Reconstructing Interventional C-Arm CT Rawdata from Non-Conventional Scan Trajectories

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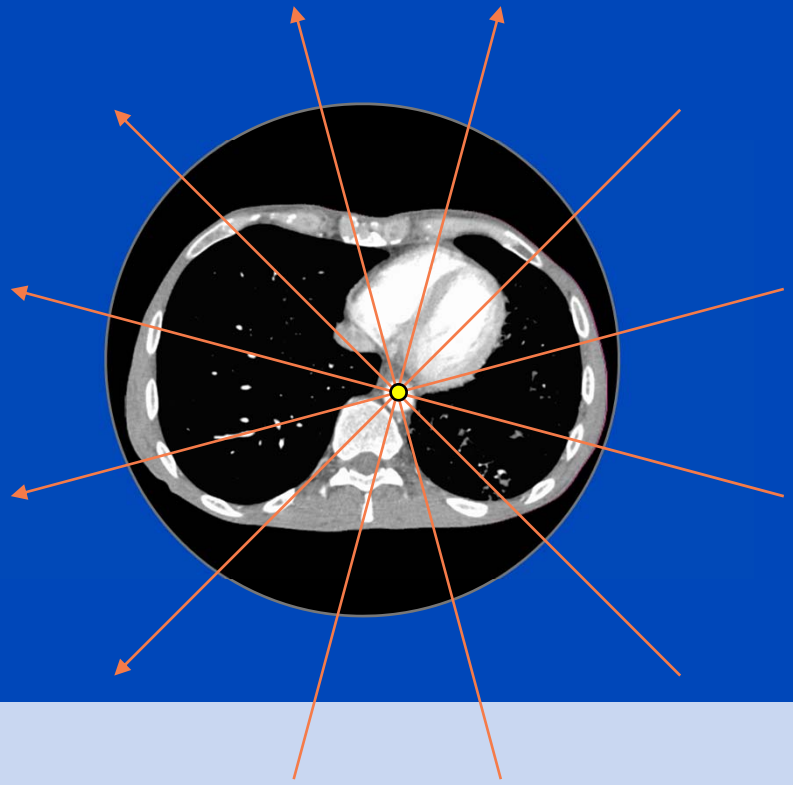
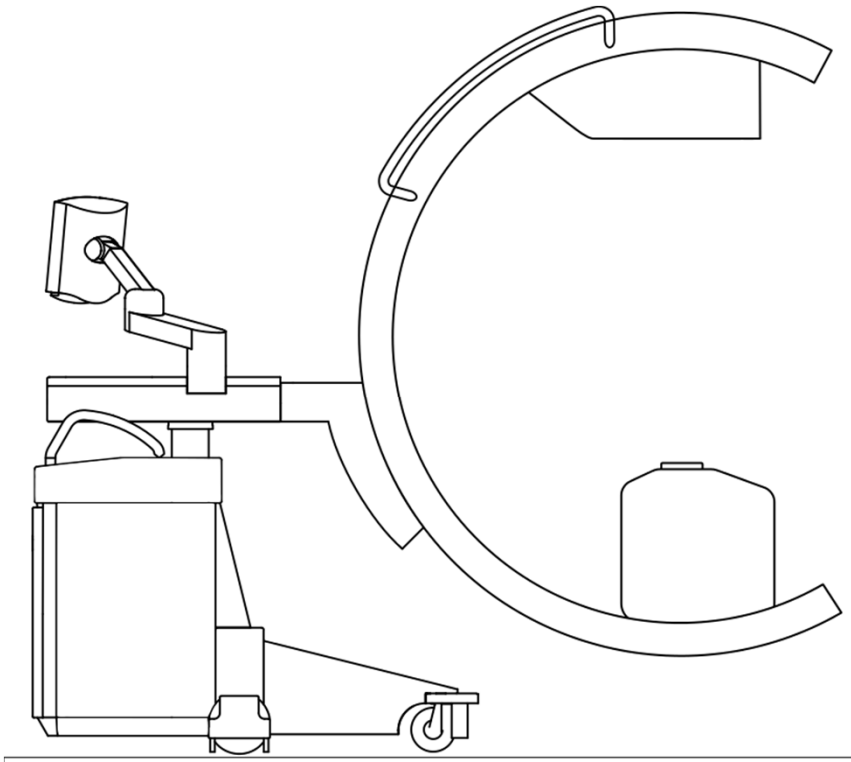
CT Completeness Condition

- Each voxel has to be acquired from at least 180° to allow for image reconstruction.
- Completeness condition leads to a rotation range of 180° + fan angle in circular trajectories

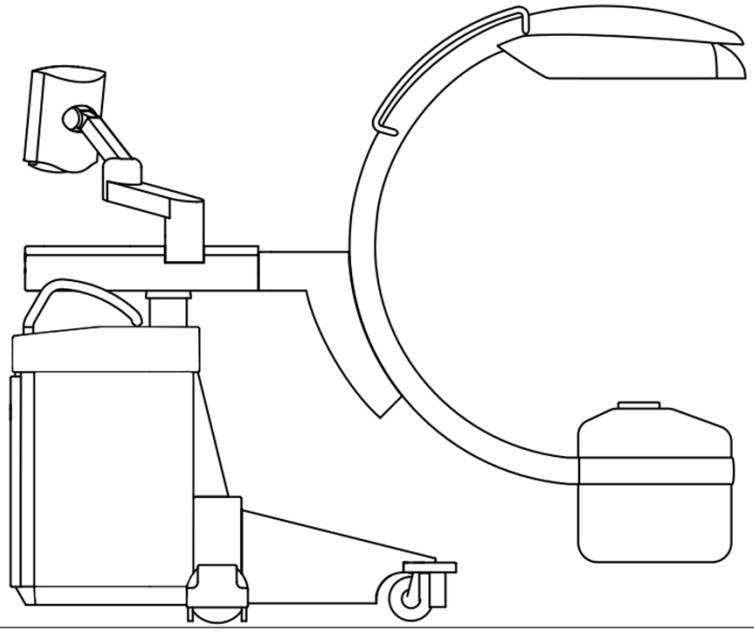


C-Arm System Design

Rotation range: ~200°

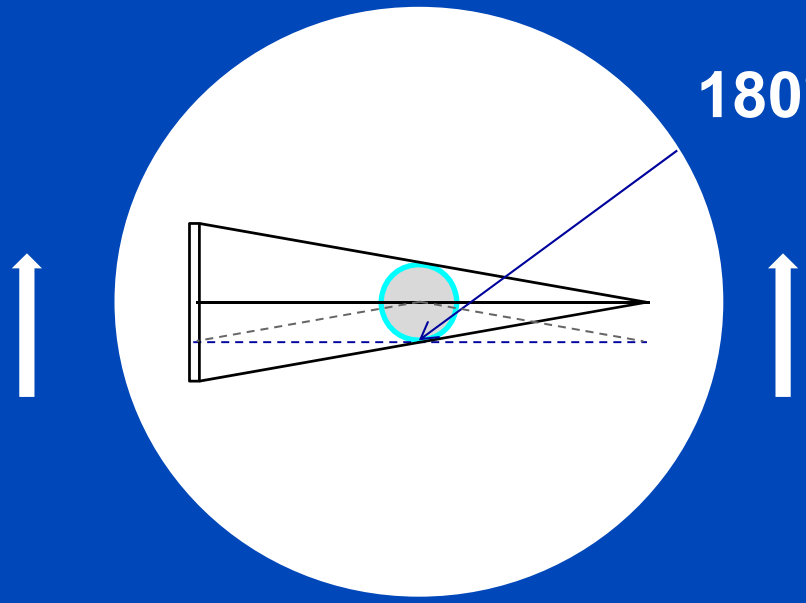


Rotation range: ~165°



Data Acquisition

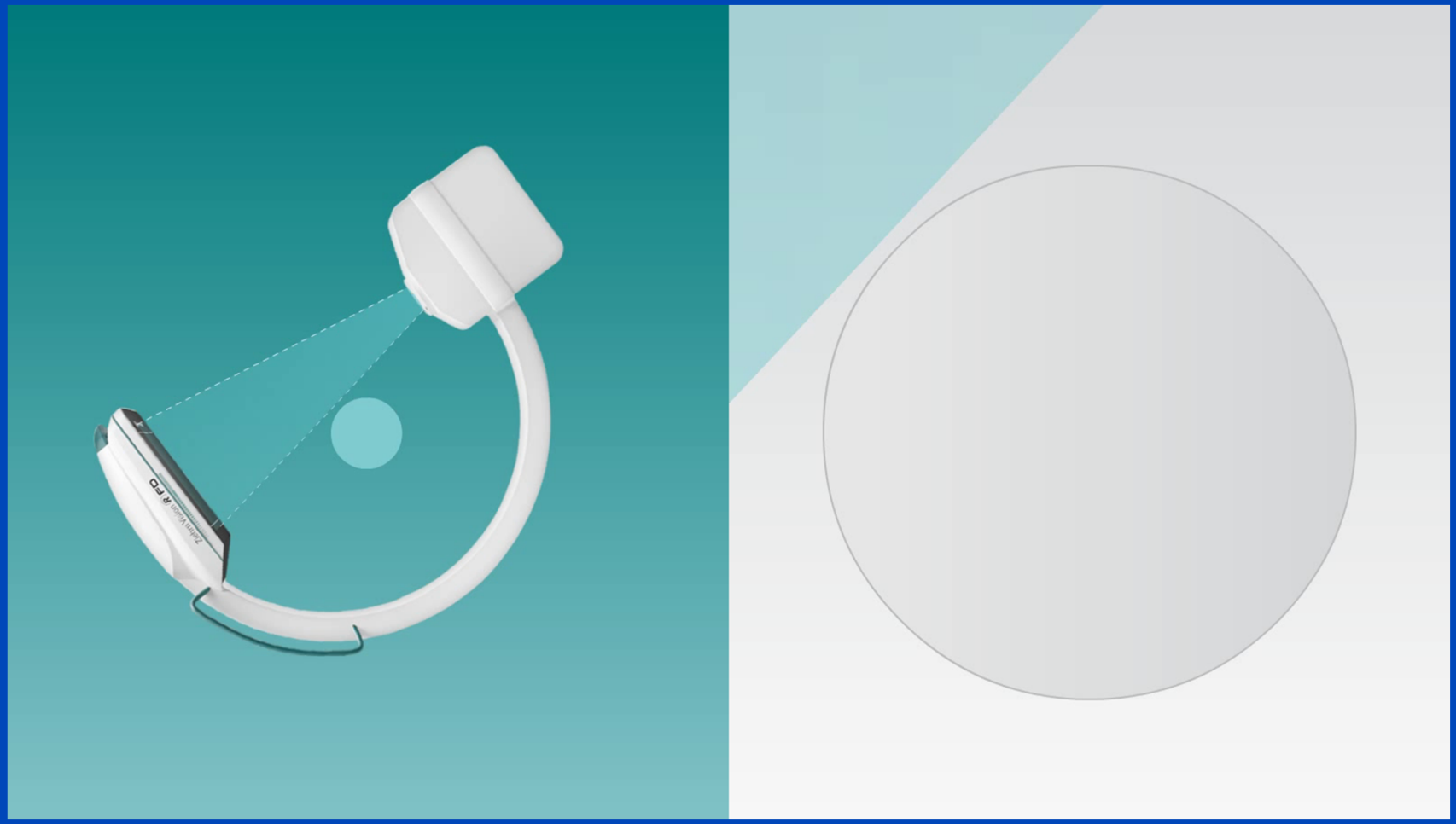
- Rotation range: 165°
- Fan angle: 15°



180° angular range!

Rotate-plus-shift trajectory: Shifting the beam over the FOV increases the angular range by up to the fan angle φ.

Rotate-Plus-Shift Trajectory

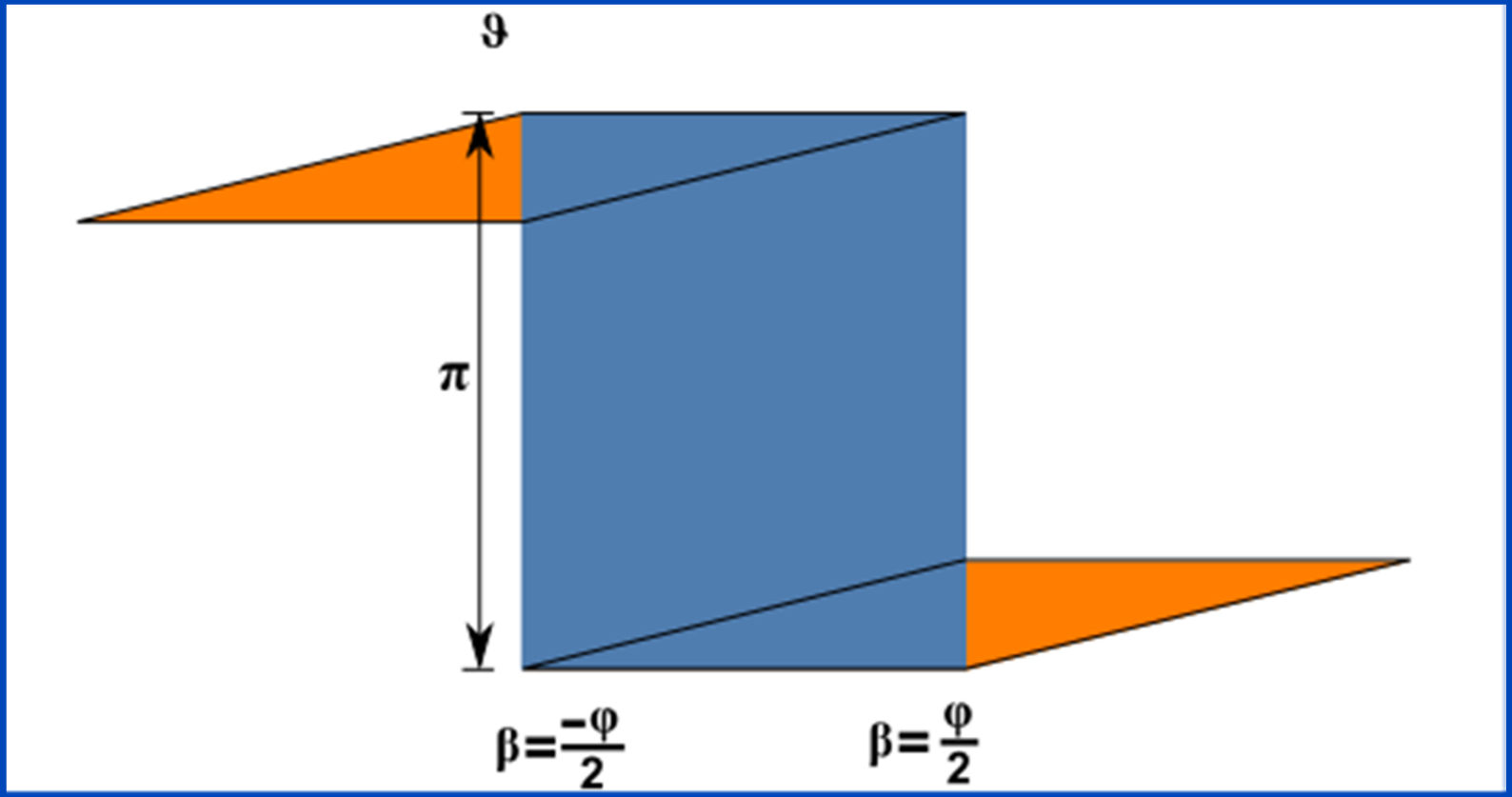


Rotate-Plus-Shift Scan

- Projection rawdata shown with fixed isocenter

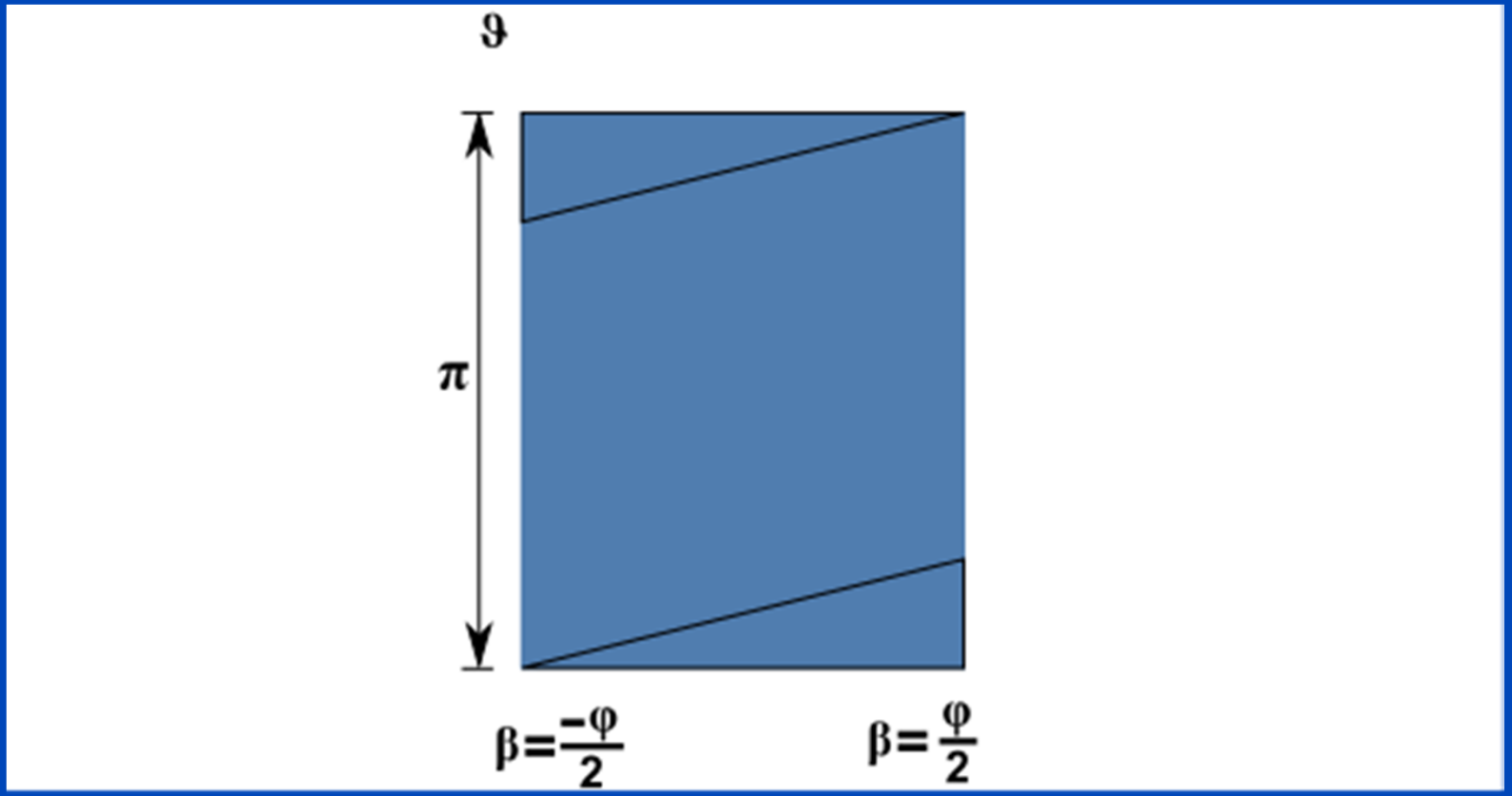
Rotate-Plus-Shift Trajectory

- Rotate-(180° minus fan angle)-plus-shift sinogram



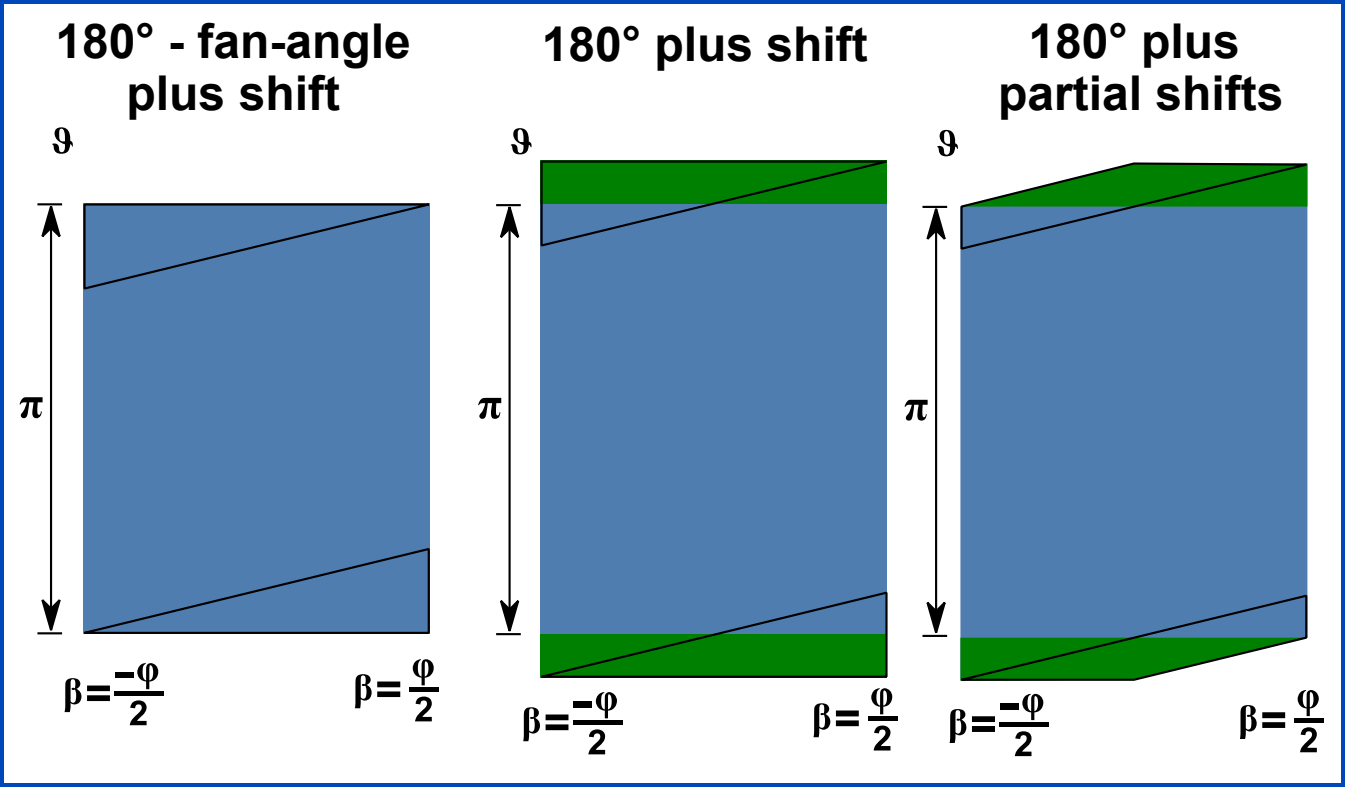
Rotate-Plus-Shift Trajectory

- Rotate-plus-shift sinogram with dynamic collimation



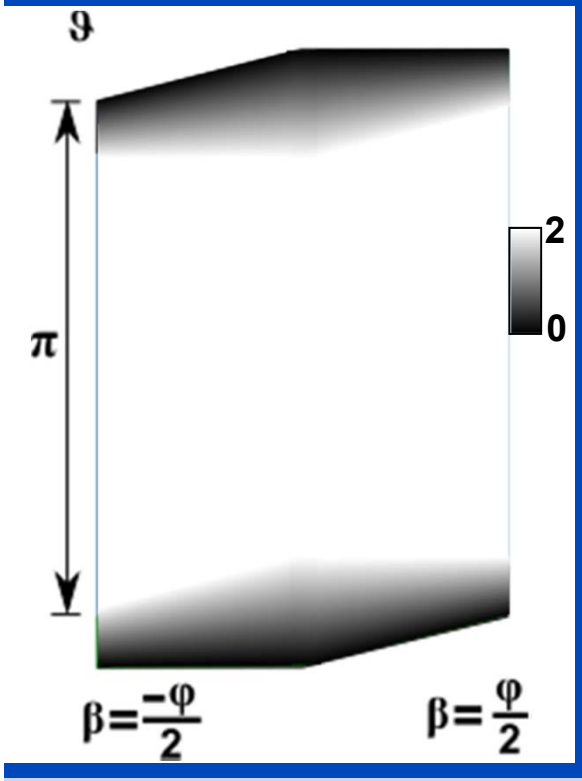
Rotate-Plus-Shift Trajectory

- Any combination of rotation and shift complying with the completeness condition is possible.



C-Arm System Design

- **Data completeness condition leads to redundant data in circular short scans.**



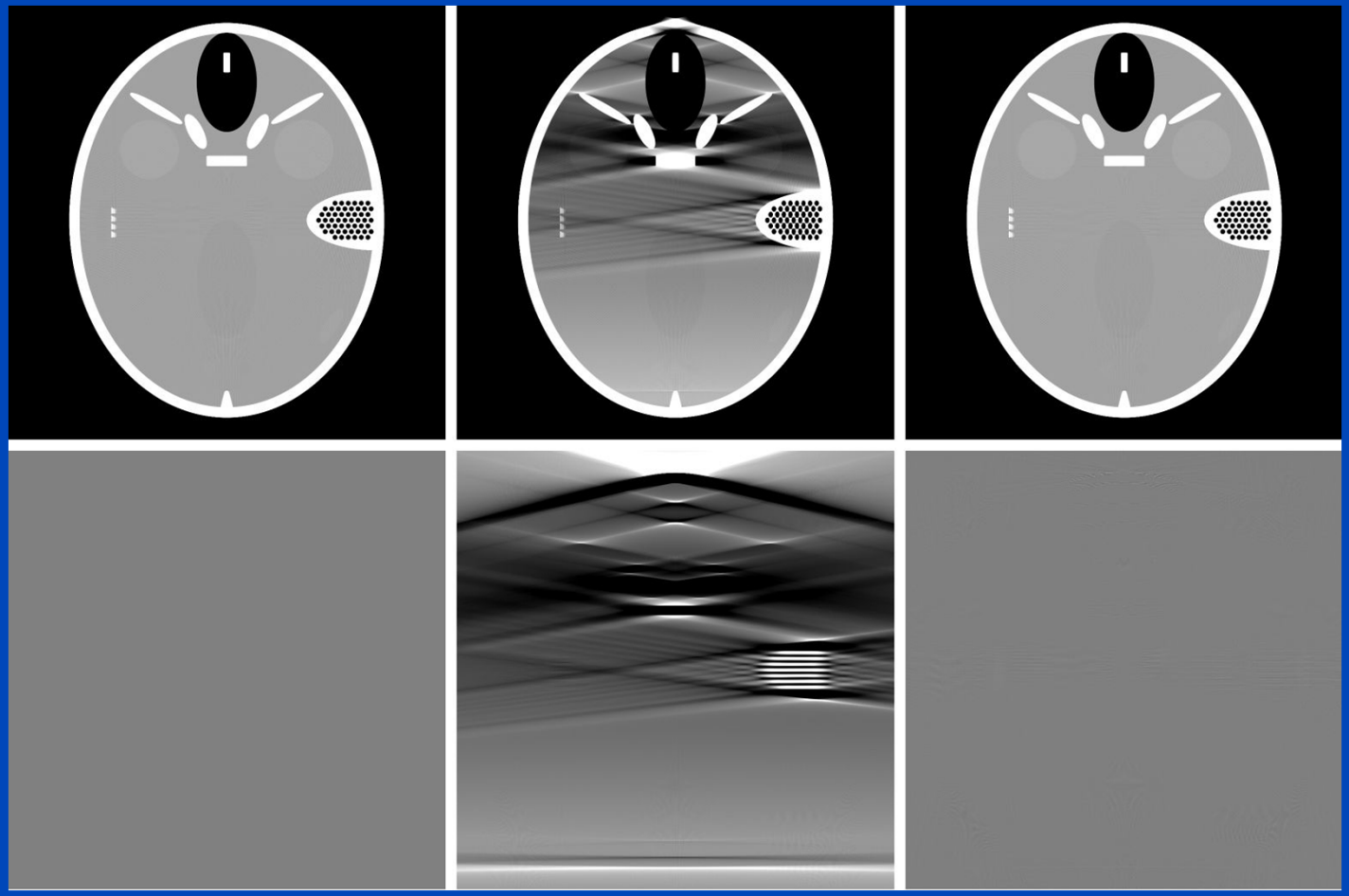
$g(\beta)$: β- **dependent angular range**

$h(\beta)$: β- **dependent offset**

A generalization of the Parker weight leads to the RPS weight:

$$w(\vartheta,\beta)=\begin{cases} 0 & \text{if } \vartheta<\alpha_1+h(+\beta)-g(+\beta) \\ 1+s\left(\dfrac{\vartheta-\alpha_1-h(+\beta)}{g(+\beta)}\right) & \text{else if } \vartheta<\alpha_1+h(+\beta)+g(+\beta) \\ 2 & \text{else if } \vartheta<\alpha_2+h(-\beta)-g(-\beta) \\ 1-s\left(\dfrac{\vartheta-\alpha_2-h(-\beta)}{g(-\beta)}\right) & \text{else if } \vartheta<\alpha_2+h(-\beta)+g(-\beta) \\ 0 & \text{else} \end{cases}$$

Forbild Head Phantom



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C = 0 HU; *W* = 400 HU

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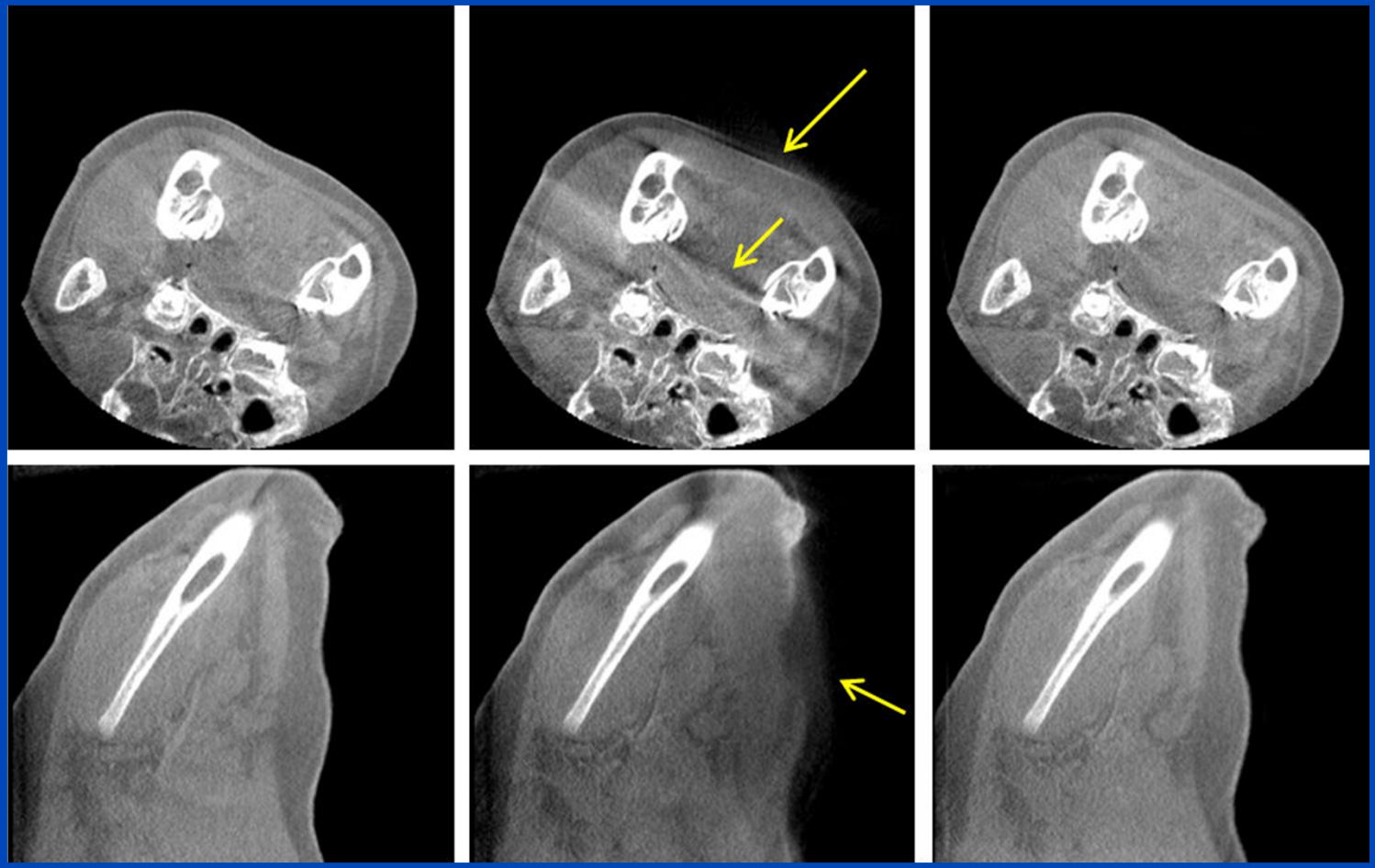
In-vivo Measurements



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C = 0 HU; *W* = 1000 HU

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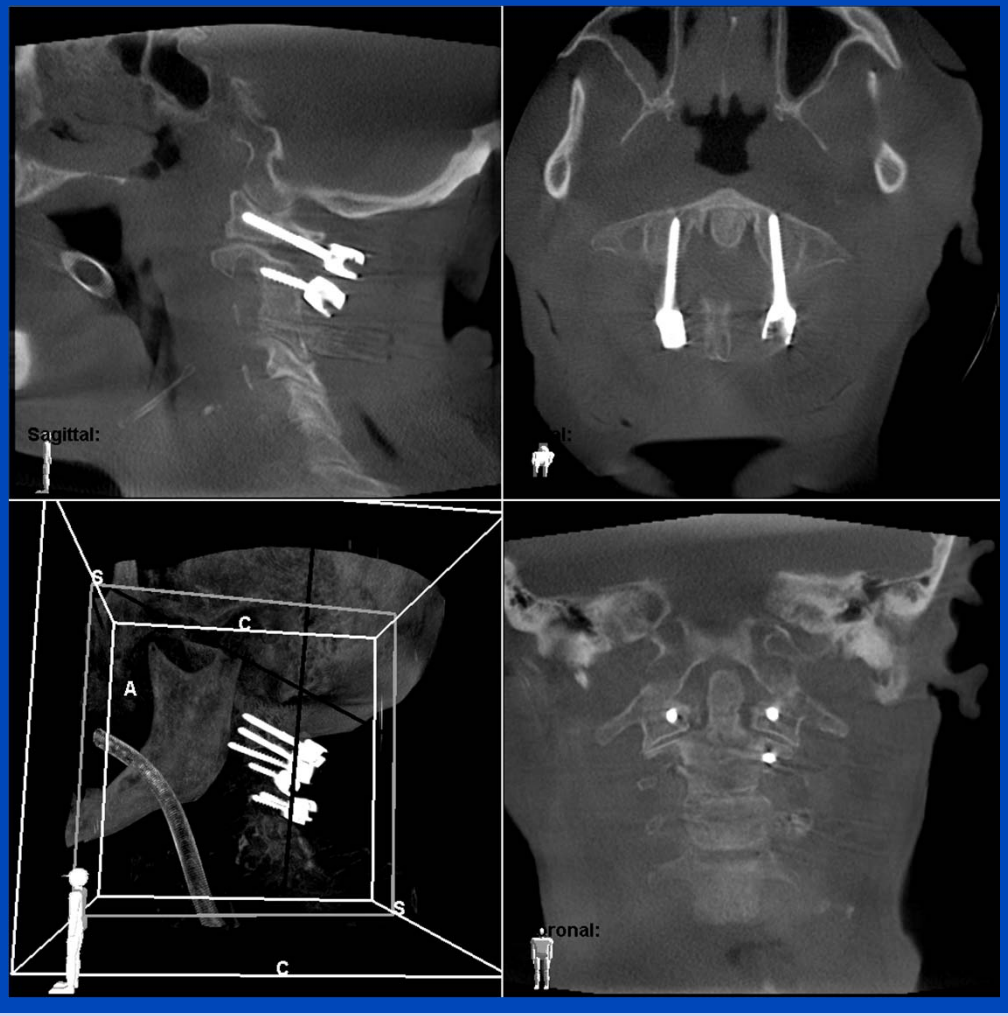
First Clinical Case

- Cervical spine fixation (University of Leipzig, Germany)



Conclusion

- The proposed weighting can be used for a wide range of non-conventional trajectories.
- Flexible and dose-efficient data acquisition can be used.
- Enables acquisition of full datasets with compact C-arm systems.

Thank You!

The 4th International Conference on

Image Formation in X-Ray Computed Tomography

July 18 – July 22, 2016, Bamberg, Germany

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Conference Chair

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

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

The study was supported in parts by the Deutsche Forschungsgemeinschaft (DFG) under Grant No. KA-1678/11-1.

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