Importance of Prior Information for Accurate Scatter Correction of Truncated Cone-Beam CT Data

Nadine Waltrich[1], Sedat Aktaş[1], Stefan Sawall[1], Joscha Maier[1], Kai Stannigel[2], Kai Lindenberg[2], and Marc Kachelrieß[1]

[1]German Cancer Research Center (DKFZ), Heidelberg, Germany
[2]Sirona Dental Systems GmbH, Bensheim, Germany

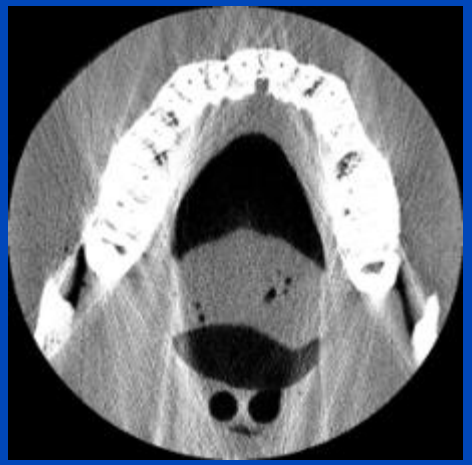
Dentsply Sirona

dkfz. DEUTSCHES KREBSFORSCHUNGSZENTRUM IN DER HELMHOLTZ-GEMEINSCHAFT

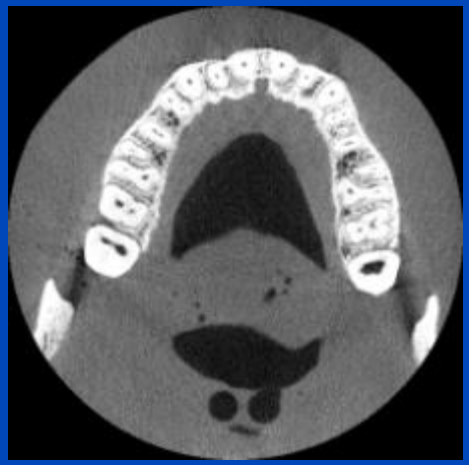
Aim

Comparison of different detruncation algorithms with respect to scatter correction to provide a quantitative scatter correction approach for truncated CBCT data.

bad scatter correction

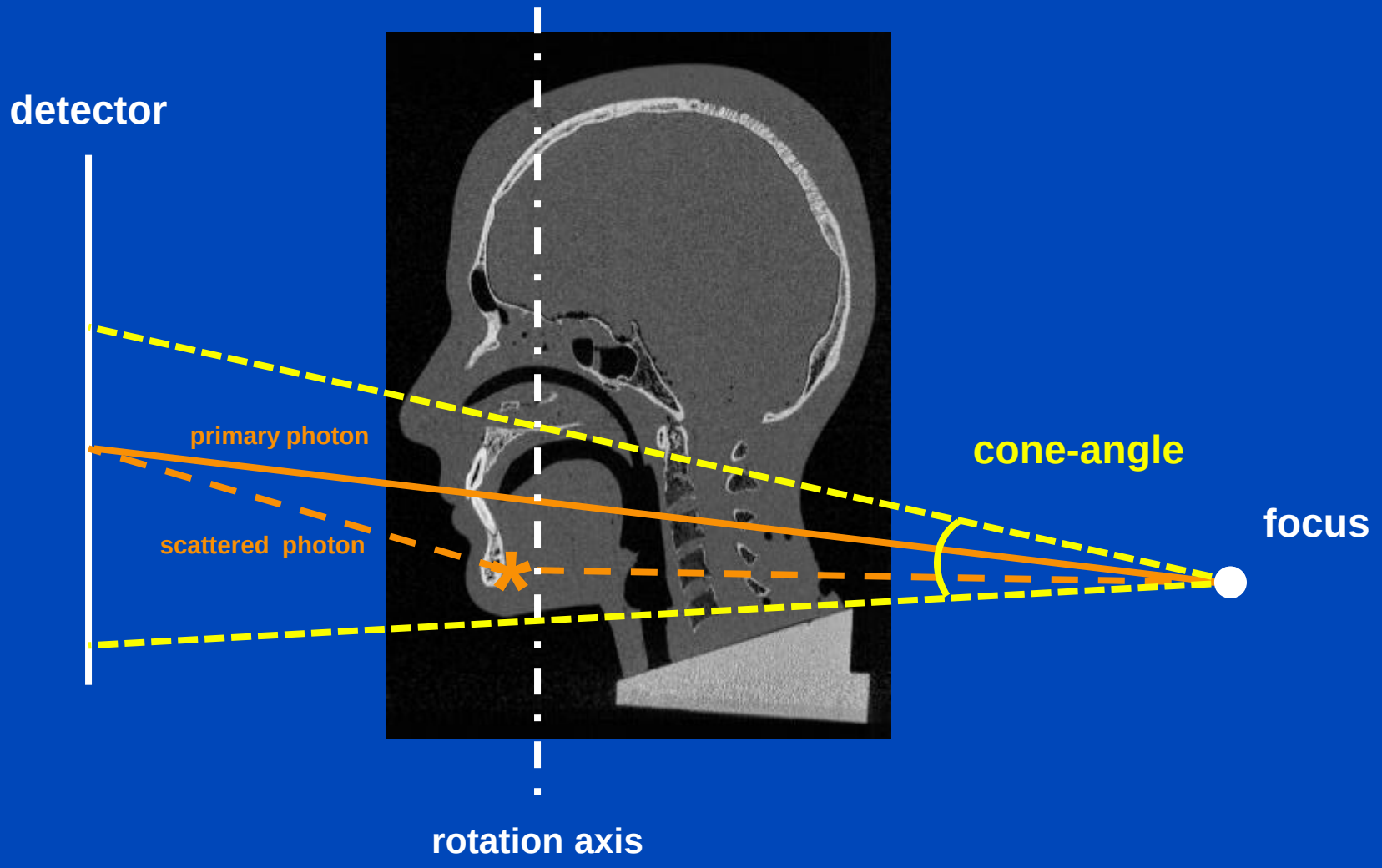


no scatter correction

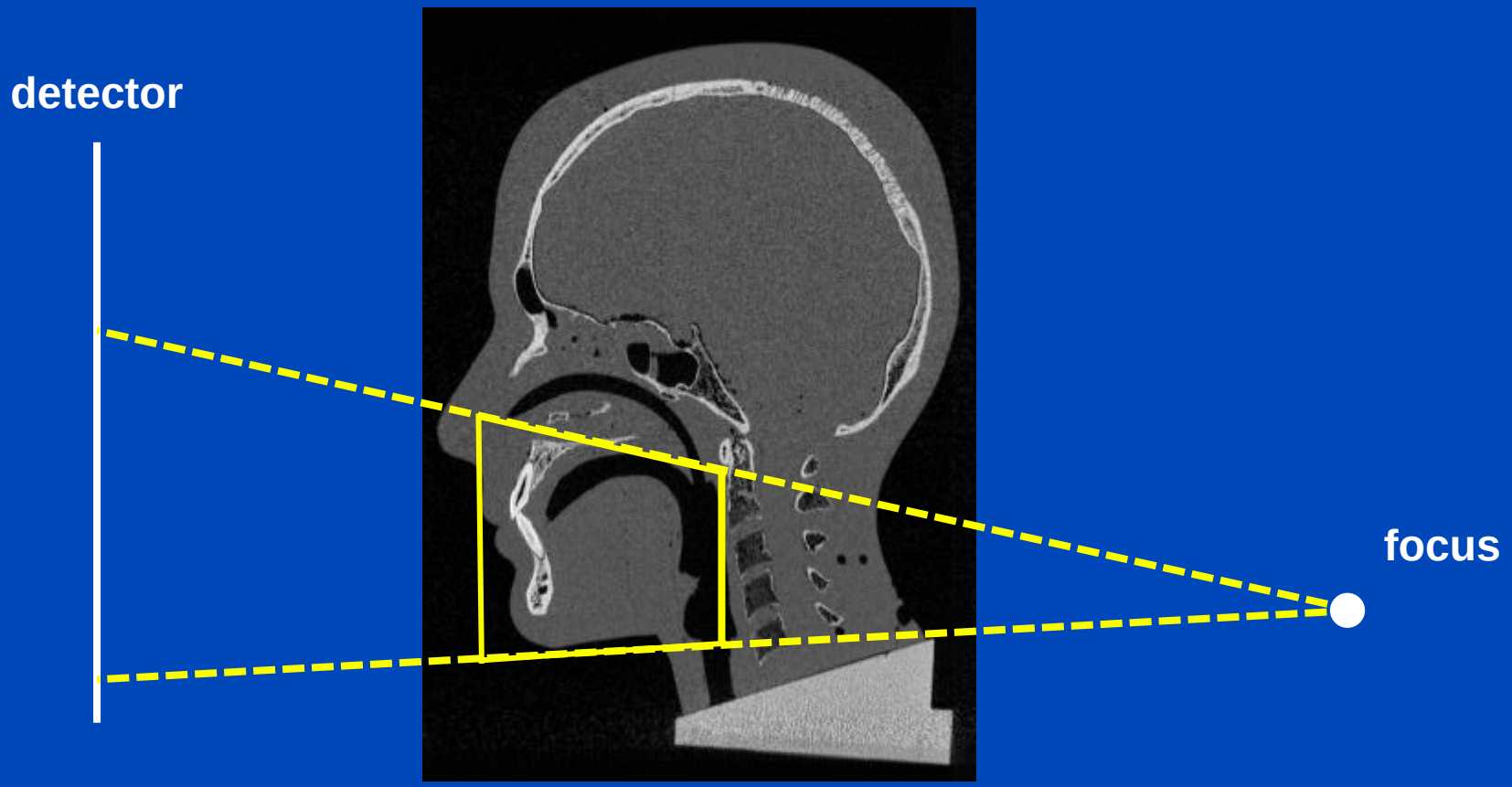


good scatter correction

Patient Positioning

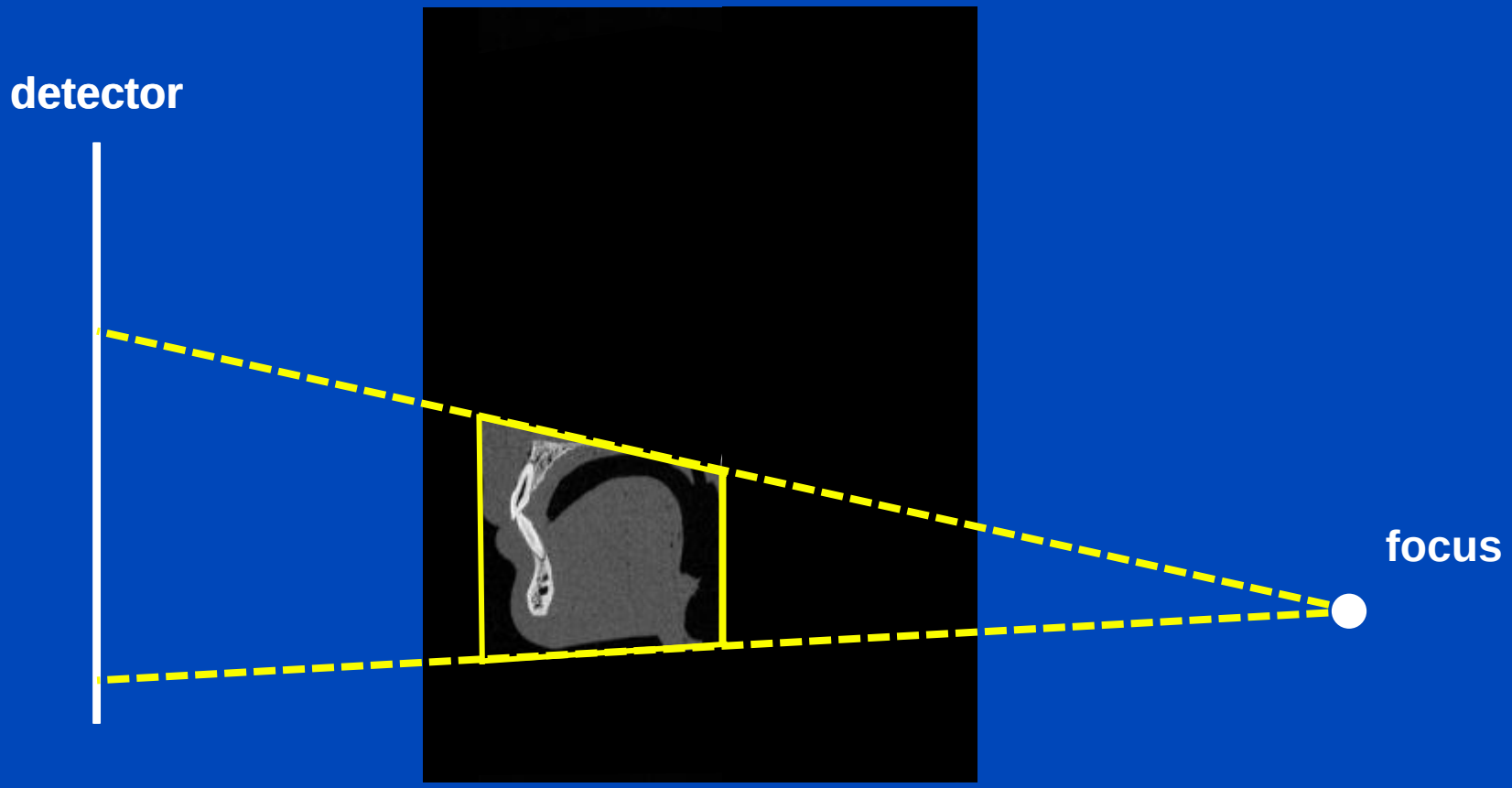


Patient Positioning



FOM of a dental CT system

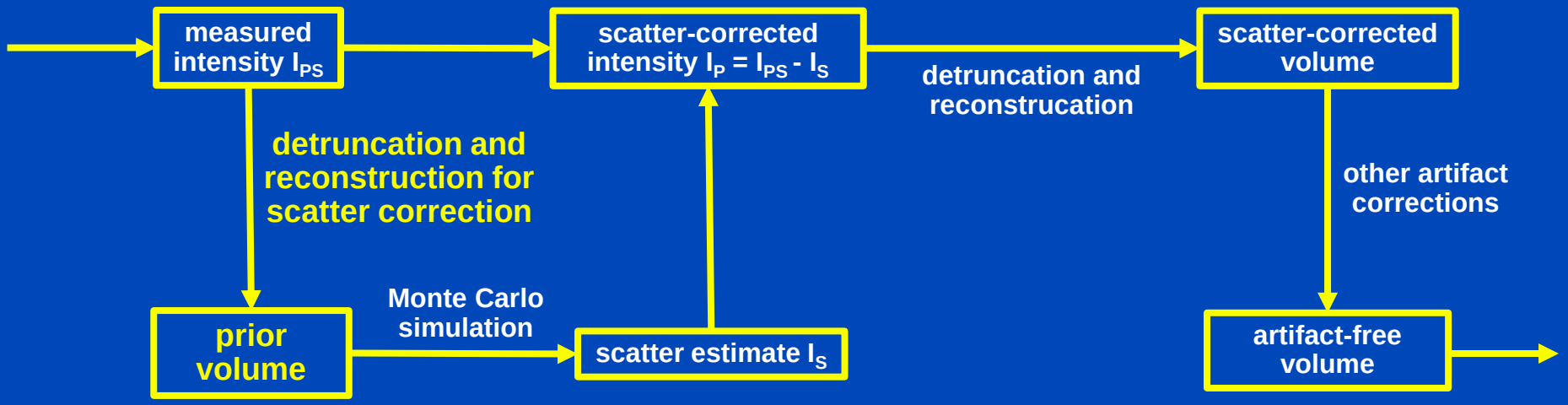
Patient Positioning



FOM of a dental CT system

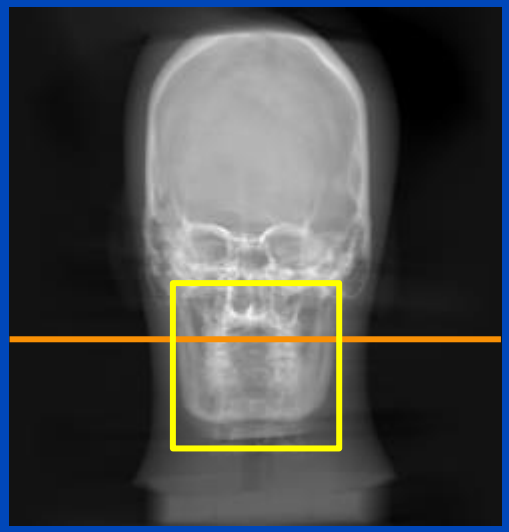
Monte Carlo Scatter Simulation

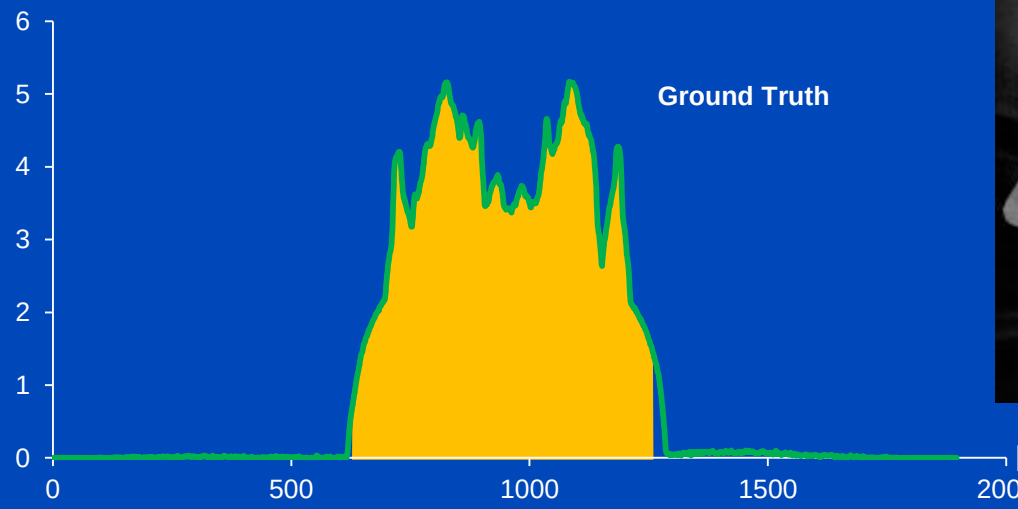
- Monte Carlo simulations are used to simulate the physical path of photons through the patient. This is done based on a model (prior volume) of the scanned object.



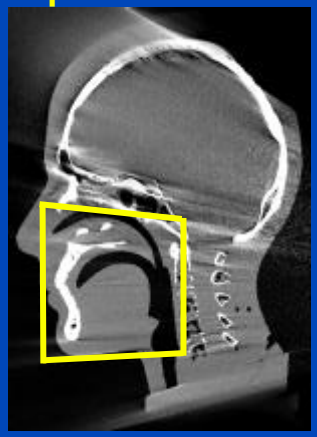
measured intensity I_{PS} = primary intensity I_P + scattered intensity I_S

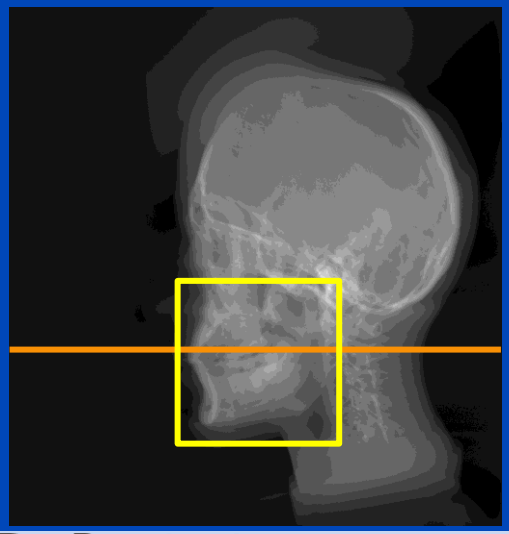
Detruncation in Projection Domain

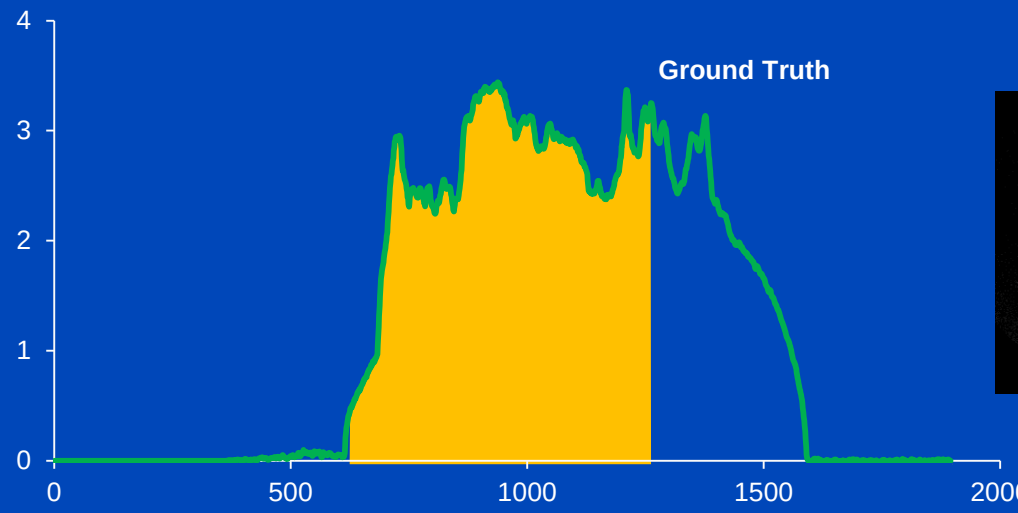




prior volume

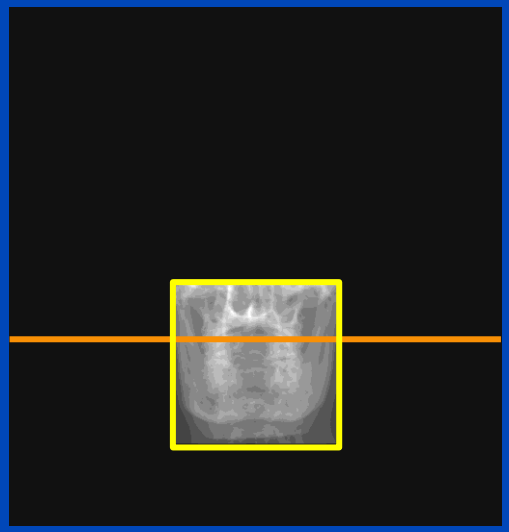


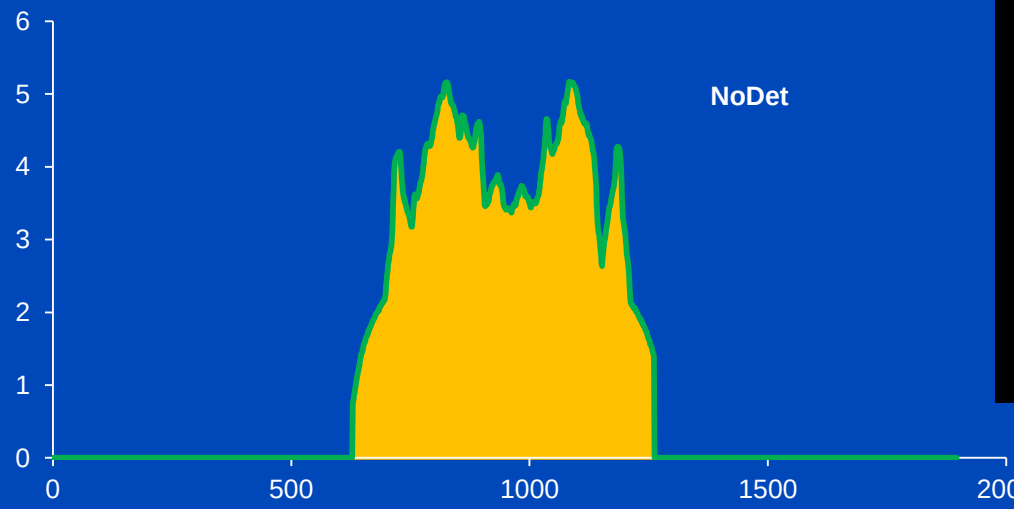




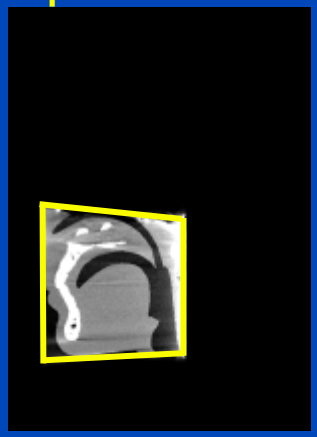
prior volume

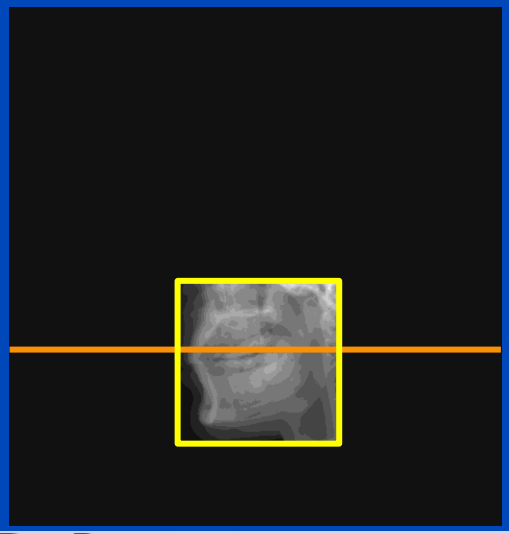
Detruncation in Projection Domain

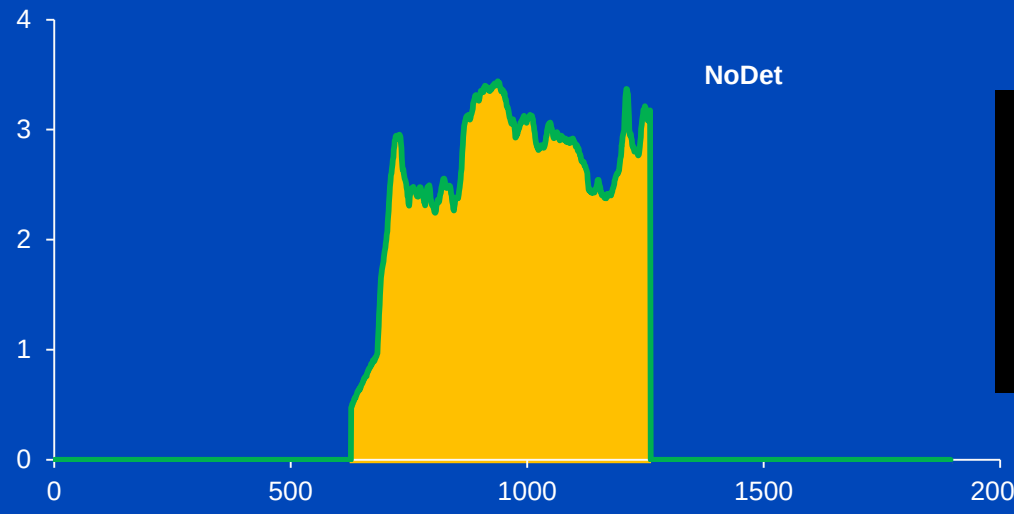




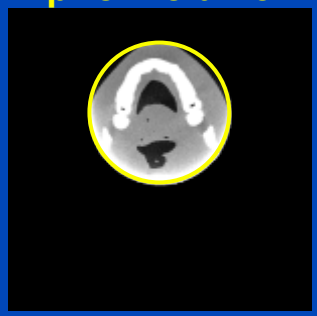
prior volume



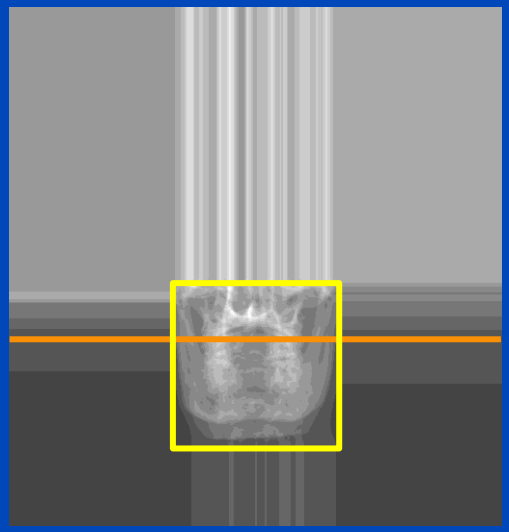


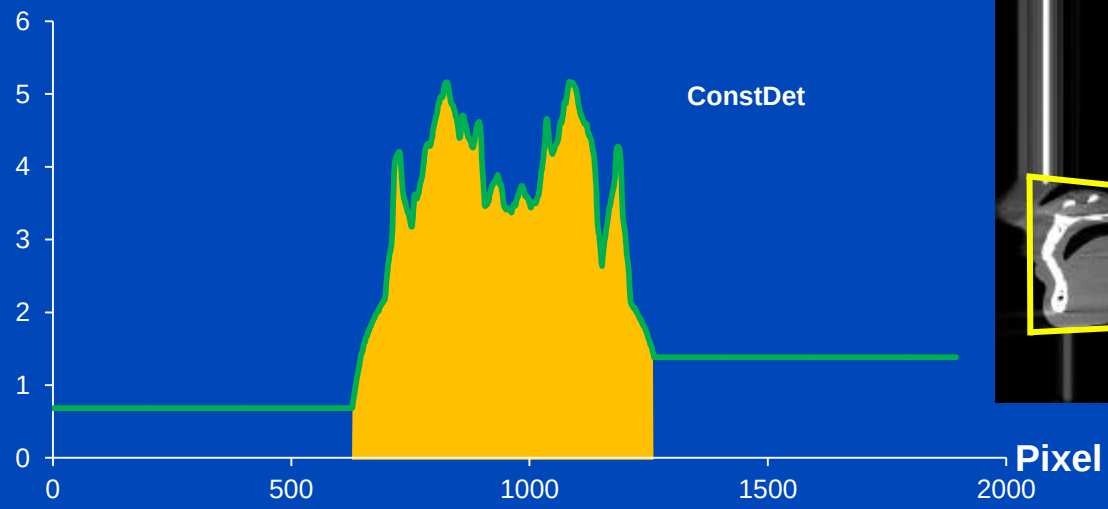


prior volume

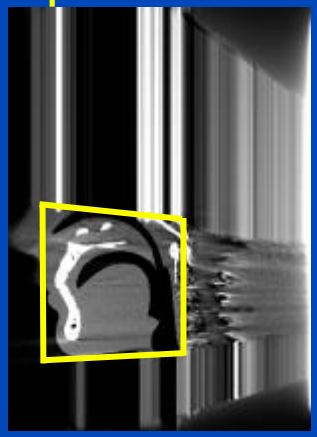


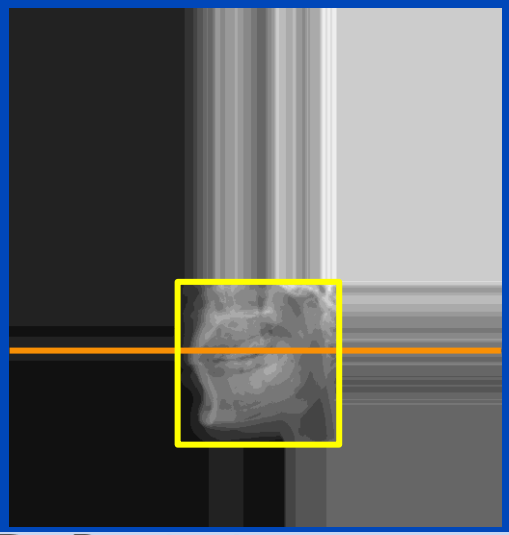
Detruncation in Projection Domain

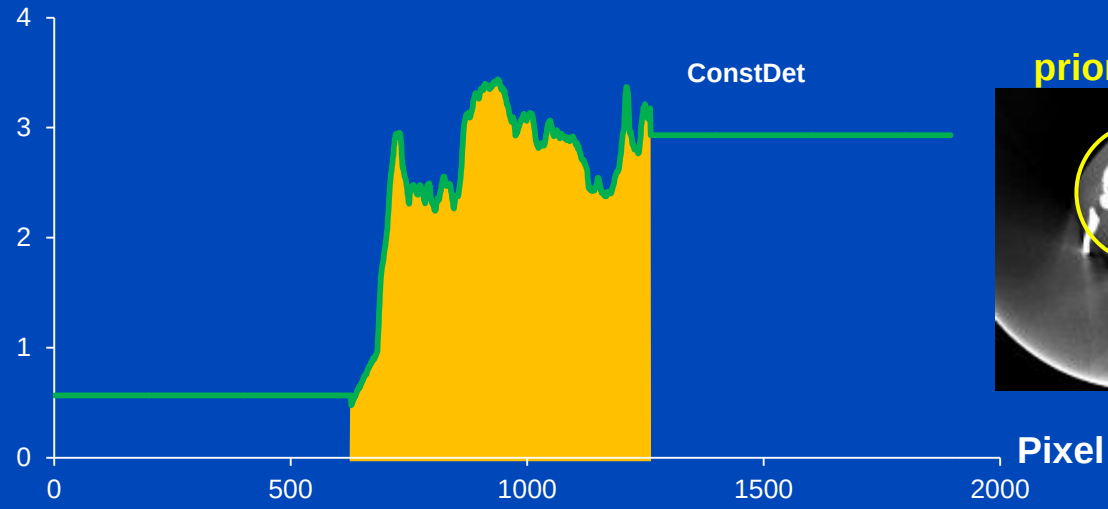




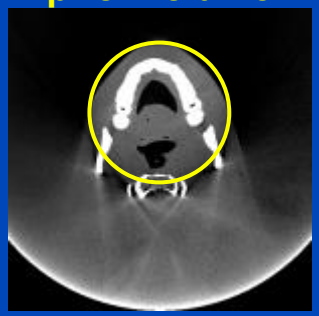
prior volume



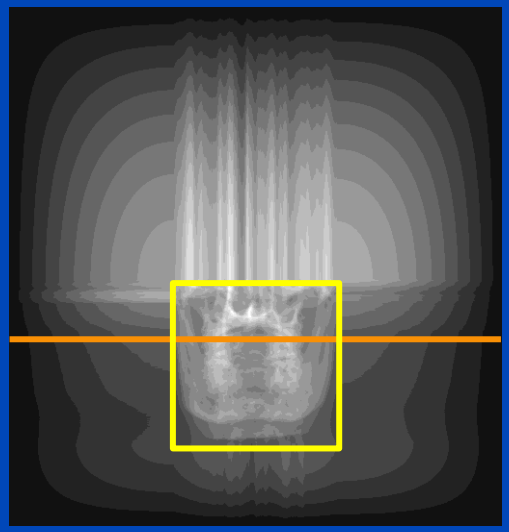


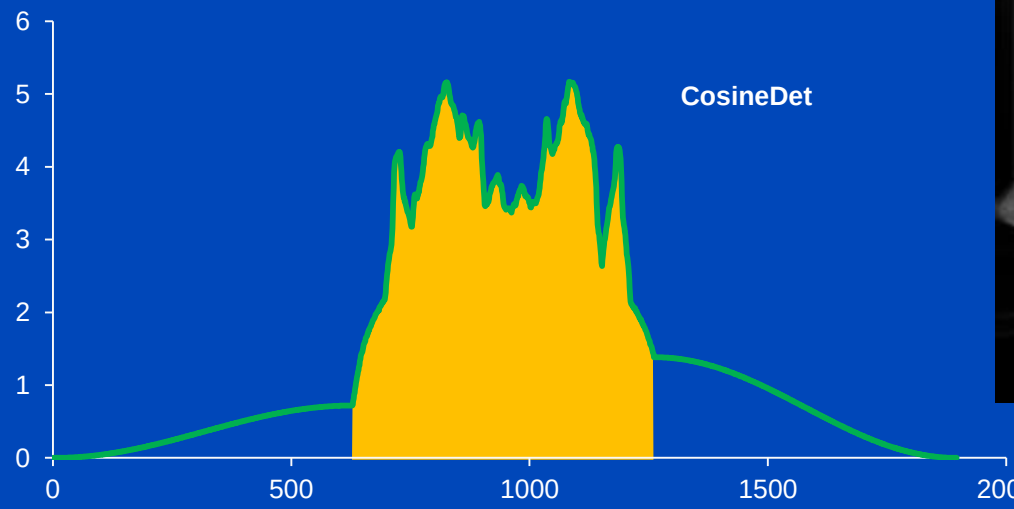


prior volume

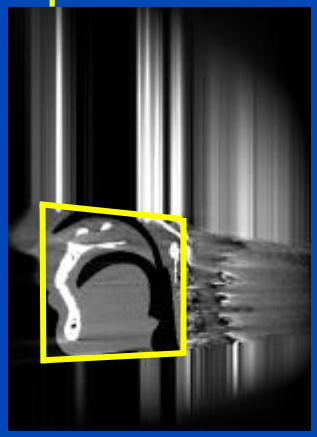


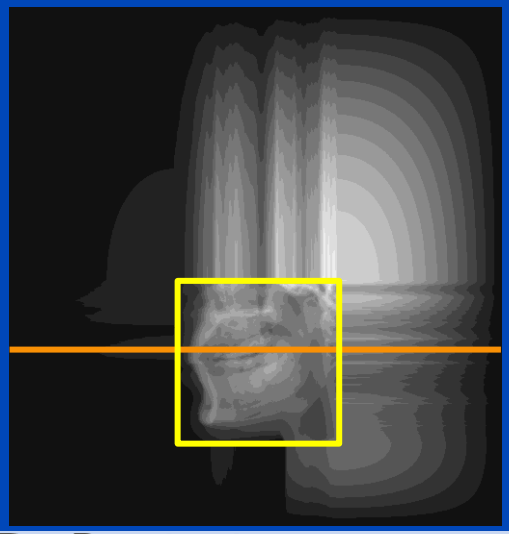
Detruncation in Projection Domain

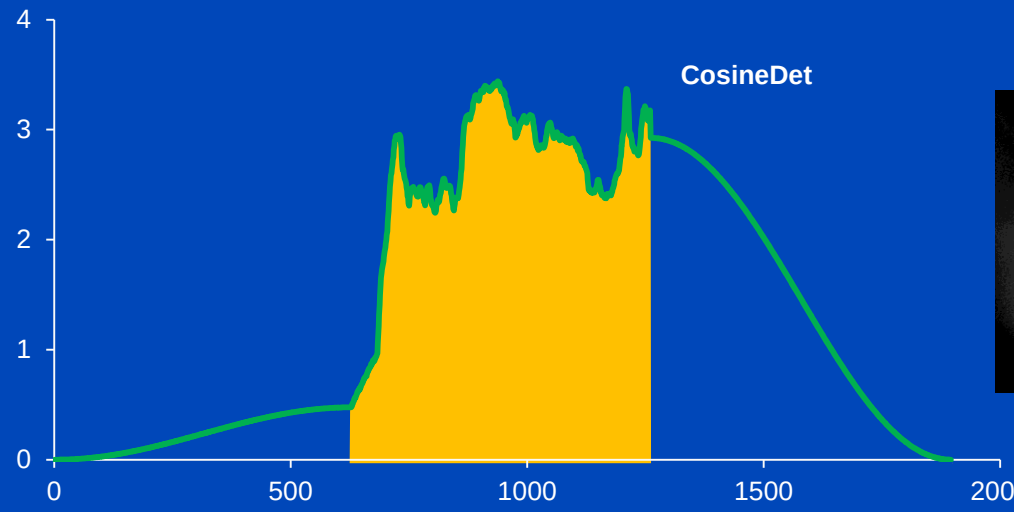




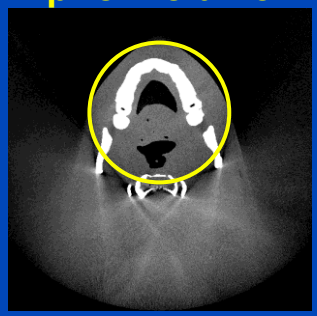
prior volume



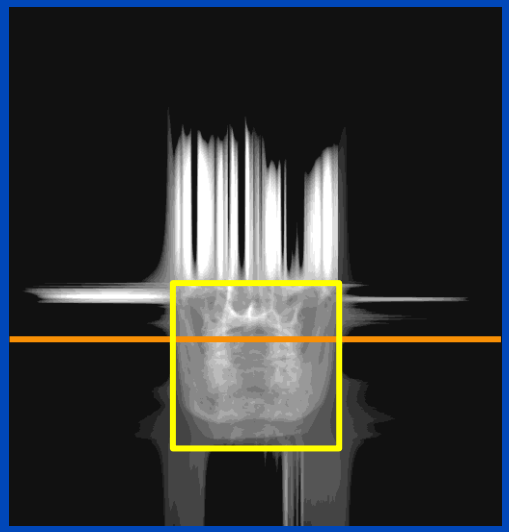


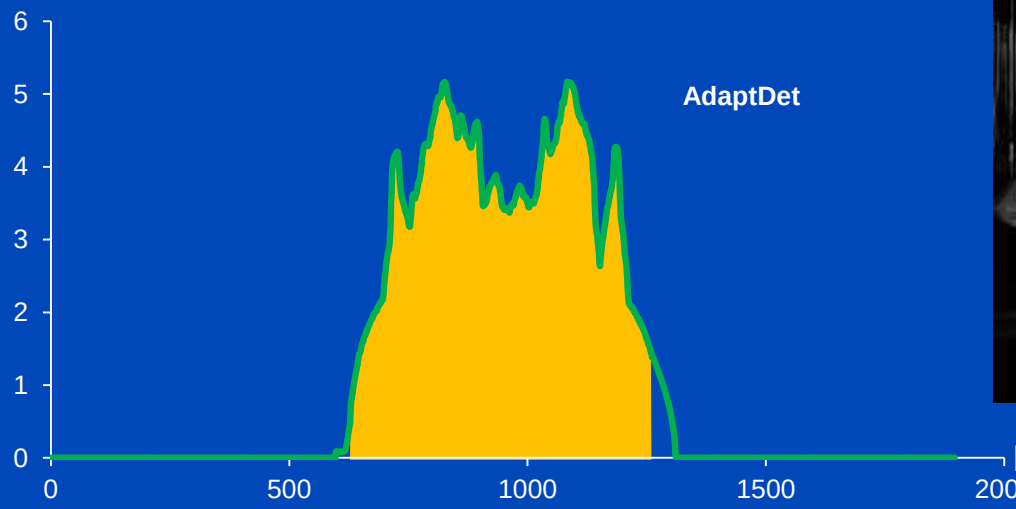


prior volume

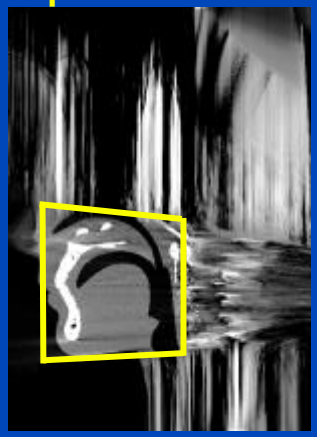


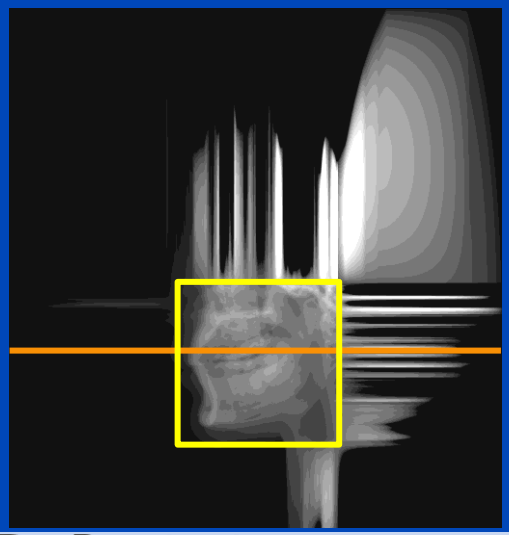
Detruncation in Projection Domain

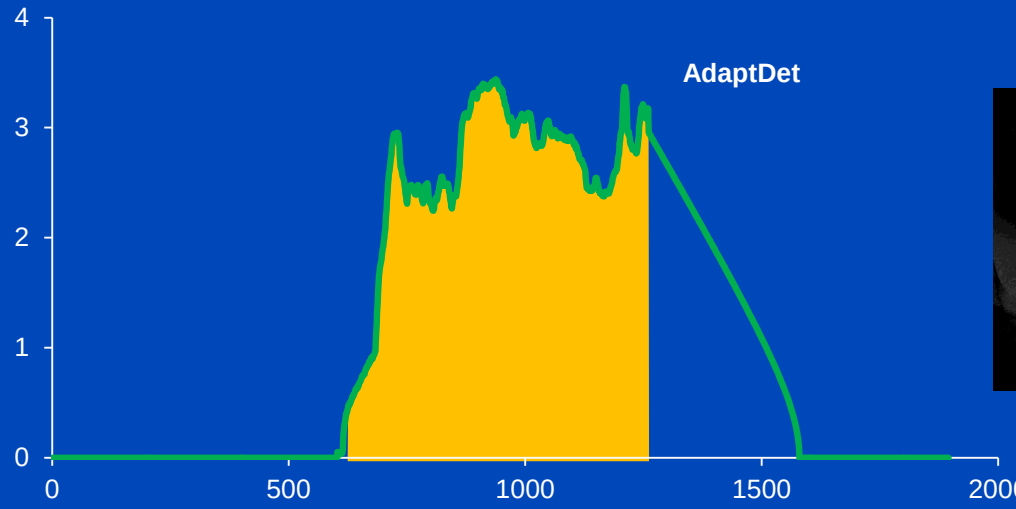




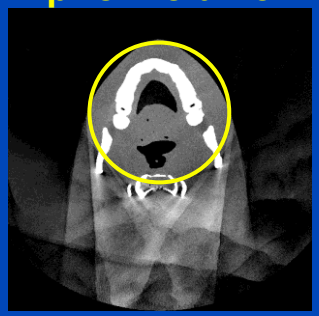
prior volume





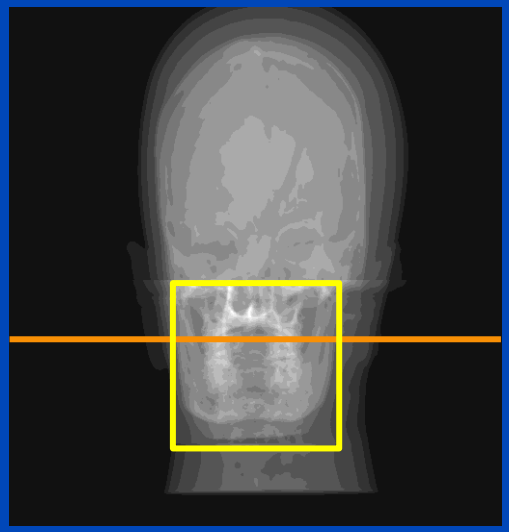


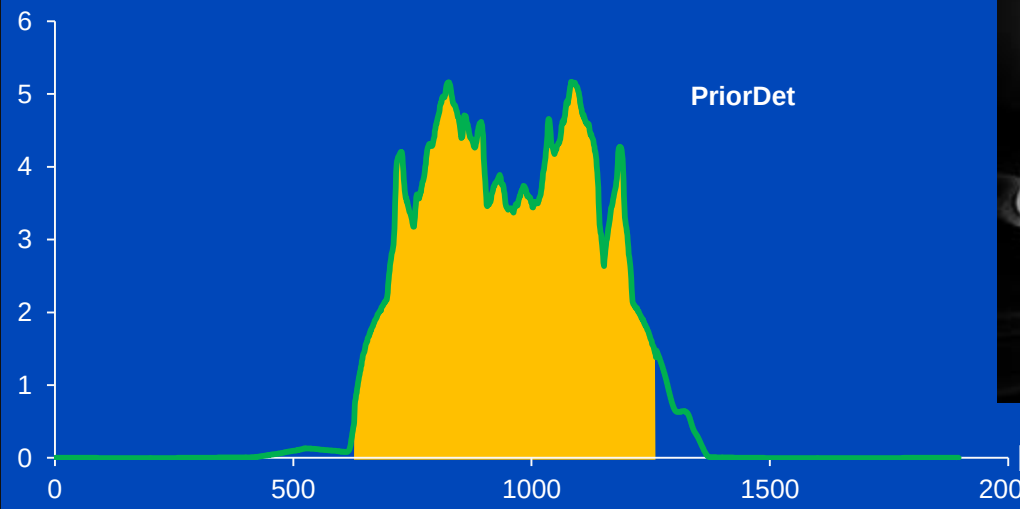
prior volume



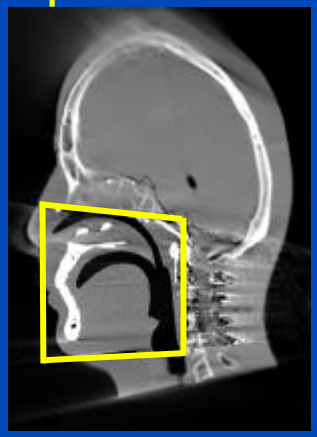
K. Sourbelle, M. Kachelrieß, and W. A. Kalender.
Reconstruction from truncated projections in CT using adaptive detruncation. European Radiology, 15(5):1008-1014, May2005.

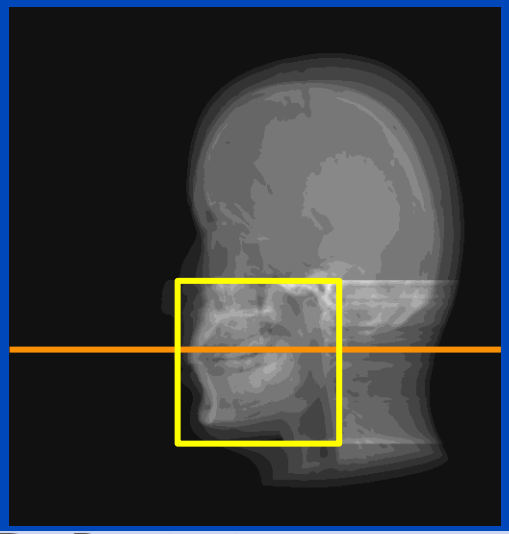
Detruncation in Projection Domain

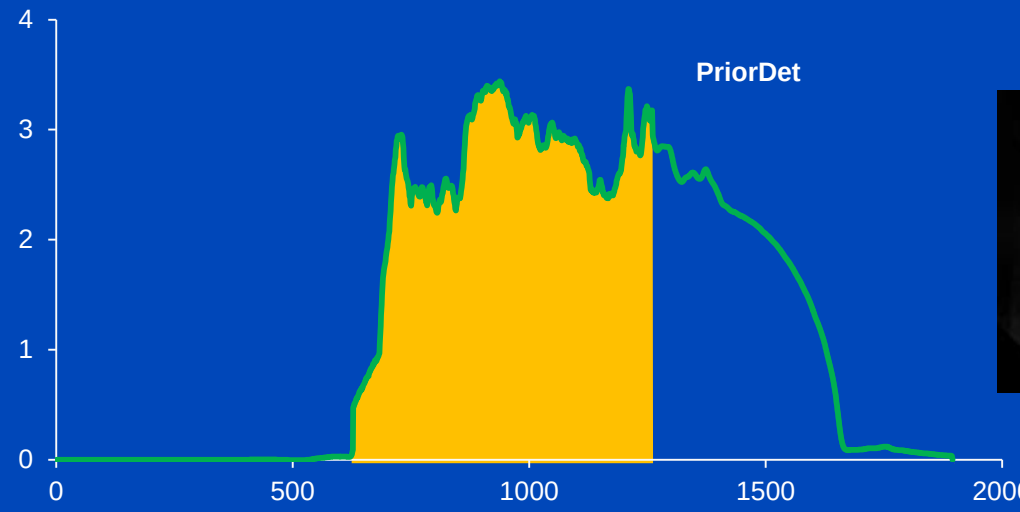




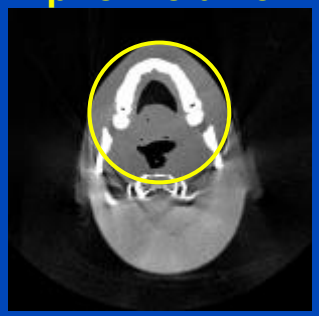
prior volume







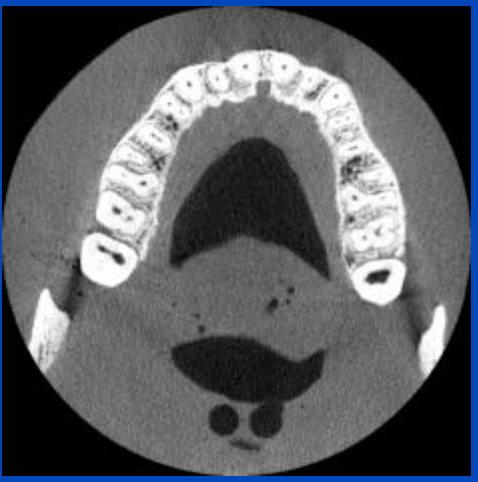
prior volume



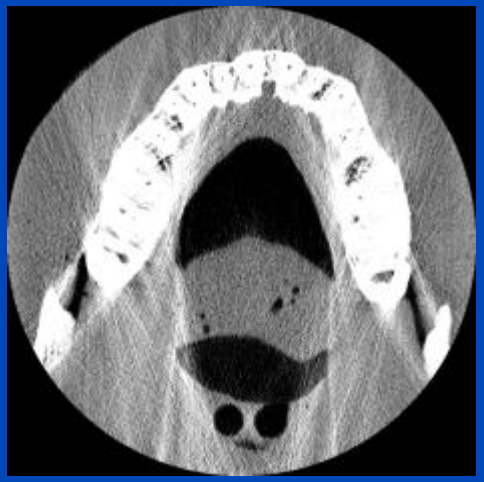
T. Heußer, M. Brehm, L. Ritschl, S. Sawall, and M. Kachelrieß.
Prior-based artifact correction (PBAC) in computed tomography. Med. Phys., 41:021906-1-16, 2014.

Results

FDK Reconstruction
no scatter correction



No Detruncation



Constant Detruncation

Cosine Detruncation

Adaptive Detruncation

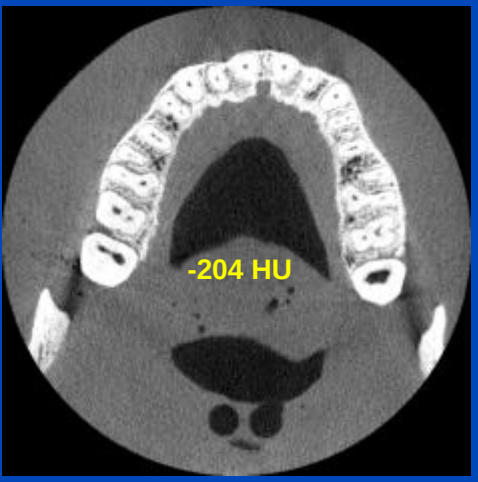
Prior Detruncation

Ground Truth (identical prior)

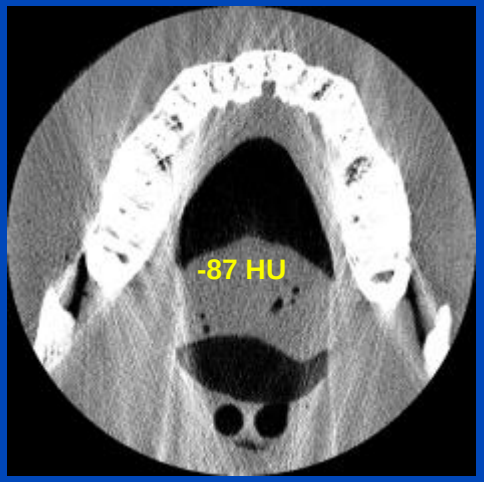
Different detruncation algorithms were used for scatter estimation and correction for this phantom. The volumes are also corrected for beam-hardening. *C* = 0 HU, *W* = 2000 HU

Results

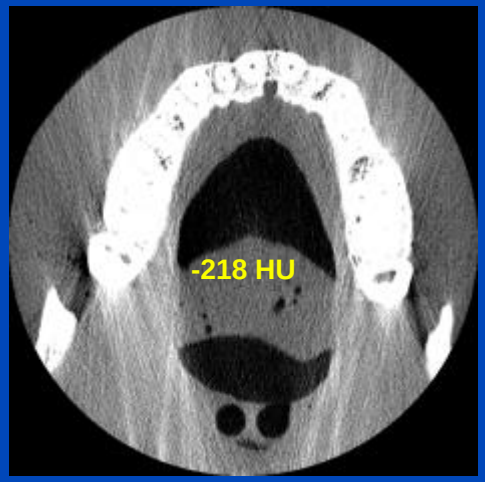
FDK Reconstruction
no scatter correction



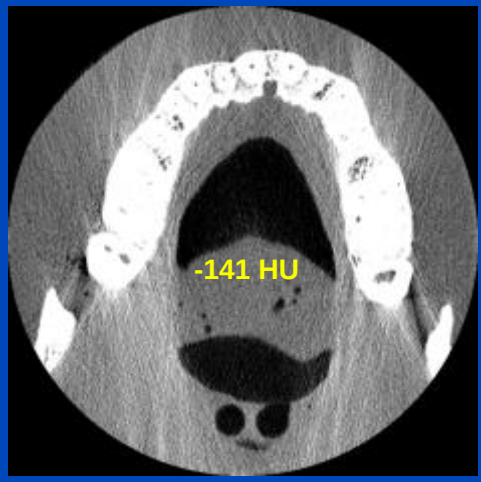
No Detruncation



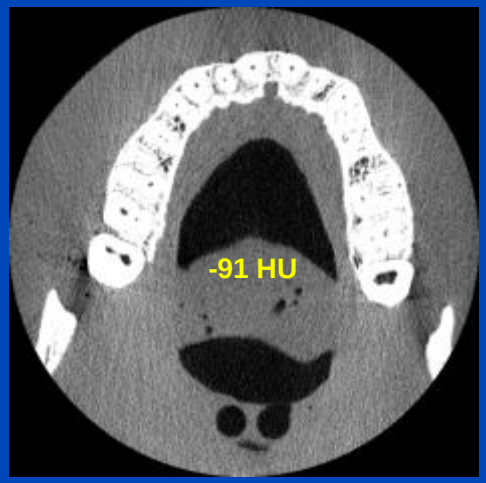
Constant Detruncation



Cosine Detruncation

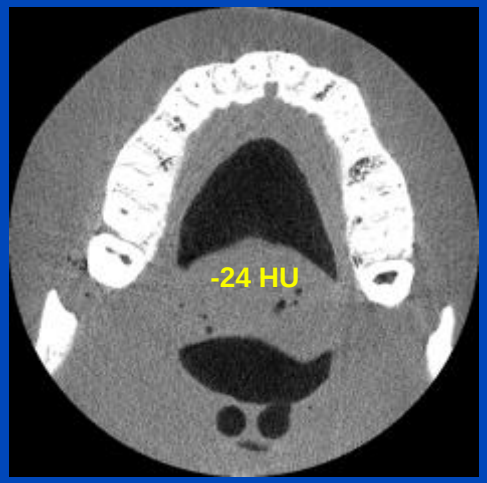


Adaptive Detruncation



Prior Detruncation

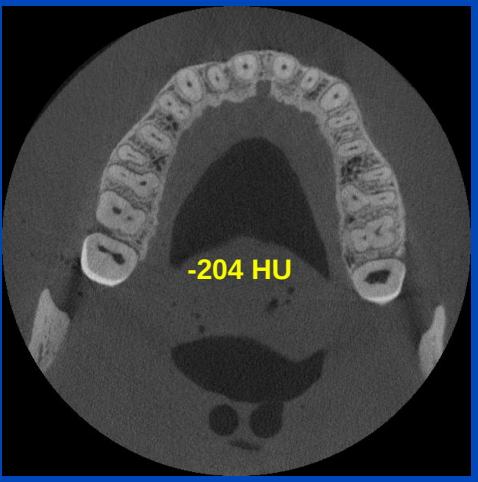
Ground Truth (identical prior)



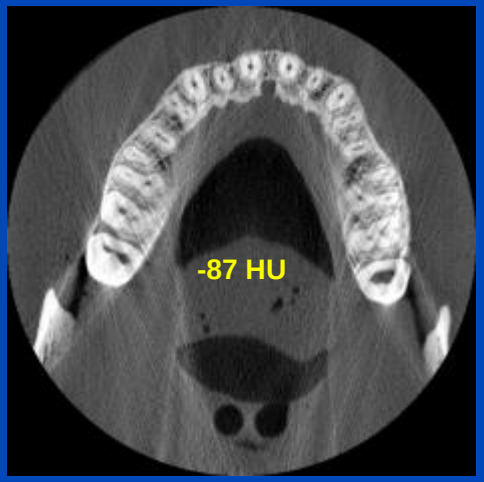
Different detruncation algorithms were used for scatter estimation and correction for this phantom. The volumes are also corrected for beam-hardening. *C* = 0 HU, *W* = 2000 HU

Results

FDK Reconstruction
no scatter correction

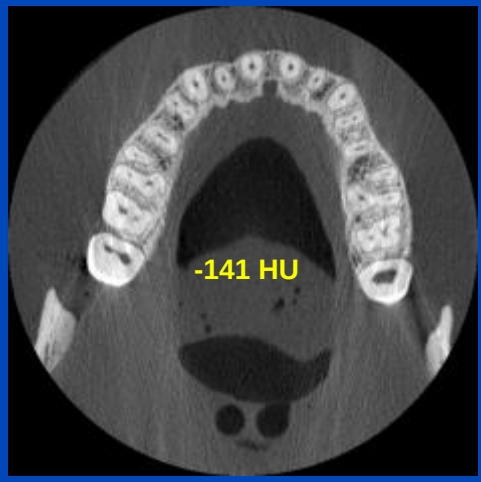


No Detruncation



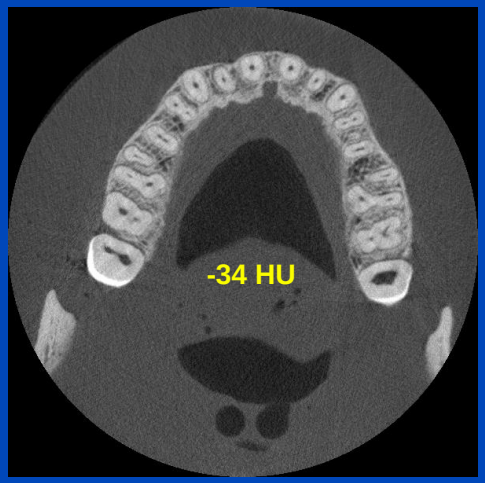
Constant Detruncation

Cosine Detruncation

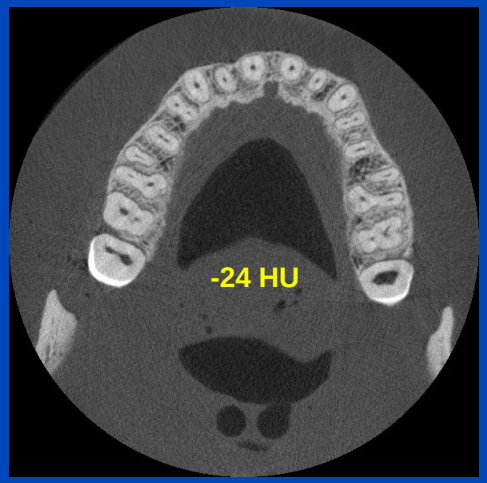


Adaptive Detruncation

Prior Detruncation



Ground Truth (identical prior)



Different detruncation algorithms were used for scatter estimation and correction for this phantom. The volumes are also corrected for beam-hardening. *C* = 1000 HU, *W* = 5000 HU

Conclusion

- Images corrected using a scatter estimation prior based on a simple detruncation algorithm suffer from an incorrect scatter estimation.
- In all cases the correction based on the prior-based detruncation leads to the most accurate CT-values, as expected. The remaining CT values only differ by 10 HU for a dental CT case.
- For the adaptive detruncation, the CT values differ by 67 HU and the reconstructions show an acceptable CT-value homogeneity.

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.