Celestron AstroFX
Nightscape Camera Control and Processing Software

TABLE OF CONTENTS

QUICK TOUR  2
The CCC Tabs  3
SNAP  3
STACK  6
STRETCH  8
SMOOTH  9
SHARPEN  10
SATURATE  11
SHARE  12
Congratulations on your purchase of Celestron’s Nightscape One-Shot-Color CCD camera! Included with Nightscape is AstroFX, our powerful, easy to use camera control software. In addition to managing your data acquisition sessions, "AFX" is also a full preprocessing program! With AstroFX, you will be able to combine individual subexposures into an RGB master file and apply further enhancements.

To make these astro-imaging tasks a breeze, AstroFX uses a unique, chronological layout, based on a system of seven alliterative S’s. No more searching through drop-down menus or asking yourself "What do I do next?" With AstroFX, you simply follow the tabs to Snap, Stack, Stretch, Smooth, Sharpen, Saturate and Share great astro-images quickly and easily. Let’s get started!

It all begins with another “S”, signal. Signal is the foundation on which we build all deep sky astro-images. It is quality signal and enough of it that adds up to data that withstands the processing necessary to create beautiful astro-images. Choose your targets wisely, creating a good matchup with Nightscape camera’s sensor size and the focal length of your telescope/lens. Does it fit, or is it “lost in the sauce”? In addition to great focus, take an extra minute to compose the image in the most artistic orientation possible. To benefit from AFX’s “Sigma” stacking, take at least seven exposures. A great mount and autoguider setup along with good polar alignment will ensure beautiful round stars over the course of your exposures. As a One-Shot-Color camera, Nightscape is able to collect Red, Green and Blue data at once [aim for a minimum of 5-minute subexposures (f/5-10 focal ratios) to take advantage of this convenience.] If using your Nightscape with a Celestron SCT in Hyperstar mode, exposure times will be dramatically reduced to 30-60 seconds each, without the need of an autoguider! If your location is susceptible to Light Pollution, consider an “LP” suppression filter. Nightscape features an optical window with an IR Cut-off filter for best color balance, especially beneficial when used with refracting telescopes. Strive for a minimum of 1-hour total exposure time to begin. In addition to Images (Light frames), carefully collect Reduction frames (Darks, Biases and Flats) as well. We will talk more about these frames later.

**QUICK TOUR**

You may be surprised upon opening AstroFX for the first time. By design, it appears different than typical software. You will quickly come to love the elegant, simple work space. The heart of AFX is the Central Control Console (Figure 1), which may be dragged to any position on your screen. The “CCC” consists of seven main tabs at the top, placed chronologically left to right. At the bottom are several navigation commands in blue.

**Helpful Hint** – Two important functions: Screen Stretch and Zoom are tucked away in a context menu, available by right-clicking the mouse in an image window. The Help files are available via the CCC screen ‘Help?’ button, and through F1 on your keyboard. Lastly, to give yourself more desk space for working with images, you can hide the CCC. While an image is open, click on the little Celestron icon at the top left corner of AFX’s main frame. This opens a context menu. Click Hide AFX dialog or use Alt+H on your keyboard. To recall the CCC, click the icon again.

Choose Show AFX dialog or hit Alt+H again. Note that additional Windows size and position functions are available here as well.
THE CCC TABS

SNAP
The Central Control Console of AstroFX defaults to the SNAP tab at far left (Figure 1). Note the little camera icon on top. This is where you begin to “snap” those great shots – “Say Cheese!”

Camera Setting controls the speed of the cooling fan. Choose High, Medium or Low.

- **High** quickly lowers the sensor’s temperature to reach your desired setpoint. This should only be used prior to actually taking Light or Dark images when thermal equilibrium is not crucial.
- **Medium** is the typical setting for imaging unless the setpoint cannot be maintained.
- **Low** may be sufficient once Nightscape has reached its desired setpoint.

Additionally, the Low setting should be used when the camera is in Fastar (f/2) configuration. With the camera in front of the telescope, this setting will provide a less turbulent, laminar airflow.

Cooler turns the Peltier cooler on and off. You will want this enabled to control CCD “dark current” noise for deep sky imaging.

Setpoint lets you choose the specific temperature you wish to cool the CCD sensor to. The Peltier will attempt to reach the setpoint and hold it steady. While the cooler is capable of reaching to -20 degrees below ambient temperature (expressed in Celsius), it will have a more difficult time achieving a low setpoint on hot summer nights.

Temp. reports the sensor’s current temperature in Celsius.

Exposure type can be set to Focus Mode, Calibration Frames (Bias, Dark, and Flat) or Astro Image. Choosing the appropriate type will aid AstroFX during the STACK process. Exposure type also affects the behavior of Nightscape, as you will see.

Focus Mode will begin a sequence of continuous exposures when the Start Imaging button is pressed. Exposures will continue until stopped by clicking the Abort button. Focus exposures are not saved to the Root Image Folder. See the Nightscape Setup Guide for more information. Focus Mode is also useful for any exposure which you do not want saved (i.e. centering a target on the sensor)

Astro Image are your Light frames = your pictures. When Start Imaging is clicked, AFX will open Nightscape’s shutter to acquire images and save them to the Root Image Folder.

Calibration Frames are necessary to get the most from your Light frames. Capture them before or after your imaging sessions so you do not waste precious time under a dark sky.

Calibration (Bias) frames are an electronic portrait of the camera and are produced by using an exposure time of ‘0’. When selected, Start Imaging will take Bias frames with Nightscape’s shutter closed to prevent any light from falling on the sensor. Bias frames are most useful for producing master Flat Dark frames or for scaling back longer Dark frame exposures to match shorter Light frame exposures. Consider taking a minimum of 25 Bias frames when they are needed. Bias frames should match Flat frames in resolution (binning) and temperature.
Calibration (Dark) frames are also an electronic portrait of the camera and contain the Bias, but also include artifacts, such as hot pixels, which appear over the length of longer exposures. When a master Dark frame is subtracted from individual Light frames, noise and hot pixels are greatly reduced, making for a clean, master Light frame. When selected, Start Imaging will take “Darks” with Nightscape’s shutter closed to prevent any light from falling on the sensor. Darks should also match Light frames in resolution (binning) and temperature but also exposure duration. Consider taking at least as many Darks as Lights, with a minimum of 12 frames preferred. Both Bias frames and Dark frames can often be reused for subsequent Stack sessions.

Calibration (Flat) frames are an optical portrait of the telescope/lens and other elements in the light path. They are useful for balancing uneven field illumination (UFI), including vignetting, gradients and for eliminating dust “donuts” (motes) on glass surfaces. When selected, Start Imaging will open Nightscape’s shutter to acquire Flat frames. Flats are harder to produce correctly and additional study is suggested. Ron Wodaski’s The New CCD Astronomy is recommended reading. The idea is to image an evenly lit field (the sky at twilight, lightbox, EL panel) using the same focus, angular camera position and resolution (binning) as the Light frames, at an exposure time to achieve one-third to one-half of the saturation level of the camera, perhaps 20k-40k ADUs [Analog to Digital Units]. This can be measured with the cursor, noting the intensity value “i” near the lower right corner of the main frame. Once an image has been color converted (with Show Full Color or STACK), intensity values are expressed in R, G, and B. Consider taking a minimum of 9 frames. You may find your optical system is more forgiving than some and Flats can be skipped. You may even replace them with post processing methods beyond the scope of AstroFX. To learn of these and other techniques, we recommend Intermediate Part-1 tutorials by IP4AP.com.

**Exposure duration (sec)** is the desired length of the exposure(s) in seconds.

**Number of exposures** is the desired amount of exposures.

**Resolution** changes the binning modes – Full (1x1), Half (2x2), and Quarter (4x4, for 10100 model only). Note that the NightScape 8300 produces color images in full (1x1) resolution only. The NightScape 10100 produces color images in all resolution/binning modes.

**Subframe** is useful for focusing and for applications where you do not need the entire frame. Select Set with Mouse from the pull down menu and draw a rectangle around a star or section of a downloaded image, or choose Central Half or Central Quarter from the drop down menu. Only that portion of the sensor will be downloaded next at a much faster rate than the entire frame. Be sure to set this back to Full Frame before the imaging sequence if that is your intention.

**Object name** assigns the target’s name (e.g., M42) to the file and to the FITS header.

**Helpful Hint** – The Flexible Image Transport System is the standard format for astronomical image files. A nice feature is the text header which stores information about the image, including: capture time, temperature, exposure duration, etc. Freeware for reading the header is available from http://heasarc.gsfc.nasa.gov/ftools/fv.

**Root Image Folder** is where downloaded files are automatically saved. By default this is C:\Users\Windows\Documents\AstroFX\Images (Windows 7), but it may be changed to a location of your choice using the navigation button at right.
Start Imaging begins the imaging sequence and may be halted at any time using the blue Abort button at the bottom right of the CCC. The exposure may be tracked by both the blue progress bar and status box at right.

Helpful Hint – To preserve friendships with your fellow astronomical neighbors and avoid light leaks from invading your shots, Night Vision mode is available. Click the small Celestron icon at the top corner of the main frame and choose Night Vision mode or use Alt+V on your keyboard. To restore AFX back to daytime mode, repeat the previous step.

As the current exposure downloads, the image is displayed on the desktop. Another unique feature of AstroFX – images are always displayed in color! Other software requires a “Debayering” step to extract color information from the One-Shot-Color matrix. The NightScape 8300 will only produce color images when operating in Full [1x1] resolution. Be advised that this QUICK COLOR display is instantaneous and is therefore of lower quality than what is produced when combining multiple images during the STACK process.

NOTE: It is recommended that when calibration files are to be used, that they be loaded under the STACK tab prior to loading your image files (Light frames). With all images autosaved to the Root Folder, you can proceed with stacking at the end of an imaging session or at a later time.

You can right-click the mouse in the image to zoom in or out, or use your mouse’s scroll wheel. Alternatively, you can change the zoom level by clicking on the indicator (i.e. ‘100%’) at the bottom of the main frame.

When the cursor is placed in the image window, its location (with regard to pixel coordinates) is reported in the main frame, to the right of the zoom level indicator and stretch presets.

Additional options are also available in the context menu. Holding down the Ctrl button allows you to pan left and right with the mouse scroll wheel. Holding down the Shift key enables you to scroll “up and down. Lastly, holding down the left mouse button allows you to drag the image.

Once an image is captured, you can adjust the visualization by right-clicking and choosing one of the Screen Stretch presets (e.g., Low). Alternatively, you can manually stretch the image by holding down the Shift key and left mouse button. In the image window, dragging up and down brightens and darkens the image by lowering and raising its White Point. Dragging left and right decreases and increases contrast by moving its White Point and Black Point further apart or closer together. You can also do this directly by placing the cursor in the histogram window of the CCC’s STRETCH, SMOOTH, SHARPPEN and SATURATE tabs. Lastly, you can change the screen stretch by clicking on the indicator (i.e. ‘Medium’) at the bottom of the main frame. This is also useful for resetting any undesired manual stretches which were done by dragging the cursor.
STACK
to the right, the second tab is STACK (Figure 2). Here, individual subexposures are "stacked" (digitally combined) into a single, master RGB file. This quality master is the foundation of all great astrophotographs. To accomplish this, STACK performs image reduction using calibration frames (Bias, Dark and Flat), high-quality Debayering (color conversion), accurate star-to-star alignment and finally, a Sigma combine to help eliminate artifacts such as cosmic ray hits and satellite trails. You can stack at any time, even if you have begun imaging another target. Be advised that download time may be increased if AFX is busy performing a processing function.

To load calibration files, click Select and navigate to the location containing Bias, Dark and Flat frames. By default this is AstroFX\Images. Calibration will report the last calibration group used when the "i" (info) button next to Select is clicked. Some pertinent facts from the FITS header are also listed. AFX will remember and reuse this folder until instructed otherwise. That’s it! AFX will examine files in the specified folder and build appropriate calibration groups. SNAP’s Exposure Type settings are taken into account as well as binning, temperature, exposure time and image/pixel dimensions to further discriminate calibration types. STACK will then apply the frames accordingly (e.g., Biases will be combined to a master Bias, subtracted from Flats; calibrated Flats will be combined to a master Flat; Darks will be combined to a master Dark and subtracted from individual Lights; reduced individual Lights will be divided by the master Flat).

Edit Image List loads your image files (Light frames).

Add opens the Add Files dialog when clicked. If you filled in SNAP’s Object name field, you may choose “Entire folder, automatically sorted by object”. Simply navigate to the appropriate folder and hit OK. Alternatively, or if you did not name the object with SNAP when they were acquired, choose “Selected files, to new object”, entering the object name in the box at right before clicking OK. Navigate to and open the appropriate folder, selecting all desired files by highlighting them, before clicking Open. You can also include additional files by returning to Add and choosing “Selected files, to”.

Remove allows you to delete an entire group of images. After clicking Select Object Name, click Edit Image List/Remove. Clicking on any individual file name will also allow you to delete it from the group with Remove.

Select Object Name at top, reports the group name of the object as entered in the Object Name field under the SNAP tab.

Available Images at left is where selected image files appear. By default they are active as indicated by the check box. AFX reports “Added _ [number of] files for 1 object”. Clicking on a file name will display the image on the desktop. You may render it inactive and exclude it from the stacking process if it does not meet your liking by unchecking the check box.
Note: Selecting and previewing individual images before loading the proper calibration files (as described above) may adversely affect their appearance when viewed on screen, especially if an old calibration group has already been saved. For best results, always select the proper calibration files corresponding to your images before previewing them on your computer.

**Prev/Next Image** allows you to view individual files by scrolling through the list.

**Alignment Mode** registers each subexposure to one another, allowing for highly accurate star-to-star alignment. Three modes are available:

- **None** – No alignment is performed. The individual frames are simply stacked together.
- **Auto Star Matching** – Performs multiple star alignments with no further intervention.
- **Manual One Star** – Lets you choose the reference star for alignment.
  1. Click on any file in the **Available Images** list.
  2. Position the cursor over the reference star of your choice and left-click once.
  3. If **“Advance to next image after marking star”** is checked, AstroFX will automatically display the next image in sequence for the object. If not checked, click the next file name in the list to advance.
  4. Click on the star corresponding to the one you chose in the first image.
  5. When you have tagged the star in each image, click **Combine**.

**Noise Rejection** sets how aggressively Sigma combine rejects pixels with values “outlying” the standard deviation of the same pixel in other subexposures by moving the slider. Try a setting of “1” at center to start.

- **Less** noise rejection is most forgiving, permitting less signal to be excluded, and can be used in the absence of major artifacts.
- **More** noise rejection is the least forgiving, permitting more signal to be excluded and can be used in the presence of major artifacts such as satellite trails.

**Combine** is used when you are ready to assemble your master file. AFX will automatically perform calibration, alignment and stacking with no further input needed.

Once the master RGB image is produced, save it to disk to protect its pristine state. Be advised that a copy is automatically saved to the Documents/AstroFX/Processed folder should you forget to do so. With the image window active, click on the SHARE tab. With “16-bit FITS Image” checked by default, click **Save** to place the master in the folder of your choice. Consider giving it a name such as M42_Master.fit for easy identification.

Please note the **Open File**, **Prev Step** and **Next Step** buttons in **blue** at the bottom of the CCC. You can open a single file at any time using **Open File**. This enables you to process a stacked master at a later date. You may also navigate between tabs using either the **Prev(lious)** or **Next Step** button.
STRETCH

Stretch is the third tab from the left (Figure 3). Stretching is a metaphor for the required manipulation of an astro-image’s “histogram”. The distribution of pixels is shown on a histogram graph, and by nature, the initial distribution is compressed due to the dim nature of the subjects and the linear response of a sensitive CCD camera. The tall spike (Figure 4a) demonstrates this compression. The spike contains all of the “good stuff” and is why images are (with the exception of stars) nearly black. STRETCH enables you to perform nonlinear pixel re-distribution using the Digital Development Process (DDP by K. Okanul). DDP is a “Gamma curve with edge emphasis in the highlights”. Simply put, DDP is a powerful and easy way to brighten your images and impart film-like, full tonal range, with an option to add a bit of High-Pass sharpening. Note the “development” or stretching of the histogram (Figure 4b) after DDP has been applied. The “good stuff” is now stretched over the majority of the graph.

Digital Development

- **No sharpening** turns off the High-Pass filter and applies the gamma curve only.
- **Emphasize fine detail** sharpens detail with a mild High-Pass filter while applying DDP.
- **Mid-level selection** chooses the all-important “breakpoint” for DDP.
- **Auto** lets AFX choose the Mid-level setting for you.
- **Mouse** gives you control. Clicking the button brings up a bubble with further instructions. Drag the green marker line to the desired location, or double-click anywhere in the histogram. Start conservatively, just a bit to the right of the initial location as illustrated (Figure 5).
- **Apply** when ready. You should see highlight detail preserved even in the brightest areas (galaxy cores, stars).
- **Hyperbolic Curve** lets you perform additional DDP-like stretches to further bring out faint detail. After DDP, you can move the slider to any position between **Less** and **More** and hit **Apply** as many times as you like, for a custom stretch.

If you are not satisfied with the result, click **Undo** in blue at the bottom of the CCC to try again.

You can perform additional stretches in the image window by dragging up/down and left/right or directly in the histogram window of the CCC. AFX will apply these subsequent settings when the image is saved, so be sure you preserved your pristine master previously.
SMOOTH

Is the fourth tab from the left (Figure 6) and a metaphor for the smoother appearance of an image after noise reduction has been applied. As stated, there is no substitute for Signal to eliminate noise but in the real world, time and weather constraints often necessitate the use of a smoothing filter. When the unattractive, grainy look of random noise (most noticeable in dim features) is reduced, an image may be further enhanced.

(Figure 6 - SMOOTH Screen)

(Figure 7) illustrates the “speckly” noise in the dim arms of a galaxy before and after smoothing.

Selective Smoothing lets you slide left for less Low-Pass smoothing and right for more. Try to reach a level of attractive smoothness, stopping short of an unrealistic “plastic” look.

Level Selection works similarly to STRETCH’s Mid-level selection. Auto allows AFX to apply smoothing adaptively – background sky and dimmer areas are smoothed more aggressively than brighter ones [better signal].

You can alternatively take control of which brightness levels to smooth by selecting Mouse and double-clicking a point in the histogram or by dragging the green marker line to the desired brightness level. The dark portion at left represents shadows, the white portion at right represents highlights, and midtones are seen in the middle.

Apply applies the filter. If you are not satisfied, simply click Undo to try again. When content, you can consider saving this version before moving ahead to the next tab.

(Figure 7) Before After
SHARPEN
The fifth tab from the left (Figure 8) is a metaphor for edge enhancement. Using a sharpening filter to create stronger contrast between dark and light tones, causes edges of objects to stand out from one another – creating the illusion of increased sharpness and finer detail. High-Pass filtering is one way of accomplishing this and is used by AstroFX to enhance detail in astronomical objects. Try to reach a point where the image “pops” but is not harsh or unnatural looking.

Sharpening can be easily accomplished by allowing AFX to automatically determine which brightness levels to enhance. Midtones will be sharpened while stars will be more gently enhanced. Background sky and dimmest areas will be left unsharpened. Use the Auto setting for both Mid level selection and High level selection at right. Select how much sharpening to apply by using the corresponding sliders at left. Choose less or more for both midtones and highlights.

For more control, choose Mouse for either or both levels. The pop-up balloons will instruct you on how to set them. Drag the green marker line to the location on the histogram where you wish sharpening to begin. Levels of brightness below the green line will not be sharpened. Drag the red marker line to the area on the graph where you would like diminished sharpening to begin. All levels between the red and green marker lines will be sharpened at the Mid level slider setting. All levels above the red marker line will be sharpened at the High level slider setting. Again, this will be milder than the sharpening of midtones. Alternatively, you can double-click in the histogram to set the levels.

Apply applies the filter. If you are not satisfied, simply click Undo to try again. When content, you can consider saving this version before moving ahead to the next tab.

(Figure 8 - SHARPEN Screen)
Is the sixth tab from left (Figure 9) and enables you to enhance the color intensity of your images. The light from all but the brightest of our ancient targets is dim. Even with your sensitive Nightscape camera, many colors will be diluted, and therefore not make as bold an artistic statement as you might like. It is therefore, adaptive saturation that allows you to enhance the depth of color to your taste. Artistry aside, color has scientific value as well, as it clearly delineates structure and different chemical compositions. Get to know the teal look of OIII (Oxygen 3), the pink-red of Ha (Hydrogen alpha), and the blues and golds of many galaxies. Studying this and the work of fine astro-imagers is beneficial for learning how to produce artful, yet tasteful color schemes.

**Saturation Adjustment** is the tool to accomplish your goal. The **Color Boost** slider lets you choose the amount of saturation to a maximum of 2x. **Taper** feathers the color boost so that the transition between unsaturated and saturated areas looks natural.

Just as with **SMOOTH** and **SHARPEN**, saturating can be easily accomplished by allowing AFX to automatically determine which brightness levels to enhance. Midtones and Highlights will be saturated, while background sky and dimmest areas will be left as is. Simply use the **Auto** settings for both the **Lower limit of full boost** and **Upper limit of full boost** at right.

For more control, choose **Mouse** for either, or both levels. The pop-up balloons will instruct you on how to set them. Drag the **green** marker line to the location on the histogram where you wish saturation to begin. Saturation in brightness levels below the **green** line will not be boosted. Drag the **red** marker line to the area on the graph where you wish saturation to terminate. This may help in not oversaturating stars. All levels between the **red** and **green** marker lines will be saturated at the **Saturation Adjustment** slider setting. All levels above the **red** marker line will not be enhanced. Alternatively, you can double-click in the histogram to set the levels.

**Apply** applies the filter. If you are not satisfied, simply click **Undo** to try again.
SHARE
Is the seventh and last tab from the left (Figure 10). By now you have Snapped, Stacked, Stretched, Smoothed, Sharpened and Saturated your way to a fine astro image. Now it is time to share it with the world!
You have used SHARE to save your pristine master file and perhaps subsequent versions as well. Celestron suggests you use descriptive names when doing so, such as Master.fit, Stretch.fit, Smooth.fit, etc. You get the idea.

Now that you are finished, SHARE can be used to export your images for different purposes. As you already know, a 16-bit FITS is always saved by default, so be sure to name files carefully, as not to risk overwriting the master or other versions you have saved. You can alternatively place the master in its own folder for safekeeping. In addition to FITS, AFX can save your images in TIFF (Tagged Image File Format) and JPEG (Joint Photographic Experts Group) formats. TIFF is a “lossless” format, while JPEG is “lossy”. JPEG deliberately discards data in order to compress the file size. Formats offered are 16 and 8-bit TIFF and three sizes of JPEG. If further processing is to be done to your FITS in a program such as Adobe Photoshop, a FITS plugin is required. You can alternatively use a 16-bit TIFF version in place of FITS without the need of a plugin. If you are ready to post your image to a website, choose JPEG. Choose from Small, Medium, and Large JPEG image sizes to share online. Simply check the desired version(s) and hit Save.

Enjoy imaging and image processing with Celestron’s Nightscape camera and AstroFX!
For more information, visit http://celestronsites.com/astroimaging/.