Online Appendix to: Progressive Photon Relaxation

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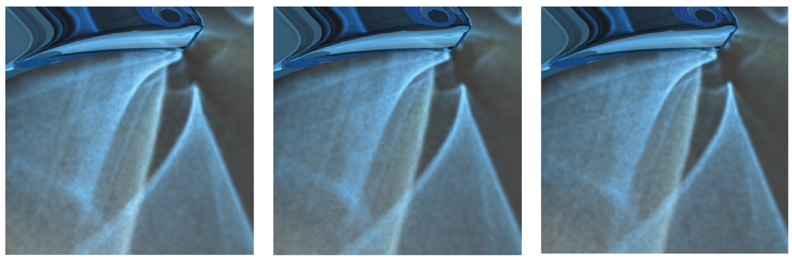
Appendix A

Comparison of trade-off between persistent and transient photons.

9M combined

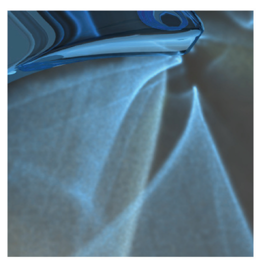


a) 110k persistent, T = 80
8-NN

b) 220k persistent, T = 40
15-NN

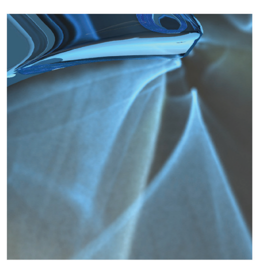
c) 440k persistent, T = 20
30-NN

Given a total budget of 9 million photons, these 3 images show the effect of smaller persistent set and more passes (left) to larger persistent set and fewer passes (right) as requested by reviewers. In each case the kernel bandwidth is chosen to offer comparable levels of kernel bias.



d) Unrelaxed. 9M persistent.

Additionally, we provide the standard photon map with 9 million photons rendered with 600-NN to give comparable bias (Figure d). This image is slightly better, but takes far longer to render due to the large number of photons in the density estimate and kd-tree. It should also demonstrate an upper limit on quality for standard photon mapping, because due to memory requirements for the kd-tree, the algorithm at some point cannot store more photons for the scene.



e) 220k persistent, T = 170
15-NN

Finally, we consider that the unrelaxed image in Figure d takes approximately 10 minutes to render at 600-NN compared to 2 minutes for the 15-NN image in Figure b. If we allow the 220k density photon map a further 8 minutes (the difference in render time) to converge, we arrive at the render in Figure e. In this case, T = 170. It should be noted that these times depend on the platform implementation and hence are not an absolute indication of algorithm performance. However, a reduction in render time due to decreased kernel bandwidth can be expected.

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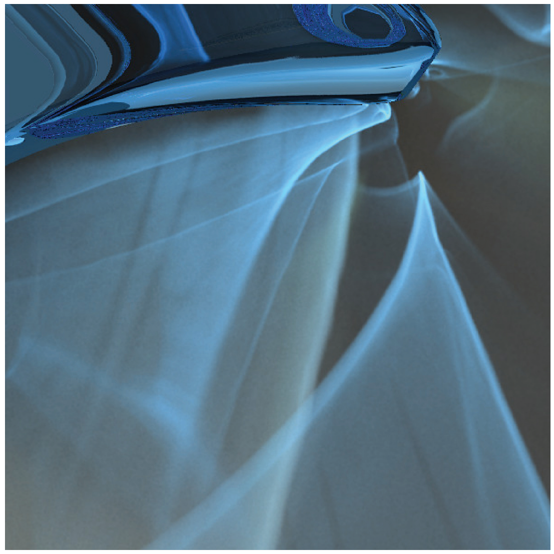
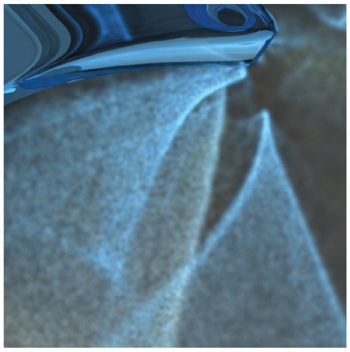
Appendix B

Reference render of the prism close-up generated using progressive photon mapping after 400M absorbed photons.

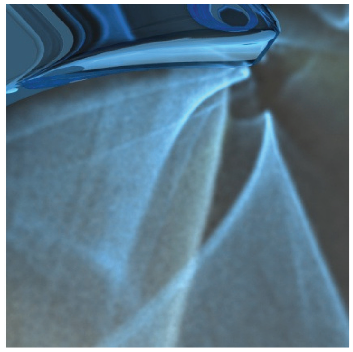


Appendix C

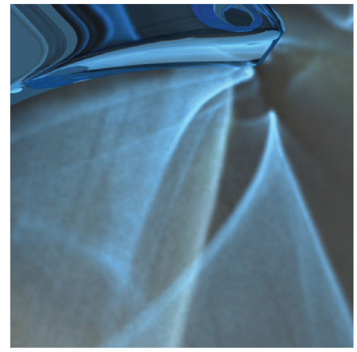
Prism close-up after varying numbers of passes of persistent photons.



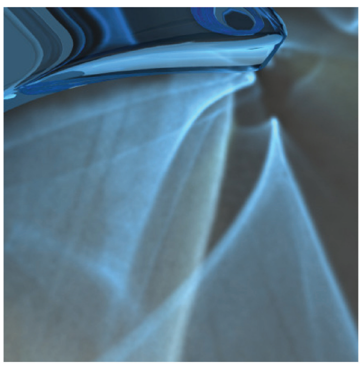
T = 10



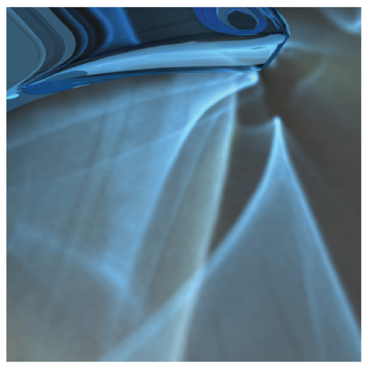
T = 50



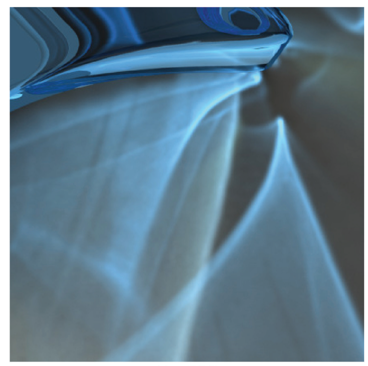
T = 100



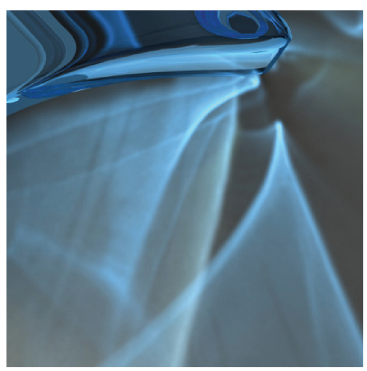
T = 200



T = 400



T = 600



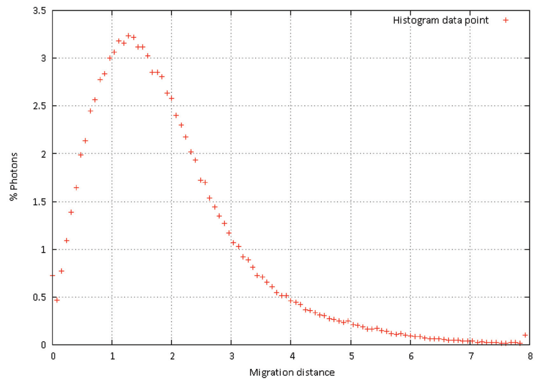
T = 800

Renders at various multiples of persistent photons. Noise effectively vanishes between 400 and 600 iterations or 80,000,000 to 120,000,000 transient photons.

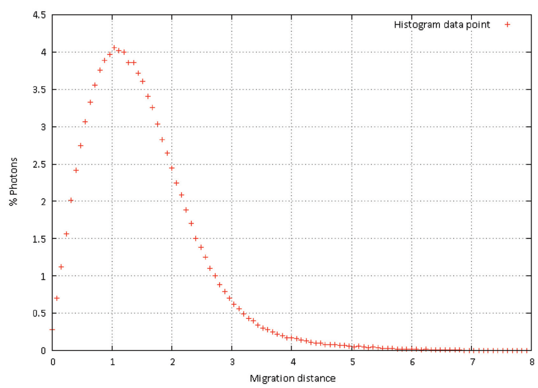
Appendix D

Histograms of photon migration distance

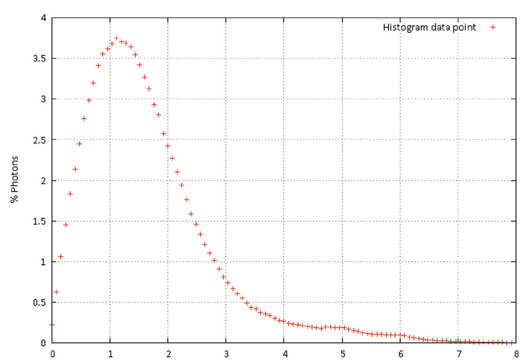
These histogram plots are generated by measuring the magnitude of the change in position of photons between the start to the end of the relaxation process. Migration distance on the x axis unitless because it is calculated as being relative to the mean distance between adjacent neighboring photons. Hence, a photon that moves a distance of 2 has moved twice the mean distance to its adjacent neighbor.



Prism scene



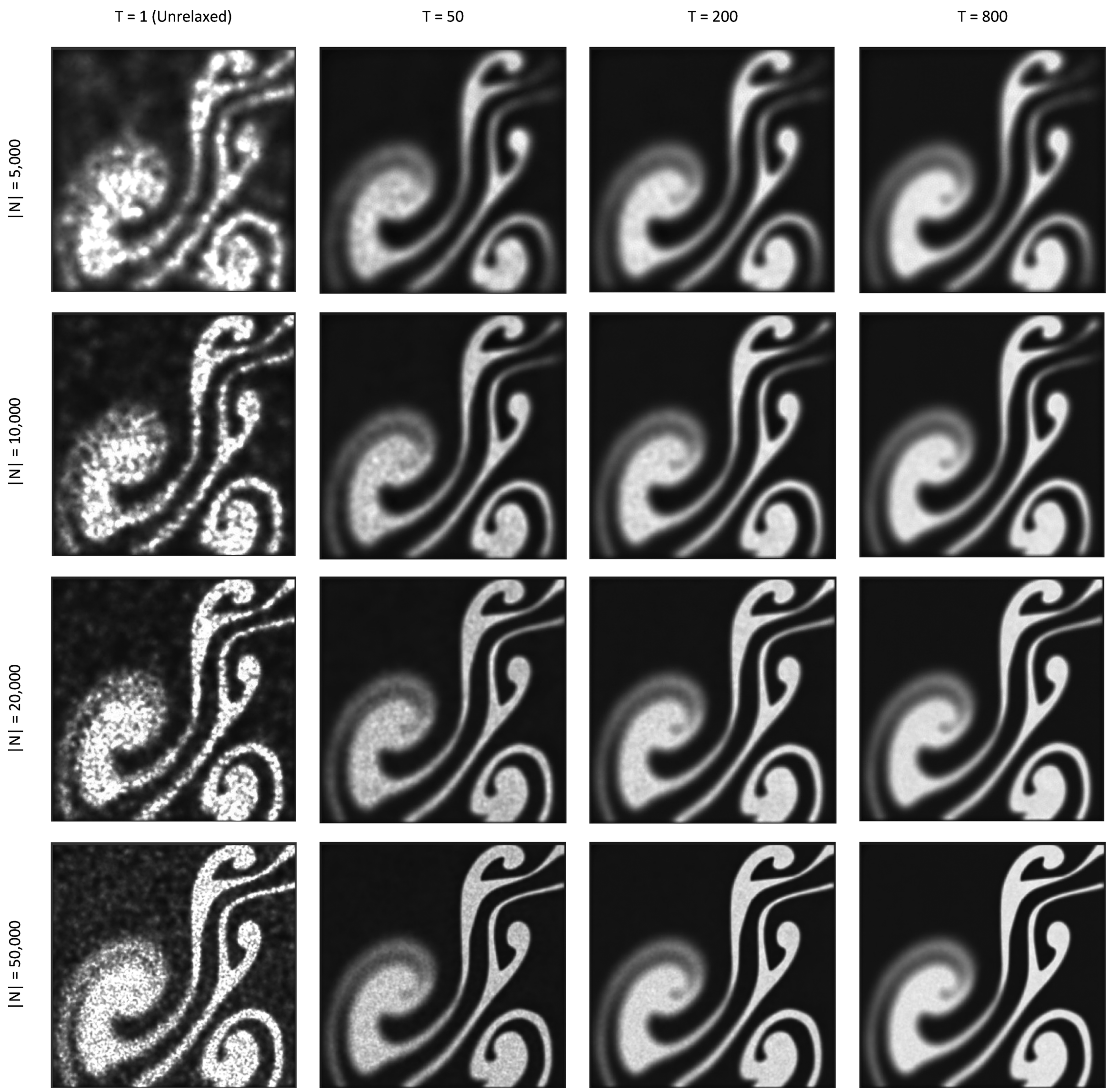
Torus cube scene



WinOSI scene

Appendix E

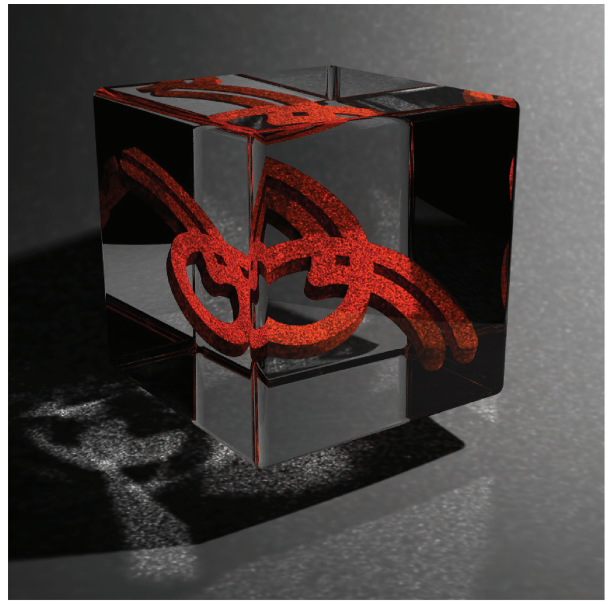
Parameter space exploration for varying values of |N| (persistent photons) and T (transient passes)



Appendix F

Caustics on a discontinuous surface with holes and varying numbers of persistent photons.

400,000 persistent photons. 20-NN. Relaxed to T = 1000.



400,000 persistent photons. 20-NN. Unrelaxed.

40,000 persistent photons. 20-NN. Relaxed to T = 1000.

40,000 persistent photons. 20-NN. Unrelaxed.