BAD-NeRF: **B**undle **A**djusted **D**eblur **Ne**ural **R**adiance **F**ields

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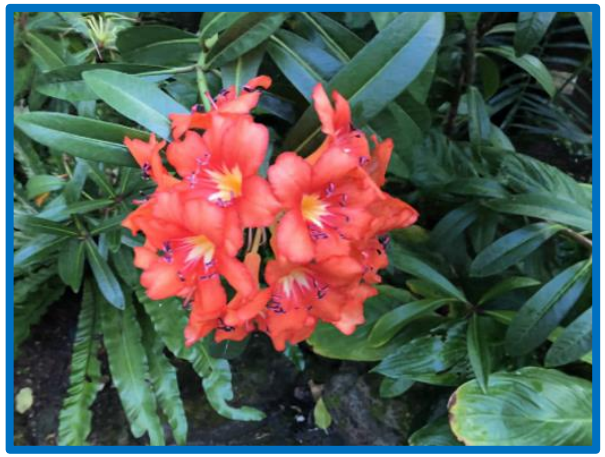
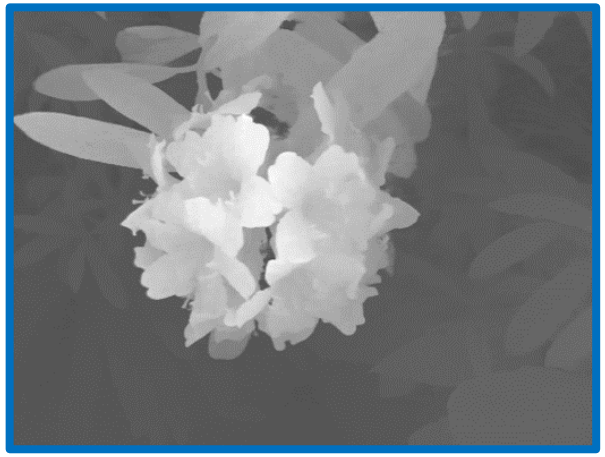
https://wangpeng000.github.io/BAD-NeRF

Input

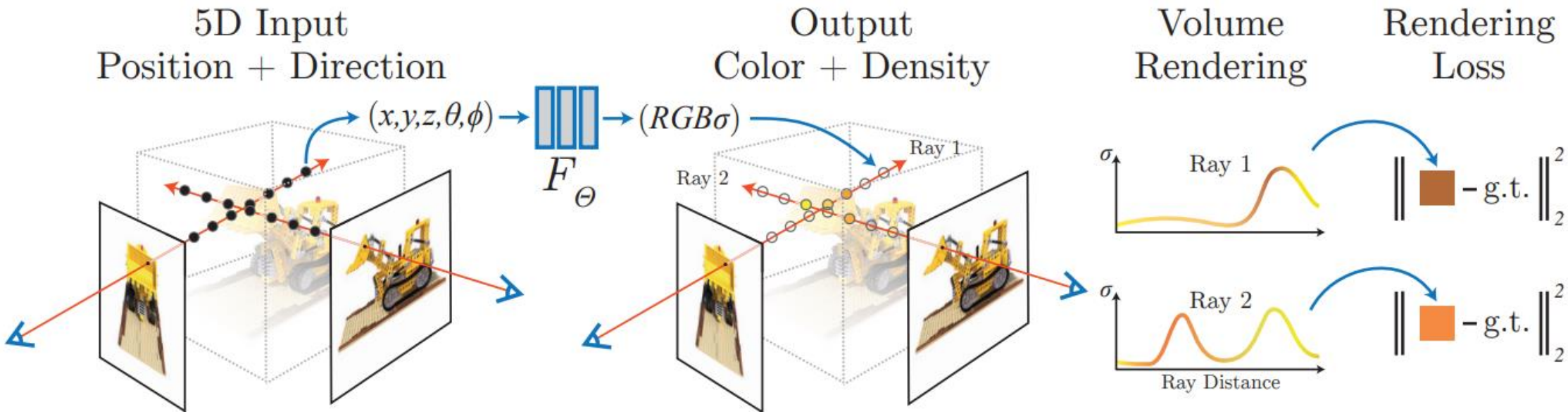
Result





Neural Radiance Fields (**NeRF**) learns 3D scene representations
from accurately posed high-quality RGB images.

Mildenhall, Ben, et al. "NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis.", 2020 ECCV



Mildenhall, Ben, et al. "NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis.", 2020 ECCV
Lin, Chen-Hsuan, et al. "BARF: Bundle-adjusting neural radiance fields." 2021 ICCV

Blurry Input

Result of NeRF

Physical Motion Blur Image Formation Model

start

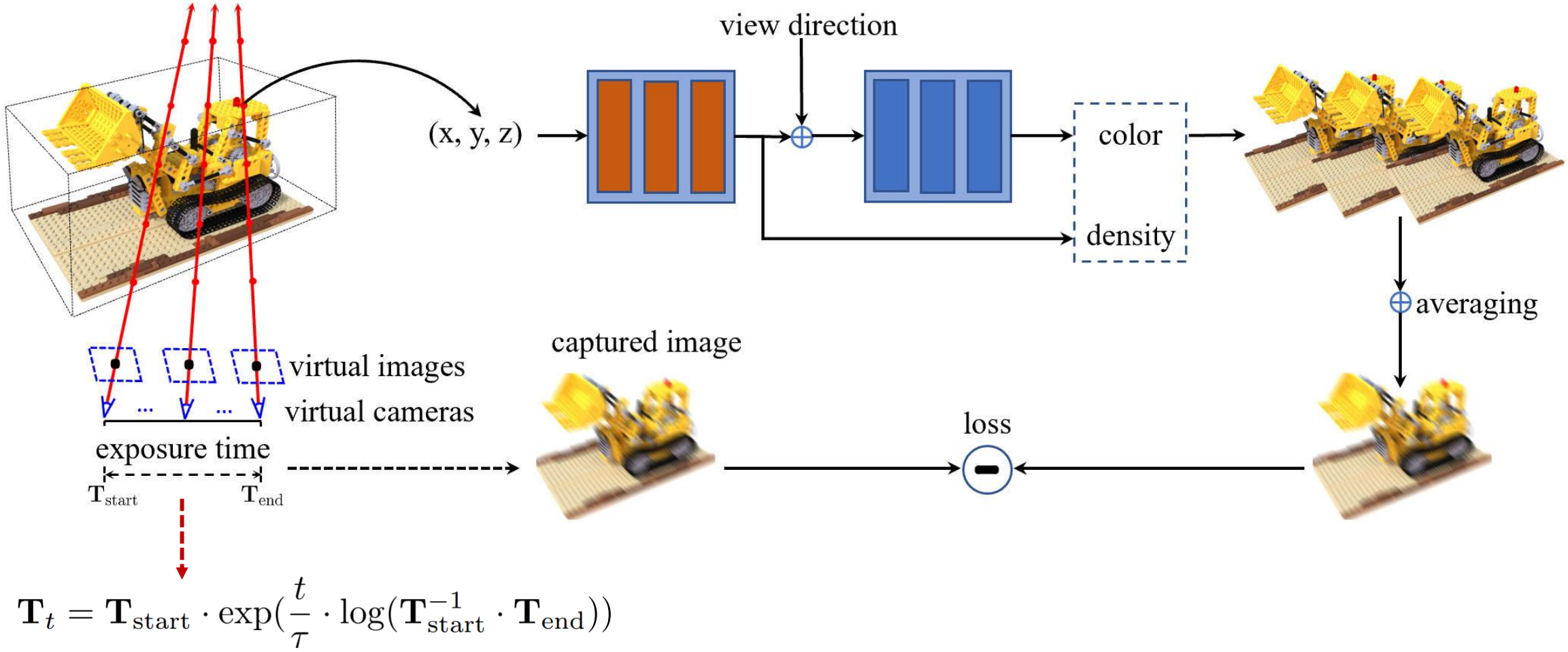
exposure time

end

average

$$\mathbf{B}(\mathbf{x}) \approx \frac{1}{n} \sum_{i=0}^{n-1} \mathbf{I}_{\mathrm{i}}(\mathbf{x})$$

Target: Given a set of severe motion blurred images, bundle adjusted deblur NeRF (BAD-NeRF) jointly learns the neural radiance fields and recovers the camera motion trajectories within exposure time.



$$\mathbf{T}_t = \mathbf{T}_{\text{start}} \cdot \exp\left(\frac{t}{\tau} \cdot \log(\mathbf{T}_{\text{start}}^{-1} \cdot \mathbf{T}_{\text{end}})\right)$$

	Cozy2room			Factory			Pool			Tanabata			Trolley			Average		
	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓
Park	23.82	.7221	.2020	21.02	.5090	.4193	27.98	.7258	.2305	17.91	.4637	.4030	19.96	.5610	.3222	22.14	.5963	.3154
MPR	29.90	.8862	.0915	25.07	.6994	.2409	33.28	**.8938**	.1290	22.60	.7203	.2507	26.24	.8356	.1762	27.42	.8071	.1777
PVD	28.06	.8443	.1515	24.57	.6877	.3150	30.38	.8393	.1977	22.54	.6872	.3351	24.44	.7746	.2600	26.00	.7666	.2519
SRNDeblur	29.47	.8759	.0950	26.54	.7604	.2404	32.94	.8847	.1045	23.20	.7274	.2438	25.36	.8119	.1618	27.50	.8121	.1691
DeblurNeRF	25.96	.7979	.1024	23.21	.6487	.2618	31.21	.8518	.1382	22.46	.6946	.2455	24.94	.7923	.1766	25.56	.7571	.1849
DeblurNeRF*	30.26	.8933	.0791	26.40	.7991	.2191	32.30	.8755	.1345	24.56	.7749	.2166	26.24	.8254	.1671	27.95	.8336	.1633
BAD-NeRF (ours)	**32.15**	**.9170**	**.0547**	**32.08**	**.9105**	**.1218**	**33.36**	.8912	**.0802**	**27.88**	**.8642**	**.1179**	**29.25**	**.8892**	**.0833**	**30.94**	**.8946**	**.0916**

Table 1. **Quantitative deblurring comparisons on the synthetic dataset of DeblurNeRF.** Note that DeblurNeRF* is trained with the ground-truth poses, while the other one is trained with the estimated poses by COLMAP.

	Cozy2room			Factory			Pool			Tanabata			Trolley			Average		
	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓
NeRF+Park	23.44	.7024	.2634	20.83	.5041	.4133	28.69	.7512	.2865	19.29	.5317	.4342	20.73	.6012	.3804	22.60	.6181	.3556
NeRF+MPR	27.17	.8334	.1196	23.78	.6375	.2499	31.15	.8402	.1837	21.24	.6914	.2801	26.14	.8154	.1979	25.90	.7636	.2062
NeRF+PVD	26.26	.7977	.1764	23.88	.6450	.3074	29.02	.7792	.2287	21.03	.6566	.3406	23.96	.7502	.2772	24.83	.7257	.2661
NeRF+SRNDeblur	27.27	.8321	.1261	26.19	.7494	.2274	31.09	.8375	.1770	21.46	.6943	.2839	25.01	.7883	.2077	26.20	.7803	.2044
Deblur-NeRF	26.05	.8084	.1072	25.17	.7253	.2447	30.97	.8447	.1554	21.77	.7172	.2515	24.45	.7785	.2088	25.68	.7748	.1935
Deblur-NeRF*	29.88	.8901	.0747	26.06	.8023	.2106	30.94	.8399	.1694	22.56	.7639	.2285	25.78	.8122	.1797	27.04	.8217	.1726
BAD-NeRF (ours)	**30.97**	**.9014**	**.0552**	**31.65**	**.9037**	**.1228**	**31.72**	**.8580**	**.1153**	**23.82**	**.8311**	**.1378**	**28.25**	**.8727**	**.0914**	**29.28**	**.8734**	**.1045**

Table 2. **Quantitative novel view synthesis comparisons on the synthetic dataset of DeblurNeRF.**

Figure 1. **Qualitative results of different methods with synthetic datasets.**

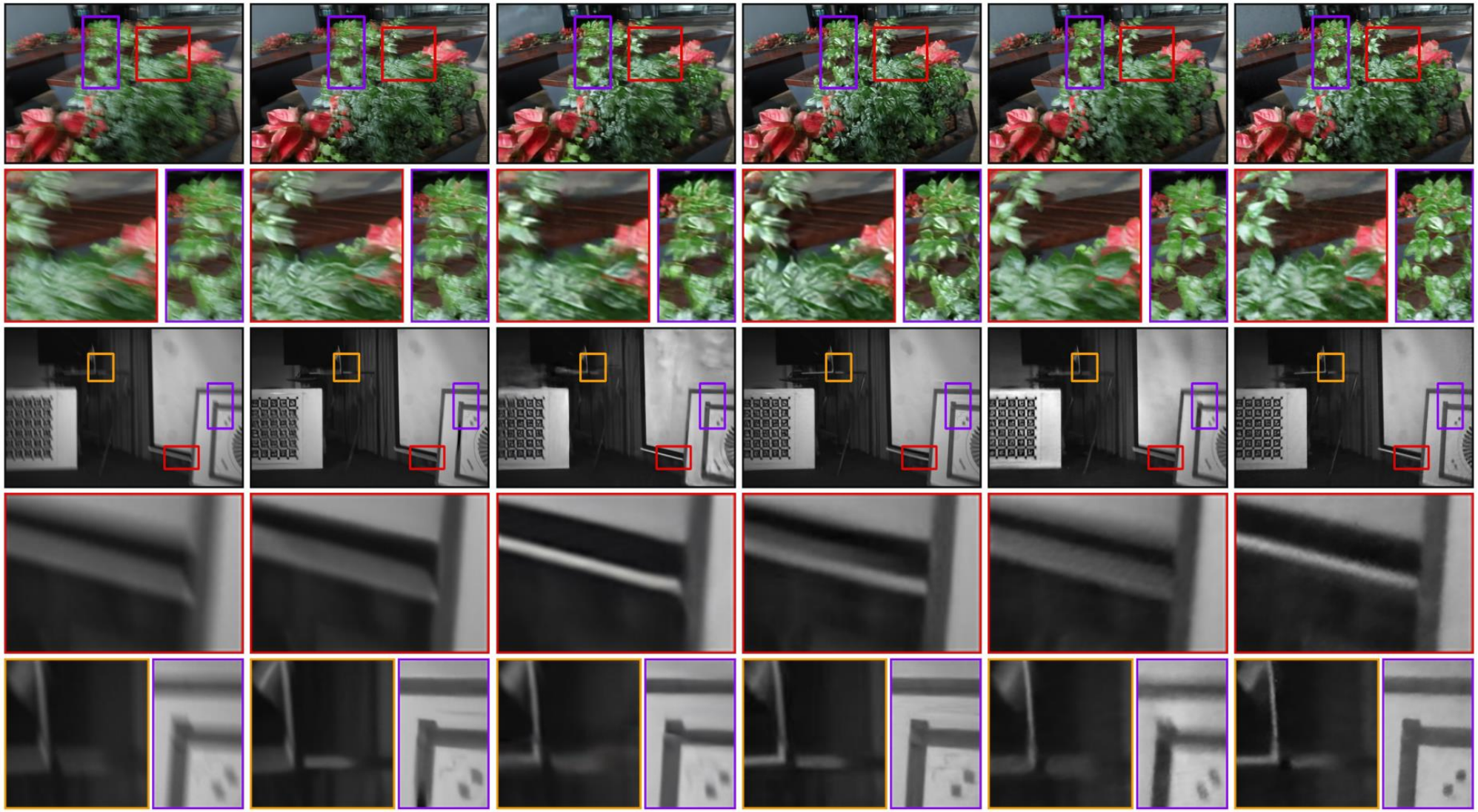


Figure 2. **Qualitative results of different methods with real datasets.**

Video 1. **Qualitative novel view synthesis results of different methods.**

	Cozy2room	Factory	Pool	Tanabata	Trolley
COLMAP-blur	.128±.090	.148±.093	.057±.026	.103±.090	.045±.042
BARF	.291±.111	.145±.088	.083±.036	.203±.091	.244±.074
BAD-NeRF (ours)	.050±.025	.033±.012	.020±.007	.016±.008	.007±.004

Table 3. **Pose estimation performance of BAD-NeRF on various blur sequences.** The results are in the absolute trajectory error metric (ATE). The COLMAP-blur represents the result of COLMAP with blurry images.

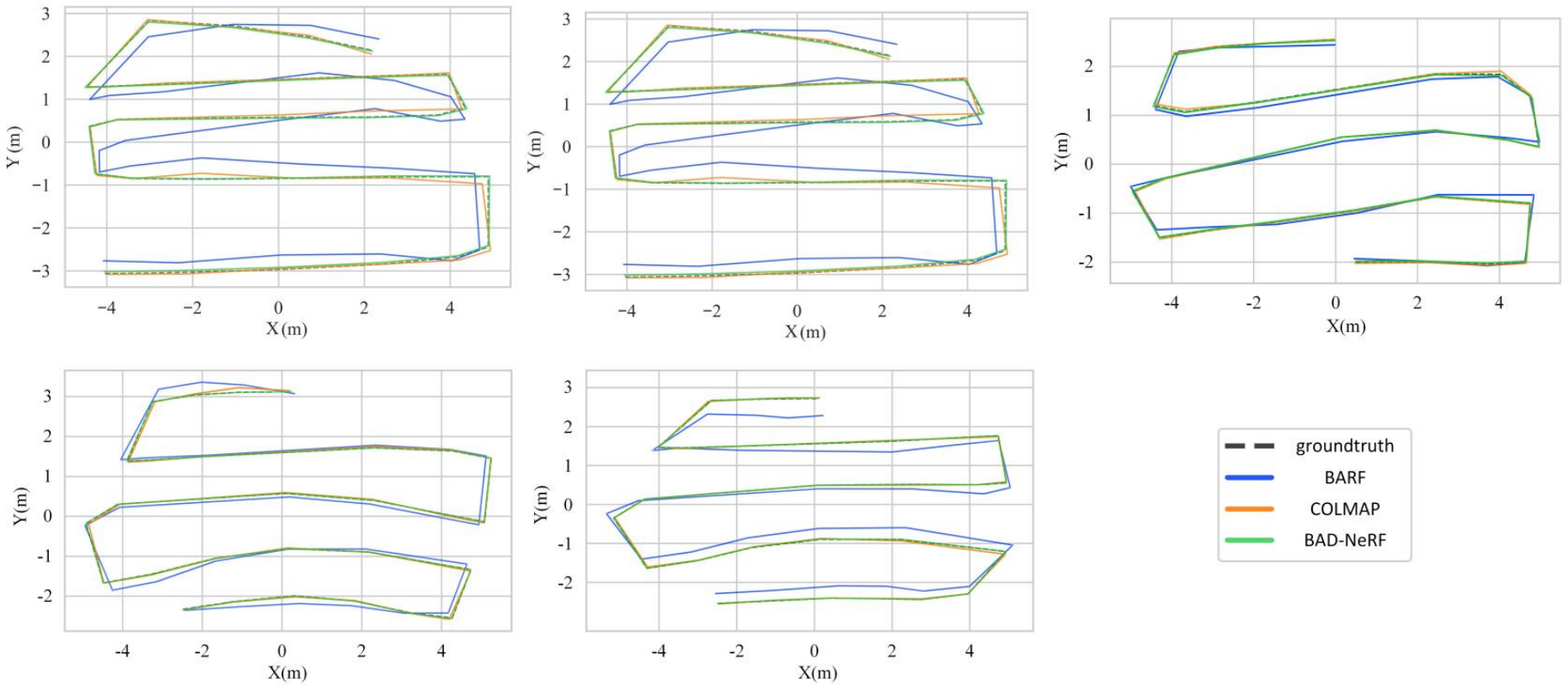


Figure 3. **Qualitative comparisons of estimated camera poses on Deblur-NeRF dataset.** These are results on *Cozy2room*, *Factory*, *Pool*, *Tanabata* and *Trolley* sequences respectively.

Thanks for watching!

Project Page: https://wangpeng000.github.io/BAD-NeRF

Source Code: https://github.com/WU-CVGL/BAD-NeRF

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