International Conference on Monte Carlo Techniques for Medical Application (MCMA2017) - *Napoli 15th-18th October 2017*

Breast Model Validation for Monte Carlo Evaluation of Normalized Glandular Dose Coefficients in Mammography

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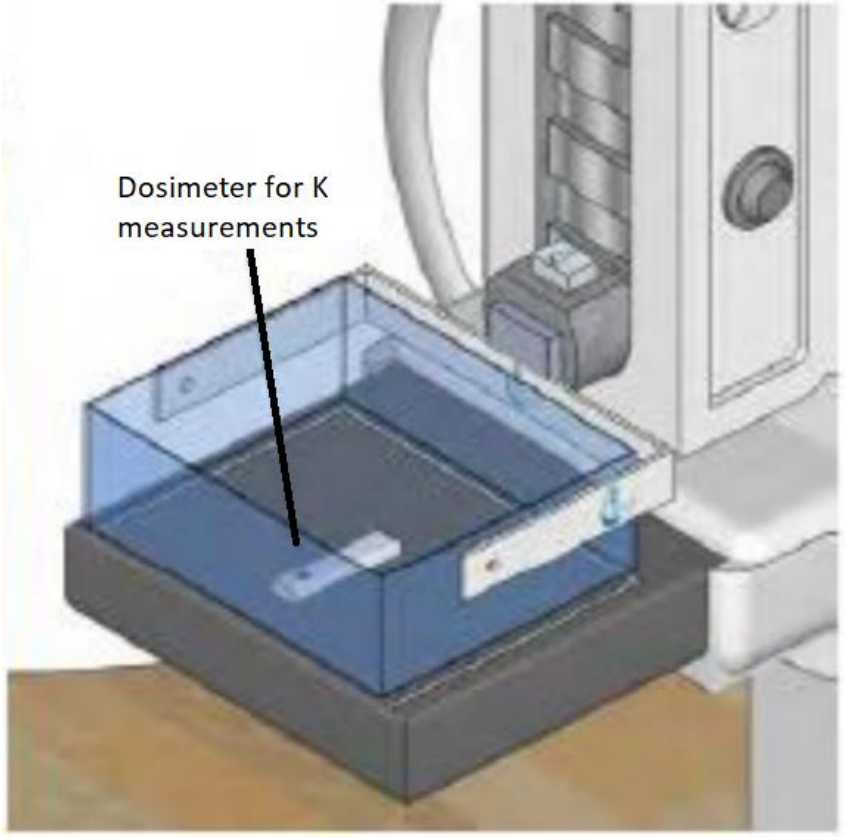
Dosimetry in mammography

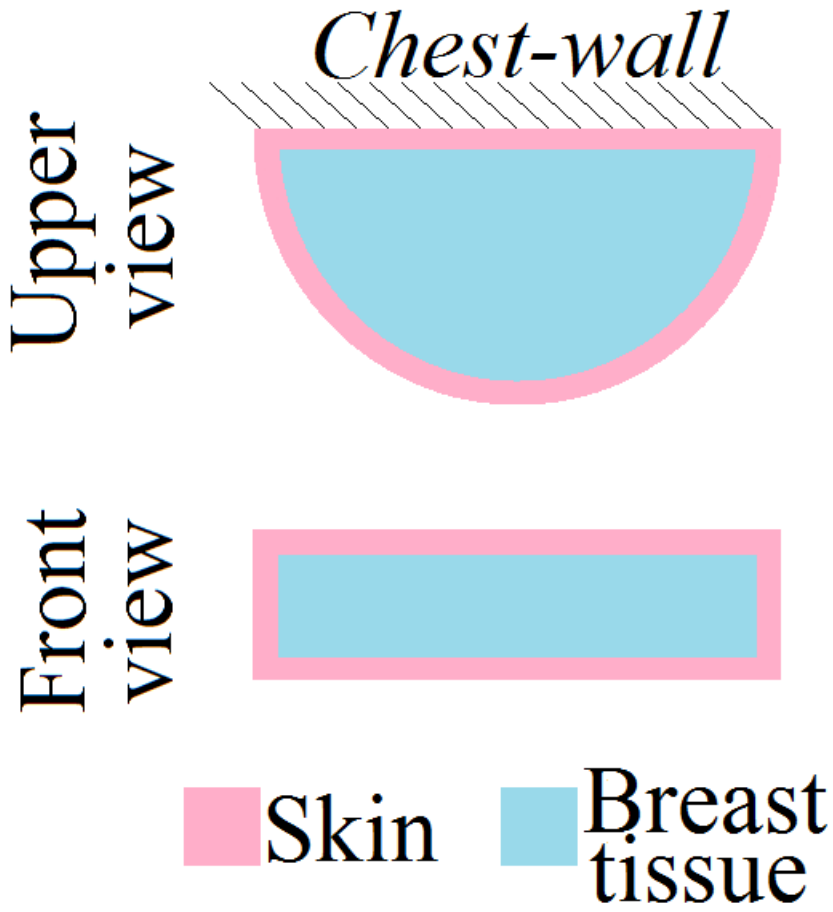
Mean Glandular Dose (MGD) = DgN (or c·g·s) · K

Air kerma at the breast surface

Coefficients calculated **via MC simulations**

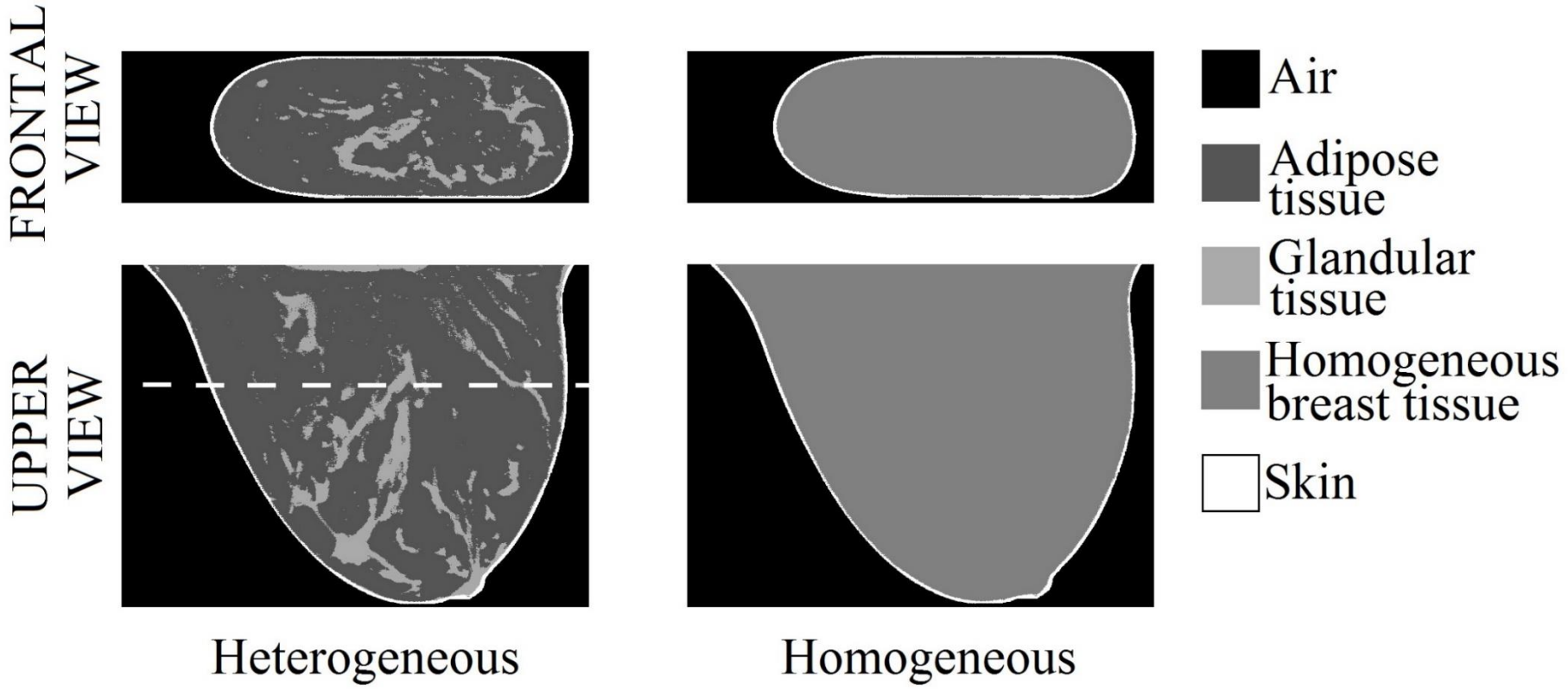


Breast model assumptions: skin thickness



Model from	Skin layer (mm)	Adipose layer (mm)
Dance (1990)	0.00	5.00
Wu et al (1991)	4.00	0.00
BCT experiments	1.45	0.00
Histology	1.45	2.00

Breast model assumptions: glandular distribution



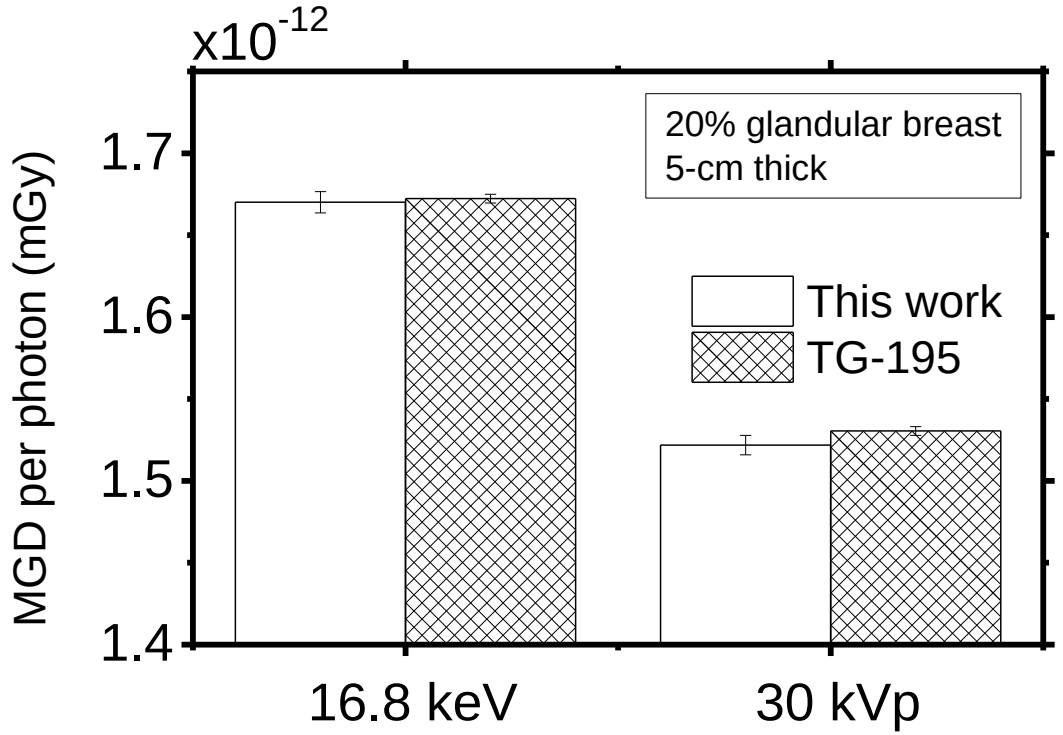
$$Probability\ of\ dose\ absorbtion\ in\ the\ gland = \frac{f_g \times \frac{\mu_{en}}{\rho}(E)_g}{f_g \times \frac{\mu_{en}}{\rho}(E)_g + (1 - f_g) \times \frac{\mu_{en}}{\rho}(E)_a}$$

MC code for breast dosimetry

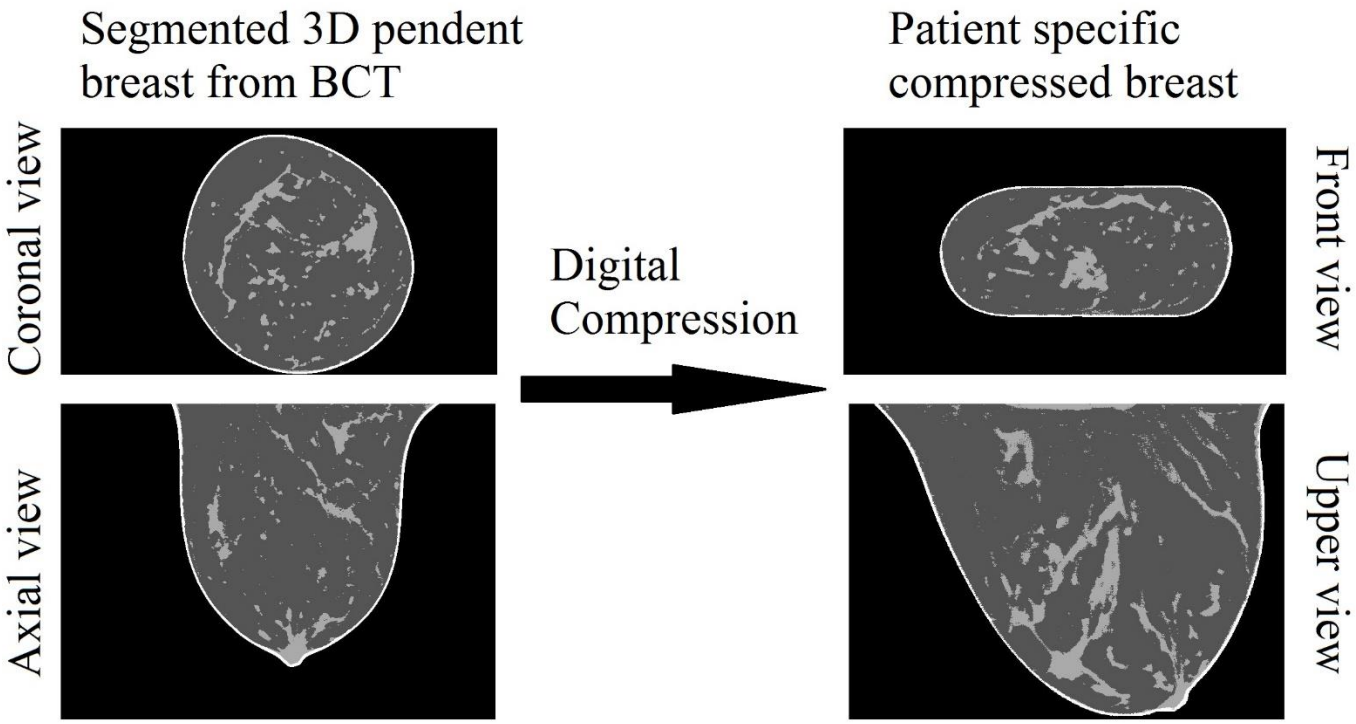
Code based on GEANT4 toolkit

Physics list: Option4

Code validated vs AAPM TG195 data



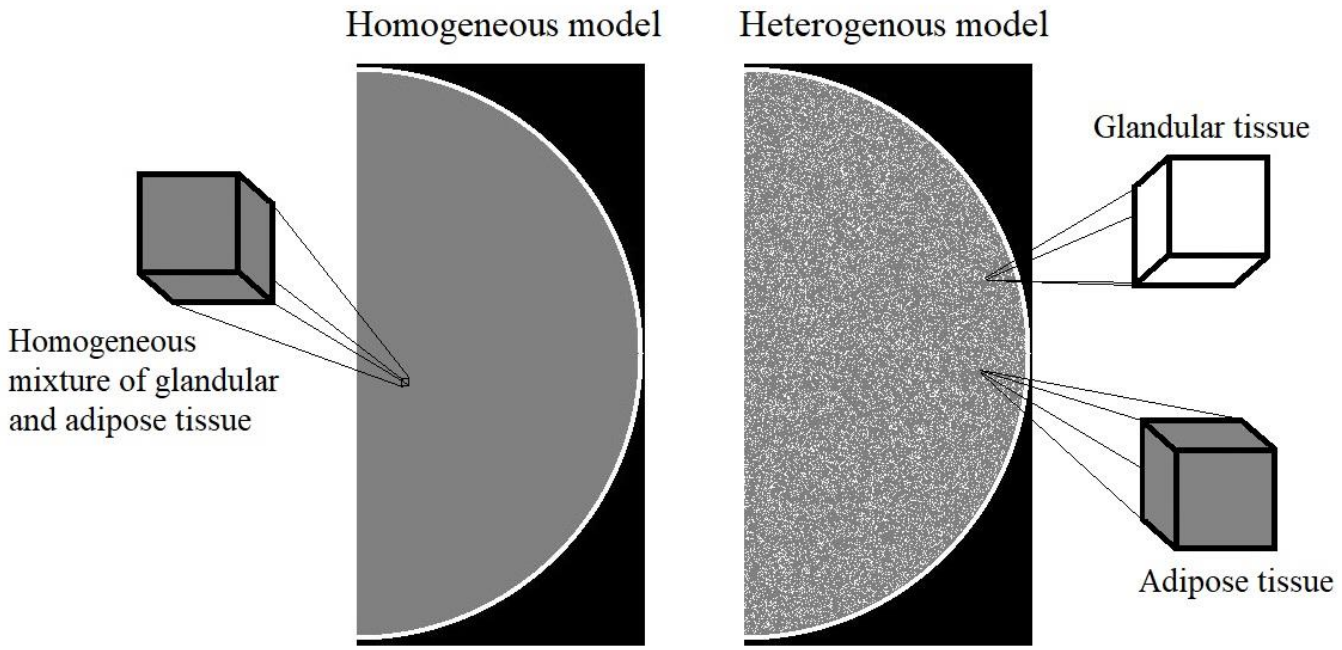
20 voxelized patient specific breast phantoms from 3D breast images

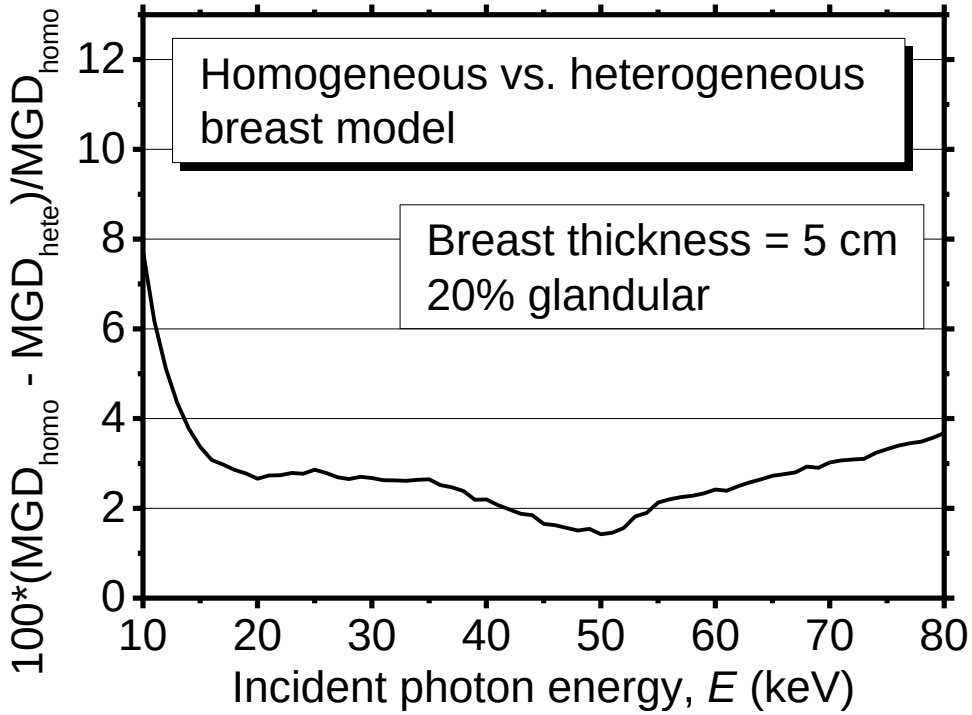


	Mean	StdDev	Min	Max
Glandular fraction (%)	23.1	15.3	5.0	54.3
Compressed thickness (cm)	5.9	1.5	2.9	7.8

*Sechopoulos et al 2012, "Characterization of the homogeneous tissue mixture approximation in breast imaging dosimetry." *Med. Phys.* 39 5050-5059.

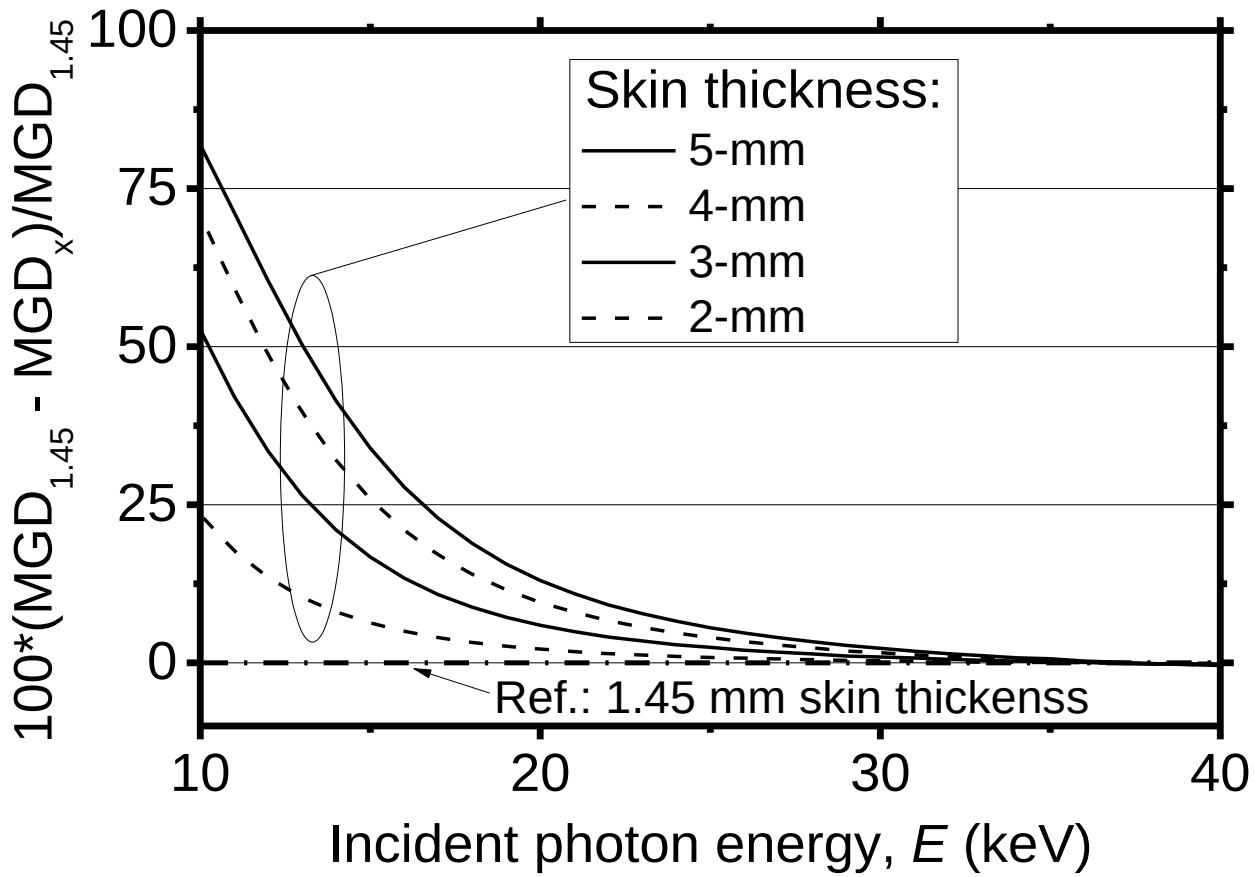
MC validation for the heterogeneous model





Skin thickness influence on the MGD

Compressed breast thickness = 5 cm; glandular fraction = 20%



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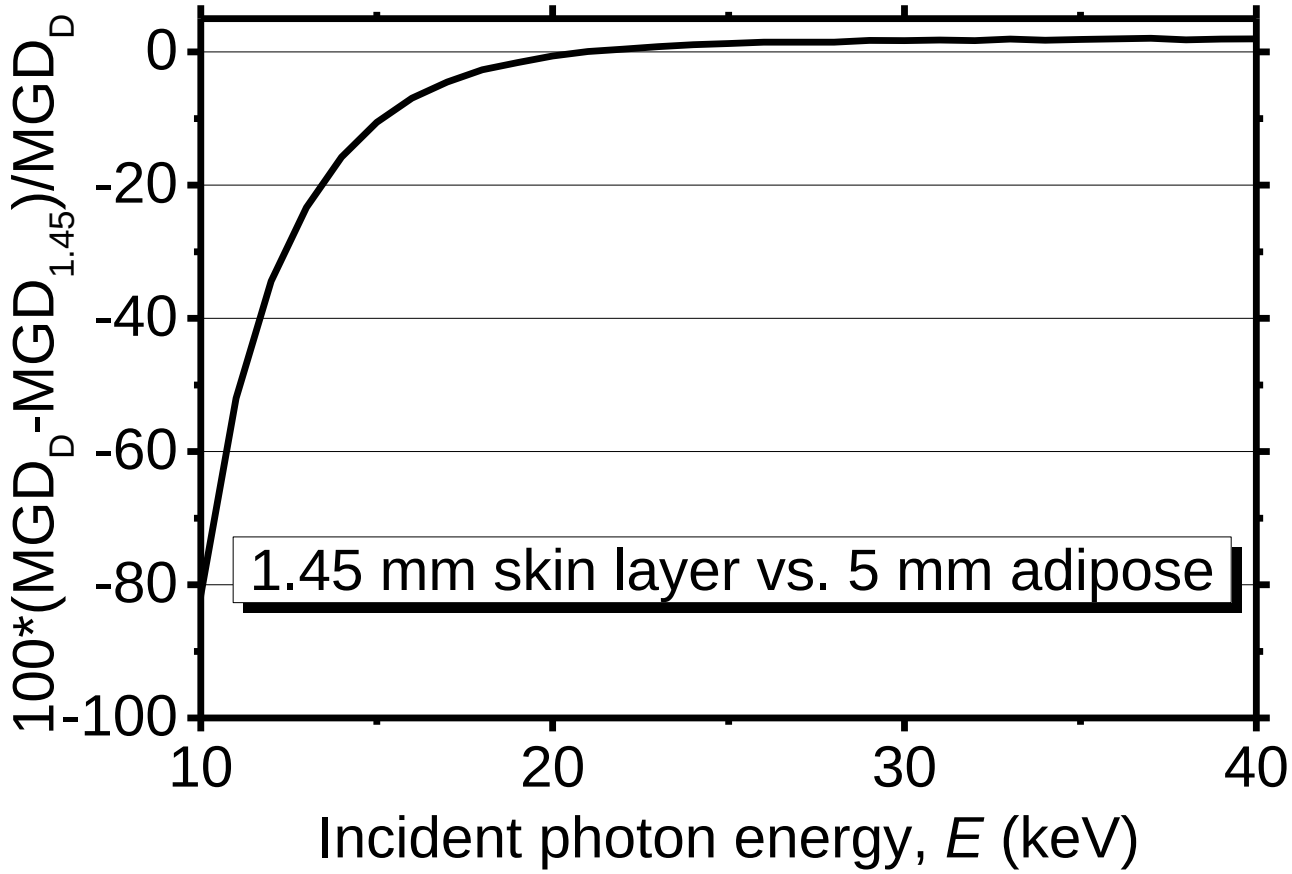
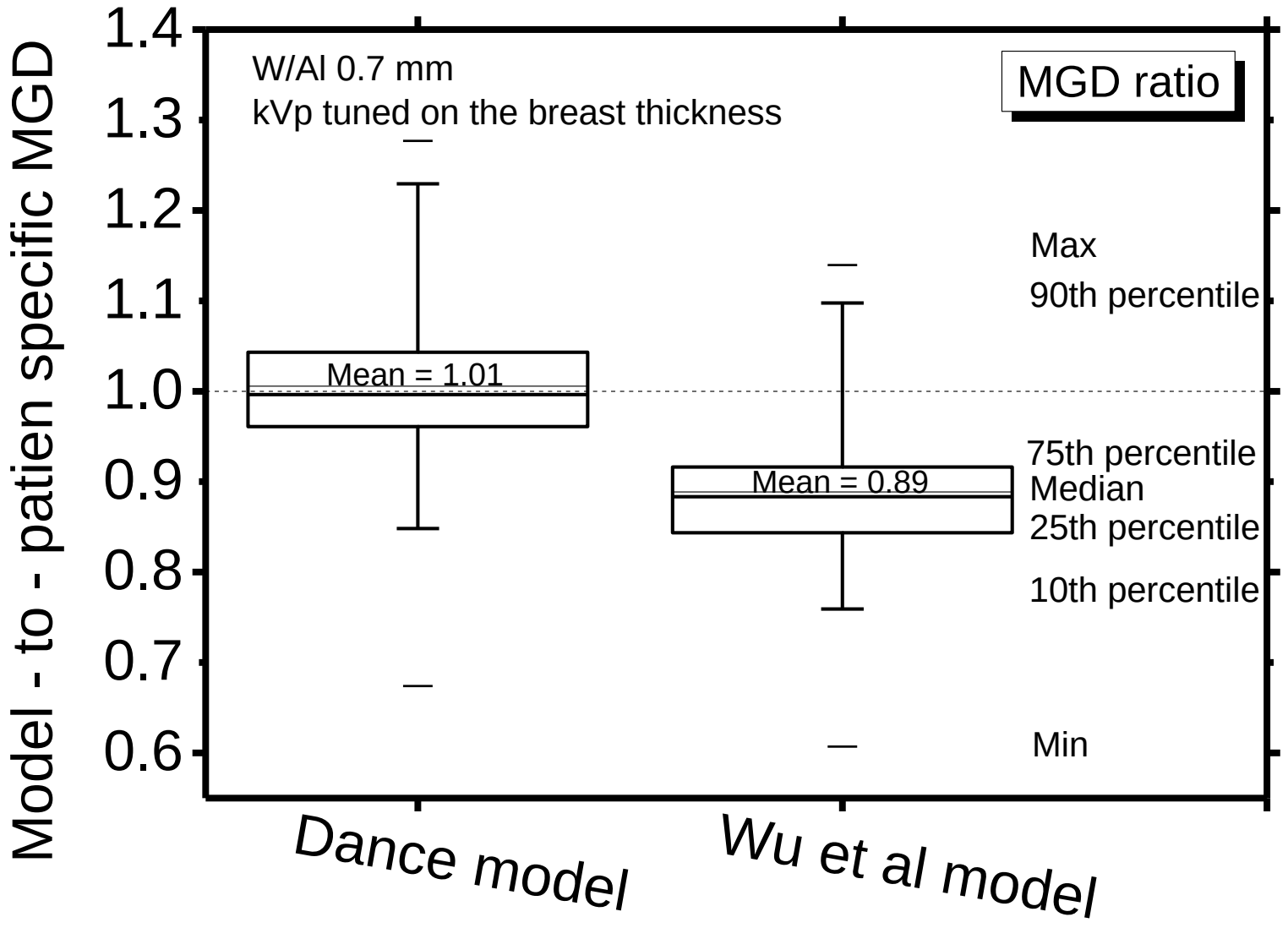
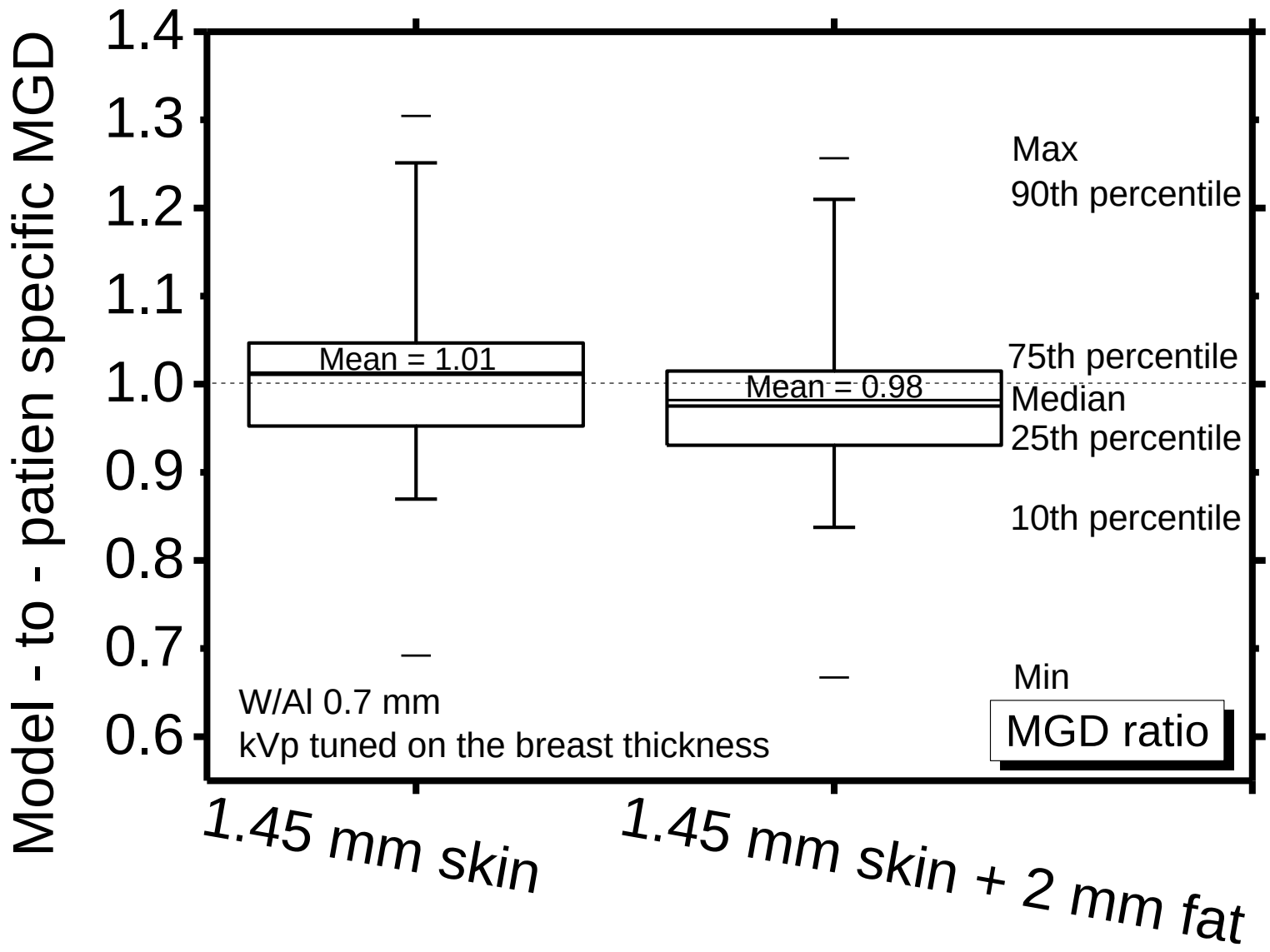


Standard models vs. patient specific phantoms



New models vs. patient specific phantoms



Conclusions

- The skin model in MC simulations presents a large influence on MGD estimates;
- A simple breast model can produce MGD underestimation up to about 40% when compared to the dose estimates via patient specific breast phantoms;
- The model proposed by Wu et al (1991) led to the lowest dose overestimation (18%) combined with the highest MGD underestimation (-40%) for a specific breast;
- Breast model with a 1.45 mm skin thickness and the Dance's model led to the lowest differences (1%), on average, when compared to patient specific breast phantoms, with respect to Wu's model (-11%).

Thank you!!!

Any questions?

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