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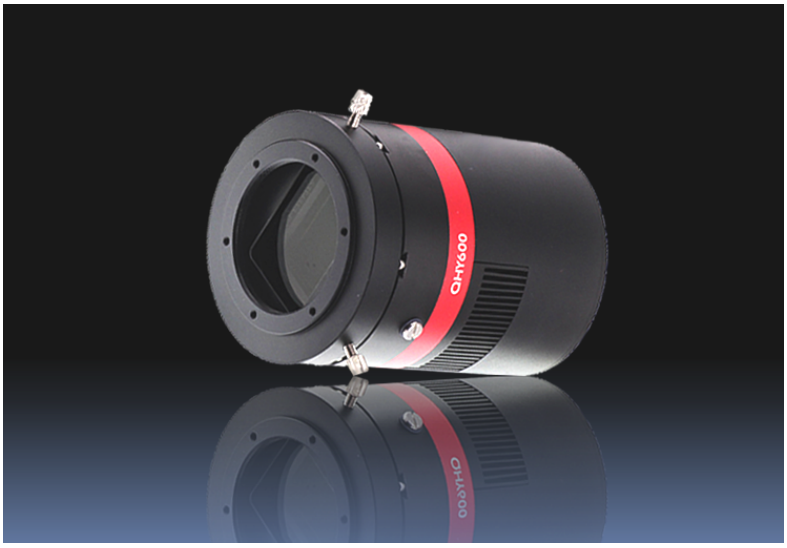
QHYCCD

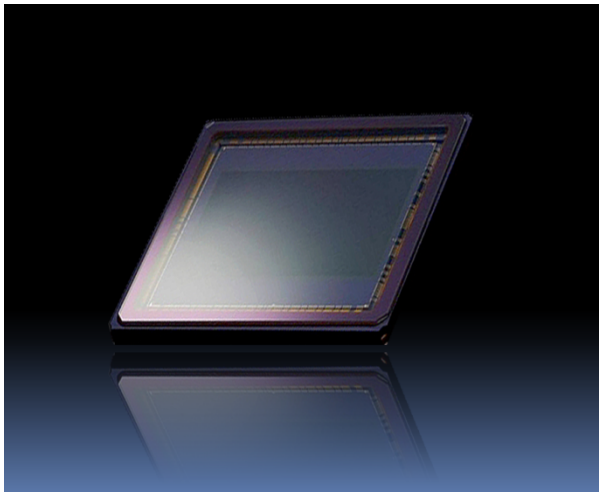
QHY600
Scientific CMOS

Light Speed Vision (Beijing) Co., Ltd., 503 Block A, Singularity Center, Shahe Town, Changping District, Beijing , China 102206

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

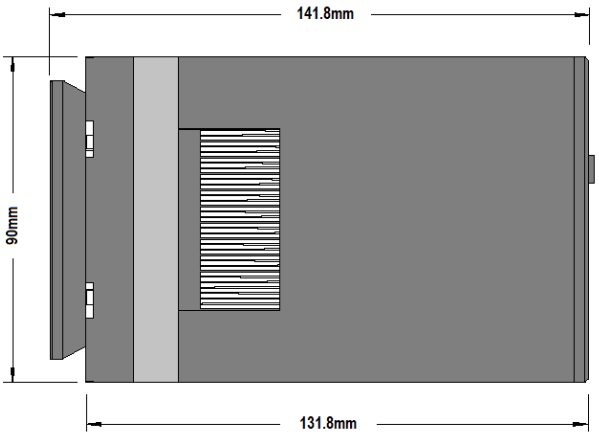
Sony's Exmor R back-illuminated technology produces sensors that Sony estimates are twice as sensitive as similar front illuminated sensors. QHYCCD tests have borne out this claim and based on our tests the peak QE is greater than 87%. Additionally, Sony sensors are well known for their low dark current. 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.

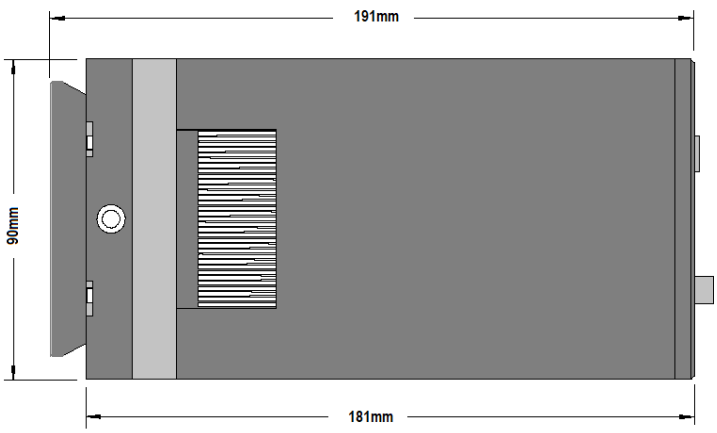
Best Match for RASA System

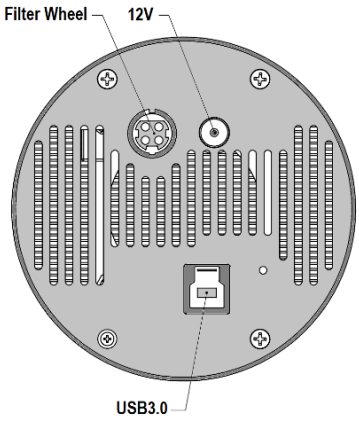
The round camera case design of QHY600 and the high resolution, large area, small pixel array is an ideal match for RASA optical systems.

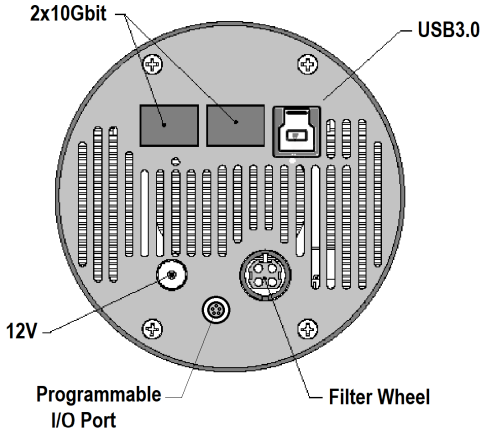
Photographic and Professional Models

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**
- **2×10Gigabit 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.

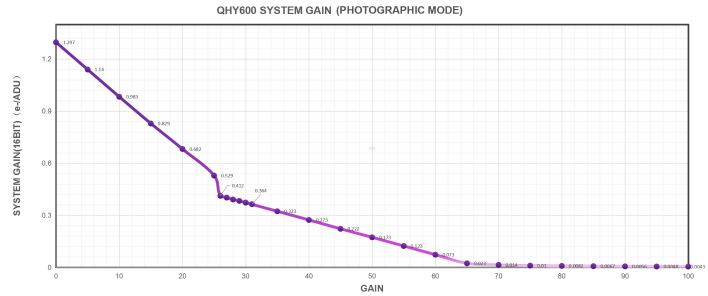
[2] 10MB user accessible internal memory for storage of images of stellar ROI frames for analysis of exoplanet investigation, occultations, atmospheric seeing measurement, focus , optic analysis, etc. Storage for 100*100 image x 500 frames, up to 10*10 image x 250,000 frames.

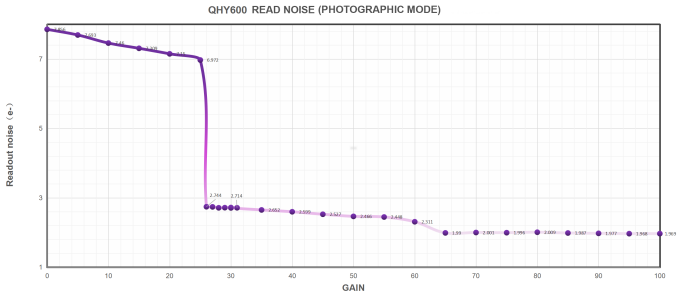
[3] An optional front plate is available that shortens the back focal length to about 6.7mm. Contact QHYCCD.

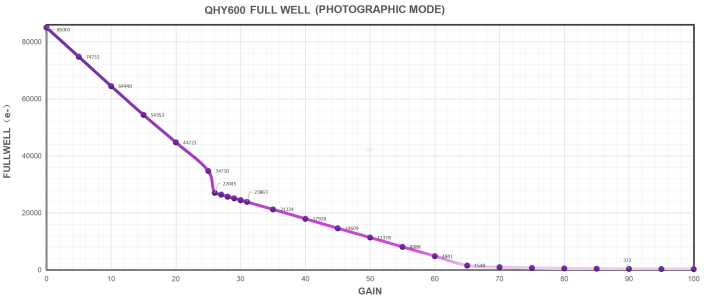
[4] A limited edition "Early Bird" model using PRO model hardware but with the specifications of the PHOTO model is USD5000. This Early Bird model can be upgraded in the future to a full PRO version for the difference in price.

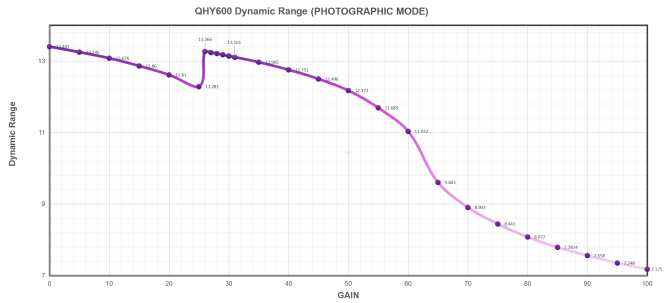
Readout Mode Selection is a new function for the QHY600 and other newer QHYCCD cameras. Different readout modes have different driver timing, etc., that cause the sensor to yield different performance results, allowing you to tailor the sensor response to your particular imaging needs. Each readout mode 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.

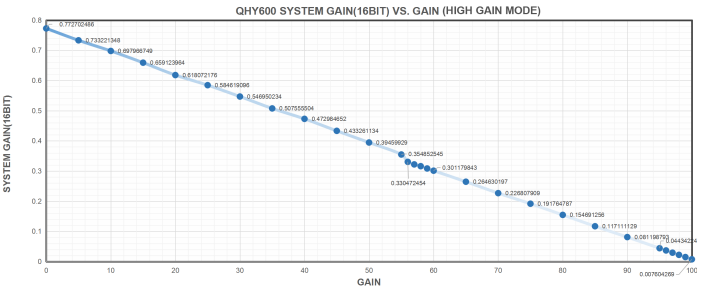


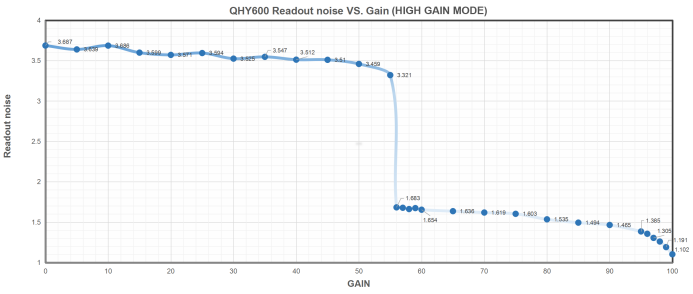


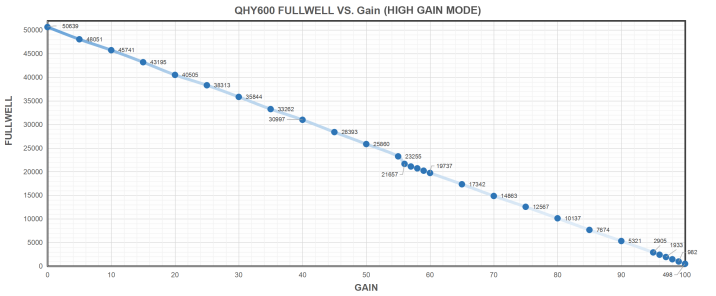


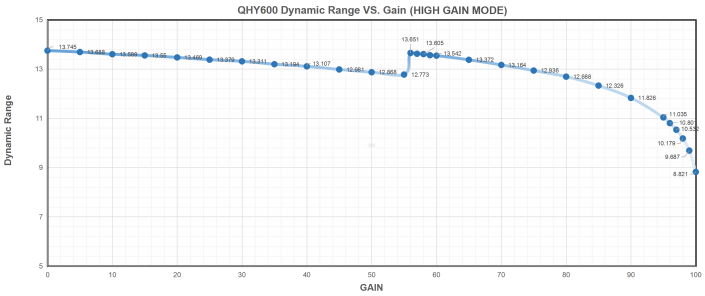


Readout Mode #1 (High Gain Mode). In this mode, the QHY600 switches from Low Gain to High Gain between gain settings of 55 and 56. Gain 0-55 uses LGC and Gain 55-100 used HGC.

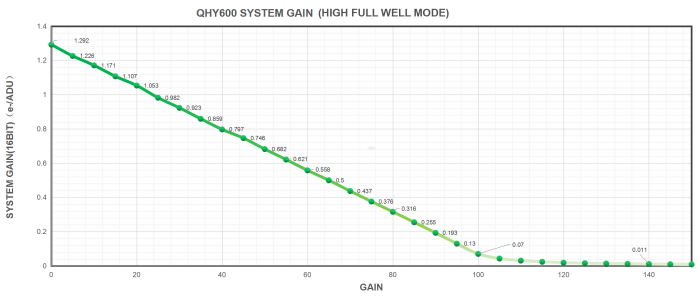


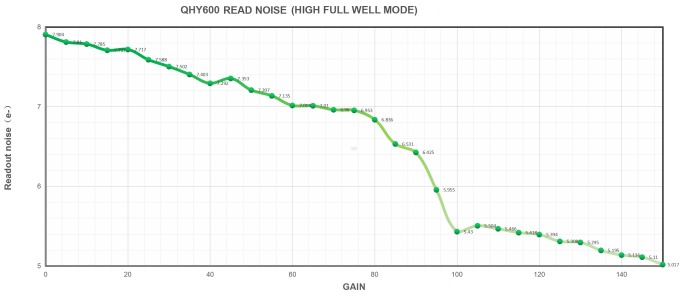


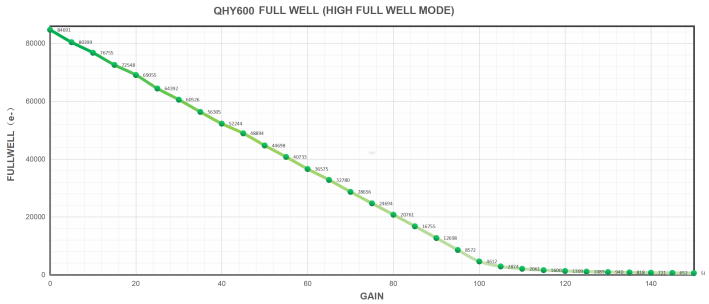


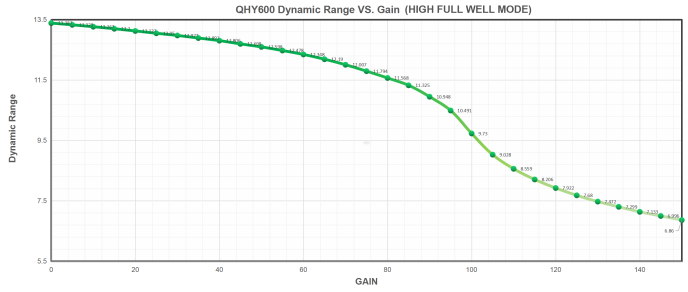


Readout Mode #2 (Extended Full Well Mode). In this Ultra-High Full Well Mode, the QHY600 exhibits an unbinned full well capacity of greater than 80,000e-. Binned 2x2 the full well is greater than 320,000e- and binned 3x3 the full well is greater than 720,000e-.



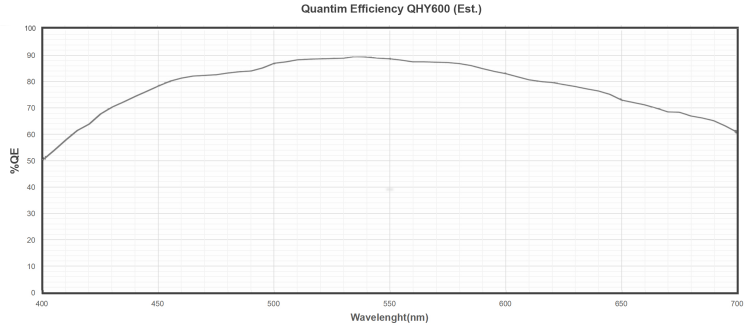






QUANTUM EFFICIENCY AND DARK CURRENT TEST RESULTS

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: