Zweispektren-CT: Lassen sich Metallartefakte durch Berechnung pseudo-monochromatischer Bilder entfernen?

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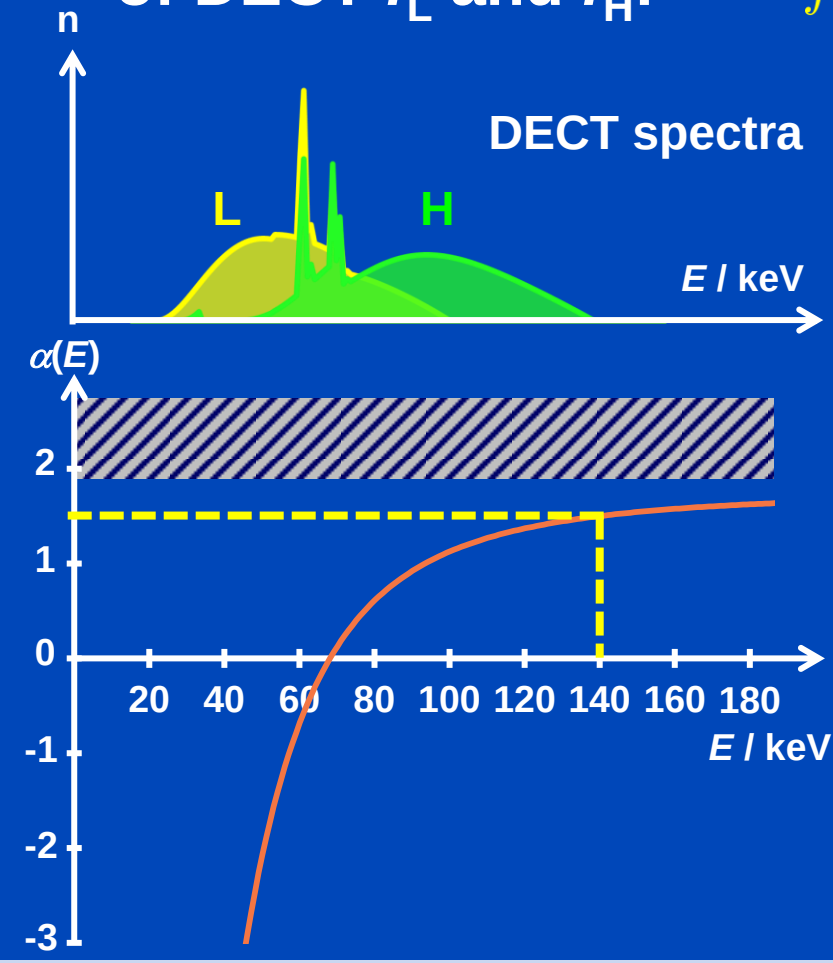
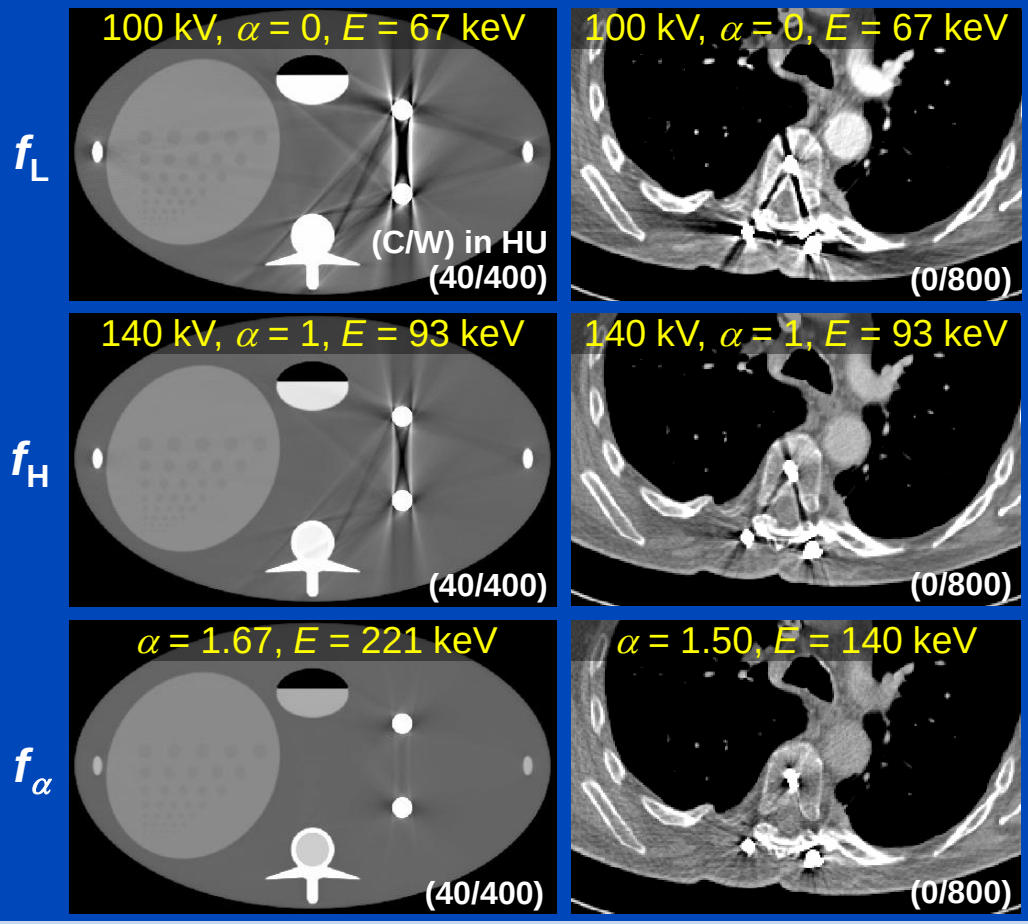
DEUTSCHES KREBSFORSCHUNGSZENTRUM IN DER HELMHOLTZ-GEMEINSCHAFT

DECT and Pseudo Monochromatic Imaging

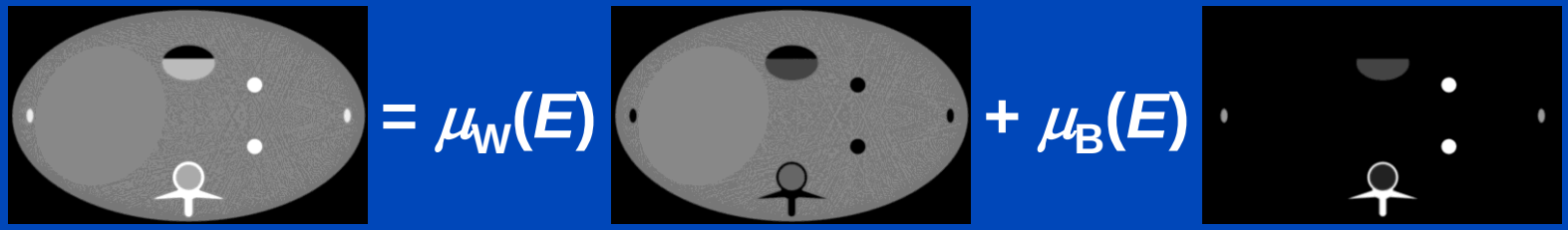
Pseudo monochromatic imaging is a linear combination of DECT f_L and f_H: $f_\alpha = (1-\alpha)\, f_L + \alpha\, f_H$





Prerequisites

- Basis functions $f(r)$ of attenuation μ in a position r are set to water W and bone B.



- A measured ray consists of a spectrum $w(E)$ and is attenuated by the object

$$q_L = -\ln \int dE\, w_L(E)\, e^{-p_W \mu_W(E) - p_B \mu_B(E)}$$

$$q_H = -\ln \int dE\, w_H(E)\, e^{-p_W \mu_W(E) - p_B \mu_B(E)}$$

- p_W and p_B are the line integrals of the ray intersecting the object.

Monochromatic Imaging

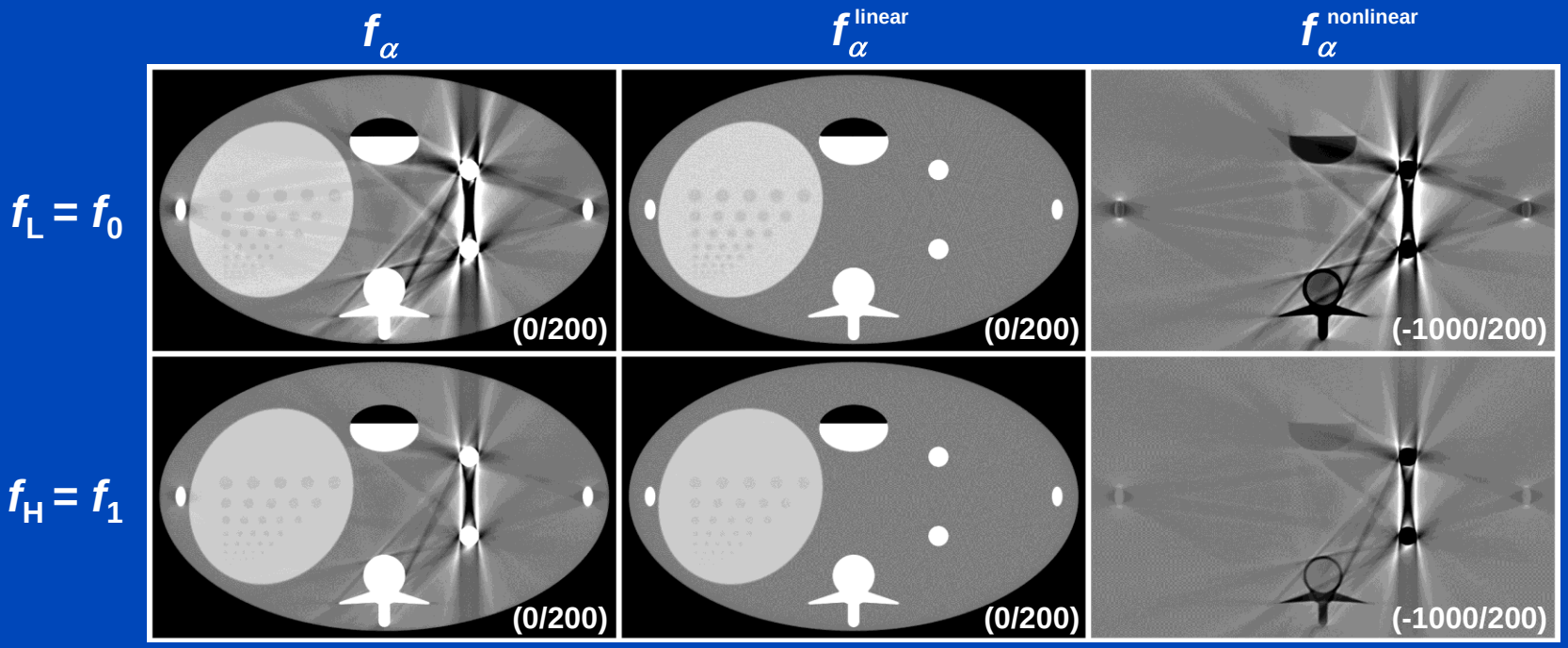
- **Pseudo monochromatic imaging** $f_\alpha = (1-\alpha)\, f_\mathrm{L} + \alpha\, f_\mathrm{H}$
  - **Image-based postprocessing (reconstructs q_L and q_H)**
  - **Provided in clinical DECT scanners**
- **Virtual monochromatic imaging** $g_\alpha = (1-\alpha)\, g_\mathrm{L} + \alpha\, g_\mathrm{H}$
  - **Rawdata-based preprocessing (reconstructs p_W and p_B)**
  - **Not available in clinical DECT systems**
- **True monochromatic imaging**
  - **Would require monochromatic x-rays – not applicable here**

$$q_\mathrm{L} = -\ln \int dE\, w_\mathrm{L}(E)\, e^{-p_\mathrm{W}\mu_\mathrm{W}(E) - p_\mathrm{B}\mu_\mathrm{B}(E)}$$
$$q_\mathrm{H} = -\ln \int dE\, w_\mathrm{H}(E)\, e^{-p_\mathrm{W}\mu_\mathrm{W}(E) - p_\mathrm{B}\mu_\mathrm{B}(E)}$$

Series Expansion

- **Series expansion of the polychromatic attenuation:**

$$q_j = -\ln \int dE\, w_j(E)\, e^{-p_{\mathrm{W}}\mu_{\mathrm{W}}(E) - p_{\mathrm{B}}\mu_{\mathrm{B}}(E)} = \sum\nolimits_{kl} c_{jkl} p_{\mathrm{W}}^{k} p_{\mathrm{B}}^{l}$$



pseudo monochromatic i. image-based processing

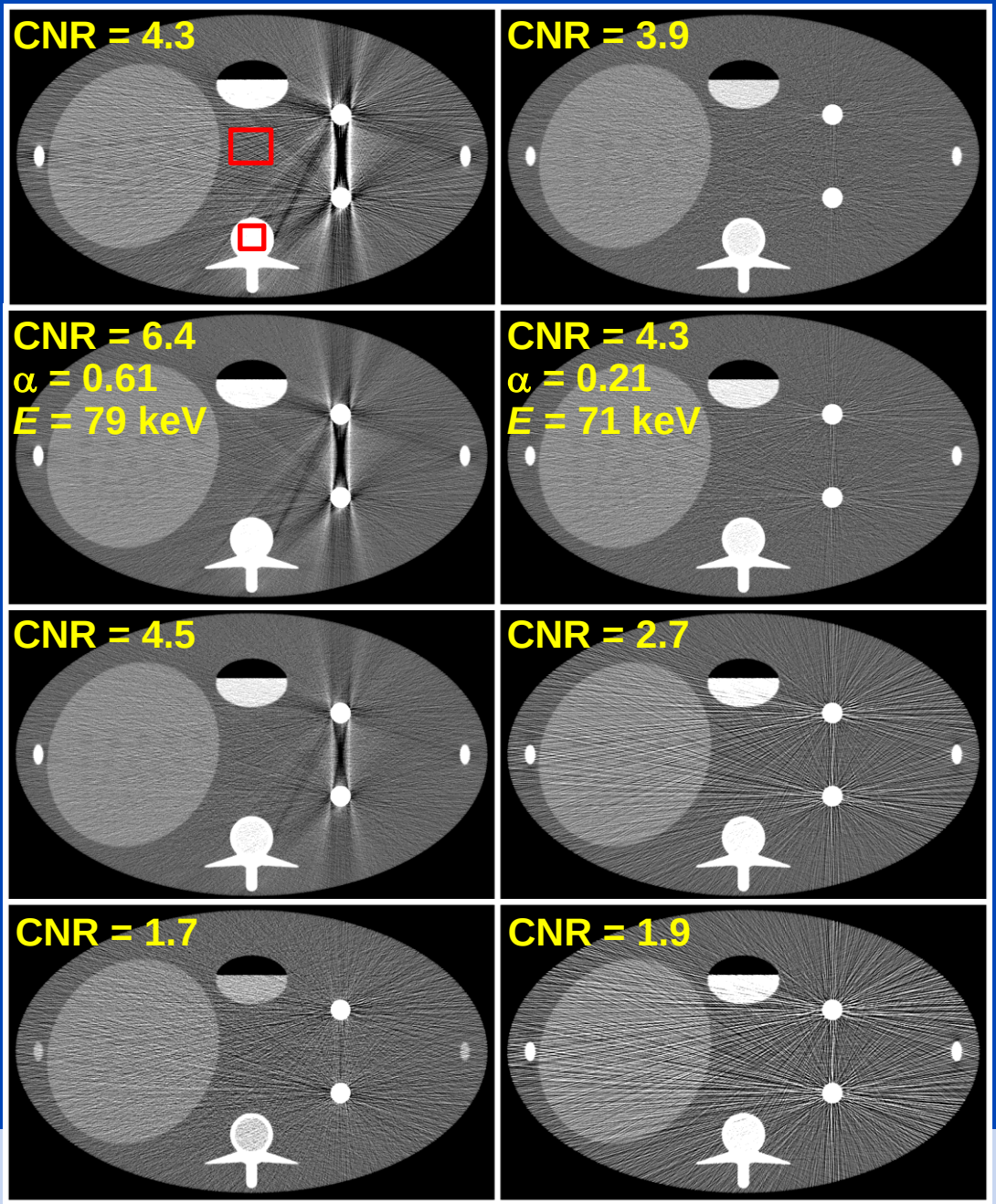
virtual monochromatic i. rawdata-based processing

$f_L = f_0$ (E = 67 keV)

maximum CNR

$f_H = f_1$ (E = 93 keV)

$f_{1.67}$ (E = 221 keV)



C = 40 HU,
W = 400 HU

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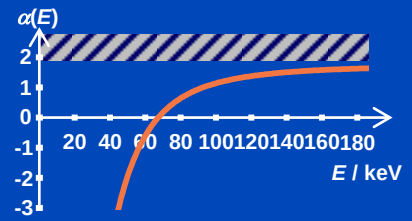
z = -723 mm

z = -792 mm

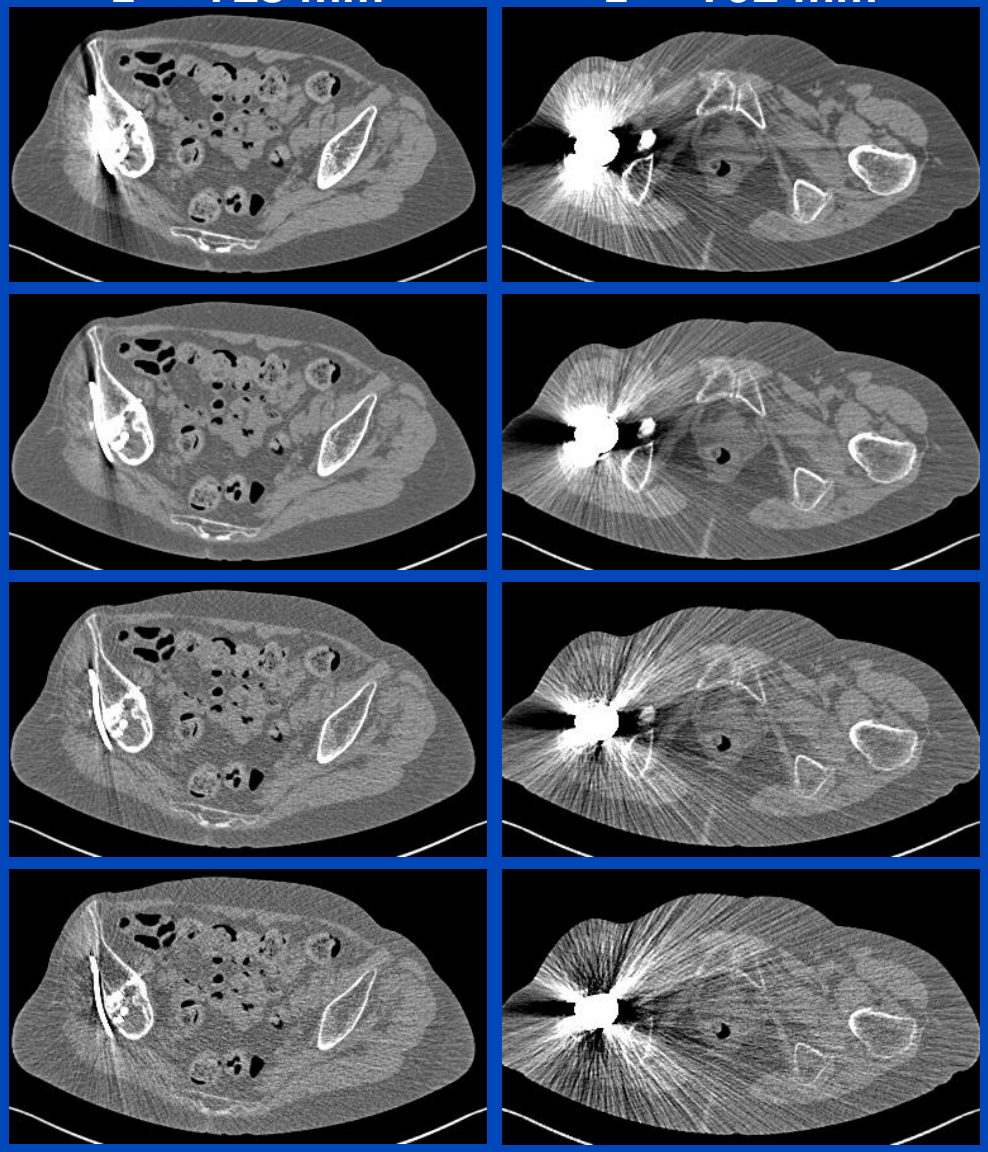


$f_L = f_0$ (E = 67 keV)

$f_H = f_1$ (E = 93 keV)

$f_{1.55}$ (E = 154 keV)

$f_{2.00}$ (E = --- keV)



C = 0 HU, W = 800 HU

dkfz.

Conclusion

- **Pseudo monochromatic imaging**
  - **is unable to remove metal artifacts but reduces them in special cases.**
  - **reduces CNR.**
- **Rawdata-based methods should be preferred.**
- **Additional information of DECT in comparison to single energy CT should rather be used for spectral imaging than for artifact reduction.**

Thank You!

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