

## PET Imaging with Yttrium-86: Comparison of phantom measurements acquired with different PET scanners

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**Aim:** Quantitative PET imaging with Y-86 allows dose estimation for therapies with Y-90 labelled radiopharmaceuticals. Y-86 is a non-pure positron emitter with a branching fraction of 33%. The remaining decay mode is electron capture followed by emission of additional gamma rays above 511 keV which may interfere with the PET-measurement. Based on phantom measurements, we examined the quantitative accuracy of Y-86 measurements using 3 different scanners with 2D and 3D acquisition modes.

**Methods:** A cylindrical phantom with cold inserts of teflon, water, and air was placed centrally in the field of view. After transmission scanning the phantom was filled with 70 MBq Y-86 and repositioned. Data were acquired with an ECAT EXACT scanner in 2D and 3D mode up to 130 h to examine different activity levels. In addition, measurements were performed on an ECAT HR+ (2D/3D) and a PC4096+ scanner (only 2D). After the standard correction procedures images were reconstructed using FBP with standard reconstruction

parameters. ROI evaluation was done on transaxial slices.

**Results:** Measurements of different activity levels showed a severe non-linearity of reconstructed Y-86 activity (ECAT EXACT measured/true ratio for 15 kBq/ml: 2D=0.84, 3D=0.93; for 4 kBq/ml: 2D=0.99, 3D=1.20). Due to the high scatter fraction relevant activity estimates were obtained for non active areas (cold water: 2D= 20%; 3D=60% (estimates in % of true Y-86 activity)); cold teflon overestimation was very strong and non-linear for 3D (65-69% 2D for all activities; 146-175% 3D increasing with lower activity levels).

The table compares the results obtained in the cold inserts related to an Y-86 activity concentration of 3-5 kBq/ml outside the inserts. In 2D the PC4096+ revealed the best results, the HR+ showed the highest overestimations of cold areas.

	ECAT EXACT		ECAT HR+		PC4096+
	2D	3D	2D	3D	2D
yttrium-86	1	1	1	1	1
teflon	0.67	1.48	1.19	1.47	0.22
water	0.21	0.51	0.46	0.56	0.11
air	-0.02	-0.14	-0.11	-0.21	0.10

**Conclusion:** The relatively low performance in 2D of the HR+ compared to the PC4096+ and the EXACT can be explained by its thin septa and different septa apex angle. Due to the high scatter, which is not corrected by the scatter correction, the 3D mode is generally not suitable for Y-86 imaging in the scanners tested here. The overestimation within the teflon-insert indicates that dose estimates based on ROIs placed on bone and bone marrow are not valid. The results demonstrate the necessity of individual phantom measurements to estimate the scanner specific bias of Y-86 imaging and

the necessity to develop appropriate correction procedures.

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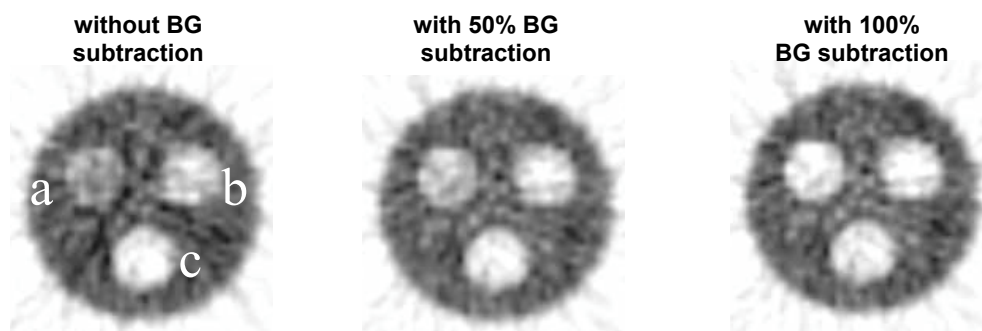


Figure 1: Outcome of different background subtraction levels in a 2D-measurement with the EXACT at 4 kBq/ml <sup>86</sup>Y-radioactivity concentration. Reconstruction with filtered back projection (FBP), cold inserts: a) teflon b) water and c) air