Performance Evaluation of a Fast Tomographic Reconstruction Software for PET

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Aim

This study evaluates the performance of a Fast Tomographic Reconstruction (FTR) software for SAFIR small-animal PET scanner [1] in terms of image quality and reconstruction time and compares it with STIR.

Introduction

High-resolution reconstruction of animal image series in SAFIR-I is currently done in STIR [2], which with typical parameters takes several hours on a single CPU core. This time is increased by a factor of 10 for SAFIR-II. However, in FTR, with a known crystal map and voxel size, the system matrix is generated and stored once for a given PET scanner, and then is used during the reconstruction [3]. This approach significantly reduces the reconstruction time.

Materials and Methods

Image quality was investigated according to NEMA NU 4-2008 standards [4]. Reconstructions were performed on an AMD Ryzen Threadripper 2950X 24-Core system on a single thread with following parameters:

Phantom	Scanner	Scan info	Voxel size	Geometry	Method	Subsets, Iteration	Filter
Image quality	SAFIR-I (24 rings with 180 LYSO crystals)	3.35 MBq 18-F 20 min	1.13 mm (FTR), 1.1 mm (STIR)	Generic block geometry	OSEM (FTR), OSMAPOSL (STIR)	6 subsets, 1 to10 iterations	1.14-mm Gaussian
Derenzo	SAFIR-II (64 rings)	365 MBq 18-F 60 sec	0.56 mm (FTR), 0.55 mm (STIR)	Generic block geometry	OSEM (FTR), OSMAPOSL (STIR)	6 subsets, 10 iterations	0.7-mm Gaussian

Results

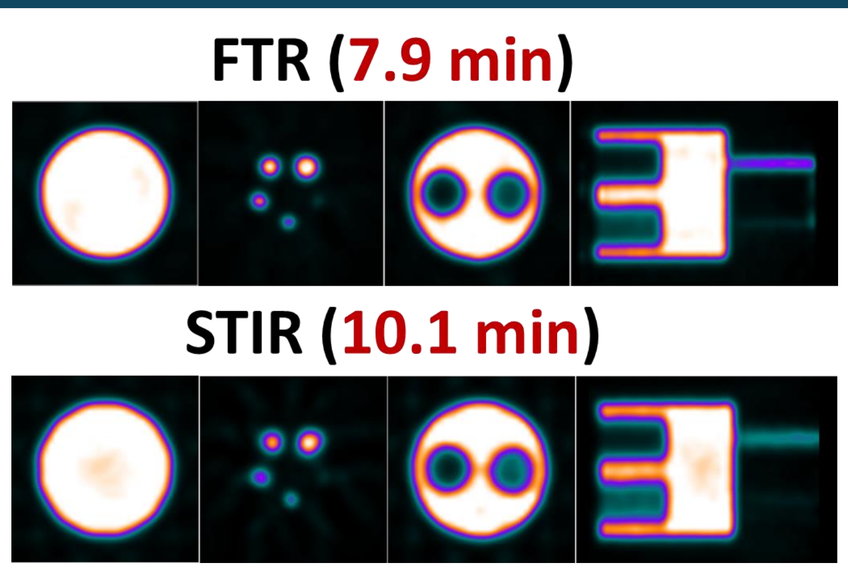

Fig. 1. Image quality phantom – SAFIR-I

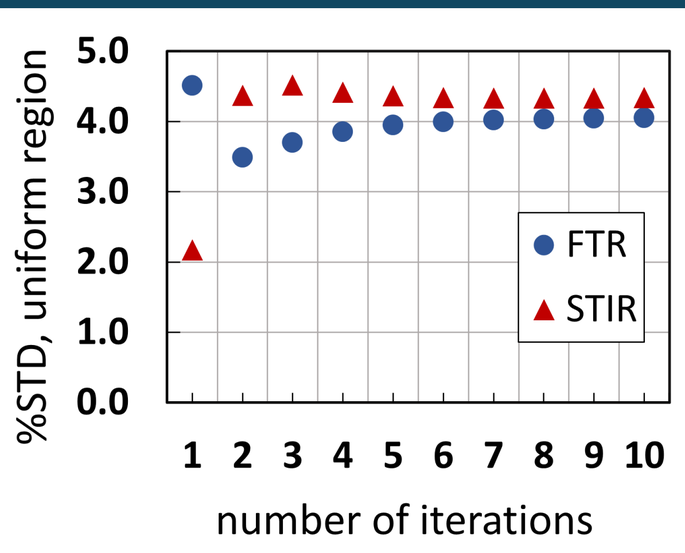

Fig. 2. Uniformity

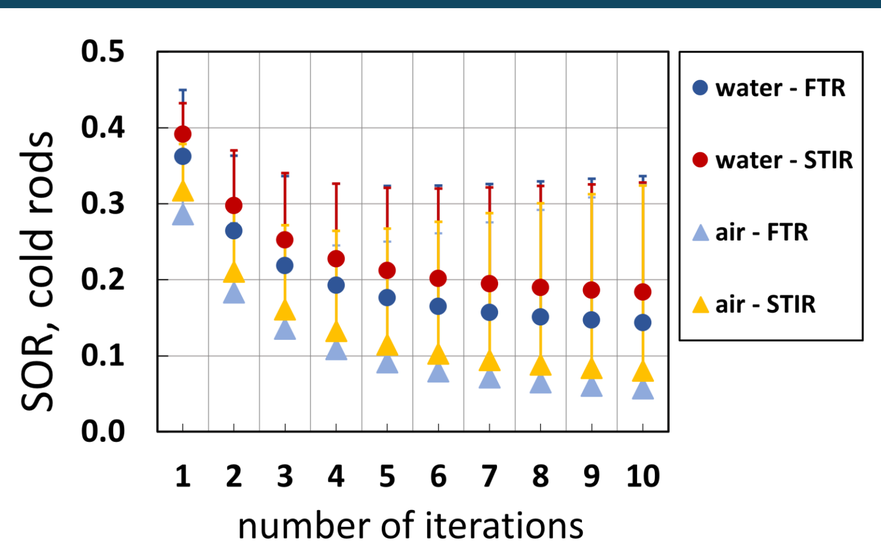

Fig. 3. Spill-over-ratio and STD (error bars)

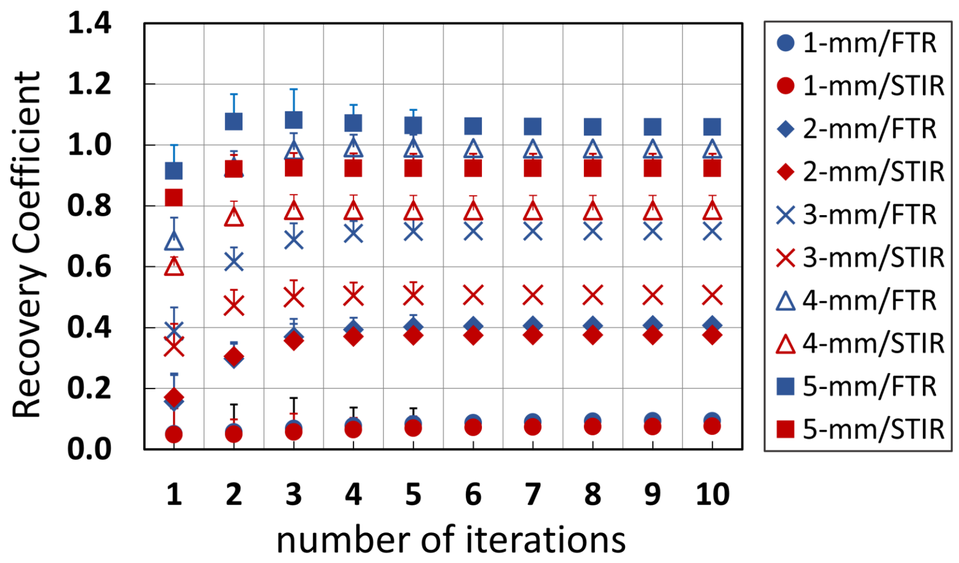

Fig. 4. RCs and STD (error bars)

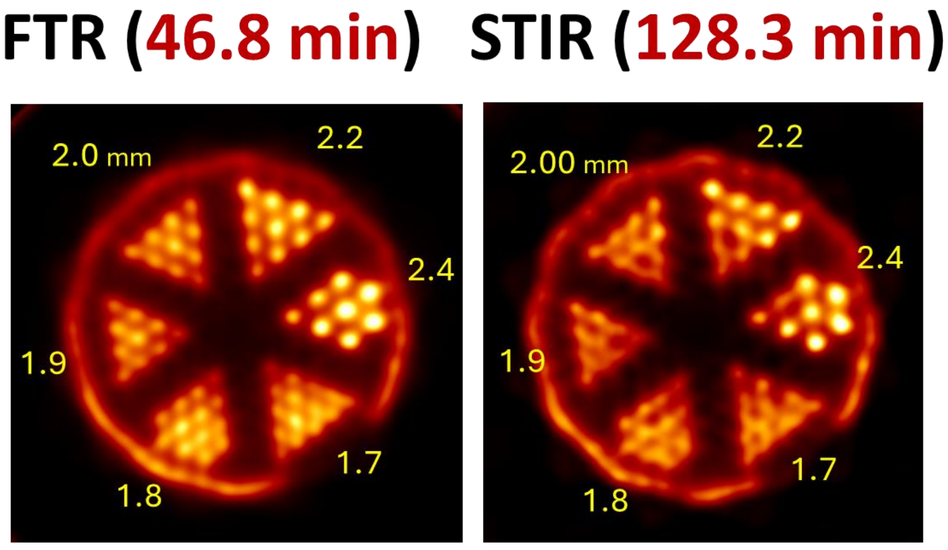

Fig. 5. Derenzo phantom – SAFIR-II

Discussions and Conclusion

- FTR demonstrates good quality images with improved values for uniformity, recovery coefficients, and spill-over-ratios, compared to STIR (Figs 1-4).
- FTR provides a better performance in resolving all rods closer to the center of the scanner in the Derenzo phantom than STIR (Fig 5). After 5 iterations, NEMA characteristics didn't vary significantly for both FTR and STIR (Figs 2-4).
- With the same reconstruction parameters, FTR reduces the time by 22% and 274% in SAFIR-I and SAFIR-II, respectively, compared to STIR (Figs 1, 5).

References

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2- K. Thielemans et al., "STIR: Software for tomographic image reconstruction release 2," *Phys. Med. Biol*. vol 57. No. 867, 2012.
3- C.E. Ritzer, "Development and First Performance Tests of the SAFIR Prototype PET-MR Scanner," Ph.D. dissertation, IPA, Dept. Phys., ETH Zurich, Zurich, Switzerland, 2020.
4- NEMA. Performance Measurements of Small Animal Positron Emission Tomographs (PETs); NEMA Standards Publication: Rosslyn, USA, 2008.