Python-based STIR Reconstruction Pipeline for NeuroLF Brain PET

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Supported by:

Prototype Brain PET (BPET)

LYSO-based. Octagonal geometry

Designed and built in the Dissertori group at ETH Zurich in 2019[1]

Clinical Trial:
October 2020 – March 2021[2][3]

Clinician from Nuclear Medicine Clinic at University Hospital Zurich (USZ) is testing BPET

Spatial resolution:
4.0 × 3.9 × 3.5 mm

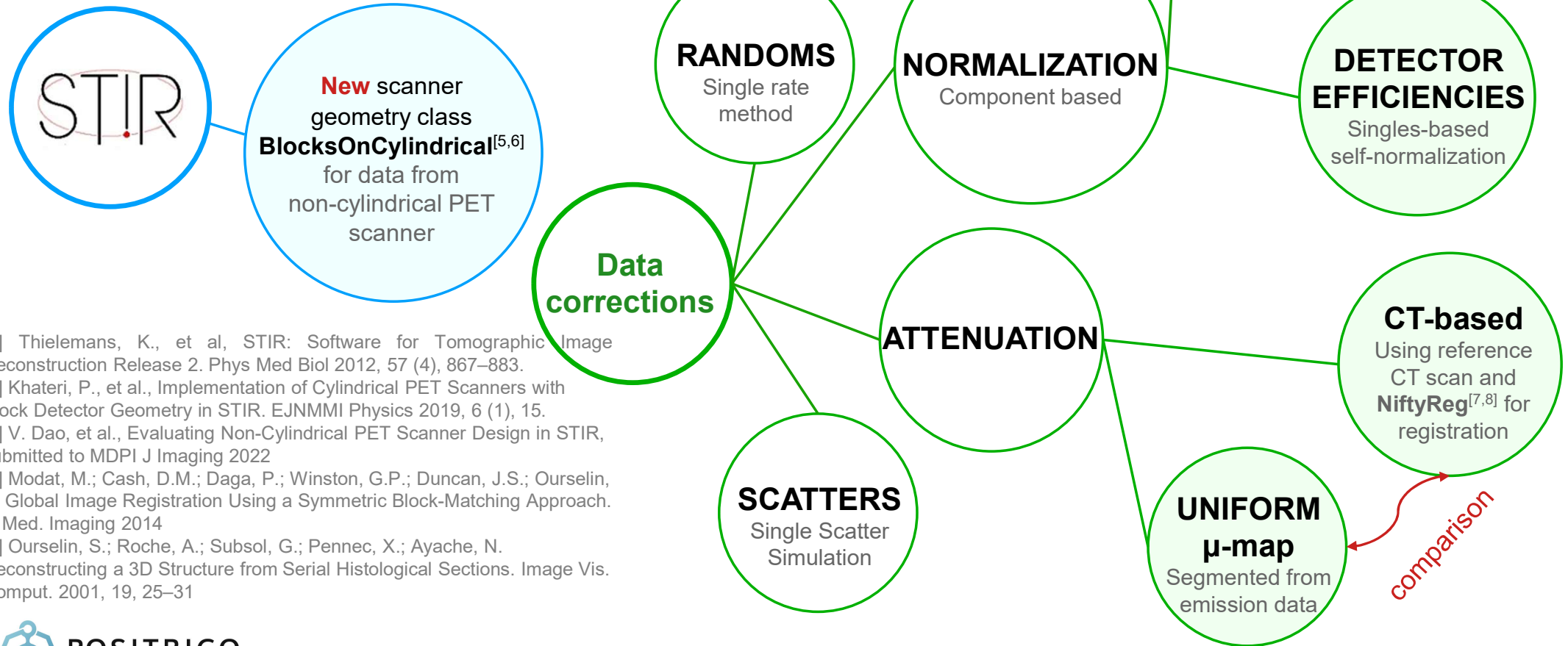BPET can be **installed in the patient waiting room** and thus increase patient throughput

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[1] Ahnen, et al. Performance of the ultra-compact fully integrated brain PET system BPET. 2020 IEEE Nucl Sci Symp Conf Rec.
[2] Mikhaylova, et.al. The First Clinical Trial of The Ultra Compact Fully Integrated Brain PET System BPET, 2021 EANM abstract
[3] https://clinicaltrials.gov/ct2/show/NCT04511546?term=explorebpet&draw=2&rank=1

BPET vs. NeuroLF

	BPET	NeuroLF (estimated)
Bore diameter, mm	254	268
Axial length, mm	128	**163**
Detector arrangement	Octagon	Octagon
Detector	LYSO + SiPM	LYSO + SiPM
Crystal size, mm³	4.1 × 4.1 × 10	**1) 3.19 × 3.19 × 10** **2) 3.19 × 3.19 × 15** **3) 3.19 × 3.19 × 20**
Crystal array	6 × 6	4 × 4
SiPM size, mm³	3 × 3	**4 × 4**
Light Sharing	4:1	4:1
Energy resolution	14.2%	13.5%
Coincidence timing resolution, ps	4000	**600**
Considered coincidence time window, ns	8	**1.8**

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Image Reconstruction

New scanner geometry class **BlocksOnCylindrical**[5,6] for data from non-cylindrical PET scanner

Data corrections

RANDOMS
Single rate method

NORMALIZATION
Component based

GEOMETRIC
Homogeneous cylinder scan

DETECTOR EFFICIENCIES
Singles-based self-normalization

ATTENUATION

CT-based
Using reference CT scan and **NiftyReg**[7,8] for registration

SCATTERS
Single Scatter Simulation

UNIFORM μ-map
Segmented from emission data

comparison

[4] Thielemans, K., et al, STIR: Software for Tomographic Image Reconstruction Release 2. Phys Med Biol 2012, 57 (4), 867–883.
[5] Khateri, P., et al., Implementation of Cylindrical PET Scanners with Block Detector Geometry in STIR. EJNMMI Physics 2019, 6 (1), 15.
[6] V. Dao, et al., Evaluating Non-Cylindrical PET Scanner Design in STIR, submitted to MDPI J Imaging 2022
[7] Modat, M.; Cash, D.M.; Daga, P.; Winston, G.P.; Duncan, J.S.; Ourselin, S. Global Image Registration Using a Symmetric Block-Matching Approach. J. Med. Imaging 2014
[8] Ourselin, S.; Roche, A.; Subsol, G.; Pennec, X.; Ayache, N. Reconstructing a 3D Structure from Serial Histological Sections. Image Vis. Comput. 2001, 19, 25–31

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Demo in Jupyter Notebook
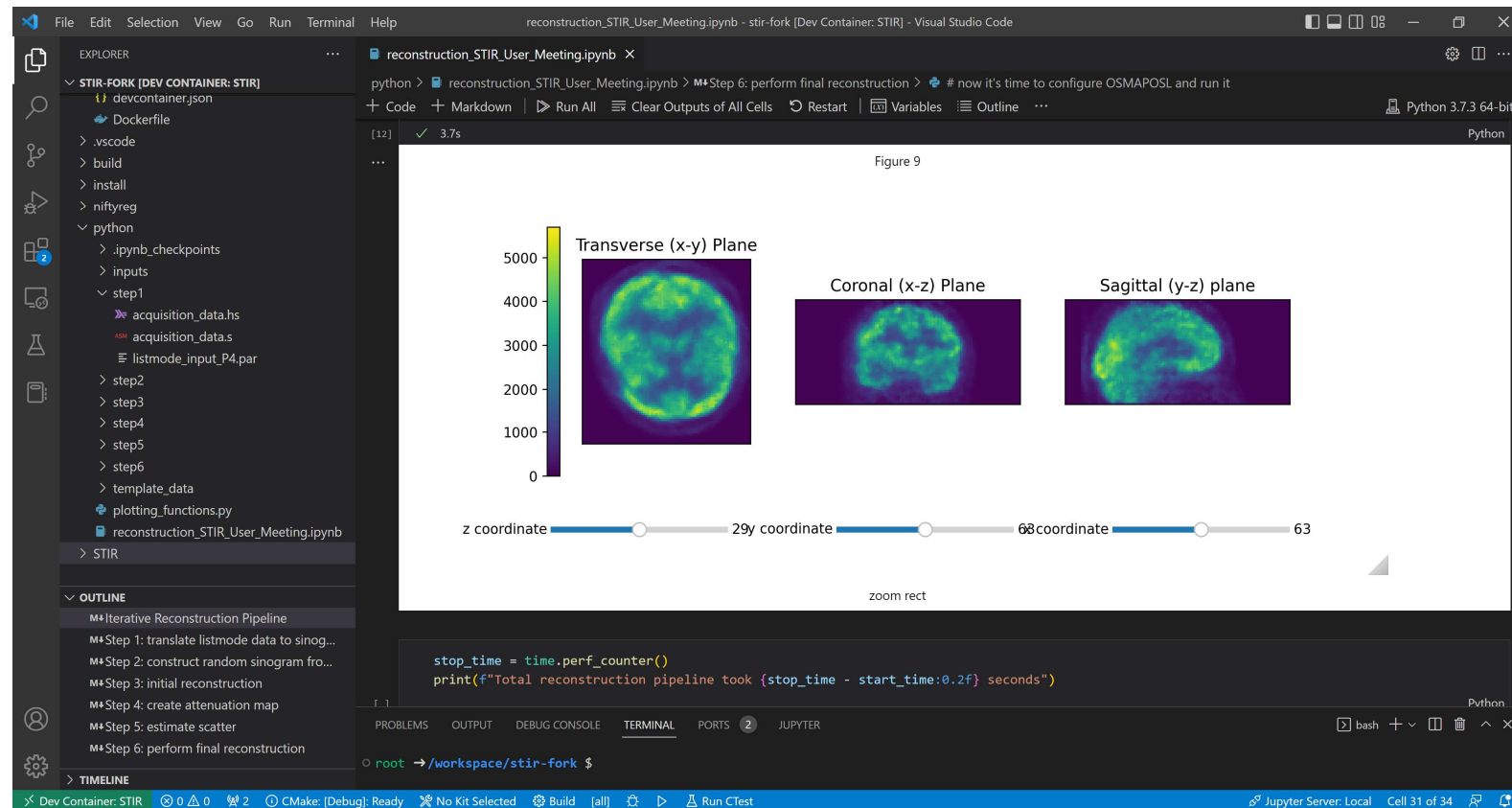
Demo in Jupyter Notebook

- STIR: very close to current master (5.0.2), just small hacks to support BlocksOnCylindrical in a couple of places (soon no longer required)

- Can be checked out from here:
  - https://github.com/markus-jehl/STIR/tree/blocks_on_cylindrical
  - Jupyter notebook is in examples/python (currently without data)

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Thank you!

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