NeRF as Non-Distant Environment Emitter in Physics-based Inverse Rendering

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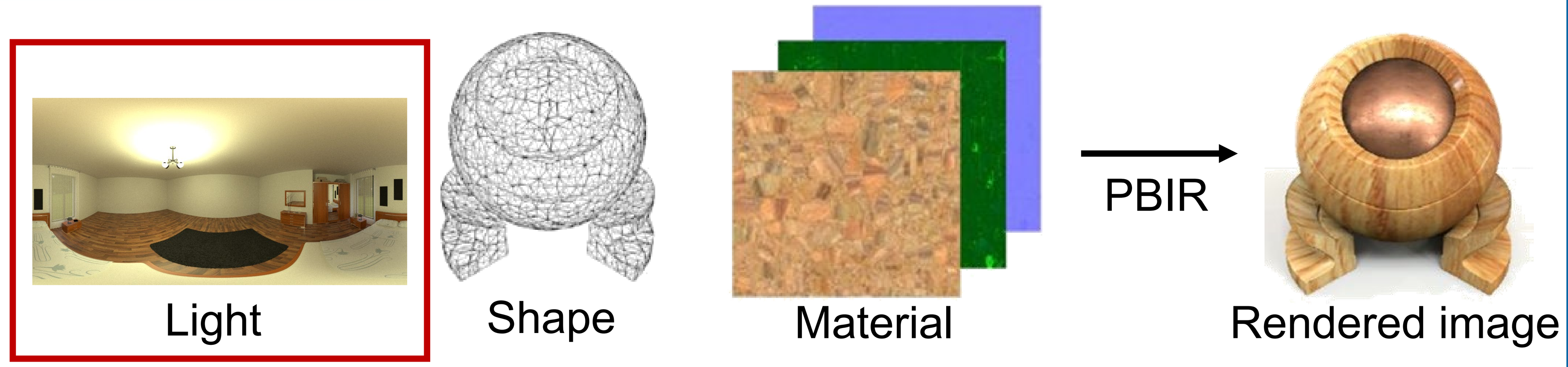
Details at Project Page

Motivation

Besides shape and material, the **light** is a key part in physics-based inverse rendering.



Environment map is commonly used, however its distant lighting assumption leads to inaccurate spatial invariant lighting.

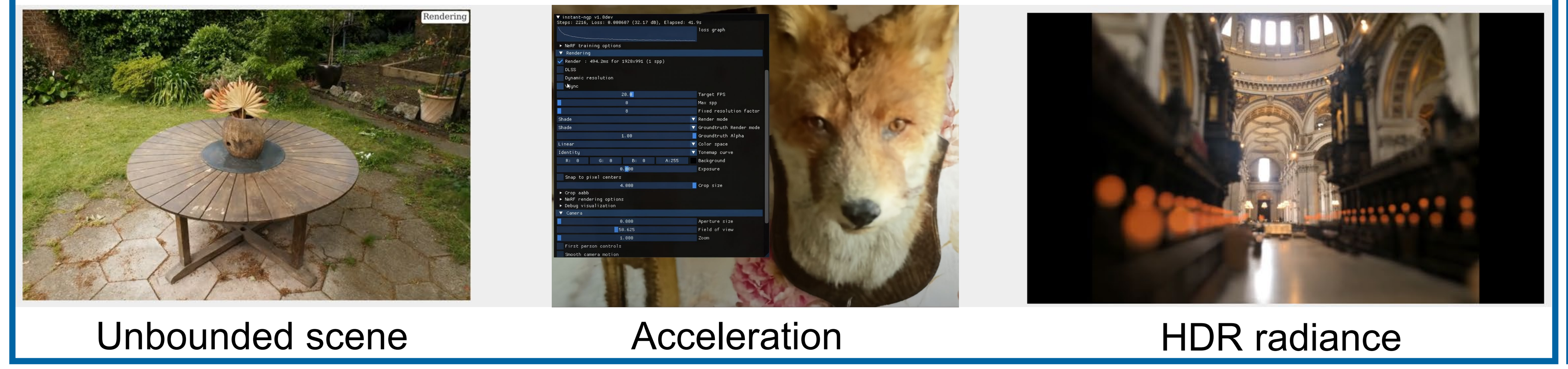
Spatial invariant light leads to artifacts, especially under shadows and reflections.

We propose to use **neural radiance fields (NeRF)** to model spatial varying lighting.

Original NeRF: Novel-view synthesis

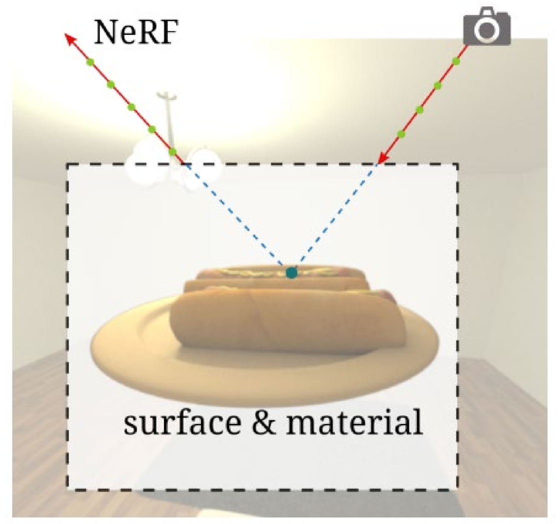
Extended NeRF: Light modeling

Recent advances make NeRF more suitable for environment light modeling



Method

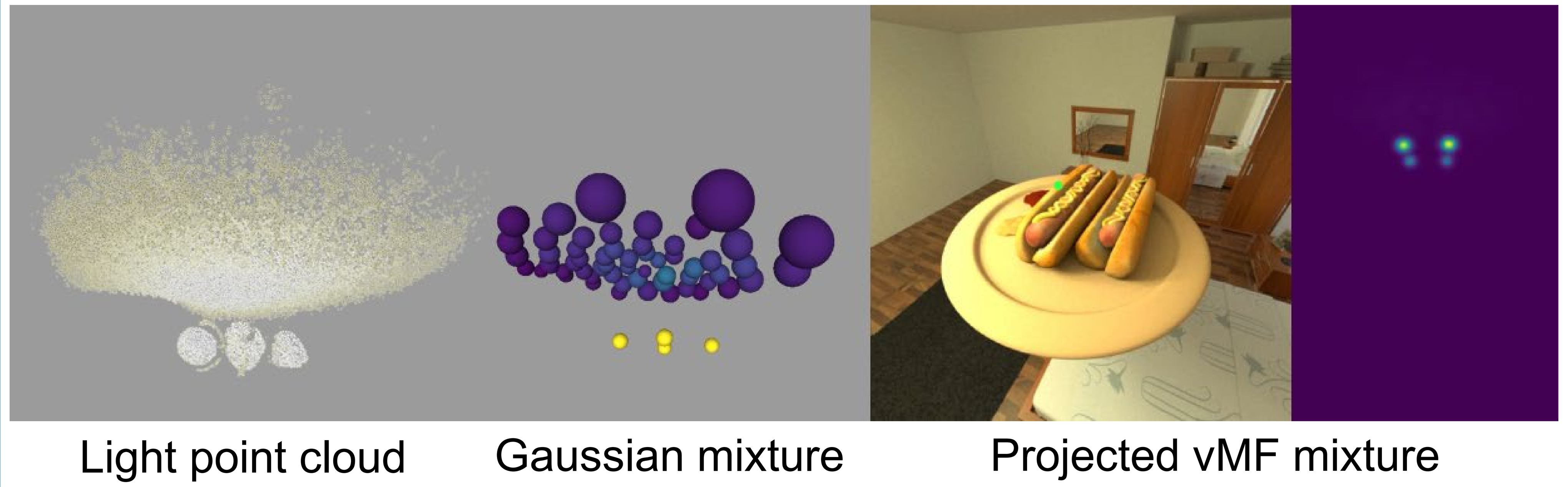
We separate the scene using a bounding box, modeling inside by surfaces and outside by NeRF.



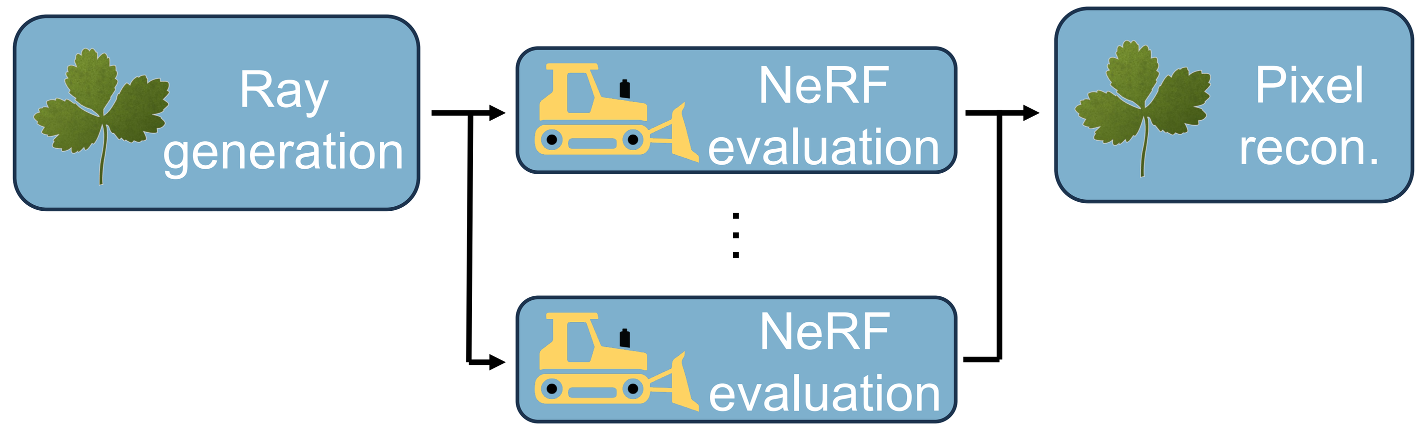
We render the surfaces under NeRF-based lighting by combining surface rendering equation and (non-scattering) NeRF rendering equation.

$$L_i(\mathbf{p}, \omega) = \boxed{L_i'^{s}(\mathbf{p}, \omega)} + \boxed{L_i'^{v}(\mathbf{p}, \omega)}.$$

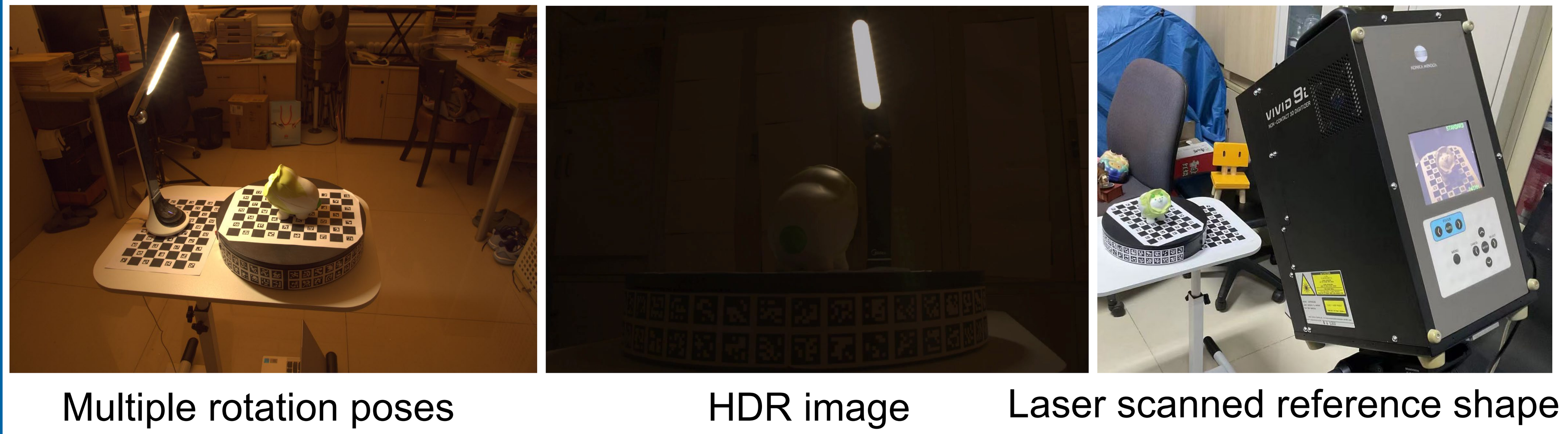
We achieve **emitter importance sampling** for NeRF by building gaussian mixtures from NeRF point cloud.



We integrate NeRF into physics-based rendering by combining Mitsuba 3 and NeRFStudio

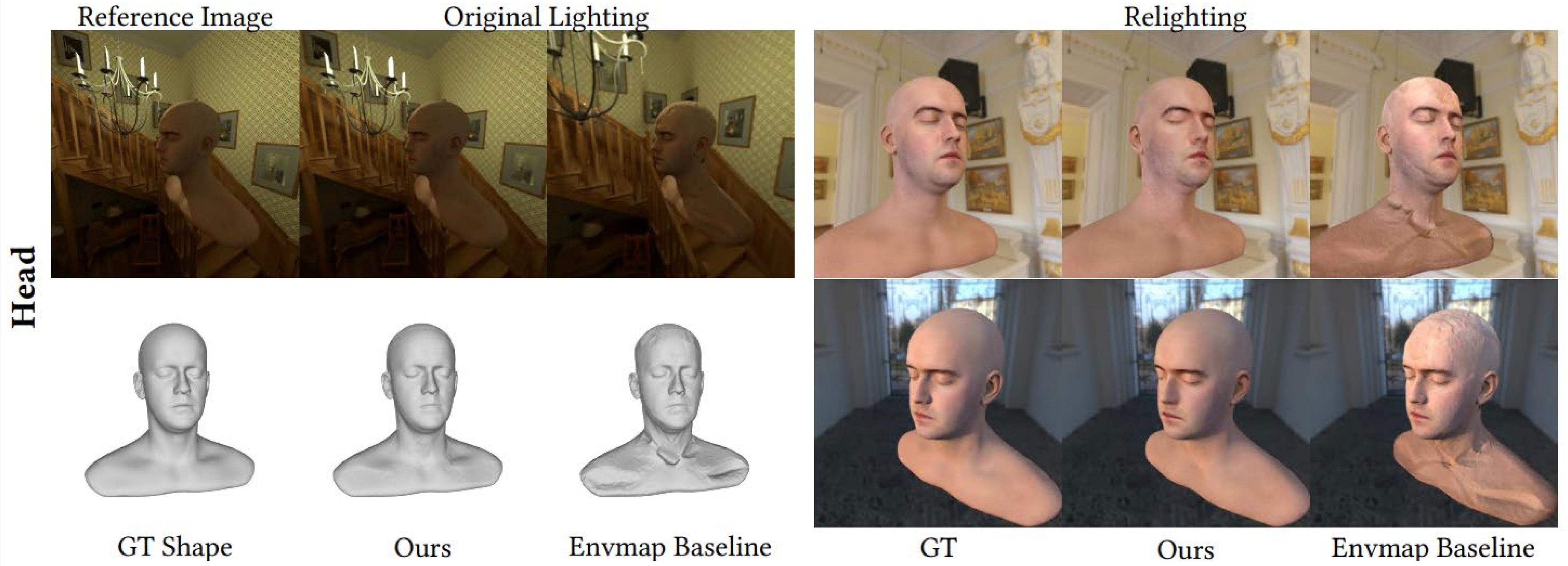


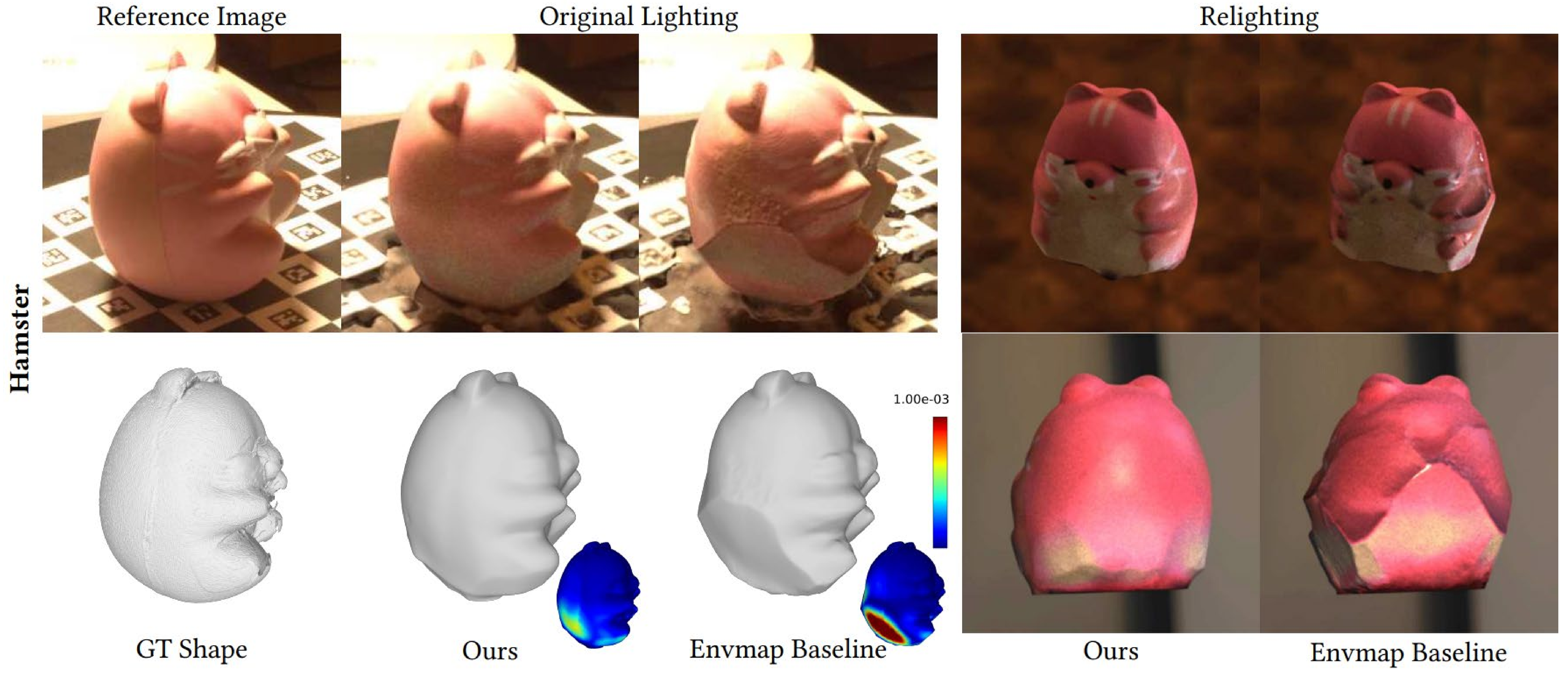
We capture a **dataset** featuring non-distant emitters.



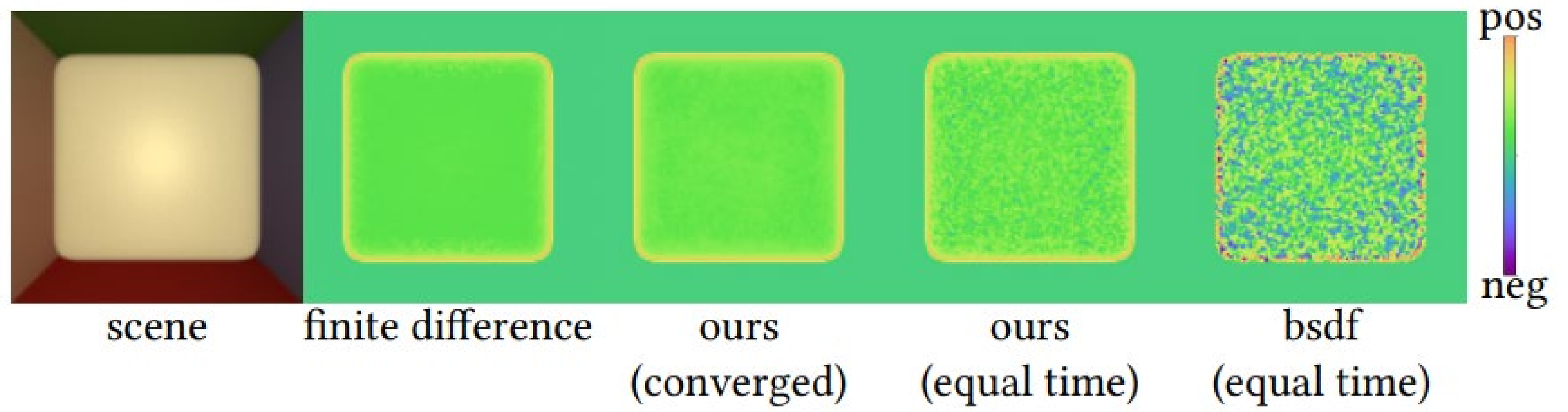
Results

Our lighting model outperforms environment map in inverse rendering on **synthetic** and **real** data.





Method	Novel View Synthesis			Relighting			Shape
	PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS	CD
Ours	30.70	0.97	0.019	27.99	0.96	0.040	8.35e-6
Envmap Baseline	22.41	0.95	0.054	21.32	0.92	0.088	1.20e-4



Comparing the gradient image rendered by different sampling methods