A novel scatter correction method for Cone Beam CT

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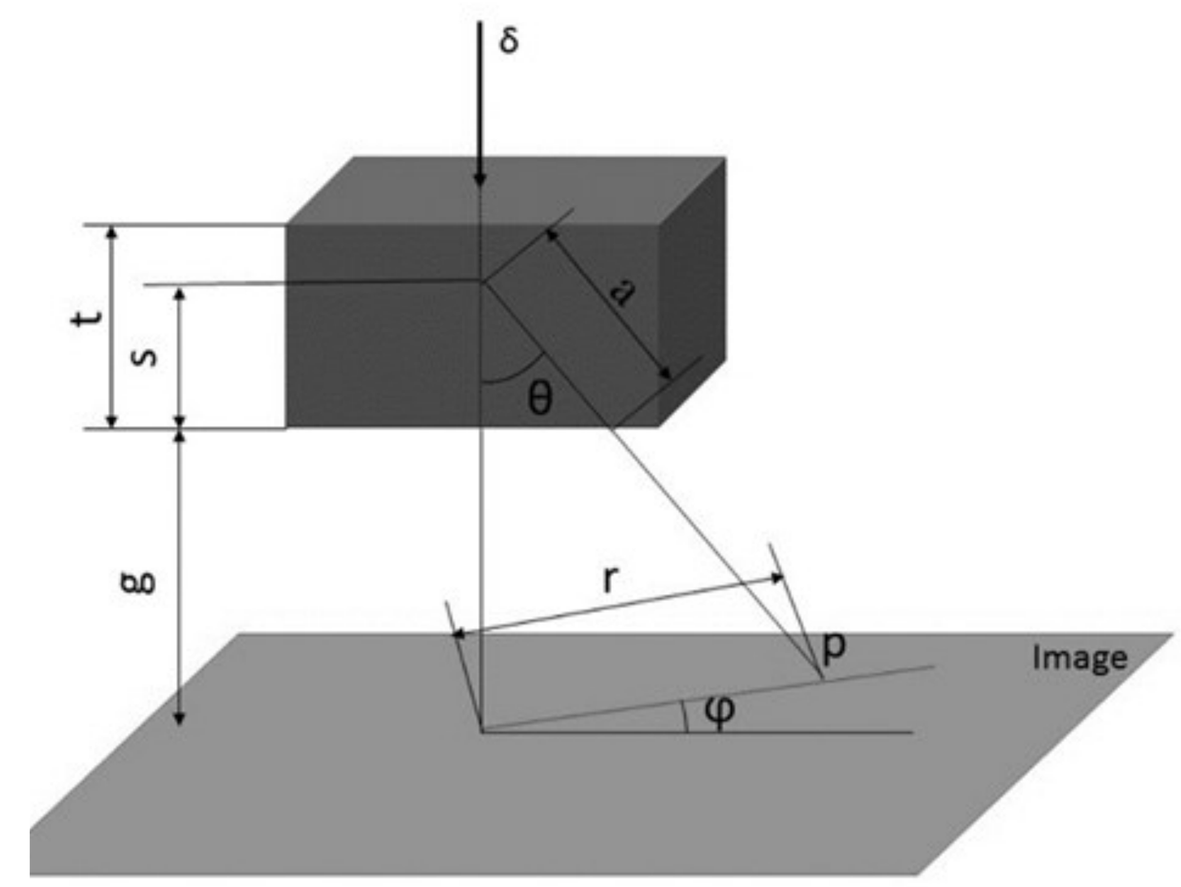
Methods

In this paper, we proposed a novel scatter correction approach for cone beam computed tomography based on Klein-Nishina formulation. Also a principle was proposed that the photons intensity distribution was determined by the attenuation coefficient μ and the path length l by deducting this formulation, which declares that two pencil beams pass through two objects with the same values of μl could result in same photons intensity distribution, i.e., point spread function (PSF), even if the corresponding μ and l are different. The simulation and experimental results demonstrated the feasibility of our approach, as well as the comparison with the beam stop array (BSA) method for evaluation.

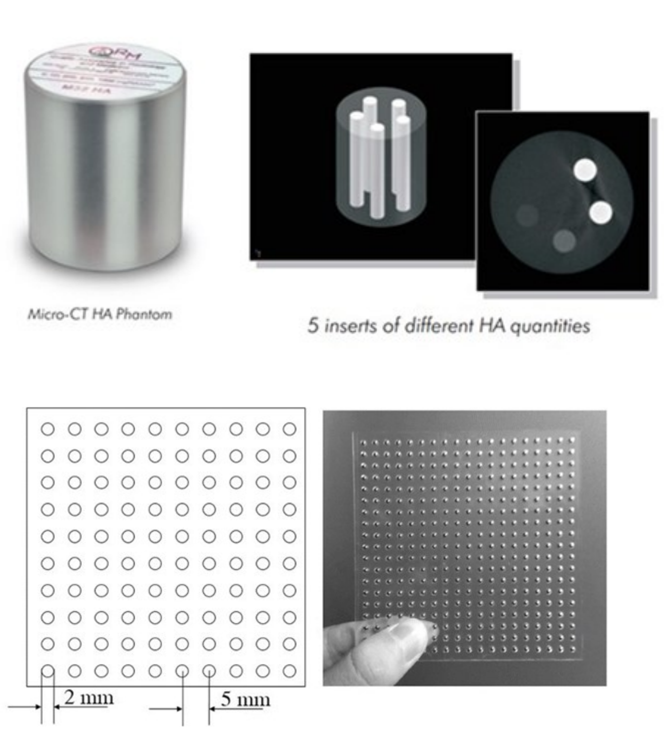


$$g'(r, \varphi) = K\int_{s=0}^{t} \exp[-\mu_s(t-s)]f(\theta)ds$$

$$f(\theta) = \exp\left(\frac{-\mu_s s}{\cos\theta}\right)\times(\sin\theta P(E_\gamma,\theta))^2[P(E_\gamma,\theta)+\frac{1}{P(E_\gamma,\theta)}-\sin^2\theta]/2\times\left(\frac{\tan\theta}{r(1+(\tan\theta)^2)}\right))/2\pi r$$

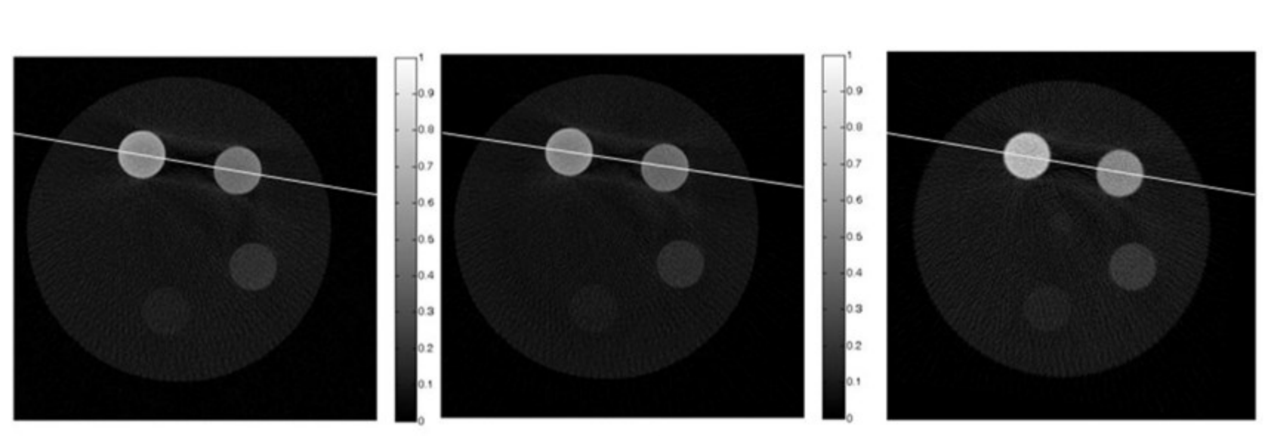
Experiment and Results

Phantom study

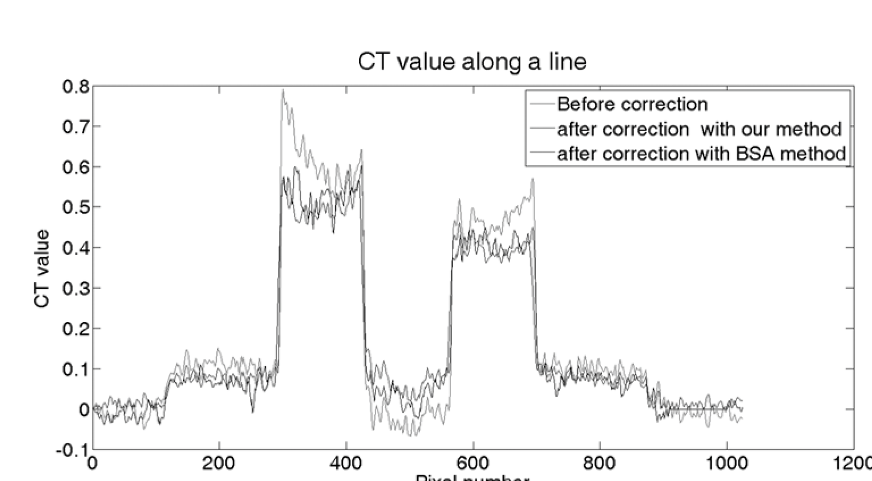


360 projection images with and without a BSA phantom were obtained with one full angle scan. The BSA phantom was placed between the X-ray source and the object. Once the projection images with BSA phantom were obtained, the scatter fraction was obtained by the typical method proposed by R. Ning. On the other hand, another scatter matrix was obtained by Eq. 13. After the scatter fraction elimination, the corrected projection images (our method and BSA method) were reconstructed to a 1024*1024*1024 size image using FDK reconstruction method with geometry calibration respectively.

Results



(a) (b) (c)



The picture and line show the image quality improvement after scatter correction, especially in the region around the brighter discs, where the scatter artifacts is much more serious, and the comparable correction effect of both methods.

Conclusions

We proposed a novel scatter correction approach based on the Klein-Nishina formulation. It has a high parallel computing features. The phantom study result showed excellent performance of our approach.

Acknowledgements

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