

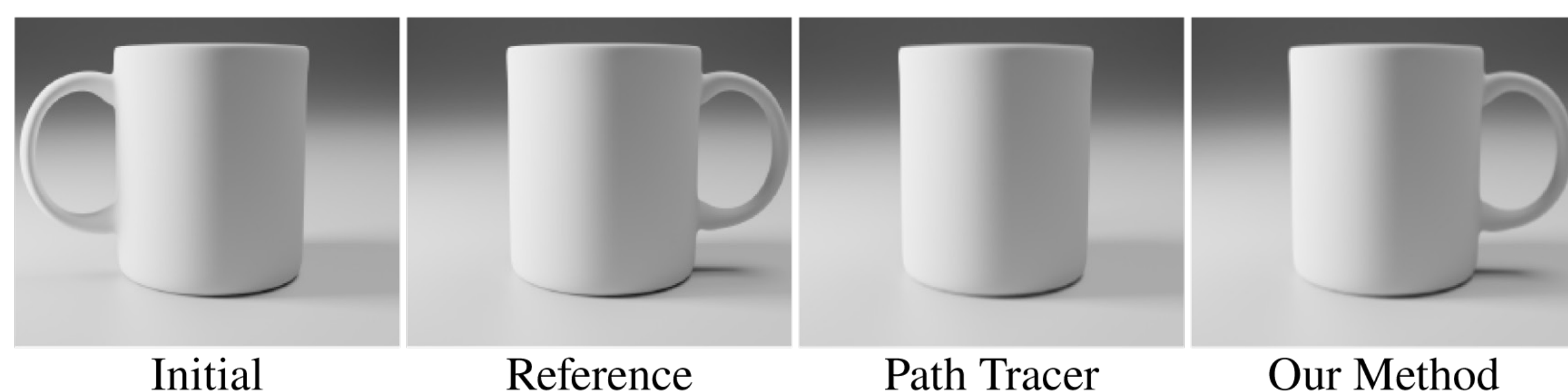
Michael Fischer Tobias Ritschel
 University College London

Motivation

Inverse Path Tracing does not converge due to **plateaus**:

no change in objective $\rightarrow \nabla_f = 0 \rightarrow$ **no convergence**.

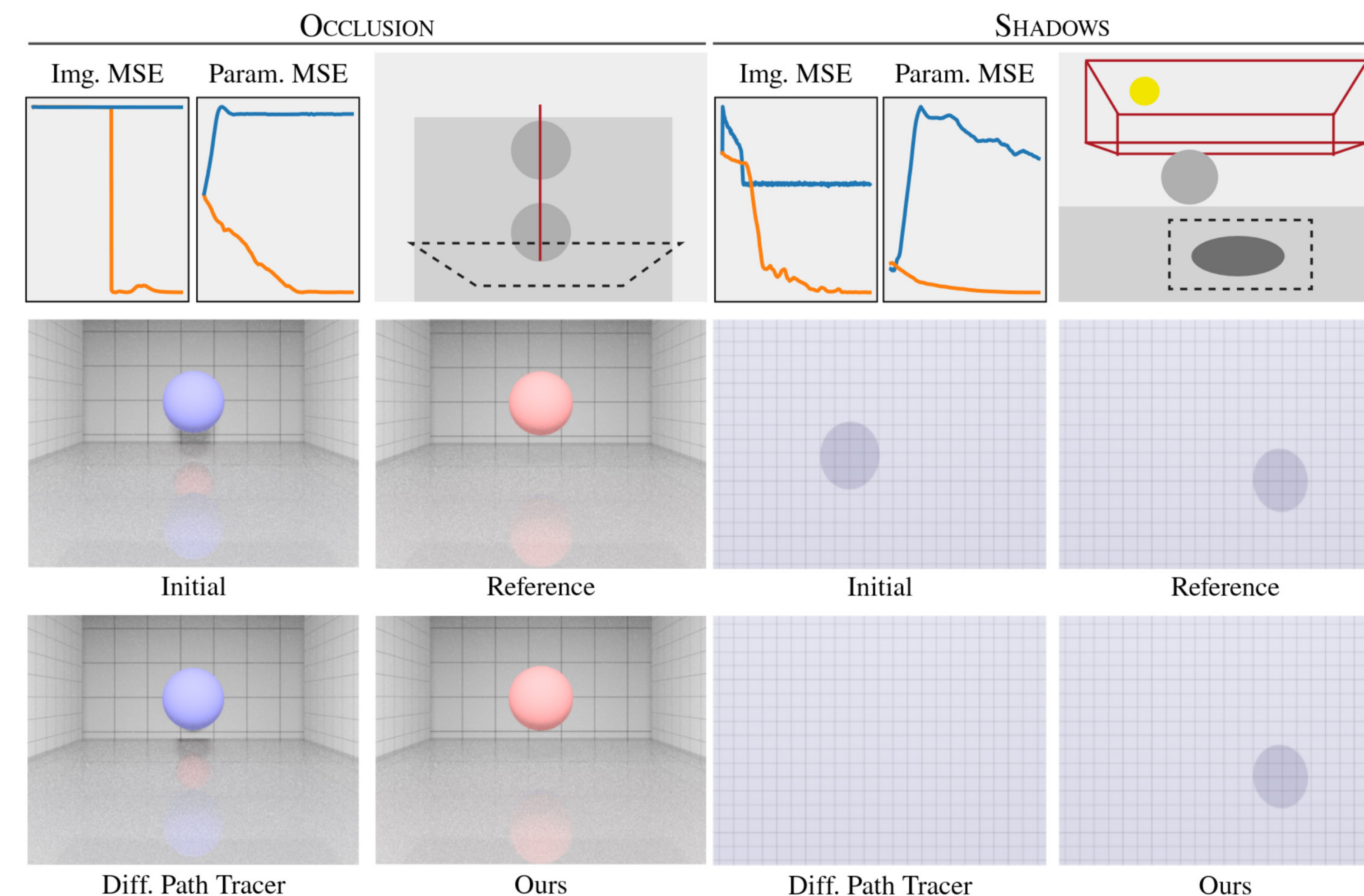
Solution: reduce plateaus via **Gaussian smoothing**!



Visualizing the plateau-reduced Rendering Equation:



Results



	Rasterizer		Path Tracer					
	SoftRas		Mitsuba		Our $_{\partial R P}$		Our $_{\kappa \partial P}$	
	Img.	Para.	Img.	Para.	Img.	Para.	Img.	Para.
CUP	3.66×10^{-1}	2.72×10^{-2}	5.49×10^{-3}	0.75×10^{-1}	4.92×10^{-6}	4.18×10^{-7}	4.75×10^{-4}	2.77×10^{-1}
SHADOWS	1.64×10^{-3}	1.42×10^{-1}	1.64×10^{-3}	5.06×10^{-0}	1.74×10^{-5}	1.81×10^{-3}	5.12×10^{-4}	1.28×10^{-0}
OCCL.	5.33×10^{-2}	7.18×10^{-3}	5.85×10^{-2}	$5.23 \times 10^{+1}$	2.34×10^{-4}	3.29×10^{-3}	5.37×10^{-2}	$1.87 \times 10^{+1}$
GLOBAL ILL.	-	-	3.78×10^{-2}	3.87×10^{-1}	5.07×10^{-5}	8.71×10^{-4}	5.88×10^{-2}	2.55×10^{-1}
SORT	1.85×10^{-2}	1.57×10^{-0}	1.18×10^{-2}	6.64×10^{-0}	3.81×10^{-3}	4.19×10^{-1}	1.02×10^{-2}	2.24×10^{-0}
CAUSTIC	-	-	3.12×10^{-1}	8.50×10^{-0}	1.89×10^{-5}	9.76×10^{-5}	2.42×10^{-1}	4.03×10^{-0}

Method

Key Idea: convolve the RE with a Gaussian

$$Q(\theta) = \kappa \star P(\theta) = \int_{\Theta} \kappa(\tau) \int_{\Omega} f(\mathbf{x}, \theta - \tau) d\mathbf{x}d\tau$$

$$= \int_{\Theta \times \Omega} \kappa(\tau) f(\mathbf{x}, \theta - \tau) d\mathbf{x}d\tau$$

$$\widehat{\frac{\partial Q}{\partial \theta}} = \frac{1}{N} \sum_{i=1}^N \kappa(\tau_i) \frac{\partial P}{\partial \theta}(\theta - \tau_i) \rightarrow \text{diff. renderer}$$

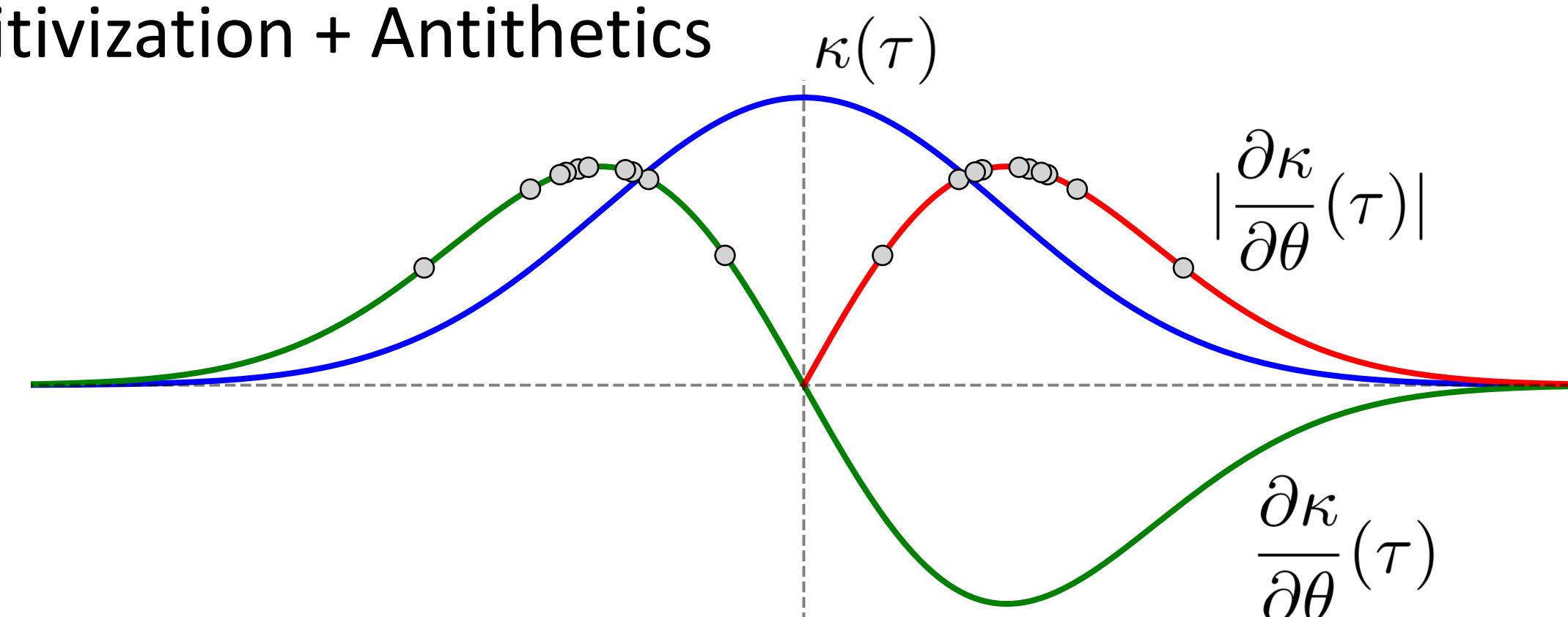
$$\widehat{\frac{\partial Q}{\partial \theta}} \approx \frac{1}{N} \sum_{i=1}^N \frac{\partial \kappa}{\partial \theta}(\tau_i) P(\theta - \tau_i) \rightarrow \text{diff. kernel}$$

Sampling

Convolution is continuous, must be sampled.

PDF is negative, how to importance sample?

Positivization + Antithetics

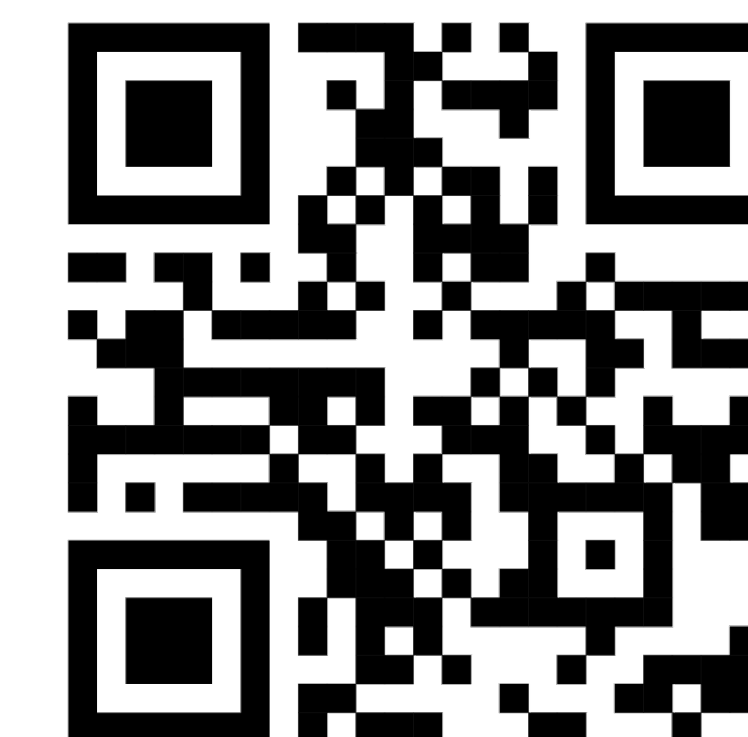


Advantages

- Better convergence
- Complex light transport retained
- Higher efficiency due to skipping backprop
- Easy to code – supports black box renderers

Acknowledgements

We gratefully acknowledge Meta Reality Labs for sponsoring this research!



project page
incl. code