# ReCon-GS: Continuum-Preserved Gaussian Streaming for Fast and Compact Reconstruction of Dynamic Scenes

(NeurIPS 2025 Poster)

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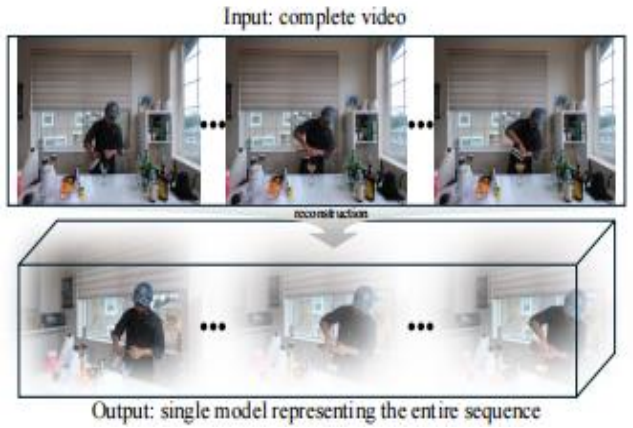
# Background

**Offline**
**Reconstruction**

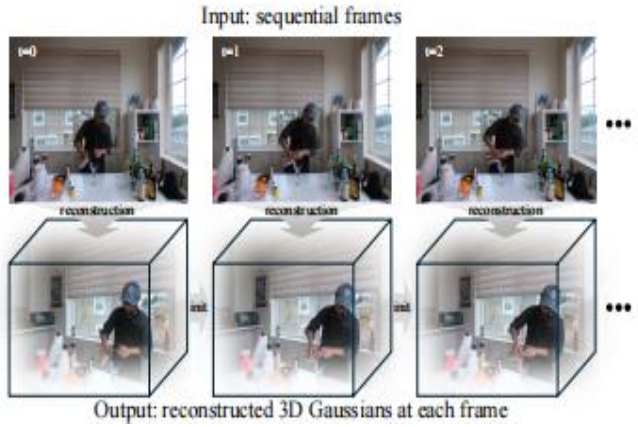



**Reconstructed All at Once**

- ✖ The video duration needs to be fixed.
- ✖ The complete video must be input at once.
- ✖ The relative parameters of the recording device need to be fixed.

→ **Poor** Practicality

**Online**
**Reconstruction**




**Reconstructed Frame by Frame**

→ **Good** Practicality

- ✖ Large-scale motion capture issues
- ✖ Error accumulation problems
- ✖ Single optimization objective limitations

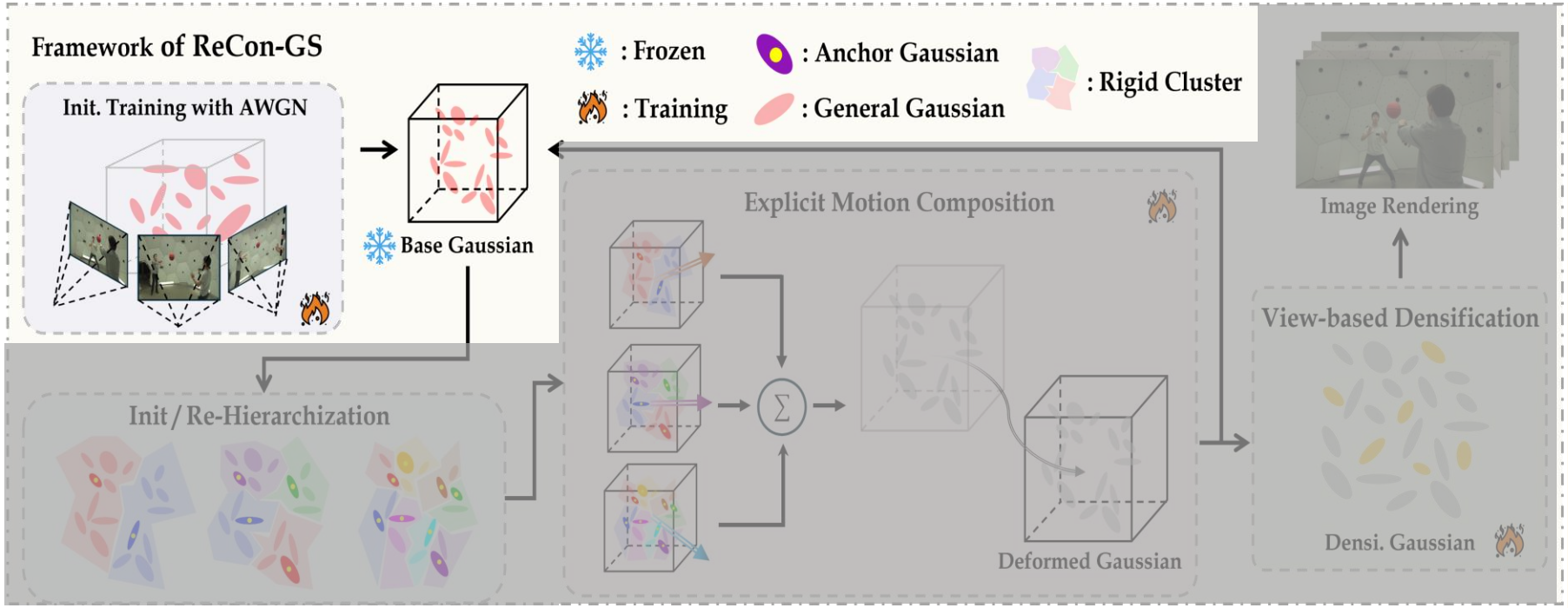
# Contribution

- We propose **Adaptive Hierarchical Motion Representation**, an anchor-driven multi-scale motion encoding paradigm, achieving an efficient yet compact motion representation. (~~Large-scale motion capture issues~~)
- We design a **Dynamic Hierarchy Reconfiguration strategy** to address *anchor drift-induced motion degradation*. (~~Error accumulation problems~~)
- By adjusting the density of Anchor Gaussians, ReCon-GS **dynamically balances storage and rendering quality**. (~~Single optimization objective limitations~~)
- Extensive experiments validate **ReCon-GS's superiority** over current SOTA streaming method.

# Methodology

1. Using 3DGS generate base Gaussian with AWGN injection

2. Through a carefully designed grid-based FPS algorithm, the base Gaussians are divided into multi-level Anchor Gaussians , which represent motion, and General Gaussians.

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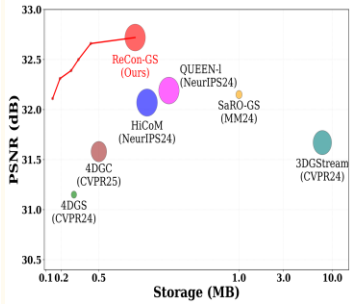


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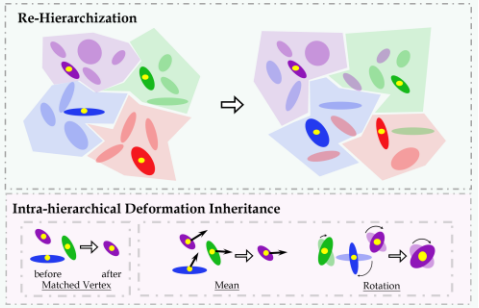
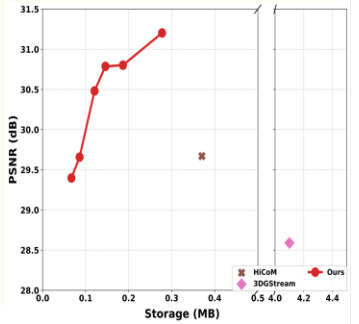
5. For specific frame intervals, ReCon-GS redistributes the Anchor Gaussians to optimize the inter-frame motion representation.



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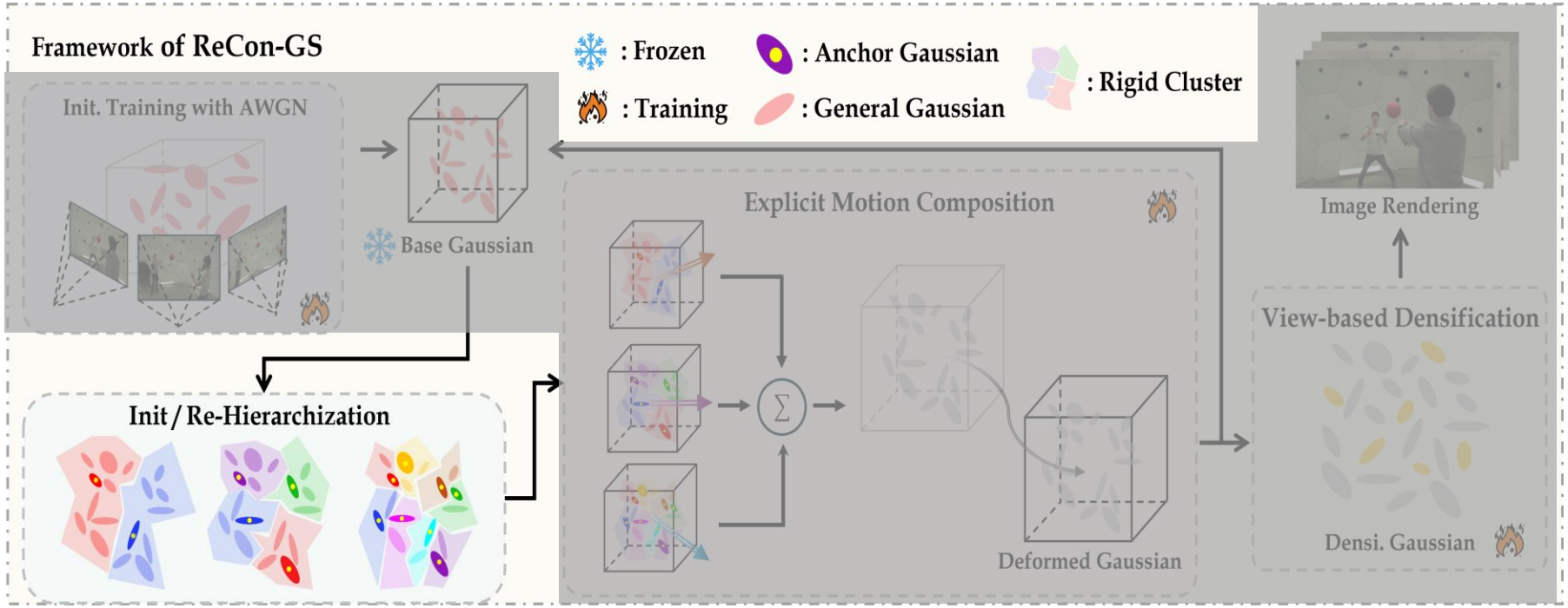


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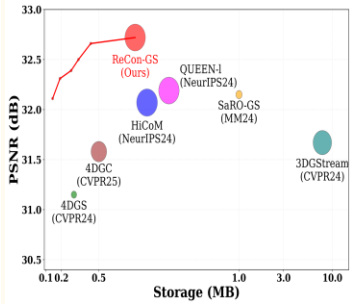


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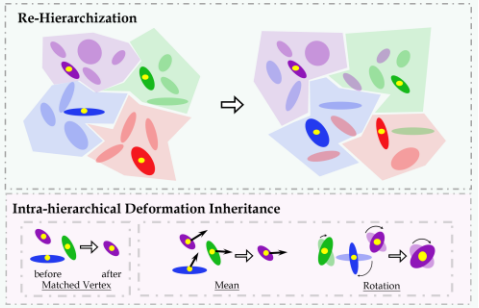


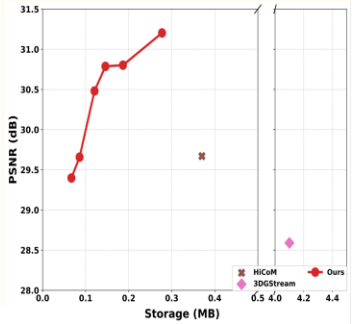

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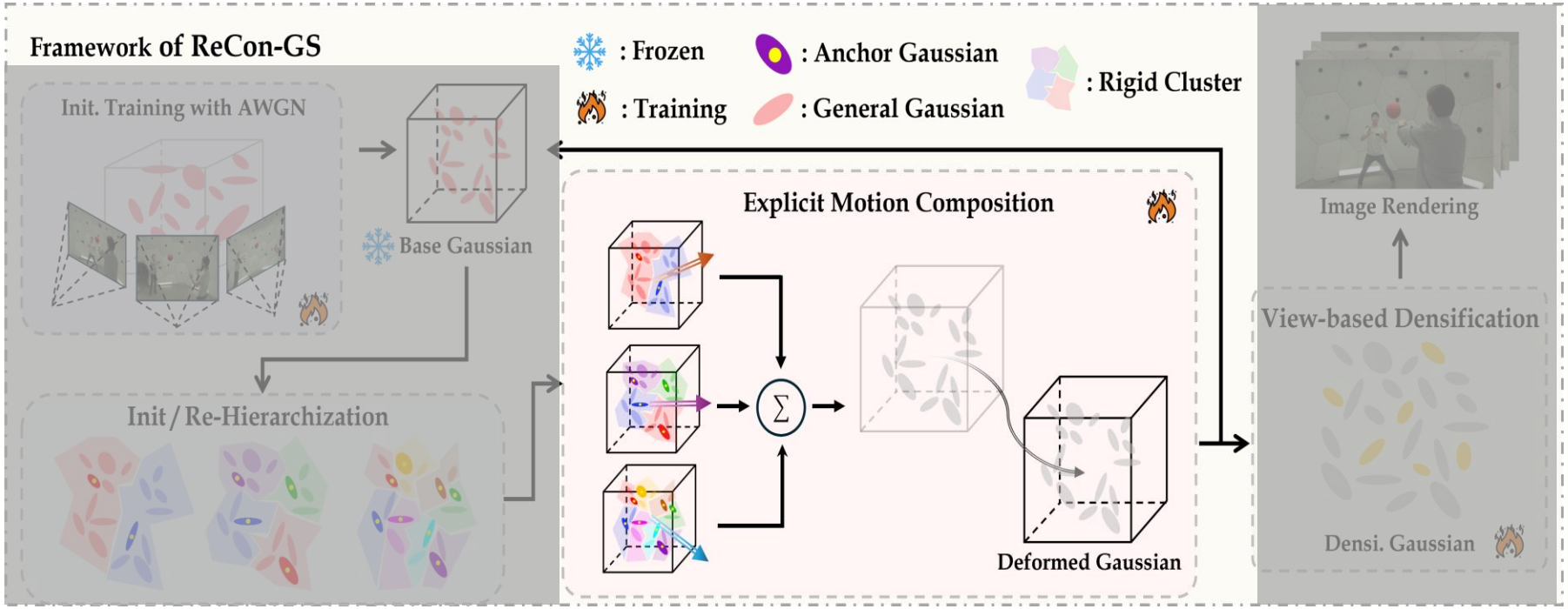


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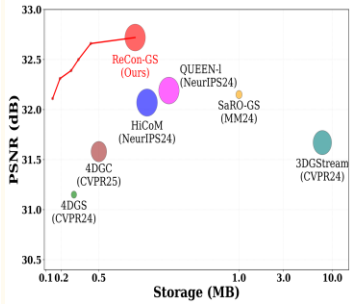


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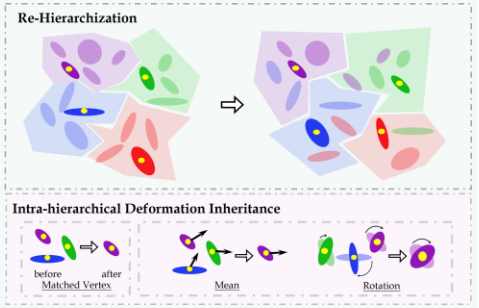


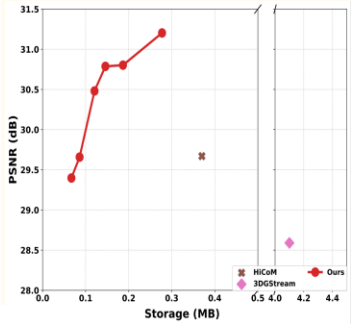

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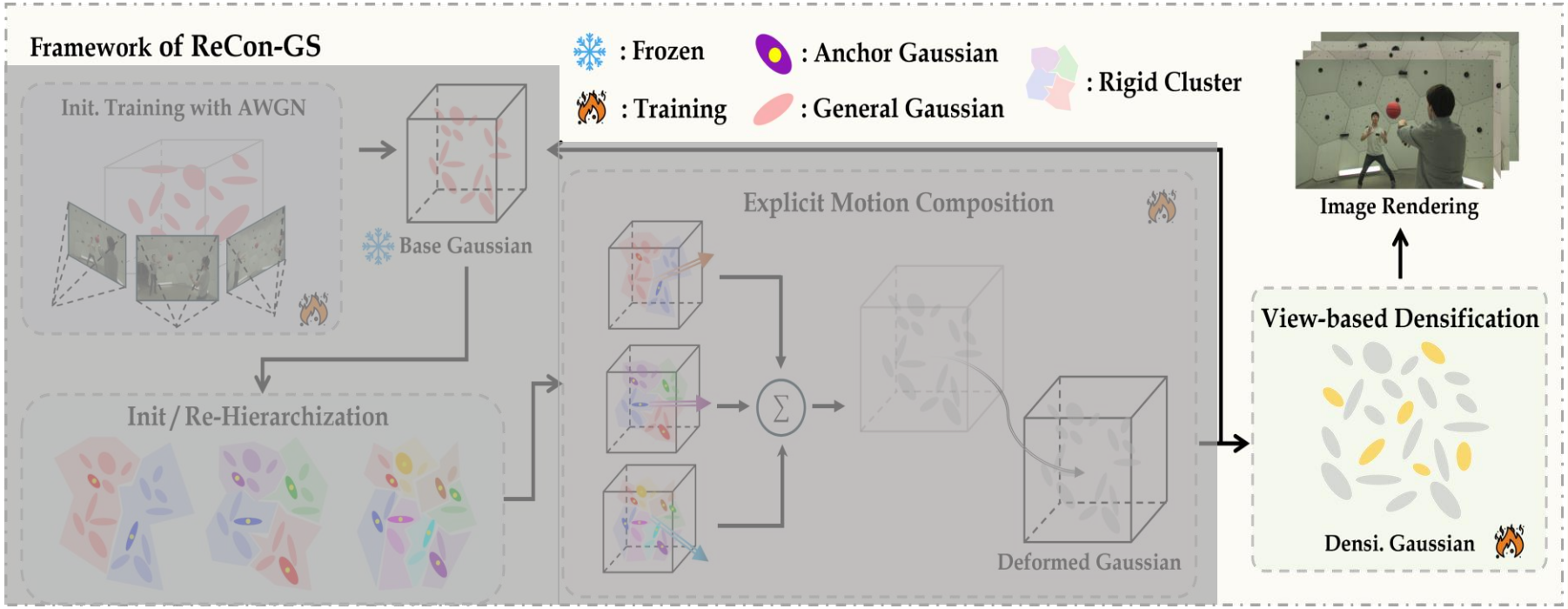


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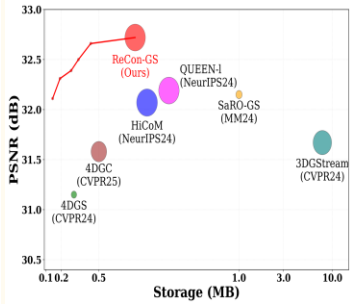


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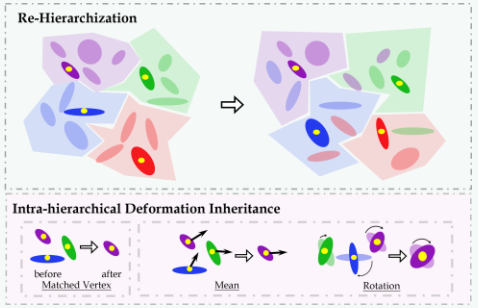


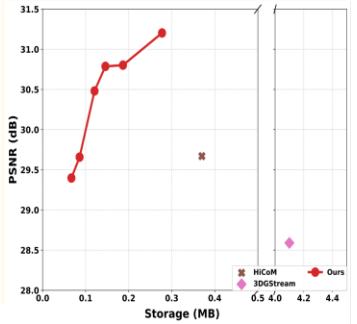

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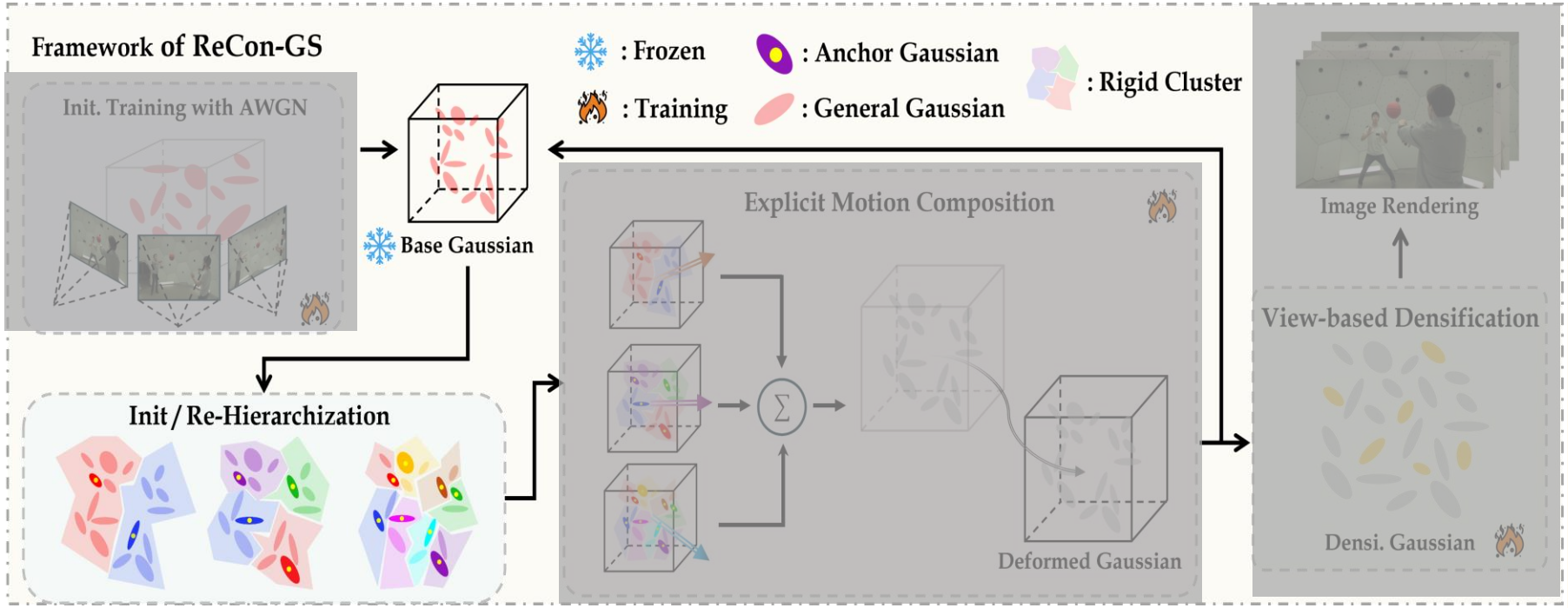


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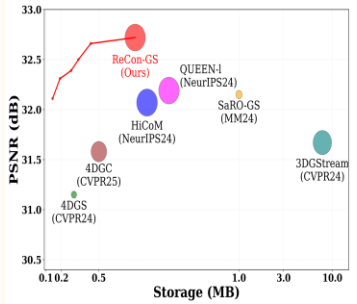


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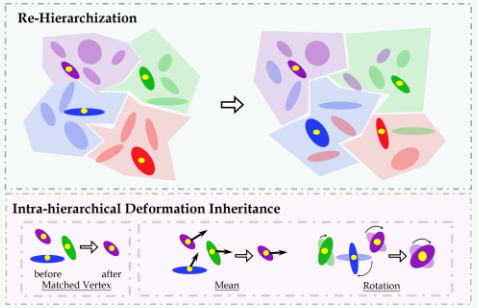


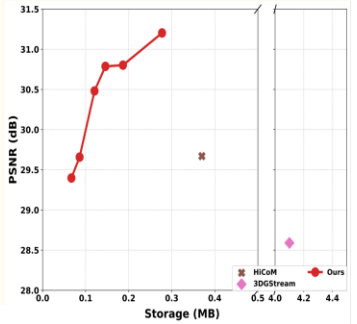

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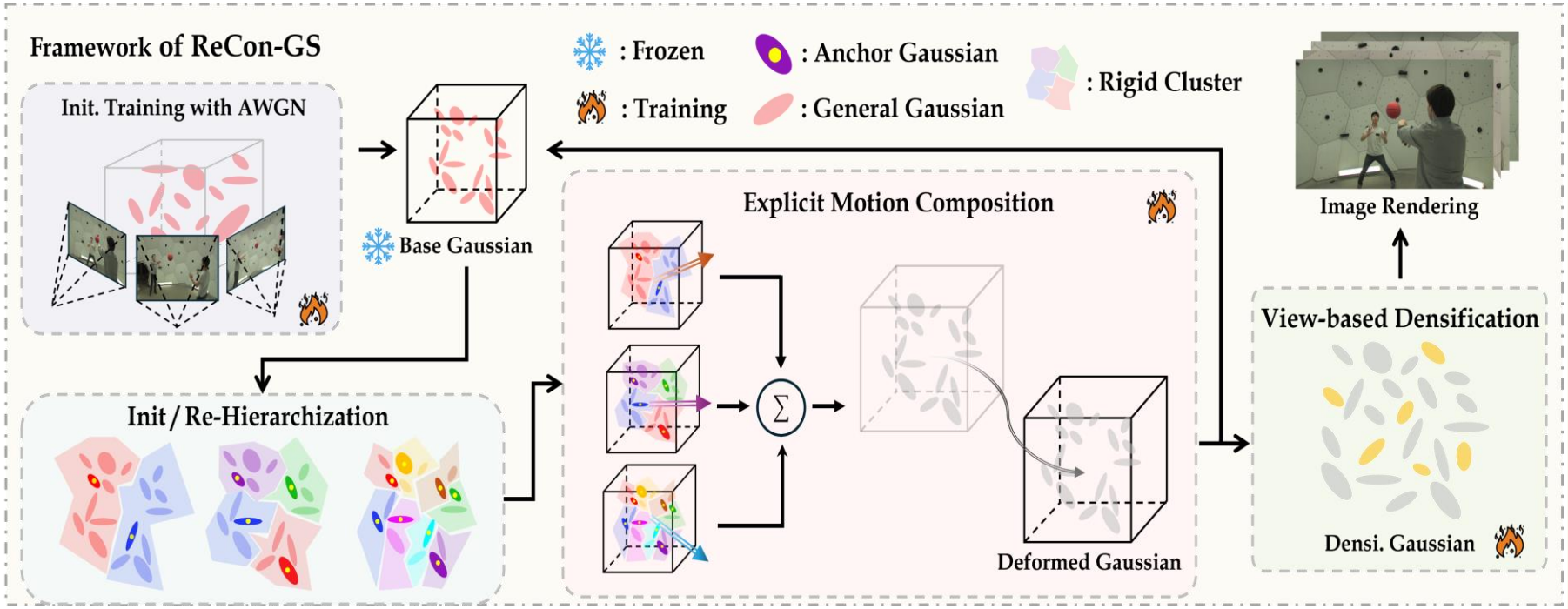


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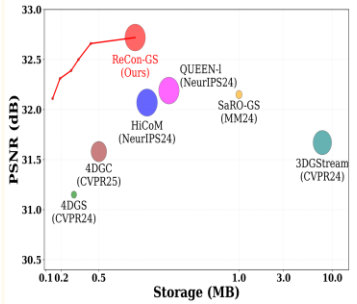


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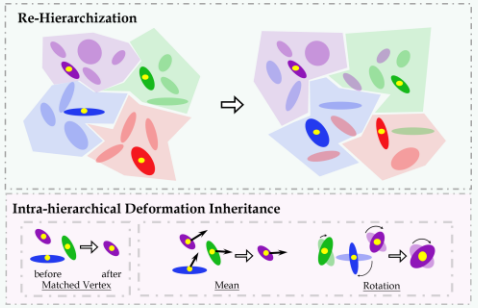
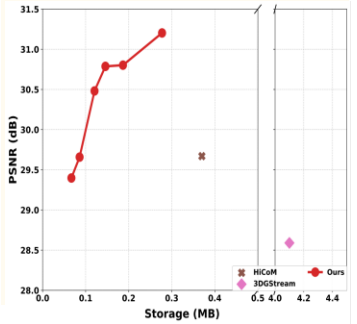


# Quantitative Results #1

- ReCon-GS achieves state-of-the-art (SOTA) performance on four commonly used datasets.

| Category | Method | PSNR (dB)↑ | SSIM↑ | LPIPS↓ | Storage (MB)↓ | Train (sec)↓ | Render (FPS)↑ |
|---|---|---|---|---|---|---|---|
| Offline | 4DGS† [1] | 31.36 | 0.950 | 0.131 | 0.3 | 7.8 | 30 |
| | STG [9] | 32.05 | 0.948 | - | 0.67 | 20 | 140 |
| | SaRO-GS [5] | 32.15 | - | - | 1.0 | - | 40 |
| | Swift4D [46] | 32.23 | - | - | 0.4 | 5.0 | 125 |
| | SplineGS [47] | 32.60 | - | - | - | 11 | 76 |
| Online | Dynamic 3DGS [42] | 30.67 | - | - | -/9.2 | 560 | - |
| | StreamRF [48] | 30.68 | 0.930 | - | 17.7/31.5 | 15 | 12 |
| | 3DGStream† [6] | 31.35 | 0.948 | 0.130 | 7.6/7.8 | 8.1 | 245 |
| | 4DGC [2] | 31.58 | 0.943 | - | -/0.5 | 50 | 168 |
| | QUEEN-l [4] | 32.19 | 0.946 | 0.136 | -/0.75 | 7.9 | 248 |
| | HiCoM† [3] | 32.08 | 0.953 | 0.130 | 0.48/0.69 | 6.6 | 255 |
| | **ReCon-GS** (ours) | 32.66 | 0.957 | 0.123 | 0.40/0.44 | 6.4 | 250 |

Quantitative Results on N3DV dataset

| Category | Method | PSNR (dB)↑ | SSIM↑ | Storage (MB)↓ | Render (FPS)↑ |
|---|---|---|---|---|---|
| NeRF-based | HyperReel [49] | 31.80 | 0.906 | 1.20 | 4 |
| Offline | STG [9] | 33.60 | - | 1.10 | 87 |
| | Ex4DGS [34] | 33.62 | 0.916 | 2.81 | 72 |
| Online | E-D3DGS [50] | 33.24 | 0.907 | 1.54 | 79 |
| | **ReCon-GS** (ours) | 33.83 | 0.932 | 0.82 | 207 |

Quantitative Results on Technicolor dataset

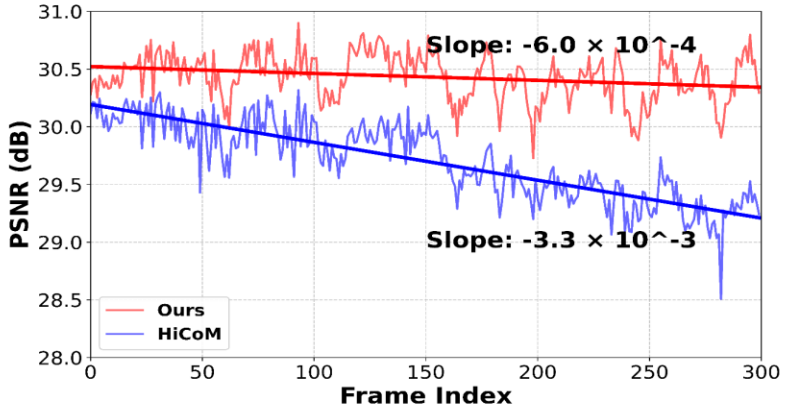
| Method | Meet Room | | | | PanopticSports | | | |
|---|---|---|---|---|---|---|---|---|
| | PSNR (dB)↑ | Storage (MB)↓ | Train (sec)↓ | Render (FPS)↑ | PSNR (dB)↑ | Storage (MB)↓ | Train (sec)↓ | Render (FPS)↑ |
| 3DGStream† [6] | 29.30 | 4.0/4.1 | 4.77 | 260 | 23.02 | 7.9/8.1 | 5.87 | 369 |
| IGS-l* [12] | 30.13 | 1.26 | 2.67 | 252 | - | - | - | - |
| HiCoM† [3] | 29.57 | 0.30/0.39 | 3.91 | 236 | 29.17 | 1.33/2.11 | 8.60 | 358 |
| Ours | 30.84 | 0.28/0.30 | 3.86 | 256 | 29.33 | 0.64/0.8 | 7.14 | 410 |

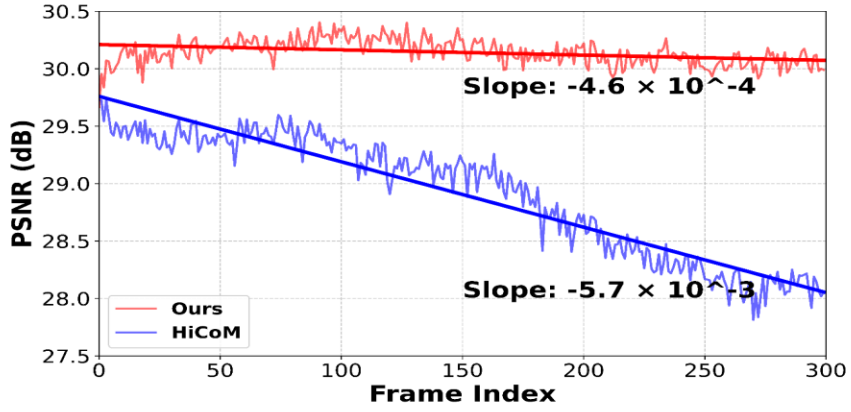
Quantitative Results on Meet Room and PanopticSports datasets

# Quantitative Result #2

- ReCon-GS effectively tackles the error accumulation issue. Additionally, it can adaptively adjust its storage footprint based on user requirements.

Flame Salmon

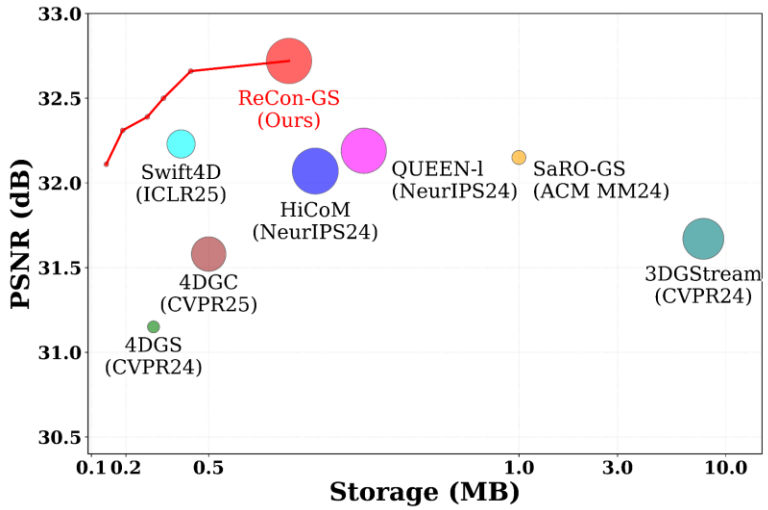


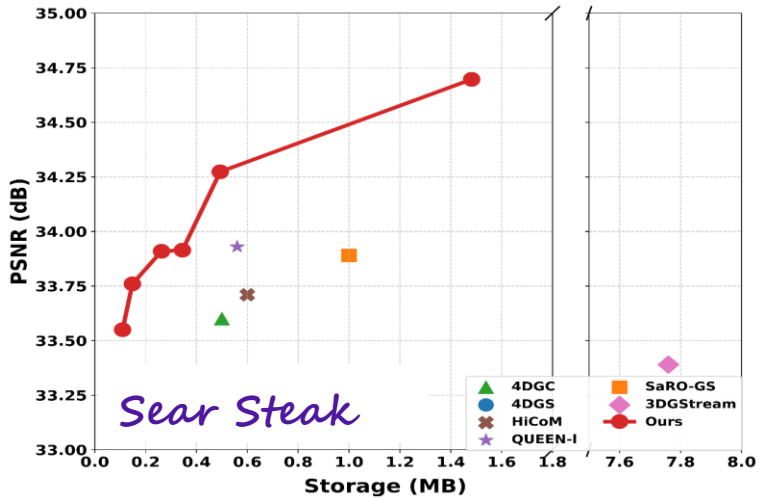



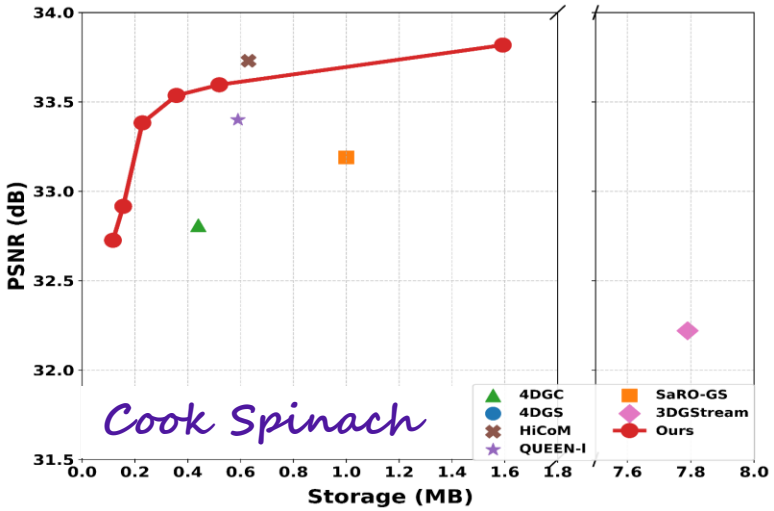

Coffee Martini

Anti-Error Accumulation

Rate-Distortion Performance

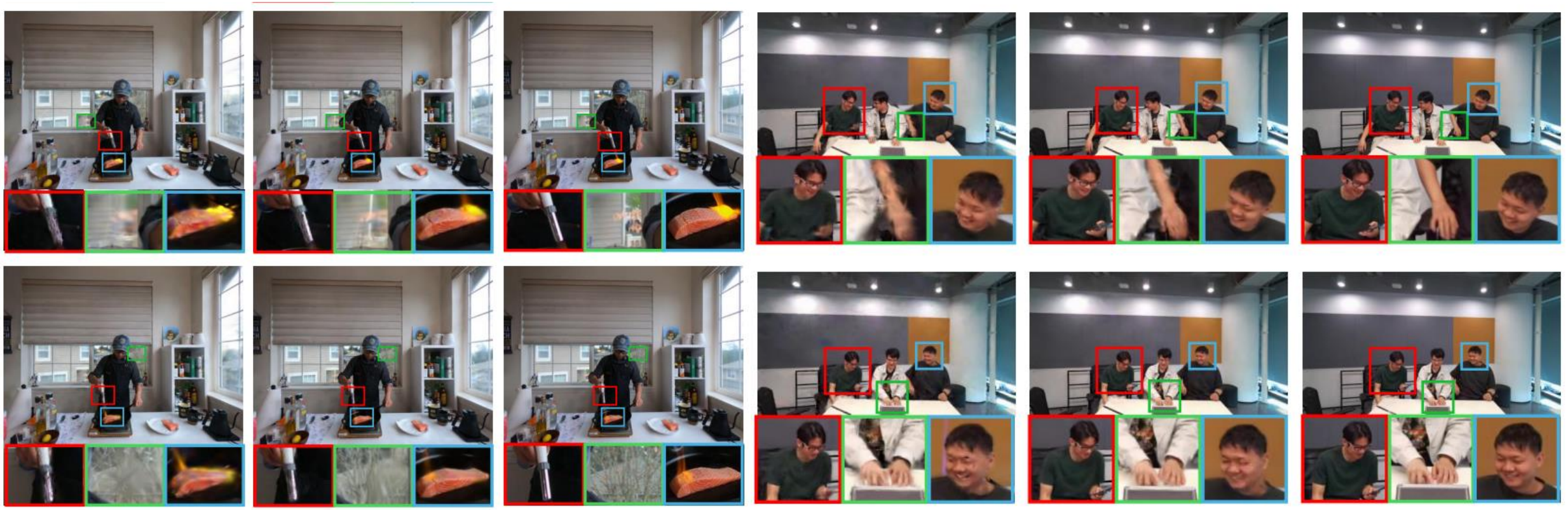


# Qualitative Results #1

- Compared to current state-of-the-art methods, ReCon-GS more effectively enhances its perceptual quality.



# Qualitative Results #2

- Compared to current state-of-the-art methods, ReCon-GS more effectively mitigates flickering artifacts in 3DGS.

# Qualitative Results #2

- Thank you!

Paper:

Code:

VILLA

https://villa.jianzhang.tech/

QR-code of our homepage: