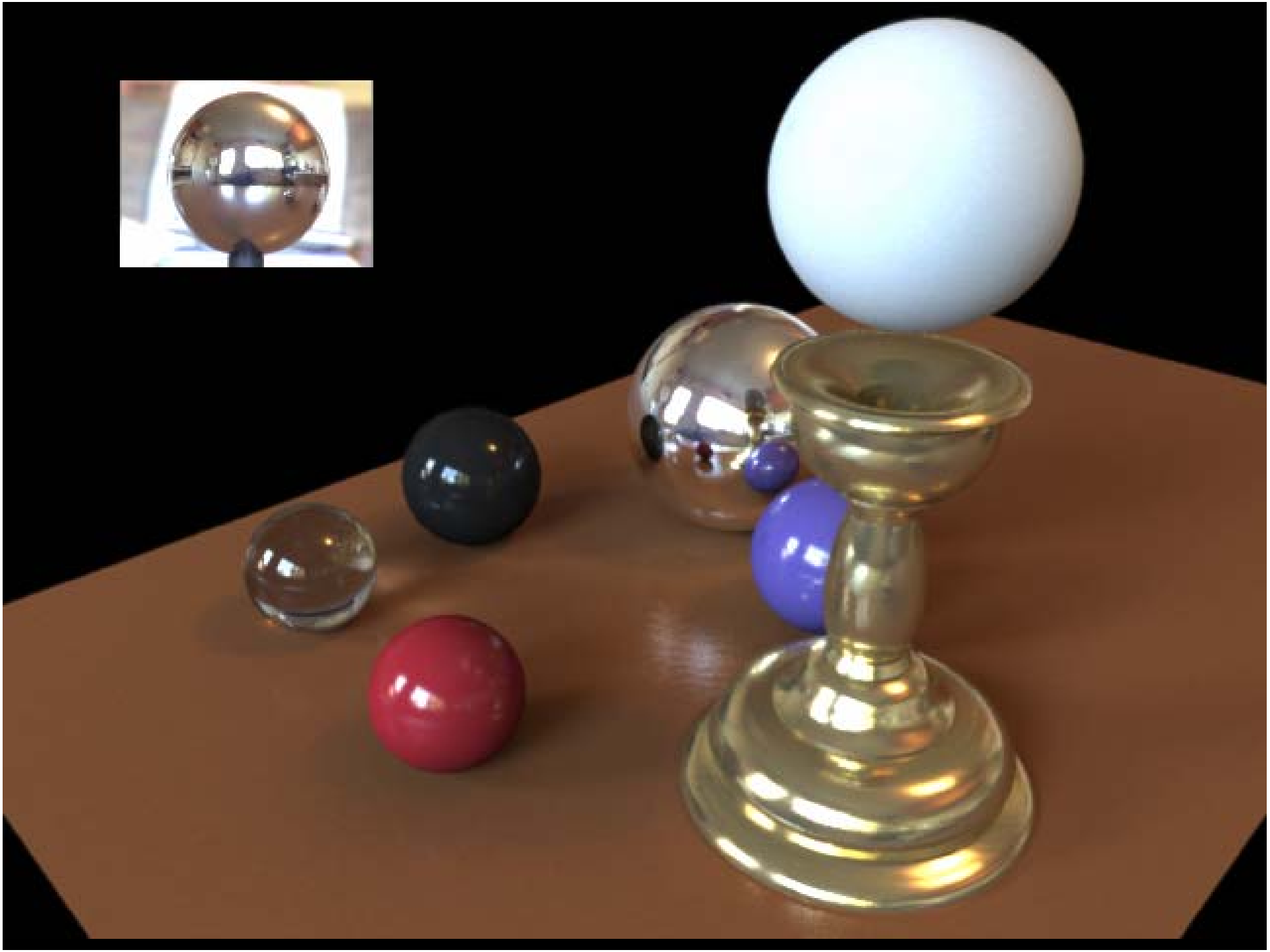
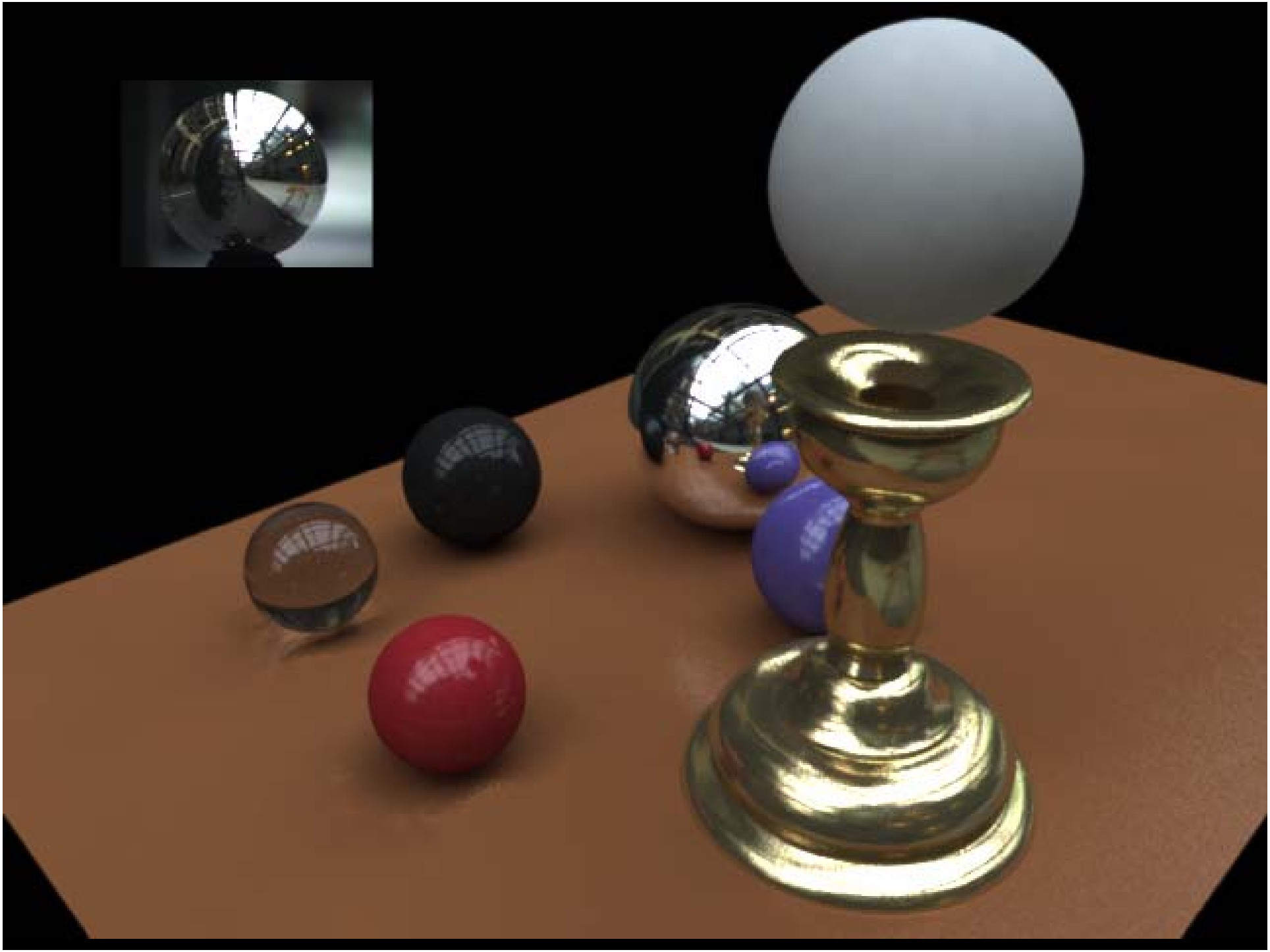
Image-Based Lighting II

© Clément Poline

…with a lot of slides donated by Paul Debevec

15-463: Computational Photography
Alexei Efros, CMU, Fall 2006





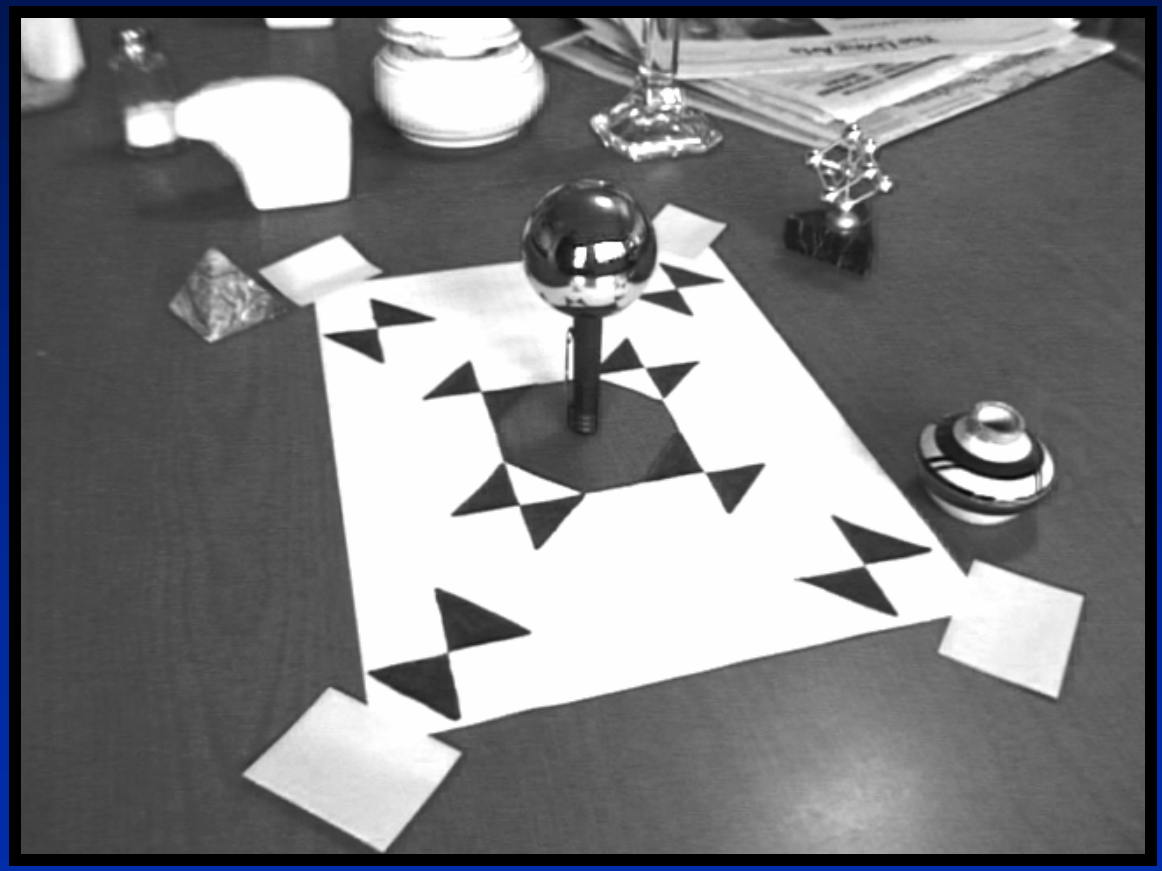
We can now illuminate
synthetic objects with real light.

How do we add synthetic objects to a
real scene?

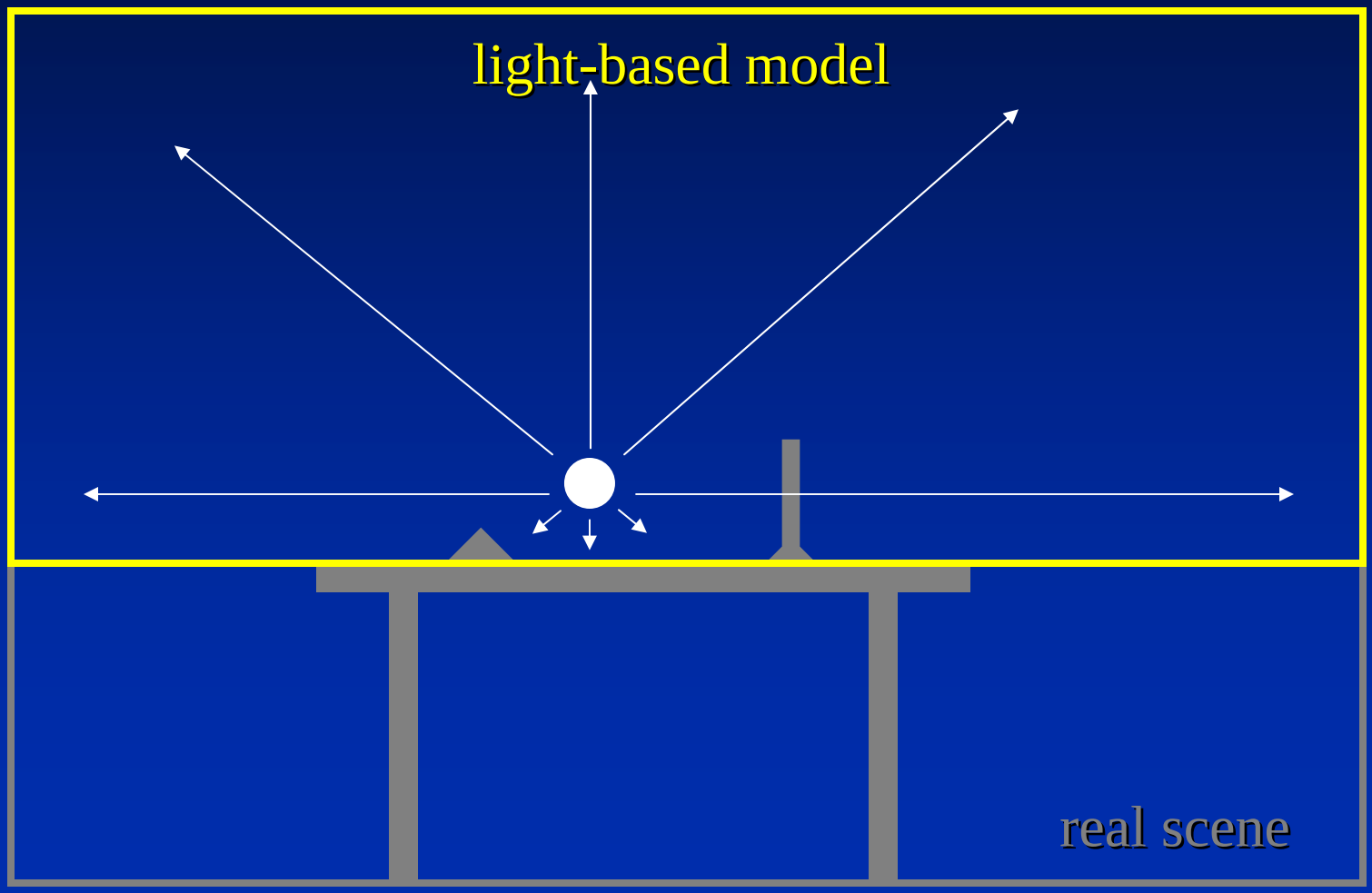
Real Scene Example

Goal: place synthetic objects on table

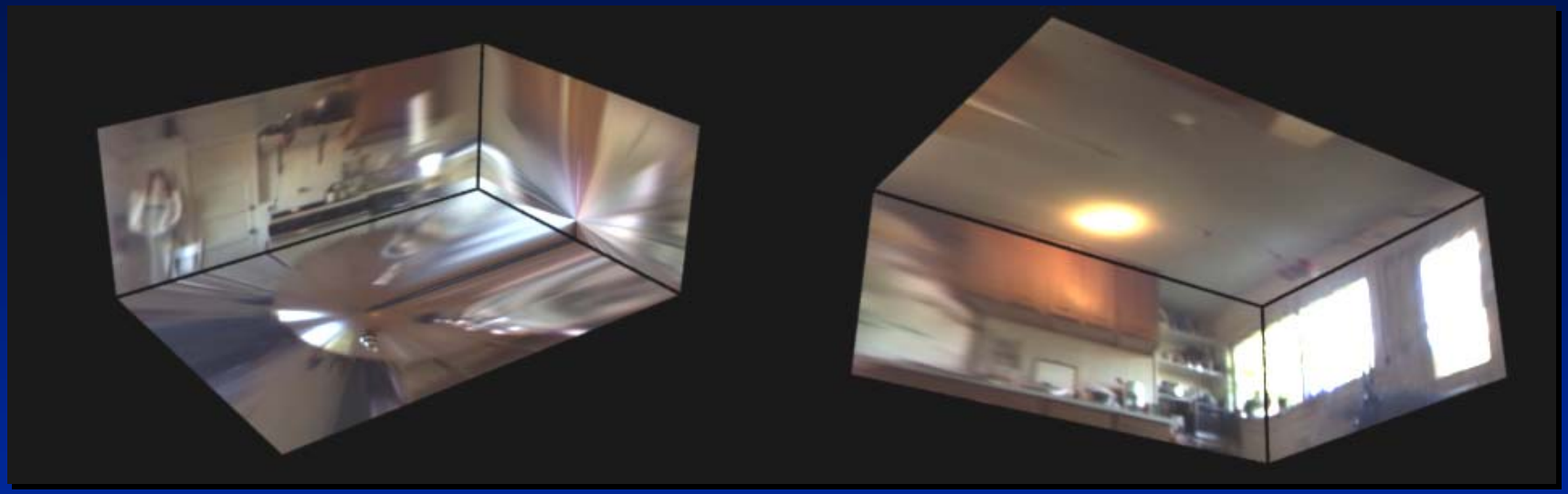
Light Probe / Calibration Grid

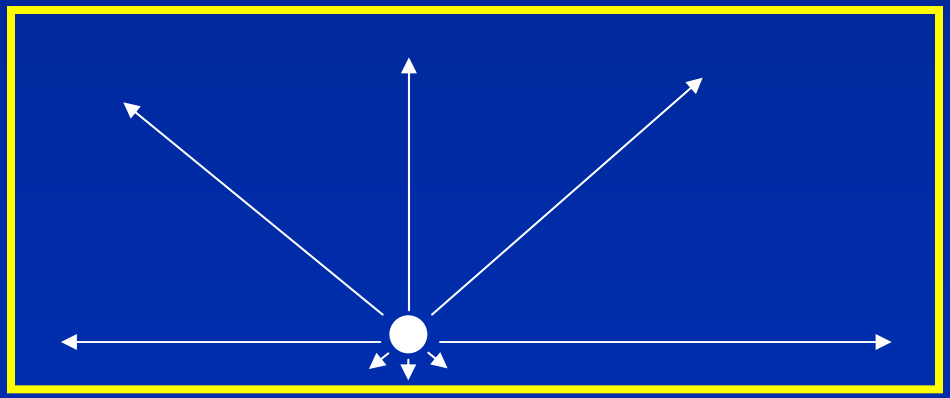


Modeling the Scene

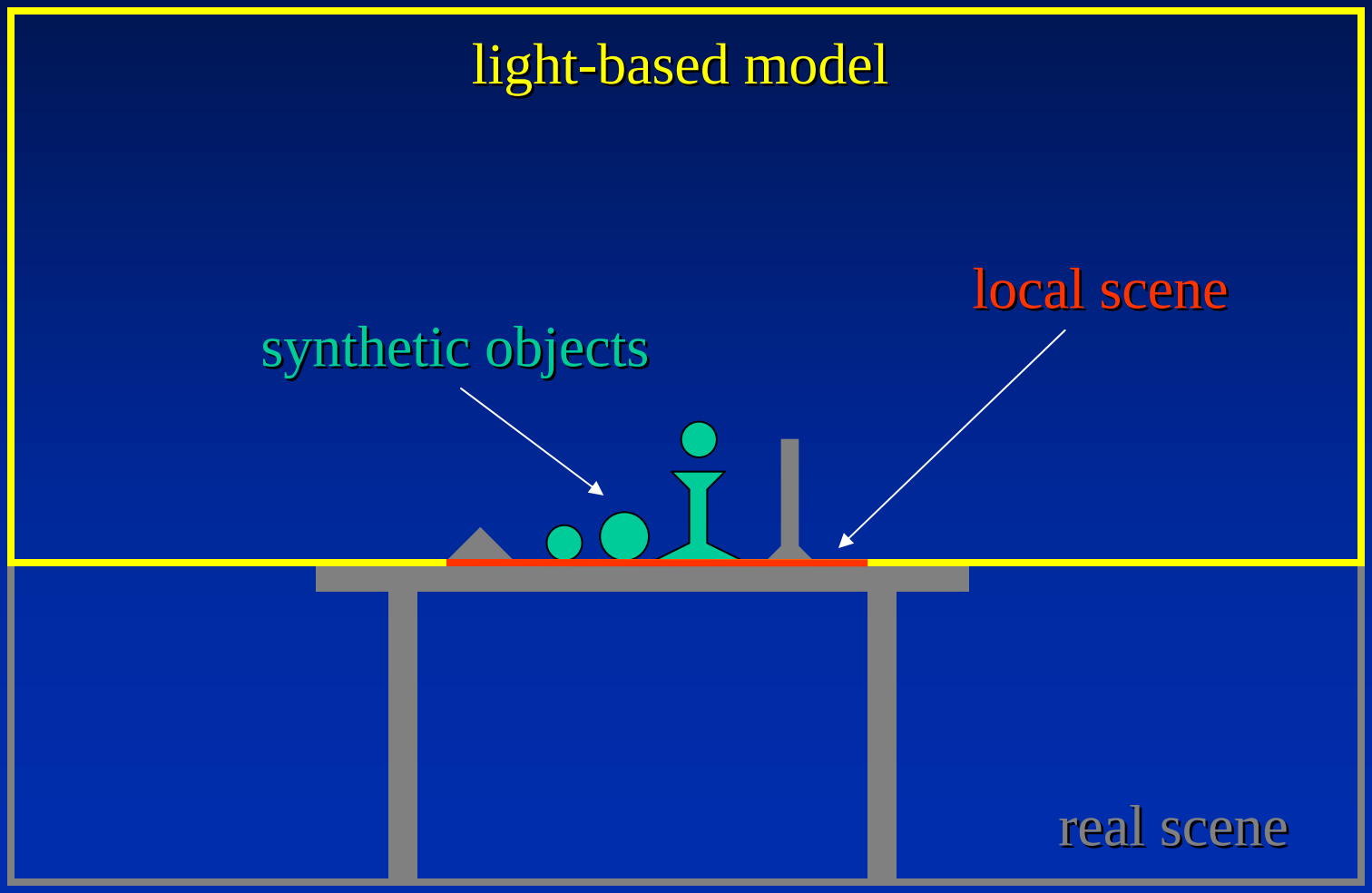


The *Light-Based* Room Model

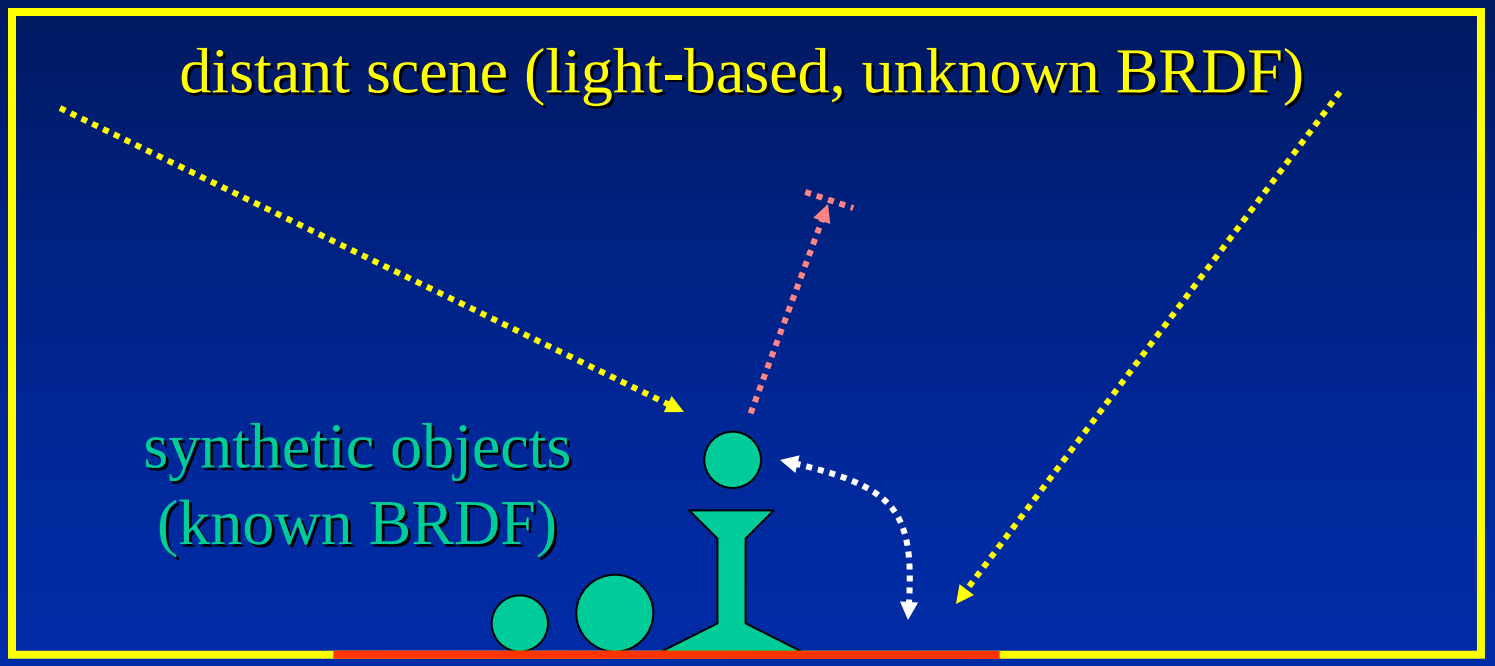




Modeling the Scene



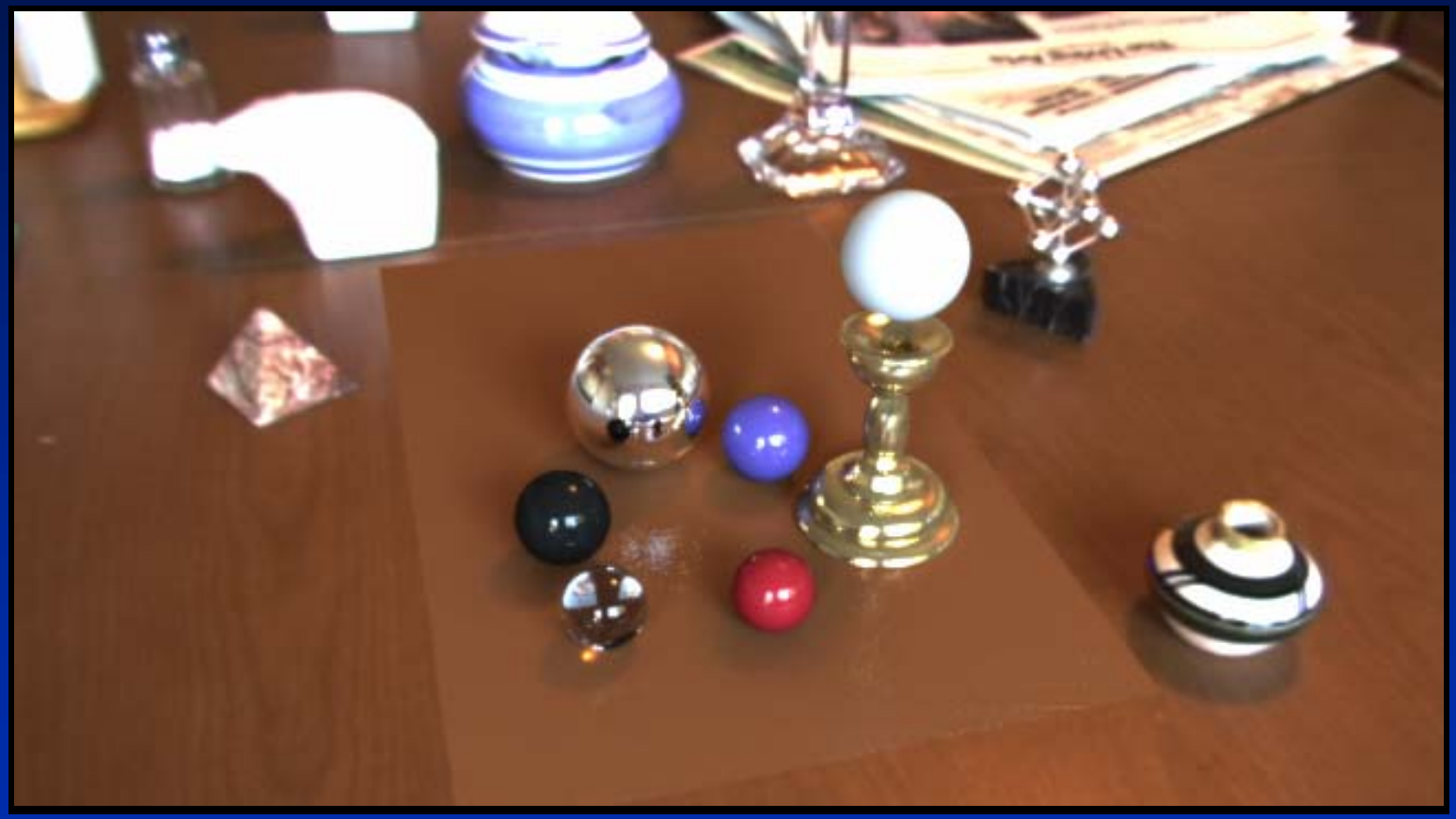
The Lighting Computation



Rendering into the Scene

Background Plate

Rendering into the Scene

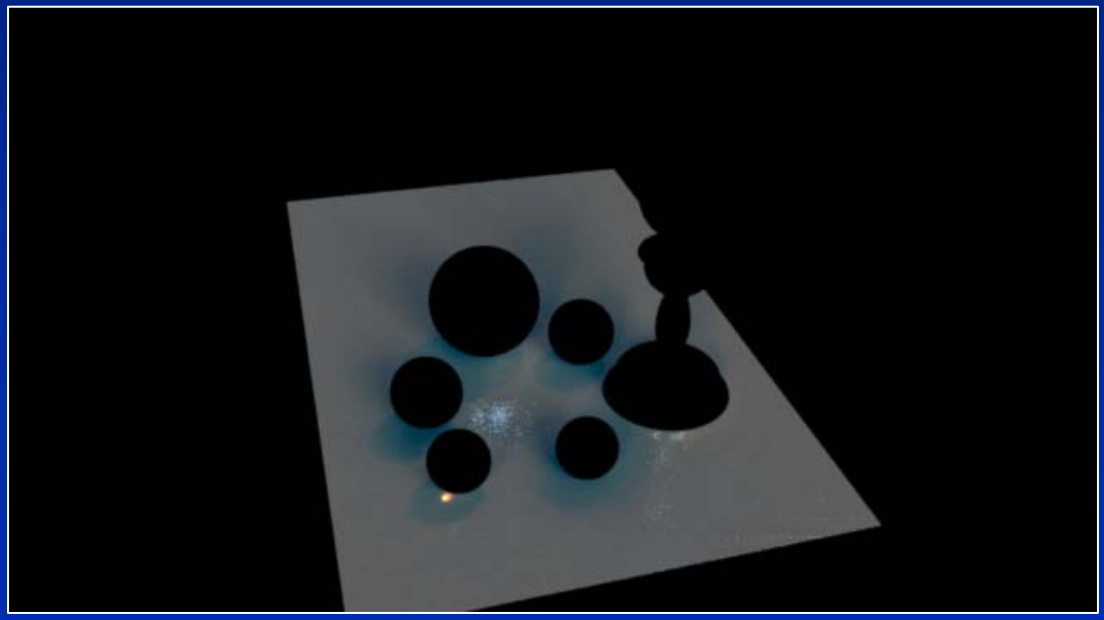


Objects and Local Scene matched to Scene

Differential Rendering

Local scene w/o objects, illuminated by model

Differential Rendering (2)
Difference in local scene



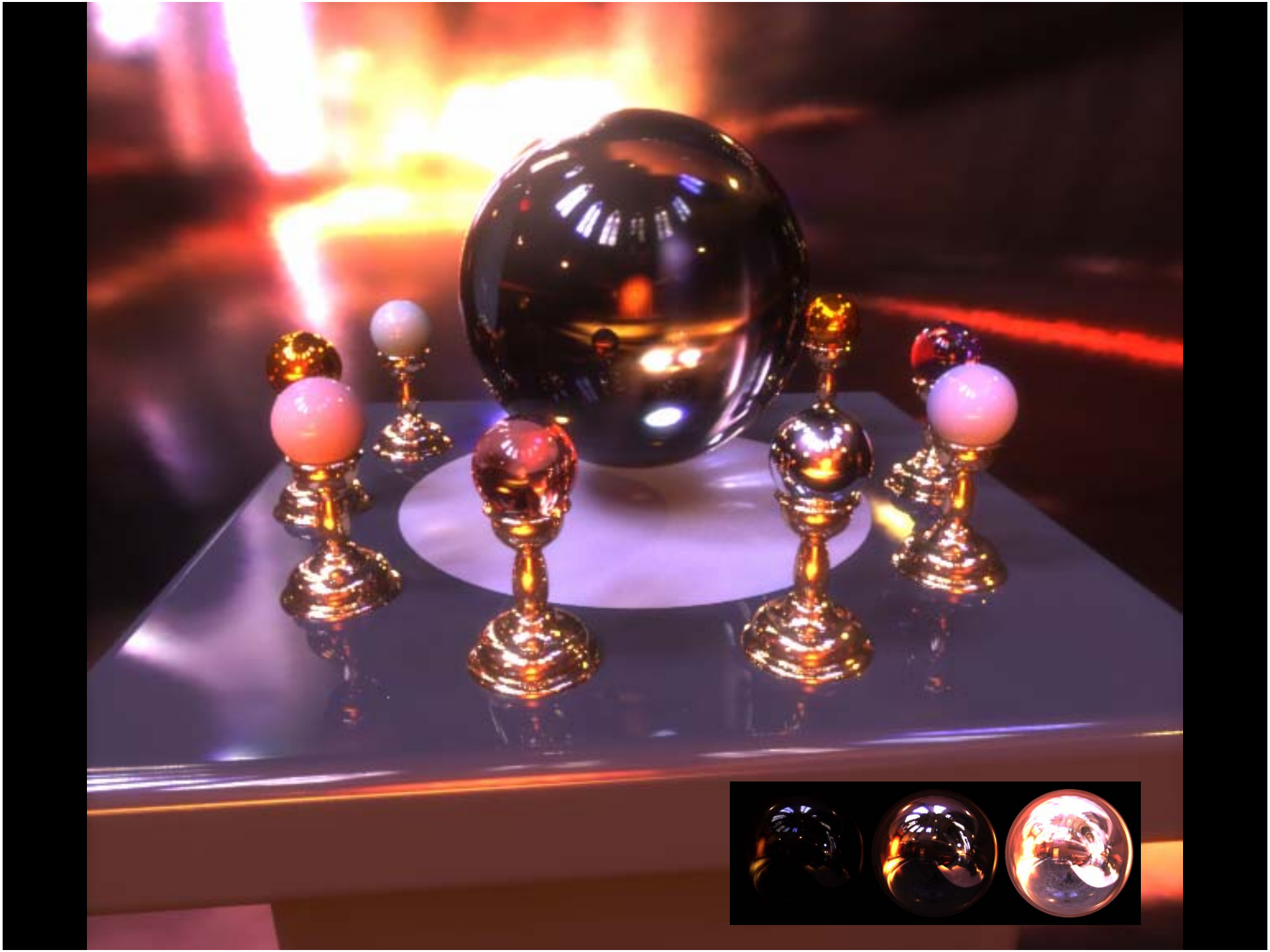
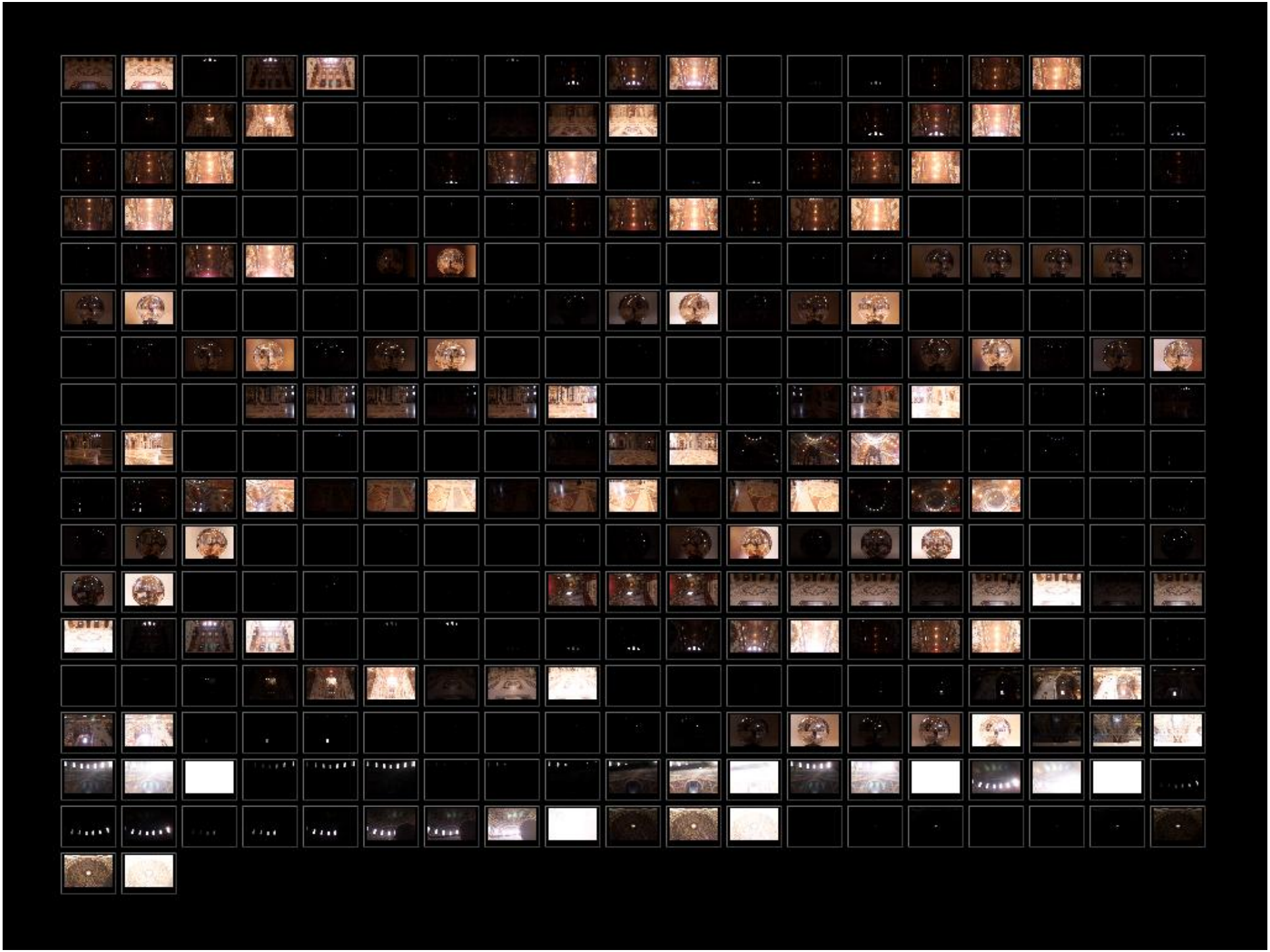


IMAGE-BASED LIGHTING IN *FIAT LUX*

Paul Debevec, Tim Hawkins, Westley Sarokin, H. P. Duiker, Christine Cheng, Tal Garfinkel, Jenny Huang

SIGGRAPH 99 Electronic Theater



HDR Image Series

2 sec

1/4 sec

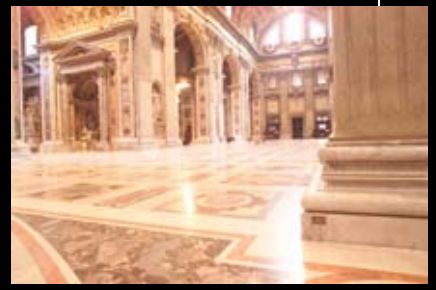
1/30 sec

1/250 sec

1/2000 sec

1/8000 sec

Stp1
Panorama



Assembled Panorama

Light Probe Images

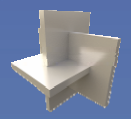
Capturing a Spatially-Varying Lighting Environment

The Movie

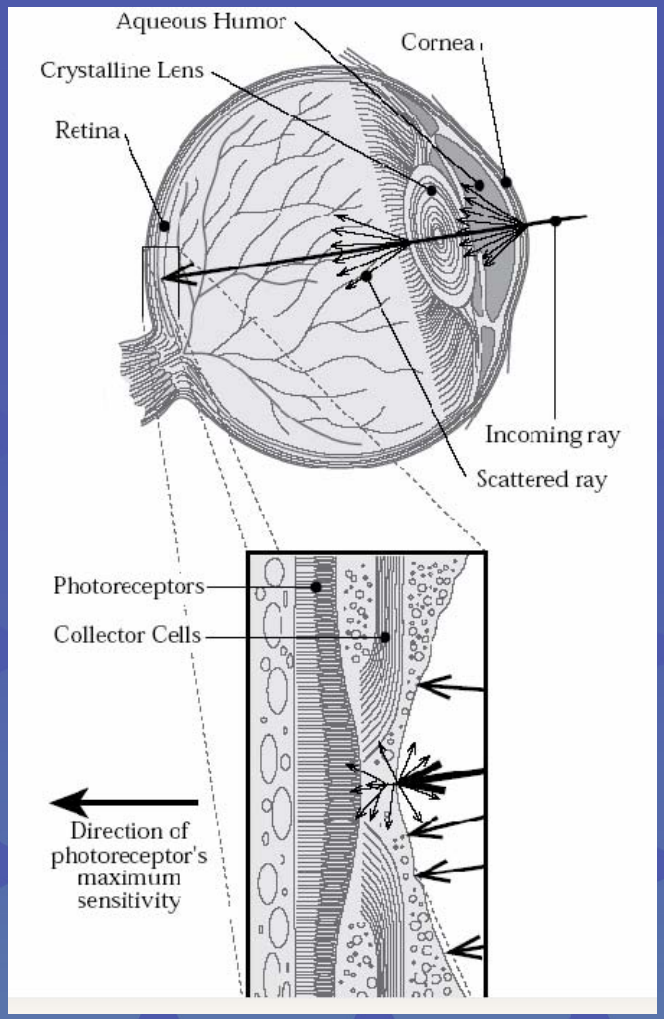
Simulating the Glare in the Human Eye

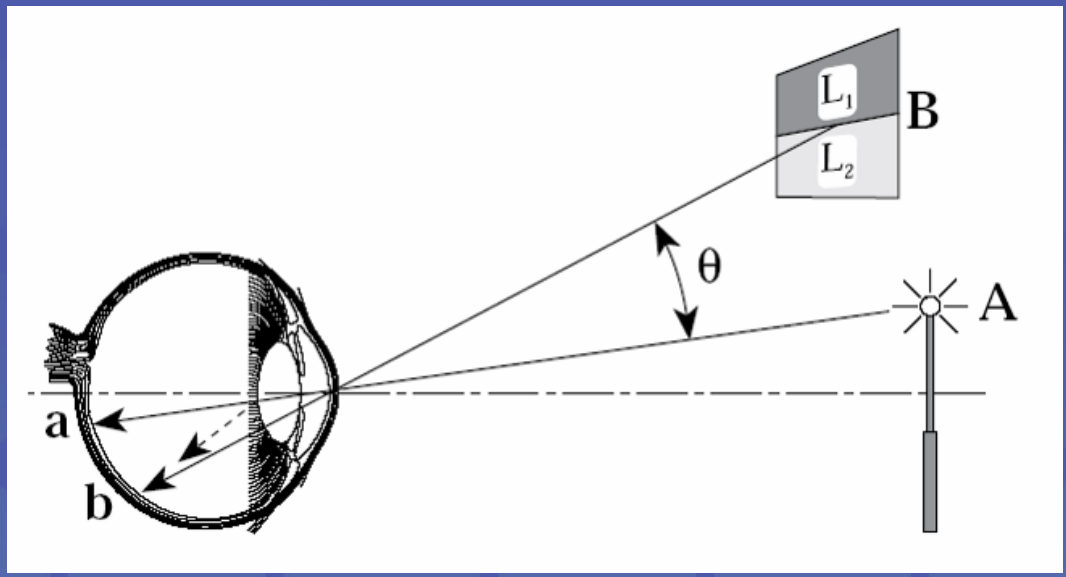
SIGGRAPH2004

- Greg Spencer, Peter Shirley, Kurt Zimmerman, and Donald Greenberg. Physically-based glare effects for digital images. SIGGRAPH 95.



Scattering in the eye





What's the scattering model?

HDR Image

Gaussian Blur, LDR information Only

Gaussian Blur, Full HDR Information

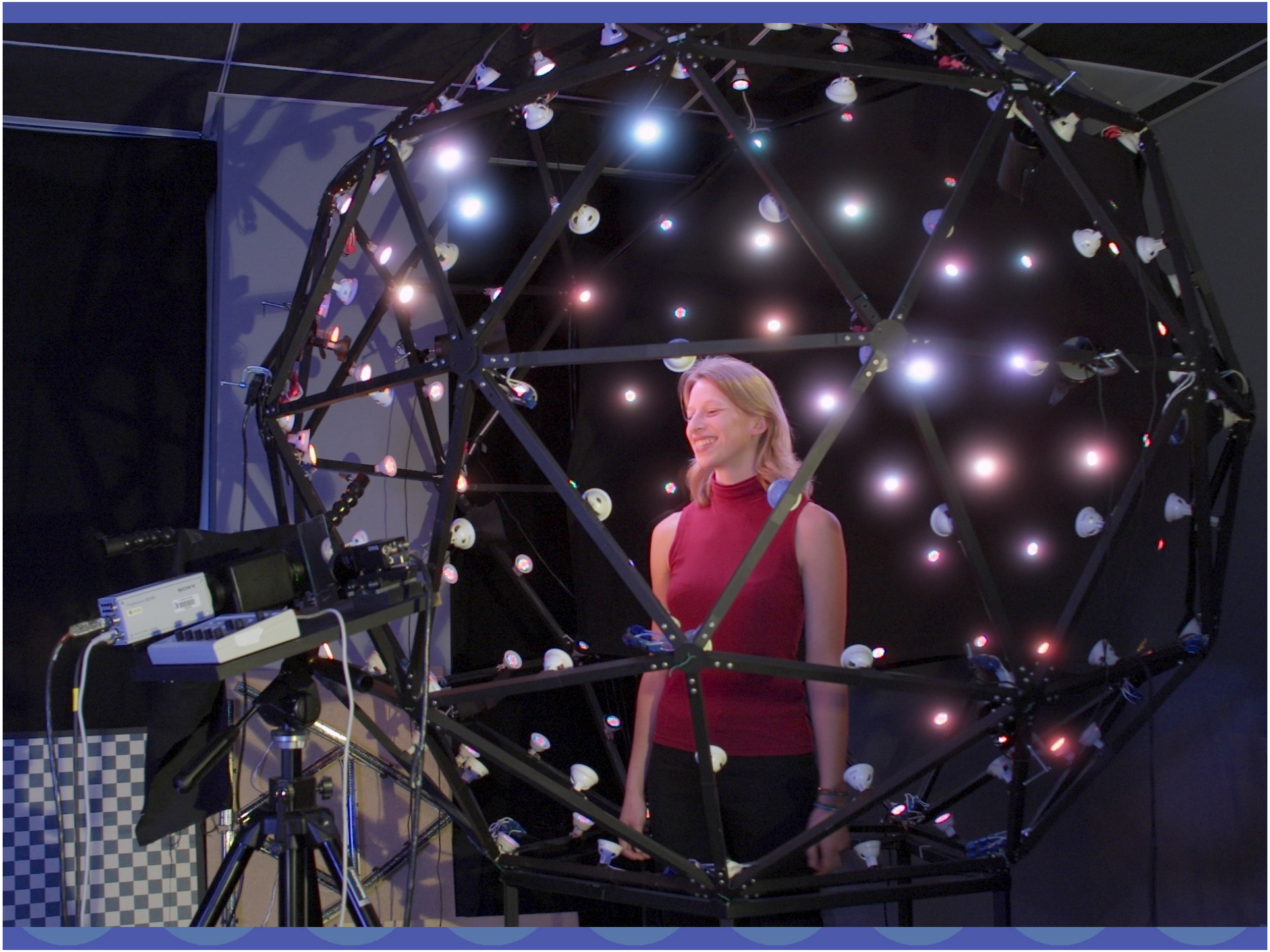
Full HDR Disc Blur

Frame Postprocessing in Rendering with Natural Light

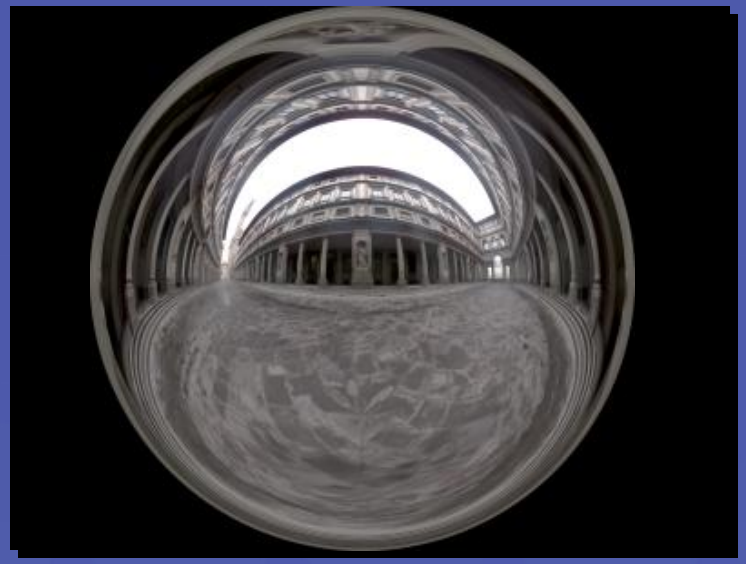
Real objects under new lighting

SIGGRAPH2004

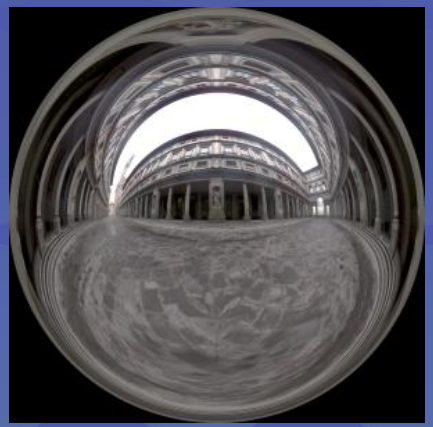
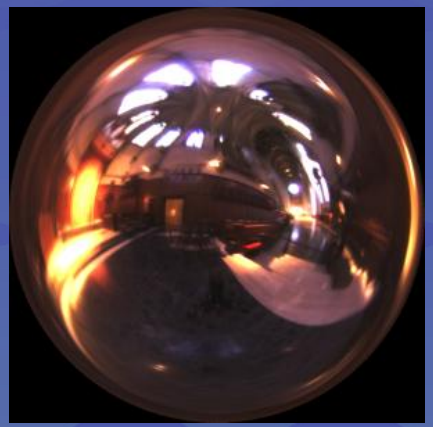
Rendering Light Probes as Light Sources



A Lighting Reproduction Approach

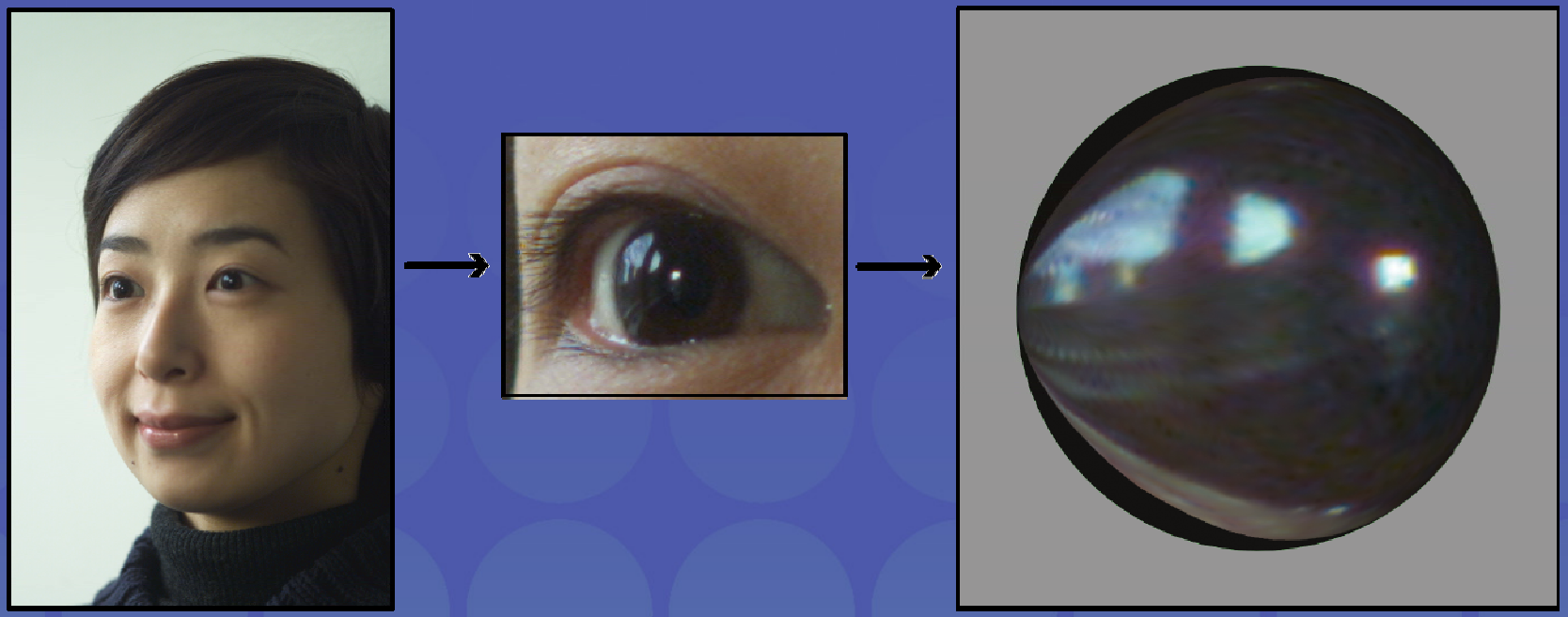


Composited Results

Environment Map from Single Image?

Eye as Light Probe! (Nayar et al)



Cornea is an ellipsoid

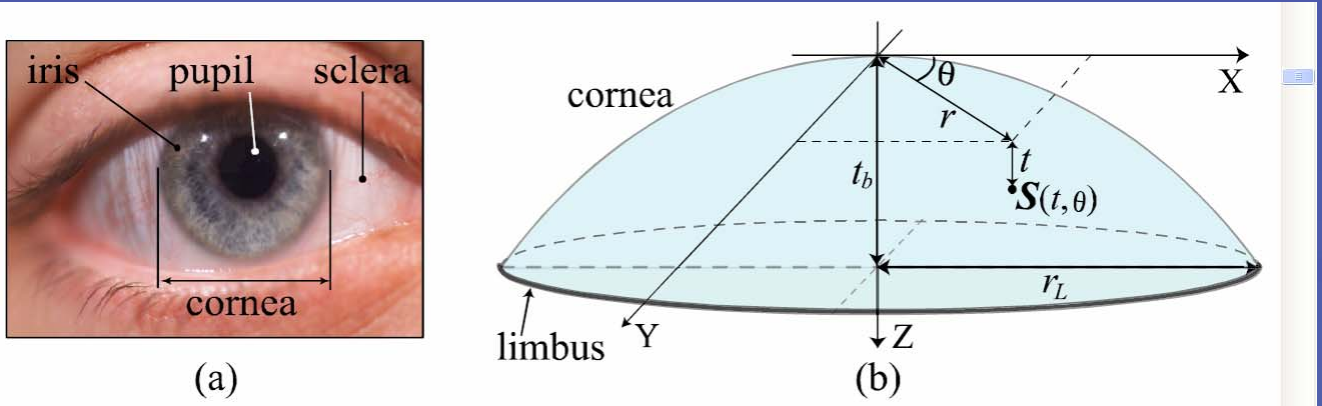
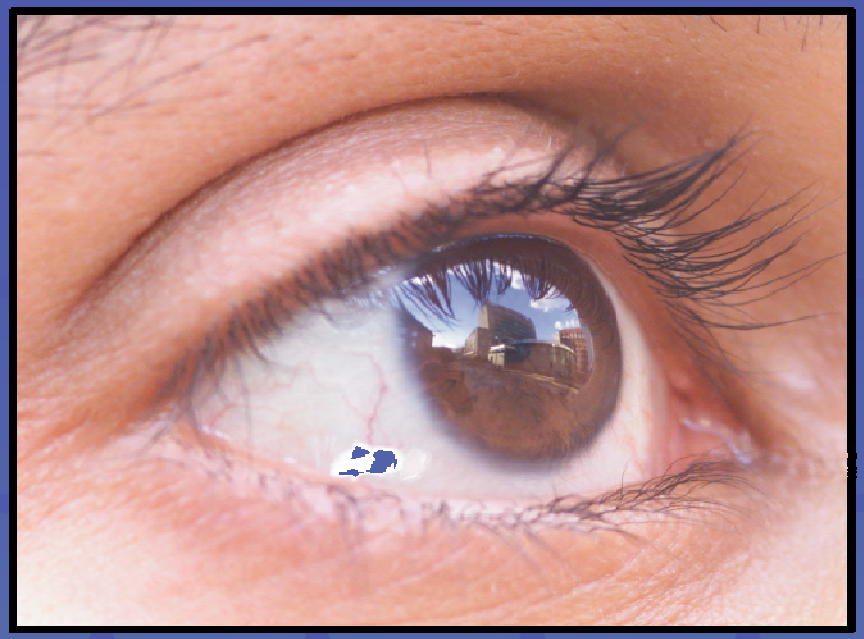


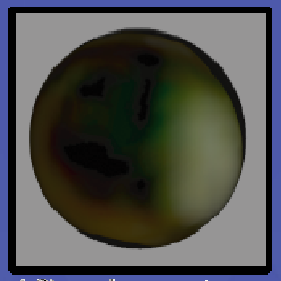
Figure 2: (a) An external view of the human eye. (b) A normal adult cornea can be modeled as an ellipsoid whose outer limit corresponds to the limbus. The eccentricity and radius of curvature at the apex can be assumed to be known.

Ellipsoid fitting



(a1) original image

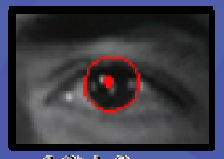
(a2) left eye



(a3) environment map

(a4) face replaced image

(a) replacing faces in *Amelie*



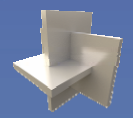
(b2) left eye

(b3) environment map

Putting it all together!

Reach for the sky

- How can we capture the whole sky as an environment map?
- What happens with the sun?



Direct HDR Capture of the Sun and Sky

- Use Sigma 8mm fisheye lens and Canon EOS 1Ds to cover entire sky
- Use 3.0 ND filter on lens back to cover full range of light
  - Only 0.1% of light gets through!

Stumpfel, Jones, Wenger, Tchou, Hawkins, and Debevec. "Direct HDR Capture of the Sun and Sky". To appear in Afrigraph 2004.

Extreme HDR Image Series

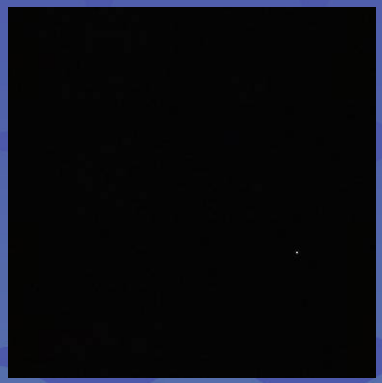
1 sec
f/4

1/4 sec
f/4

1/30 sec
f/4

1/30 sec
f/16

1/250 sec
f/16



1/1000 sec
f/16

1/8000 sec
f/16

Extreme HDR Image Series
- sun closeup

1 sec
f/4

1/4 sec
f/4

1/30 sec
f/4

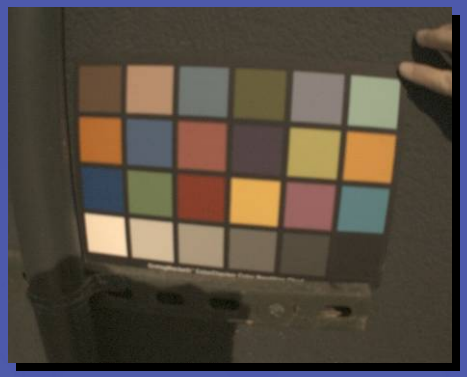
1/30 sec
f/16

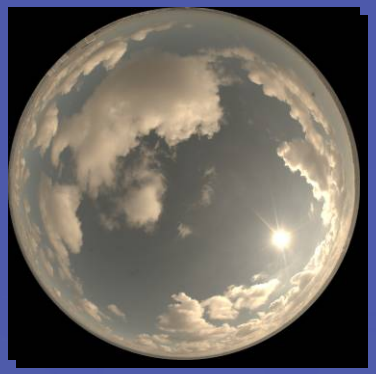
1/250 sec
f/16

1/1000 sec
f/16

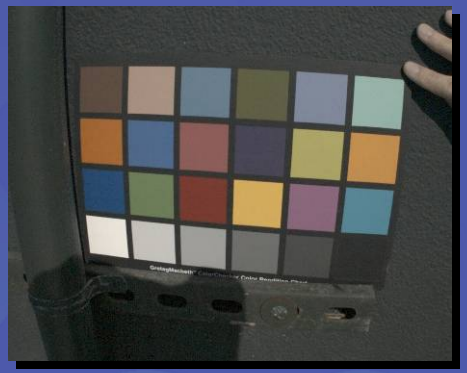
1/8000 sec f/16
only image that does not saturate!

Spectral Calibration – ND filters are NOT Necessarily Neutral!





Before correction

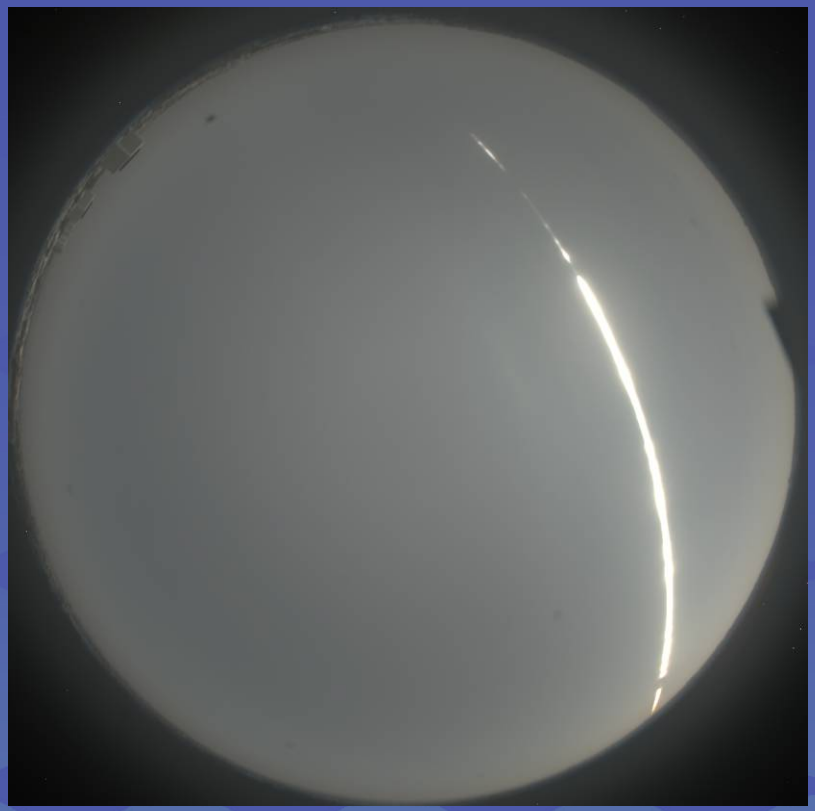


After correction based on MacBeth ColorChecker chart appearance

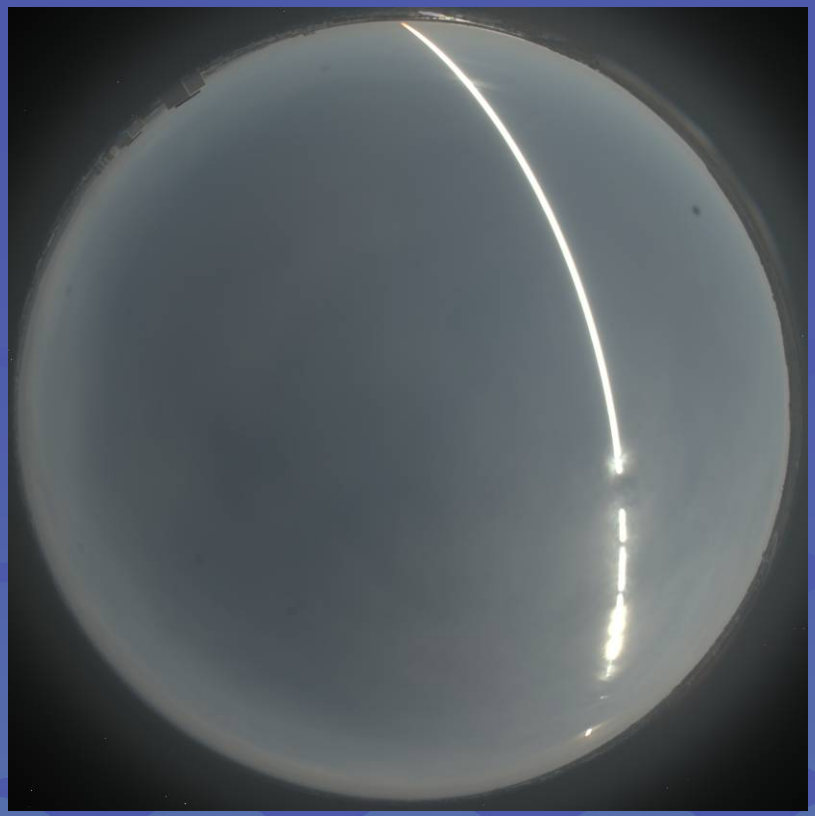
Two Complete days of HDR Lighting (see video)

SIGGRAPH2004

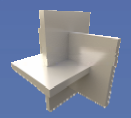
(day averages at 1 min. intervals)



Feb 22, 2004



Feb 23, 2004



Lit by sun and sky

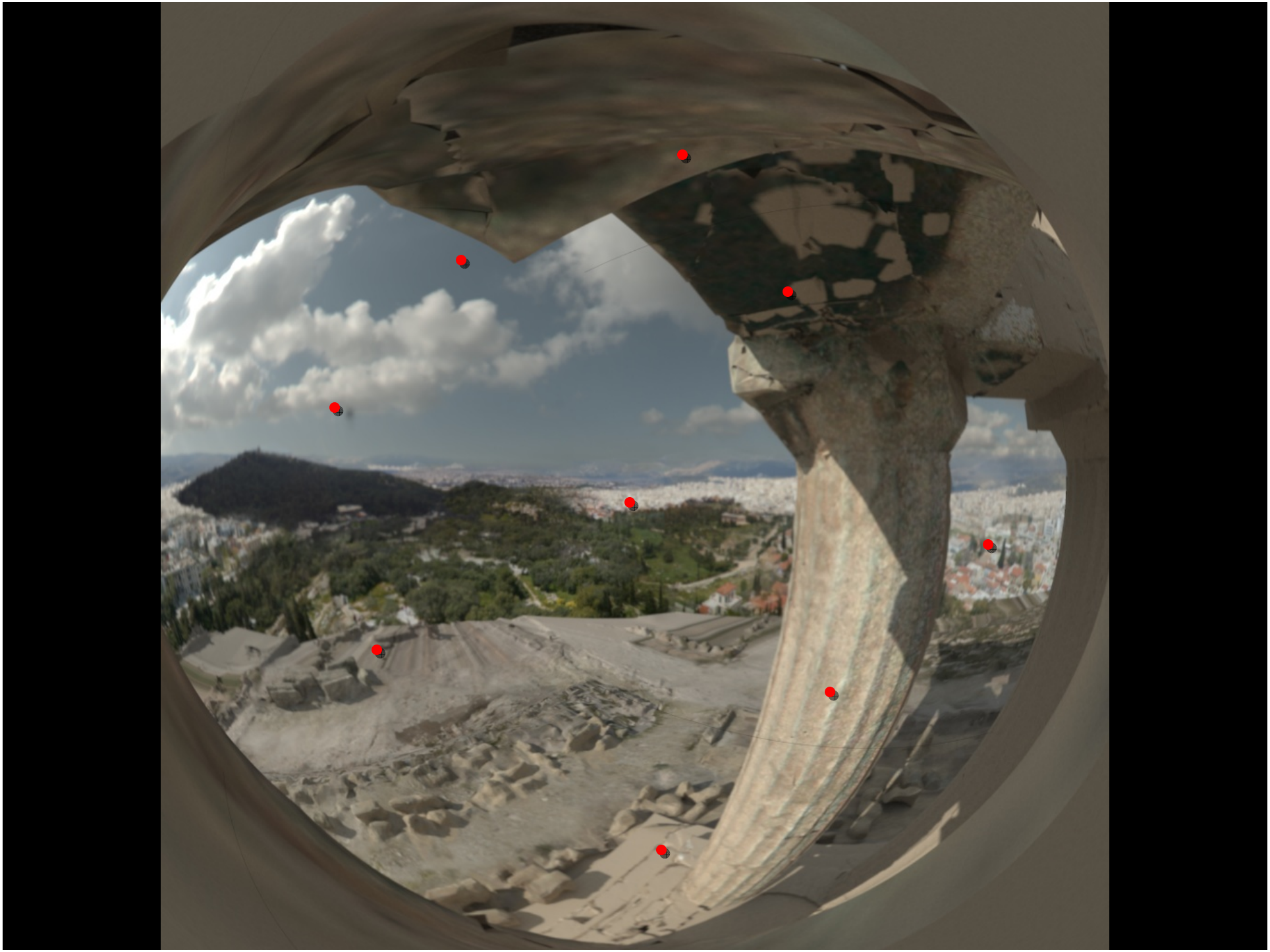
9 samples per pixel, 17 min.

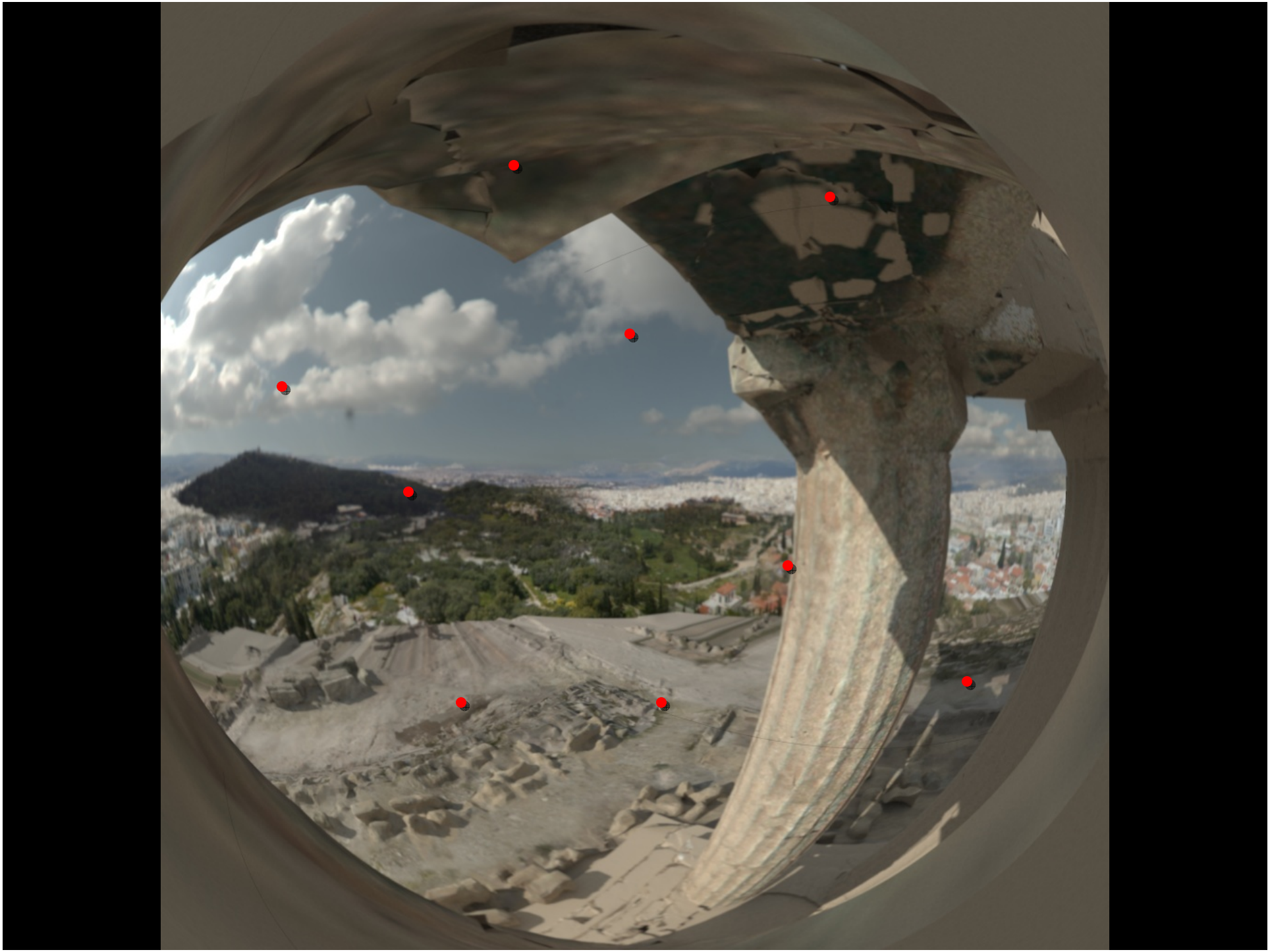
16 samples per pixel, 46 min.

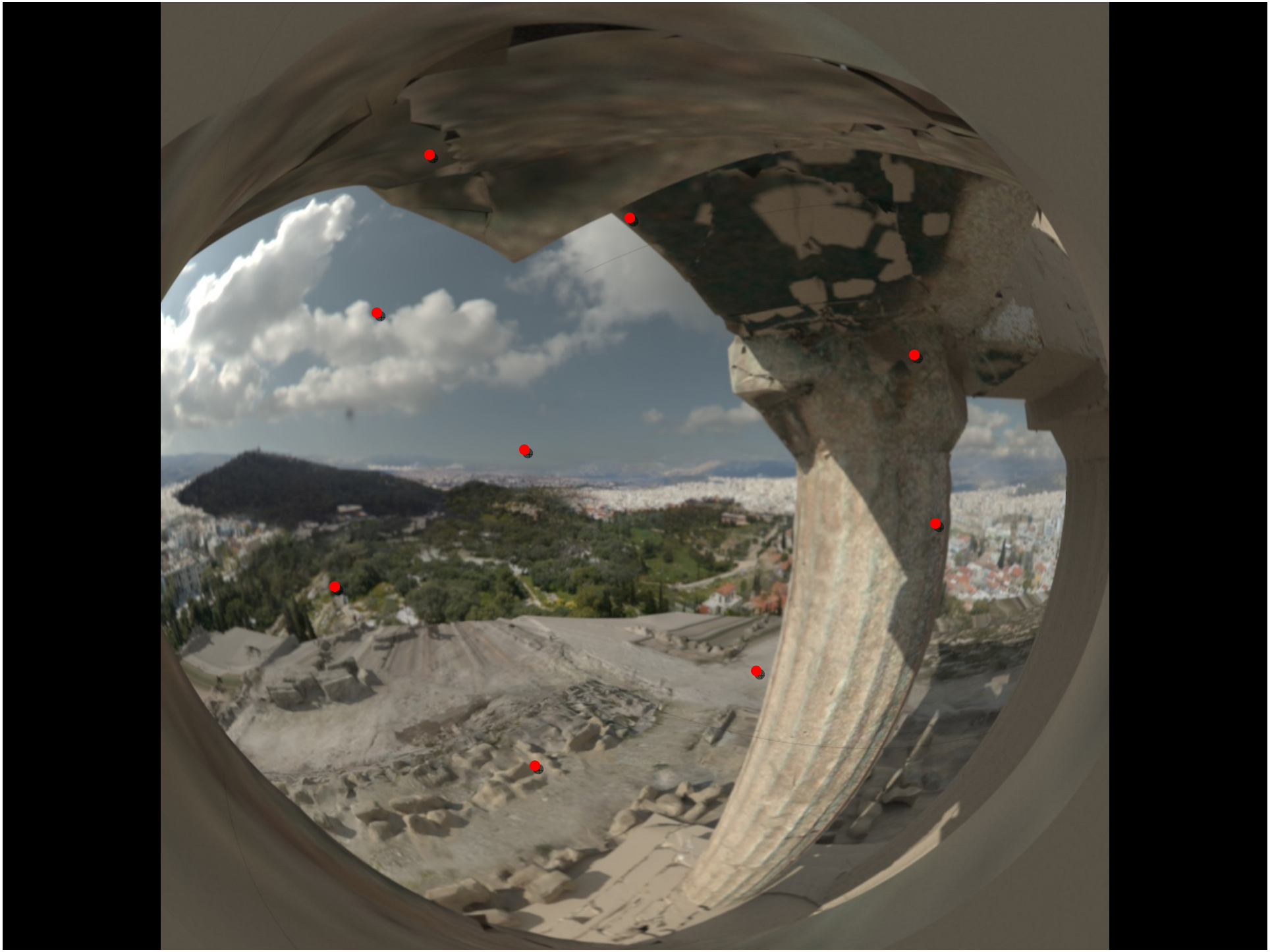
100 samples per pixel, 189 min.

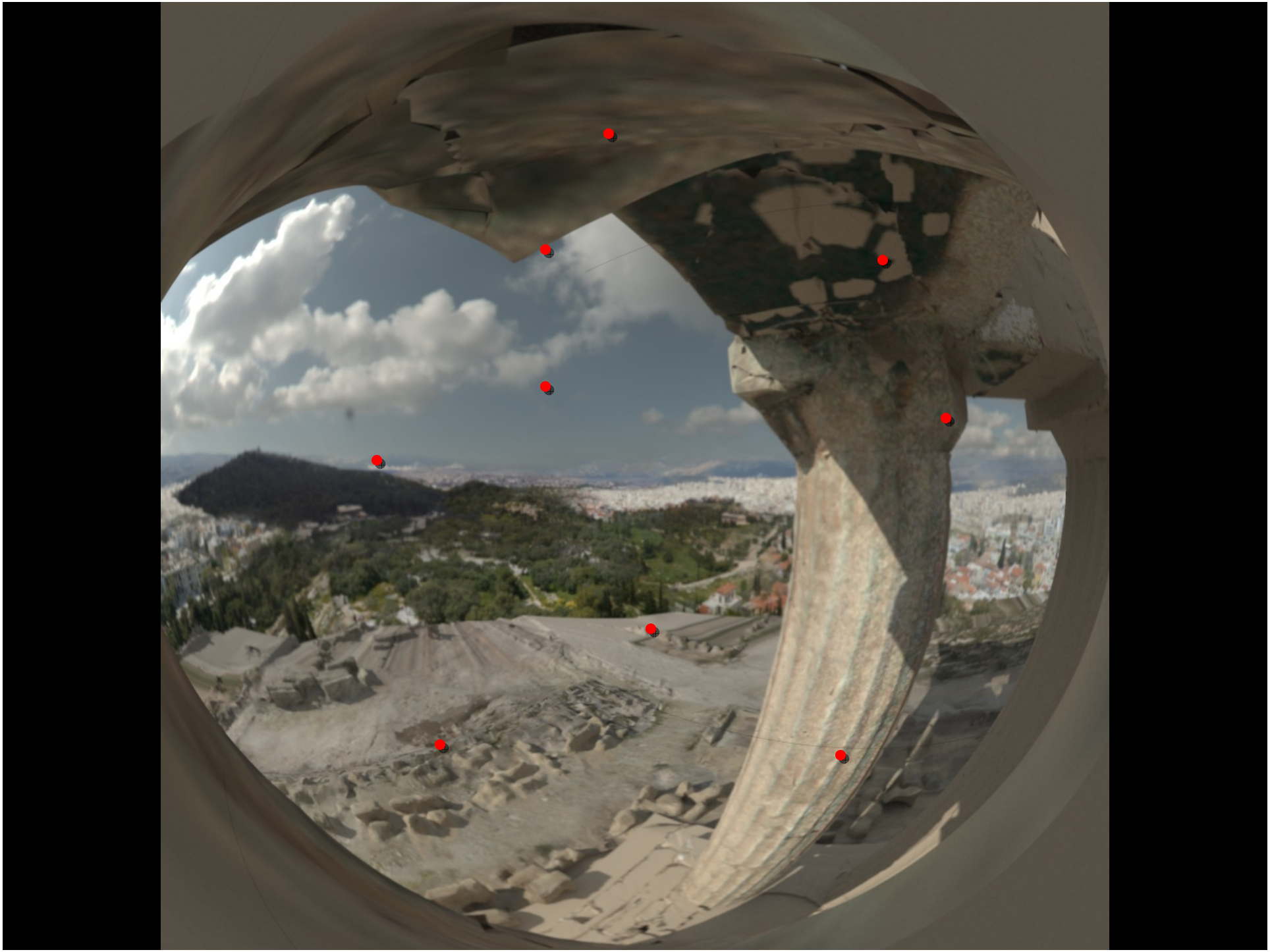
A sunlit sample point

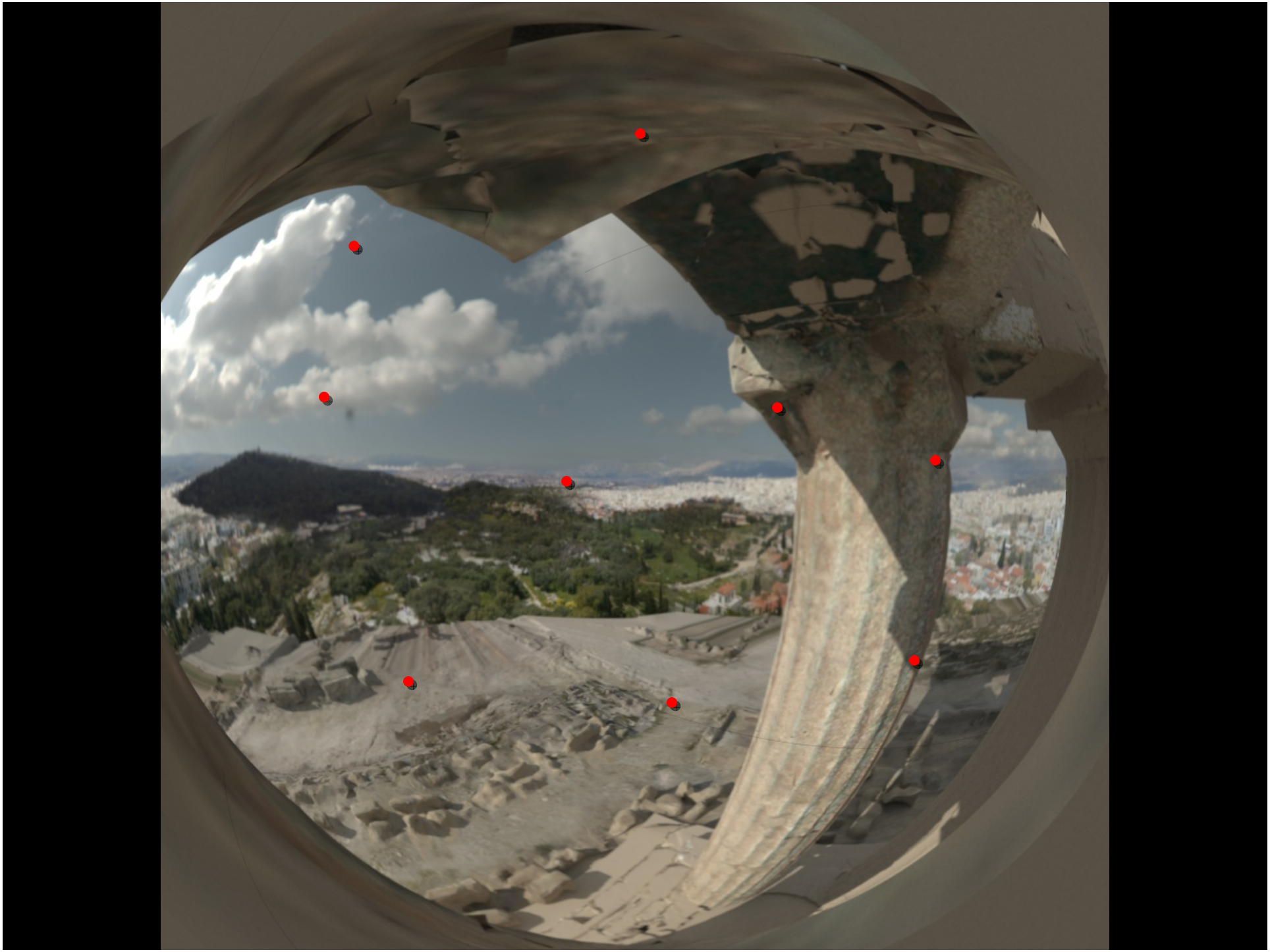
A shadowed sample point



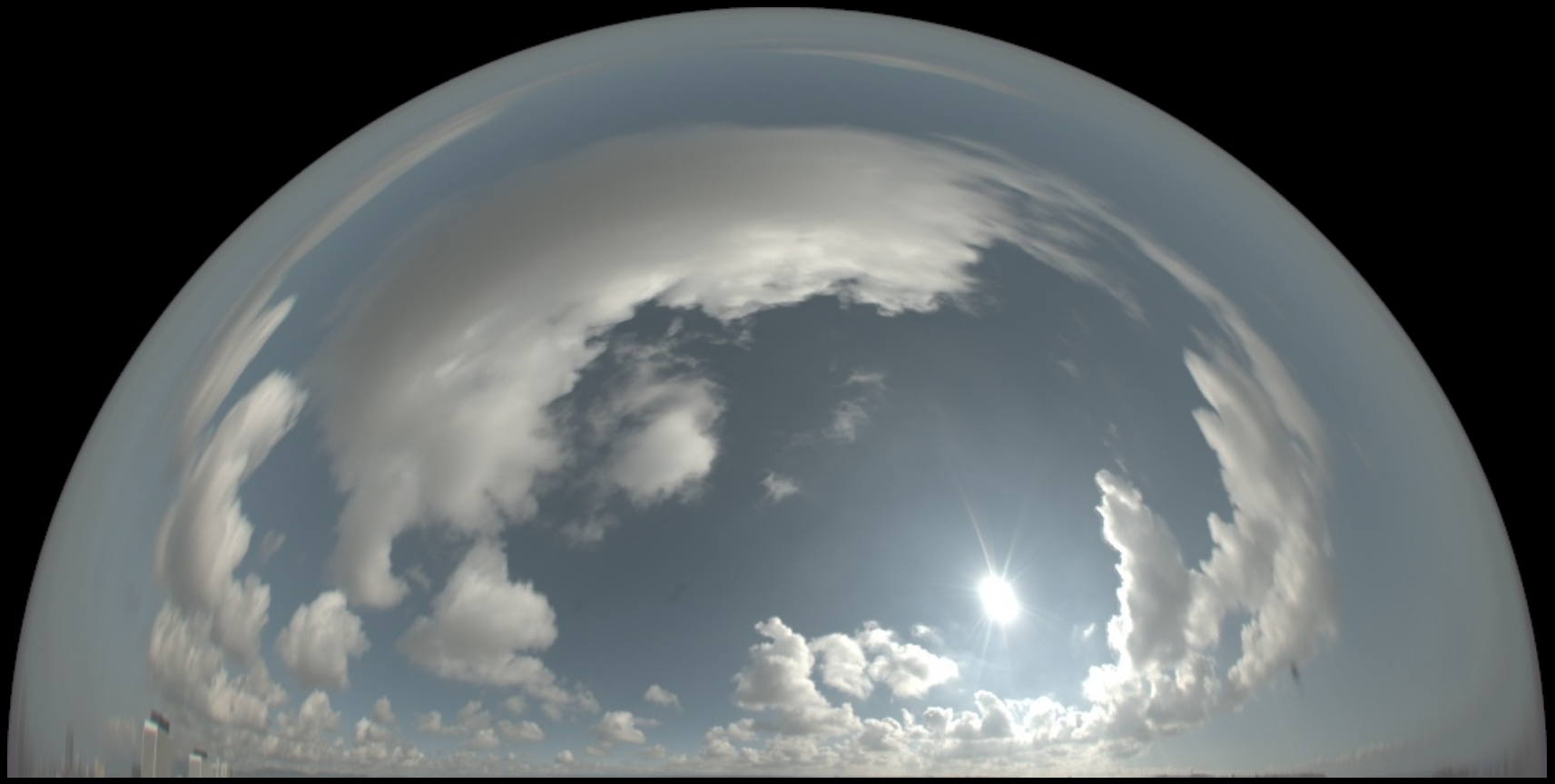




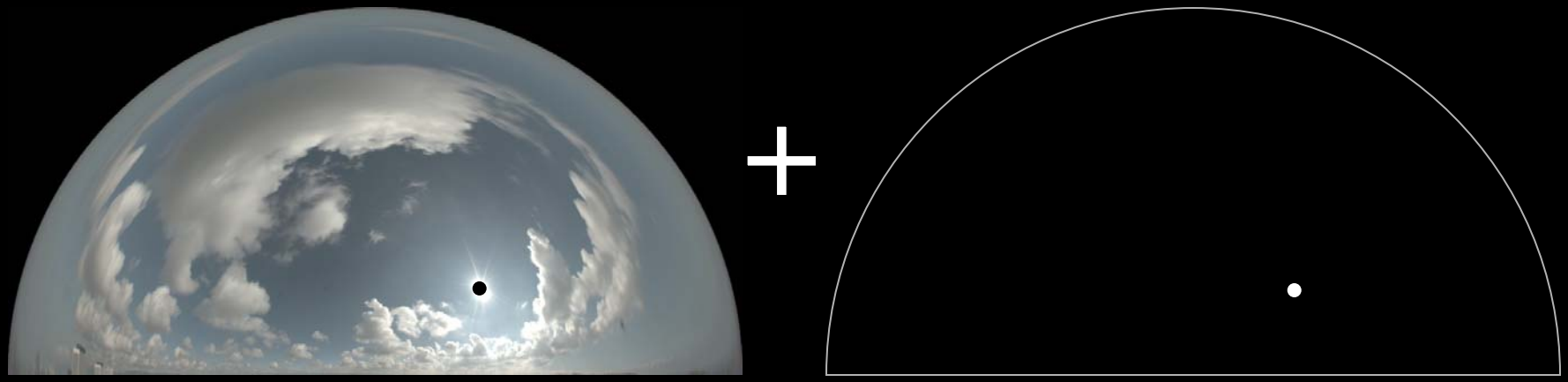




HDRI Sky Probe

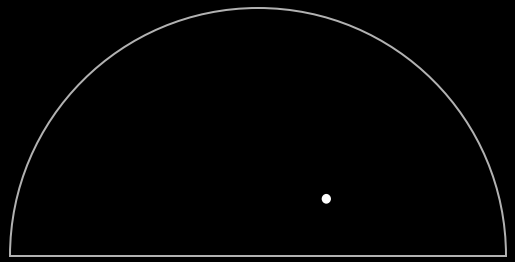
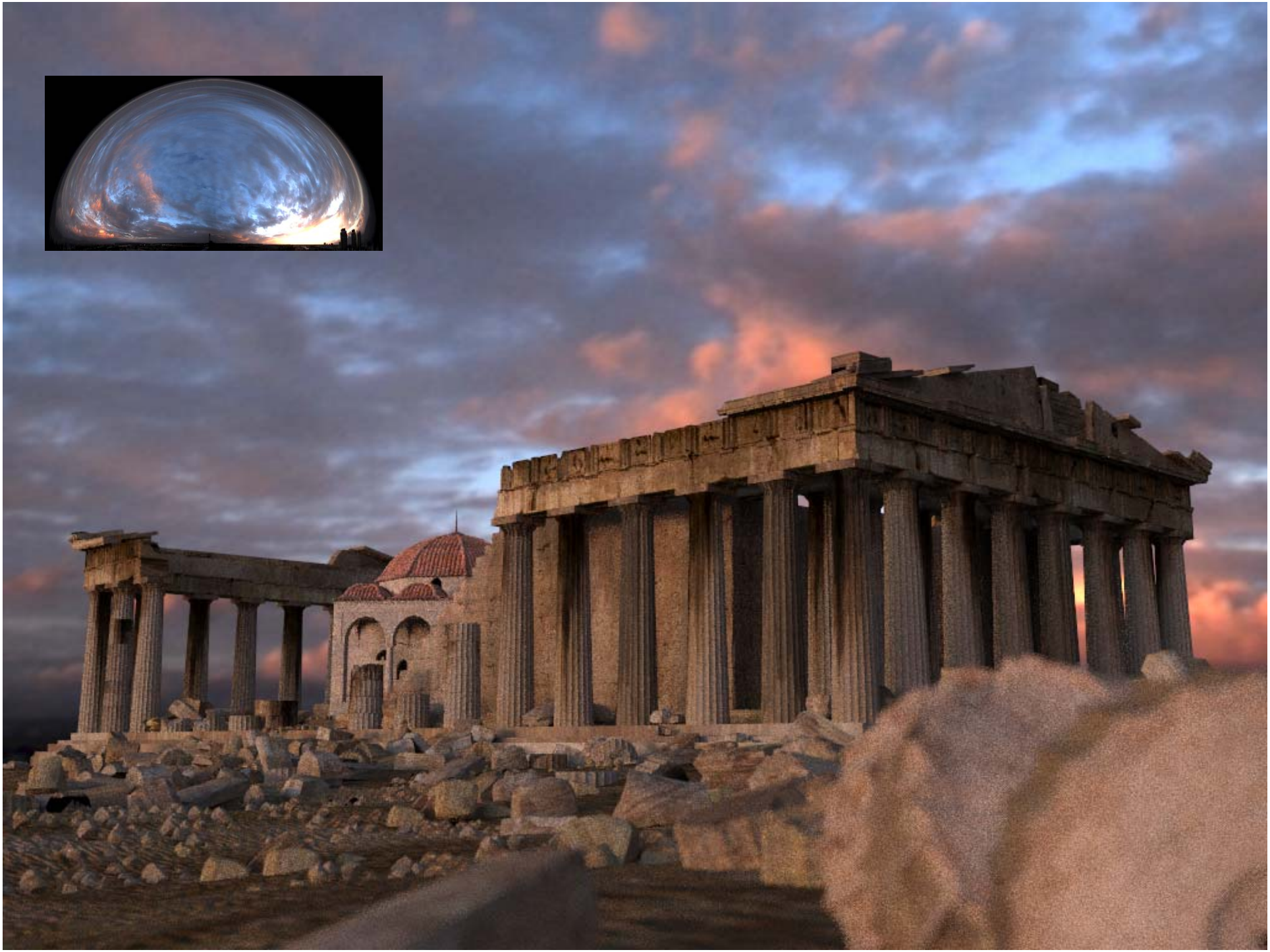


Clipped Sky + Sun Source



Lit by sky only, 17 min.

Lit by sun only, 21 min.



Lit by sun and sky, 25 min