

# MEGAPLUS<sup>®</sup>

## Industrial Imaging Cameras

High resolution | Low noise  
High dynamic range | Unparalleled sensitivity



cameras with  
**GiG**  
VISION

Vision At Its Best

# MEGAPLUS®

MEGAPLUS brand cameras are renowned worldwide for producing unmatched image quality and delivering the most accurate results, in applications ranging from surveillance and critical inspection to major motion picture film production.

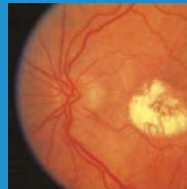
Princeton Instruments (PI) is proud to bring decades of experience in low-noise electronics and digital camera technology to the MEGAPLUS brand of cameras. PI is the world's leading designer and manufacturer of high-performance light detection systems for spectroscopy, scientific imaging and X-ray applications, and is recognized as the industry leader in the design and development of cutting edge, high-performance optical coatings.



A multi-head controller and four MEGAPLUS ES4020 cameras configured to output 16 megapixels at 15 fps.

## MEGAPLUS cameras are the right choice for your application.

**Flat Panel Display**



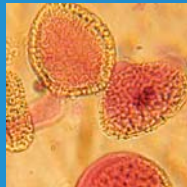
**Ophthalmology/Medical**

**PCB Inspection**



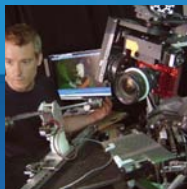
**Semiconductor/Electronics**

**Film/Document Scanning**



**Automated Microscope Slide Scanning**

**Aerial/Surveillance**



**Motion Picture Film Production**

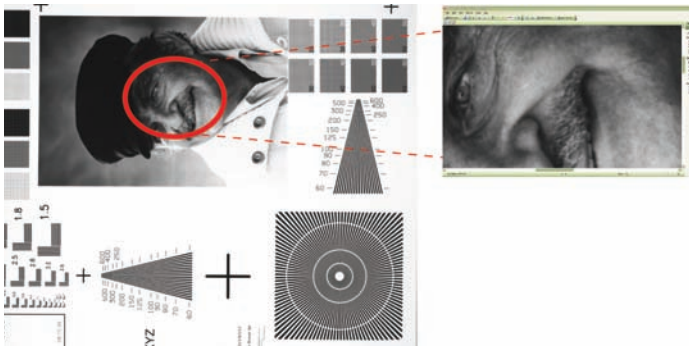
Courtesy of LAIKA, Inc./2009

# Choosing the Right Camera

There are many factors to consider when selecting a digital camera. On the following pages we will explain the most important criteria in a digital camera system. Understanding these camera parameters will ensure the digital camera you select will best satisfy the requirements of your application.

## Resolution

The resolution of an imaging system refers to its ability to distinguish the finest detail in the image. MEGAPLUS cameras are available in resolutions from 2 to 16 million pixels.



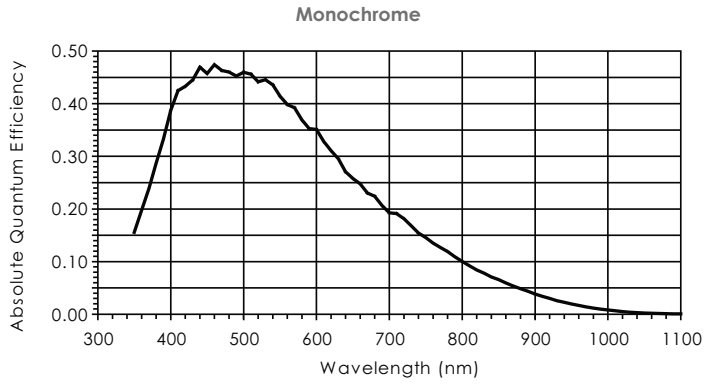
Standard resolution target image captured by a 11 megapixel camera (MEGAPLUS EC11000). Inset shows a part of the image at 400% zoom.



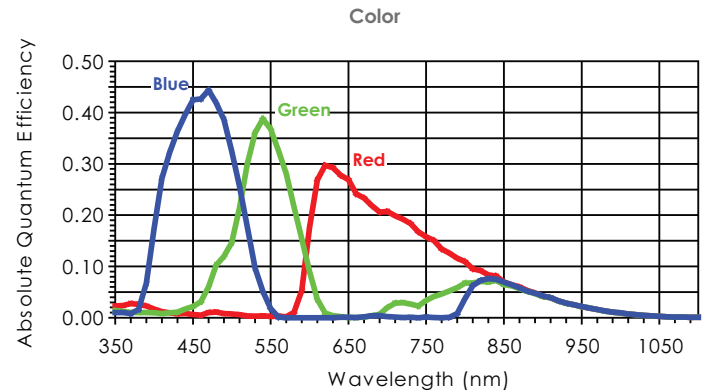
MEGAPLUS cameras enable capturing the finest details.

# Sensitivity

The sensitivity of a camera is a measure of its ability to detect the lowest light level. Cameras with high sensitivity are best because they can be used in a wider range of applications. The graphs below represent the camera's response to both the visible (VIS) and near infrared (NIR) spectrums of light.



Typical quantum efficiency curve for monochrome CCD sensors (measured with AR coated cover glass).



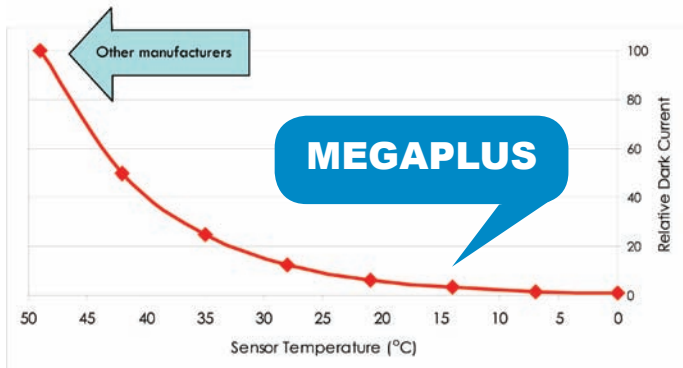
Typical quantum efficiency curves for color CCD sensors (measured without AR coated cover glass).

# Dynamic Range

In digital imaging, dynamic range describes the ratio between the minimum and maximum light intensities (dark and light respectively) captured by the camera. The resulting image is not truly black and white, but rather the combination of varying degrees of light intensity and subject reflectivity acquired by the camera. The ability to capture the entire dynamic range of an image is critical to users requiring the best resolution for their applications. Typically expressed in decibels (dB), a higher dB value indicates a greater range of dark to light that will be captured.

## Noise

Noise is any unwanted signal either from the captured light, called photon shot noise, or added by the imaging process. Noise can be related to the camera's electronics, or to its sensor, where it can be classified as noise from the readout amplifier or thermal noise resulting from the sensor's temperature. A camera with low noise is ideal for applications with a wide range of illumination conditions. MEGAPLUS cameras are designed to minimize noise from heat produced by the camera's electronics and sensor by utilizing a 2-piece design which reduces the number of heat-generating components near the image sensor. MEGAPLUS cameras offer both active and passive cooling options - active cooling utilizes a thermoelectric (TE) cooler to lower the sensor's temperature, while passive cooling utilizes "fins" incorporated into a unique camera housing design.



Cooling the sensor in a digital camera results in lower dark current. Typically, relative dark current is halved for every 7°C drop in sensor temperature.

## Sensor Type

Two types of CCDs are generally used in high performance imaging applications. They are interline transfer and full-frame readout CCDs. Interline transfer CCDs offer fast frame rates (up to 30 frames/sec), electronic shuttering, and anti-blooming suppression, making them well suited for industrial, aerial and medical applications. Full-frame CCD sensors have slower frame rates, require mechanical shutters and provide a 100% light sensitive area, making them well suited for scientific and digital photography applications.

	<i>Interline CCD</i>	<i>Full-Frame CCD</i>
<b>Frame Rate</b>	High (~30fps)	Low (1-10fps)
<b>Shuttering</b>	Electronic	Mechanical
<b>Minimum Exposure</b>	Microseconds	Milliseconds
<b>Overlapped Exposure</b>	Yes	No
<b>Dynamic Range</b>	+	++

## The MEGAPLUS Edge

### Superior Imaging Technology

- High resolution
- Low noise
- High dynamic range
- Unparalleled sensitivity
- Robust industrial design
- Designed for 24/7 operation
- Resilient in harsh or diverse environments
- Expert consultation
- Valuable customer solutions development
- Rapid response



MEGAPLUS cameras offer multiple data interfaces including Firewire, CameraLink and GigE Vision.

## Data Interface

Throughput requirements must be considered before selecting an appropriate data interface. For example, an 11 megapixel monochrome camera running at 4.5 frames per second needs an interface that is capable of 50 MBytes/sec (@ 1 Byte/pixel) to 100 MBytes/sec (@ 2 bytes/pixel). For such data intensive applications, CameraLink usually provides enough bandwidth to reliably transfer image data to the host computer. When the highest frame rate is not required, plug-and-play interfaces such as GigE Vision and Firewire/IEEE1394 allow easy operation of the camera from a laptop, or even from remote locations (GigE Vision) that might be too dangerous or too far removed from the CPU's home base.

Additional factors such as mechanical size, fit and lens mount options should also be considered when making your final decision as to which camera will work best for your application.

## MEGAPLUS Cameras System Features at a Glance

- On-board flat-field normalization
- Advanced color management (internal Bayer de-multiplexing)
- Anti-blooming control
- Customer LUT download option
- Double trigger exposure
- Binning (2x2, 3x3 and 4x4) and partial scan
- Manual and semi-auto white balance
- Various trigger options
- Field updatable FPGA and DSP architecture

## The MEGAPLUS Advantage

MEGAPLUS, the world's leading digital imaging camera platform, provides:

- Outstanding image quality and detail
- Thermoelectric cooling to reduce sensor temperature and minimize dark current
- Flexible programmability and industry-leading automation & integration capabilities
- Reliability
- World class service
- Decades of experience in low-noise electronics development and digital camera technology

## Reduced Sensor Temperature

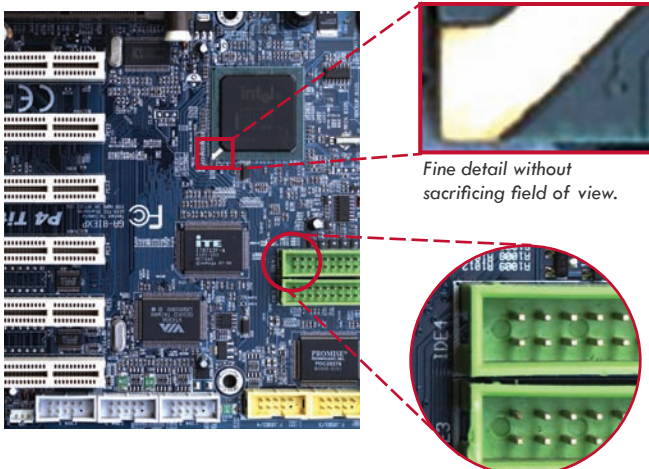
Traditional camera designs integrate image acquisition electronics and sensors in a very close space, increasing heat/dark noise which deteriorates image quality. The innovative, passive, thermoelectric cooling design of MEGAPLUS cameras removes all the heat generating electronics from the sensor's path, lowering its operating temperature. This provides additional options for customers who may not have considered a cooled camera because of interference from fan vibration. For those applications that do require active cooling, an optional fan is available, providing cooling capability to  $\sim 12^{\circ}\text{C}$  below ambient temperature, directly translating into better image quality.



EC and EP series MEGAPLUS cameras utilize advanced thermal designs to minimize sensor temperature

## Image Quality

MEGAPLUS cameras are designed to consistently deliver excellent resolution and color reproducibility. By carefully optimizing sensor clocking, MEGAPLUS cameras from Princeton Instruments operate with lower noise and a higher dynamic range than any other camera on the market. This design also allows complete on-board pre-processing of image data, including user programmable flat-field normalization (FFN), defect correction and real-time advanced color management.



Fine detail without sacrificing field of view.

The robust FPGA-based advanced color processing algorithms in MEGAPLUS cameras provide cleaner, sharper images.

## Flexibility

Flexibility is at the core of the MEGAPLUS design. Whether it is the large selection of sensors, the user-uploadable flat-field normalization tables, or various mechanical form factors, MEGAPLUS cameras offer the user maximum flexibility in tailoring the performance of the camera to the application. In addition, industry-leading automation and integration capabilities, including various data interface options, provide the MEGAPLUS user with more application options than previously available.



MEGAPLUS EM cameras  
in a 2x2 stack



MEGAPLUS EM cameras  
in a line

Miniature EM11000 cameras can easily be installed in space-constrained environments. Since a single controller can operate multiple cameras, these cameras are also ideal when image acquisition needs to be tightly synchronized.

## Reliability

Reliability begins with design, and is incorporated into every camera detail. MEGAPLUS cameras are ready to tackle the harshest environments - from precise thermal management contained in the rugged housing, to grueling tests conducted by our expert engineers and production managers, to high-flex cables, our state-of-the-art production facilities ensure that each camera is manufactured to strict quality standards, with every component chosen for reliability and performance. For example, our patented mechanical shutter, used in full-frame cameras, is rated for millions of cycles!

## World Class Service

It starts long before the sale, when our experienced applications engineers discuss your imaging needs to determine the best camera solution for your application. We pride ourselves in providing imaging solutions that exceed your expectations. And with Princeton Instruments' worldwide network of sales and service centers, our customers are never far removed from the support provided by our seasoned imaging professionals.



MEGAPLUS cameras are manufactured in state-of-the-art clean room facilities utilizing the latest manufacturing methods.

## Unparalleled Expertise

Princeton Instruments is proud to build its decades of experience in low-noise electronics development and digital camera technology expertise into every MEGAPLUS camera, providing the best possible digital imaging solution for your application.



ISO 9001  
QMI-SAI Global

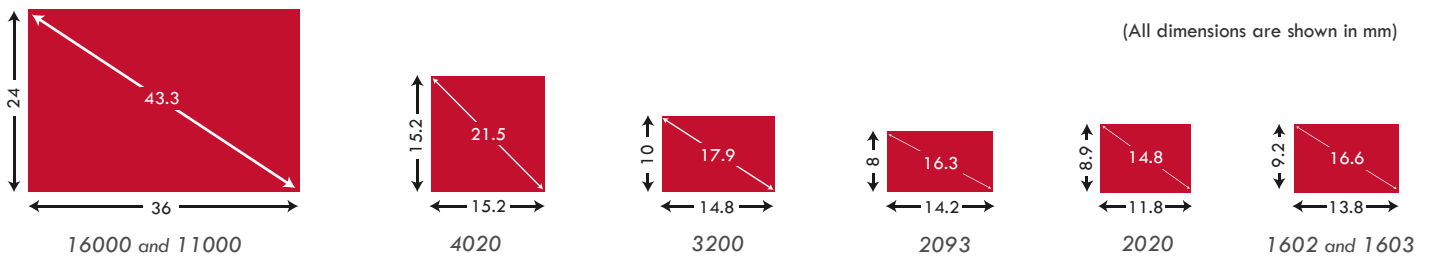
# Camera Selection Chart

Camera	Resolution	Pixel size	Sensor size (Diagonal)	Frame rate @ full resolution (CameraLink)
EC/EP 16000	4872 x 3248	7.4 $\mu\text{m}$	36 mm x 24 mm (43.3 mm)	3.2
ER 11000	12024 x 8016	3 $\mu\text{m}$ (effective)	36 mm x 24 mm (42.3 mm)	0.68
EC/EP/ES/EM 11000	4008 x 2672	9 $\mu\text{m}$	36 mm x 24 mm (42.3 mm)	4.6
ES 4020	2048 x 2048	7.4 $\mu\text{m}$	15.2 mm x 15.2 mm (21.5 mm)	15
ES 3200 (Full frame)	2184 x 1472	6.8 $\mu\text{m}$	14.8 mm x 10.0 mm (17.9 mm)	2.9
ES 2093	1920 x 1080	7.4 $\mu\text{m}$	14.2 mm x 8.0 mm (16.3mm)	30
ES 2020	1600 x 1200	7.4 $\mu\text{m}$	11.8 mm x 8.9 mm (14.8 mm)	30
ES 1603 (Full Frame)	1536 x 1024	9 $\mu\text{m}$	13.8 mm x 9.2 mm (16.6mm)	6.4



All cameras can be operated by multi-head or single-head controllers.

## Field of View Comparison (actual sensor sizes shown)



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We continue to expand  
the MEGAPLUS product portfolio.

Please visit [www.princetoninstruments.com](http://www.princetoninstruments.com) for the most current product information.