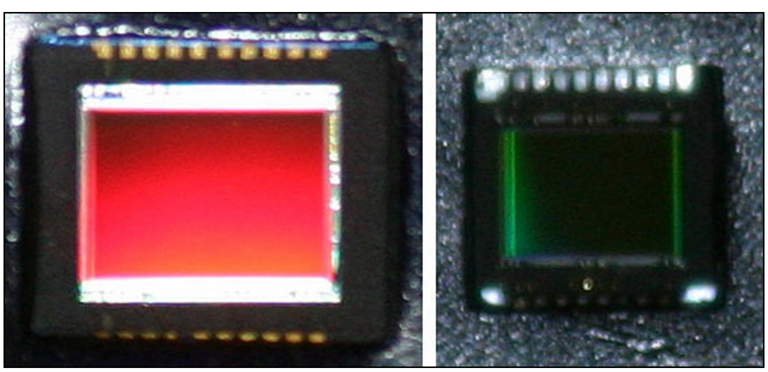
Overview

For the past four years, Meade has taken the imaging world by storm with the introduction of its new Meade DSI (Deep Sky Imager) family of astronomical imaging cameras. In 2004 they re-entered the imaging market with the first DSI, a color camera with a Sony ExView HAD chip soon followed by a monochrome variant the next year. By the end of 2005, Meade introduced another version of the DSI in the DSI II and DSI Pro II, with larger chips and greater sensitivity. The cameras quickly took their place within the astro-imaging community as a good introductory product at a great price gathering a large following of not only new but also experienced imagers. One Yahoo group set up to support the new line of cameras had over 500 members prior to the actual release of the camera, such was the fan fare surrounding these new products.

By 2007, the thousands of dedicated DSI users were looking to Meade once again take the next step in its astro-imaging product line and Meade was listening. The DSI III and Pro III cameras are Meade's answer to those requests and once again, they have gone above and beyond the competition in maintaining their pledge to producing a high quality product at a great price. But the DSI III is not only the next logical upgrade for current DSI owners, it is also a camera which new imagers will find as easy to use as the previous versions and experienced imagers will find meets the demanding requirements of long exposure deep space astrophotography. With its larger chip, extremely low noise, binning capabilities, and progressive scan image transfer, the DSI III provides a platform that serves equally well from very short planetary exposures to hour long narrowband deep space imaging.

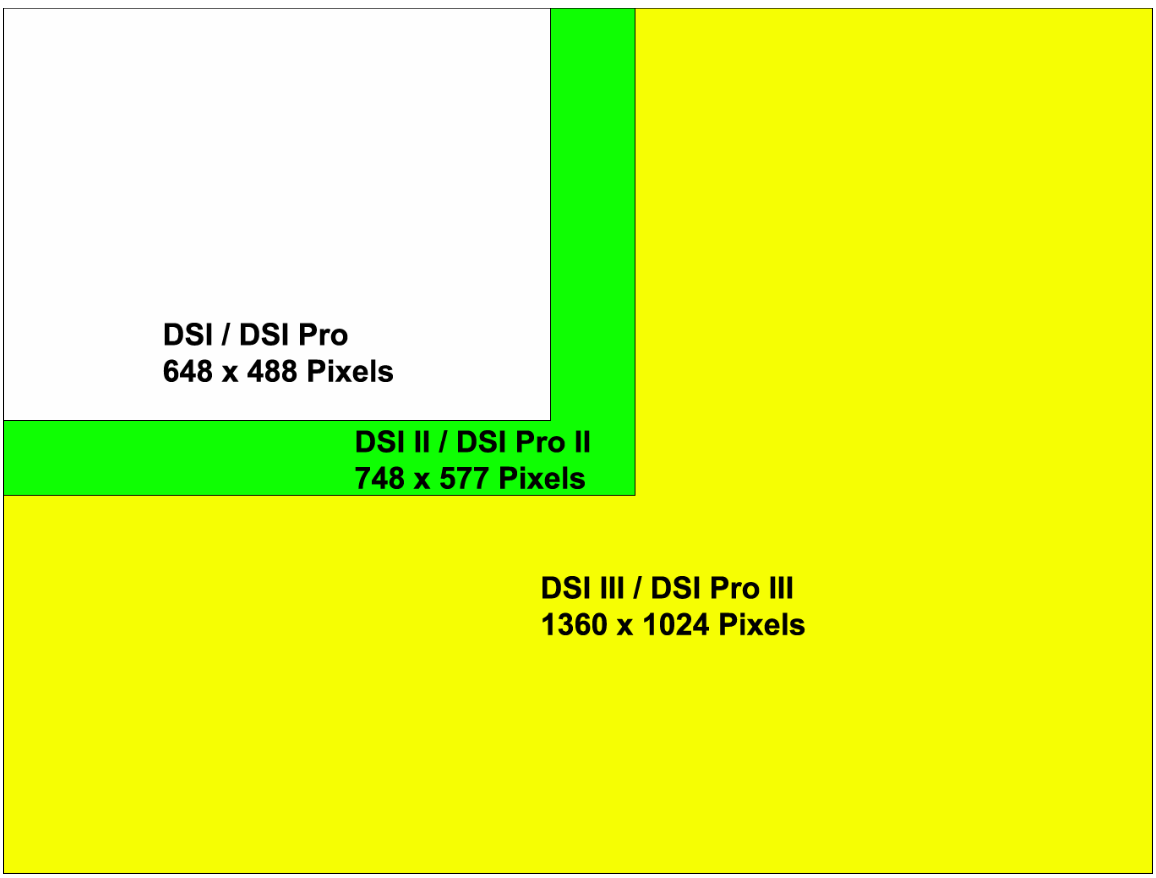
The CCD Chip

The most obvious improvement in the new DSI III is of course the larger CCD. For this camera, Meade selected the largest ExView HAD chip that Sony makes, the ICX285AL for the monochrome DSI Pro III and the ICX285AK for the color DSI III. These chips are 2/3rds of an inch in size and boast a large 1360 x 1024 pixel array producing images of approximately 1.4M Pixels. The image below shows a comparison of the DSI Pro II chip along side the new DSI Pro III chip.



While the chip is larger then its previously used cousins, other major improvements not immediately noticed by just looking at the chip size are as a result of the pixel composition itself. The pixels in the DSI III cameras are 25% smaller then in previous versions with the pixels on these chips being 6.4 x 6.4 microns in size. This smaller pixel size greatly increases the capabilities of this camera for wide field DSO imaging allowing the astro-imager to use shorter focal length scopes without undersampling. In fact, the optimum focal length for these chips for wide field imaging falls between 400 and 800mm, or around 1.5 arcseconds per pixel, which also makes telescopes such as the Meade 80ED APO and the Meade 8" Schmidt-Newtonians a nearly perfect match for these cameras. Many astro-photographers using smaller chip cameras attempt to get very wide field images by reducing focal lengths below 400mm with the results often being bloated stars and a loss of image detail. The DSI III, with its 6.4 micron pixel size makes these wide field images possible without sacrificing image quality.

As mentioned before, the chip size in the new DSI III cameras is quite a bit larger then the previous DSI's with the new camera have a pixel array nearly twice the size of the DSI II and over twice the size of the original DSI. The image below shows how each of these cameras stack up against each other in terms of image size.



Of course, along with a larger image size comes a larger FOV. It should be noted that while the number of pixels is roughly double that of the DSI II, the pixels are smaller and as such, the FOV is not quite double that of the DSI II. However, as can be seen in the image on the following page, the FOV provided by the new chip is significantly larger then that provided previously and puts many larger objects on the chip in a single image that required a mosaic with the previous cameras.

DSI Pro II - 4 Frame Mosaic

DSI Pro III - Single Frame Image

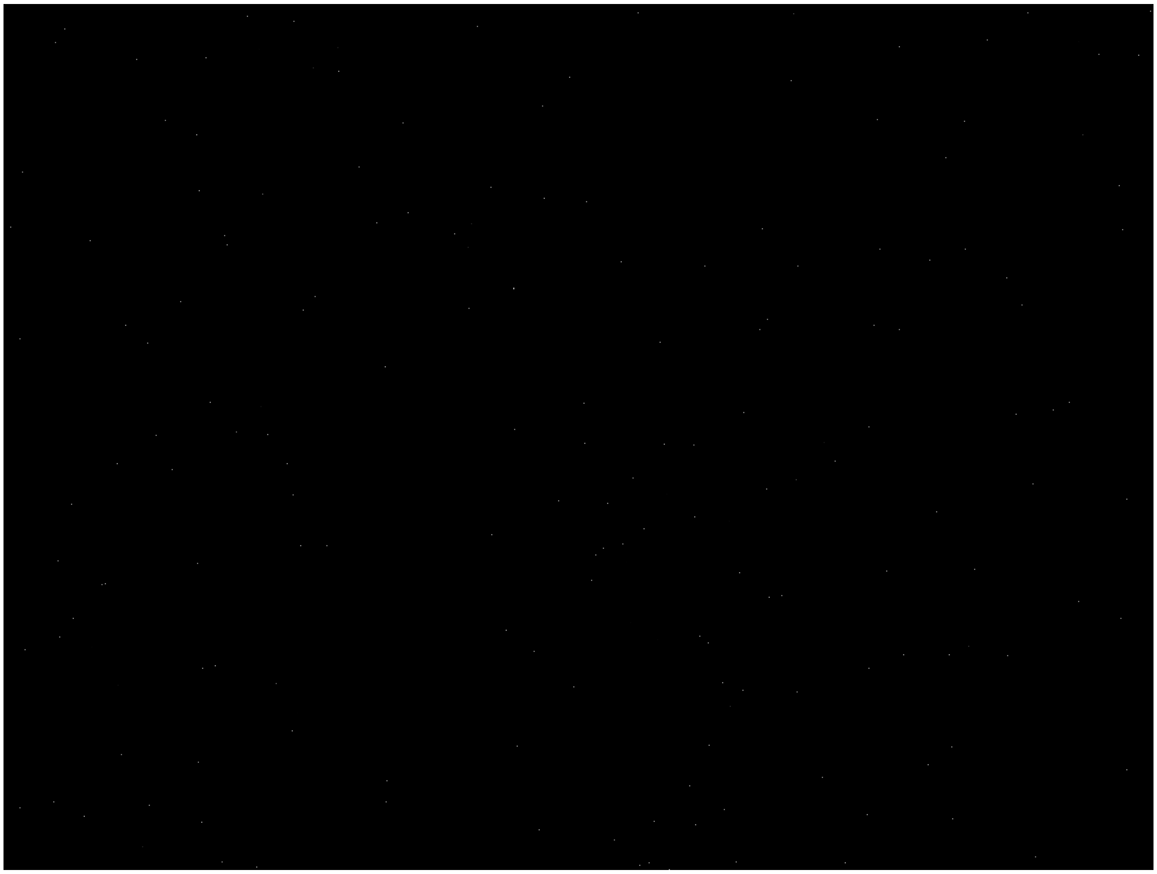
These two images of M31 were taken with scopes at nearly the same focal length. As can be seen, the image on the left was taken with a DSI Pro II and required several hours to capture and process into a four frame mosaic. The image on the right was taken with the DSI Pro III and required less then 1 hour to capture with no processing needed to form a mosaic as with the previous image. This feature alone will greatly increase the capabilities of the DSI cameras and objects that astro-photographers can add to their list as possible targets.

Low Noise

Noise generally exhibits itself in two ways in a CCD camera. The first is thru heat noise or hot pixels that show up in images as a direct result of exposure time and the temperature of the chip. The second type of noise is the random electronic noise that shows up as pixels of various brightness's throughout the image. Imagers have long known that in order to increase the signal to noise ratio, many images must be captured and stacked, or averaged, together and dark frames must be subtracted from each individual image prior to stacking. This can mean many long hours of imaging the same target to achieve this perfect signal to noise ratio.

One of the greatest benefits to the use of these chips in the new DSI III cameras is the extremely low noise when capturing long exposure images and the incredibly low dark current that will be seen in the dark frames. For the astro-photographer, this translates directly into fewer images required to gain the needed signal to noise ratio. Imagers that have used previous versions of the DSI or other cameras will notice a marked improvement in the signal to noise ratio and the ability to capture images in a much shorter time period then previously required.

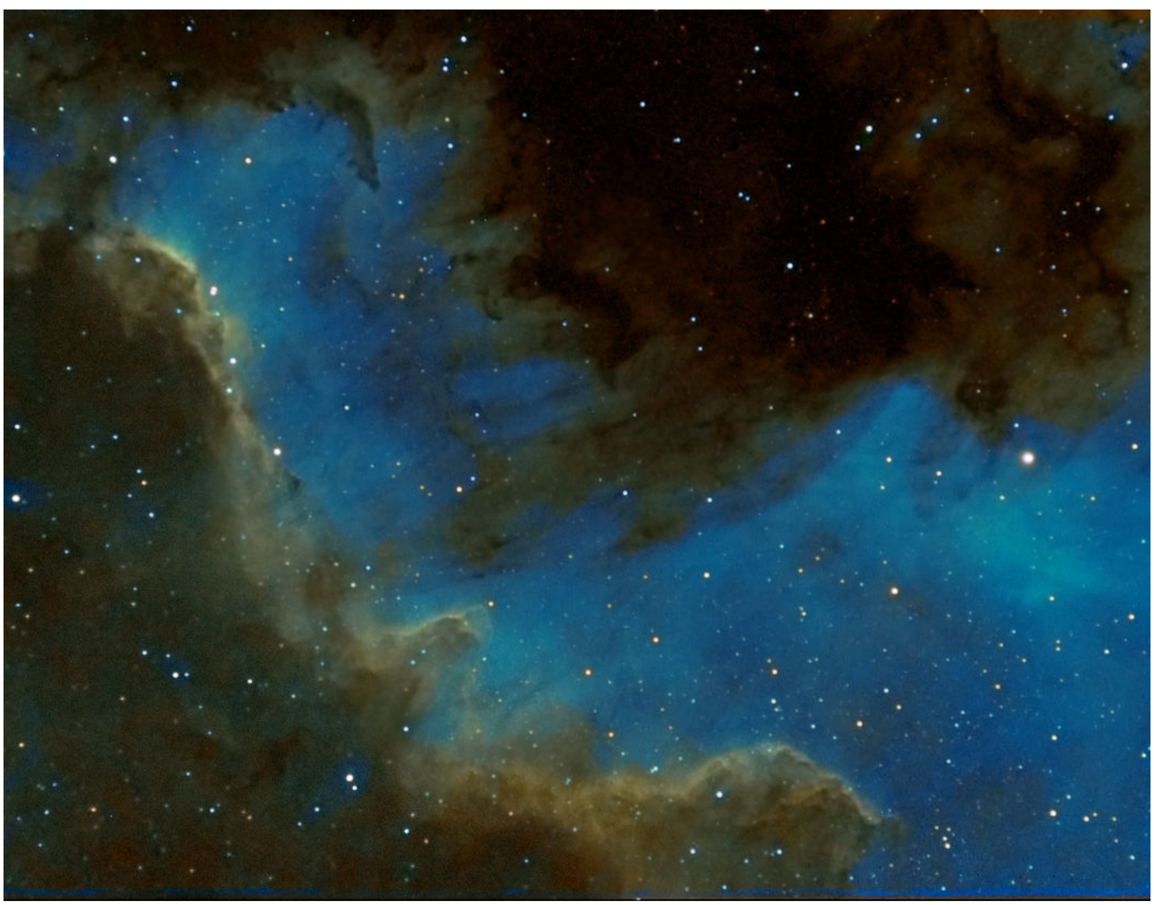
The image below shows the extremely low dark current of these chips. This image is a 20 minute dark frame captured at 21.5 degrees Celsius. As can be seen, the number of hot pixels evident in the image is very low and the image must be highly stretched to see many of them at all.



Due to the very low dark current of these cameras, Meade has been able to continue their tried and true approach to managing dark frames without the need for active cooling. In fact, since these cameras exhibit such a low count of hot pixels, users will find that they are able to utilize dark frames over a greater period of time and that they are able to take less dark frames for a given temperature allowing them to spend less time taking darks and more time capturing images. In tests performed at various temperatures on the new DSI Pro III, the author has found that for images of less then 2 minutes, it is quite possible to capture reasonably good images without the use of dark frames by simply increasing the number of images captured and averaging them together using a sigma clip combine methodology.

Of course, the real proof of the low noise characteristics of these cameras is in the images themselves. The image shown on the following page shows a single 3 minute exposure of M27 on the left (not stacked) and the resulting color image, on the right, created by taking L,R,G, and B filtered images. The low noise level and high contrast is easily evident in this image and is carried thru to the final image resulting in a highly detailed, low noise image.

Another obvious benefit of such a low noise chip is its increased suitability to very long exposures as well. Exposures of 10 to 30 minutes are well within the capabilities of these cameras and when combined with their vast sensitivity across the light spectrum, they will open the door to greater use of both conventional and narrow band imaging. This image of a portion of the North American nebula was captured using Ha, SII, and OIII filters and 10 minute exposures over a period of 3 hours.



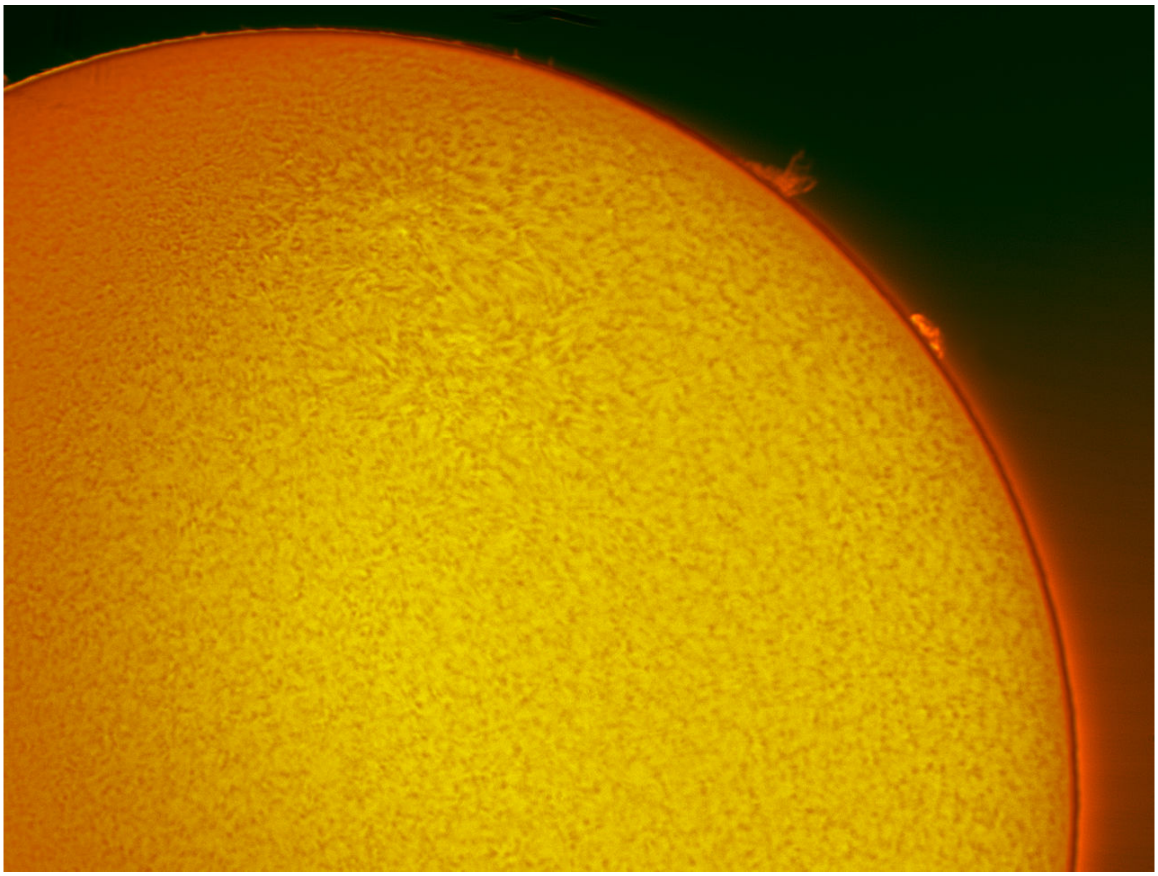
Progressive Scan vs Interlaced

Another major improvement in the use of these chips for the DSI III cameras is the move form interlaced capture and download to a progressive scan download. In previous version of the cameras, the images captured by the chip were read off in odd and even lines, then combined back together to get the full image. For long exposures over a few seconds this was never an issue but for shorter exposures of less then a second, the lines were easily visible and restricted the camera from being very usable for planetary or lunar imaging.

The new DSI's now utilize a progressive scan approach to downloading the images meaning that the image is read off of the chip in larger chunks and as such does not exhibit the lines seen in images before. While this has a definite benefit in limiting noise in the longer exposures, it also has the added benefit of allowing imagers to now use their DSI III cameras in a dual role as both a DSO and Planetary imager.

The image above was taken at exposures of less then a second an only 30 images were combined to utilizing the built in stacking routines of the Envisage software. Due to the cameras new smaller pixels and the progressive scan technology, it is now possible have an "All in one" camera that serves equally well on long and very short exposures.

To put this to the ultimate test, I decided to try something I had never been able to do before and that was to take an image of the sun. For this I used the DSI Pro III Camera thru a PST solar scope and a Meade 3x Series 5000 barlow. The images ranged from 3 hundredths to 1/3rd of a second and again, I used the built in Envisage align and stack capabilities to capture an image of solar flares on the sun. The image below shows the results of that test and speak to not only what one could do with no experience but shows what might be done even better by someone with solar imaging experience.

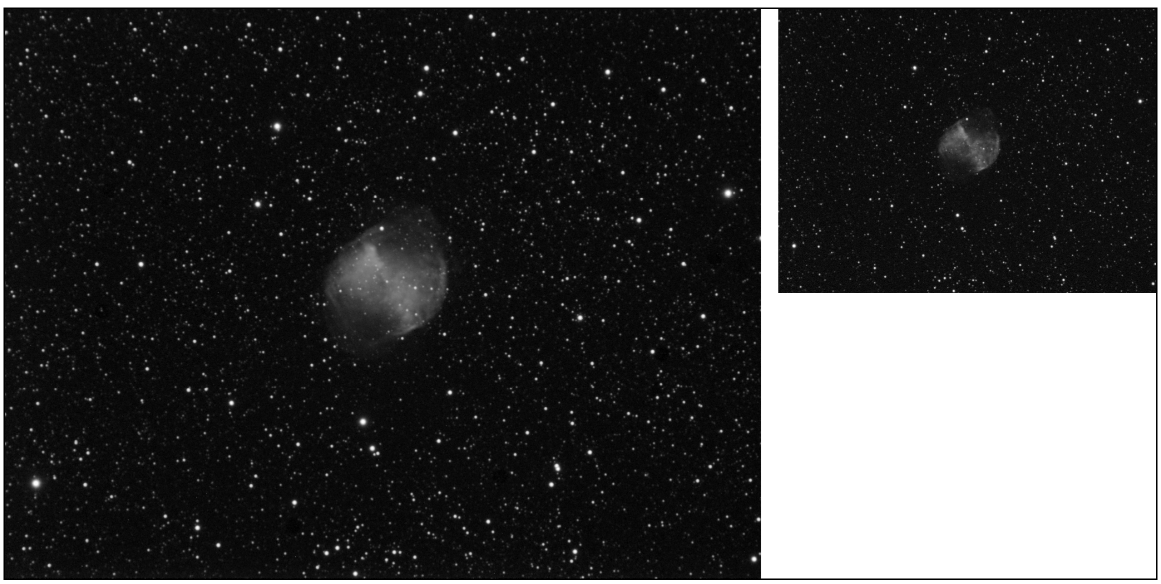


While I discovered that solar imaging poses many challenges that you might not find in other forms of astronomical imaging, the DSI III cameras are more then suited to the task of providing the imager with a platform that is highly capable of capturing these difficult images.

Binning

On Chip Binning is the ability of the chip produce an image that is half the size of the normal output by combining every other pixel together to produce a brighter image at a shorter exposure then would be possible at full output image size. This comes in very handy when doing RGB imaging and can become very important when doing long exposure narrow band imaging. By allowing the imager to take images in half the time but at the same brightness of a full frame image, the photographer is able to concentrate more time on the Luminance portion of an image taken at full frame size, and less time capturing the color channels that will go behind the luminance in the final image.

Binning has been one of the more requested features of the previous DSI cameras and for the first time since the introduction of the DSI, Meade has provided binning to their users. To demonstrate how well this works, the image below shows a full frame luminance image on the left and a binned color channel image on the right.



The image on the left is a stack of 3 minute images captured at the camera's normal full frame size and the image on the right shows the red channel captured in a 2x2 binned mode at 1 minute and 30 seconds, half the exposure time of the full frame. As can be seen, the red channel image is equally as bright as the full frame image meaning that the imager is able to capture all of their color data in half the time and still get the excellent results they have come to expect form these cameras.

Conclusions

In this article, I have touched on many of the new and important enhancements that have been incorporated into the new DSI III and DSI Pro III cameras. As with previous versions, Meade has invested a great deal of time, energy, and testing into these cameras to ensure that the final camera is not only a great product at a great price, but also that they continue a tradition of quality and ever increasing capabilities for which the DSI family of cameras have become known. With the introduction of the DSI III cameras, Meade is once again set to take the imaging world by storm and cement thier place at the table as a premier provider of high quality imaging products.

At less then half the price of their competitor's cameras, Meade has taken astronomical imaging to the next level and made it possible for many new and experienced imagers to participate in a world of previously reserved for purchasers of high priced cameras. Whether your goals are casual DSO imaging, very long exposure narrow band imaging, or even planetary, lunar, or solar imaging, the DSI III cameras are the single solution that will meet the needs of new and experienced imagers for many years to come.

Stephen P. Hamilton
King George Observatory
38° 21' 26" , -77° 03' 04"