Luca^{EM} R

ANDOR™ TECHNOLOGY

Low Light Imaging Cameras

Features & Benefits

EMCCD Technology
Ultimate in sensitivity from EMCCD gain. Even single photons are amplified above the noise. Full QE of the sensor is harnessed (visit www.emccd.com)

Megapixel sensor
High resolution over a large field of view.

RealGain™
Linear and quantitative EM gain scale. The EM gain you ask for is the gain you get!

iCam
Unique innovation that empowers the EMCCD to operate with market-leading acquisition efficiency through live cell microscopy software.

Small pixel size
8 x 8 µm pixels for fine resolution in microscopy.

Application Flexibility
Operate 'gain off' for conventional CCD operation under brighter conditions - apply EM gain when the photons become scarce!

Baseline Clamp
Essential for quantitative accuracy of dynamic measurements.

Rapid frame rates
Follow dynamic low-light processes at rapid frame rates. Full sub-array and binning flexibility.

USB 2.0
Universal 'Plug and play' connectivity ♦[1].

Visual Acquisition
Follow events in real time during data acquisition.

Auto Dynamic Range
Pre-amplifier gains are automatically tuned to enable maximum dynamic range with EM gain on or off.

Fan Control
Turn off fan for zero vibration during acquisition periods of up to several minutes! Ideal for combined optical/AFM set-ups.

Extremely compact
The most compact scientific digital EMCCD on the market. 'Extreme-compact' OEM version available also.

Multiple camera
Operate multiple Luca^{EM} cameras, synchronized in parallel.

"Andor's high-resolution Luca^{EM} R EMCCD; Now with UV response"

Andor's Luca^{EM} family represents the latest Electron Multiplying CCD innovation, a highly cost-effective yet powerful camera making EMCCD available to every laboratory. Luca^{EM} represents a new performance standard in 'workhorse' cameras.

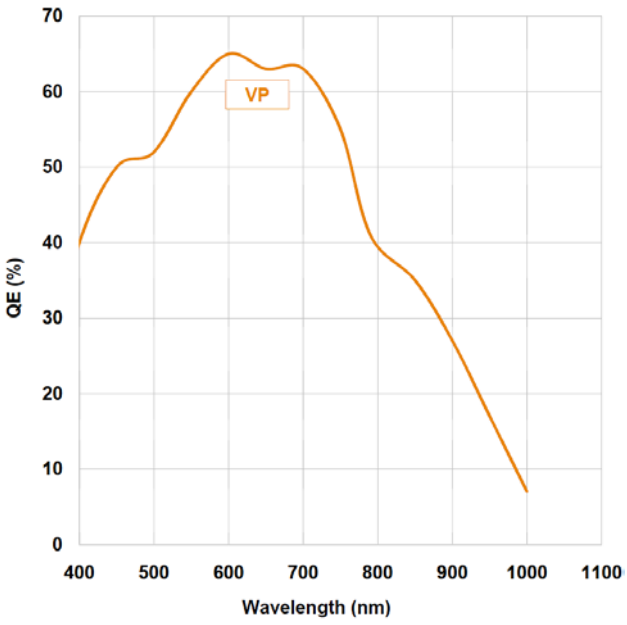
Operate EM gain off for conventional CCD operation under brighter conditions – turn on the EM gain when the photons become scarce.

Luca^{EM} R utilizes a monochrome megapixel frame transfer EMCCD sensor, providing single photon detection sensitivity and unrestrained QE (65% max), in a TE cooled, USB 2.0 camera platform. Andor's exclusive RealGain™ EM gain control offers enhanced user-friendliness and quantitative reproducibility, setting a new precedent in day-to-day EMCCD use.

Camera overview

Active Pixels	1004(H) x 1002(V)
Pixel Size (W x H; µm)	8 x 8
Image Area (mm)	8 x 8
Active Area pixel well depth (e^-, typical)	30,000
Gain Register pixel well depth (e^-, typical)	80,000
Max Readout Rate (MHz)	13.5
Frame Rate (frames per sec)	12.4
Read Noise (e^-)	<1 to 18 @ 13.5 MHz

Quantum efficiency♦[2]



Peak Quantum Efficiency	
CCD Type	**Typical**
VP @ 600nm	65%

Luca^{EM} R

Low Light Imaging Cameras

Technical specifications

System characteristics

Pixel Readout Rate (MHz)	13.5
Linearity (%, maximum)♦3	1
Vertical Clock Speed (µs)	0.9
Electron Multiplier Gain - RealGain™ ♦4	1 - x1000 linear scale. Simple pre-defined selections for 'max dynamic range' and 'max sensitivity'.
Digitization	14 bit
Auto pre-amplifier gains♦5	Auto-selects to deliver optimal dynamic range for 'EM on' or 'EM off'.

System Readout Noise (e^-)♦6

Typical	With Electron Multiplication
18	<1

Minimum Temperature

Air cooled (ambient air at 20ºC)	-20ºC

Dark current♦7

Dark Current @ -20°C (e^-/pix/sec): 0.17

Maximum frames per second♦8

	Array Size			
Binning	Full Frame	512 x 512	256 x 256	128 x 128
1 x 1	12.4	23.8	45.8	85.0
2 x 2	24.2	45.5	84.6	148.2
4 x 4	46.1	83.8	146.8	235.9

Power requirements

- 0.22A @ +9V
- 0.089A @ -9V
- 2.12A @ +5V

Operating & storage conditions

Operating Temperature	0ºC to 30ºC ambient
Relative Humidity	< 70% (non-condensing)
Storage Temperature	-25ºC to 55ºC

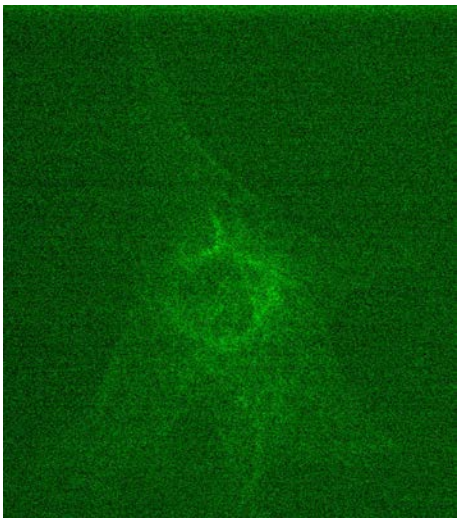
Computer requirements

To handle data transfer rates of 13.5 MHz readout over extended kinetic series, a powerful computer is recommended, e.g.:

- 3 GHz Pentium (or better)
- ≥1GB RAM
- Minimum of SATA 7200rpm hard drive (for operating system) and SATA 10,000rpm hard drive preferred for extended kinetic series
- 32 Mbytes free hard disc space

Need more information? Please contact us at:

International Office	US Office
Phone: +44 28 9023 7126	**Phone:** 800.296.1579
Fax: +44 28 9031 0792	**Fax:** 860.290.9566
Japanese Office	**Chinese Office**
Phone: +81 3 3511 0659	**Phone:** +86-10-5129-4977
Fax: +81 3 3511 0662	**Fax:** +86-10-6445-5401



Low light image from camera incorporating a 1.3 Megapixel Interline CCD sensor (6.45µm pixel size; 5.5 e^- rms read noise)

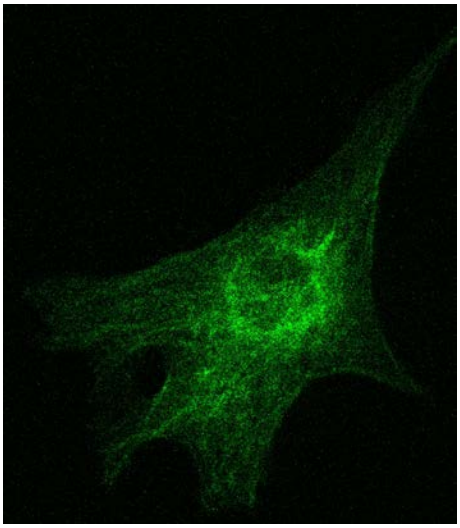


Image from Luca^{EM} R under the same conditions of laser power and exposure time

Ordering information & notes

To order the camera you require, please quote one of the following model numbers:

DL-604M-#VP	Megapixel frame-transfer EMCCD
DL-604M-OEM	Megapixel frame-transfer EMCCD in 'Extreme Compact' OEM housing

The Luca^{EM} R 604 also requires one of the following software options:

Andor Solis (i)	A ready-to-run Windows 2000 or XP-based package with rich functionality for data acquisition and processing.
Andor SDK	A ready-to-run Windows 2000 or XP-based package with rich functionality for data acquisition and processing. Available for Windows 2000 or XP and Linux.
Third party software compatibility	Drivers are available so that the Luca^{EM} range can be operated through popular third party imaging packages

Figure 1: Rear view (Standard housing)

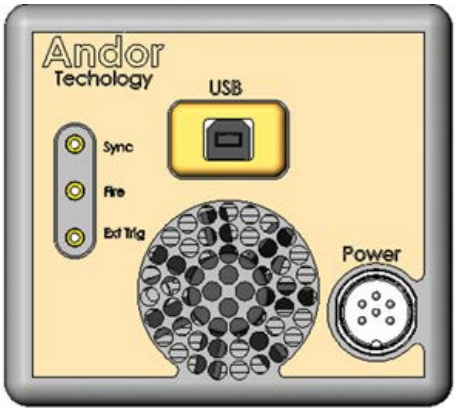


Figure 2: Rear view (OEM housing)

Specifications are subject to change without notice

♦1 USB 2.0 is truly universal to all PCs, in contrast to a Firewire interface which often requires an internal interface card for PC compatibility.

♦2 Quantum efficiency of the CCD sensor as measured by the CCD Manufacturer.

♦3 Linearity is measured from a plot of Signal vs. Exposure Time over the 14 bit dynamic range. Linearity is expressed as a percentage deviation from a straight line fit. This value is not measured on individual systems.

♦4 Whilst a RealGain calibration up to x1000 EM gain is available, we do not recommend operating under such high EM gain values as dynamic range of the measurement is severely compromised. For the vast majority of applications, optimal S/N is obtained at no greater than x200 EM gain. Extending EM gain beyond this value has negligible further impact on S/N.

♦5 EMCCD sensors have gain register well depths (where the signal amplification occurs) which are greater than the well depth of the light capturing pixels of the sensor. As such, different pre-amplifier settings are required to match the A/D capacity to well depth, depending on whether or not EM gain is ON or OFF, thus maximising the available dynamic range in each mode of operation.
Luca^{EM} R automatically selects the optimal pre-amp gain for each mode. Note that when EM gain is first turned on, this auto pre-amp switch will manifest as a slight lowering of counts in the signal (which does NOT mean the actual absolute signal strength is reduced) which is overcome as EM gain is subsequently increased.

♦6 System Readout noise is for the entire system. It is a combination of CCD readout noise and A/D noise. Measurement is for Single Pixel readout with the CCD at a temperature of 20°C and minimum exposure time under dark conditions. Under Electron Multiplying conditions, the effective system readout noise is reduced to sub 1e$^-$ levels.

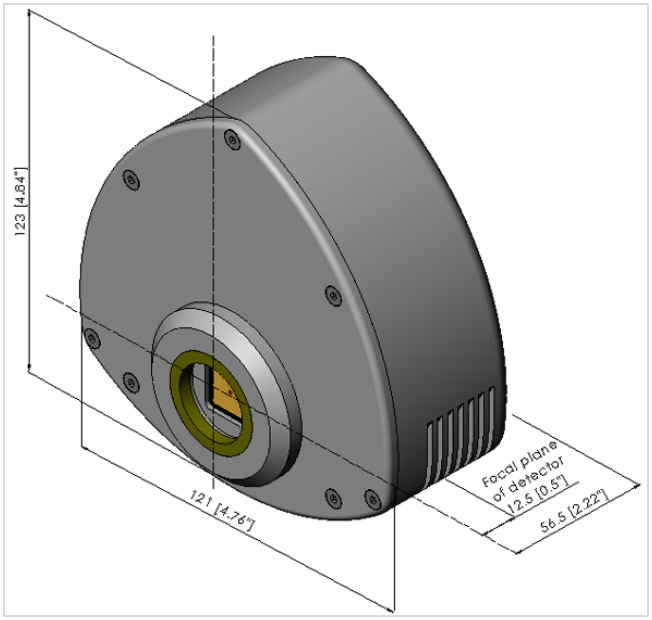
♦7 This value is obtained using the traditional method of measuring dark current, as for any CCD camera, i.e. taking a long integration time (with no EM gain applied) to get a dark signal that is well above the read noise. The dark current measurement is averaged over the CCD area excluding any regions of blemishes.

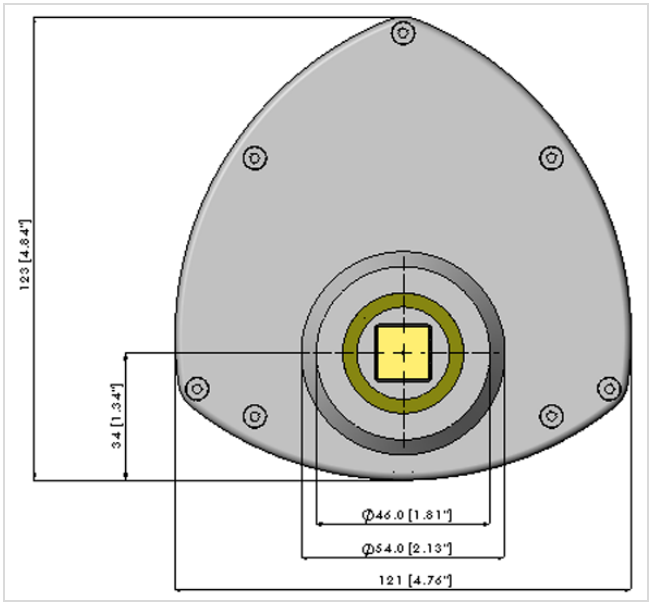
♦8 The max frames/second for the Luca^{EM} R is the maximum speed at which the device can acquire images in a standard system. Shown are the frame rates at 13.5 MHz digitization rates for a range of binning or array size combinations. It also assumes internal trigger mode of operation.

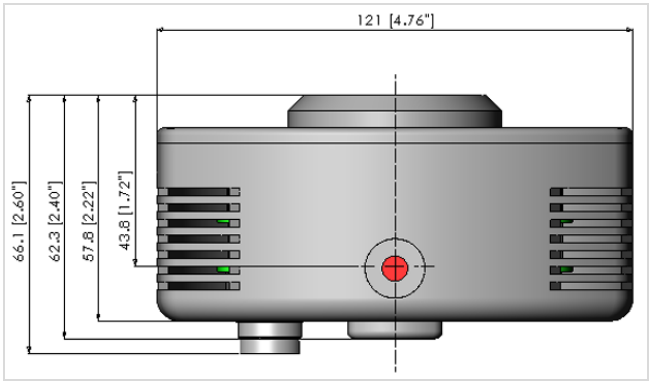
Standard Housing

Dimensions

Weight: 610g (1lb 5oz)







‘Extreme-Compact’ OEM Housing

Dimensions

Weight: 610g (1lb 5oz)