Photographic stories over time

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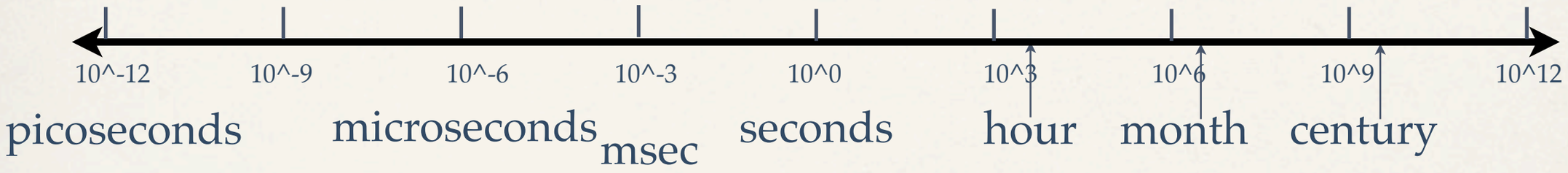
Dept. of Electrical Engineering and Computer Science,
Computer Science and Artificial Intelligence Lab (CSAIL),
Massachusetts Institute of Technology

Dec. 9, 2011

Time scales

Photography can tell stories about events over each timescale



May 15, 2002 / Vol. 27, No. 10 / OPTICS LETTERS 815

Observation of light propagation by holography with a picosecond pulsed laser

Toshihiro Kubota and Yasuhiro Awatsuji

rtment of Electronics and Information Science, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan

laser pulse and thus exposure duration:
10 pico-seconds=10^-11 sec
speed of light: 3x10^10 cm/sec thus 3mm length

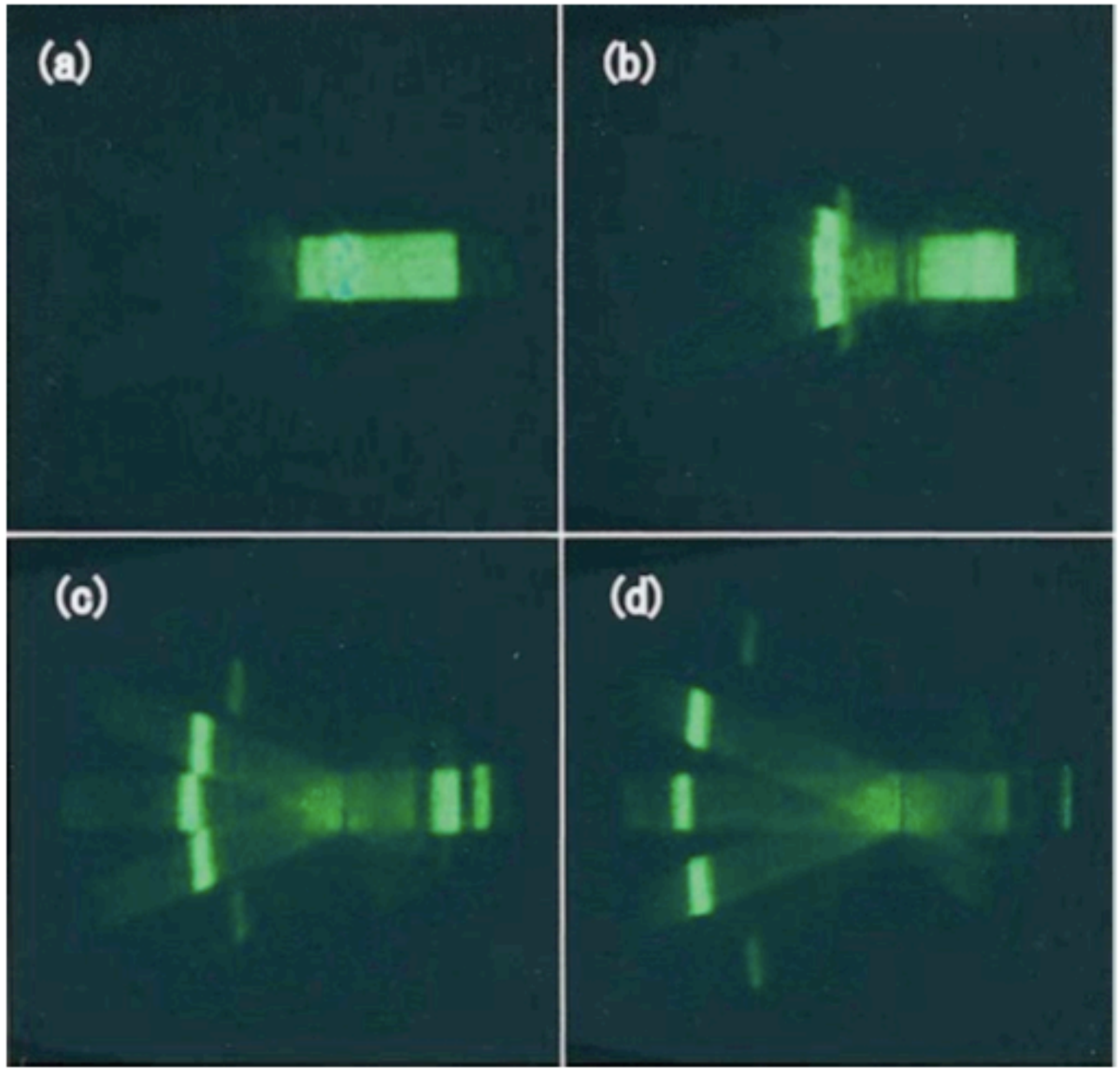


Fig. 5. Propagation of an ultrashort light pulse diffracted by a diffraction grating. (a) The pulse travels toward the grating. (b)–(d) The pulse diffracted by the grating travels away from the grating. The incident pulse is diffracted by the grating into the first and second orders, together with the zeroth order.

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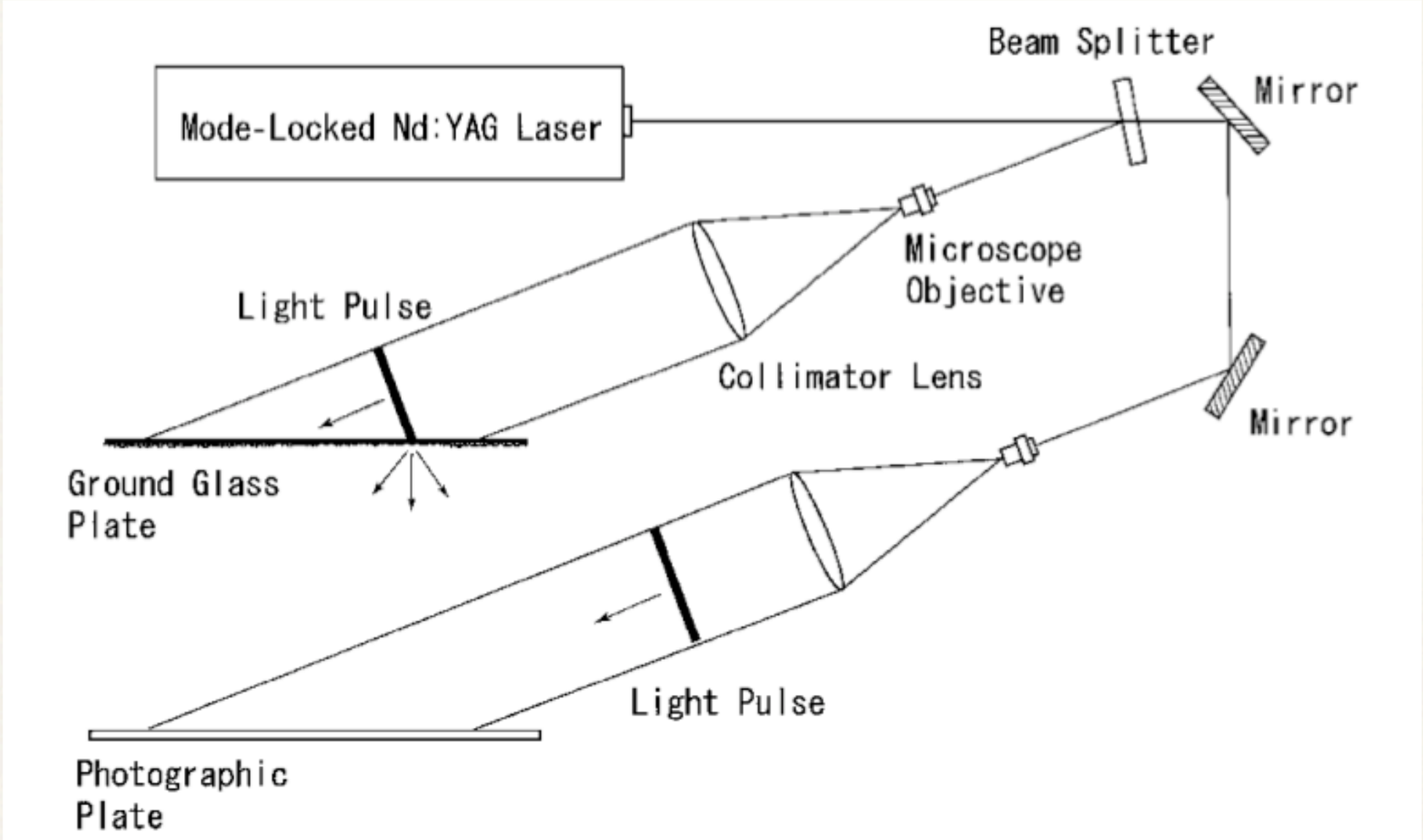

Fig. 1. Basic recording arrangement of a hologram for visualizing light propagation.

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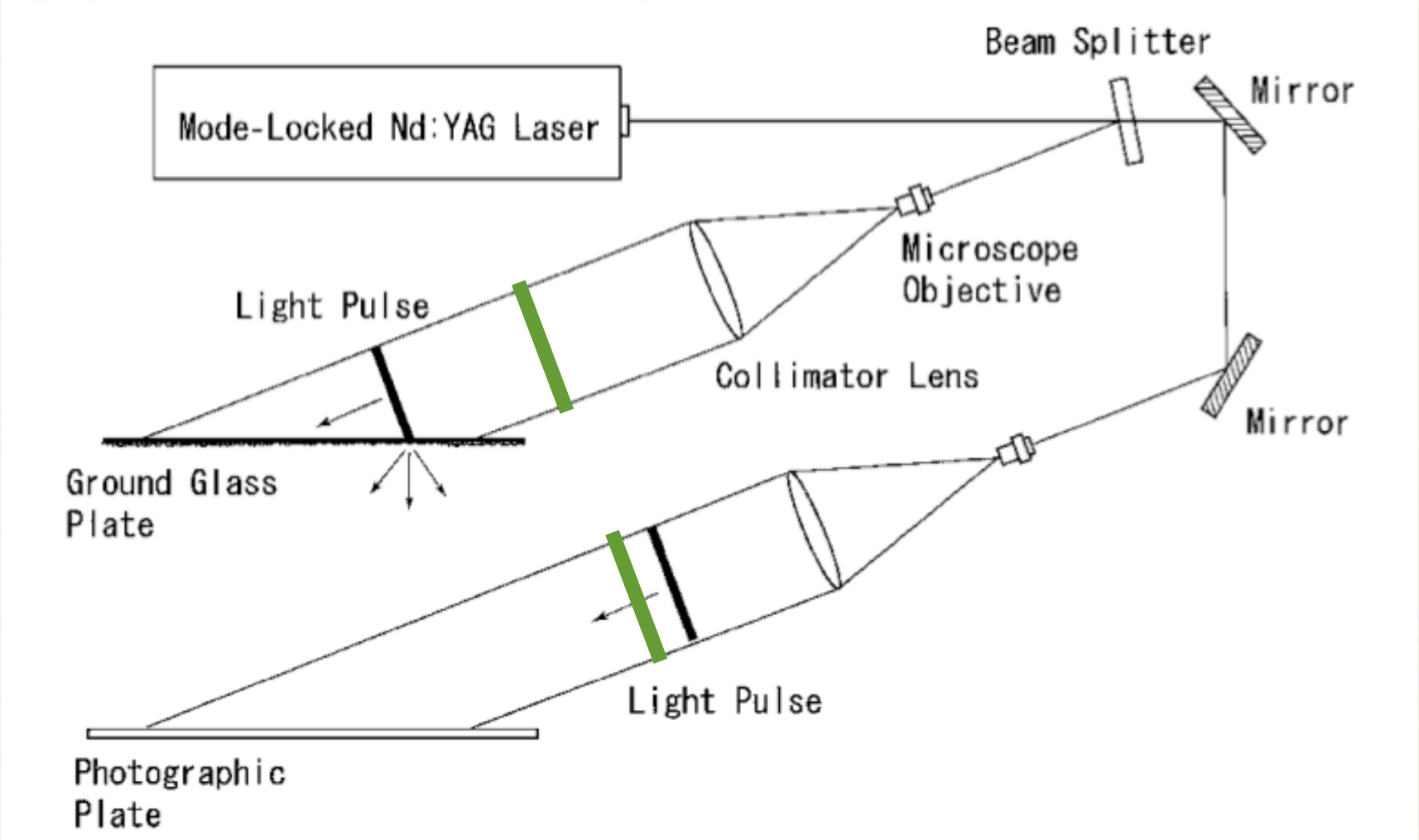

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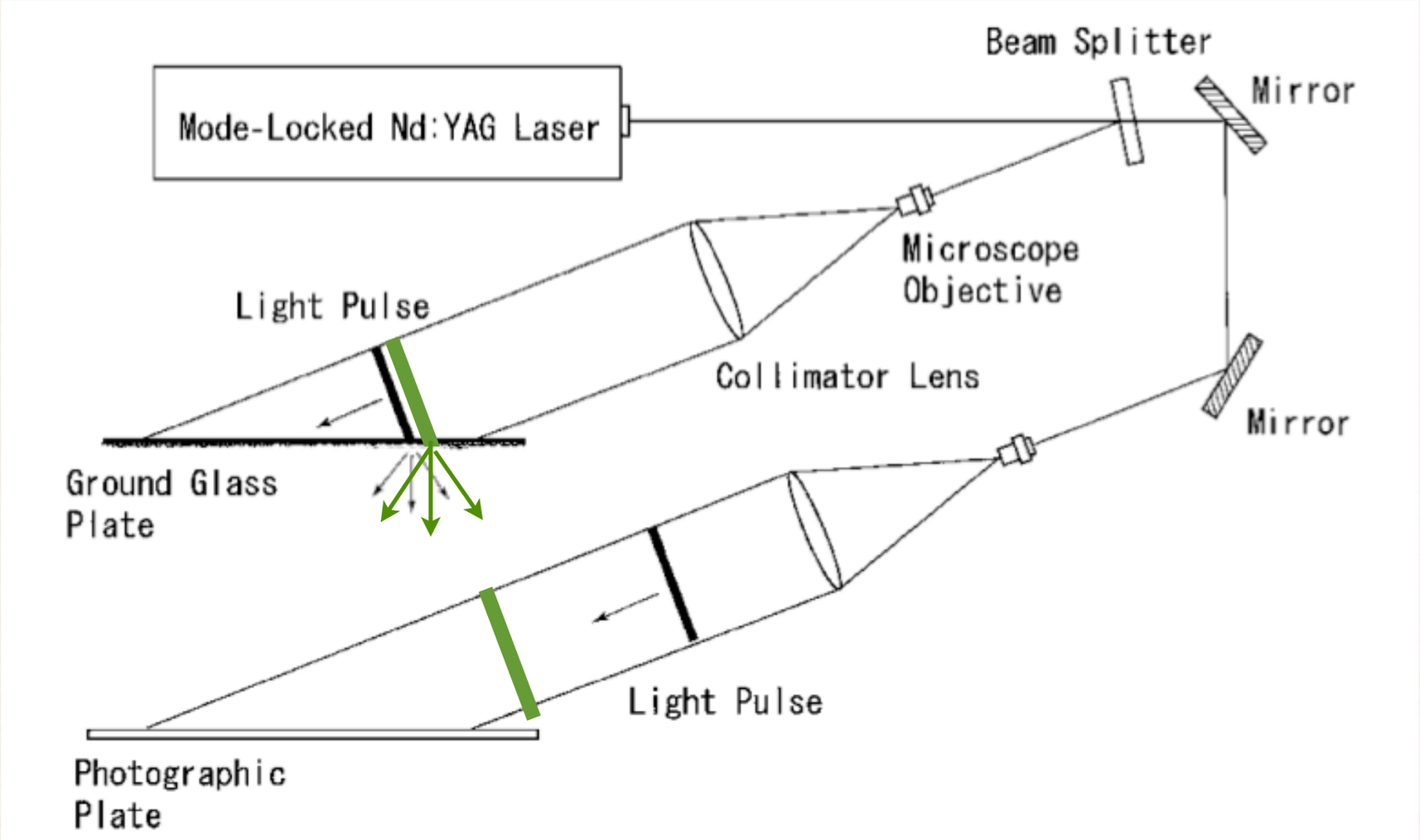

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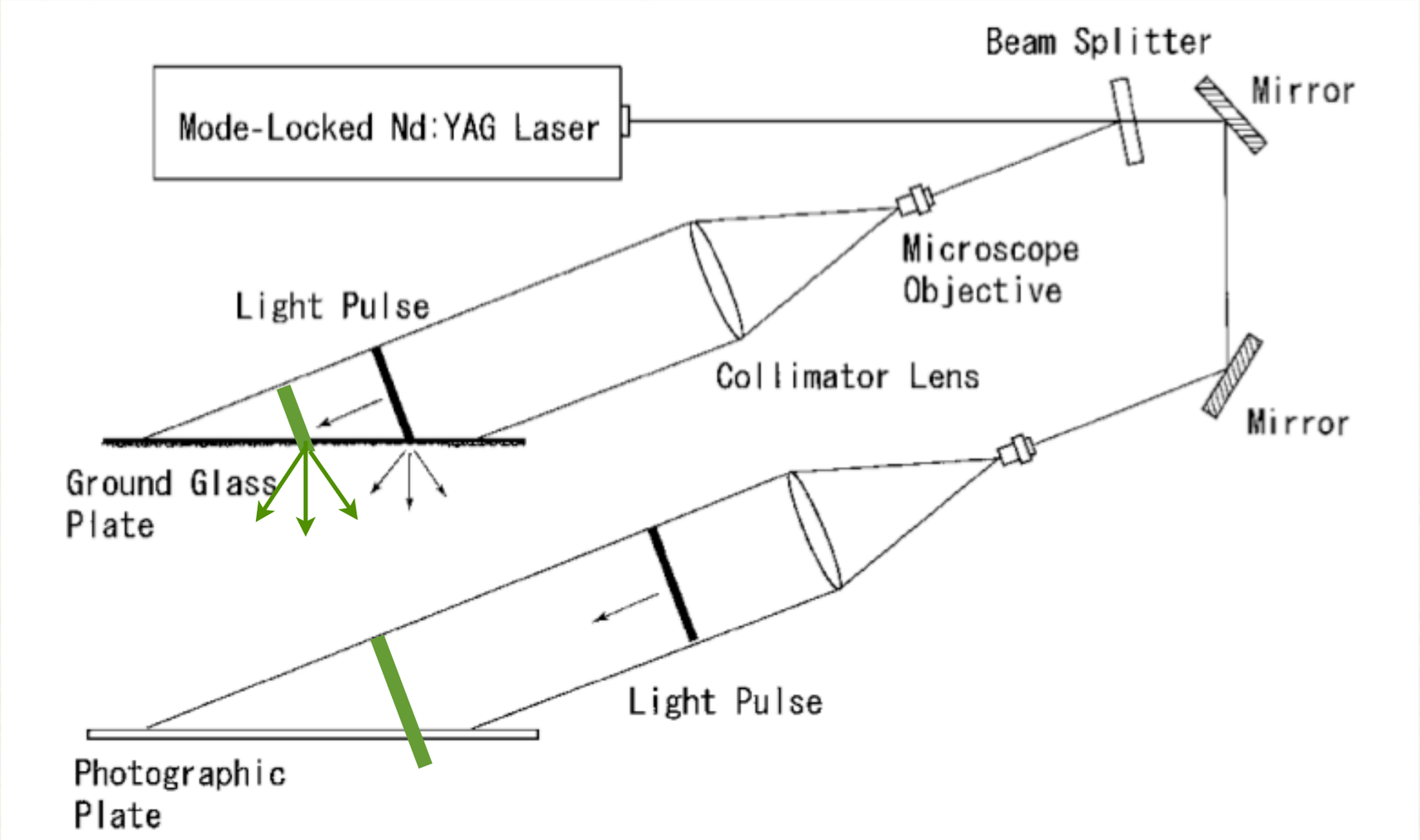

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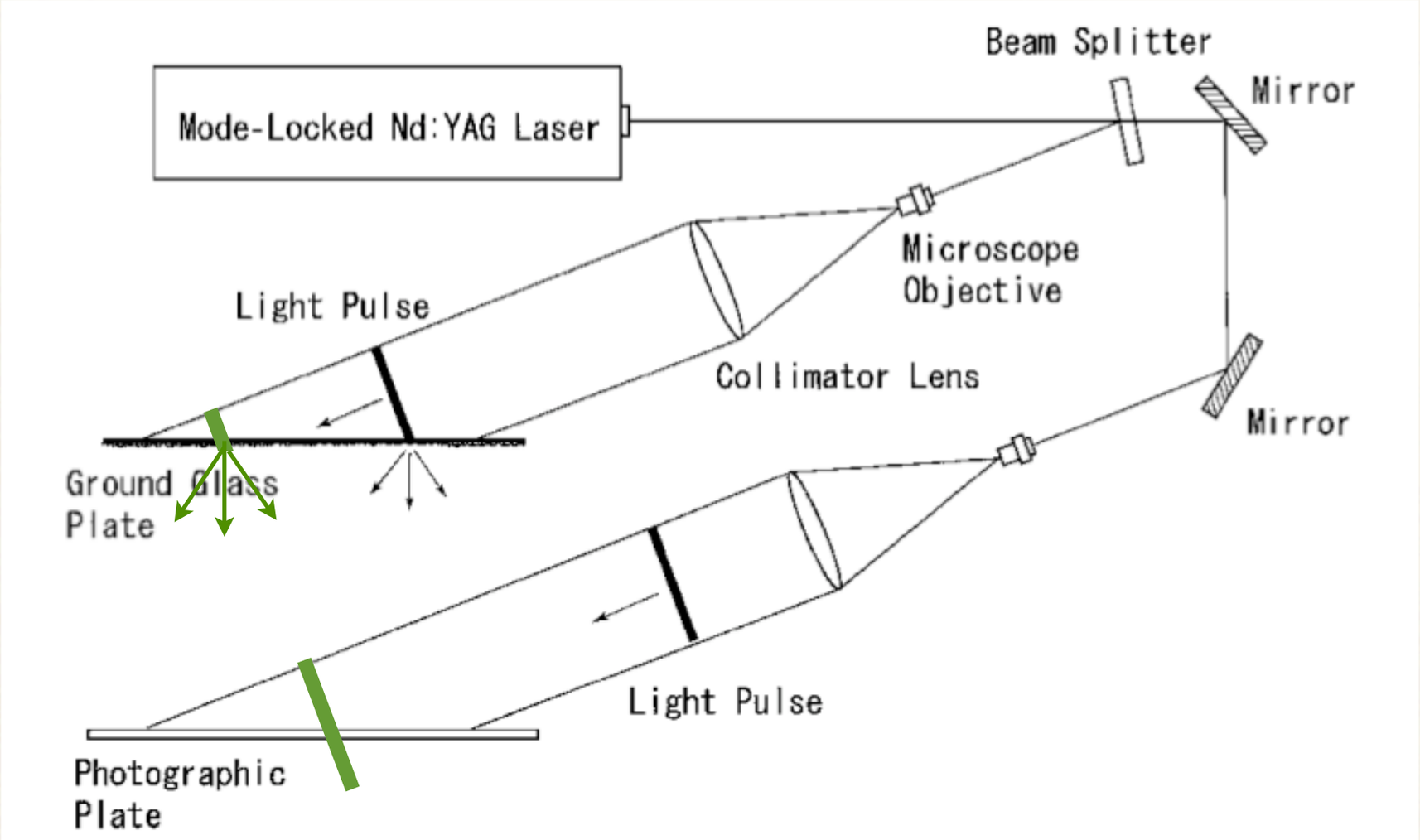

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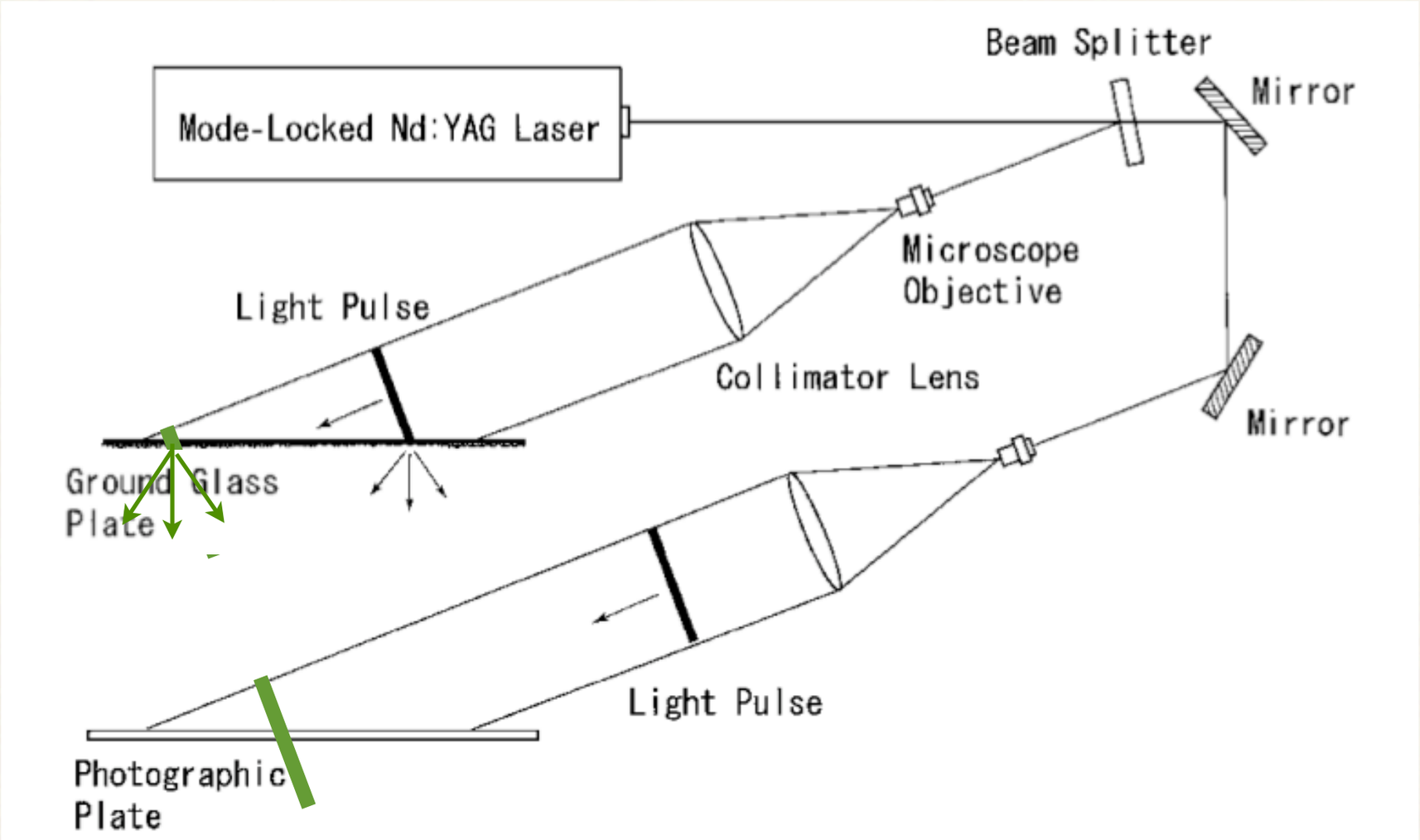
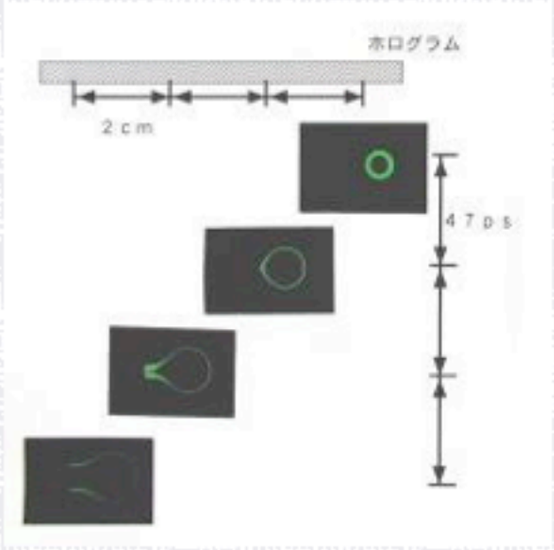
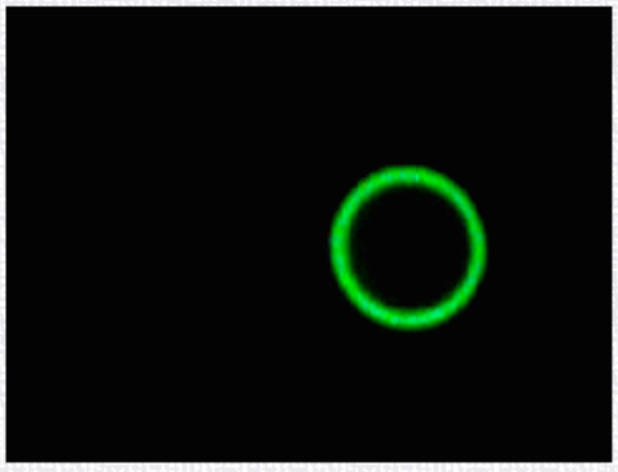


Fig. 1. Basic recording arrangement of a hologram for visualizing light propagation.

The light passed by a light bulb

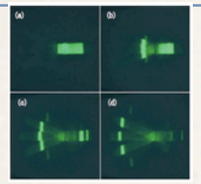
The following pictures are the reconstructed images of light pulses passing through the light bulb. You can see the situation of light propagation passing by the light bulb when you look through the hologram and your eye moves laterally.

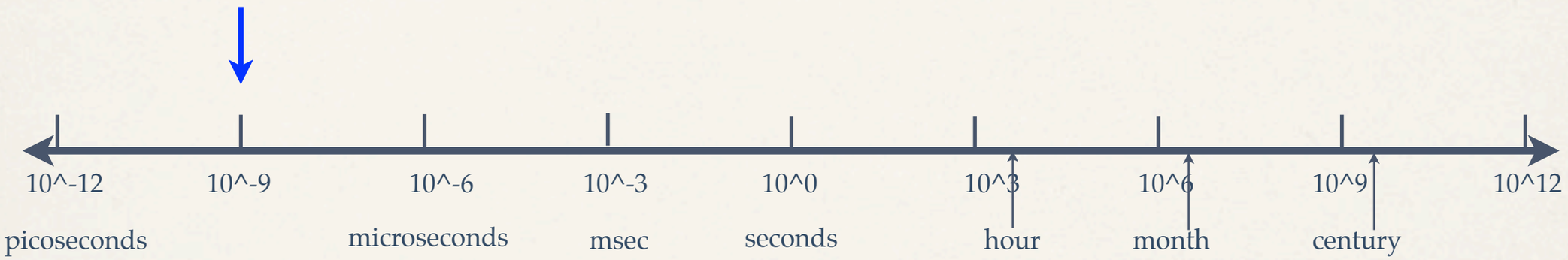




http://homepage2.nifty.com/kubotaholo/ehamen.htm

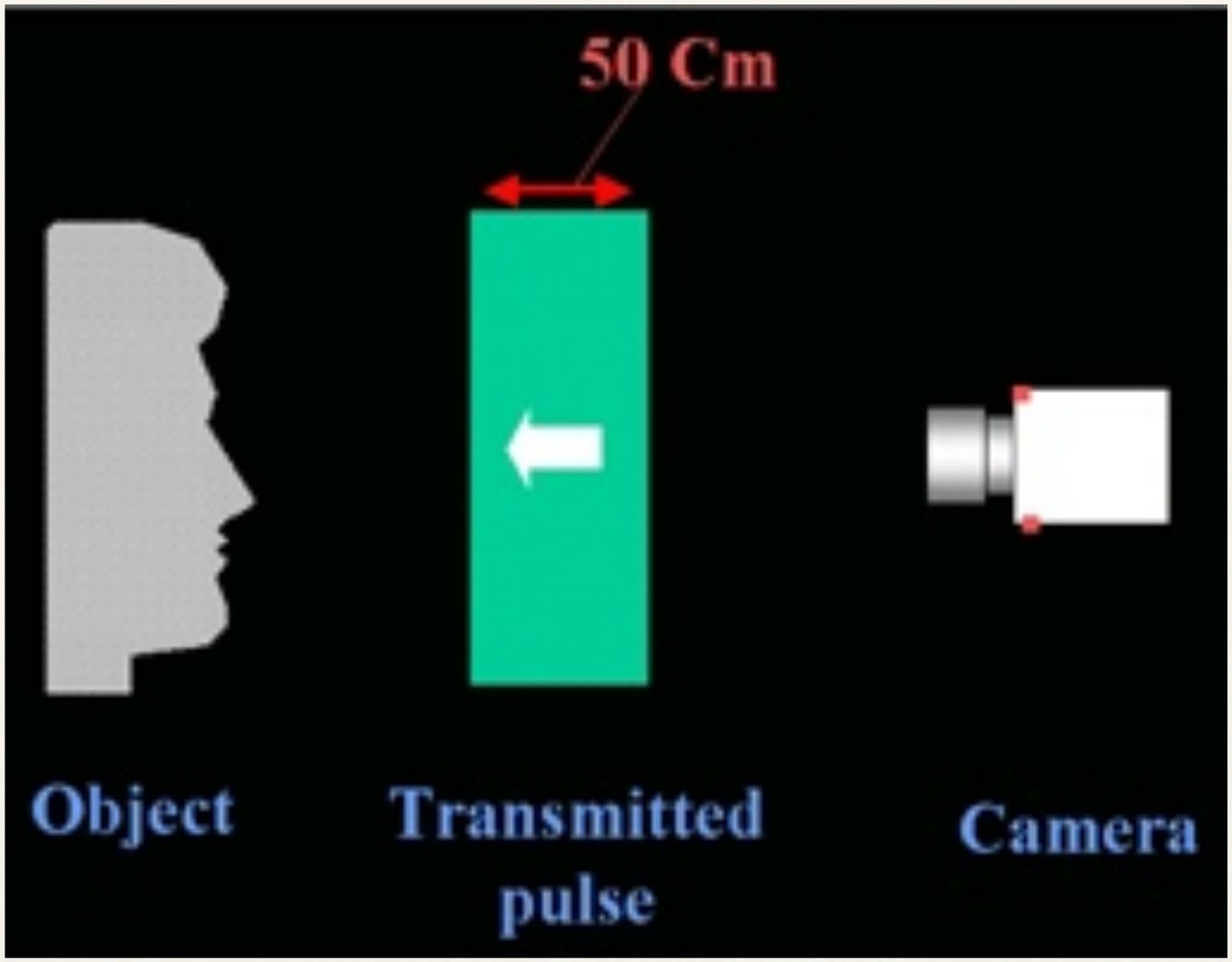
time-of-flight imaging





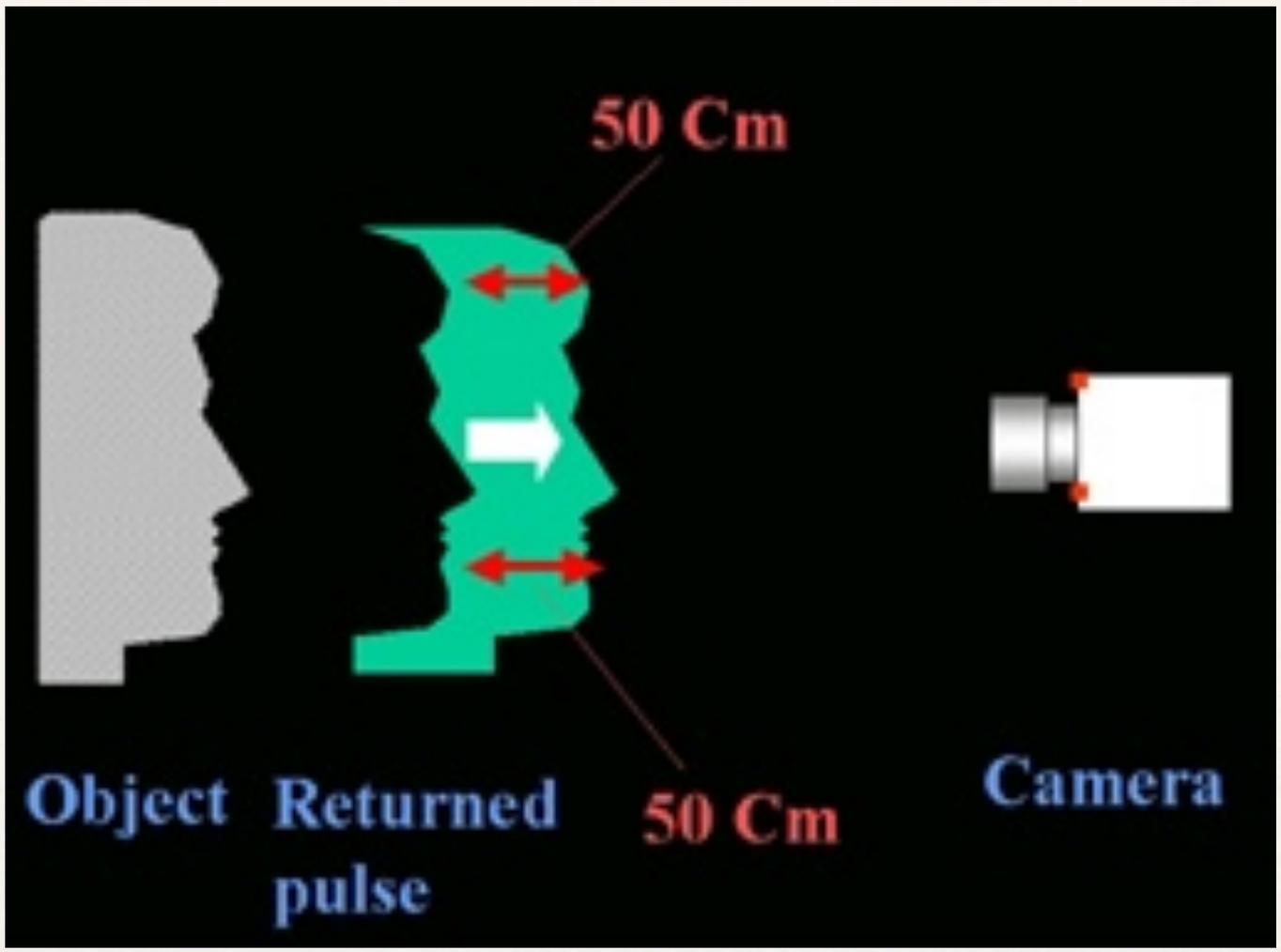
3DV camera operation

50 cm / 3x10^10 cm/sec = 1.7 nanoseconds



http://www.3dvsystems.com

3DV camera operation

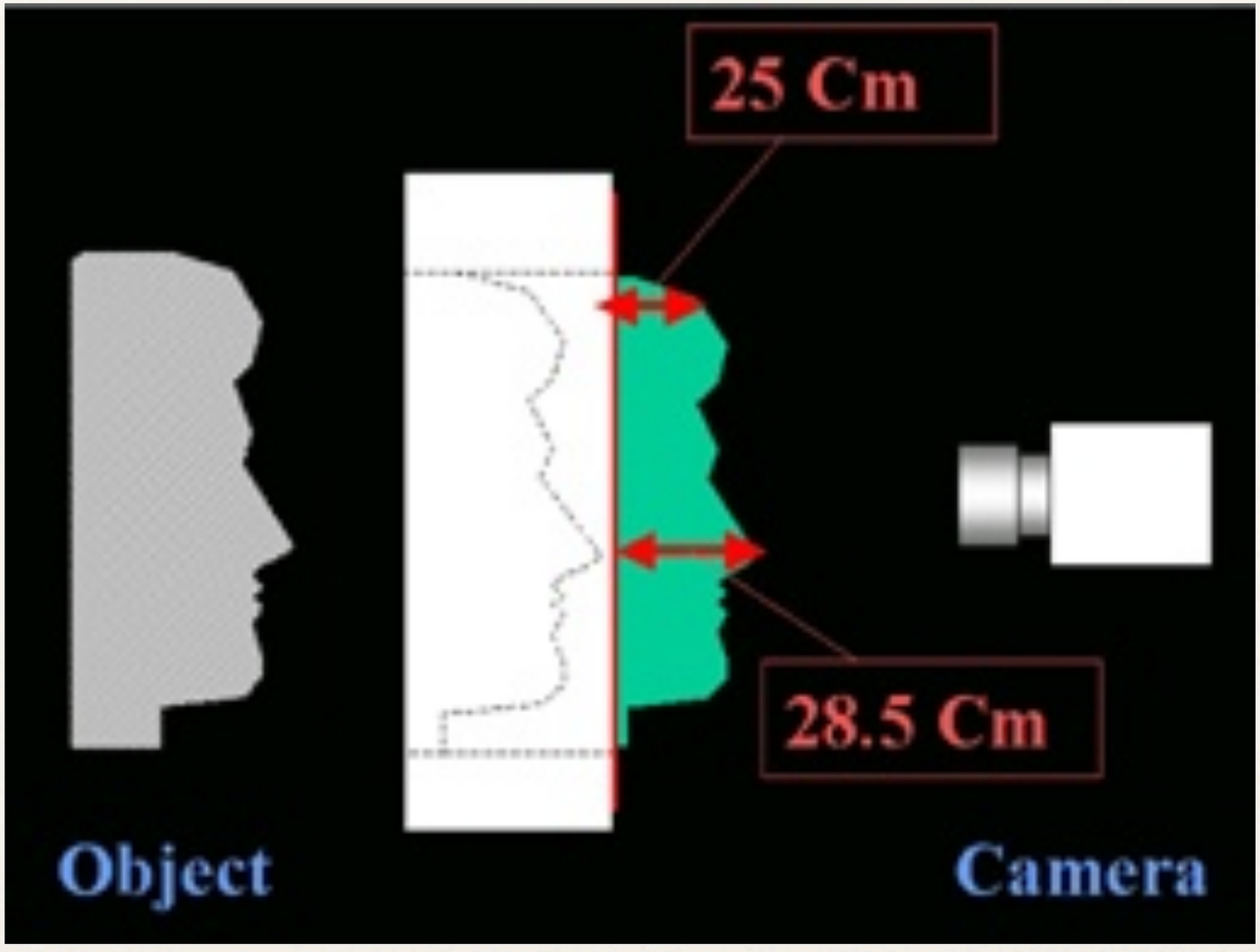


1 x 10-9 second slab of light

http://www.3dvsystems.com

3DV camera operation

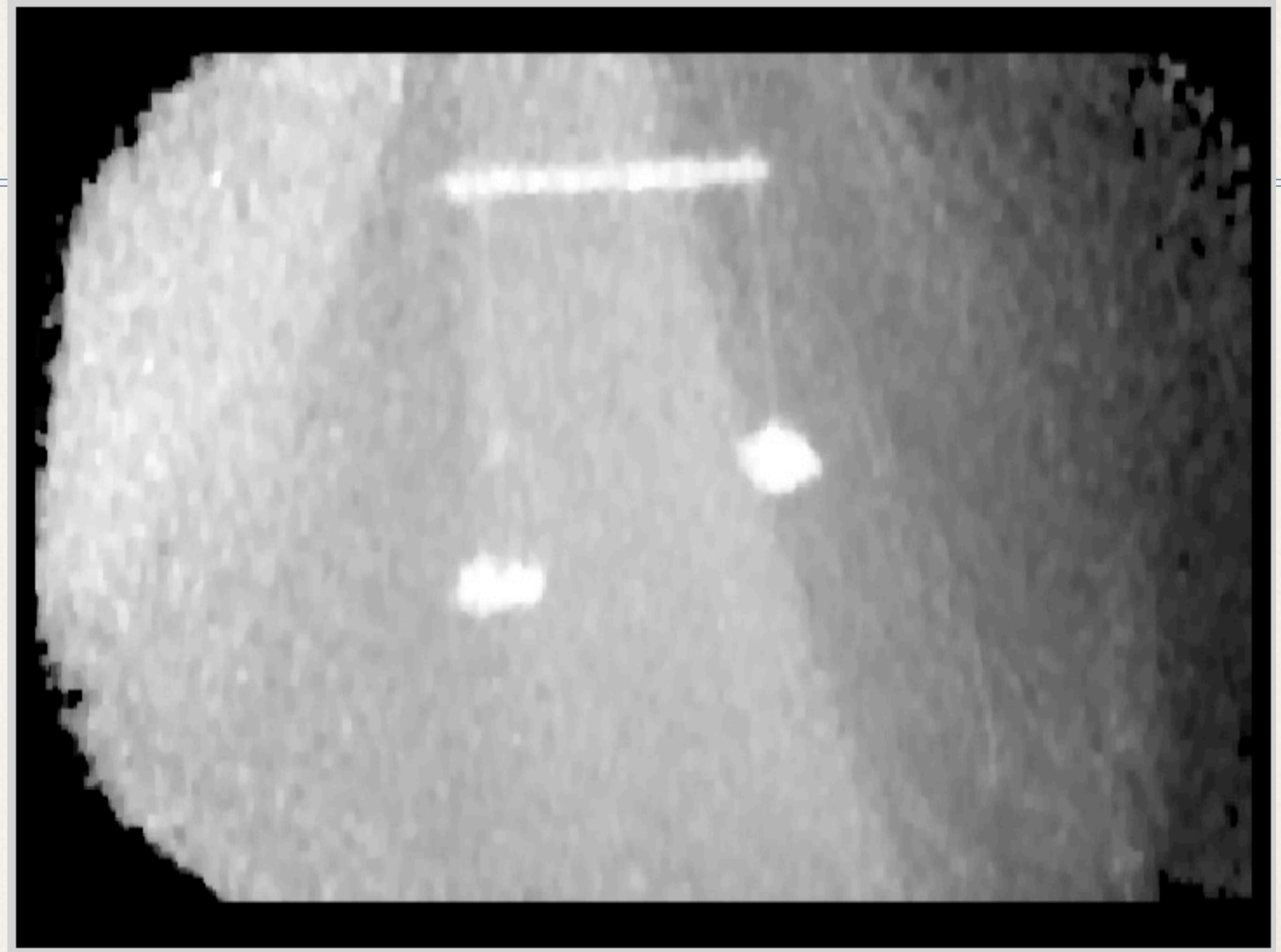
chop return pulse with fast gating mechanism



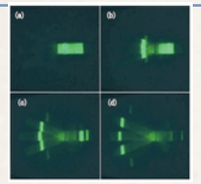
http://www.3dvsystems.com

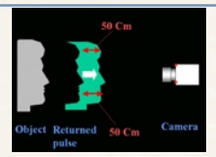
RGB image

Z image



1-200 microseconds--flash photography





1 - 200 microseconds

Notebooks « Harold "Doc" Edge...

http://edgerton-digital-collections.org/notebooks

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Harold "Doc" Edgerton

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Home | Doc's Life | Galleries | Techniques | Stories | Notebooks

Notebooks

T-1: Sep 1927 - Jul 1931

03: Feb 1930 - Jun 1937

11: Sep 1930 - Dec 1941

aa: Jul 1931 - Jan 1932

bb: Oct 1931 - Jan 1932

12: Dec 1931 - Aug 1942

T-3: Jan 1932 - Jul 1933

G2: Feb 1932 - Feb 1934

T-4: Jun 1933 - Nov 1934

T-5: Oct 1934 - Aug 1935

cc: Apr 1935 - Jan 1937

T-6: Aug 1935 - Apr 1936

07: Apr 1936 - May 1937

08: Jun 1937 - Apr 1938

09: Apr 1938 - Jun 1939

B1: Jul 1938 - July 1939

10: Jun 1939 - Sep 1940

13: Aug 1942 - Mar 1943

Harold "Doc" Edgerton's laboratory notebooks illustrate through notes, diagrams, data, and photographs the step-by-step evolution of Doc's innovative ideas from inspiration to hard work to finished plan or product. The notebook entries reveal the excitement generated at MIT by his early demonstrations of stroboscopic phenomena and, show how techniques developed by him to discover ways of improving industrial efficiency found useful applications in other areas.

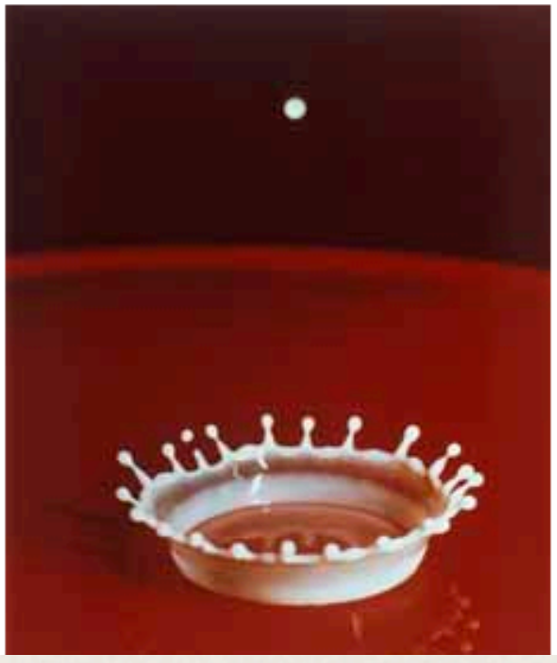
The notebooks, approximately 8,400 pages, are a consistent record of Edgerton's research activities in his MIT lab from 1930 to 1990. Doc also recorded personal diary entries regarding births, marriages, visits by friends, and recreation in his laboratory notebooks, sandwiched between entries containing complicated calculations and diagrams.

This digital archive provides the first online access to Harold Edgerton's research notebooks held by MIT, constituting the material record of an extraordinary man who shaped public perception about science and

Help us tag Doc's notebooks!

Your tags will help everyone find topics and images in Doc's notebooks. When you're browsing a notebook page on this site, please add helpful tags to help our search engine read the the hand-written page content and images.

Start tagging »



Massachusetts Institute of Technology

COMPUTATION BOOK

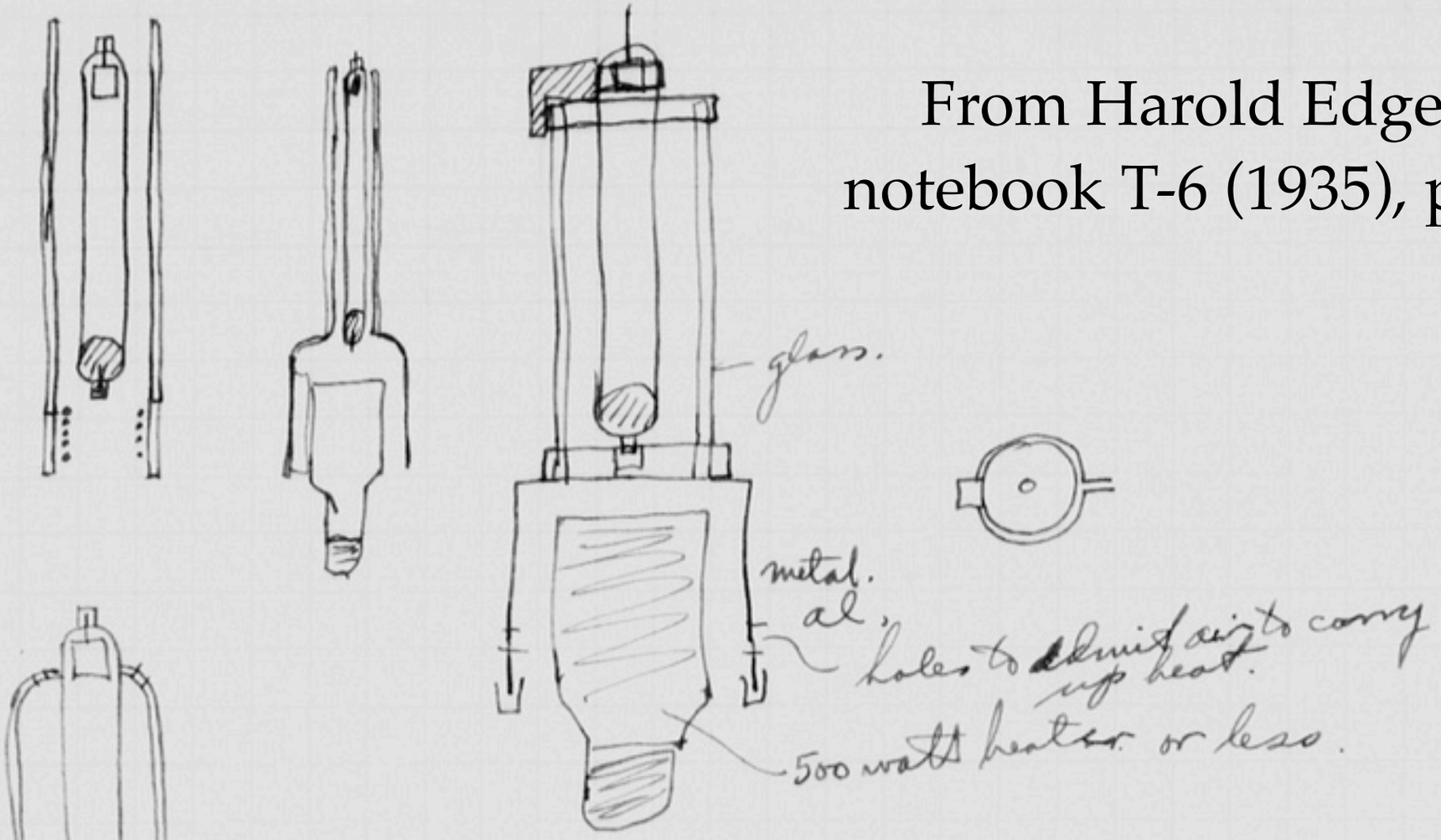
NAME	Number
HAROLD E. EDGERTON.	T-6.

Room 4-111 M.I.T.

Course .....

Used from AUGUST 27 1935, to APRIL 28 1936.

From Harold Edgerton
notebook T-6 (1935), page 18



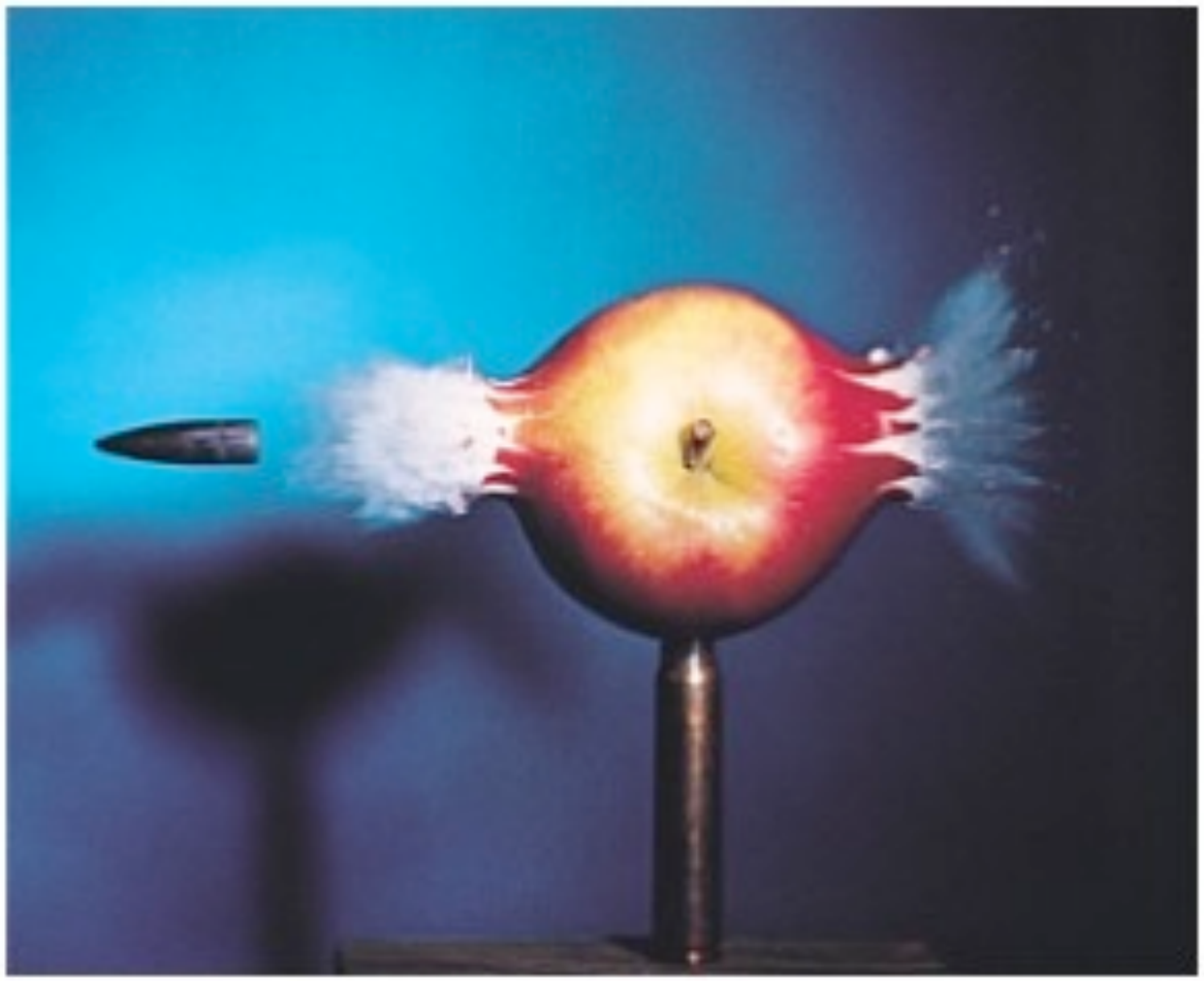
Experiment to measure
1. time duration as function of
a. voltage b. capacity, c length of tube
d. temperature.

2. time constant, (thermal).

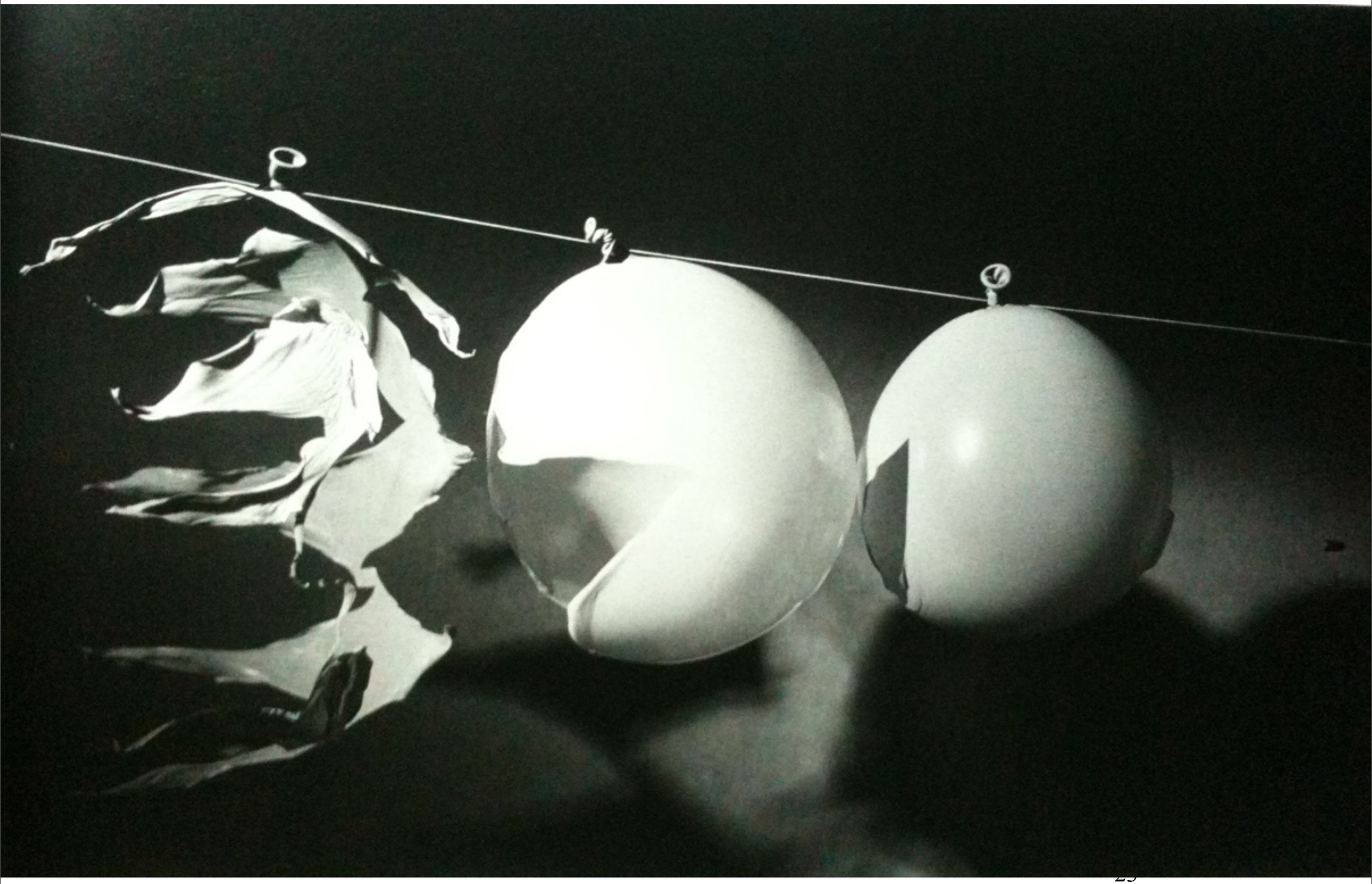
3. Intensity of the light as function
of the variables of item 1.

Strobe photograph by Edgerton

Other photographs by Doc Edgerton



flash: about 10 micro seconds, but showing bullet effect over 1m/500m/sec = 2 milliseconds Doc Edgerton



By **nebarnix** Jasper Nance

traveling 0.002 m at ~500m/s takes 0.4 microsec

http://www.flickr.com/photos/nebarnix/640437476/sizes/l/in/pool-77268029@N00/

http://www.highspeedflashphotography.com/high-speed-flash-images/

Smashed Cookie

 http://www.flickr.com/photos/kalimistuk/1098190315/in/pool-77268029@N00/

taken with a Make highspeed controller and a panasonic FZ50.
shot with a .22 cal pellet.

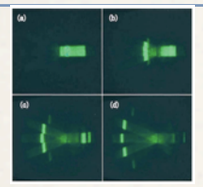
Photographs by Heinz Maier

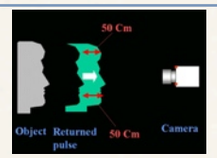
http://www.thisiscolossal.com/2011/10/high-speed-liquid-and-bubble-photographs-by-heinz-maier/

Photographs by Heinz Maier

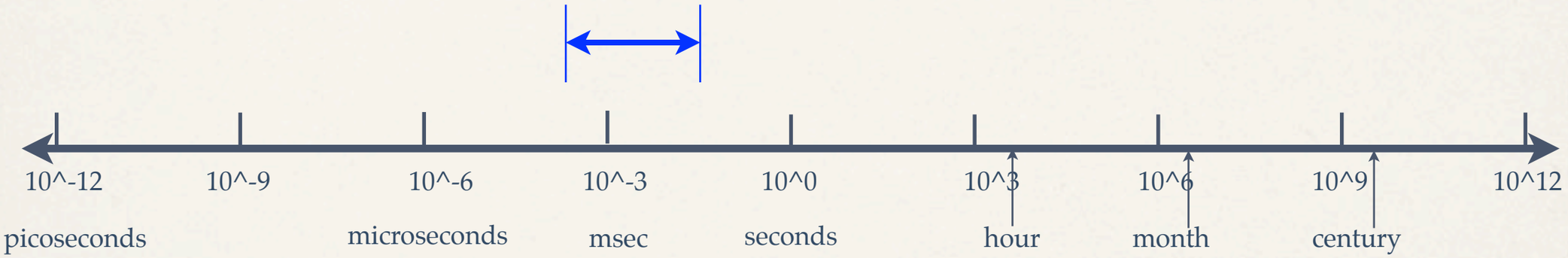
http://www.thisiscolossal.com/2011/10/high-speed-liquid-and-bubble-photographs-by-heinz-maier/

Conventional photography



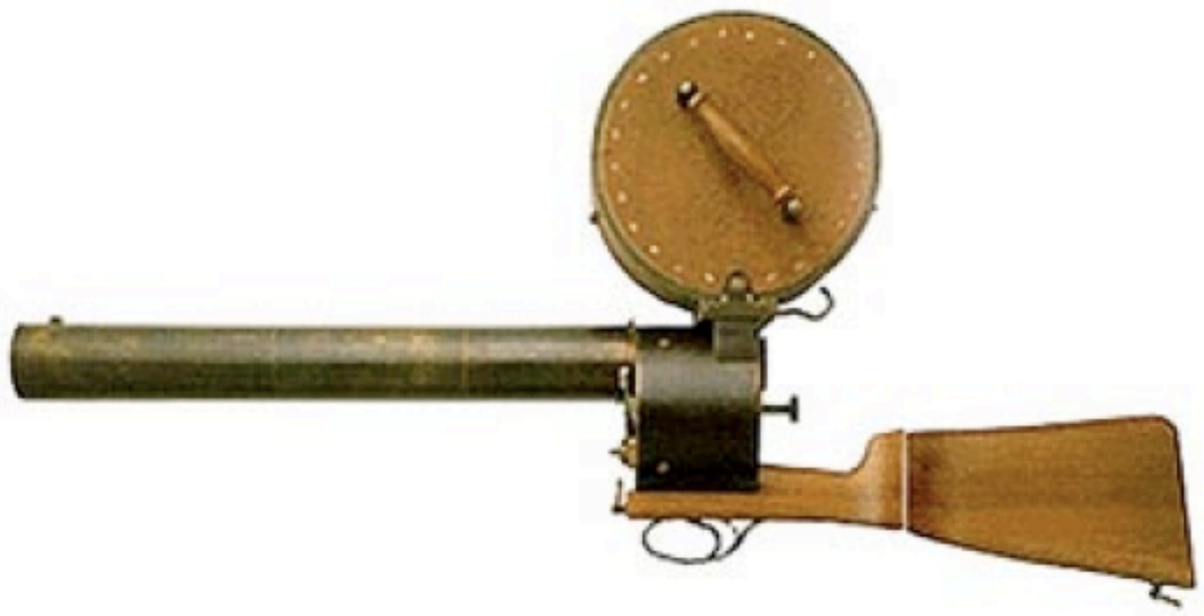


1/5000 - 1/25 sec



Marey photographic rifle (12 fps)

pigeons, and the leg movements of horses and men. Marey heard of the work of **Eadweard Muybridge** an English professional photographer: so he invited the latter in 1881 to give a demonstration to the scientists at Paris. Marey immediately saw, from Muybridge's results, the ideal, inertialess transmission and recording technique in photography. Using a rotating photographic glass plate, he introduced his 'photographic gun' which took twelve consecutive pictures per second.

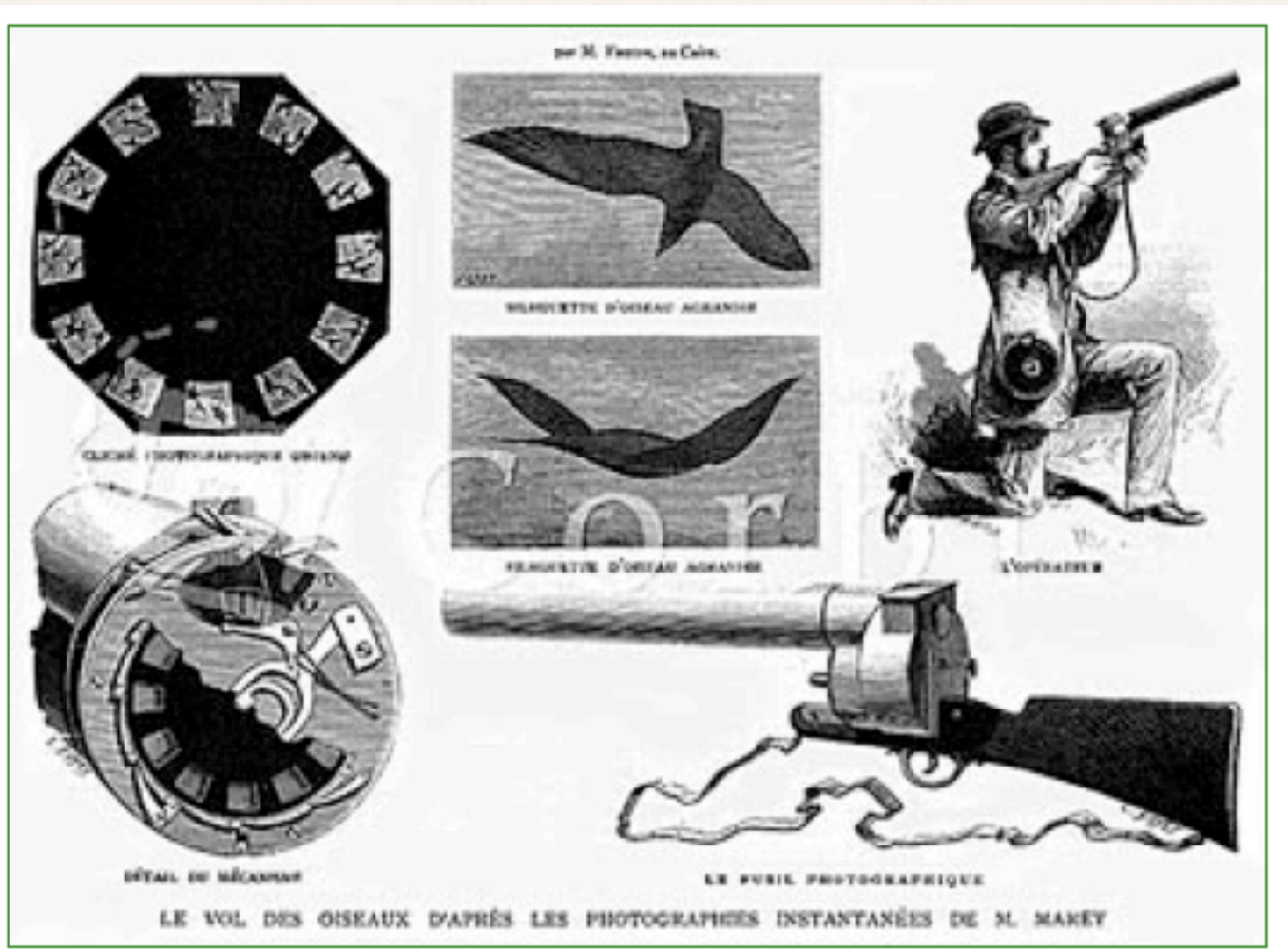


Étienne-Jules Marey, Fusil Photographique

http://www.ctie.monash.edu.au/hargrave/marey.html

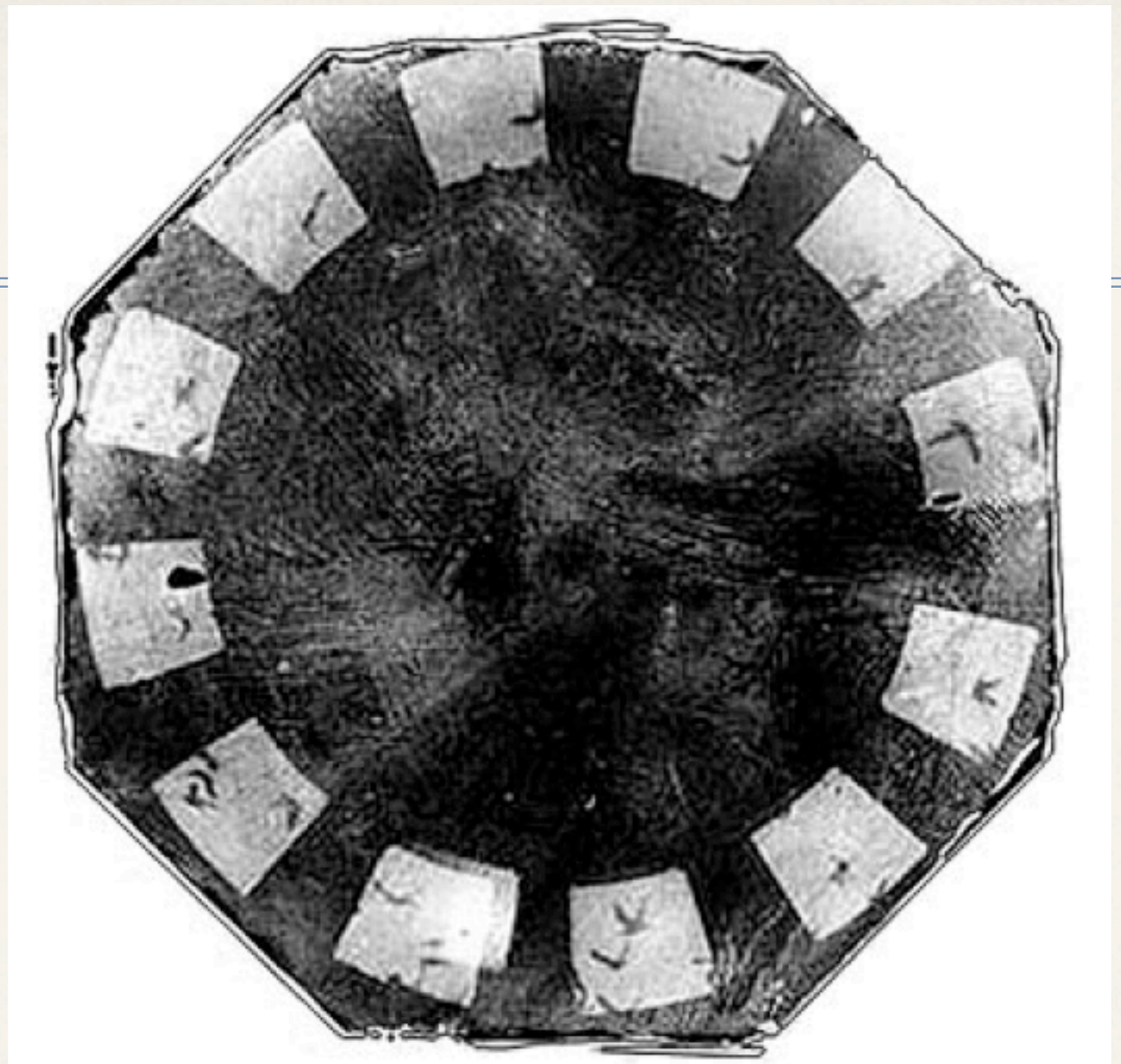
http://en.wikipedia.org/wiki/%C3%89tienne-Jules_Marey

Marey photographic rifle (12 fps)



Étienne-Jules Marey, Fusil Photographique

http://www.ctie.monash.edu.au/hargrave/marey.html



Étienne-Jules Marey, Plate, Fusil Photographique

http://www.ctie.monash.edu.au/hargrave/marey.html

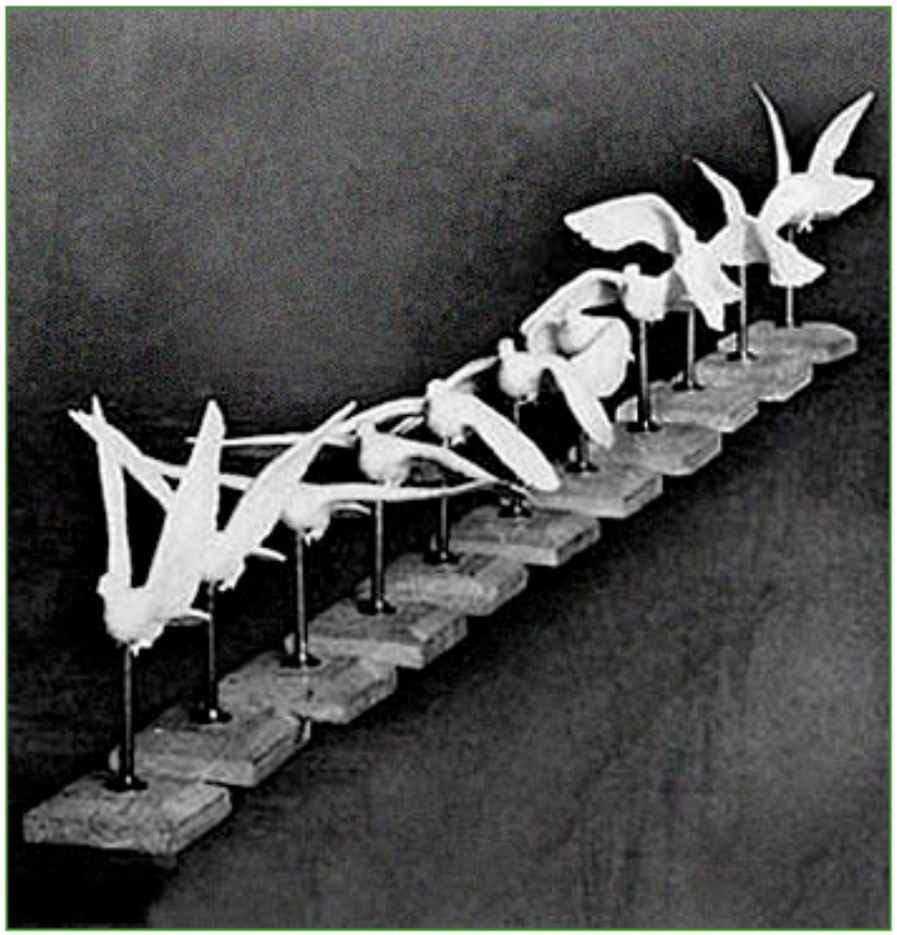
http://www.ctie.monash.edu.au/hargrave/marey.html

Marey

Étienne-Jules Marey, Bird Flight, Pigeon Landing, 1894

Animation by Charl Lucassen

Marey

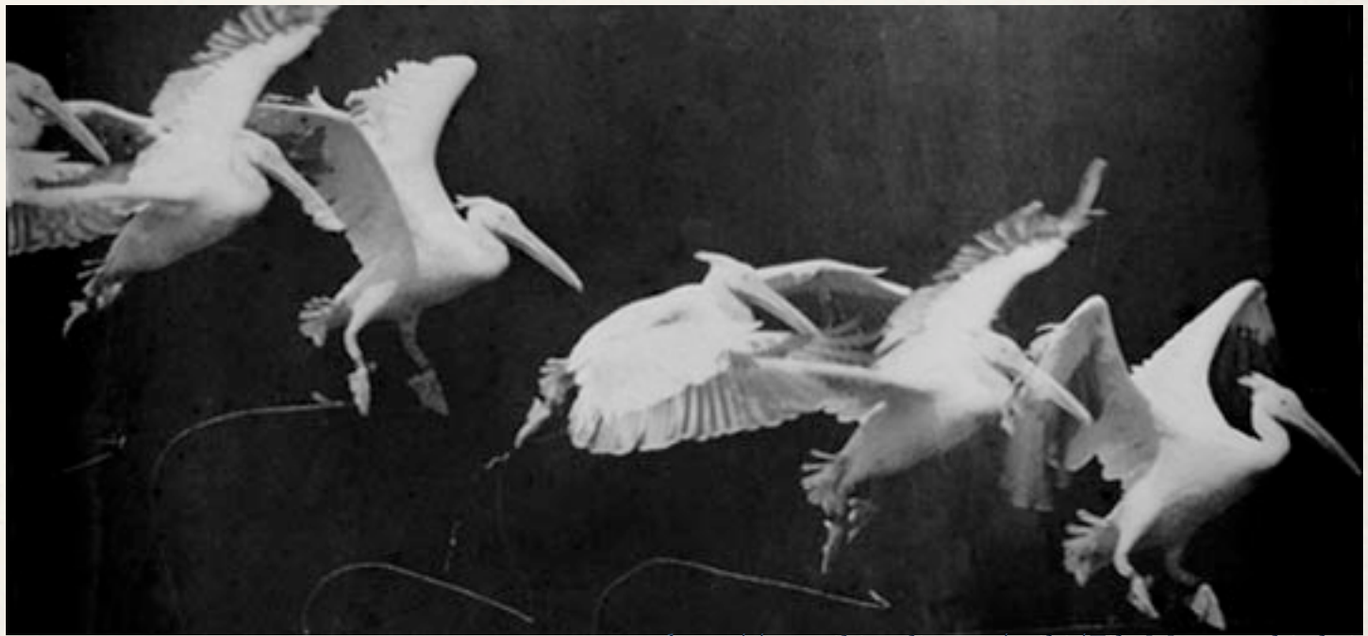


Étienne-Jules Marey, Sculptures of birds in flight

http://www.ctie.monash.edu.au/hargrave/marey.html

Drawings and sculptures of flying birds (1886-1890)
http://www.expo-marey.com

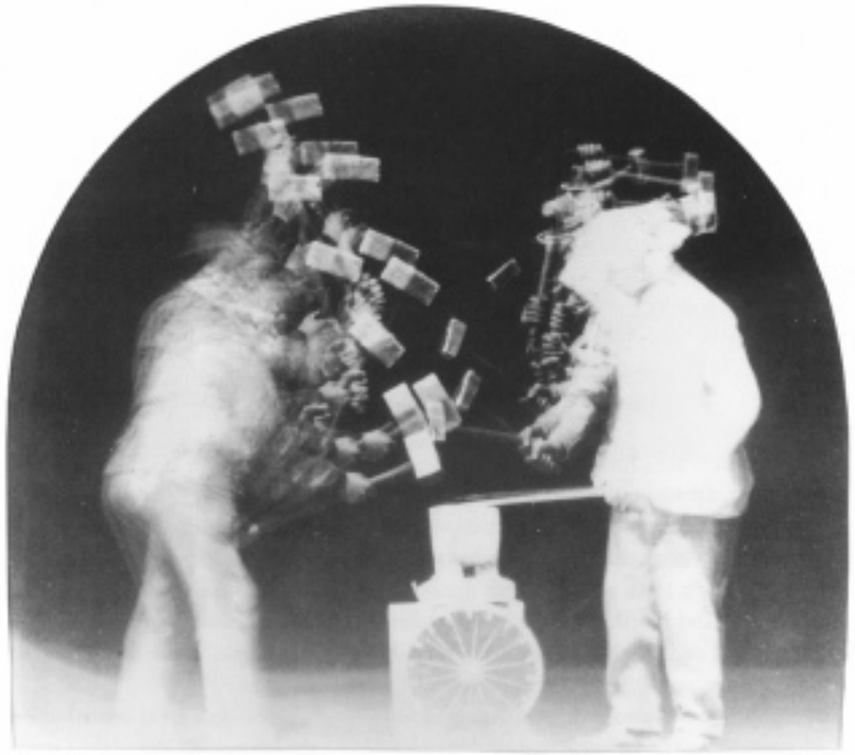
Using his chronophotographic cameras, first with glass plates and then with celluloid film, Marey succeeded in photographing the different phases of the flight of birds - seagulls, pigeons, herons and so on. The results, when compared with the graphs he had previously obtained, allowed Marey to publish a substantial volume entitled Le Vol des Oiseaux ("The Flight of Birds") in 1890. Alongside the plates and films, and with Georges Demenÿ's assistance, Marey once again produced sets of magnificent drawings. Better still, in 1887 he created a number of bronze and plaster sculptures which were truly kinetic works of art.

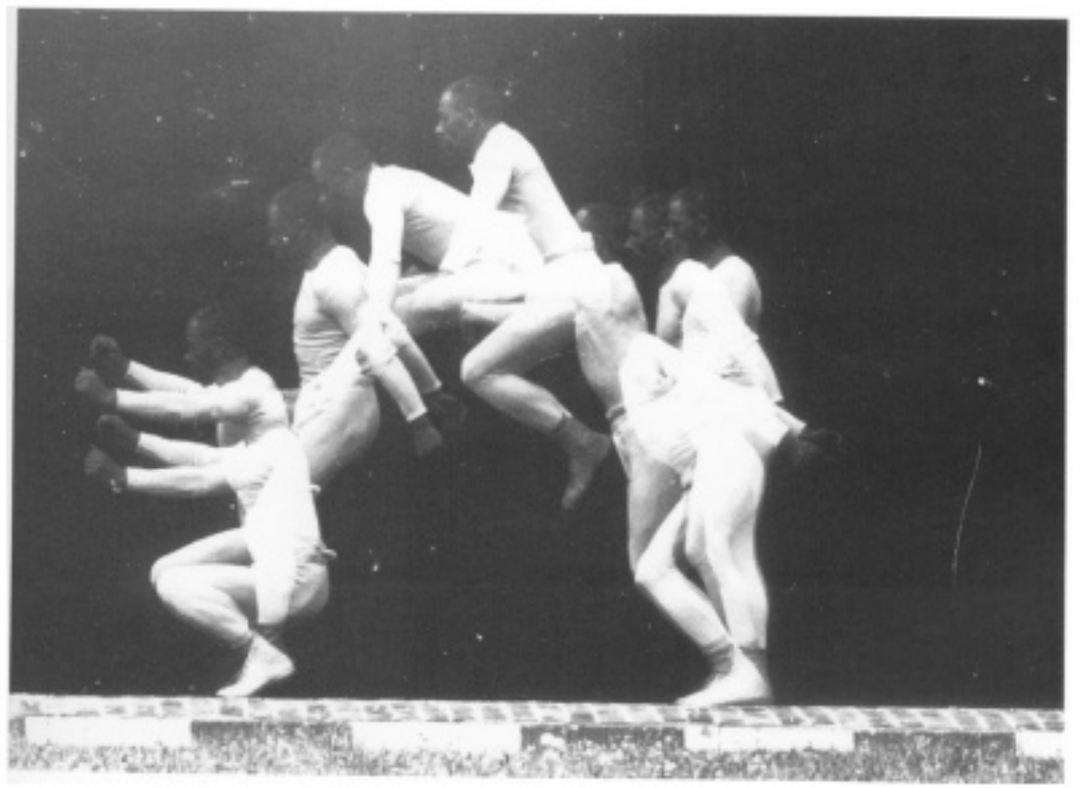


http://en.wikipedia.org/wiki/File:Marey_-_birds.jpg

Marey, 1882

Marey

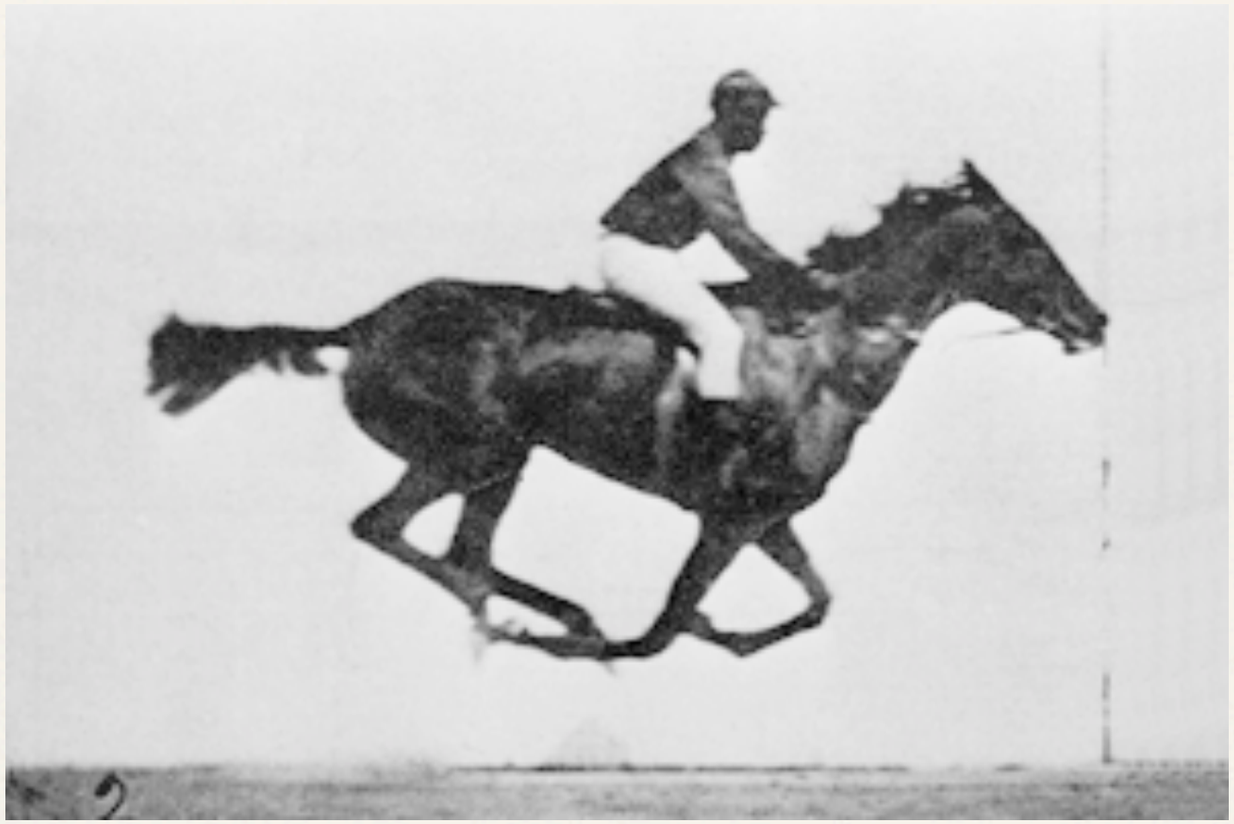




Muybridge

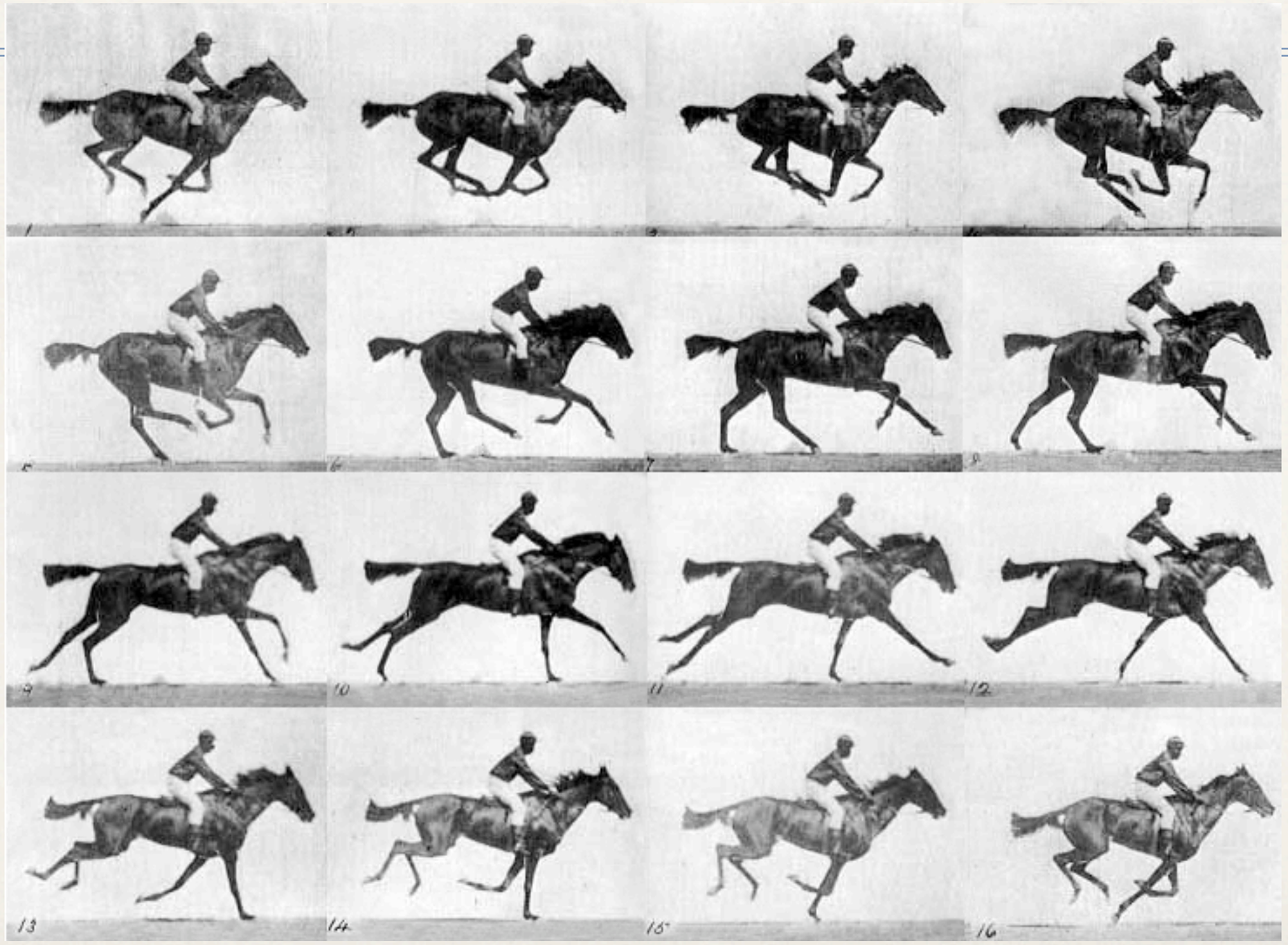
http://upload.wikimedia.org/wikipedia/commons/d/dd/Muybridge_race_horse_animated.gif

Muybridge



http://upload.wikimedia.org/wikipedia/commons/d/dd/Muybridge_race_horse_animated.gif

Muybridge



Carli Davidson Pet Photography

http://carlidavidson.photoshelter.com/gallery-image/Shake/G0000s_trsF9CDFI/I0000Sz03P1L2rr4

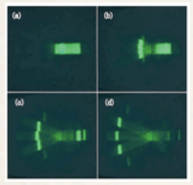
Carli Davidson Pet Photography

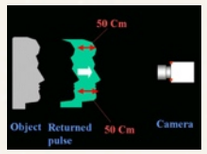
http://carlidavidson.photoshelter.com/gallery-image/Shake/G0000s_trsF9CDFI/I0000B1xJe9AJDbI

Carli Davidson Pet Photography

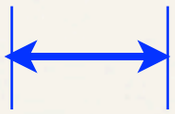
http://carlidavidson.photoshelter.com/gallery-image/Shake/G0000s[illegible]rsF9CDFI/I0000fA42.3dHwwA

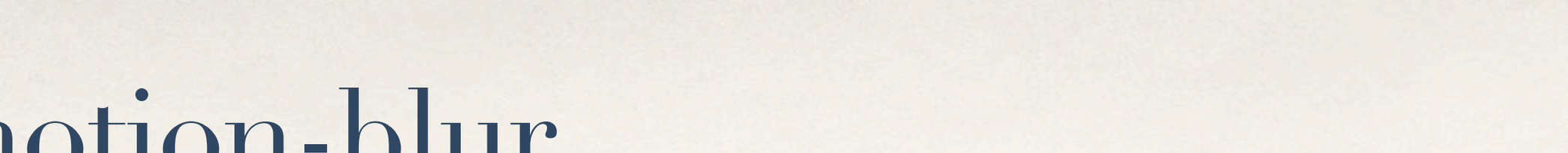
motion-blur





1/25 - 1 second





Blur tells a story

http://www.flickr.com/photos/kups/6030209 57/sizes/l/in/pool-77268029@N00/

By K.u.p.s. Cristiano Fonseca+ Add Contact

This photo was taken on June 3, 2007 using a Canon EOS Digital Rebel XTi.

Ernst Haas

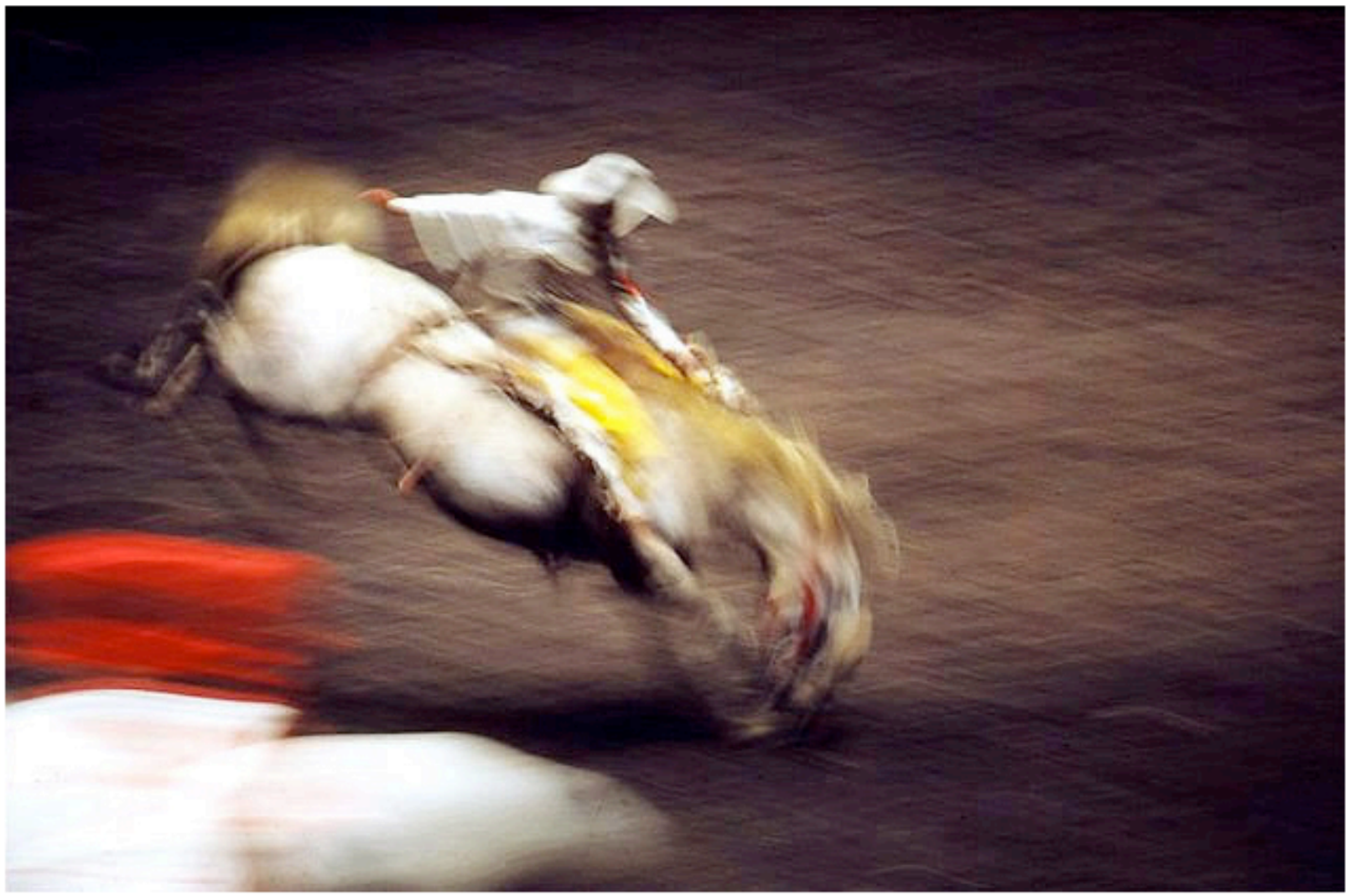
1921-1986

"Motion" collection by Ernst Hass

http://www.ernst-haas.com/colorGallery03.html

Ernst Haas

1921-1986



Rodeo, Madison Square Garden, NYC, 1957

"Motion" collection by Ernst Hass

http://www.ernst-haas.com/colorGallery03.html

Ernst Haas

1921-1986

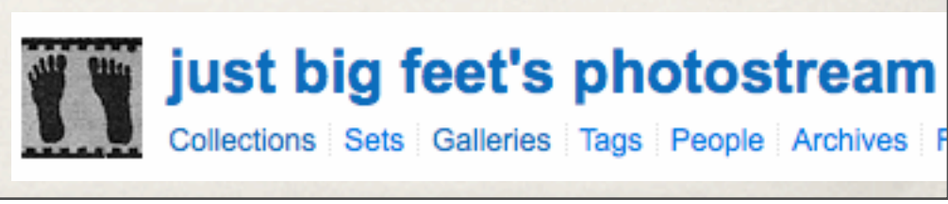
"Motion" collection by Ernst Hass
http://www.ernst-haas.com/colorGallery03.html

http://www.flickr.com/photos/kington/5660831674/in/photostream

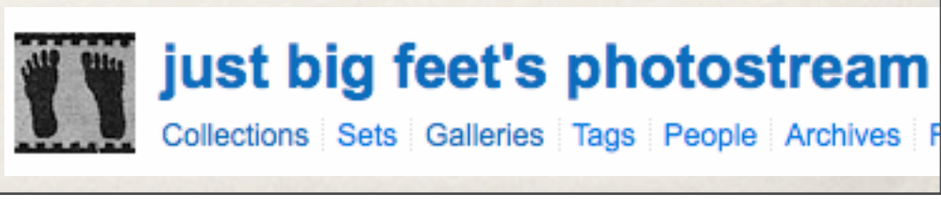
just big feet's photostream

Collections | Sets | Galleries | Tags | People | Archives

http://www.flickr.com/photos/kington/5660831448/in/photostream/lightbox/



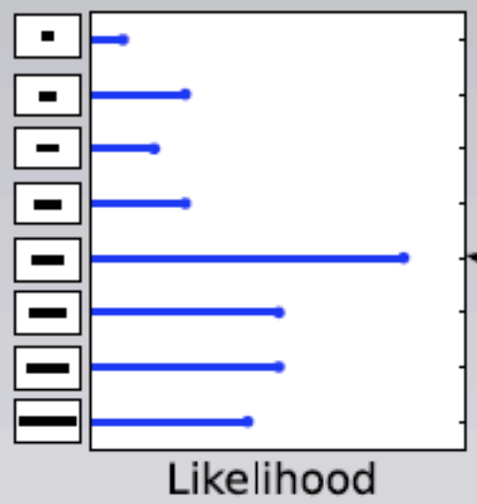
http://www.flickr.com/photos/kington/page3/

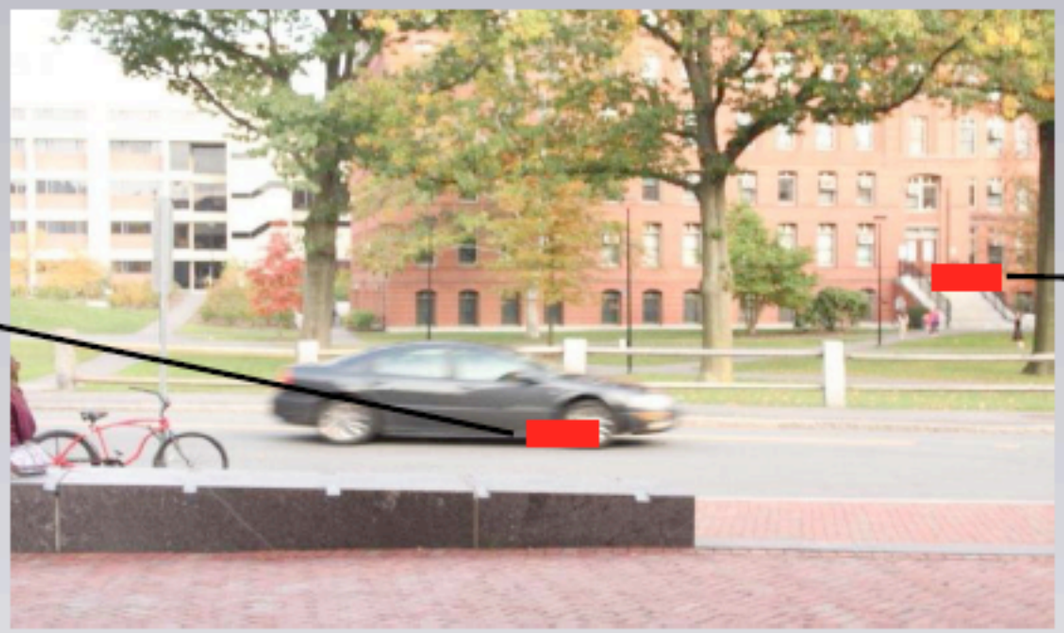


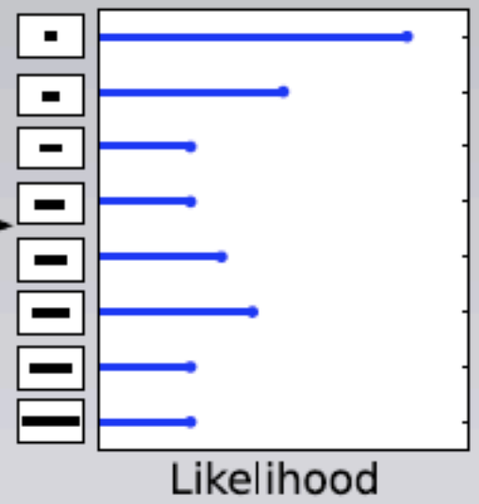
The Local Blur Cue

Ayan Chakrabarti
ayanc@eecs.harvard.edu

Joint work with Todd Zickler & Bill Freeman







$$p(\{y_i^{\nabla}[n]\}_i|k) \propto \int_s \prod_i \mathcal{N}(y_i^{\nabla}[n]|0, s\sigma_{ki}^2 + \sigma_{zi}^2)\, ds$$

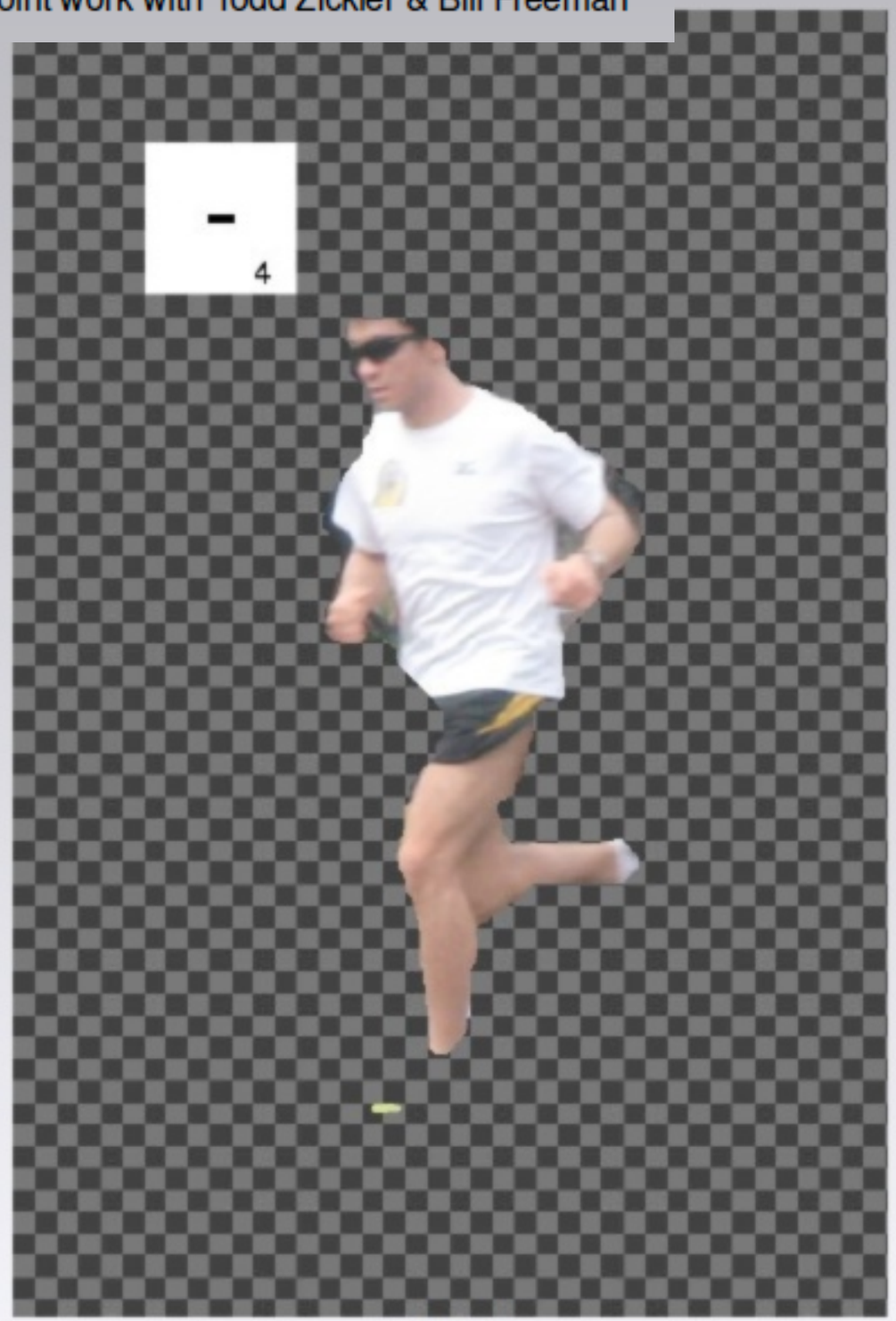
σ_{zi}^2: Noise variance

Analyzing spatially varying blur

Ayan Chakrabarti
ayanc@eecs.harvard.edu

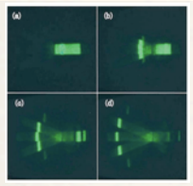
Joint work with Todd Zickler & Bill Freeman

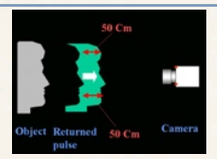
Input



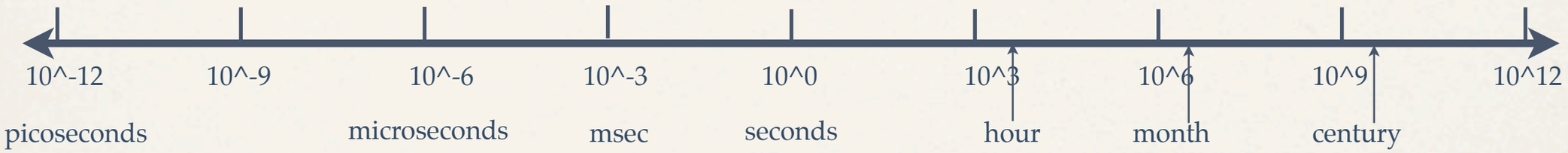
Output

seconds to hours

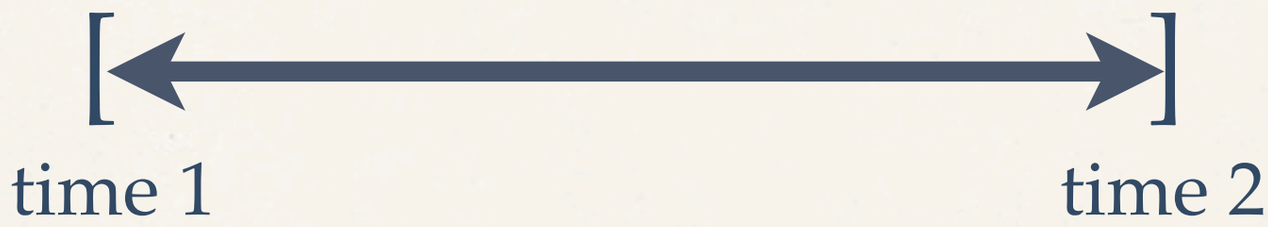




seconds to hours

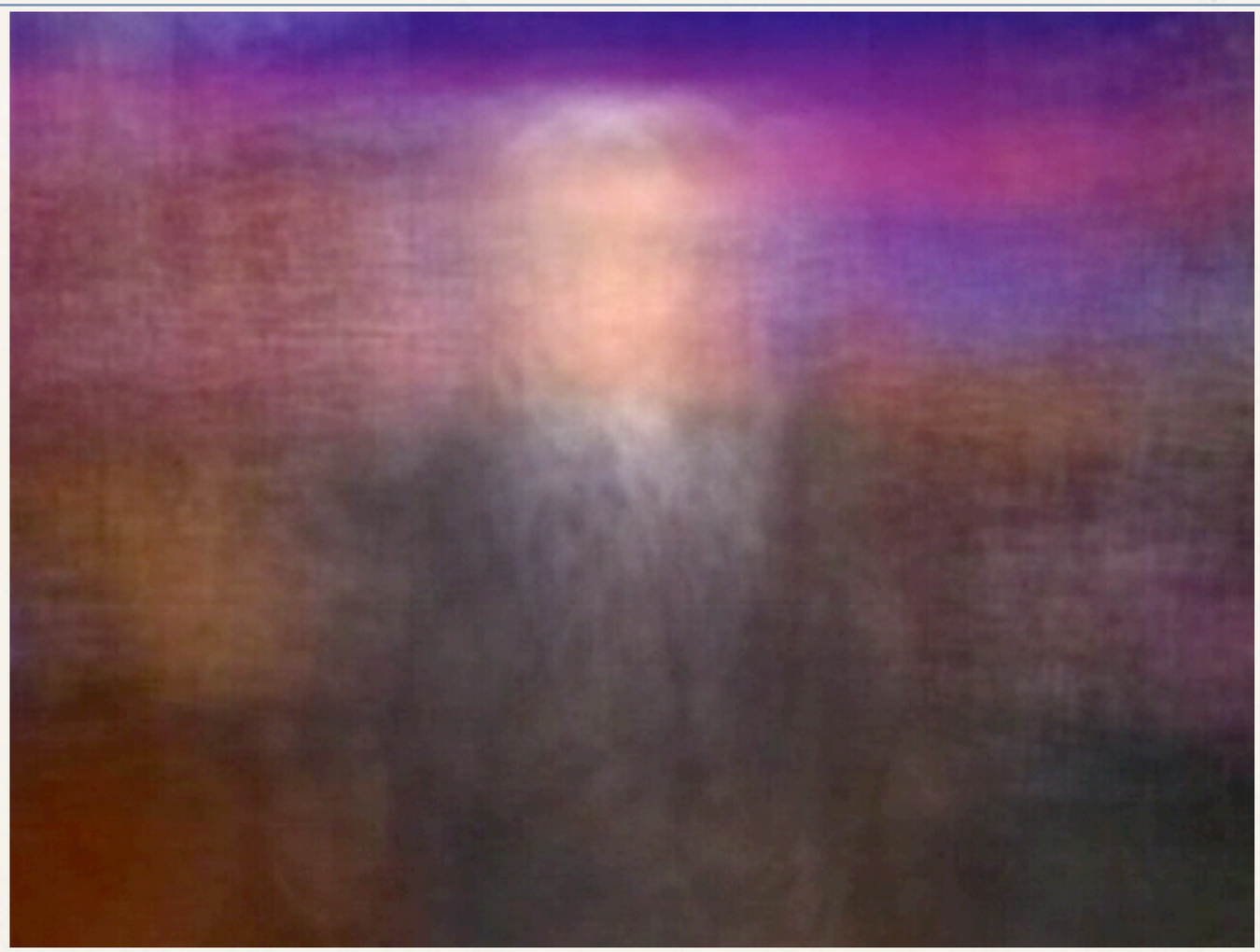


Operations on images over an interval



- averaging
- image selection
  - synopsis
  - shapetime photography
  - lucky imaging
- analyze how things have changed

Jason Salavon



http://salavon.com/LateNite/Leno_Detail.html

Jason Salavon

http://salavon.com/LateNite/Conan_Detail.html

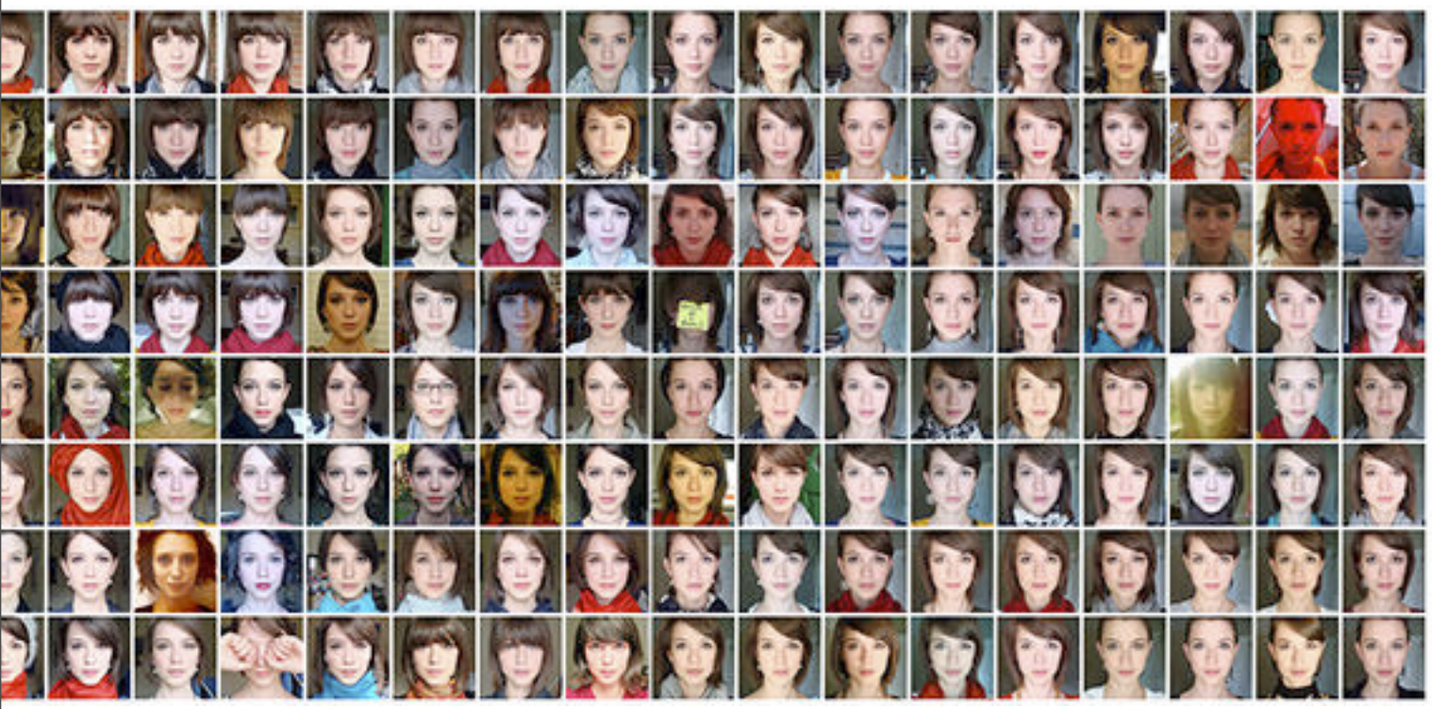
Jason Salavon

The Late Night Triad 2003
Part I: The Tonight Show with Jay Leno
Part II: Late Night with Conan O'Brien
Part III: Late Show with David Letterman
3 Synced single-channel DVD projections
Running time: 3 min 35 sec looped. Dimensions variable. Ed. 3 + 1 APs.

http://salavon.com/LateNite/Letterman_Detail.html

In this installation, from a broader series begun in 1997, 64 nights' worth of the major US late night talk shows have been aligned and averaged using basic transformations. The result is a triptych of video projections with soundtrack, presenting an amalgamation of monologues which reveals the ghosts of repetitious structure and nightly activity.

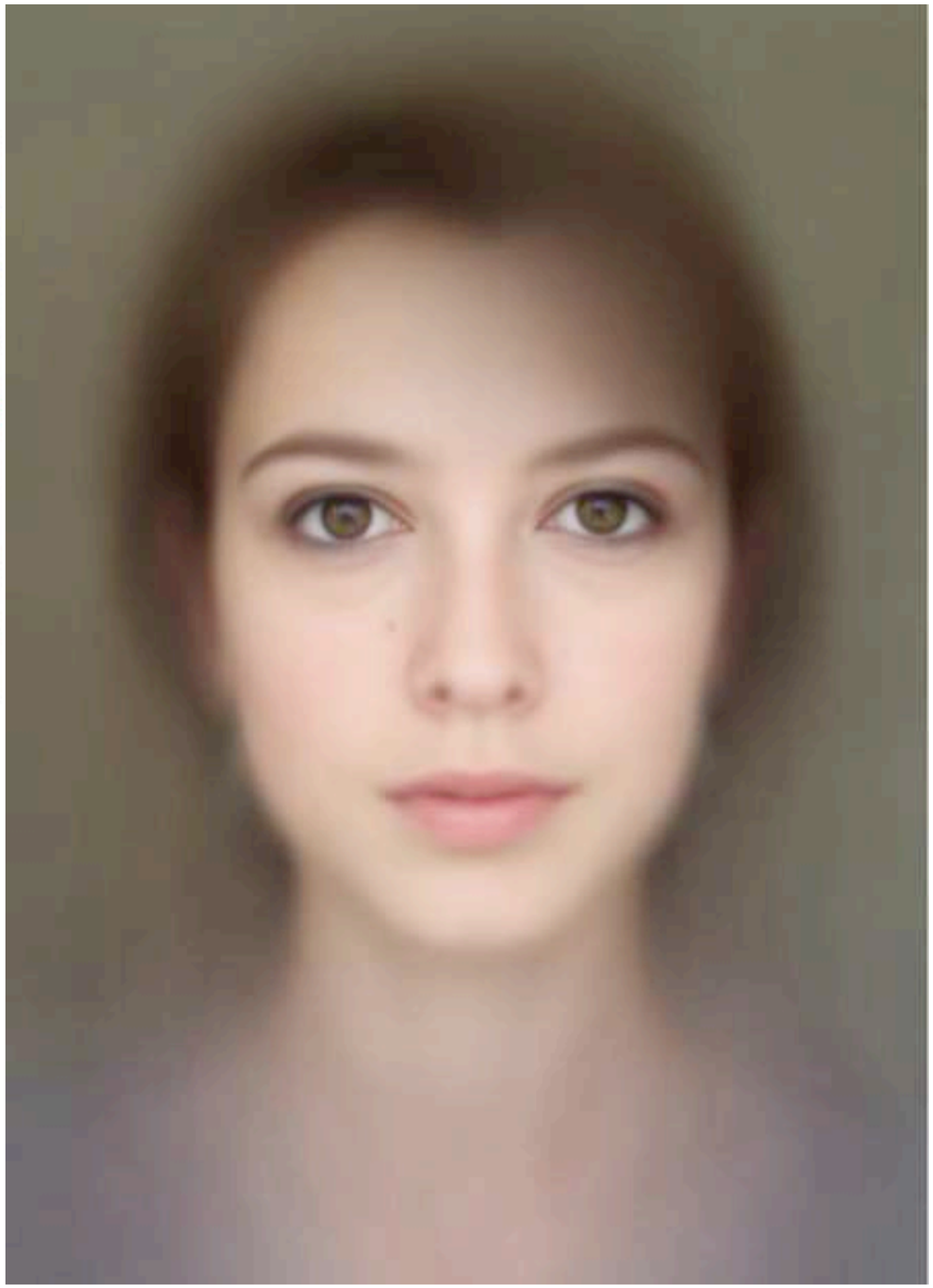
clickflashwhirr



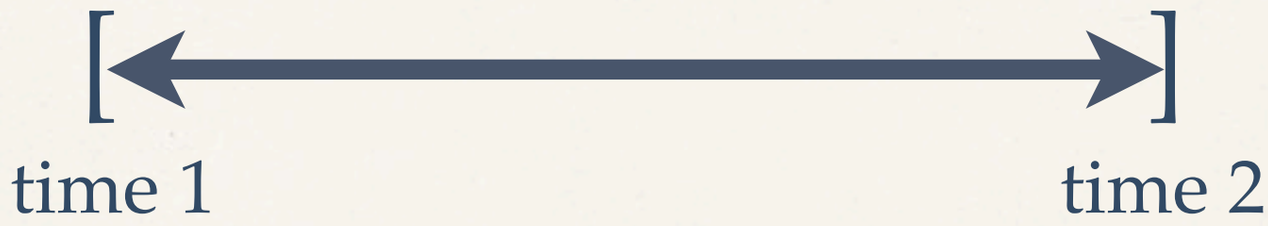
Inspired by Noah Kalina's viral *everyday* video a girl who goes by clickflashwhirr has been doing a similar self-portrait-a-day project. Designer Tiemen Rapati decided to make a composite image showing what the average of the self-portraits looks like. Taking 500 images from clickflashwhirr's Flickr set, Rapati wrote a script that counts the individual RGB values for each pixel, averaging them across the 500 portraits.

http://www.petapixel.com/2011/11/02/composite-self-portrait-made-using-500-photographs-of-one-face/

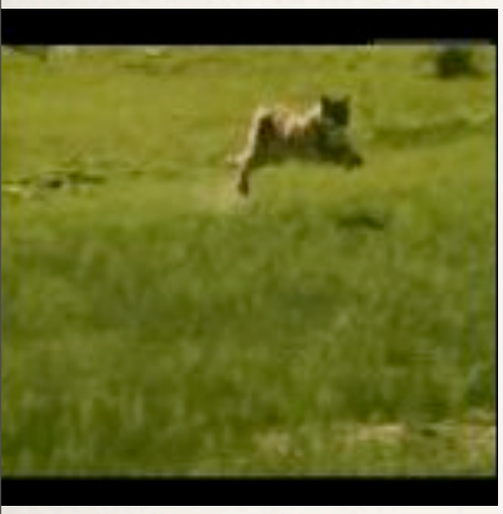
average of 500 photos of clickflashwhirr



Selection over time based on shape



- averaging
- image selection
  - synopsis
  - shapetime photography
  - lucky imaging
- analyze how things have changed



Video Synopsis and Indexing

Yael Pritch, Alex Rav-Acha, Shmuel Peleg

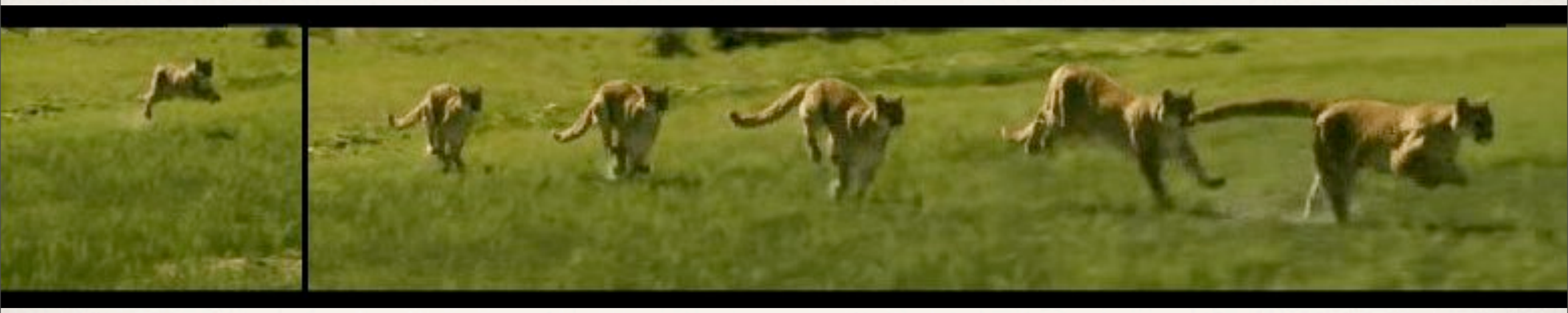
Abstract

The amount of captured video is growing with the increased numbers of video cameras, especially the increase of millions of surveillance cameras that operate 24 hours a day. Since video browsing and retrieval is time consuming, most captured video is never watched or examined. Video synopsis is an effective tool for browsing and indexing such video. It provides a short video representation, while preserving the essential activities in the original video. The activity in the video is condensed into a shorter period by simultaneously showing multiple activities, even when they originally occurred at different times. The synopsis video is also an index into the original video by pointing to the original time of each activity.

Video Synopsis can be applied to create a synopsis of an endless video streams, as generated by webcams and by surveillance cameras. It can address queries like ``Show in one minute the synopsis of this camera broadcast during the past day''. This process includes two major phases: (i) An online conversion of the endless video stream into a database of objects and activities (rather than frames). (ii) A response phase, generating the video synopsis as a response to the user's query.

Project Publications (PDF)

- Y. Pritch, S. Ratovitch, A. Hendel, and S. Peleg, Clustered Synopsis of Surveillance Video, 6th IEEE Int. Conf. on Advanced Video and Signal Based Surveillance (AVSS'09), Genoa, Italy, Sept. 2-4, 2009. in press.
- Y. Pritch, A. Rav-Acha, and S. Peleg, Nonchronological Video Synopsis and Indexing, IEEE Trans. PAMI, Vol 30, No 11, Nov. 2008, pp. 1971-1984.
- Y. Pritch, A. Rav-Acha, A. Gutman, and S. Peleg, Webcam Synopsis: Peeking Around the World, ICCV'07, October 2007. 8p.



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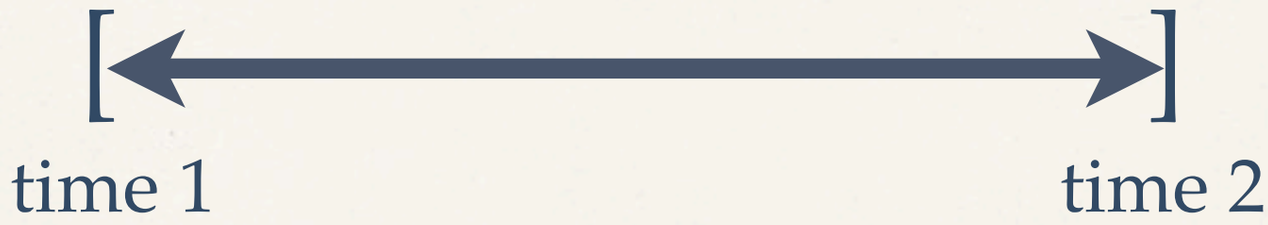
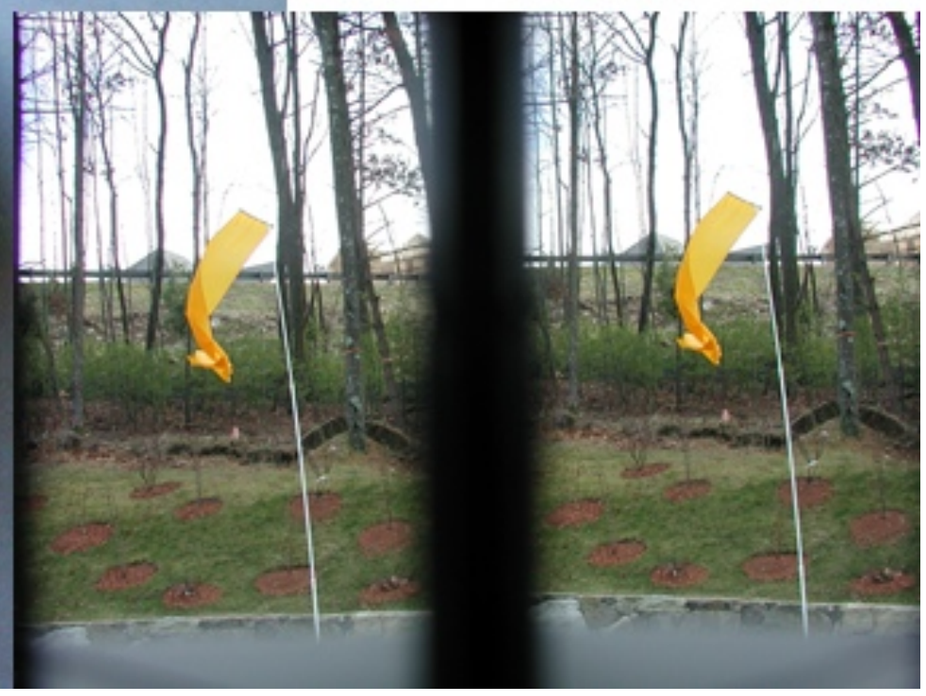


- averaging
- image selection
  - synopsis
  - shapetime photography
  - lucky imaging
- analyze how things have changed

W. T Freeman and H. Zhang, *Shapetime photography,*
IEEE Computer Vision and Pattern Recognition (CVPR), Madison, WI, June, 2003



Video frames

Video frames

Video frames

Video frames

Video frames

Video frames

Video frames

Multiple-exposure

Video frames

Multiple-exposure

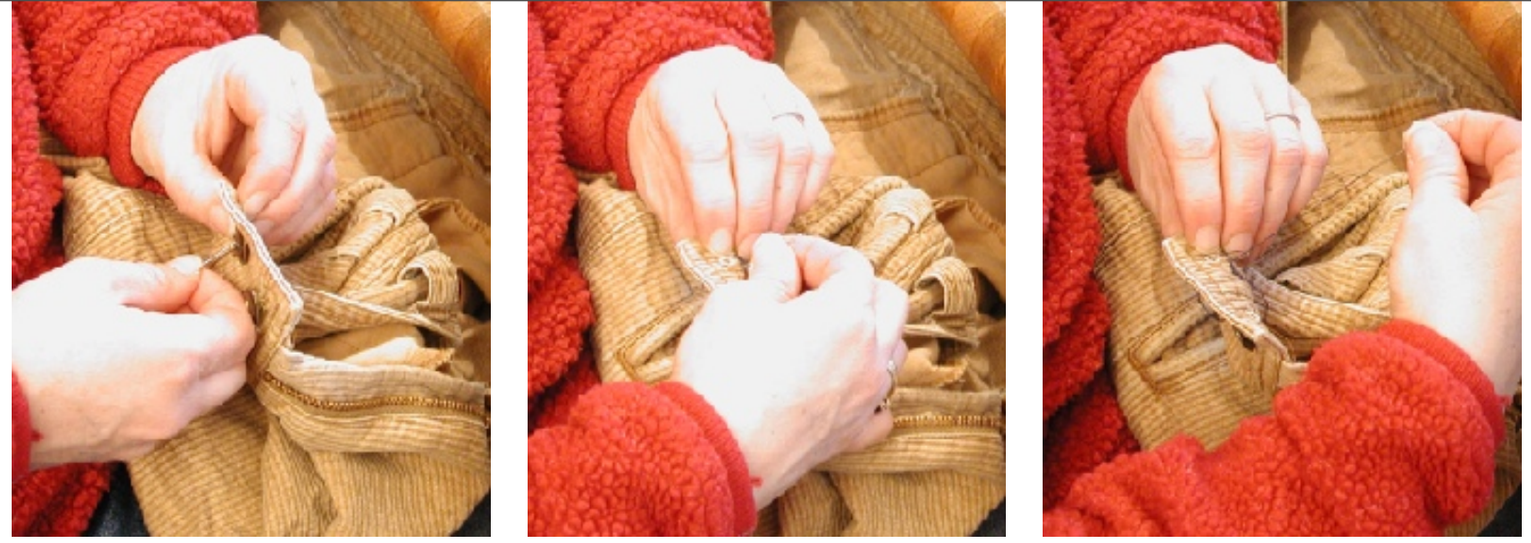
Layer-By-Time

Video frames

Multiple-exposure

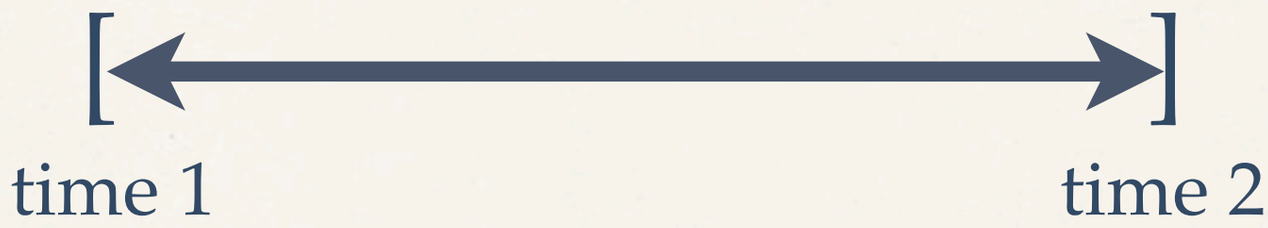
Layer-By-Time

Shape-Time



“how to sew”

illustrate an instant, by selecting images over an interval



- averaging
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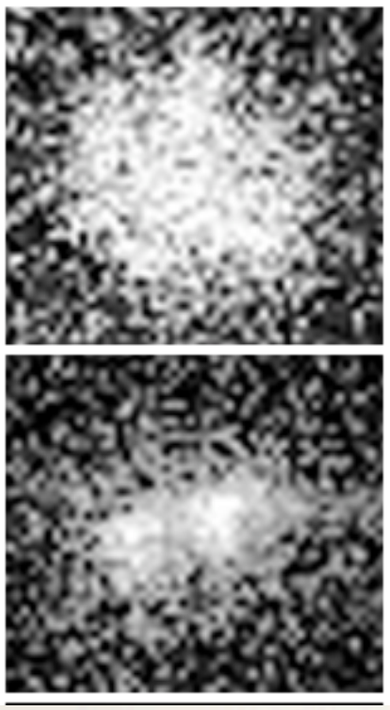
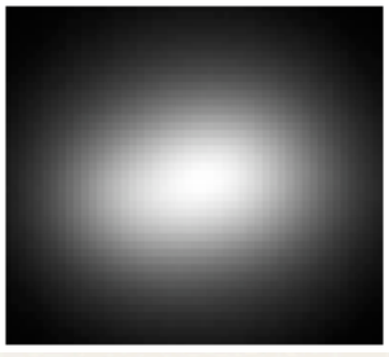
lucky imaging



Single exposure with very low image quality, not selected for Lucky Imaging.

Single exposure with very high image quality, selected for Lucky Imaging.

http://en.wikipedia.org/wiki/Lucky_imaging



The image shows the sum of all 50,000 images, which is almost the same as the 21 minutes (50,000/40 seconds) long exposure seeing limited image. It looks like a typical star image, slightly elongated. The full width at half maximum (FWHM) of the seeing disk is around 0.9 arcsec.

The image shows the 500 (1% selection) best images added together with the brightest pixel in each image moved to the same reference position. The seeing halo is further reduced. The signal-to-noise ratio of the brightest object is the highest in this image.

Seeing Mt. Rainier: Lucky Imaging for Multi-Image Denoising, Sharpening, and Haze Removal

Neel Joshi and Michael F. Cohen
Microsoft Research
[neel,mcohen]@microsoft.com

(a) Original Single Input

(b) Dehazed Single Input Image

Seeing Mt. Rainier: Lucky Imaging for Multi-Image Denoising, Sharpening, and Haze Removal

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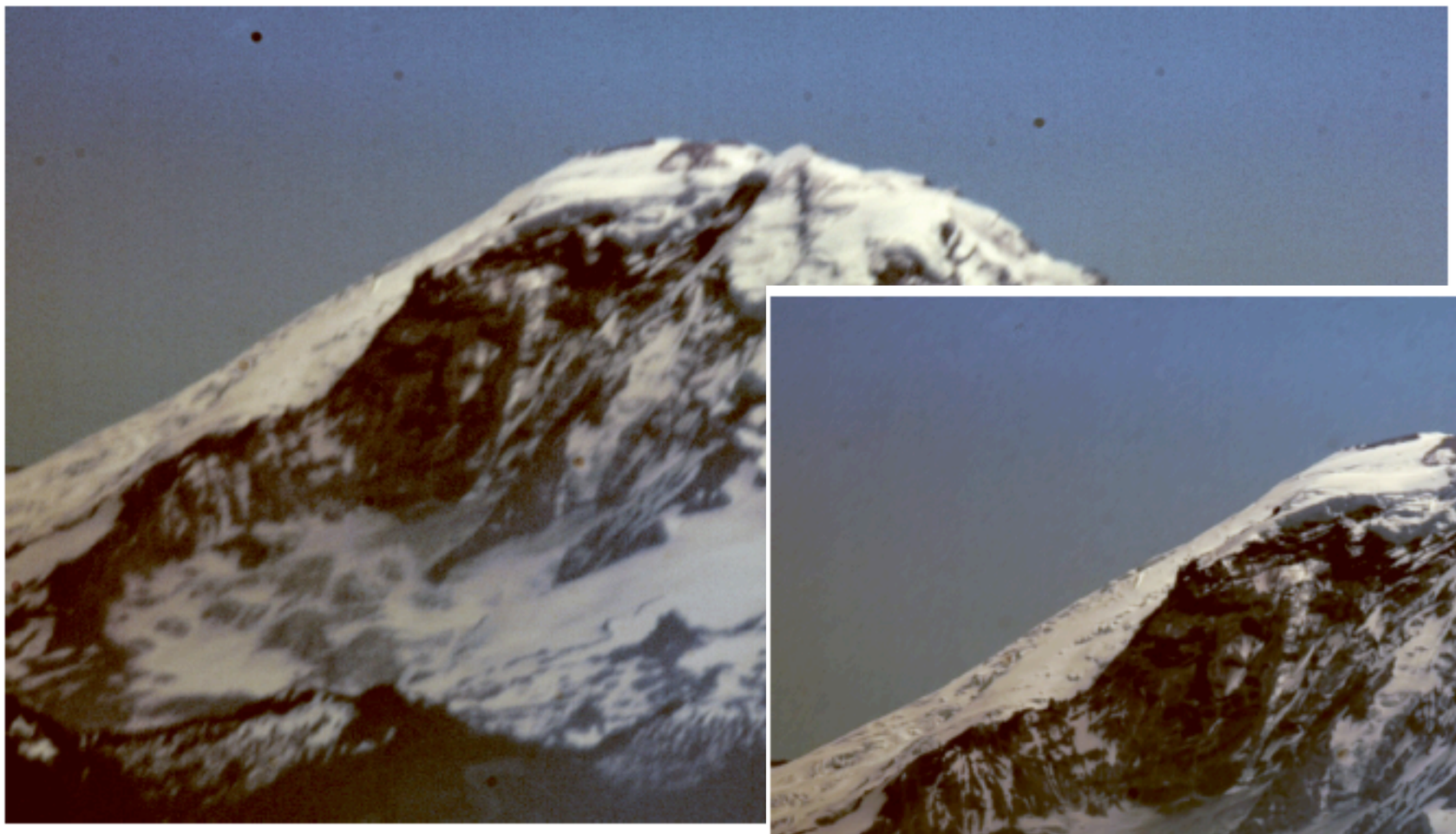

(c) Dehazed Mean

(f) Dehazed Weighted Mean of Globally + Locally Aligned Images

Image Stacks

Michael F. Cohen Alex Colburn Steven Drucker
Microsoft Research Technical Report
MSR-TR-2003-40

http://www.peterfunch.com/

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MAIN : PETER FUNCH

PETER FUNCH

WORKS

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NEWS
INSTALLATION VIEWS
BABEL TALES BOOK
COMMISSIONS
INQUIRIES/CONTACT
BIOGRAPHY
MAIN

Find: | Next | Previous | Highlight all | Match case

Done

Peter Funch

Peter Funch, http://www.v1gallery.com/artist/show/3

Peter Funch

Peter Funch, http://www.v1gallery.com/artist/show/3

Peter Funch

Peter Funch, http://www.v1gallery.com/artist/show/3

Peter Funch

Peter Funch, http://www.v1gallery.com/artist/show/3

Peter Langenhahn: all the fouls of a soccer match

http://www.peterlangenhahn.com/

http://www.peterlangenhahn.com/images/bilder/new/Stadion_8bit_repariert.jpg

Cassandra C Jones--found animations

After Muybridge, by Cassandra C. Jones

http://www.youtube.com/watch?v=Oyi0lzbDJVc

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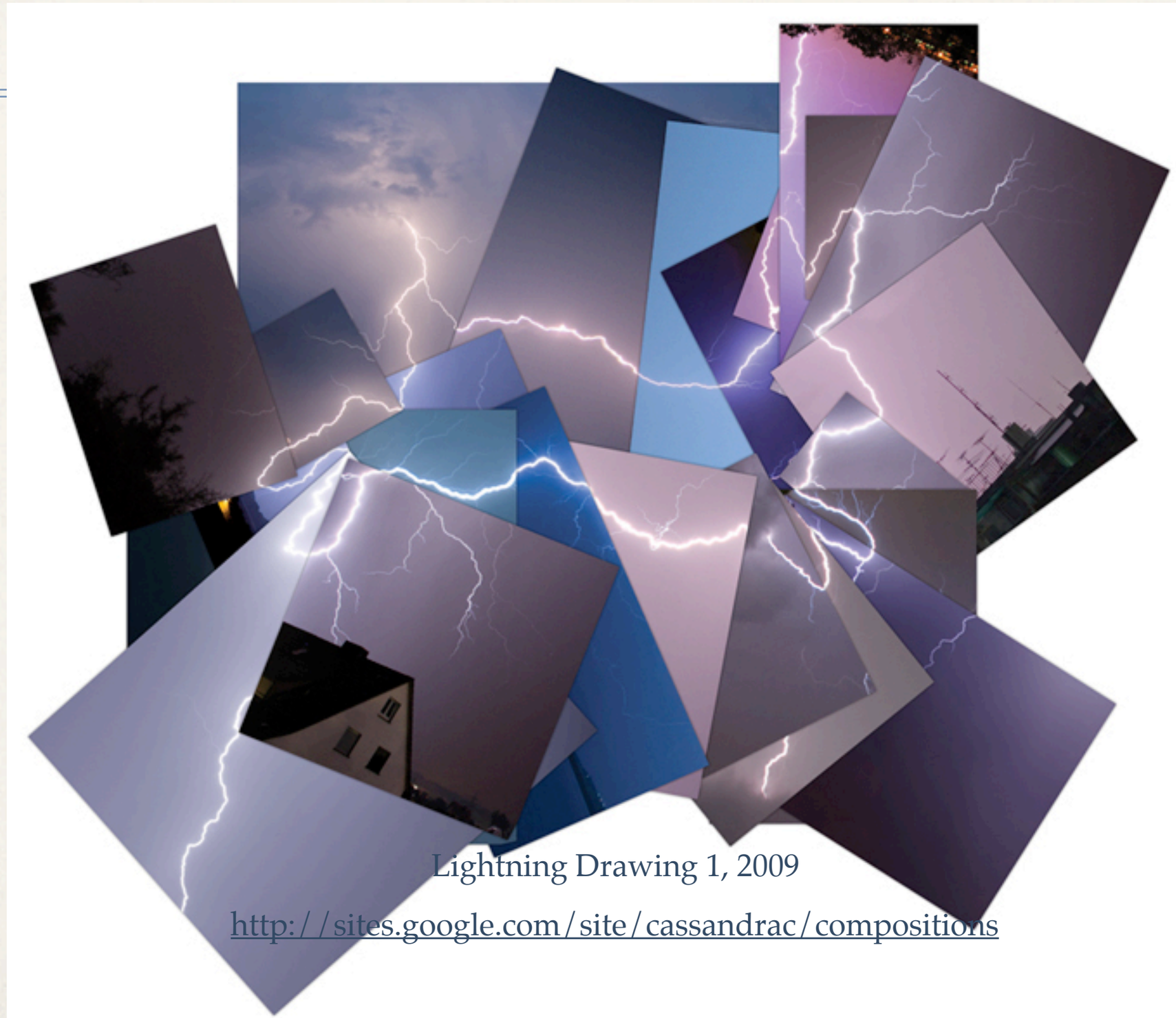
Cassandra C Jones--found images



Lightning Drawing 1, 2009

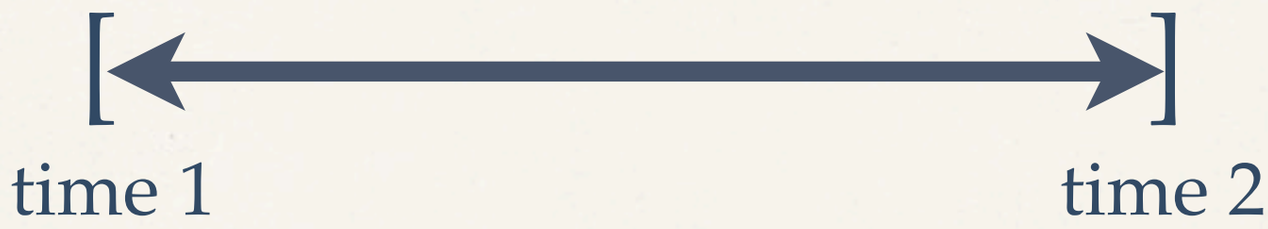
http://sites.google.com/site/cassandrac/compositions

Cassandra C Jones

Lightning Drawing 2, 2009

http://sites.google.com/site/cassandrac/compositions

telling a story, within one image, of change over time



- averaging
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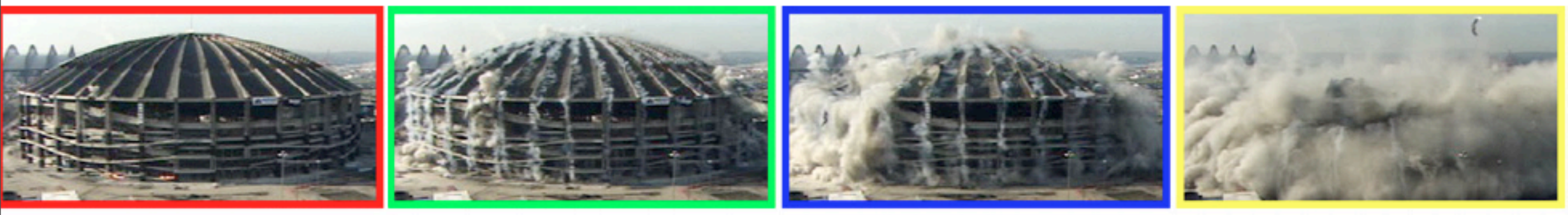
To appear in the ACM SIGGRAPH '04 conference proceedings

Interactive Digital Photomontage

Aseem Agarwala[1] Mira Dontcheva[1] Maneesh Agrawala[2] Steven Drucker[2] Alex Colburn[2]
Brian Curless[1] David Salesin[1,2] Michael Cohen[2]

[1]University of Washington [2]Microsoft Research



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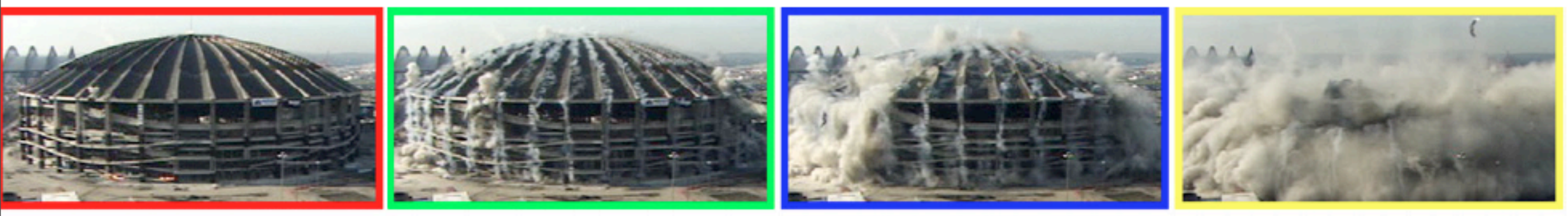

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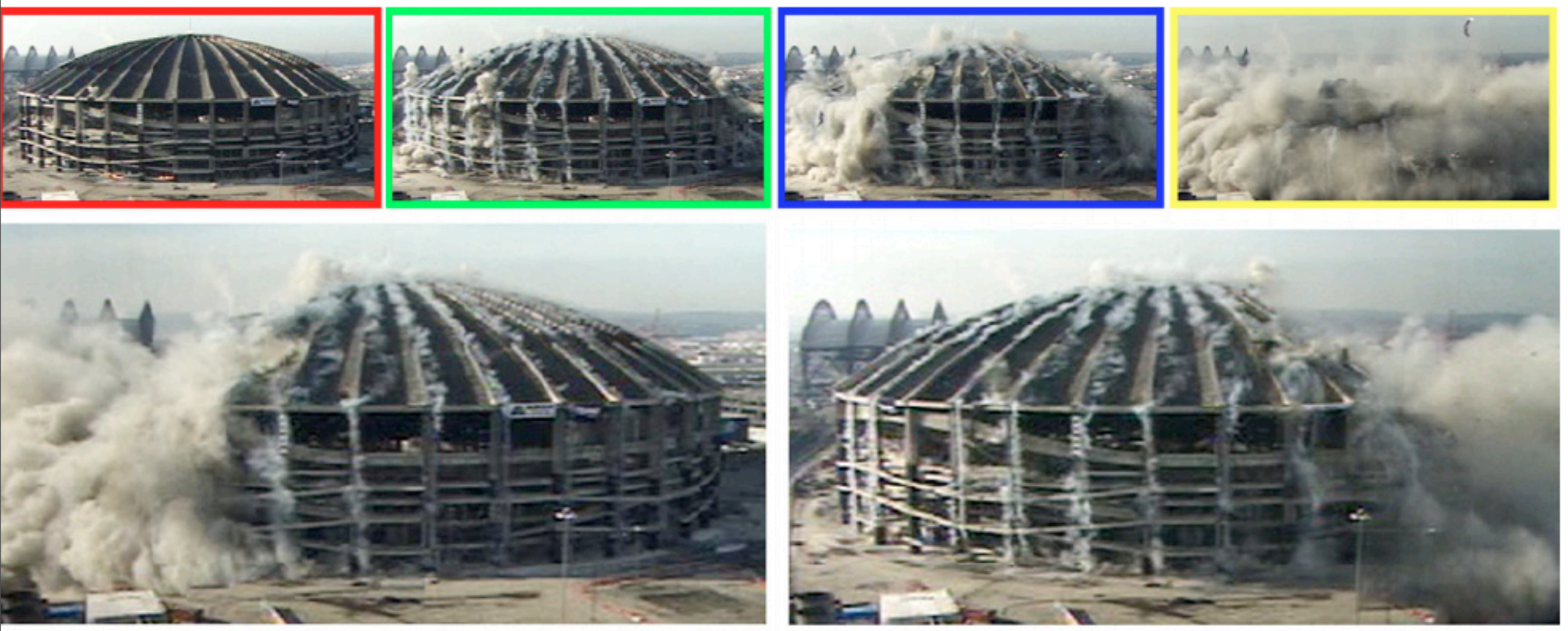
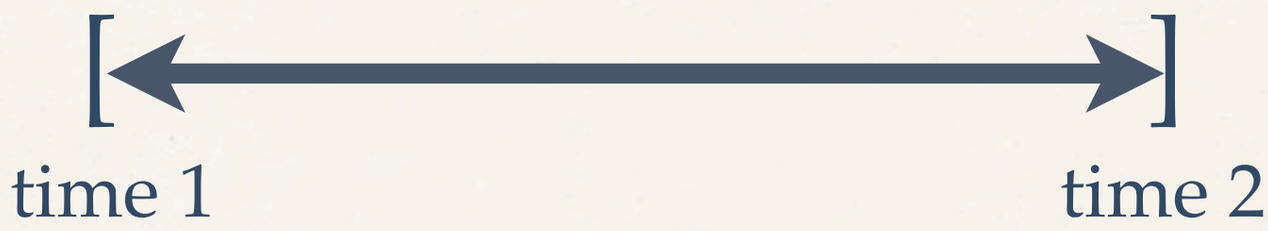


amplifying changes over time, in a video



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Motion Magnification

Ce Liu
Antonio Torralba
William T. Freeman
Fredo Durand
Edward H. Adelson

Massachusetts Institute of Technology
Computer Science and Artificial Intelligence Laboratory

SIGGRAPH2005
The 32nd International Conference on Computer Graphics and Interactive Techniques

Motion magnification.
Ce Liu, Antonio Torralba, Bill Freeman, Fredo Durand, and Edward Adelson

We can register, then amplify, one motion *relative to* another.

empty trunk

full trunk

Original footage courtesy of Paul Robertson, BBN.

Motion magnification.
Ce Liu, Antonio Torralba, Bill Freeman, Fredo Durand, and Edward Adelson

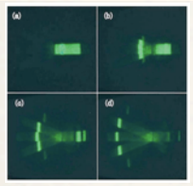
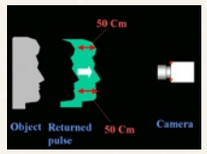
We can register, then amplify, one motion *relative to* another.

empty trunk

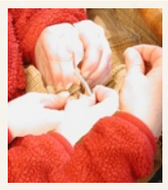
**full trunk
(motion difference amplified)**

Original footage courtesy of Paul Robertson, BBN.

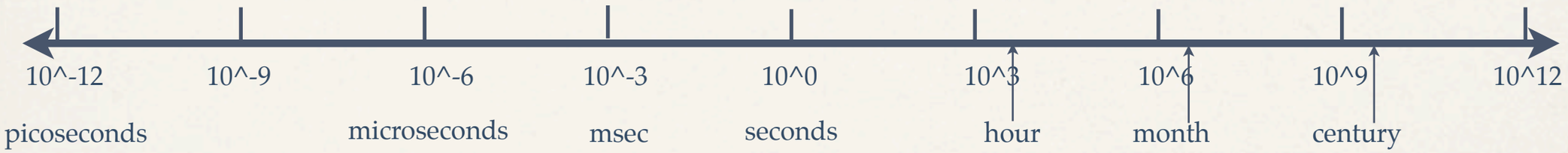
hours to months





hours to months



in addition to selection, we now have matching and alignment and decomposition--computer vision tasks.

http://dsc.discovery.com/tv/planet-earth/

http://dsc.discovery.com/tv/planet-earth/

Sunkavalli, Matusik, Pfister and Rusinkiewicz

Factored Time-Lapse Video

Kalyan Sunkavalli
MERL

Wojciech Matusik
MERL

Hanspeter Pfister
MERL

Szymon Rusinkiewicz
Princeton University

SIGGRAPH 2007

(a) Original (b) Reconstructed, no shadows (c) Sun illumination only (d) Modified reflectance

Authors decompose a time-lapse sequence of photographs (a) into sun, sky, shadow, and reflectance components.

Sunkavalli, Matusik, Pfister and Rusinkiewicz

Factored Time-Lapse Video

Kalyan Sunkavalli
MERL

Wojciech Matusik
MERL

Hanspeter Pfister
MERL

Szymon Rusinkiewicz
Princeton University

SIGGRAPH 2007

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SIGGRAPH 2007

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MERL

Wojciech Matusik
MERL

Hanspeter Pfister
MERL

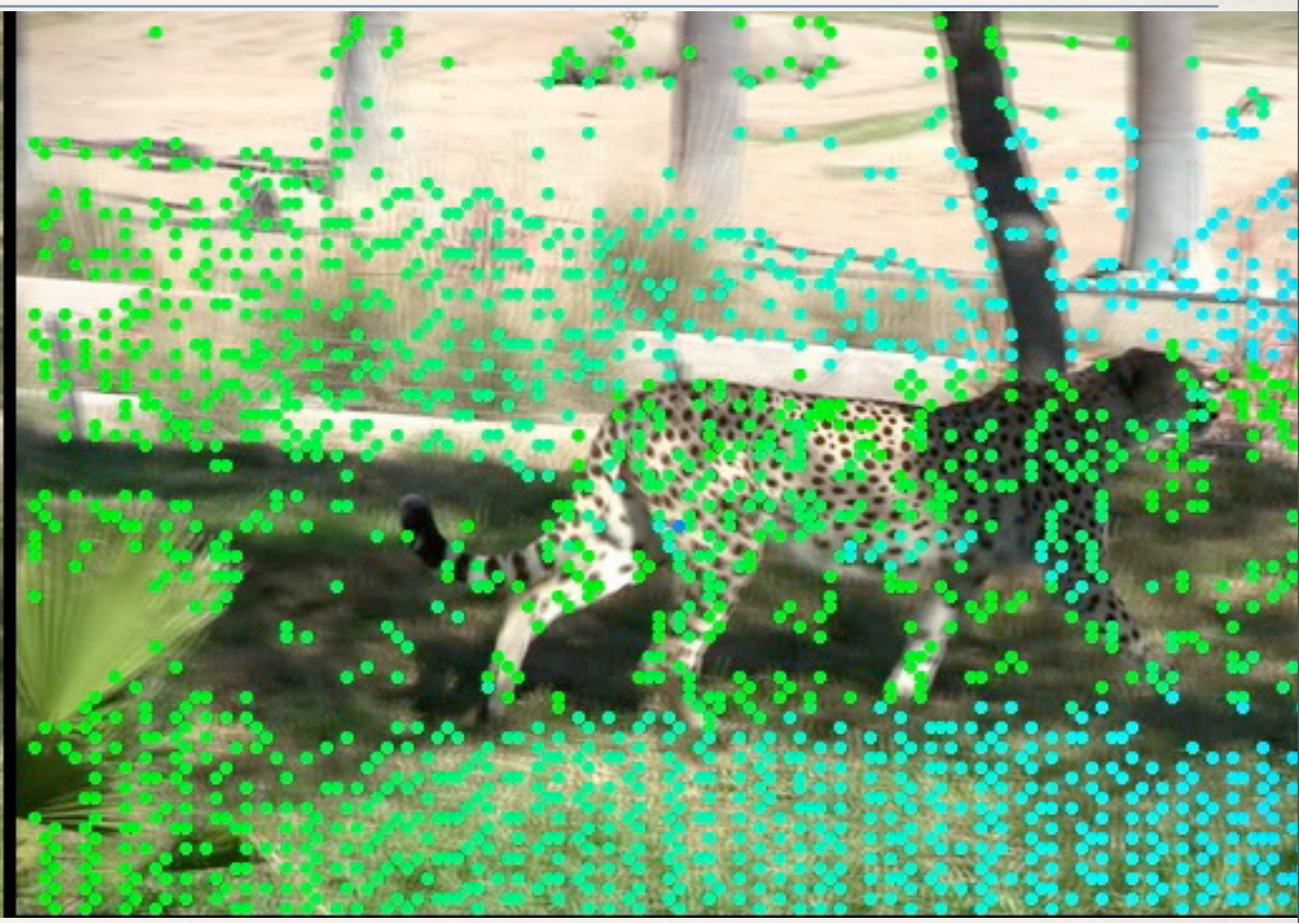
Szymon Rusinkiewicz
Princeton University

SIGGRAPH 2007

A key to much long-time-scale photography: tracking and matching.

Brox and Malik tracker (IEEE PAMI 2011),
as implemented from their publication by Michael Rubinstein
(include point correspondences from feature descriptor matching into a variational optical flow method).

A key to much long-time-scale photography: tracking and matching.



Brox and Malik tracker (IEEE PAMI 2011),
as implemented from their publication by Michael Rubinstein
(include point correspondences from feature descriptor matching into a variational optical flow method).

Motion denoising: M. Rubinstein, C. Liu, P. Sand, W. Freeman, and F. Durand, CVPR 2011

Motion denoising, Rubinstein et al, CVPR 2011

Motion denoising: M. Rubinstein, C. Liu, P. Sand, W. Freeman, and F. Durand, CVPR 2011

Motion denoising, Rubinstein et al, CVPR 2011

Motion denoising: M. Rubinstein, C. Liu, P. Sand, W. Freeman, and F. Durand, CVPR 2011

Motion denoising / video short and long-term separation
Want to do this without motion estimation.

Motion denoising, Rubinstein et al, CVPR 2011

The energy function to specify optimal spatio-temporal displacements

Three terms in objective function for optimal displacement map:

(1) L1 fidelity to original timelapse sequence;
(2) constancy of processed video over time;
(3) spatial L1 smoothness of displacement field.

$$E(w) = \sum_p \left|I(p + w(p)) - I(p)\right| +$$

$$\alpha \sum_{p,r \in \mathcal{N}_t(p)} \left|\left|I(p + w(p)) - I(r + w(r))\right|\right|^2 +$$

$$\gamma \sum_{p,q \in \mathcal{N}(p)} \lambda_{pq} \left|w(p) - w(q)\right|$$

Motion denoising, Rubinstein et al, CVPR 2011

The equation to specify optimal spatio-temporal displacements, viewed as an MRF

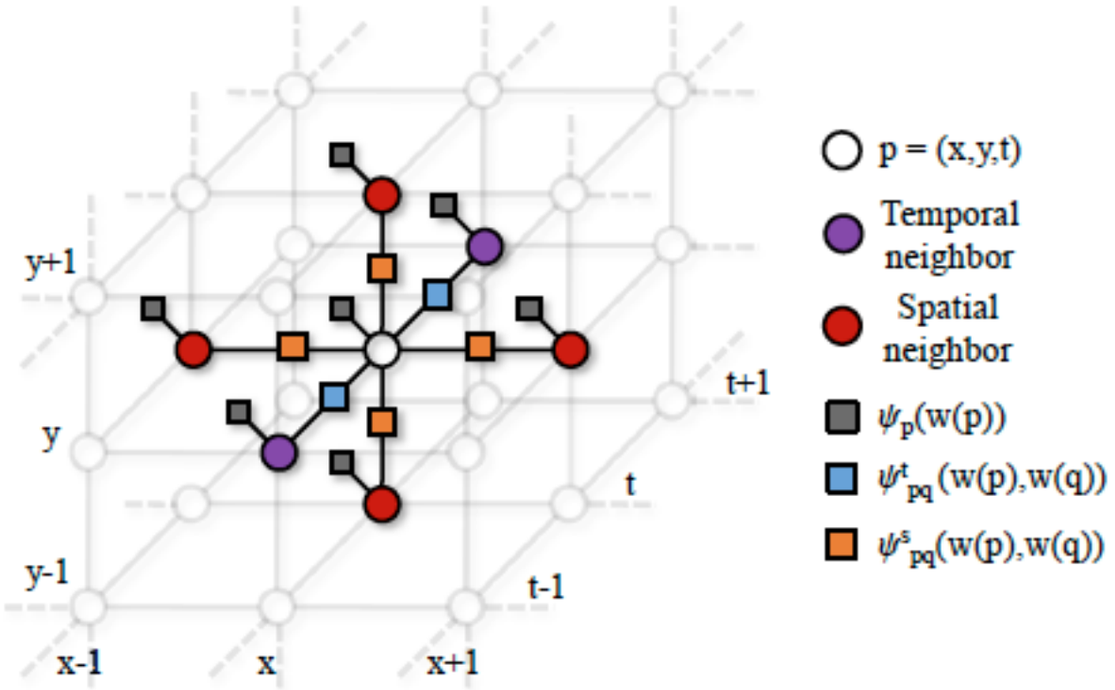
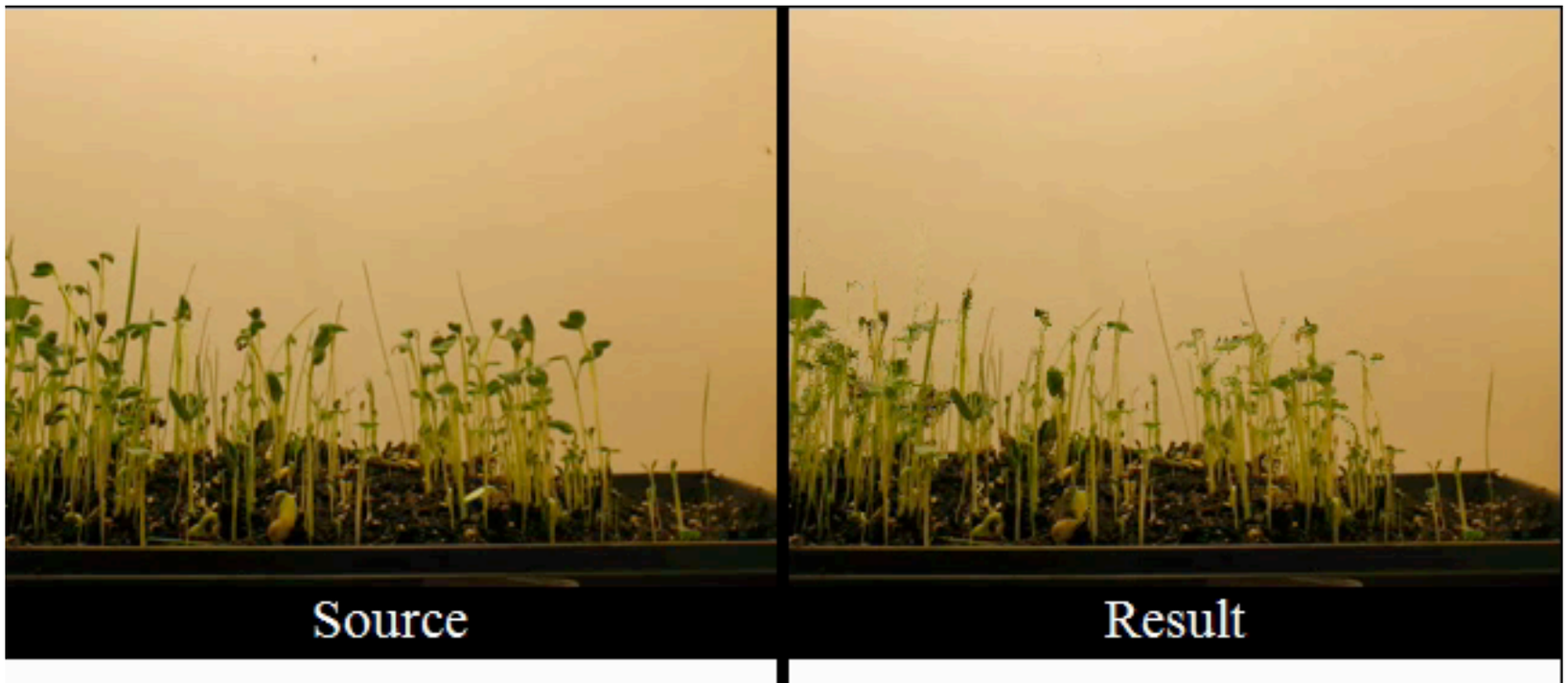
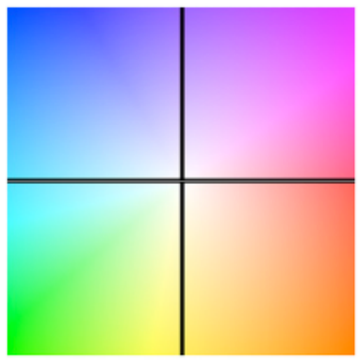


Figure 4. An illustration of the graphical model corresponding to Equation 5. Note that each node contains the three (unknown) components of the spatiotemporal displacement at that location.

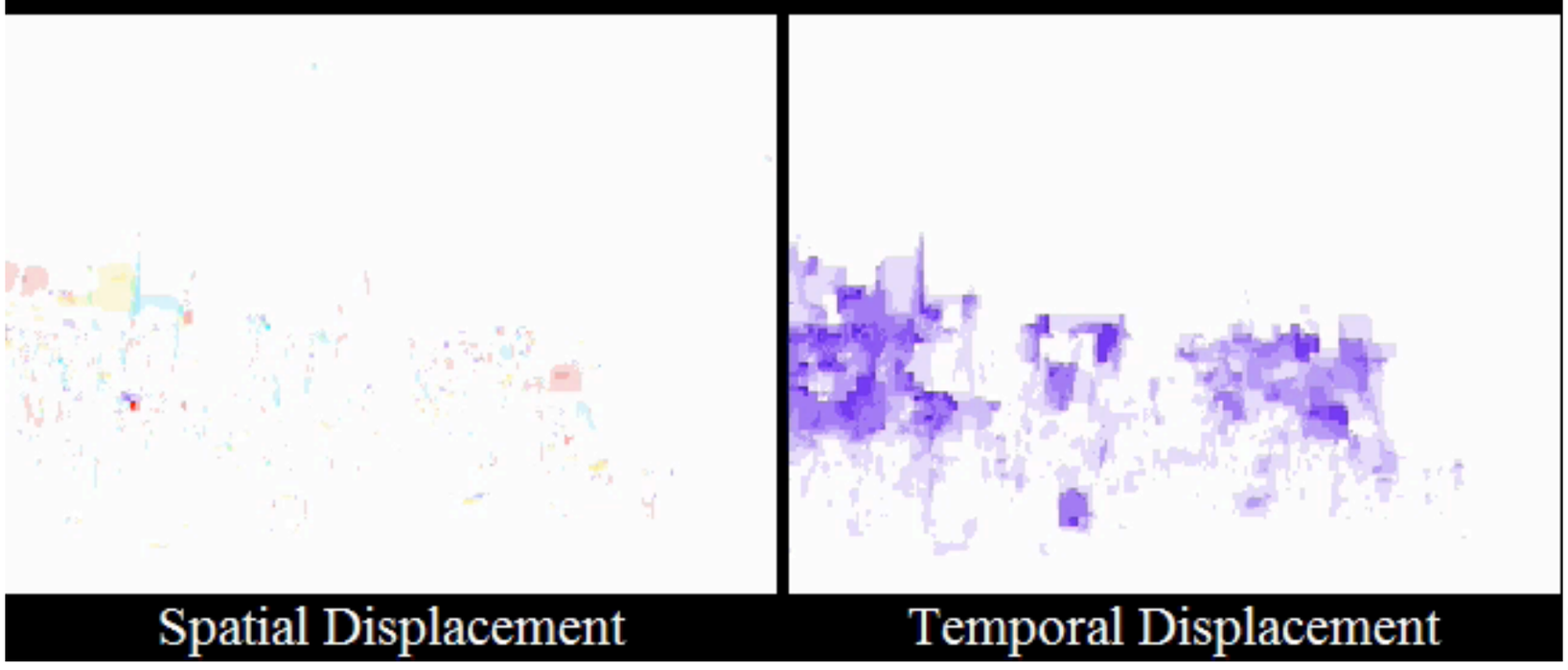
Motion denoising, Rubinstein et al, CVPR 2011

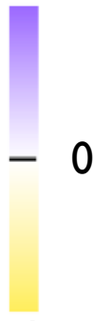
Sprouts





Color code for spatial displacements





Color code for temporal displacements

Motion denoising, Rubinstein et al, CVPR 2011

Effect of region of support

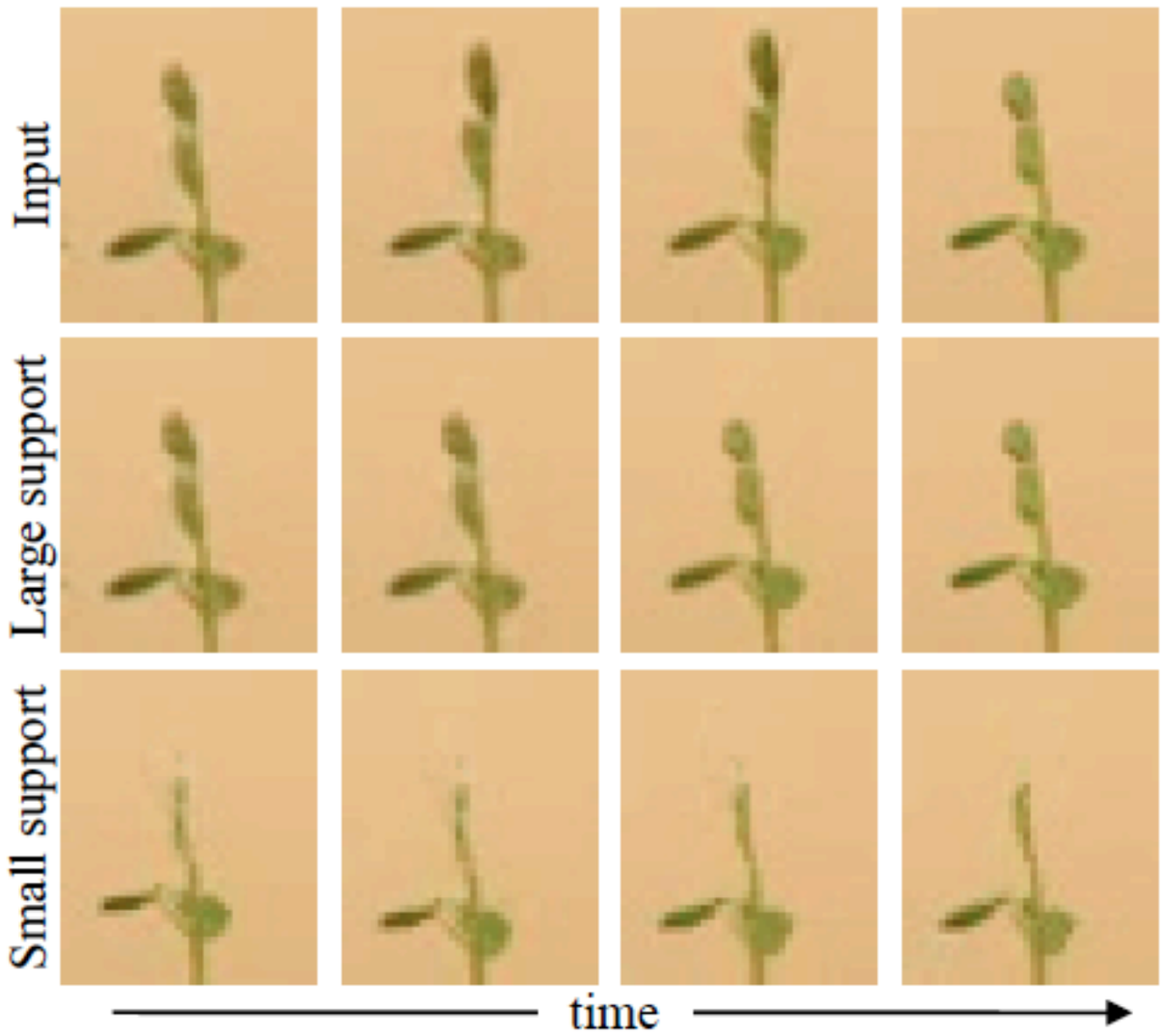
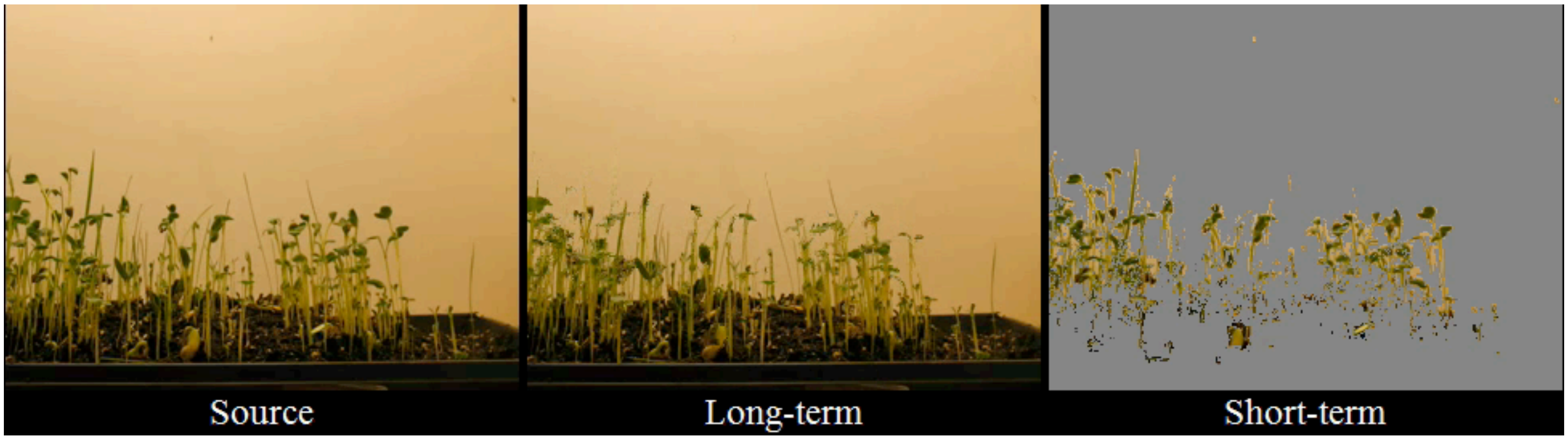


Figure 7. Zoom-in onto the rightmost plant in the `sprouts` sequence in fours consecutive frames show that enlarging the search volume used by the algorithm can greatly improve the results. "Large support" corresponds to a $31 \times 31 \times 5$ search volume, while "small support" is the $7 \times 7 \times 5$ volume we used in our experiments.

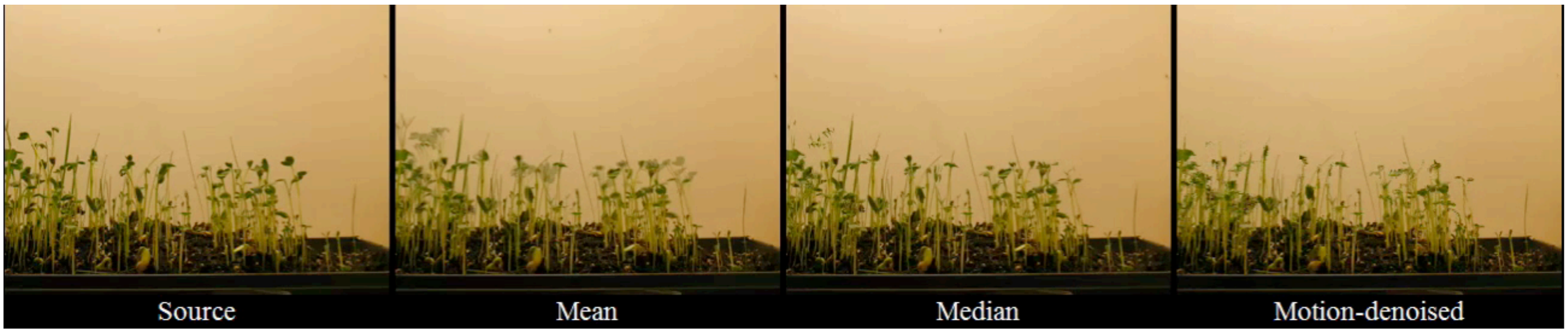
Split into short-term and long-term motions

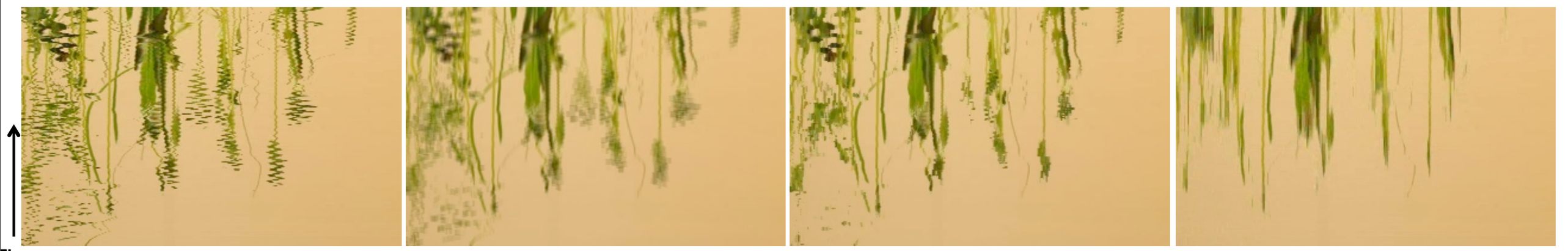


Motion denoising, Rubinstein et al, CVPR 2011

Comparison of motion denoising methods

Comparison of motion denoising methods

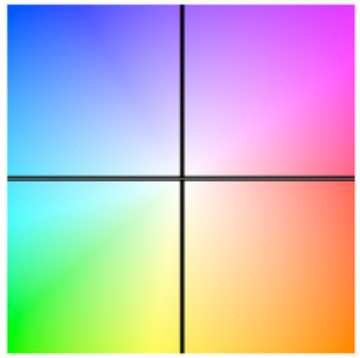




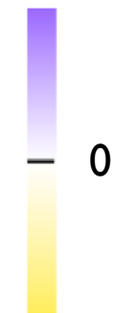
Split into short- and long-term video streams

Motion denoising, Rubinstein et al, CVPR 2011

Swimming pool excavation



Color code for spatial displacements



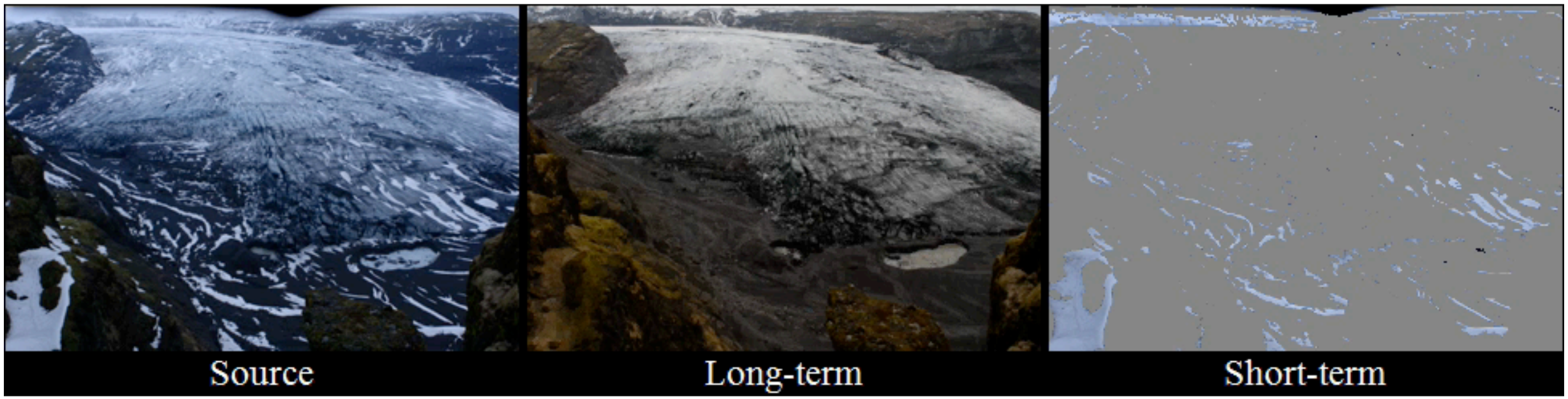
Color code for temporal displacements

Motion denoising, Rubinstein et al, CVPR 2011

Split into short- and long-term video streams

Motion denoising, Rubinstein et al, CVPR 2011

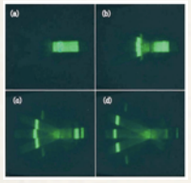
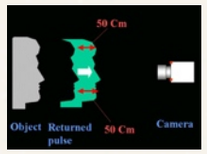
Glacier (courtesy Extreme Ice Survey)



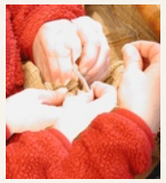
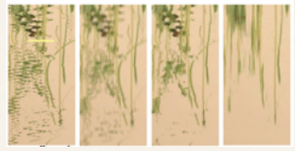
timelapse courtesy Extreme Ice Survey

Motion denoising, Rubinstein et al, CVPR 2011

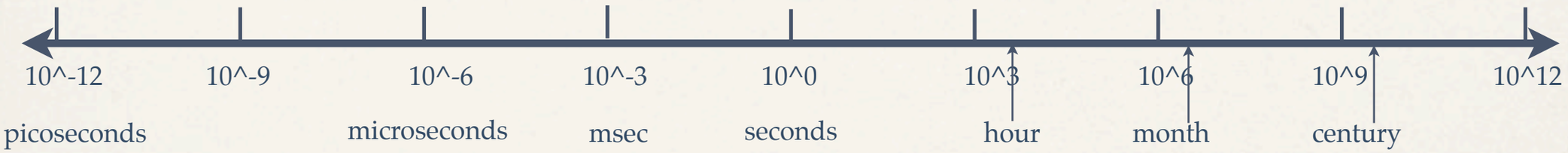
years to centuries



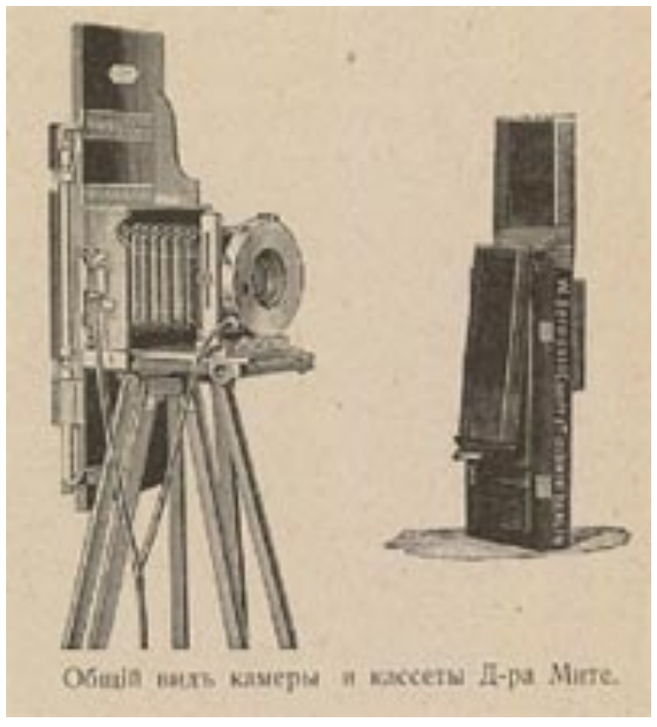
years to centuries

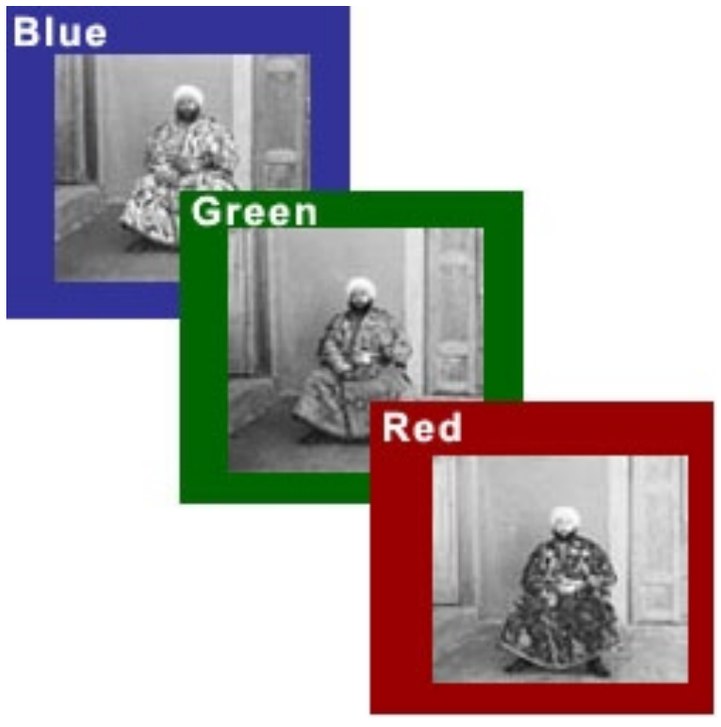


Prokudin-Gorskii

Prokudin-Gorskii

- **Some of the oldest color photos still preserved (1880-1920): Prokudin-Gorskii** http://www.loc.gov/exhibits/empire/





Prokudin-Gorskii

Rephotography

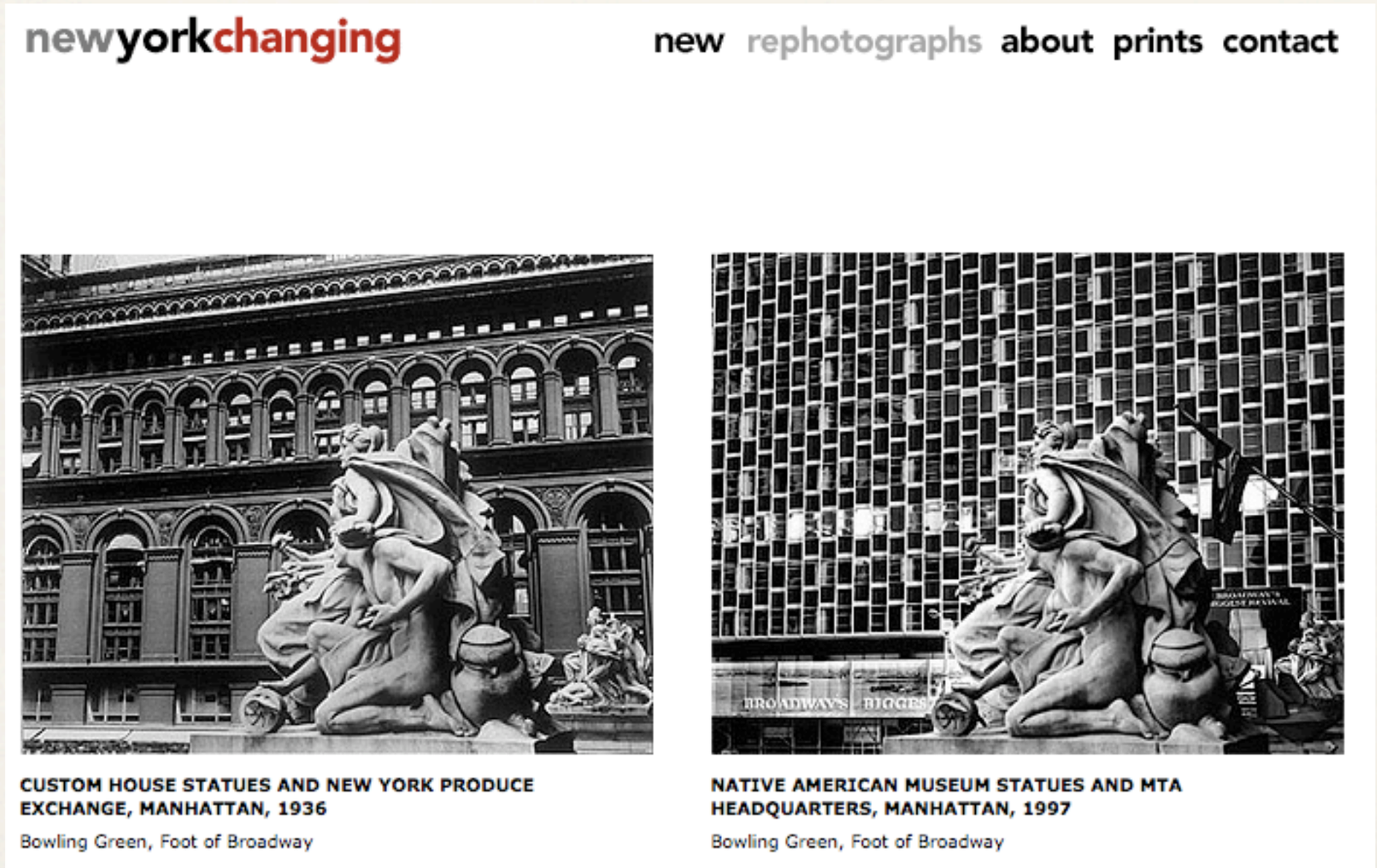
- Given reference (old) photograph
- Take new photo at the exact same viewpoint

[McNulty 2002].

[Dorpat and Sherrard 2007*].*

[Collins 2002].

New York Changing (rephotographs)



http://newyorkchanging.com/

New York Changing (rephotographs)

MANHATTAN BRIDGE LOOKING UP, MANHATTAN, 1935

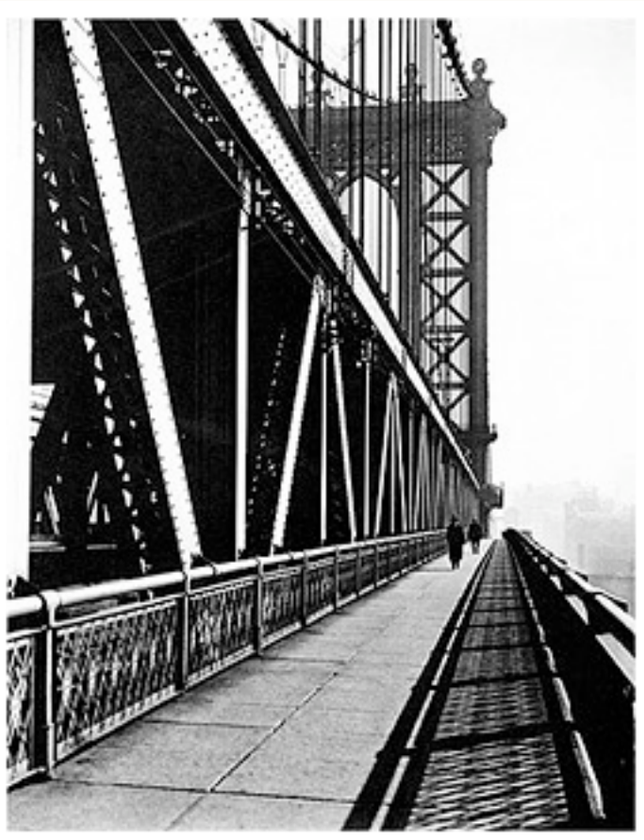
http://newyorkchanging.com/

New York Changing (rephotographs)

MANHATTAN BRIDGE LOOKING UP, MANHATTAN, 2000

http://newyorkchanging.com/

New York Changing (rephotographs)



MANHATTAN BRIDGE, MANHATTAN, 1935

South walkway looking East

http://newyorkchanging.com/

New York Changing (rephotographs)

MANHATTAN BRIDGE, MANHATTAN, 2001

South walkway looking East

http://newyorkchanging.com/

New York Changing (rephotographs)

COMMERCE STREET NOS. 39-41, MANHATTAN, 1936

http://newyorkchanging.com/

New York Changing (rephotographs)

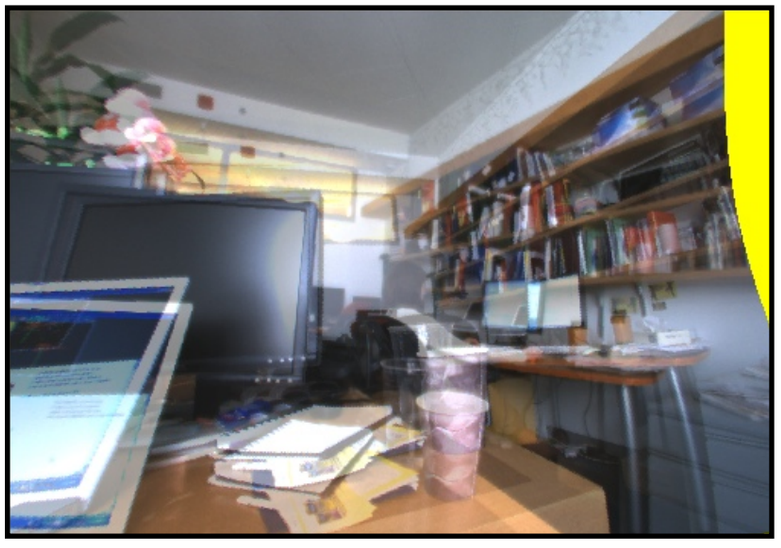
COMMERCE STREET NOS. 39-41, MANHATTAN, 2001

http://newyorkchanging.com/

Computational Re-Photography:
Bae, Agarwala and Durand, ACM TOG 2010

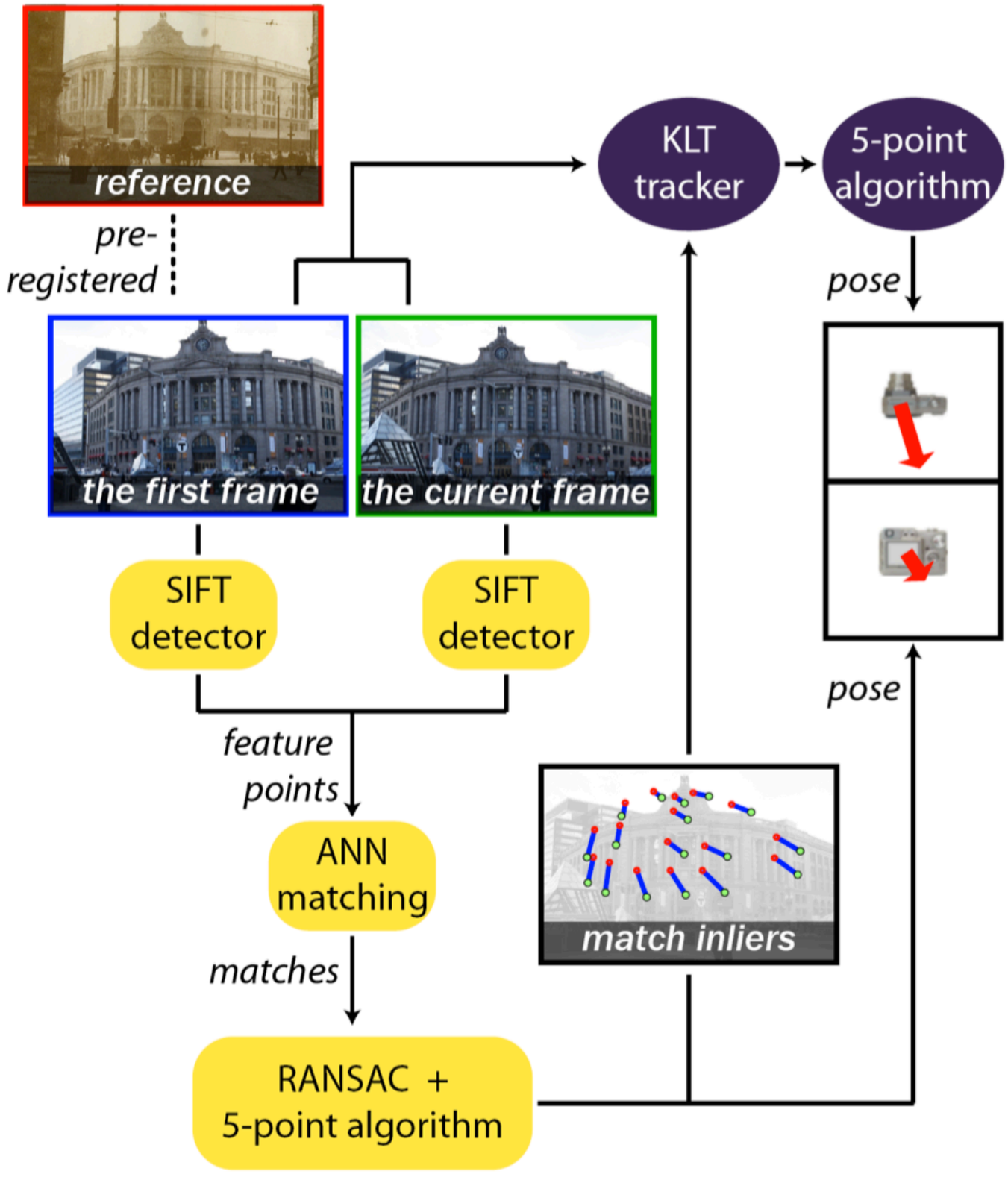
- Estimate Relative viewpoint
- Guide user using two 2D arrows
- Resolve rotations computationally using homographies

- Currently based on a laptop



Viewpoint estimation

- Two interleaved processes
  - Accurate based on SIFT features and RANSAC
  - Fast using KLT



Results

Bae, Agarwala and Durand, ACM TOG 2010

Results

Bae, Agarwala and Durand, ACM TOG 2010

Results after style transfer

Bae, Agarwala and Durand, ACM TOG 2010

Results after style transfer

Bae, Agarwala and Durand, ACM TOG 2010

Results after style transfer

Bae, Agarwala and Durand, ACM TOG 2010

Results after style transfer

Bae, Agarwala and Durand, ACM TOG 2010

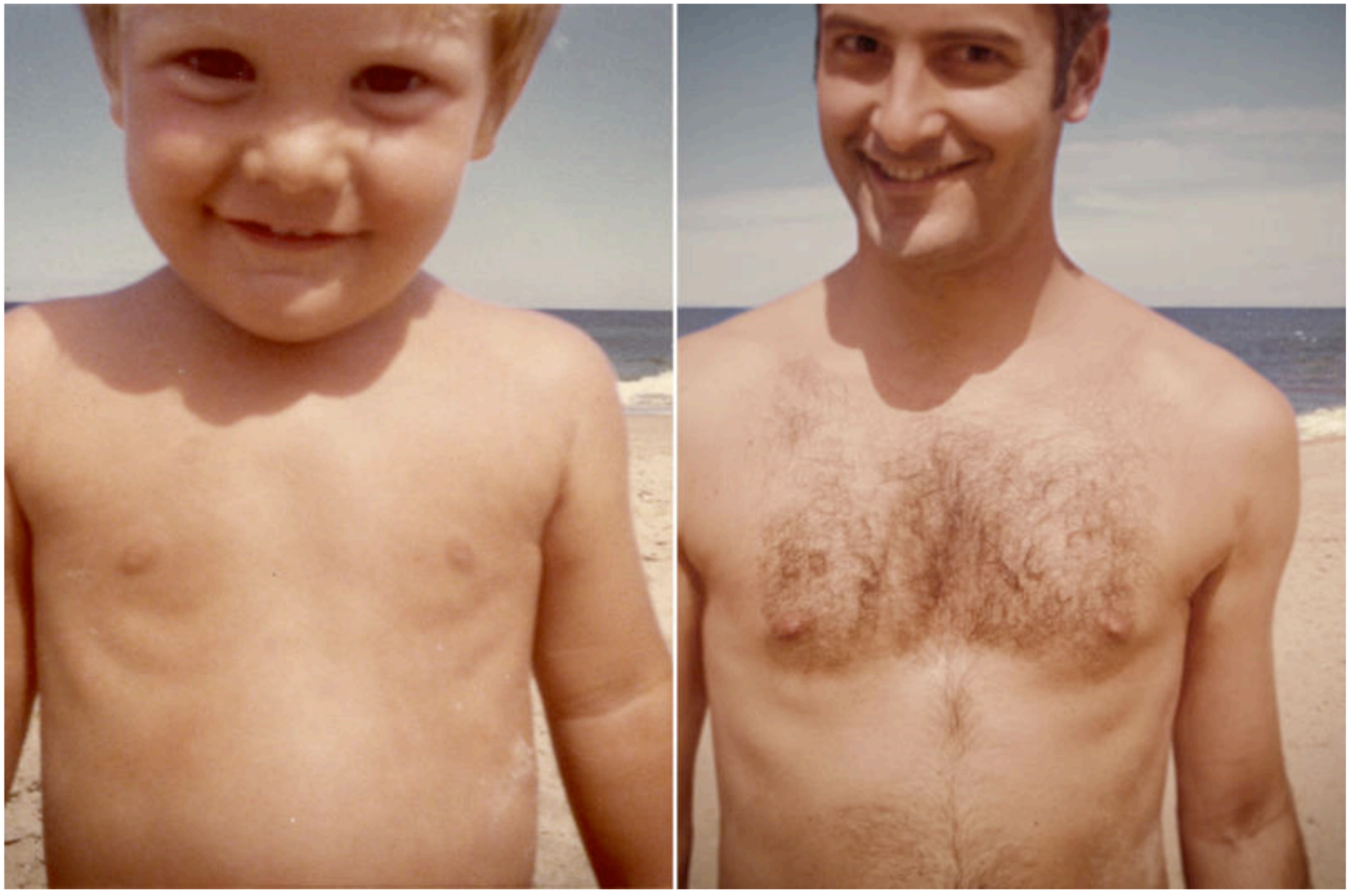
human rephotography

Irina Werning

http://irinawerning.com/back-to-the-fut/back-to-the-future/

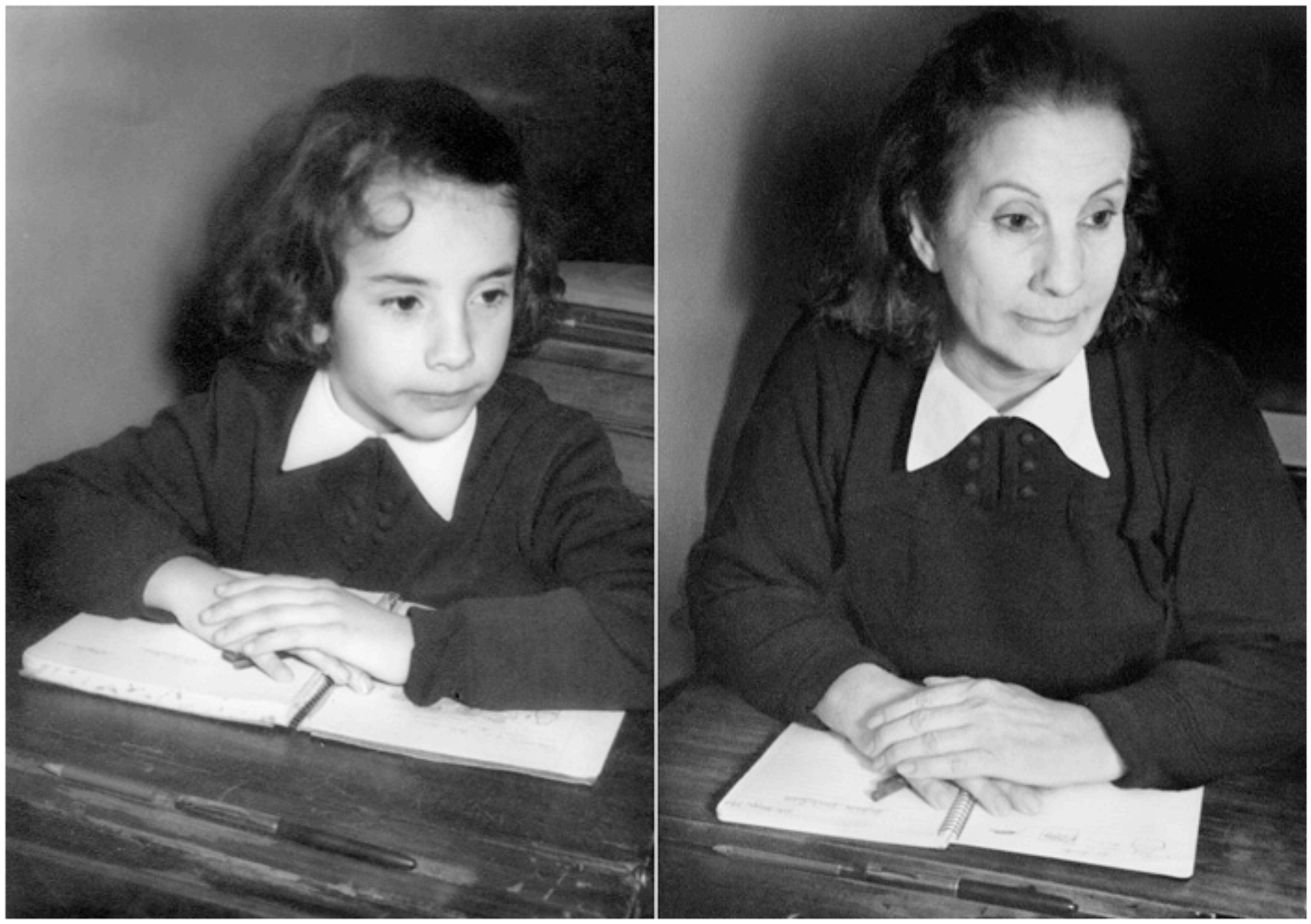
Irina Werning

http://irinawerning.com/back-to-the-fut/back-to-the-future/



Irina Werning

http://irinawerning.com/back-to-the-fut/back-to-the-future/



: LUCIA IN 1956 & 2010, Buenos Aires

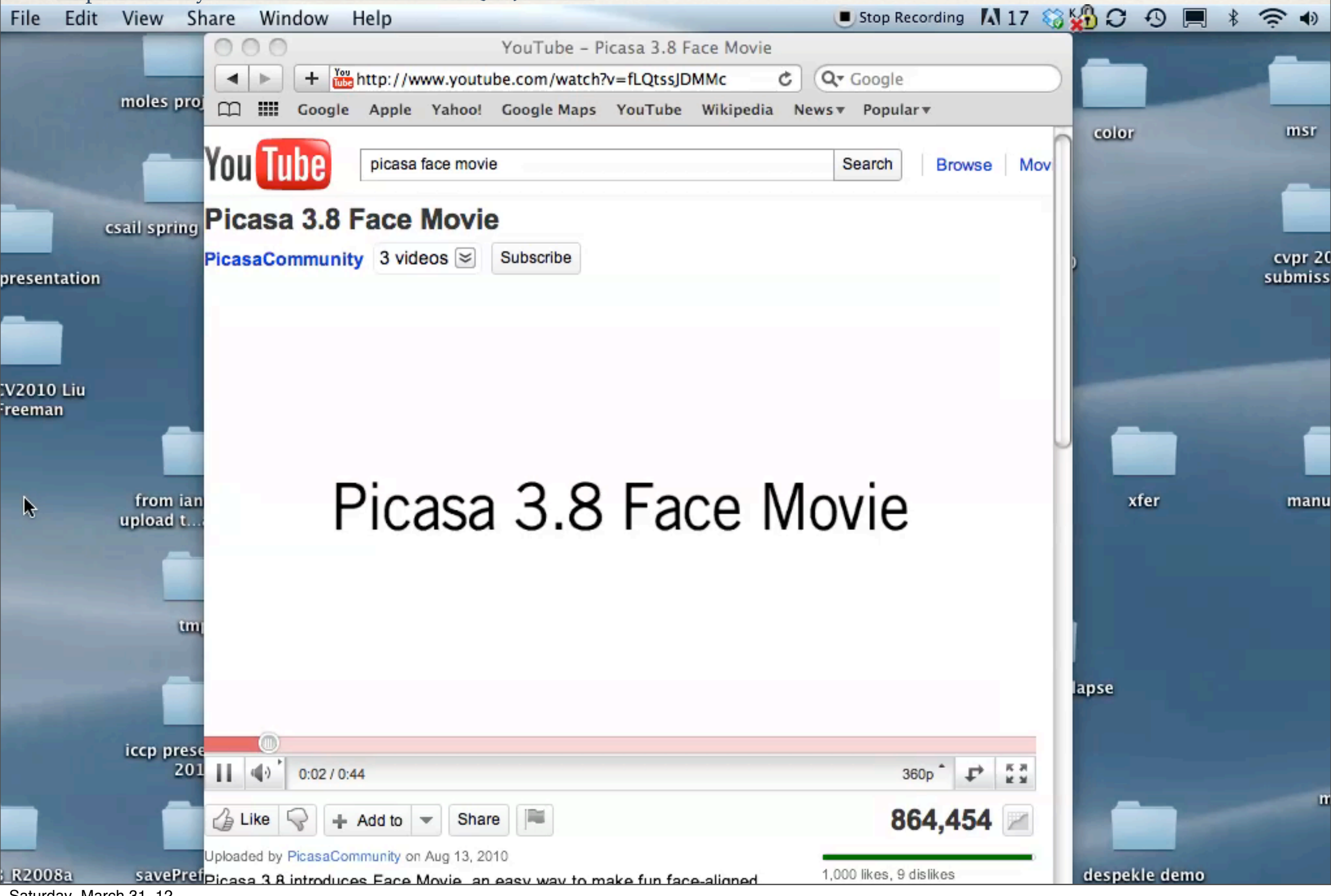
http://beta.news.yahoo.com/photos/dear-photograph-1308768825-slideshow/

Picasa Face Movie

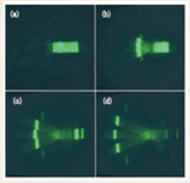
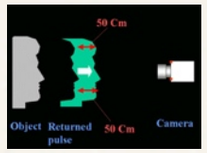
http://www.youtube.com/watch?v=fLQtssJDMMc

Picasa Face Movie

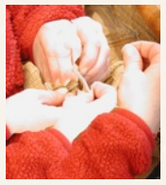
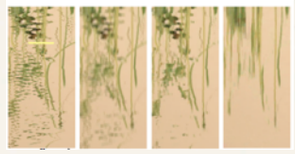
http://www.youtube.com/watch?v=fLQtssJDMMc

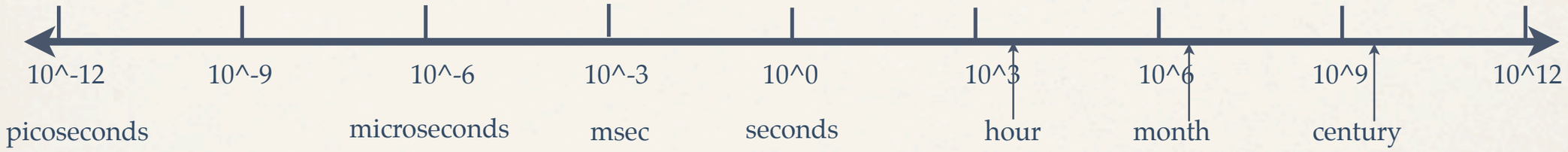


Beyond centuries



The 10,000 Year Clock

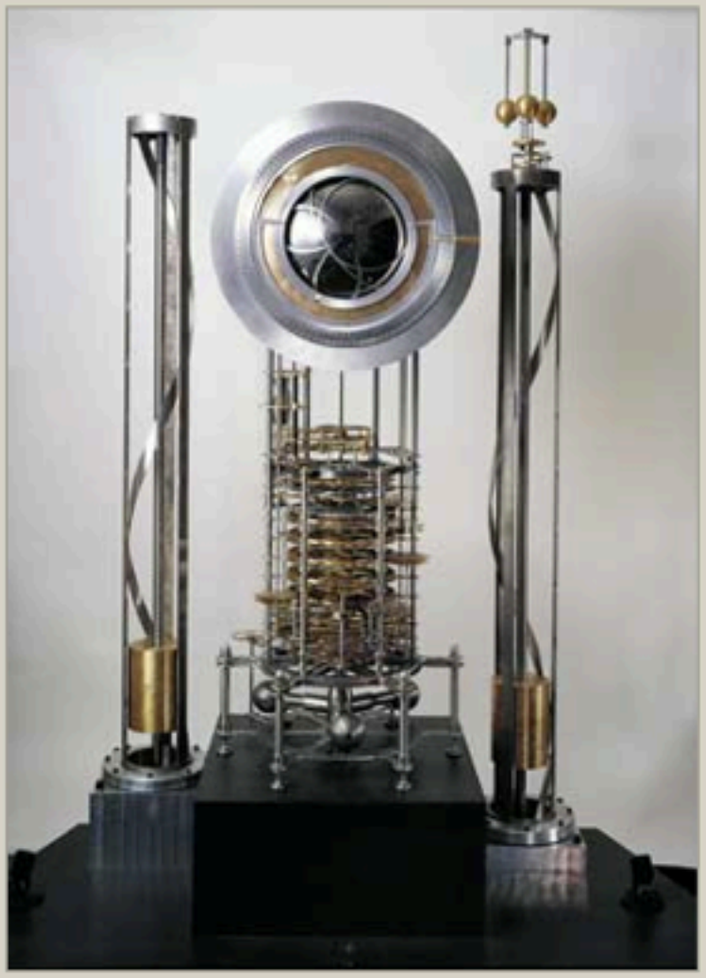


Photo by Rolfe Horn

Prototype 1

Completed on December 31st 01999

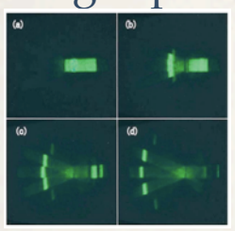
This first prototype of the 10,000 Year Clock is currently on loan to the Science Museum of London, and can be seen as the final piece in the "Making of the Modern World" exhibit. This prototype began to tick on December 31, 01999 after an almost three year research and design effort. Following lead designer Danny Hillis, the team included project manager and designer Alexander Rose, mechanical engineer Liz Woods, horologist David Munro, and lead machinists Chris Rand and Erio Brown.

Power for the Clock comes from the two helical weight drives on either side of the Clock. The timing for the Clock is generated both by a torsional pendulum, with a one minute period, and by a Solar Synchronizer that re-calibrates the Clock to solar noon on any sunny day. To correct from solar time to the absolute time of the pendulum there is a special Equation of Time Cam. The display on the Clock is made of two elements; the Serial Bit Adders and the dials. The Adders convert the timing generated from the pendulum, using their

http://apod.nasa.gov/apod/ap110427.html

5,000 years in the past

22 orders of magnitude larger than the structures in the light pulse



The Dark Tower in Scorpius
Credit & Copyright: Don Goldman

Explanation: In silhouette against a crowded star field toward the constellation Scorpius, this dusty cosmic cloud evokes for some the image of an ominous dark tower. In fact, clumps of dust and molecular gas collapsing to form stars may well lurk within the dark nebula, a structure that spans almost 40 light-years across this gorgeous telescopic portrait. Known as a cometary globule, the swept-back cloud, extending from the lower right to the head (top of the tower) left and above center, is shaped by intense ultraviolet radiation from the OB association of very hot stars in NGC 6231, off the upper edge of the scene. That energetic ultraviolet light also powers the globule's bordering reddish glow of hydrogen gas. Hot stars embedded in the dust can be seen as bluish reflection nebulae. This dark tower, NGC 6231, and associated nebulae are about **5,000 light-years away**.

http://apod.nasa.gov/apod/ap110427.html

50,000,000 years in the past

The Sombrero Galaxy from Hubble
Credit: NASA, ESA, and the Hubble Heritage Team (STScI / AURA)

Explanation: What's going on in the center of this spiral galaxy? Named the Sombrero Galaxy for its hat-like resemblance, M104 features a prominent dust lane and a bright halo of stars and globular clusters. Reasons for the Sombrero's hat-like appearance include an unusually large and extended central bulge of stars, and dark prominent dust lanes that appear in a disk that we see nearly edge-on. Billions of old stars cause the diffuse glow of the extended central bulge. Close inspection of the bulge in the above photograph shows many points of light that are actually globular clusters. M104's spectacular dust rings harbor many younger and brighter stars, and show intricate details astronomers don't yet fully understand. The very center of the Sombrero glows across the electromagnetic spectrum, and is thought to house a large black hole. **Fifty million-year-**old light from the Sombrero Galaxy can be seen with a small telescope towards the constellation of Virgo.

http://apod.nasa.gov/apod/ap110427.html

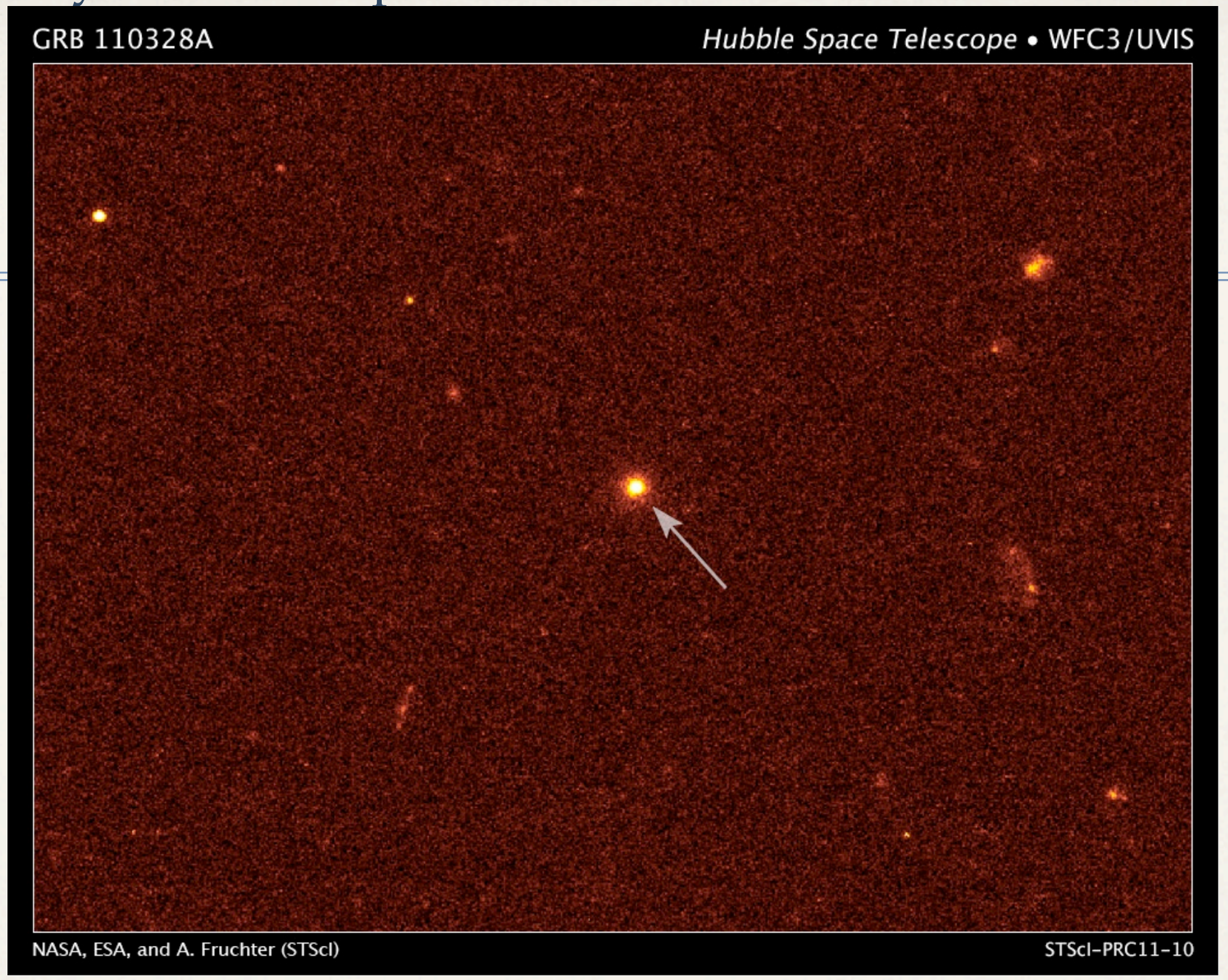
200,000,000 years in the past

Giant Galaxy NGC 6872
Image Credit: Sydney Girls High School Astronomy Club,
Travis Rector (Univ. Alaska), Ángel López-Sánchez (Australian Astronomical Obs./ Macquarie Univ.), Australian Gemini Office

Explanation: Over 400,000 light years across NGC 6872 is an enormous spiral galaxy, at least 4 times the size of our own very large Milky Way. About **200 million light-year**s distant, toward the southern constellation Pavo, the Peacock, the remarkable galaxy's stretched out shape is due to its ongoing gravitational interaction, likely leading to an eventual merger, with the nearby smaller galaxy IC 4970. IC 4970 is seen just below and right of the giant galaxy's core in this cosmic color portrait from the 8 meter Gemini South telescope in Chile. The idea to image this titanic galaxy collision comes from a winning contest essay submitted last year to the Gemini Observatory by the Sydney Girls High School Astronomy Club. In addition to inspirational aspects and aesthetics, club members argued that a color image would be more than just a pretty picture. In their winning essay they noted that "If enough colour data is obtained in the image it may reveal easily accessible information about the different populations of stars, star formation, relative rate of star formation due to the

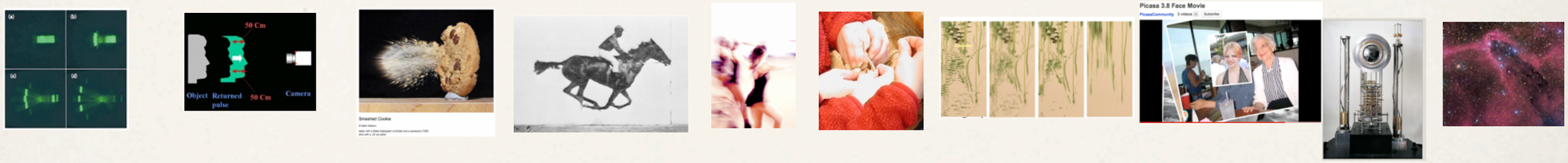
http://apod.nasa.gov/apod/ap110427.html

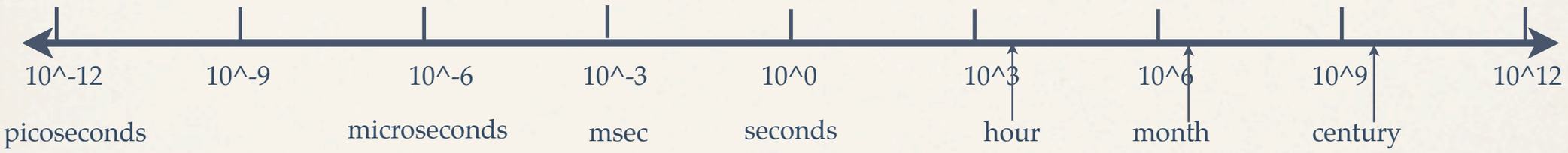
3,800,000,000 years in the past



April 7, 2011: NASA's Swift satellite, Hubble Space Telescope, and Chandra X-ray Observatory have teamed up to study one of the most puzzling cosmic blasts ever observed. More than a week later, high-energy radiation continues to brighten and fade from its location. Astronomers say they have never seen such a bright, variable, high-energy, long-lasting burst before. Usually, gamma-ray bursts mark the destruction of a massive star, and flaring emission from these events never lasts more than a few hours.On Monday, March 28, 2011, the Swift satellite's Burst Alert Telescope discovered the source in the constellation Draco when it erupted with the first in a series of powerful blasts. Swift determined a position for the explosion, which is now cataloged as gamma-ra burst (GRB) 110328A, and informed astronomers worldwide. As dozens of telescopes turned to the spot, astronomers quickly noticed a small, distant galaxy very near the Swift position. A deep image, taken by Hubble on Monday, April 4, 2011, pinpointed the source of the explosion at the center of this galaxy, which lies 3.8 billion light-years away from Earth. That same day, astronomers used NASA's Chandra X-ray Observatory to make a four-hour-long exposure of the puzzling source. The image, which locates the X-ray object 10 times more precisely than Swift, shows that the source lies at the center of the galaxy Hubble imaged. Astronomers previously have detected stars disrupted by supermassive black holes, but none have shown the X-ray brightness and variability seen in GRB 110328A. The source has undergone numerous flares. Since Sunday, April 3, it has brightened by more than five times. Although research is ongoing, astronomers feel the unusual blast likely arose when a star wandered too close to it galaxy's central black hole. Intense tidal forces tore the star apart, and the infalling gas continues to stream toward the hole. According to this model, the spinning black hole formed an outflowing jet along its rotational axis. A powerful blast of X-rays and gamma rays is seen if this jet is pointed in our direction. Hubble observations of GRB 110328A's host galaxy were taken with the Wide Field Camera 3 in visible and near-infrared light. This Hubble image of the galaxy was taken in visible light. Astronomers plan additional Hubble observations to see if the galaxy's core changes brightness.

Photographic stories over time





Plenty of computational challenges in photographing events over long time scales. And many applications in monitoring health, buildings, societal changes, etc.