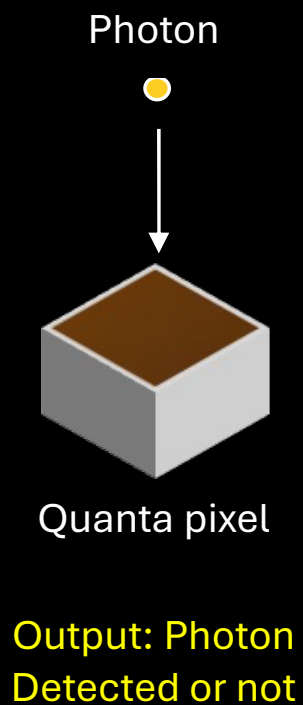


# gQIR: Generative Quanta Image Reconstruction

# What are Quanta Sensors?



Simulated Quanta  
Sensor Output



Ground Truth

# Why Use These Sensors In the First Place?



Low Light Conditions

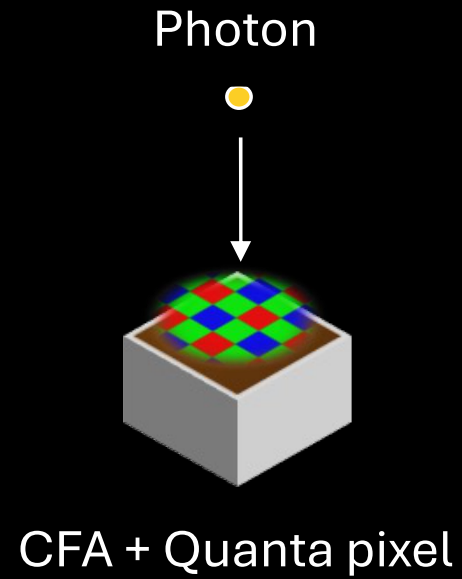
Ma et al. 2020, 2023  
Zhang et al. 2024  
Chennuri et al. 2024



High Speed Phenomena (2k fps)

XD-Dataset Scene: JetEngine

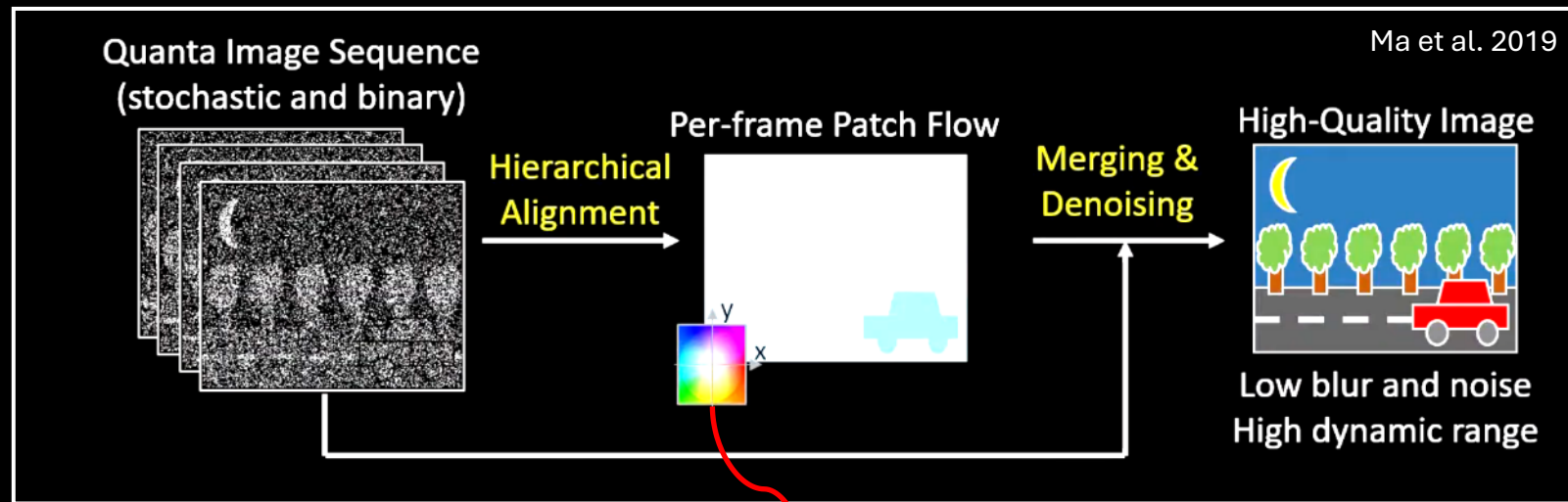
# For the First Time, Quanta Sensors See **Color** as well





# How Do Quanta ISPs Operate?

*The Align-and-Aggregate Philosophy*



Breaks down under extreme motion (extreme photon starvation) and/or  
deforming and/or non-Lambertian conditions

# The Need - Understanding The World Apriori Reconstruction

Ways:

1. Learn Physics

2. Understand the Natural Image Manifold

Internet-scale Pretrained  
Generative Priors!

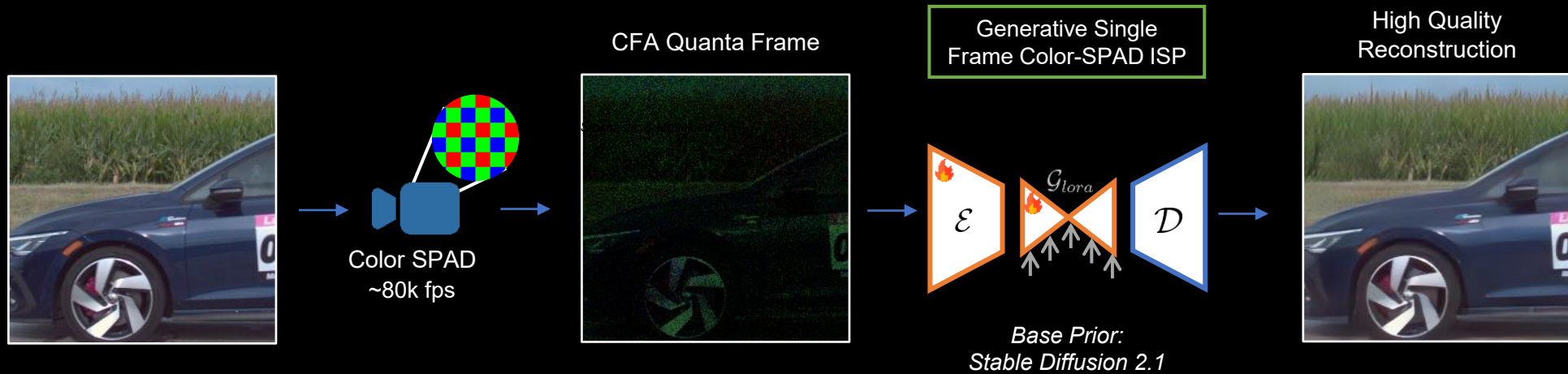


Stable Diffusion v2.1-768 CLIP | <https://stability.ai/news/stablediffusion2-1-release7-dec-2022>



<https://stability.ai/>

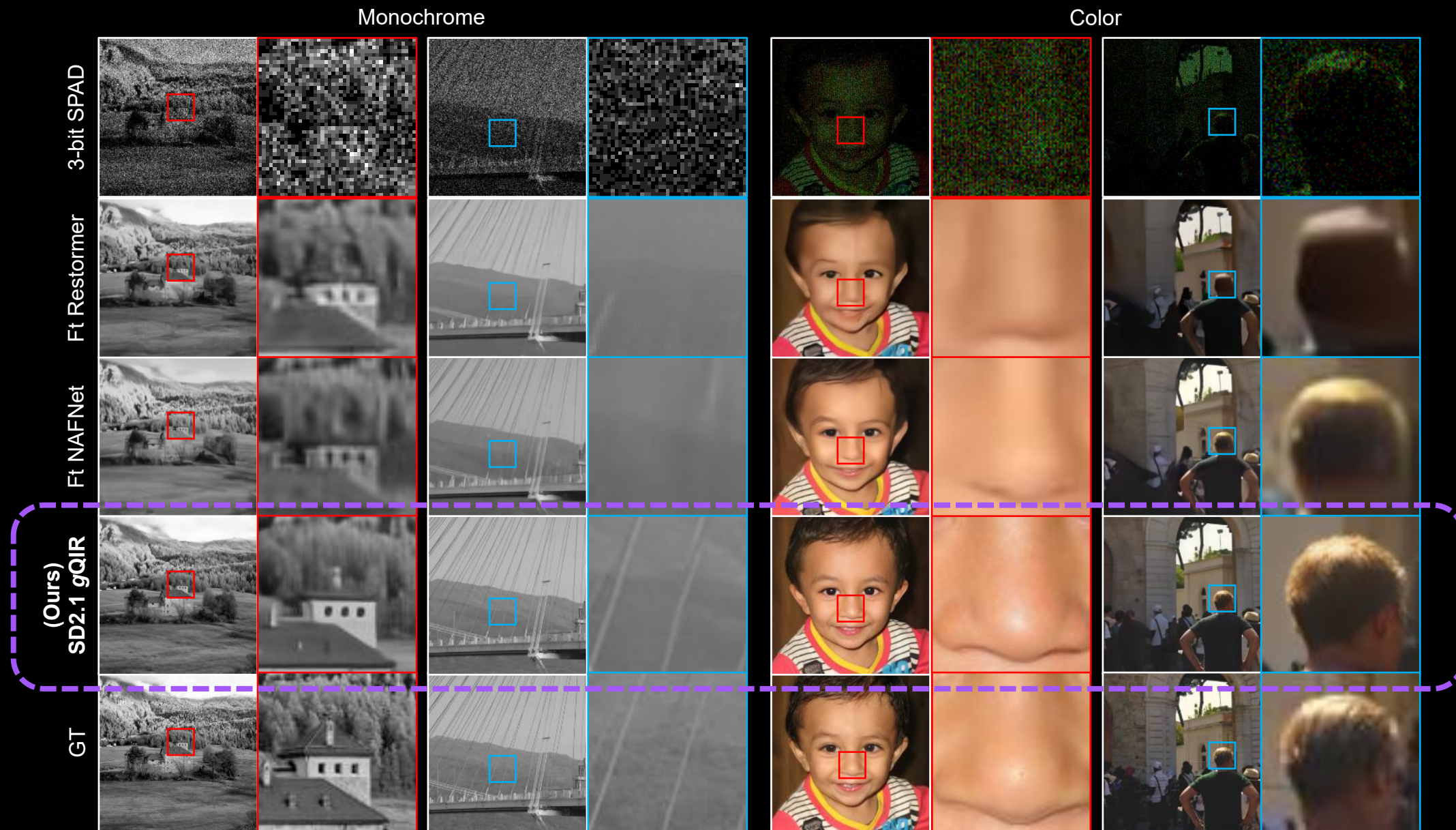
# Overview: Generative Quanta Image Reconstruction



Breaking the Age Old Align-and Aggregate Philosophy with Generative Priors

*Single Quanta Frame Reconstruction*

# Comparing with Single Frame Adapted Baselines

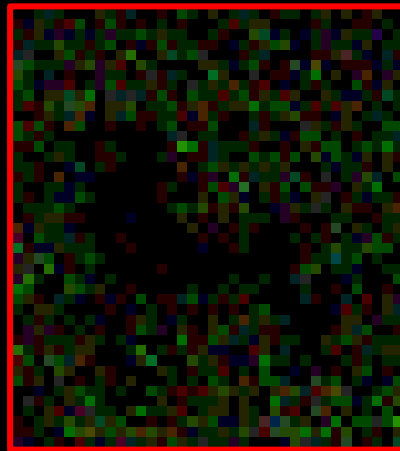
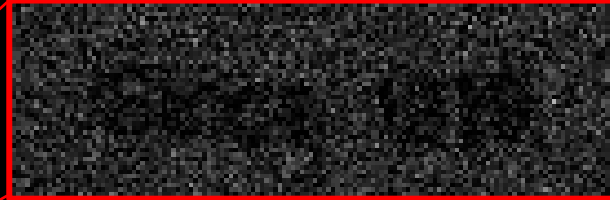




# What are Ambiguous Regions in Quanta Reconstruction?



3-bit Mono SPAD



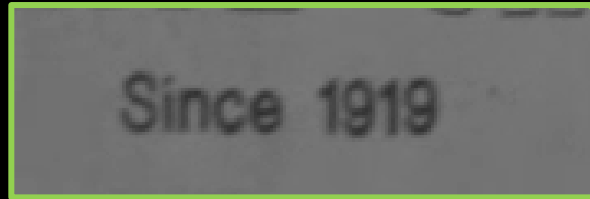
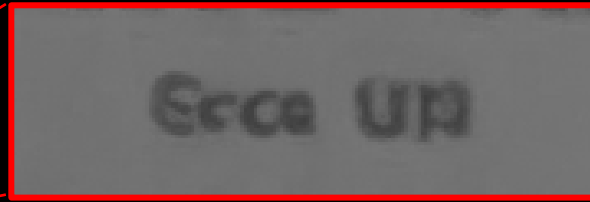
What Do You See?



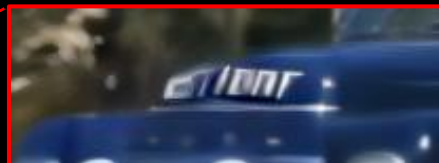
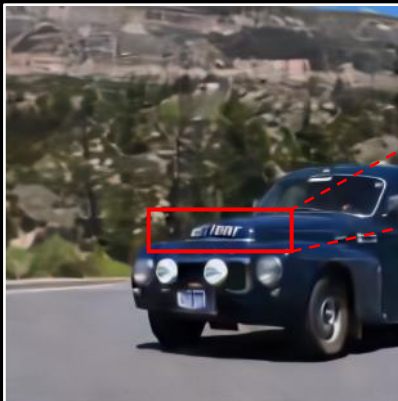
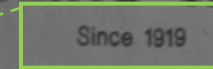
3-bit Color SPAD

# The Text Problem

gQIR Reconstruction



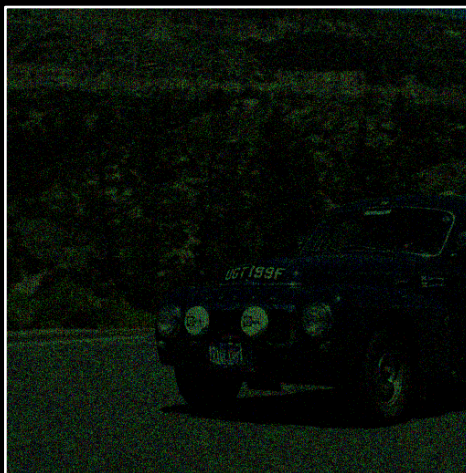
Ground Truth





# Solution: Scale The Latent Space 4x

3-bit Color SPAD



SD2.1 qVAE



SD3.5 qVAE

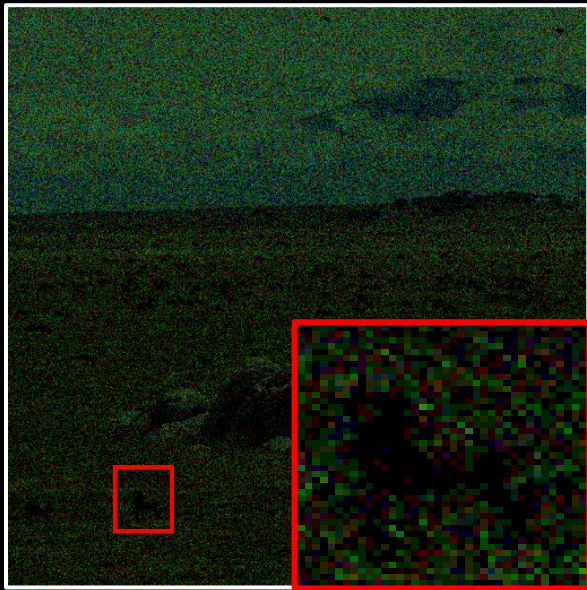


GT



# Ambiguity is Semantic Guidance Opportunity?

3-bit Color SPAD



Prompt:  
“... Wild Animal...”



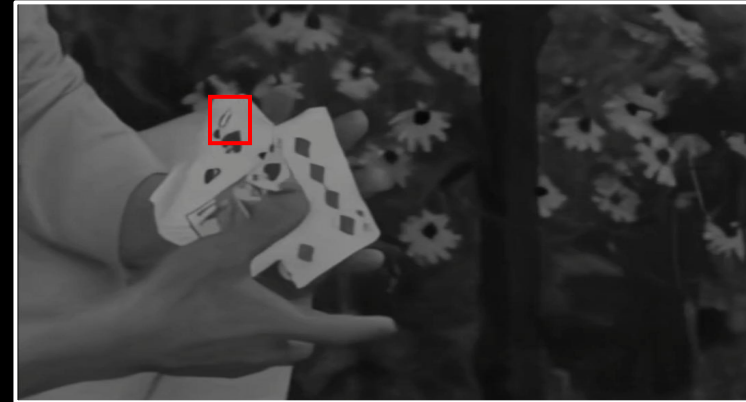
Prompt:  
“... Rock ...”



Was it a rock or a wild animal?

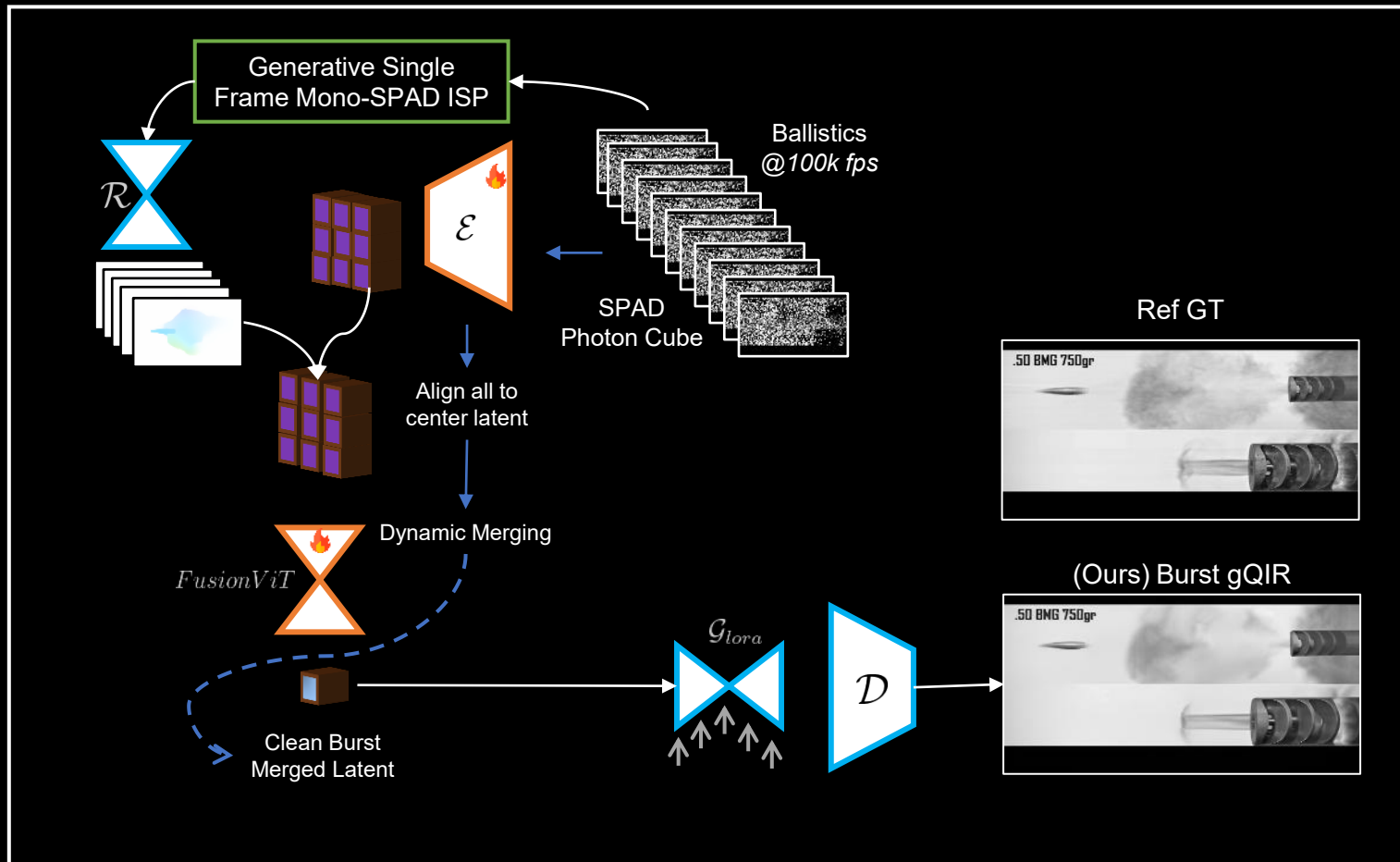


# Reconstructing Videos with gQIR



Critical Issue: Content Drift

# Can we feed temporal context to gQIR?



Generalizing the  
Align-and-Aggregate  
philosophy to the  
latent space

# Burst-gQIR vs. gQIR

3-bit SPAD



gQIR (Stage 2)



Burst-gQIR (Stage 3)



Ground Truth



# Burst-gQIR compared with existing quanta literature





# Outlook

