Photographic lighting

CS 178, Spring 2009

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Outline

- taxonomy of light sources
- lighting for portraiture
- studio lighting
- special lighting problems
- flash photography

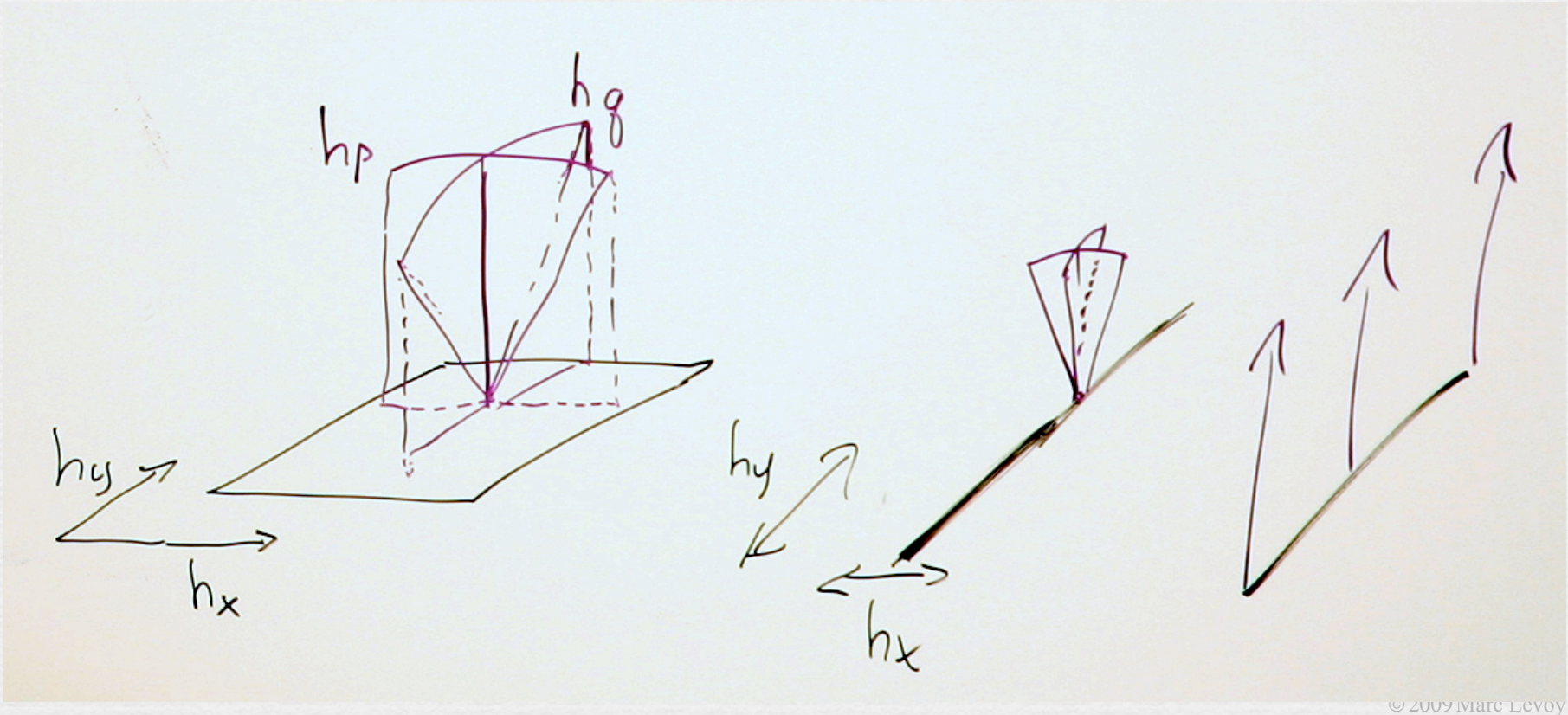
Taxonomy of light sources

[Langer and Zucker, CVPR 1997]

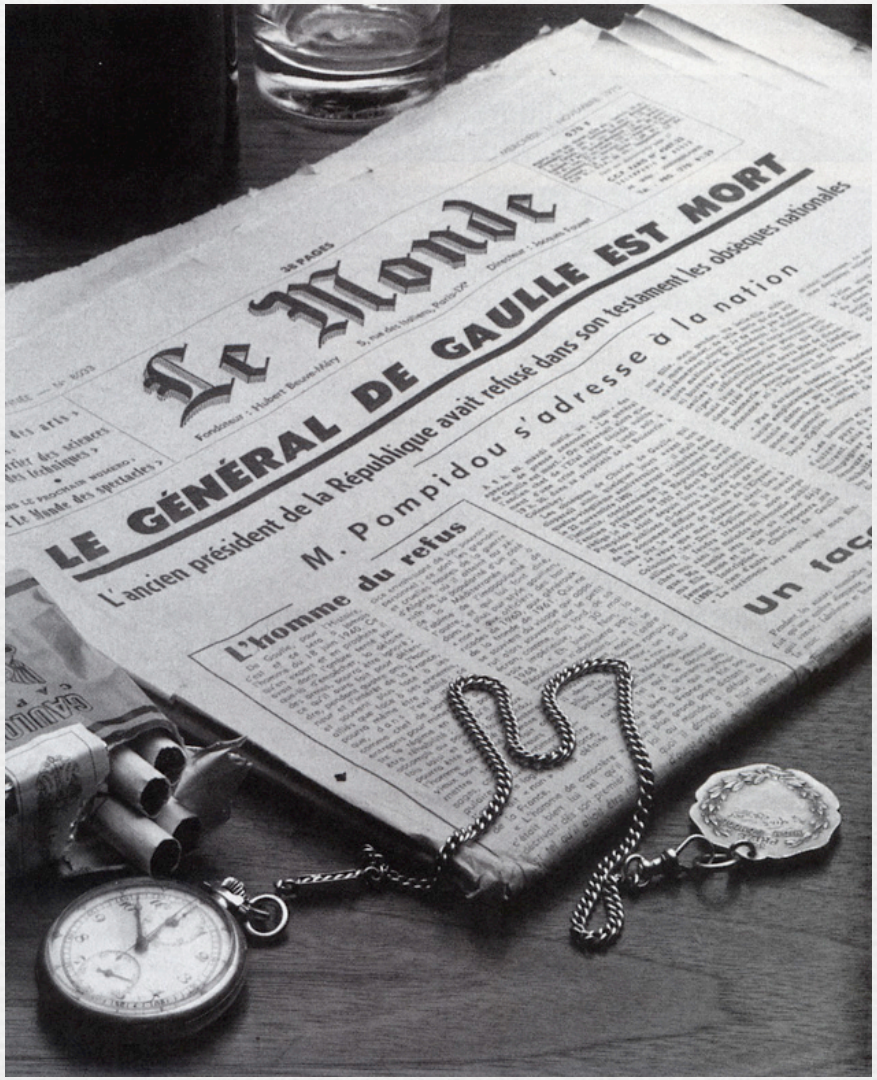
Non-ideal example	*Ideal model*	h_x	h_y	h_p	h_q	dimension
overcast sky	uniform source	∞	∞	∞	∞	4
Cyberware^{TM} scanner		∞	∞	∞	0	3
		∞	∞	0	∞	
fluorescent tube	linear source	∞	0	∞	∞	3
		0	∞	∞	∞	
sunlight	point source at infinity	∞	∞	0	0	2
	uniform distribution of rays in a plane	∞	0	∞	0	2
		0	∞	0	∞	
louvered linear source (see text)	fan of rays perpendicular to a linear source	∞	0	0	∞	2
		0	∞	∞	0	
small panel light	point source	0	0	∞	∞	2
sunlight through crack in doorway	parallel rays in a plane	∞	0	0	0	1
		0	∞	0	0	
rotating spotlight	fan of rays	0	0	0	∞	1
		0	0	∞	0	
spotlight or laser	single ray	0	0	0	0	0

Geometry for table on previous slide

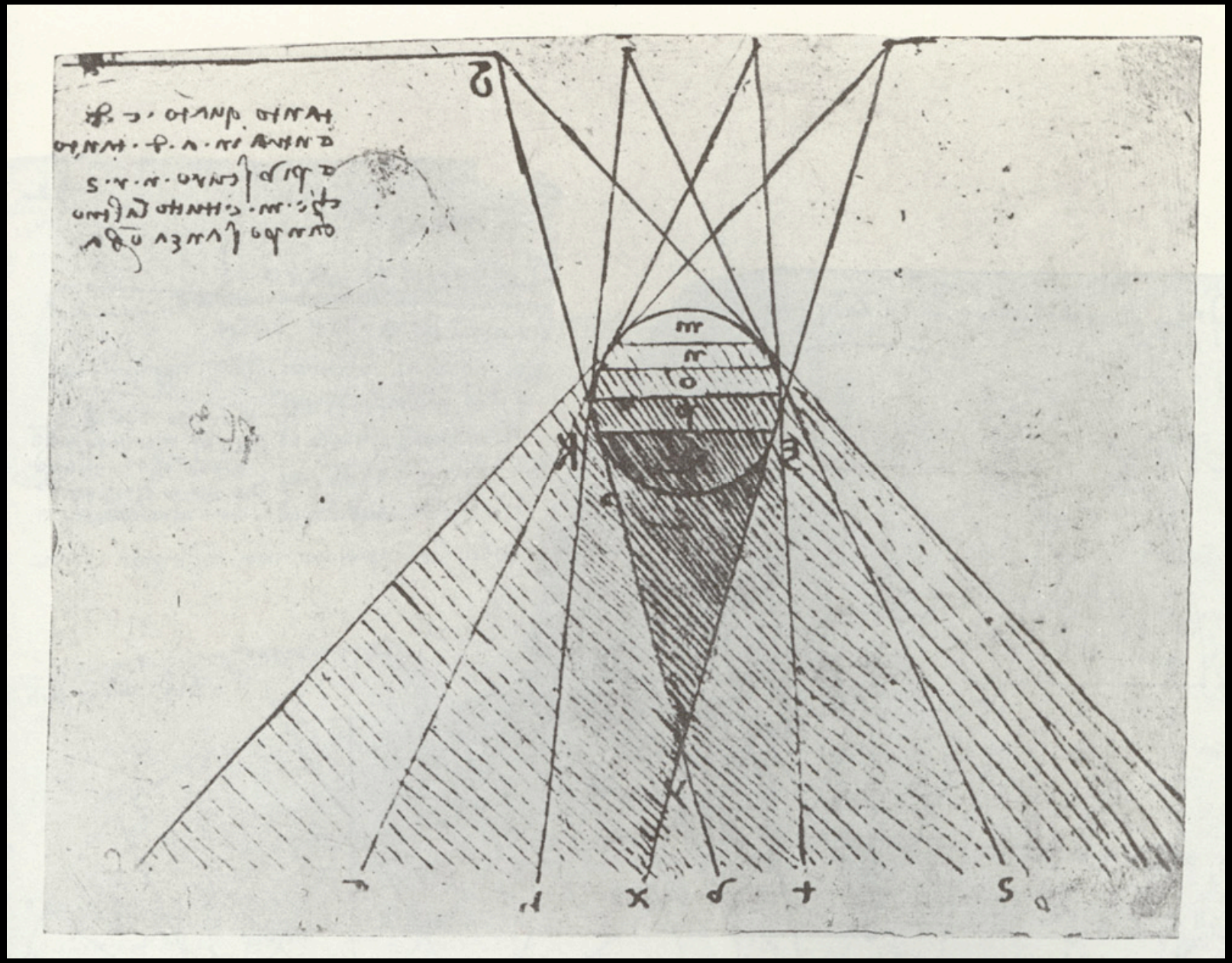
- h_x and h_y give spatial extent of light source (zero or infinity, i.e. point or area), and h_p and h_q give angular extent (zero or infinity, i.e. parallel beam or fan beam)



What's different between these two?



(Hunter)



Leonardo, study of umbra and penumbra

Lighting for portraiture

- conventional studio lighting
- unconventional lighting
- available light
- narrative light

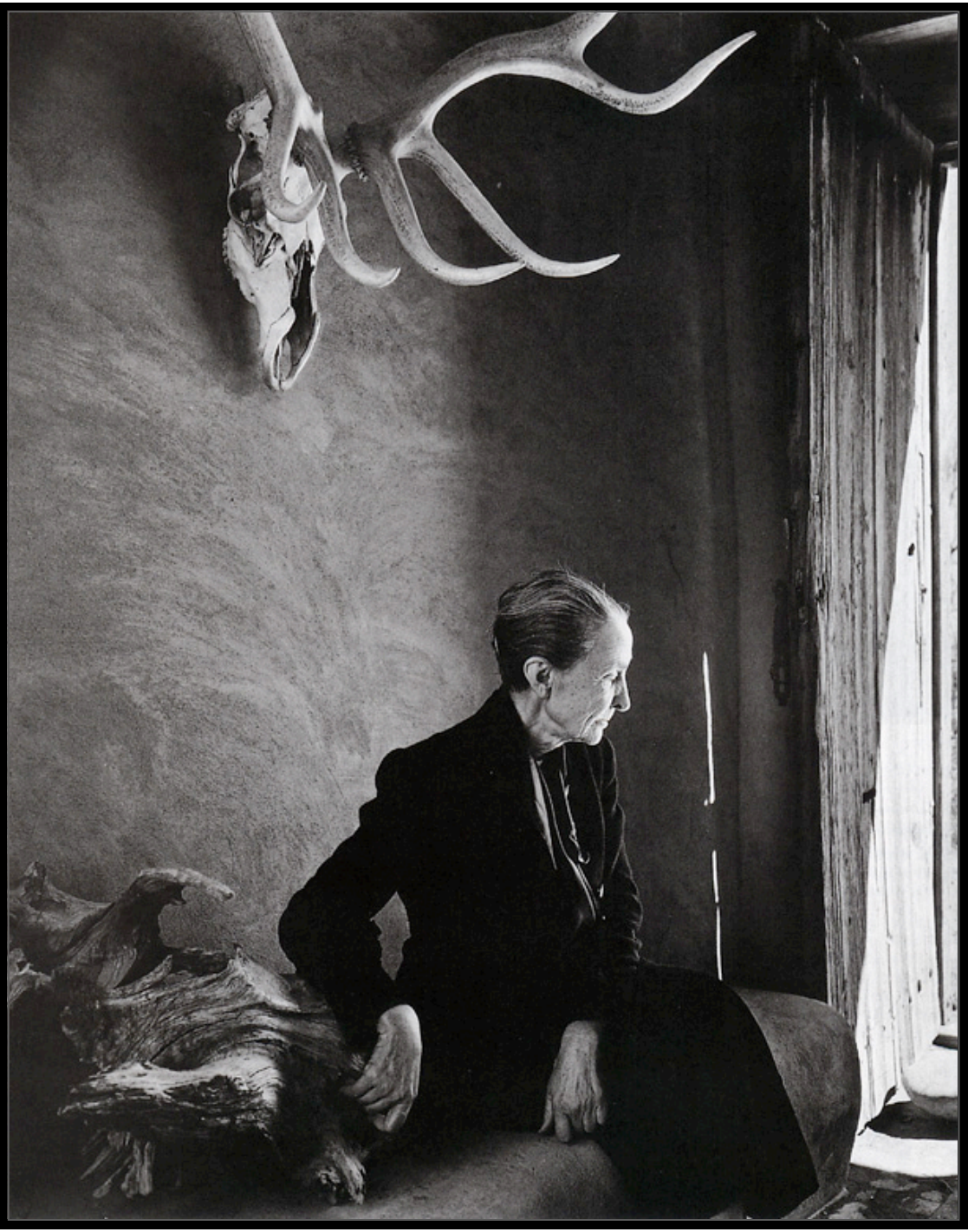
As I discussed in class, last time we looked at this portrait, we focused on its triangle composition (head-hand-hand). This time, think about figure-ground. It is accents of light against a dark background. Compare this to the next portrait...

Yousuf Karsh,
Winston Churchill,
1941

Unlike the previous portrait, here Karsh is using accents of dark against a mainly light-colored composition. Note also the strong lower-right to upper-left diagonal of the subject's back and famously long neck. By tilting her head just so, Karsh balances this diagonal with smaller upper-right to lower-left diagonals formed by her nose, eyelashes, and gaze direction.

Yousuf Karsh,
Audrey Hepburn
1956

Yousuf Karsh,
Peter Lorre,
1946



Yousuf Karsh,
Georgia O'Keeffe,
1956

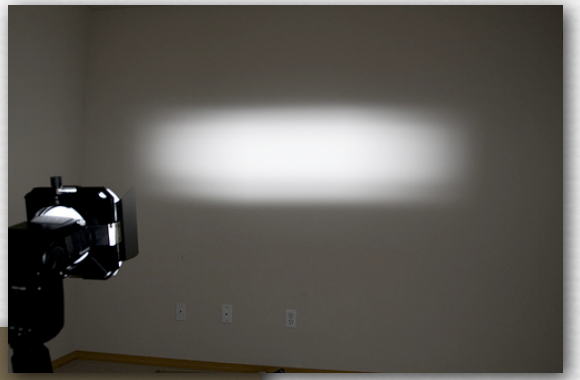
Caravaggio, The Calling of St. Matthew, 1599

Rembrandt, Belshazzar's Feast, 1599

Studio lighting

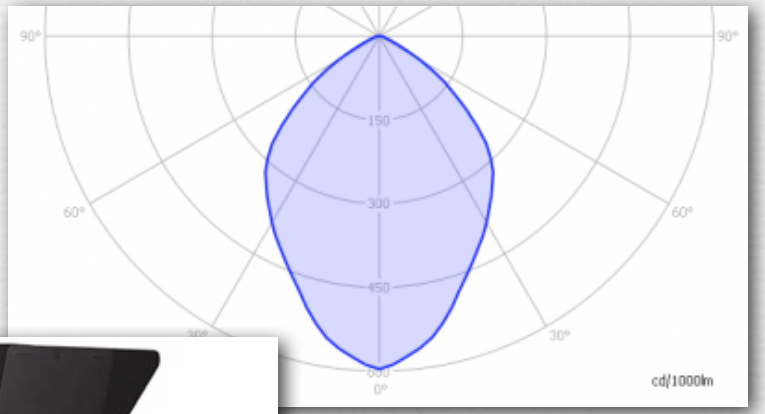
(Kodak)

Adjustments on studio spotlights



barn doors

goniometric diagram showing luminous intensity at each angle



zoom control

filter holder

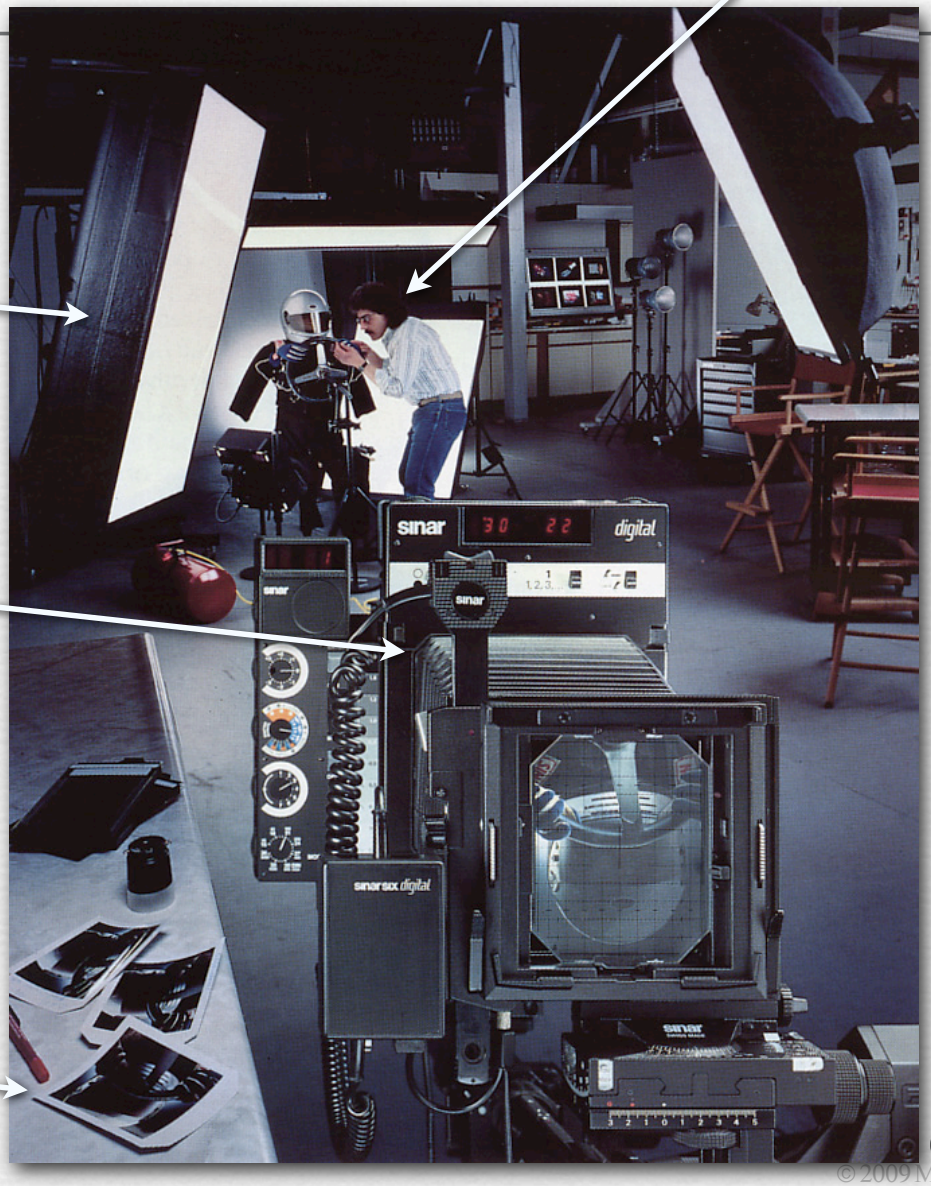
Lighting rigs can be large

1970's haircut

soft box

film view camera with digital light meter

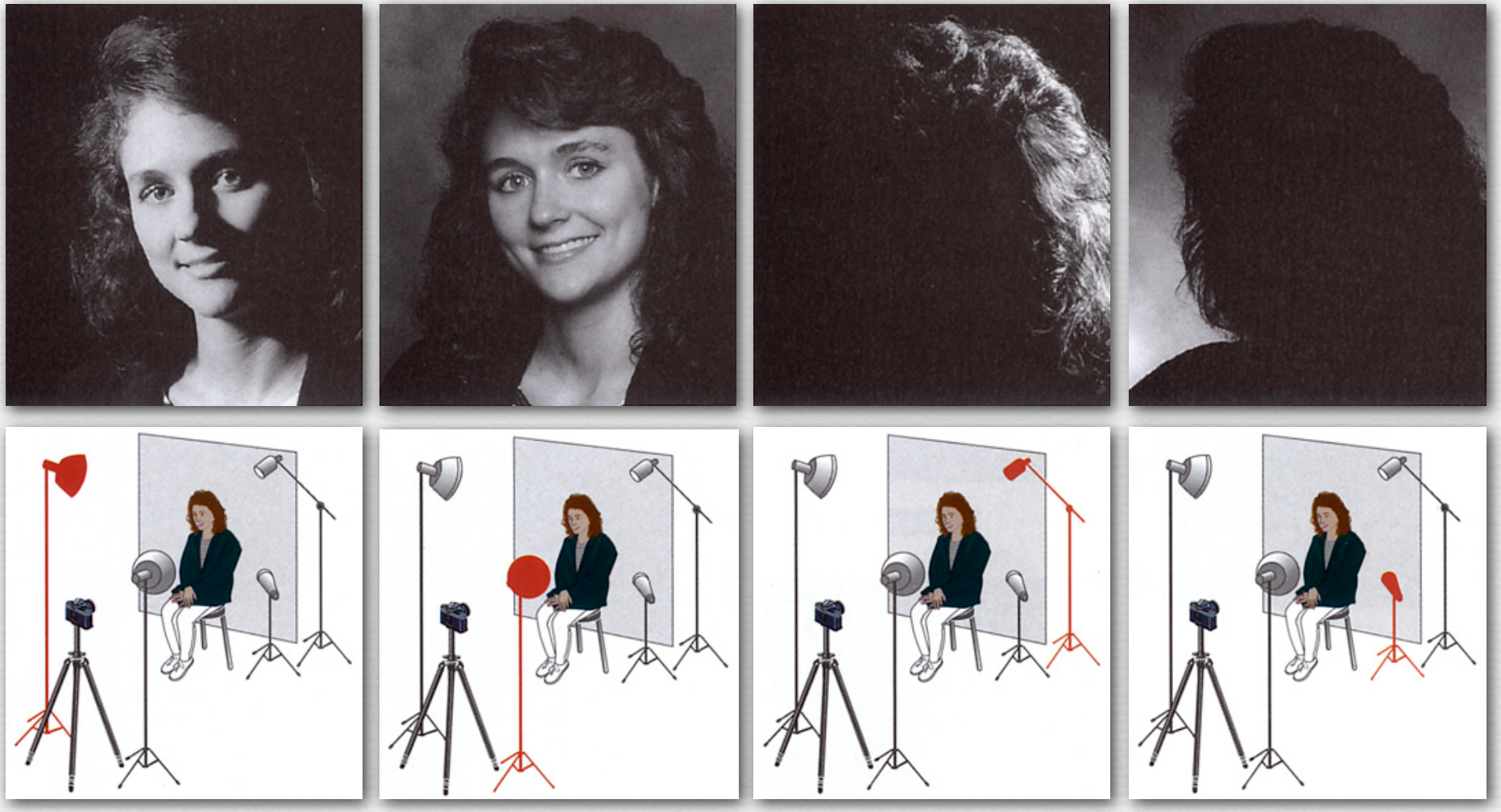
polaroid preview pictures



(Kodak)

Basic portrait lighting

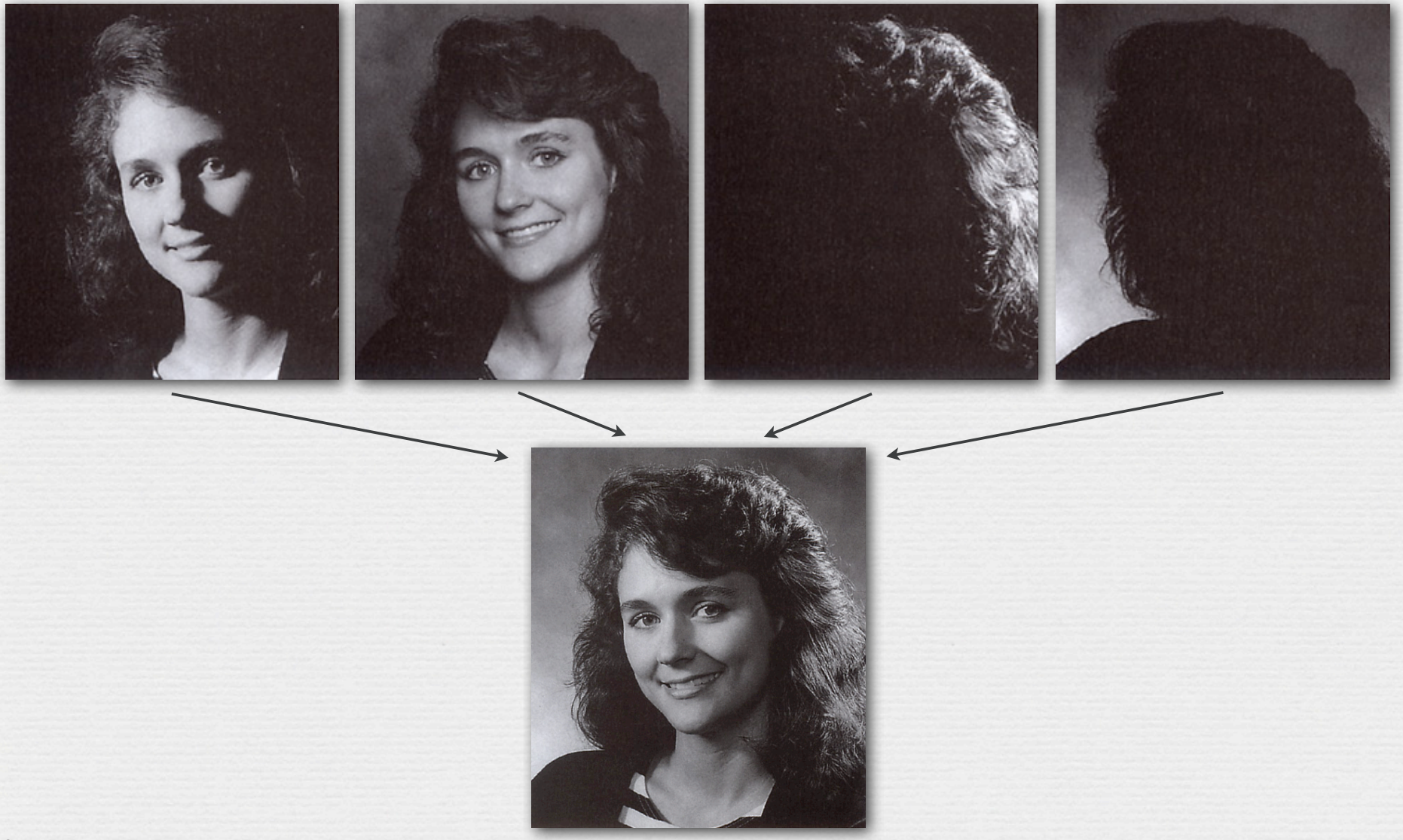
(London)



main/key | fill | accent/rim | background

Basic portrait lighting

(London)



Alternative lighting arrangements

- main light on side towards camera - broadens narrow faces
- main light on side of face away from camera - most common
- main light directly in front of face - glamour lighting

broad

short

butterfly

key:fill light ratio

(London)

1:1

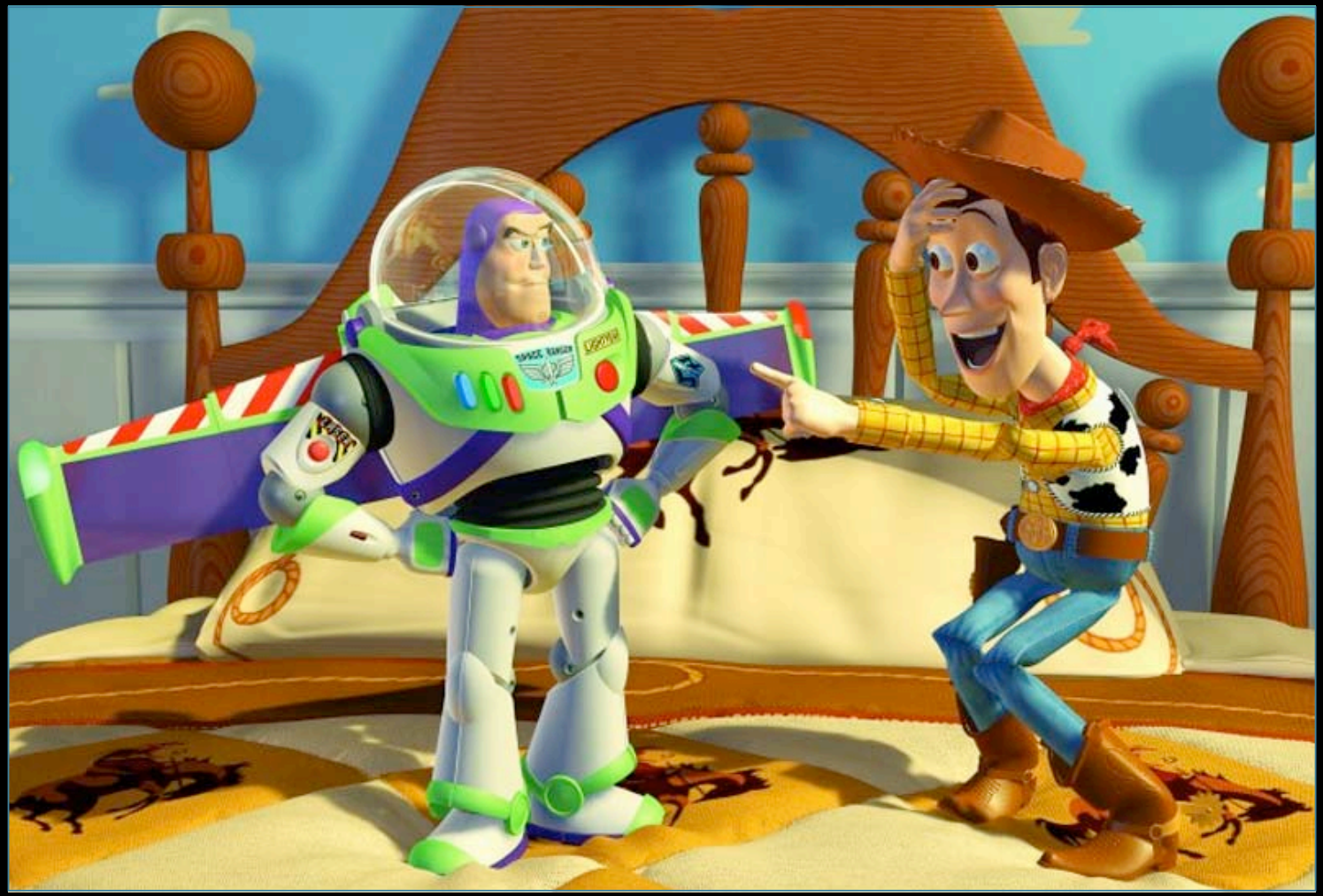
2:1

4:1

8:1

- 8:1 means 3 f/stops (3 doublings)
- think about the mood you want to convey
- the color of the key and fill lights can be different...

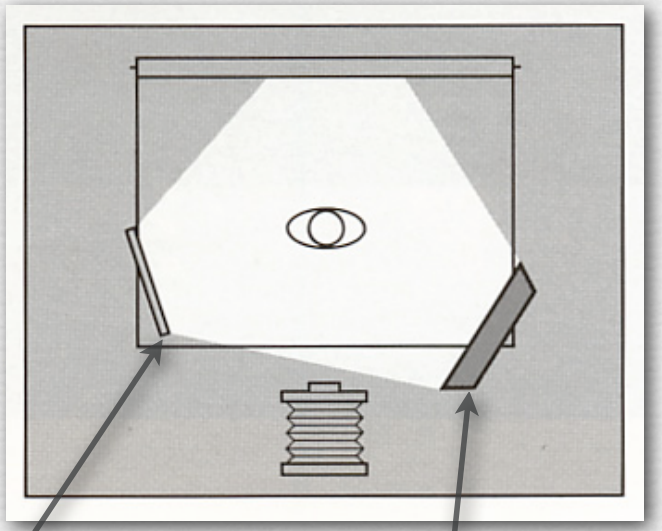
Maxfield Parrish, Daybreak, 1922



Pixar, Toy Story, 1995

Professional photographic lighting manuals

photographed by
D.W. Mellor



diffuse reflector

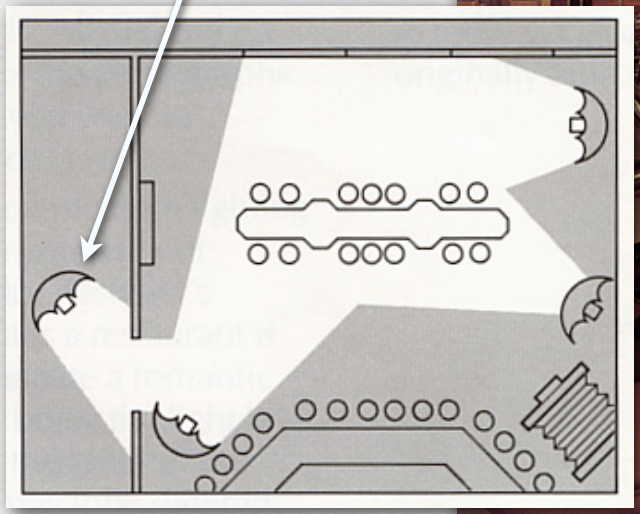
diffused spotlight

(Kodak)

Special problems: architectural interiors

2-second exposure to show dusk outdoors

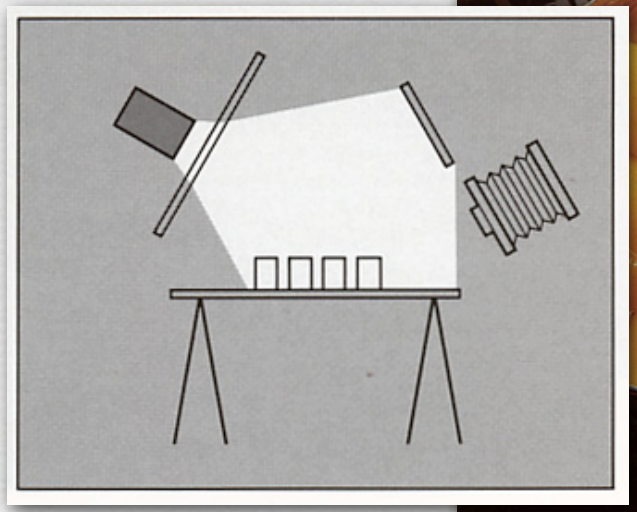
note lighting in 2nd room



(Kodak)

Special problems: food (without breaking FTC laws)

photographed by Richard Fukuhara



(Kodak)

Special problems: surface details

(Hunter)

overhead light

grazing light

How is this sculpture lit?



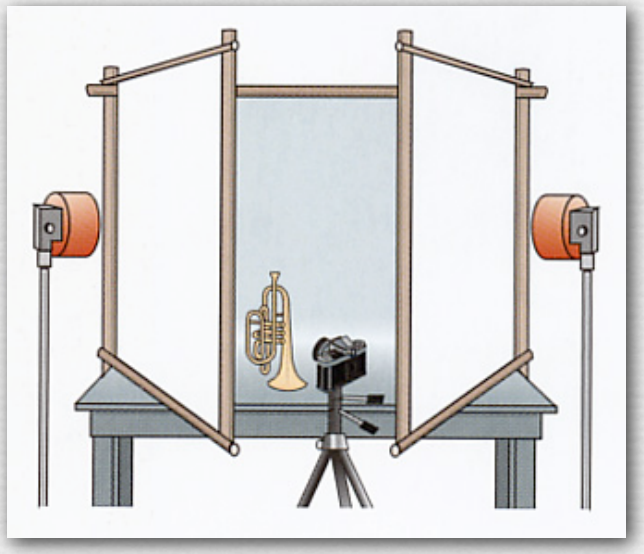
The bas-relief ambiguity

[Belhumeur CVPR 1997]

- changing the depth of an object is equivalent to changing the angle of lighting on it - they produce the same image
  - otherwise, bas-relief sculpture wouldn't work

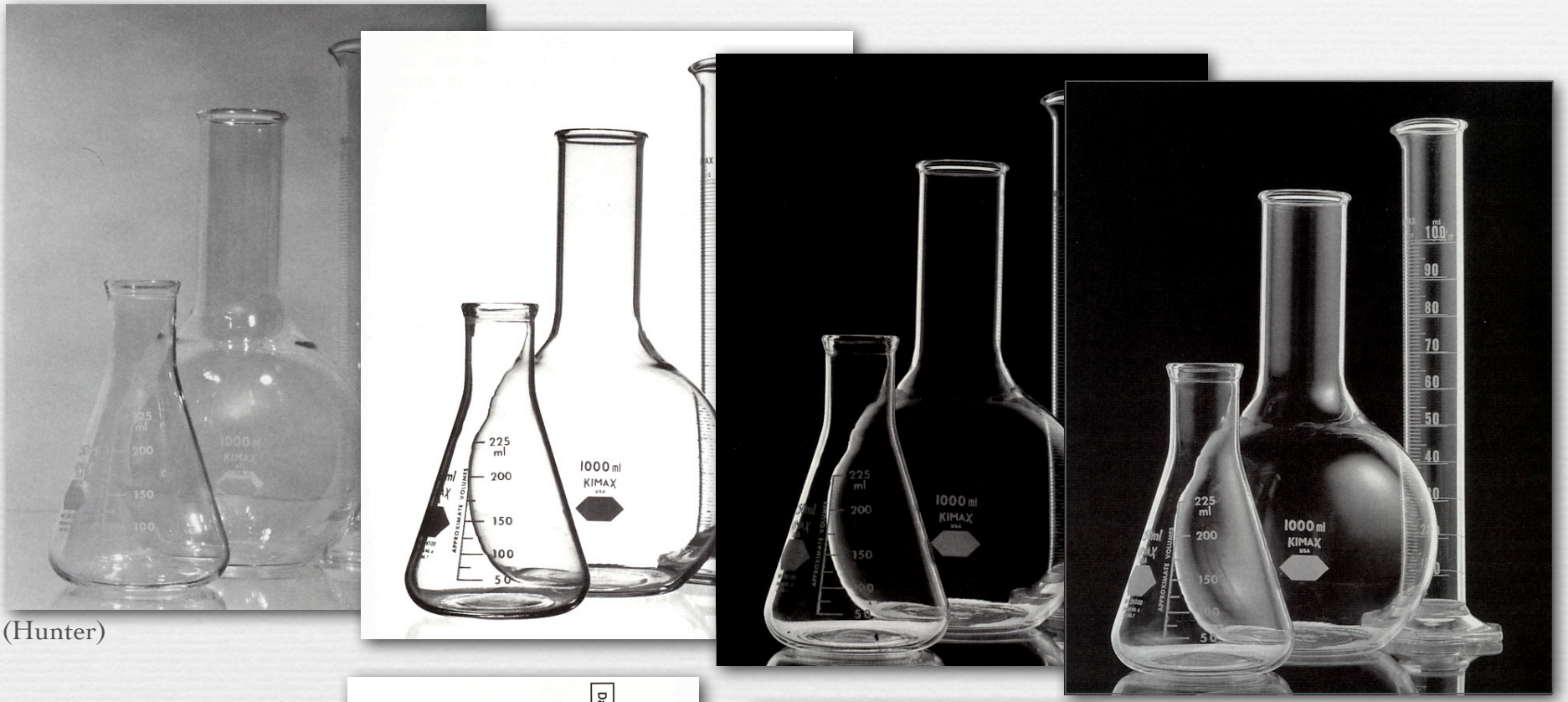
Special problems: shiny objects

photographed by
Fil Hunter

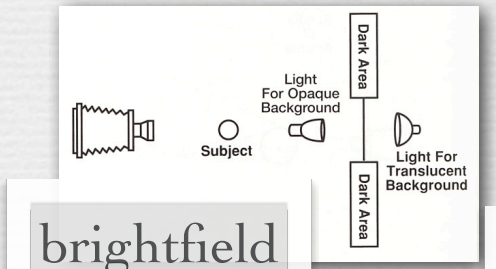


(London)

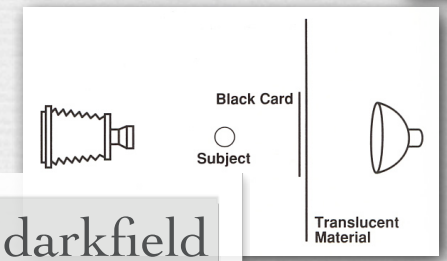
Special problems: glassware



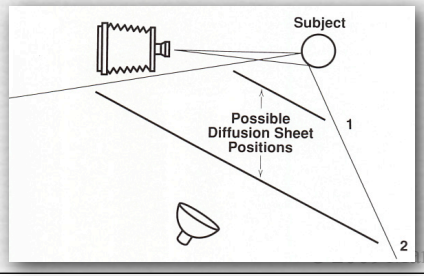
(Hunter)

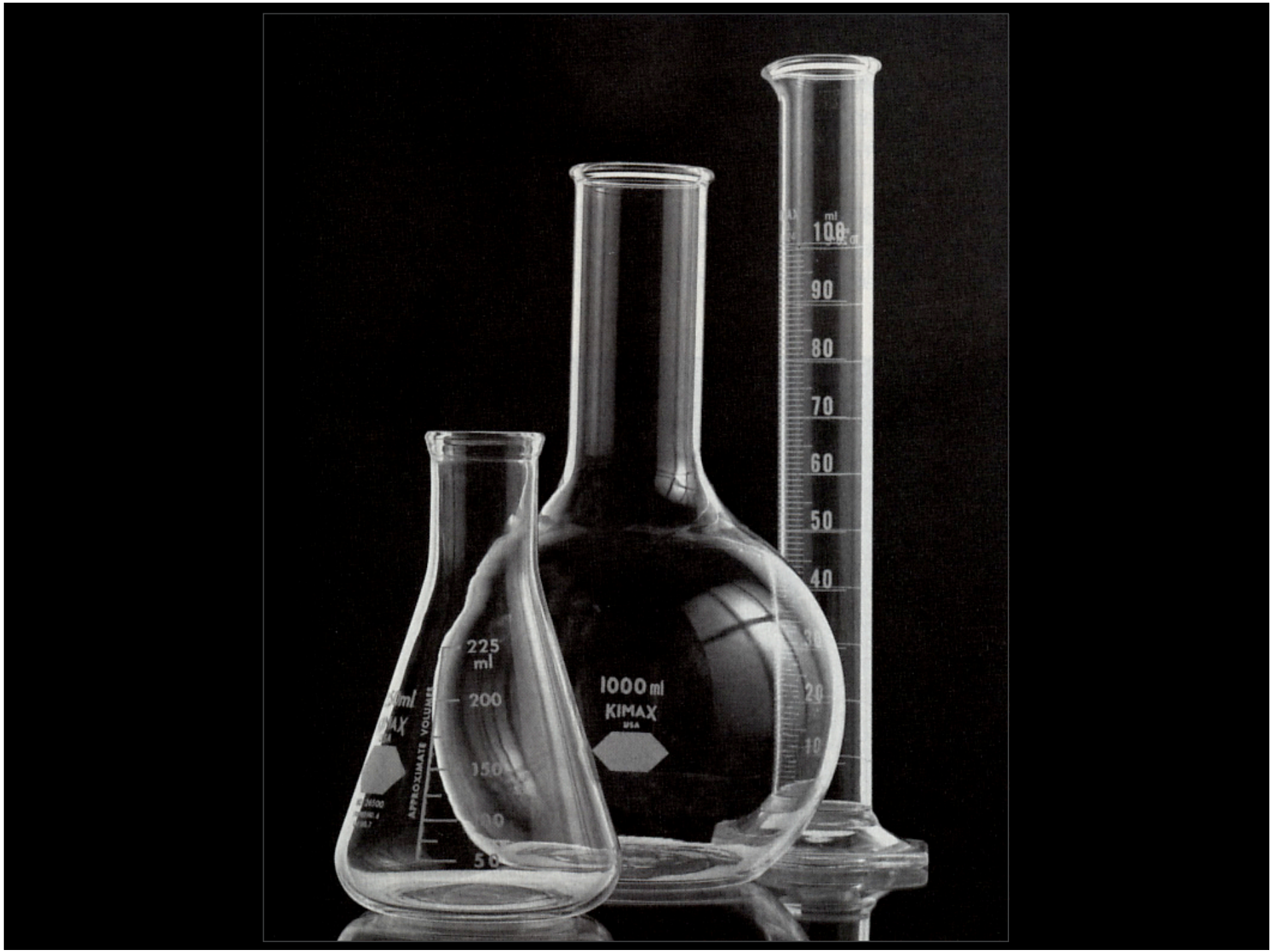


brightfield



darkfield




225 ml
200
1000 ml
KIMAX
USA
APPROXIMATE VOLUME
ml
100
90
80
70
60
50
40
20
10

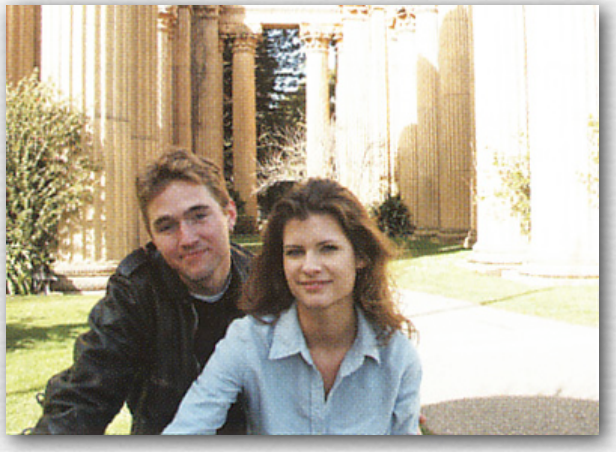
When to use flash?

- freezing the action
- fill-flash
- flash-plus-ambient
- ways to avoid using flash

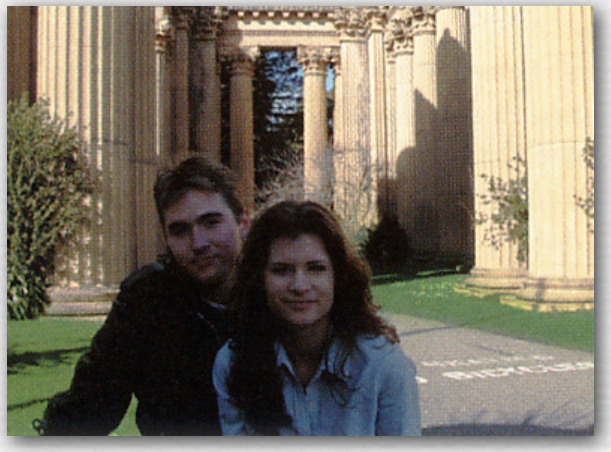
Lois Greenfield,
dance photography, 1988-

Fill-flash (for brightly lit backdrops)

(London)



exposed for foreground



exposed for background

exposed for background, with fill flash

- shorten exposure, then add flash
- could instead use HDR, but that requires multiple shots

Flash-plus-ambient (in low light)

(Ang)

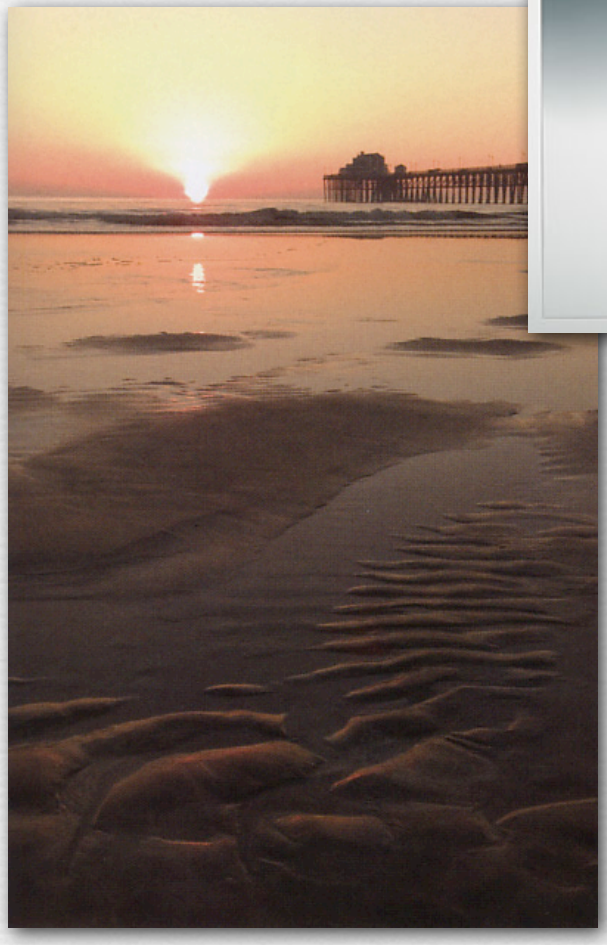
standard flash
exposure

1/4 second
with flash

- use flash, and lengthen exposure
- avoids isolating the foreground from its background

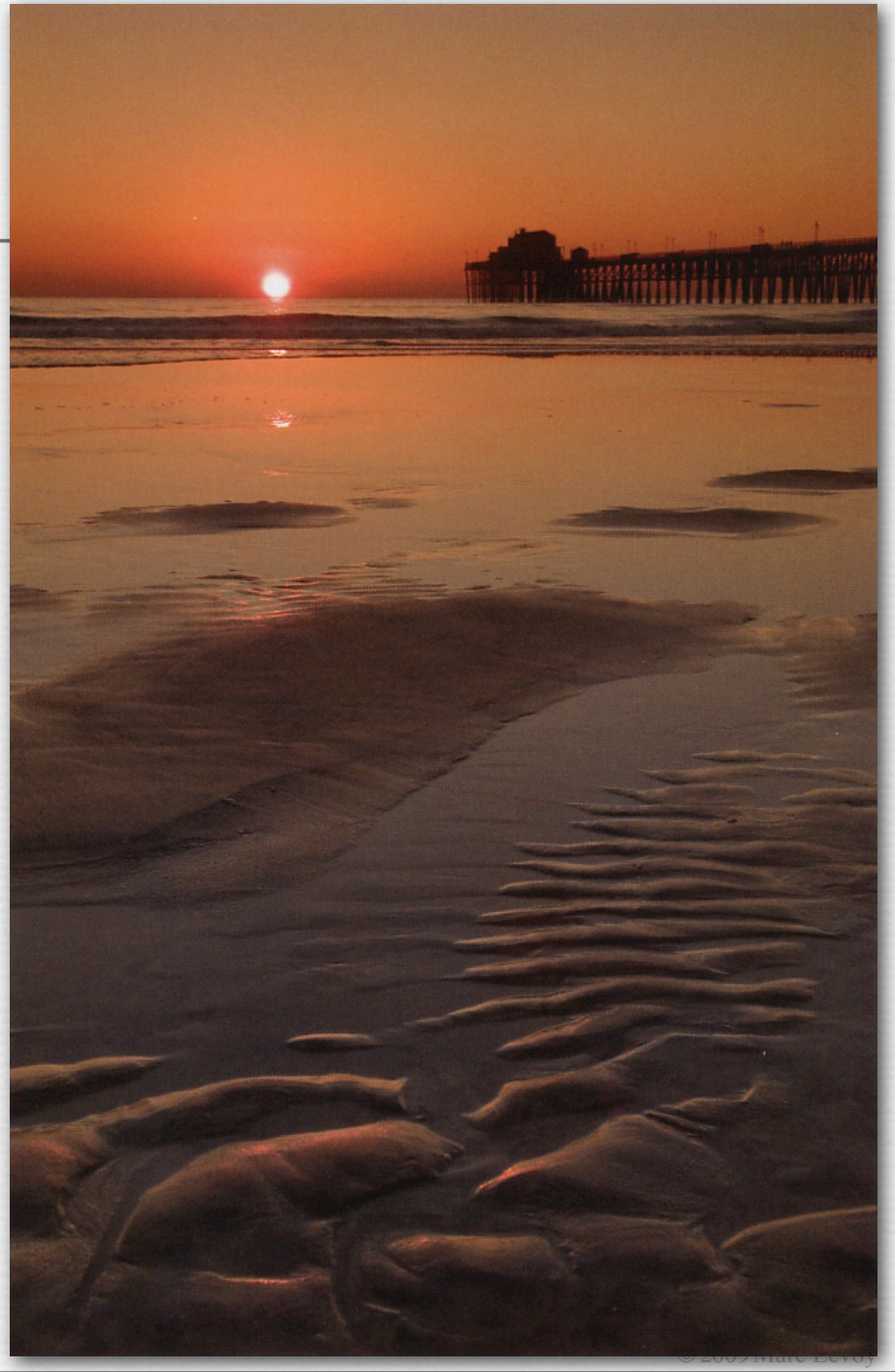
Avoiding flash

(Peterson)



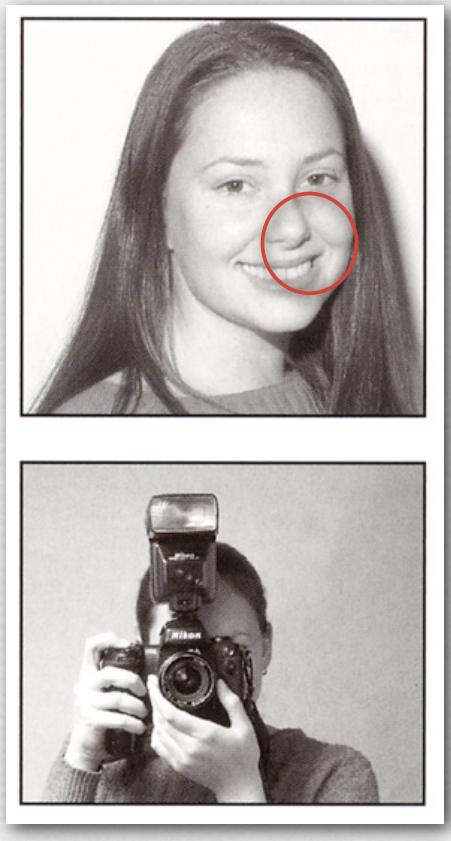
straight shot

with graduated
neutral-density filter



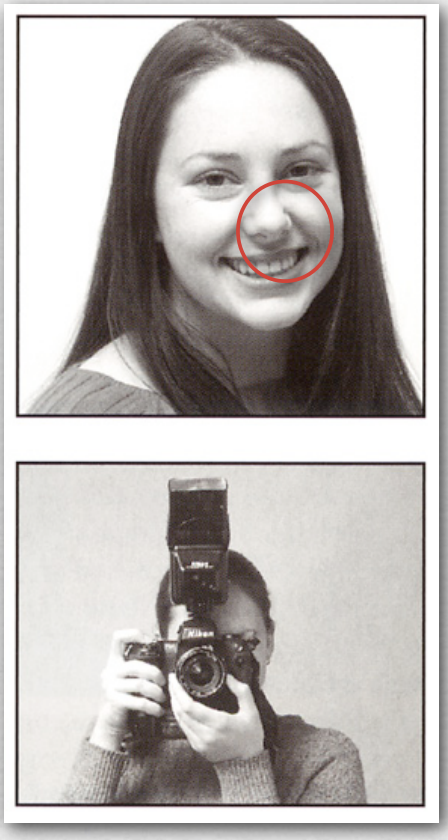
Flash placement

(London)

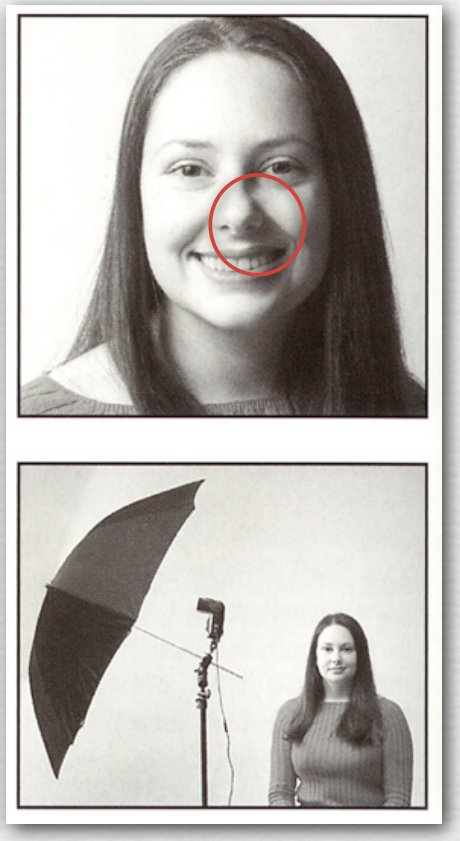


direct flash,
on camera

direct flash,
off camera



bounce flash,
from above



bounce flash,
from the side

Flash technology

(Race Gentry)

1880: flash powder

powdered magnesium +
potassium chlorate +
antimony sulfide

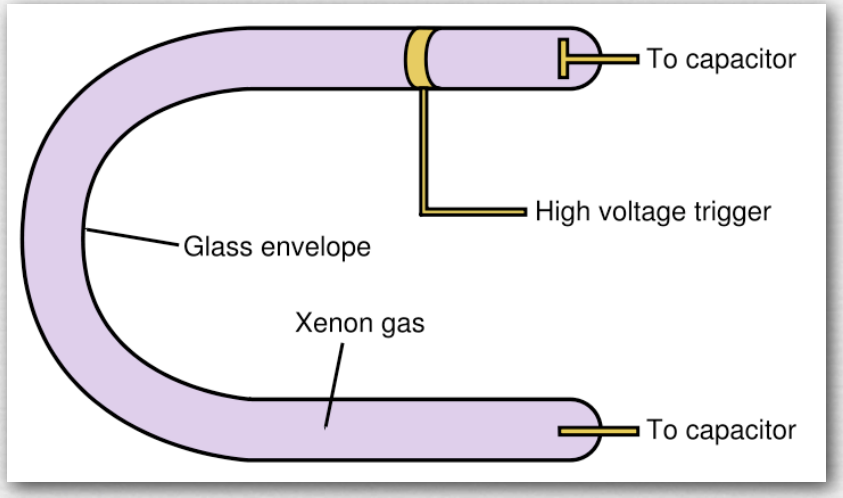
1927: flashbulbs

aluminum foil in oxygen,
later tungsten or zirconium filament
coated in explosive primer paste

1960s: flashcubes

Electronic flash

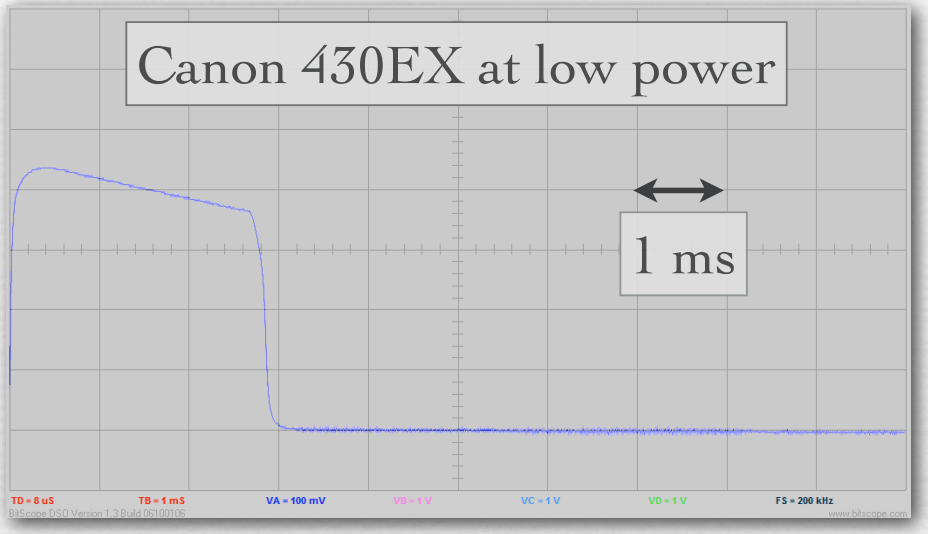
Canon 580EX

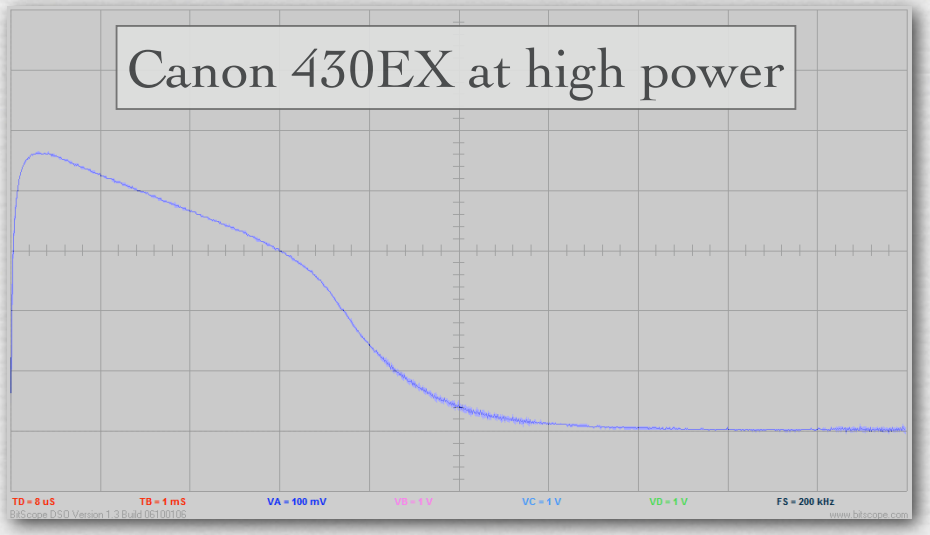


- battery charges up a capacitor (dangerous when disassembled!)
- high-voltage trigger ionizes the gas inside the tube, reducing its resistence to the flow of electricity and causing streamers of ionized gas to form (like "leaders" in lightning)
- the capacitor discharges through the ionized gas, heating it to a plasma state and causing an intense but brief discharge of light

Controlling exposure in flash photography

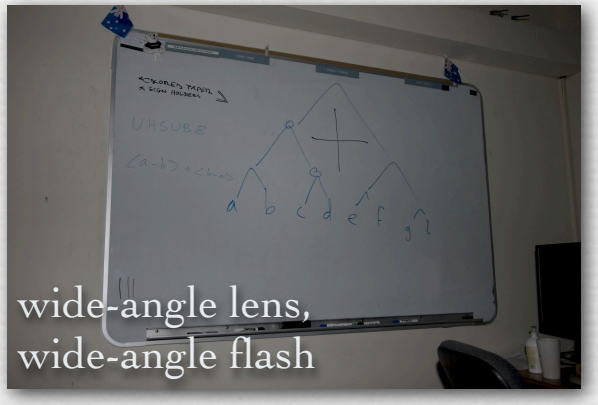
- the luminous intensity of a particular xenon flash tube is fixed
- flash is briefer than the shutter, so you can't use shutter speed to control illuminance on sensor
  - you can still use it to control ambient light
- aperture and ISO affects recording of both flash and ambient light
- instead, adjust duration of the flash pulse

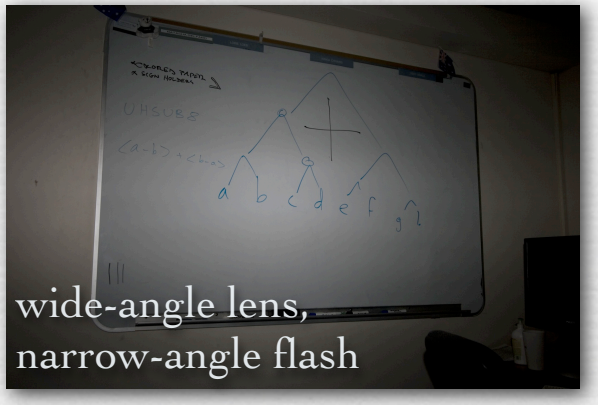




Guide numbers

- flash power is measured in *guide numbers*
  - proper aperture size = guide number / distance to subject
  - varies with focal length for zooming flashes
  - assumes ISO 100

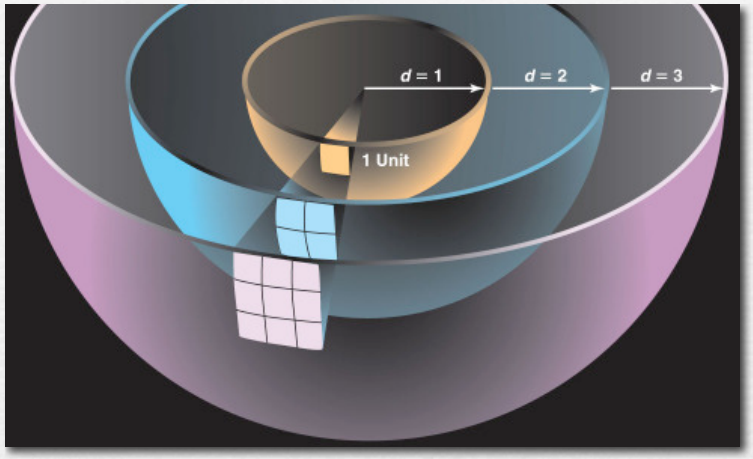

wide-angle lens,
wide-angle flash


wide-angle lens,
narrow-angle flash

- examples
  - Canon 580 EX hot-shoe flash: guide number 58
  - Nikon D40 pop-up flash: guide number 15
  - Canon SD800 point-and-shoot: guide number 4

  - for Canon 580EX and a subject 10' away, use f/5.6
  - for Canon 580EX and f/1.4 lens, subject can be 41' away !

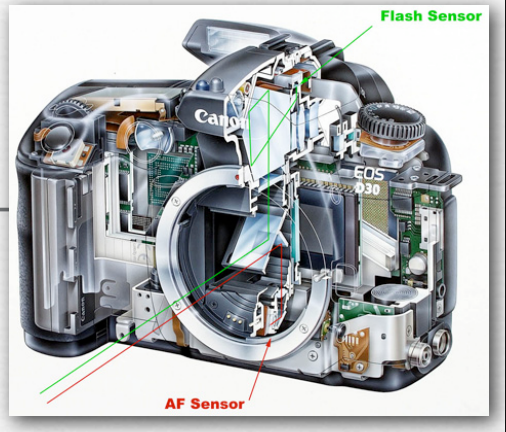
The effect of distance to the subject



(Thomson)

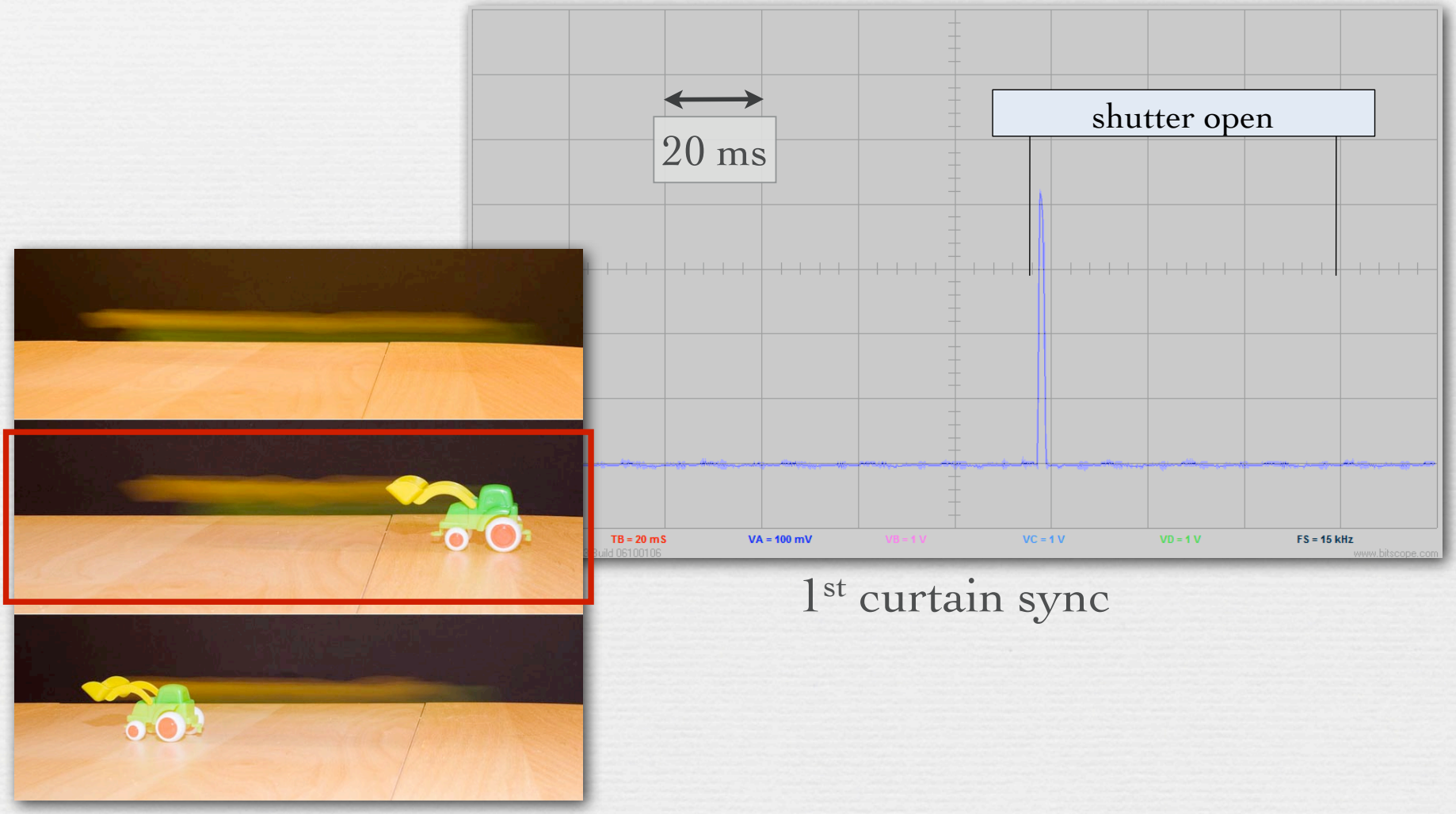
- if you treat flash as a point source, then illuminance (power per unit area) arriving on a subject from the flash falls as d^2
- with respect to a camera pixel, a subject is an area source, so the illuminance arriving on a pixel is independent of d
- hence, under ambient light subjects don't dim with distance, but under flash illumination they dim quadratically !
- to double the distance a flash can reach (~guide number), you must increase its luminous intensity (power per sr) by 4× !!

Metering for flash photography
(Canon E-TTL or Nikon iTTL, including Nikon D40)



- on shutter half-press, focus under ambient light (or AF assist light) and meter for ambient light
- on shutter press, fire weak preflash and record on flash sensor
- compute some combination of aperture, flash duration, and ISO
  - decision uses multi-point metering of ambient light, multi-point autofocusing, shooting mode, etc.
- flip up mirror, open shutter, and fire flash
- drawbacks
  - fooled by specular objects, scenes that fool metering and focusing,...
  - delay between pre-flash and flash is long enough to cause some people to blink, especially if using 2nd curtain sync

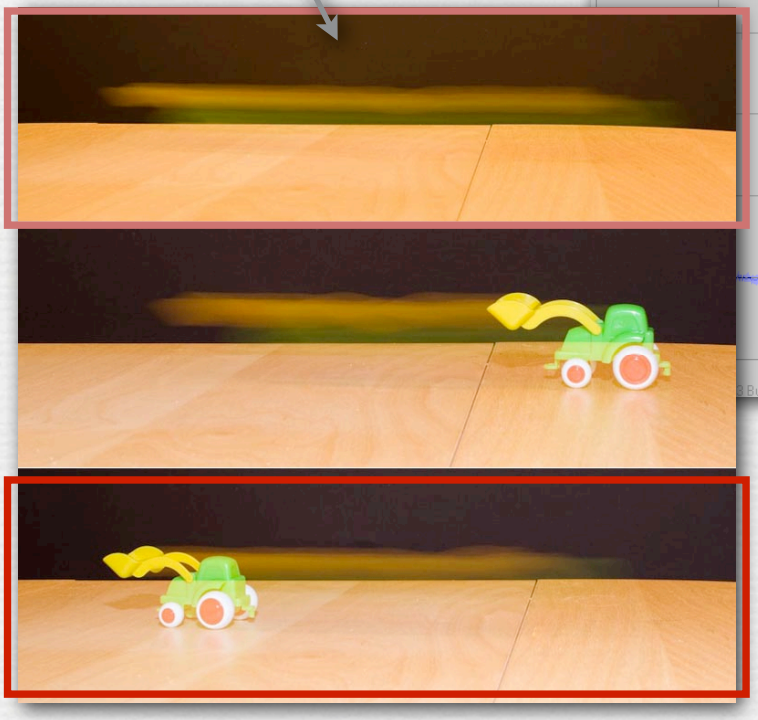
Second-curtain sync

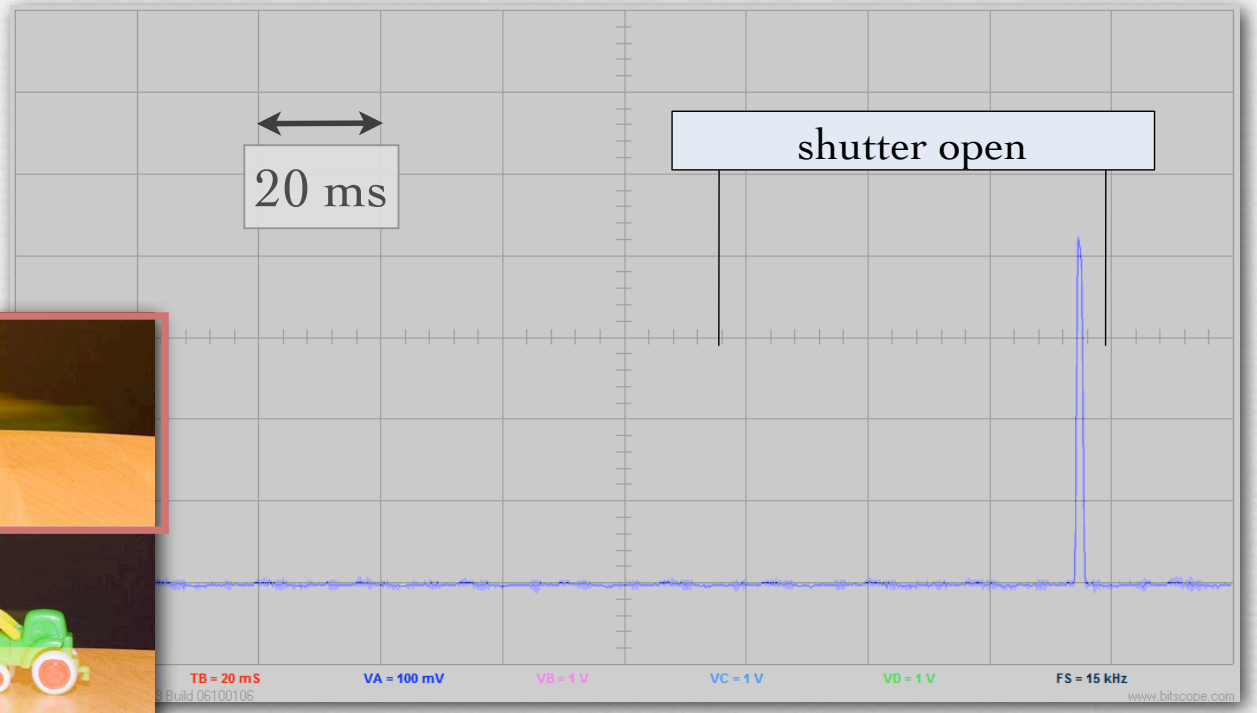


1st curtain sync

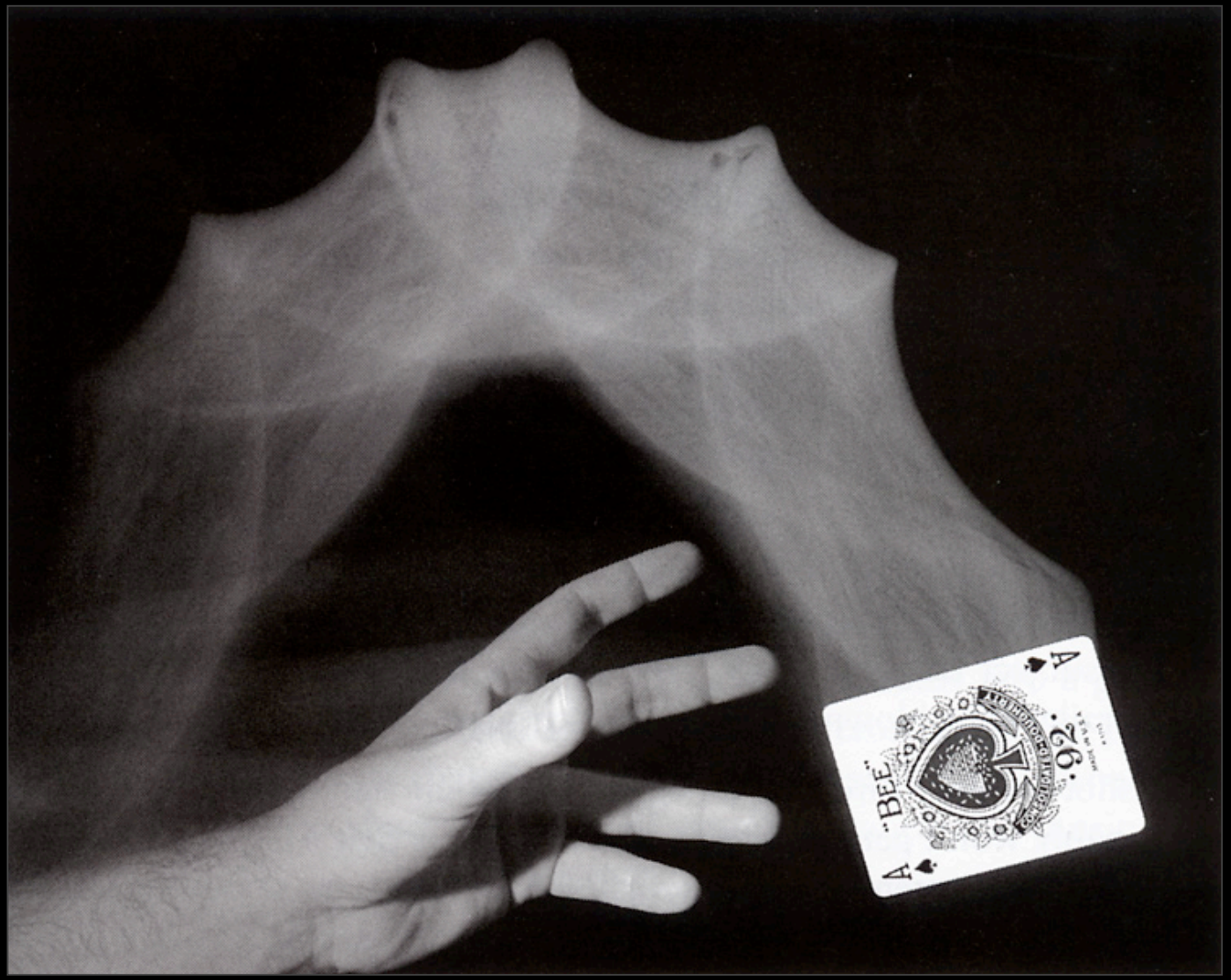
Second-curtain sync

ambient light only





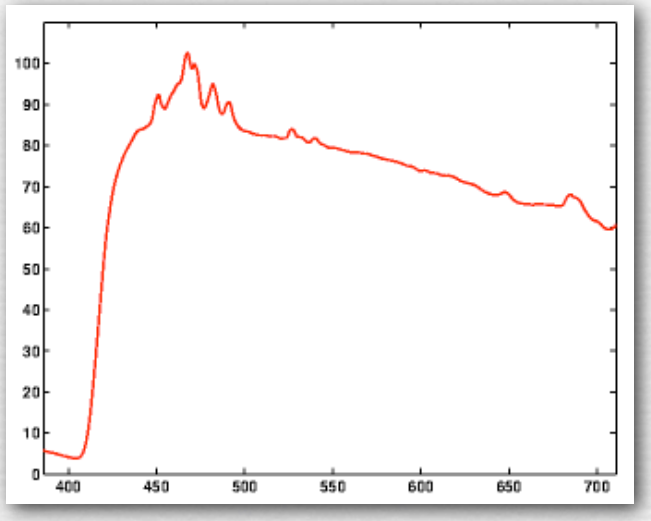
2nd curtain sync



Derrick Story, card flip using second-curtain flash

Color temperature of xenon flash

(graphics.cornell.edu)



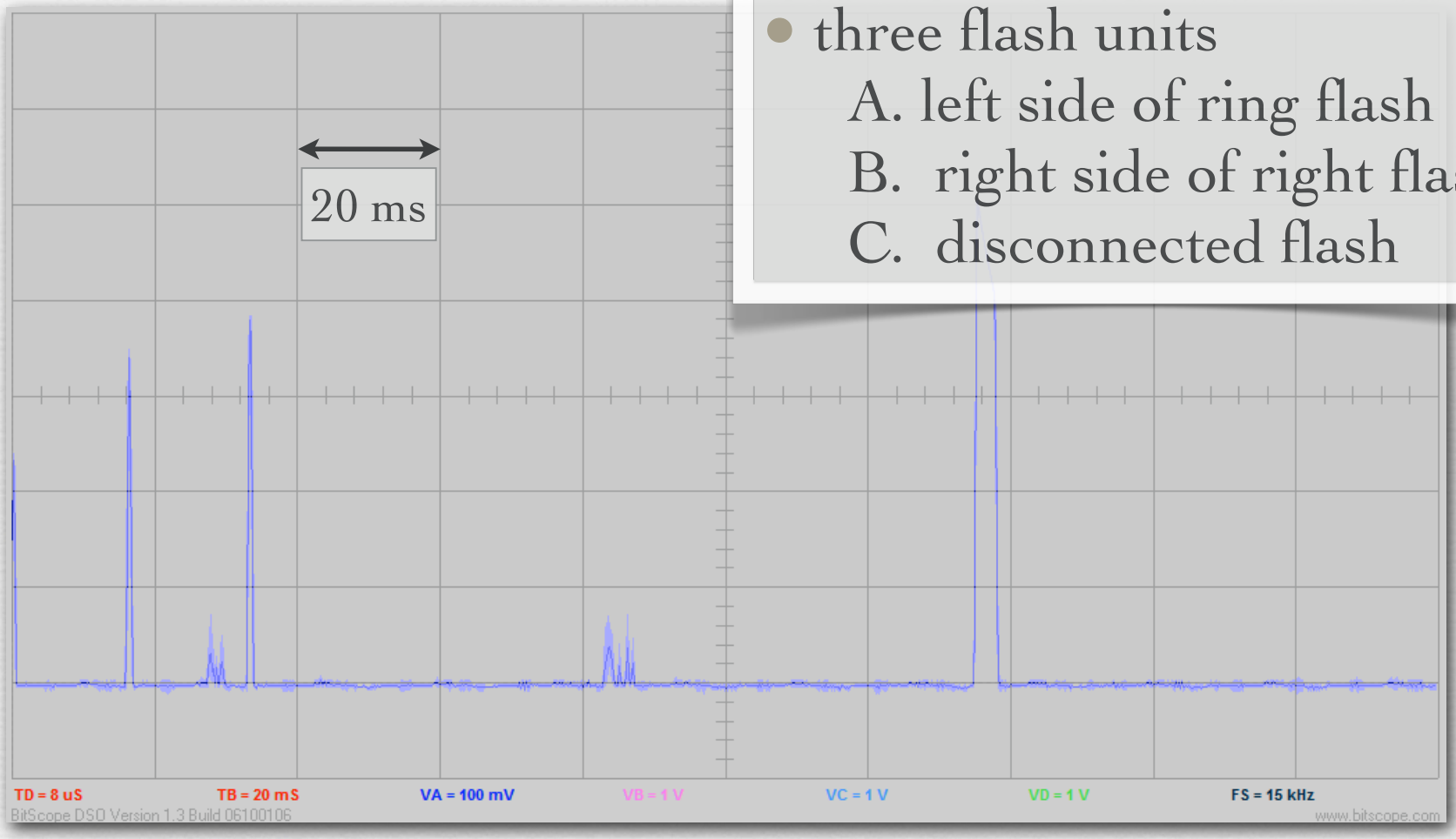
- broad spectrum, approximates daylight (6500°K, i.e. D65)
- if mixed with ambient tungsten light, flash will look blue if WB is Tungsten, or background will look orange if WB is Flash
  - can compensate with color correction filter on the flash
  - filters are enumerated in °K of correction
  - filters reduce effective flash power

Other flash features

- flash exposure lock (FEL)
- flash exposure compensation (FEC)
- flash exposure bracketing (FEB)
- strobe modes
- speciality flashes, like ring flash
- wireless master-slave
  - uses light pulses to pass messages, not radio!

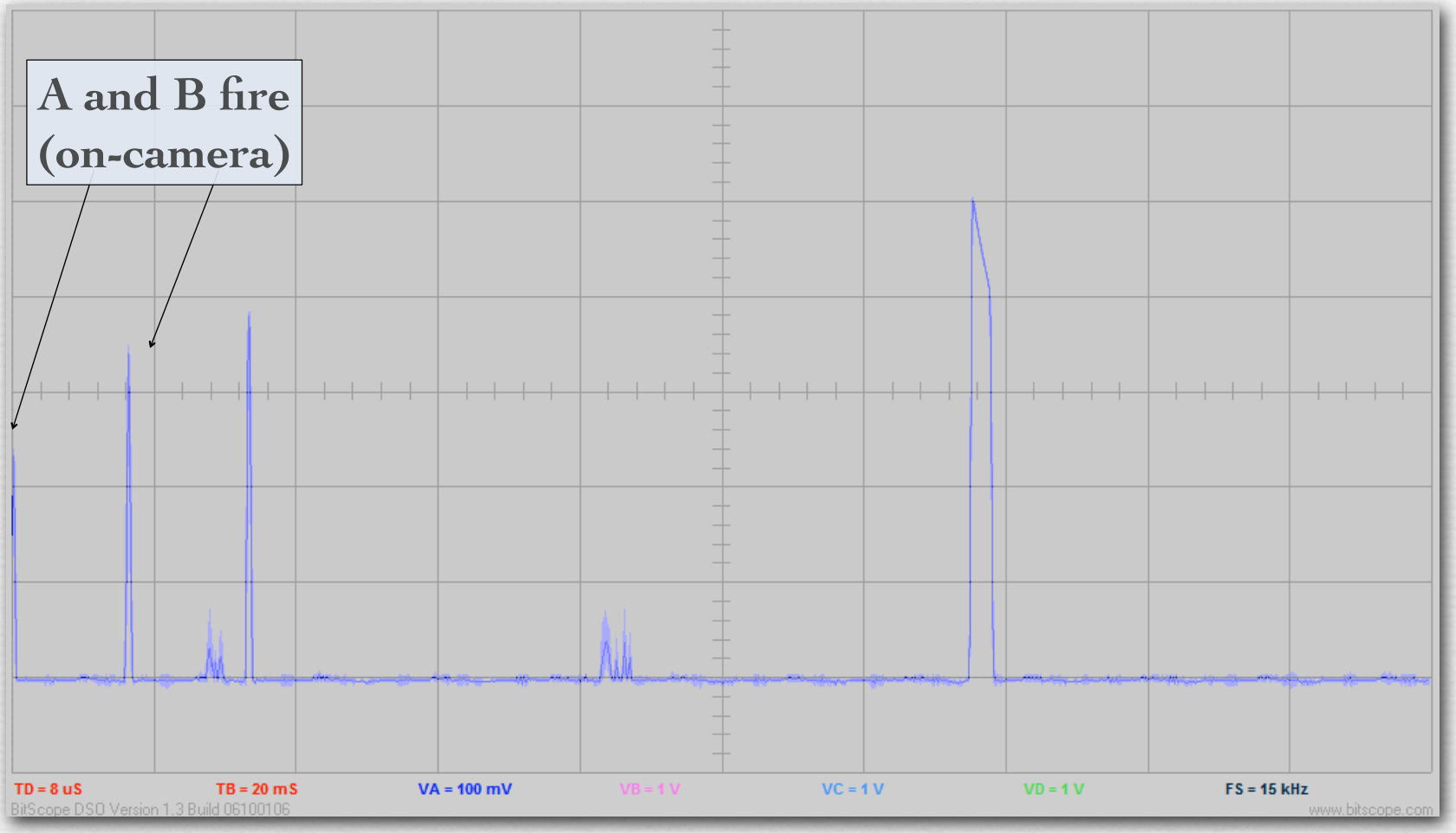
- check out http://photonotes.org/articles/eos-flash/index2.html

Master-slave metering and firing

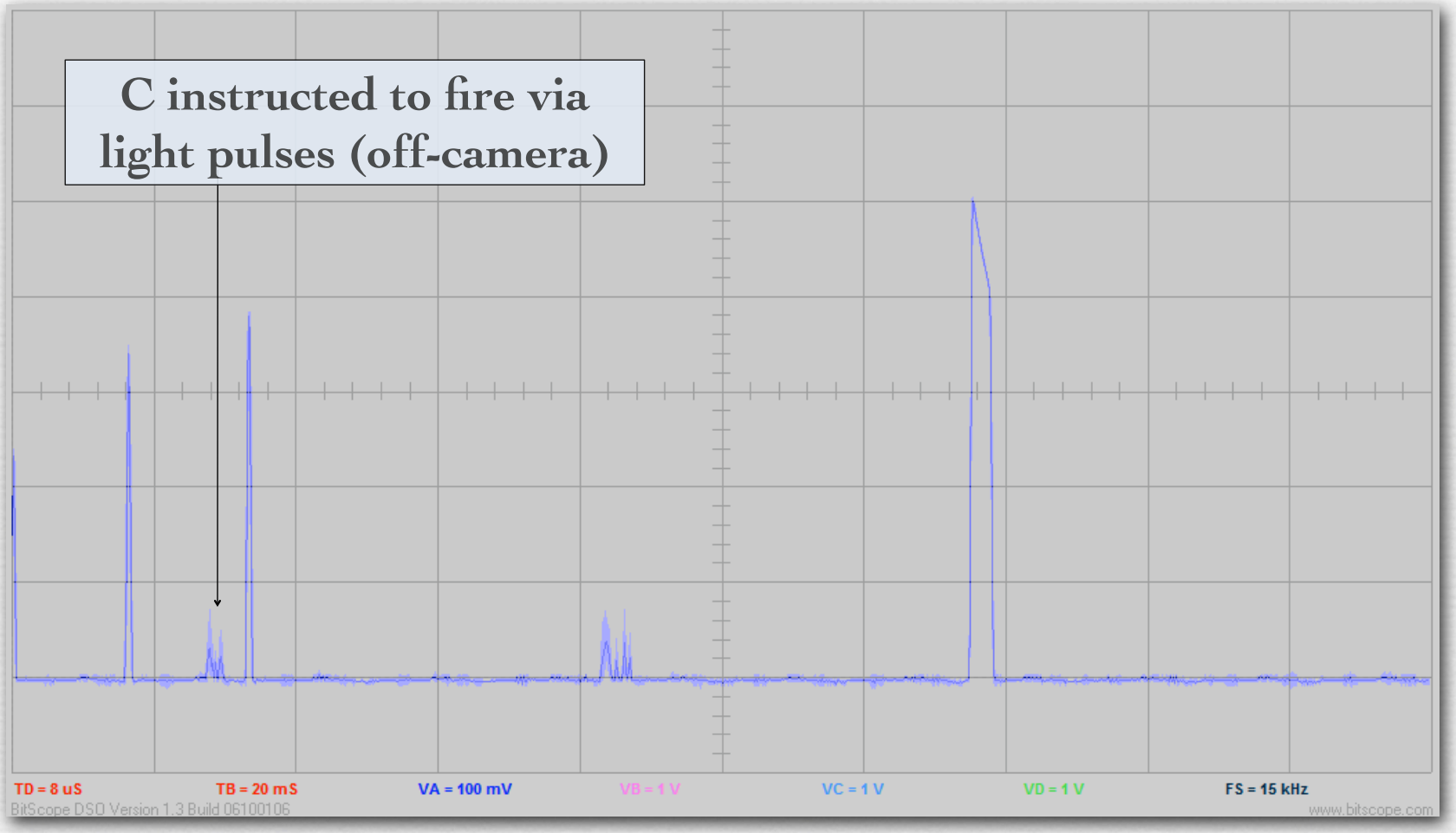


- three flash units
  - A. left side of ring flash
  - B. right side of right flash
  - C. disconnected flash

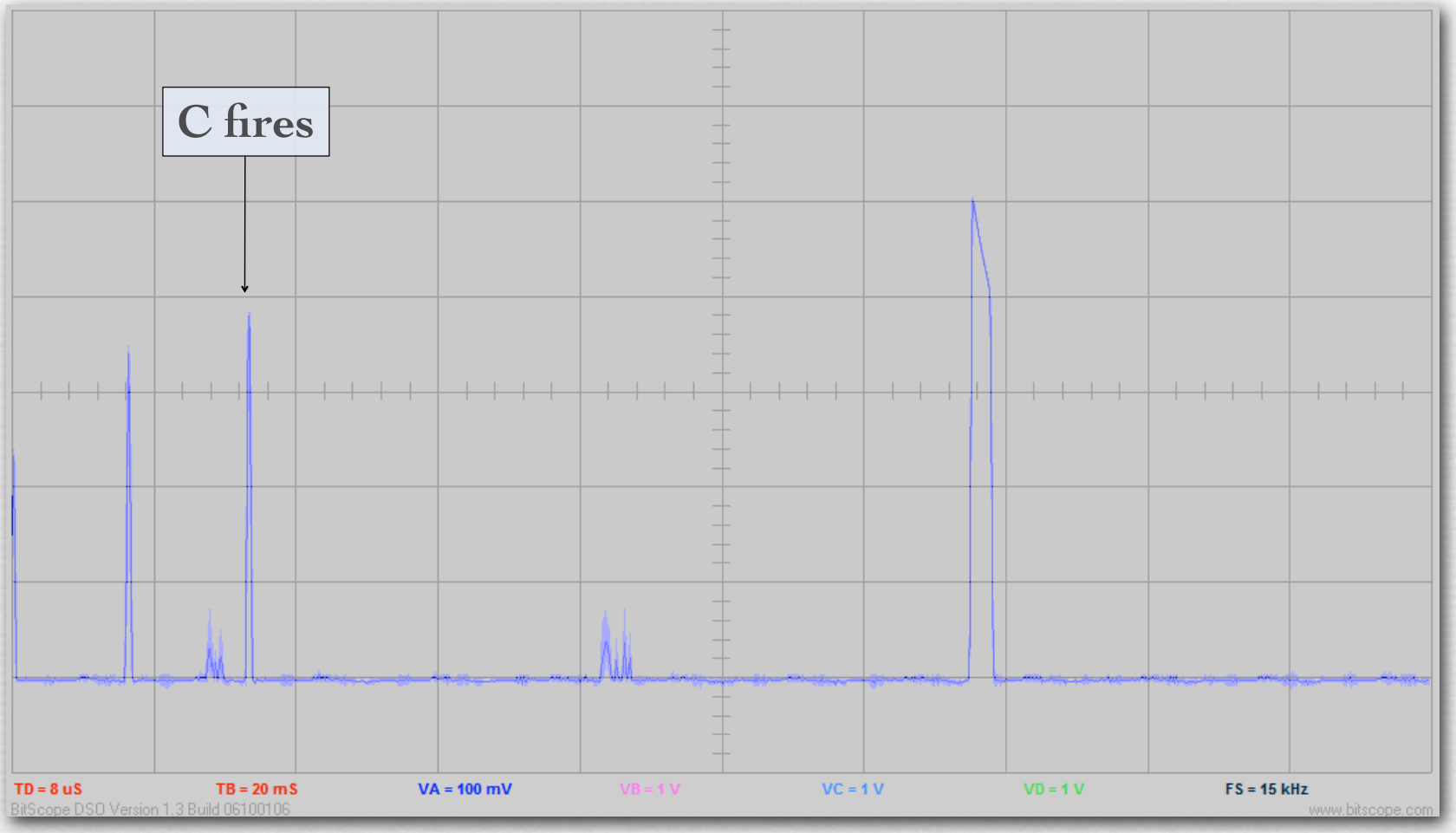
Master-slave metering and firing



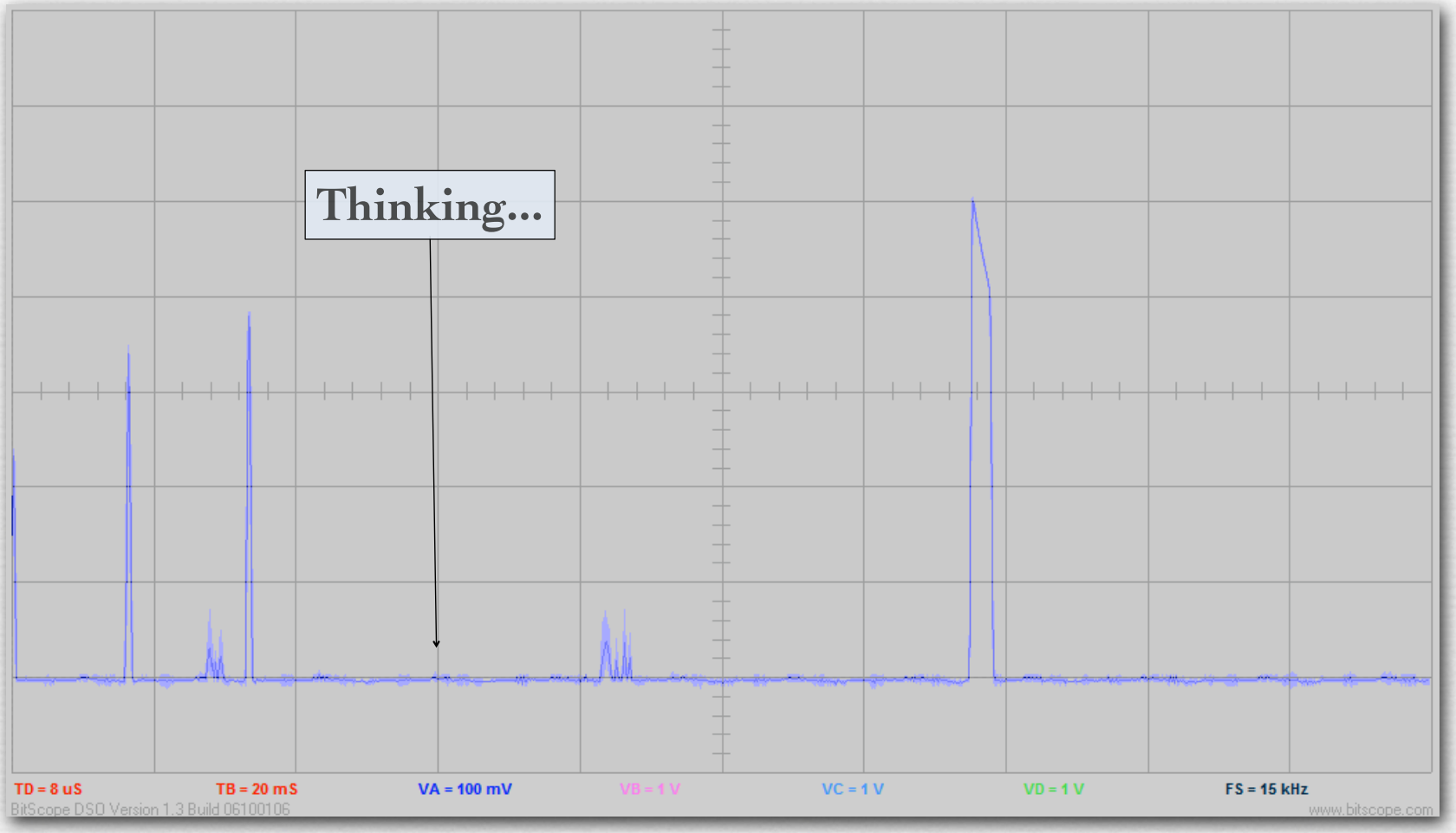
Master-slave metering and firing



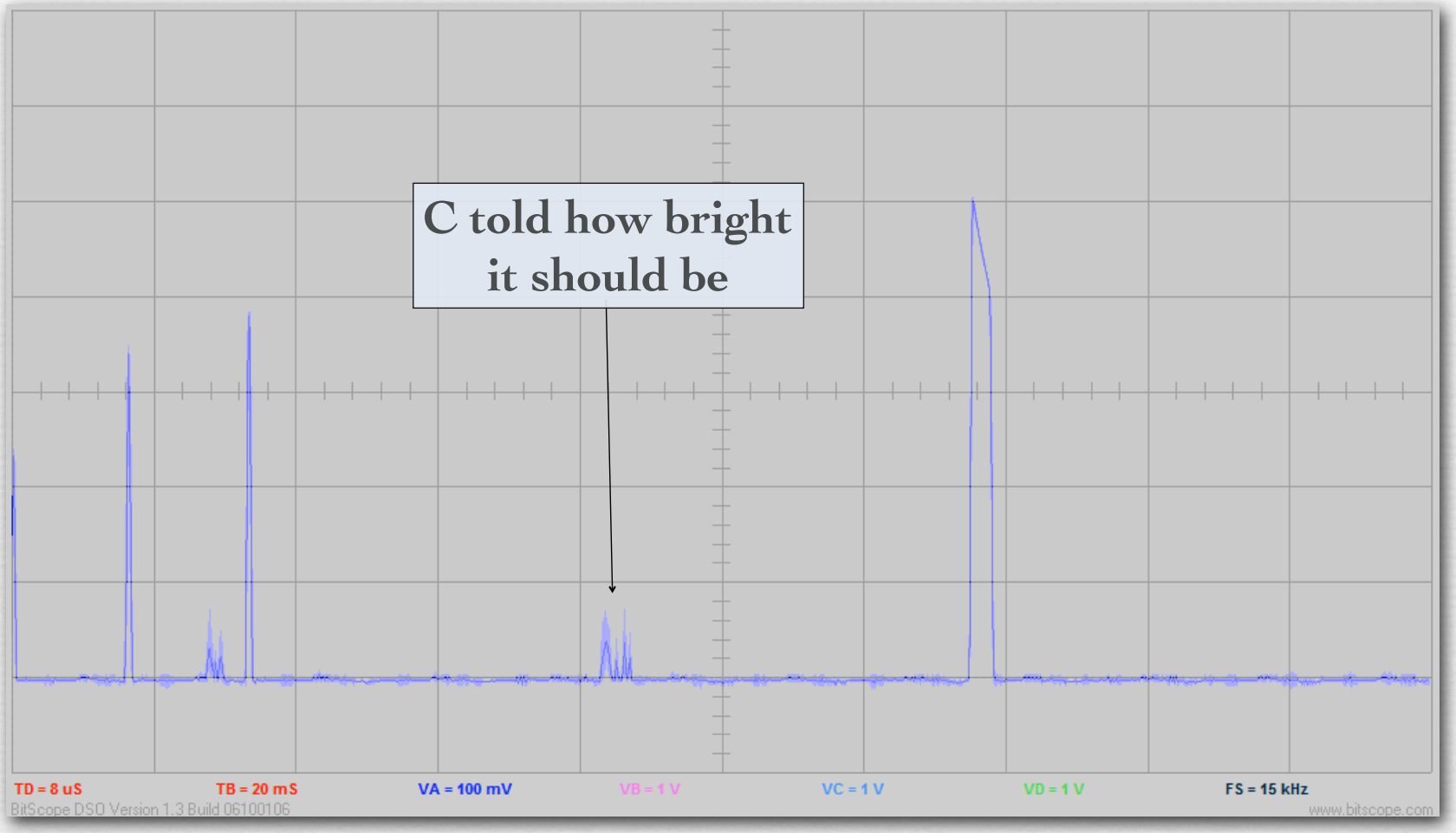
Master-slave metering and firing



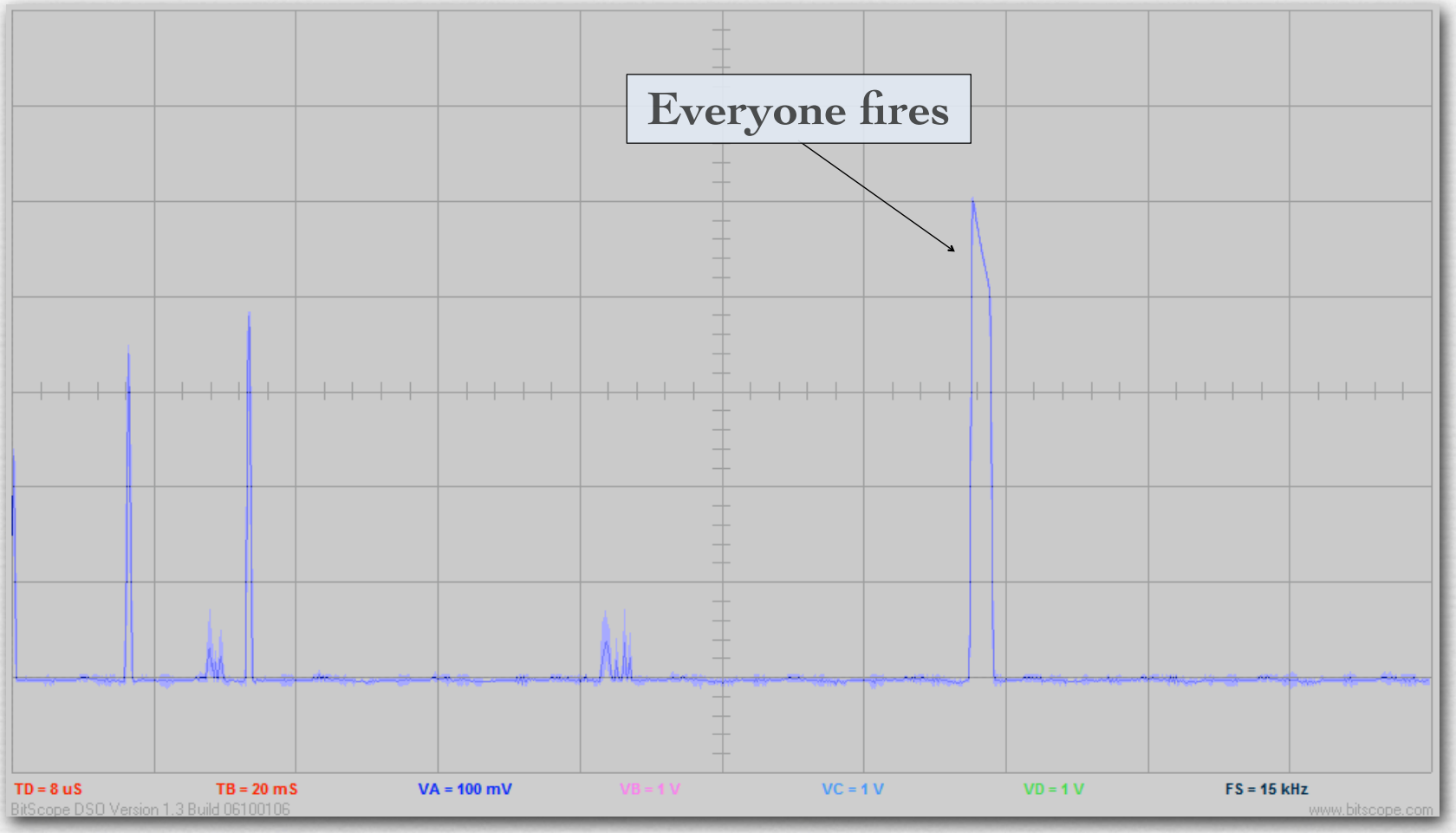
Master-slave metering and firing



Master-slave metering and firing



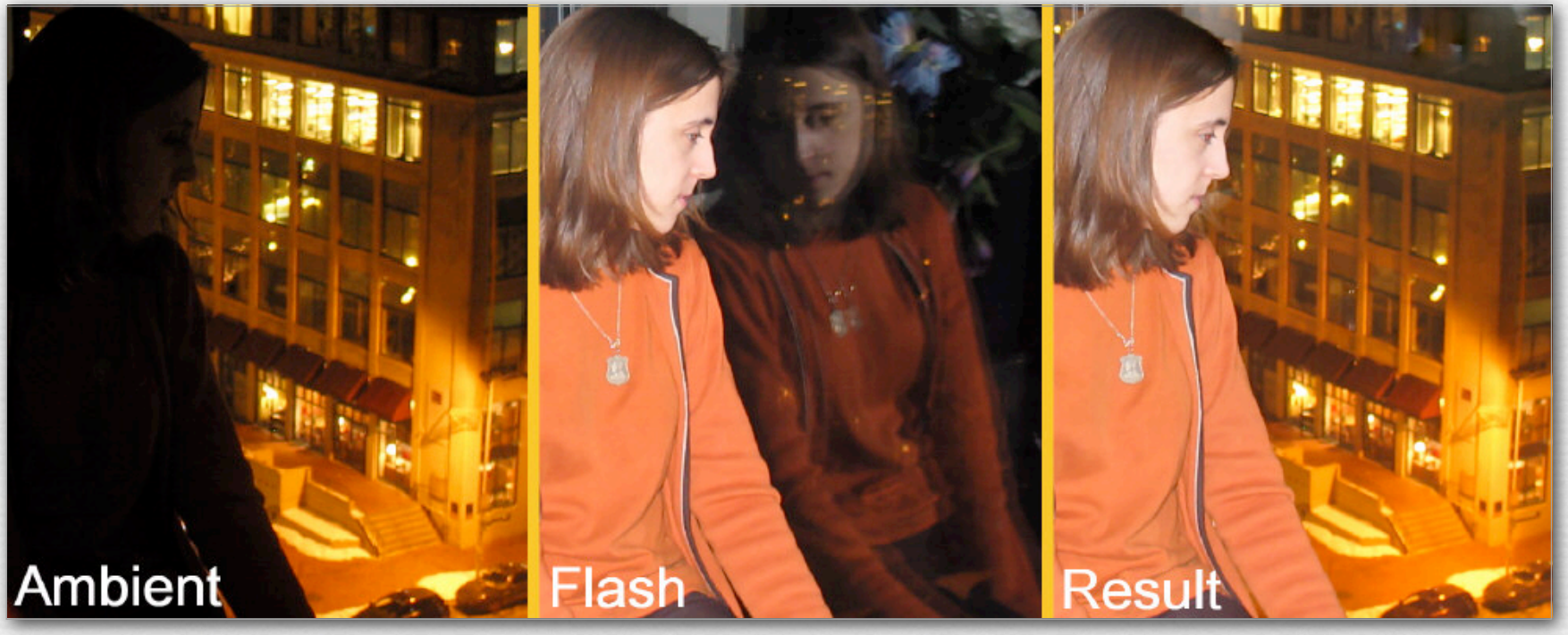
Master-slave metering and firing



Problems with flash

- power falls as distance squared
  - subject is too bright
  - background is too dark
- in-camera flash is too close to lens
  - no shadows on subject
  - shadow of lens in wide-angle view
- red-eye
  - worse with in-camera flash
  - worse in low light (pupils are wide open)
  - pre-flash to shrink pupils, which looks better anyway
- shutter speed must be low enough that shutter is completely open
  - 1/90 - 1/250 sec on Canon EOS cameras ("flash synch speed")
  - limits the range of shutter speeds for fill-flash
- don't shoot perpendicularly into glass

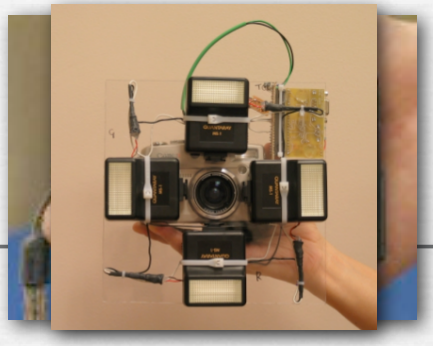
Flash-noflash photography
[Agrawal SIGGRAPH 2005]



- compute ambient + flash – features in sum that don't appear in ambient alone (as determined from image gradients) (except where ambient image is nearly black)

Multi-flash photography

[Raskar SIGGRAPH 2004]



- flash photographs cast small shadows in one direction
- flash image minus no-flash image = shadow-only image
- repeat from several directions and add shadow-only images

Slide credits

- Andrew Adams

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