

Dynamic Range and Full Well Capacity

A definition of CCD dynamic range

The dynamic range of a CCD is typically defined as the full-well capacity divided by the camera noise and relates to the ability of a camera to record simultaneously very low light signals alongside bright signals. The ratio is often expressed in decibels which is calculated as $20\log(\text{Full well capacity/read noise})$ or in the equivalent number of A/D units required to digitise the signal.

Camera	Pixel Size μm^2	Full Well Capacity e-	Read Noise e-	Dynamic Range	Decibels dB	Bits
iXon3 885 EMCCD <i>EM Amplifier with No Gain</i> <i>(dynamic range higher with EM gain)</i>	8 x 8	30,000	20 (x3 pre-amp)	1,500	64	11
Luca S EMCCD <i>EM Amplifier with No Gain</i>	10 x 10	25,000	15	1,667	64	11
iXon3 897 EMCCD <i>Conventional Amplifier @ 1MHz</i> <i>(dynamic range higher with alternative pre-amp)</i>	16 x 16	180,000	9 (x1 pre-amp)	20,000	86	15
Newton 920 CCD <i>50kHz Readout Rate</i>	26 x 26	510,000	10 (x3 pre-amp)	51,000	94	16

The full well capacity is the largest charge a pixel can hold before saturation which results in degradation of the signal. When the charge in a pixel exceeds the saturation level, the charge starts to fill adjacent pixels, a process known as Blooming. The camera also starts to deviate from a linear response and hence compromises the quantitative performance of the camera. Larger pixels have lower spatial resolution but their greater well capacity offers higher dynamic range which can be important for some applications.

The table above shows the full well capacity and dynamic range of a small selection of cameras.