

EffiDec3D: An Optimized Decoder for High-Performance and Efficient 3D Medical Image Segmentation

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Background

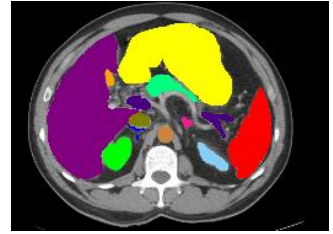
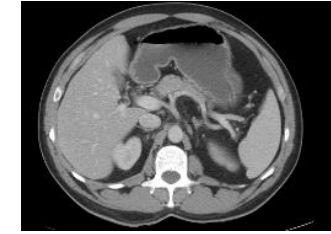
 **3D Medical Image Segmentation:** Automatically labels organs, lesions, or tumors in volumetric CT/MRI scans.

 **Clinical Value:** Critical step in accurate disease diagnosis, surgical planning, and treatment monitoring.

 **SOTA 3D Networks** SwinUNETR, SwinUNETRv2, 3D UX-Net, MedNeXt achieve high accuracy, but demand large memory and compute resources.

 **Deployment Barrier:** Their computational complexity blocks real-time use in point-of-care and low-resource settings (limited to no GPU access).

 We introduce **EffiDec3D**, a plug-and-play decoder optimized for computational efficiency without segmentation performance loss.



A frame (left) from a 3D CT volume with segmentation mask overlay (right).



disease diagnosis
and monitoring

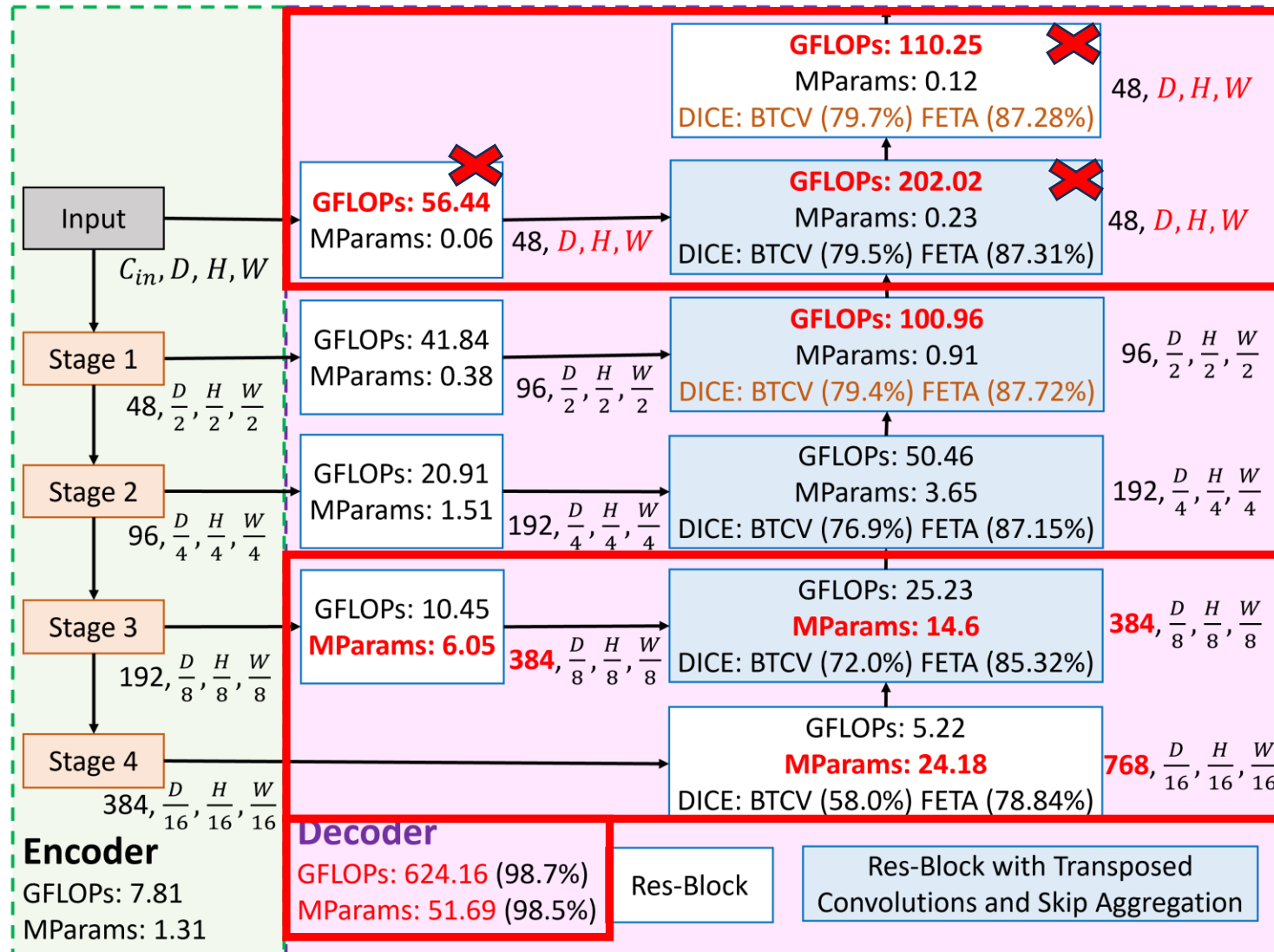


surgical planning



Point-of-care ultrasound

Architecture Complexity Analysis



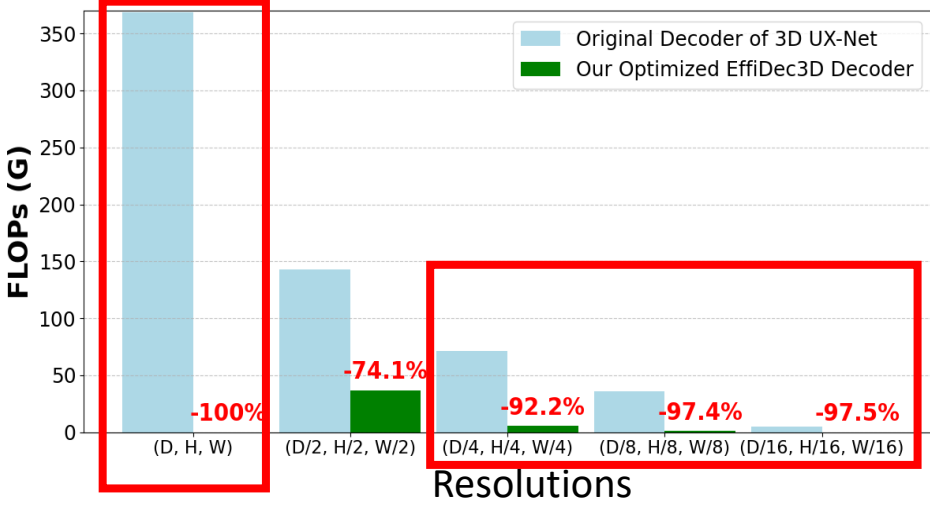
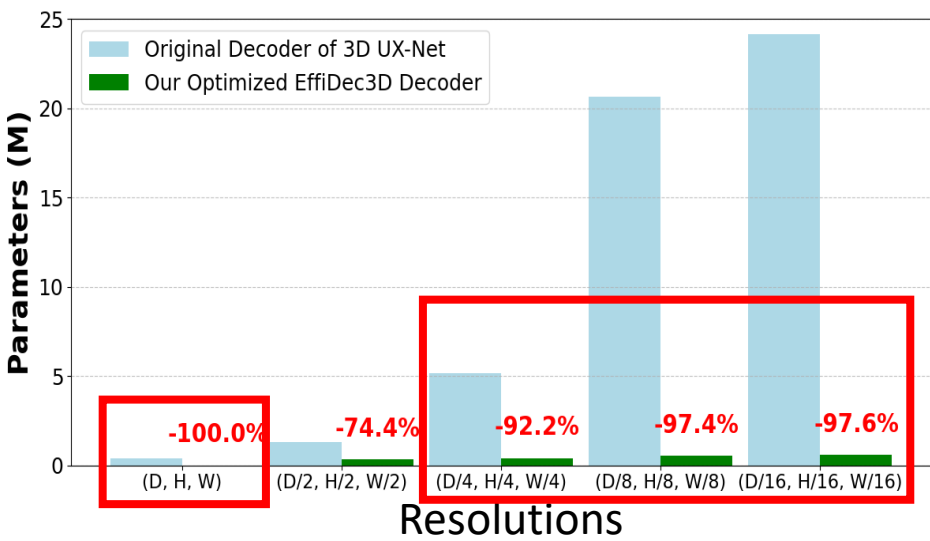
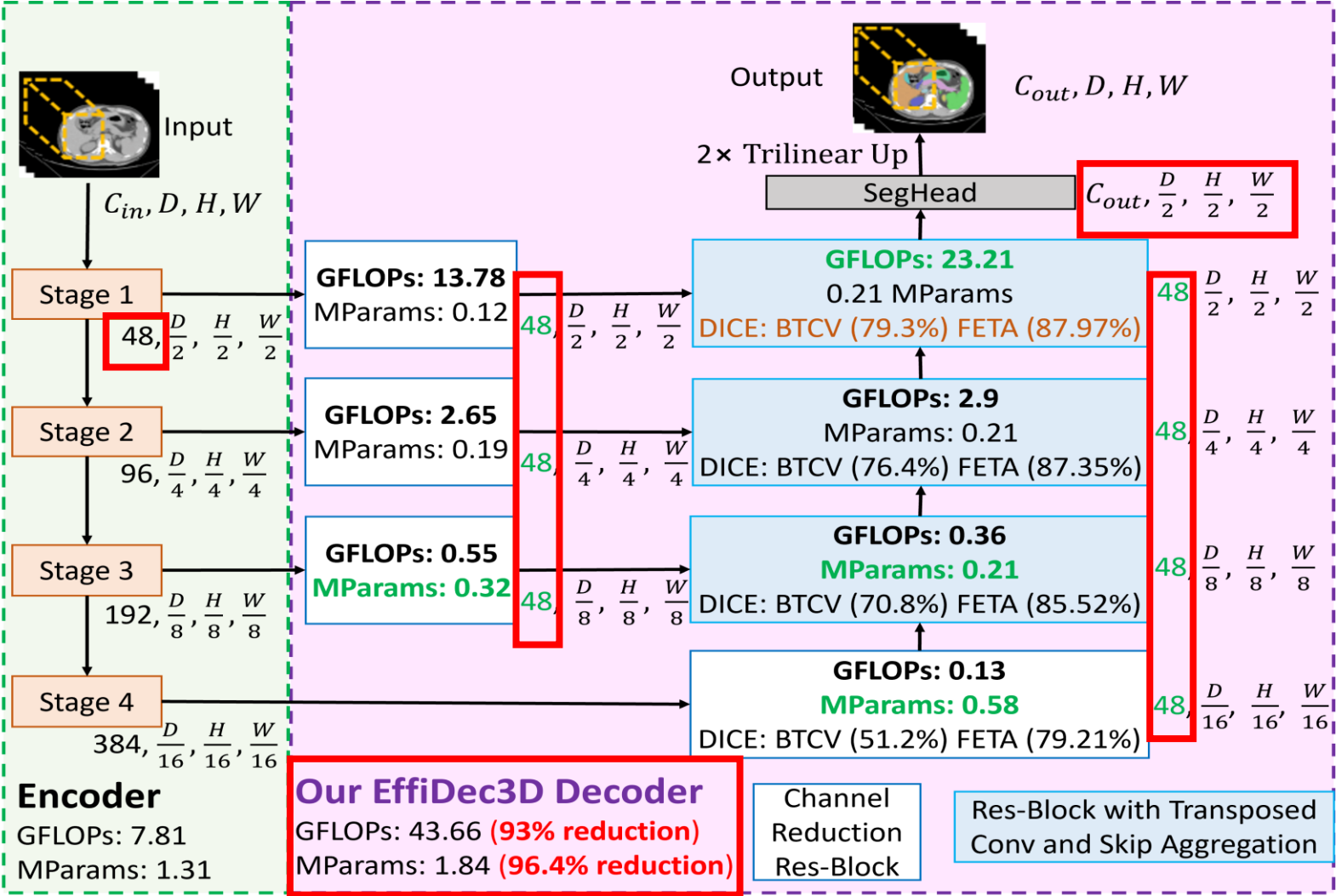
~60% FLOPs

Main Culprits → Optimization Strategies

- High FLOPs in High-Resolution Decoder Stages → Resolution Restriction
- High #Parameters for Excessive Decoder #Channel → Channel Reduction

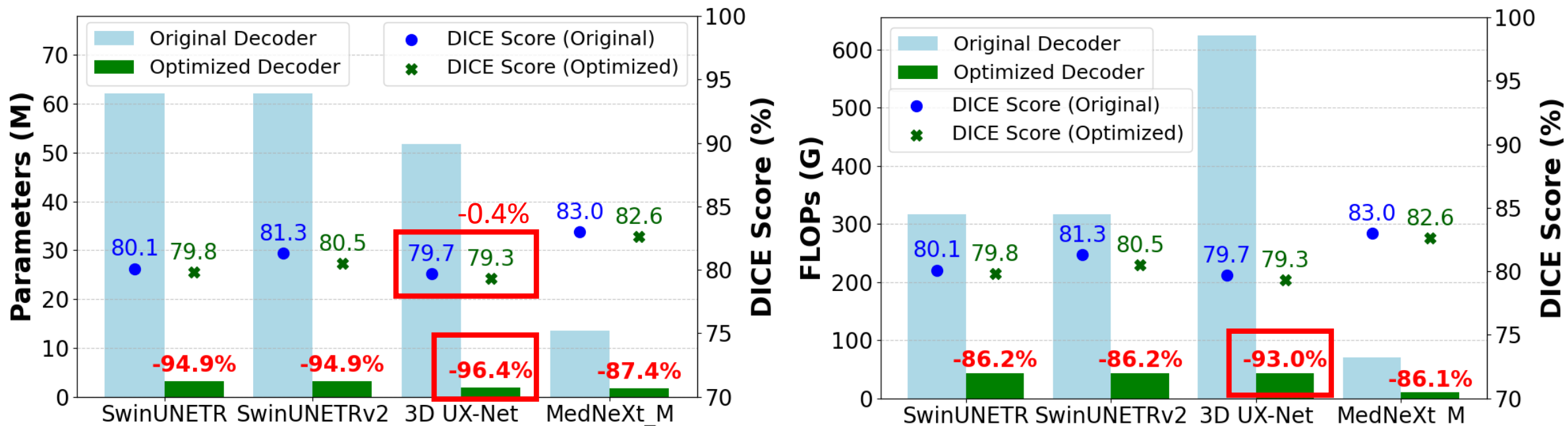
~87% Parameters

Optimized Architecture



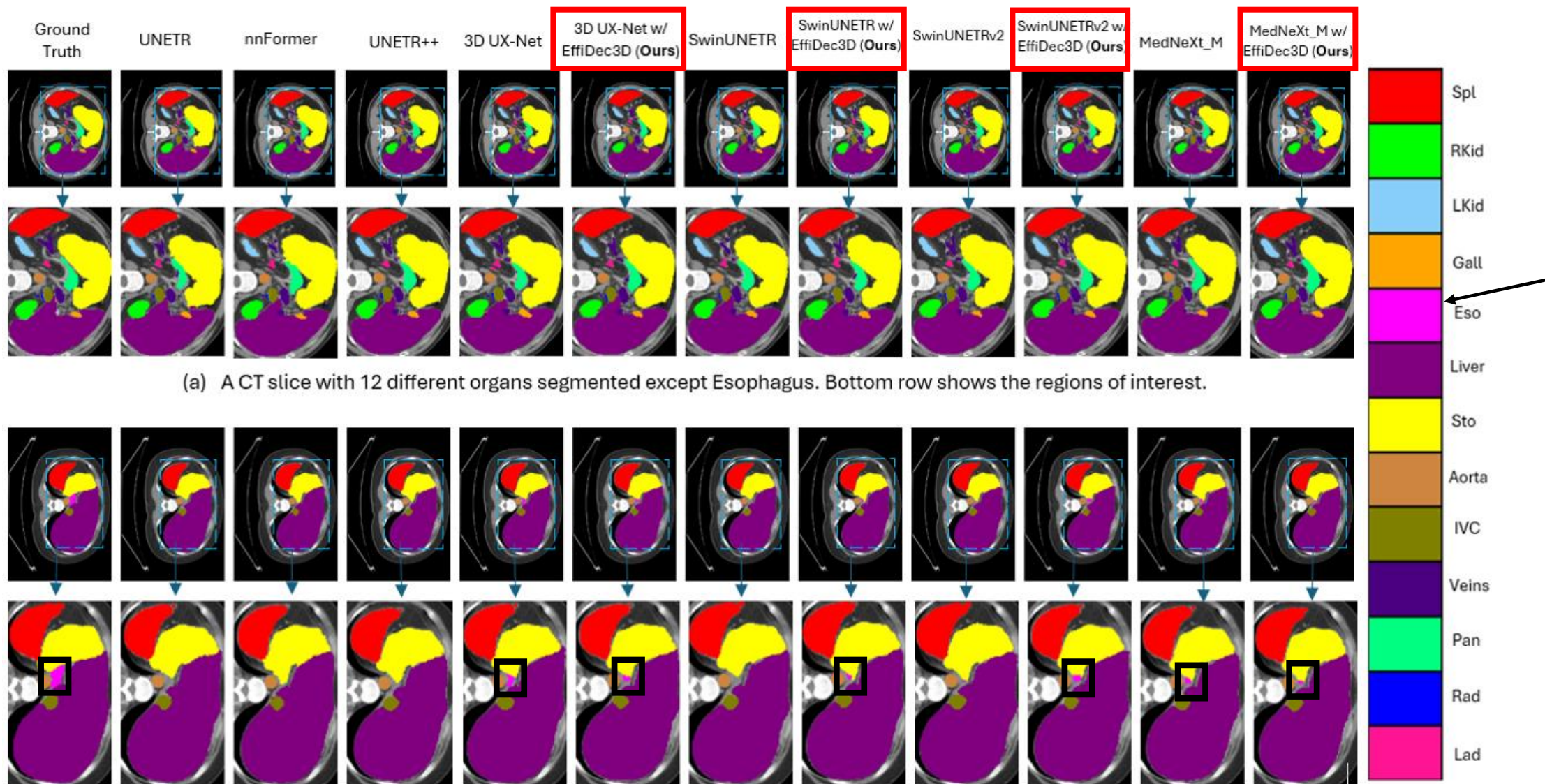
Optimized 3D UX-NET (Encoder + Our EffiDec3D Decoder) **51.47 GFLOPs, 3.15 MPARAMs**

Experimental Results



Our optimized EffiDec3D decoder achieves up to **96.4% reduction** in #Params and **93.0% reduction** in #FLOPs compared to the original decoder.

Qualitative Results



Key Takeaways



EffiDec3D: Fast, Lightweight, and Accurate Decoder



Plug-and-play with 3D UX-Net, SwinUNETR, SwinUNETRv2, MedNeXt

- **Parameters:** Reduction up to 16.8×
- **FLOPs:** Reduction up to 12.3×
- **Inference Time:** Reduction up to 4.5× (GPU) and 8× (CPU)



Evaluated on 13 tasks: BTCV13, BTCV8, FeTA, 10 MSD tasks

- **DICE score** increases up to +1.33% (avg. on 13 tasks)
- DICE score increases in simple datasets, but marginal drops in complex multi-class datasets

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My Website



Code



SLD Group

