

Extreme photography

CS 178, Spring 2013



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Computer Science Department
Stanford University

Extremes

- ◆ high resolution
- high speed
- low speed
- small aperture
- large aperture



Nokia 808
41 megapixels

low field of view
wide field of view
high dynamic range
low dynamic range



Sinar view camera
10,000 × 8,000 pixels



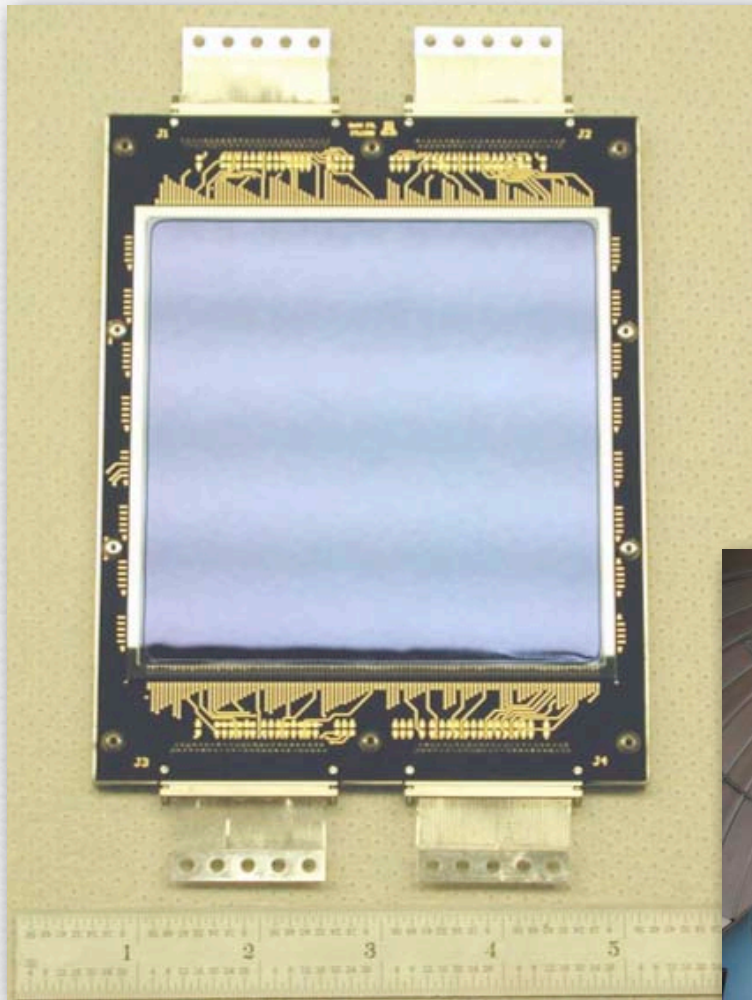
CRAYONS

Different Brilliant Colors

TOYS 'R' US
68 17 F
PRICE
X >> \$2.57



111-megapixel wafer-scale sensor



- ◆ 95mm × 95mm CCD sensor
- ◆ 10,580 × 10,560 pixels
- ◆ low yield, very expensive



5" (aperture) telescope at
the U.S. naval observatory,
Flagstaff, AZ

Graham Flint's gigapixel.org



- ◆ custom camera and lens
- ◆ 18" negative → drum scanner → printer
- ◆ 40,000 pixels × 25,000 pixels



Balboa Park, San Diego

(full-resolution print in Gates Hall, 3rd floor, entrance to graphics wing)



San Diego Skyline



xrez.com (also gigapixel resolution)



GigaPan Epic Pro

xrez.com (also gigapixel resolution)

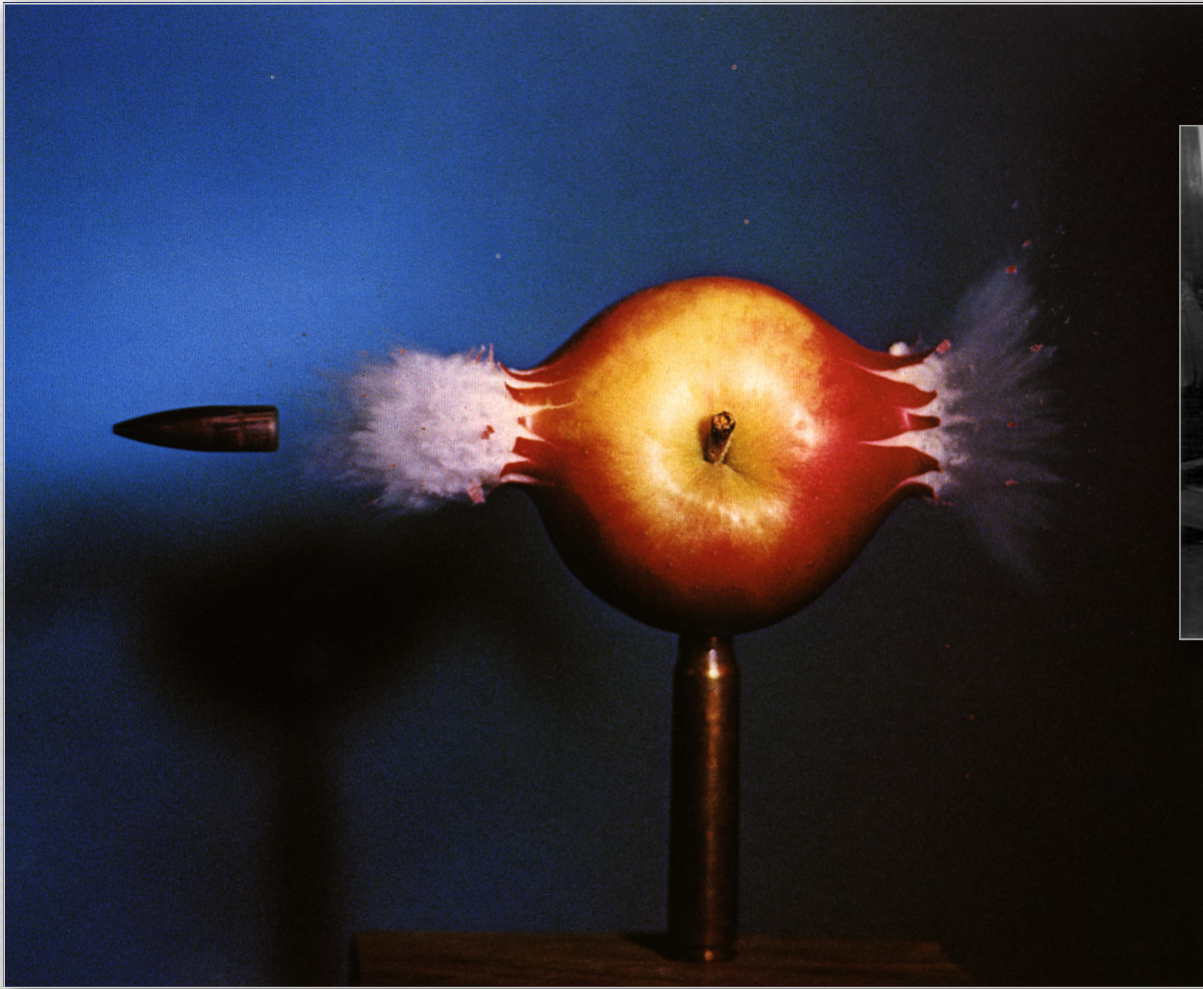


Extremes

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- ◆ high speed
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- small aperture
- large aperture
- narrow field of view
- wide field of view
- high dynamic range
- low dynamic range

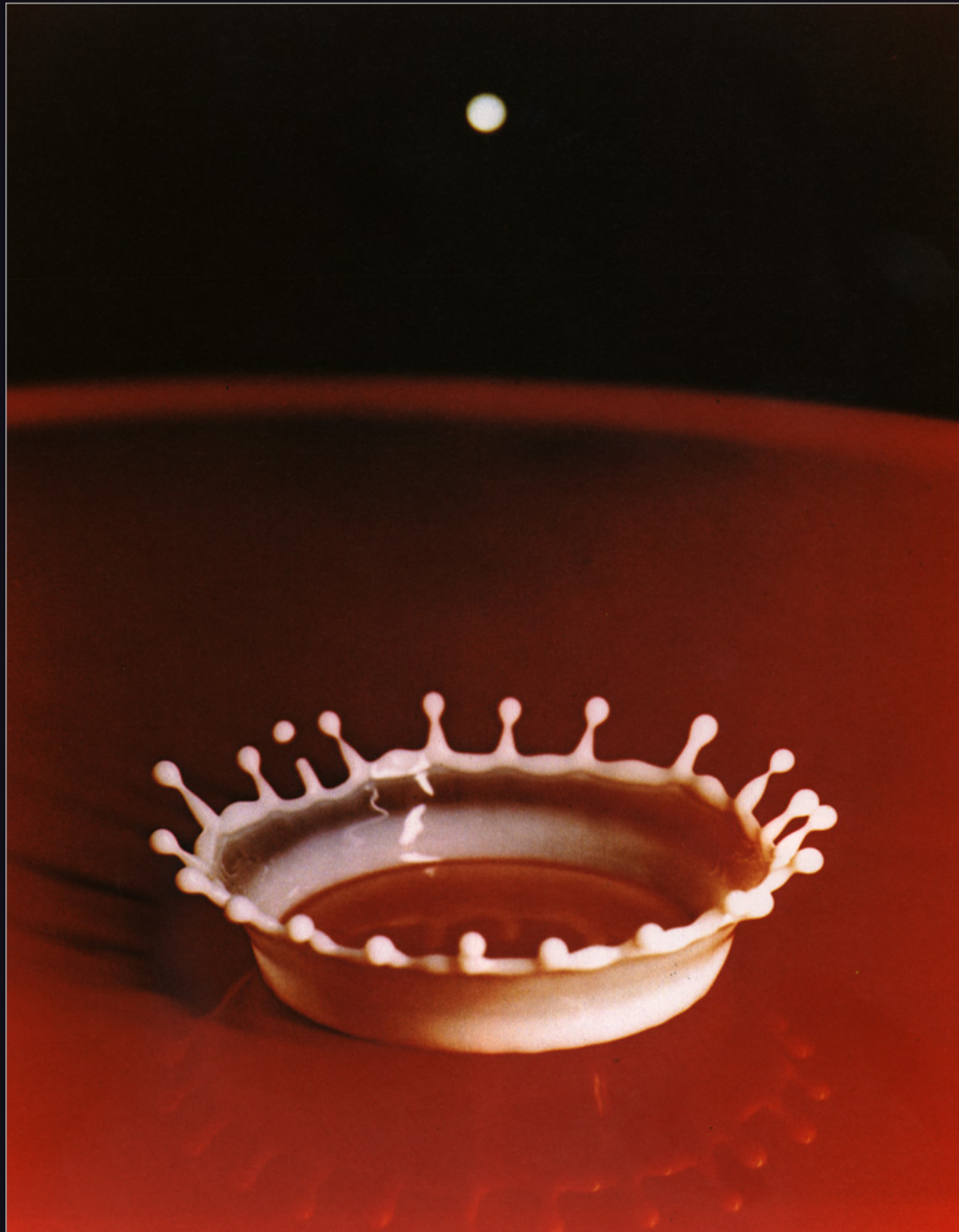
Harold Edgerton:

“father” of high-speed photography

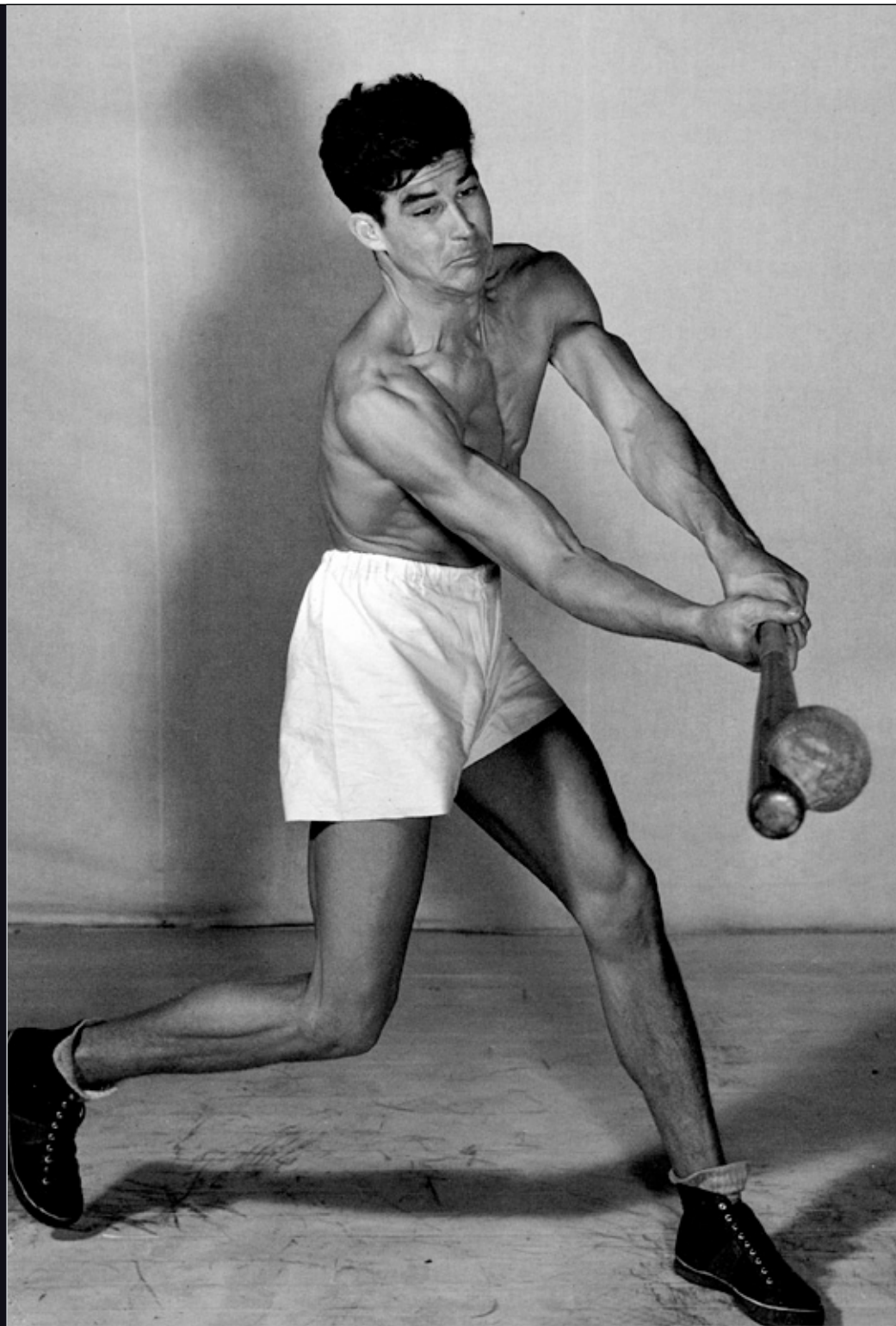


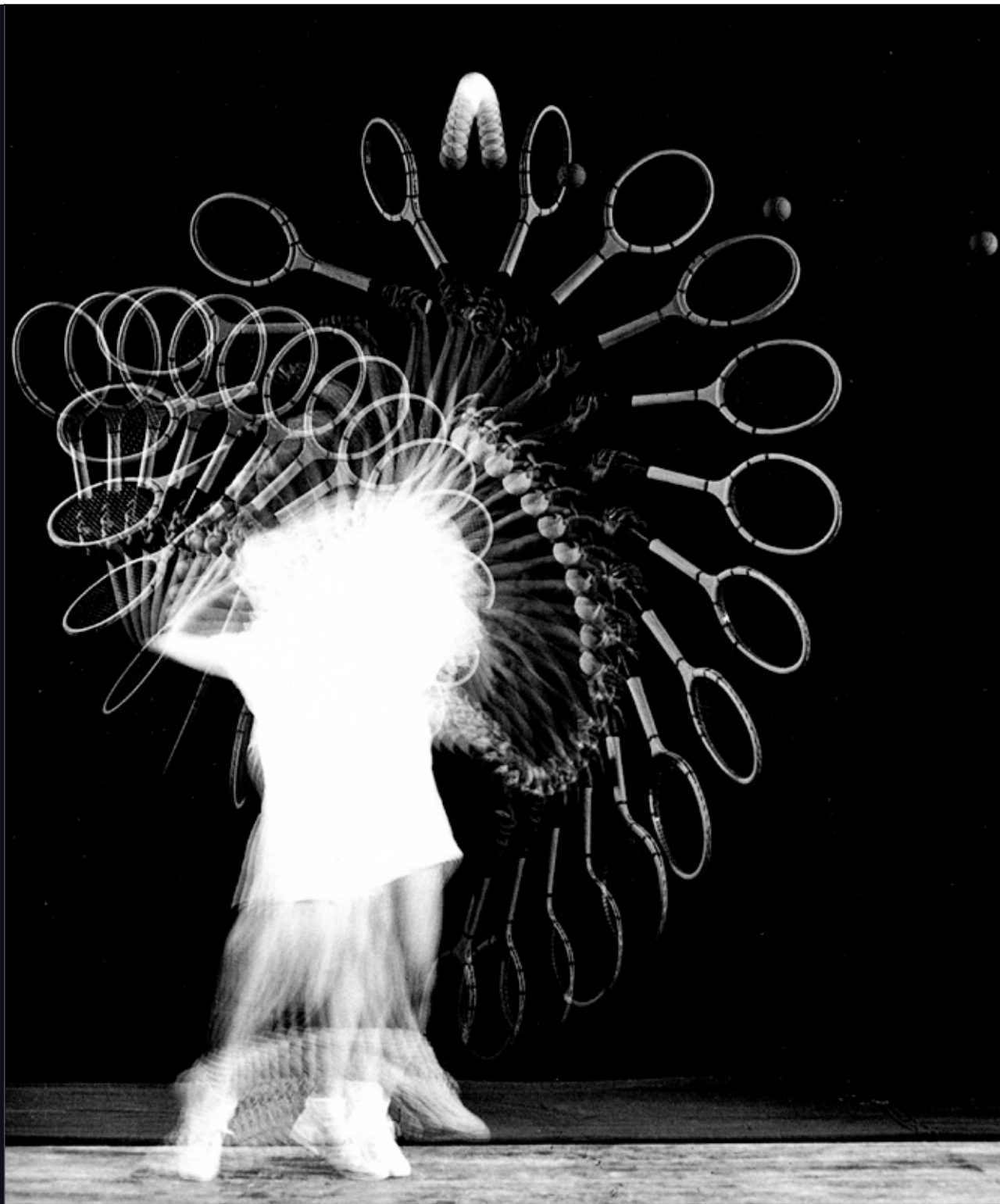
from Stopping Time, 1964

- no shutter
- electronic strobe
- microphone near gun

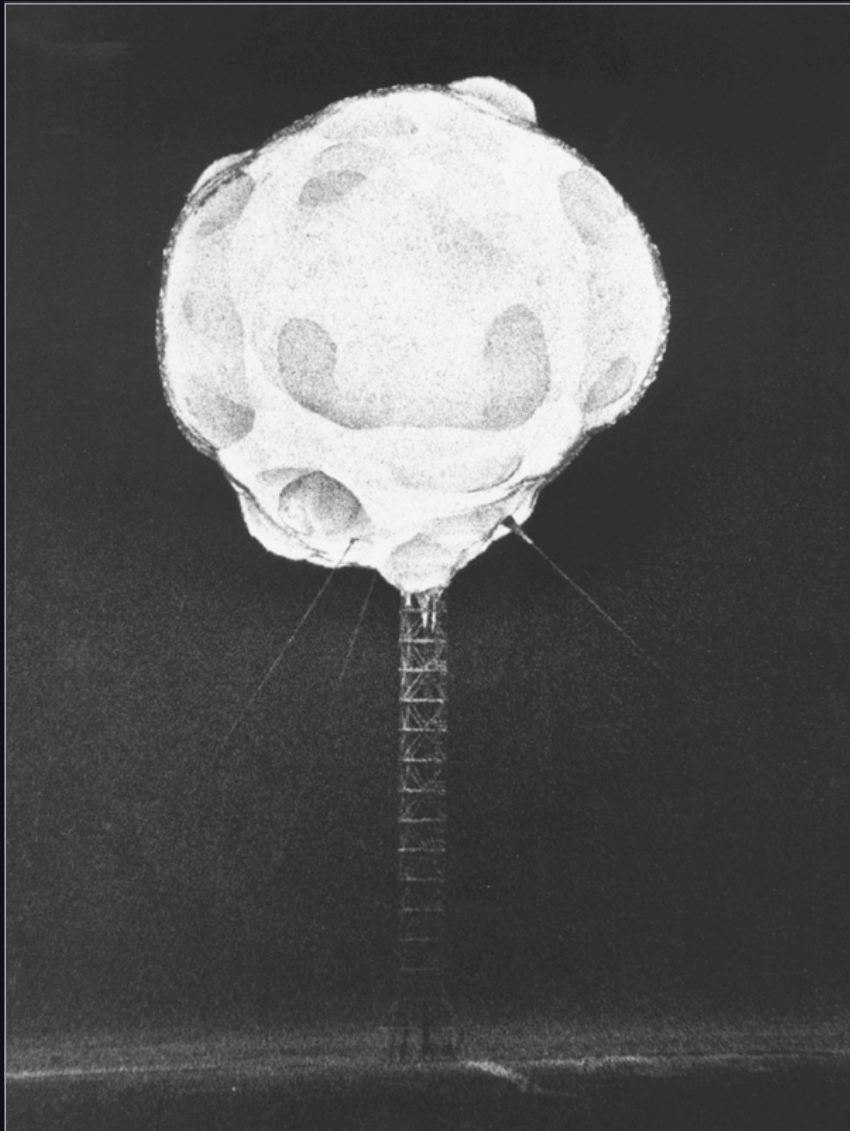




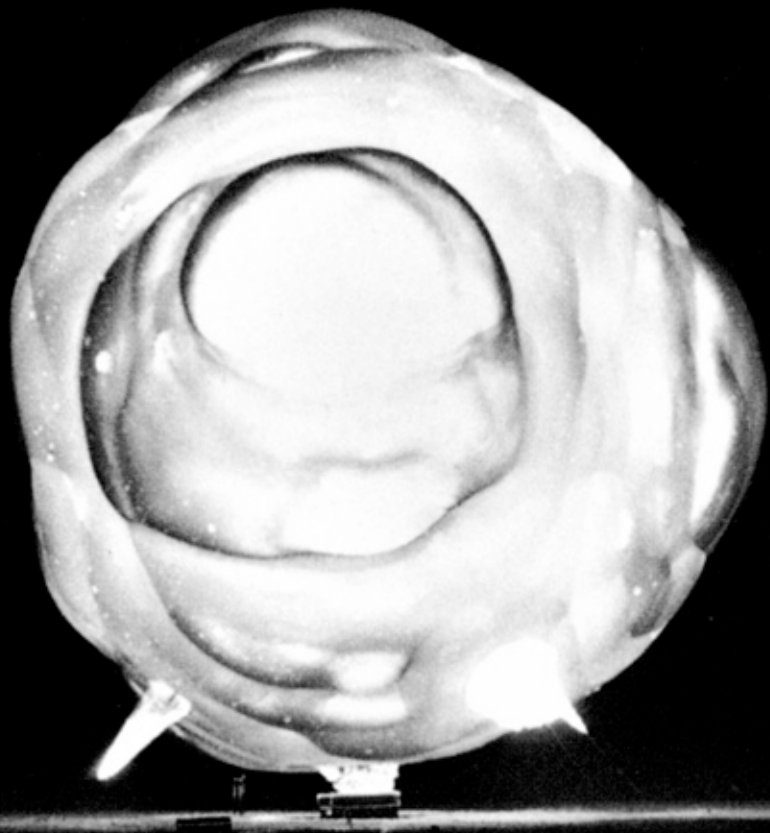


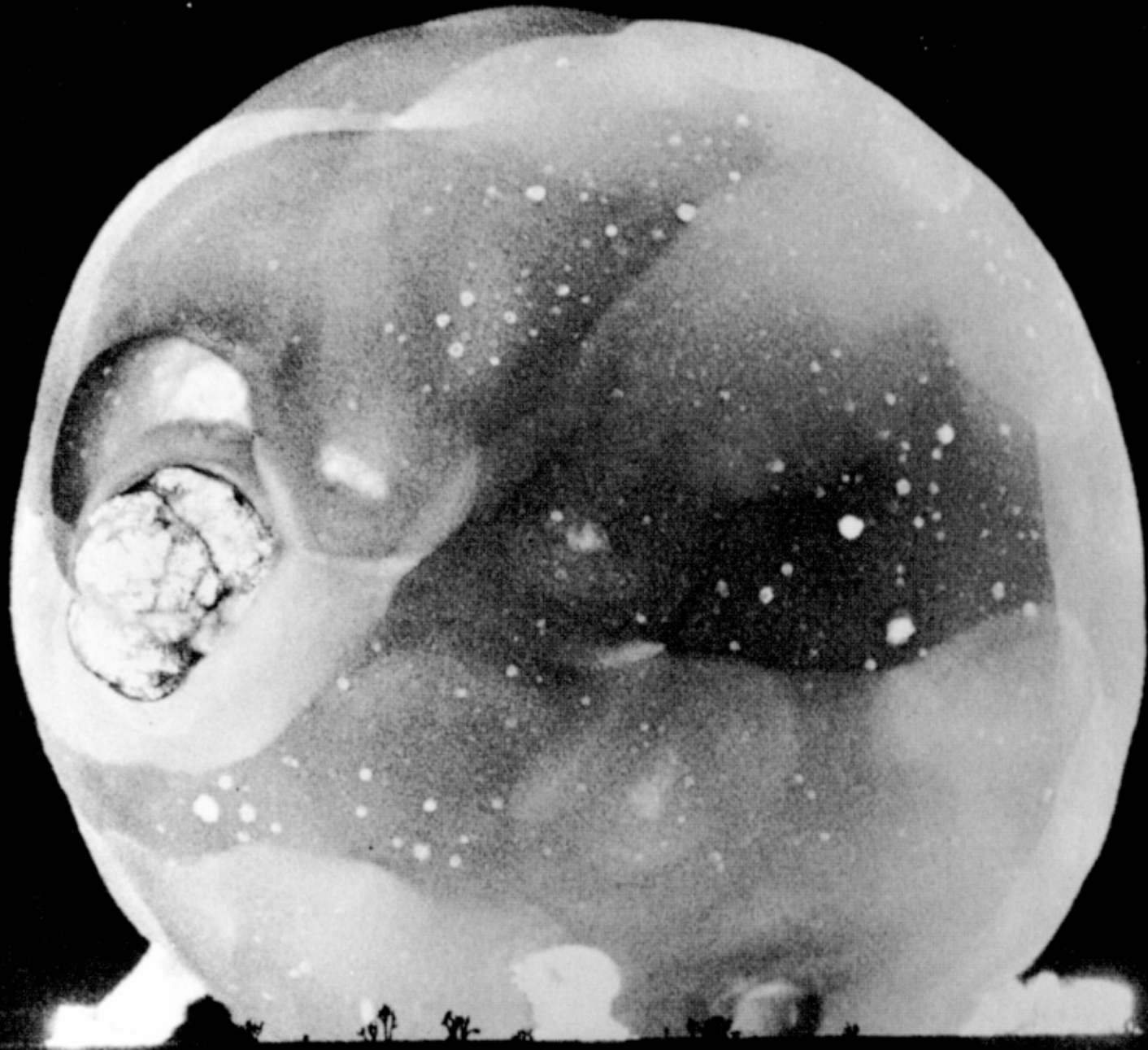


Ultra-high speed photography



- atomic explosion
- $1/100,000,000$ second
- camera was 7 miles away
- telescopic lens





High-speed video with a still camera: the Casio EX-F1



- 640 × 480 pixels
- 300 frames per second
- border collie



- 320 × 480 pixels
- 600 frames per second



- 160 × 480 pixels
- 1200 frames per second

Extremes

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Low-light photography



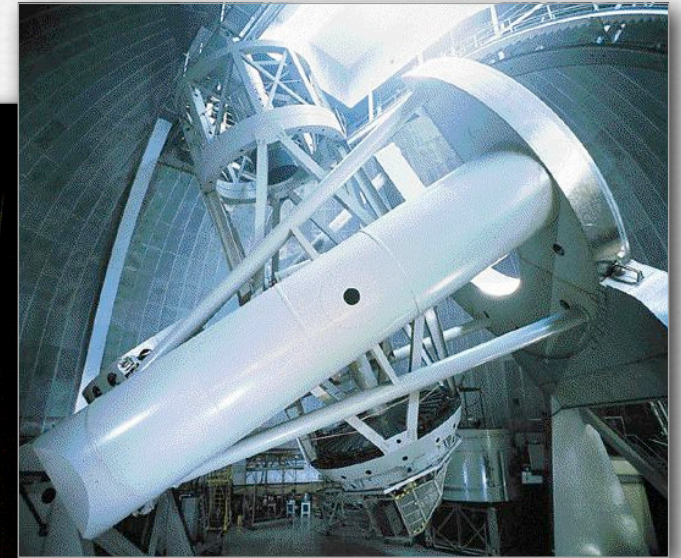
Lee Frost, Santorini, Greece

- composite of two exposures
- cityscape was 30 seconds

Time exposures in astronomy

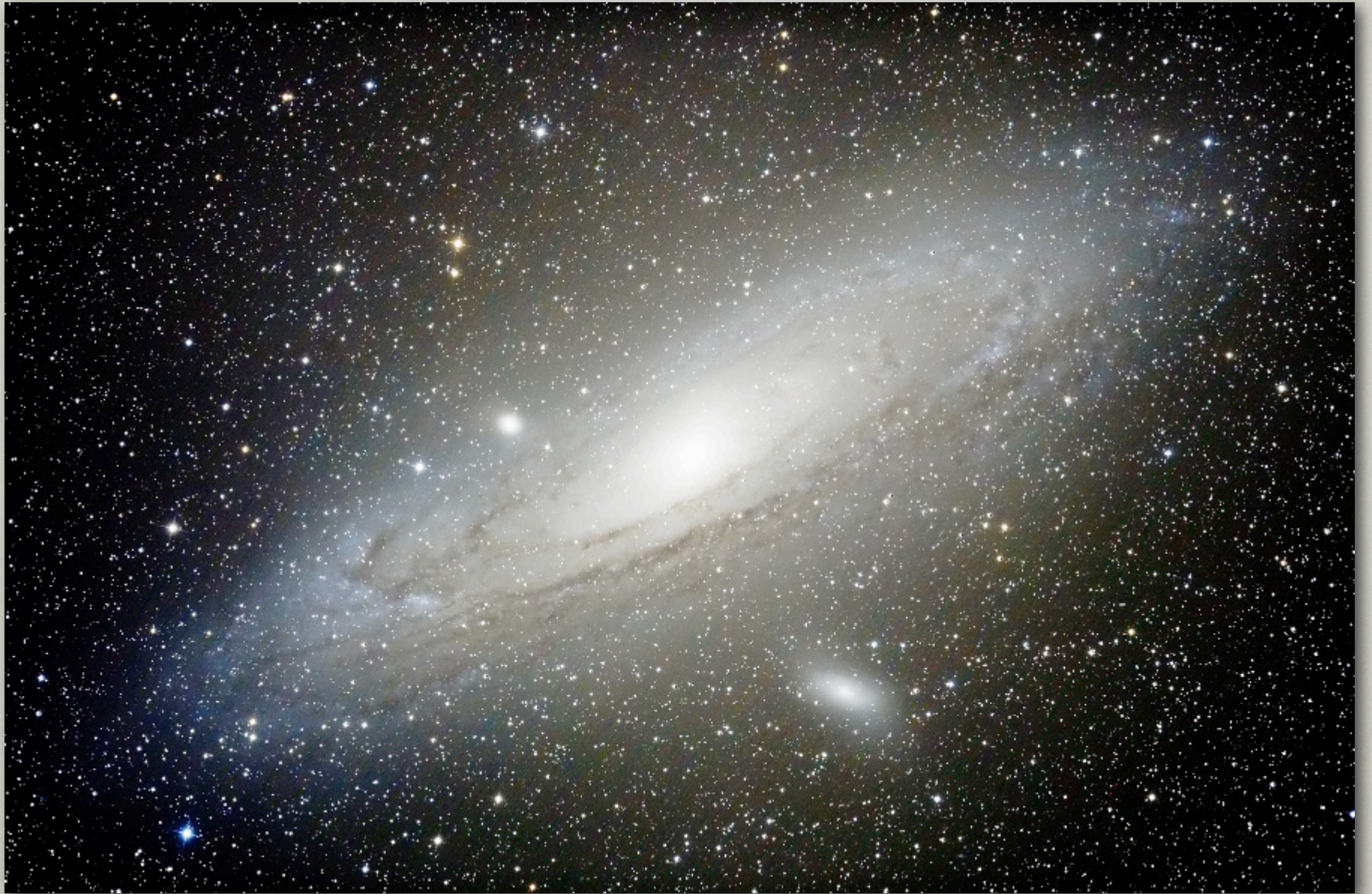


Lee Frost, star trails



(Palomar 200-inch)

- 30-minute exposure
- telescopes can rotate to avoid smearing stars
- What is the unmoving star in the middle?



Jesse Levinson, Andromeda

Painting with light



Lee Frost, railroad yard

- 30-second exposure
- multiple flashes
- Don't stand between the flash-lit part of the scene and the camera!



Stephen Lesser, CS 178, Spring 2009



David Jacobs and Jongmin Baek, 2011

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Small aperture (large depth of field)



- the f/64 club

Ansel Adams, Mission San Xavier del Bac, Tucson

Extremes

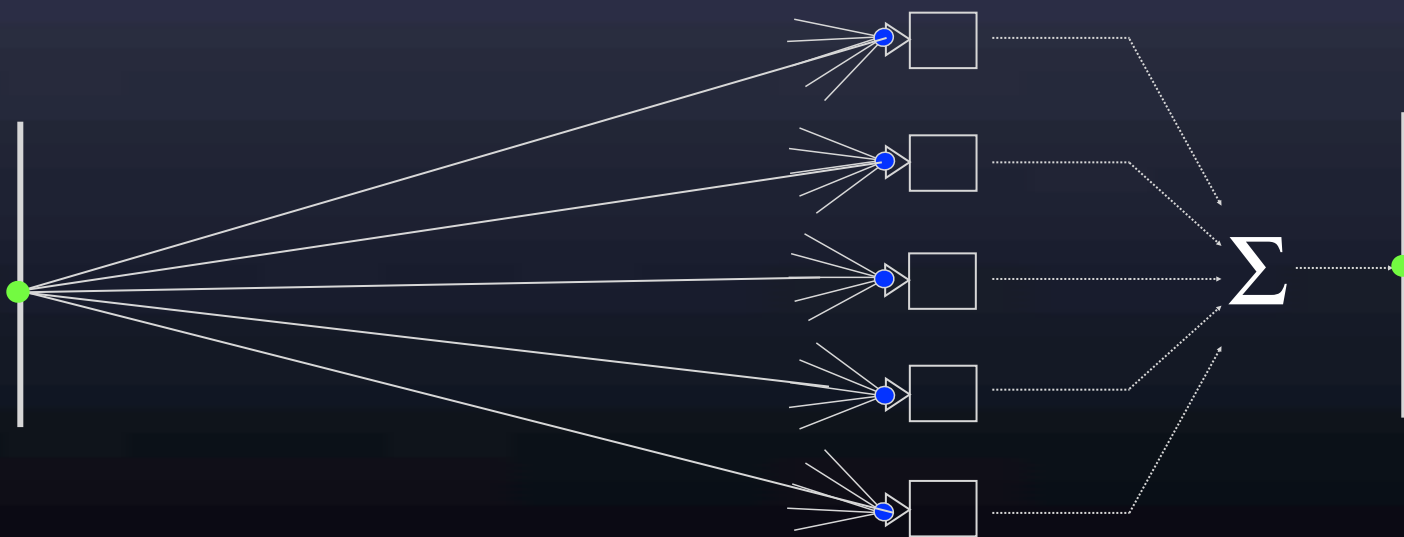
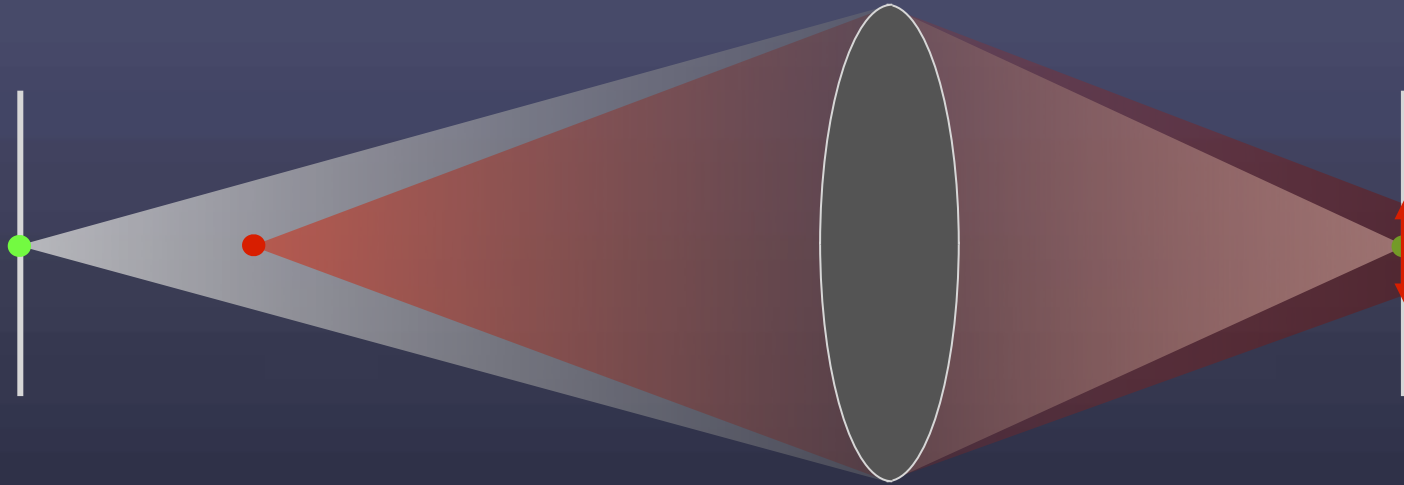
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Large aperture (shallow depth of field)



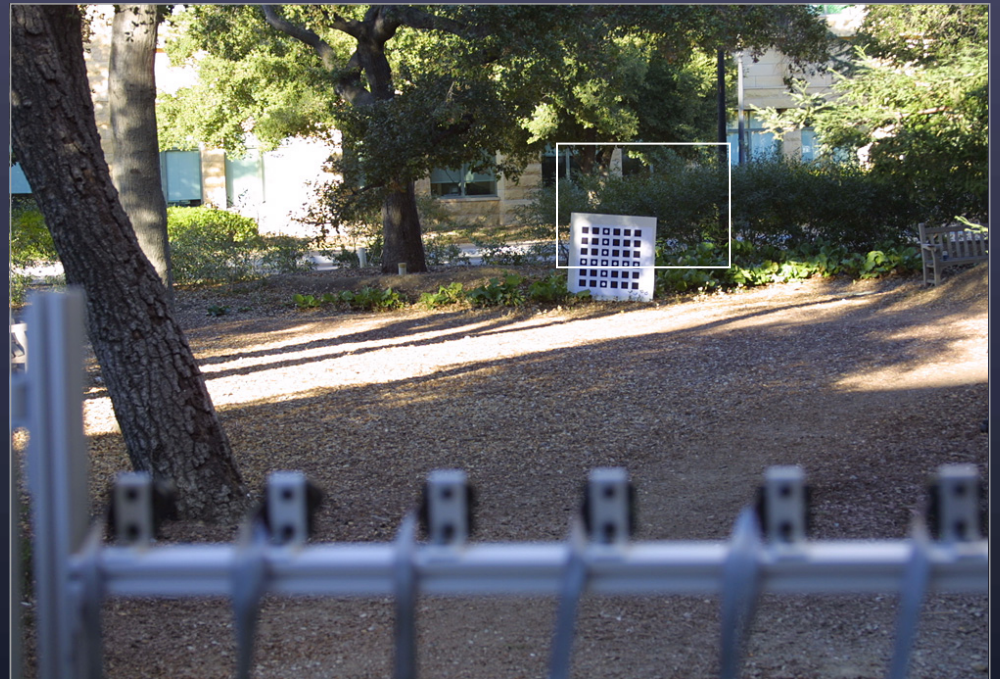
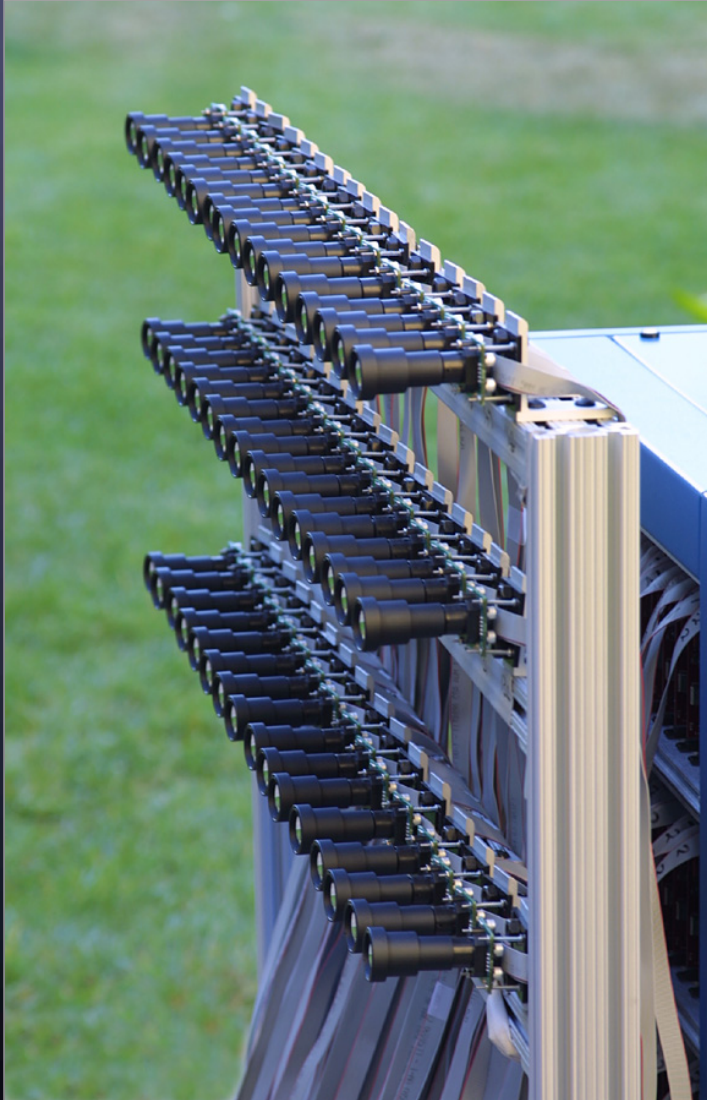
Lewis Hine, Girl Worker in Cotton Mill, 1908

Synthetic aperture photography



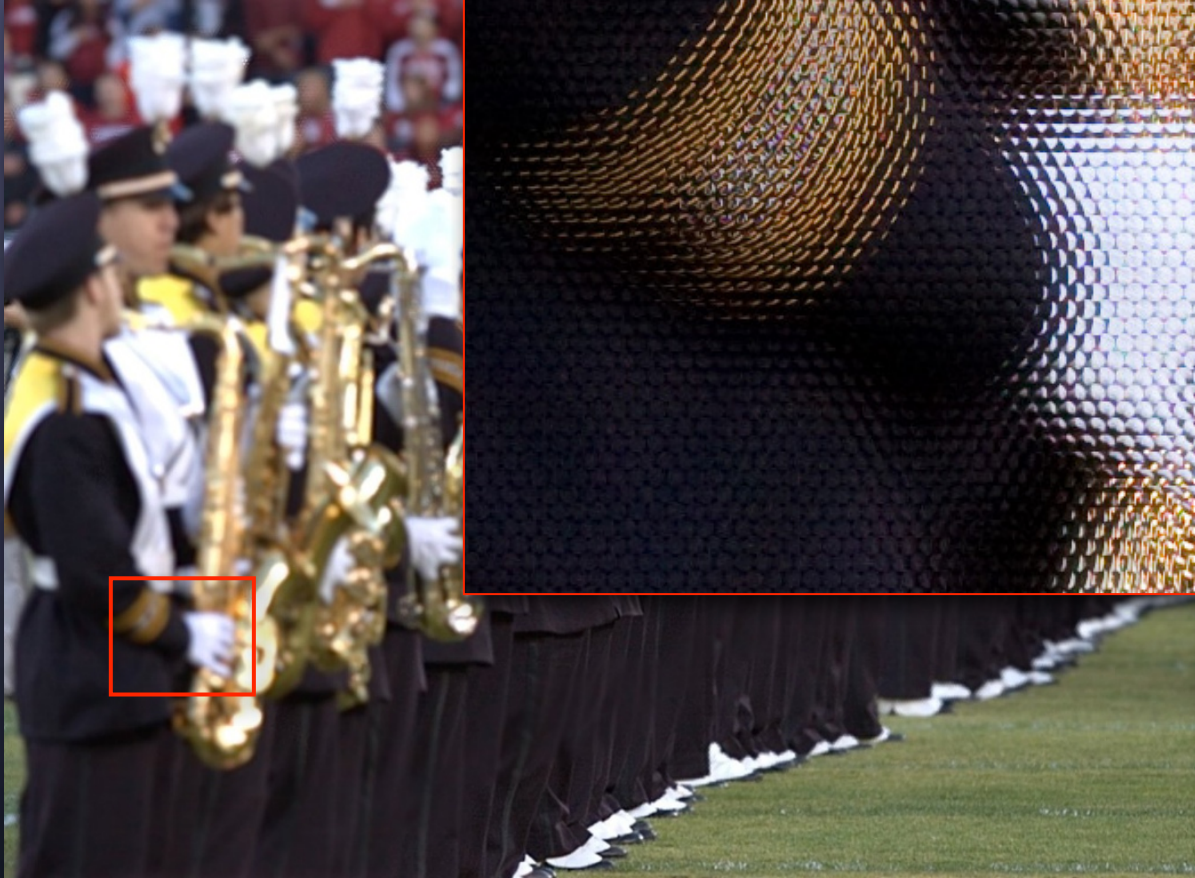
Example using 45 cameras

[Vaish CVPR 2004]





Light field photography



- we'll have a lecture on this later in the course



The banner features a dark red background. On the left, there is a large, stylized lens with a red and green light flare. To the right, several smaller, blue-tinted lens icons are arranged in a grid-like pattern. The title 'SynthCam' is centered in a white, 3D-style font.

SynthCam

SynthCam is an app for the iPhone 4, 3GS, iPod Touch 4G, and iPad2
(requires iOS 4.2 or higher)

Price: **Free**

Current version: 2.0

Available on the iPhone
App Store



single frame



synthetic aperture photograph





Tilt-shift of Stanford quadrangle as seen from Hoover Tower

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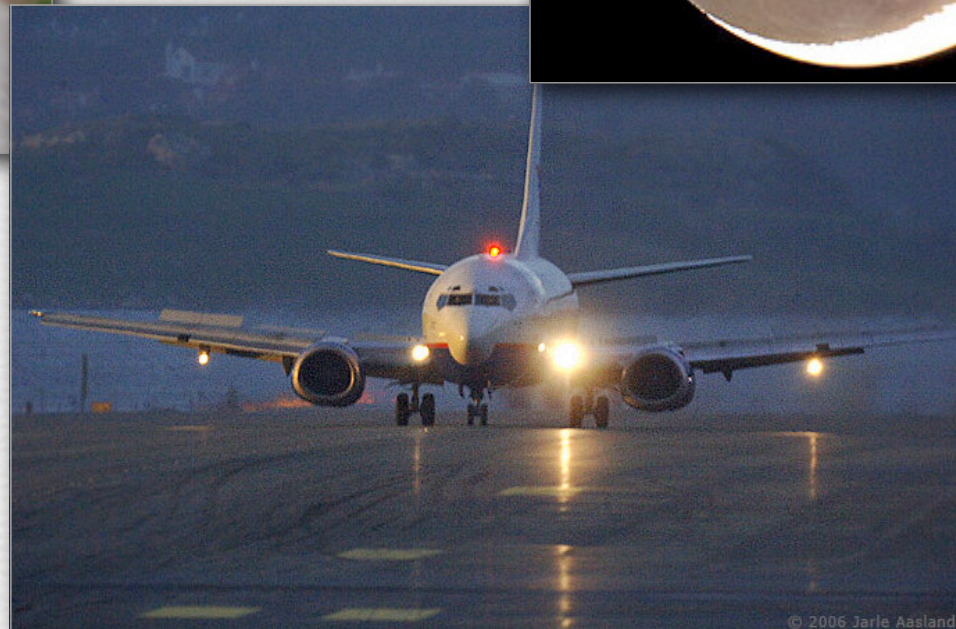
Narrow field of view: telephoto lens



- 300mm lens

Bryan Peterson, Golden Gate Bridge

Extreme telephoto



- Nikon 1540mm Cassegrain reflector

Other extreme telephoto lenses



Canon 1200mm

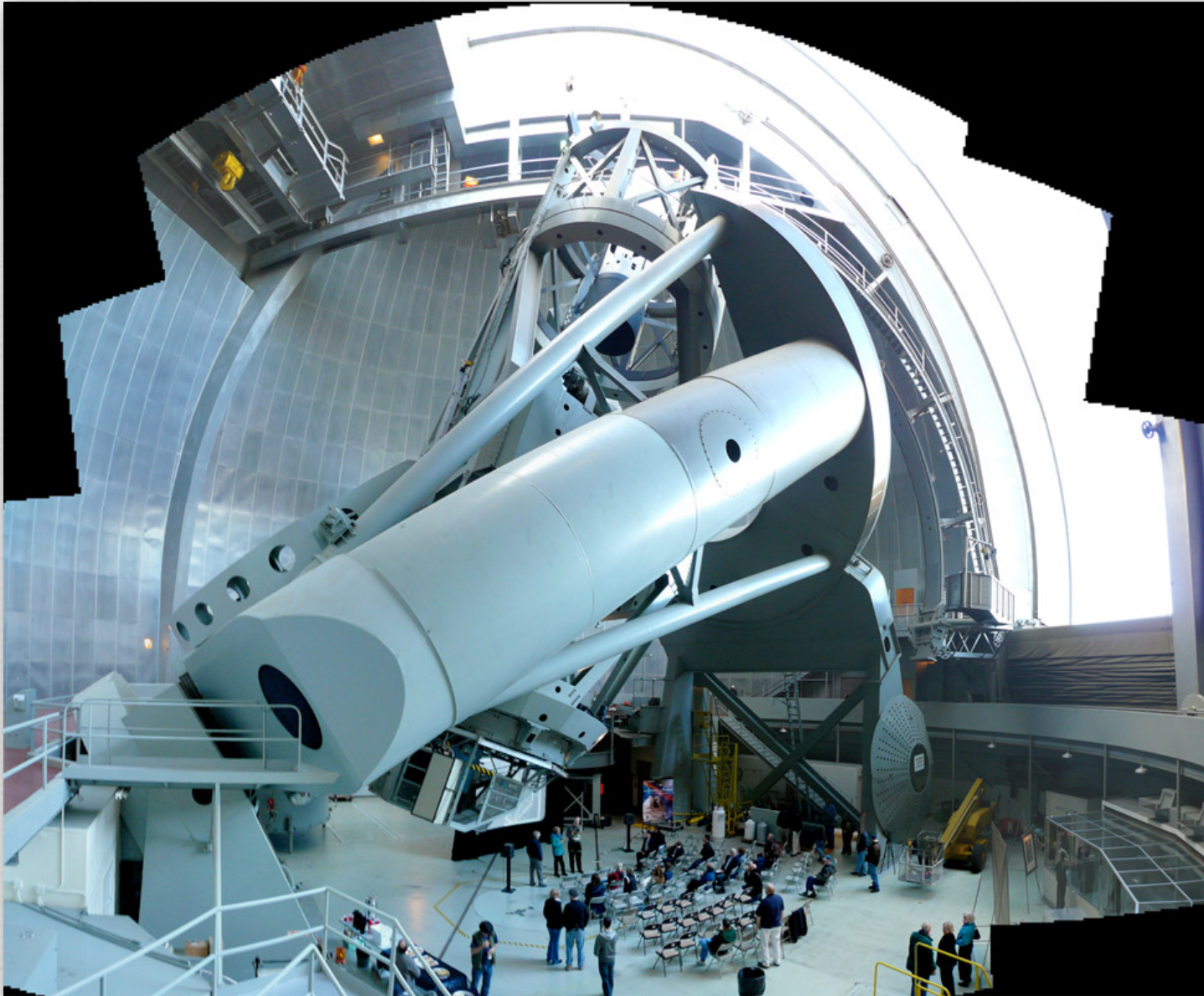


Nikon 2000mm



Zeiss 1700mm

Really extreme



Hale telescope on
Mt. Palomar, CA

$$A = 200'' \text{ (16')}$$

$$f = 650'' \text{ (50')}$$

$$N = f/3.3$$

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Wide field of view: stitched panoramas



Wide field of view: stitched panoramas



Crater Lake, Oregon

- 4 photos, total = 90° field of view
- Canon point-and-shoot camera, handheld
- stitched using Photoshop CS3

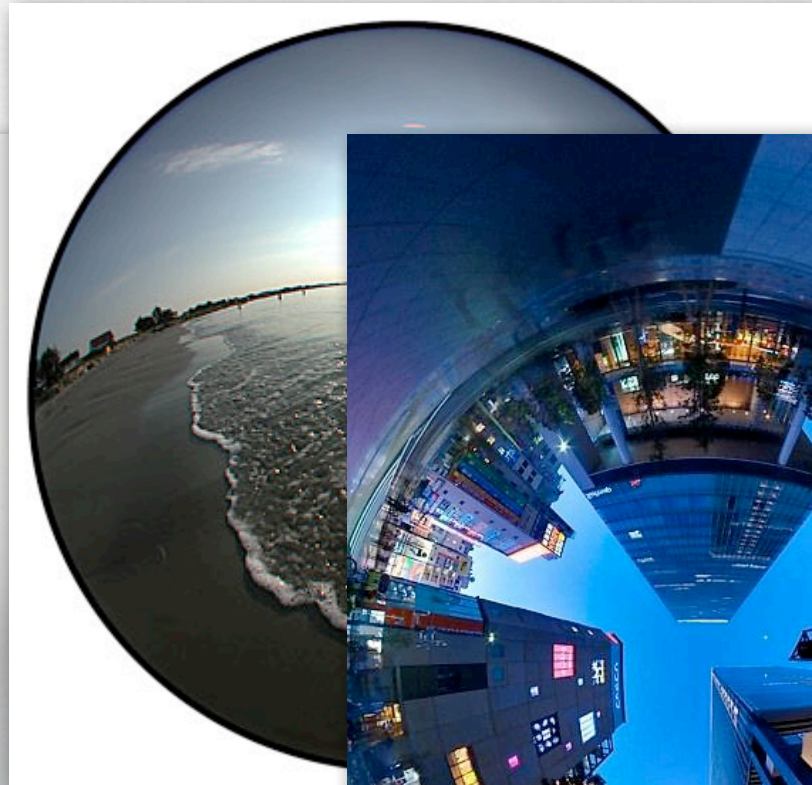
Games with stitched panoramas

- 5 shots, with camera aimed slightly downwards and rolled clockwise around its optical axis between shots left to right, producing a curved world effect when stitched using Photoshop with cylindrical projection



Nikon 6mm fisheye lens

**NOW ONLY
\$34,000
ON EBAY !!**



- 220° field of view measured diagonally
- 11.4 pounds

(DigitalFreak.net)

Stanford CityBlock Project (now Google StreetView)

- ◆ capture video while driving
- ◆ extract middle column from each frame
- ◆ stack them to create a panorama



Stanford CityBlock Project



Stanford CityBlock Project

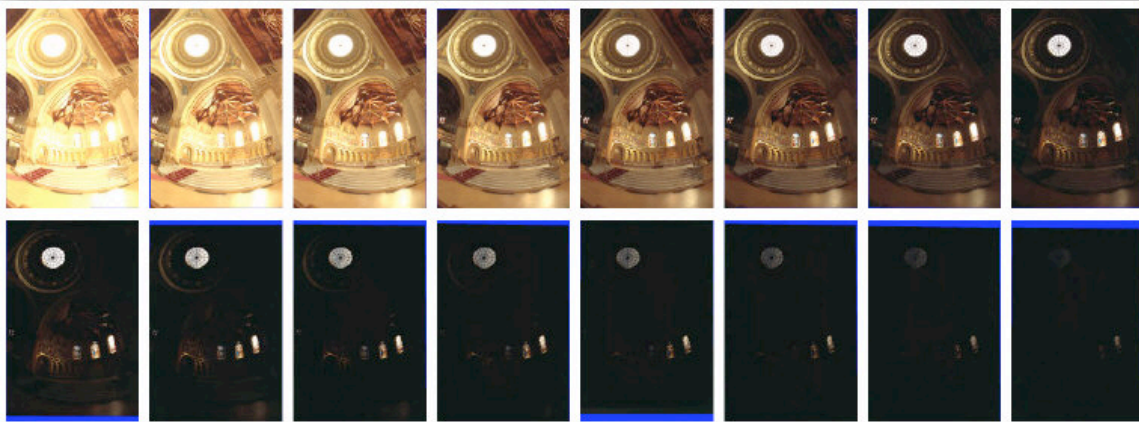


Extremes

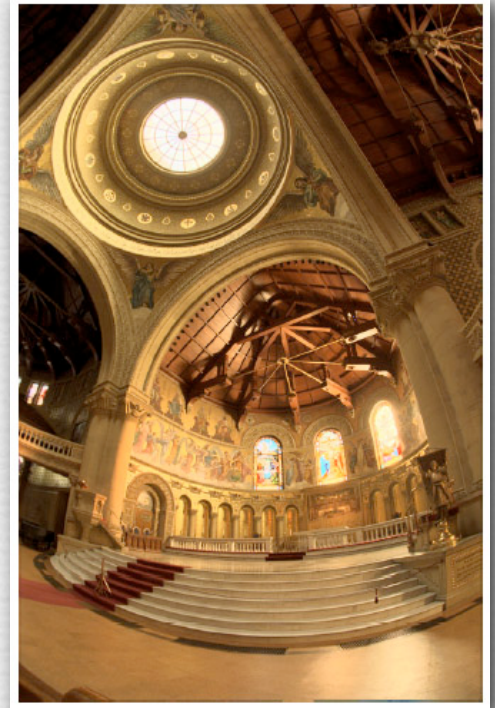
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High dynamic range (HDR)

- ◆ one of photography's key limitations
 - negative film = 250:1 (8 stops)
 - paper prints = 50:1
 - example below = 250,000:1 (18 stops)



(Paul Debevec)



DIY HDR



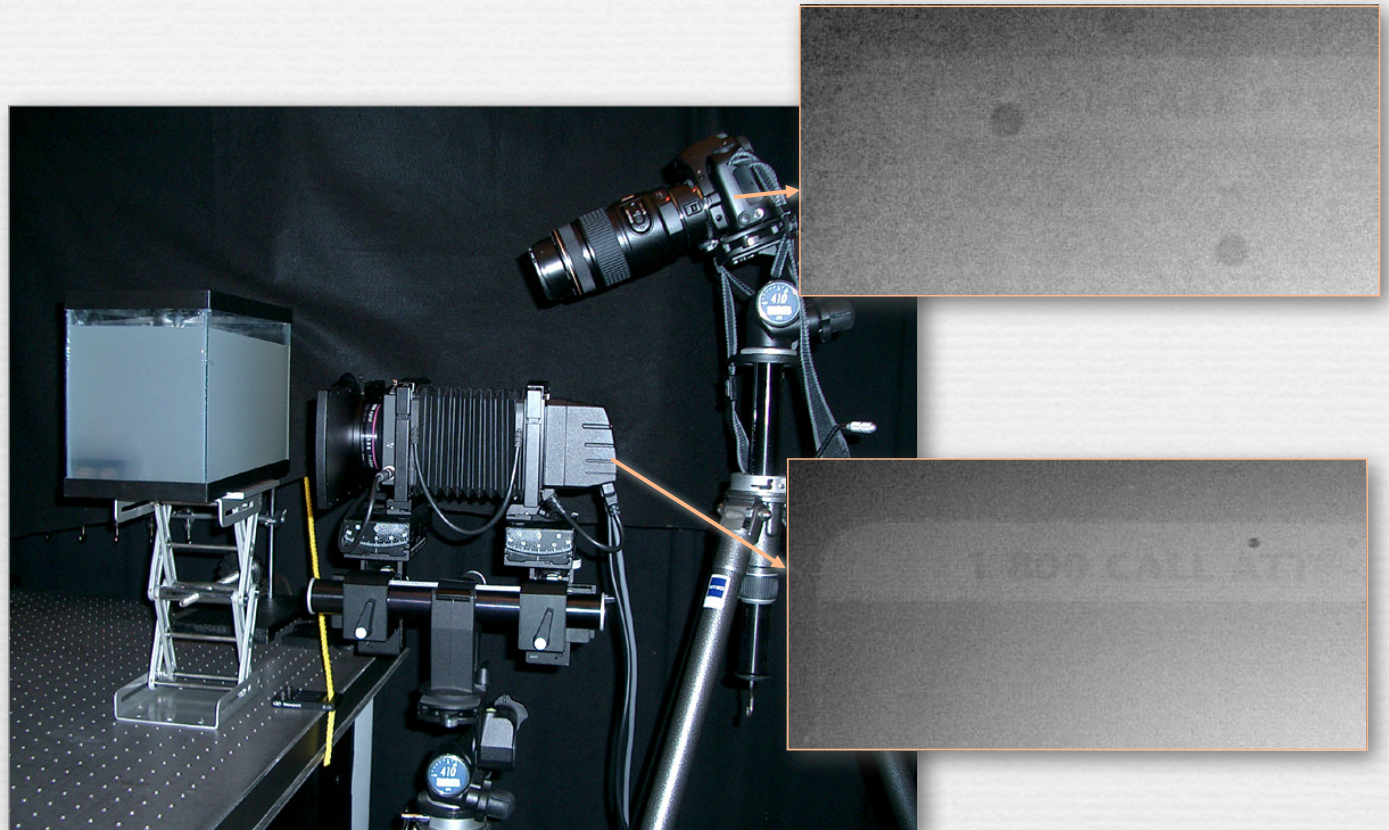
- 2 shots
- Photoshop CS4

Early morning in Zurich

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Sinar P3 view camera with 54H digital back



- ◆ $2\frac{1}{4} \times 2\frac{1}{4}$ sensor, actively cooled, 14 real bits

single frame
in dark room
using iPhone 4



average of
~30 frames
using SynthCam

SNR increases as
 $\sqrt{\text{\# of frames}}$



Slide credits

(in addition to individually credited images)

- ◆ Kayafas, G., Jussim, E., *Stopping Time: The Photographs of Harold Edgerton*, Harry Abrams Inc., 1987.
- ◆ Frost, L., *Night & Low-Light Photography*, Watson-Guptill, 1999.
- ◆ Peterson, B., *Learning to See Creatively*, Watson-Guptill, 1988.
- ◆ Kemp, M., *Leonardo On Painting*, Yale University, 1989.
- ◆ <http://gigapixl.org>
- ◆ <http://xrez.com>