Running Prior for Patient Motion Correction in Low Dose 3D+Time Interventional Flat Detector CT

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DEUTSCHES KREBSFORSCHUNGSZENTRUM IN DER HELMHOLTZ-GEMEINSCHAFT

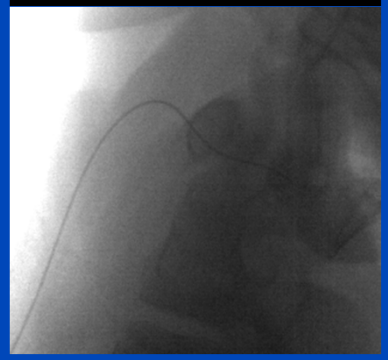
Purpose

- 4D (= 3D+T) reconstruction for interventional guidance at dose level as low as in 2D+T-fluoroscopy

Today:

3D

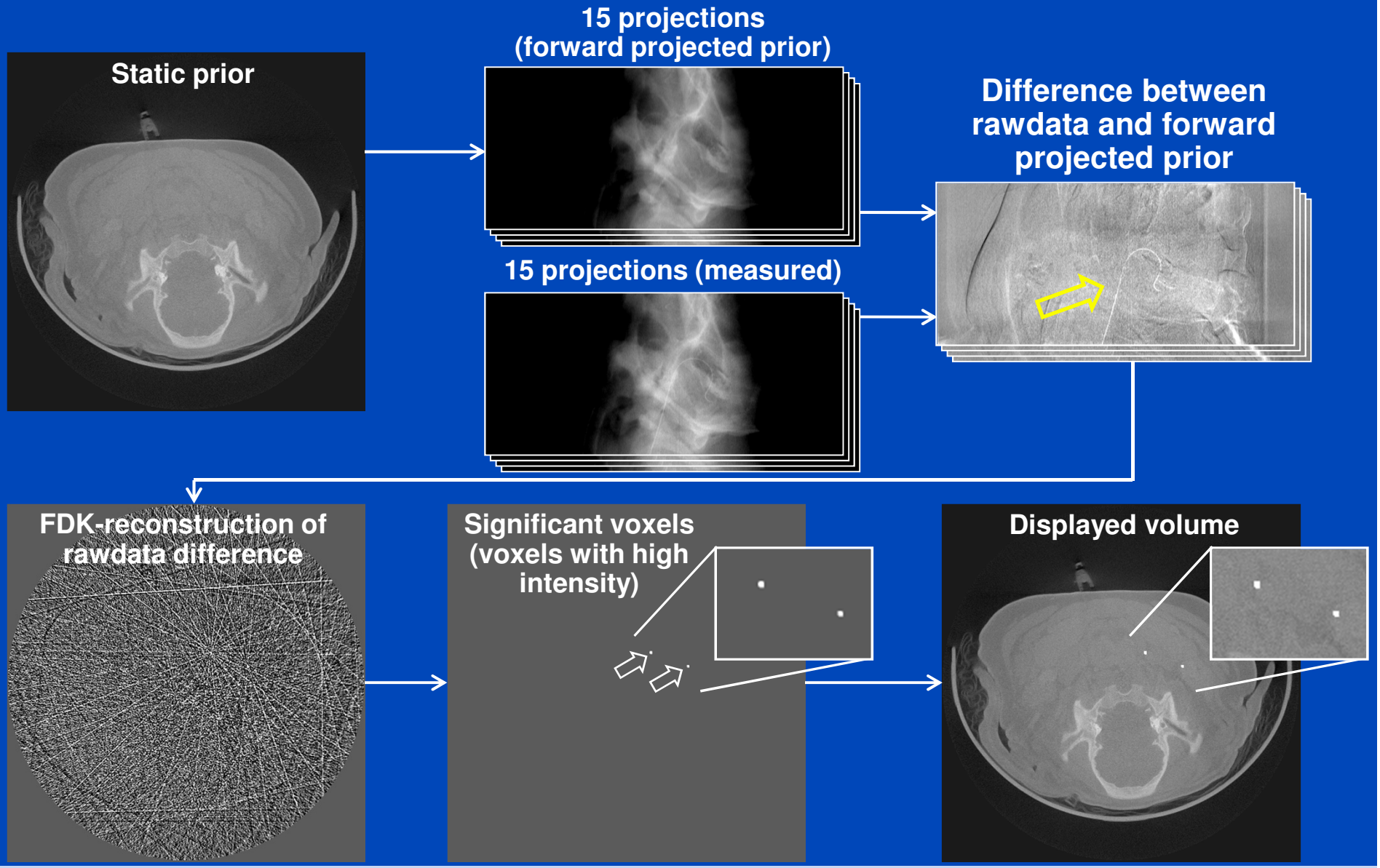
2D+T



Future:

3D+T

PrIDICT-Algorithm[1]

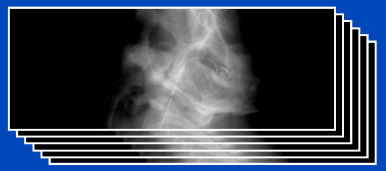


[1]J. Kuntz *et al.*, "Real-time X-ray-based 4D image guidance of minimally invasive interventions", Submitted to European Radiology for publication.

Why Running Prior?

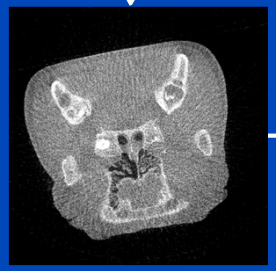
- Problem with PrIDICT algorithm: Patient motion after prior scan
- Aim: Allow for patient motion by updating the prior continuously – for dose reasons without additional projections
  - Deformation via registration
  - Incorporation of current projections into the prior

Workflow of Running Prior Technique



Last 120 projections
(16 seconds)

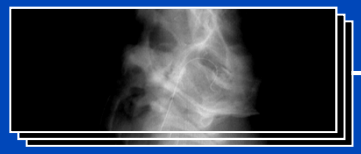
FDK



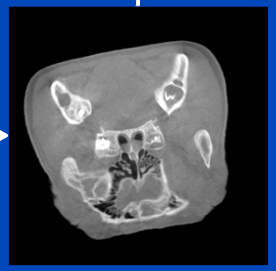
Target prior

Registration
(affine, Demons)

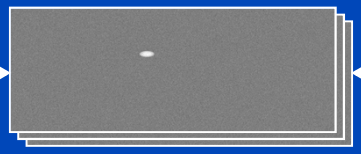
Current running prior



Forward projection
(same projection angles as
last 15 projections)

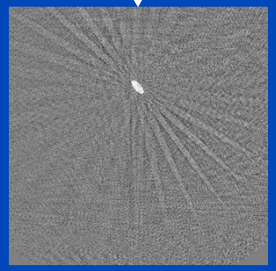


Deformed running
prior

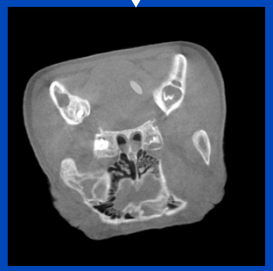


Difference
projections

FDK



Difference
reconstruction



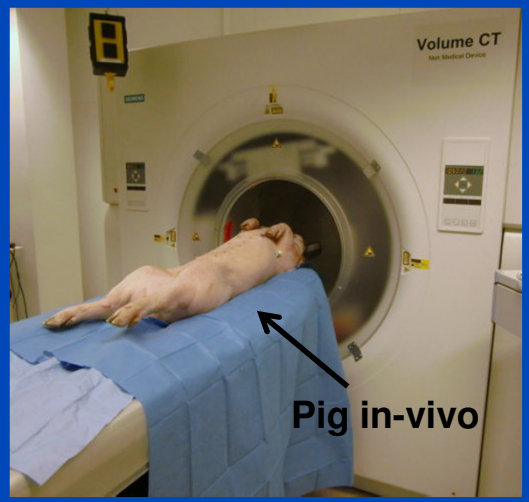
Next running prior

Last 15 projections
(2 seconds)

Measurement

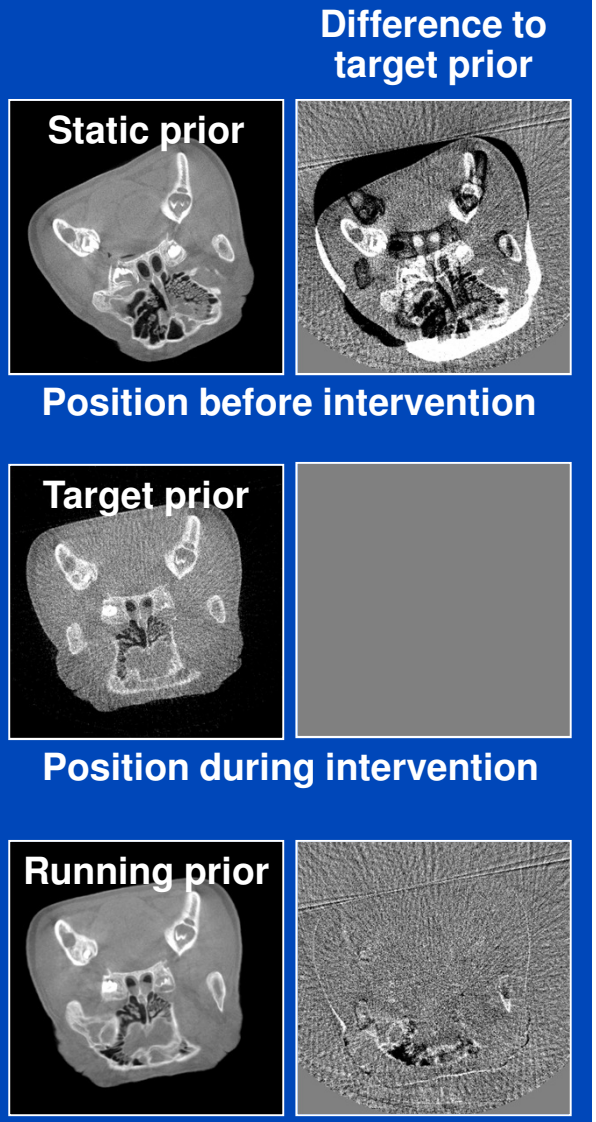
- **System:**
  Volume CT prototype
  - Flat detector like C-Arms
  - Clinical CT gantry

Experimental setup



- **Prior scan:**
  - Before intervention
  - N_{360} = 600 std. dose projections per 360°
  - T_{rot} = 19 s
  - 1 single rotation

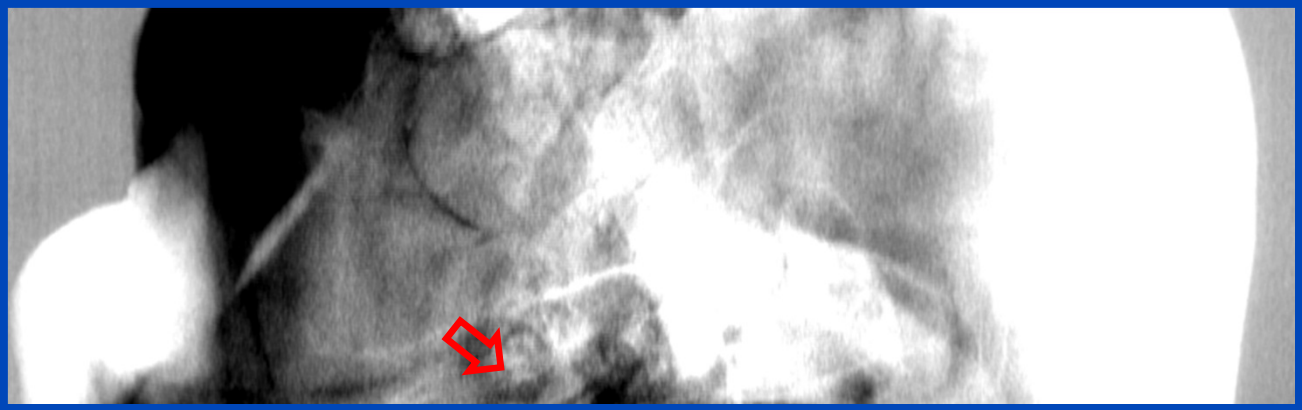
- **Intervention scan:**
  - During intervention
  - N_{360} = 30 low dose projections per 360°
  - T_{rot} = 4 s
  - Many rotations (depending on time needed for intervention)
  - Guide wire inserted into the carotid of the pig‘s head during the scan



FAU dkfz.

Improvement in Rawdata Difference

Difference between measured rawdata and forward projected static prior



Difference between measured rawdata and forward projected running prior

Static Prior vs. Running Prior I

PrIDICT using static prior

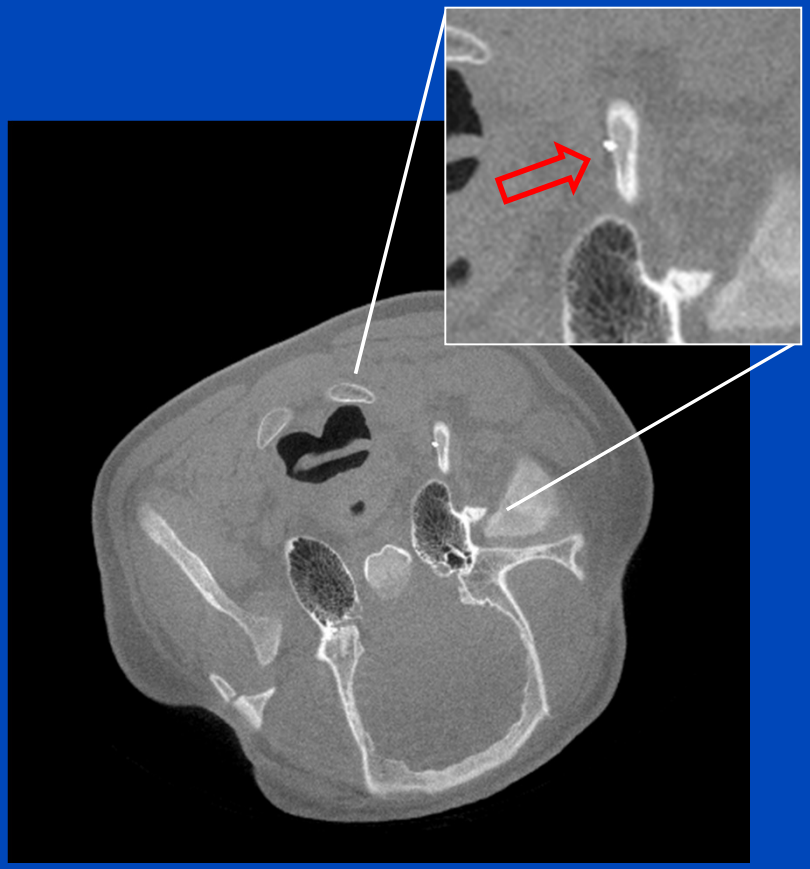
Artifacts resulting from motion

PrIDICT using running prior

No artifacts

Static Prior vs. Running Prior II

PrIDICT using static prior



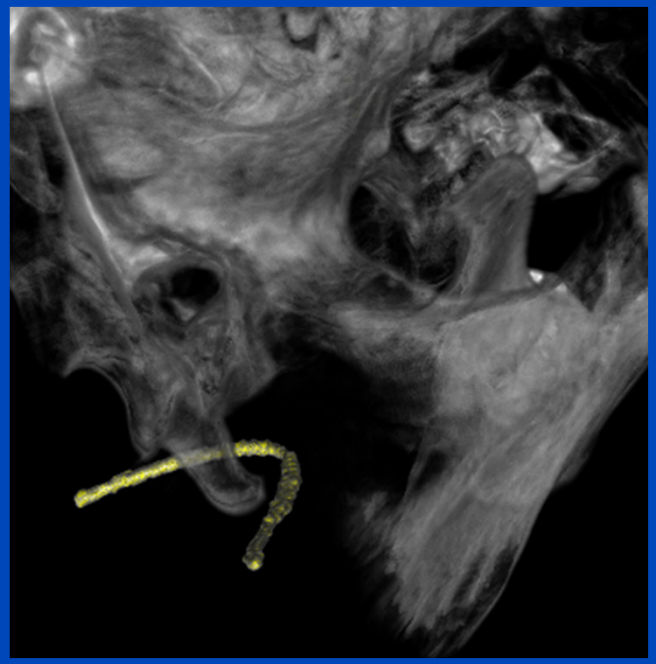
Wrong wire position

PrIDICT using running prior

Correct wire position

Conclusion

- Advantages of the running prior compared to the static prior:
  - Less artifacts in the update volumes resulting from motion between prior scan and intervention scan
  - Higher reliability because interventional material is displayed at correct position
- No additional dose needed for continuously updating the prior



- 4D interventional guidance at dose level comparable to fluoroscopy may become possible also with patient motion by using the running prior technique

Thank You!

This study was supported by the Deutsche Forschungsgemeinschaft (DFG) under grant KA 1678/6-1.

The high performance compute hardware was provided by the Universitätsbund Erlangen-Nürnberg e.V., Erlangen, Germany.

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

FAU dkfz.