

Glossary of CCD terminology

Amplifier Noise

Whenever a signal is passed through an electrical component like an amplifier, some noise is added to the processed image. This noise is caused by the thermal characteristics of components, bandwidth, and shot noise from moving electrons.

Analogue to Digital Convertor

An electronic component that turns a series of voltages into a series of digital numbers.

Anti-Blooming

When too much light hits a pixel, the signal spills out of the original pixel into surrounding pixels. The pixel is then said to "bloom". Special structures are built onto the sensor at each pixel to provide a path to remove excess electrons from the overflowing pixel. These structures are called anti-blooming circuits.

Binning

The process by which groups of pixels (2 x 2, 4 x 4 or 8 x 8) are combined to create one large pixel. This 'superpixel' can collect increased amounts of light. This increases sensitivity and speed but sacrifices resolution.

CCD

An acronym for Charge Coupled Device, a silicon based imaging device (chip) which converts photons of light into electron representatives.

Chemiluminescence

It is a chemical reaction that occurs between an enzyme, such as horseradish peroxidase (HRP), and a chemiluminescent molecule, such as luminol, resulting in a light emission. This light emission can be detected with traditional x-ray films and CCD or PMT based detectors.

Chemifluorescence

Chemifluorescence attaches a fluorescent molecule to either the secondary or tertiary antibody, which requires excitation via laser or some other high intensity light source. Once the fluorescent molecule is excited, it will generate a light emission that can be collected by a CCD or PMT based detector.

Dark Charge

The amount of electrons produced in a pixel caused by heat energy. More commonly known as thermal charge.

Dark Current

The rate at which thermal electrons are generated at a specific temperature. Also called thermal current. Generally the units are electrons per second per pixel

per square micron per second. This means that longer exposures allow more to build up.

Dark Field Correction

The thermal charge is usually reproducible and can be removed from the image using a dark field correction. This correction works assuming that the temperature and exposure times of the dark field are identical to those of the image to be corrected.

Dynamic Range

Also called Signal to Noise Ratio (SNR). The range of intensities that a sensor is capable of discriminating i.e. the difference between the signals from two pixels is more than the noise and so we can tell the two values apart. Bits are also used to determine dynamic range i.e. 8 bit camera $2^8 = 256$ Grey Shades = 0-2.5 orders of dynamic range. Thus a 16 bit camera = 64,000 Grey Shades which is 0-4.8 orders of dynamic range.

Flat Field Correction

Flat Field correction involves subtracting the image information from an empty field of view from that of the same field of view with the sample added. This process subtracts all background image information associated with such things as uneven lighting sources, lens dust etc. Syngene does not use this method of addressing uneven illumination. See 'Neutral Fielding below'.

Fluorescence

Describes the event whereby UV light excites a fluorescent molecule and produces light.

Frame Rate or Read Out Rate

The speed at which images are captured by an imaging system is called the frame rate and is expressed as number of frames per second – FPS. Higher frame rates are far better for easier focusing and sample positioning and general ease of use. Live action on a television is typically 28FPS, which prevents stuttering on the image.

F-Stop Ratio

This number is the ratio that describes the focal distance, as determined by the diameter of the lens aperture. So the greater the aperture the lower the f-stop value; the more light strikes the sensor, the greater the sensitivity. Zoom capability is sacrificed with very low f-stops.

Full Well Capacity

The total number of electrons a pixel can hold before blooming. Also called the Saturation level.

Neutral Fielding

An image of a Neutral Field sample is acquired and this image is normalised for light illumination. This normalisation is then applied to the gel image, such that uneven illumination generated by the light source is addressed, maintaining GLP compliance. Also see Neutral Fielding application note 8.

Noise

In all measurements there is noise. Noise is the property that is seen by repeated measurements of the same object. Sources of noise in a CCD can be categorised as amplifier read noise, dark current, photon noise etc.

Optical Density (OD)

A measure of Optical Transmission. A filter placed in front of a known light source that allows only 10% of the light to pass through is said to have an optical density of 1 OD.

Pixel

These are the building blocks of a CCD sensor. The word pixel is short hand for "picture element". A pixel consists of the control gates and layers that define the well confining the electrons.

Resolution

Commonly defined as the number of pixels on a CCD. However the measure of resolution is described by the resolving power and is expressed in line pairs per millimetre. It is evaluated from the ability to distinguish distinct line patterns from standard test charts. These can be subjective so should be viewed with caution until computerised methods are tested and adopted.

Quantum Efficiency

A measure of the efficiency by which photons generate electrons in a pixel. The Q/E is a function of wavelength.

Read Noise

The amount of noise present in the electronics between the pixel and the output of the analogue/digital converter.

Saturation Level

See Full Well Capacity.

Thermal Noise

See Dark Current.

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