ACE Control System
SARA NORTH 0.9-m Observatory
User's Manual

Created for:

SARA Consortium

Created By:

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CHANGE RECORD

Version	Date	Affected Sections	Reason/initiation/remarks
11.1	2011 Jan 20	N/A	**Initial Release**

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1.0 INTRODUCTION

1.1 PURPOSE

This User's Manual gives details of the ACE Observatory Control System. The information contained herein is proprietary and the intellectual property of Astronomical Consultants & Equipment, Inc. (A.C.E.) and was produced entirely at private expense without public funding. Nothing in this manual is to be considered as "public domain".

This manual is a primer for the daily operating procedures of the telescope, instruments and dome. New observers should spend at least an evening with a faculty member of staff to learn the system. This manual is not intended to be a substitute for this requirement!

1.2 OVERVIEW

The SARA North Observatory is the re-birth of the one of the 36-inch KPNO telescopes, originally located where the WIYN 3.5m telescope now stands. The mount from that telescope and the optical tube assembly from the other 36-inch B&C telescope were combined to create the SARA North observatory at Mercedes Peak, one of the high points on Kitt Peak. Inaugurated in 1995 this Boller & Chivens telescope has been operated by the SARA consortium. The telescope and observatory have undergone several major renovations, all by ACE Inc.

The telescope is an off-axis torque-tube mount, which is constrained to sit the Optical Tube Assembly on the EAST side of the mount.

The telescope is equipped with a dual filter wheel, containing 24 slots with 2-inch square filters. A total of 22 filters are available, the first position in each wheel being left empty. An autoguider, mounted on an X-Stage, permits stars to be found to the east and west of the main field.

The ASH dome is fully automated with an ACE SmartDome™ system that operates both doors. The dome is capable of closing by itself if there is a system failure.

The camera is controlled through the ACE Observatory Control System. It currently communicates with MaxIm-DL.

A 12 megapixel all-sky camera produces color images every 30 seconds showing details in the Milky Way. Other auxiliary equipment, including daytime color video cameras, weather station and remotely controllable power outlets permit complete control and servicing of the system both onsite and remotely.

There is no "night assistant" available for this facility. It is intended to be run unattended by an experienced observational astronomer. It is not recommended to operate this facility on those nights that experience marginal weathers conditions, especially when rain or snow is predicted within the next 12 hours.

1.3 ACRONYMS

A list of acronyms are presented in Table 1-1.

TABLE 1-1 ACRONYMS

ACE	Astronomical Consultants & Equipment, Inc.
B&C	Boller & Chivens (the original telescope manufacturer)
KPNO	Kitt Peak National Observatory
NOAO	National Optical Astronomical Observatory
NSF	National Science Foundation
PDU	Power Distribution Unit
SDSS	Sloan Digital Sky Survey
VPN	Virtual Private Network

1.4 QUICK VIRTUAL TOUR

The Boller & Chivens telescope is an equatorial torque tube mount. The instrument can swing past the mount when pointing at the North celestial pole.

The telescope tube sits on the EAST side of the mount. It is capable of moving to large hour angles (unlike the classical German mount). However, at this time movement is restricted because of external cables (see **Error! Reference source not found.**). It is *not* possible to polar-reverse the telescope

The telescope is equipped with a 120mm f/9 achromatic air-spaced doublet finder. It can be used for eyepiece viewing.

The dome is a wide slit with two shutter doors. The main door goes "up and over" and the dropout door hinges down to reveal the horizon. The dome has power slip rings so it can be opened and closed at any azimuth. It is also equipped with a real-time rain detector.

A set of video cameras gives remote observer key views of the facility. They are accessed from the Observatory computer or from your own computer.

The equipment is all housed in a control cabinet located in the basement on the north wall of the pier. Four computer monitors are located in the basement. It is important for on-site observers to turn these off before leaving to prevent light pollution. (They cannot be turned off by remote users).

There is a wireless weather station and an all sky camera located on a tower to the North East side of the observatory.

The wind speed at the site varies dramatically. We have lost the weather vanes twice in excessive wind speeds over 200 km/hr. The seeing is almost always poor and bad weather can rapidly close in when the wind is from the SOUTH- EAST to EAST.

Unlike the SARA South facility this observatory does *not* have a generator backup for coping with long power outages. The telescope is on a 115 VAC 3kw UPS and the dome is on a 240 VAC 3kW UPS. Power glitches are fairly common, several times a month, but should be unnoticeable to the remote observer. However, long power outages are a concern. The batteries slowly drain down and the system becomes inoperable if the power is lost for more than about 30 minutes.

1.5 PLANNING YOUR OBSERVATIONS

The SARA North observatory is located at Kitt Peak National Observatory, Arizona. On site observers cannot just turn up un-announced! Permission must be granted for each visit to the observatory.

Sometimes there are tour groups being shown inside the observatory. It is advised to be cautious and to look at the dome video camera to make sure there are no people near the telescope before any operation.

The following information will help you when planning your observations:

Table 1-2 Observatory Parameters	
Time Zone	UTC -7
Longitude	WEST 111 DEG 35 MIN 59.4 SEC
Latitude	NORTH 31 DEG 57 MIN 36.0 SEC
Elevation	2133 METERS
Altitude Limit	10 DEG
North Limit	+89 DEG
South Limit	-40 DEG

The telescope will become out of bounds when one or more of the limits are reached. The software will not permit slews outside of the observing boundaries. If you need to observe between 89 degrees and the north celestial pole please contact ACE so that this region can be opened up. It is normally closed to prevent accidental reversal of the telescope by using the local hand paddle or by using telescope offsets.

Error! Reference source not found. lists the permissible motion east and west as a function of declination. Use this Telescope Horizon Map when planning your observations. This map is implemented inside the telescope control software and the system checks in real time to make sure the telescope is above this horizon.

Please note that Arizona does not observe daylight savings time. Technical support (when things go wrong) is available from ACE through 22h00 most nights. Basic training is not provided by ACE. New observers must spend time with a seasoned observer to learn the system. Contact the Observatory Director for more information.

Telescope Optics

This B&C Telescope has only secondary mirror, giving an effective focal ratio of f/7.5.

The original optical diagram is shown in Figure 1-1. The key relevant parameters are translated into metric units in Table 1-3 from the original inch measurements shown in Figure 1-1.

TABLE 1-3 OPTICAL PARAMETERS

Primary		
	Diameter (Clear Aperture)	914 mm
	Focal Length	6858 mm
	f/ratio	3.27
Secondary		
	Diameter (Clear Aperture)	355 mm
	Prime focus intercept	1156 ± 12.7 mm
System		
	Effective f/ratio	7.5
	Primary-Secondary spacing	1972 mm
	Effective Focal Length	6858 mm
	Field diameter	102 mm (48 arc min)
	Plate Scale	28.3 Arc seconds / mm
	Mounting flange to focal plane	372.9 mm

The optical quality of the SARA North facility is not as good as the SARA South facility. The system is capable of delivering images of around 2 arc seconds on most good nights.

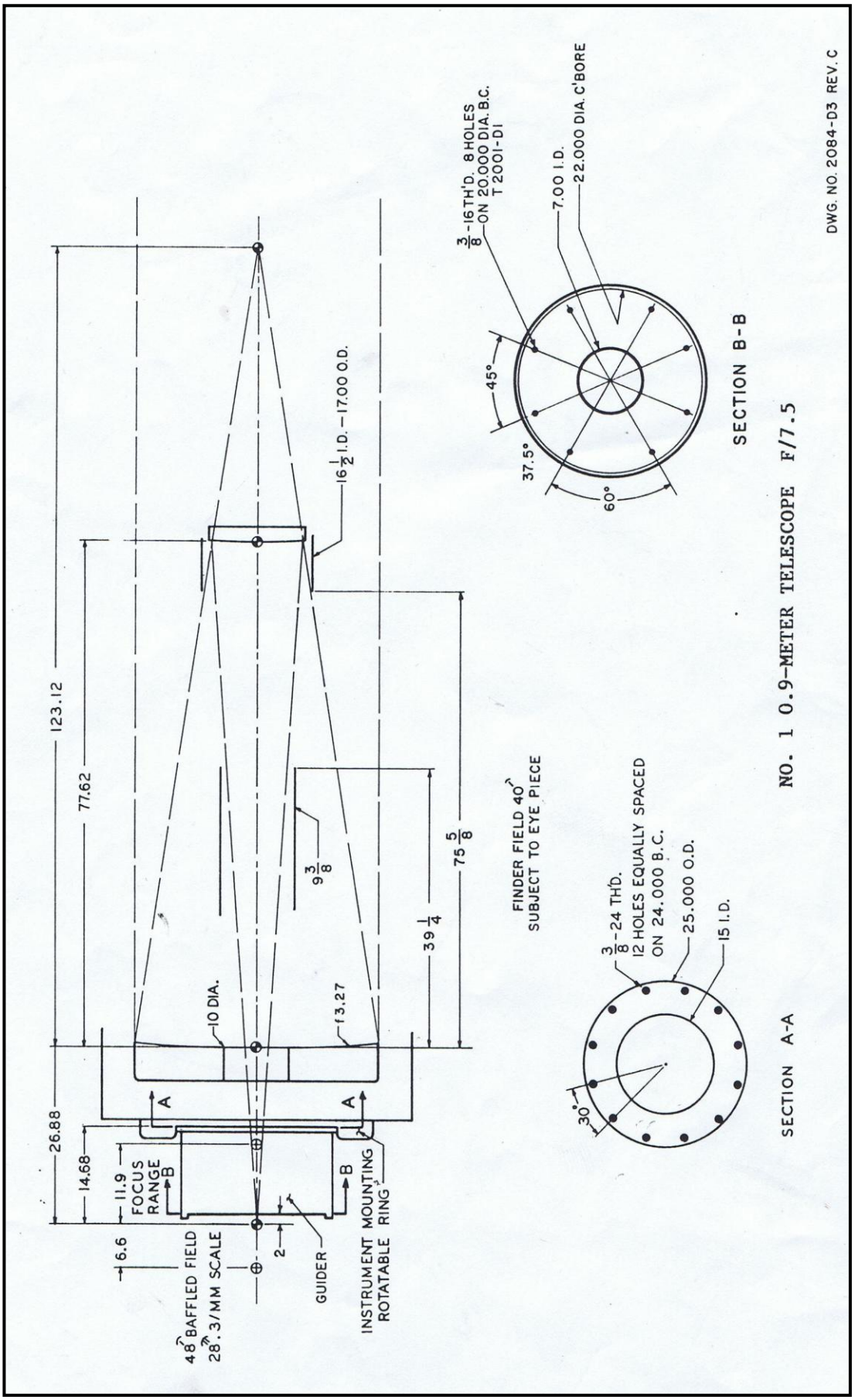


FIGURE 1-1 TELESCOPE OPTICAL DIAGRAM

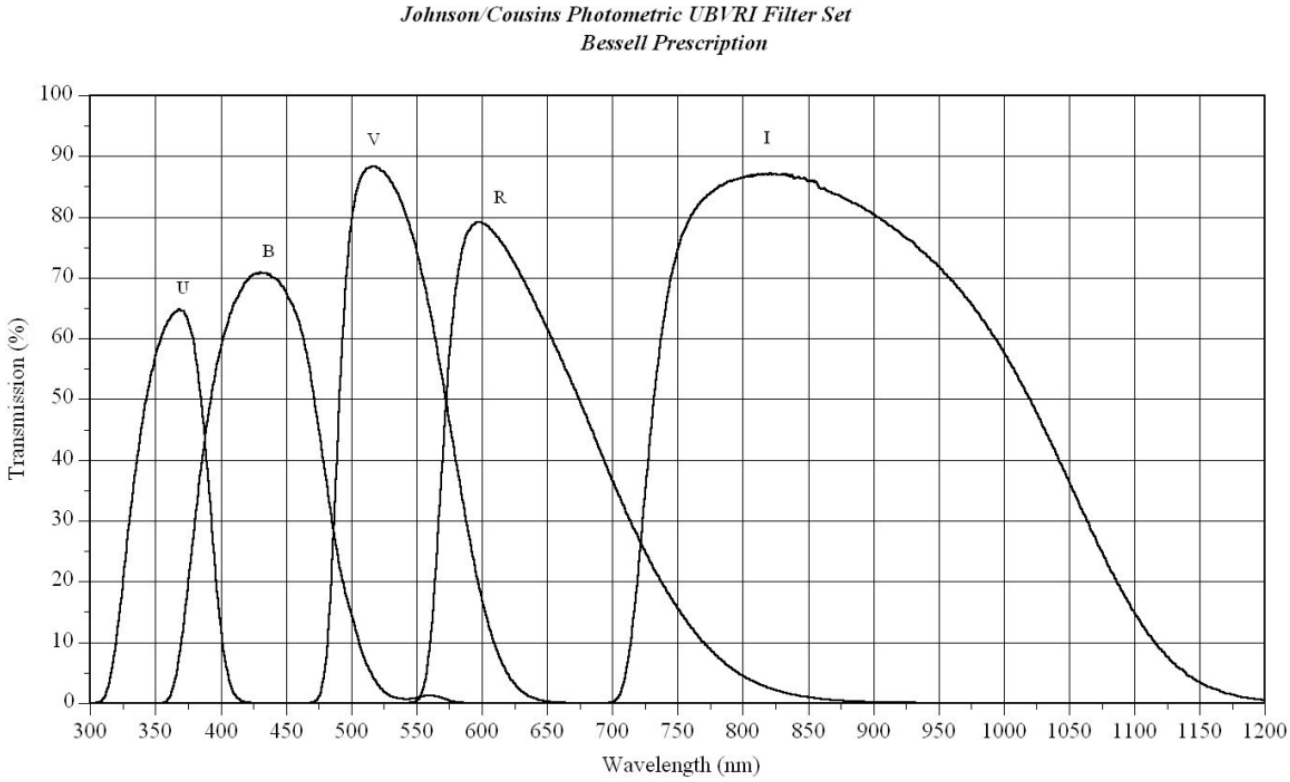
1.6 FILTERS

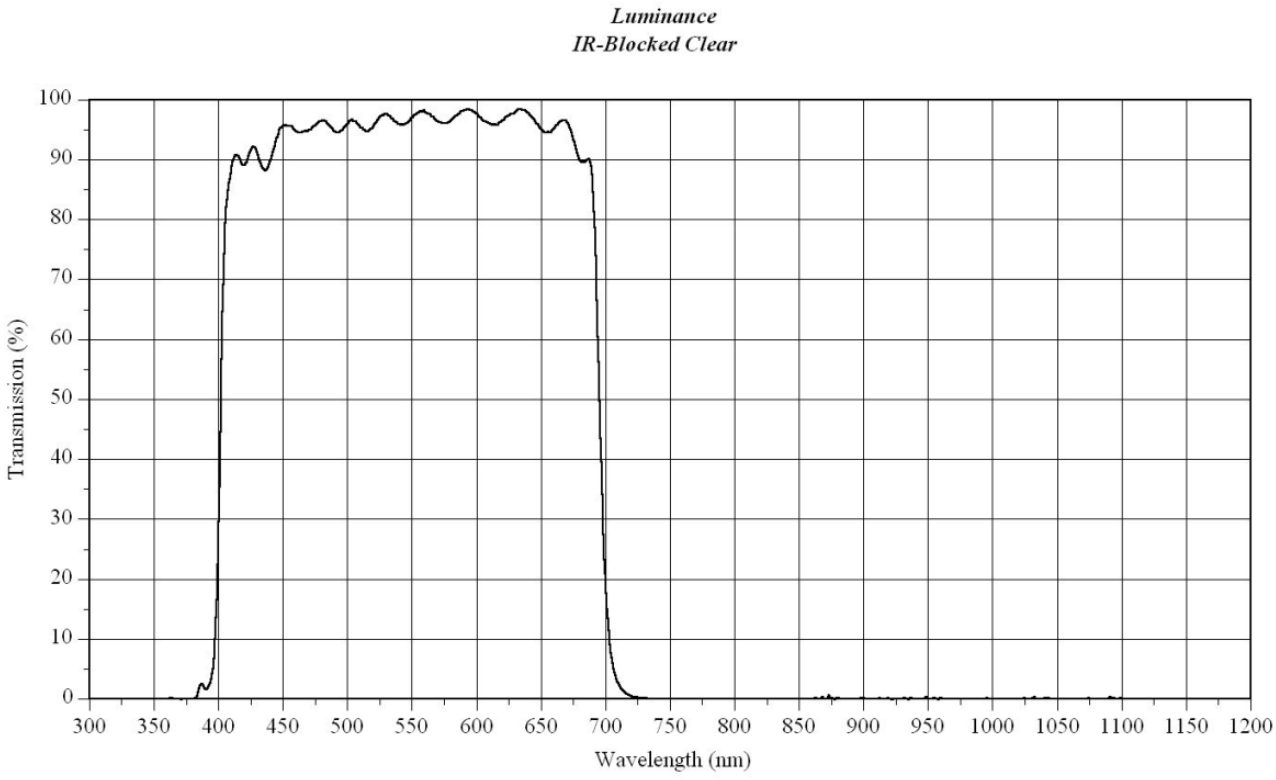
The following filter are normally available. Currently one slot (Wheel #1, Slot #11) is available for another filter. Any additional filters will require additional filter jackets, available from ACE. Note that the filter wheel has slots engraved from ZERO through 11.

Table 1-4 Available Filters

SLOT	WHEEL #1	WHEEL #2
0	EMPTY	EMPTY
1	IR-BLOCKING	ND2
2	Bessell B	U
3	Bessell V	B
4	Bessell R	V
5	Bessell I	R
6	H-BETA	I
7	476/10 BC	657 / 7
8	H ALPHA	659 / 7
9	645 / 10 RC	664 / 7
10	683 / 13 CaH	671 / 7
11	EMPTY	510 / 10 GC

1.6.1 Filter Transmission Curves





1.7 DETECTORS.

The telescope is equipped with 2 cameras.

Location	Camera	Array (pixels)	Field (arcmin)
f/13.5 Cassegrain	Alta-E6-1105	1024x1024	9.5 x 9.5
Guider Port	SBIG	510 x 765	

It is important to put the cameras back in the same orientation, should they be removed for any reason.

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1.8 FAILURES AND EMERGENCIES

There is no on-site staff available for you to contact. Do not use this facility when precipitation is predicted within 12 hours or if conditions are marginal. Internet failures are common and the outages have been known to last for half a day or more when cables are severed.

Emergencies are categorized as situations like the dome being unable to close after an earthquake, as opposed to a camera being inoperable. If a piece of equipment fails in the night it will be at least the next day before it can be seen to. Observers should report non-critical equipment failures in the usual manner and a response team will see to getting things back to normal.

Contact ACE during normal business hours if there is a non-critical equipment failure. For the SARA North facility *technical* support is available until 22h00 MST. Technical support is for when things malfunction. It is not a service for basic training, weather reports, etc.

More information about contacts can be found at http://www.saraobservatory.org/sarans.html

In the event of a true emergency contact ACE 24x7.

Table 1-5 Emergency Contact Information	
From within USA	
520 219 8722	ACE Office / Peter's home
520 979 0101	Peter's Cell Phone

For general technical support either use the SARA-N Nightly Report or send requests to support@astronomical.com which is automatically distributed to all technical staff at ACE. Please do not send support request to individual email addresses at ACE.

2.0 COMPUTERS

2.1 ACCESS TO THE OBSERVATORY

The SARA observatories computer system is a part of the NOAO network. Please bear in mind that the privilege to access the system comes with the responsibility to use it properly and keep the NOAO network safe. As NOAO is considered a large research facility by the NSF all users of the north or south networks are required to follow the NOAO Cyber security and Acceptable Use Policy. Please refer to and agree to follow the policies and guidelines in the document found at:

http://www.noao.edu/cis/secbasics/cybersec/cybersecurity_and_acceptableuse.html

The SARA North Observatory can be accessed via RADMIN software. This is discussed clearly in the later chapters.

Finally, one more important responsibility. The computers at the observatory should not be treated simply as another desktop computer. Rather, think of them as dedicated control computers designed for a specific task, like moving the telescope. Therefore, do not download and install any software on these computers. The only files that should be created are your own CCD images and telescope catalog files.

Do not update any system files, windows updates, etc. This will be done on a regular basis by the System Engineer.

2.2 NETWORK OVERVIEW

The control system utilizes four computers, one called "*TELSECOPE"*, one called "*CAMERA"*, one called "*OBSERVATORY*" and the last one called *"WEATHER"*.

Various additional devices are controllable over the network including a switchable power outlet racks and an 8-channel video switcher

Under normal circumstances these devices are all left powered on all the time and protected from surges and power outage by a UPS system.

2.3 REMOTE CONNECTIONS

Unlike SARA South, the network can be connected to directly with RADMIN.

2.3.1 Remote Administrator using Windows®

Remote Administrator viewer is available free of charge at www.radmin.com. It is designed for the windows platform but it is much faster than real VNC and is able to perform remote shutdown, file transfer, chat tool and remote access.

The user name is `SARA` and the password is `Flam1ng0x10`. (Substitute one for i and zero for o)

The port selection is as follows:

TABLE 2-1 RADMIN PORT ASSIGNMENTS

Computer	IP Address	Port Address
SARATEL	140.252.85.83	4899
SARAOBS	140.252.85.89	4899
SARACCD	140.252.85.85	4899
SARAWX	140.252.85.86	4899

For the system to work efficiently the screen resolution of your computer must be equal or greater than the (1600 x 900) setting of the remote computer otherwise the screen will pan and scroll all the time making the experience very slow and frustrating. To avoid this problem right mouse click on the connection icon and select Properties from the pop-up menu (Figure 2-1). Select Full screen from the Video Mode. You can dramatically speed up the connection by reducing the amount of color. For normal use 8 bits is fine. It even works with 1 bit although the screen looks odd!

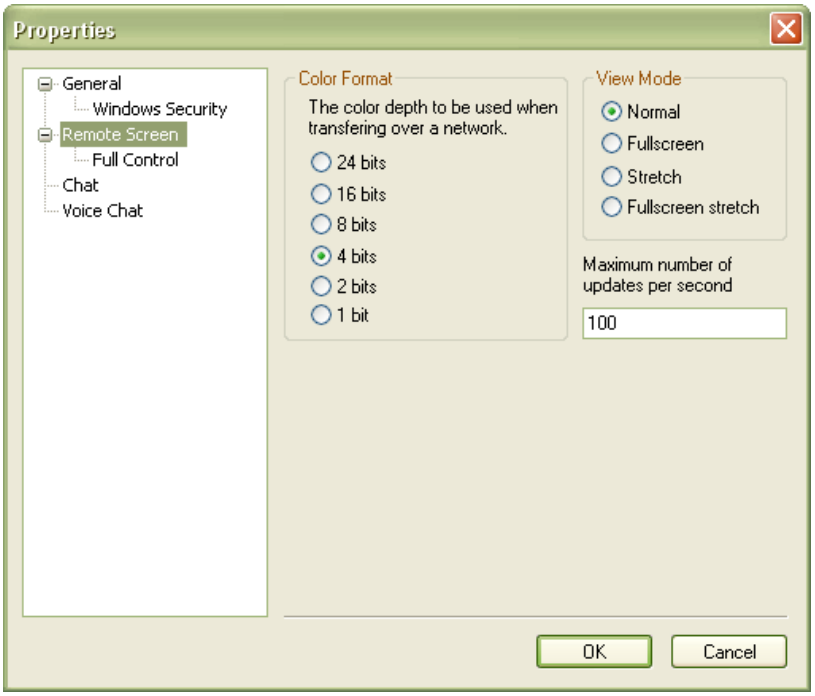


FIGURE 2-1RADMIN REMOTE SCREEN PROPERTIES

2.3.2 Remote Administrator using a Mac

Here are some notes for Mac Users. We have tried this approach on a Mac in our office; we do not provide support for this feature but these notes may be helpful.

You can install Wine on the Mac (for Intel only) using Wine Bottler:
http://winebottler.kronenberg.org/ This will allow you to run Windows programs on a Mac.

To use Wine, you will need the X server. There's a copy included on the Mac OS install CD / DVD. There are instructions at http://macsingularity.org/x11/.

All you have to do then is download and run the Radmin Viewer installer. It installs fine to a location you specify when installing WineBottler -- the default is "~/Wine Files/" -- just navigate to "~/ Wine Files/drive_c/Program Files/Radmin Viewer 3" and launch Radmin.exe.

2.3.3 Real VNC

Real VNC can also be used to connect remotely. The viewer is available free of charge at www.realvnc.com. This works from any platform (choose the correct operating system for your remote computer). However, it does not allow for a chat tool and file transfer, and it is not as fast as Radmin.

TABLE 2-2 REAL VNC PORT ASSIGNMENTS

Computer	IP Address	Port Address
SARATEL	140.252.85.83	5900
SARAOBS	140.252.85.89	5900
SARACCD	140.252.85.85	5900
SARAWX	140.252.85.86	5900

2.4 APC SWITCHED RACK PDU

The Switch Rack PDU (Power Distribution Unit) is a networkable device with eight power outlets. It is possible to turn on/off and reboot each individual outlet or a set of outlets. Choosing the control action "*Reboot Immediate*" will turn off a given device for a pre-determined number of seconds and then turn it back on again. The longest reboot cycle to turning back on is set at 25 seconds.

There is only one PDU in the system with the following assignments:

TABLE 2-3 SWITCHED RACK PDU ASSIGNMENTS

Outlet #	Rack #1 http://140.252.85.90
1	Camera/Instrument/Icron
2	Telescope Computer
3	CCD Computer
4	All Sky Computer
5	Weather Computer
6	Always OFF for Dome ON
7	All Sky Camera
8	Focus Power/Video Switcher

To access the Switched Rack PDU use a web browser and enter the address shown above. Alternatively, from one of the SARA computers use internet explorer to find the device from the favorites list.

The username and password for both PDU's is:

User Name: `sara`
Password: `Flam1ng0`

The control interface is shown in Figure 2-2. Please note that only one user can be logged into the system. If the interface is idle it will log out after 9 minutes.

NOTE: The Dome Outlet 6 is always left OFF to enable the dome to close in case there is a power outage. Turning Outlet 6 on will turn the dome off making it inoperable.

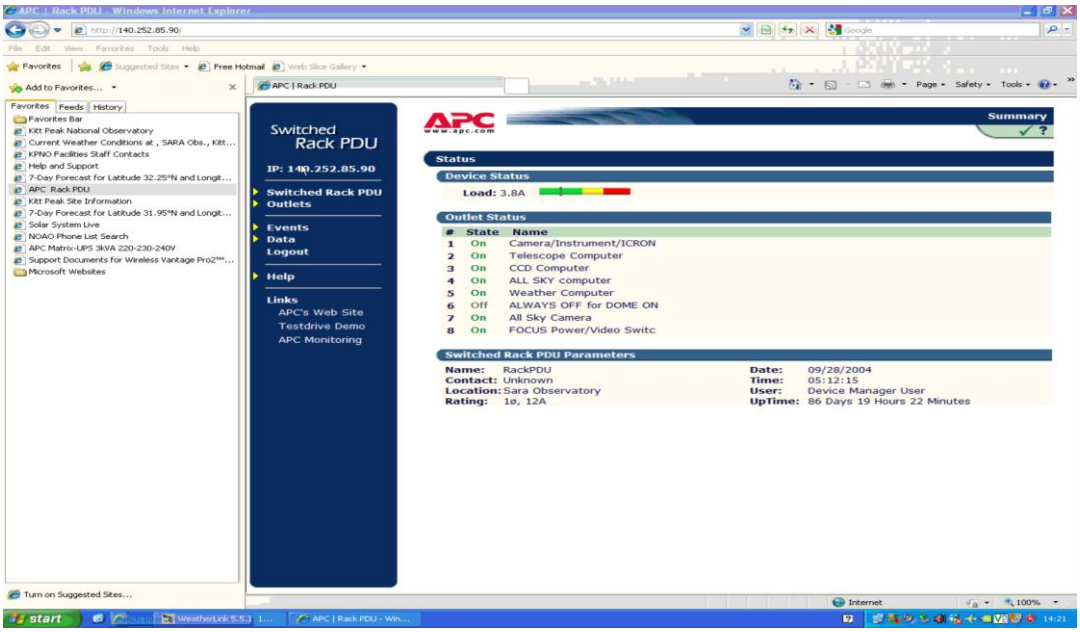
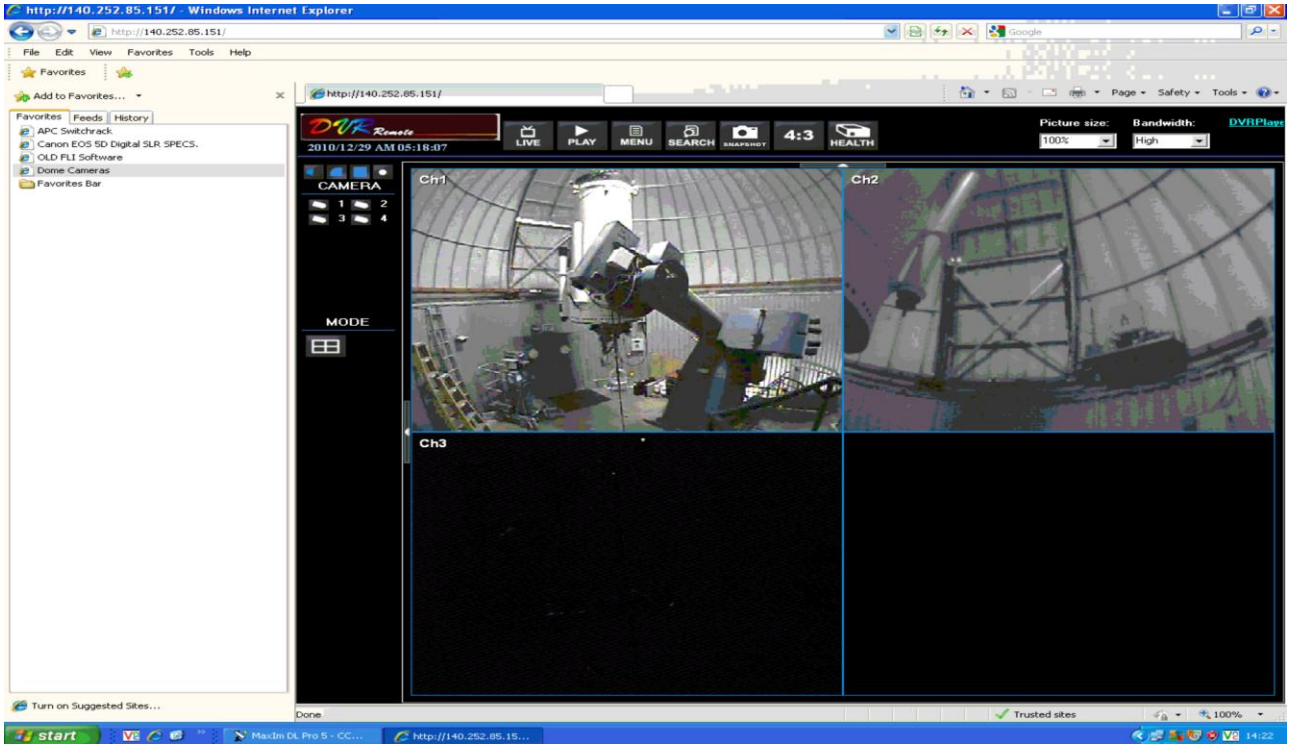


FIGURE 2-2 SWITCHED RACK PDU INTERFACE

2.5 8-PORT VIDEO SWITCHER

The observatory has a suite of video cameras attached to a digital video switcher. Use your remote browser to point to

http:// 140.252.85.151



It is faster if you use the browser on your own computer to display the dome cameras.

The software may ask you to install a local applet. The screen will fill with a blank black window. Click once in the area and a login dialog will appear.

When using your own computer it may be necessary to modify the Advanced Internet Explorer settings to enable the video content to display.

There are currently three cameras installed:

CAMERA	TITLE	NOTES
1	NORTH WEST	Color, inside dome looking south east
2	East mount	Color, inside dome looking east
3	EAST	Color, outside, looking west at instrument on zenith park.

3.0 ACE CONTROL SOFTWARE: MAIN SCREEN

3.1 STARTING THE SOFTWARE

FIGURE 3-1 THE ACE START ICON

The ACE software is always run out of the directory D:\ACE\Current Release. An icon appears on both the desktop and the START menu. The date in the icon reports the version of the software.

3.2 LOGON

If your administrator requires logging onto the system then the logon dialog appears (Figure 3-2).

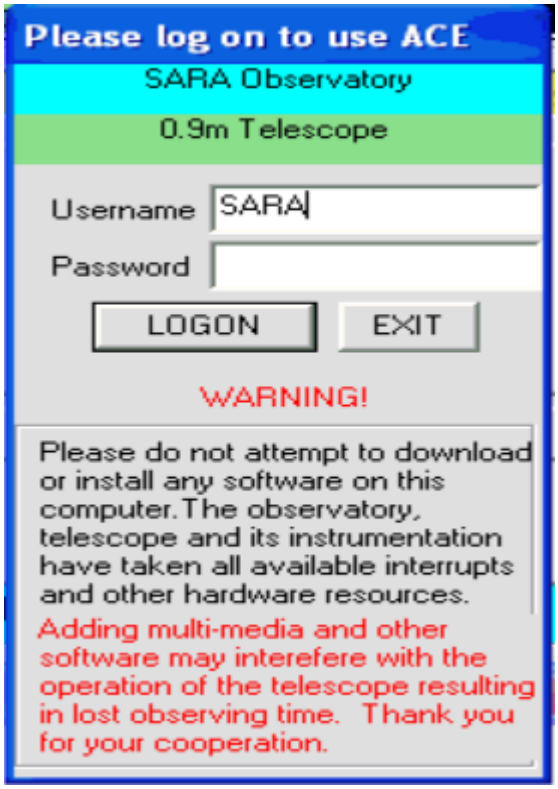


FIGURE 3-2 ACE LOGON DIALOG

WARNING.

THIS IS A TELESCOPE CONTROLLER, NOT A GENERAL PURPOSE COMPUTER. DO NOT LOAD ADDITIONAL SOFTWARE AND KEEP THE DATA STRUCTURES NEAT AND TIDY BY FOLLOWING THE PROTOCOLS OUTLINED IN THIS MANUAL

The standard login is:

Username: `SARA`
Password: `Flam1ng0x10`

The login and logout functions are available from the `User` menu. When you have finished with the system it is best to log out. It is possible to log on as another user without disturbing tracking or other critical settings. The menus displayed in ACE change depending on the user level. Unless otherwise noted all the features described in this manual are available to all users.

3.3 INITIAL SCREEN

Assuming that the software has just been started and that no user has yet logged on the screen will look like Figure 3-3. (Note*: some screen captures are from other ACE installations and there may be small differences in the screen captures where the content is not important*)

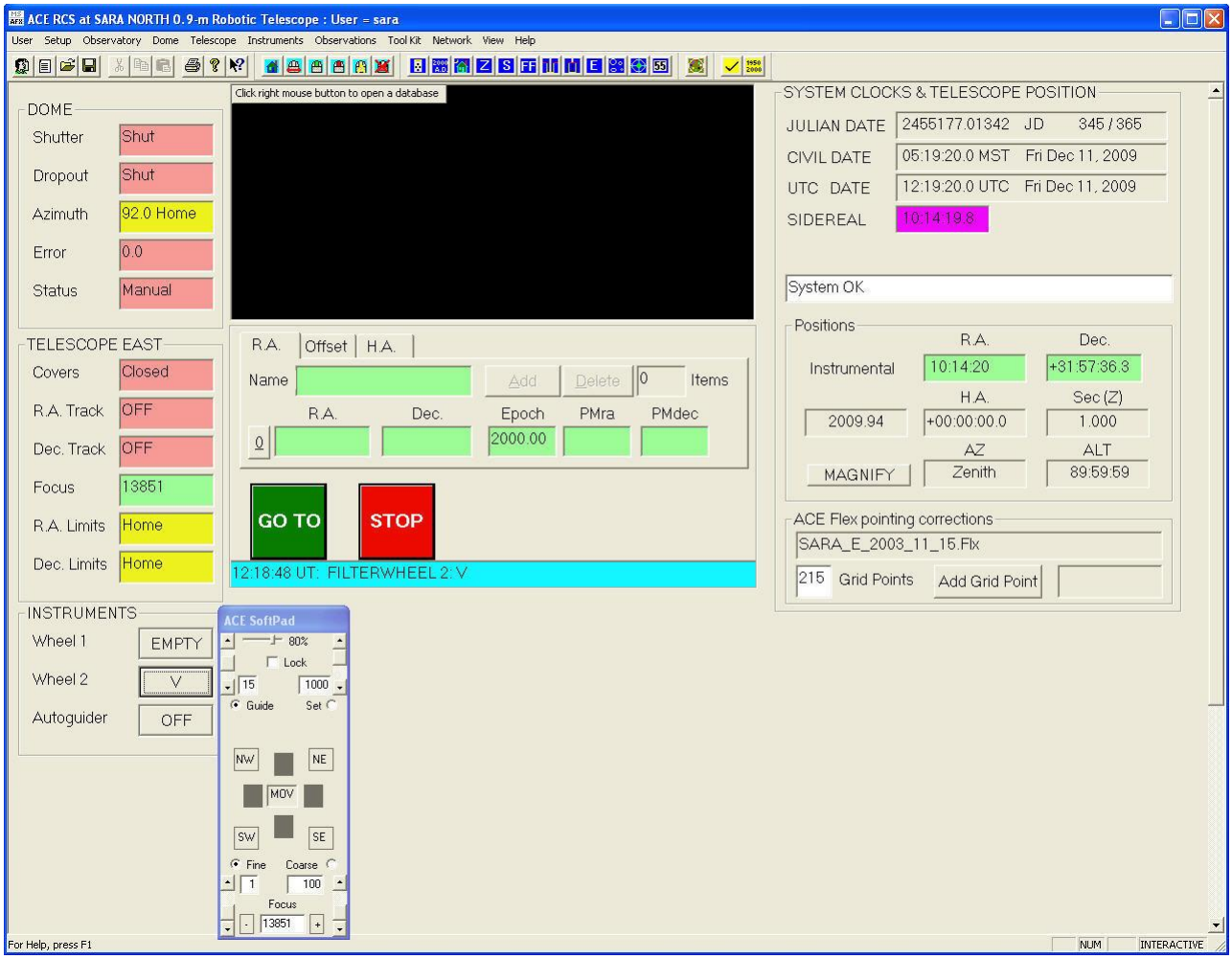


FIGURE 3-3 INITIAL SCREEN APPEARANCE

The ACE Control System uses a "traffic light" scheme for colors. Red items are closed, at a limit or otherwise in a non-observing state. Yellow objects are changing or at a temporary "home" position, and green items are ready for use.

The status of the dome, telescope and instruments is shown at the left of the screen. The center of the screen has a catalog area, GOTO and STOP buttons, and a series of message boxes. The right side displays system clocks and the current position of the telescope.

Other features are accessed by a series of menus.

3.4 STOP BUTTON

Pressing the STOP button is the software equivalent of pressing the physical emergency stop button located on the dome floor. It will stop all motion and issue a statement.

This button also resets many of the velocity, acceleration and other parameters in the system back to their default values.

The system fully recovers from using the STOP button without any loss of position, etc. When performing a GOTO move and wishing to stop the motion the CANCEL button can be used; this prevents the statement dialog from appearing.

3.5 R.A., OFFSET AND H.A. TABS

The GOTO button moves the telescope to the coordinates specified by the data fields in the R.A, Offset or H.A. tabs.

Using the R.A. tab will send the telescope to a (RA, DEC) position and the tracking will automatically start. The boxes will be green and the RA and DEC tabs will be highlighted to the right side of the screen.

Using the H.A. tab will send the telescope to a static (HA, DEC) position and the tracking will automatically stop. The boxes will be orange and the HA and DEC tabs will be highlighted to the right side of the screen.

Using the Offset. tab will offset the telescope in (RA, DEC) by a given number of arc seconds. The tracking must be turned on to use this feature. The boxes will be yellow with red numbers and the RA and DEC tabs will be highlighted in yellow to the right side of the screen.

These fields automatically check in real time the data entry. If a user makes an error (Figure 3-4) such as entering -10 11 76 for the declination then a warning message appears and the GOTO button will not do anything until the condition is cleared.

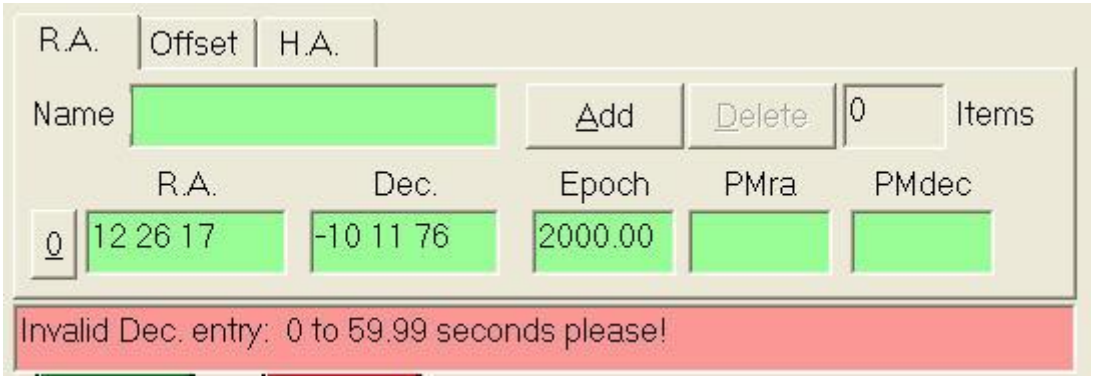


FIGURE 3-4 BAD DATA ENTRY

3.6 CATALOGS

The area above the data entry tabs is for catalogs. Three standard catalogs are provided.

- Yale Bright Star Catalog (`ACE_BSC5.cat`)
- Messier Catalog (`Messier.cat`)
- NGC Catalog (`NGC.cat`)

Other catalogs can be imported. Users are also able to create, modify and save their own catalogs.

3.6.1 Opening a Catalog

Point anywhere on the screen and press the right mouse button. A pop-up menu appears.

FIGURE 3-5 DATABASE POPUP MENU

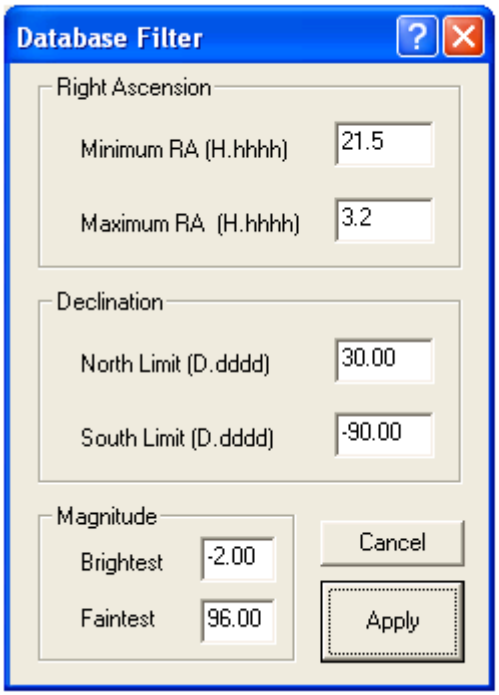
Select **Open Existing Catalog…** A list of available catalog files appears. They all have the file extension `.cat`.

The catalog is loaded and the number of entries in the catalog is displayed in the **Items** box at the right side of the Tabs pane.

If nothing appears in the catalog area then the database filters may be set so as to exclude all items (see below).

3.6.2 Filter a Catalog

Catalogs can be filtered (Figure 3-6) according to the user requirements. Use the right mouse button and select the **Filter Catalog** option from the pop-up menu. The most obvious filter is to remove objects which are below the declination limit of the observing site. These objects remain in the catalog; they are just not displayed. However, it is possible to permanently remove objects, as discussed in section 3.6.3.



MESSIER	R.A.	Dec.	AltName	Notes	m#
M2	21 33 27.00	-00 49 24.00	N7089	Gb	002
M30	21 40 22.03	-23 10 44.60	N7099	Gb	030
M74	01 36 41.84	+15 46 59.60	N0628	Gx	074
M77 CETUS A	02 42 40.83	-00 00 48.40	N1068	Gx	077

FIGURE 3-6 FILTER CATALOG

If the minimum RA is greater than the maximum R.A. as in the example shown above then the wrap through zero hours will occur. The result of this filter being applied to the Messier Catalog is to reduce the listing to four items. Once the filters have been applied click on the red X button to quit the dialog.

3.6.3 Sorting Catalogs

Catalogs can be sorted by clicking on the column header. Note that the ACE_BSC5 catalog is sorted by magnitude. You can save the catalog (under a different name please!) so that is sorted by R.A. To do this, we sort by R.A. And then use **Save Catalog As….** Note that only the objects which are displayed will be saved. Any objects which have been filtered out will not be saved.

3.6.4 Editing Catalogs

Catalogs can be edited by selecting the **Catalog Cells Editable** option from the pop-up menu. The background of the catalog changes from green to pink. You can then select any one of the cells and change values.

If you wish to edit one of the three standard catalogs please save your private version under a different name so as not to corrupt the original.

When a catalog has been changed and not saved (Figure 3-7) the column headers will turn red to warn the user.

Name	R.A.	Dec.	V	B-V	R-I	U-B
SA_140-84	00 03 37.90	-28 41 46.00	11.96	0.67	0.36	0.14
SA_140-85	00 03 38.50	-28 37 25.00	12.22	0.72	0.37	0.20
HD_315	00 07 44.10	-2 32 55.27	6.44	-0.14	-0.06	-0.50
SA_116-99	00 17 40.70	-13 53 41.00	12.13	0.73	0.36	0.34
SA_68-280	00 18 04.80	15 54 21.00	11.26	0.88	0.42	0.51
SA_116-180	00 18 04.90	-13 57 22.00	12.25	0.43	0.27	-0.03
SA_68-216	00 18 18.40	15 49 16.00	12.41	0.58	0.36	-0.03
SA_44-28	00 29 04.60	30 23 06.00	11.33	0.74	0.37	0.22
SA_44-113	00 29 36.90	30 23 18.00	11.71	1.21	0.57	1.03
PG_0029+024	00 31 42.10	02 37 45.00	15.27	0.36	0.34	-0.18
HD_2892	00 32 12.15	01 11 17.30	9.37	1.32	0.62	1.41
BD-15_0115	00 38 20.26	-14 59 54.15	10.88	-0.19	-0.10	-0.86

FIGURE 3-7 CUSTOM CATALOG NOT SAVED

To create a custom catalog use either the **Open New Catalog** tool from the pop-up menu or use the **Import Catalog** tool from the Toolkit menu.

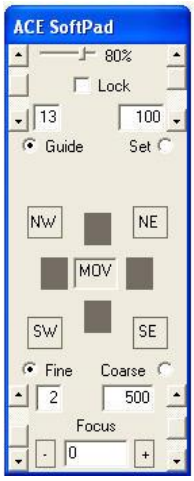
Also, it is possible to enter values into the data entry boxes above the GoTo button and then use the **Add** button to add this entry to a catalog.

4.0 ACE CONTROL SOFTWARE: TELESCOPE MENU

4.1 OVERVIEW

The Telescope menu gives access to additional telescope functions not included on the main screen. The icons shown at the left side of the menu are also available from the toolbar at the top of the main screen.

4.2 ACE SOFTPAD™



The ACE SoftPad™ automatically displays when the application starts. There is only one way to alter the visibility, by clicking on the menu (or the Toolbar shortcut).

The four black squares (■) represent the cardinal N S E W directions.

It is also possible to move in two axes at once using the **NE NW SE SW** buttons.

To move simply click the left mouse button over the square and hold it down for as long as motion is required.

The speed at which the telescope moves depends upon the **Guide** and **Set** radio buttons.

The slider bars permit changing the guide and set rates

In the same manner the **Fine** and **Coarse** radio buttons dictate the **Focus** speeds. The **Lock** check box hides the slider bars.

The physical hand paddle (located in the dome) reads the **SoftPad** speeds. You can change the focus speeds for eyepiece viewing this way. Otherwise we do not recommend moving the telescope focus using the ACE SoftPad™. There are better ways such as using offsets.

Both the actual hand paddle and the ACE SoftPad™ have little use in everyday observing. To move the telescope while observing remotely use the RA, Offset and HA tab fields and the GoTo button.

For on-site observers there is a wired hand paddle.
The paddle has four buttons for the cardinal directions NSEW. Pressing the buttons moves the telescope at guide speed, which is very slow. Press and hold the SET button with the desired NSEW to go faster. Use SLEW to go even faster.

SET and SLEW also give three speeds for all the other functions.

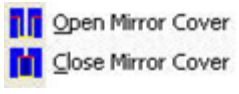
IN and OUT buttons are used to move secondary focus.

4.3 TELESCOPE PARKING

By definition a Park position is one where the telescope tracking is turned off. There are three pre-canned positions. Pressing these will enter values into the HA tab data entry fields. The Zenith will move on a Yes/No answer and the other requires pushing the GOTO button.

Parking the telescope is a safe way to leave the system. The tracking will be off.

4.4 MIRROR COVERS



The telescope tube has automated covers. A single command is used to operate the covers. The status of the mirror covers is shown in the Telescope Status window.

The mirror covers are designed to automatically close in the event of a computer power loss or when restarting the computer.

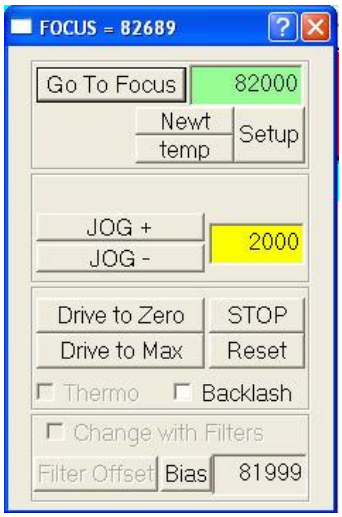
4.5 RESET ENCODERS

This is only available from the toolbar, not the menu, so as to discourage its use. This function is used to reset the position of the telescope with a known bright star. Use this function with caution as resetting on a wrongly identified star will cause other objects to be out of the field. For systems with absolute encoders the amount of reset is limited to a fraction of a degree and it adds a DC offset to the encoder values.

4.6 HOME

This function will park the telescope at the zenith for absolute encoder systems. The RA and DEC Limits will report HOME. (The main purpose of this routine is for telescopes without absolute encoders. Use ZENITH PARK instead).

4.7 FOCUS

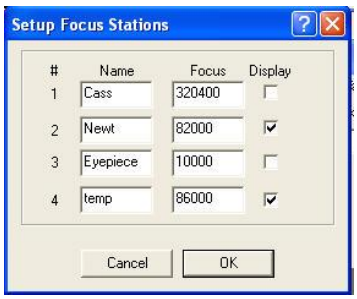


The **Telescope Focus** menu toggles the visibility of the **Focus** dialog. This dialog is multitasking - it can remain on the screen while other tasks are being executed.

The current value of the telescope focus is displayed in the title bar of the **Focus** dialog and in the TELESCOPE status pane at the left of the screen. The latter display will be green unless at a limit when it turns red.

Clicking on the **Go To Focus** button will move the focus ram to the absolute value displayed in the green box.

The focus is equipped with a 24-bit absolute multi-turn encoder. The Reset button is disabled and cannot be used. It is not possible for the user to change the value of the encoder to some arbitrary value.



The **Setup** button displays a modal dialog that requires immediate attention. It can be used to store default values for up to four instruments.

Clicking on the instrument button name (e.g. **Newt**) will load the default value into the green Go To Focus edit box. This is a convenient way to store approximate values of different instruments.

It is also possible to move the focus by an incremental amount. Use the **JOG +** and **JOG -** buttons to offset the focus by the amount shown in the yellow edit box. A focus change of 50 units can be detected. When establishing a coarse focus use a jog of 2000 units.

Drive to Zero will send the focus ram all the way to the OUT limit at high speed. Zero is defined as the maximum separation of the primary and secondary mirrors.

Drive to In moves the focus ram all the way to the in limit switch (minimum primary-secondary separation).

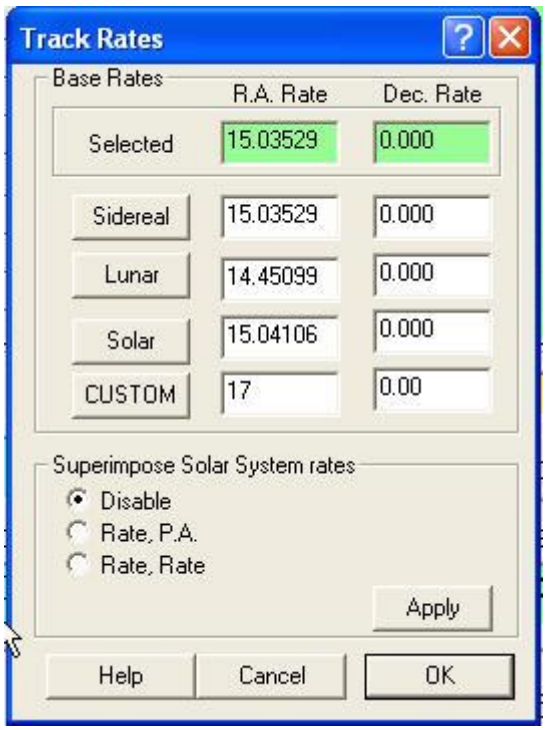
The **STOP** button will arrest the focus ram. It is useful when using a real-time video camera or for stopping the ram when an unintended destination was issued.

It is possible to compensate for different thickness filters loaded in an ACE Filter Wheel. Focus the telescope and then press the **Bias** button. This will set the DC level and it is displayed in the read-only edit box. To calculate the offset for a given filter press the **Filter Offset** button.

4.8 TRACK ENABLE

This toggles the status of the tracking if you want to manually turn it on or off. Otherwise just let the system take care of tracking. It knows when you want to track or park.

4.9 TRACK RATES



The **Track Rates** menu command permits sidereal or non-sidereal tracking. The desired rates are entered in arc seconds per second. The rates are limited to the following ranges:

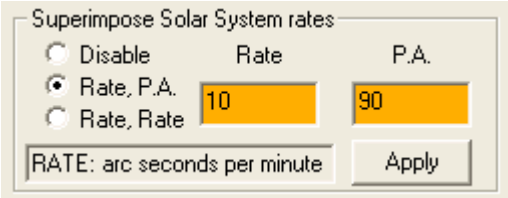
- R.A. 15.000 ±3.000 arc_seconds/s
- Dec 0.000 ±3.000 arc_seconds/s

Click the **Sidereal** button to load the standard tracking rates. Mean Lunar and Solar rates are also available. It is possible to **Save Custom Rates** for a comet or asteroid. Use the **Load Custom Rates** to retrieve the settings.

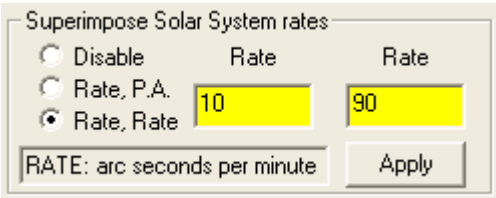
The current tracking rates are shown in the TELESCOPE pane at the left of the main screen. Sidereal tracking has a green background. Non-sidereal tracking has a yellow background.

4.9.1 Superimpose Solar System rates

You can also enter non-sidereal tracking rates as listed in web sites such as the Minor Planet Circulars (MPC). This site, and others, give the motion of the solar system object either as a rate and position angle, or as a rate in both R.A. and Dec.



The **Rate, Position Angle** dialog requires rates in arc seconds per minute and a position angle in degrees, which are the same units used by the MPC.
(Note: The required units are displayed when the cursor is placed in each edit box).



The **Rate, Rate** dialog requires rates in arc seconds per minute for R.A. and Declination. Again, these rates are relative to sidereal motion.

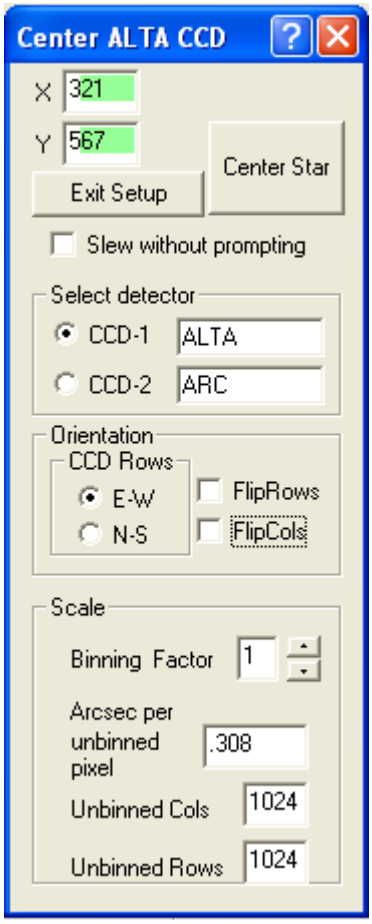
Pressing the **Apply** button will add these rates to the current (sidereal) tracking rate.

When you have finished with this feature re-enter the Track Rates dialog if it is not already displayed and press the **Disable** button. The tracking will go back to the previous state, which is usually sidereal, and the declination tracking will turn off.

4.10 CENTER CCD

This tool is in the telescope menu because its function is really to center the telescope.

Enter the pixel (X,Y) coordinates of a star from the CCD frame and the dialog will calculate the offset in R.A. and Declination to put that star at the center of the CCD. Using MaxIm-DL on the CAMERA computer the coordinates will be displayed in the center of the bottom window pane.



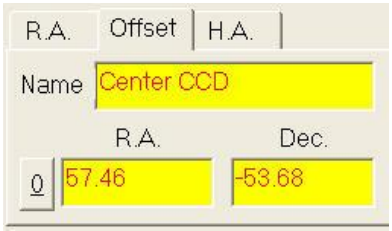
Setup Options

This expands the dialog to show setup parameters. Two sets of parameters are stored catering for two CCD's. In this example we have stored information for the two cameras called OWL and NEWT.

The most important first step is to ensure that the CCD images are being displayed with NORTH up and EAST to the left. If not change the parameters in your display tool.

Now select a star that is in the NE of the frame. To center this star you know that the telescope has to move NE. This means that the offset tab must display positive numbers for both R.A. and Declination.

Click on Center Star and examine the offset tab:



Alter the FlipRows and FlipCols check boxes until both entries are positive.

The Scale pane specifies the current Binning Factor. The number of arcseconds per unbinned pixel and the number of unbinned rows and columns complete the required information.

Press Exit Setup to get back to the smaller dialog and to save the information to disk.

Note: *All this has already been set and you only need to do this for new configurations*.

5.0 ACE CONTROL SOFTWARE: DOME MENU

5.1 OVERVIEW

The dome can be controlled by push buttons on the ACE SmartDome™ Controller located on the dome wall. The ACE SmartDome™ lower box talks to the upper box by means of a wireless radio. In the event of a radio failure or other equipment failure the dome doors can be operated by the top box push buttons.

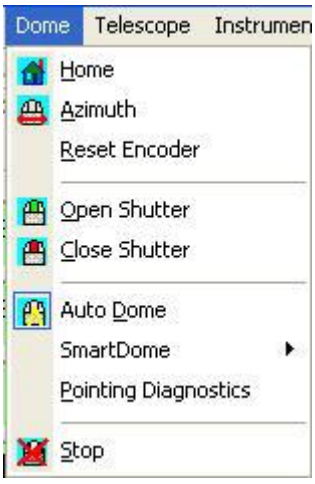
Caution for on-site personnel: The top box buttons are for emergency use only. They purposefully bypass the limits and computers to provide the simplest failsafe solution to close the dome.

The dome has two shutter doors. The main door takes approximately 2 minutes to open. The horizon door takes approximately 1 minute. The two doors are interlocked. The main door must be partially opened before the lower door will operate.

Under normal circumstances the dome is operated in "synchronized mode" which means that where possible both doors will operate simultaneously.

The dome is connected to the telescope controller by a COM serial port.

The following functions are available for software control:



5.2 HOME

The dome is equipped with an encoder. When it passes a "home" position it automatically resets the dome azimuth to the home value. The main purpose of the home function is to reestablish the position in the event of a power loss. For this reason it is recommended to park the dome at the home position.

5.3 AZIMUTH

Select Dome>Azimuth from the Dome menu.

The dome can be sent to a particular azimuth. Just enter the desired azimuth in degrees (0 to 359) measured North through West.

If AutoDome is currently engaged a dialog requesting to turn it off pops up. Answering No will deny your request.

5.4 RESET ENCODER

This function is not available for domes equipped with absolute encoder systems.

If the dome has been moved with the SmartDome controller off then the dome position will be lost. You can easily re-establish position by placing the dome due south. Standing under the polar axle and against the north pier look south. The telescope polar axle should bisect the view of the dome. It is then at 180°. However, the preferred method for reestablishing position remotely is to use the Home function.

Select Dome>ResetEncoder from the Dome menu.

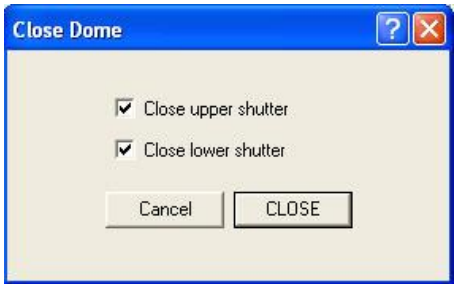
The reset azimuth defaults to the current azimuth.
Enter a new value (0 to 359) and press reset.

5.5 OPEN SHUTTER

Select Dome>OpenShutter from the Dome menu.

It is not possible to open the lower shutter without first opening the upper shutter. The status of the dome doors is reported in the DOME pane at the top left of the screen. If selected, the lower door will start to open approximately 5 seconds after the main shutter has fully opened or after the main shutter has cleared its interlock is the SmartDome controller has been set to allow synchronized opening.

5.6 CLOSE SHUTTER



Select Dome>CloseShutter from the Dome menu.

If the SmartDome™ has synchronized closing enabled and the main door is fully opened then both doors will close together. Otherwise the dropout will close followed by the main door. The status of the dome doors is reported in the DOME pane at the top left of the screen. If selected, the main door will start to close approximately 5 seconds after the dropout horizon shutter has fully closed.

5.7 AUTODOME

Select Dome>AutoDome from the Dome menu. This makes the dome slave to the telescope. The dome will move approximately every two minutes when the telescope is tracking.

If you use the Hand Paddle the dome will go into "sleep" condition until the next GOTO command. This feature allows offsetting the dome to get an auxiliary instrument centered in the slit.

5.8 SMARTDOME DIALOG

The SmartDome Dialog permits low level control of the dome and is used by the *SystemEngineer* for setup purposes.

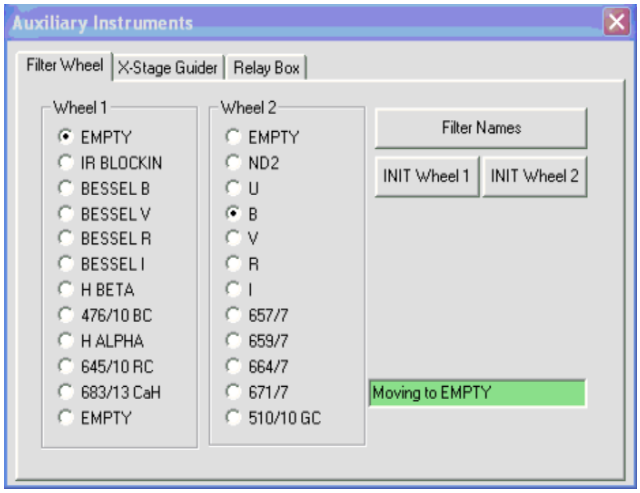
6.0 ACE CONTROL SOFTWARE: INSTRUMENTS MENU

6.1 OVERVIEW

The instruments menu may vary depending on the equipment installed.

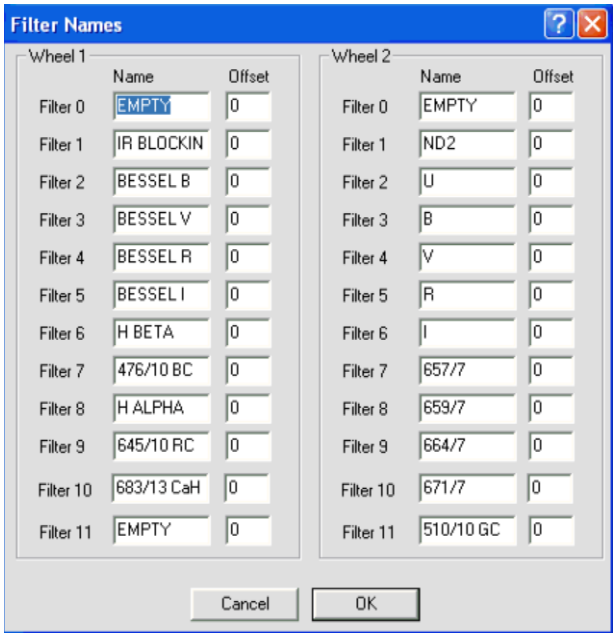
Clicking on the filter wheel icon on the main toolbar will also display the tabbed instruments dialog button.

6.2 FILTER WHEEL



The Filter Box contains two wheels, each with 8 slots. The wheels are stacked together so that light passes through both wheels. Therefore, slot 0 of each wheel is left empty.

To change filters click on the desired radio button. The filter wheel is equipped with an absolute encoder so it knows the status at all times. When moving, or not at a filter location, the radio buttons will be grayed out. It is possible to initialize the wheel to the nearest slot by clicking on the Init Wheel 1, Init Wheel 2 buttons.



To change the names of the filters click on Filter Names.

The position and filter name for each wheel is recorded in the FITS header.

6.3 X-STAGE GUIDER

The X-stage guider is a linear stage that moves a 57mm minor axis diagonal pick-off mirror east-west across the main field. When the stage is centered the diagonal mirror blocks the main science detector and the guider port then has the same view that the science detector had.

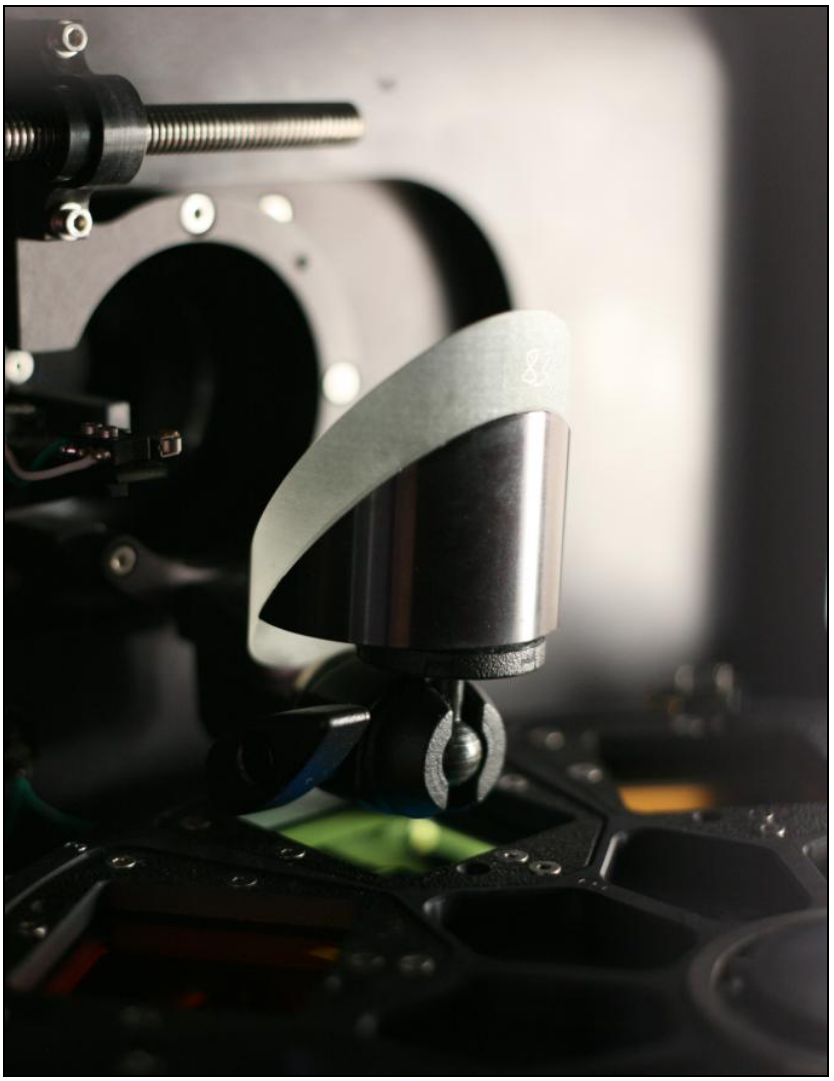


FIGURE 6-1 PICK-OFF MIRROR BLOCKING SCIENCE BEAM.

The situation for the X-Stage being centered is shown in Figure 6-1. The green filter, which is in the science beam, is completely blocked by the pick-off mirror which is directing the beam to the guider camera or eyepiece.

If you cannot find your object (or see any stars in the main CCD) check that position of the pick-off mirror!

FIGURE 6-2 DUAL FILTER WHEEL & X-STAGE GUIDER INSTRUMENT

When the X-Stage is not centered the diagonal pick-off mirror is used for finding guider stars. When the stage is moved "left" as seen from the front of the instrument the camera is looking at stars in the EAST, as shown in Figure 6-2. This photograph was taken near position E2 (Refer to the Control Dialog Figure 6-4). There is often confusion about this. The stage has actually moved west but it has gone further east on the sky, which is all that you really need to be concerned about. The layout in the software control dialog is also with east at the left and west at the right.

A ST402 auto-guider camera is mounted in a "standard" 2-inch focuser. It can be swapped out for an eyepiece or other equipment. It is necessary to use an eyepiece extension tube to keep the main CCD camera in focus and at the same time have the eyepiece in focus.

Figure 6-3 shows the X-stage centered (Picture from SARA SOUTH). It is symmetric about the box walls and the lower part of the ball slides, visible in Figure 6-2, are now no longer visible.

FIGURE 6-3 X-STAGE CENTERED WITH EYEPIECE INSTALLED

The focuser is driven by a digital stepper motor and is equipped with limits (which are hidden inside the box). The minus limit is when the camera is closest to the guider box; the plus limit is when the focus unit is at its maximum extension.

The X-Stage guider control is a page in the Auxiliary Instruments dialog.

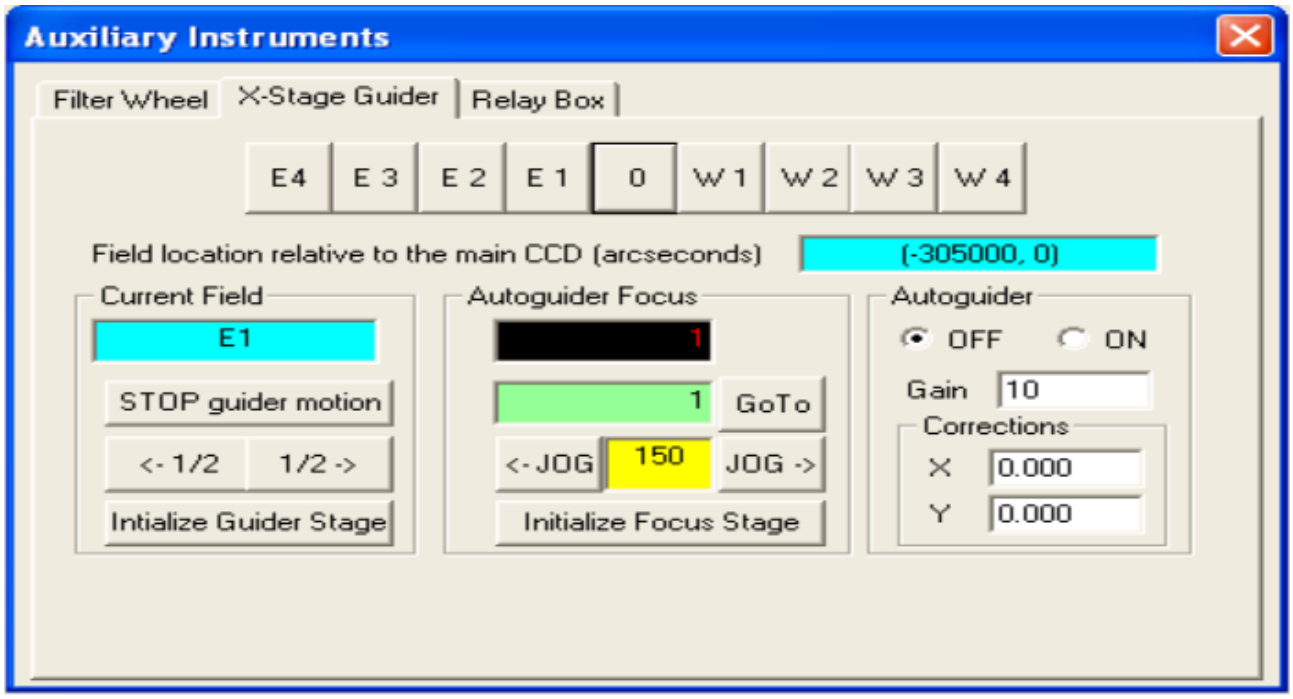


FIGURE 6-4 X-STAGE GUIDER DIALOG

To move the stage press the desired East, West or 0 (centered) button. The current position is reported. The two buttons called **<-1/2** and **1/2->** allow the stage to be moved half way between standard fields. Pressing the **Initialize Guider Stage** button will send the stage all the way to the left (minus) limit, load a predetermined value, and then move to a position specified by the *System Engineer*, typically the E1 field so as not to block the main beam.

To focus the autoguider use the buttons in this dialog. Pressing **Initialize Focus Stage** will drive the guider focus to the in limit, reset the counts to zero, and then move the stage to the approximate focus. (This value is pre-determined by the *System Engineer*). The stage can also be sent to an absolute value or jogged incrementally, in exactly the same manner as the main telescope focus.

Figure 6-5 shows the movement of the stage between field W3 and the two intermediate fields using the half buttons. Note that the CCD is orientated with the long axis N-S while the stage moves E-W. This gives the maximum possible coverage on the sky to find guide stars. The field orientation is the usual NORTH to the top and EAST to the left.

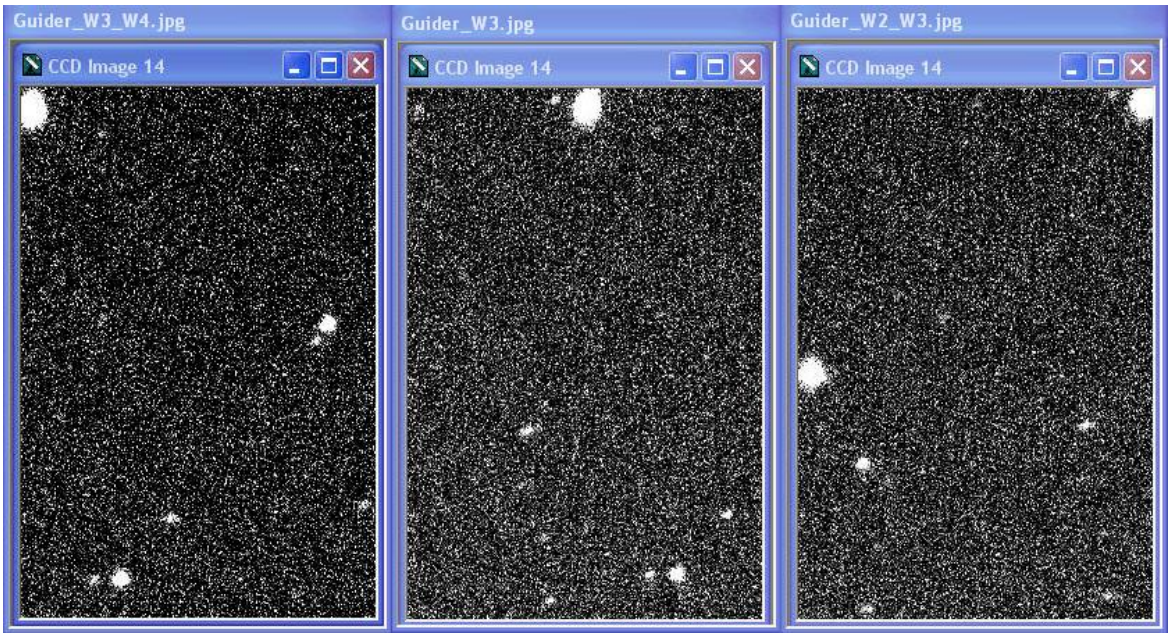


FIGURE 6-5 X-STAGE GUIDER FIELDS

6.4 AUTO GUIDER

The auto-guider is used for long exposures, or when staying on an object for an extended period of time.

To successfully use the autoguider the following conditions must be met:

- MaxIm-DL must have been started using the ACE software (see Observations menu)
- The autoguider camera must be working (able to take images) using MaxIm-DL
- The telescope must be tracking on an object.
- A cable between the serial port of the TELESCOPE and CAMERA computers must be present.

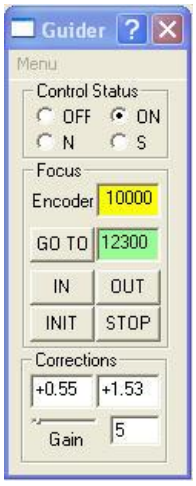


FIGURE 6-6 AUTO GUIDER

When operating the guider corrections are reported in the dialog. A ceiling of 2 arc-seconds per second is imposed on the guider.

The corrections from ACE are received from Maxim-DL. So it's essential to have the correct settings entered.

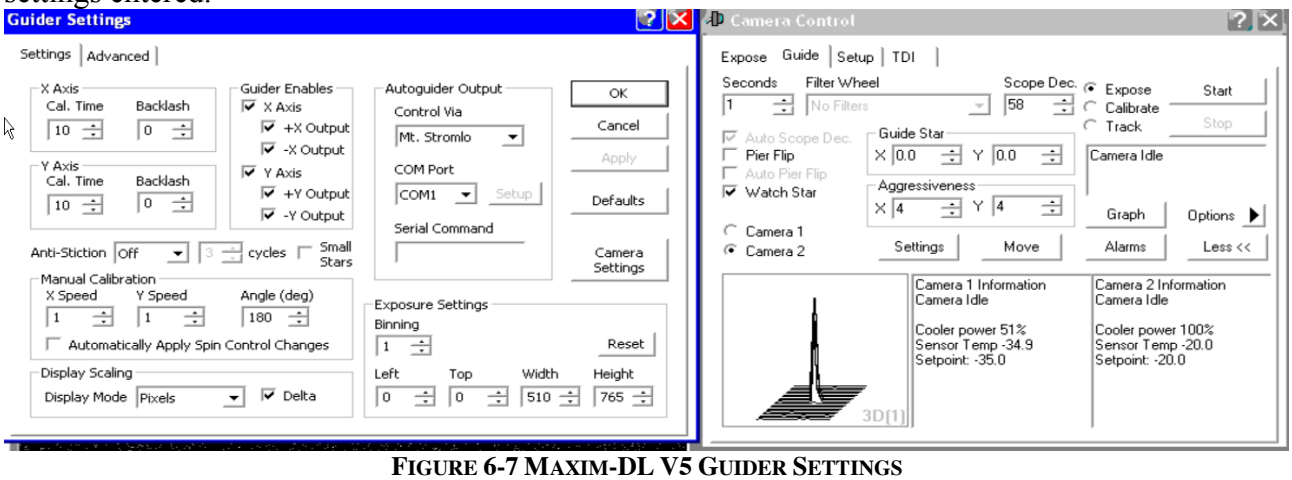


FIGURE 6-7 MAXIM-DL V5 GUIDER SETTINGS

6.5 RELAY BOX

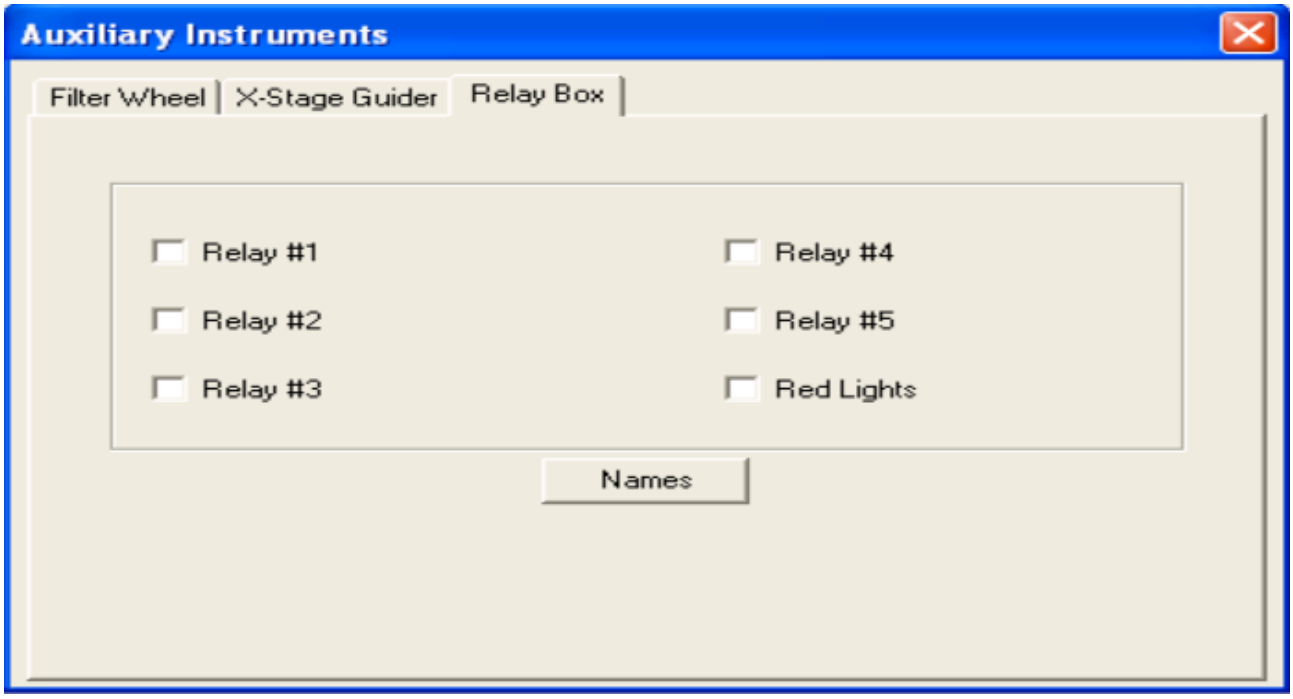


FIGURE 6-8 POWER OUTLETS DIALOG

The Relay Box tab allows for different external devices to be controlled.

The RED LIGHTS controls the strip of lights around the dome. These red lights provide sufficient illumination for the video cameras in the dome. Turn them off while collecting data.

7.0 ACE CONTROL SOFTWARE: OBSERVATIONS MENU

7.1 OVERVIEW

This User's Manual gives details of the ACE Telescope Control System. The information
The cameras are controlled through the Observations dialog.

For cameras operating using MaxImDL it is necessary to setup the system first using the camera computer. Obtain images with the main camera and the guider so that north is up and east is to the left. Once the cameras are operating correctly in stand-alone mode then the system can be run by ACE. To do this exit MaxIm-DL and restart using ACE, as describe herein. The settings inside MaxIm DL will need to be re-entered again because the instance of the application started by ACE knows nothing about the settings previously obtained. Therefore, note the settings in the stand-alone version of MaxIm-DL for use with the ACE instance, which is owned by "System" and not the local user.

The ACE Control System can control cameras through a DCOM program written by Astronomical Consultants & Equipment, Inc., called MaxImServ. This program is run as a service and is always available to the user.

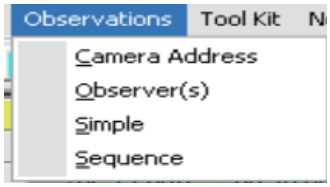
Both the TELSECOPE and CAMERA computers must be turned on and the user must be logged on. Moreover, the cameras must be turned on and be in a normal communications state with the computers.

If MaxIm-DL is started by ACE then FITS header information is available and the camera can be controlled by either MaxIm-DL or by ACE.

If MaxIm-DL is started at the CAMERA computer then no there is no access to FITS headers from TELESCOPE and ACE cannot control the camera.

When displaying the Auto Guider MaxIm-DL will start on the CAMERA computer if it is not already running. If it fails to start then try starting MaxIm-DL using the camera computer, get it going there, and then close the application down before restarting again with ACE.

Three different pages are available in the Observations menu:



The Observers page sets basic communications and data entry.
The Simple page allows for single object single filter observations.
The Sequence page allows for multi-color photometry.
The Camera Address is the IP address of Camera computer.

7.2 OBSERVER(S)

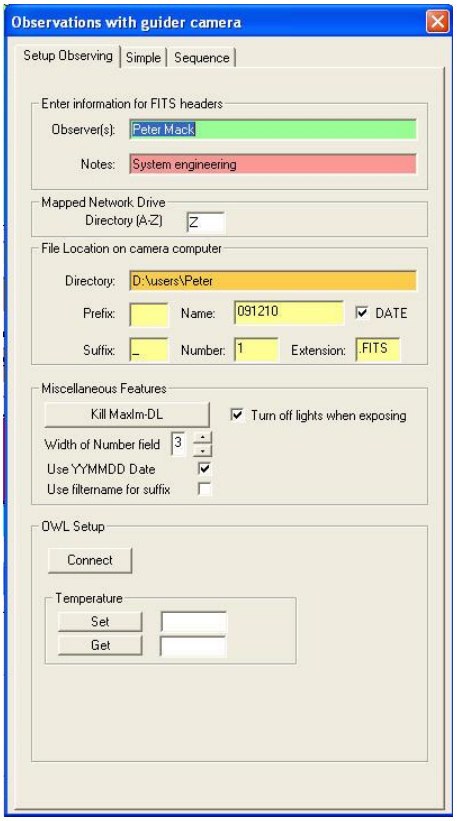


FIGURE 7-1 SETUP OBSERVING

The Observer(s) menu puts the tabbed dialog to the **Setup Observing** page. Information from this page is written into the FITS headers. The directory refers to the path on the CAMERA computer where images are to be stored.

Note: *Take a sample image and check that the image is being saved in the correct place and with the desired naming convention*.

Checking the **DATE** box will put the date as the filename. Use this in conjunction with the YYMMDD Date check box. If this is unchecked then the year will appear as four digits.

Enter an prefix, suffix and extension to suit your particular requirements.

The **Kill MaxIm-DL** button can be used to try and stop a hung instance of MaxIm-DL.

7.3 SIMPLE

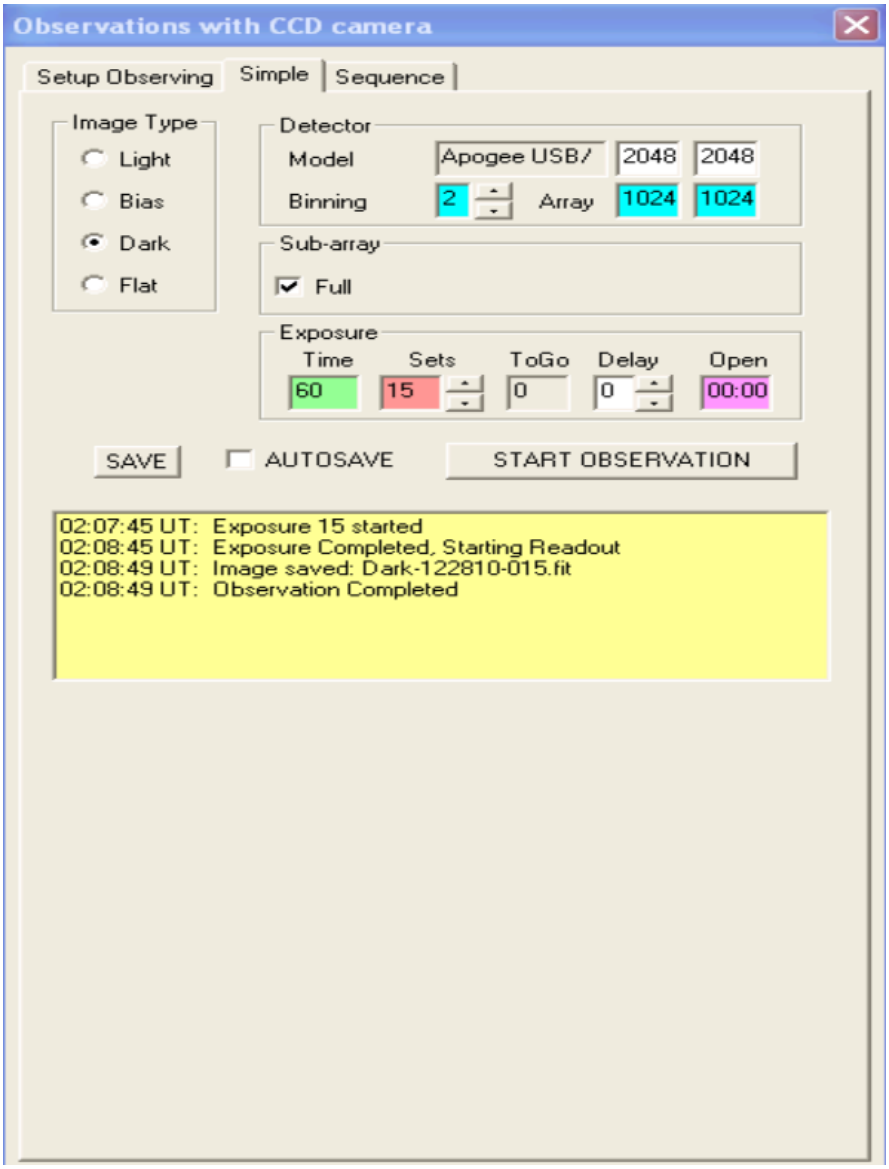


FIGURE 7-2 SIMPLE OBSERVATIONS PAGE

As soon as the Simple page is selected the Instruments tabbed dialog will be displayed and it cannot be closed until observations are completed.

The dialog is more or less self explanatory. The radio buttons Dark and Flat will write those words into the FITS header.

The Binning allows 2x2 and 4x4 binning. The array size changes accordingly.

Sub arraying is allowed. The settings for the sub-array are remembered for use in the future.

When the observations are idle the background is a light yellow color. When the observations are being taken the background is green. The number of images to go and the time remaining on the shutter are displayed.

7.4 SEQUENCE

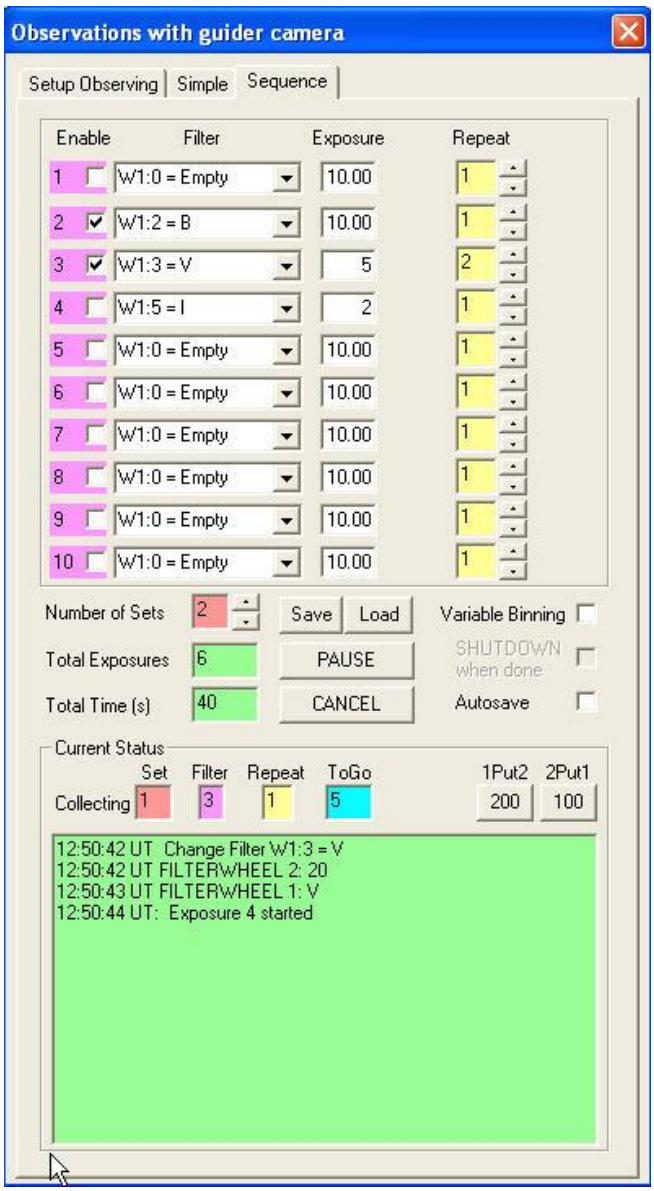


FIGURE 7-3 SEQUENCE OBSERVATIONS PAGE

This page is designed for multi-color photometry. There are 10 entry fields; only those checked will be executed. Select the filter and the time and the number of repeats required in each field. It is also possible to have different binning factors for each field.

The **Sets** spin control allows multiple repeats of the selected (enabled) fields. It is possible to **Save** and **Load** your sequences.

The **1Put2** and **2Put1** buttons allow you to specify where the other wheel will be positioned. The positions are 100, 101, 102 etc for wheel 1 and 200, 201, 202 etc for wheel 2.

8.0 TROUBLESHOOTING

The SARA North Observatory has no local technical support that can be directly accessed by the observer. See section 1.6 for emergency contact information.

Table 8-1 outlines possible solutions which can be tried by the observer.

Notes:

Hard boot: Power turned off the computer *after* an orderly shutdown.
Soft boot: Windows restart button is used.

TABLE 8-1 TROUBLESHOOTING TIPS

Symptom	Remedy?	Notes
Cannot Find *any* Star	X-Stage in way? Dome in way? Mirror petals closed? Tracking turned off? Camera shutter not opening? Telescope way out of focus? Cloudy!!!?	All system should be green or yellow on the left side of screen. Increase exposure time to 30 seconds. Is it the same as a bias frame?
ACE not responding. Mirror covers report is flashing closing / closed.	A hard reboot can sometimes cause this	The MaxP driver has failed. If Setup->ControlCard->Version reports "Card not found" do a soft boot.
ACE hangs when trying to start Maxim	Make sure you are already logged into the camera computer. Also be sure another instance of Maxim is not already running by using the Task Manager (Start->Run->Taskmgr on Camera)	It takes about 20 seconds for ACE to get back an OK signal from Maxim when establishing the link.
ACE-Maxim not talking anymore.	The camera is probably not talking to Maxim. Try restarting Maxim. If that does not work restart the camera and a hard boot on the camera computer (after an orderly shutdown).	If you cannot "connect" using Maxim then no amount of trying from ACE will work! If you have TWO cameras attached (main, guider) disconnect one of them to see if the remaining camera connects. This will tell you which camera is misbehaving.
Target out of range.	Check coordinates	
Autoguider signals not getting through to ACE	Use Task Manager processes to kill all copies of MaxIm-DL.	Phantom copy of Maxim-DL running? This ties up the serial port so the "real" Maxim-DL cannot use it.

Autoguider signals not getting through to ACE	Check Guider Settings.	COM3 is used the telescope computer and COM on the camera computer for guiding.
No FITS Headers	Stop MaxImDL and restart using ACE.	In the Task Manager Maxim-DL should be shown as owned by *System* and not the local user.
Dome not pointing correctly.	Move the dome to home position and perform autodome again.	If still not working correctly, the dome encoder may be faulty.
Dome not rotating.	Fault in the Variable Frequency Drive. Power cycle the Smartdome using APC switch rack and re-home the dome.	The dome is always OFF in APC rack.
No Dome video	Try refreshing the IE webpage.	If not working, try powercycling the DVR via APC switch rack.

9.0 REMOTE OBSERVING CHECKLIST

9.1 SARA-N (0.9-M) COORDINATES AND PARALLAX CONSTANTS

- SARA-N 0.9-m (Long. 111.59975 W, Lat. 31.96006 N, Alt. 2061 m)
- Observatory code, longitude (E of Greenwich), ρsin(φ'), ρcos(φ') [φ': geocentric latitude] [G82, 248.40025, 0.849488, +0.526449]

9.2 STARTUP PROCEDURES:

1. Be sure the CCD cooler is turned on, the CCD chip is at the proper temperature and the correct selection for binning has been made.
2. Make sure all SARA systems are communicating, including the weather station and the all-sky camera.
3. With CCD at operating temperature, but before opening the dome, take dark and bias frames, then
    - Check GOES satellite photo of Arizona
    - Check KPNO Camera linked to KPNO Observer info web page
    - Check Tucson weather forecast
    - Link to Bill Keel's Observing Links Page
4. Open dome in early evening so telescope can cool. Open video window and monitor progress. Also, watch for tours in the dome area as dome lights will affect calibration frames.
5. When dome shutter is fully open, open mirror covers
6. Wait for sunset
7. Engage Autodome so dome shutter follows telescope
8. Sky flats (short -> long wavelength filters, then clear) Dither between frames if track on, or leave track off (HA = -2 hrs)
9. Check pointing using Bright Star using the ACE_BSC5.cat catalog (enable tracking)
10. Focus on star or star cluster near zenith. Find one bright enough to give ~few thousand ADU in ~3 sec exposure. Use Focus tab in Maxim and adjust focus setting until best focus achieved
11. Go to first target star
12. Nominal track rates are 15.01 and 0.007 - the telescope will guide reasonably well will these rates, but they are a small function of HA and dec, too.
13. If problems arise, follow troubleshooting procedures outlined here

9.3 SHUTDOWN PROCEDURES:

1. Finish last data frame
2. Slew telescope to Zenith Park
3. Close mirror covers
4. Close dome dropout and main shutter
5. Take bias sequence (if not taken earlier in evening, ~25-30 bias frames)
6. Take dark frames (if not taken earlier in evening)
7. Download data using ssh/scp or the download option in RADMIN
8. Complete your SARA-N Nightly Report or SARA-S Nightly Report while dome is closing or at least before you go to bed for the night. (ACE requires reports early in the day if any problems are to be attended to for the following observing session).
9. Send dome to home position, and logout of ACE software.
10. When finished do User->Logout to bring back the password-protected login dialog for ACE.
11. Note:- Visit http://www.saraobservatory.org/remotechecklist.html for the latest copy of this checklist.