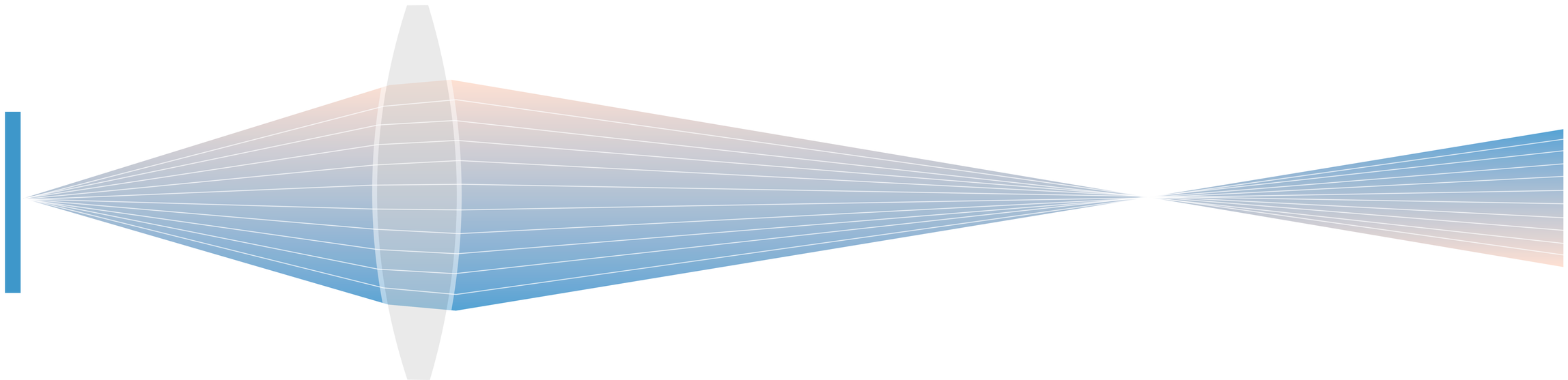
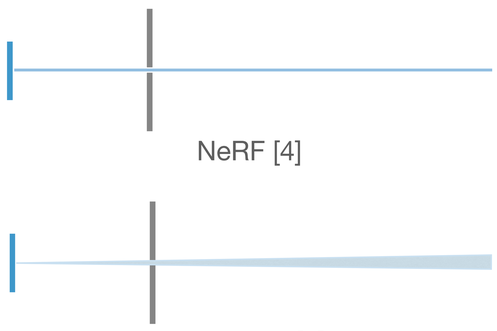
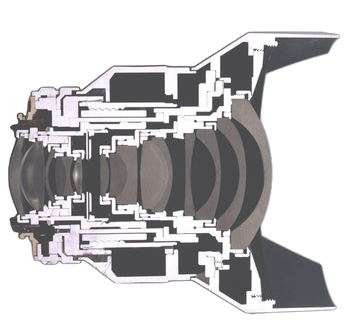
Sampling multiple rays per pixel in NeRF realistically simulates camera optics and is surprisingly fast.



Model realistic cameras with multi-ray sampling in NeRF

Most NeRF methods [1-4] adopt the pinhole camera model, which causes camera effects such as defocus blur being "baked" into the reconstruction.

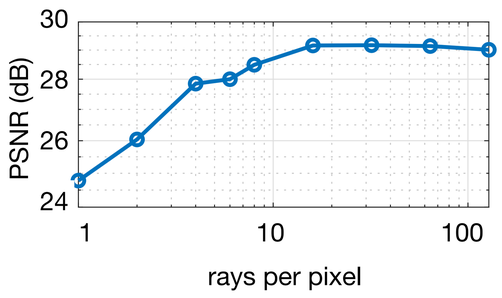


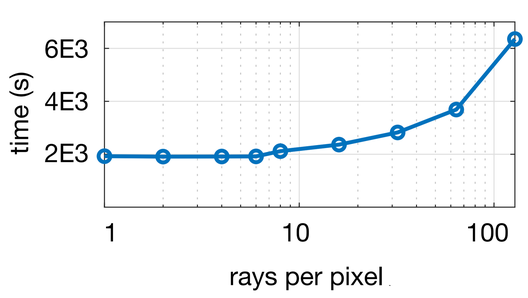

complex lens

Motivated by reconstruction from large aperture cameras, we adopt a Monte-Carlo approach and sample multiple rays through the camera lens, refacting at the lens surface, to simulate the aggregation process of light at the sensor level.

Surprisingly fast

Recent progress in accelerating reconstruction and rendering for radiance fields [3,5] made tracing multiple rays through the lens tractable. Our experiments show practical runtime impact remains limited, presumably due to similarities in rays cast (e.g. memory access patterns).

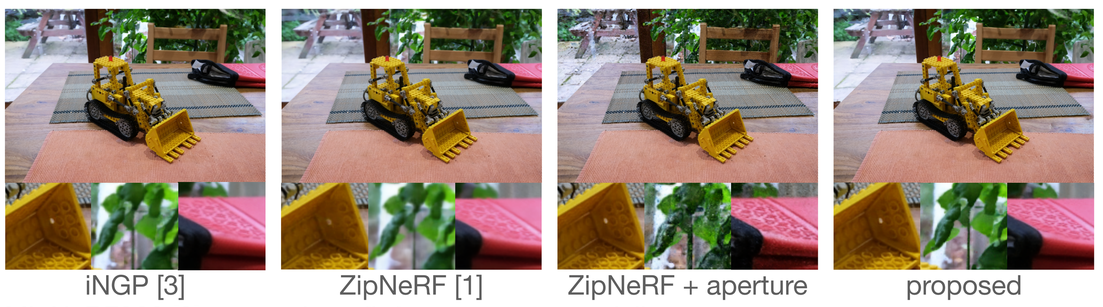




Sharper reconstruction

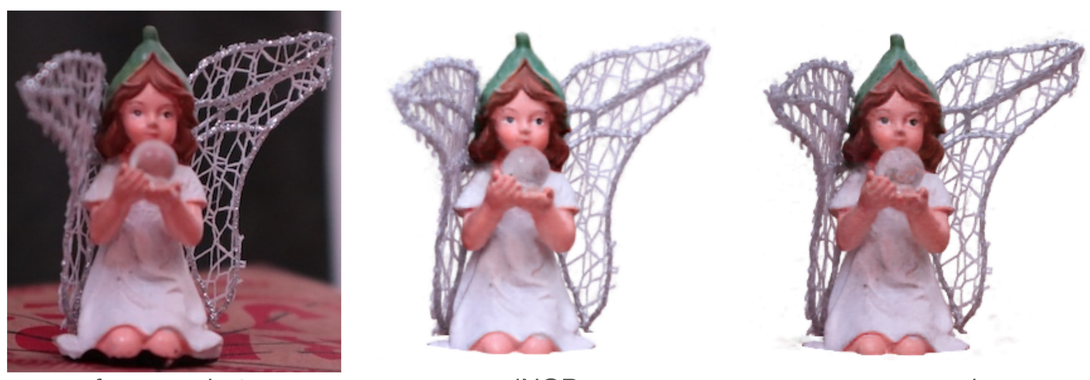
More accurate modeling of camera optics result in sharper reconstructions, improving the PSNR on validation all-in-focus images, on both synthetic and real datasets, by up to 3dB.

Left to right: input from closest viewpoint; reconstructed with iNGP [3]; ZipNeRF [1]; ZipNeRF + aperture modeling; proposed ƒNeRF with 6 rays; ƒNeRF with 32 rays; ground truth.



iNGP [3] | ZipNeRF [1] | ZipNeRF + aperture | proposed

MipNeRF360 [2] scenes benefit from aperture modeling.



reference photo | iNGP | proposed

A 5cm × 8cm × 6cm figurine captured with an ƒ/5.6 aperture.

References

[1] Barron, Jonathan T. et al. "Zip-NeRF: anti-aliased grid-based neural radiance fields." ICCV 2023.
[2] Barron, Jonathan T., et al. "Mip-NeRF 360: unbounded anti-aliased neural radiance fields." *CVPR* 2022.
[3] Müller, Thomas, et al. "Instant neural graphics primitives with a multiresolution hash encoding." *ACM transactions on graphics (TOG)* 41.4 (2022): 1-15.
[4] Mildenhall, Ben, et al. "Nerf: Representing scenes as neural radiance fields for view synthesis." *Communications of the ACM* 65.1 (2021): 99-106.
[5] Božič, Aljaž, et al. "Neural assets: Volumetric object capture and rendering for interactive environments." *arXiv preprint arXiv:2212.06125* (2022).

ƒNeRF: High Quality Radiance Fields from Practical Cameras

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EPIC GAMES