FLUID IMAGING TECHNOLOGIES

Particle Analysis with Vision®

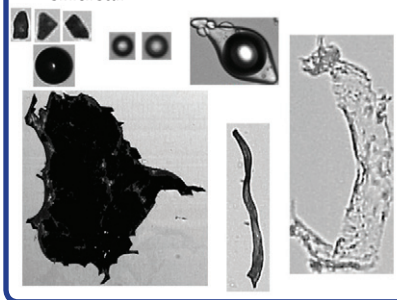
FlowCAM® Tech Brief #3

Color Versus Black & White Cameras

Summary: While most imaging particle analyzers only offer gray-scale (black and white) cameras for image acquisition, FlowCAM® offers a choice of either gray-scale ***or*** color cameras. This Tech Brief will explain the difference between these two camera choices, and discuss the inherent trade-offs that should be considered when choosing which camera to use (summarized in Figure 1).

Use B&W Camera:

- Opaque particles
- Transparent particles with no color information
- Particles are small relative to calibration factor
- Precision in measurements is critical



Use Color Camera:

- Transparent particles with color information that helps characterize them
- Particles are large relative to calibration factor
- Precision in measurements is less critical

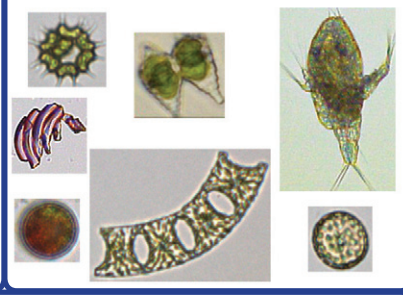


Figure 1: Summary of recommendations.

Definitions:

Gray-Scale (Black and White) Digital Camera*:** In a gray-scale camera, each pixel on the sensor captures information on the quantity of light striking it, or ***intensity, regardless of wavelength. Each pixel in the resultant image is then represented by an 8-bit number where 0=black and 255=white, and the intermediate numbers represent the range of gray between those two extremes.

Color Digital Camera: In a color camera, each pixel is the same as those on a gray-scale camera with the exception that each pixel has a color filter in front of it so that it is measuring the ***intensity*** of the light striking it only in that color range. The color filters are either red, green or blue, measuring the intensity in the three primary colors.

Camera Resolution: Usually expressed in millions of pixels or ***megapixels***, the camera's spatial resolution is found by multiplying the number of horizontal pixels found on the sensor by the number of vertical pixels (e.g. a ***1 Megapixel*** camera might have a 1,024 x 1,024 pixel sensor array).

Output Resolution: The output resolution is the spatial resolution of the final image created by the sensor in pixels. It is the same as the camera resolution, with the exception that a gray scale camera has only one intensity value per pixel, whereas in a color camera, each output pixel has three intensity values, one each for red, green and blue.

Bayer Filter Pattern: A Bayer filter is the most common color filter array (CFA) pattern used in color cameras. It is the arrangement of color filters in front of the monochrome pixels contained in a color camera (see Figure 2).

How a Color Image is Formed: As described in the definitions, a color camera actually uses a monochrome (gray-scale) sensor with a color filter array (CFA) in front of it. Typically the CFA is the Bayer pattern shown in Figure 2. Figure 3 shows the resulting pattern created by the CFA on the sensor for red, green and blue values. Note that there are actually two times (2X) the number of green sensors versus red and blue ones. The reason for this is because the human eye is most sensitive to green light, so having an emphasis on green yields an image which will be interpreted closest to "true color" by the human eye.

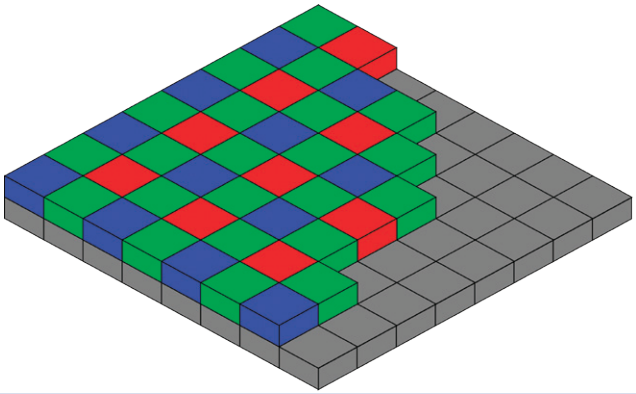


Figure 2: Bayer color filter array (CFA) arrangement on a monochrome sensor.
(Image Source: http://en.wikipedia.org/wiki/File:Bayer_pattern_on_sensor.svg)