

GUIDING INDIRECT ILLUMINATION

JIŘÍ VORBA
WETA DIGITAL

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GUIDED DIRECTIONAL SAMPLING

HISTORY

Learning from photons

- Jensen [1995]

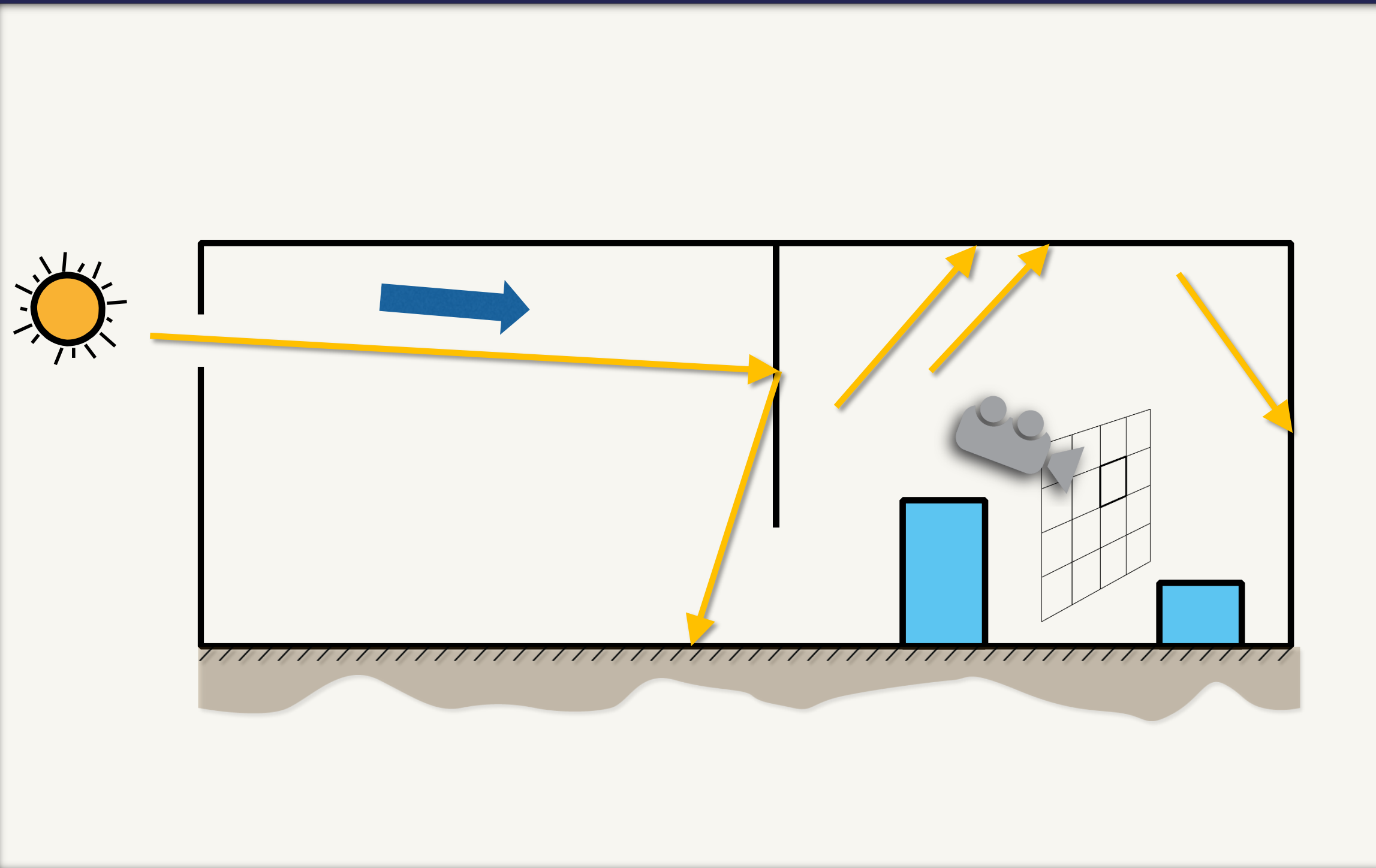
Learning from forward samples

- Lafortune and Willems [1995]

HISTORY

Learning from photons

- Jensen [1995]



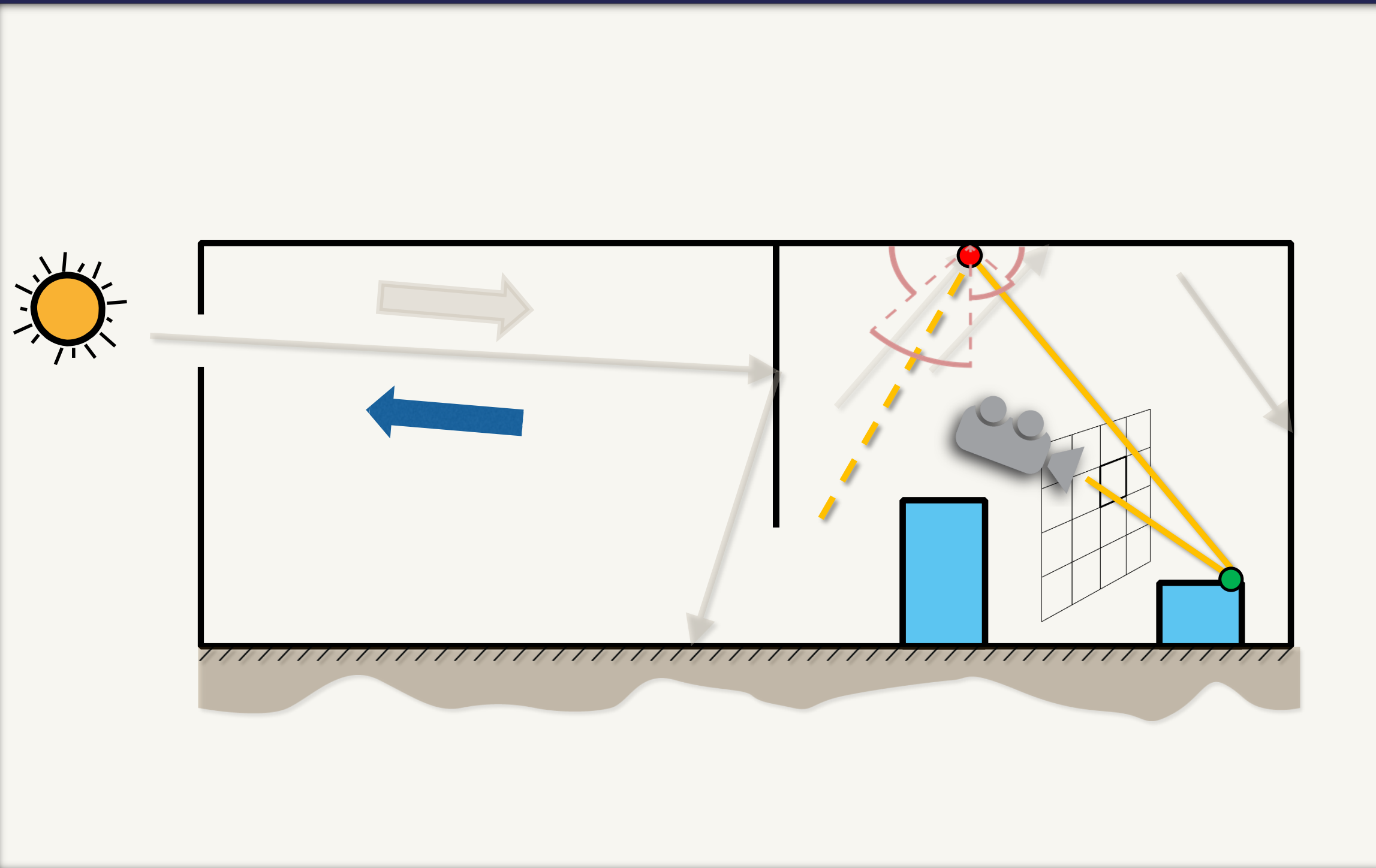
Learning from forward samples

- Lafortune and Willems [1995]

HISTORY

Learning from photons

- Jensen [1995]



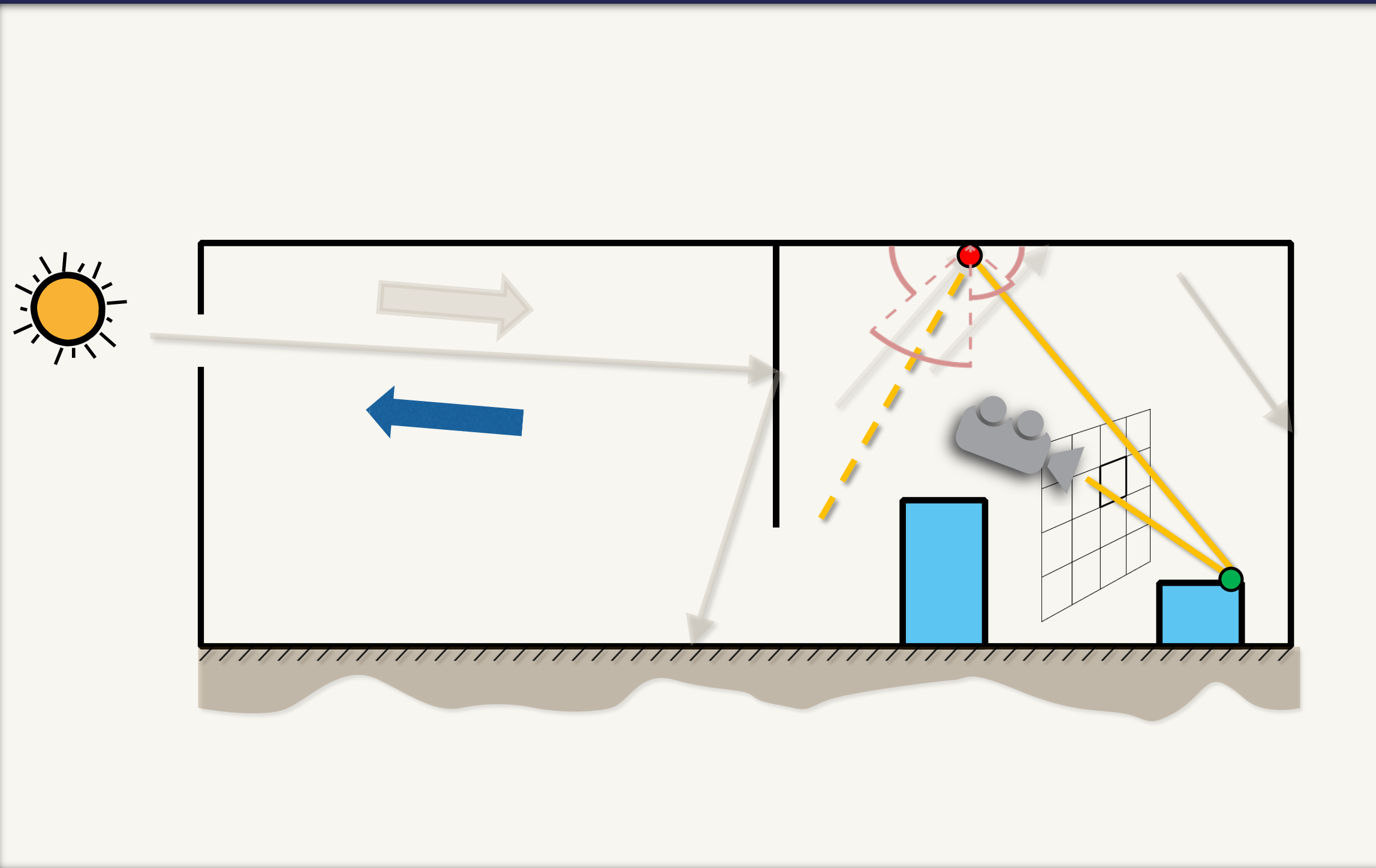
Learning from forward samples

- Lafortune and Willems [1995]

HISTORY

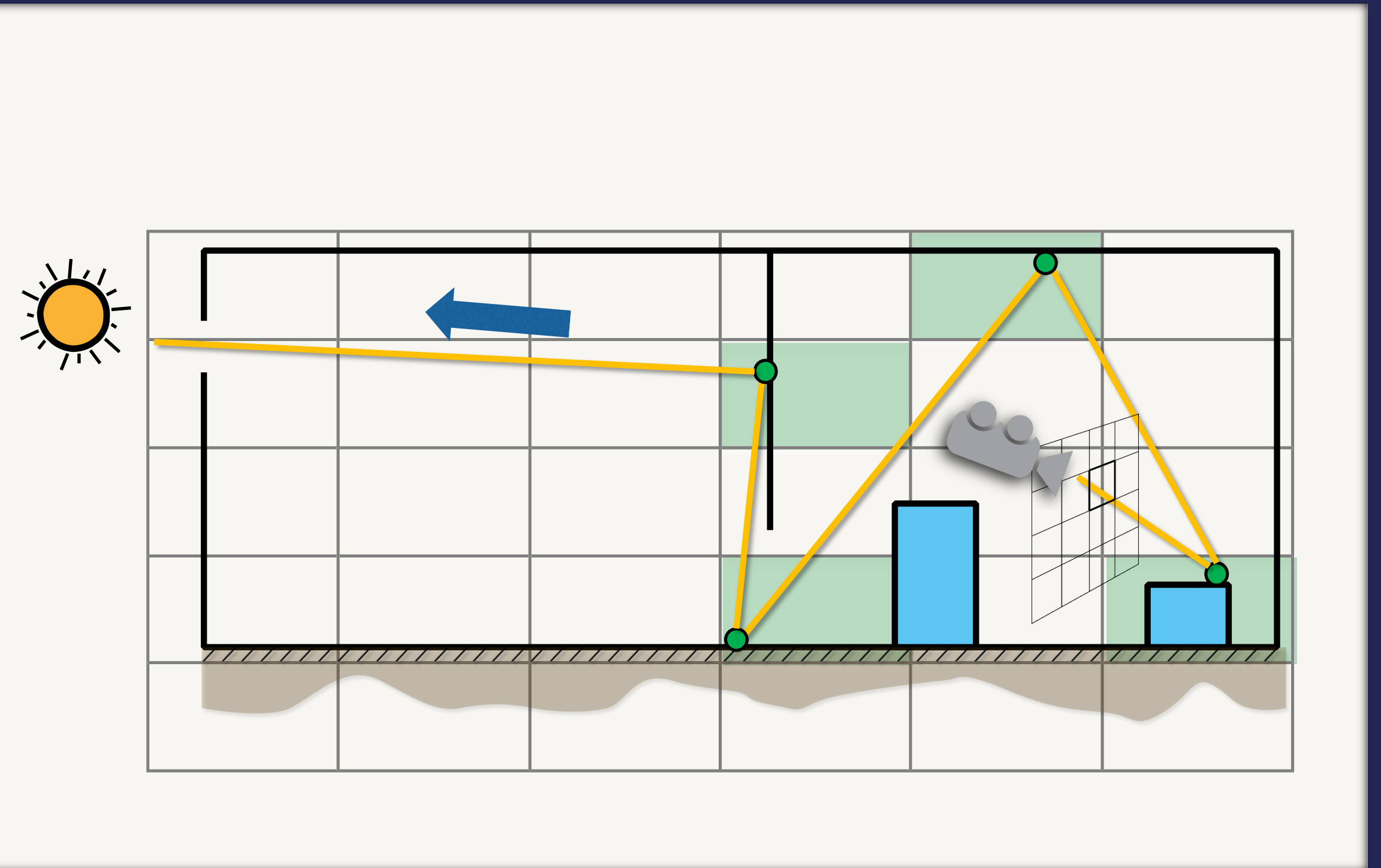
Learning from photons

- Jensen [1995]



Learning from forward samples

- Lafortune and Willems [1995]



HISTORY

Learning from photons

- Jensen [1995]
- Hey and Purgathofer [2002]
- Vorba et al. [2014]
- Herholz et al. [2016, 2019]

Learning from forward samples

- Lafortune and Willems [1995]
- Pegoraro et al. [2008]
- Bashford-Rogers et al. [2012]
- Müller et al. [2017]
- Dahm and Keller [2018]
- Simon et al. [2018]

2D DIRECTIONAL MODELS



Jensen [1995]
(Histograms)



Hey and Purgathofer [2002]
(Kernel density)



Vorba et al. [2014]
(Gaussian mixtures)

On-line Learning of Parametric Mixture Models for Light Transport Simulation

Jiří Vorba^{1*}

Ondřej Karlík^{1*}

Martin Šik^{1*}

Tobias Ritschel^{2†}

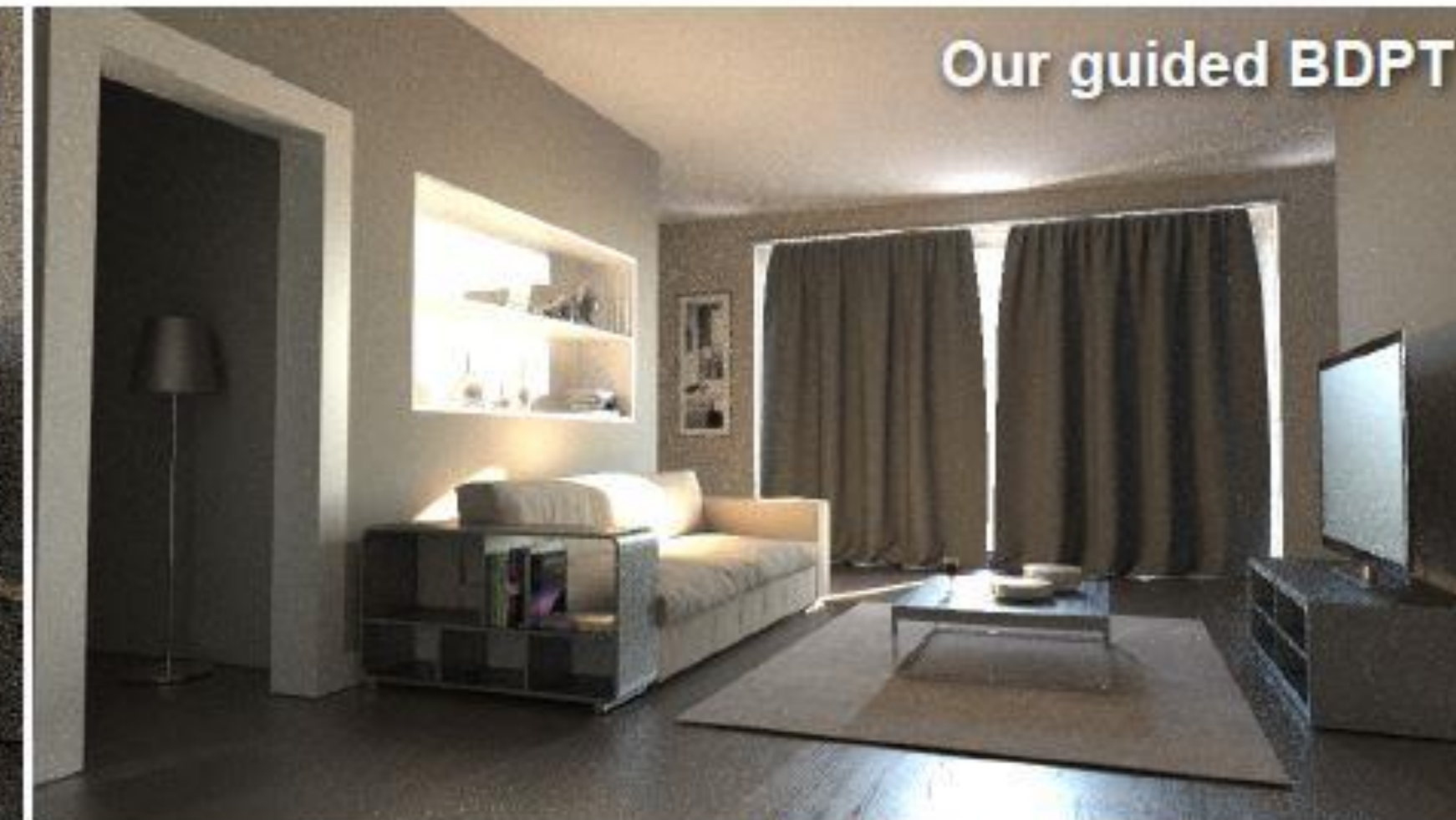
Jaroslav Křivánek^{1‡}

¹Charles University in Prague

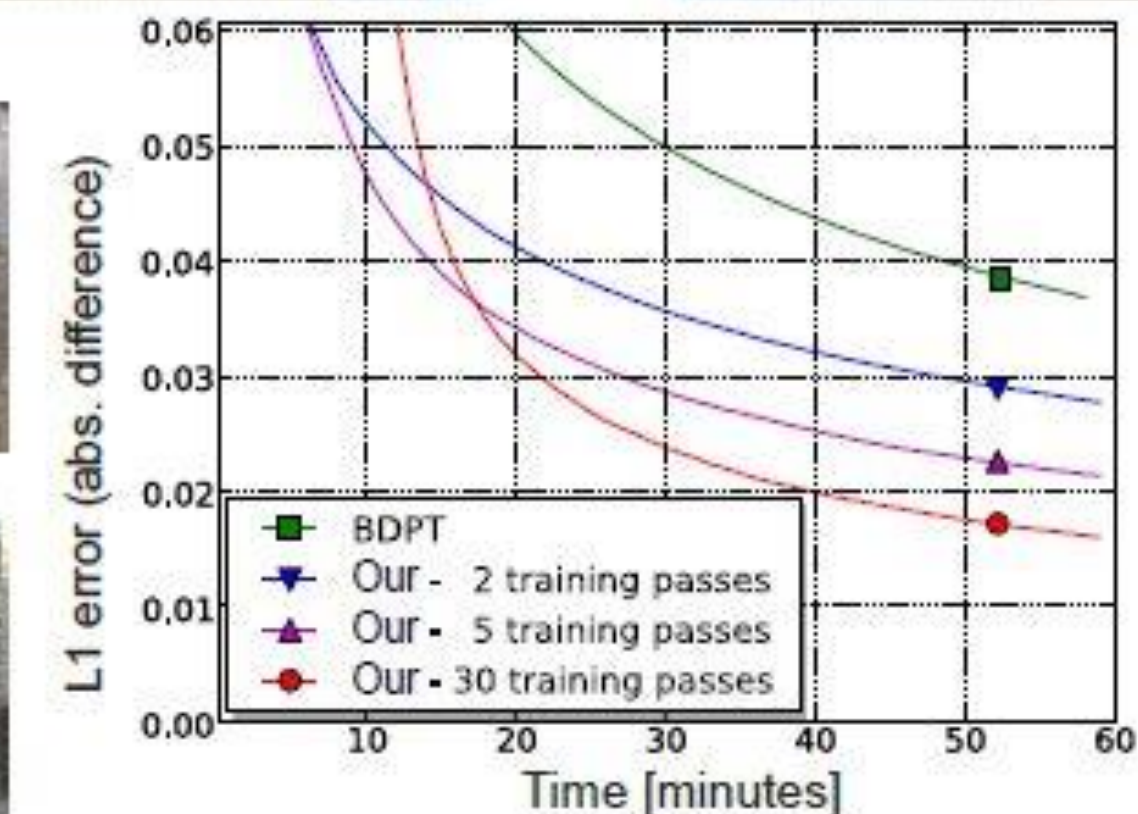
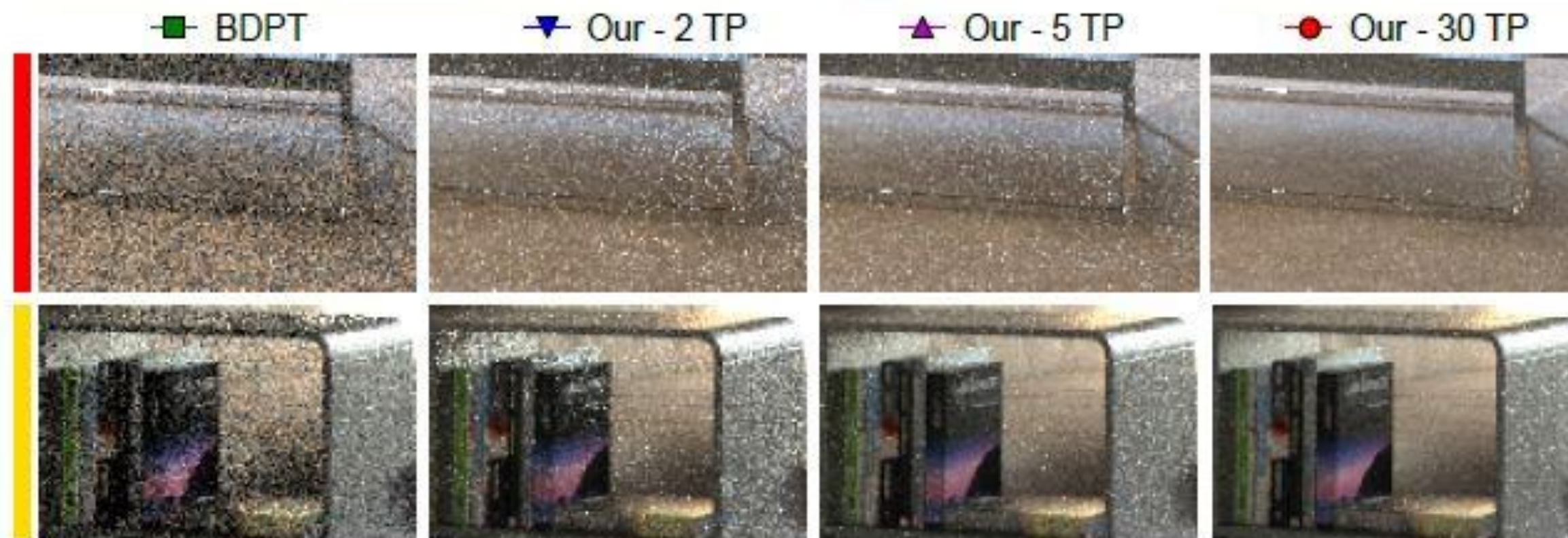
²MPI Informatik, Saarbrücken



Bidirectional path tracing (BDPT)



Our guided BDPT



On-line Learning of Parametric Mixture Models for Light Transport Simulation

Jiří Vorba^{1*}

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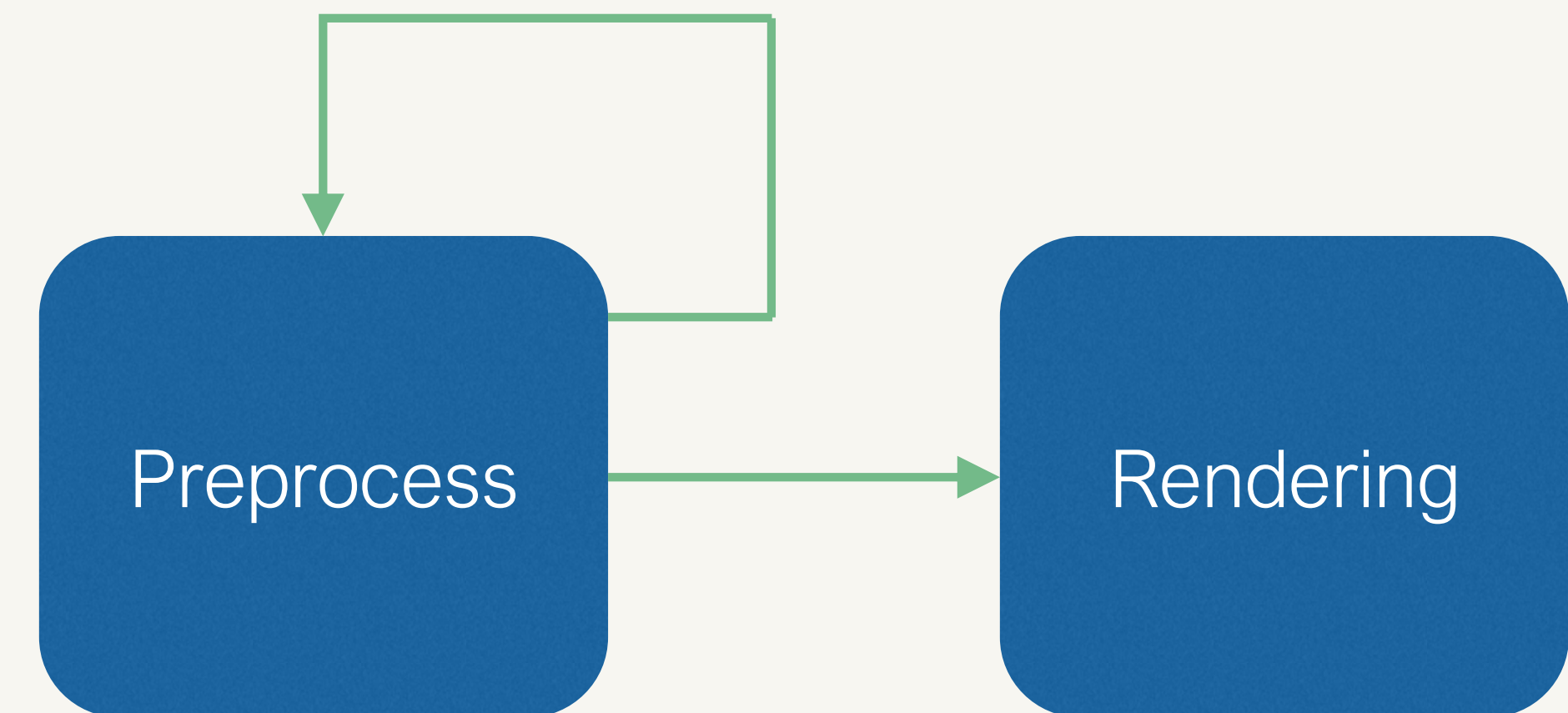
Tobias Ritschel^{2†}

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²MPI Informatik, Saarbrücken

- How to **learn** from samples?
 - Preprocess, interleaved tracing
- How to **represent** the knowledge?
 - Mixtures of Gaussians cached in the scene
- How to **exploit** it in the simulation?
 - Fetch nearest mixture







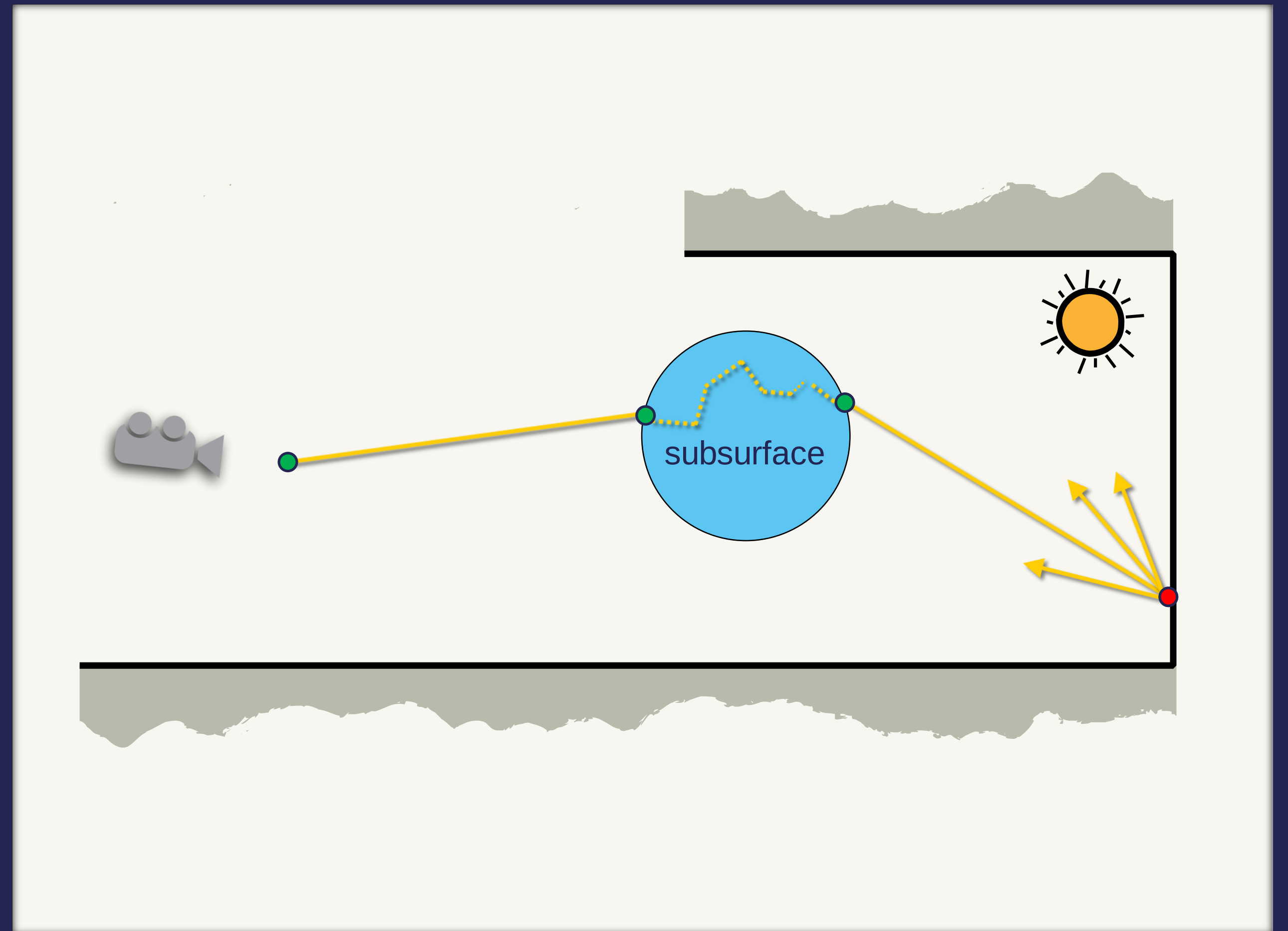


OPTIMAL PATH LENGTH

Guided Russian roulette and splitting

GUIDED RUSSIAN ROULETTE AND SPLITTING

- Importance sampling of path length
- Splitting when expected contribution is high
- Vorba et Křivánek [2016]



ALBEDO BASED RUSSIAN ROULETTE

- Termination probability

Current path weight

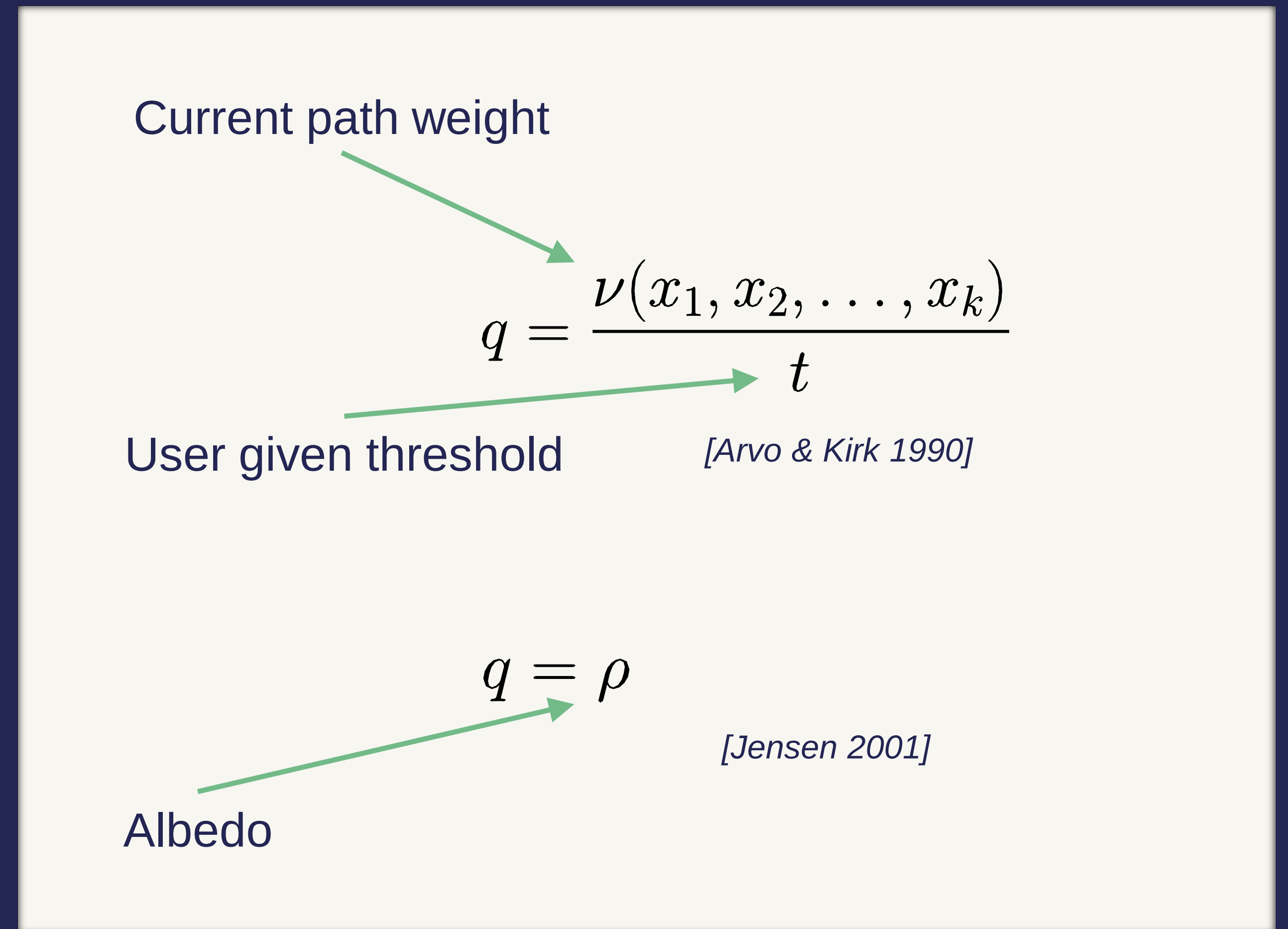
$$q = \frac{\nu(x_1, x_2, \dots, x_k)}{t}$$

User given threshold

[Arvo & Kirk 1990]

ALBEDO BASED RUSSIAN ROULETTE

- Termination probability



ALBEDO BASED RUSSIAN ROULETTE

- Termination probability
- Problem: it's **local**
- Kill paths too early
- Waste time on long paths

Current path weight

$$q = \frac{\nu(x_1, x_2, \dots, x_k)}{t}$$

User given threshold

[Arvo & Kirk 1990]

$$q = \rho$$

[Jensen 2001]

Albedo

GUIDED RUSSIAN ROULETTE AND SPLITTING

- Input
 - approximation of radiance field
 - estimate of pixel values
- Output
 - Termination probability / path split ratio

Expected path contribution
(given current vertices)

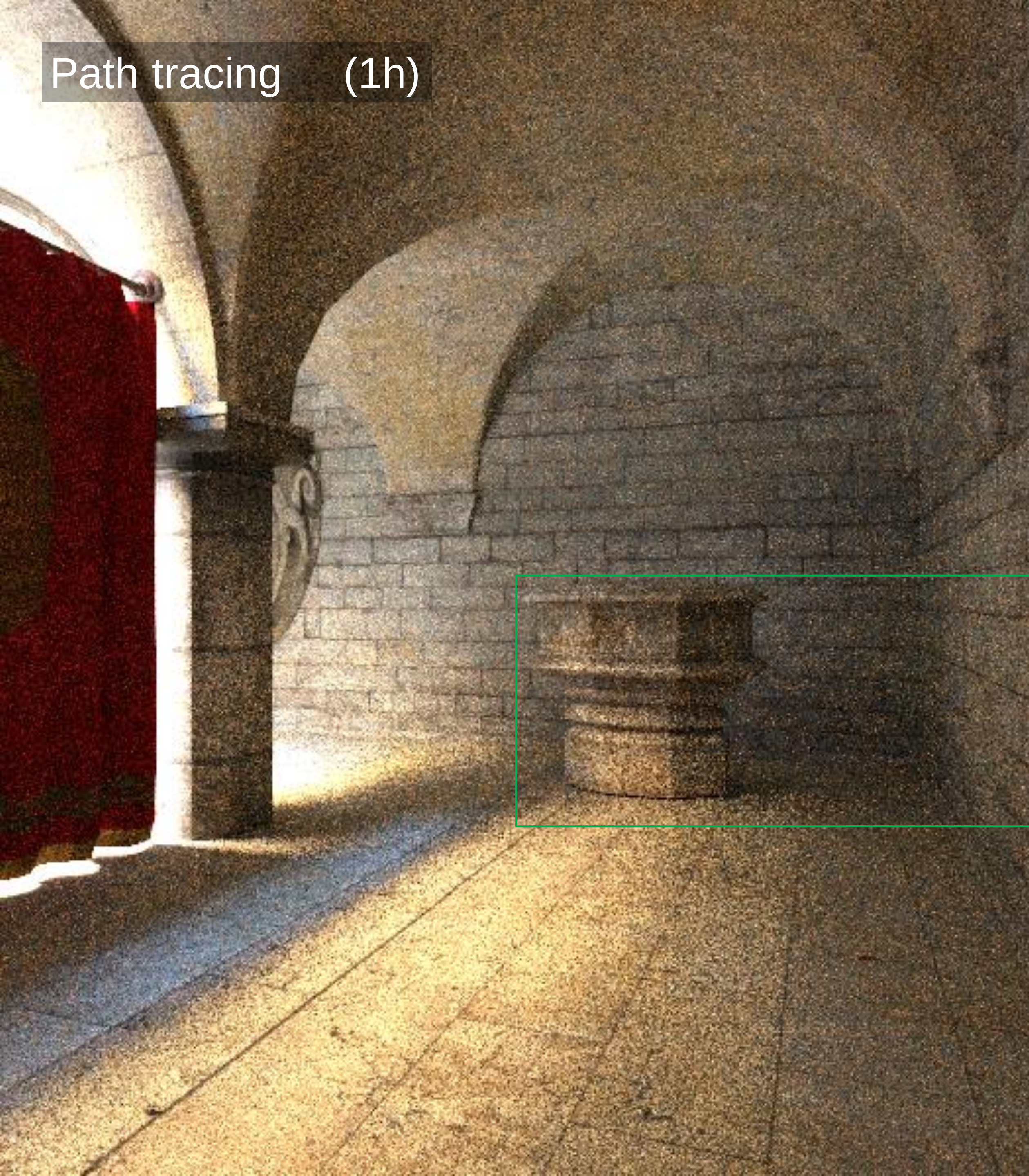
$$q = \frac{E[X | x_0, x_1, \dots, x_k]}{I}$$

Pixel estimate

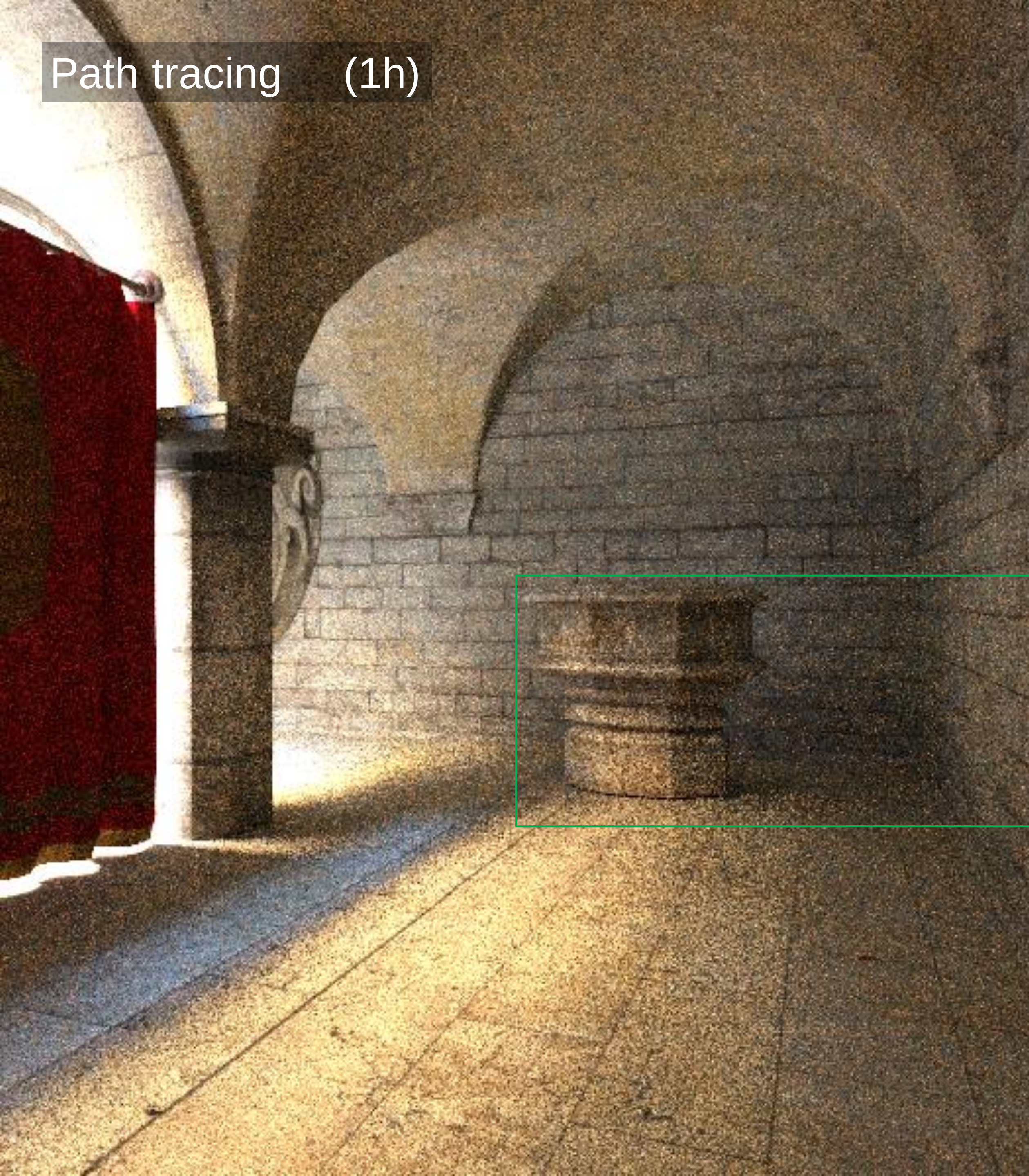
[Vorba a Křivánek 2016]

The diagram illustrates the calculation of the termination probability q . It features the equation $q = \frac{E[X | x_0, x_1, \dots, x_k]}{I}$ in the center. A green arrow points from the text 'Expected path contribution (given current vertices)' to the numerator $E[X | x_0, x_1, \dots, x_k]$. Another green arrow points from the text 'Pixel estimate' to the denominator I . The citation '[Vorba a Křivánek 2016]' is located at the bottom right of the diagram area.

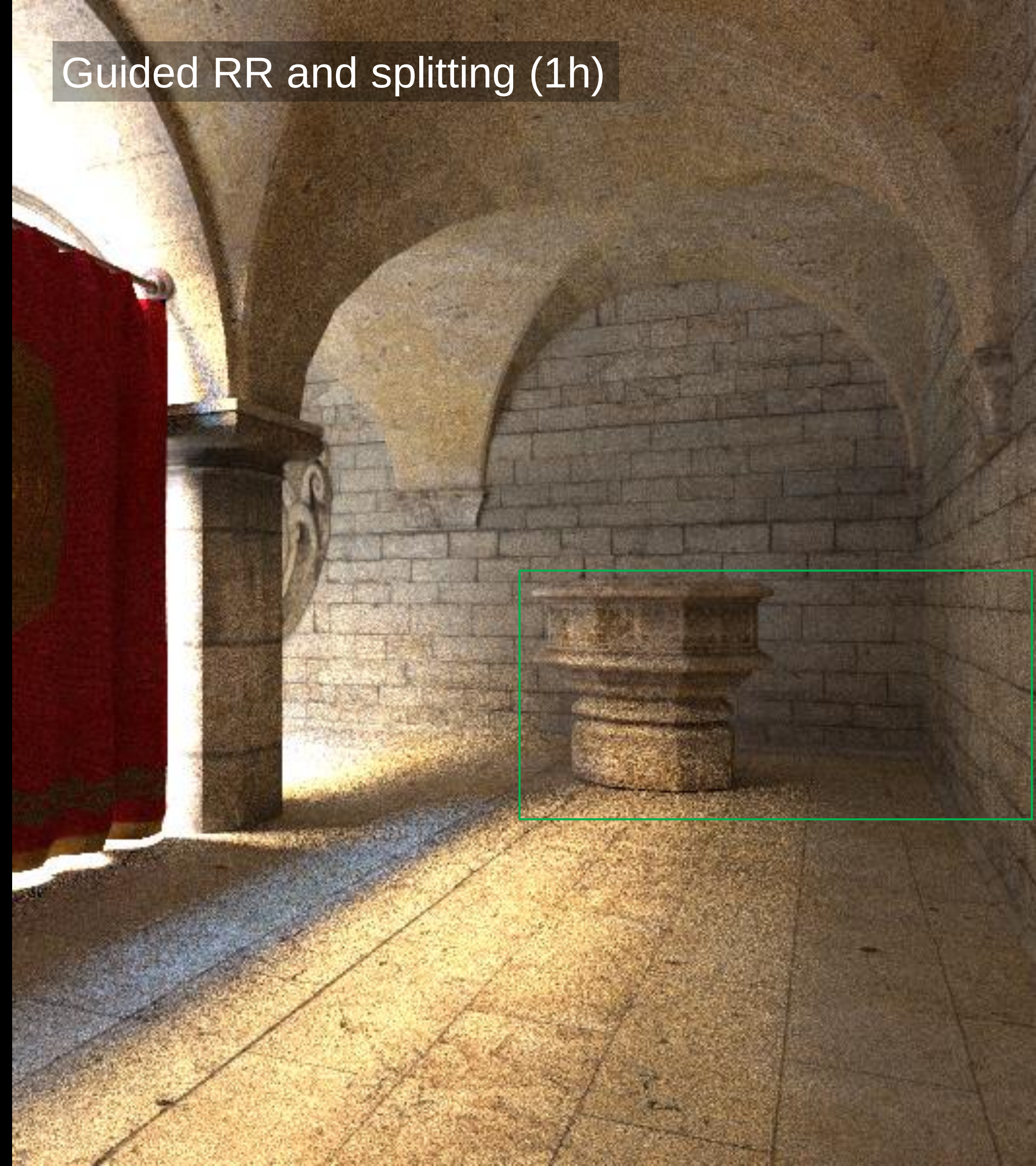
Path tracing (1h)



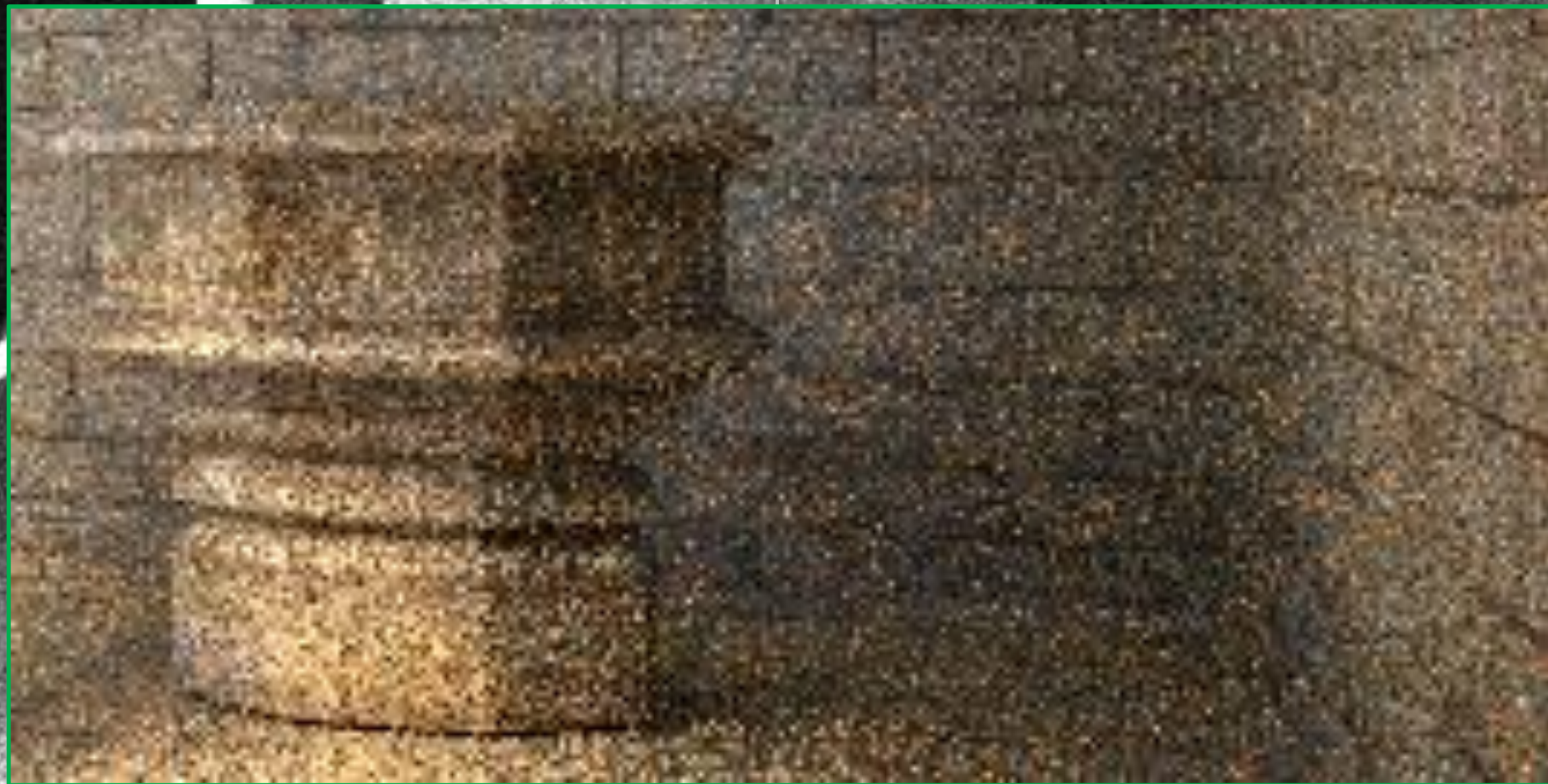
Path tracing (1h)



Guided RR and splitting (1h)



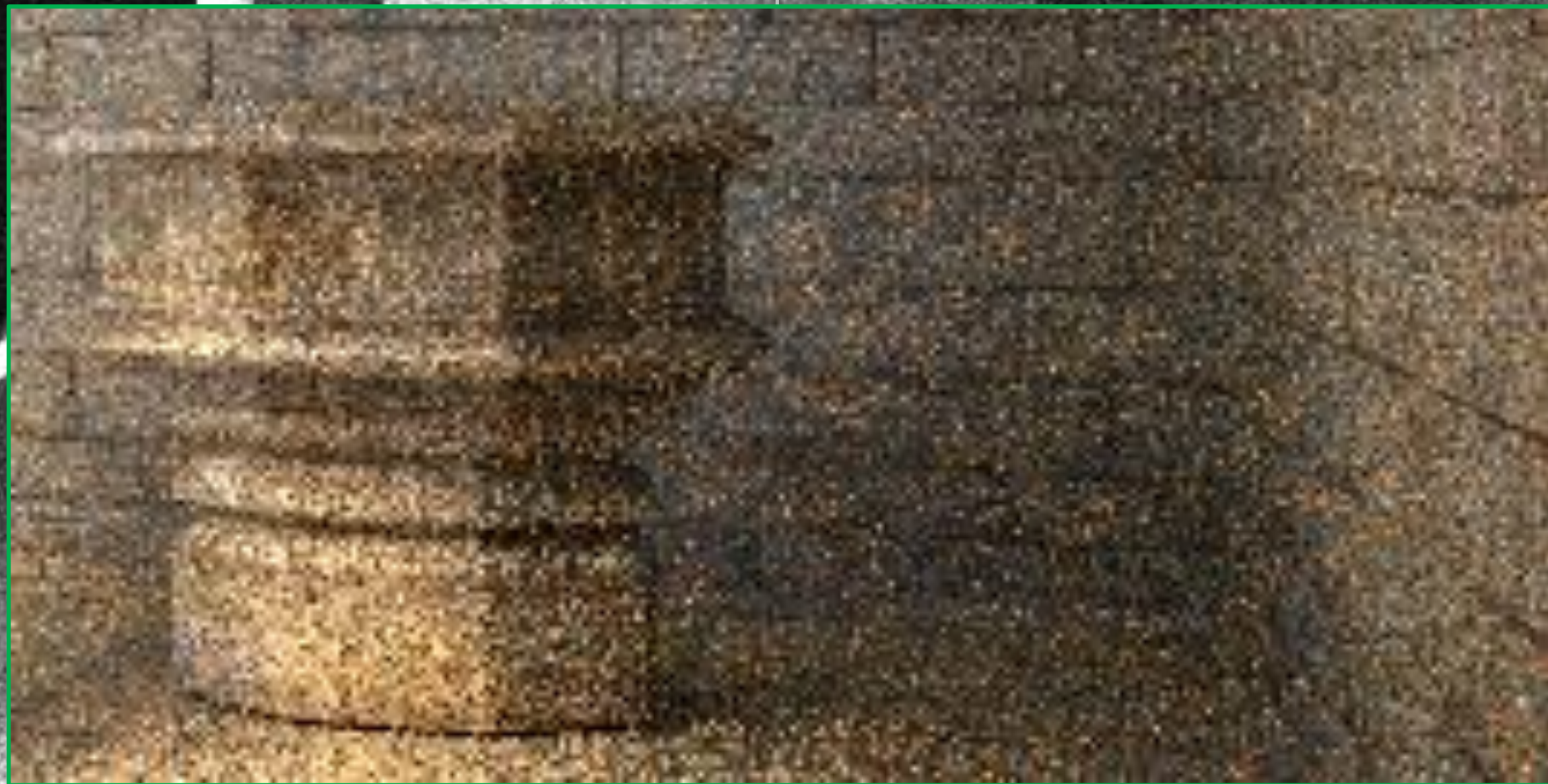
Path tracing (1h)



Guided RR and splitting (1h)



Path tracing (1h)



Guided RR and splitting (1h)



Path tracing (1h)



Guided RR and splitting + Directional guiding (1h)



Guided RR and splitting (1h)



PIXEL VALUE ESTIMATES (Vorba et Křivánek [2016])

Estimate

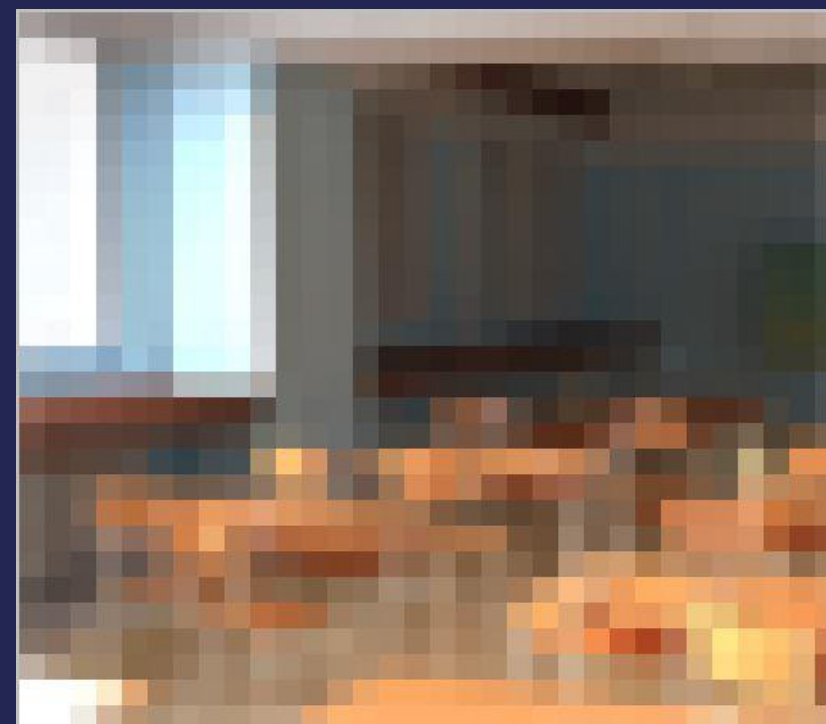
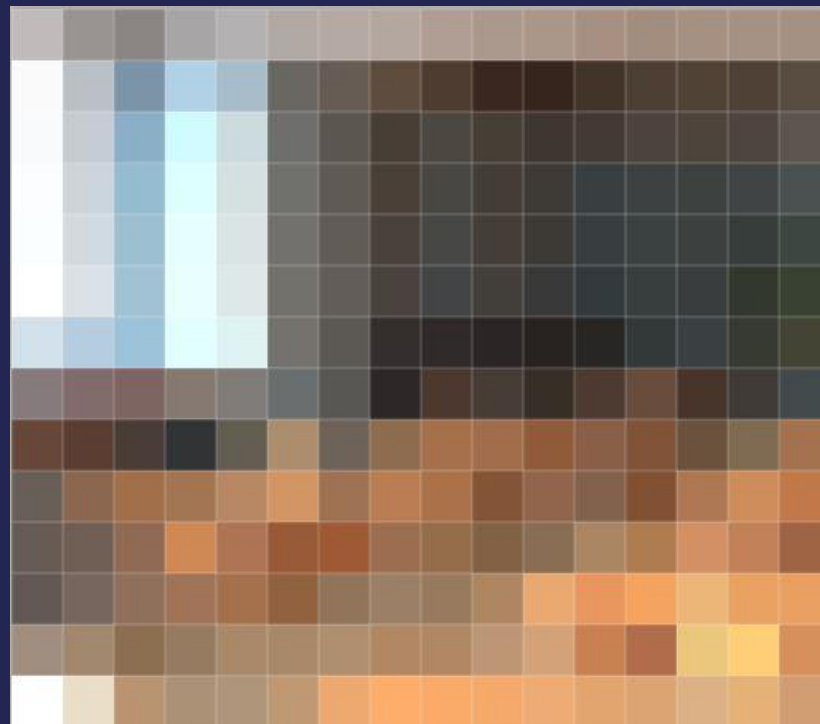


Reference



PIXEL VALUE ESTIMATES (progressive rendering)

- Can be simplified in practice
- Many possible approaches (low sample count -> denoising)
- MIP mapping of beauty image (at Weta)



SYNERGY

- Minimal overhead
- Makes guiding cheap
- Better results than each method alone

Directional guiding
+
Guided RR and splitting

Summary

- Path guiding as adaptive sampling in path space
- Guide all the decisions
 - Guided directional sampling
 - Guided Russian roulette and splitting (Path length)
 - Guided light sampling (Next-event estimation)
 - Guided free flight (Ray-distance sampling)

THANK YOU

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VISIT US AT THE JOB FAIR, BOOTH #1

Tuesday, 30 July, 9:30am - 6pm

Wednesday, 31 July, 9:30am - 6pm

<http://careers.wetafx.co.nz>

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