1 Extended Experimental

1.1 Experiments Under Non-Uniform Lighting

We evaluate the proposed method on the MipNeRF360-varying dataset, which contains scenes captured under varying exposure conditions. We compare against four state-of-the-art baselines: 3DGS (foundational 3D Gaussian Splatting), Aleth-NeRF (illumination adaptation via concealing field), GS-W (Gaussian feature decoupling), and Luminance-GS (view-adaptive curve adjustment). Core quantitative metrics include Peak Signal-to-Noise Ratio (PSNR, higher is better), Structural Similarity Index (SSIM, higher is better), and Learned Perceptual Image Patch Similarity (LPIPS, lower is better), covering objective fidelity and subjective perceptual quality.

Scene	Metric	3DGS	Aleth-NeRF	GS-W	Luminance-GS	Ours
"bicycle"	PSNR ↑	**18.523**	12.943	15.616	18.383	18.237
	SSIM ↑	0.514	0.195	0.563	0.646	**0.691**
	LPIPS ↓	0.396	0.796	0.371	0.330	**0.274**
"garden"	PSNR ↑	20.187	12.685	20.482	20.984	**21.526**
	SSIM ↑	0.736	0.229	0.756	0.791	**0.807**
	LPIPS ↓	0.203	0.813	0.212	0.195	**0.191**
"counter"	PSNR ↑	15.098	12.454	15.892	16.850	**17.341**
	SSIM ↑	0.527	0.324	0.624	0.645	**0.739**
	LPIPS ↓	0.368	0.780	0.337	0.302	**0.224**
"bonsai"	PSNR ↑	12.533	8.141	15.526	15.708	**17.973**
	SSIM ↑	0.299	0.403	0.554	0.563	**0.684**
	LPIPS ↓	0.561	0.685	0.419	0.433	**0.273**
"kitchen"	PSNR ↑	22.310	11.357	20.672	**23.100**	16.858
	SSIM ↑	0.831	0.397	0.802	0.833	**0.848**
	LPIPS ↓	0.177	0.579	0.164	**0.143**	0.148
"room"	PSNR ↑	14.354	7.151	**17.198**	16.825	17.150
	SSIM ↑	0.549	0.315	0.558	0.643	**0.762**
	LPIPS ↓	0.299	0.733	0.375	0.319	**0.245**
"stump"	PSNR ↑	16.619	12.434	14.891	15.639	**19.458**
	SSIM ↑	0.476	0.471	0.503	0.532	**0.664**
	LPIPS ↓	0.402	0.665	0.432	0.389	**0.304**

Table 1: Quantitative Results on MipNeRF360-varying Dataset (Non-Uniform Lighting)

To further verify robustness under low-light conditions, we evaluate on the LOM dataset, which contains paired low-light and normal-light images. We add **LLGS** (ICASSP 2025, Gaussian illumination via absorptance modulation) as an additional baseline to enhance comparison comprehensiveness.

Scene	Metric	3DGS	Aleth-NeRF	GS-W	Luminance-GS	**LLGS**	Ours
"bike"	PSNR ↑	18.447	9.378	**26.747**	20.358	15.753	22.371
	SSIM ↑	0.547	0.254	0.851	0.754	0.623	**0.858**
	LPIPS ↓	0.328	0.751	0.278	0.368	0.445	**0.219**
"bubu"	PSNR ↑	14.472	13.288	**27.012**	16.486	22.877	26.119
	SSIM ↑	0.634	0.633	0.895	0.741	0.878	**0.916**
	LPIPS ↓	0.407	0.639	0.199	0.376	0.218	**0.176**
"shrub"	PSNR ↑	16.582	12.229	19.173	16.161	16.543	**19.845**
	SSIM ↑	0.449	0.169	0.557	0.667	0.511	**0.714**
	LPIPS ↓	0.374	0.713	0.289	0.207	0.366	**0.204**

Table 2: Quantitative results (with LLGS method added)

Under non-uniform lighting conditions, our method achieves outstanding performance: on the MipNeRF360-

varying dataset, it yields the optimal SSIM and LPIPS across all scenes, and attains the best PSNR in 5 out of all scenes; on the LOM dataset, it delivers the best SSIM and LPIPS in all scenarios, with all three metrics ranking first in the "shrub" scene, outperforming all baseline methods by a significant margin, including LLGS.

1.2 Experiments Under Uniform Lighting

To verify the generalizability of our method (i.e., not compromising performance under standard lighting), we supplement experiments on the MipNeRF360-varying dataset under uniform/normal lighting conditions. We compare against 3DGS and Pixel-GS (a pixel-aligned Gaussian splatting method) using the same three metrics.

The following tables (including an average result table and multiple per-scene result tables) present the performance metrics of different methods on the MipNeRF360-varying dataset under normal lighting conditions.

Method	SSIM ↑	PSNR ↑	LPIPS ↓
3DGS	0.870	28.691	0.182
Pixel-GS	0.886	29.490	0.152
Ours	**0.895**	**29.601**	**0.108**

Table 3: Average performance comparison of different methods on image quality metrics

Method	bicycle	bonsai	counter	garden
3DGS	0.771/25.246/0.205	0.938/31.980/0.205	0.905/28.700/0.204	0.868/27.410/0.103
Pixel-GS	0.793/25.739/**0.173**	0.951/**32.697**/0.162	**0.921**/29.299/0.162	0.878/27.834/**0.094**
Ours	**0.808**/**26.365**/0.204	**0.955**/32.183/**0.057**	0.920/**29.373**/**0.080**	**0.893**/**28.549**/0.096

Note: Each cell presents results in SSIM ↑ / PSNR ↑ / LPIPS ↓ order; Red bold = optimal.

Table 4: Quantitative Results of Different Methods on Partial Scenes (Normal Lighting Conditions) – Part 1

Method	kitchen	room	stump
3DGS	0.922/30.317/0.129	0.914/30.632/0.220	0.775/26.550/0.210
Pixel-GS	0.936/31.956/0.106	0.930/31.794/0.183	**0.796**/**27.111**/**0.181**
Ours	**0.954**/**32.107**/**0.041**	**0.950**/**32.115**/**0.064**	0.787/26.518/0.211

Note: Each cell presents results in SSIM ↑ / PSNR ↑ / LPIPS ↓ order; Red bold = optimal.

Table 5: Quantitative Results of Different Methods on Partial Scenes (Normal Lighting Conditions) – Part 2

Although tailored explicitly for non-uniform illumination scenarios, our method still delivers state-of-the-art (SOTA) performance in normal lighting conditions, as evidenced by experimental results. This not only validates the compatibility of our method's design with standard illumination settings but also highlights its strong generalizability across a wide range of lighting scenarios.

1.3 Qualitative comparison under normal and non-uniform illumination conditions

As illustrated in the following figure, the superior performance of our method is presented in a more intuitive manner.

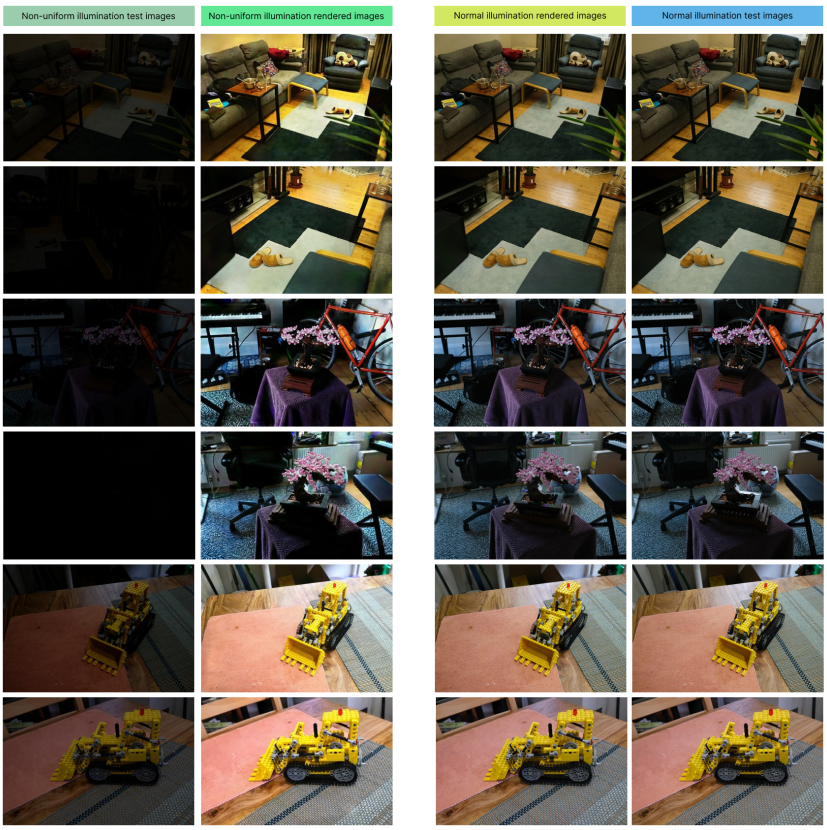

Figure 1: Rendered Results of Our Method vs. Test Images Under Uniform/Non-uniform Illumination

1.4 Conclusion

Our method achieves consistent superiority across both uniform and non-uniform illumination conditions. Under non-uniform lighting: On MipNeRF360-varying, it dominates SSIM and LPIPS in all 7 scenes (e.g., 0.807 SSIM and 0.191 LPIPS in "garden") and tops PSNR in 5 scenes. On LOM, it leads SSIM and LPIPS in all tested scenes, with "shrub" achieving best-in-class PSNR (19.845), SSIM (0.714), and LPIPS (0.204) over specialized baselines like LLGS.

In particular, even under uniform lighting, our method sets a new state-of-the-art on MipNeRF360-varying, with average 0.895 SSIM, 29.601 PSNR, and 0.108 LPIPS—outperforming 3DGS and Pixel-GS across all metrics. This validates its robustness and versatility, excelling in both targeted non-uniform scenarios and general uniform lighting conditions.