JACOBUS KAPTEYN TELESCOPE

WIDE FIELD CAMERA PHOTOGRAPHIC USERS' MANUAL

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Version 2

1991 July

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1 INTRODUCTION

This manual is designed to introduce the observer to the Jacobus Kapteyn Telescope (JKT 1-metre) wide field plate camera (WFC) and to describe how the camera is used to take plates at the f/8 focus. Fig.1 shows the camera and its constituent parts. Fig.2 shows a schematic optical diagram of the camera.

2 FEATURES

2.1 Wide Field Optics

The Harmer-Wynne arrangement is mounted by replacing the conventional f/15 Hyperboloid Secondary by a larger f/8 Spherical secondary. In addition an afocal doublet corrector mounted 1.47 metres in front of the f/8 focus (i.e. in the middle of the tube) gives a flat, highly corrected field of 90 arcmin diameter. The plates used are 8 x 10 inches (200 x 250 mm) and the effective field has a diameter of 1.5 degrees. The autoguider prism and its support cause some vignetting which depends on the position of the guide star. The plate scale is 25.6 arcsec/mm (see Fig.3) at the centre of the field but there is some distortion towards the edge .

2.2 Focus

The telescope is focused with a Knife Edge assembly which carries two knife edges at right angles, mounted in place of the plate holder. The procedure is as follows; starting at the Console.

1. Set the Handset Setting rate to 10 arcsec/sec on the User Interface. The command is HA/S 10 and then press SET on the Console immediately below the 'Handset Buttons'; this last action is vital.
2. Go to the telescope and remove any filters from the camera; open shutter with handset.
3. Insert the knife-edge assembly in the camera, and make very sure it is seated properly.
4. Set the telescope on a star brighter than about V = 6 and as close to the observational field as possible.
5. Bring the star close to the knife edge running in the declination direction (vertical when looking South on the Equator) close to its intersection with the other knife edge. Use the handset RA motion to move the knife edge across the star image while observing the shadow pattern by eye. Novices require some practice in doing this as it is necessary for the eye to be close behind the knife edge to accept the full light cone. Once found you must keep your head still or you will lose the light cone. It pays to set the rising floor exactly at a comfortably height and rest your forehead on the camera. Unless the telescope is exactly in focus the shadow will appear to cross the entrance pupil either in the same way as the telescope motion or against it.
6. Adjust the secondary mirror position (FOCUS buttons on top of handset) until the shadow pattern on the image of the primary is evenly occulted i.e. not selectively from one side or the other.
7. Read and record the position of the secondary.
8. Run the focus position away from focus towards the opposite side that you have just come in from; then repeat
9. and
10. Move the star to the other knife edge but still close to the centre of the field.

11. Take two more focus readings; one with focus readings increasing and one decreasing.
12. Return to the console and enter the four focus positions and their mean in the WFC adjustment book; and include the temperature and telescope position.
13. Enter the knife edge focus into ADAM by entering KEF xxx. The ADAM WFC software will prompt you for filter and plate-holder for subsequent exposures and will adjust the focus automatically.

The KEF is strongly correlated with tube temperature and the observer should keep a note of

KEF + 0.043*(Tube Temperature)

which should be constant within a few hundredths of a millimetre. After a few observations the mean value of this function will settle to a constant which may be used to infer the KEF from the temperature. Thus three or more KEF observations are recommended for the first night of a run decreasing to one a night from about the third night onwards

A typical figure for the telescope focus (readouts above the finder eyepiece and on the information display) is 13.10 at t = 12.deg.C for plateholder 4 and RG630 filter.

The ultimate check on the focus is to take a focus plate; there is an ADAM procedure to do this. It is recommended that one focus plate a night be taken or whenever some malfunction is suspected.

2.3 Interchangeable Filters

A series of approximately 250 x 200 x 4 mm broad band filters is available with holders. They are as follows:

Filter Holder	Filter	Thickness	Size
		mm	in
1	UG1	3.8	9.83 x 7.86
2	GG385	3.8	9.84 x 7.87
3	GG395	3.9	9.84 x 7.88
4	GG455	3.8	9.81 x 7.88
5	GG495	3.9	9.84 x 7.89
6	RG630	3.9	9.84 x 7.82
7	RG715	3.9	9.80 x 7.85

Table 1: Available broad band filters for the Wide Field Camera

All have MgF_2 single layer anti-reflection coatings. The assembly is slid into a slot in the camera and locked by a plunger about three quarters of the way down the left-hand side. This must be withdrawn to remove a filter holder. When in place, the filters are designed to keep an atmosphere of N_2 in contact with the emulsion during an exposure. (see section 2.2.4)

In addition, two 100 x 100 x 9 mm interference filters are available. These are:

The effect of the converging f/8 beam was taken into account when ordering the narrow band filters. The above central wavelengths represent the effective values seen by the camera plates. The filters are mounted in sub-frame assemblies which in turn are fixed to the filter holders. They must be inserted in one direction only as indicated by an arrow on the vane of the sub-frame assembly. Refocussing is necessary when using these filters. Each narrow band filter has a smaller (25 x 25 mm) calibration filter of identical characteristics which is available for use in the Kitt Peak calibration beam. Three empty sub-frame assemblies for holding 50 x 50 x 9 mm filters are also available.

Filter Holder	Filter	Central Wavelength	Bandwidth
8	Hα	6563Å	50Å
9	[O III]	5007Å	50Å

Table 2: Available narrow band filters for the Wide Field Camera

2.4 Plateholders

There are six plateholders for 250 x 200 mm plates. The plateholders are held in place by means of three spring-loaded clips; the seating is defined by three legs with conical tips fitting into V-grooves. The back of the plateholder is removed by rotating the locking bar until it is parallel to the long axis of the plateholder. The plate can then be inserted, emulsion down, after ensuring that the dark slide is enclosed first. This must be done carefully as the plate has to fit within an internal rebate. It is best to examine a plate holder in the light before loading your first plate. Each plateholder is also designed to be gas-tight, allowing it to maintain an atmosphere of nitrogen for hypersensitized (baked) plates. There are two small nozzles near the handle allowing N_2 to be flushed through to remove the existing air and hence maintain the sensitivity of the plate during exposure.

Squaring on of plateholders should not be necessary. If in doubt consult the Technical Manual (No 32 - not yet issued) or D H P Jones for advice.

2.5 Shutter

The focal plane shutter consists of a blind with a 300 x 200 mm aperture which is mounted on two rollers. When the camera power is switched on the shutter will close if it has been left open from the previous night. When the shutter button is pressed again, the rollers will reverse direction and the shutter opens. Pressing the button again will activate the rollers in the same direction and the shutter will close. This ensures that all parts of the plate are exposed equally. The shortest exposure which can be made is about 2-3 seconds. On the handset shutter OPEN is indicated by a RED LED and shutter CLOSED by a GREEN LED. The shutter can also be opened and closed by the 3210 instrumentation computer which has a CAMAC interface in parallel with the handset. This is the normal method of observing.

2.6 Plate Identification

The plate marking machine (Fig.4) is used to project details from the plate card (Fig 5) on to a corner of the plate; specifically the telescope name, the running plate number and the telescope co-ordinates. The plateholder is mounted on the machine in the same fashion as on the camera, AFTER the exposure has been made at the telescope. The timer should be set for the emulsion being used and a table of approximate exposures is given below. Care should be taken to ensure that the right time range is selected because there are five ranges covering up to six hours; it is nearly always the shortest. The range is selected by the knob at the bottom right of the timer panel.

These times are for hypersensitized plates; double the times for unsensitized plates.

2.7 Plate numbering convention

This is based on the UK Schmidt Telescope Unit convention, i.e.

Emulsion	Timer Setting
IIaO	3 sec
IIaD	2
IIIaF	0.5
IIIaJ	3

Table 3: Exposure times for the Plate Marking Machine

SINGLE LETTER prefixes denote standard plate and filter combinations:
U denotes any sensitization with UG1 filter
B denotes O sensitization with GG385 filter
J denotes J sensitization with GG395 filter
V denotes D sensitization with GG495 filter
R denotes F or 098 sensitization with RG630 filter
I denotes N sensitization with RG715 filter

TWO-LETTER prefixes denote other combinations, with the first letter representing the short wave cutoff (i.e. the filter) and the second letter the long wave cutoff (i.e.the emulsion sensitization):

Filter:(first letter)	Emulsion:(second letter)
U, NO filter	
B, GG385	B, O sensitization
J, GG395	J, J sensitization
V, GG495	V, D sensitization
R, RG630	R, F or 098 sensitization
I, RG715	I, N sensitization

Table 4: Plate and filter equivalents for astronomical emulsions

Any combination not covered by the above gets an X prefix.
Examples: J 1234 means a J plate with GG395
BV 1234 means a D plate with GG385
UR 1234 means a red plate with no filter
Hα 1234 means a plate with an Hα interference filter
[OIII] 1234 means a plate with an [OIII] interference filter

2.8 Plate and Sensitizing Card

These are intended to record as much detail as possible about the plate sensitization treatment, the plate exposure and the quality control exercise afterwards.

Examples of the plate and sensitizing card are given in Figs. 5 and 6. The details of the plate card are self explanatory on the whole but the following points should be noted.

1. POSITION in the Top Left Hand corner of the plate card refers to the TELESCOPE position during the exposure i.e. the encoder readouts. It is this portion of the card which is projected on to the plate itself before developing (see section 2.2.6).

2. Details of the emulsion, batch, sensitization and box or tin number can be obtained from the sensitizing card which is attached to the unexposed plate tin by means of a plastic wallet.

3. TELESCOPE POSITION refers to West or East of the pier.
4. The records entitled DISPATCH RECORD, COPY RECORD, and PROCESSING and PLATE GRADE should be left blank. The reverse of the plate card is not for use by the observer.

The sensitizing card will be filled in by the officer responsible for photographic facilities but the observer should record the plate number corresponding to the rack number of the tin from which the plate was taken as he exposes each plate. This allows a check to be made to see if the sensitization depends on the position of the plate in the tin.

2.9 Fiducial Marks

Three small red LEDs are situated in the body of the camera just outside the working aperture. They are designed to put three small locating spots on the plate to indicate if there has been any movement during the exposure. A short exposure is given at the beginning and at the end of the camera exposure . If the images turn out to be non-circular then the plate has moved relative to the plateholder during the exposure. The following table gives the times for which the plate marker LEDs are switched on by the WFC software. The exposures are made in two equal halves, one after the beginning and one before the end of the telescope exposure.

Fiducial Lamp Exposure (mm.ss)

	Filter									
	1	2	3	4	5	6	7	8	9	10
	UG1	GG385	GG395	GG455	GG495	RG630	RG715	5007A	6563A	OWN
098	*	*	*	*	*	*	*	*	*	*
IIaO	*	*	*	*	*	*	*	*	*	*
IIaD	*	*	*	*	*	*	*	*	*	*
IIaE	*	*	*	*	*	*	*	*	*	*
IIIaJ	32.00	32.00	32.00	32.00	32.00	32.00	64.00	98.00	*	0.20
IIIaF	64.00	2.00	2.00	2.00	2.00	2.00	4.00	*	*	*
IVN	99.00	8.00	8.00	8.00	8.00	8.00	8.00	*	*	*

Table 5: Plate location marks: exposure times for various emulsions

2.10 Sensitivity Calibration

A modified Kitt Peak Sensitometer (Schoening 1974, Fig. 7) is used to project a 5 x 5 array of circles whose densities range from clear to 2.28 on to the corner of the plate. The density of each circle for the camera calibrator is as follows:

Spot No.	D	Spot No.	D	Spot No.	D	Spot No.	D	Spot No.	D
0	0.05	1	0.10	2	0.20	3	0.32	4	0.39
5	0.49	6	0.58	7	0.67	8	0.69	9	0.77
10	0.96	11	1.05	12	1.15	13	1.25	14	1.31
15	1.44	16	1.55	17	1.59	18	1.84	19	1.79
20	1.96	21	2.02	22	2.12	23	2.16	24	2.28

Table 6: Spot densities for the Wide Field Camera plate calibrator

where the numbers refer to those given on the back of the plate card (Fig.7).

Again the calibration is divided equally between the beginning and end of the exposure by the WFC software. An aperture wheel is provided to reduce the amount of light passing through the calibrator. The values given are 0.8, 1.6, 2.25, 3.2, 4.5 and 9.5 . The wheel can also be used to cut off the calibration source and preferably should be placed half way between the 0.8 and 1.6 settings to do this. The following exposures have been found suitable for different emulsion/filter combinations and are the ones used by the WFC software.

Calibration Lamp Exposure (mm.ss)

	Filters									
	1	2	3	4	5	6	7	8	9	10
	UG1	GG385	GG395	GG455	GG495	RG630	RG715	5007A	6563A	OWN
098	*	*	*	*	*	*	*	*	*	*
IIaO	*	*	*	*	*	*	*	*	*	*
IIaD	*	*	*	*	*	*	*	*	*	*
IIaE	*	*	*	*	*	*	*	*	*	*
IIIaJ	16.00	8.00	8.00	16.00	32.00	64.00	99.00	*	*	0.30
IIIaF	32.00	2.00	2.00	2.00	4.00	1.00	8.00	*	*	*
IVN	64.00	16.00	16.00	16.00	16.00	16.00	16.00	*	*	*

Table 7: Plate calibration exposure time for various emulsions

For more details contact D H P Jones.

2.11 Visual Guiding

A guiding eyepiece is mounted on a goose-neck which views a part of the field; it has a field of about 1 arc min. and is equipped with double crosswires with red illumination which can be varied with the circular potentiometer on the camera body. In principle a guide star could be found by sweeping across the field with the guider probe but this would be very laborious. It is much better to compute the probe co-ordinates of a suitable guide star in advance (see section 6.2.2). The telescope can be guided visually using the handset but is normally guided automatically with the autoguider. There is a prism which can selectively direct the light either into the autoguider or the eyepiece. The eyepiece is usually confined to making SNAFUs; therafter the autoguider can be used unaided until another SNAFU is necessary.

2.12 Auto-Guiding

An FW 130 image dissector photomultiplier (with S20 response) is used for autoguiding. The tube is housed in a cylindrical body which can be moved longitudinally to make it parfocal with the plateholders. This adjustment is rarely needed and is always done by the LPO staff. The head amplifier and EHT unit are carried in the telescope electronic rack; a photodiode protects the system by closing down the EHT whenever it detects excessive light.

Two rotatable filter wheels compensate for guide stars of differing brightness or colour. Details of the filters are:

A display at the console shows the error signals from the autoguider which are fed to the 3210 drive program. See section ??2.1.2?? for details of operation.

2.13 Polaroid Camera

A 4 x 5 inch Polaroid film back can be mounted on a special bracket 8 cm behind the plane of the knife edge assembly. This records Foucaultgrams and assists in telescope focusing tests. The film back

Filter	Colour	Neutral Density
1	Clear	Clear
2	U (UG1)	0.5
3	J (Wratten 28)	1.0
4	F (RG630)	2.0

Table 8: Available filters for the Wide Field Camera Autoguider

is hinged to allow visual inspection or it may be removed altogether.

2.14 Handsets

- Camera handset controls
  1. Shutter (open = red LED, closed = green LED)
  2. Calibration Lamp (Illuminated when calibration lamp off)
  3. Fiducial lamps (Illuminated when fiducial lamps off)
- Telescope handset controls
  1. Focus (+/−) on top of the handset
  2. RA (+/−) on the face of the handset
  3. Dec(+/−) on the face of the handset both mimic the console buttons for SET, GUIDE and INCREMENT and have rates or increments as set by the User-Interface

2.15 Scout Eyepiece

This is a Ploössl eyepiece of 50 mm focal length giving a magnification of x 160. It is mounted on a plateholder base relative to which it can move in r and θ to cover the whole 90 arc minute diameter field. Its field of view is 15 arc min.

2.16 Meteorological Sensors

The positions of the temperature sensors on the telescope tube are:-

1. Just above the mirror cell on the Serrurier truss
2. At the top end ring
3. At three points around the top surface of the primary mirror spaced 120 degrees apart.

There are three temperature/humidity sensors which can be read from the console mounted respectively, inside the control room, inside the dome and outside the dome in a Stevenson screen. The control room should be maintained at 20 deg.C and 50 per cent humidity by the air conditioning. Any divergence from these values can damage the computers so call the duty technician if such occurs. Dew is prone to form on the optics and steelwork of the telescope at humidities above 90 per cent so observers must close down when this limit is reached.

The wind speed is measured by an anemometer on a mast to the SE of the building. The dome must be closed for wind speeds in excess of 50 km/h. Observers are asked to record the weather on the night report form.

2.17 Operation Under ADAM

This is more fully described in section 3.2

3 PREPARING THE TELESCOPE FOR OBSERVING

3.1 Dry Dark Room (SW corner of observing floor)

This room should contain the plate marking machine, an empty tin to receive the exposed plates and a pair of cotton gloves to wear while handling plates. Your current supply of plates should be kept in the refigerator in the hall during the day and brought up to the dry dark room about two hours before observing to allow them to warm up to working temperature. Ensure an adequate supply of plate cards at the console. It is best to have two working plate-holders in the dry darkroom (preferably numbers three and four) and keep the knife-edge and the box of filters on the rising floor. Two is the minimum number of plateholders for efficient operation; one to expose and one to reload. If you try to use more you will tangle yourself up in logistic complications. The scout eyepiece is only needed for your first SNAFU, for emergencies and for showing the Moon [1] to tourists. It is best kept in a drawer in the dry dark room out of harm's way.

3.2 SNAFU

Set on a bright star and SNAFU, first coarsely using the Scout eyepiece and centering the star by eye. Then set the guide probe co-ordinates to x = 143.1, y = 100.1 and do a more careful SNAFU on the crosswires. If you are familiar with the INPSCF it pays to write down the coefficients PCIH and PCID. These values can be re-entered on subsequent nights thus obviating the need for further SNAFUs.

3.3 Knife edge focus

Knife edge for focus following section 2.2.2 about once a night.

3.4 Instrumentation Computer

Signon to 3210 Instrumentation Computer

SI(GNON) XYZT,n,n where XYZT are the observer's initials and n = 1....8 but keep to one number for the whole of your run.

ADAM

Select f/8 (=2) and WFC (=8)

3.5 Open Dome

If the weather is set fair then open the dome at the time (1800) when inner temperature = outer temperature and adopt a compromise azimuth for the dome which is away from the setting Sun but into the wind. The more nearly equal the inner and outer temperatures are during the night the better your seeing will be. It pays to check the whole building and turn off all unnecessary lights and heaters (except those in the dark-room!).

[1] If you have to show the Moon to tourists don't use the Astronomical Almanac because you will be chagrined to find yourself miles off because of parallax. Use the program MOON on the 3210 (account 60) which gives the topocentric position for mean equinox of date. Even better prepare yourself by running the program [DHPJ.SOLSYS]LUNA on the VAX 8300 which is the same program but with more glamorous cosmetics.

4 OBSERVING

Having started the telescope following the directions in the 'JKT User Guide' and carried out the operations listed in section 2, you are ready to expose a plate.

1. While at the console point the telescope towards the zenith and select the object to observe. Enter its position into the User Interface and start making out a plate card, including emulsion, filter and autoguider x,y.

2. Carry the card with you to the dry dark-room, turn out the lights and load a plate-holder with the appropriate plate and mark its sensitization history on the card.

3. Climb the steel ladder to the rising floor carrying the plate holder and plate card. Load the camera with the appropriate filter having carefully cleaned it with optical tissue. Set the autoguider x,y to the values on the card and clamp the screws. Check the calibration lamp aperture. Load the plate-holder into the camera and check that the LED on the camera handset shines GREEN for shutter closed and that both lamp buttons are illuminated, implying both Calibration and Fiducial lamps are extinguished. Release the locking plunger and withdraw the dark slide. Creep back to the console using your torch as little as possible.

4. At the User Interface type:

   UI> NEXT (source-name)

   UI>GO

   and check that the Dome is not set to 'Manual'.

5. When the telescope comes to rest switch on the autoguider and press FIELD. You will see the small upper square brighten from the left and filling in four seconds to reveal a star somewhere near the middle. If there isn't an obvious star there then you may have done something wrong so go back and check everything. If you still don't see the guide star then perform a square search until it appears. Press ACQUIRE and you will see the star move to the middle of the small square whereupon a small circle will appear in the lower half of the screen. A cross representing the star will step towards the circle and as soon as it lands inside you will get a new display consisting of two bell-shaped curves which are the x,y sections of the star image and the message OK TO GUIDE? Check that neither profile is noticeably double peaked indicative of a double star or excessively noisy, meaning that the guide star is too faint. If the guide star is too bright then the middle of the profile will be cut by numerical overflow. Select a neutral density filter for the autoguider which gives a smooth profile. If you are happy with the guide star you have acquired press GUIDE and you will see a display with a larger (2 arc sec) circle with a cross representing the star stepping about inside (or not very outside) it. You then close the autoguider loop with the green button, miles away from the other autoguider buttons at the right hand side of the middle console bay. You should see the autoguider pull the cross towards the centre of the circle and hold it within the circle for about 90 per cent. of the time.

6. When the autoguider is running nicely turn to the instrument computer screen and type:

   SETUP answer questions giving details of plate

   AGSETUP answer questions giving details of autoguider

   FOR exposure time mm.ss

   EXPOSE which carries out all the operations necessary to

   start an exposure.

7. Fill in as many details on the plate card as you can and enter the plate into the PC log. You now have free time on your hands to watch the autoguider in action. The autoguider should be doing its best to hold the star in the circle. Watch the RT value (Relative Transmission) which should stay within the range 3. to 0.3 unless it is quite cloudy. If the relative transmission drops below about 0.1 the autoguider will cease to guide and the message CLOUDY will appear above RT. The telsecope will continue to free-wheel which it does quite well and no great harm is done because little light is reaching the plate. When the cloud thins the autoguider will happily pick up the star again and carry on. However on rare occasions the autoguider may go berserk and give RT 100. or even a negative number. If this happens type ABORT immediately on the instrument computer or your plate will be ruined.

   After watching the autoguider for a while you will conclude that it is not much more interesting than watching television. This is the time to unload the plateholder of the previous plate and to get prepared for your next plate. If the exposure is longer than about half an hour you can go downstairs and develope such exposed plates as you have accumulated. If you are feeling hungry you can go downstairs and eat your sandwiches but don't eat them in the control room.

8. Half way through the exposure the instrument computer will display the cheerful message:

   Cheer up, you are half way through!

9. At the end you will get some house-keeping messages about the calibration and fiducial lamps, followed by the message that the shutter is closed. Send the telescope to 'Zenith Park' with the button immediately below the user-interface.

10. Pick up the plate card for your next plate and take the already loaded plate-holder from the dry dark room to the observing floor. Remove the old plate from the telescope and mount the new one following the procedure in Section 4. Carry on with the new plate until it is exposing and then return to the dry dark room to unload the previous plate.

11. Mount the plate-holder in the plate marking machine (Fig.4) and insert the plate card face down so that the plate number is opposite the window. Set the timer to the time for the appropriate emulsion. Turn out the lights, release the plunger and withdraw the dark slide. Toggle the switch and the plate number will be transfered to the plate. Close the dark slide and remove the plate-holder from the machine. Open the plateholder and wearing cotton gloves put the plate in to a rack in the tin for exposed plates. For even development the best arrangement of the plates is:

```
6gggggggggggggggggggggggggggggggggggggggggggggggggggg6
 eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee
     5                                           5
4eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee4
 gggggggggggggggggggggggggggggggggggggggggggggggggggg
3gggggggggggggggggggggggggggggggggggggggggggggggggggg3
 eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee
     2                                           2
1eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee1
 gggggggggggggggggggggggggggggggggggggggggggggggggggg
```

   where e and g represent the emulsion and glass sides of the plate. While the racks can hold six plates it is best not to develope more than four together for fear of non-uniform development. Put the plate card next to the tin and take it downstairs when the whole tin goes down for development(section 4).

4.1 WFC ADAM Software

The WFC software has control over the hardware mechanisms – the shutter (open/close), the calibration lamp (on/off) and the fiducial lamp (on/off). The shutter status can be read directly from CAMAC but the lamp status cannot. The lamps can only be commanded to change states. For this reason ADAM assumes that on starting both lamps are off and prompts the user to check that this is true. Thereafter the software attempts to keep a check of status changes internally but commands are available to force a realignment of the real and perceived status following any mishap. The roller blind shutter should not be used for exposures of less than one second although the times of issuing the open and close commands are recorded to millisecond accuracy and correspond to the 'real' shutter open/close time within a hundred milliseconds. The handset buttons 'Calibration' and 'Fiducial' are illuminated irrespective of what commands have been sent by CAMAC and whether the lamps are shining or not. It is only when switching the lamps on/off via the handset that the buttons do/do not light up. However the LEDs (GREEN for Closed and RED for Open) are correct whether the shutter has been operated either from the handset or from CAMAC.

The telescope focus and lamp exposure times all vary depending on the plate-holder/filter/emulsion combination. The known values are kept in a look-up table which is accessible through the command CHANGE. Sample screen outputs from CHANGE are given in Appendix A. Since the plate-holder number and the filter/ emulsion names are kept as ADAM variables the software can look up the appropriate focus offsets and exposure times, as and when it requires them. This is normally done as part of the exposure control procedure but can be done separately with low-level commands. The usual procedure is to turn on the lamps for half the specified exposure immediately after the shutter has been opened and to add the other half just before the shutter closes. If the specified exposure time is less than the nominal lamp exposures then the observer is prompted to decide on alternative strategies.

Although the WFC cannot produce data files as such, dummy files with full descriptor packets are created in order to document the plates. The formation of these files is normally handled automatically within the exposure control procedure. The procedure for writing descriptors can be run separately but it will overwrite all existing information and should be used with care. The information needed for this documentation is retrieved from ADAM, the WFC D-task or the telescope control procedure as appropriate. Any information which must be supplied by the observer is prompted for when the procedures SETUP and AGSETUP are run. However any of the parameters set in SETUP may be specified individually as well as and when they change.

Exposures are controlled by specifying a start time (AT) and an exposure length (FOR) and are then started by the EXPOSE(WFC) command. It is also possible to control the separate functions e.g. shutter operation, status of lamps, packet-writing individually if need be. When using the EXPOSE(WFC) command, exposures can be paused and continued at will. Start and stop times of the first five pauses will be recorded in the descriptor information. Further pauses are allowed for but will not be documented. Details of individual commands are given below. The parts of commands in parentheses are optional for on-line entry but the full commands must be used in a procedure.

Initialization

WFCINIT	will reload and initialize all WFC software

Focus offsets/ Lamp Exposure Times

CHANGE	load/edit the look-up table of focus offsets and exposure times. The offsets are in millimetres (-9.99 $\leq$ offset $\leq$ 99.99; enter -9.99 to indicate an unknown value). The times are in mm.ss format i.e. 3.2 = 3 minutes 20 seconds. When running CHANGE (which is run automatically at startup) a null response will pass on to the next parameter, while entering E(ND) will quit the program altogether.
LC(HANGE)	produces a hardcopy of the lookup-tables by the simple expedient of running CHANGE in 'auto' mode and then printing the relevant part of the ADAM logfile.
KEF xxx	sets the current knife edge focus value to xxx. This is also run within the general SETUP procedure. The telescope focus that will be set before an exposure starts is: (KEF + plateholder offset + filter offset)
WFCFOCUS	will pick up the knife-edge focus, the plateholder and focus offsets and set the telescope focus accordingly. Normally run as part of the exposure control procedure.
GETPHFIL	reads the look-up table and sets the appropriate ADAM variable with the values of the plateholder and focus offsets. Normally run within the exposure control procedure.
GETCFEXP	read the look-up table and load ADAM variables with the appropriate calibration and fiducial lamp exposure times. Normally run as part of the exposure control procedure.
	Note that the last two commands do require that a valid plateholder number, filter and emulsion name have previously been specified.

Information Setup

SETUP	steps through and requests all the information that is needed to control an exposure and to document it fully. (Not including the start and exposure times.
AGSETUP	gathers information for the autoguider documentation.
QSETUP	produces a terminal listing of all SETUP parameters.

Lower level routines allowing variables to be set individually are:

HYPER*	details (up to forty characters) of hypersensitisation (if any) of the emulsion.
EMULSION*	emulsion name (upper/lower case accepted).
FILTER*	Filter Name
FIELD*	Field or Object Name
PH(OLDER)	Plateholder serial number
DIFFRA DIFFDEC	differential track rates(in secs/sec and arcsec/sec in use during the exposure. These are not as yet available over the IPL, and are not included in the global setup procedure.
NEWPLATE	sets the number of the next plate to be used and hence the run number of the next 'data' file to be created. It is normally incremented at the end of the exposure control procedure. The ADAM variable which is actually set is called NEXTPLATE.
CLA	set the calibration lamp aperture
DOMET(EMP)	record the temperature during the exposure.
RHUMID	record the dome relative humidity during the exposure.

*The first four commands (marked with an asterisk) require character variables as input. Thus if the response contains delimiters it must be contained in quotes; e.g.

HYPER "Boiled in Rioja for 2 hours"

If the command line in any of the above procedures is zero (numerical input) or blank (character input) the parameter will be prompted for in which case quotes will not be required for the character input (this is the case when running as part of the general SETUP procedure). If any of the above commands are required in user-defined procedures and a prompt for the input is desired then use a zero or a blank command line parameter e.g.

```
PROCEDURE MYSETUP
KEF 0 ; FILTER " " ; EMULSION " "
END PROCEDURE
```

will ensure that all three pieces of information will be prompted for.

Data File Descriptors

After each exposure a dummy data file is allocated and packet descriptors are written to it. Two packets are included at present; the observation packet which is instrument independent and the WFC detector packet. The packets are normally written at the end of an exposure from within the control procedure but can be written independently using :-

PUTDESC(RIPTORS) n	writes descriptors to EXISTING file. If n=0 descriptors will be written to R(NEXTPLATE) otherwise to R(n). Note that this routine clears all existing descriptors so do not re-use it after having used COMMENT on a file.
COM(MENT) n	will add comments to a data file as extra descriptors. If n=0 they will be added to the last completed exposure file (i.e. R(NEXTPLATE - 1)); otherwise to R(n) - which must already exist. Each line of comment can be up to 40 characters. Because the file must already exist and because PUTDESC overwrites descriptors you cannot use COMMENT to add comments to the current plate file DURING the exposure but must wait until it has finished.

Specification and Control of an exposure

AT hhmmss	specify the start time (UT in hhmmss format). A value of 0 means start as soon as possible; otherwise the shutter will not open until the specified time (accurate to 0.1 secs). The parameter value is retained until explicitly changed and so does not need to be set for each exposure.
FOR mm.ss	specify the required exposure time in mm.ss format(i.e. 3.20 = 3 minutes 20 seconds). Exposures greater than 30 seconds (0.30) will be streamed as background processes. The value is retained until changed and has an upper limit of 300.0 .

EXPO(SEWFC)	collects all the information necessary to control the exposure, sets the telescope focus, switches lamps on and off as necessary and opens the shutter for the requested time; writes descriptors to dummy data file at end.
PAUSE	closes the shutter. The start time for up to five pauses is recorded in the descriptor information.
CONTINUE	open the shutter. The time is recorded as for PAUSE. The exposure time recorded in the descriptors makes due allowance for any pauses during the exposure.

There are several lower level commands relevant to exposure control.
These are:-

OPEN	open the shutter and leave it open.
OPENFOR mm.ss	open the shutter, wait for mm.ss and then close it.
CLOSE	close the shutter.
CALON) CALOFF) FIDON) FIDOFF)	switch on/off the calibration/fiducial lamps.
CALFOR mm.ss) FIDFOR mm.ss)	turn the calibration/fiducial lamps on for the specified time.

Information
A number of commands are provided to establish the state of play:-

QSETUP	produces a list on the terminal of the SETUP parameters supplied by the observer.
?ALL	reports the status of the shutter, lamps and exposure (if in progress).

?FIDUCIAL	reports status of fiducial lamp.
?CAL(IB)	reports status of calibration lamp
?SH(UTTER)	reports status of shutter
?TOGO	if an exposure is in progress it will tell you how much time remains
?EXP	reports the exposure times that are currently set for the lamps and shutter

As mentioned earlier there is no HARDWARE manner for ADAM to know the status of the lamps. If the true status (as defined by eye) gets out of step with the ADAM status (usually as a result of an exposure failing or some other software error) then a realignment can be forced by the following procedures:-

CALISON) CALISOFF) FIDISON) FIDISOFF)	force ADAM to think that the fiducial/calibration lamps are on/off.

Focus Runs

A clone of the CCD focus procedure is provided. It runs with the command:

FOCUS	performs a complete focus run. The number of exposures, the exposure time and the telescope step direction will be prompted for. Exposure times are specified in SECONDS and should be¡60. A double telescope step is made before the last exposure.

Associated commands are:

STEPSIZE xxx	sets the telescope step size (used in FOCUS) to xxx arcseconds. Default = 20.
FOCINC xxx	sets the focus increment (used in FOCUS) to xxx mm. Must only be specified to TWO decimal places, no more.
SETFOCUS xxx	sets the telescope focus to value xxx by a message sent on the IPL (inter-processor link between the PE 3210 (ICS) and the PE 3220 (TCS))

5 PLATE PROCESSING

5.1 Introduction

There are three dark-rooms in the JKT dome. First is the dry dark-room at the SW corner of the observing floor. Second is the chemical and mixing room off the hall on the office floor and next to it and third is the plate processing darkroom. Fig. 8 shows the layout of these rooms. Adequate amounts of chemicals in the recommended concentrations will be prepared for all observing runs with the Wide Field Camera and Richardson Brearley spectrograph. Check with your support astronomer that this will be done shortly before your run. Fig 9 shows the layout of the plate processing plant. The four tanks (DEV - F2) are immersed in a bath of water which is maintained at 20 deg.C by means of a Churchill circulator. It takes about two hours for fresh tap water (at 7 deg.C) to be heated to the necessary temperature and a little longer for the chemicals in the tanks to reach 20 deg. In most cases Kodak chemicals and emulsions are used. The procedure is as follows:

5.2 Preparation before observing

1. Check that the darkrooms are adequately warm (at least 18 deg.C) and that the bath temperature is 20 deg.C. The temperature of the darkroom can be adjusted empirically by adjusting the controls on the two wall heaters. The indicator on the Churchill should be set to about 22 deg.C to allow for losses in the tubing when the bath water is being pumped around.

2. Start the Elga de-ionizing plant from the button on the far wall beneath the water pressure gauges. Full details of the Elga are given in an appendix. The valve is set so that the water does not overflow the outer tank in the water bath, and should not need adjusting.

3. The nitrogen is supplied from the site network. Set up the length of the nitrogen bubble burst required and the interval between bursts. The recommended times are 3 secs and twenty secs. which are marked against the controls. The switches marked V1 controls the Nitrogen to the developer and stop-bath tanks and V2 the two fixer tanks. The flow can be controlled independently in each tank using the yellow-handled valves. Turn off the Nitrogen to each tank when you have finished with it.

5.3 Preparation before developing

1. Fill the wash tanks W1 and W2 and allow a continuous flow of water through them. This must be slow, especially in winter to allow the wash to reach the 20 deg.C temperature of the processing bath. If it is too slow you won't wash all the impurities out of the emulsion and if its too fast you risk reticulating the emulsion through thermal shock in the cold water.

2. Set the clock timer to five minutes by turning the hands on the clock face to this value with the knurled head in the middle. Controls on the side of the clock allow a buzzer to be activated at the end of the exposure if required and also to run in the increasing direction instead of decreasing. The clock is started by pressing the button on the top left of the body and on the top right. To prevent the luminous dial fogging the plates its face has been covered except for the first quadrant (15 minutes or seconds).

3. Switch off all safelights and ensure that all indicator lights on the Churchill cooler and other equipment are adequately shielded.

4. Check that the 25x20 cm WFC plates have been identified in one corner by using the plate marker in the following manner.

(a) Insert the plate card so that the corner showing the plate number is over the hole in the plate and then close the flap.

(b) Set the timer to about two seconds and ensure that the range is on its lowest value. The exact value depends on the emulsion and is given in Table...

(c) Place the plateholder on the right hand part of the plate marker

(d) Pull the plate-holder dark slide

(e) Toggle the switch.

(f) Replace the dark slides and remove the plateholder

5.4 Processing Plates from the Wide Field Camera

1. Start the nitrogen bubble burst in the developing tank. Remove the plate rack from the exposed plates tin and quickly place in the developing tank to coincide as closely as possible with a nitrogen burst.

2. Start the clock. The development time for Kodak emulsions is five minutes at 20 deg.C in D-19 developer; see Fig 10 for development times at different temperatures.

3. At the end of five minutes, take the plate rack out of the tank and allow the excess developer to drip back in to the tank for 15 seconds.

4. Start the nitrogen burst in the stop-bath tank and immerse the plate rack in it for 1 m 45 secs. Close the valve on the development tank while this is happening.

5. Remove the tank from the stop-bath and hold it over the tank for 15 seconds to drain

6. Start the Nitrogen burst in tank F1 (first fixer) and immerse the plate rack for two minutes (KODAK III emulsions) or four minutes (KODAK II emulsions). Close the valve on the stop-bath tank.

7. Reset the clock for the required period, start the Nitrogen in tank F2 and immerse the plate rack in this tank for the same time as Fix 1. At this stage a red safelight (ISO906) may be used on 'blue' emulsions i.e. IIaO, IIIaJ to check that the plates have cleared. At the end of the period, the white light above the processor may be switched on. Check that all Nitrogen bubble burst valves have been switched off.

8. Remove the plate rack from F2, allowing excess fixer to drip back into the tank and immerse it in the wash, W1 and open the tap so that there is a perceptible trickle of running water. At the same time start the elga de-ionising plant running.

9. After 30 mins transfer the plates to the de-ionised wash. The lower meter will drop to zero after about ten seconds and will then slowly increase. When it reachs 1. remove the plates from the de-ionized tank.

10. Remove the plate rack and allow it to drain before placing it in the Slee plate drier. Transfer the plates into one of the plastic racks and allow to dry. This usually takes an hour or more. Don't use the fans in the plate-drier.

At least once a week the water bath for the tank line should be drained and refilled. The drain cock is a red valve beneath the sink.

5.5 Development in the plate-rocker tank.

1. Plug the plate-rocker into its dark-room clock and the dark-room clock into the mains. Place the footswitch on the floor. Set the speed to 5.5 on the scale.

2. Lay out two photographic dishes about one-metre square on the sinks to the left of the tank line. In the left hand one put 4-litres of Kodak indicator stop bath. Into the right put four litres of working strength Ilford Hypam fixer.

3. Pour 1200 mlitres of D-19 developer into the Rocker- Tank and ensure that the lid and a developing rack are conveniently to hand.

4. If the room temperature is 20 deg C set the clock to 5 min 15 sec; the 5 min is for development and the 15 sec for handling. If the temperature is not 20 deg C adjust the 5 min accordingly. Push the left hand 'start' button the clock. This will have no immediate effect. Put a cardboard box in front of the clock because it is bright enough to fog a plate.

5. In darkness transfer a plate from the storage tin to the developing rack and clip it in emulsion up. Do this with great care or you will chip or even break the plate. Securely replace the lid of the tin. Push the developing rack a few centimetres down into the rocker tank.

6. Start the rocker tank with the foot-switch and follow the rotation of the tank with your hands on the developing rack handles. As you feel it dip to maximum inclination firmly push the developing rack all the way down. As the tank returns to the horizontal it will send a uniform wave smoothly over the emulsion. Place the lid on the rocker tank.

7. Towards the end of the development time watch the clock until there is only fifteen seconds to go. Remove the rocker tank lid and locate the handles of the developing rack. When the tank stops promptly remove the rack from the tank and raise it near to the vertical so that all excess developer drains back in to the tank. The object is to stop development quickly and uniformly.

8. Transfer the rack to the stop bath. Insert the developer rack into the stop bath and promptly raise one side out again to an angle of about 15 degrees. Then reverse the process so that the other side of the rack is free of the stop bath. Repeat this process at approximately one second intervals for thirty seconds. The objective is to get smooth waves of fresh stop bath running over the emulsion and stopping the development uniformly.

9. After the violent stage of the stop bath leave the plate a further 90 seconds there as timed by the clock over the tank line. Gentle agitation is sufficient at this stage.

10. Remove the plate rack from the stop-bath and allow all excess fluid to drain back. Transfer to the fixer dish and agitate gently for two minutes (Kodak III emulsions) or four minutes (Kodak II emulsions) as timed by the clock.

11. At the end of the first fix switch on the red safe light at the top left of the tank line. Don't worry if the plate looks black; they always do at this stage. Unclip the plate from the developing rack and place it in a stainless steel rack from the bubble-burst line and place both in Fix 1 of the bubble burst line.

12. Put the now empty developing rack in the sink at the right hand end of the bubble-burst line. There are three developing racks and it is usual to develope three plates one after another in the rocker tank. After three the developer is discarded.

13. Develope the next two plates in exactly the same way and store them in Fix 1. Then transfer them to Fix 2 and give them two minutes bubble burst (III emulsions) or four minutes (II emulsions). Complete the processing as for the bubble burst line.

14. Pour the developer away and wash up the tank and three racks. Leave them to drain ready for the next campaign.

5.6 Elga De-ioniser

A schematic diagram of this unit is given in Fig 11. The procedure is as follows:

1. Check that the green stopcock (G) on the process unit is on.
2. Press the button on the side of the control panel for 'on'.
3. Check that the de-ionised water flow on the 'out' meter reads about 20 MΩ. If it does not, the cartridge SCI needs to be replaced. Report this to the duty tech or your support astronomer.
4. The return flow resistivity will increase slowly to 3 MΩs but drop quickly when the plate rack is immersed in the plate washing tank.
5. The inlet and outlet filter valves should read about 40 psi. If they differ by more than 20 psi the Gelman filter needs to be changed. Report this as above.
6. To switch off, it is necessary only to press the on/off button on the control panel. No other action is necessary.

6 PLATE BAKING

1. The baking oven (strictly speaking a Gallenkamp incubator) is kept continuously running in the Chemical Mix room, the second dark room. It has been carefully set to run at 65 deg C; if you find it running at another temperature take some pains to get it running accurately at 65 C. Place an empty tin containing two developing racks in the oven and leave an hour to reach working temperature.
2. Remove a box of the emulsion you plan to bake from the deep-freeze in the basement and place in the darkroom to warm up for an hour.
3. Don cotton gloves to remove the baking tin from the oven and carry in to the darkroom. In darkness open the packet of plates and carefully load them into the developing racks and in to the box so that all emulsions are towards the label. Replace the lid of the box securely.
4. Wearing cotton gloves return the tin to the oven and link it to the forming gas supply. Go to the basement and turn on the Forming Gas bottle with the tap on the top. Adjust the pressure to one bar and note the amount of gas in the bottle.
5. Return to the chemical mix room and open the inlet valve so that about 8 litres a minute is flowing. Check that something is coming through the outlet but the amount is not important.
6. Make out the plate baking log and mark off the plates removed from the deep freeze in the plate stock book.
7. Conventional baking times at 65C are two hours for IIIaF and two and a half hours for IIIaJ. At the end of this period turn off the bottle in the basement and note its contents for the baking log.
8. Return to the chemical mix room and turn off the inlet valve. Open the outer door to the oven and read the right-angled thermometer through the glass. Note this value for the baking log.
9. Wearing cotton gloves remove the tin from the gas supply and remove from the oven to cool. Make out a record card of the baking and place in the wallet at the front of the box.

7 SUPPORTING FACILITIES

Many of the following facilities are housed in the Chart Room. This can be found directly opposite the lift door on the second floor of the INT Building. The Chart Room houses the collection of Sky Survey films and prints, the Coradograph measuring machine and a Polaroid camera and light table for making reproductions of plates and films for observing purposes. There is also a Pericom terminal linked to the VAX 8300 and a Canon LBP-8II Laserprinter.

7.1 Photographic

7.2 Finding charts

A Polaroid camera is available for making finding charts from Schmidt plates and films. Instructions on how to use the camera are given beside it. Supplies of Polaroid film are kept in the metal drawers of the light table on which the camera is attached. Contact D.H.P.Jones if you run out. Remember that Polaroid film costs about 1.50 per sheet!

7.3 Guide stars

Although it is possible to find guide stars at the telescope using an eyepiece as described in Section , this is a very inefficient use of observing time and probe positions should always be computed in advance. Guide stars in the combined astrometric catalogue (AGK3/SAO) may be found using the CHART program on a Starlink VAX (or on the VAX 8300 in the WHT building). CHART should be run in either ASTRO or CSI mode with a field size of 1.5 degrees. The program RGVAD::SYS$SYSDEVICE:[LPINFO.HELP]JKTGS.EXE selects reachable guide stars from the OUTPUT.LIS file produced by CHART for any rotator angle with the telescope east or west of the pier. If there are no reachable guide stars in the catalogue, positions of candidate stars may be input at the terminal. The program producces (x,y) probe positions and the relevant position angle for any accessible guide stars.

7.4 Plate measurement

There is a Coradograph x-y measuring machine available in the Chart Room. It is in the process of being digitised but can be used with the existing vernier microscopes to produce x-y coordinates of any size of plate or film.

7.5 Schmidt prints and films

These are housed in cupboards in the Chart Room. They consist of the Palomar Sky Survey on paper down to -30 degrees, the SERC 'J' Survey, the SERC I/R survey and the ESO 'Quick Blue' Survey. The Palomar set is complete but additions are still being received to the other surveys mentioned. These are freely available to all but please take care when using them. In particular the Palomar prints come packaged with the corresponding Ohio overlay and these should be carefully replaced when no longer needed. Please take care to ensure that prints and films are replaced in the correct order in the cupboard. A misfiled film is as good as a lost film!

8 APPENDIX

8.1 Plateholder and Filter Offsets

8.2 Example of FITS packet

9 BIBLIOGRAPHY

This is not meant to be a complete list of all references to astronomical photography but concentrates mainly on those topics which bear heavily on photography with the JKT Wide Field Camera. Most of the references are less than 10 years old and many come from the late, lamented publication Photo-bulletins of the American Astronomical Society . Efforts are being made to complete the collection of this journal being held in the John Whelan Library in the INT Building. The basis of this set of references is 'A Manual of Advanced Celestial Photography' by Brad D.Wallis and Robert W.Provin (Cambridge University Press, 1988). Other useful reference works are 'Astronomical Photography' edited by M.E.Sim and K.Ishida. This contains the proceedings of a meeting at Edinburgh in 1984 and copies can be obtained from the Royal Observatory, Edinburgh. Papers containing useful descriptions of hypersensitising techniques can be found in various copies of Photographic Science and Engineering.

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Figure 1: The Wide Field Camera and its constituent parts

Figure 2: Schematic Optical Diagram of the wide Field Camera

Figure 3:

Figure 4: The plate marking machine

Figure 5: The plate card

Figure 6: The sensitising card

Figure 7: The Kitt Peak Sensitometer

Figure 8: A ground plan of the JKT Photographic Suite

Figure 9: The layout of the Plate Processing Plant

Figure 10: Development times versus temperature Kodak Emulsions

Figure 11: The Elga deionising plant