

Focal Spot Blur Correction for Cone-Beam CT

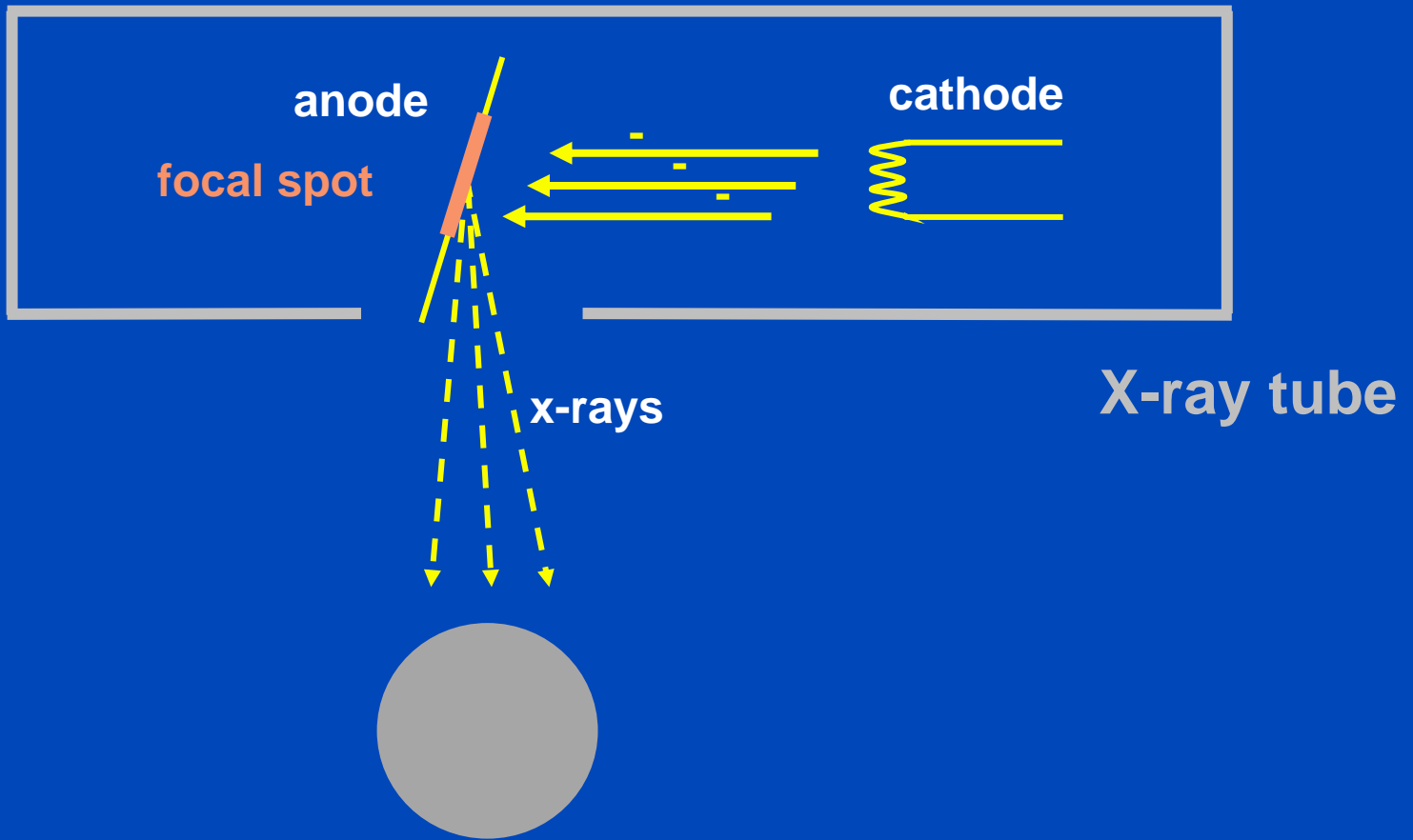
Nadine Waltrich^{1,2}, Stefan Sawall^{1,2}, and Marc Kachelrieß^{1,2}

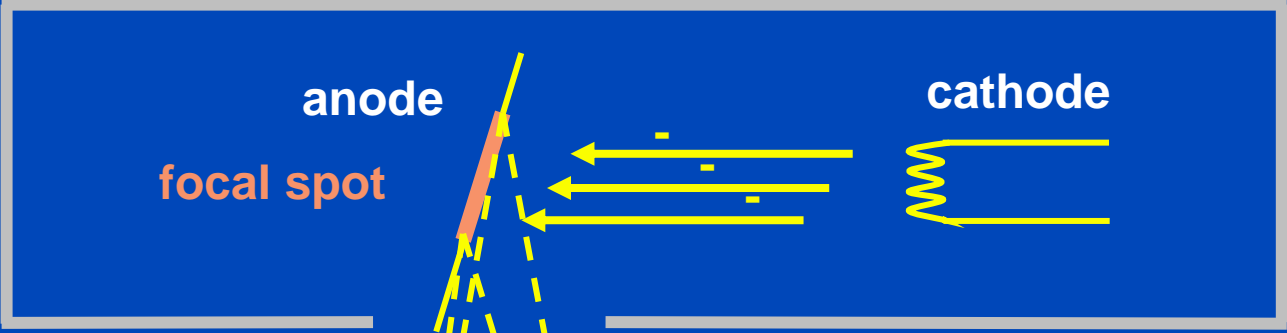
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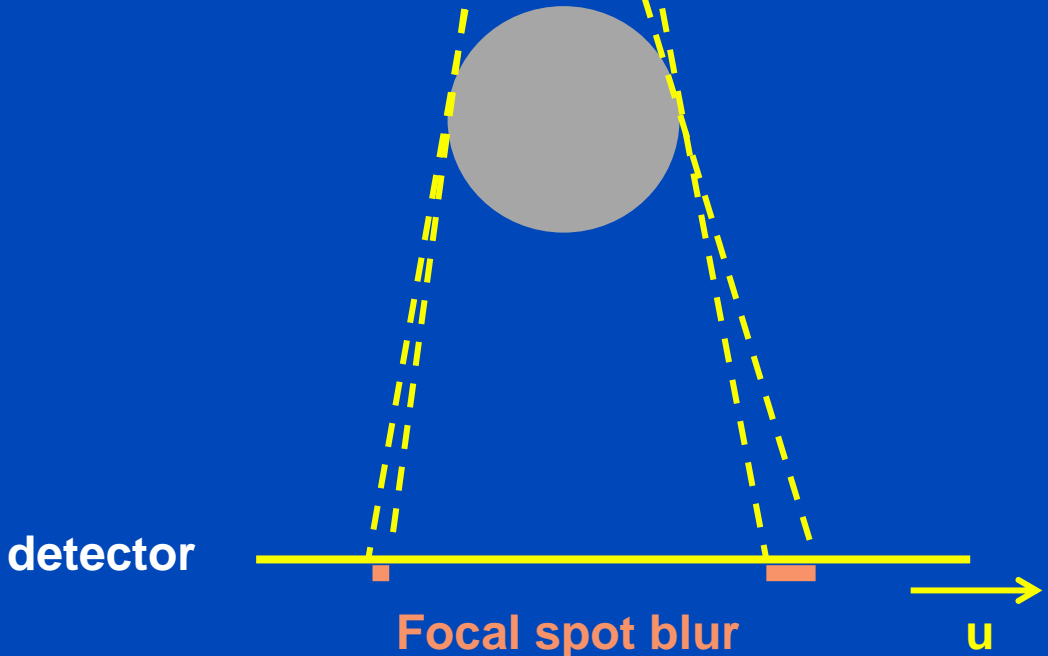
Aim

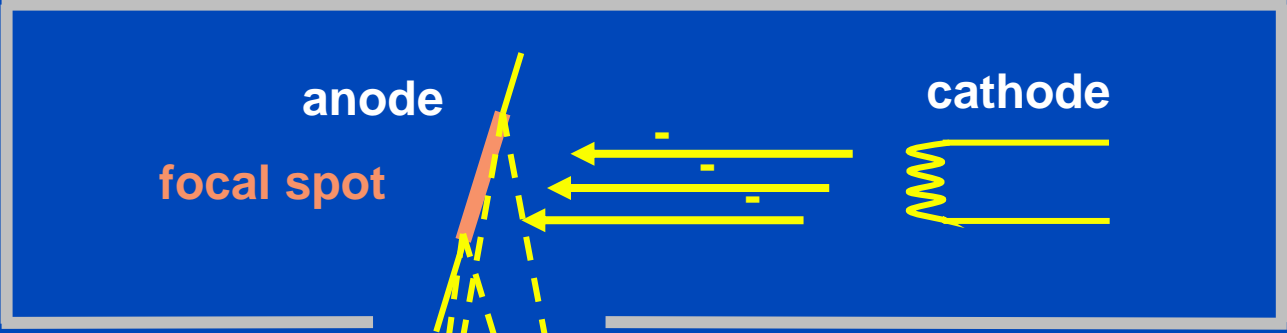
To correct for the spatial resolution mismatch caused by anode angulation in short scan CBCT.



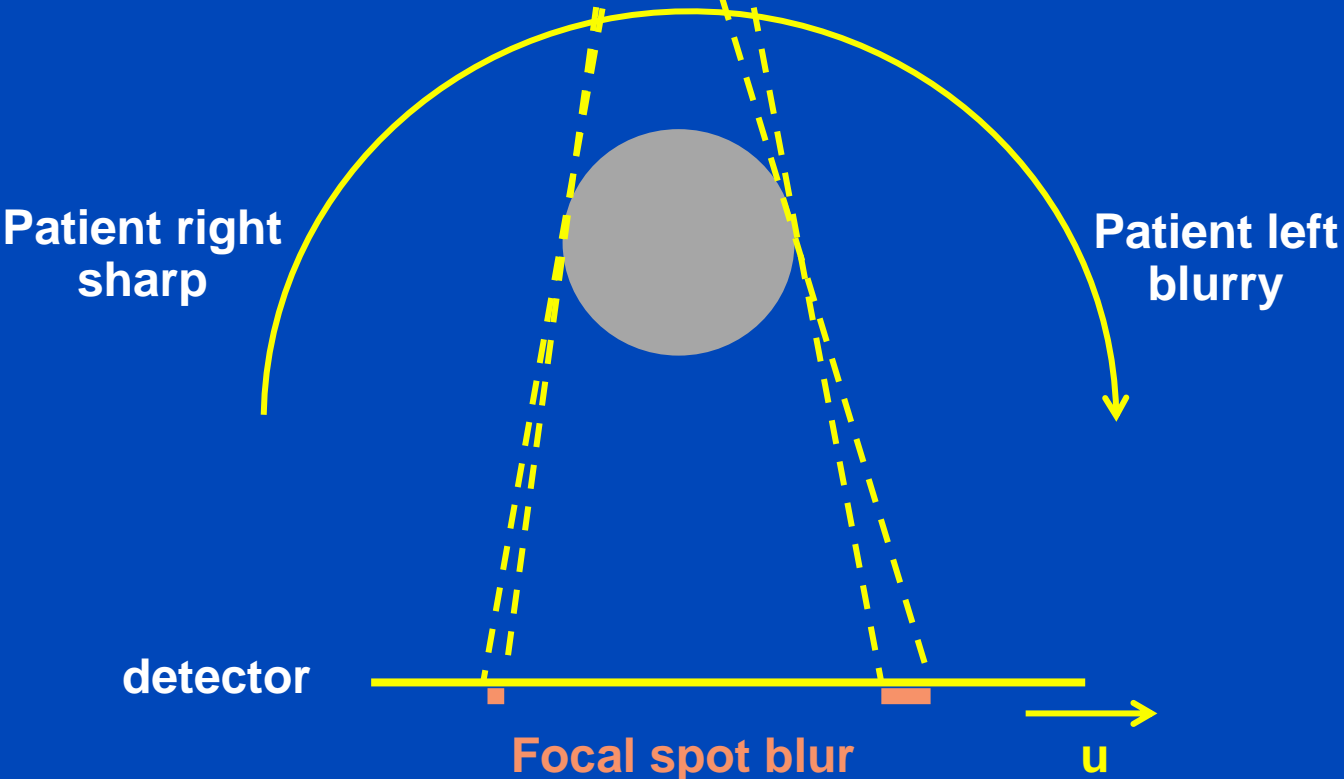


X-ray tube



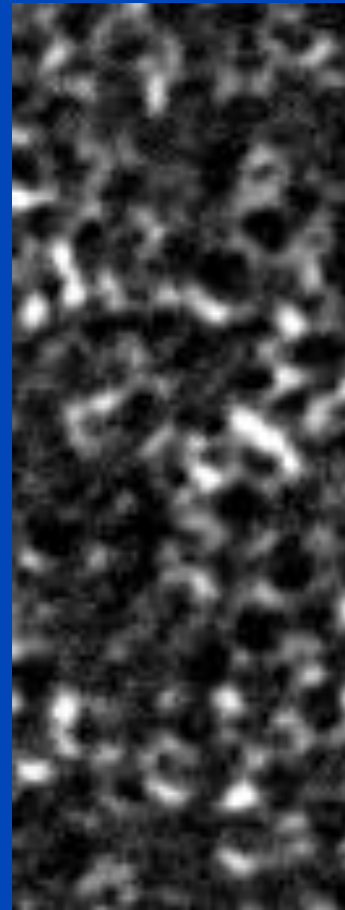
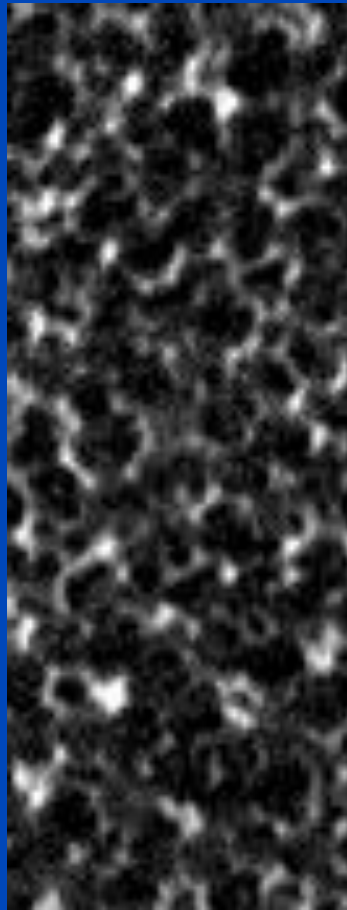


X-ray tube

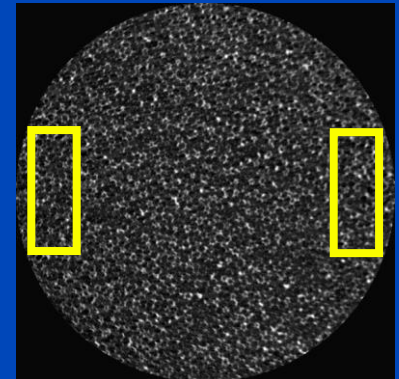


FDK Reconstruction of Fine-Pored Aluminum Foam

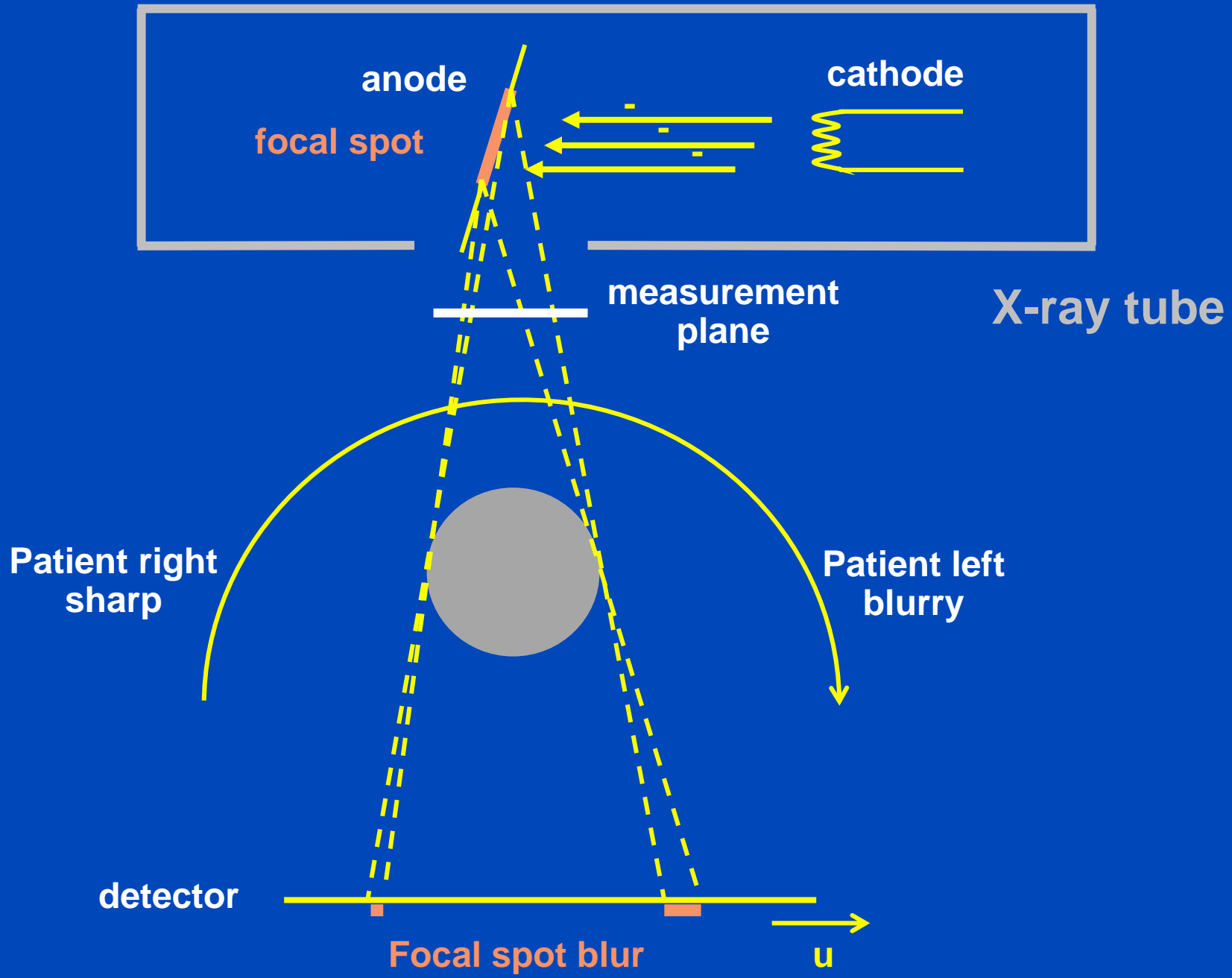
left
sharp

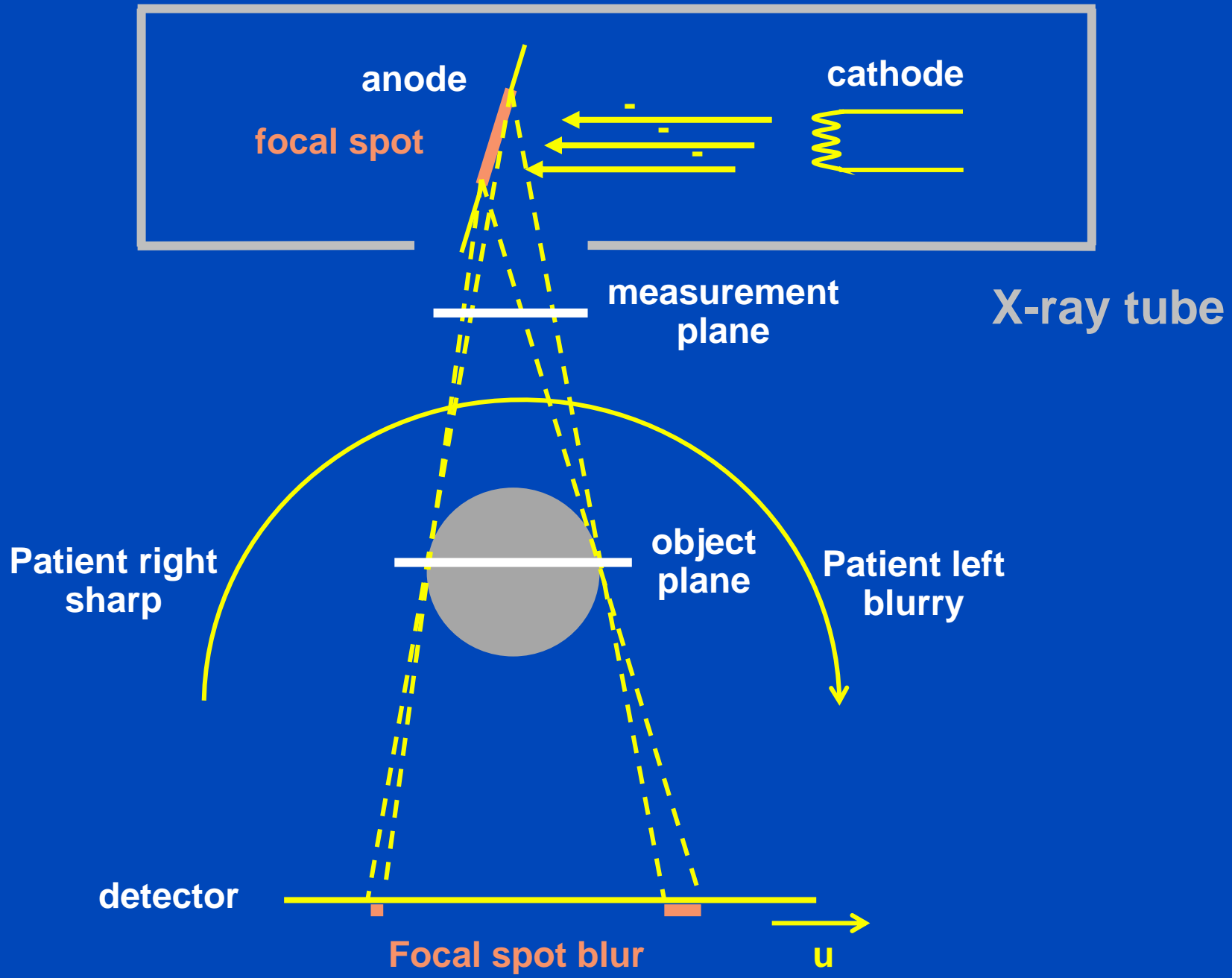


right
blurry

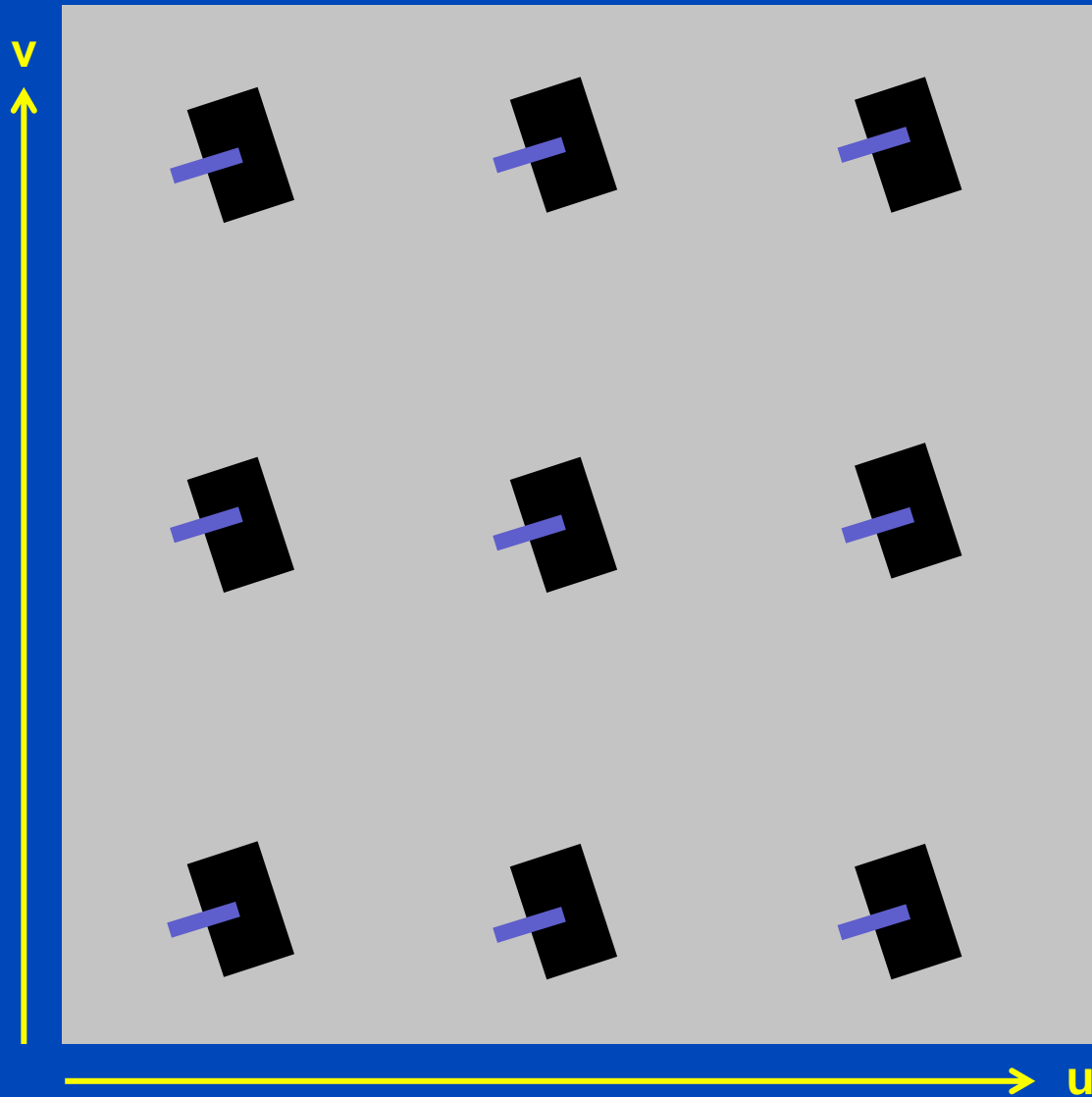


$C = -350 \text{ HU}$; $W = 1500 \text{ HU}$

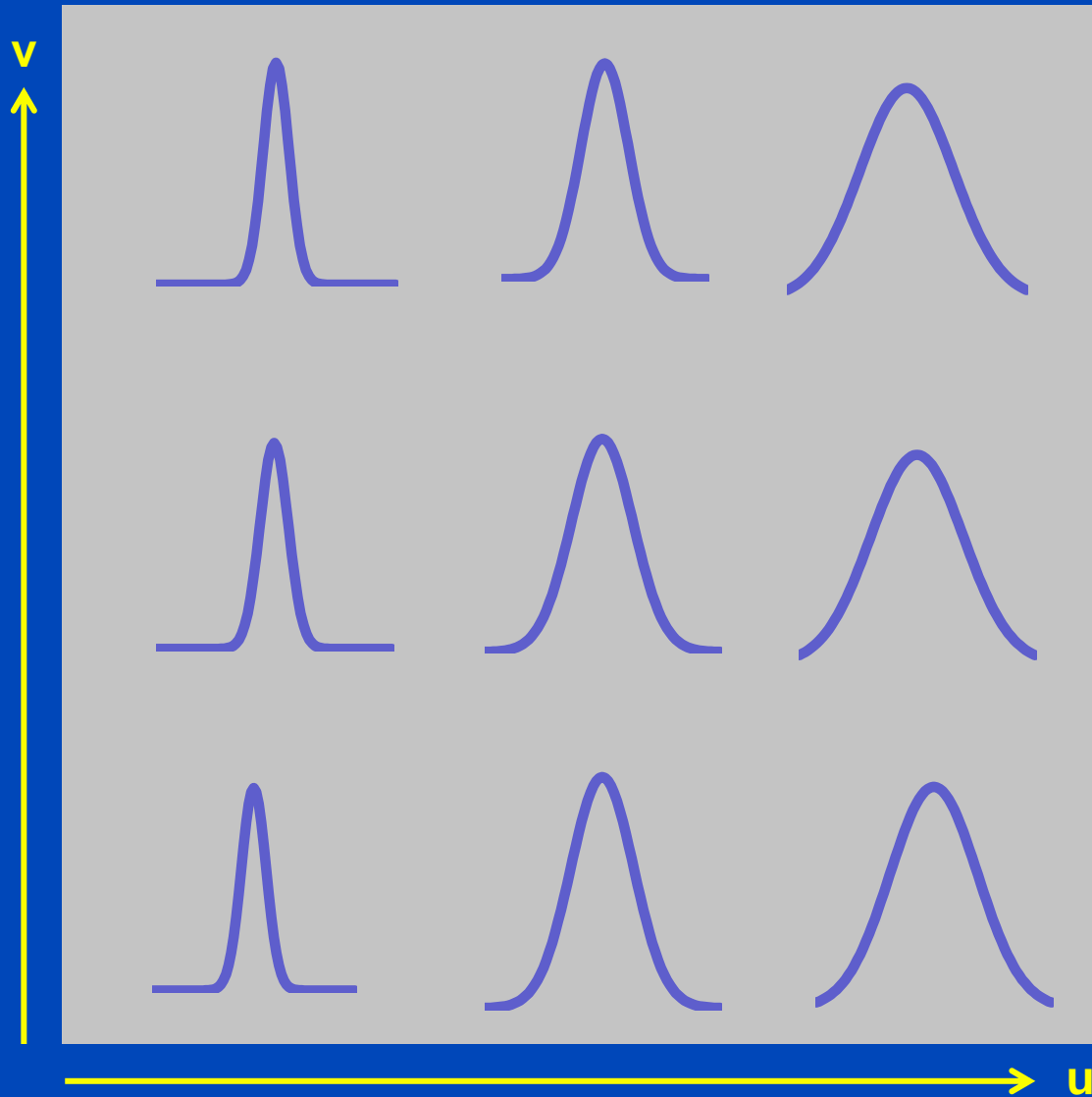




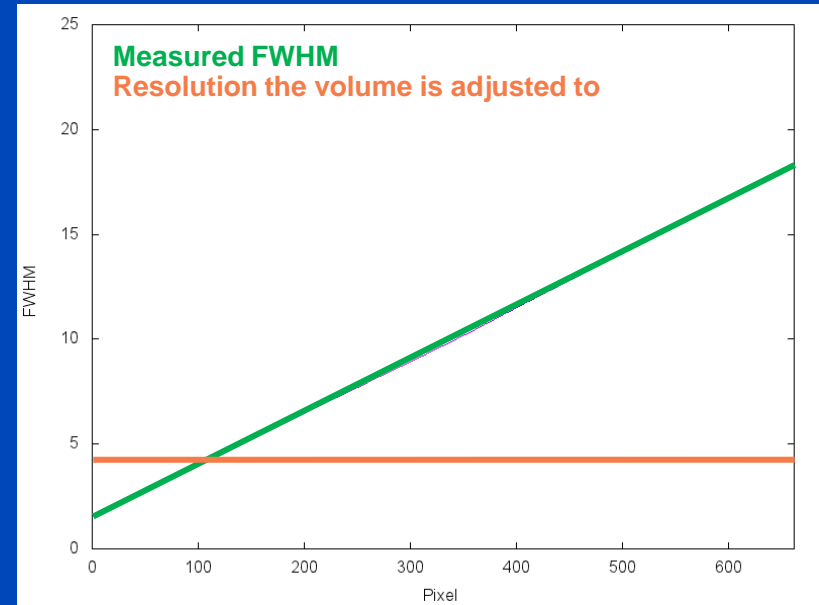
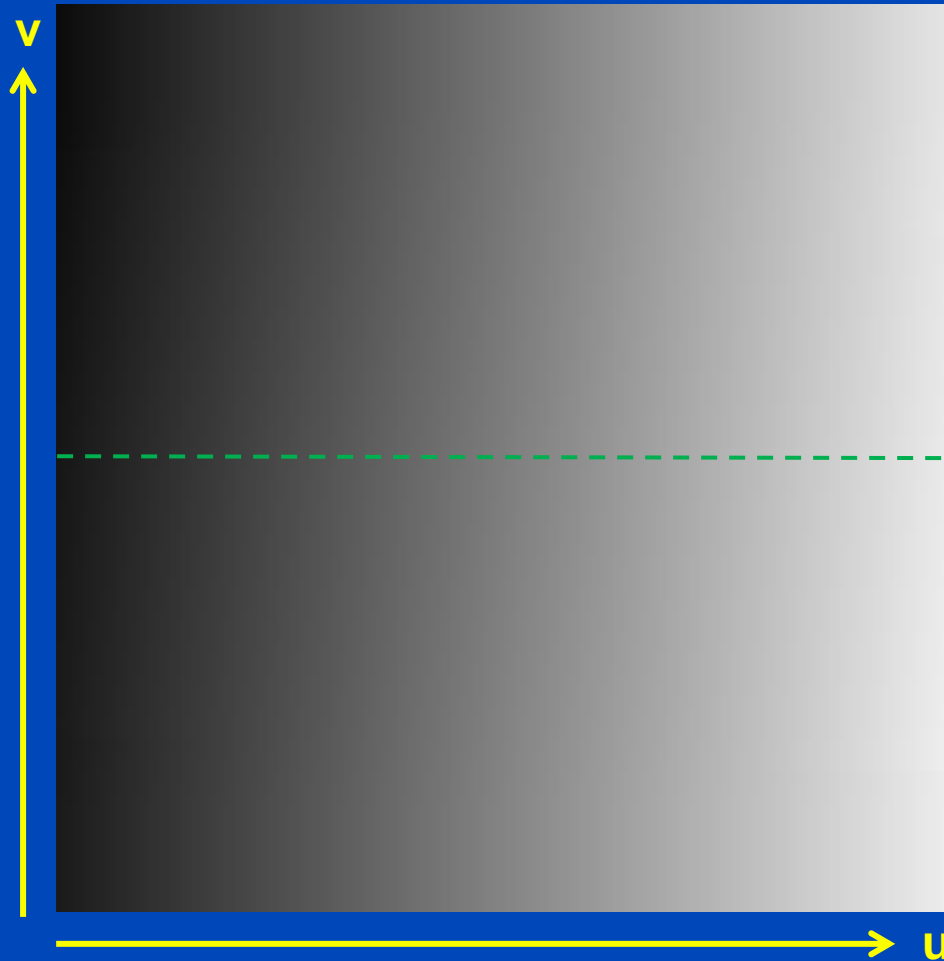
Positions of the Metal Edges on the Measurement Plane in u-Direction



Positions of the Metal Edges on the Measurement Plane in u-Direction



2D Voxel-Wise Focal Spot Blur Distribution



FWHM = 0 px  FWHM = 20 px

$C = 10 \text{ px}$; $W = 20 \text{ px}$

1. Projection-Based Iterative Focal Spot Blur Correction (PBiFSC)

Cost function: $C(\hat{p}) = \|G\hat{p} - p\|$

$G \hat{=}$ shift variant Gaussian convolution operator

$p \hat{=}$ projection data

Minimize the cost function

$$\nabla C(\hat{p}) = G^T (G\hat{p} - p)$$

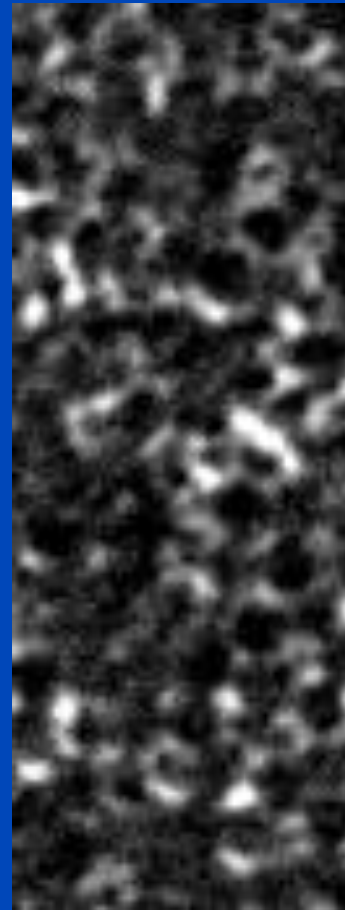
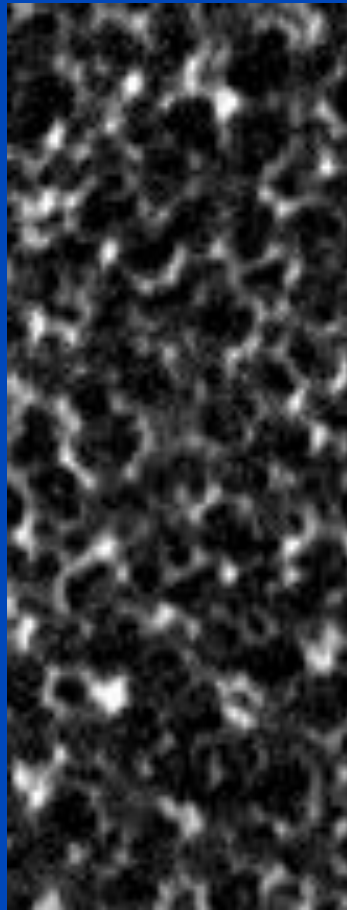
$$\hat{p}_{n+1} = \hat{p}_n + \lambda \nabla C(\hat{p}_n)$$

starting with $\hat{p}_0 = p$

The stepsize λ is chosen to minimize the cost function.

FDK Reconstruction of Fine-Pored Aluminum Foam

left
sharp

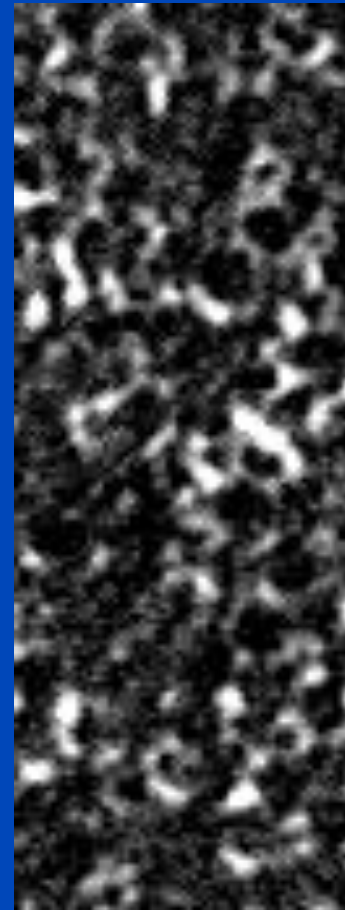
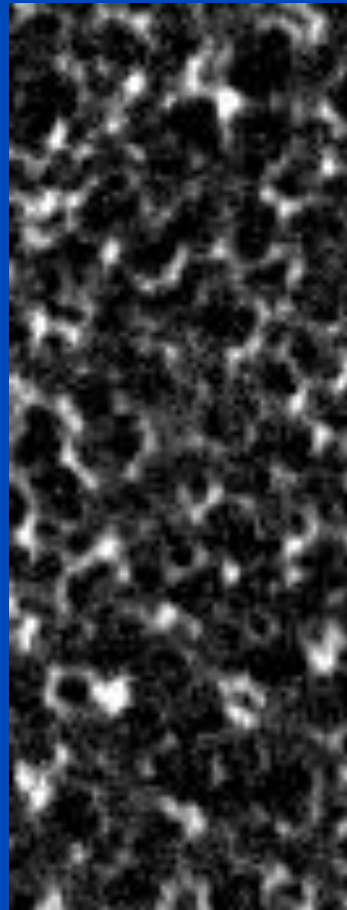


right
blurry

$C = -350 \text{ HU}$; $W = 1500 \text{ HU}$

PBiFSC 5 Iteration Fine-Pored Aluminum Foam

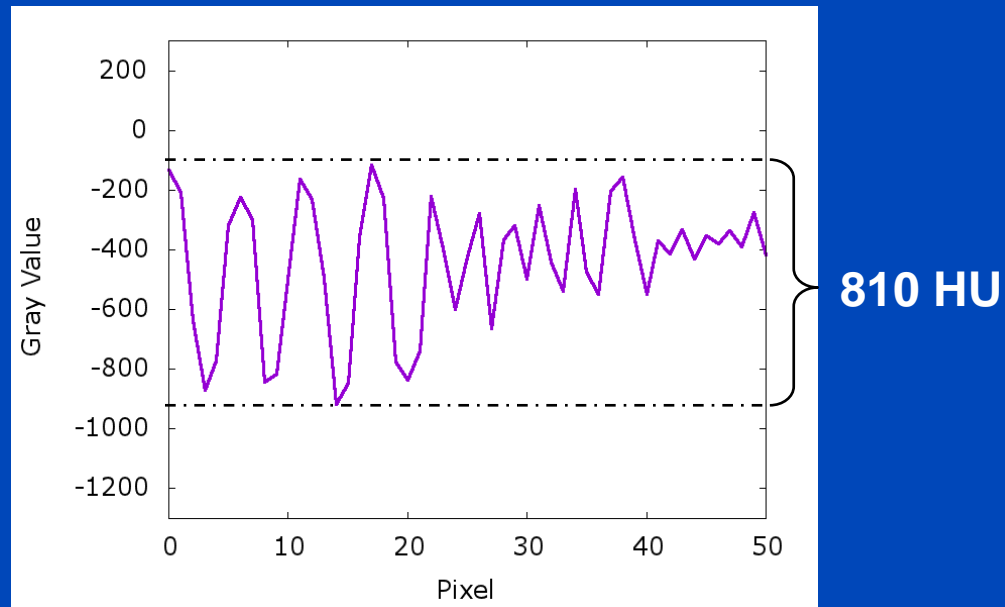
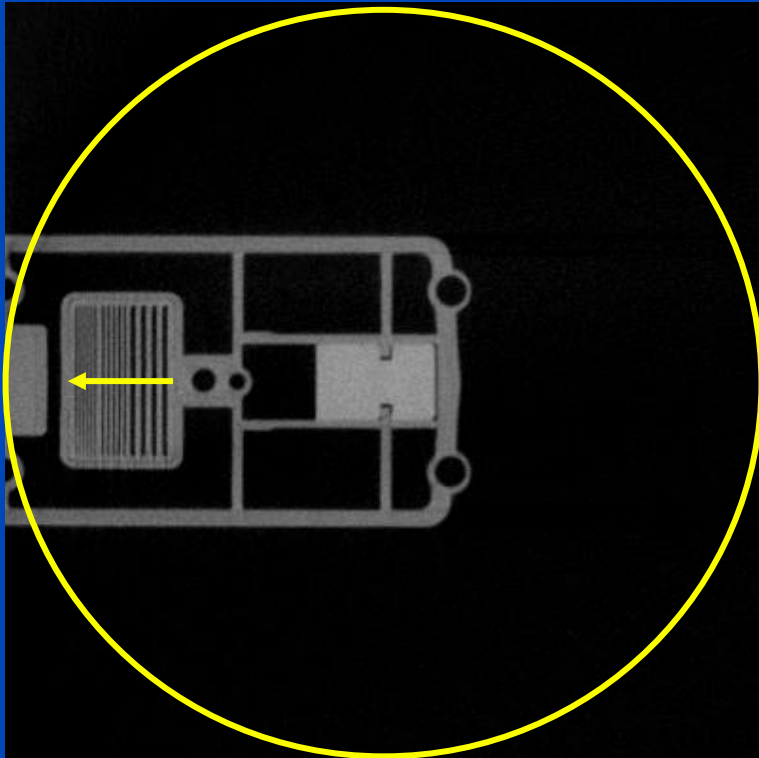
left
sharp



right
blurry

$C = -350 \text{ HU}$; $W = 1500 \text{ HU}$

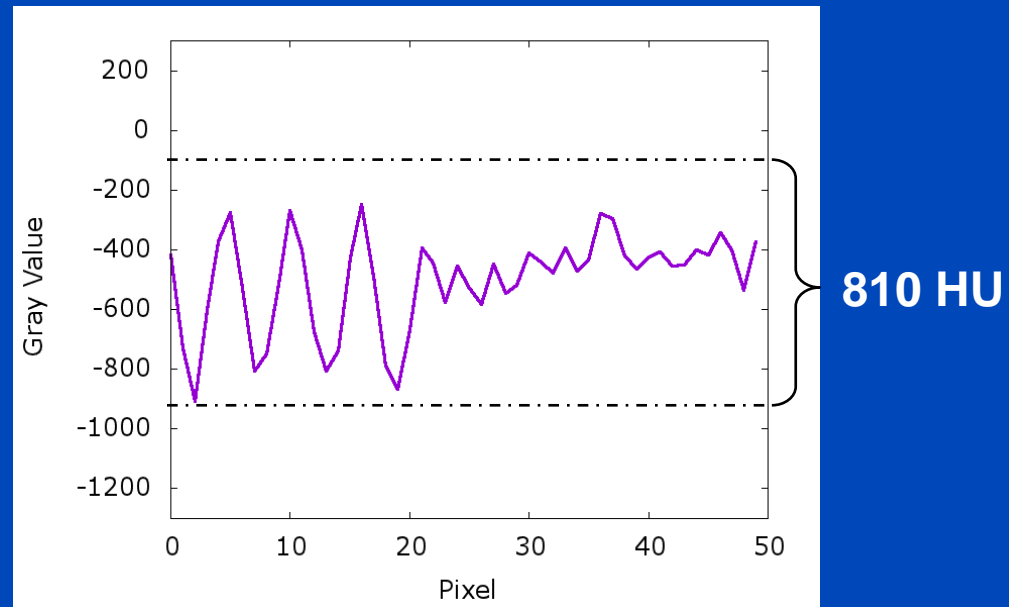
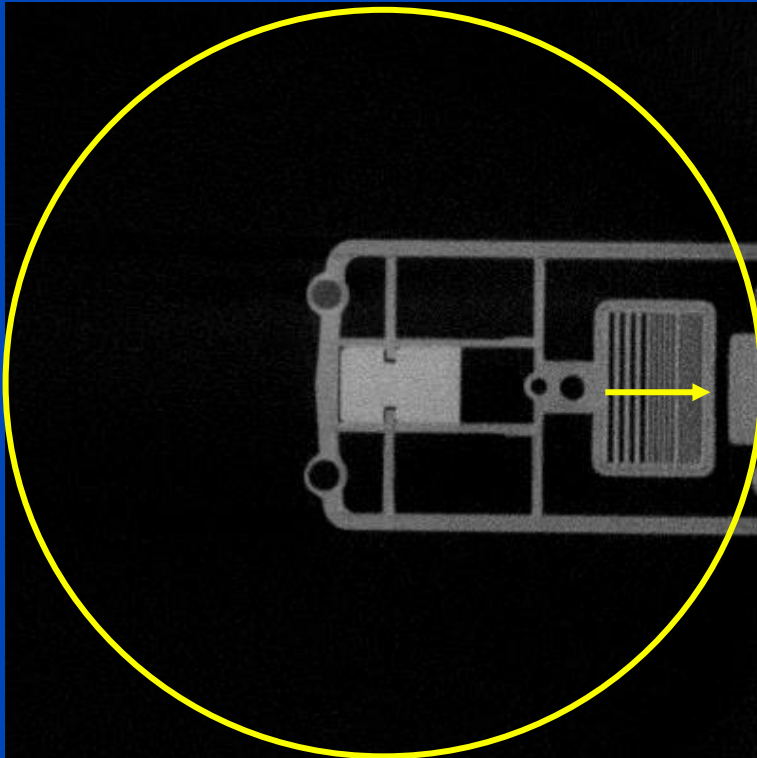
FDK Reconstruction, Object Positioned on the Left



maximal peak-to-peak value of 810 HU

$C = 0 \text{ HU}$; $W = 2000 \text{ HU}$

FDK Reconstruction, Object Positioned on the Right

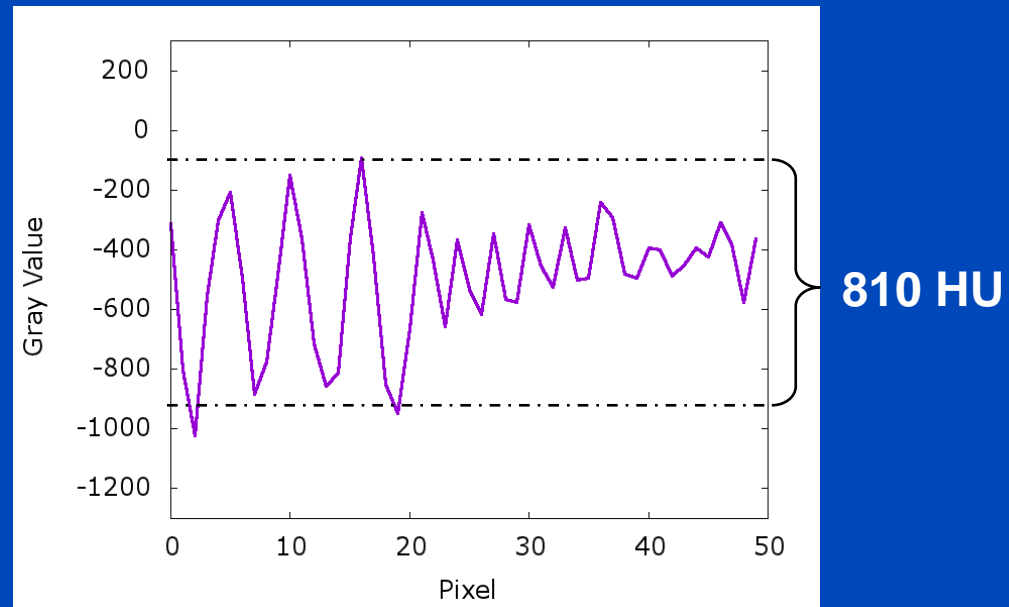
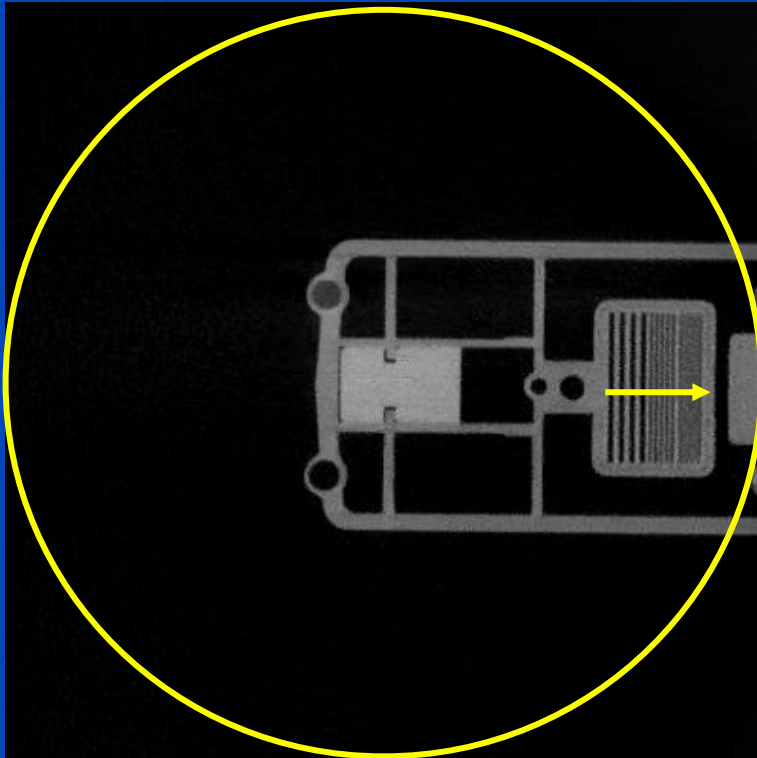


maximal peak-to-peak value of 620 HU

$C = 0 \text{ HU}$; $W = 2000 \text{ HU}$

PBiFSC 5 Iterations

Smoothed with an Position-Dependent Bilateral Filter



maximal peak-to-peak value of 820 HU

$C = 0 \text{ HU}$; $W = 2000 \text{ HU}$

Conclusions

- **5 iterations of the deconvolution algorithm result in a good spatial resolution restoration.**
 - **An adjustment of the image resolution is possible.**
- **The disadvantage is the slight increase in the noise level. Thus, for practical use an additional filter is used.**
- **Fast alternative compared to a conventional iterative focal spot blur correction.**

Thank You!

Job opportunities through DKFZ's international PhD or Postdoctoral Fellowship programs (www.dkfz.de), or directly through Marc Kachelriess (marc.kachelriess@dkfz.de).

Parts of the reconstruction software were provided by RayConStruct® GmbH, Nürnberg, Germany.