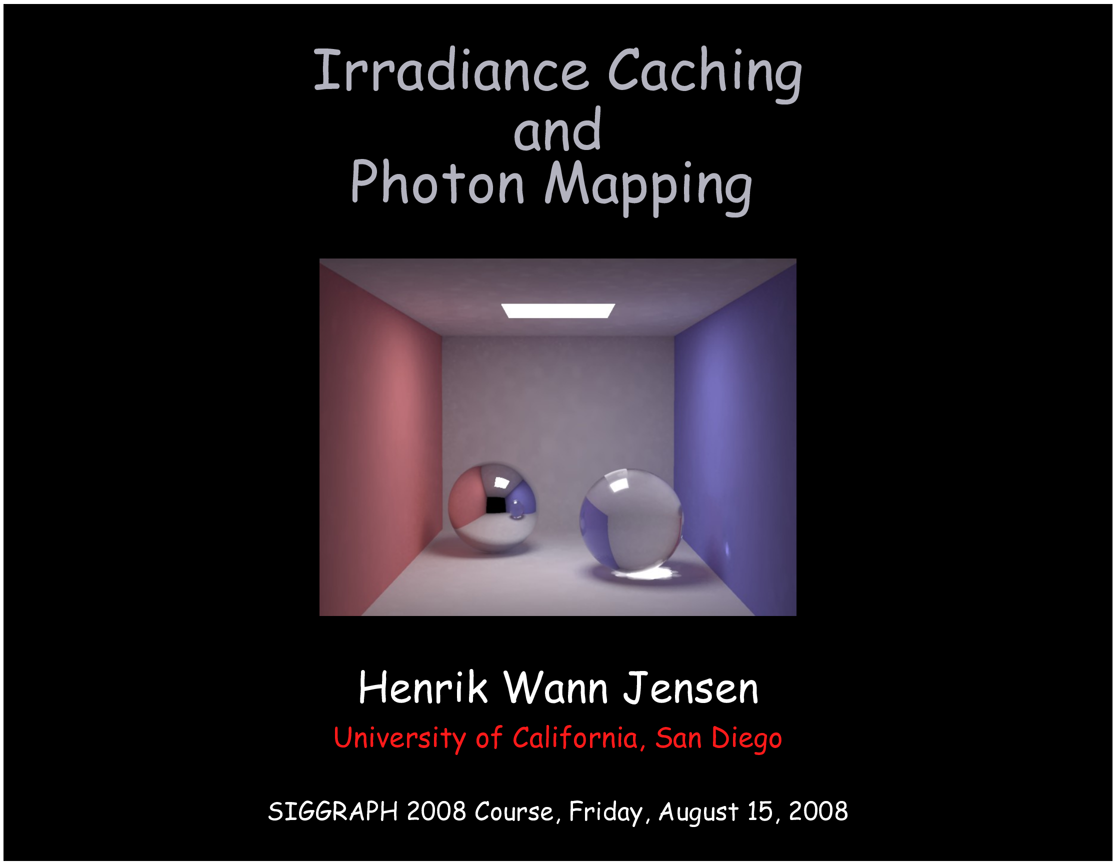
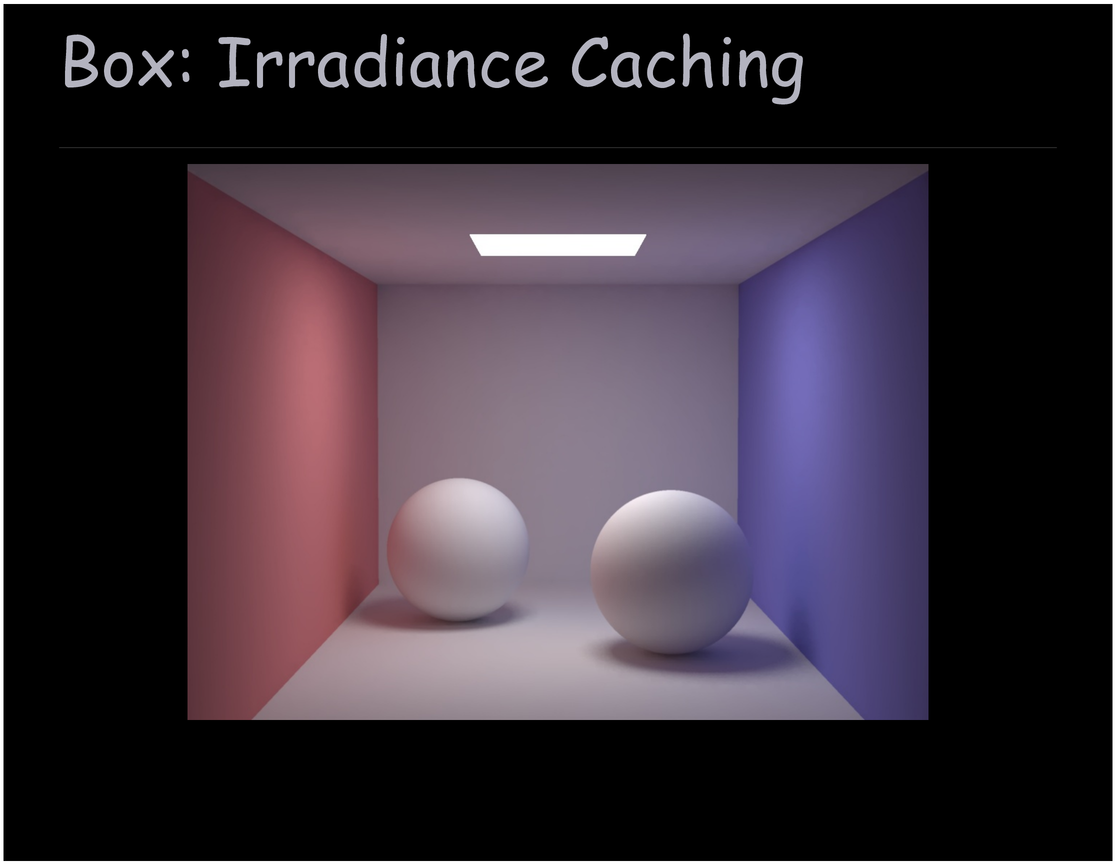

Irradiance Caching
and
Photon Mapping
Henrik Wann Jensen
University of California, San Diego
SIGGRAPH 2008 Course, Friday, August 15, 2008

Irradiance caching

Greg Ward, Francis Rubinstein and Robert Clear:
"A Ray Tracing Solution for Diffuse Interreflection".
Proceedings of SIGGRAPH 1988.

Idea: Irradiance changes slowly $\rightarrow$ interpolate.


Box: Irradiance Caching

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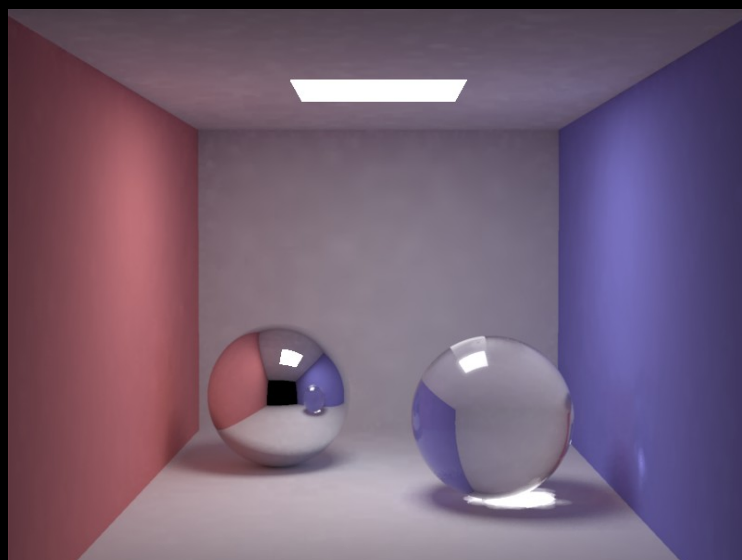
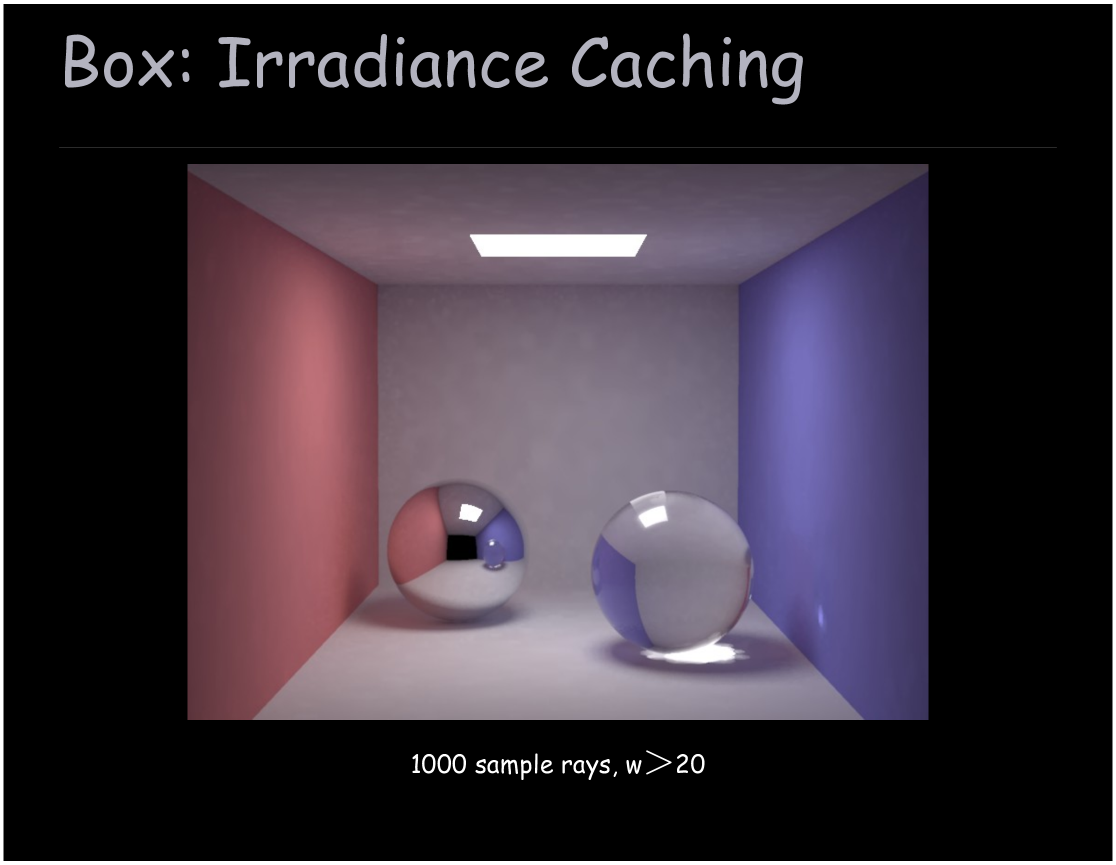
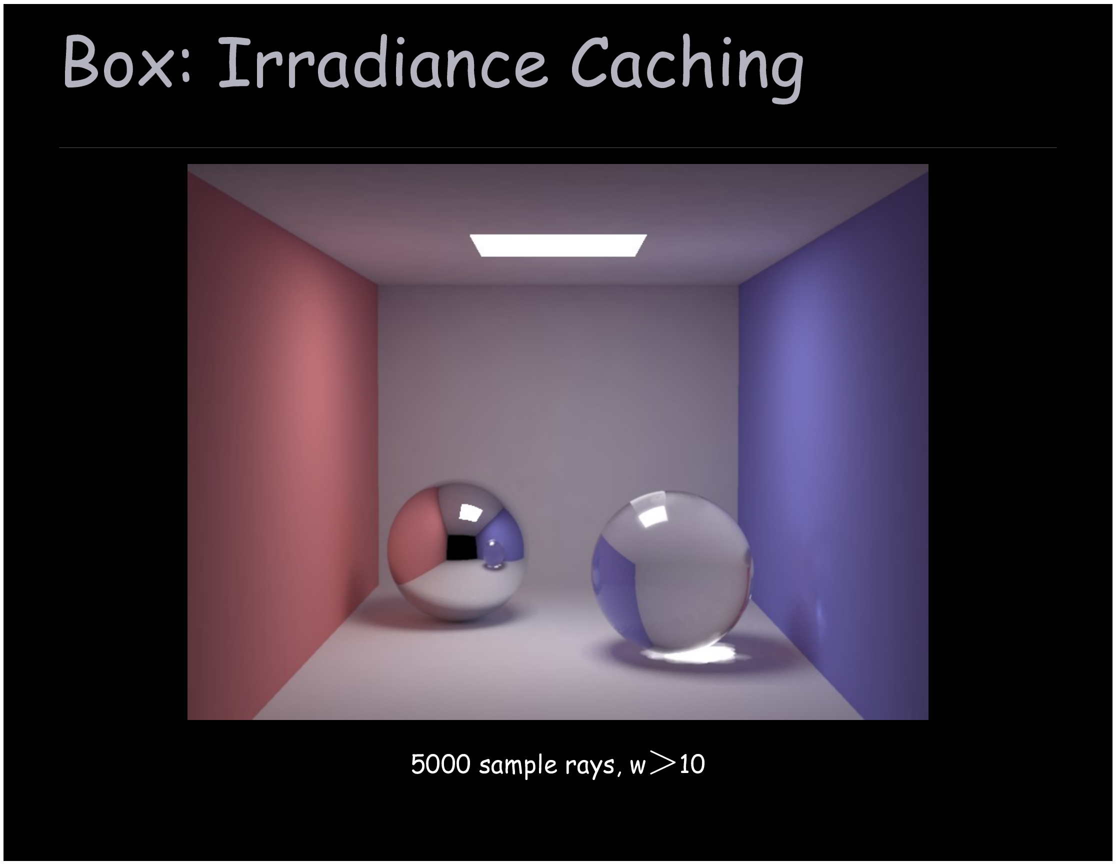
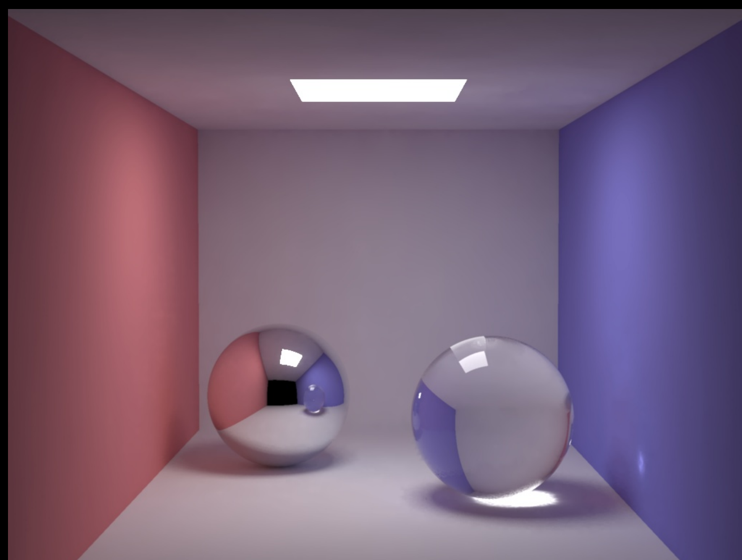


1000 sample rays, w>10


Box: Irradiance Caching
1000 sample rays, w>20


Box: Irradiance Caching
5000 sample rays, w>10

Box



Photon mapping + irradiance caching

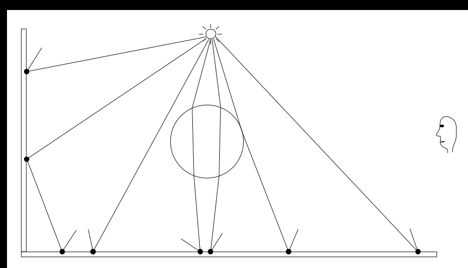
Photon mapping

A two-pass method

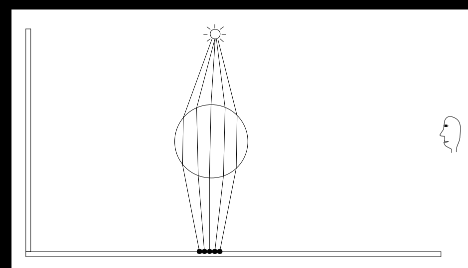
Pass 1: Build the photon map (photon tracing)

Pass 2: Render the image using the photon map

Two photon maps



global photon map



caustics photon map

The Rendering Equation

$$L_r(x,\vec{\omega}) = \int_{\Omega_x} f_r(x,\vec{\omega}',\vec{\omega}) L_i(x,\vec{\omega}') \cos\theta' \, d\omega'$$

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Split incoming radiance:

$$L_i = \underbrace{L_{i,l}}_{\text{direct}} + \underbrace{L_{i,c}}_{\text{caustics}} + \underbrace{L_{i,d}}_{\text{soft indirect}}$$

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Split incoming radiance:

$$L_i = \underbrace{L_{i,l}}_{\text{direct}} + \underbrace{L_{i,c}}_{\text{caustics}} + \underbrace{L_{i,d}}_{\text{soft indirect}}$$

Split the BRDF

$$f_r = \underbrace{f_{r,d}}_{\text{diffuse}} + \underbrace{f_{r,s}}_{\text{specular}}$$

The Rendering Equation

$$L_r = \int_{\Omega_x} f_r \, L_i \, \cos\theta' \, d\omega'$$

The Rendering Equation

$$
\begin{aligned}
L_r &= \int_{\Omega_x} f_r \, L_i \, \cos\theta' \, d\omega' \\
&= \int_{\Omega_x} f_r \, L_l \, \cos\theta' \, d\omega' +
\end{aligned}
$$

direct

The Rendering Equation

$$
\begin{aligned}
L_r = & \int_{\Omega_x} f_r \, L_i \, \cos\theta' \, d\omega' \\
= & \int_{\Omega_x} f_r \, L_l \, \cos\theta' \, d\omega' + && \text{direct} \\
& \int_{\Omega_x} f_{r,s} \, (L_{i,c} + L_d) \, \cos\theta' \, d\omega' + && \text{specular}
\end{aligned}
$$

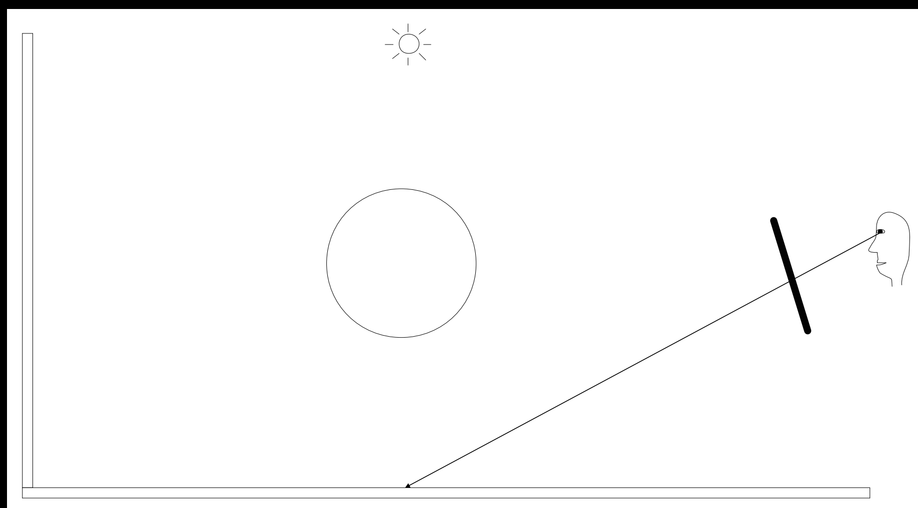
The Rendering Equation

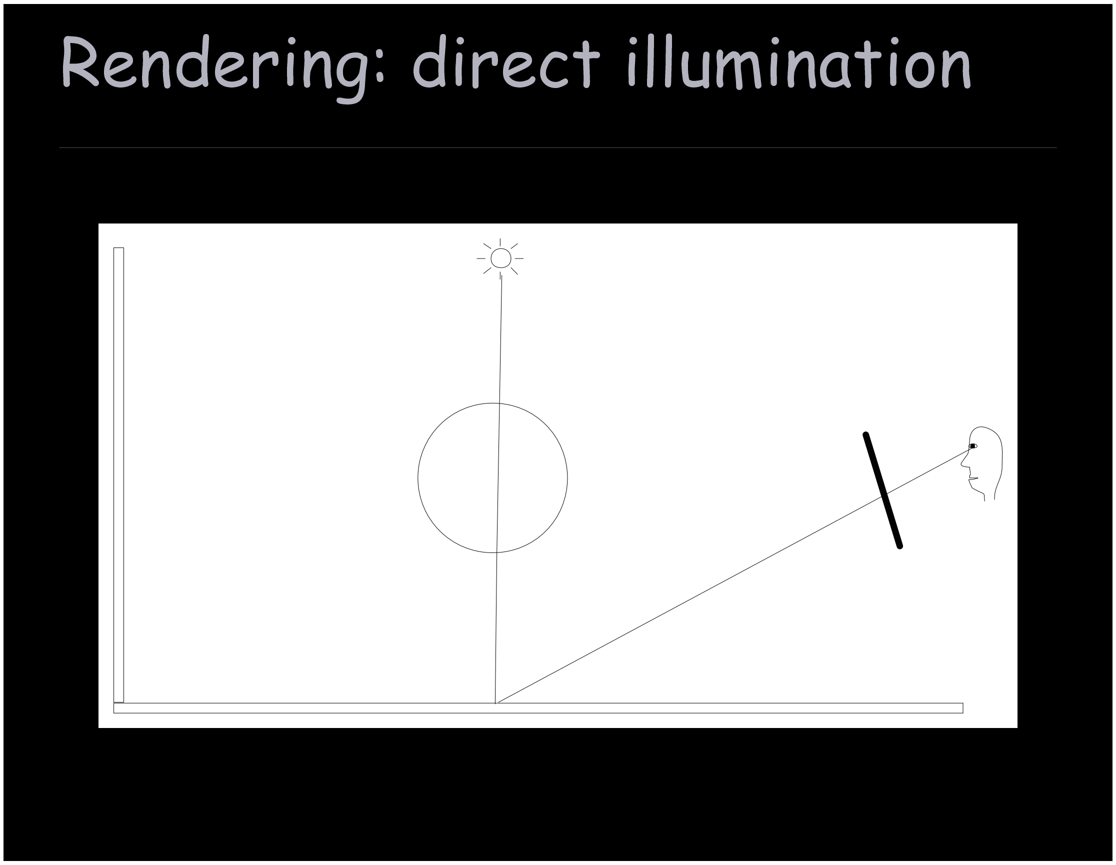
$$
\begin{aligned}
L_r = & \int_{\Omega_x} f_r \, L_i \, \cos\theta' \, d\omega' \\
= & \int_{\Omega_x} f_r \, L_l \, \cos\theta' \, d\omega' + && \text{direct} \\
& \int_{\Omega_x} f_{r,s} \, (L_{i,c} + L_d) \, \cos\theta' \, d\omega' + && \text{specular} \\
& \int_{\Omega_x} f_{r,d} \, L_c \, \cos\theta' \, d\omega' + && \text{caustics}
\end{aligned}
$$

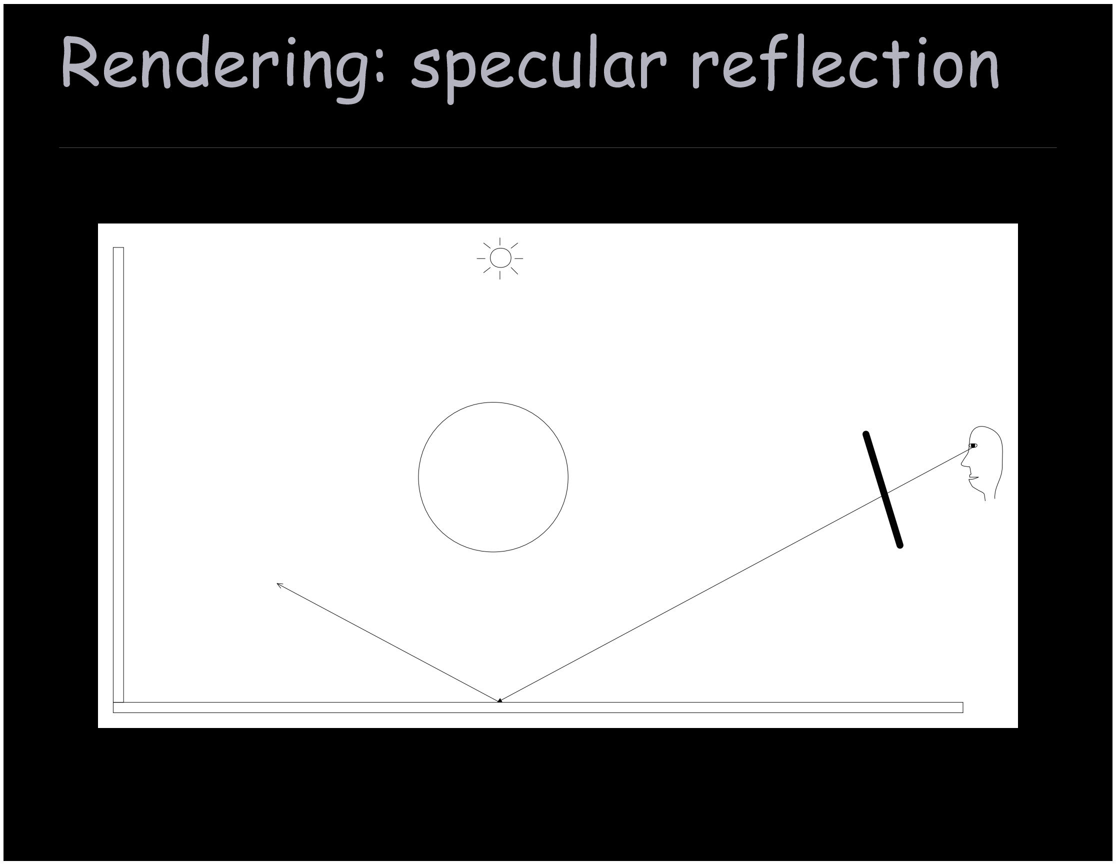
The Rendering Equation

$$
\begin{aligned}
L_r &= \int_{\Omega_x} f_r\, L_i\, \cos\theta'\, d\omega' \\
&= \int_{\Omega_x} f_r\, L_l\, \cos\theta'\, d\omega' + && \text{direct} \\
&\quad \int_{\Omega_x} f_{r,s}\, (L_{i,c} + L_d)\, \cos\theta'\, d\omega' + && \text{specular} \\
&\quad \int_{\Omega_x} f_{r,d}\, L_c\, \cos\theta'\, d\omega' + && \text{caustics} \\
&\quad \int_{\Omega_x} f_{r,d}\, L_d\, \cos\theta'\, d\omega' && \text{soft indirect}
\end{aligned}
$$

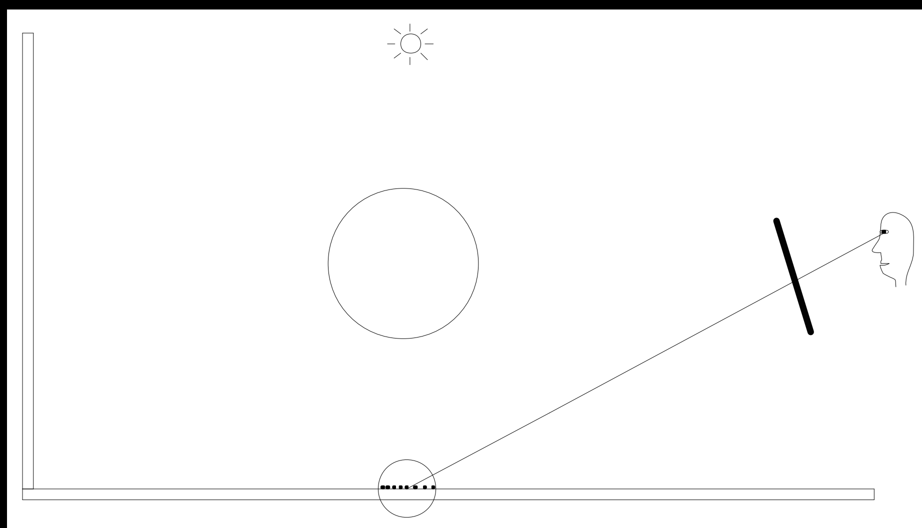
Rendering

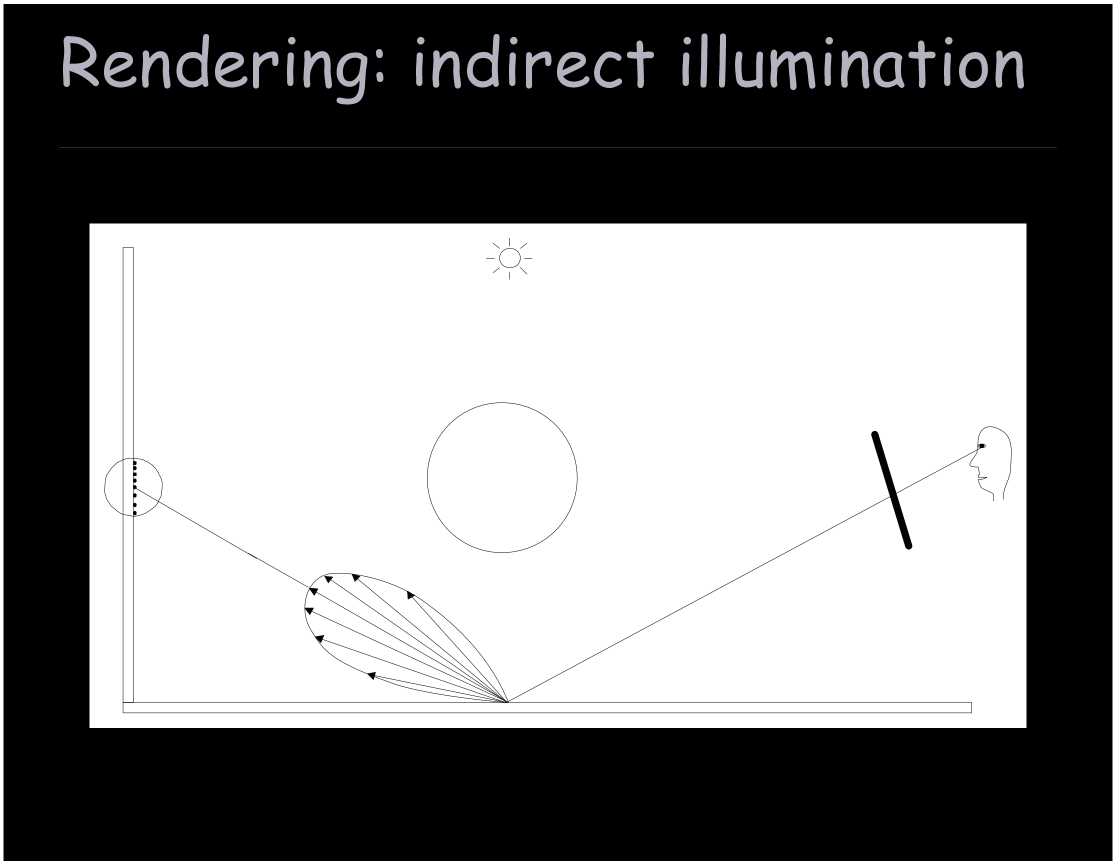



Rendering: direct illumination


Rendering: specular reflection

Rendering: caustics

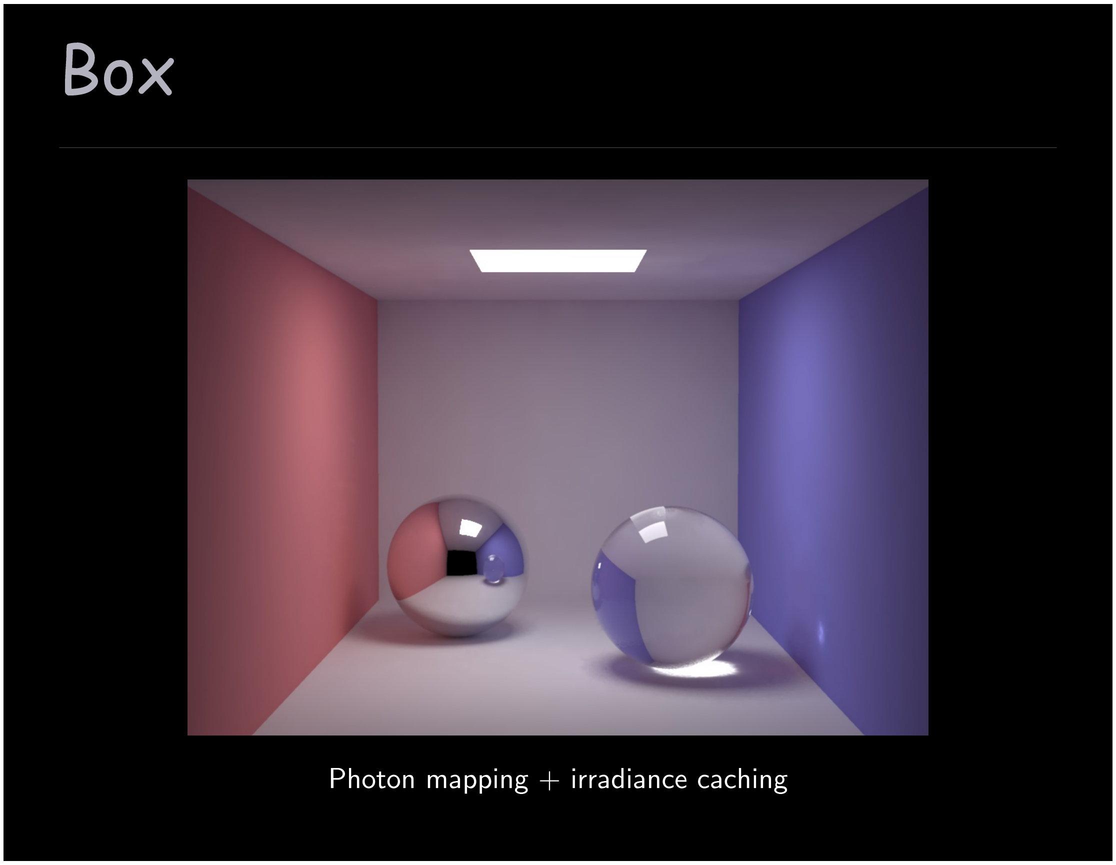



Rendering: indirect illumination

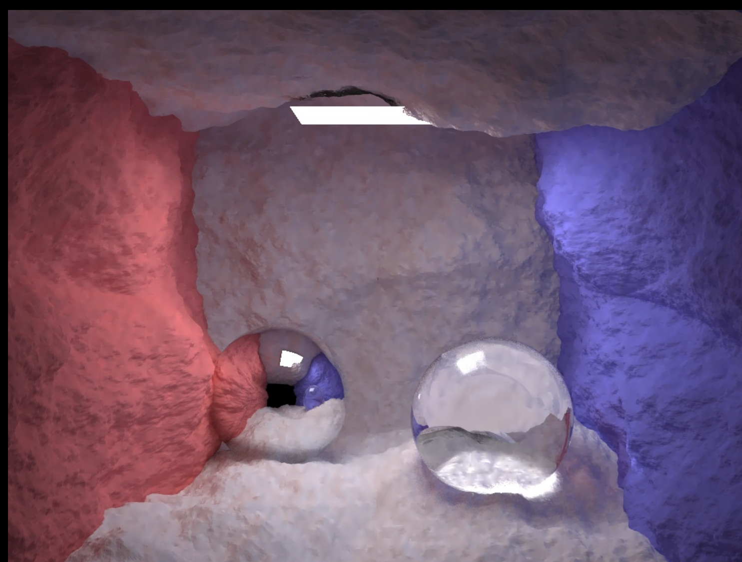
No Importance Sampling

Importance Sampling

(Using the 50 nearest photons)

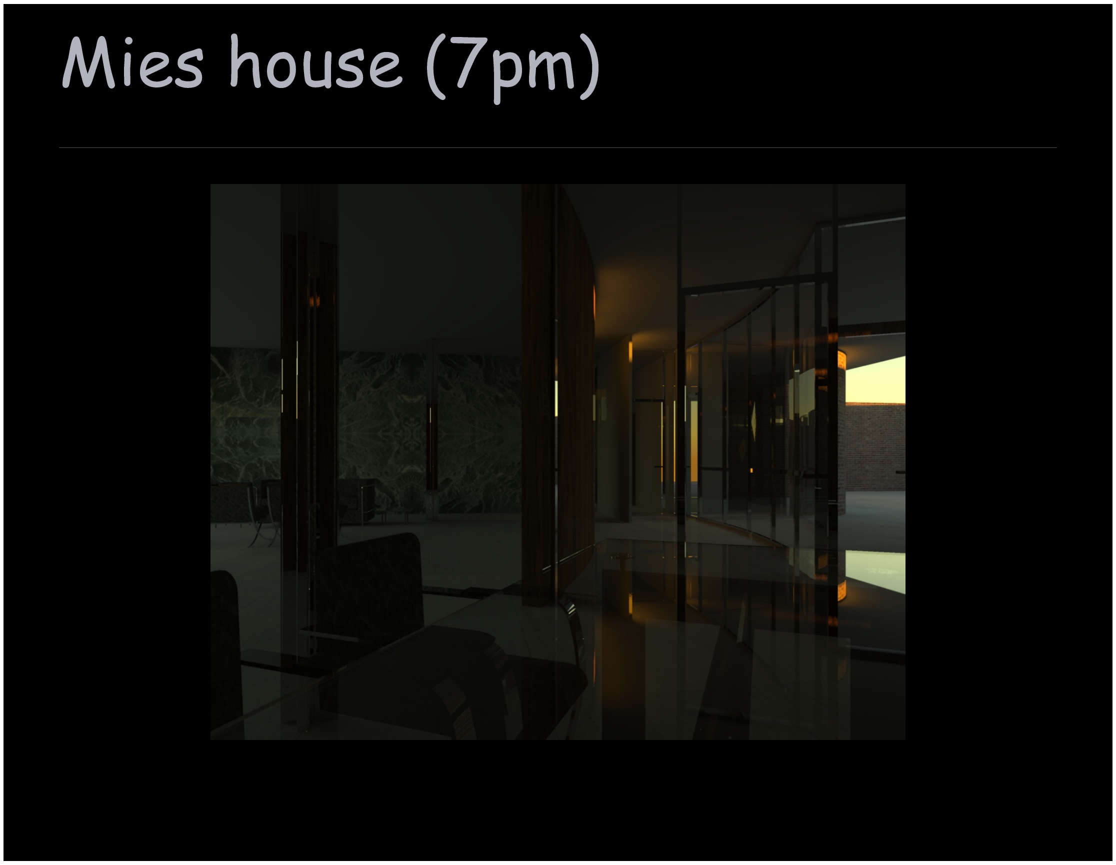

Box
Photon mapping + irradiance caching

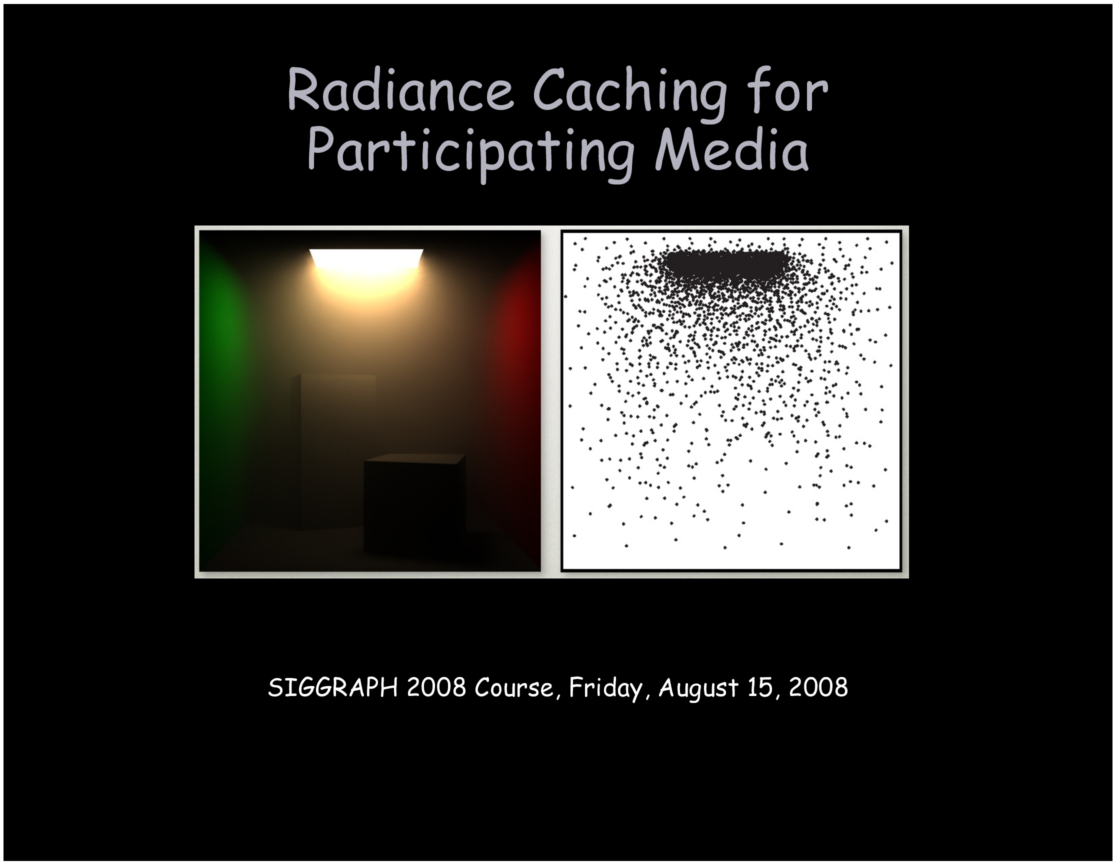
Fractal box



Expo

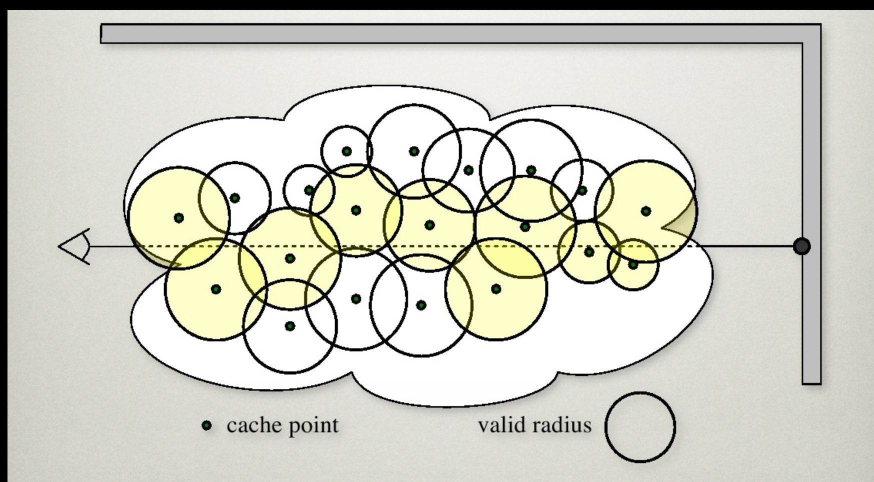

Mies house (2pm)


Mies house (7pm)


Radiance Caching for
Participating Media
SIGGRAPH 2008 Course, Friday, August 15, 2008


Participating Media
http://www.kevinyank.com

Radiance Caching

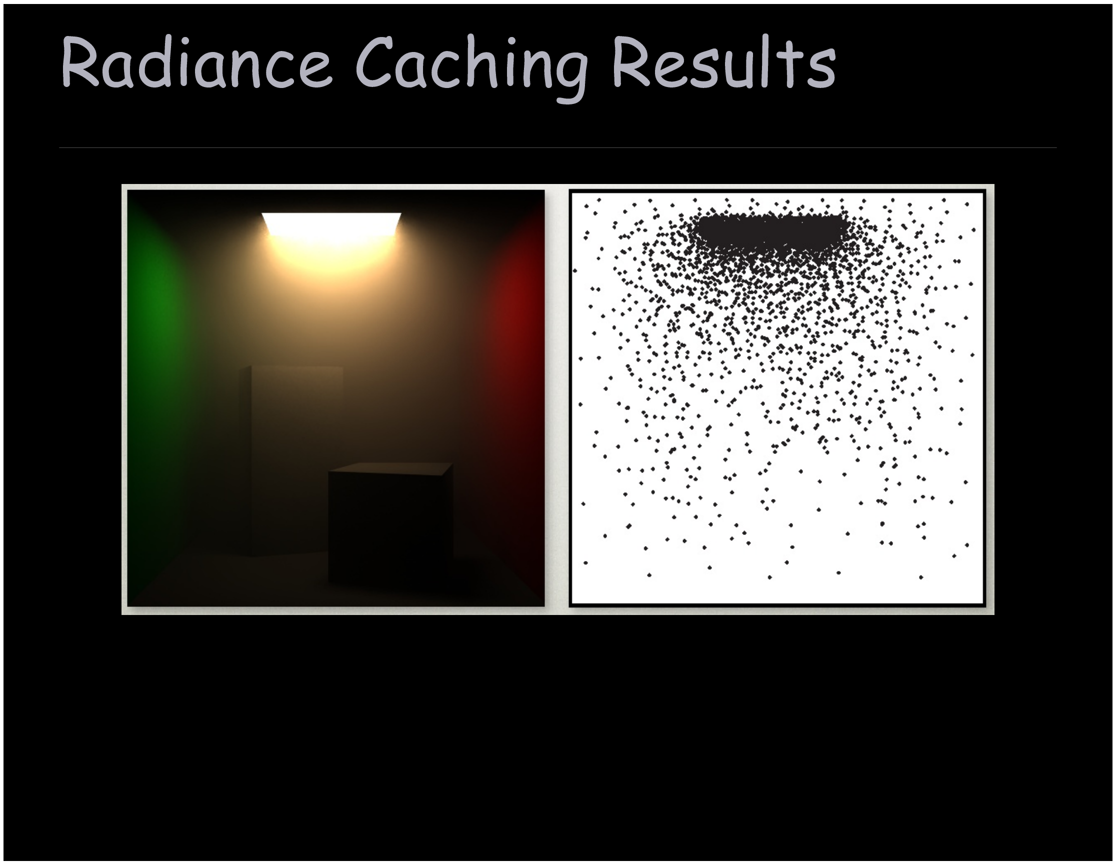


Gradient Evaluation

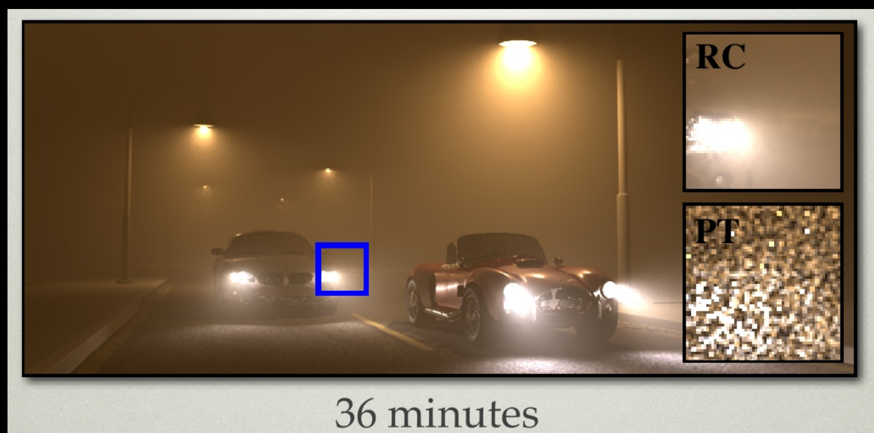
$$L_s(\mathbf{x},\vec{\omega}) = \int_A p(\vec{\omega},\mathbf{x}'\!\to\!\mathbf{x}) L_r(\mathbf{x}'\!\to\!\mathbf{x}) V(\mathbf{x}'\!\leftrightarrow\!\mathbf{x}) H(\mathbf{x}'\!\to\!\mathbf{x})\; d\mathbf{x}'$$

$$\downarrow$$

$$\nabla L_s(\mathbf{x},\vec{\omega}) = \int_A (\nabla p) L_r V H + p(\nabla L_r) V H + p L_r V (\nabla H)\; d\mathbf{x}'$$


Radiance Caching Results

Cars in Fog



JMore Details

Wojciech Jarosz, Craig Donner, and Henrik Wann Jensen

"Advanced Global Illumination Using Photon Mapping"

Course this afternoon... in this room...