Things You Can or Can't Fix in Post: Video Acquisition

You Can Fix *Anything* in Post

If whole characters can be created (and an actor's legs atrophied) in computers, it must be possible to fix *anything* that is not live in post

Questions?

You Can Fix Anything in Post *only* with enough time & money

Acquisition Starts the Chai

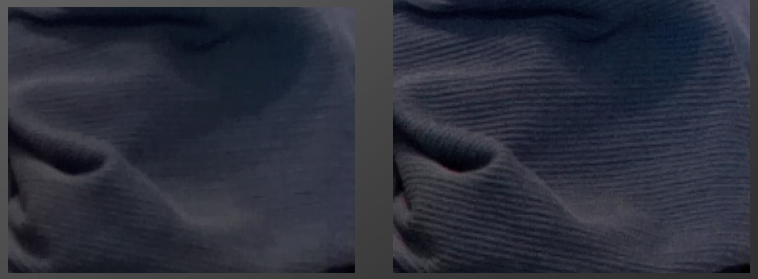
- Affects everything that follows
  - problems should be fixed there (if possible)
- Isn't just cameras
  - lighting, lenses, filters, & even mounts play major roles
- Affected more by operator actions than by most camera characteristics
  - lighting, lens adjustments, processor settings, etc.
- Sharpness affected by contrast as well as resolution
  - contrast affected by diffraction and lenses

Which Camera Looks Better?

1

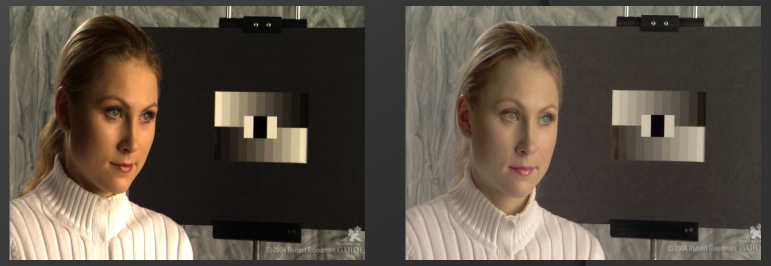
2

3



4

5



Credits:
1 – Dave.Hulick, attribution required
2 – lowel.com
3 – cambridgeincolour.com
4 – tiffen.com
5 – Goodman's Guides

Same Camera & Lens in Each Pair

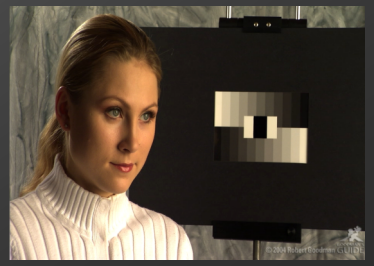
1

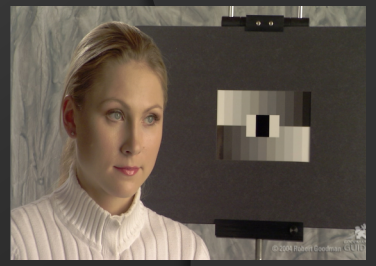
2

3

4

5

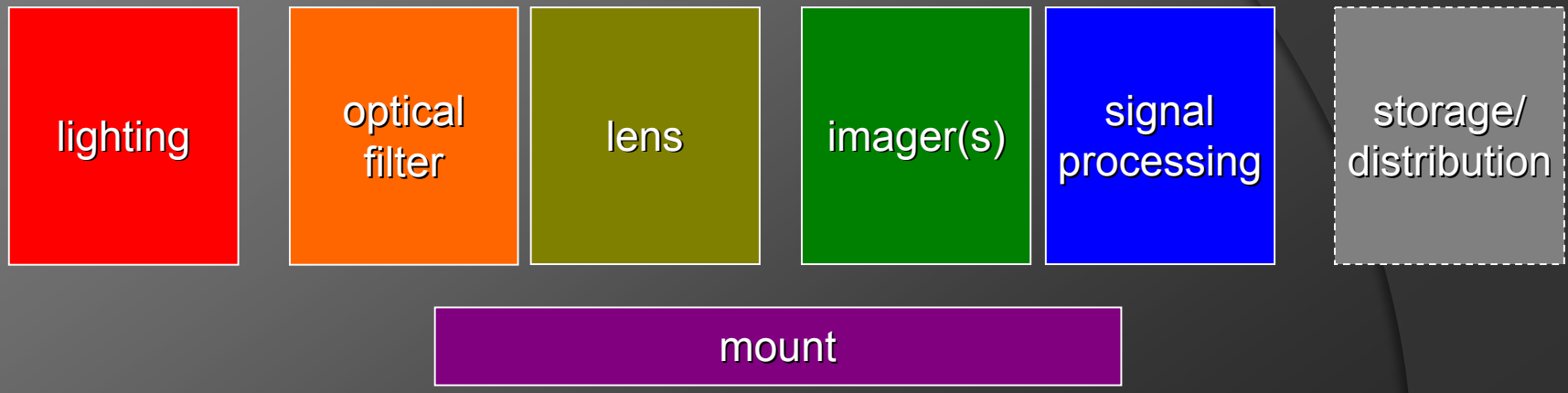




1 – stability
2 – lighting
3 – aperture

4 – filter
5 – settings

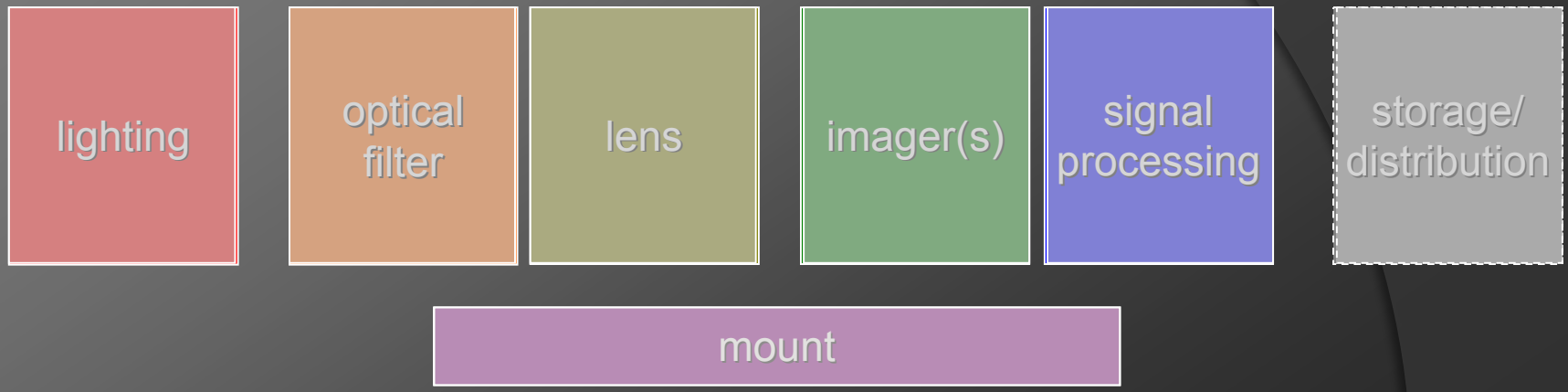
Video Acquisition: It's *Not* Just Cameras



lighting: *huge* effect on final image
optical filter: reduction of post, but…
lens: design, focal length, aperture, etc.
imagers: quantity, type, design, size
signal processing: many parameters
mount: image stability, camera motion

storage/distribution: no effect (*except* money, time, size, weight, life, labor, labeling, reliability, audibility and, ultimately, quality)

Most Important Acquisition Resource



operator(s)

light, position, zoom, focus, pan, tilt, filter, iris, paint, etc.

Storage

less rest?

not great for labels

not great for hand-held

Mounts – the Problem

courtesy of Aseem Agarwala, Adobe

Mounts – Fixed in Post?

courtesy of Aseem Agarwala, Adobe

Mounts – Not Exactly “Fixed”

Wher
the re
the pict

chang
frami
reduc
deta

INPUT

OUTPUT

courtesy of Aseem Agarwala, Adobe

Lighting – Start of Acquisition

http://lowel.com/edu/

LEDs: “Green,” Portable, and Effects

Litepanels

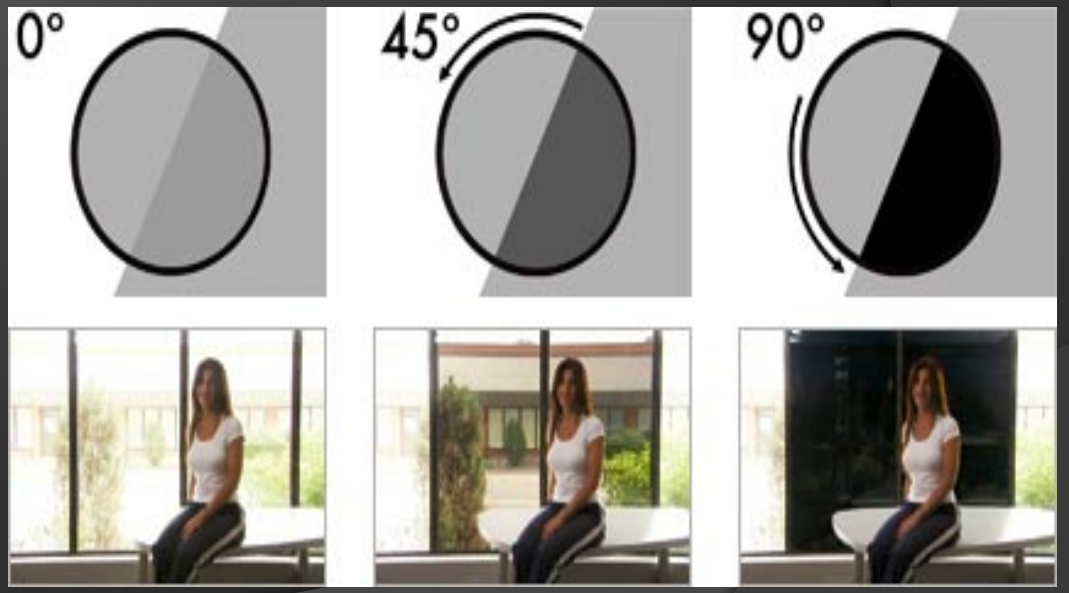
DataVideo

And Don’t Forget Shade

Lastolite reflectors

Rosco View

available light
can be controlled



Filters – Try Doing *This* in Post

Tiffen UltraPol

Filters: On the Other Hand…

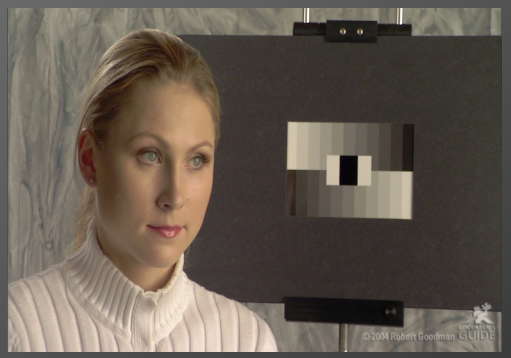
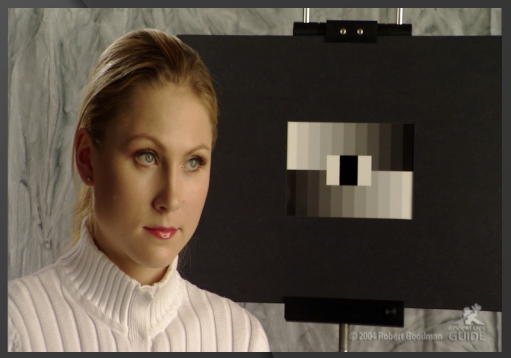
Tiffen Pro-Mist 3

Tiffen DFX (et al.) for non-live

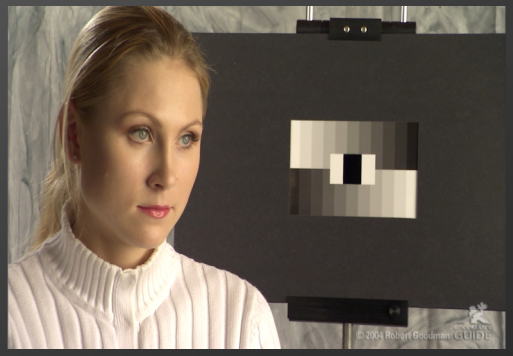
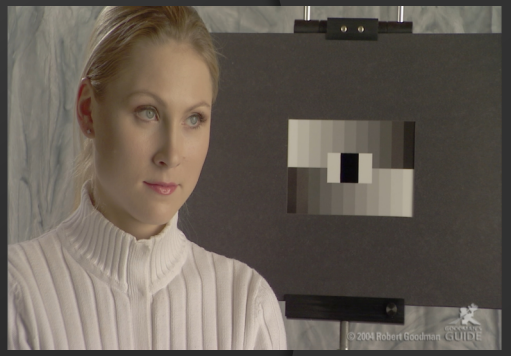
Processor Settings: Camera or Post

RAW Question:
Would iris, lighting, makeup, hair, and costume change?

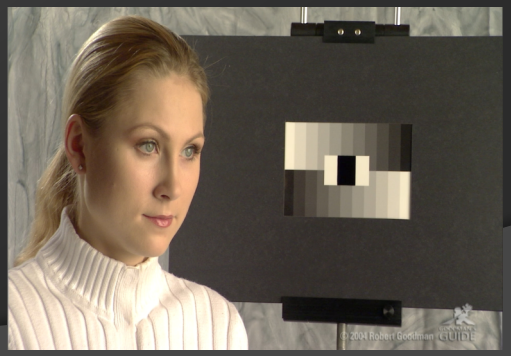
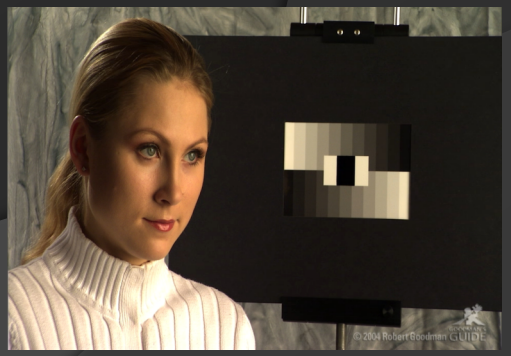
Black Stretch +3, -3

Dynamic Level 200, 500

Master Gamma .35, .75

from *Goodman's Guide to the Panasonic Varicam,* by Robert Goodman, AMGMedia Publishers

What's Left?

Aiptek AHD-1
<$80 list

Sony SRW9000PL
"price on request"
camera part ~$250,000

Lens Range

Fujinon TF15DA-8
1.5 inches long
0.1 lb.

optical
image
stabilization

38.2 inches long, 85 lbs.

Similar Range

Canon XJ23x7
20.6 inches long
42.5 lbs
f/1.6 to 132 mm

Canon HJ22x7.6
8.7 inches long
4 lbs.
f/1.8 to 114 mm

Even Closer

Canon XJ22x7.3
13.2 inches long
13.4 lbs
f/1.8 to 111 mm

Canon HJ22x7.6
8.7 inches long
4 lbs.
f/1.8 to 114 mm

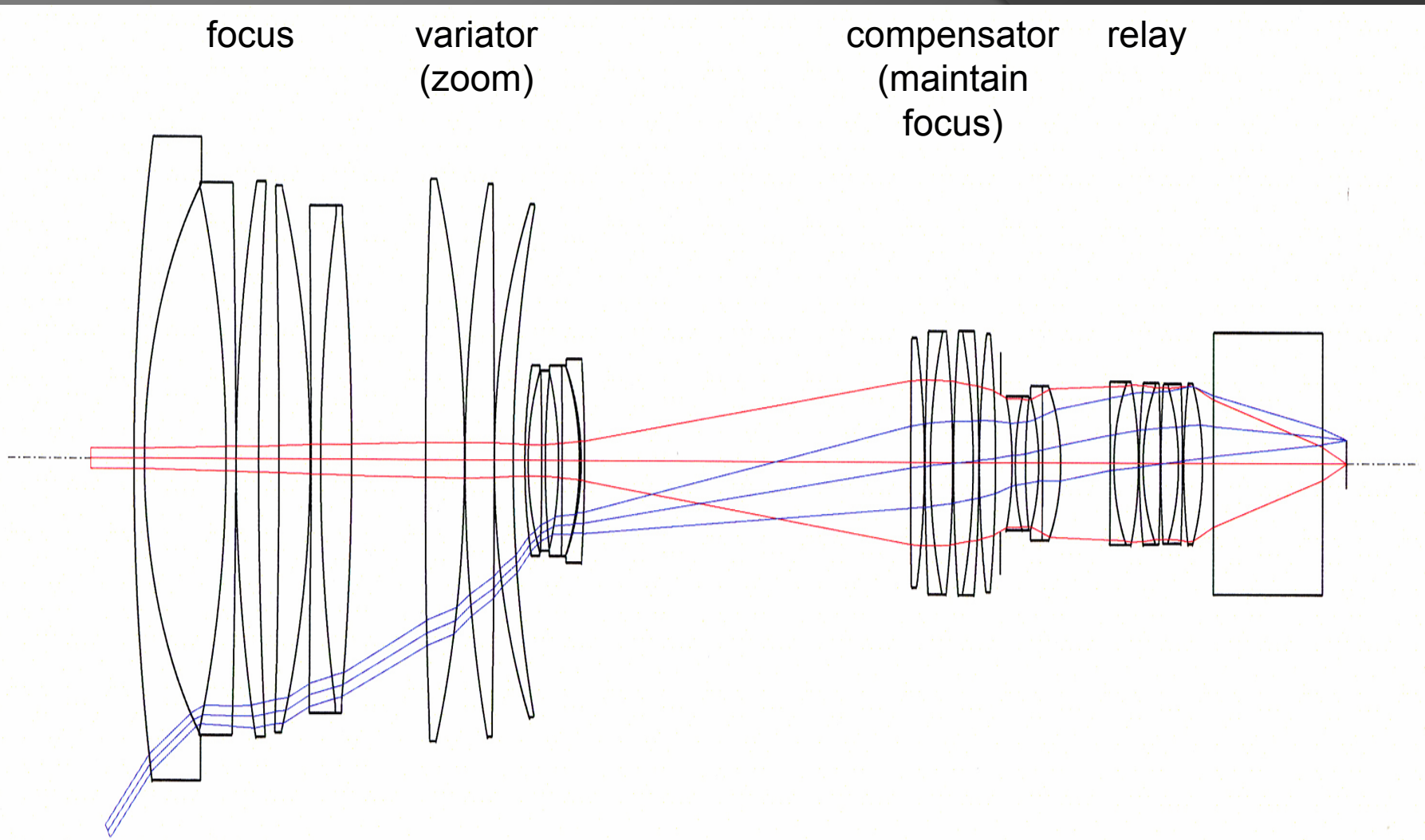
Even Closer

current B&H $54,625

Canon XJ22x7.3
13.2 inches long
13.4 lbs
f/1.8 to 111 mm

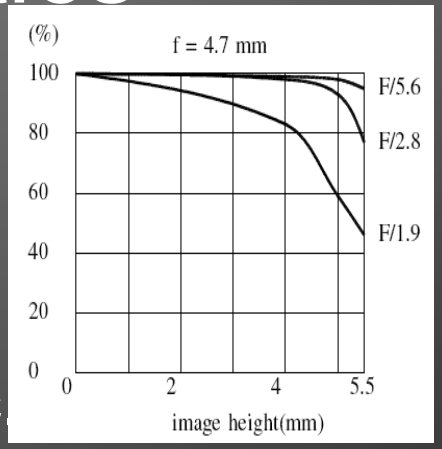
current B&H $31,050

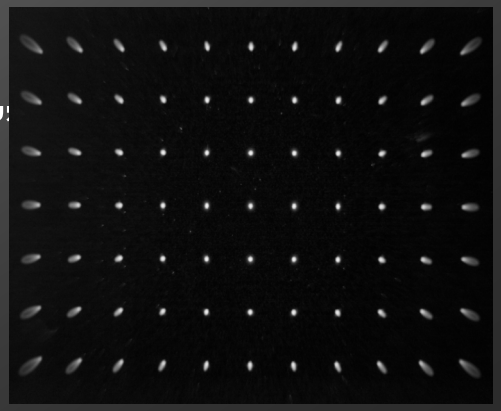
Canon HJ22x7.6
8.7 inches long
4 lbs.
f/1.8 to 114 mm


focus
variator
(zoom)
compensator
(maintain
focus)
relay

Little-Discussed Lens Characteristics

- Uniformity
- "Defects"
  - Flare, Ghosts, Vignetting, etc.
- Aberrations
  - "Defocusing"
- MTF
  - Resolution
  - Contrast



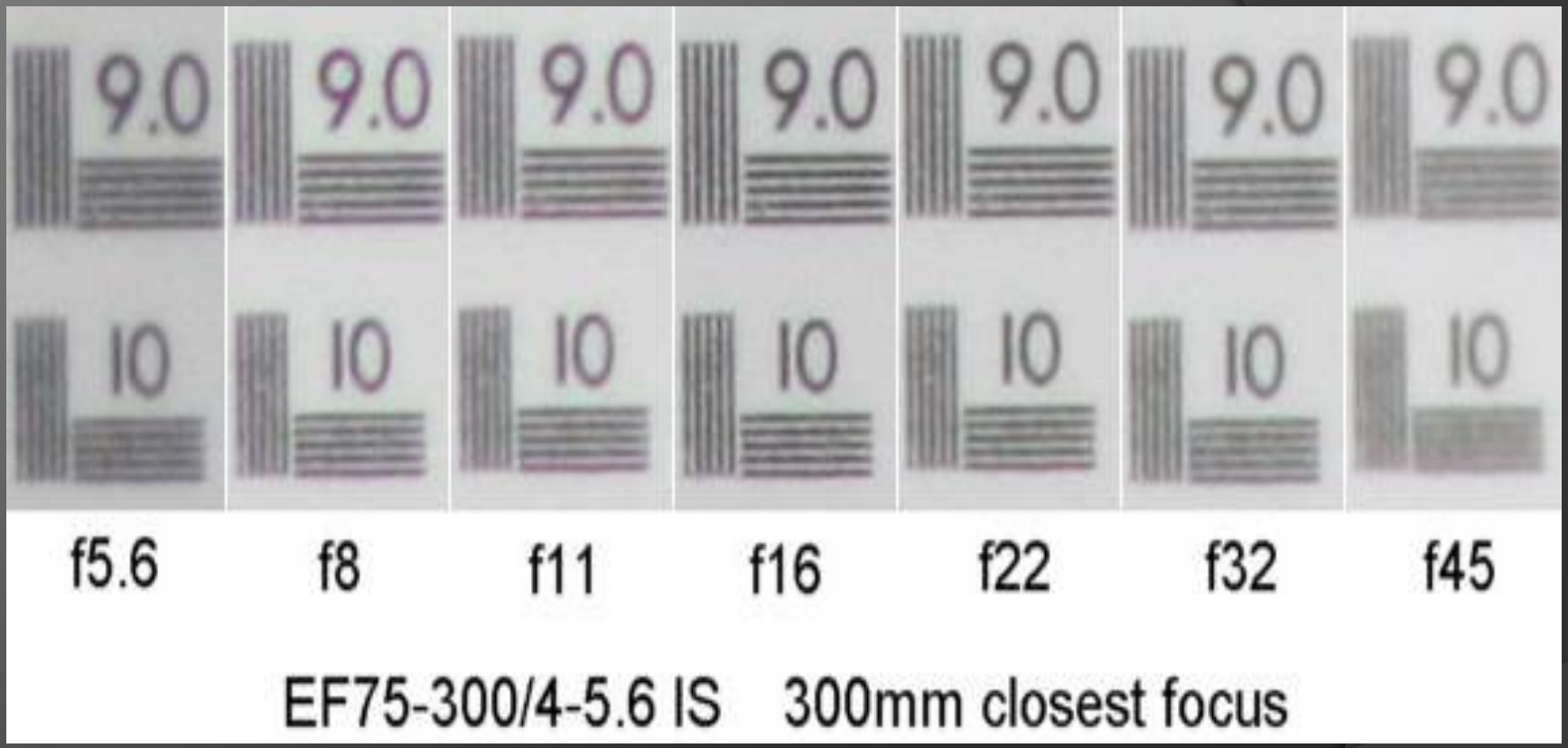


astigmatism
courtesy of Paul Van Walree
http://toothwalker.org/optics/astigmatism.html

chromatic aberration
Stan Zurek
attribution required

New: Camera CAC

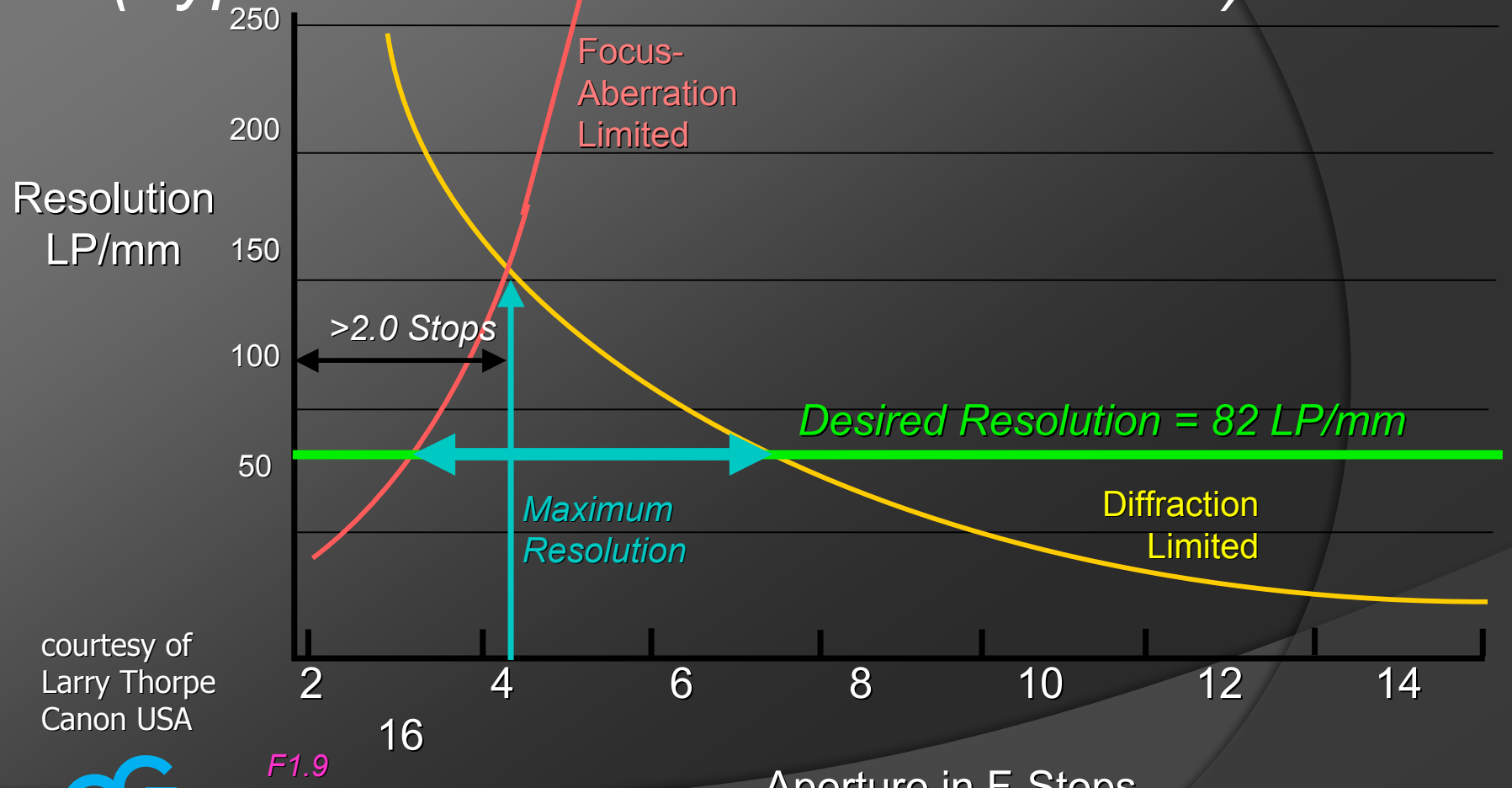
Iris vs. Sharpness



courtesy of Bob Atkins

http://www.bobatkins.com/photography/technical/diffraction.html

Lens Resolution versus Aperture Setting
(Typical 2/3-Inch HD Portable Lens)



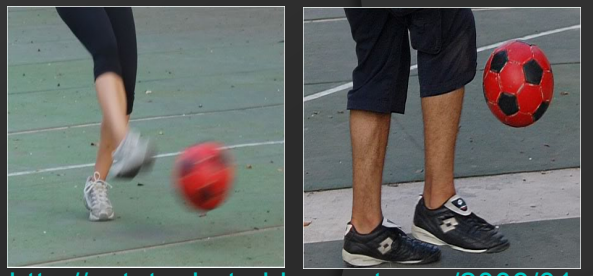
courtesy of
Larry Thorpe
Canon USA

Getting to the Sharpness Sweet Spot

- Iris: one setting is best
- Lighting: add or subtract
- Gain
  - noise if increased
- Shutter: for larger aperture
  - also reduces motion blur
  - but introduces motion “judder”
- Neutral-density filtering
  - for larger aperture
  - possible glass flaws
    - reflection, color shift, e

Matthews Studio Equipment

www.hisupplier.com

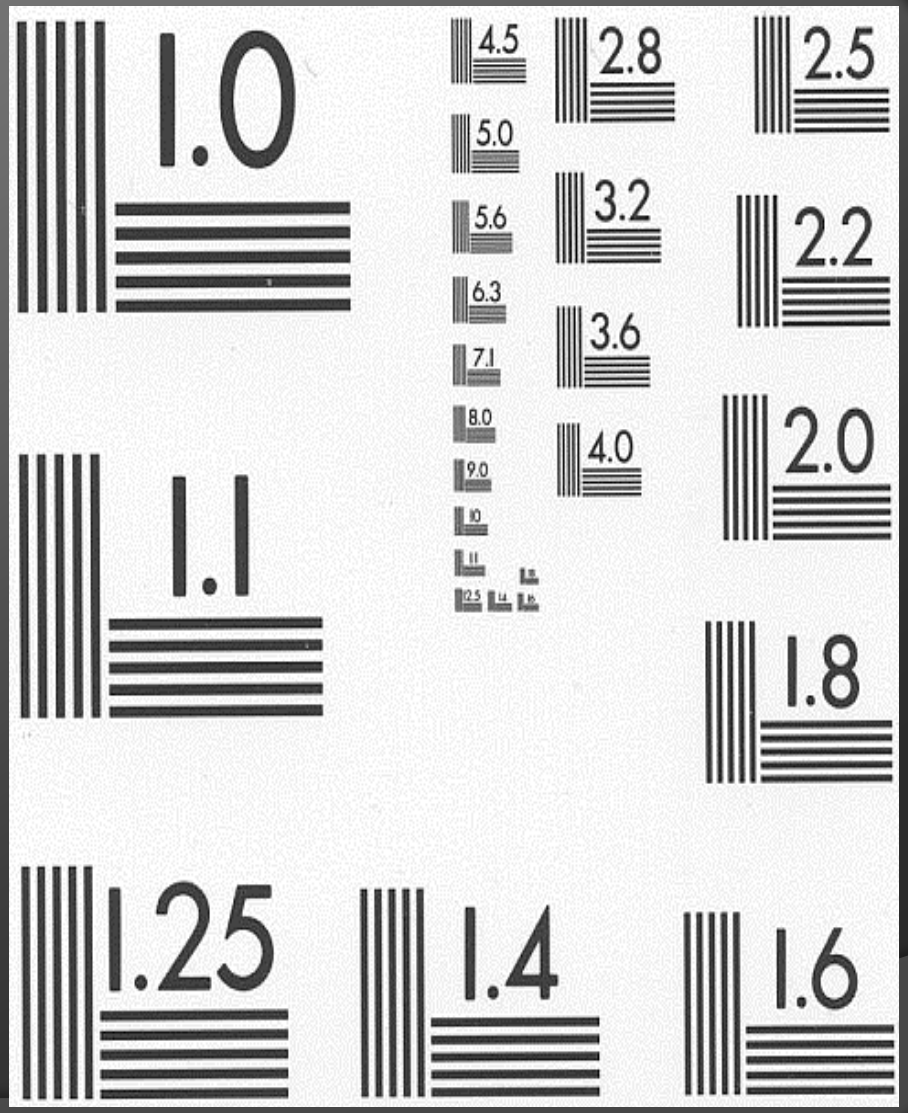


http://astutephoto.blogspot.com/2008/01/blurriness-how-to-solve-it-iq-1.html

filter wheel
AstroLab.be

Don't Worry *Too* Much

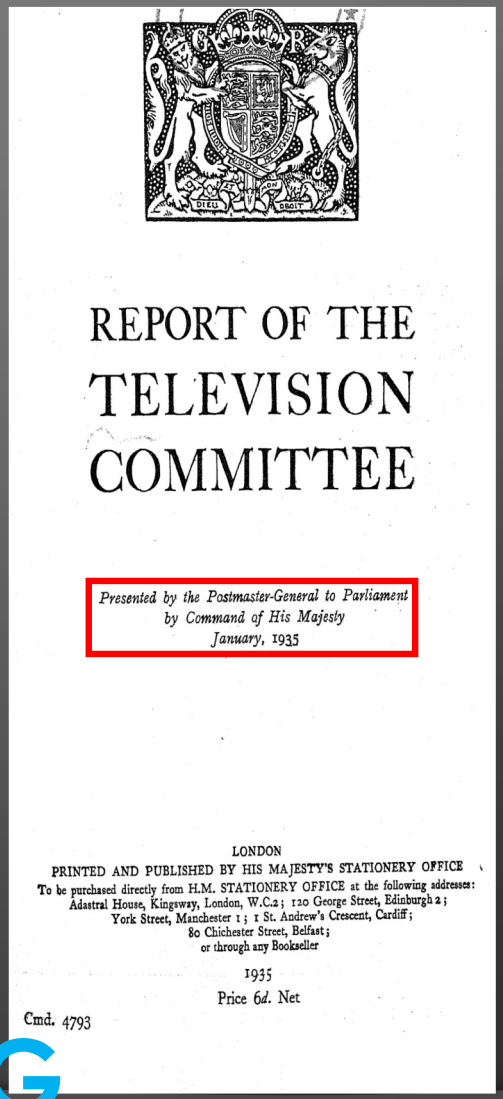
NBS
1010A



worst-case
diffraction from
two slides back

notice
reduced
contrast

What Is HDTV?



REPORT OF THE
TELEVISION
COMMITTEE

Presented by the Postmaster-General to Parliament
by Command of His Majesty
January, 1935

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
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or through any Bookseller
1935
Price 6*d*. Net
Cmd. 4793

Presented by the Postmaster-General to Parliament
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HIGH DEFINITION TELEVISION

27. With a view to extending the application of Television to a wider field and thereby increasing its utility and entertainment value, much attention has been given in recent years to the problem of obtaining better definition and reduced "flicker" in the received pictures.

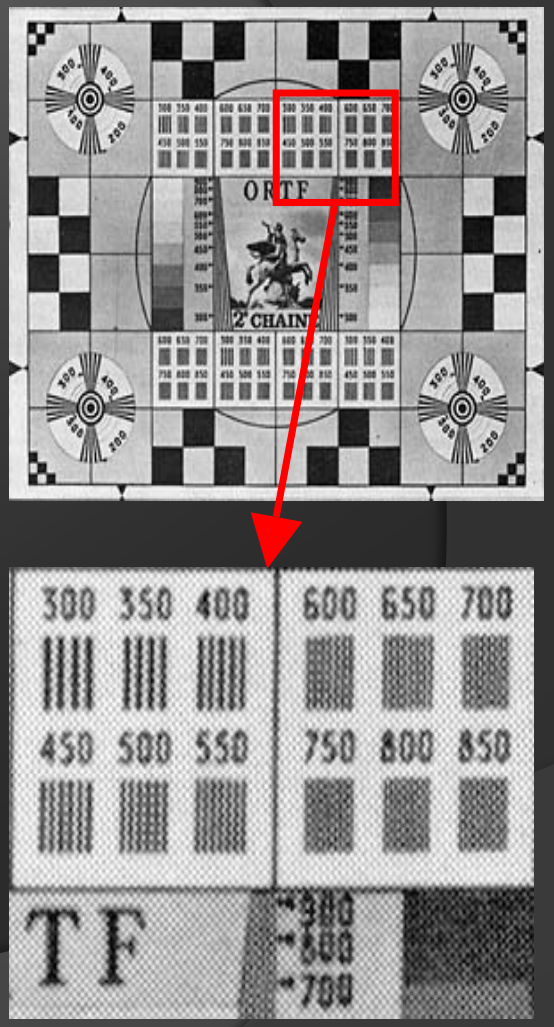
28. The degree of definition it is essential to obtain is necessarily a matter of opinion, but the evidence received and our own observations lead us to the conclusion that it should be not less than 240 lines per picture, with a minimum picture frequency of 25 per second. The standard which has been used extensively for experimental work

it should be not less than 240 lines

TV D That Was More H

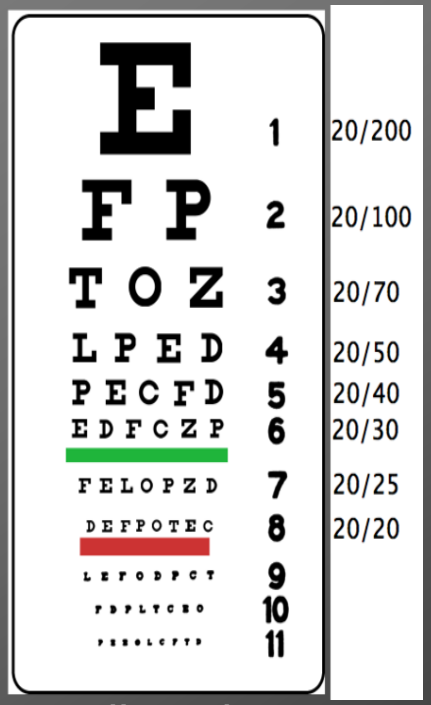
Baird 600-line color 1940

French TV
819-line
1948-1986

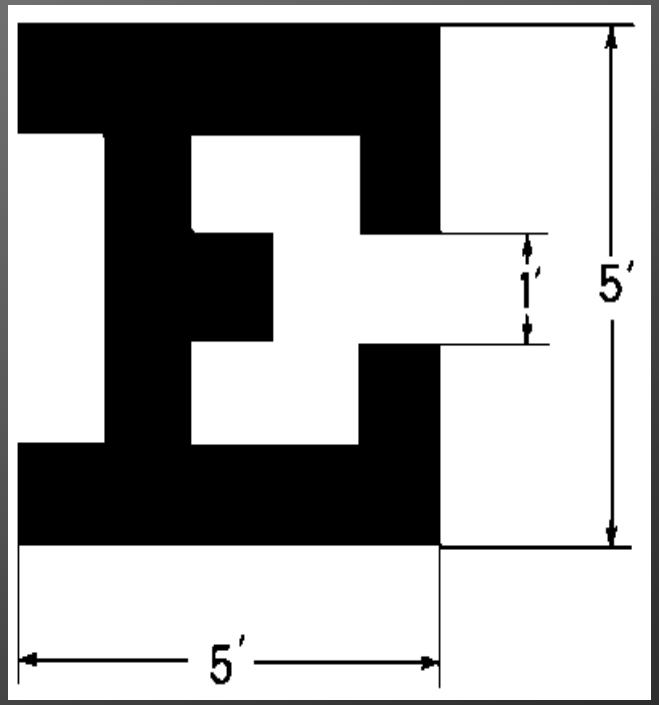


Thousand-line
systems tested
in the 1940s

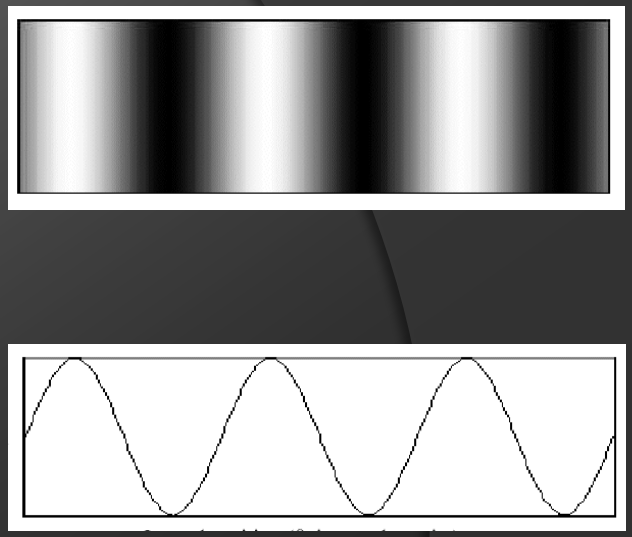
Human Resolution Theory - 1862



Snellen Chart



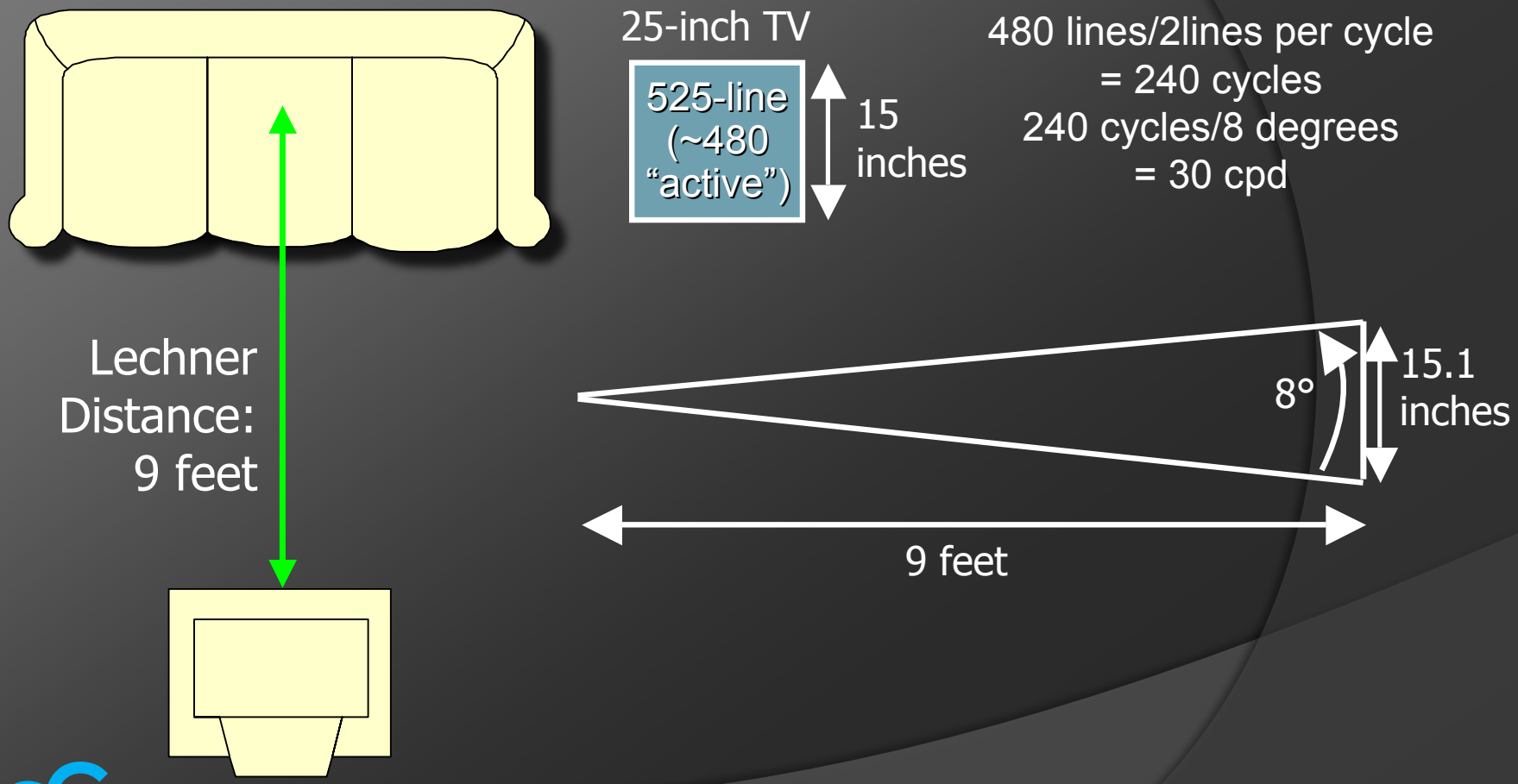
20/20 "optotype" = 30 cpd
(cycles per degree)



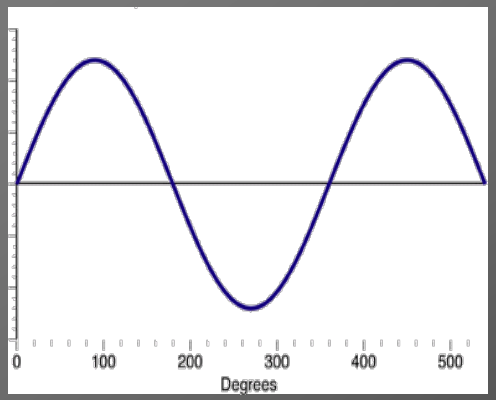
2 lines
(one white & one black)
= 1 cycle

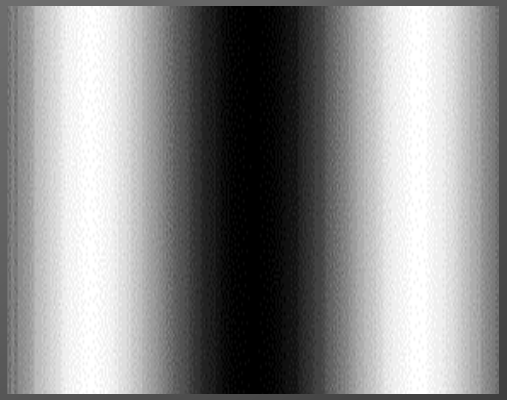
1° = 60'

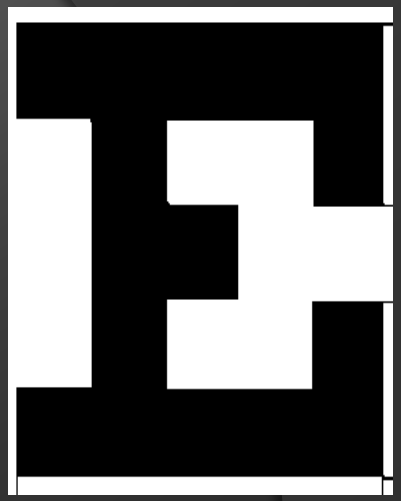
Seeming Lack of Need for HDTV

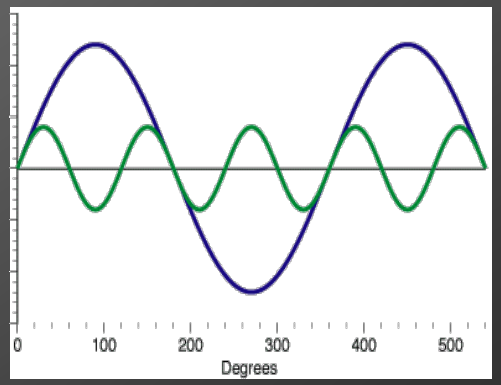


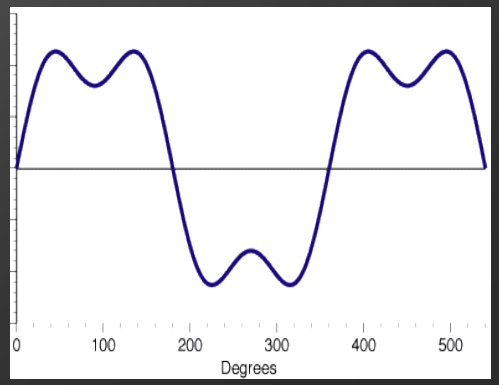
Sharp Edges Are High Resolution

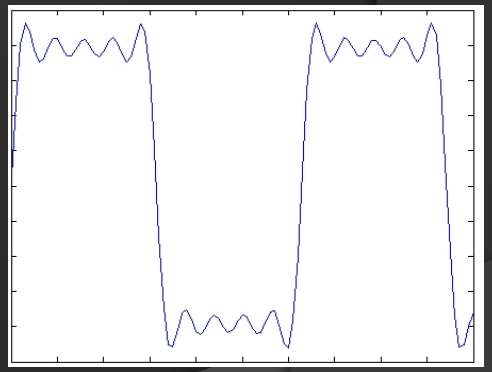












original + 3x + 5x + 7x + 9x

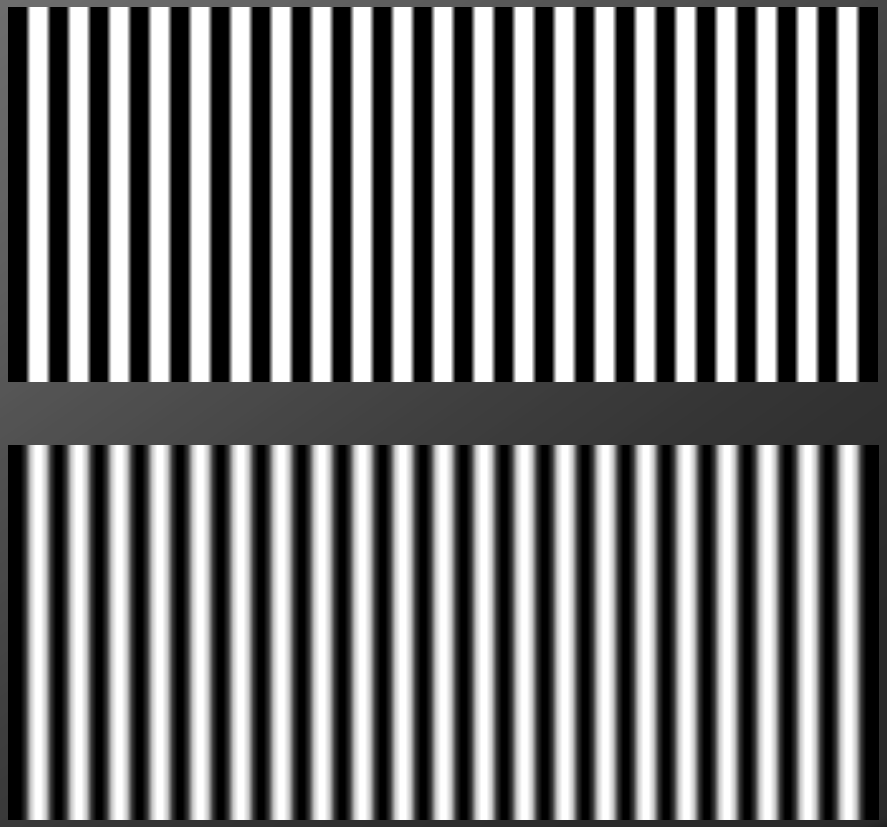
Different Kinds of Resolution

- Temporal (frames per second) & Spatial
- Dynamic (moving) & Static
- Chroma (color) & Luma
- Non-dimensional (lines, pixels)

linear (dots per inch, line-pairs per millimeter)

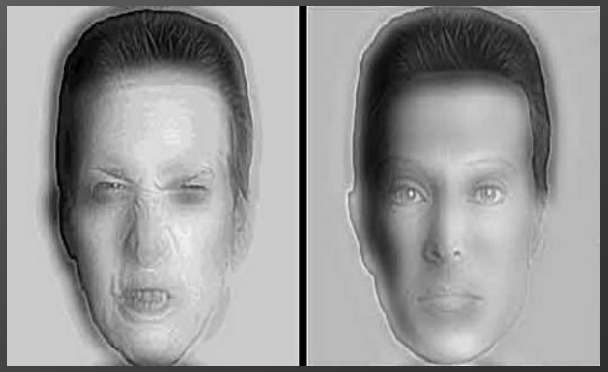
1080 / 2 = 540 line pairs (lp) / 5.4 = 100 lp/mm for a 16:9 image sensor in a 2/3-inch format

Introducing Sharpness



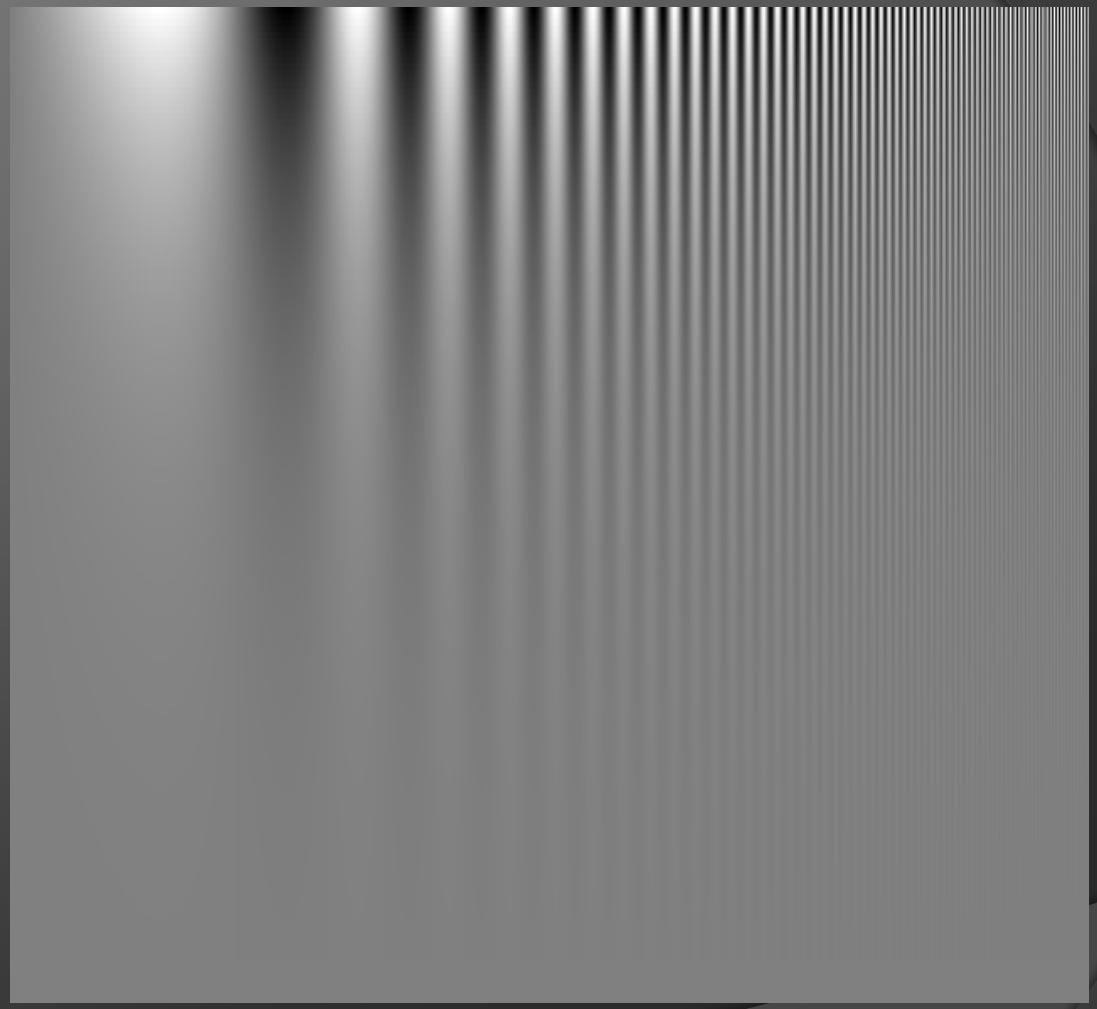
courtesy of Sean T. McHugh
http://www.cambridgeincolour.com/tutorials/diffraction-photography.htm

Which Person Looks Angrier?

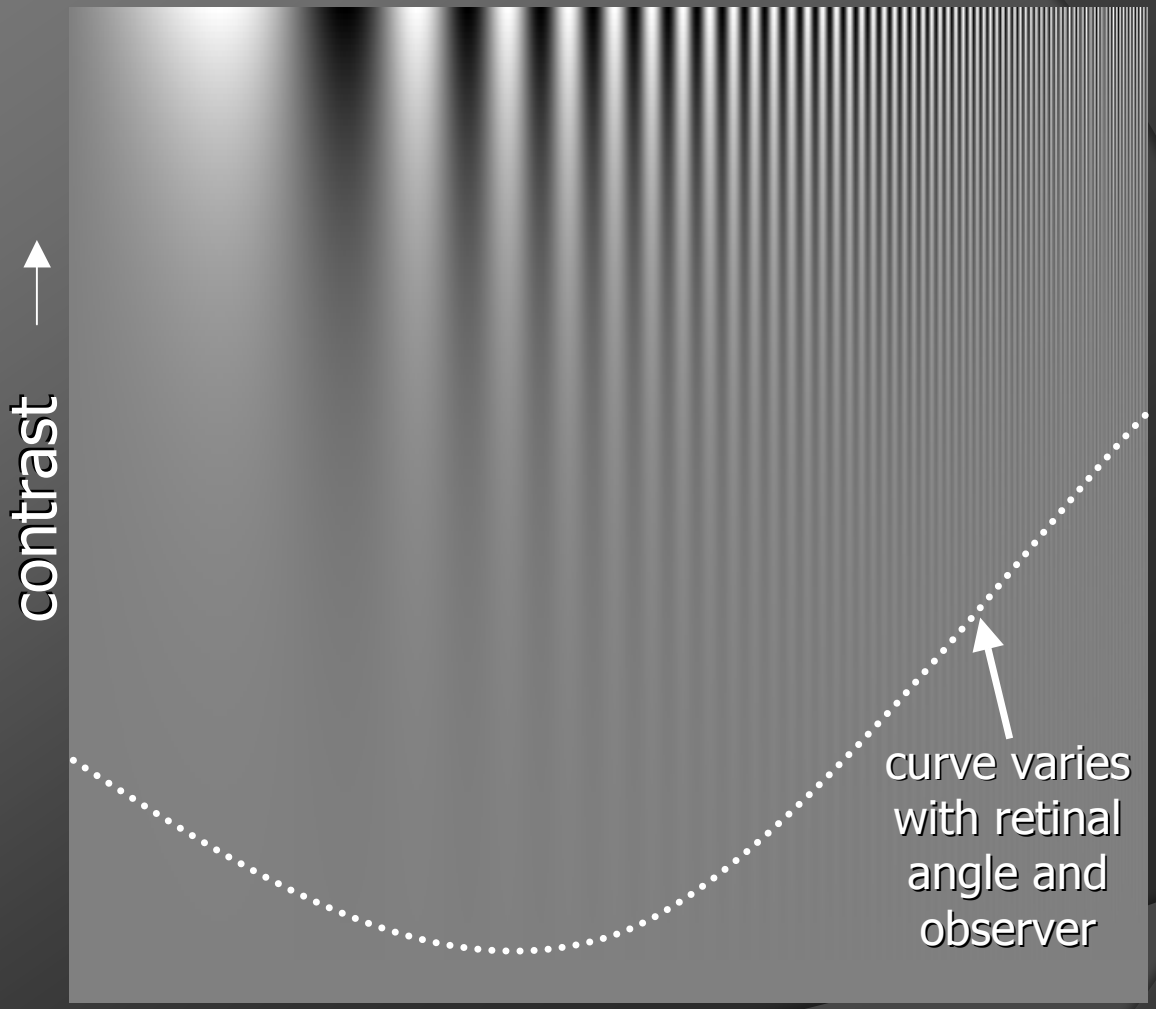


"Angry Man/Neutral Woman," 1997
copyright Aude Oliva, MIT and
Philippe G. Schyns, University of Glasgow
used with permission

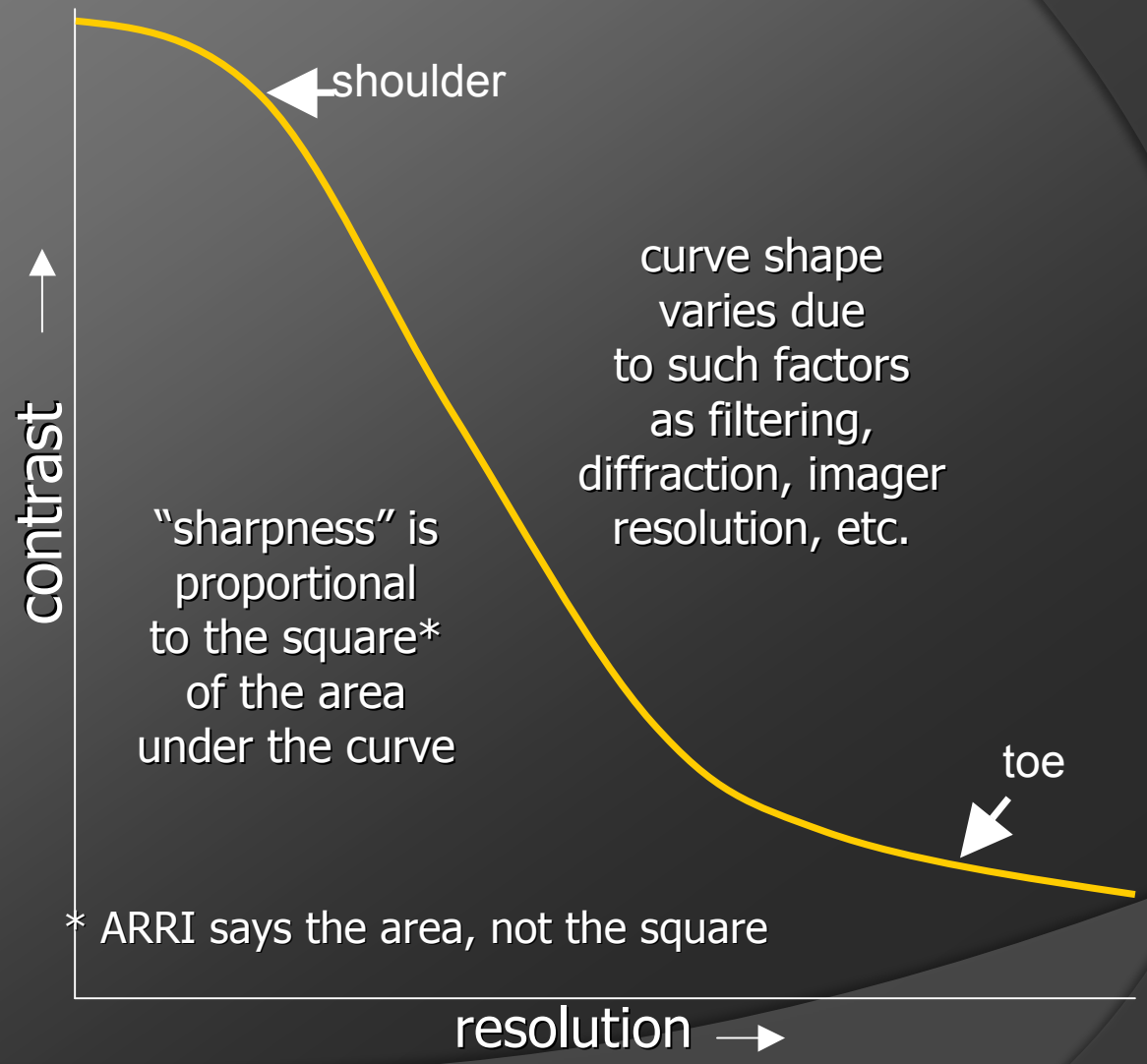
Do You See a Curve at the Bottom?



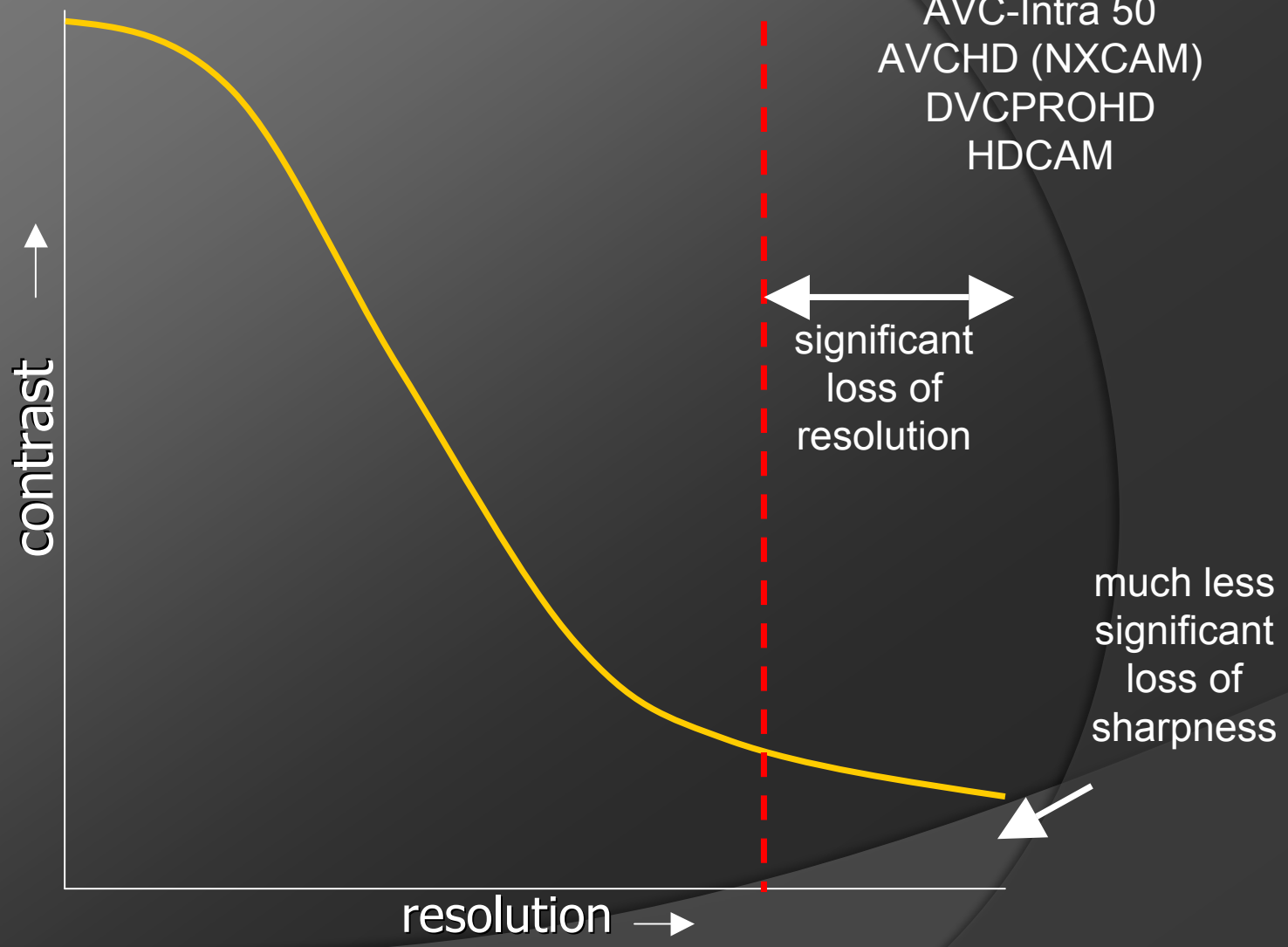
Contrast-Sensitivity Function



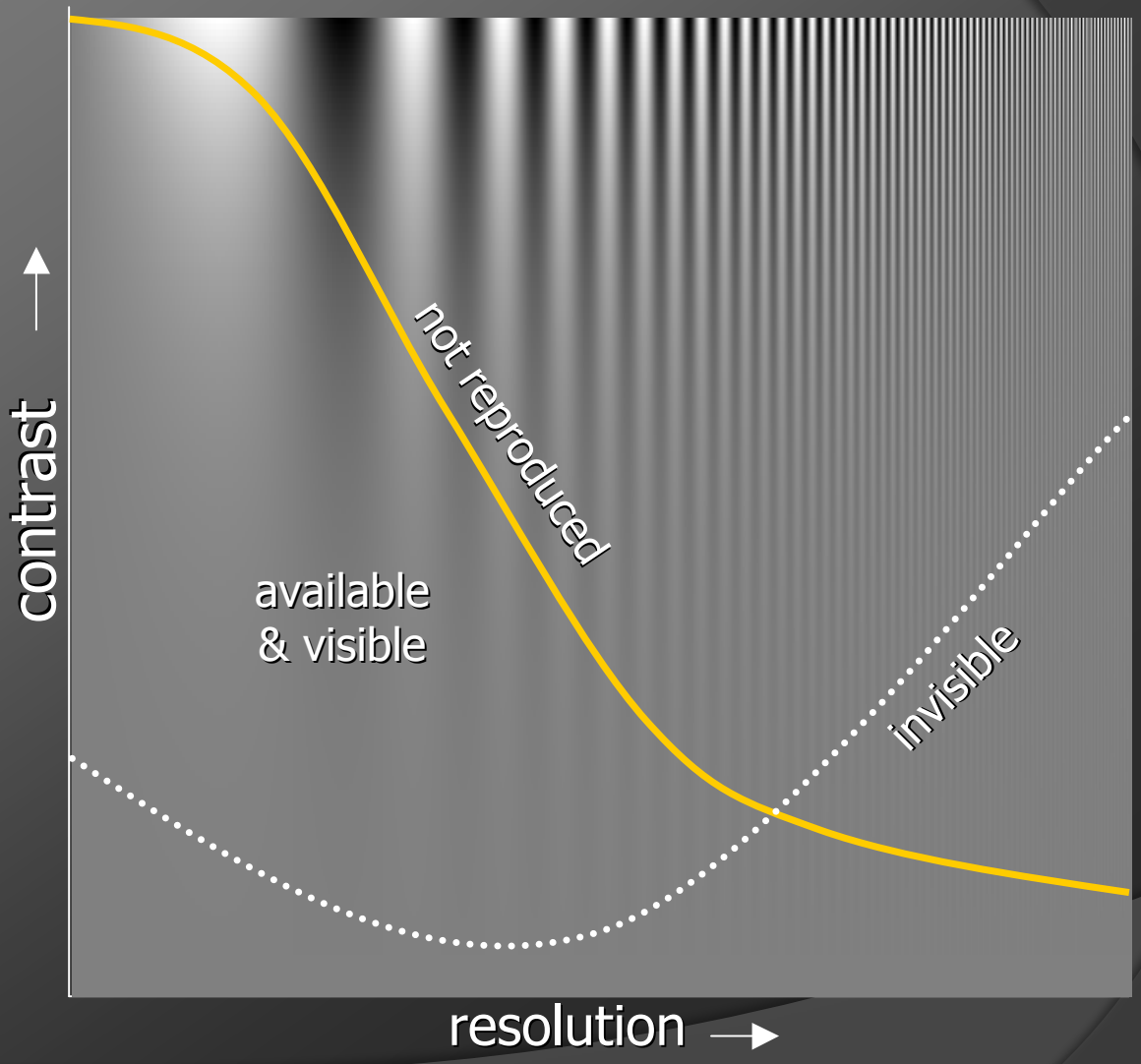
Modulation-Transfer Function (MTF)



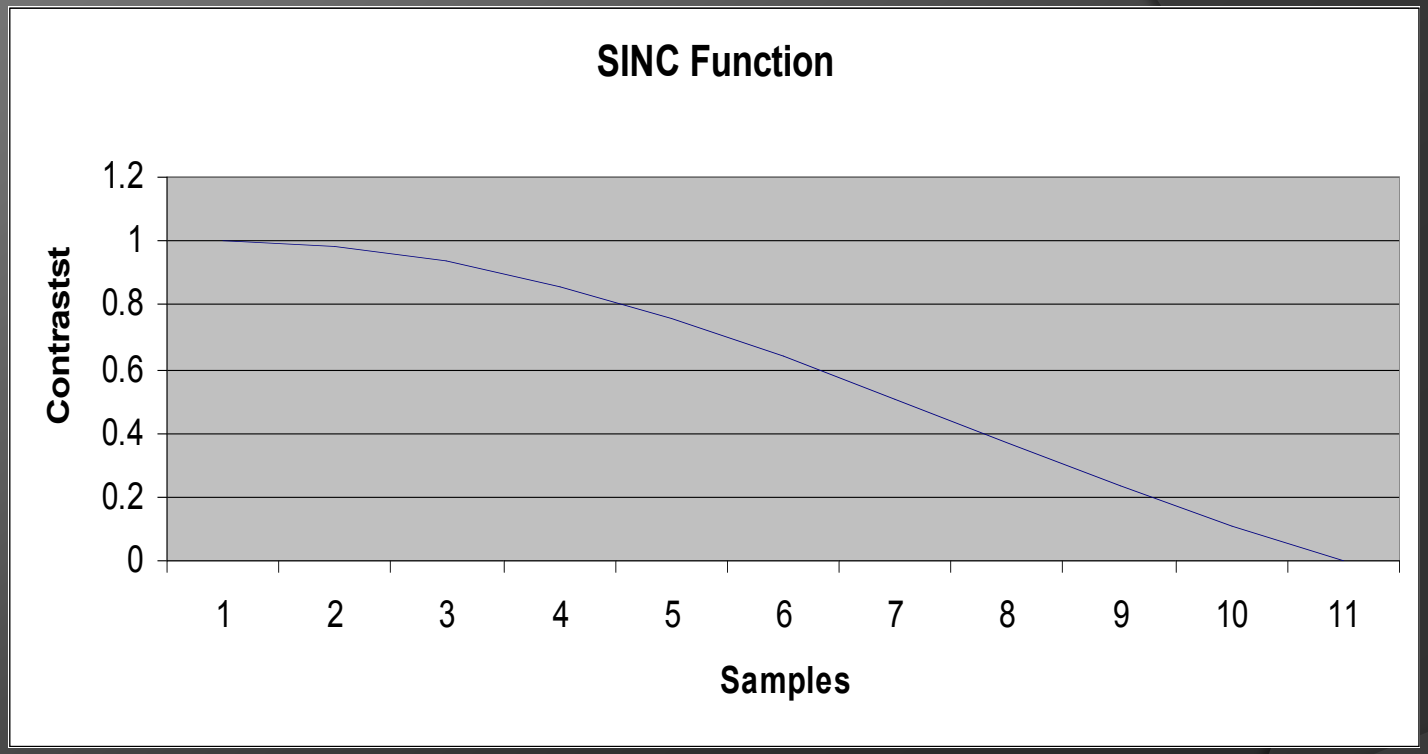
HD Camcorder Compromise



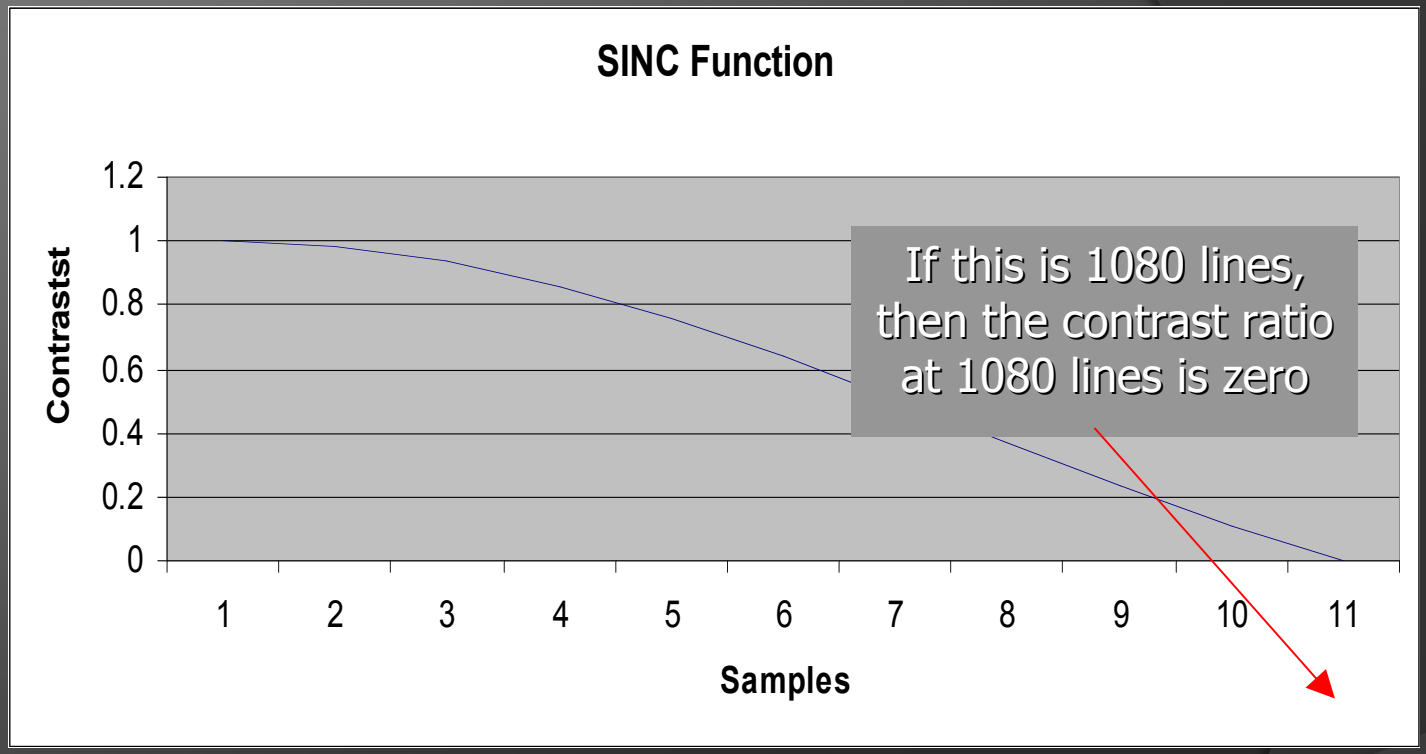
Combining Vision & Technology

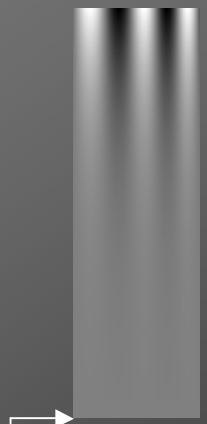


One Way to Extend the MTF Shoulder



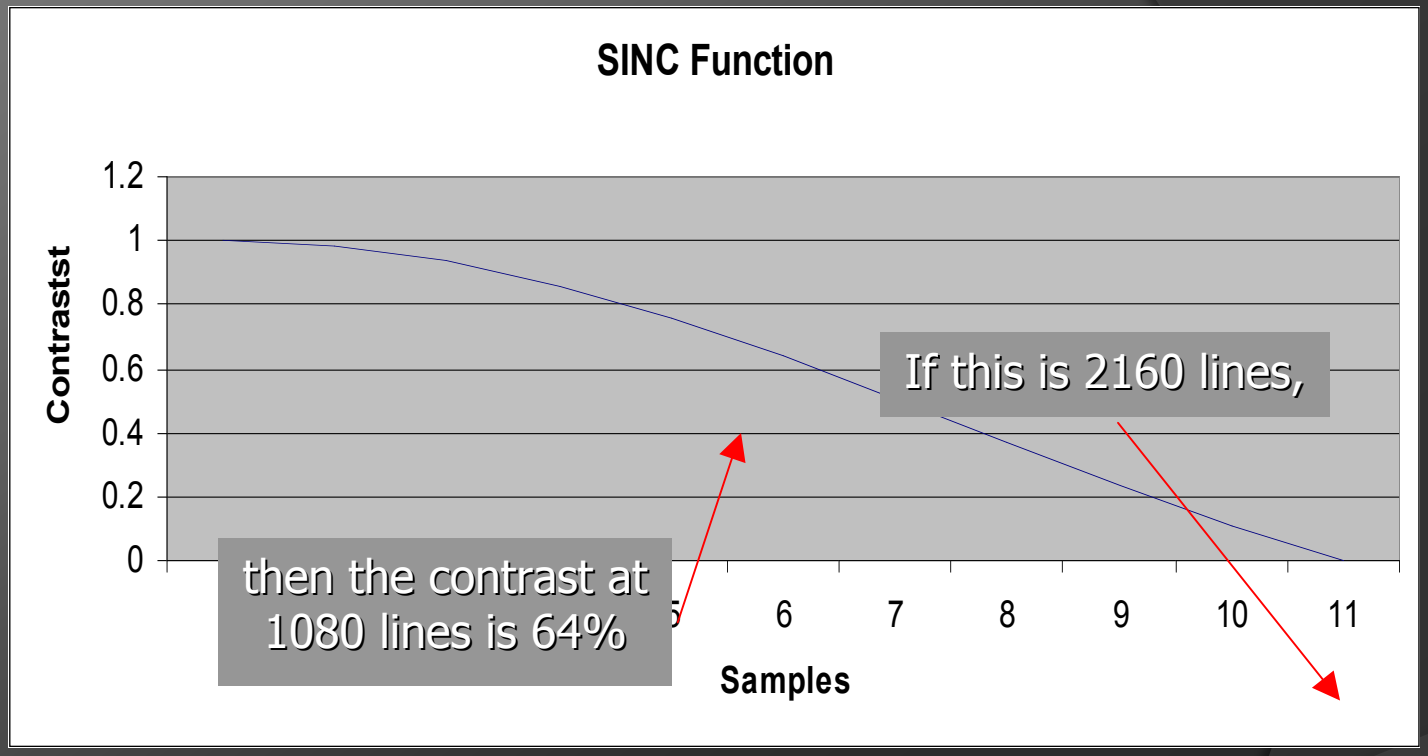
Use More Imager Resolution

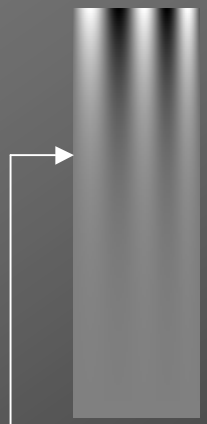




zero contrast

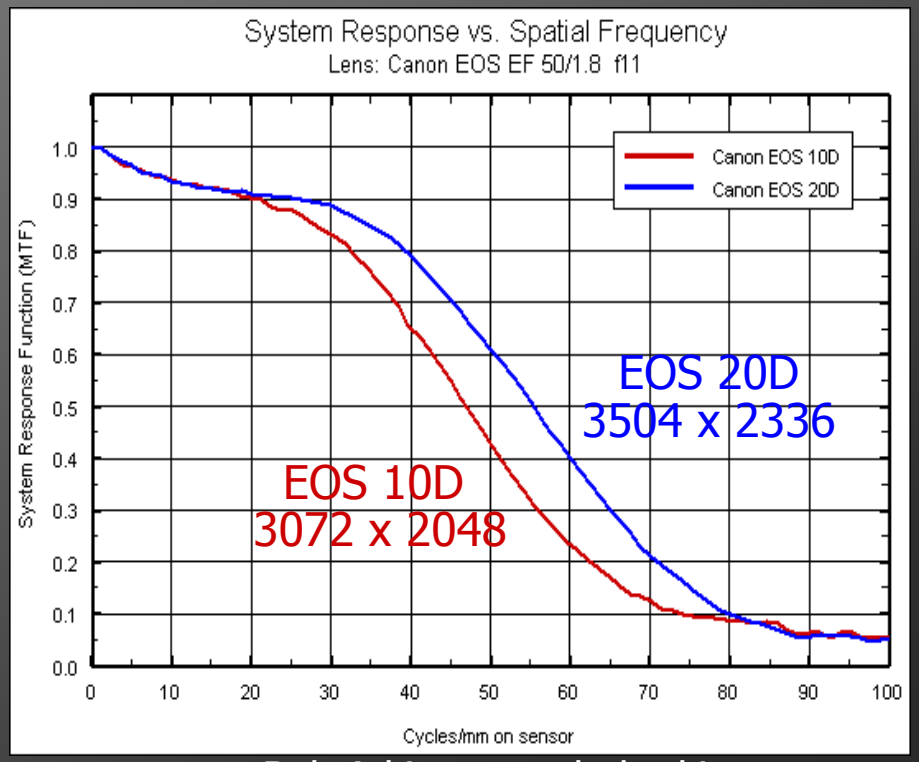
Why a “4K” Camera Can Be Good for HD





64% contrast

Real MTF Curves



courtesy Bob Atkins www.bobatkins.com
used with permission

14% linear increase in sensors
(1080 over 480 is 225%)

Real-World Sharpness Change

EOS 10D
3072 x 2048

courtesy Bob Atkins www.bobatkins.com
used with permission

EOS 20D
3504 x 2336

again, just 14% more resolution

Imager Size

- 1/5-inch
- 1/4-inch

1/3

1/2

2/3-inch

4/3-inch

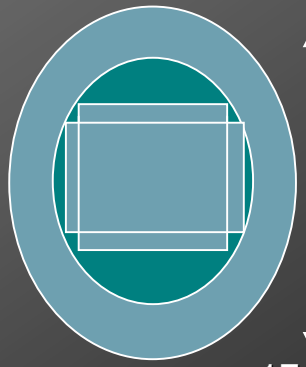
APS-C, ARRI D-21 Dalsa, Panavision Genesis, Red One, Sony F35

slight variations

Canon EOS 5D Mark II

-

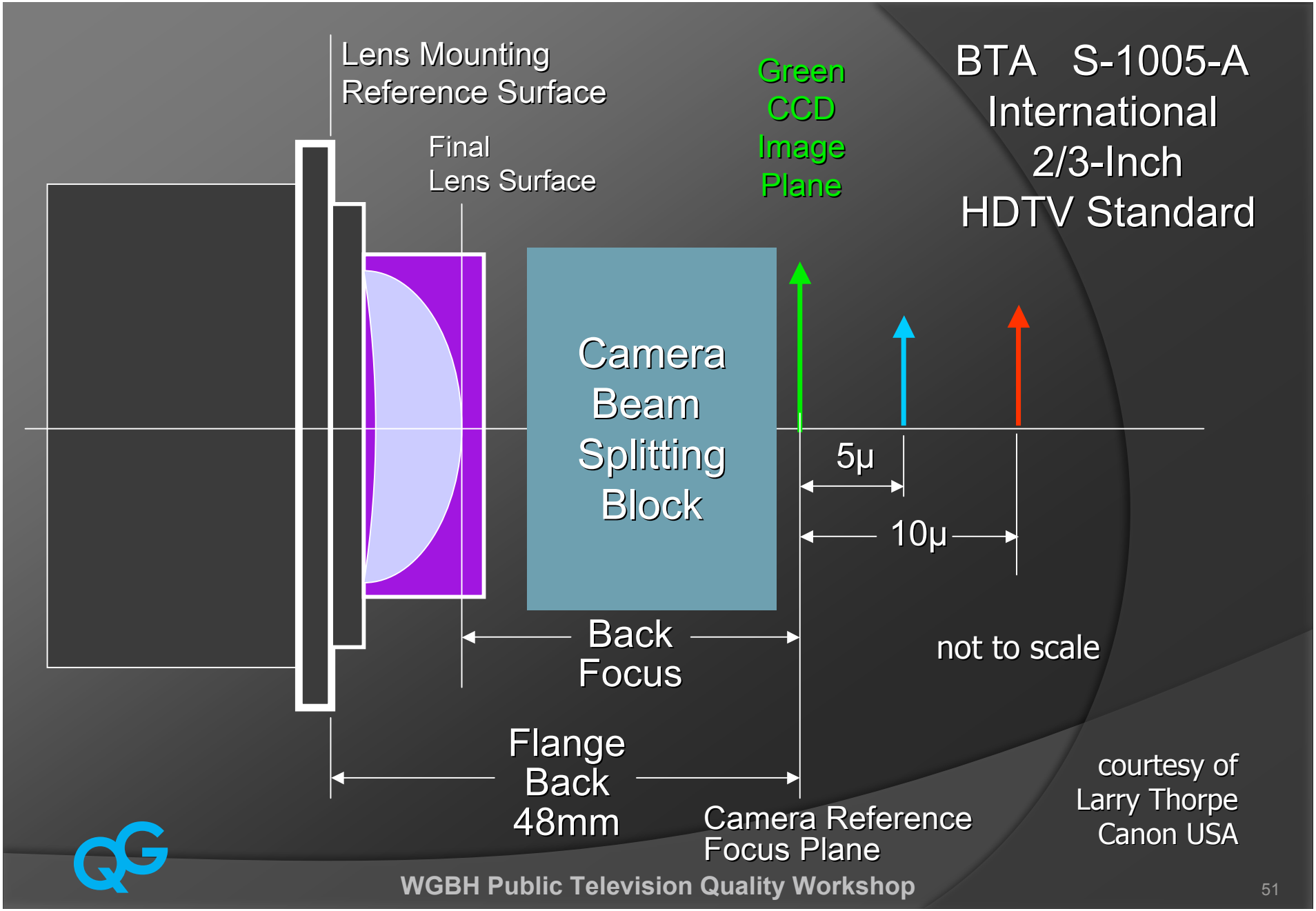
Panasonic HDC-SD100 1/6-inch



4:3 – 8.8 x 6.6 mm
16:9 – 9.6 x 5.4 mm

Vision Research Phantom 65

- Lens Quality
- Dynamic Range
- Sensitivity
- Depth of Field


Lens Mounting
Reference Surface
Final
Lens Surface
Green
CCD
Image
Plane
BTA S-1005-A
International
2/3-Inch
HDTV Standard
Camera
Beam
Splitting
Block
5µ
10µ
Back
Focus
not to scale
Flange
Back
48mm
Camera Reference
Focus Plane
courtesy of
Larry Thorpe
Canon USA

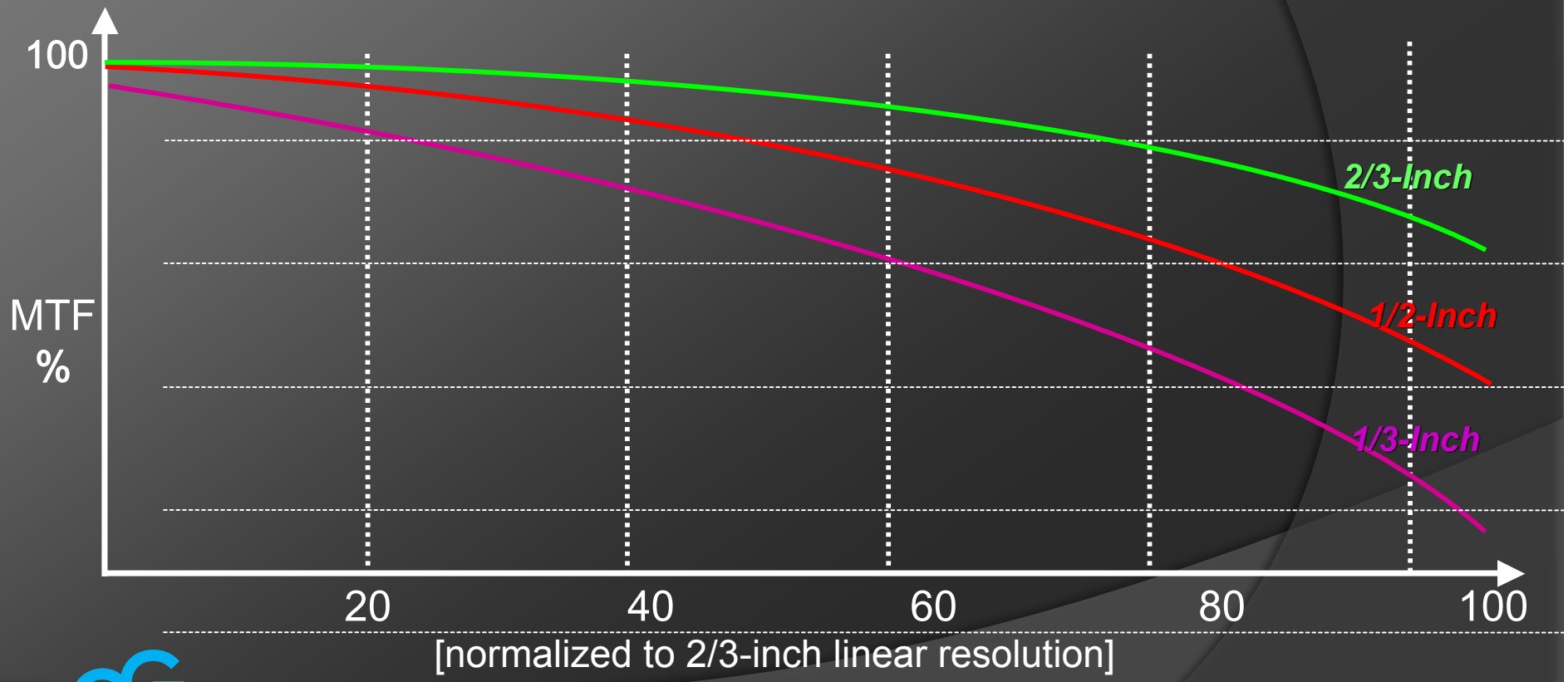
Linear Resolution for 1080 HD

Format	lp/mm
1/6-inch	379
1/5-inch	316
1/4-inch	245
1/3-inch	197
1/2-inch	138
2/3-inch	100
16-mm movie	~90*
1-inch	69
4/3-inch	51
35-mm movie	~40*
35-mm full-frame	27
Phantom 65	19

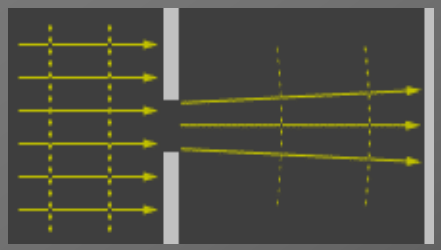
* there are minor variations in the sizes of these two formats (APS-C is 35-mm movie size)

Relative MTF of HDTV 2/3-Inch, 1/2-Inch, and 1/3-Inch Lens
Measured at Picture Center

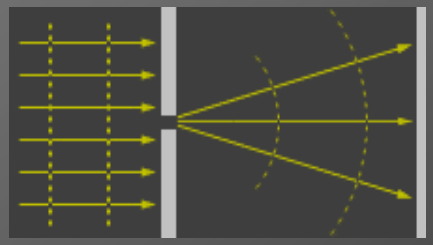
(from *Small Format HD Acquisition,* Larry Thorpe, Canon,
2005 SMPTE Fall Technical Conference – updated 2010)



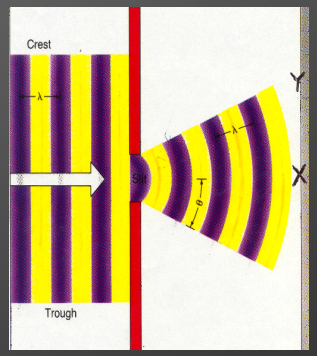
Understanding Diffraction

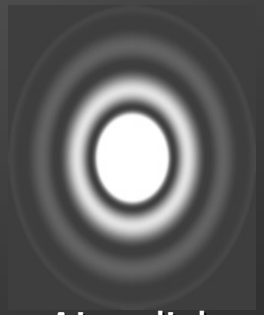


large hole

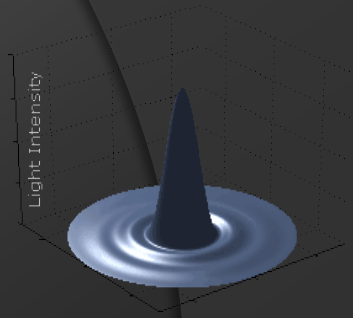


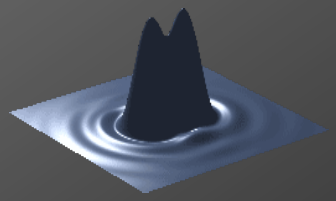
small hole



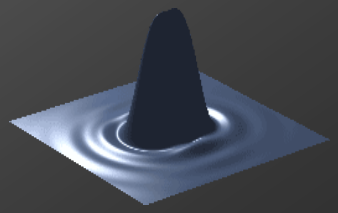


Airy disk





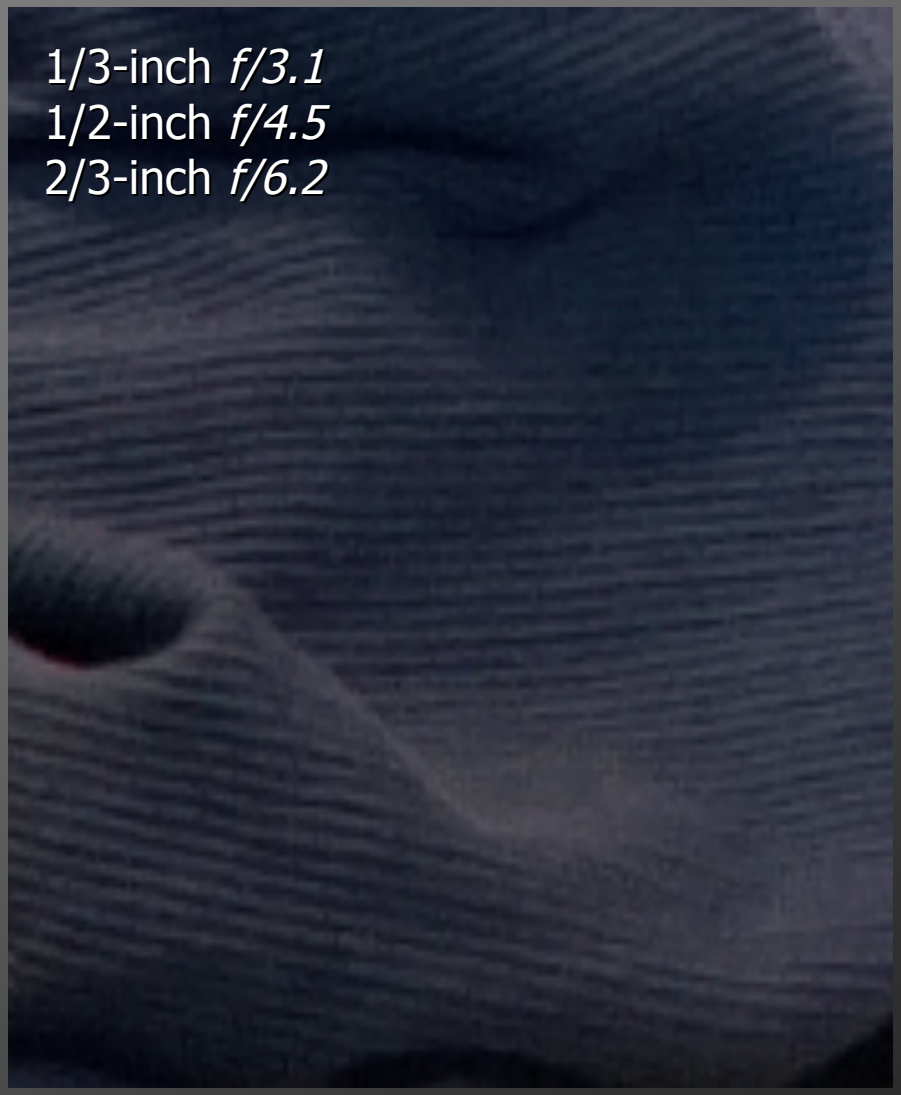
MTF reduced, resolution unaffected



resolution reduced

Engineers: MDMTF = 1-(1.22*λ*f#*lp/mm)
Non-Engineers: Contrast = 100%-something ("something" includes linear resolution)

courtesy of Sean T. McHugh
http://www.cambridgeincolour.com/tutorials/diffraction-photography.htm


1/3-inch *f/3.1*
1/2-inch *f/4.5*
2/3-inch *f/6.2*


1/3-inch *f/9.5*
1/2-inch *f/12.4*
2/3-inch *f/17*

True or False?

- Larger-format cameras offer wider angles
- Larger-format cameras are more sensitive
- Larger-format cameras have shallower depth of field

True or False?

- Larger-format cameras offer wider angles
- Larger-format cameras are more sensitive
- Larger-format cameras have shallower depth of field

Answer: Yes

True or False?

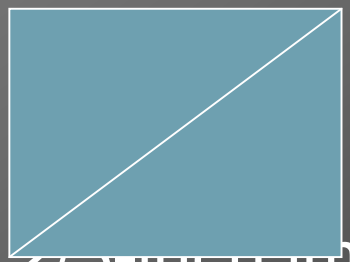
- Larger-format cameras offer wider angles
- Larger-format cameras are more sensitive
- Larger-format cameras have shallower depth of field

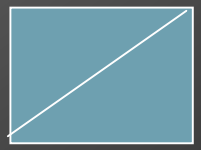
Answer: Yes

(the statements are both true and false)

Introducing the Format Factor

Divide equivalent factors of one format by another's.



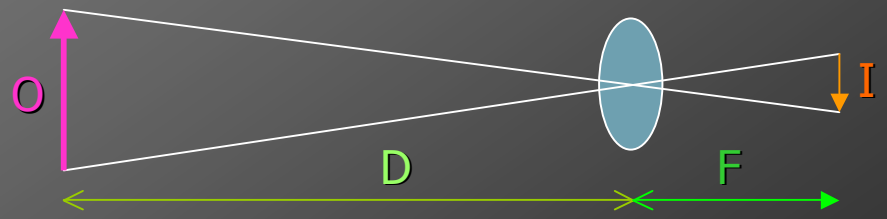


e.g., 2/3-inch imager 11-mm diagonal divided by 1/3-inch imager 5.6-mm diagonal yields a format factor of ~2.

- Applies to many imaging characteristics
  - acceptance angle, sensitivity, dynamic range, depth of field, diffraction, lens MTF

Shot Size

The Format Factor affects focal lengths



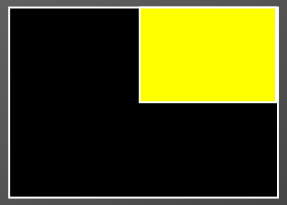
$$\frac{O}{D} = \frac{I}{F}$$

- Acceptance Angle (shot size):
  - 20 mm lens in 2/3” ~ same as 10 mm in 1/3”
  - But 4.5 mm in 2/3” ~ same as 2.3 mm in 1/3”, 1.8 mm in 1/4”, 1.5 mm in 1/5”, 1.2 mm in 1/6”

Sensitivity

The Format Factor affects sensitivity

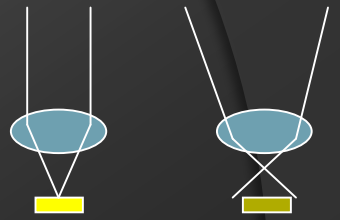
Full output



Quarter output

Quarter output

microlenses best at high f-stops



- Sensitivity (exclusive of microlens issues):
  - *f/20* in 2/3” ~ same as *f/10* in 1/3”
  - But *f/2* in 2/3” ~ same as *f/1.0* in 1/3”, *f/0.8* in 1/4-inch, *f/0.7* in 1/5”, and *f/0.5* in 1/6”

Shallow Depth of Field

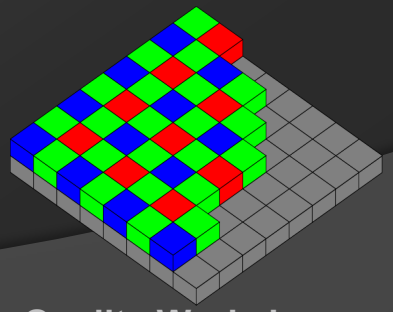
http://toothwalker.org/optics/dof.html

- Depth of Field
  (not in macro or hyperfocal regions):
  - Range of distances appearing to be in focus with the lens focused at some particular distance
  - Complex equations based on f-stop*, focal-length*, shooting distance, and "circle of confusion*" (circle that is visually indistinguishable from a dot)
    * format-factor-related
  - 20 mm *f/20* in 2/3" ~ same as 10 mm *f/10* 1/3"
  - But 4.5 mm *f/2* in 2/3" ~ same as 2.3 mm *f/1* 1/3", etc.

Large Format for Everything?

- Wider angles, more sensitive, shallower DOF, less diffraction, better lens performance
- Can be inexpensive
  - Panasonic, Red, Sony
  - DSLRs: *House* 2010 finale

- Larger than iPhone
- Can lack video-camera features
- Limited zoom-lens availability
- Usually CMOS
  - "rolling shutter" issue
- Usually single sensor



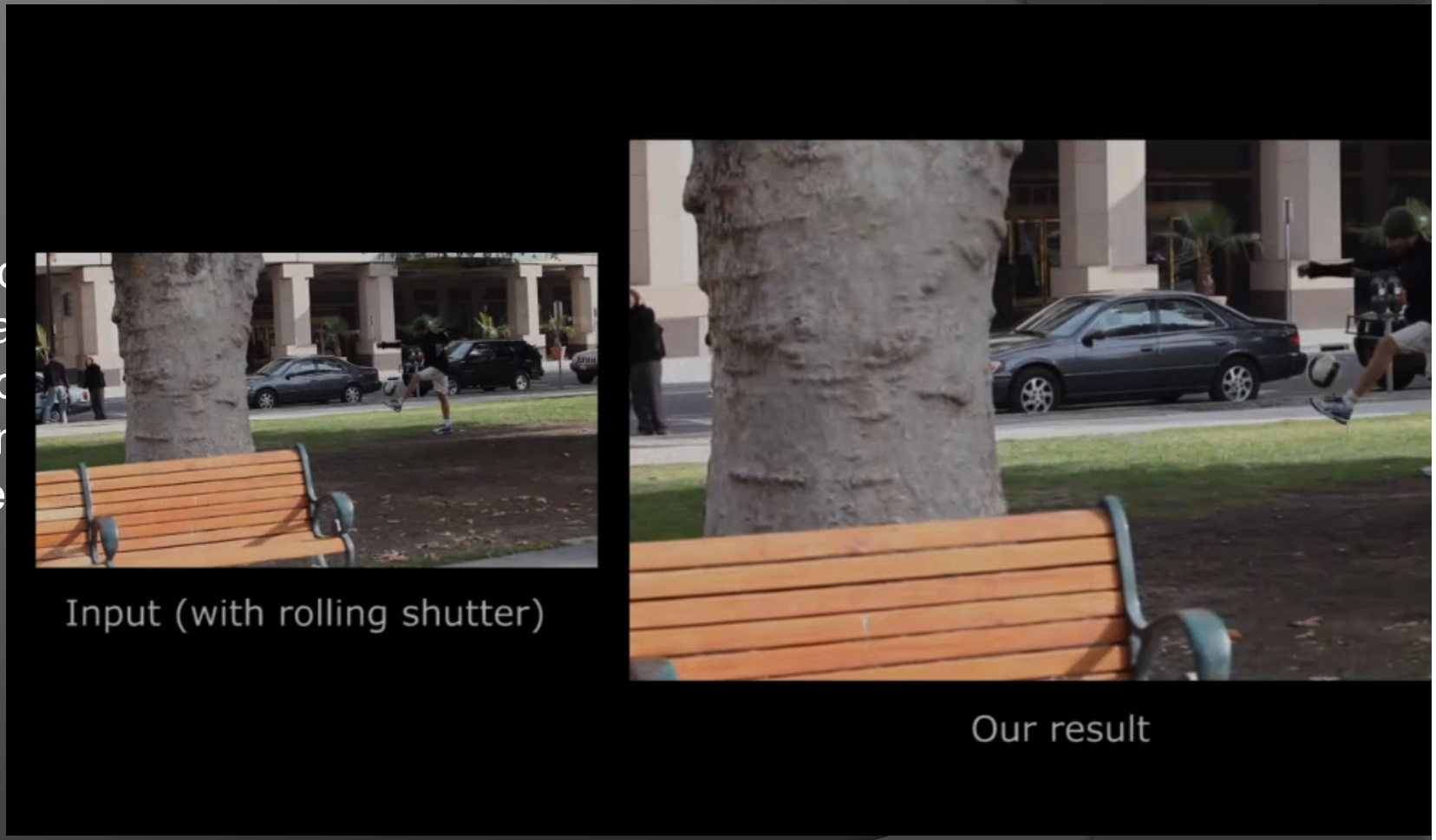
iPhone 4 (HD phone)

- 1/3.2-inch-format image sens
- 2592x1936 (4:3 aspect ratio)
  - therefore 1/4.3-inch for HD videc
- 3.85 mm *f*/2.8
  - 2/3” equivalent: 11 mm *f*/8
- Everpresent
- Stability?

Owle
Bubo

“Rolling Shutter”

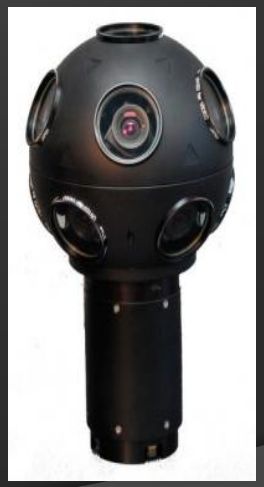
notic
vertica
post c
left ar
tree



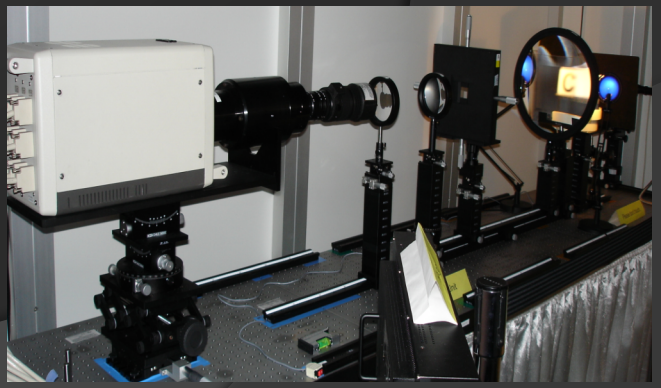
courtesy of Aseem Agarwala, Adobe

Anything for Everything?

- Ultra HD
- Ultra high sensitivit
- High speed (slow motion
- 3D
- Tiny
- Panoramic
- Holographic
- H-bomb proo



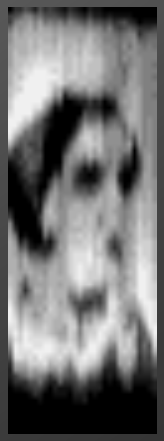
- Small
- Low cost



To Sum Up

- Acquisition affects everything that follows
  - problems should be fixed there (if possible)
- Acquisition equipment isn't just cameras
  - lighting, lenses, filters, & mounts play major roles
- Operator actions affect pictures more than do most camera characteristics
  - lighting, lens adjustments, processor settings, etc.
- Sharpness is affected by contrast as well as resolution
  - contrast is affected by diffraction and lenses

We've come a long way



1932 30-line mechanical-TV recording of Betty Bolton

Questions?

We've come a long way

Download a version of this presentation free at
SchubinCafe.com
(click on "Get the Download")

Questions?