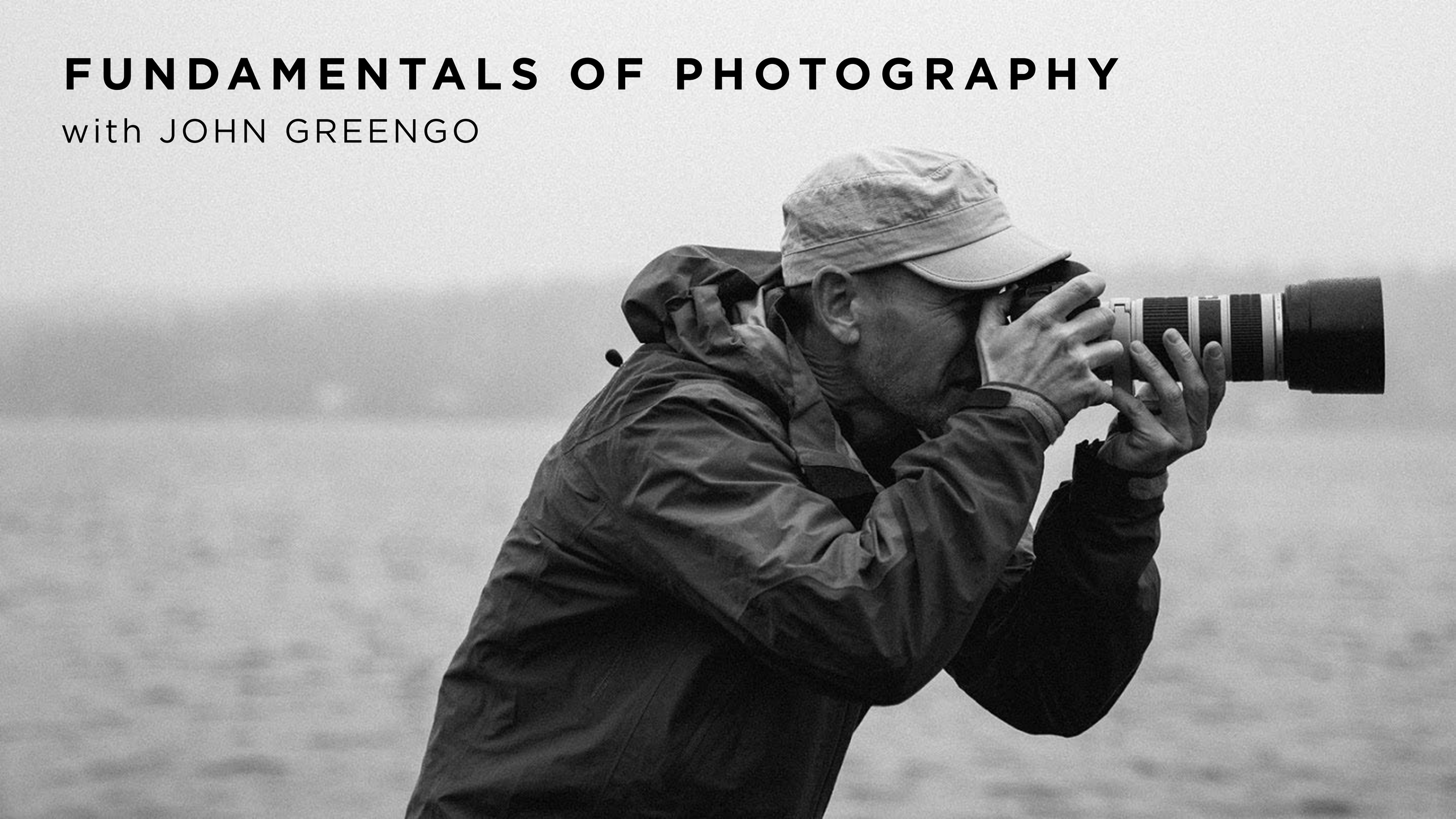
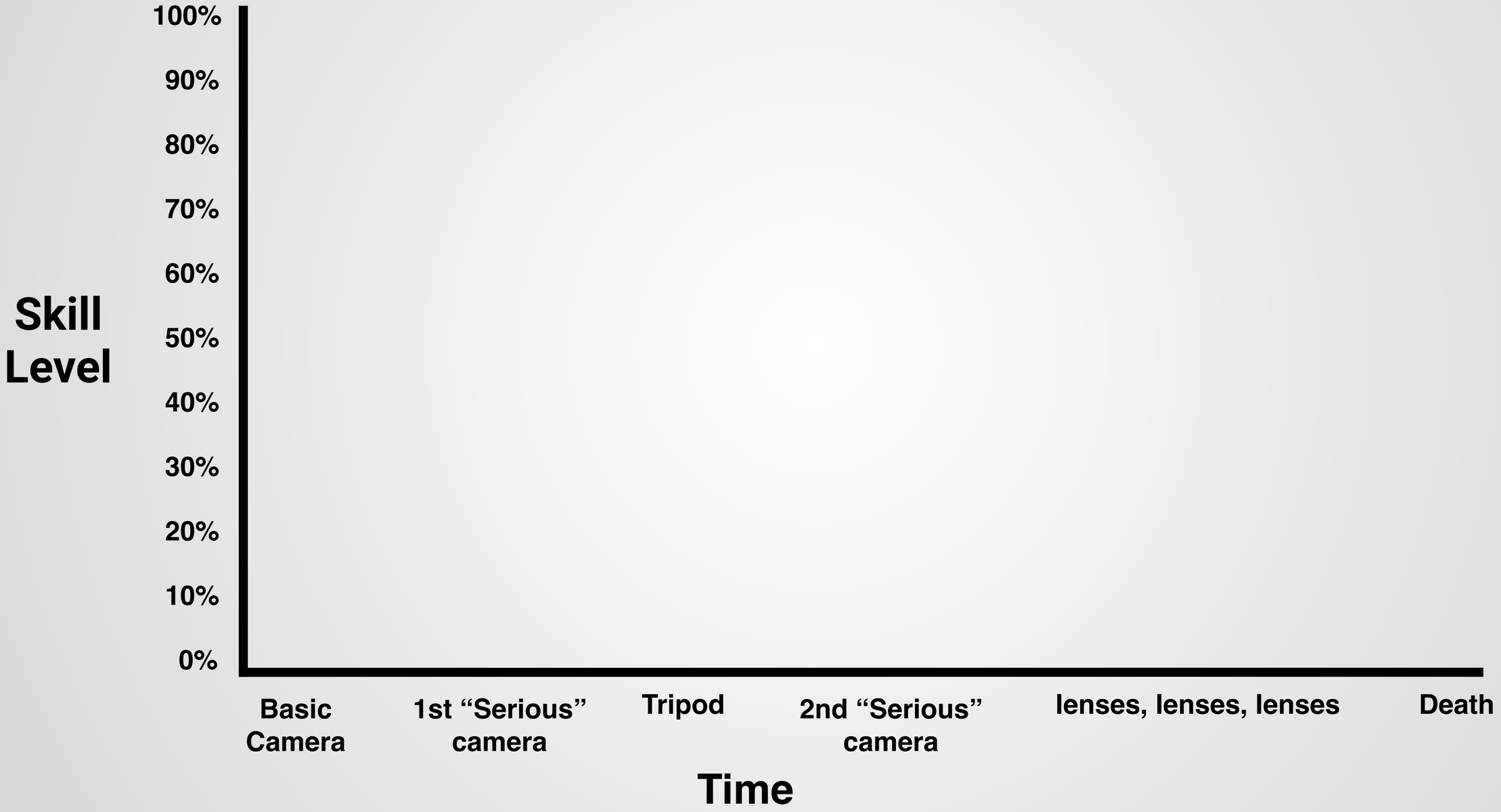
FUNDAMENTALS OF PHOTOGRAPHY

with JOHN GREENGO

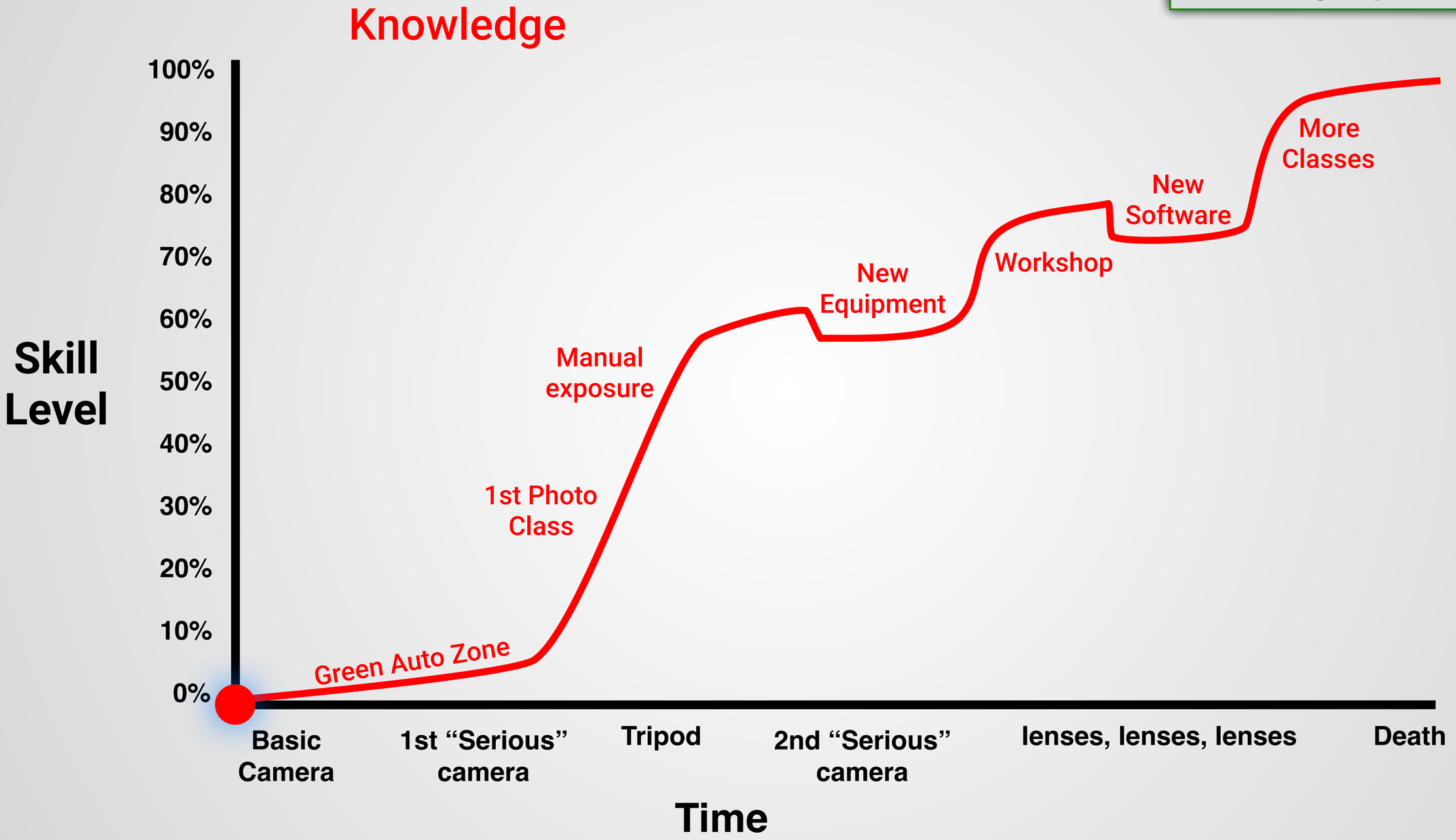


FUNDAMENTALS OF PHOTOGRAPHY

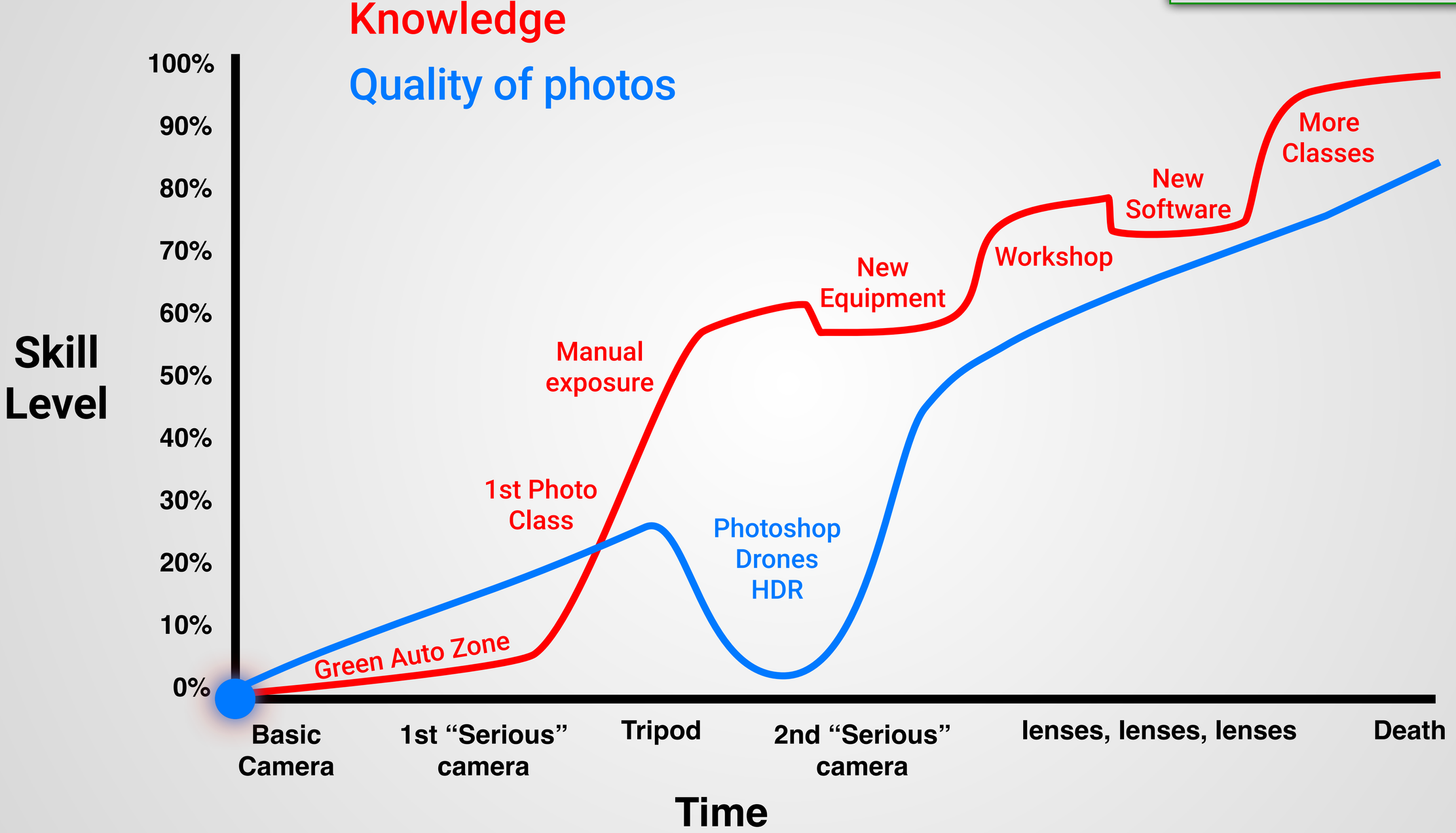
Photographer's Life



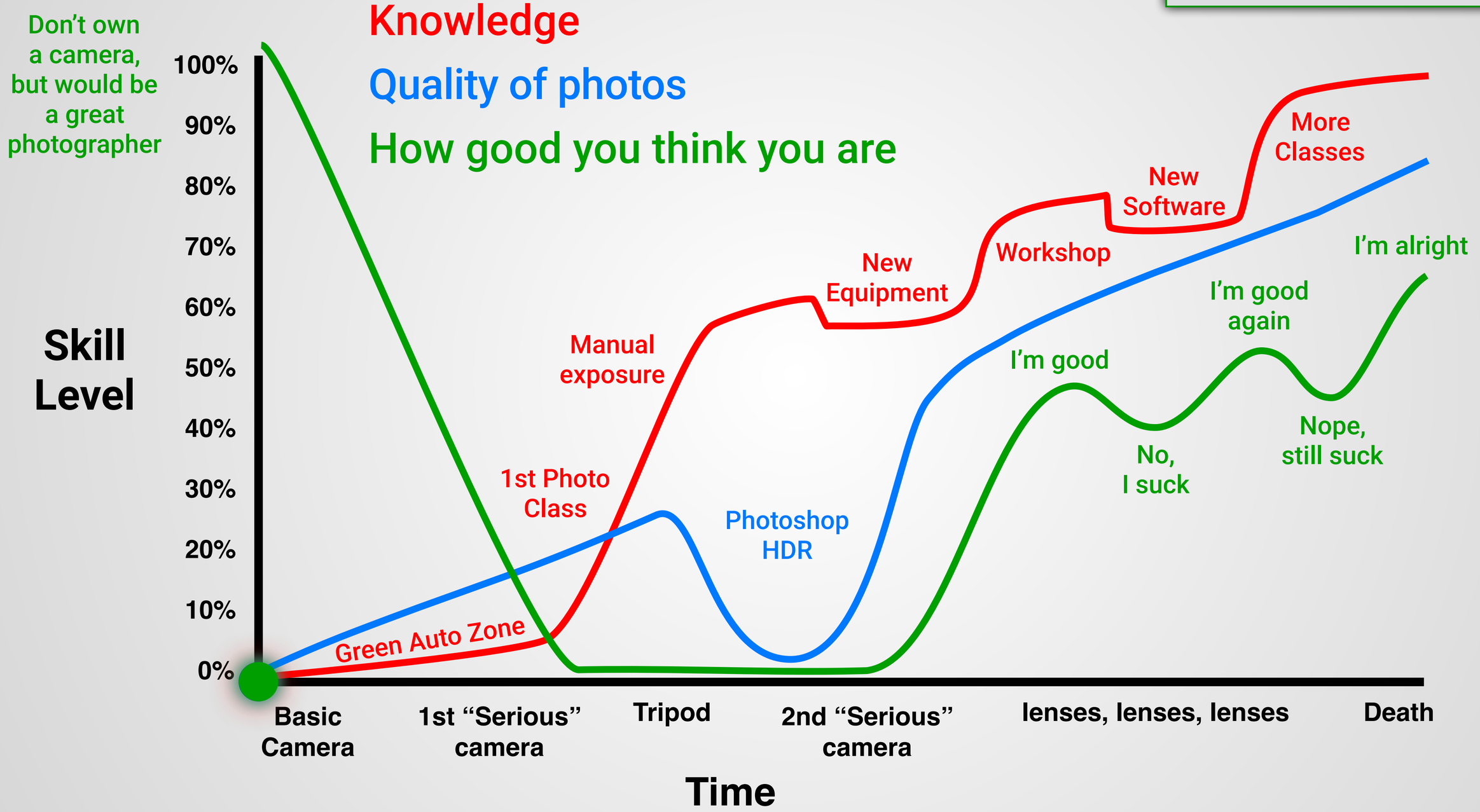
Photographer's Life



Photographer's Life



Photographer's Life



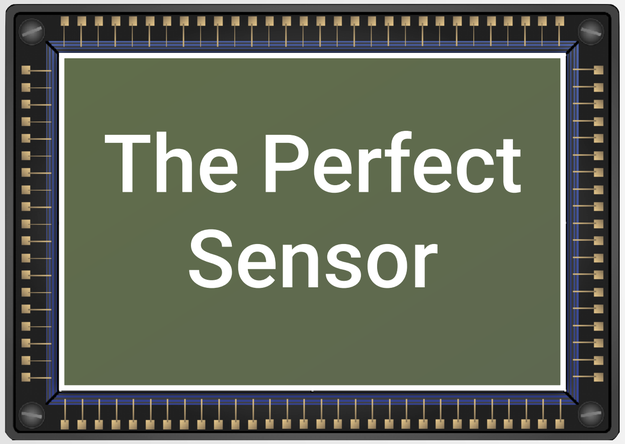
THE SENSOR

THE SENSOR

- Sensor Size
  Sensor Sizes: Compared
  Pixels
  ISO

The Sensor


Canon
CANON LENS EF 50mm 1:1.4
LENS MADE IN JAPAN CANON
EOS
5D
Mark IV



- More pixels / less pixels
- Bigger / smaller
- Accurate color
- Greater dynamic range
- Faster processing
- Less cost


SONY

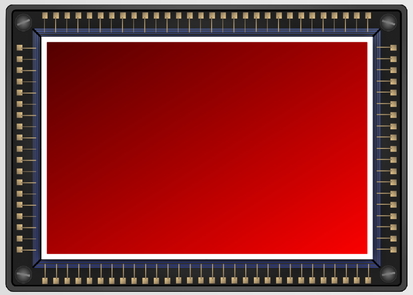

Nikon

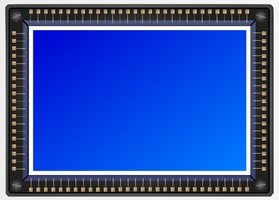

Canon

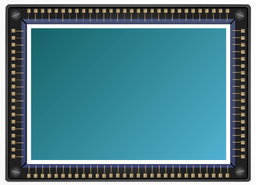

OLYMPUS

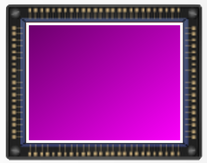

SONY

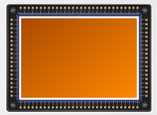

Canon





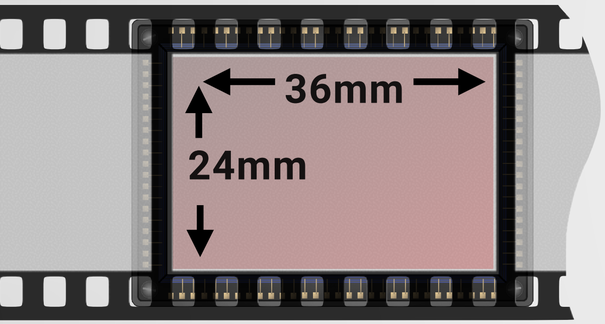




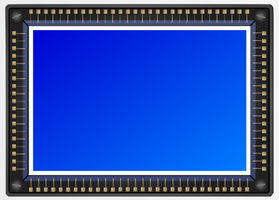


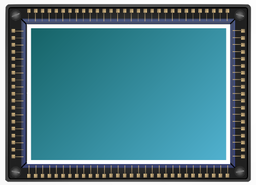
Full Frame

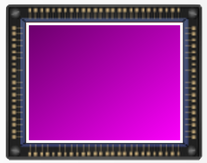
36x24mm

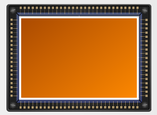


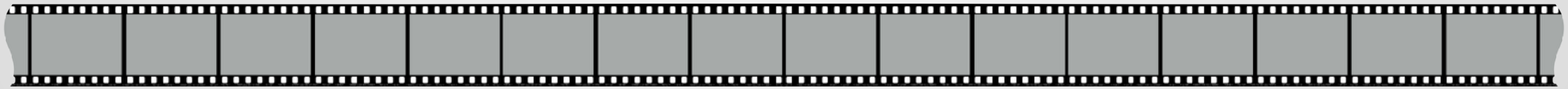
35mm Film





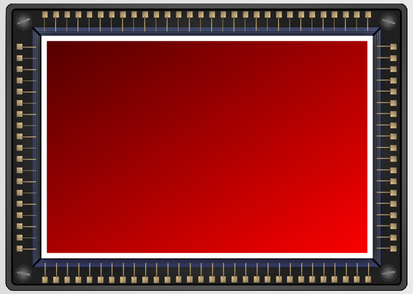






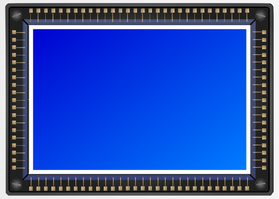
Full Frame

36x24mm



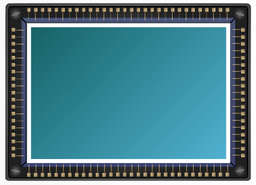
APS-C

24x16mm



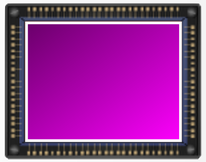
APS-C

22x15mm



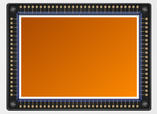
Four Thirds

17x13mm



1”

13x9mm



1/2.3”

6x5mm

1/3”

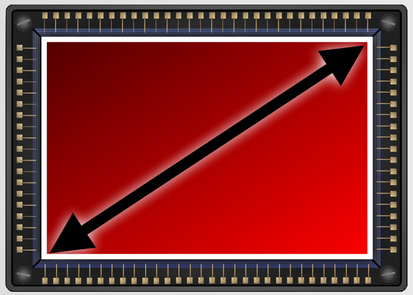
5x4mm

1” Type Sensor

(1” = 25.4mm)

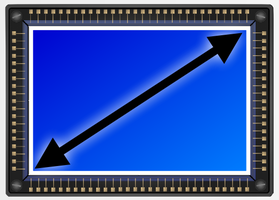
Full Frame

43mm



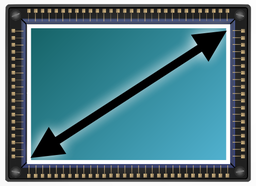
APS-C

28mm



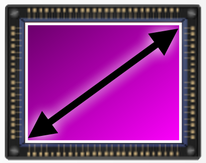
APS-C

27mm



Four Thirds

22mm



1”

16mm

1/2.3”

8mm

1/3”

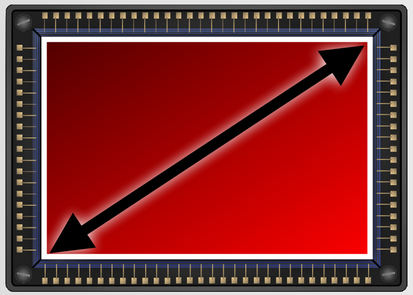
6mm

Rule of Thumb
Sensor Size & Lens Choice

Sensor Size			=	Normal Lens
Sensor Size	÷	2	=	Landscape
Sensor Size	x	2	=	Portrait
Sensor Size	x	4	=	Sports Lens
Sensor Size	x	8	=	Wildlife Lens

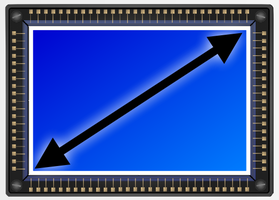
Full Frame

43mm



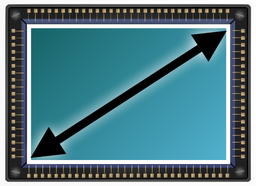
APS-C

28mm



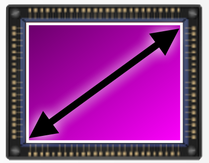
APS-C

27mm



Four Thirds

22mm



1”

16mm

1/2.3”

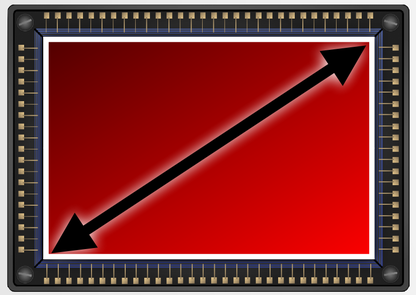
8mm

1/3”

6mm

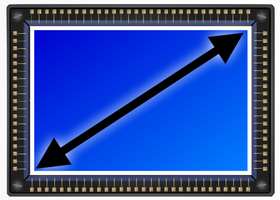
Full Frame

43mm



APS-C

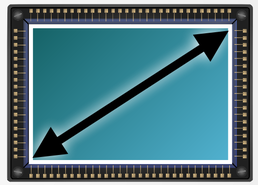
28mm



(43mm ÷ 28mm = 1.5)
(28mm x 1.5 = 43mm)

APS-C

27mm



Four Thirds

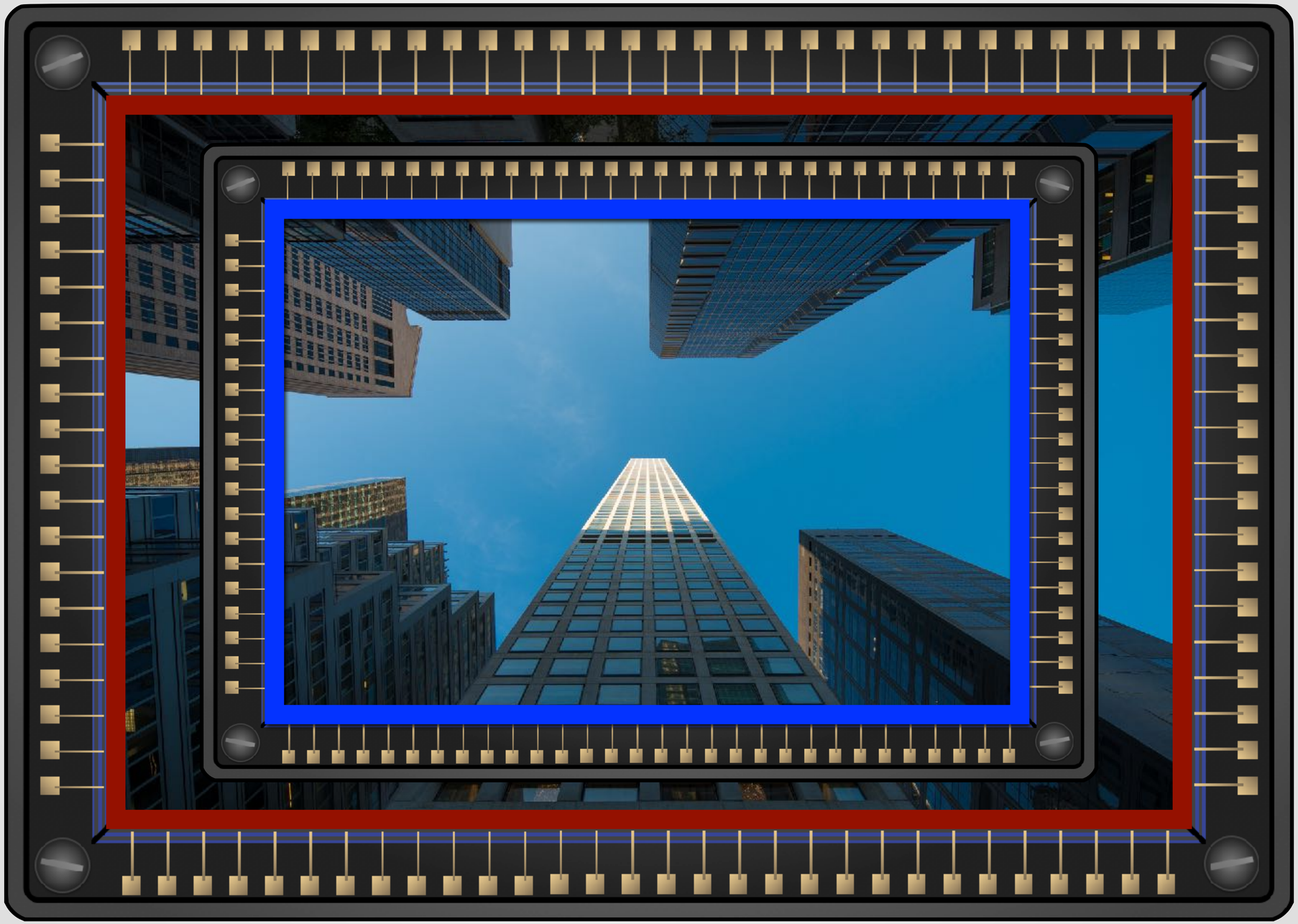
22mm

Crop Factor

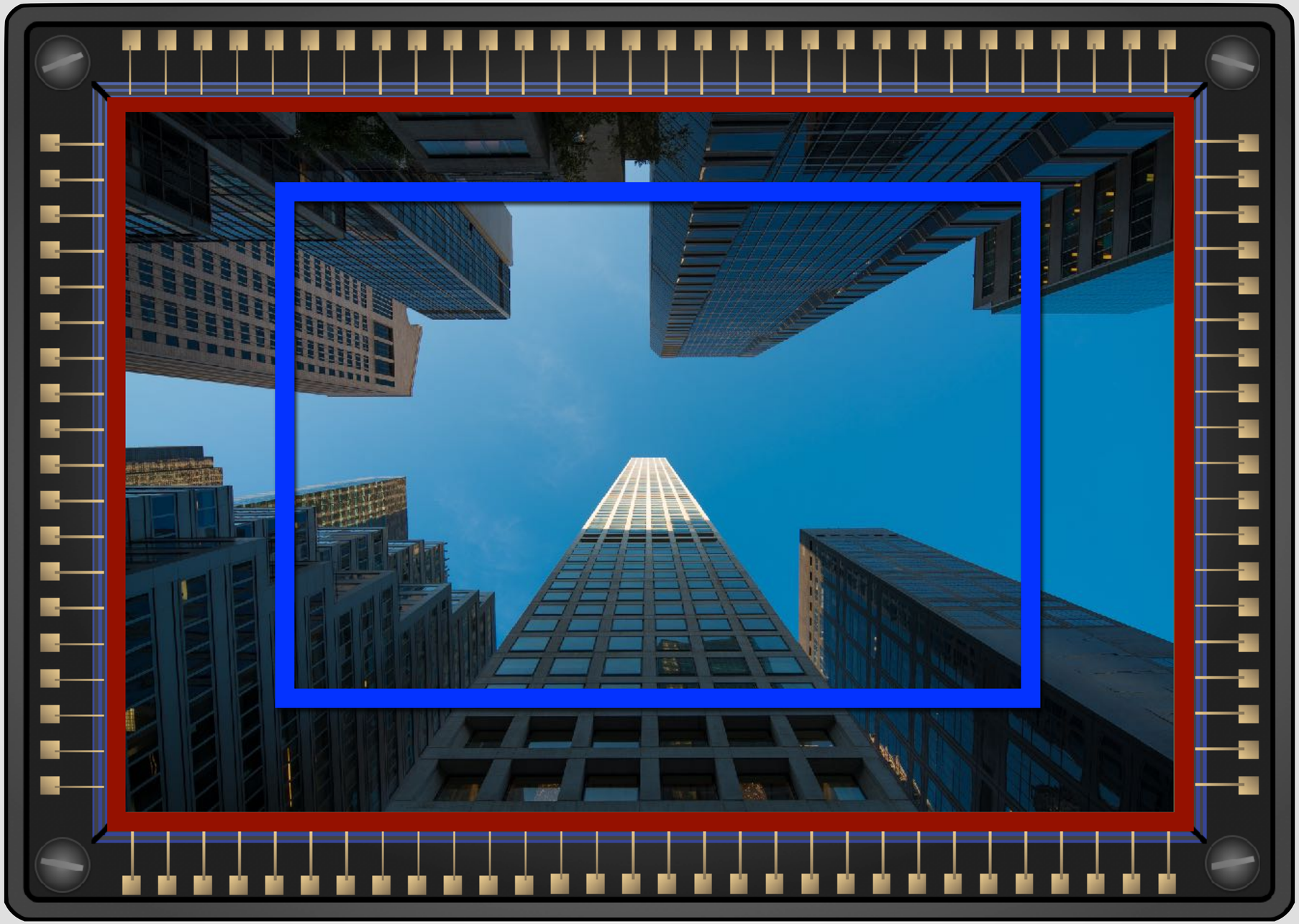
1.0x	1.5x	1.6x	2.0x
Canon Leica Nikon Pentax Sony	Fujifilm Leica Nikon Pentax Sony	Canon	Panasonic Olympus

Full Frame

1.6x Crop



Full Frame vs 1.6x Crop



Sensor Size

The Sensor

16 - 35mm

43mm Sensor

Full Frame

10mm

x 1.6

16mm

27mm Sensor

1.6x Crop

10 - 22mm

Full Crop

Full Frame vs 1.6x Crop

Sensor Size

The Sensor

43mm Sensor Full Frame

500mm f/4

15 in.

8.5 lb.

$9,000

300mm x 1.6 = 480mm

27mm Sensor 1.6x Crop

300mm f/4

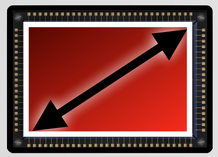
9 in.

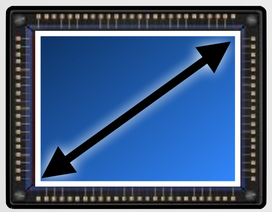
2.5 lb.

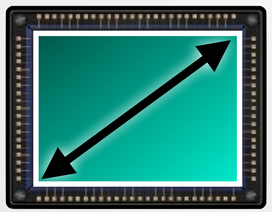
$1,400

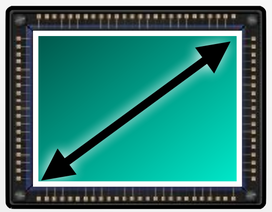
Medium Format Cameras

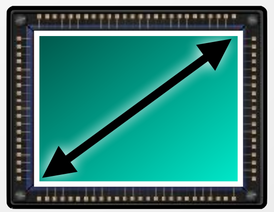
Full Frame	Leica S (Type 007)	Fujifilm GFX-50S	Hasselblad X1D-50C	Pentax 645Z	Hasselblad H6D-400c	Mamiya Leaf Credo
43mm	54mm	55mm	55mm	55mm	67mm	69mm
36x24mm	45x30mm	44x33mm	44x33mm	44x33mm	54x40mm	54x40mm

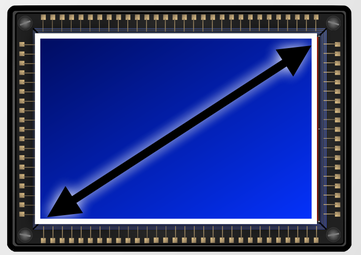


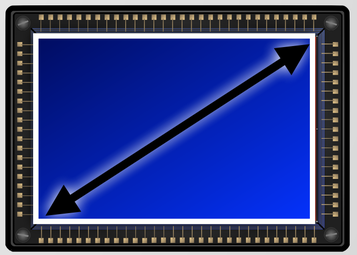










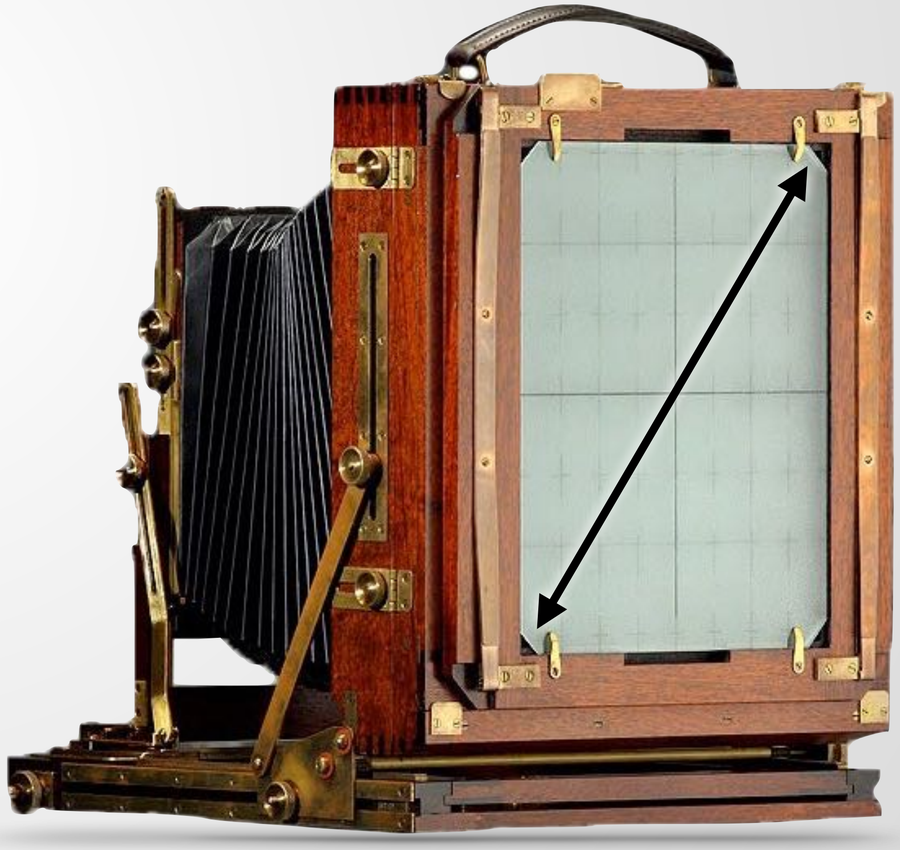


Large Format Cameras

8”x10” View Camera

320mm

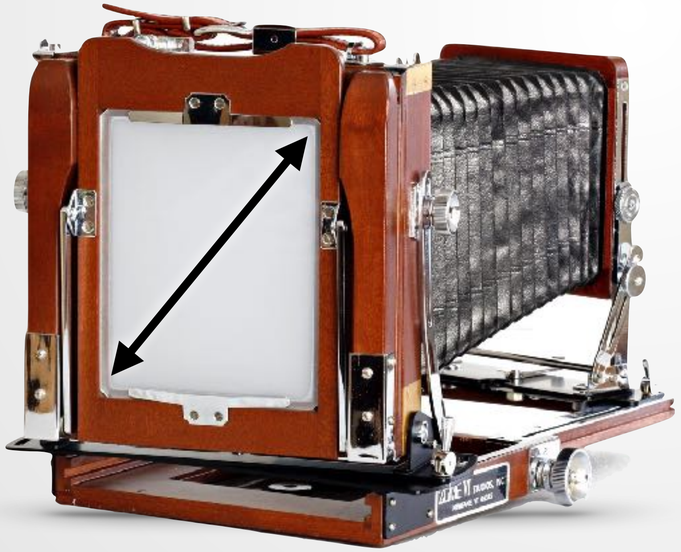
200x250mm



4”x5” View Camera

162mm

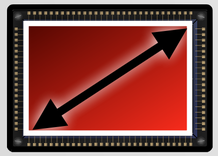
102x127mm



Full Frame

43mm

36x24mm




SONY

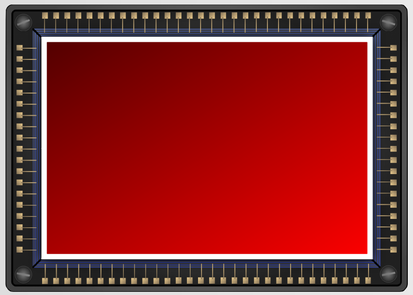

Nikon

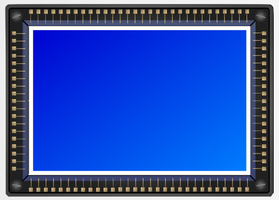

Canon

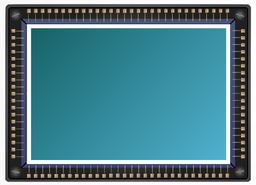

OLYMPUS

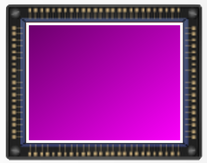

SONY

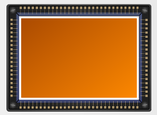

Canon







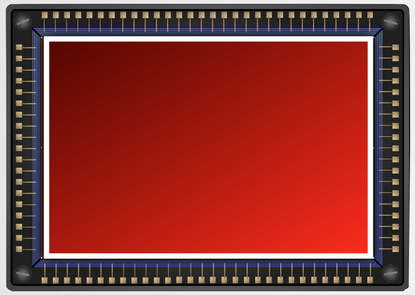




THE SENSOR

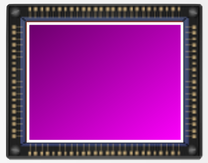
- Sensor Size
- Sensor Sizes: Compared
- Pixels
- ISO

Bigger



- Bigger pixels
- More pixels
- Shallower depth of field

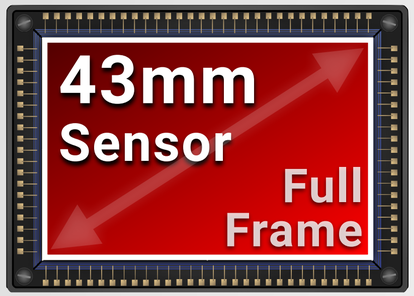
Smaller

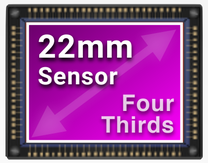


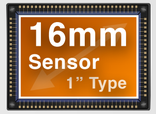
- Smaller camera
- Less money
- More depth of field

Camera Size

Sensor Size: Compared | The Sensor





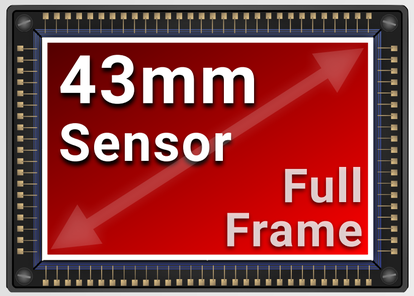


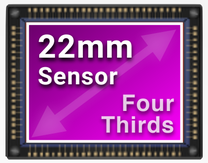
1,560g

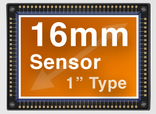
538g

299g

Camera Size







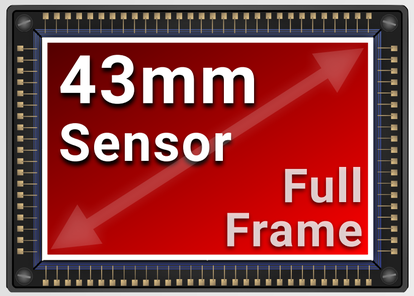
1,560g

538g

299g

Camera Size

Sensor Size: Compared | The Sensor



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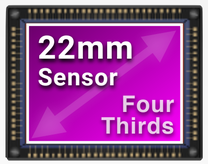

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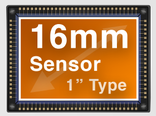
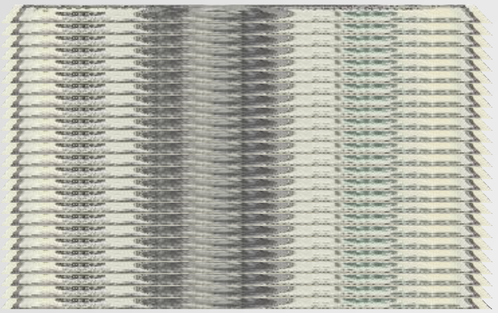


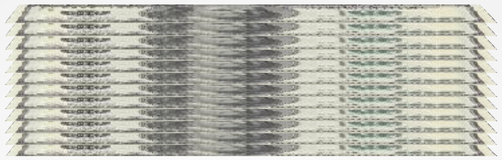
299g

Camera Cost



$2,200 USD

1,560g



$1,200 USD

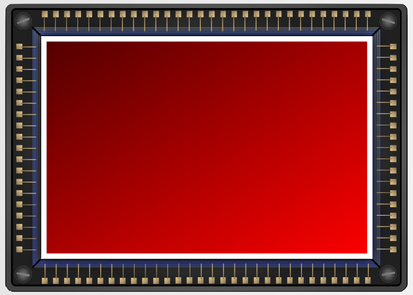
538g

$1,000 USD

299g

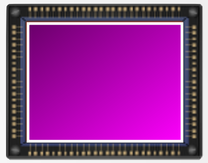
Depth of Field

Bigger



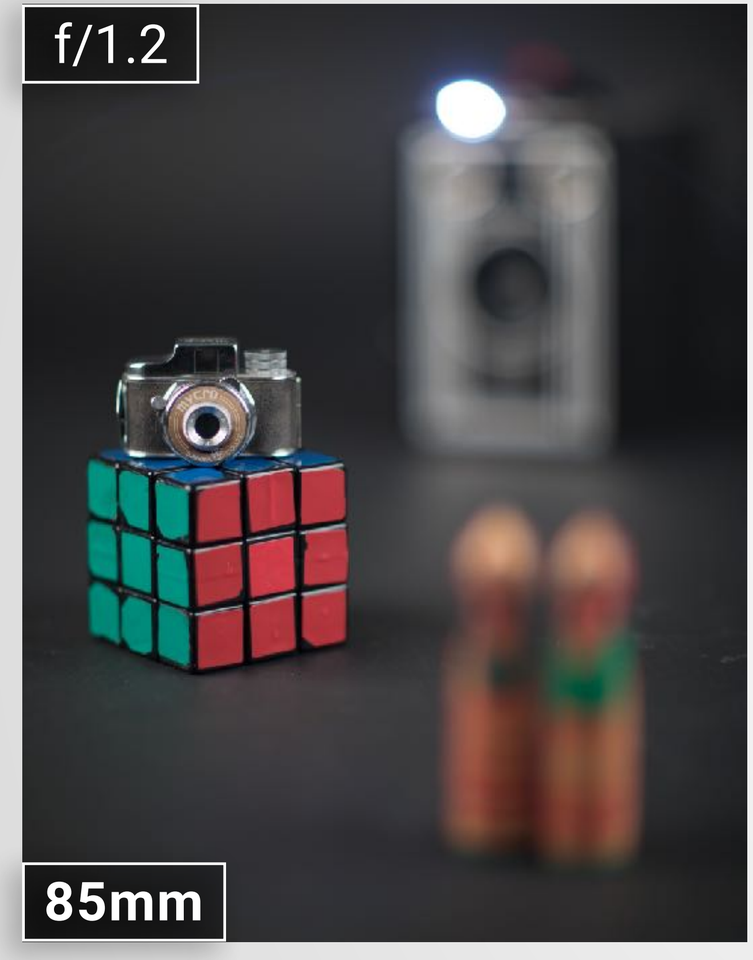
- Bigger pixels
- More pixels
- Shallower depth of field

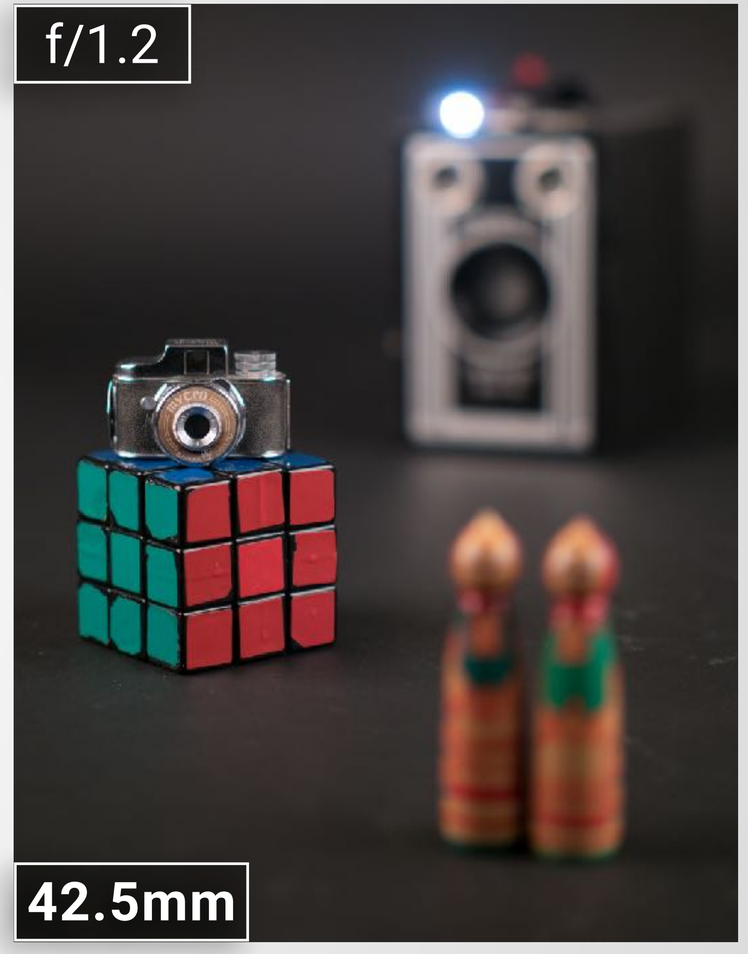
Smaller

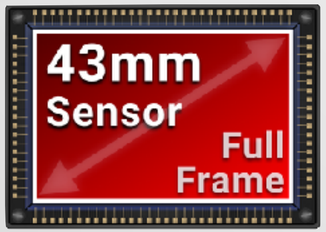


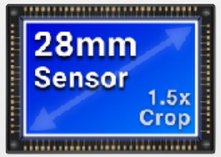
- Smaller camera
- Less money
- More depth of field

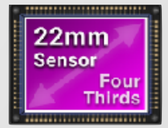
Depth of Field



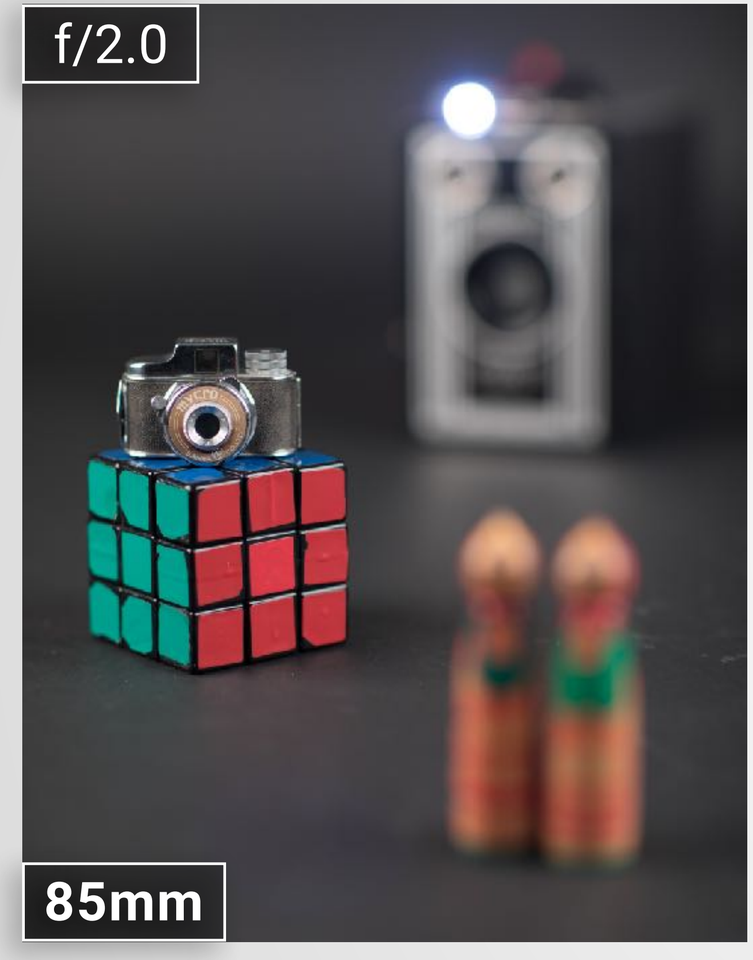


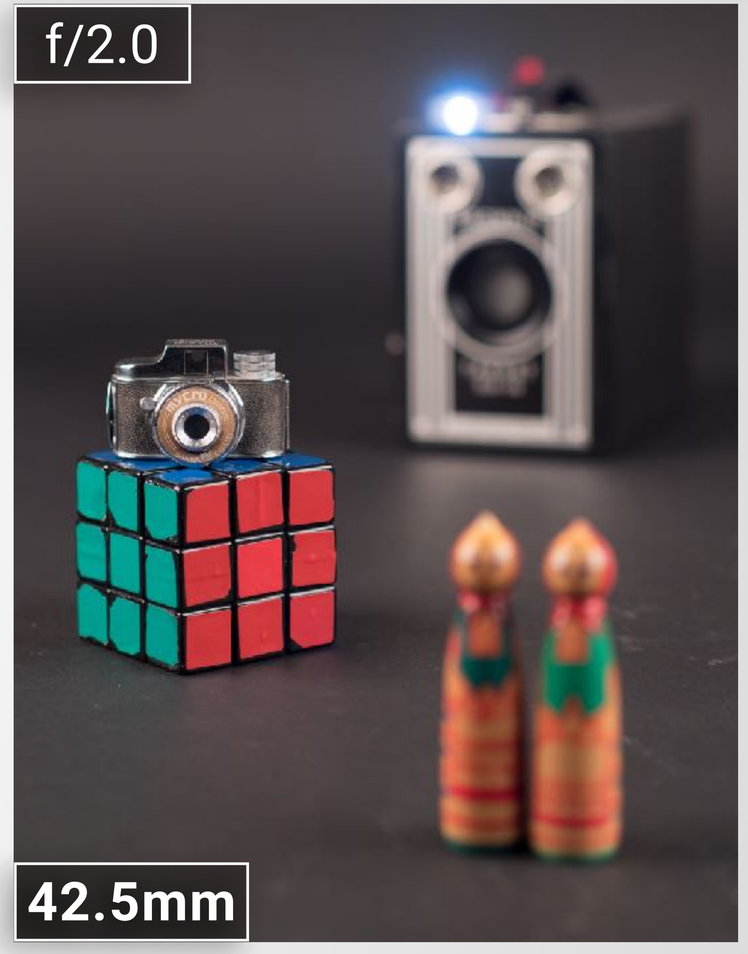


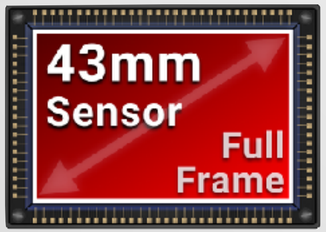


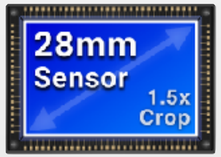


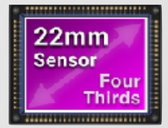
Depth of Field



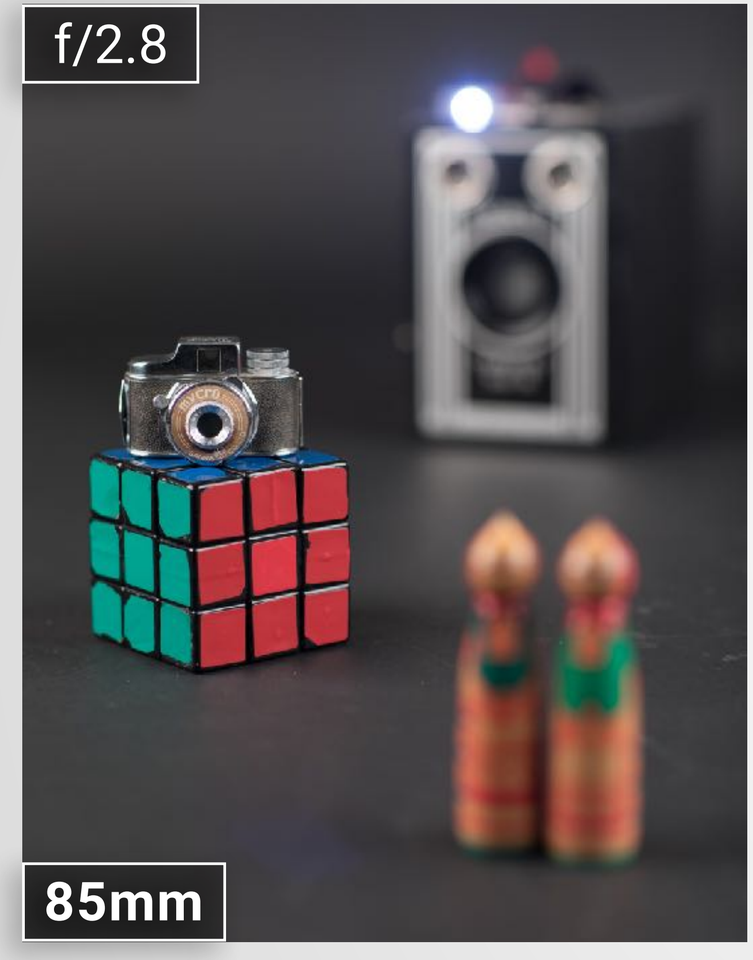


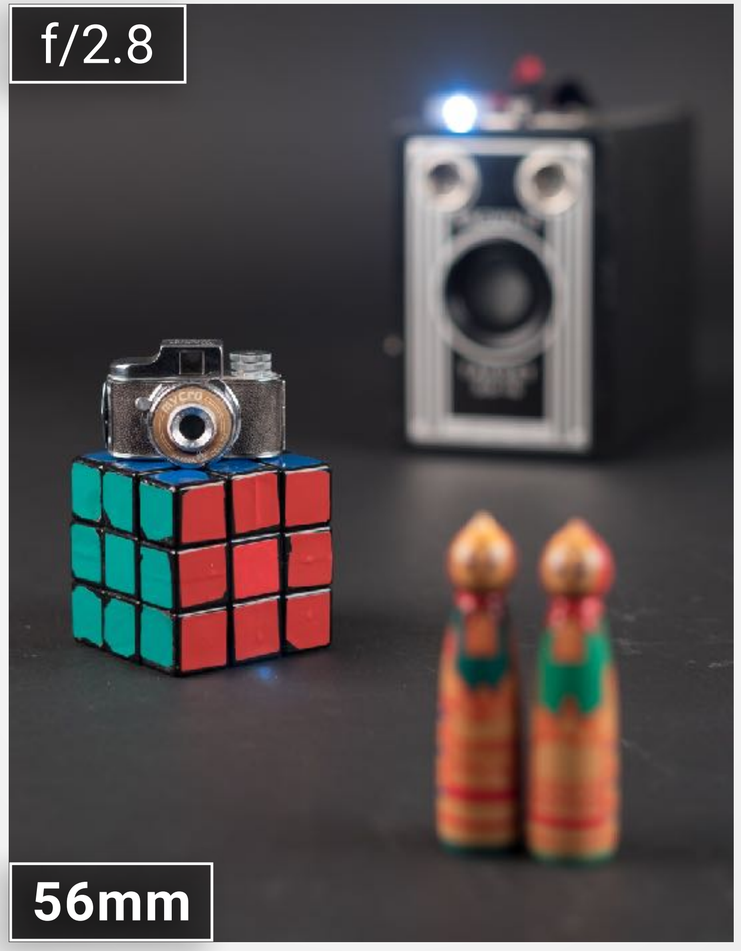


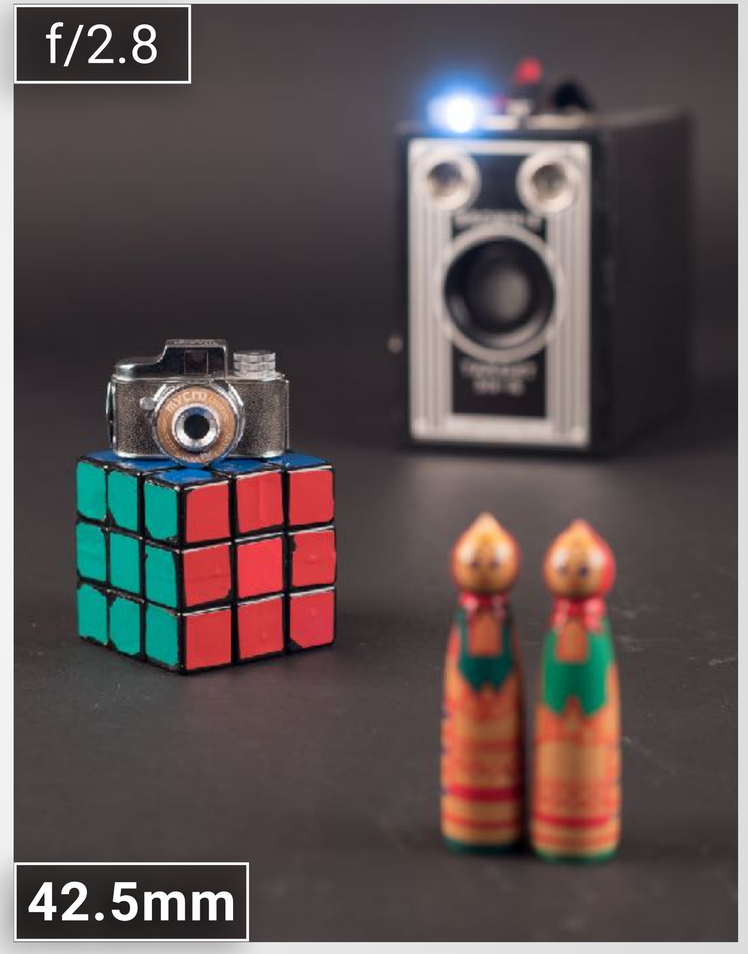


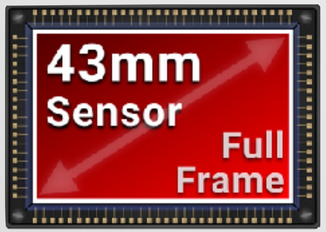


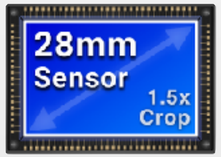
Depth of Field

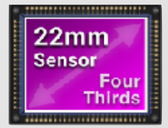




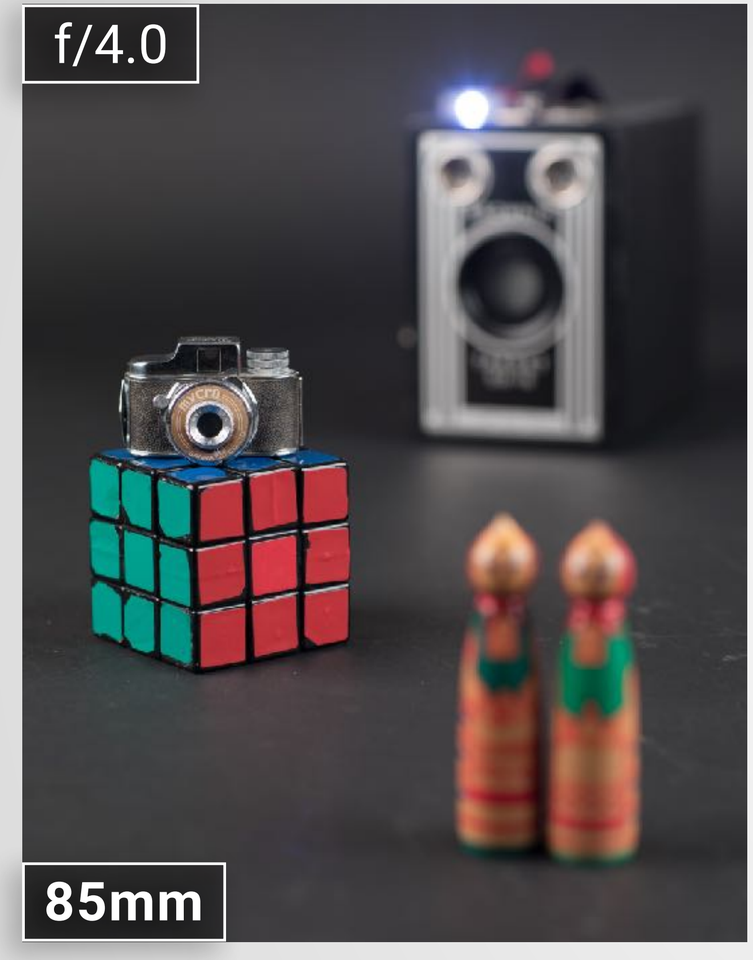


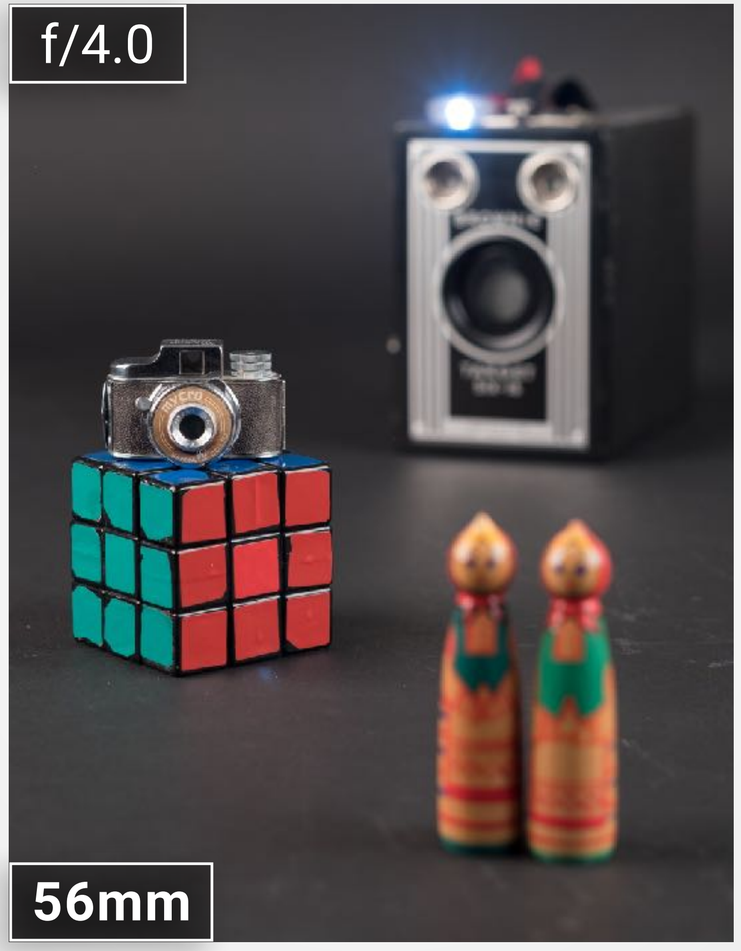


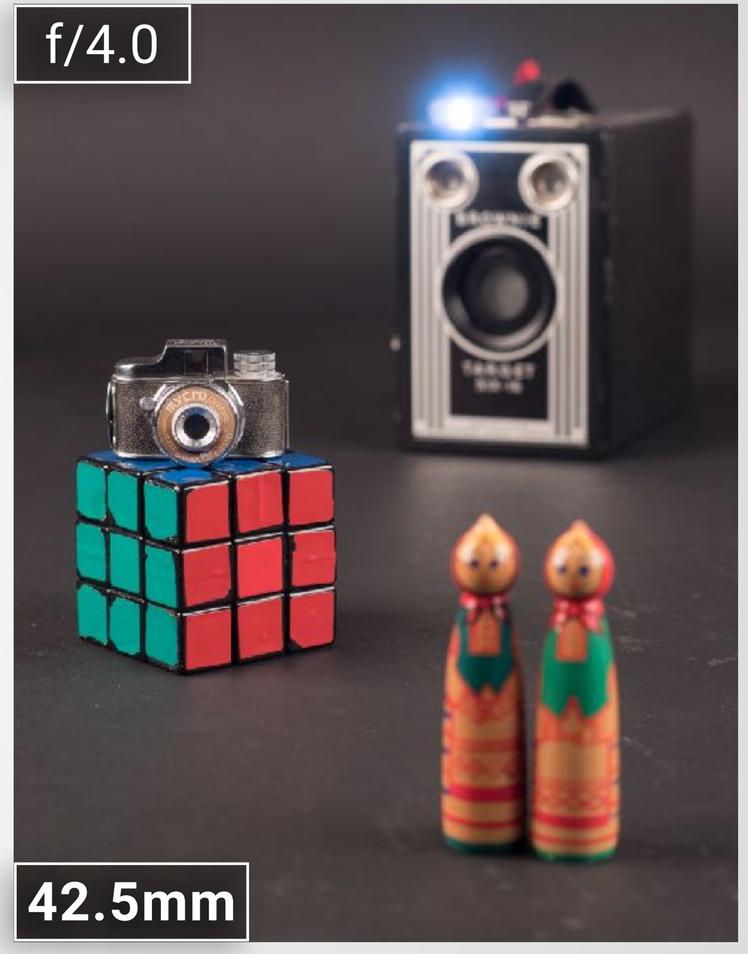


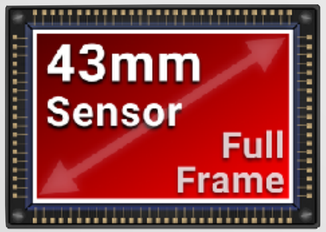


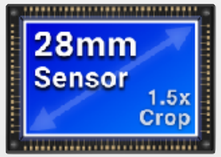
Depth of Field

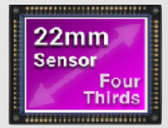












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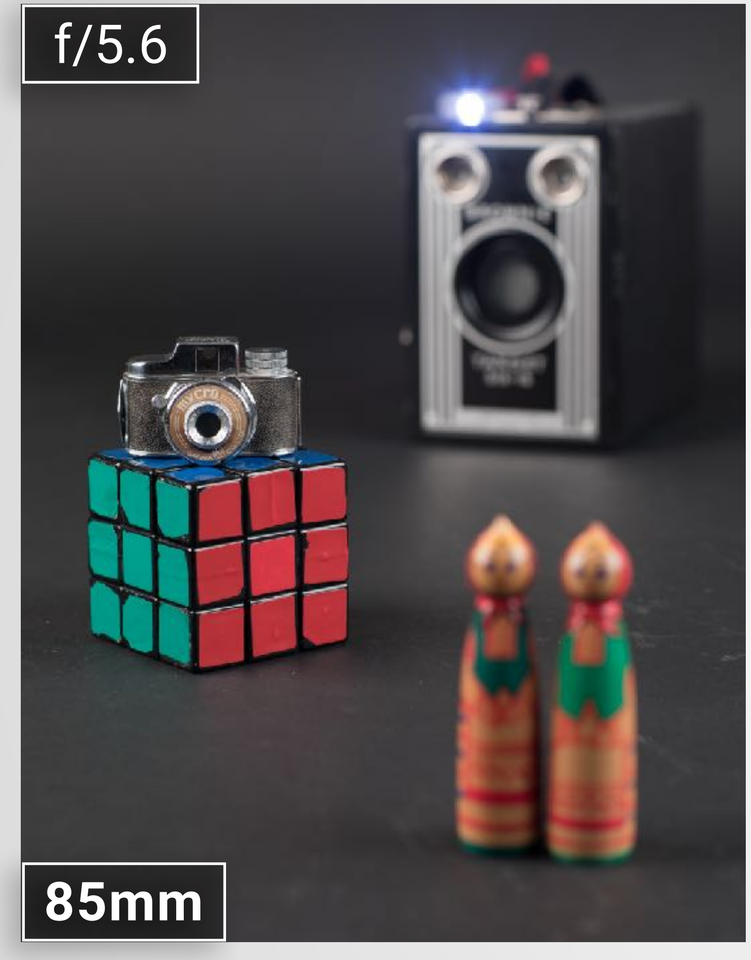

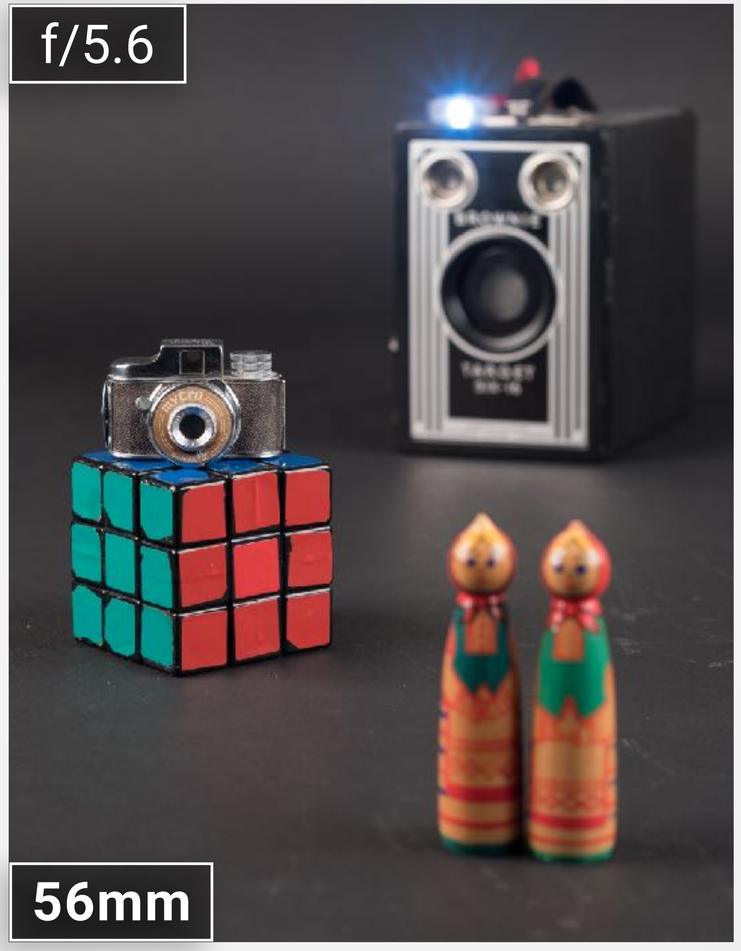

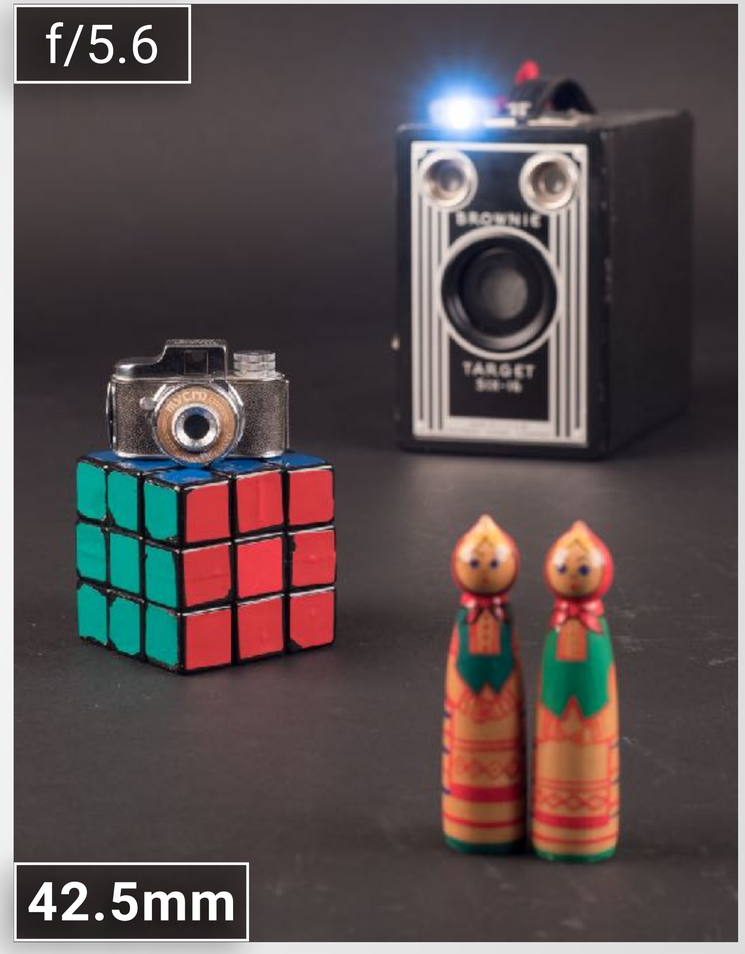

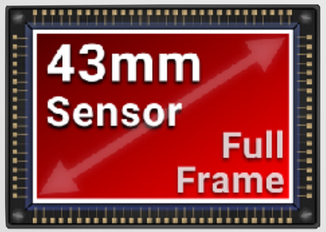

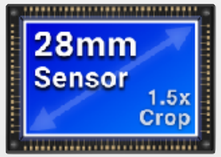

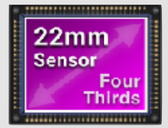

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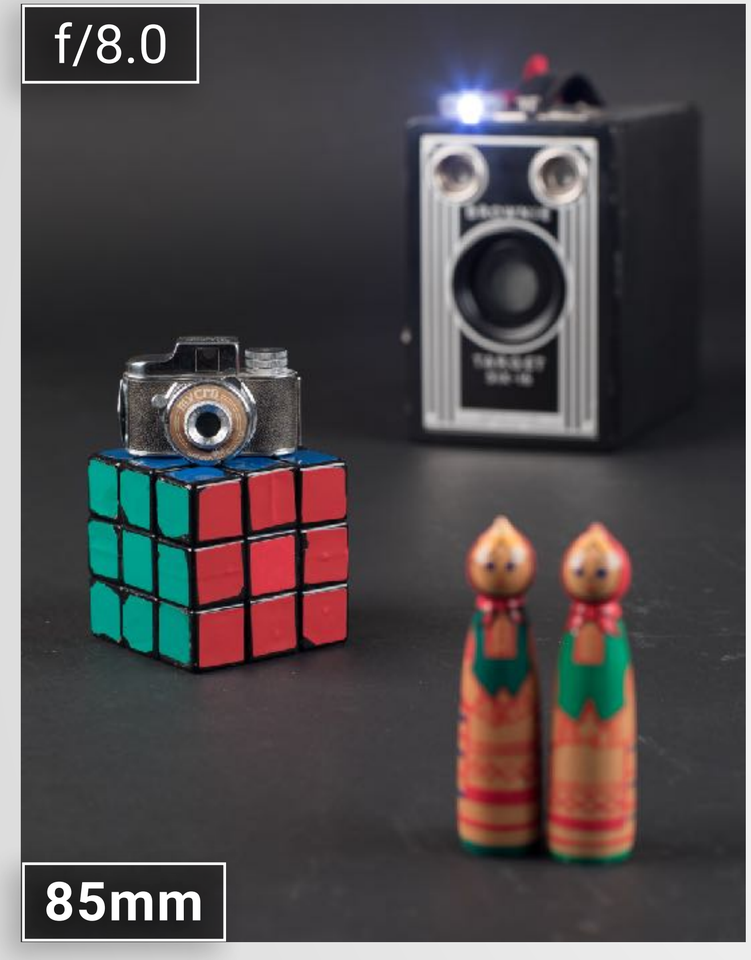

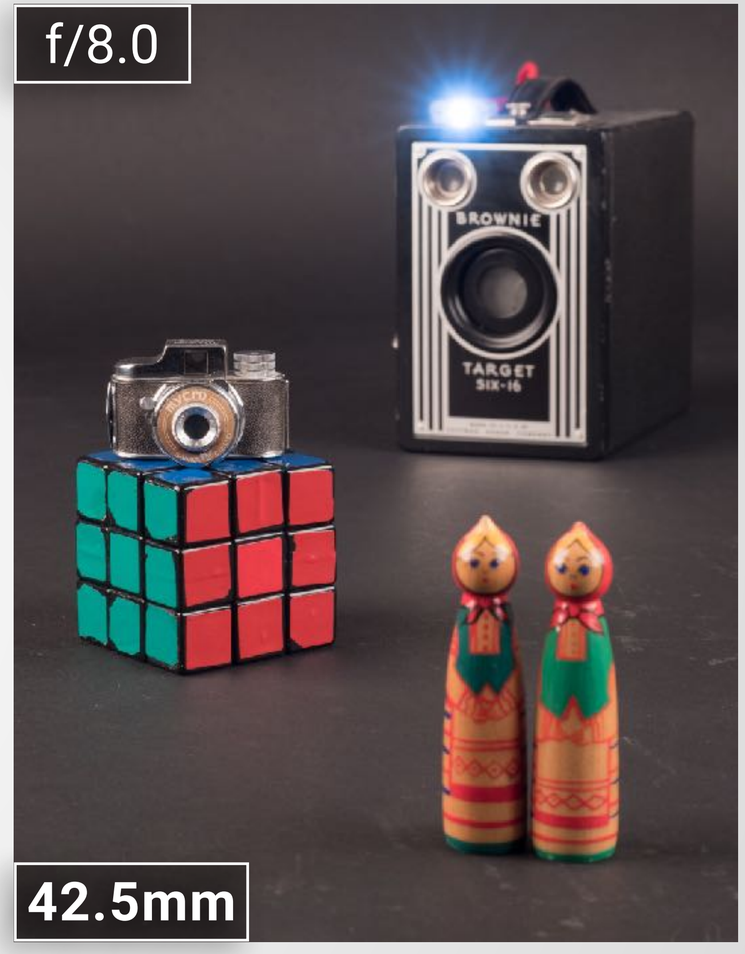

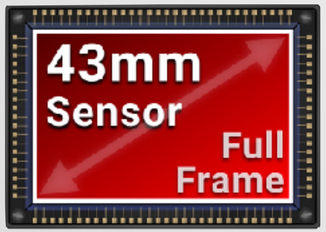

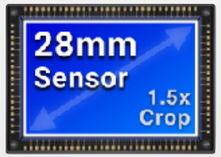

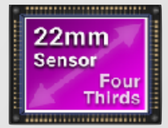

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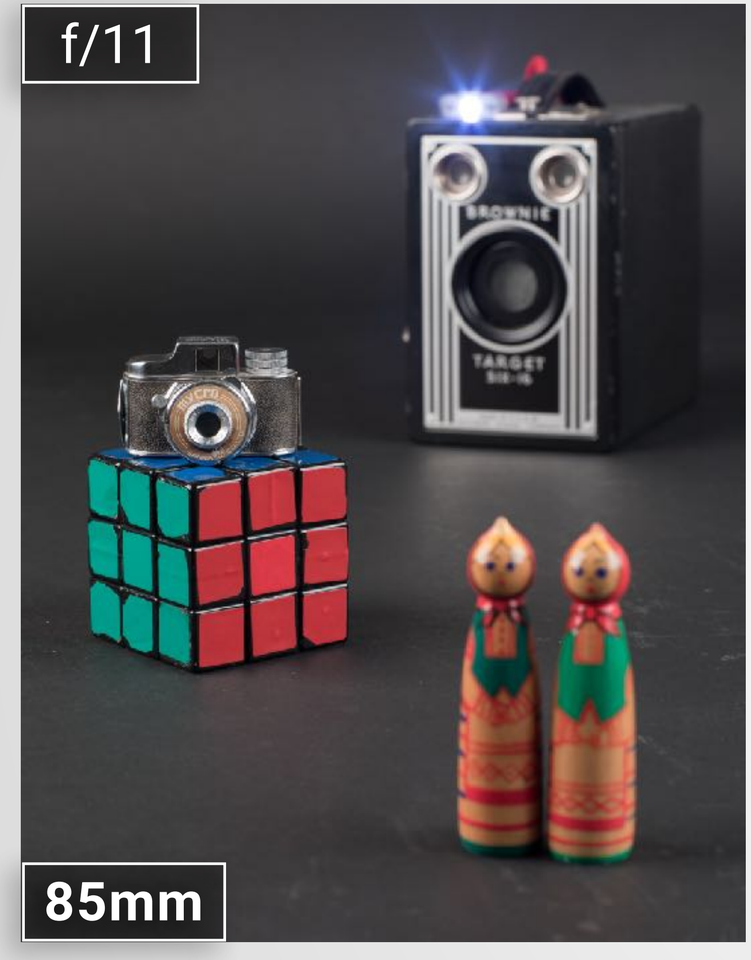
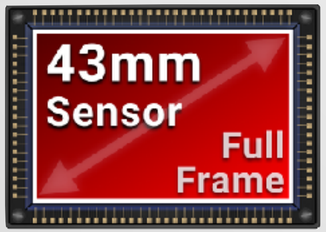
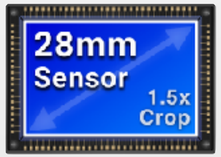
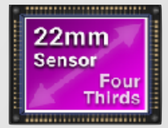
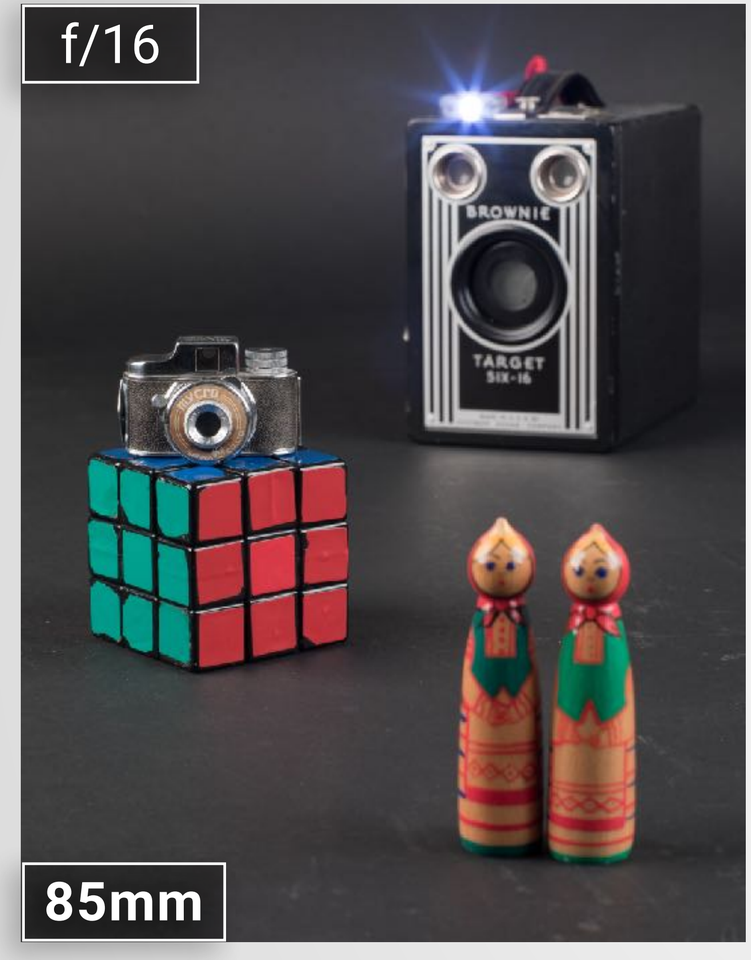


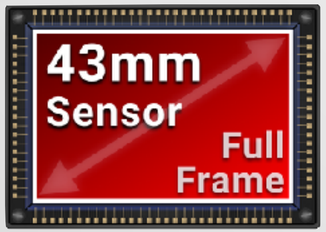


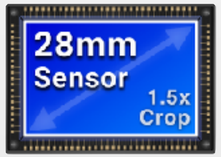


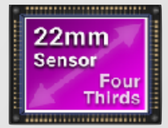


Depth of Field

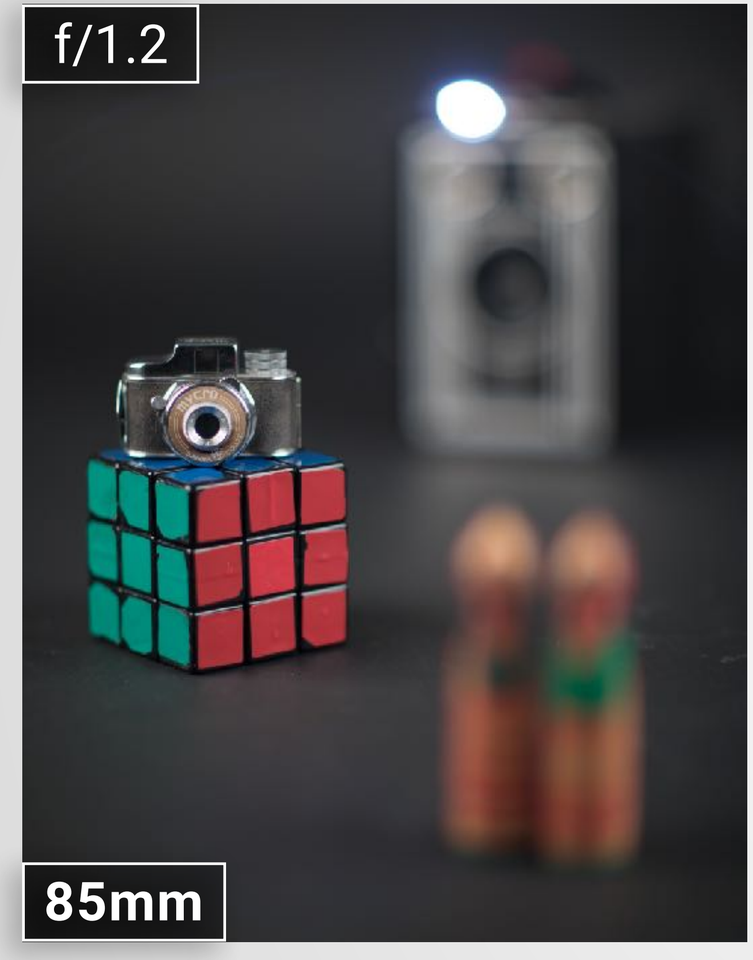


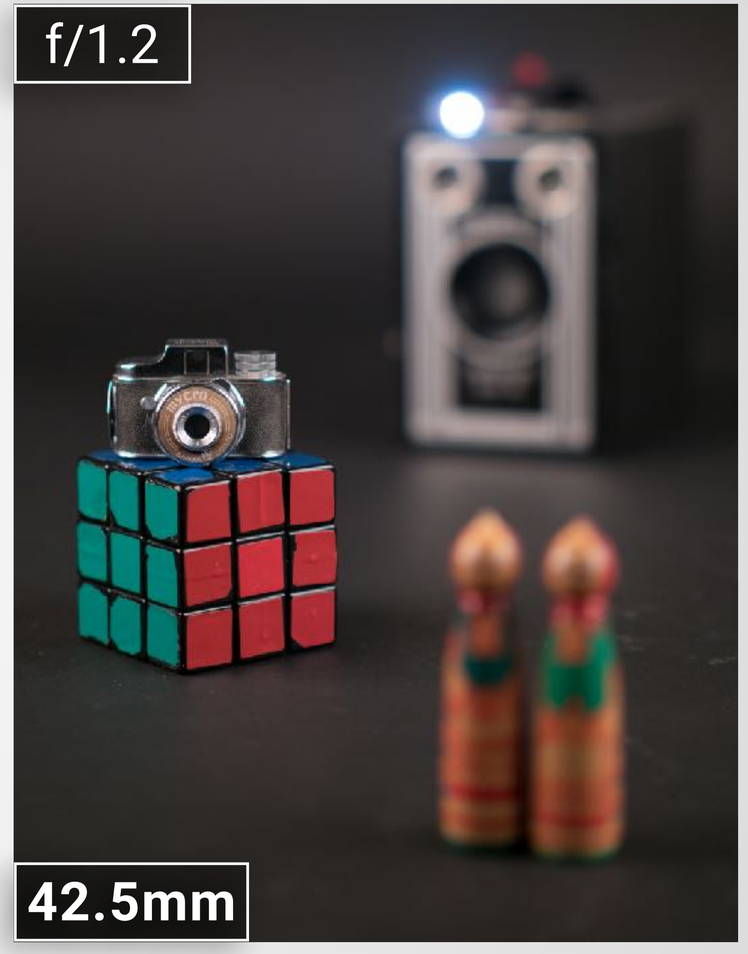


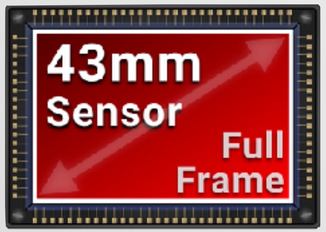


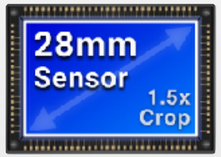


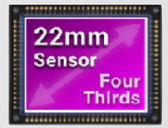
Depth of Field



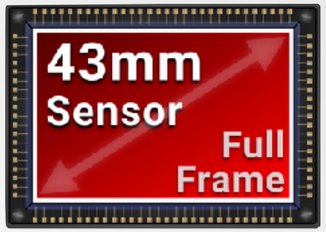




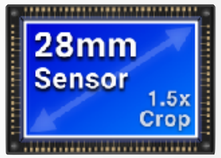





22mm
Sensor
Four
Thirds
25mm @ f/1.4

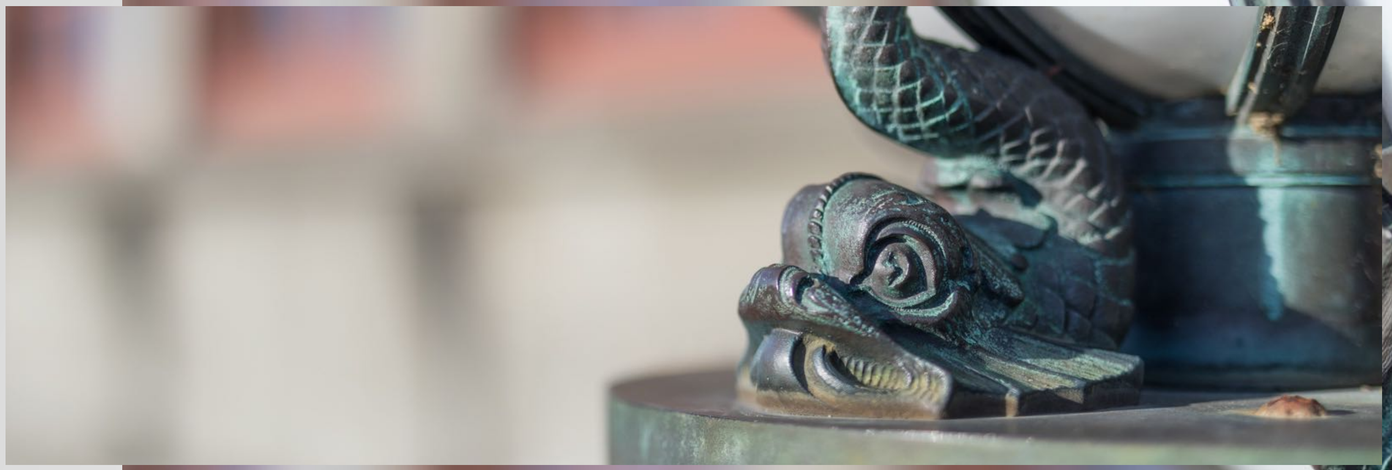


50mm @ f/1.4

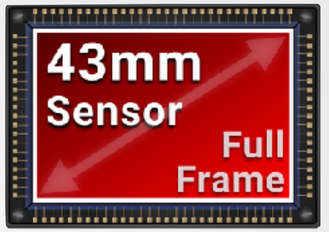


35mm @ f/1.4

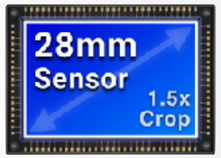
25mm @ f/1.4




22mm
Sensor
Four
Thirds
42.5mm @ f/1.2



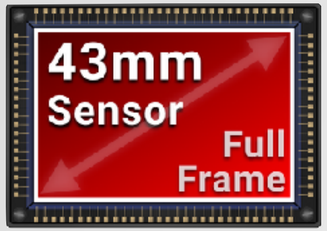
85mm @ f/1.2



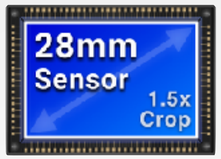
56mm @ f/1.2

42.5mm @ f/1.2

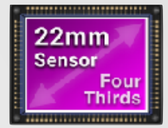
Depth of Field



f/5.6



f/5.6



f/5.6

Canon 300mm

Length - 143mm (5.6”)
Weight - 1050g (70oz)
Cost - $1,300 USD

Fuji 55-200mm

Length - 118mm (4.7”)
Weight - 580g (20oz)
Cost - $500 USD

Panasonic 45-150mm

Length - 73mm (2.9”)
Weight - 201g (7oz)
Cost - $200 USD

300mm @ f/5.6

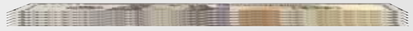
200mm @ f/5.6

150mm @ f/5.6

$7,500 USD

$3,000 USD

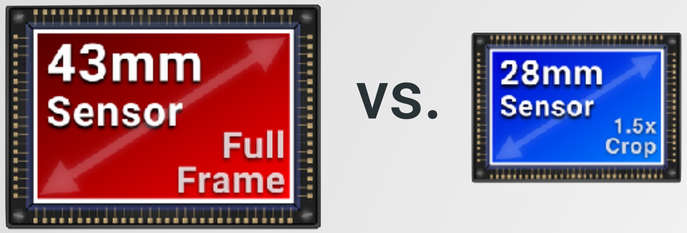
$2,000 USD



$600 USD

$600 USD

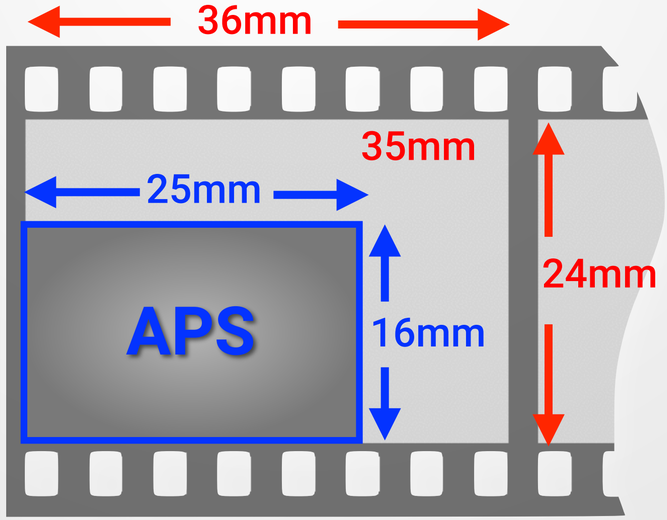
Full Frame vs. APS



vs.

APS Advanced Photo System

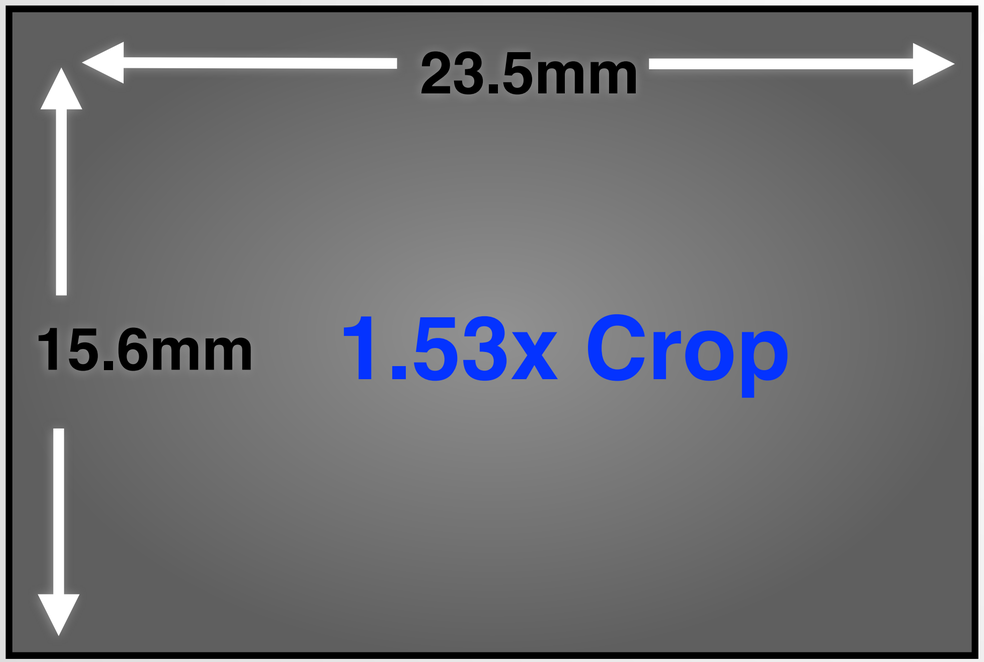
Camera & film system introduced in 1996



APS-N vs. APS-C

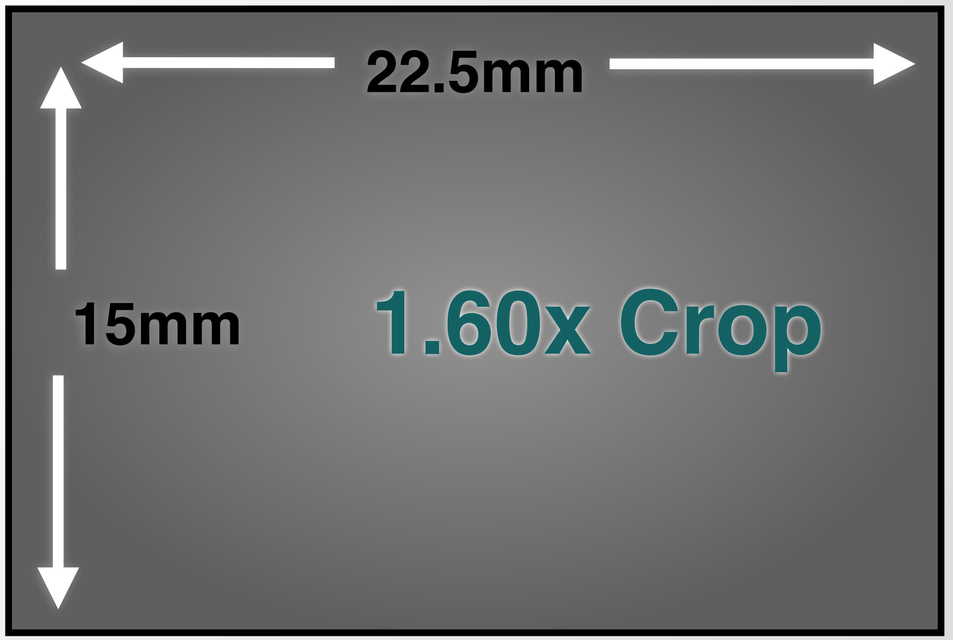
SONY Nikon FUJIFILM PENTAX

APS-N



APS-C

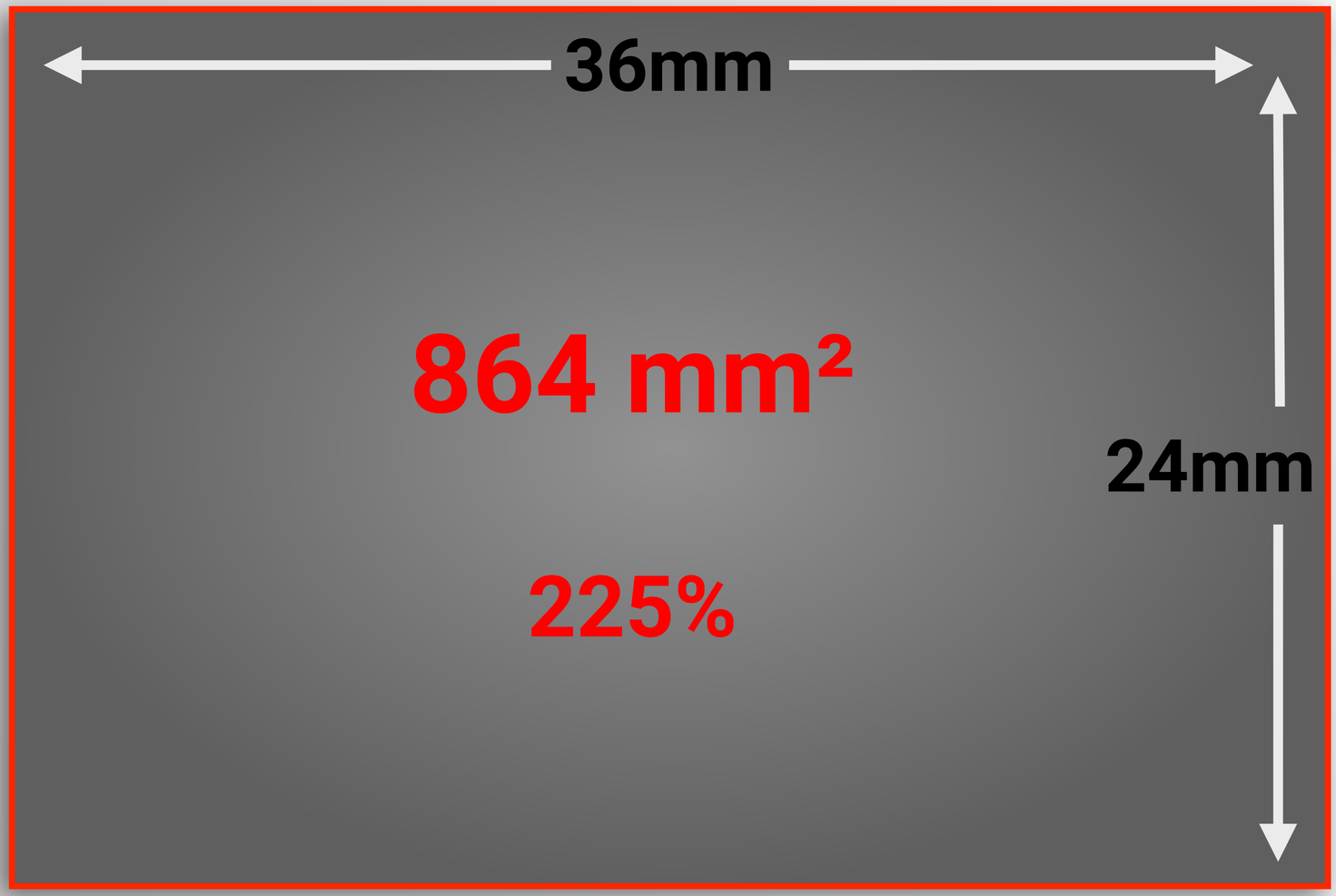
Canon

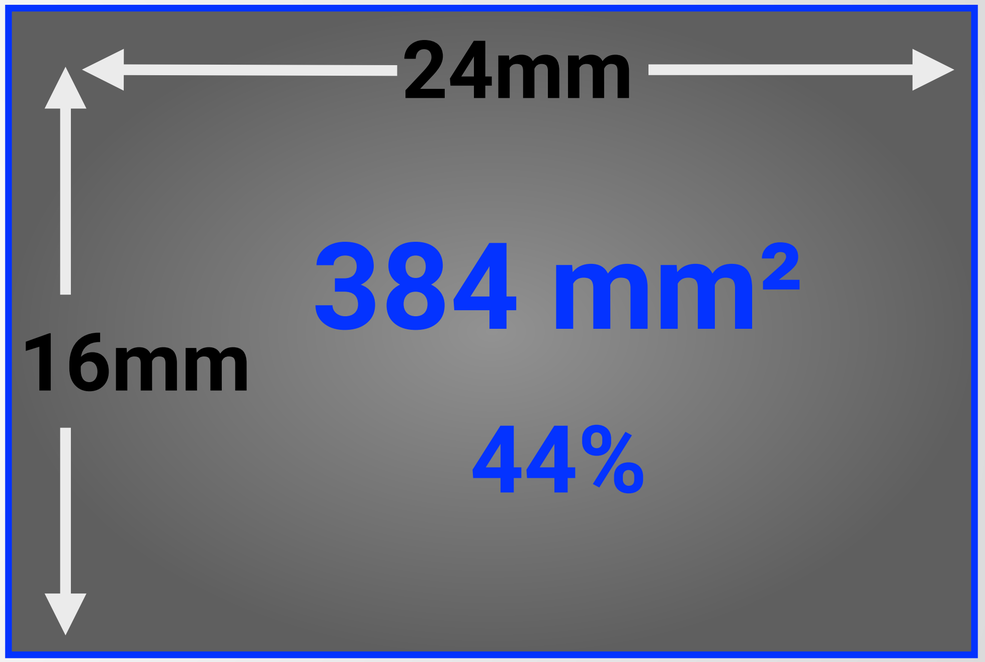


APS-N vs. APS-C

Full Frame vs. APS

43mm vs. 28mm





Full Frame vs. APS

Viewfinder

43mm vs. 28mm

12% Larger

CANON 5D MARK IV

0.71x Viewfinder

CANON 7D MARK II

1.0x Viewfinder

Full Frame vs. APS

Viewfinder

43mm vs. 28mm

14% Larger

NIKON D750

0.7x Viewfinder

NIKON D7500

.94x Viewfinder

Full Frame vs. APS

Viewfinder

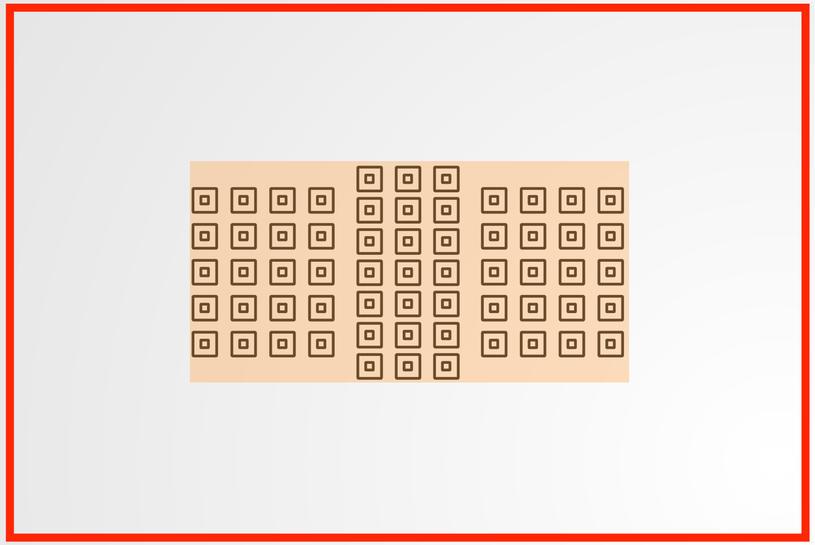
43mm vs. 28mm

Full Frame vs. APS

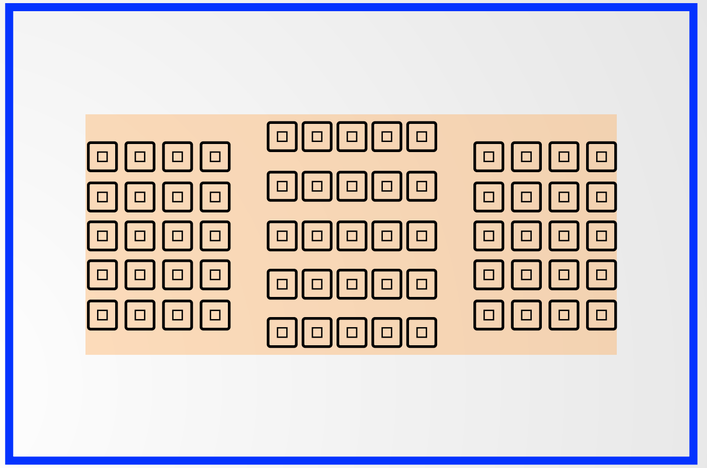
Focusing

43mm vs. 28mm

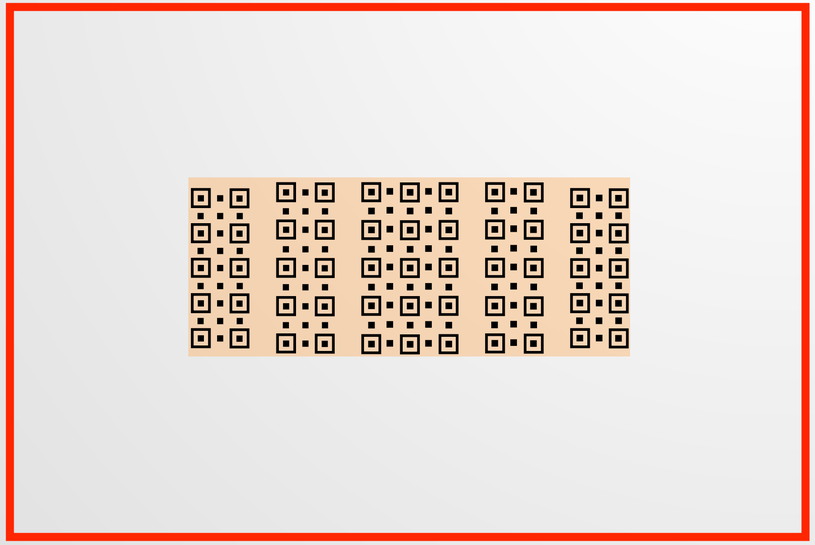
Canon 5D Mark IV



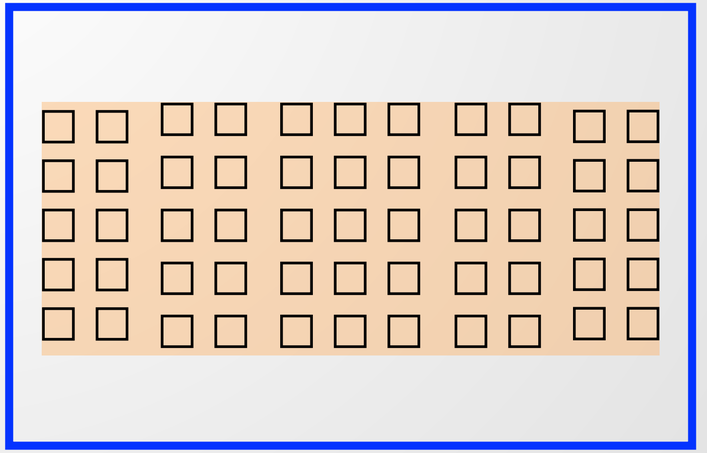
Canon 7D Mark II



Nikon D850



Nikon D500



Full Frame vs. APS

Wide Lenses

43mm vs. 28mm

16-35mm

10-18mm

10mm x 1.6 = 16mm

Full Frame vs. APS

Sensor Size: Compared | The Sensor

Wide Lenses

43mm vs. 28mm

20mm

8-15mm f/4 Fisheye

11-24mm f/4L

14mm f2.8L II

TS-E 17mm f4L

20mm f2.8

16-35mm f2.8L

16-35mm f4L IS

84º

Canon

12.5mm

8-15mm f/4 Fisheye

10-18mm f3.5-5.6 IS STM

10-22mm f3.5-4.5

Full Frame vs. APS

Sensor Size: Compared | The Sensor

Wide Lenses

43mm vs. 28mm

20mm

8-15mm f3.5-4.5
Fisheye

14mm f2.8

14-24mm f2.8

16-35mm f4

17-35mm f2.8

18-35mm
f3.5-4.5

20mm f1.8

84º

Nikon

13mm

12-24mm
f4

10-24mm
f3.5-5.6

10-20mm
f4.5-5.6

8-15mm
f3.5-4.5
Fisheye

10.5mm
f2.8
Fisheye

Full Frame vs. APS

Telephoto Lenses

43mm vs. 28mm

Canon

CANON 5D MK IV

$ 3,300

300mm f2.8

$6,100

200mm f2.8

$750

CANON 7D II

$ 1,350

Full Frame $9,400 USD

7° & f/2.8

APS $ 2,100 USD

Full Frame vs. APS

System Cost

43mm vs. 28mm

Nikon D750

$ 1,800

Nikon

Nikon D7500

$ 1,250

24-120mm

$ 1,100

80-400mm

$ 2,300

Full Frame Package

$ 5,200

APS Package

$ 2,700

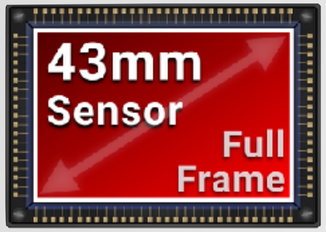
16-85mm

$ 700

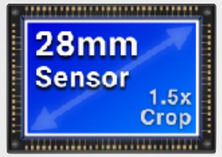
70-300mm

$ 750

Full Frame vs. APS



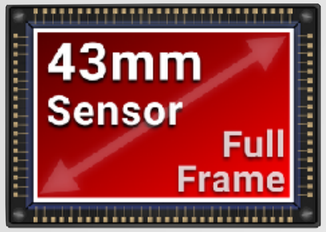
vs.



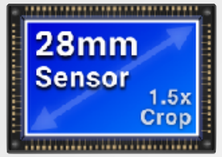
“Should I buy a Full Frame camera?”

- If you need a professional quality camera — YES
- If you need the highest level of image resolution — YES
- If you need top-of-the-line, low light performance — YES
- If you need images with shallow depth of field — YES
- If you have demanding wide angle needs — YES

Full Frame vs. APS



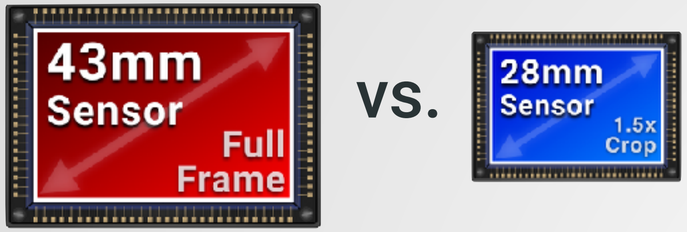
vs.



"Should I buy an APS camera?"

- If you want an more affordable digital SLR — YES
- If you want a camera with a good value — YES
- If you need good telephoto capabilities — YES

Full Frame vs. APS



vs.

	Full Frame	APS
New to photography & spending less $5,000	☐	☑
New, but *very* serious about photography	☑	☐
Serious enthusiast	☑	☑
Working Pro	☑	☑

Upgrade from APS to Full Frame?

Do you have the $$$$$ for the lenses?

Sensor Size: Compared

The Sensor

43mm Sensor Full Frame

Canon 6D Mark II

24-70mm
f/2.8

70-200mm
f/2.8

$5,600USD

6.6 lb.

3.2kg

28mm Sensor 1.5x Crop

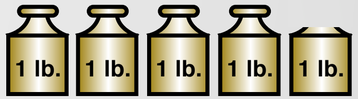
Fujifilm X-T2

16-55mm
f/2.8

50-140mm
f/2.8

$4,000USD

4.7 lb.



2.1kg

22mm Sensor Four Thirds

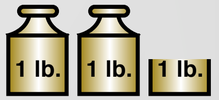
Olympus OM-D EM-5 II

12-40mm
f/2.8

35-100mm
f/2.8

$2,800USD

2.5 lb.



1.1kg

THE SENSOR

Sensor Sizes: Compared

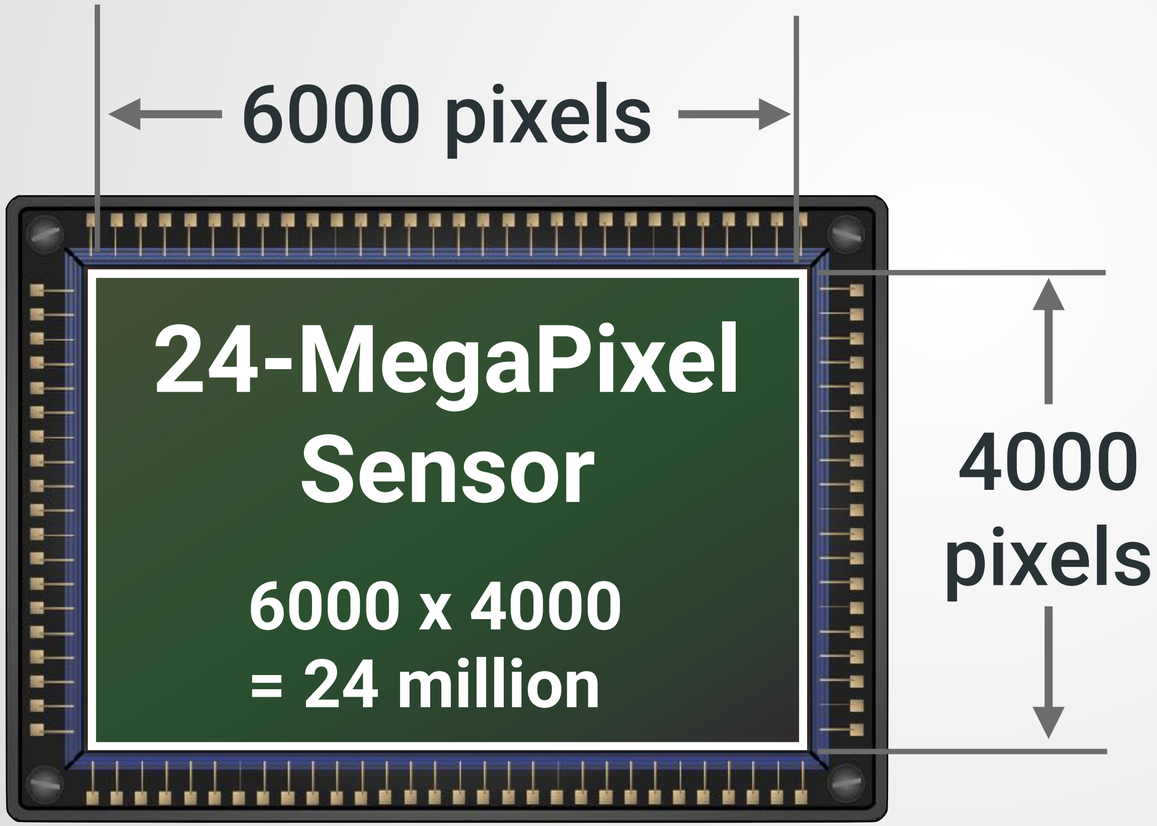
Q & A

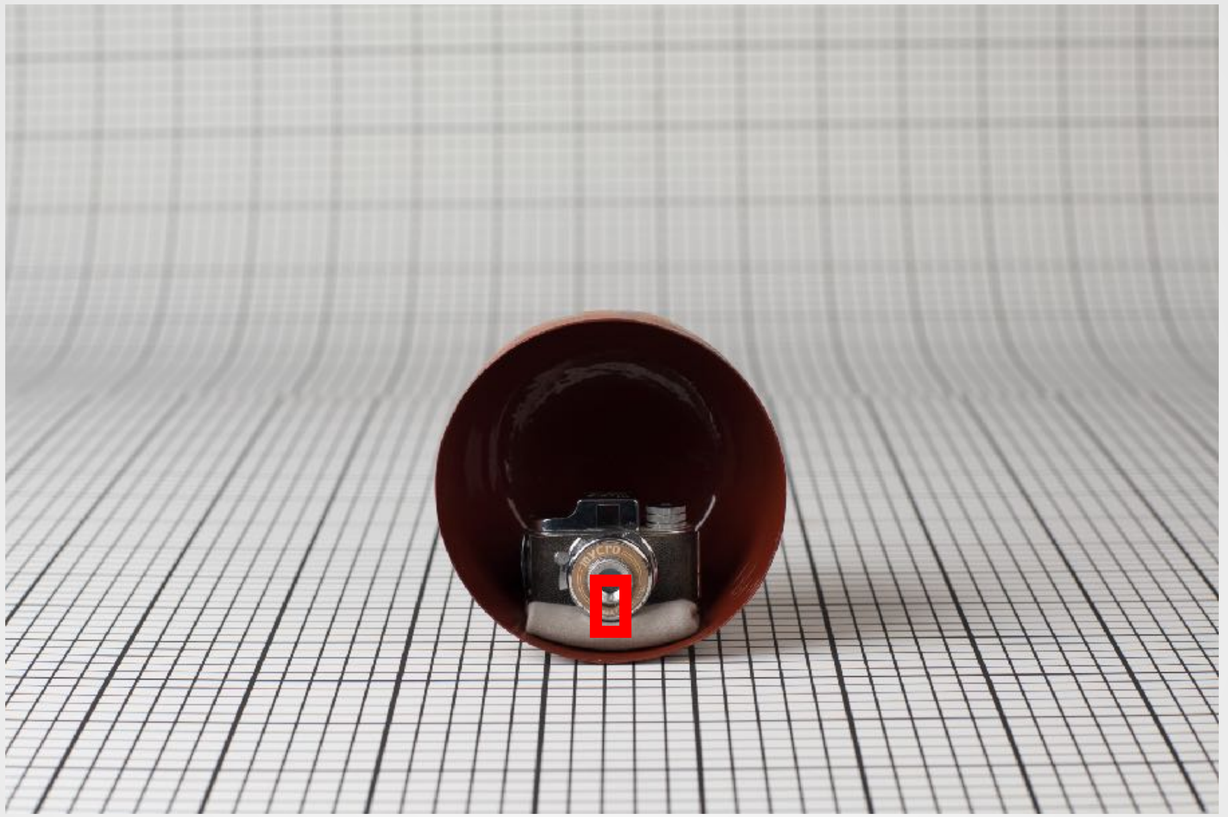
THE SENSOR

- Sensor Size
- Sensor Sizes: Compared
- Pixels
- ISO

Quantity & Size

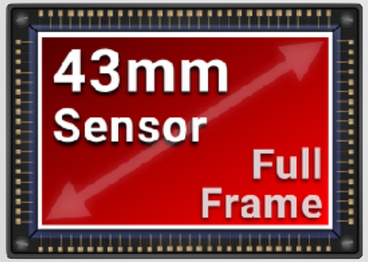
Pixel - Picture **El**ement = **Light Sensitive Cell**



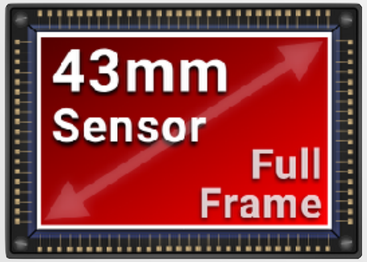


42 MP	30 MP	24 MP	20 MP	20 MP
43mm Sensor Full Frame	43mm Sensor Full Frame	28mm Sensor 1.5x Crop	27mm Sensor 1.6x Crop	22mm Sensor Four Thirds

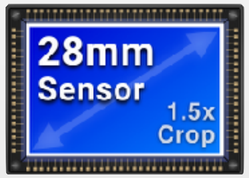
42 MP

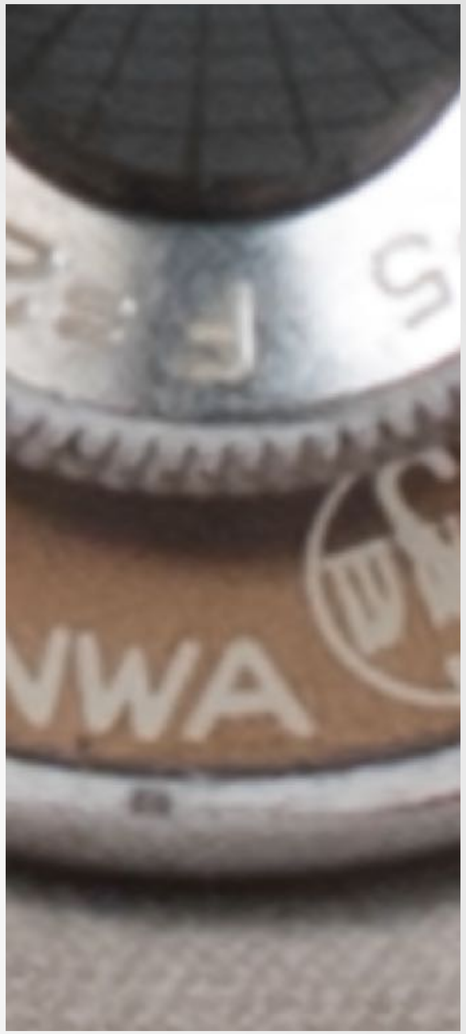


30 MP

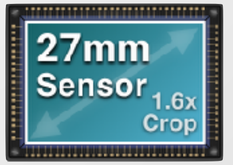


24 MP

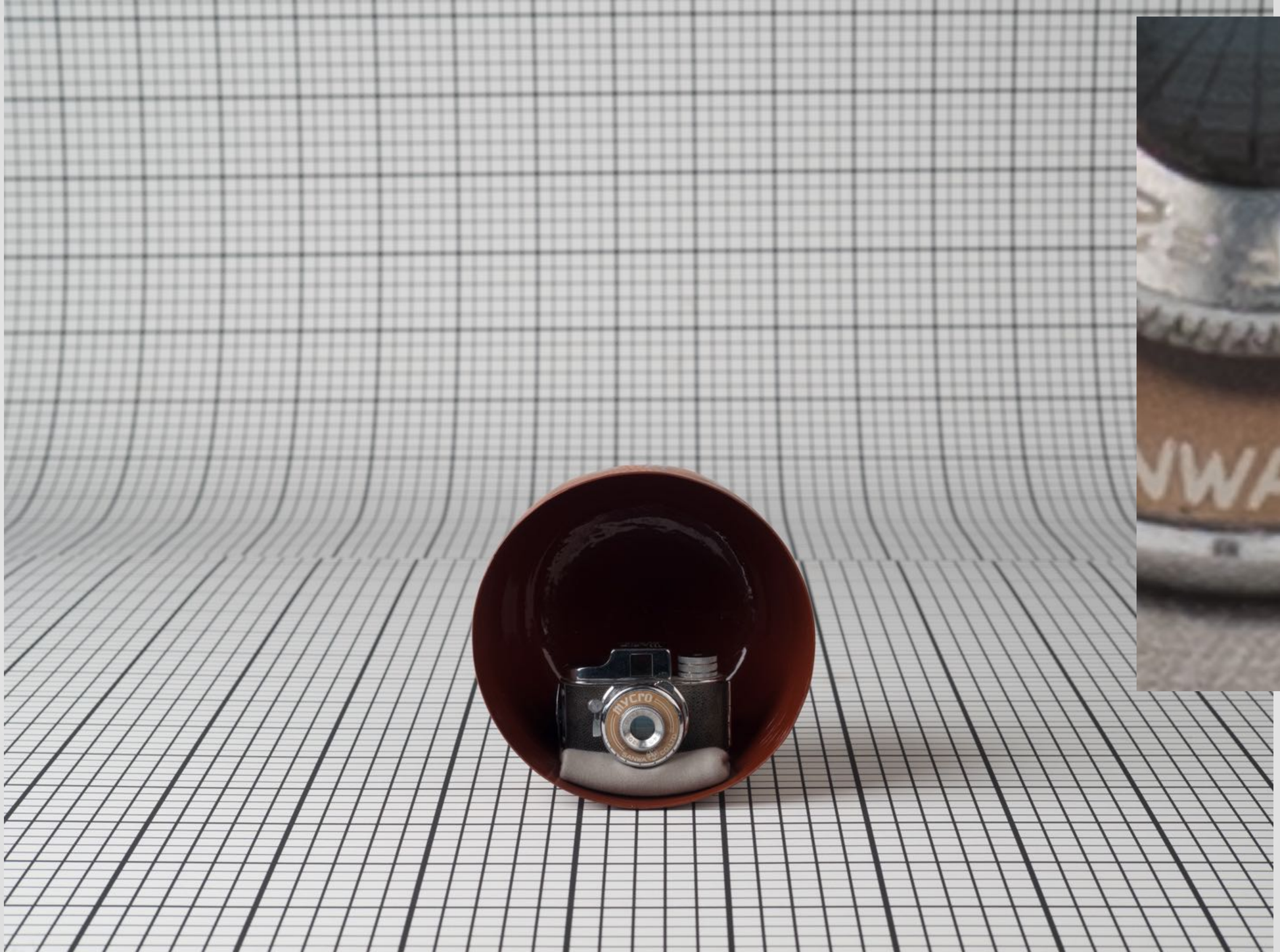




20 MP

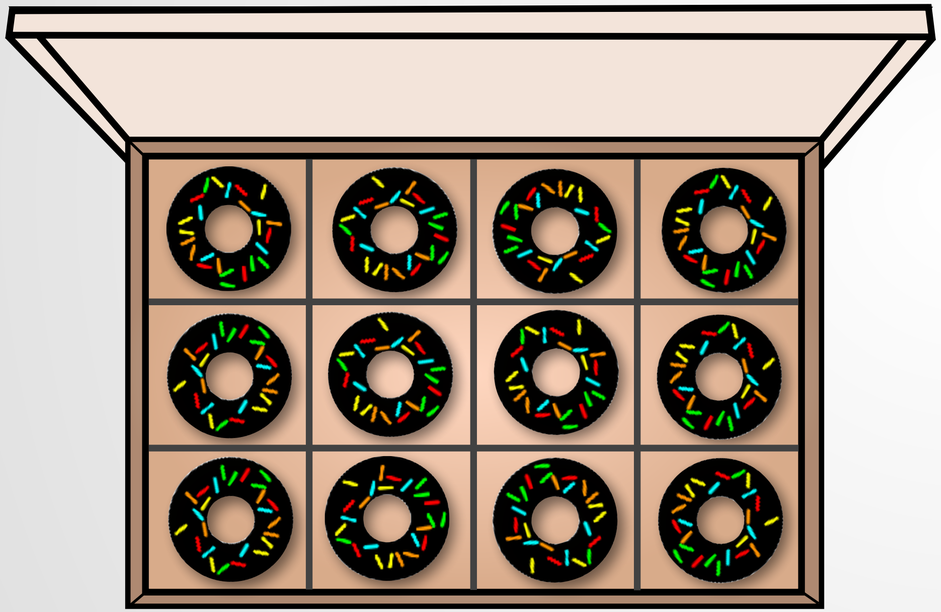


20 MP

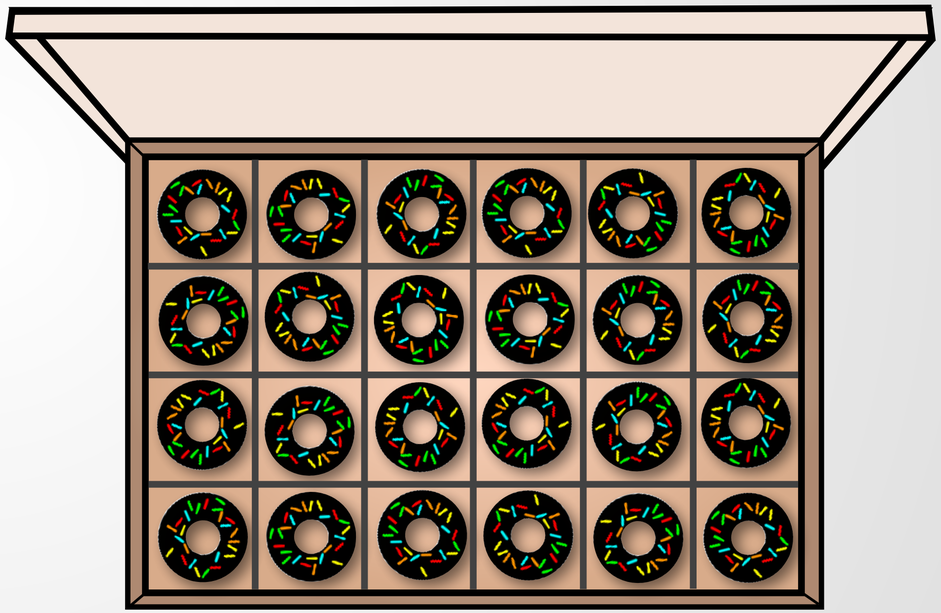

minox

Quantity & Size

Size vs Quantity



12 Donuts

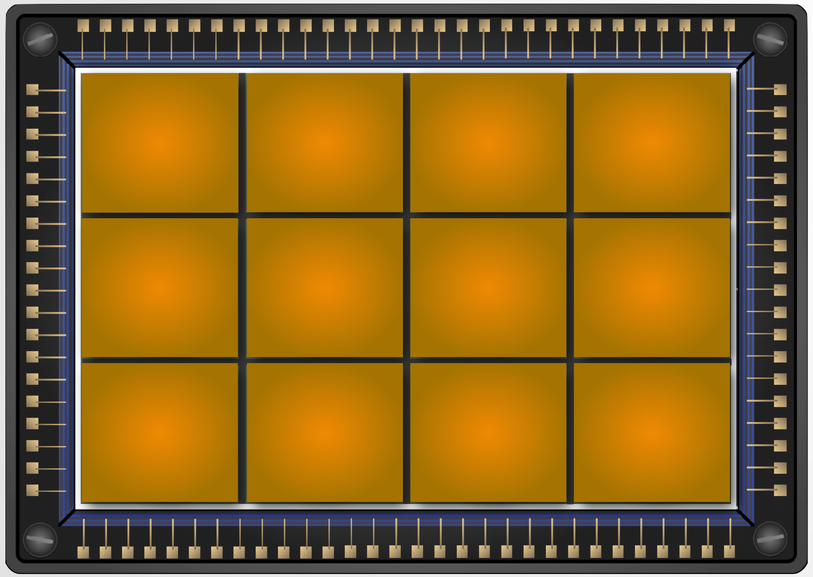


24 Donuts

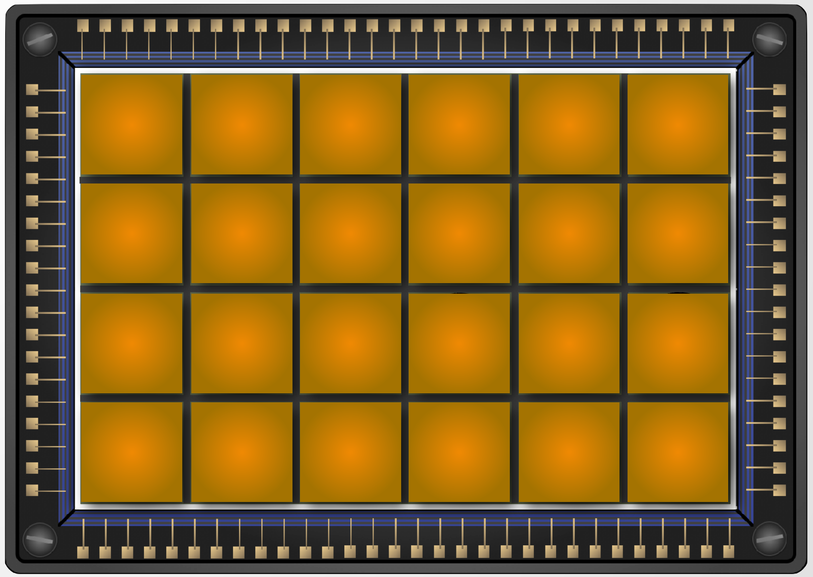
Quantity & Size

Size vs Quantity

More is better, if you need them



12 MPixels

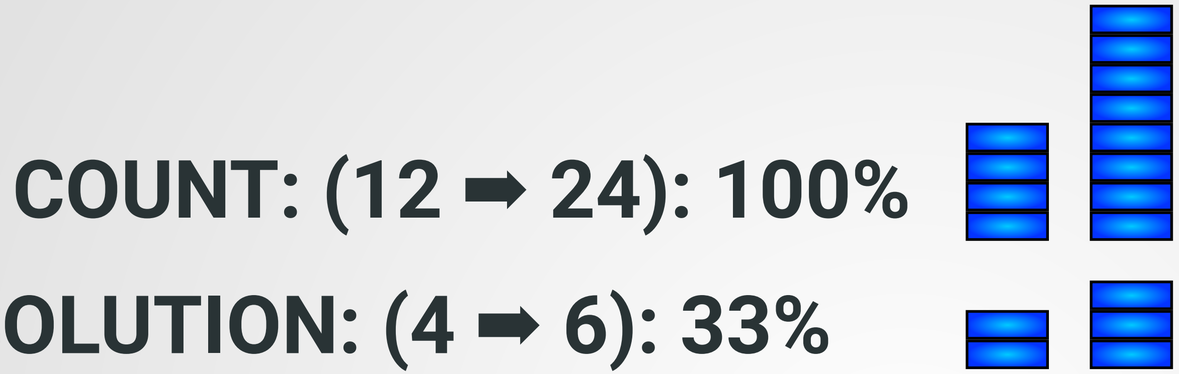


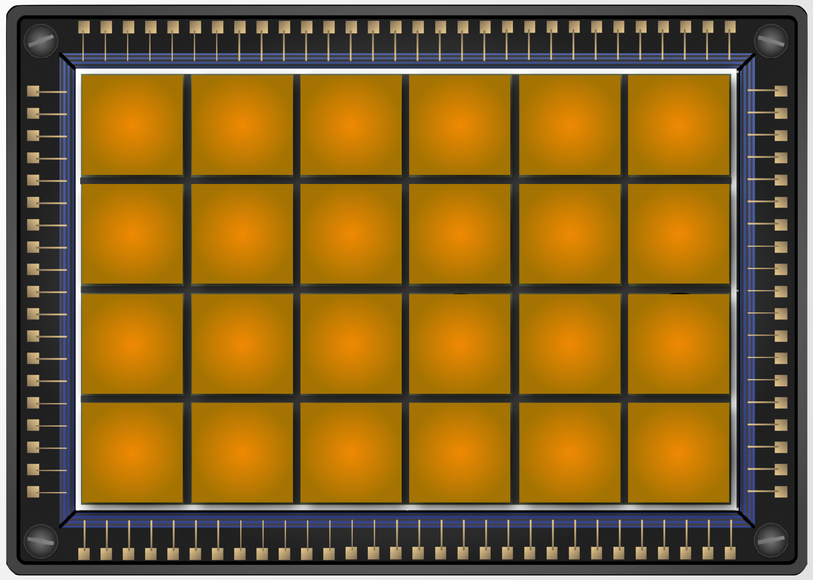
24 MPixels

Quantity & Size

PIXEL COUNT: (12 ➡ 24): 100%

RESOLUTION: (4 ➡ 6): 33%



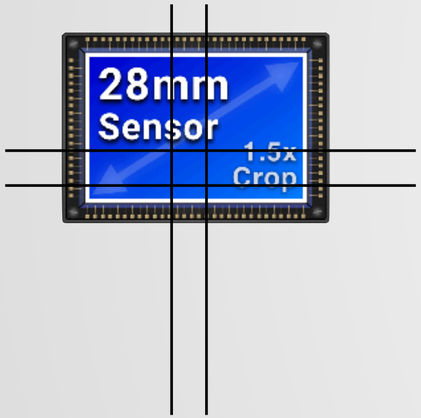


12

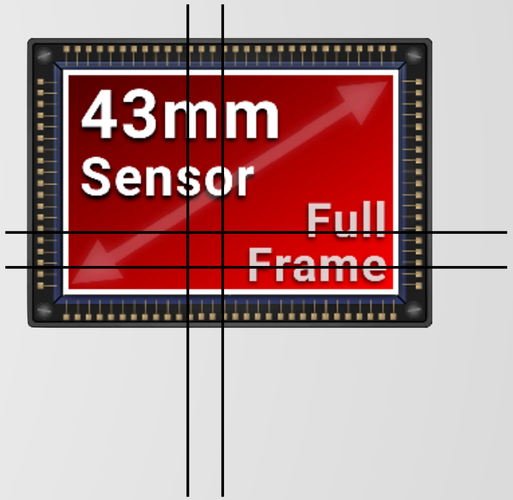
24

Pixel Size

24 MP

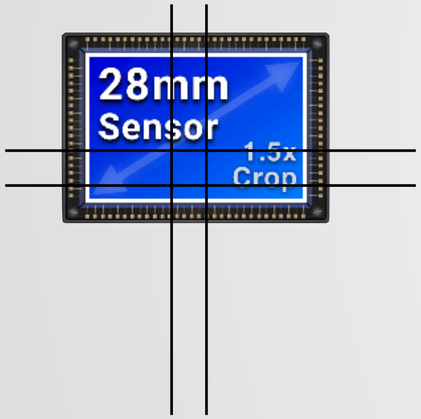


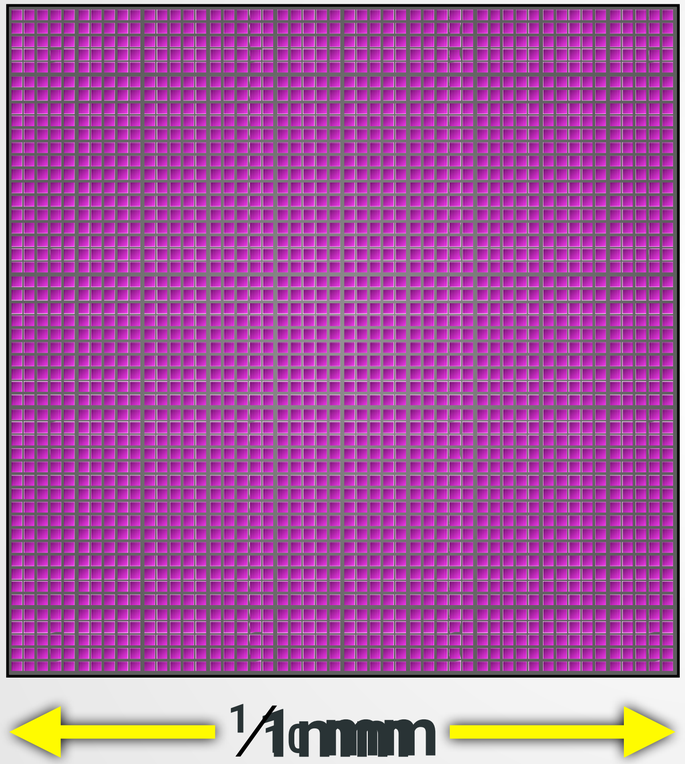
24 MP



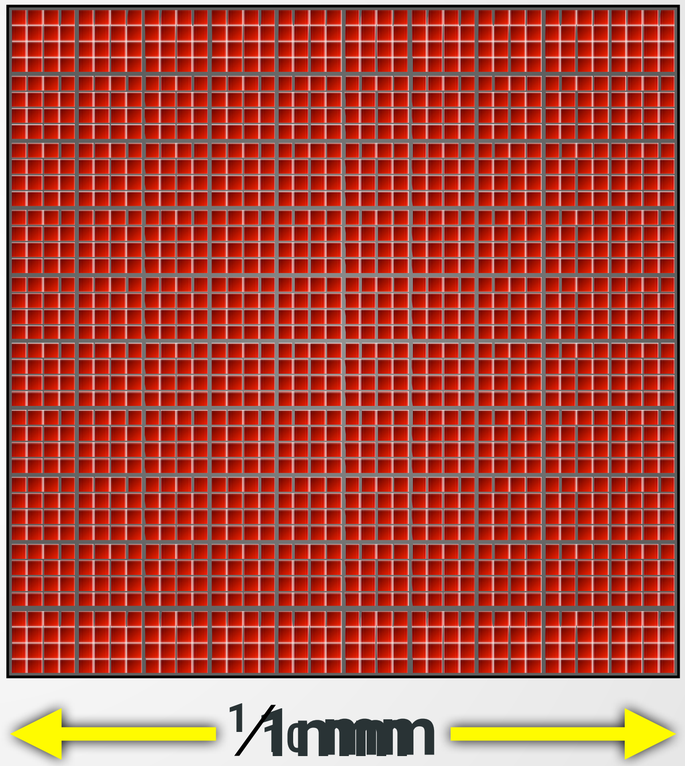
Pixel Size

24 MP



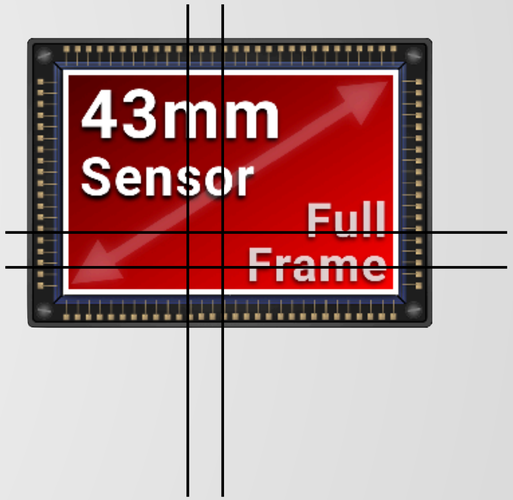


25 pixels per 1/10 mm²



16 pixels per 1/10 mm²

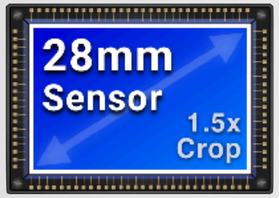
24 MP



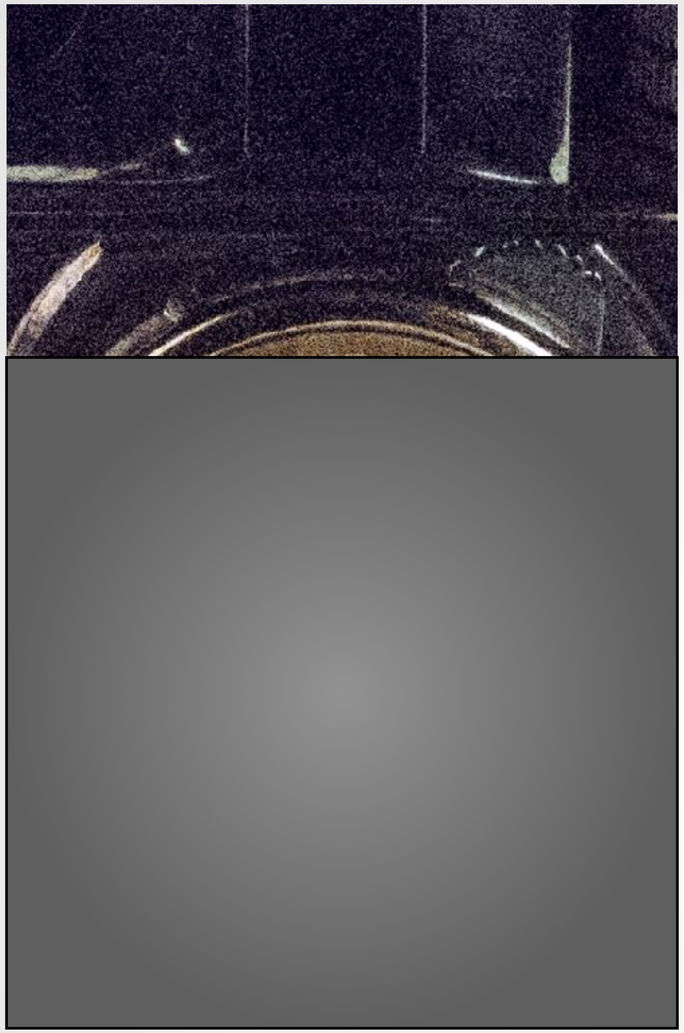
Pixel Size

ISO 25,600

24 MP



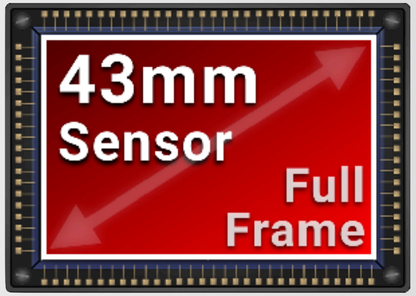
ISO 100



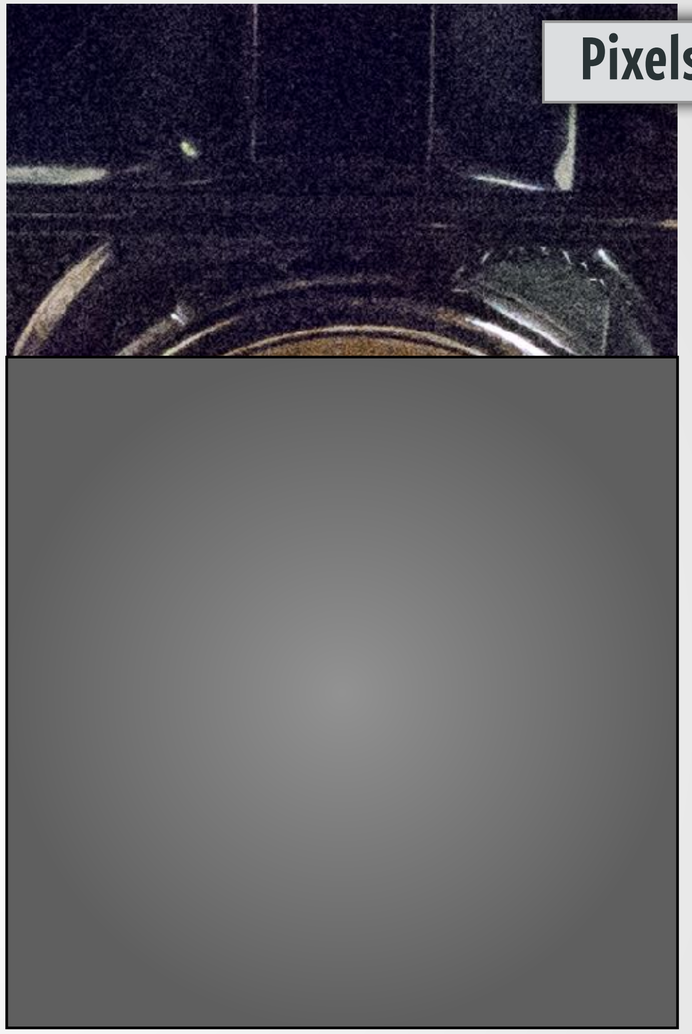
Pixels | The Sensor

ISO 25,600

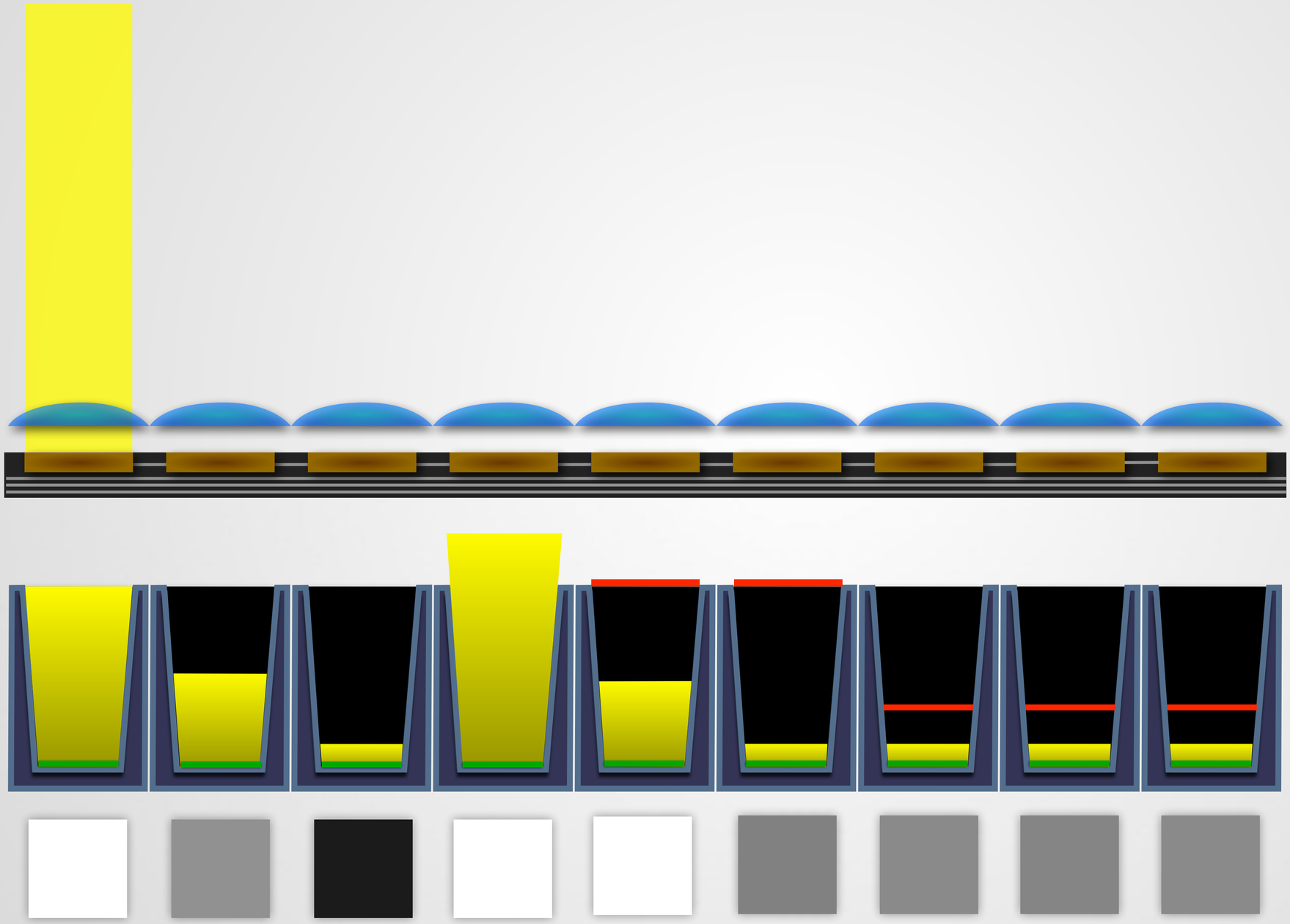
24 MP

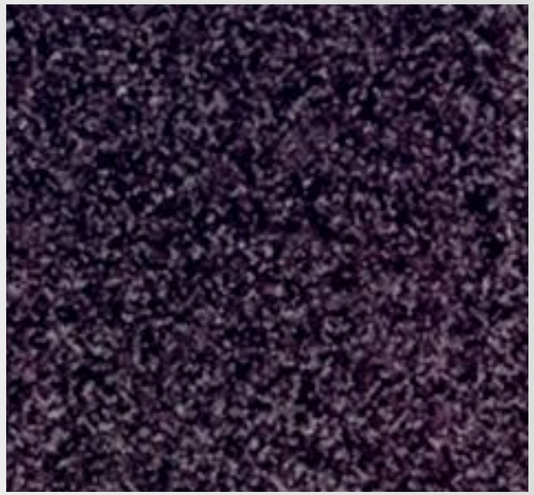


ISO 100



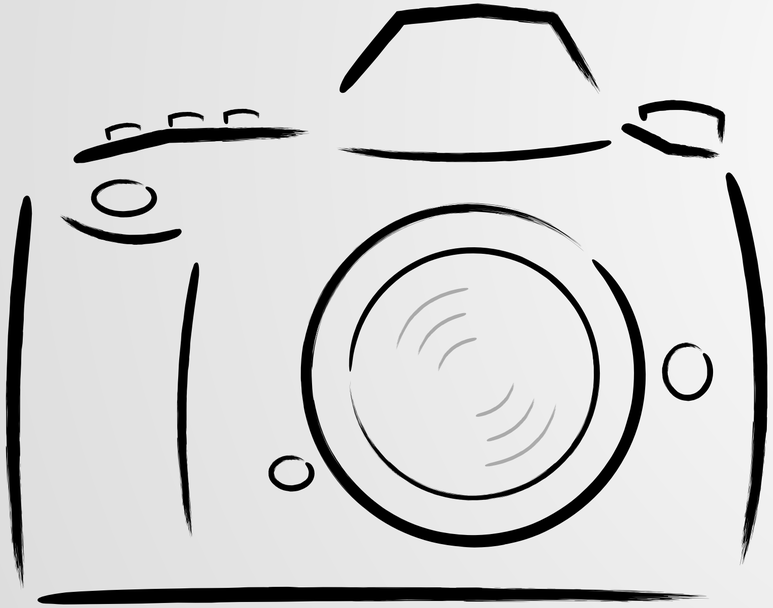
Pixel Size





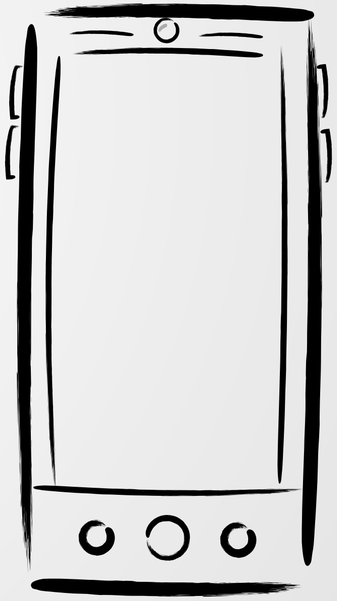
Pixel Size

Camera



VS

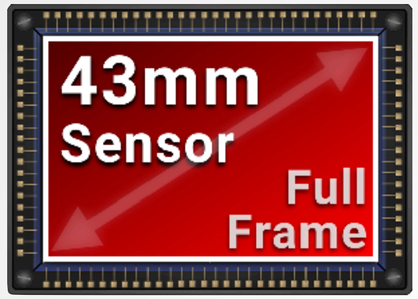
Smart Phone



Pixel Size

Sony a7R II

42 Megapixels



1/3” ‘Type’ Sensor
6mm Sensor

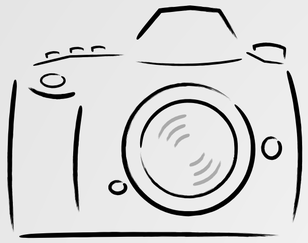
Apple iPhone X

12 Megapixels

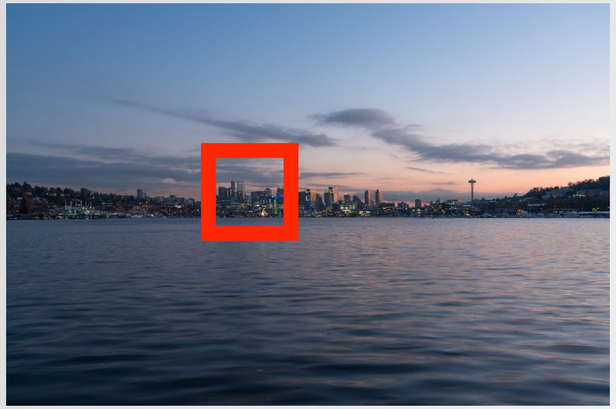
One Pixel

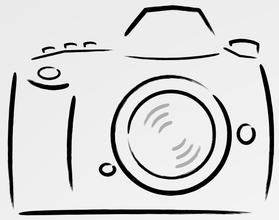
One Pixel

Pixel Size

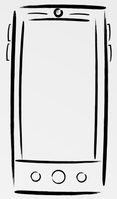


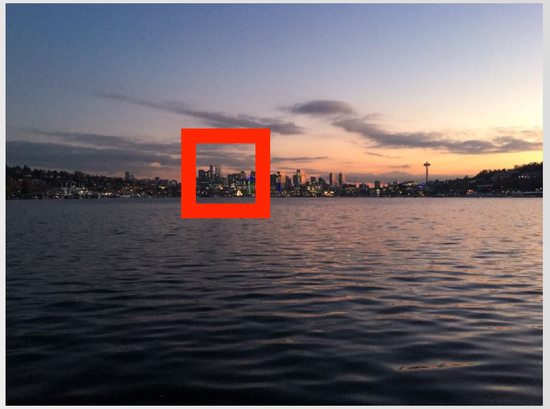
VS

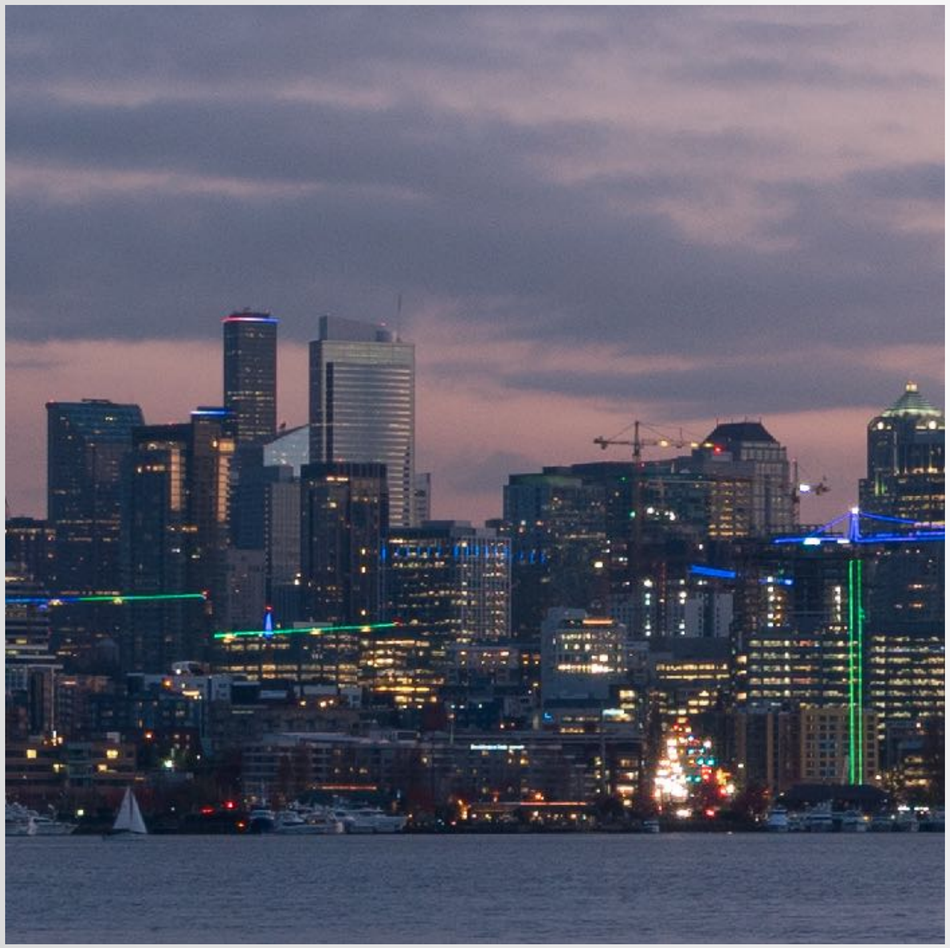


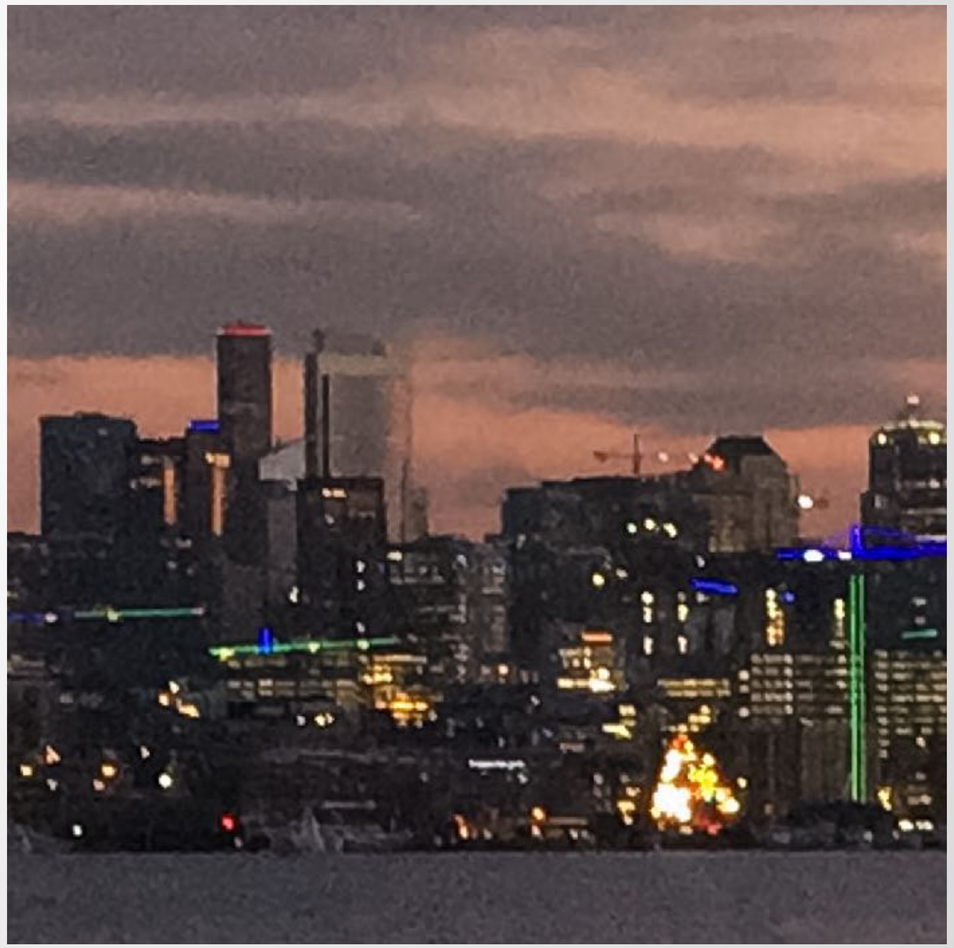


VS









SONY A7R III
42MP

CANON 5D IV
30MP

FUJI X-T2
24MP

CANON 7D II
20MP

OLYMPUS E-M1 II
20MP

SONY A7R III
42MP

CANON 5D IV
30MP

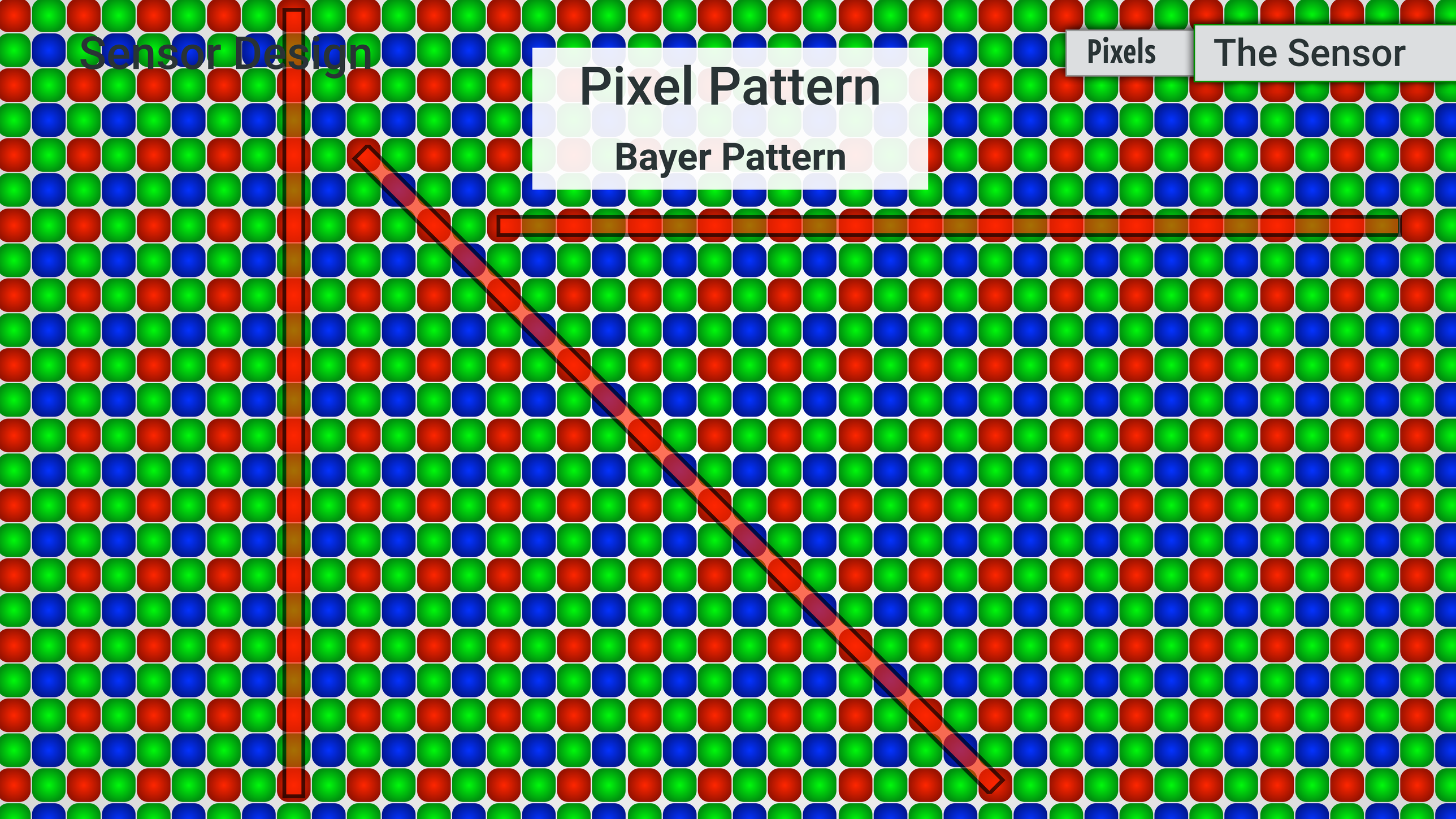
FUJI X-T2
24MP

CANON 7D II
20MP

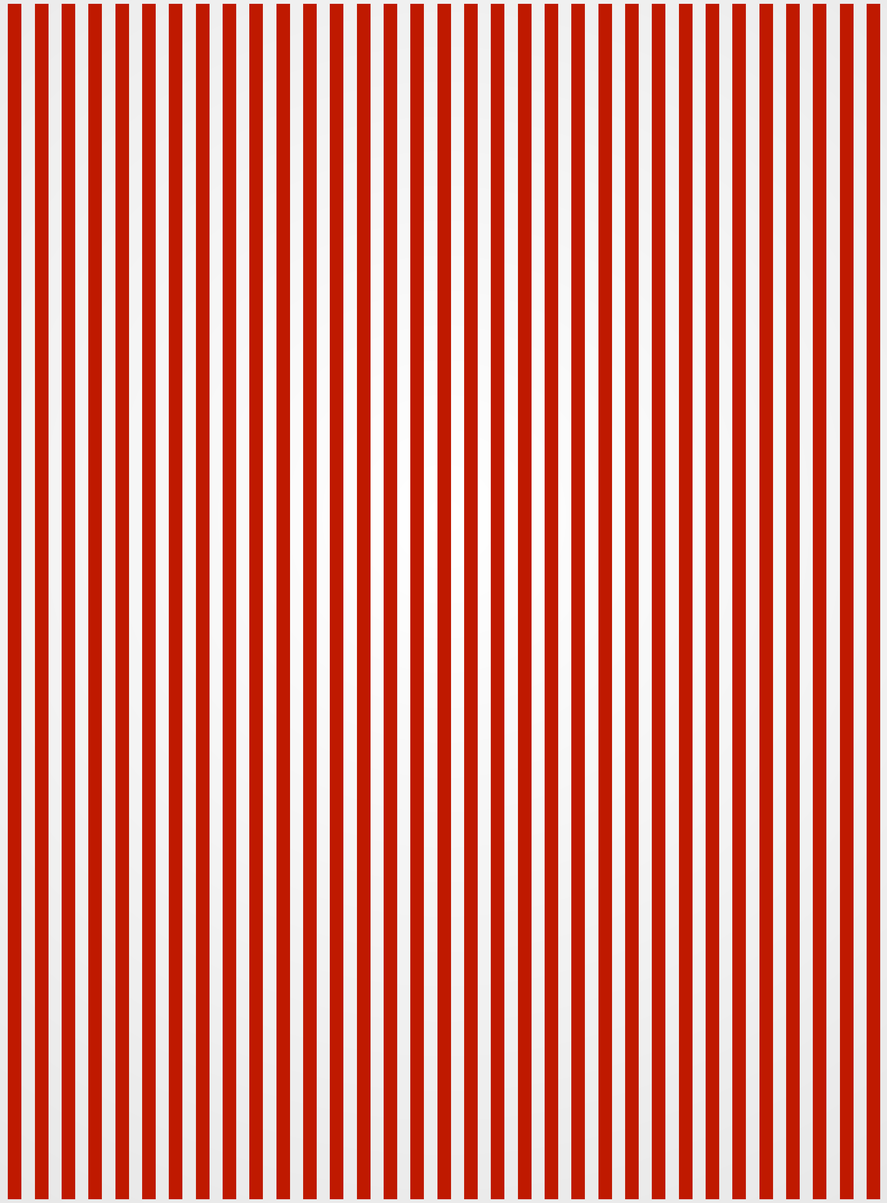
OLYMPUS E-M1 II
20MP

Pixel Pattern

Bayer Pattern



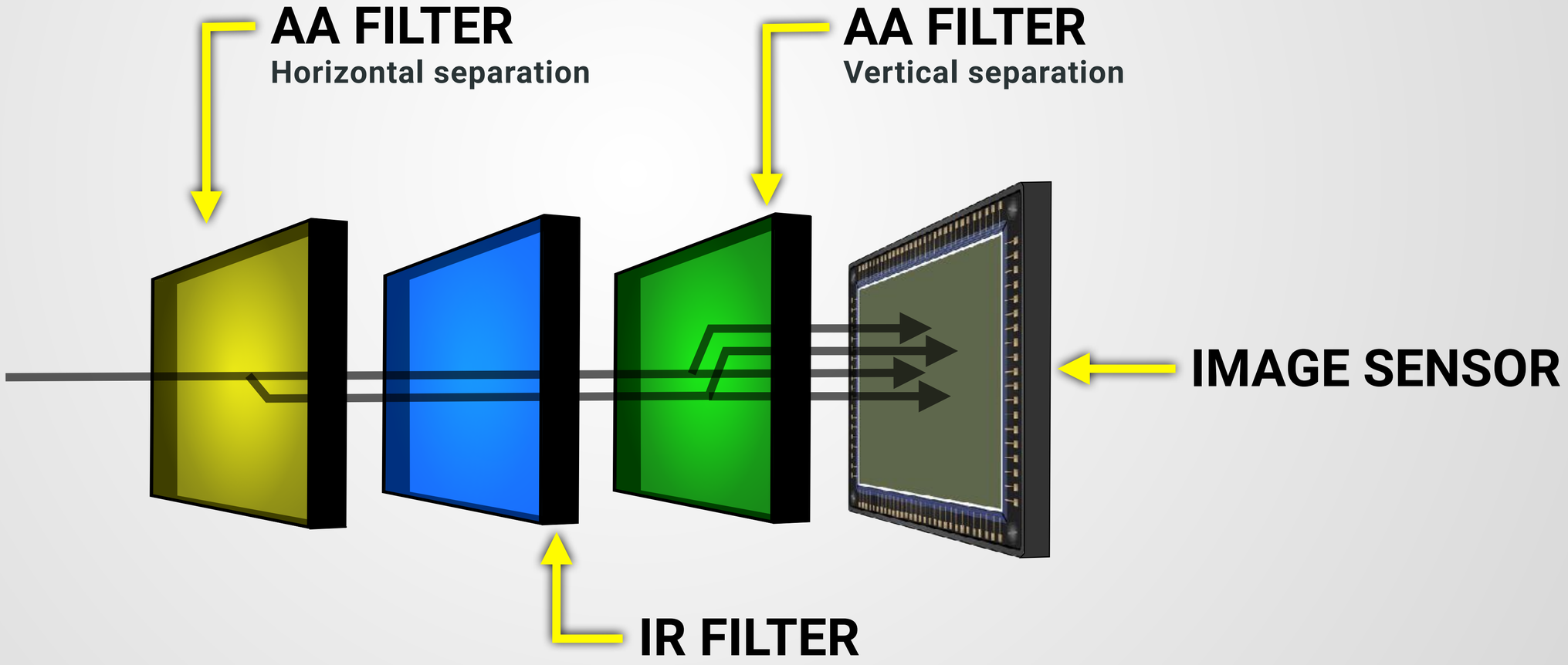
Moirè



Sensor Design

AA Filter Anti-Aliasing Filter

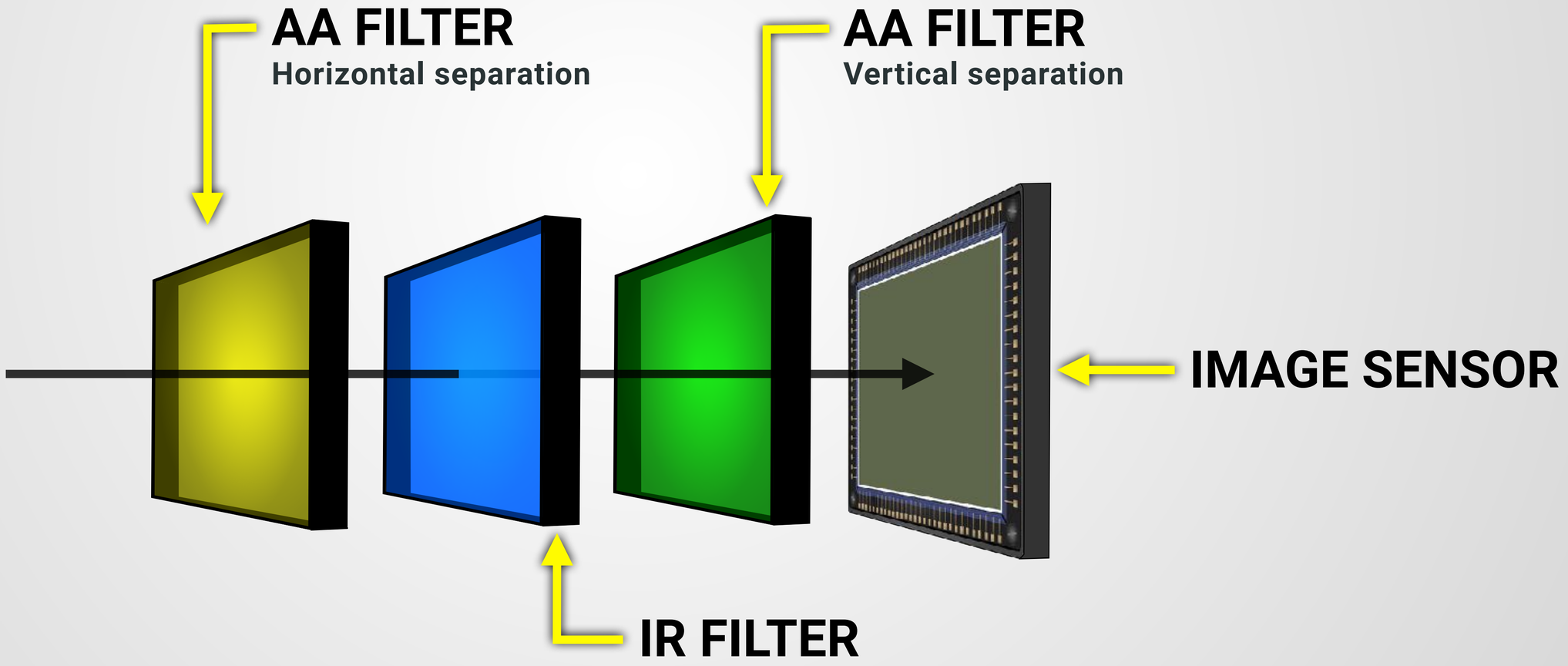
(Optical lowpass filter)



Sensor Design

AA Filter Anti-Aliasing Filter

(Optical lowpass filter)



Sensor Design

Cameras with no AA filter

Nikon
D850

Nikon
D750

Fujifilm
XT-2

Olympus
OM-D E-M1 Mark II

Nikon
D5600

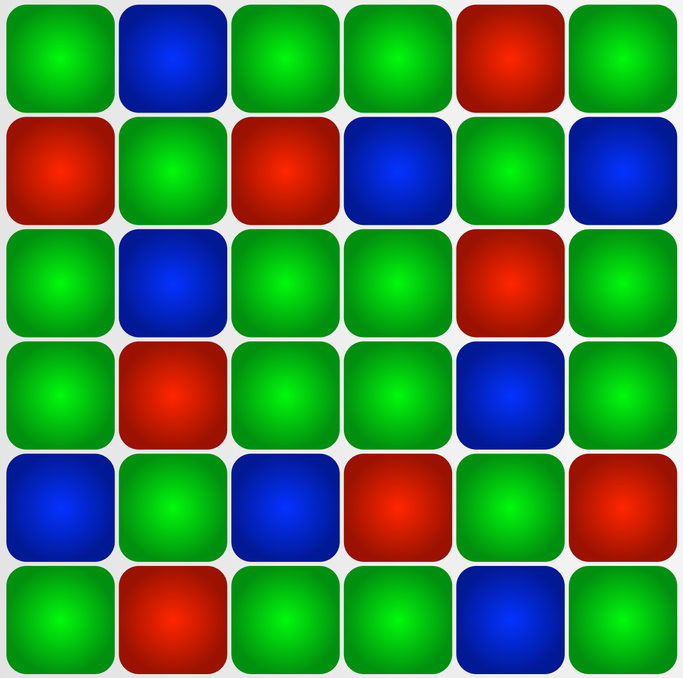
Nikon
D3400

Canon
5DSR

Sony
A7R III

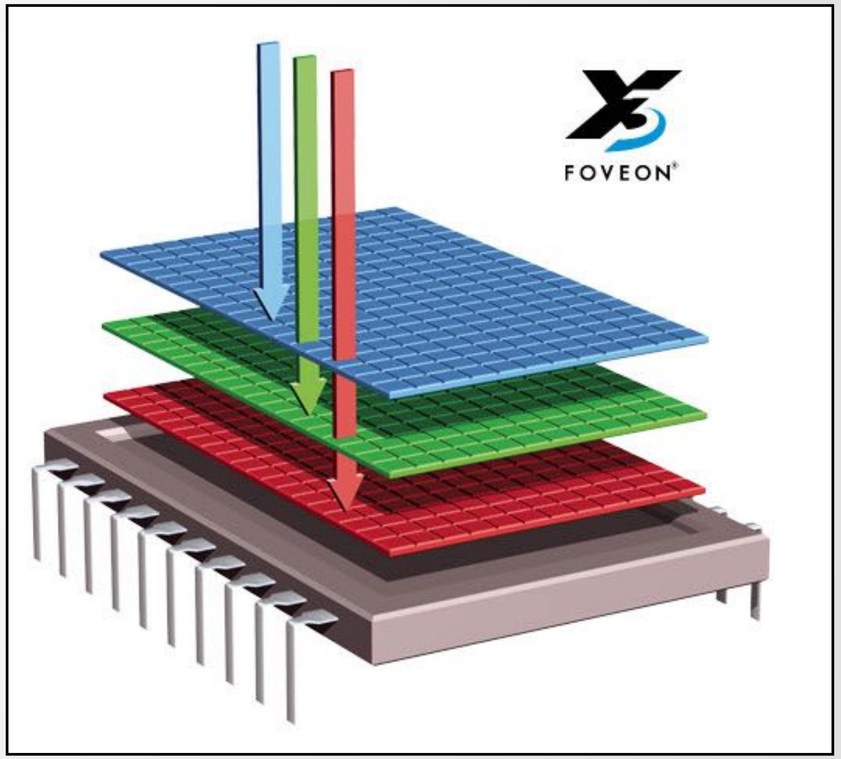
Sensor Design

FUJIFILM



X-Trans CMOS II & III sensor

SIGMA



Foveon Sensor

THE SENSOR

Pixels

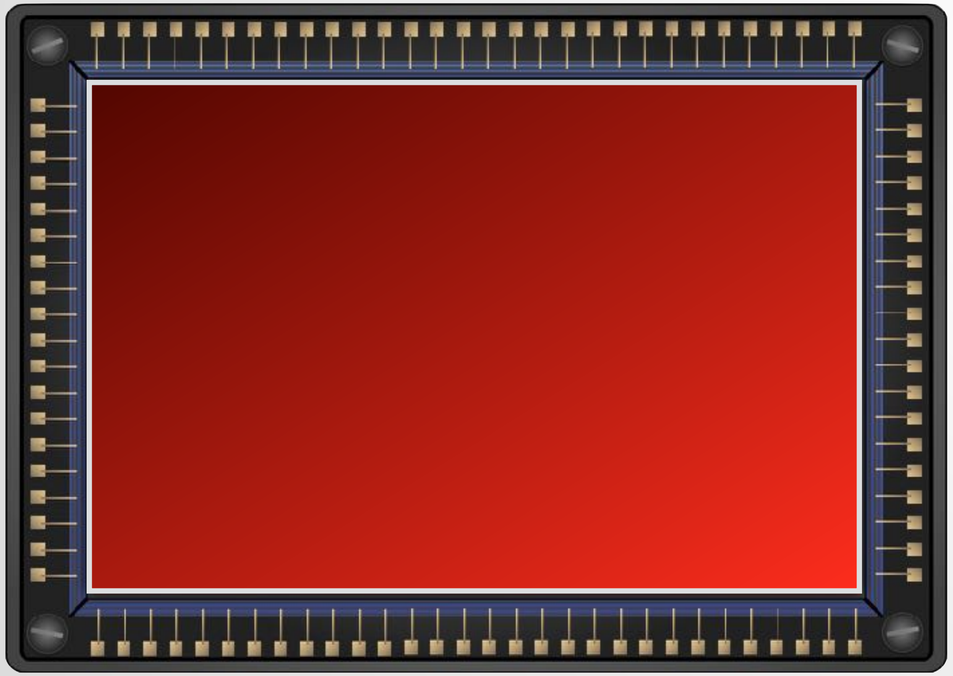
Q & A

THE SENSOR

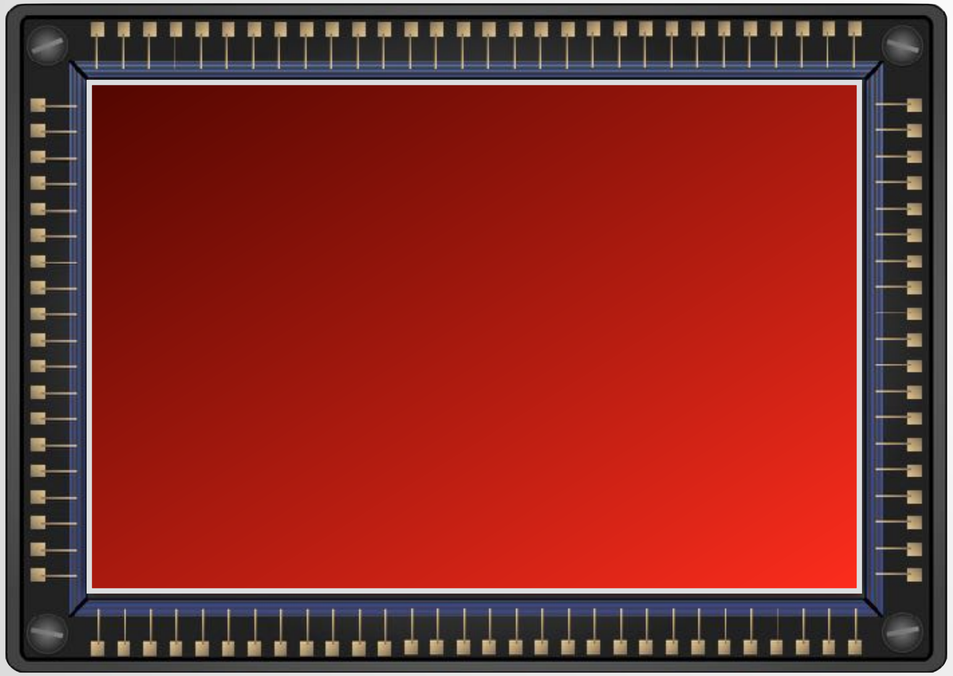
- Sensor Size
- Sensor Sizes: Compared
- Pixels
- ISO

Sensor Sensitivity = ISO

nternational rganization for tandards



Sensor Sensitivity = ISO



100 — Base/native sensitivity*

200 — 2x as sensitive as ISO 100

400 — 4x as sensitive as ISO 100

800 — 8x as sensitive as ISO 100

1600 — 16x as sensitive as ISO 100

3200 — 32x as sensitive as ISO 100

6400 — 64x as sensitive as ISO 100

*Most cameras


OPTIMUM IMAGE QUALITY
½ x Sensitivity
Full Stop
Full Stop
2 x Sensitivity
HIGH SENSITIVITY
32
50
100
200
400
800
1600
3200
6400
12800
25600
51200
102400
204800
409600
820000
1640000
3280000
125
160
⅓ STOP
1000
1250
⅓ STOP
L1
100
200
400
800
1600
3200
6400
H1
H2

Auto ISO

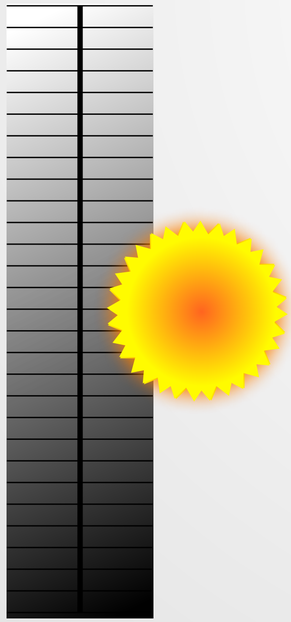
LIGHT METER

-2 • • 1 • • 0 • • 1 • • +2

Keep the Light Meter at ±0

Auto
ISO
100
200
400
800
1600
3200
6400

Bright



Dark

Auto ISO

LIGHT METER

-2 • • 1 • • 0 • • 1 • • +2

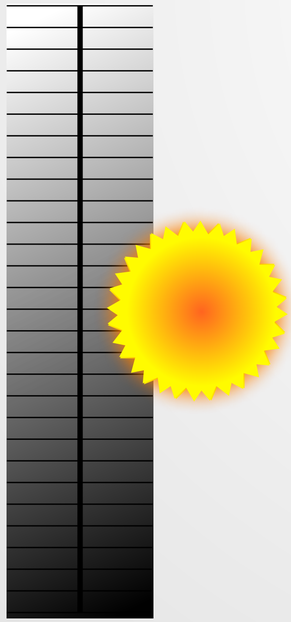
Keep the Light Meter at ±0

Auto
ISO
100
200
400
800
1600
3200
6400

Auto
Shutter Speeds
8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1″
2″
4″
8″
15″
30″

Minimum Shutter Speed

Bright



Dark

Auto ISO

LIGHT METER

-2 • • 1 • • 0 • • 1 • • +2

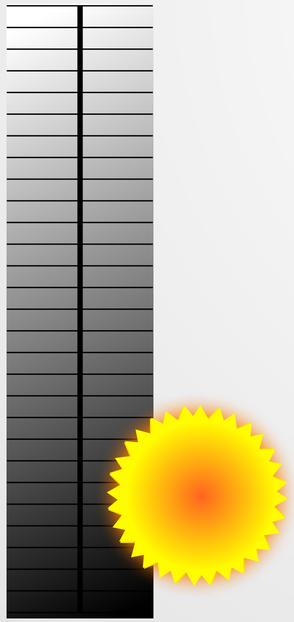
Keep the Light Meter at ±0

Auto
ISO
100
200
400
800
1600
3200
6400

Auto
Shutter Speeds
8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1″
2″
4″
8″
15″
30″

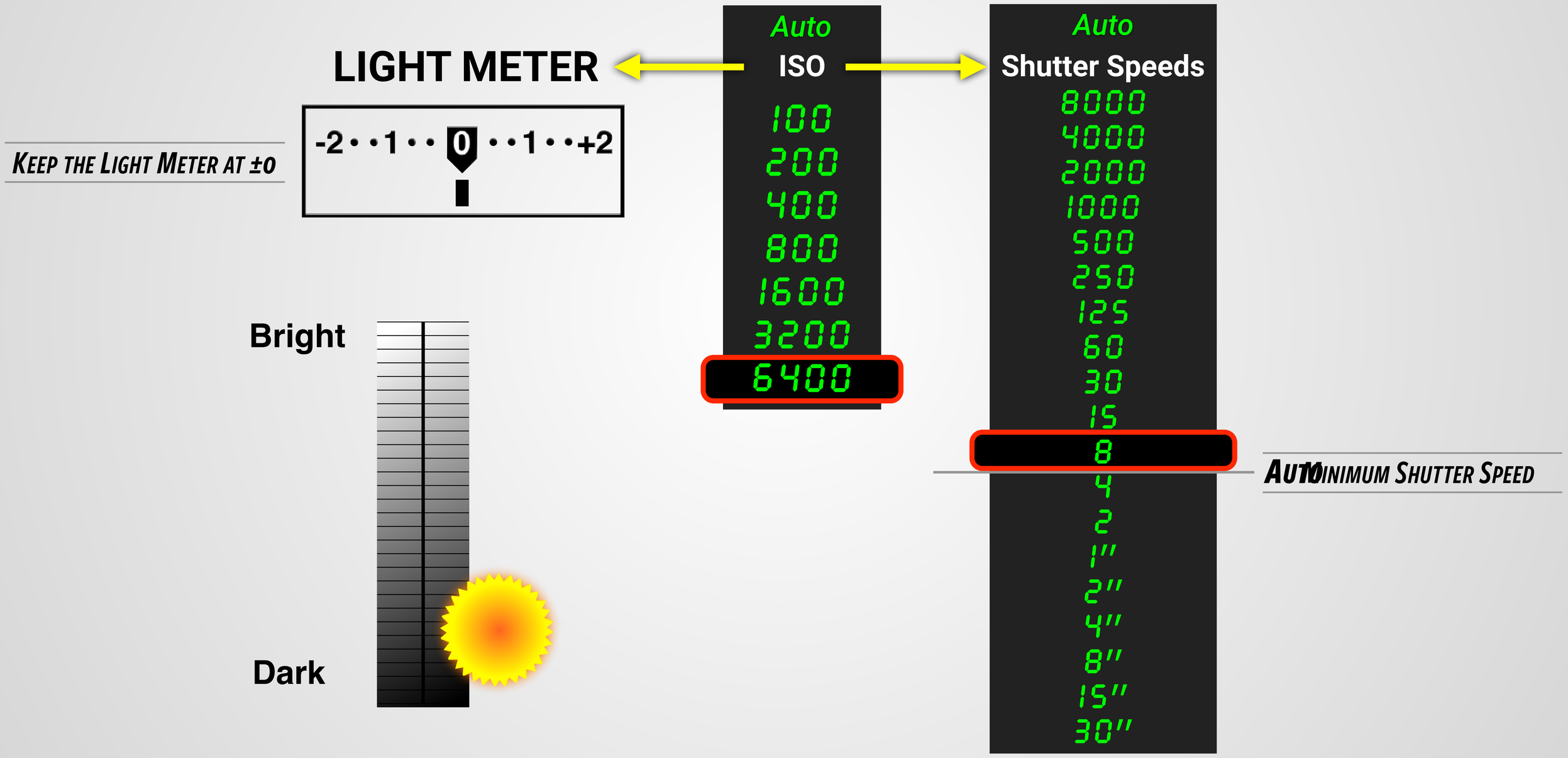
Minimum Shutter Speed

Bright



Dark

Auto ISO


LIGHT METER
-2 • • 1 • • 0 • • 1 • • +2
KEEP THE LIGHT METER AT ±0
Auto
ISO
100
200
400
800
1600
3200
6400
Auto
Shutter Speeds
8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1"
2"
4"
8"
15"
30"
AUTO MINIMUM SHUTTER SPEED
Bright
Dark

Auto ISO

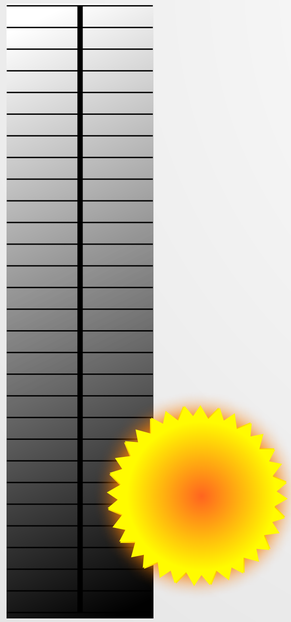
LIGHT METER

-2 • • 1 • • 0 • • 1 • • +2

Keep the Light Meter at ±0

Bright

Dark



Auto ISO
100
200
400
800
1600
3200
6400

Auto Shutter Speeds
8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1″
2″
4″
8″
15″
30″

Auto Minimum Shutter Speed

24-120mm

Auto ISO

LIGHT METER

-2 • • 1 • • 0 • • 1 • • +2

Keep the Light Meter at ±0

Auto ISO
100
200
400
800
1600
3200
6400

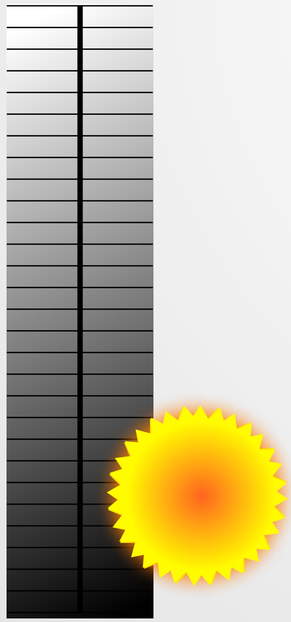
Auto Shutter Speeds
8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1″
2″
4″
8″
15″
30″

24-120mm

Auto Minimum Shutter Speed

Bright

Dark

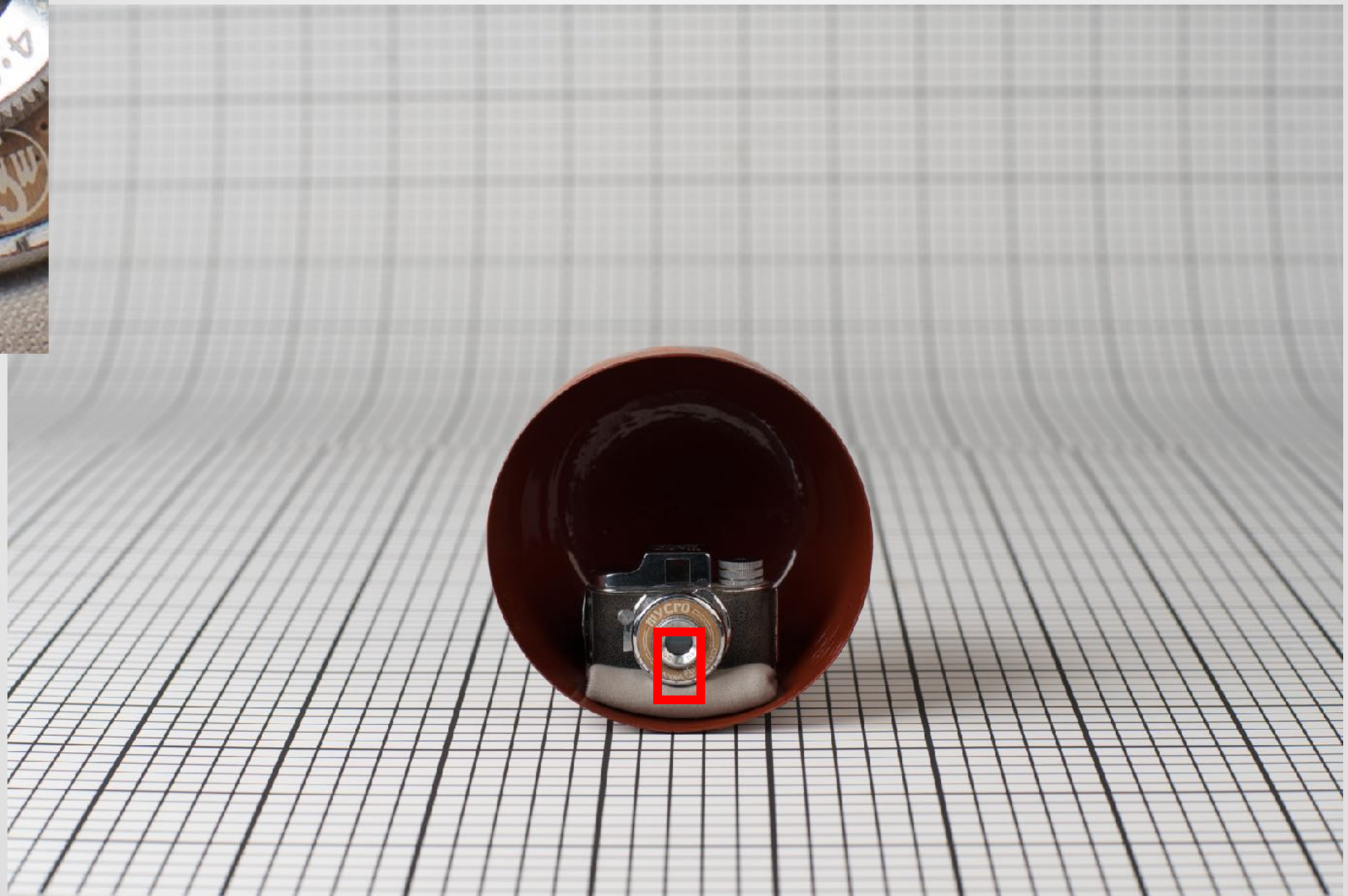


Auto ISO
Minimum Shutter Speed

Slower — Faster

− | | | 0 | | | +


4.5 F=20
ANWA


MYCRO

ISO 50

ISO 100

ISO 200

ISO 400

ISO 800

ISO 1600

ISO 3200

ISO 6400

ISO 12,800

ISO 25,600

ISO 51,200

ISO 102,400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

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100

200

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6400

ISO

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200

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200

400

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6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400


ISO
100
200
400
800
1600
3200
6400

ISO

100
200
400
800
1600
3200
6400

ISO

100

200

400

800

1600

3200

6400

ISO

100

200

400

800

1600

3200

6400

12800

ISO

100

200

400

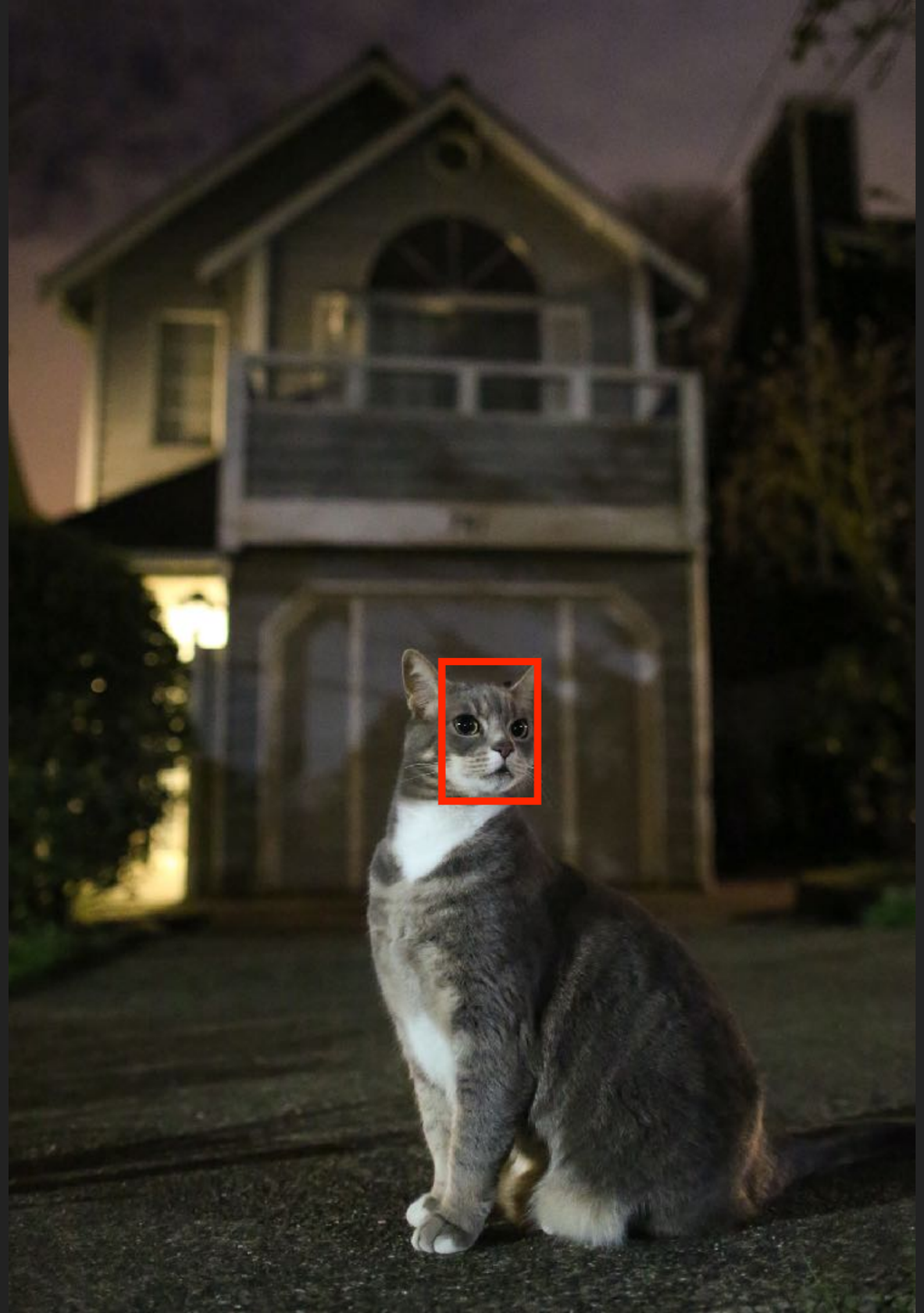
800

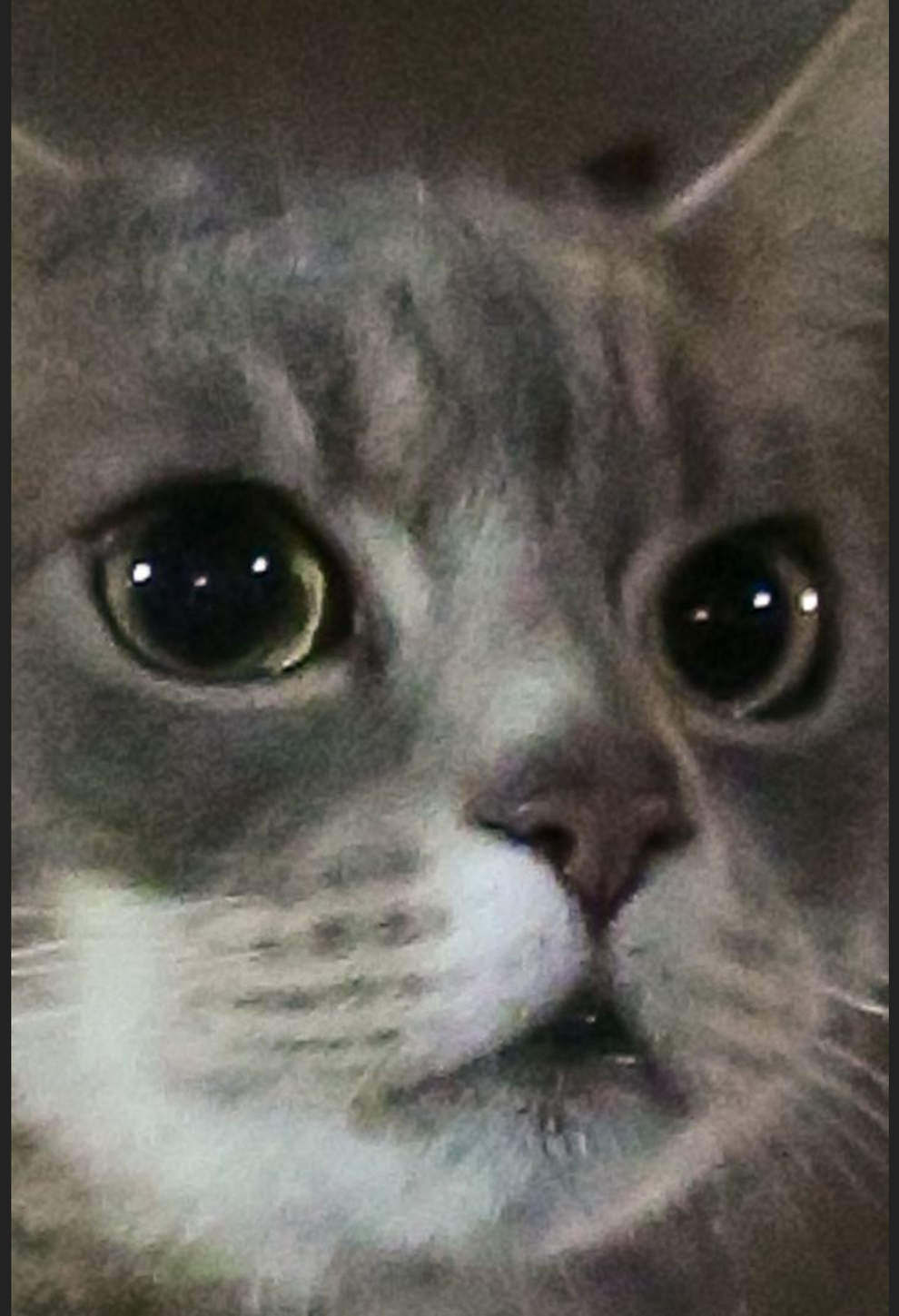
1600

3200

6400

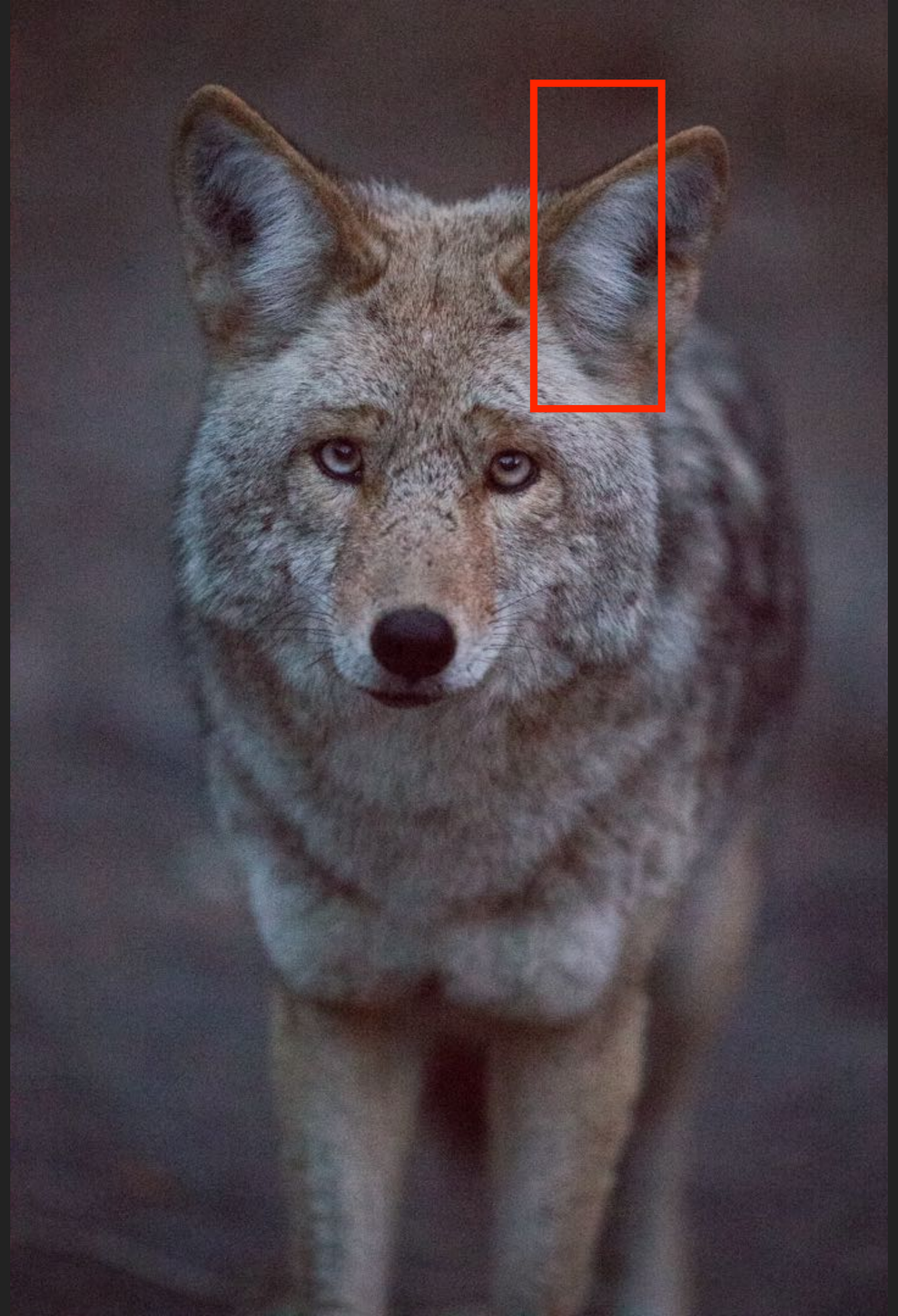
12800



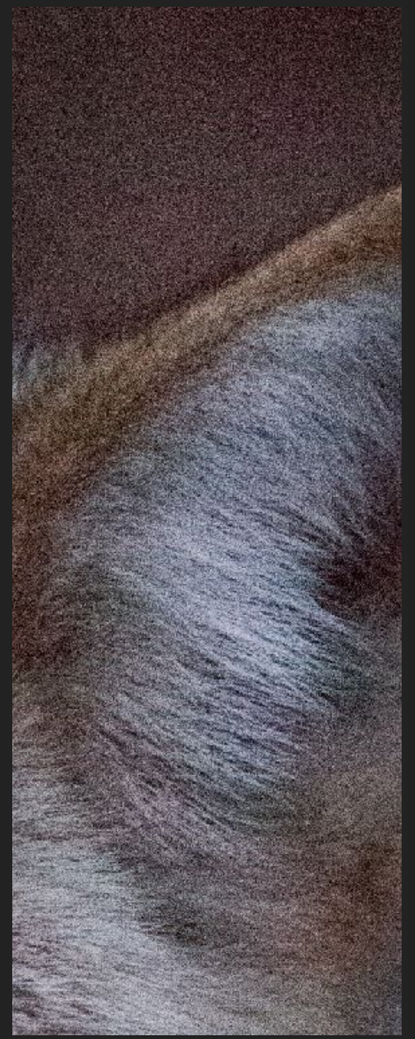


ISO

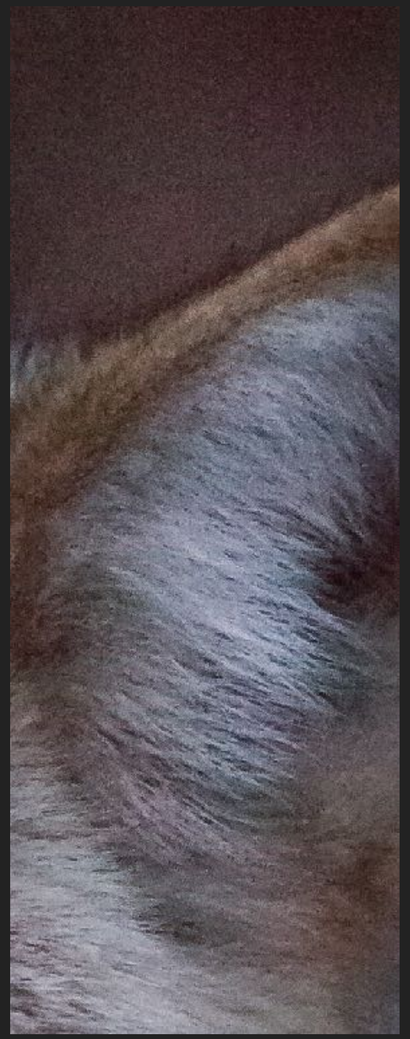
100
200
400
800
1600
3200
6400
12800
25600



Original RAW



Noise Reduction



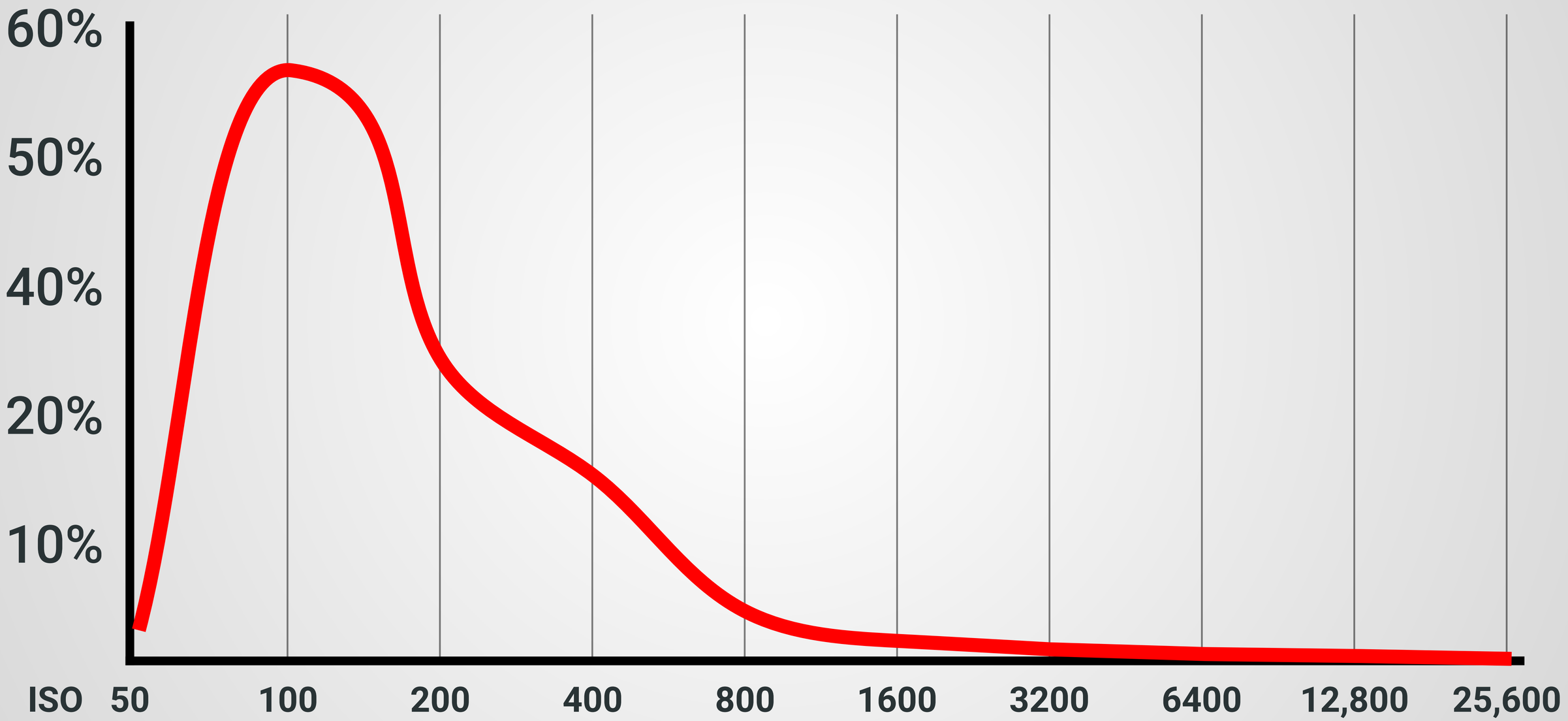
Q. *With what type of subject, does ISO not matter?*

A. *None**

*Small image size will hide noise

ISO

The Sensor



ISO Guidelines

1. Keep the ISO low
2. Raise the ISO for...
   - faster shutter speeds

Technical

Optimum Quality

High Sensitivity

Learning Project 3

ISO test

THE SENSOR

Q&A

Sensor Size
Sensor Size: Compared
Pixels
ISO

Tanzania & Kenya Safari 2018

- Ngorongoro Crater, Serengeti, Masa Mara
- 10 participants max
- AUG. 6-17, 2018

More info at johngreengo.com

Tanzania & Kenya Safari 2018

August 6-17, 2018

New Tour Announcement

Wednesday January 24

JOHN GREENGO | PHOTOGRAPHY

www.johngreengo.com

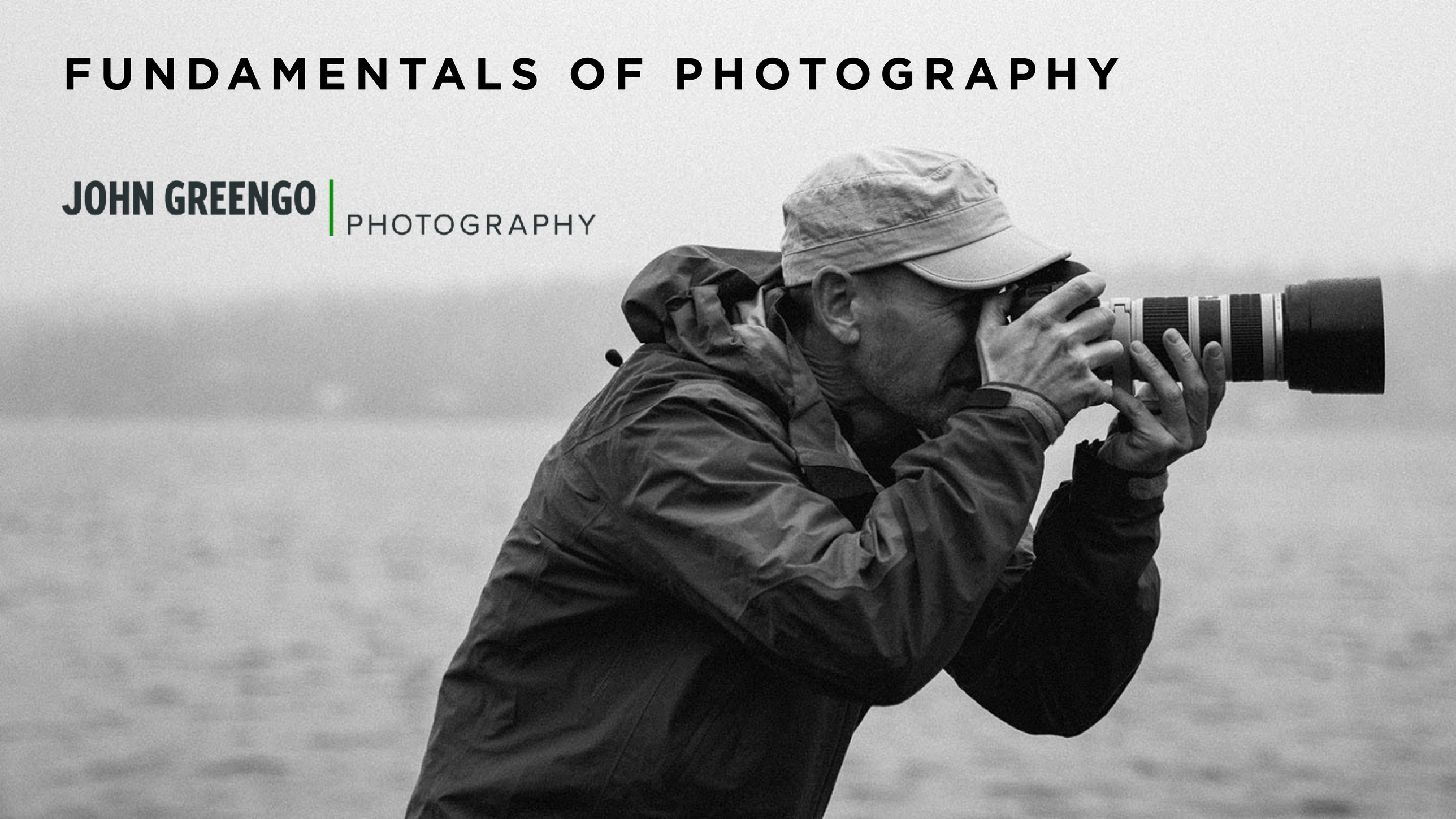
John Greengo Photography

@john_greengo

FUNDAMENTALS OF PHOTOGRAPHY

FUNDAMENTALS OF PHOTOGRAPHY

JOHN GREENGO | PHOTOGRAPHY



JOHN GREENGO | PHOTOGRAPHY