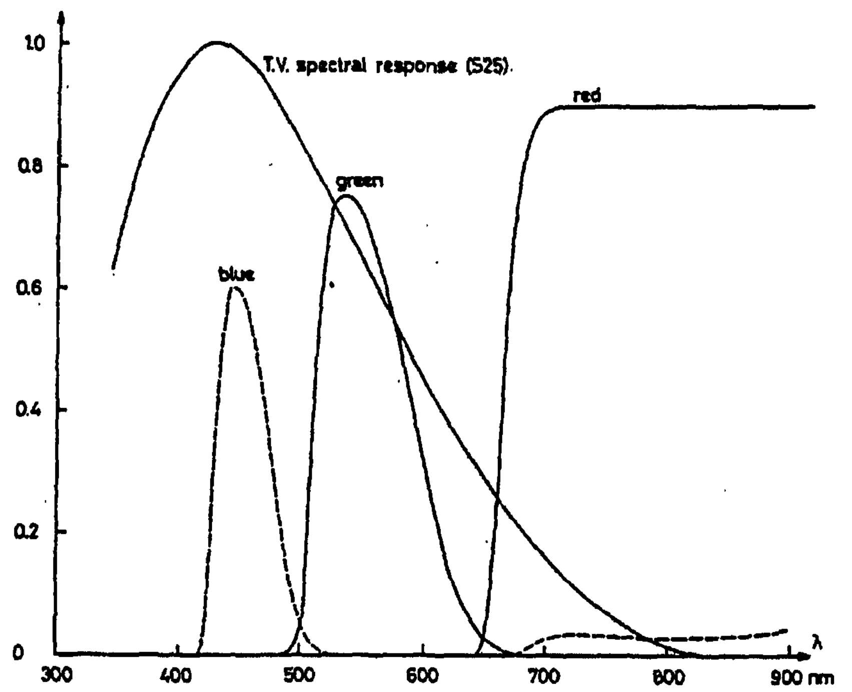


Figure 2.6: Spectral response of slit view TV camera and transmission curves of slit view filters.

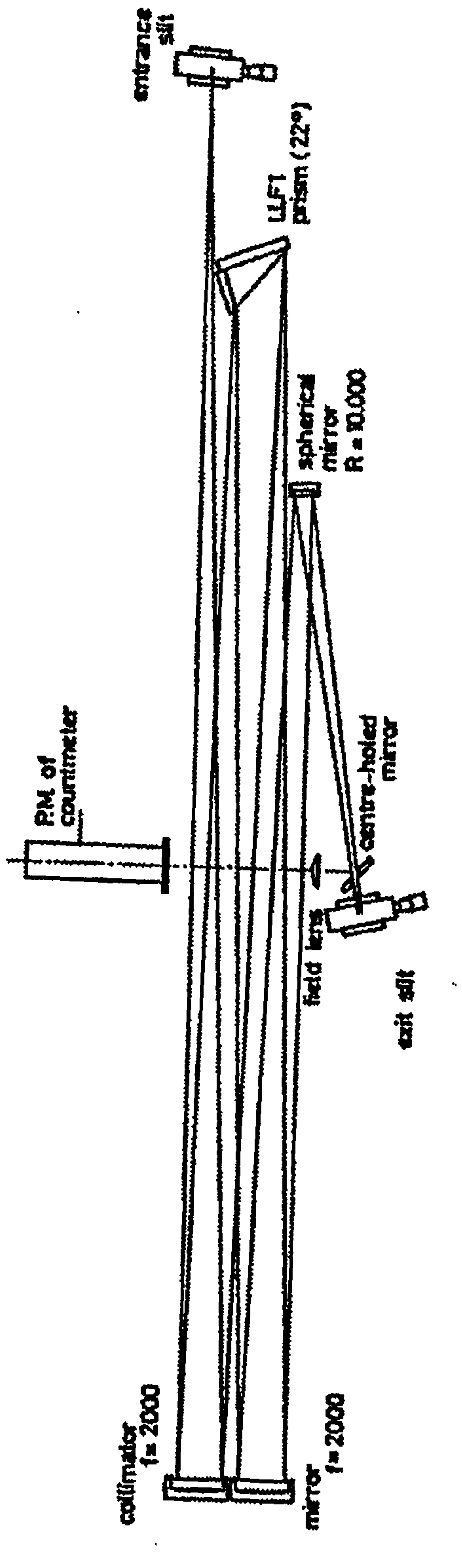


Figure 2.7: Optical Arrangement of Predisperser

Table 2.2: CES Long Camera and CCD#38 measured resolving power vs. nominal resolving power at 4435 Åand at 5876 Å.

	4435 Å		5876 Å	
Nominal R	Measured R	Meas/Nom	Measured R	Meas/Nom
40000	39300	0.98		
50000	46500	0.93	48000	0.96
60000	55660	0.92		
70000	60800	0.87	62000	0.89
80000	63300	0.79		
90000	68000	0.76	70000	0.78
100000	71800	0.72		
110000	76000	0.69	80000	0.73
120000	77000	0.64	82000	0.68

each wavelength ($R\alpha$=124600 for α = 1 arcsec). Note, however, that with CCD#38 the nominal resolving power cannot be achieved (see section 2.3.3).

2.3.3 Detectors

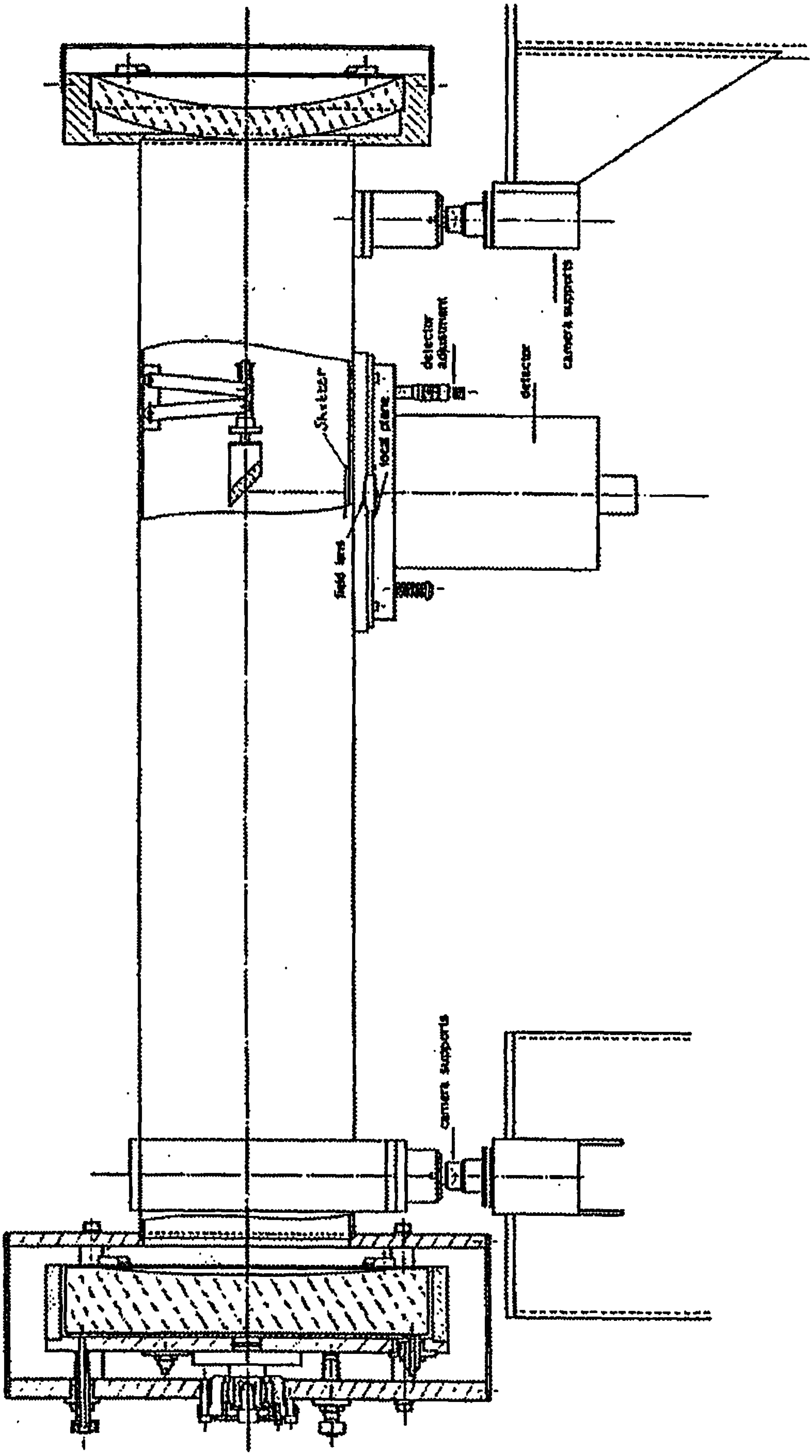
At present, two CCD's are available for the Long Camera: CCD#34 and CCD#38 (see Tab. 2.3).

Since August 1995 a LORAL/LESSER 2688 $\times$ 512 thinned, backside illuminated device (pixel size 15 $\times$ 15 μm) is installed (ESO CCD#38). The pixel size of 15 $\times$ 15 μm corresponds to 0.56″ and 0.45″ in the dispersion and slit directions, respectively. The quantum efficiency (QE) is about 80% throughout the visible wavelength range (3500-8000 Å) with a peak value of 90% at 7000 Å. The high QE is obtained after flooding the CCD with intense UV light. The new chip is mounted in a continuous flow cryostat, with a hold time of about 5 days.

The properties of CCD #38 are summarized in Tab. 2.3. In Fig. 2.9 the measured QE of CCD#38 is given before and after flooding the CCD with intense UV light. UV flooding, on the other hand, produces a degradation in resolution, relevant at high resolving powers (R > 70.000). In Tab. 2.2 the measured resolution of the LongCamera with CCD ESO#38 is given versus the nominal resolution at 4435 Å and at 5876 Å.

Due to this limitation, another CCD: ESO#34, is also offered. CCD#34 is a LORAL 2048 $\times$ 2048, frontside illuminated and UV-coated CCD (pixel size 15 $\times$ 15 μm^2). The characteristics of CCD#34 are listed in Tab. 2.3 and the QE is shown in Fig. 2.9.

Due to the large differences in QE, the use of CCD#38 is strongly recommended for observing programs requiring R <70000, while for programs demanding higher resolution CCD#34 should be requested.


camera supports
detector adjustment
detector
Shutter
focal plane
field lens
camera supports

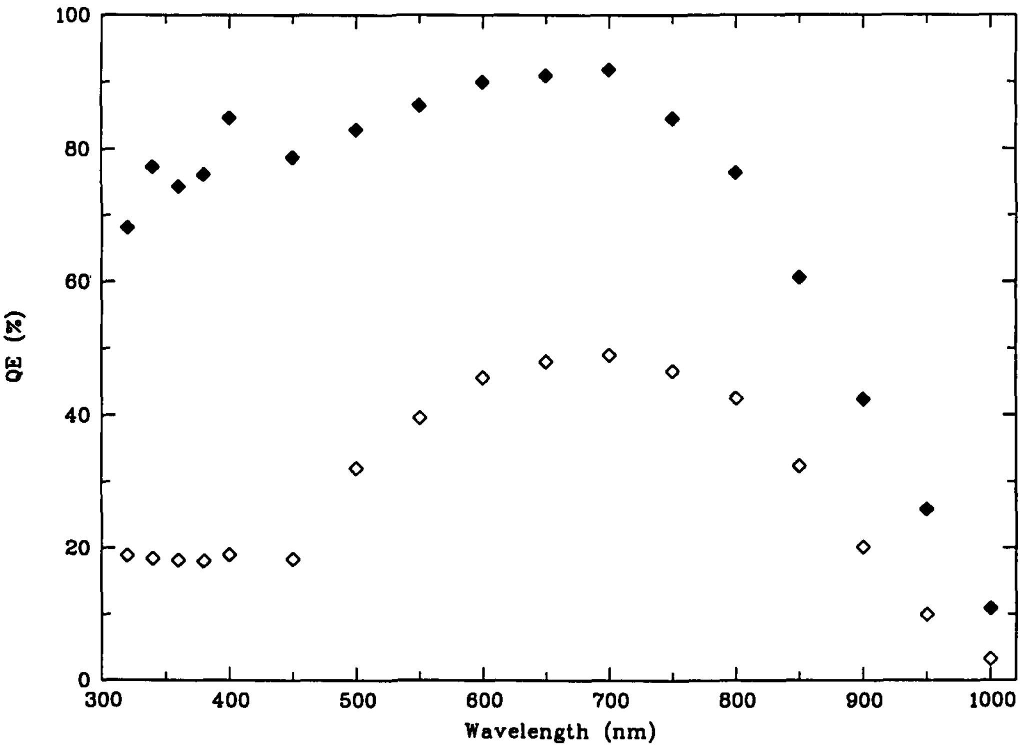


Figure 2.9: Measured quantum efficiency curve for CCD#38 (filled symbols) and CCD#34 (open symbols)

2.4 Software

A complete description of the CES software can be found in reference [8]. The program controlling the Long Camera and CCD is called MULTI, with a spectrograph (RCES) and CCD control part (RCCD). RCES computes the positions of the different spectral elements according to the specifications in the exposure definition sheet and sets the elements to the required positions. RCCD sets up the CCD, executes exposures, and stores the result on disk and tape. The observer interacts with all control programs mainly via an extended set of softkey menus. The detailed use of these programs is illustrated in Chapter 5.

It is possible to select the working area as well as the binning factors of the CCD. IHAP and a MIDAS workstation are available for on-line reduction and data analysis. We refer to section 5.5 for some guidelines on on-line data reduction.

The full-well capacity of the CCDs exceeds 65538 ADU, but IHAP can only handle 15-bits numbers. To be able to register 16-bits numbers the parity bit has to be used. Therefore, the CCD counts range between -32768 and 32768 ADU. Thus, before starting the reduction one has to add an offset value of 32768 ADU.

Table 2.3: CCD characteristics

CCD ESO#38	
Type :	LORAL/LESSER 2688, thinned, backside illuminated, UV-flooded, anti-reflection coating, MPP
Format:	2688×512, 16 pre-scan pixels in horizontal direction
Pixel Size:	15×15 μm^2
Conversion Factor:	1.7 e^-/ADU
Full-well capacity:	130.000 e^-/pixel
Read-Out-Noise:	8.3 e^- (A amplifier without binning)
Linearity:	deviation < 0.3% up to 100.000 e^- per pixel
Blemishes:	No strong hot or cold columns at all. Compared to all other LORAL CCDs delivered to ESO, this chip has has good cosmetics. Remanence of 3.5 e^- per pixel was noted on a 10 min dark taken after an exposure of 40 times saturation.
Dark Current:	$\sim 1.8 \pm 0.5$ e^-/pixel/hour at 164 K.
Charge Transfer Eff.:	0.9999646 (parallel) and 0.9999884 (serial)
R.Q.E.:	Peak value 90% at 700 nm (Fig. 2.9)
Operating Temp.:	160-183 K
Cosmic Ray Events:	1.5 ± 0.2 events/min/cm^2
CCD ESO#34	
Type :	LORAL 2048, edge buttable, left CCD, frontside illuminated, UV-coated
Format:	2048×2048, 16 pre-scan pixels in horizontal direction
Pixel Size:	15×15 μm^2
Conversion Factor:	1.47 ± 0.03 e^-/ADU
Full-well capacity:	210.000 e^-/pixel
Read-Out-Noise:	6.6 e^-
Linearity:	deviation < 1% up to 100.000 e^- per pixel
Blemishes:	Two defect double lines at X=1884,1885 and X=803,804, and about 30 traps, which is usual for frontside illuminated devices. Remanence of 9 e^- per pixel was measured on a 10 min dark taken after an exposure of 10 times saturation.
Dark Current:	$\sim 2 \pm 1$ e^-/pixel/hour at 161 K.
Charge Transfer Eff.:	0.9999985 (horizontal) and 0.9999792 (vetical)
R.Q.E.:	Peak value 49% at 700 nm (Fig. 2.9)
Operating Temp.:	165 K
Cosmic Ray Events:	1.3 ± 0.1 events/min/cm^2

Chapter 3

Instrument performance

3.1 Total efficiency

Table 3.1 presents the total CES + CAT efficiency rates at the blaze wavelength of seven different orders of the echelle grating, four in the blue path and three in the red path. The efficiencies were derived from measurements of spectrophotometric standard stars. The values express the percentage of photons detected by the CCD as compared to the number entering the CAT. A large slitwidth was used to avoid effects of varying seeing. In calculating the number of arriving photons the following formula was used:

$$N_\lambda = S \times \frac{5.5 \times 10^{10}}{\lambda} \times 10^{-0.4(m_\nu + A_\lambda X)}$$

S is the surface area of the CAT mirror (=1.47 m^2), N_λ the number of photons at wavelength λ on the CAT per second and Ångström. La Silla mean extinctions have been used for A_λ, X is the airmass. The monochromatic magnitude per frequency unit, m_ν, is found from the tabulated values of the flux standards. A conversion factor of 1.47 e$^-$/ADU (CCD#34) and 1.7 e$^-$/ADU (CCD#38), respectively, was used to derive the number of events registered by the CCD. When interpolating in Table 3.1, the variation of the QE of the CCD have to be taken into account, as well as the variations of efficiency along the grating orders. In Tab. 3.2 the blaze and 50% efficiency wavelength for each order are given.

Table 3.1: Efficiency of the CES + CAT

Wavelength	3500Å	3589Å	4035Å	4435Å	5400Å	6450Å	8092Å
LC + CCD#38	0.7%	1.9%	4.4%	5.6%	7.5%	8.5%	4.8%
LC + CCD#34	0.12%	0.38%	1.15%	1.9%	3.1%	4.3%	3.0%

3.2 Wavelength coverage

The wavelength coverage is about 58 and 44 Å at 5000 Å (see Tab. 3.2) for CCD#38 and CCD#34, respectively, but vignetting affects the outermost pixels, getting worse towards the blue ($\sim$ 200 pixels). In Table 3.2 the spectrum length is listed as a function of echelle order and wavelength.

3.3 Expected S/N ratios

Figures 3.1 and 3.2 have been derived using the efficiency values at 4035 and 6450 Å, respectively. The figures show the predicted S/N ratio as a function of magnitude and exposure time for the Long Camera and CCD#38 (drawn lines). For comparison, the predicted S/N ratio is also given for CCD#34 (dotted lines). In constructing the figures, photon noise, read-out-noise and dark current have been taken into account. A resolving power of 60.000 (corresponding to a slitwidth of 2 arcseconds) has been assumed; furthermore, we adopted that the spectrum is spread over 18 pixels (about 8 arcseconds) in the cross-dispersion direction. Note that in practice on-chip binning only yields a marginal increase of the S/N ratio.

3.4 Spectral resolution

Table 3.3 summarizes for a different number of settings the spectral resolution that can be achieved with the Long Camera, together with sampling and entrance slit widths. Resolving powers used with the Long Camera range between 60.000 and 110.000. To use a resolving power lower than 60.000 is not justified; the sampling at this resolution is already about 4 pixels. Due to the low CCD read-out-noise, binning along the dispersion direction by a factor more than 2 does not significantly improve the spectrograph perfomances and makes the elimination of high energy events troublesome. In addition, if a resolving power less than $\sim$30.000 is used, the predisperser exit slit will become too large, and contamination from adjacent orders may occur.

As mentioned earlier, for CCD#38 the specified resolution may differ from the actual resolution (see Tab. 2.2). For the highest spectral resolution one is advised to request for CCD#34.

Table 3.2: Listed are the limiting (50% intensity) wavelengths and the wavelength at maximum light for each echelle order (due to the blaze of the echelle grating); the spectrum length is computed for the CES Long Camera for a central wavelength corresponding to the "blaze" wavelength.

Order	Wavelength			Spectrum length (Å)	
	Min	Blaze	Max	CCD#38	CCD#34
65	3459.0	3479.3	3512.9	39.9	30.4
64	3513.0	3533.7	3567.9	40.7	31.0
63	3568.0	3589.8	3624.9	41.2	31.4
62	3625.0	3647.7	3682.9	42.0	32.0
61	3683.0	3707.4	3741.9	42.5	32.4
60	3742.0	3769.2	3806.9	43.3	33.0
59	3807.0	3833.1	3871.9	44.1	33.6
58	3872.0	3899.2	3938.9	45.2	34.4
57	3939.0	3967.6	4008.9	45.7	34.8
56	4009.0	4038.5	4080.9	46.5	35.4
55	4081.0	4111.9	4154.9	47.3	36.0
54	4155.0	4188.0	4231.9	48.0	36.6
53	4232.0	4267.1	4312.9	49.1	37.4
52	4313.0	4349.1	4396.9	49.9	38.0
51	4397.0	4434.4	4483.9	50.9	38.8
50	4484.0	4523.1	4572.9	52.0	39.6
49	4573.0	4615.4	4666.9	53.0	40.4
48	4667.0	4711.5	4765.9	54.1	41.2
47	4766.0	4811.8	4867.9	55.4	42.2
46	4868.0	4916.4	4973.9	56.4	43.0
45	4974.0	5025.7	5084.9	57.8	44.0
44	5085.0	5139.9	5201.9	59.1	45.0
43	5202.0	5259.4	5324.9	60.4	46.0
42	5325.0	5384.6	5452.9	62.0	47.2
41	5453.0	5516.0	5587.9	63.3	48.2
40	5588.0	5653.9	5727.9	64.8	49.4
39	5728.0	5798.8	5875.9	66.7	50.8
38	5876.0	5951.4	6031.9	68.3	52.0
37	6032.0	6112.3	6195.9	70.4	53.6
36	6196.0	6282.1	6369.9	72.2	55.0
35	6370.0	6461.6	6557.9	74.3	56.6
34	6558.0	6651.6	6747.9	76.4	58.2
33	6748.0	6853.2	6954.9	78.8	60.0
32	6955.0	7067.3	7173.9	81.1	61.8
31	7174.0	7295.3	7407.9	83.7	63.8
30	7408.0	7538.5	7656.9	86.6	66.0
29	7657.0	7798.4	7924.9	89.5	68.2
28	7925.0	8076.9	8209.9	92.9	70.8
27	8210.0	8376.1	8517.9	96.3	73.4
26	8518.0	8698.2	8849.9	100.0	76.2
25	8850.0	9046.2	9208.9	104.0	79.2
24	9209.0	9423.1	9596.9	108.2	82.4
23	9597.0	9832.8	10019.9	112.9	86.0
22	100020.0	10279.7	-	118.1	90.0

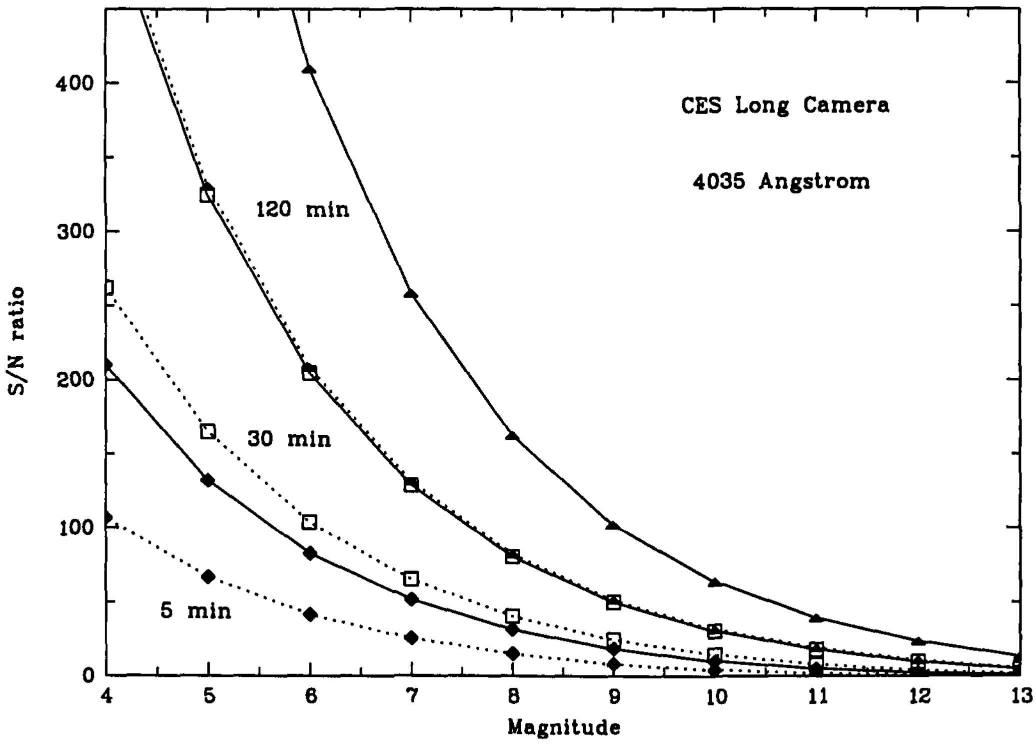


Figure 3.1: Predicted S/N ratios for the Long Camera at 4035 Å for CCD#38 (drawn lines) and CCD#34 (dotted lines) as a function of magnitude and exposure time. Filled diamonds correspond to 5, open squares to 30, and filled triangles to 120 minutes exposure time.

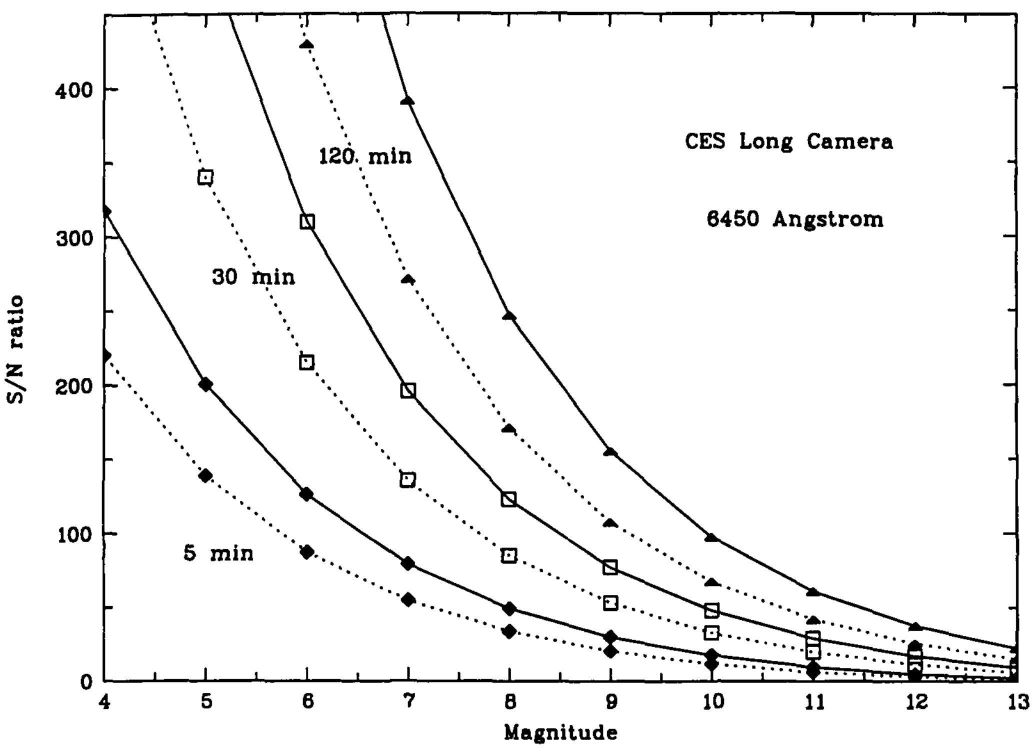


Figure 3.2: Predicted S/N ratios for the Long Camera at 6450 Å for CCD#38 (drawn lines) and CCD#34 (dotted lines) as a function of magnitude and exposure time. Filled diamonds correspond to 5, open squares to 30, and filled triangles to 120 minutes exposure time.

Table 3.3: Spectral Resolution of the CES

LONG CAMERA + CCD								
Wavelength (Å)	Order	Disp (Å/mm)	Res. power 60.000		Res. power 80.000		Res. power 100.000	
			Spect. res. (mÅ)		Spect. res. (mÅ)		Spect. res. (mÅ)	
4000	57	1.12	66.7		50.0		40.0	
5500	41	1.63	91.7		68.7		55.0	
7000	32	2.13	116.7		87.5		70.0	
			Pixels/ Resol. elem.		Pixels/ Resol. elem.		Pixels/ Resol. elem.	
4000	57	1.12	4.0		3.0		2.4	
5500	41	1.63	3.8		2.8		2.3	
7000	32	2.13	3.7		2.7		2.2	
			Entr.slit width		Entr.slit width		Entr.slit width	
			″	μm	″	μm	″	μm
4000	57	1.12	2.2	498	1.6	373	1.3	298
5500	41	1.63	2.1	470	1.5	352	1.2	282
7000	32	2.13	2.0	458	1.5	343	1.2	275

Chapter 4

Calibration Database and Ghosts

A full set of calibration (Th-Ar and Flat Field) spectra was acquired, which is accessible to the users. About 140 Th-Ar and Flat Field frames were obtained in the RED path covering the range between 5215 and 8990 Å, while 80 frames were taken in the BLUE path covering the 3790-5200 Å domain. The calibration database was acquired with ESO CCD#30 with characteristics similar to those of CCD#34. Work on a calibration database for CCD#38 is in progress.

The aim of the calibration data set is twofold:

- To analyse the occurence of spectrograph ghosts present in the wavelength domain commonly used by the observers.
- To provide the potential CES users with a complete set of calibration data, to facilitate the planning of their observations.

The database is described in [17], and is available from the 360cat WWW page.

The main characteristics of the ghosts can be described as follows: Th-Ar ghosts are present in the whole RED domain, at virtually all wavelength settings, but their number and intensity increases with wavelength. Th-Ar ghosts appear at constant wavelengths; they are not reported for a wavelength setting shorter than 5000 Å. Their intensity is typically much lower than that of true Th-Ar lines. The presence of these low intensity ghosts will therefore be most critical in those regions in the red domain where the paucity of suitable lines makes the wavelength calibration troublesome. A careful inspection of the calibration frames is always suggested in the reduction phase.

Flat Field ghosts are found in the spectral range 4560-6170 Å. Most of them fall outside the range of the science spectrum, thus not influencing the astronomical results for point-like sources, but some of them do fall over the science spectrum. Although their intensity is mostly very low (~ 0.5 %) care should be taken when the ghost is overlapping a spectral line of interest or in case of very high S/N observations. The ghost also appears in the scientific frame, but cannot be "flatfielded out" completely.

A list of FF ghosts cannot be provided, because, unlike Th-Ar ghosts, FF ghosts do *not* appear at a constant wavelength, but shift by a few pixels when changing the CES central wavelength by several Ångström. This characteristic might be useful in avoiding the presence of a FF ghost at a given wavelength: this can be done by slightly changing the required CES central wavelength.

Chapter 5

CES Operating Procedure

A detailed step by step description of the handling of the CES spectrograph and Long Camera is given below. For observations carried out in remote control from ESO Garching we also refer to Chapter 8. Although in remote control observations several of the steps described below are performed by the night assistant in La Silla, we do recommend remote observers to read this chapter carefully.

5.1 Starting up

In the spectrograph room:

- Check that the covers are removed from the collimator (it is magnetically attached to the mirror support) and the Long Camera.
- Check that the viewing microscope is in its lowest position and does not obscure the camera.
- Check that all dust-covers protecting the predisperser and the intermediate slit area are in place and properly fastened. If not, ask the 360cat team coordinator for assistance.
- The dewar of the CCD normally does not need any attention. If the operating temperature of the CCD is wrong a warning will be given by the MULTI program.
- Turn off the lights in the spectrograph room and check that no light is visible anywhere. Pay special attention to small control lamps on electronic equipment and to possible leaks from the computer corridor.
- Check that the door between the Coudé room and the slit room is properly closed.

In the slit room:

- Check that all predisperser dust-covers are in place.
- Open the cover in front of the focal reducer. If you are doing calibrations during daytime, leave it closed to prevent daylight entering from the CAT dome.
- Check that the lever of the TV mirror is pushed in to send the light to the TV viewing system. Select your filter in front of the TV camera (normally white for objects at lower airmass). Do not use the red filter with the blue path or the blue with the red! You will have problems with atmospheric differential dispersion during autoguiding if you do.
- Switch off the light and check that no lights are visible from control lamps or leaking in from outside the slit room.
- Close the door between the slit room and the control room carefully.

In the control room:

- Turn off the lights in the computer corridor and in the stairs leading to the control room. Use the switch in the control room (next to the bookshelves) to turn off the lights of the observing floor.
- The three red warning lamps ("FAULT", "AIR FAIL" and "DATUM LOST") on the grating-table control rack should be off to indicate that the table is in operational status. If one of these is on, the reason may be that the table air pressure is, or temporarily was, too low. Check that the table is on line: "ON LINE" button should be in. If not, press it.
- Mount the appropriate magnetic tape, one for each night of the week. Remember the write-ring. Leave the drive "ON LINE" with "SELECT CODE" 0.
- Dim the lights in the control room.

5.2 The MULTI progam

In general, the MULTI session will be left open by the 3.60m+CAT Telescope Team that prepared the set-up of the instrument. In this case, you will not have to go through the whole procedure describer below. If the MULTI session is not running on the CES console, please contact your introducing astronomer or the Telescope Team coordinator. To start a MULTI session: Hit any key on the main terminal to get the RTE-prompt `USERNAME?` and type `MULTI`. This will start the MULTI session.

Follow the instructions written by MULTI, in particular the computer Universal Time check. The MULTI program modules are loaded.

Answer the question `Initialize CAMAC?` with `NO`.

The MULTI program checks the functioning of the remotely controlled moving parts of the spectrograph. No time-out error messages should occur during these tests.

If no other errors are encountered by the MULTI program the first menu will appear:

OBSERVATION	MOTORS	ENGINEERING	Help
Status	Restore sts screen	Function disabling	TERMINATE

On the left screen the optical parameters of the CES are displayed. After a CAMAC initialization the actual values are shown for the predisperser, the slit and the grating table position. The other optical parameters are set to zero. Also given in the form are several temperature readings as well as the light-path status of the focal reducer and the collimators. Check that these optical elements are either all "BLUE" or all "RED" according to the path chosen. If MULTI is started without a CAMAC initialization, the values in form # 2 will be those which were used in the previous run.

Press MOTORS and a new menu will appear:

Move decker	Open shutter		Help
	Close shutter	Function disabling	PREVIOUS MENU

In this menu hit Move decker. Form # 38 will be displayed. Choose your slit-height, the maximum height is about 20″. It is advantageous to use a rather long slit (15″ – 20″). Press "ENTER" and check on the left screen that it has been accepted.

In any form you can exit by pressing softkey f1 if you do not want any action to be taken. You can move the terminal cursor by the arrowed keys or by the "TAB"-key in which case you move it to the next white input field. "CTRL-TAB" moves it back to the previous field.

Press PREVIOUS MENU to come back to the observation menu.

The area covered by the spectrum on the CCD is only a small part of the full CCD frame. This area, with the addition of some adjacent columns on each side of the spectrum for background monitoring, is the only one to be written on the tape. The pixel coordinates defining this part of the CCD as well as the binning factor, are entered from a softkey

CCD Frame/Binning found under the CCD menu. If binning is selected, all exposures should be done with the same binning factor.

The spectrum should be aligned with the CCD columns to within a fraction of a pixel width. The alignment is made during the set-up of the CCD but it should be checked by the observer.

Press STATUS. The temperature control should be set to 130–135 K and the actual temperature must be within two degrees of this value.

Press OBSERVATION to enter the following menu:

Define single exp.	--- ETC ---		Help
Start single exp.	MOTORS	IHAP	PREVIOUS MENU

Then Define single exp.. The define exposure menu will appear. The left screen displays the different calibration lamps and neutral density filters used in front of these lamps (form # 13). These filters are not situated in the main light-path of the CAT/CES:

```
* COUDE ECHELLE SPECTROMETER * Multichannel instrument setting help * Form# 13 *

 Calibration lamp (only valid if exposure type is 'CL' or 'FF'):
           #1      #2      #3      #4      #5      #6      #7      #8
         h.c.Fe  h.c.Th    Hg      Ne     None    White   Laser   None

 Neutral density filter:
           #1      #2      #3      #4      #5      #6      #7      #8
  - blue:  zero    1.89    2.97    3.44    zero    0.49    0.98    1.61
  - red:   zero    1.87    3.01    3.97    zero    0.45    0.99    1.58

 Extensive help on the 'SINGLE EXPOSURE DEFINITION' form is available.
 Use the 'HELP' softkey!
```

First define a regular exposure to get a display of the appropriate optical parameters:

```
EXPOSURE DEFINITION
    Type          RE (REgular, Flat Field, DarK current, CaLibration)
    Exposure time 0. 2. 0 h.mm.ss (for ex.)  Tape recording 0 (0=off,
    Identifier    Test only         (test only, don't save)    1=IHAP format)
    Batch file    ------------------(Ignore) Number of exposures  1 (1-99)
```

```
INSTRUMENT SETTING    1 (0=No, 1=Yes)
    Calibration lamp# - (Ignore)             Neutral density filter - (Ignore)
    Central wavelength (2800-12000)  6563.00 Angstroms (or your own choice)
    Spectral resolution (0-1000)      ----.0 milli-Angstroms     (Ignore)
      or resolving power (0-100000)   50000.          (or your own choice)
      or entrance slit width (50-5000) ----. microns             (Ignore)
      or image slicer (Y/N) ? -                                  (Ignore)

TELESCOPE SETTING   0 (0=No, 1=Preset)
    Right ascension --:--:--.-    Declination ---:--:--.-        (Ignore)

 Press ENTER key to proceed  (or softkey #1 to abort).
```

You may choose to define the spectral resolution or the entrance slit width instead of the resolving power. But fill in only one of the three options. Corresponding parameters will be calculated by the MULTI program. Telescope coordinates are automatically read from the CAT control program.

Press the $\boxed{\text{ENTER}}$ key to validate the form (and not the 'RETURN' key). The instrument setting will now appear on the left screen with all the chosen and calculated instrument parameters (Form # 02). Check that the grating angle is identical with the one displayed on the turntable control rack.

```
*  COUDE ECHELLE SPECTROMETER  *  Multichannel instrument status  *  Form# 02 *

Pre-disperser prism position  27274. encoder units in RED  path; DISabled
Decker height                  20.00 arcseconds
Entrance slit width             575. microns
Pre-disperser exit slit width  1697. microns

Grating position     276:22:15.2

Focal reducer front element RED          Temperature turntable in    17.6
Focal reducer back element  RED          Temperature turntable out   16.9
Predisperser collimator     RED          Temperature Coude room      15.8
Main collimator             RED          Temperature slit room       18.8
                                         Temperature dome            19.3

Calibration lamp undef.-                 Neutral density filter      zero

Central wavelength   6563.00 Angstrom    Grating order           34.
Spectrum  length       87.04 Angstrom    Grating efficiency       55 % of max
Incidence angle      64.7903 degrees     Predispersion         138.1 A/mm
Diffraction angle    59.1003 degrees     Linear dispersion      2.03 A/mm
```

```
Spectral resolution    131.3 mAngstrom    Free spectral range  187.5 Angstrom
Resolving power       50000.              Projected entr slit   69.6 microns
```

The predisperser is a small prism spectrograph which preselects a narrow wavelength range centered around the wavelength you have chosen. Typically this range is ~ 3 times larger than that registered by the detector. In this way very little light with wavelengths outside the range under investigation will enter the main spectrograph and cause scattered light. The width of the predisperser exit slit can be calculated as follows:

$$d_{\mathrm{pred}} = \frac{l_{\mathrm{CCD}} \times D_{\mathrm{lin}}}{D_{\mathrm{pred}}} + d_{\mathrm{slit}} + 500$$

where d_{pred} is the width of the predisperser exit slit, l_{CCD} the length of the CCD in micron (CCD#34 30720 μm, CCD#38 40320 μm), D_{lin} the linear dispersion (in Å/mm), D_{pred} the predispersion (in Å/mm), and d_{slit} the width of the entrance slit (in micron). For central wavelengths below ~4000 Å the addition of 500 has to be dropped. Check if the predisperser exit slit width computed with the formula above corresponds to the value calculated by MULTI. Especially in the case of CCD#38 the predisperser exit slit width might be set too small causing vignetting in the spectrum.

5.2.1 Predisperser position check

The centering of the predisperser is the first action that has to be undertaken. The predisperser encoder value computed by the MULTI program is not accurate enough for a correct observation. Usually, proper centering is done during the setup, but it is always better to check it. This procedure should be repeated after a change of the central wavelength.

In order to see the central wavelength of the region defined by the predisperser, the entrance and exit slit of the predisperser have to be closed down to $\sim 50\mu$m. This produces a sharp intensity peak which should be centered at the working wavelength. The procedure to do this is the following:

Press $\boxed{\text{Define single exp.}}$

```
EXPOSURE DEFINITION
    Type          FF         (for internal flat field lamp)
    Exposure time       5 sec                Tape recording 0 (test only)

    Identifier    TEST OF PREDISP. POS.
    Batch file    (Ignore)               Number of exposures  1
INSTRUMENT SETTING    1
    Calibration lamp# 6                      Neutral density filter 1 (no filt)
```

The central wavelength and resolving power should not changed. Press the "ENTER" key.

Now go into the menu under --- ETC --- and press Special setting. The first try should be made at the predisperser setting chosen by MULTI (or the value provided by the operation team). Change the entrance slit width of the CES and the exit slit of the predisperser to 50μm each. Leave the other parameters unchanged:

```
*  COUDE ECHELLE SPECTROMETER  *    Multichannel special setting* Form# 07 *

 Predisperser prism position  26070. encoder steps;    ENabled
 Entrance slit width            50. microns (50-5000)
 Pre-disperser exit slit width  50. microns (50-5000)
 Decker height  5.00 arcseconds (0.70 - 21.30)
 Calibration lamp# 2              Neutral density filter 1
 Grating order  .  (0-76)  or grating position  275:12:22.3
 Exposure time 0. 1. 0 h.mm.ss

  Press ENTER key to proceed (or softkey #1 to abort)
```

Press "ENTER" and wait for the slits to close to 50μm. MULTI will return by itself to the Define single exp. menu. If you escape with f1 or an error is found in form # 7, MULTI will stay in the Special setting menu.

Up on the left-most instrument rack two rows of control lights are present. In the upper row a red light indicates that the corresponding calibration lamp is lit. An orange light means that the lamp is heating. The lower row shows the position of the mirror which selects the light from the different lamps and sends it to the "45° mirror" which in turn reflects the light onto the CES main slit.

Wait until the flat field lamp is ready, then press Start single exp.. Display the image on the RAMTEK or use the IHAP command "SADD" (or "XADD", depending on the orientation of the CCD) to construct a one-dimensional frame, collapsed in the cross-dispersion direction. Display the 1-d frame with the IHAP command "TRANS,#" followed by the filenumber produced by the "SADD" command. If necessary, change the integration time and/or filters with Special setting. If the intensity peak does not fall close to the center of the frame you have to adjust the setting by inserting the corrected value in the predisperser prism position window. If the peak falls too far to the right use a lower value, if too far to the left a higher one. Two predisperser encoder steps correspond to about 50 pixels, but this depends on the selected central wavelength. The correct value of the predisperser position has to be found with trial and error. Again press Start single exp. and make a new exposure. The final peak position should be correct to within ~ 2 encoder steps.

Note

The $\boxed{\text{Define single exp.}}$ softkey always (except for DarK exposures) resets both slits to their correct working values as well as (if ENabled) resets the predisperser prism to its calculated position.

Once you have found the correct predisperser prism position you must disable its motor to ensure that you do not move the prism again. Disable the predisperser by typing the command "DIS,PRE" at the command line or go to $\boxed{\text{Special setting}}$ and enter DISabled in the second input window. The next $\boxed{\text{Define single exp.}}$ will reset the slits but *not* move the prism. Keep the prism disabled until you change your working wavelength, at which time you have to enable it and thereafter repeat the whole procedure. Also note that the displayed prism encoder value does not always correspond to a unique prism position. This value may be changed without a corresponding movement of the prism. Thus, you can not be sure to return to a previous prism position by giving the value you used previously. You may however use it as a first guess, but it has to be checked with the flat field lamp as described above.

Working with the prism in an erroneous position may result in a total loss of your signal. You may also experience gradient shifts in your flat fields or vignetting at either end of the spectral range. Even a moderate error in position results in a loss of efficiency. If the initial prism position given by the MULTI program for some reason is wrong by a considerable amount, you may find yourself working in a wrong diffraction order at a completely wrong central wavelength. If you can not recognize your spectral range this may be the reason. It is thus important that you really take the trouble to carefully check the prism position after every time it has been moved.

5.3 Calibrations

To enable a proper reduction of the data, a set of calibration frames is needed. Although the type and number of calibrations depend on the nature of the scientific program, a minimum set of calibrations should include: BIAS (0 second exposure to measure the electronic offset level of the CCD detector), FLAT FIELD (continuum lamp exposure to determine pixel-to-pixel variations), ARC-LAMP SPECTRUM (e.g. Th-Ar lamp for wavelength calibration), and long DARKS (long exposure with shutter closed to measure the dark current).

For Flat Field and Arc exposures, the required integration time will depend on the central wavelength, spectral resolution (for FF) and the required intensity level. Flatfield lamps are more intense in the red than in the blue wavelength domain. For CCD#34 the calibration database (cf. Chapter 4) can be used as a reference. For CCD#38 the database integration times should be corrected for the CCD's QE ratio. Note that, if exposure times differ substantially from the expected ones, this may indicate either an ageing of the lamps or a mulfunctioning of the filter wheel. Please call in that case 360cat Telescope Team operation.

5.3.1 BIAS

A short dark exposure will show the offset level of the CCD. The bias value is normally between 180-200 ADUs. Since the bias level of the presently used CCD's does not show gradients or patterns the averaged bias level can be subtracted from all subsequent exposures (expressed as a real number, not the image). Again press Define single exp. to enter the exposure definition menu:

```
Type               DK
Exposure time      0 sec
Tape recording     0
Identifier         Bias
No. of exposures   1
```

Since a DK-exposure will not set or change anything in the spectrograph, the other parameters are not relevant. Press "ENTER" and then Start single exp.. Wait until the exposure is finished. During a DK-exposure the shutter is not opened.

To "automatically" display a CCD exposure on the RAMTEK type in the exposure definition form after Batch file "KDISPC" (not for remote observations). Alternatively, enter IHAP and use the softkey BATCH,KDISPC,,# followed by the file number. KDISPC is a batch program that will calculate cut levels and display the file on the RAMTEK monitor. Since the beginning of 1996 a workstation is available in the CAT/CES control room (see section 5.5). The obtained spectrum is directly transferred into a MIDAS session running on the workstation and displayed. MIDAS routines can be used for on-line reduction.

At the end of an integration every exposure is written at the end of the IHAP file stack. It is also written to tape if the "Tape Recording" was set to 1 during the **last** exposure definition.

Check that the RMS of the frame on a small area does not differ substantially from the expected RON of the CCD; check it in several regions of the CCD (note that the RON is given in e-, while you are measuring ADU; therefore the RMS has to be be multiplied by the e-/ADU conversion factor) (commands `SAMPLE` in IHAP, `STAT/IMA` in MIDAS). It is suggested to acquire several BIAS frames at regular intervals, to check the stability of the BIAS level and to obtain better statistics.

5.3.2 Flat Field exposures

Because of the small spectral range covered in the CES spectra, Flat Fields are often not only used to correct for pixel to pixel variations, but also for rectifying the object's continuum. The required exposure times and the eventual selection of neutral-density filters depend on wavelength, resolution, and the state of the flat field lamp. For 6562 Å and $R = 50.000$ an exposure time of 5 sec and neutral density filter No. 7 ($= 0.99$ D) gives an exposure level of $\sim$ 9500 ADUs (CCD#34).

Press $\boxed{\text{Define single exp.}}$:

```
EXPOSURE DEFINITION
    Type           FF
    Exposure time        5 sec                  Tape recording 0
    Identifier     FF 5sec D=0.99
    Batch file     (Ignore)                     Number of exposures  1
INSTRUMENT SETTING    1
    Calibration lamp# 6                         Neutral density filter 7
```

and leave the rest unchanged. Press "ENTER" and $\boxed{\text{Start single exp.}}$ in the usual way. The saturation level of the CCD can be found in Table 2.3. Approaching this level the CCD may show non-linearity effects.

The spatial profile of the flatfield should be flat-topped, if not call the Telescope Team. Also, choose a decker height much longer than the object profile (15-20 arcsec); for long exposures on faint objects a check of the sky on either side of the object might be of value.

At longer wavelengths ($\gtrsim$ 6500 Å) where interference fringes might develop, it is safer to complement the internal lamp flat fields with dome flats. Dome flat lamps will show an emission line at 6708 Å when overheated, therefore be sure that cooling fans are working in the dome.

For very high S/N observations early-type stars spectra can be used as flat fields. Make sure that you illuminate the same pixels on the CCD in both cases. Even better is to turn off the autoguiding and slightly trail the flat field star along the slit and repeat the trailing several times. In this way a S/N ratio of 800 or more can be obtained. Under all circumstances you should check that you do not divide your science exposure with flatfield pixels which have not been sufficiently exposed.

Note that the FF lamp is not a fully stable source, and it is normal to have different (10-15%) intensities when acquiring a series of exposures. An easy check of the flatfield stability is to divide (bias subtracted) exposures taken at different times during the night. The result should of course be a straight horizontal line with very little noise.

For most purposes the internal quartz flat field lamp is sufficient to correct for the pixel-to-pixel sensitivity variations. However, after all appropriate reductions have been made it is not uncommon to find a slight bending of the stellar continuum towards the blue end of the spectrum. This is probably a result of a slight difference in the way the slit is illuminated by the lamp and the star. You may improve this by taking flats using (early-type) stars close to your target star in the sky, as continuum reference. Hot stars may also give a check of the earth's atmospheric lines.

With CCD #38 a number (4-5) of very narrow (1 pixel) absorption features may be present even after FF correction. These features are due to the presence of traps in the CCD.

Their intensity depends on the total number of electrons recorded in the column affected by the trap above it, and for that reason they cannot be flatfielded out.

5.3.3 Wavelength calibration

For wavelength calibration the Th-lamp (# 2) is normally used. Exposure type is "CL". One higher and one lower exposure level is recommended to take advantage of lines of different intensity. The number of Th exposures depends on the required accuracy. Typical shifts with the long camera amount to half a pixel during one night.

Check with a thorium line atlas (for example ref. [13]) that you really are working at the correct central wavelength. Using good Th wavelength tables a very high accuracy may be reached; an RMS scatter of the line positions around the dispersion curve of $\sim 1-2$ mÅ is typical. A second order polynomial based on ~ 15 emission lines is usually sufficient.

Also check the actual resolving power by measure the FWHM of a few ThAr lines. For this purpose one might use the IHAP command "SLCE" (or MIDAS command center/gauss gcursor) on a collapsed 1-d ThAr spectrum. Especially in the case of CCD#38 the actual resolving power might differ substantially from the specified value (in Form#2).

5.3.4 Long dark exposures

The dark current of the present CCD detectors is very low, less than 2.5 e^-/pix/hr. It can in most cases be ignored. It is however still useful to do some long darks with the detector open to ensure that no parasitic light is present in the CES room.

5.4 Science exposures

The next Chapter describes how to start up the CAT and how to find and center the object on the spectrograph slit. From Figs. 3.1, 3.2, and table 3.1 you can estimate what exposure time is needed. One must, however, take into account the difference in grating order efficiency between your central wavelength and those listed in the table. Furthermore, the choice of resolution and in particular the seeing at the time of observation, may strongly affect the required integration times. Check also the detector response curve as a function of wavelength.

In practice, it is far safer to do a short exposure on a bright star to get a first idea of the exposure time. The requested S/N ratio can be estimated from the ADU level: for a photon-noise limited spectrum the noise is given by the square-root of the number of detected electrons (photons), i.e. the ADU level times the conversion factor. If an exposure time longer than approximately 1 hour is foreseen, it may be advantageous to split it into two exposures. Blemishes due to radiation events are then much easier to identify and to remove.

Stellar exposures are defined as RE (Regular). During the exposure you will have access to the following menu:

STATUS	Comments	EXTM,n	HELP
Pause exposure	Abort exposure	IHAP	

The remaining exposure time is continuously displayed below this menu. By touching EXTM,n you may change the exposure time by adding or subtracting a number of seconds. The ABORT exposure pressed twice aborts the exposure without reading the CCD.

It is advisable to check now and then that all information in the IHAP file header is correct. Use IHAP command `DLIST,# ,LO,` and check the UT, ST, coordinates etc. The MIDAS session on the workstation does not keep track of the file headers.

In general, it is highly recommended to continuously monitor the quality of the science exposures. During long integrations, the previously obtained exposures should be at least preliminary reduced and checked. Things like resolution, S/N ratio, continuum slope, presence of fringes and optical ghosts can be investigated during the night.

It is essential to check that all calibration exposures for the central wavelength under investigation have been made before an attempt is made to change wavelength range. Even though the CES is a stable instrument, care should be taken in doing all calibration and science exposures under identical conditions.

5.5 MIDAS session on workstation

Since the beginning of 1996 a workstation has been installed in the CAT/CES control room. After read-out of the CCD the spectrum is transferred to the workstation and in parallel stored as an IHAP file on the "IHAP harddisk" and the magnetic tape. The MIDAS session running on the workstation automatically converts the file in a MIDAS format (extension .bdf) file and displays (part of) the spectrum. For manually loading a spectrum in the MIDAS display the MIDAS command "`LOAD/IM` *file*" is used. MIDAS is equiped with an extensive help facility; just type the command "help" to get a list with all available MIDAS commands.

Here we give a brief summary of the most important MIDAS commands that can be used for an inspection of the spectrum's quality.

- `LOAD/IM` *file*

  Loads a file into the image display; useful additional parameters that can be specified with this command are `cuts=low,high` and `scale=x,y` to change the cut values of the display and the scale in x and y-direction, respectively.

- `GET/CURSOR`

  After typing this command clicking of the left mouse button inside the image display return the position and pixel value. The command is deactivated by pressing the right mouse button.

- `EXTRACT/TRACE`

  Extracts a line from the displayed 2-d frame; move the opposite cross with the arrow keys.

- `PLOT/IM` *file*

  Plots 1-d file on graphics display.

- `SET/GRAP xaxis=xmin,xmax yaxis=ymin,ymax`

  To set plot limits.

- `AVER/ROW 1-d = 2-d [first,last]`

  Extract 1-d file from 2-d frame by averaging (`first` and `last` are the numbers of the first and last row to be included). `AVER/ROW` is used for CCD#38, `AVER/COL` for CCD#34.

Most of the MIDAS commands listed above can be executed with help of MIDAS batches (see top panel in MIDAS session screen).

An on-line MIDAS reduction batch can be used for quick reduction of the spectra. Flatfield correction, bias subtraction and wavelength calibration is automatically performed. The batch job can be activated by typing `@@ ces`. For final reductions of CES data, reference is made to the relevant parts of the MIDAS User Manuals. A special MIDAS context (LONG) has been developed to perform spectrum extraction and calibration.

The workstation can also be used to make a telnet connection to the home institute. Another interesting option is the meteo monitor, which can be found in a separate window.

5.6 Closing down

In the control room:

- Check that the exposure meter shutter is closed.

- Dismount the magnetic tape. Press "RESET" and "REWIND", wait until the tape is at loadpoint, then press "REWIND" again. The tape will snap loose from the lower reel. Fill in the small label and place it together with the tape. The tape should be brought to the "DATA TAPES" mailbox outside the dining room. Here it will be picked up by the computer center operators and copied into the La Silla data bank. At the end of the observing run all your observations will be collected on separate tapes and given to you. Standard format is FITS format on DAT tape. If you have other wishes for the format contact the operators.

In the slit room:

- Close shutter in front of focal reducer.

In the spectrograph room:

- Place cover on collimator mirror.
- Place cover on Long Camera.

Fill in the Telescope Operations Report. The white original should be placed in a binder situated in the control room. The pink and blue copies should be brought in the morning to the red box at the hotel entrance. Problems encountered during the night should be described in the Report as well as all types of suggestions and comments on instrument behavior.

Chapter 6

CAT operating procedure

Details on the CAT control system can be found in ref. [10].

6.1 Starting up

When the dome is being closed or opened, the mirror covers must be CLOSED.

<u>In the dome:</u>

Check that the CAT is free to move without danger of colliding with ladders, chairs, the flat field lamp assembly etcetera.

Check that the dome rotation, hatch 1 and hatch 2 switches are in a vertical (inactive) position.

Set the Local/Remote switch to Remote. Only check that no calibration lamps are on.

<u>In the control room:</u>

The 'COMP' switch should be always on (power to the CAT computer).

Switch 'SERVO' power on.

Push 'ON-LINE'.

The status of the CAT is displayed on the upper HP screen:

```
          C o u d e - A u x i l i a r y - T e l e s c o p e
          - - - - - - - - - - - - - - - - - - - - - - - - - -
          Control            Instr.             Detector
---------------------------------------------------------------------------
          Shhmmss.s              Degr.         km/h                  Cels.
Hour angle   24611.4  Zen.-dist.:40.9     Wind:----     Outside temp.:-----
Sider.time: 165033       Airmass:1.323                 CAT-Dome temp.:-----

Focus pos.: 2570   Mirror 2: BLUE
---------------------------------------------------------------------------
 Telescope status   Autoguider status    Cover status      Dome / Hatches
Roll    : OPEN LOOP  Autoguider OFF     Mirror 1:  CLOSED  Mode:   Manual
Pitch   : OPEN LOOP                     Mirror 2:  CLOSED  Low.hatch:    UP
Mirror3:  OFF LINE                      Mirror 3:  CLOSED  Upp.hatch:    UP
Initialized:  YES                                          Ringseal: UNDEFIN.

                       HATCH WILL OBSCURE WITHIN 15 MINUTES

East  [--------------------------z-----------------------] West   37.2Deg.Roll
                                                   ^
North [-----------------------z--------------------------] South -27.3Deg.Pitch
                 ^
```

Check against the CERMÉ display that the TCS (Telescope Control System) sidereal time is correct.

Select the main TCS menu on the lower HP-display and hit the CONSTANT HANDL. key. Check that the date is correct.

¿From the main menu go into the DOME/HATCH CNTR. and from this press Upp.Hatch UP to open the upper hatch. Wait until the hatch has stopped moving. This can be checked on the upper main status screen-display as well as by the small yellow control light on the CAT control panel. This light is lit during movement and goes off when the hatch is completely open.

Push 'OPEN' button on telescope panel. This will open the covers of the telescope mirrors. Wait until the lamp goes on. Also check that the covers have been correctly opened by looking at the status display; mirrors 1, 2 and 3 should show 'OPEN'. In order to protect the mirrors, the hatches should always be opened **before** the mirrors.

Select your secondary mirror, normally 'RED' or 'BLUE' according to the wavelength you are working at. The limit between blue and red is $\sim$ 5200 Å.

Press 'INIT' and wait until the light of this button goes off and the 'SLEW' light goes on. This operation initializes the telescope coordinate system and leaves the telescope close to zenith. The initialization should end with delta coordinate close to $-28°30'$; if this is not the case, repeat the 'INIT'. Check on the status screen that all telescope functions have been properly initialized; Roll and Pitch: Tracking, Mirror 3: Operative, Initialized: Yes.

Switch on the power to the finder TV and the monitor (only when the sky is sufficiently dark). Turn the gain to near maximum; during the night adjust it to the brightness of your stars. Normally the pointing of the CAT should be good enough to allow you to identify your field from the 'Large field' mirror setting of the CES without use of the finder telescope. At some telescope/dome positions the finder may be obscured by the dome.

Switch on power to the integrating slit-viewing video system and its TV monitor. The main (red) power switch is located to the left on the panel above the terminal. To the right is the black (HV) gain control turn button. At start, leave the gain turned down completely. Be careful when you do calibration exposures not to damage the TV camera with too much light. This is especially important when using the flat field lamp. To see the CES slit use the thorium lamp (or a bright star) and the 'Small field' mirror position. Check that you have the slit in focus. The TV focus control is to be found on the right side of the monitor. Remember to focus on the vertical slit-jaws and not on the horizontal decker.

Switch on the autoguider with 'ON'. During operation the following push-buttons should be lit on the Cross Hair Generator control box: 'CROSS HAIR', 'SIGHT BOX', the four box dimensions, 'W on B', '312', 'AUTO' and 'DOT'.

To center the cross on the slit, turn on the thorium lamp (by defining a CL exposure or typing the command `LAMP,2,ON`) and select the 'Small field' view. Increase the gain of the TV camera slowly until you see the slit clearly. From the main softkey menu go into AUTO-GUIDER and from this to CROSS-HANDLING. Move the cross by means of Move box left etc. Center the cross in the middle of the slit. Choose an almost square box with, for example, a width a few times larger than the CES slit. The relative position of the slit and cross may change slightly during the night. Adjust if necessary.

The video signals in the four quadrants formed by the cross and the box are used to drive the autoguider in such a way as to keep these signals equal. A binary display of these can be seen down at the floor of the right-most panel. When the telescope is under autoguider control it is in off-set mode. The integrating time of the autoguider is around 1 sec. When attempting to guide on faint objects it may pay off to change the lower detection level of the autoguider. The maximum and minimum offset steps can also be changed from the autoguider menu. The autoguider may work on any pointlike object not necessarily situated in the slit, but not on extended objects. The field rotation has to be kept in mind if the autoguider is used outside the slit.

6.2 Telescope pointing and guiding

Check first on the main status display that the dome is in automatic mode. If not, go into DOME/HATCH CNTR. and press Autom/Manual.

The CAT TCS program employs a catalogue handling system. In the main menu press CATALOGUE and then Coordinate entry. Fill in the identifier, alpha, delta and the epoch. You must type the decimal points in alpha and delta. Press the 'ENTER' button on the terminal. If you want to see the content of the catalogue use List catalogue and give the location of the first object you wish to display followed by the number of objects. Press 'ENTER'. The whole catalogue will be written if you leave the input fields empty. The catalogue can be saved on a tape; this to overcome the situation to type in the catalogue again after an unforeseen reboot of the TCS computer.

The telescope pointing is done from the PRESETTING menu which can be reached from the main menu or directly from CATALOGUE. If your object is already in the catalogue use the Go to object key. Give the identifier (or the object number in the catalogue) and press 'ENTER'. You can also point by Go to coordinate in which case you have to provide the coordinates.

Select the 'Large field' mirror. You should now see your object in the finder telescope monitor as well as in the CES slit view monitor. Move the object close to the center of this screen. Go into 'Small field' and center the star on the slit. Adjust the TV gain until you clearly see the wings of the stellar image on the slit decker. For faint objects you may have to use the integration mode.

Start the autoguiding: Press AUTO-GUIDER then Autoguiding ON. The telescope should go into OFFSET mode and start to move the star into the slit. The light of the corresponding alpha or delta control button goes on momentarily when the correction is performed. You are now ready to start your science exposure. During long exposures it may be necessary to change the position of the lower hatch. A message will appear that the "hatch will obscure in 15 minutes". Change the position of the obscuring hatch and switch the dome back in automatic mode.

6.3 Closing down

- Switch off power to the TV camera on the finder telescope. Monitor off.
- Turn down the gain of the CES slit view camera. Main switch and monitor off.
- Push 'CLOSE' and wait until the lamp is lit. It should take about one minute. The telescope will move to the zenith and the mirror covers will close. Check on status display.
- Close the hatches from the DOME/HATCH CNTR menu. Wait until they are fully closed. Again check the status display and the small control lights to the left on the

CAT panel. Do not close hatches prior to telescope covers.

- Switch off 'ON-LINE' and 'SERVO'.
- Go to the CAT dome and switch the dome control to 'LOCAL'.

Chapter 7

Trouble-shooting

7.1 In case of problems

If you encounter problems with the CES or the CAT which require intervention from the Observatory staff, please contact the 360cat Telescope Team, paging no. 93 + 53 or 93 + 63. You may also get help from your introducing astronomer, the resident astronomer (paging no. 93 + 13) or the astronomer in charge of the CES. Do not hesitate to call any of these people, they are there to help you. It is important that you write down a description of the problems in the Telescope Operations Report. If a solution can not be found during the night, repairs based on this description will be attempted during the following day.

7.2 Currently known problems

- Drift of the predisperser position encoder. See section 5.2.
- When moving the decker a time out error may occur. This may be due to the decker motor (a circular one on the side of the slit unit) which gets stuck. Check in the slit room if this wheel is rotating, and if not, give it a soft push into the direction it tries to rotate.
- At several central wavelengths a ghost image may appear (see Chapter 4).
- If a malfunction occurs in one of the motors driving the slits, decker, mirrors etc., it may help to reinitialize it. In the $\boxed{\text{OBSERVATION}}$ menu press $\boxed{\text{ENGINEERING}}$ and then $\boxed{\text{Initialize motors}}$. Form #11 will appear:

```
     Coude echelle Spectrograph        * Initialize motor *   Form 11    *


   Initialize motor  5
```

```
                         0= All motors belonging to instrument in use (+CAMAC Z)
                         1= pred. entrance slit
                         2= scanner exit slit
                         3= scanner interm. slit
                         4= blue exit slit
                         5= calibr. lamp mirror
                         6= decker
                         7= filter
                         8= red exit slit
                         9= predisperser
                        10= short camera focus
                        11= mod C, motor 3 (N/C)
                        12= mod C, motor 4 (N/C)

 Press ENTER key to proceed  (or softkey#1 to abort).
```

Type the code for the motor in question in the window, press "ENTER".

- Shifts of the spectrum in the dispersion direction have been strongly reduced with respect to the past. Some residual effect is still present, however: wavelength drifts up to 0.6 pixel of total amplitude over a night have been observed. As these drifts are progressive they seldom exceed 0.2 pixel during an observation, so that they do not compromise significantly the resolution. But it is wise to take a ThAr spectrum before and after each exposure if high accuracy in radial velocity is aimed at.

- Sometimes, MULTI gives the following error message:

```
** WARNING: turntable drifting; # 1/10 of arcsec it has drifted: nnn
      -- check the air pressure and reinitialize the turntable
     -- if this does not help, have the CUPE electronics checked
```

  This message means that the actual grating position differs by more than $0''.2$ from the requested position. This may indicate a serious problem. Nevertheless, sometimes, the message is unduly displayed, because of some conflict during the reading of the grating turntable position. Always note the grating position angle indicated on the (orange) display in the CAT control room (in case of RC observations, ask the night assistant). After receiving a turntable drift message, check if the grating position angle indicated on the display has changed. A quantative check can be made by taking a ThAr spectrum and compare it with the previous one you have obtained. If they are not abnormally shifted with respect to each other, you can ignore the warning and continue to observe normally. Otherwise you should immediately call the 360cat team.

- It sometimes occurs that some of the CES function encoders loose their initialization. As a result, when the corresponding function is moved (*and only in that case*), it may end up at a wrong value *without any warning to the observer.* Accordingly, it is advisable to check, after function moves, that the actually set values correspond to the requested ones. This verification can only be performed indirectly, through inspection of the recorded spectrum. If it reveals a failure, the problem will usually be cured by reinitializing the faulty function. A new verification after the reinitialization is, of course, a wise precaution.

The two most typical failures are those of the entrance slit width and of the neutral density filter wheel. The former occurs when the slit width is changed. After any adjustment of the slit width, one should thus check on a Th spectrum that the lines have the expected FWHM. The neutral density filter is mostly used for flat-field exposures, and more rarely to take wavelength calibrations. It should always be verified that these exposures are neither saturated nor strongly underexposed (both of which would most likely indicate that a wrong density filter was used). In particular, before starting a series of flat-field exposures, it is wise to take one single such exposure first as a check, and then to go on with the series.

- Especially when using CCD#38 strong vignetting might occur when the predisperser exit slit is set to a wrong value. Check the value computed by the system with the one given by the formula in section 5.2. If the predisperser exit slit has a wrong value, correct this value with Special Settings and disable the motor of the predisperser exit slit.

- Exposure sequences do not presently work reliably; this option should *not* be used. Note that the automatic repetition of a given single exposure is safe.

Chapter 8

Remote Control

The Remote Control System described in this Chapter was designed and implemented by Georg Kraus, Gianni Raffi and Manfred Ziebell. This chapter is based on the RC document [18] written by Anders Wallander, updated by Jesus Rodriguez.

8.1 Introduction

Since 1987 ESO has provided a facility for European astronomers to observe using telescopes at La Silla, while remaining at the Headquarters in Garching. This is made possible by using a satellite link between Garching and La Silla.

The main philosophy in developing the system has been to emulate the control rooms at La Silla. The astronomer uses the same type of devices and the same software as he/she would have used at the observatory. With other words the user interface is the same in Garching and at La Silla. The fact that the astronomer interacts in real-time with the instrument is underlined by the name remote control.

Throughout this Chapter the term `remote` will be used for Garching and the term `local` will be used for La Silla unless otherwise stated. Note that the RCES session in Garching uses the reversed notation for the IHAP sessions running in Garching (local) and La Silla (remote).

The communication between Garching and La Silla is carried out by satellite link, available 24 hours a day. The satellite link is used for telecommunication between Garching and La Silla (and Santiago) and the remote control operation of the New Technology Telescope (NTT) and the CAT/CES.

In short, for the remote use of the CAT/CES, the CAT is operated by a night assistant in La Silla (telescope pointing, focussing, etc.) and the CES is controled by the user in Garching. The astronomer in Garching communicates with the night assistant in La Silla by means of computer message exchange. In Garching, the observer is supported by a system operator. Also, upon request, an introduction for the remote use of the CAT/CES is given by an ESO astronomer.

8.1.1 Remote operations

The control of the CES during remote observations is identical to the local operating procedure of the CES (see previous chapter). After the exposure the data are written to the IHAP database on harddisk in La Silla. The data are also stored on tape, which will be sent to the astronomer's institute after the completion of the observations. In order to inspect the quality of the data, the remote system allows access to the IHAP database at La Silla. This is rather confusingly called remote IHAP, taking the stand point of the user in Garching, and is accessible through normal softkeys on the instrument terminal. Because the data are stored in La Silla the possibilities for image processing are limited. Simple IHAP functions like list files, averaging, maxmin etc. may be performed, but a closer inspection using Ramtek and graphics terminal is not possible unless the data are transferred to Garching.

It is possible to transfer an IHAP file from La Silla to Garching, but this is not done automatically (a high resolution CCD image may contain 10.000.000 bits of information!). The file is compressed before transfer in order to reduce the transmission time. A typical compression factor is 1/3 to 1/4. Provided that a small CCD window has been chosen, a typical spectrum will take a few seconds to transfer, while a complete image may take five minutes. Data will be written to the Garching IHAP database and normal image processing using Ramtek, graphics terminal and plotter can then be performed. Alternatively, a 2-dimensional CCD image can be collapsed into a 1-dimensional frame using the IHAP commands XADD or SADD in the La Silla IHAP session (resulting in a frame containing the collapsed spectrum or the spatial profile). The file transfer of a 1-dimensional frame takes only a few seconds.

An IHAP file can be transfered in parallel with a running integration. In order to save time it is suggested to transfer a previous file during a subsequent exposure. The astronomer should also consider if he/she really needs to transfer all data, especially if he/she performs many integrations of short duration.

8.2 RC Operating Procedures

8.2.1 Start Up and Shut Down of Remote Control Session

The astronomer should normally not be concerned with starting up or shutting down the system. He/she will be assisted during the remote control session by a remote control operator, whose task it is to start up and shut down the system and to assist in case of technical failure. For completeness the procedures are explained below.

1. Make sure the Remote Control Computer is connected to the relevant telescope/instrument control computer.

2. Logon instrument terminal as *RCES* for Coude Echelle Spectrometer. Follow the instructions in the login file. The startup will take about five minutes.

3. Logon telescope terminal as *RCAT* for CAT telescope. Follow the instructions in the login file. The startup will take only a few seconds.

4. Perform some test exposures.

The normal shut down procedure is performed by using the softkeys TERMINATE or FINISH. The telescope control program should be terminated before the instrument program.

8.2.2 Control of the remote link

The first difference the astronomer will observe when arriving in the control room in Garching is an additional terminal. This terminal is used to control the usage of the line and to pass messages to the control room at La Silla.

The communication software running on this terminal is normally never stopped. However if it is not running the procedure to start is to log on the terminal using the user name *RCALL* and follow instructions in the login file. Providing the software is running there will be a prompt indicating the destination for subsequent messages and commands.

During the remote control session the astronomer will type instructions for the night assistant in La Silla on the PC. Messages from the night assistant appear in the bottom panel of the PC. The messages are time stamped.

The second function of the software running on the communication terminal is to switch between the different modes the line may be used for (see below). In order to enter a command the user has to type F1. The prompt will then changed to **Enter cmd** :. The most common commands are listed below.

- **RBST** - read status of switching box in Garching. Will display the usage of the line in Garching on the system console.

- **RRST** - read status of switching box at default destination. Will display the usage of the line at La Silla on the system console.

- **MSER** - switch line to computer-to-computer connection between Garching and default destination at La Silla.

- **PABX** - switch line to connect the PABXes in Garching and La Silla.

- **AUTO** - automatic suspending and restarting (see below).

- **READ** - transfer an IHAP file from La Silla to Garching.

8.2.3 Transfer of IHAP files

After an integration has been performed the data are stored in the IHAP data base at La Silla. In order to perform image processing the data have to be transfered to the IHAP data base in Garching.

A single IHAP file is transfered using the command **READ** or the F2 PC key followed by the IHAP file number (in La Silla). This command is executed on the communication console like any other command (give F1 to enter command mode, then give command). The file transfer includes a data compression/decompression to speed up the transmission. This does not in any way reduce the information contents of the file. Progress of the transfer can been seen on the system console. To speed up transfer, one might consider to use IHAP commands like TRUNCATE, XADD, SADD, etc. to reduce the size of a file in the remote IHAP database at La Silla and transfer only the compacted, one-dimensional file.

8.3 A typical RC Session

8.3.1 Preparation and arrival in Garching

Remote control observers will normally arrive in Garching *the day before* their observations start. Before arrival the RC observer has to inform the 360cat Instrument Team about the instrument set-up (central wavelengths, resolving power, spectrograph path, CCD) and the target list. Eventual finding charts can be faxed to La Silla. The information has to be sent to the email account **360cat@eso.org** in La Silla.

In case an introdution is needed, the RC observer should contact the introducing astronomer in order to fix the time when the introduction to the system and the first calibration observations will start. Since Garching is six hours ahead of La Silla in the northern summer and four hours in winter, this will normally be between 8 and 12 p.m. Garching time. (A general guide to the user facilities in Garching is available from the Visiting Astronomers Section in Garching.)

8.3.2 Starting up

It is generally a good policy to keep IHAP databases as small as possible. For RC observers, managing the data base is a twofold task because there is both a local and a remote IHAP session. At the beginning of each night the observer will on either system purge all IHAP files that are no longer needed (the maximum number of files for each IHAP session is 280, and when CCD#38 is used only about 160):

1. On instrument terminal press softkey TERMINATE to get the main softkey menu.
2. Press softkey Remote IHAP to start IHAP at La Silla.

3. Use IHAP commands **PURGE, RENUMBER** and **PACK** to clear the IHAP data base.
4. Press softkey TERMINATE to get back to main menu.
5. Press softkey Local IHAP to start IHAP in Garching.
6. Use IHAP commands **PURGE, RENUMBER** and **PACK** to clear the IHAP data base.
7. Press softkey TERMINATE to get back to main menu.

The RC operator will on request provide the astronomer with special forms to facilitate the book keeping of the files created during the course of the night.

The next step is to do a number of test integrations (using flatfield or arc lamps) in order to check the instrument set-up (instrument focus, central wavelength, predisperser position) and to find the optimal exposure times for calibration frames. It is also advisable to check if the night assistant in La Silla received the list of objects and all finding charts. If many objects are to be observed, the night assistent could already start to enter the first coordinates in the catalog of the telescope control system (TCS).

When everything is working normally and the real calibration exposures can start, the night assistant should be dismissed for the rest of the afternoon. But a clear agreement should first be reached as to when the scientific observations will begin and, in case of poor weather, where the night assistant can be reached (normally by beeper). Also, it should be ensured that the telescope dome is opened well in advance of the astronomical observations.

The time in the afternoon is important to get acquainted with the operating procedures, the establishment of communiciation patterns with La Silla, and the testing of the performance of the instrumentation. Any efforts of these kinds in the afternoon will pay off during the night. The tests to be performed of course include the transfer of data to Garching.

8.3.3 Science observations

The general practice is that the night assistant takes care of the telescope presetting. The user will instruct the night assistant to point the telescope to the required object on the target list. After the identification of the object by the night assistant, he will inform the astronomer when the system is ready to start the exposure.

The astronomer should be aware that the night assistant is largely "blind" as to what the system is doing; the night assistant also has no access to the remote IHAP. This gives rise to the danger that the communication between La Silla and Garching ends up in a deadlock. For instance, the astronomer is waiting for the night assistant to confirm a telescope preset while the night assistant is waiting for the astronomer to start the exposure, and nothing happens. The night assistant has no way to find out important things like type of exposure, remaining exposure time, etc. so that this information should always be communicated to him through the message system. Usually the night assistants at La Silla are experienced and always prepared to help in case something goes wrong; but they can do so only if they are told clearly what they are expected to do and what they are not supposed to do. The best results are obtained if a positive working atmosphere is established with a maximum of information exchange, collaboration and communication.

The observer will ask the night assistant to move the telescope to the next object on his list. In parallel, he/she will define the exposure using the familiar form filling system. The observer starts the integration after the identity of the object has been checked using the STATUS command on the telescope terminal. When the integration is completed the CCD exposure level can be measured by means of the remote IHAP session. The previous observation could be transferred to Garching after a new observation has been started.

8.4 Summary of various tips and things to remember

1. Come with precise coordinates. The more objects are to be observed per night the more it is advisable to send a list with legible coordinates in advance to La Silla. Number all objects. When communicating with the night assistant at La Silla, refer to objects only by these numbers!

2. If in doubt bring finding charts which will be sent to the night assistant. They should have a high contrast so that they FAX well. Alternatively they could be mailed with diplo bag. In this case they should be sent to the RC operation group in Garching at least two weeks in advance. Identify all targets by their number on the object list. If other prominent features may provide useful reference points for the communication with the night assistant, mark them with letters.

   Especially when using telefax, *number* all finding charts and mention on the first sheet how many pages there are in total.

3. For efficiency reasons, file transfer from La Silla should normally be done only during a later integration. If for some reason the transfer of all files during the same night is considered essential, the integration times need, therefore, to be somewhat longer than the file transfer time. If, in spectroscopy, background correction does not require sampling a large sky area, rigorous windowing of the CCD speeds up things considerably.

4. Always ask yourself if you really need to transmit the full amount of data.

5. Remember that you can ftp your data from the CAT WS. This transfer is very efficient, but FITS headers will be missing.

6. Simple quality checks can also be done without file transfer by using the remote IHAP at La Silla so long as the commands do not require interaction with a graphics or colour display. Examples are MAXMIN and SAMPLE.

7. Give your files meaningful names, indicating object names, filters, wavelengths, dates, times, etc. as applicable.

8. As a general rule, all IHAP commands with a large amount of output to the session terminal (such as `DLIST,ALL` or `SINFO`) are dangerous when used in the *remote* IHAP.

9. Be as clear as possible when communicating your wishes to the night assistant at La Silla. Explain the goals for your observation and trust his experience. He has no possibility to monitor or check what you or the instrument are doing (integration / no integration, remaining exposure time, etc.). Please make sure that the calibration mirror is not in the light path before asking the night assistant to center the next target (do this by defining the next regular exposure).

10. If you have special operations requests (such as changing between blue and red path of the CES), communicate them one night in advance to La Silla to make sure someone is around to perform them.

11. Try to do as many of your flatfield exposures as possible in the afternoon or evening. Upon request, the night assistant prepares the telescope for dome flats.

12. In case of problems during the night you can ask the night assistant to contact the 360CAT operations or support astronomer for assistance.

13. *Always* give a precise description with as many details as possible in the nightly operations reports. Write legibly so that the report can be FAXed to La Silla if necessary. Don't forget to fill the end of run report.

14. The observer will recieve a DAT tape containing all obtained spectra about two weeks after the completion of the observing run.

The ESO library is situated only a few meters from the remote control room and is accessible at any time for the visiting astronomer. In addition the following manuals and information are available in the remote control room.

A guest account can be used to make a telnet connection to the home institute. Furthermore, upon request an account can be prepared for performing off-line data reduction in Garching.

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