Overview and Features

CCDAutoPilot
Version 3
Standard and Professional
Software and Documentation

Written by John Smith and Andrew Read,
and Richard Bennion.

Thanks to Matt and Steve Bisque, Doug George, Stan Moore,
Ray Gralak, Tim Puckett and Dave Toth for invaluable assistance along the way.
Thanks to Frank Barnes, Bob Benamatti and Morgan Wilson for their tireless beta testing.

Dedication by John Smith

CCDAutoPilot is once again dedicated to my astro-wife, Diane, for putting up with my countless hours writing and testing this code. It would have been impossible without her continuous generous and loving support.

Continuing to add features while improving ease of use, this version of CCDAutoPilot represents the sixth generation of automated image acquisition software. Originally intended to allow the computer to do the acquisition work while the operator was otherwise engaged (or asleep!), CCDAutoPilot has evolved into a tool to maximize your image acquisition quality by supporting a repeatable and reliable protocol. With this version, greatly enhanced target framing and acquisition is supported.

The user interface has been greatly advanced so that the user simply goes down the buttons on the left side to set up your unattended run literally from sunset to sunrise. A new status window reports on all activities as they occur in an easy to understand report. Of course, more detail is available if needed.

CCDAutoPilot comes in two versions - Standard and Professional. The Professional version provides unlimited multitarget imaging with the same easy-to-understand point-and-click user interface that CCDAutoPilot users have come to expect. The Standard version is limited to a single target but has all of the other capabilities of the Professional version.

CCDAutoPilot is a multi-threaded application. What this means is that instead of plodding from step to step, key events and activities can be monitored independently of the main session thread, allowing appropriate action such to be taken immediately instead of waiting to be asked.

Key Features

- **Enhanced User Interface:** Sporting a completely revised user interface, version 3 puts everything you need to easily set up your unattended run. A set of major functions is accessed via the buttons from Settings to set up your equipment to Run Session to review and execute your run. Reference links are provided that are germane to each function.

- **Application Flexibility:** Supports all popular camera control programs (CCDSoft and Maxim), telescope control programs (TheSky6 and ASCOM), focus control programs (FocusMax and @Focus2), rotators (RCOS PIR, Optec Pyxis and Astrodon TAKometer) and dome control programs (AutomaDome, ASCOM, Digital DomeWorks). When AutomaDome is used, a separate, high performance thread is used to keep the dome slot aligned during long exposures, eliminating the need to resource-hogging scripts. A required technology is plate solving and either PinPoint (full version), or the combination of CCDSoft and TheSky6 can be used. Support for the Cloud Sensor is seamlessly integrated into operations via a high performance separate monitoring thread.

- **One Step Setup:** For a given equipment arrangement, hitting the Initialize button calibrates your entire system, including your guider. You can then slew all over the sky with high accuracy, select a target and begin guiding *without guider calibration*. Just enter RA, Dec and PA and you will be right on the target. If you use TheSky6 (recommended!) you can position TheSky6's FOV Indicator as desired and begin accurate guiding, thanks to CCDAutoPilot's powerful internal algorithms for guider calibration.

- **Enhanced Target Selection:** After a one-time imager and guider initialization, you can point to literally any point in the sky and the telescope will accurately point there. Additionally if there is a guide star in the FOV, your guider will be calibrated not based on a simple and somewhat inaccurate guider calibration routine, but instead based on an accurate algorithm for enhanced guiding. CCDAutoPilot works entirely from RA, Dec. and PA (Position Angle) to point the scope and rotator (if installed) to the desired target. There is no need to be aware or rotator position - it is handled "under the hood" by CCDAutoPilot. Convenient reference information for sun, moon and target rise and set information is available. A programmable target midpoint altitude is provided to define your preferred lower altitude limit and when it occurs.

- **MultiTarget Acquisition:** Incorporating the ease-of-use CCDAutoPilot customers have come to expect, the Professional version provides a number of ways to acquire multiple targets. One can simply select the target by placing the FOVI (Field Of View Indicator) in TheSky6 as desired and hit a single button to get the coordinates. For mosaics, the user simply creates the Mosaic in TheSky6 and hits a single button to get the coordinates for all the mosaic sub-frames. There are also a number of importers. A plan from Starry Night Pro can be imported as well as the essentials of one from ACP. A user can also import a CSV (Comma Spaced Variables) file. Finally, target information can be entered manually via an edit window. Multiple target data can be acquired either with a common set of light frame data for all targets or individual sets, called profiles, for each target. The user has nearly unlimited

flexibility.

- **Focusing:** In addition to a generous selection of alternatives for focusing, filter offsets, starting focus exposure time and focusing using a user-specified filter (For those with parfocal filters) are provided.

- **Tracking and Guiding:** Depending on whether your are doing guided or unguided imaging a number of options are provided. You can dither to the desired amount with either technique. You can image through the meridian, depending on your equipment capability to go through minimal atmosphere for those all-important clear or luminance frames. A number of options and alternatives are provided to support your specific equipment complement. If unguided, your scope will be realigned periodically to take out any cumulative drift. If guided, you can program your guide exposure as a function of filter chosen and enable the Automatic Guide Star Recovery feature. With AGRS, CCDAutoPilot will wait until the guide error is within a specified accuracy within a specified number of attempts. If it isn't, AGRS will attempt to reacquire the guide star and change guide star exposures to continue guiding.

- **Guider Calibration:** For the first time anywhere, CCDAutoPilot brings a new and powerful approach to guider calibration. Instead of relying on a single guider calibration, and perhaps modifying that calibration result as the camera is rotated or the sky position changes as other products do, a completely new approach is used. Based on a system calibration via CCDAutoPilot's new Initialize function, guiding is optimally determined by analytical prediction and ***replaces*** guider calibration in the camera control program by these optimal vectors. No longer are multiple calibrations required to get good guider performance. And once initialized, this optimum guider performance is achieved no matter where in the sky the system is pointed, no matter how the camera is rotated, manually or automatically.

- **Light Frames:** Using the same point-and-click user interface as prior versions of CCDAutoPilot, version 3 adds some editing aids to make data entry easier. You can also elect to focus on the first exposure of a series or not. From the same page, you can edit the target exposure settings (target profiles) for every target on your list.

- **Dark and Bias Frames:** You can easily select specific dark and bias frames to be acquired either before the light frames while waiting for the target to rise, or afterward, when the light frames are complete, or both. You can optionally flush the imager before any frames are acquired.

- **Flat Frames:** As with the previous version, flat frames can be acquired from either TheSky or a light box. Additionally, you can now specify a position angle for the flat to match key target data. Automatic exposure dawn and dusk sky flats are supported with either tracking off or tracking on and dithered, depending on your preferences.

- **Session Tasks:** More automation tasks are provided including opening your dome and starting your cooler at a specified time. After your light frames you can park your scope and optionally close your dome. If you elect dawn flats, you can leave the dome open and at the appropriate time, the telescope will unpark, take dawn flats, re park the scope and warm up the cooler. At key points in the evening's activities, user developed applications or scripts can be run for maximum flexibility. To aid in data management, folders for the evenings activities can be automatically generated if desired, giving a readily recognizable folder name as to date and target.

- **Run Session:** Here the equipment setup can be reviewed as well as the session plan. Warning messages are provided to make sure nothing has been overlooked. Once satisfied, hitting the Run Session button minimizes the main window and opens the status window, enabling the user to track session progress to the degree desired. Of course the ability to pause and resume a run, as well as abort one, is provided.

- **Professional Support:** Stand FITS keywords, spectroscopy binning and inserting of World Coordinate System data in the FITS header is provided for professional users.

- **Smart Sub-framing:** With the advent of larger imaging sensors, many optical systems prevent full illumination of the sensors. Smart Sub-framing allows only useful data, as defined by the user, to be taken and downloaded. Once the user has defined the sub-frame size to be used, it is applied equally to light, dark, bias and flat frames. Any slew adjustments are then made to the center of the sub-frame.

Software Requirements

The following software components and versions are the minimum necessary for successful operation with CCDAutoPilot. CCDAutoPilot will simply **not work** with older versions or without the specified components properly installed. Version checking is incorporated to prevent operation with applications whose versions do not meet these minimums. In most cases, updates are freely available from the software publisher and must be implemented for successful CCDAutoPilot operation.

- Net Framework (version 2.0) Usually a part of an updated Windows system, it is essential to operation and may be downloaded here

One of the following camera control programs:

- CCDSoft version 5.00.170 or later
- MaxImDL/CCD version 4.10 or later Version 4.54 is required for AO support and direct guider programming for min/max move and aggressiveness.

One of the following telescope control programs:

- TheSky Professional Edition, version 6.0.0.40 or later
- ASCOM platform 4.1 or later, the NOVAS-COM Vector Astrometry Engine, v2.0.5 or later and The Kepler Orbit Engine v1.0a

Filter offset programming and Focusing:

- FocusMax 3.3.21 or later. The basic installer for version 3.2.1 and a patch file to version 3.3.21
- TheSky6, 6.0.0.40 or later for the Sky Star focusing method. See the Focusing section.
- ASCOM platform 4.1 or later
- PinPoint (Required for plate solving with Maxim alone and Acquire Star function only, see the Setup section info for details)
- For @Focus2, TheSky6 and CCDSoft are required.

One of the following rotator control programs:

- RCOS TCC software, version 1.5.23 or later
- Native support included for the Optec Pyxis rotator.
- AstroDon TAKometer Control, version 0.0.1 or later

One of the following dome control :

- AutomaDome version 1.00.011 or later
- ASCOM platform 4.1 or later
- Technical Innovation's Digital Dome Works

For the Boltwood Cloud Sensor:

- Clarity software, version 2.019 or later

Version History

3.42.7 June 2, 2008
- Buf fix: Corrected Maxim Initialization error introduced in 3.42.6.

3.42.6 June 1, 2008
- Enhancement: Changes for Maxim v5 compatability.

3.42.5 April 6, 2008
- Bug fix: Eliminated occasional unguided series when guided operation was selected
- Enhancement: Prevented an uninitialized profile from erasing camera control program guide calibration.

3.42.4 March 9, 2008
- Enhancement: Workaround for bug in RCOS PIR TCCII code
- Bug fix: Correct Starry Night import for PC and Mac
- Bug fix: Correct No Filter operation

3.42.3 March 2, 2008
- Bug fix: Corrected PIR wrap timer

3.42.2 February 9, 2008
- Improved compatibility with Starfish guider
- Turn off guider if altitude limit is hit
- Prevent TheSky6 RPC server unavailability
- Correct Maxim overrun error

3.42.1 December 25, 2007
- Enhancement: Abort session at start if very cloudy/rain reported by Boltwood
- Bug fix: Turn tracking back on for dithered flats if turned off previously
- Bug fix: Correct Maxim overrun error management

3.42.0 December 7, 2007
- Enhancement: Add PA to plate solve log
- Enhancement: Prevent guider start fault with FishCamp Starfish guider

3.41.9 November 26, 2007
- Enhancement: New meridian tracking value added. AM Stop Delay is deleted. See Meridian Flip
- Enhancement: Explicitly call selected filter in Maxim expose routine
- Bug fix: Prevent Pyxis position = 360 in additional routines

3.41.8 November 10, 2007
- FocusMax/@Focus2 timeout increased to 15 minutes.
- Added traps for multiple FOVI's, bad characters in description field

3.41.7 September 29, 2007
- Enhancement: Added timeout to prevent FocusMax hang
- Enhancement: AO Recentering when checked now happens at start of each series
- Bug Fix: Focus Now properly uses the filter specified in the camera control program

3.41.6 July 15, 2007
- Enhancement: Improve version checking routine
- Bug fix: Prevent Pyxis position = 360
- Bug fix: Make all registrations persistent

3.41.5 July 9, 2007
- Bug fix: Wrong build released

3.41.4 July 8, 2007
- Ehhancement: Improved error handling and logging
- Bug fix: Improved international format handling
- Bug fix: Improved operation with and without filter wheels

3.41.3 June 21, 2007

- Enhancement: Version checking incorporated for key controlled applications. See Software Requirements.
- Enhancement: Add target name and coordinates to review session and target coordinates to log
- Bug fix: Corrected slewing errors with non-US environments.

3.41.2 June 9, 2007
- Enhancement: Get from File target will not enter unless plate solve is successful.
- Bug fix: Correct Maxim correction in 3.41.1 to account for dark frame.

3.41.1 June 4, 2007
- Enhancement: Improve plate solving with Maxim and exposures greater than 15 sec.
- Bug fix: Correct Maxim guider start failure with long guide exposures
- Bug fix: Correct plate solve exposure sub-frame error

3.41.0 May 29, 2007
- Enhancement: Added Smart Sub-framing feature. See Equipment
- Enhancement: RCOS PIR flash writes minimized
- Enhancement: Try to park mount in case of cloud sensor abort
- Ehnancement: Help file search function added
- Bug fix: Prevent main window page change from interfering with running session

3.40.7 May 16, 2007
- Enhancement: PinPoint errors on plate solving now reported directly.
- Enhancement: Cooler off replaced by Cooler Warmup to 25°C. See Options
- Ehnancement: Added retry logic in case Maxim guider doesn't start
- Bug fix: Wait for focus completion with AcquireStar

3.40.6 April 21, 2007
- Bug fix: Eliminate ObjectDispositionException error ("CCDAutoPilot needs to close") on program close

3.40.5 April 10, 2007
- Enhancement: Focus deferral is active only if Enable meridian flip is checked. See Focusing

3.40.4 April 2, 2007
- Bug fix: logging error with ASCOM dome selection
- Bug fix: focusing now works properly with no filter wheel selected.
- Correction to help file, Focusing topic.

3.40.3 March 21, 2007
- Bug fix: Close error on single core processors fixed.

3.40.2 March 20, 2007
- Enhancement: Insensitive to localization in coordinate edits
- Enhancement: Added programmable cooler wait delay. See Options
- Enhancement: Focus prevented within 10 minutes east of meridian. See Focusing
- Bug fix: AO guide box size programming fixed
- Bug fix: IndexOutOfRange error trapped
- Bug fix: Eliminate interaction between Cloud Sensor and run pause function.

3.40.1 Not publicly released

3.40.0 February 16, 2007
Important notes: *The web update facility **cannot** be used to upgrade to this version. Download and install the complete package from http://www.ccdware.com/downloads/. After installing this version, future web updates will function as in the past. **CCDStack users**: Installing CCDAutoPilot version 3.40 or greater may require re-entering your license information in CCDStack.*
- Vista compatibility. Default location for Images, System Profiles and Target Lists is moved to My Documents\CCDWare\CCDAutoPilot3 (XP and Prior) and Documents\CCDWare\CCDAutoPilot3 (Vista). Existing license(s) will need to be re-entered. You will no longer need to install CCDAutoPilot2 for an upgrade but you will need to enter the license info. See the Licensing topic for details. During web update with User Account Control enabled (Vista only), you may be asked to approve Updater operation for web updates. As an added bonus, the trial period is reset to 60 days.
- Enhancement: Improved meridian efficiency. See PM Tracking
- Enhancement: Trace and reset functions not part of the Help menu. See Troubleshooting
- Bug fix: Manual guide star acquisition after flip now works as documented

3.31.1 January 28, 2007

- Insure dithering after off-target focus return and meridian flip

3.31.0 January 24, 2007
- Enhancement: Eliminate redundant guider start after meridian flip
- Enhancement: Start guider with full autodetect after off-target focus return and meridian flip
- Bug fix: Prevent exception when no filter wheel is selected

3.30.9 January, 19, 2007
- Bug fix: Start times corrected for year mis-match
- Clarified target coordinate equinox requirement. See Target Entry and Edit

3.30.8 January 15, 2007
- Enhancement: Eliminated cardinal point limitation. Can now calibrate at any angle.
- Enhancement: Max flat exposure time increased to 999 sec.
- Bug fix: Maxim now calibrates properly during initialization
- Bug fix: Prevent unrecoverable minimized status window

3.30.7 January 10, 2007
- Bug fix: Internal error

3.30.6 January 9, 2007
- Bug fix: ":" is replaced by "_" when target is from Guide Star Catalog to prevent file name exception
- Bug fix: Restored Az/Alt info to FITS header when Insert WCS is selected
- Bug fix: Target times are now properly reset after an aborted run
- Bug fix: Promulgated CCDSOft bug fix to all instances of guide exposure setting.
- Bug fix: Properly account for exposure delay times in time estimates
- Enhancement: Added "Planning Mode" to main window title as a reminder.
- Enhancement: Planning function improved for ASCOM and further described. See Planning

3.30.5 December 31, 2006
- New feature: Guide exposure and whether to guide can be set on a per series and per target basis. See Light Frames
- New feature: Post-focus offset focusing for minimizing the effect of field curvature. See Focusing
- New feature: Focus Now function added. See Focusing
- New feature: Darks Now function added. See Dark Frames
- New feature: Direct programming of min. move, max move, aggreessiveness in Maxim now supported. See Guiding
- New feature: Diffraction Limited (Boltwood) Cloud Sensor version I and version II now supported. See Software and Boltwood Cloud Sensor
- New feature: WCS data can be optionally inserted in the FITS header of light frames. See Professional Applications
- New feature: Plan mode added to make target planning easier. See Software
- New Feature: Spectroscopy binning. See Professional Applications
- Change: A default entry on the Target page will no longer be generated. If there is no target entry on the targets page, no light frames will be acquired.
- Bug fix: AO now works with Maxim. See Equipment Setup under cameras for important information.
- Bug fix: Improved CCDSoft exposure abort logic.
- Bug fix: Resolved index out of bounds exception in Review setup
- Workaround: For CCDSoft guide exposure setting bug
- Enhancement: Added delays for ASCOM dome control response to close shutter command.
- Enhancement: Mount now backs away from any limits when east if the meridian before parking.

3.25.6 November 18, 2006
- Bug fix: restore AutomaDome code to prior working version
- Bug fix: insure guide exposure is properly set when not dithering

3.25.5 November 16, 2006
- Bug fix - guider not being restarted after a focus run

3.25.4 November 15, 2006
- If dithering = 0, guider will not be stopped between exposures. See Guided Operation
- Initialization will be aborted if plate solve fails
- Added target ephemeris to log file
- Import | XML changed to Import | CCDNavigator
- Bug fix: Corrected wrong location for failed SyncImages

3.25.3 November 6, 2006

- Added open and close dome test buttons. See Options
- Improved AutomaDome reliability
- Prevent dis-allowed characters in the target portion of the default file name.
- Bug fix: Rotator does no longer rotates crossing the meridian with fork mounts.

3.25.2 (not released)

3.25.1 October 22, 2006

- Added support for TheSky6, Japanese version
- Improved meridian flip with Gemini and similar mounts by Safety Slew. See Meridian Flip topic

3.24.5 October 9, 2006

- Bug fix: Focus occasionally being skipped
- Increased web searh timeout a bit
- Added PinPoint LE error checking

3.24.4 October 8, 2006

- Added XML import facility
- Added Center TheSky function. See Target Entry and Edit topic

3.24.3 October 2, 2006

- Increased Internet connection timeout before Retrying
- Check for Updates check state now properly reported
- Added Update Now menu selection. See ~~Updates~~
- Added Updates topic to the help system.
- Added delay for FocusMax reporting succes or fail focus result for slow systems

3.24.2 September 30, 2006

- Maintain checked state of menu item Check for Updates
- Corrected help file on initialization topic

3.24.1 September 29, 2006

- Added automatic updating via the Internet. See the Help menu section of the User Interface
- Added new information to the Troubleshooting topic.
- Added warning to Setup Review about taking flats after closing dome shutter
- Further changes to AutomaDome control for Meridian Controls
- Bug fix: invalid path upon Flats Now
- Bug fix: Tracking On button

3.23 September 25, 2006

- "Object not found" bug fix. Can occasionally occur with certain locations in TheSky6.

3.22 September 23, 2006

- Added SkyStar capability when using @Focus2. This permits centering the focus star and magnitude range selection.
- When using TheSky, any target that is slewed to will be displayed in TheSky, along with the FOVI's Position Angle.
- Bug fix for getting a GSC star's coordinates, AutomaDome alignment to telescope. Improved shutter control reliability

3.21 September 17, 2006

- Bug fix for TAKometer rotation direction.

3.20 September 16, 2006

- Migrate to .NET 2.0 framework. See **new** Software Requirements
- CCDSoft @Focus2 focusing method is now supported. See Focusing
- Focuser temperature compensation is now performed completely in CCDAutoPilot. See Focusing
- Astrodon TAKometer rotator is now supported
- Added minimum altitude limit. See Options
- Extended Pyxis com port to COM16
- For dome users, if the shutter is commanded to open and doesn't, the run will abort. See Options
- Any applications to be run on the Options page must complete and close before the session continues. See Options
- Improved diagnostics and error messaging
- Added Equipment Setup to aid in hardware setup.

3.19 July 18, 2006

- Added target list Export function - see the User Interface menu section
- AO centering now occurs before focusing to insure accurate SkyStar target return
- Spurious prompt to save an unchanged target file on exit has been eliminated.
- Unguided realign now times properly

3.18 June 26, 2006

- Factored in calibration time for DirectGuide
- Handle exceeding slew limits more gracefully
- Added AO centering option - see the Guided Operation topic
- Added debug facility - see the Troubleshooting topic

3.17 June 1, 2006

- New trouble shooting section added to the Help system.
- CCDAutoPilot Reset Tool added for troubleshooting
- Enhanced monitoring thread reliability
- Corrected negative filter offset move bug introduced in 3.16
- Corrected unhandled exception with temp comp enabled with some focusers
- Factored in number of light sets into target time duration and total lights time

3.16 May 26, 2006

- Bug fix for TCC Focuser

3.15 May 22, 2006

- Corrected target run start time change detection
- Added CCDSoft support for SBIG Remote Guide Head
- Customization to support RCOS TCC temperature compensation - see **new** Software Requirements
- Fixed AO guider start bug with Maxim
- Stopped guider if running during run abort due to Cloudy/Very Cloudy.

3.14 May 5, 2006

- Expanded explanation of Initialize
- Corrected Dome find home timeout to 4 minutes (was 2 minutes). Changed thread states.
- Improved error trapping for bad initialization inputs, incompatible system profiles and missing FOVI in TheSky

3.13 May 1, 2006

- Fixed bad guiding with certain equipment combinations
- Added focus position and temperature logging for focuser temperature compensation
- Flat field min exposure now .01 sec and max exposure now .02 sec. for shutterless cameras

3.12 April 28, 2006

- Limited guider filter change upon guider start to self-guided configurations.
- Resolved ASCOM telescope exception.
- Corrected estimated start and end times.
- Added timeouts and retry logic for Tracking On, Tracking Off and some CCDSoft activities.
- Corrected Initialize button enable with some control program settings.

3.11 April 14, 2006

Corrected CCDSoft/TheSky plate solve bug introduced in 3.10

3.10 April 12, 2006

New features added.

- When using AutomaDome, a separate thread is used launched to maintain dome slit to telescope alignment. This eliminates the need for any high resource loading tracking script. AutomaDome support now **requires** AutomaDome version 1.00.011 or later.
- Added support for the Boltwood Cloud Sensor via an independent thread.
- Manual camera rotation without recalibrating is now provided.
- Guide Calculator with CCDSoft programming option added.
- Optional actions to turn tracking off and/or park the scope while waiting for a target start time
- The session start time is now user-settable for delayed start based on time or sunset after the run is initiated.

Bug fixes for always opening the dome on run start, failure to reload profiles when focuser temperature compensation was checked,some flat states not being saved, exposure delay not working, target lookup without defined FOVI, improved PIR position

reporting of TCC application, focus on flip not working, licensing bug for standard to pro upgrade. Dome rotation test increased to 15° for domes with large deadbands. Some log entries enhanced or added. **Note:** If you are using a profile created under a previous version of CCDAP, check the entries on the Flat Frames page for Sun Elevation. Enter defaults of 0.5 for dusk and - 8.0 for dawn and then save the profile to insure proper sky flat defaults are entered.

3.04 March 6, 2006

- Added code to support slow responding peripherals such as the TCC focuser and the Meade DSI imager.
- Improved UI responsiveness while focusing. FocusMax 3.3.15 is required.
- Expanded help file on Initializing

3.03 February 20, 2006

New features added:

- Centering of focus star and selectable focus star magnitude ranges in SkyStar.

Bug fixes for dawn abort, flats now slewing when it shouldn't, force filter change to sync filter at run start, temp comp being enabled for flats when not specified.

3.02 February 15, 2006

- Filter offset/filter change bug fixed.
- Additional bad user input trapping.
- Initialized guide exposure to sync filter.

3.01 February 13, 2006

- Added workaround for TheSky6 international issue, other international issues resolved, Dome Open enabled for Automadome users.
- Dome close now works correctly.
- Background colors now follow themes.
- Fixed filter changing during periodic focusing.
- Fixed temperature compensation logic.

3.00 February 6, 2006

- Initial release

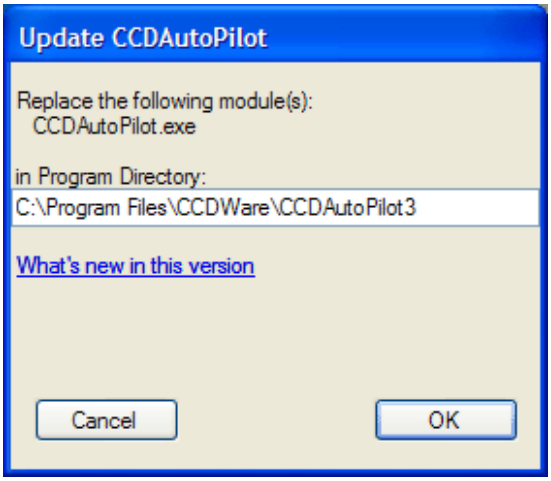
Updates

CCDAutoPilot has the ability to check for program updates automatically from the Internet. There are two menu items under Help that apply to this feature.

- **Get Updates from Web:** When checked, the first time CCDAutoPilot is loaded each day it will check for program updates via the Internet. If not checked, this checking will not take place.
- **Update Now:** When this menu item is selected, CCDAutoPilot will immediately check for updates.

Updates Available

If there are updates available, you will be presented with a choice to get more information before downloading if you select Yes. Next you will see this window:



First, the module(s) to be replaced, CCDAutoPilot.exe in this example, are listed. You can see where the replacements will be installed. This is where the program is installed.

You can click on the "What's new in this version" link to be taken to a web site with the version history.

If you click OK, the updates will be downloaded, the module(s) will be replaced, and CCDAutoPilot will start with the new version. It is that easy!

Update Options

As described above, you can disable the daily update checking. This is handy if you are on a slow internet connection or do not have internet access. This condition can be changed at any time by checking the "Get Updates from Web" menu entry. Merely opening it changes the presence or absence of a check mark to the opposite state.

Regardles of the checked state of "Get Updates from Web", you can always immediately check for updates by selecting the Updates Now menu item.

No Internet Connection at the Observatory

In this case, you should install CCDAutoPilot on your home or office PC so that you can check for updates. Note which modules are replaced and in what folder they are located. Copy those files to an appropriate media (flash drive, CD-ROM), and copy those to the appropriate folder, usually
C:\Program Files\CCDWare\CCDAutoPilot3, overwriting those that already exist.

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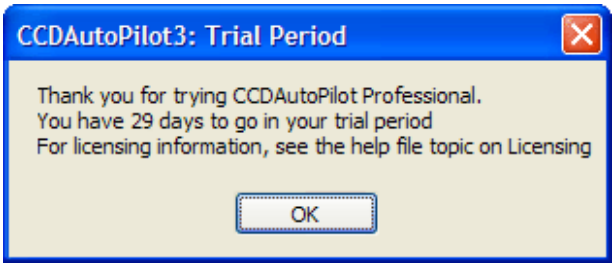
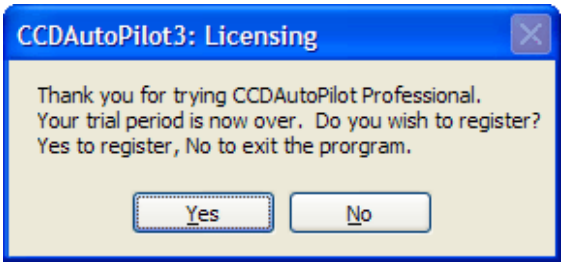
Licensing

Trial Period

CCDAutoPilot begins with a trial license to the Professional (multi-target) edition that allows you to see how it works with your particular system before you must purchase a license. The trial period is 60 days and 15 uses. This means you can use it as often as you wish in the first 60 days but if you don't use it at all in that period, you still have 15 trial starts regardless of how long after that you load the program. While you are in the trial period, an opening screen tells you how many days you have left in the trial.



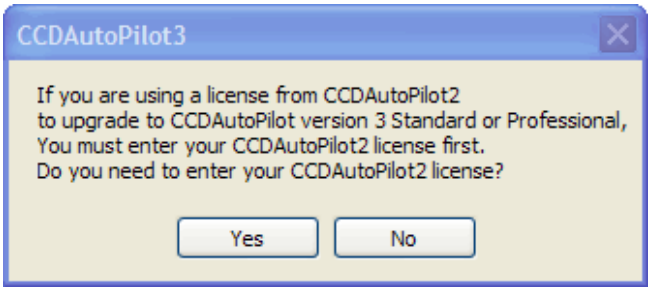
In this example, there are 29 days remaining in the trial period. This screen is no longer displayed when the product is licensed. If the trial period is expired, you will see this screen:



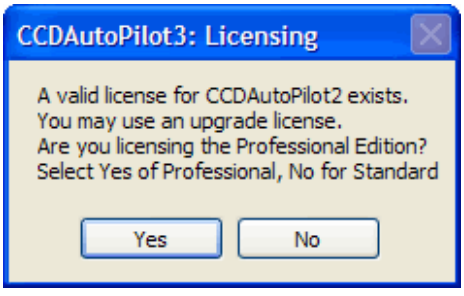
If you hit the No button, the program will exit. The Yes button will take you to the licensing dialog.

License Selection

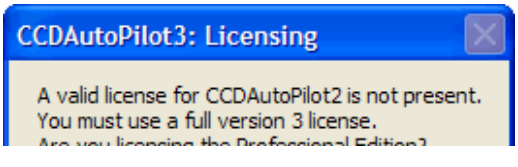
Licensing can be accessed at any time from the Help | Register menu. There a a number of possibilities for licensing, depending on the Edition you are licensing and whether or not you are upgrading from version 2 of CCDAutoPilot.

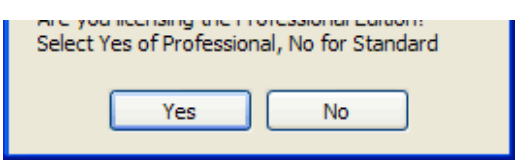


If you respond yes, you will be presented with an opportunity to enter your CCDAutoPilot2 registration info. If successfully entered, you will see:

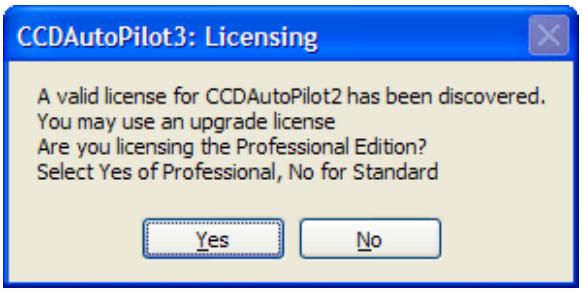


If not, you will see:

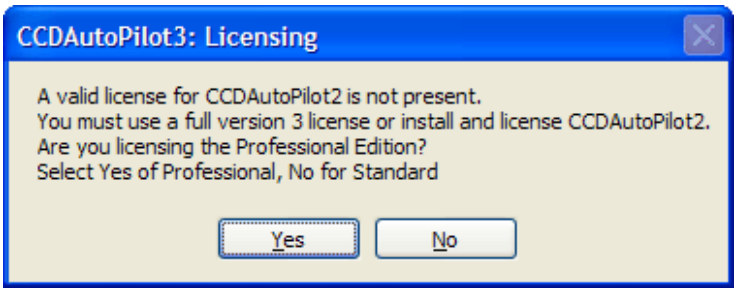




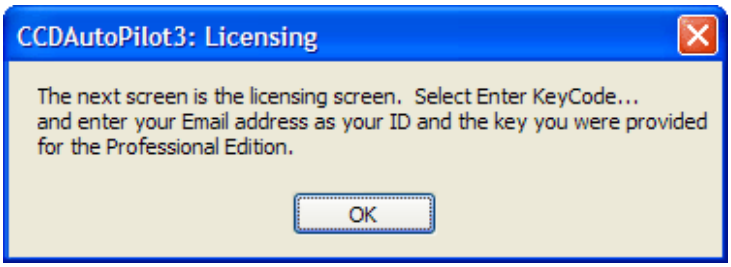
From this point on, you will be presented with one of the following two screens:



or

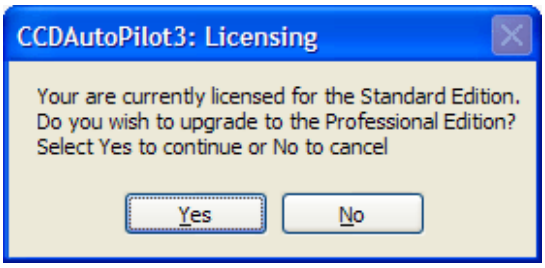


When you purchase your license, you should purchase the one appropriate for whether or not you have an existing license to CCDAutoPilot2. The license keys are not interchangeable. If you are using an full license key, it can not be used with a valid CCDAutoPilot2 license present. After making your choice on whether to license the Standard or Professional Edition, you will be presented with one of the following screens:

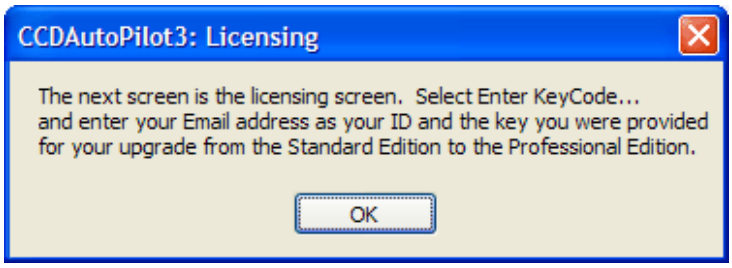


or

If you have licensed the Standard Edition and are upgrading to the Professional edition, selecting the Help | Register menu item will bring up the following screens:

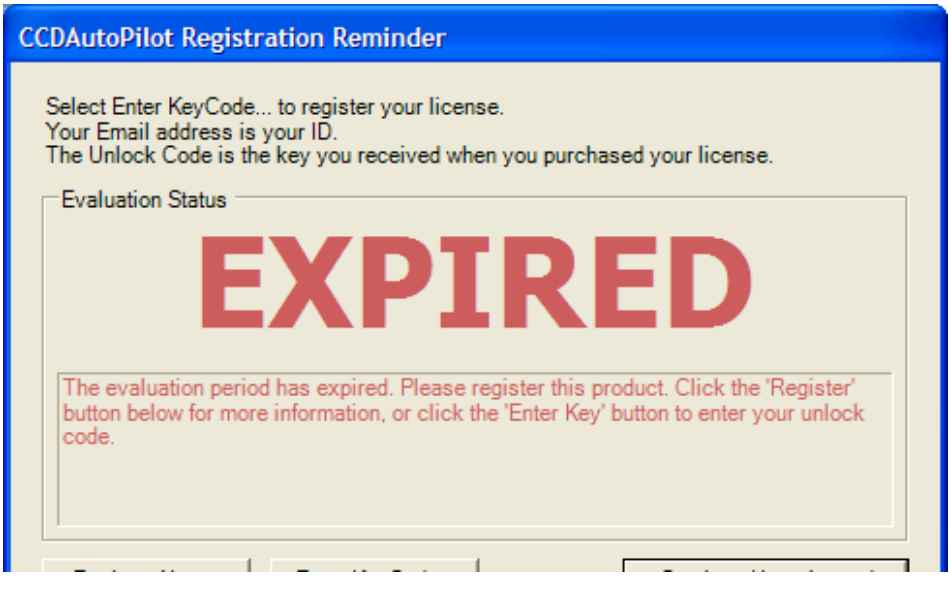


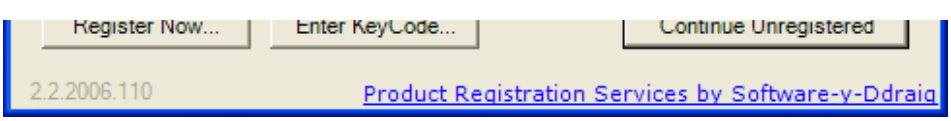
followed by



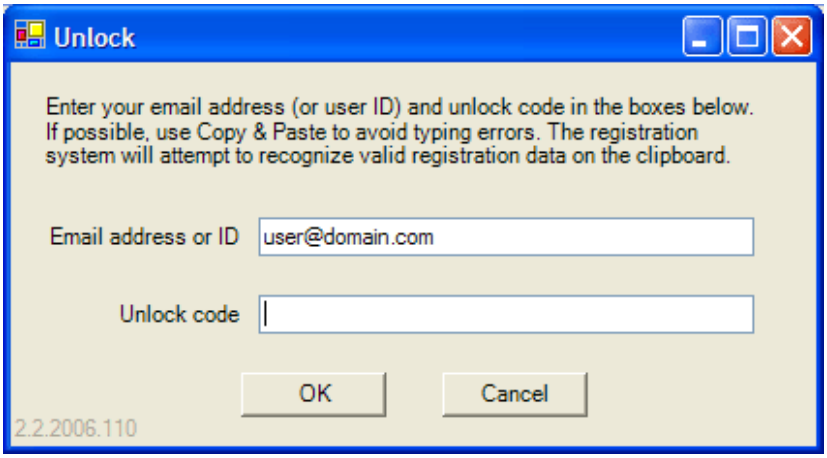
Entering the license info

From this point, you will get an information screen and finally the registration screen, as shown below:





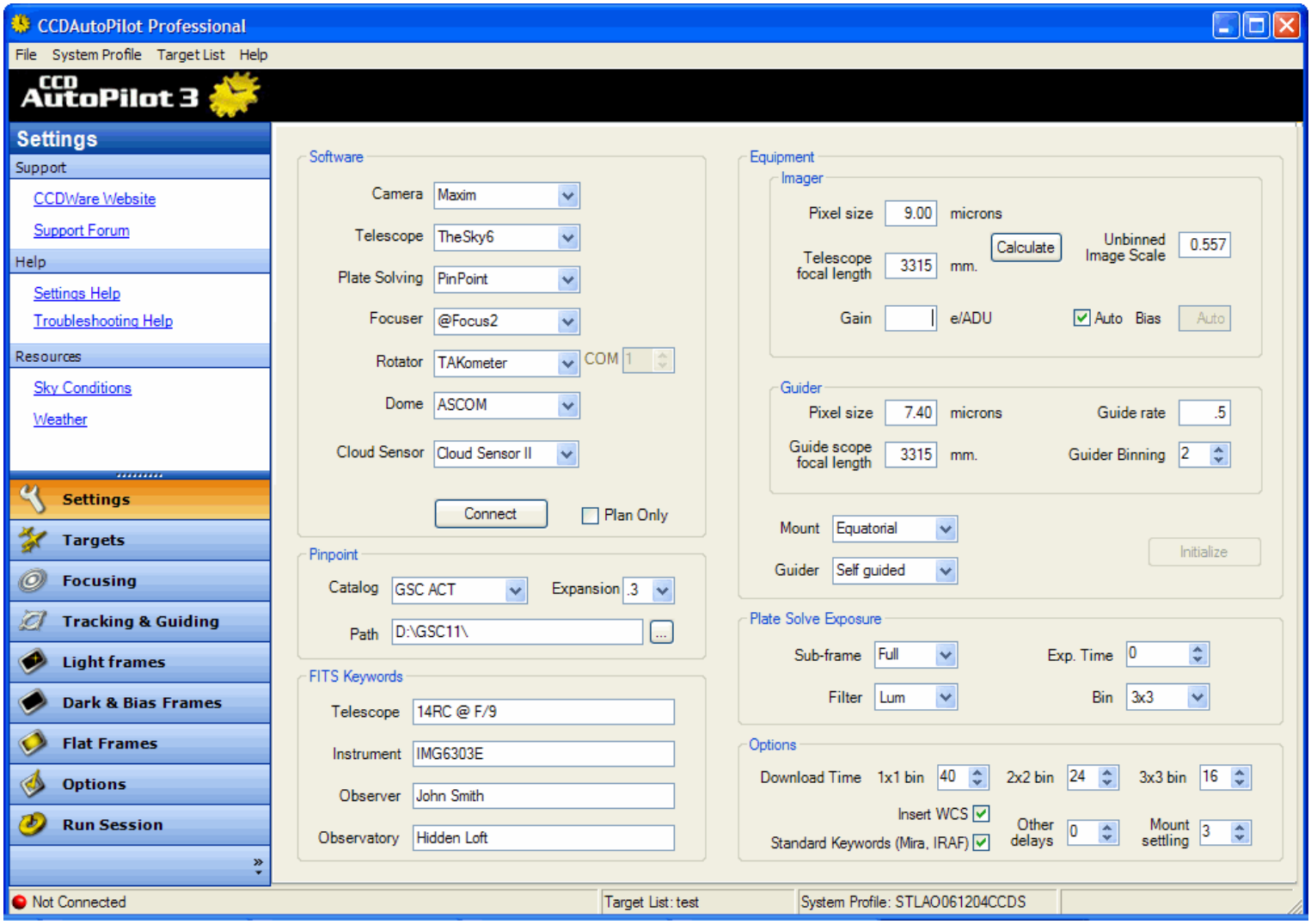
In the above example, the Trial Period is expired. If you are entering your license information before trial expiration, you will still see a similar screen, without the "Expired" statement. Hit the EnterKeyCode... button and you will see this final screen:



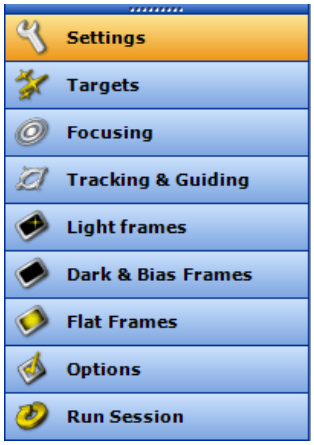
Enter your Email as your ID and the key you received as the Unlock code. Hit OK and you will be registered. You may confirm your successful registration by selecting the Help | About menu item.

User Interface

CCDAutoPilot's user interface has been completely redone to reflect modern human factors considerations in making the user's experience friendly and intuitive even when dealing with a complex topic like image acquisition. With a modern point-and-click user interface and its internal decision processes, CCDAutoPilot eliminates most if not all of the tedious commands, file manipulations, actions, scripts and directives common to other less facile programs. Key information is maintained in two files: the System Profile and the Target List. The System Profile contains all the information pertinent to the observatory setup and usage, as defined by the various pages in the main window. The Target List contains the key information for the target(s) entered, including location coordinates (RA, Dec, Position Angle), start time and exposure and folder location.

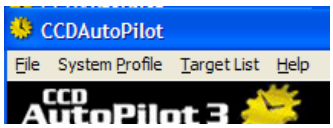


When starting CCDAutoPilot, the user sees the main window. This is used to set up the night's activities. Once the run is launched, this window minimizes and a smaller status window is presented to allow monitoring the activities with the degree of detail the user requires. Of course both windows are completely resizable as the user desires and each window's size and position are remembered for subsequent startups.



The two items shown above represent the left side of the user interface. The buttons are arranged in a logical sequence to take the user from initial setup through the various steps acquire the desired data and manage the observatory. The last button, Run Session, provides a review of the setup, the planned session and then launches the run.

Above the button panel are handy links to online resources as well as to the section of the help system that corresponds to the page displayed by the specific button. Sky Conditions and Weather are customizable by entering your preferred links for your local conditions and these settings are also maintained. For example, for Sky Conditions, I use a local Clear Sky Clock link and for Weather, I use a local weather link.



The menu system provides access to broadly used functions that need to be accessible at any time. Menu functions are as follows:

File

- **Exit:** Exits the program. The user can also use the standard Alt-F, X key sequence as well to exit the program.

System Profile

- **Load:** Loads a system profile. System profiles end with .app (AutoPilotProfile). The starting directory is that of the last saved system profile.
- **Save:** Saves the current system profile to its current location.
- **Save As:** Offers the opportunity to save the system profile with a different name. The starting directory is that of the last saved system profile.

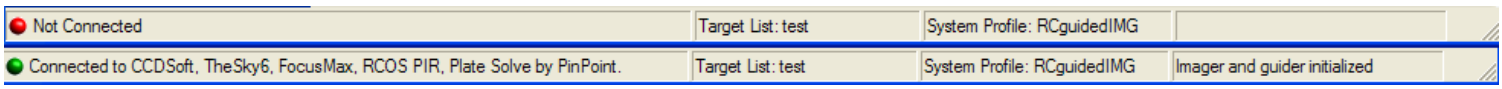
Target Lists

For the standard version, the target list is limited to one item. For the professional version, it is essentially unlimited.

- **Load:** Loads a target list. Target lists end with .apt (AutoPilotTarget). The starting directory is that of the last saved target list.
- **Save:** Saves the current target list to its current location.
- **Save As:** Offers the opportunity to save the target list with a different name. The starting directory is that of the last saved target list.
- **Import:** This selection offers a number of imports to assist the user that may have other target lists, plans and schedules in different formats or from other programs. Target lists can be imported from CCDNavigator or in Comma Spaced Variable (CSV) format and from such programs as Starry Night, ACP Planner and ACP. Thus a user can bring his desired targets into CCDAutoPilot Professional and still take advantage of the flexibility and features offered in CCDAutoPilot.
- **Export:** Exports the target information shown on the target page to a text file. Unfortunately, the light frame details will not be able to be exported.

Help

- **Help Topics:** Accesses the CCDAutoPilot Help System.
- **Troubleshooting**: Accesses Troubleshooting information, Trace and Reset tools. See Troubleshooting for details.
- **Get Updates from Web:** When checked, CCDAutoPilot will check each time CCDAutoPilot is started to see if there are any updates availabe. If there are, they will be automatically downloaded and installed. This feature may be disabled by clearing the check mark next to the menu item. If it is checked, it will be updated on the next day CCDAutoPilot is loaded. See Updates topic.
- **Update Now:** Forces an immediate update check. See Updates topic.
- **Upgrade to Professional Edition:** Provides a link to purchase the Professional Edition upgrade
- **About:** Brings up the version number and user licensing information



The status bar runs along the bottom of the main window and provides key information and status. There are four boxes.

1. The first box shows whether CCDAutoPilot is connected and to what applications it is connected in order to control them.
2. The second box indicates the Target List in use.
3. The third box indicates the System Profile in use.
4. The fourth box shows status based on any activity on the given page.

User Aids and Information

A context sensitive help system is available either from the menu, the links at the left or by selecting the entry on any page and hitting the F1 key.

All buttons and many functions have tool tips associated with them. Hover the mouse cursor over a button for a reminder of what it does.

Text entry boxes that may have long entries from either a path or a link will display the full data when the mouse hovers over the box.

Walk through

Installation
CCDAutoPilot is an executive program. This means it controls other programs that must be properly installed and up and running before CCDAutoPilot is launched. Depending on your installed software, certain underlying applications must be installed first.

1. Install .Net 2.0 framework. This is normally installed as part of the Windows Update process. If you have TheSky6 installed, the .NET framework is installed as part of it. To see if it is already present, go to Control Panel | Add/Remove Programs and scroll down the list. If .NET 2.0 is installed, you will see an entry for Microsoft .NET framework 2.0. If the entry is present, then close the Add/Remove Programs window. If it is not present, install it using the link found in Software Requirements

2. If needed, install the latest ASCOM platform, including the Kepler and NOVAS utilities. Links are found in Software Requirements

3. Extract the CCDAutoPilot set up files to a new folder and double-click on setup. When the setup completes, you will find a CCDAutoPilot3 icon on your desktop.

4. If you are using Software Bisque applications such as TheSky and/or CCDSoft, you must enable the underlying software communication system for the Software Bisque applications. For TheSky, ensure in Telescope | Server Settings that all boxes checked. "Log Current Telescope Connection..." is not necessary to be checked. For CCDSoft (if installed), ensure in Camera | Server Settings that all boxes checked except two. "Make BMP copy" and "Make GIF Thumbnail Copy" must not be checked. If they are checked, CCDAutoPilot will uncheck them. In CCDSoft, File | Preferences, be sure you have selected TheSky6 Professional edition. In order for SkyStar to properly function, in TheSky6, Telescope | Setup, be sure to uncheck "Always keep telescope crosshairs on screen".

5. In your chosen camera control program(s), be sure to enter your telescope focal length for camera (and guider if different) and your filter names. CCDAutoPilot needs this data for proper operation.

First Time Users
First time users and experienced CCDAutoPilot users are encouraged to go through the next steps. There are many new features and capabilities that can best be understood by going through these steps.
It is not necessary to connect to anything to set up a run. CCDAutoPilot has a set of default binning and filter assignments that may or may not agree with your specific camera. Once you connect CCDAutoPilot to your camera via your camera control program for the first time, the filter and binning selections will be updated and stored. To orient yourself to the program, step through the various pages using the buttons at the lower left. CCDAutoPilot follows a logical flow to set up an automation session.

1. CCDAutoPilot opens with the Settings page. Here you define the basics of your system - software, equipment and configuration.

2. The Targets page is where you would select your target(s) for the evening. Using the Add button, you can add a target manually. If you use TheSky6 and are connected to it, you can get a target a number of ways using the power of TheSky6. A selected target's ephemeris is provided with customizable midpoints. For reference, the sun and moon rise and set times are provided to aid in target planning.

3. The next thing to consider is how and when to focus during the run. The Focusing page brings up a host of options for maximum focusing flexibility. The little buttons with the inverted triangle on them are like ditto marks. They copy the first entry to all the entries below as an editing aid.

4. Having determined your focusing strategy, your Tracking and Guiding decisions are next. Depending on whether you choose guided or unguided operation, you can select dithering, meridian flip (with an equatorial mount of course) and guide exposures.

5. Now we are ready to select the Light Frames. Your target(s) will be available in the top pull down. You can select each target and assign it a specific light frame sequence, as defined by the eight series below. Checking the left box activates the series and you can control the number per series, filter, exposure, binning and even whether or not to focus at the start of each series. You can also set how many times to repeat each series set on the page.

6. Next we select our Dark & Bias Frames for calibration. You can select whether to take them before or after the light frames or at both points. You can select bias or dark frames. And of course all the normal number, binning, filter and exposure selections are available. Depending on your imaging camera, you may want to enable the Flush series. This series is run once before every series set to help remove any residual image (stored charge) in the imager's CCD array. And as with the Lights Frame, you can also set how many times to repeat each series on the page.

7. The last set of calibration frames are Flat Frames. Flat frame acquisition was once a tedious operation at best but is now streamlined by CCDAutoPilot by its automatic exposure facility. For each flat series, you specify the number, filter, binning and target ADU level and CCDAutoPilot does the rest. You can specify dusk or dawn flats or both and they will be automatically taken at the appropriate point in the twilight sky - automatically! For extra critical flat field matching to your target, you can even specify the position angle to match your target exposures. You can either have tracking on or off for flat acquisition. If you have tracking on, you can dither between flats to remove any stray stars that appear during twilight. If you use a light box instead, you can put the light box on your scope and hit the Flat Frames Now button to acquire them with the same ease as sky flats.

8. Having defined all the required data and method of acquiring it, the Options page is the next stop. The session is divided into 3 sections. At the end of each section, a user-supplied program can be run if desired. A fully configured flow could be something like this:

- Open the dome, wait until 5 PM for the dome to cool down and then start the camera cooler at a setting of -10°C. After cooling to the desired temperature and before twilight is over, take dusk flats.
- Take some dark and bias frames and then the desired light frame. Then park the mount, take some more darks until twilight. Abort any remaining darks at twilight. Slew to the appropriate point in the sky and take the desired dawn flats.
- Repark the mount, close the dome, turn off the cooler and run any additional housekeeping application desired.

Thus an entire evenings activities can be planned here.
Now, notice the Image Managementt box. In addition to setting the exposure's starting serial number, a very powerful default storage mechanism is provided. First set the base or root imaging folder, C:\Astronomy in this example. Assume today's date is January 15, 2006, you are imaging M1 and M2, and the Auto-generate sub folders is checked. Your entire imaging run will be stored as follows:

Light Frames : C:\Astronomy\060115_M1 for the M1 light frames
and C:\Astronomy\060115_M2 for the M2 light frames.
Bias, Dark and Flat calibration frames: C:\Astronomy\060115_CalibrationFrames
CCDAutoPilot log files: C:\Astronomy\CCDAutoPilot_Logs

The Test box allows testing of your hardware in response to typical CCDAutoPilot generated functions via the appropriate camera control program. You should test each function to make sure the hardware responds appropriately before committing to an unattended operation.

IMPORTANT: CCDAutoPilot can only send the Tracking Off and Park command to your telescope control program. It is your responsibility to verify that your mount behaves properly when it receives these commands. Please take advantage of the Test buttons to verify proper communications with your mount and dome. Hit these buttons one at a time to test whether your chosen telescope control program turns off tracking or parks the mount. If you don't get the expected results, consult the manufacturer of your telescope control program for support. CCDAutoPilot sends standard commands for tracking off and park in accordance with ASCOM and TheSky6's defined interfaces.

The Resources box allows saving any desired links to Sky Conditions and Weather you may desire.

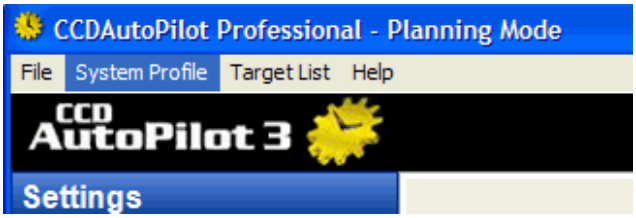
9. Having set everything up, the Run Session page gives a preview of the run and the setup. Look both over for any warning messages before initiating the session via the Run Session. It is grayed out since there is no camera control program connected.

This completes the orientation. To increase your familiarity with the program, try running some sessions with a simulated camera and telescope. Here is some outline information on how to set up the simulators. You must use the minimum versions specified in Software Requirements. You can of course use more recent versions. CCDAutoPilot's operation will be inhibited for out-of-revision applications. For more details, refer to the individual application's documentation:

- CCDSoft: Open the Camera Control Window and select the Setup tab. For the Camera, select "Simulator". Select the radio button for AutoGuider and again select "Simulator". For the Filter Wheel, select "CFWAPI". You can change the filter names to something meaningful. For the Focuser, select "<None Selected>" Select the autoguider radio button and again select Simulator for the Camera.
- Maxim: Open the Camera Control Window and select the Setup tab. For the Main CCD Camera, hit the Setup button and select Simulator. For the Autoguider, hit the setup button and select "Same as main camera". For the Filter Wheel, hit the Setup button and select "Simulator". You can change the filter names to something meaningful.
- TheSky6: Go to Telescope | Setup and select "Simulator" for the Telescope.

First, set up your base image folder on the Options tab. Check Auto-generate sub-folders. You can experiment with acquiring targets using TheSky6. Click on get and see the FOV Center target acquired. Enter M1 and hit enter to see the coordinates for M1 entered. Try setting up a mosaic and acquiring the points of the mosaic. Set up a single, brief exposure in the lights tab and watch the telescope slew to the mosaic point. Try obtaining some dark and bias frames before and after the lights. Check your base images folder to see how sub-folders are automatically created and note the default file names. Try entering your own descriptions for light frames and calibration frames to see how the file names are created in that case.
In short, the best way to get familiar with CCDAutoPilot's capabilities is to play with it with the simulators. There is context sensitive help available from most points in the program. Click on a form or function and hit F1 to get information specific to that item. And feel free to take advantage of our support forum and other resources linked at www.ccdware.com

Planning



CCDAutoPilot allows developing a target list that will encapsulate all data-gathering activities for one or more targets, depending on your CCDAutoPilot version. No connection to hardware is required. You can use the full power of TheSky6 without a telescope connection to develop your exposure paramters as defined on the Targets and Light Frames pages.

Planning mode is initiated selecting a suitable Telescope Control Program (ASCOM or TheSky6), checking the Plan Only checkbox and hitting the Connect button. Any other selections for Camera Control, Focuser Control, etc. will be ignored when in Planning Mode. Upon connection, the CCDAutoPilot title bar will indicate planning mode.

Once connected you can import target lists from CCDNavigator or any of the other data structures supported by CCDAutoPilot. You can also manually enter and edit target data. There are some differences in capabilities of the two telescope control programs:

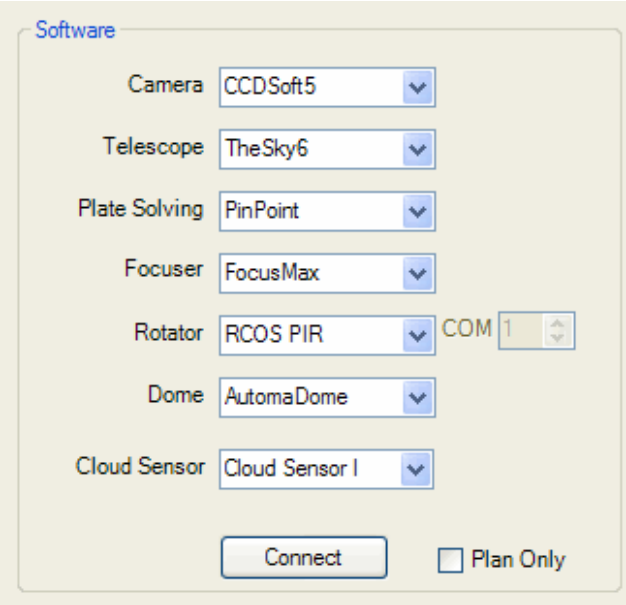
ASCOM Telescope Control: When ASCOM is selected as the Telescope Control program and Plan Only is checked, the ASCOM telescope simulator is automatically loaded. By entering your site data in the telescope simulator setup, you will get accurate sun ephemeris data on the Targets page. There is no connection made to your "real" ASCOM telescope driver. Your target entry and edit is limited to manually entered target coordinates and imported data structures.

TheSky6 Telescope Control: When TheSky6 is selected as your Telescope Control program and Plan Only is checked, CCDAutoPilot is able to attach to TheSky6 to take advantage of its power for defining targets. There is no connection to a telescope at any point in Planning Mode. You can take advantage of all the features in Target Entry and Edit as well as FOVI targetting.

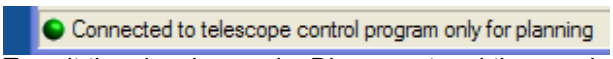
Once you have your targe plan defined, you can save the target list. The saved target list will have all of the light frame and target data in it you have defined above. You can then use that target list for the evening's activities. You can transmit the target list to your remote observatory and load it for a remote session. If you want to use an ASCOM driver for telescope control, you can still do that, even after having used TheSky6 for planning!

Software

This is where you define the control programs that will be used for controlling your equipment. In order to set up an evenings run, the only connection required is to the telescope control program, although the telescope need not be powered on or connected, so that target information can be obtained. Thus with only TheSky6 running (for example) it is possible to set up your entire evening's run without any observatory equipment connected or energized.



- **Camera:** Select from Maxim, CCDSoft or None as desired.
- **Telescope:** Select from TheSky6, ASCOM or None as desired
- **Plate Solving:** Select from CCDSoft/TheSky, PinPoint or None as desired. Regardless of what plate solving selection is made, either Maxim or CCDSoft can be used as the camera control program for image acquisition and guiding. Due to licensing restrictions, the full version of PinPoint is required. By the manufacturers intent, an exception is thrown if the LE version that accompanies Maxim is used. When CCDSoft/TheSky6 is used for plate solving, both programs must of course be present. For most of the features of CCDAutoPilot, one of the plate solving selections must be chosen.
- **Focuser:** Select from FocusMax, @Focus2 or None. Either FocusMax or @Focus2 can be used for automatic focusing at various times in the course of a run.
- **Rotator:** Select from Optec Pyxis, RCOS PIR or none. When the Optec Pyxis is selected, a COM port for controlling the rotator must be specified. Any other program used to control the rotator must be closed. Manual control of the rotator is still possible on the Targets page. When the RCOS PIR is selected, the TCC software is controlled via CCDAutoPilot but the TCC application can remain open and "live".
- **Dome:** Select from ASCOM, AutomaDome, Digital Dome Works Control Program (DDWCP) or none. CCDAutoPilot will use this selection for dome automation at various parts of the run as programmed by the user.
- **Cloud Sensor:** Select the desired cloud sensor. Boltwood Cloud Sensor version I and version II are supported. If the cloud sensor doesn't report a sky condition within a specified period of time, then a warning message is shown and the cloud sensor is set back to none.
- **Connect:** Once your selections are complete, hitting this button establishes the software connections to the chosen applications so that they can be controlled by CCDAutoPilot. Once the connections are established, this button changes to Disconnect. Hitting this button will then disconnect the chosen application. You can Disconnect, change the selected applications and then Connect again without closing CCDAutoPilot
- **Plan Only:** When checked and the Connect button is hit, only the specified telescope program is connected to CCDAutoPilot. The telescope mount itself is not connected to either the telescope program or CCDAutoPilot. This mode allows target planning either independently with TheSky or manually with ASCOM, or importing CCDNavigator plans. You are able to edit and adjust your image acquisition plan without being connected to your observatory. See the Planning topic for more details. You are notified of this condition in the status bar as shown:



To exit the planning mode, Disconnect and then unchcek the Plan Only checkbox

Cloud Sensor

CCDAutoPilot incorporates support for the Diffraction Limited (Boltwood) Cloud Sensor, version I and version II. The cloud sensor reports sky conditions as indicated below. CCDAutoPilot monitors this report via a high performance separate thread to provide immediate response to changing sky conditions.

Sky Conditions

Unknown: The cloud sensor is not reporting sky conditions. CCDAutoPilot assumes the sky is clear and the run proceeds. An error condition is logged indicating the unknown sky condition.

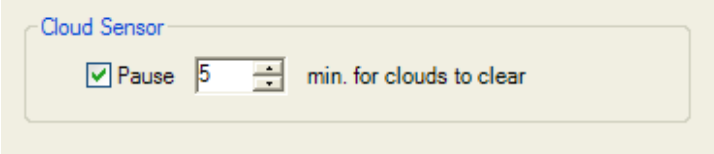
Clear: The cloud sensor is reporting a clear sky. The run proceeds.

Cloudy: Different actions are taken in the event of a cloudy report from the cloud sensor, depending on the selected option. If CCDAutoPilot is waiting for the clouds to clear and dawn is approaching, then the shutdown tasks will be initiated.

Very Cloudy: the appropriate user-specified shutdown tasks are executed immediately upon the cloud sensor reporting this condition. A session can not be started if this condition exists.

Wet/Rain: the appropriate user-specified shutdown tasks are executed immediately upon the cloud sensor reporting this condition. A session can not be started if this condition exists.

Cloud Sensor option on the Options Page



If Pause is checked, the run will pause for the specified number of minutes to wait for the clouds to clear. If they clear in that period of time, the run resumes. If they do not, the run aborts and the appropriate user-specified shutdown tasks are executed. If pause is not checked, then the appropriate user-specified shutdown tasks are executed immediately upon the cloud sensor reporting a cloudy condition.

Shutdown tasks

Upon initiating the shutdown event, the tasks specified on the Options page under "3. Shutdown", **if checked**, will be executed. If these options are not checked, they will not be executed.

1. Any light exposures in process will be aborted.
2. If a dome is connected to CCDAutoPilot, a command will be sent to the dome via the automation interface to close the dome.
3. Commands will be sent to the telescope control program to park the telescope and/or turn tracking off, if selected by the user on the options page.
4. Any scheduled dark/bias frames will continue
5. Any scheduled dawn flats will **not** be taken.
6. Any scheduled shutdown activities such as turning the camera cooler off or running a shutdown application task will be executed.

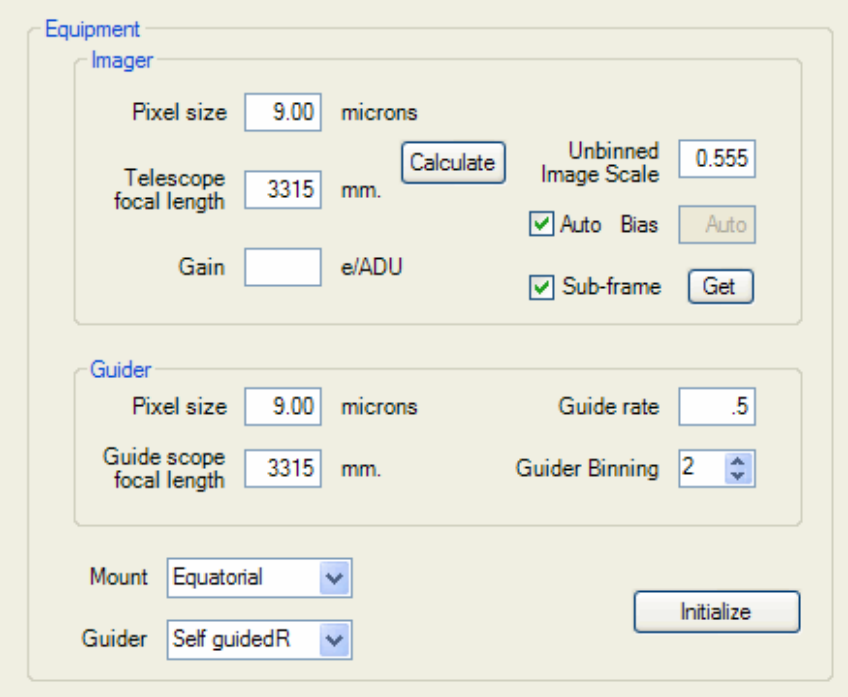
CAUTION

Both the Cloud Sensor documentation and common sense advise against relying on this device to protect valuable equipment. It is mainly intended as a monitor of sky conditions. See the Cloud Sensor documentation for details. CCDAutoPilot responds to changing sky conditions as a convenience to the user and in no way should be considered a fail safe approach. The most reliable usage, again without guarantees, is to have a direct connection between the Cloud Sensor and the dome control hardware emergency close switch with no intervening software. The dome controller should be on an uninterruptible power supply (UPS) to be able to close the dome in the event of a power failure.

None of this is any substitute for an attendant.

Equipment

This section is used to provide CCDAutoPilot with essential information about your equipment. This data must be entered correctly to insure proper automation control of your observatory. Much of this information will be automatically obtained by the Initialize button but should it fail, you will need to enter it manually. See Equipment Setup for hardware-specific information as it becomes available.



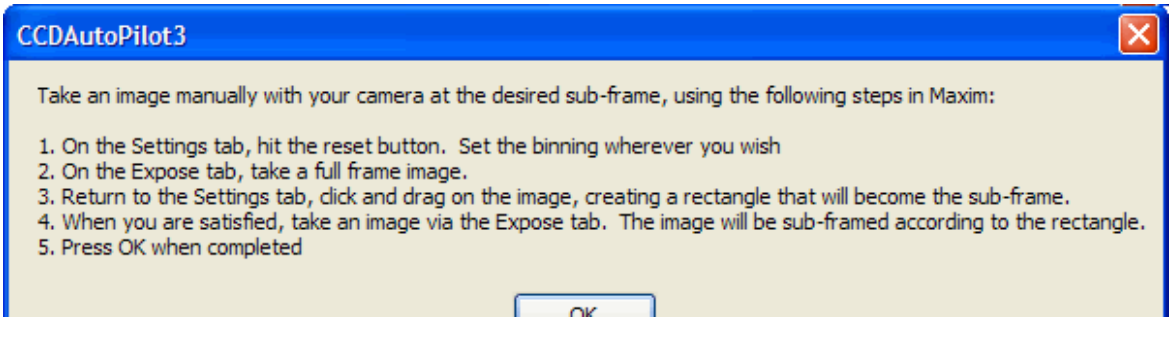
Imager

- **Pixel size:** This is the size of the pixels used in your imager. If your chosen camera control application properly provides the information, it will be obtained automatically with the Initialize button. If not, you must enter it manually.
- **Telescope focal length:** This is the focal length of your imaging telescope. If you have properly entered it in the defaults/settings section of your camera control program, it will be obtained automatically with the Initialize button.
- **Unbinned image scale:** You need to provide an estimate here. You can enter pixel size and focal length estimates here and hit the calculate button to get a rough estimate. The Initialize button will refine all data.
- **Gain:** If provided by the camera control program, this data will be filled in. Otherwise it can be entered manually.
- **Auto Bias:** If this is checked, the average bias level will be measured and added to the specified target ADU for sky flats. The higher the average bias level of your camera, the more necessary this is to insure best accuracy. Of course you will still need to subtract a master bias from the resultant sky flats, best made from many bias frames to insure lowest noise. If your average bias level is consistent or if your camera does not have a shutter, you should uncheck Auto and enter your average bias value. This will allow unattended operation to progress without having to cover the telescope for the automatic bias frame acquisition.
- **Sub-Frame:** When checked, the Get button is activated to allow acquiring a suitable sub-frame. When cleared, the full frame of the sensor is used.

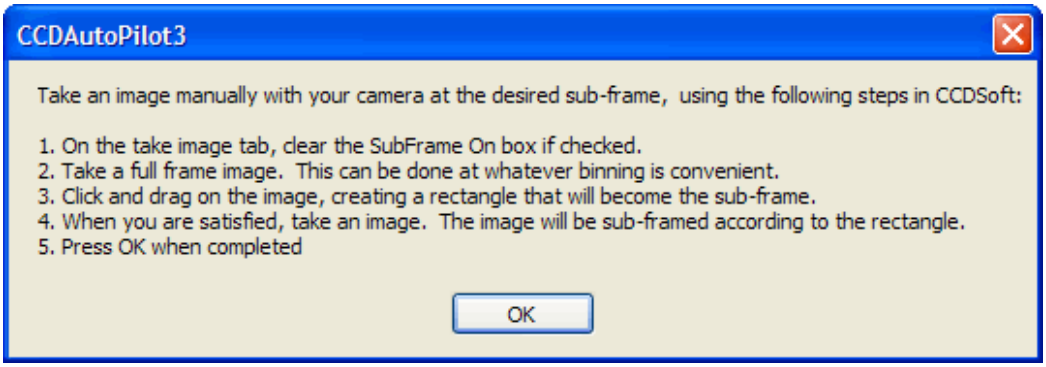
Sub-framing is useful any time you want to limit the pixels used in your imaging sensor. It may be that you have a larger sensor than can be fully illuminated by your optical system. By using sub-framing, you only take and download the data you will ultimately use. Once defined, this sub-frame information is stored in the system profile for subsequent reuse. This sub-frame definition is applied identically to light frames, dark and bias frames and flat frames. Any precision slews use a plate solve that is taken from the center of the sub-frame.

To define a sub-frame, follow the instructions presented when you hit the Get button. They will be different, depending on your camera control program. The sub-frame data reported below may be slightly different than that shown by the camera control program. This is done to insure binned to unbinned integer relationships, i.e. no "fractional" pixels.

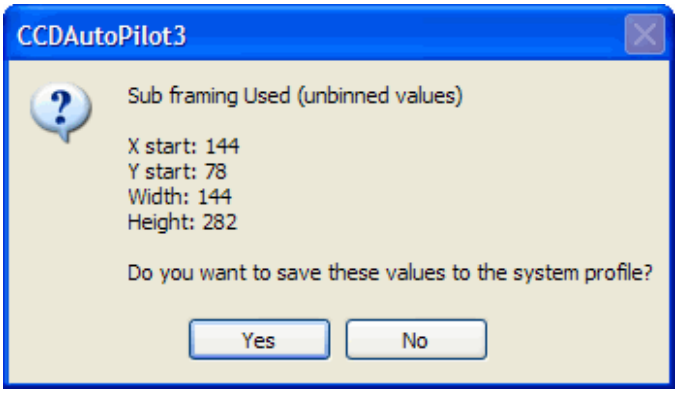
For Maxim:



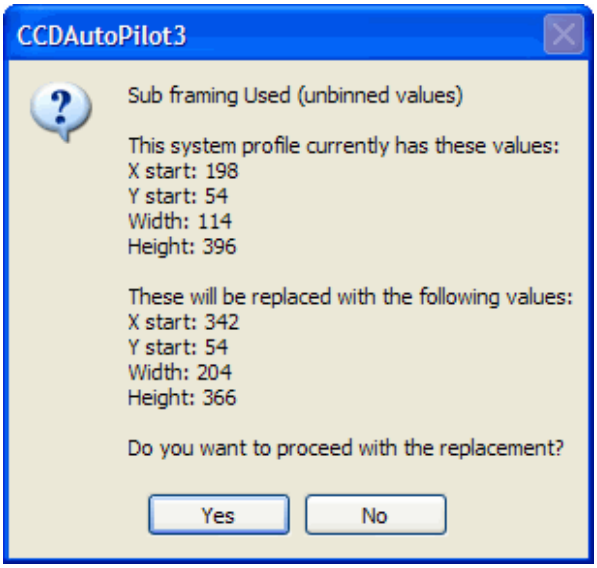
For CCDSoft:



Once you have made your selection, you will be given an opportunity to save it to your system profile:



In either case, if you wish change the defined sub-frame, you will be presented with the old and new with an opportunity to accept or reject the new one:



If you select No, the previous sub-frame information will be maintained. Sub-framing will be calculated proportionally for any binned sub-frames. The sub-framing data is always reported unbinned.

When sub-framing is active for a session, the default file name will end in "Sub", just before ".fit". Here are some typical default file names when sub-framing is used:
Light frame: `Clear169W_M101_00062Sub.fit`
Dark frame: `-15Dark600s1x1_070528_00076Sub.fit`
Bias frame: `-15Bias1x1_070528_00074Sub.fit`
Flat frame: `Clear_Flat169w_M101_00102Sub.fit`

Warnings will be given in the Session review and log file that you are using sub-framing. A typical warning at the start of a session will look like this:

```
22:55:01 Root save path: \\Reggie\astronomy\
22:55:01 System profile: C:\Astronomy\_Documents\U16M_DG070524.app
22:55:01 Target List: C:\Astronomy\_Documents\M101.xml
22:55:01 Start sequence number: 61
22:55:01
```

```
22:55:01
22:55:01 WARNING: Sub-framed exposures selected and being used.
22:55:02
22:55:02
22:55:02 Light Frames
22:55:02 Telescope connected
```

You can see what sub-frame information you are using by the Review Setup button on the Run Session page. A typical entry will look like this when sub-framing is used:

```
WARNING: Sub-framed exposures used for imaging
    Note: these are unbinned values
    X start: 342
    Y start: 342
    Width: 3402
    Height: 3402
```

Guider

- **Pixel size:** This is the size of the pixels used in your guider. If your chosen camera control application properly provides the information, it will be obtained automatically with the Initialize button. If not, you must enter it manually.
- **Guide scope focal length:** This is the focal length of your guide telescope. If you are using the self-guided mode, this will be the same as the Telescope focal length, above. It will be entered automatically by the Initialize button.
- **Guide rate:** This is the guiding rate as a factor of sidereal tracking and must be entered manually. This is usually a defined value for your mount and can be obtained by consulting your mount's documentation. This is an essential parameter and must be filled in for proper operation.
- **Guider binning:** This is the guider binning you normally use. If your chosen camera application properly provides this information, it will be obtained automatically by the Initialize button

- **Mount:** Specify Equatorial if you are using a German Equatorial Mount such as a Paramount, Astro-Physics or Losmandy for example. Specify Fork if you are using a Meade or Celestron fork mount for example.

- **Guider:** Select Self guided or Self guidedR if you are using a guider that shares the telescope with the imager. This would be appropriate for most SBIG cameras and off-axis guider (OAG) systems. For most systems, Self guided is the appropriate setting. If you are using an OAG and the guider field of view indicator (FOVI) is below the imager FOVI, then Self guidedR is appropriate. This distinction is only necessary when using rotators. This can be easily determined experimentally. See below. Guide scope is selected when you have another telescope for you guider. Unguided is selected for unguided imaging.

- **Initialize:** This function determines a number of key parameters for your system for subsequent seamless automation. A plate solving method is an absolute necessity for initialization. Before hitting this button, your camera, telescope, plate solving method and rotator (if used) must be connected. For guided operation, you must have centered a guide star on your guider and have run one manual calibration at your chosen binning, insuring the guide star stays on the chip for all movements and actually moves properly in each direction, just as you would do for a normal calibration. ~~The guider should be oriented at an angle of 10° or more to the RA/Dec axes, as opposed to lining up with one of the cardinal points.~~ Your guider binning should be set in your camera control program before initialization. The telescope can be pointed to either side of the meridian and at any Dec, although a lower Dec. will give better results. Dec does not need to be 0 for example. Make sure you have properly set the Plate Solve Exposure settings (below). When ready, hit the Initialize button. The status bar on the lower right reports progress and completion. When Initialization is complete, you will be prompted to save the results to a profile. You should choose a descriptive name for this profile so you can easily identify the conditions. For example, I use 14RCselfguidedRIMG, which tells me it was for my 14RC scope, self-guided with the R option and my IMG camera. This technique is helpful if you have multiple setups. CCDSoft users should have separate profiles for guiding with DirectGuide and Camera Relays as the internal operations are different. If you switch between Maxim and CCDSoft, then the same system profile can be used, consistent with the CCDSoft DirectGuide or Camera Relays consideration. You will need to initialize both Maxim and CCDSoft if you use both.

The initialize function calibrates your system for accurate Position Angle (PA) entry. Your unbinned image scale is refined. Essential guider parameters appropriate to your camera control program are developed and optimized. After a successful initialize, you will never need to calibrate your guider again, no matter where you go in the sky in RA, Dec, and PA, as long as your equipment does not change! Your guiding calibration is determined by internal algorithms that are optimized for your specific coordinates.

You need to reinitialize when you:

- Change your system, represented by your mount guide rate, camera, guider and optical system.
- Change your camera control system
- Change your guider type
- Change your guider binning
- Change between DirectGuide and Camera Relays in CCDSoft
- Rotate your guider relative to your camera
- Lose your home setting with the RCOS PIR

If you have an instrument rotator, there is a convenient way to initialize.

1. Set the Guider to unguided and initialize. This will calibrate the rotator to the position angle.
2. Go to the target page. Using the FOV Center target as described here, translate and rotate the FOVI so that a guide star is in the

guider FOV.
3. Slew to the target with precision slew checked. Once this process completes, you should have the guide star on the guider chip.
4. Run a guider calibration with your camera control program to insure the guide star stays on the chip for all movements
5. Now initialize again and the guider parameters needed for CCDAuoPilot to develop optimized vectors are collected.

Self guided note

The best way to determine whether you should use Self Guide or Self GuideR is a simple test. After successfully initializing as described above, do a short run on the present location to insure guiding runs appropriately, i.e. the guide star stays in the box and the guide errors are reasonable. Then, rotate the camera by 90°, recenter a guide star and repeat the run. The guide star should stay in the box and the guide errors should remain reasonable. If the guide star tends to wander out of the box, then stop the run, select Self GuideR and repeat the same run. This time the guide star should stay in the box with reasonable guide errors. If you still have problems, rotate the guide camera by 180° and then try Self Guide and Self GuideR again.

Plate solve exposure

Plate solving consists of using star pattern matching against a given stellar catalog to calculate the coordinates of the center of a given image. In order for many of the features and functions of CCDAutoPilot to be successful, plate solving is required. And in order for plate solving to be successful, proper setup is mandatory.

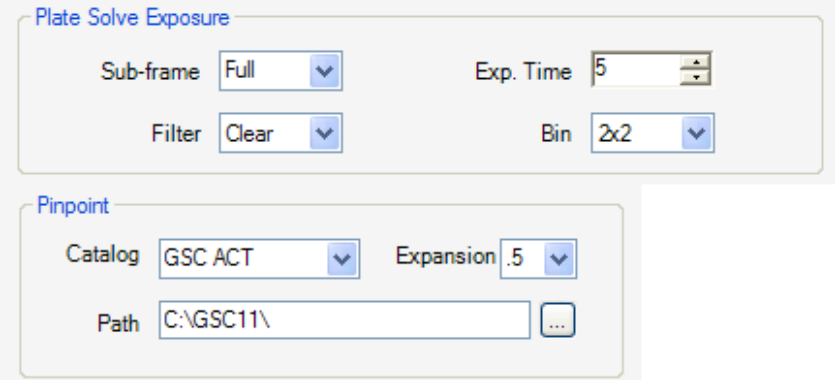


Plate Solve Exposure

- **Sub-frame:** For most imagers, this setting can be left at Full. However, if you have a large chip imager and/or a wide field scope, you may need to set that to a lower fraction. Choices go down to 1/16. The fraction is a percentage of the chip size by which the imager is sub-framed, while keeping the sub-frame in the center of the chip. This has to be determined experimentally for your given system. PinPoint seems to be more tolerant of wide fields and CCDSoft/TheSky6 is limited to 1 square degree. In the latter case, it is best to use a sub-frame. There is no loss of accuracy.
- **Filter:** This selects the filter that will be used for plate solving. For maximum sensitivity and performance, the most transparent filter is generally used. In the above example, a clear filter is specified.
- **Exp. Time:** This is the exposure time for the plate solve exposure. Usually 5 - 10 sec. exposures are sufficient.
- **Bin:** This is the binning that will be used for the guide exposure. Increasing the binning gives better sensitivity and should be used with long focal length systems. For my 3315 mm system, a bin of 2x2 is used.

PinPoint

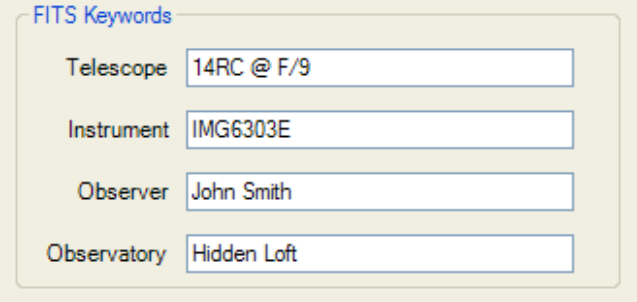
- **Catalog:** Select the catalog appropriate for your system. I generally use the GSC ACT catalog with excellent results.
- **Path:** Using the '...' button, navigate to the folder that contains the catalog you wish to use. Note that catalogs from TheSky6 can **not** be used with PinPoint.
- **Expansion:** This parameter determines how much error can be accommodated during the plate solve operation, *at the expense of solve time.* Consult PinPoint documentation for details.

CCDSoft/TheSky6

There is no explicit setup in CCDAutoPilot. TheSky6 can be configured to use a number of optional reference stellar databases. In general, the Guide Star Catalog (alone) has proved effective for my applications. If you have a particularly narrow FOV system, you may need to use the UCAC/USNO B sub-set selection with appropriately longer plate solve exposures. CCDSoft has the ability to customize the detection threshold. See CCDSoft documentation for details. In general, the detection threshold should be around 1.5 to 2. If you are imaging an area with bright nebulosity, a higher detection threshold of 3 - 4 may give better results.

FITS keywords

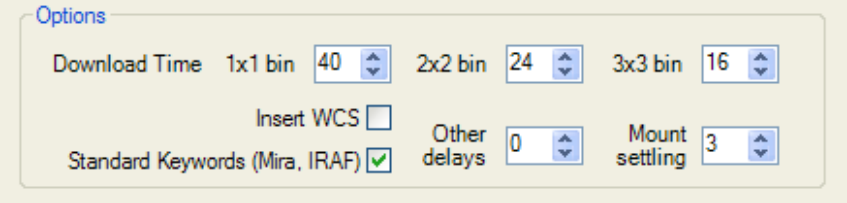
Your image data is normally acquired in the .fit standard. This standard supports significant data in the "header" of the file. In this box, you can select what information is entered in every image file you acquire. The data entered in the fields below is reported as the "value" for the associated "keyword".



- **Telescope:** (Keyword: TELESCOP). Enter a suitable description of your telescope system here.
- **Instrument:** (Keyword: INSTRUME). Enter a suitable description of you camera here. Some image processing programs, notably CCDStack, use this data as part of their image processing so a consistent name is recommended.
- **Observer:** (Keyword: OBSERVER). Enter your name, initials, etc. here
- **Observatory:** (Keyword: OBSERVAT). Enter your observatory name here.

Setup Options

In order to more accurately predict run times, an estimate of download times can be entered. This becomes more significant as larger imaging cameras, with the generally attendant longer download times are used. You can experimentally determine your download times by setting up a sequence of 5 bias frames, timing the sequence and dividing by 5.



- **1x1 bin:** Enter the estimated download time for a 1x1 (unbinned) frame
- **2x2 bin:** Enter the estimated download time for a 2x2 binned frame
- **3x3 bin:** Enter the estimated download time for a 3x3 binned frame

- **Insert WCS:** Checking this option will insert World Coordinate System (WCS) data into the FITS header for each light frame acquired. This is accomplished by a plate solve at the completion of each sub-exposure acquisition. If plate solve fails, no WCS data will be inserted. This is supported with PinPoint only as the plate solve method.

- **Standard Keywords:** (Keyword: IMAGETYP). This determines which set of values are associated with your images. When checked, the IRAF/Mira standard set is used. When not checked, the SBIGFITSEXT set is used. The standard set is recommended and is supported by Maxim's image processing. For light frames, dark frames, bias frames and flat fields, the standard keyword values respectively are LIGHT, DARK, BIAS, Flat; for the SBIGFITSEXT, the keyword values are Light Frame, Dark Frame, Bias Frame and Flat Field.

- **Other delays:** Enter any other imager related periodic delays you may have. This entry will be added once per any exposure - light or dark/bias.

- **Mount Settling:** This is the number of seconds CCDAutoPilot will wait after slewing the telescope to allow the mount to settle. This is best determined for your specific mount.

Professional Applications

FITS Keywords

When Standard Keywords is checked on the Settings page, generally accepted keywords for frame types are applied to each frame. Additionally, standard keywords for TELESCOP, INSTRUME, OBSERVER and OBSERVAT are also applied, according to their entries on the Settings page.

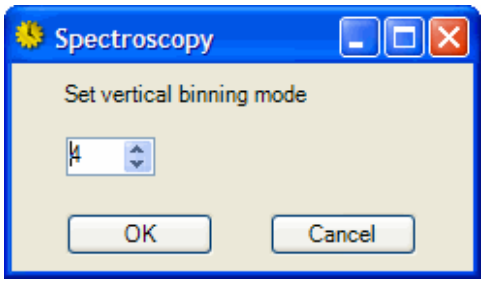
World Coordinate System

When Insert WCS is checked on the Settings page, apprpriate WCS data is inserted into the FIT header. Enabling this feature will add some time to the overall session and should be determined by the user. Once determined, it can be accounted for in session planning by entering an appropriate value in the other delay box on the Setting page, Options.

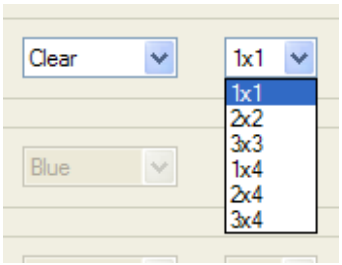
Spectroscopy

When the camera control program is appropriately set for spectroscopy, CCDAutoPilot provides suitable binning alternatives. Due to differences in camera control programs, there are two separate behaviors:

- CCDSoft: Setting the Vertical N binning on the imager setting window will provide 1xN, 2xN and 3xN binning choices, in addition to the standard binnings provided by the camera.
- Maxim: When a suitable camera driver is selected for the spectroscope and spectroscopy binning is specified in the Advanced window of camera setup, a window will appear, giving the user a chance to enter the desired vertical binning upon hitting the CCDAutoPilot Connect button as shown below:



The vertical binning mode may be set here. If Cancel is hit, no spectroscopy binning options will be added to the binning choices. Hitting OK will add those choices. With the binning mode set to 4, the following binning choices are available:

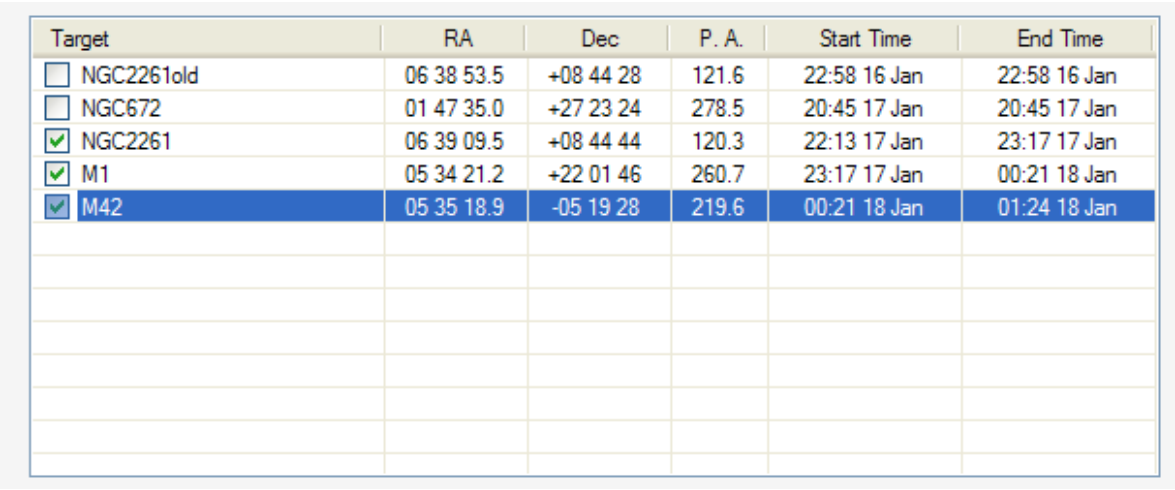


Target List

(In order to use the Targets page, a telescope control program must be connected on the Settings page. The actual telescope does not need to be connected to the telescope control program.)

The Standard version is limited to a single target.

The **Target List** gives the pertinent information for a given target.



Target	RA	Dec	P. A.	Start Time	End Time
☐ NGC2261old	06 38 53.5	+08 44 28	121.6	22:58 16 Jan	22:58 16 Jan
☐ NGC672	01 47 35.0	+27 23 24	278.5	20:45 17 Jan	20:45 17 Jan
☑ NGC2261	06 39 09.5	+08 44 44	120.3	22:13 17 Jan	23:17 17 Jan
☑ M1	05 34 21.2	+22 01 46	260.7	23:17 17 Jan	00:21 18 Jan
☑ M42	05 35 18.9	-05 19 28	219.6	00:21 18 Jan	01:24 18 Jan

<checkbox> When checked, the indicated target is part of the session. You may uncheck the box by clicking on it to have that specific target skipped. At least one target must be checked when light frames are active.

Target This is the target name that is entered either manually by the add button or automatically by the Get and From Fit buttons, described below. The name may be edited by a slow double-click on it.

RA This is the right ascension coordinate of the target in the J2000 equinox

Dec This is the declination coordinate of the target in the J2000 equinox

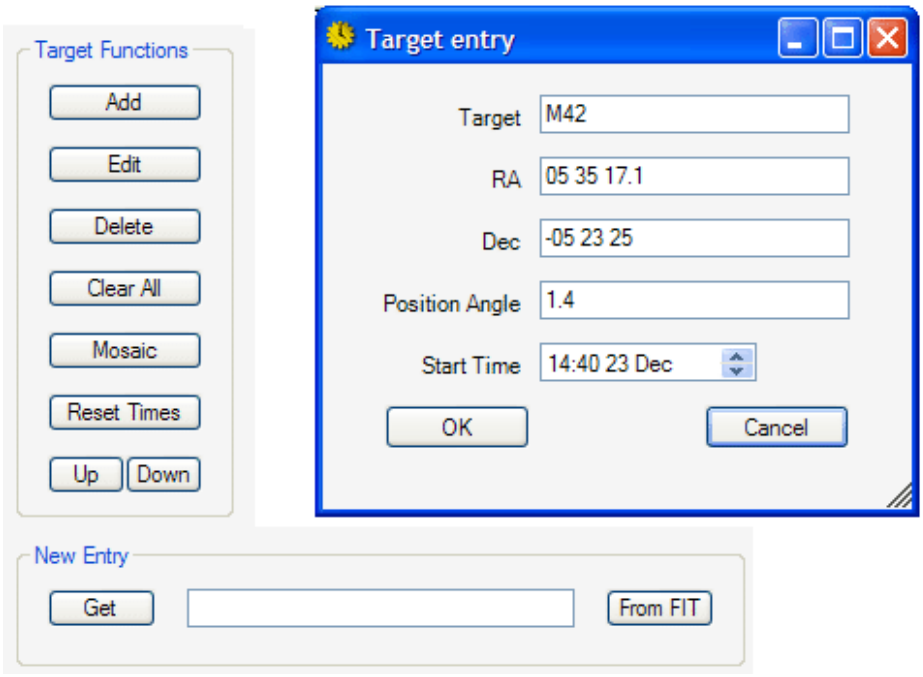
PA This is the position angle as conventionally defined. 0 = north and going CW goes east, to south, to west.

Start Time This is the default start time for the given target's light frames to start.

End Time This is the time at which the light frames are estimated to complete. The time is computed based on the entries on the Light Frames page.

Target Entry and Edit

These controls and the edit window are used to enter target info and edit as needed. At least one target entry is required for acquiring light frames.



Target Functions Buttons

Add brings up a blank target entry window for the user to add the necessary information. Target coordinates must be entered in J2000 equinox.

Edit brings up the target entry window with the related data for the user to edit as desired. Target coordinates must be entered in J2000 equinox.

Delete will delete a selected target line. The target line to be deleted is selected by clicking on it to highlight it.

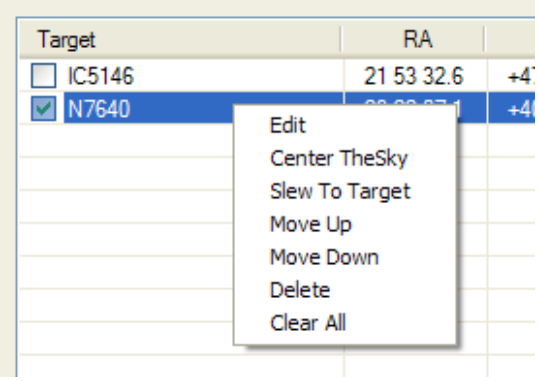
Clear All will remove all entries from the target list. At least one target must be added back before running a session that includes light frames.

Mosaic When this button is hit, any mosaic that is set up in TheSky is automatically imported into the target list. In order to successfully import the mosaic, a mosaic must be set up properly in TheSky and is must be visible. Once imported, the Edit function can be used to change the names as desired. If you are doing guided imaging, then you can move the FOV indicator as needed to locate a guide star and replace each Mosaic entry in the target list with an adjusted FOV Center, via the Get button.

Reset Times adjusts the target start times to occur immediately after the preceding one. Use this feature if you want maximum target acquisition efficiency. If you wish imaging for a given target to start at a specific time, for example around the meridian, then adjust the target start time via the Edit function and do not hit the Reset Times button after doing this.

Up/Down adjusts the position of the selected target in the target list. Select a target and hit the Up button to move it to the top of the list and the Down button to move it lower in the list.

By right clicking on a target, you can bring up a context menu for quick access to most of the target editing controls. The functions are identical to those described above. There is an additional menu item available when connected to TheSky. When a target is highlighted, right-clicking and selecting Center TheSky will move TheSky's view to the desired target and rotate the FOV indicator to the specified position angle.



You can also sort the targets by clicking on the header of the target list. For example, you can sort in order of ascending right ascension by clicking on the RA title box.

You can control whether a specific target is imaged by clicking on the check box in front of the target name.

Adding a Target

As targets are added, they will be added with the Light Frame settings as defined on the Light Frame page. These can be

subsequently edited on the Light Frames page either individually or all together.

- As described above, you can add a mosaic by the Mosaic button described above. There are many other ways of adding a target to the list.

- Use the Add button to manually enter the information for a given target. The RA coordinates **must** be in the <hh mm ss.s> format and the Dec coordinate **must** be in the <+dd mm ss> format (leading plus sign required if positive declination. There should be no characters other than spaces between the fields.

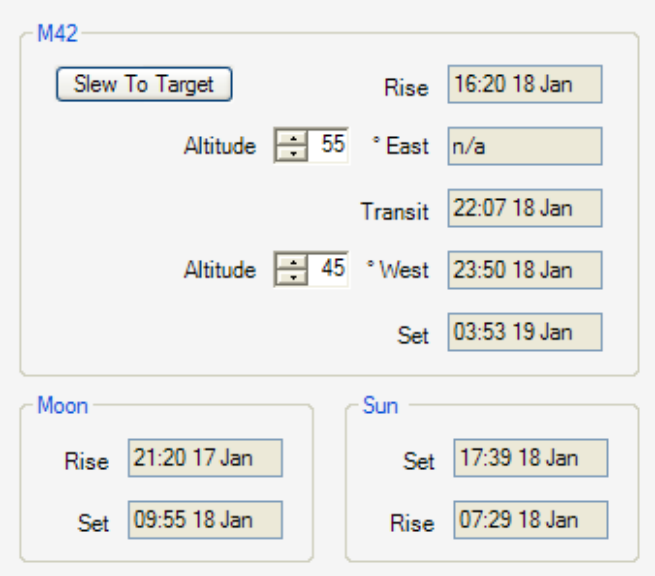
- Use the Get button. This requires TheSky6. Hitting the Get button with no entry will enter the coordinates of the FOV Indicator, Ra, Dec and PA, into the target column. If you enter an object description, M42 for example, the target coordinates for M42 will be added but with a position angle of 0.0. If you wish to properly frame M42 for a guide star, you should position the FOVI so that the guide star is in the guider FOVI, hit Get with no entry and then rename the target to M42 via the Edit function.

- Use the From FIT button. This method opens up a file dialog to allow navigation to a specific .fit file. If the standard information is in the .fit file's header and the proper unbinned plate scale is entered on the Settings page, the .fit file will be plate solved and the appropriate information will be entered in the Target list. The target name will be the file name but this can be easily edited with the Edit function.

The above steps completely define the target to be acquired. There is no need to go to the targets in advance for guide star positioning or guider calibration. If you have properly initialized your equipment, as defined on the Settings page, and select Precision Slew to Target in the Options box, the target will be precisely centered and the guide star will be in the guider FOV.

Information

Information is provided for sun and moon rise and set times as well as information for the selected target.



Sun and moon rise and set times require TheSky. If connected to TheSky, this information will be displayed.

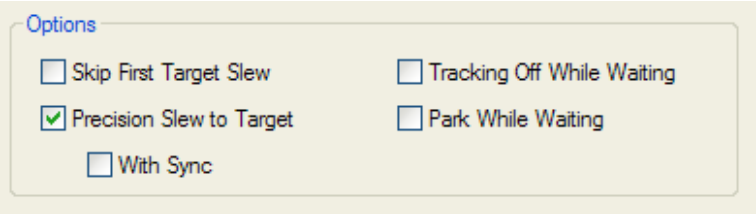
To display information about a target, highlight that specific target by clicking on it. In addition to the rise and set time, additional times are provided.

Transit is the time the target crosses the meridian. This is the optimal point for high resolution imaging as you are looking through the least amount of atmosphere. With automatic meridian flipping, you can make best use of this region.

East and West provide the times the target crosses the specified altitude. This can be customized for a given user's desired preferences. For example, I prefer not to image below 45° and set those points. If you are horizon-limited say in the east, you can set that limit to that altitude. You can do the same thing for the west. This tool provides you a way to estimate the length of your imaging session for a particular target, based on your local limitations.

Target Options

These options define how your mount gets to a specific target.



Skip First Target Slew
When checked, a slew to the first target is skipped. This may be useful where you have already framed the target to your satisfaction and are ready to proceed with imaging it. If Tracking Off While Waiting or Park While Waiting is checked, Skip First Target Slew will be unchecked.

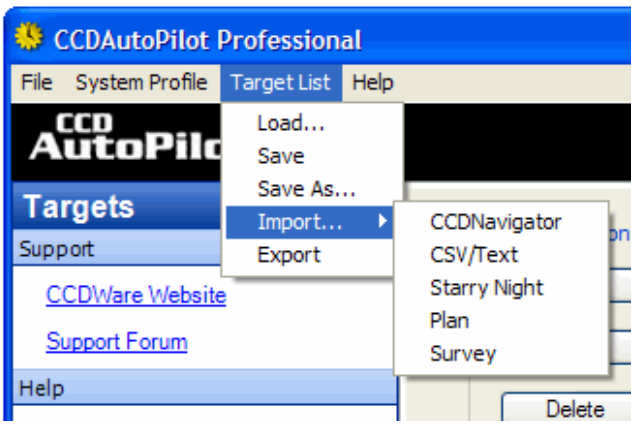
Precision Slew to Target
When checked, the slew to every target consists of a translation to the specified RA/Dec coordinates, rotator movement to the desired position angle and a plate solve and correcting slew to insure a very accurate positioning of the telescope. Unless you have excellent pointing, and/or a wide field guider, this option should be used for guided operation.

With Sync
When checked, the telescope will be sync'd to the plate solved coordinates. This can be used if your mount has significant pointing errors to insure SkyStar centers the focus star on your imager for accurate focusing. If this is not a concern, then this option can be left unchecked.

Tracking Off While Waiting
When checked, tracking will be turned off while waiting for the target exposure start time to occur. If dusk flats are selected, tracking will be turned off as soon as dusk flats are completed. At target exposure start time, tracking will be turned on. When checked, Skip First Target Slew will be unchecked.

Park While Waiting
When checked, the telescope will be parked while waiting for the target exposure start time to occur. If dusk flats are selected, the telescope will be parked as soon as dusk flats are completed. At target exposure start time, the telescope will be unparked to allow slew to the target. When checked, Skip First Target Slew will be unchecked.

Importing Target Lists



CCDAutoPilot is able to import a number of file formats for building the target list. Select the file format from the Target List/ Import menu, and an Open File dialog will appear. Select the chosen file and click "OK" to import. Starting an import automatically clears the existing target list. When importing a large target list, it is recommended that the Images folder be specified before importing. For imported lists that don't have an existing exposure plan and a common exposure sequence is planned, that it be set up on the Light Frames page before importing. This will save editing after the import.

CCDNavigator

Imports a target plan from CCDNavigator.

CSV/Text

Comma Separate Variable (CSV) files are simple text files that can be created in Notepad or with a spreadsheet program. Each target is represented on a new line in the format: target name, RA coordinate, Dec coordinate, Position angle (optional). RA and Dec. coordinates are to be specified in J2000 equinox values. For example:

Crab Nebula, 05 34 54, 22 01 05, 45
M45, 03 46 11, 24 23 19

In this case the first target is the Crab Nebula at a position angle of 45 degrees. The second target is M45, and since no position angle is specified it will be set at 0.0 degrees.

There is no arbitrary restriction on the number of targets that can be imported into CCDAutoPilot.

Starry Night

Starry Night files are exported by the built-in planner feature of the Starry Night planetarium software. To export a plan from Starry Night use the features available under the "Planner" tab within Starry Night to create your observing plan and then "Export..." it.

CCDAutoPilot fully supports this format and will import the following information for each target:

- Target name
- RA and Dec coordinates

A position angle of 0.0 is assigned to each target.

ACP Planner

ACP Planner files are created by the ACP Planner plug-in for The Sky and Starry Night planetarium software. CCDAutoPilot fully supports this format and will import the following information for each target:

- Target name
- Start time
- RA and Dec coordinates
- Position angle
- Number of exposure sets
- Exposure filter*
- Exposure time

- Exposure repeats

*The name of the filter setup in ACP Planner should correspond exactly with the name of the filter setup in CCDSoft or Maxim so that CCDAutoPilot is able to match appropriately

ACP survey

ACP survey files are a legacy format in use with supernova and other search teams globally. CCDAutoPilot fully supports this format and will import the following information for each target:

- Target name
- Save folder
- RA and Dec coordinates

A position angle of 0.0 is assigned to each target.

Rotator Control

While control of the rotator is essentially automatic and transparent to the user once the system has been initialized, the rotator controls are provided as a convenience to the user. It is recommended that all camera rotation be handled by selecting the desired Position Angle. CCDAutoPilot will handle the rest.

Rotator In Use
When a rotator is connected, the controls will be active and the title of the box will indicate the rotator being used. Here, a RCOS Precision Instrument Rotator is shown.

Position shows the current position of the rotator in the rotator's units. It is also used to enter a desired position for the Go To button

Step Size determines the amount the rotator will move either counter-clockwise when the CCW button is hit or clockwise when the CW button is hit. Although step sizes are indicated by the drop down box, a manual entry will also be taken and used

Stop stops the rotator movement.

Go To slews the rotator to a specific position. This position is defined when the user enters the desired position into the Position box.

CCW moves the rotator counter-clockwise by an amount indicated in the Step Size box.

CW moves the rotator clockwise by an amount indicated in the Step Size box.

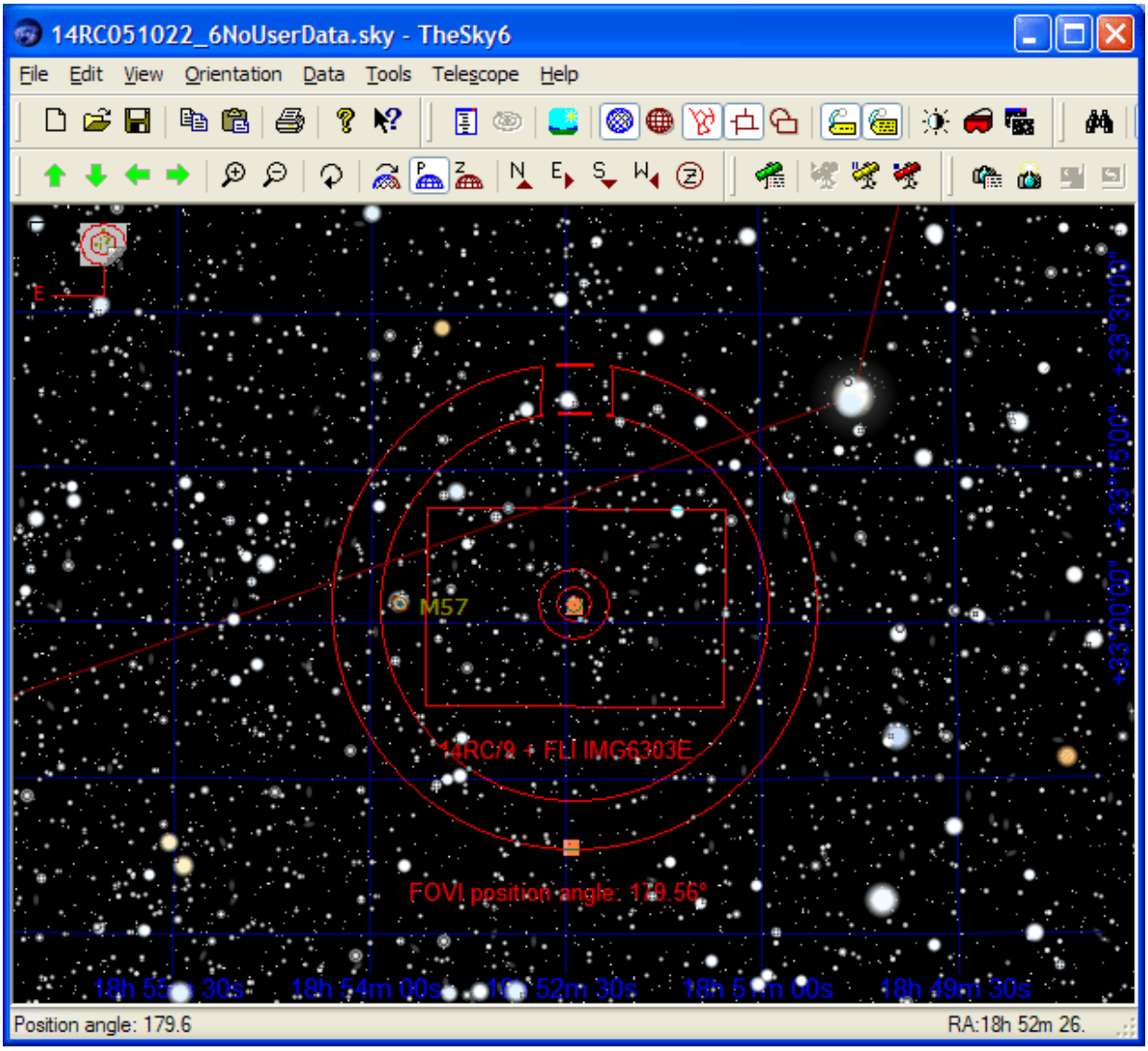
Home moves the rotator to its home position

No Rotator In Use
In this case, all controls associated with a rotator are disabled and the title box will so indicate.

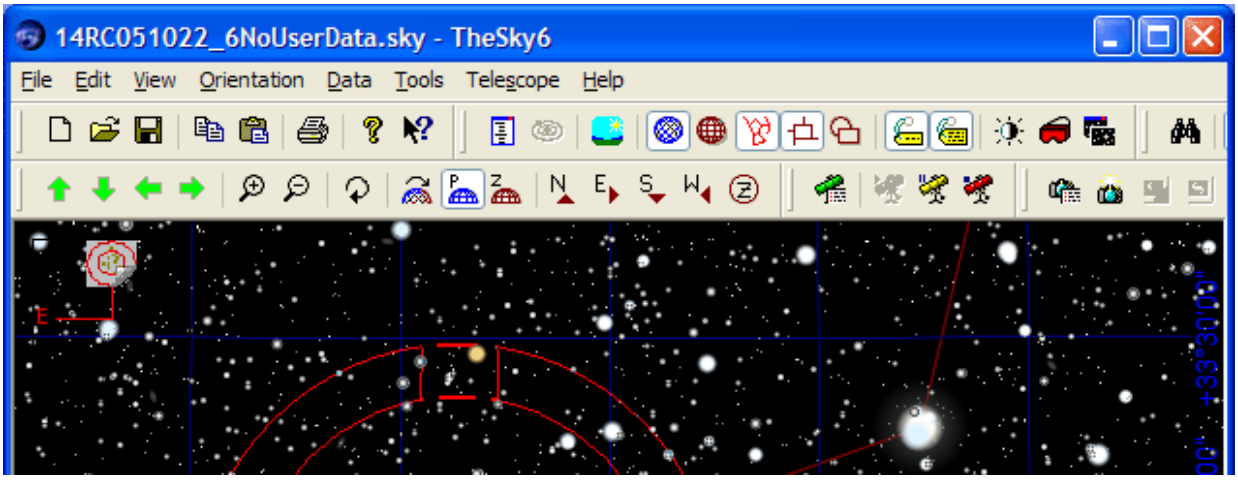
Entering Targets with TheSky6

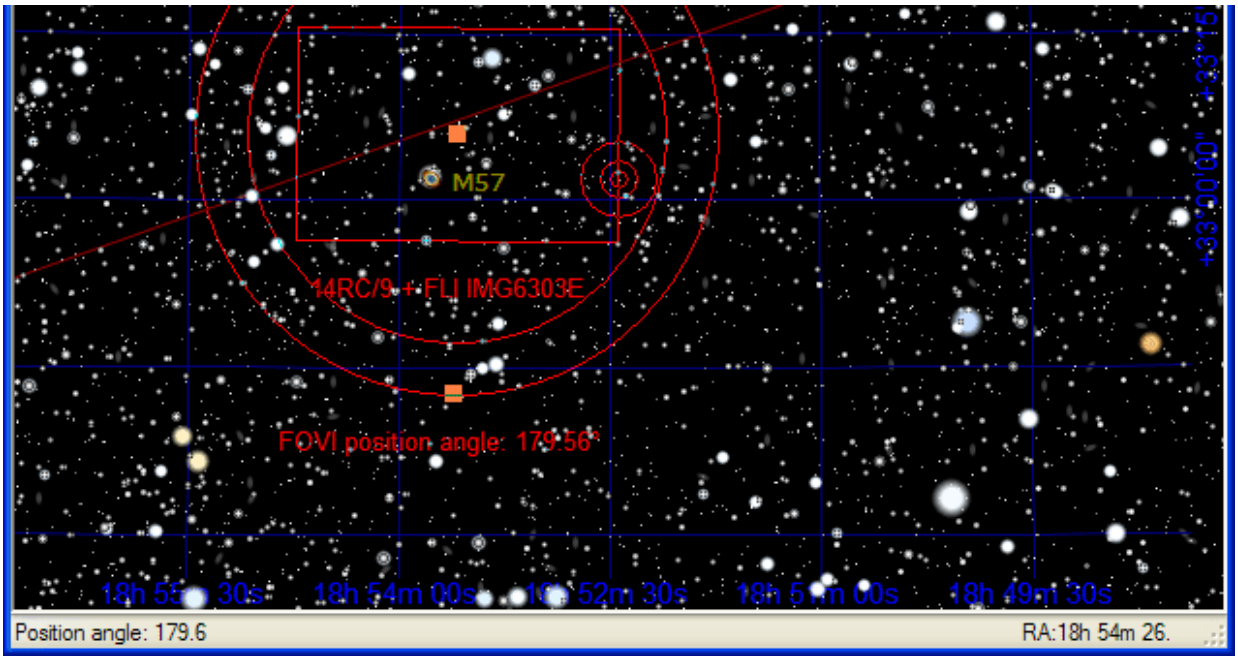
By combining the power of CCDAutoPilot and TheSky6, target planning an acquisition becomes immensely easier. No more image links or plate solving or trial and error. All that is required is TheSky6 and an accurate Field Of View Indicator (FOVI). All that is needed is to orient the FOVI appropriate to your situation and use a precision slew to target as part of your session. The coordinates will be precisely arrived at by the mount and, if you have a rotator, it will rotate to the appropriate position angle (PA) automatically. Here is an example.

Assume you want to image M57. Here is what you might see in TheSky6

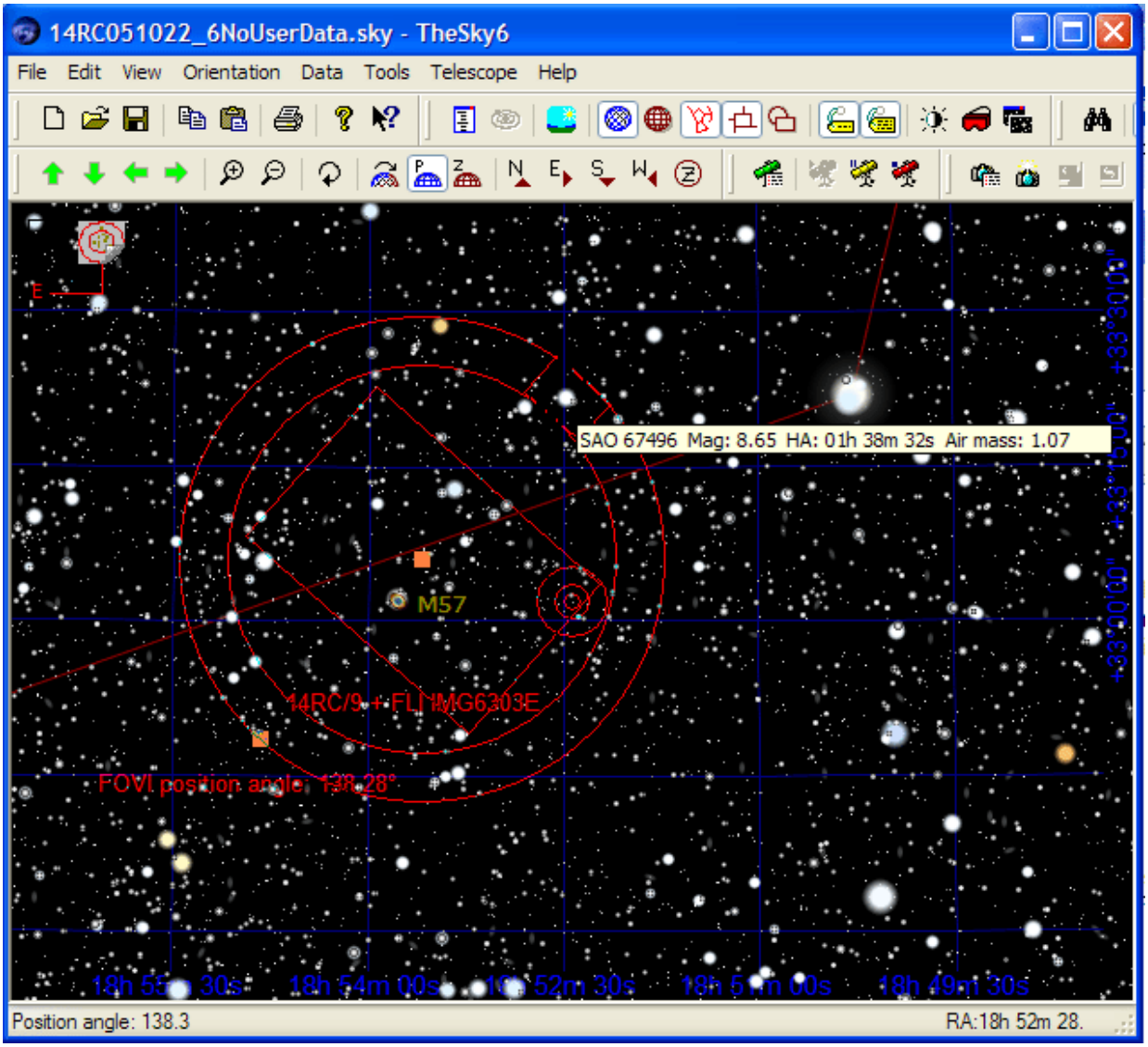


M57 is located to the left of the imager FOVI. The guider FOVI is at 12 o'clock and happens to be positioned over a suitable guide star but that is of no help. Note the two squares that are part of the FOVI. Clicking and dragging on the center one translates the FOVI; clicking and dragging the lower one in a circle rotates the FOVI. First I will translate the FOVI to a position that includes M57 and a guide star is somewhere between the two circles.

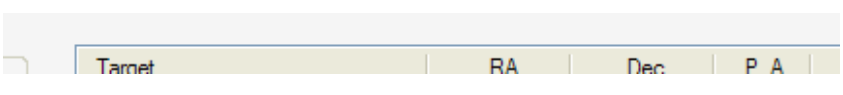


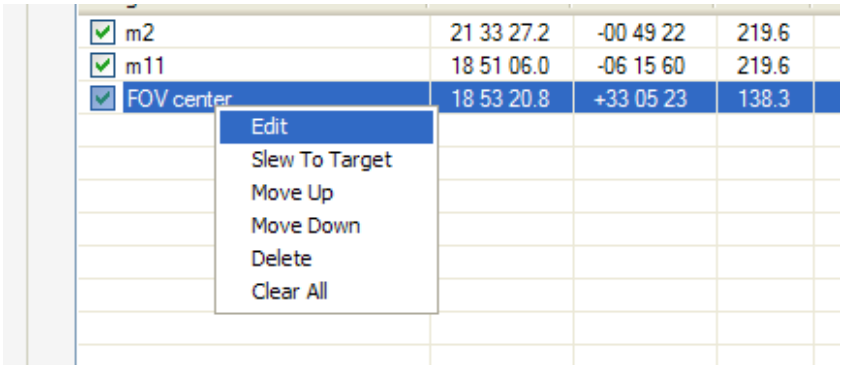


I have moved the FOVI off-center and there is a suitable guide star at the 1 o'clock position.

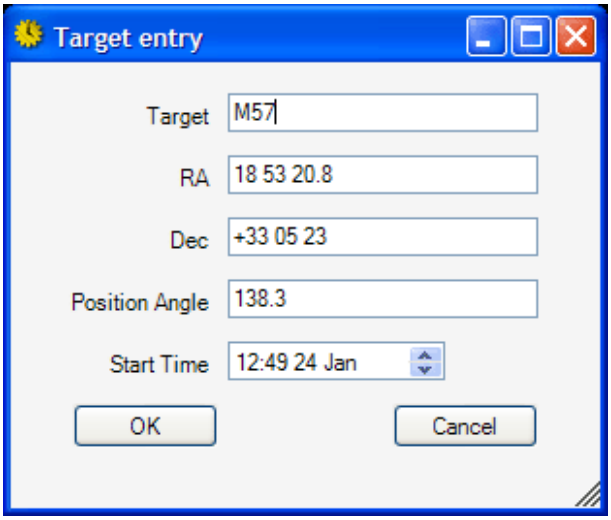


The guider FOVI now includes the guide star. TheSky6 indicates a position angle of 138.3. By hovering the cursor over the guide star, I see information about the magnitude of the guide star. This guide star is more than suitable for this image. The next step is to use this information as a target for CCDAutoPilot. With CCDAutoPIlot connected to TheSky6, all that is required is to hit the Get button on the Targets page with no entry in the field. The RA and Dec of the center of the FOVI and it's position angle will be automatically transferred to the Targets List as shown below.

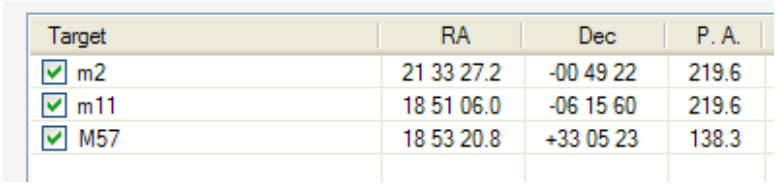




Note the coordinate information is now in the Target list with the non-unique name "FOV Center". By right-clicking on FOV Center, I can then select the edit menu to change the name to something more descriptive, like M57!



I have entered M57 for the target name. After hitting OK, the target list looks like this:



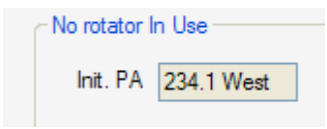
Target	RA	Dec	P. A.
m2	21 33 27.2	-00 49 22	219.6
m11	18 51 06.0	-06 15 60	219.6
M57	18 53 20.8	+33 05 23	138.3

I have now completely described the position of the target for CCDAutoPilot. When this target is selected for running, the telescope will slew to the target, rotate the rotator as needed to match the PA of 138.3, plate solve and adjust the telescope pointing so that it is within a few arc-sec. of the desired target. Since guider calibration is no longer necessary with the automatic calibration algorithm of CCDAutoPilot, guided imaging can now begin at this location.

This same technique can be repeated as many times as required for an evening's imaging session. You do not need to be connected to the actual telescope or camera hardware, just be connected to TheSky6. You can plan an entire evening's imaging away from the telescope and, when you are later connected to your telescope and camera, focuser and rotator if used, begin imaging. You can be sure imaging will proceed as planned.

For those without a rotator...

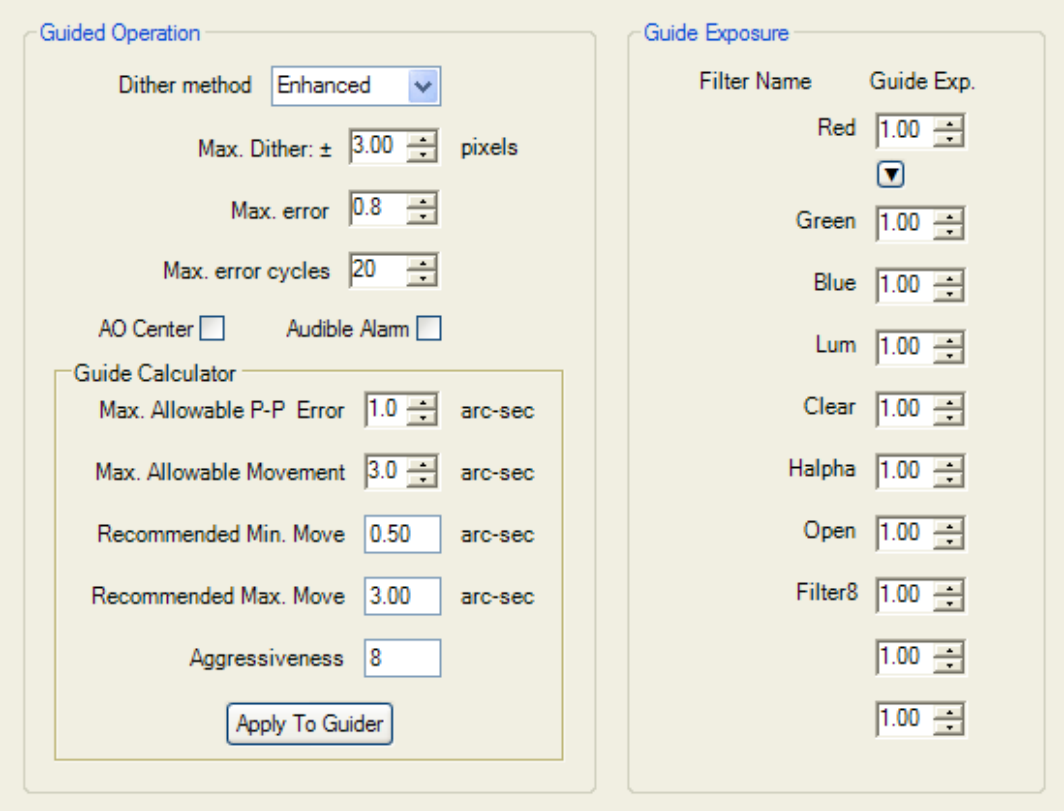
You can use much of the same technique described above but with some modification. If you do not have a rotator connected, and have initialized your system, you will find this entry in the "No Rotator In Use" box:



When you move the FOVI as described above, and assuming the value shown above for Init. PA, you will need to insure your FOVI PA is 234.1 if the target is on the same side of the meridian as that indicated in Init. PA and 234.1 - 180 or 54.1 if the target is on a side of the meridian different from that indicated in Init. PA. Of course, if you can not get a suitable guide star in the guider FOV, you will need to physically rotate your camera and then Initialize. Initializing will of course give better guider calibration than conventional calibration.

Guided Operation

CCDAutoPilot provides many options and alternatives for guided operation. You can set dithering to remove unwanted artifacts, hot and cold pixels and other unwanted artifacts from your combined images, Automatic Guide Star Recovery (AGRS) parameters with or without an audible alarm and guide exposures for different filters. With CCDSoft, you can also set the size of your guide star box.



Dithering

Dithering is a process whereby the guide star location on the guider chip is moved between image exposures in either a random or optimized manner. When the guider control repositions the guide star to the new location, the image will be slightly displaced on the imager chip. When the resultant images are aligned and properly combined, hot and cold pixels, cosmic ray hits and other sensor-specific artifacts are removed, much better than any hot/cold pixel routine can ever hope to achieve. The resultant image is smoother and artifact-free. See this link for more details on this technique.

Dithering can be done either totally randomly, as determined by a random number generator, or in a controlled manner to maximize separation between each sub-exposures artifacts while minimizing the overall guide star movement. Both options are provided. The amount of the dither is user-definable. Here is a discussion on how to set the amount of dithering.

- **Dither method:** Select Enhanced (preferred) or Random.
- **Maximum Dither:** This is the peak dither value and can go +/- from the starting direction. As an example, suppose Enhanced Dithering is selected with a Max Dither of 3 pixels. The first sub-exposure will leave the guide star position undisturbed. The second will move the X position of the guide star + 3 pixels. The third will move the X position of the guide star - 3 pixels *from the first exposure*. Thus the total movement between the second and third exposure is 6 pixels but the movement relative to the first sub-exposure is ± 3 pixels. If dither is set to 0, guiding will not be stopped between exposures except for any specified focusing actions.

Automatic Guide Star Recovery (AGRS)

Many times when a guide star fades, the guider drives the telescope off the target in its quest to find the guide star. CCDAutoPilot has a technique, to prevent this from happening in an attempt to minimize data loss. If the guide star position is not recovered to the user-specified tolerance in a user-specified number of attempts, AGRS institutes a number of procedures in an attempt to recover the guide star. If all those attempts fail, the image is allowed to continue unguided to prevent the guide star search from driving the telescope from its intended target. AGRS is repeated at the start of the next sub-exposure so that, if the passing cloud has passed for example, the guide star is recovered and guiding continues on target. An optional alarm can be sounded to alert a nearby operator of the failed guide star recovery attempt. This has proved instrumental for some users in alerting them to an impending bad weather condition, although this should not be relied upon for equipment protection.

- **Max. Error:** If the maximum error is specified at 0, AGRS is disabled; if it is any other value, AGRS is enabled. This entry specifies the value the guide error has to get down to during guider restart before the exposure is permitted to continue.
- **Max. Error Cycles:** This specifies how many tries the guider has to get the guide star error below the Maximum Error. If the guider does not get the guide error below the specified Maxim Error in the specified Maximum Error Cycles. AGRS is activated.

- **AO Center:** When an Adaptive Optic corrector is used for guiding, the mirror/glass position could be at some point other than 50% when slewing to a target. Checking this box centers the mirror/glass at the neutral position. See also the SBIG/AO notes here.

Guide Calculator

This calculator allows you to determine your optimum minimum and maximum move parameters for your system. Proper setting of

these parameters is important for optimal guiding. When connected to your camera control program, the guide calculator will automatically determine whether DirectGuide (CCDSoft only) or camera relays is in use and calculate minimum and maximum recommended moves automatically. These parameters can be loaded into your camera control program. For more information, see the online Guide Calculator.

Max. Allowable P-P Error: Here we try to determine when we want your mount to actually make a correction. If your guider error is only .05" arc-seconds, there is no need to make an correction. If your min move setting is set to low, then you guider relays will move the mount every guider cycle. This can result in mount oscillations or chasing atmospheric turbulence. My best suggestion in setting this value is about 75% the image scale in which you are imaging. For example, if you are imaging at 1.2" asp, then set this value to 0.9" asp. This way a guider correction is only sent when the centroid of the guide star is 0.45" asp off in either the X or Y axis from the selected guide star position.

Max. Allowable Movement: This value is not required to achieve great autoguiding, but it does protect us from some extreme situations that could ruin a sub-exposure. For instance, if a cosmic ray hit is sensed on the autoguider CCD, this could cause your autoguiding software to think that the centroid of the star has moved many, many pixels from center. Therefore it is going to attempt to correct the mount for this error. If you have no max move setting, this will result in a very large correction and a ruined exposure. If you have a limit to the size of the correction, i.e. max move, then this effect can be mitigated by not allowing a large correction. Setting this value too low may result in under correction, so its best to set this value about 2X - 4X larger than the above 'Peak to Peak Maximum Allowable Error' setting.

- **Recommended Min. Move:** Based on the above entries, this is the recommended minimum move amount for your guider.
- **Recommended Max. Move:** Based on the above entries, this is the recommended maximum move amount for your guider
- **Aggressiveness:** With the recommended minimum and maximum move, this is the recommended aggressiveness setting for your guider
- **Apply To Guider:H**itting this button will automatically enter the recommended values into your camera control program. With CCDSoft, the Guide Calculator will determine whether DirectGuide or camera relays are being used and enter the appropriate values.

Guide Exposure: Guide exposure is settable on the Light frame page for each series and/or target.

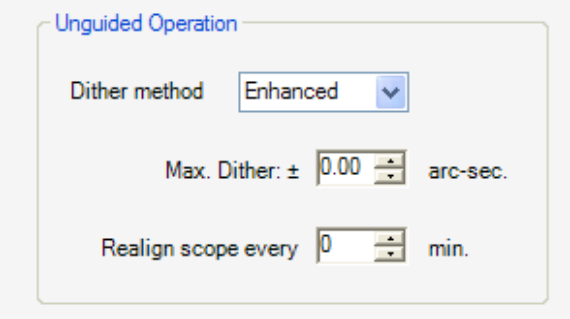
Guide Box Size (CCDSoft only)

This setting allows adjusting the size of the guide star box. This is the image that is visible when the guider is operational. The settings must be set before guiding is enabled. You can set either the AO7 guide star box or the conventional guider guide star box. Changing during guiding will not have any effect. Due to Maxim's automation interface limitations, this feature is available only with CCDSoft.

- **Set:** Enters the values shown for the guide box size.
- **Reset:** Resets the guide box size to the default values of 8 for the AO7 and 32 for conventional guiders.

Unguided Operation

Automatic dithering is provided for unguided operation along with an option to periodically realign the telescope to the desired target coordinates.



Dithering

Dithering is a process whereby the guide star location on the guider chip is moved between image exposures in either a random or optimized manner. When the guider control repositions the guide star to the new location, the image will be slightly displaced on the imager chip. When the resultant images are aligned and properly combined, hot and cold pixels, cosmic ray hits and other sensor-specific artifacts are removed, much better than any hot/cold pixel routine can ever hope to achieve. The resultant image is smoother and artifact-free. See this link for more details on this technique.

Dithering can be done either totally randomly, as determined by a random number generator, or in a controlled manner to maximize separation between each sub-exposures artifacts while minimizing the overall guide star movement. Both options are provided. The amount of the dither is user-definable. Here is a discussion on how to set the amount of dithering.

- **Dither method:** Select Enhanced (preferred) or Random.
- **Maximum Dither:** This is the peak dither value and can go +/- from the starting direction. As an example, suppose Enhanced Dithering is selected with a Max Dither of 3 arc-sec. The first sub-exposure will leave the guide star position undisturbed. The second will move the X position of the guide star + 3 arc-sec. The third will move the X position of the guide star - 3 arc-sec. *from the first exposure.* Thus the total movement between the second and third exposure is 6 pixels but the movement relative to the first sub-exposure is ± 3 arc-sec.

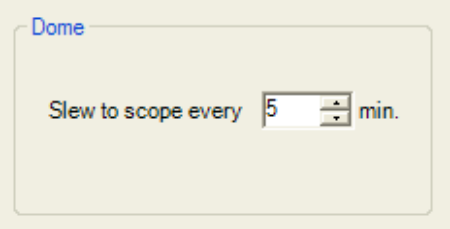
Periodic Realignment

When a long series of unguided exposures are taken, the mount will gradually track off the target. By using this feature, the telescope is periodically realigned to the target coordinates. (If any periodic focusing using SkyStar is implemented, target realignment will occur during that process. If that is used, additional periodic realignment will occur only as long as the time between SkyStar focus runs has exceeded the realignment period.

- **Realign scope every x minutes:** If 0 is entered, this function is disabled. If a non-zero value is entered, the telescope will be realigned to the target coordinates via a precision slew after the current exposure completes and after the specified interval has elapsed.

Dome Alignment

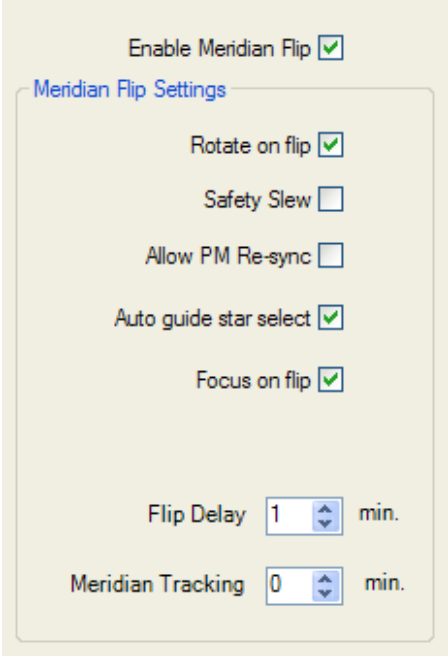
When using the AutomaDome dome control program, the dome can be programmed to periodically align the dome slit to the telescope during exposures. This maintains slit-to-scope alignment during long light exposures.



Entering a value greater than 0 will cause the dome to align to the scope that number of minutes. If 0 is entered, no slit alignment will take place

Meridian Flip

Automatic meridian flipping essentially uses software to turn an equatorial mount into a fork mount functional equivalent. This is achieved by allowing the telescope to track a target up to the meridian, stop the exposure, move the telescope to the other side of the meridian and then continue tracking. If a rotator is employed, the camera is rotated by 180°, the guide star is reacquired and guide calibration is appropriately adjusted. All this is accomplished automatically. Automatic meridian flipping depends on plate solving and proper settings on the Settings page.



- **Enable Meridian Flip:** Checking this enables the telescope to track through the meridian when going from east of the meridian. If checked and the target is west of the meridian, it will of course have no effect. For most users, this option can be left checked. Uncheck it if you are using a fork mount or an equatorial mount that is capable of tracking through the meridian without damage.
- **Rotate on Flip:** If checked and a rotator is connected to CCDAutoPilot, the meridian crossing event will also trigger a rotator movement by 180°. Thus the images on the west of the meridian will be the same orientation as on the east side of the meridian.
- **Safety Slew:** Some mounts, notably the Gemini, will not flip even though the target has crossed the meridian. Checking Safety Slew will slew the mount one hour past the meridian, which will force the flip, and then back to the target. This should eliminate the need for the AM stop offset setting and it should be set to 0.
- **Allow PM Re-sync:** If this option is checked, an image is taken and plate solved after a meridian flip. The mount is then sync'd to the center of the solved image. The correcting slew is then from this reference. Recommended for portable setups or for setups with poor pointing accuracy. If this option is cleared, there is no sync and the correcting slew is from the plate solved position. This option should be cleared for permanent setups with good pointing accuracy as may be obtained with a suitable Tpoint mode. If checked, any Tpoint models should be disabled for best results.
- **Auto guide star select:** If checked, an automatic detect of the brightest star in the field will be used to guide. If unchecked, the run will pause until you select a guide star and tell it to continue.
- **Focus of flip:** When checked, the focus method chosen on the Focus page will be executed immediately after the meridian flip and before the next exposure.
- **Flip Delay:** This is the number of minutes to delay the meridian flip. Some mounts may require a longer delay than the default 1 minute to determine the target has passed the meridian. You should experimentally determine you particular mount's characteristic.
- **Meridian Tracking: If the value entered is positive**, this indicates the number of minutes your mount can track past the meridian and defers the flip for the your specified number of minutes. Depending on the above two settings, you may be able to get another exposure in before meridian crossing and eliminate the wait time for the meridian flip. Observatory users using DDW or ASCOM for observatory control should insure their shutters permit crossing the meridian by the PM Tracking time since dome tracking is disabled 2 minutes before a meridian flip. AutomaDome has no such limitation since it integrates tightly with TheSky. **If the value entered is negative**, the mount backs up 1 hour in RA in the east and the session waits for the specified number of minutes. This is helpful if you cannot allow your OTA to point to the zenith (Alt. = 90°) due to interference with a camera. It can also be used if your mount has some ambiguity in slewing to a location whose RA has passed the meridian. By setting Meridian Tracking to -10 or so, the target RA will be 10 minutes past the meridian before meridian flip is enabled. Some experimentation may be required for the smallest negative value that will work.

Tips on efficient meridian usage

With the various time settings, you can increase your meridian usage efficiency. AM stop offset is generally not needed and can be left at 0. Flip delay is the amount of time your mount has to track past the meridian before it (the mount) knows it is time to flip and will do so. For most mounts, this can be set to 1. PM Tracking requires a bit more discussion. Let's assume you have determined your mount can safely track past the meridian for 15 minutes. Set the PM Tracking to 12 minutes for a safety margin. Now, assume you are taking 10 minute sub-exposures at the time the mount approaches the meridian. Assume your meridian crossing is at 22:05. Here is a schedule of events you might see:

21:50	Take 10 minute exposure
22:00	Take 10 minute exposure
22:05	(Time to flip - deferred)
22:15	Flip meridian
22:18	Take 10 minute exposure

Now, if PM Tracking were set to 0, this would be the result

21:50	Take 10 minute exposure
22:00	Wait for meridian flip
22:05	Flip meridian
22:09	Take 10 minute exposure

Here are some excerpts from an actual log with PM Tracking set at 10 minutes:

>>> Here is the target information
20:02:28 Target: M1
20:02:28 Rise: 13:51 6 Feb
20:02:28 45° E elevation: 17:32 6 Feb
20:02:28 Transit: 20:50 6 Feb
20:02:28 45° W elevation: 00:09 7 Feb
20:02:28 Set: 03:50 7 Feb

20:05:49 Solved RA: 05 34 30.2, Dec: +21 59 17
20:05:49 Target RA: 05 34 30.2, Dec: +21 59 17 , PA: 358.4
20:05:49 Meridian flip after 20:51 Tue 6 Feb
>>> The mount would have flipped at 20:51 without the buffer time

>>> The exposure completed after the meridian flip time but before the 10 minute buffer elapsed.
20:43:31 Exposing...
20:54:15 D:\Astronomy\070206_M1\Clear356E_M1_00006.fit

>>> And then the mount flipped immediately.
20:54:18 Waiting for meridian flip time...
20:54:18 Meridian flip starting...

If your mount is capable of longer tracking past the meridian, the flip can be deferred longer, for example in the case of an Astro-Physics mount which can track for a number of hours past the meridian, depending on telescope, camera, declination, etc.

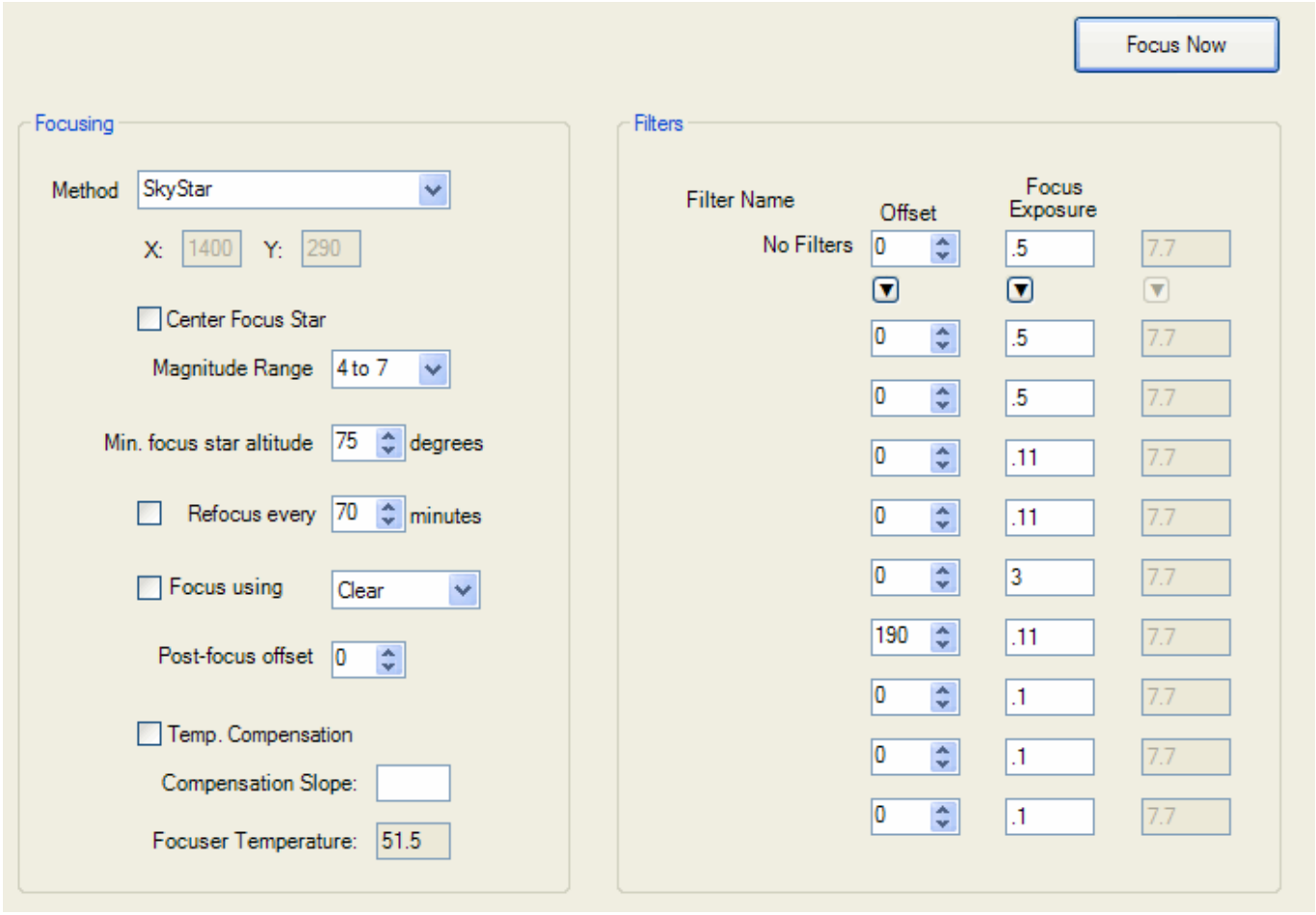
Warning: It is up to the user to determine the proper setting for PM Tracking. In addition to consulting your mount's documentation, you should also experiment at various declinations, while watching the mount. If you rotate your camera, you should also verify the PM tracking at various camera rotations.

Focusing

Since the quality of any automated imaging run depends on achieving and maintaining an accurate focus over the course of the evening, CCDAutoPilot provides many choices for automated focusing. In addition to some active methods, you can also use passive methods such as filter offsets and temperature compensation. You can even use a combination of methods. You should choose the strategy that works best for your equipment and seeing. Both FocusMax and CCDSoft's @focus2 focusing methods are supported.

When an equatorially-mounted telescope is pointed east of the meridian, any focusing activity scheduled to occur within 10 minutes of the meridian crossing will be deferred until the after telescope has crossed the meridian and the mount has flipped.This deferral does not take place with fork-mounted telescope. This focus deferral only occurs when Enable meridian flip is checked

FocusMax



Before proceeding, insure that FocusMax is set up properly for your system. Consult FocusMax documentation for specifics. Once all the software is connected to CCDAutoPiulot, you can use the Focus Now button to verify operation.

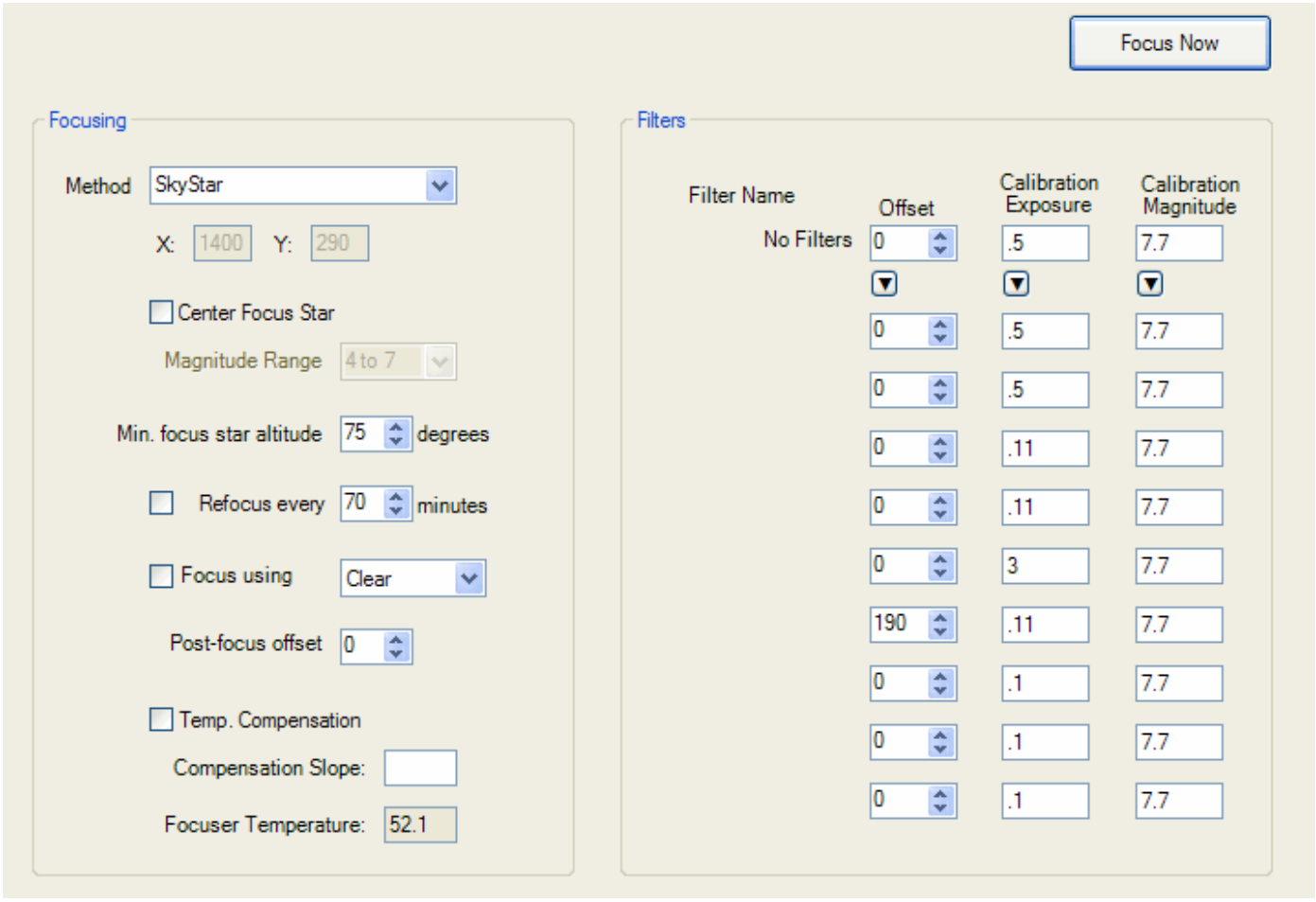
FocusMax can be used with either CCDSoft or Maxim. When FocusMax is connected, there are a number of active methods of focusing available. Active methods do not rely on predicting the focus position but actually *focus* the system at appropriate times. As such, this would be expected to give you the most optimal focus at any point in time. The trade-off here is the time to do the focusing. Depending on the method chosen, active focusing can add from 30 to 240 seconds, depending on the method used, camera download time etc.

- **Focus Now:** This button will focus the system using the options specified on this page.

- **Focus Exposure:** As mentioned above, these fields provide a convenient entry point for the FocusMax starting exposure. With most systems, the shortest exposure is suitable for focusing through the clear filter and the exposure time should be increased for less transparent filters. For example, you might set a 1 sec. exposure for color filters and a 2 - 4 second exposure for narrow band filters such as Halpha or OIII.
- **Brightest star in FOV:** FocusMax will choose the brightest object in the field of view. This is fine if there are no bright extended objects such as galaxies in the field but if there are, FocusMax will attempt to focus on that and will most likely be unsuccessful.
- **Focus at X, Y:** One way to avoid the above problem is to select a specific x,y coordinate for a target star. Take an unbinned image and note the coordinates of the brightest star. Enter those coordinates in the X and Y boxes. FocusMax will use that coordinate with a 100 x 100 pixel box around it to focus.

- **Sky Star:** With this technique and TheSky6, CCDAutoPilot will plate solve the current location, slew the scope to an nearby star, focus there using FocusMax and slew back to the original location. If guiding was in process, it will be stopped for focusing and restarted automatically once the telescope has returned to the target coordinates. This technique guarantees a suitable star for focusing and uses the very powerful data query technology of TheSky6 to select stars of an appropriate magnitude to be used for focusing. SkyStar has some additional options: **Center Focus Star:** When checked, a precision slew to the focus star will be made, insuring the focus star is in the center of the FOV. **Magnitude Range:** 4 magnitude ranges are provided for the focus star - 4 to 7, 5 to 8, 6 to 9 and 7 to 10. Select the range that is appropriate for your system. **Minimum focus star altitude:** Regardless of where the telescope is pointing, focusing will always use a star above this minimum altitude. As a minimum, you **must** have the Guide Star Catalog (GSC) selected as one of the Stellar Core databases in TheSky.
- **Focus Program Picks Star:** This is similar to Sky Star but it is all done within FocusMax using AcquireStar and requires the full version of PinPoint. Unlike SkyStar, whatever filter you use to focus on will be the same filter used for plate solving. This may be problematic when using low transmission filters such as Halpha and other narrow band filters.
- **None:** No focusing is used. This setting might be used if it is desired to use only filter offsets.

CCDSoft/@Focus2



Before proceeding, insure @Focus2 is properly set up for your system. @focus2 is a feature of CCDSoft and can therefore only be used with CCDSoft. @Focus2 requires a calibration of what length exposure is required for what magnitude star to achieve approximately 20,000 ADU counts. This calibration is required for each filter and may be entered in the appropriate fields as shown in the above screen shot. Consult the CCDSoft documentation for proper setup. Depending on the spectral type (star color) of a chosen focus star, you may get different results, even with the same magnitude star. The effect is minimal with broadband filters such as clear filters and gets progressively more pronounced as the filter bandwidth tightens. For example, a red filter will show this effect more than a clear filter but much less than a Halpha filter. For RGB filters, I recommend calibrating on a G2V filter to "center" the spectral range. For best results with @Focus2, you should focus using the clear filter, determine and use filter offsets for your system. Once calibrated and with all the software connected, you can use the Focus Now button to verify operation.

- **Focus Now:** This button will focus the system using the options specified on this page.
- **Calibration Exposure:** This is the exposure time in seconds required to achieve a peak count of 20,000 ADU for the corresponding stellar magnitude below.
- **Calibration Magnitude:** This is the stellar magnitude required to achieve a peak count of 20,000 ADU for the corresponding exposure, ablve.
- **Brightest Star in FOV:** @Focus2 will choose the brightest object in the field of view. This is fine if there are no bright extended objects such as galaxies in the field but if there are, FocusMax will attempt to focus on that and will most likely be unsuccessful.
- **Sky Star:** With this technique and TheSky6, CCDAutoPilot will plate solve the current location, slew the scope to an nearby star, focus there using @Focus2 and slew back to the original location. If guiding was in process, it will be stopped for focusing and restarted automatically once the telescope has returned to the target coordinates. This technique guarantees a suitable star for focusing and uses the very powerful data query technology of TheSky6 to select stars of an appropriate magnitude to be used for

focusing. SkyStar has some additional options: **Center Focus Star:** When checked, a precision slew to the focus star will be made, insuring the focus star is in the center of the FOV. **Magnitude Range:** 4 magnitude ranges are provided for the focus star - 4 to 7, 5 to 8, 6 to 9 and 7 to 10. Select the range that is appropriate for your system - 4 to 7 is a recommended starting point. **Minimum focus star altitude:** Regardless of where the telescope is pointing, focusing will always use a star above this minimum altitude. As a minimum, you **must** have the Hipparcos/Tycho Catalog selected as one of the Stellar Core databases in TheSky.

- **Focus Program Picks Star:** Working in concert with TheSky6, CCDAutoPilot will first plate solve the current location. @Focus2 will then slew to a suitable focus star and focus the system. If guiding was in process, it will be stopped for focusing and restarted automatically once the telescope has returned to the target coordinates. **Magnitude Range:** 4 magnitude ranges are provided for the focus star - 4 to 7, 5 to 8, 6 to 9 and 7 to 10. Select the range that is appropriate for your system. **Minimum focus star altitude:** Regardless of where the telescope is pointing, focusing will always use a star above this minimum altitude. As a minimum, you **must** have the Hipparcos/Tycho Catalog selected as one of the Stellar Core databases in TheSky.
- **None:** No focusing is used. This setting might be used if it is desired to use only filter offsets.

Both Focusing Programs

- **Refocus every xx minutes:** Depending on the numeric entry, the focus method will be executed at the start of each series and every xx minutes thereafter. The next exposure that comes along that is xx or more minutes after the last focus will be executed. In other words, the time for an interval focus is determined before an exposure starts. If xx minutes has elapsed since the last focus, a focus run will be performed; if it hasn't elapsed, the checking process will repeat before the next exposure starts. You should set up a brief series of exposures to insure FocusMax can focus satisfactorily with all of the planned filters in place, adjusting the focus exposure to be appropriate to a given filter as described below. Make any adjustments to the FocusMax settings required.
- **Focus using <filter>:** If your filters are sufficiently parfocal, i.e. they all focus at the same point, you may choose to use one specific filter for focusing. That way you can avoid having to deal with different focus exposures for different filters. If your filters are not parfocal, you should determine and use filter offsets.
- **Post Focus Offset:** This setting can be used to minimize the effects of OTA field curvature. The intent is to "split the difference" between perfect focus at the center and focusing at the edge of the field of view. For OTA's without a field flattener and/or a large imaging chip, there can be a significant difference in the focus position between center and edge. First, determine the focus at the center of your OTA and then determine it at some point away from the center. A good starting point is 60% of the way to the corner. You can use the Focus Now button to determine these values. Average a number of focus runs at each location. Calculate the offset and enter it in the Post Focus Offset. For best results, the Center Focus Star option and SkyStar focusing should be used. After achieving focus, the post focus offset will be added or subtracted to the focus results, according to the sign of the entry.

Passive Focusing Methods

These are methods that rely on the predictability of your system's optimal focus position. To the degree your system is not predictable, your focus will be less optimal

- **Temperature Compensation:** If this box is checked and your focuser supports temperature compensation, it will be enabled. Temperature compensation will be disabled automatically during the main exposure. At the conclusion of the main exposure, temperature compensation will be re-enabled and a 5 second delay will be initiated to allow time for temperature compensation. To use temperature compensation, the user must provide a **Compensation Slope** that appropriately characterizes the system. This value should be counts/temperature needed to maintain focus. When **Temp. Compensation** is checked, the Focuser Temperature will be shown. If "n/a" is shown, the focuser does not report temperature and temperature compensation can not be used. There are many ways to determine the compensation slope. The basic process is to measure the focus point at different temperatures and calculate the slope. Am imaging session with 10 minute exposures and a focus before every exposure during a period of temperature change is a good way to get the raw data. A least squares fit then gives a good slope. The compensation slope should be in units of focuser count per unit temperature. Be sure the temperature reported, °C, °F or counts used for the measurement is the same as that reported as Focuser Temperature. The focus starting point will be determined at the beginning of a run and the starting temperature noted. At each subsequent focus, the starting point and temperature will be redefined. Between exposures, the focus point will be adjusted, based on the current temperature and the user-supplied Compensation Slope. **Note:** If focuser temperature compensation is enabled in either your focuser or focus control program, it will be disabled when CCDAutoPilot is connected.
- **Offset:** enter how many counts you wish your focuser to move for a given filter. Normally one filter would be the reference and the others would move an amount, either + or -, relative to that reference. The reference filter should be the filter you select for plate solving - usually a clear or luminance filter. If your filters are parfocal, i.e. they all focus at the same focuser position, you would enter 0 for all the filter offsets. The  button at the top sets all filter offsets to the same value as that of the first filter entry. If some filters, typically some Halpha filters, are sufficiently non-parfocal, you can speed up the active focusing method considerably by entering the offset. That way, automatic focusing will start closer to the ultimate focus position

Focusing Strategies

There are of course many ways to achieve and maintain focus during the course of the evening. For most users, focusing off-target at the start of each series will give the best results. If a given series is lengthy, then adding a periodic focus will insert a focus activity *within* the series.

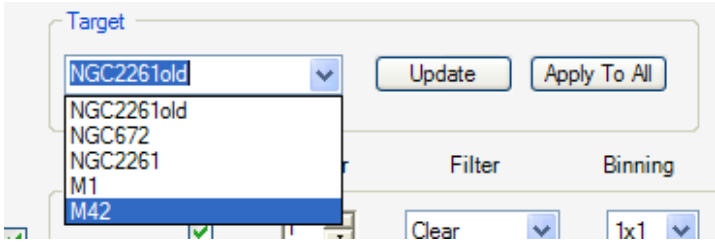
Focusing is generally done with the filter you are exposing. This is especially important if your system is not parfocal. Most modern color filters are parfocal, i.e. they have the same substrate thickness. When used with a reflecting telescope, the system will be parfocal. However, the same filters, when used with a refractor, will generally not result in a parfocal filter. This is because refractors are generally a compromise to achieve close to the same focal point with red and blue light. This is what an APO design strives to achieve.

However, there is another approach if you know the difference in focus for each filter (filter offset), say referenced to a clear filter. You can use the "Focus using filter" option and select the clear filter. Then you can program in the offsets as determined for your system, in the Offset fields. When set up this way, you may be able to use a star in the FOV to focus, which is quicker than using off-target focusing. During a run with this configuration, the clear filter would be used for focusing whenever focusing is called, either at the start of a series or at a specific interval. Once focusing is achieved, the correct filter would be inserted and its specified filter offset would be inserted. To the degree the filter offsets are accurate, so too would be focus.

Light Frames

This page sets up the actual light frames that will be acquired during the imaging session. For a multi-target session (Professional edition only), you can specify a unique set of exposure conditions, including guide exposure, *for each target independently.* For the standard edition, there is one target and one set of exposures.

Target



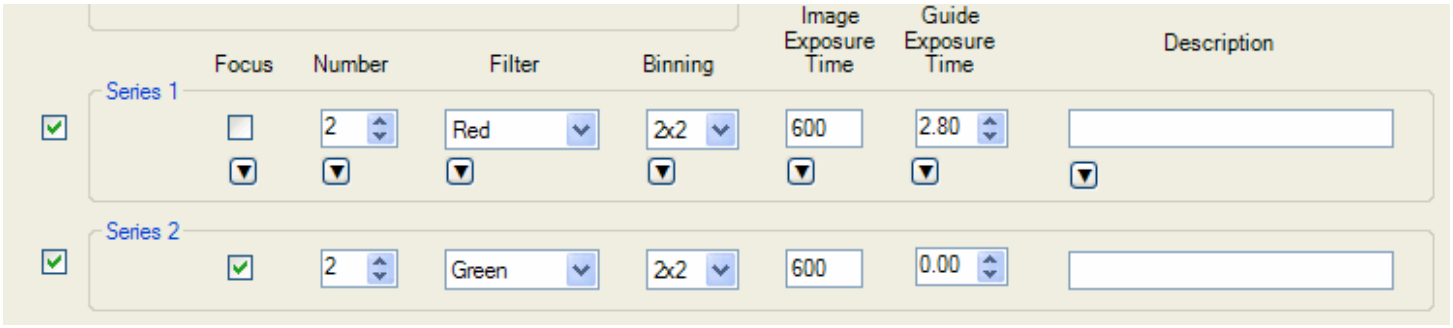
This box selects the target whose light exposures you wish to edit. The drop down will be populated with all the target names that are present in the target list from the Targets page. Select the one whose light frames you wish to edit. After editing the light frames (see below), you have two choices:

- **Update:** Hitting this button will apply the light frame selections to that specific target.
- **Apply to All:** Hitting this button will apply the light frame selections to all of the targets on the list.

There is an "auto-save" feature that automatically saves the light frame selections to the selected target when you leave the Light Frames page.

Exposures

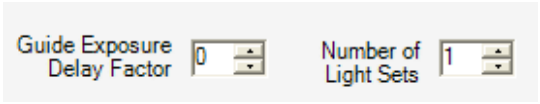
Here is where you set the specifics of your exposure plan. There are 8 series of exposures possible for each target but you are not limited to 8! By using multiple identical target entries, it is possible to select a virtually unlimited number of exposure prescriptions.



For each series, the checkbox at the left of each series enables or disables that series. When disabled, the series information is grayed out. The remainder of the series information is:

- **Focus:** When checked, the chosen active focusing method will be applied at the start of each series.
- **Number:** This is the number of exposures that will be taken in this series before moving on to the next series.
- **Filter:** This is the filter that will be used for this series. Filter naming and selection will be according to the names and capabilities of your camera control program.
- **Binning:** This is the degree of binning that will be used for this series. Binning will be according to that reported by your camera control program and your specific camera.
- **Image Exposure Time:** This is the length of time your imaging camera will be exposed in seconds.
- **Guide Exposure Time:** This is the length of time for your guide exposure. Allowable range is 0 to 50 sec. in 0.1 sec steps. If 0 is entered, that series will not be guided.
- **Description:** Here you can enter a specific description for the exposure. If no description is entered, the file name for the exposure will be automatically generated as follows: <Filter><E/W>_<Target>_<sequence number>.fit. <Filter> is the name of the filter for the series. <E/W> indicates which side of the meridian, East or West, the image was taken. <Target> is the target name, as defined in the target pulldown. The sequence number is a 5-digit number that identifies one exposure from another. If you enter a description, the file name will be <Description>_<Target>_<sequence number>.fit, where <Description> is the description entered.

Below each item in Series 1 is the ▼ button, which replicates the series 1 settings into all of the other series for easy editing.



- **Guide Exposure Delay Factor:** If this value is non-zero, a delay equal to the guide exposure for the specified filter times the number entered is applied before the actual exposure initiates. With AGRS enabled, this can usually be left at 0.
- **Number of Light Sets:** This is the number of times each series will be repeated for each target. For example, assume series 1 has 3 red-filtered (R) exposures, series 2 has 2 green-filtered (G) exposures and series 3 has 5 blue-filtered (B) exposures. If this number were set at 3, the selected target would be exposed in this sequence: RRRGGBBBBBRRGGBBBBBRRGGBBBBB. With this capability, you can be sure to get at least some data with each filter, when conditions may not bode will for a totally clear evening.

Dark & Bias Frames

CCDAutoPilot give many possibilities for automatically acquiring calibration frames to make maximum use of your available evening. Without good calibration data, your resultant images will be less than they could be. Dark and Bias Frames, together with Flat Frames, provide the calibration data needed for best results.

For each series, the checkbox at the left of each series enables or disables that series. When disabled, the series information is grayed out. When the Flush Imager series is checked, the series will be run once before any subsequent dark or bias frames are acquired. The Flush series is used to remove any residual image that may remain after light frame exposures of bright objects. You should experiment with your specific camera to see what kind of flush series is appropriate. For my camera, an IMG6303E, I find that 3 exposures of 200 sec. each binned 1x1 does a good job of removing these residual images.

The remainder of the settings for each series is:

- **Relative to Light Frames:** You have the ability to take the series before, after or both before and after the light frames. Depending on your automation plan, you can maximize the calibration frames acquired in an evening this way.
- **Number:** This is the number of exposures that will be taken in this series before moving on to the next series.
- **Filter:** This is the filter that will be used for this series. Filter naming and selection will be according to the names and capabilities of your camera control program. If you have a shutterless camera, you can select an opaque filter slot for your darks.
- **Binning:** This is the degree of binning that will be used for this series. Binning will be according to that reported by your camera control program and your specific camera.
- **Type:** Select either bias or dark. A bias frame is essentially a 0-length exposure time dark.
- **Exposure Time:** This is the length of time your camera will be exposed in seconds.
- **Description:** Here you can enter a specific description for the exposure. If no description is entered, a default file name for the exposure will be automatically generated. For a bias frame, the file name will be <Camera temperature>Bias<Binning>_<yymmdd>_<sequence number>.fit, where <Camera Temperature is the operating temperature of the camera, Binning is the selected binning, <<yymmdd> is the date the exposure is taken and <sequence number> is the 5-digit sequence number used to identify one exposure from another. For a dark frame, the default file name <Camera Temperature>Dark<Exposure Time><Binning>_<sequence number>.fit. The only difference from the bias frame default is the addition of the exposure time to the file name. If you enter a description, the file name will be <Description>_<yymmdd>_<sequence number>.fit, where <Description> is the description entered.

Below each item in Series 1 is the ▼ button, which replicates the series 1 settings into all of the other series for easy editing

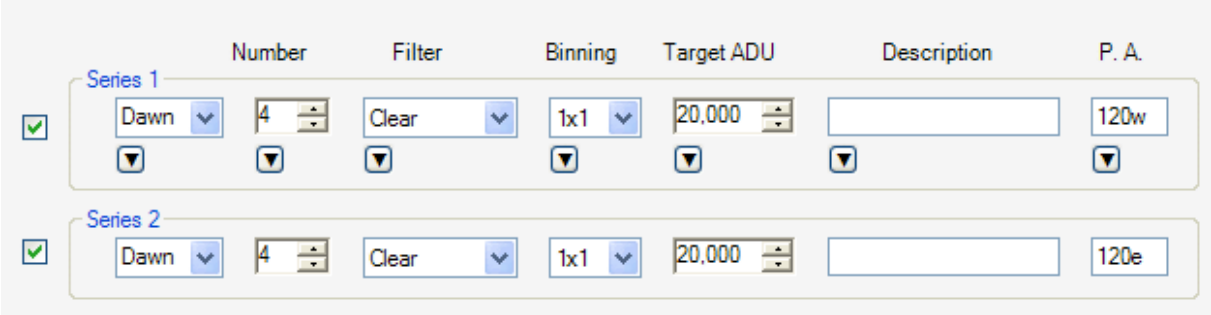
- **Number of Dark Sets:** This is the number of times each series will be repeated.

- **Dark Frames Now:** This button will take the dark and bias frames specified on this series immediately. All that is required is a camera connection.

Flat Frames

Get any group of professional astronomers together and sooner or later the subject will turn to flat fielding. Flat frames are essential if the faintest parts of a target are to be detected. The basic concept is to point the system to a uniformly illuminated light source and take an exposure. The resultant exposure will capture all of the imperfections in the system - vignetting, dust on the optical surfaces, off-axis optics and other disturbances. Various illuminated screens are normally used for a target. Or, the twilight sky itself can be used! There is a specific point in the twilight sky called the null point that has the most uniform lighting. When dawn or dusk flats are selected, the telescope is automatically slewed to this point at the appropriate time.
While some may avoid flat frames due to the assumed difficulty in acquiring good ones, CCDAutoPilot makes the acquisition of high quality flats very easy. By pointing the telescope to the proper point in the twilight sky, a very uniform light source for flat fields is obtained. The difficulty of dealing with the changing brightness of the twilight sky is resolved by the efficient auto exposure routine that dynamically adjusts the exposure to the changing conditions to meet the desired exposure target, expressed in ADU (Analog-Digital Units) or "counts" as it is commonly called. Even with an artificial light source, such as a dome screen or light box, flats can be taken automatically.

Exposures
There are 8 series of exposures possible for your flat series and these can be obtained at dusk, at dawn or both.



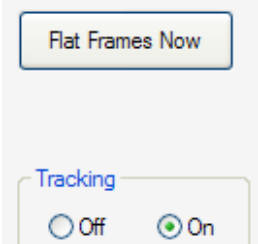
For each series, the checkbox at the left of each series enables or disables that series. When disabled, the series information is grayed out. The remainder of the series information is:

- **Dawn/Dusk/Both:** The specified series will be taken at the selected point in the day.
- **Number:** This is the number of exposures that will be taken in this series before moving on to the next series.
- **Filter:** This is the filter that will be used for this series. Filter naming and selection will be according to the names and capabilities of your camera control program.
- **Binning:** This is the degree of binning that will be used for this series. Binning will be according to that reported by your camera control program and your specific camera.
- **Target ADU:** This is the desired count level for your flats. The level should be chosen to be in the linear range of your camera. The linear region is 30-45% of the full count level. For a 16-bit camera, typical levels are 20,000 to 30,000 ADU
- **Description:** Here you can enter a specific description for the exposure. If no description is entered, the file name for the exposure will be automatically generated as follows: <Filter>_Flat<Rotation>_<Target>_<sequence number>.fit. <Filter> is the name of the filter for the series. <Rotation> is the position angle for the flat. <Target> is the target name, as defined in the target pulldown. The sequence number is a 5-digit number that identifies one exposure from another. If you enter a description, the file name will be <Description>_<Target>_<sequence number>.fit, where <Description> is the description entered.
- **PA:** This is the position angle at which the flat will be taken. If you have any field asymmetry due to camera rotation, best practices encourage taking a flat at all rotations. Assume you have a target that you tracked across the meridian at a position angle of 120°. If you wanted a flat to match target exposures from both sides of the meridian, you would enter 120e for one series and 120w for the other. The two series of flats would be obtained with one rotated 180° from the other. This assumes a rotator of course. If you wanted flats at a specific rotator setting, just enter the number without 'e' or 'w' and the flat will be taken at that specific rotator setting. Leaving this field blank results in no rotation and the flats will be taken wherever the rotator happens to be.

Below each item in Series 1 is the  button, which replicates the series 1 settings into all of the other series for easy editing.

The need for separate flats for each filter and rotation depends on each situation. Experimentation is needed to determine what kind of sensitivity your system (and you!) have to flat optimization. CCDAutoPilot gives you all the tools and capabilities you need to get the flat frames of your choice automatically and with minimal work on your part.

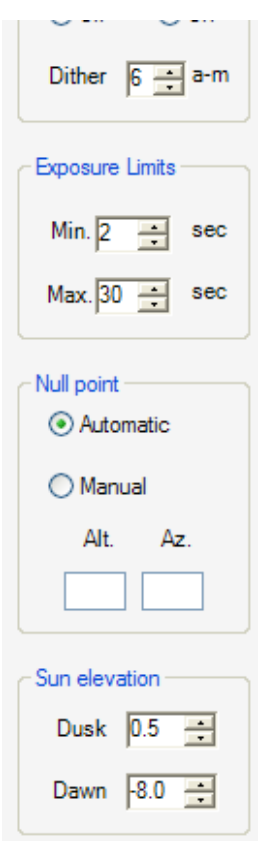
Options



- **Flat Frames Now** Hitting this button immediately begins acquisition of the flat frames specified in the active series. This is most useful when an artificial flat illumination source, such as a screen or light box is available. Exposure will be automatically determined and flat acquisition will proceed unattended.
- **Tracking** When Tracking Off is selected, tracking will be turned off when the telescope slews to the null point. If your telescope does not support turning tracking off, or you choose to take flats with tracking on, select Tracking On. When Tracking On is selected, as in dithering during image acquisition, the telescope will be moved appropriately between flat exposures. This becomes significant when the master flat is

created. With tracking off, any stars that appear in the image are trailed and lower intensity. With tracking on, stars appear as point sources and are displaced from one flat exposure to the other. In that way, a median combine should effectively eliminate either the point source stars or the trailed star images.

- **Exposure Limits** This sets the minimum and maximum exposure over which you will allow the auto-exposure function to operate. Too short and the camera shutter movement itself will distort your flats. Too long, and you may not get all the flats you need at dawn or dusk. Recommended starting values are 2 seconds minimum and 30 seconds maximum for cameras with a mechanical shutter. Shutterless cameras can go as short as .01 sec. for the minimum setting and .02 sec. for the maximum setting.
- **Null Point** This is the point in the sky calculated for most uniform illumination, based on studies by professional astronomers. It is recommended that the Automatic setting be used but if you wish to experiment, you can select Manual and enter your own azimuth and altitude settings.
- **Sun Elevation** Here you can enter the sun elevation at which the taking of sky flats will begin. These settings should normally not need to be changed but it may be appropriate for some conditions. For example, if you want to take dusk flats through a narrow band filter which needs more light, you may set the dusk elevation at 1 or 2. Defaults are Dusk: 0.5, Dawn: -8.0.



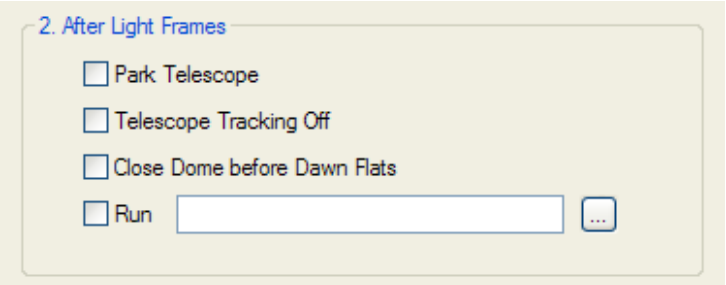
Options

This page gives you the ability to completely customize the session to your needs and your systems capabilities. The session is roughly divided into three phase, each with their own set of customization options and each include the ability to launch a user-provided program at the conclusion of each phase.

Startup
These tasks are run before any calibration frames or exposures take place

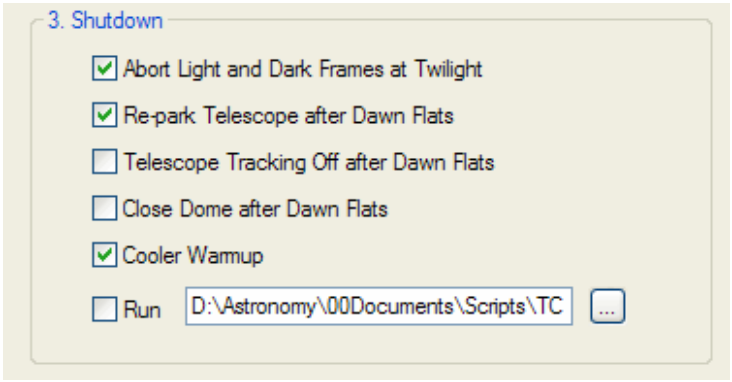
- **Begin Session at a specified starting time:** When checked, the session will start at the specified time
- **Begin Session at a number of minutes relative to Sunset:** When checked, the session will start the specified number of minutes before (-) or after (+) sunset. Note that only one of the two Begin Session options can be checked.
- **Open Dome:** When checked and connected to appropriate dome automation software, the dome shutter will be opened at the session start time. If the dome fails to open, the run will abort.
- **Cooler start Delay:** When checked, this will allow the cooler to come on after the specified number of minutes delay and at the specified set point. The delay is defined as the time from the previously completed startup task. If this is the first checked task, it will be measured from session start.
- **Wait up to:** CCDAutoPilot will wait up to the specified number of minutes for the cooler to reach the set point specified above. As soon as the set point is reached, the session will continue; if the set point is not reached in the after the specfied number of minutes, the session will continue.
- **Run:** When checked, the application in the space provided will be run. Navigate to this application by using the ... file open button. The run will not proceed until this application completes and closes.

After Lights
These tasks are run at the conclusion of the light frames and before any calibration frames are acquired after the light frames.



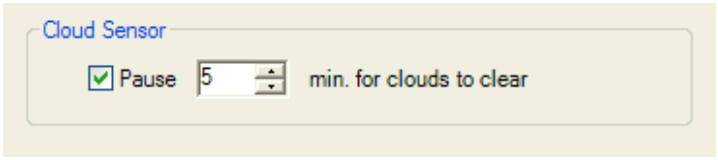
- **Park Telescope:** When checked, the telescope will be parked at its user-defined park position
- **Telescope Tracking Off:** If desired, or if the mount doesn't support parking, the telescope tracking will be turned off, leaving the telescope in its current position.
- **Close Dome before Dawn Flats:** When checked, the dome shutter will be closed. This option could be used either when no dawn flats are planned and only dark and bias frames are needed.
- **Run:** When checked, the application in the space provided will be run. Navigate to this application by using the ... file open button. The run will not proceed until this application completes and closes.

Shutdown
These tasks are run after all scheduled calibration frames are completed.



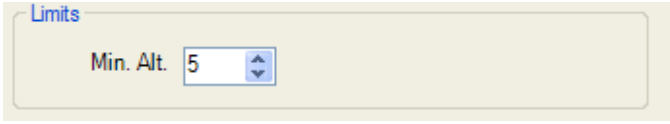
- **Abort Light and Dark Frames at Twilight:** When checked, any light and dark frames being taken at the start of twilight will be aborted. This box is automatically checked if any dawn flats are selected.
- **Re-park Telescope after Dawn Flats:** When checked, the telescope will return to its park position after dawn flats are completed.
- **Telescope Tracking Off after Dawn Flats:** If desired, or if the mount doesn't support parking, the telescope tracking will be turned off, leaving the telescope in its current position.
- **Close Dome after Dawn Flats:** When checked, the dome shutter will be closed at the conclusion of dawn flats.
- **Cooler Warmup:** When checked, the camera cooler set point will be set to +25°C. This is done in place of merely turning the cooler off in case the camera's driver controls the cooler ramp-up. This becomes more important in large chip cameras. In such cases, wait for the cooloer duty cycle to get to 0% before turning off the camera.
- **Run:** When checked, the application in the space provided will be run. Navigate to this application by using the ... button. The run will not complete until this application completes and closed.

Cloud Sensor
This option refers to the cloud sensor, if installed, reporting a cloudy sky condition. See the Boltwood Cloud Sensor topic.



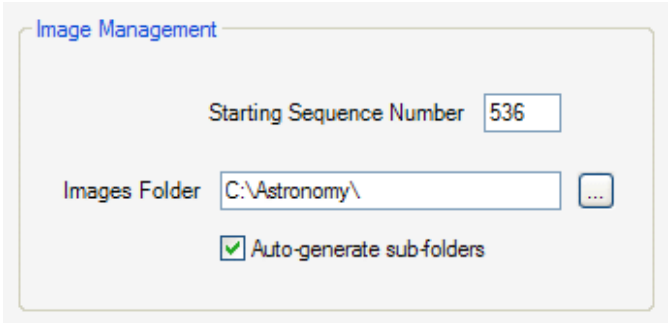
If Pause is checked, the run will pause for the specified number of minutes to wait for the clouds to clear. If they clear in that period of time, the run resumes. If they do not, the run aborts and the appropriate user-specified shutdown tasks are executed. If pause is not checked, then the appropriate user-specified shutdown tasks are executed immediately upon the cloud sensor reporting a cloudy condition.

Limits



- **Min. Alt:** Sets the minimum altitude to which CCDAutoPilot will slew the telescope. If Min. Alt is set to 0, there will be no minimum altitude limit applied.

Image Management
These options provide image folder locations and enable the starting sequence number to be set.



- **Starting Sequence Number:** This entry will be the sequence number of the first exposure taken in the series. The number is maintained in the registry so that all exposures in a consecutive period are assured of having a unique identity. While it is possible

to edit this entry, it is recommended it be left intact so that the chance of over-writing previous data is minimized.

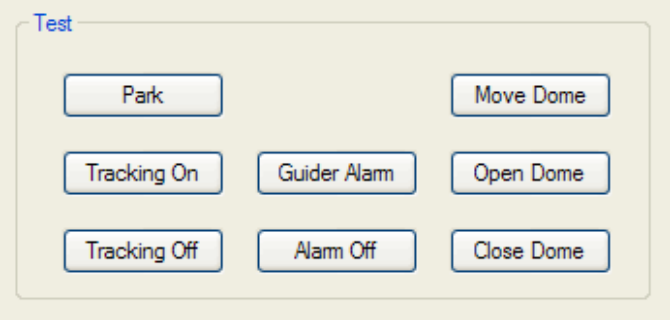
- **Images Folder:** This is the root or base folder in which all exposure files are located. Using the ... button, navigate to the desired base folder for your images.
- **Auto-generate sub-folders:** When checked, this powerful option will arrange your exposures in an easy-to-use and logical manner, without your having to worry about folder names. The Images Folder specified above will be the base. Light frames will be located in a folder with the name <yymmdd><Target>. Calibration frames, consisting of dark frames, bias frames and flat frames, will be located in a folder with the name <yymmdd>_CalibrationFrames. And all CCDAutoPilot logs will be located in a folder with the name CCDAutoPilot_Logs.

Here is an example. Assume you have defined your Images Folder as C:\Astronomy and on January 22, 2006, you imaged M42 and M78. At the end of your automated run, you will find the following folders created with the appropriate data in them:

Light frames: C:\Astronomy\060122_M42 and C:\Astronomy\060122_M78
Calibration frames: C:\Astronomy\060122_CalibrationFrames
And your log for the night's activities will be in C:\Astronomy\CCDAutoPilot_Logs

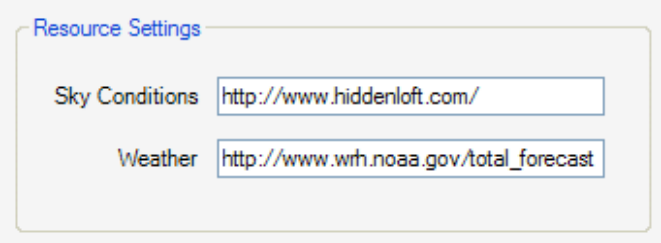
Test
These buttons cause the indicated actions to be performed. They may be used to test communications to the ultimate hardware through the various software layers before committing to an automated run. It is recommended this facility be used whenever hardware changes or a suspicion of things not going right arises.

IMPORTANT: CCDAutoPilot can only send the Tracking Off and Park command to your telescope control program. It is your responsibility to verify that your mount behaves properly when it receives these commands. Please take advantage of the Test buttons to verify proper communications with your mount and dome. Hit these buttons one at a time to test whether your chosen telescope control program turns off tracking or parks the mount. If you don't get the expected results, consult the manufacturer of your telescope control program for support. CCDAutoPilot sends standard commands for tracking off and park in accordance with ASCOM and TheSky6's defined interfaces.



- **Park:** This button should send the mount to its park position. With most telescope control programs and/or mounts, this park position must be pre-defined by the user.
- **Tracking On:** This button should turn the mount tracking on.
- **Tracking Off:** This button should turn the mount tracking off.
- **Guider Alarm:** This gives an example of the alarm that sounds when guiding fails and the AGRS cannot restore it. This button can be used to set the sound level desired.
- **Alarm Off:** This turns off the alarm.
- **Move Dome:** This is a simple test of slewing the dome. Hitting this button should move the dome 15° clockwise.
- **Open Dome:** This button should open the dome shutter.
- **Close Dome:** This button should close the dome shutter.

Resources
The desired URL's for your Sky Conditions and Weather can be entered here for easy access anywhere within CCDAutoPilot.

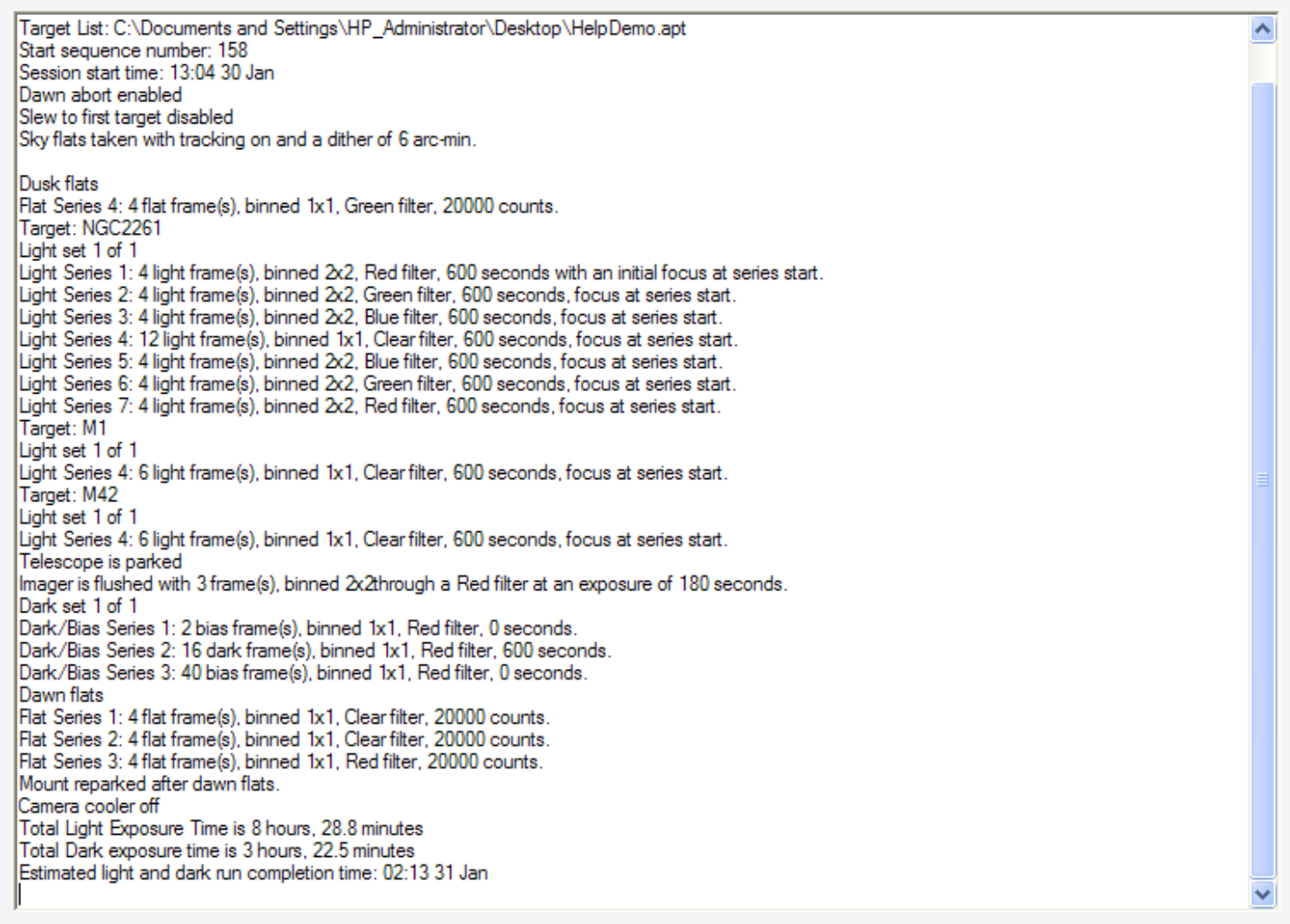


- **Sky Conditions:** Enter or paste the URL of a site that indicates your sky conditions. A nearby Clear Sky Clock is handy for this in the U.S. and Canada.
- **Weather:** Enter or paste the URL of your favorite weather site.

Reviewing the Session

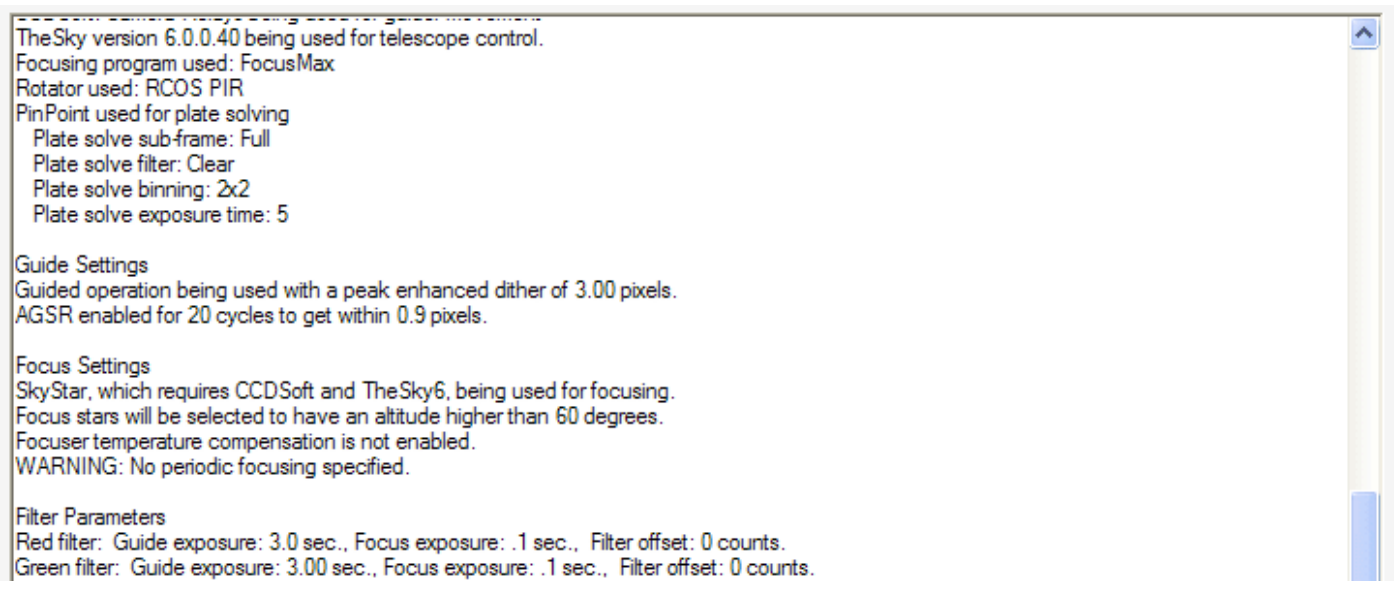
When everything is ready for your run, you can review both the setup and the session itself from the Run Session page. On first switching to this page, and assuming a camera, real or simulated, is connected, you will immediately be presented with a preview of the planned session if your target list is less than 10. If you have more than 10 targets, you will have to generate the session review explicitly by hitting the Review Session button.

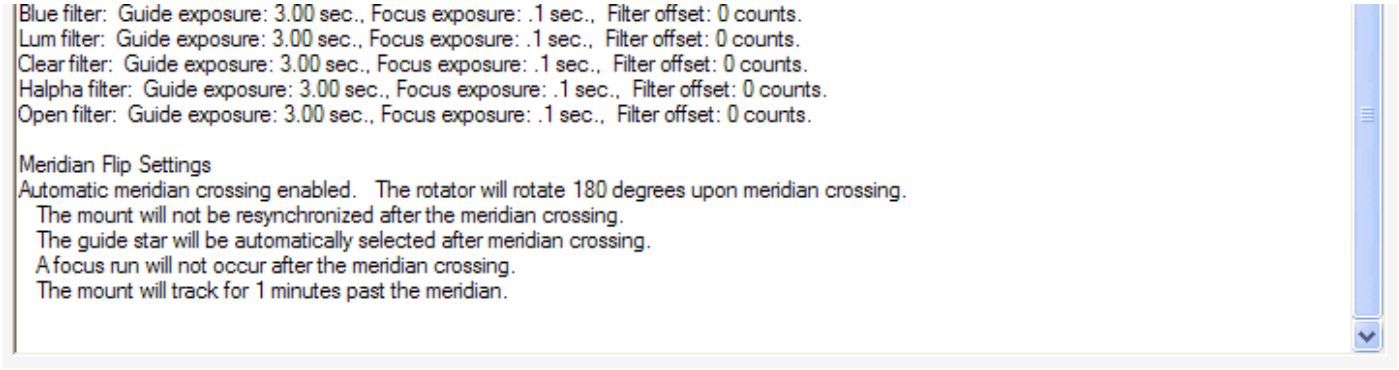
Session Review



This is a typical preview log. It shows information in summary form about the session to be run, ending with an estimate of the elapsed time. By using the additional controls, more information may be obtained before committing the run.

Setup Review





This is a typical setup review window. It will show information about the equipment, software, tracking, guiding and focusing that will be used for the run.

Controls

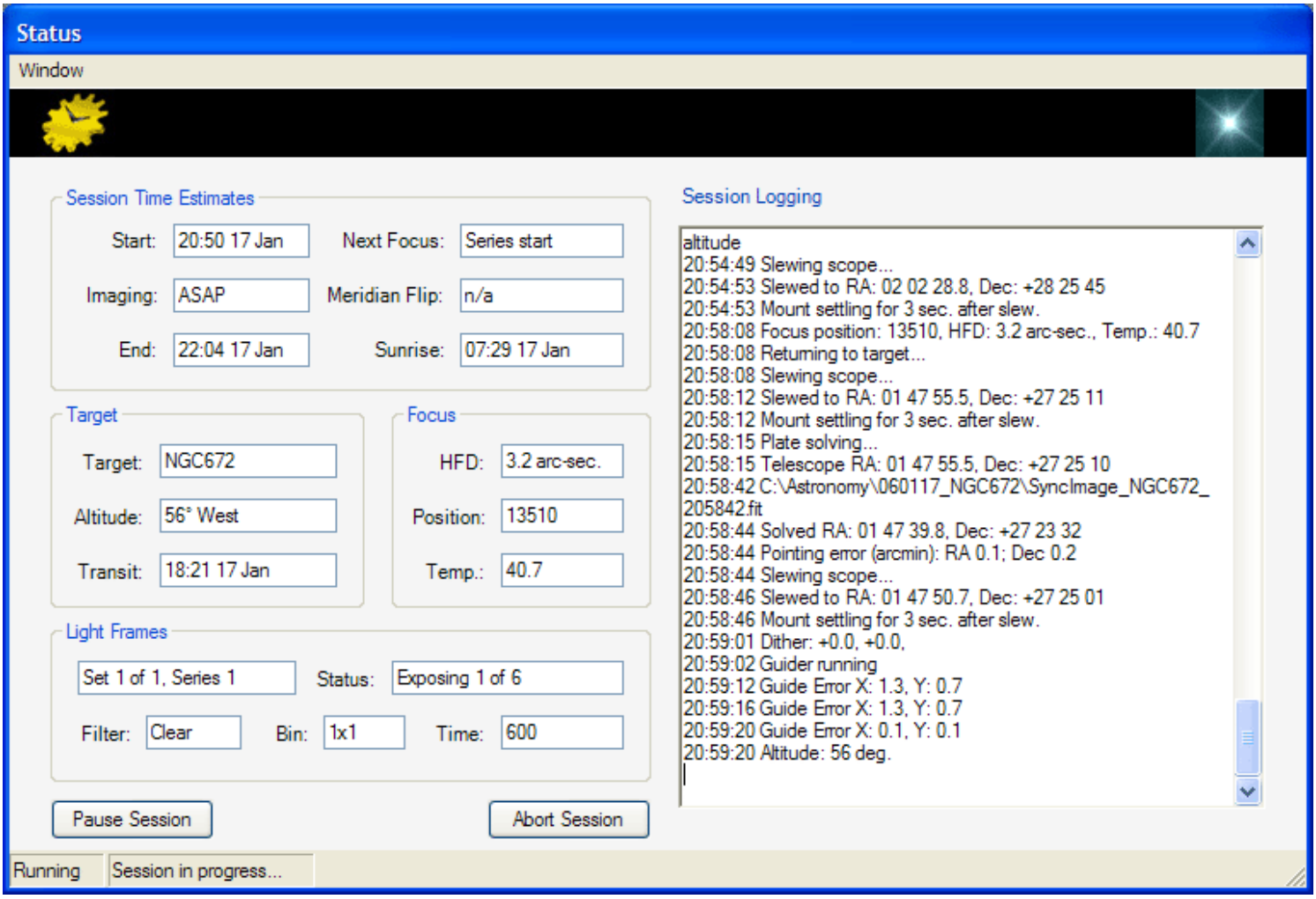
- **Show Details:** Checking this option will show more detail in the preview, including actual file names where possible. Leaving this box unchecked provides summary information.
- **Review Setup:** Hitting this button generates the Setup Review information. It may be called at any time by hitting the Review Setup button.
- **Review Session:** A session review is generated whenever the user switches to the Run Session page. It may also be called at any time by hitting the Review Session button.
- **Run Session:** This button initiates the actual session. When it is hit, the main window is minimized, the status window is opened and the run begins, with monitoring provided by the smaller and scalable status window.

A note about starting a run...

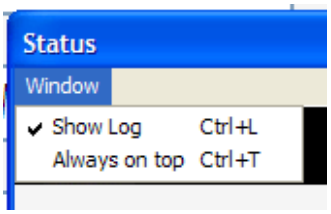
Since CCDAutoPilot has no way of knowing where your system is with respect to filter offsets and focusing, it assumes that the system is in focus with user-specified plate solve filter in place and that filter is the reference or zero-offset point for any other filter offsets used.

Status Window

Once the Run Session is hit on the Run Session page, the main window is minimized and the Status window is loaded. If the main window is restored via the Windows Task Bar, all of the controls will be disabled (grayed out), until the run is either competed or aborted.



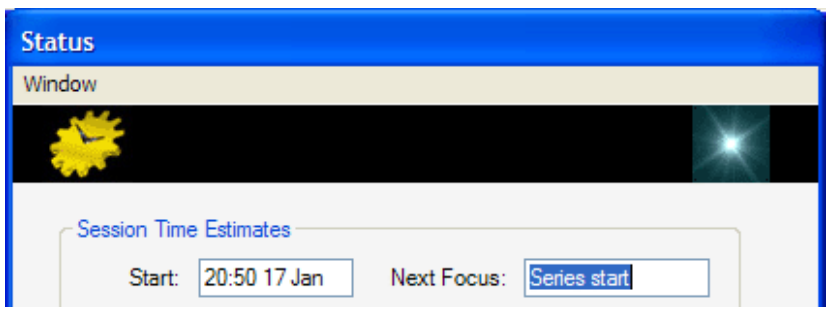
The window is resizeable as the user desires. There are also some options selectable from the Windows menu:



- **Show Log (Ctrl-L):** When this item is checked, the detailed log at the right is shown. When it is not checked, only the summary information is displayed. This selection may be toggled by holding down the Control key and then hitting 'L'
- **Always on Top (Ctrl-T):** When this item is checked,d the status window is made the topmost window on the desktop. This prevents other windows from hiding crucial session information. When it is not checked, the status window's behavior is normal, i.e. it can be hidden by other windows. This selection may be toggled by holding down the Control key and then hitting 'T'

Summary Information

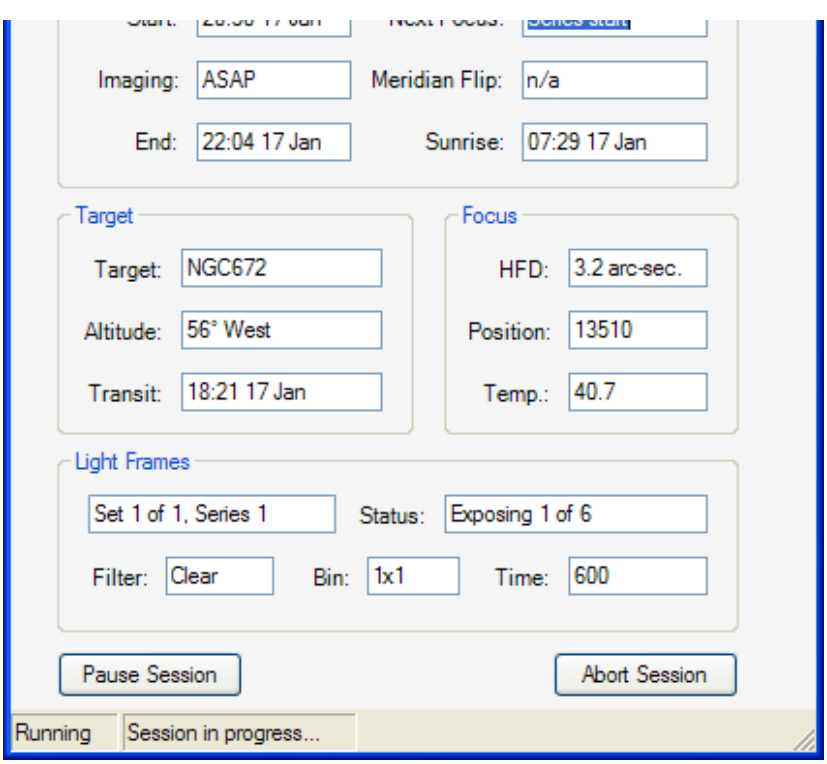
Session Time Estimates



- **Start:** indicates the run start time
- **Imaging:** indicates the time the light frames will begin. If the user has specified a delayed start for the first target on the Targets page, this will indicate that time. Otherwise, it will indicate ASAP.
- **End:** indicates the expected ending time of the run, not

including any dawn flats

- **Next Focus:** indicates when the next automatic focusing activity will take place. Series start indicates at the next series, otherwise the time of the next scheduled focus is indicated.
- **Meridian Flip:** If the target is east of the meridian, this indicates the expected time of the meridian flip. If the target is west of the meridian, this field will so indicate. If a fork mount is being used, n/a will be indicated since there is no meridian flip with a fork mount.
- **Sunrise:** indicates the time of local sunrise



Target

- **Target:** indicates the target, as defined on the Targets page.
- **Altitude:** indicates the altitude of the target and whether it is east or west (of the meridian).
- **Transit:** indicates the time the target will transit (cross) the meridian.

Focus

If no focus program is used, all these entries will indicate "n/a". Otherwise:

- **HFD:** indicates the Half-Flux Density of the focused star, as reported by FocusMax. This is not necessarily the same as FWHM (Full Width Half Maximum) as normally used for stellar profile measurements. HFD is a good relative indicator of focus however.
- **Position:** indicates the focuser position, as reported by FocusMax, for your focused position.
- **Temp:** Reports the ambient temperature in whatever units (°F, °C, counts, etc.) the focuser in use reports temperature. If the focuser doesn't report temperature, then "n/a" is indicated.

Bottom Box

The title of this box will change, depending on the activity in progress. For Light Series as shown above, it will show the progress in terms of the number of Sets, what series is underway, what progress is made in the series and what Filter, Binning and Exposure time is being used for the exposure in process.

- **Pause:** The Pause button allows the run to be paused at an appropriate point, usually the completion of the exposure in process. Once paused, the title of this button changes to Resume and hitting it again will resume the run. This is convenient if you have to go out to the telescope, put a light on and adjust something. When you are done, you can resume the run from where you paused.
- **Abort Session:** This is used to totally abort the running session. When hit, the session abort routines will be initiated and the Abort Session button will be grayed out. Once the abort routines complete, the main window will be restored. Be sure to wait for the main window to reappear to insure CCDAutoPilot is in the proper state to restart a run. If there is any doubt, close and restart CCDAutoPilot. The status window can either be left open or closed as desired. Closing the status window causes its position and size to be remembered so that it will be restored to the same size and position when Run Session is hit again.

Status Bar

A status bar is provided at the bottom of the status window to indicate various activities.

Troubleshooting

Observatory automation is a complex undertaking. While every attempt has been made to make this undertaking as simple as possible, the complexity should not be underestimated. Over half of all problems reported arise from failure to read the Help system. If you are having problems in a specific area, first carefully read the associated Help topic. The First Use topics are specifically recommended before starting. Remember that while CCDAutoPilot is open, you can always bring up the Help topic for a specific page by hitting the F1 key.

CCDAutoPilot is an executive program. As such, it issues commands via defined software interfaces to the programs it controls such as camera control programs, telescope control programs, focusing programs, rotators and dome control programs. In order to function, the controller programs (called servers) must be properly loaded and accessing their appropriate hardware properly. The steps outlined below should get you up and running.

There are many complex interactions and, while every effort has been made to make this software as bug-free as possible, they unfortunately can and do occur. Additionally, new features will be added from time to time. CCDAutoPilot has the capability of automatically updating the program from the web. See Updates for more information.

Step-by-step

1. Make sure the .NET 2.0 framework is installed. You can verify its installation by going to Control Panel, Add/Remove Programs and making sure there is an entry for "Microsoft .NET Framework 2.0". If that entry is not present, please install it before proceeding. See the Software Requirements topic for a link to the Microsoft download location.

2. Insure installation of all programs required for your operation is proper and functional by testing them standalone. See the Software Requirements topic for links to all programs. Make sure you are using the latest version of CCDAutoPilot. The most recent version information and change history can be found here.

3. Verify you have the minimum version level for the above programs. CCDAutoPilot will warn of out-of-revision programs and prevent operation. See the Software Requirements topic for minimum version requirements. Of course, higher version numbers can be used. Program version numbers can generally be checked by the Help | About menu on the individual program. For programs that do not support this feature, you must locate the program's .exe file, right click on it, select properties and select the version tab.

4. Before connecting CCDAutoPilot to any of your programs, be sure the programs are able to properly control their related hardware. Can you take an image with your camera control program? Can you slew the telescope with your telescope control program? Can you control your focuser and focus with your focuser program? Does your rotator program control your rotator? Does your dome control program move your dome?

Hint: It is always best to start the lowest level programs first and then load the higher level programs next. For example, assume you are using RoboFocus to control your focuser, FocusMax for focusing and CCDSoft to control your camera. Load and start RoboFocus, confirming it connects to and can control your focuser hardware. Next Load CCDSoft, confirming it connects to your camera. Take a short image to be sure. Next, load FocusMax since it must control both RoboFocus and CCDSoft. Finally, load CCDAutoPilot. If you close any program out of order, then you should close the chain and restart in the appropriate order. If you close CCDSoft, you must therefore close CCDAutoPilot and FocusMax. Then restart CCDSoft, restart FocusMax and restart CCDAutoPilot. Failure to start programs properly or in the proper order may cause subsequent automation failure.

5. Connect to CCDAutoPilot and use the test buttons on the Options page to verify CCDAutoPilot is able to control the appropriate hardware *through* your programs.

6. On the Targets page, create a target using the Get function with TheSky6 or the Add button otherwise. Uncheck Precision Slew to Target and hit the Slew to Target button. Does the mount slew properly?

7. Set up a single, short exposure on the Light Frame page. Run a short session to confirm the telescope slews to the target and takes a short exposure.

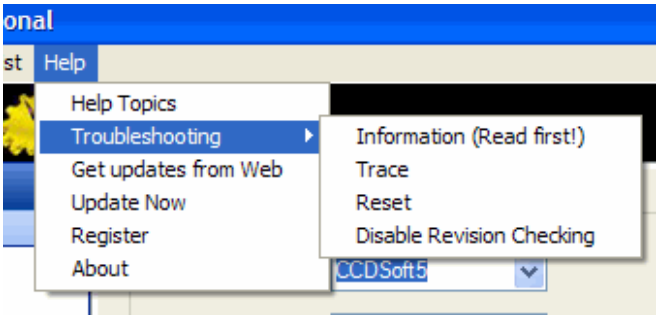
8. Add other functions and complexities gradually, verifying proper operation with each addition.

When things don't go as expected

While every effort has been made to trap invalid user entries, some slip by. These are addressed as they are identified but with over 600 controls, there is a lot of opportunity for bad entries or combinations. Here are some techniques to help resolve such a problem.

- **Task Review:** Open Task manager and select the Processes tab. If you click on the Image Name table header, the processes will be sorted in alphabetical order for easy viewing. Verify that one and only one process is running for each server program you have operating. If you see more than one process, then proper automation is not possible. You should either reboot your PC (easiest) or close all programs and use the End Process button to stop any server programs that remain running. This can happen when a run is aborted and the abort process is not allowed to complete. After hitting the Abort button on the status window, remember to wait until the main window restores (re-opens). This minimizes the chance of multiple processes in task manager.

- **Rename the System Profile:** By renaming the system profile, CCDAutoPilot will create a new, default profile. Of course you will need to re-enter all your settings but often this resolves the issue of a bad setting.



- **Information (Read First):** links to this topic.

- **Trace:** While the status window and the attendant log provide event logging during an active run, there are possible occasions when things don't go as expected before starting an actual session. The trace facility can be used whenever things don't seem to be "working right" before running a session. The Trace facility provides diagnostic information for this condition. When this topic is selected, CCDAutoPilot's trace facility is turned on and CCDAutoPilot closes. When CCDAutoPilot is next started, the trace facility is engaged and a trace file will be written in the CCDAutoPilot3 data directory. The data directory is located at My Documents\CCDWare\CCDAutoPilot3 (XP and Prior) and Documents\CCDWare\CCDAutoPilot3 (Vista).A new file is written each time CCDAutoPilot is started. The file has a file name of `Trace<yyyymmdd>_<HHmmss>.log` and will record any error messages. Trace being on is indicated by a check next to the Help menu selection. To turn Trace off, select this topic again. CCDAutoPilot will close and Trace will be disabled when CCDAutoPilot is next started. Contact support for interpretation of any messages in the trace file.

- **Reset:** Selecting this topic resets all key data as if CCDAutoPilot were never installed (except for the trial period status of course). Your system profile(s) and target list(s) are not affected. In the unlikely case where CCDAutoPilot fails to load, select CCDAutoPilot3 Reset in the CCDAutoPilot3 folder of the start menu. This program does the same thing and can be used in case of a load failure.

- **Disable Revision Checking:** This should normally not be checked to enable revision checking of the various applications that will be connected to CCDAutoPilot. However, it may be checked for trouble shooting purposes. When checked, application revision checking is not enabled and CCDAutoPilot operation may be compromised. Checking this in concert with enabling the Trace facility above can be used to trouble shoot unexpected results.

- **Remove and Reinstall CCDAutoPilot:** While this should not be necessary. it has been shown to help resolve some unique issues. This should be used in conjunction with the CCDAutoPilot Reset Tool. First remove CCDAutoPilot then run the CCDAutoPilor Reset Tool. If possible, it is a good idea to reboot your PC before reinstalling.

Support

If none of the above resolves the issue you are having, please use the CCDAutoPilot support forum linked from CCDAutoPilot itself. If you have problems during a run, be sure to post the related .log file as an attachment. If you are having problems that prevent a run from starting, you should include a .zip file that includes your system profile and target list. The more detail you include in your problem report along with the suggested attachments, the sooner the issue can be resolved.

Equipment Setup

This section will include some notes, growing over time, to aid proper setup for unattended imaging.

Cameras

- **SBIG AO/Maxim:** The current Maxim automation interface does not support predictive mount bumping. As a result, drive calibration for mount bumping must be performed for every target. This is done by using 4x the planned guide exposure of the first series for each target but using the specified plate solve filter. This is done to maximize guide star detection during the drive calibration. It is up to the user to make sure the guide star is sufficiently centered on the guider chip so that the guide star remains on the chip for all calibration movements. With this proviso, drive calibration will be performed automatically at the start of every target series.
- **SBIG AO/CCDSoft:** A successful initialization with CCDSoft will allow predictive drive calibration and therefore no calibration at each target is needed.

Telescope Mounts

- **Gemini:** To allow proper meridian flip operation, check the Safety Slew box on the Tracking and Guiding page. See Meridian Flip for details.
- **Paramount GT1100:** For the original Paramount, check Safety Slew on the Tracking and Guiding page. See Meridian Flip for details.

Rotators

In order to achieve successful operation with rotators, it is important that rotators move in the proper direction. Some rotators have no way to change them and are coded as such. Others are settable and settings must be made so that operation is in the correct direction. References to direction are viewed from the camera end and should be as follows:

- **RCOS PIR:** This is fixed by design. CCW rotation should result increasing position counts or degrees.
- **Optec Pyxis:** There are setup options. The option should be chosen in which CCW rotation results in increasing position counts or degrees. For the 2" Pyxis, this is normally the Reverse direction and for the 3" Pyxis, this is normally the default direction. See the Pyxis control software help file under PYXISparms.txt for specifics.
- **Astrodon TAKometer:** By design intent, CCW rotation should result in increasing position counts or degrees. If the rotator position is negative, it should get less negative; if it is positive, it should get larger. For example, CCW rotation should result in the position moving from -150 to-140 or 30 to 40. Unlike other rotators, the TAKometer must be accurately calibrated to give good results. Follow the instructions in the TAKometer documentation. Once you have completed calibration, rotate the TAKometer to +180 and note the rotator's position, perhaps against a fixed reference. Then rotate to -180. The rotator should come to the same point If it does not, re-calibrate as needed. Ideally, you should get within ±1 degree.

Focusers

Domes

Running a Session

First Use

Setting up a session