Bioengineering 280A
Principles of Biomedical Imaging

Fall Quarter 2014
CT/Fourier Lecture 7

Example

Assume that the Nyquist sampling periods of $f(x)$ and $g(x)$ are Δf and Δg, respectively. Determine the Nyquist sampling periods for

$a) f(x - x_0)$

$b) f(x) + g(x)$

$c) f(x) * f(x)$

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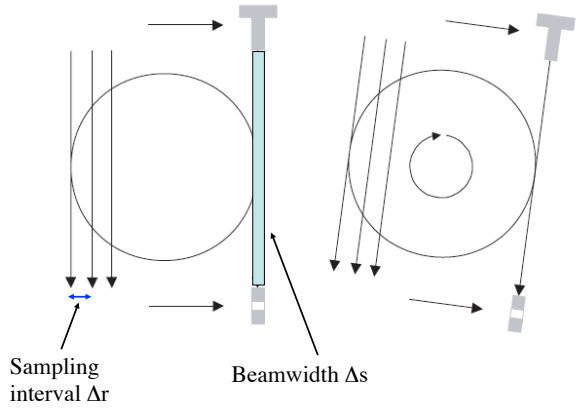
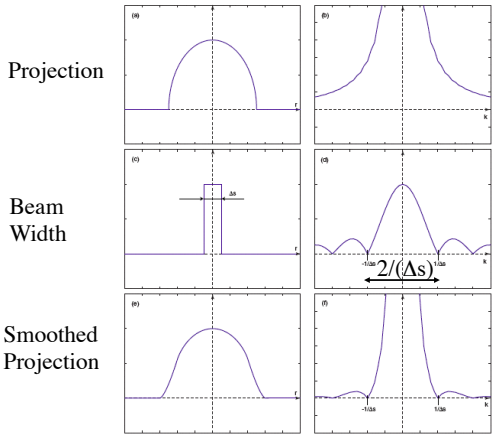
from Prince and Links 2006

Detector Sampling Requirements



Suetens 2002

Smoothing of Projection



Suetens 2002

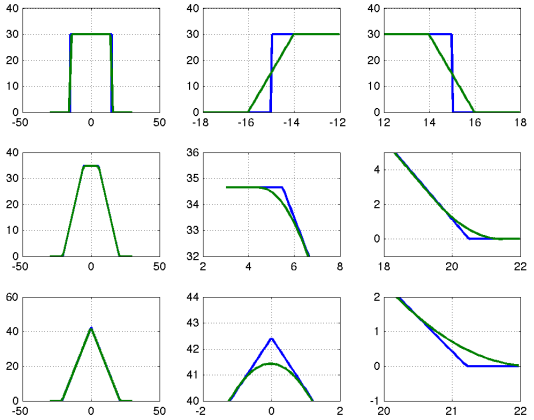
Smoothing of Projection

$$g_s(l,\theta) = rect(l/\Delta s) * g(l,\theta)$$

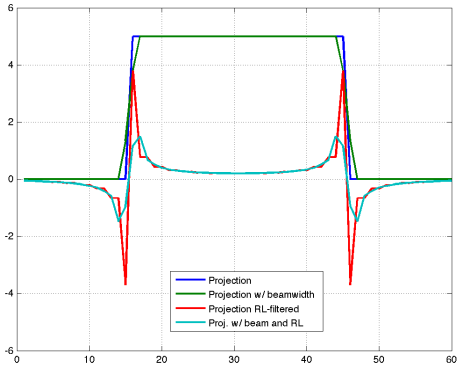
$$G_s(k_x,\theta) = \Delta s \sin c(k_x \Delta s) G(k_x,\theta)$$

Suetens 2002

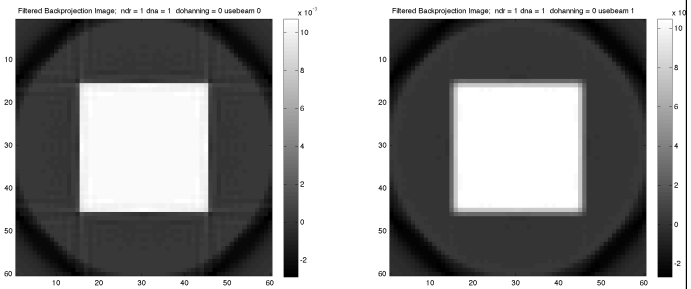
Smoothing of Projections



Smoothing of Projections



Smoothing of Projections

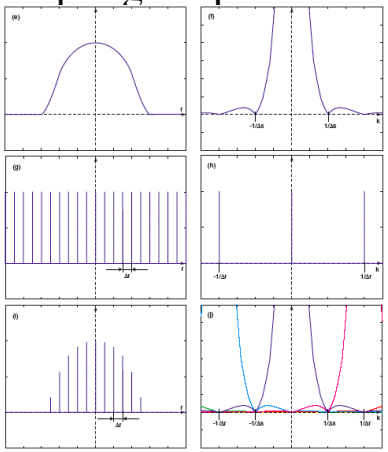


Sampling Requirements

Smoothed Projection

Detectors $\Delta r \leq \Delta s/2$

Sampled Smooth Projection



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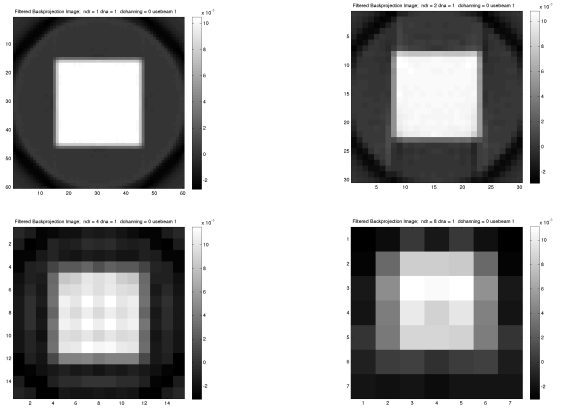
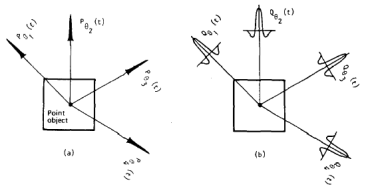
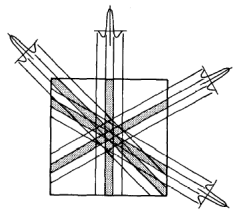
Sampling of Projections



View Aliasing





Kak and Slaney

View Sampling Requirements

View Sampling -- how many views?

Basic idea is that to make the maximum angular sampling the same as the projection sampling.

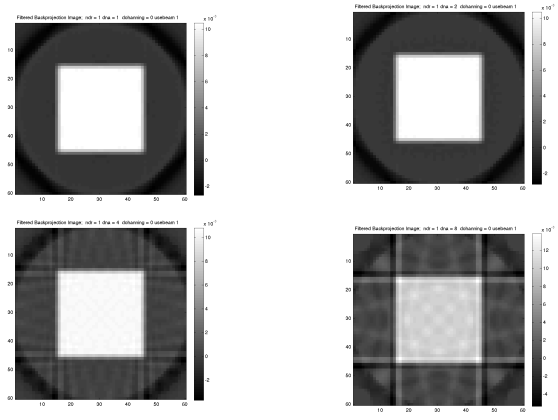
$$\frac{\pi FOV}{N_{views}} = \Delta r$$

$$N_{views,360} = \frac{\pi FOV}{\Delta r} = \pi N_{proj} \quad \text{(for 360 degrees)}$$

$$N_{views,180} = \frac{\pi N_{proj}}{2} \quad \text{(for 180 degrees)}$$

Suetens 2002

View Aliasing



Kak and Slaney

Example

beamwidth Δs = 1 mm

Field of View (FOV) = 50 cm

$\Delta r = \Delta s/2$ = 0.5 mm

500 mm/ 0.5 mm = N = 1000 detector samples

$\pi * N$ = 3146 views per 360 degrees

$\approx$ 1500 views per 180 degrees

CT "Rule of Thumb"

$N_{view} = N_{\det ectors} = N_{pixels}$

Suetens 2002

Example

Consider a rectangular object of width 20mm and height 40mm centered at (-10mm, -10mm). The attenuation coefficient of the object is 1 mm^{-1}. The object is imaged with a 1st generation CT scanner with a beamwidth of 1mm. The desired FOV is 100 mm.

Determine the appropriate detector size Δr and the number of radial samples needed to span the FOV. Assume that the middle two samples are acquired at coordinates of $-\Delta r/2$ and $\Delta r/2$.

Determine the number of angular samples required.

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