22.058, Principles of Medical Imaging
Fall 2002
Homework #4

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1. Write a complete system description for the instrument function of a planar x-ray imager (assume scanned fan beam). Include:
   • Finite size source
   • Heal effect on source intensity and energy spectrum
   • Oblique angle effects
   • Depth dependent magnification
   • Quantum efficiency and PSF for the scintillator/photographic plate.

2. For a cylindrical object (long axis perpendicular to the beam) calculate the profile of X-ray intensity in a fan beam geometry, assuming that the beam is mono-energetic.

3. Calculate the effect of beam hardening on the CT image of a disk.

4. For the following sample, show (a.) the projections and (b.) the filtered projections
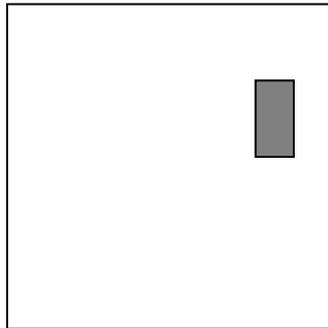
4. A sinusoidally modulated x-ray image is recorded by a one-sided screen film system as shown below. Find the recorded S/N as a function of frequency, where the signal is the sinusoidal component and the noise is the average background. On average the screen produces l photons per x-ray photon, t of which are transmitted to the emulsion where r is recorded. The pixel area of the film is much smaller than the system resolution. Neglect any critical angle effect between the screen and the film.

X-ray photon number as a function of $z = n_0 (1+\cos(2 \pi k z))$.
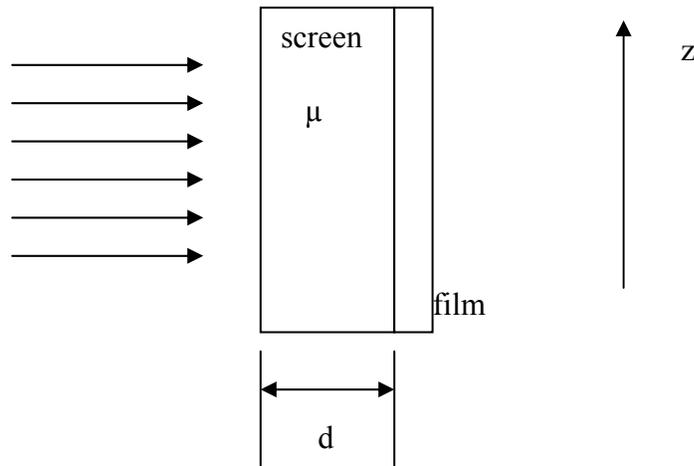
5. Write a program that calculates the Radon transform of an object function, then Fourier filters the projects, and finally reconstructs an image via back projection.