Monte Carlo simulation of 4-ring Discovery MI PET/CT scanner and its extended axial field-of-view to 2 m

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INTRODUCTION

There has been a significant interest in the development of the extended axial field of view scanners. This interest has spawned due to the several limitations associated with the scanners with a small axial field of view, such as low photons detection efficiency, longer scan time, requirements of higher radioactivity, and difficulty in parametric PET imaging. The PET scanners with LAFOV available as of now are uEXPLORER, PennPET EXPLORER, Siemens Biograph Quadra.

AIM

The aim of this work was to project the performance of a large axial field of view scanners (20 and 40-ring configurations) with the GE Discovery MI PET scanner architecture with LYSO crystals. In this work, the scanner performance was projected in terms of scanner sensitivity, spatial resolution, and noise equivalent count rates.

METHOD

- Discovery MI PET scanner was simulated, and its architecture was used to design extended AFOV up to 2
- First, we validate the 4-ring scanner and subsequently added more rings to make the extended version of scanners
- The system deadtime was empirically estimated and fed into GATE for scanner simulations
- Sensitivity, NECR, SF, spatial resolution were measured according to the NEMA NU-2 2018 guidelines and recent literature recommendations

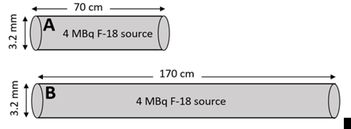


Fig 1. Phantoms for sensitivity measurements

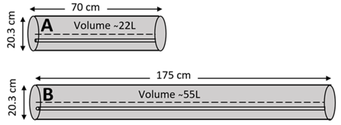
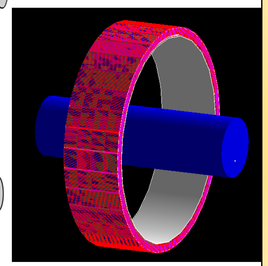
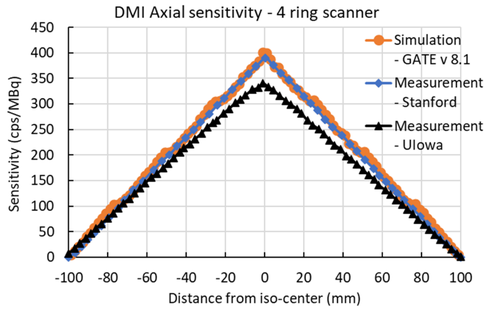


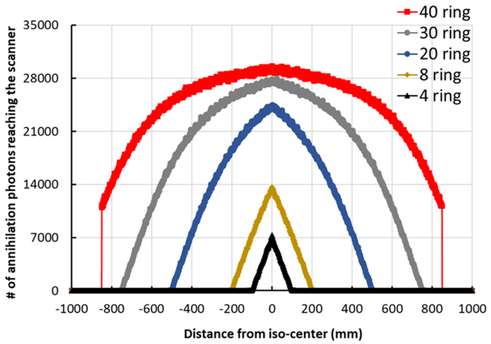
Fig 2. Scatter phantoms

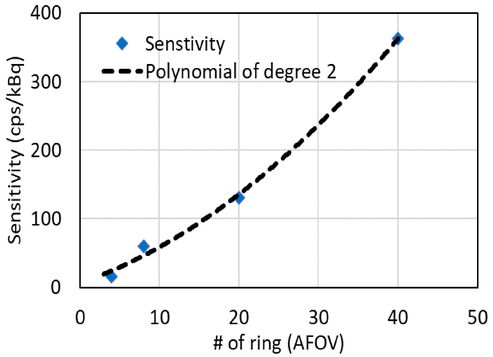


RESULTS

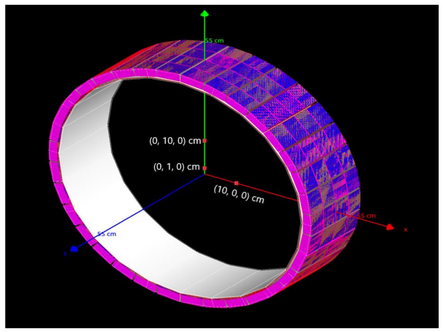
Sensitivity





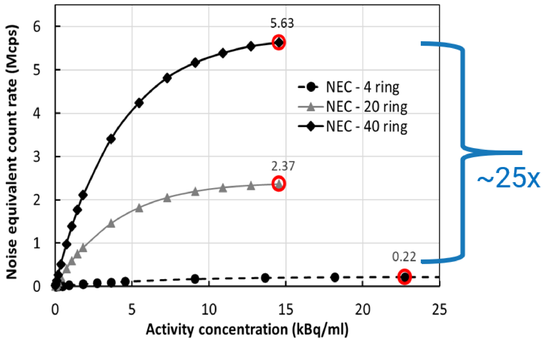


Spatial Resolution

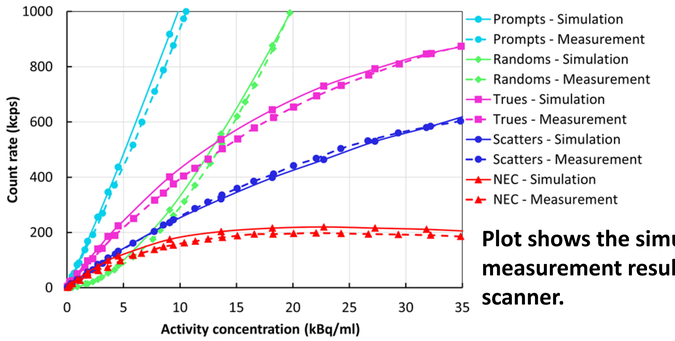


	GATE (this work)		Measurement (Stanford)	
	FWHM	FWTM	FWHM	FWTM
		(0, 1, 0) cm		
Radial	3.84	8.82	4.17	9.14
Tangential	4.00	8.64	4.40	9.17
Axial	4.41	9.76	4.57	10.38
		(0, 10, 0) cm		
Radial	5.17	9.43	5.65	10.36
Tangential	4.96	9.03	4.74	9.68
Axial	5.90	11.41	6.39	12.34

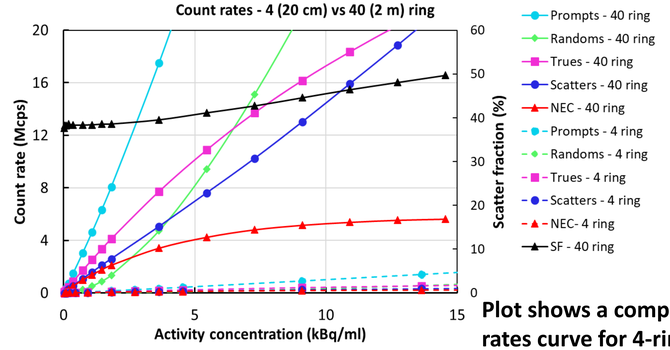
Count rates comparison



Noise Equivalent Count rates



Plot shows the simulation vs measurement results for 4-ring scanner.



Plot shows a comparison of count rates curve for 4-ring vs 40-ring hypothetical scanner.

CONCLUSIONS

- Simulation vs measurements ~9%
- Sensitivity gain of ~24-fold if we increase the AFOV to 2 m
- NECR comparison gives a performance gain of ~25-fold
- Overall, gain of ~25-fold can be achieved for the DMI scanner of AFOV of 2 m using the existing DMI architecture

CONTACT

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