Noise in accelerated in-silico x-ray breast images: impact on the breast anatomy and the detector.

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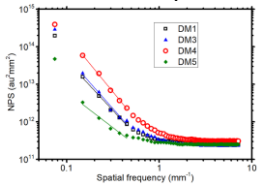
Background: Virtual clinical trials (VCT) in x-ray breast imaging may substitute or assist clinical trials with patient population, by means of in-silico (computational) examinations. Platforms for VCT should guarantee realisms in the simulated images and reasonable computation times. We investigated the noise power spectrum (NPS) of the generated projection images when algorithm or architectures for speeding up in-silico simulations are employed.

Material and Methods: We compared three Geant4 based Monte Carlo (MC) software for in-silico breast images computation: a CPU multithread software [1], a code based on GPU GGEMS toolkit (ggems.fr) and a code based on GATE software (opengatecollaboration.org) which employs a variance reduction technique (VRT). Digital breast phantoms were taken from an open database [2]. The anatomical noise was evaluated as β parameter [3], and NPS for the three codes were computed from images of water slabs.

Preliminary results: Fig. 1 reports NPS evaluated for 4 of the simulated mammograms. The evaluated β values ranges are compliant with the expected value of ca. 3, except for phantom DM5, derived from a very low-density breast. Fig. 2 compares NPS functions obtained with CPU classical MC approach and with the VRT algorithm. This last approach permits to reduce the computation times up to 10 times with a slight reduction of the noise content with respect to CPU based classical MC.



	T (mm)	Gf	β
DM1	65	19%	2.7±0.1
DM3	65	19%	2.8±0.2
DM4	59	11%	3.0±0.1
DM5	87	3%	1.9±0.2

Figure 1: NPS of simulated DM images (left) and corresponding β values (right). T = breast thickness; Gf = glandular fraction.

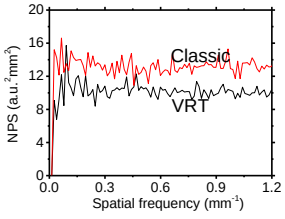


Figure 2: NPS of flood illumination of the detector for classical code and for VRT.

[1] A. Sarno *et al.* IWBI2020, vol. 11513 (2020)
[2] A. Sarno *et al.* Med Phys 48 (2021): 2682-2693.
[3] L. Chen *et al.* Med Phys 39 (2012): 1435-1441.