SBIG
ASTRONOMICAL
INSTRUMENTS

Product Catalog

Company Philosophy

Our company has brought together a group of unique individuals, each with years of experience in his or her particular discipline. People with this much expertise can accomplish a great deal when they share a common goal. Our goal is to design and manufacture the best astronomical instrumentation in the world, at a price an amateur can afford.

Our company's philosophy is to listen to our customers. With your input and our efforts we have a winning combination. We look forward to continuing development of instrumentation to benefit the field of astronomy and science education.

The Employees
SANTA BARBARA
INSTRUMENT GROUP

M27 *by Chris Schur.*
Saturn *by Ed Grafton.*
Horsehead *by Alan Holmes and Michael Barber / SBIG*

INTRODUCTION

SBIG, The Pioneering CCD Company

In most high technology markets there are "pioneers", companies who have the technology and dedication to influence the direction of an entire industry. In the past 15 years SBIG has been that pioneer in the electronic imaging industry. We have a reputation for outstanding quality products, service and customer support. We were the first company to introduce CCD autoguiding with the Model ST-4, Track and Accumulate (TRACCUM) with the Model ST-6, and dual CCD self-guiding with the Models ST-7 and ST-8. SBIG pioneered tricolor imaging for amateur astronomers with both hardware and software and we pushed the technology forward again with the introduction of Adaptive Optics and a stand-alone video camera and autoguider.

Along the way we were granted two U.S. Patents, one for Track and Accumulate and the other for Self-Guiding.

Of more significance to customers reading this catalog for the first time is that we have brought back to life the long forgotten practice of offering quality "technical support". SBIG's company philosophy, "basic values, good products, strong technical support and honesty". We can help you take photographic quality CCD images, measure the surface brightness of a spiral galaxy, image a comet, or obtain high resolution densitometry images of x-ray plates. We can help you obtain long, uninterrupted autoguided astrophotographs. As stated in our ads, "We understand how our products work and we want you to consider us a part of your technical staff". If you want to deal with a company that understands CCD imaging and will take the time to help you, contact SBIG.

The introduction of Charge-Coupled Devices (CCDs) has dramatically changed the methods astronomers use to view objects. The remarkable sensitivity and dynamic range of CCDs has made them the detector of choice. A CCD is an array of photosites (pixels) on a silicon substrate. The pixels are arranged in rows and columns. Light falling on the CCD is recorded as an electrical signal by converting the photons to electrons. The sensitivity of a CCD is many times faster than the fastest films and is linear in response (which films are not). The number of photons converted to electrons, referred to as Quantum Efficiency, is now in the order of 65% across the visible wavelengths with peaks approaching 90%. These advantages as well as the digital nature of the data make CCD devices ideal for astronomical imaging.

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Cover photo: Comet Hale-Bopp taken with Pentax 6 x 7 camera, 300 mm f/4 lens, piggyback on a Celestron C-8 equipped with ST-4 autoguider. Michael Barber / SBIG

Facing Page: NGC4565 taken with ST-8E camera through 12.5" RC telescope courtesy William McLaughlin

SBIG CCD IMAGING CAMERAS

The SBIG product line consists of a series of thermoelectrically cooled CCD imaging cameras designed for a wide range of applications ranging from astronomy, tricolor imaging, color photometry, spectroscopy, medical imaging, densitometry, to chemiluminescence and epifluorescence imaging, etc. This catalog includes information on astronomical imaging cameras, scientific imaging cameras, autoguiding, and accessories. We have tried to arrange the catalog so that it is easy to compare products by specifications and performance. The tables shown below compare some of the basic characteristics on each CCD imaging camera in our product line. You will find a more detailed set of specifications with each individual imaging camera description.

ST-2000XM with 35mm camera lens attached

HOW TO GET STARTED
USING YOUR CCD IMAGING CAMERA

It all starts with the software. If there's any company well known for its outstanding imaging camera software it's SBIG. Our CCDOPS Operating Software is well known for its user oriented camera control features and stability. For parallel cameras, our CCDOPS software is available for MS-DOS, Macintosh and Windows applications. For USB cameras we offer CCDOPS for Windows as well as CCDSoftV5 for Windows. CCDOPS is also available for free download from our web site along with sample images that you can display and analyze using the image processing and analysis functions of the CCDOPS software. You can become thoroughly familiar with how our imaging cameras work and the capabilities of the software before you purchase an imaging camera.

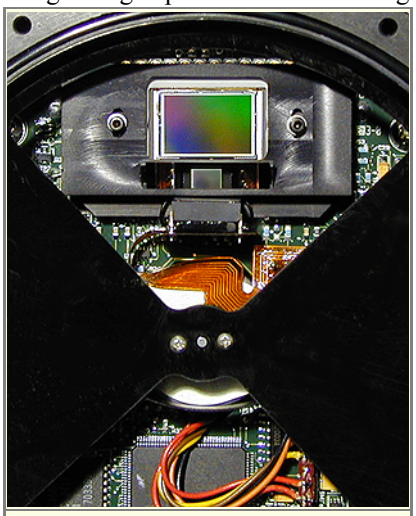
New customers receiving their CCD imaging camera should first read the installation section in their CCDOPS Operating Manual. Once you have read that section you should have no difficulty installing CCDOPS software on your hard drive, connecting the parallel or USB cable from the imaging camera to your computer, initiating the imaging camera and within minutes start taking your first CCD images. Many of our customers are amazed at how easy it is to start taking images. Additional information can be found by reading the image processing sections of the CCDOPS and CCDSoftV5 Manuals. This information allows you to progress to more advanced features such as automatic dark frame subtraction of images, focusing the imaging camera, viewing, analyzing and processing the images on the monitor, co-adding images, taking automatic sequences of images, photometric and astrometric measurements, etc.

A PERSONAL TOUCH FROM SBIG

At SBIG we have had much success with a program in which we continually review customer's images sent to us on disk or via e-mail. We can often determine the cause of a problem from actual images sent in by a user. We review the images and contact each customer personally. Images displaying poor telescope tracking, improper imaging camera focus, oversaturated images, etc., are typical initial problems. We will help you quickly learn how to improve your images. You can be assured of personal technical support when you need it. The customer support program has furnished SBIG with a large collection of remarkable images. Many customers have had their images published in SBIG catalogs, ads, and various astronomy magazines. We welcome the chance to review your images and hope you will take advantage of our trained staff to help you improve your images.

TRACK AND ACCUMULATE (U.S. Patent # 5,365,269)

Using an innovative engineering approach SBIG developed an imaging camera function called Track & Accumulate (TRACCUM) in which multiple images are automatically registered to create a single long exposure. Since the long exposure consists of short images the total combined exposure significantly improves resolution by reducing the cumulative telescope periodic error. In the TRACCUM mode each image is shifted to correct guiding errors and added to the image buffer. In this mode the telescope does not need to be adjusted. The great sensitivity of the CCD virtually guarantees that there will be a usable guide star within the field of view. T his feature provides dramatic improvement in resolution by reducing the effect of periodic error and allowing unattended hour long exposures. SBIG has been granted U.S. Patent # 5,365,269 for Track & Accumulate.



ST-8XE with built-in TC237 guider

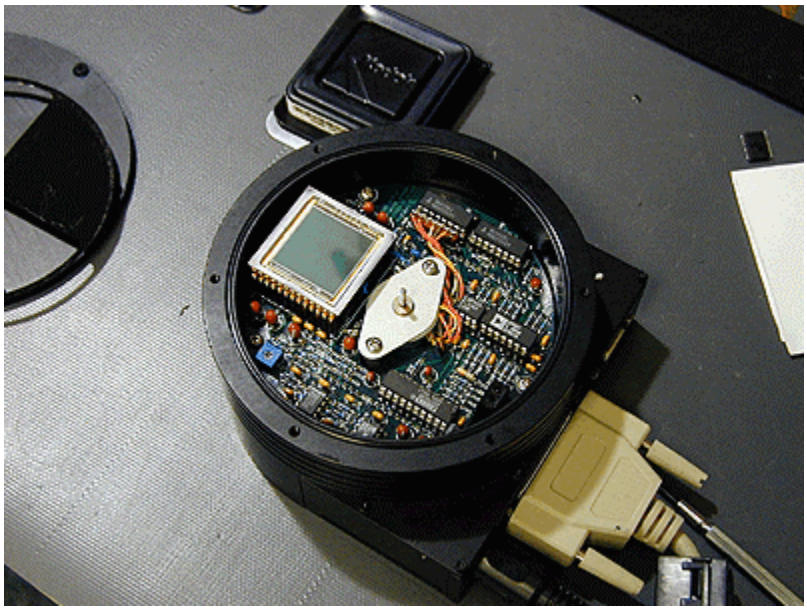
DUAL CCD SELF-GUIDING (U.S. Patent # 5,525,793)

With the introduction of Models ST-7 and ST-8 CCD Imaging Cameras, which incorporate two separate CCD detectors, SBIG was able to accomplish the goal of introducing a truly self-guided CCD imaging camera. The ability to select guide stars with a separate CCD through the full telescope aperture is equivalent to having a thermoelectrically cooled CCD autoguider in your imaging camera. This feature has been expanded to all dual sensor ST series cameras (ST-7/8/9/10/2000) and all STL series cameras (STL-1001/1301/4020/6303/11000). One CCD is used for guiding and the other for collecting the image. They are mounted in close proximity, both focused at the same plane, allowing the imaging CCD to integrate while the PC uses the guiding CCD to correct the telescope. Using a separate CCD for guiding allows 100% of the primary CCD's active area to be used to collect the image. The telescope correction rate and limiting guide star magnitude can be independently selected. First tests at SBIG indicated that 95% of the time a star bright enough for guiding will be found on a TC211 tracking CCD without moving the telescope, using an f/6.3 telescope. Since with the release of USB electronics and new camera models, the tracking CCD used in all dual sensor cameras has been upgraded to a larger TC237 CCD with twice the area of the TC-211. The self-guiding function quickly established itself as the easiest and most accurate method for guiding CCD images. Placing both detectors in close proximity at the same focal plane insures the best possible guiding. Many of the long integrated exposures now being published are taken with this self-guiding method, producing very high resolution images of deep space objects. SBIG has been granted U.S. Patent # 5,525,793 for the dual CCD Self-Guiding function.

CAMERA FEATURES

Camera Model	*Remote Control Autoguide*	*Stand Alone Autoguide (no computer)*	*Self-guide (dual CCD)*	*Electronic Shutter*	*Mechanical Shutter*	*Integrated Filter Wheel*	*AO-7 Compatible*	*Video Output*	*Track & Accumulate*
STV	Yes [1]	Yes	No	Yes	Yes	Yes	No	Yes	Yes
ST-402/1603/3200	Yes [3]	No	No	No	Yes	ST-402ME	No	No	Yes
ST-7/8/9/10/2000	Yes [2]	No	Yes	ST-2000	Yes	CFW8A	Yes	No	Yes
STL Series	Yes [2]	No	Yes	STL-4020 STL-11000	Yes	Internal	AO-L	No	Yes

Notes:
(1) The STV does not require a computer to autoguide or to take video or digital images.
(2) The ST-7XME, ST-8XME, ST-9XE, ST-10XME, ST-2000XM, and ST-2000XCM can autoguide and self-guide.
(3) The ST-402ME, ST-1603ME, ST-3200ME can autoguide but not self-guide



COMPUTER PLATFORMS

SBIG is unique in its support of both PC and Macintosh platforms for our parallel cameras. The imaging cameras in this catalog communicate with the host computer through standard serial, parallel or USB ports depending on the specific models. Since there are no external plug-in boards required with our imaging camera systems we encourage users to operate with the new family of high resolution graphics laptop computers. We furnish Operating Software for you to install on your host computer. Once the software is installed and communication with the imaging camera is set up complete control of all of the imaging camera functions is through the host computer keyboard. The recommended minimum requirements for memory and video graphics are as shown below.

MINIMUM COMPUTER SYSTEM REQUIREMENTS

MODEL	COMPUTER MEMORY	VIDEO GRAPHICS
STV	4 MEG	640 x 480, 256 Color or higher
ST-7XME	4 MEG	800 x 600, 256 Color or higher
ST-8XME	8 MEG	800 x 600, 1280 x 1024 preferred, 256 Color or higher
ST-9XE	4 MEG	800 x 600, 256 Color or higher
ST-10XME	16 MEG	800 x 600, 1280 x 1024 or greater preferred, 256 Color or higher
ST-2000XM/XCM	16 MEG	800 x 600, 1280 x 1024 preferred, 256 Color or higher
STL Series	16 MEG or more	800 x 600, 1280 x 1024 or greater preferred, 256 Color or higher

COMPUTER INTERFACE AND MECHANICAL SPECS

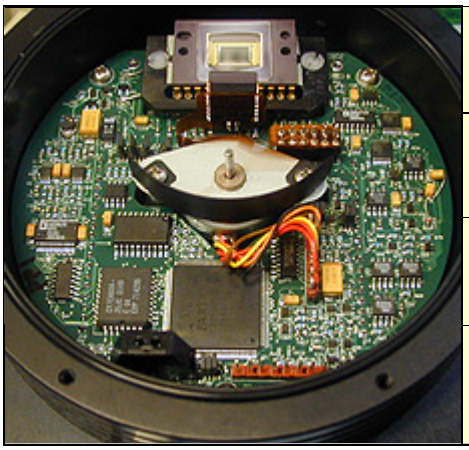
Camera Model	*Computer Interface*	*Remote Operating Distance*	*Control Software*	*Optical Head Size*	*Optical Head Weight*	*CPU Size*	*CPU Weight*	*Power Supply*	*Custom Case*
STV	Video/Serial	>150'	WIN	3.5" round	1 lb.	12x9x3"	4 lb.	Yes	Optional
ST-402ME/1603ME/3200ME	USB 2.0	>300' (1)	WIN	4 x 5"	1.5 lb.	None	n/a	Yes	No
ST-7/8/9/10/2000	USB 1.1	>300' (1)	WIN / Mac Linux (2)	5" round	2 lb.	None	n/a	Yes	Yes
STL Series	USB 1.1	>300' (1)	WIN / Mac Linux (2)	6.5 x 6"	4.5 lb.	None	n/a	Yes	Yes

Notes:
(1) Estimated operational distance between computer and camera/CPU with appropriate cable. The limit is determined by the user's computer and the quality of the cable. The 300' distance for USB cameras requires a USB extender with CAT5 cable. Download rate for USB 2.0 cameras will be limited to USB 1.1 rates determined by the extender used.
(2) Windows operating software is supplied with the camera. Mac (OS-X) and Linux operating software is available from third party sources.

COMMON FEATURES OF THE NEW USB ST-7XME, ST-8XME, ST-9XE, ST-10XME, ST-2000XM/XCM SELF-GUIDING CAMERAS:

FASTER DOWNLOADS

High speed electronics and high speed USB interface are now standard with data transfer rates up to 426,000 pixels per second!

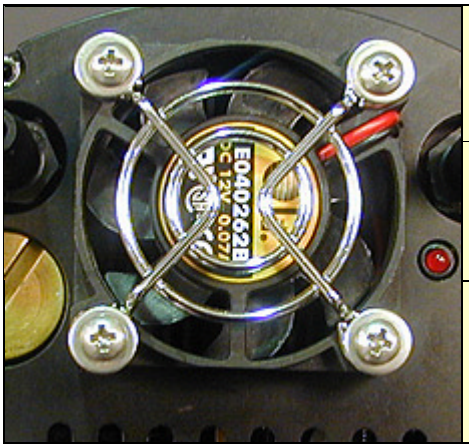


High Speed USB Download Rates	ST-2000XM	ST-7XE	ST-8XE	ST-9XE	ST-10XE
Full Frame	**4.5 sec.**	**1 sec.**	**3.7 sec.**	**0.7 sec.**	**8.7 sec.**
Focus Mode	~0.5 sec	~0.5 sec	~0.5 sec	~0.5 sec	~0.5 sec

Note: USB download times are processor dependent and will vary from computer to computer. These download times were measured on a 933 MHz Pentium III. Focus Mode rates were the fastest achieved using a 20 x 20 pixel subframe in Focus / Planet mode.

BETTER COOLING

The standard single stage cooling design has been improved to provide cooling performance previously available only with an optional second stage cooling booster.

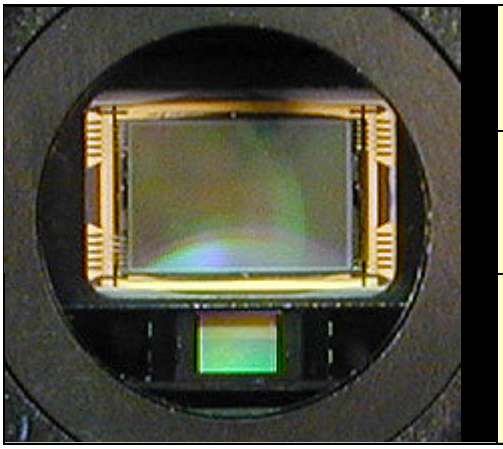


Cooling Performance (delta from ambient)	**Typical**	Minimum	Previous design typical
Standard single stage with water assist	**-45° C**	-40° C	not available
Standard single stage without water	**-35° C**	-30° C	-25° C

The standard cooling configuration is a single stage cooler with a newly designed heat exchanger that includes an inlet and outlet for water circulation should the user desire to maximize the cooling performance for hot climates. The new design does not require an additional power supply and may be operated with or without water supplied by the user. Even without water, the new design offers similar performance to two-stage cooling with much less current draw than a two-stage cooler. It is therefore less demanding on battery capacity when operating in the field.

A circulating water pump and tubing are available from SBIG as optional accessories. In our experience, further cooling of Kodak CCDs beyond the performance above is unnecessary.

BETTER AUTOGUIDING
The TC-211 tracking CCD has been replaced with a larger TC-237 in the ST-7/8/9/10/2000 models



Built-in Autoguider	Array	Pixel Size	CCD Dimension -------- (Area)	Field of View at 80" FL
TC-237 CCD	**657 x 495**	**7.4 x 7.4 u**	**4.9 x 3.7 mm ----- 18.3 mm^2**	**8.2 x 6.2 arcminutes (51 $arcmin^2$)**
TC-211 CCD	192 x 164	~ 15 u	2.6 x 2.6 mm ----- 6.8 mm^2	4.5 x 4.5 arcminutes (20 $arcmin^2$)

The TC-237 autoguiding CCD is seen here just below the larger KAF-1602E in an ST-8XE camera is the same CCD used in our $1300 ST-237A imaging camera and $2300 STV autoguider. The TC-237 is 2.7X larger than the TC-211 CCD which means there is a more than double the chance you will find suitable guide stars anywhere you happen to be looking without searching. The images below demonstrate the difference in field of view.

Field of View of TC-211 autoguider through an 8" SCT at F/7

30 second unguided image centered on NGC 2903 taken with the **TC-211** tracking CCD.

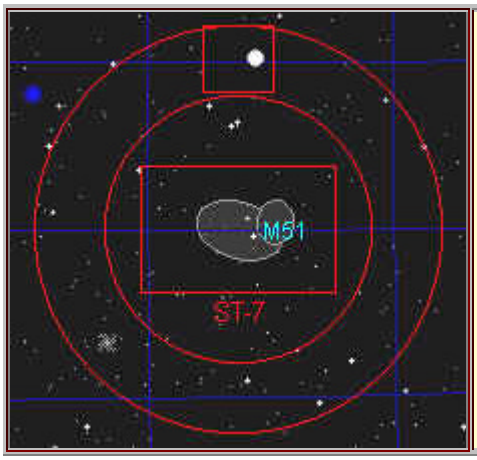
192 x 164 pixels at ~15 microns (unbinned).

Field of View of TC-237 autoguider through an 8" SCT at F/7

30 second unguided image of the same area taken with the **TC-237** tracking CCD demonstrates the benefit of having 2.7X the field of view: An increase in the number of potential guide stars stars.

328 x 247 pixels at 14.8 microns (binned 2x2).

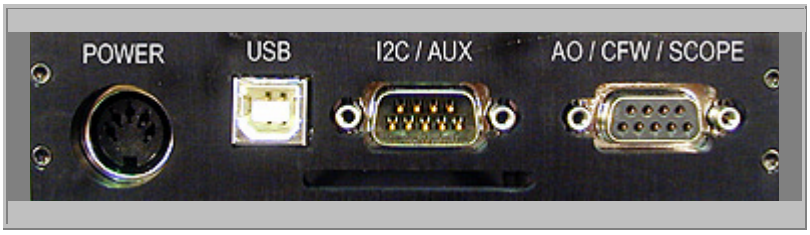
In the tracking configuration, the TC-237 CCD will normally be binned 2x2 for increased sensitivity. When binned 2x2 the field of view remains 2.7X that of the TC-211 however as the pixel size is increased to 14.8 microns. The user may also image with the TC-237 CCD in high resolution (unbinned) mode if desired. Even with a smaller field of view, however, the TC-211 remains an excellent autoguider on our older cameras. With ~15 micron pixels and low noise performance the TC-211 unbinned is more sensitive than the TC-237 in unbinned mode and as sensitive as the TC-237 in binned mode. In tests performed under moderate light pollution with an F/6 telescope, random pointing of the telescope in areas of the sky away from the Milky Way, we found stars on the TC-211 image bright enough to guide on 95% of the time. ThsSky software from Software Bisque automatically generates finder charts showing the correct placement of the guiding CCD field of view relative to the imaging CCD's field of view. Using this tool to plan your nights imaging is a great compliment to the self-guiding cameras.



Previously, the camera had to be oriented so that the X and Y dimensions of the tracking CCD were aligned with the RA and DEC of the telescope, limiting the possible rotation of the camera to four possible positions around a target at at 90 degree steps. Now, with CCDSoftV5, the autoguiding capability of the TC-211 (and TC-237) is improved so that the camera may be placed in any orientation relative to the telescope's RA and DEC, allowing a full 360 degrees of rotation around a target for easier guide star acquisition.

Guiding with either the TC-211 or the TC237 tracking CCD means that the imaging CCD spends 100% of its time and quantum efficiency gathering the image. You are not required to compromise for half the quantum efficiency or twice exposure time as you might with other self-guiding designs.

GREATER EXPANSION CAPABILITY
All new production USB cameras and upgrades will include a bi-directional I^2C accessory port.



The new I^2C accessory port adds bi-directional communication capability for the development of a new family of "smart" accessories such as the new CFW-10, ten-position filter wheel, and the large format AO-L Adaptive Optics accessory. The standard accessory port is also provided in order to maintain backwards compatibility with our existing accessories (CFW8, AO-7, Relay Adapter Box) and customer's existing telescope interface cables.

COMPLETE SYSTEMS
It is the little things that count:

These cameras are complete systems. There is no need to add in the additional cost of an interface or an autoguider or a nosepiece or better software to make these cameras actually operate as they should. Everything that is needed to make these camera systems operational is included in the base price. We even include some non-essential, but desirable, items such as a custom hard carrying case and extra nosepiece on selected models.

Each ST-7XME, ST-8XME, ST-9XE, ST-10XME and ST-2000XM/XCM camera system INCLUDES at no additional cost:

- Camera body with thermoelectrically cooled imaging CCD and new analog and digital electronics
- Built-in 16 bit, cooled, TC-237 autoguider
- I^2C bi-directional expansion port
- Standard accessory / telescope port
- USB interface
- User rechargeable desiccant plug (no need to return camera to the factory for frosting problems)
- "Dummy" desiccant plug for dust prevention during recharging procedure
- Internal shutter
- 2" Nosepiece
- Cooling Fan
- New heat exchanger design with additional water cooling capability
- Tripod mount 1/4-20 threaded side plate
- T-thread ring
- 15 foot USB cable (third party extenders available for up to 500 meters!)
- Adapter plug for telescope interface cable
- Telescope interface cable (for autoguiding)
- Universal 90-240VAC power supply with remote on/off switch
- SBIG's CCDOPS version 5 camera control software
- ***Software Bisque's CCDSoftV5*** camera control and image processing software
- Software Bisque's TheSky Version 5, Level II
- Operating Manual
- Custom design hard carrying case with pre-cut foam for selected models

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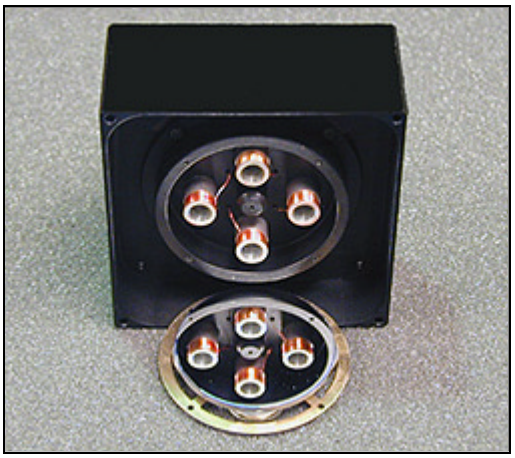
MORE OPTIONS

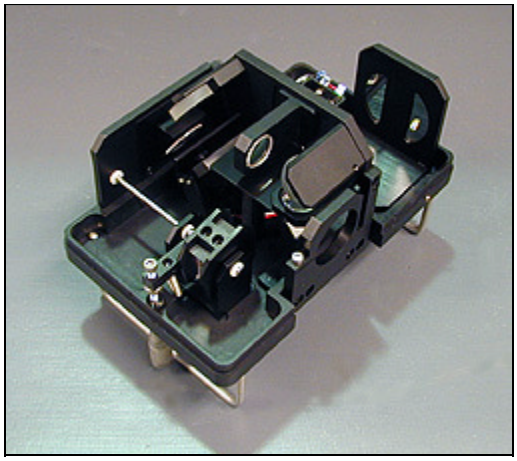
SBIG continues to explore new methods and accessories to make professional quality imaging an achievable standard for amateurs.



SBIG was the first company to offer adaptive optics and a self-guiding spectrograph to the amateur astronomy community at an affordable price. Both the current AO-8 and AO-L Adaptive Optics devices and the SGS Self-Guiding Spectrograph are available to amateurs because of our patented dual sensor self-guiding camera design. In the case of the AO, the smaller tracking CCD is exploited to monitor star motion and drive the AO's optical element to stabilize the image. The Self-Guiding spectrograph uses both CCDs in the camera head to provide simultaneous images of the object, slit location and spectra. It then guides itself during the exposure to keep the object on the slit.

The following options and accessories are available for the ST cameras:

- Integrated CFW8 or CFW10 color filter wheel with research grade, custom RGB dichroic filters
- Research grade UBVRI Photometric filters and extra carousel for CFW8
- AO-7 or AO-L adaptive optics device
- SGS Self-guiding spectrograph
- DSS-7 Deep Space Spectrograph
- Industrial camera models including C-mount adapters
- Relay adapter box
- T-thread visual back for threaded connection to SCT
- 35mm camera lens adapters
- 12VDC power supply with battery clips
- 110VAC submersible water pump and tubing



PRICE vs. PERFORMANCE

We feel that if one compares all of the included parts, features and costs of the camera / autoguider system with any competitor, SBIG remains a leader in price vs. performance. For example, simply adding in the cost of a TC-237 based autoguider and premier software comparable to CCDSoftV5 could run well over $1000. Water cooling capability is now standard, as is USB. There is no extra charge for a custom hard carrying case on many models.

Model ST-402ME
ST-1603ME and ST-3200ME
CCD Imaging Cameras

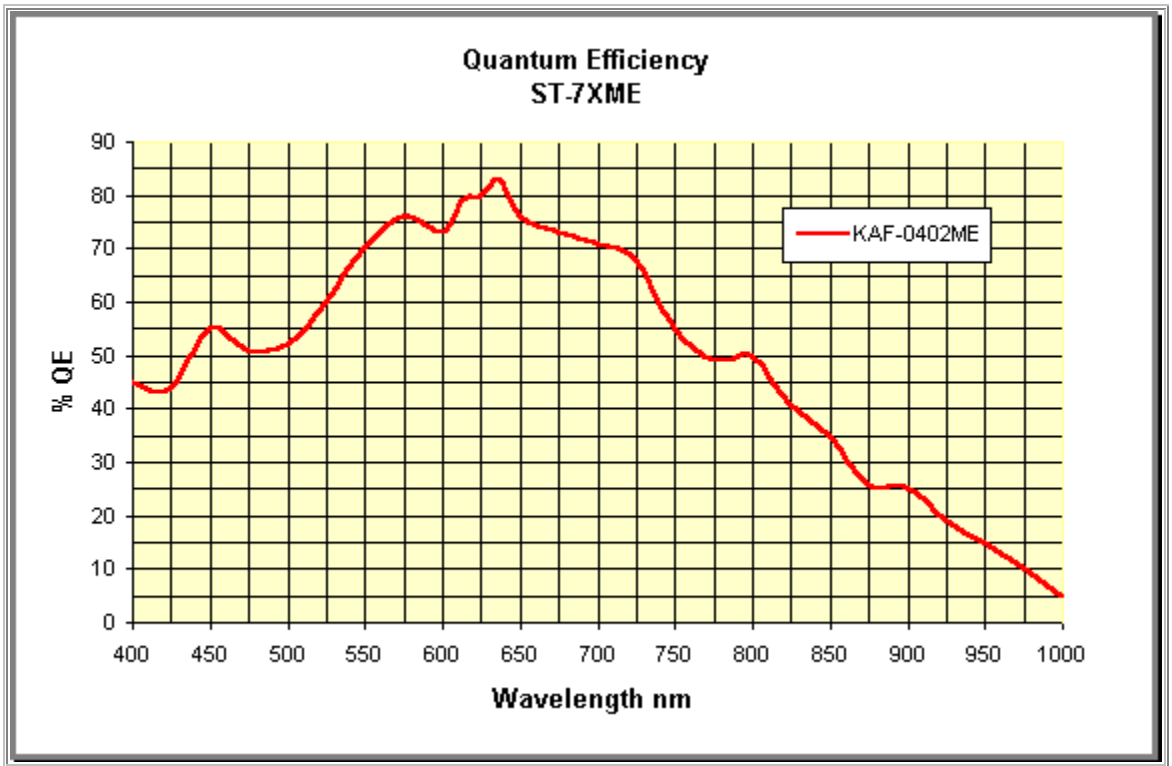
SBIG

ASTRONOMICAL
INSTRUMENTS

Model ST-402ME
Simple and Powerful:

ST-402ME CCD IMAGING CAMERA

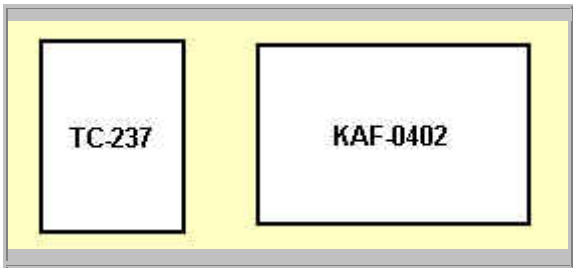
These were the design goals for the ST-402ME camera: We wanted something simple and easy to use yet powerful enough to carry the "ST" model prefix. The new ST-402ME is seen at right equipped with the optional T-thread to C-mount adapter ring and lens. For use at the telescope, a 1.25" nosepiece screws into the T-threads of the front plate.The small size and light weight makes this camera very easy to handle and set up. A custom internal filter wheel and shutter lets you take dark frames and tri-color images automatically. Best of all, the low noise and extraordinary QE of the KAF-0402ME CCD makes this one of the most sensitive CCD cameras available to amateurs at any price. Simply put, there is nothing that can touch it in its class, except of course the dual sensor, self-guiding ST-7XME camera. The same technology that is used to achieve such high quantum efficiency in the KAF-3200ME CCD is also used with the same effectiveness in the KAF-0402ME CCD. With a peak QE of nearly 85%, this camera bows its head to no other when it comes to recording faint detail in dim objects.



The ST-402ME has the same high QE as the ST-7XME, ST-8XME and ST-10XME

Similarities to the former ST-237A:

Like its predecessor, the ST-237A, this single sensor camera is designed for light weight, low cost and high performance. The camera uses a monochrome CCD with an optional internal filter wheel and custom filters enabling it to do both high sensitivity B&W imaging and RGB/LRGB color imaging with the same camera. The CCD is centered in the camera body and is correctly spaced for Celestron telescopes having Fastar or Hyperstar optics. The camera body is all metal construction (black hard anodized aluminum). Single stage, regulated, thermoelectric cooling with fan are standard. At 4 x 5 inches, the camera head is somewhat wider than the ST-237A, but it is only 1.8 inches deep with electrical connections on the side. This gives the camera the shortest possible protrusion from the rear of the telescope to allow maximum clearance when imaging objects in the north with a fork-mounted telescope. This size and shape also makes it possible to put the filter wheel inside the camera, even though the KAF-0402ME CCD requires larger filters than the ST-237A. Electronic relays provide typical autoguider output from the RJ-11 jack, so the camera can be used as a highly sensitive autoguider with a larger field of view than most other autoguiders. While somewhat wider than the ST-237A, this new camera is still fine for all Fastar equipped telescopes. The additional width will not affect its use as a Fastar camera in the slightest.

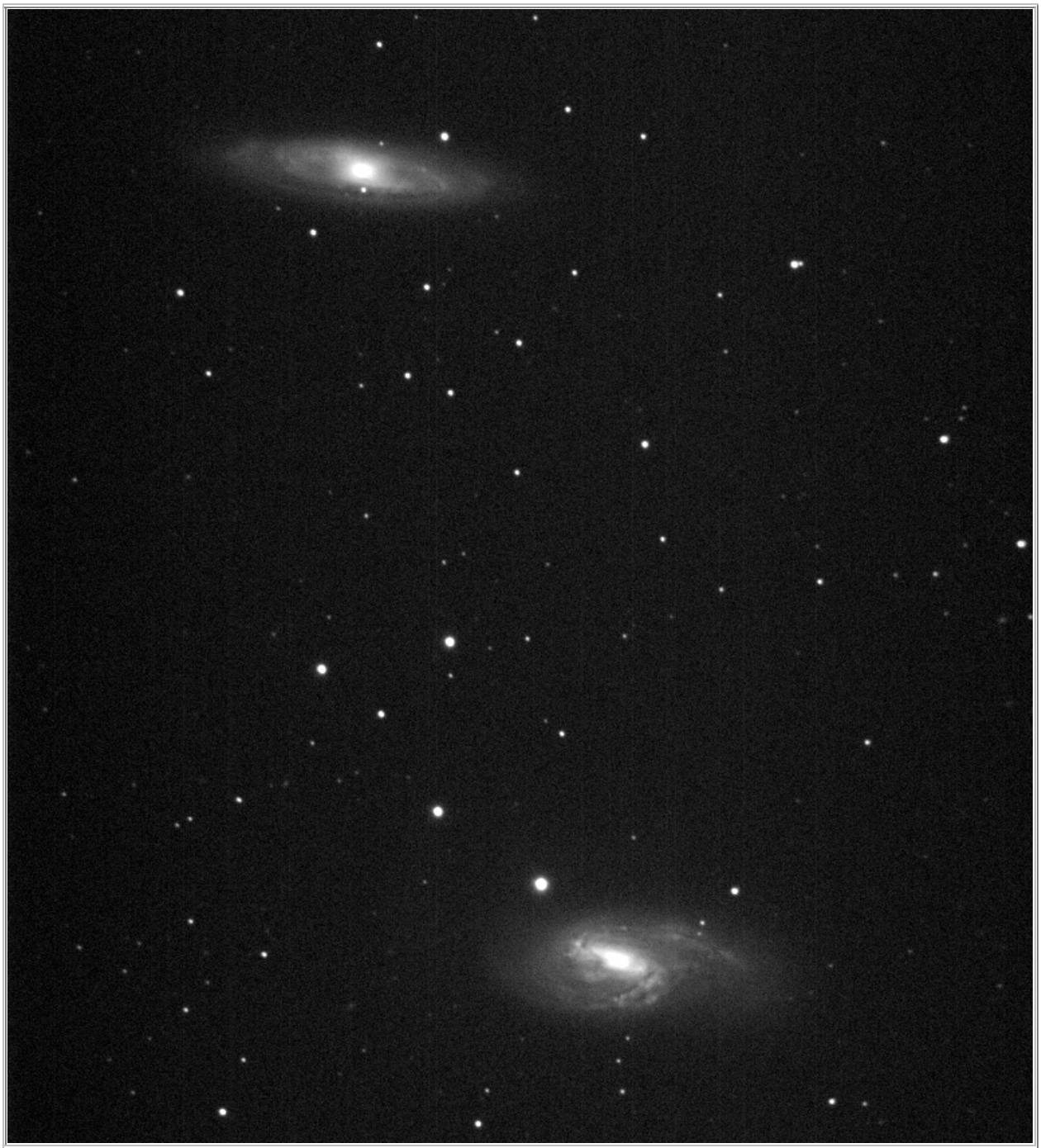


Relative Size of TC-237 and KAF-0402ME

Differences from the ST-237A:

The KAF-0402ME Imaging CCD is about 75% larger than the TC-237. It also has slightly better read noise, much lower dark current, significantly greater dynamic range and higher QE than the TC-237. All of these factors combine to make a more sensitive detector with greater field of view. The KAF-0402E/ME CCD is available only in NABG. For fast systems such as the Faster, the KAF-0401LE (ABG) version is also available as an option. All new electronics are contained entirely in the camera head. There is no separate CPU box. The computer interface is USB 2.0 (USB 1.1 compatible). The high-speed readout rate is approximately 2 Mega pixels per second. With some overhead, a full frame, high-resolution image will download in approximately 0.8 seconds using USB2.

A regulated power supply is built into the camera so you can operate directly from a 12V battery or other unregulated 12VDC source. A wall transformer is also supplied for operation in North America from 110VAC.



Object: **M65 and M66**
Exposure: **67 seconds - Single TDI Exposure taken with KAF-0402E CCD**
Scope: **C-8 at F/4.8**
Image size: ***765 x 874***
Processing: **No dark frame, log scaled with CCDOPS**

ST-402ME Typical Specifications

CCD Specifications	
CCD	Kodak KAF-0402ME
Pixel Array	765 x 510 pixels, 6.9 x 4.6 mm
Total Pixels	390,000
Pixel Size	9 x 9 microns
Full Well Capacity (ABG)	~50,000 e-
Full Well Capacity (NABG)	~100,000 e-
Dark Current	$1e^-$/pixel/sec at 0° C
Antiblooming	NABG standard, ABG Optional (specify at time of order)

Readout Specifications	
Shutter	Electromechanical
Exposure	0.04 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.5e- / ADU unbinned, 2.0e- binned
Read Noise	17e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	Up to 800,000 pixels per second
Full Frame Acquisition	less than 1 second

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, -20 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	12 VDC at 2 amps, power supply included
Computer Interface	USB 2.0 (USB 1.1 compatible)
Computer Compatibility	Windows 98/2000/Me/XP/Mac OS-X

Physical Dimensions	
Optical Head	4 x 5 x 1.8 inches
Weight	1.5 pounds, 0.7kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread 1.25" nosepiece included
Backfocus	0.69 inches / 2.7 cm

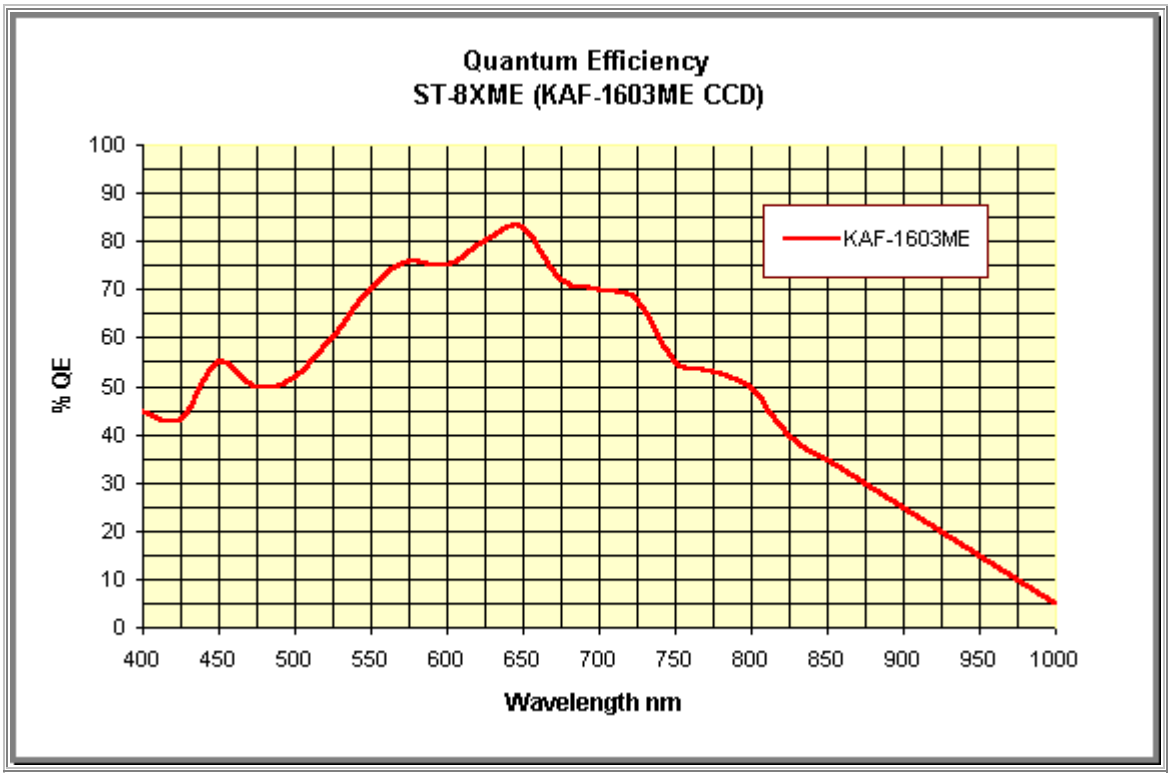
Prices and specifications are subject to change without notice

MODEL ST-1603ME
CCD IMAGING CAMERA

ST-1603ME CCD IMAGING CAMERA

The ST-1603ME is the same as the ST-402ME, with the exception of the imaging CCD. The ST-1603ME uses the KAF-1603ME CCD, the same sensor we use in the ST-8XME. This CCD is 1530 x 1020 pixels at 9 microns. However, due to the size of the array, the CFW-402 internal color filter wheel cannot be used. For color or photometric applications the CFW10-SA with standard 1.25" filters can be used instead.

The ST-1603ME, like it bigger brother, the ST-3200ME, is intended primarily for industrial and life science applications where a faster download rate is more



important than maximum cooling or self-guiding. Of course it will also perform very well for astronomical applications, particularly where an external guider is already available. For astronomical applications where greater cooling and lower read noise performance is more important than the somewhat faster download rate, we also offer the ST-8XMEI single sensor camera, and ST-8XME dual sensor, self-guiding camera, with the KAF-1603ME imaging CCD and USB 1.1 electronics.

Comparison of ST-1603ME and ST-8XMEI:

ST-1603ME vs. ST-8XMEI Comparison Chart		
	ST-1603ME	**ST-8XMEI**
High QE (>80% Peak) "ME" CCD	KAF-1603ME	KAF-1603ME
Class of CCD in standard camera	Class 2	Class 2
Column Defects Allowed	None	None
High Speed USB Interface	USB 2.0	USB 1.1
Full Frame Download Rate	800kps	425kps
Full Frame Download Time	~2 sec	~4 sec
Internal shutter for automatic dark frames	Yes	Yes
Internal ROM for CFW8A control	No	Yes
I2C Port for CFW10	No	Yes
Upgradeable to self-guiding model	No	Yes
Read Noise	17e-	15e-
Cooling	-20 C	-35 C
Water Cooling Heat Exchanger	No	Optional
Power requirements	12VDC Unregulated	12VDC and 5VDC Regulated
Current requirements	~ 2A	~3A
Power supply included	Yes	Yes
Size	5 x 4 x 1.8" (12.7x10.2x4.6 cm)	5 x 5 x 3" (12.7x12.7x7.6cm)
Weight	20 oz. (0.6kg)	32oz. (0.9kg)

Since both the ST-1603ME and the ST-8XMEI cameras are single sensor models using the KAF-1603ME CCD, a brief comparison is in order to distinguish the features of each:

Both cameras use the same Class of CCD in the standard price. A Class 1 is available in both models for the same additional charge. The ST-1603ME will download a full frame image in approximately 2 seconds. The ST-8XMEI takes just under 4 seconds. However, the ST-8XMEI has lower read noise and better cooling performance, and it is upgradeable to a self-guiding model by adding an

internal TC-237H guiding CCD. The ST-1603ME has no provision for a second CCD, so it cannot be upgraded to a self-guiding camera.

In both cases, all new electronics are contained entirely in the camera head. There is no separate CPU box. The computer interface is USB 2.0 for the ST-1603ME and USB 1.1 for the ST-8XMEI. The ST-1603ME camera can be used on USB 1.1 at a slower download rate. The USB 2.0 transfer rate is approximately 800kps.

A regulated power supply is built into the ST-1603ME camera so it can be operated from any 12VDC source. The ST-8XMEI requires our desktop supply or our 12VDC supply.

The ST-8XMEI is capable of controlling either the matching CFW8A or replacement CFW10. The ST-1603ME must use an external filter wheel that it cannot control directly like the CFW10-SA (Stand Alone) version.

The bottom line is that for astronomy the ST-8XMEI is a better choice albeit at a slightly higher price. The ST-1603ME is a good choice for industrial and life science applications where the light can be controlled and download rate is a more significant factor.

ST-1603ME Typical Specifications

CCD	
CCD	Kodak KAF-1603ME
Pixel Array	1530 x 1020 pixels
CCD Size	13.8 x 9.2 mm
Total Pixels	1.56 million
Pixel Size	9 x 9 microns
Full Well Capacity	~100,000 e-
Dark Current	$1e^-$/pixel/sec at 0° C
Antiblooming	Optional
Readout Specifications	
Shutter	Electromechanical
Exposure	0.04 to 3600 seconds
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.5e-/ADU unbinned, 2.0e- binned
Read Noise	$17e^-$ RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download Rate	**USB 2**: Up to 800,000 pixels / sec.
Full Frame Download Time	~2 seconds with USB 2.0
System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, -20 C from Ambient
Temperature Regulation	±0.1°C
Power	12VDC Power supply included
Computer Interface	USB 2.0 (USB 1.1 compatible)
Computer Compatibility	Windows 98/2000/Me/XP
Physical Dimensions	
Optical Head	5 x 4 x 1.8 inches
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" nosepieces included
Weight	Approx. 20 oz. (0.6kg)
Backfocus (C-mount compatible)	0.69 inches

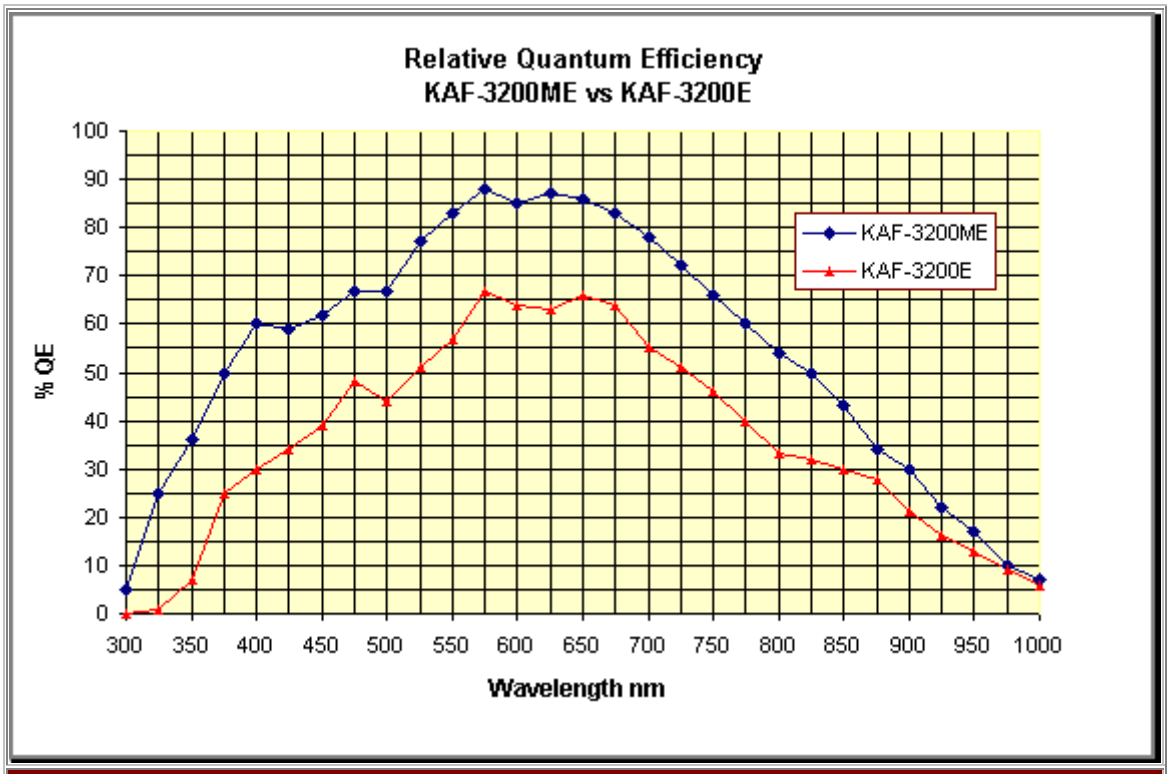
Specifications are subject to change without notice

MODEL ST-3200ME
CCD IMAGING CAMERA

The ST-3200ME is essentially the same camera as the ST-402ME and except that the imaging CCD is over 4X larger and it has more than 8X the number of pixels. The ST-3200ME uses the KAF-3200ME CCD, the same sensor we use in the ST-10XME. This CCD is 2184 x 1472 pixels at 6.8 microns. However, due to the size of the array, the internal filter wheel cannot be used. For color or photometric applications the CFW10-SA can be used instead, with standard 1.25" filters.

ST-3200ME CCD Camera Body with Optional C-mount Adapter and Lens

The ST-3200ME, like the ST-1603ME, is intended primarily for industrial and life science applications where a faster download rate is more important than maximum cooling or self-guiding. Of course it will also perform very well for astronomical applications, particularly where an external guider is already available. For astronomical applications where greater cooling and lower read noise performance is more important than the somewhat faster download rate, we also offer the ST-10XMEI single sensor camera, and ST-10XME dual sensor, self-guiding camera, with the KAF-3200ME imaging CCD and USB 1.1 electronics.



The ST-3200ME has the same high QE as the ST-10XME

Comparison of ST-3200ME and ST-10XMEI:

Since both the ST-3200ME and the ST-10XMEI cameras are single sensor models using the KAF-3200ME CCD, a brief comparison is in order to distinguish the features of each:

Both cameras use the same Class of CCD in the standard price. A Class 1 is available in both models for an additional charge. The ST-3200ME will download a full frame image in approximately 4 seconds. The ST-10XMEI takes just under 8 seconds. However, the ST-10XMEI has lower read noise and better cooling performance, and it is upgradeable to a self-guiding model by adding an internal TC-237H guiding CCD. The ST-3200ME has no provision for a second CCD, so it cannot be upgraded to a self-guiding camera.

In both cases, all new electronics are contained entirely in the camera head. There is no separate CPU box. The computer interface is USB 2.0 for the ST-3200ME and USB 1.1 for the ST-10XMEI. The ST-3200ME camera can be used on USB 1.1 at a slower download rate. The USB 2.0 transfer rate is approximately 800kps. A regulated power supply is built into the ST-3200ME camera so it can be operated from any 12VDC source. The ST-10XMEI requires our desktop supply or our 12VDC supply. The ST-10XMEI is capable of controlling either the matching CFW8A or replacement CFW10. The ST-3200ME must use an external filter wheel that it cannot control directly like the CFW10-SA (Stand Alone) version.

ST-3200ME vs. ST-10XMEI Comparison Chart		
	ST-3200ME	**ST-10XMEI**
High QE (>80% Peak) "ME" CCD	KAF-3200ME	KAF-3200ME
Class of CCD in standard camera	Class 2	Class 2
Column Defects Allowed	None	None
High Speed USB Interface	USB 2.0	USB 1.1
Full Frame Download Rate	800kps	425kps
Full Frame Download Time	~4 sec	~8 sec
Internal shutter for automatic dark frames	Yes	Yes
Internal ROM for CFW8A control	No	Yes
I2C Port for CFW10	No	Yes
Upgradeable to self-guiding model	No	Yes
Read Noise	17e-	15e-
Cooling	-20 C	-35 C
Water Cooling Heat Exchanger	No	Optional
Power requirements	12VDC Unregulated	12VDC and 5VDC Regulated
Current requirements	~ 2A	~3A
Power supply included	Yes	Yes
Size	5 x 4 x 1.8" (12.7x10.2x4.6 cm)	5 x 5 x 3" (12.7x12.7x7.6cm)
Weight	20 oz. (0.6kg)	32oz. (0.9kg)

The bottom line is that for astronomy the ST-10XMEI is a better choice albeit at a slightly higher price. The ST-3200ME is a good choice for industrial and life science applications where the light can be controlled and download rate is a more significant factor.

ST-3200ME Typical Specifications

CCD	
CCD	Kodak KAF-3200ME
Pixel Array	2184 x 1472 pixels
CCD Size	14.9 x 10 mm
Total Pixels	3.21 million
Pixel Size	6.8 x 6.8 microns
Full Well Capacity	~77,000 e-
Dark Current	<1e^-/pixel/sec at 0° C
Antiblooming	N/A (NABG Only)
Readout Specifications	
Shutter	Electromechanical
Exposure	0.04 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.8e-/ADU unbinned, 1.2e- binned
Read Noise	10e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download Rate	**USB 2**: Up to 800,000 pixels per second
	USB 1: Up to 400,000 pixels per second
Full Frame Download Time	~4 seconds with USB 2.0
System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, -20 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	12VDC Power supply included
Computer Interface	USB 2.0 (USB 1.1 compatible)
Computer Compatibility	Windows 98/2000/Me/XP

Model ST-7XE/XME
CCD Imaging Camera

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Model ST-7XE/XME Dual CCD Self-Guiding Camera

ST-7XME CCD IMAGING CAMERA

The Model ST-7XE/XME is a self-guided imaging camera and contains two CCD detectors; one for guiding and the other for collecting the image. They are mounted in close proximity, both focused at the same plane, allowing the imaging CCD to integrate while the PC uses the guiding CCD to correct the telescope. Using a separate CCD for guiding allows 100% of the primary CCD to be used to collect the image. The telescope correction rate and limiting guide star magnitude can be independently selected. Tests at SBIG indicate that 95% of the time a star bright enough for guiding will be found on the guiding CCD without moving the telescope, using an f/6.3 telescope. Carefully guided exposures up to one hour are possible, enabling a standard Celestron C-8 to capture images showing 19th magnitude stars from typical background observing sites. The imaging camera includes an electro-mechanical shutter, 16 bit analog to digital (A/D) converter, regulated temperature control, and has all of the electronics integrated into the CCD head. Communication to the PC or Mac is through the USB port.

The imaging CCD in the ST-7XE version is the enhanced KAF-0401E CCD from Kodak. This CCD is available with or without antiblooming protection (ABG). The non-ABG part has approximately twice the quantum efficiency of the antiblooming part. The Full Frame Resolution is 765 x 510 pixels at 9 microns square. The imaging CCD in the ST-7XME version is the new KAF-0402ME CCD from Kodak. The KAF-0402ME CCD has very high Quantum Efficiency, greater than 85% peak. The XME version is available only without antiblooming.

M82. ST-7E image using AO-7 adaptive optics device and 8" f/12.4 cassegrain telescope. *Primary image by Stan Moore with deconvolution by Benoit Schillings and color data supplied by by Al Kelly.*

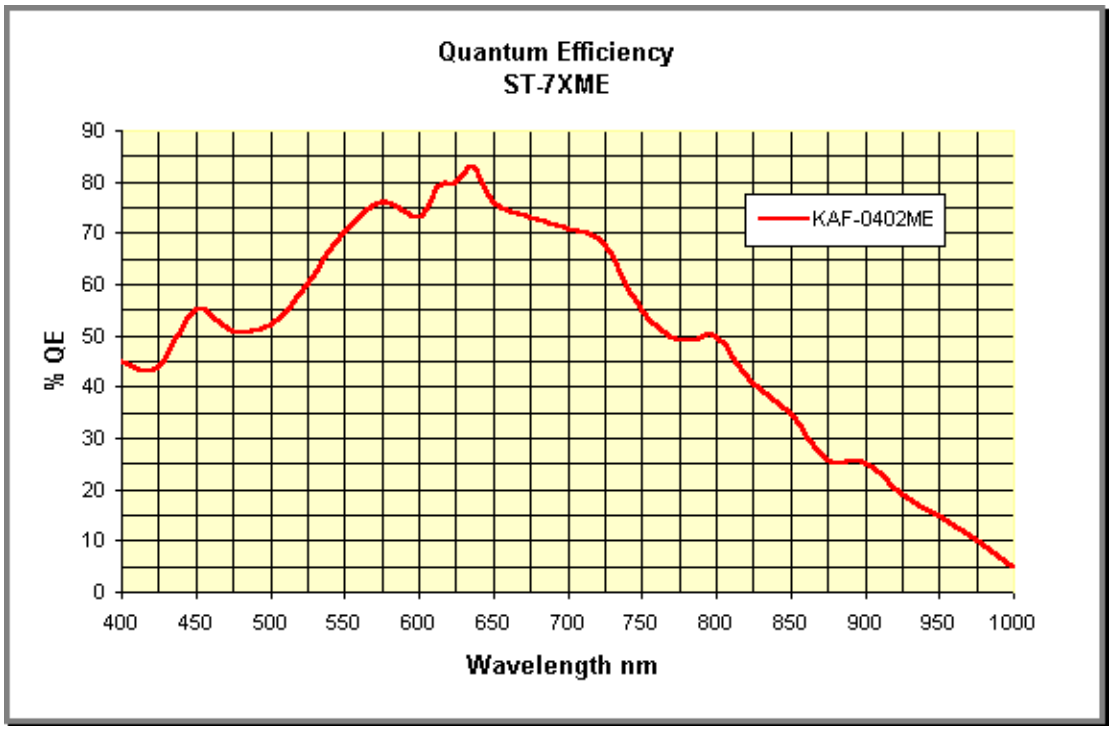
Each imaging camera is furnished with CCDOPS Windows operating software. Software for the Mac OS-X is also available. The CCDOPS Windows software includes camera control and image processing plus photometric and astrometric measurement functions. The CCDOPS Windows software is unsurpassed in performance and ease of operation. Optional operating software can be expanded to include remote telescope control, a large stellar data base from the SAO

catalog and Hubble Guide Star Catalog, plus a non-stellar data base from NCC, IC, PCC (Principle Galaxies Catalog), PK planetary nebulae, WDS (double star catalog), and GCVS (variable star catalog).

M1. ST-7E LRGB image taken with an AO-7 adaptive optics device through a 16" f/10 telescope. Corrections were made at 4Hz. *Courtesy Marko Moilanen*

More on the ST-7XME

In March of 2003, Kodak released two new versions of the CCD that SBIG uses in the ST-7XE cameras. The new CCDs are designated the KAF-0402E and KAF-0402ME. These CCDs have the same array architecture as the KAF-0401E NABG with some improvements.



Model ST-7XME self-guiding CCD camera with optional l35mm lens adapter

Of greatest significance is the increased quantum efficiency due to the addition of a microlens array over the pixels and the use of MAR coated cover glass on the KAF-0402ME version. The same kind of improvement has already met with great success in the ST-10XME camera. The peak quantum efficiency for the KAF-0402ME is almost 85%. It is the most sensitive CCD camera in its class. The QE for the blue wavelength of 400 nm is 50% higher than that of the previous KAF-0401E CCD (increased from 30% to 45% absolute QE) and 15% higher in the red spectrum near H-alpha (increased from 72% to nearly 85% absolute peak QE). The resulting high QE from UV to IR makes the ST-7XME perfect for imaging deep space objects such as dim galaxies and emission nebula. By fortunate circumstance, the peak QE occurs very near the H-alpha emission line at 656 nm, making this camera extraordinarily sensitive at this important wavelength. It could be said that this camera was "made for" capturing H-alpha! Previously, this level of QE was achievable only through the process of thinning the wafer and illuminating the image sensor from the backside. However, thinned, back-illuminated CCDs are very expensive. With the KAF-0402ME, similar performance to a back-illuminated CCD is achieved with lower dark current and superior cosmetic specifications in a full frame front illuminated detector.

A single 1200 second H-alpha exposure of the California Nebula taken with an ST-7XME camera through a 100 mm F/2.8 camera lens and H-alpha filter under the glare of a nearly full moon. Michael Barber / SBIG

Except for the increased QE, the CCD specifications remain the same as the ST-7XE. The cosmetic grades also remain the same: The ST-7XME is supplied with a Class 1 CCD as standard. A Class 1 KAF-0402E(ME) CCD has no column or cluster defects.

The KAF-0402ME is available in NABG only. With our new high speed electronics and USB interface, a full frame image will download in 1 second. Partial frame modes and focus mode will update faster than once per second. Kodak full frame CCDs are well known for their low dark current and low noise characteristics. Additionally, the new camera design has superior cooling and is water assist ready. Thermoelectric cooling to -40 degrees C below ambient is possible. Imagine focusing in full frame mode!

The KAF-0402E CCD, without microlens, is also available as an alternative to the microlens part for applications where a microlens may not be desired. The QE for the KAF-0402E CCD is essentially the same as for the previous KAF-0401E. The difference is the addition of greater static protection. The ABG version of this part, the KAF-0401LE remains unchanged. While we recommend that our customers select the ST-7ME for astronomy, we will continue to offer all three versions of the camera (ST-7XME, ST-7XE NABG and ST-7XE ABG) so long as Kodak continues to manufacture all three varieties of this CCD.

ST-7XE/XME Typical Specifications

CCD Specifications	
CCD	Kodak KAF-0402E/ME + TC-237
Pixel Array	765 x 510 pixels, 6.9 x 4.6 mm
Total Pixels	390,000
Pixel Size	9 x 9 microns
Full Well Capacity (NABG)	~100,000 e-
Dark Current	1e^-/pixel/sec at 0° C
Antiblooming	Standard (non ABG as option)

Readout Specifications	
Shutter	Electromechanical
Exposure	0.12 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	2.3e^-/ADU
Read Noise	15e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	Up to 420,000 pxels per second
Full Frame Acquisition	~1 second

Optical Specifications (8" f/10)	
Field of View	12 x 8 arcminutes
Pixel Size	.9 x .9 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -45 C from Ambient Typical w/water
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Win 98/2000/Me/NT/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Specifications subject to change without notice

Model ST-8XE/XME
CCD Imaging Camera

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Model ST-8XME Dual CCD Self-Guiding Camera

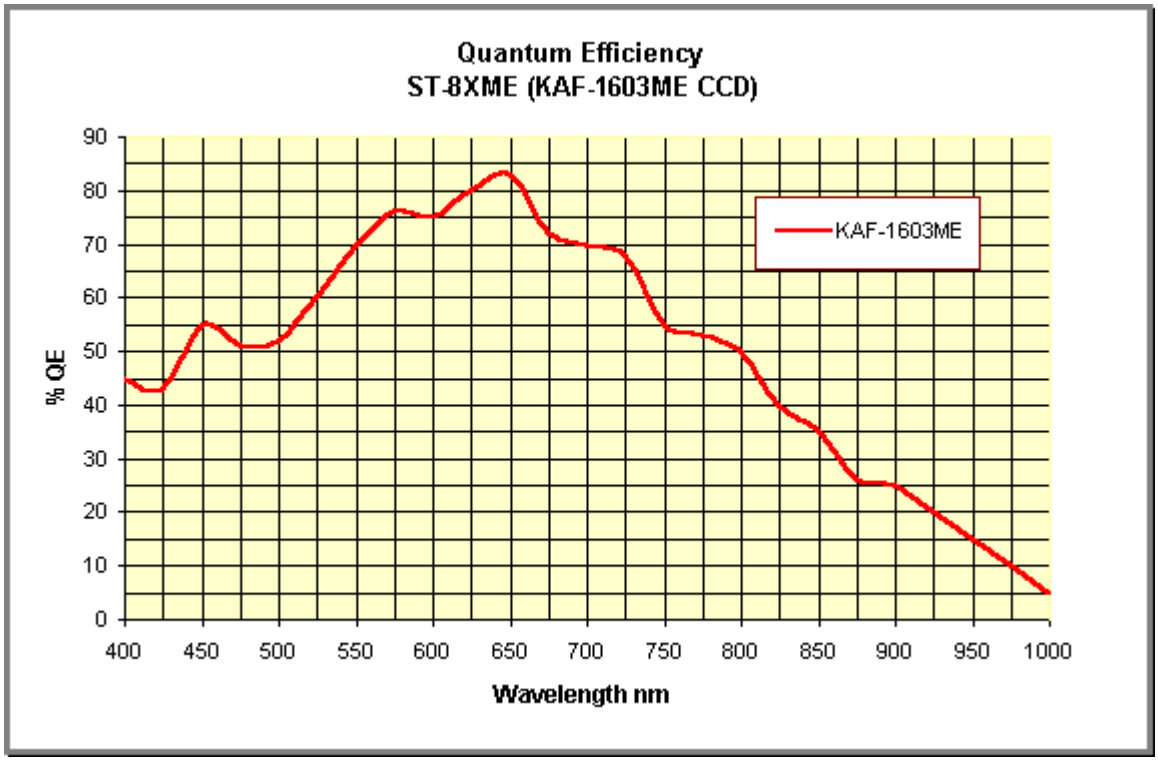
ST-8XME CCD IMAGING CAMERA

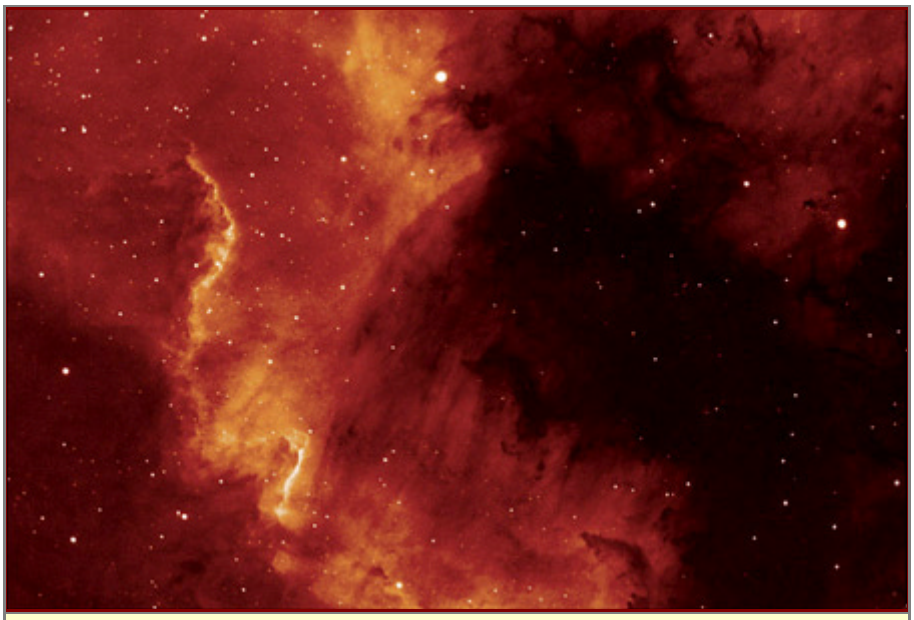
The Model ST-8XME is identical to the Model ST-7XME except that it is furnished with a 4x larger imaging CCD. The imaging CCD has a Full Frame Resolution of 1530 x 1020 pixels at 9 microns square and the tracking CCD has 657 x 495 pixels at 7.4 microns square. The imaging CCD utilizes the latest microlens technology and AR coated cover glass found in the ST-7XME and ST-10XME cameras. This technology boosts the peak Quantum Efficiency of the CCD to nearly 85% and improves sensitivity across the visible sprectrum. Since the ST-7XME and ST-8XME imaging CCD detectors are pin to pin compatible, SBIG designed the CCD head to accept either detector. As a result the Model ST-7XME is easily upgraded to the Model ST-8XME. The large CCD active area of 13.8 x 9.2 mm allows the user to image large fields of view with the ST-8XME. The various binning modes of 9, 18, and 27 micron pixels allows the user to match the focal length of a wide range of telescopes and lenses to this imaging camera. The imaging camera includes an electro-mechanical shutter, 16-bit analog to digital (A/D) converter, regulated temperature control with all of the electronics integrated into the CCD head and a built-in, cooled, TC-237H, 656x495 pixel,guiding CCD. Communication to the PC is through the USB port. The Full Frame download time is approximately 3.7 seconds, nearly 14 times faster than the previous parallel port version of this camera. The image update rate in focus mode is approximately 2 frames per second.

M31. ST-8E two image mosaic of Andromeda galaxy taken through a 4" refractor using a CFW8 filter wheel**.** *Courtesy Robert Gendler*

SBIG actively encourages wide field imaging with the Model ST-8XME. We offer Camera Lens Adapters (CLA-7) to attach standard camera lenses to the imaging camera. In wide field imaging the ST-8XME, CLA-7 and camera lens are typically mounted piggyback on the primary telescope, which acts as a guiding platform. The ST-8XME is set for the high resolution (9 x 9 micron) pixel mode to match the short focal lengths of the camera lens. SBIG has received wide field customer images with 4 to 5 degrees field of view showing large extended objects with much detail and structure. Wide field imaging (i.e., f/2 to f/4) is easy to do, as locating objects becomes a relatively simple matter and guiding is much less critical at the short focal lengths of 100 to 400 mm. We urge our customers to try this technique with both Models ST-7XME and ST-8XME.

M51. Model ST-8E image of the Whirlpool Galaxy taken through a 12.5" f/6.7 telescope. *Courtesy William McLaughlin*





NGC 7000. A portion of the North American nebula was captured with 5" f/6 telescope using an ST-8 camera equipped with an H-alpha filter . Three 20 minute frames were averaged to create this false color image. *Courtesy Brad Ehrhorn*

In its price range, the Model ST-8XME is unmatched in resolution, performance, low noise and field of view in the amateur astronomy market and, therefore, is widely used in astronomy for high resolution imaging and wide field searches for near earth asteroids, comets, supernova, etc. The dual CCD structure allowed SBIG to design an Adaptive Optics System to work in conjunction with the ST-8XME and ST-7XME. This unique system is described under the Accessory Products section of this catalog.

NGC 5128. This ST-8E image of Centarus A was taken through a C14 telescope at f/11**.** *Courtesy Peter Ward*

ST-8XME Typical Specifications

CCD Specifications	
CCD	Kodak KAF-1603ME + TC-237H
Pixel Array	1530 x 1020 pixels, 13.8 x 9.2 mm
Total Pixels	1.56 million
Pixel Size	9 x 9 microns
Full Well Capacity (NABG)	~100,000 e-
Dark Current	$1e^-$/pixel/sec at 0° C
Antiblooming	Standard (non ABG as option)

Readout Specifications	
Shutter	Electromechanical
Exposure	0.11 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	2.3e- /ADU
Read Noise	15e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	Up to 420,000 pxels per second
Full Frame Acquisition	~3.7 seconds

Optical Specifications (8" f/10)	
Field of View	24 x 16 arcminutes
Pixel Size	.9 x .9 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -45 C from Ambient Typical w/water
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Win 98/2000/Me/NT/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Prices and specifications are subject to change without notice

Model ST-9XE
CCD Imaging Camera

SBIG

ASTRONOMICAL
INSTRUMENTS

Model ST-9XE Dual CCD Self-Guiding Camera

ST-9XE CCD IMAGING CAMERA

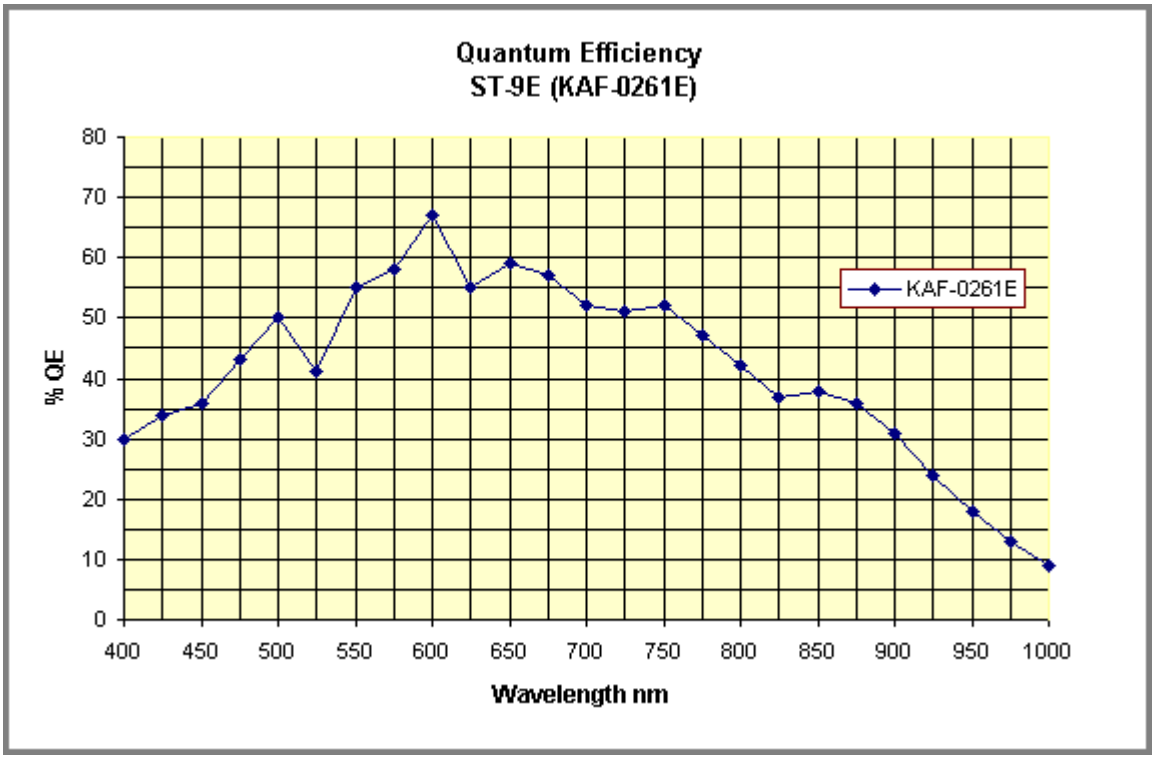
The ST-9XE is identical to the ST-7/8/10/2000 cameras with the exception of the imaging CCD. The ST-9XE utilizes the same patented dual sensor head design integrating one CCD for self-guiding and another CCD for imaging. In the case of the ST-9XE the imaging sensor is the Enhanced KAF-0261E detector from Kodak with 512 x 512 pixels at 20 microns square (Due to its large pixel size, this CCD is not available in a microlens version). The ST-9XE Imaging Camera is ideal for use on long focal length scopes where a larger field of view than an ST-7XE is desired, but one's budget does not allow for an ST-8XE camera. Large scopes, even those with relatively fast f/ratios, have focal lengths that "waste" sensitivity of cameras using detectors with small pixels. Longer focal lengths also mean smaller fields of view given a fixed detector size. Take, for example, a C-14 at f/7, 16" SCT at f/6.3 and a 20" f/5. In all of these cases the telescopes have focal lengths of about 98 to 100 inches. When used at 100 inches of focal length, the 9 micron pixels of the ST-7XME and ST-8XME cameras subtend about 0.7 arcseconds - a bit small for this focal length under average seeing conditions. So these cameras are often operated binned 2x2 at focal lengths of 100 inches or more unless the optics and seeing are rather exceptional.

M13. ST-9E prototype First Light: a single 120 second cropped image taken through a 10" f/6.3 SCT (1/4 size). Michael Barber / SBIG

M33. ST-9E production First Light: a single 360 second image taken through a 12" SCT at f/6.3. Courtesy Gary Hug

For the ST-8XE this is no problem because the detector has 1.5 million pixels and binning 2x2 still leaves the user with a reasonable 765 x 510 pixels @ 18 microns. But binning the ST-7XE 2x2 yields an image that is 382 x 255 so the image size on the monitor begins to get small for this size camera. However, the ST-9XE's 20 micron pixels subtend about 1.6 arcseconds per pixel at 100 inches focal length without binning. Just

about perfect for optimum sensitivity under typical seeing conditions. This gives the long focal length user the advantage of larger more sensitive pixels and a reasonably large image of 512 x 512 at a substantial savings compared to an ST-8XE. Moreover, the FOV of the ST-9XE is nearly as large as an ST-8XE.



Sensitivity:

With its relatively large (20 micron) pixels, the ST-9XE is approximately 20 times as sensitive as an ABG version of the ST-7XE (binned 1x1) with a field of view approximately 3.3x as large as the ST-7XE. This compares very favorably with an ST-8XE NABG operating in 2x2 binned mode at about half the cost of the ST-8XE. So for long focal lengths where one cannot take advantage of the smaller pixels of the ST-7XE or ST-8XE, the ST-9XE is an excellent choice

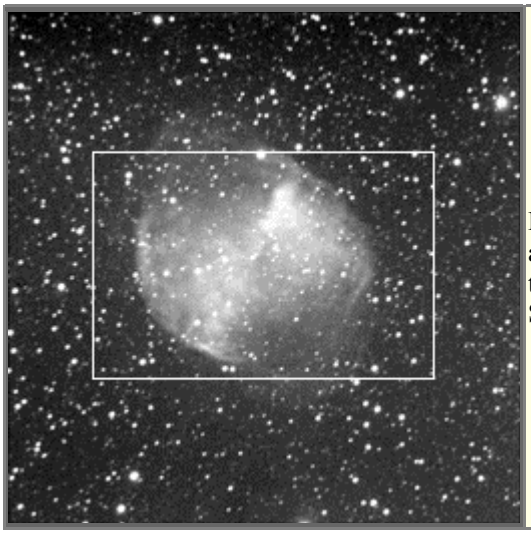
M27. LRGB color image for reference only by Robert Dalby

Relative Intensities Recorded in image	ST-8 ABG	ST-8E ABG	ST-9E NABG
(A) Background	1	1.3	14.2
(B) Star peak (color unknown)	1	2.0	13.7
(C), (D) H-a regions	1	2.2	18.4
(E) OIII bright (~50% above background)	1	2.1	25.0
(F) OIII faint (>10% above background)	1	1.5	20.0

Field of View:

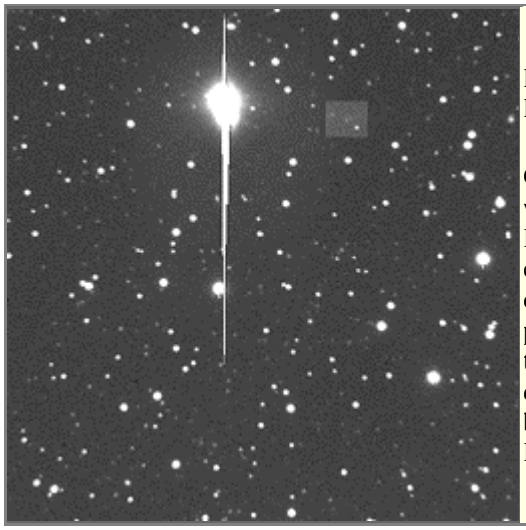
The image and diagram below demonstrates the larger field of view one obtains with the ST-9XE detector compared to the ST-7XE. Note this has nothing to do with the number of pixels on the detector or how the image is displayed on your computer monitor. Rather, it is strictly based on the overall size of the detector.

The ST-9XE is an excellent choice for minor planet and supernova searches when one's budget does not allow for a very large CCD camera such as the KAF-1001E based ST-1001E camera. Moreover, the ST-9XE is capable of self-guiding with a built-in TC237 tracking CCD. It is therefore capable of hour long self-guided exposures for deep space imaging. The ST-9XE accepts all of the same accessories as the ST-7XE and ST-8XE cameras including the integrated CFW8A color filter wheel for color imaging or UBVRI photometric measurements, AO-7 adaptive optics device, CLA7 camera lens adapter, etc.



Full frame is the field of view of the ST-9E at 110 inches focal length. The area inside the white box is the field of view of the ST-7 at the same focal length.

One month after taking delivery of one of our first production ST-9E cameras, two amateurs, Gary Hug and Graham Bell, discovered a ~19th magnitude comet: **Comet P/1999 X1 Hug-Bell**. With a single exception we are informed that this is the faintest comet ever discovered by an amateur astronomer. Gary and Graham were using a 12" SCT at f/6.3. The discovery was made while blinking 6 minute exposures taken in search of an asteroid. Subsequent 10 minute and 20 minute exposures revealed the comet's tail.



Discovery image (reduced) with comet P/1999 X1 Hug-Bell in the highlighted box.

Gary Hug writes: "The comet (P/1999 X1 Hug-Bell) was discovered Dec 10th and has been published in the IAU Circular #7331. Orbital information shows this comet to orbit between Mars and just outside Jupiter's orbit although some distance above the giant planet's path. It's currently about magnitude 18.5, located near the beehive cluster, and was magnitude 18.8 at discovery. The comet will maintain a near even brightness for the next few weeks then gradually fade. It's period is 7.01 yrs.

ST-9XE Typical Specifications

CCD Specifications	
CCD	Kodak KAF-0261E + TC-237
Pixel Array	512 x 512 pixels, 10.2 mm x 10.2 mm
Total Pixels	262,000
Pixel Size	20 x 20 microns
Full Well Capacity (NABG)	~150,000 e-
Dark Current	10e^{-}/pixel/sec at 0° C
Antiblooming	Non-ABG only

Readout Specifications	
Shutter	Electromechanical
Exposure	0.11 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.6e-/ADU
Read Noise	15e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	Up to 420,000 pxels per second
Full Frame Acquisition	~ 1 seconds

Optical Specifications (8" f/10)	
Field of View	17.3 x 17.3 arcminutes
Pixel FOV	2 x 2 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -45 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Win 98/NT/2000/Me/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches, 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Prices ans specifications are subject to change without notice

Model ST-10XE/XME
CCD Imaging Camera

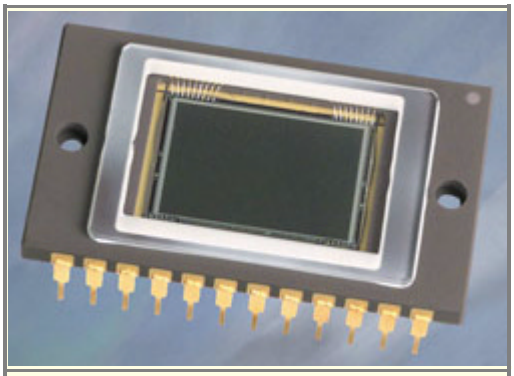
SBIG

ASTRONOMICAL
INSTRUMENTS

Model ST-10XE/XME Dual CCD Self-Guiding Camera

ST-10XME CCD IMAGING CAMERA

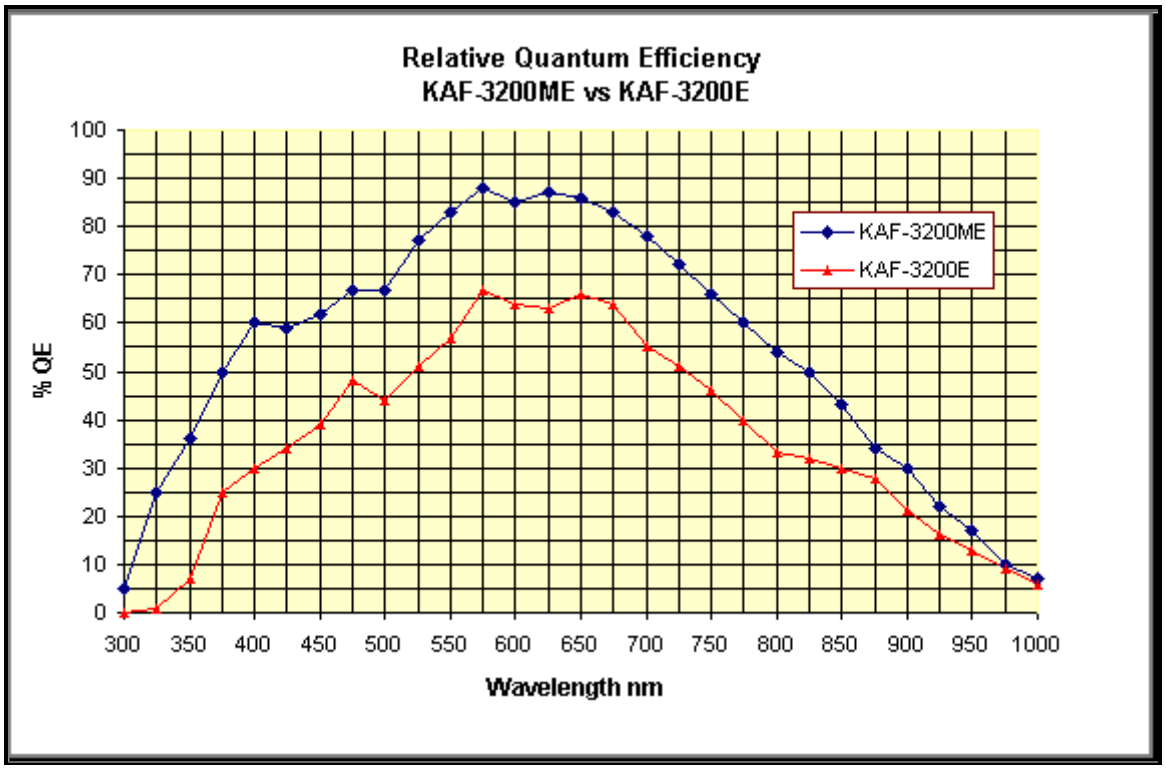
The Model ST-10XE and ST-10XME are the highest resolution CCD cameras in the "ST" series from SBIG. The body is identical to the ST-7XME, ST-8XME, ST-9XE, and ST-2000XM models with some slight modifications to accommodate the larger detector. The **ST-10XE** contains an enhanced KAF-3200E imaging detector from Kodak. The **ST-10XME** contains an enhanced KAF-3200ME imaging detector from Kodak. The only difference between the CCDs is the addition of a micro lens layer over the pixels of the KAF-3200ME CCD for increased sensitivity. These 3.2 megapixel CCDs have a Full Frame Resolution of 2184 x 1472 pixels at 6.8 microns making them the ultimate cameras for wide field apochromatic refractors. The active imaging area is 17% greater than the ST-8XME and the arrays contain approximately twice as many pixels. The imaging camera includes an electro-mechanical shutter, 16 bit analog to digital (A/D) converter, regulated temperature control, and built-in TC-237H, guiding CCD with all of the electronics integrated into the CCD head. Communication to the PC is through the USB port at up to 425,000 pixels per second.



Multi-megapixel KAF-3200E

The KODAK DIGITAL SCIENCE ^{TM} KAF-3200E Image Sensor is a high density, 3.2 million pixel, full-frame Blue Plus image sensor. It joins the family of Kodak Blue Plus sensors with improved quantum efficiency across the visible spectrum. Ultra-low dark current of less than 1e-/pixel/second at 0^{o} C (typical) allows moderate cooling for applications involving extended exposures. With an improved liquid cooling design, the ST-10XE/XME cameras will reach approximately 45^{o} C below ambient temperature for best performance even in hot climates. The KAF-3200ME is the same CCD as the KAF-3200E with the exception of the addition of micro lenses over the pixels. This has the effect of increasing the effective quantum efficiency of the CCD. Although the ST-10XE/XME camera is a perfect match to high quality refractors in high resolution mode, with 3.2 million pixels the ST-10XE/XME is easily adapted to a variety of focal lengths. The various binning modes of 6.8, 13.6 and 20.4 micron pixels allow you to match the focal length of a wide range of telescopes and lenses to this imaging camera. There are also half-frame and quarter-frame modes available for each resolution setting. Moreover, even when binned 2x2 or 3x3 the number of pixels is still comparable to the ST-7XE, ST-8XE and ST-9XE as the table below illustrates. For example, in addition to 2184 x 1472 at 6.8 microns, the user can elect to image at 1092 x 736 with 6.8 micron pixels or 1092 x 736 with 13.6 micron pixels. In "low" resolution, full frame mode, the ST-10EXE/XME still operates much like a ST-9XE with 36% more pixels and 43% larger field of view! The various combinations of useable frame and pixel sizes make this an extremely versatile camera.

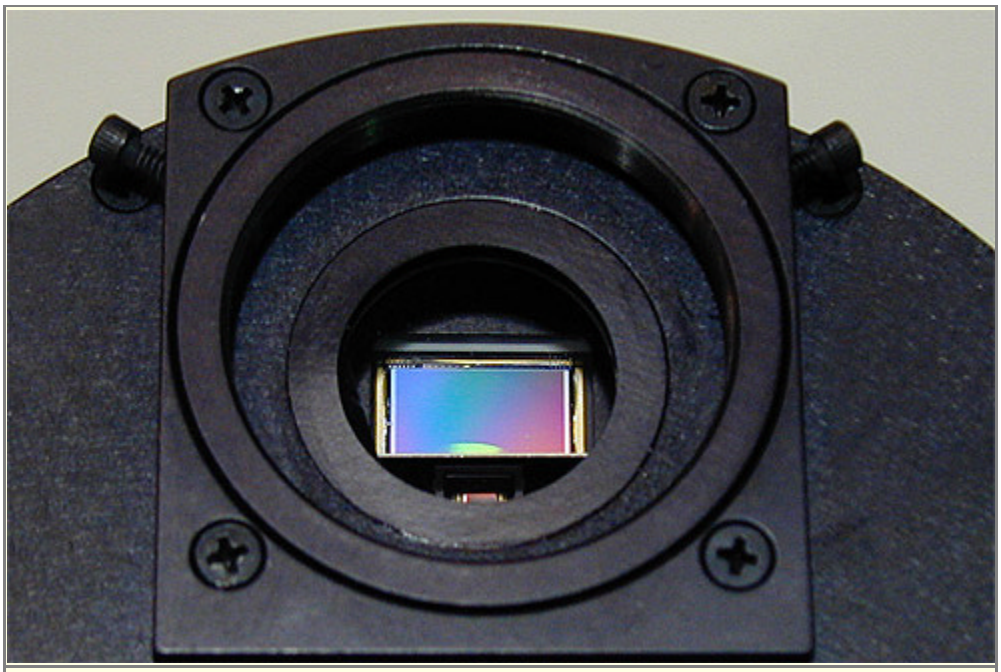
Rosette Nebula, ST-10 image courtesy Loke Tan



The file size of high resolution images can be reduced by about half by saving the images in SBIG compressed file format. The benefit of this format is that the compression is lossless, unlike JPEG and other compression techniques. The original file size and amount of compression varies somewhat depending on the content of the image and the resolution mode selected, but the information contained in the table below is typical.

	Full Frame	Half Frame	Quarter Frame
High Res (unbinned)	2184 x 1472 @ 6.8 u	1092 x 736 @ 6.8 u	548 x 370 @ 6.8 u
Medium Res (binned 2x2)	1092 x 736 @ 13.6 u	546 x 368 @ 13.6 u	275 x 186 @ 13.6 u
Low Res ((binned 3x3)	728 x 490 @ 20.4 u	364 x 245 @ 20.4 u	184 x 124 @ 20.4 u

The ST-10XE/XME camera utilizes SBIG's high speed analog and digital electronics with a USB interface to the PC. This interface is up to 14 times faster than our older parallel interface, and even using USB 1.1 is about as fast as competitors' cameras using USB 2.0. The full frame download rate for the ST-10XE/XME is approximately 8.7 seconds. For finding and centering objects and for focusing, various binning or partial frame modes may be selected to significantly shorten the download time. For instance, in focus mode with a 20 x 20 pixel box the download time is about 0.5 seconds per frame. CCDOPS software also has an Auto Resolution feature that makes using this type of large array easier. The Model ST-10XE/XME camera maintains similar performance, low noise and high QE as the ST-8XME camera. In fact, the ST-10XE/XME has slightly less dark current and lower read noise than the ST-8XME. The dual CCD structure also allows the full range of existing accessories to work with the ST-10XE/XME: The AO-7 Adaptive Optics System, CFW8 and CFW10 color filter wheels, camera lens adapters, etc., are all the same for the ST-10XE/XME as the ST-8XME.



The Multi-Megapixel KAF-3200E enhanced CCD installed in the ST-10XE Camera.
Our highest resolution, dual sensor, self-guiding CCD camera.

Omega Centauri, ST-10 image. *Courtesy Peter Ward*

Veil Nebula, ST-10 image courtesy Loke Tan

ST-10XE/XME Typical Specifications

CCD Specifications	
(ST-10XE) CCD	Kodak KAF-3200E + TC-237
(ST-10XME) CCD	Kodak KAF-3200ME + TC237
Pixel Array	2184 x 1472 pixels, 14.9 x 10 mm
Total Pixels	3.2 million
Pixel Size	6.8 x 6.8 microns
Full Well Capacity	~77,000 e-
Dark Current	0.9e^-/pixel/sec at 0° C
Antiblooming	Non-ABG only

Readout Specifications	
Shutter	Electromechanical
Exposure	0.11 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.3e- /ADU
Read Noise	8.8 e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	Up to 420,000 pxels per second
Full Frame Acquisition	~8.7 seconds

Optical Specifications (8" f/10)	
Field of View	25 x 17 arcminutes
Pixel Size	.7 x .7 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -45 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Win 98/NT/2000/Me/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Price and specifications subject to change without notice

Model ST-2000XM/XCM
CCD Imaging Camera

SBIG

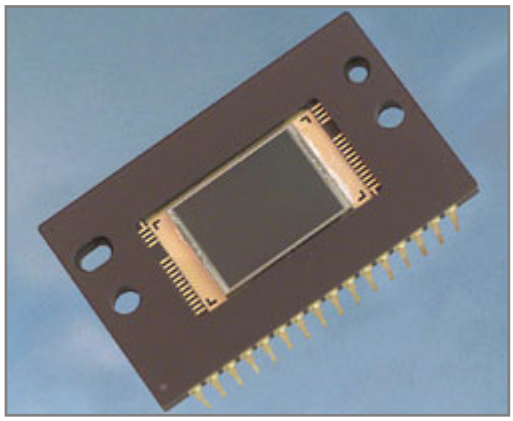
ASTRONOMICAL
INSTRUMENTS

Model ST-2000XM Dual CCD Self-Guiding Camera

ST-2000XM CCD IMAGING CAMERA

Our customers have been invaluable sources of inspiration and direction. It was in direct response to customer inquiries that we developed the ST-2000XM. Now those casual imagers who wanted something bigger and better but not at such a high price as the ST-8 or ST-10 have got what they asked for. The ST-2000XM has been developed to meet the needs of the astro imager looking for:

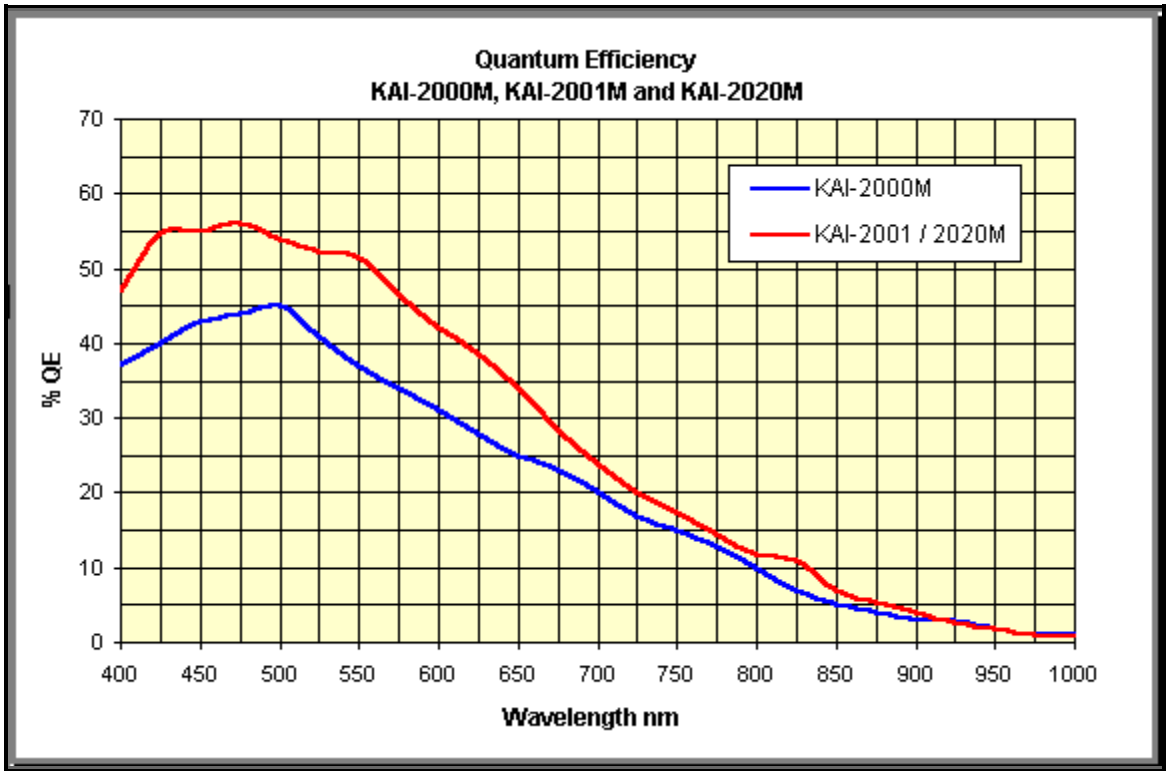
- A relatively large CCD with a generous field of view
- Lots of pixels - more than a megapixel
- Good sensitivity
- Low noise
- Antiblooming protection
- High resolution on smaller telescopes
- Flexibility of binning 2x2 on larger scopes with good image size
- Self-guiding
- High speed download
- Professional software
- Easy to use
- Full compliment of optional custom accessories
- Lower price
- SBIG quality and support



The new model ST-2000XM uses an high quality interline CCD from Kodak, the KODAK DIGITAL SCIENCE™ KAI-2020M Image Sensor Megapixel Progressive Scan Interline CCD. The KODAK DIGITAL SCIENCE™ KAI-2020M is a high-performance multi-megapixel image sensor designed for a wide range of scientific, medical imaging, and machine vision applications. The 7.4 mm square pixels with microlenses provide high sensitivity and the large full well capacity results in high dynamic range. The vertical overflow drain structure provides antiblooming protection, and enables electronic shuttering for precise exposure control. Other features include low dark current, negligible lag and low smear. The KAI-2020M CCD is a 2 megapixel progressive scan detector with an active image area of 1.92 million pixels. The active image area is 1600 x 1200 pixels. This array is 75% larger than the Sony CCD used in competitors' "megapixel" cameras and the ST-2000XM is a self-guiding camera, utilizing SBIG's patented dual sensor design. The imaging CCD is nearly the same size as the KAF-1603ME used in the ST-8XME but due to the smaller pixel size it contains nearly half a million more pixels than the ST-8XME. Full frame download time is approximately 4.5 seconds with our high speed USB 1.1 electronics. This camera is also fully compatible with all of our existing accessories such as the CFW8 filter wheel and AO-7 adaptive optics device. The ST-2000XM has antiblooming protection and the quantum efficiency is comparable to the ABG versions of the new enhanced full frame "E" detectors used in the ST-7XE cameras with a shift in the peak sensitivity toward the blue. Compared to the ABG versions of the full frame "E" series cameras, the ST-2000XM is more sensitive in the blue and green, and slightly less sensitive in the red. Moreover, because the ST-2000XM has two CCDs (a guiding CCD as well as an imaging CCD) in the same camera head, it is

capable of self-guiding without any compromise in the quantum efficiency of the imaging CCD. In other words, not only CAN it self-guide, it can do so without having to double the exposure time to compensate for the guiding feature. Kodak has improved the sensitivity and noise performance of this CCD since it was introduced, and we now use the latest higher QE, lower noise KAI-2020M in all ST-2000 cameras.

The ST-2000XM is a complete camera system. There is no need to add in the additional cost of an interface or an autoguider or a nosepiece or better software to make these cameras actually operate as they should. Everything that is needed to make the camera operational is included in the base price



Each ST-2000XM camera system INCLUDES at no additional cost:

- Rugged camera body with imaging and autoguiding CCDs and new analog and digital electronics
- ***2 Megapixel KAI-2020M imaging CCD***
- ***Built-in TC-237 CCD autoguider with 10X the sensitivity of an ST-4***
- ***High speed USB 1.1 interface (up to 421,000 pixels per second)***
- New I^2C bi-directional expansion port
- Standard accessory / telescope port
- User rechargeable desiccant plug (no need to return the camera to the factory for frosting problems)
- "Dummy" desiccant plug for dust prevention during recharging procedure
- Internal shutter
- 2" Nosepiece
- Cooling Fan - on/off controlled by software
- New heat exchanger design with water cooling capability
- Tripod mount 1/4-20 threaded side plate
- T-thread ring
- 15 foot USB cable (third party USB extenders available for up to 500 meters!)

- Adapter plug for telescope interface cable (for autoguiding)
- Telescope interface cable (for autoguiding)
- Universal 90-240VAC power supply with remote on/off switch
- SBIG's CCDOPS version 5 camera control software
- ***Software Bisque's CCDSoftV5*** camera control and image processing software
- Software Bisque's TheSky version 5, level II
- Operating Manual
- Custom design hard carrying case with pre-cut foam for your camera

What you get with the ST-2000XM	***Feature***	***ST-2000XM***
Megapixels	High Pixel Count	2 million (1.92 million image area)
Good pixel resolution on small scopes	Small pixels	7.4 microns
Big field of view on small and medium scopes	Large CCD Array	1648 x 1214 (1600 x 1200 image area)
High blue response	QE at 400 nm	47%
Mechanical shutter for dark frames	Auto dark frames	Yes
Second CCD included	Self-guiding	Yes
Regulated cooling to 0.1 degrees	Reuse Dark Frames	Yes
Improved cooling capability	Water cooling available	Included (up to -45C delta)
Premium software: CCDSoftV5 and TheSky	Extra Software	Included at no additional cost
Fast electronics	High Speed A/D	~425,000 pixels / sec
Fast Full Frame Downloads	High Speed USB 1.1	~4.5 sec

ST-2000XM First Light Images:

M51. ST-2000XM.
This LRGB test shot was taken by Ron Wodaski through a 6" refractor using a CFW8A filter wheel. The Luminance frame was 7x3 minutes and four sets of RGB frames were 3:3:3 minutes. The full field of view is shown above reduced 50% to 600 x 800. The central portion at high resolution is shown below.

ST-2000XM Typical Specifications

CCD Specifications	
CCD	Kodak KAI-2020M + TC-237
Pixel Array	1600 x 1200 pixels, 11.8 x 8.9 mm
Total Pixels	2 million
Pixel Size	7.4 x 7.4 microns
Full Well Capacity	45,000 e- unbinned 90,000 e- binned 2x2
Dark Current	0.5e^-/pixel/sec at 0° C
Antiblooming	Standard

Readout Specifications	
Shutter	Electromechanical
Exposure	0.001 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.6e- /ADU unbinned, 0.9 e- binned
Read Noise	7.6 e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3, and 1 x N, 2 x N, 3 x N
Pixel Digitization Rate	Up to 425,000 pxels per second
Full Frame Acquisition	4.5 seconds

Optical Specifications (8" f/10)	
Field of View	20 x 15 arcminutes
Pixel Size	.75 x .75 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -35 C from ambient with air only -45 C from Ambient with water
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Windows 98/NT/2000/Me/XP Mac OS-X (on request) Linux (third party suppliers)
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Price and specifications subject to change without notice

Model ST-2000XCM Dual CCD, Self-Guiding Camera with Single-Shot Color CCD

ST-2000XCM Single-Shot Color CCD IMAGING CAMERA

The ST-2000XCM is the same camera as the ST-2000XM monochrome, except that it uses a Kodak KAI-2020CM color CCD for single-shot color imaging. The KAI-2020CM CCD is a high-performance 2 million pixel sensor designed for a wide range of medical, scientific and machine vision applications. The 7.4 um square pixels with microlenses provide high sensitivity and the large full well capacity results in high dynamic range. The vertical overflow drain structure provides antiblooming protection and enables electronic shuttering for precise exposure control. Other features include low read noise, low dark current, negligible lag and low smear.

Like the monochrome version, the ST-2000XCM has an active image area of 1600 x 1200 pixels. This array is 75% larger than the Sony CCD used in competitors' "megapixel" one shot color cameras and the ST-2000XCM is a self-guiding camera, utilizing SBIG's patented dual sensor design. The imaging CCD is nearly the same size as the KAF-1603ME used in the ST-8XME but due to the smaller pixel size it contains nearly half a million more pixels than the ST-8XME. Full frame download time is approximately 4.5 seconds with our high speed USB 1.1 electronics. This camera is also fully compatible with all of our existing accessories such as the AO-7 adaptive optics device.

M33. ST-2000XCM Single-Shot Color

The benefit of one-shot color is that no external color filters are used and self-guiding is always done through an unfiltered optical train (except for a UV/IR blocker if required). This makes finding guide stars easier and guiding a single exposure takes less time than guiding three or four RGB or LRGB exposures through color filters. On the other hand, the benefit of the monochrome version is that the filters can be selected by the user to match the CCD characteristics better, to perform photometry, or to do narrow band imaging. Ultimately, the monochrome camera with custom filters will produce a superior result. The trade-off is ease of use vs. sensitivity and flexibility.

ST-2000XCM Typical Specifications

CCD Specifications	
CCD	Kodak KAI-2020CM + TC-237
Pixel Array	1600 x 1200 pixels, 11.8 x 8.9 mm
Total Pixels	2 million
Pixel Size	7.4 x 7.4 microns
Full Well Capacity	45,000 e- unbinned 90,000 e- binned 2x2
Dark Current	0.5e^-/pixel/sec at 0° C
Antiblooming	Standard

Readout Specifications	
Shutter	Electromechanical
Exposure	0.001 to 3600 sec., 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.6e- /ADU unbinned, 0.9 e- binned
Read Noise	7.9 e- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3, and 1 x N, 2 x N, 3 x N
Pixel Digitization Rate	Up to 425,000 pxels per second
Full Frame Acquisition	4.5 seconds

Optical Specifications (8" f/10)	
Field of View	20 x 15 arcminutes
Pixel Size	.75 x .75 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

System Specifications	
Cooling - standard	Single Stage Thermoelectric, Active Fan, Water Assist Ready -35 C from ambient with air only -45 C from Ambient with water
Temperature Regulation	±0.1°C
Power	5 VDC at 1.5 amps, ±12 VDC at 0.5 amp desktop power supply included
Computer Interface	USB
Computer Compatibility	Windows 98/NT/2000/Me/XP Mac OS-X (on request) Linux (third party suppliers)
Guiding	Dual CCD Self-Guiding

Physical Dimensions	
Optical Head	5 inches dia. x 3 inches 12.5 cm dia. x 7.5 cm deep, 2 pounds/0.9 Kg
CPU	All electronics integrated into Optical Head, No CPU
Mounting	T-Thread, 1.25" and 2" nosepieces included
Backfocus	0.92 inches/2.3 cm

Price and specifications subject to change without notice

SBIG Research Series
STL-1001E, STL-1302E, STL-4020M, STL-6303E and STL-11000M
Large Format CCD Cameras

Santa Barbara Instrument Group, Inc.
147-A Castilian Drive
Santa Barbara, CA 93117
Tel: (805) 571-7244 ◊ Fax: (805) 571-1147
E-mail: sbig@sbig.com ◊ Web site: http://www.sbig.com

Research Series
Dual Head, Triple Sensor, Self-Guiding, Large Format CCD Cameras

Research Series Camera with Optional Remote Guiding Head

The Research Series Self-Guiding CCD cameras from SBIG represent a new step forward in the field of astronomical imaging. These cooled, large format cameras leave nothing to be desired in the way of features and functionality. All Research models include the following:

- Large area imaging CCDs, up to 35mm format
- 1 Megapixel to 11 Megapixels
- Built-in 657x495 pixel TC-237H guiding CCD
- Optional remote guiding head with TC-237H CCD
- Internal 2" filter carousel
- Two-stage thermoelectric cooling
- Provision for water circulation, cooling to –50 degrees C below ambient
- Fast USB electronics, up to 425,000 pixels per second transfer rate
- Professional software: CCDOPS version 5, CCDSoftV5
- Software selectable binning modes, 1x1, 2x2, 3x3, 9x9, 1xN
- 12VDC Operation
- Status and Power level indicator lights
- Optional Nikon camera lens adapter
- Universal 90-240VAC power supply
- Custom waterproof, dustproof, crushproof Pelican carrying and storage case.

The Research Series cameras support a variety of imaging sensors. The 4 Megapixel STL-4020M and the 11 Megapixel STL-11000M with interline CCDs offer large imaging areas, excellent anti-blooming characteristics and high pixel density at a reasonable cost. The CCD used in the 11 Megapixeel STL-11000M camera is a full 35mm format CCD. These cameras are excellent choices for wide field imaging with short focal length scopes.

Research Series Camera with Optional Nikon Camera Lens Adapter

The STL-1001E, STL-1301E and STL-6303E with full frame CCDs offer high quantum efficiency and greater dynamic range. These cameras are the best choices for use on telescopes with longer focal lengths.

The built-in guiding CCD is a TC-237H frame transfer device with high sensitivity and a 657x495 pixel array. The optional remote guiding head contains an identical TC-237H CCD. When the remote head is attached to the main camera the user can select either the internal or the remote guiding CCD for self-guiding a a long exposure.

The internal filter carousel makes adding an expensive 2" filter wheel unnecessary. The built-in filter carousel accepts both 50mm unmounted round filters and filters mounted in 48mm threaded cells. Filter selection is accomplished with the camera control software. Optional LRGB and UBVRI filter sets are available from SBIG. The front cover of the camera is easily removed for changing filters. Since the CCD is in a separate sealed chamber, removal of the front cover to change filters does not expose the CCD to dust or air and the desiccant does not need to be recharged after replacing the cover. Extra carousels may be purchased for

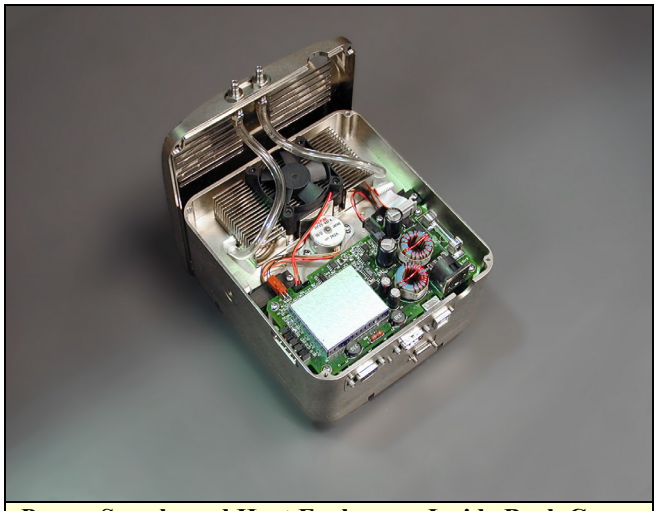
quick and easy transition between filter sets. A shutter mechanism is also located inside the camera body, between the filter wheel and the sealed CCD chamber.

We have added an internal 12VDC regulated power supply to the camera for simplified power requirements and greater tolerance of input voltage variation. When operating in the field from a 12V battery, current drain, power cord extensions and cold temperatures may cause the input voltage to drop below 12 volts. The internal regulated supply will accommodate some variation in input voltage (from about 10 volts to 18 volts) and keep the camera operating normally. This will allow for longer power cords to be used with less concern for voltage drops so long as the input voltage stays within a certain range. A set of indicator LEDs will let you know if your input voltage at the camera is getting too low for normal operation. A universal 90-240VAC, 50-60 Hz power supply is also included for operation from virtually any line voltage in the world.

Filter Carousel with 2" Filters Inside Front Cover

The standard cooling design utilizes a very efficient two-stage TE cooler for maximum performance with large format detectors. Each camera is also liquid assist ready so that additional cooling in warm climates may be achieved by circulating water if needed. We are currently testing a special magnetic levitating fan to eliminate even the smallest vibration. Cooling to -50 Degrees C below ambient can be achieved with this system.

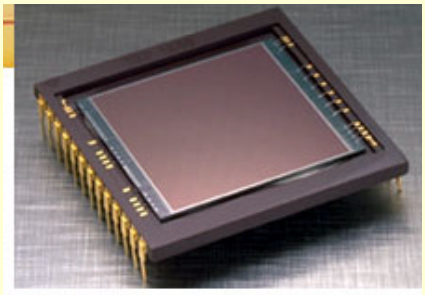
A set of five LED indicator lights on the side panel of the camera provides critical camera status information. The green LED lets you know the camera is booting up and gives camera exposure status during normal operation. One red LED provides a warning if the heat-sink gets too hot. This could happen, for instance, if you were running high power to the cooler and the fan failed for some reason. In this case the camera automatically reduces power to the two-stage cooler to prevent damage. One amber LED warns of an input voltage drop to 11 volts or less but the camera will continue functioning normally. The second amber LED warns of an input voltage drop to 10 volts but the camera will still continue functioning normally. The last red LED warns of an input voltage drop to 9 volts or less. In this case, the camera automatically turns off the TE cooler and continues to operate normally without cooling until the voltage drops to the point that the camera shuts down (around < 7 volts).



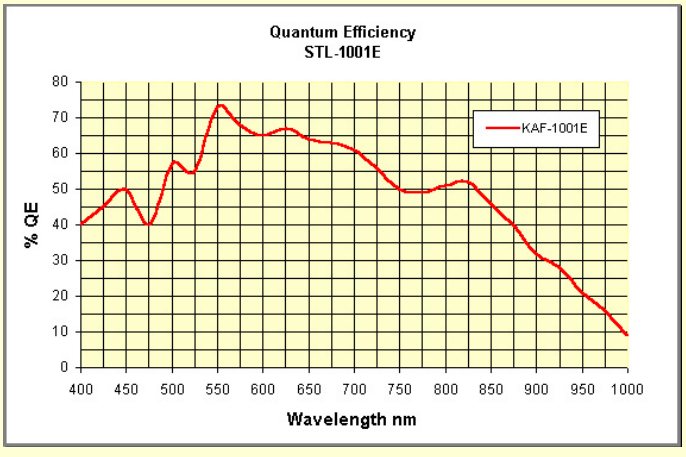
Power Supply and Heat Exchanger Inside Back Cover

All of these unique features make the Research Series cameras unmatched in features and flexibility. For more information please visit the SBIG web site at http://www.sbig.com or contact SBIG at (805) 571-7244, e-mail to sbig@sbig.com

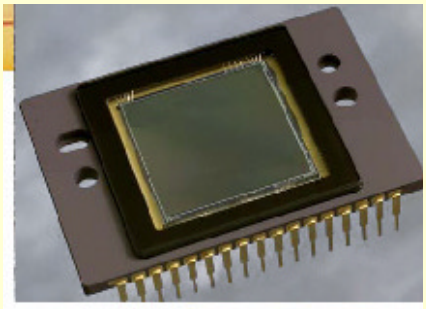
Model STL-1001E Typical Specificaitons	
CCD SPECIFICATIONS	
Imaging CCD	Kodak Enhanced KAF-1001E
Pixel Array	1024 x 1024 pixels, 24.6 x 24.6 mm
Total Pixels	1.0 million
Pixel Size	24 x 24 microns
Full Well Capacity (NABG)	150,000 e-
Dark Current	9 e-/pixel/second at 0 degrees C
Antiblooming	NABG only
READOUT SPECIFICATIONS	
Shutter	Electromechanical
Exposure	0.12 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	2.0e^-/ADU
Read Noise	15e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download	2.5 seconds
SYSTEM SPECIFICATIONS	
Cooling - standard	Two-Stage Thermoelectric, Water Assist, -40 C from Ambient Typical w/water
Temperature Regulation	±0.1°C
Power	10 - 18VDC, 12VDC nominal, Universal AC to 12VDC desktop supply
Computer Interface	USB 1.1
Computer Compatibility	Windows 98/NT/2000/Me/XP/ Mac OS-X
Guiding	Dual CCD Self-Guiding Standard, Remote Guiding Head Optional
PHYSICAL SPECIFICATIONS	
Dimensions	6.5 x 6 x 3.5” (16.5 x 15.2x8.9cm)
Weight	4 pounds (1.8 Kg) without filters
Internal Filter Carousel	5 positions for 48mm threaded cells or 2” unmounted filters (optional)
Mounting	2” nosepiece included
Backfocus	Approximately 1.7 inches (~4.3 cm) with 2" nosepiece attached



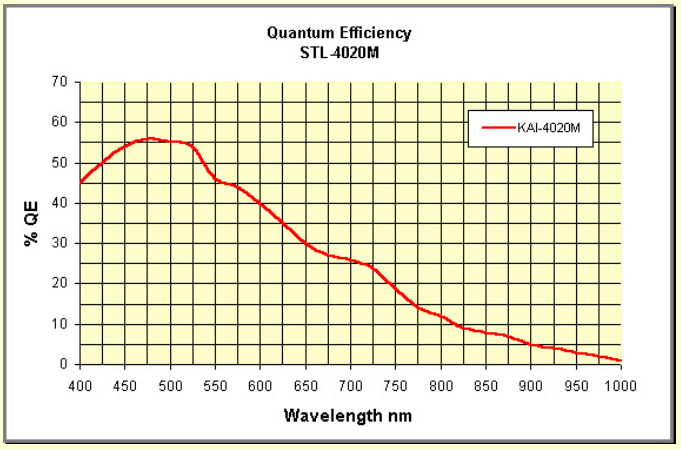
KAF-1001E
Quantum Efficiency
(Spectral Response)



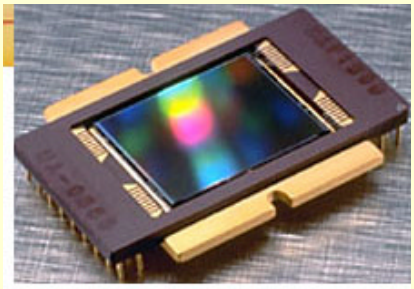
Model STL-4020M/CM Typical Specificaitons	
CCD SPECIFICATIONS	
Imaging CCD	Kodak Enhanced KAI-4021M (KAI-4021CM for single shot color model)
Pixel Array	2048 x 2048 pixels, 15.2 x 15.2 mm
Total Pixels	4.2 million
Pixel Size	7.4 x 7.4 microns
Full Well Capacity (NABG)	40,000 e-
Dark Current	0.07e-/pixel/second @ 0 degrees C
Antiblooming	ABG only
READOUT SPECIFICATIONS	
Shutter	Electromechanical
Exposure	0.001 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.6 e^-/ADU
Read Noise	7.9 e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download	9.8 seconds
SYSTEM SPECIFICATIONS	
Cooling - standard	Two-Stage Thermoelectric, Water Assist, -40 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	10 – 18VDC, 12VDC nominal, Universal AC to 12VDC desktop supply
Computer Interface	USB 1.1
Computer Compatibility	Windows 95/98/NT/2000/Me/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding Standard, Remote Guiding Head Optional
PHYSICAL SPECIFICATIONS	
Dimensions	6.5 x 6 x 3.5” (16.5 x 15.2x8.9cm)
Weight	4 pounds (1.8 Kg) without filters
Internal Filter Carousel	5 positions for 48mm threaded cells or 2” unmounted filters (optional)
Mounting	2” nosepiece included
Backfocus	Approximately 1.7 inches (~4.3 cm) with 2" nosepiece attached



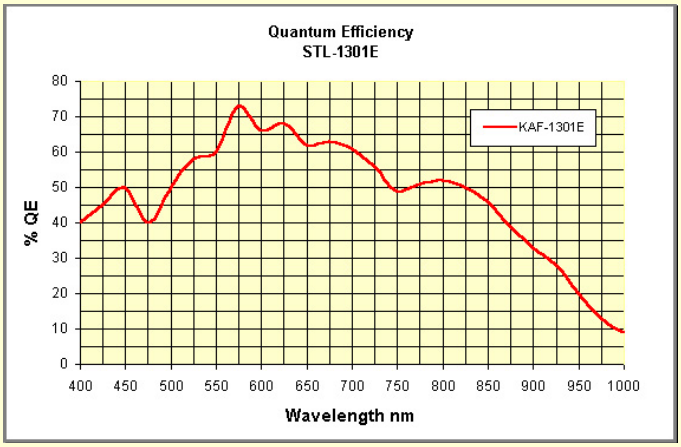
KAI-4020M CCD Quantum Efficiency (Spectral Response)



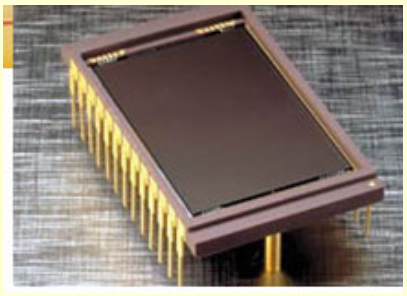
Model STL-1301E Typical Specificaitons	
CCD SPECIFICATIONS	
Imaging CCD	Kodak Enhanced KAF-1301E
Pixel Array	1280 x 1024 pixels, 20.5 x 16.4 mm
Total Pixels	1.3 million
Pixel Size	16 x 16 microns
Full Well Capacity (NABG)	120,000 e-
Dark Current	3e-/pixel/second @ 0 degrees C.
Antiblooming	NABG standard, ABG optional
READOUT SPECIFICATIONS	
Shutter	Electromechanical
Exposure	0.12 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.6 e^-/ADU
Read Noise	17e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download	3 seconds
SYSTEM SPECIFICATIONS	
Cooling - standard	Two-Stage Thermoelectric, Water Assist, -40 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	10 - 18VDC, 12VDC nominal, Universal AC to 12VDC desktop supply
Computer Interface	USB 1.1
Computer Compatibility	Windows 95/98/NT/2000/Me/XP
Guiding	Dual CCD Self-Guiding Standard, Remote Guiding Head Optional
PHYSICAL SPECIFICATIONS	
Dimensions	6.5 x 6 x 3.5” (16.5 x 15.2x8.9cm)
Weight	4 pounds (1.8 Kg) without filters
Internal Filter Carousel	5 positions for 48mm threaded cells or 2” unmounted filters (optional)
Mounting	2” nosepiece included
Backfocus	Approximately 1.7 inches (~4.3 cm) with 2" nosepiece attached



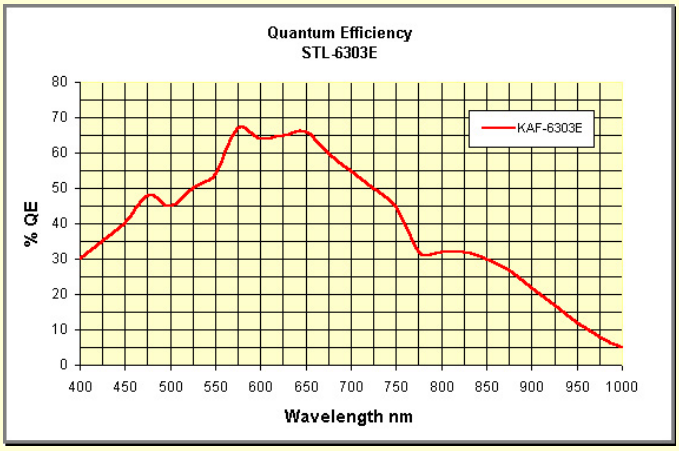
KAF-1301E
Quantum Efficiency
(Spectral Response)



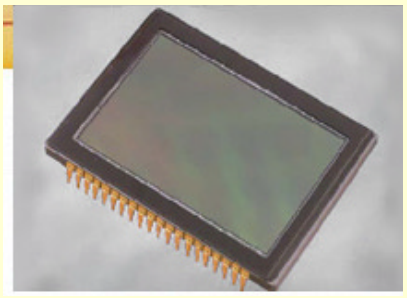
Model STL-6303E Typical Specificaitons	
CCD SPECIFICATIONS	
Imaging CCD	Kodak Enhanced KAF-6303E
Pixel Array	3060 x 2040 pixels, 27.5 x 18.4 mm
Total Pixels	6 million
Pixel Size	9 x 9 microns
Full Well Capacity (NABG)	100,000 e-
Dark Current	0.3e-/pixel/second @ 0 degrees C
Antiblooming	NABG standard, ABG optional
READOUT SPECIFICATIONS	
Shutter	Electromechanical
Exposure	0.12 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	1.4 e^-/ADU unbinned, 2.3e- binned
Read Noise	13.5 e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download	14 seconds
SYSTEM SPECIFICATIONS	
Cooling - standard	Two-Stage Thermoelectric, Water Assist, -40 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	10 - 18VDC, 12VDC nominal, Universal AC to 12VDC desktop supply
Computer Interface	USB 1.1
Computer Compatibility	Windows 98/NT/2000/Me/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding Standard, Remote Guiding Head Optional
PHYSICAL SPECIFICATIONS	
Dimensions	6.5 x 6 x 3.5" (16.5 x 15.2x8.9cm)
Weight	4 pounds (1.8 Kg) without filters
Internal Filter Carousel	5 positions for 48mm threaded cells or 2" unmounted filters (optional)
Mounting	2" nosepiece included
Backfocus	Approximately 1.7 inches (~4.3 cm) with 2" nosepiece attached



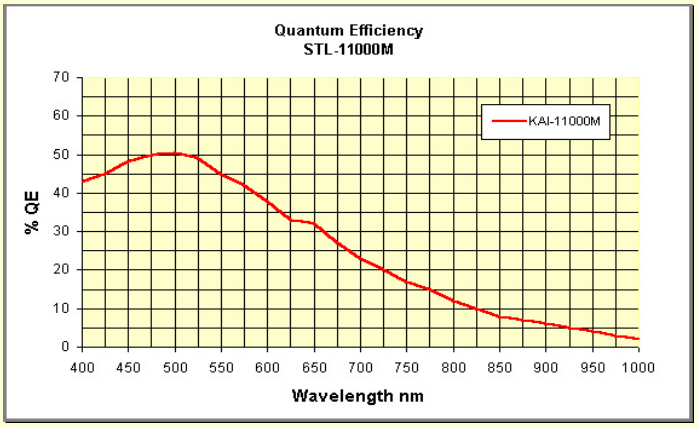
KAF-6303E
Quantum Efficiency
(Spectral Response)



Model STL-11000M/CM Typical Specificaitons	
CD SPECIFICATIONS	
Imaging CCD	Kodak Enhanced KAI-11000M (KAI-11000CM for single shot color model)
Pixel Array	4008 x 2672 pixels, 36 x 24 mm
Total Pixels	11 million
Pixel Size	9 x 9 microns
Full Well Capacity (NABG)	50,000 e-
Dark Current	0.5 e-/pixel/sec @ 0 degrees C
Antiblooming	ABG only
READOUT SPECIFICATIONS	
Shutter	Electromechanical
Exposure	0.001 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.8e^-/ADU unbinned, 1.6e- binned
Read Noise	13 e^- RMS
Binning Modes	1 x 1, 2 x 2, 3 x 3
Full Frame Download	26 seconds
SYSTEM SPEIFICATIONS	
Cooling - standard	Two-Stage Thermoelectric, Water Assist, -40 C from Ambient Typical
Temperature Regulation	±0.1°C
Power	10 - 18VDC, 12VDC, 4.5A nominal, Universal AC to 12VDC desktop supply
Computer Interface	USB 1.1
Computer Compatibility	Windows 98/NT/2000/Me/XP/Mac OS-X
Guiding	Dual CCD Self-Guiding Standard, Remote Guiding Head Optional
PHYSICAL SPECIFICATIONS	
Dimensions	6.5 x 6 x 3.5” (16.5 x 15.2x8.9cm)
Weight	4 pounds (1.8 Kg) without filters
Internal Filter Carousel	5 positions for 48mm threaded cells or 2” unmounted filters (optional)
Mounting	2” nosepiece included
Backfocus	Approximately 1.7 inches (~4.3 cm) with 2" nosepiece attached



KAI-11000M
Quantum Efficiency
(Spectral Response)



Remote Guiding Head Specifications (Typical)	
Dimensions	2.75 x 2 x 2 inches (7 x 5 x 5 cm) excluding nosepiece, desiccant plug and connector
Weight	Approx. 0.5 lbs. (0.23kg)
Camera Interface	A small flexible cable, 3’ long (6’ optional) to the camera provides power, control signal and image transfer.
Computer Interface	USB 1.1 through main camera to computer. Proprietary protocol between remote head and camera body.
Telescope Interface	T-thread or supplied 1.25" nosepiece, optional T-thread to C-mount and 35mm camera lens adapters are available
Shutter	Internal Mechanical Shutter for dark frames plus electronic shutter (frame transfer) for short exposures
Power Requirements	None (Remote head receives power through the head cable from the main camera)
Mounting connections	1/4-20 threaded holes on two sides of head
Cooling	Single-stage TE cooling to approximately –25 degrees C below ambient
	**REMOTE GUIDING HEAD SENSOR** **CCD:** Texas Instruments TC-237H **Pixel Array:** 657 x 495 pixels **Pixel Size:** 7.4 x 7.4 microns **CCD Size**:4.9 x 3.7 mm **Cooling;** Single-stage Thermoelectric **Antiblooming:** Yes

All Weather
SEEING MONITOR

Figure One: Seeing Monitor

Professional observatories often employ a monitor to determine the quality of seeing each night. This can be useful in helping to decide whether to take certain kinds of images, or whether to image at all. If you happen to be at the observatory you can sometimes just look through an eyepiece and see whether the night "looks" good or not. But more and more of our customers are mimicking professional observatory installations with remote observing sites and fully automated observing systems. Remote can mean anything from a few meters to a few thousand kilometers. No matter where one observes, it is often a time consuming matter to get ready for a nights imaging session. It would be convenient to know before hand what kind of results one could expect. Even if the expectation was that the night's seeing would be no better than several arc seconds, the type of imaging one decided to set up for could be changed to make the best use of the conditions available for that evening.

Figure Two: 10 second image of Celestial North Pole and Polaris

SBIG has developed an automated unit for monitoring and logging the seeing throughout a night. The Seeing Monitor, pictured on the right, uses the same ST-402ME camera board and weatherproof box as the Meteor Camera with some different optics and

different software. The Seeing Monitor is intended to be set up once and left outdoors for an indefinite period.

The Seeing Monitor uses an uncooled, shutterless version of the ST-402ME mated to a 150 mm focal length F5.3 lens inside the weatherproof box. The box also contains a USB extender, and a 12 VDC power supply for the camera. The window in the top of the box is clear. The window is heated to prevent condensation on the outside. The USB extender allows operation up to 150 feet (50 meters) from the controlling PC. The lens and box is permanently pointed at Polaris by the user. It is assumed the user will mount posts in the ground outside his observatory or home for this purpose. Roof mounting is not recommended because small vibrations from the building may affect the monitor's measurements.

When properly aligned, one will get an image of Polaris as shown in Figure Two. Of course, Polaris is not eactly at the pole. The field of view is just large enough that the entire orbit of Polaris about the north celestial pole can be captured no matter what time of night the measurements are taken with the camera set up on a fixed mount.

Figure Three shows a sequence of images over a night superimposed. The position of the pole is now quite apparent.

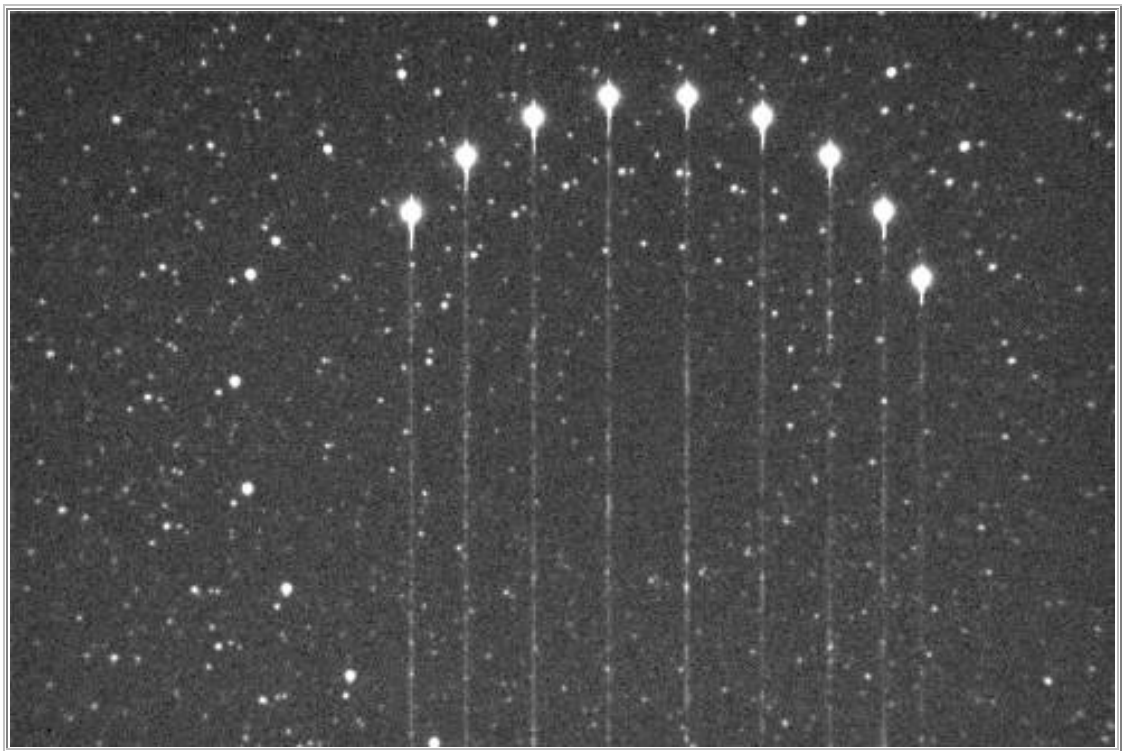


Figure Three: Sequence of 10 second Images Superimposed

The streaks below Polaris in these images are due to the fact that the camera is shutterless and Polaris is exposing the CCD while it is being read out. This has no effect on the calculations for this application. Also, there is no need to take dark frmaes for such short exposures. This system is used to measure the seeing by measuring the hoizontal jitter in the position of Polaris at high speed. A set of equations then can be used to calculate the zenith Full Width Half Maximum (FWHM) that one will obtain in a long exposure image from the rms jitter. The jitter is measured by reading out the CCD while it is being exposed by the light from Polaris in Time Delay and Integration (TDI) mode. An example of the resulting image is shown in Figure Four.

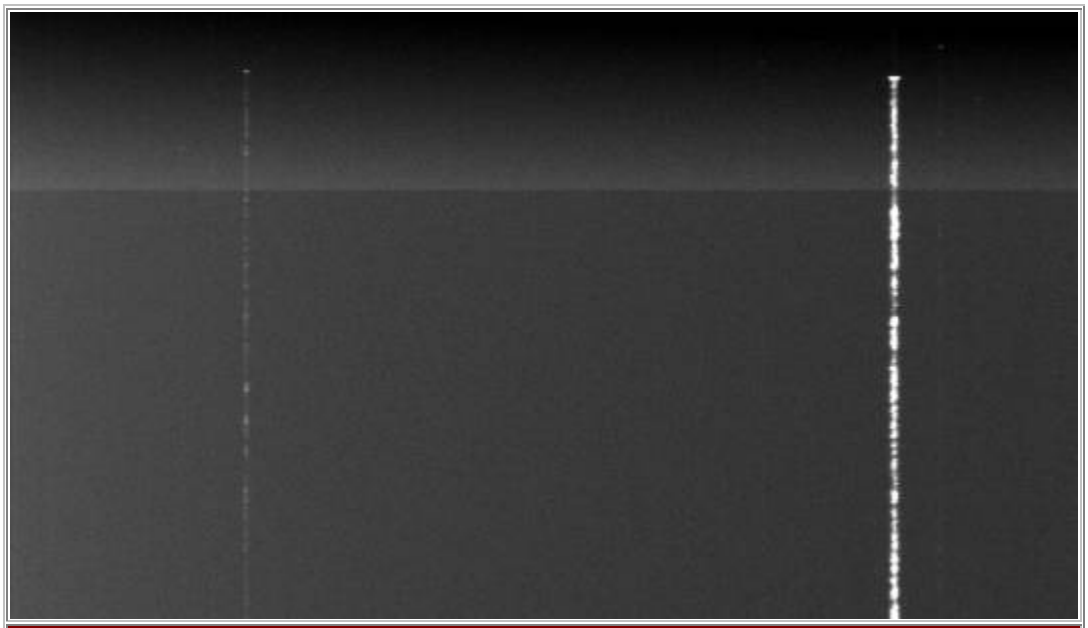


Figure Four: TDI Readout Image of Polaris

Polaris leaves the bright streak on the right. The CCD is binned vertically by 4 pixels, which causes the start region to be compressed into the top third of the frame shown here. The data below Polaris is fluctuating wildly in brightness due to scintillation, the same effect that causes stars to "twinkle". What is not obvious here is that the line is being deviated left and right as Polaris's position is perturbed by seeing. The software measures this perturbation, and automatically calculates FWHM at the zenith. The readout is fast, so a new measurement of Polaris' position is being obtained every 5 milliseconds. This is important, since too slow a rate will underestimate the seeing jitter due to exposure averaging.

The results can be very revealing. For example, at the test site, we have two kinds of clear nights. The first, most common, clear night is a two to three hour period between sunset and the fog coming in from the ocean like a wall. The

second is when we get “Santa Ana” winds off the mountains behind Santa Barbara, which is a hot wind characterized by really clear, but highly turbulent air. It can get pretty good after midnight. In Figure Five, below, a graph shows how good it got one night while monitoring with the seeing monitor. What started out as a night with rather poor seeing turned into a very good night after about 1:00 AM.

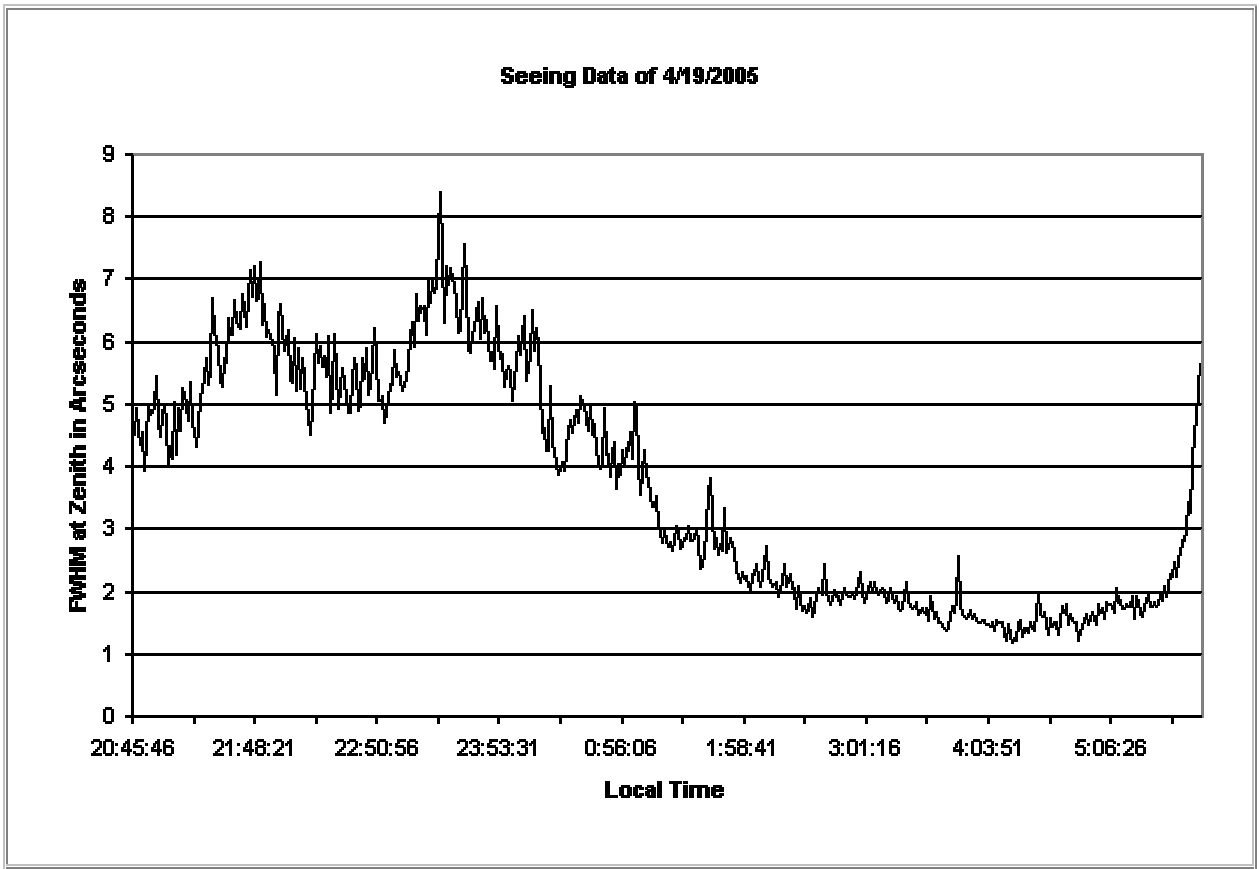
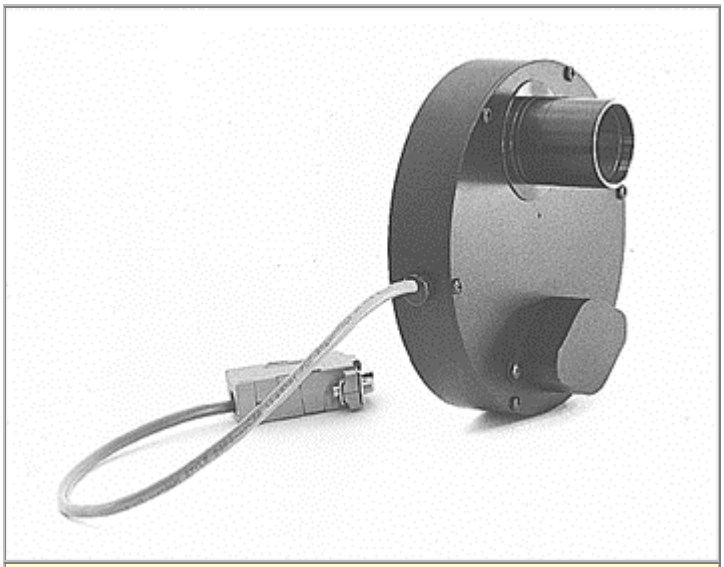


Figure Five: Excel Spreadsheet showing Seeing over a “Santa Ana” Night

This kind of information can be very helpful for remote imagers or anyone who must decide whether it is worth it to begin a nights imaging session, and if so, when. It can also signal when a night is degrading to the point that it is not longer worth the effort of continuing the next hour long series of exposures.

MODEL CFW-9
COLOR FILTER WHEEL



Model CFW-9 Color Filter Wheel

SBIG pioneered tricolor imaging for amateurs by developing hardware and software to register and color balance Red, Green, and Blue images that display spectral emission of deep space objects. When interference filters are carefully selected to match the spectral regions of ionized gases the images taken through the filters can be summed together to represent the distribution of these gases. Tricolor images are taken through the CFW-9 Color Filter Wheel and processed with CCDOPS, CCDSoftV5, or third party software. The primary color images are taken through Red, Green and Blue filters. After the images are taken they are processed with the software to co-align the Red, Green and Blue images. The co-aligned image is then color balanced on the computer monitor to become a tricolor RGB image, which can then be saved to disk. A similar process is used to make LRGB images except that a greyscale luminance image is added for detail. CCDOPS software also allows the user to perform image processing functions such as smoothing and sharpening as well as saving images in TIFF format. The raw images can also be saved in a variety of formats for export to any of the many commercially available software programs for color image processing such as Maxim DL and Photoshop.

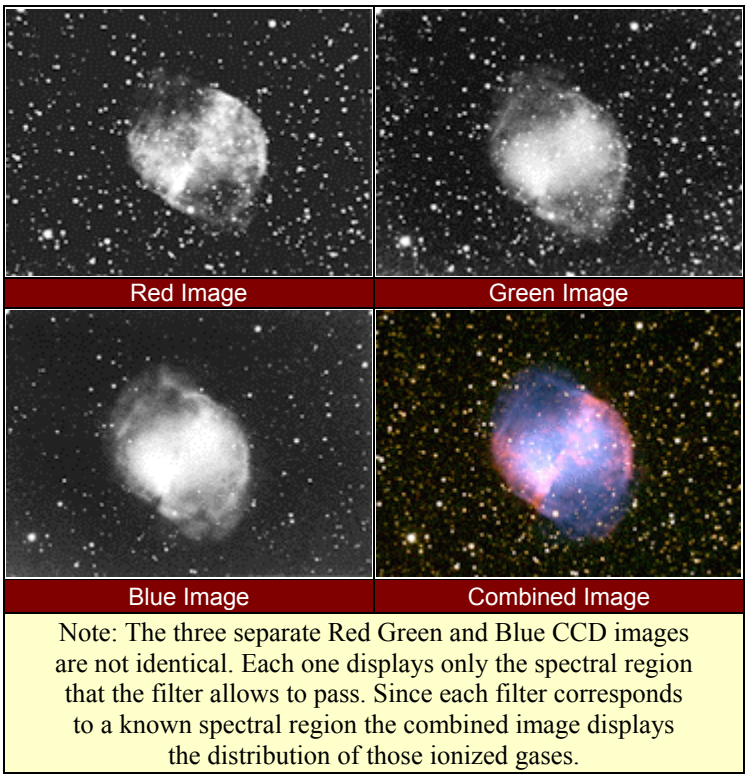
The CFW-9 system is designed to be "direct connected" to any ST-7/8/9/10/2000 imaging camera for a thinner, more rigid mounting. An optional male-to-male t-thread adapter is also available allowing easier (but less rigid) attachment and detachment for occasional use. On the front end a variety of optional

CFW-9 Attached to an "ST" Series Camera

T-Thread accessories are available including 1.25 inch and 2 inch diameter nose pieces as well as a "Visual Back Adaptor" for direct connection to SCT's. A new optional accessory is the AO adapter plate which makes it possible to firmly connect the camera, filter wheel and AO-7 without using a screw-in t-thread adapter.

The CFW-9 is operated through the CCDOPS software and utilizes a closed loop stepper motor system with positional accuracy of ±0.01 inches. It holds up to five standard 1.25" diameter thread-in filters. It is available with Red, Green, and Blue (RGB) interference filter sets and a clear filter (focusing). The new SBIG RGB filters also block Infrared (IR) so an inline IR Blocking filter is no longer required. These filters are mounted in standard size cells that normally fit into 1.25" eyepiece barrels. The CFW-9 adds back focus of approximately 1 inch. Although some examples of tricolor imaging are shown in this catalog it is difficult to display the wide range of techniques that our customers have developed. The CFW-9 can produce photographic quality tricolor images that rival color astrophotographs. However, these RGB images also contain an entirely new and added level of valuable information; the identification and

distribution of different ionized gasses in an object. SBIG also furnishes precision UBVRI filter sets with the Model CFW-9, filters that allow the user to perform color photometry to measure the classification and temperature of objects.



Red Image	Green Image
Blue Image	Combined Image

Note: The three separate Red Green and Blue CCD images are not identical. Each one displays only the spectral region that the filter allows to pass. Since each filter corresponds to a known spectral region the combined image displays the distribution of those ionized gases.

THE RGB PROCESS IN THREE SIMPLE STEPS
1. Using the CFW-8 and CCDOPS software take three images, one each though the Red, Green,and Blue filters respectively.
2. Using CCDOPS, CCDSoftV5 or third party software, register the three images and color balance them on the computer monitor.
3. Combine the RGB files to create a tricolor image.

Model CFW10 and CFW10-SA Filter Wheel

CFW-10 Ten-position Filter Wheel

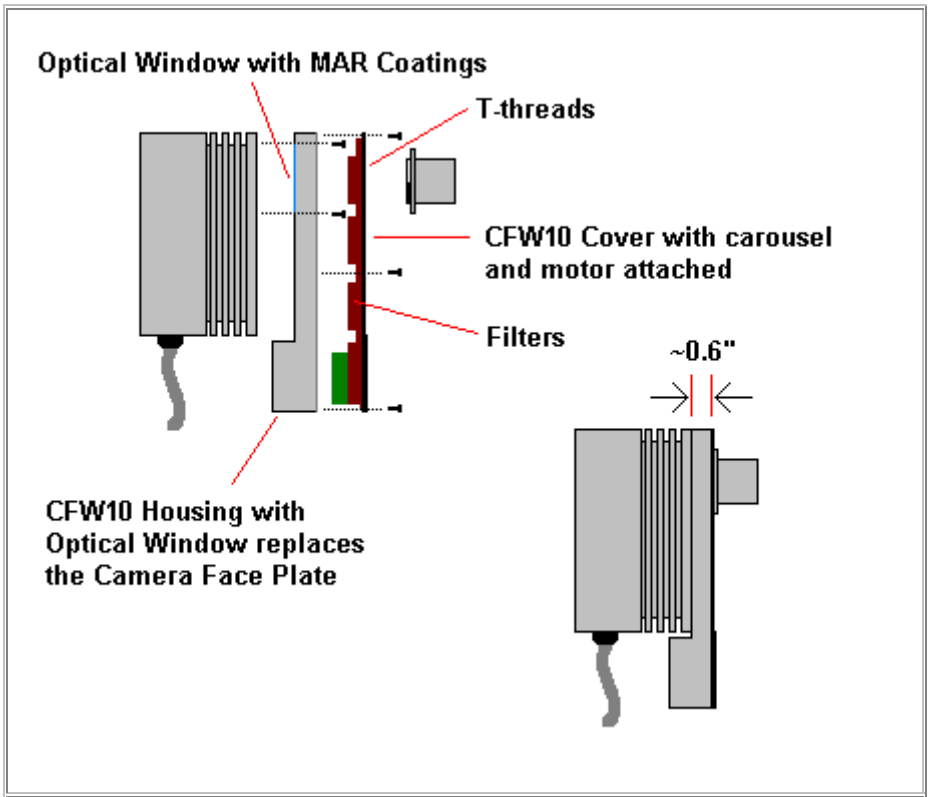
The new CFW10 is a ten-position filter wheel designed for the USB version of our ST camera series or any camera where a serial port is available for controlling the wheel. The CFW10 accepts control input via either the I2C port or the RS232 serial port. When attached to an ST-7/8/9/10/2000 USB camera, the filter wheel receives power and control commands through the I2C accessory port of the camera - no additional power or cable to the computer is required. The stand-alone version, CFW10-SA, is for use with other cameras, the filter wheel is controlled via an RS232 serial port and is powered by an external 12VDC power supply. The filter slots are threaded for standard 1.25" filters.

The portion of the housing between the camera and the telescope is only about 3/4" (20mm) thick for minimum back focus. Two versions of the housing make it possible to use the CFW10 either as a separate unit, or as an integral piece replacing the face-plate of the ST series camera. The replacement version contains a high quality optical window with superior AR coatings. By using the filter wheel housing as a replacement face plate for the camera, an additional 1/4" (6mm) in back focus is eliminated and normal 35mm camera lenses may be used with the filter wheel in place.

The front aperture of the CFW10 contains standard t-threads. A custom camera lens adapter will be available for commonly available 35mm Nikon, Canon, Olympus and other lenses. For attachment to the telescope, a 1.25" nosepiece (shown) or 2" nosepiece may be used, or a t-thread to visual back adapter for more secure fit to Schmidt-Cassegrain scopes. For other scopes, any adapter with male t-threads can be used to secure the filter wheel.

The CFW10 will be offered in addition to the CFW8A as an option for any ST series camera. It should be noted, however, that the CFW10 will not work with

older parallel cameras unless one has an available serial port on the computer to control the CFW10 through a separate serial cable.



CFW10 Exploded View - Thickness is approximately 0.6" when attached to camera in lieu of the camera's face plate, and approximately 0.76" when attached over the camera's face plate. CFW10 cover is removed for access to filters without opening the camera cavity in either configuration.

Filters for RGB and LRGB Color Imaging, Narrow Band Imaging and Photometry

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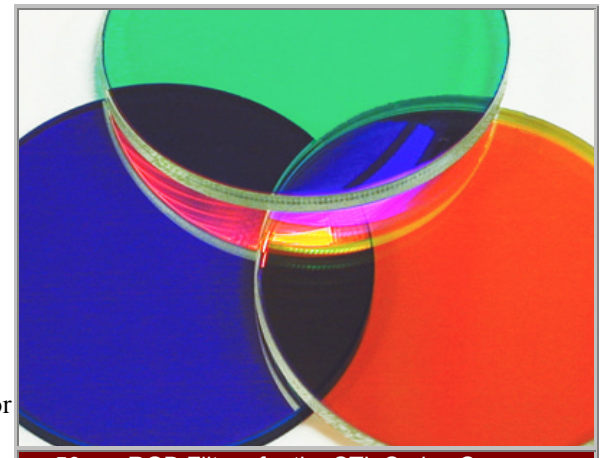
Many of the best astro images seen in Sky & Telescope and Astronomy magazine are taken with monochrome CCD cameras and color filters using RGB or LRGB combination techniques (L=luminance, R=red, G=green, B=blue, C=clear). A luminance filter typically blocks UV and IR light, passing only the same wavelengths as the RGB filters. A clear filter does not block UV or IR but is used for maximum signal transmission over the full range of the CCD. By taking separate images through custom filters, and combining the results to make an RGB image, the full resolution of the CCD is utilized and a great deal of latitude is preserved for image processing.



50mm RGB Filters for the STL Series Cameras

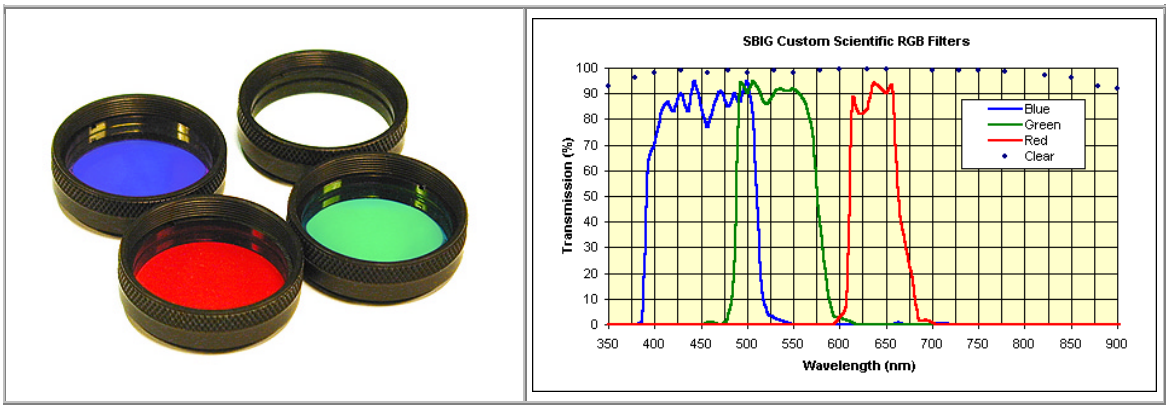
In addition to traditional Red, Green and Blue filters, some astro imagers combine H-alpha with RGB to enhance the appearance of emission nebula. Narrow band filters may also be used exclusively to create dramatic "Hubble like" false color images of emission nebula. Some of the most beautiful images taken of large emission nebula are simple monochrome images taken through an H-alpha filter. One of the benefits of narrow band imaging is that light pollution and sky glow is suppressed by the narrow band filters. With the right filter, it is possible to capture detailed images of emission nebula from one's backyard in the middle of the city under the light of a full moon!

1.25" Filters:	1.25" Filters	50mm Filters:
Custom Scientific RGBC Filter Set	**Astrodon LRGBCH-a Filter Set**	**Custom Scientific LRGBC Filter Set**
Custom Scientific H-alpha Filters	**Astrodon H-alpha, [O-III], [SII] Filters**	**Custom Scientific H-alpha Filters**
Custom Scientific UBVRI Filter Sets	**Baader UV / IR Blocking (Luminance) Filter**	**Custom Scientific UBVRI Filter Sets**

Those studying variable stars and performing other photometric measurements use standardized UBVRI or BVI filter sets to record their observations. These photometric filters have evolved over the years to provide results that are as close as possible to the measurement obtained with earlier instruments such as the photometer.

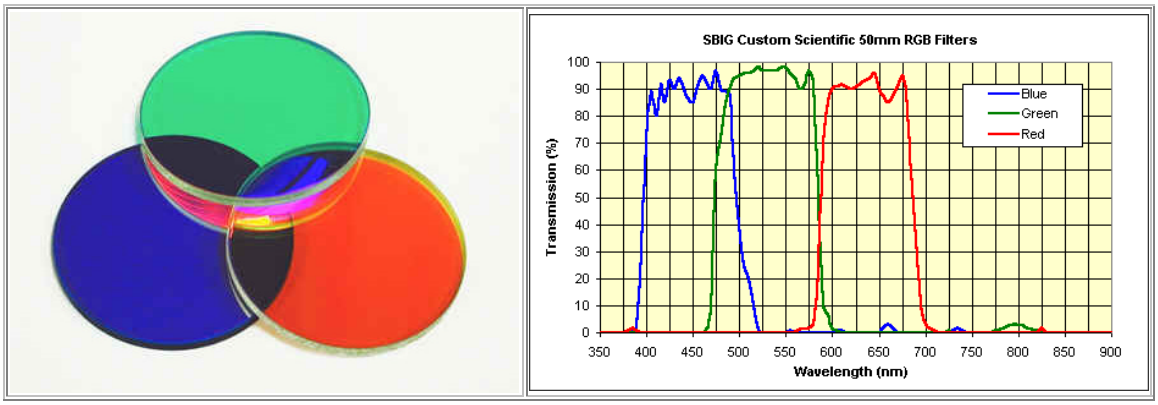
All of the filters described below are of the best quality. The RGB sets are dichroic filters designed for the highest transmission. The passbands are carefully designed for SBIG cameras. Our Custom Scientific RGB filter set is designed for excellent all around use with an accurate balance of emission sources and continuum light. In the case of the Astrodon filters, where the goal was equal exposure times, there is a different set for cameras using interline CCDs and those using full frame CCDs due to the different response curves of the two types of CCD. One benefit of the Astrodon filters is that they are parfocal with Astrodon narrow band filters and the full set of LRGBCH-a [OIII] [SII] can be used in our CFW10 ten-position filter wheel without having to refocus between filter changes.

Custom Scientific 1.25" RGBC 4 filter set:



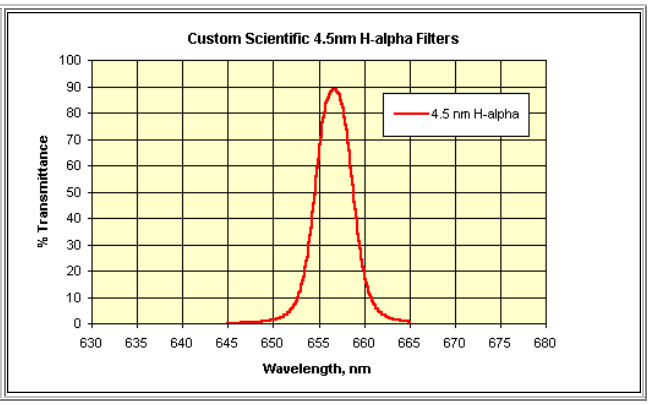
This RGBC filter set is the standard SBIG set that comes with the CFW8A filter wheel and is intended for use with the ST-7/8/9/10/2000 cameras. The set is also available separately. It is designed to give a proper balance of continuum light from stars and proper ratios of H-alpha and [O-III] emission line sources (e.g., bright nebula and planetary nebula) at the same time. These professional quality, high transmission, dichroic filters have been tested over time by some of the best astro-imagers in the world. Many of the remarkable images seen in the gallery of Sky & Telescope and Astronomy magazines have been taken with this filter set and an "ST" series camera. The colored filters are parfocal, antireflection coated and IR blocked. The clear filter is AR coated.

Custom Scientific 50mm LRGBC five-filter set



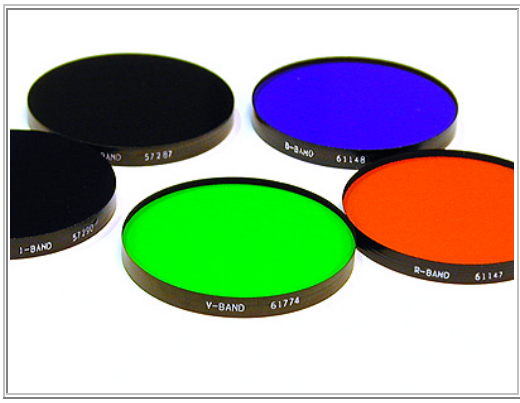
This LRGBC five filter set for the STL series cameras is designed to drop into the STL filter carousel without vignetting the largest (35mm format) CCD in the series. The STL carousel is threaded for 48mm ("2") filter cells as well, but the full 50 mm diameter of these filters provided the maximum aperture for the large format CCDs. For this reason they are supplied without threaded cells. Like the smaller Custom Scientific RGB filters, this 50 mm filter set is professional quality, antireflection coated, IR blocked. The Luminance filter is UV and IR blocked to match the RGB cutoffs, it is also AR coated. The clear filter is AR coated only.

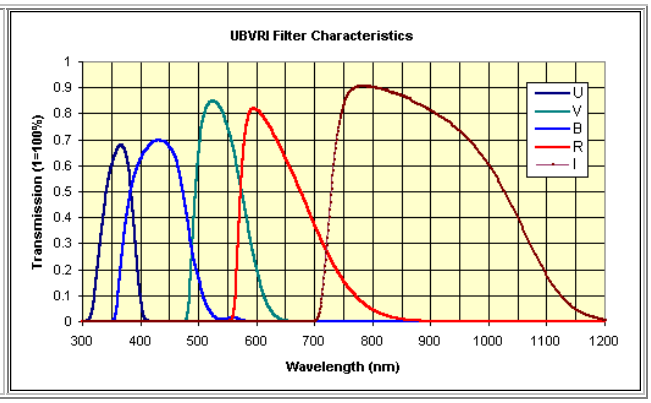
Custom Scientific 1.25" and 50mm H-alpha Filters



SBIG offers two versions of H-alpha filter from Custom Scientific, a relatively narrow 4.5 nm filter and a wider 10 nm filter. Both are available in either 1.25" size or 50 mm size. The smaller 1.25" filter fits in the CFW8A or CFW10 filter wheel and is suitable for the ST-7/8/9/10/2000 cameras. The 50mm size fits in the STL carousel and is suitable for any of the large format STL series cameras. The benefit of the narrower 4.5nm filter is greater suppression of sky background and light pollution. Very detailed images of faint H-alpha nebula can be faithfully captured even when imaging in heavily light polluted skies or under the glare of a full moon. The 10nm filter is also very good at suppressing light pollution, but not quite as good as the narrower 4.5nm filter. The 10nm filter is better for darker skies, and it is also less expensive than the 4.5nm filter.

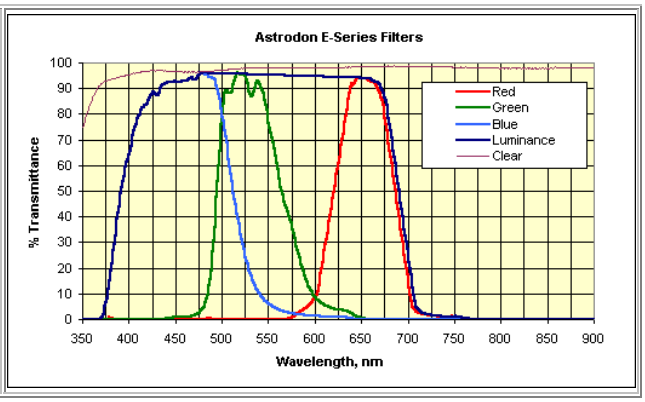
Custom Scientific 1.25" and 50mm UBVRI Photometric Filters





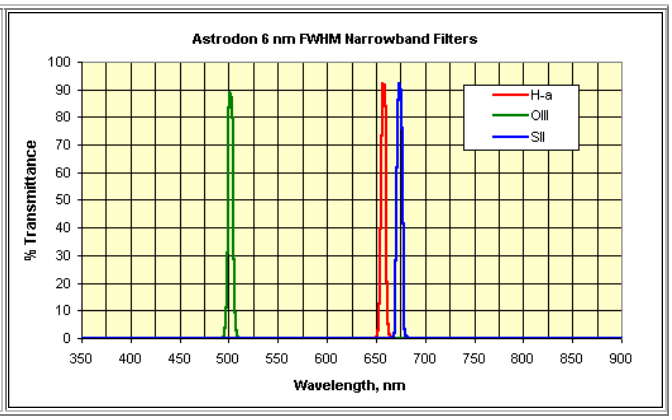
In the 1950's Harold Johnson (Yerkes and Macdonald Observatories) established three photometric bands, the U, B, and V based on the sensitivity of the photomultiplier tube that he used at the time. Later on he established red and infrared (R and I) bands using a PMT with enhanced red sensitivity. In the mid-1970's, A.W.J. Cousins and John Menzies (South African Astronomical Observatory) used different filters, that when used with a newer, better detector, would reproduce the Johnson bands. Then, in the 1980's CCD detectors were beginning to replace the photomultipliers so a new set of filters was required that, when used with the CCD's would give the same results as the older filters when used with the PMT. Bessell (Mt. Stromlo and Siding Spring Observatories in Australia) did this in 1990 (PASP, 102, 1990, 1181). It is Bessell's filter definitions that are the industry standard today when using CCD's. These professional quality, polished, AR coated, photometric filters are available in both 1.25" and 50mm sizes.

Astrodon 1.25" LRGBC plus Narrowband Filter Sets



This "expanded" color imaging set from Astrodon is a new entry for SBIG. In May of 2005 we began delivering our new CFW10 ten-position filter wheel for the ST-7/8/9/10/2000 cameras. This filter wheel lets the user put a variety of filters in the carousel and not worry about which ones might be needed at a given time. For maximum flexibility both a Luminance and a Clear filter are included in the Astrodon sets. A parfocal H-alpha filter rounds out the expanded set. Many imagers prefer to take H-alpha images along with RGB images and combine them using the H-alpha frame as one color channel or as the luminance layer. This process of capturing H-alpha at the same time as the rest of the RGB frames is made much easier if the process can be automated. Astrodon filters, RGB and narrow band, are all parfocal. This eliminates the need to refocus between any filter, even the H-alpha filter, when automatically capturing a sequence of images and it makes them ideal sets for the larger 10 position filter wheel. Individual narrow band, [O-III] and [SII] can be added later, or a "Super Set" can be ordered that includes all 8 filters. These are also parfocal with the rest of the Astrodon line. SBIG offers two sets of Astrodon filters: A 6 piece "Expanded" Color set consisting of LRGBCHa, and an 8 piece "Super Set" consisting of: LRGBCHa [O-III] [SII]. These Astrodon filters are currently available from SBIG only in 1.25" size. The "E" series is designed for the ST-7/8/9/10E/ME cameras, and the "I" series is designed for the ST-2000XM camera.

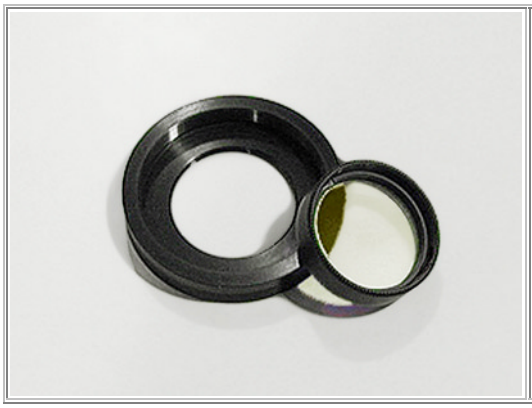
Astrodon 1.25" Narrowband Filters

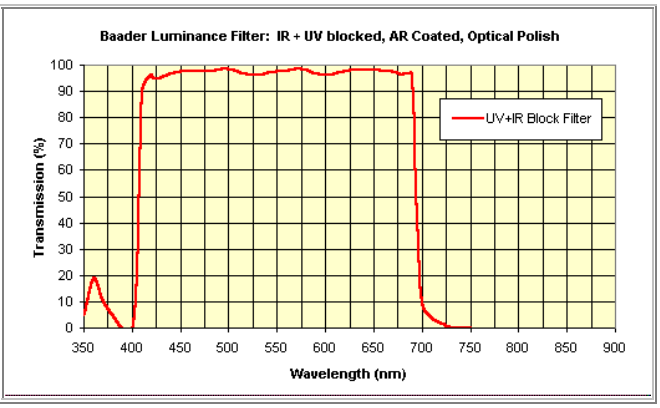


The three narrow band Astrodon filters included in the "Super Set" are [O-III] (500.3 nm), H-alpha (656.3 nm), and [SII] (680.nm). These passbands are chosen by amateurs most often because of the abundance of emission nebula containing some or all of these emission lines. Narrow band filters are designed to pass

the emission line wavelength while rejecting other wavelengths outside the filters passband. This makes them very effective at suppressing light pollution. Some imagers restrict their imaging to only these narrow bands, assigning a "color" (R,G and B) to each filter in order to create a false color image. The most famous example of such a false color image is probably the Hubble Space Telescope's "Pillars of Creation." Each of these narrow band filters has a 6 nm passband, and each is parfocal with the other Astrodon RGB filters.

Baader 1.25" UV / IR Blocking Filter

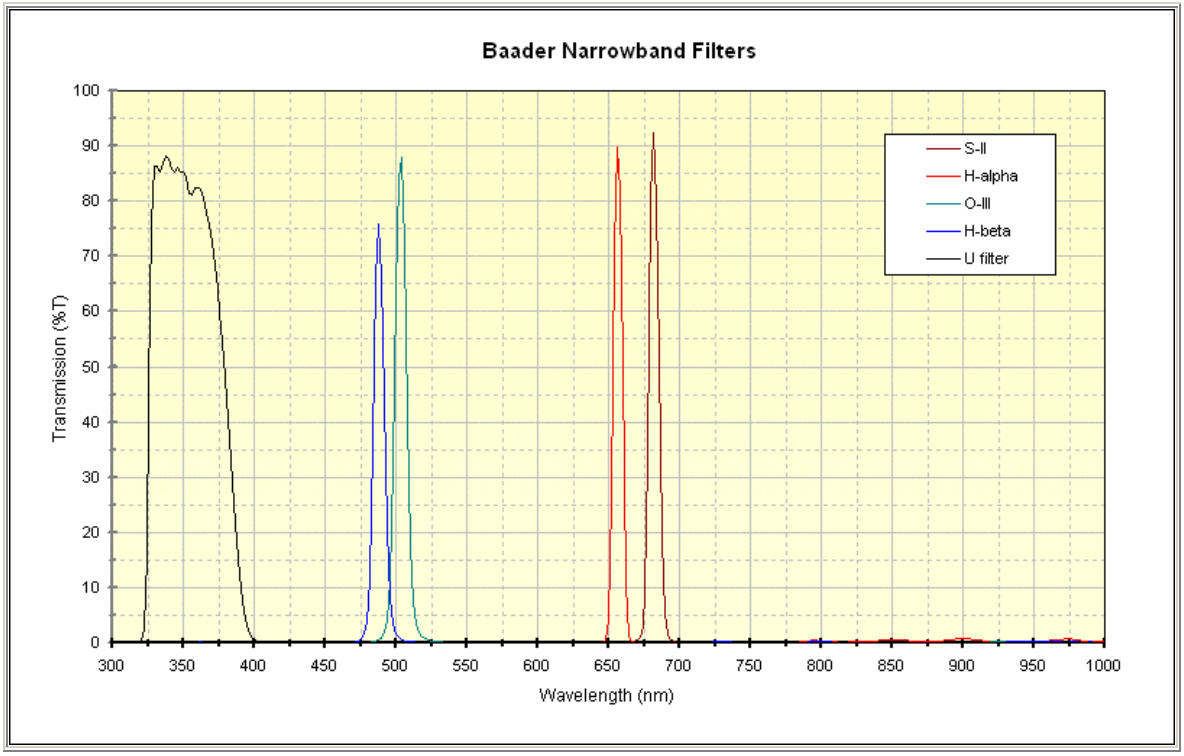




The Baader UV / IR blocking filter is essentially a luminance filter. It is included with ST-2000XCM color cameras to improve the color balance of the single shot color CCD by blocking the near IR light. It is shown here along side the optional T-ring with filter threads for use on any ST cameras. It can be placed behind a camera lens adapter and used to block the out of focus near IR light that causes stars to look bloated with using a typical 35mm camera lens to shoot wide field images.

BAADER NARROWBAND FILTERS

SBIG is pleased to offer a custom set of Baader narrowband filters for the ST and STL cameras effective as of this announcement. SBIG and Baader Planetarium, Mamendorf, Germany, have enjoyed a longstanding relationship. Some accessories for the ST and STL cameras have been made by Baader for SBIG over the years, including the UV/IR cut filter that we supply with every single-shot color camera for optimum color balance. Now, this relationship translates into incredible savings for SBIG customers. Baader Planetarium has developed a set of narrowband filters in in 1.25" and 2" sizes. The 2" filter is specifically made for the STL series cameras in the 50.8mm (2" unmounted) size for the STL filter carousel. These drop in both the 5 position and 8 position filter wheels for the maximum clear aperture in a 2" filter for our large 11000 CCDs. Moreover, these new narrowband filters are the same thickness as our standard 50.8mm LRGBC set making them all parfocal for the STL models. Each filter is made of high quality substrate, polished to yield 1/4 wave flatness or better, with hard multiple anti-reflection coatings on both sides. The narrowband filters are available in a 7nm wide H-alpha filter, 8nm wide H-beta filter, 8nm wide OIII, and 8.5nm wide SII. In addition, there are some specialty filters such as an IR pass filter and a U filter ("Venus" filter). The narrowband filters typically have around 90% peak transmission at the design wavelength. These filters are also available in 1.25" sizes for ST series cameras, in threaded cells for the CFW8A, CFW9 and CFW10 filter wheels. Note, however, that due to the different thickness of the smaller 1.25" RGBC filters the narrowband filters are not parfocal in the smaller size at this time. The remarkable news is that a set of the 3 most commonly used narrowband filters (H-alpha, OIII, SII) is available for under $400 for the ST cameras (1.25" size), and under $900 for the STL camera (50.8mm size)!



The IR-Pass filter blocks wavelengths below 670 nm. At these longer wavelengths, planetary images are less disturbed by wavefront distortions in the atmosphere. By combining a luminance image taken with the IR-Pass filter, along with RGB frames, overall image sharpness is significantly enhanced. Some of the world's best amateur planetary images have been taken with this technique. This filter is available only in 2" OD threaded cell (48mm threads).

The latest coating technologies permit the Baader U Filter (Venus Filter) to transmit from 300nm to 400nm, with a peak transmission of 80%! The filter completely blocks the rest of the region from 200nm to 1500nm, through the use of a complex 20 layer dielectric coating stack, on top of a special UG-11 substrate. Up till now, Amateur efforts typically relied upon deep violet colored filters, or combinations with simpler interference filters, which do not provide the high transmission and efficient rejection outside the important spectral region from 320nm to 390nm. Given the poor transmissions of many optics in the UV and the lower sensitivity of some CCDs to this wavelength, high filter efficiency and complete rejection at longer wavelengths becomes paramount to recording good contrast at reasonable exposures. The same high optical quality and features as the other Baader filters ensures the highest contrast and sharpest images possible. Interestingly, the solar Calcium K-Line is also within the pass band of this filter. This opens up the exciting possibility

for recording flare structures on the solar disk or edges. This filter is available only in 2" OD threaded cell (48mm threads

Baader's innovative new designs and features, together with the very latest thin film coating technologies, result in outstanding performance, efficiency, and image quality. Baader filters are unique, in that they utilize true optically polished flat substrates. Ultra-thin precision cells deliver the maximum clear aperture and minimize vignetting. Ion beam hardened coatings ensure your filter will withstand real-world use and repeated cleaning - they are tough enough to survive boiling water!

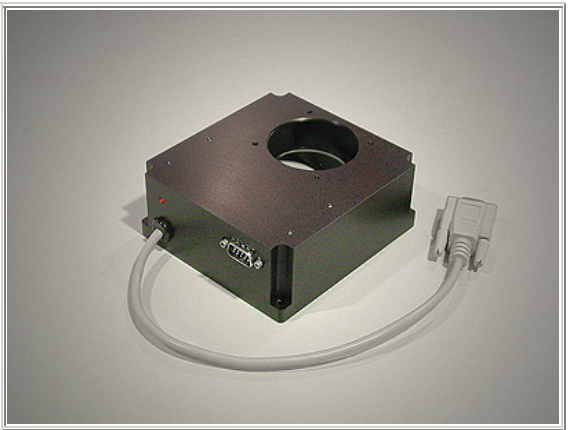
Baader Planetarium filters are made from striae-free substrates, and actually fine optically polished flat to within 1/4 wave p-v over the entire surface, plane parallel to within 30 seconds of arc. This important and unique custom step adds cost - but the result is a filter that maintains the full wavefront quality of the telescope without double images or ghosting, even at high magnifications. Critical to maintaining this level of flatness are Baader's carefully balanced coating designs, which prevent coating surface stresses from warping the substrate. Such high flatness enables Baader filters to be used far in front of the focal plane, ahead of star diagonals.

Durability has always been a hallmark of Baader Planetarium. The multi-layer dielectric coatings are plasma assisted and Ion beam hardened using the latest technology (the coatings are harder than the glass substrate itself!). Baader filters withstand repeated real-world exposure to the elements and physical cleaning. Users need not leave their precious filters dull and dust encrusted to avoid cleaning - Baader filters may be used and cleaned without fear. Baader Filters will truly last lifetimes.

Baader's special filter cell design offers unique features that enhance their reliability and usability. Though difficult to produce, the ultra-thin filter cell results in the maximum possible clear aperture, in order to minimize vignetting (1¼" Filter clear aperture is 27mm!). The special threading has been designed to fit the wide variety of eyepieces and accessories (there is significant variation between the 1¼” filter threading used by eyepiece and accessory manufacturers). The front 'crown' of the filter incorporates milled notches which make handling and threading the filter a more secure operation in the dark.

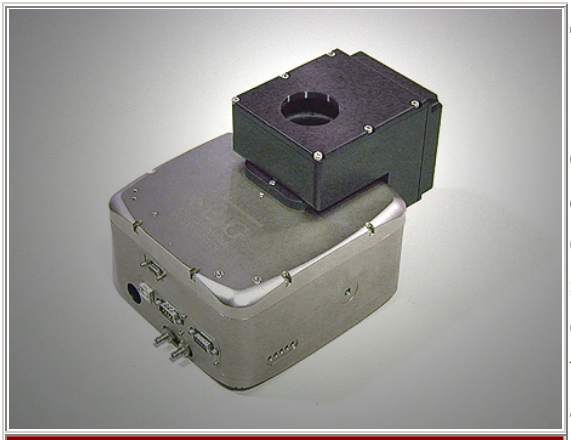
Despite the high quality and advanced technology, Baader Planetarium filters are affordable. By leveraging high volumes across all filters in the Baader family, these filters can be offered at very reasonable prices.

MODELS AO-L and AO-8 ADAPTIVE OPTICS



Model AO-8 Adaptive Optics System for ST Series Camerashed

The AO-L and AO-8 are second generation adaptive optics systems from SBIG specifically designed to enable an SBIG camera user to obtain the ultimate in image resolution that his/her telescope and site can achieve. The AO-L is designed for the STL series cameras. The AO-L can also be used with any ST-7/8/9/20/2000 USB camera with the appropriate adapter kit. The smaller AO-8 is a replacement for the former AO-7 and can only be used with ST-7/8/9/10/2000 USB cameras. Both of these units get power and commands directly from the camera via a short cable to camera's I^2C port. No other external cables are required for power or control. Both units have an I^2C output port as well so they are fully compatible with other I^2C accessories that you might add to the system, such as a CFW9 or CFW10 filter wheel.



Model AO-L Adaptive Optics System Attached to STL Camera

TIP-TILT HIGH SPEED GUIDING

SBIG has exploited the second guiding CCD detector in our self-guiding cameras to stabilize stellar images, enhancing resolution. These new AO systems use a tip-tilt transmissive element to correct for image wander due to low order local atmospheric effects and for correction of mount errors, wind vibration and other erratic motion of the optical system that is otherwise too fast for an autoguider or telescope drive corrector to respond to effectively. By monitoring a guide star with the smaller tracking CCD that is built-in to SBIG cameras, or the Remote Guide Head, the AO makes fine corrections at approximately 10 times per second to hold the image fixed on the CCD during the exposure.

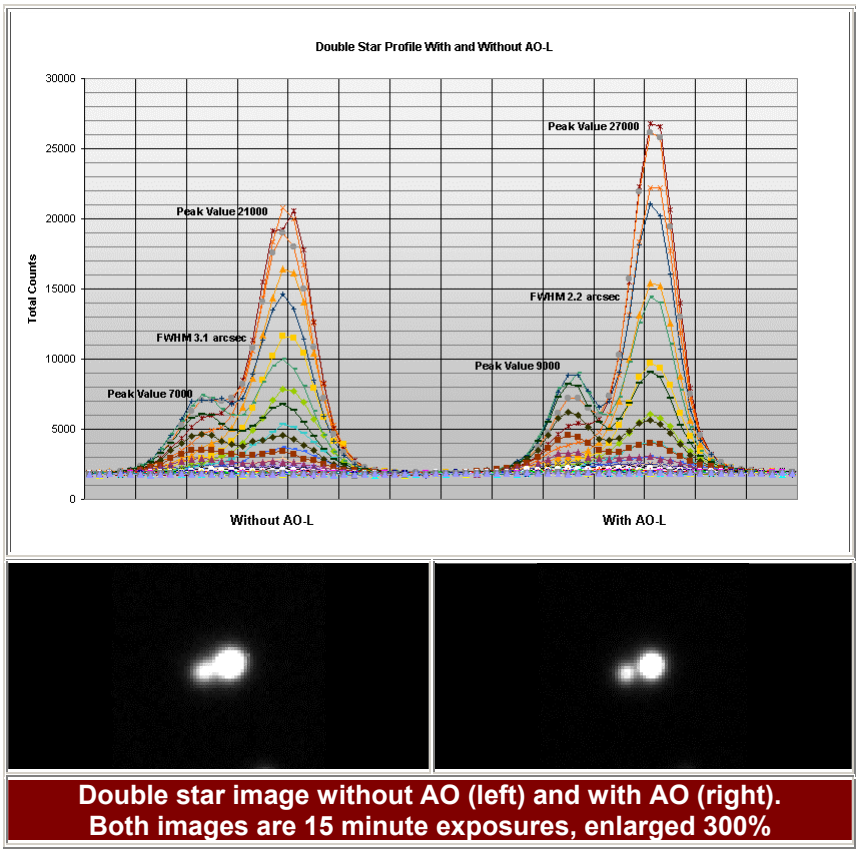
The system is closed loop, which means that it checks the position of the guide star after every move and makes adjustments on the next move. This results in a series of small, fast and very precise moves that continue over the course of a long exposure. This is possible because the guide chip is located behind the AO device and can measure the results of each move it makes. In the past, with the AO-7, this presented some difficulties when using narrow band filters because light from potential guide star candidates was attenuated by the narrow band filter to one degree or another resulting is guide stars that could be difficult to find or too dim to use. However, the new AO design and new camera improvements eliminate this problem. Because of their more compact design, the new AO systems lend themselves to the use of off-axis guiders that can place a pick-off mirror or diagonal in front of the filter wheel. Also, all new USB cameras support a Remote Guide Head that essentially places the on-board guiding CCD anywhere in front of the filter wheel the user decides and this Remote Guider duplicates all the functions of the built-in tracking CCD, including the fast readout function required to control the AO. This means that by using a custom off-axis guider, one can still have all of the benefit of the AO no matter what filter is being used, even filters that make starlight nearly invisible to the imaging CCD

Another benefit of the new AO design is that they take up far less backfocus. The former AO-7 required about 3.5 inches of backfocus and placed the camera at right angles to the optical system. Inserting an off-axis guider or other pick-off mechanism added even more backfocus. However, the AO-L and AO-8 require only about 2 inches of backfocus (when attached directly to the camera) and leave the camera square in the optical path. Additionally, the transmissive element of the new AO design has a relatively large range of motion. In the AO-8 for example, the range of correction is roughly +/- 40 pixels. Assuming one is imaging at approximately 1 arcsecond per pixel, this means the AO-8 can correct for up to about 40 arcseconds of periodic error in the telescope mount. Since most modern mounts with PE error correction are capable of reducing any residual periodic error within this range, it is possible to guide long exposures with the AO-8 without making any guiding corrections to the mount at all. Guiding in this manner is also far more accurate than can be achieved by issuing corrections to the telescope drive. The tilt of the element during operation does not lead to any image rotation or measurable defocusing at the edges of the frame, even when relatively large ranges of correction are required from beginning to end of the exposure. If the image drifts slowly during the exposure due to Periodic Error or slight misalignment of the mount, the AO can continue to operate without having to issue any corrections to the mount to re-center the guide star. This larger range of motion is one more

advantage of the AO-8 over the earlier AO-7 design which worked best when making corrections within a narrower range, requiring mount calibration and interaction.

RESULTS

The results one can achieve with the AO-L or AO-8 depends on a number of factors and no two imaging sites are exactly the same. However, many years of experience with the former AO-7 and now the AO-L make it clear that SBIG's implementation and design of a closed loop AO offers a distinct advantage in image resolution, even when one has superior optics, mount and calm seeing. Take for example the test images below of the same double star captured with and without the AO-L operating. The brighter star is approximately mag 14.7 and the dimmer star is approximately mag 15.7. Separation is approximately 3.7". Two 15 minute images were taken one right after the other on the same night with an STL-11000M-C1 camera through a 20" F/8.3 RC scope mounted on a Paramount. The AO-L image clearly shows a tighter, brighter, better resolved stars compared to the non-AO image. The AO improved the measured FWHM (Full Width at Half-Maximum) and peak brightness of both stars by nearly 30%.

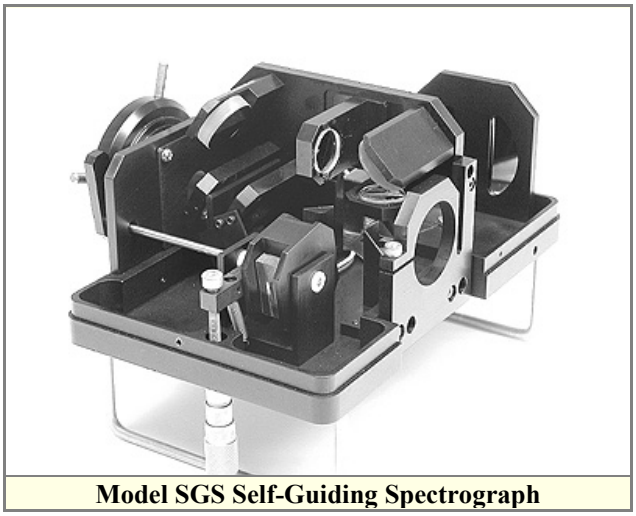


Double star image without AO (left) and with AO (right). Both images are 15 minute exposures, enlarged 300%

In the case of a mount with an erratic drive error the results can actually be more dramatic. Some imagers have told us that without the AO it was virtually impossible to obtain high quality images without some star trailing due to the behavior of their mount or drive system. But by adding the AO, it was like upgrading to a nearly perfect mount and drive yielding untrailed star images in long exposures.

The AO-8 systems can be installed by the user to any dual sensor ST-7/8/9/10/2000 USB cameras. The AO-L can be installed by the user to any STL camera, and to any dual sensor ST-7/8/9/10/2000 USB cameras. A USB camera equipped with the optional Remote Guide Head is required to use either AO with an off-axis guider. This remarkable system has had a profound effect on CCD imaging by reducing the atmospheric turbulence, wind induced vibrations, and eliminating the remaining periodic errors in most telescope drives. Some of the best, high resolution images we have seen produced by amateur astronomers have taken advantage of the AO technology introduced by SBIG.

Model SGS Dual CCD
Self-Guiding Spectrograph



Model SGS Self-Guiding Spectrograph

The Self-Guiding Spectrograph is designed to be used with the ST-7XE/XME camera. For convenience, it can also be used with any dual sensor ST/7/8/9/10/2000 camera, but there is no advantage in bandwidth when using the larger format cameras. The spectrometer and camera body are coupled and mounted as a unit onto the telescope. The system is quite handy for collecting spectra since both the object of interest and the spectrometer entrance slit are simultaneously imaged onto the tracking CCD, allowing the object to be viewed and accurately placed onto the slit. The slit is backlit by an LED during the setup so it clearly shows on the tracking CCD. Once the object is maneuvered onto the slit, self guiding will then hold the object on the slit. The object that is to be analyzed is viewed on the tracking CCD, simultaneously with the slit. The slit is backlit by an LED during setup to render it clearly visible on the tracking CCD. The object is manually maneuvered onto the slit using the telescope controls, and is held there using SELF GUIDING during a long exposure. The spectra is recorded by the imaging CCD, oriented long-ways so the spectra falls across 763 pixels, with a height of about 16 pixels for stellar sources. Two gratings and two slits are available for maximum versatility. The standard grating, 150 rulings per mm, gives a dispersion of 4.3 angstroms per pixel, and allows the user to capture the entire interesting range from the calcium H and K lines to H-Alpha with a single exposure. Depending on the slit size, the resolution will be 10 or 38 angstroms per pixel. An interchangeable high resolution grating can also be used that gives 1.07 angstrom per pixel dispersion, with a resolution of about 2.4 angstroms when used with the narrow slit. The spectral range is smaller, being only about 75 angstroms. This resolution is adequate to detect the Doppler shift due to the earth's motion around the sun when carefully calibrated, and detect spectroscopic binaries.

Overview of SBIG's Self-Guided Spectrograph Capabilities	
Measure Stellar Spectra: ***- Determine spectral class*** ***- Measure radial velocities***	Figures 2, 3, 9, 10
Measure Emission Nebula: ***- Determine spectral lines*** ***- Measure relative line strengths***	Figures 4, 5
Measure Galactic Objects: ***- Measure radial velocity (red shift) of brighter galaxies*** ***- Distinguish quasars from other objects***	Figures 6, 7, 8

Identify Stellar Spectral Class

Spectrum of B Class Star

Spectrum of G Class Star

Spectrum of M Class Star

Figure 2
Sample Stellar Spectra

Measure Stellar Radial Velocities

Stellar Radial Velocity of Selected Stars Measured to +/- 6 km/sec with 8" SCT		
Star	km/sec*	If you face the celestial equator, straight south at sunset, you are looking BEHIND the earth in orbit (the wind is against your back)!
ATAU1	88	
ATAU2	88	
ATAU3	95	
AORI1	54	
AORI2	51	
AORI3	56	
GLEO1	-15	
GLEO2	-30	
GLEO3	-14	
**** Uncorrected for earth's orbital velocity***		

Measure Emission Nebula

The spectra of M57 below was obtained using the low resolution grating and the narrow slit:

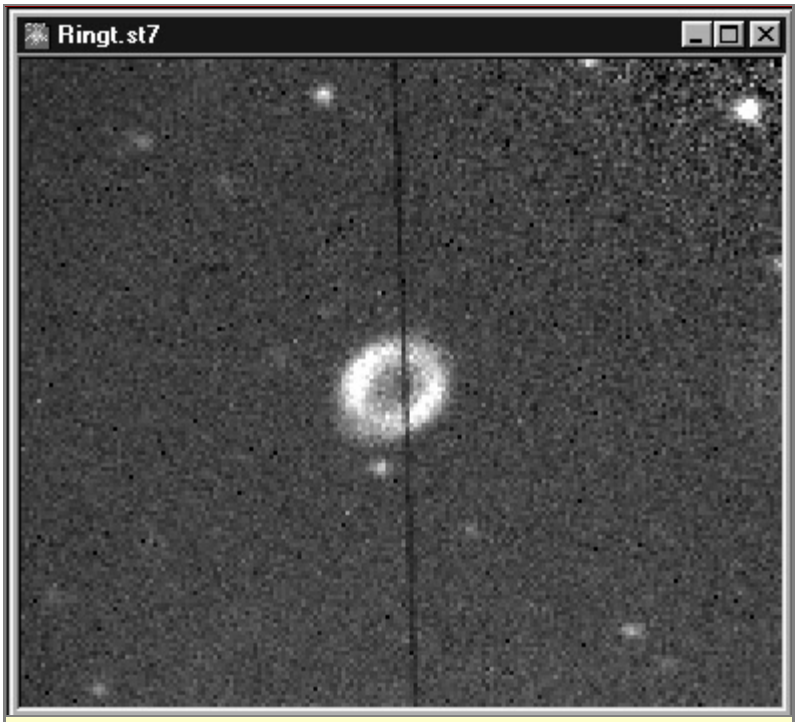


Figure 4

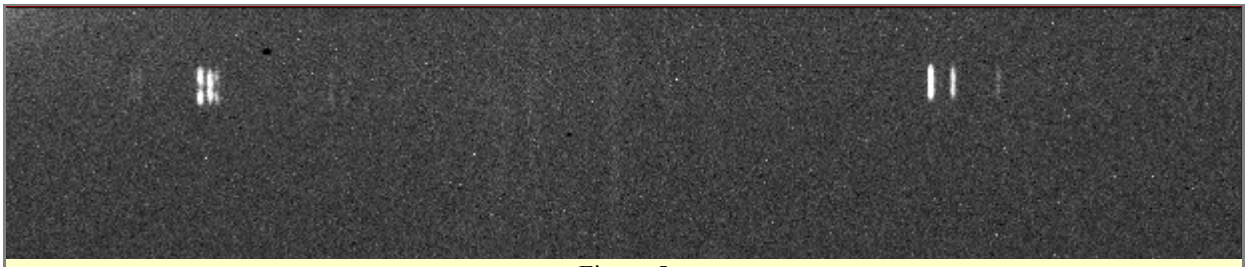


Figure 5
The top image (Figure 4) is a screen shot showing the view of the tracking CCD displaying the slit and the object (M57) simultaneously. The lower image (Figure 5) is a screen shot showing the view of the imaging CCD with emission lines from M57.

Measure Galactic Objects and Distinguish Quasars

The self-guiding feature of the ST-7/8 camera makes taking long exposures relatively painless and helps to keep the object centered on the slit for extended periods of time. This technique is necessary if one attempts to measure the red shifts of galaxies of emission lines of quasars. The samples below of M104 show the red shift of the galaxy relative to the star Mu UMA:

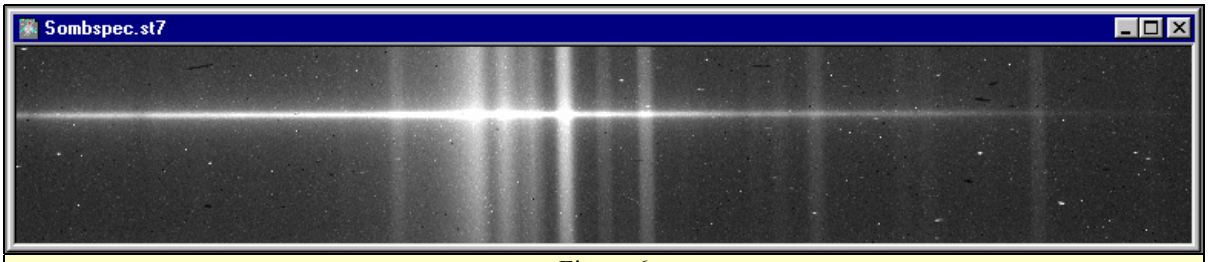


Figure 6
Screen shot of spectrum obtained of M104, The Sombrero Galaxy
(The many small white spots are cosmic ray hits)

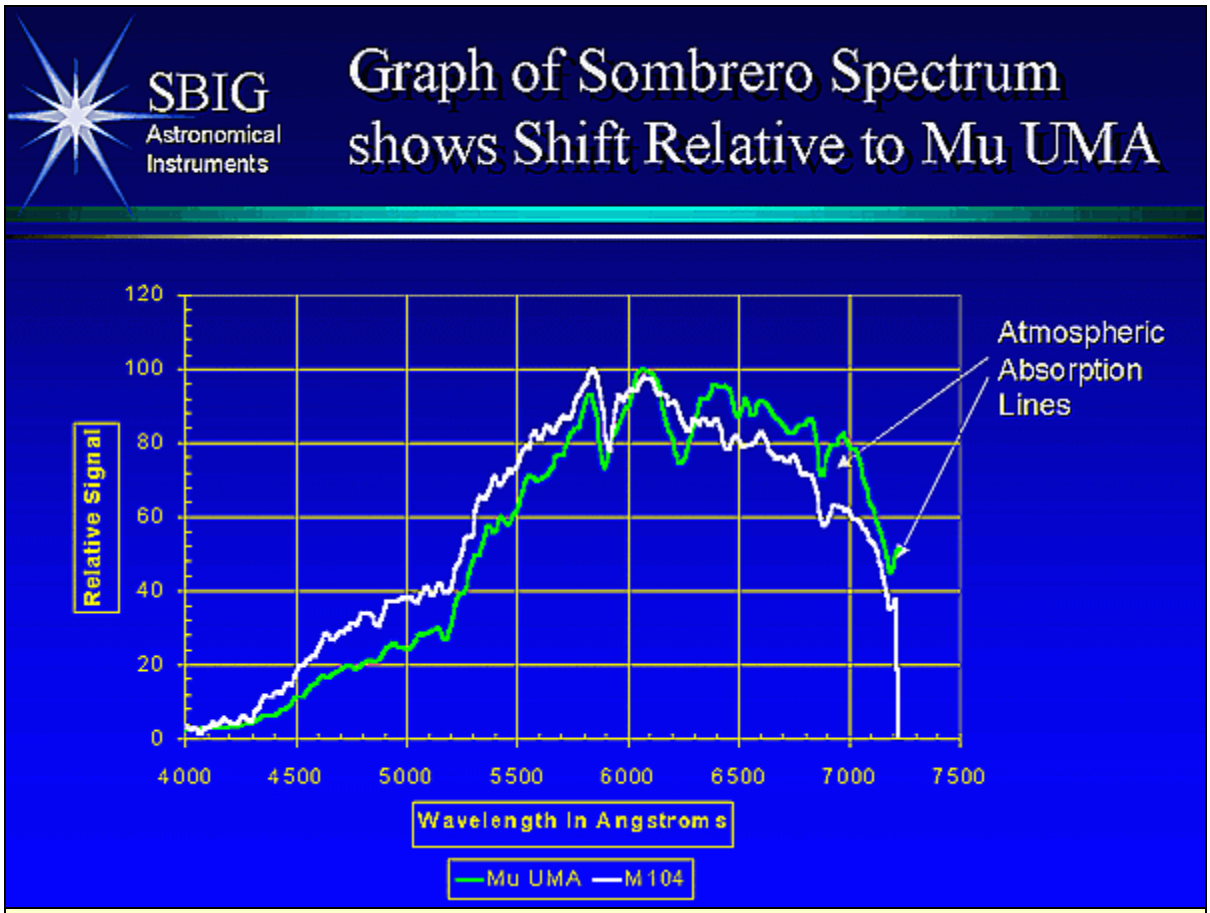


Figure 7
Graph showing the measured red shift of M104 relative to Mu UMA

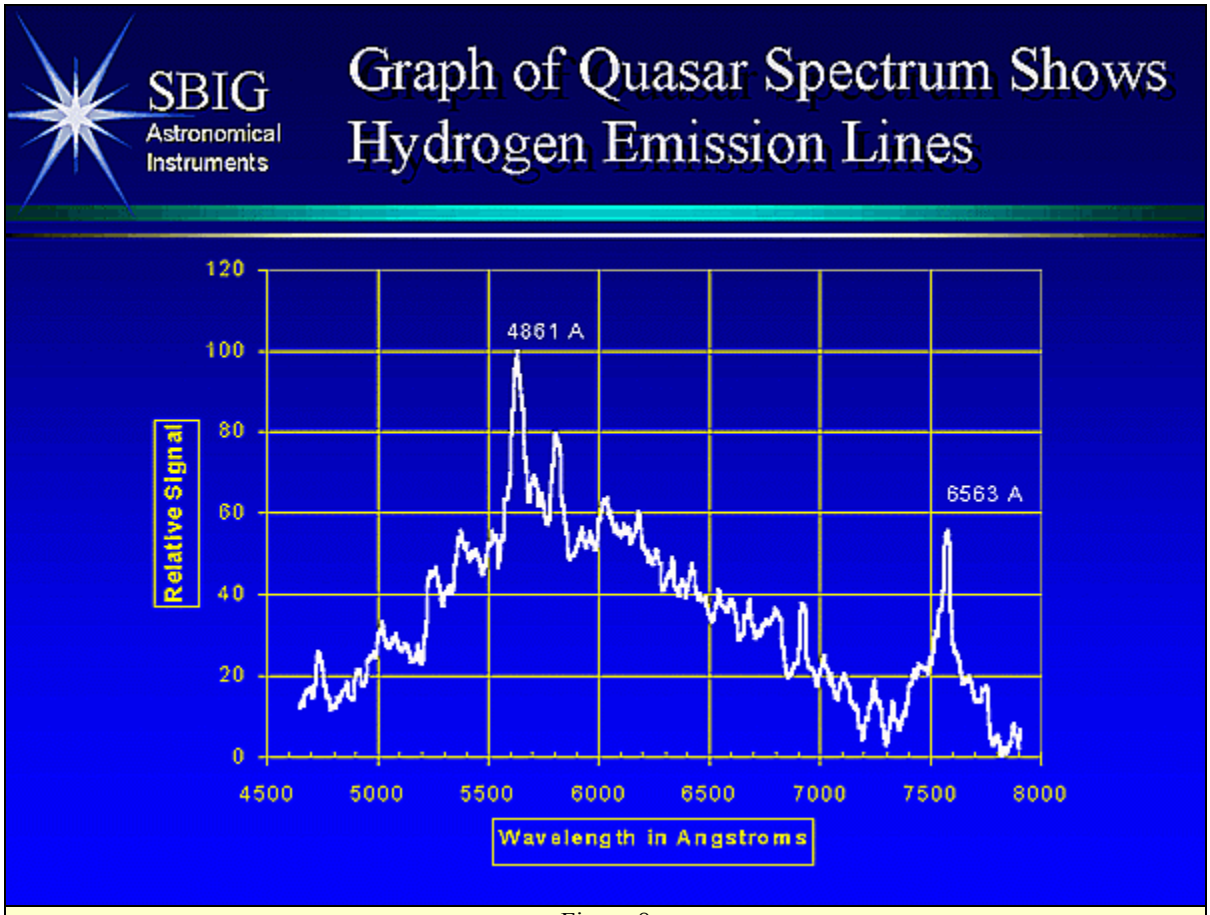


Figure 8
Graph of emission lines in Quasar 3C273 obtained using an 8" SCT

Obtain High Resolution Spectra

Using the high resolution grating and the narrow slit the spectrograph is capable of resolving narrowly separated lines. The sodium doublet lines in Figure 9 below are easily separated although they are only 6 angstroms apart. The magnesium lines in the three stars shown in Figure 10 are separated by only 5.4 angstroms.

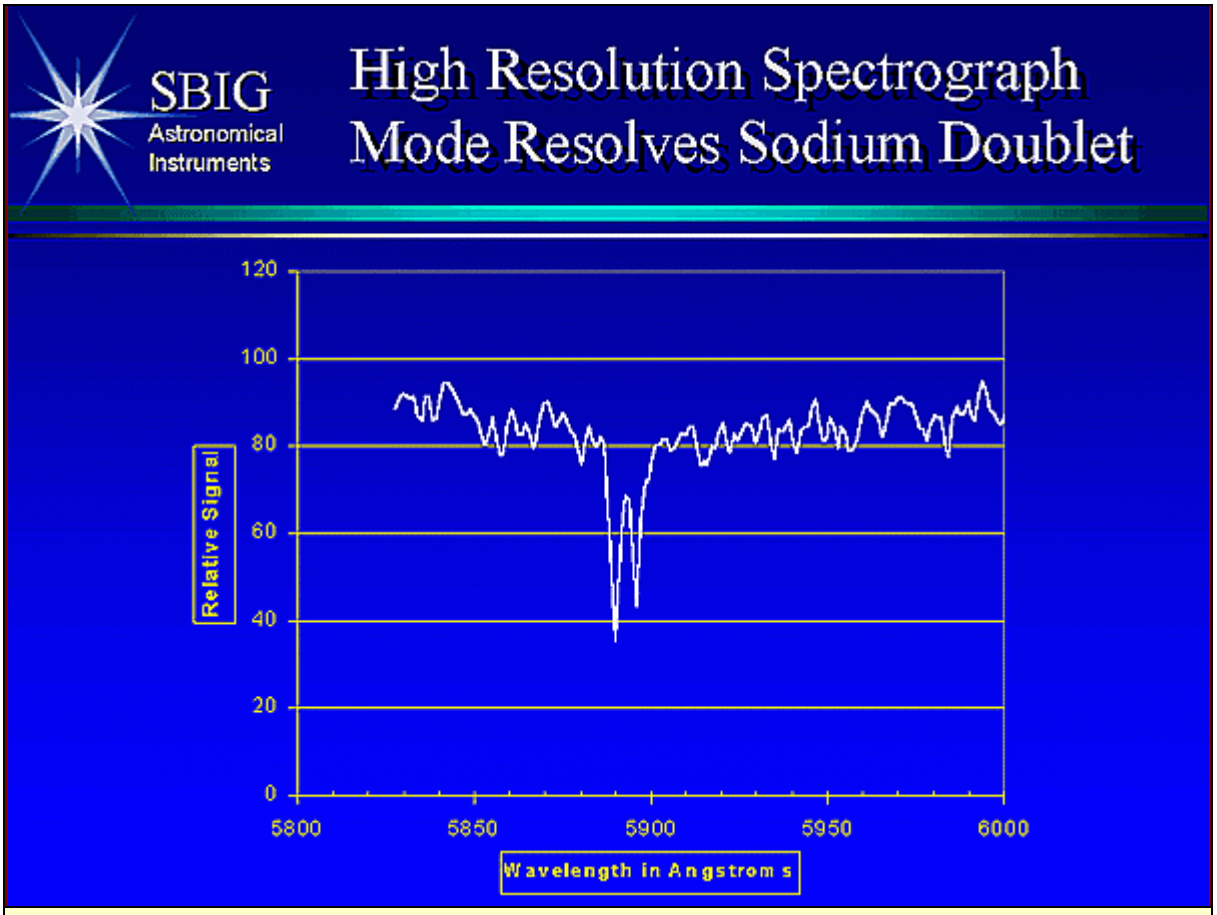


Figure 9

Acquisition and Analysis Software Included

The spectrograph is provided with a special version of CCDOPS for data acquisition and SBIG's Spectral Calibration Program for analysis. These programs make the spectrograph immediately useable as an analytical instrument without the need for the user to write or obtain third party software.

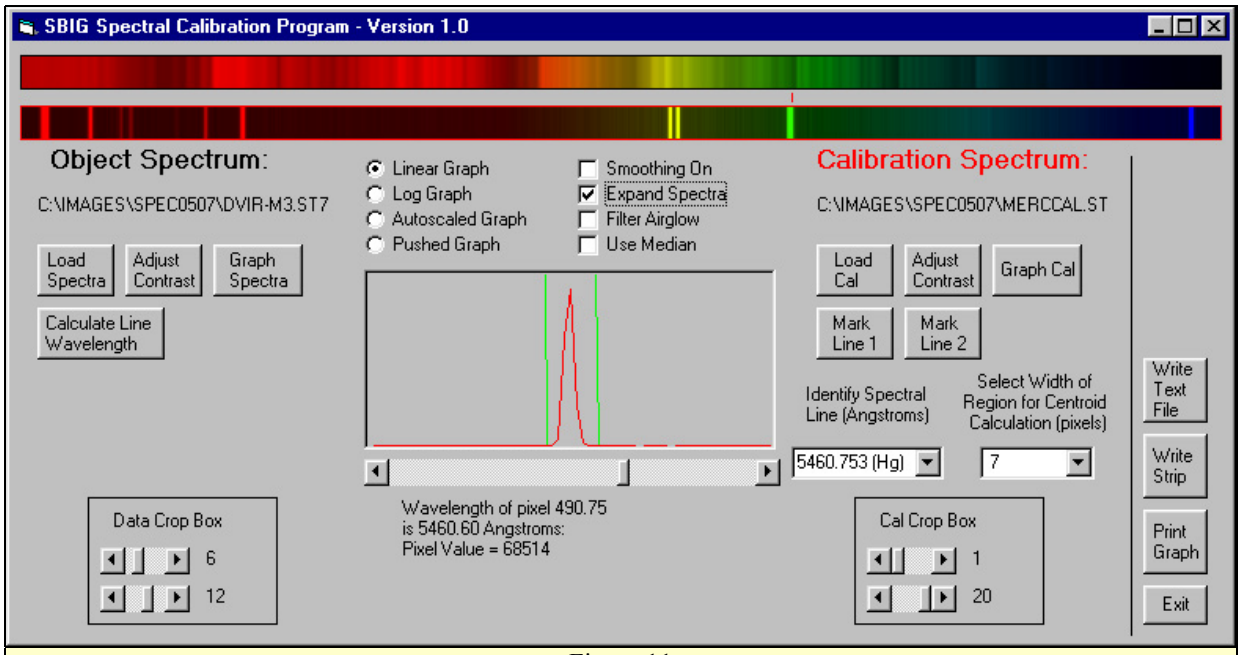


Figure 11
Screen shot of the Spectral Calibration Program supplied with the spectrograph

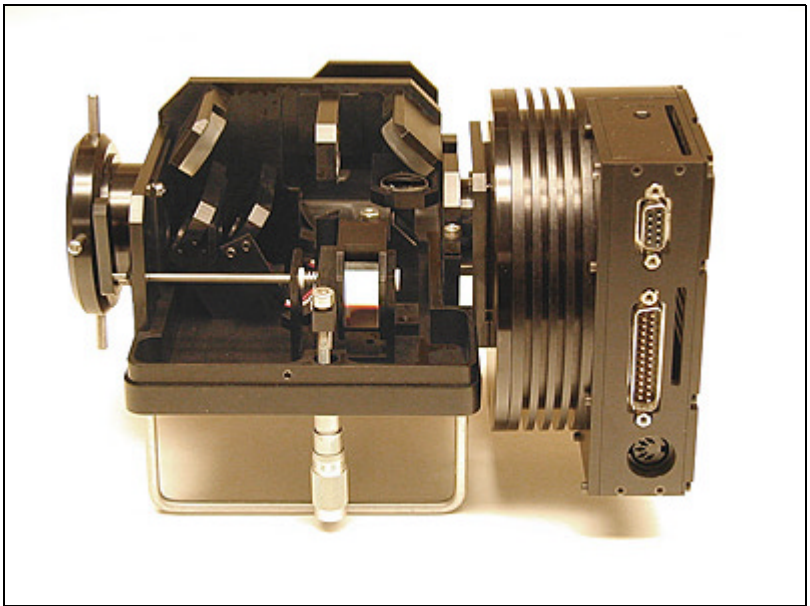


Figure 12 SBIG Spectrograph shown attached to an ST-7E

Optical Specifications

Dispersion:	
Two gratings are available, on a carousel for rapid selection ***- 150 lines per mm (4.3 Angstroms per pixel)*** ***- 600 lines per mm (1.0 Angstroms per pixel)***	
Slit Width ***Interchangeable slits are included*** ***18 microns wide (2 arcseconds at 80 inch focal length)*** ***Best for stellar work*** ***72 microns wide (8 arcseconds at 80 inch focal length)*** ***Best for galaxies***	
Acceptance cone angle: F/6.3 by F/10	
Resolution:	
Narrow slit & 600 lines/mm	2.4 Angstroms
Narrow slit & 150 lines/mm	10 Angstroms
Wide slit & 600 lines/mm	10 Angstroms
Wide slit & 150 lines/mm	38 Angstroms
Relative Sensitivity to Diffuse Sources:	
Narrow slit & 600 lines/mm	1.0
Narrow slit & 150 lines/mm	4.0
Wide slit & 600 lines/mm	4.0
Wide slit & 150 lines/mm	16.0

Typical Specifications

General Specifications
Dispersion: 1.07 or 4.3 Angstroms per pixel
Resolution: emission line is recorded with 2.4, 10 or 38 Angstroms Full Width at Half Maximum
Spectral coverage per frame: about 750 Angstroms with the high resolution grating, or 3200 with the low resolution grating
Center Wavelength Selection: Calibrated Micrometer Adjustment
Wavelength Range: 3800 to 7500 Angstroms
Sensitivity: Signal to noise ratio of 10:1 for a 9^{th} Mag star, 20 minute exposure using a non-ABG ST-7 and a 10 inch (25 cm) aperture in high resolution mode. An ABG ST-7 will reach magnitude 8. The low resolution mode will be 1.5 magnitudes more sensitive.
Entrance Slit: 18 micron (2.3 arcseconds wide with 63 inch focal length telescope) or 72 microns.
Dimensions: 3 x 4 x 7 inches (7.5 x 10 x 18 cm)
Weight: 3 pounds (with ST-7 head attached)
Uses: Stellar Classification *Analysis of Nebular Lines* *Identification of spectroscopic binaries* *Measurement of Stellar proper motion to +/- 6 km/sec accuracy* *Measurement of Emission Nebula Proper Motions* *Spectra of Laboratory and field sources*
Galactic Red Shifts: When used with the new Kodak "E" detectors red shifts of bright galaxies are possible with amateur sized telescopes.

Model DSS-7 Deep Space Spectrograph

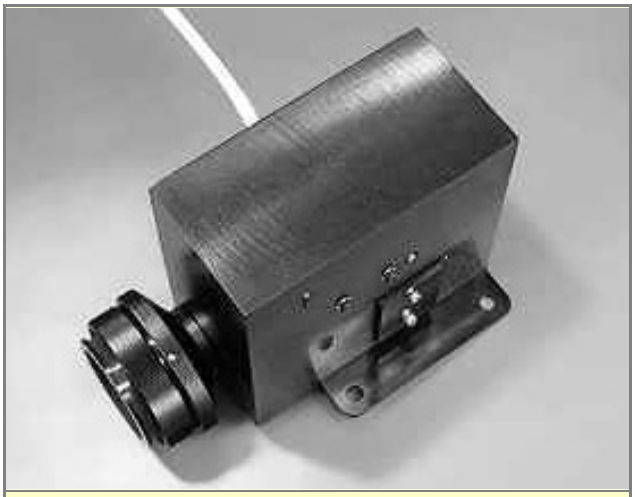


Figure 1. Model DSS-7 Deep Space Spectrograph

SBIG's new Deep Space Spectrograph is a spectrograph optimized for the types of spectral observations that an amateur has always been interested in, from stellar classification to nebular analysis to galactic red shifts. It is a more general purpose instrument than our Self Guided Spectrograph (SGS), which is optimized for stellar work, and is much less expensive. It is optimized for the ST-7XME or the low cost ST-402ME, and will work well with ST-8/9/10/2000 cameras and ST-237s. It will not work with the STL series due to their deeper backfocus required by the built in filter wheel. This memo describes the DSS-7 in detail, and present examples of observations that can be made by the amateur.

Figure 2. DSS-7 attached to ST-7XME camera

Spectroscopy Fundamentals: a spectrograph is a device that can produce a graph of the intensity of light as a function of color, or wavelength. A spectrometer is a device that measures only one selectable color, and a monochromator is a device that transmits only one color. The DSS-7 spectrograph is designed to separate and focus wavelengths from 4000 to 8000 angstroms across the width of an ST-7 CCD. The human eye is sensitive from about 4500 (deep blue) to 7000 (deep red) angstroms, with its peak sensitivity at 5550 angstroms. The silicon CCDs used in SBIG cameras has a larger range of sensitivity than the eye. Most stars put out a continuum of wavelengths with a number of absorption lines superimposed on it. Most emission nebula like the Orion Nebula produce a spectrum this is composed of a few bright emission lines, such as H-alpha (a hydrogen line at 6563 angstroms), H-beta (a hydrogen line at 4861 angstroms), and O-III (a triply ionized oxygen line at 5007 angstroms). An angstrom is one ten billionth of a meter. You will also quite often see wavelengths written in nanometers, which is one billionth of a meter. 6563 angstroms (A) is 656.3 nanometers (nm). Galaxies have a spectrum that is an aggregate of many stars, and have a similar spectrum. Most galaxies only have a few obvious features – the cores tend to show a sodium absorption line due to the older stars there. Seyfert galaxies and other active galaxies show an excess of H-alpha, which is great since it makes a red shift much easier to determine. Quasars, nova and supernova in general exhibit strong 6563 emission. In the case of quasars it can be red shifted quite a bit, hundreds of angstroms, so it may actually appear at a different wavelength. For a nova, the line will only be shifted slightly since the star is in our own galaxy, but it may be greatly broadened. The individual hydrogen atoms are moving very fast due to the tremendous temperatures involved, producing Doppler broadening that smears out the line.

Stars can be classified spectrally into the well know OBAFGKM groups. The very hot stars have few features in their spectrum, perhaps only a few hydrogen lines. The spectrum of Vega shown later illustrates this. The cool stars tend to be old, with many metallic lines producing a very complex and structured spectrum. There are also several types of peculiar stars, which show strong emission lines or other structure. The DSS-7 can reveal these features.

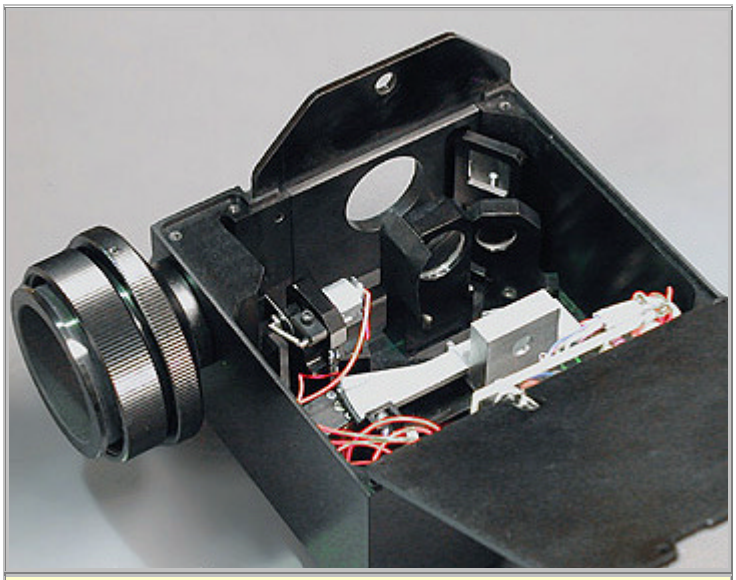


Figure 3. Inside view of the DSS-7 with SCT connector at left and exit aperture at top center of image

Optical Design: the optical design of the DSS-7 is illustrated in Figure One. Light enters the spectrograph through an entrance slit and is folded and then collimated (made parallel) by the collimation lens. The light then impinges upon a diffraction grating, which causes different colors to be reflected at different angles. You can see a similar effect in the light reflected from a CD or DVD. The light diffracted from the grating is then collected by a focusing lens, and imaged onto the CCD. Light of a discrete wavelength through the slit will be imaged into a vertical line. If the light does not fill the slit (such as is the case with a star) the discrete wavelength will produce a star like point on the CCD, with different wavelengths spread out along a line. This is illustrated by the next few figures.

The DSS-7 is designed to accept an F/10 cone of light, a value typical of popular commercial Schmidt-Cassegrain telescopes. In the imaging mode, it acts like a 2:1 focal reducer, increasing the field of view of the CCD. It also is effectively a 2:1 focal reducer in spectrograph mode, increasing the sensitivity to extended objects like nebulas or galaxies. It will accept the center portion of the cone of light from a faster telescope, but light is lost around the edges of the collimator lens.

The small DC motors in the DSS-7 are powered by a 9 volt battery. The motors are controlled by signals from the CCD camera's relay port through a phone jack connector. There is no provision for guiding. The length of exposure one can take will be limited by your telescope's ability to track unguided unless you have another camera set up to work as a guider. For stellar work, it is not easy to keep the star on the narrowest slit. For diffuse objects it is much easier since a little motion still usually leaves some nebulosity passing through the slit. Reasonable spectra of stars as faint as 9th magnitude can be achieved in 30 seconds with an eight inch (20 cm) aperture telescope. Putting the star in one of the wider slits helps, but will yield some blurring of the spectrum. The 100 and 200 micron slits are included mainly for diffuse object observations.

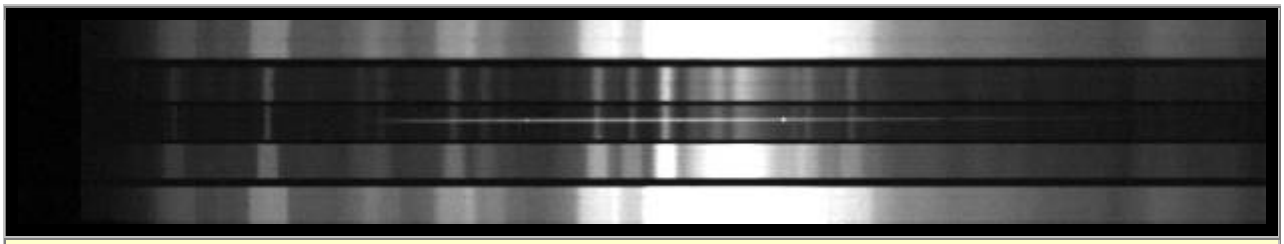


Figure 4. Spectra of P Cygni and Sky Glow: Bright Points are 4861 and 6563 Angstroms
This shows a spectrum collected while examining P Cygni, a peculiar star with permanent emission lines. The broadband radiation from the star produces a horizontal line, while the emission lines show up as bright points, and the airglow lines (some natural, some light pollution) show up as copies of the slit pattern. For this image the airglow lines have been exaggerated to illustrate them better – P Cygni is bright enough that exposures are short and airglow is not so prominent.

Comparison to Slitless Spectrographs: the inclusion of an entrance slit in this design allows the user to obtain good spectra of extended objects, a measurement that was impossible with low cost slitless spectrographs using transmission gratings. The other advantage of the slit is the sky background is both resolved spectrally and reduced considerably, improving the signal to noise ratio for faint objects. With slitless spectrographs, guiding errors blur the spectrum. For the DSS-7, guiding errors cause the object to move away from the slit and light is lost.

Analysis Software: SBIG has modified the SPECTRA software originally developed for the SGS to make is simple to use with the DSS-7. The software allows the user to easily perform a wavelength calibration on collected data, and save the result as a text file that can be read by Microsoft Excel. Software features include the ability to subtract the sky background from stellar data, and display modes that smooth or colorize the data to aid in visualization of the spectra in a traditional manner.

Observations: We have used a prototype DSS-7 to measure a number of objects, which illustrate its capabilities. One result is shown below. Figure 5 illustrates the red shift of NGC 7603, a 14th magnitude Seyfert galaxy in the Virgo cluster. The red shift of the H-alpha line at 6563 angstroms is obvious, and is about 190 angstroms, an easily measurable amount (35 pixels). This required three 15 minute exposures using a Celestron 8 guided by an STV. Some residual artifacts from subtraction of the light pollution lines remain between 5400 and 6000 angstroms. This galaxy is interesting since the relative brightness of the 6563 emission relative to the continuum has increased three-fold since the 1970's, a change an amateur can now track!

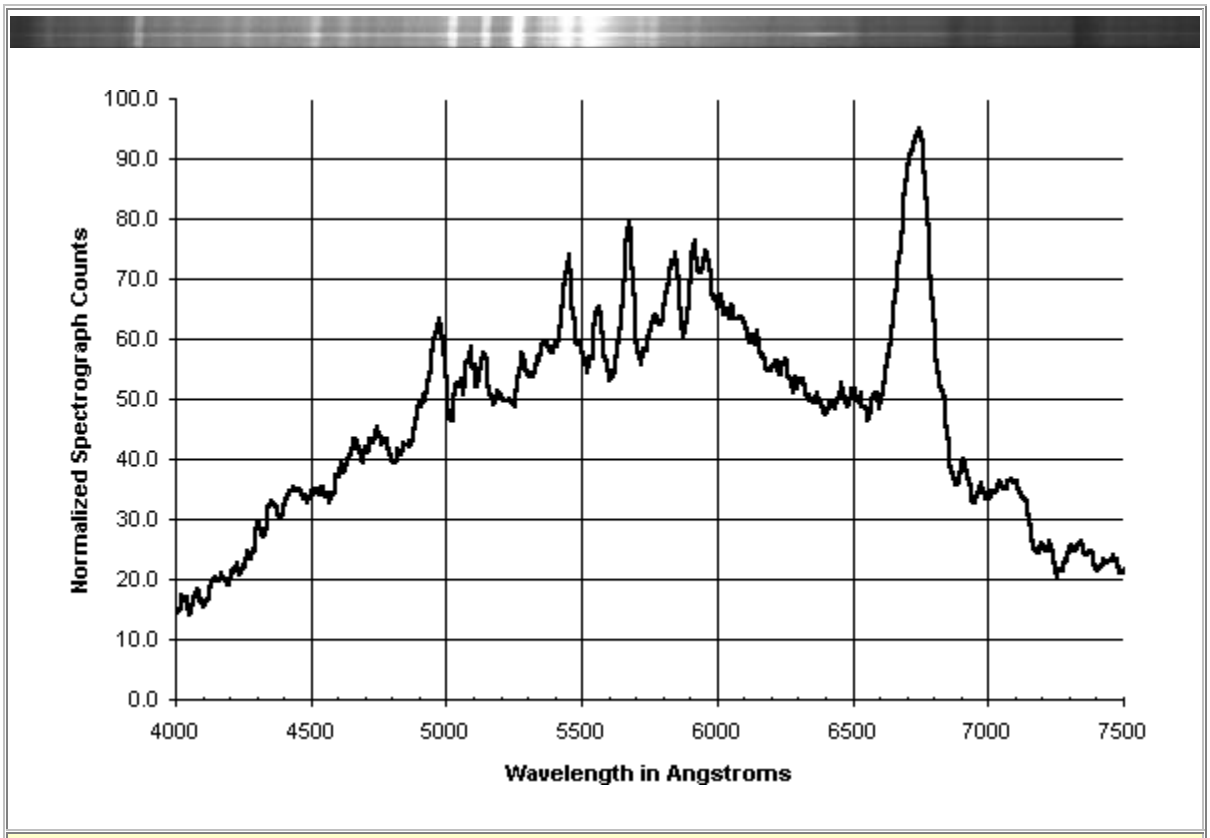


Figure 5. Galactic Red Shift of NGC7603

Specifications

Comparison of DSS-7 to SGS Self-Guided Spectrograph

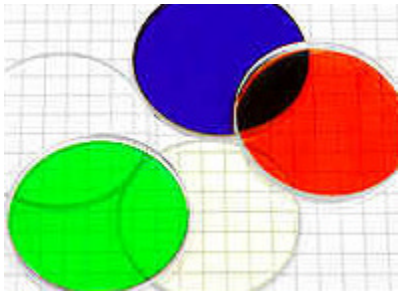
	DSS-7	SGS
Input F/number	F/10	F/6.3 x F/10
Dispersion	5.4 Angstroms/pixel	High Res = 1.07 Angstroms/pixel Low Res = 9 Angstroms/pixel
Resolution with 9u pixels (ST-7XME or ST-402ME)	15 Angstroms	High Res = 2.4 Angstroms Low Res = 9 Angstroms
Spectral range (ST-7XME or ST-402ME)	4130 Angstroms	High Res = 820 Angstroms Low Res= 3290 Angstroms
Projected width of narrowest slit on CCD	25 microns	18 microns
Blur perpendicular to slit	~ 25 microns	~ 100 microns
Lower resolution slit choices	50, 100 and 200 mcirons	72 microns
Ideal for measuring	Extended Objects	Stars
Relative sensitivity for dim extended objects near H-alpha	5 - 10X	1X
Dimensions (excluding connectors)	2.2 x 4 x 4.3 in.	3 x 4 x 7 in
Weight (excluding camera)	1.5 lb.	1.5 lb.
Self-Guiding with ST-7XME or Other Dual CCD Camera	No	Yes
ST-402ME Compatible	Yes	No

Accessories for the ST-402ME / 1603ME / 3200ME Cameras

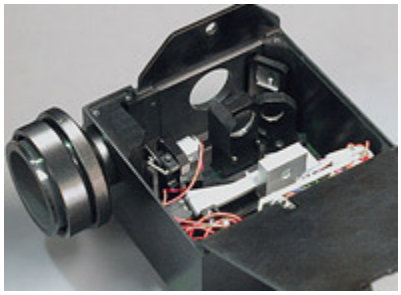
CFW402 Filter Wheel with RGB+C Filters
This is the internal filter wheel for the ST-402ME only. It contains very high quality interference filters custom made for this camera. Note that the filters are premanently attached to the filter carousel and cannot be changed. Also, due to the size of the CCDs, the internal filters will not cover the KAF-1603ME or KAF-3200EM CCDs in this camera body. Therefore, for the larger ST-1603ME and ST-3200ME cameras, the external CFW10 filter wheel with 1.25" filters must be used.

CFW402 Filter Wheel with BVI+C Filters
This product is in development. We have been asked to provide an inexpensive internal filter wheel for the ST-402ME for photometric work using the B, V, I filters of the common UBVRI filter set used by professionals. Contact SBIG for further details.

CFW10-SA Ten Position Filter Wheel
Also seen here attached to an ST camera for comparison. The CFW10 allows you to carry a large array of filters in one filter wheel without having to change carousels. LRGB+Clear filters for color imaging can be installed along with several narrow band filters such as H-alpha, O[III] and S[II], or a complete color plus photometric set. The CFW10 adds only 0.56" of backfocus to SBIG cameras and can be used with camera lens adapters. A stand alone model is available for other cameras.



RGB and UBVRI Filters for CFW10-SA Filter Wheel
Red, Green, Blue, plus Clear and Luminance filters for color imaging are available in several varities. Our standard set suppresses light pollution while giving an excellent balance for all ST cameras. Astrodon filters are parfocal with other Astrodon narrowband filters and offer 1:1:1 exposure ratios. H-alpha, O[III] and S[II] filters are available for narrow band imaging of emisison nebula. UBVRI filters are available for photometric studies.



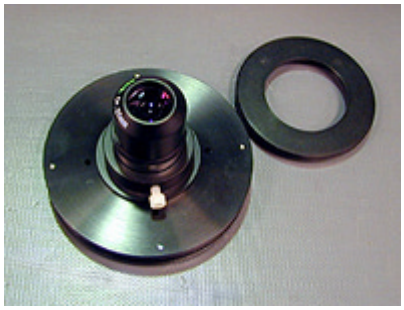
DSS-7 Deep Space Spectrograph
The DSS-7 is a lower cost alternative to the SGS. The DSS-7 is actually more sensitive than the SGS making it excellent for Deep Space objects. It does not self-guide and it has slightly lower resolution than the SGS. It is optimised for popular Schmidt-Cassegrain telescopes but can be used on any system with an F/10 focal ratio.

Extra Nosepiece: 1.25" and 2"
These T-thread nosepieces screw into the female t-threads on ST cameras. All ST cameras include at least one nosepiece. Each nosepiece is threaded to accept filters and notched for extra security in the event the retaining screw comes loose slighlty during the night. For a more solid connection to Schmidt-Cassegrain scopes, we also offer the SCT to T-thread Visual Back (see below).

eFinder focal reducer and 25mm f/4 guiding scope
Many owners of the ST-402ME use it as an autoguider. The eFinder accessory originally made for the STV works very well with the ST-402ME. The efinder consists of a doublet lens held at the end of a tube that screws into the t-threads on the face of the camera. The entire assembly is extremely rigid. When attached, the lens acts as a 100mm FL f/4 guide scope capable of 1 arcsecond guiding with a wide field of view.

Precision Rotating Nosepiece
This nosepiece with micrometer adjustment attaches to the ST-402/1603/3200 camera body by way of the 1/4-20 tripod mounting hole. It allows a small but precise rotation of the camera for aligning the CCD with the direction of drift of stars when setting up for TDI (Time Delay Integration) imaging - also called drift scan imaging. During TDI imging, the telescope drive is turned off and the image scrolls out of the CCD at the same rate as the stars drift across the image plane. Thus there is no drive error, no tracking and the image can be quite large.

SCT to T-thread Visual Back
For a more secure attachment of your camera to a Schmidt-Cassegrain telescope (or any scope using typical SCT threads) replace your nosepiece with this adapter. One end screws into the female t-threads on the front of the camera or filter wheel, and the other end screws onto the rear cell threads typically found on most commercial Schmidt-Cassegrain telescopes. A matching hard plastic dust cap screws over the t-thread end if the camera is removed for any period of time.



Quick Disconnect
The Quick Disconnnect accessory lets you quickly remove the camera from the telescope, replace it with an eyepiece, and then return the camera to the telescope all without losing focus or position. It also lets you easily rotate the camera without losing focus. It is designed for use with an SCT.

Male-to-Male T-thread adapter
This adapter is also threaded internally for 1/25" filter cells, so it can be used to hold a single filter when attached to the front of the camera.

110VAC to 12VDC Wall Transformer
This 110VAC to 12VDC supply is a replacement for the power supply that is included with the ST-402ME camera. The polarity is correct for this product (center pin positive) and the plug has a locking ring to hold it in place. The locking ring differentiates it from a similar supply with negative center pin used for the STV.

Power Supply Extension Cable
This cable extends the cord from the wall transformer to the camera. It is custom made with heavy gauge conductor for minimum voltage loss, similar to the extension cables offered for the ST and STL series cameras. (The ST-402/1603/3200 versions may appear slightly different from the STL version shown in the photo).

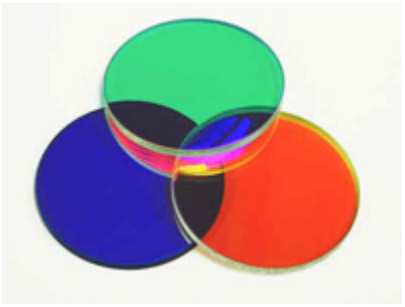
CLA-5 Camera Lens Adapter with T to C Mount Adapter
This lens adapter comes in two parts: A T-to-C Thread adapter ring and a C-thread to 35mm lens adapter. Both are necessary for using a 35mm camer lens with the ST-402/1603/3200 cameras. However, if you have C-mount lenses, only the T-to-C Thread adapter ring is required.

Relay Adapter
The relay adapter box converts the ST-402/1603/3200 electronic relays to mechanical relays. Most commercially available mounts such as those from Software Bisque, AP, Meade and Celestron do not require mechanical relays, but others, such as the classic Losmandy G-11 do require some other form of electrical isolation between the camera and the mount. If you are not sure, check with your mount manufacturer.

Accessories for the ST-7/8/9/10/2000 Series Cameras

CFW9 Five Position Filter Wheel
Seen here attached to an ST camera body. The CFW9 makes it possible to automatically take color images with LRGB filters. Add an H-alpha filter for emission nebula, or perform photometric measurements with UBVRI filters. Add an extra carousel and do both by switching entire filter sets. The CFW9 is available with or without filters. The CFW9 gets its power and control commands from the camera is designed to match the ST-7/8/9/10/2000 body style in size and shape.

CFW10 Ten Position Filter Wheel
Also seen here attached to an ST camera for comparison. The CFW10 allows you to carry a large array of filters in one filter wheel without having to change carousels. LRGB+Clear filters for color imaging can be installed along with several narrow band filters such as H-alpha, O[III] and S[II], or a complete color plus photometric set. The CFW10 adds only 0.56" of backfocus to SBIG cameras and can be used with camera lens adapters. A stand alone model is available for other cameras.



LRGBC, UBVRI and Narrowband Filters
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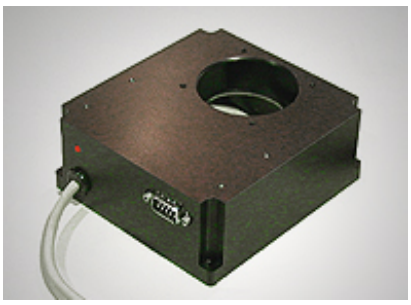
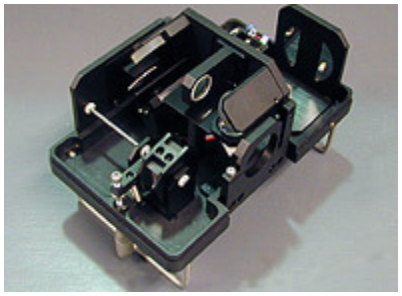
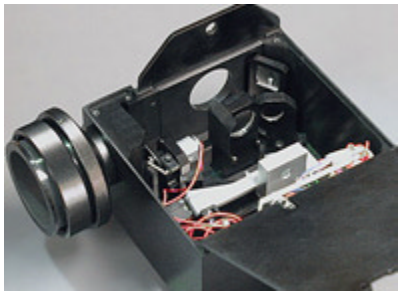


AO-8 Adaptive Optics
Get the last bit of resolution from your system. The AO-8 uses the built-in tracking CCD of an ST-7/8/9/10/2000 dual sensor camera to monitor the jitter of a guide star and make appropriate tilt-tip corrections to the image using a refractive optical element. Local and low order atmospheric effects, telescope vibration and drive error are reduced or eliminated resulting in a sharper image.

AO-L Adaptive Optics
The AO-L was designed for the larger CCDs used in the Research Series cameras, however it will also work on the ST-7/8/9/10/2000 cameras. The AO-L uses a transmissive correcting element The full scale correction rate is slower than the AO-7 at about 5 - 10 Hz, but individual moves are actually made quicker. An accessory element is planned for the AO-L that will also correct for atmospheric extinction when imaging away from the zenith.



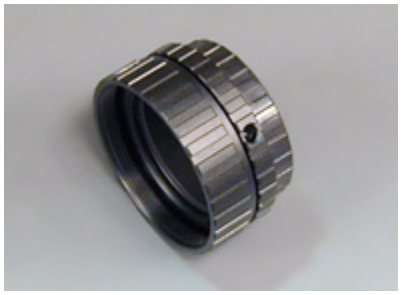
SGS Self-Guiding Spectrograph
The SGS utilizes the guiding CCD in the ST-7/8/9/10/2000 cameras to hold the object being measured on the narrow entrance slit for an extended period of time. The full bandwidth is displayed on an ST-7 sized CCD. For convenience, other self-guiding ST series cameras can also be used although there is no benefit to using a larger camera than the ST-7XME. Dispersion with the high resolution grating is approximately 1 Angstrom per pixel at 9u.



DSS-7 Deep Space Spectrograph
The DSS-7 is a lower cost alternative to the SGS. The DSS-7 is actually more sensitive than the SGS making it excellent for Deep Space objects. It does not self-guide and it has slightly lower resolution than the SGS. It is optimised for popular Schmidt-Cassegrain telescopes but can be used on any system with an F/10 focal ratio. It is ideal for deep space objects such as galaxies and nebula.

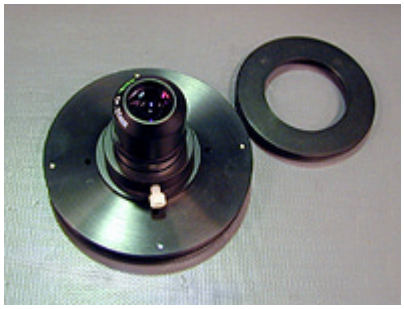
Port Splitter
The port splitter attaches to the accessory port on the bottom of an ST-7/8/9/10/2000 camera and gives you three 9 pin ports for attaching a variety of accessories such as a CFW8A, AO-7 and Relay Adapter at the same time. An additional RJ11 relay output port is also provided and four red LEDs indicate relay activity. The port splitter should be used to replace the temporary ribbon type dual relay cable for more robust connections.

Extra Nosepiece: 1.25" and 2"
These T-thread nosepieces screw into the female t-threads on ST cameras. All ST cameras include at least one nosepiece. Each nosepiece is threaded to accept filters and notched for extra security in the event the retaining screw comes loose slighlty during the night. For a more solid connection to Schmidt-Cassegrain scopes, we also offer the SCT to T-thread Visual Back (see below).

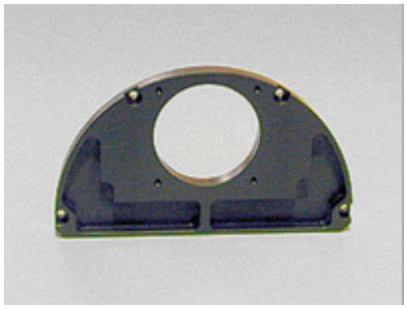


SCT to T-thread Visual Back
For a more secure attachment of your camera to a Schmidt-Cassegrain telescope (or any scope using typical SCT threads) replace your nosepiece with this adapter. One end screws into the female t-threads on the front of the camera or filter wheel, and the other end screws onto the rear cell threads typically found on most commercial Schmidt-Cassegrain telescopes. A matching hard plastic dust cap screws over the t-thread end if the camera is removed for any period of time.

Precision Rotating Nosepiece
This nosepiece replaces the D-block on the ST-7/8/9/10/2000 camera. It allows a small but precise rotation of the camera for aligning the CCD with the direction of drift of stars when setting up for TDI (Time Delay Integration) imaging - also called drift scan imaging. During TDI imging, the telescope drive is turned off and the image scrolls out of the CCD at the same rate as the stars drift across the image plane. Thus there is no drive error, no tracking and the image can be quite large.



Quick Disconnect
The Quick Disconnnect accessory lets you quickly remove the camera from the telescope, replace it with an eyepiece, and then return the camera to the telescope all without losing focus or position. It also lets you easily rotate the camera without losing focus. It is designed for use with an SCT.



CFW8A to AO-7 Adapter Plate
This adapter provides a solid direct connection of the AO-7 Adaptive Optics Device to the CFW8A filter wheel when the filter wheel is also hard mounted to the camera. The entire train of Camera-CFW-AO becomes one unit. Previously the AO-7 had to be attached using a male-to-male thread adapter that screwed into the CFW8A and AO-7, but could also add flexure or unwanted rotation if the parts became loose for any reason.

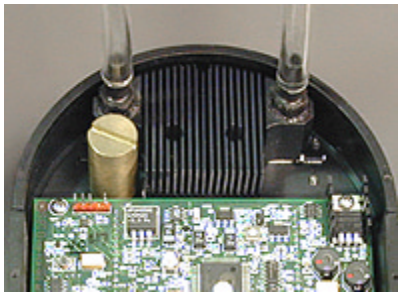
Replacement "D" Block and T-thread Ring
This block with adjustable inner t-thread ring is a standard part on ST-7/8/9/10/2000 cameras. It can be removed for direct connection of the CFW8A or CFW10 filter wheel.

Male-to-Male T-thread adapter
This adapter is also threaded internally for 1/25" filter cells, so it can be used to hold a single filter when attached to the front of the camera.

Water Pump and Tubing (110VAC)
This 110VAC (only) submersible water pump may be used with any ST-7/8/9/10/2000 camera equipped with the water circulation heat exchanger. Most models have this feature, except for some of the "I" models where it is an option. Water circulation results in a greater cooling delta from ambient and is desireable in areas where it stays very warm at night.

Water Pump and Tubing (12VDC)
This 12VDC submersible water pump was added as an accessory for the larger STL series cameras. However, if you are operating an ST-7/8/9/10/2000 camera in the field or any place where there is no convenient 110VAC supply, then it may be adapted for use with an ST series camera by using two pieces of step down tubing from the camera to the smaller tubing supplied with the 12VDC pump. A 110VAC adapter (below) can be added for dual use.

110VAC to 12VDC power supply for 12V Water Pump
This 110VAC to 12VDC supply is may be used to power the 12VDC pump when 110VAC is available. It is the same power supply that we use with the ST-402ME camera.



ST-7/8/9/10/2000 Water Circulation Heat Exchanger
Some "I" model ST-7/8/9/10/2000 cameras do not include the water circulation heat exchanger. If you have an "I" camera and wish to increase the cooling performance with water circulation this part may be added at time of purchase or later. Adding water circulation improves the cooling delta by approximately 6 - 9 degrees C. Note: If you have a self-guiding (dual CCD) version of the ST-7/8/9/10/2000 camera with USB elecrronics, this feature is already installed. It is also included in all upgrades to USB.

90-240VAC Universal Power Supply
The universal power supply provides the required 5VDC and 12VDC to the camera from typical line voltages found around the world. It has an on/off switch and green LED showing power is on to the camera. A separate cord is available with regional plug for N. America and Europe / Asia. This is the supply that is included with all current models of ST-7/8/9/10/2000 cameras. It is compatible with all all past models as well.

12VDC Power Supply
This optional power supply converts 12VDC from a battery to the 5VDC and 12VDC required by the camera. It is for operating your ST-7/8/9/10/2000 camera from a battery in the field, or anywhere there is no convenient AC power.

Power Supply Extension Cable
This cable extends the cord from the power "brick" to the camera by approximately 6 feet (~1.8m). The standard power cable that is attached to the power brick is about 6 feet long so this heavy duty extension cable will double that length. It is custom made with heavy gauge conductor for minimum voltage loss (current versions may appear slightly different from the photo).

Accessory Test Lens
This inexpensive test lens allows the user to become familiar with CCD camera operation and software in the daytime. The lens is a modest double convex plastic lens with a focal length of 25 mm and an aperture of 1.5 mm (F/16), in a metal housing with a T-thread on the outside. It is very handy for capturing images during daytime when testing the camera or learning the software. Simply unscrew the nosepiece and screw this lens in place.

Camera Lens Adapter
This adapter mates the ST-7/8/9/10/2000 cameras with popular 35mm camera lenses for wide field imaging. Adapters are available for Pentax bayonet, Olympus, Canon FD, or Nikon. Note: Canon FD lenses are manual only. The CLA-7 cannot be used with a filter wheel, but it can be used with the male-to-male t-thread adapter in place of the threaded barrel to hold a 1.25" filter behind the camera lens. This can be useful for taking wide field H-alpha images, for example.

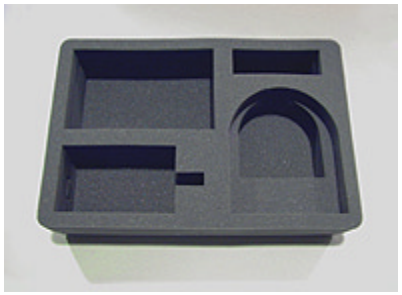
Relay Adapter
The relay adapter box converts the ST-7/8/9/10/2000 electronic relays to mechanical relays. Most commercially available mounts such as those from Software Bisque, AP, Meade and Celestron do not require mechanical relays, but others, such as the classic Losmandy G-11 do require some other form of electrical isolation between the camera and the mount. If you are not sure, check with your mount manufacturer.

Ethernet to Parallel Adapter
The E2P adapter converts a parallel ST-7/8/9/10 camera to Ethernet. A server utility is provided with the adapter box that allows you to operate your parallel camera remotely over a local area network.

NOTE: This product has been discontinued

SCSI to Parallel Adapter
This adapter converts older Mac SCSI ports to parallel for controlling parallel version of the ST-7/8/9/10 cameras with a Macintosh computer. Note: Our newer USB cameras can be operated from a Mac running OS-X and Equinox software without the need for any adapter so long as the Mac has a USB port.

NOTE: This product has been discontinued



Replacement Foam Insert for CFW10 and Pelican Cases
A new foam insert is now available for the standard Pelican case that lets you store and transport an ST-7/8/9/10/2000 camera with the larger CFW10 attached. Cut-outs include provisions for the camera with or without the CFW10, power supply and other accessories. The large rectangular compartment can hold an ST camera with CFW8A and AO-7 hard mounted together. This foam insert fits the Pelican case originally supplied with the ST-7/8/9/10/2000 cameras (see below).

Pelican Carrying Case with Custom Cut Foam
This case includes the custom cut foam (above) for your ST series camera and accessories. It will hold an ST-7/8/9/10/2000 camera with or without a CFW10 filter wheel attached. The case is waterproof, dustproof, and crushproof and comes with a lifetime guarantee from Pelican. It is included as a standard accessory for current ST series cameras except for some "I" models. It can be ordered separately for "I" cameras and older ST-7/8/9/10/2000 models.

Accessories for the STL Series Cameras

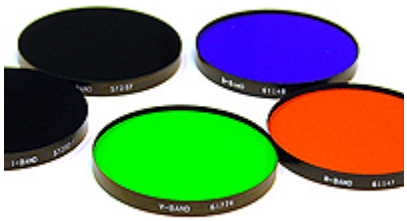
(STL-1001E, STL-1301E, STL-4020M, STL-4020CM, STL-6303E, STL-11000M, STL-11000CM)

Remote Guiding Head

The remote guiding head contains a cooled, 16 bit 657x495 TC-237H CCD indentical to internal self-guiding CCD in the STL camera body. The remote head is equipped with t-threads on the front cover and it will accept the eFinder assembly for guiding, a camera lens adapter, a T to C adapter, or the provided 1.25" nosepiece for use with an external guide scope. The external guider will also control the AO-L when used with an off-axis assembly or pellicle splitter.

Extra Filter Carousel

For changing an entire set of filters at once, the internal STL filter carousel can be easily removed and replaced with a new one containing a different filter set. For instance, the standard LRGBC color filters may be quickly exchanged for a UBVRI set or a narrow band set for emission line objects. The carousel fits neatly inside the front cover of the camera. The sealed CCD chamber and shutter are not disturbed when changing filters or the filter carousel.



LRGBC, UBVRI and Narrowband Filters

50mm drop in filters are offered for the STL series cameras to minimize vignetting with the largest (35mm format) CCDs. Red, Green, Blue, plus Clear and Luminance filters for color imaging are available. UBVRI filters are available for photometric studies. H-alpha, O[III] and S[II] filters are available for narrow band imaging of emisison nebula.

AO-L Adaptive Optics

The AO-L was designed for the larger CCDs used in the Research Series cameras, however it will also work on the ST-7/8/9/10/2000 cameras. The AO-L uses a transmissive correcting element instead of a reflecting element. The full scale correction rate is slower than the AO-7 at about 5 - 10 Hz, but individual moves are actually made quicker. An accessory element is planned for the AO-L that will also correct for atmospheric extinction when imaging away from the zenith.

90-240VAC Universal Power Supply

The STL universal power supply provides the required 12VDC to the camera from typical line voltages found around the world. A separate cord is included with regional plug for N. America or Europe / Asia. This is the same power supply that is included with all current models of STL cameras. The output connector is 6 pin DIN. (Note that this is not compatible with the ST-7/8/9/10/2000 cameras which require both 5 volts and 12 volts out and use a 5 pin connector).

Power Supply Extension Cable
This 6 pin DIN to 6 pin DIN cable extends the power cord from the STL power supply to the camera by approximately 9 feet (~2.7m). The standard power cable that is attached to the power brick is about 6 feet long so this heavy duty extension cable will increase the total length to approximately 15 feet (4.5 m). It is custom made with heavy gauge conductor for minimum voltage loss. (Note, this extension cable is not compatible with the power supply for the ST-7/8/9/10/2000 cameras).

12VDC Power Cord with Cigaretter Lighter Adapter
This cable is used to directly power the STL camera from a 12VDC source using cigarette lighter plug.

Water Pump and Tubing
This 12VDC submersible water pump may be used with any ST-7/8/9/10/2000 camera equipped with the water circulation heat exchanger. Most models have this feature, except for some of the "I" models where it is an option. Water circulation results in a greater cooling delta from ambient and is desireable in areas where it remains very warm at night.

110VAC to 12VDC power supply for 12V Water Pump
This wall transformer is equipped with the proper polarity plug for powering the 12VDC submersible water pump (above). It is the same power supply and plug used with the ST-402ME, ST-1603ME and ST-3200ME cameras

Nikon 35mm Camera Lens Adapter
This adapter mates the STL series cameras with Nikon 35mm camera lenses for wide field imaging.

Relay Adapter
The relay adapter box converts the ST-7/8/9/10/2000 electronic relays to mechanical relays. Most commercially available mounts such as those from Software Bisque, AP, Meade and Celestron do not require mechanical relays, but others, such as the classic Losmandy G-11 do require some other form of electrical isolation between the camera and the mount. If you are not sure, check with your mount manufacturer.

Pelican Carrying Case
This is a replacement case with custom cut foam for your STL series camera and accessories will hold an STL camera, remote guide head, cables, and accessories. The case is waterproof, dustproof, and crushproof and comes with a lifetime guarantee from Pelican. It is included as a standard accessory for current STL series cameras

Third Party Products Supporting SBIG Cameras:

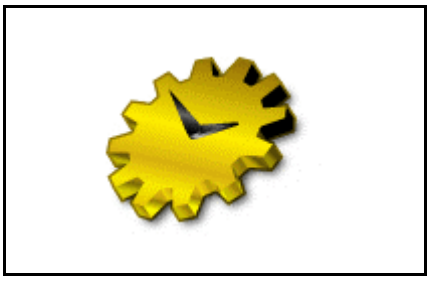
TheSky version 5, level II is distributed with SBIG cameras at no additional charge. This is a full working demo version of the program. Software Bisque offers a discount on upgrades to the latest version 6 at their web site http://www.bisque.com Save $10 to $30 depending on the package you choose. Or keep the demo version and run it as long as you like. It contains full version 5 capability with telescope control for many popular commercial goto scopes.

A discount certificate is included with most models of SBIG cameras for Maxim DL/CCD. Maxim contains full SBIG camera control, including the ability to run 2 USB cameras at the same time, STV control and autoguiding through a series of exposures. The certificate entitles the purchaser to obtain this popular camera control and image processing program for $50 off the current list price when purchased directly from SBIG.

A discount certificate is included with all models of SBIG cameras for Ron Wodaski's popular book: The New CCD Astronomy. This book covers all the basics you need to know to get started in CCD imaging. But it is more than a beginner's book. It contains a wealth of information on imge processing ahd tips for getting the most from you camera. Keep it as a reference book. The certificate if for $10 off the list price when purchased directly from SBIG.

EquinoX

Microproject's Equinox program for Macintosh is a planetarium program, including full camera control for SBIG USB cameras. SBIG will provide a free copy of EquinoX for Macintosh on request to any new camera purchaser who wants to use a Mac OS-X system to control his or her camera. Send us a copy of your camera purchase invoice and we will send you EquinoX at no charge.



CCDAutoPilot from CCDWARE automates many of the key functions of the image acquisition process without the need to learn complex scripting or specialized languages. CCD Autopilot also supports the self-guiding features of SBIG cameras as well as the AO-7 adaptive optics. A free 60 day trial version of CCD Autopilot will be included with all new SBIG cameras starting May 1, 2005. A certificate for a $50 discount will be included for those who like the program and wish to purchase the full retail version.

CONTACTING SBIG

Thank you for your interest in our products. We would like to make ourselves easily available for you. Please contact us with any questions or requests for further information. Our normal office hours are from 8AM to 5PM Pacific Time, Monday through Friday, excluding holidays. We are normally closed the week between Christmas and New Year.

SBIG Headquarters

Mailing Address	E-Mail
SBIG 147-A Castilian Dr. Santa Barbara, CA 93117 USA	General Information and Technical Support sbig@sbig.com
Telephone	**Shipping Address**
Voice: (805) 571-7244 FAX: (805) 571-1147	SBIG 147-A Castilian Dr. Santa Barbara, CA 93117 USA
Web Site	
http://www.sbig.com	

Please visit our web site for up to date pricing and product information. We also have an extensive gallery of customer images and technical application notes.

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