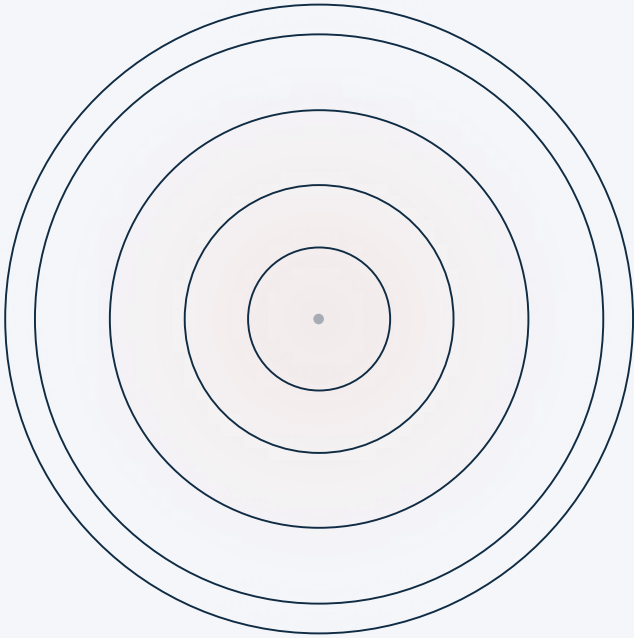
INTERNATIONAL CONFERENCE · MEDICAL PHYSICS & IMAGING · 2026

# From Filtered Back-Projection to Interpretable Self-Supervised Denoising

## A Comparative Study of Image Reconstruction for Low-Dose CT in Radiation Oncology



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WHY THIS MATTERS

# The Dose–Quality Trade-off

Reducing CT dose protects the patient — but reshapes the image radiotherapy depends on.

### Lower dose

Less ionizing exposure per scan.

›

### More noise

Streaks & grain degrade target / organ-at-risk delineation.

›

### Black-box AI

Supervised denoisers need paired low/normal-dose data and offer no transparency.

THE GAP

A data-light, interpretable denoiser that a medical physicist can audit.

CT is the principal modality for radiotherapy planning; repeated cone-beam CT in adaptive workflows is intrinsically noisier than diagnostic CT.

METHODS · STUDY DESIGN

# Two Branches, One Yardstick

### CONVENTIONAL BRANCH

Radon transform → Fourier-slice gridding → back-projection → FBP with 5 apodization filters.

Shepp–Logan phantom · varying projections & Poisson dose.

### LEARNING-BASED BRANCH

Filter2Noise (F2N): self-supervised, single-image, attention-guided bilateral filter.

Simulated low-dose thoracic CT slice.

Both assessed with PSNR & SSIM against a known reference.

F2N is the work of Sun et al., arXiv:2504.13519 (2025). This study evaluates & interprets it for radiation oncology — it does not propose a new denoiser.

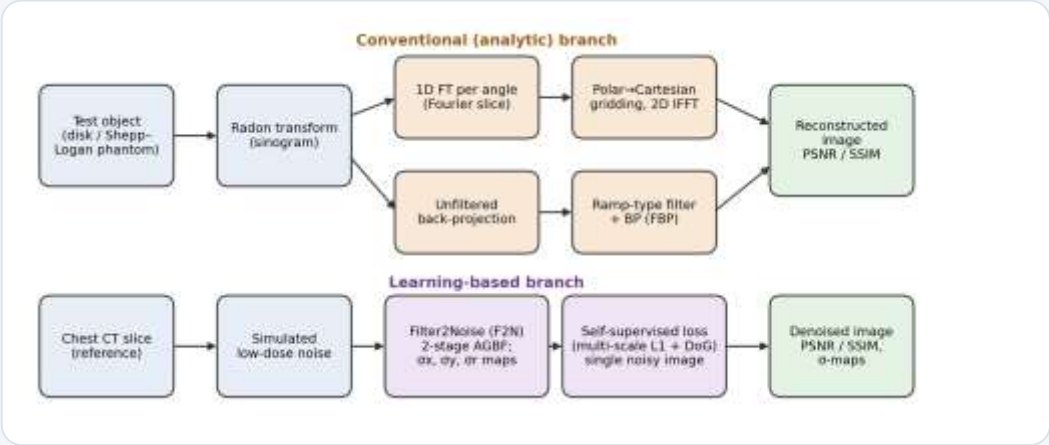


Fig 1 · Study overview. Top: analytic reconstruction chain. Bottom: self-supervised F2N denoising.

# Angular Sampling Drives FBP Quality

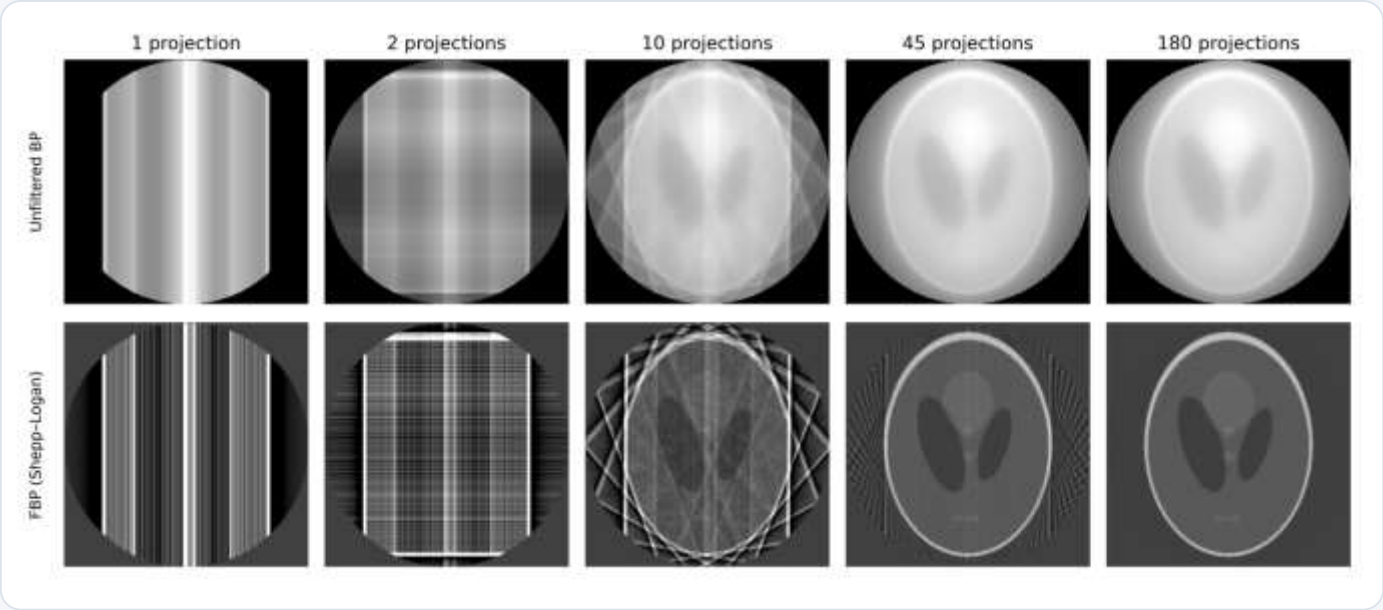


Fig 5 · Shepp–Logan phantom reconstructed from 1, 2, 10, 45, 180 projections. Top row: unfiltered back-projection. Bottom row: FBP (Shepp–Logan filter).

| 29.94 dB | 25.44 dB | ≈14.9 dB |
|---|---|---|
| 0.926 SSIM | −4.5 dB vs 180 | `flat across views` |
| FBP @ 180 views | FBP @ 45 views | Back-projection (no filter) |

Without the filter, more views only sharpen a blurred image — the ramp filter restores the missing high frequencies.

# Single-Image · No Clean Reference · Interpretable

**+3.72 dB** PSNR GAIN | **+0.081** SSIM GAIN | **0** CLEAN REFERENCES USED

Noisy 34.98 dB / 0.8206 → F2N 38.70 dB / 0.9014

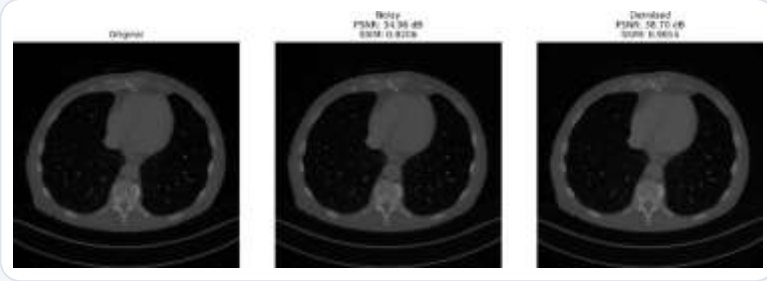

Fig 7 · Reference · Noisy · F2N-denoised (simulated low-dose thoracic slice).

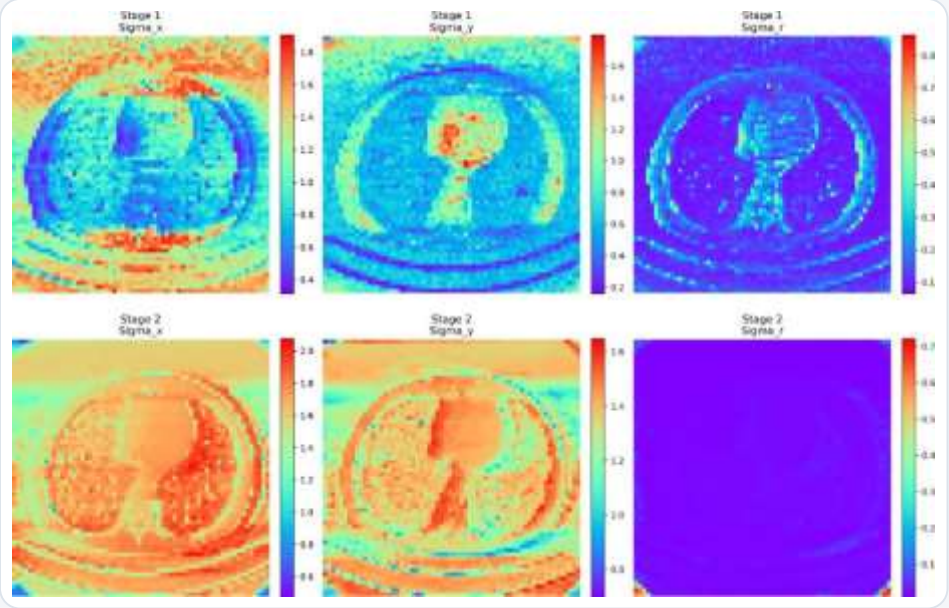


Fig 8 · Two-stage AGBF parameter maps. Stage 1 smooths soft tissue (large σr over mediastinum); Stage 2 keeps a near-zero σr — edge-preserving refinement.

CONCLUSIONS

# Interpretable, Data-Light Denoising for Low-Dose CT

Analytic reconstruction stays the transparent reference; F2N adds a data-light, auditable denoising lever.

### Analytic FBP, demystified

Quality is governed by angular sampling and the filter window — a clear resolution↔noise trade-off.

### F2N delivers, transparently

+3.7 dB / +0.081 SSIM from a single image, no clean reference; σ-maps can be audited and bounded per region.

### Built for radiotherapy

Acts on reconstructed images → applicable to existing FBP incl. cone-beam CT; lightweight and per-image.

LIMITATIONS

Simulated noise · single thoracic slice · no competing denoisers · PSNR/SSIM are surrogates, not clinical validation.

NEXT

Real low-dose data vs BM3D / ZS-N2N / supervised nets, with task-based endpoints — HU fidelity, contour agreement, dose-calc Δ.