

Computational Photography

- * Study the basics of computation and its impact on the entire workflow of photography, from capturing, manipulating and collaborating on, and sharing photographs.



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Cameras, Optics, Lenses, and Sensors

- * Cameras: Sensors (and Film),
where Rays of Light become
Pixels



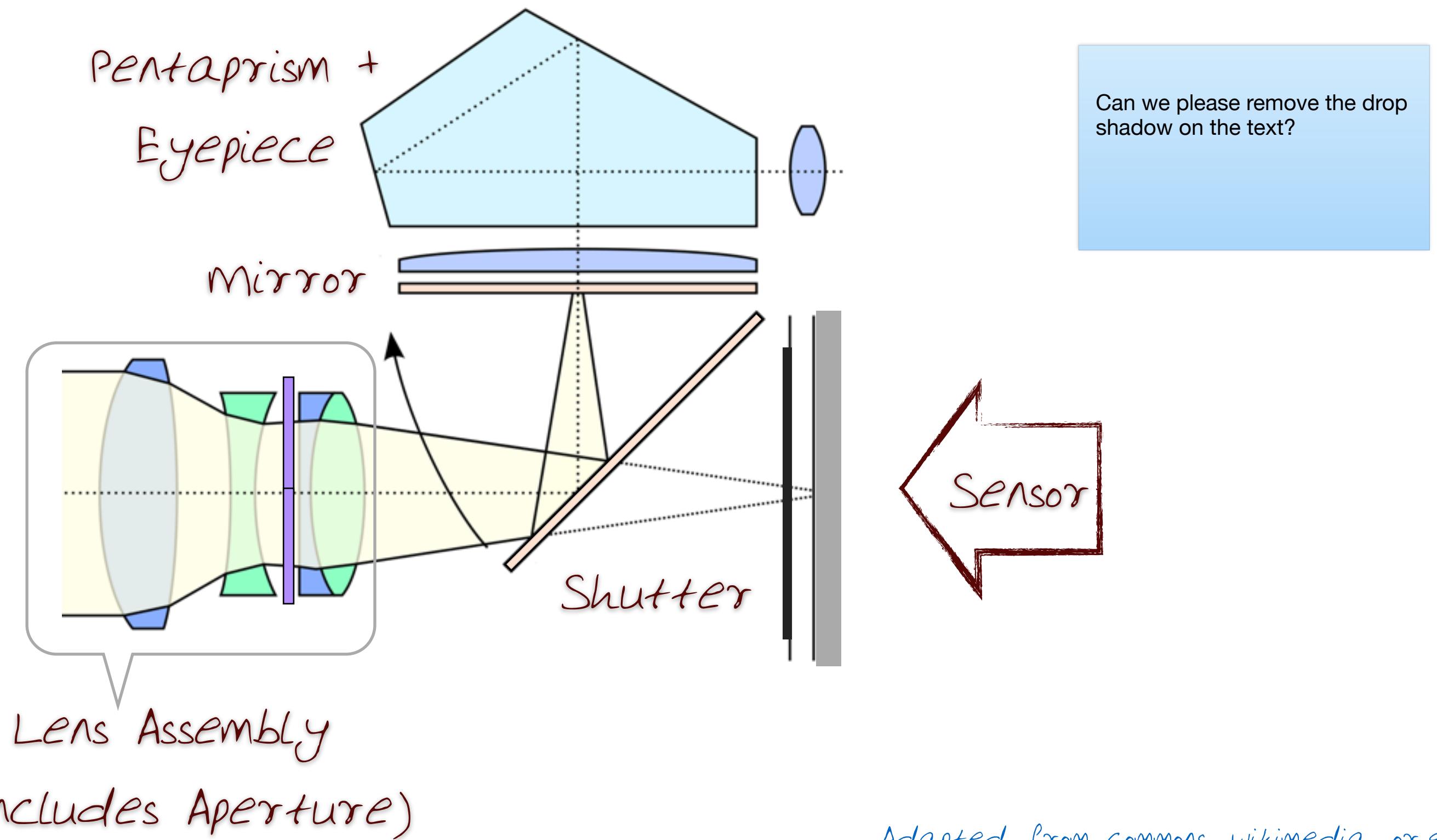
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Lesson Objectives

1. Photographic Processes for Digital and Film Capture
2. Eight layers of Color Film
3. Five layers of a CCD
4. Differences between a CCD and CMOS Sensor
5. Two benefits of using the Camera Raw Format

Recall: Inside a Camera (an SLR)



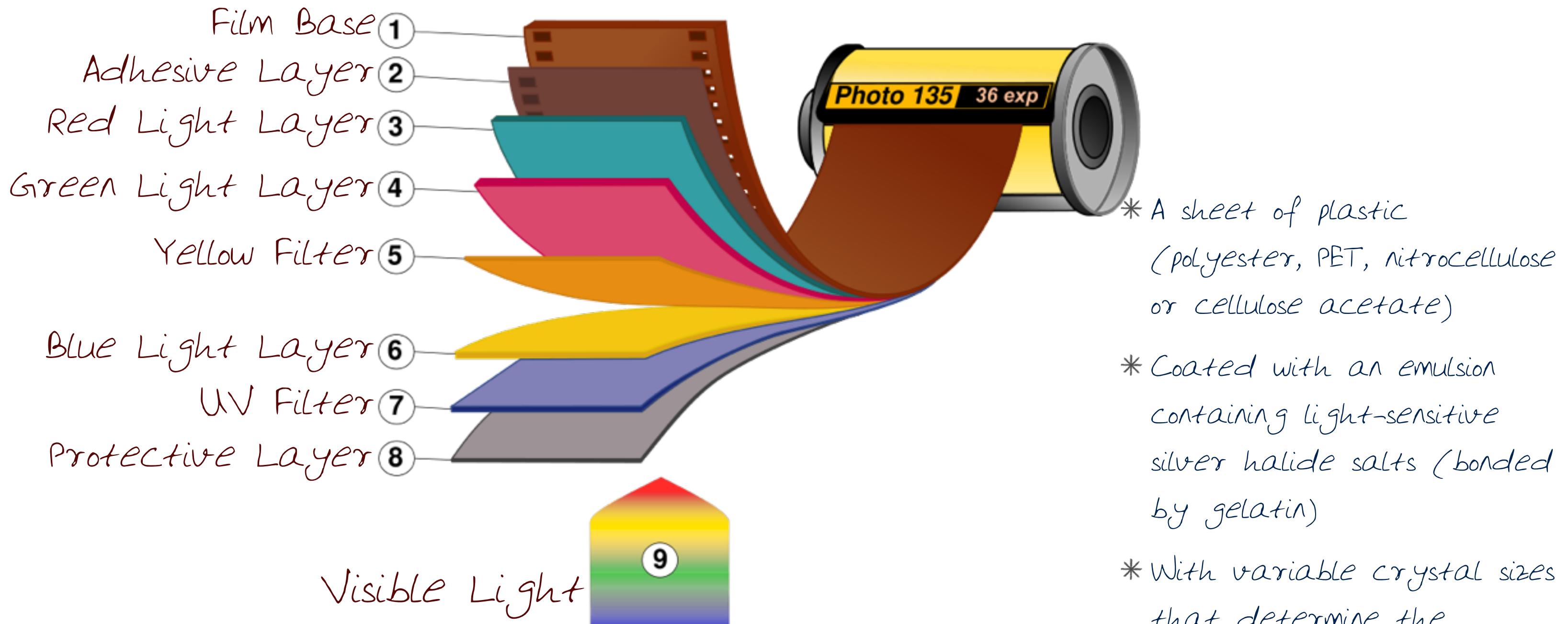
Adapted from commons.wikimedia.org/

Film vs. Digital

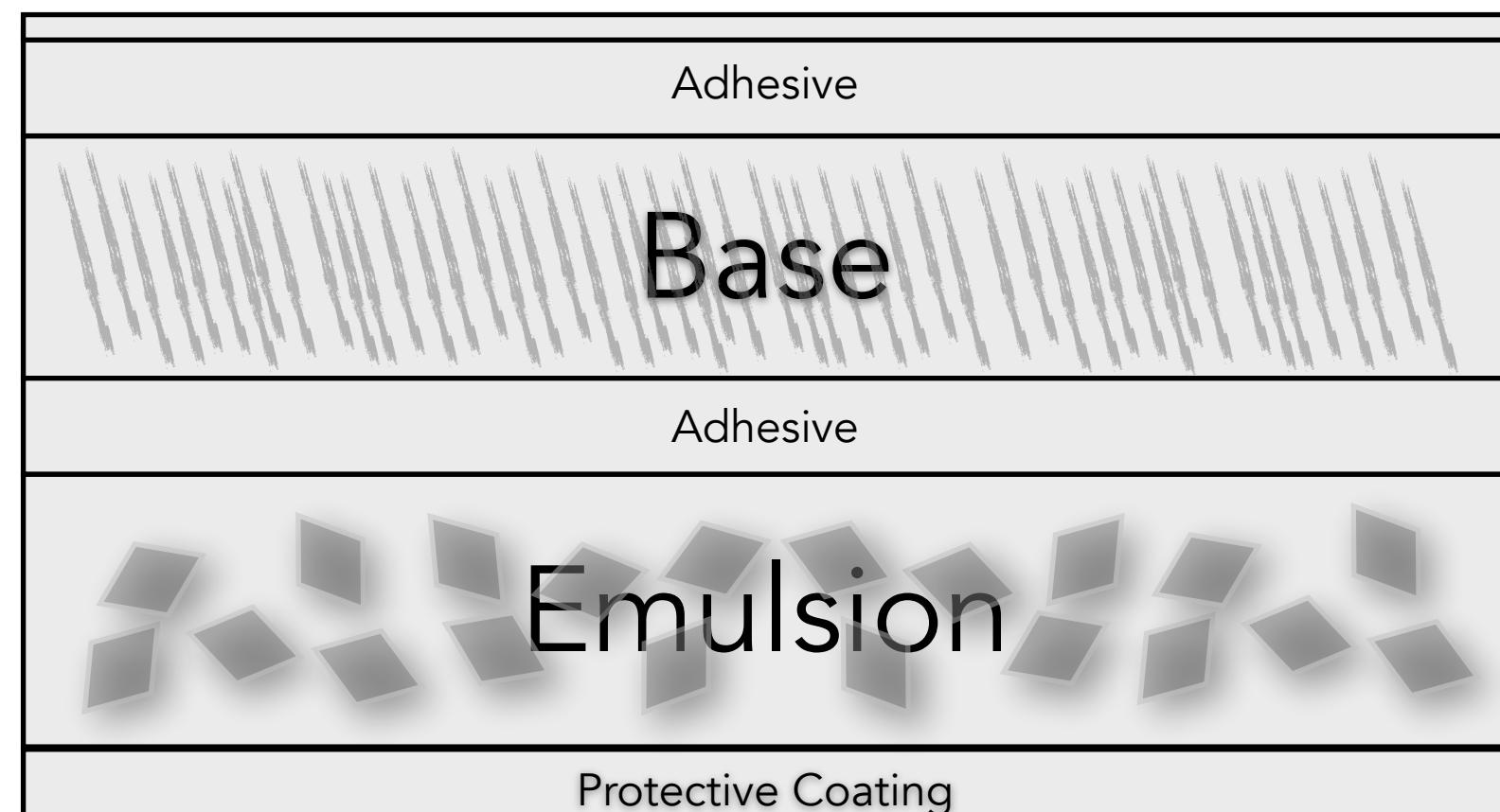
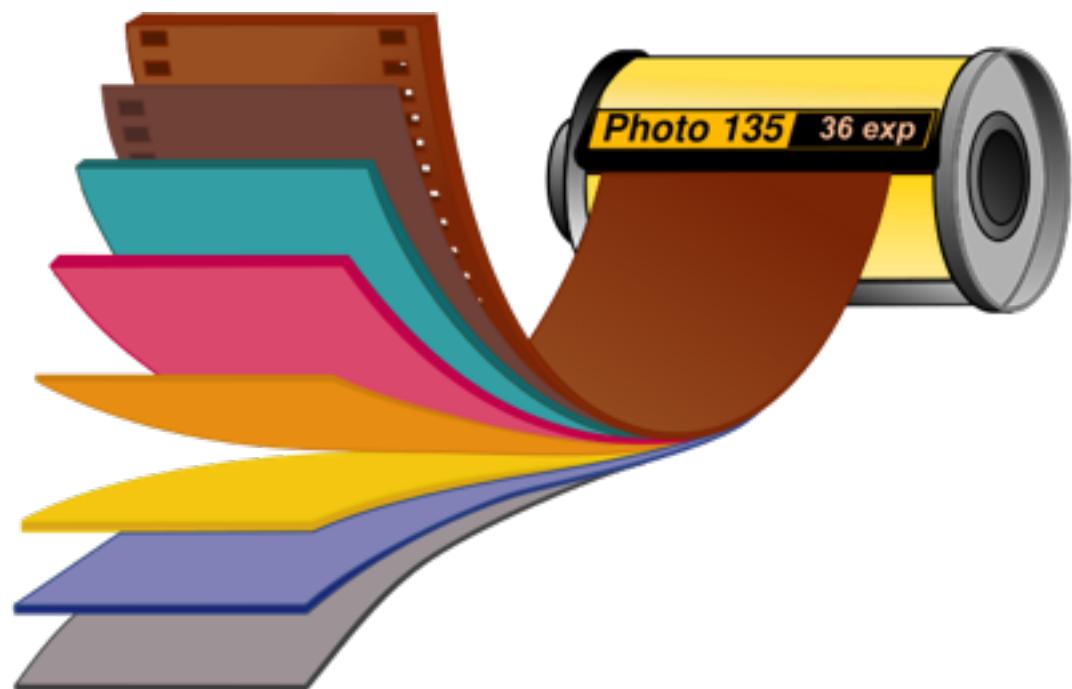


- * Film and Digital Cameras are the same
- * There have been significant improvements in actuators, and lenses
- * Difference is how light is trapped and preserved
- * Chemical process for Film, and Electronic for Digital capture the moment in Time and Space

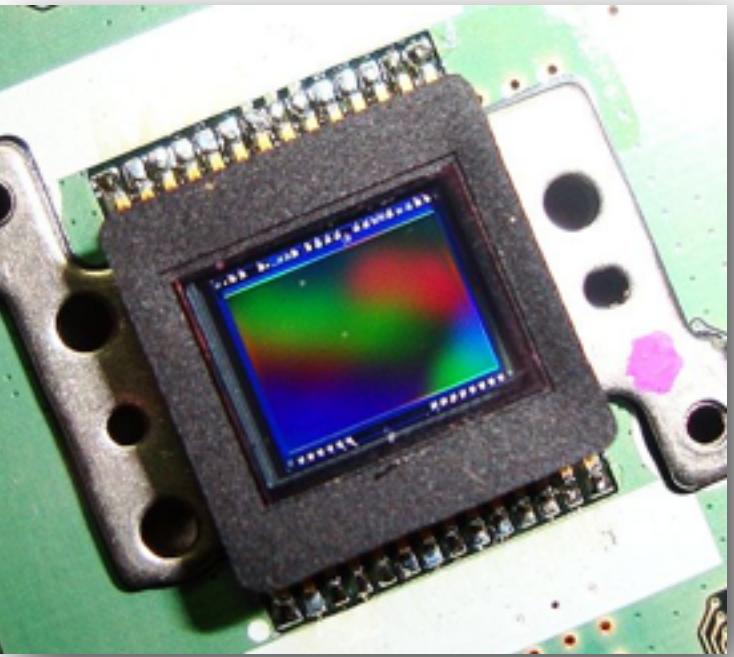
Film: Reaction between Light and Chemicals



Film: Reaction Between Light and Chemicals



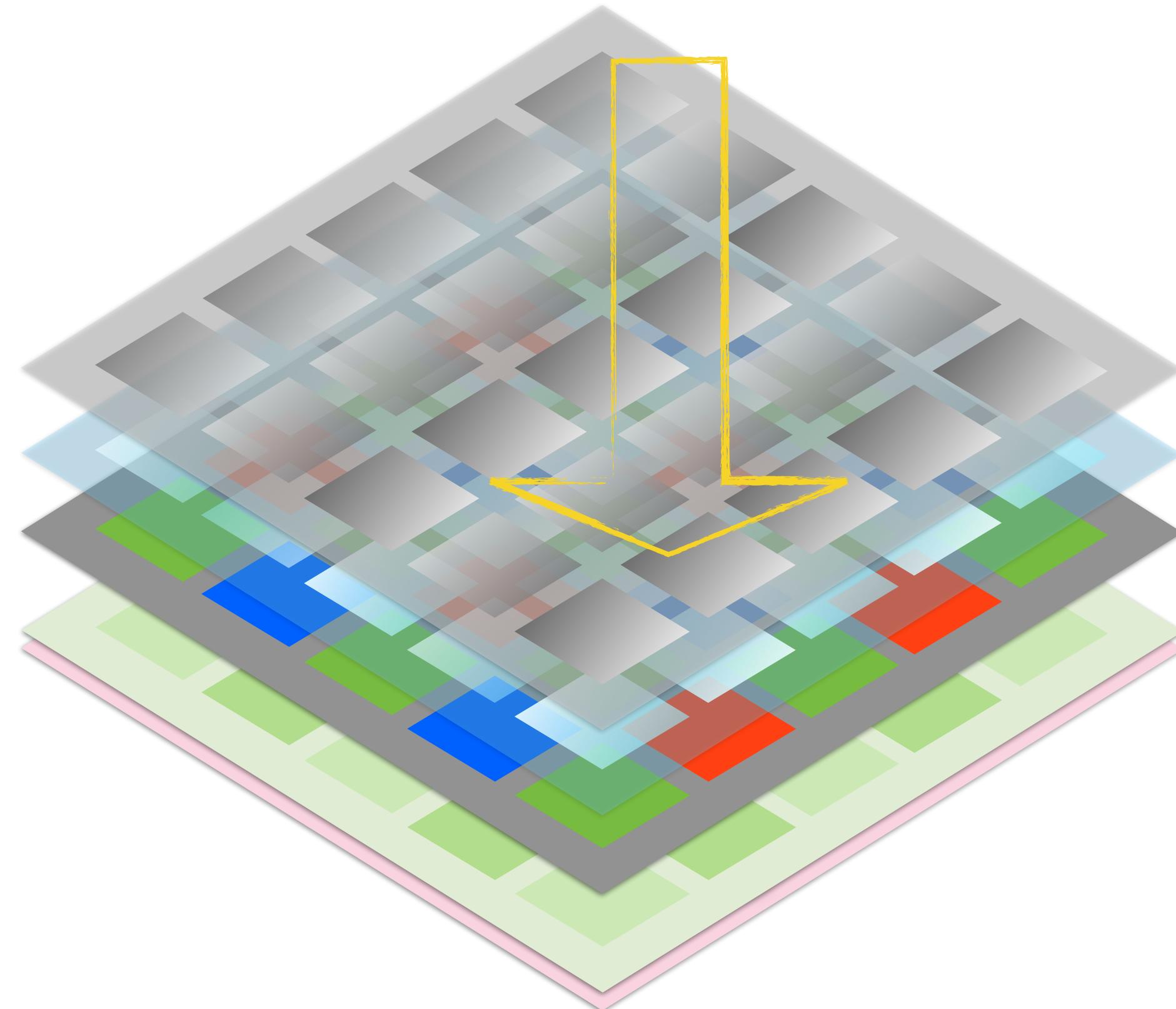
Digital: Converting Light to Data



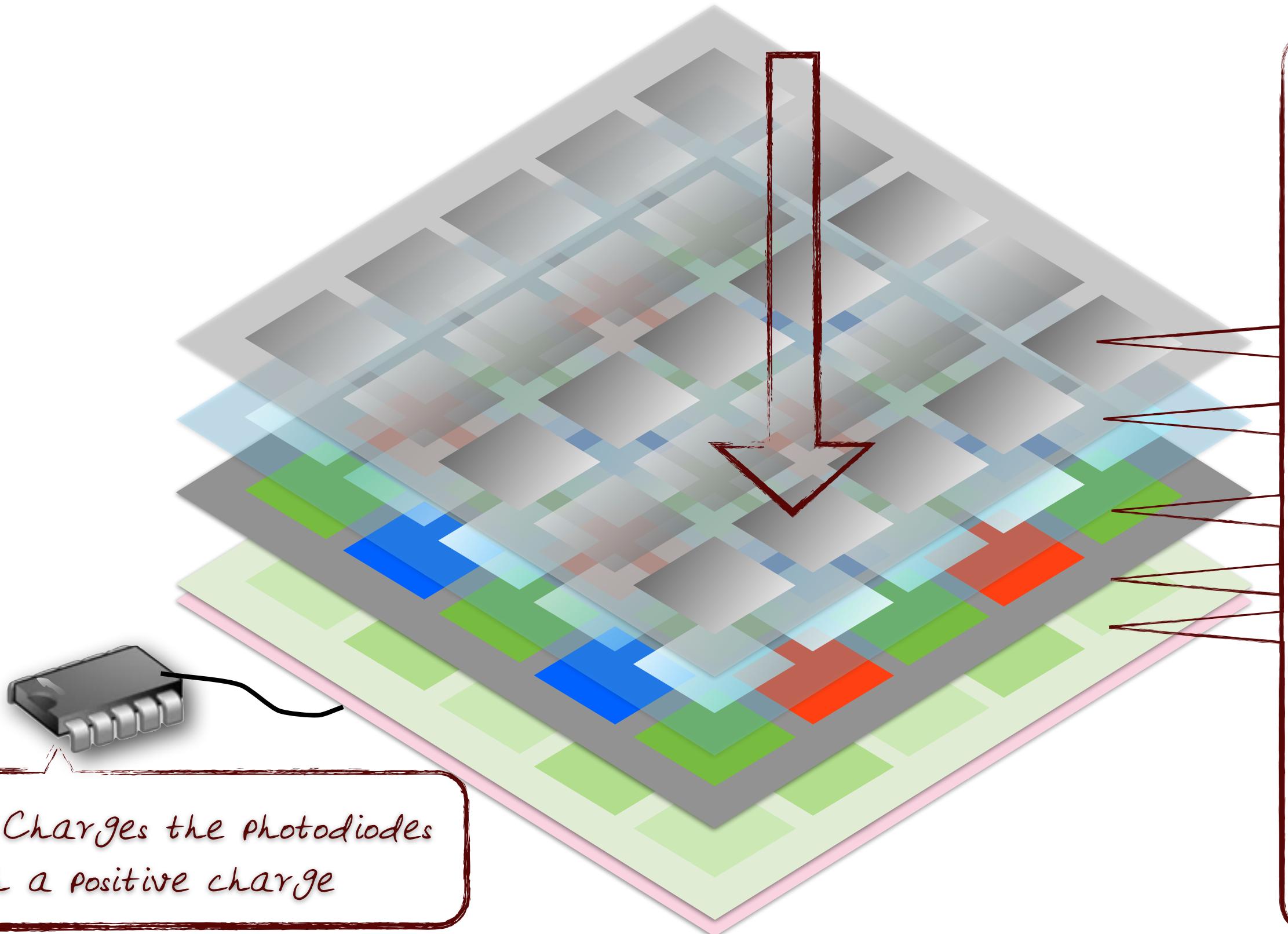
Smith and Boyle

- * CCD: Charge-Coupled Device, a device for converting electrical charge, into a digital value
- * Pixels are represented by capacitors, which convert and store incoming photons as electron charges
- * Willard Boyle and George E. Smith, 1969 (Won a Nobel Prize in Physics in 2009).

Digital: Converting Light to Data



Digital: Converting Light to Data



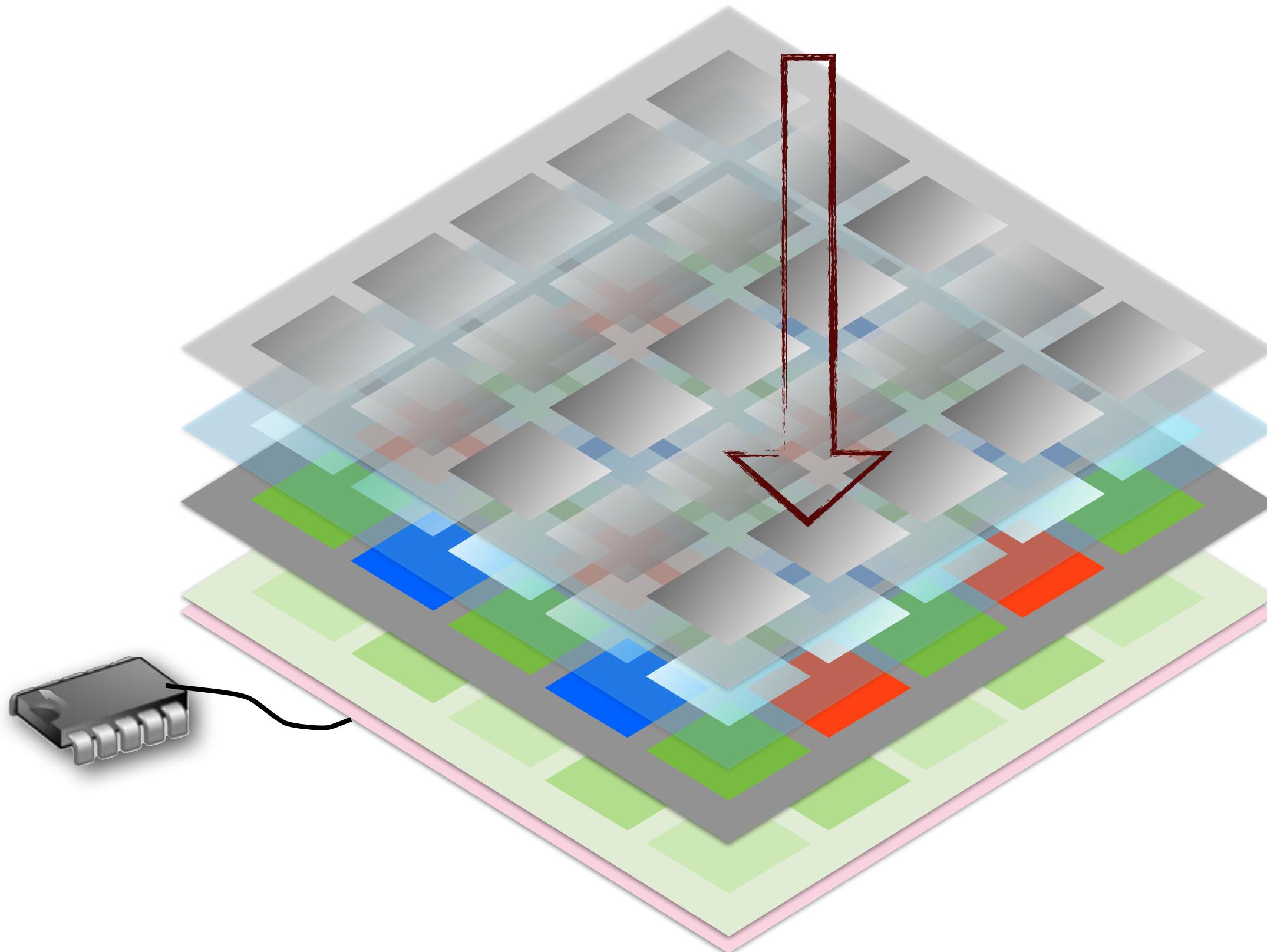
Histogram

Photodiodes
Photo diodes

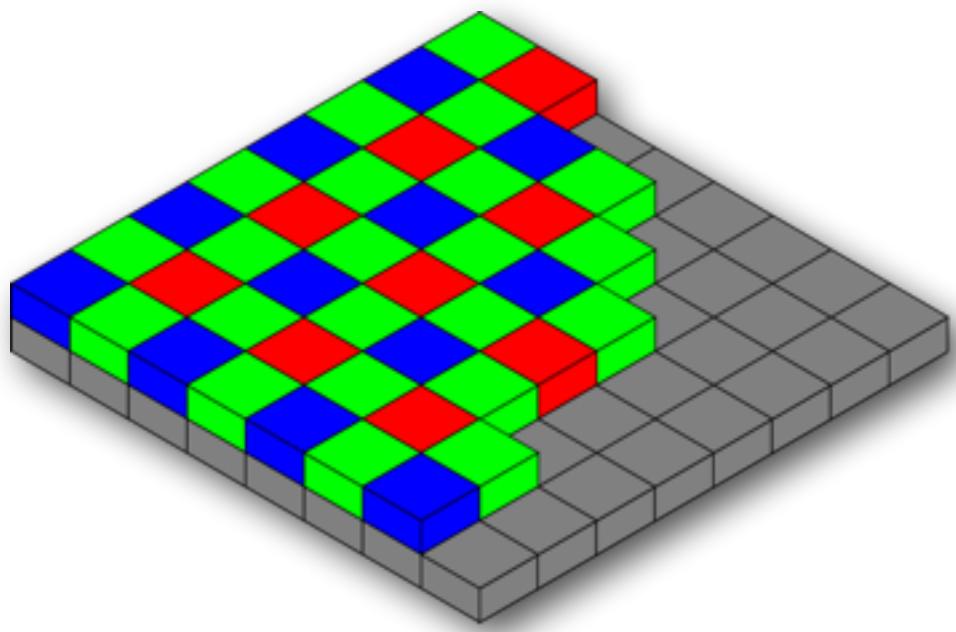
Microlenses
This is where the
Color filtered light
is reflected off of
in light insensitve
is converted
part of the
sensitive parts of the
spectra of the
light into Red
exceptional good
light, green, blue
which is kind of
what kind of
aspects.

reflected off as
backgrounds.

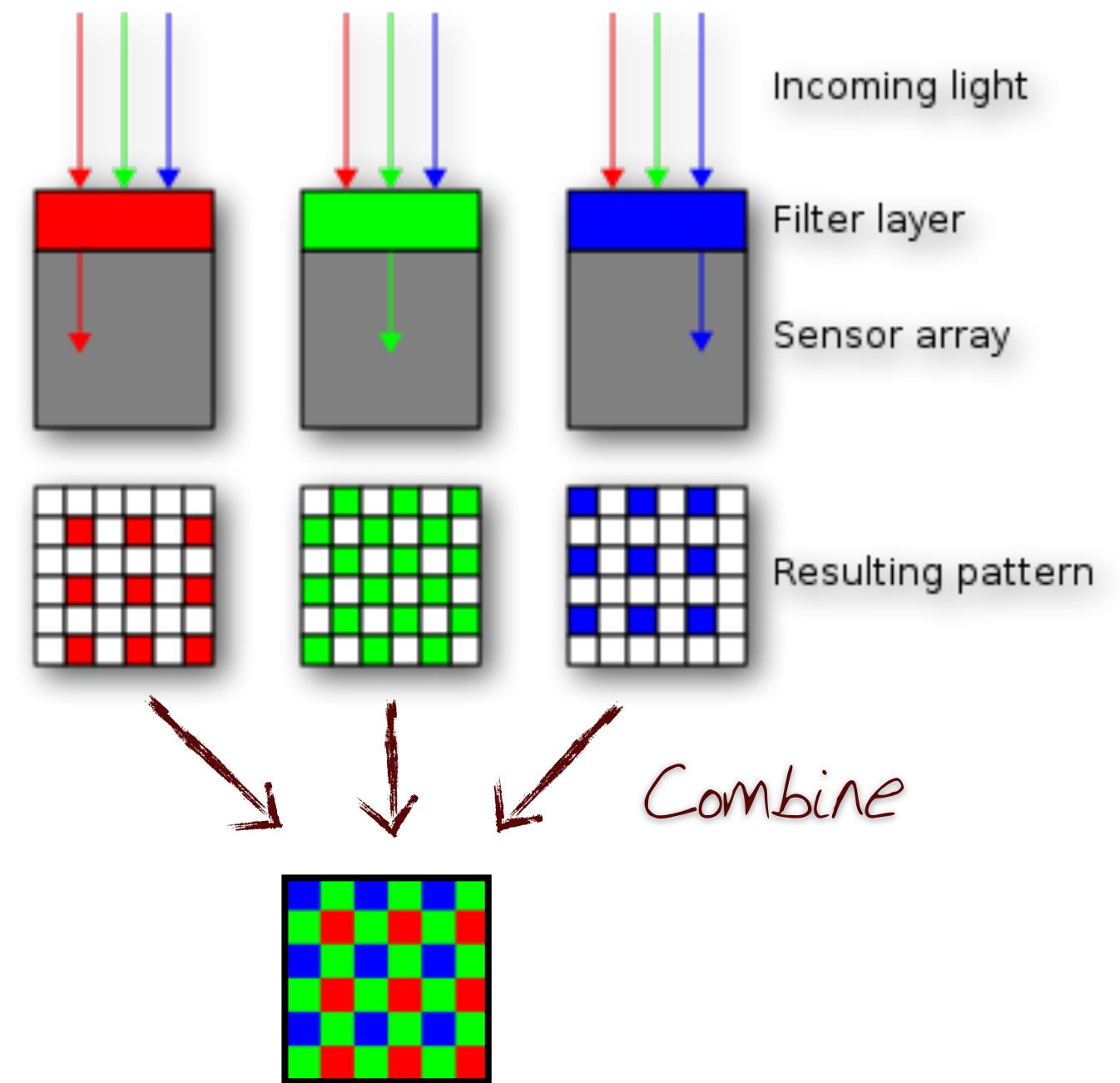
Digital: Converting Light to Data



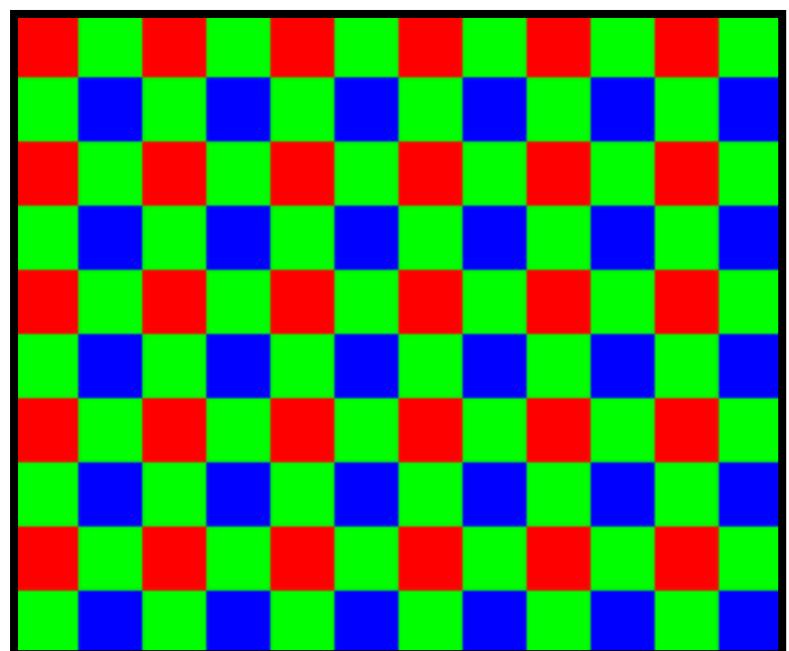
Digital: Converting Light to Data



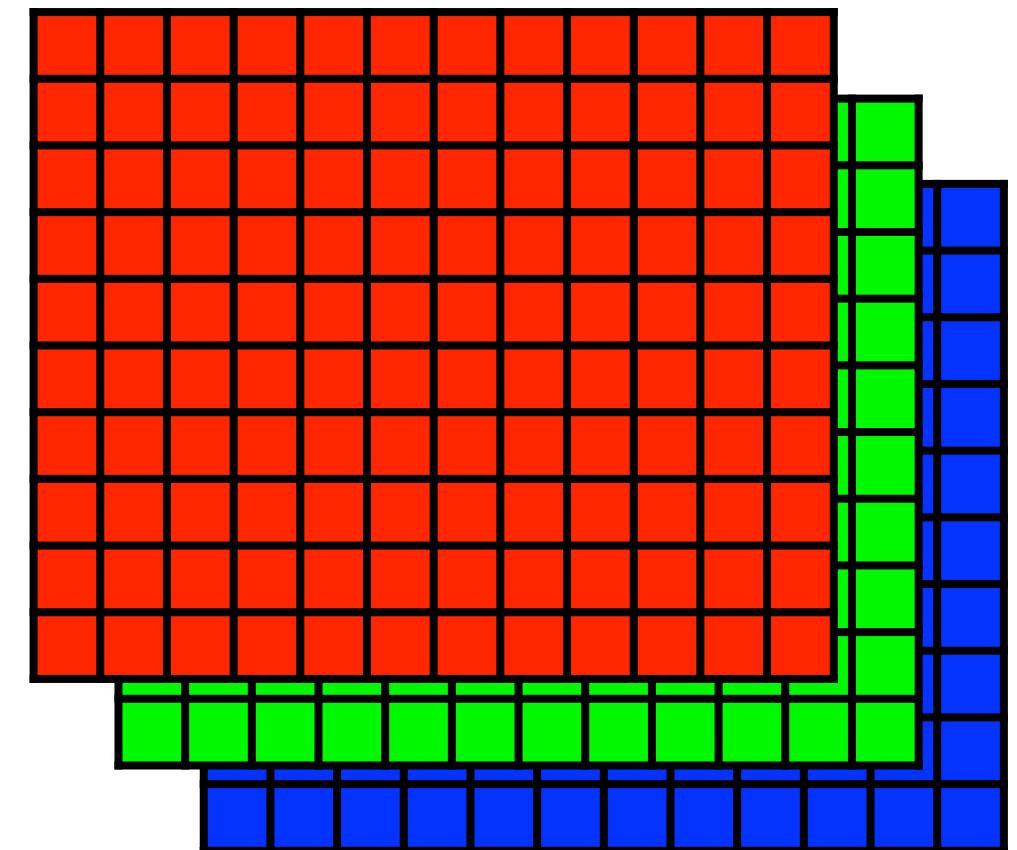
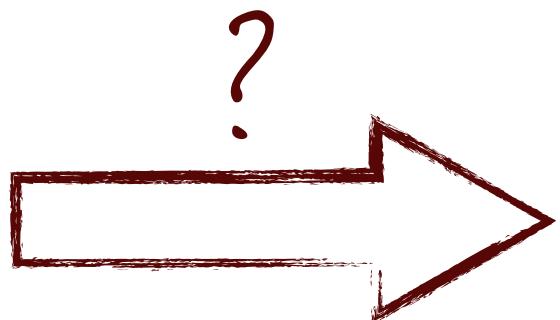
Bayer filter on a sensor



Digital: Converting Light to Data

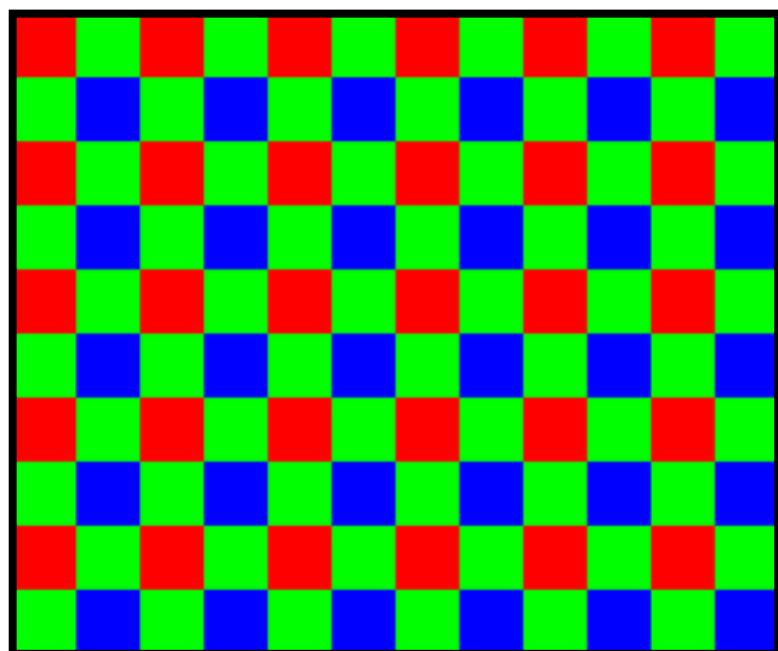


Raw input in Bayer
mosaic format

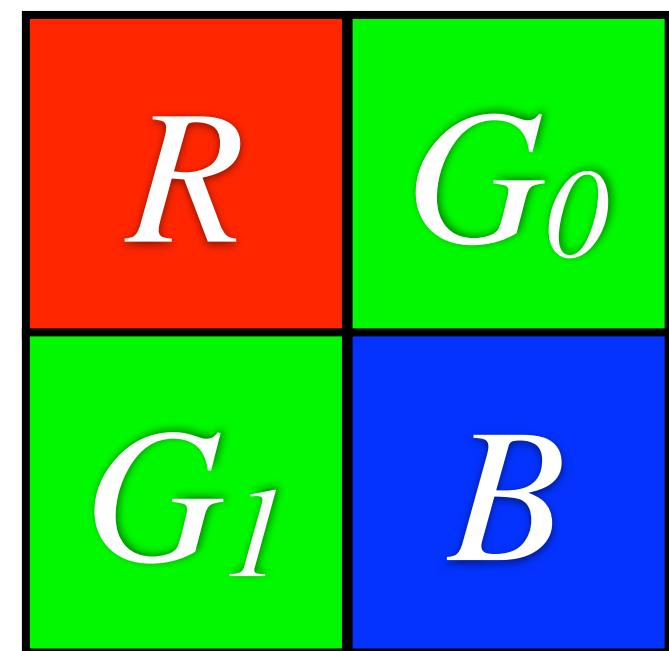


RGB color planes

Bayer to RGB “Demosaicing”

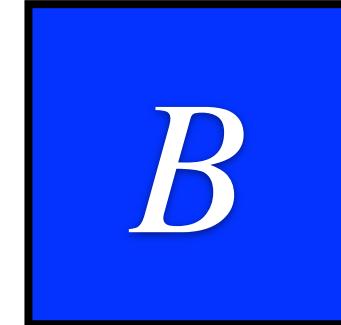


Raw input in Bayer
mosaic format



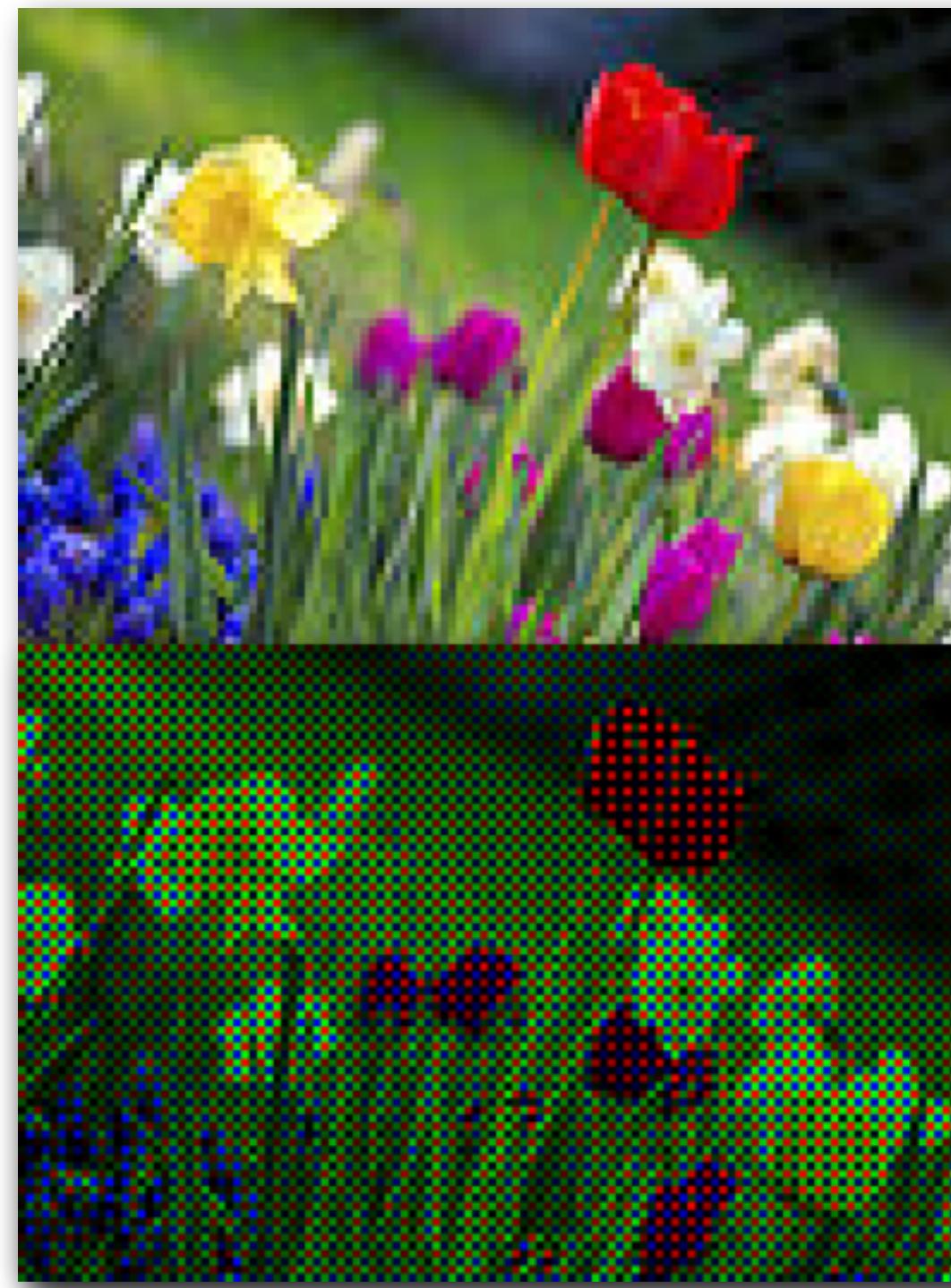
A 4x4 subset

$$R \quad (G_0 + G_1) / 2 \quad B$$



Resulting RGB triple

Digital: Converting Light to Data

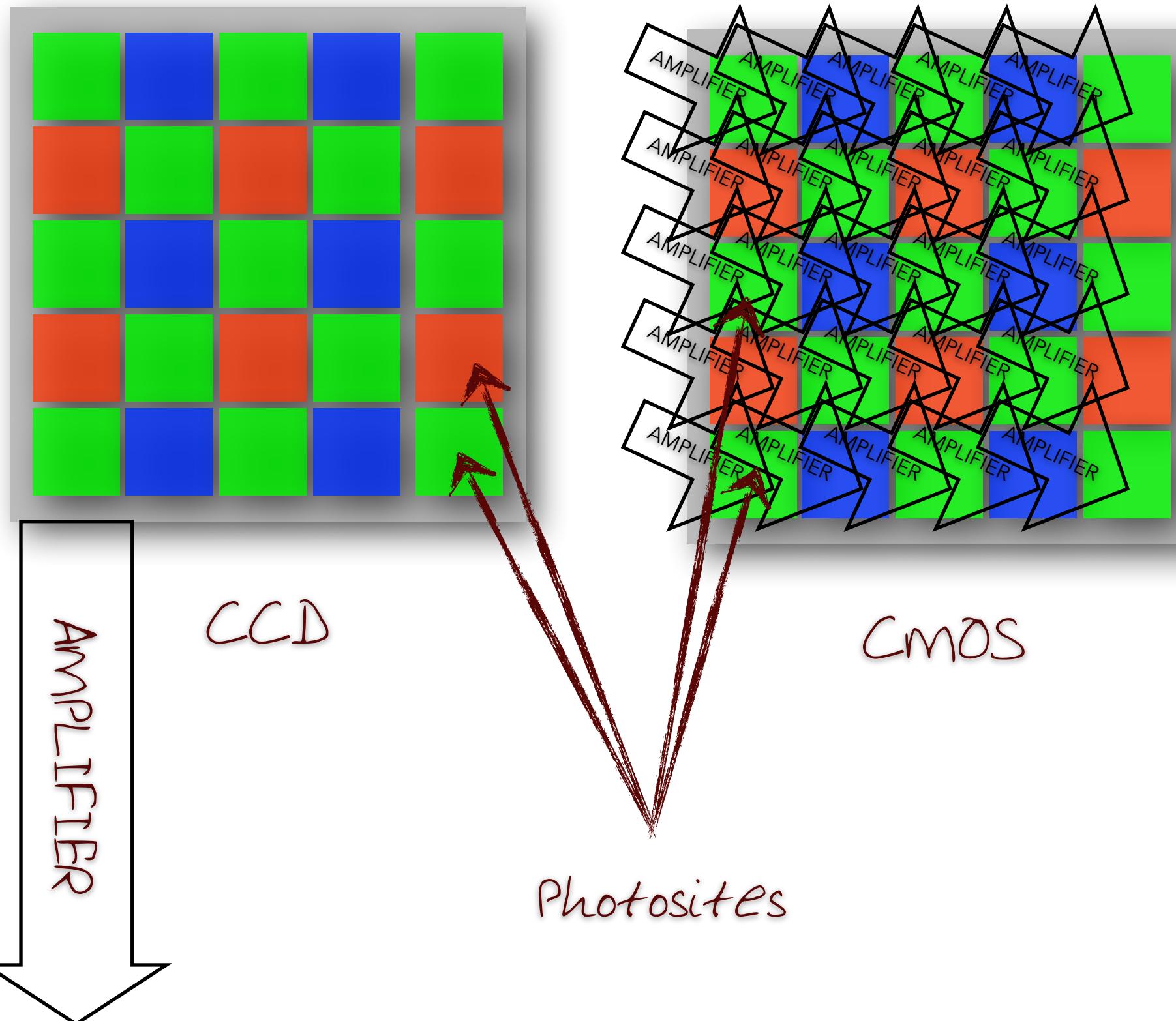


Reconstructed
Image after
Interpolation

Actual Sensor
Information
with Bayer Filter

Images: Wikipedia

CCD vs. CMOS Sensors



- * CMOS: Complementary metal Oxide Semiconductor
- * Photosites in CCD are passive and do no "work"
- * Photosites in CMOS are amplifiers and can do local processing



Camera RAW File Format

- * Contains minimally processed data from the sensor
- * Image encoded in a device-dependent colorspace
- * Captures radiometric characteristics of the scene
- * Viewable image from the camera's sensor data
- * Like a photographic negative
 - * has a wider dynamic range or color; preserves most of the information of the captured image



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Summary



- * Described the Photographic Processes for Digital and Film Capture
- * Presented how sensors work in cameras
- * Discussed how a Color filter works in a sensor
- * Presented CCD and CMOS sensors
- * Discussed the benefits of the Camera Raw Format

Neat Class

- * Doing Computational Photography
- * Blending/Fading
- * Panoramas
- * High-Dynamic Range Imaging





Credits

- * For more information, see
 - * Hecht, E. (2002). Optics, 4th ed. Reading, MA: Addison-Wesley,
 - * London, B., Stone, J., & Upton, J. (2011), Photography, 10th ed. Upper Saddle River, NJ: Prentice Hall, and
 - * White, R. (2006), How Digital Photography Works, Que Publishers
- * Some images retrieved from
 - * <http://commons.wikimedia.org/>
 - * List will be available on website

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