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ST-2000XM and ST-2000XMI

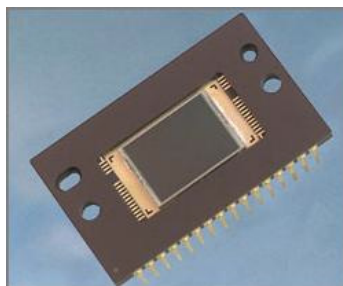
Multi-megapixel CCD Cameras



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 who wanted something bigger and better but at a lower price than 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 - nearly the same size as the ST-8XME
- More than a million pixels – nearly two megapixels
- Good sensitivity
- Low noise
- Antiblooming protection - good for small refractors
- High resolution on smaller telescopes with 7.4 micron square pixels
- Flexibility of binning 2x2 on larger scopes with good image size
- Self-guiding with a built-in TC-237H CCD
- Remote Guide Head Port
- High speed download - about 4.5 seconds for a full 1.9 megapixel image
- Professional software - see below
- Easy to use
- Full compliment of optional custom accessories
- Lower price
- SBIG quality and support

The ST-2000XM and ST-2000XMI cameras are the same, except that the ST-2000XMI does not include the built-in TC-237H tracking CCD and some of the accessories that are included with the ST-2000XM (see the comparison table below). In March of 2006 we also added the Remote Guide Head Port to both the single sensor ST-2000XMI and dual sensor ST-2000XM cameras. Both versions use the same 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 to 0.001 seconds. 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, nearly as large as an ST-8XME, and the ST-2000XM is a self-guiding camera, utilizing SBIG's patented dual sensor design. Although the imaging CCD is nearly the same size as the KAF-1603ME used in the ST-8XME, due to the smaller pixel size it contains nearly half a million more pixels than the ST-8XME.



The latest KAI-2020M 2 megapixel CCD retains the improved QE of the KAI-2001M and adds a high gain output amplifier that reduces the read noise by almost half compared to the previous CCD. In addition to lower read noise, the bright points have been reduced by a factor of ~10X and our tests show the typical dark current is also reduced by approximately 2X compared to the previous versions of the CCD. These same improvements are also found in the single shot color version of the CCD used in the ST-2000XCM color camera as of July, 2004 (All ST-2000 monochrome and color cameras beginning with serial number 20407000 or higher). Previously, Kodak improved the Quantum Efficiency of the 2000 series CCD when it upgraded the KAI-2000M to the KAI-2001M. This higher QE is retained in the new KAI-2020M, with approximately 25% to 40% higher QE (10% to 15% absolute) across the visible spectrum than the former KAI-2000M. Also, In August, 2003, we switched to the larger TC-237H built-in guiding CCD instead of the TC-211. This improvement was the same as the upgraded autoguider installed on the larger ST-8XE, ST-9XE and ST-10XE cameras.

In May of 2004 SBIG began including a custom Pelican carrying and storage case with the ST-2000XM and ST-2000XCM models. This case is dustproof, waterproof and crushproof and carries a lifetime guarantee from Pelican. As of the date of this announcement, we are also upgrading the version of TheSky software by Software Bisque that we include with the ST-2000XM

camera from version 4 to version 5, a \$129 value. If you have a Macintosh computer running OS-X we will even throw in Equinox camera control and planetarium software for the Mac as well! A Linux acquisition program is free and other Linux software is also available. We continue to include CCDSoftV5 in addition to CCDOPS version 5 the most complete package of camera control, image processing, astrometric, star charting and planetarium software available with any new CCD camera from any manufacturer. Upgrades are available for most of these improvements for older ST-2000XM camera owners. All of these improvements have come at no additional increase in the price of the ST-2000XM camera since it was introduced. In fact, the ST-2000XM is priced lower in 2005 than it was in 2004.

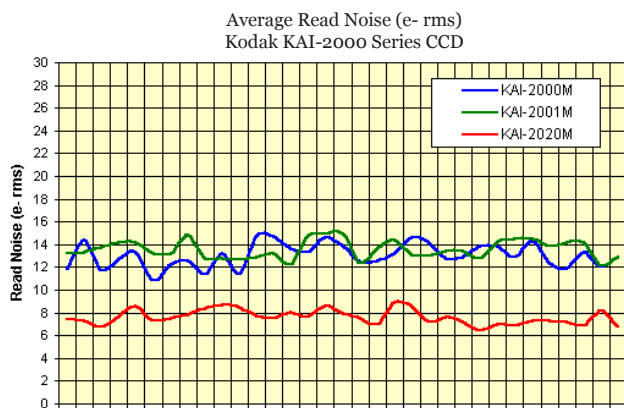
The full frame download time is approximately 4.5 seconds with our high speed USB electronics. This camera is also fully compatible with all of our existing accessories such as the CFW8 filter wheel and AO-7 adaptive optics device. The ST-2000XM has antiblooming protection and the quantum efficiency is comparable to the ABG versions of the enhanced full frame "E" detectors used in the former ST-7XE and ST-8XE 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.

Features

Improved Read Noise and Dark Current

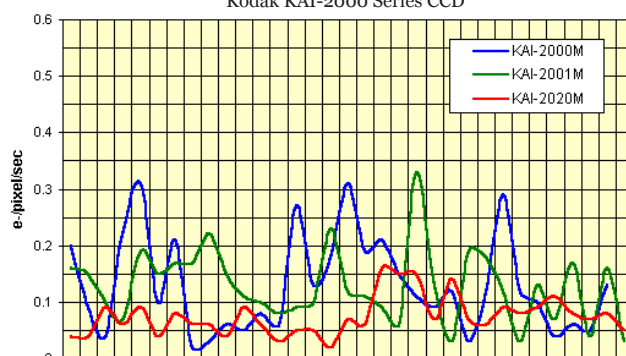
Parameter	KAI-2000M KAI-2001M	KAI-2020M
Typical Read Noise (rms) average	13.5e-	7.6e-
Typical Dark Current (average e-/p/s at 0°C)	0.18e-	0.06e-
Typical Dark Current in the top 1% of pixels	2.5e-	1.1e-

The average read noise has been reduced by almost half in the new KAI-2020M CCD. Previous KAI-2000 series CCDs tested just under 14e- rms but the new KAI-2020M typically measures less than 8e-.



Measurements made of a number of cameras show that the previous CCDs had an average dark current of 0.13e- and 0.18e- for the KAI-2000M and KAI-2001M respectively. Tests of a similar sampling of cameras made with the new KAI-2020M CCD show an average dark current of 0.06e-.

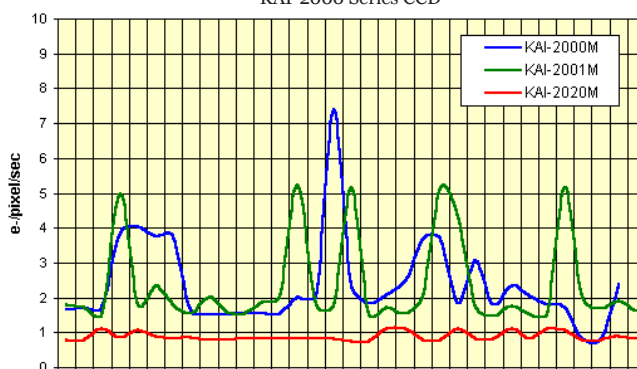
Average Dark Current at 0 C
Kodak KAI-2000 Series CCD



Measurements of the dark current in the top 1% of pixels shows a dramatic improvement. The previous detectors measured showed an average dark current in these pixels of around 2.5e- whereas the KAI-2020M measures on average only about 1.1e-.

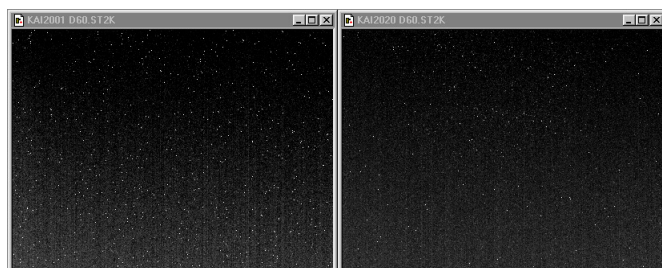
The lower read noise, lower dark current and reduced bright points (see below) combine to significantly enhance the performance of this new CCD.

Dark Current Top - 1% of Pixels at 0 C
KAI-2000 Series CCD



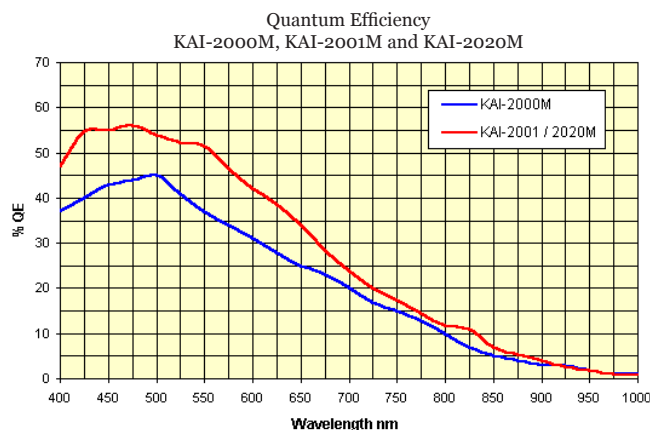
Reduced Bright Points

Bright points are different from dark current. Bright points are a population of brighter than average pixels. A comparison of one minute dark frames from the KAI-2020M and KAI-2001M illustrates the effect of the ~10X reduction in bright points. The KAI-2020M image is on the right, above. In either case, the bright points are very effectively removed with a filter in CCDOPS and other programs, and whenever a dark frame is subtracted from a light frame. The reduction in bright points does make a cosmetic improvement in unsubtracted images, however. The larger 4 Megapixel KAI-4020M CCD, for example, is very similar in performance to the KAI-2020M, it has virtually the same CCD architecture, read noise and dark current, just more pixels.



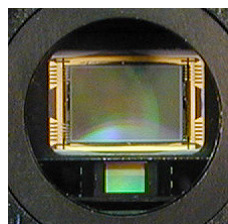
Improved Quantum Efficiency

The QE of the new KAI-2020M CCD used in the ST-2000M Camera since July 2004 is the same as the ST-2001M, in use since January 2003. It is significantly higher across the visible spectrum than the former KAI-2000M CCD. Typical of the Kodak interline CCDs, this improvement is greater towards the blue and green portion of the spectrum and smaller towards the red and near IR portion of the spectrum. Nevertheless, the camera is quite capable of H-alpha imaging through a narrow band filter. For examples of some H-alpha images with the new CCD click [here](#). The KAI-2001M CCD is used in all ST-2000XM cameras produced in 1993, up until July, 2004 (serial numbers beginning with 20301xxx and ending with 20406xxx). The KAI-2020M CCD is used in cameras beginning with serial numbers 20407xxx.

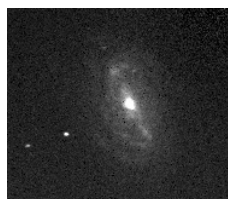


Improved Autoguiding with a Built-In TC-237H Autoguiding

Built-in Auto-guider	Array	Pixel Size	CCD Dimension (Area)	Field of View at 80" FL	Number of Pixels
TC-237H CCD	657 x 495	7.4 x 7.4 μ	4.9 x 3.7 mm (18.3 mm ²)	8.2 x 6.2 arcminutes (51 arcmin ²)	325,215
TC-211 CCD	192 x 164	~15 μ	2.6 x 2.6 mm (6.8 mm ²)	4.5 x 4.5 arcminutes (20 arcmin ²)	31,000



The TC-237 autoguiding CCD is seen here just below the larger imaging CCD. The TC-237H is the same CCD used in our \$1300 ST-237A imaging camera and \$2300 STV autoguiding. The TC-237H 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 having to hunt. The sample images below demonstrate the difference in field of view.



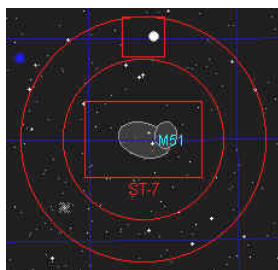
Field of View of TC-211 autoguiding through an 8" SCT at F/7. 30 second unguided image centered on NGC 2903 taken with the TC-211 tracking CCD. 192 x 164 pixels at ~15 microns (unbinned).



Field of View of TC-237 autoguiding 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. 328 x 247 pixels at 14.8 microns (binned 2x2).

In the tracking configuration, the TC-237H 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.

As of March, 2006, both the single CCD and dual CCD models also come with the Remote Guide Head port for attaching an external guiding head. TheSky 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.



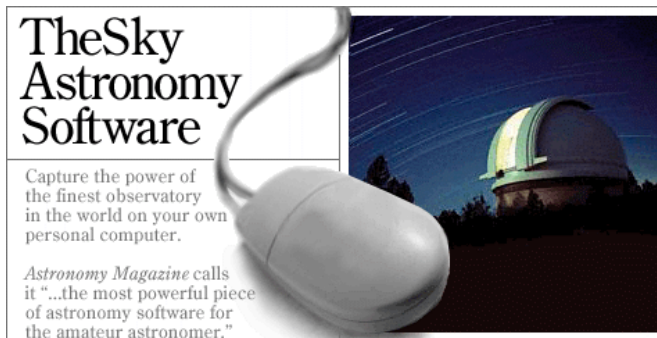
Previously, the camera had to be oriented so that the X and Y dimensions of the tracking CCD were aligned with the RA and DEC of the telescope, limiting the possible rotation of the camera to four possible positions around a target at 90 degree steps. Now, with CCDSoftV5, the autoguiding capability of 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.

Of course, 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.

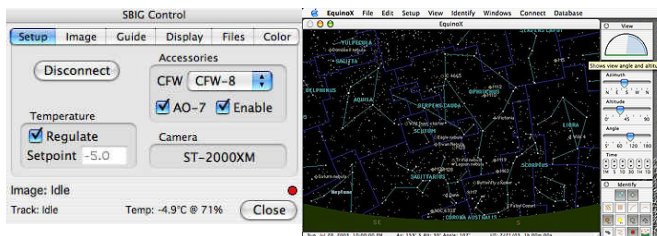
Upgraded Software – TheSky, Version 5, Level II from Software Bisque

Beginning with all camera shipped in October, 2004, we will include TheSky version 5, level II, instead of version 4. TheSky version 5, level II, is a complete camera control, image processing, astrometric, star-charting and planetarium software program for the PC. This is a full version of TheSky version 5, complete with manual on CD-ROM. This is a \$129 value at no additional cost. Users of TheSky version 5 may upgrade to the latest version 6 at a discount.



New – Equinox Planetarium Software with SBIG Camera Control for Mac OS X by Microprojects

If you use an Apple Macintosh G3, G4 or G5, with OS X 10.2 or later, Equinox 5.1 can control SBIG USB and Ethernet cameras. SBIG will send a free copy of Equinox upon request to any new SBIG camera purchaser with proof of purchase. Send us a copy of your invoice with camera serial number. Click on the Microprojects web site for more information.



Deluxe Carrying and Storage Case

The ST-2000XM and ST-2000XCM models now include a high quality carrying and storage case made for SBIG by Pelican. This deluxe carrying case is dust proof, water proof, crush proof and carries a lifetime guarantee from the manufacturer. The custom cut foam securely holds the camera and power supply with additional spots for accessories, cables, etc. There is even room for the camera with filter wheel and AO-7 attached.



Upgrades

Upgrades to a TC-237H autoguiding CCD are available to all previous ST-2000XM owners for \$395. Upgrades to the new KAI-2020M imaging CCD are available for \$995 for owners of older cameras. Upgrades from TheSky version 5 to the latest version 6 are available from Software Bisque. The custom Pelican carrying case is available for \$149.

Each new ST-2000XM camera system includes:

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. We even include some non-essential, but desirable, items such as a custom hard carrying case.

- Rugged camera body with imaging and autoguiding CCDs and new analog and digital electronics
- 2 Megapixel KAI-2020M imaging CCD with reduced read noise, lower dark current and 10X reduced bright pixels.
- Built-in TC-237H CCD autoguider with 10X the sensitivity of an ST-4 (TC-211 prior to 8/18/03).
- Remote Guide Head Port
- High speed USB interface (up to 421,000 pixels per second)
- New I2C bi-directional expansion port, compatible with the new CFW-10 filter wheel.
- 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 with new, updated, CCDOPS manual on CDROM
- Software Bisque's CCDSoftV5 camera control and image processing software
- Software Bisque's TheSky version 5, level II, with manual on CD-ROM
- Printed Camera Operating Manual
- Custom design hard carrying case with pre-cut foam for your camera and accessories.

Comparison Chart	ST-2000XMI	ST-2000XM
2 Megapixel KAI-2020M CCD	One Class	One Class
Column defects allowed	None	None
High Speed USB Interface	I	I
Internal shutter for automatic dark frames	I	I
Internal ROM for CFW8A control	I	I
Regulated thermoelectric cooling with fan	I	I
Universal Power Supply	I	I
USB Cable	I	I
Adjustable t-thread interface block	I	I
2" nosepiece with t-thread base	I	I
CCDOPS ver.5 software on CD-ROM	I	I
CCDOPS ver.5 manual on CD-ROM	I	I
Camera Operating Manual	I	I
TheSky v.5, level II software on CD-ROM	I	I
TC-237H Tracking CCD (657x495 at 7.4u)	\$395	I
Custom Pelican Carrying Case	\$169	I
Water Cooling Heat Exchanger	\$99	I
ST-7RC Adapter and Relay Cable	\$9	I
Printed Camera Operating Manual	\$15	I
Printed CCDOPS ver.5 Manual	\$15	\$15
1.25" nosepiece	\$49	\$49

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