

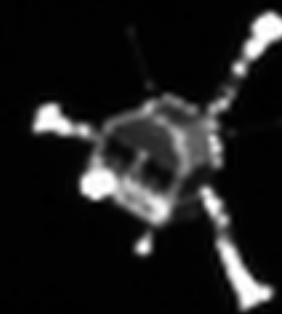
CS50 SEMINAR

# EXPOSING DIGITAL PHOTOGRAPHY

DAN ARMENDARIZ

[DANALLAN@CS.HARVARD.EDU](mailto:DANALLAN@CS.HARVARD.EDU)

# PHILAE



LANDER SELFIE

PHILAE



[http://www.esa.int/spaceinimages/Images/2014/11/Welcome\\_to\\_a\\_comet](http://www.esa.int/spaceinimages/Images/2014/11/Welcome_to_a_comet)



# PHILAE + CANON EOS D2000?







© JAXA/NHK

Image from [http://global.jaxa.jp/press/2007/11/img/20071113\\_kaguya\\_02l.jpg](http://global.jaxa.jp/press/2007/11/img/20071113_kaguya_02l.jpg)



# EXPOSURE: THE BIG FOUR

- Amount of available light
- Shutter speed
- ISO
- Aperture

2014: 1/3200s, f/2.8, ISO 200



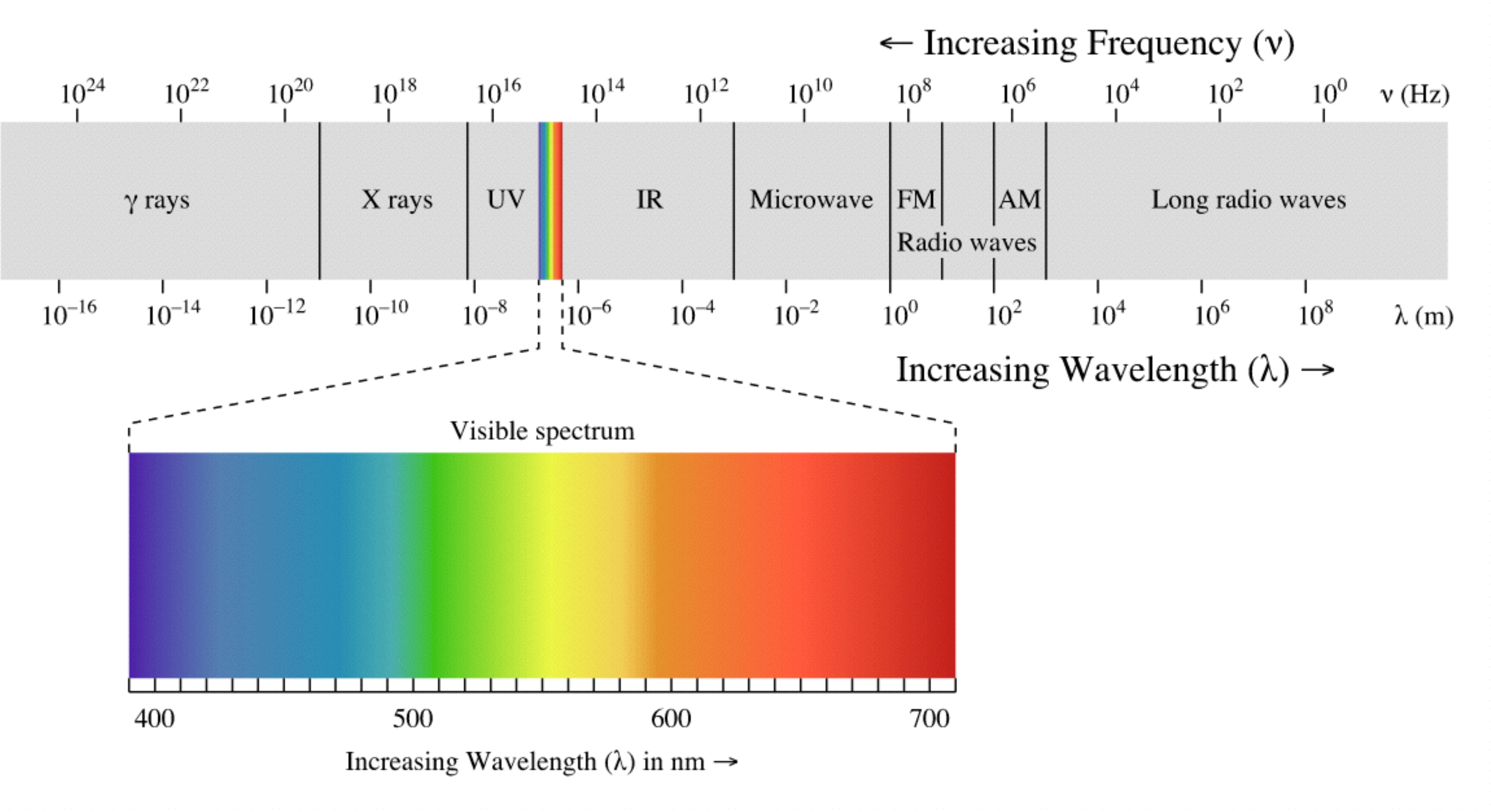


LIGHT



PROPERTIES OF WAVES & PARTICLES

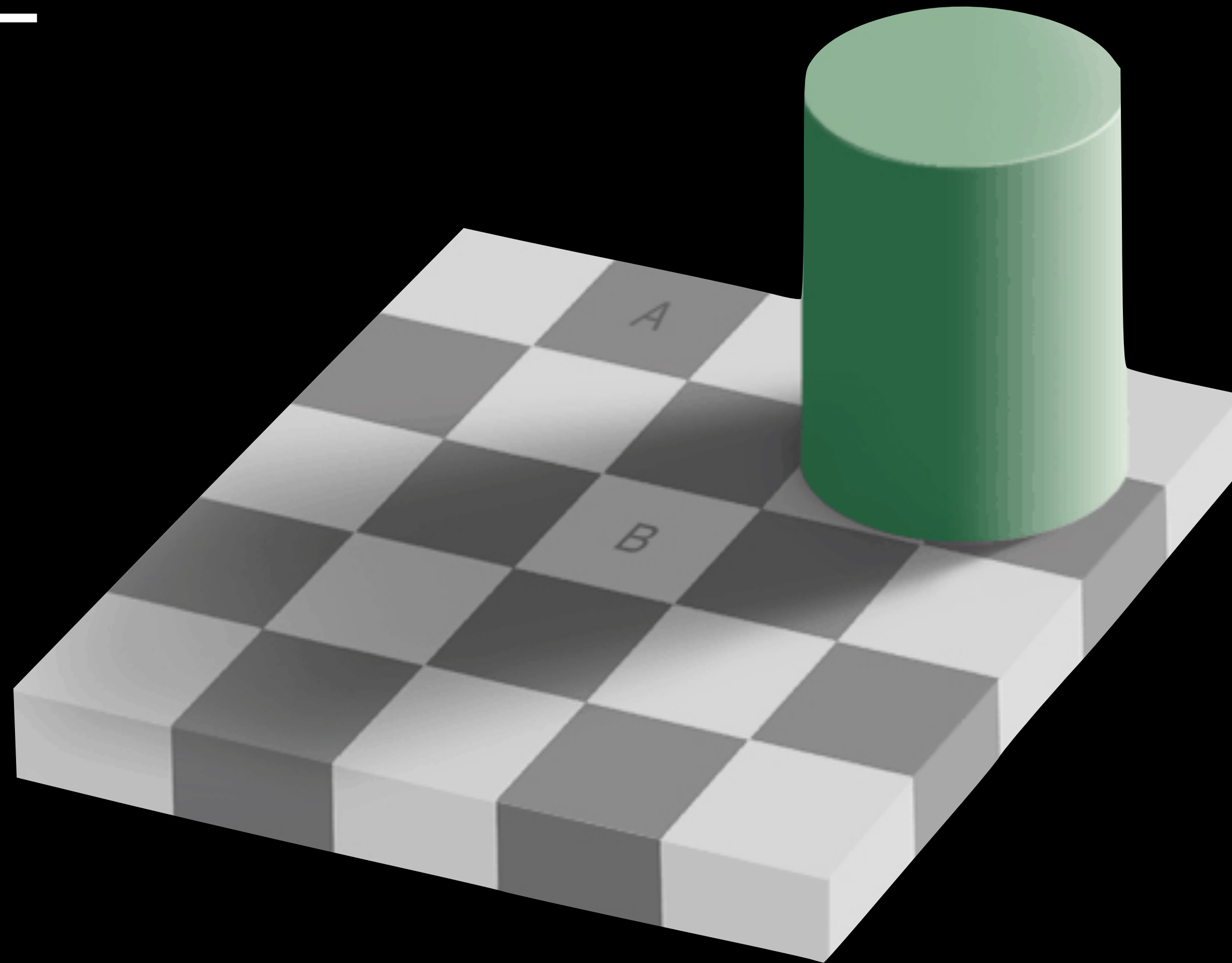
LIGHT





# OPTICAL ILLUSIONS

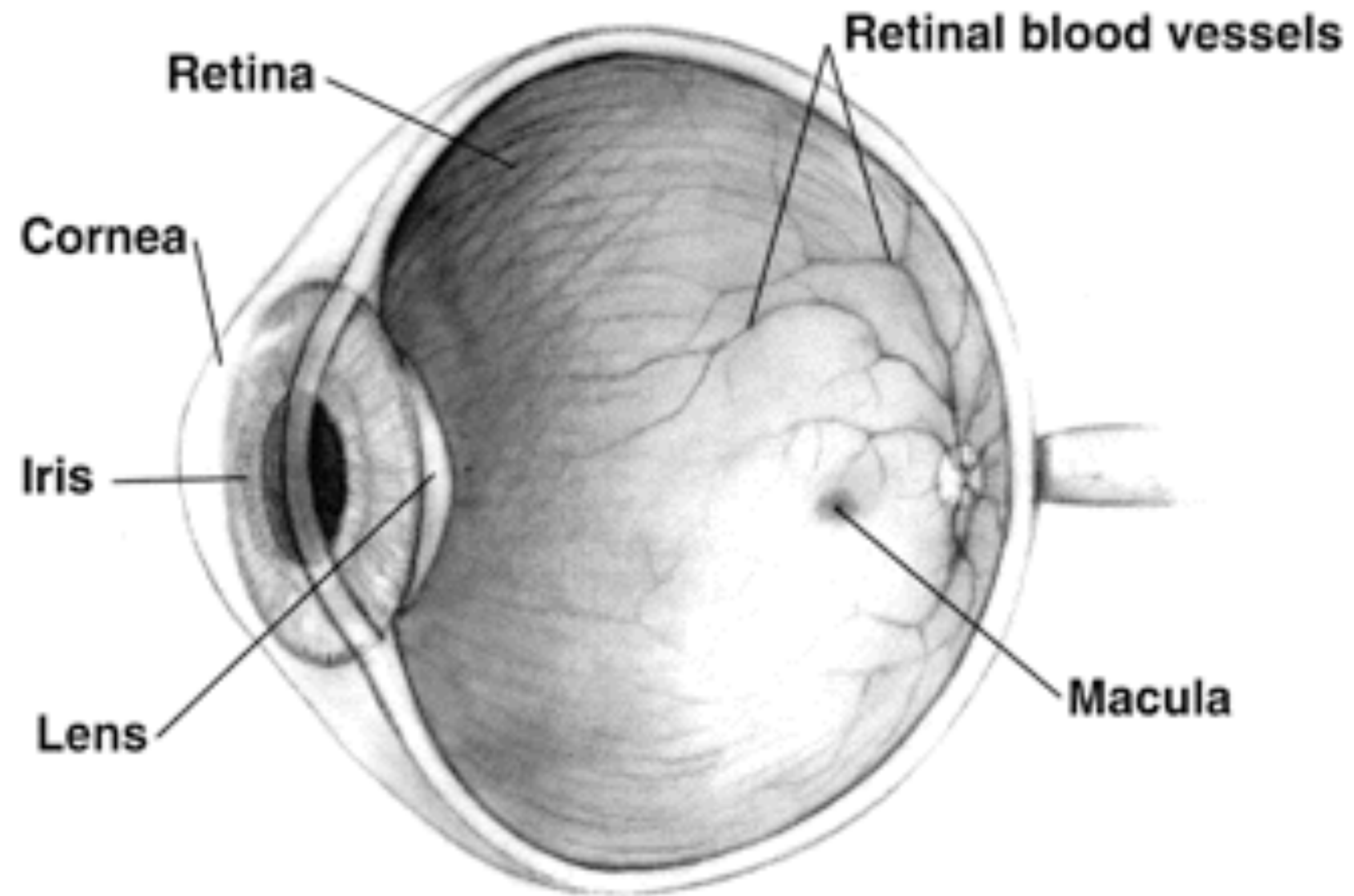
# THE EYE





IN A NUTSHELL

# THE EYE





RODS AND CONES

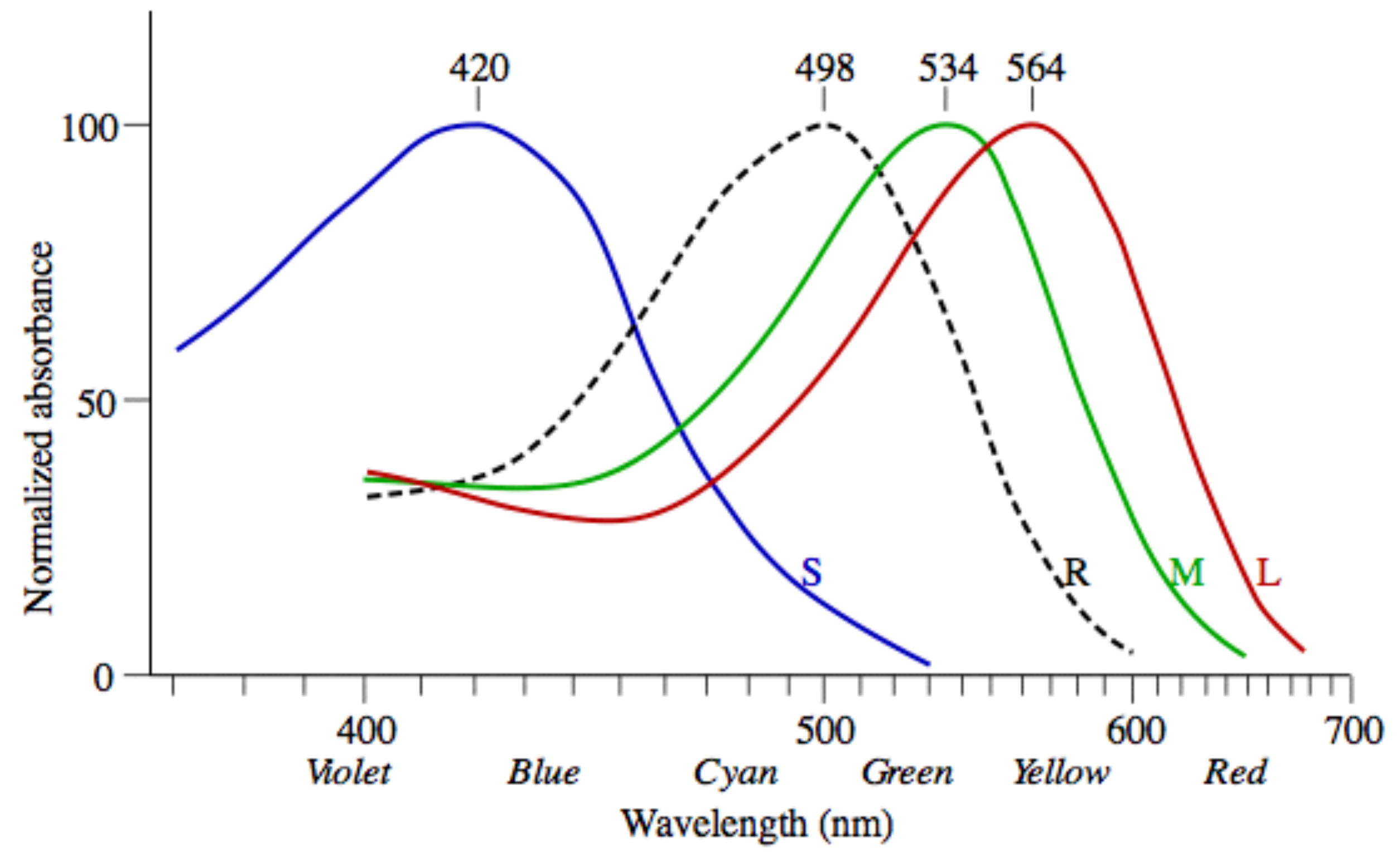
# THE EYE

PROPERTY	RODS	CONES
VISION TYPE	NIGHT VISION	DAY VISION
LIGHT SENSITIVITY	MORE	LESS
FOVEAL CONCENTRATION	LOW	HIGH
RELATIVE PRESENCE	22 RODS FOR EVERY 1 CONE	
PRIMARY STIMULUS	MONOCHROMATIC	TRICHOMATIC (COLOR)
DETECTION	MOTION	DETAIL



RODS & CONES

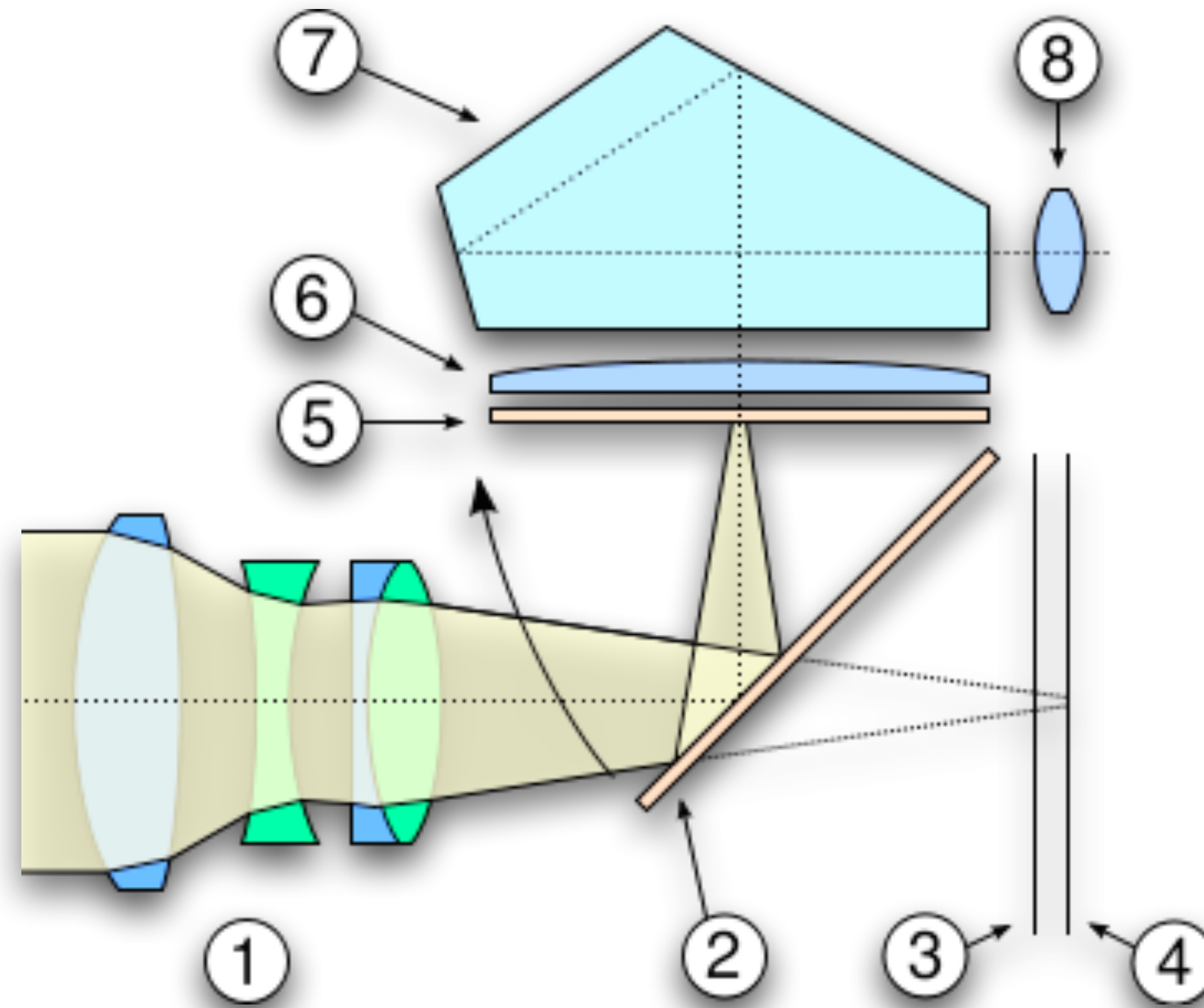
# THE EYE





SIMILARITY TO THE EYE

# CAMERAS



STOPS & EXPOSURE VALUE (EV)

# EXPOSURE



-2 EV



-1 EV



+0 EV



EXPOSURE

# EXPOSURE: THE BIG FOUR

- Amount of available light
- Shutter speed
- ISO
- Aperture

2014: 1/3200s, f/2.8, ISO 200





EFFECTS

# SHUTTER SPEED



2011: 1/5s, f/10, ISO 100, +1EV.





2007: 10s, f/8, ISO 100



2013: 1s, f/4.5, ISO 200, +0.7EV

2012: 4s, f/6.3, ISO 100.



STOPPING MOTION

SHUTTER SPEED

2004: 1/1250s, f/2.8, ISO 200





STOPPING MOTION

# SHUTTER SPEED



2007: 1/250s, f/5.6, ISO 200



MIXING MOTION WITH STILL

# SHUTTER SPEED



2011: 1s, f/8, ISO 100

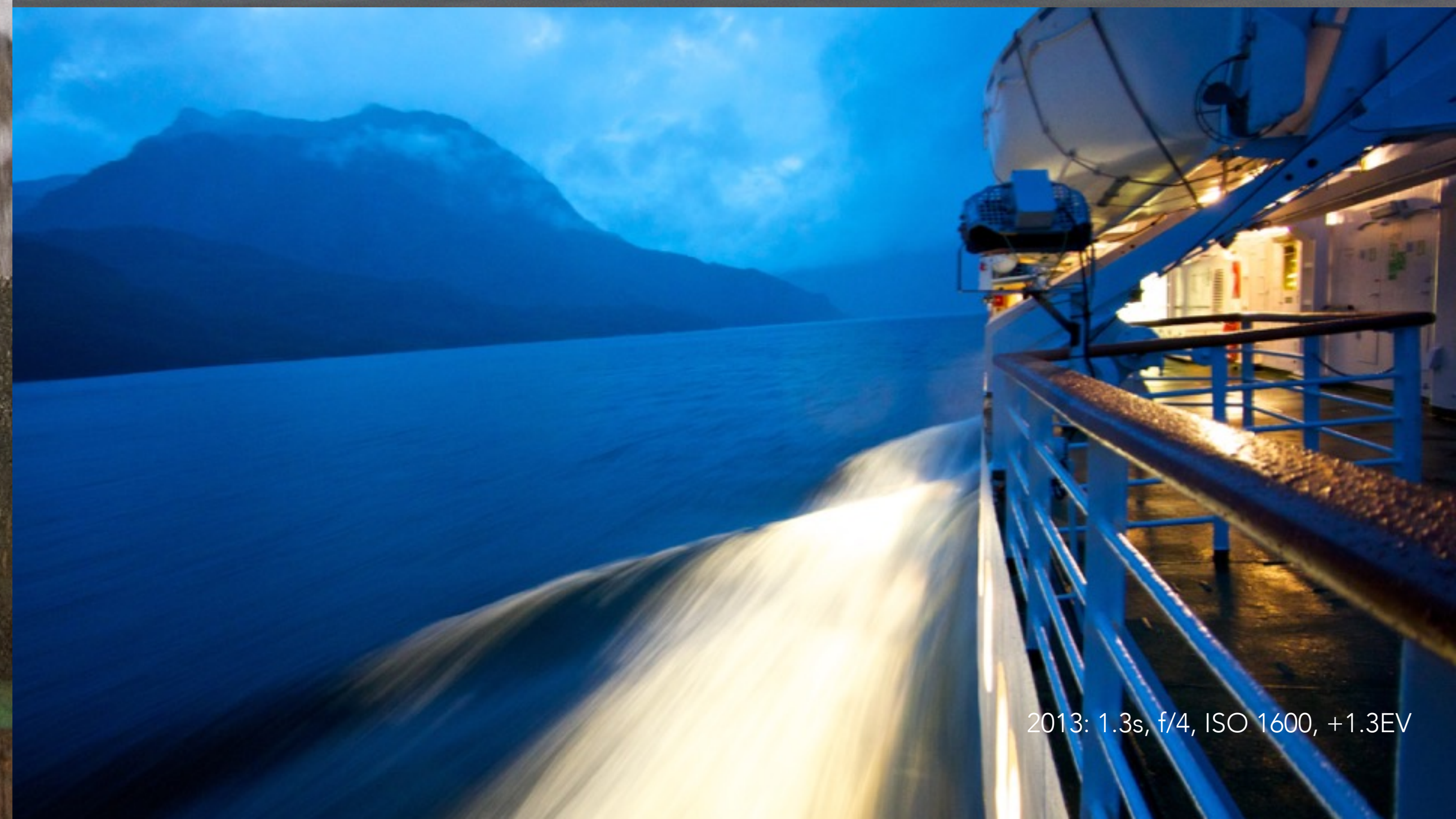




2013: 1/60s, f/6.3, ISO 200, +1.3EV



2009: 1/320s, f/9, ISO 100

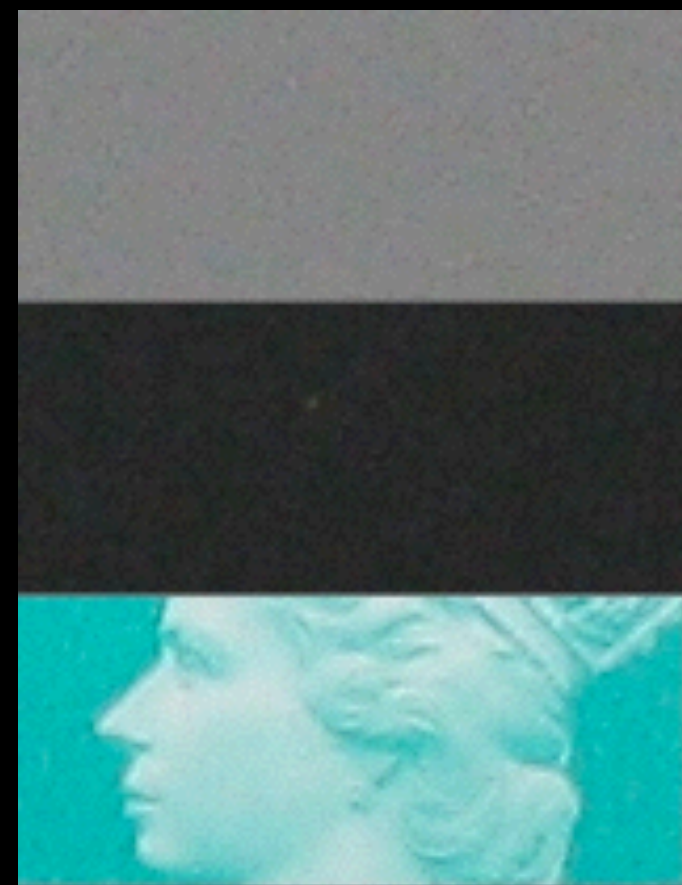


2013: 1.3s, f/4, ISO 1600, +1.3EV

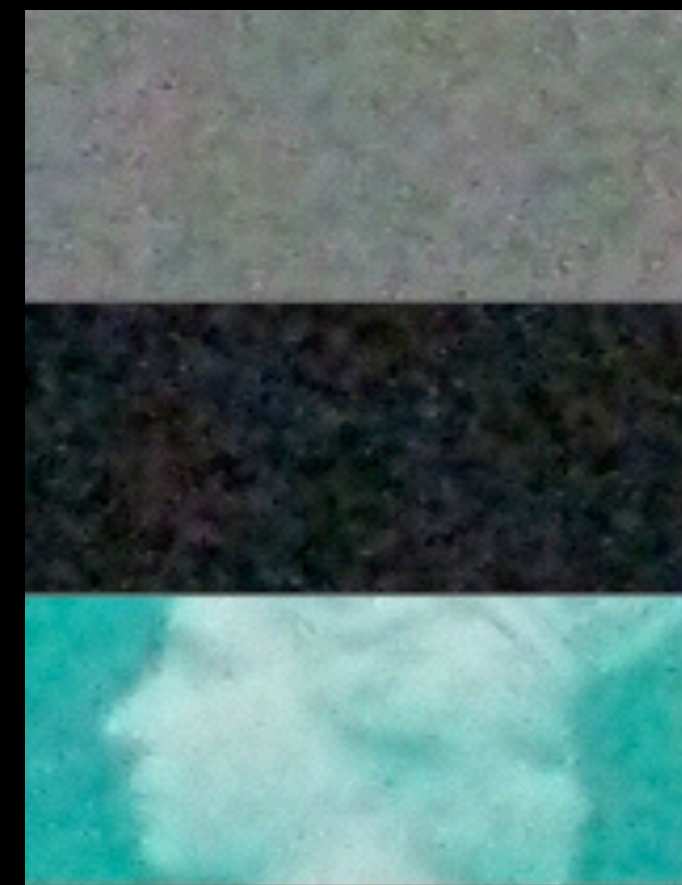


COMPACT VS DIGITAL SLR CAMERAS

# ISO "SENSITIVITY"

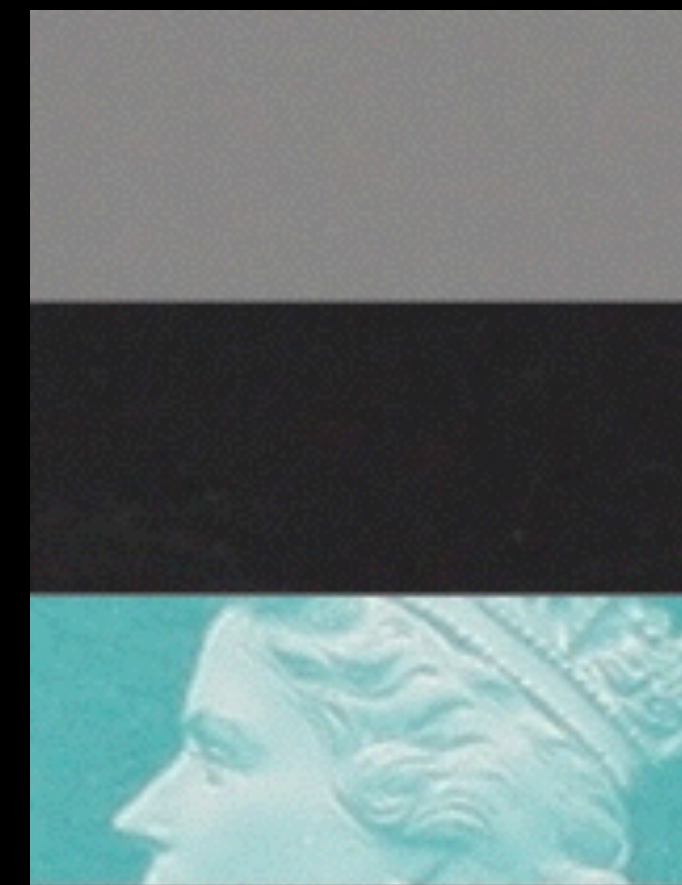


ISO 100

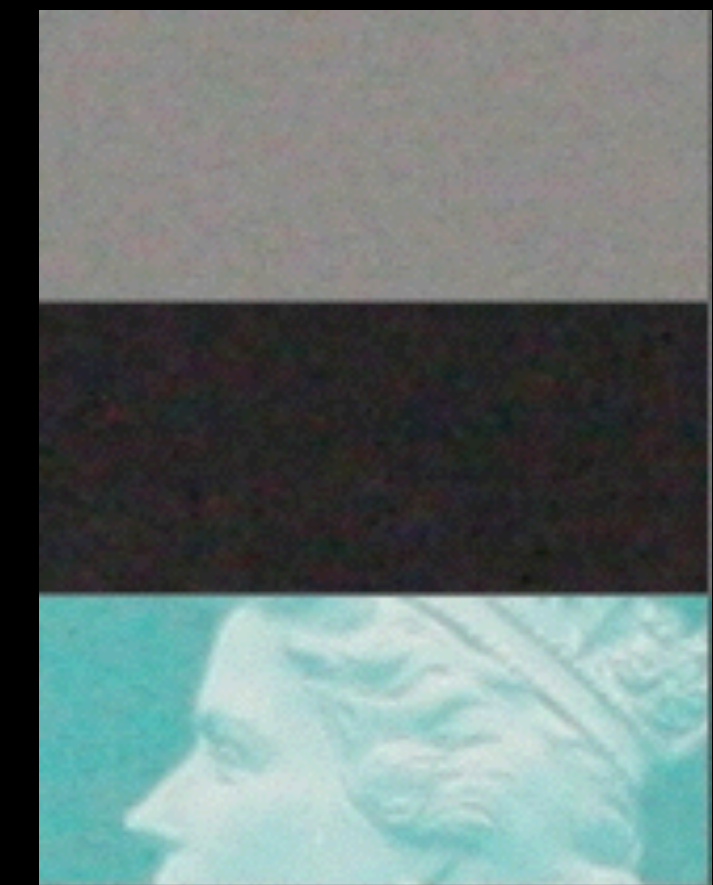


ISO 1600

COMPACT CAMERA



ISO 100



ISO 1600

DIGITAL SLR



COMPARISON TO FILM (POSSIBLY UNFAIR)

# ISO "SENSITIVITY"



ISO 1,600 (film negative)

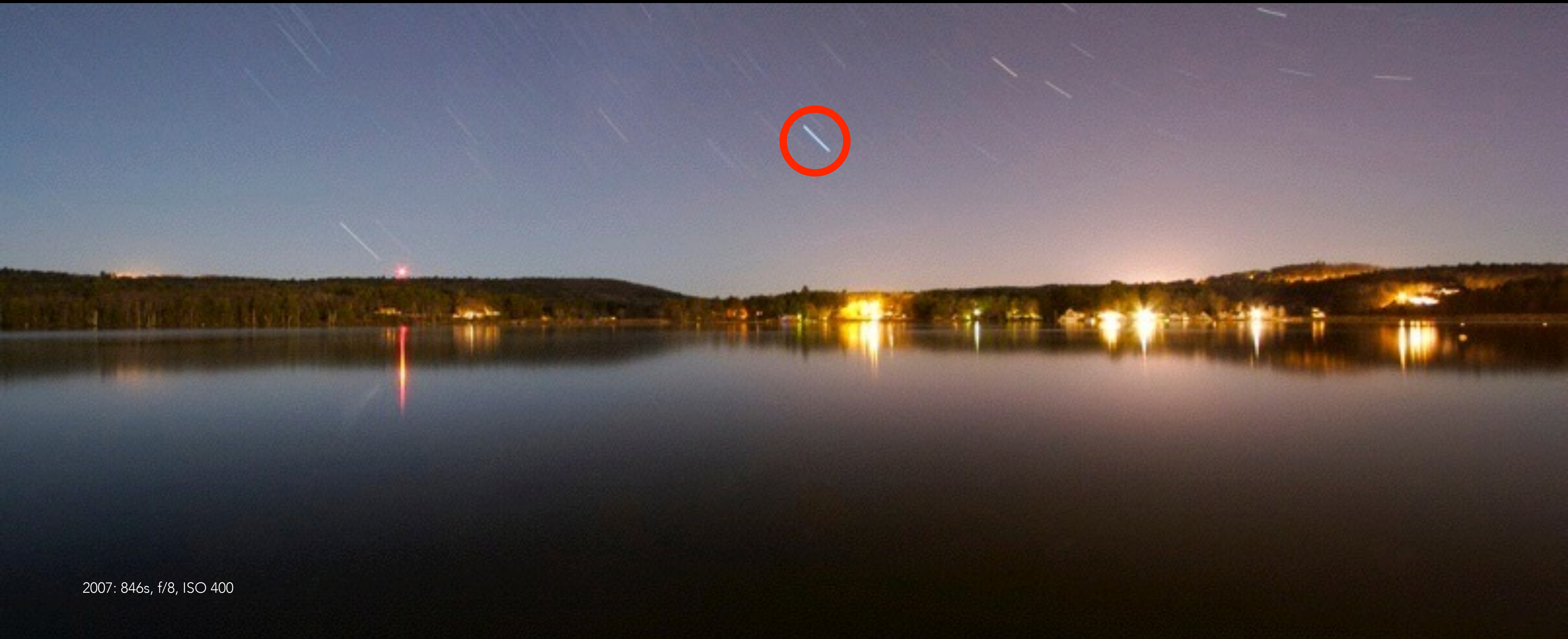


ISO 25,600 (Nikon D3)



COMBINED WITH SHUTTER SPEED

ISO "SENSITIVITY"





COMBINED WITH SHUTTER SPEED

# ISO "SENSITIVITY"



2007: 846s, f/8, ISO 400



2007: 336s, f/8, ISO 800



APERTURE

EXPOSURE





$$\text{F-number} = f/D$$

where

$f$  = focal length

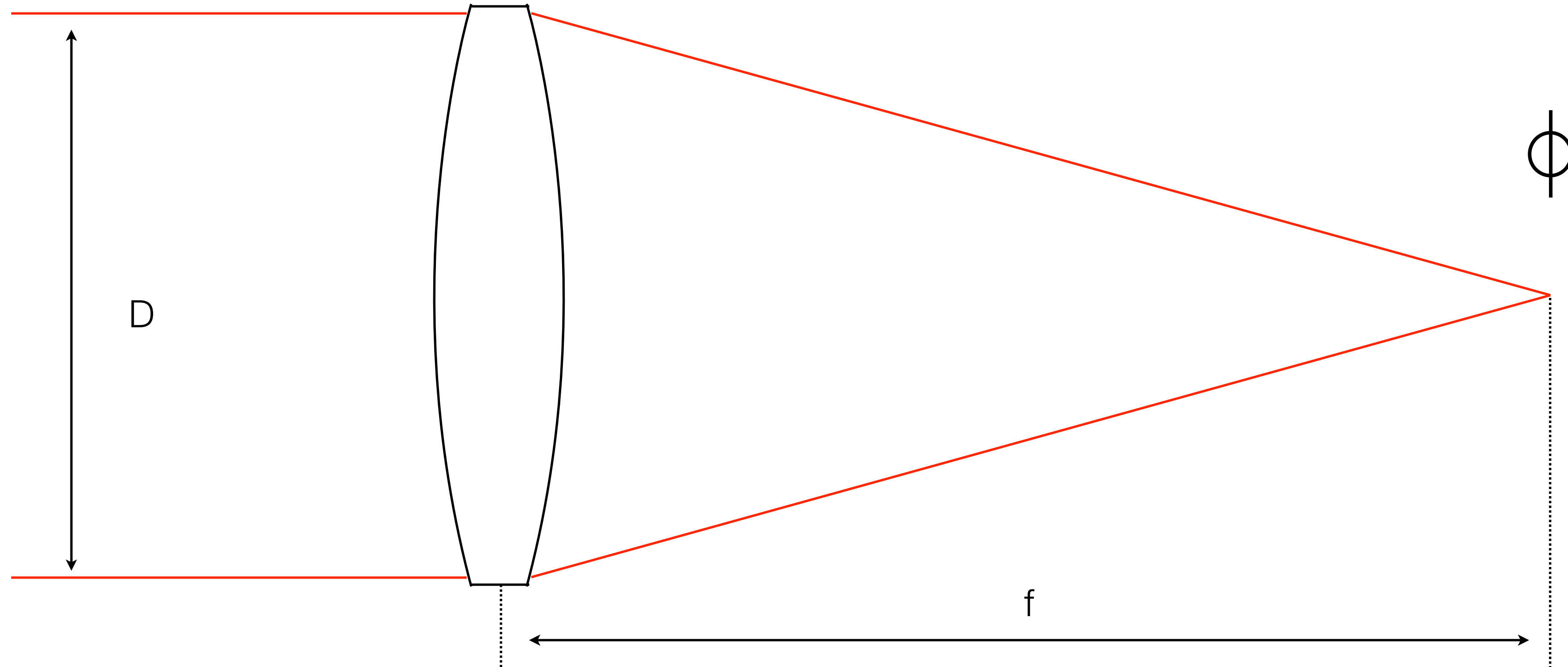
$D$  = aperture's effective diameter

APERTURE



F-NUMBER =  $F/D$

# APERTURE





BACKGROUND BLUR

2012: 1/250s, f/4, ISO 160, -0.6EV



MAKING EVERYTHING SHARP

# APERTURE



2013: 1/15s, f/4.5, ISO 200, +0.7EV



# EXPOSURE: THE BIG FOUR

- Amount of available light
- Shutter speed
- ISO
- Aperture

2014: 1/3200s, f/2.8, ISO 200





MOON LANDINGS

# EXPOSURE



Image from [http://nssdc.gsfc.nasa.gov/imgcat/html/object\\_page/a11\\_h\\_40\\_5903.html](http://nssdc.gsfc.nasa.gov/imgcat/html/object_page/a11_h_40_5903.html)



Underexposed

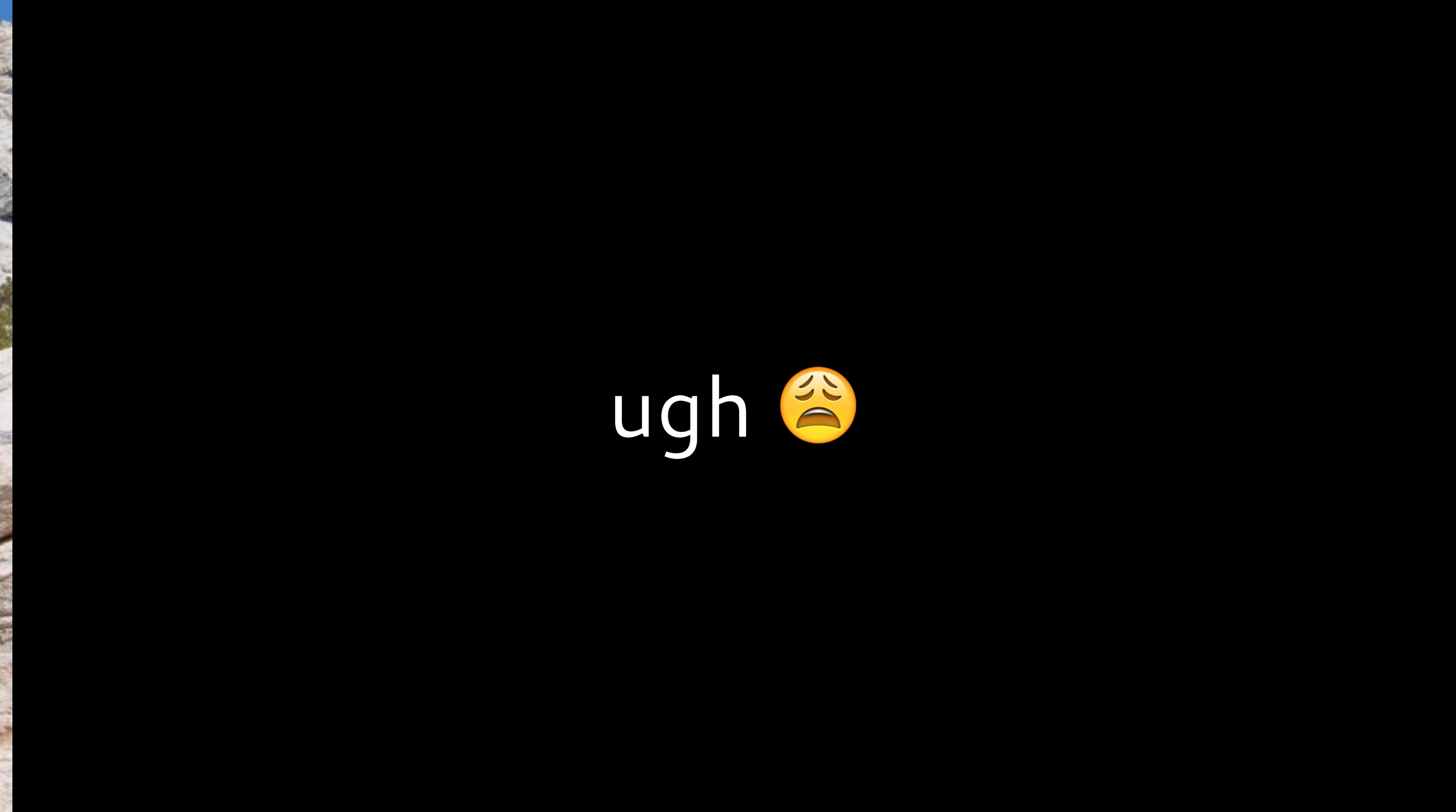


Both



Overexposed

ugh 🙄





The power of good light





METERING



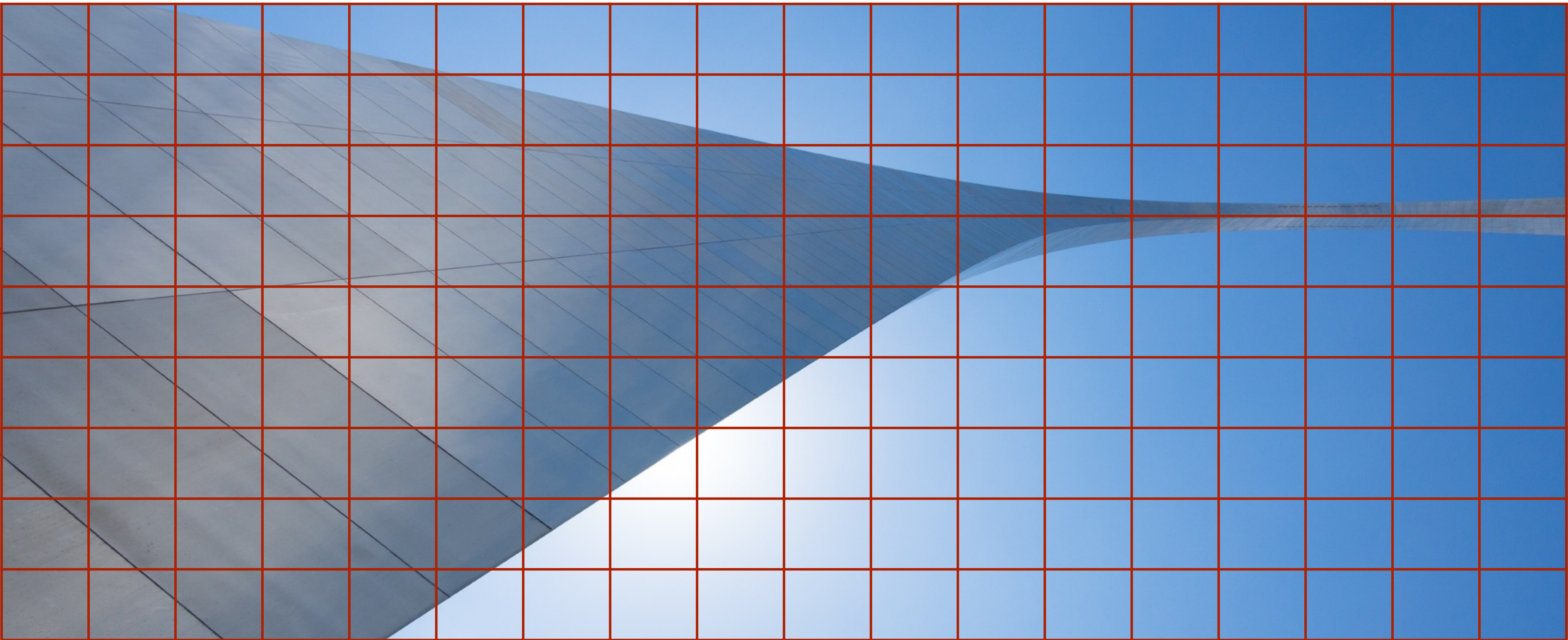
MIDDLE GREY

# METERING



## ZONE METERING

# METERING





EXPOSURE COMPENSATION

# METERING

2014: 1/125s, f/2.8, ISO 200, +1 EV







+0 EV



+1 EV



CAMERA MODES

# METERING



Images from [dpreview.com](http://dpreview.com)'s Nikon d40x and Canon 5D reviews

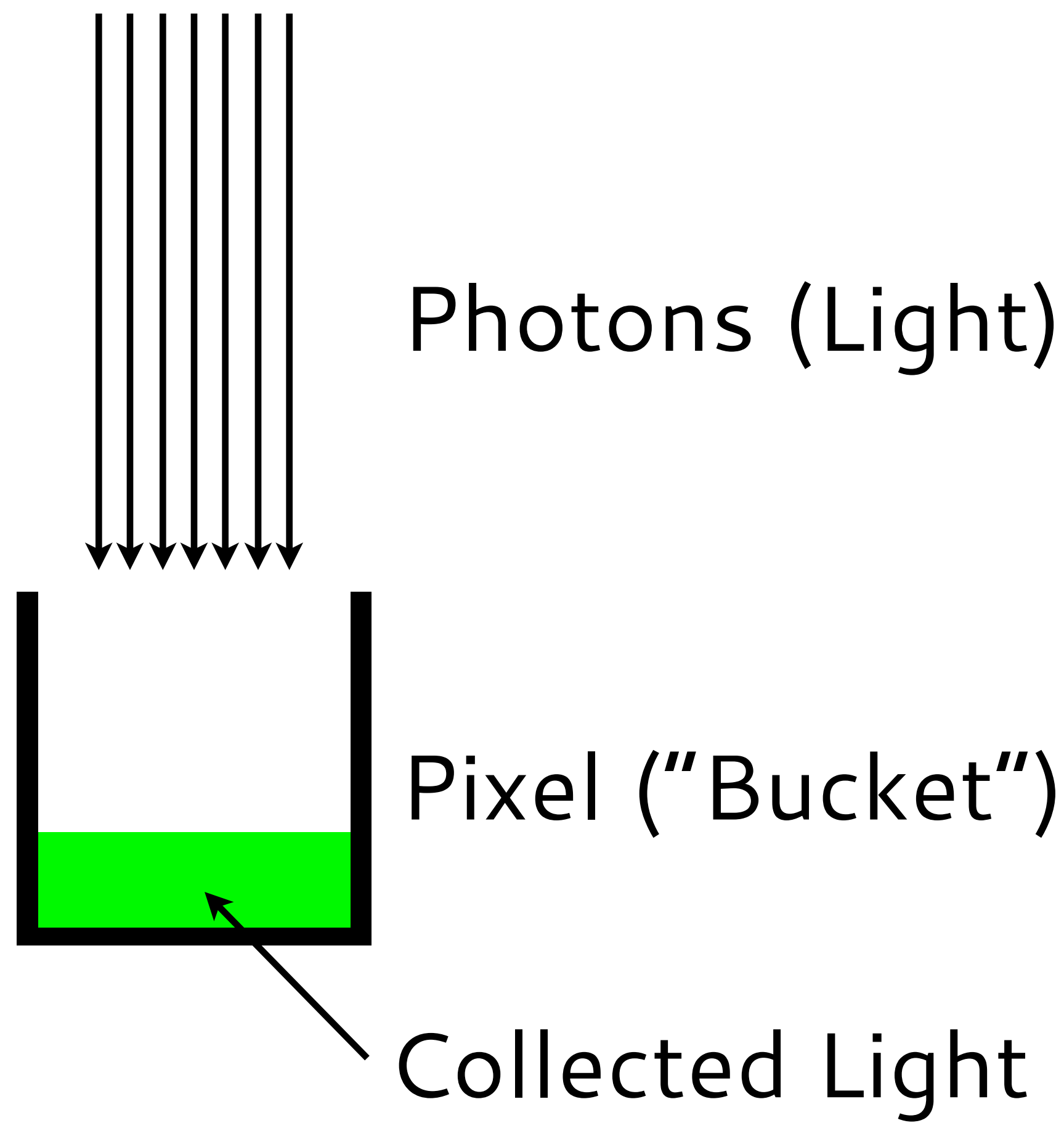


SENSORS



DIGITAL CAMERAS

# DYNAMIC RANGE





$$\text{Dynamic Range} = \frac{\text{Biggest signal (full "bucket")}}{\text{Smallest detectable signal}}$$

SIMPLIFIED DYNAMIC RANGE CALCULATION



IN SCENES

# DYNAMIC RANGE

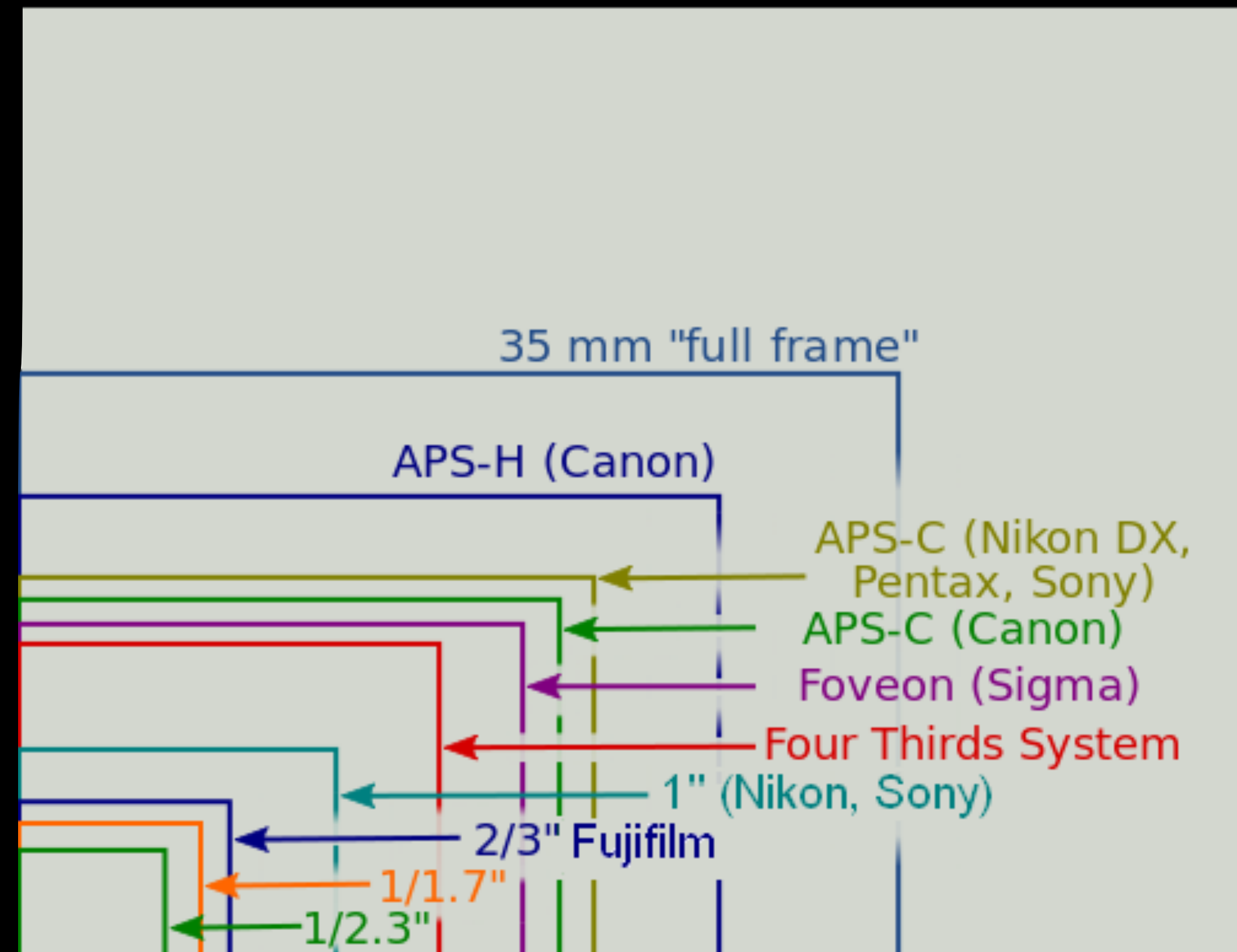


2013: 1/250s, f/5.6, ISO 200, -1/3EV, 28mm



SENSOR SIZES

# DIGITAL CAMERAS

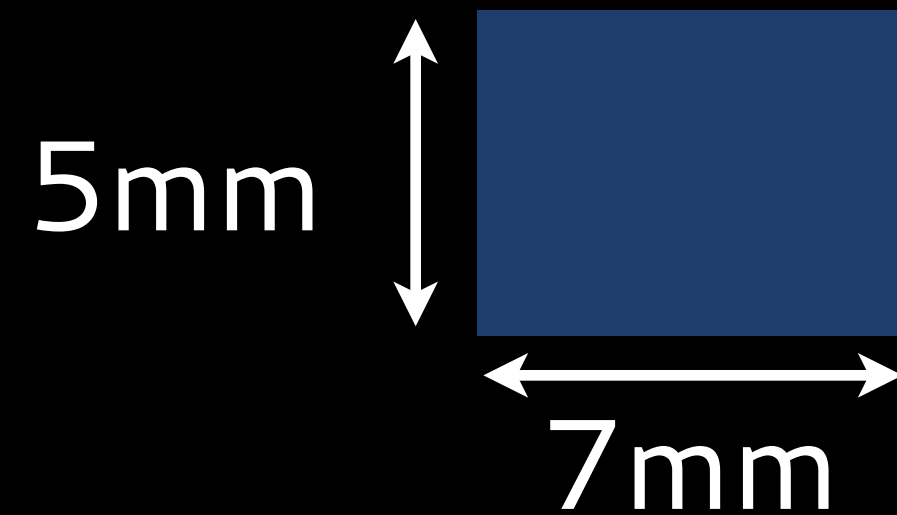




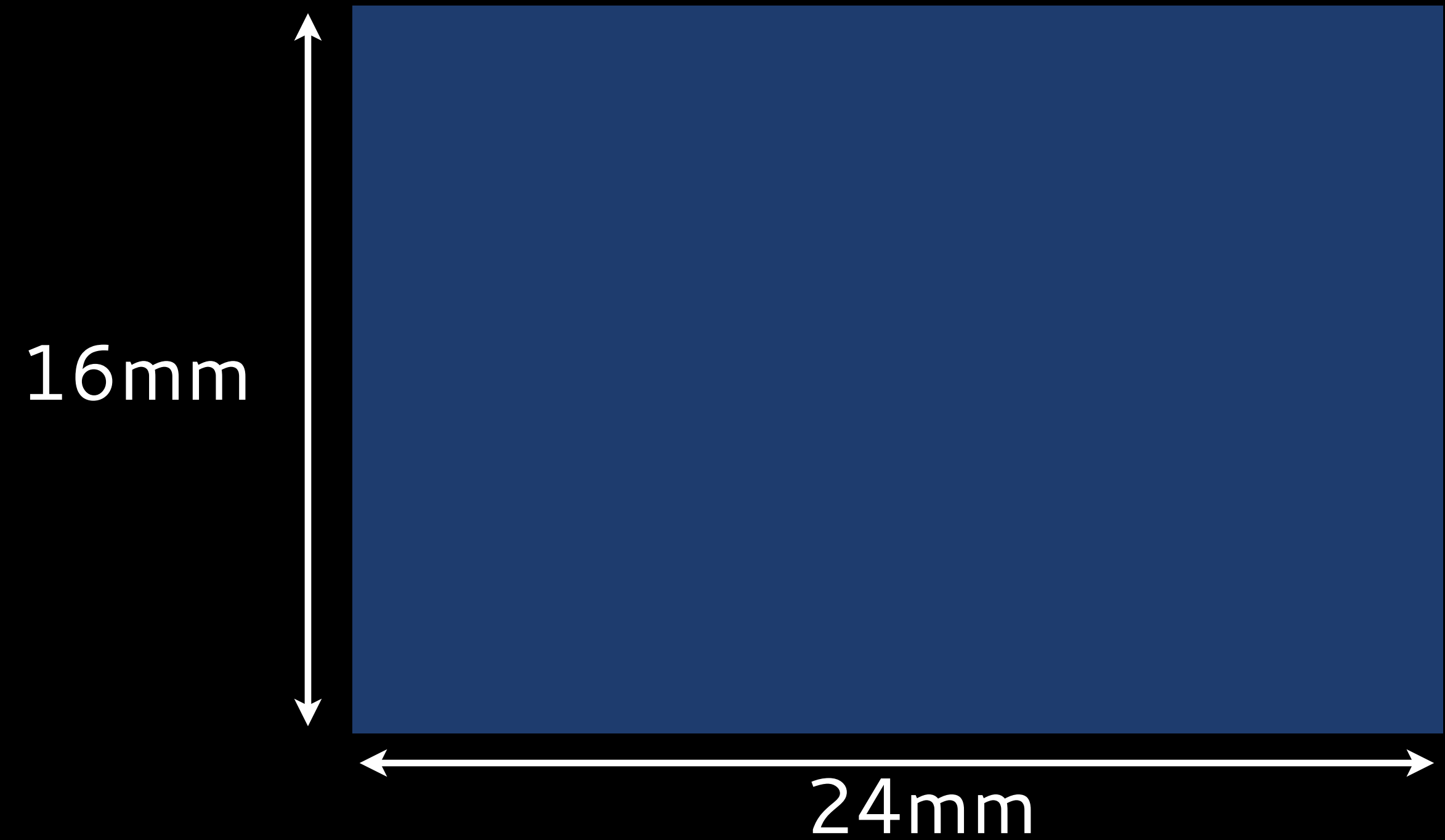
WHAT ARE THE PIXEL SIZES?

# SENSOR SIZES

1/2.5", 6MP

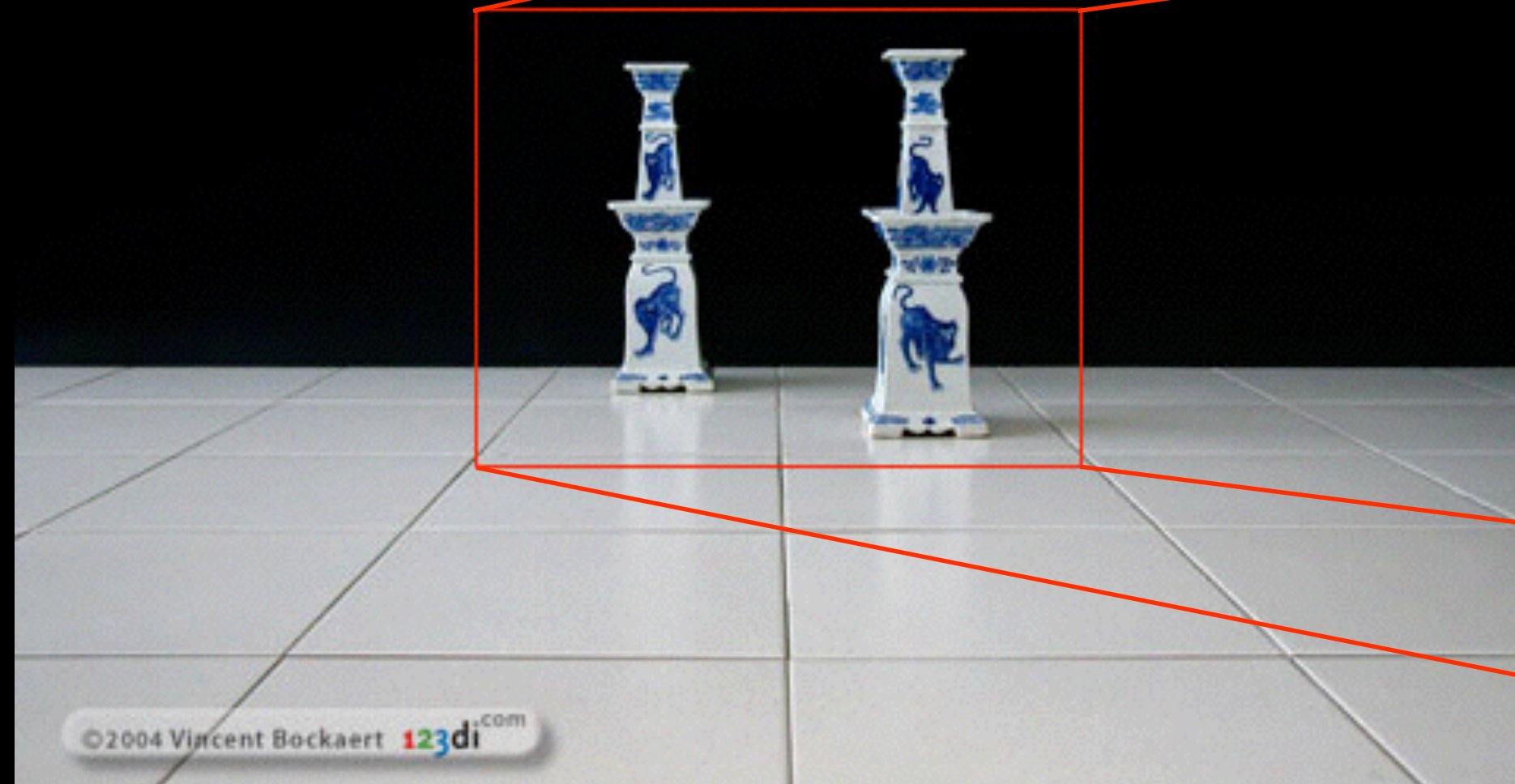


APS-C, 6MP





33mm



Crop



80mm



33mm & moved





FOCAL LENGTH AND PERSPECTIVE

# SENSOR SIZES

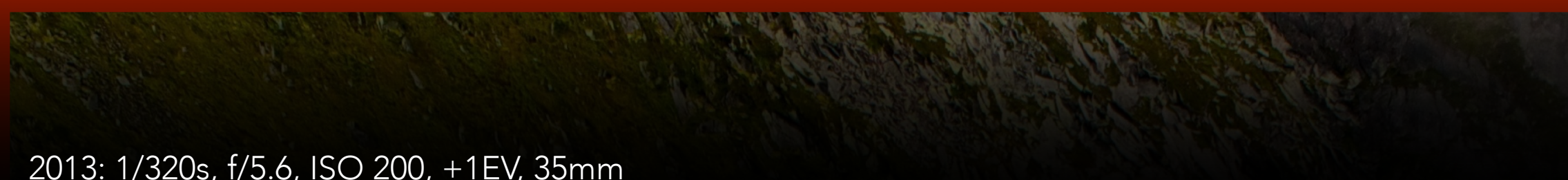


2013: 1/320s, f/5.6, ISO 200, +1EV, 35mm

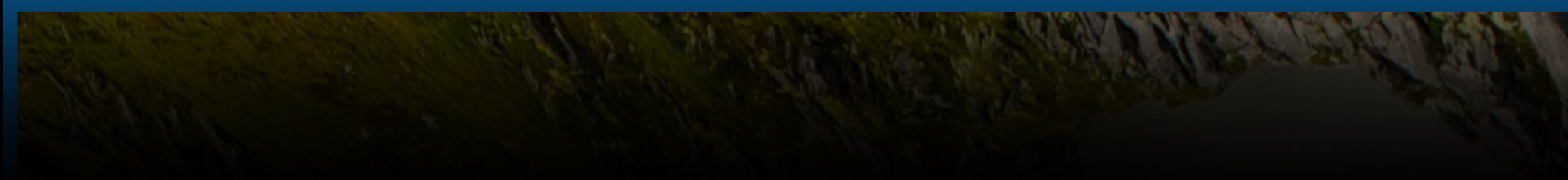
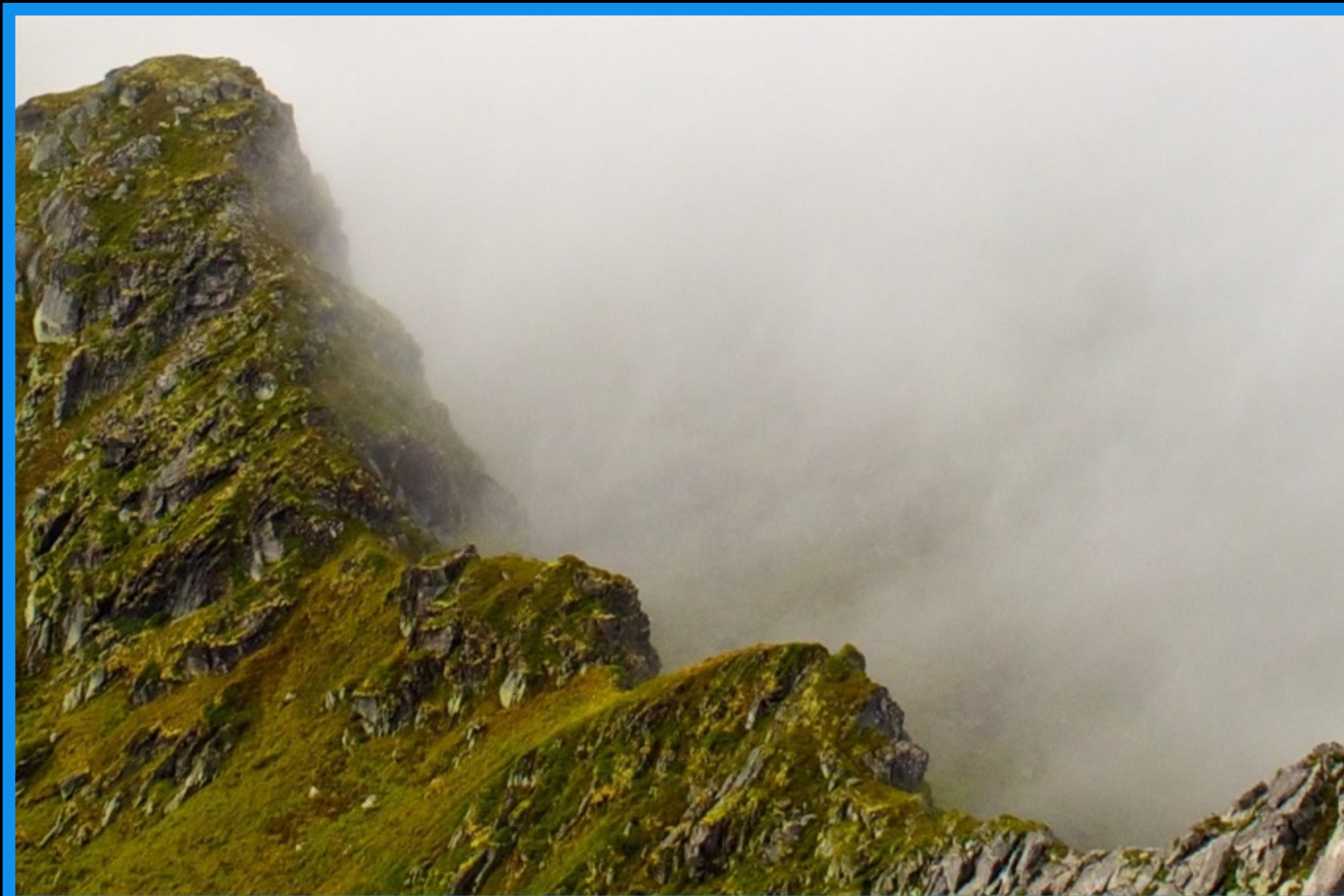


FOCAL LENGTH AND PERSPECTIVE

# SENSOR SIZES



2013: 1/320s, f/5.6, ISO 200, +1EV, 35mm





CS50 SEMINAR

# EXPOSING DIGITAL PHOTOGRAPHY

DAN ARMENDARIZ

[DANALLAN@CS.HARVARD.EDU](mailto:DANALLAN@CS.HARVARD.EDU)