

**Phase 1:
Fixed-Weight Analysis**

Representative
Medical Image

Shallow Net Instance
with Fixed Random
Weights + Specific AF

Spatial & 2D FFT Analysis
(Pre vs. Post Activation)

Initial AF Transform-
ation Characteristics

**Phase 2:
Mild Training Analysis**

Generated Patch Pairs
(Small Set / Per
Task/Modality/Arch)

Task-Specific Archi-
tecture with Specific
AF (Train ~5 Epochs)

Evaluate on Full De-
graded Image vs. Original

Early Learning Dynamics
(Prelim. PSNR/SSIM
Rank Qualitative Output)

**Phase 3:
Full Training
& Evaluation**

Full Generated Datasets
(4k Train / 500 Val
/ 500 Test Pairs)

Task-Specific Architec-
ture with Selected AF
(Full Training Protocol)

Evaluate on Test
Set (500 Pairs)

Evaluation Metrics (PSNR,
SSIM, EPI,HFR%, LPIPS)

Internal Feature Analysis
(Spatial & 2D FFT
on Trained Models)

Statistical Anal-
ysis (ANOVA)

**Validated Perform-
ance & Mech-
anistic Insights**