Enhancement of the lesion detectability by Total-Body J-PET with mini-bar plastic scintillators

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Outline

- Metastases lesions
- Importance of early metastases lesion detection
- Lesion detestability by PET scans
- Jaszczak Phantom
- Lesion detestability by Total-Body J-PET with minibars plastic scintillators

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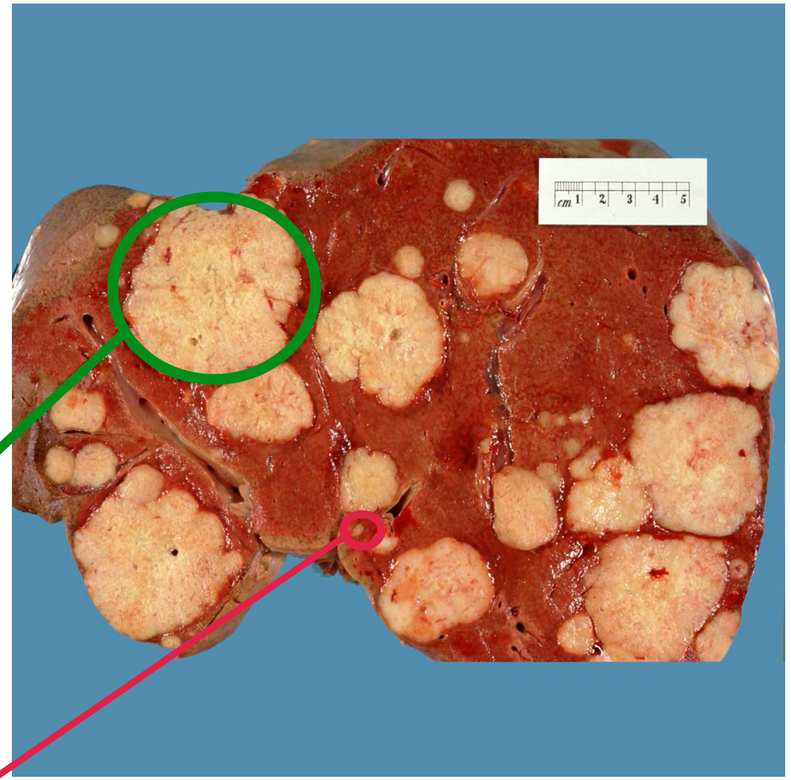
Metastatic lesions

- Cancer cells are the same type of the healthy cells but they are dividing continuously, while healthy cells duplicating only if needed.

- Metastatic lesion occurs when cancer cells detach from their primary site and home in distant organs.



Lesion in human liver with approximately 6 cm diameter.

Sub-centimeter grade lesions with diameter of the about 4 mm.

Gaillard, F. (n.d.). Liver metastases (gross pathology): Radiology Case. Retrieved from https://radiopaedia.org

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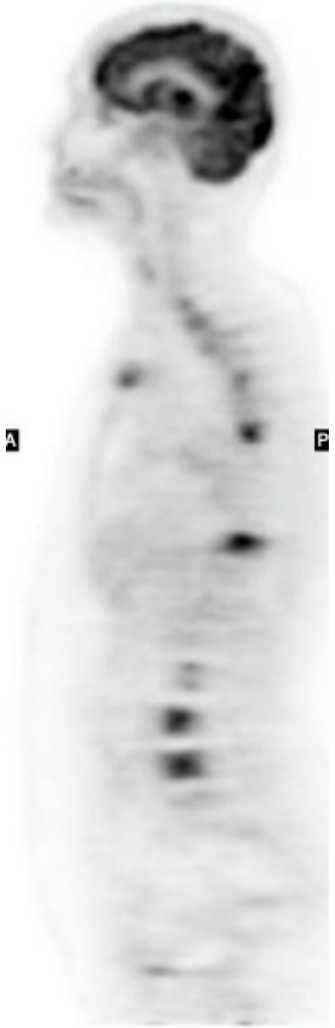
Importance of metastases detection

- Metastatic cancers most dangerous
- Depend on organs it has high mortality rate
- Approximately 90% of depths are because of metastases

What is the importance of early detection of metastases?

Observation of any new lesions in new organs of patient need to redefine new treatment plan such as drug delivery, chemotherapy, radiation therapy …



Caglar, M., Kupik, O., Karabulut, E., & Høilund-Carlsen, P. (2016). Detection of bone metastases in breast cancer patients in the PET/CT era: Do we still need the bone scan? *Revista Española De Medicina Nuclear E Imagen Molecular, 35*(1), 3-11. doi:10.1016/j.remn.2015.08.006

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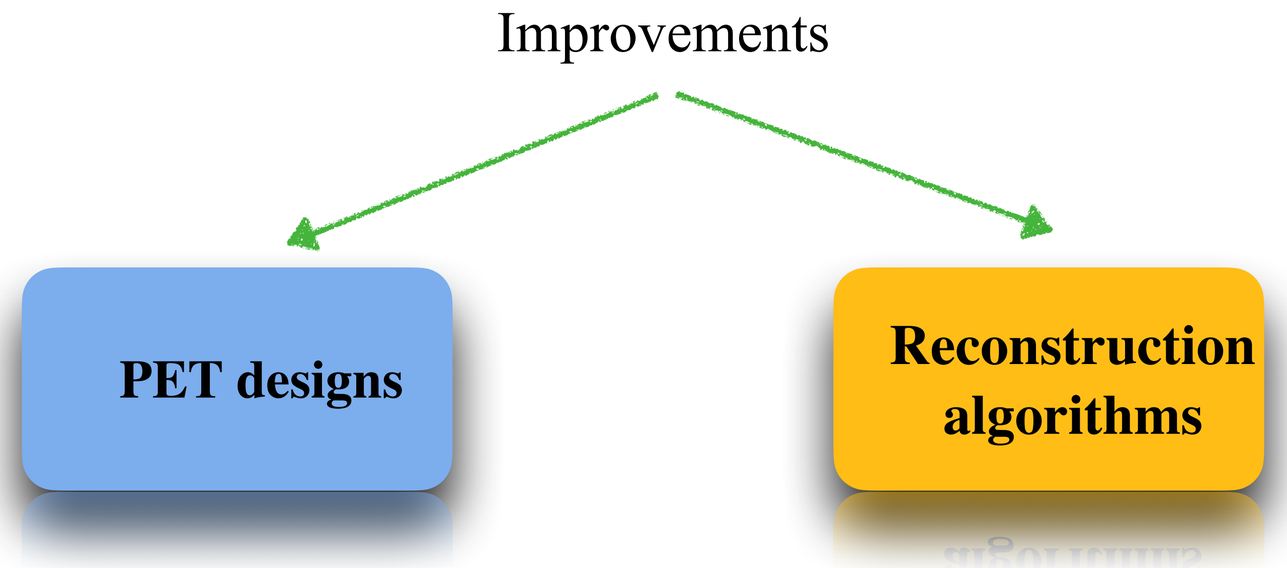
Lesion detectability of PET

Lesion detectability is one of the important side field of PET imaging. In this field, **sensitivity**, **resolution** and **reconstruction algorithms** come together to make PET scan able to detect lesions.



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Surti S, Scheuermann J, El Fakhri G, Daube-Witherspoon ME, Lim R, Abi-Hatem N, Moussallem E, Benard F, Mankoff D, Karp JS, Impact of time-of-flight PET on whole-body oncologic studies: a human observer lesion detection and localization study.vJ Nucl Med. 2011 May; 52(5):712-9.

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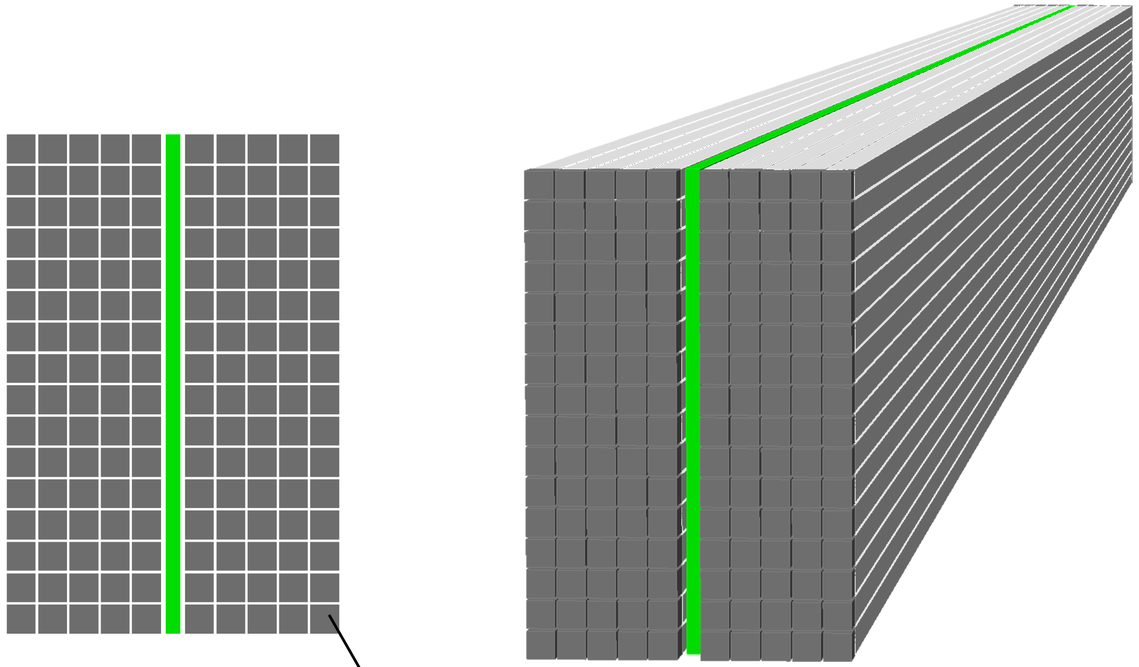
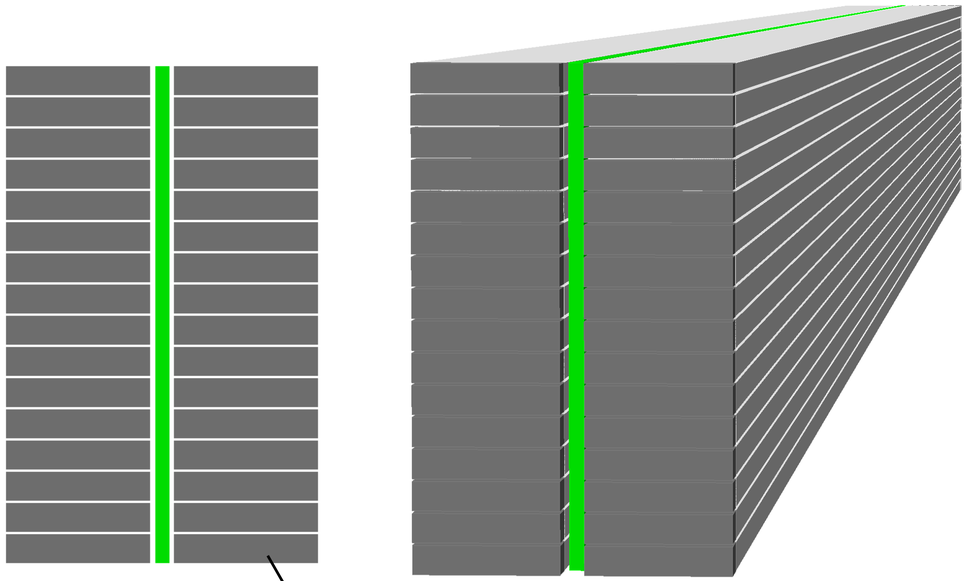
Total-Body J-PET (Strips vs. mini-bar plastic scintillators)



6x6x2000 mm
0.5 mm Gap between bars



6x30x2000 mm

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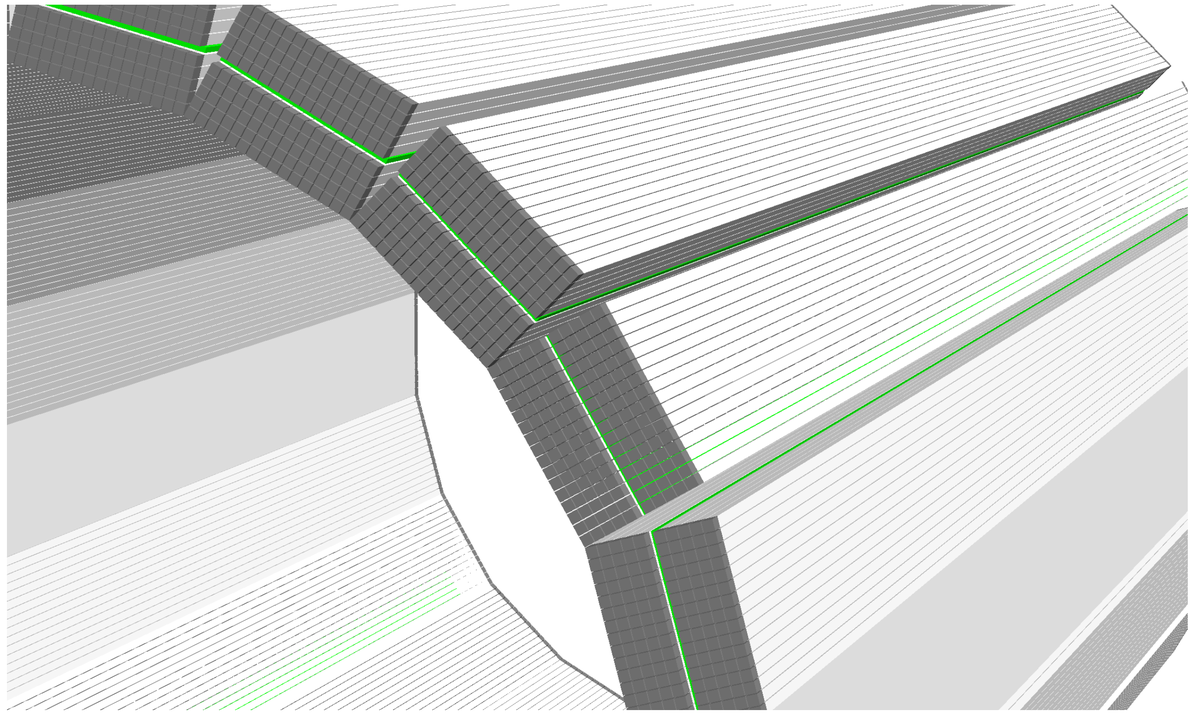
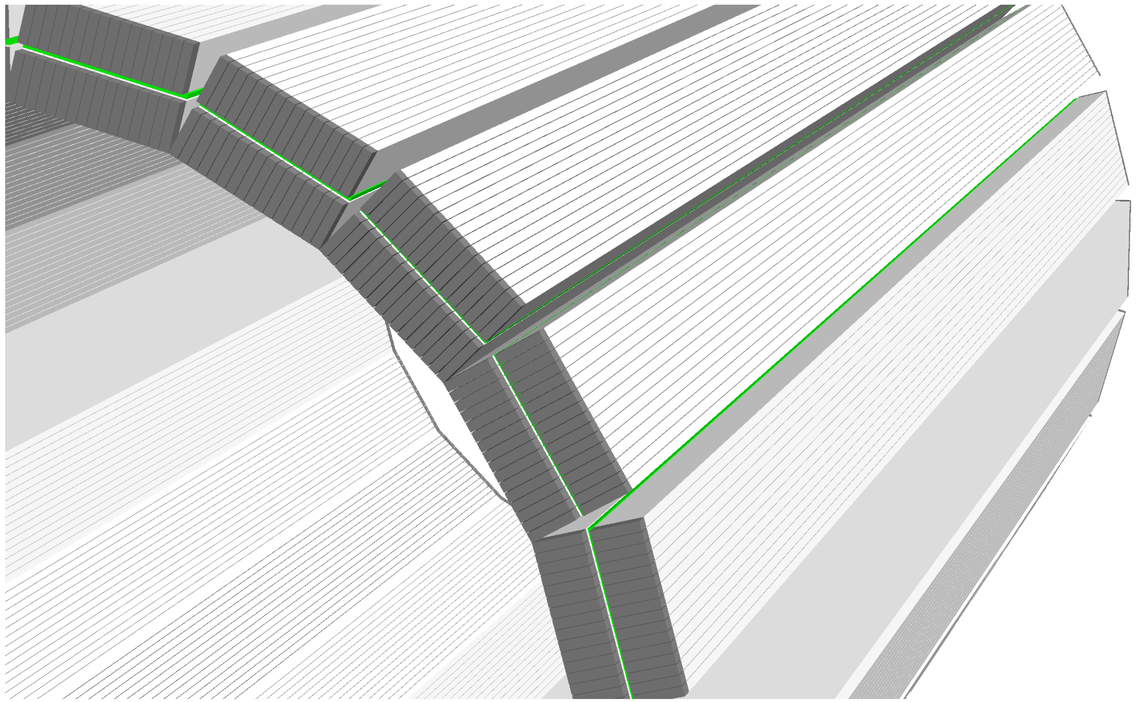
Total-Body J-PET (Strips vs. mini-bar plastic scintillators)



Total-Body J-PET with mini-bar plastic scintillator



Total-Body J-PET with strip plastic scintillator

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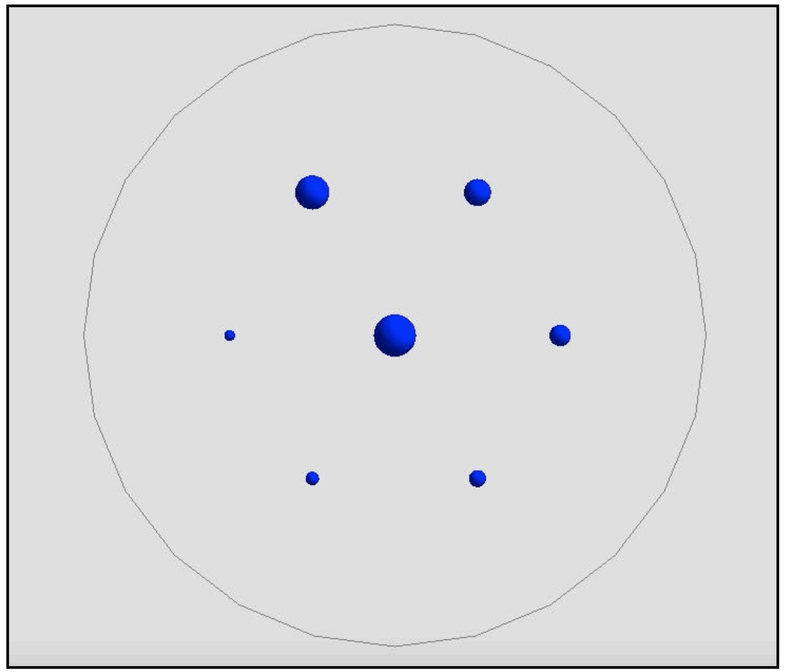
Jaszczak Phantom

Source	Radius mm	Volume
Source 1	1.975	32.253
Source 2	2.475	63.473
Source 3	3.115	126.544
Source 4	3.890	246.443
Source 5	4.945	506.253
Source 6	6.125	1005.059
Source 7	7.715	1922.544
Background	110	11390.820



Jaszczak Phantom with 11 cm radios and 20 cm height, with 7 spherical sources

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Adler S, Seidel J, Choyke P, et al. Minimum lesion detectability as a measure of PET system performance. *EJNMMI Phys*. 2017;4(1):13. doi:10.1186/s40658-017-0179-2

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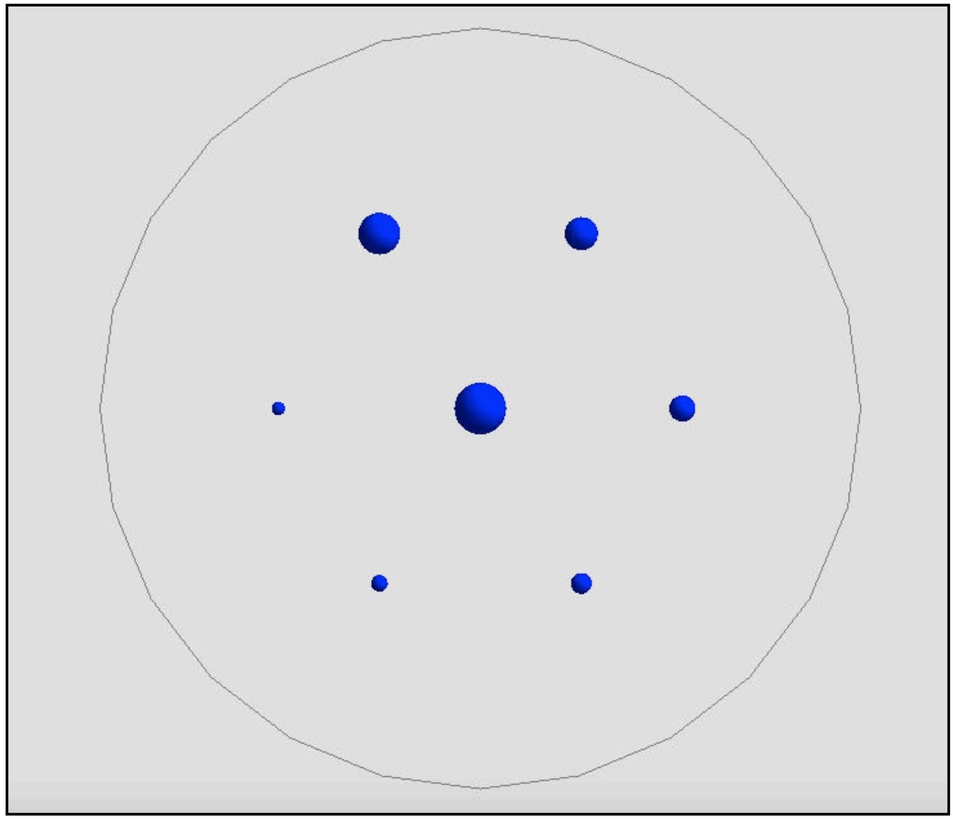
Jaszczak Phantom

Target to background ratio

Source	2:1	4:1	8:1	16:1
Source 1	341.237 Bq	682.473 Bq	1364.947 Bq	2729.894 Bq
Source 2	671.555 Bq	1343.110 Bq	2686.229 Bq	5372,439 Bq
Source 3	1338.836 Bq	2677.671 Bq	5355.342 Bq	10710.684 Bq
Source 4	2607.367 Bq	5214.734 Bq	10429.468 Bq	20858.936 Bq
Source 5	5356.157 Bq	10633.535 Bq	21267.07 Bq	42534,140 Bq
Source 6	10633.524 Bq	21267,048 Bq	42534,096 Bq	85068,194 Bq
Source 7	20340.510 Bq	40681.020 Bq	81362,041 Bq	162742.082 Bq
Background	60257,438 Bq	60257,438 Bq	60257,438 Bq	60257,438 Bq



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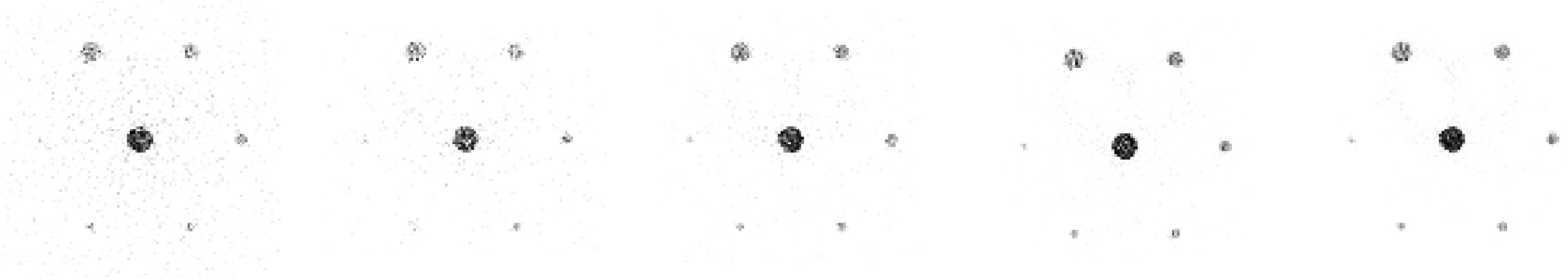
MLEM Image reconstruction of Jaszczak phantom by Total-Body J-PET mini-bar plastic scintillators

- Voxel Size: 1.556072 x 1.556072 x 2.590674 mm^3
- TOF resolution: 230 ps
- 50 iterations
- Reconstruction with smeared data ($\sigma_z = 2.12$ mm)



TB 2:1 TB 4:1 TB 8:1 TB 16:1 TB 16:0

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Thank you for your attentions

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