MotionTTT: 2D Test-Time-Training Motion Estimation for 3D Motion Corrected magnetic resonance imaging or MRI

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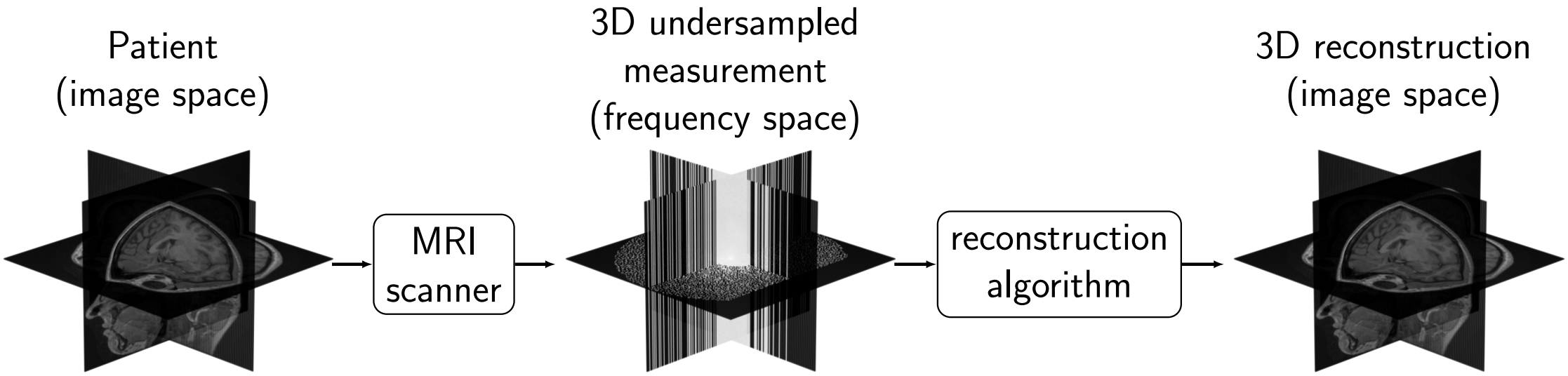
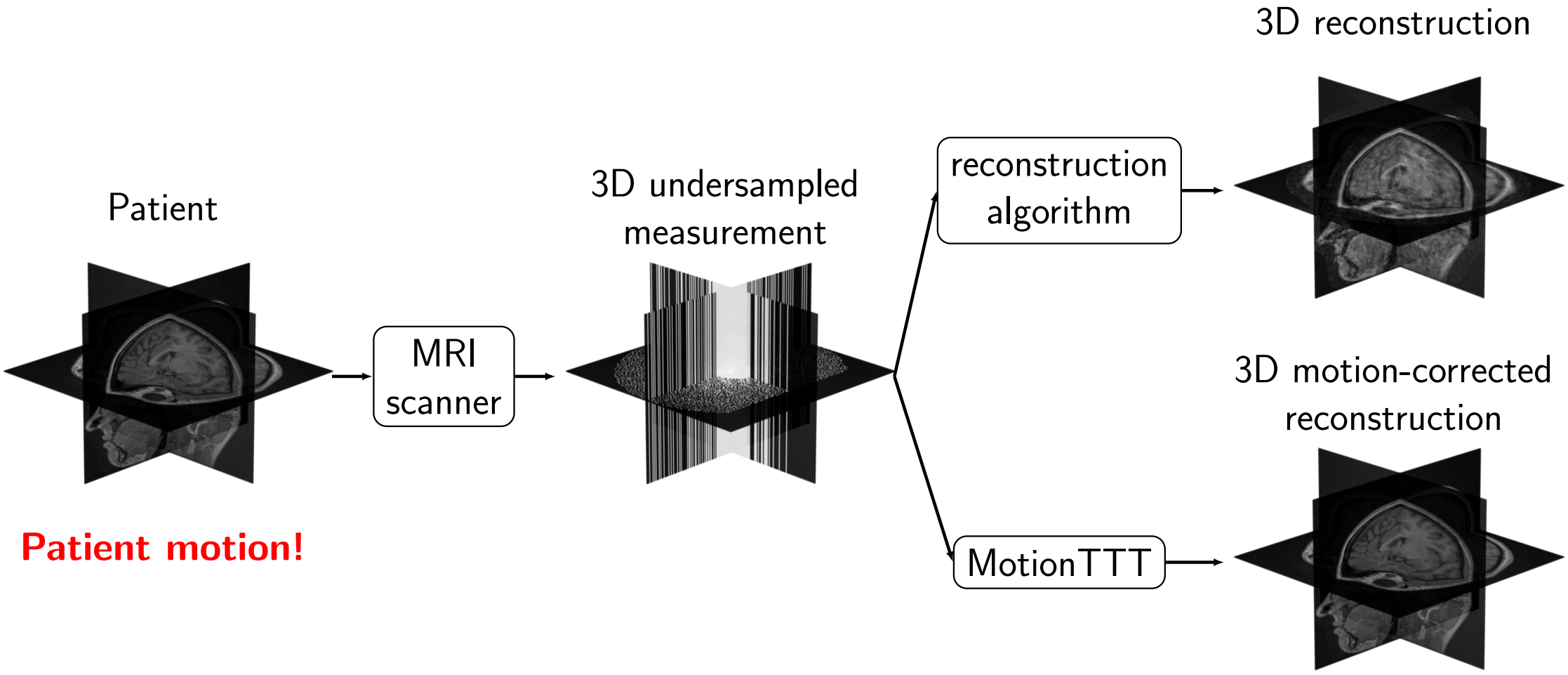
3D MRI


Patient
(image space)
MRI
scanner
3D undersampled
measurement
(frequency space)
reconstruction
algorithm
3D reconstruction
(image space)

3D MRI under motion

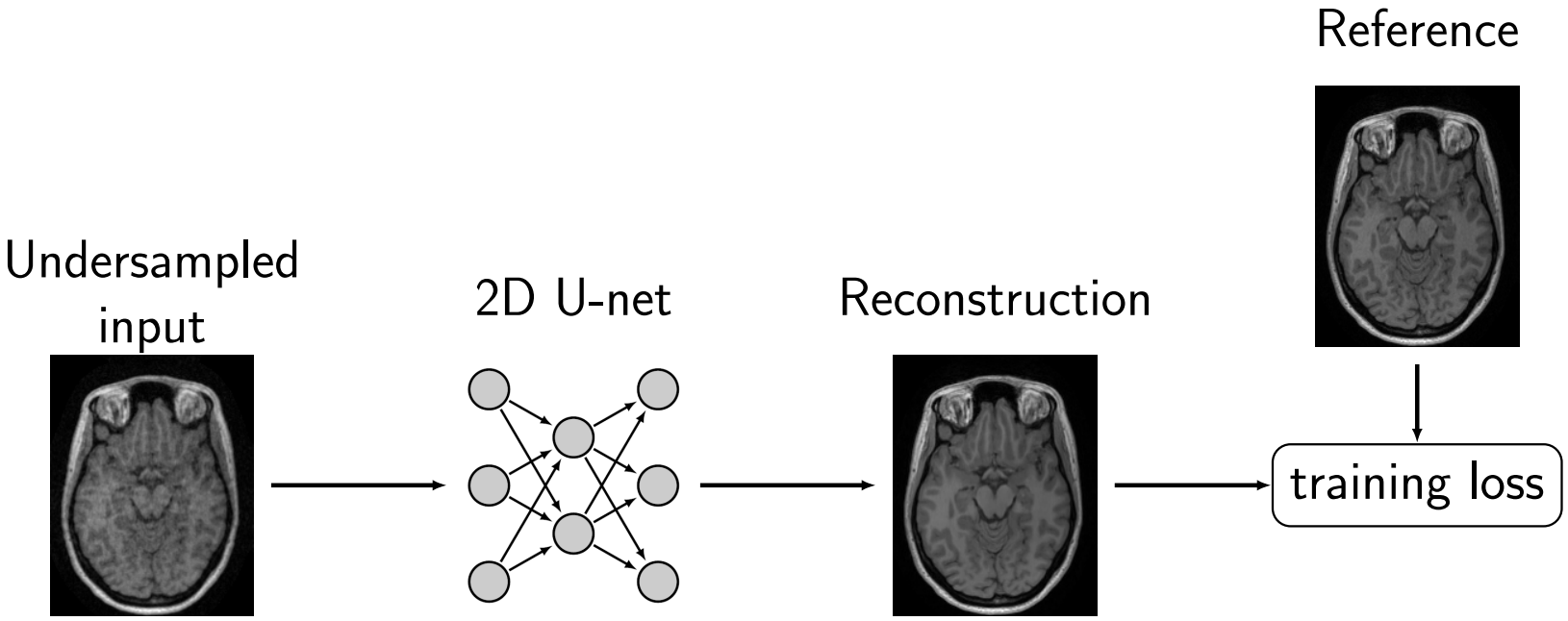


The three steps of MotionTTT

1. Pre-training
2. Test-time-training for motion estimation
3. Reconstruction

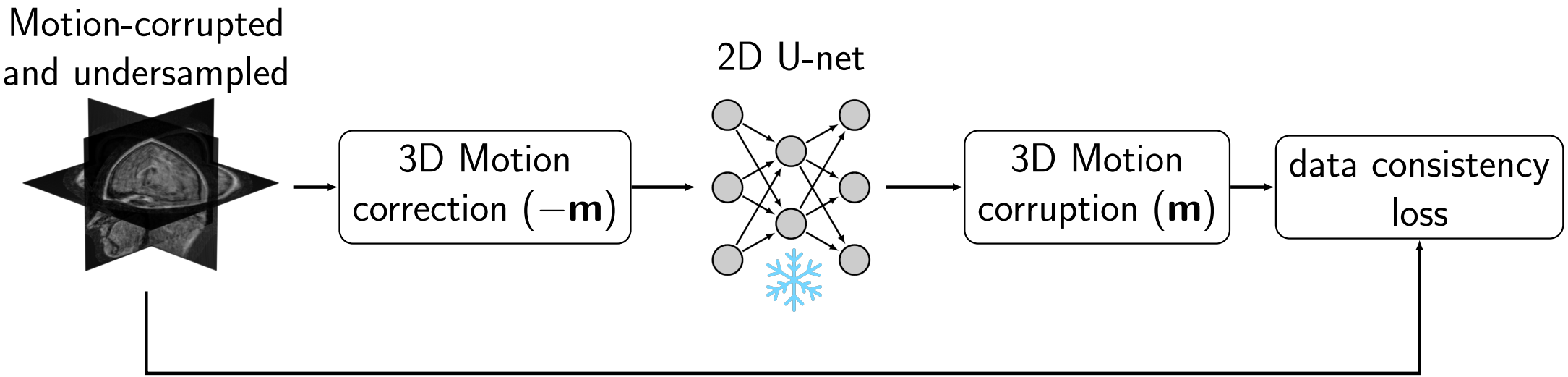
Step 1: Pre-training

Goal: Train 2D model for motion-free MR reconstruction



Step 2: Test-time-training for motion estimation

Goal: Estimate motion trajectory $\mathbf{m} \in \mathbb{R}^{6 \times N_s}$

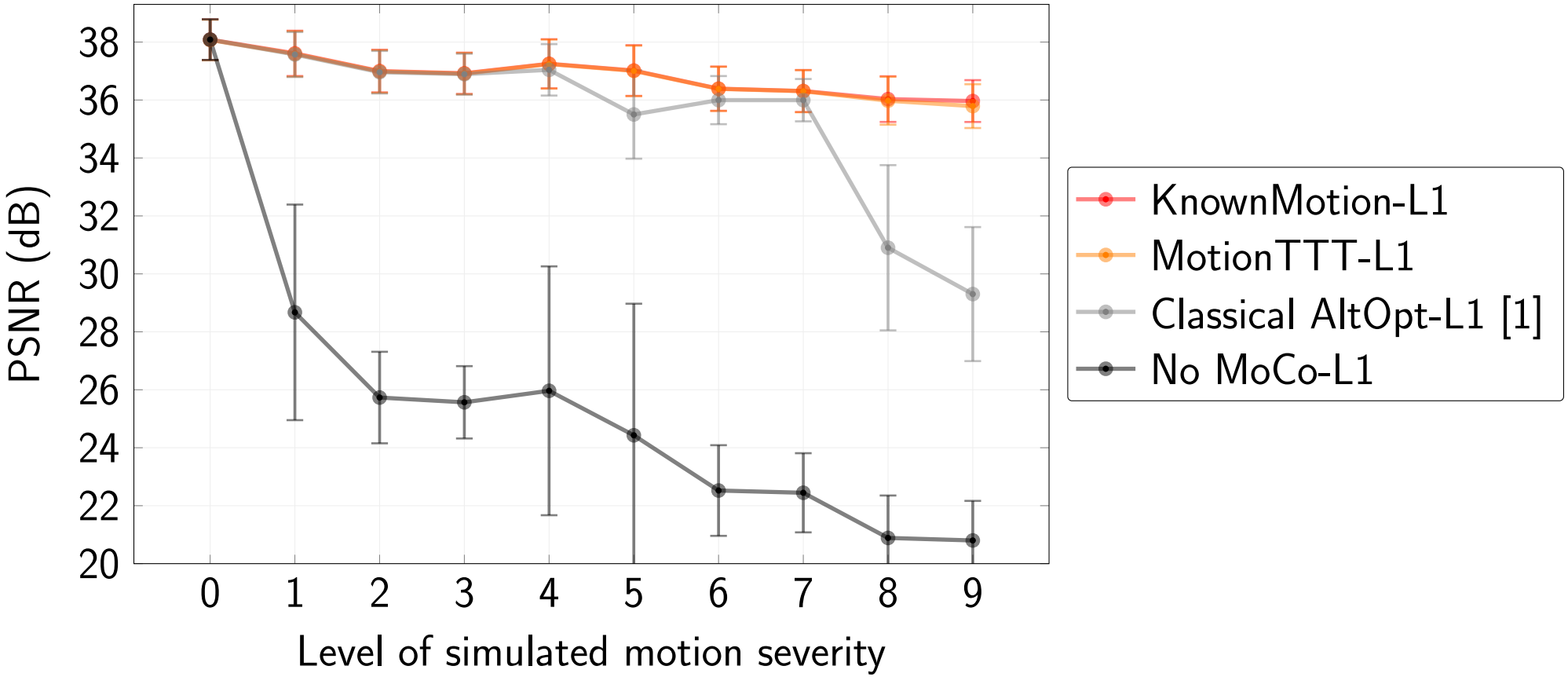


Step 3: Reconstruction

Goal: Obtain final reconstruction based on estimated motion parameters using, e.g.,

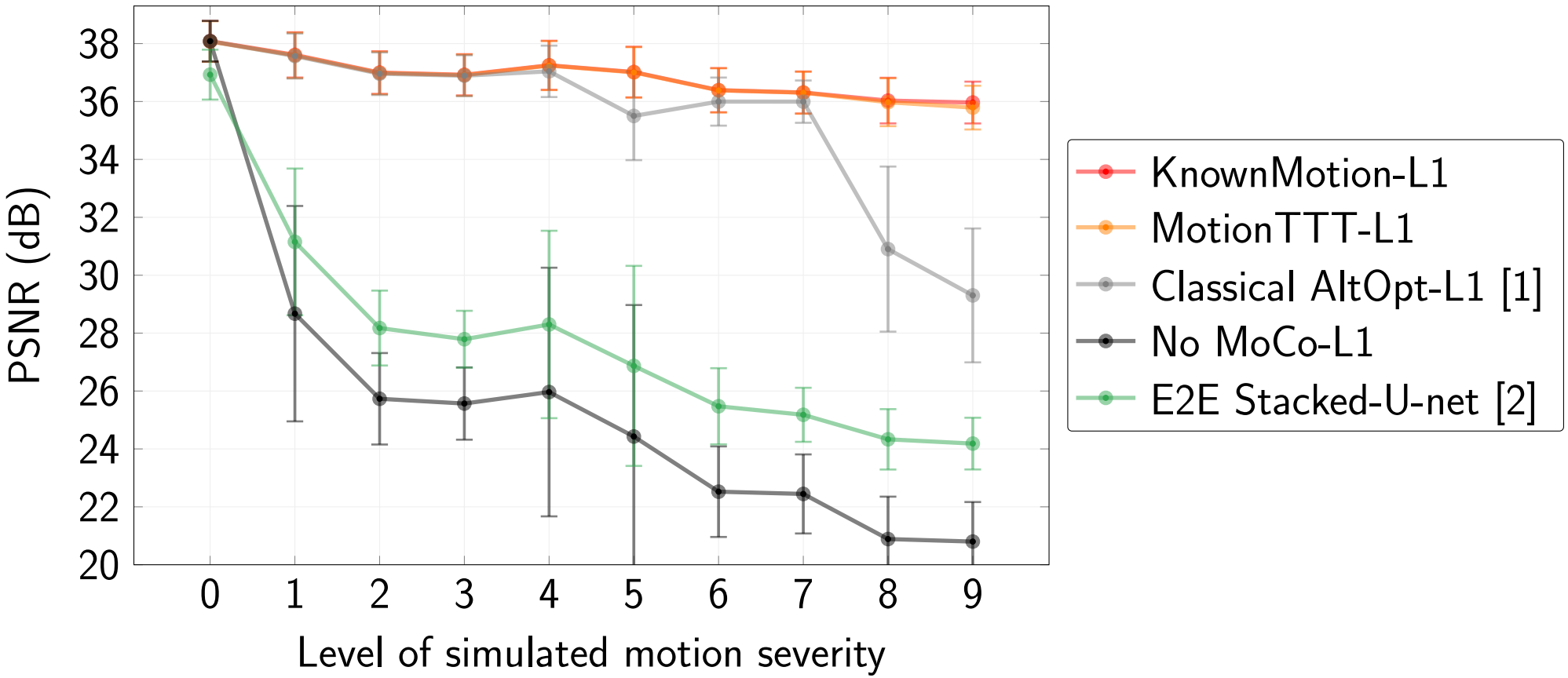
- classical reconstruction
- deep-learning based iterative reconstruction
- deep-learning based end-to-end reconstruction

Quantitative evaluation



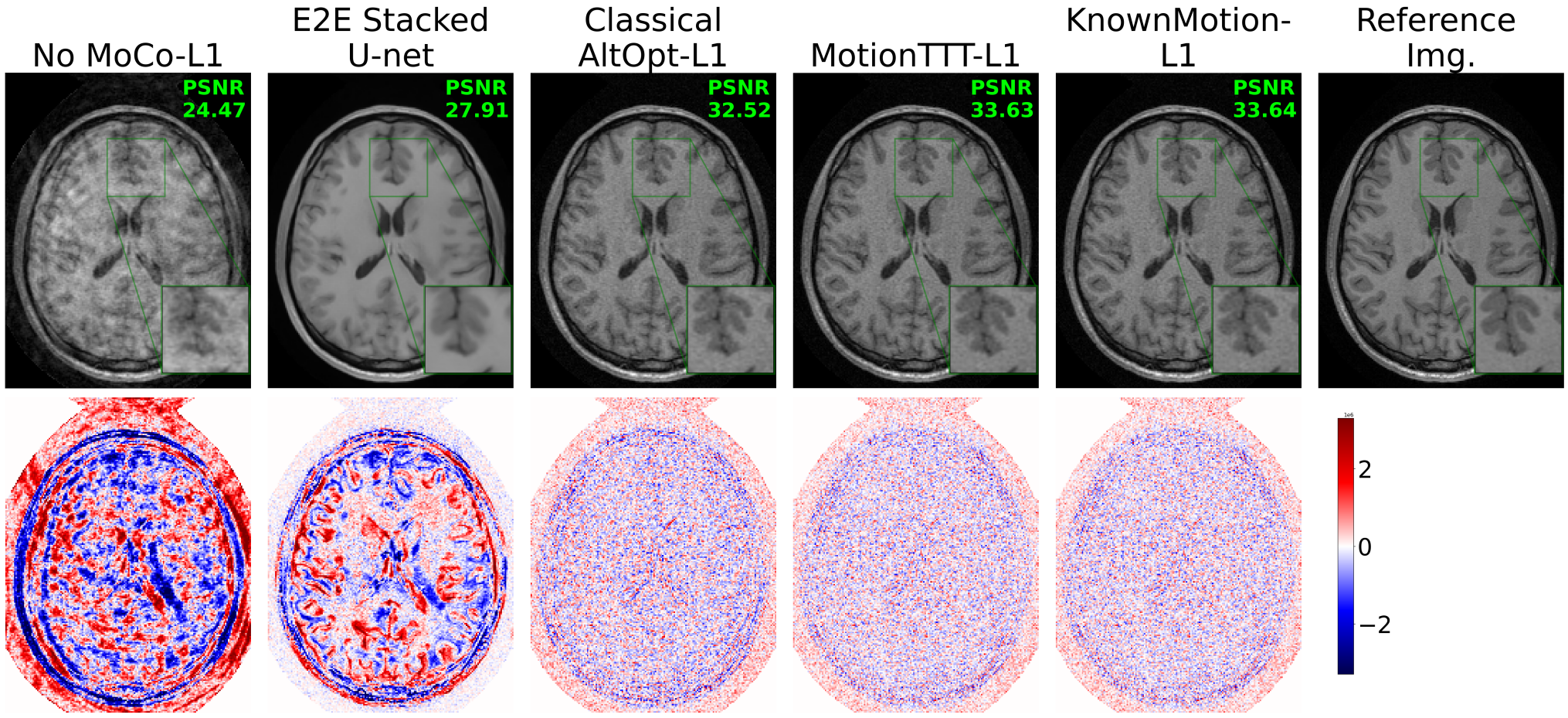
[1] Cordero-Grande et al. "Sensitivity Encoding for Aligned Multishot Magnetic Resonance Reconstruction". In: IEEE Transactions on Computational Imaging (2016).

Quantitative evaluation



[1] Cordero-Grande et al. "Sensitivity Encoding for Aligned Multishot Magnetic Resonance Reconstruction". In: IEEE Transactions on Computational Imaging (2016).
[2] Al-Masni et al. "Stacked U-Nets with Self-Assisted Priors towards Robust Correction of Rigid Motion Artifact in Brain MRI". In: NeuroImage (2022).

Qualitative evaluation



Summary

MotionTTT is

- the first deep learning based approach towards motion estimation in 3D MRI,
- outperforming classical optimization in terms of estimation accuracy and speed,
- outperforming deep learning based end-to-end motion correction,
- not relying on motion simulation during pre-training,
- not interfering with the clinical work routine.

- Paper: `https://arxiv.org/abs/2409.09370`
- Implementation: `https://github.com/MLI-lab/MRI_MotionTTT`
- Poster session: Wednesday, December 11th, 2pm

Thank you for watching!