Radon transform for cone beam CT

rotation of the sample

$$\begin{pmatrix} r \\ s \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

length of the perpendicular lines

$$a = \left(r - u \cdot \frac{A+s}{B} \right) \cdot \cos\phi = \left(r - u \cdot \frac{A+s}{B} \right) \cdot \frac{B}{\sqrt{B^2+u^2}} = \frac{B \cdot r - u \cdot (A+s)}{\sqrt{B^2+u^2}}$$

$$b = \left(z - w \cdot \frac{A+s}{B} \right) \cdot \cos\psi = \left(z - w \cdot \frac{A+s}{B} \right) \cdot \frac{B}{\sqrt{B^2+w^2}} = \frac{B \cdot z - w \cdot (A+s)}{\sqrt{B^2+w^2}}$$

projection for a single beam

$$p(u,w) \approx \Delta_{xy} \cdot \sum_{x,y,z} f(x,y,z) \cdot \mathrm{sinc}\left(\pi \cdot \frac{a}{\Delta_{xy}} \right) \cdot \mathrm{sinc}\left(\pi \cdot \frac{b}{\Delta_z} \right)$$

where

Δ_{xy} : grid interval of $f(x,y,z)$ along x and y directions
Δ_z : grid interval of $f(x,y,z)$ along z direction