Globale Beleuchtungsalgorithmen

Implementierung und Analyse von Many-Light und Photon Mapping

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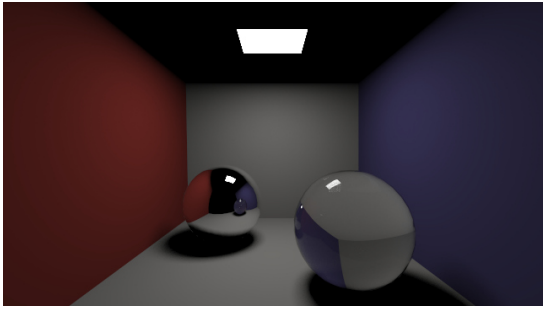
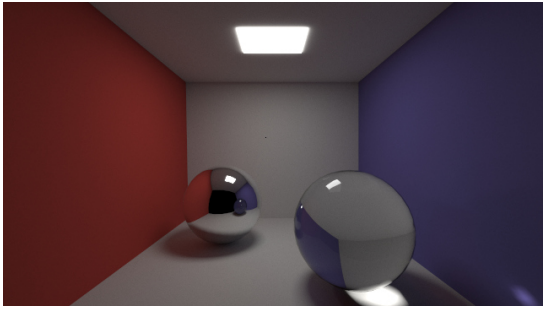
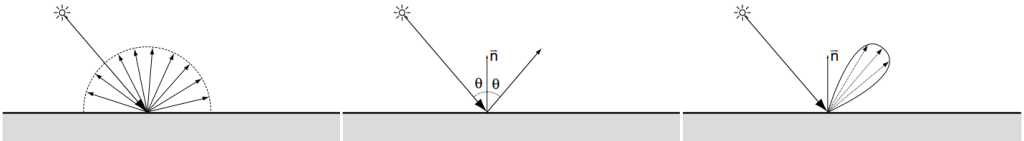
09.08.2023



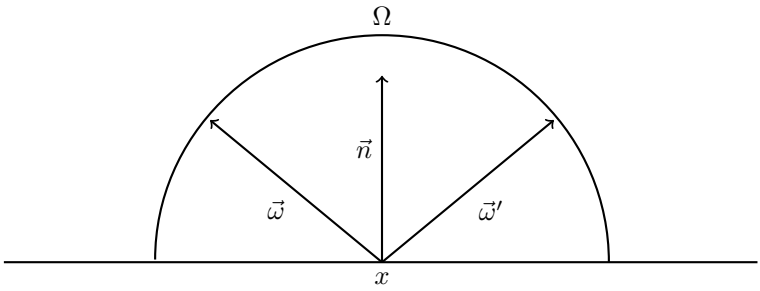
direkte Beleuchtung



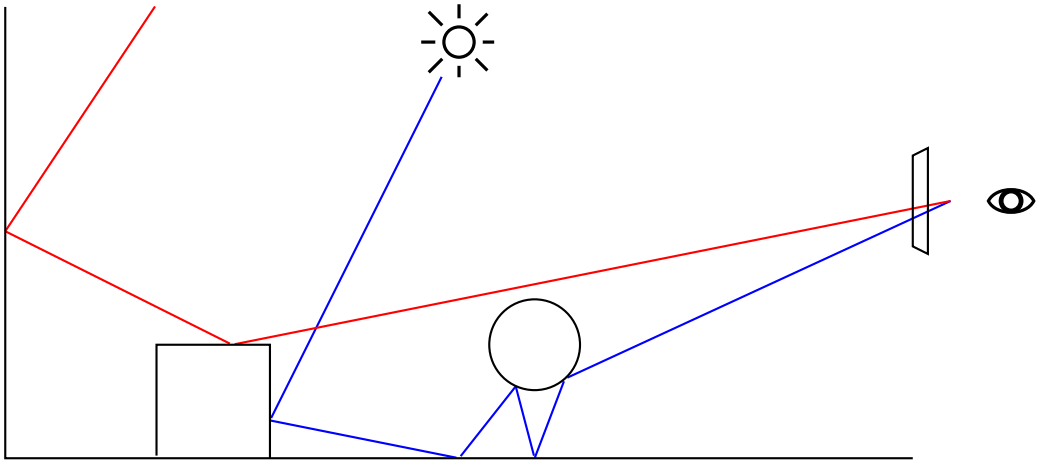
globale Beleuchtung

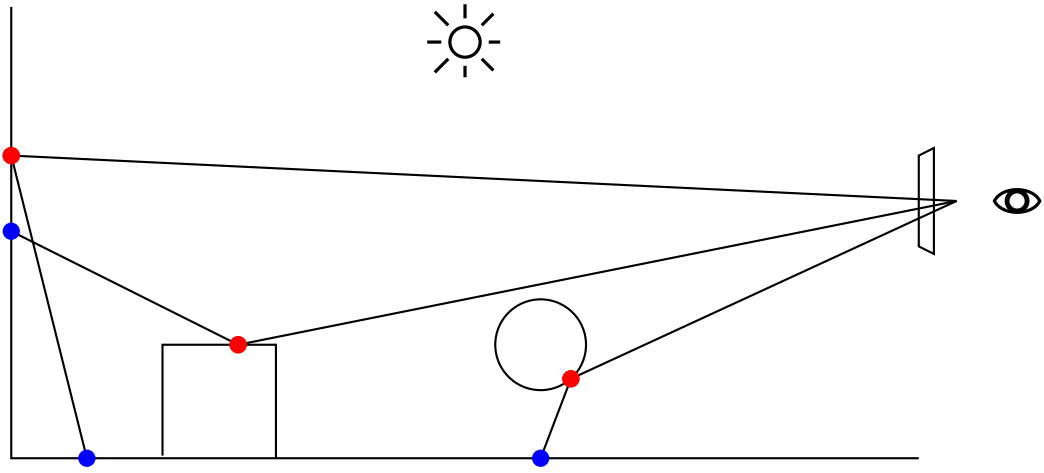


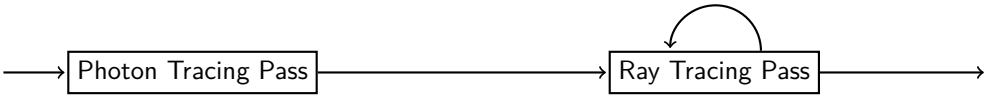
lambertsch | perfekt spiegelnd | glänzend



$$L_o(x,\vec{\omega}) = L_e(x,\vec{\omega}) + \int_\Omega f_r(x,\vec{\omega}',\vec{\omega}) L_i(x,\vec{\omega}') \langle \vec{\omega}' | \vec{n} \rangle d\vec{\omega}'$$



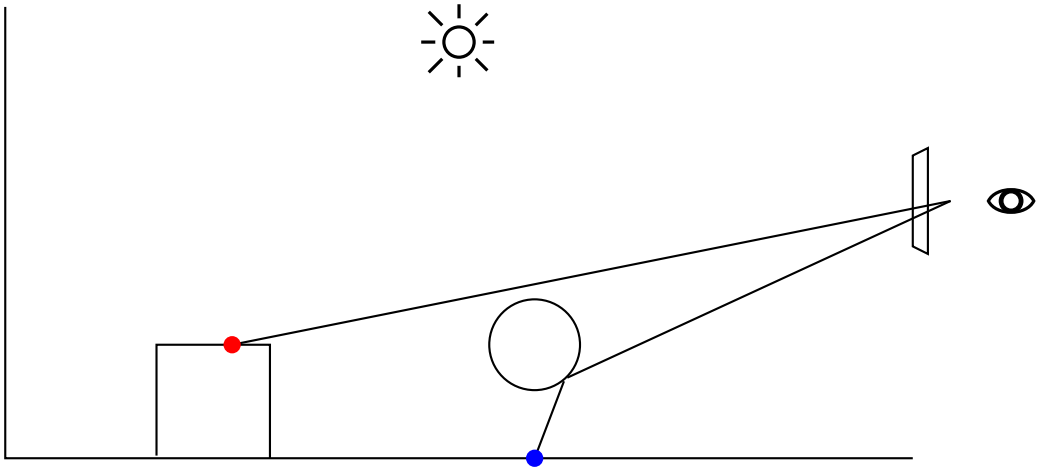


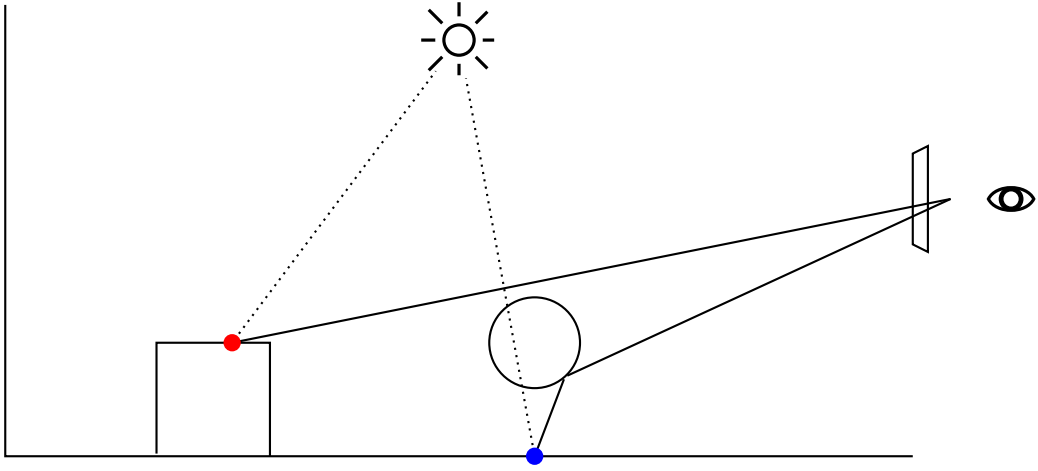


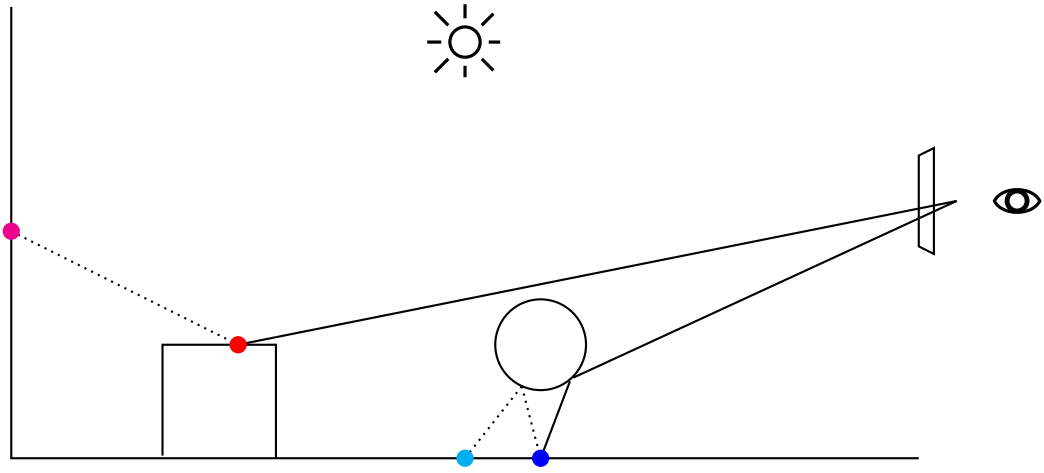
- Strahlen von den Lichtquellen aus
- globale Photon Map
- Kaustik Photon Map
- kd-Baum

- Strahlen von der Kamera aus
- vier Teilgleichungen
- beliebig oft ausgeführt
- $L_{\mathrm{r}}(x,\vec{\omega}) \approx \sum_{p=1}^{N} f_{\mathrm{r}}(x,\vec{\omega}_{\mathrm{p}},\vec{\omega}) \frac{\Delta\Phi_{\mathrm{p}}(x,\vec{\omega}_{\mathrm{p}})}{\pi r^2}$

Spekulare Reflexionen und Kaustiken



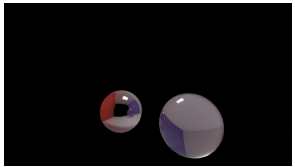


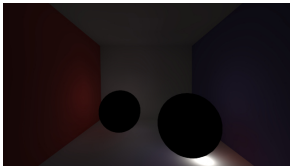


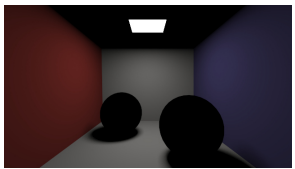
Finales Bild

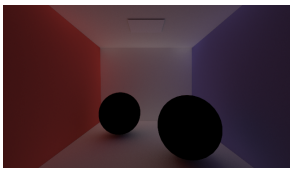
Spekulare Reflexionen

Kaustiken



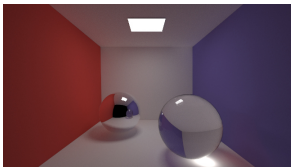




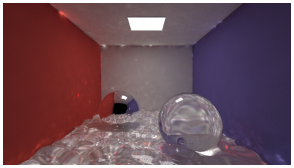
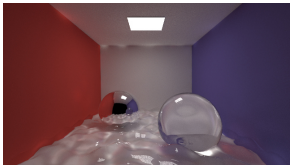
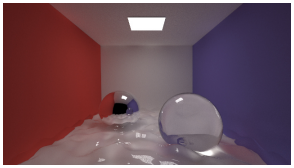
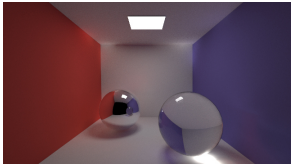
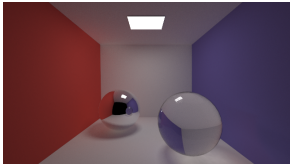
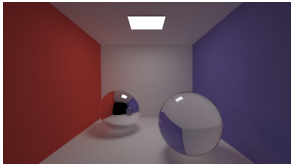


direkte Beleuchtung

indirekte Beleuchtung

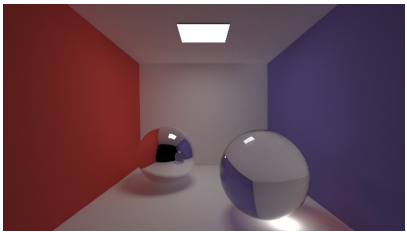


Parameter

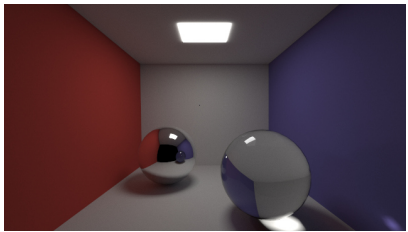
	10 in Suche	100 in Suche	500 in Suche
50000 in Maps			
200 in Maps			
	10 in Suche	50 in Suche	100 in Suche

Qualität

Photon Mapping

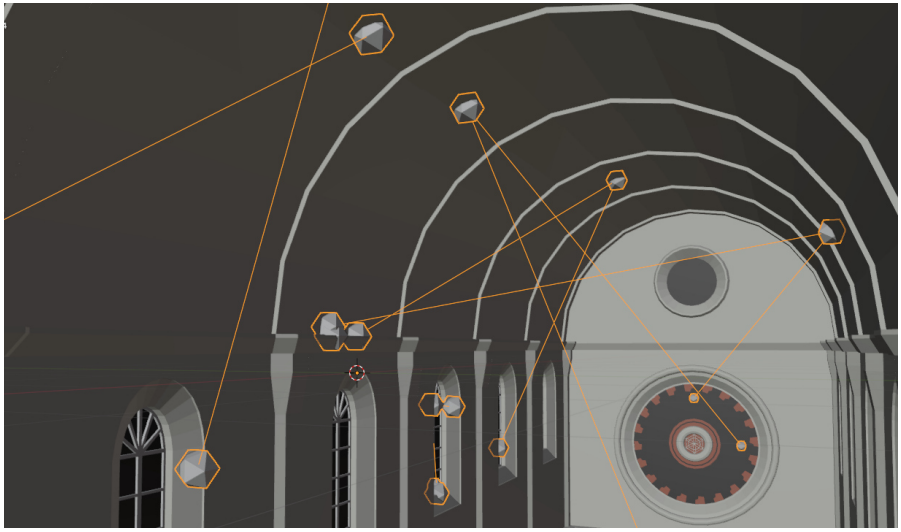


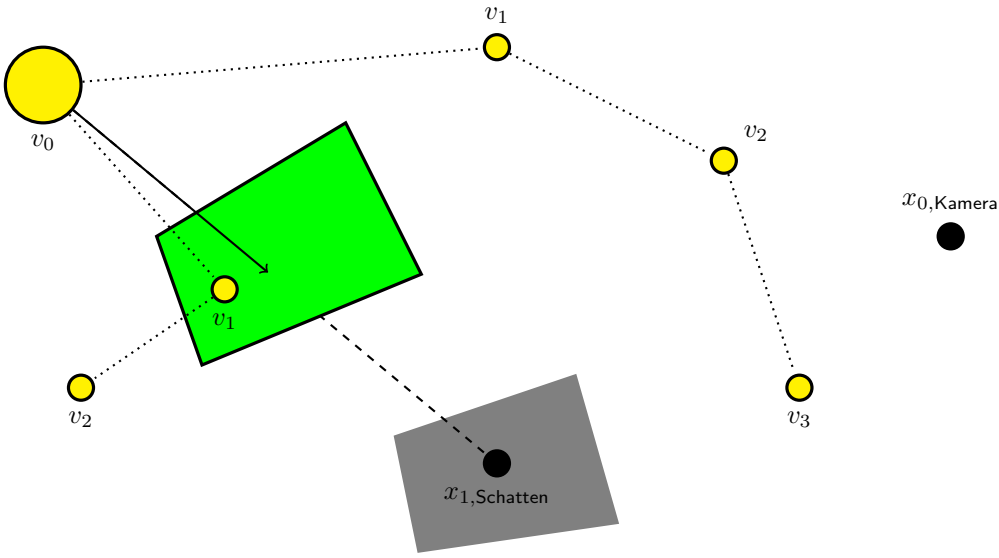
Path Tracing

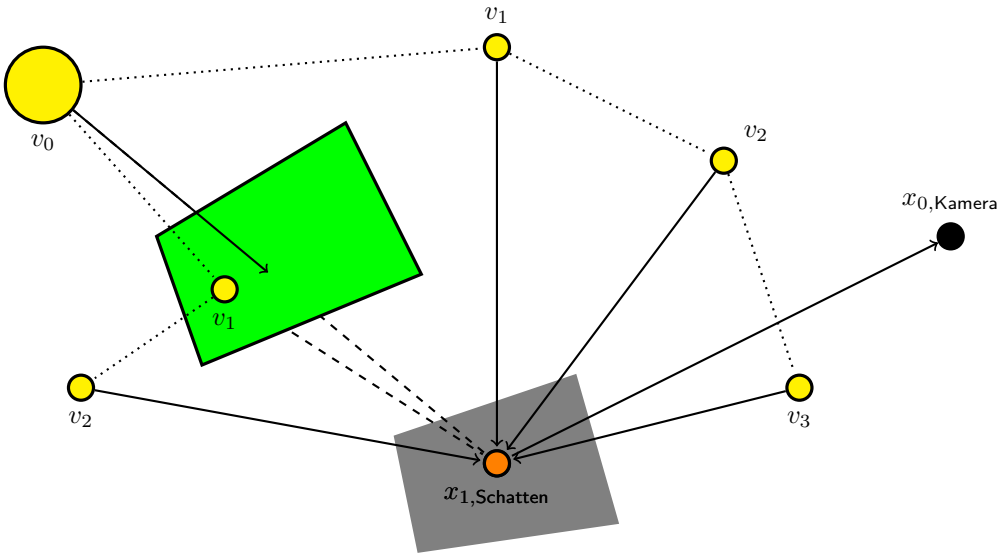


Variante	Basis	WF-CPU	WF-CUDA
Phasen		**Zeiten**	
Vorbereitungsphase	78,79ms	76,20ms	199,69ms
Integrationsphase	31.534.687,09ms	2.274.228,42ms	210.907,41ms
Gesamtzeit	**31.534.765,88ms** **525,6min**	**2.274.320,91ms** **37,9min**	**211.114,88ms** **3,5min**

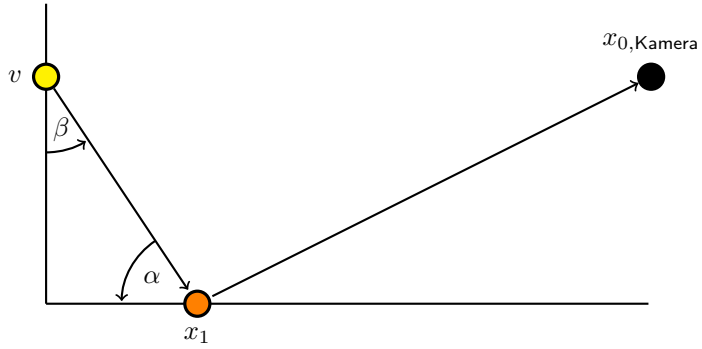
Variante	Basis	WF-CPU	WF-CUDA
Phasen		**Zeiten**	
Integrationsphase	– ms	22.160,40ms	839,80ms
Gesamtzeit	**555.008,00ms** **9,3min**	**22.163,39ms** **0,4min**	**842,53ms** **0,01min**




v_1
v_0
v_2
$x_{0,\text{Kamera}}$
v_1
v_2
v_3
$x_{1,\text{Schatten}}$

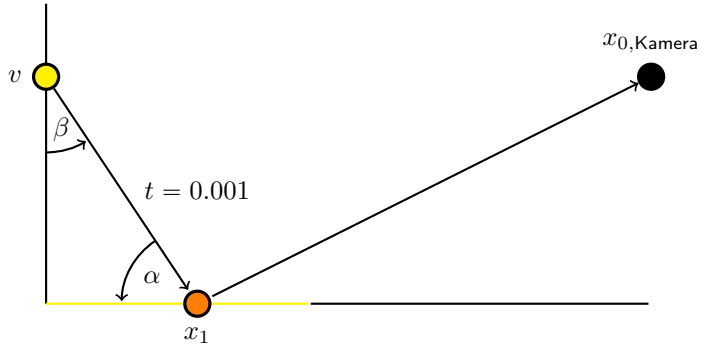

v_1
v_0
v_2
$x_{0,\text{Kamera}}$
v_1
v_2
v_3
$x_{1,\text{Schatten}}$

Helle Artefakte



$$G(x_1 \leftrightarrow v) = \frac{\cos^+(\alpha) \cdot \cos^+(\beta)}{t^2}$$

Problem der schwachen Singularität

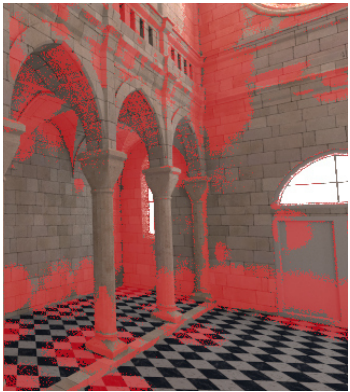


$$G(x_1 \leftrightarrow v) = \frac{\cos^+(\alpha) \cdot \cos^+(\beta)}{t^2}$$

Problem der schwachen Singularität

Helle Artefakte

Artefakte bereinigt



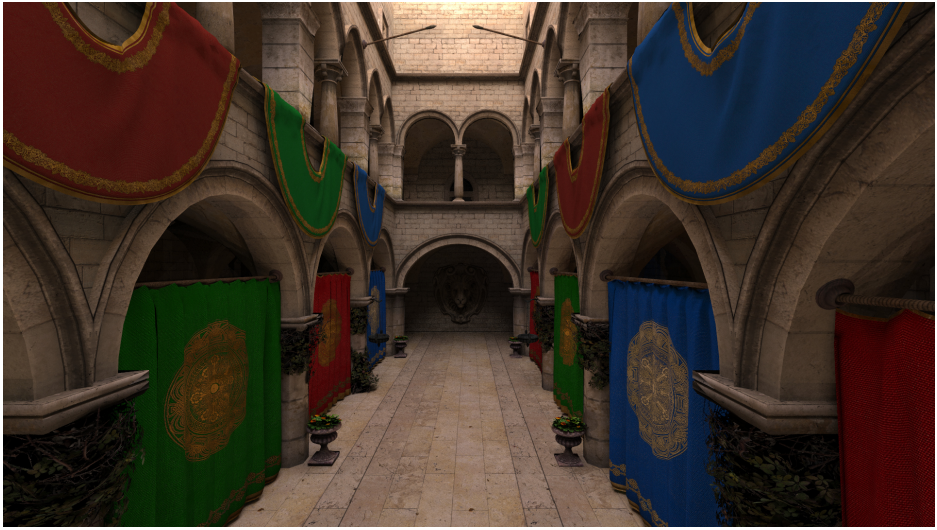
Differenz der Bilder

Strided Loop (CUDA)

Sampled VPL (CPU)

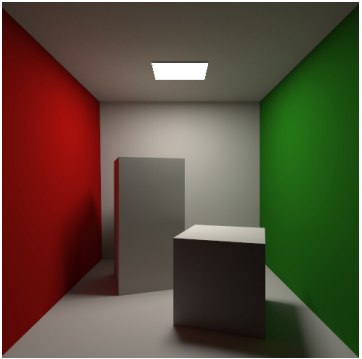
Video: https://www.youtube.com/watch?v=ZYKB1ATWkEk

Skylight: Sponza-Szene

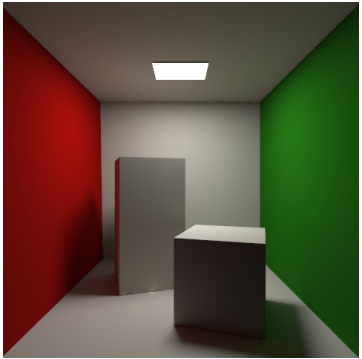


Skylight: San Miguel-Szene

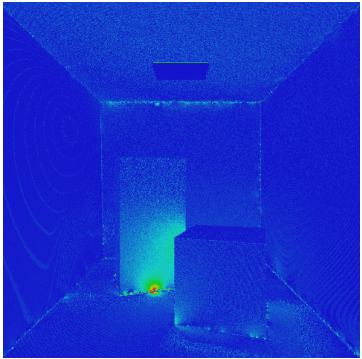
Vergleich mit Path Tracing



Path Tracing



Many-Light



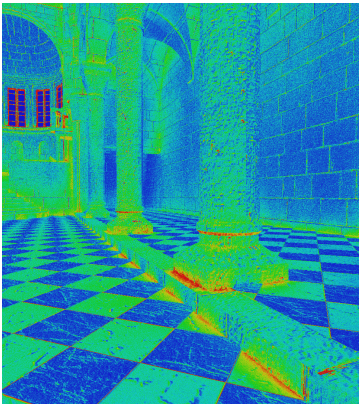
Abweichung der Bilder

$\varnothing$ Abweichung = 0,39%

Vergleich mit Path Tracing

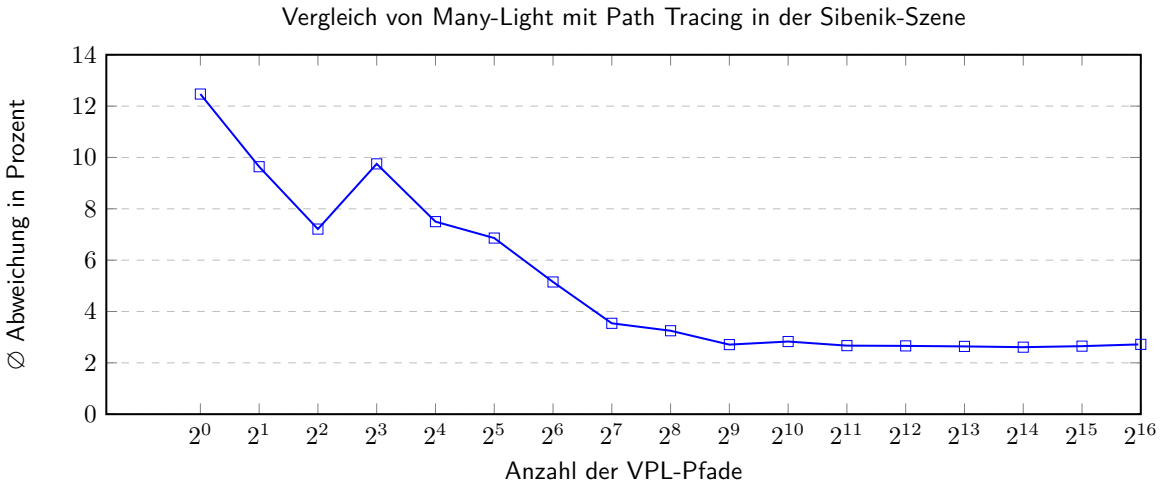
Path Tracing

Many-Light



Abweichung der Bilder

$$\varnothing \text{ Abweichung} = 2{,}76\%$$

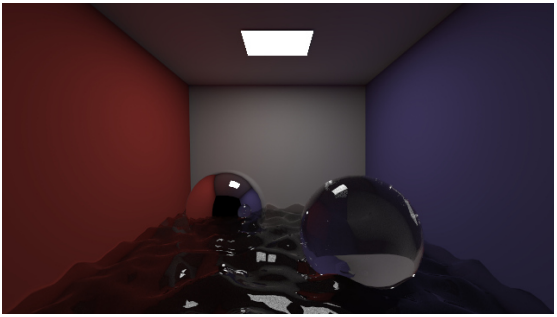

Vergleich von Many-Light mit Path Tracing in der Sibenik-Szene
∅ Abweichung in Prozent
0
2
4
6
8
10
12
14
2^0 2^1 2^2 2^3 2^4 2^5 2^6 2^7 2^8 2^9 2^{10} 2^{11} 2^{12} 2^{13} 2^{14} 2^{15} 2^{16}
Anzahl der VPL-Pfade

Sibenik: Diffuse Oberflächen

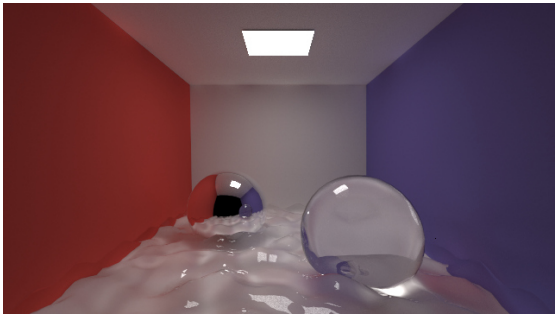
Many-Light

Photon Mapping

Cornell Box: Spekulare Oberflächen



Many-Light



Photon Mapping

Zeitmessung Many-Light – Wavefront CUDA

Phase	Zeit	Anteil
Vorbereitungsphase	8,18 ms	0,6%
Integrationsphase	1.357,72 ms	99,3%
Gesamtzeit	**1.368,15 ms**	100,0%
	1,4 s	100,0%

Zeitmessung Photon Mapping – Wavefront CUDA

Phase	Zeit	Anteil
Vorbereitungsphase	199,69 ms	0,1%
Integrationsphase	210.907,42 ms	99,9%
Gesamtzeit	**211.114,89 ms**	100,0%
	211,1 s	100,0%