Depth of Field, Lens, Filters

Creative Camera Club

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Depth of Field (DOF) Defined

- “Depth of Field (DOF) is the range of distance in a photo that appears to be in sharp focus ... Depth of field is a creative decision and one of your most important choices when composing nature photographs.”
  - Nature Photography Photo Workshop, Nat Coalson, 2011
- “Simply put, depth-of-field is how much of a photograph is in sharp focus from front to back.”
  - Digital Landscape Photography: In the Footsteps of Ansel Adams and the Masters, Michael Frye, 2010.
- “Depth of Field (DOF), also called focus range or effective focus range, is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image.”
  - https://en.wikipedia.org/wiki/Depth_of_field

DOF Demo

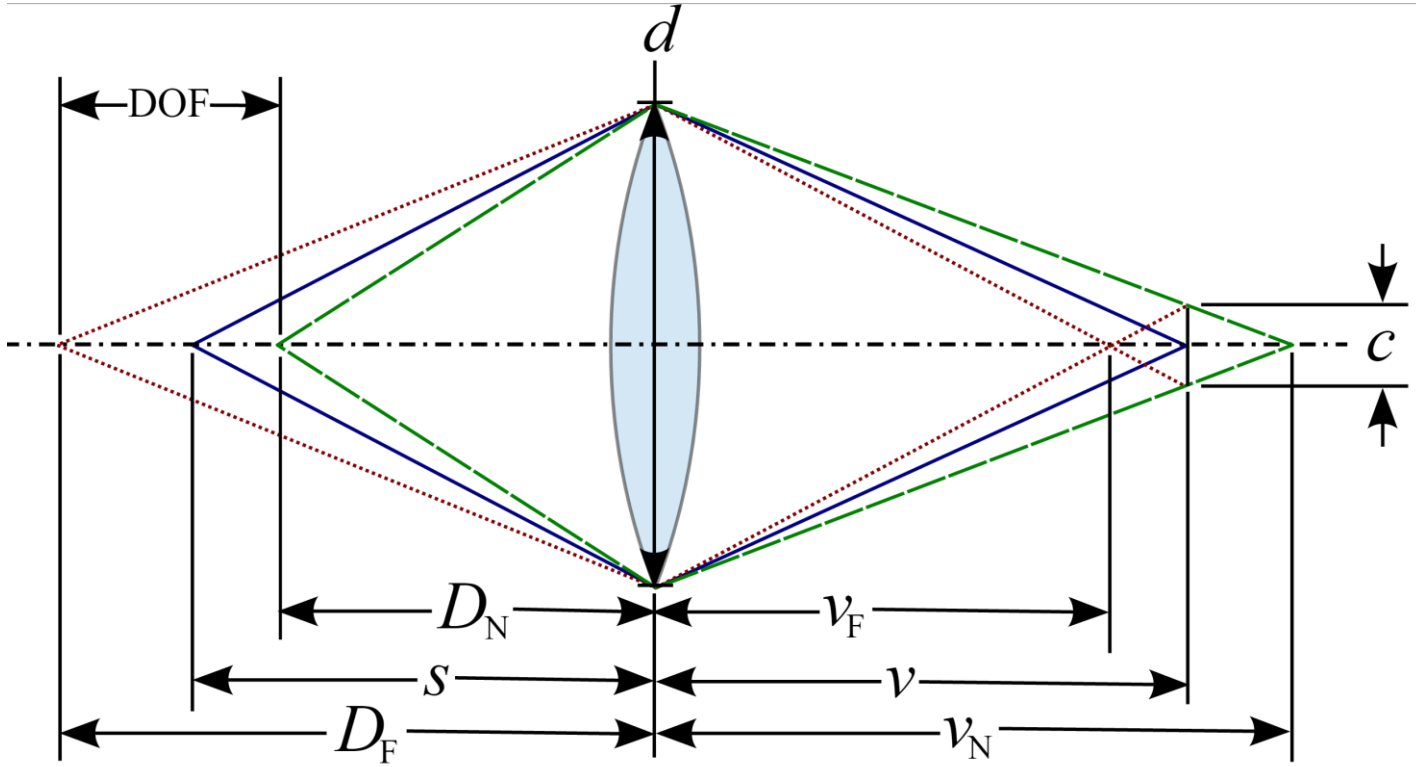
- http://www.bdebaca.com/uploads/1/0/5/2/10520339/6323860_orig.gif

Circle of Confusion

- Precise focus is possible at only one distance; at that distance, a point object will produce a point image.
- At any other distance, a point object is defocused, and will produce a blur spot shaped like the aperture.
- When this circular spot is sufficiently small, it is indistinguishable from a point, and appears to be in focus; it is rendered as "acceptably sharp".
- The diameter of the circle increases with distance from the point of focus; the largest circle that is indistinguishable from a point is known as the acceptable *circle of confusion.*
  - *For full-frame 35mm still photography, the circle of confusion is usually chosen to be about 1/30 mm. Because the human eye is capable of resolving a spot with diameter about 1/4 mm at 25 cm distance from the viewing eye, and the 35 mm negative needs about an 8X enlargement to make an 8x10 inch print, it is sometimes argued that the criterion should be about 1/32 mm on the 35mm negative, but 1/30 mm is close enough.*

Circle of Confusion

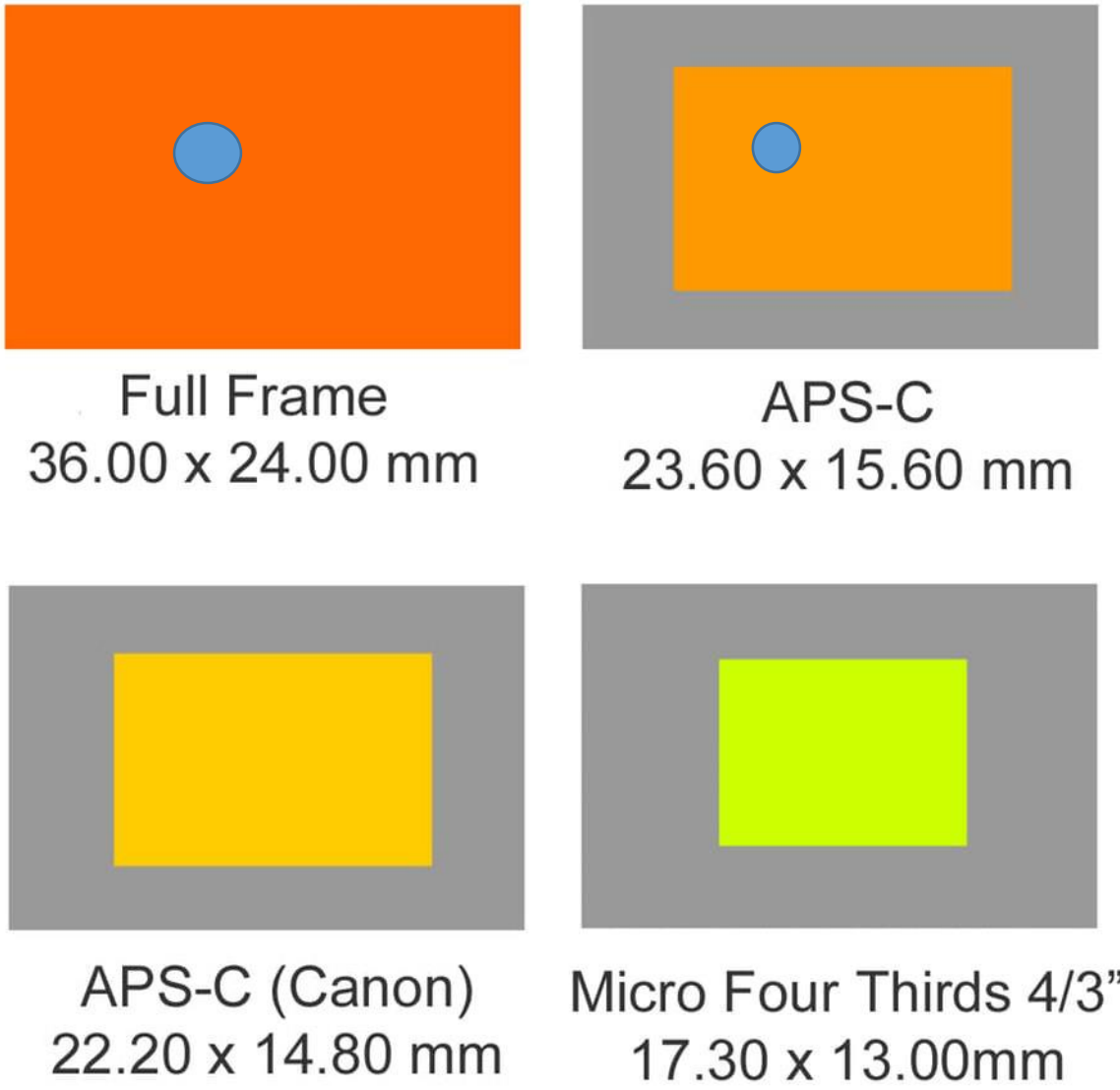
- d – Aperture diameter
- c – Circle of Confusion
- D – Distance to Subject
  - N - Near
  - S - Subject
  - F – Far
- V – Focus Distance



- By JeffConrad - Based on DoF-sym.png, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=11608245

Sensor Size

- Sensor size does change DOF
  - CoC varies with sensor size because magnification to print size changes
- Sensor size changes field of view
  - Full Frame 50 mm
  - APS-C 35 mm
- Shorter focal length on APS-C increases DOF for same view as Full Frame
  - Smaller CoC on APS-C reduces the effect



Selecting an Aperture – DOF Summary

- Landscape – Deep DOF – f16 to f32
- Who Cares? – f8
- Emphasize Subject – Wide open (f1.8, f2.8, f3.5)

- f# - Low = Shallow DOF High = Deep DOF
- Focal Length – Short = Deep DOF Long = Shallow DOF
- Subject Distance – Short = Shallow DOF Long = Deep DOF

Hyperfocal Distance

- In optics and photography, **hyperfocal distance** is a distance beyond which all objects can be brought into an "acceptable" focus. There are two commonly used definitions of *hyperfocal distance*, leading to values that differ only slightly:
  - *Definition 1:* The hyperfocal distance is the closest distance at which a lens can be focused while keeping objects at infinity acceptably sharp. When the lens is focused at this distance, all objects at distances from half of the hyperfocal distance out to infinity will be acceptably sharp.
  - *Definition 2:* The hyperfocal distance is the distance beyond which all objects are acceptably sharp, for a lens focused at infinity.
- The distinction between the two meanings is rarely made, since they have almost identical values. The value computed according to the first definition exceeds that from the second by just one focal length.
- https://en.wikipedia.org/wiki/Hyperfocal_distance

Hyperfocal Distance

HYPERFOCAL DISTANCE: APS-C sensors

Focal length	12mm	15mm	17mm	20mm	24mm	28mm	35mm	50mm	70mm	100mm	135mm
Aperture f/8	3.2ft	5ft	6.4ft	8.9ft	12.6ft	17ft	27ft	55ft	105ft	218ft	395ft
f/11	2.3ft	3.5ft	4.5	6.2ft	9ft	12ft	19ft	39ft	75ft	155ft	280ft
f/16	1.7ft	2.5ft	3.3ft	4.4ft	6.4ft	8.6ft	14.5ft	27ft	54ft	110ft	198ft
f/22	1.2ft	0.9ft	2.3ft	3.2ft	4.5ft	6ft	9.5ft	19.2ft	38ft	77ft	140ft

HYPERFOCAL DISTANCE: Full-frame sensors

Focal length	16mm	20mm	24mm	28mm	35mm	50mm	70mm	100mm	135mm
Aperture f/8	3.8ft	5.6ft	8.0ft	11ft	17ft	35ft	68ft	138ft	250ft
f/11	2.6ft	3.9ft	5.8ft	7.8ft	12ft	25ft	48ft	98ft	178ft
f/16	1.9ft	2.9ft	4.0ft	5.5ft	8.5ft	17.5ft	34ft	70ft	125ft
f/22	0.4ft	2.0ft	2.9ft	3.9ft	6ft	12.5ft	24ft	49ft	89ft

www.digitalcameraworld.com

- http://www.digitalcameraworld.com/2013/02/08/how-to-calculate-hyperfocal-distance-free-photography-cheat-sheet/3/

Hyperfocal Distance

- In manual mode, Hyperfocal Distance can be set using the lens distance scale
- In auto focus mode, select an object in the scene at the Hyperfocal Distance

Bokeh

- Bokeh is the official name for a specific photography effect. The name actually comes from the Japanese word for blur or haze: boke. It also comes from the Japanese word for blur quality: boke-aji.
- All you need to know is that bokeh is the aesthetic quality of out-of-focus blur in a photograph.
- When a point object is defocused, and will produce a blur spot shaped like the aperture. (From CoC discussion.)
- Many artistic opinions about what is the best boken.
  - Circular aperture blades produce circular boken
  - Angular aperture blades produce angular boken

Boken Example

Calculations

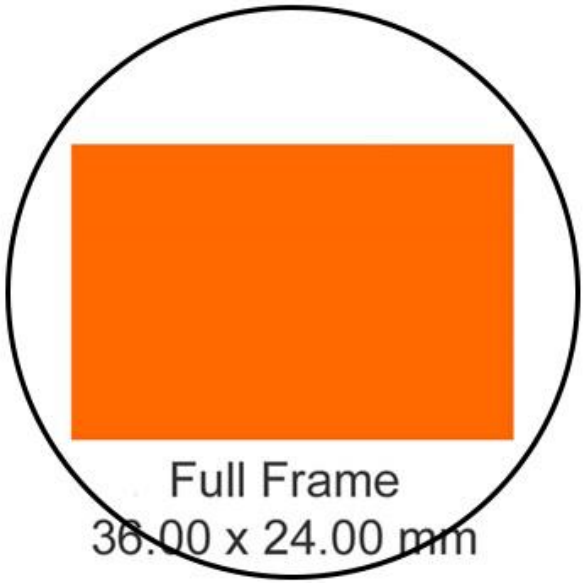
- Full Frame
  - 1/30 mm CoC
  - 24 * 30 * 4 = 720 * 4 = 2880 pixels (mm * 1/mm * pixel)
  - 36 * 30 * 4 = 1080 * 4 = 4320 pixels
  - 2880 * 4320 = 12,441,600 = 12.4 Mega Pixel with 4x4 pixel CoC
- APS-C Chip size 15.6 x 23.6
  - 15.6 * CoC = 720, CoC = 0.021667 mm = 1/46.15
  - 1/46.15 mm APS-C CoC
- Hyperfocal Distance
  - H = f + (f*f/Nc), f=focal Length, N=f Number, c= CoC
  - H(FF) = 50 + (50*50/2.8*(1/30) =

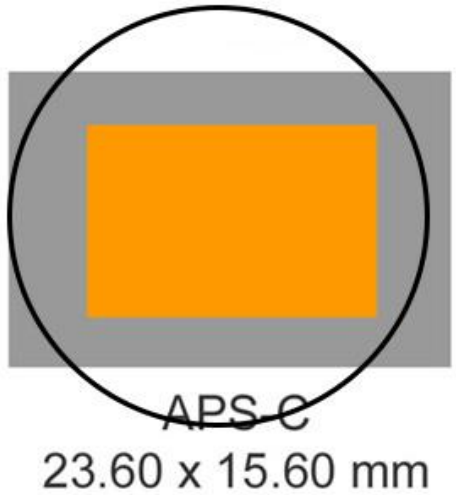
Lens Design Factors

- Target Price
- Prime or Zoom
- Focal length or Range of focal lengths
- Widest Aperture, Zoom Fixed or Variable Aperture
- Sensor Size
- Automation (Aperture, Focus, Image Stabilization)
- Size and Weight
- Weather sealing
- Materials (Glass, Metal, Composite, Plastic)

Lens Design Factors - Coverage

- Full frame lens is larger to provide larger coverage





Lens Design Factors

- Nikon AF-S FX NIKKOR 24-70mm f/2.8G ED (No VR!) $1800

- Nikon AF-S FX NIKKOR 24-85mm f/3.5-4.5G ED VR $400

Selecting Lens

- Lens will be useful on many camera bodies
- Lens can be considered an investment, Camera bodies an expense
- Kit Lens for low cost
- Consider extended zoom (18-200 for APS-C)
  - Size, weight, and cost factors
- Add lens based on your photography interest
- Nikon 71, Cannon 80

Selecting Lens

- Define your budget
- Set target parameters
  - Maximum aperture
  - Focal length range
  - Automation features as “Must haves”
  - Size and weight constraints
  - Optical Performance (Sharpness, Light falloff, Distortion, etc.)
- Ask other users with your photography interest

Photographic Filters

- A filter is a camera accessory consisting of an optical filter that can be inserted into the optical path.
- The filter can be of a square or oblong shape and mounted in a holder accessory, or, more commonly, a glass or plastic disk in a metal or plastic ring frame, which can be screwed into the front of or clipped onto the camera lens.

Filter Types – Most Used

- UV/Clear/Haze Filter
  - Protects the front element of a lens from dust, dirt, moisture and potential scratches. High quality UV filters can be permanently mounted on lenses with a minimum impact on image quality
- Polarizing Filter
  - Filters out polarized light, dramatically reducing reflections, enhancing colors and increasing contrast. Can be used for any type of photography. Polarizing filters are typically circular, allowing for easy control of the effect of polarization.
- Neutral Density (ND) Filter
  - Reduces the amount of light entering the lens, thus decreasing camera shutter speed. Useful for situations where motion blur needs to be created (rivers, waterfalls, moving people) or large apertures must be used with flash to avoid overexposure

Filter Types - Other

- Color/Warming/Cooling Filter
  - Corrects colors, resulting in a change in camera white balance. Some color filters can subtract colors, blocking one type of color and allowing other colors through. These types of filters were popular for film. They are rarely used in digital photography, since their effects can be **easily applied in post-processing**.
- Close-Up Filter
  - Also known as “diopter”, a close-up filter allows a lens to focus closer on subjects. These filters are only used for macro photography.
- Special Effects Filter
  - There are a few different types of special effects filters. Star filters make bright objects look star-like; softening/diffusion filters create a “dreamy” look used for portraits, multivision filters create multiple copies of a subject; infrared filters block infrared and pass visible light; bokeh filters have a certain shape cut in the middle of the filter that makes bokeh highlights have the same shape, etc.

Filter Types - Other

- Hard-Edge Graduated Neutral Density (GND) Filter
  - Hard-edge GND filters are primarily used in high contrast situations, where the sky is much brighter than the foreground and the horizon is flat. These filters are always rectangular (giving the ability to move them in all directions) and are typically used with filter holders. Effects can be **easily applied in post-processing**.
- Soft-Edge Graduated Neutral Density (GND) Filter
  - Soft-edge GND filters are also used in high contrast situations, but where the horizon is not necessarily flat. The soft edge allows for smoother transitions, making the use of a filter less evident. Soft-edge GND filters are also rectangular and are normally used with filter holders. Effects can be **easily applied in post-processing**.
- Reverse Graduated Neutral Density (GND) Filter
  - The reverse GND is a specialized filter used by landscape photographers when shooting against the sun while it is setting close to the horizon. While a regular GND filter gradually transitions from dark to clear towards the center, a reverse GND filter transitions from dark to less dark from the center to the edge. Effects can be **easily applied in post-processing**.

Filter Types - Other

- Infrared
- Software
  - Color correction
  - Color conversion (or light balance)
  - Color separation, also called color subtraction
  - Contrast enhancement
  - Graduated
- Special effects of various kinds, including
  - Graduated color, called color grads
  - Cross screen and star diffractors
  - Diffusion and contrast reduction
  - Spot
  - Close-up or macro diopters, and split diopters or split focus.

Filter Examples

- Slides
- Samples
- Discussion

DOF, Boken, and Filter References

- https://en.wikipedia.org/wiki/Depth_of_field
- http://www.dofmaster.com/dofjs.html Online Depth of Field Calculator
- http://dofsimulator.net/en/ Bokeh simulator & depth of field calculator
- http://www.pocket-lint.com/news/127591-what-is-bokeh-here-s-the-photography-effect-explained
- https://en.wikipedia.org/wiki/Photographic_filter
- https://photographylife.com/lens-filters-explained