

Dose-Dependent Estimation of the Left Ventricular Volume Using Cone-Beam Micro-CT

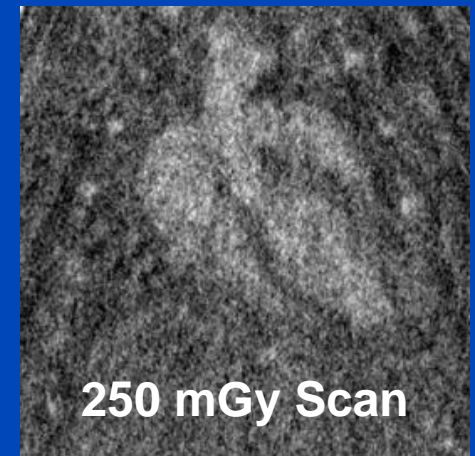
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Motivation

- The Left ventricular volume (LVV) is used as predictor of cardiovascular diseases in several small animal models.
- Conventional micro-CT reconstruction requires high radiation dose levels.
- Investigation of achievable dose reduction by more sophisticated reconstruction algorithms.

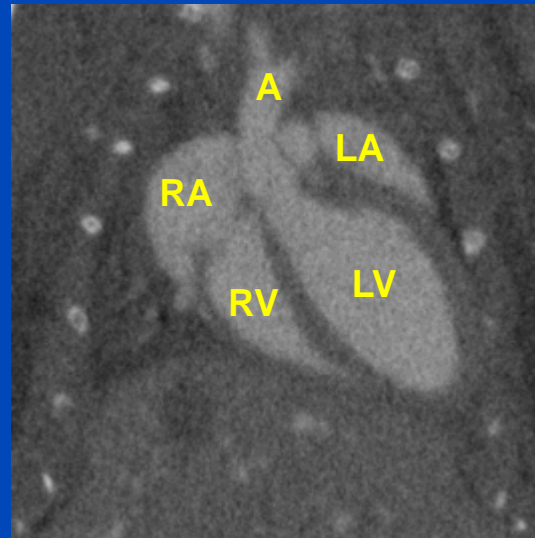


Workflow – Estimation of LVV

Data
Acquisition

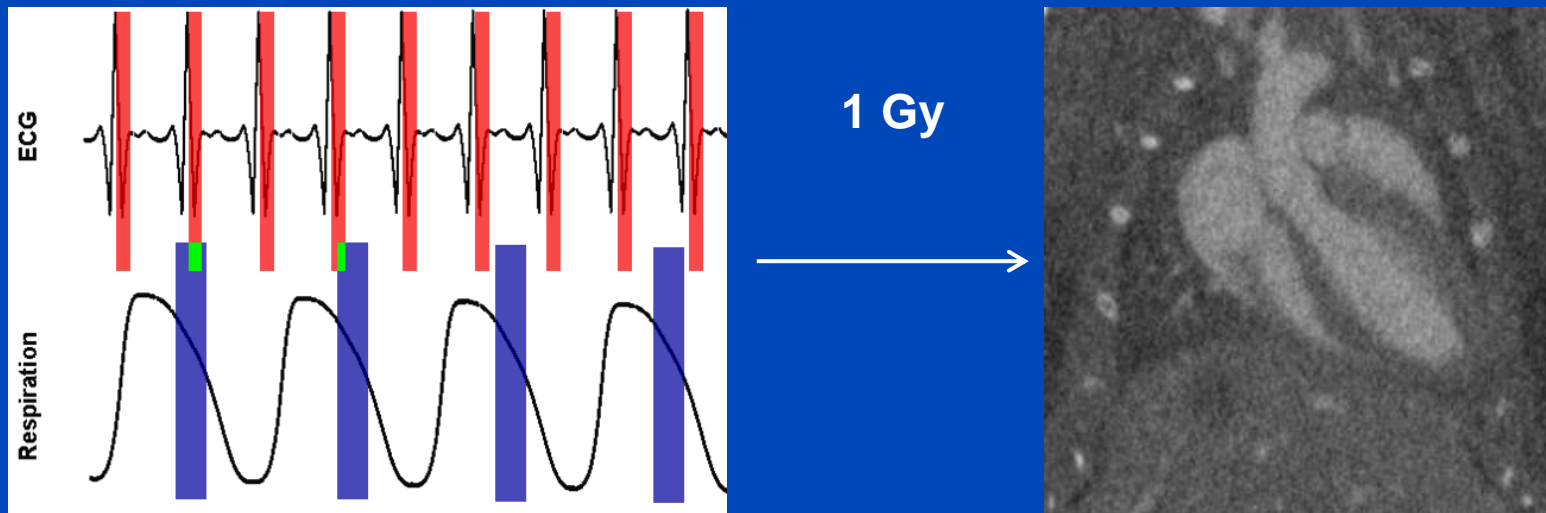
Reconstruction

Segmentation



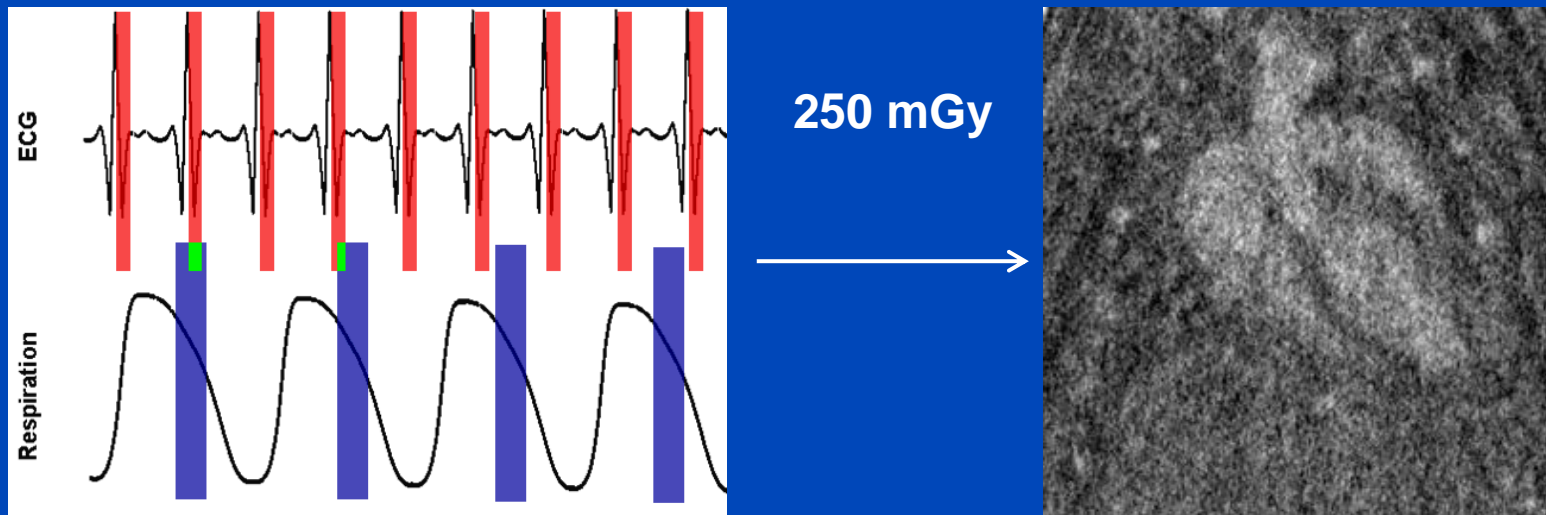
Phase-Correlated Reconstruction (PCF)

- Definition of a cardiac and respiratory window.
- Use only projections that were acquired within that window.
- Only about 3 % of the total amount of projections is used.



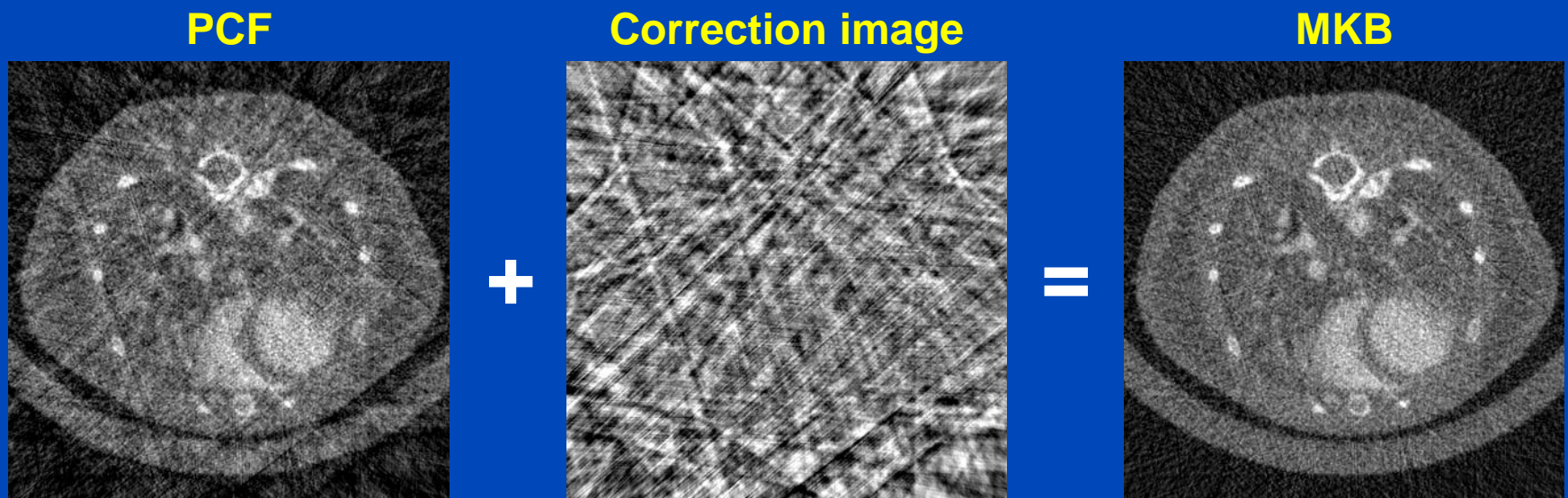
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McKinnon-Bates Algorithm (MKB)

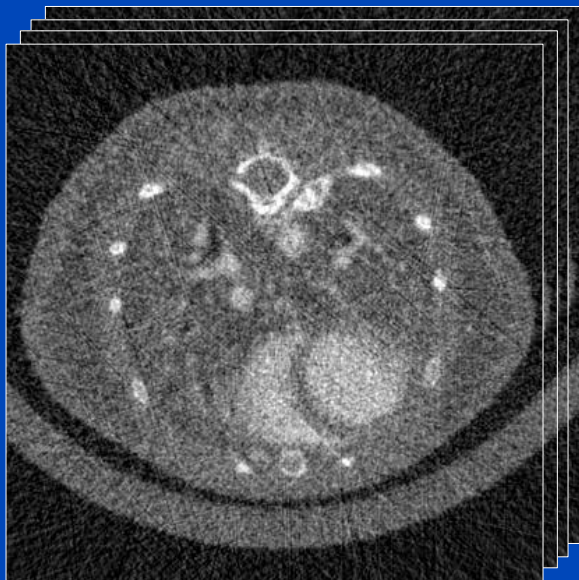
- Reduction of streak artifacts by adding a correction image to the PCF reconstruction.



Low-Dose Phase-Correlated Reconstruction (LDPC)

- Application of a five-dimensional edge-preserving bilateral filter on MKB image to reduce high noise levels and remaining streak artifacts.

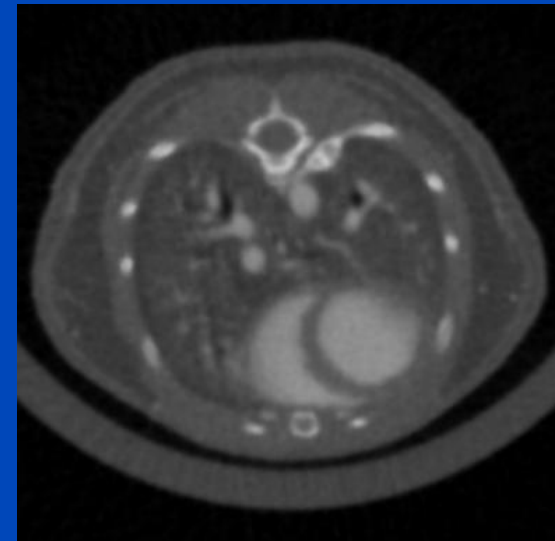
MKB



5D bilateral filter

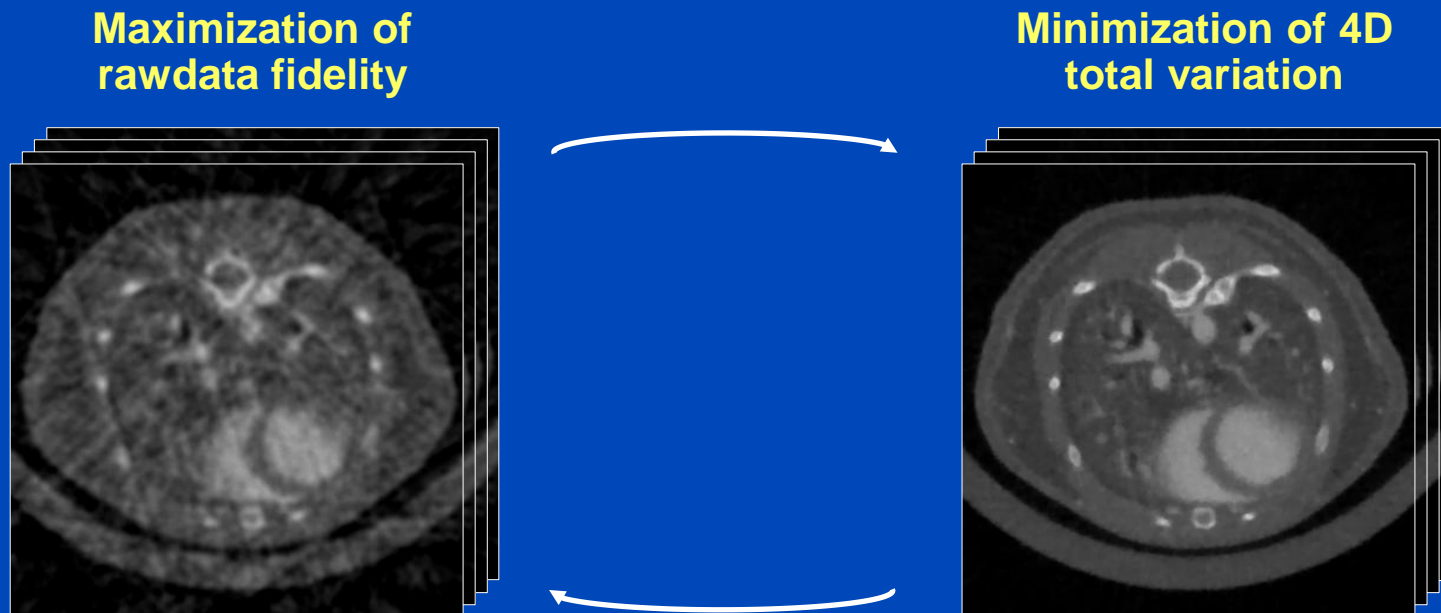


LDPC

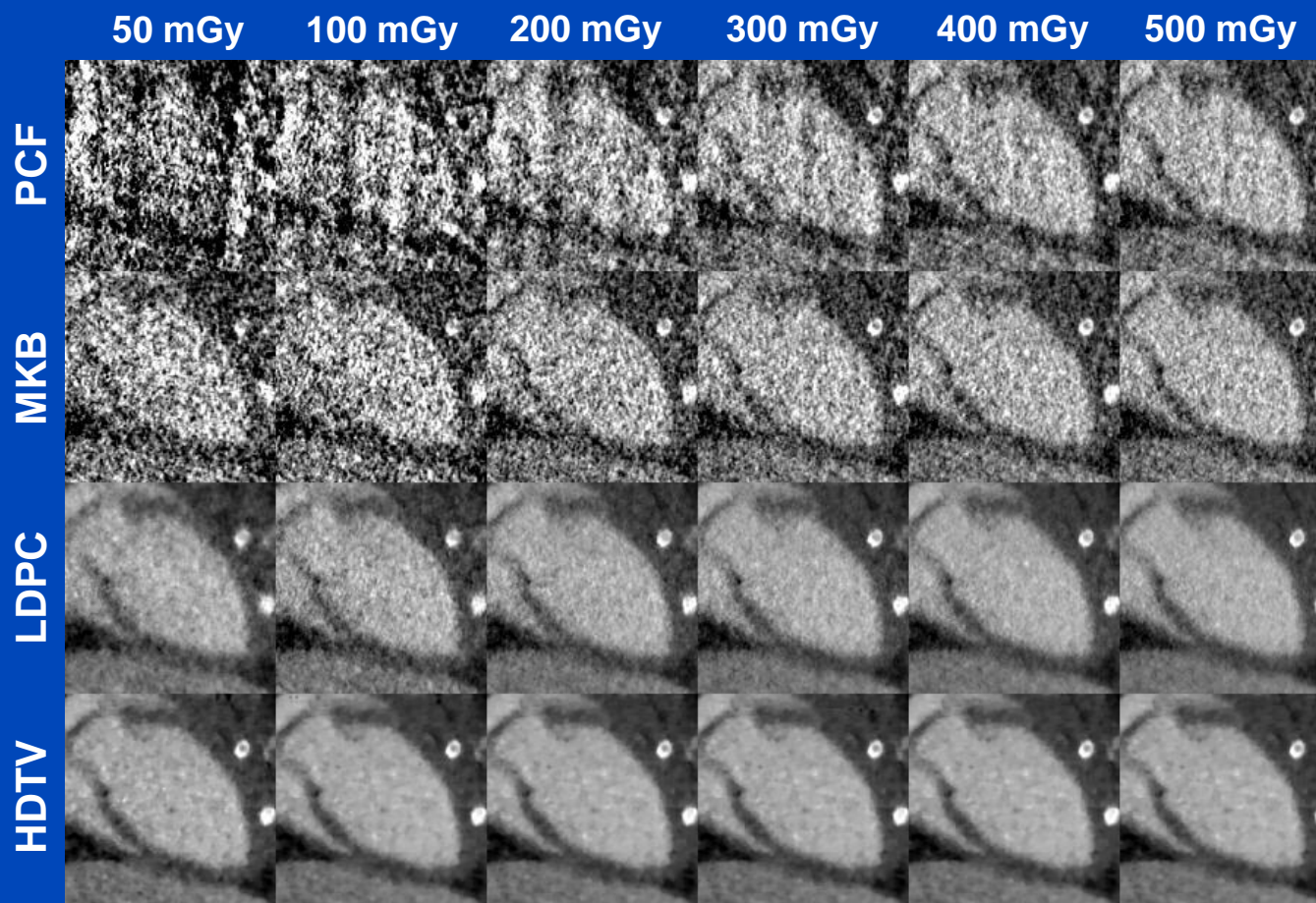


High-Dimensional Total Variation Reconstruction (HDTV)

- Iterative reconstruction based on compressed sensing theory.
- Reduction of noise and streak artifacts by 4D total variation minimization.



Reconstruction Results: Diastole

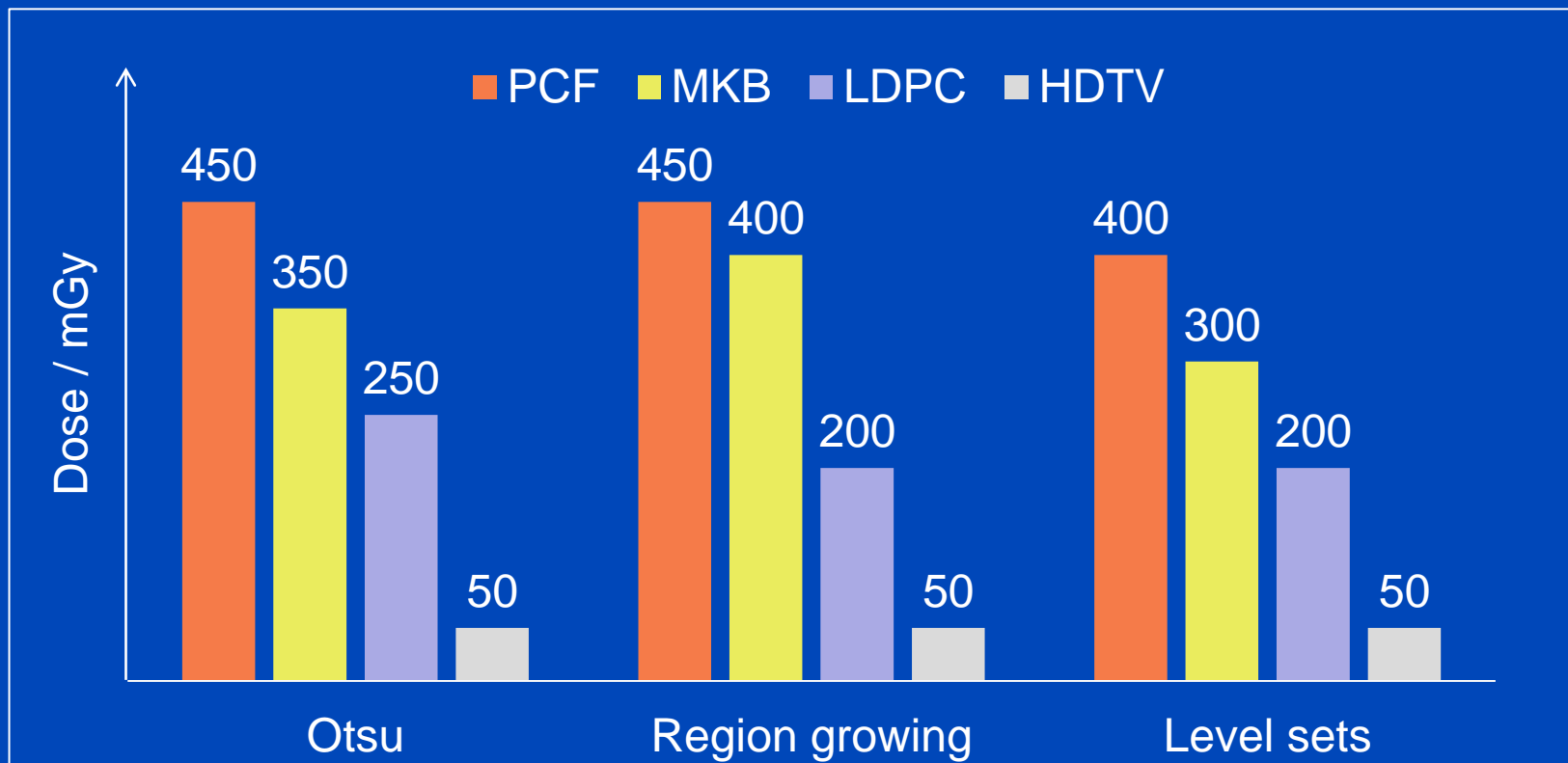


Evaluation

- **Micro-CT scans (TomoScope Synergy Twin) of eight mice with blood pool contrast agent (ExiTron nano 12000).**
- **Different dose levels from 50 mGy to 500 mGy for each mouse.**
- **Reconstruction of the heart in diastole and systole with PCF, MKB, LDPC, and HDTV.**
- **Segmentation of reconstructed volumes using Otsu, level sets, and seeded region growing.**
- **Comparison to the LVV determined at 500 mGy.**

Segmentation Results

- Minimal dose level that is required to reproduce the LVV determined at 500 mGy with a deviation less than 5 %.



Conclusion

- The LDPC and the HDTV reconstruction algorithm can be used to reduce radiation dose in phase-correlated micro-CT imaging.
- Morphological parameters as the left ventricular volume can be determined accurately at reduced dose levels.
- LDPC and HDTV open new options for longitudinal studies of the heart of small animals.

Thank You!

Acknowledgements:

The high-speed image reconstruction software RayConStructIR was provided by **RayConStruct GmbH**, Nürnberg, Germany.

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