Large Volume Data Acquisition for Intraoperative Imaging with Mobile C-Arm CT Systems

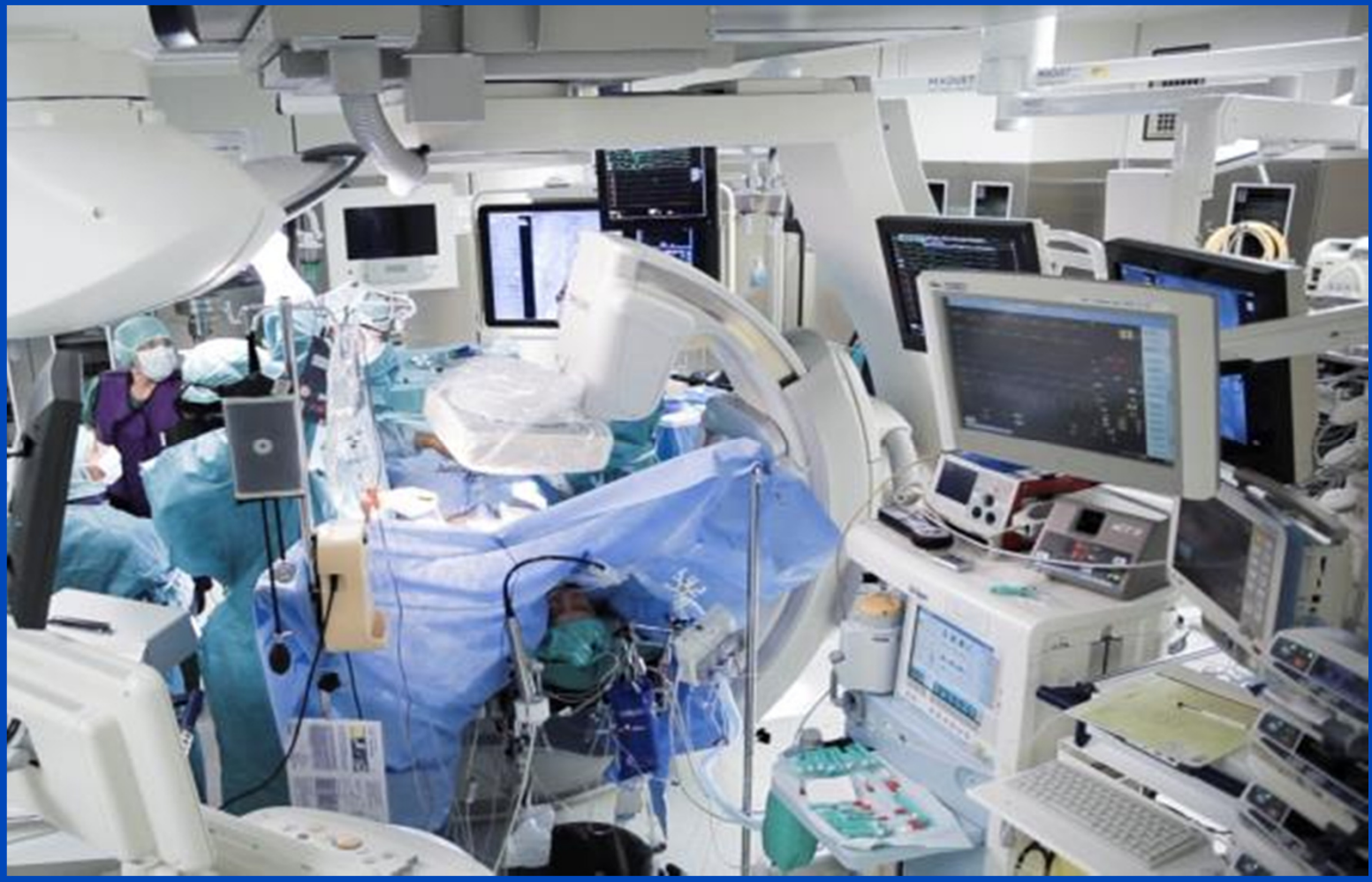
Jan Kuntz[1], Michael Knaup[1], Christof Fleischmann[2], and Marc Kachelrieß[1]

[1]German Cancer Research Center (DKFZ), Heidelberg, Germany
[2]Ziehm Imaging GmbH, Nürnberg, Germany

ziehmimaging

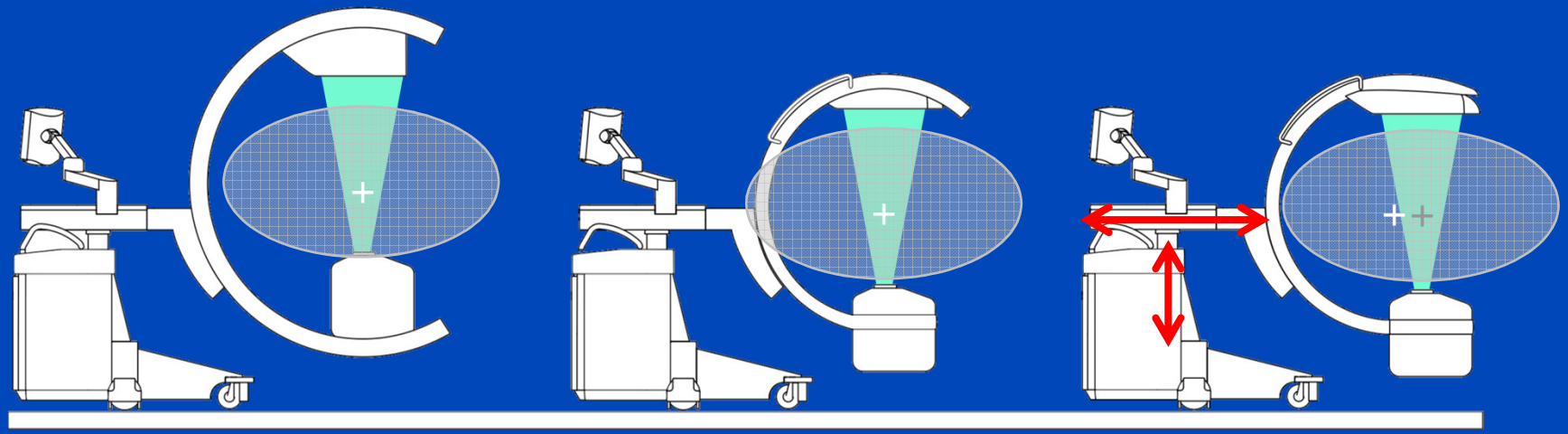
dkfz. DEUTSCHES KREBSFORSCHUNGSZENTRUM IN DER HELMHOLTZ-GEMEINSCHAFT

Typical OR Situation



The compactness of C-arm systems is of particular importance when complex interventions are carried out and many other medical devices are in the OR.

C-Arm Designs



Vendor A … Vendor Z

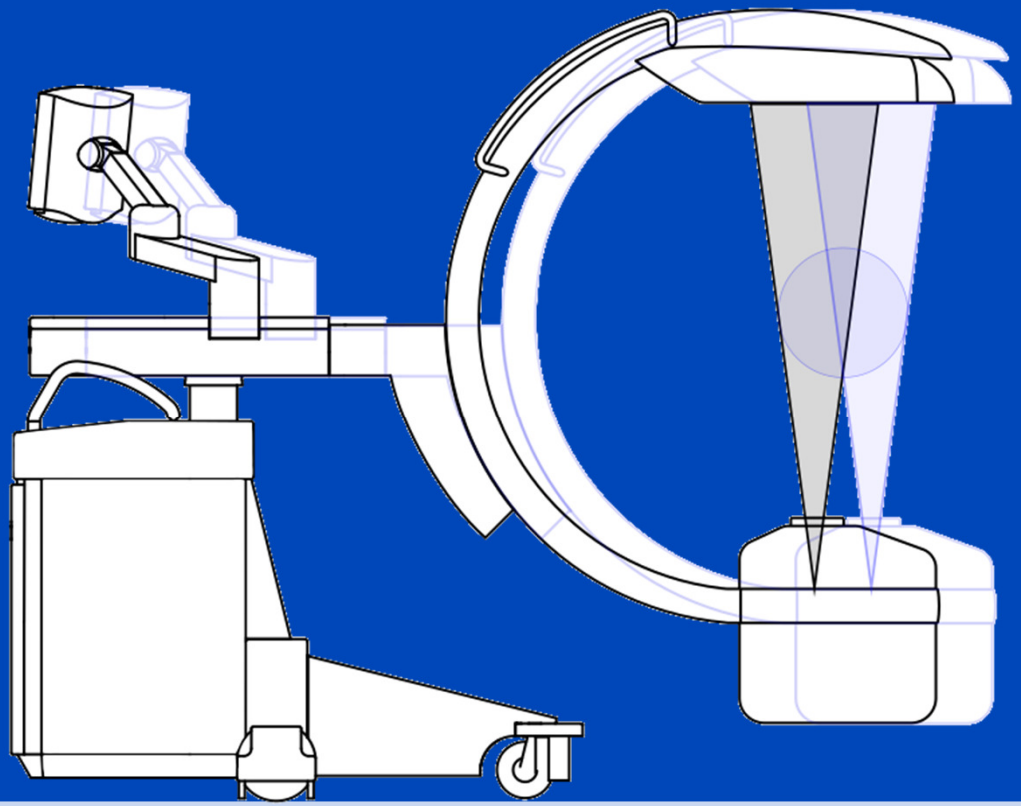
Mobile C-arm systems should be small and compact to ensure flexible use in the operation room. From this point-of-view a non-isocentric design with rotation range of less than 180° is optimal.

Rotate-Plus-Shift[1] (RPS) Trajectory

[1]J. Kuntz, L. Ritschl, C. Fleischmann, M. Knaup, and M. Kachelrieß. The Rotate-Plus-Shift C-Arm Trajectory (Parts I and II). MedPhys 2016 in press.

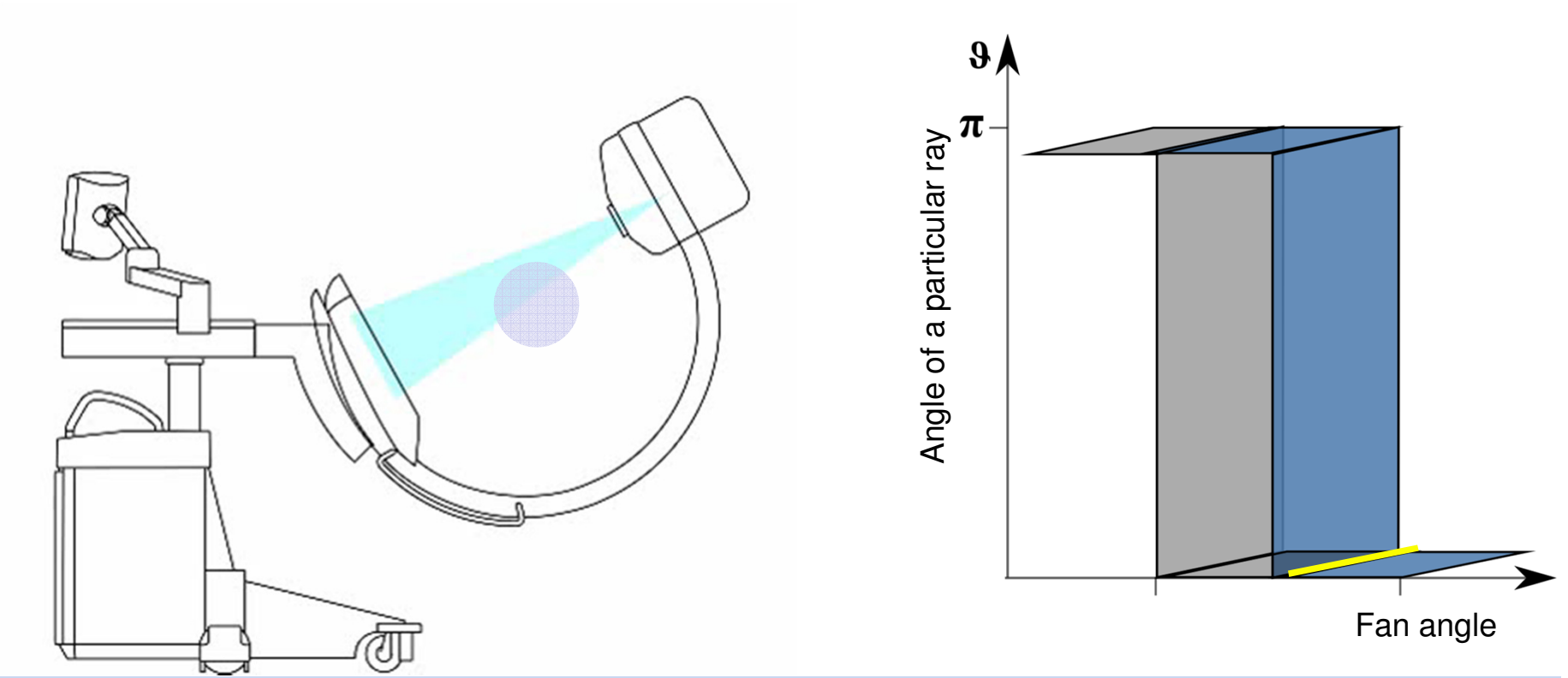
Purpose

- To increase the FOM acquired with mobile C-arm CT systems using a shifted detector option.



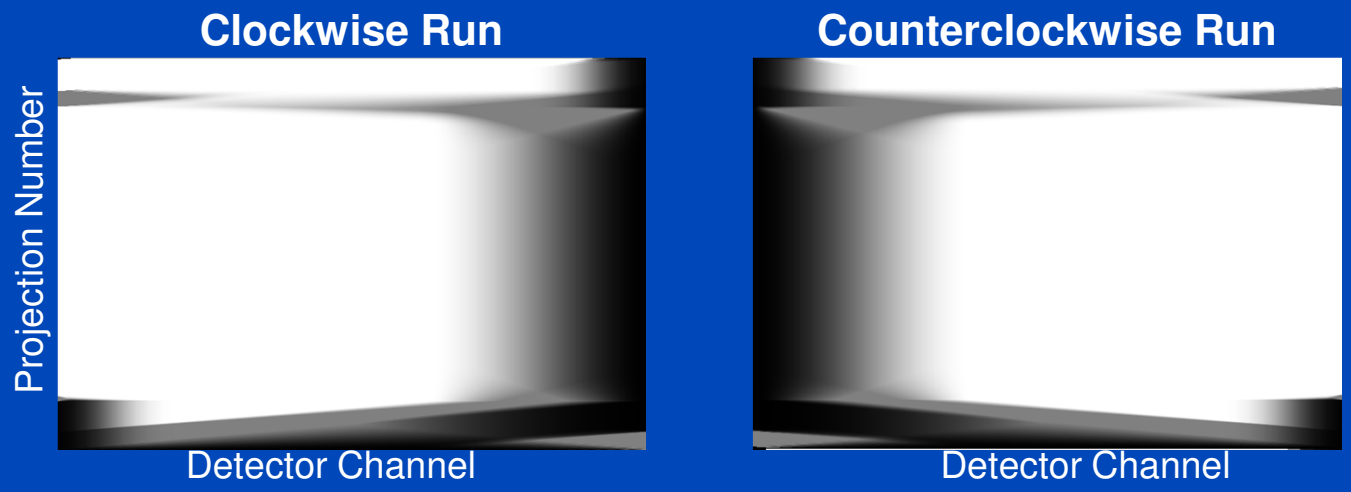
SDRPS Trajectory

- **Combining the shifted detector (SD) technology with the RPS trajectory yields the new shifted detector rotate-plus-shift (SDRPS) trajectory.**



SDRPS Rawdata Weights

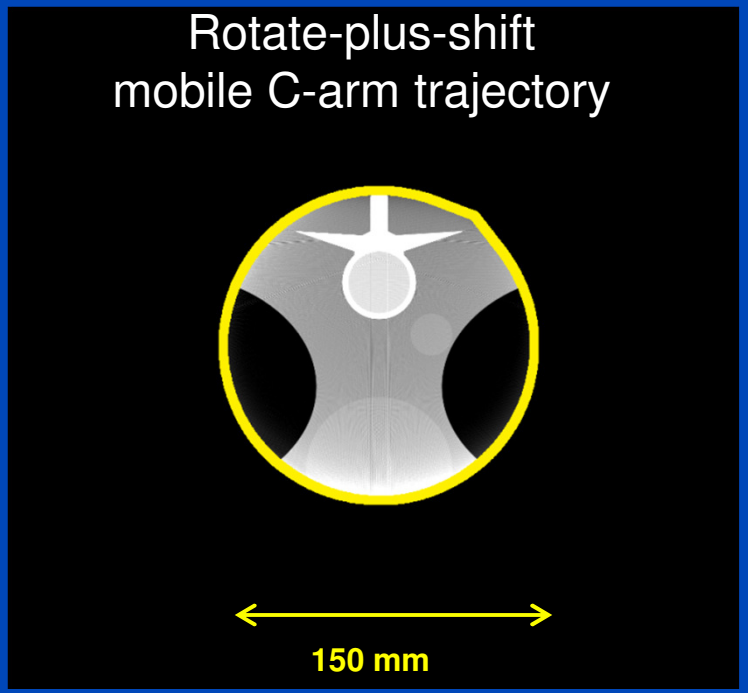
- Determine coverage in virtual parallel sinogram[1]
- Find redundancies in virtual parallel geometry[1]
- Calculate redundancy weights[1] that ensures that
  - the all redundant rays sum up to 1: $\sum_h w\left(\vartheta + h\pi, (-1)^h \xi\right) = 1 \quad \forall \vartheta, \xi$
  - all transitions zones in the weight sinogram are smooth



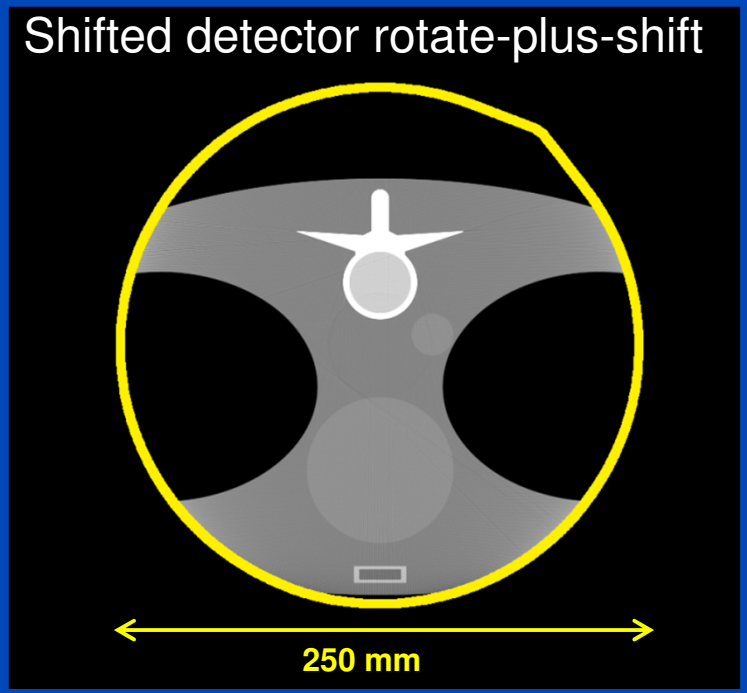
[1]M. Knaup, J. Kuntz, S. Sawall, and M. Kachelrieß. A General Projection Weight for Feldkamp-Type Cone-Beam Image Reconstruction from Arbitrary CT Scan Trajectories. Proceedings of the Fully 3D 2015

Reconstructions of RPS and SDRPS Simulations

- **The proposed SDRPS trajectory increases the FOM significantly, which is advantageous for spinal and thoracic surgery and many other applications.**



RPS



SDRPS

Reconstructions of RPS and SDRPS Simulations

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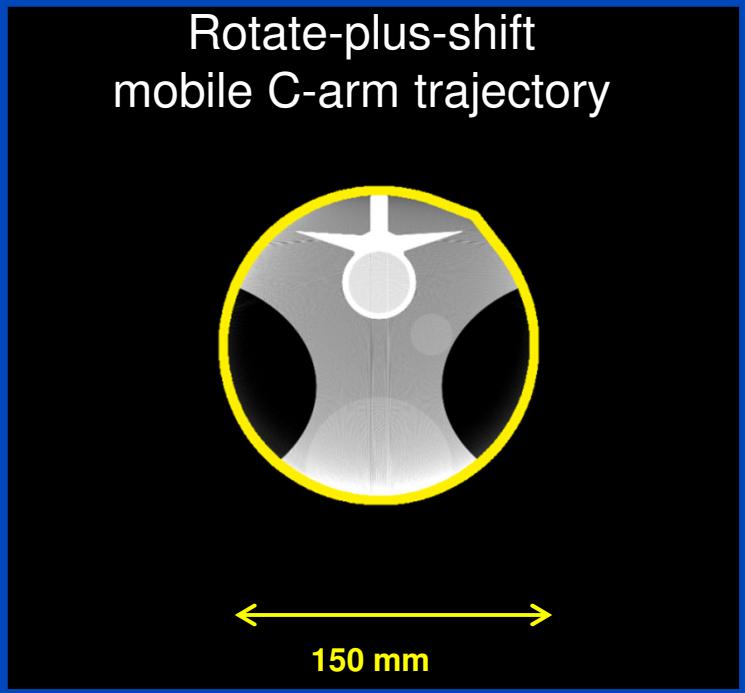
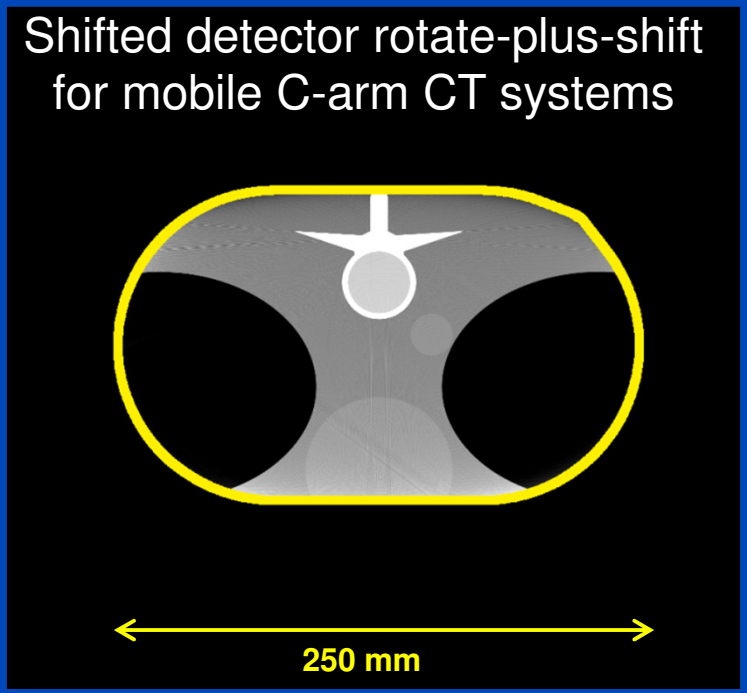
Rotate-plus-shift
mobile C-arm trajectory



RPS

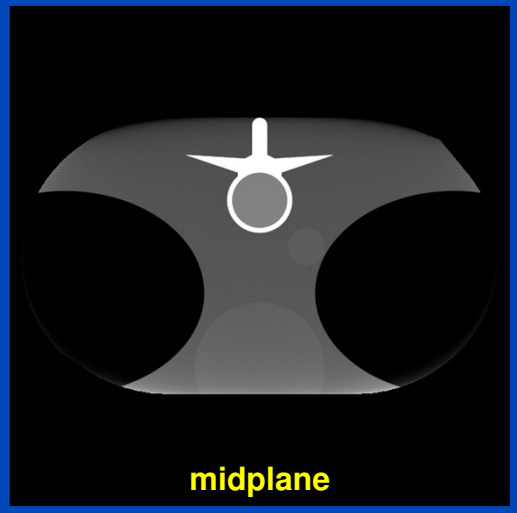
Shifted detector rotate-plus-shift
for mobile C-arm CT systems

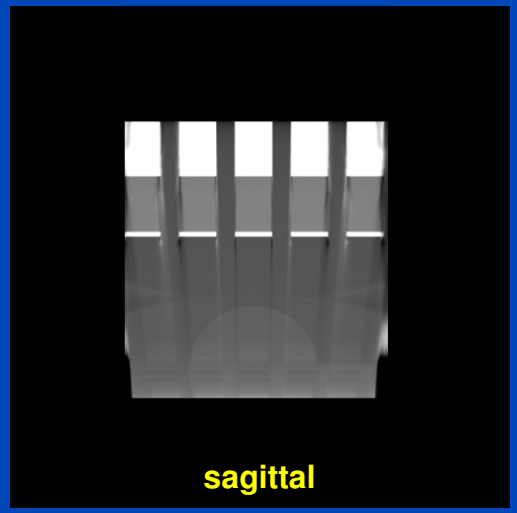


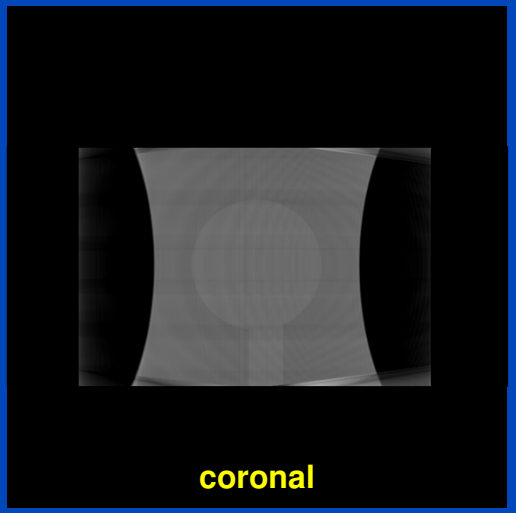
SDRPS

Reconstructions of SDRPS Simulations

- Axial slices do not suffer from limited angle artifacts
- Cone-beam artifacts are similar to those of conventional short scans.

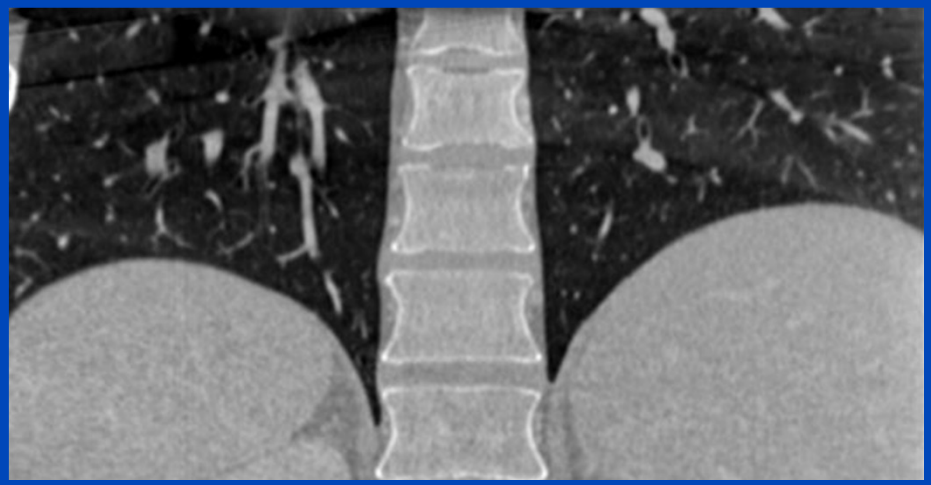






Conclusions

- The SDRPS trajectory can extend the FOM and provide intraoperative 3D images of a larger anatomical area.
- Image reconstruction is exact in the midplane.
- The trajectory can be readily implemented in fully motorized C-arm CT systems.



Thank You!

The 4th International Conference on

Image Formation in X-Ray Computed Tomography

Conference Chair

Marc Kachelrieß, German Cancer Research Center (DKFZ), Heidelberg, Germany

This presentation will soon be available at www.dkfz.de/ct.

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