

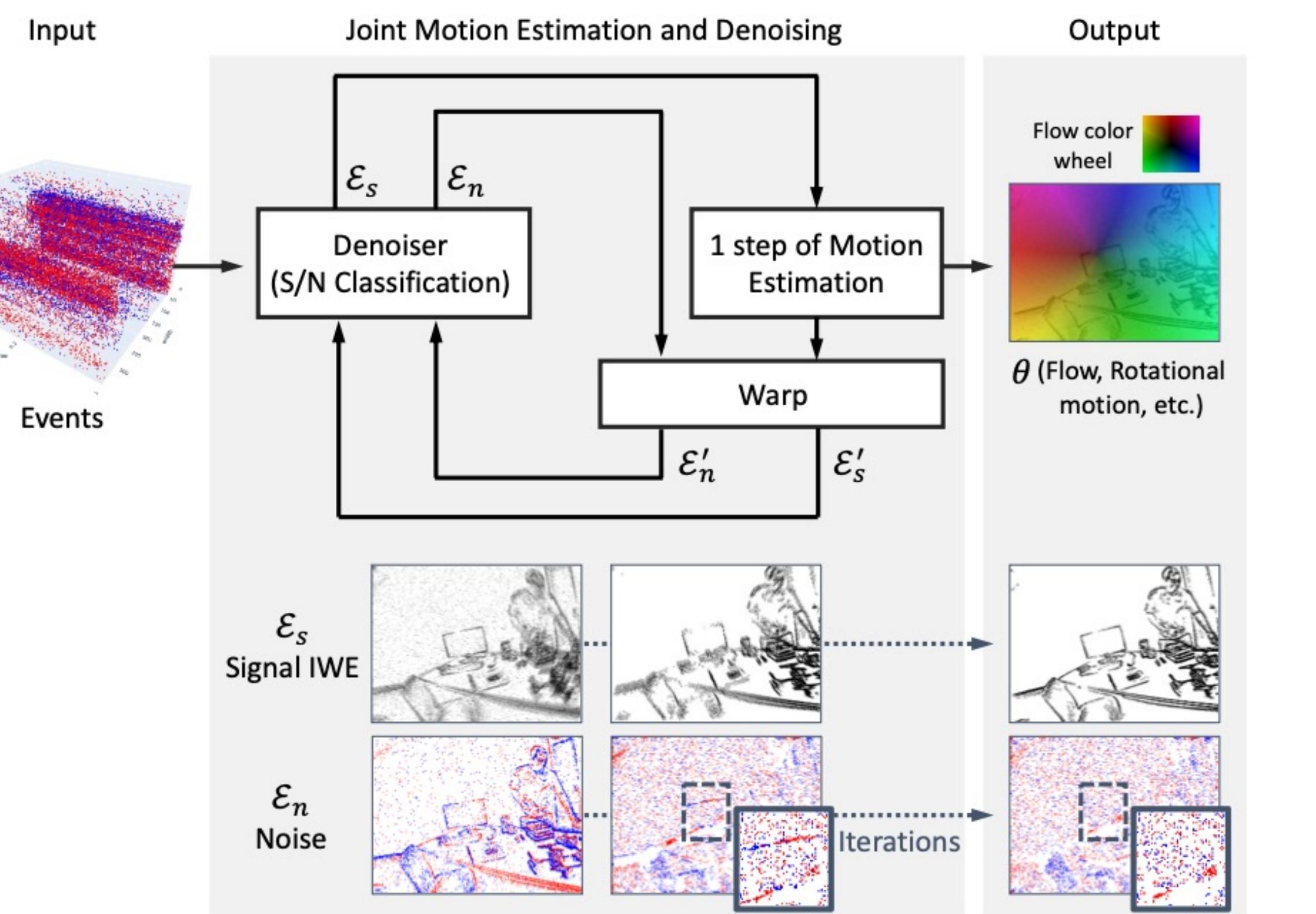
# Simultaneous Motion And Noise Estimation with Event Cameras

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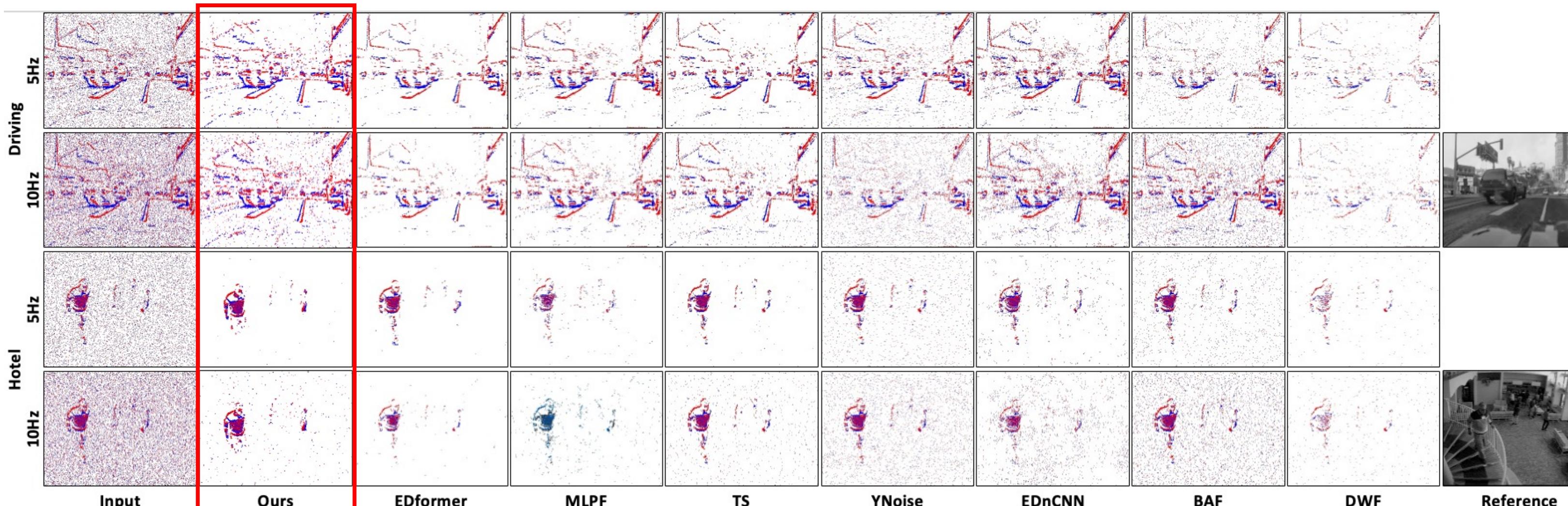
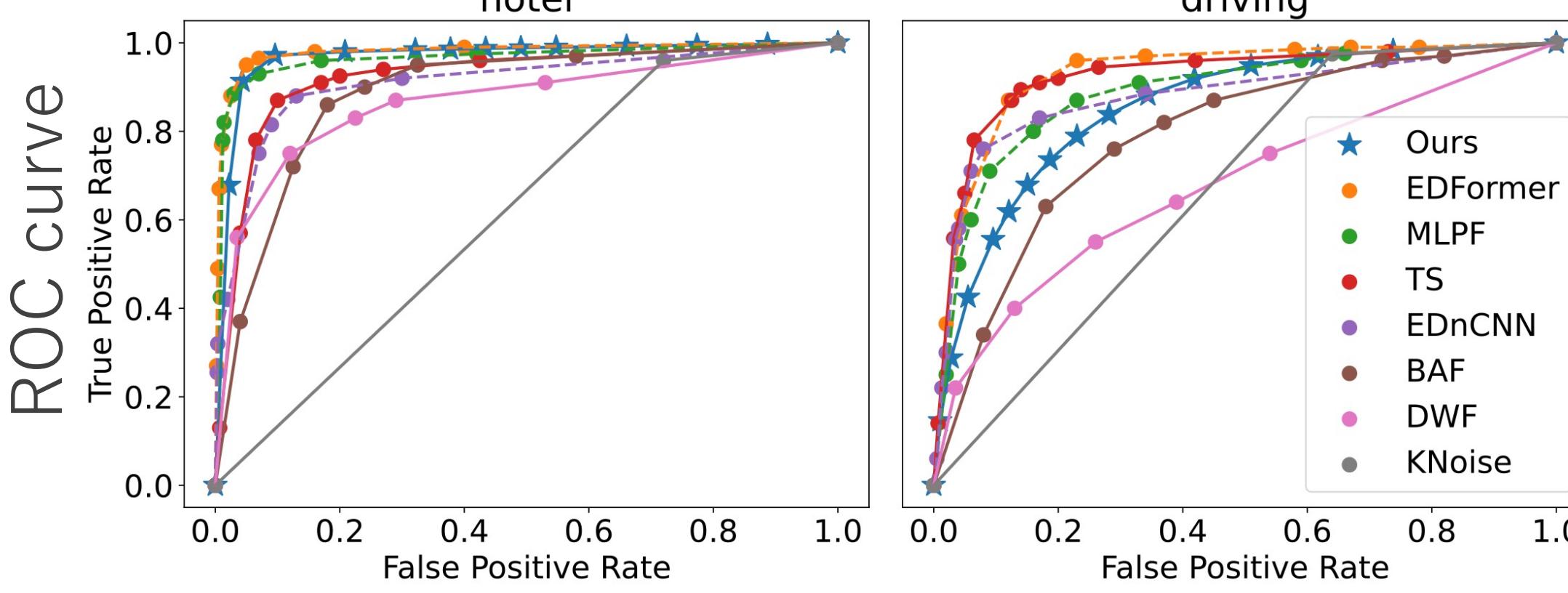


## Summary

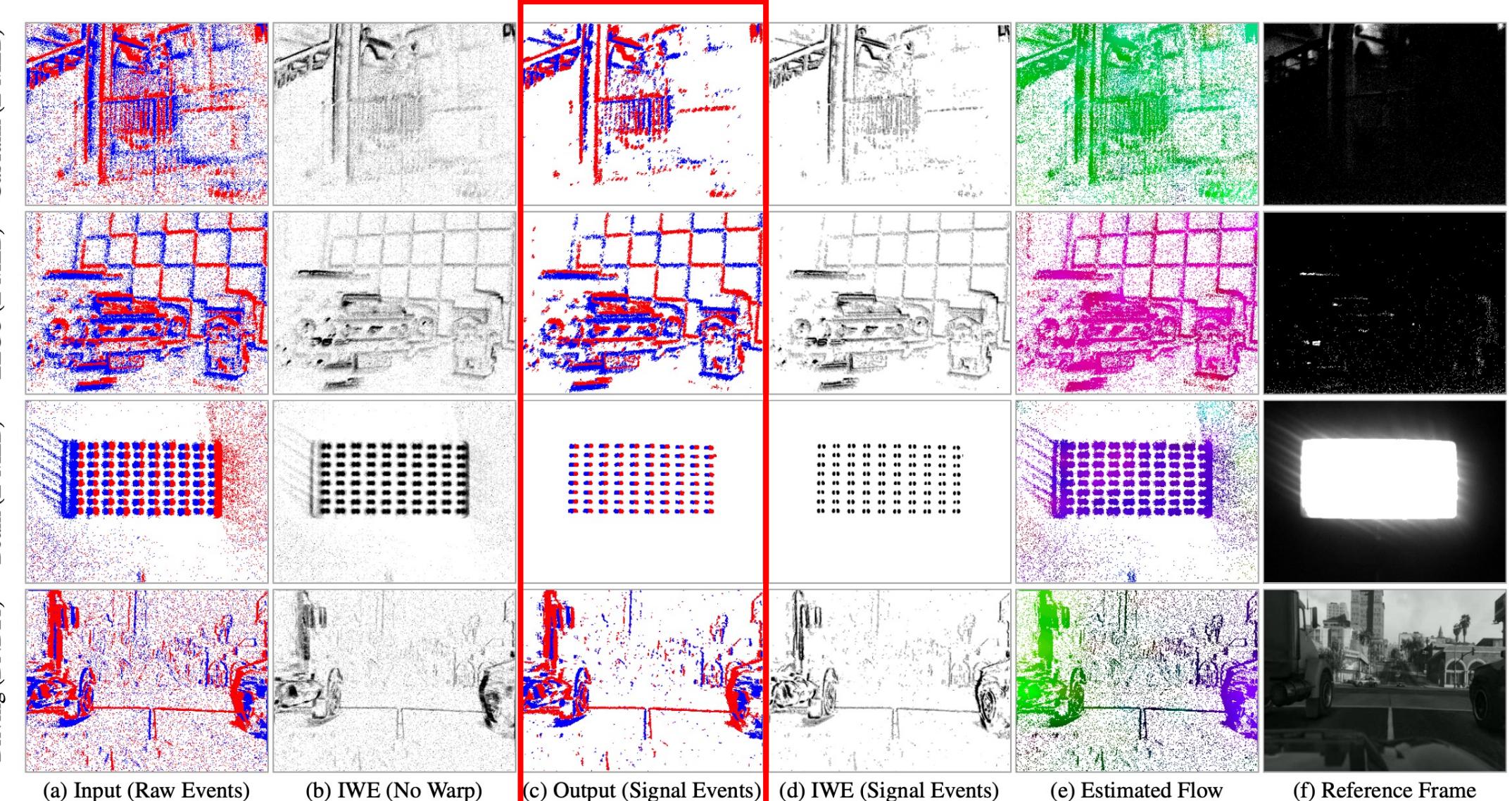
- A **novel method** to jointly estimate **motion and noise** only from events.
- Key idea:** events are caused by moving edges. Use motion to classify events (signal vs. noise) and use events to estimate motion.
- The method achieves **state-of-the-art results** in denoising benchmarks.
- It **robustifies motion estimation** (improves Contrast Maximization).
- It is **flexible**: improves intensity reconstruction and is compatible with learning-based estimators.



## Denoising Results with Ground Truth



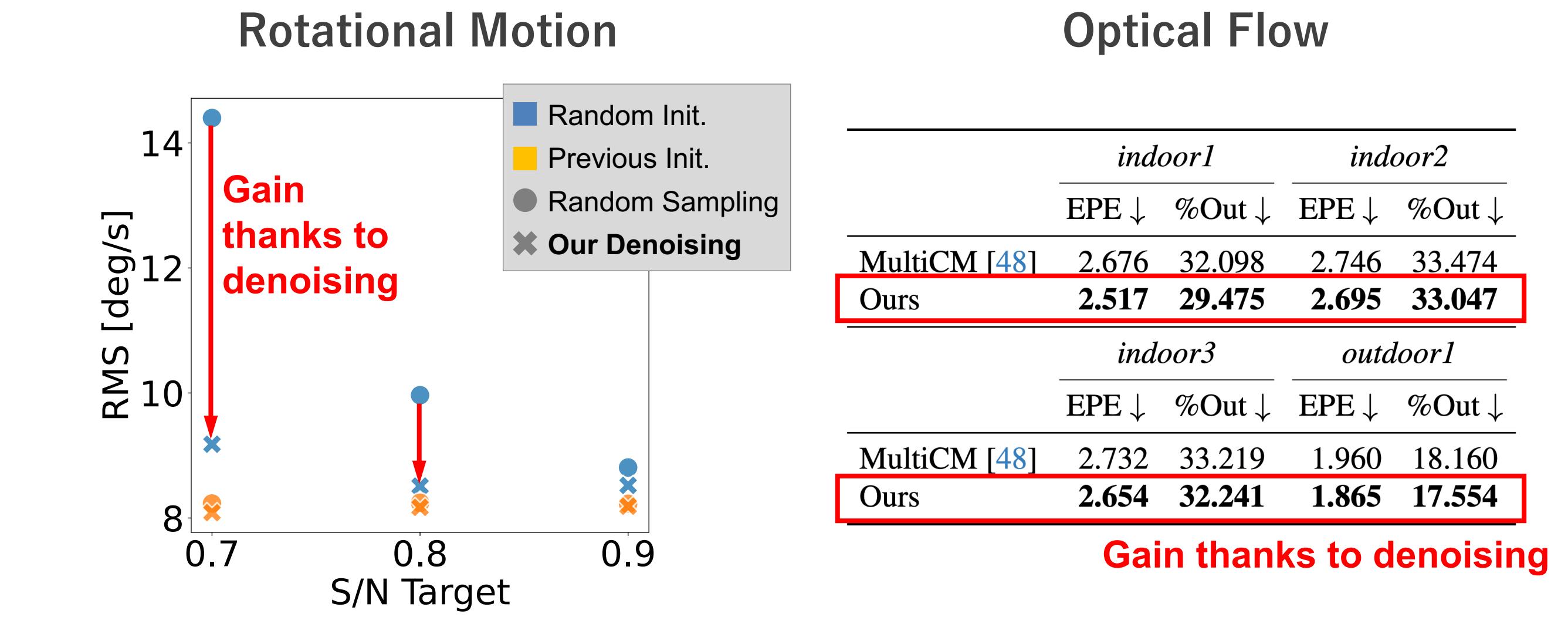
## Results without GT



	E-MLB (Day)				E-MLB (Night)				DND21			
	ND1	ND4	ND16	ND64	ND1	ND4	ND16	ND64	ND1	ND4	ND16	ND64
Raw	0.821	0.824	0.815	0.786	0.890	0.824	0.786	0.768	0.869			
BAF [9]	0.861	0.869	0.876	0.890	0.946	0.973	0.992	0.942	0.920			
TS [34]	0.877	0.887	0.870	0.837	1.033	0.944	0.886	0.797	0.985			
KNoise [31]	0.846	0.837	0.830	0.807	0.954	0.956	0.871	0.817	0.887			
IETS [5]	0.772	0.785	0.777	0.753	0.950	0.823	0.804	0.711	0.900			
Ynoise [14]	0.866	0.863	0.857	0.821	1.009	0.943	0.875	0.792	0.966			
GEF [11]	1.051	0.938	0.935	0.927	1.027	0.955	0.946	0.935	0.932			
DWF [24]	0.878	0.876	0.866	0.865	0.923	0.962	0.988	0.932	0.905			
Ours	0.938	0.958	0.986	0.950	1.037	0.961	0.945	0.932	0.992			
EDnCNN [4]	0.887	0.908	0.903	0.912	1.001	1.024	1.079	1.086	0.977			
EventZoom [12]	<b>0.996</b>	<b>0.988</b>	<b>0.996</b>	<b>0.970</b>	<b>1.055</b>	1.007	1.010	0.988	<b>1.059</b>			
MLPF [24]	0.851	0.876	0.846	0.840	0.926	0.928	0.910	0.906	0.944			
EDformer [29]	0.952	0.955	0.956	0.942	1.048	1.019	1.076	1.099	1.041			

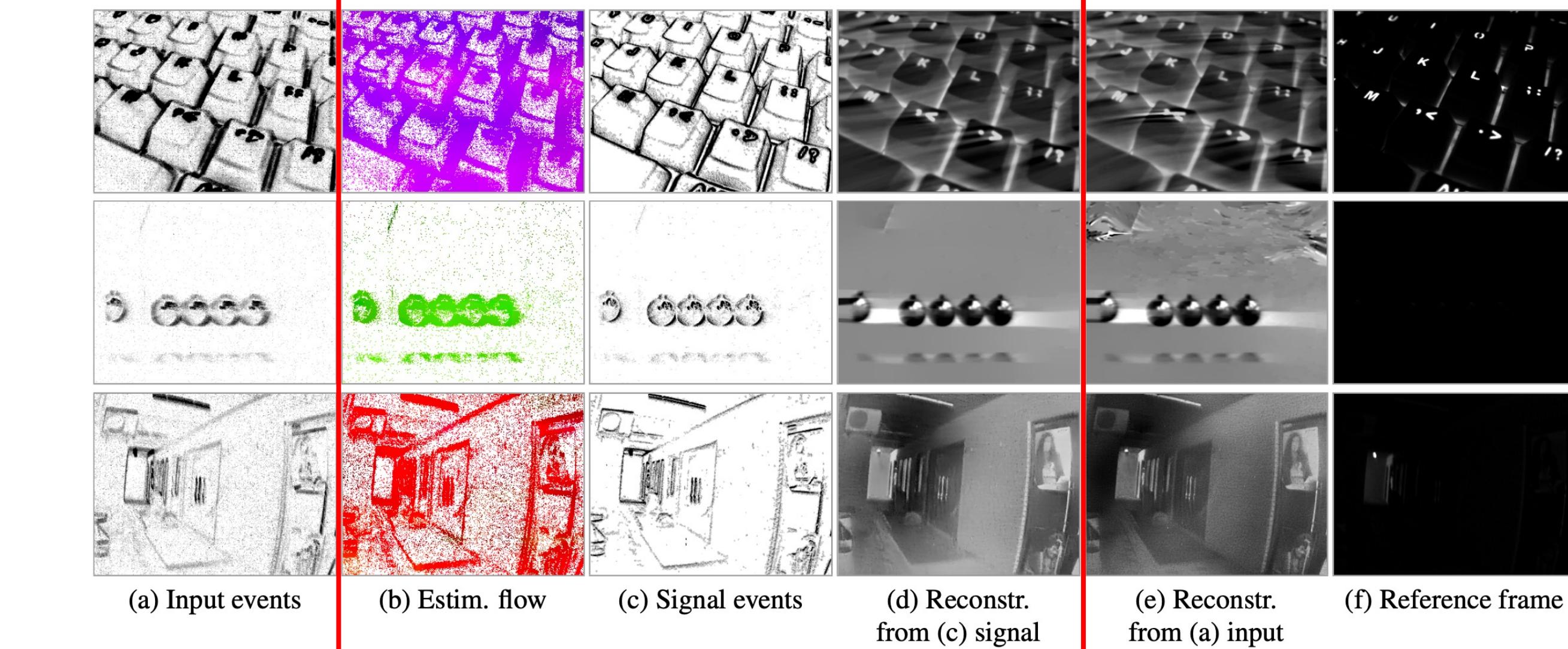
Evaluation on E-MLB dataset shows state-of-the-art among model-based methods.

## Motion Estimation Improvement

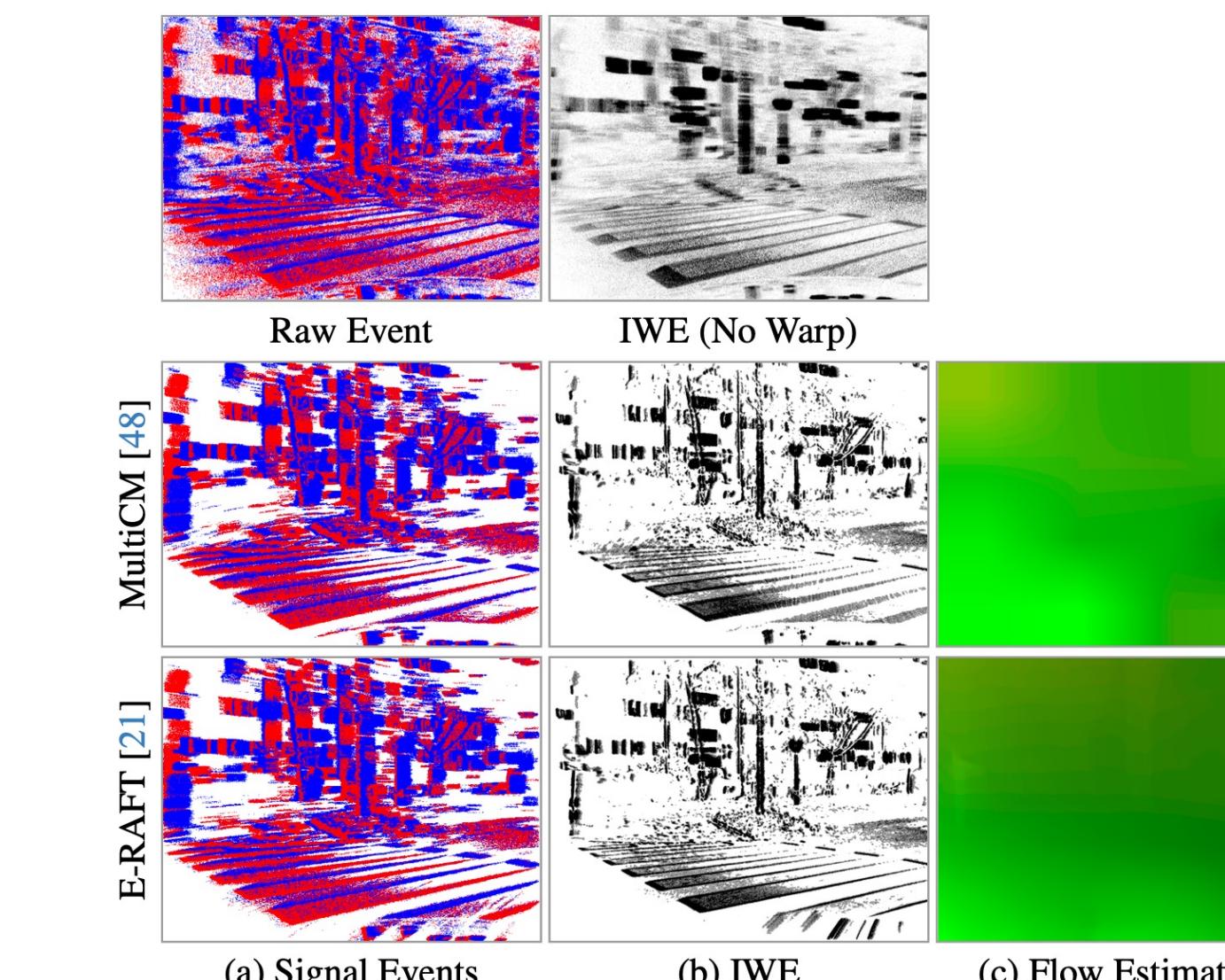


Gain thanks to denoising

## Image Reconstruction Improvement



## Beyond Brightness Constancy Assumption



- Our method works with various motion estimators including learning-based.
- It can remove noisy events from flickering lights.