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**Scientific Cameras
Catalog 2020**



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Inside Front Cover



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Scientific Camera Models

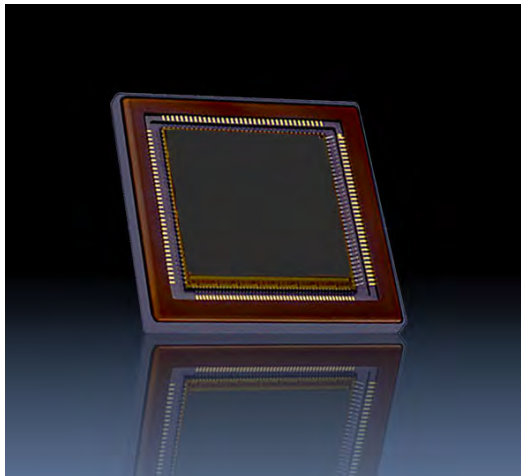
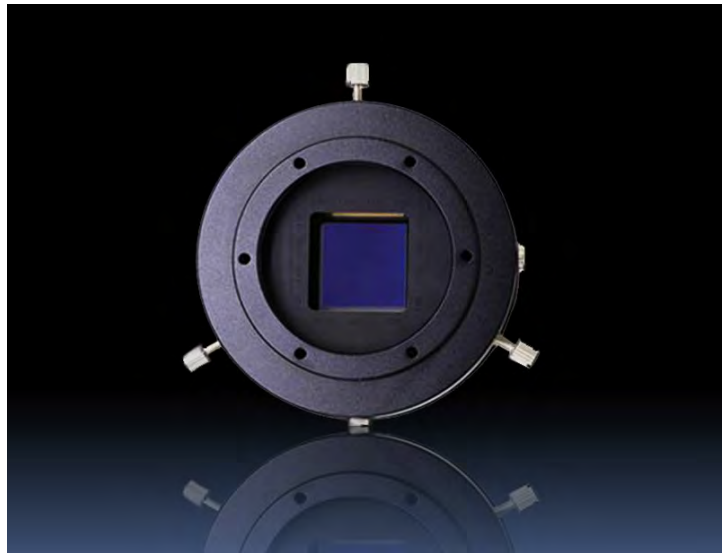
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QHY42PRO

sCMOS

4.2 Megapixels
Back-Illuminated
1.7e- Read Noise
Monochrome



Features:

- 4.2 Megapixels
- Back-Illuminated
- 95% Peak QE
- 1.7e- Read Noise
- UV Enhanced Version Available
- Dual 12-bit A/D
- 24 FPS at 12 bits, 48FPS at 8 bits

Back-Illuminated, 95% QE

The QHY42PRO uses the GSENE400 BSI Scientific CMOS sensor with extraordinary 95% peak QE, 79% UV QE and very good NIR response, plus extremely low read noise of 1.7e-. This camera is ideal for astronomical and biological science research. The QHY42PRO has relatively large 11um pixels in a 2k x 2k array. The sensor size is 22.5mm x 22.5mm yielding a good field of view even at longer focal lengths.

Ultra Low Read Noise 1.7e- Photon Counting

The low read noise and high QE make it possible to achieve high SNR even when imaging dim objects. Only 5 photons produce a SNR>3. Also, there is no microlens array that might influence photometric calibration.

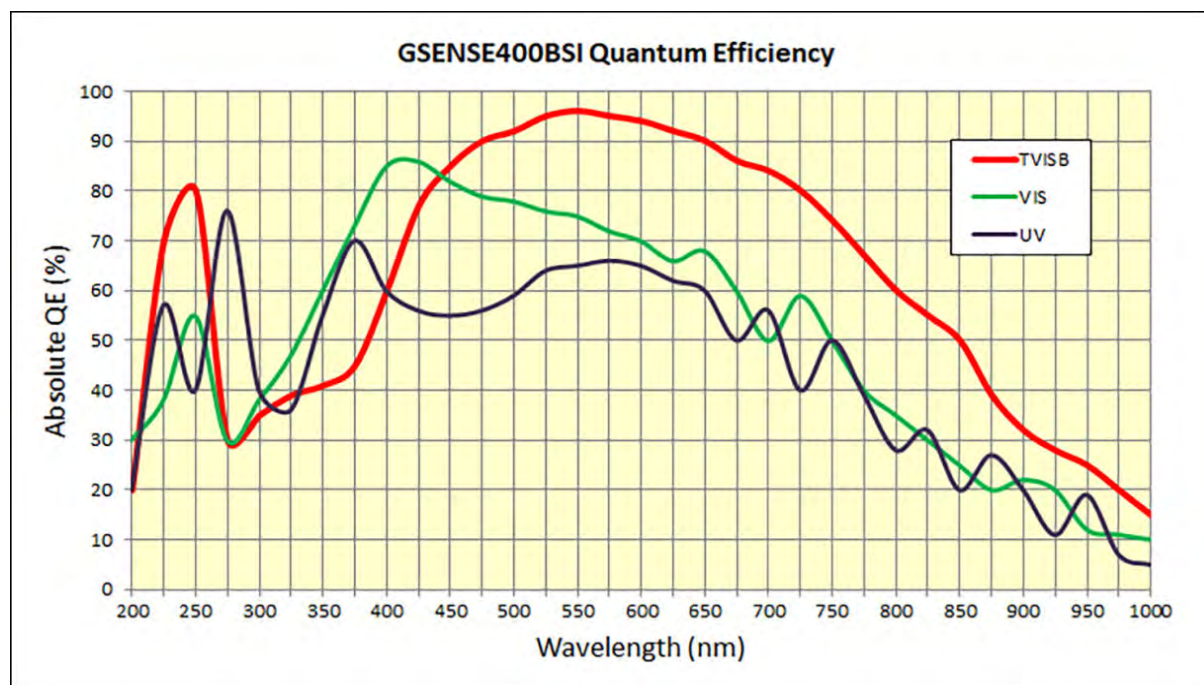
Multiple Interfaces USB3.0 / 10GigaE Custom Design

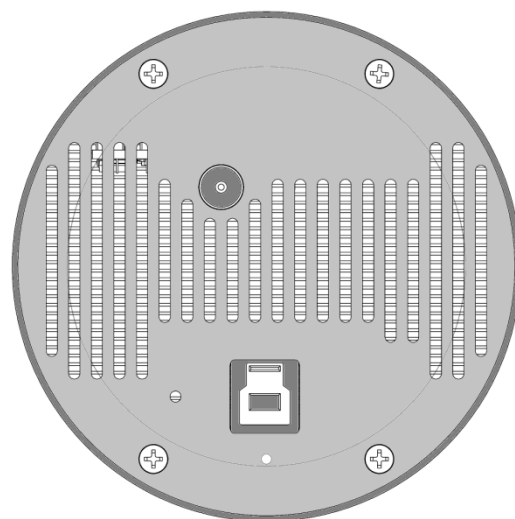
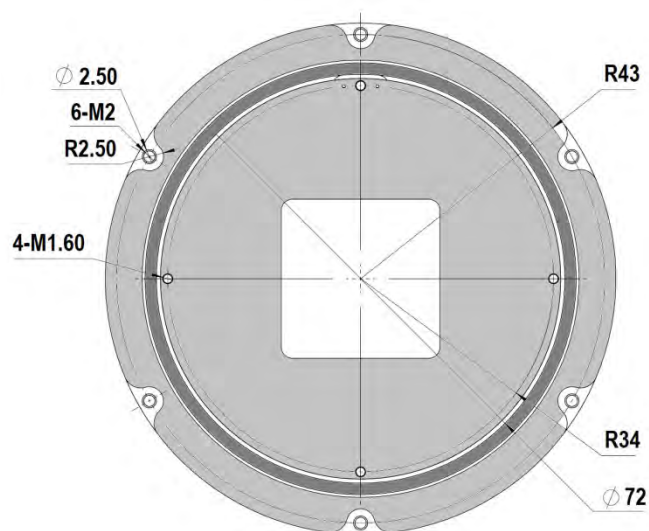
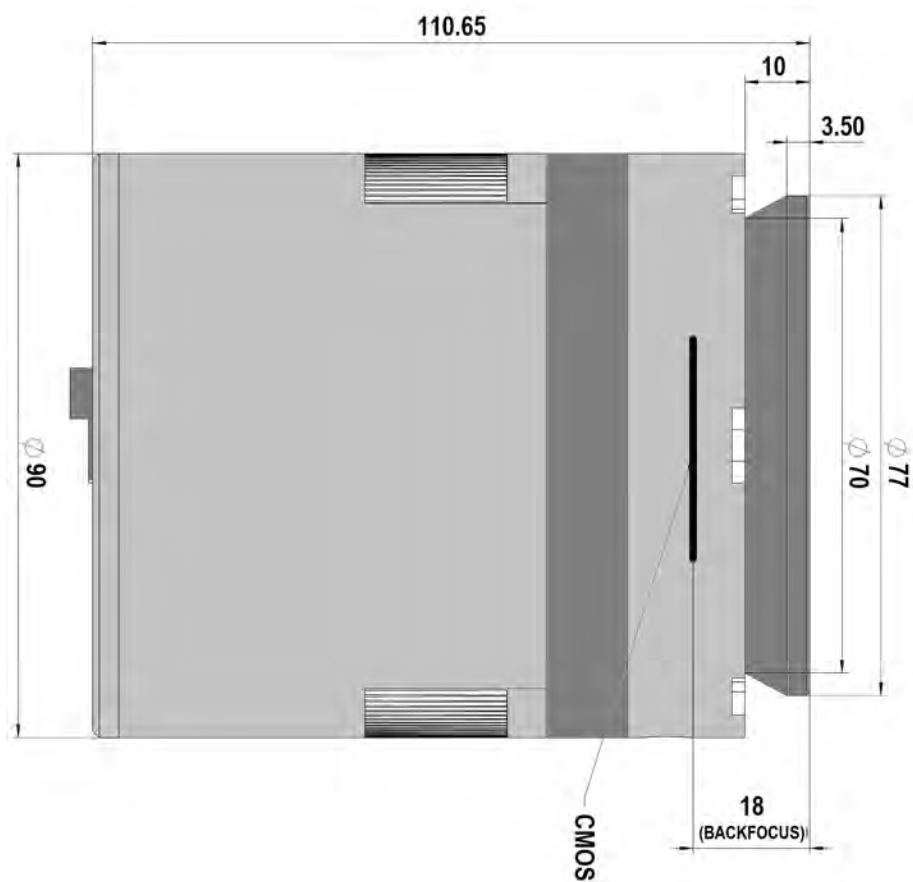
QHYCCD currently produces the standard USB3.0 version QHY42PRO with 24FPS in HDR mode and 48FPS in STD mode. The high speed 10GigaE version is under development and will support 48FPS HDR (2K x 2K x 2 A/D channels with 4096 x 2048 12-bit output).



Standard Version, 10GigaE Version, Custom Designs

The standard version has 2-stage TE cooling and USB3.0 interface. Single channel output is 24FPS at 12-bits. Dual channel HDR output is 12FPS at 12-bits and 48 FPS at 8-bits in STD mode. Currently under development, the 10GigaE version produces 48FPS with 2 x 12-bit dual channel outputs. (4096 x 2048 RAW HDR output). QHYCCD can supply the QHY42 CMOS sensor board plus the high-performance FPGA based image calculation platform. Five FPGA modes ensures maximum flexibility for the customized project. The original version can be upgraded without cost.





Preliminary Specifications QHY42PRO	
Sensor	Gpixel GESENSE400 BSI / UV
Pixel Size	11um x 11um
Sensor Surface Glass	Clear Glass / UV enhanced AR coating
Effective Pixel Area	2048 x 2048
Effective Pixels	4 Megapixels
Effective Image Area	22.5mm x 22.5mm
Fullwell	89ke-
A/D	Dual 12-bit A/D (High Gain Channel and Low Gain Channel)
Sensor Size	Typical 2-inch
Full Frame Rate and ROI Frame Rate	24FPS@4096*2048 dual 8bit (HDR mode) 12FPS@4096*2048 dual 12BIT (HDR mode) 48FPS@2048*2048 8bit (STD mode) 24FPS@2048*2048 12BIT (STD mode)
Readout Noise	1.7e-
Dark Current	0.7e-/pixel/sec @ -15C
Exposure Time Range	20us-300sec
Shutter Type	Electric Rolling Shutter
Computer Interface	USB3.0 (QHY42/HDR), 10GigaE Fiber (QHY42/HDR-10G)
Built-in Image Buffer	128MByte (512Mb) DDR2 memory in QHY42/PRO
Non-volatile internal flash memory for image storage	Built-in 100Kbytes user accessible memory for image storage of stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus, optics analysis etc. Support 100*100 image x 10 frames, 50*50 image x 40 frames, 25*25 image x 60 frames, 10*10 image x 1000 frames.
Cooling System	Dual Stage TEC cooler, -35C below ambient
Anti-Dew Heater	Yes
Telescope Interface	M54/0.75 female thread on the fast installer/center adjust ring
Optic Window Type	AR+AR High Quality Multi-Layer Anti-Reflection Coating
FPGA firmware remote upgrade	Yes, via USB port
Trig Out signal	Optional Support TrigOut hardware signal output



QHYCCD

QHY45GX, QHY50GX Large Area Cooled Research CCD Cameras



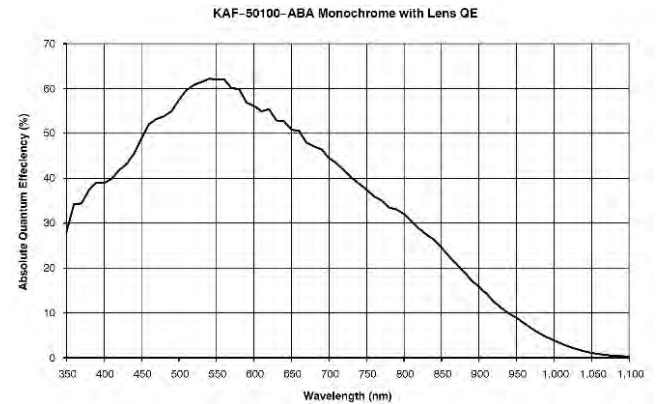
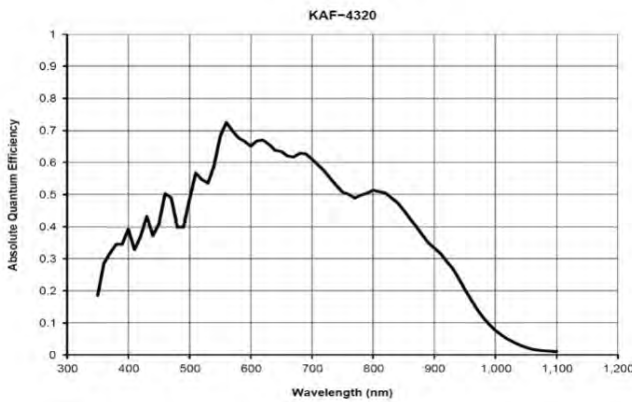
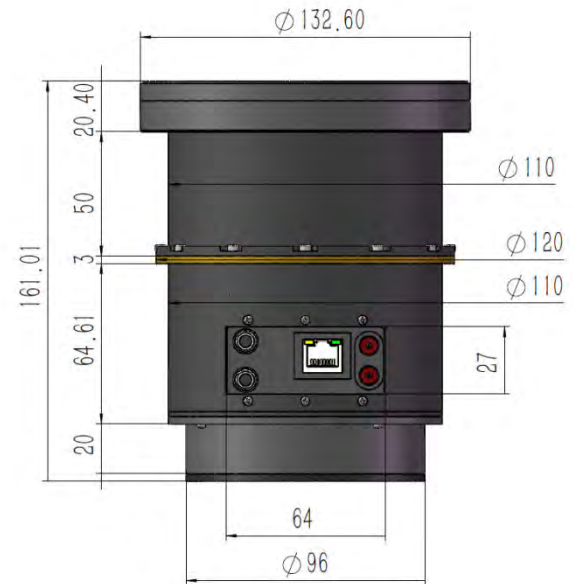
The QHY45GX and QHY50GX are large area liquid cooled CCD cameras intended for professional observatory use, or installations on large, long focal length optical systems. The QHY45GX imaging sensor is 50mm x 50mm (70mm diagonal) with 2k x 2k pixels at 24μm. The QHY50GX is a 50.1 Mp array that is 49.1 x 36.8mm (61mm diagonal) with 8176 x 6132 pixels at 6μm. Both cameras have round bodies and are water cooled to avoid fan vibration and to prevent air turbulence in the optical path. Both cameras have a GigaE interface with 100 meter data transfer capability and industry level high data transfer stability.

The QHY45GX uses the On Semiconductor (Kodak) KAF-4320 Image Sensor, a high performance monochrome area CCD designed for a wide range of image sensing applications. The sensor incorporates true two-phase CCD technology, simplifying the support circuits required to drive the sensor as well as reducing dark current without compromising charge capacity. The sensor also utilizes the TRUESENSE Transparent Gate Electrode to improve sensitivity compared to the use of a standard front side illuminated polysilicon electrode. The full imaging array is read out of four outputs, each of which is driven by a low impedance two stage source follower that provides a high conversion gain. This combination enables low noise at a net readout rate of 12 MHz (3 MHz per output).

The QHY50GX uses On Semiconductor (Kodak) KAF-50100 Image Sensor, a high performance, 50-megapixel CCD. Based on the TRUESENSE 6.0 micron Full Frame CCD Platform, the sensor features ultra-high resolution, broad dynamic range, and a four-output architecture. A lateral overflow drain suppresses image blooming, while an integrated Pulse Flush Gate clears residual charge on the sensor with a single electrical pulse. A Fast Dump Gate can be used to selectively remove a line of charge to facilitate partial image readout. The sensor also utilizes the TRUESENSE Transparent Gate Electrode to improve sensitivity compared to the use of a standard front side illuminated polysilicon electrode.



LAMOST, the largest optical observatory in China currently uses four QHY45GX cameras

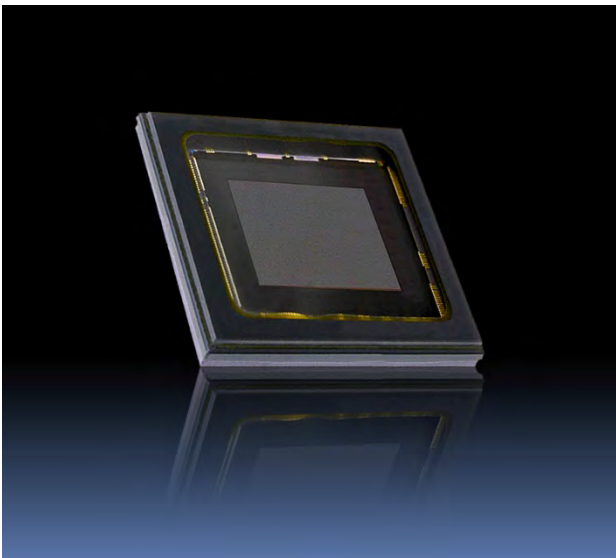


Model	QHY45GX	QHY50GX
Sensor	KAF-4320 CCD	KAF-50100-ABA CCD
Illumination	Back Illuminated	Back Illuminated
Total Pixels	4.3 Megapixels	50.1 Megapixels
Pixel Size	24um x 24um	6um x 6um
Pixel Array	2084 x 2085	8176 x 6132
Optical Format	645 Medium format	645 1.1x Medium Format
Photosensitive Area	50mm x 50mm, 70.7mm diagonal	49.1mm x 36.8mm, 61.3mm diagonal
Exposure	100us – 3600sec	50us – 300sec
FPS @ Full Resolution	24FPS	24FPS
Shutter	Mechanical	Mechanical
A/D Resolution	16-bit	12-bit
Read Noise	25e-	9e- to 10e-
Full Well Capacity	500ke-	40.3ke-
Cooling Delta	-40C, Regulated	-40C, Regulated
Peak Quantum Efficiency	73% @ 560nm	62% @ 550nm
Reference Price	\$50,000	\$16,500 (2 channel), \$17,500 (4 channel)



QHY550

**On-chip Polarizing Filters
4 Directions in Single Shot
High Frame Rates
Global Shutter**



Features:

- **World's First Color Polarizing Camera**
- **On-chip Four-Direction Polarizer**
- **Single Shot Polarized Images**
- **High Frame Rates**
- **Global Shutter**
- **ROI Mode**
- **Trigger Mode**
- **Low Dark Current**
- **2-Stage TE cooling**

World First Color Polarizing Camera

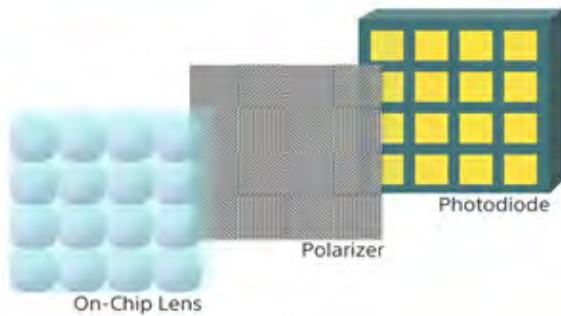
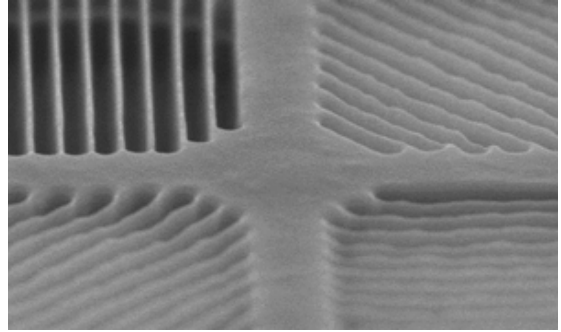
The QHY550 is the world's first color CMOS camera with on-pixel, four direction polarizing filters. The camera uses a 2/3-inch, 5 Megapixel, SONY IMX250 CMOS sensor with global shutter. The sensor is available in monochrome, color and a polarizing version. With the on-pixel four direction polarize filter, it can capture a polarized image with only one exposure. There is no need change the polarizing filter three times. It can generate a polarized video image at 68FPS high frame rate.

Wire-Grid Polarizers Semiconductor Process

The polarizer is formed on the photodiode of the image sensor chip. In addition to capturing brightness and color the image sensor can also capture polarization information that cannot be detected by a normal image sensor. Polarsens is a Sony CMOS Image Sensor pixel technology that places polarizing filters for several different angles of polarized light on chip during the semiconductor process allowing highly accurate pixel alignment.

Polarizer is formed on chip under the on-chip lens layer

With conventional types of polarization sensors, the polarizer is attached on top of the on-chip lens layer, however with Sony Semiconductor Solutions' polarization sensor the polarizer is formed on chip under the on-chip lens layer. A shorter distance between the polarizer and the photodiode improves the extinction ratio and the incident angle dependence. Since the polarizer is formed during the semiconductor process, form and formulation of polarizer, uniformity, mass productivity and durability are excellent compared to conventional polarization sensors. Furthermore, Sony's Polarization sensor is covered with an anti-reflection layer which helps to reduce reflectance and avoids poor flare and ghost characteristics.



Polarized Images at High Frame Rates, 67FPS @ 5.0mp

The QHY550 can capture a four-direction polarized image in one shot. It can calculate the direction and degree of polarization (DoP) based on the intensity of each directional polarization. Together with subsequent signal processing, it can capture the polarization information in real time. The QHY550 uses a USB3.0 interface. It can output 67FPS, full resolution 8-bit images. For 12-bit

output it achieves 34FPS at full resolution. By selecting a region of interest (ROI) it can output hundreds of frames per second.

Global Shutter

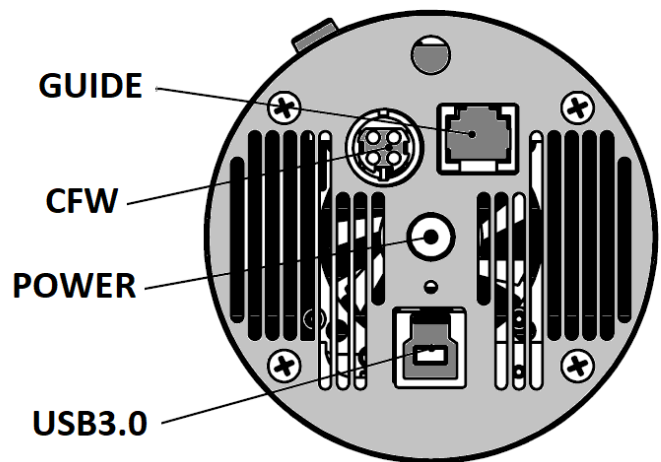
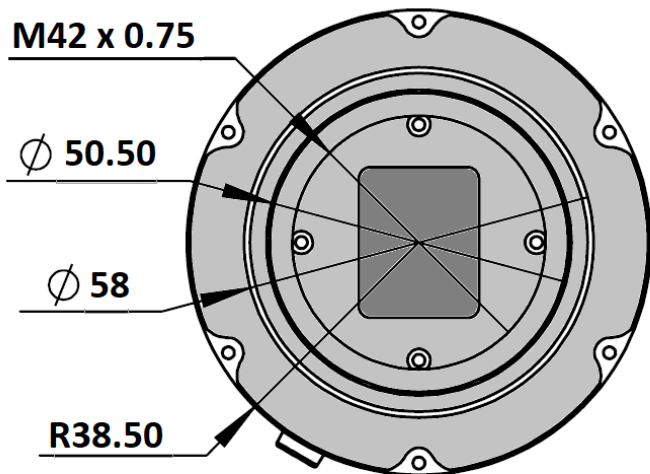
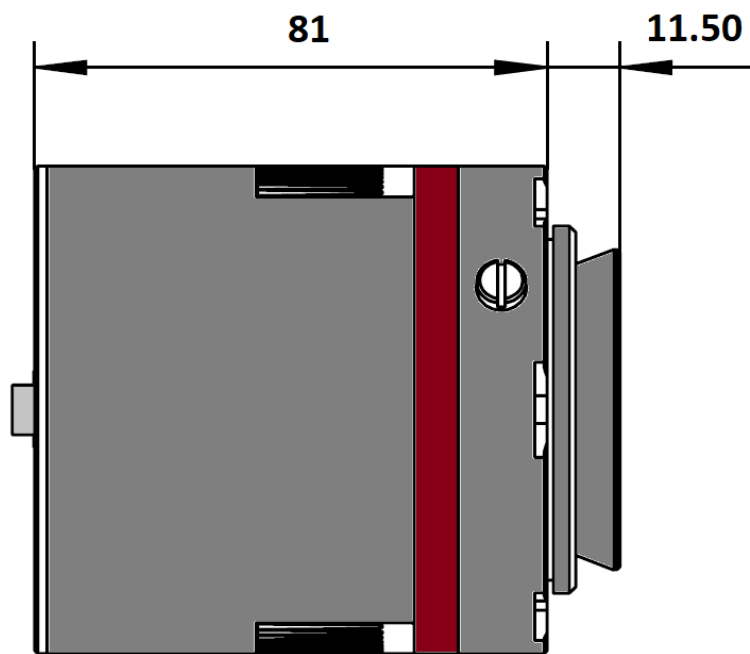
Some applications require imaging of fast-moving objects. However, existing CMOS image sensors are often unable to accurately identify such objects due to the focal plane distortion of fast-moving objects caused by the rolling shutter function. The IMX250 addresses this issue by providing an analog memory inside each pixel and realizing the global shutter function to enable high-picture-quality without focal plane distortion.

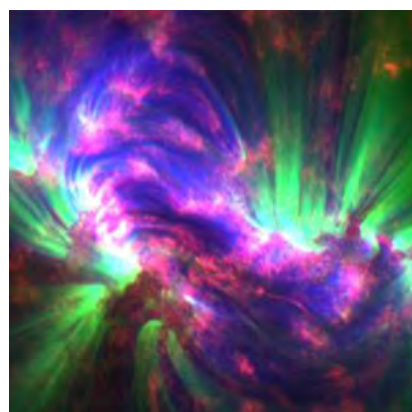
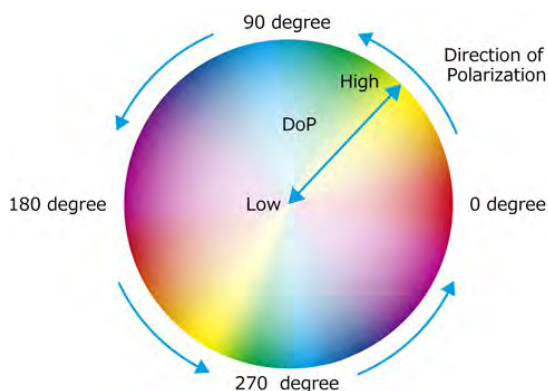
Low Dark Current, 2-stage TEC cooled, Temperature Regulated

QHY550 uses a two stage TEC to cool the sensor to -35°C below ambient. This can reduce the dark current of IMX250 significantly and greatly improves the dim signal detection performance. This is of benefit when detecting small differences in the polarized light in astronomical objects such as comets or the sun, in life science applications and in the optical lab.

Industrial, Gemstone and Biological Imaging

For production inspection, a polarized detector can be used to detect imperfections, scratches, etc., that might otherwise be missed. Polarized light has long been used in gemstone geology, material science and biological applications.





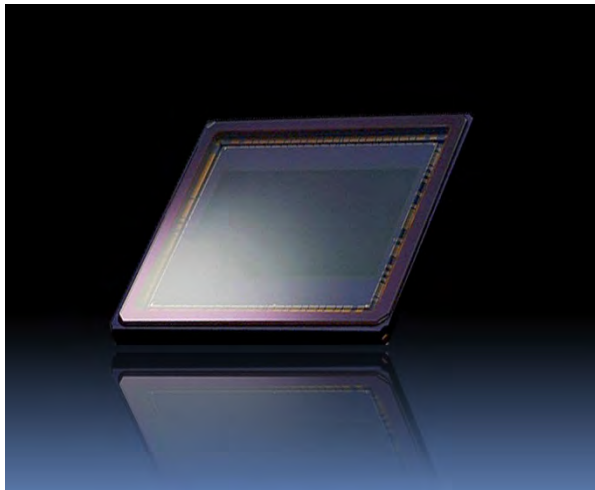
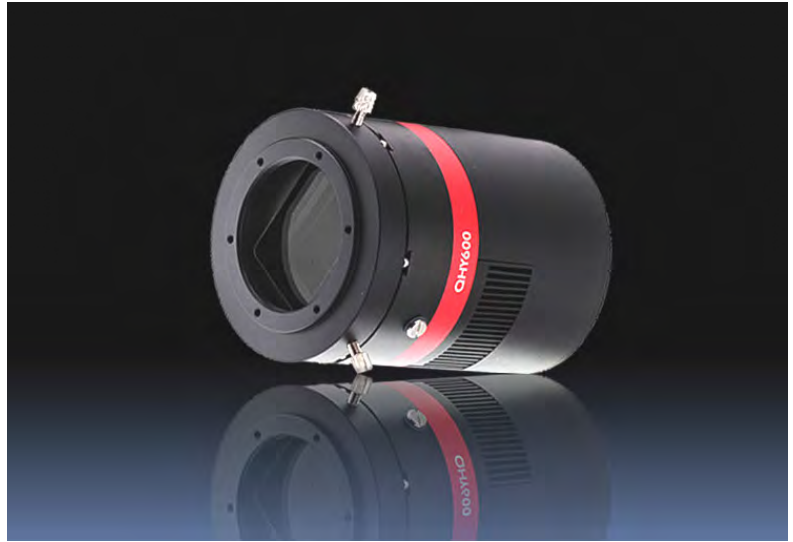
PRELIMINARY SPECIFICATIONS	
Model	QHY550M (Monochrome), QHY550C (Color), QHY550P (Polarized)
Sensor	SONY IMX250 Pregius Global Shutter CMOS Sensor
Pixel Size	3.45um x 3.45um
Effective Pixel Area	2464 x 2056
Effective Pixels	5.0 Megapixels
Effective Image Area	8.50mm x 7.09mm
Full Well	TBD
AD Sample Depth	12-bit (output as 16-bit or 8-bit format)
Sensor Size	Typical 2/3-inch
Full Frame Rate and ROI Frame Rate	2458*2056 68FPS@8BIT, 2458*2056 34FPS@12BIT ROI 1080lines (eg.2458*1080,1920*1080) 126FPS@8BIT ROI 480lines (eg.2458*480, 640*480) 270FPS@8BIT ROI 100lines (eg.2458*100,100*100) 940FPS@8BIT
Readout Noise	TBD
Dark Current	TBD
Exposure Time Range	20us-600sec
Anti-Glow Control	Yes
Shutter Type	Electronic Global Shutter
Computer Interface	USB3.0
Built-in Image Buffer	128MByte DDR2 memory
Cooling System	Dual Stage TEC, -35C Below Ambient
Anti-Dew Heater	Yes
Telescope Interface	M42/0.75 (C-mount optional)
Optical Window	AR+AR High Quality Multi-Layer Anti-Reflection Coating for QHY550M and QHY550P. IR cut Coating for QHY550C

*Note: QHYCCD has optimized the CMOS drive frequency and limits the max frame rate. The CMOS sensor may not work under the maximum frequency to ensure the better noise performance. If you need a higher frame rate version please contact QHYCCD.



QHY600

61 Megapixels
Back-Illuminated
1e- Read Noise
16-Bit A/D



Features:

- 61 Megapixels
- Back-Illuminated
- Native 16-bit A/D
- Ultra-Low 1e- Read Noise
- Deep Full Well, High Dynamic Range
- Low Dark Current
- USB 3.0 and 2x10GigaE

High Resolution, 61 Megapixels, Full Frame

The QHY600 uses the new Sony Full Frame (35mm format) IMX455 Back-Illuminated CMOS Sensor. It is available in both a monochrome version and a color version. The IMX455 is a 61 Megapixel, scientific CMOS sensor with 3.76um square pixels and 16-bit ADC. The sensor size is 36mm x 24mm.

Full Well Capacity, >51ke- at 3.76um, >400ke- Binned and up to >720ke- in Extended Mode

One benefit of the back-illuminated CMOS structure is improved full well capacity. This is particularly helpful for sensors with small pixels. Even with unbinned 3.76um pixels the QHY600 has a full well capacity >51ke-. When binned 2x2 to 7.5um the full well is >204ke- and when binned 3x3 to 11um the full well is >408ke-. In extended mode the full well is >80ke- unbinned, >320ke- binned 2x2 and >720ke- binned 3x3.

Native 16-bit ADC

With native 16-bit A/D on-chip, the output is real 16-bits with 65536 levels. A 16-bit ADC has a higher sample resolution than 12-bit or 14-bit ADC and the system gain will be less than 1e-/ADU. The QHY600 uses software digital binning. With digital summing, 2x2 binning will be four 16-bit summed = 18-bits.



Breakthrough Low Read Noise 1e- to 3.7e-

The QHY600 is capable of only one electron of read noise at high gain and 2 FPS high readout speed. One electron of read noise means the camera can achieve a $SNR > 3$ at only 3 to 4 photons. This is perfect performance when conditions are photon limited, i.e., short exposures, narrow band imaging, etc., making this large area sensor ideal for sky surveys and time domain astronomy.

Back-Illuminated, >87% QE, Low Dark Current

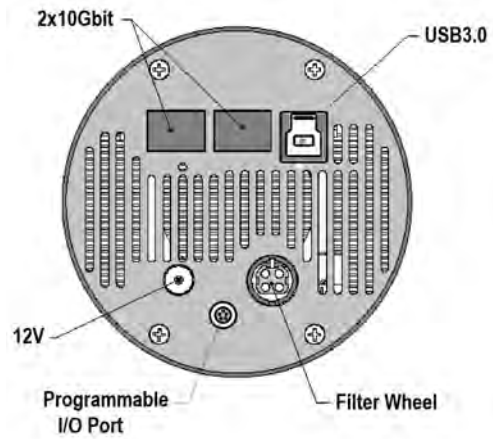
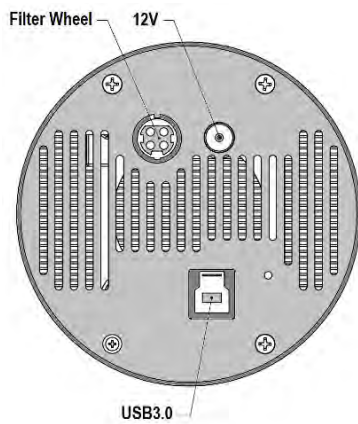
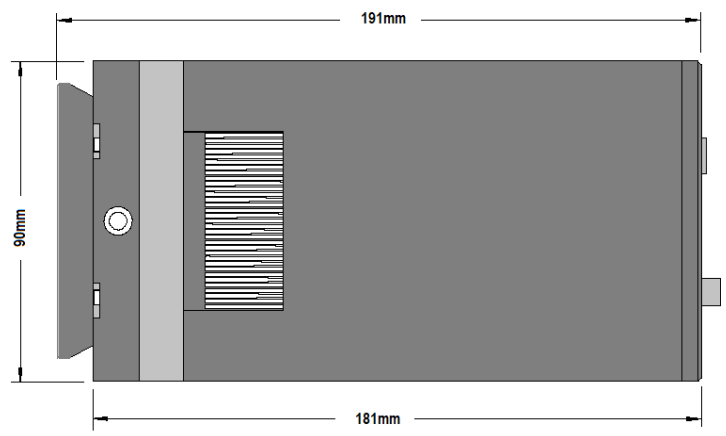
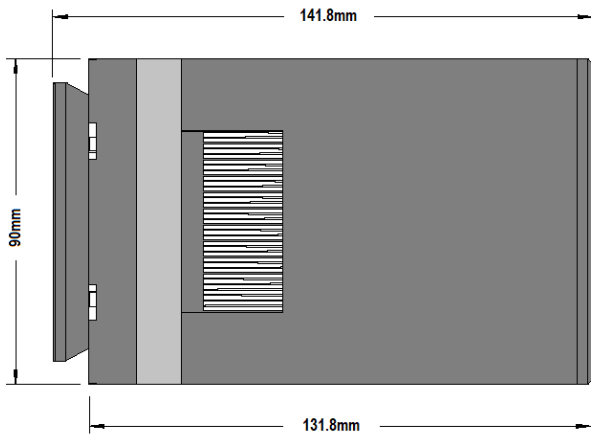
Sony's Exmor R back-illuminated technology produces sensors that Sony estimates are twice as sensitive as similar front illuminated sensors. QHYCCD tests have borne out this claim and based on our tests the peak QE is greater than 87%. Additionally, Sony sensors are well known for their low dark current. QHYCCD's proprietary thermal noise reduction technology and the QHY600's dual-stage regulated thermoelectric cooling further reduce dark current to extremely low levels, $0.0032e-/p/s$ at $-20C$ for clean, long duration exposures.

Best Match for RASA System

The round camera case design of QHY600 and the high resolution, large area, small pixel array is an ideal match for RASA optical systems.

Photographic and Professional Models

Choose between two models: The Photographic Model QHY600U3 or the Professional Model QHY600U3G20. Each model is available in monochrome or color. Image quality is identical between the two models, however the Professional Model with the longer body has additional features.



Photographic Model QHY600U3:

- USB3.0
- 2.5 FPS, full frame, 16-bit images
- 4.0 FPS, full frame, 8-bit image
- Support for ROI at higher frame rates

Professional Model QHY600U3G20:

- USB3.0
- 2x10Gigabit optical fiber interface *
- Programmable trigger in/out
- Advanced timing interface for GPS
- 4.0 FPS, full frame, 16-bit images
- 10 FPS, full frame, 14-bit images
- 30 FPS 8K video
- Support for ROI at higher frame rates
- Customizable FPGA

* Requires optional PCIe card from QHYCCD. Two 5m double optical fiber cables and two optical fiber modules are included with the camera.

Typical Specifications		
Model	QHY600U3 (Photographic Model)	QHY600U3G20 (Professional Model)
Image Sensor	Sony IMX455 Back-Illuminated CMOS	Sony IMX455 Back-Illuminated CMOS
Pixel Size	3.76um x 3.76um	3.76um x 3.76um
Color / Mono Version	Mono: QHY600U3M Color: QHY600U3C	Mono: QHY600U3G20M Color: QHY600U3G20C
Sensor Cover Glass	AR+AR Multi-Coated	AR+AR Multi-Coated
Sensor Type	Back Illuminated (BSI)	Back Illuminated (BSI)
Effective Pixels	61.7 Megapixels 9576 x 6388 effective pixels 9600 x 6422 with overscan and optically black pixels	61.7 Megapixels 9576 x 6388 effective pixels 9600 x 6422 with overscan and optically black pixels
Effective Image Area	36mm x 24mm, Full Frame Format	36mm x 24mm, Full Frame Format
FFull Well Capacity (1x1, 2x2, 3x3)	Standard Mode: >51ke- / >240ke- / >408ke- Extended Mode: >80ke- / >320ke- / >720ke-	Standard Mode: >51ke- / >240ke- / >408ke- Extended Mode: >80ke- / >320ke- / >720ke-
A/D	16-bit @ 1X1Binning, 18-bit @ 2X2, 19-bit @ 3X3, 20-bit @ 4X4	16-bit @ 1X1Binning, 18-bit @ 2X2, 19-bit @ 3X3, 20-bit @ 4X4
Exposure Time	40us - 3600sec	40us - 3600sec
Full Frame Rate	USB3.0 FRAME RATE 4.0FPS @ 8-bit 2.5FPS @ 16-bit 7.2FPS @ 9600x3194, 22.5FPS @ 9600x1080, 28FPS @ 9600x768, 47FPS @ 9600x480, 160FPS @ 9600x100	USB3.0 FRAME RATE Same as QHY600U3 2x10GIGABIT FRAME RATE 4FPS @ 16-bit 10FPS @ 14-bit, 30FPS 8K video
Read Noise	1.0e- to 3.7e- (Standard Mode)	1.0e- to 3.7e- (Standard Mode)
Dark Current	0.0032e-/p/s @ -20C	0.0032e-/p/s @ -20C
GPIO	N/A	4-Pin, High Speed, user programmable as Trigger In/Out, Multiple Camera Sync Capture Control, High Precision GPS time measurements. etc.
Firmware / FPGA Remote Upgrade	Supported via USB Port	Supported via USB Port
Shutter Type	Electronic Rolling Shutter	Electronic Rolling Shutter
Computer Interface ¹	USB3.0	USB3.0 and 2x10Gigabit Optical Fiber
Built-in Image Memory ²	1GByte (8Gbit) DDR3 Image Buffer plus 10MB user accessible non-volatile memory for (JPEG) Image Storage	2GByte (16Gbit) DDR3 image buffer plus 10MB user accessible non-volatile memory for (JPEG) Image Storage
Cooling System	Dual Stage TEC, -35C below ambient	Dual Stage TEC, -35C below ambient
Anti-Dew Heater	Yes	Yes
Telescope Interface	M54/0.75	M54/0.75
Optical Window Type	AR+AR High Quality Multi-Layer Coatings	AR+AR High Quality Multi-Layer Coatings
Power	40W@100%, 20W@50%, 13.8W@/0% TEC	40W@100%, 20W@50%, 13.8W@/0% TEC
Back Focus ³	17.5mm (±0.2)	17.5mm (±0.2)
Weight	TBD	915g
Reference Price ⁴	TBD	USD8000

¹ 2x10Gigabit Optical Fiber operation requires an optional PCIe card from QHYCCD. Contact QHYCCD.

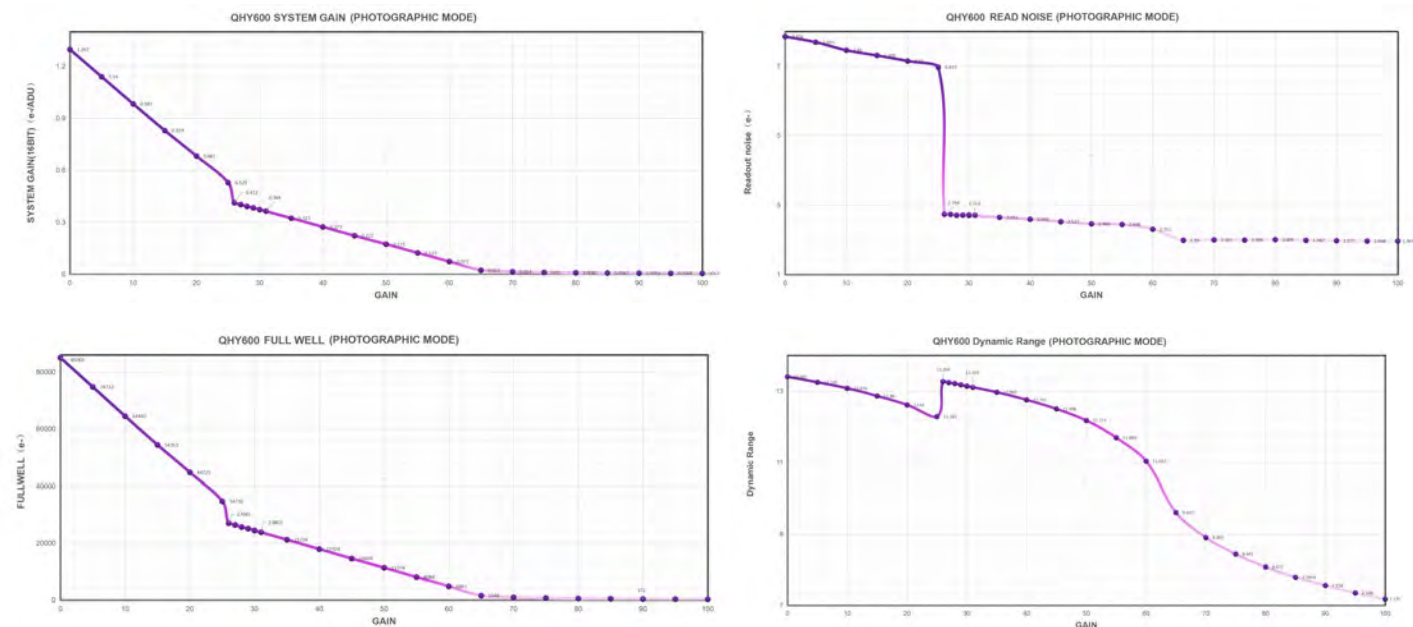
² 10MB user accessible internal memory for storage of images of stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus, optic analysis, etc. Storage for 100*100 image x 500 frames, up to 10*10 image x 250,000 frames.

³ An optional front plate is available that shortens the back focal length to about 6.7mm. Contact QHYCCD.

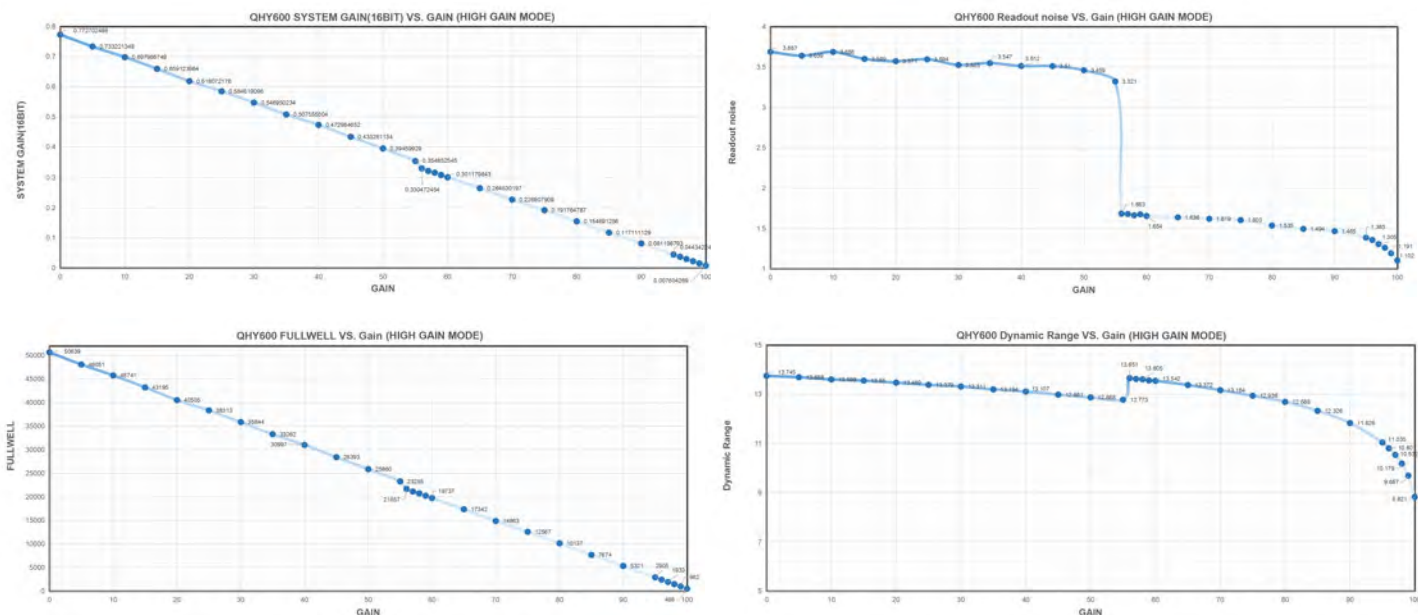
⁴ A limited edition "Early Bird" model using PRO model hardware but with the specifications of the PHOTO model is USD5000. This Early Bird model can be upgraded in the future to a full PRO version for the difference in price.

Readout Mode Selection is a new function for the QHY600 and other newer QHYCCD cameras. Different readout modes have different driver timing, etc., that cause the sensor to yield different performance results, allowing you to tailor the sensor response to your particular imaging needs. Each readout mode has its advantages and disadvantages. The QHY600 currently has three readout modes. In the future QHYCCD may add more modes.

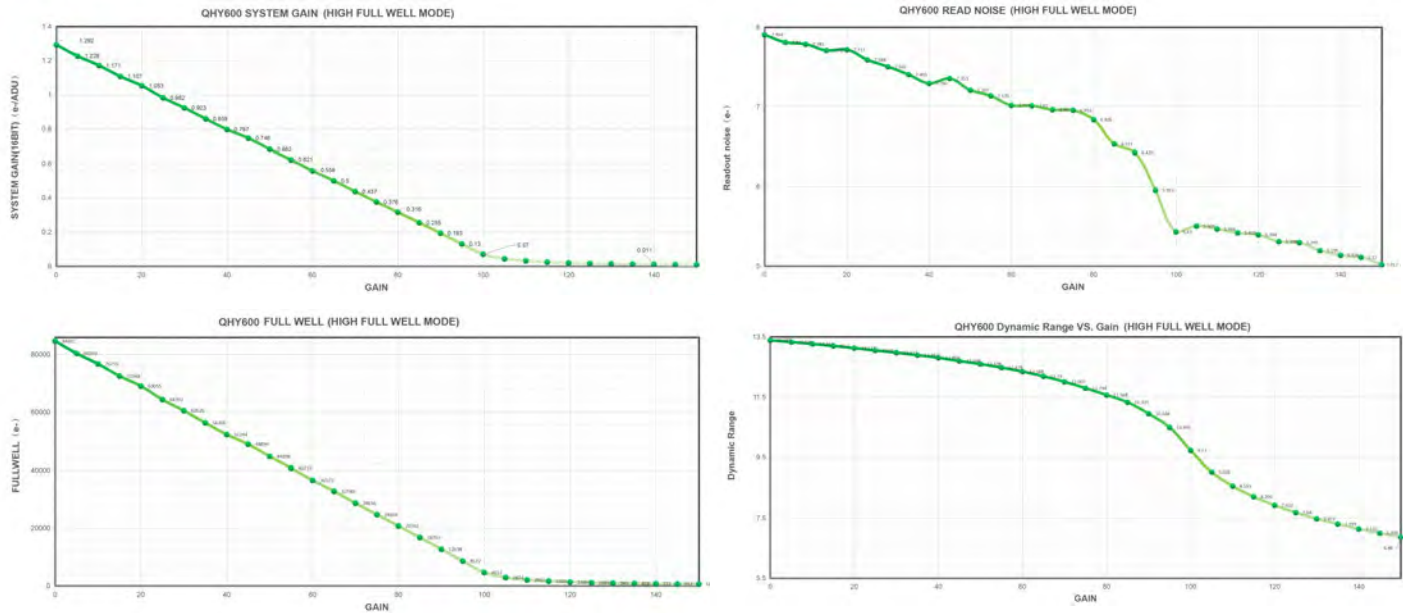
Readout Mode #0 (Photographic Mode). In this mode, the read noise of the QHY600 drops between a gain setting of 25 and 26. We therefore recommend setting the gain to 26 as a starting point. At gain=26, the full well is 27ke- and read noise is 2.7e-. For long exposures where read noise performance is not as critical, lowering the gain results in higher full well.



Readout Mode #1 (High Gain Mode). In this mode, the QHY600 switches from Low Gain to High Gain between gain settings of 55 and 56. Gain 0-55 uses LGC and Gain 55-100 used HGC.

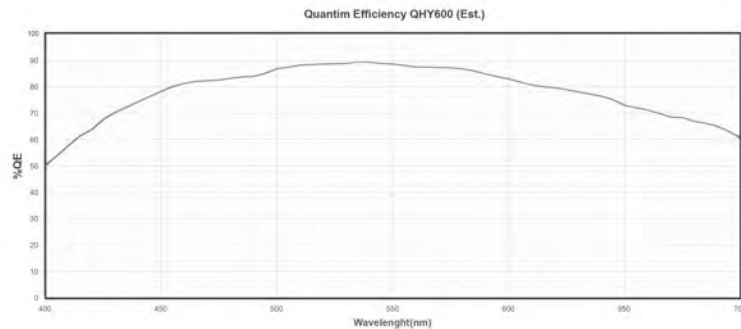


Readout Mode #2 (Extended Full Well Mode). In this Ultra-High Full Well Mode, the QHY600 exhibits an unbinned full well capacity of greater than 80,000e⁻. Binned 2x2 the full well is greater than 320,000e⁻ and binned 3x3 the full well is greater than 720,000e⁻.

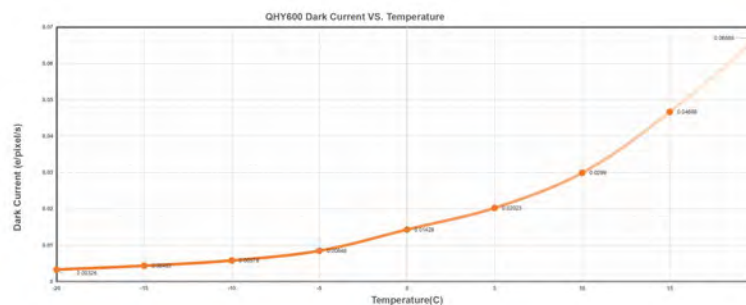


QUANTUM EFFICIENCY AND DARK CURRENT TEST RESULTS

Quantum Efficiency. Sony provides a relative QE curve for the IMX455 sensor. In order to determine the absolute QE of this curve QHYCCD ran tests comparing the response of the IMX455 sensor against a camera of known absolute QE at two wavelengths along this curve (489nm and 656nm). From these test results we can plot a good estimate of the QHY600 QE curve in absolute terms with a peak QE >87%:



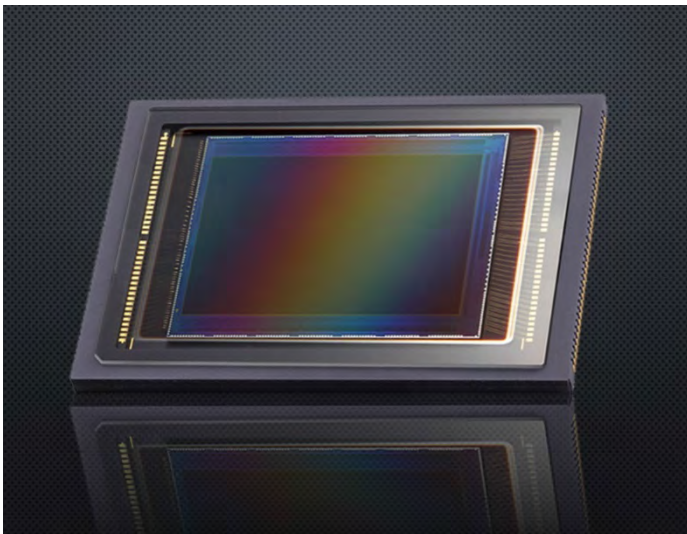
Dark Current. Dark current results for the QHY600 are based on measurements of the dark current of the IMX455 sensor installed in the QHY600 camera. At 0C the dark current is 0.014e⁻/p/s and at -20C it is 0.003e⁻/p/s:





QHY411

151 Megapixels
Back-Illuminated
16-bit A/D
1e- Read Noise
Mono or Color



Features:

- **World's Highest Resolution sCMOS**
- **151 Megapixels, 3.76um**
- **67.2mm Diagonal**
- **Native 16-bit A/D**
- **Ultra-Low 1e- Read Noise**
- **Deep Full Well, High Dynamic Range**
- **Back-Illuminated High QE Sensor**
- **Low Dark Current**
- **USB 3.0 and 10GigE**
- **Air and Water Cooling**

World's Largest Resolution, 151 Megapixels

The QHY411 is the highest resolution cooled scientific CMOS camera in the world. The 151 Megapixel SONY IMX411 back-illuminated sensor has a 14192 x 10640 pixel array with 3.76um pixels. The sensor size is 54mm x 40mm. The QHY411 is available in both monochrome and color versions.

Native 16-bit A/D, 65536 levels

The QHY411 is also the world's first scientific CMOS camera with native 16-bit A/D on-chip. The output is real 16-bits with 65536 levels. Most CMOS sensors are 12-bit or 14-bit. This means that the conversion ratio cannot achieve 1e-/ADU and weak signals are not very highly sampled. Photometric measurements of low signals in such case are not as accurate. Some cameras combine two 12-bit outputs to create 16-bit images, but the actual number of levels is still $4096 \times 2 = 8192$ levels, significantly less than native 16-bits.



Ultra-Low Read Noise, 1 Electron at High Gain, 2.4e- to 2.8e- at Low Gain

The QHY411 has only one electron of read noise at high gain and 1FPS (16-bit), 2FPS (8-bit) high readout speed. One electron of read noise means the camera can achieve a $SNR > 3$ at only 3 to 4 photons. This is perfect performance when conditions are photon limited, i.e., short exposures, narrow band imaging, etc., making this large area sensor ideal for sky surveys and time domain astronomy. At low gain the read noise is still only 2.4e- to 2.8e-.

Full Well Capacity of 44ke- at 3.76um, 396ke- at 11um

One benefit of the back-illuminated CMOS structure is improved full well capacity. This is particularly helpful for sensors with small pixels. The QHY411 has a full well capacity of 44ke- even with unbinned 3.76um pixels. When binned 2x2 to 7.5um the full well is 176ke- and when binned 3x3 to 11um the full well is 396ke-.

Back-Illuminated, Electric Rolling Shutter, Low Dark Current

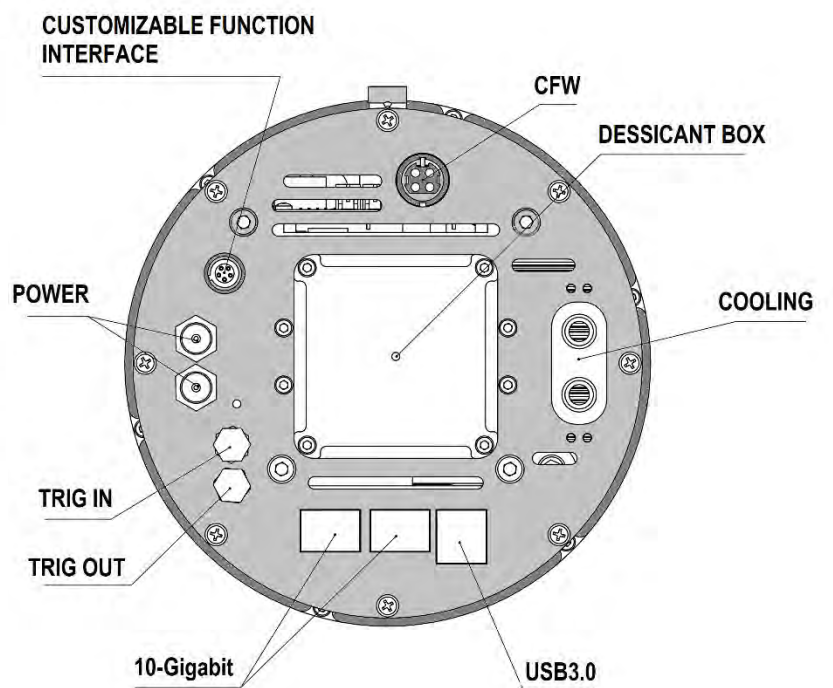
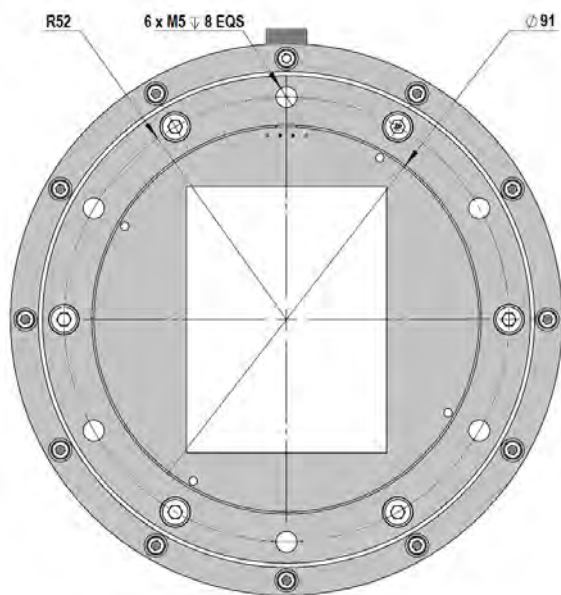
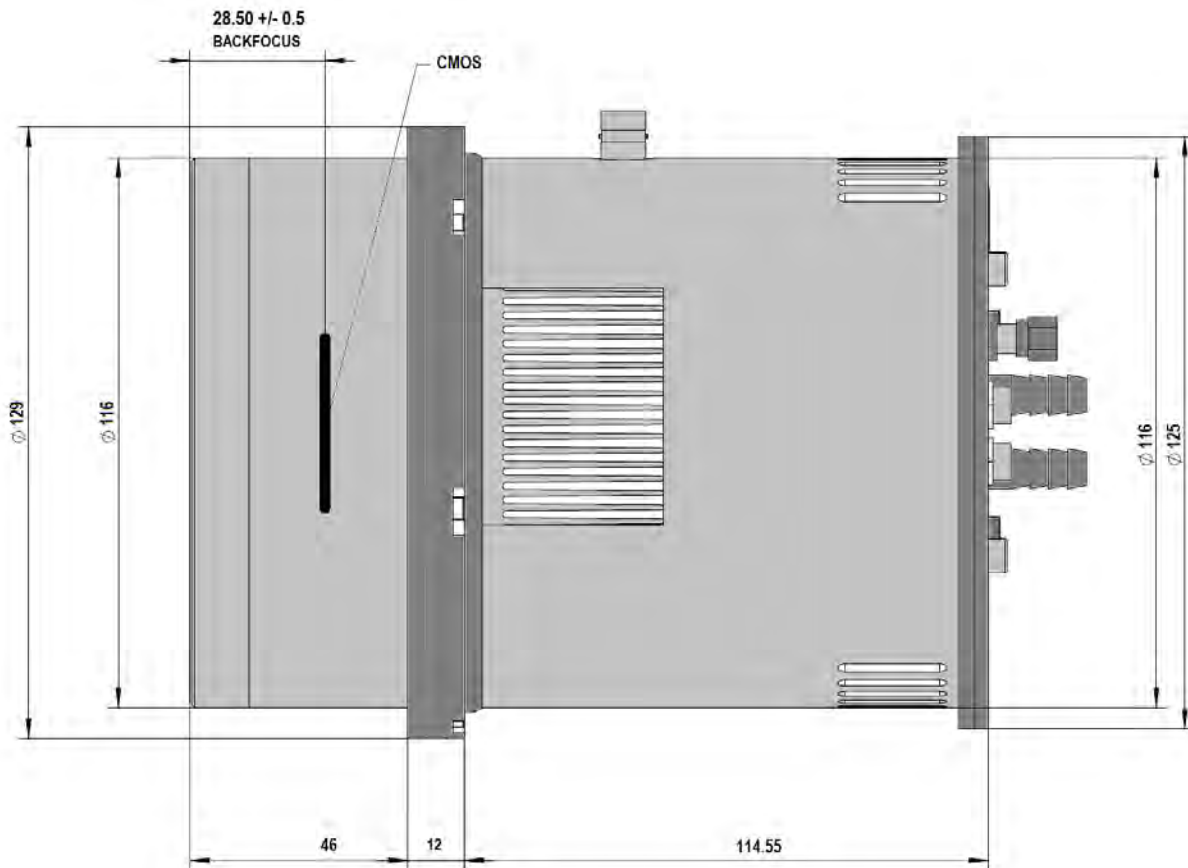
The QHY411 sensor is back-illuminated and has extremely low dark current using SONY's Exmor BSI sCMOS technology. This means the camera is not only ideal for short exposures due to its low read noise, but is also ideal for long exposures where dark current noise often dominates. To further reduce the dark current noise, the QHY411 incorporated QHYCCD's proprietary thermal noise reduction technology and two-stage thermoelectric cooling to reduce the temperature of the sensor.

USB3.0 / 2 x 10Gigabit Fiber

The QHY411 interface is USB3.0 plus 2 x 10Gigabit Fiber port. USB3.0 supports 2 FPS readout speed at 8-bits, 1 FPS at 16-bits and short bursts of 2 FPS at 16-bits. 10Gigabit supports 2.6 FPS at 16-bits continuous.

Air / Liquid Cooling

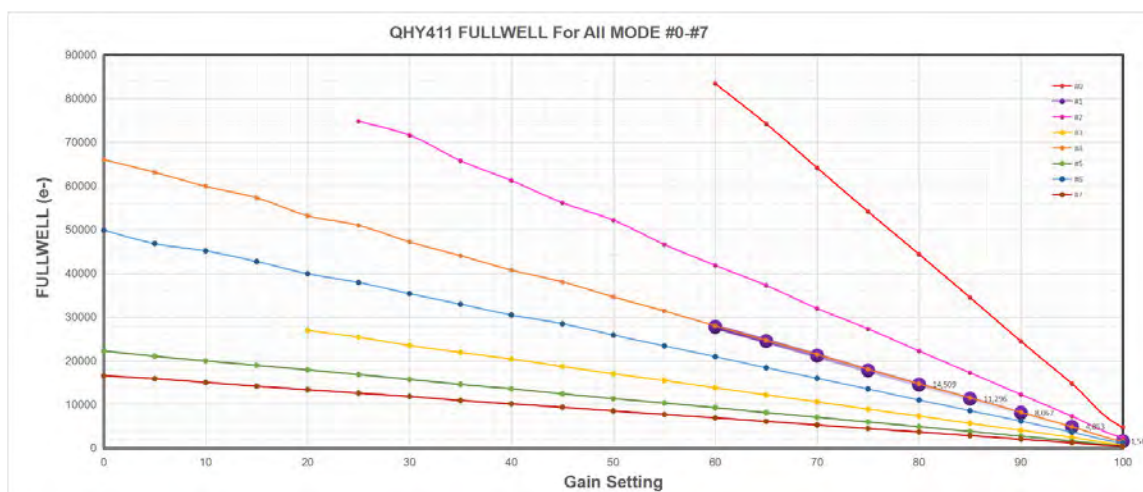
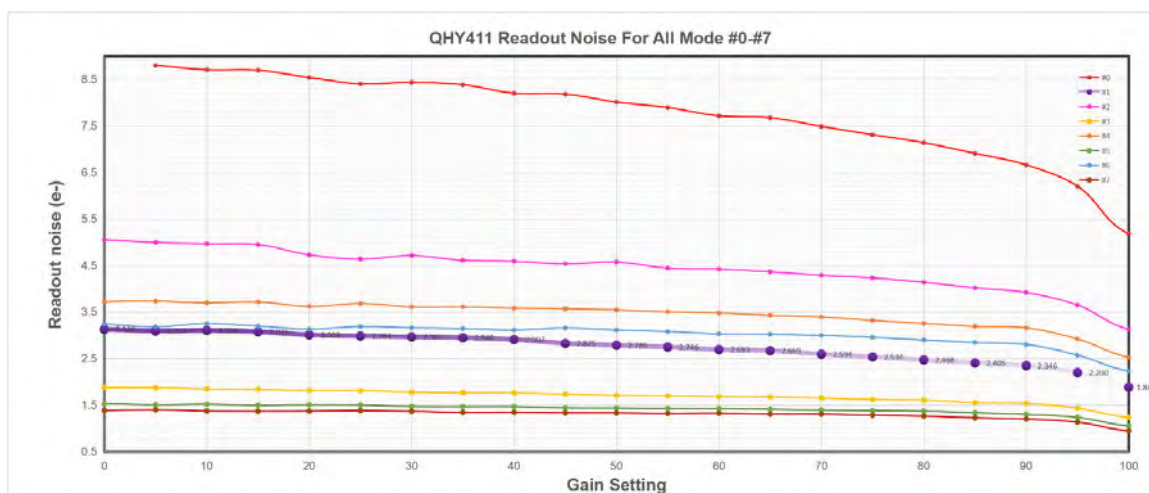
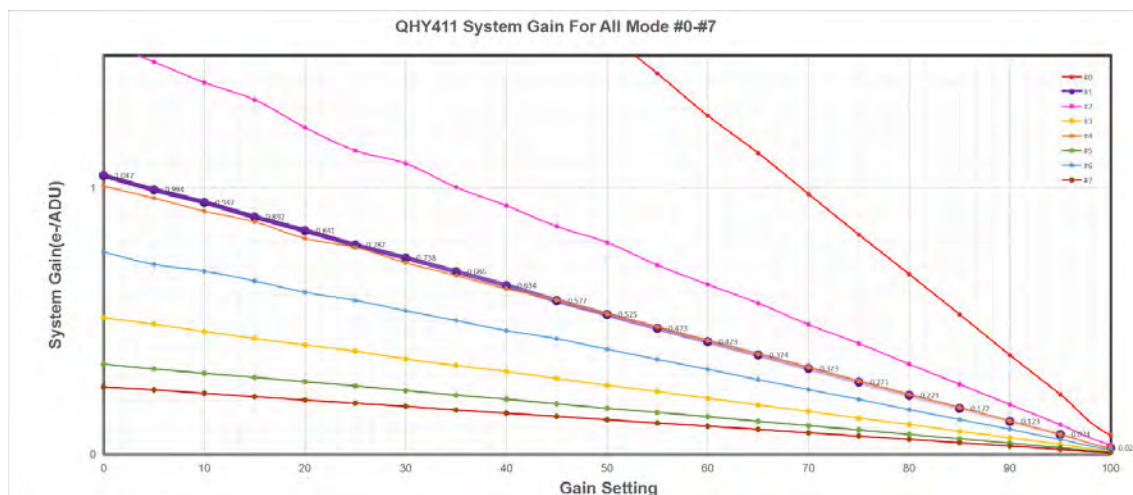
The QHY411 has 2-stage TE cooling that will cool to -30C below ambient with air (fan) only, or -45C below ambient with water circulation.



PRELIMINARY SPECIFICATIONS	
Model	QHY411U3G20
Image Sensor	SONY IMX411 BSI CMOS Sensor
Mono / Color Version	Both Available (QHY411U3G20M / QHY411U3G20C)
Pixel Size	3.76um x 3.76um
Effective Pixels	151 Megapixels
Sensor Diagonal Size	67.2mm
Effective Image Area	54mm x 40mm
Full Well Capacity (1x1, 2x2, 3x3)	44ke- / 176ke- / 396ke-
A/D	16-bit (0-65535 greyscale)
Sensor Optical Format	TYPICAL 4.2inch
Full Frame Rates	USB3.0 2.0 FPS at 8-bits 1.0 FPS at 16-bits 2.6 FPS at 16-bits in burst mode (< 6 frames) 2x10Gigabit Fiber 2.6 FPS at 16-bits
Read Noise	1.0e-at high gain, 2.4e- to 2.8e- at low gain
Dark Current	TBD
Exposure Time Range	20us -3600sec
Shutter Type	Electronic Rolling Shutter
Computer Interface	USB 3.0 and 2x10Gigabit Fiber
Trigger Port	Trigger In / Out, High Speed Sync Port
Built-in Image Buffer	2 GByte (16 Gb)
Internal Image Storage	Total 64MByte Flash Memory. 10MBytes user-accessible for stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus , optic analysis etc. Support 100x100 image x 500 frames, 50x50 image x 4000 frames, 25x25 image x 16000 frames, 10x10 image x 250000 frames
FPGA Upgrade Via USB	Supported
Cooling System	Dual Stage TEC. -45C from ambient with water, -30C with fan only
Anti-Dew Heater	Yes
Telescope Interface	TBD
Optical Window	AR+AR High Quality Multi-Layer Anti-Reflection Coating
Power Requirements	12VDC, 5A

QHY411 Performance Curves

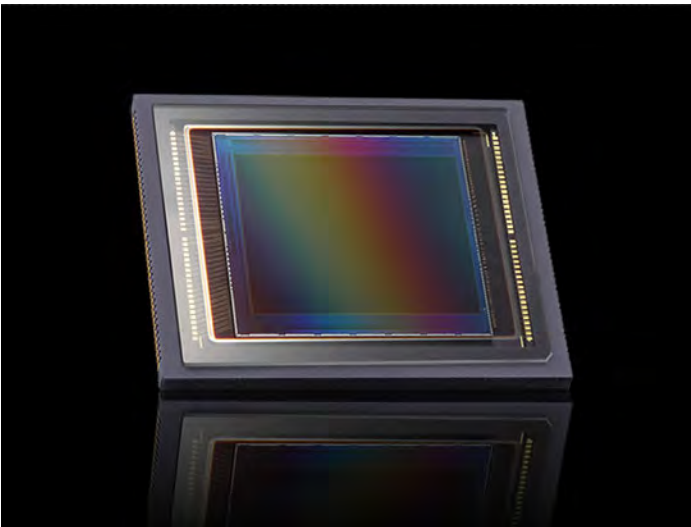
As a scientific camera, the QHY411 allows the user access to the various readout modes of the sensor in order to provide the maximum flexibility and usability of the camera in a wide variety of imaging applications. Currently there are 8 readout modes (more may be activated in the future). Different readout modes result in different behavior in full well, read noise and some other conditions. The eight readout modes are mode #0 to mode #7. The following graphs show the system gain, read noise and full well capacity of each these 8 modes.





QHY461

102 Megapixels
Back-Illuminated
16-bit A/D
1e- Read Noise
Mono or Color



Features:

- 102 Megapixels, 3.76um
- 44x33mm, 55mm Diagonal
- Native 16-bit A/D
- Ultra-Low 1e- Read Noise
- Deep Full Well, High Dynamic Range
- Back-Illuminated High QE Sensor
- Low Dark Current
- USB 3.0 and 10GigaE
- Air and Water Cooling

High Resolution Scientific CMOS with 102 Megapixels

The QHY461 uses a Sony IMX461 Exmore R scientific CMOS sensor with similar architecture as the larger IMX411. The QHY461 has 102 Megapixels in a 11656 x 8742 array with 3.76um pixels. The IMX461 is back-illuminated for high QE and dynamic range. The sensor size is 44mm x 33mm, 55mm diagonal. The QHY461 is available in both mono and color versions.

Native 16-bit A/D, 65536 levels

The QHY461 is also the world's first scientific CMOS camera with native 16-bit A/D on-chip. The output is real 16-bits with 65536 levels. Most CMOS sensors are 12-bit or 14-bit. This means that the conversion ratio cannot achieve 1e-/ADU and weak signals are not very highly sampled. Photometric measurements of low signals in such case are not as accurate. Some cameras combine two 12-bit outputs to create 16-bit images, but the actual number of levels is still $4096 \times 2 = 8192$ levels, significantly less than native 16-bits.



Ultra Low Read Noise, 1 Electron at High Gain

The QHY461 has only one electron of read noise at high gain and 1 FPS (16-bit), 2 FPS (8-bit) high readout speed. One electron of read noise means the camera can achieve a $SNR > 3$ at only 3 to 4 photons. This is perfect performance when conditions are photon limited, i.e., short exposures, narrow band imaging, etc., making this large area sensor ideal for sky surveys and time domain astronomy.

Full Well Capacity of 44ke- at 3.76um, 396ke- at 11um

One benefit of the back-illuminated CMOS structure is improved full well capacity. This is particularly helpful for sensors with small pixels. The QHY461 has a full well capacity of 44ke- even with unbinned 3.76um pixels. When binned 2x2 to 7.5um the full well is 176ke- and when binned 3x3 to 11um the full well is 396ke-.

Back-Illuminated, Electric Rolling Shutter, Low Dark Current

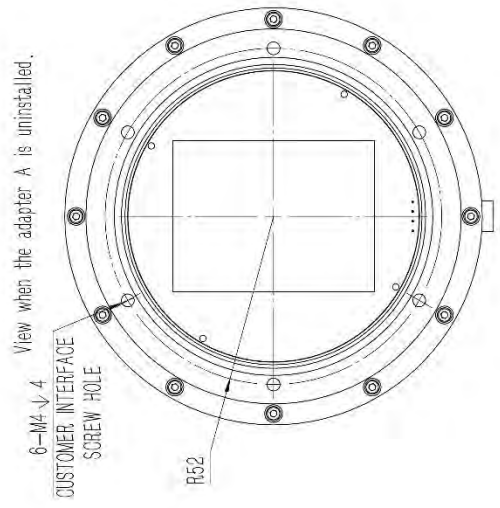
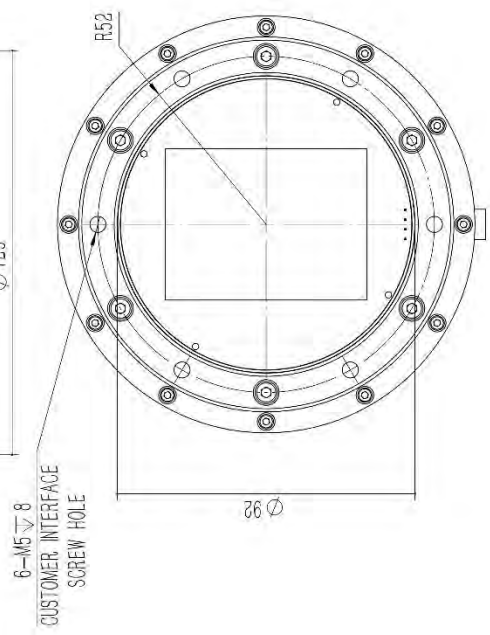
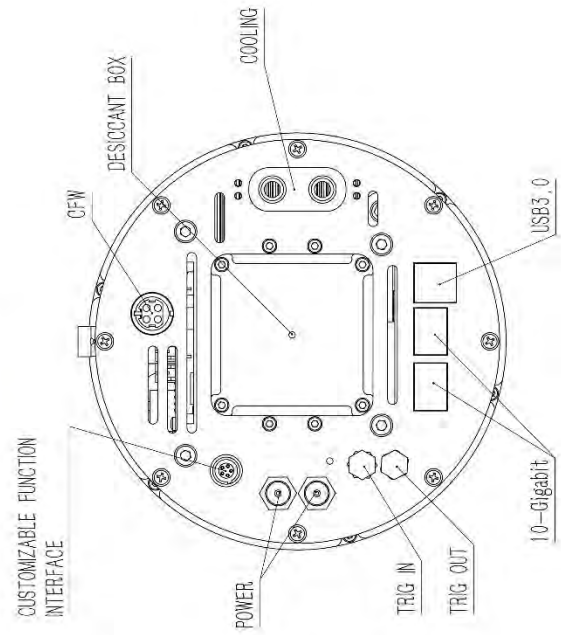
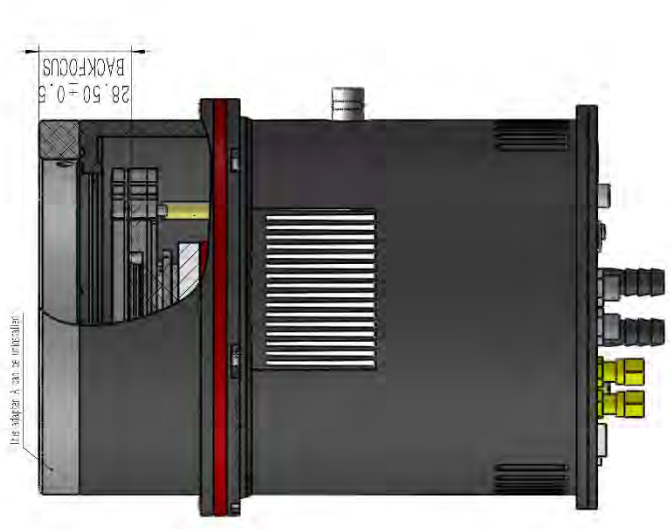
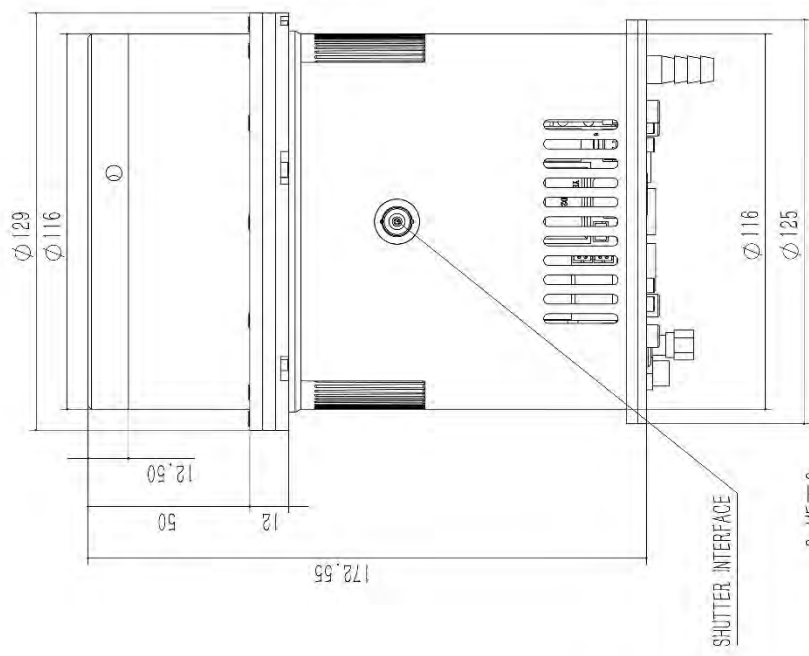
The QHY461 sensor is back-illuminated and has extremely low dark current using SONY's Exmor BSI sCMOS technology. This means the camera is not only ideal for short exposures due to its low read noise, but is also ideal for long exposures where dark current noise often dominates. To further reduce the dark current noise, the QHY461 incorporated QHYCCD's proprietary thermal noise reduction technology and two-stage thermoelectric cooling to reduce the temperature of the sensor.

10GigaE / USB3.0

The QHY461 comes in two versions, USB3.0 and 10GigaE. The USB3.0 supports 1FPS readout speed. The 10GigaE version supports 2.6FPS readout speed.

Air / Liquid Cooling

The QHY461 has air or liquid cooling with 2-stage TE Cooler.



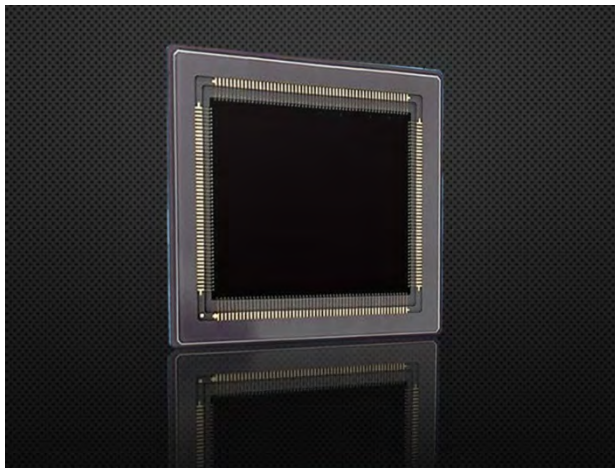
View when the adapter A is uninstalled.

PRELIMINARY SPECIFICATIONS	
Model	QHY461U3G20
Image Sensor	SONY IMX461 BSI CMOS Sensor
Mono / Color Version	Both Available (QHY461U3G20M / QHY461U3G20C)
Pixel Size	3.76um x 3.76um
Effective Pixels	102 Megapixels
Sensor Diagonal Size	55mm
Effective Image Area	44mm x 33mm
Full Well Capacity (1x1, 2x2, 3x3)	44ke- / 176ke- / 396ke-
A/D	16-bit (0-65535 greyscale)
Sensor Optical Format	TYPICAL 4.2inch
Full Frame Rates	USB3.0 2.7 FPS at 8-bits 1.3 FPS at 16-bits 2x10Gigabit Fiber 2.7 FPS at 16-bits 6 FPS at 14-bits
Read Noise	1e- to 3.7e- (in HGC mode)
Dark Current	Approx. 0.003e-/pixel/sec @ -20C
Exposure Time Range	50us -3600sec
Shutter Type	Electronic Rolling Shutter
Computer Interface	USB 3.0 and 2x10Gigabit Fiber (in development)
Trigger Port	Trigger In / Out, High Speed Sync Port
Built-in Image Buffer	2 GByte (16Gb)
Internal Image Storage	Total 64MByte Flash Memory. 10MBytes user-accessible for stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus , optic analysis etc. Support 100x100 image x 500 frames, 50x50 image x 4000 frames, 25x25 image x 16000 frames, 10x10 image x 250000 frames
FPGA Upgrade Via USB	Supported
Cooling System	Dual Stage TEC. -45C from ambient with water, -30C with fan only
Anti-Dew Heater	Yes
Telescope Interface	Six Screw Holes + Tilt Adjust Ring
Optical Window	AR+AR High Quality Multi-Layer Anti-Reflection Coating
Power Requirements	12VDC, 5A



QHY2020 Mono

4.2 Megapixels
Back-Illuminated
1.7e- Read Noise



Features:

- **Back-Illuminated sCMOS**
- **94% Peak Quantum Efficiency**
- **1.2e- Read Noise**
- **Low Dark Current**
- **High Dynamic Range**
- **Dual Channel / Dual Gain Output**
- **High Frame Rate**
- **USB 3.0**

Illuminated Scientific CMOS Camera, 94% QE

The QHY2020 uses a GSENSE2020BSI back-illuminated scientific CMOS image sensor with 4.2MP resolution and 6.5 μ m pixel size. With six-transistor (6T) pixel architecture, GSENSE2020BSI features readout noise of 1.6e-, full well of 54ke-, as well as peak QE of 94%. The 13.3mm x 13.3mm array has wide spectral response from 200nm to 1100nm. It has 94% peak QE at 550nm-600nm and 60% QE at 240nm. It also has very good QE in the NIR range, 60% at 800nm, 38% at 900nm.

Ultra-Low Read Noise, 1.6e-

With read noise as low as 1.6e-, this camera can capture photons from very dim objects. At 3.5 electrons it can achieve SNR=2, which means 4 photons. In addition, the sensor supports correlated multiple sampling (CMS). The read noise can be further reduced to 1.2e- with 2-CMS operation. The GSENSE2020BSI is offered in two variations: -H and -M. -H has better MTF and higher full well capacity, while -M has lower dark current.

Efficient Two-Stage Thermoelectric Cooling

The QHY2020 has dual stage TE cooling that reduces the sensor temperature to -40C below ambient.



Dual 12-bit A/D, High Dynamic Range, Dual Image Output

The effective image size is 2048 x 2048 pixels. However, it has the capability to output dual channels as a 4096 x 2048 image with one half at low gain, high dynamic range and the other half at high gain, low read noise. The two ADCs will sample the same signal at the same time to generate the two images.

Electronic Rolling Shutter, Microlens Free Array

The GSENSE2020 sensor has an electronic rolling shutter with Global Reset and does not use a microlens array over the pixels. Microlens are often employed to increase the quantum efficiency of the sensor by redirecting light from obscured areas of the pixel toward the photosites. This microlens effect can vary depending on the angle of incidence of the light cone making photometric calibration of large fields taken at low f/ratios problematic. However, the back-illuminated GSENSE2020 achieves high quantum efficiency without microlens making it ideally suited to photometric calibration.

High Frame Rate, 43 FPS USB3.0

The standard version of the QHY2020 with USB3.0 produces a maximum frame rate of 43 frames per second for 8-bit images, or 25 frames per second for dual 12-bit images. The camera can also transfer selected regions of interest for extremely fast rates, e.g., 430 FPS at 200lines, 4300 FPS at 10 lines, and 21,500 FPS at 2 lines. This specially addressed line readout mode can also be customized.

Astronomical Imaging

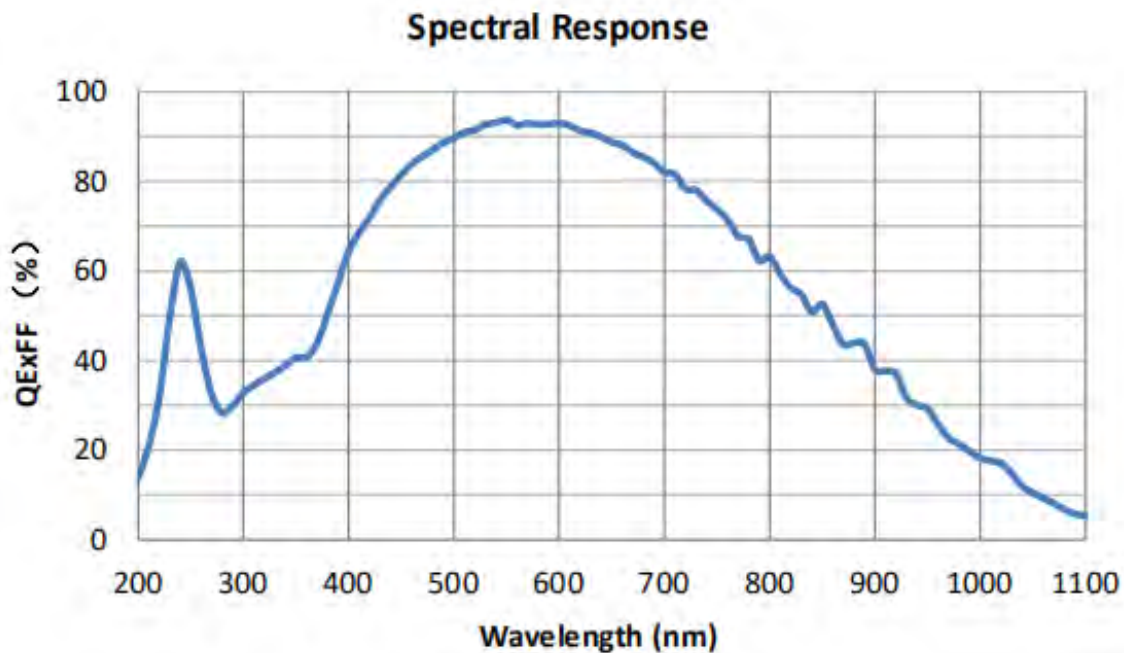
With ultra high QE and ultra low read noise, the QHY2020 is an ideal camera for time-domain astronomy, autoguiding large professional telescopes, and transient source detection and spectrum analyze.

Biological Imaging

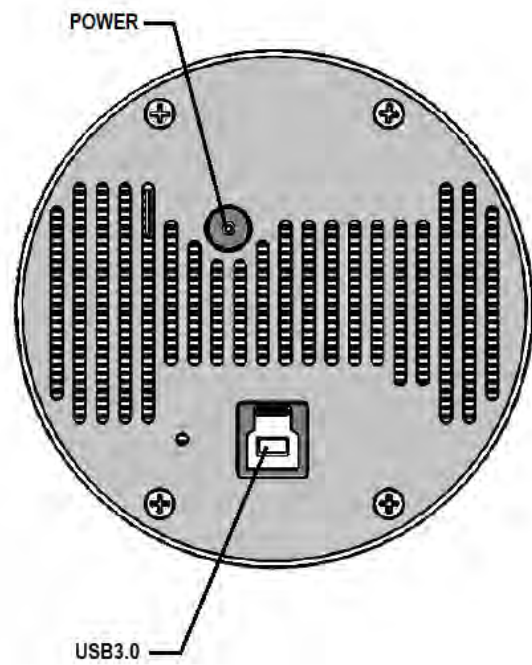
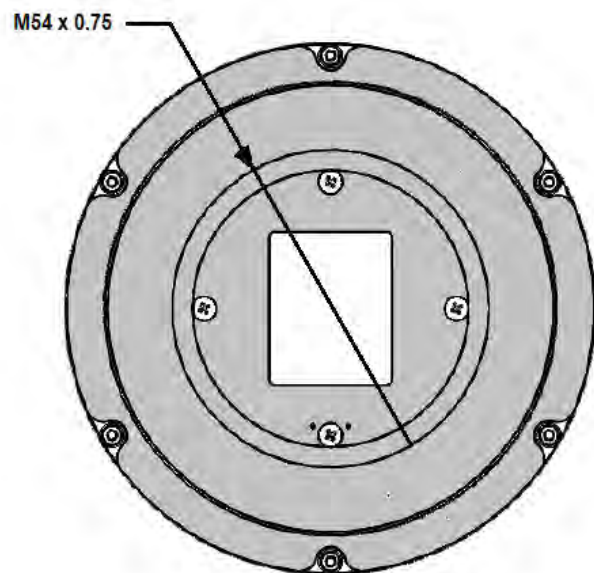
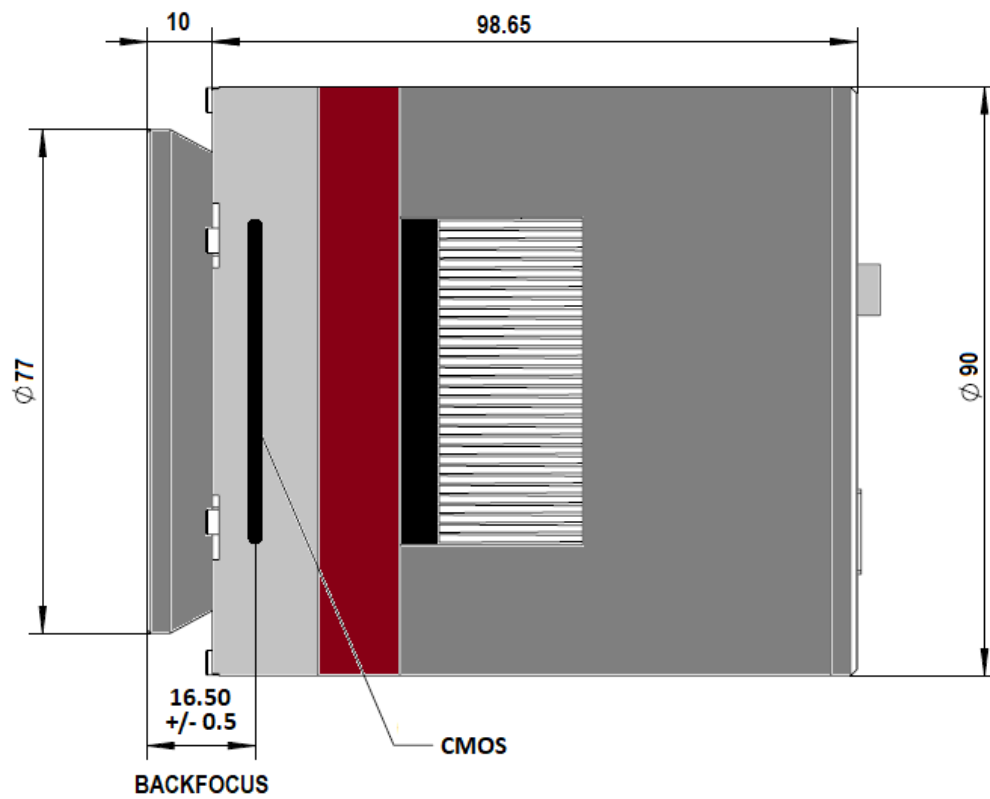
The 13.3mm x 13.3mm sensor size is well matched to a microscope image circle. Microscopy applications will benefit from its high QE, low noise and fast readout. The QHY2020 is an ideal scientific CMOS camera for Fluorescence imaging .

Spectroscopy

The high, wide response from NIR to UV makes the QHY2020 a perfect camera for spectrum analysis and spectrum imaging systems.



QHY2020 SCIENTIFIC CMOS CAMERA SPECIFICATION	
Model	QHY2020
CMOS Sensor	Gpixel Gense2020 BSI
Pixel Size	6.5um x 6.5um
Sensor Surface Glass	Clear Glass
Effective Pixel Area	2048 x 2048
Effective Pixels	4.2 Megapixels
Effective Image Area	13.3mm x 13.3mm
Full Well	56ke-
AD Sample Depth	Dual 12-bit A/D (High Gain Channel and Low Gain Channel) *
Sensor Size	Typical 2-inch
Full Frame Rate and ROI Frame Rate	43FPS@2048*2048 8-bit 43FPS@4096*2048 8-bit x2 HDR 25FPS@4096*2048 8-bit x2 HDR (Clock 2) 20.5FPS @ 4096*2048 8-bit x2 / 12bit x2 (Clock 3)
Readout Noise	1.6e- (High Gain)
Dark Current	TBD
Exposure Time Range	20us - 300sec
Anti-Glow Control	Yes. Can be enabled and disabled. Significant Glow Reduction
Shutter Type	Electric Rolling Shutter
Computer Interface	USB 3.0
Built-in Image Buffer	128MByte (512Mb) DDR2
Internal Image Storage	Total 64MByte Flash Memory. 10MBytes user-accessible for stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus , optic analysis etc. Support 100x100 image x 500 frames, 50x50 image x 4000 frames, 25x25 image x 16000 frames, 10x10 image x 250000 frames
Cooling System	Dual Stage TE Cooler, -40C below ambient
Anti-Dew Heater	Yes
Telescope Interface	M54/0.75 female thread on the fast installer/center adjust ring
Optic Window Type	AR+AR High Quality Multi-Layer Anti-Reflection Coating





QHY4040 sCMOS

16.8Megapixels

1e- Read Noise

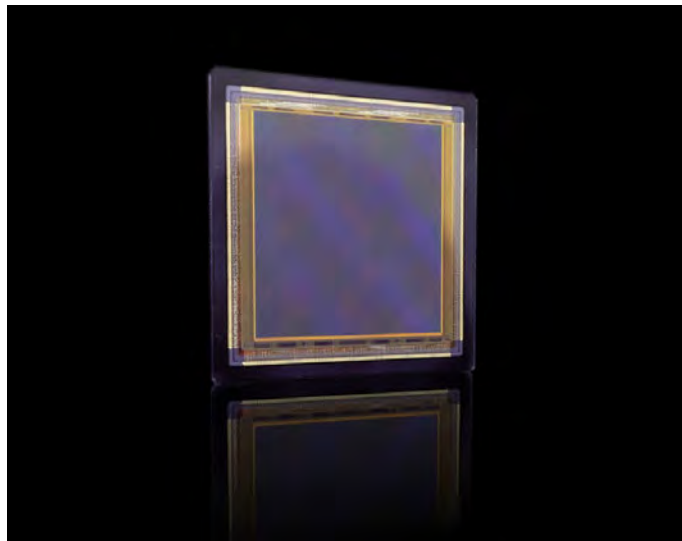
Up to 20 FPS FF

Monochrome



Features:

- 16.8 Megapixels, 9 μ m
- 36.9mm x 36.9mm
- 74% QE at 600nm
- 4e- Read Noise Typical
- 70ke- Full Well at Low Gain
- 0.2e- Dark Current at -15C
- 2-Stage TE Cooling -35C
- Zero Amplifier Glow
- 20 FPS Full Frame
- USB 3.0



Large Area Sensor, 36.9 x 36.9mm 4K x 4K

The QHY4040 uses a GSENSE4040FSI front-illuminated, 16.8 Megapixel, 36mm square, scientific CMOS image sensor. With a five transistor (5T) HDR pixel design and a 9 μ m pitch, the sensor can achieve 3.7e-read noise and 74ke- full well capacity in HDR mode. The QHY4040 camera achieves 20 FPS at full resolution with USB 3.0. This makes the QHY4040 an ideal camera for various applications. The GSENSE4040 sensor is offered in two variations: CMN and CMT. CMN is a monochrome sensor without microlens array and is protected by a removable glass lid, which is ideal for X-ray imaging, charged particle detection, and micro-CT application; while CMT is a monochrome sensor with microlens array and sealed with D263T lids with anti-reflective coating on both sides, ideal for medical imaging and astronomy applications.

Multiple Pixel Clocks, 20 FPS at Full Resolution

The QHY4040 has a USB3.0 high-speed interface with up to 5GB of bandwidth. The camera achieves 1:1 video output at 20 frames per second (8-bit) with 4096 x 4096 resolution or 8FPS in low noise 12-bit mode. As different clock rates affect read noise performance, the QHY4040 supports five readout clocks and 8FPS, 12FPS, 16FPS, 18FPS and 20FPS frame rates.



74% QE, 86dB Dynamic Range, 3.7e- Read Noise

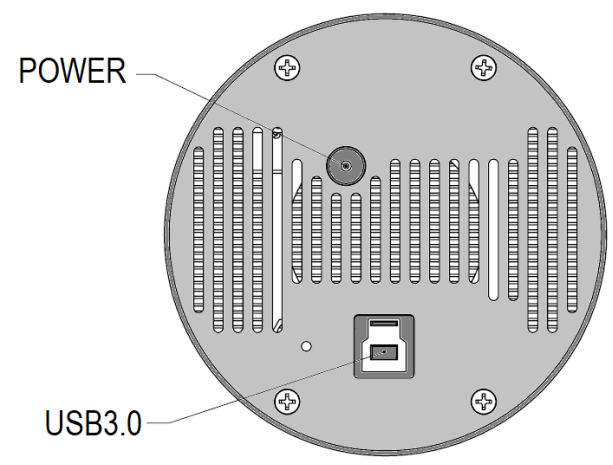
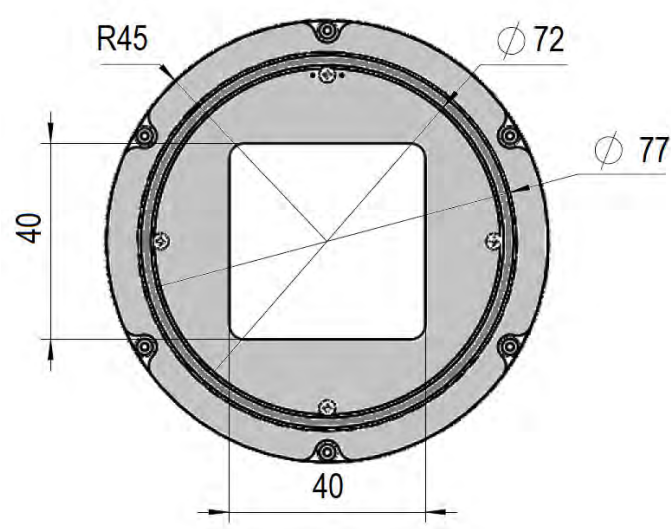
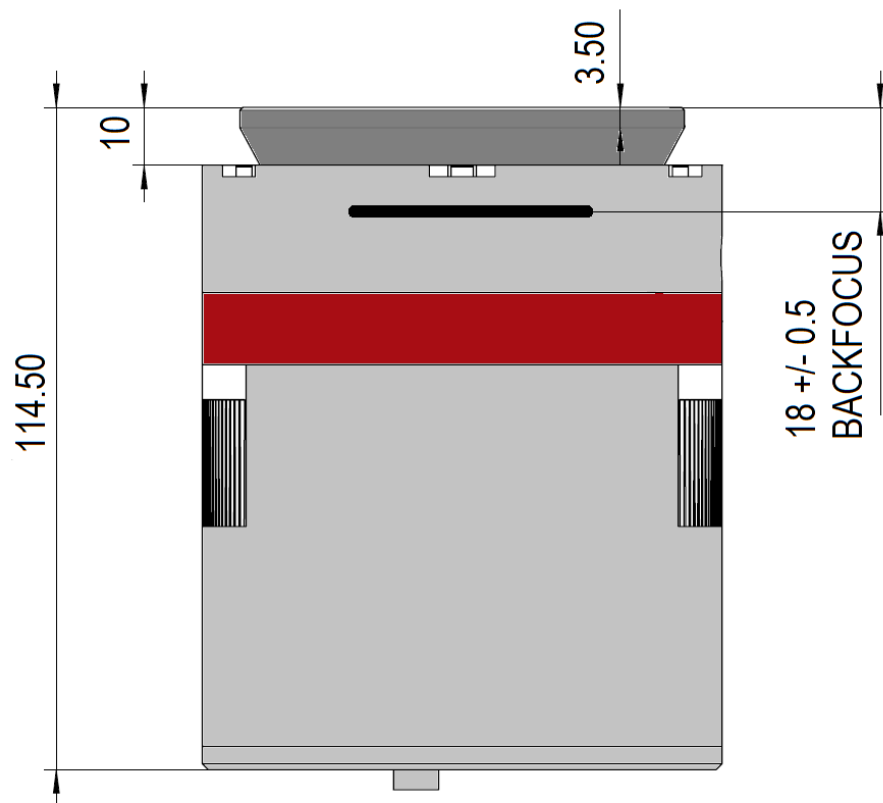
Currently, the QHY4040 is only available in a front illuminated version. A back-illuminated version of this sensor is rumored to be available in the future. In general, the fan-blade mechanical shutter will be broken if it is used 200,000 times or so, and in some specific cases it is easy to fail to switch on or off. The advantage of electronic shutter over mechanical shutter is high reliability and stability when the observatory shoots a large number of pictures. The electronic shutter is a relatively perfect choice for the observatory. The QHY4040 has an ultra-high dynamic range of 86dB and an extremely low readout noise of 3.7e-. This makes the camera exceptional for astronomical imaging, medical imaging, life sciences, fluorescence detection, trace sciences.

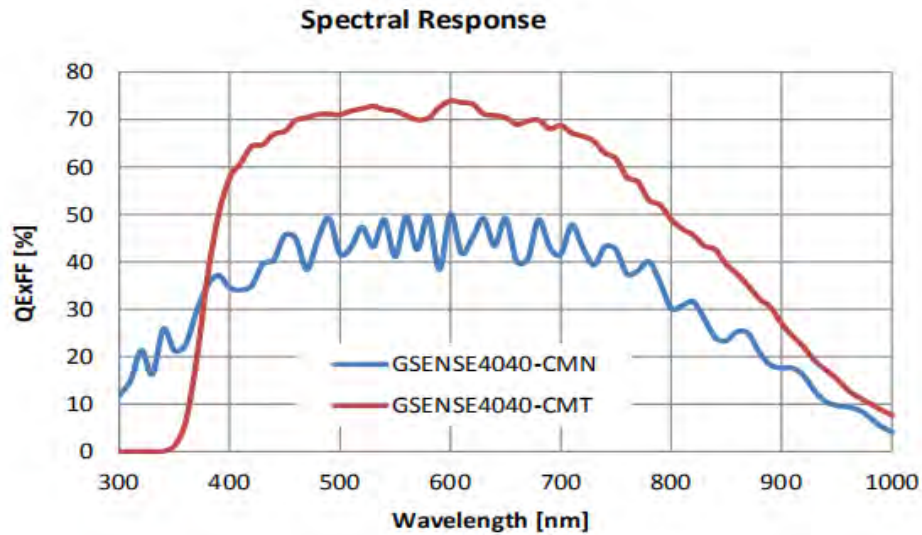
Dual Stage Regulated TE Cooling -35C

The QHY4040 has 2-stage thermoelectric cooling that reduces the sensor temperature to -35 °C below ambient. TE cooling significantly reduces dark current and produces cleaner, lower noise images over long exposures.

Astronomical Imaging, Biological Imaging, X-Ray Imaging, Dynamic DR

The high sensitivity, large field of view, 9um pixel size and large dynamic range are all ideal for astronomical imaging. The large 36.9mm x 36.9mm sensor with high resolution, high quality Image output also makes the QHY4040 ideal for Biological imaging. For dynamic medical x-ray DR imaging the QHY4040 sensor size matches most industry-standard DR lenses and the high frame rate and low readout noise performance is ideal for X-ray imaging.





	QHY4040FSI Preliminary Specifications
COMS Sensor	Gpixel GSENSE4040 FSI
Pixel Size	9.0um x 9.0um
Sensor Surface Glass	Clear Glass
Optical Window	AR+AR multiple layer coating anti-reflection glass
Effective Pixel Area	4096 x 4096
Effective Pixels	16.8 Megapixels
Effective Image Area	36.9mm x 36.9mm
Fullwell	Pixel >70ke. For single high gain channel max full well is 26ke @ gain 0
AD Sample Depth	Single 12-bit output, 12-bit or 8-bit output (See Note 1)
Sensor Size	36.9mm*36.9mm
Full Frame Rate	20FPS@4096*4096 8bit (Clock Speed 4), 18FPS@4096*4096 8bit (Clock Speed 3), 16FPS@4096*4096 8bit (Clock Speed 2), 12FPS@4096*4096 8bit (Clock Speed 1), 8FPS@4096*4096 8bit (Clock Speed 0), 8FPS@4096*4096 12bit (Clock Speed 0)
Readout Noise	Typical 4e- @ Gain31 (16.5x)
Dark Current	0.2e/pixel/sec @ -15C
Exposure Time Range	20us - 600sec
Shutter Type	Electronic Rolling Shutter
Computer Interface	USB3.0 in QHY4040FSI-USB3 (See Note 2)
Built-in Image Buffer	128MByte (512Mb) DDR2 memory in QHY4040FSI-USB3 (See Note 3)
Non-volatile memory In camera storage	Built-in 100Kbytes user accessible memory for image storage of stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus , optic analysis etc. Support 100*100 image x 10 frames, 50*50 image x 40 frames, 25*25 image x 60 frames, 10*10 image x 1000 frames.
End Exposure Pulse Output	Hardware pulse out with Trigger-Out signal in the camera
Cooling System	Dual Stage TE Cooler, -35C below ambient
Anti-Dew Heater	Yes
Telescope Interface	M54/0.75 female thread on the fast installer/center adjust ring

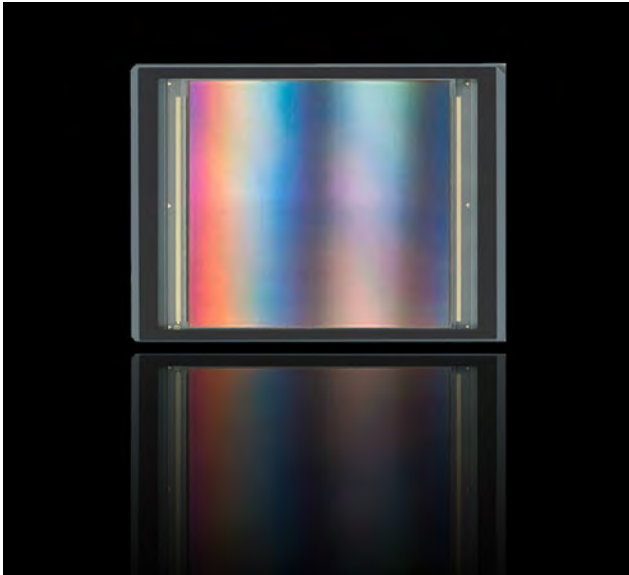
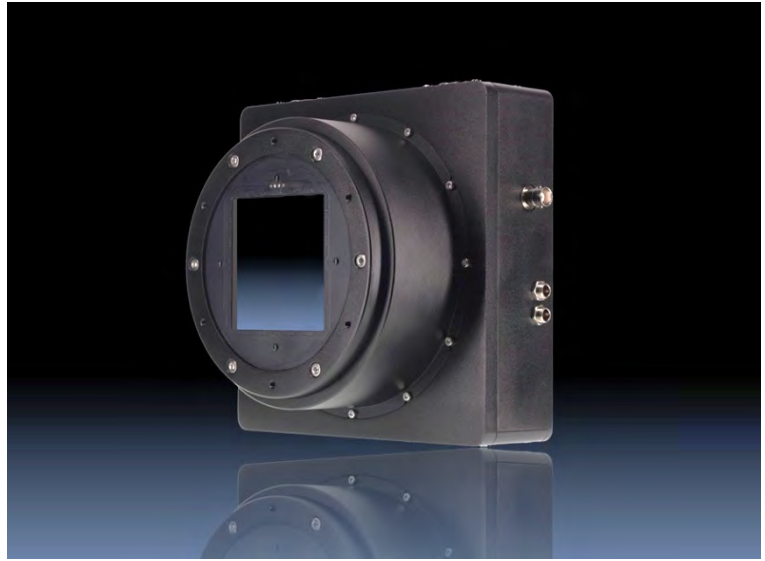
NOTES:

1. Due to the limitation of USB 3.0 transfer speed, the USB3.0 version only supports single A/D channels. Dual A/D channels will be supported in the upcoming QHY4040 10GigaE version.
2. 10GigaE Fiber is under development for the upcoming QHY4040 FSI-10G.
3. The upcoming QHY4040FSI-10G version will have 2GByte (8Gb) DDR3 internal memory buffer. The 2 Chanel PRO version will increase internal image storage to 10MB



QHY6060

37.7 Megapixels
Back-Illuminated
Large Area
95% Peak QE
Monochrome



Features:

- Front or Back-Illuminated
- 95% Peak QE (BSI)
- 37.7 Megapixels at 10um
- 6144 x 6144 Array
- 86.8mm Diagonal
- 2 x 12-bit, 14-bit CMS
- Low 4e- Read Noise
- Deep Full Well 80ke- to 120ke-
- High Dynamic Range 72dB to 90dB
- 14fps 14-bit FF (>40fps 12-bit FF)

The GSENSE6060 Sensor

The GENSENSE6060 is designed with a large imaging area for demanding astronomical and scientific applications. With its top and bottom readouts, the sensor maximum frame rate is more than 40fps with 12bit ADC, allowing scientists to observe with remarkable temporal resolution. The on-chip 14-bit ADC combined with a correlated multisampling (CMS) technique unprecedentedly extends the sensor intra-scene dynamic range to 16-bits. The two readout chains also provide the possibility for HDR combination up to 90dB. The Aluminum Nitride package provides 10x better thermal conductivity compared to traditional Alumina packages and also provides excellent flatness both at room temperature and with deep-cooling.



Large Area Sensor

The GSENSE6060 CMOS sensor is 61.44mm square, with a diagonal of 86.8mm, about twice the diagonal dimension and over four times the area of a full frame 35mm format sensor.

High Quantum Efficiency FSI 75% / BSI 95%

The GSENSE6060 will be available in both back-illuminated and front-illuminated versions. The back-illuminated version has a peak QE of 95%, the front-illuminated version has 75% peak QE.

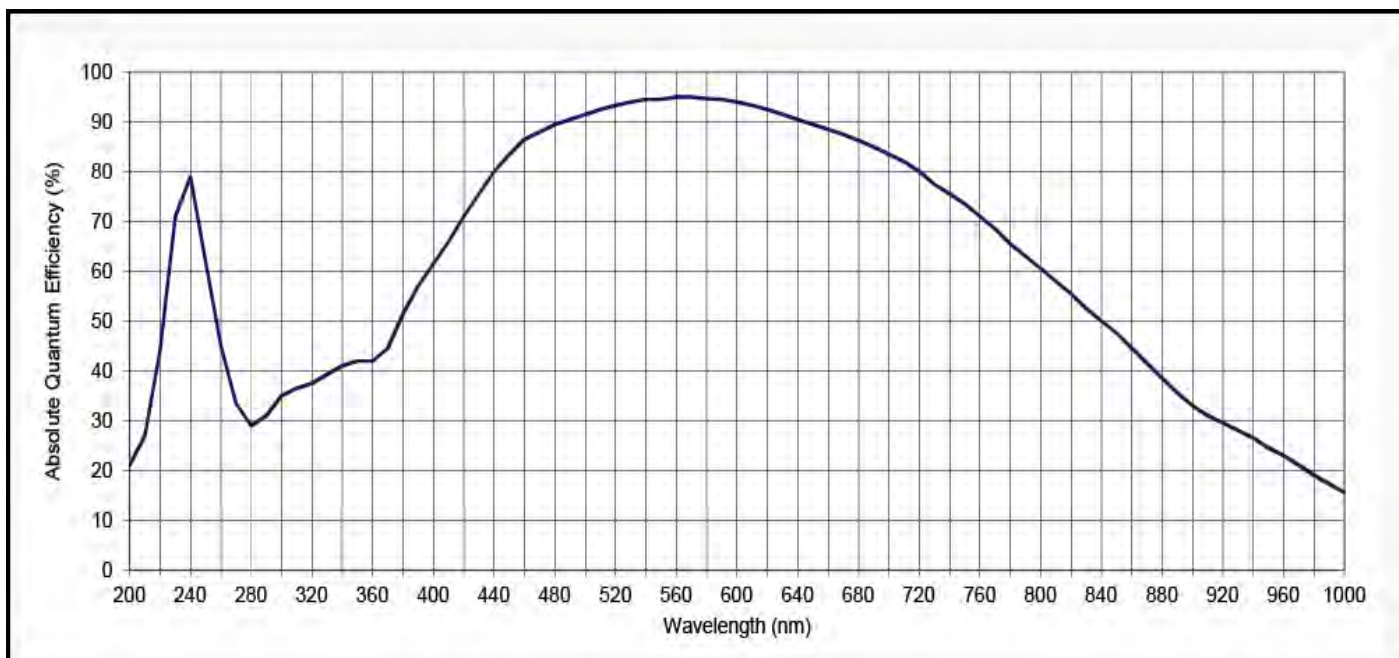
Efficient TC Cooling

The QHY6060 has dual stage TE cooling that reduces the sensor temperature to -40C below ambient.

12-bit / 14 bit - 90dB dynamic range

The COMS technique of five transistor (5T) HDR pixel design on a 10μm pitch enables the GSENSE6060 to decrease dark noise and increase the dynamic range to as much as 90dB.

Operation mode	Full well capacity	Dark noise	Intra-scene dynamic range	Max. Frame rate
14bit Standard	>80ke ⁻	<3.5e ⁻	76dB (single 14bit)	14fps
14bit @ 16-CMS	>80ke ⁻	<4e ⁻	84dB (14bit + 16-CMS)	0.4fps
12bit Standard	>120ke ⁻	<4e ⁻	72dB (single 12bit)	>40fps
12bit @ 2-CMS	>120ke ⁻	<4e ⁻	75dB (12bit + 2-CMS)	>20fps
12bit @ HDR	>120ke ⁻	<3.5e ⁻	90dB (2 × 12bit)	>15fps



PRELIMINARY

	QHY6060BSI Preliminary Specifications
COMS Sensor	Gpixel GSENSE6060 BSI
Pixel Size	10.0um x 10.0um
Effective Pixel Area	6144 x 6144
Effective Pixels	37.7 Megapixels
Effective Image Area	61.44mm x 61.44mm
Full Well	80ke- to 120ke-
A/D	2 x 12-bit, 14-bit
Optical Window	AR+AR multiple layer coating anti-reflection glass
Full Frame Rate	14 FPS @ 14-bits, 40 FPS @ 12-bits
Readout Noise	Typical 4e-
Dark Current	0.6e-/pixel/sec @ -20C
Exposure Time Range	20us - 600sec
Shutter Type	Electronic Rolling Shutter with Global Reset
Computer Interface	USB3.0
Built-in Image Buffer	TBD
Non-volatile Internal Image Storage	TBD
Cooling System	Dual Stage TE Cooler, -40C below ambient
End Exposure Pulse Output	Hardware pulse out with Trigger-Out signal in the camera
Anti-Dew Heater	Yes
Telescope Interface	TBD

