

Why CI-MAS?

Clinical simulation requires both anatomical fidelity and restoration plausibility.

1

Paired clean/artifact CBCT data are clinically scarce

Limiting supervised training of metal artifact reduction models.

2

Existing simulation assumes predefined restorations

Missing clinically informed restoration-configuration modeling.

3

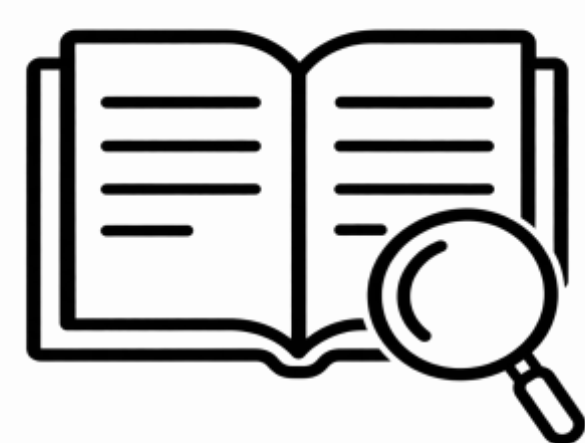
CI-MAS models where and what to simulate

Introducing restoration configuration before artifact simulation.

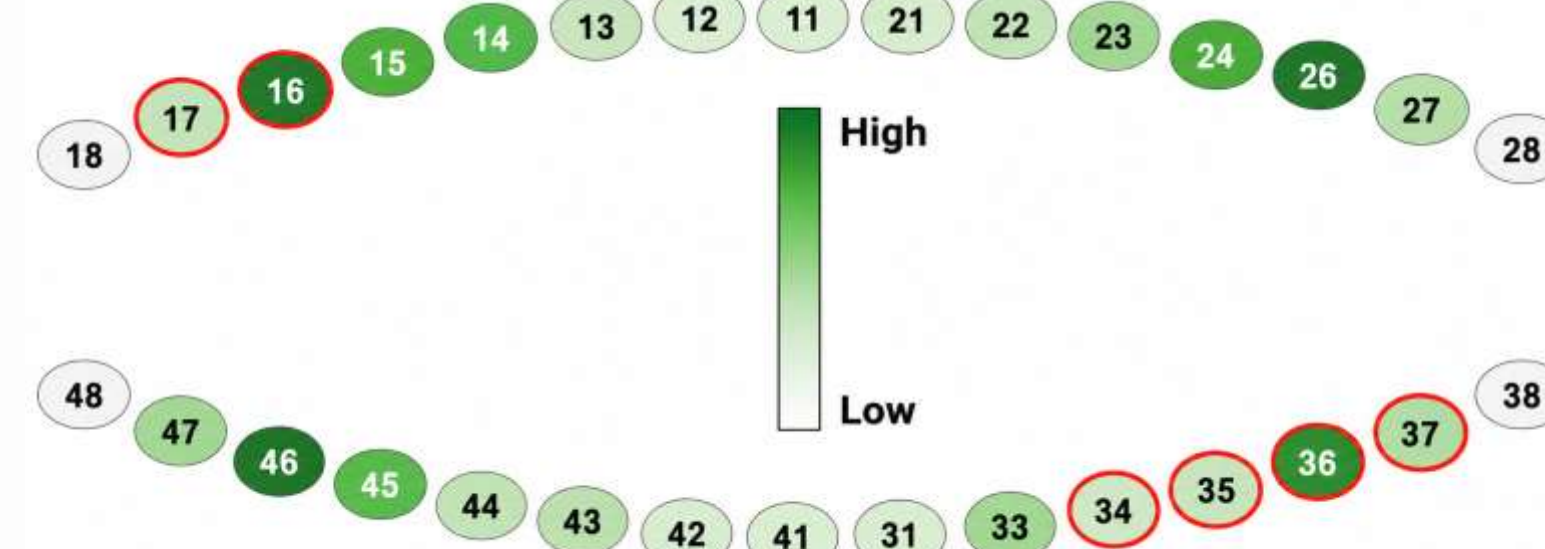
Method Overview: CI-MAS Workflow

From patient anatomy to clinically informed artifact simulation.

Clinical evidence



FDI tooth-site prevalence

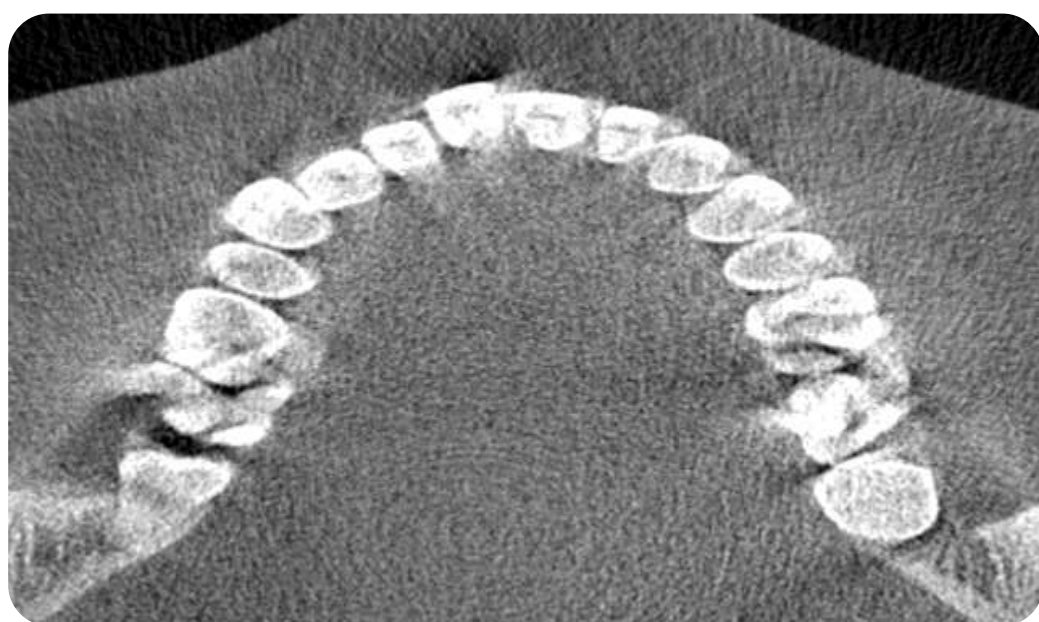


Prior-guided site selection

Patient-specific tooth semantics

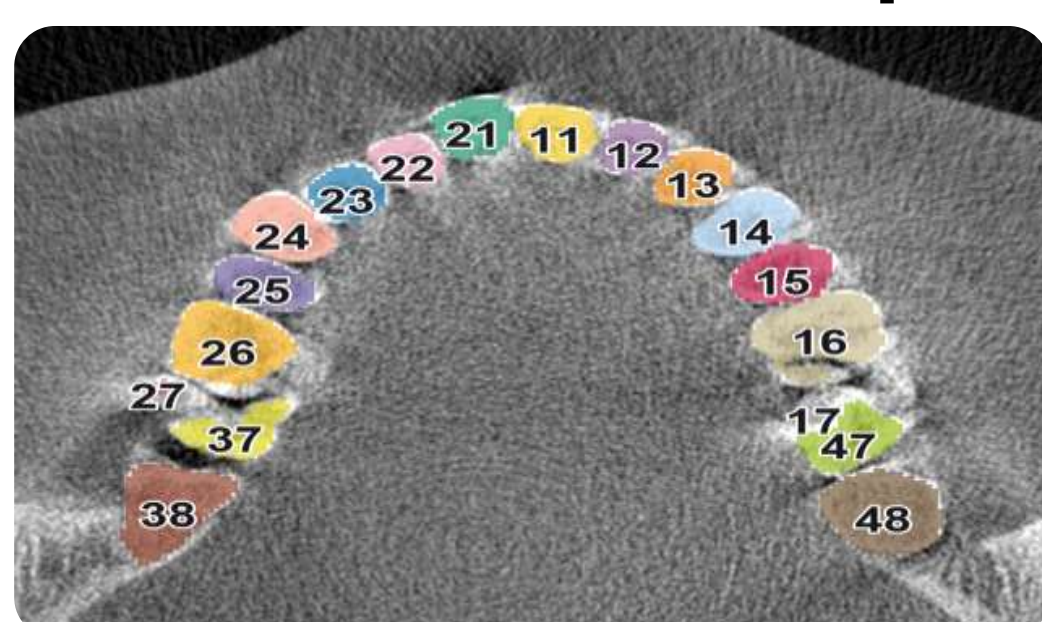
Extract patient-specific tooth identity and geometry.

Metal-free CBCT



Seg. + FDI

FDI semantic map

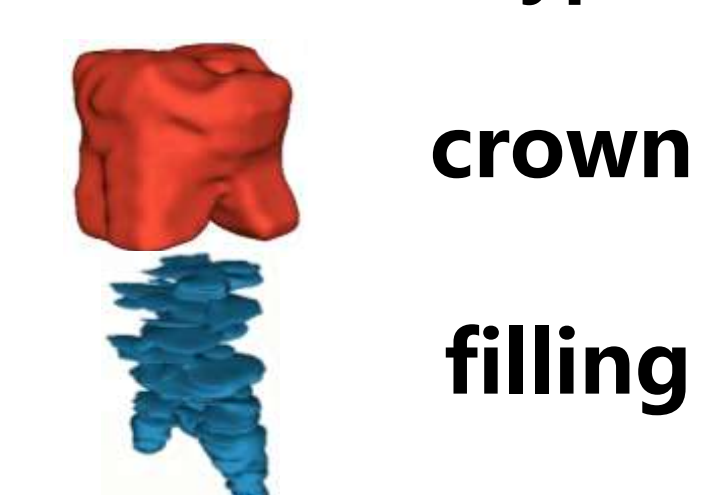


Patient-specific tooth identity & geometry

Configuration space

Generate clinically plausible restoration configurations using restoration type and FDI-site priors.

Restoration types



Prior-guided FDI Sites



Configuration instantiation

Example configuration: C36 + F37



FDI 36 - Crown

FDI 37 - Filling

3D configuration

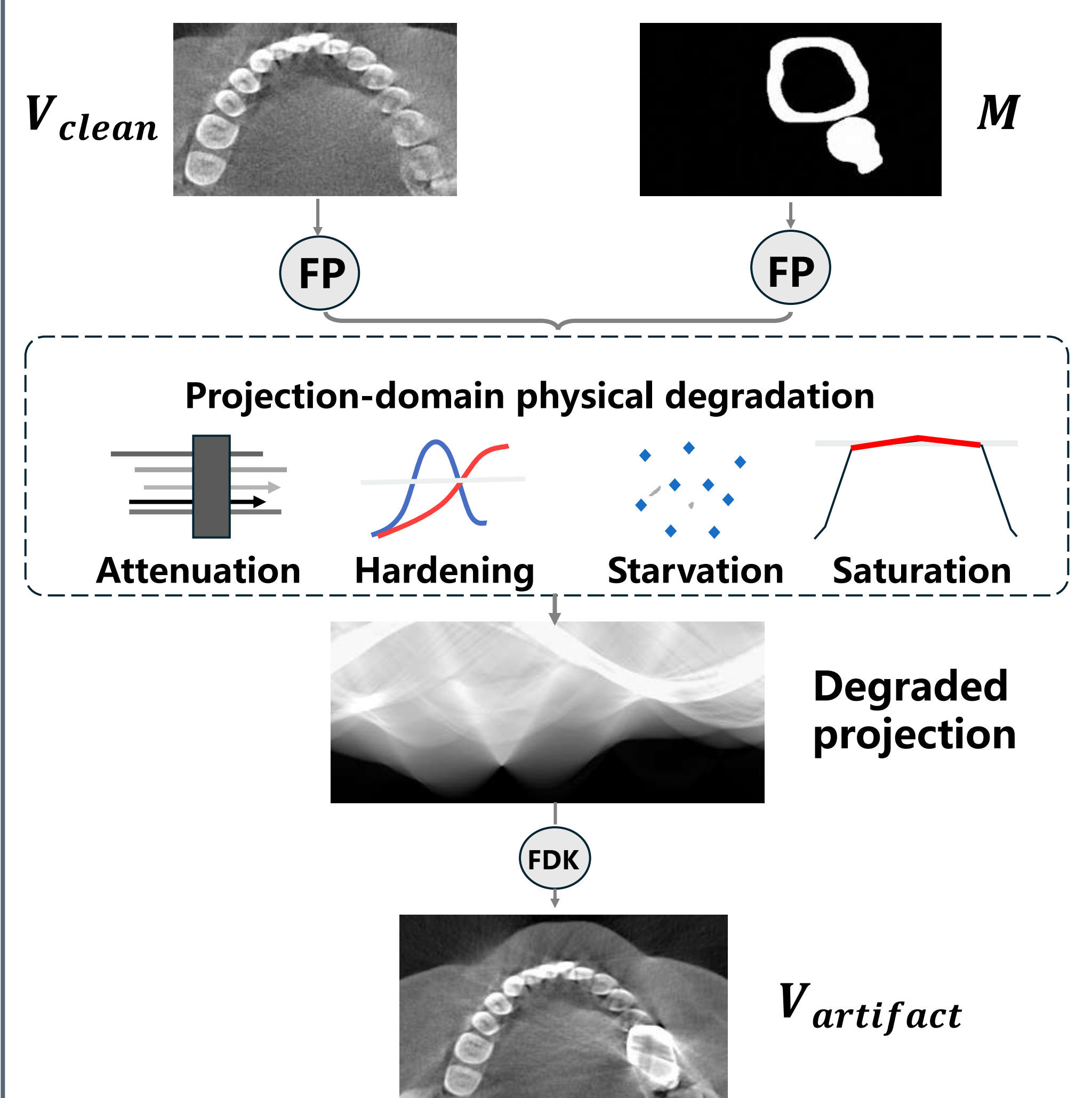


Simulation mask slice



Projection-domain Metal Artifact Simulation

Generate paired artifact CBCT through physical degradation and reconstruction.



Legend

Crown (restoration type)
Filling (restoration type)
Candidate FDI site (selected for simulation)
→ Main workflow
 - - - - - Prior guidance

Abbreviations:

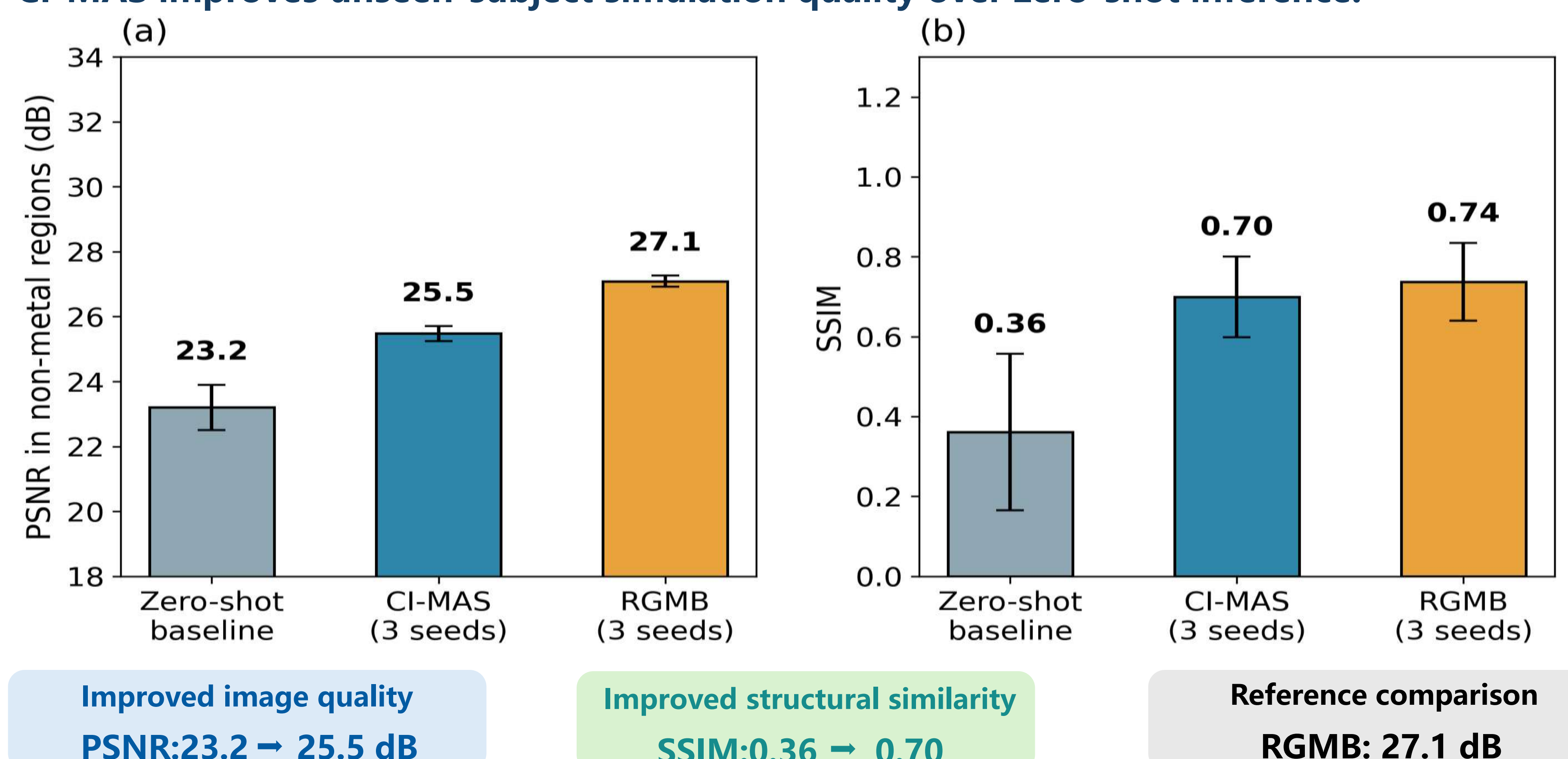
FP Cone-beam forward projection
 FDK FDK reconstruction

Experimental Setup

- 9 metal-free CBCT volumes
- Real patient scans from different cases
- 17 simulated configurations
- Crown, filling, and mixed cases
- Subject-disjoint train/val/test split
- 3 unseen test subjects, 3 training seeds

Key Results

CI-MAS improves unseen-subject simulation quality over zero-shot inference.



Take-home Message

CI-MAS introduces restoration configuration as an explicit decision layer for dental CBCT artifact simulation.

Clinically informed configurations enable more realistic and controllable artifact generation.